This manual links to Knowledgebase Technote: Kinetix 5100 Servo Drive Fault Codes and Parameters; download the spreadsheets for offline access.



Kinetix 5100 EtherNet/IP Indexing Servo Drives

Catalog Numbers 2198-E1004-ERS, 2198-E1007-ERS, 2198-E1015-ERS, 2198-E1020-ERS, 2198-E2030-ERS, 2198-E2055-ERS, 2198-E2075-ERS, 2198-E2150-ERS, 2198-E4004-ERS, 2198-E4007-ERS, 2198-E4015-ERS, 2198-E4020-ERS, 2198-E4030-ERS, 2198-E4055-ERS, 2198-E4075-ERS, 2198-E4150-ERS

Allen-Bradley
by ROCKWELL AUTOMATION

User Manual Original Instructions

Important User Information

Read this document and the documents listed in the additional resources section about installation, configuration, and operation of this equipment before you install, configure, operate, or maintain this product. Users are required to familiarize themselves with installation and wiring instructions in addition to requirements of all applicable codes, laws, and standards.

Activities including installation, adjustments, putting into service, use, assembly, disassembly, and maintenance are required to be carried out by suitably trained personnel in accordance with applicable code of practice.

If this equipment is used in a manner not specified by the manufacturer, the protection provided by the equipment may be impaired.

In no event will Rockwell Automation, Inc. be responsible or liable for indirect or consequential damages resulting from the use or application of this equipment.

The examples and diagrams in this manual are included solely for illustrative purposes. Because of the many variables and requirements associated with any particular installation, Rockwell Automation, Inc. cannot assume responsibility or liability for actual use based on the examples and diagrams.

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Throughout this manual, when necessary, we use notes to make you aware of safety considerations.



WARNING: Identifies information about practices or circumstances that can cause an explosion in a hazardous environment, which may lead to personal injury or death, property damage, or economic loss.



ATTENTION: Identifies information about practices or circumstances that can lead to personal injury or death, property damage, or economic loss. Attentions help you identify a hazard, avoid a hazard, and recognize the consequence.

IMPORTANT Identifies information that is critical for successful application and understanding of the product.

Labels may also be on or inside the equipment to provide specific precautions.



SHOCK HAZARD: Labels may be on or inside the equipment, for example, a drive or motor, to alert people that dangerous voltage may be present.



BURN HAZARD: Labels may be on or inside the equipment, for example, a drive or motor, to alert people that surfaces may reach dangerous temperatures.



ARC FLASH HAZARD: Labels may be on or inside the equipment, for example, a motor control center, to alert people to potential Arc Flash. Arc Flash will cause severe injury or death. Wear proper Personal Protective Equipment (PPE). Follow ALL Regulatory requirements for safe work practices and for Personal Protective Equipment (PPE).

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This manual provides detailed installation instructions for mounting, wiring, and troubleshooting your Kinetix® 5100 drive; and system integration for your drive/motor combination with a Logix controller.

This manual is intended for engineers and technicians that are directly involved in the installation and wiring of the Kinetix 5100 drive and programmers who are directly involved in operation, field maintenance, and integration of the Kinetix 5100 drive.

If you do not have a basic understanding of the Kinetix 5100 drive, contact your local Rockwell Automation sales representative for information on available training courses.

Summary of Changes

This publication contains the following new or updated information. This list includes substantive updates only and is not intended to reflect all changes. Translated versions are not always available for each revision.

Topic	Page
Added 400V-class drive information.	Throughout
Added drive compatibility with Kinetix TL/TLY (200V-class) servo motors.	Throughout
Added Table 96 Kinetix 5100 Output Assembly Data (Instance 106).	230
Added Table 98 CAM Parameters.	233
Added Figure 86 CAM Execution.	234
Added I/O Mode - CAM section.	244
Added Message Service - Get/Set Chunk data to the Data Array section.	329
Added power wiring examples.	430...434
Added Add-On Instruction information for raC_Dvc_K5100_MAPC.	483...485
Added Automatic Device Configuration appendix.	457

Conventions

These conventions are used throughout this manual:

- Bulleted lists such as this one provide information, not procedural steps.
- Numbered lists provide steps or hierarchical information.
- Parameters are shown in this format: ID185 (P2.000).

Access Fault Codes and Parameter List



For Kinetix® 5100 fault code descriptions and parameters, see Knowledgebase Technote: Kinetix 5100 Servo Drive Parameter Data and Fault Codes. You can download the spreadsheet from this public article.

You will be asked to log in to your Rockwell Automation web account or create an account if you do not have one. You do not need a support contract to access this article.

Additional Resources

These documents contain additional information concerning related products from Rockwell Automation.

Resource	Description
Kinetix Rotary Motion Specifications Technical Data, publication KNX-TD001	Product specifications for Kinetix VPL, VPC, VPF, VPH, and VPS; Kinetix MPL, MPM, MPF, and MPS; Kinetix TLY and TL; Kinetix TLP; and Kinetix HPK rotary motors.
Kinetix Servo Drives Specifications Technical Data, publication KNX-TD003	Provides product specifications for Kinetix Integrated Motion over the EtherNet/IP™ network, Integrated Motion over sercos interface, EtherNet/IP networking, and component servo drive families.
Kinetix Motion Accessories Specifications Technical Data, publication KNX-TD004	Provides product specifications for Bulletin 2090 motor and interface cables, low-profile connector kits, drive power components, and other servo drive accessory items.
Kinetix 5100 Drive Systems Design Guide, publication KNX-RM011	System design guide to select the required (drive specific) drive module, power accessory, feedback connector kit, and motor cable catalog numbers for your Kinetix 5100 drive system.
Ultra3000 to Kinetix 5100 Servo Drive Migration Guide, publication 2198-RM003	Provides information on how to migrate from the Ultra3000 drive to the Kinetix 5100 servo drive.
Kinetix 300 to Kinetix 5100 Servo Drive Migration Guide, publication 2198-RM004	Provides information on how to migrate from the Kinetix 300 drive to the Kinetix 5100 servo drive.
Kinetix 5100 AC Line Filter Installation Instructions, publication 2198-IN017	Provides information on how to install and wire the Kinetix 5100 AC line filters.
Kinetix 5100 Auxiliary Feedback Connector Kit Installation Instructions, publication 2198-IN018	Provides information on how to attach the Kinetix 5100 auxiliary feedback connector kit to your shielded, twisted-pair customer-supplied cable.
Kinetix 5100 Feedback Connector Kit Installation Instructions, publication 2198-IN019	Provides information on how to attach the Kinetix 5100 feedback connector kit to 2090-Series flying lead motor feedback cables.
Kinetix 5100 I/O Terminal Expansion Block Installation Instructions, publication 2198-IN020	Provides information on how to install and wire the Kinetix 5100 I/O terminal expansion block.
Kinetix 5700 Shunt Passive Modules Installation Instructions, publication 2198-IN011	Provides information on how to install and wire 2198-R004 and 2198-R031 passive shunts for use with Kinetix 5100 servo drives.
Kinetix 300 Shunt Resistor Installation Instructions, publication 2097-IN002	Provides information on how to install and wire 2097-R6 and 2097-R7 shunt resistors for use with Kinetix 5100 servo drives.
Feedback Battery Box Installation Instructions, publication 2198-IN022	Provides information on how to install or replace a battery box, install a battery, and prepare a feedback cable for a battery box installation.
Shaft Seal Kits for Kinetix TLP Motors Installation Instructions, publication 2090-IN044	Provides information about how to remove and replace shaft seals on Kinetix TLP motors.
2090-Series Kinetix TLP Power and Feedback Cables, publication 2090-IN046	Provides information on how to build cables for Kinetix TLP servo motors.
Build Your Own Kinetix TLP Motor Cables Installation Instructions, publication 2090-IN048	Provides information on how to attach Bulletin 2090 connector kits to bulk cable and build your own Kinetix TLP motor power and feedback cables.
Kinetix TLP Multi-purpose Servo Motors Installation Instructions, publication TLP-IN001	Provides information on how to install the Kinetix TLP multi-purpose servo motor.
System Design for Control of Electrical Noise Reference Manual, publication GMC-RM001	Provides information, examples, and techniques designed to minimize system failures caused by electrical noise.
Servo Drive Installation Best Practices Application Technique, publication MOTION-AT004	Best practice examples to help reduce the number of potential noise or electromagnetic interference (EMI) sources in your system and to make sure that the noise sensitive components are not affected by the remaining noise.
Kinetix Motion Control Selection Guide, publication KNX-SG001	Overview of Kinetix servo drives, motors, actuators, and motion accessories designed to help make initial decisions for the motion control products best suited for your system requirements.
MicroLogix™ 1100 Programmable Controllers User Manual, publication 1763-UM001	Provides information on how to install, wire, and troubleshoot the MicroLogix programmable controllers.
MicroLogix 1200 Programmable Controllers User Manual, publication 1762-UM001	
MicroLogix 1400 Programmable Controllers User Manual, publication 1766-UM001	
Micro810® Programmable Controllers User Manual, publication 2080-UM001	Provides information on how to install, wire, and troubleshoot the Micro800™ programmable controllers.
Micro820® Programmable Controllers User Manual, publication 2080-UM005	
Micro830®, Micro850, Micro870, Programmable Controllers User Manual, publication 2080-UM002	
GuardLogix 5570 Controllers User Manual, publication 1756-UM022	Provides information on how to install, configure, program, and use ControlLogix® controllers and GuardLogix® controllers in Studio 5000 Logix Designer® projects.
GuardLogix 5580 Controllers User Manual, publication 1756-UM543	
Compact GuardLogix 5370 Controllers User Manual, publication 1769-UM022	Provides information on how to install, configure, program, and use CompactLogix™ and Compact GuardLogix controllers.
Compact GuardLogix 5380 Controllers User Manual, publication 5069-UM001	

Resource	Description
GuardLogix 5570 and Compact GuardLogix 5370 Controller Systems Safety Reference Manual, publication 1756-RM099	Provides information on how to achieve and maintain Safety Integrity Level (SIL) and Performance Level (PL) safety application requirements for GuardLogix and Compact GuardLogix controllers.
GuardLogix 5580 and Compact GuardLogix 5380 Controller Systems Safety Reference Manual, publication 1756-RM012	
ControlFLASH Firmware Upgrade Kit User Manual, publication 1756-UM105	Provides information on how to upgrade your drive firmware by using ControlFLASH™ software.
Rockwell Automation Product Selection website http://www.rockwellautomation.com/global/support/selection.page	Online product selection and system configuration tools, including AutoCAD (DXF) drawings.
Motion Analyzer System Sizing and Selection Tool website https://motionanalyzer.rockwellautomation.com/	Comprehensive motion application sizing tool used for analysis, optimization, selection, and validation of your Kinetix Motion Control system.
EtherNet/IP Network Devices User Manual, ENET-UM006	Describes how to configure and use EtherNet/IP devices to communicate on the EtherNet/IP network.
Ethernet Reference Manual, ENET-RM002	Describes basic Ethernet concepts, infrastructure components, and infrastructure features.
Safety Guidelines for the Application, Installation, and Maintenance of Solid-State Control, publication SGI-1.1	Designed to harmonize with NEMA Standards Publication No. ICS 1.1-1987 and provides general guidelines for the application, installation, and maintenance of solid-state control in the form of individual devices or packaged assemblies incorporating solid-state components.
Industrial Automation Wiring and Grounding Guidelines, publication 1770-4.1	Provides general guidelines for installing a Rockwell Automation industrial system.
Product Certifications website, rok.auto/certifications.	Provides declarations of conformity, certificates, and other certification details.

Notes:

Start

Use this chapter to become familiar with the Kinetix® 5100 drive system and obtain an overview of installation configurations.

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About the Kinetix 5100 Drive System	11
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About the Kinetix 5100 Drive System

The Kinetix 5100 EtherNet/IP™ indexing servo drives are designed to provide a solution for applications with output power requirements between 0.4...15.0 kW (2.6...78 A rms).

Table 1 - Kinetix 5100 Drive System Overview

Kinetix 5100 System Component	Cat. No.	Description
Kinetix 5100 Servo Drive	2198-E*xxxx*-ERS	Kinetix 5100 EtherNet/IP indexing drives with Safe Torque Off (STO) are available with 120V single-phase, 200...230V single-phase, 230V three-phase, and 480V three-phase (nom) input voltages.
Terminal block for I/O connector	2198-TBIO	50-pin terminal block. Plugs into I/O connector for control interface connections.
Motor Feedback Connector Kit	2198-K51CK-D15M	Motor feedback connector kit with 15-pin connector plug for compatible servo motors. Kit features battery backup for Kinetix TLP, TL, and TLY multi-turn encoders.
Auxiliary Feedback Connector Kit	2198-AUXKIT	Auxiliary feedback connector kit for master feedback and load feedback connections to the AUX connector.
Feedback Battery Box	2198-KTBT	The feedback battery box is used in applications where Kinetix TLP motor position data must be maintained in the event of a power loss. The battery box is included with 2090-series cables for Kinetix TLP motors and is also available as this replacement kit.
Logix PAC® Controller Platforms	Bulletin 5069 and 1769	EtherNet/IP networking with CompactLogix™ 5370 and CompactLogix 5380 controllers with embedded dual-port. CompactLogix 5480 controllers for the benefits of Logix control with Windows®-based computing.
	1756-EN2T, 1756-EN2TR, and 1756-EN3TR module	EtherNet/IP network communication modules for use with ControlLogix® 5570 and ControlLogix 5580 controllers.
Micro Controller Platforms	MicroLogix™ 1100 and 1400 controllers provide communication ports, an isolated combination RS-232/485 communication port, an Ethernet port, and (MicroLogix 1400 only) a non-isolated RS-232 communication port.	
	Micro800® controllers with embedded inputs/outputs can accommodate from two to five plug-in modules and up to four expansion I/O modules.	
Configuration Software	Studio 5000® Environment	Studio 5000 Logix Designer® application (version 30 or later) is used to program, commission, and maintain Logix 5000™ controllers.
	Connected Components Workbench software	Connected Components Workbench™ design and configuration software (CCW), version 10.0 or later, provides support for programming, configuration of Micro800 controller, and integration with the HMI editor.
	KNX5100C software	KNX5100C software, version 1.001 or later, provides configuration and tuning of Kinetix 5100 drives via the mini-USB cable connection.
	RSLogix 500® software	RSLogix 500 software is used to program MicroLogix 1100 and 1400 controllers.

Table 1 - Kinetix 5100 Drive System Overview (Continued)

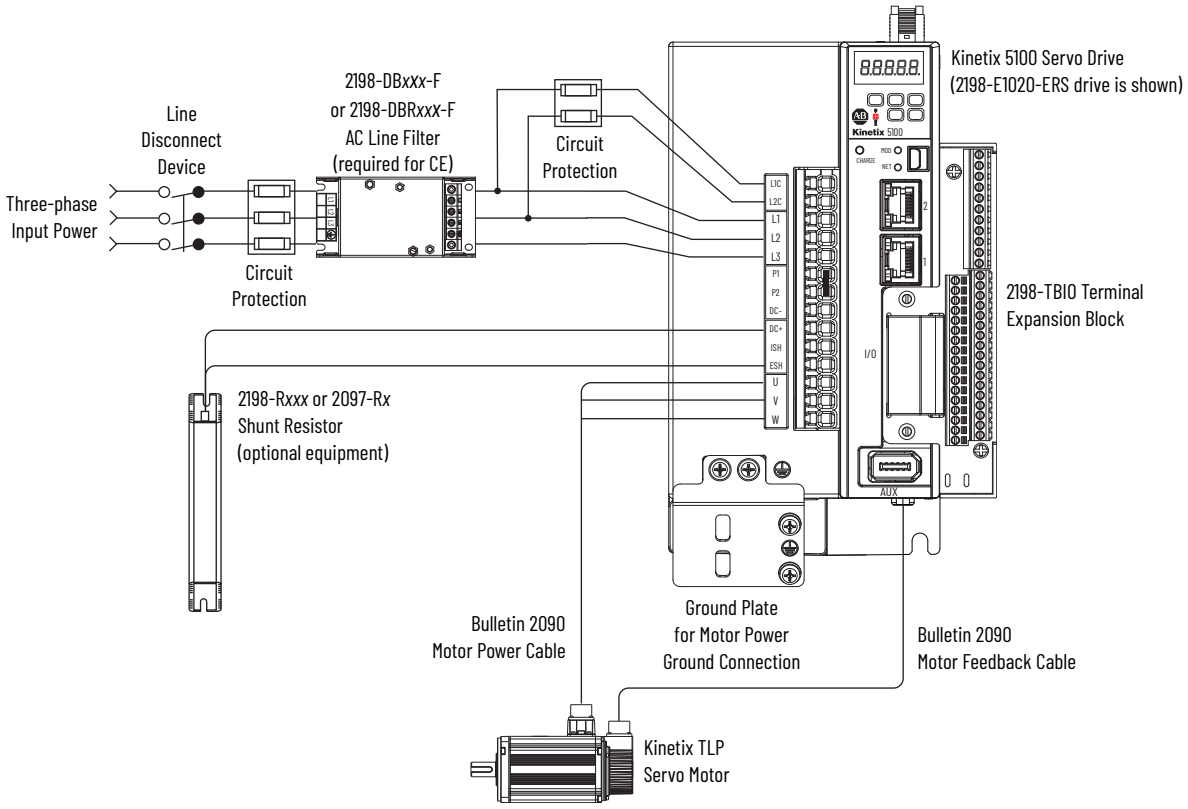
Kinetix 5100 System Component	Cat. No.	Description
Rotary Servo Motors	Kinetix TLP	Compatible rotary motors include Kinetix TLP (200V and 400V-class) servo motors.
	Kinetix MP	Compatible rotary motors include Kinetix MPL, MPM, MPF, and MPS (200V and 400V-class) servo motors.
	Kinetix TL and TLY	Compatible rotary motors include Kinetix TL and TLY (200V-class) servo motors.
Cables	2090-CTFB-MxDx-xxxxx	Bulletin 2090 motor feedback cables for Kinetix TLP motors.
	2090-CTPx-MxDx-xxxxx	Bulletin 2090 motor power/brake cables for Kinetix TLP motors.
	2090-CFBM6Dx-CxAAxx	Motor feedback cables for Kinetix TLY servo motors.
	2090-CPxM6DF-16AAxx	Motor power/brake cables for Kinetix TLY servo motors.
	2090-DANFCT-Sxx	Motor feedback cables for Kinetix TL servo motors.
	2090-DANPT-16Sxx	Motor power cables for Kinetix TL servo motors.
	2090-DANBT-18Sxx	Motor brake cables for Kinetix TL servo motors.
	2090-CFBM7DF-CEAxxx	Motor feedback cables for Kinetix MP servo motors with Hiperface encoders.
	2090-CPxM7DF-xxAxxx	Motor power/brake cables for Kinetix MP servo motors.
	2090-XXNFMF-Sxx 2090-CFBM7DF-CDAFxx	Standard and continuous-flex feedback cables that include additional conductors for use with incremental encoders.
	1585J-M8CBJM-x 1585J-M8UBJM-x	Ethernet cables are available in standard lengths. Shielded cable is required to meet EMC specifications.
	2198-USBC	Interface cable with mini-USB connector for KNX5100C software configuration.
	2198-USBF	Filter for mini-USB port to reduce the vulnerability to electrical noise.
AC Line Filters	2198-DBxxx-F 2198-DBRxxx-F	Bulletin 2198 three-phase AC line filters are required to meet CE and are available for use in all Kinetix 5100 drive systems.
24V DC Power Supply	1606-XLxxx	Bulletin 1606 24V DC power supply for digital input/output, Safe Torque Off (STO) circuitry, and motor brake control.
External Shunt Resistors	2097-R6 and 2097-R7	Bulletin 2097 and 2198 external passive shunt resistors are available for when the internal shunt capability of the drive is exceeded.
	2198-R004, 2198-R031	

Typical Hardware Configuration

Typical Kinetix 5100 drive systems include single-phase and three-phase standalone configurations.

In this example, three-phase input power is applied to the Kinetix 5100 drive.

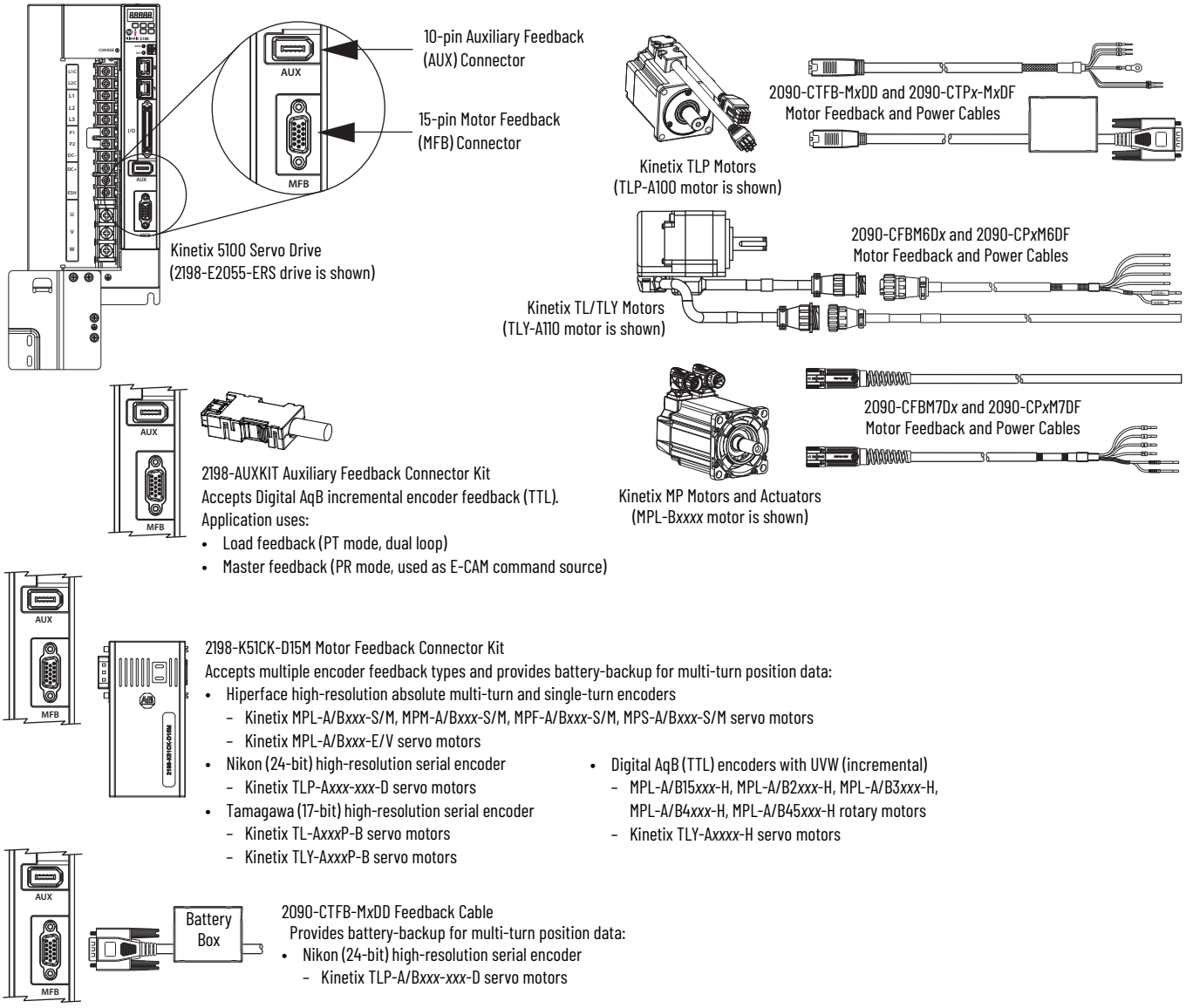
Figure 1 - Kinetix 5100 Standalone Drive with Three-phase Input Power



Motor and Auxiliary Feedback Configurations

Motor feedback connections are made at the 15-pin motor feedback (MFB) connector. Auxiliary feedback connections are made by using the auxiliary feedback (AUX) connector. These examples illustrate how you can use the Bulletin 2198 connector kits for making these connections. To see motor power and brake connections, refer to Chapter 4 on page 83.

Figure 2 - Feedback Configuration Example



Typical Communication Configurations

The Kinetix 5100 drives support linear, ring, and star Ethernet topologies by using ControlLogix, CompactLogix, MicroLogix, and Micro800 controllers.

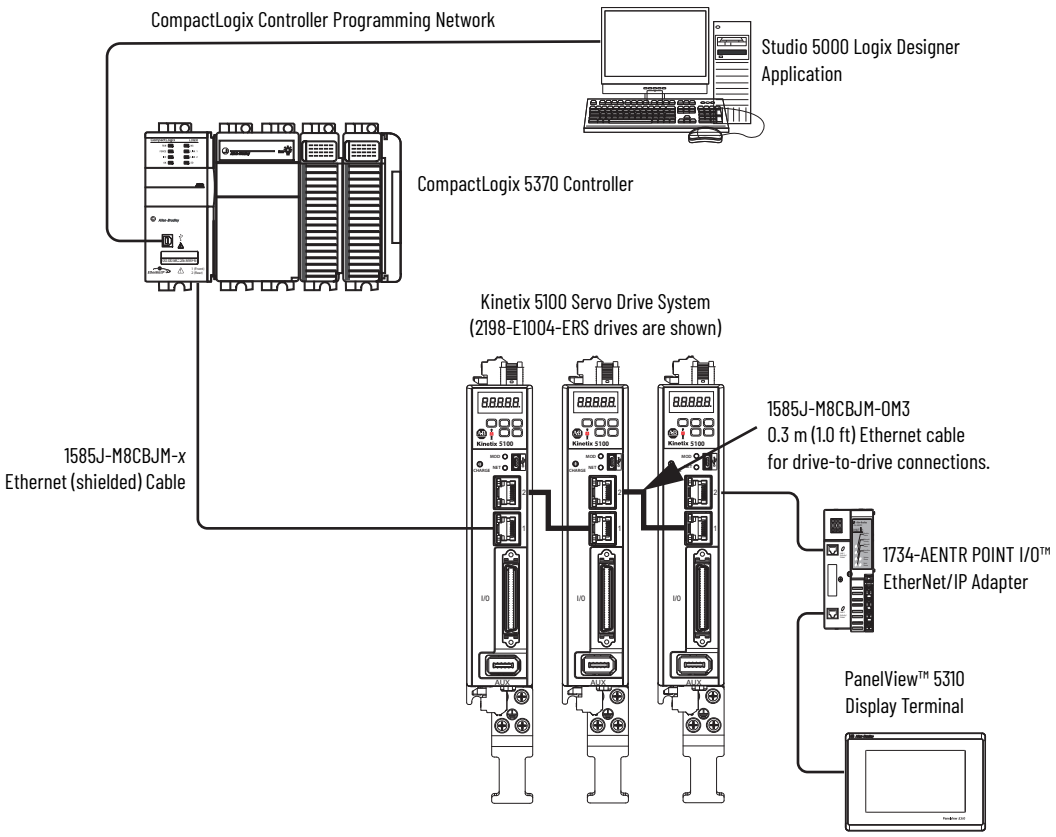
These examples feature the CompactLogix 5370 programmable automation controllers (catalog number 1769-L*xx*ER, for example) with support for Kinetix 5100 drives via implicit messaging (Add-On Instruction, for example) or Explicit Messaging over the EtherNet/IP network. Other Allen-Bradley® controllers are also compatible with the Kinetix 5100 servo drives.

Refer to CompactLogix Controllers Specifications Technical Data, publication 1769-TD005, for more information on CompactLogix 5370 L1, L2, and L3 controllers.

Linear Topology

In this example, all devices are connected in linear topology. The Kinetix 5100 drives include dual-port connectivity, however, if any device becomes disconnected, all devices downstream of that device lose communication. Devices without dual-ports must include the 1783-ETAP module or be connected at the end of the line.

Figure 3 - Kinetix 5100 Linear Communication Installation

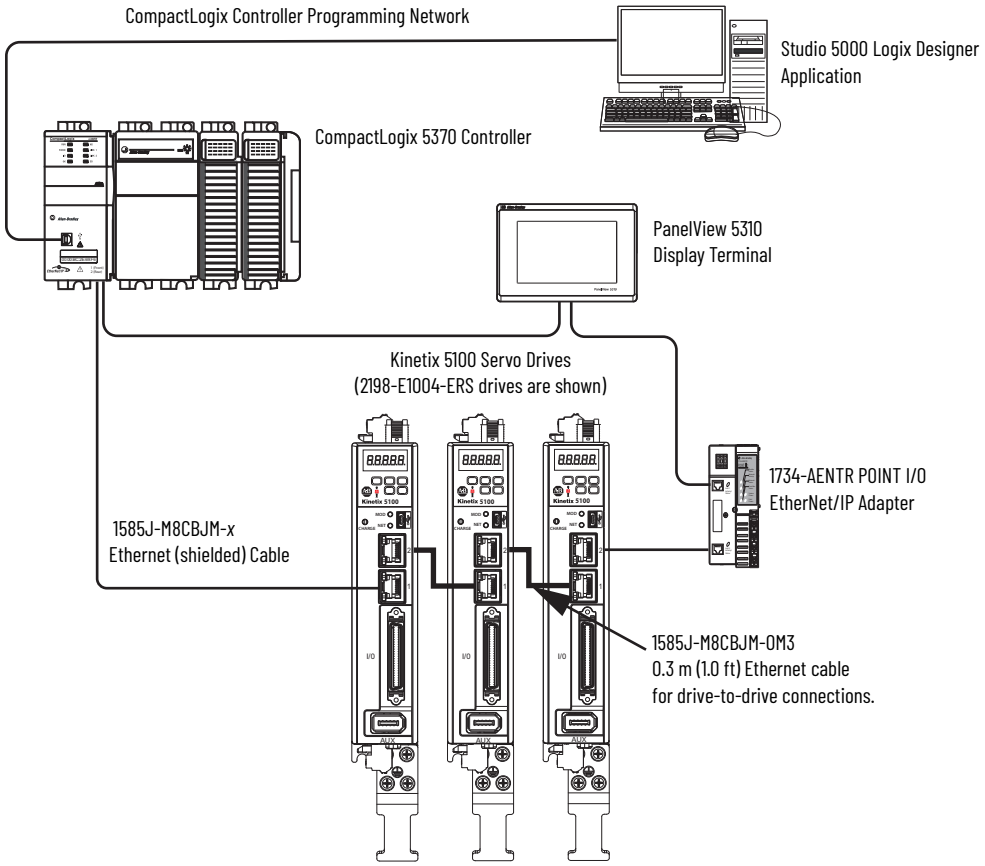


Ring Topology

In this example, the devices are connected by using ring topology. If only one device in the ring is disconnected, the rest of the devices continue to communicate. For ring topology to work correctly, a Device Level Ring (DLR) supervisor is required (for example, the Bulletin 1783 ETAP device). DLR is an ODVA standard. For more information, refer to the EtherNet/IP Embedded Switch Technology Application Guide, publication ENET-AP005.

Devices without dual-ports, for example the display terminal, require a 1783-ETAP module to complete the network ring.

Figure 4 - Kinetix 5100 Ring Communication Installation

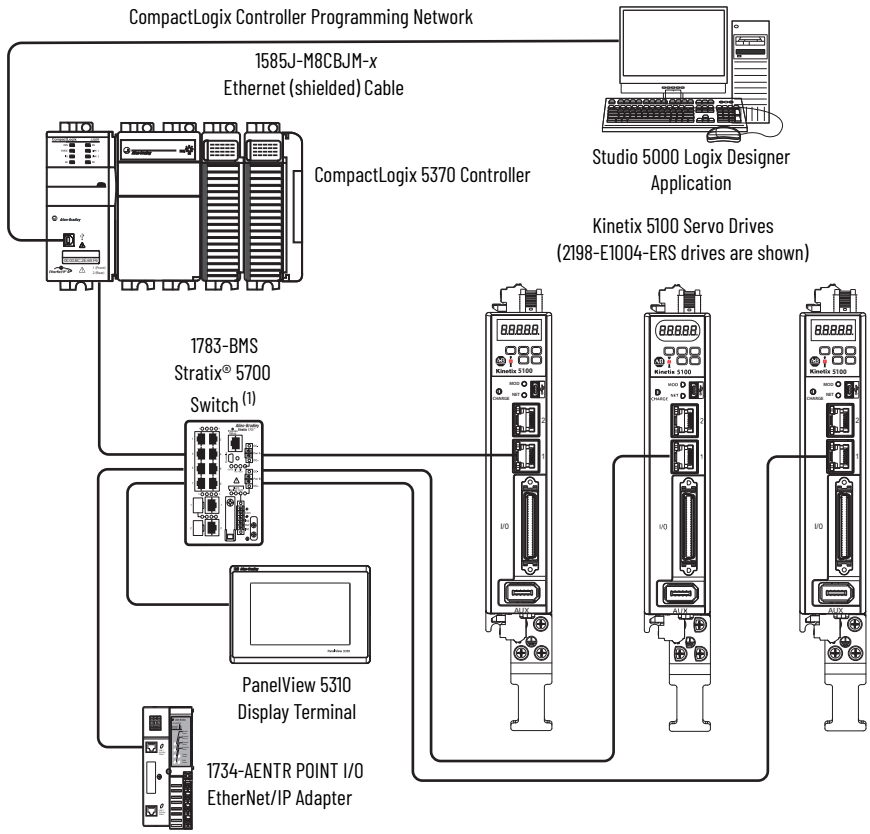


Star Topology

In this example, the devices are connected by using star topology. Each device is connected directly to the switch.

Kinetix 5100 drives have dual-ports, so linear topology is maintained from drive to drive, but the drives and other devices operate independently. The loss of one device does not impact the operation of other devices.

Figure 5 - Kinetix 5100 Star Communication Installation



(1) While a switch with PTP is shown in this example, the Kinetix 5100 drive does not require a switch with the PTP function.

Typical Control Configurations

You can configure Kinetix 5100 servo drives by using various methods for network control.

Figure 6 - Kinetix 5100 Drive System with PAC Controller and EtherNet/IP Network Control

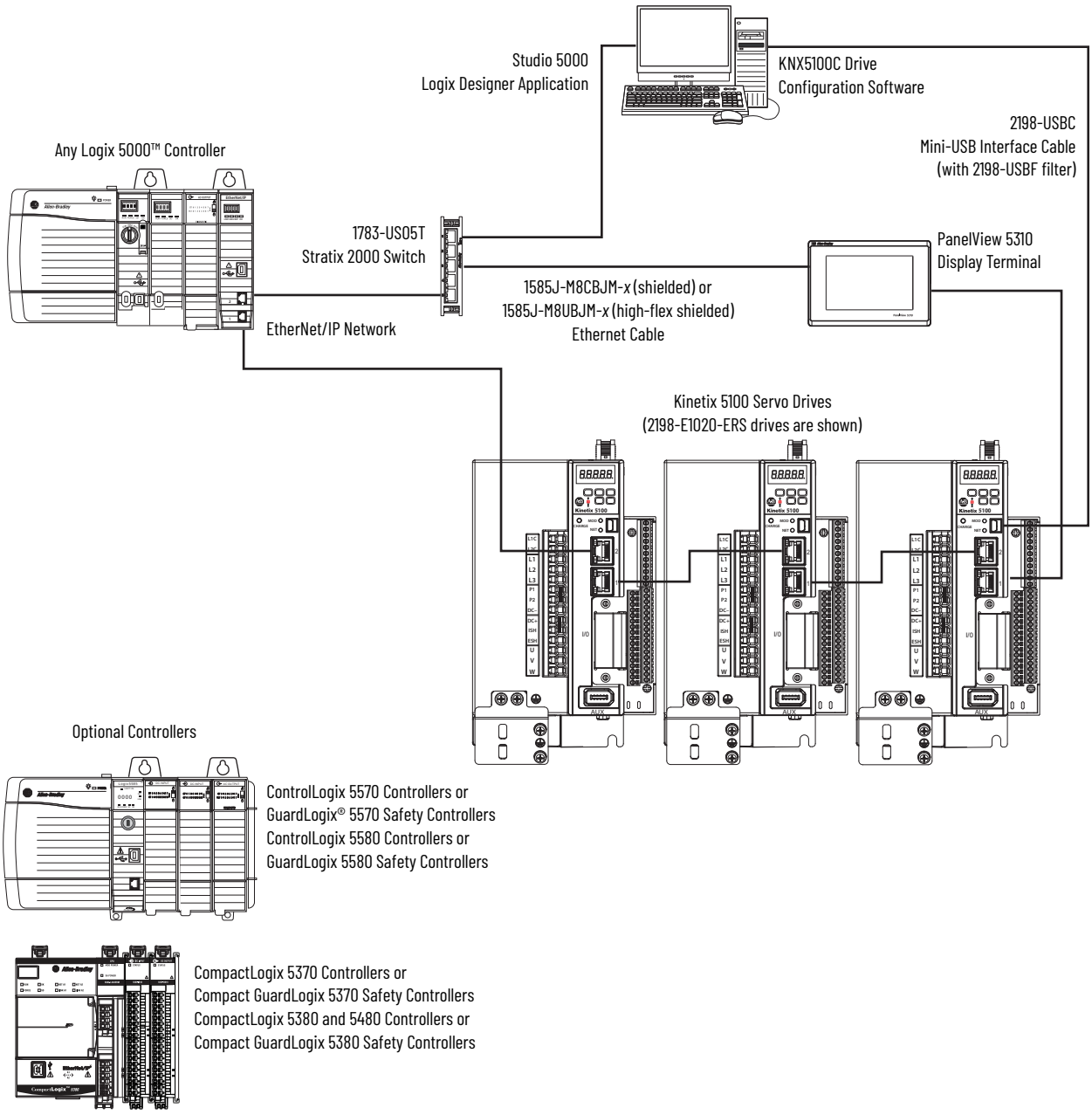


Figure 7 - Kinetix 5100 Drive System with PLC Controller and Class 3 EtherNet/IP Explicit Messaging Control

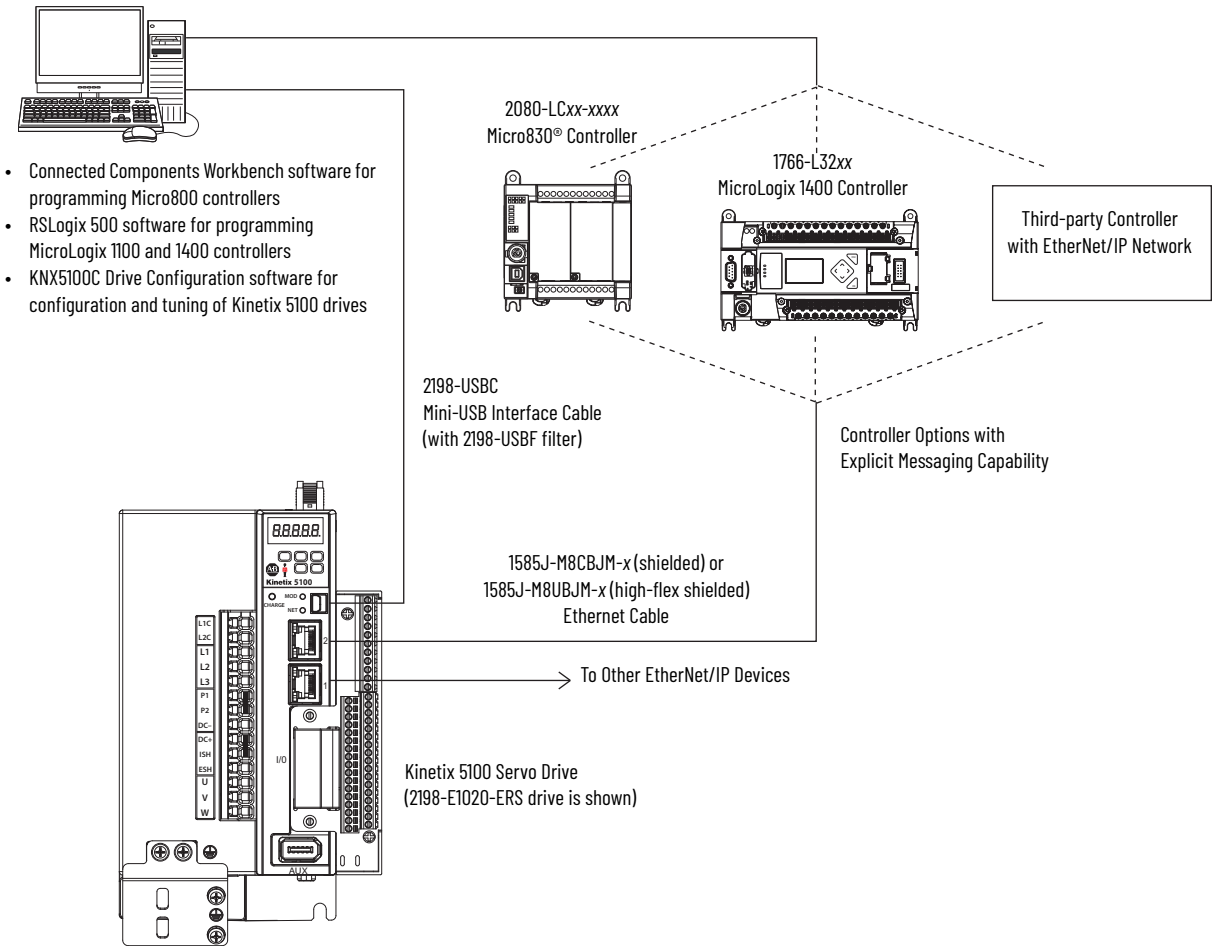
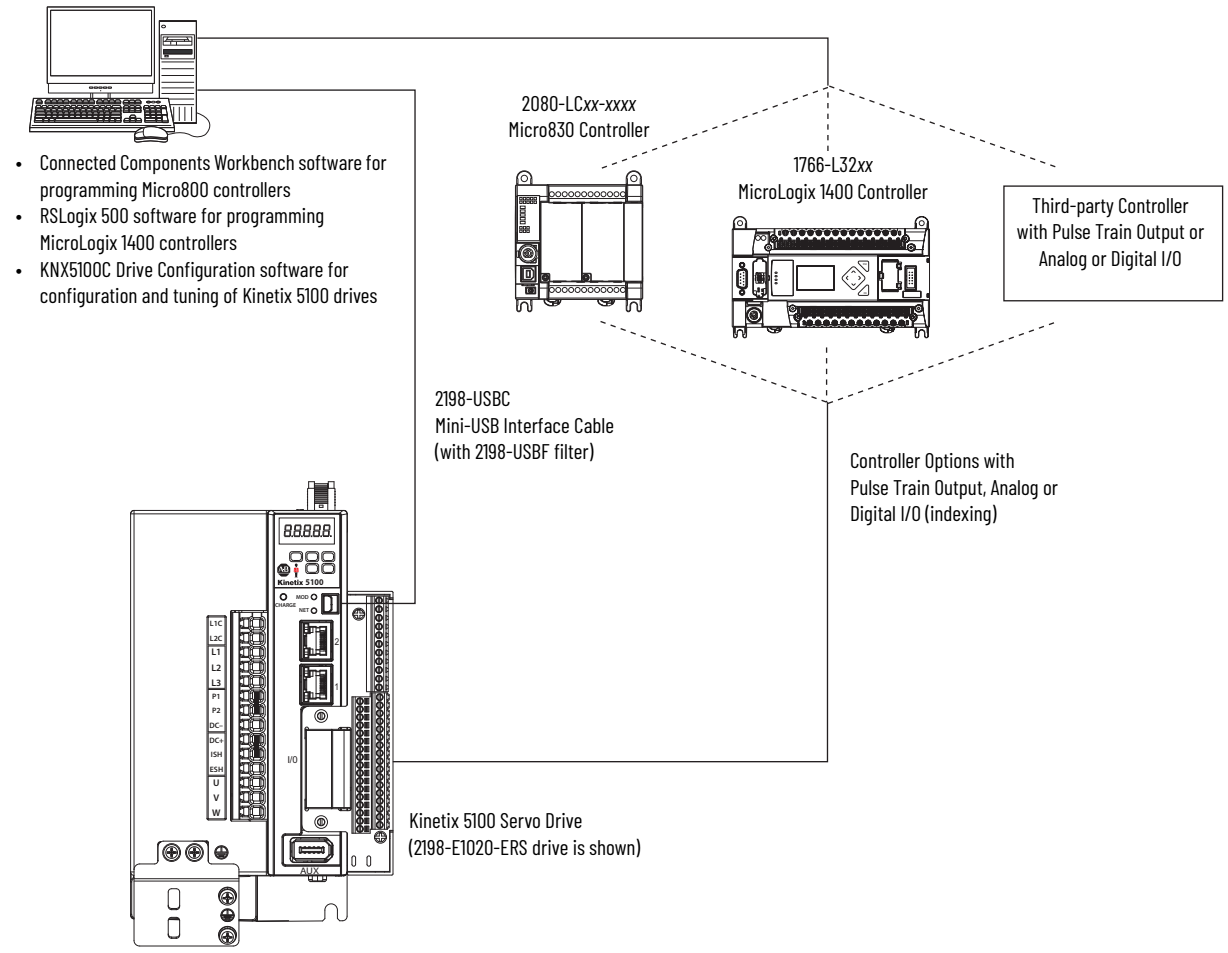


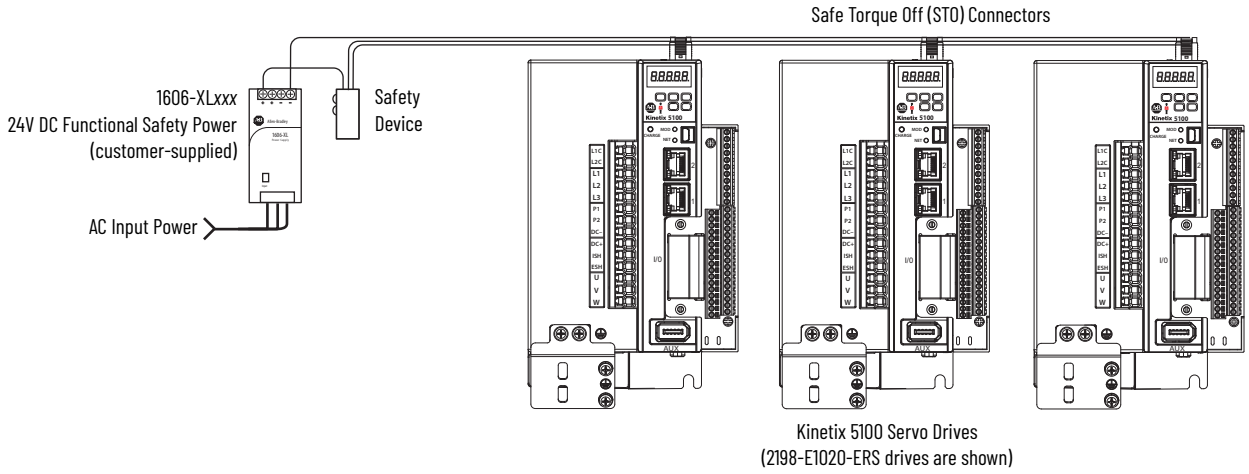
Figure 8 - Kinetix 5100 Drive System with PLC Controller and PTO, Analog or Digital I/O Control



Safe Torque Off Configurations

Kinetix 5100 servo drives are capable of Safe Torque Off (STO) safety functions via hardwired connections. In this example, the Safe Torque Off (STO) connectors are wired to external safety-devices with cascading hardwired safety-connections from one drive to another.

Figure 9 - Hardwired Safe Torque Off



Catalog Number Explanation

Kinetix 5100 drive catalog numbers and descriptions are listed in these tables.

Table 2 - Kinetix 5100 EtherNet/IP Indexing Servo Drives

Cat. No.	Input Voltage	Continuous Output Power kW	Continuous Output Current A (rms)	Peak Output Current A (rms)
2198-E1004-ERS	95...132V rms single-phase 170...253V rms single-phase 170...253V rms three-phase	0.20 0.40 0.40	2.6	6.5
2198-E1007-ERS		0.375 0.75 0.75	5.1	15.4
2198-E1015-ERS		0.75 1.50 1.50	7.9	23.7
2198-E1020-ERS		1.00 2.00 2.00	13.4	40.6
2198-E2030-ERS	170...253V rms three-phase	3.00	17.9	55.9
2198-E2055-ERS		5.50	41.3	91.4
2198-E2075-ERS		7.50	49.0	127.5
2198-E2150-ERS		15.00	78.0	162.0
2198-E4004-ERS	342...528V rms three-phase	0.40	1.60	5.4
2198-E4007-ERS		0.75	3.19	8.0
2198-E4015-ERS		1.50	6.05	15.11
2198-E4020-ERS		2.00	7.42	20.78
2198-E4030-ERS		3.00	13.95	26.08
2198-E4055-ERS		5.50	24.80	37.65
2198-E4075-ERS		7.50	31.0	53.32
2198-E4150-ERS		15.00	41.26	70.14

Table 3 - Kinetix 5100 Servo Drive Accessories

Cat. No.	Drive Components
2198-TBIO	Terminal block for I/O connections
2198-R004, and 2198-R031 2097-R6 and 2097-R7	External passive-shunt resistors for use when additional shunt capability is needed.
2198-DB*xxx*-F 2198-DBR*xxx*-F	AC line filters (required to meet CE)
2198-K51CK-D15M	Motor feedback connector kit
2198-AUXKIT	Auxiliary feedback connector kit
2198-KTBT	Feedback battery-box replacement kit

Agency Compliance

If this product is installed within the European Union and has the CE marking, the following regulations apply.

ATTENTION: The drive and line filter must be grounded. Failure to do this renders the filter ineffective and can cause damage to the filter. For ground examples, see Ground the Drive System on page 75.

For more information on electrical noise reduction, see the System Design for Control of Electrical Noise Reference Manual, publication GMC-RM001.

To comply with IEC 61800-3 (category C3) and IEC 61800-5-2, these requirements apply:

- Install an AC line filter (catalog number 2198-D*xxx*-F) as close to the drive as possible.
- Bond drive modules and line-filter grounding screws by using a braided ground strap as shown in Figure 50 on page 75.
- Use 2090 series motor-power cables or use connector kits and connect the cable shields to the subpanel with clamp provided.
- Use 2090 series motor-feedback cables or use connector kits and properly connect the feedback cable shield.
- Drive-to-motor cables must not exceed 50 m (164 ft), depending on AC input power and feedback type. See Maximum Cable Length on page 84 for specifications.
- Install the Kinetix 5100 system inside an enclosure. Run input power wiring in conduit (grounded to the enclosure) outside of the enclosure. Separate signal and power cables.
- Separate signal and power cables. Segregate input power wiring and motor power cables from control wiring and motor feedback cables. Use shielded cable for power wiring and provide a grounded 360° clamp termination.

See Appendix A on page 429 for interconnect diagrams, including input power wiring and drive/motor interconnect diagrams.

Plan and Install the Kinetix 5100 Drive System

This chapter describes system installation guidelines used in preparation for mounting your Kinetix® 5100 drive components.

Topic	Page
System Design Guidelines	23
Electrical Noise Reduction	31
Mount Your Kinetix 5100 Drive	38



ATTENTION: Plan the installation of your system so that you can cut, drill, tap, and weld with the system removed from the enclosure. Because the system is of the open type construction, be careful to keep any metal debris from falling into it. Metal debris or other foreign matter can become lodged in the circuitry, which can result in damage to components.

System Design Guidelines

Use the information in this section when you design your enclosure and plan to mount your system components on the panel.

For online product selection and system configuration tools, including AutoCAD (DXF) drawings of the product, see http://www.rockwellautomation.com/global/support/selection.page.

System Mounting Requirements

- To comply with UL and CE requirements, the Kinetix 5100 drive system must be mounted in a grounded conductive enclosure offering protection as defined in standard IEC 60529 to IP20 such that they are not accessible to an operator or unskilled person.
- To maintain the functional safety rating of the Kinetix 5100 drive system, this enclosure must be appropriate for the environmental conditions of the industrial location and provide a protection class of IP54 or higher.
- The panel you install inside the enclosure for mounting your system components must be on a flat, rigid, vertical surface that won't be subjected to shock, vibration, moisture, oil mist, dust, or corrosive vapors in accordance with pollution degree 2 (EN 61800-5-1) because the product is rated to protection class IP20 (EN 60529).
- Size the drive enclosure so as not to exceed the maximum-ambient temperature rating. Consider heat dissipation specifications for all drive components.

- Use high-frequency (HF) techniques for bonding to connect the enclosure, machine frame, and motor housing, and to provide a low-impedance return path for high-frequency (HF) energy and reduce electrical noise.

  Bond the Kinetix 5100 drive modules and line filter grounding screws by using a braided ground strap as shown in Figure 50 on page 75.

See the System Design for Control of Electrical Noise Reference Manual, publication GMC-RM001, to better understand the concept of electrical noise reduction.

AC Line Filter Selection

An AC line filter is required to meet CE requirements. Install an AC line filter for input power as close to the 2198-E*xxxx*-ERS servo drive as possible.

IMPORTANT Kinetix 5100 servo drives support only grounded wye power configurations. For facility power configuration examples, see Determine the Input Power Configuration on page 70.

Table 4 - AC Line Filter Selection

Kinetix 5100 Drive Cat. No.	Input Voltage (nom)	AC Line Filter Cat. No. (single-phase operation)	AC Line Filter Cat. No. (three-phase operation)
2198-E1004-ERS	120V single-phase 200...230V single-phase 230V three-phase	2198-DB111-F	2198-DB310-F
2198-E1007-ERS		2198-DB127-F	
2198-E1015-ERS			2198-DB324-F
2198-E1020-ERS			
2198-E2030-ERS	230V three-phase	–	
2198-E2055-ERS		–	2198-DB335-F
2198-E2075-ERS		–	2198-DB356-F
2198-E2150-ERS		–	2198-DBR90-F
2198-E4004-ERS	480V three-phase	–	2109-DB418-F
2198-E4007-ERS		–	
2198-E4015-ERS		–	
2198-E4020-ERS		–	
2198-E4030-ERS		–	
2198-E4055-ERS		–	2198-DB433-F
2198-E4075-ERS		–	
2198-E4150-ERS		–	2198-DBR40-F

Circuit Breaker/Fuse Selection

The Kinetix 5100 drives use internal solid-state motor short-circuit protection and, when connected to a suitable branch circuit protection, are rated for use on a circuit that can deliver up to 5000 A (fuses or circuit breakers).

IMPORTANT Do not use circuit protection devices on the output of an AC drive as an isolating disconnect switch or motor overload device. These devices are designed to operate on sine-wave voltage and the drive's PWM waveform does not allow it to operate properly. As a result, damage to the device occurs.

Make sure the selected components are properly coordinated and meet acceptable codes including any requirements for branch circuit protection. Evaluation of the short-circuit available current is critical and must be kept below the short-circuit current rating of the circuit breaker.

See the Kinetix Servo Drives Specifications Technical Data, publication KNX-TD003, for input current and inrush current specifications for your Kinetix 5100 drive.

Circuit Breaker/Fuse Specifications

Kinetix 5100 servo drives use internal solid-state motor short-circuit protection and, when protected by suitable branch circuit protection, are rated for use on a circuit capable of delivering up to 5000 A when protected by fuses or circuit breakers. These fuses and Allen-Bradley circuit breakers are recommended for use with 2198-E*xxxx*-ERS drives.

Table 5 - Control Power Circuit-protection Specifications

Cat. No.	Fuse (Bussman) Cat. No	Miniature CB Cat. No.
2198-E1004-ERS	KTK-R-2 (2 A)	1489-M2D010
2198-E1007-ERS		
2198-E1015-ERS		
2198-E1020-ERS		1489-M2D020
2198-E2030-ERS		1489-M2D010
2198-E2055-ERS	KTK-R-3 (3 A)	1489-M2D016
2198-E2075-ERS		
2198-E2150-ERS	KTK-R-5 (5 A)	1489-M2D030

Table 6 - Input Power UL/CSA Circuit-protection Specifications

Kinetix 5100 Drive Cat. No.	Drive Voltage	Fuses (Bussmann) Cat. No.	Miniature CB (1) Cat. No.	Molded Case CB Cat. No.
2198-E1004-ERS	120V/230V, single-phase	KTK-R-15 (15 A)	1489-M2D100	–
	230V, three-phase	KTK-R-10 (10 A)	1489-M3D100	–
2198-E1007-ERS	120V/230V, single-phase	KTK-R-20 (20 A)	1489-M2D200	–
	230V, three-phase	KTK-R-15 (15 A)	1489-M3D130	–
2198-E1015-ERS	120V/230V, single-phase	KTK-R-30 (30 A)	1489-M2D300	–
	230V, three-phase	KTK-R-25 (25 A)	1489-M3D200	–
2198-E1020-ERS	120V/230V, single-phase	LPJ-40SP (40 A)	1489-M2D400	–
	230V, three-phase	LPJ-35SP (35 A)	1489-M3D300	–
2198-E2030-ERS	230V, three-phase	LPJ-50SP (50 A)	1489-M3D350	–
2198-E2055-ERS		LPJ-70SP (70 A)	1489-M3D600	–
2198-E2075-ERS		LPJ-80SP (80 A)	–	140G-G2C3-C70
2198-E2150-ERS		LPJ-125SP (125 A)	–	140G-G2C3-D12
2198-E4004-ERS	380...480V AC, three-phase	KTK-R-10 (10A)	1489-M3D100	–
2198-E4007-ERS		KTK-R-15 (15A)	1489-M3D100	–
2198-E4015-ERS		KTK-R-20 (20A)	1489-M3D150	–
2198-E4020-ERS		KTK-R-25 (25A)	1489-M3D200	–
2198-E4030-ERS		KTK-R-30 (30A)	1489-M3D300	–
2198-E4055-ERS		LPJ-35SP (35A)	–	–
2198-E4075-ERS		LPJ-45SP (45A)	–	–
2198-E4150-ERS		LPJ-90SP (90A)	–	–

(1) There are no recommended motor-protection circuit breakers for the Kinetix 5100 servo drives.

Table 7 - Input Power IEC (non-UL/CSA) Circuit-protection Specifications

Kinetix 5100 Drive Cat. No.	Drive Voltage	DIN gG Fuses Amps, Max	Miniature CB (1) Cat. No.	Molded Case CB Cat. No.
2198-E1004-ERS	120V/230V, single-phase	15	1489-M2D100	–
	230V, three-phase	10	1489-M3D100	–
2198-E1007-ERS	120V/230V, single-phase	20	1489-M2D200	–
	230V, three-phase	15	1489-M3D130	–
2198-E1015-ERS	120V/230V, single-phase	30	1489-M2D300	–
	230V, three-phase	25	1489-M3D200	–
2198-E1020-ERS	120V/230V, single-phase	40	1489-M2D400	–
	230V, three-phase	35	1489-M3D300	–
2198-E2030-ERS	230V, three-phase	50	1489-M3D350	–
2198-E2055-ERS		70	1489-M3D600	–
2198-E2075-ERS		80	–	140G-G2C3-C70
2198-E2150-ERS		125	–	140G-G2C3-D12
2198-E4004-ERS	380...480V AC, three-phase	10	1489-M3D100	–
2198-E4007-ERS		15	1489-M3D100	–
2198-E4015-ERS		20	1489-M3D150	–
2198-E4020-ERS		25	1489-M3D200	–
2198-E4030-ERS		30	1489-M3D300	–
2198-E4055-ERS		35	1489-M3D350	–
2198-E4075-ERS		45	–	140G-G6C3-C45
2198-E4150-ERS		90	–	140G-G6C3-C60

(1) There are no recommended motor protection circuit breakers for the Kinetix 5100 servo drives.

Transformer Selection

The Kinetix 5100 drive does not require an isolation transformer for three-phase input power. However, a transformer can be required to match the voltage requirements of the drive to the available service.

To size a transformer for the main AC power inputs, see Circuit Breaker/Fuse Selection on page 25 and Kinetix Servo Drives Specifications Technical Data, publication KNX-TD003.

IMPORTANT Transformers (auto transformer is not supported) must have WYE secondary with grounded neutral. Phase to neutral voltage must not exceed the input voltage rating of the drive.

IMPORTANT Use a factor of 1.5 for single and three-phase power (this factor is used to compensate for transformer, drive, and motor losses, and to account for utilization in the intermittent operating area of the torque speed curve).

For example, size a transformer to the voltage requirements of catalog number 2198-E2030-ERS = 3 kW continuous x 1.5 = 4.5 KVA transformer.

IMPORTANT A line reactor must be used if the source transformer is greater than 150 KVA, max and 3% impedance, min.

Passive Shunt Considerations

See Table 8 for the 2198-E*xxxx*-ERS servo drives that include internal shunt resistors. Bulletin 2198-R*xxx* and 2097-R*x* external passive shunts are available to provide additional shunt capacity for applications where the internal shunt capacity is exceeded or in applications requiring shunt capacity for drives without an internal shunt.

Table 8 - External Passive-shunt Options

Kinetix 5100 Servo Drive Cat. No.	Internal Shunt Resistor	Shunt Power Capacity of Resistor	External Shunt Resistance, min	Bulletin 2198 External Shunt Module (1) Cat. No.		Bulletin 2097 External Shunt Module (1) Cat. No.	
	Ω	W	Ω	2198-R031	2198-R004	2097-R6	2097-R7
2198-E1004-ERS	100	5	60	–	–	X	X
2198-E1007-ERS		14		–	–	X	X
2198-E1015-ERS			30	X	X	X	X
2198-E1020-ERS	20	20	15	X	X	X	X
2198-E2030-ERS				X	X	X	X
2198-E2055-ERS	–	–	10	X	X	X	X
2198-E2075-ERS	–	–		X	X	X	X
2198-E2150-ERS	–	–	5	X	X	X	X
2198-E4004-ERS	80	10	80	–	–	–	X
2198-E4007-ERS		10	60	–	–	X	X
2198-E4015-ERS		10	40	–	–	X	X
2198-E4020-ERS	–	–		–	–	X	X
2198-E4030-ERS	–	–	30	X	X	X	X
2198-E4055-ERS	–	–	20	X	X	X	X
2198-E4075-ERS	–	–	15	X	X	X	X
2198-E4150-ERS	–	–	12	X	X	X	X

(1) Shunt resistor selection is based on the needs of your actual hardware configuration.

ATTENTION: See Table 8 for the minimum external shunt resistance. Connecting an external shunt resistor of with resistance rating lower than specified results in (drive-side) shunt circuitry damage.

Catalog number 2198-R031 is composed of resistor coils that are housed inside an enclosure. Catalog numbers 2198-R004, 2097-R6, and 2097-R6 are shunt resistors without an enclosure.

Figure 10 - External Passive Shunts

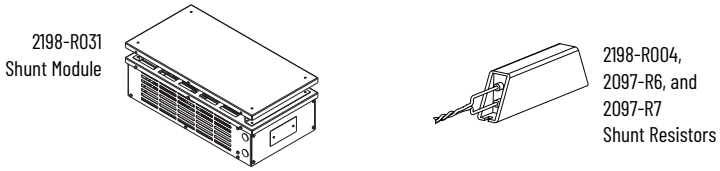


Table 9 - External Shunt Module Specifications

Shunt Module Cat. No.	Resistance Ω	Continuous Power W	Weight, approx kg (lb)
2097-R6	75	150	0.3 (0.7)
2097-R7	150	80	0.2 (0.4)
2198-R004	33	400	1.8 (4.0)
2198-R031	33	3100	16.8 (37)

How the Bulletin 2198-R*xxx* and 2097-R*x* shunts connect to the Kinetix 5100 drive is explained in External Passive-shunt Resistor Connections on page 95 and illustrated with interconnect diagrams in Passive Shunt Wiring Examples on page 437.

Enclosure Selection

This example is provided to assist you in size selection for an enclosure for your Kinetix 5100 drive system. You need heat dissipation data from all components that are planned for your enclosure to calculate the enclosure size. See Table 10 on page 29 for the Kinetix 5100 drive heat dissipation specifications.

With no active method of heat dissipation (such as fans or air conditioning), either of the following approximate equations can be used.

Metric	Standard English
$A = \frac{0.38Q}{1.8T - 1.1}$	$A = \frac{4.08Q}{T - 1.1}$
Where T is temperature difference between inside air and outside ambient (°C), Q is heat that is generated in enclosure (Watts), and A is enclosure surface area (m^2). The exterior surface of all six sides of an enclosure is calculated as	Where T is temperature difference between inside air and outside ambient (°F), Q is heat that is generated in enclosure (Watts), and A is enclosure surface area (ft^2). The exterior surface of all six sides of an enclosure is calculated as
A = 2dw + 2dh + 2wh	A = (2dw + 2dh + 2wh) /144
Where d (depth), w (width), and h (height) are in meters.	Where d (depth), w (width), and h (height) are in inches.

If the maximum ambient rating of the Kinetix 5100 drive system is 50 °C (122 °F) and if the maximum environmental temperature is 20 °C (68 °F), then T=30. In this example, the total heat dissipation is 416 W (sum of all components in enclosure). So, in the equation below, T=30 and Q=416.

$$A = \frac{0.38\,(416)}{1.8\,(30) - 1.1} = 2.99\ m^2$$

In this example, the enclosure must have an exterior surface of at least 2.99 m^2. If any portion of the enclosure is not able to transfer heat, do not include that value in the calculation.

Because the minimum cabinet depth to house the Kinetix 5100 system (selected for this example) is 300 mm (11.8 in.), the cabinet needs to be approximately 1500 x 700 x 300 mm (59.0 x 27.6 x 11.8 in.) HxWxD.

$$1.5 \times (0.300 \times 0.70) + 1.5 \times (0.300 \times 2.0) + 1.5 \times (0.70 \times 2.0) = 3.31\ m^2$$

Because this cabinet size is considerably larger than what is necessary to house the system components, it can be more efficient to provide a means of cooling in a smaller cabinet. Contact your cabinet manufacturer for options available to cool your cabinet.

Table 10 - Power Dissipation Specifications

Kinetix 5100 (200V) Drives Cat. No.	Loss, max W
2198-E1004-ERS	38.06
2198-E1007-ERS	66.33
2198-E1015-ERS	87.23
2198-E1020-ERS	139.83
2198-E2030-ERS	179.53
2198-E2055-ERS	328.52
2198-E2075-ERS	372.33
2198-E2150-ERS	648.55

Kinetix 5100 (400V) Drives Cat. No.	Loss (380V), max W	Loss (480V), max W
2198-E4004-ERS	51	56
2198-E4007-ERS	71	86
2198-E4015-ERS	99	117
2198-E4020-ERS	109	123
2198-E4030-ERS	214	220
2198-E4055-ERS	342	363
2198-E4075-ERS	467	494
2198-E4150-ERS	501	541

Table 10 provides total power dissipation for Kinetix 5100 drives @ 230V, three-phase operation, with 100% rated current and speed.

Minimum Clearance Requirements

This section provides information to assist you in sizing your cabinet and positioning your Kinetix 5100 drive system:

- Additional clearance is required for cables and wires connected to the drive modules.
- Additional clearance is required if other devices are installed above and/or below the drive module and have clearance requirements of their own.
- Additional clearance left and right of the drive module is required when mounted adjacent to noise sensitive equipment or clean wireways.
- Recommended minimum cabinet depth:
  - 300 mm (11.81 in.) for 2198-E1004, 2198-E1007, 2198-E1015, 2198-E1020, 2198-E2030, 2198-E2055, and 2198-E2075 servo drives
  - 300 mm (11.81 in.) for 2198-E4004, 2198-E4007, 2198-E4015, 2198-E4020, 2198-E4030, 2198-E4055, and 2198-E4075 servo drives
  - 350 mm (13.78 in.) for 2198-E2150 and 2198-E4150 servo drives

To maintain adequate ventilation:

- Install cooling fans above servo drives inside the cabinet to remove excess heat.
- Keep servo drives away from heat sources.
- Make sure that the ambient temperature at 5.0 cm (1.96 in.) beneath the drives does not exceed the operating temperature range.

ATTENTION: To avoid damage to drives due to overheating, cooling fans must be installed when 2198-E1004-ERS drives are mounted in the cabinet. Make sure that there is a minimum of 0.5 m/s (1.6 ft/s) air flow at 10 mm (0.4 in.) above the top-center of the drive.

Figure 11 - Minimum Clearance Requirements

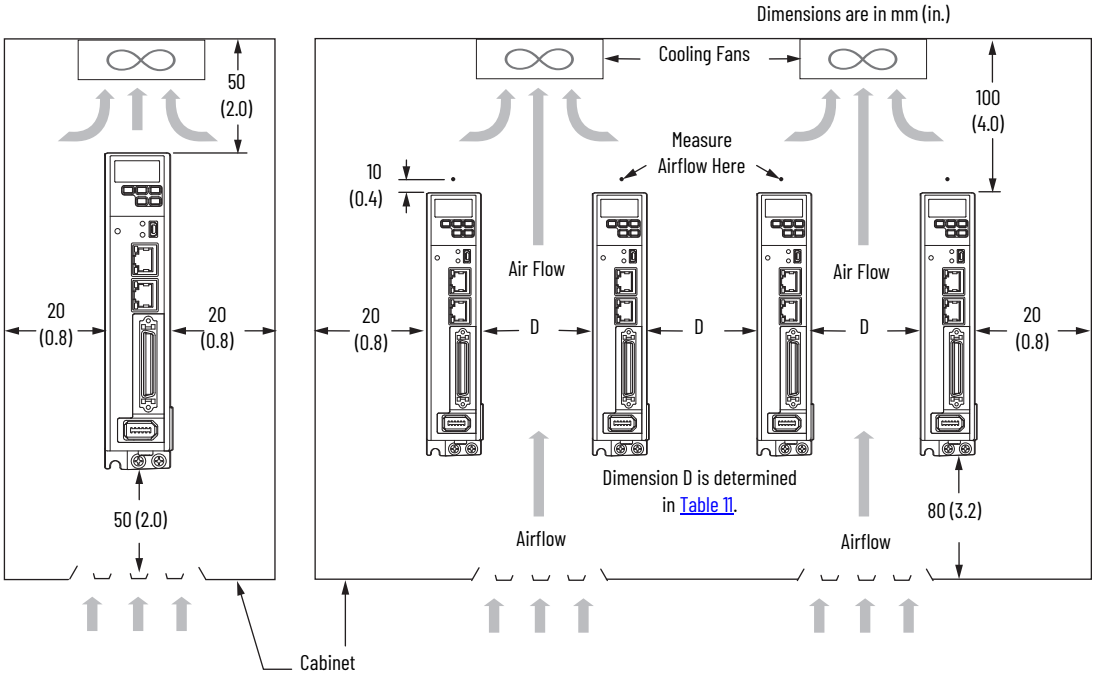
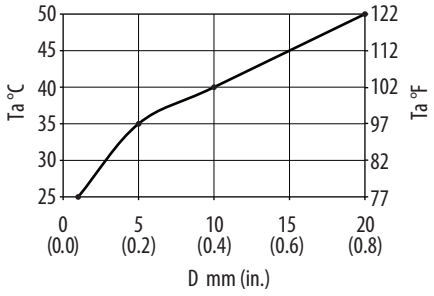


Table 11 - Dimension D

Kinetix 5100 Drive Cat. No.		Temperature, Ambient Versus Dimension D
2198-E1004-ERS	2198-E4004-ERS	
2198-E1007-ERS	2198-E4007-ERS	
2198-E1015-ERS	2198-E4015-ERS	
2198-E1020-ERS	2198-E4020-ERS	
2198-E2030-ERS	2198-E4030-ERS	
2198-E2055-ERS	2198-E4055-ERS	
2198-E2075-ERS	2198-E4075-ERS	
2198-E2150-ERS	2198-E4150-ERS	

IMPORTANT Mount the drive in an upright position as shown. Do not mount the drive on its side.

See Kinetix Servo Drives Specifications Technical Data, publication KNX-TD003 for Kinetix 5100 drive dimensions.

Electrical Noise Reduction

This section outlines best practices that minimize the possibility of noise-related failures as they apply specifically to Kinetix 5100 system installations. For more information on the concept of high-frequency (HF) bonding, the ground plane principle, and electrical noise reduction, see the System Design for Control of Electrical Noise Reference Manual, publication GMC-RM001.

HF Bond the Drives

Bonding is the practice where you connect the metal chassis, assemblies, frames, shields, and enclosures to reduce the effects of electromagnetic interference (EMI).

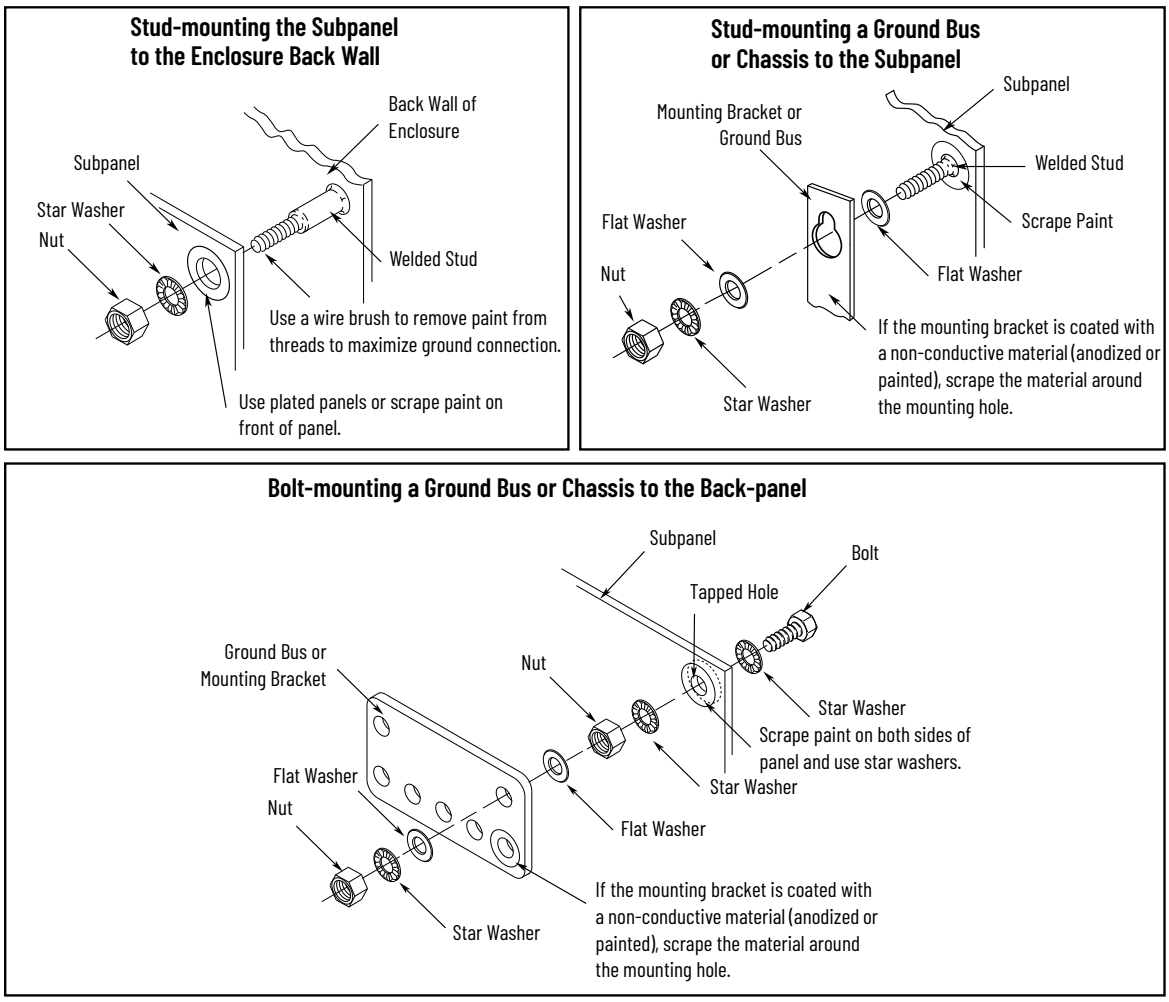
Unless specified, most paints are not conductive and act as insulators. To achieve a good bond between drive and the subpanel, surfaces must be paint-free or plated. Bonding the metal surfaces creates a low-impedance return path for high-frequency energy.

IMPORTANT To improve the bond between the drive and subpanel, construct your subpanel out of zinc-plated (paint-free) steel.

Improper bonding of the metal surfaces blocks the direct return path and allows high-frequency energy to travel elsewhere in the cabinet. Excessive high-frequency energy can affect the operation of other microprocessor controlled equipment.

These illustrations show recommended practices for bonding the painted panels, enclosures, and brackets.

Figure 12 - Recommended Bonding Practices for Painted Panels

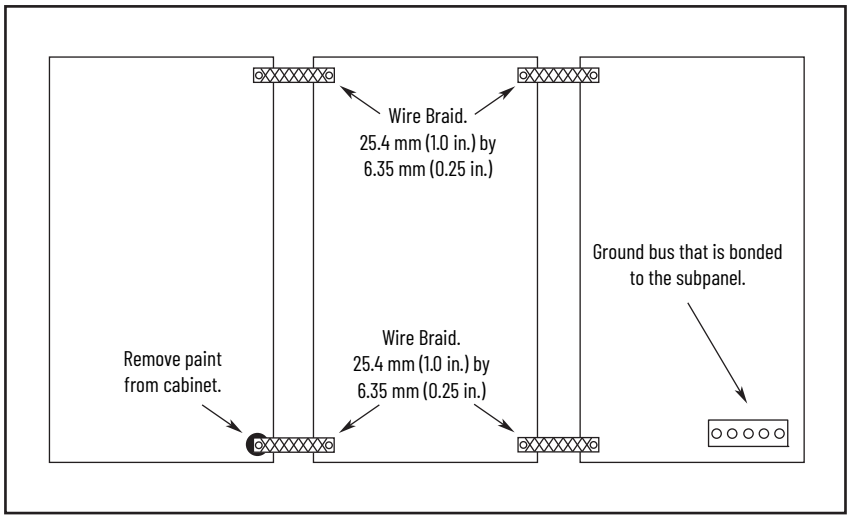


HF Bond Multiple Subpanels

Bonding multiple subpanels creates a common low-impedance exit path for the high frequency energy inside the cabinet. Subpanels that are not bonded together do not necessarily share a common low-impedance path. This difference in impedance can affect networks and other devices that span multiple panels.

- Bond the top and bottom of each subpanel to the cabinet by using 25.4 mm (1.0 in.) by 6.35 mm (0.25 in.) wire braid. As a rule, the wider and shorter the braid is, the better the bond.
- Scrape the paint from around each fastener to maximize metal-to-metal contact.

Figure 13 - Multiple Subpanels and Cabinet Recommendations

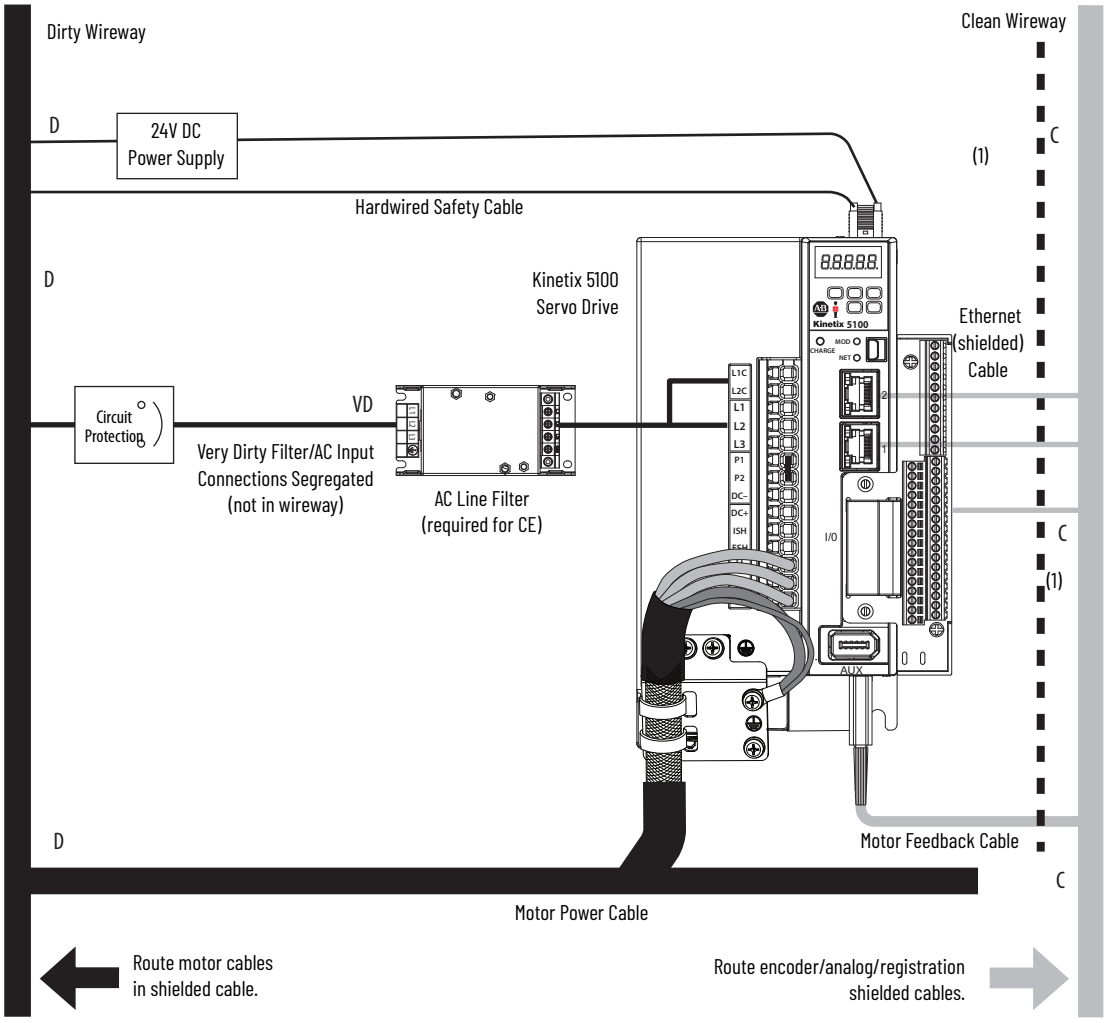


Establish Noise Zones

Observe these guidelines when routing cables used in the Kinetix 5100 system:

- The clean zone (C) is right of the drive system and includes the digital inputs wiring and Ethernet cable (gray wireway).
- The dirty zone (D) is left and below the drive system (black wireways) and includes the circuit breakers, 24V DC power supply, safety, and motor cables.
- The very dirty zone (VD) is limited to where the AC (EMC) line filter VAC output jumpers over to the DC-bus power supply. Shielded cable is required only if the very dirty cables enter a wireway.

Figure 14 - Noise Zones



(1) When space to the right of the module does not permit 150 mm (6.0 in.) segregation, use a grounded steel shield instead. For examples, refer to the System Design for Control of Electrical Noise Reference Manual, publication GMC-RM001.

Cable Categories for Kinetix 5100 Drive Systems

Table 12 indicates the zoning requirements of cables that connect to the Kinetix 5100 drive components.

Table 12 - Kinetix 5100 Drive Systems

Wire/Cable	Connector Function	Zone			Method	
		Very Dirty	Dirty	Clean	Ferrite Sleeve	Shielded Cable
L1, L2, L3 (shielded cable)	Mains input power	–	X	–	–	X
L1, L2, L3 (unshielded cable)		X	–	–	–	–
L1C, L2C (unshielded cable)	Control input power	–	X	–	–	–
U, V, W (motor power)	U, V, W (motor power)	–	X	–	–	X
Motor feedback (MFD)	Motor feedback (MFD)	–	X	–	–	X
DC+, ISH, ESH	Shunt resistor	–	X	–	–	–
24V DC	24V DC for Safe Torque Off (STO) feature and control power on 2198-E4xxx-ERS (400V) drives	–	X	–	–	–
Digital and analog I/O	Registration and analog inputs/outputs (I/O)	–	–	X	–	X
	Dedicated digital inputs (other than registration inputs and other I/O signals)	–	X	–	–	–
Ethernet	Ethernet RJ45 (Port 1 and Port 2)	–	–	X	–	X

Noise Reduction Guidelines for Drive Accessories

See this section when mounting an AC line filter or shunt resistor module for guidelines that are designed to reduce system failures caused by excessive electrical noise.

AC Line Filters

Observe these guidelines when mounting your AC line filter:

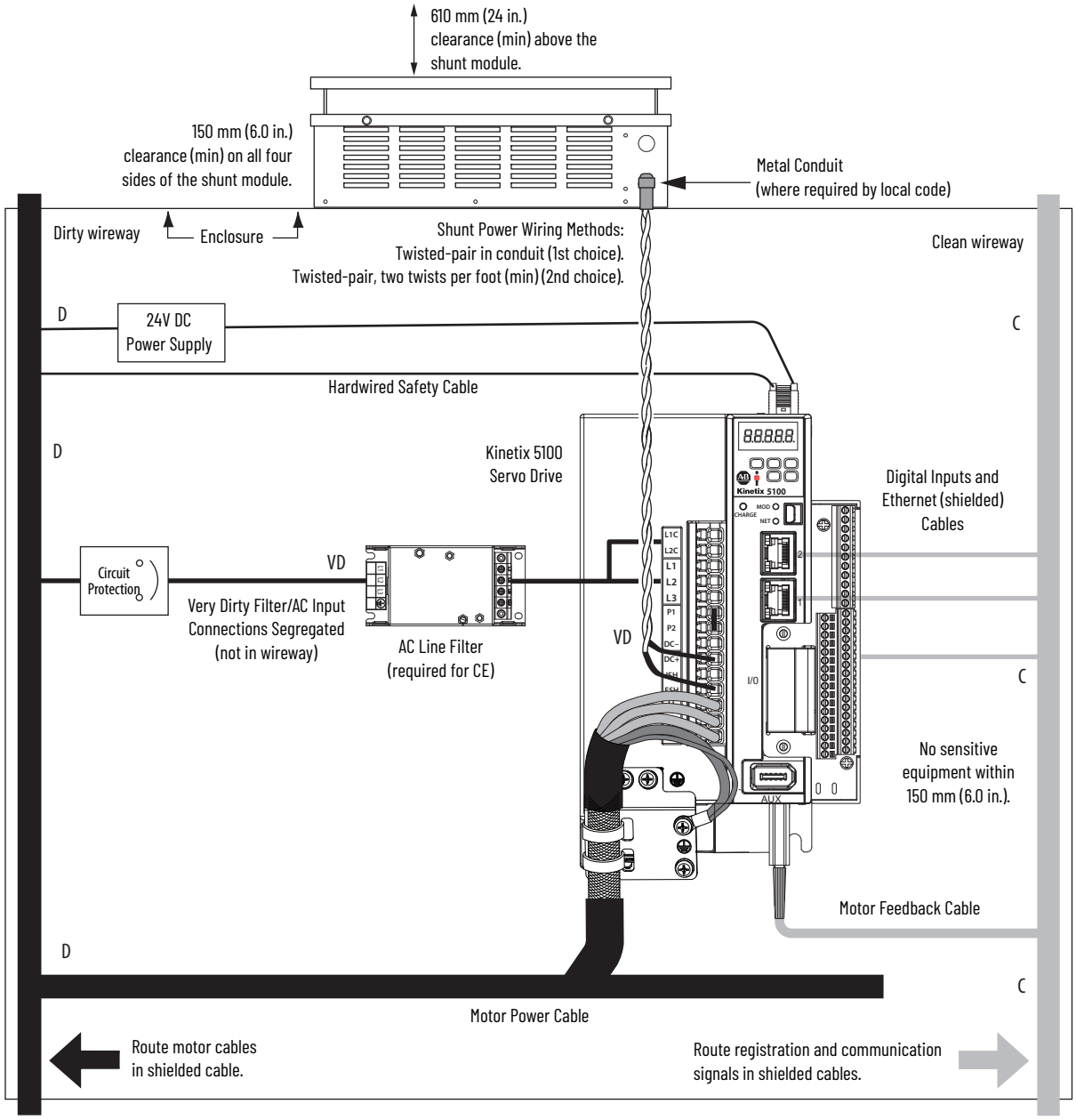
- If you are using a Bulletin 2198 line filter, mount the filter on the same panel as the Kinetix 5100 drive, and as close to the drive as possible.
- Good HF bonding to the panel is critical. For painted panels, see the examples on page 32.
- Segregate input and output wiring as far as possible.

External Passive Shunt Modules

Observe these guidelines when mounting your Bulletin 2198 and 2097 external passive shunt outside of the drive system enclosure:

- Mount the shunt module so that wiring routes in the very dirty zone inside the drive system enclosure.
- Keep unshielded wiring as short as possible, not to exceed 3 m (9.8 ft). Keep shunt wiring as flat to the cabinet as possible.

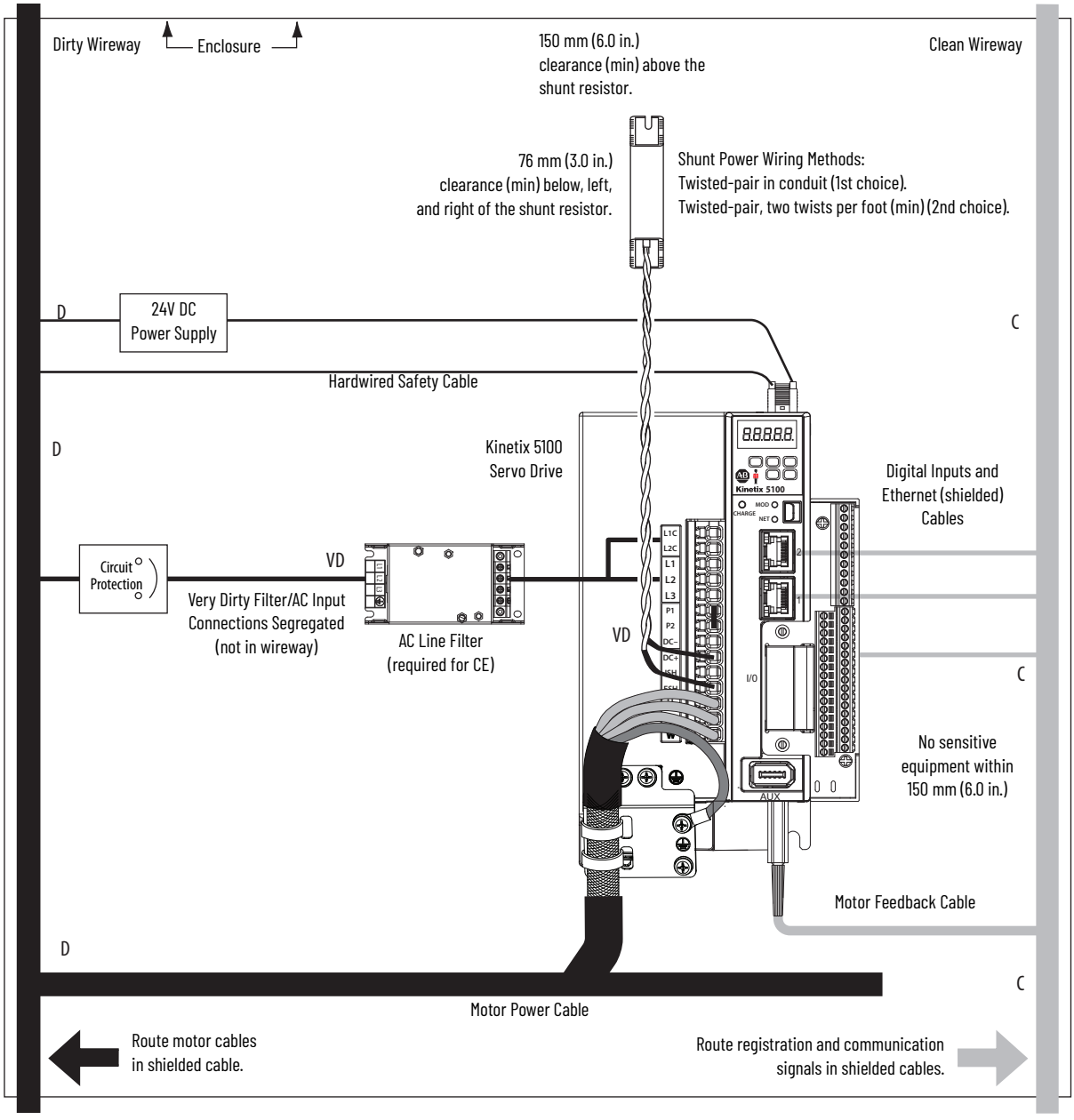
Figure 15 - External Passive Shunt Module Mounted On Top of the Drive System Enclosure



Observe these guidelines when mounting your Bulletin 2198 and 2097 external passive shunt inside the drive system enclosure:

- Mount the shunt resistors anywhere in the dirty zone, but as close to the Kinetix 5100 power supply as possible.
- Route the shunt power wires with other very dirty wires.
- Keep unshielded wiring as short as possible, not to exceed 457 mm (18 in.). Keep shunt wiring as flat to the cabinet as possible.
- Separate shunt power cables from other sensitive low-voltage signal cables.

Figure 16 - External Shunt Resistor Mounted Inside the Drive System Enclosure



Mount Your Kinetix 5100 Drive

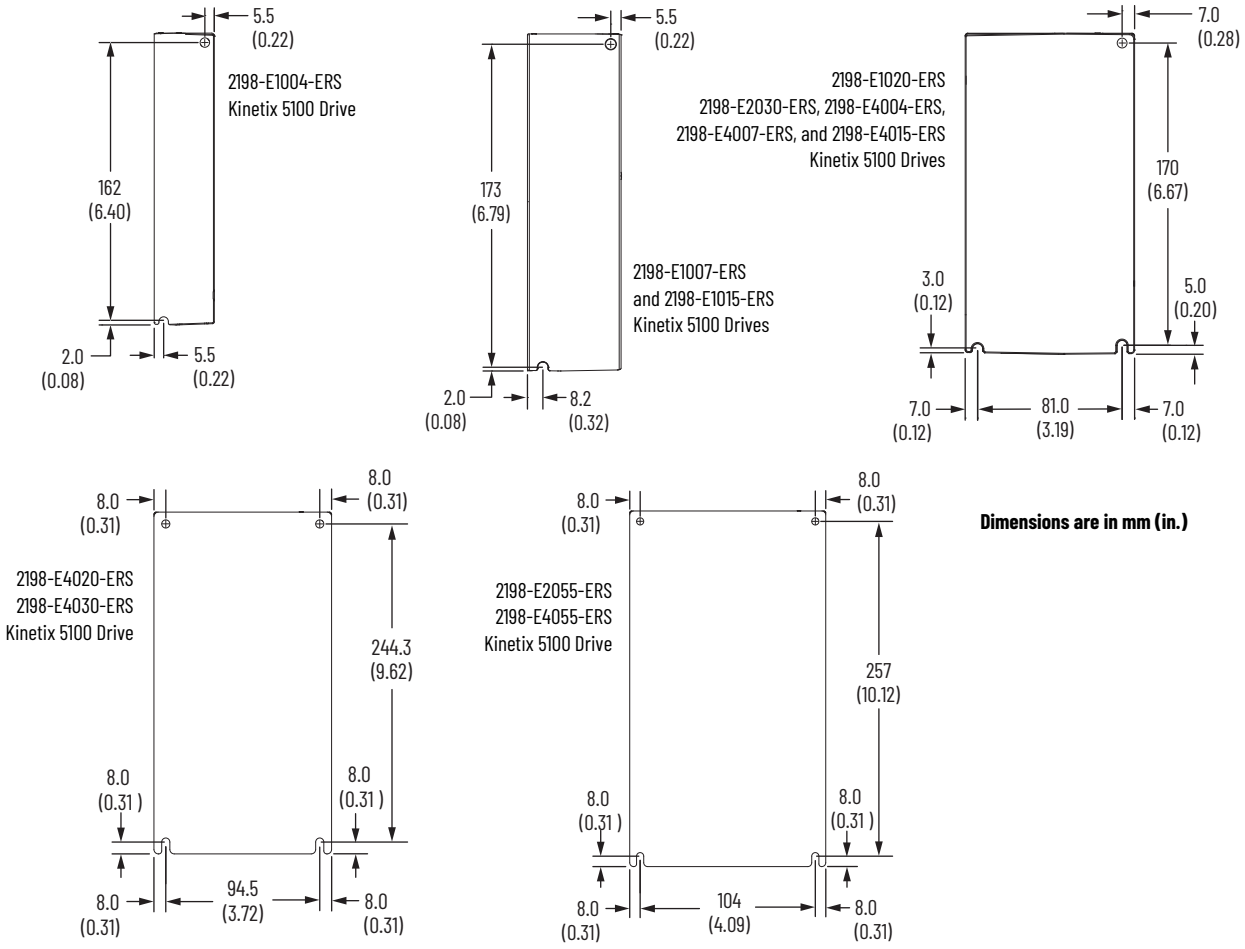
This procedure assumes that you have prepared your panel and understand how to bond your system. For installation instructions regarding other equipment and accessories, see the instructions that came with those products.

ATTENTION: This drive contains electrostatic discharge (ESD) sensitive parts and assemblies. You are required to follow static control precautions when you install, test, service, or repair this assembly. If you do not follow ESD control procedures, components can be damaged. If you are not familiar with static control procedures, see Allen-Bradley publication 8000-4.5.2, Guarding Against Electrostatic Damage or any other applicable ESD Protection Handbook.

Drill-hole Patterns

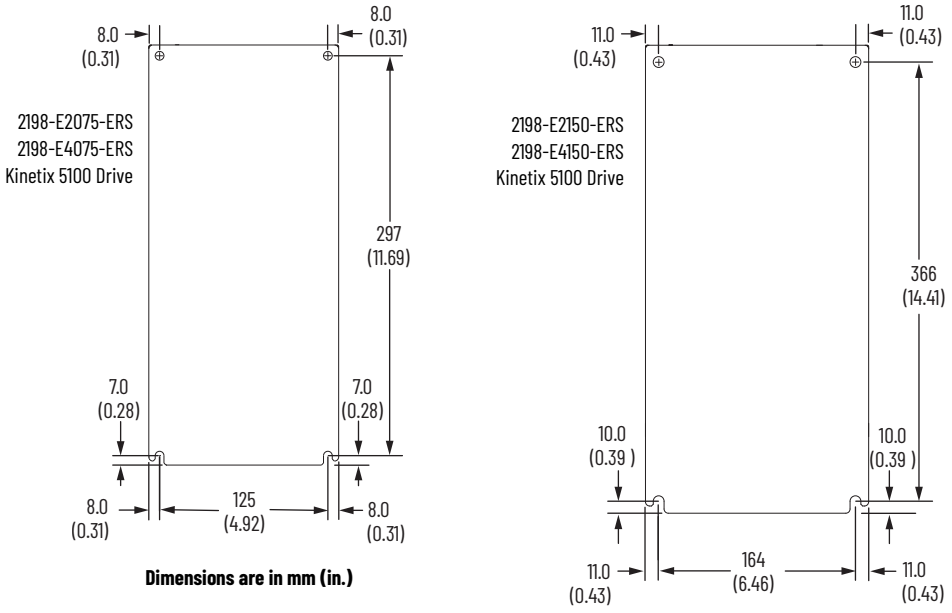
The following views provide mounting-hole dimensions for the Kinetix 5100 servo drives.

Figure 17 - Mounting-hole Dimensions



Dimensions are in mm (in.)

Figure 18 - Mounting-hole Dimensions (continued)



Mount the Drive

Follow these steps to mount your Kinetix 5100 drive.

1. Lay out the position for the Kinetix 5100 drive and accessories in the enclosure.

   See Establish Noise Zones on page 34 for panel layout recommendations.

   IMPORTANT To improve the bond between the Kinetix 5100 drive and subpanel, construct your subpanel out of zinc-plated (paint-free) steel.

2. Drill holes in the panel for mounting your servo drive.

   Refer to Drill-hole Patterns on page 38. For drive dimensions, see the Kinetix Servo Drives Specifications Technical Data, publication KNX-TD003.

3. Loosely attach the servo drive to the panel.

   The recommended mounting hardware is M4 (#8-32) steel machine screws. Observe bonding techniques as described in HF Bond the Drives on page 31.

4. Tighten all mounting fasteners.
5. Apply 2.0 N•m (17.7 lb•in) maximum torque to each fastener.

Notes:

Connector Data and Feature Descriptions

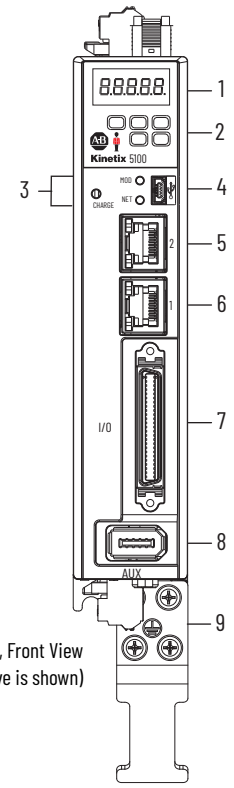
This chapter illustrates connectors and indicators for the Kinetix® 5100 servo drives. Also included in this chapter are control/feedback signal specifications and overviews of the functional safety feature and the Kinetix 5100 drive modes of operation.

Topic	Page
Kinetix 5100 Connector Data	42
Control Signal Specifications	49
Feedback Specifications	62
Safe Torque Off Feature	67
Operation Modes	67

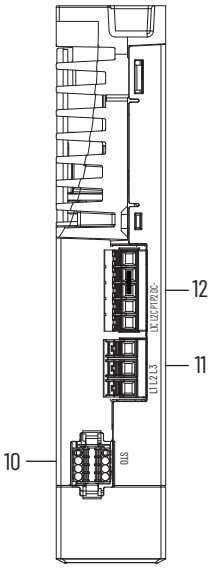
Kinetix 5100 Connector Data

Use these illustrations to identify the connectors and indicators for Kinetix 5100 servo drives.

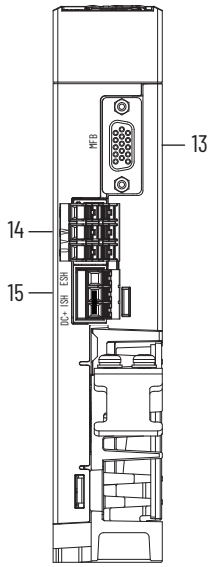
Figure 19 - Features and Indicators (catalog numbers 2198-E1004-ERS, 2198-E1007-ERS, and 2198-E1015-ERS)



Kinetix 5100 Drive, Front View
(2198-E1004-ERS drive is shown)



Kinetix 5100 Drive, Top View
(2198-E1004-ERS drive is shown)



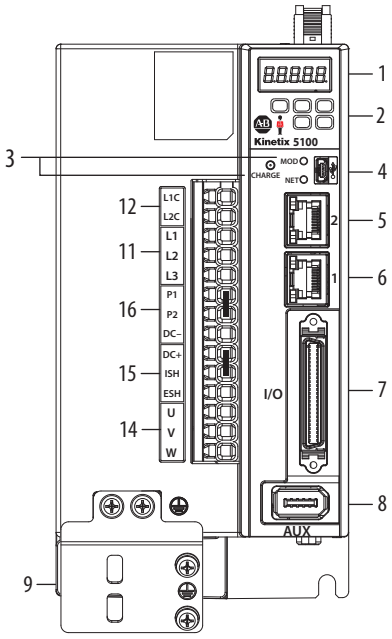
Kinetix 5100 Drive, Bottom View
(2198-E1004-ERS drive is shown)

Table 13 - Features and Indicators Description

Item	Description
1	Status display
2	Navigation push buttons
3	Module, Network, and Charge status indicators
4	Mini USB connector
5	Ethernet (PORT2) RJ45 connector
6	Ethernet (PORT1) RJ45 connector
7	I/O signal connector
8	Auxiliary feedback (AUX) connector

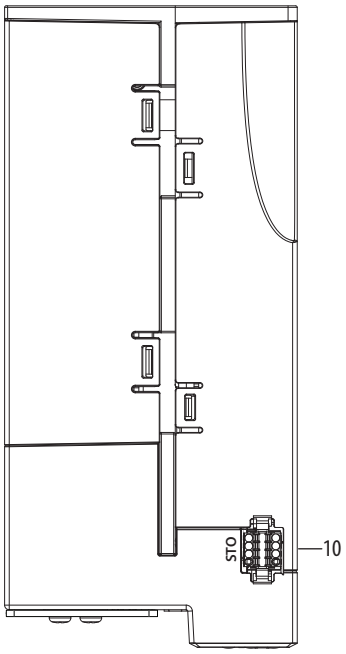
Item	Description
9	Motor cable ground plate
10	Safe torque-off (STO) connector
11	Mains input power connector
12	• Control power input (L1C and L2C) connections • Reserved (P1, P2, and negative DC-bus are not used)
13	Motor feedback (MFB) connector
14	Motor power output terminals
15	Shunt resistor terminals

Figure 20 - Features and Indicators (catalog numbers 2198-E1020-ERS, 2198-E2030-ERS, 2198-E4004-ERS, 2198-E4007-ERS, 2198-E4015-ERS)

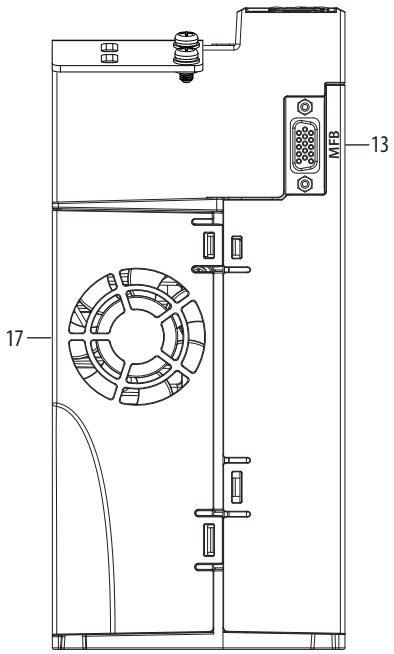


Kinetix 5100 Drive, Front View
(2198-E1020-ERS drive is shown)

For feature descriptions see table on page 44.

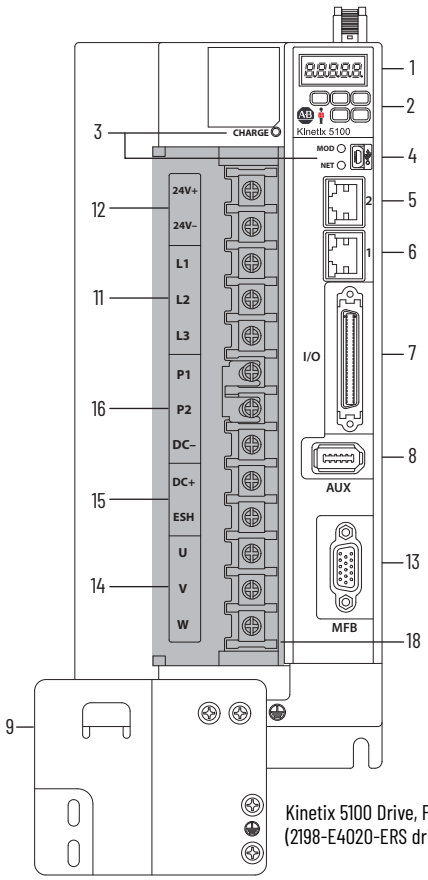


Kinetix 5100 Drive, Top View
(2198-E1020-ERS drive is shown)

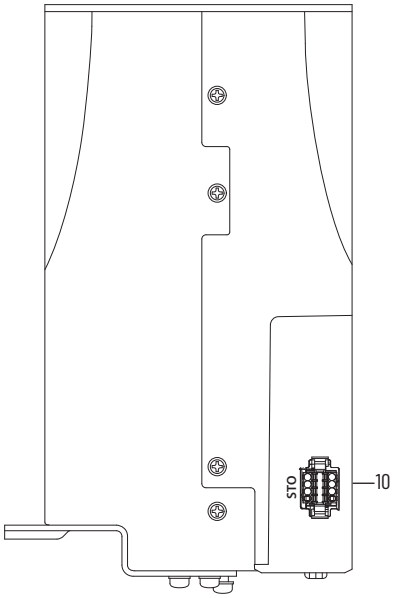


Kinetix 5100 Drive, Bottom View
(2198-E1020-ERS drive is shown)

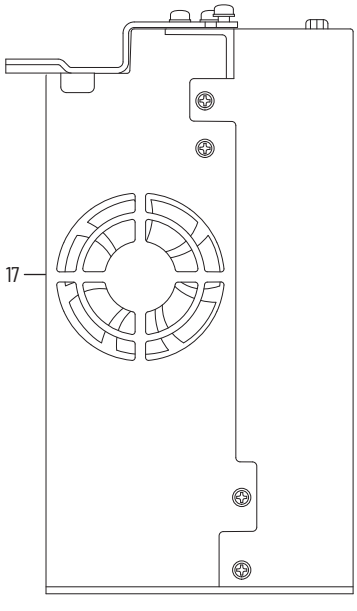
Figure 21 - Features and Indicators (catalog numbers 2198-E4020-ERS, 2198-E4030-ERS)



Kinetix 5100 Drive, Front View
(2198-E4020-ERS drive is shown)



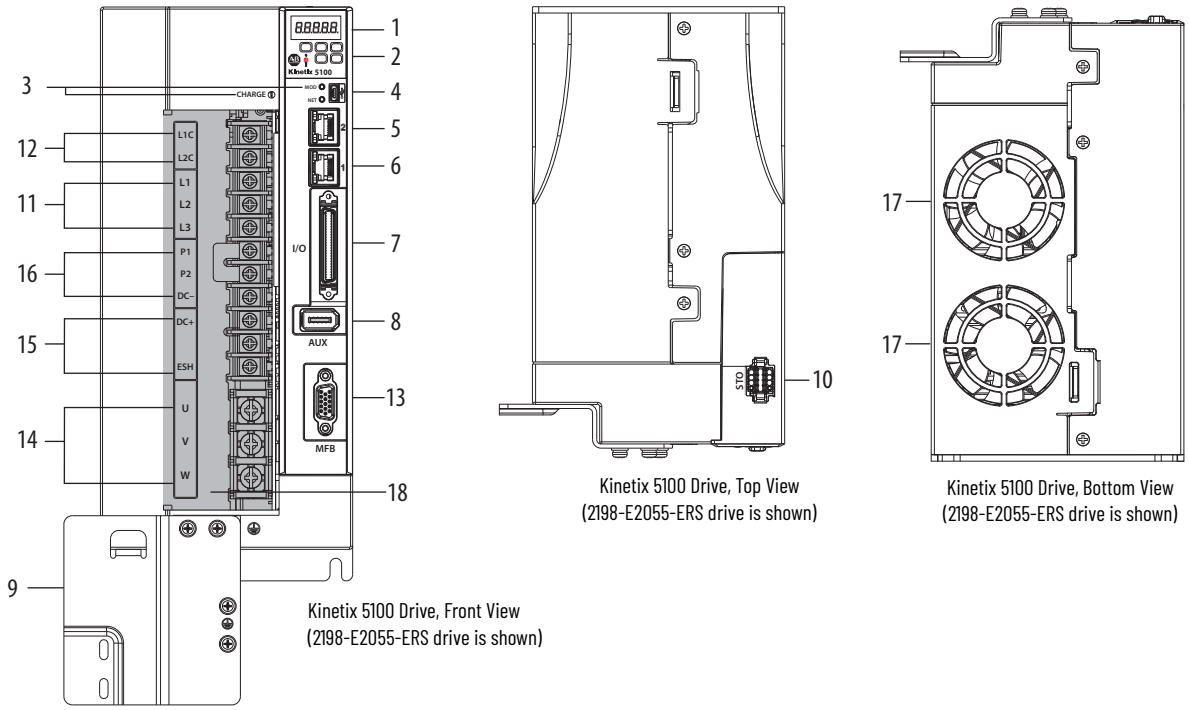
Kinetix 5100 Drive, Top View
(2198-E4020-ERS drive is shown)



Kinetix 5100 Drive, Bottom View
(2198-E4020-ERS drive is shown)

For feature descriptions see table on page 44.

Figure 22 - Features and Indicators (catalog numbers 2198-E2055-ERS, 2198-E2075-ERS, 2198-E2150-ERS, 2198-E4055-ERS, 2198-E4075-ERS, and 2198-E4150-ERS)



Kinetix 5100 Drive, Front View
(2198-E2055-ERS drive is shown)

Kinetix 5100 Drive, Top View
(2198-E2055-ERS drive is shown)

Kinetix 5100 Drive, Bottom View
(2198-E2055-ERS drive is shown)

Table 14 - Features and Indicators Description

Item	Description
1	Status display
2	Navigation push buttons
3	Module, Network, and Charge status indicators
4	Mini USB connector
5	Ethernet (PORT2) RJ45 connector
6	Ethernet (PORT1) RJ45 connector
7	I/O signal connector
8	Auxiliary feedback (AUX) connector
9	Motor cable ground plate

Item	Description
10	Safe torque-off (STO) connector
11	Mains input power terminals
12	Control power input terminals (1)
13	Motor feedback (MFB) connector
14	Motor power output terminals
15	Shunt resistor terminals
16	Reserved (P1, P2, and negative DC-bus are not used)
17	Cooling fans
18	Protective cover

(1) Control power terminals are labeled L1C/L2C for 2198-1*xxx*-ERS and 2198-2*xxx*-ERS (200V-class) drives and 24V+/24V- for 2198-4*xxx*-ERS (400V-class) drives.

Safe Torque-off Connector Pinout

The hardwired safe torque-off (STO) connector pinouts apply to all Kinetix 5100 servo drives. For feature descriptions and wiring information, refer to Chapter 13 beginning on page 383.

Power Connector Pinouts

Catalog numbers 2198-E1004-ERS, 2198-E1007-ERS, and 2198-E1015-ERS have connector plugs on the top and bottom of the drive for power connections.

Table 15 - AC Input Power Connector Pinouts

Signal	Description
L1	AC power in - L1 phase
L2	AC power in - L2 phase
L3	AC power in - L3 phase

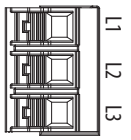


Table 16 - Control AC Input Power Connector Pinout

Signal	Description
L1C	Control AC power in - L1C phase
L2C	Control AC power in - L2C phase
P1	Reserved (not used) (1)
P2	
DC–	Negative DC bus

(1) P1 and P2 jumper is applied (default) at the factory. Do not remove jumper.

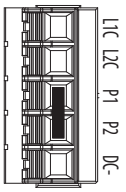


Table 17 - Shunt Resistor Connector Pinout

Signal	Description
DC+	Positive DC bus
ISH	Internal shunt connection (1) (applies to only 2198-E1004-ERS, 2198-E1007-ERS, and 2198-E1015-ERS drives)
ESH	External shunt connection (applies to all drives)

(1) For internal shunt, keep jumper applied between DC+ and ISH (default). Remove jumper and connect external shunt between DC+ and ESH.

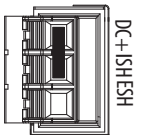
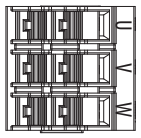


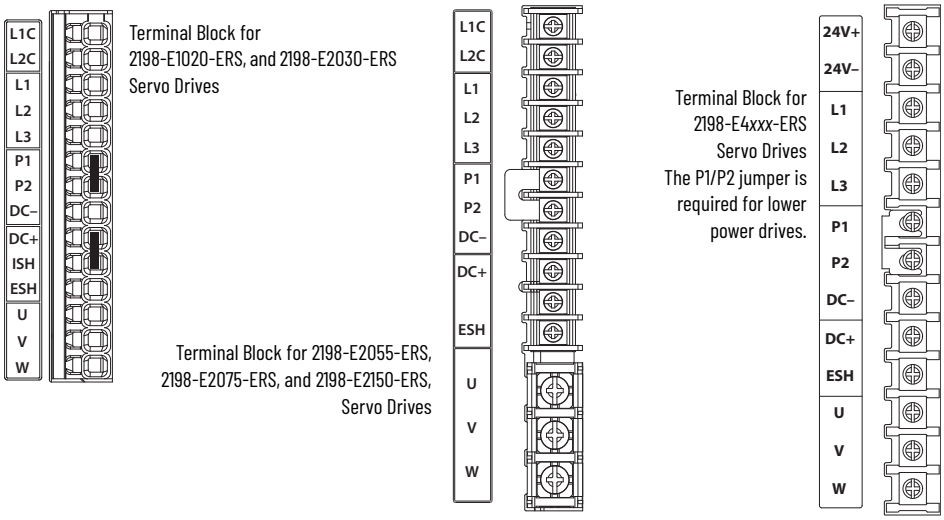
Table 18 - Motor-Power Connector Pinout

Signal	Description
U	Motor power out - U phase
V	Motor power out - V phase
W	Motor power out - W phase



Catalog numbers 2198-E1020-ERS, 2198-E2030-ERS, 2198-E2055-ERS, 2198-E2075-ERS, 2198-E2150-ERS, and 2198-E4*xxx*-ERS have power connections on the terminal block on the front of the drive.

Figure 23 - Power Pinouts on Terminal Block



For connector pinout descriptions, see Table 13 and Table 14 beginning on page 42.

The 2198-E2055-ERS, 2198-E2075-ERS, and 2198-E2150-ERS, 2198-E4020-ERS, 2198-E4030-ERS, 2198-E4055-ERS, 2198-E4075-ERS, and 2198-E4150-ERS drives do not include an internal shunt resistor. However, an external shunt resistor can be connected to the DC+ and ESH terminals.

Table 19 - Shunt Resistor Connector Pinout

Signal	Description
DC+	Positive DC bus
ISH	Internal shunt connection (1) (applies to only 2198-E1020-ERS, 2198-E2030-ERS, 2198-E4004-ERS, 2198-E4007-ERS, and 2198-E4015-ERS drives)
ESH	External shunt connection (applies to all drives)

(1) For internal shunt, keep jumper applied between DC+ and ISH (default). Remove jumper and connect external shunt between DC+ and ESH.

Table 20 - Control Input Power Connector Pinout

Signal	Description
24V+	Control 24V+ DC
24V-	Control 24V- DC common

Table 21 - I/O Connector Pinout

I/O Pin	Signal	Description
1	OUTPUT4+	Digital output 4+
2	OUTPUT3–	Digital output 3–
3	OUTPUT3+	Digital output 3+
4	OUTPUT2–	Digital output 2–
5	OUTPUT2+	Digital output 2+
6	OUTPUT1–	Digital output 1–
7	OUTPUT1+	Digital output1+
8	INPUT4	Digital input 4
9	INPUT1	Digital input 1
10	INPUT2	Digital input 2
11	DCOM	Common for digital inputs, connected to +24 or 0V DC
12	AGND	Analog input signal ground
13	AGND	Analog input signal ground
14	–	Reserved (1)
15	AOUT2	Analog monitor output 2
16	AOUT1	Analog monitor output 1
17	–	Reserved (1)
18	COMMAND1	Analog torque input
19	AGND	Analog input signal ground
20	–	Reserved (1)
21	AMOUT+	Buffered encoder output Ch A+
22	AMOUT–	Buffered encoder output Ch A–
23	BMOUT–	Buffered encoder output Ch B–
24	ZMOUT–	Buffered encoder output Ch Z–
25	BMOUT+	Buffered encoder output Ch B+

I/O Pin	Signal	Description
26	OUTPUT4–	Digital output 4–
27	OUTPUT5–	Digital output 5–
28	OUTPUT5+	Digital output 5+
29	INPUT9	Digital input 9 (high speed)
30	INPUT8	Digital input 8
31	INPUT7	Digital input 7
32	INPUT6	Digital input 6
33	INPUT5	Digital input 5
34	INPUT3	Digital input 3
35	BPWR	External power input of BX+/BX- for single-end operation
36	BX+	Pulse input B+/DIR+/CCW+
37	BX–	Pulse input B–/DIR–/CCW–
38	INPUT10	Digital input 10 (high speed)
39	APWR	External power input of AX+/AX- for single-end operation
40	OUTPUT6–	Digital output 6–
41	AX–	Pulse input A–/Step–/CW–
42	COMMAND2	Analog position or speed command input
43	AX+	Pulse input A+/Step+/CW+
44	AGND	Analog input signal ground
45	–	Reserved (1)
46	OUTPUT6+	Digital output 6+
47	–	Reserved (1)
48	OCZMOUT	Buffered Encoder Output Ch Z open collector
49	–	Reserved (1)
50	ZMOUT+	Buffered encoder output Ch Z+
⏚	⏚	Drain wire

(1) The reserved pins are not present on the 2198-TBIO terminal expansion block.

Figure 24 - Pin Orientation for 50-pin SCSI I/O Connector

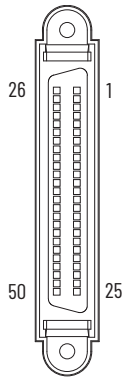


Table 22 - Motor Feedback (MFB) Connector Pinout

MFB Pin	Signal	Description
1	SIN+ AM+	Sine differential input+ AM+ differential input+
2	SIN– AM–	Sine differential input– AM– differential input–
3	COS+ BM+	Cosine differential input+ BM+ differential input+
4	COS– BM–	Cosine differential input– BM– differential input–
5	DATA+ IM+	Data differential input + Index pulse+
6	ECOM	Common
7	EPWR_9V (2)	Encoder power (+9V)
8	S3	Single-ended 5V Hall effect commutation

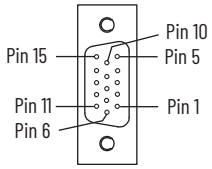
MFB Pin	Signal	Description
9	–	Reserved
10	DATA– IM–	Data differential input – Index pulse–
11	TS	Motor thermal switch (normally closed) (1)
12	S1	Single-ended 5V Hall effect commutation
13	S2	Single-ended 5V Hall effect commutation
14	EPWR_5V (2)	Encoder power (+5V)
15	–	Reserved

(1) Not applicable unless motor has integrated thermal protection.
(2) Determine which power supply your encoder requires and connect to only the specified supply. Do not make connections to both.

ATTENTION: The motor feedback will determine which encoder power source is used. Be sure you use the correct power source for your encoder to avoid equipment damage.

IMPORTANT For the maximum length of the drive to motor power and feedback cable, see Maximum Cable Length on page 84. System performance was tested at these specifications and also applies when meeting CE requirements.

Figure 25 - Pin Orientation for 15-pin Motor Feedback (MFB) Connector

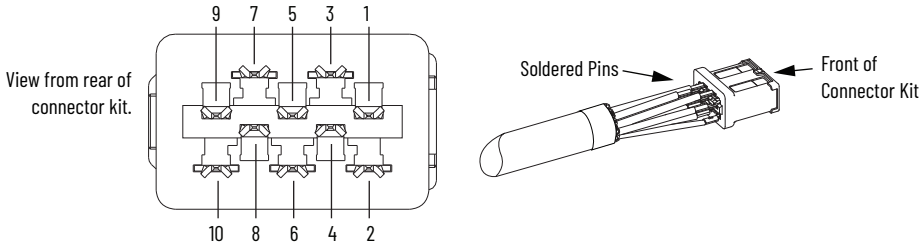


Auxiliary Feedback Connector Pinout

Pin	Signal	Description
1	AM+	Channel A Differential Input +
2	AM–	Channel A Differential Input -
3	BM+	Channel B Differential Input +
4	BM–	Channel B Differential Input -
5	IM+	Channel Index Differential Input +

Pin	Signal	Description
6	IM–	Channel Index Differential Input -
7	ECOM	Encoder Common
8	EPWR5V	Encoder 5V Power Output
9	Reserved	Reserved
10	Reserved	Reserved

Figure 26 - Pin Orientation for Auxiliary Feedback (AUX) Connector

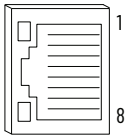


Ethernet Communication Connector Pinout

Port 1 Pin	Signal	Description
1	+ TX	Transmit Port (+) Data Terminal
2	- TX	Transmit Port (-) Data Terminal
3	+ RX	Receive Port (+) Data Terminal
4	-	-

Port 1 Pin	Signal	Description
5	-	-
6	- RX	Receive Port (-) Data Terminal
7	-	-
8	-	-

Figure 27 - Pin Orientation for 8-pin Ethernet Communication Port



Control Signal Specifications

This section provides a description of the Kinetix 5100 drive digital I/O, analog outputs, Ethernet communication, motor brake circuitry, and control power current specifications.

Digital Inputs

The Kinetix 5100 drives support ten customer-defined digital input (DI) points to provide maximum flexibility. There are two fast inputs to support registration or print marks.

Registration inputs can only be assigned to high-speed inputs as shown in Table 23.

Table 23 - Digital Input Assignments

Digital Input	Function	Function
INPUT1	Digital input 1	User configurable, excluding registration
INPUT2	Digital input 2	
INPUT3	Digital input 3	
INPUT4	Digital input 4	
INPUT5	Digital input 5	
INPUT6	Digital input 6	
INPUT7	Digital input 7	
INPUT8	Digital input 8	
INPUT9	Digital input 9 (high speed)	User configurable, including registration
INPUT10	Digital input 10 (high speed)	

There are various modes of operation available (see Operation Modes on page 67). The default input configuration is disabled for all modes. Assignments can be changed via KNX5100C software > Digital IO/Jog Control in the Function List.

The digital input functions are defined in Description of Digital Input Functions on page 405. If the defined digital input function needs to change to meet your application requirements, you can change the program for the function of INPUT1...INPUT10 by using the corresponding parameters listed in Table 24.

Table 24 - Digital Input Signal Parameters

Signal	Pin	Configuration Parameter
INPUT1	9	ID195 (P2.010)
INPUT2	10	ID196 (P2.011)
INPUT3	34	ID197 (P2.012)
INPUT4	8	ID198 (P2.013)
INPUT5	33	ID199 (P2.014)

Signal	Pin	Configuration Parameter
INPUT6	32	ID200 (P2.015)
INPUT7	31	ID201 (P2.016)
INPUT8	30	ID202 (P2.017)
INPUT9	29	ID220 (P2.036)
INPUT10	38	ID221 (P2.037)

Wiring and Signal Specifications

The digital inputs are optically isolated and sink up to 24V DC. Electrical details are shown in Table 25. You can configure the inputs for PNP sourcing or NPN sinking.

Figure 28 - Digital Input Circuitry

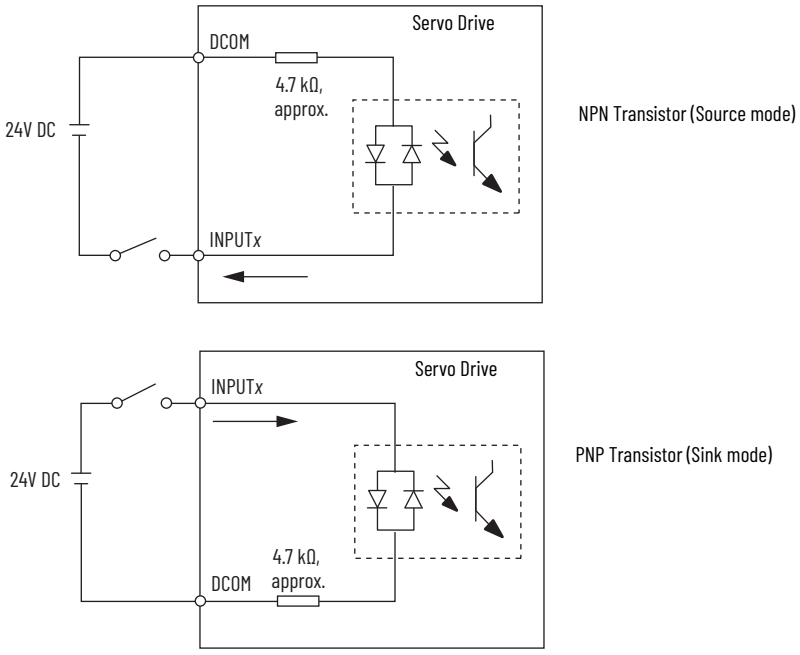


Table 25 - Digital Input Specifications

Attribute	Value
Digital input response (delay)	• Standard inputs: 1.25 ms, max • High speed inputs: 3 µs
Digital inputs scan time	• Standard inputs: 500 µs, max • High speed inputs: 1 µs
Type	Current sourcing and current sinking (IEC61131-2 Type 1)
Dedicated functions	• Standard inputs: INPUT1...INPUT8 and DCOM. • High speed inputs (registration inputs): INPUT9, INPUT10, and DCOM. • When configured as Disabled, inputs can be used by programs as a programming condition. Only one function at a time is possible.
Input current (with 26.4V applied)	6 mA, max
ON state voltage	15...26.4V
OFF state voltage	–1.0...5.0V
Pulse reject filtering (all digital inputs)	0.5 µs
Propagation delay (registration functions)	3 µs
Registration accuracy	3 µs
Registration repeatability	1 µs

Digital Outputs

The Kinetix 5100 drives support six customer-defined digital output (DO) points to provide maximum flexibility. OUTPUT1...OUTPUT6 are available on the 2198-TBIO connector. Outputs are optically isolated open-collector/emitter and are fully isolated from the drive circuits. Each output, OUTPUT1...OUTPUT6, is disabled for all modes by default.

The digital output functions are defined in Description of Digital Output Functions on page 409.

If the defined digital output function needs to change to meet your application requirements, you can program the function of OUTPUT1...OUTPUT6 by using the corresponding parameters listed in Table 26.

Table 26 - Digital Output Signal Parameters

Signal	Pin	Configuration Parameter
OUTPUT1+	7	ID203 (P2.018)
OUTPUT1-	6	
OUTPUT2+	5	ID204 (P2.019)
OUTPUT2-	4	
OUTPUT3+	3	ID205 (P2.020)
OUTPUT3-	2	

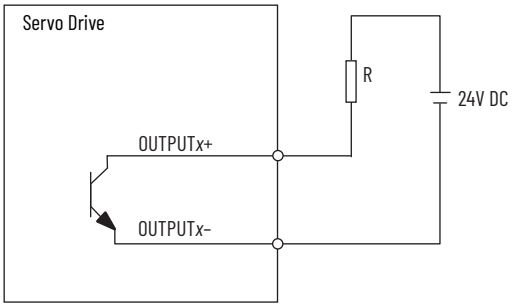
Signal	Pin	Configuration Parameter
OUTPUT4+	1	ID206 (P2.021)
OUTPUT4-	26	
OUTPUT5+	28	ID207 (P2.022)
OUTPUT5-	27	
OUTPUT6+	46	ID225 (P2.041)
OUTPUT6-	40	

Wiring and Signal Specifications

The digital outputs are optically isolated and sink up to 24V DC. Electrical details are shown in Table 27.

Figure 29 - Digital Output Circuitry

In this example, the drive applies the external 24V DC power supply to a resistive load.



In this example, the drive applies the external 24V DC power supply to an inductive load.

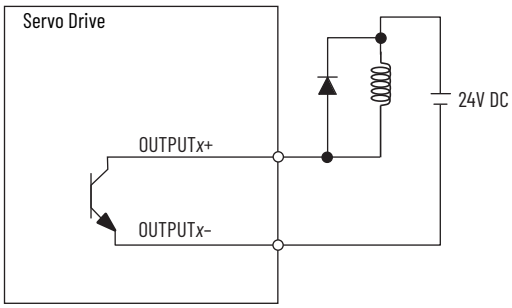


Table 27 - Digital Output Signal Specifications

Parameter	Description	Min	Max
ON state current	Current flow when the output transistor is ON	–	40 mA
OFF state current	Current flow when the output transistor is OFF	–	0.1 mA
ON state voltage	Voltage across the output transistor when ON	–	1.5V @ 40 mA
OFF state voltage	Voltage across the output transistor when OFF	–	30V
Scan time	Interval of the digital outputs status updating in drive firmware	–	250 µs
Pass through delay	Signal propagation delay from the firmware-accessible registers to the digital output	–	1.0 ms

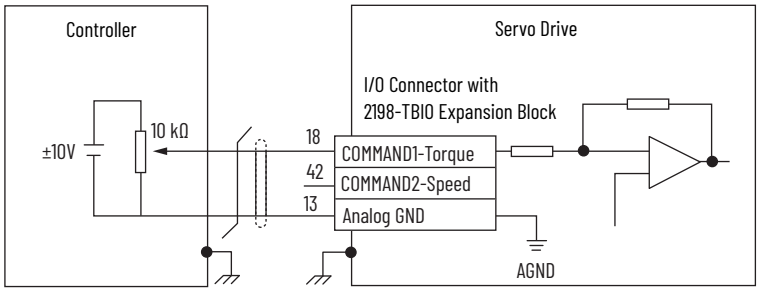
Analog Inputs

There are two analog inputs, COMMAND1 and COMMAND2, available on the I/O connector. When the drive mode is configured for Speed or Torque, the analog inputs are used for Torque and Speed commands.

Table 28 - Analog Input Specifications

Parameter	Description
Analog inputs voltage	–10 V... +10 Vs
Analog inputs resolution	11 bits, min
Analog inputs scan time	0.0625 ms, max
Analog inputs impedance	12 kΩ typical, approx.

Figure 30 - Analog COMMAND Input Configuration



Pulse Inputs

There are pulse inputs available on the 2198-TBIO connector. They support either single-ended or differential pulse signals. When using the single-ended signals, they can be wired as current sinking (PNP) or sourcing (NPN) inputs.

Figure 31 - Pulse Input - Single-ended Configuration (current sourcing)

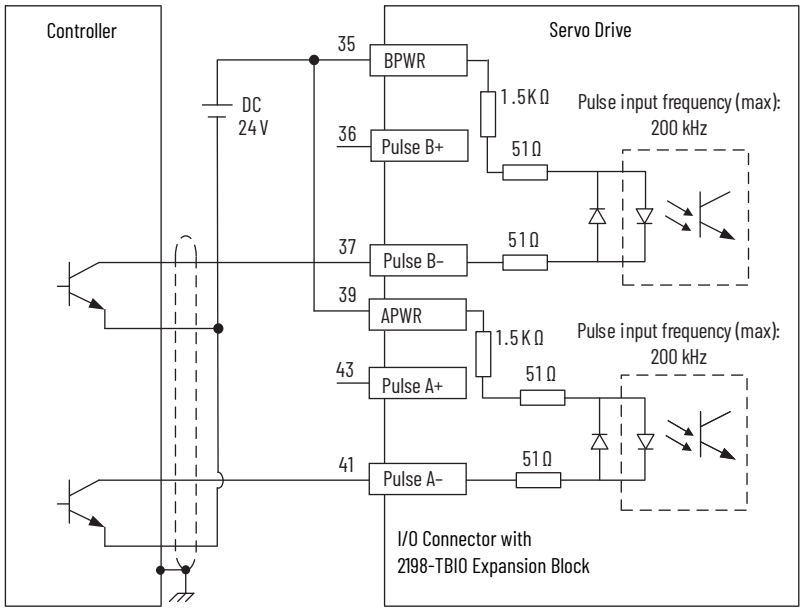
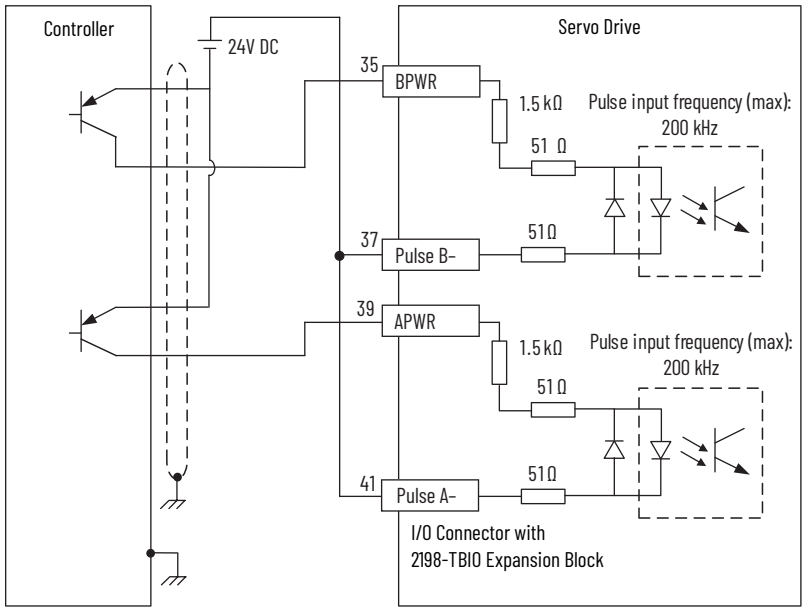
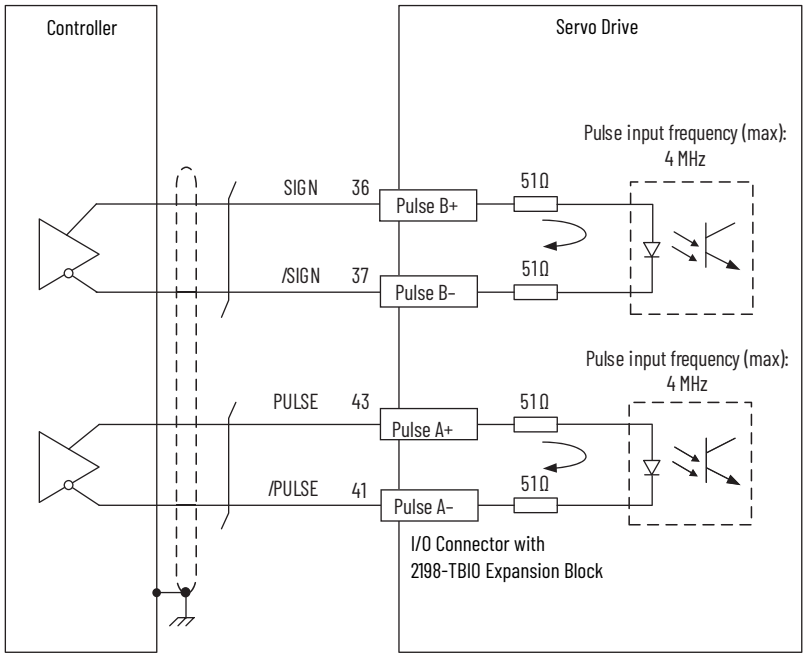


Figure 32 - Pulse Input - Single-ended Configuration (current sinking)



In Differential mode, the pulse input (line driver) only accepts 2.8...3.6V DC (5V DC nominal). Do not apply 24V power.

Figure 33 - Pulse Input (line driver) Configuration



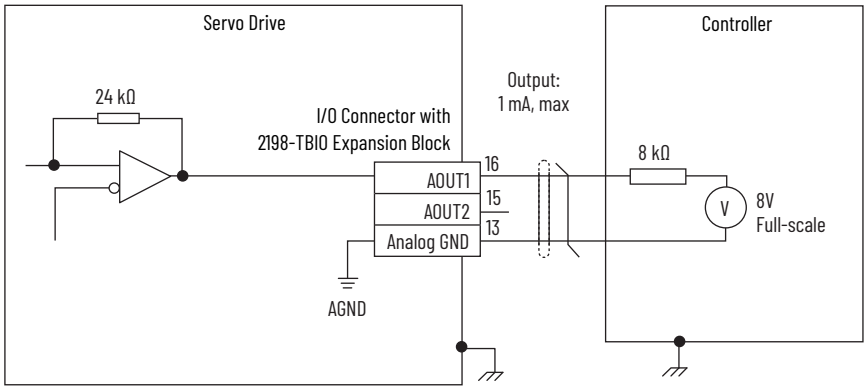
Analog Outputs

There are two analog outputs, AOUT1 and AOUT2, available on the I/O connector. Assignments are changed via KNX5100C software > Function List > Analog IO > Output Monitor.

Table 29 - Analog Output Specifications

Parameter	Description
Analog outputs voltage	–8V... +8V DC or -10V...+10VDC, user configurable
Analog outputs resolution	10 bits, min
Analog outputs current	1 mA, max
Analog outputs scan time	0.25 ms, max

Figure 34 - Analog Output Circuitry



Buffered Encoder Outputs

Encoder output signals can be connected to the receiving device with line receiver (differential) or opto-coupler isolated inputs. The encoder output signals are flexible. The signals are scaled and programmed by using KNX5100C software > Function List > Pulse Output.

Figure 35 - Encoder Output Position (line driver)

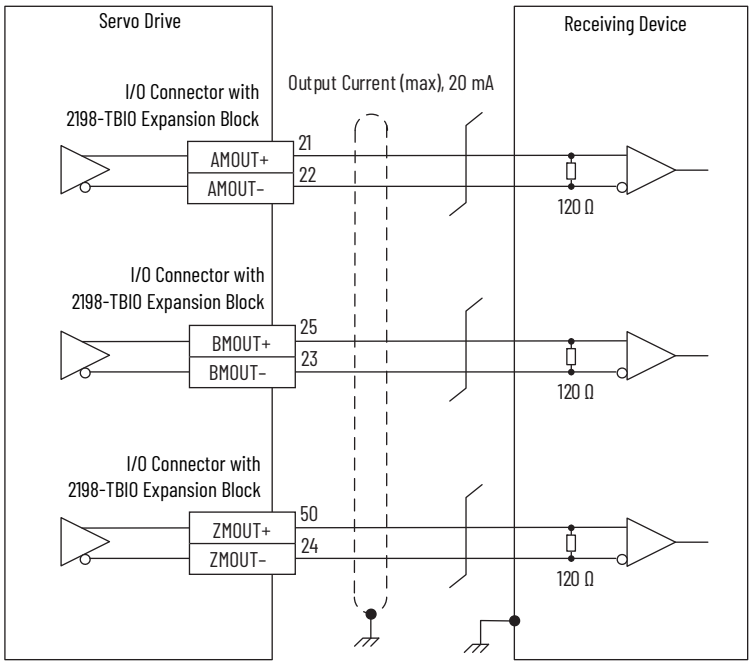


Figure 36 - Encoder Output Position (opto-isolator)

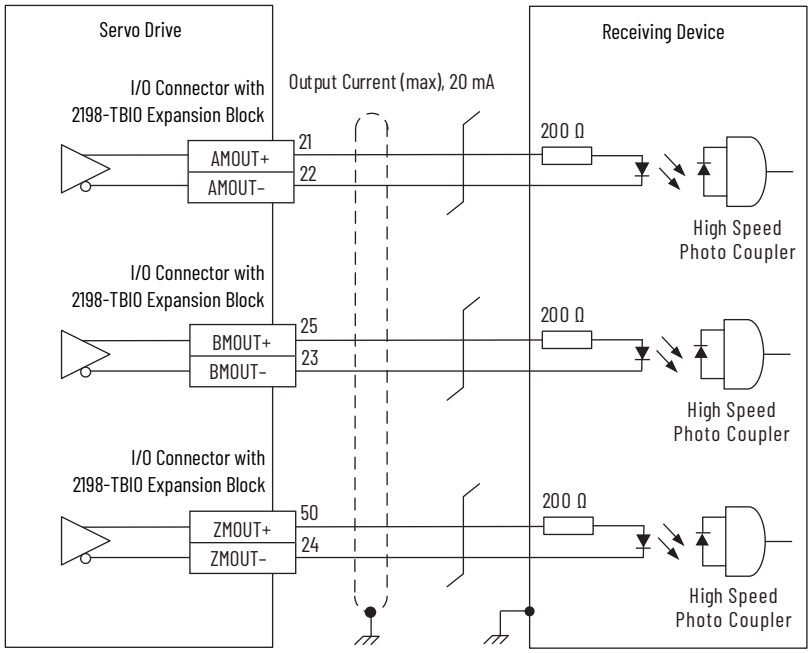
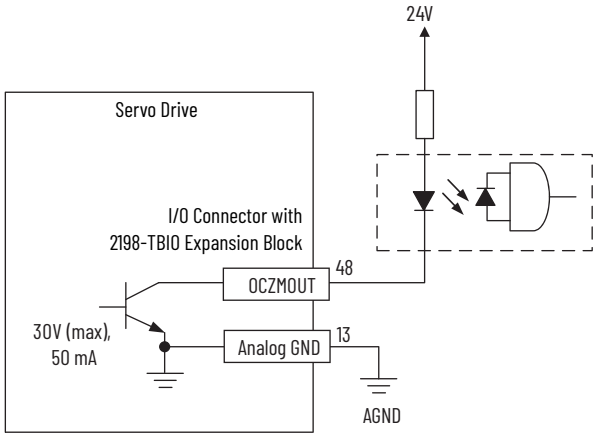


Figure 37 - Encoder OCA Output (open collector Z pulse output)



Ethernet Communication Specifications

The PORT1 and PORT2 (RJ45) Ethernet connectors provide EtherNet/IP communication.

Table 30 - Ethernet Communication Specifications

Attribute	Value
Communication	The drive auto-negotiates Speed and Duplex modes. These modes can be forced through the Logix Designer application. 100BASE-TX, full-duplex is recommended for maximum performance.
Request Packet Interval (RPI)	2.0 ms, min
Auto MDI/MDIX crossover detection/ correction	Yes
Cabling	CAT5e shielded, 100 m (328 ft), max

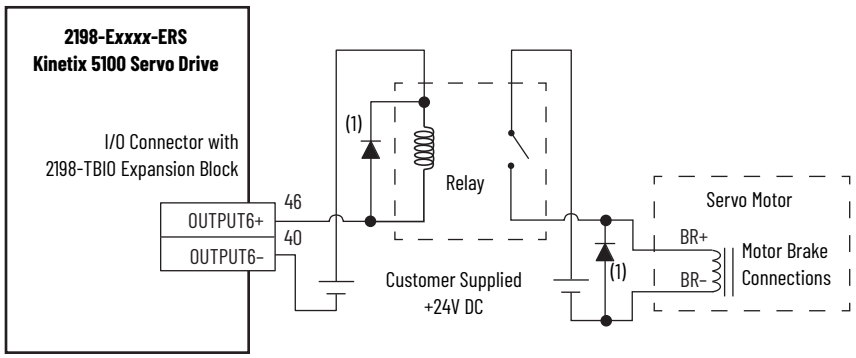
Motor Brake Circuit

The brake option is a motor mounted spring-set holding brake that releases when voltage is applied to the brake coil in the motor. The customer-supplied 24V power supply drives the brake output through a relay.

Wire the Brake Control Circuit

One digital output can be used for motor brake control. In this example, OUTPUT6 is used. Wire the brake control circuit according to the appropriate interconnect diagram in Kinetix 5100 Drive/Rotary Motor Wiring Examples beginning on page 438. An external customer-supplied 24V power supply is required.

Figure 38 - Brake Control Circuit Example



(1) Customer-supplied diode or MOV suppression device.

An example brake circuit contains the following components:

- Digital output 40 mA (max) continuous current.

Choose relay rated for 40 mA continuous current or less.

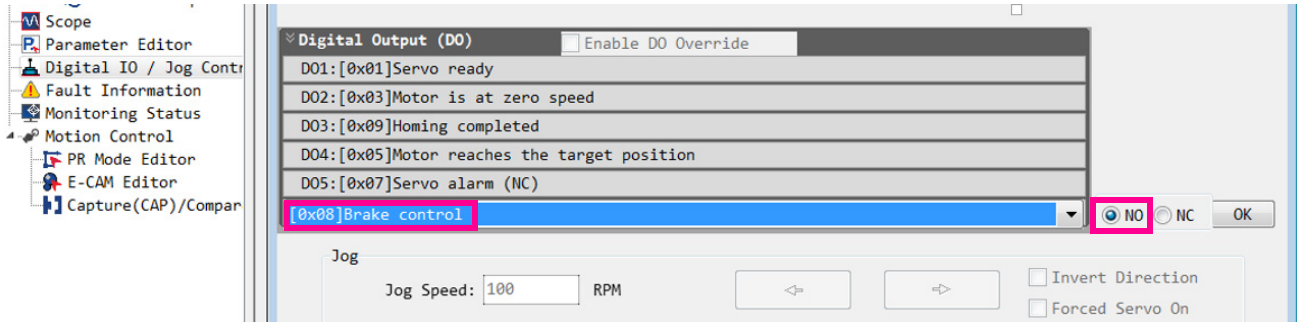
- Relay 700-HK36Z24 with DIN mount 700-HN121 or equivalent
- Suppression device examples include 1N4004 diode, Bulletin 199-MSMV1 MOV, or equivalent

See Kinetix Rotary Motion Specifications Technical Data, publication KNX-TD001, for coil current ratings and brake response times.

Configure the Brake Control Circuit

Follow these steps to configure brake control in KNX5100C software.

1. Click Digital IO/Jog Control in the Functional List.
2. Check Edit DIO configurations.
3. From the Digital Output (DO) pull-down menu, choose Brake Control.



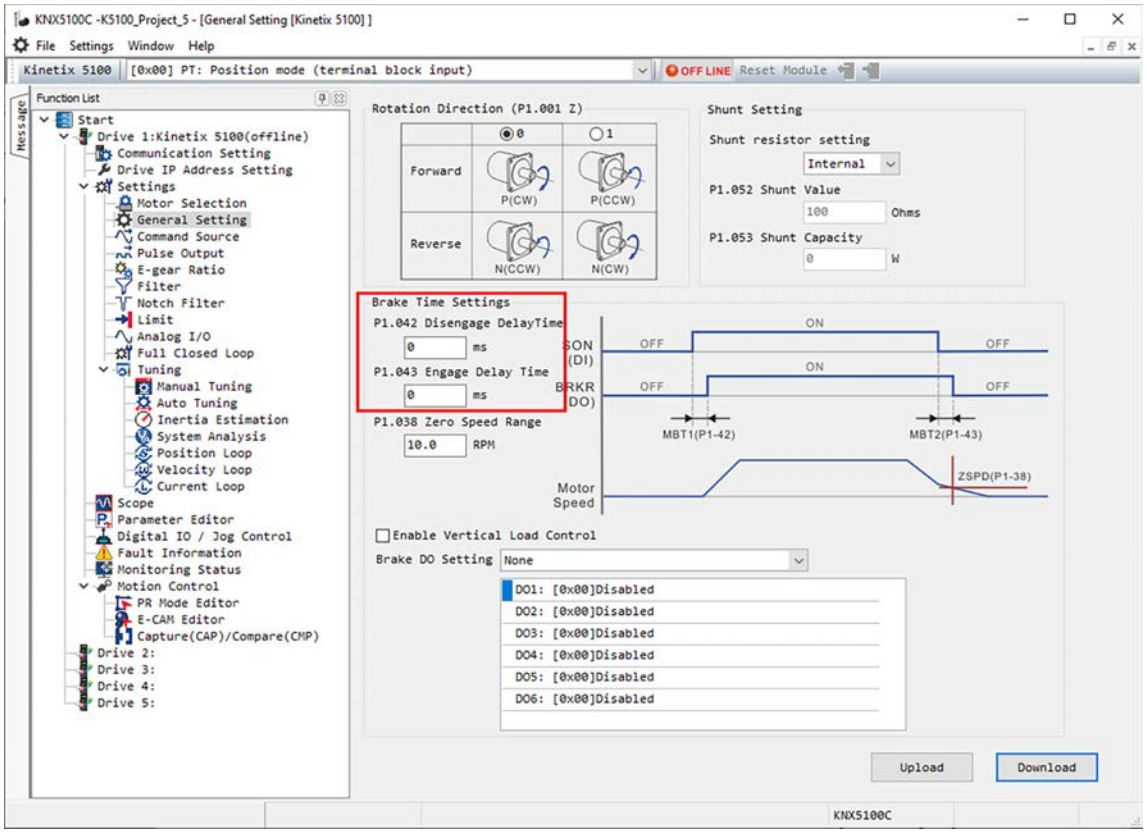
4. Verify that N.O. (normally open) is selected.
5. Uncheck Edit DIO configurations.
6. Click Settings>General Setting and configure the brake response engage and disengage delay times based on the motor selected.

   For motor brake coil-current and response time specifications for all Allen-Bradley® motor families, see Kinetix Rotary Motion Specifications Technical Data, publication KNX-TD001.

   Brake control is configurable in KNX5100C software. An active signal releases the motor brake. Turn-on and turn-off delays are specified by ID149 (P1.042) Disengage Delay Time and ID150 (P1.043) Engage Delay Time parameter settings.

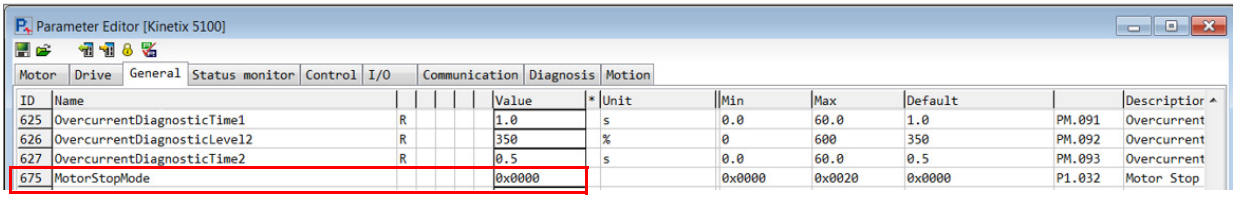
IMPORTANT	Holding brakes that are available on Allen-Bradley rotary motors are designed to hold a motor shaft at 0 rpm for up to the rated brake-holding torque, not to stop the rotation of the motor shaft, or be used as a safety device. You must command the servo drive to 0 rpm and engage the brake only after verifying that the motor shaft is at 0 rpm.

7. In Brake Time Settings, enter ID149 (P1.042) Disengage Delay Time and ID150 (P1.043) Engage Delay Time parameter values.



8. Verify that the MotorStopMode ID675 (P1.032) parameter is set to 0000.

   Refer to Parameter Editor screen General parameter group.



ID	Name		Value	*	Unit	Min	Max	Default		Description
625	OvercurrentDiagnosticTime1	R	1.0		s	0.0	60.0	1.0	PM.091	Overcurrent
626	OvercurrentDiagnosticLevel2	R	350		%	0	600	350	PM.092	Overcurrent
627	OvercurrentDiagnosticTime2	R	0.5		s	0.0	60.0	0.5	PM.093	Overcurrent
675	MotorStopMode		0x0000			0x0000	0x0020	0x0000	P1.032	Motor Stop

For vertical loads, MotorStopMode 0000 controls the motor to below the ID145 (P1.038) motor speed where the brake function executes (see Figure 39).

IMPORTANT For MPL-A/B15*xxx* and MPL-A/B2*xxx* motors when MotorStopMode is set at 0000 or 0020 (dynamic brake is enabled), there is a risk that these motors can demagnetize during the stop. For these motors, set MotorStopMode at 0010 (disabled and coast).

Motor Brake Control Operation

Brake control is automatic. Figure 39 shows the timing of the brake control in two different scenarios. Below is a description of the brake control operation shown in Figure 39:

- Brake Disengage (release)

  When the Servo On condition is ON (digital input 'Servo On' activates or Add-On Instruction command raC_Dvc_k5100MSO is issued), ID149 (P1.042) DisengageDelayTime begins timing. When this delay expires, the brake output is set and motion can occur.

- Brake Engage

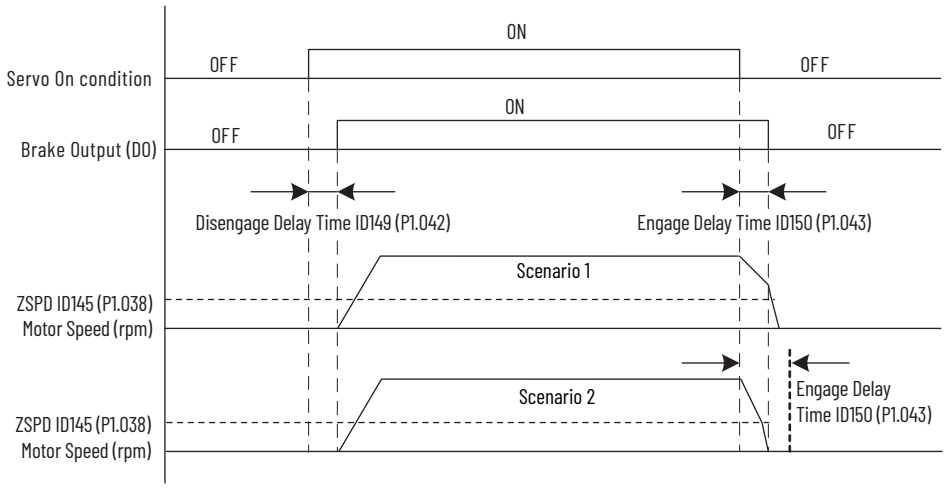
  This operation involves parameters ID145 (P1.038) ZeroSpeedRange rpm and ID150 (P1.043) EngageDelayTime.

  Zero Speed Range is a programmable value. When the motor speed (rpm) is below the Zero Speed Range value, the zero speed condition is met.

  When the Servo On condition is OFF (digital input 'Servo On' is removed, Add-On Instruction command raC_Dvc_k5100MSF is issued, or the drive faults), ID150 (P1.043) Engage Delay Time begins timing. The Zero Speed Range condition is actively evaluated. If the zero speed condition occurs before the Engage Delay Time expires, the brake output is OFF (scenario 2). If the zero speed condition is not met and the Engage Delay Time expires, the brake output is OFF (scenario 1).

IMPORTANT If the Zero Speed Range and Brake Delay parameters are not set correctly, the brake can set while the motor is in motion.

Figure 39 - Brake Control Timing Diagram



For motor brake specifications to size the interposing relay, see Kinetix Rotary Motion Specifications Technical Data, publication KNX-TD001. See the interconnect diagram for your Kinetix 5100 drive/motor beginning on page 438 for typical motor brake wiring.

Control Power

Kinetix 5100 200V-class drives require 95...132V AC (120V nom) single-phase, with 120V AC input power or 170...253V AC (200...230V nom) single-phase, with 200...230V AC input power.

Table 31 - Control Power Specifications - 200V-class Drives

Kinetix 5100 (200V-class) Drives Cat. No.	Input Current of Control Power A rms at 120V rms, nom	Inrush Current of Control Power, max A 0-pk at 120V rms, nom	Input Current of Control Power A rms at 230V rms, nom	Inrush current of Control Power, max A 0-pk at 230V rms, nom
2198-E1004-ERS	0.34	15.80	0.20	37.0
2198-E1007-ERS	0.38	18.20	0.22	37.40
2198-E1015-ERS	0.38	19.20	0.22	39.80
2198-E1020-ERS	0.63	19.20	0.35	32.40
2198-E2030-ERS	–	–	0.35	36.40
2198-E2055-ERS	–	–	0.46	32.80
2198-E2075-ERS	–	–	0.48	40.0
2198-E2150-ERS	–	–	0.92	37.0

Kinetix 5100 400V-class drives require 21.6...26.4V DC (24v, nom) input power.

Table 32 - Control Power Specifications - 400V-class Drives

Cat. No.	Maximum Input Current of Control Power A rms at 24V DC	Inrush current of Control Power A at 24V DC
2198-E4004-ERS	1.27	4.14
2198-E4007-ERS		
2198-E4015-ERS		
2198-E4020-ERS	1.40	4.97
2198-E4030-ERS	1.77	4.97
2198-E4055-ERS	2.03	3.24
2198-E4075-ERS		
2198-E4150-ERS	4.43	3.40

Feedback Specifications

The Kinetix 5100 drive uses the MFB connector for various types of motor feedback. The AUX connector uses TTL incremental feedback only.

Use the 2198-K51CK-D15M feedback connector kit for terminating feedback conductors when building your own cables.

Table 33 - Feedback General Specifications

Attribute	Motor Feedback	Auxiliary Feedback
Feedback device support	• Nikon (24-bit) serial (Kinetix TLP motors) • Hiperface • Tamagawa (17-bit) serial (Kinetix TL/TLY motors) • Digital AqB with or without UVW, incremental	Digital AqB incremental
Power supply (EPWR5V)	5.09...5.41V, 300 mA, max	
Power supply (EPWR9V)	8.3...9.9V, 150 mA, max	
Motor thermostat	Single-ended input: • Under 500 Ω = No Fault • Over 10 kΩ = Fault	

Motor Feedback Supported by Using the MFB Connector

The Kinetix 5100 drive accepts motor feedback signals from Hiperface, Nikon, Tamagawa, and TTL incremental encoders on the MFB connector.

Table 34 - Feedback Signals by Device Type

Pin	Hiperface (all compatible motors)	Nikon (Kinetix TLP)	Tamagawa (Kinetix TL/TLY-B)	Digital AqB with UVW (all compatible motors)
1	MTR_SIN+	–	–	MTR_AM+
2	MTR_SIN–	–	–	MTR_AM–
3	MTR_COS+	–	–	MTR_BM+
4	MTR_COS–	–	–	MTR_BM–
5	MTR_DATA+	MTR_T+	MTR_DATA+ (TLY-B) MTR_SD+ (TL-B)	MTR_IM+
6	MTR_ECOM	MTR_ECOM	MTR_ECOM	MTR_ECOM
7	MTR_EPWR9V (1)	–	–	–
8	–	–	–	MTR_S3
9	–	–	–	–
10	MTR_DATA–	MTR_T–	MTR_DATA– (TLY-B) MTR_SD– (TL-B)	MTR_IM–
11	MTR_TS	–	–	–
12	–	–	–	MTR_S1
13	–	–	–	MTR_S2
14	MTR_EPWR5V (1)	MTR_EPWR5V	MTR_EPWR5V	MTR_EPWR5V
15	–	–	–	–

(1) Determine which power supply your encoder requires and connect to that supply only. Do not make connections to both supplies.



ATTENTION: The motor feedback will determine which encoder power source is used. Be sure you use the correct power source for your encoder to avoid equipment damage.

The selected motor determines if the motor thermostat connections (MTR_TS) are used.

Table 35 - Hiperface Encoder Specifications

Attribute	Value
Protocol	Hiperface
Memory support	Encoders programmed with Allen-Bradley motor data
Hiperface data communication	RS-485, 9600 communication, 8 data bits, no parity
Sine/Cosine interpolation	2048 counts/sine period
Input frequency (AM/BM)	250 kHz, max
Input voltage (AM/BM)	0.6...1.2V, p-p, which is measured at the drive inputs
Line loss detection (AM/BM)	Average ($\sin^2 + \cos^2$) > constant

Table 36 - Nikon Encoder Specifications

Attribute	Value
Communication protocol	Proprietary format
Encoder nonvolatile memory usage	Programmed with Kinetix TLP motor data as Allen-Bradley memory format
Differential input voltage	1.0...7.0V
Data communication	8 Mbps, 21 data bits with ECC, no parity
Battery type	3.6V, ER14252 or equivalent, 1/2AA size

Table 37 - Tamagawa Serial Specifications

Attribute	Value
Encoder nonvolatile memory usage	Programmed with TL-A*xxxx*-B and TLY-A*xxxx*-B motor data as Allen-Bradley memory format.
Differential input voltage	1.0…7.0V
Data communication	2.5 Mbps, 8 data bits, no parity
Battery	3.6V, ER14252 or equivalent, 1/2AA size

Table 38 - Generic TTL Encoder Feedback Specifications

Attribute	Value
TTL incremental encoder support	5V, differential A quad B
Quadrature interpolation	4 counts / square wave period
Differential input voltage (MTR_AM, MTR_BM, and MTR_IM)	5V DC, differential line driver (DLD) output compatible
DC current draw (MTR_AM, MTR_BM, and MTR_IM)	30 mA, max
Input signal frequency (MTR_AM, MTR_BM, and MTR_IM)	5.0 MHz, max
Edge separation (MTR_AM and MTR_BM)	42 ns min, between any two edges
Commutation verification	Commutation angle verification performed at the first Hall signal transition and periodically verifies thereafter
Hall inputs (MTR_S1, MTR_S2, and MTR_S3)	Single-ended, TTL, open collector, or none

Auxiliary Feedback Specifications

The Kinetix 5100 drives support TTL incremental feedback devices on the 10-pin auxiliary feedback connector (AUX). See Table 38 on page 64 for Digital AqB encoder feedback specifications.

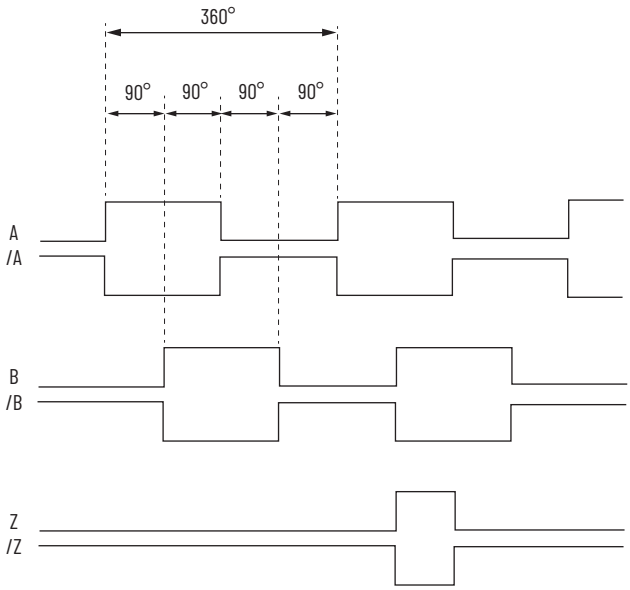
Table 39 - Auxiliary Feedback Signals by Device Type

Pin	Digital AqB Incremental
1	AUX_AM+
2	AUX_AM-
3	AUX_BM+
4	AUX_BM-
5	AUX_IM+
6	AUX_IM-
7	AUX_ECOM
8	AUX_EPWR5V
9	Reserved
10	Reserved

Encoder Phasing Definitions

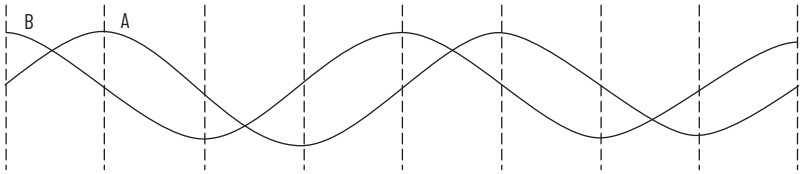
For TTL encoders, the drive position increases when A leads B. Clockwise motor rotation is assumed, when looking at the motor shaft.

Figure 40 - TTL Encoder Phasing



For Sin/Cos encoders, Hiperface for example, the drive position increases when Cosine (B) leads Sine (A). Clockwise motor rotation is assumed, when looking at the motor shaft.

Figure 41 - Sine/Cosine Encoder Phasing

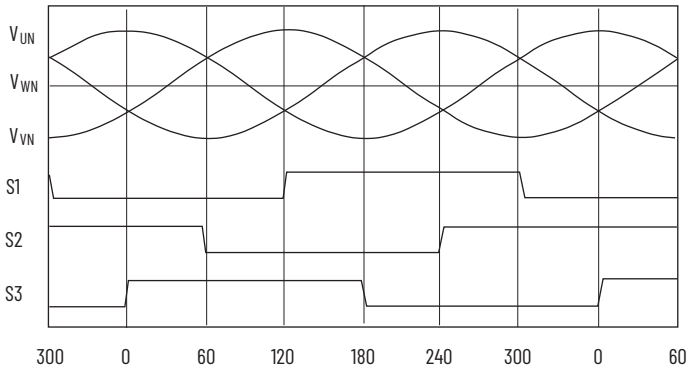


IMPORTANT The Sine/Cosine encoder signal phasing is different than the TTL encoder signal phasing.

IMPORTANT When using absolute feedback devices (for example, Hiperface) the drive simulates a marker signal because these devices don't have a marker signal required for the home-to-marker sequence to complete.

The drive MFB connector uses Hall signals to initialize the commutation angle for permanent magnet motor commutation.

Figure 42 - Hall Encoder Phasing



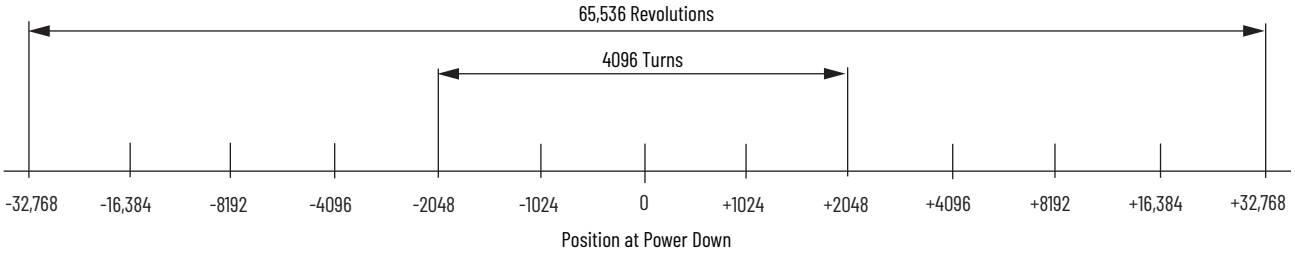
Absolute Position Feature

The absolute position feature tracks the position of the motor, within the multi-turn retention limits, while the drive is powered off. The absolute position feature is available with only multi-turn encoders.

Table 40 - Absolute Position Retention Limits

Encoder Type	Cat. No. Designator	Motor Cat. No.	Retention Limits
			Turns (rotary)
Hiperface	-M	MPL-A/B*xxxxx*-M MPM-A/B*xxxxx*-M MPF-A/B*xxxxx*-M MPS-A/B*xxxxx*-M	4096 (±2048)
	-V	MPL-A*xxxxx*-V	
Nikon (24-bit) serial with battery backup	-D	TLP-A/B*xxxx*-D	65,536 (±32,768)
Tamagawa (17-bit) serial with battery backup	-B	TL-A*xxxx*-B TLY-A*xxxx*-B	

Figure 43 - Absolute Position Limits (measured in turns or revolutions)



Safe Torque Off Feature

Kinetix 5100 servo drives have Safe Torque Off (STO) capability and can safely remove inverter power when the STO signals are removed, resulting in Stop Category 0 behavior.

2198-E*xxxx*-ERS (hardwired) servo drives support parallel input connections for cascading additional drives. For applications that do not require the STO safety capability, you must install jumper wires to bypass the safe torque-off feature.

Refer to Safe Torque Off Feature on page 384 for the STO connector pinout, installation, and wiring information.

Operation Modes

The Kinetix 5100 servo drive supports three basic modes of operation: Position, Speed, and Torque. You can switch between these modes by using Dual or Multi mode selections. The Kinetix 5100 servo drive uses EtherNet/IP communication with IO Mode (Class 1 Messaging).

Table 41 - Single Mode

Mode	Mode Abbreviation	Code	Description
Position mode (terminal block input)	PT	00	This mode is sometimes referred to as Pulse Train Output or Step & Direction. The servo drive receives the Position command and commands the motor to run to the target position. The Position command is communicated through the terminal block and the signal type is pulse.
Position mode (register input)	PR	01	The servo drive receives the Position command and commands the motor to run to the target position. Position commands are issued from the program registers (99 sets in total). You can select the register number with binary-weighted DI signals or through communication.
Speed mode	S	02	The servo drive receives the Speed command and commands the motor to run at the target speed. The Speed command is issued from the internal registers (3 sets in total) or by analog voltage (-10V…+10V) that is communicated through the terminal block. You can select the command with binary-weighted DI signals.
Speed mode (no analog input)	Sz	04	The servo drive receives the Speed command and commands the motor to run at the target speed. The Speed command can only be issued from the internal registers (3 sets in total). You can select the command with binary-weighted DI signals.
Torque mode	T	03	The servo drive receives the Torque command and commands the motor to run with the target torque. The Torque commands can be issued from the internal registers (3 sets in total) and by analog voltage (-10V…+10V) that is communicated through the terminal block. You can select the command with binary-weighted DI signals.
Torque mode (no analog input)	Tz	05	The servo drive receives the Torque command and commands the motor to run with the target torque. The Torque command can only be issued from the internal registers (3 sets in total). You can select the command with binary-weighted DI signals.
IO mode	IO	0C	The servo drive receives commands from the Logix controller through the EtherNet/IP network connection. Commands are issued through the Add-On Instruction instructions in the Logix Designer application.

Table 42 - Dual Mode

Mode	Mode Abbreviation	Code	Description
Position mode PT (terminal block input) and Speed mode	PT-S	06	Switches PT and S mode with DI signals.
Position mode PT (terminal block input) and Torque mode	PT-T	07	Switches PT and T mode with DI signals.
Position mode PR (register input) and Speed mode	PR-S	08	Switches PR and S mode with DI signals.
Position mode PR (register input) and Torque mode	PR-T	09	Switches PR and T mode with DI signals.
Speed mode and Torque mode	S-T	0A	Switches S and T mode with DI signals.
–	–	0B	Reserved
Position mode PT (terminal block input) and Position mode PR (register input)	PT-PR	0D	Switches PT and PR mode with DI signals.

Table 43 - Multi Mode

Mode	Mode Abbreviation	Code	Description
Position mode PT (terminal block input), Position mode PR (register input), and Speed mode	PT-PR-S	0E	Switches PT, PR, and S mode with DI signals.
Position mode PT (terminal block input), Position mode PR (register input), and Torque mode	PT-PR-T	0F	Switches PT, PR, and T mode with DI signals.

Connect the Kinetix 5100 Drive System

This chapter provides procedures for wiring your Kinetix® 5100 drive system and making cable connections.

Topic	Page
Basic Wiring Requirements	69
Determine the Input Power Configuration	70
Ground the Drive System	75
Wiring Requirements	76
Wiring Guidelines	78
Wire the Input Power Connectors	79
Wire the I/O Connector	81
Wire the Safe Torque Off Connector	81
Wire the Motor Power Connector	81
Wire the Motor Feedback Connector	89
External Passive-shunt Resistor Connections	95
Ethernet Cable Connections	97

Basic Wiring Requirements

This section contains basic information on how to wire the Kinetix 5100 drive.



ATTENTION: Plan the installation of your system so that you can cut, drill, tap, and weld with the system removed from the enclosure. Because the system is of the open type construction, be careful to keep any metal debris from falling into it. Metal debris or other foreign matter can become lodged in the circuitry, which can result in damage to components.



SHOCK HAZARD: To avoid hazard of electrical shock, mount and wire the Kinetix 5100 drive before you apply power. Once power is applied, connector terminals can have voltage present even when not in use.

IMPORTANT This section contains common PWM servo system wire configurations, size, and practices that can be used in most applications. National Electrical Code, local electrical codes, special operating temperatures, duty cycles, or system configurations take precedence over the values and methods provided.

Build Your Own Cables

IMPORTANT Factory-made cables are designed to minimize EMI and are recommended over hand-built cables to optimize system performance.

- Connect the cable shield to the connector shells on both ends of the cable with a complete 360° connection.
- Use twisted-pair cable whenever possible. Twist differential signals with each other and twist single-ended signals with the appropriate ground return.

When using Kinetix TLP servo motors, see Build Your Own Kinetix TLP Motor Cables Installation Instructions, publication 2090-IN048, to attach motor-side power and feedback connector kits to bulk cable.

When using other Allen-Bradley servo motors and actuators compatible with 2090-C*xx*M7DF motor cables, see 2090-Series Circular-DIN Connector Kits, Flange Kits, and Crimp Tools Installation Instructions, publication 2090-IN042, to attach motor-side power and feedback connector kits to bulk cable.

Also, see Kinetix 5100 Feedback Connector Kit Installation Instructions, publication 2198-IN019, to terminate the flying lead feedback-cable connections.

Route Power and Signal Wiring

Be aware that when you route wiring on a machine or system, radiated noise from nearby relays, transformers, and other electronic drives can be induced into motor or encoder feedback signals, input/output communication, or other sensitive low voltage signals. Radiated noise can cause system and communication faults.

See Electrical Noise Reduction on page 31 for examples of routing high and low voltage wiring. See the System Design for Control of Electrical Noise Reference Manual, publication GMC-RM001, for more information.

Determine the Input Power Configuration

Before wiring input power to your Kinetix 5100 drive, you must know the type of input power within your facility. The drive is designed to operate with only grounded wye input power.

This section contains examples of typical single-phase and three-phase input power that is wired to single-phase and three-phase Kinetix 5100 drives.

The grounded power configuration lets you ground your single-phase or three-phase power to a neutral point. When you use one of the examples, be certain to include the grounded neutral connection.

For Kinetix 5100 drive power specifications, see Kinetix Servo Drives Specifications Technical Data, publication KNX-TD003. For Kinetix 5100 drive input-wiring diagrams, see Power Wiring Examples on page 430.

Three-phase Power Wired to Three-phase Drives

These examples illustrate grounded three-phase systems that are wired to three-phase Kinetix 5100 drives.

ATTENTION: The power system must be center-grounded wye secondary configuration for 230V AC and 480V AC mains.

Figure 44 - Three-phase (200...230V) Grounded Power Configuration (wye secondary)

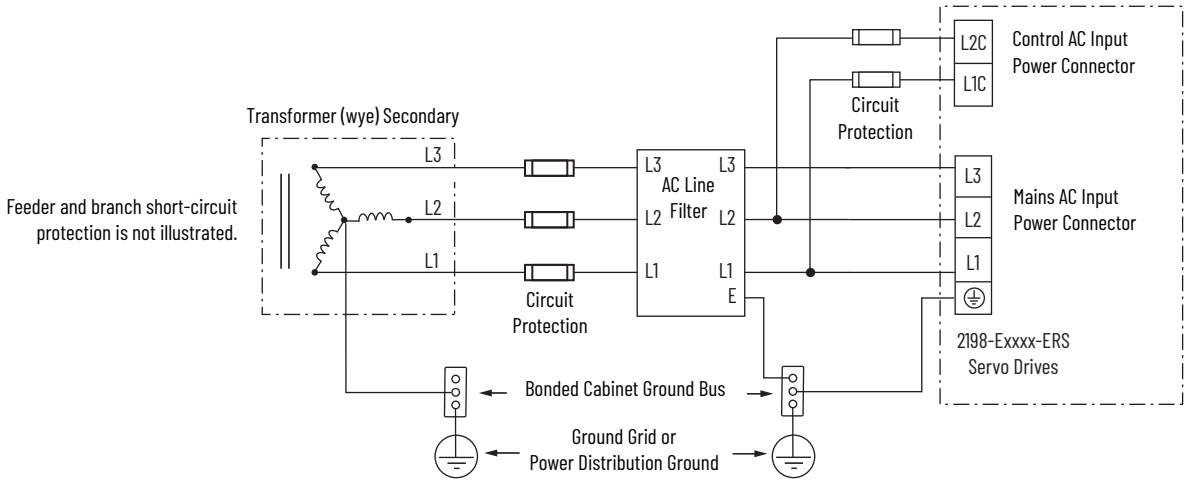
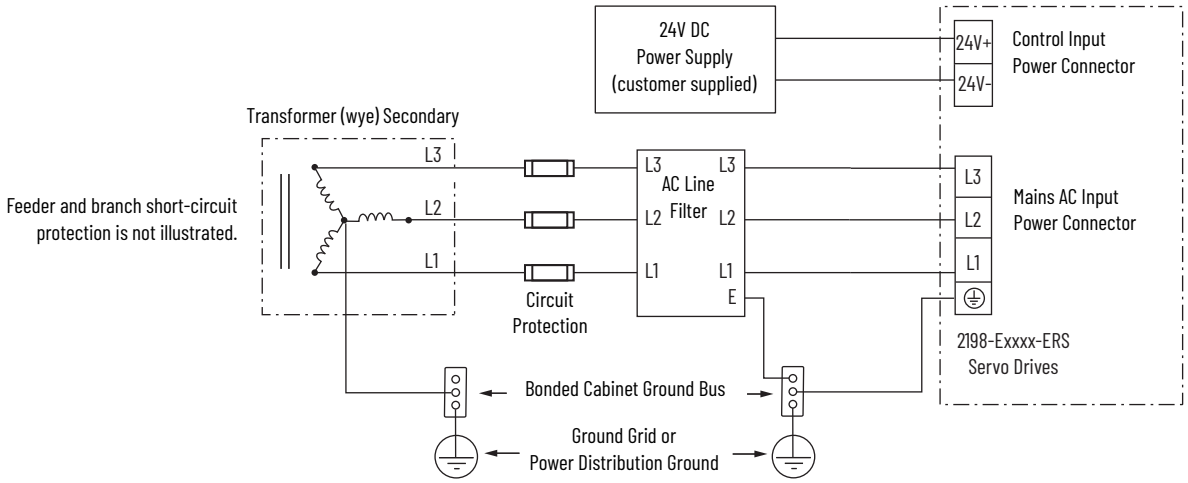


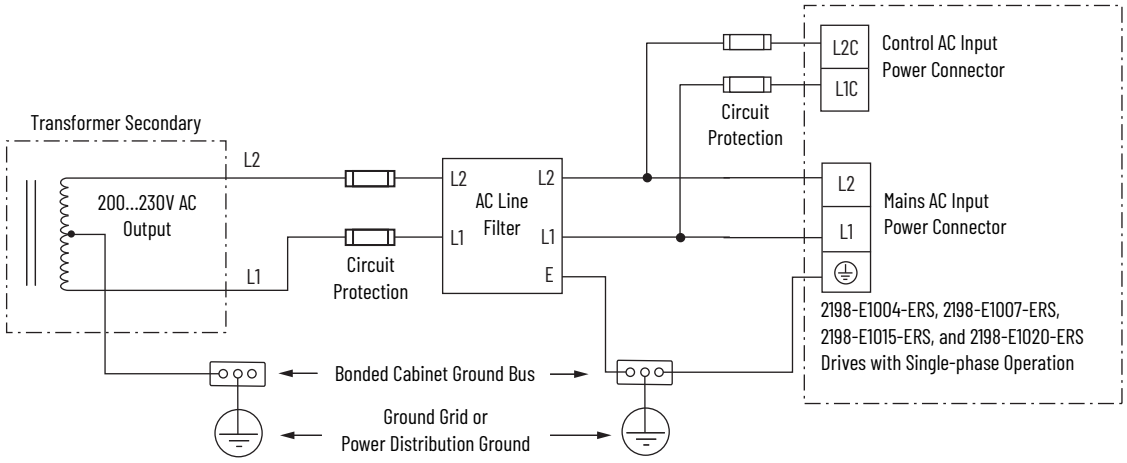
Figure 45 - Three-phase (380...480V) Grounded Power Configuration (wye secondary)



Single-phase Input Power used with Single-phase Drives

These examples illustrate grounded single-phase power that is wired to single-phase Kinetix 5100 drives.

Figure 46 - Single-phase (200...230V) Grounded Power Configuration



Reducing the transformer output reduces motor speed. Feeder and branch short-circuit protection is not illustrated.

Figure 47 - Single-phase (120V) Grounded Power Configuration

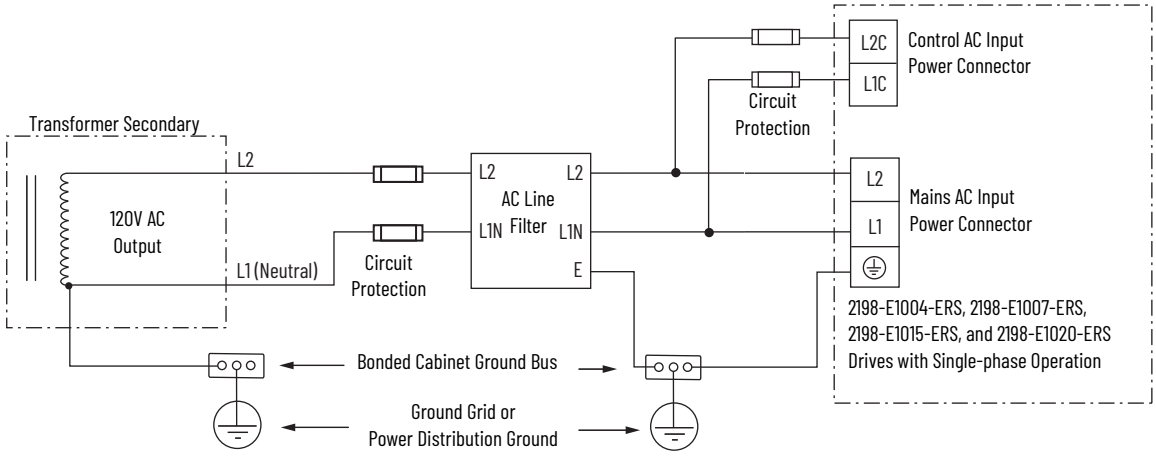
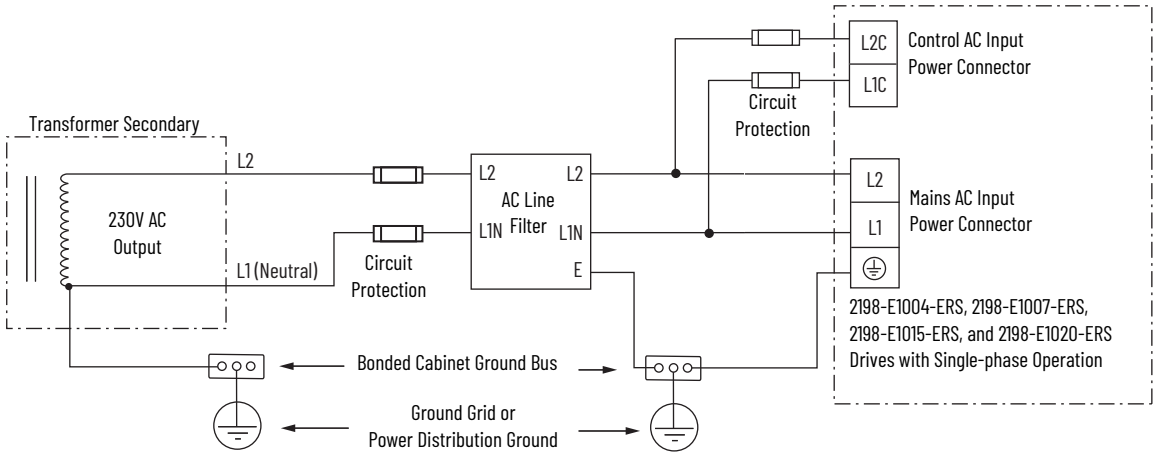


Figure 48 - Single-phase (230V) Grounded Power Configuration



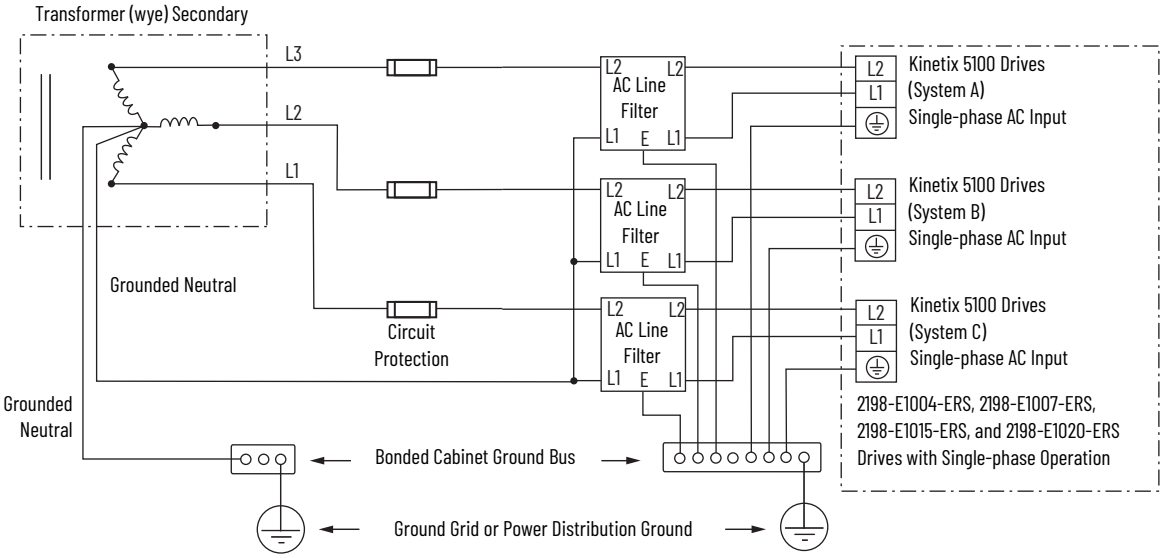
Three-phase Input Power used with Single-phase Drives

This example illustrates grounded three-phase power that is wired to single-phase Kinetix 5100 drives when phase-to-phase voltage exceeds drive specifications.

A neutral must be connected when single-phase drives are attached to a three-phase isolating transformer secondary. It is not necessary that all three-phases be loaded with drives, but each drive must have its power return via the neutral connection.

ATTENTION: Failure to connect the neutral can result in supply voltage swings at the individual drives. Voltage swings occur when the neutral point changes as a result of load variations experienced by the individual drives. The supply voltage swing can cause undervoltage and overvoltage trips on the drives, and the drive can be damaged if the overvoltage limit is exceeded.

Figure 49 - Single-phase Amplifiers (one AC line filter per drive)



Feeder and branch short-circuit protection is not illustrated.

IMPORTANT An AC line filter for each drive is the preferred configuration, and required for CE compliance.

If a three-phase line filter is used to feed multiple single-phase drives (not recommended), it is important that the filter has a neutral connection as shown in Figure 49. This neutral connection applies if three-phase power is wired directly into the filter and no isolation transformer is present.

Voiding of CE Compliance

The three-phase with neutral in-line filter applications that are described in Three-phase Input Power used with Single-phase Drives are not adequate for EMC and aspect for CE compliance. Therefore, EMC validity and CE marking by Rockwell Automation is voided when three-phase and neutral in-line filters are used.



ATTENTION: The three-phase isolation transformers with neutral in-line filter applications described in this document have not been tested for EMC compliance and products that are used in such installations are not considered CE compliant.
If this three-phase isolation transformer and neutral in-line filter application is used, you are responsible for EMC validation and CE marking of the system.

If CE compliance is a customer requirement, single-phase or three-phase line filters, tested by Rockwell Automation, and specified for the product must be used. See Kinetix Servo Drives Specifications Technical Data, publication KNX-TD003 for catalog numbers.

Using Isolation Transformers with Grounded Power Configurations

When using an isolation transformer, attach a chassis ground wire to the neutral connection. This grounded neutral connection does the following:

- Prevents the system voltage from floating and avoids high voltages that can otherwise occur, for example due to static electricity
- Provides a solid earth path for fault conditions

IMPORTANT Transformers (auto transformers are not supported) must have a WYE secondary with grounded neutral. Phase to neutral voltage must not exceed the input voltage rating of the drive.

Ground the Drive System

All equipment and components of a machine or process system must have a common earth ground point connected to chassis. A grounded system provides a ground path for protection against electrical shock. Grounding your drives and panels minimize the shock hazard to personnel and damage to equipment caused by short circuits, transient overvoltages, and accidental connection of energized conductors to the equipment chassis.

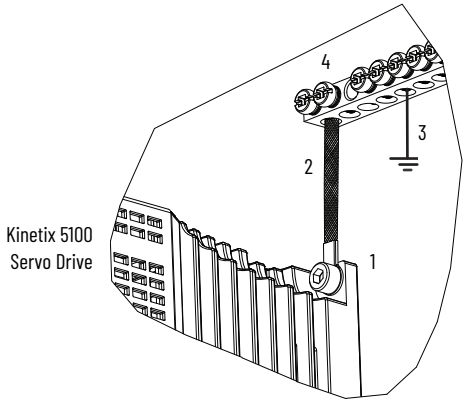
IMPORTANT To improve the bond between the Kinetix 5100 drive and subpanel, construct your subpanel out of zinc-plated (paint-free) steel.

ATTENTION: The National Electrical Code contains grounding requirements, conventions, and definitions. Follow all applicable local codes and regulations to safely ground your system.
For CE grounding requirements, refer to Agency Compliance on page 22.

Ground Your Drive to the System Subpanel

Ground Kinetix 5100 drives to a bonded cabinet ground bus with a braided ground strap with at least 10 mm^2 (0.0155 in^2) cross-sectional area. Keep the braided ground strap as short as possible for optimum bonding.

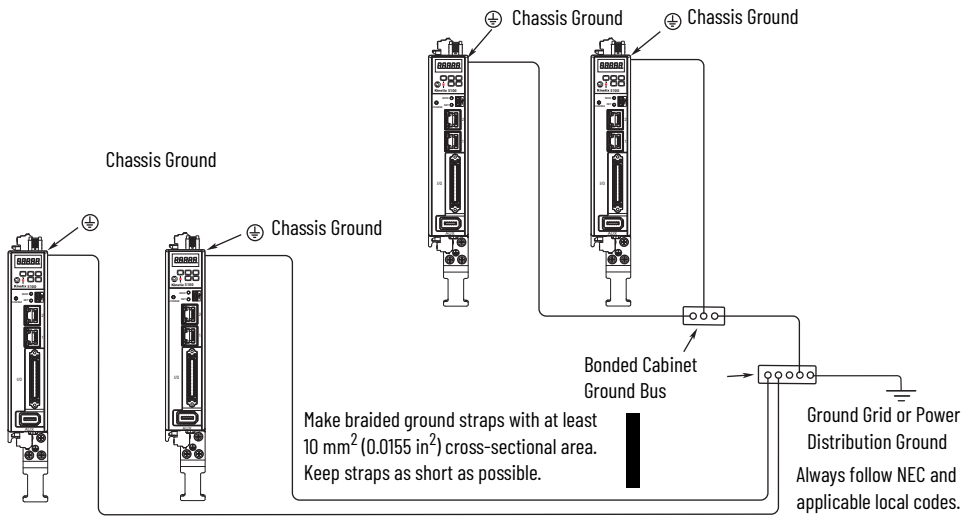
Figure 50 - Connect the Braided Ground Strap Example



Item	Description
1	Ground lug attached to mounting fastener, 2.0 N•m (17.7 lb•in), max
2	Braided ground strap (customer supplied)
3	Ground grid or power distribution ground
4	Bonded cabinet ground bus (customer supplied)

Refer to the System Design for Control of Electrical Noise Reference Manual, publication GMC-RM001, for more information.

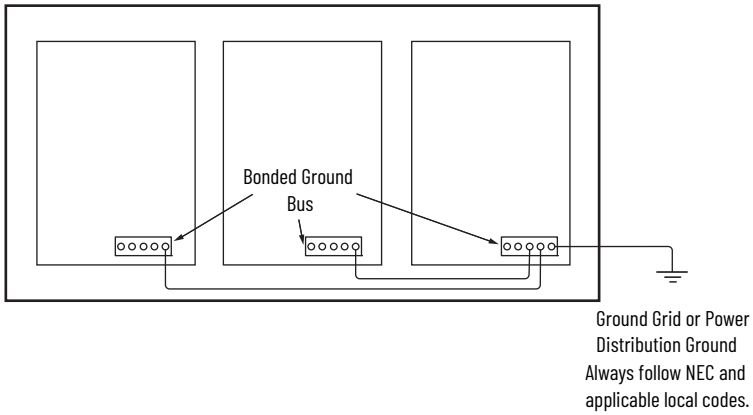
Figure 51 - Chassis Ground Configuration (multiple Kinetix 5100 drives on one panel)



Ground Multiple Subpanels

In this figure, the chassis ground is extended to multiple subpanels.

Figure 52 - Subpanels Connected to a Single Ground Point



Wiring Requirements

Wire must be copper with 75 °C (167 °F) minimum rating. Phasing of main AC power is arbitrary and earth ground connection is required.

See Appendix A beginning on page 429 for interconnect diagrams.

IMPORTANT	The National Electrical Code and local electrical codes take precedence over the values and methods provided.

Table 44 - Wiring Requirements

Kinetix 5100 (200V) Drives Cat. No.	Kinetix 5100 (400V) Drives Cat. No.	Description	Connects to Terminals	Recommended Wire Size mm² (AWG)	Strip Length mm (in.)	Torque Value N•m (lb•in)
2198-E1004-ERS 2198-E1007-ERS 2198-E1015-ERS	–	Mains V AC input power Control V AC input power Control 24V DC input power	L1 L2 L3 L1C (1) L2C 24V+ (2) 24V-	0.20…3.31 (24…12)	11 (0.4)	N/A (3)
2198-E1020-ERS 2198-E2030-ERS	2198-E4004-ERS 2198-E4007-ERS 2198-E4015-ERS			0.20…5.26 (24…10)	13 (0.5)	N/A (3)
–	2198-E4020-ERS 2198-E4030-ERS 2198-E4055-ERS			0.82…8.36 (18…8)		1.6 (5) (13.90)
2198-E2055-ERS	–					1.8 (5) (15.49)
2198-E2075-ERS	2198-E4075-ERS				11 (0.4)	1.6 (5) (13.90)
2198-E2150-ERS	2198-E4150-ERS			2.08…21.1 (14…4)	13 (0.5)	3.1 (5) (27.44)
2198-E1004-ERS 2198-E1007-ERS 2198-E1015-ERS	–	Motor power (4)	U V W	0.20…3.31 (24…12)	11 (0.4)	N/A (3)
2198-E1020-ERS 2198-E2030-ERS	2198-E4004-ERS 2198-E4007-ERS 2198-E4015-ERS			0.20…5.26 (24…10)	13 (0.5)	N/A (3)
–	2198-E4020-ERS 2198-E4030-ERS 2198-E4055-ERS			0.82…8.36 (18…8)		1.6 (5) (13.90)
2198-E2055-ERS 2198-E2075-ERS 2198-E2150-ERS	2198-E4075-ERS 2198-E4150-ERS			2.08…21.1 (14…4)		3.1 (5) (27.44)
2198-E1004-ERS 2198-E1007-ERS 2198-E1015-ERS	–	Shunt resistor	DC+ ISH ESH	0.20…3.31 (24…12)	11 (0.4)	N/A (3)
2198-E1020-ERS 2198-E2030-ERS	2198-E4004-ERS 2198-E4007-ERS 2198-E4015-ERS			0.20…5.26 (24…10)	13 (0.5)	N/A (3)
–	2198-E4020-ERS 2198-E4030-ERS 2198-E4055-ERS			0.82…8.36 (18…8)		1.6 (5) (13.90)
2198-E2055-ERS	–					1.8 (5) (15.49)
2198-E2075-ERS	2198-E4075-ERS				11 (0.4)	1.6 (5) (13.90)
2198-E2150-ERS	2198-E4150-ERS			2.08…21.1 (14…4)	13 (0.5)	3.1 (5) (27.44)
2198-E1004-ERS 2198-E1007-ERS 2198-E1015-ERS 2198-E1020-ERS 2198-E2030-ERS 2198-E2055-ERS 2198-E2075-ERS 2198-E2150-ERS	2198-E4004-ERS 2198-E4007-ERS 2198-E4015-ERS 2198-E4020-ERS 2198-E4030-ERS 2198-E4055-ERS 2198-E4075-ERS 2198-E4150-ERS	Safe Torque Off	SB+ SB- S1 S1C S2 S2C SS+ SS-	0.75 (18) (stranded wire with ferrule) 1.5 (16) (solid wire)	8.0 (0.31)	N/A (3)

(1) Applies to 2198-E1*xxx*-ERS and 2198-E2*xxx*-ERS (200V) drives.
(2) Applies to 2198-E4*xxx*-ERS (400V) drives.
(3) This connector uses spring tension to hold wires in place.
(4) Motor power wire size depends on drive and motor combination. See Kinetix 5100 Drive Systems Design Guide, publication KNX-RM011, for specific drive and motor combination.
(5) Attach using a terminal crimp lug.

Wiring Guidelines

Use these guidelines when wiring the connectors on your Kinetix 5100 servo drives.

SHOCK HAZARD: DC-bus capacitors can retain hazardous voltages after input power has been removed. DO NOT touch the P1, P2, DC-, DC+, ISH or ESH terminals within the capacitor discharge time (listed in Table 45). Before working on the drive, measure the DC-bus voltage to verify that it has reached a safe level. When DC-bus voltage is above 50V DC, the Charge status indicator is on. Failure to observe this precaution could result in severe bodily injury or loss of life.

Table 45 - DC-bus Capacitor Discharge Time

Kinetix 5100 (200V) Drives Cat. No.	Capacitor Discharge Time Minutes
2198-E1004-ERS	5
2198-E1007-ERS	15
2198-E1015-ERS	15
2198-E1020-ERS	20
2198-E2030-ERS	20
2198-E2055-ERS	35
2198-E2075-ERS	45
2198-E2150-ERS	110

Kinetix 5100 (400V) Drives Cat. No.	Capacitor Discharge Time Minutes
2198-E4004-ERS	5
2198-E4007-ERS	5
2198-E4015-ERS	5
2198-E4020-ERS	5
2198-E4030-ERS	5
2198-E4055-ERS	5
2198-E4075-ERS	10
2198-E4150-ERS	10

IMPORTANT For connector locations of the Kinetix 5100 drives, see Kinetix 5100 Connector Data on page 42.

When you remove insulation or tighten screws to secure the wiring, see the table on page 76 for torque values.

IMPORTANT To improve system performance, run wires and cables in the wireways as established in Establish Noise Zones on page 34.

Follow these steps when wiring the connectors on your Kinetix 5100 drive modules.

1. Prepare the wires by removing insulation as shown in Table 44.

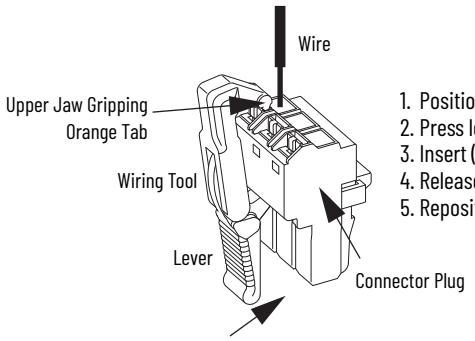
   IMPORTANT Use caution not to nick, cut, or otherwise damage strands as you remove the insulation.

2. Route the cable/wires as described in Chapter 2.
3. Insert wires into connector plugs or the terminal block.

   See connector pinout tables in Chapter 3 and Appendix A beginning on page 429 for interconnect diagrams.

   - Tighten the terminal screws on 2198-E2055-ERS, 2198-E2075-ERS, and 2198-E2150-ERS (200V) drives and 2198-E4055-ERS, 2198-E4075-ERS, and 2198-E4150-ERS (400V) drives to the specified torque value.
   - Connectors on 2198-E1004-ERS, 2198-E1007-ERS, 2198-E1015-ERS, 2198-E1020-ERS, and 2198-E2030-ERS (200V) drives and 2198-E4004-ERS, 2198-E4007-ERS, 2198-E4015-ERS (400V) drives use spring tension to hold wires in place.

- 2198-E1004-ERS, 2198-E1007-ERS, and 2198-E1015-ERS drives include connector plugs and a wiring tool.



4. Gently pull on each wire to make sure that it is secured in the terminal; reinsert and/or tighten any loose wires.
5. When the wiring is complete, plug the connector into the drive.

Wire the Input Power Connectors

Input power connections are made at the input power connector on the bottom of the drive or the terminal block on the front of the drive. This section provides examples and guidelines to assist you in making connections to the input power connector or terminal block.

Figure 53 - 2198-E1004-ERS, 2198-E1007-ERS and 2198-E1015-ERS Servo Drives

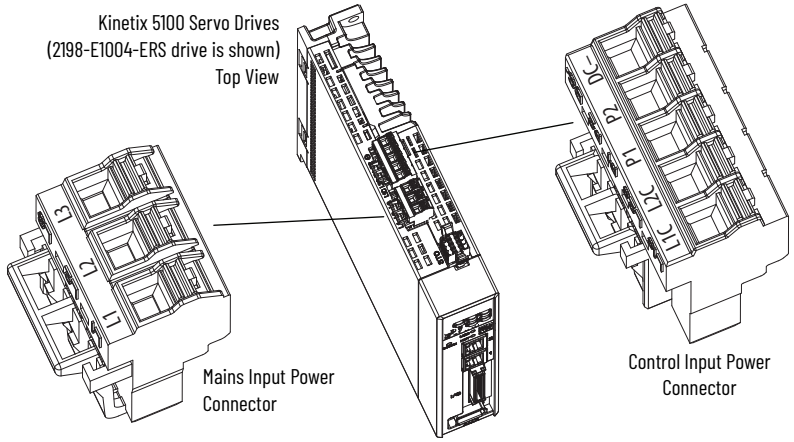


Figure 54 - 2198-E1020-ERS, 2198-E2030-ERS, 2198-E2055-ERS, 2198-E2075-ERS, and 2198-E2150-ERS Servo Drives

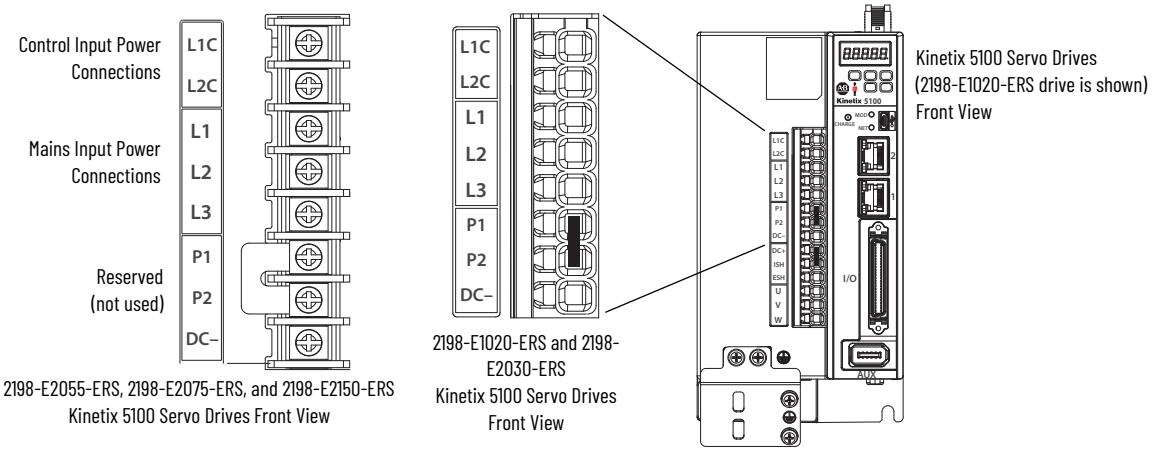


Figure 55 - 2198-E4020-ERS, 2198-E4030-ERS, 2198-E4055-ERS, 2198-E4075-ERS, and 2198-E4150-ERS Servo Drives

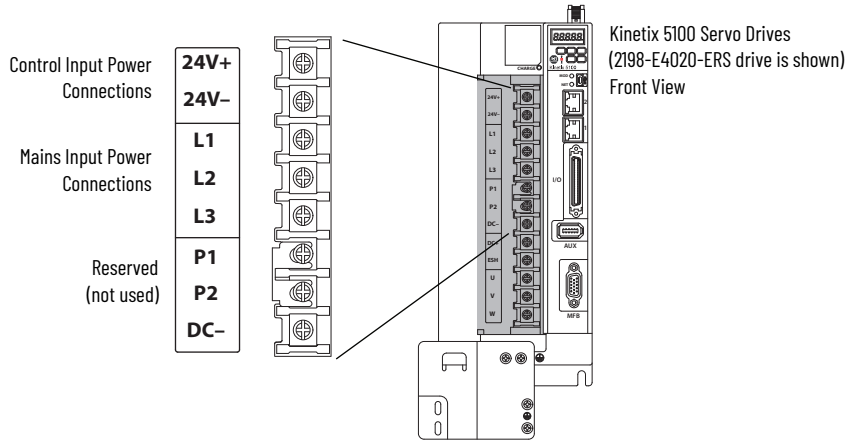


Table 46 - Input Power Connector Specifications

Kinetix 5100 Drive Cat. No.	Connects to Terminals	Recommended Wire Size mm^2 (AWG)	Strip Length mm (in.)	Torque Value N•m (lb•in)
2198-E1004-ERS 2198-E1007-ERS	L1 L2 L3 L1C L2C P1 P2 DC-	0.20…3.31 (24…12)	11 (0.4)	N/A (1)
2198-E1015-ERS				
2198-E1020-ERS 2198-E2030-ERS		0.20…5.26 (24…10)	13 (0.5)	N/A(1)
2198-E2055-ERS		0.82…8.36 (18…8)		1.8 (2) (15.49)
2198-E2075-ERS			11 (0.4)	1.6 (2) (13.90)
2198-E2150-ERS		2.08…21.1 (14…4)	13 (0.5)	3.1 (2) (27.44)
2198-E4004-ERS 2198-E4007-ERS 2198-E4015-ERS	L1 L2 L3 24V+ 24V- P1 P2 DC-	0.20…5.26 (24…10)	13 (0.5)	N/A(1)
2198-E4020-ERS 2198-E4030-ERS 2198-E4055-ERS		0.82…8.36 (18…8)		1.6 (2) (13.90)
2198-E4075-ERS			11 (0.4)	
2198-E4150-ERS		2.08…21.1 (14…4)	13 (0.5)	3.1 (2) (27.44)

(1) This connector uses spring tension to hold wires in place.
(2) Attach using a terminal crimp lug.

Wire the I/O Connector

Connect your digital/analog inputs/outputs to the I/O connector by using the 2198-TBIO terminal expansion block. For the terminal block pinout, see I/O Connector Pinout on page 47. See the Kinetix 5100 I/O Terminal Expansion Block Installation Instructions, publication 2198-IN020 for more information.

Figure 56 - Kinetix 5100 Drive (I/O connector and terminal block)

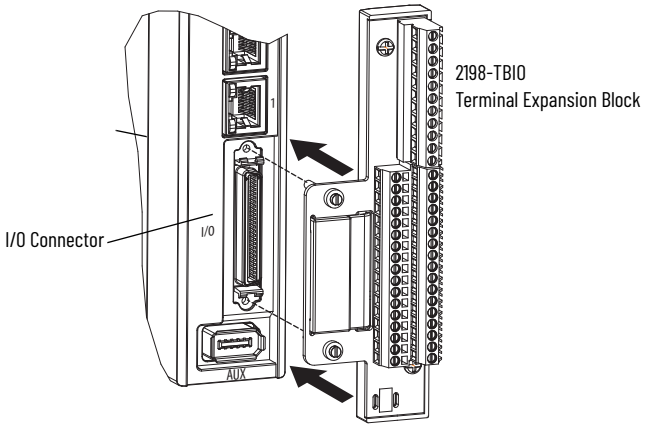


Table 47 - I/O Terminal Expansion Block Specifications

I/O Terminal Expansion Block Cat. No.	Recommended Wire Size mm^2 (AWG)	Strip Length mm (in.)	Torque Value N•m (lb•in)
2198-TBIO	1.5...0.05 (16...30)	6...7 (0.24...0.27)	20 (1.77)

Wire the Safe Torque Off Connector

For the Safe Torque Off (STO) connector pinouts, feature descriptions, and wiring information, see Chapter 13 beginning on page 383.

Wire the Motor Power Connector

Motor power connections are made at the motor power connector on the bottom of the drive or the terminal block on the front of the drive. This section provides examples and guidelines to assist you in making the motor power connections.

Figure 57 - 2198-E1004-ERS, 2198-E1007-ERS and 2198-E1015-ERS Servo Drives

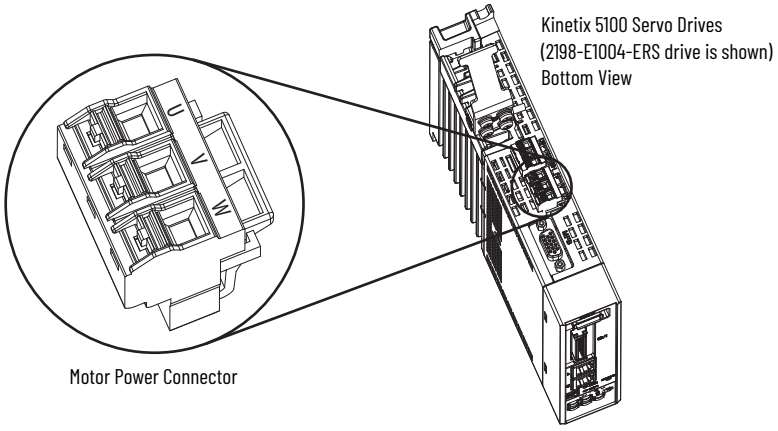


Figure 58 - 2198-E1020-ERS, 2198-E2030-ERS, 2198-E2055-ERS, 2198-E2075-ERS, and 2198-E2150-ERS and 2198-E4*xxx*-ERS Servo Drives

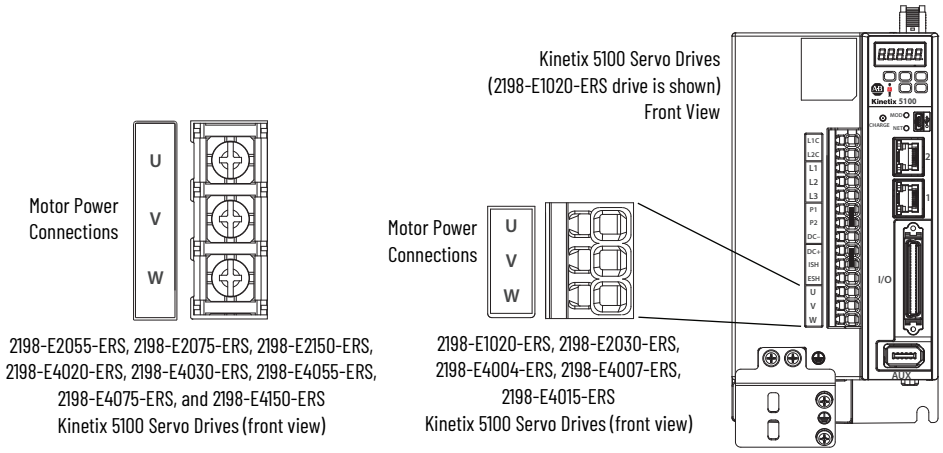


Table 48 - Motor Power Connector Specifications

Kinetix 5100 Drive Cat. No.	Connects to Terminals	Recommended Wire Size mm^2 (AWG)	Strip Length mm (in.)	Torque Value N•m (lb•in)
2198-E1004-ERS 2198-E1007-ERS 2198-E1015-ERS	U V W	0.20…3.31 (1) (24…12)	11 (0.4)	N/A (2)
2198-E1020-ERS 2198-E2030-ERS		0.20…5.26 (24…10)	13 (0.5)	N/A (2)
2198-E2055-ERS 2198-E2075-ERS 2198-E2150-ERS		2.08…21.1 (14…4)		3.1 (3) (27.44)
2198-E4004-ERS 2198-E4007-ERS 2198-E4015-ERS	U V W	0.20…5.26 (24…10)	13 (0.5)	N/A (2)
2198-E4020-ERS 2198-E4030-ERS 2198-E4055-ERS		0.82…8.36 (18…8)		1.6 (3) (13.90)
2198-E4075-ERS 2198-E4150-ERS		2.08…21.1 (14…4)		3.1 (3) (27.44)

(1) Motor power cable depends on motor/drive combination.
(2) This connector uses spring tension to hold wires in place.
(3) Attach using a terminal crimp lug.

Servo Motor and Motor Cable Compatibility

Kinetix 5100 drives are compatible with the following Allen-Bradley rotary motors:

- Kinetix TLP servo motors
- Kinetix MP motor family that includes Kinetix MPL, MPM, MPF, and MPS servo motors
- Kinetix TL and TLY servo motors

IMPORTANT To configure these motors with your Kinetix 5100 servo drive (see Table 50 and Table 51), you must have drive firmware revision 1.001 or later. When using I/O mode with ControlLogix® or CompactLogix™ controllers, see Table 49 to determine if you need the revision of the Kinetix 5100 Add-on Profile.

Table 49 - AOP Installation Requirement

Drive Firmware Revision	Logix Designer Application Version	Kinetix 5100 AOP Needed?
1.001 or later	30, 31, or 32	Yes
	33.00 or later	No

See Install the Kinetix 5100 Add-On Profile on page 165 for information on downloading the AOP.

Motor Power and Brake Cables

Kinetix TLP motors use power cables that can combine the power and brake wiring (<4.5 kW with brake). The power/brake cable attaches to the ground plate on the drive and power/brake conductors attach to the motor power and I/O connectors respectively. Motors (with brake) and a power rating ≥5.5 kW have separate power and brake cables.

Table 50 - Kinetix TLP Motor Power/Brake Cable Compatibility

Servo Motor Cat. No.	Motor Power Cat. No. (1) (with brake wires)	Motor Power Cat. No. (1) (without brake wires)	Brake Cat. No. (1)
TLP-A046-*xxx*, TLP-A070-*xxx*, TLP-A090-*xxx*, TLP-A100-*xxx*	2090-CTPB-MADF-18A*xx* (standard) or 2090-CTPB-MADF-18F*xx* (continuous-flex)	2090-CTPW-MADF-18A*xx* (standard) or 2090-CTPW-MADF-18F*xx* (continuous-flex)	Not applicable. Brake conductors are included in the power cable.
TLP-A115-100, TLP-A145-050, TLP-A145-100	2090-CTPB-MCDF-16A*xx* (standard) or 2090-CTPB-MCDF-16F*xx* (continuous-flex)	2090-CTPW-MCDF-16A*xx* (standard) or 2090-CTPW-MCDF-16F*xx* (continuous-flex)	
TLP-A115-200, TLP-A145-090, TLP-A145-150, TLP-A145-250	2090-CTPB-MCDF-12A*xx* (standard) or 2090-CTPB-MCDF-12F*xx* (continuous-flex)	2090-CTPW-MCDF-12A*xx* (standard) or 2090-CTPW-MCDF-12F*xx* (continuous-flex)	
TLP-A200-200, TLP-A200-300, TLP-A200-350	2090-CTPB-MDDF-12A*xx* (standard) or 2090-CTPB-MDDF-12F*xx* (continuous-flex)	2090-CTPW-MDDF-12A*xx* (standard) or 2090-CTPW-MDDF-12F*xx* (continuous-flex)	
TLP-A200-450	2090-CTPB-MDDF-08A*xx* (standard) or 2090-CTPB-MDDF-08F*xx* (continuous-flex)	2090-CTPW-MDDF-08A*xx* (standard) or 2090-CTPW-MDDF-08F*xx* (continuous-flex)	
TLP-A200-550, TLP-A200-750 (2) TLP-A235-11K	–	2090-CTPW-MEDF-06A*xx* (standard) or 2090-CTPW-MEDF-06F*xx* (continuous-flex)	2090-CTPB-MBDF-20A*xx* (standard) or 2090-CTPB-MBDF-20F*xx* (continuous-flex)
TLP-A235-15K (2)	–	2090-CTPW-MEDF-04A*xx* (standard) or 2090-CTPW-MEDF-04F*xx* (continuous-flex)	
TLP-B070-040 TLP-B090-075	2090-CTPB-MADF-18A*xx* (standard) or 2090-CTPB-MADF-18F*xx* (continuous-flex)	2090-CTPW-MADF-18A*xx* (standard) or 2090-CTPW-MADF-18F*xx* (continuous-flex)	Not applicable. Brake conductors are included in the power cable.
TLP-B115-100, TLP-B115-200 TLP-B145-050, TLP-B145-090, TLP-B145-100 TLP-B145-150, TLP-B145-200	2090-CTPB-MCDF-16A*xx* (standard) or 2090-CTPB-MCDF-16F*xx* (continuous-flex)	2090-CTPW-MCDF-16A*xx* (standard) or 2090-CTPW-MCDF-16F*xx* (continuous-flex)	
TLP-B145-250, TLP-B200-300	2090-CTPB-MDDF-12A*xx* (standard) or 2090-CTPB-MDDF-12F*xx* (continuous-flex)	2090-CTPW-MDDF-12A*xx* (standard) or 2090-CTPW-MDDF-12F*xx* (continuous-flex)	
TLP-B200-450	2090-CTPB-MDDF-08A*xx* (standard) or 2090-CTPB-MDDF-08F*xx* (continuous-flex)	2090-CTPW-MDDF-08A*xx* (standard) or 2090-CTPW-MDDF-08F*xx* (continuous-flex)	
TLP-B200-550, TLP-B200-750 (2)			2090-CTBK-MBDF-20A*xx* (standard) or 2090-CTBK-MBDF-20F*xx* (continuous-flex)
TLP-B235-11K	–	2090-CTPW-MEDF-06A*xx* (standard) or 2090-CTPW-MEDF-06F*xx* (continuous-flex)	
TLP-B235-14K	–	2090-CTPW-MEDF-04A*xx* (standard) or 2090-CTPW-MEDF-04F*xx* (continuous-flex)	

(1) Refer to the Kinetix Motion Accessories Specifications Technical Data, publication KNX-TD004, for cable specifications.
(2) Only these motors have separate brake connectors and brake cables. All other motors have brake wires included with the power connectors.

Table 51 - Kinetix MP Servo Motors and Power Cable Compatibility

Servo Motor Cat. No.	Motor Power Cat. No. (1) (with brake wires)	Motor Power Cat. No. (1) (without brake wires)
MPL-A/B15*xxx*-*xx*7xAA and MPL-A/B2*xxx*-*xx*7xAA, MPL-A3*xxx*-*xx*7xAA...MPL-A5*xxx*-*xx*7xAA, MPL-B3*xxx*-*xx*7xAA...MPL-B9*xxx*-*xx*7xAA,	2090-CPBM7DF-*xx*AA*xx* (standard) or 2090-CPBM7DF-*xx*AF*xx* (continuous-flex)	2090-CPWM7DF-*xx*AA*xx* (standard) or 2090-CPWM7DF-*xx*AF*xx* (continuous-flex)
MPM-A/B*xxxx*, MPF-A/B*xxxx*, MPS-A/B*xxxx*		

(1) Refer to the Kinetix Motion Accessories Specifications Technical Data, publication KNX-TD004, for cable specifications.

Table 52 - Kinetix TL and TLY Motor Power/Brake Cable Compatibility

Motor/Actuator Cat. No.	Motor Power Cat. No. (1) (with brake wires)	Motor Power Cat. No. (1) (without brake wires)	Brake Cat. No. (1)
TLY-A*xxxx*	2090-CPBM6DF-16AA*xx* (standard)	2090-CPWM6DF-16AA*xx* (standard)	Not applicable. Brake conductors are included in the power cable.
TL-A*xxxx*	–	2090-DANPT-16S*xx*	2090-DANBT-18S*xx*

(1) Refer to the Kinetix Motion Accessories Specifications Technical Data, publication KNX-TD004, for cable specifications.

Refer to Table 48 on page 82 for the motor power connector specifications.

Table 53 - Legacy Motor Power Cables for Kinetix MP Servo Motors

Motor Cable	Description	Motor Power Cat. No.
Standard	Power/brake, threaded	2090-XXNPMF-*xx*S*xx*
	Power-only, bayonet	2090-XXNPMP-*xx*S*xx*
Continuous-flex	Power/brake, threaded	2090-CPBM4DF-*xx*AF*xx*
	Power-only, threaded	2090-CPWM4DF-*xx*AF*xx*
	Power-only, bayonet	2090-XXTPMP-*xx*S*xx*

Maximum Cable Length

Maximum cable length depends on the feedback type and input voltage that is used in the application.

Table 54 - Maximum Cable Lengths (200V-class) Motors

Compatible Motor and Actuator Cat. No.	Feedback Type	Cable Length, max m (ft)
TLP-A*xxx*-*xxx*-D	Nikon (24-bit) absolute high-resolution, multi-turn and single-turn	50 (164)
MPL-A15*xxx*-V/Ex7xAA MPL-A2*xxx*-V/Ex7xAA	Hiperface, absolute high-resolution, multi-turn and single-turn	
MPL-A3*xxx*-S/Mx7xAA, MPL-A4*xxx*-S/Mx7xAA MPL-A45*xxx*-S/Mx7xAA, MPL-A5*xxx*-S/Mx7xAA		
MPM-A*xxxx*-S/M MPF-A*xxxx*-S/M MPS-A*xxxx*-S/M		
MPL-A15*xxx*-Hx7xAA MPL-A2*xxx*-Hx7xAA	Incremental	30 (98.4)
MPL-A3*xxx*-Hx7xAA MPL-A4*xxx*-Hx7xAA MPL-A45*xxx*-Hx7xAA		
TLY-A*xxxx*-B	Tamagawa (17-bit) absolute high-resolution, multi-turn	
TL-A*xxxx*-B		
TLY-A*xxxx*-H	Incremental	

Table 55 - Maximum Cable Lengths (400V-class) Motors

Compatible Motor and Actuator Cat. No.	Feedback Type	Cable Length, max m (ft)	
		≤400V AC Input	480V AC Input
TLP-B200-*xxx*-D	Nikon (24-bit) absolute high-resolution, multi-turn and single-turn	50 (164)	15 (49.2)
TLP-B070-*xxx*-D, TLP-B090-*xxx*-D, TLP-B115-*xxx*-D, TLP-B145-*xxx*-D, TLP-B235-*xxx*-D			50 (164)
MPL-B15*xxx*-V/Ex7xAA MPL-B2*xxx*-V/Ex7xAA	Hiperface, absolute high-resolution, multi-turn and single-turn	50 (164)	20 (65.6)
MPL-B3*xxx*-S/Mx7xAA, MPL-B4*xxx*-S/Mx7xAA MPL-B45*xxx*-S/Mx7xAA, MPL-B5*xxx*-S/Mx7xAA MPL-B6*xxx*-S/Mx7xAA, MPL-B8*xxx*-S/Mx7xAA MPL-B9*xxx*-S/Mx7xAA		50 (164)	
MPM-B*xxxx*-S/M MPF-B*xxxx*-S/M MPS-B*xxxx*-S/M			
MPL-B15*xxx*-Hx7xAA MPL-B2*xxx*-Hx7xAA	Incremental	30 (98.4)	20 (65.6)
MPL-B3*xxx*-Hx7xAA MPL-B4*xxx*-Hx7xAA MPL-B45*xxx*-Hx7xAA		30 (98.4)	

Cable Preparation for Kinetix TLP Servo Motors

Because the 2090-CT*xx*-M*x*D*x* motor cables are designed specifically for Kinetix TLP motors, there is no preparation required.

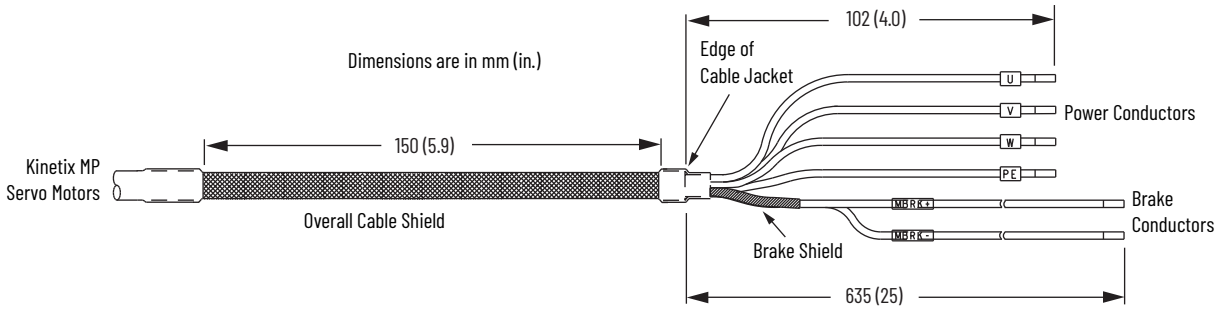
- 2090-CTPW-M*x*DF flying lead power cables are equipped with ring lugs where required, so no cable preparation is needed.
- 2090-CTFB-M*x*DD feedback cables are equipped with premolded connectors on the drive end, so no cable preparation is needed.

If you are building your own cables, see Build Your Own Kinetix TLP Motor Cables Installation Instructions, publication 2090-IN048, to attach motor-side power and feedback connector kits to bulk cable. Also, see Kinetix 5100 Feedback Connector Kit Installation Instructions, publication 2198-IN019, to terminate the flying lead feedback cable connections.

Cable Preparation for Kinetix MP Servo Motors

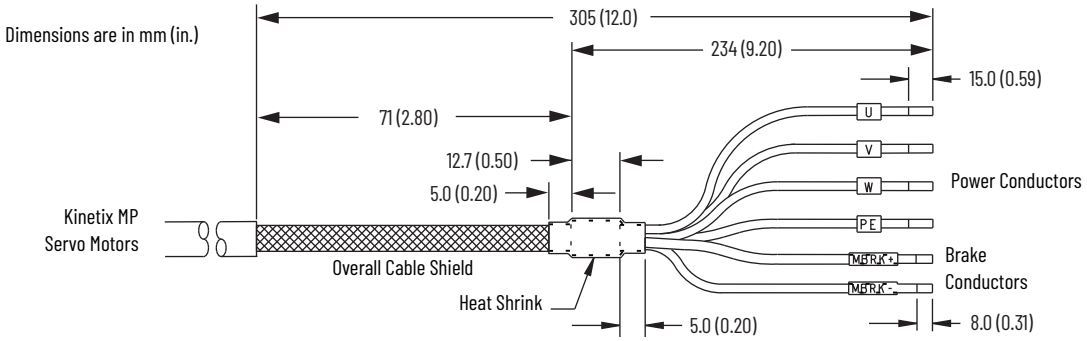
Motor power and brake conductors on 2090-CPBM7DF (series A) cables have the following dimensions from the factory. If your cable is reused from an existing application, the actual conductor lengths could be slightly different.

Figure 59 - 2090-CPBM7DF (series A) Power/brake Cable Dimensions



Motor power and brake conductors on 2090-CPBM7DF (series B) 12 and 10 AWG standard, non-flex cables provide (drive end) shield braid and conductor preparation designed for compatibility with multiple Kinetix servo-drive families, including Kinetix 5100 drives.

Figure 60 - 2090-CPBM7DF (series B, 10 or 12 AWG) Power/brake Cable Dimensions



See Build Your Own Kinetix TLP Motor Cables Installation Instructions, publication 2090-IN048, to attach the proper ring lugs to PE, U, V, and W conductors to 2090-CPBM7DF power cables when used with 2198-E2055-ERS, 2198-E2075-ERS, 2198-E2150-ERS, and 2198-4*xxx*-ERS servo drives.

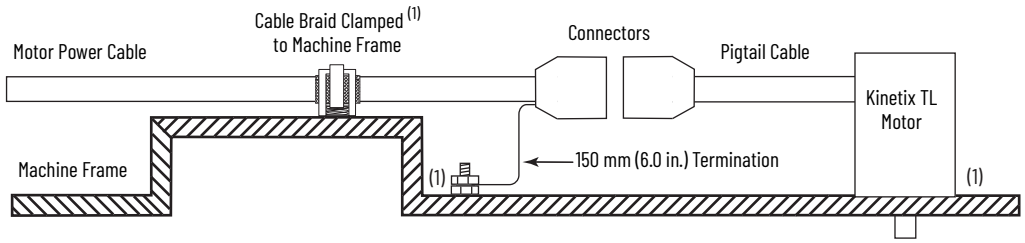
Cable Preparation for Kinetix TL and TLY Motor Power Cables

2090-CPBM6DF motor power cables, used with Kinetix TLY motors, require no preparation. However, 2090-DANPT-16S*xx* power cables, used with Kinetix TL motors have a short pigtail cable that connects to the motor, but is not shielded. The preferred method for grounding the Kinetix TL power cable on the motor side is to expose a section of the cable shield and clamp it directly to the machine frame.

The motor power cable also has a 150 mm (6.0 in.) shield termination wire with a ring lug that connects to the closest earth ground. The termination wire can be extended to the full length of the motor pigtail if necessary, but it is best to connect the supplied wire directly to ground without lengthening.

IMPORTANT For Kinetix TL motors, connect the 150 mm (6.0 in.) termination wire to the closest earth ground.

Figure 61 - 2090-DANPT-16S*xx* Cable Preparation



(1) Remove paint from machine frame to provide HF-bond between machine frame, motor case, shield clamp, and ground stud.

Apply the Cable Shield Clamp

This procedure assumes that you have completed wiring your motor power connector and are ready to apply the cable shield ground plate. Factory-supplied motor power cables for Kinetix TLP and Kinetix MP motors are shielded. The braided cable shield must terminate at the drive during installation.

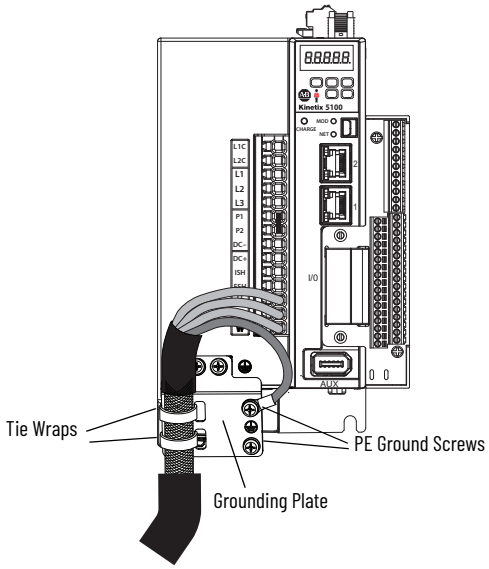
- 2090-CTP*x*-M*x*D*x* motor power cables are designed specifically for Kinetix TLP motors and require no preparation.
- For 2090-CP*x*M7DF cables, used with Kinetix MP motors, ring lugs need to be crimped to the PE, U, V, and W conductors when attaching to 2198-E2055-ERS, 2198-E2075-ERS, 2198-E2150-ERS, and 2198-E4*xxx*-ERS servo drives.

See Build Your Own Kinetix TLP Motor Cables Installation Instructions, publication 2090-IN048, to attach the proper ring lugs to PE, U, V, and W conductors to 2090-CPBM7DF power cables.

SHOCK HAZARD: To avoid hazard of electrical shock, make sure shielded power cables are grounded according to recommendations.

Follow these steps to apply the cable shield clamp.

1. Route the conductors with service loops to provide stress relief to the motor power and brake conductors.



2. Apply tie wraps through the ground plate slots and around the exposed cable shield.

   Make sure the cable clamp tightens around the cable shield and provides a good bond between the cable shield and the drive chassis.

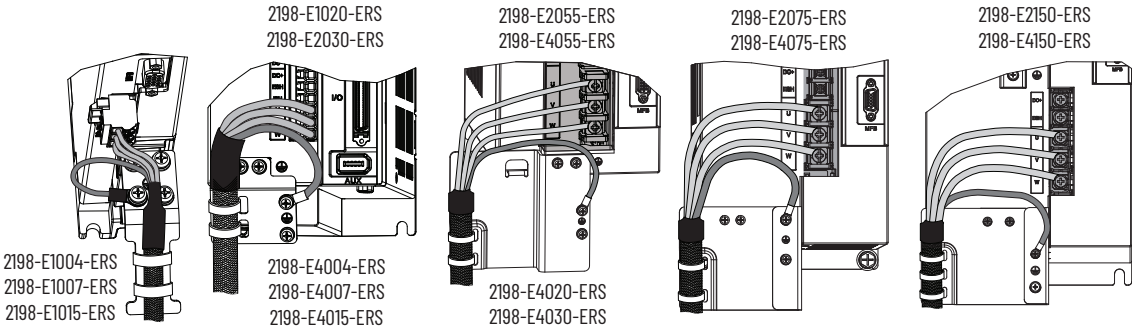
3. Attach the motor-power ground wire to one of the PE ground screws.

   Tighten the PE ground screw until the maximum torque value of 2.0 N•m (17.7 lb•in) is achieved.

IMPORTANT If the power/brake cable shield has a loose fit between the ground plate and tie wraps, the cable shield ground is ineffective. When the tie wraps are pulled tight, the result must be a high-frequency bond between the cable shield and the drive chassis.

Figure 62 displays examples of how the motor cable conductors and shield can be routed and attached for each of the servo drives.

Figure 62 - Kinetix 5100 Drive Ground Plate Examples



Motor Brake Connections

For wiring the brake circuit, see Motor Brake Circuit on page 57 for wiring and configuration details. See Kinetix 5100 Drive/Rotary Motor Wiring Examples on page 438 for motor brake wiring examples.

- Kinetix TLP servo motors use 2090-CTPB-M*x*D*x* power/brake cables. Servo drives with a power rating ≥5.5 kW require a separate brake cable. See Kinetix TLP Motor Power/Brake Cable Compatibility on page 83 for the drive catalog numbers that require a separate brake cable.
- Kinetix MP motors use 2090-CPBM7DF power/brake cables.
- Kinetix TLY motors use 2090-CPBM6DF power/brake cables.
- Kinetix TL motors use 2090-DANBT-18S*xx* brake cables.

Wire the Motor Feedback Connector

2090-CTFB-M*x*DD motor feedback cables are designed specifically for Kinetix TLP motors. The drive-end connector plugs directly into the 15-pin (MFB) feedback connector. The 2198-K51CK-DM15 feedback connector kit is also available when making your own cables. See Wire the 2198-K51CK-D15M Feedback Connector Kit on page 94 for pinouts and wiring.

2090-CFBM6DD and 2090-CFBM7DD motor feedback cables also provide a drive-end connector that plugs directly into the 15-pin (MFB) feedback connector. The 2198-K51CK-DM15 feedback connector kit can also be used with 2090-CFBM6DF and 2090-CFBM7DF flying-lead cables.

When using the 2198-K51CK-DM15 feedback connector kit, 2090-CFBM7DF flying-lead cables require preparation to make sure the ground plate attaches properly and conductors route smoothly to the connector terminals. All of the current and legacy feedback cables listed below are compatible with the 2198-K51CK-D15M connector kit.

Table 56 - Kinetix TLP Motor Feedback Cable Compatibility

Servo Motor Cat. No.	Feedback Cable Cat. No. (1)
TLP-A046-*xxx*, TLP-A/B070-*xxx*, TLP-A/B090-*xxx*, TLP-A100-*xxx*	2090-CTFB-MADD-CFA*xx* (standard) or 2090-CTFB-MADD-CFF*xx* (continuous-flex)
TLP-A/B115-*xxx*, TLP-A/B145-*xxx*, TLP-A/B200-*xxx*, TLP-A/B235-*xxx*	2090-CTFB-MFDD-CFA*xx* (standard) or 2090-CTFB-MFDD-CFF*xx* (continuous-flex)

(1) Refer to the Kinetix Motion Accessories Specifications Technical Data, publication KNX-TD004, for cable specifications.

Table 57 - Compatible Motors and Actuators

Single-turn or Multi-turn Absolute Encoders		Incremental Encoders	
Servo Motor Cat. No.	**Feedback Cable (1) Cat. No.**	**Servo Motor Cat. No.**	**Feedback Cable (1) Cat. No.**
MPL-A/B15*xxx*...MPL-A2*xxx*-V/E MPL-A/B3*xxx*...MPL-A5*xxx*-M/S	2090-CFBM7DF-CEA*xx* 2090-CFBM7DD-CEA*xx* 2090-CFBM7DF-CERA*xx* (standard) or 2090-CFBM7DF-CEAF*xx* 2090-CFBM7DD-CEAF*xx* 2090-CFBM7DF-CDAF*xx* (continuous-flex)	MPL-A/B15*xxx*...MPL-A/B2*xxx*-H MPL-A/B3*xxx*...MPL-A/B45*xxx*-H	2090-XXNFMF-S*xx* (standard) 2090-CFBM7DF-CDAF*xx* (continuous-flex)
MPM-A/B*xxxxx*-M/S		–	
MPF-A/B*xxxx*-M/S		–	
MPS-A/B*xxxx*-M/S		–	
TLY-A*xxxx*-B	2090-CFBM6DF-CBAA*xx* (standard) 2090-CFBM6DD-CCAA*xx* (standard)	TLY-A*xxxx*-H	2090-CFBM6DF-CBAA*xx* (standard) 2090-CFBM6DD-CCAA*xx* (standard)
TL-A*xxxx*-B	2090-DANFCT-S*xx* (standard)	–	–

(1) Refer to the Kinetix Motion Accessories Specifications Technical Data, publication KNX-TD004, for cable specifications.

Table 58 - Legacy Motor Feedback Cables

Motor Cable	Description	Cable Cat. No.
Standard	Encoder feedback, threaded	2090-XXNFMF-S*xx* 2090-UXNFBMF-S*xx*
	Encoder feedback, bayonet	2090-UXNFBMP-S*xx* 2090-XXNFMP-S*xx*
Continuous-flex	Encoder feedback, bayonet	2090-XXTFMP-S*xx*
	Encoder feedback, threaded	2090-CFBM4DF-CDAF*xx*

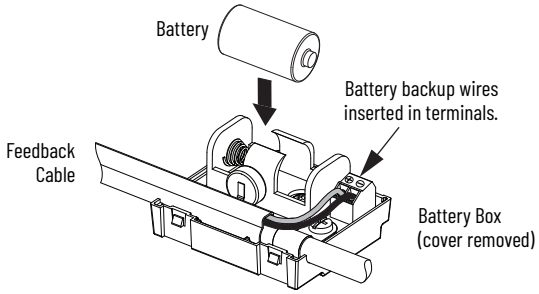
Cable Preparation for Kinetix TLP Feedback Cables

For Kinetix TLP motors, 2090-CTFB-M*x*DD feedback cables (with battery box) are available for applications with and without the need for battery backup.

- For multi-turn feedback, use 2090-CTFB-M*x*DD cables with drive-end connector plugs and wire the battery box (included with each Kinetix TLP feedback cable) and install a customer-supplied battery.

  See Feedback Battery Box Installation Instructions, publication 2198-IN022, for more information.
- For single-turn feedback, use 2090-CTFB-M*x*DD cables with drive-end connector plugs, however, the battery box option is not required.
- If you build your own cables, see Build Your Own Kinetix TLP Motor Cables Installation Instructions, publication 2090-IN048, and make flying-lead feedback connections to the 2198-K51CK-D15M connector kit.

Figure 63 - Battery Box Wired With Battery



Cable Preparation for 2090-CFBM7D*x* Feedback Cables

2090-CFBM7DD motor feedback cables, used with Kinetix MP motors and actuators (with Hiperface encoders), also provide a drive-end connector that plugs directly into the 15-pin Kinetix 5100 (MFB) feedback connector. Use the 2198-K51CK-D15M feedback connector kit with 2090-CFBM7DF flying-lead cables.

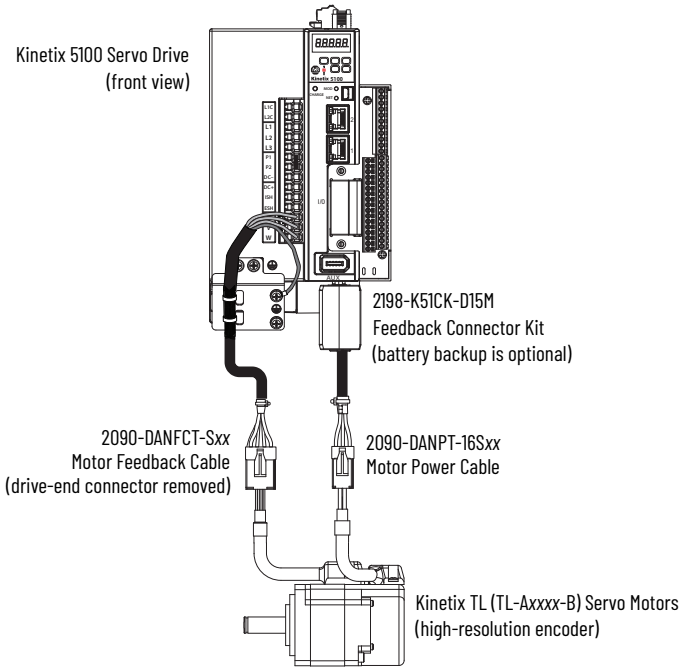
Cable Preparation for Kinetix TL and TLY Feedback Cables

For Kinetix TLY motors, 2090-CFBM6D*x* feedback cables are available for applications with and without the need for battery backup.

- For multi-turn encoders (TLY-A*xxxx*-B motors), use the 2198-K51CK-D15M feedback connector kit (with customer-supplied battery) and 2090-CFBM6DF flying-lead cables.
- For incremental encoders (TLY-A*xxxx*-H motors), use 2090-CFBM6DD cables with drive-end connector and plug directly into the 15-pin (MFB) feedback connector.
  - If the 2090-CFBM6DF flying-lead cable is preferred, the 2198-K51CK-D15M connector kit (without battery) can also be used.

For Kinetix TL-A*xxxx*-B motors, use 2090-DANFCT-S*xx* feedback cables. You must remove the drive-end connector and prepare the leads for terminating at the 2198-K51CK-D15M connector kit. Install a (customer-supplied) battery for multi-turn encoder position backup.

Figure 64 - Feedback Connection for Kinetix TL Motors



Motor Feedback Cable Preparation

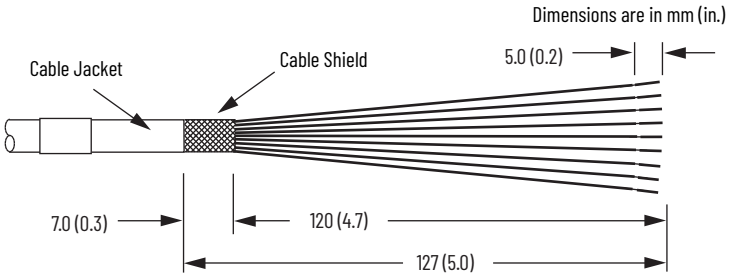
When using the 2198-K51CK-D15M feedback connector kit, you must prepare the 2090-Series flying-lead conductors with the proper strip length. The cable shield requires a high-frequency bond with the ground pad.

Follow these steps to prepare feedback cables.

1. Remove 127 mm (5.0 in.) of cable jacket and 120 mm (4.7 in.) of cable shield.

   IMPORTANT This length of wire is needed for the longest wires terminated at each 8-pin connector. However, most wires are trimmed shorter, depending on the terminal they are assigned to.

2. Determine the length for each wire and trim as necessary.
3. Remove 5.0 mm (0.2 in.) of insulation from the end of each wire.



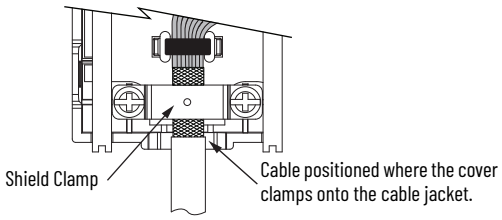
Apply the Connector Kit Shield Clamp

Follow these steps to apply the connector kit shield clamp.

1. Position the 12 mm (0.5 in.) of exposed cable shield over the ground pad to achieve a high-frequency bond.

IMPORTANT	Cable preparation and positioning that provides a high-frequency bond between the shield braid and clamp is required to optimize system performance. Also, make sure that the cable is positioned where the cover clamps onto the jacket for added stress relief.

2. Place the shield clamp over the cable shield and install the clamp screws.
   Apply 0.34 N•m (3.0 lb•in) torque to each screw.



3. Route and insert each wire to its assigned terminal, apply 0.20 N•m (1.8 lb•in) maximum torque to each screw.
   Refer to the connector pinout as shown in Figure 65 on page 94.
4. Attach the tie-wrap (customer-supplied) through the slots and around the cable shield for stress relief and to create a high-frequency bond between shield and ground pad.

2090-Series Feedback Cable Pinouts

The following tables provide motor connector pinouts and wire colors to the 2198-K51CK-D15M connector kit.

Table 59 - 2090-CFBM7DF-CEA*xxx* Feedback Cables

Absolute, High-resolution Feedback	**MPL-B15*xxx* and MPL-B2*xxx*-V/Ex4/7xAA MPL-B3*xxx*...MPL-B9*xxx*-M/Sx7xAA MPL-A5*xxx*-M/Sx7xAA**	**MPL-A15*xxx* and MPL-A2*xxx*-V/Ex4/7xAA MPL-A3*xxx*-M/Sx7xAA MPL-A4*xxx*-M/Sx7xAA MPL-A45*xxx*-M/Sx7xAA MPM-A115*xxx*...MPM-A130*xxx*-M/S MPF/MPS-A3*xx*-M/S MPF/MPS-A4*xx*-M/S MPF/MPS-A45*xx*-M/S**	**Wire Color**	**2198-K51CK-D15M Connector Kit Pin**
Motor/Actuator Pin	**MPM-A165*xxx*...MPM-A215*xxx*-M/S MPM-B*xxxxx*-M/S MPF-B*xxx*-M/S MPF-A5*xxx*-M/S MPS-B*xxx*-M/S**			
1	SIN+	SIN+	Black	1
2	SIN-	SIN-	White/Black	2
3	COS+	COS+	Red	3
4	COS-	COS-	White/Red	4
5	DATA+	DATA+	Green	5
6	DATA-	DATA-	White/Green	10
9	Reserved	EPWR_5V	Gray	14
10	ECOM	ECOM	White/Gray	6 (1)
11	EPWR_9V	Reserved	Orange	7
13	TS+	TS+	White/Orange	11

(1) The ECOM and TS- connections are tied together and connect to the cable shield.

Table 60 - 2090-CTFB-MxDD-CF*xxx* Feedback Cables

Motor Pin	TLP-A*xxx*-*xxx* and TLP-B*xxx*-*xxx* 24-bit Absolute, Multi-turn/Single-turn High-resolution	Wire Color	2198-K51CK-D15M Connector Kit Pin
A	T+	White	5
B	T–	White/Red	10
C	BAT+	Red	Pin +
D	BAT–	Black	Pin –
L	Drain	–	⏚
R	ECOM	Blue	6
S	EPWR_5V	Brown	14

Table 61 - 2090-XXNFMF-S*xx* or 2090-CFBM7DF-CDA*xxx* Feedback Cables

Incremental Feedback Motor Pin	MPL-A/B15*xxx*...MPL-A/B2*xxx*-Hx4/7xAA	Wire Color	2198-K51CK-D15M Connector Kit Pin
1	SIN+	Black	1
2	SIN-	White/Black	2
3	COS+	Red	3
4	COS-	White/Red	4
5	DATA+	Green	5
6	DATA-	White/Green	10
9	EPWR_5V	Gray	14
10	ECOM	White/Gray	6 (1)
11	EPWR_9V	Orange	7
13	TS+	White/Orange	11
15	S1	White/Blue	12
16	S2	Yellow	13
17	S3	White/Yellow	8

(1) The ECOM and TS- connections are tied together and connect to the cable shield.

Table 62 - 2090-CFBM6DF-CBAA*xx* Feedback Cables

Motor Pin	TLY-A*xxxx*-H Incremental Encoder Feedback	Wire Color	2198-K51CK-D15M Connector Kit Pin
9	AM+	Black	1
10	AM–	White/Black	2
11	BM+	Red	3
12	BM–	White/Red	4
13	IM+	Green	5
14	IM–	White/Green	10
22	EPWR_5V	Gray	14
23	ECOM	White/Gray	6 (1)
15	S1	White/Blue	12
17	S2	Yellow	13
19	S3	White/Yellow	8
24	Drain	–	⏚

(1) The ECOM and TS- connections are tied together and connect to the cable shield.

Table 63 - 2090-CFBM6DF-CBAA*xx* Feedback Cables

Motor Pin	TLY-A*xxxx*-B 17-bit Absolute, Multi-turn, High-resolution Feedback	Wire Color	2198-K51CK-D15M Connector Kit Pin
13	DATA+	Green	5
14	DATA–	White/Green	10
22	EPWR_5V	Gray	14
23	ECOM and BAT-	White/Gray	6 (1)
6	BAT+	Orange	BAT+
24	Drain	–	⏚

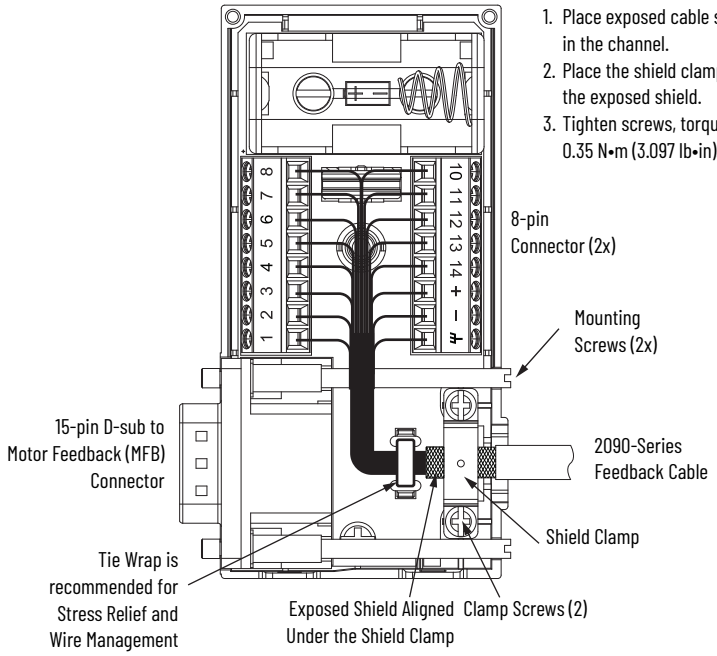
(1) BAT- is tied to ECOM (pin 23) in the cable.

Table 64 - 2090-DANFCT-S*xx* Feedback Cables

Motor Pin	TL-A*xxxx*-B 17-bit Absolute, Multi-turn, High-resolution Feedback	Wire Color	2198-K51CK-D15M Connector Kit Pin
12	SD+	Brown	5
13	SD–	White/Brown	10
7	EPWR_5V	Gray	14
8	ECOM and BAT-	White/Gray	6 (1)
14	BAT+	Orange	BAT+
9	Drain	–	⏚

(1) BAT- is tied to ECOM (pin 8) in the cable.

Figure 65 - Wire the 2198-K51CK-D15M Feedback Connector Kit



Terminal	Signal		Wire Color
1	SIN+	AM+	Black
2	SIN–	AM–	White/Black
3	COS+	BM+	Red
4	COS–	BM–	White/Red
5	DATA+	IM+	Green
6	ECOM (1)		White/Gray
7	EPWR_9V		Orange
8	S3		White/Yellow
10	DATA–	IM–	White/Green
11	TS+		White/Orange
12	S1		White/Blue
13	S2		Yellow
14	EPWR_5V		Gray
+	Battery +		N/A (2)
–	Battery –		N/A (2)
⏚	Drain		Shield

(1) The ECOM and TS- connections are tied together and connect to the cable shield.
(2) See cable pinouts for wire colors.

External Passive-shunt Resistor Connections

Passive shunt connections are made at the shunt connector on the bottom of the drive or the terminal block on the front of the drive.

Follow these guidelines when wiring your 2198-R*xxx* or 2097-R*x* passive shunt:

- Refer to External Passive Shunt Modules on page 35 for noise zone considerations.
- Refer to Passive Shunt Wiring Examples on page 437.
- Refer to the installation instructions provided with your Bulletin 2198 shunt module, publication 2198-IN011.
- Refer to the installation instructions provided with your Bulletin 2097 shunt resistor, publication 2097-IN002.

IMPORTANT To improve system performance, run wires and cables in the wireways as established in Chapter 2.

All Kinetix 5100 servo drives have internal shunt IGBT. However, only 2198-E1004-ERS...2198-E2030-ERS (200V) drives and 2198-E4004-ERS... 2198-E4015-ERS (400V) drives have an internal shunt resistor. The DC+ to ISH jumper connects the internal shunt resistor.

IMPORTANT You must remove the internal shunt jumper in the shunt connector (between DC+ and ISH) before connecting the Bulletin 2198 or 2097 passive shunt resistor wires.

Figure 66 - 2198-E1004-ERS, 2198-E1007-ERS and 2198-E1015-ERS Servo Drives

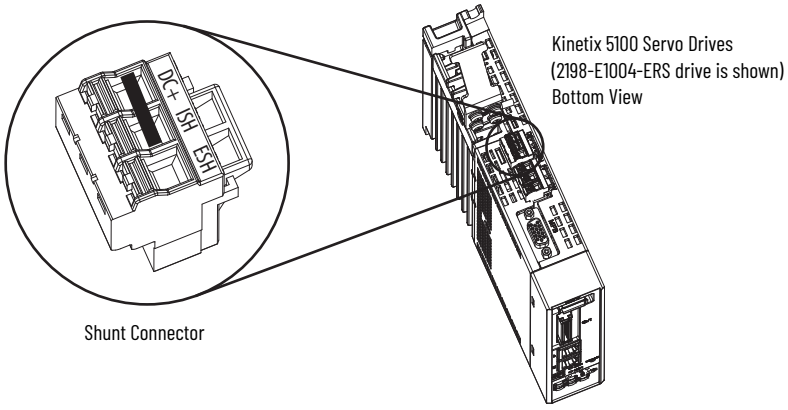


Figure 67 - 2198-E1020-ERS, 2198-E2030-ERS, 2198-E2055-ERS, 2198-E2075-ERS, 2198-E2150-ERS, and 2198-E4*xxx*-ERS Servo Drives

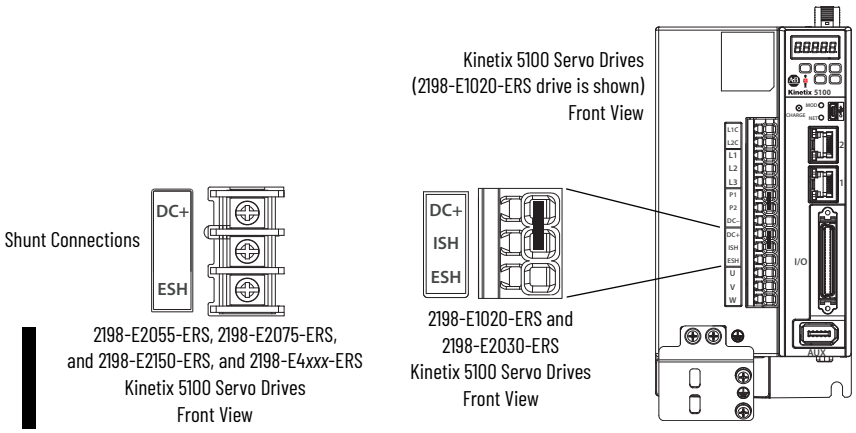


Table 65 - Shunt Connector Specifications

Kinetix 5100 Drive Cat. No.	Connects to Terminals	Recommended Wire Size mm² (AWG)	Strip Length mm (in.)	Torque Value N•m (lb•in)
2198-E1004-ERS 2198-E1007-ERS 2198-E1015-ERS	DC+ ISH ESH	0.20…3.31 (24…12)	11 (0.4)	N/A (1)
2198-E1020-ERS 2198-E2030-ERS		0.20…5.26 (24…10)	13 (0.5)	N/A (1)
2198-E2055-ERS	DC+ ESH	0.82…8.36 (18…8)		1.8 (2) (15.49)
2198-E2075-ERS			11 (0.4)	1.6 (2) (13.90)
2198-E2150-ERS		2.08…21.1 (14…4)	13 (0.5)	3.1 (2) (27.44)
2198-E4004-ERS 2198-E4007-ERS 2198-E4015-ERS	DC+ ESH	0.20…5.26 (24…10)	13 (0.5)	N/A (1)
2198-E4020-ERS 2198-E4030-ERS 2198-E4055-ERS		0.82…8.36 (18…8)		1.6 (2) (13.90)
2198-E4075-ERS			11 (0.4)	
2198-E4150-ERS		2.08…21.1 (14…4)	13 (0.5)	3.1 (2) (27.44)

(1) This connector uses spring tension to hold wires in place.
(2) Attach using a terminal crimp lug.

See Passive Shunt Considerations on page 27 for shunts compatible with your Kinetix 5100 servo drive.

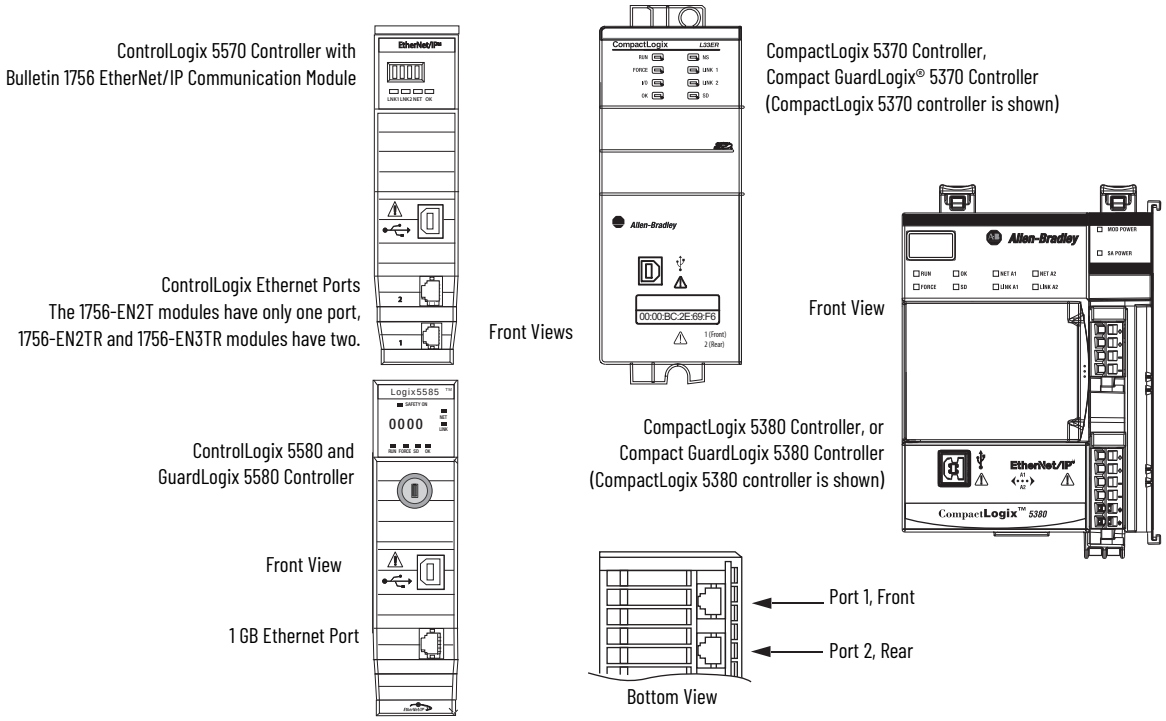
Ethernet Cable Connections

This procedure assumes that you have your Logix 5000™ controller and Kinetix 5100 drives mounted and are ready to connect the network cables.

The EtherNet/IP™ network is connected by using the PORT 1 and PORT 2 connectors. Refer to page 42 to locate the Ethernet connectors on your drive module. Refer to Figure 68 to locate the connectors on your Logix 5000 controller.

Shielded Ethernet cable is required for EMC compliance and is available in several standard lengths. Ethernet cable lengths that connect drive-to-drive, drive-to-controller, or drive-to-switch must not exceed 100 m (328 ft). Refer to the Kinetix Motion Accessories Specifications Technical Data, publication KNX-TD004, for more information.

Figure 68 - ControlLogix and CompactLogix Ethernet Port Locations



The Logix 5000 controllers accept linear, ring (DLR), and star network configurations. Refer to Typical Communication Configurations on page 15 for linear, ring, and star configuration examples.

Notes:

Set Up EtherNet/IP Communication

Topic	Page
Set Network Parameters by Using the Display	99
Set Network Parameters by Using KNX5100C Software	101
Configure IP Address by Using BOOTP-DHCP Tool	102

You can include the drive in your Studio 5000 Logix Designer® application by adding it to a configured EtherNet/IP™ module or controller under the I/O configuration tree. After setting network parameters, you can view the drive status information in Studio 5000® environment and use it in your Logix Designer application.

Settings are stored in nonvolatile memory. You can change the IP address through the Module Configuration dialog box in RSLinx® software, by using KNX5100C software, or through the Internet Protocol page of Module Properties in your Logix Designer application. Changes to the IP address take effect after power is cycled.

If configure DHCP is turned ON in the Network Parameters, you must configure the IP address of drive by using BOOTP-DHCP tool.

Use one of the following three methods to set the network parameters:

- Panel display
- KNX5100C software on page 101
- BOOTP-DHCP tool on page 102

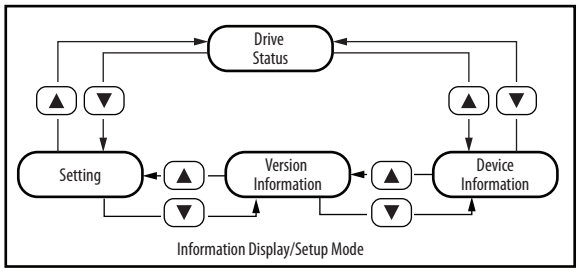
The drive is factory programmed to static IP address of 192.168.1.1 and Gateway address of 192.168.1.254.

Set Network Parameters by Using the Display

Follow these steps to set network parameters.

1. Apply power to your drive.

   BOOT*x* appears on the display as the drive boots up. After a successful boot process, the drive display scrolls 5100 192.168.1.1, then STOP 192.168.1.1.



2. In the Device Information screen or Drive Status screen, the current IP address is shown.
3. Press ▼ key.

   SETTING appears on the display.
4. Press S key.

   NET SETTING scrolls across the display.
5. Press S key.

   STATIC IP scrolls across the display.

   To enter the IP ADDR, press S key, and use the ▲▼ keys to enter the IP Address octets.

   To enter the SUBNET, press ▼ key, and use the ▲▼ keys to enter the subnet address octets.

   To enter the GATE, press ▼ key, and use the ▲▼ keys to enter the Gateway octets.

   Press M to return to the Static IP display.
6. Press ▼ key.

   DHCP appears on the display.

   To show the current DHCP setting (OFF or ON), press S key.

   To change the DHCP setting, and press ▲ or ▼ key.

   The display toggles between OFF and ON.

   To apply the setting, press S key or to exit the setting press M keypad.

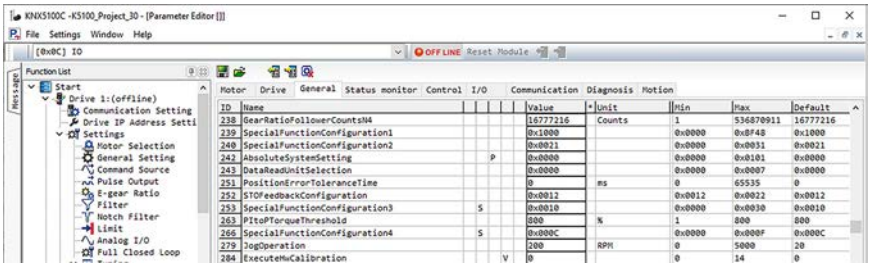
See Chapter 6, Use the Keypad Interface for help with setting the network parameters

Set Network Parameters by Using KNX5100C Software

Follow these steps to network parameters.

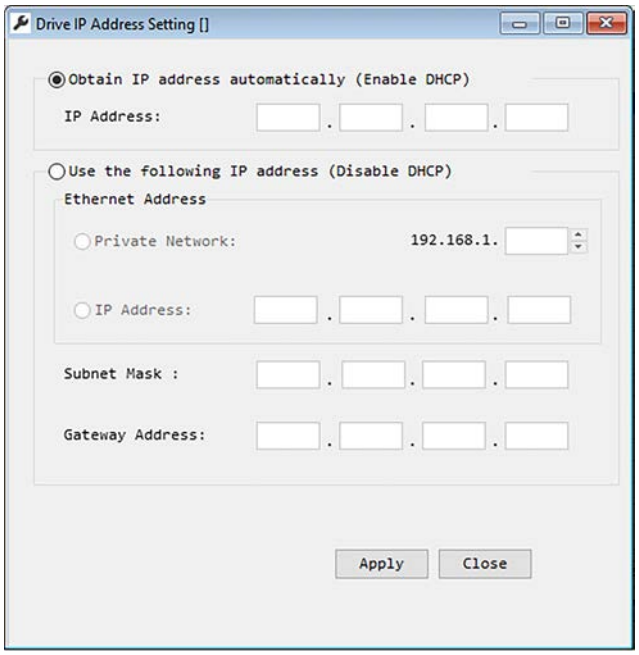
1. Connect USB cable between your drive and workstation, and then apply power to your drive
2. Open your KNX5100C software and click New Device.
3. To go online with the drive, click the OFFLINE button.

   The KNX5100C software reads the parameters from your drive.



4. From the Function List, click Drive IP Address Setting.

   The Drive IP Address Setting dialog box appears, and the current IP Settings are displayed.



5. Choose between STATIC IP and DHCP.

   The default setting is STATIC IP.
6. If STATIC IP, then configure the following parameters:
   - IP address
   - Gateway
   - Subnet mask
7. Click Apply.
8. To have the IP Settings take effect, click Reset Module from the tool bar.

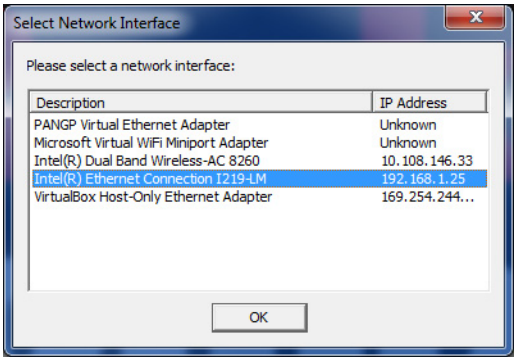
Configure IP Address by Using BOOTP-DHCP Tool

Follow these steps to configure the IP address.

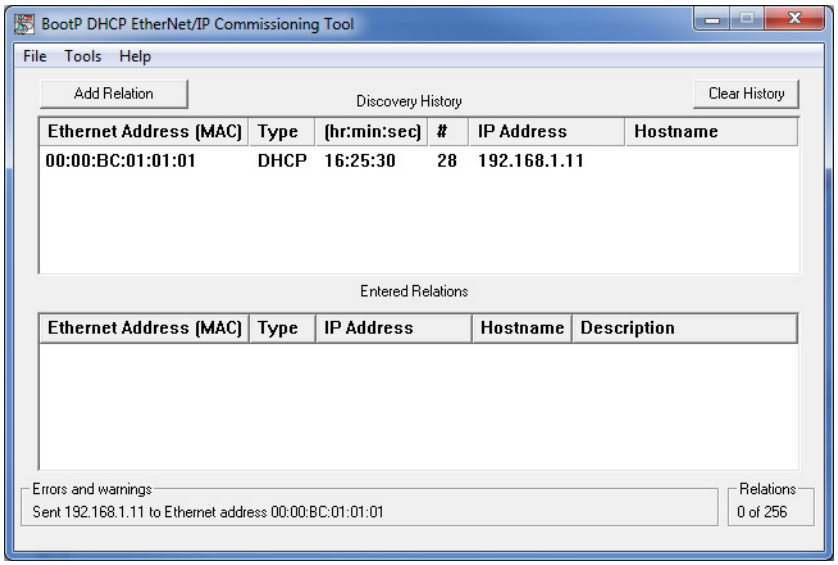
The Kinetix 5100 drive supports DHCP only, not BootP. You can use other DHCP server software to configure the IP address of the Kinetix 5100 drive. This example shows a software tool called BootP-DHCP Tool, which is installed together with the Studio 5000 application.

1. Connect your PC with a Kinetix 5100 drive via Ethernet cable, and then apply the power to the drive.
2. Open BOOTP-DHCP tool in your workstation, and select network interface according to your environment as shown.

   In this example, the IP address of workstation is 192.168.1.25.



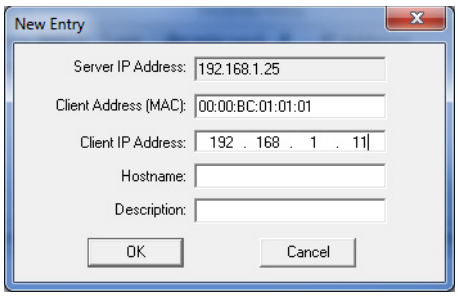
   The BOOTP-DHCP tool automatically scans the devices that are configured to DHCP on the network, and displays the device MAC addresses as shown.



   You can find the MAC address of your drive on the drive label. In this example, the MAC address 00:00:BC:01:01:01 is used.

3. From the dialog box, double-click the MAC address of your drive.

   The New Entry dialog appears.



4. Type your specified IP address in the New Entry dialog, and then click OK.

Notes:

Use the Keypad Interface

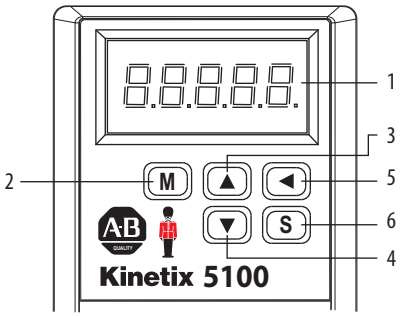
Topic	Page
Keypad Input and Panel Display	105
Drive Displays	106
Edit Settings From the Display	110

Keypad Input and Panel Display

The Kinetix® 5100 drive is equipped with a diagnostic status indicator and five push buttons that are used to display information and to edit a limited set of parameter values.

The drive has three status indicators: Charge, MOD, and NET. For an explanation of their functions, see Status Indicators on page 421. For more information on how the keypad and status indicator can be used to do tuning, see Autotuning via the Drive Panel on page 176.

Figure 69 - Keypad and Display



Item	Key	Name	Description
1	–	Display	A 5-digit, 7-segment status indicator that displays the monitoring values, parameters, and setting values.
2	M	Mode key	Use this key to return to the parent menu or, if there is one, to return to the previous menu.
3	▲	Up key	Use this key to return to the previous menu. It is also increases the values that you edit while in the configuration and parameter edit screens.
4	▼	Down key	Use this key to advance to the next menu. It also decreases the values that you edit while in the configuration and parameter edit screens.
5	◀	Shift key	Use this key to toggle between the digits or menus in the same level.
6	S	Set key	Use this key to enter a sub-menu, if one exists, or to confirm a value that you have edited.

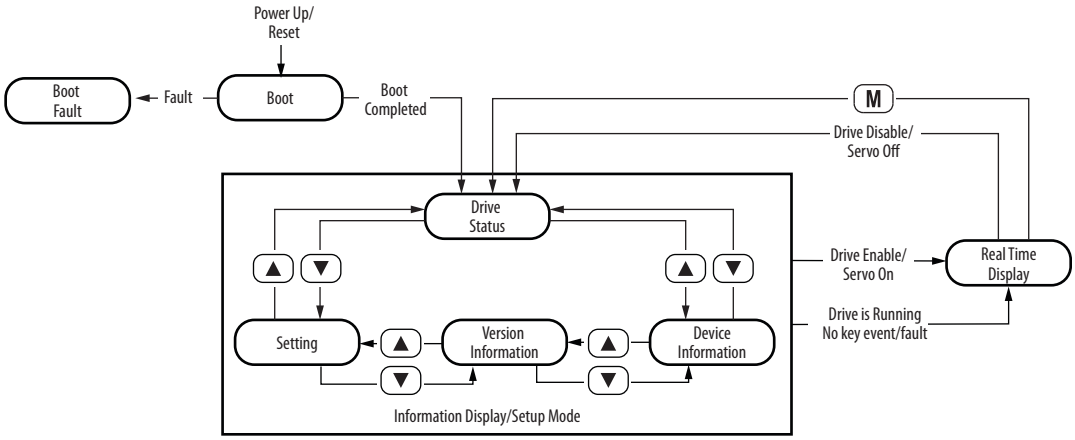
Drive Displays

After the drive boots up successfully, it displays Kinetix 5100 briefly and then transitions to the Drive Status display, assuming the drive is disabled/servo off. If the drive is enabled/servo on with no faults, then the Real Time display is shown. If a fault occurs, then the fault screen displays an E, followed by the fault code. If a warning occurs, then the fault screen displays an A, followed by the warning code.

For more information on fault codes, see Chapter 16, Troubleshoot the Kinetix 5100 Drive System.

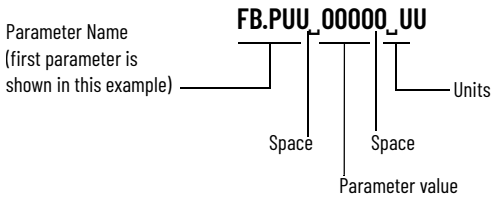
Main displays are as follows.

- Real time data
- Drive status
- Setting



Real Time Data

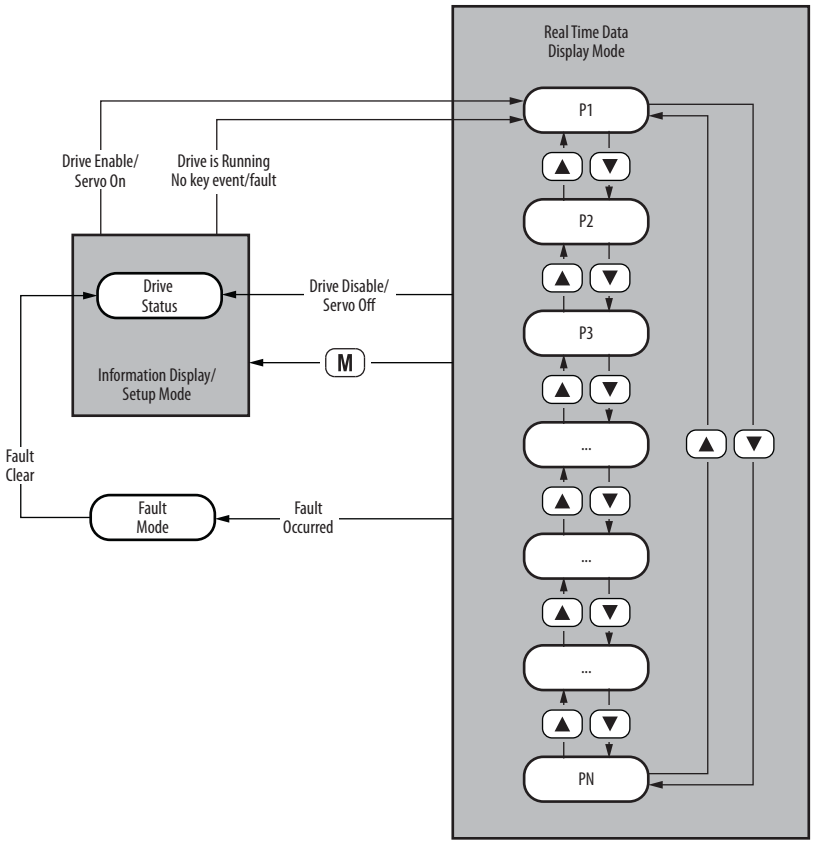
Real Time Data screen shows the real-time value of the selected parameter. The Real Time Data display format is as follows.



Use the  keys to move between parameters.

When the drive is enabled/servo on, you can use the M key to access the Drive Status screen to view information. If no button is pressed and no fault or alarm occurs within one minute, then the display reverts back to Real Time Data.

Figure 70 - Real Time Data Display



For example:

On the Real Time Display, the drive displays FB.PUU. When you press (▲), the drive displays C-PUU, which is the input pulse number. See Table 66 for the description of the Real Time Display symbols.

Table 66 - Real Time Display Symbols

Code	Real Time Displayed Symbol	Description	Unit
0	FbPUU	Motor feedback pulse number after the scaling of electronic gear ratio.	User unit
1	c-PUU	Input pulse number of pulse command after the scaling of electronic gear ratio.	User unit
2	ErPUU	The deviation between control command pulse and feedback pulse number.	User unit
3	Fbcnt	Motor feedback pulse number (encoder unit) (1.28 million count/rev)	Count
4	c-cnt	Input pulse number of pulse command before the scaling of electronic gear ratio. (encoder unit)	Count
5	Ercnt	Error pulse number after the scaling of electronic gear ratio. (encoder unit)	Count
6	cP-Fr	Input frequency of pulse command.	kpps
7	SPEEd	Motor speed.	rpm
8	cSPd1	Speed command.	Volt

Table 66 - Real Time Display Symbols (Continued)

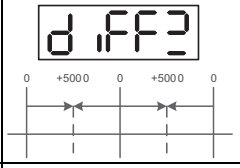
Code	Real Time Displayed Symbol	Description	Unit
9	cSPd2	Speed command.	rpm
10	c-t91	Torque command.	Volt
11	c-t92	Torque command.	%
12	AVG-L	Average torque.	%
13	PE-L	Peak torque.	%
14	U bUS	Main circuit voltage.	Volt
15	J-L	Load/motor inertia ratio. If 13.0 is displayed, the actual inertia is 13.	1 time
16	iGbt.t	IGBT temperature.	°C
17	rSnFr	Resonance frequency. Low byte is the first resonance and high byte is the second resonance.	Hz
18		The absolute pulse number of encoder Z phase equals the homing value, 0. The absolute pulse number can be +5000 or -5000 pulses depending on whether the motor rotates in a forward or reverse direction.	–
19	nMAP1	Map parameter number 1 displays the content of parameter ID55 (P0.025). Specify the map target by using ID60 (P0.035).	–
20	nMAP2	Map parameter number 2 displays the content of parameter ID56 (P0.026). Specify the map target by using ID61 (P0.036).	–
21	nMAP3	Map parameter number 3 displays the content of parameter ID57 (P0.027). Specify the map target by using ID62 (P0.037).	–
22	nMAP4	Map parameter number 4 displays the content of parameter ID58 (P0.028). Specify the map target by using ID62 (P0.038).	–
23	vAr-1	Monitor variable number 1 displays the content of parameter ID663 (P0.009). Specify the monitor variable code by using ID668 (P0.017).	–
24	vAr-2	Monitor variable number 2 displays the content of parameter ID664 (P0.010). Specify the monitor variable code by using ID669 (P0.018).	–
25	vAr-3	Monitor variable number 3 displays the content of parameter ID665 (P0.011). Specify the monitoring variable code by using ID670 (P0.019).	–
26	vAr-4	Monitor variable number 4 displays the content of parameter ID666 (P0.012). Specify the monitoring variable code by using ID667 (P0.020).	–
27	2-diF	Offset value between motor position and Z phase in PUU unit. The value is 0 when the position overlaps with Z phase. The greater the value, the greater the offset.	User Unit
28	FLt-c	Current drive fault.	–

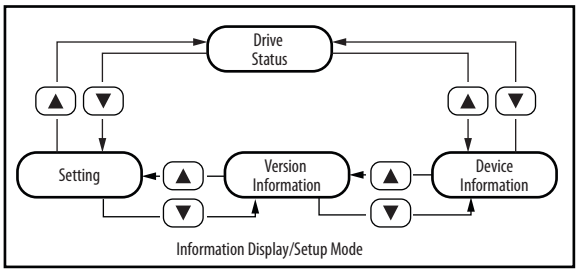
Table 66 - Real Time Display Symbols (Continued)

Code	Real Time Displayed Symbol	Description	Unit
29	AFb.UU	Position feedback from the auxiliary encoder.	User Unit
30	AEr.UU	Position deviation between the position feedback and the command from the auxiliary encoder.	User Unit
31	nAE.UU	Feedback position deviation between main encoder and auxiliary encoder.	User Unit

Drive Status Display

This display provides drive information and access to the Setting display, which shows network and parameter information. When the drive is enabled/servo on, the information can only be viewed.

Use the keys to move between status information displays.



Device Information Screen

Drive Status Name	Display String	Description
Standby	Stdby	If the drive has passed boot steps and self-testing, but the drive has not been configured. • DHCP off: Stdby_192.168.1.180 • DHCP on (before IP address is assigned): Stdby_DHCP_0.0.0.0 • DHCP on (after IP address is assigned): Stdby_DHCP_192.168.1.180
Stopped	StoP	If the drive has been configured, but it is still not enabled/servo on.
Running	RUN	The drive is enabled/servo on.
Fault		A fault or warning occurred during operation.

Version Information Screen

This screen displays hardware and firmware versions of the drive. The display string is h␣01.002␣␣F␣01.102. h represents the hardware version, and F represents the firmware version.

Setting Screen

When the drive is disabled/servo off, the Setting screen lets you edit the network address or drive parameters, or reset the drive.

For more information, see Edit Settings From the Display on page 110.

Edit Settings From the Display

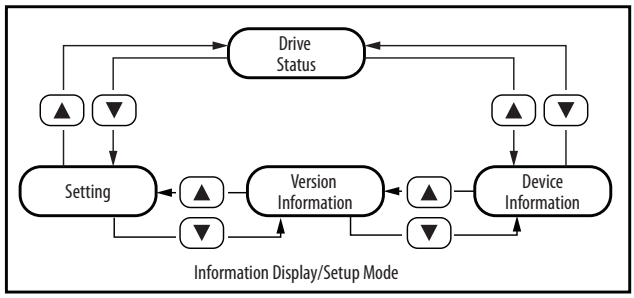
Access the Setting display from the Drive Status display by pressing the ▼ key.

When the drive is disabled/servo off, perform the following steps.

1. Press the S key to enter the editing mode.

   Use the ▲ ▼ keys to scroll through the Network setting, reset, and parameter setting displays.
2. Press the M key to return to the previous display.

Figure 71 - State Switch Machine of Information Display and Setup



Edit Network Settings

From the Setting display, perform the following steps.

1. Press the S key to go to Network Setting display.
2. Press S again to enter the Static IP display.

   From that display, there are two choices:

   - Press S again to set a static IP address. See Set Static IP Address.
   - Press the ▼ key to turn DHCP on or off. See Turn DCHP On or Off on page 112.

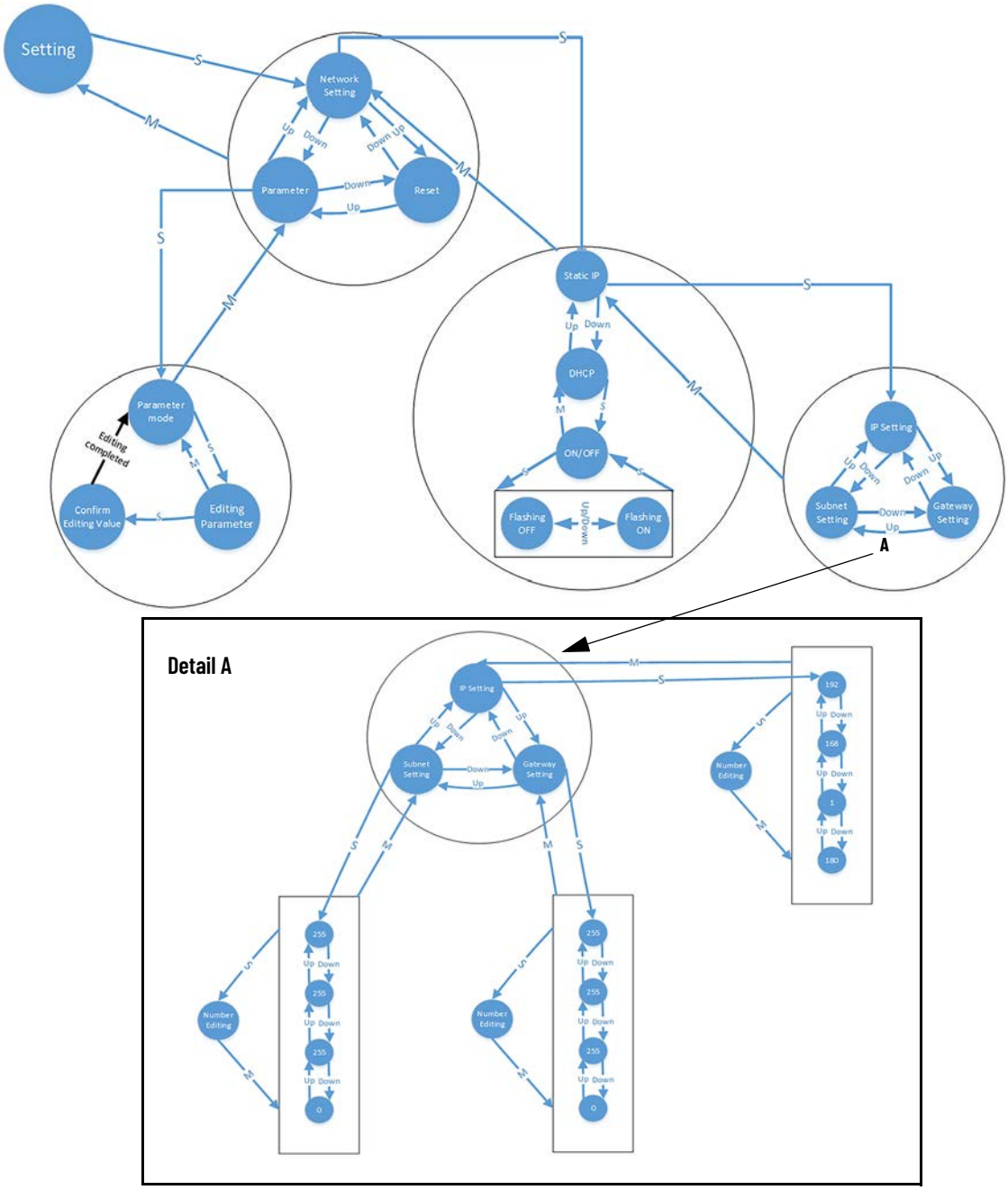
Set Static IP Address

On the Static IP Address display, perform the following steps.

1. Press the S key to enter the IP Setting display.
2. Press the S key to enter the edit display.
3. Use the ▲ ▼ keys to move between the IP Address, Gateway, and Subnet setting screens.

   See Detail A in Figure 72.
4. Press the key in any one of those settings displays and use the ▲ ▼ keys to edit the values.
5. Press the M key to set the values and return to the setting display.
6. Press the M key to return to the IP Address display.

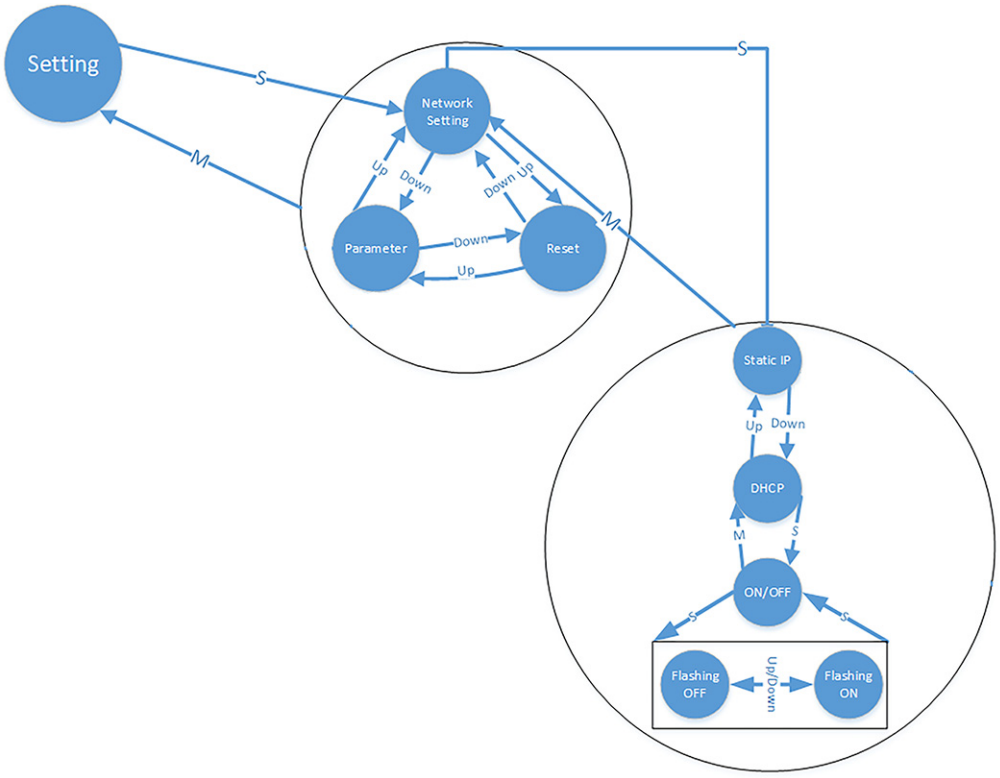
Figure 72 - State Switch Machine of Setting



Turn DCHP On or Off

On the DHCP display, perform the following steps.

1. Press the S key to enter the DHCP editing display.
2. Press the S key to turn the switch OFF or ON.
3. Press the M key to return to the DHCP editing display.
4. Press the ▲ key to return to the IP Setting display.



Edit Parameter Settings

From Settings display, perform the following steps.

1. Press the S key to get to Network Settings.
2. Press the ▼ key for Parameters.
3. Press the S key for the parameter editing mode.

   Starting with group 0, Use the ▲/▼ keys to move between parameter numbers within the group.
4. Use the ◄ key to move to the next parameter group.

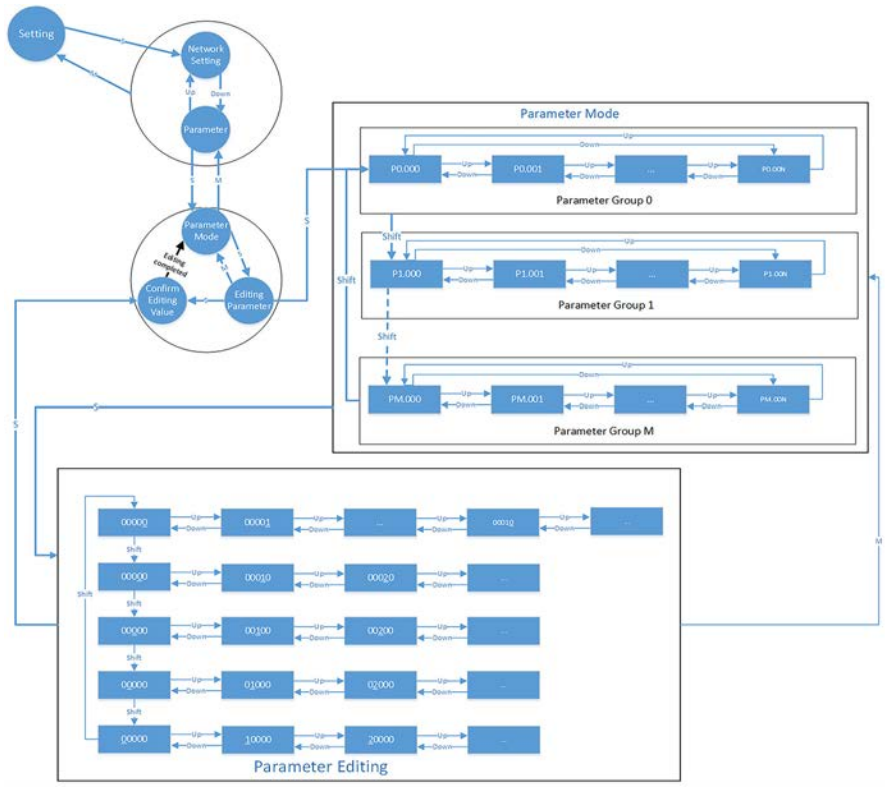
   Use the ▲/▼ keys to move between parameter numbers within a group.

5. Once you have navigated to the parameter you want to edit, press the S key to select it.

   Use the ▲ ▼ keys to change the value of the selected digit (flashing). Use the ◄ key to move between digits.

6. Press the S key to confirm the edit or the M key to cancel the change and to return to the Parameter display.

When you press the S key, the drive saves the value and displays Saved or another status message on the display. See Table 67 on page 113.



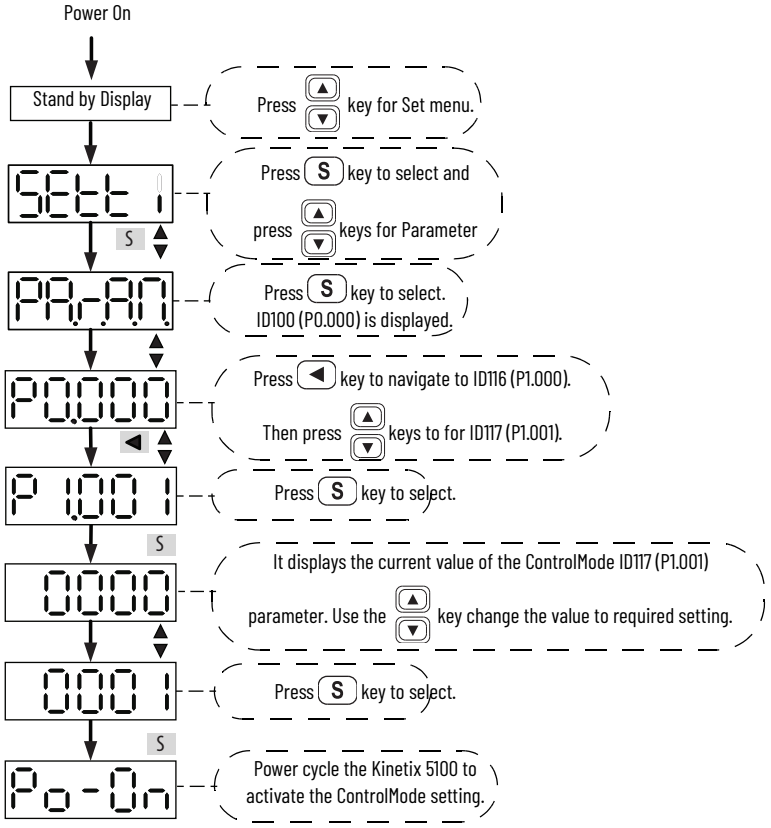
Save Display

When you have set the parameter, press the S key to save. The display shows one of the following symbols for one second.

Table 67 - Parameter Status Display

Displayed Symbol	Meaning	Description
SAVEd	Saved	Correctly saved the setting value.
Out-r	Out of Range	Incorrect value or the input is reserved for this value.
Po-On	Power On	The parameter will be effective after the servo drive is re-powered.

Example



Reset the Drive via Keypad

To reset the drive, perform the following steps.

1. From the Parameter display, press the ▼ key to get to the Reset display.
2. On the Reset display, press the S key.

   The reset string blinks.
3. Press the S key again.

   The drive resets.
4. Press the ▲ key to return to the Parameters display.

Display Low Byte, High Byte, and Negative Values

In the real-time data display, all values are scrolled and displayed as decimal or hexadecimal. On the parameter editor screen, the value range can be shown in one of two ways:

- The real-time value is ‘short’ or 16 bits (can be shown in one screen).
- The real-time value is ‘long’ or 32 bits (must be shown in two screens). The first screen is the high byte and the second screen is the low byte. In these instances, use the ◀ key to move between screens.

How the panel displays 16-bit and 32-bit values is shown in Table 68.

Table 68 - 16-Bit and 32-Bit Display Formats

Example of the displayed value	Description	
 (Dec)	16 bits	If the value is positive 12345, the display shows 12345 in decimal format.
 (Hex)		If the value is 0x011F, the display shows 0x011F in hexadecimal format; the highest digit is not shown.
 (Dec high)	32 bits	If the value is (positive) 1230478900, the display for the high byte shows 12304, and display for the low byte shows 78900, both in decimal format.
 (Dec low)		
 (Hex high)		If the value is 0x001F0000, the display for the high byte shows h001F, and display for the low byte shows L0000 in hexadecimal format.
 (Hex low)		

Figure 73 shows the panel display of positive and negative signs.

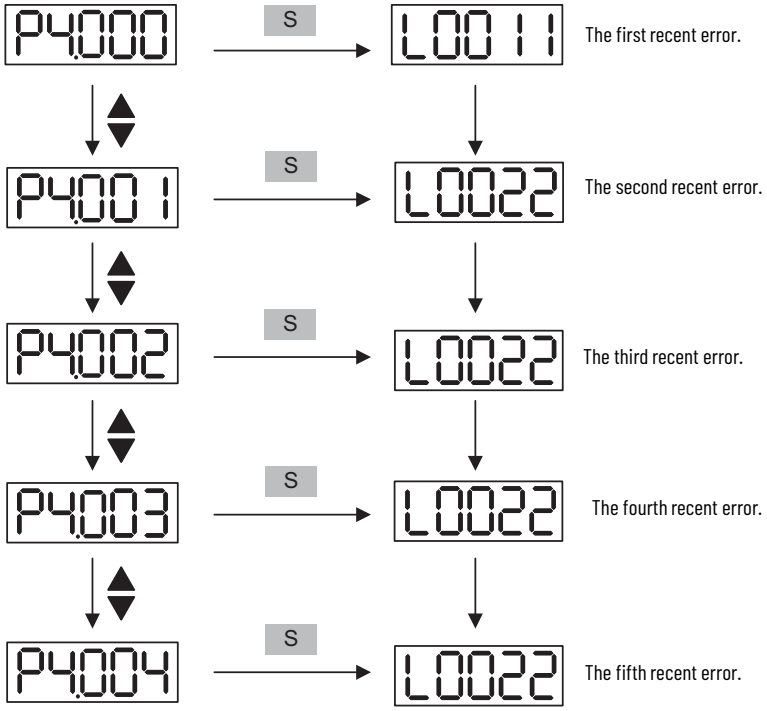
Figure 73 - Panel Display

Positive Sign	Negative Sign
	

Display Fault Record

From the Diagnosis display, use the ◄ key to move between high and low byte. Parameter ID274 (P4.000) FaultRecordN displays the most recent fault. It is not read-only and can be set to 0 to reset all fault records.

Parameters ID275...ID278 (P4.001 ...P4.004) are read-only.



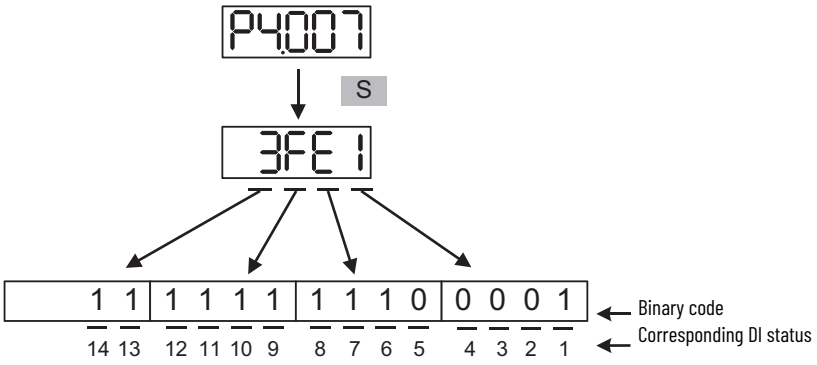
Diagnosis Parameters via Keypad

You can use the keypad to display the status of digital inputs and outputs.

Digital Input Diagnosis Operation

When external output signal triggers DI1...DI10, the display shows the corresponding signal by bit. When the bit is equal to 1, the DI is on.

For example, if hexadecimal number 3FE1 is displayed, the binary equivalent for E is 1110, then DI6...DI8 are on.

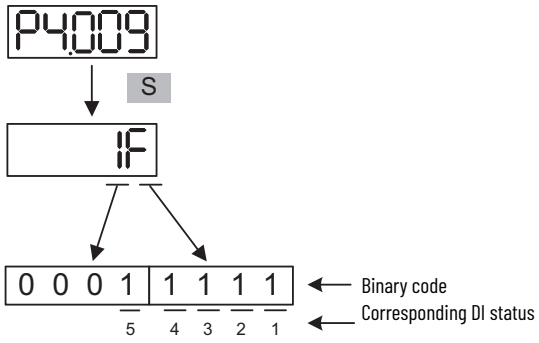


The display is in hexadecimal format.

Digital Output Diagnosis Operation

The output signal DO1...DO5 are triggered and the corresponding signals are shown on the display by bit. When 1 is displayed, the DO is on.

For example, if hexadecimal number 1F, is displayed, the binary equivalent for F is 1111, then DO1...DO4 are on.



The display is in hexadecimal format.

Display Firmware Upgrade Information

See Upgrade Kinetix 5100 Drive Firmware on page 445.

Notes:

Configure the Drive with KNX5100C Software

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Set the IP Address	126
Select a Motor and Configure Feedback in KNX5100C Software	127
Parameter Editor	138
Choose an Operation Mode	141
Configure Settings	144
Configure Position, Velocity, and Current Loops	158
Configure Velocity Loop	159
Configure Current Loop	160
Digital I/O and Jog Function in KNX5100C Software	160

Before You Begin

This section provides procedures to launch KNX5100C and configure your Kinetix® 5100 drive system with a Micro800® controller by using the Connected Components Workbench™ software. It also provides instructions to download and install KNX5100C configuration software.

For help using the Connected Components Workbench as it applies to configuring the Micro800 controllers, see Additional Resources on page 8.

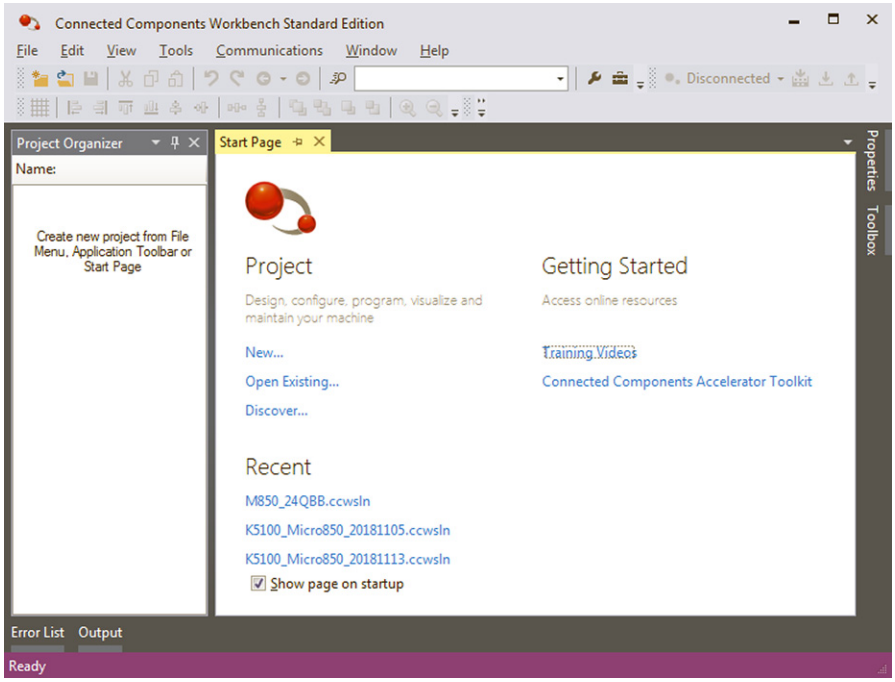
The Connected Components Workbench application, version 11.00 or later, makes it possible to launch KNX5100C Configuration Tool and to configure a Kinetix 5100 drive.

These procedures assume that you have wired your Kinetix 5100 drive system.

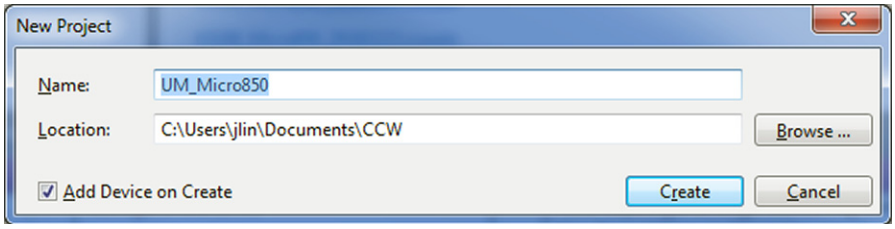
Configure the Micro800 Controller

To configure the Micro800 controller, perform the following steps.

1. Apply power to your controller and open your Connected Components Workbench software.

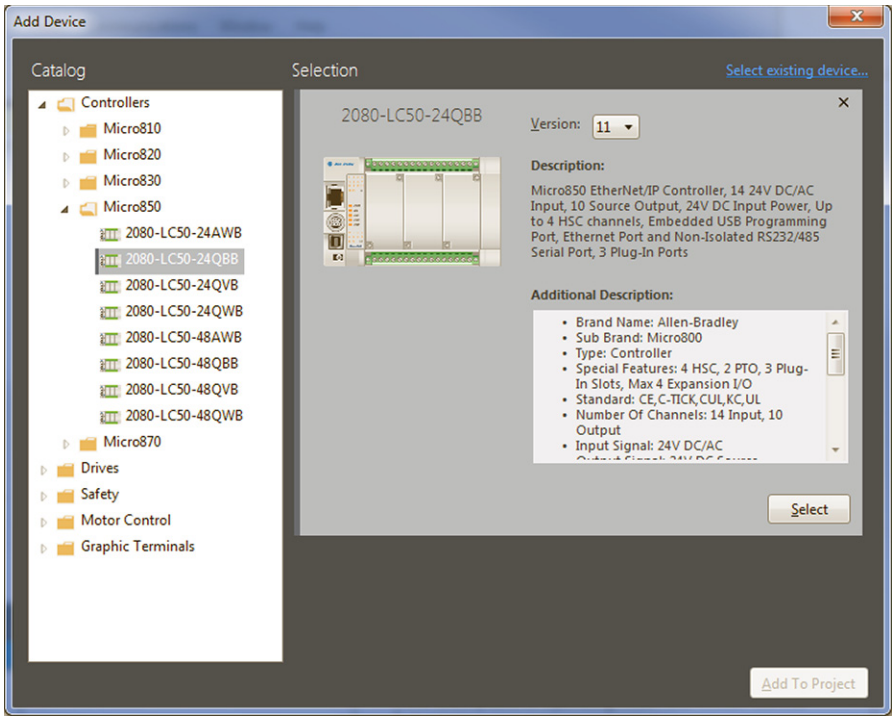


2. From the Project menu, choose New ...
3. Type a name and click Create.



4. From the Catalog field, select your Micro controller.

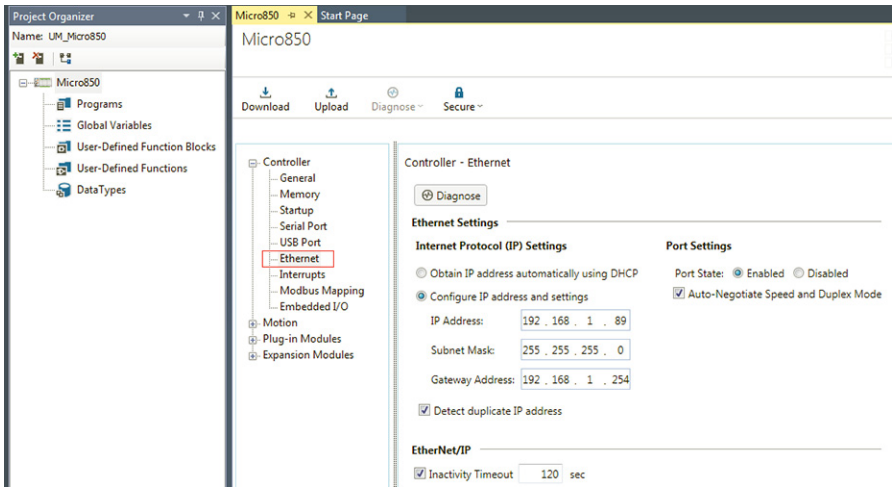
   In this example, Micro850® (24QBB) is used.



5. Click Add To Project.
6. From the Controller Menu, click Ethernet to configure the Network settings of the controller.

   This step is required to control the Kinetix 5100 drive through message instructions.

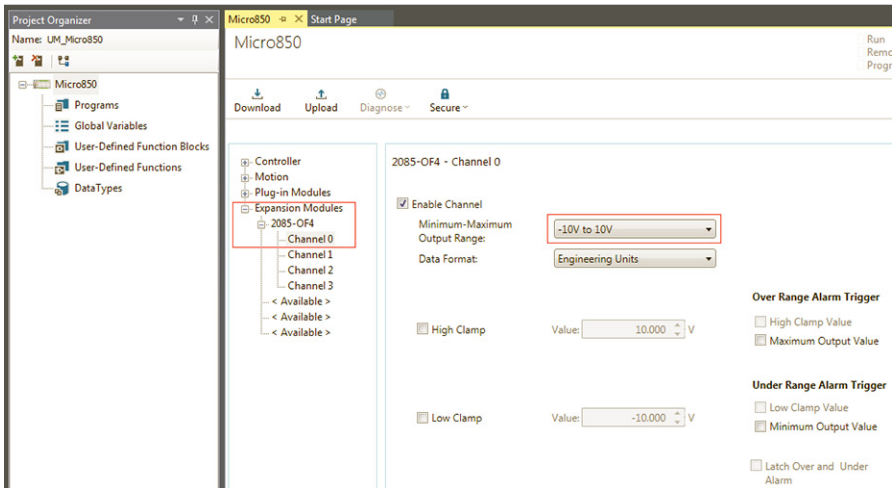
   In this example, we used the IP address of 192.168.1.89.



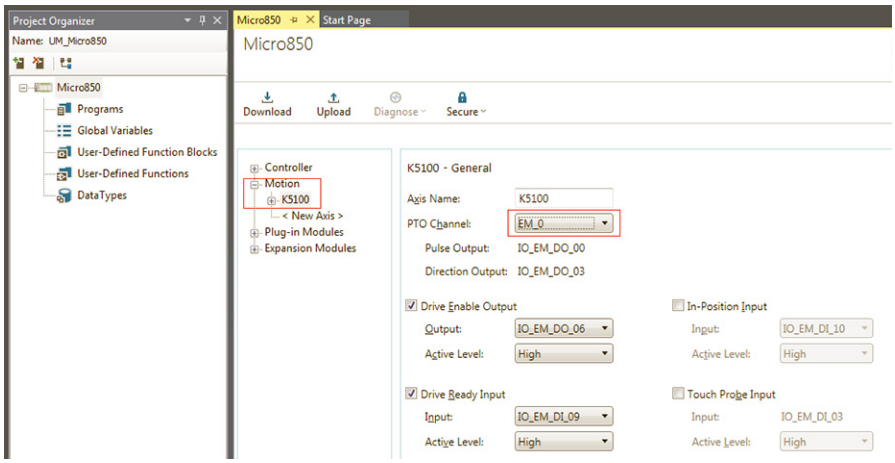
7. From the Controller menu, expand Plug-in Modules or Expansion Modules, then right-click <empty> to add analog output module (2080-OF2 or 2085-OF4).

   This step is required to control the Kinetix 5100 drive through S (Analog to Speed) mode, T (Analog to Torque) mode or PT (Analog to Position) mode.

   In this example, 2085-OF4 expansion module is used.



8. From the Controller menu, expand Motion, then right-click <New Axis> to add one PTO Channel for motion control.



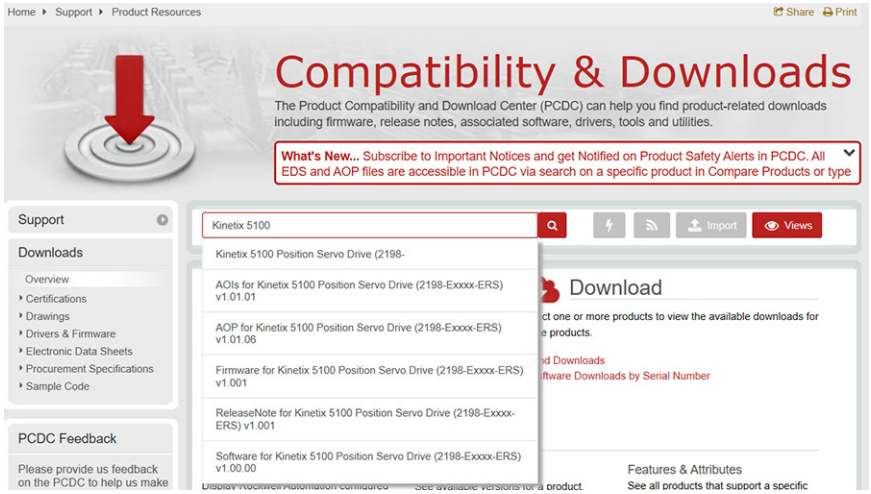
Download KNX5100C Software

KNX5100C configuration software is available for download at the Product Compatibility Download Center (PCDC) website: https://compatibility.rockwellautomation.com/Pages/home.aspx.

To download the KNX5100C configuration software, perform the following steps.

1. Go to the Product Compatibility Download Center website.

   The Compatibility and Downloads webpage appears.
2. In the Search PCDC window, enter Kinetix 5100.



3. Click the appropriate software version and follow prompts to download.
4. Extract the zip file and run Setup.

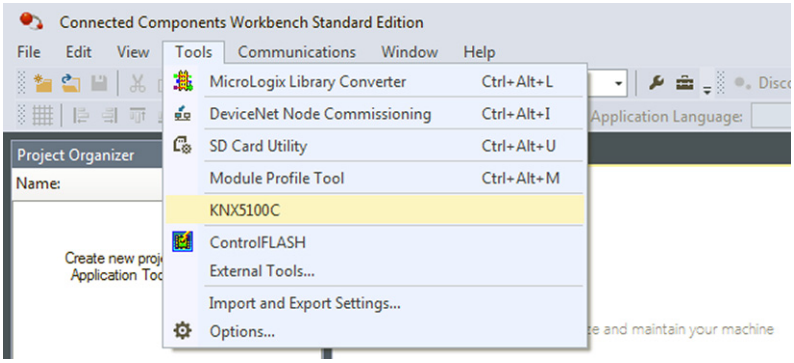
Launch KNX5100C Configuration Tool

To launch the KNX5100C configuration tool, perform the following steps.

1. Use one of two methods to launch the KNX5100C software:
   a. On your personal computer desktop, double-click the KNX5100C shortcut icon.

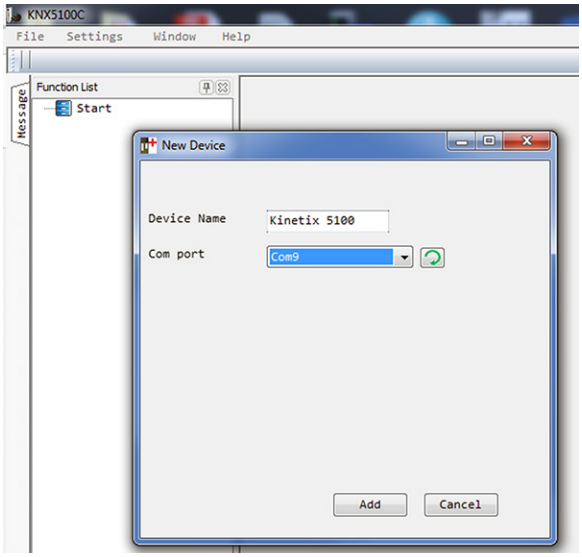


b. If you have Connected Components Workbench software installed, open it and select Tools > KNX5100C.



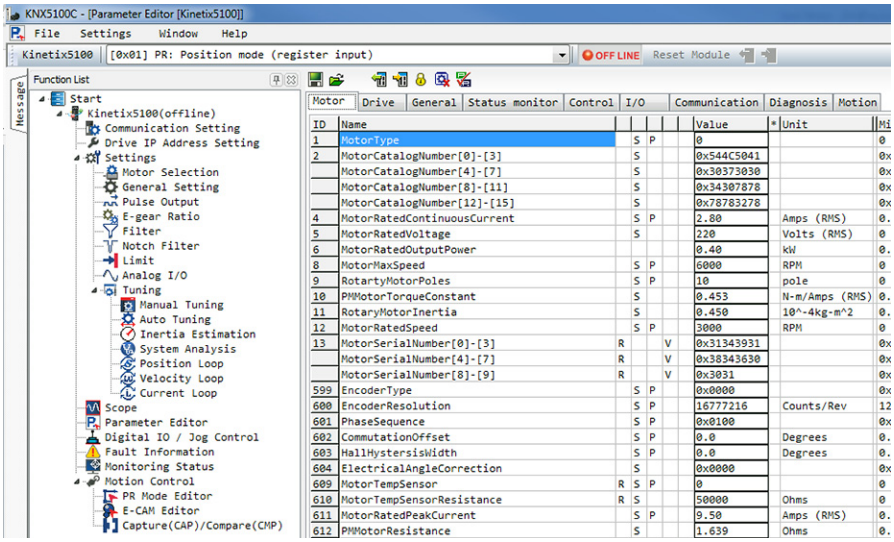
When the KNX5100C configuration software is launched, it starts with New Device.

2. Choose the COM port associated with your drive.



3. Click Add to add your drive to the Function List.

By default, Kinetix 5100 is used as the device name.



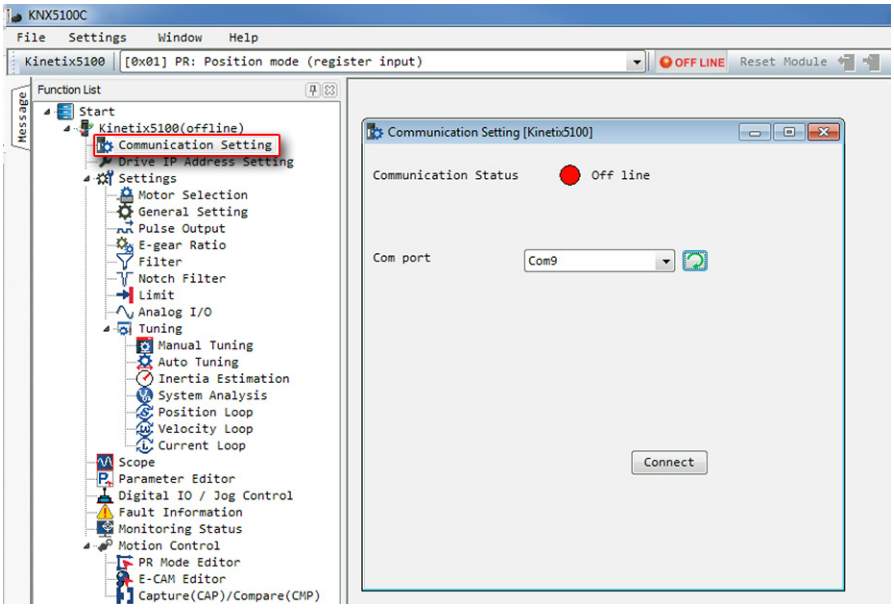
To add more drives that are connected your computer, from the File menu, choose Add New Drive or right-click Start/Add Device in the Function List.

Connect to the Drive

You can change the COM port associated with your device after it was initially set.

To change the COM port, perform the following steps.

1. From the Function List, click Communication Setting.

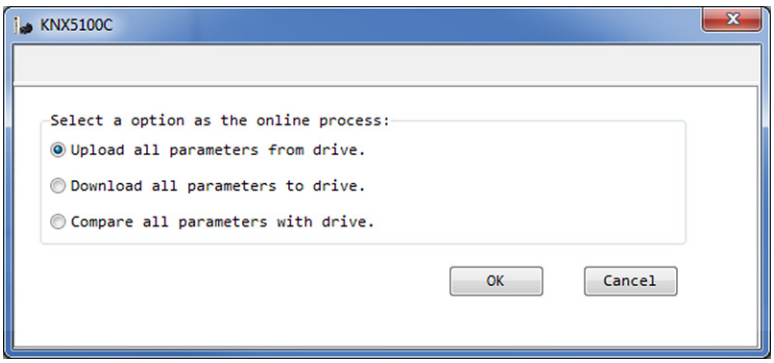


2. Choose the COM port associated with your drive.

You can choose the COM port from the pull-down menu, or click to refresh the COM port.

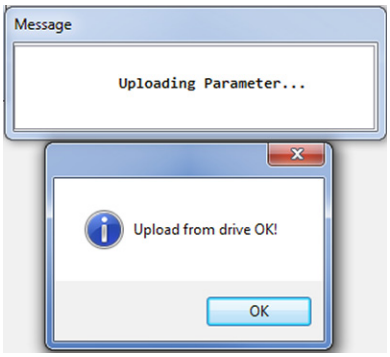
3. Click Connect to connect your drive.

   The online process options dialog appears.

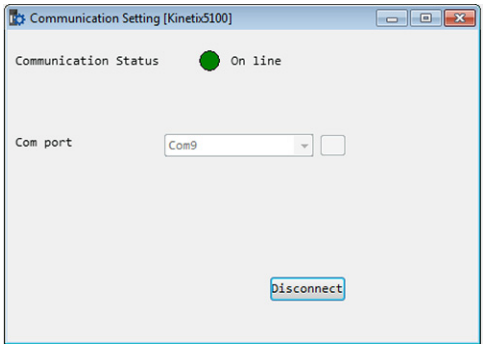


4. From the three options, choose the one that is best suited as your online process, and then click OK.

5. If you select the first option, an uploading message box appears until the process is completed.



6. In the Communication Setting dialog, communication status is shown as online.

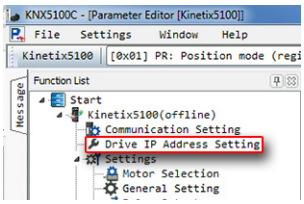


Set the IP Address

You can change the IP address (network) setting through the Function List.

To change the IP address, perform the following steps.

1. Under the Function List, click Drive IP Address Setting.



2. Choose between STATIC IP and DHCP.

   If Static IP, then configure the IP address, Gateway, and Subnet mask.

IMPORTANT Settings are stored in nonvolatile memory, and changes to the IP address take effect after power is cycled.

For more information on setting the network parameters, refer to Chapter 5, Set Up EtherNet/IP Communication.

Select a Motor and Configure Feedback in KNX5100C Software

There are three data sources available to configure the motor through the Function List.

The parameters displayed in the Motor Selection dialog box depend on the data source and the type of motor selected.

You can specify the motor data source and configure the related parameter value via the motor pages according to data source and motor type.

Data Source

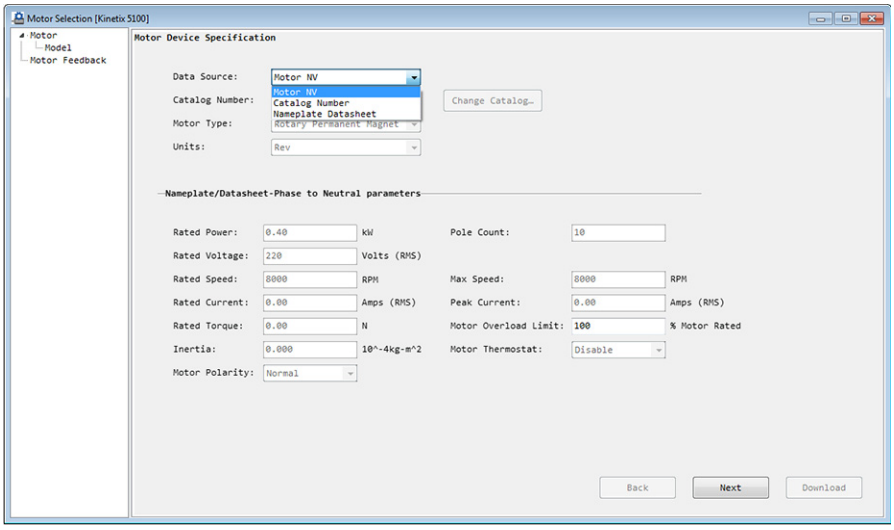
You can specify the data source where the motor parameters values originate.

The available data sources are:

- Motor NV: Motor parameter values are from the nonvolatile memory of a motor. If the motor has an intelligent encoder, the value is used by the drive to automatically identify the attached motors.
- Catalog number: Motor parameter values are from a catalog number. Select the motor from the motor database embedded into the KNX5100C software.
- Nameplate datasheet: Motor parameter values are from a motor nameplate and data sheet. You must input this data manually.

IMPORTANT When the nameplate data sheet is selected, the parameter field of nameplate/data sheet parameter section of the Motor, Model, and Motor Feedback pages are enabled, and you can input these values.

If a data source other than Nameplate data sheet is selected, the parameter field of nameplate/data sheet parameter section of the Motor, Model, and Motor Feedback pages are disabled and the motor parameters values are read either from the intelligent encoder or the KNX5100C motor database.



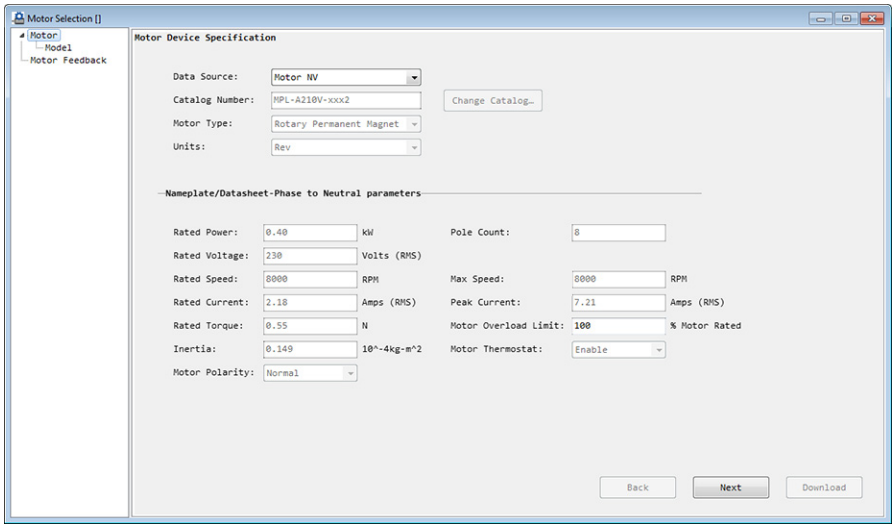
Motor NV

When Motor NV is selected as the data source and the attached motor has a smart encoder with internal memory that includes motor-related parameters, the drive can identify the motor automatically and read all motor parameter values.

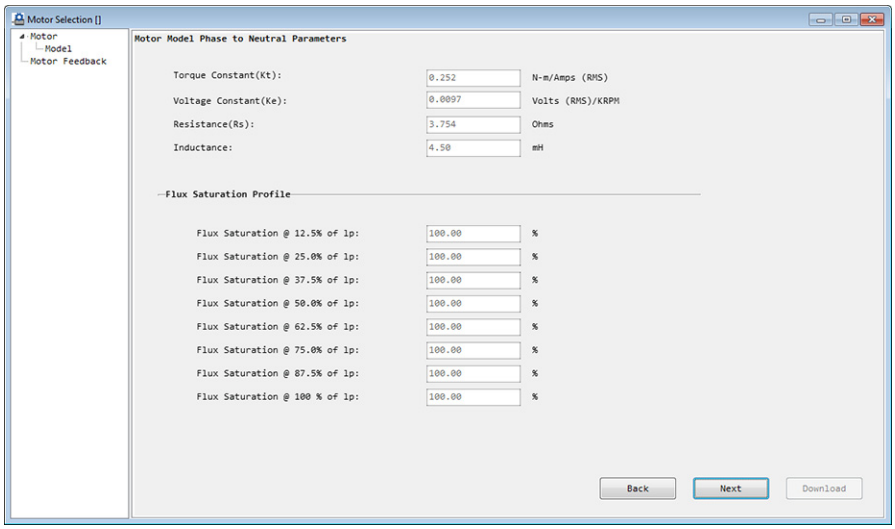
If the attached motor has no smart encoder, then fault E 60B, Motor Selection Error, occurs. If the attached motor has a Nikon encoder that is not a smart encoder and no motor parameters are stored, then fault E 004, Motor Combination Error, occurs.

When Motor NV is selected as the data source, then all parameter data is disabled on the Motor Device Specification dialog box except for the motor overload limit field and the Next button.

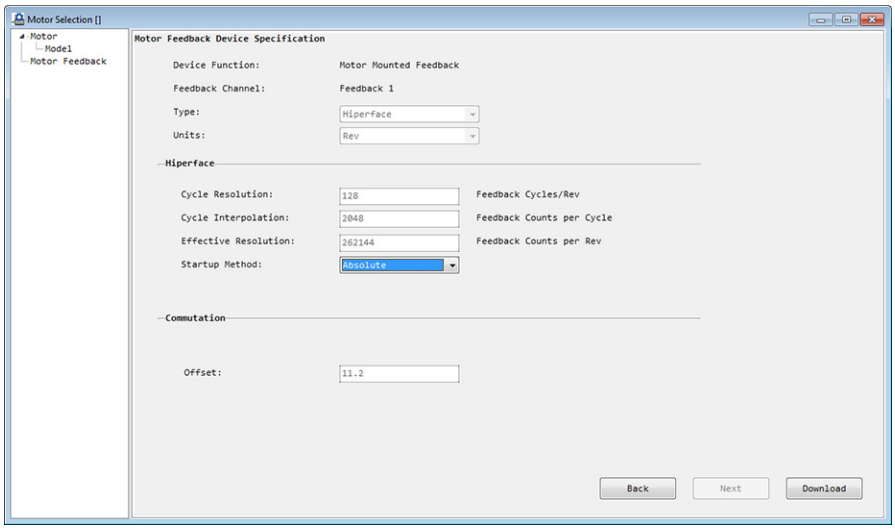
1. Type an appropriate motor overload limit and click Next.



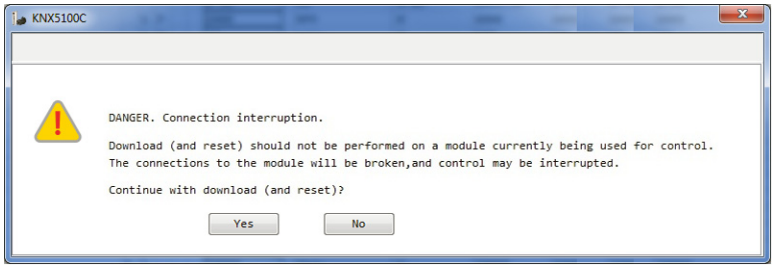
2. On the Motor Model Phase screen, click Next.



3. On the Motor Feedback Device screen, click Download to download all parameters to the drive.



The following screen notifies you that the drive requires a reset and power cycle.



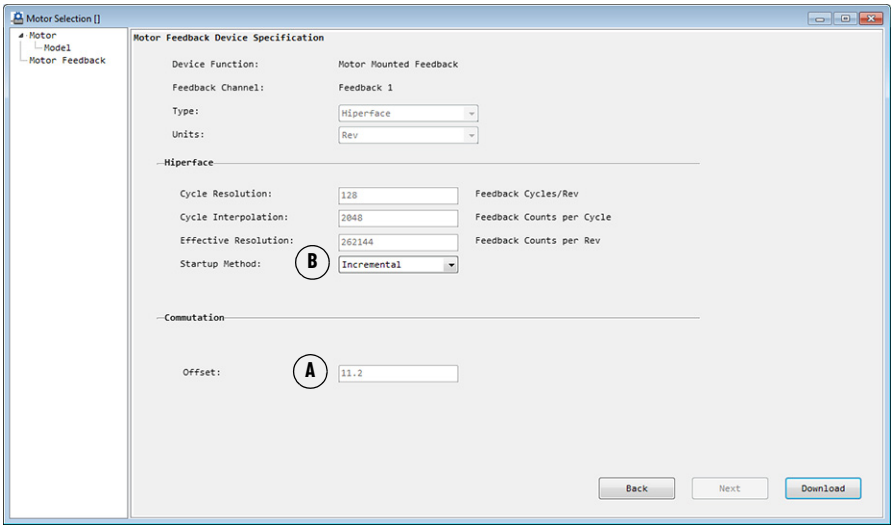
After you click Yes, the drive performs the following sequence:

- Sets ID628 (PN.000) MotorDataSource to 0 (Motor NV selection)
- Sets the value of ID629 (PN.001) MotorOverloadLimit
- Automatically triggers a power cycle

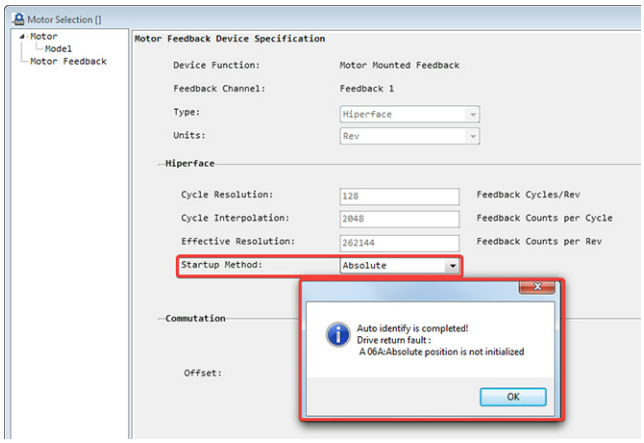
After the reset and power cycle, the identified motor catalog number is shown in the motor page, and the motor related parameters are updated according to encoder internal memory.

After Motor NV is selected and the drive power cycles, these other changes are made:

- Commutation alignment is fixed as Motor offset (A in next figure)
- The default Startup Method is set as Incremental (B in next figure)
- The position feedback is zero



If your axis requires absolute positioning, you can change the startup method to Absolute from the pull-down menu. If you do, click Download to initiate the change. Then parameter ID242 (P2.069) AbsoluteSystemSetting is set to 1 and the drive automatically triggers a power cycle. Warning A 06A (Absolute position is not initialized) occurs after the power cycle, so you must initialize the absolute position to clear this fault to let the absolute operation start.



IMPORTANT If the startup method is set to Absolute but the attached motor is not equipped with an appropriate encoder or is not configured correctly, then the following faults are posted:

	Kinetix MP Motor-related Faults		
	Single Turn (-E, -S)	**Multi-turn (-V, -M)**	**Incremental (-H)**
Change startup method to Absolute	E 069	A 06A	E 069

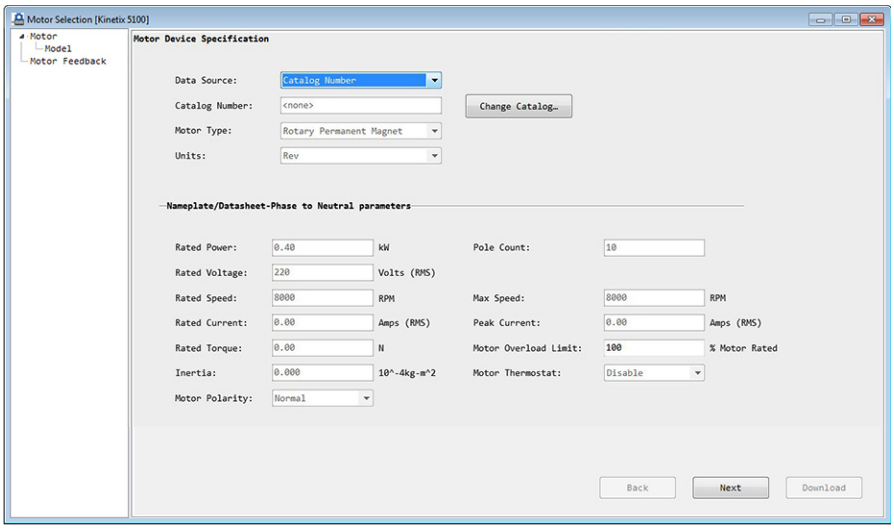
	Kinetix TLP and TL/TLY (-B) Motor-related Faults	
	Without Battery	**With Battery**
Change startup method to Absolute	A 060	A 06A

Catalog Number

When the catalog number is selected as the data source, you must select the appropriate motor from the Change Catalog Number dialog box.

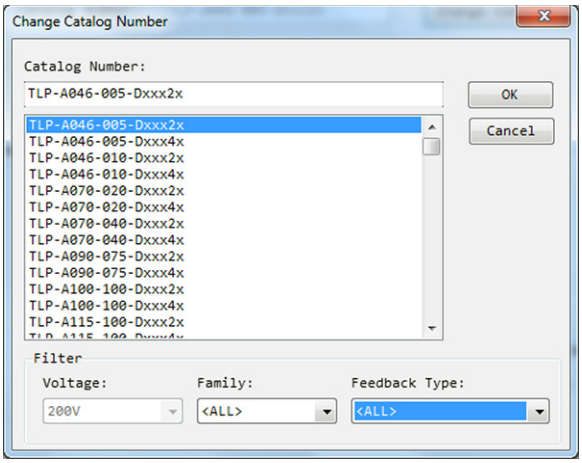
To change the catalog number, perform the following steps.

1. Choose Function List > Settings > Motor Selection, and select Catalog Number from the Data Source pull-down menu.



2. Click Change Catalog...

3. In the Change Catalog Number dialog box, find and select the motor for your application.



Catalog number availability is from the motor database embedded into the KNX5100C software.

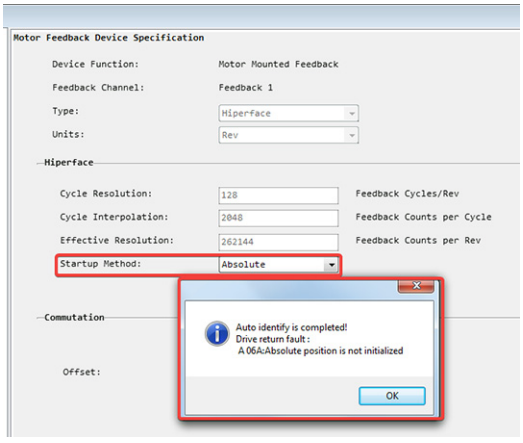
Use the Family and Feedback Type pull-down menus to further filter the related motors.

4. Click OK to select that catalog number and to close the Change Catalog Number dialog box.

   When you click OK, all motor parameter values for that catalog number are retrieved from the KNX5100C motor database.

5. From the Motor Device Specification dialog box, click Download.
6. Drive power is automatically cycled. When power is restored to the drive, all motor parameter values for the selected catalog number are downloaded to the drive and take effect.

IMPORTANT If you select the wrong catalog number, an E 60A (Catalog Number Match Error) fault occurs at the drive.



To correct the error, use one of three methods of commutation alignment explained in step 3 on page 135, and to Considerations for Drive Offset Alignment on page 135.

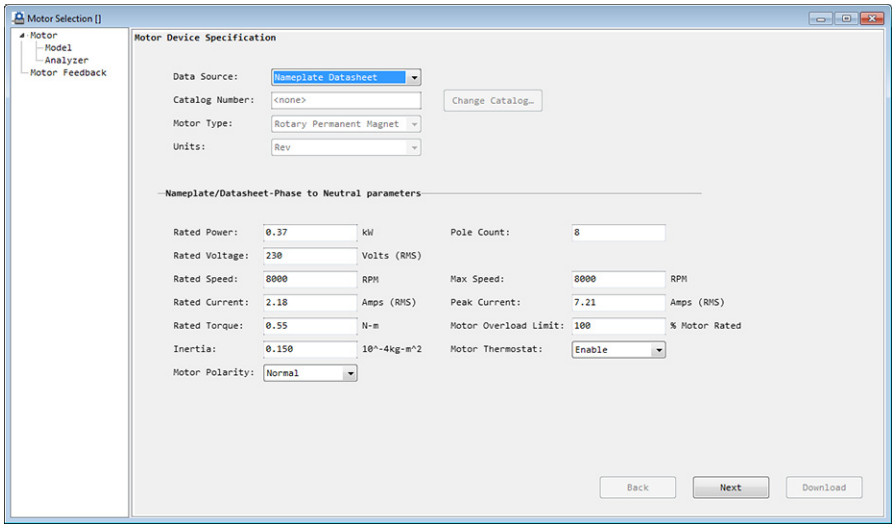
Nameplate Data Sheet

Motor parameter values are from a motor nameplate and data sheet. You must input this data manually on the Motor and Model pages.

IMPORTANT	Nameplate data sheet as a data source only operates with an AqB feedback type motor. If the attached motor has a smart encoder, then the error code E 60B, Motor Selection error, occurs when you use this data source.

To select Nameplate data sheet as your data source, perform the following steps.

1. Choose Function List>Settings>Motor Selection>Motor Device Specification, and select Nameplate Datasheet from the Data Source pull-down menu.

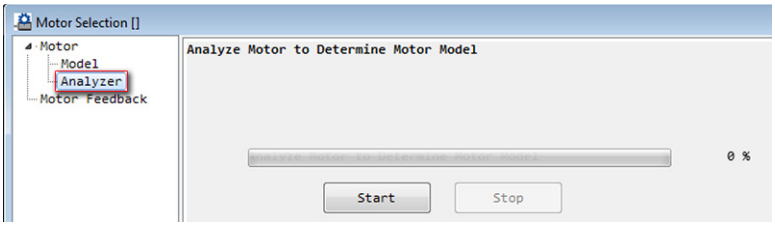


2. After you add data manually to the fields under the Nameplate/ Datasheet-Phase to Neutral Parameters section, click Next.
3. From the Motor Model Phase to Neutral Parameters dialog box, add data manually.

   When you are done, click Next.
4. From the Motor Feedback Device Specification dialog box, select applicable feedback type from the Type pull-down menu.
5. Click Download.
6. After the motor parameters are downloaded, you can use the motor analyzer feature, where the drive analyzes the motor and provides suggested parameter values.

   To use the motor analyzer feature, perform the following steps.

   a. Select Motor > Analyzer.

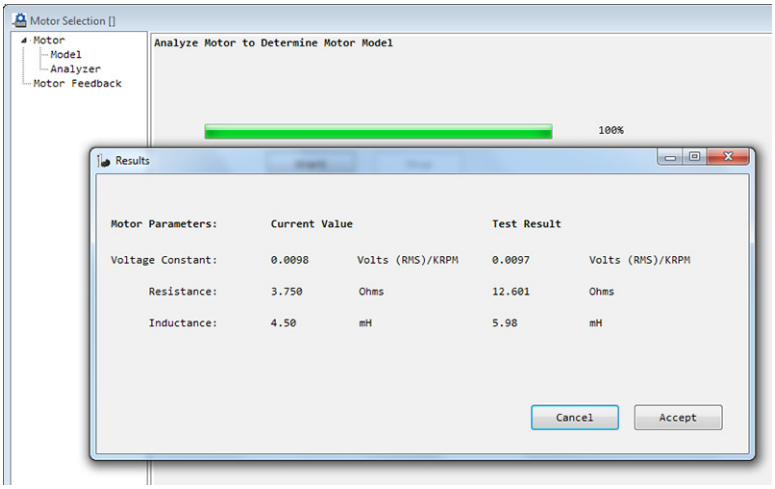


   b. Click Start to initiate the analyze process.

c. After each step of the analyzing process is completed, a confirmation window appears; click OK.

d. A results window appears with suggested parameter values.

e. Click Accept if you want to use those values, or click Cancel if you want to stay with the parameters that you added manually.



7. If you click Accept, drive power is automatically cycled. When power is restored to the drive, all motor parameter values that you added manually are downloaded to the drive and take effect.

Motor Feedback

With some motor type selections, the feedback type is automatically selected for the corresponding motor. For others, the selection can be changed.

For example, when the Nameplate Datasheet method is used to select a motor, only AqB feedback type can be chosen. These motors can only be operated as incremental, so the startup method is always incremental. In this scenario, there are two choices for the feedback type:

- Digital AqB - when the attached motor is not equipped with a Hall sensor.
- Digital AqB with UVW - when the attached motor is equipped with a Hall sensor.

IMPORTANT If you select Digital AqB when the attached motor has a Hall sensor, the drive ignores the Hall sensor.

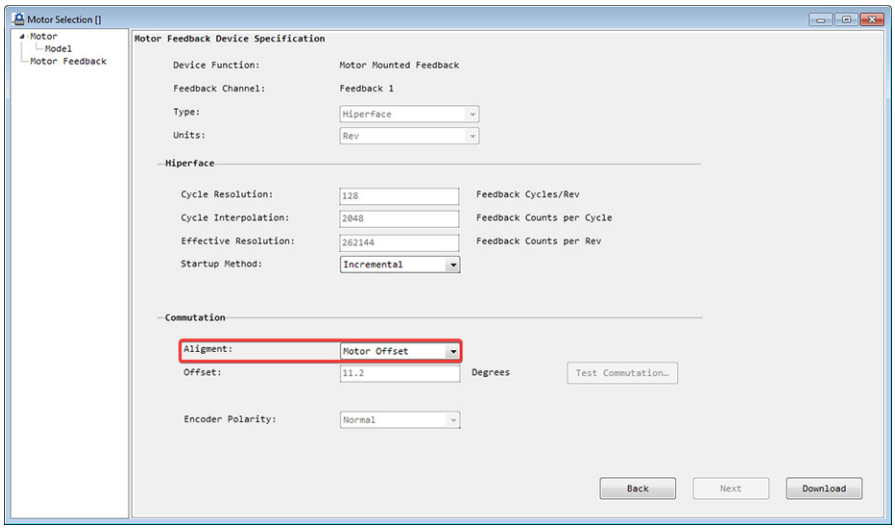
To choose a motor feedback type, perform the following steps.

1. Under Motor, select Motor Feedback.
2. On Motor Feedback Device Specification, choose either Incremental or Absolute as the startup method.

The chosen startup method determines how the device applies the feedback count value during drive startup.

For Incremental, the device zeros the feedback count accumulator at drive startup.

For Absolute, the device initializes the feedback count accumulator to the absolute feedback position value from the feedback device at drive startup.



3. Under Commutation, choose one of the following from the Alignment pull-down menu.
   - Motor Offset: This setting is the default if the selected catalog number and the attached motor has a smart encoder. The drive reads the internal commutation offset saved in the smart encoder.
   - Self-sense: This setting enables automatic magnetic field detection, where the commutation offset is detected automatically from the drive whenever the drive is powered up.

   Any commutation offset that is detected by self-sense alignment is not shown in the Offset field on Motor Feedback Device Specification.

   Self-sense alignment cannot read commutation offset from parameter ID602 (PM.007) CommutationOffset.

   - Drive Offset: You must input the commutation offset and encoder polarity manually.

Considerations for Drive Offset Alignment

If you select Drive Offset as the Commutation Alignment type, the valid range of the Commutation Offset is calculated based on the Commutation Offset from the encoder's internal value (x):

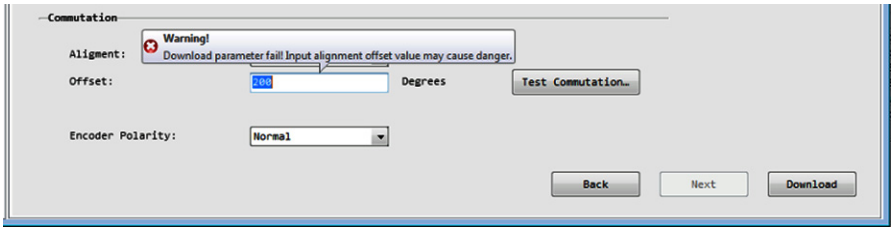
x-85 < Commutation Offset setting < x+85 (unit: degree)

For example:
By using the KNX5100C software, choose Start>Parameter Editor>Motor>CommutationOffset (ID 602).

With Motor Offset selected as the commutation alignment, the parameter ID602 (PM.007) CommutationOffset is 11.2°.

Therefore, the Commutation Offset setting for the Drive Offset type must be in the range of 0...96.2° and 286.2...360°.

If you click Download and the input value of 200 exceeds the range, the following warning appears.



You must change the input value before you can click Download again and have the input value accepted.

Run a Commutation Test

The commutation test determines an unknown commutation offset and can also be used to determine (or verify) the polarity of the start-up commutation wiring.

You can choose to keep or discard the test results.

IMPORTANT This test mainly applies to third-party or custom permanent-magnet motors equipped with (TTL with Hall) incremental encoders that are not available as a catalog number in the Motion Database.

This test also applies to Kinetix MP and Kinetix TLP motors that are available as a catalog number in the Motion Database, and use to verify a known commutation offset or use the test result other than the commutation offset specified in the motion Database.

The following parameters are updated after commutation test:

- Phase Sequence (PM.006)
- Commutation Offset (PM.007)
- Hall Hysteresis Width (PM.008)

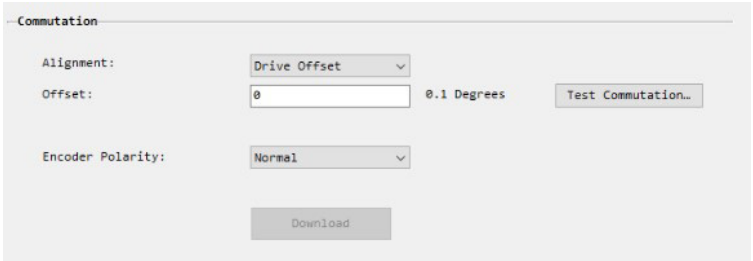
To test commutation, perform the following steps.

1. Verify the load is detached from the motor (unloaded).

ATTENTION: To avoid personal injury or damage to equipment, you must remove the load from each axis as uncontrolled motion can occur when an axis with an integral motor brake is released during the test.

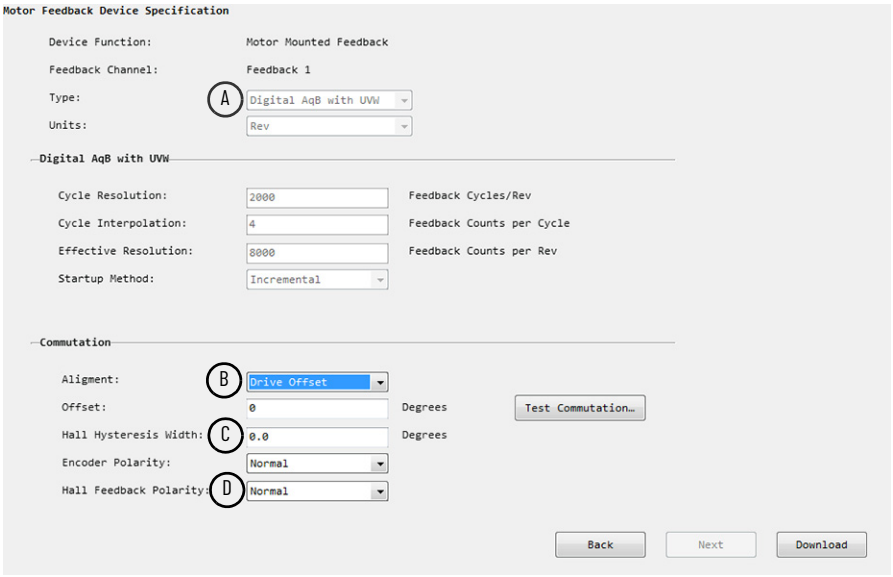
2. In the Alignment field, select Drive Offset.

   Different encoder types result in different configuration fields.



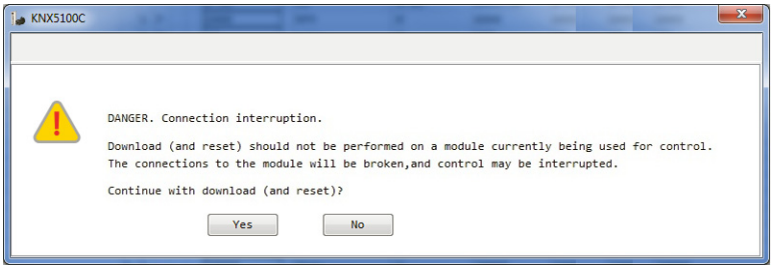
3. Type an offset.

4. If the attached motor feedback type is Digital AqB with UVW (A in the following figure) and the Commutation Alignment is Drive Offset (B), then you must add additional data to the Hall Hysteresis Width (C) and Hall Feedback Polarity (D) fields.



5. Click Test Commutation.

   After you click Test Commutation, the following message appears to alert you that this operation resets the drive.

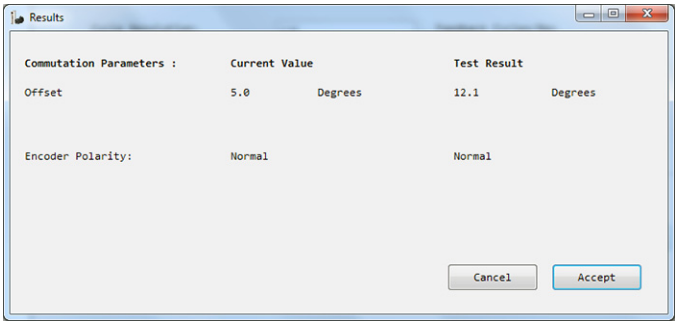


6. Click Yes.

   A message window alerts you that the process might take some time to complete.

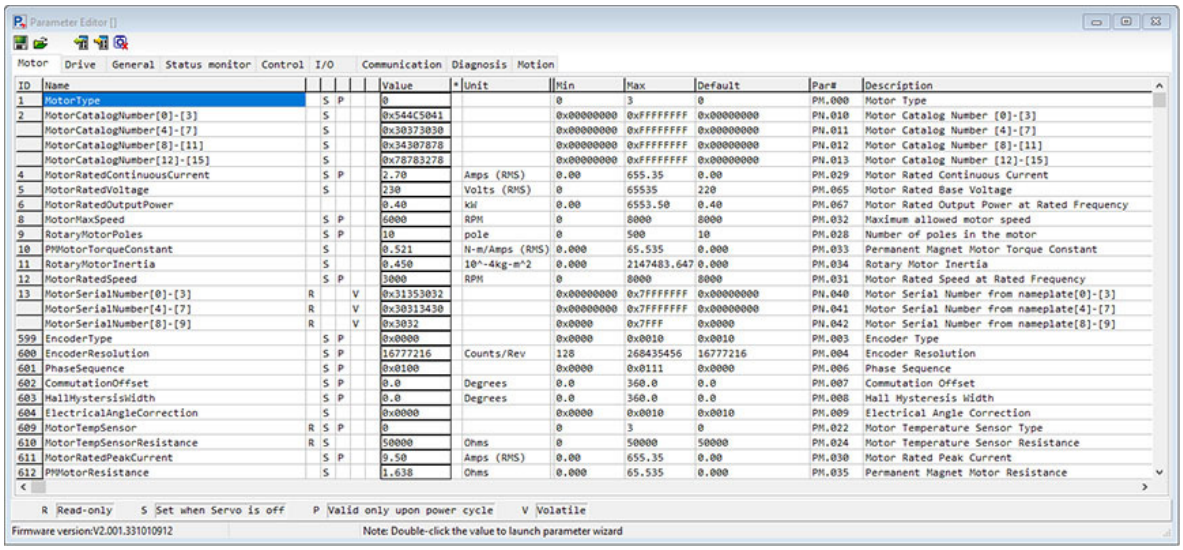
   When the process is complete, a results window appears with suggested parameter values.

7. Click Accept to use those values, or click Cancel to stay with the original parameter values.



Parameter Editor

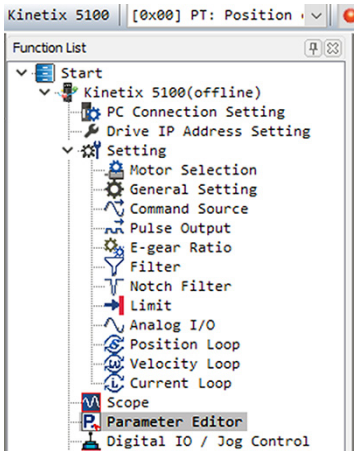
You can read all Kinetix5100 parameters of the servo drive and upload them to your personal computer by using KNX5100C software, choose Function List>Kinetix Drive>Parameter Editor. You can also use the Parameter Editor to view or modify all Kinetix5100 parameters then download them to the servo drive.



ID	Name					Value	*	Unit	Min	Max	Default	Par#	Description
1	MotorType		S	P		0			0	3	0	PM.000	Motor Type
2	MotorCatalogNumber[0]-[3]		S			0x544C5041			0x00000000	0xFFFFFFFF	0x00000000	PM.010	Motor Catalog Number [0]-[3]
	MotorCatalogNumber[4]-[7]		S			0x30373030			0x00000000	0xFFFFFFFF	0x00000000	PM.011	Motor Catalog Number [4]-[7]
	MotorCatalogNumber[8]-[11]		S			0x34307878			0x00000000	0xFFFFFFFF	0x00000000	PM.012	Motor Catalog Number [8]-[11]
	MotorCatalogNumber[12]-[15]		S			0x78783278			0x00000000	0xFFFFFFFF	0x00000000	PM.013	Motor Catalog Number [12]-[15]
4	MotorRatedContinuousCurrent		S	P		2.70		Amps (RMS)	0.00	655.35	0.00	PM.029	Motor Rated Continuous Current
5	MotorRatedVoltage		S			230		Volts (RMS)	0	65535	220	PM.065	Motor Rated Base Voltage
6	MotorRatedOutputPower					0.40		kW	0.00	6553.50	0.40	PM.067	Motor Rated Output Power at Rated Frequency
8	MotorMaxSpeed		S	P		6000		RPM	0	8000	8000	PM.032	Maximum allowed motor speed
9	RotaryMotorPoles		S	P		10		pole	0	500	10	PM.028	Number of poles in the motor
10	PMMotorTorqueConstant		S			0.521		N-m/Amps (RMS)	0.000	65.535	0.000	PM.033	Permanent Magnet Motor Torque Constant
11	RotaryMotorInertia		S			0.450		10^-4kg-m^2	0.000	2147483.647	0.000	PM.034	Rotary Motor Inertia
12	MotorRatedSpeed		S	P		3000		RPM	0	8000	8000	PM.031	Motor Rated Speed at Rated Frequency
13	MotorSerialNumber[0]-[3]	R			V	0x31353032			0x00000000	0x7FFFFFFF	0x00000000	PM.040	Motor Serial Number from nameplate[0]-[3]
	MotorSerialNumber[4]-[7]	R			V	0x30313430			0x00000000	0x7FFFFFFF	0x00000000	PM.041	Motor Serial Number from nameplate[4]-[7]
	MotorSerialNumber[8]-[9]	R			V	0x3032			0x0000	0x7FFF	0x0000	PM.042	Motor Serial Number from nameplate[8]-[9]
599	EncoderType		S	P		0x0000			0x0000	0x0010	0x0010	PM.003	Encoder Type
600	EncoderResolution		S	P		16777216		Counts/Rev	128	268435456	16777216	PM.004	Encoder Resolution
601	PhaseSequence		S	P		0x0100			0x0000	0x0111	0x0000	PM.006	Phase Sequence
602	CommutationOffset		S	P		0.0		Degrees	0.0	360.0	0.0	PM.007	Commutation Offset
603	HallHystersisWidth		S	P		0.0		Degrees	0.0	360.0	0.0	PM.008	Hall Hysteresis Width
604	ElectricalAngleCorrection		S			0x0000			0x0000	0x0010	0x0010	PM.009	Electrical Angle Correction
609	MotorTempSensor	R	S	P		0			0	3	0	PM.022	Motor Temperature Sensor Type
610	MotorTempSensorResistance	R	S			50000		Ohms	0	50000	50000	PM.024	Motor Temperature Sensor Resistance
611	MotorRatedPeakCurrent		S	P		9.50		Amps (RMS)	0.00	655.35	0.00	PM.030	Motor Rated Peak Current
612	PMMotorResistance		S			1.638		Ohms	0.000	65.535	0.000	PM.035	Permanent Magnet Motor Resistance

The Parameter Editor consists of parameter groups, a toolbar, and a status indicator that includes the firmware version and other information.

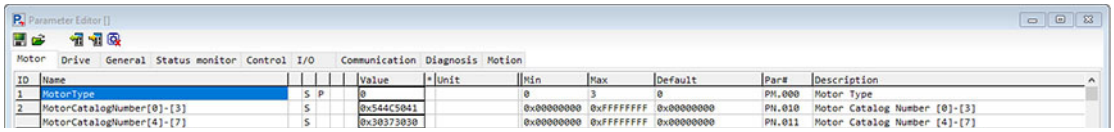
To access the Parameter Editor, select Start > Kinetix 5100 > Setting > Parameter Editor in the Function List.



All Kinetix5100 parameters are divided into the following server groups:

- Motor
- Drive
- General
- Status monitor
- Control
- I/O
- Communication
- Diagnosis
- Motion

Click each parameter group tab to toggle between tabs.



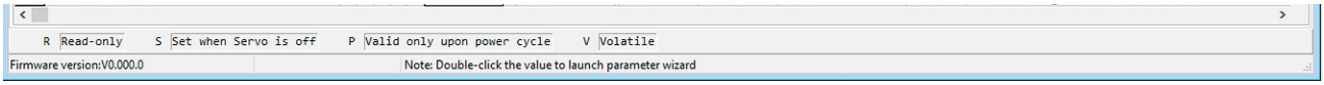
The following information is displayed for each parameter:

- ID
- Name
- Property
- Value
- Min (value)
- Max (value)
- Default (value)
- Parameter Number
- Description

The Parameter Editor provides the status of the parameter:

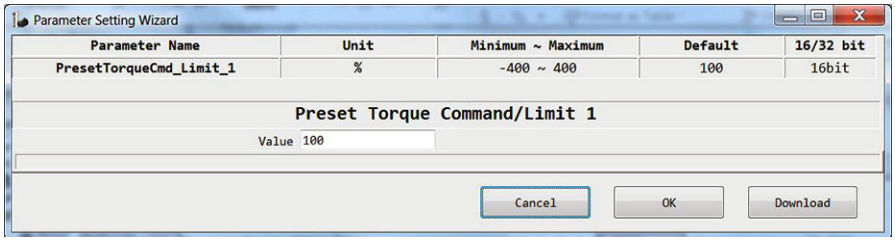
- (R) Read-only
- (S) Value is set when servo power is off
- (P) Value is applied after a Power Cycle
- (V) Value is volatile (cleared once power is cycled)

The firmware version is also shown in this window.



Parameter Wizard

Double-click a parameter value to open the parameter wizard, which provides a simple method to change parameter values.



Parameter Toolbar

The toolbar at the top of Parameter Editor contains six icons.



The function of each icon is as follows.

Save Parameters File

All Kinetix 5100 parameters that are shown on the screen (which are those also saved to your personal computer) are saved as a *.par file.

Open Parameter File

All Kinetix 5100 parameter files (.par) on your personal computer can be opened and displayed.

Read Parameters

All Kinetix 5100 parameters are read.

Download Parameters

When online with the Kinetix 5100 drive, a dialog box lets you choose to download all the parameters or just the parameters that have been modified.

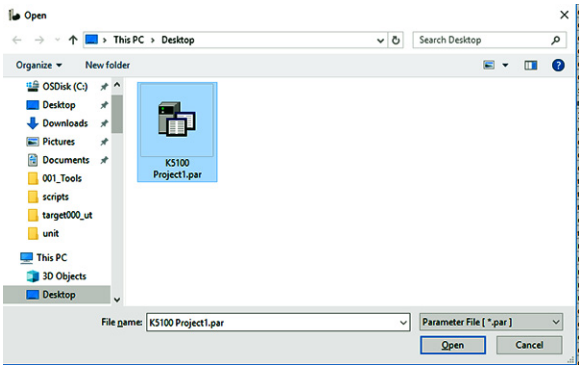
Stop Operation

This stops any operation in progress.

Compare Parameters

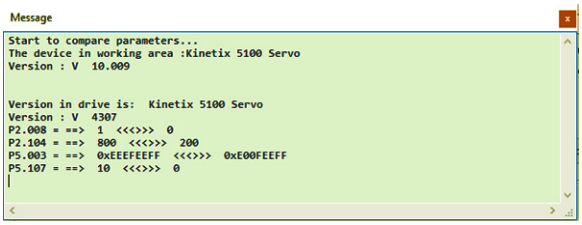
Use this function to compare the file you open with existing parameters.

1. On your personal computer, navigate to your target saved *.par file.



2. Select the file and click Open.

   A message appears that the comparison process has started.



Choose an Operation Mode

There are three ways to change the operation mode in the KNX5100C software:

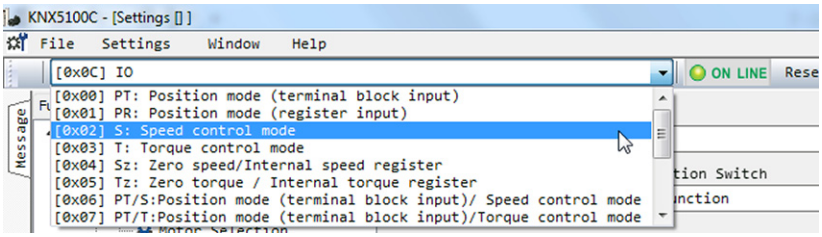
- By using the Operation Mode Selection List
- By using the Setting dialog box
- By using the Parameter Editor

For detailed information on how the drive operates in each mode, see Chapter 10, Modes of Operation.

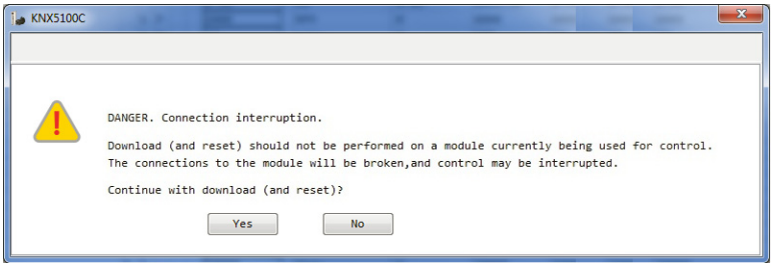
Using the Operation Mode Selection List

To select an operation mode, perform the following steps.

1. Use the pull-down menu to select an operating mode setting.



When you choose a new operation mode setting, the following message appears.



If you click Yes, a power cycle is triggered. We recommend this choice.

If you click No, you are returned to the Settings view without a power cycle. However, a reminder appears until you initiate a power cycle.

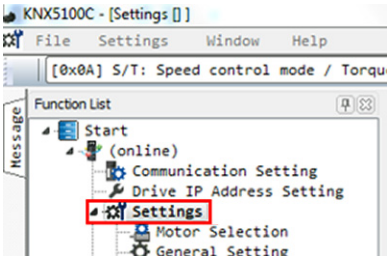


IMPORTANT Parameter ID117 (P1.001), ControlMode, is valid only after power cycle.

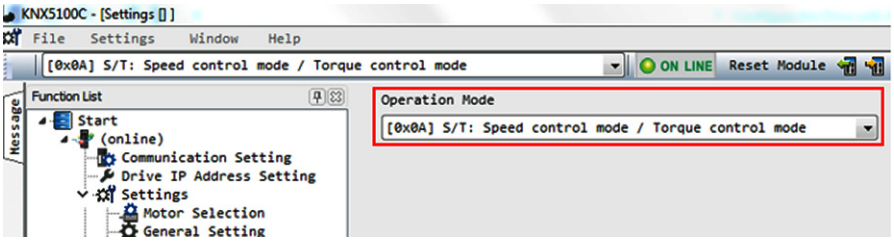
Using the Setting Page

To change the operation mode setting, perform the following steps.

1. From the Function List, select Start > Kinetix 5100 > Settings.

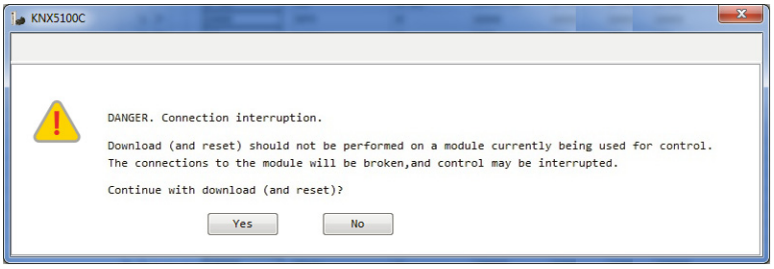


2. From the Operation Mode pull-down menu, select an operation mode.



3. Click  .

   When you choose a new operation mode setting, the following message appears.





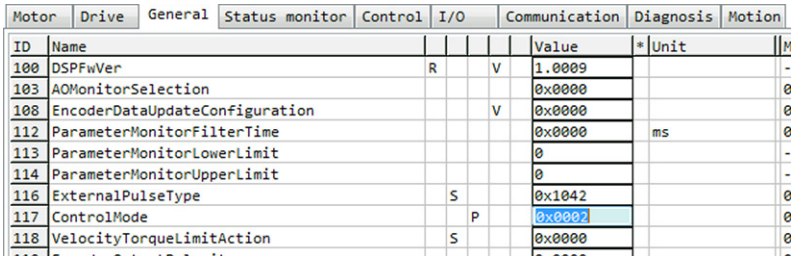
If you click Yes, a power cycle is triggered.
If you click No, the original operation mode value is restored.

Using the Parameter Editor

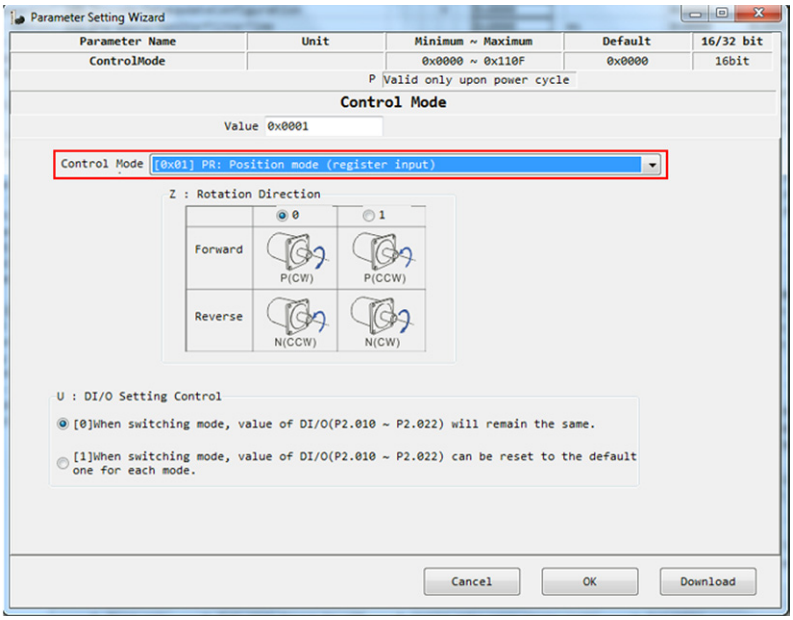
To change the control mode in the Parameter Editor, perform the following steps.

1. From Function List, select Start > Kinetix 5100 > Setting > Parameter Editor.

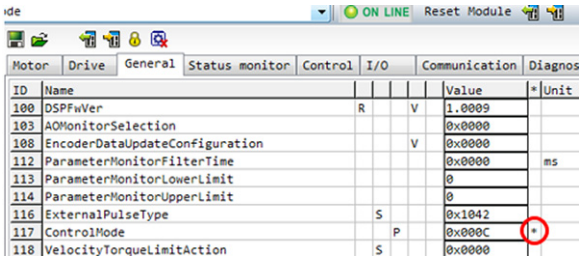
2. There are two ways to change parameter ID117 (P1.001) ControlMode:
   - Change the ControlMode value by clicking directly in its value field and typing a new value.



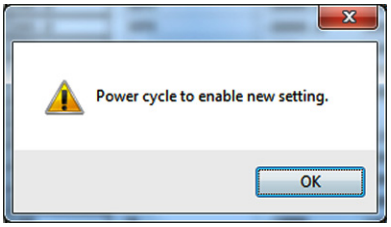
   - Double-click the Control Mode value field to open the Parameter Setting Wizard and change its value.



When the parameter value is changed and has not been downloaded to the drive, there will be a '*' mark next to the value field.

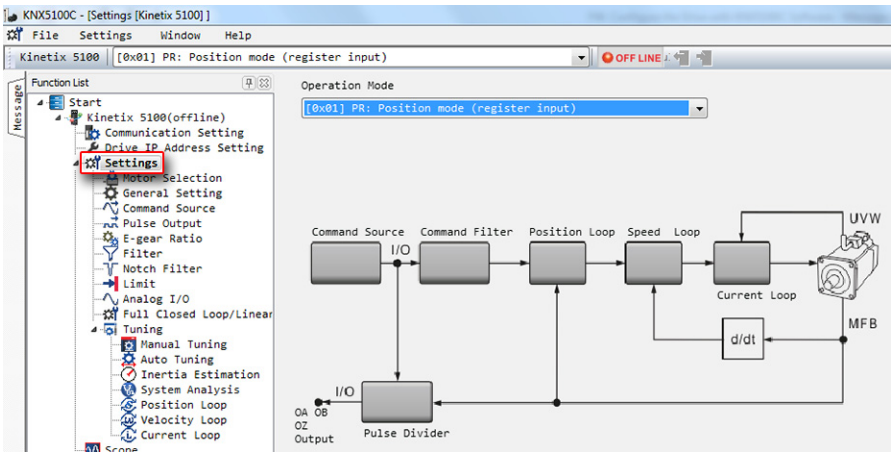


After the parameter value is changed, the following reminder appears.

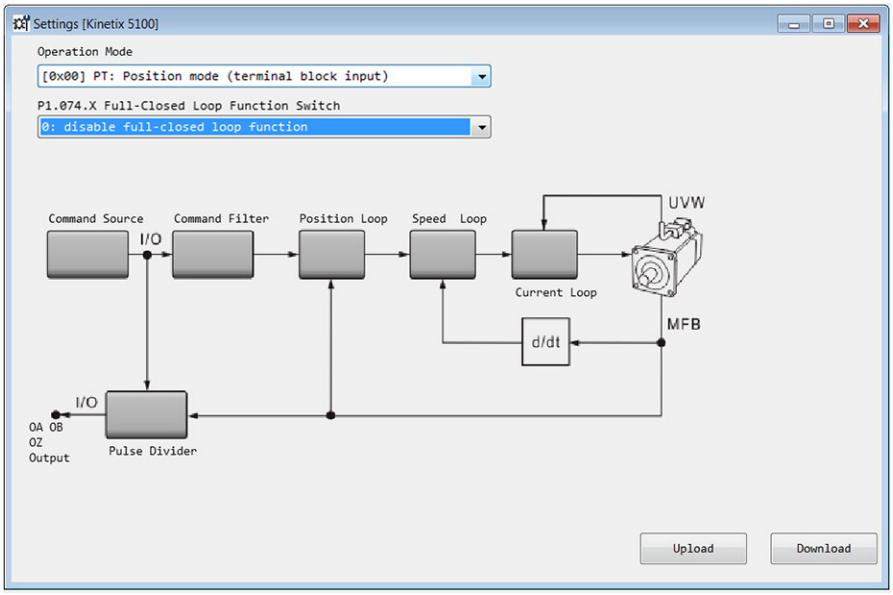


Configure Settings

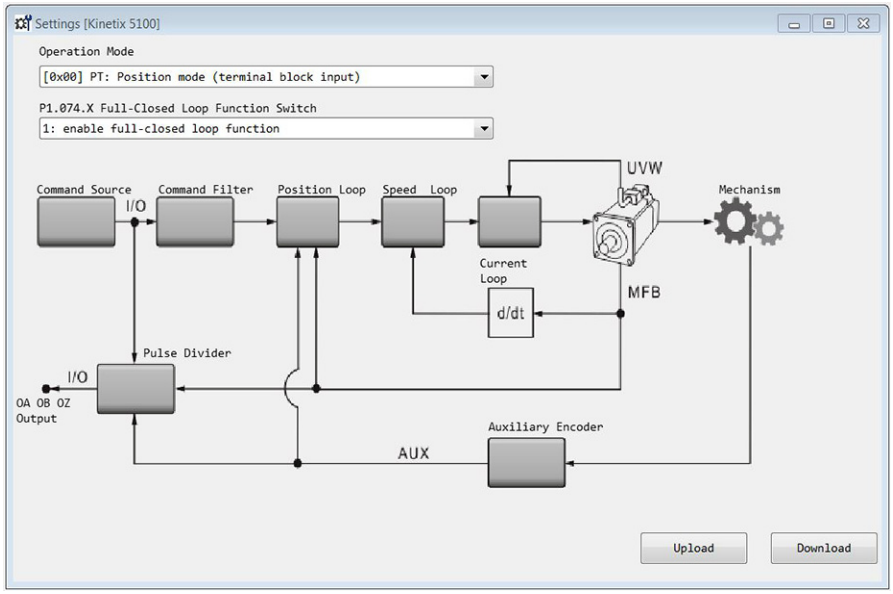
From the Settings page, you can view and change the operation mode. The Operation Mode flow chart is updated based on the chosen mode.



When the Operation Mode value is changed from the pull-down menu, subsequent pull-down menus can appear.



The Operation Mode flow chart updates as values are selected from both pull-down menus.



The gray boxes show the functions included in the each operation mode.

You can double-click a box to open a dialog box and to configure the related functions.

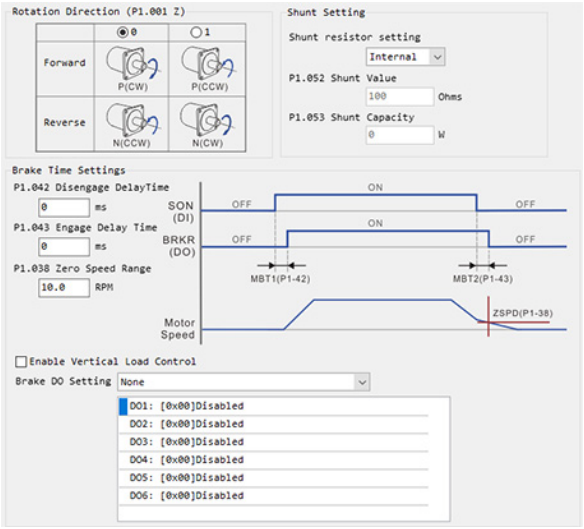
Click Download to download any changed parameters to the servo drive.

Configure General Settings

The General page lets you configure parameters related to the motor, shunt, and brake operation.

To access the General page, perform the following steps.

1. From the Function List, select Start > Kinetix 5100 > Settings > General Setting.
2. On General Settings, change the fields manually as needed.



3. Click Download to send any changed parameters to the servo drive.

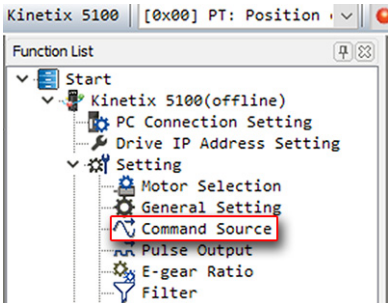
Configure the Command Source

The selected operation mode allows the modification of different parameters. The configuration of the Command Source is available with: Terminal Block input, Speed Mode, and Torque Mode. Command Source is not available for Position Register (PR) or IO Modes.

Configure the Command Source for Position mode (Terminal block input -PT mode)

To configure the Command Source for Position mode, perform the following steps.

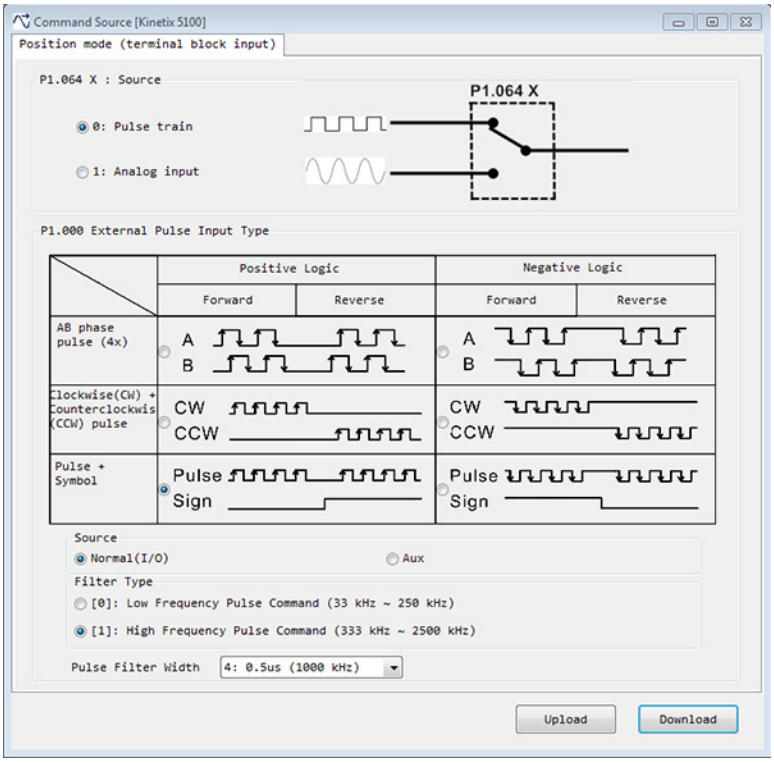
1. From the Function List, choose Start>Kinetix 5100>Settings and select the Operating Mode as PT:Position Mode (terminal block input).



2. In Command Source, select the Position Mode (terminal block input) tab.

IMPORTANT If you have configured a dual or multiple operation mode, more than one tab is visible. For example, if you have PT/S mode, you get a Position mode (terminal block input) tab and a Speed mode tab.

3. On the Position Mode tab, select either Pulse Train or Analog Input as the position command source.
4. If you select Pulse train, you can specify the External Pulse Input Type, Source, Filter Type, and Pulse Filter Width.



If the Control Mode is PT (Position Terminal), and Pulse train>AB phase pulse 4x is used, the Source indicates the origin of the master pulses.

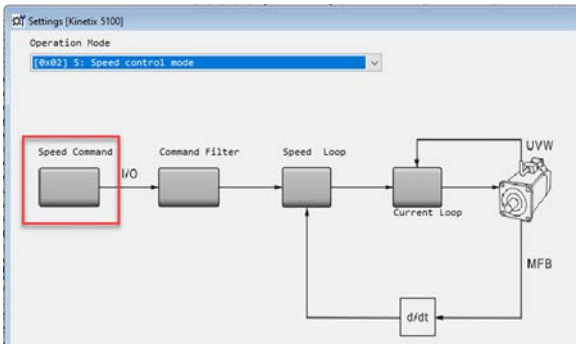
5. Click Download to download any changed parameters to the servo drive.

   For more information, see PT Mode (Position Command with Terminal Block Input) on page 197.

Configure the Command Source for Speed Mode (-S mode)

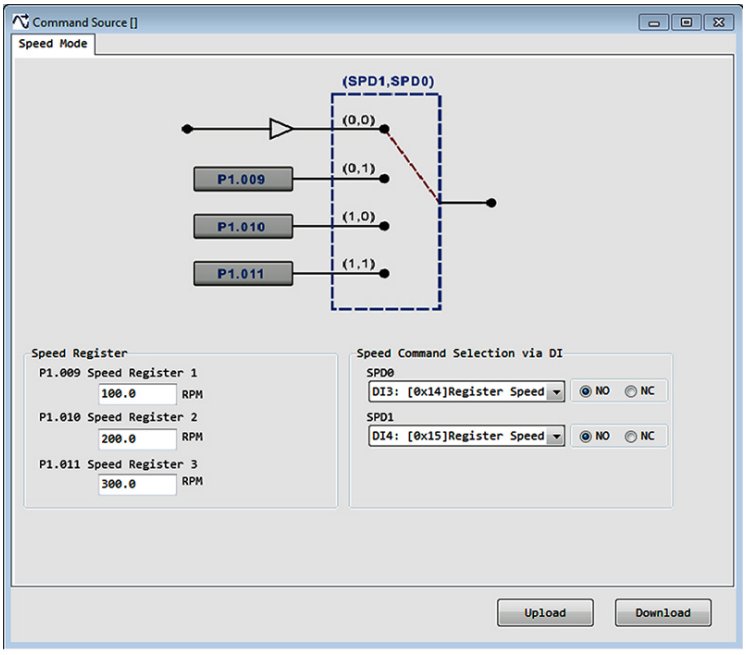
IMPORTANT The Speed Mode tab is visible if you have configured a dual or multiple operation mode, such as PT/S mode.

1. From the Function List, choose Start>Kinetix 5100> Settings and select the Operating Mode as S:Speed Control Mode.
2. Click the Speed Command box.



3. On the Speed Mode tab, select the speed command source from either an analog input or preset speed registers via digital input signals DI.SPD0 and DI.SPD1.

   You can change the program for the Speed registers 1...3 by using ID125...ID127 (P1.009...P1.011), and configure them as DI to N.O. or N.C.



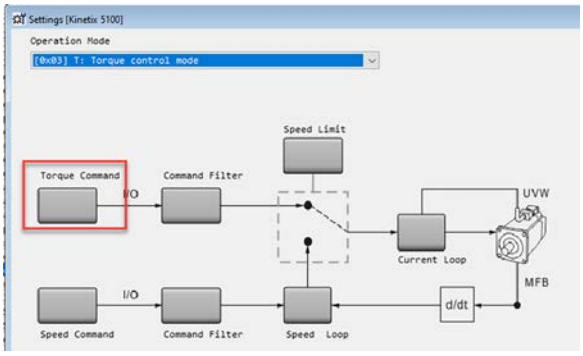
4. Click Download to download any changed parameters to the servo drive.

   For more information, see Selection of Speed Command on page 211.

Configure the Command Source for Torque Mode (-T Mode)

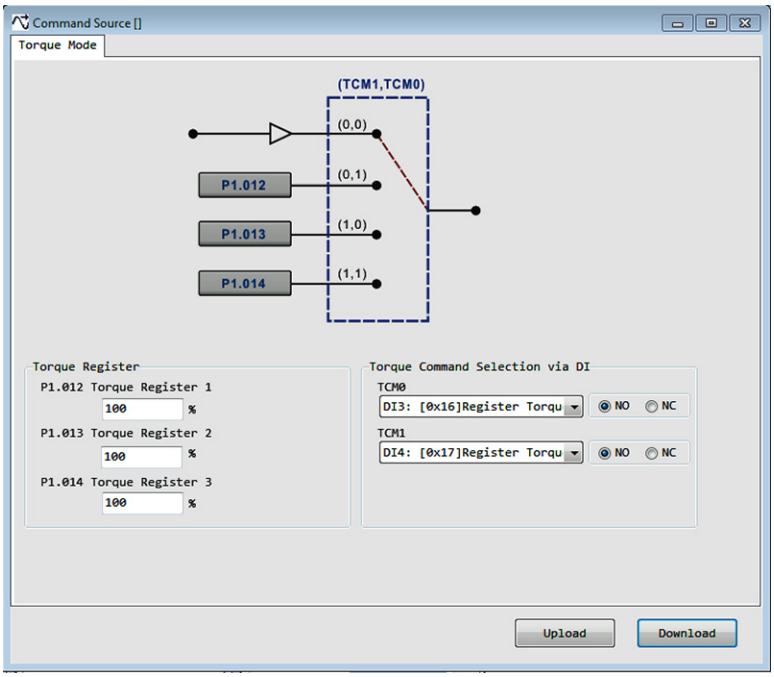
IMPORTANT The Torque Mode tab is visible if you have configured a dual or multiple operating mode.

1. From the Function List, choose Start>Kinetix 5100>Settings and select the Operating Mode as T:Torque Control Mode.
2. Click the Torque Command box.



3. In the Torque Mode tab, select the torque command source from either an analog input or preset torque registers via the DI.TCM0 and DI.TCM0 signals.

   You can change the program for the torque registers 1...3 by using ID128...ID130 (P1.012...P1.014), and configure them to be N.O. or N.C.



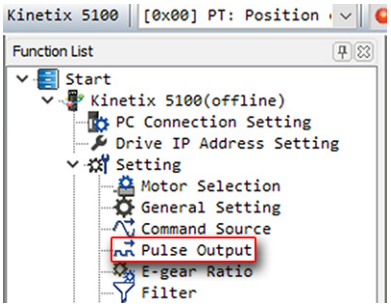
For more information, see Selection of Torque Command on page 223.

Configure the Pulse Outputs

Use the Pulse Output as a form of buffered encoder outputs. Use these pulses to provide a master signal to another drive or to provide feedback for closed loop, or pulse train control.

To access and use Pulse Output, perform the following steps.

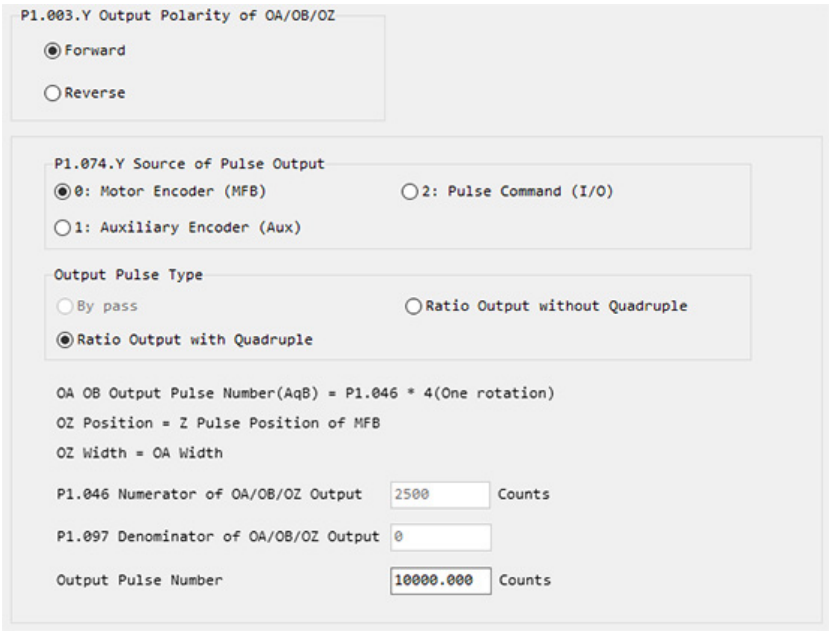
1. From the Function List, select Start > Kinetix 5100 > Setting > Pulse Output.



2. In the Pulse Output dialog box, you can configure the following:
   - The output polarity of OA/OB/OZ to either forward or reverse
   - The source of pulse output from motor encoder, auxiliary encoder, or pulse command (I/O)
   - The output pulse type to by-pass, ratio output without quadruple, or ratio output with quadruple

IMPORTANT Output pulse type selection depends on the source of the pulse output. For example, bypass is only available when pulse command (I/O) is chosen as the source.

   - The output pulse number, which automatically populates the fields for the numerator and denominator parameters



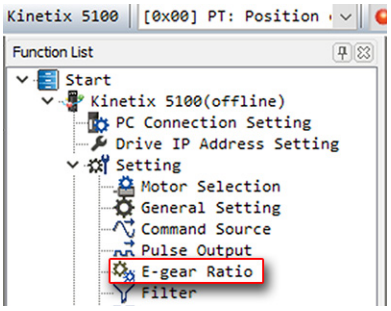
Click Download to write any changed parameters to the servo drive.

Configure E-gear Ratio

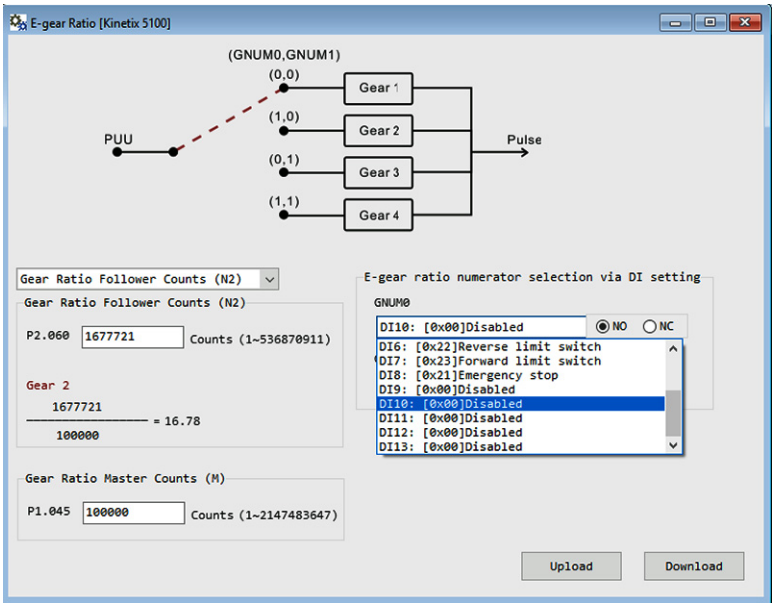
Depending on the Operating Mode, the E-gear ratio serves two different purposes. If the drive is using PT mode, this ratio provides an actual gearing relationship used for following pulses provided by the Command Source. If any other mode is used, this ratio represents the drive scaling in user units/ motor rotation.

To access and use E-gear Ratio, perform the following steps.

1. From the Function List, select Start > Kinetix 5100 > Setting > E-gear Ratio.



2. In the E-Gear dialog box, you can configure the following:
   - The E-gear Ratio - Gear Ratio Slave Counts/Gear Ratio Master Counts
   - The gear ratio slave counts, in certain modes can be changed through programing, by using ID236...ID238 (P2.060...P2.062) and ID152 (P1.045)
   - The numerator is selectable by using a digital input signal



3. Click Download to write any changed parameters to the servo drive.

For more information, see Electronic Gear (E-Gear) Ratio on page 204.

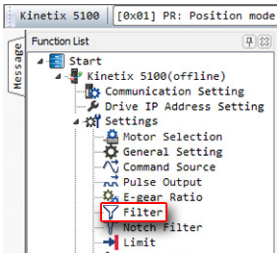
Configure Filter

There are different filters available to use with the Kinetix 5100. There is a Low Pass Filter and Moving Average Filter which are both used to remove unwanted resonance from the drive (these filter types are available for use in different drive modes).

Use the Filter dialog box to configure the Kinetix 5100 Low Pass and Moving Average Filters.

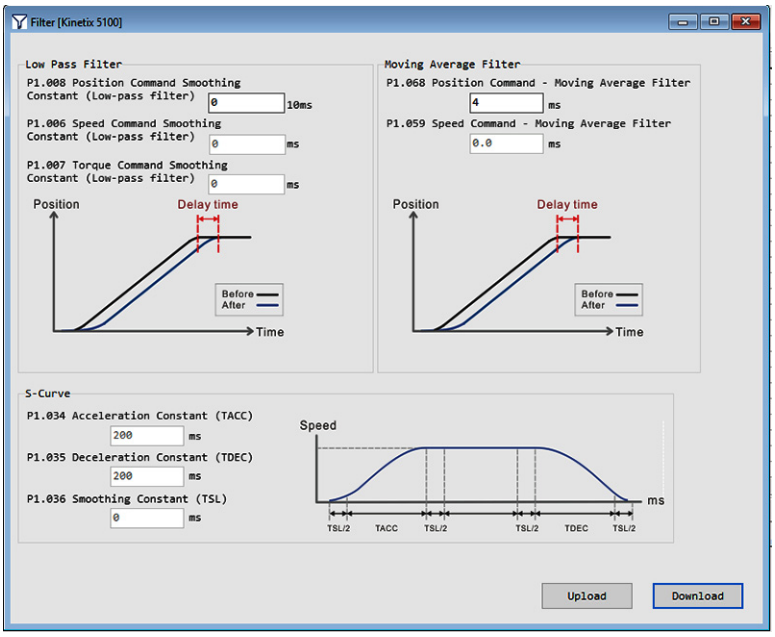
To access Filter, perform the following steps.

1. From the Function List, choose Start > Kinetix 5100 > Setting > Filter.



2. In the Filter dialog box, you can configure the following:
   - The Low Pass Filter smoothing time constant parameters for Position Command ID124(P1.008), Speed Command ID122(P1.006) and ID123(P1.007).
   - The Moving Average Filter time constant parameters for Position Command ID170(P1.068) and Speed Command ID164(P1.059).
   - The acceleration, deceleration, and smoothing constants of the S-curve.

     Filters available for Position Mode, Speed Mode, and Torque Mode are described in Chapter 10, Modes of Operation.



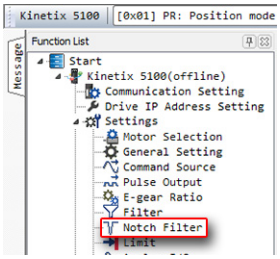
3. Click Download to write any changed parameters to the servo drive.

Configure Notch Filter

The Notch Filter is used to attenuate a specific resonant frequency. The Kinetix 5100 drive uses up to five Notch Filters simultaneously.

To access the Notch Filter, perform the following steps.

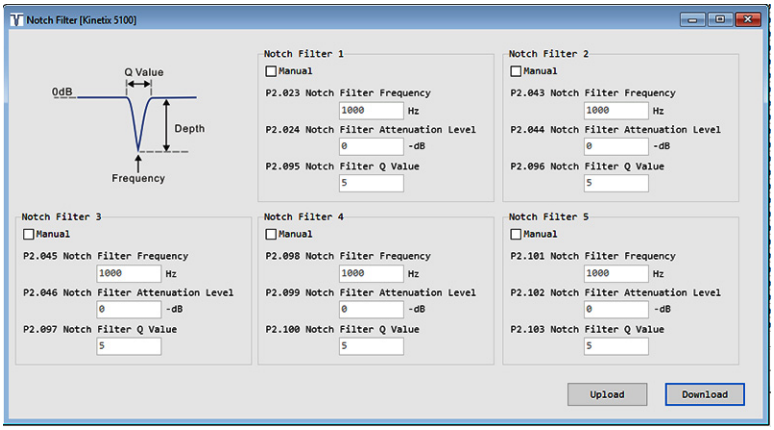
1. From the Function List, choose Start > Kinetix 5100 > Setting > Notch Filter.



2. In the Notch Filter dialog box, you can modify the five notch filters.

To edit any notch filter parameter, you must first check Manual for that notch filter.

You can use any frequency diagnosing tool (FFT) to diagnose the frequency and magnitude of the resonance.

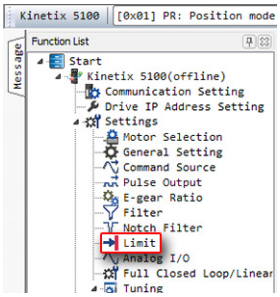


3. Click Download to write any changed parameters to the servo drive.

For more information, see Resonance Suppression (Notch Filter) on page 217.

Configure Limits

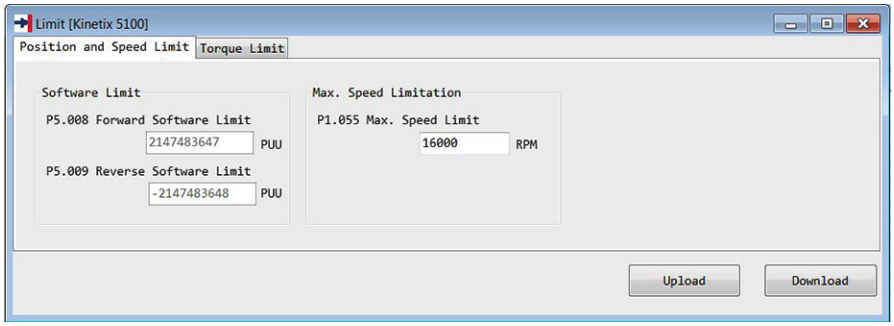
From the Function List, choose Limit to configure Position, Speed, and Torque Limits.



In the Limit dialog box, there are two tabs: Position and Speed Limit, and Torque Limit.

Position and Speed Limit

On the Position and Speed Limit tab, you can forward and reverse software limits and the maximum speed limits by changing the values of the related parameters.

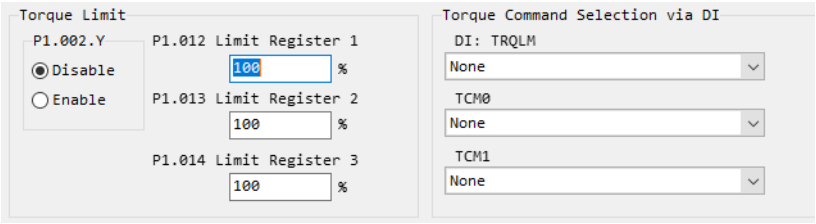


Click Download to write any changed parameters to the servo drive.

For more information, see Speed and Torque Limit Functions on page 245.

Torque Limit

On the Torque Limit tab, you can enable or disable torque limits and set torque limit values. You can also select torque command preset values by changing binary weighted digital inputs.

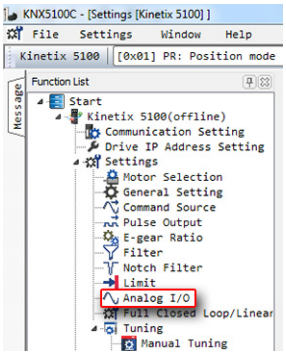


For more information on the torque limit, see Speed and Torque Limit Functions on page 245. For more information on digital input function descriptions, see Description of Digital Input Functions on page 405.

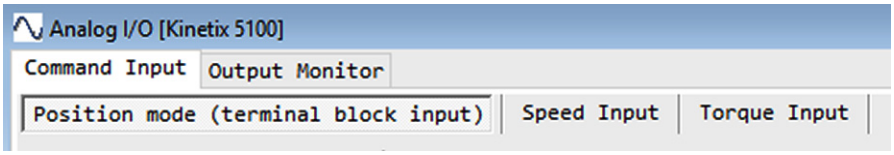
Configure Analog I/O

The Kinetix 5100 servo drive can use different analog input signals for command operation. These operations include using analog inputs for Position, Speed, or Torque control from another source. The drive can use up to two analog outputs to display selected drive parameters. This output is typically used to provide status information to another device. This servo drive provides two output channels for this purpose, MON1 and MON2.

From the Function List, choose Analog I/O to select the type of analog command input and the output data to be monitored.



In the Analog I/O dialog box, there are two tabs: Command Input and Output Monitor.

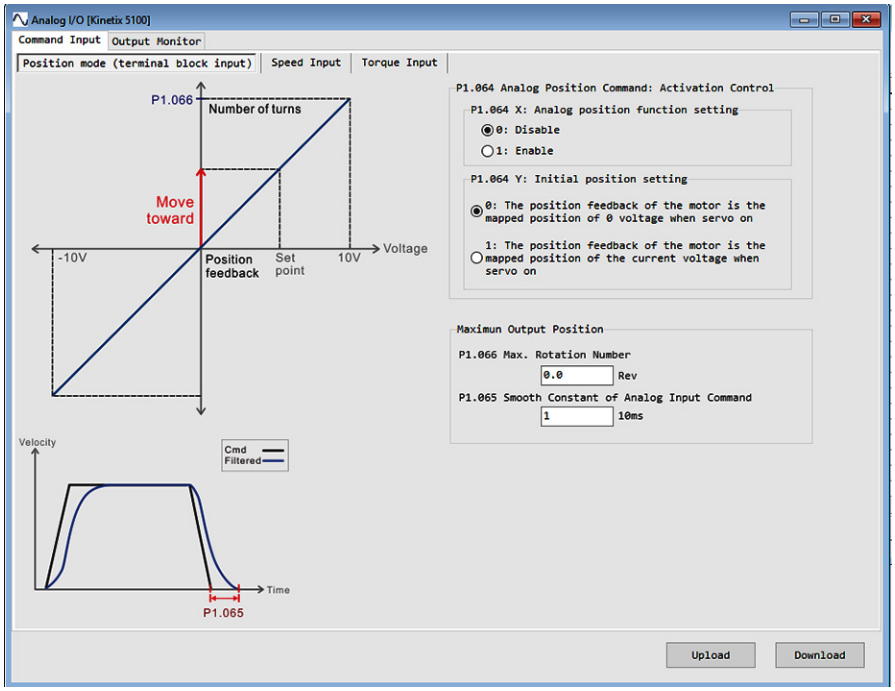


On the Command Input tab, you can configure three types of analog input: position mode (terminal block input), speed input, and torque input.

Position Mode (terminal block input) Tab

This mode is useful when you want to relate an analog voltage command to motor position. On this tab, you can enable the analog position function, set the initial position of the motor, and the maximum motor position value (in motor rotations).

Click Download to write any changed parameters to the servo drive.

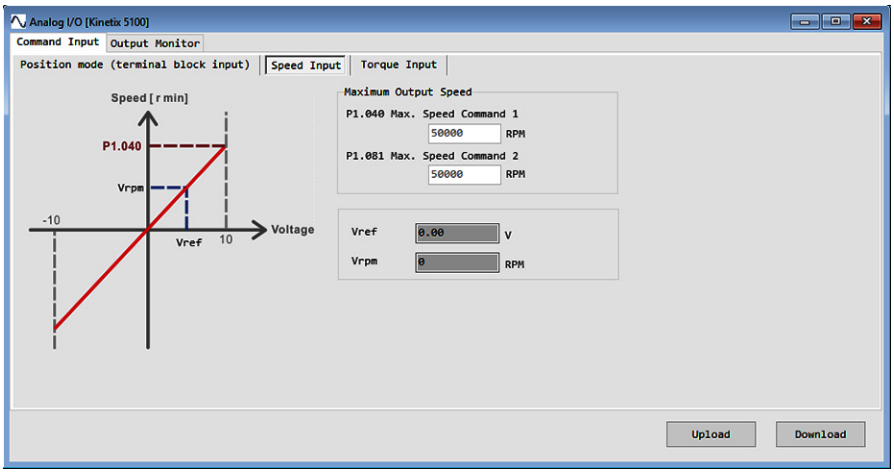


Speed Input Tab

This mode is useful when you want to relate an analog voltage command to motor speed. For example, if a ControlLogix® 1756-M02AE module was configured for Velocity mode, its analog output could be used with this speed input for the Kinetix 5100 drive to provide full closed-loop control.

On this tab, you can set the maximum output speed by using parameters ID147 (P1.040) and ID679 (P1.081).

Click Download to write any changed parameters to the servo drive.

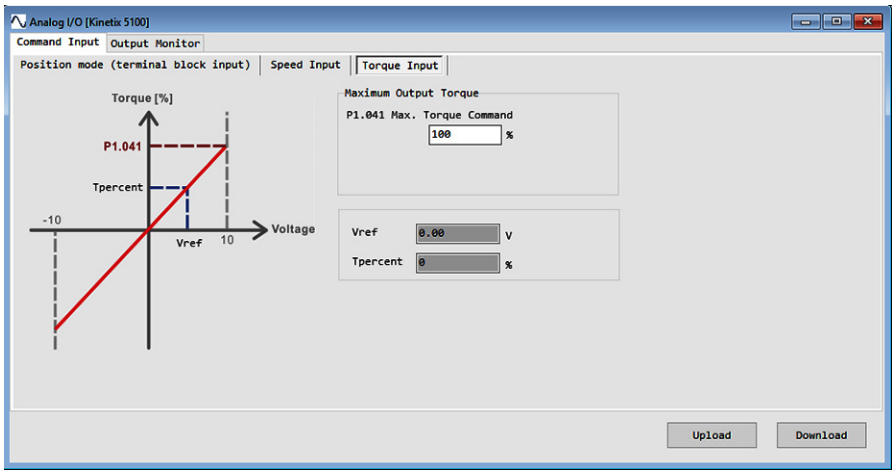


Torque Input Tab

This mode is useful when you want to relate an analog voltage command to motor torque. For example, if a ControlLogix 1756-M02AE module was configured for Torque mode, its analog output could be used with this torque input for the Kinetix 5100 drive to provide full closed-loop control.

On this tab, you can change the maximum output torque command by using parameter ID148 (P1.041).

Click Download to write any changed parameters to the servo drive.

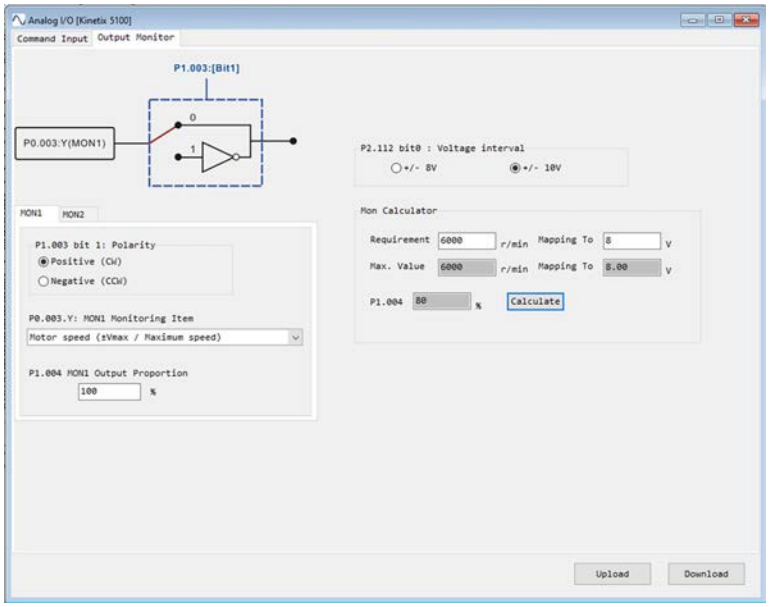


Output Monitor Tab

On the Output Monitor tab, you can change the Monitored Value using a pull-down menu. You can change the scaling, proportion, and the polarity of the output.

The Mon Calculator lets you enter a unique Motor Speed (can be the maximum Motor Speed) with your desired Analog Voltage at that speed. Click Calculate to determine the corresponding Maximum values and analog scaling ID120 (P1.004). For more information, see Analog Monitoring on page 248.

Click Download to write any changed parameters to the servo drive.



Configure Position, Velocity, and Current Loops

The Operation Mode controls which control loops you can view and modify. Each dialog box lets you configure the parameters for the gain and filter values that correspond to the command type.

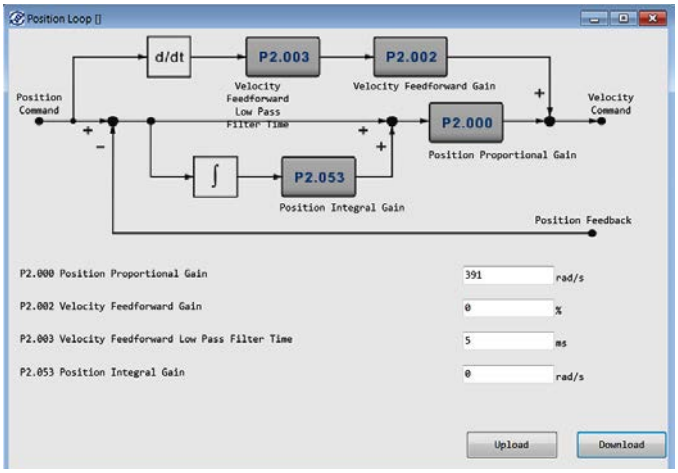
Configure Position Loop

From the Function List, choose Position Loop to view or change the parameters that apply to the position command.

Table 69 - Position Loop Parameters

Parameter	Name
ID185 (P2.000)	PositionProportionalGain
ID187 (P2.002)	VelocityFeedforwardGain
ID188 (P2.003)	VelocityFeedforwardLowPassFilterTimeConstant
ID235 (P2.053)	PositionIntegralGain

Click Download to download any changed parameters to the servo drive.



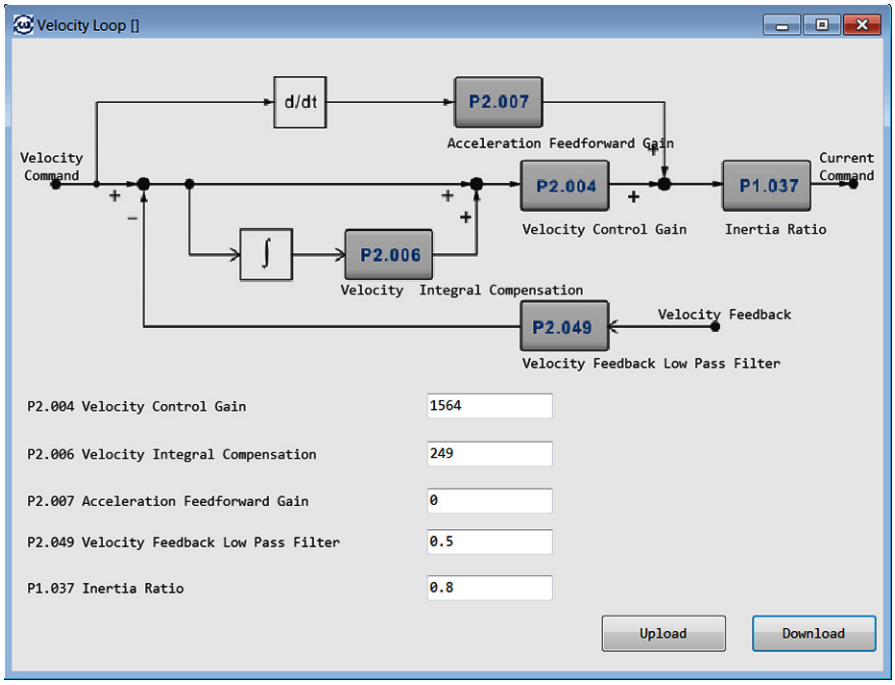
Configure Velocity Loop

From the Function List, choose Velocity Loop to view or change the parameters that apply to the velocity command.

Table 70 - Velocity Loop Parameters

Parameter	Name
ID189 (P2.004)	VelocityProportionalGain
ID191 (P2.006)	VelocityIntegralGain
ID192 (P2.007)	AccelerationFeedforwardGain
ID232 (P2.049)	VelocityFeedforwardLowPassFilterTimeConstant
ID144 (P1.037)	LoadInertiaRatio

Click Download to write any changed parameters to the servo drive.

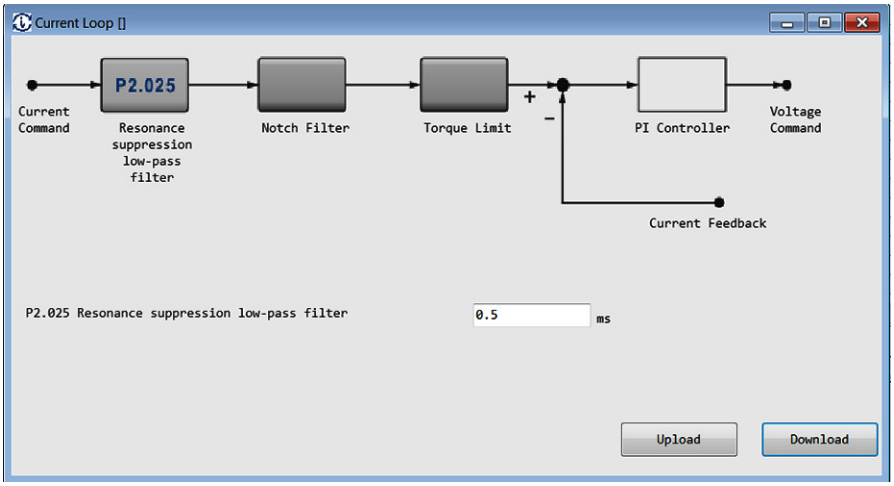


Configure Current Loop

From the Function List, choose Current Loop to view or change the parameters that apply to the current command.

The affected parameter is ID210 (P2.025) Resonance Suppression Low Pass Filter Time Constant. This Low Pass Filter is used to dampen an aggressive output that can potentially cause an unwanted resonance with the mechanical equipment.

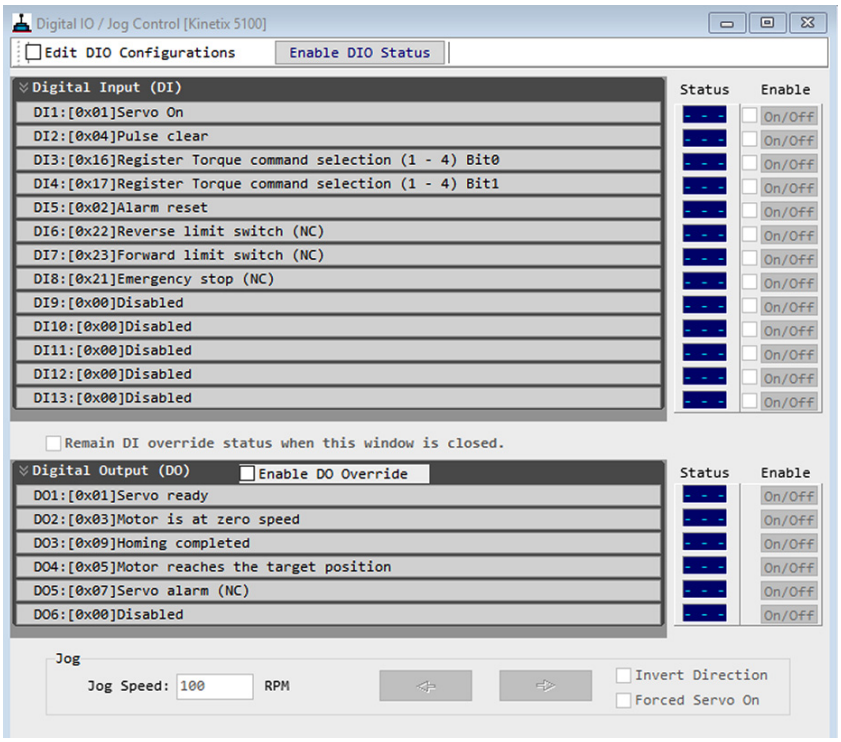
Click Download to write any changed parameters to the servo drive.



Digital I/O and Jog Function in KNX5100C Software

From the Function List, choose Digital IO/Jog Control to view or change the IO function and to see the status of digital inputs (DI) and digital outputs (DO), or to control the IO signals manually.

There are three sections in the dialog box: Digital Input (DI), Digital Output (DO), and Jog Control.



Configuration and Status of Digital Input (DI) and Digital Output (DO) Signals

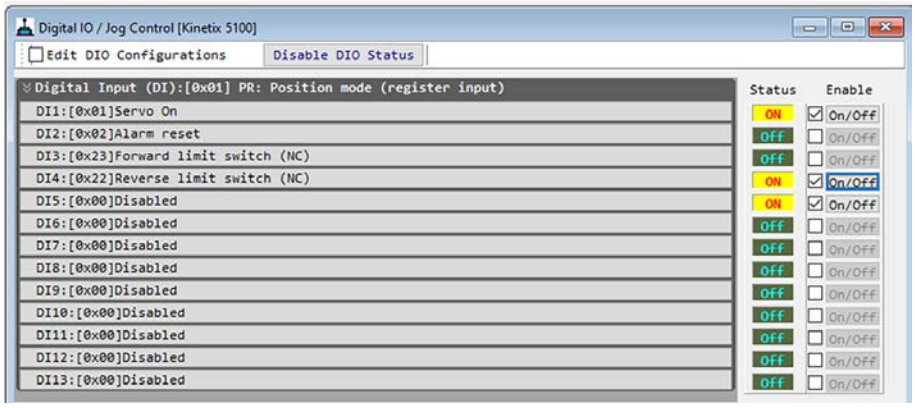
In the DI and DO sections, the defined signals are shown with their individual configurations.

If the contact type of the DI or DO signal is normally closed, 'NC' is added at the end of the signal name. Click ‘Edit DIO Configurations’ to change the configuration of the signal.

This dialog box also shows the On/Off status of the DI or DO signals and offers manual control of the DI or DO signal state. This control is useful when testing or troubleshooting the signals.

Control Digital Input Signals Manually

To manually control the digital input signals, click Enable. Use the On/Off buttons on the right side to enable the DI and DO control. You can use these On/Off buttons to control the DI or DO signals while the drive is connected.



To change and control the DI signals manually, perform the following steps.

1. Check Enable DIO Configurations.
2. Configure the Digital Inputs as required.
3. Clear the Edit DIO Configurations checkbox.
4. Go online with the drive.
5. Check Enable so that On/Off is visible.
6. Click On/Off to change the status of the DI signals directly.

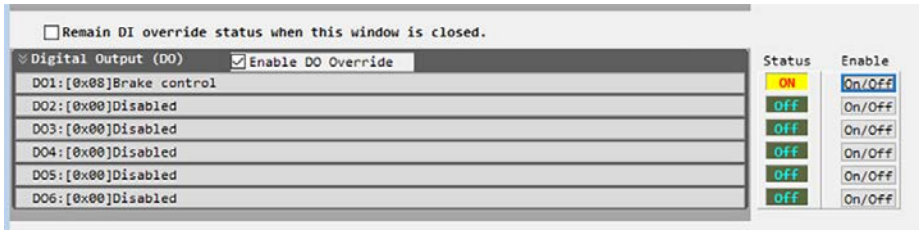
   You can see the signal status by looking at the Status window.

Control Digital Output Signals Manually

To change and control the digital outputs via the communication software settings when the servo drive is connected, perform the following steps.

1. Check Edit DIO Configurations.
2. Configure the Digital Outputs as required.
3. Clear the Edit DIO Configurations checkbox.
4. Go online with the drive.
5. Check Enable DO Override so that On/Off is visible.
6. Click On/Off to change the status of the DO signals directly.

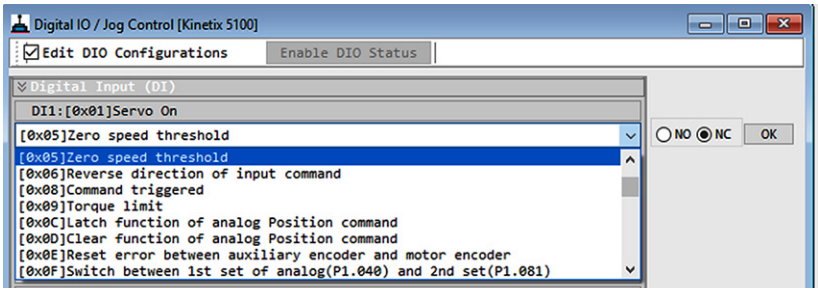
   You can see the signal status by looking at the Status window.



Edit DIO Configurations

When Edit DIO Configurations is checked, the digital input (DI) and digital output (DO) actual state is always Off. To change the function and status of DI and DO signals, perform the following steps.

1. Check the box next to Edit DIO Configurations to enable the editing function.
2. Use the pull-down menu to change the DIO function in the drive.
3. Click OK to save the changes and write to the drive.



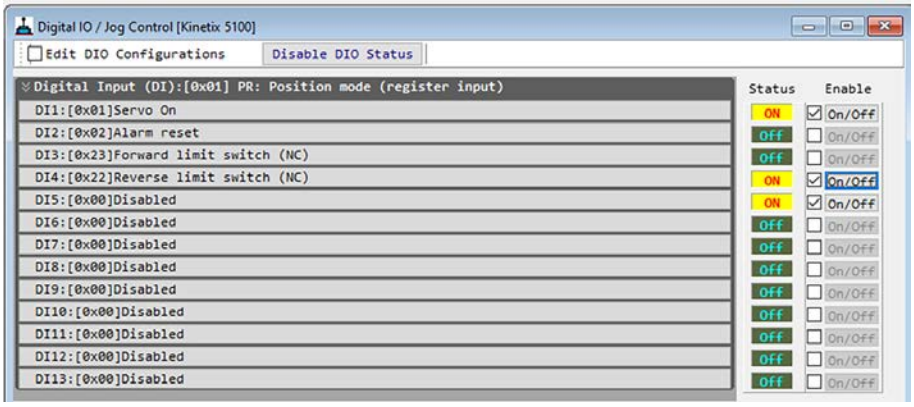
Jog Function

The Jog Function commands the motor to run at a constant speed (Jog Speed). To control the jog operation, enter the desired jog speed and then determine the motor rotation direction. The existing motor rotation (Settings>General Setting>Rotation Direction) is used as the directional context in this dialog box.

There are two ways to activate the Servo ON signal.

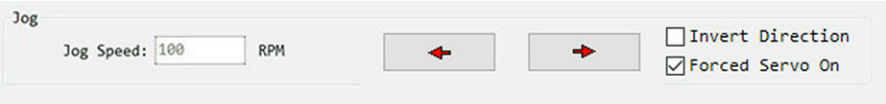
1. Use Enable On/Off of DI1 (Servo On) signal manually.
   a. Check Enable DIO Configurations.
   b. Configure the Servo On Digital Input.
   c. Clear the Edit DIO Configurations checkbox.
   d. Go online with the drive.
   e. Check Enable so that On/Off is visible.
   f. Click On/Off to change the status of the DI signals directly.

   You can see the signal status by looking at the Status window.



2. Check Forced Servo On.
   a. When Forced Servo ON is checked, or your digital input is ON, click the left and right arrows to move the motor in that specific direction.
   b. Stop clicking the left and right arrows to stop the motor rotation.
   c. If the observed rotation is opposite to what is desired, check Invert Direction.

      The direction of the jog command is inverted.



Configure the Drive in Studio 5000 Logix Designer Application

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Download the Program	172

Studio 5000 Logix Designer Application

For help using the Studio 5000 Logix Designer® application as it applies to configuring the ControlLogix® or CompactLogix™ controllers, see the Additional Resources on page 8.

Version History

Each release of the Studio 5000 Logix Designer application makes possible the configuration of additional Allen-Bradley® motors, actuators, power supplies, and drive features not available in previous versions.

IMPORTANT To configure additional motors, actuators, and drive features with your Kinetix® 5100 servo drive, you must have drive firmware 1.001 or later. Refer to Table 71 to determine if you need to install the Kinetix 5100 Add-on Profile.

Table 71 - AOP Installation Requirement

Drive Firmware Version	Logix Designer Application Version	Kinetix 5100 AOP Needed
1.001 or later	30.00, 31.00, 32.00	Yes
	33.00 or later	No

Install the Kinetix 5100 Add-On Profile

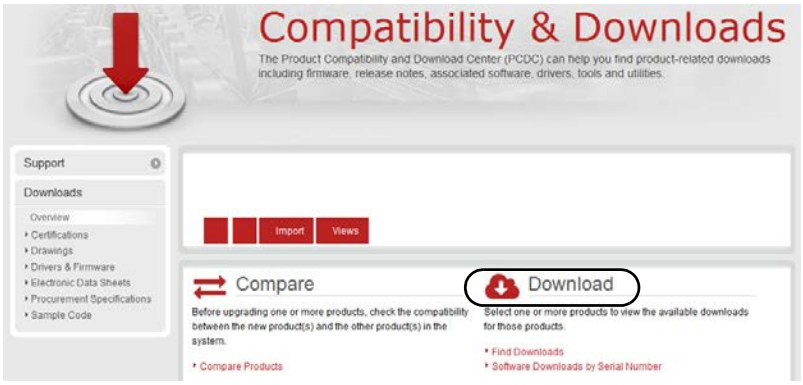
Download Add-On profiles (AOP) from the Product Compatibility Download Center (PCDC) website: http://compatibility.rockwellautomation.com/Pages/home.aspx.

Follow these steps to download the Kinetix 5100 Add-On profile.

1. Go to the Product Compatibility Download Center.

   The Compatibility & Downloads webpage appears.

2. Click Download.



3. Enter Kinetix 5100 in the Search PCDC window.
4. Click the appropriate AOP revision and follow prompts to download.
5. Extract the AOP zip file and run Setup.

Configure the Logix 5000 Controller

These procedures assume that you have wired your Kinetix 5100 drive system. These procedures show the dialog boxes for following devices.

- ControlLogix 5570 controller with a 1756-EN2TR EtherNet/IP™ communication module
- CompactLogix 5370 controller with an embedded EtherNet/IP connection

See the list of other compatible Logix PAC® and PLC Controller Platforms in Kinetix 5100 Drive System Overview on page 11.

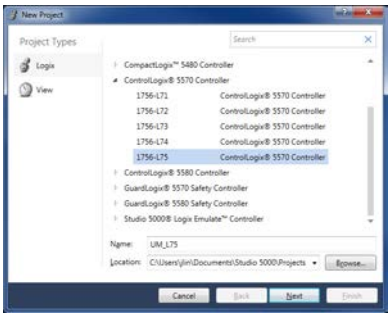
IMPORTANT To use your Kinetix 5100 servo drive with the provided AOP and pre-defined AOIs, you must configure your Kinetix 5100 drive in KNX5100C software first and change the control mode to IO mode. See Download KNX5100C Software on page 123.

To configure your controller do the following.

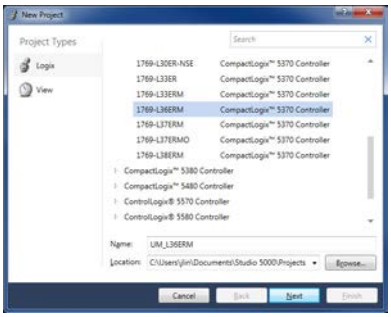
1. Apply power to your controller and run the Studio 5000 Logix Designer application.
2. From the Create menu, choose New Project.

   The New Project dialog box appears.

ControlLogix 5570 Controller



CompactLogix 5370 Controller



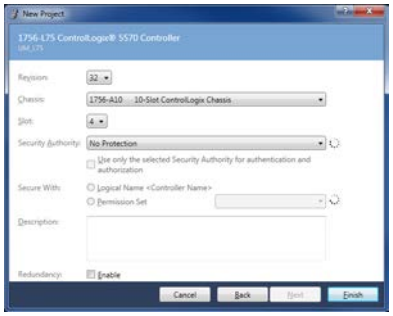
In this example, the typical dialog boxes for 1756-ENxT EtherNet/IP modules and CompactLogix 5370 controllers with embedded Ethernet are shown.

Follow these steps to configure your Logix 5000 controller.

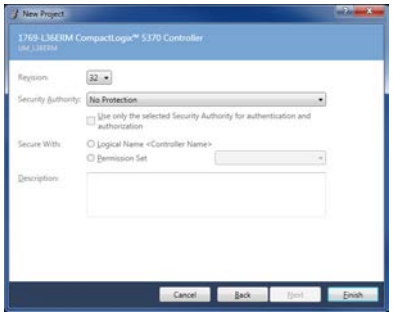
1. Expand the Logix 5000 controller family and select your controller.
2. Type the file Name.
3. Click Next.

   The New Project dialog box appears.

ControlLogix 5570 Controller



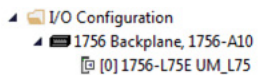
CompactLogix 5370 Controller



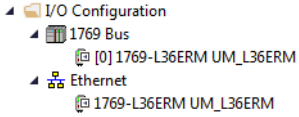
4. From the Revision pull-down menu, choose your software revision.
5. Click Finish.

   The new controller appears in the Controller Organizer under the I/O Configuration folder.

ControlLogix 5570 Controller



CompactLogix 5370 Controller

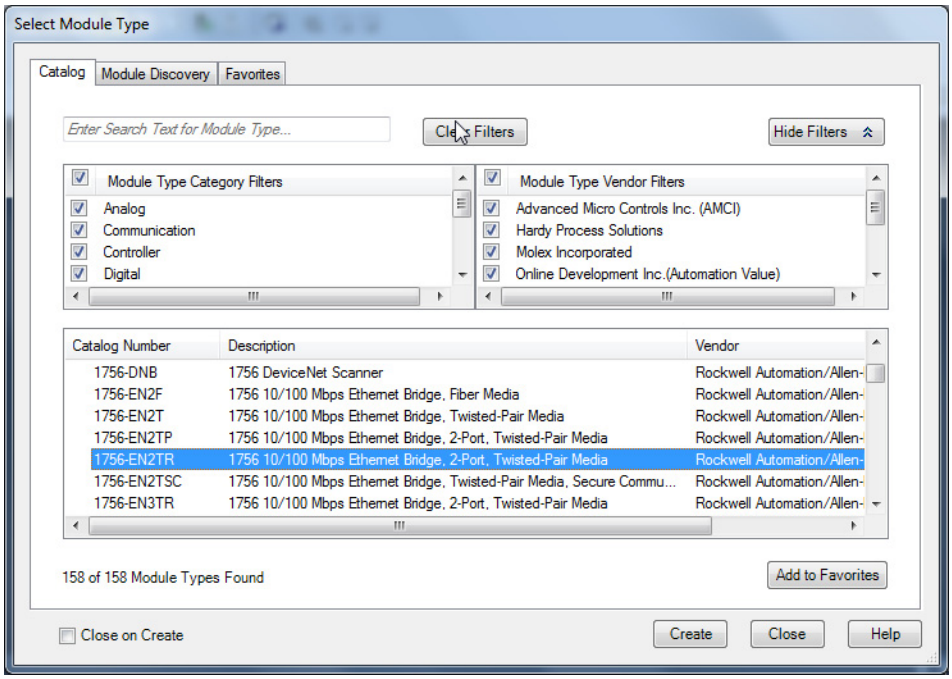


IMPORTANT If your project includes a ControlLogix or GuardLogix® 5570 controller, you need to add an EtherNet/IP communication module to your Bulletin 1756 chassis and configure it for use in your application.

- For ControlLogix 5570, and GuardLogix 5570 controllers, go to step 6.
- For CompactLogix 5370, Compact GuardLogix 5370, CompactLogix 5380, ControlLogix 5580, or GuardLogix 5580 controllers, go to step 13.

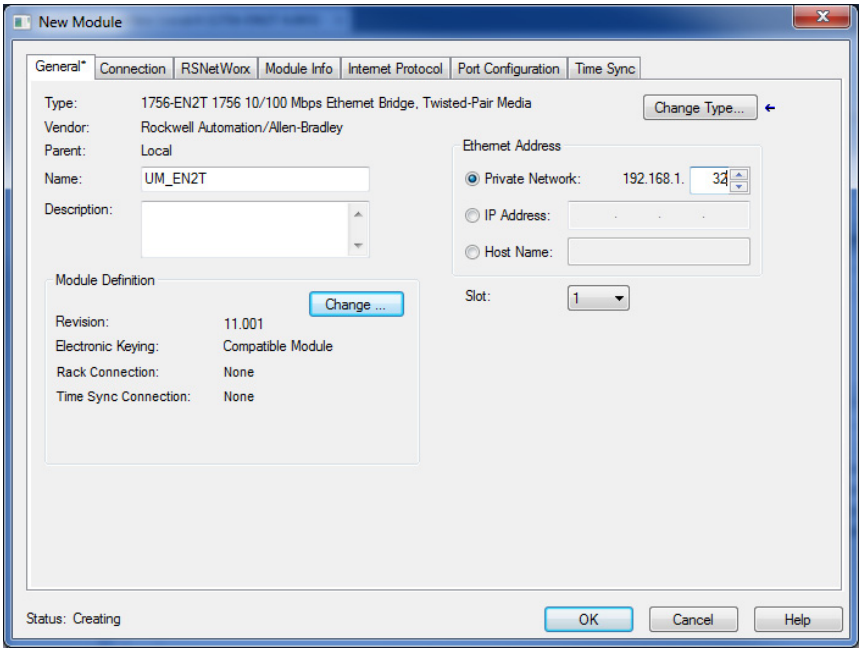
Refer to the EtherNet/IP Network Configuration User Manual, publication ENET-UM006 for more information on EtherNet/IP modules.

6. Right-click I/O Configuration in the Controller Organizer and choose New Module.



7. By using the filters, check Communication and Allen-Bradley, and select 1756-EN2T, 1756-EN2TR, or 1756-EN3TR as appropriate for your hardware configuration. In this example, the 1756-EN2T module is selected.
8. Click Create.

   The New Module dialog box appears.



9. Configure the new module.
   a. Type the module Name.
   b. Enter the Logix EtherNet/IP module slot (leftmost slot = 0).
   c. Select an Ethernet Address option.

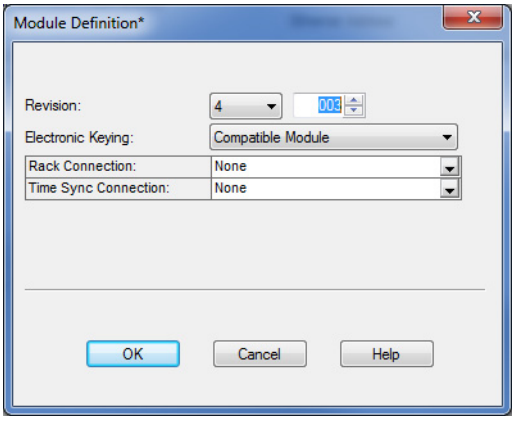
      In this example, the Private Network address is selected.

   d. Enter the address of your EtherNet/IP module.

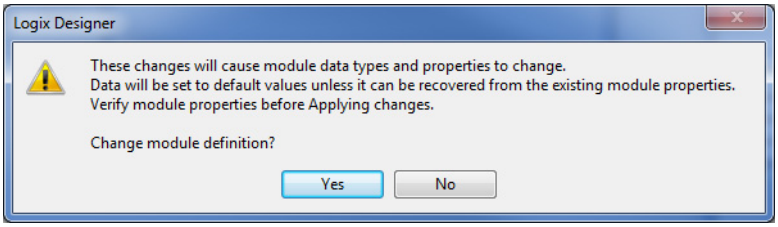
In this example, the last octet of the address is 32.

e. Click Change in the Module Definition area.

The Module Definition dialog box opens.



10. To close the Module Definition dialog box, click OK.
11. When prompted to confirm your module definition changes, click Yes.



12. To close the New Module dialog box, click OK.

    Your new 1756-EN*x*T Ethernet module appears under the I/O Configuration folder in the Controller Organizer.

13. Click OK.

Configure the Kinetix 5100 Drive Modules

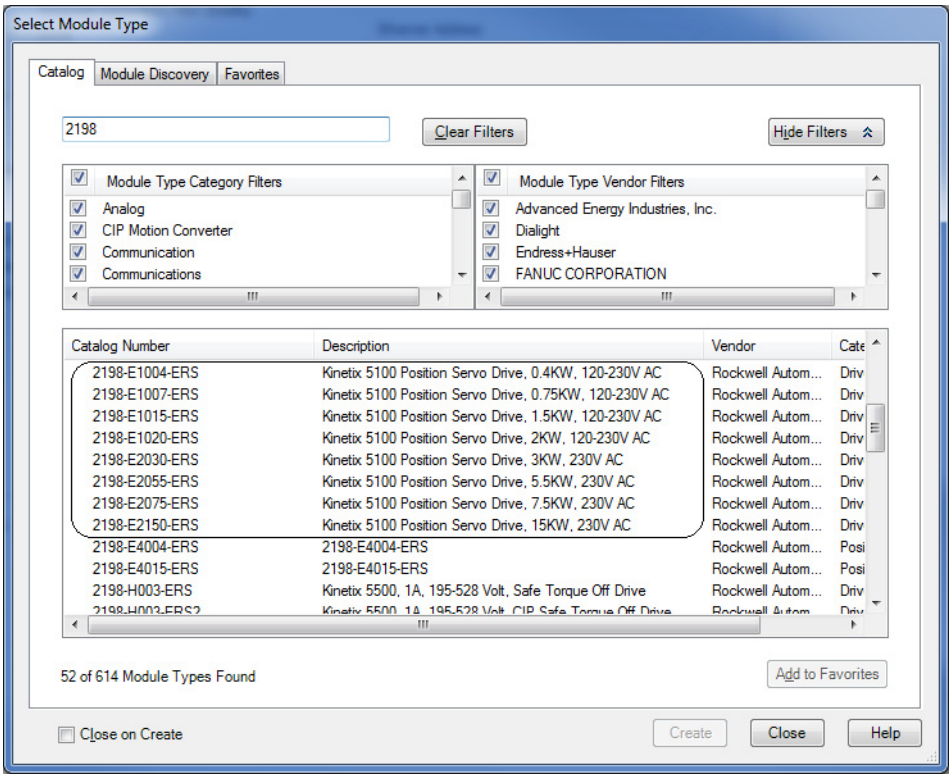
IMPORTANT To configure Kinetix 5100 drive systems, you must be using the Logix Designer application, version 30.00 or later.

In this example, a 2198-E1004-ERS drive is configured.

Follow these steps to configure Kinetix 5100 drives.

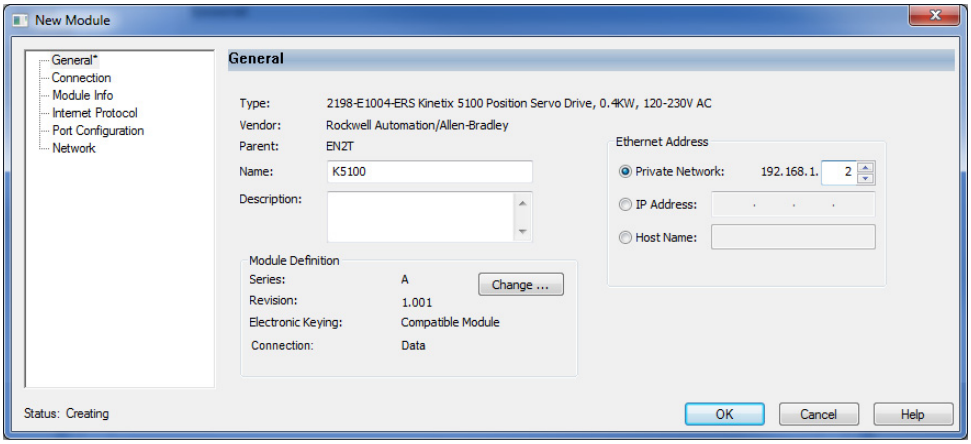
1. Right-click Ethernet/IP Module and choose New Module.

   The Select Module Type dialog box appears.



2. By using the filters, check Motion and Allen-Bradley, and select your 2198-E*xxxx*-ERS drive as appropriate for your hardware configuration.
3. Click Create.

   The New Module dialog box appears.



4. Configure the new drive.
   a. Type the drive Name.
   b. Select an Ethernet Address option.

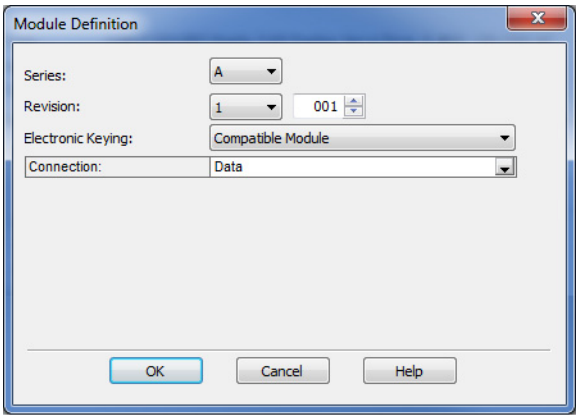
      In this example, the Private Network address is selected.

   c. Enter the address of your 2198-Exxxx-ERS drive.

      In this example, the last octet of the address is 2.

   d. Under Module Definition click Change.

The Module Definition dialog box appears.



e. Set Series and Revision to match your drive.

f. Choose an Electronic Keying option.

The electronic keying feature automatically compares the expected module, as shown in the configuration tree, to the physical module before communication begins. We recommend using either `Exact Match' or `Compatible Keying'. You cannot use Disable keying with safety applications. For more information about electronic keying, see the Electronic Keying in Logix 5000™ Control Systems Application Technique, publication LOGIX-AT001.

g. From the Connection pull-down menu, choose the Connection mode for your motion application.

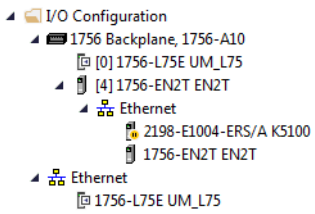
Table 72 - Module Connection Definitions

Connection Mode	Controller Needed	Safety Options	Description
Data	ControlLogix 5570, ControlLogix 5580, GuardLogix 5570, GuardLogix 5580, CompactLogix 5370, CompactLogix 5380, Compact GuardLogix 5370, Compact GuardLogix 5380	Hardwired STO mode	• Connections are managed by this controller. • Hardwired STO is controlled by the hardwired safety inputs.

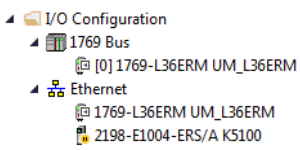
5. To close the Module Definition dialog box, click OK.
6. To close the Module Properties dialog box, click OK.
7. To close the Select Module Type dialog box, click Close.

Your 2198-*xxxx*-ERS drive appears in the Controller Organizer under the Ethernet network in the I/O Configuration folder.

ControlLogix 5570 Controller

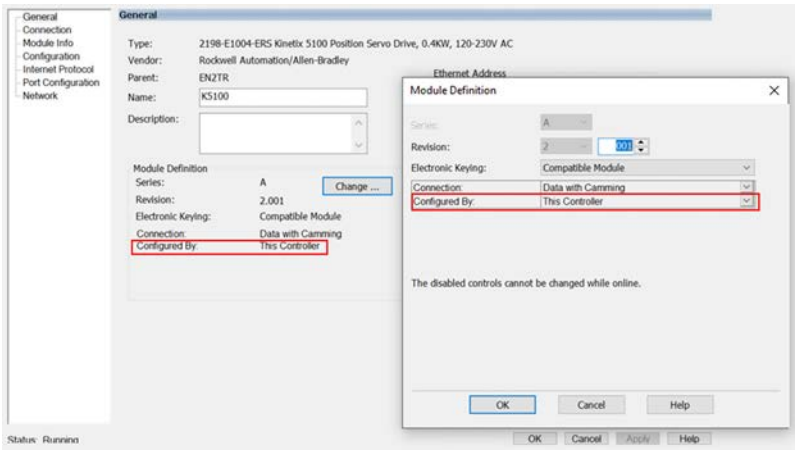


CompactLogix 5370 Controller



Support ADC (Automatic Device Configuration) in AOP Version 2

ADC function can be enabled by setting 'Configured by' as 'This Controller'.



See Appendix F, Automatic Device Configuration on page 499 for more information.

Download the Program

When the Logix Designer application is complete and the file saved the file you must download your program to the Logix 5000 controller.

Tuning

This chapter provides information about tuning.

Topic	Page
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Autotuning	174
Tuning via Tuning Mode 1 and Tuning Mode 2	184
Tuning in Manual Mode	190

For Kinetix® 5100 fault code descriptions and parameters, see Knowledgebase Technote: Kinetix 5100 Servo Drive Parameter Data and Fault Codes. You can download the spreadsheet from this public article.

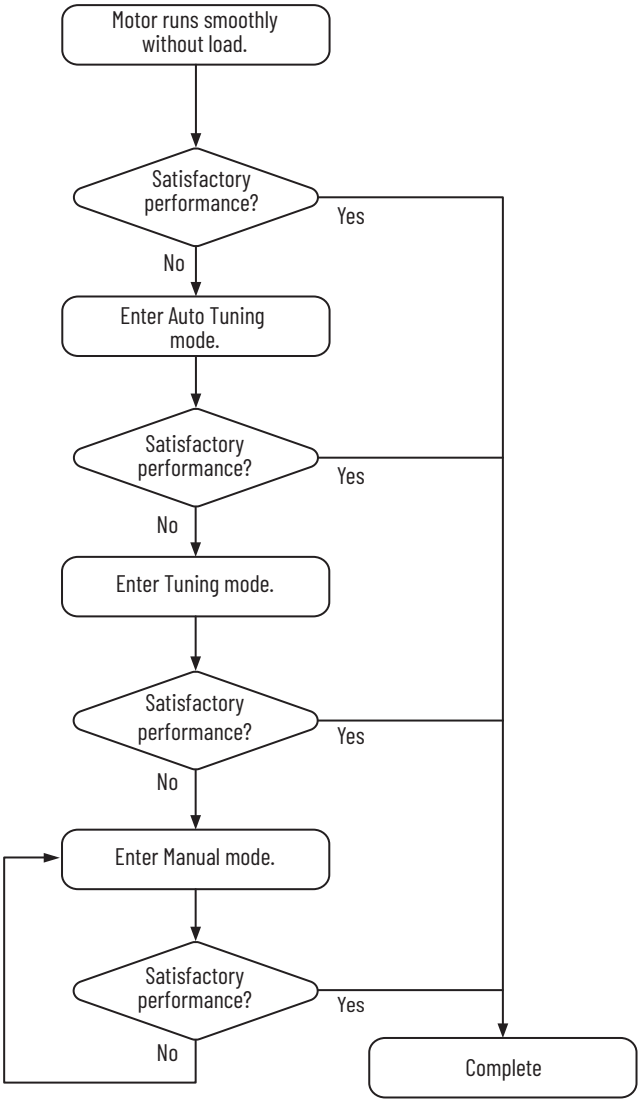
You will be asked to log in to your Rockwell Automation web account or create an account if you do not have one. You do not need a support contract to access this article.

Tuning Process

The autotuning function enables the drive to do a real-time mechanism inertia estimation and update the velocity and position loop control gains, resonance suppression filter parameters, and so on accordingly. If autotuning does not provide suitable performance, then tuning mode 1, tuning mode 2, and the manual tuning mode can be used.

The flowchart in Figure 74 provides an overview of the tuning process.

Figure 74 - Tuning Procedure Flowchart



Autotuning

Autotuning can be performed via KNX5100C software or via the drive panel. Currently, autotuning cannot be performed via Studio 5000 Logix Designer® application.

Through the autotuning function, the servo drive helps you find the most suitable parameters according to the machine characteristics for your system. The values of the parameters listed in the following tables can change as a result of autotuning.

Table 73 - Gain-related Parameters

Parameter	Name
ID144 (P1.037)	LoadInertiaRatio
ID185 (P2.000)	PositionProportionalGain
ID189 (P2.004)	VelocityProportionalGain
ID191 (P2.006)	VelocityIntegralGain
ID216 (P2.031)	SystemGainResponseLevel
ID217 (P2.032)	GainAdjustMode

Table 74 - Filter and Resonance Suppression Parameters

Parameter	Name
ID135 (P1.025)	LowFreqVibrationSuppression1Frequency
ID136 (P1.026)	LowFreqVibrationSuppression1Gain
ID137 (P1.027)	LowFreqVibrationSuppression2Frequency
ID138 (P1.028)	LowFreqVibrationSuppression2Gain
ID208 (P2.023)	NotchFilter1Frequency
ID209 (P2.024)	NotchFilter1Depth
ID210 (P2.025)	ResonanceSuppressionLowPassFilterTime
ID226 (P2.043)	Notch Filter2Frequency
ID227 (P2.044)	Notch Filter2Depth
ID228 (P2.045)	Notch Filter3Frequency
ID229 (P2.046)	Notch Filter3Depth
ID232 (P2.049)	VelocityFeedbackLowPassFilterTime
ID257 P(2.098)	Notch Filter4Frequency
ID258 P(2.099)	Notch Filter4Depth
ID260 P(2.101)	Notch Filter5Frequency
ID261 P(2.102)	Notch Filter5Depth

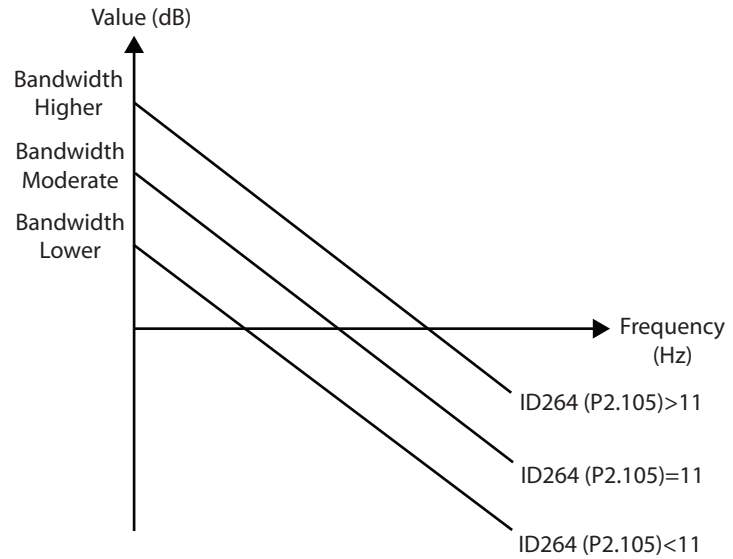
Autotuning Configuration Parameters

Parameters ID264 (P2.105) AutoTuningBandwidth and ID265 (P2.106) Auto TuningOvershoot can be used to adjust the responsiveness and rigidity, respectively, in autotuning mode

ID264 (P2.105) - AutoTuningBandwidth Parameter

This parameter is used to adjust the bandwidth when autotuning. If the value is larger, the bandwidth after autotuning is higher, but the bandwidth margin may be insufficient, causing machine jitter. If the value is smaller, the bandwidth after autotuning is lower, but the response is slower.

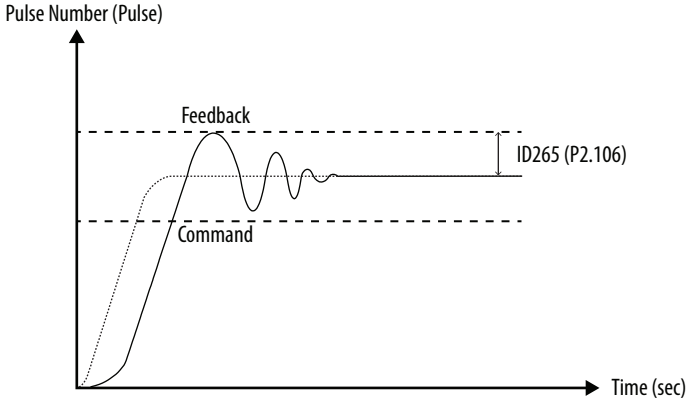
Figure 75 - AutoTuningBandwidth Parameter Graph



ID265 (P2.106) - AutoTuningOvershoot Parameter

This parameter is used to adjust the maximum allowable overshoot when autotuning. The overshoot range is set according to the user or machine. If the value is larger, the maximum overshoot that is allowed by autotuning will be greater, but the response will be faster. If the value is smaller, the maximum overshoot that is allowed by autotuning will be smaller, but the response will be slower.

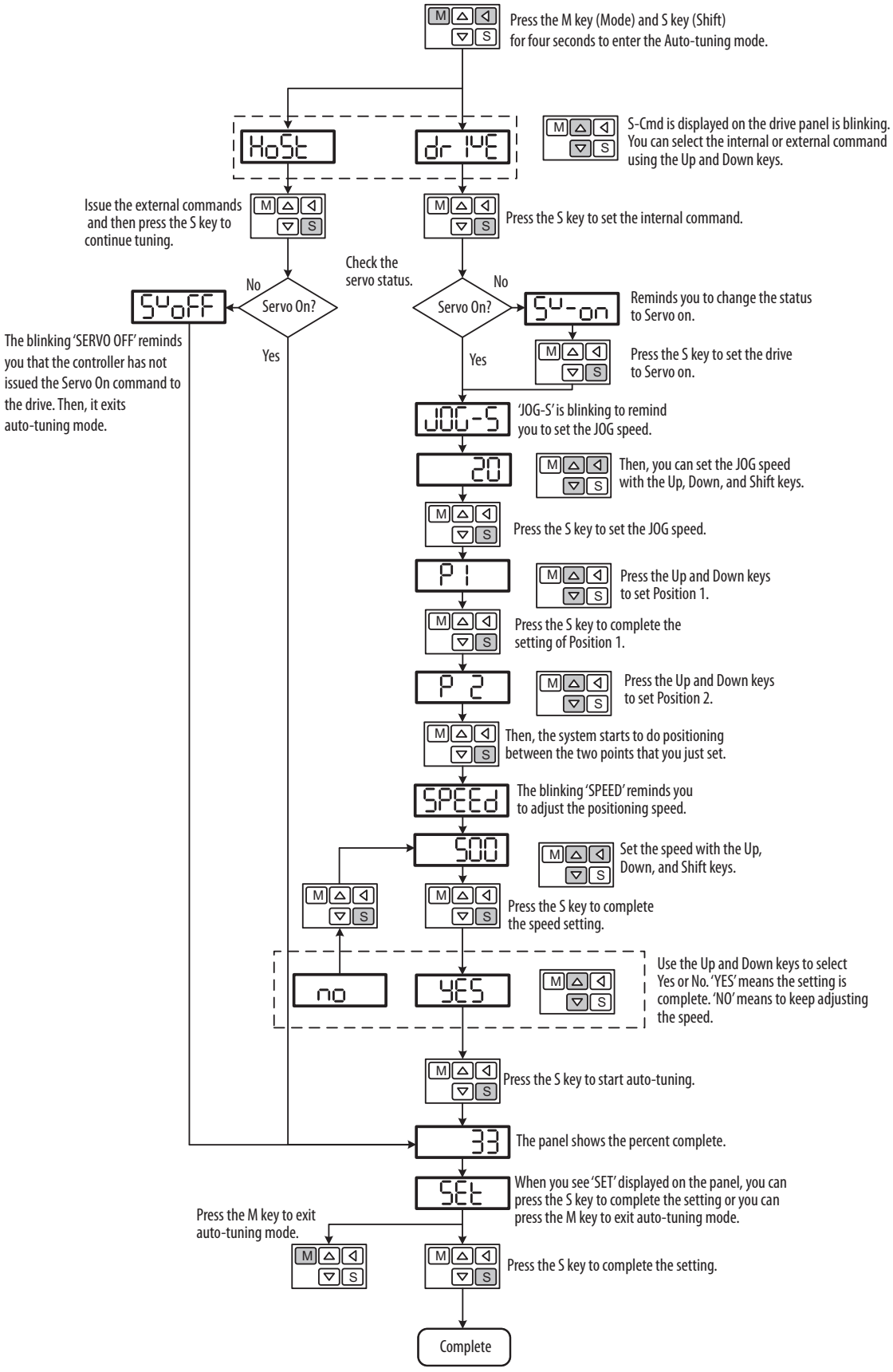
Figure 76 - AutoTuningOvershoot Parameter Graph



Autotuning via the Drive Panel

See Figure 77 for an overview of autotuning via the drive panel. Make sure that the emergency stop and the positive and negative limit works properly before you start to tune the system.

Figure 77 - Autotuning Via the Drive Panel Flowchart



Autotuning via KNX5100C Software

Autotuning can also be performed using KNX5100C software. When the drive and motor are connected, and the drive is online with the KNX5100C software, follow these steps to autotune the drive.

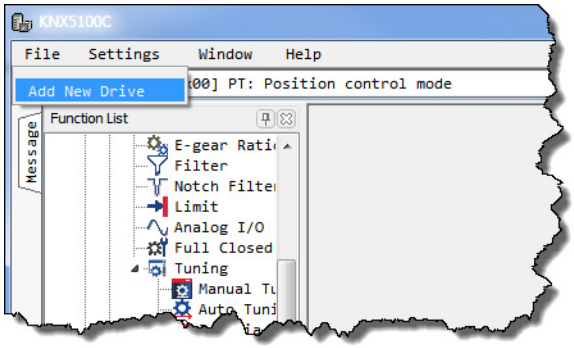
There are two options available that determine how the motor is commanded to drive.

- Host controller plans the path and issues the command to drive the motor
- Drive plans the path and issues the command to drive the motor

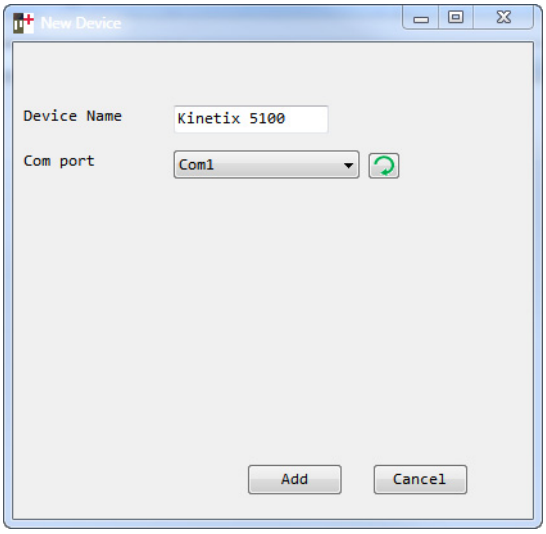
ATTENTION: The motor rotates during this tuning procedure. Hazard of personal injury exists due to motor shaft rotation and/or machinery motion.

Connect to Drive and Select Autotuning

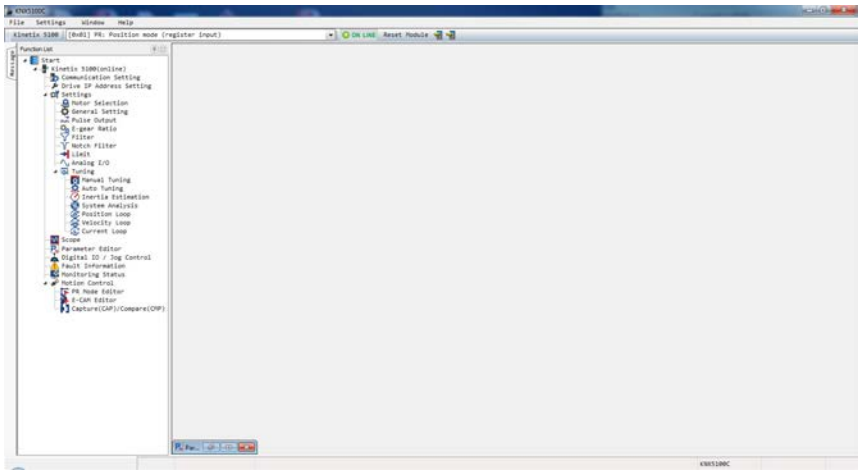
1. Select **Add New Drive** from the **New** menu.



2. On the New Device dialog box, click **Add**.



3. Once a connection is created, the following window is displayed. Click **Auto Tuning** from the tree view.

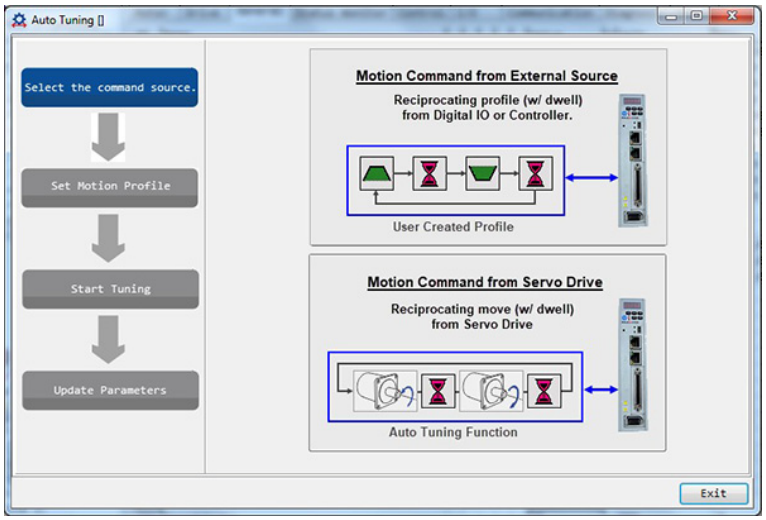


4. Continue with the steps that are shown in Motion Command From Controller or Motion Command From Drive.

Motion Command From Controller

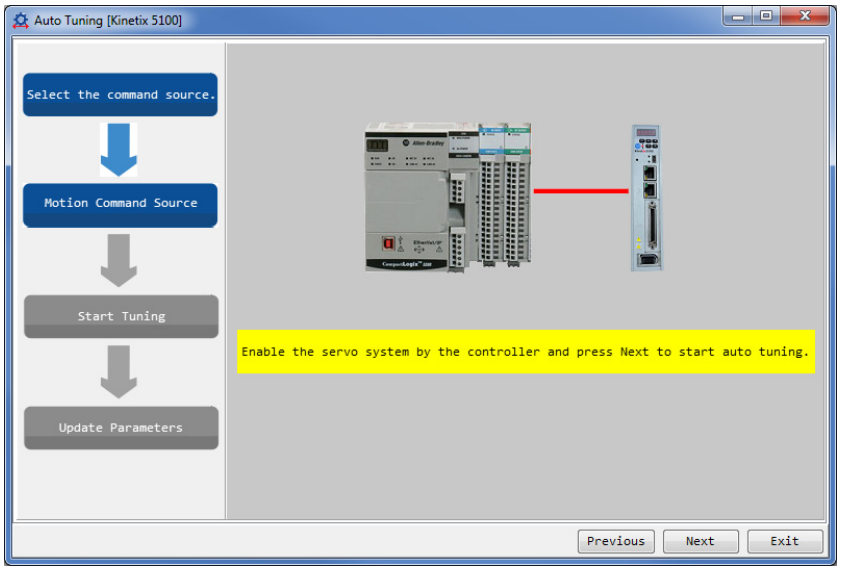
Follow these steps to have the host controller plan the path and issue the command to drive the motor.

1. Select **Controller: Motion Command From Controller** and make sure that the motion/machining path is set correctly.

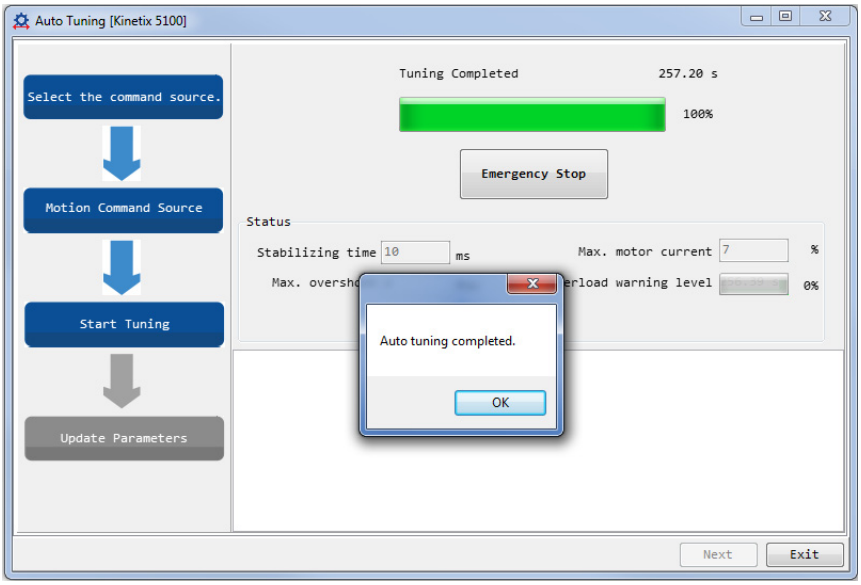


Set the motor to operate at least one cycle in both forward and backward directions.

2. After the setting is done, run the motor repeatedly using the path you just set. Then, click **Next**.

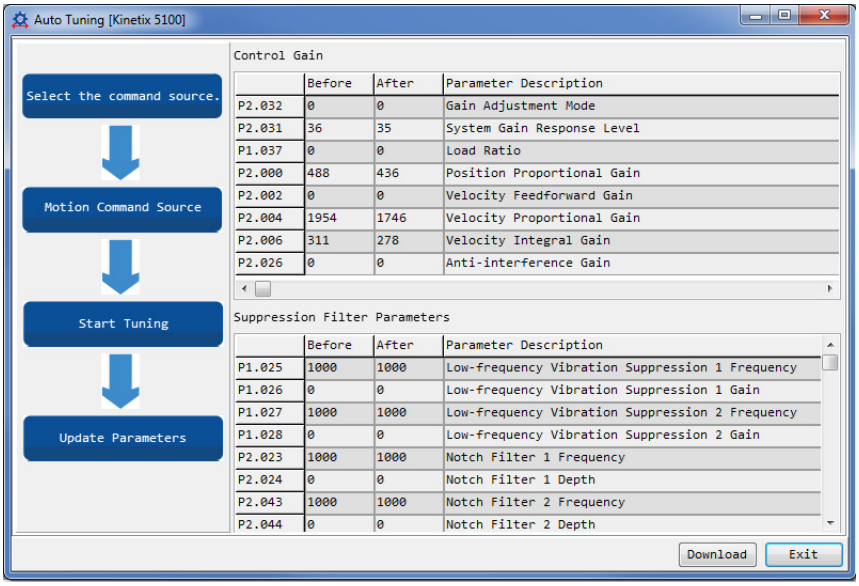


3. Wait until the tuning progress bar reaches 100%, a dialog box showing autotuning completed is displayed, and then click **OK**.



You can click Emergency Stop to stop the tuning process.

A table is displayed that shows the values of parameters before and after autotuning.

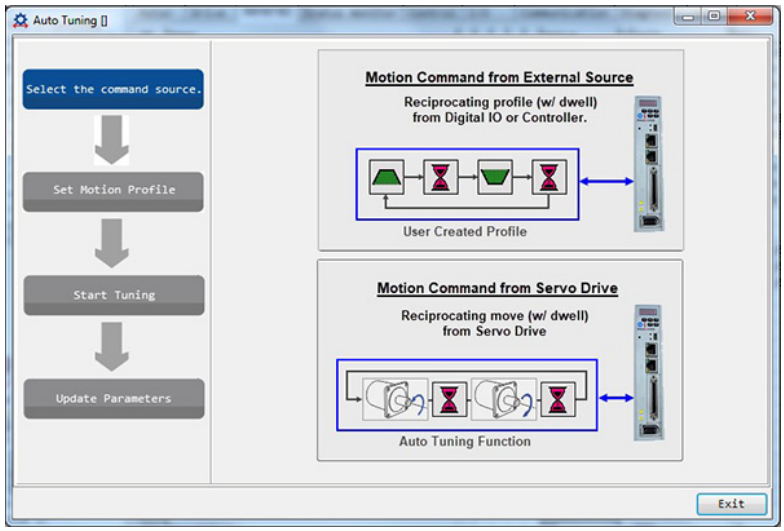


4. Click Download (apply the tuning result) or Exit (ignore the tuning result) to complete autotuning.

Motion Command From Drive

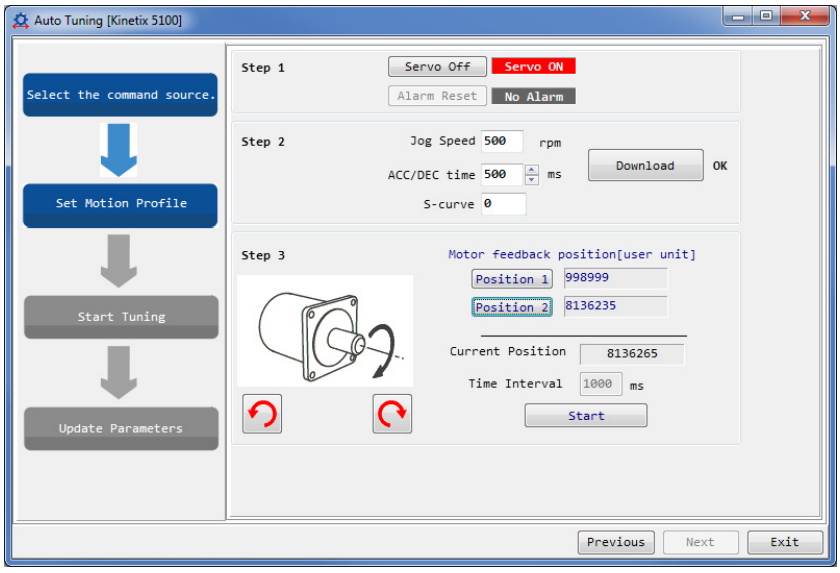
Follow these steps to have the drive plan the path and issue the command to drive the motor.

1. Select **Drive: Motion Command From Drive**.

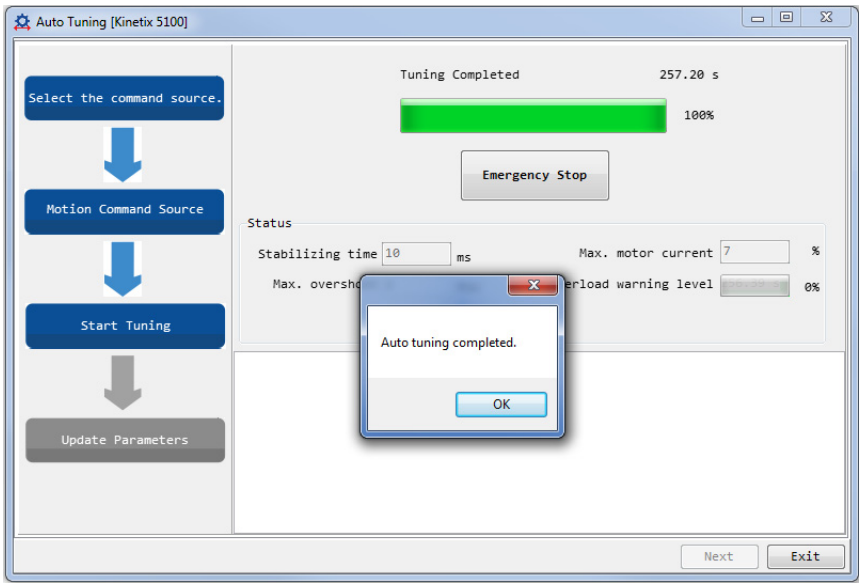


2. Complete the following steps to set the motor's running path.
   a. Set the system to **Servo ON** state.
   b. Set the acceleration/deceleration time and jog speed.
      The default setting of acceleration/deceleration time is 500 ms.
      The jog speed should be set to no less than 500 rpm.
   c. Click **Download**.

d. When the motor running path is set, use the Left or Right key to run the motor to position 1 and 2. Then, click **Start** to run between two positions. The motor operates to position 1 and 2 in forward and backward directions.

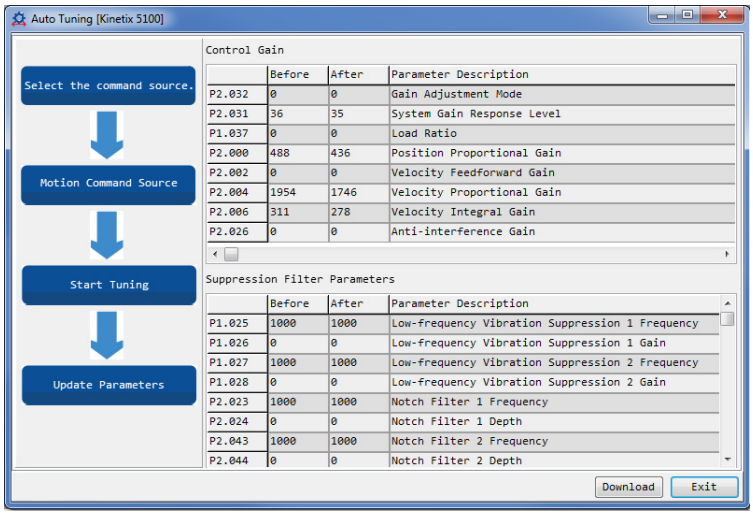


3. Wait until the tuning progress bar reaches 100%, a dialog box showing Auto tuning completed is displayed, and then click **OK**.



You can click Emergency Stop to stop the tuning process.

A table is displayed that shows the values of parameters before and after autotuning.

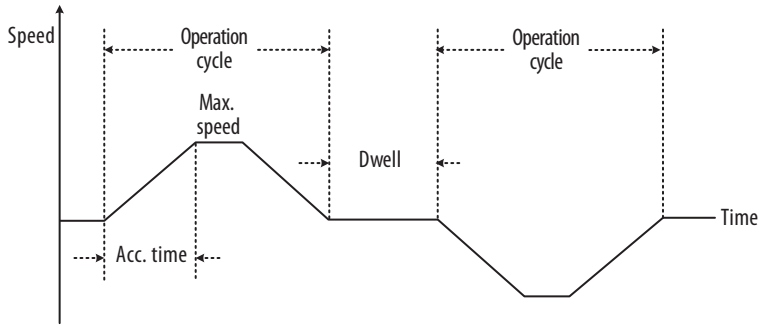


4. Click Download (apply the tuning result) or Exit (ignore the tuning result) to complete autotuning.

Alarms Related to Autotuning

In autotuning mode, it is vital to program the command path, including the operation cycle (such as acceleration, constant speed, and deceleration) and dwell time. See Figure 78.

Figure 78 - Settings Required for Autotuning



If any of these settings are not correct, the servo drive will stop and display a fault. See Table 75 for possible causes and solutions.

Table 75 - Faults Related to Autotuning

Fault Code	Fault Name	Possible Causes	Possible Solutions
E 08A	Autotuning command error	The external source command was not issued.	Check the external source command.
		Cable connection error.	Check the cable connection.
		Position 1 and 2 were the same when command was issued.	Reconfigure position 1 and 2.
E 08B	Dwell time too short	Dwell time too short.	Setting the dwell time is required. Increase the dwell time to more than 1 second.
E 08C	Inertia estimation error	Acceleration/deceleration time was too long.	Verify that the acceleration/deceleration time for motor to start from 0...3000 rpm is within 1.5 sec.
		Speed is too slow.	The recommended speed setting is 500 rpm. The lowest possible speed setting is 200 rpm.
		Inertia mismatch.	Verify that load inertia is not more than 50 times the motor inertia.
		Inertia variation is too vigorous.	Resize the system requirements.

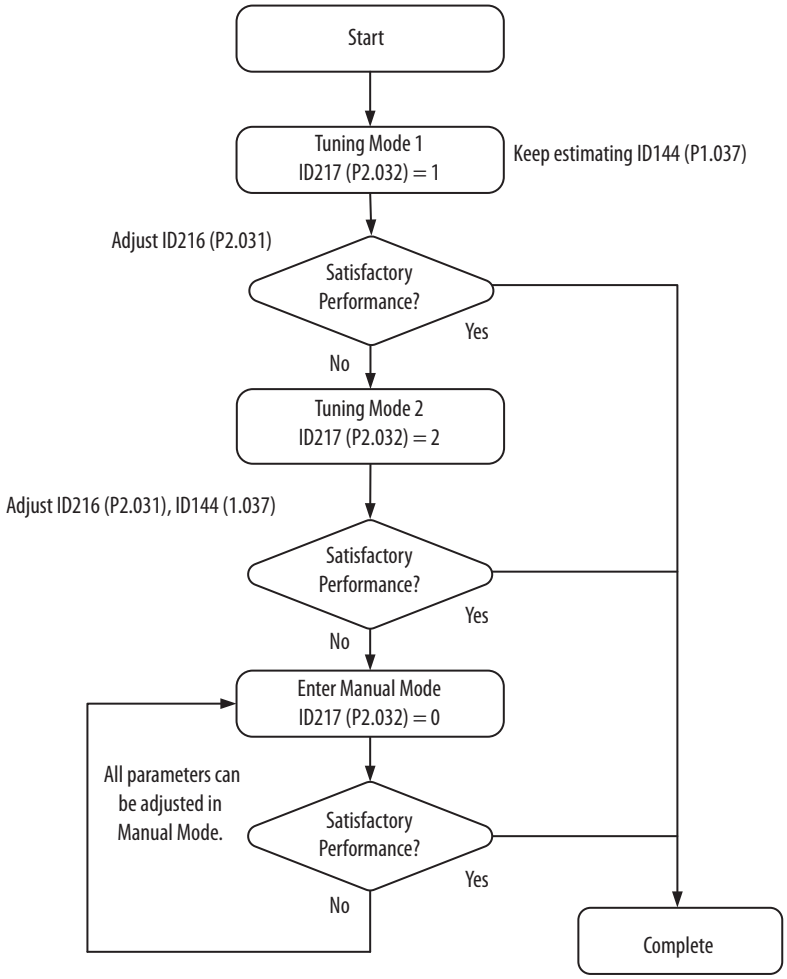
Tuning via Tuning Mode 1 and Tuning Mode 2

Apart from the autotuning function described earlier, there are two other tuning modes provided to fine-tune the system.

Tuning Mode Process

See Figure 79 for an overview of the tuning mode process.

Figure 79 - Tuning Mode Process



Tuning Mode 1

In this mode, the drive keeps estimating the mechanical inertia and updating the value of parameter ID144 (P1.037). As shown in Table 76, note that the parameters in the Manual Tuning column can be adjusted while in Tuning Mode 1, but the parameters in the Autotune column are still adjusted automatically.

Table 76 - Tuning Mode 1, Related Parameters

ID217 (P2.032) Setting Value	Tuning Mode	Inertia Estimation	Parameter	
			Manual Tuning	Autotuning
1	Tuning Mode 1	Real-time estimation	ID216 (P2.031)	ID144 (P1.037)
				ID185 (P2.000)
				ID189 (P2.004)
				ID191 (P2.006)(
				ID208 (P2.023)
				ID209 (P2.024)
				ID210 (P2.025)
				ID229 (P2.046)
				ID226 (P2.043)
				ID 227 (P2.044)
				ID228 (P2.045)
				ID232 (P2.049)
				ID257 (P2.098)
				ID258 (P2.099)
				ID260 (P2.101)
				ID261 (P2.102)

Inertia Estimation

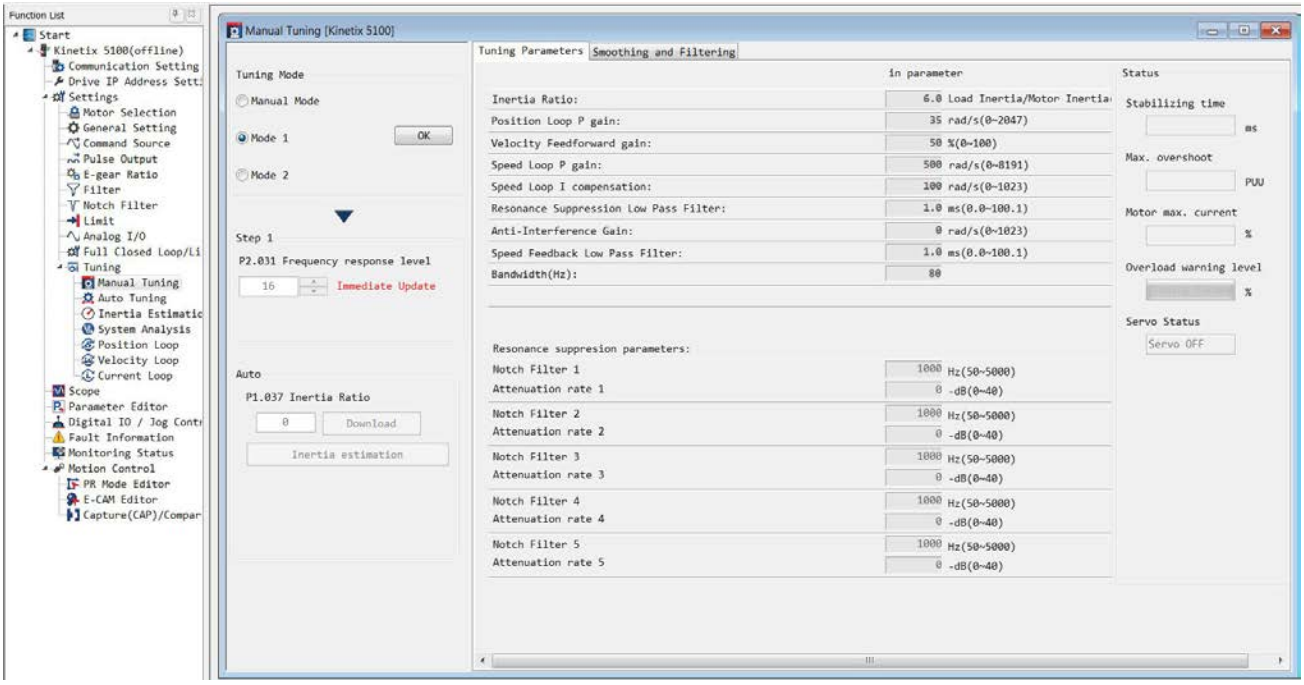
Requirements for Inertia estimation:

- Motor speed increases from 0 rpm...3000 rpm within 1.5 seconds.
- It is suggested to set the speed to 500 rpm or greater. The lowest speed should be no less than 200 rpm.
- The load inertia should be less than 50 times the motor inertia.
- The change in the external force or inertia ratio cannot be too great.

Tuning Mode 1 in KNX5100C Software

You can use KNX5100C software for manual tuning in Mode 1 by choosing Manual Tuning from the Function List and selecting Mode 1.

Figure 80 - Selecting Mode 1 Manual Tuning



The Smoothing and Filtering tab lets you configure the parameters related to the Low Pass and Moving filters and S-curve, depending upon your configured Operating mode. See Chapter 10 for details on filters and s-curves.

Tuning Mode 2

When Tuning Mode 1 cannot meet your demand, you can try Tuning Mode 2 to tune the servo system. In Tuning Mode 2, the system does not automatically estimate the inertia. As shown in Table 77, note that the parameters in the Manual Tuning column can be adjusted while in Tuning Mode 2, but the parameters in the Autotune column are still adjusted automatically.

The correct mechanical inertia must be entered in parameter ID144 (P1.037).

Table 77 - Tuning Mode 2, Related Parameters

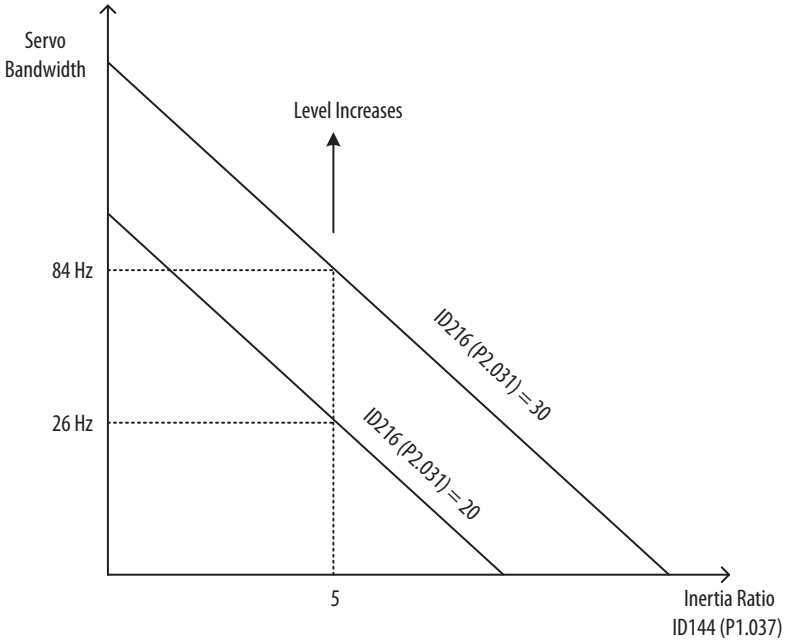
ID217 (P2.032) Setting Value	Tuning Mode	Inertia Estimation	Parameter	
			Manual Tuning	Autotuning
2	Tuning Mode 2	Value of ID144 (P1.037)	ID144 (P1.037) ID216 (P2.031)	ID185 (P2.000)
				ID189 (P2.004)
				ID191 (P2.006)
				ID208 (P2.023)
				ID209 (P2.024)
				ID210 (P2.025)
				ID226 (P2.043)
				ID227 (P2.044)
				ID228 (P2.045)
				ID229 (P2.046)
				ID232 (P2.049)
				ID257 (P2.098)
				ID258 (P2.099)
				ID260 (P2.101)
				ID261 (P2.102)

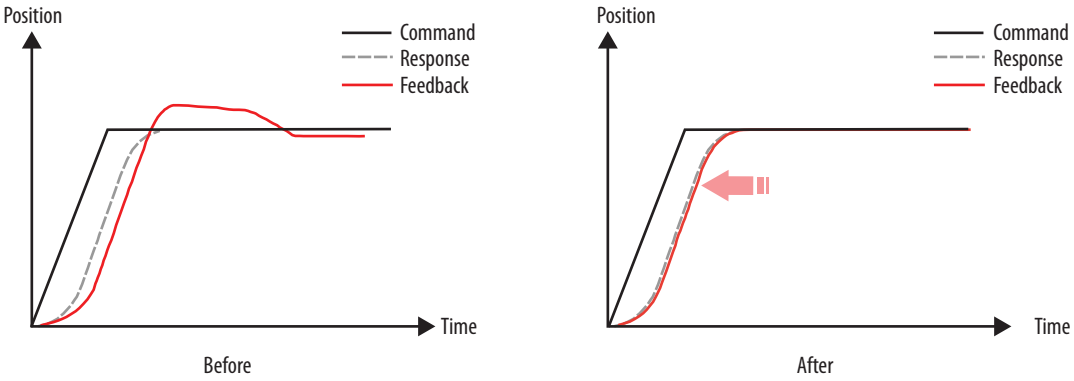
Setting ID216 (P2.031) SysGainResponseLevel

Parameter ID216 (P2.031) SysGainResponseLevel is provided to tune the servo system in an easy and user-friendly way. When using the fixed inertia ratio and increasing this parameter, the servo bandwidth is also increased. If resonance occurs, lower one or two bandwidth levels. Adjust the bandwidth level according to the actual situation.

For instance, if the setting value of ID218 (P2.031) was 30, the bandwidth level can be reduced to 28. When adjusting the value of this parameter, its corresponding parameters is adjusted by the servo system, such as ID185 (P2.000) PositionProportionalGain and and ID189 (P2.004) VelocityProportional Gain.

Figure 81 - Settings for SysGainResponseLevel

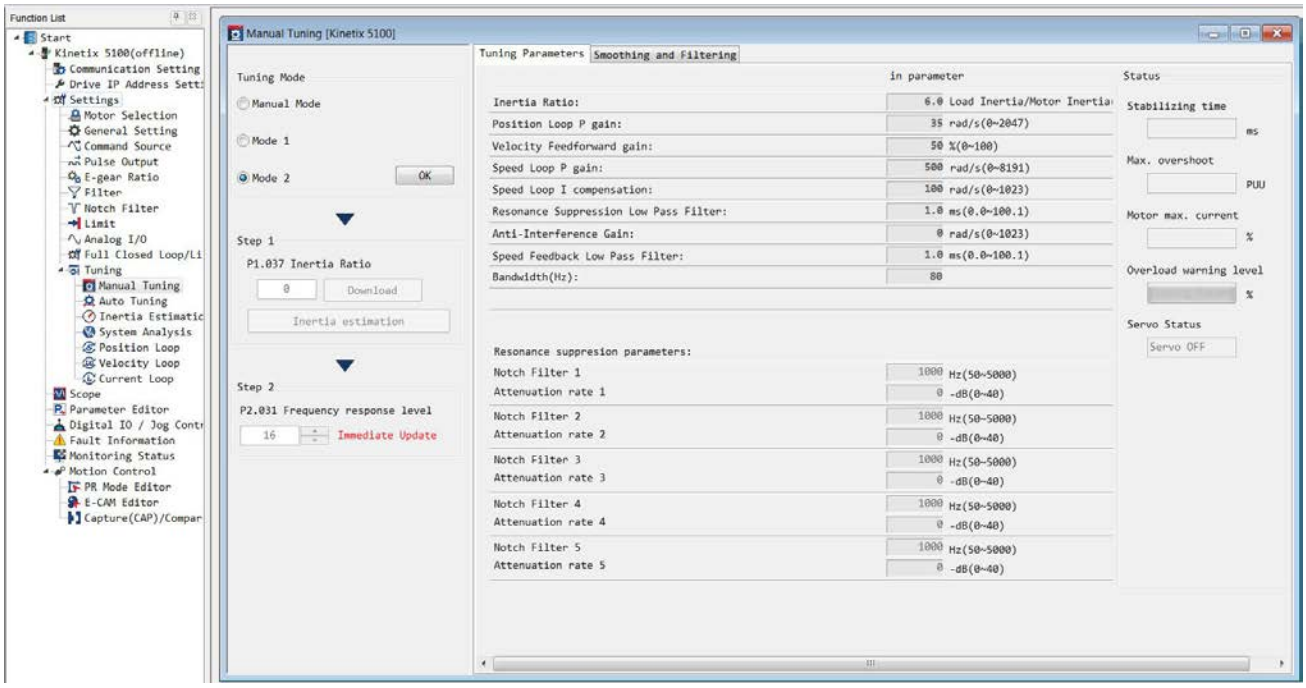




Tuning Mode 2 in KNX5100C Software

You can use KNX5100C software for manual tuning in Mode 2 by choosing Manual Tuning from the Function List and selecting Mode 2.

Figure 82 - Selecting Mode 2 Manual Tuning



The Smoothing and Filtering tab lets you configure the parameters related to the Low Pass and Moving filters and S-curve, depending upon your configured Operating mode. See Chapter 10 for details on filters and s-curves.

Tuning in Manual Mode

Table 78 lists parameters used in Manual Mode tuning.

Table 78 - Manual Mode Tuning

ID 217 (P2.032) Gain Adjustment Mode Setting	Tuning Mode	Inertia estimation	Parameter	
			Manual Tuning	Autotuning
0	Manual	Value of ID144 (P1.037)	ID144 (P1.037)	–
			ID188 (P2.000)	
			ID189 (P2.004)	
			ID191 (P2.006).	
			ID208 (P2.023)	
			ID 209 (P2.024)	
			ID210 (P2.025)	
			ID226 (P2.043)	
			ID227 (P2.044)	
			ID228 (P2.045)	
			ID229 (P2.046)	
			ID232 (P2.049)	
			ID257 (P2.098)	
			ID258 (P2.099)	
			ID260 (P2.101)	
			ID 261 (P2.102	

The selection of the position and speed response frequency should be determined by the machinery stiffness and the application. Generally, for applications or machines that require high speed and high precision, higher frequency response bandwidth is required. However, increasing the response bandwidth might cause resonance. Thus, machinery with higher stiffness is used to solve this problem.

When the resonance frequency is unknown, you can gradually increase the gain parameter values to increase the system response bandwith until you hear the sound of resonance. Then, decrease the gain parameter values.

The following are the descriptions of the gain adjustment parameters.

ID185 (P2.000) PositionProportionalGain [KPP]

This parameter determines the response of the position loop. The larger the KPP value, the higher the response frequency of the position loop. This lowers following error and position error, and shortens the settling time. However, if you set the value too high, it can cause the machinery to vibrate or cause overshoot when positioning. The calculation of position loop frequency response is as follows:

$$\text{Frequency response bandwidth of position loop (Hz)} = \frac{KPP}{2\pi}$$

See Gain Adjustment of the Position Loop on page 207 for more information.

ID189 (P2.004) VelocityProportionalGain [KVP]

This parameter determines the response of speed loop. The larger the KVP value, the higher the response frequency of the speed loop and the lower the following error. However, if you set the value too high, it could cause machinery resonance. The response frequency of the speed loop must be 4-6 times higher than the response frequency of the position loop; otherwise, the machinery might vibrate or it might cause overshoot when positioning. The calculation of speed loop frequency response is as follows:

$$fv = \left(\frac{KVP}{2\pi}\right) \times \left(\frac{1 + (P1.037)/10}{1 + \frac{JL}{JM}}\right) Hz$$

JM= Motor Inertia; JL: Load Inertia; P1.037: 0.1 (times)

When ID144 (P1.037) (auto estimation or manually set value) is equal to the real inertia ratio (JL / JM), the real speed loop frequency response is:

$$fv = \left(\frac{KVP}{2\pi}\right) Hz$$

ID191 (P2.006) VelocityIntegralGain [KVI]

The higher the KVI value, the better the mitigation of the deviation. However, if you set the value too high, it can cause the machinery to vibrate. It is suggested that you set the value as follows:

$$\text{KVI (P2.006)} \leq 1.5 \times \text{Speed loop frequency response}$$

ID210 (P2.025) ResonanceSuppressionLowPassFilterTime [NLP]

A high inertial value ratio reduces the frequency response of the speed loop. Therefore, you must increase the KVP value to maintain the response frequency. Increasing KVP value might cause machinery resonance. Use this parameter to mitigate the noise from resonance. The higher the value, the better the capability for reducing high-frequency noise. However, if you set the value too high, it can cause instability in the speed loop and overshoot in positioning. It is suggested that you set the value as follows:

$$\text{NLP (P2.025)} \leq \frac{10000}{6 \times \text{Speed loop frquency response (Hz)}}$$

ID211 (P2.026) AntiInterferenceGain [DST]

Use this parameter to increase the ability to resist external force and mitigate overshoot during acceleration / deceleration. The default value is 0. Adjusting this value in Manual mode is not suggested unless it is for fine-tuning.

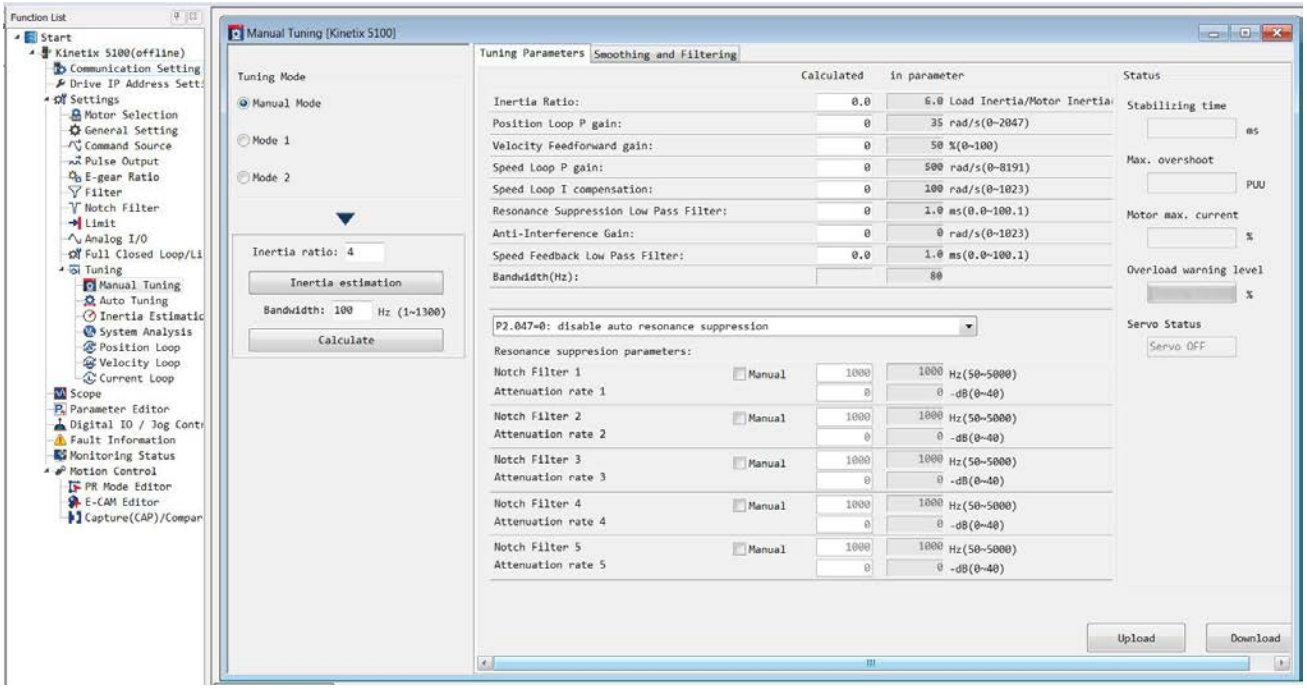
ID187 (P2.002) VelocityFeedforwardGain [PFG]

This parameter can reduce the position error and shorten the settling time. However, if you set the value too high, it might cause overshoot in positioning. If the setting of the e-gear ratio is larger than 10, it might cause noise as well.

Manual Mode Tuning in KNX5100C Software

You can use KNX5100C software for manual mode tuning by choosing Manual Tuning from the Function List and selecting Manual.

Figure 83 - Selecting Manual Mode Tuning

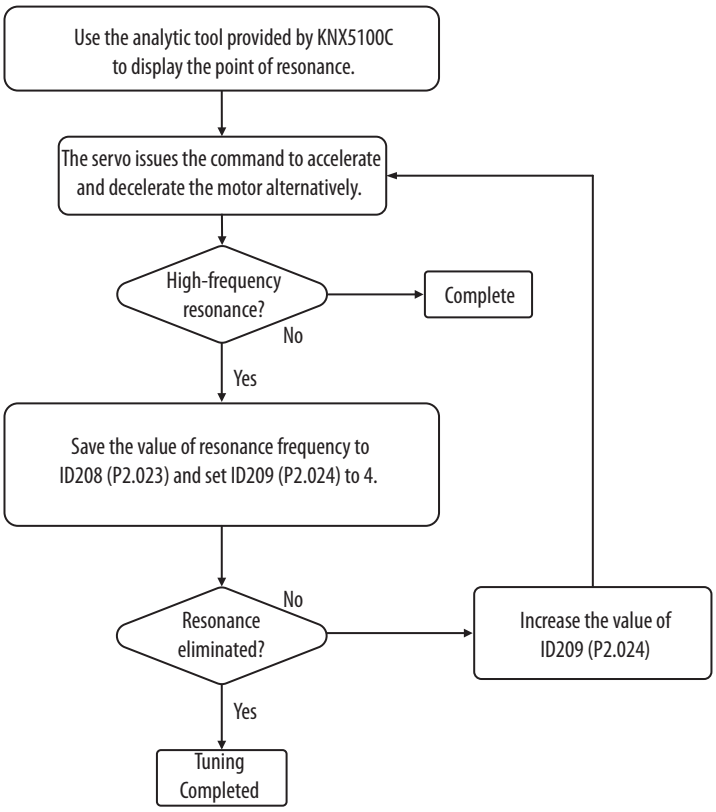


The Smoothing and Filtering tab lets you configure the parameters related to the Low Pass and Moving filters and S-curve, depending upon your configured Operating mode. See Chapter 10 for details on filters and s-curves.

Mechanical Resonance Suppression

Figure 84 shows an overview of the procedure to suppress mechanical resonance. Five sets of notch filters are provided to suppress mechanical resonance. All five sets can be set to auto-resonance suppression (set by parameter ID230 (P2.047) ResonanceSuppressionConfig) and manual adjustment.

Figure 84 - Mechanical Resonance Suppression Flowchart



Modes of Operation

Topic	Page
Select Operation Mode and Direction Control	195
Position Control	197
Speed Mode	211
Torque Mode	222
Dual and Multi-modes	226
I/O Mode	228
Speed and Torque Limit Functions	245



For Kinetix® 5100 fault code descriptions and parameters, see Knowledgebase Technote: Kinetix 5100 Servo Drive Parameter Data and Fault Codes. You can download the spreadsheet from this public article.

You will be asked to log in to your Rockwell Automation web account or create an account if you do not have one. You do not need a support contract to access this article.

Select Operation Mode and Direction Control

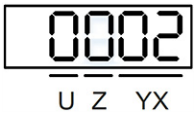
Follow these steps to switch the operation mode:

1. Switch the servo drive to Servo Off status.

   You can do this by setting DI.SON to OFF.
2. Set ID117 (P1.001) and refer to YX: Control Mode Setting for the mode selection.
3. After setting the parameter, cycle power to the servo drive.

The following tables explain how to set the ID117 (P1.001) Control Mode parameter.

Settings:



	YX = Control Mode Setting	Z = Directional Control	U = DIO Setting Value Control
Where:	See below	0 = Forward direction	0 = Same value
		1 = Reverse direction	1 = Resets to default value

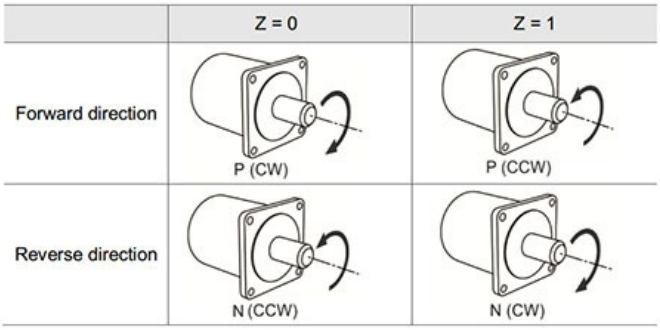
- YX: Control Mode Setting

Mode	PT	PR	S	T	Sz	Tz
00	▲					
01		▲				
02			▲			
03				▲		
04					▲	
05						▲
Dual mode						
06	▲		▲			
07	▲			▲		
08		▲	▲			
09		▲		▲		
0A			▲	▲		
0B	Reserved					
0C	I/O (Ethernet)					
Multi-mode						
0E	▲	▲	▲			
0F	▲	▲		▲		

Table 79 - Kinetix 5100 Drive Control Modes

Control Mode	Short Name	Description
Position mode (terminal block input)	PT	This mode is sometimes referred to as Pulse Train Output or Step and Direction. The servo drive receives the Position command and commands the motor to run to the target position. The Position command is communicated through the terminal block and the signal type is pulse.
Position mode (register input)	PR	The servo drive receives the Position command and commands the motor to run to the target position. Position commands are issued from the program registers (99 sets in total). You can select the register number with binary-weighted DI signals or through communication.
Speed mode	S	The servo drive receives the Speed command and commands the motor to run at the target speed. The Speed command is issued from the internal registers (3 sets in total) or by analog voltage (-10V…+10V) that is communicated through the terminal block. You can select the command with binary-weighted DI signals.
Speed mode (no analog input)	Sz	The servo drive receives the Speed command and commands the motor to run at the target speed. The Speed command can only be issued from the internal registers (4 sets in total, one is fixed at 0). You can select the command with binary-weighted DI signals.
Torque mode	T	The servo drive receives the Torque command and commands the motor to run with the target torque. The Torque commands can be issued from the internal registers (3 sets in total) and by analog voltage (-10V…+10V) that is communicated through the terminal block. You can select the command with binary-weighted DI signals.
Torque mode (no analog input)	Tz	The servo drive receives the Torque command and commands the motor to run with the target torque. The Torque command can only be issued from the internal registers (4 sets in total, one is fixed at 0). You can select the command with binary-weighted DI signals.
I/O mode	IO	The servo drive receives commands from the Logix controller through the EtherNet/IP network connection. Commands are issued through the Add-On Instruction (AOI) instructions in the Logic Designer application.
Dual mode	PT-S	Switches PT and S mode with DI signals.
	PT-T	Switches PT and T mode with DI signals.
	PR-S	Switches PR and S mode with DI signals.
	PR-T	Switches PR and T mode with DI signals.
	S-T	Switches S and T mode with DI signals.
	–	Reserved
	PT-PR	Switches PT and PR mode with DI signals.
Multi-mode	PT-PR-S	Switches PT, PR, and S mode with DI signals.
	PT-PR-T	Switches PT, PR, and T mode with DI signals.

- Z: Direction Control



- U: DIO Setting Value Control

Setting No.	Description
0	When switching modes, DIO settings ID195...ID207 (P2.010...P2.022) remain the same value.
1	When switching modes, DIO settings ID195...ID207 (P2.010...P2.022) and ID220...ID225 (P2.036...P2.041)are reset to the default of each mode.

Position Control

Three input modes for position control are available on the drive: External pulse or analog input (PT mode), internal register (PR mode) and I/O mode. In PT mode, the servo drive is able to receive pulse command of directions (motor runs forward or reverse), and the rotation angle of motor can be controlled by the input pulse. The drive can receive pulse command of up to 4 million packets per second (Mpps).

You can also complete the position control by internal register (PR) without external pulse command. The drive provides 99 command registers with two input modes:

- You can set the 99 registers first before switching the drive to Servo On state and set DI.POS0...DI.POS6 signals of the I/O connector for the switch.
- You can directly set the register values via communication.

The position command can also come from the controller when ID117 (P1.001) is set to 0xC (I/O mode). There are two types of command inside:

- Target Position (position mode)
- External Pulse PTO input (gear mode)
- Auxiliary port input (gear mode)

Details can be found in I/O Mode on page 228.

PT Mode (Position Command with Terminal Block Input)

PT position command is the external pulse input from terminal block. There are three pulse types and each type has positive/negative logic, which can be set in ID116 (P1.000).

The following tables explain how to set the ID116 (P1.000) External Pulse Type parameter.

Settings:

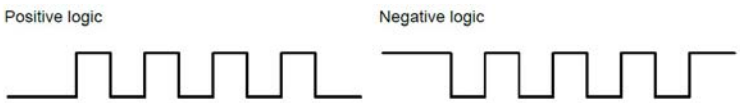


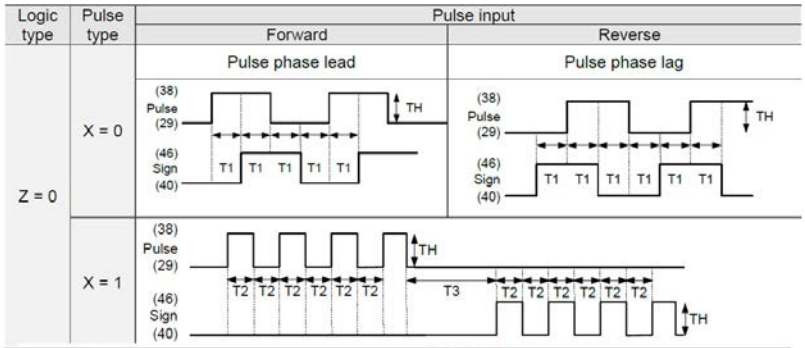
	X = Command Source	Z = Logic Type	UY = Filter Width
Where:	0 = I/O, AB phase pulse (4x) 1 = I/O, Clockwise and counterclockwise pulse 2 = I/O, Pulse + direction	0 = Positive logic	See UY: Filter Width Setting on page 198
	3 = Reserved	1 = Negative logic	
	4 = AUX, AB phase pulse (4X)		
	5 = AUX, clockwise and counterclockwise pulse		
	6 = AUX, pulse + direction		

- Z: Logic Type

Digital circuits use 0 and 1 to represent the voltage level of high and low. In positive logic, 1 represents high voltage and 0 represents low voltage; in negative logic, 1 represents low voltage and 0 represents high voltage.

For example:





Pulse specification	Max. input frequency	Min. allowed time width					
		T1	T2	T3	T4	T5	T6
Differential signal	4 Mpps	62.5 ns	125 ns	250 ns	200 ns	125 ns	125 ns
Open-collector	200 Kpps	1.25 µs	2.5 µs	5 µs	5 µs	2.5 µs	2.5 µs

Pulse specification	Max. input frequency	Voltage	Forward current
Differential signal	4 Mpps	5V	< 25 mA
Open-collector	200 kpps	24V (Max.)	< 25 mA

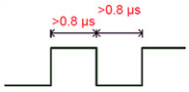
- UY: Filter Width Setting

When the pulse frequency is too high, the pulse width becomes smaller than the filter width setting, which causes this pulse to be filtered out as noise. Thus, the filter width must be set smaller than the actual pulse width. Set the filter width to be four times smaller than the actual pulse width.

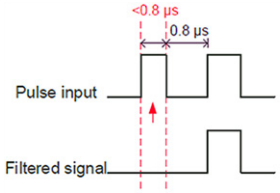
Y setting value	U = 0 Unit: µs (kHz)	U = 1 Unit: µs (kHz)
0	No filter function	No filter function
1	2 (250)	0.2 (2500)
2	3 (166)	0.3 (1666)
3	4 (125)	0.4 (1250)
4	5 (100)	0.5 (1000)
5	6 (83)	0.6 (833)
6	7 (71)	0.7 (714)
7	8 (62)	0.8 (625)
8	9 (55)	0.9 (555)
9	10 (50)	1 (500)
A	11 (45)	1.1 (454)
B	12 (41)	1.2 (416)
C	13 (38)	1.3 (384)
D	14 (35)	1.4 (357)
E	15 (33)	1.5 (333)

For example:

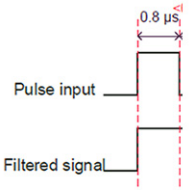
If	Then
U is set to 1 and Y is set to 1 (filter width is 0.2 µs [2500 kHz]) and The high and low duty width of the command pulse are both larger than 0.8 µs (625 kHz) (filter width is four times of 0.2 µs [2500 kHz])	The pulse command is not filtered out.



When the high or low duty width of the pulse is smaller than the filter width, then the pulse command is filtered out.



If this first pulse width is shorter than 0.8 µs (625 kHz), it can be filtered, and thus two input pulses are regarded as one pulse. If this pulse width is shorter than 0.2 µs (2500 kHz), it is filtered.



If this low level pulse width is shorter than 0.8 µs (625 kHz), it can be filtered, and thus two input pulses are regarded as one pulse. If this low level pulse width is shorter than 0.2 µs (2500 kHz), it is filtered.

If 125 ns (4 Mpps) input pulse is used, set the filter setting value Y to 0 as no filter function.

IMPORTANT When the signal is the high-speed pulse specification of 125 ns (4 Mpps) and the setting value of the filter is 0, then the pulse is not filtered.

Analog Input

The source for the analog position command is from two pins of the 50-pin I/O connector: pin #42 (V_REF) and pin #44 (GND) as the input voltage source.

Table 80 - Relevant Parameters

Parameter	Name
ID167 (P1.064)	AnalogToPositionStartupConfiguration
ID168 (P1.065)	AnalogToPositionSmoothTime
ID169 (P1.066)	AnalogToPositionMaxRotationNum

Settings for ID167 (P1.064):



	X = Analog Position Command Function	Y = Initial Position Setting of Analog Position Command	UZ = Reserved
Where:	0 = Disable	0 = After servo on, the motor regards the original position as 0V and runs to the corresponding position according to the current analog input command.	
	1 = Enable	1 = After servo on, the motor does not run if the analog command is not changed. The motor only runs if the analog command changes.	

- Settings for ID168 (P1.065):

The analog position command smoothing constant is only valid for analog position commands.

- Settings for ID169 (P1.066):

The number of revolutions when the maximum voltage (10V) is inputted as the analog position command. Analog position command is determined as follows:

$$\frac{\text{Input voltage value}}{10} \times \text{ID168 (P1.066) setting} = \text{Analog position command revolutions}$$

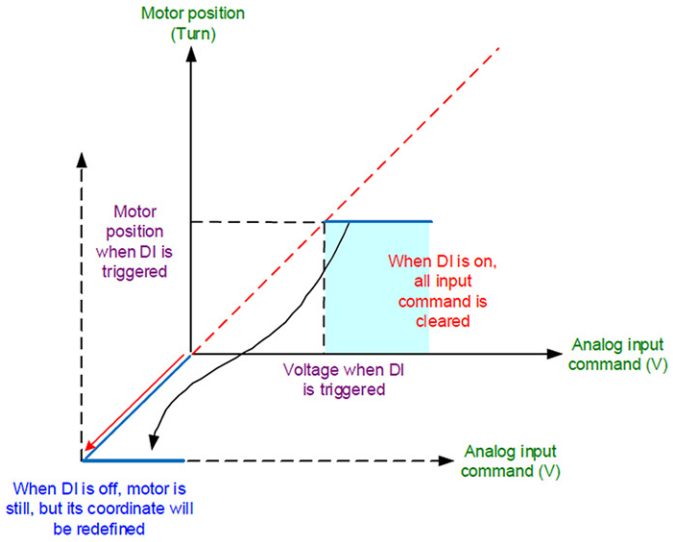
For example:

If the parameter ID169 (P1.066) is set to 30 from the panel and the external voltage is input 5V, then the analog position command is as follows:

$$\frac{5V}{10} \times 30 = 15 \text{ revolutions}$$

VPL (DI code: 0x0C) Latch Function of Analog Position Command

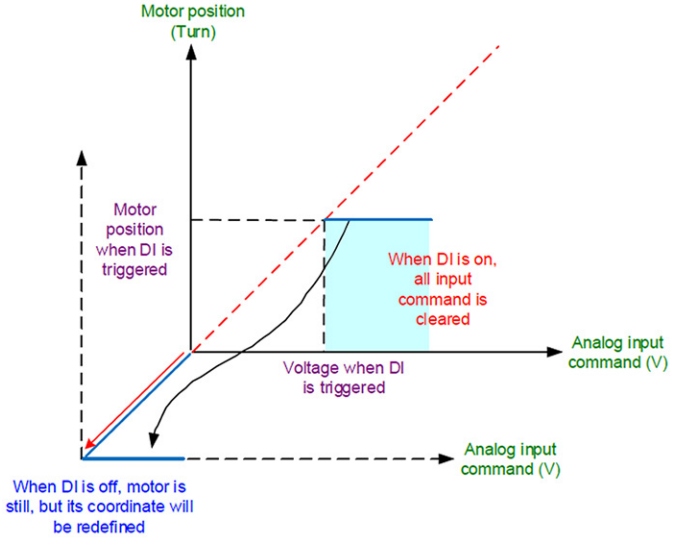
If this digital input (DI) is on, motor position is held at the current position when the DI is triggered. During DI on, the motor does not operate, even when there is a change of analog command. When this DI is off, the motor completes the command that is changed during the time when the DI is on.



VPRS (DI code: 0x0D) Clear Function of Analog Position Command

If this DI is on, motor position is held at the current position when the DI is triggered.

Even if the analog command changes while the DI is on, the motor remains at the current position, which includes when the DI is off. However, the current motor position corresponds to the new analog command. Thus, the analog input command redefines the coordinate system of the motor.



PR Mode (Position Command with Internal Register Input)

PR command source is selected by parameters ID397 and ID398(P6.000 and P6.001), and ID595 and ID596 (P7.098 and P7.099), which are the 99 built-in command registers.

The drive supports the following motion command types, which are described in detail in Chapter 11, Motion Control in PR Mode:

- Homing
- Speed
- Position
- Jump
- Parameter write
- Arithmetic operation

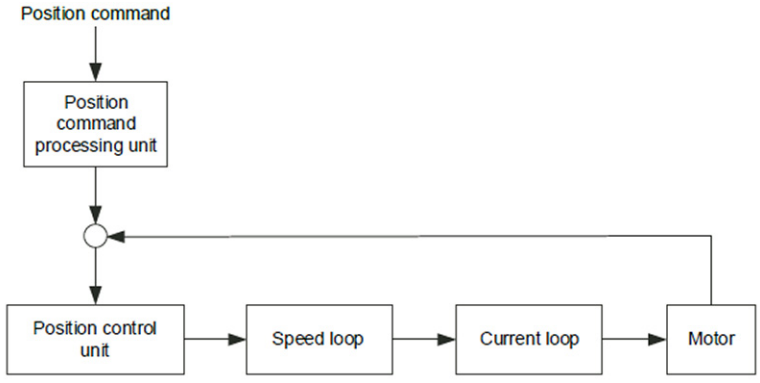
The drive provides the following PR triggering methods:

- Digital input (DI)
- Event-triggered
- ID300 (P5.007)
- Capture (high-speed position capturing)
- Compare-triggered (high-speed position comparing)
- E-Cam

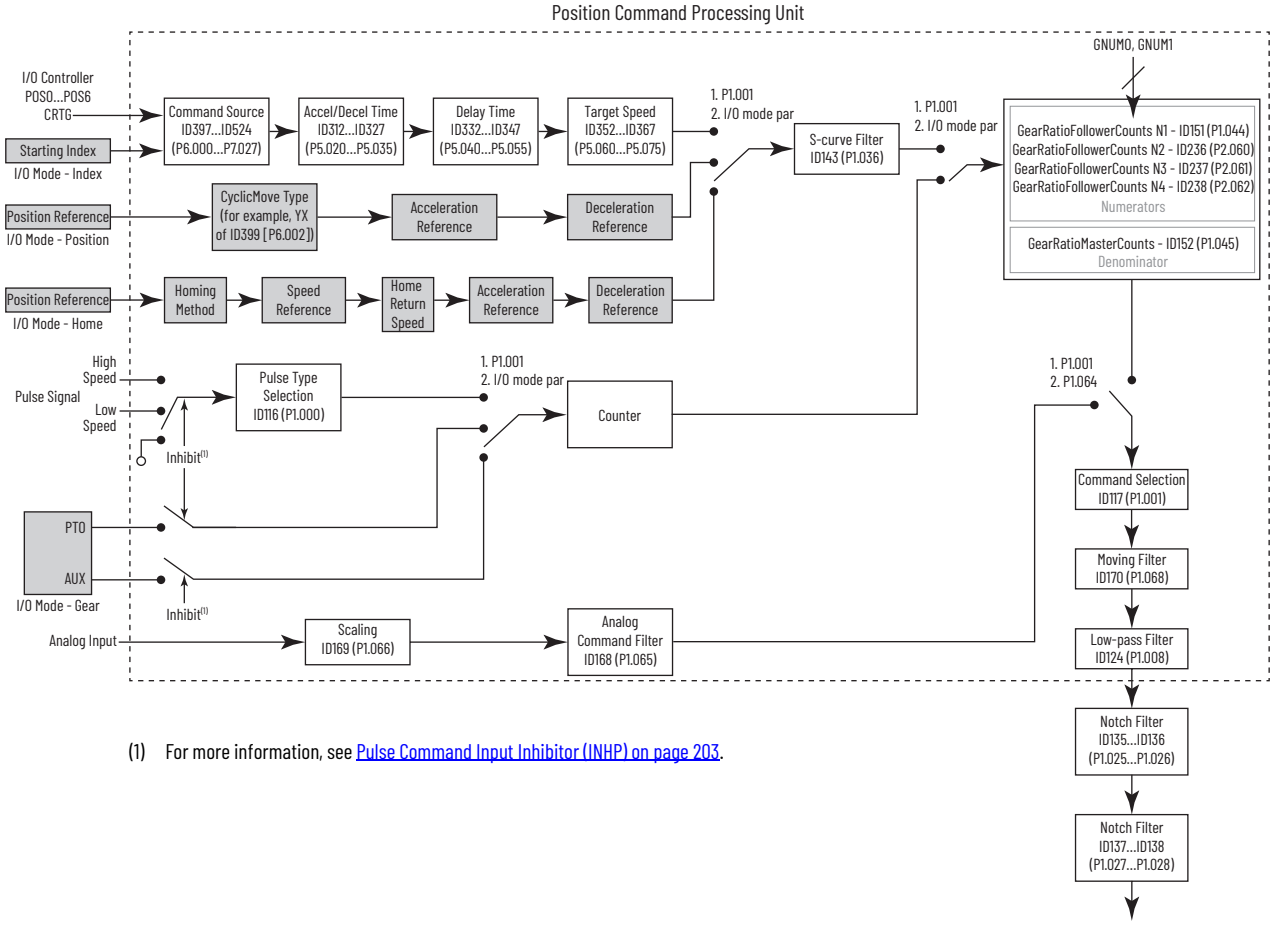
You can choose the most suitable triggering method according to the applications and requirements. For detailed descriptions of the methods, see Trigger Method for PR Commands on page 296.

Control Structure of Position Mode

The basic control structure is as follows:



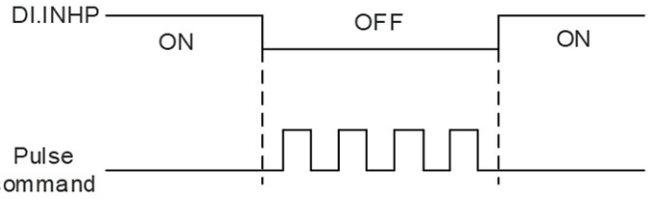
For better control, the pulse signals are processed by the position command processing unit. Structure is shown in the following diagram.



(1) For more information, see Pulse Command Input Inhibitor (INHP) on page 203.

Pulse Command Input Inhibitor (INHP)

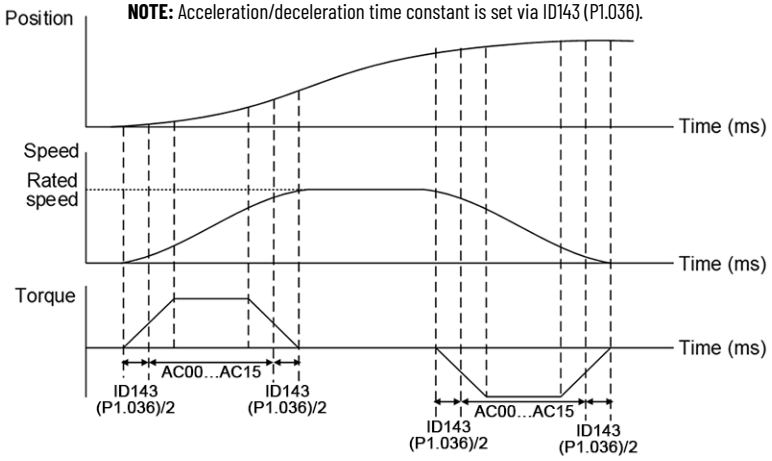
In PT mode, when the DI.INHP signal is on, the servo stops receiving external pulse command and the motor stops running. As this function is only supported by DI 8, setting 0x45 (DI.INHP) to IP202 (P2.017, DI 8) is required.



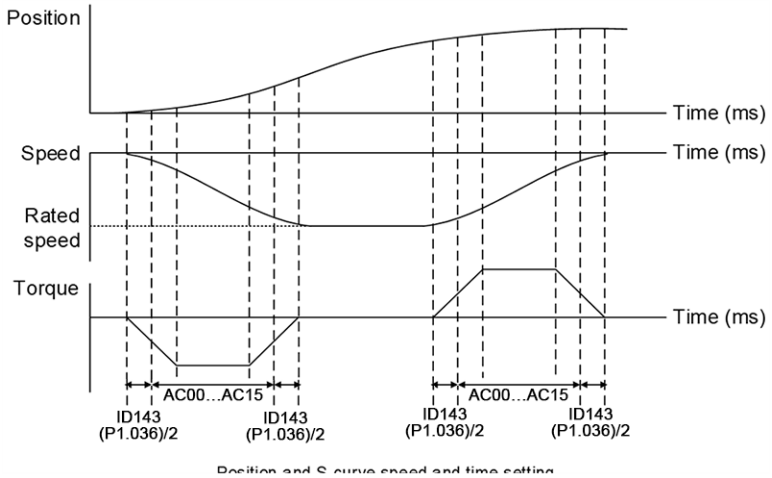
For more information on the INHP function, see the Description of Digital Input Functions on page 405.

S-curve Filter (Position Mode)

S-curve filter smooths the motion command in position mode. With this filter, speed/acceleration can be continuous and jerk is reduced, and a smoother mechanical operation can be achieved. If the load inertia increases, the operation of the motor will be influenced by friction and inertia when it starts or stops rotating. Setting a larger acceleration/deceleration constant of S-curve (TSL) and acceleration/deceleration time (numbers 0...15) in ID312...ID327 (P5.020...P5.035) can increase the smoothness of operation. When the position command source is pulse, its speed and angular acceleration are continuous, thus, S-curve filter is not a must.



Position and S-curve speed and time setting



Position and S-curve speed and time setting

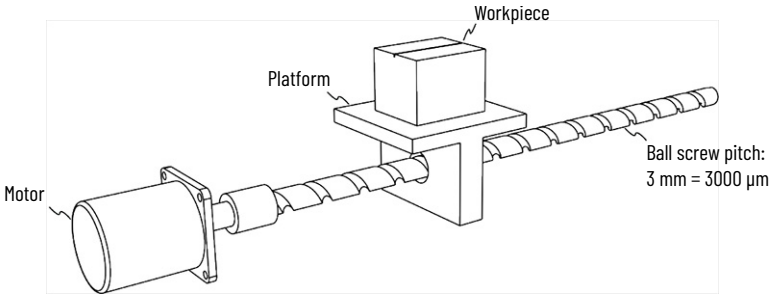
Electronic Gear (E-Gear) Ratio

Electronic gear (E-Gear) ratio defines the relationship between PUU and internal encoder counts. It is determined by a ratio between ID151 (P1.044) and ID152 (P1.045). Normally, ID151 (P1.044) is set to the encoder resolution. For example, if ID151 (P1.044) is set to 10000, ID151 (P1.044) is set to 16,777,216 with 24-bit encoder. If you move 10000 PUU in PR mode or received 10000 pulse in PT mode, it causes the motor rotate one revolution.

When the ratio is set to 1, then every one pulse from the command (controller) corresponds to one pulse of the motor. However, a larger E-Gear ratio can create a sharp corner of the profile and lead to a high jerk. To solve this problem, you can apply S-curve acceleration/deceleration or low-pass filter to reduce the jerk.

For example:

The ball screw pitch is 3 mm, when using a 4 bit encoder, if the E-Gear ratio is set to 16777216/3000, then the workpiece moves 1 μm per 1 pulse command.



E-Gear Status	Gear Ratio	Moving Distance per 1 Pulse Command
E-Gear is not applied	$= \frac{1}{1}$	$= \frac{3000 \frac{\mu m}{rev}}{16777216 \frac{pulse}{rev}} \times \frac{1}{1} = \frac{3000}{16777216}$ (Unit: $\frac{\mu m}{pulse}$)
E-Gear is applied	$= \frac{16777216}{3000}$	$= \frac{3000 \frac{\mu m}{rev}}{16777216 \frac{pulse}{rev}} \times \frac{16777216}{3000} = 1$ (Unit: $\frac{\mu m}{pulse}$)

Table 81 - Relevant Parameters(1)

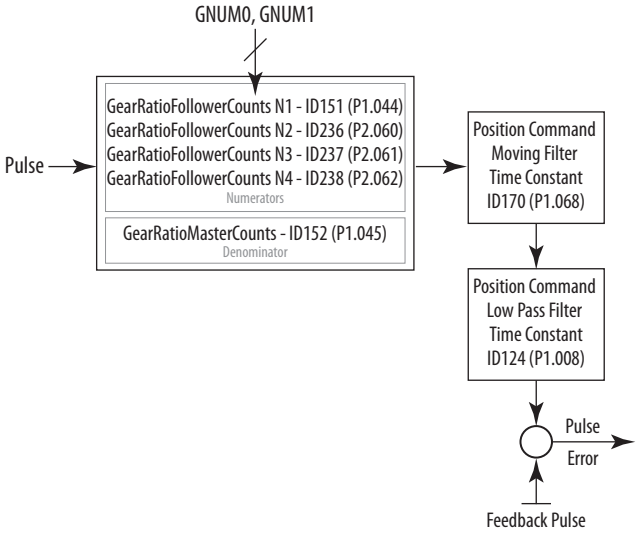
Parameter	Name
ID151 (P1.044)	GearRatioslaveCountsN1
ID236 (P2.060)	GearRatioslaveCountsN2
ID237 (P2.061)	GearRatioslaveCountsN3
ID238 (P2.062)	GearRatioslaveCountsN4
ID152 (P1.045)	GearRatioMasterCounts (denominator)
ID170 (P1.068)	PositionCmdMovingFilterTime

(1) Do not change the setting value in servo on state.

If you are changing the gear ratio while in operation, you can define multiple numerators but only one denominator. The numerator of the E-Gear ratio can be selected via the DI.GNUM0 and DI.GNUM1 signals. If the DI.GNUM0 and DI.GNUM1 signals are not defined, ID151 (P1.044) is the default numerator. To avoid mechanical vibration, switch the DI.GNUM0 and DI.GNUM1 signals during stop status.

IMPORTANT
- If you change gear ratio during operation, you can cause an abrupt, uncontrolled acceleration event.
- ID236 (P2.060), ID237 (P2.061), and ID238 (P2.062) are for PT mode only. ID151 (P1.044) is for both PR mode and PT mode. All of the parameters can be changed in PT mode only.
- If PT/PR mode is selected, and ID151 (P1.044) is changed in PT mode, it remains active through any subsequent execution if you switch to PR mode.

See Description of Digital Input Functions on page 405.



Low Pass Filter (Position Mode)

Low pass filter for commands is typically used to filter out unwanted high-frequency response or noise so that the speed becomes smoother.

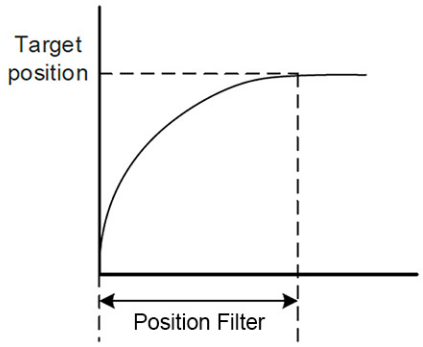


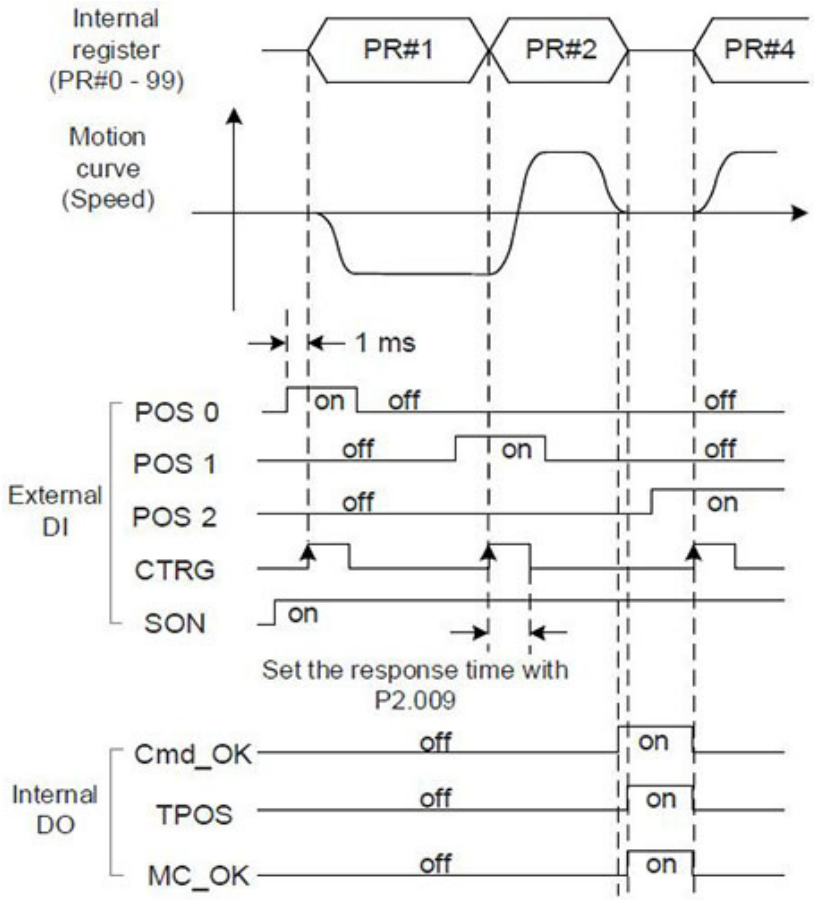
Table 82 - Relevant Parameters

Parameter	Name
ID124 (P1.008)	PositionCmdLowPassFilterTime

IMPORTANT These values are disabled when the parameter values are set to 0.

Position Mode Timing (PR Mode)

In PR mode, the position command is issued via DI signal (POS0...POS6 and CTRG) of the I/O connector signals. The following are the timing diagrams.



The following apply to the internal digital output (DO) timing diagram:

- Cmd_OK is on when PR command is completed.
- TPOS is on when the error is smaller than value set by the ID159 (P1.054) In Position Window parameter.
- MC_OK is on when Cmd_OK and TPOS are both on.

Table 83 - Relevant Parameter

Parameter	Name
ID159 (P1.054)	InPositionWindow

When the deviation between the target position and the actual motor position is smaller than the setting range of ID159 (P1.054) in PR mode, then the DO.TPOS signal is on.

Gain Adjustment of the Position Loop

There are two types of gain adjustment for the position loop: auto and manual.

Auto adjustment is when the servo drive provides an auto tuning function so you can easily complete the gain adjustment.

For a detailed description, refer to Autotuning on page 174.

Manual adjustment is when you must manually set the speed control unit ID189 and ID191 (P2.004 and P2.006) before you set the position control unit, since a speed loop is included in the position loop. After you manually set the speed control unit, you must then manually set the parameters Position Proportional Gain ID185 (P2.000) and Velocity Feedforward Gain ID187 (P2.002).

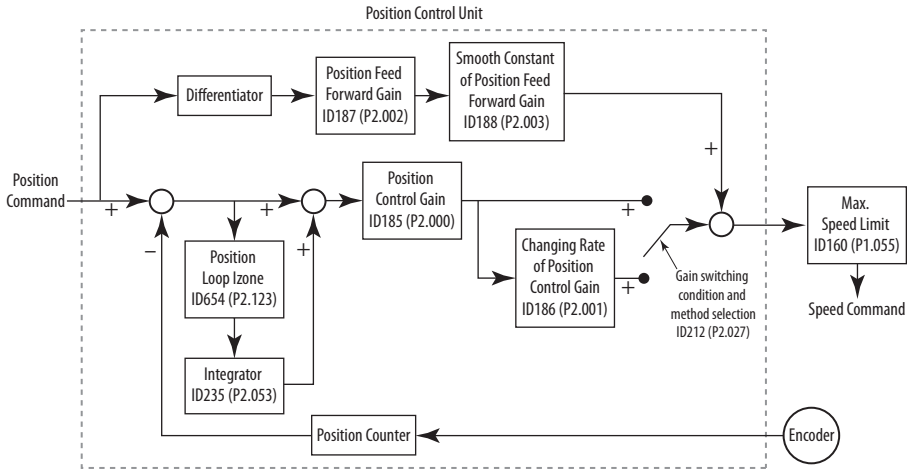
There are two types of gain:

1. Proportional gain: a larger gain increases the response bandwidth of position loop.
2. Feed forward gain: reduces the deviation of phase delay.

The position loop bandwidth should not be larger than the speed loop bandwidth.

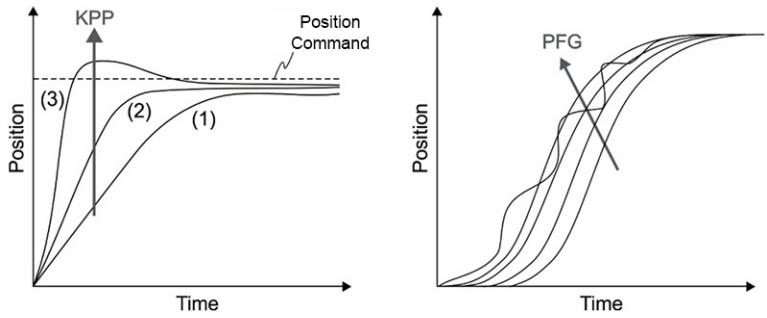
$fp \leq \frac{fv}{4}$ *Where:*
fv = response bandwidth of **speed** loop (Hz)
fp = response bandwidth of **position** loop (Hz)

$KPP = 2 \times \pi \times fp$ *Example:* If the desired position bandwidth is 20 Hz, then adjust the KPP (ID185, P2.000) to 125 ($2 \times \pi \times 20$ Hz = 125).



In counts, the region around the commanded position where integral gain is active. If the position error is greater than the Position Loop Izone, the integrator is reset.

When you set the value of position control gain (KPP, ID185/P2.000) too high, the bandwidth for the position loop is increased and the phase margin is reduced. Meanwhile, the motor rotates and vibrates in the forward and reverse directions. In this case, you have to decrease KPP until the rotor stops vibrating. When the external torque is too high, the low value for KPP cannot meet the demand of reducing position error. In this case, increasing the position feed forward gain, (PFG, ID187/P2.002), can effectively help reduce the following error.



The actual position curve changes from (1...3) with the increase in the KPP value.

Low Frequency Vibration Suppression in Position Mode

If the mechanism's rigidity is too low, the vibration of transmission part will persist even when the motor stops running after positioning command is executed completely. The function of low-frequency vibration suppression can reduce the vibration of mechanism. The suppression range is between 1.0 Hz and 100.0 Hz. Both manual setting and auto setting are available.

Table 84 - Relevant Parameters

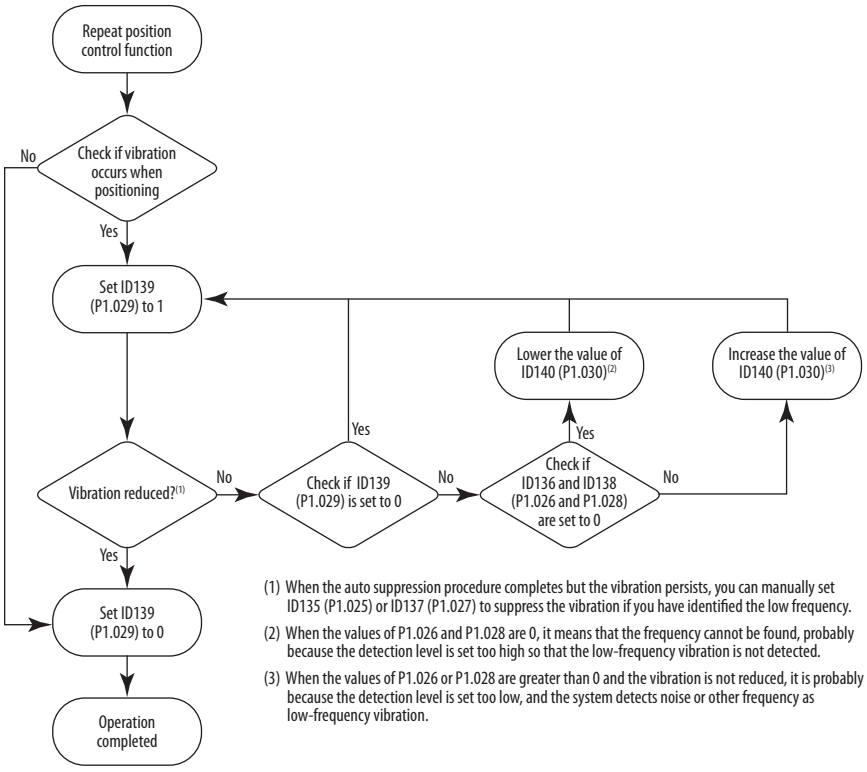
Parameter	Name
ID135 (P1.025)	LowFreqVibrationSuppression1Frequency
ID136 (P1.026)	LowFreqVibrationSuppression1Gain
ID137 (P1.027)	LowFreqVibrationSuppression2Frequency
ID138 (P1.028)	LowFreqVibrationSuppression2Gain
ID139 (P1.029)	LowFreqVibrationSuppressionMode
ID140 (P1.030)	LowFreqVibrationDetectionLevel

Automatic Setting

If you have difficulty in finding out the frequency of resonance, you can enable the function of auto low-frequency vibration suppression, which searches the specific frequency of resonance occurrence. If parameter Low-frequency Vibration Suppression Mode Setting ID139 (P1.029) is set to 1, the system will disable this function automatically and starts to search the vibration frequency. When the detected frequency remains at the same level, ID139 (P1.029) is set to 0 automatically and set the first frequency in parameter ID135 (P1.025) and set parameter ID136 (P1.026) to 1. The second frequency will be set in parameter ID137 (P1.027) and then set parameter ID138 (P1.028) to 1. If parameter ID139 (P1.029) is automatically reset to 0, but low-frequency vibration persists, check if the function of parameter ID136 (P1.026) or ID138 (P1.028) is enabled. If the values of parameters ID136 (P1.026) and ID138 (P1.028) are both 0, it means no frequency has been detected. Lower the value of parameter ID140 (P1.030) and set parameter ID139 (P1.029) to 1 so as to search the vibration frequency again.

IMPORTANT When the detection level is set too small, noise might be regarded as low-frequency vibration.

Figure 85 - Auto Low-frequency Vibration Suppression



The parameter ID140 (P1.030) is to set the range to detect the magnitude of low-frequency vibration. When the frequency is not detected, it is probably because the value of parameter ID140 (P1.030) is set too high and exceeds the range. In this case, it is suggested to decrease the value of parameter ID140 (P1.030). If the value is too small, the system might regard noise as vibration frequency. You can also use scope to observe the range of position error (pulse) between upper and lower magnitude of the curve to adjust the value of parameter ID140 (P1.030).

Manual Setting

There are two sets of low-frequency vibration suppression. One is parameters ID135 and ID136 (P1.025 and P1.026), and the other is parameters ID137 and ID138 (P1.027 and P1.028). These two sets of low-frequency vibration suppression can be used to reduce two different frequency vibrations. Parameters ID135 (P1.025) and ID137 (P1.027) are used to suppress the low-frequency vibration. The function works only when the low-frequency vibration setting is close to the real vibration frequency. Parameter P1.026 and P1.028 are used to set the response after frequency filtering. The bigger the setting values of parameters ID136 (P1.026) and ID138 (P1.028) are, the better the response is. However, if the value is set too big, the motor might not operate smoothly. The default values of parameters ID136 (P1.026) and ID138 (P1.028) are 0, which means the two filters are disabled.

Speed Mode

This servo drive includes three types of command input: analog, register and I/O mode. Analog command controls the motor speed by external voltage. Register command controls the speed by two ways. One is to set different speed values in three command registers and to switch the speed by using DI.SPD0 and DI.SPD1 signals from the I/O connector. Another way is to change the value of register by communication in I/O mode.

To deal with the problem of non-continuous speed when switching registers, an S-curve acceleration/deceleration setting is provided. In a close-loop system, this servo drive adopts gain adjustment and integrated PI controller and two modes (manual and auto) for selection.

Manual mode is for manual parameter setting. In this mode, all auto or auxiliary function will be disabled. The gain adjustment function provides different modes for you to estimate load inertia and tune the bandwidth as well as responsiveness. In addition, the parameter values set by you are regarded as the default.

Selection of Speed Command

There are two types of speed command source: analog voltage and internal register (parameters). You can select the source by using the DI signal from the I/O controller when the operating mode is S or Sz.

The following table shows the command source selection.

Speed Command	DI Signal(1)		Command Source			Content	Range
	SPD1	SPD0					
S1	0	0	Mode	Speed (S)	External analog signal	Voltage difference between V-REF and GND	-10V...+10V
				Speed without analog signal (Sz)	–	Speed command is 0	0
S2	0	1	Register parameters			P1.009	-60000...+60000
S3	1	0				P1.010	
S4	1	1				P1.011	

(1) I/O connector on Kinetix 5100 EtherNet/IP™ drive.

- Status of DI.SPD0 and DI.SPD1 signals: 0 means that DI is off, and 1 means that DI is on.
- In Sz mode, the command is 0 when both DI.SPD0 and DI.SPD1 signals are 0. Thus, if the speed command that is using an analog voltage type is not required, you can use Sz mode to address the problem of zero drift in the voltage.

  If it is in S mode, the command is the voltage deviation between V-REF and GND. The range of the input voltage is between -10V and +10V, and you can adjust the Analog to Speed Scale ID147 (P1.040) parameter. For more information, see Scaling the Analog Command (Speed Mode) on page 215.

- When either DI.SPD0 or DI.SPD1 signal is not 0, the Speed command comes from the internal register. The command is activated once the status of DI.SPD0 and DI.SPD1 signals are changed. There is no need to use the DI.CTRG signal for triggering.
- The parameter setting range (internal register) is -60000...+60000.

  Setting value = setting range x unit (0.1 rpm).

  For example:

  If ID125 (P1.009) = 30000,
  then rotation speed = 30000 x 0.1 rpm = 3000 rpm

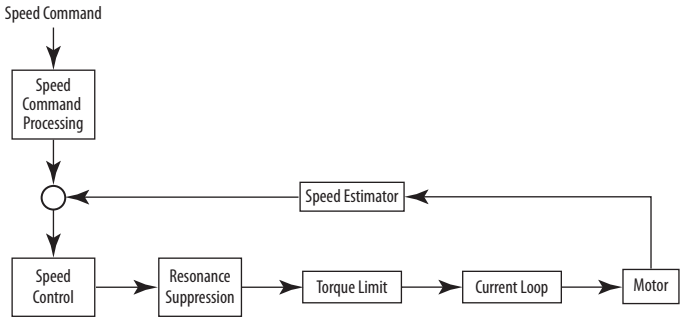
The speed command can also come from the controller when Operating Mode ID117 (P1.001) is set to 0xC (I/O mode). The command name is Target Speed. See I/O Mode - Speed on page 242.

When the control mode is Torque mode (T or Tz), the Speed command can be used for speed limit.

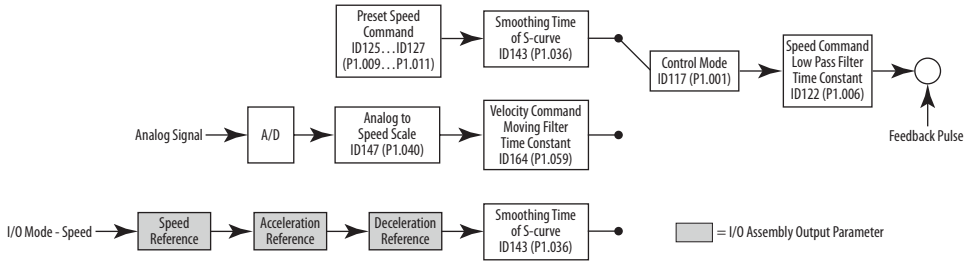
ID125...ID127 (P1.009...P1.011) Speed Limit Setting Value	Valid Speed Range	Speed Limit	
		In Forward Direction	In Reverse Direction
+1000	-100...+100 rpm	+100 rpm	-100 rpm
-1000			

Control Structure of Speed Mode

The following diagram illustrates basic control structure.



The speed command processing unit is to select the command source, including the parameter ID147 (P1.040) scaling setting for rotation speed and S-curve setting for smoothing the speed. The speed control unit manages the gain parameters of the servo drive and calculates the current command for servo motor in time. The resonance suppression unit is to suppress the resonance of mechanism.

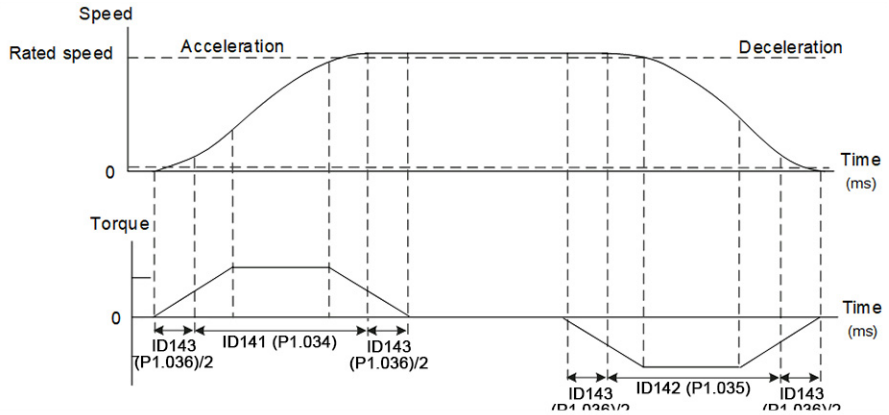


In the above diagram, the upper path is the processing path of the command issued by the register, the middle path is the processing path of external analog command, and the lower path is the processing path of Ethernet communication. The command is selected according to the status of the DI.SPD0 and DI.SPD1 signals, and ID117 (P1.001), S or Sz. In this condition, S-curve and low-pass filter are applied for the purpose of achieving a smoother response.

S-curve Filter (Speed Mode)

During the process of acceleration or deceleration, S-curve filter applies the three-stage acceleration curve and tailors a smoother motion trajectory performance. It is used to avoid jerk (the differentiation of acceleration), resonance as well as noise caused by abrupt speed variation. You can use the parameter ID141 (P1.034), Acceleration Time Constant of S-Curve Velocity Profile (TACC), to adjust the slope changed by acceleration; the parameter ID142 (P1.035), Deceleration Time Constant of S-curve Velocity Profile (TDEC), to adjust the slope changed by deceleration, and the parameter ID143 (P1.036), Smoothing Time of S-curve (TSL), to improve the status of motor activation and stop. This device can calculate the total time for executing the command.

T (ms) signifies the operation time and S (rpm) signifies the absolute speed command, which is the absolute value of initial speed minus end speed.



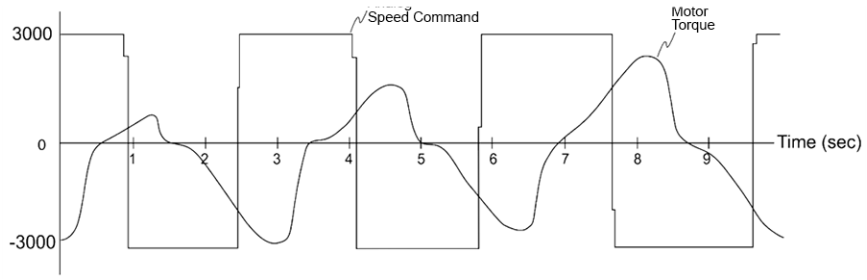
IMPORTANT These three parameters can be set individually and even when the parameter ID143 (P1.036), Smoothing Time of S-curve, is set to 0 (disabled), the S-curve still has acceleration/deceleration of a trapezoid curve.

Error Compensation Function	When ID143 (P1.036) = 0	When ID143 (P1.036) = 1	When ID143 (P1.036) >1
Smoothing function of S-curve	Disable	Disable	Enable
Following error compensation function	Disable	Enable	Determine by ID 241 (P2.068.X)(1)

(1) For ID241 (P2.068) following error compensation, 0: Disable or 1: Enable.

Analog Speed Command Filter

Analog speed command filter provided by the drive helps to stabilize the motor operation when the analog input signal (speed) changes rapidly.



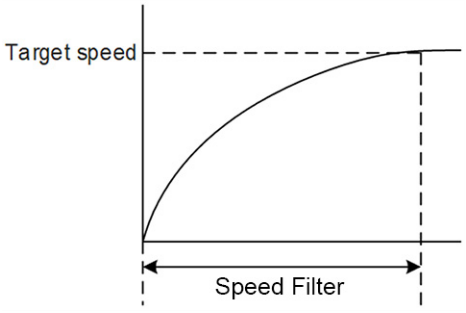
Analog speed command filter smooth the analog input command. Its time program is the same as S-curve filter at normal speed. Also, the speed curve and the acceleration curve are both continuous. The above is the curve of speed command and motor torque when analog speed command filter is applied. In the diagram above, the slopes of speed command in acceleration and deceleration are different. You can adjust the time setting by using parameters ID141 (P1.034), ID142 (P1.035), and ID143 (P1.036), according to the actual application to improve the performance.

Low Pass Filter for Speed Command

Parameter ID122 (P1.006) filters out unwanted high-frequency response or noise so that the speed becomes smoother.

Table 85 - Relevant Parameters

Parameter	Name
ID122 (P1.006)	SpeedCmdLowPassFilterTime
ID164 (P1.059)	SpeedCmdMovingFilterTime



ID122 (P1.006) is a low-pass filter, while ID164 (P1.059) is a moving filter. Their difference is that ID164 (P1.059) smooths at the beginning and end of the step command, while ID122 (P1.006) can smooth only at the end of the step command.

If the speed loop receives command from the controller to form the position control loop, then use ID122 (P1.006). If it is only for the speed control, then ID164 (P1.059) provides better smoothing.

Scaling the Analog Command (Speed Mode)

The motor's speed command is determined by the analog voltage difference between V_REF and VGND. Use parameters ID147 (P1.040), Analog To Velocity Scale, and ID679 (P1.081), Analog To Velocity Scale 2, to adjust the slope of speed and its range.

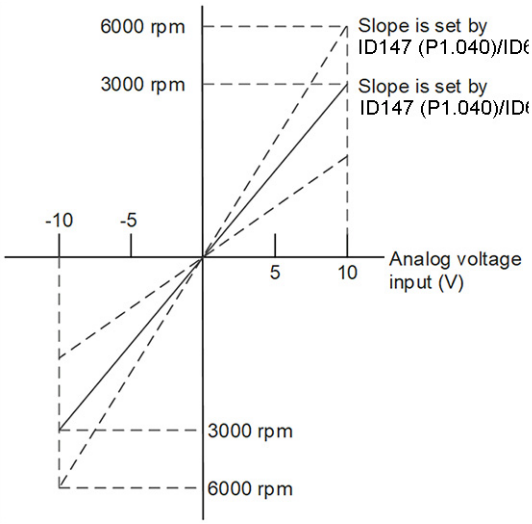
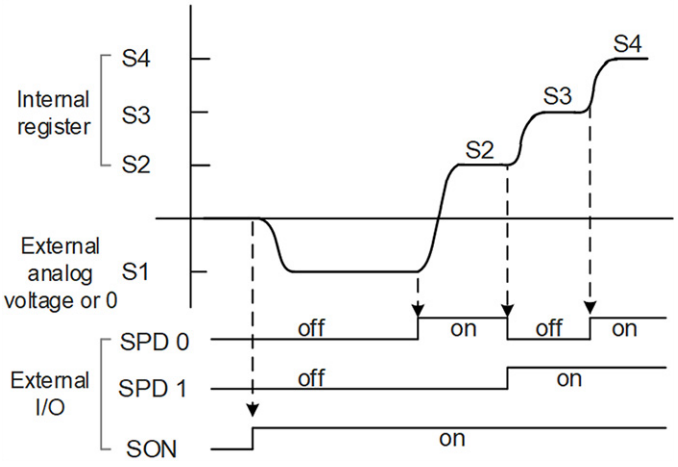


Table 86 - Relevant Parameters

Parameter	Name
ID147 (P1.040)	AnalogToVelocityScale
ID679 (P1.081)	AnalogToVelocityScale2

IMPORTANT: 0x0F of digital input can be used to switch between ID147 (P1.040) and ID679 (P1.081).

Speed Mode Timing

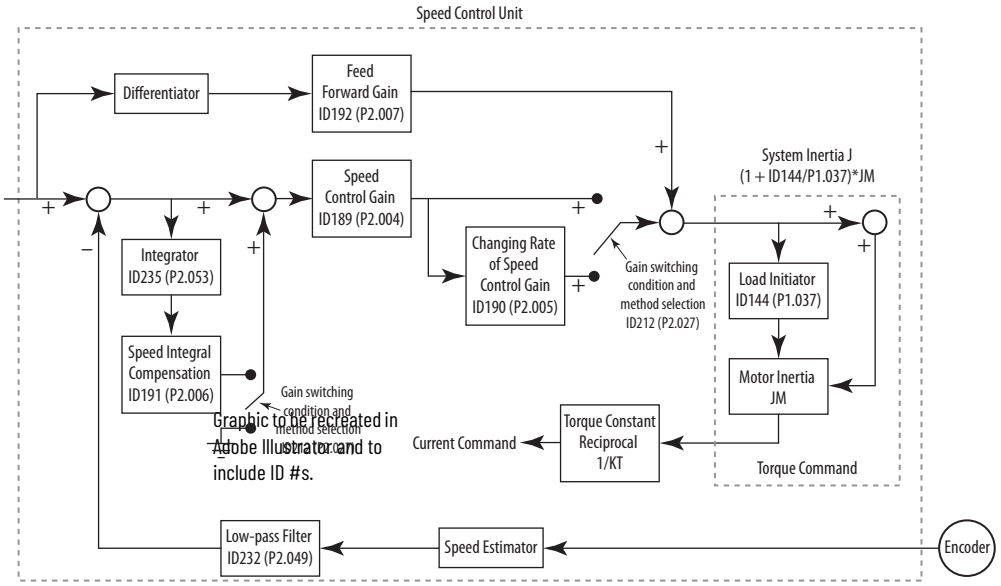


In the above diagram, the following applies.

- 'Off' signifies the contact is open while 'On' signifies the contact is closed.
- When the drive is in Sz mode, the speed command S1=0.

  When the drive is in S mode, the speed command S1 is the external analog voltage input.
- In servo-on state, the command is selected according to the state of digital inputs SPD0 and SPD1.

Gain Adjustment of Speed Loop



In the speed control unit, different types of gain can be adjusted. You can adjust manually or use the three gain adjustment modes provided.

- Manual: You make all the parameter settings. Auto and auxiliary functions are disabled.
- Gain adjustment mode: See Autotuning on page 174.

Manual Mode

When the parameter ID217 (P2.032), Gain Adjustment Mode, is set to 0, then you must set parameters ID189 (P2.004), Speed Proportional Gain, ID191 (P2.006), Speed Integral Gain, and ID192 (P2.007), Acceleration Feedforward Gain. More detail about adjusting the gains is as follows:

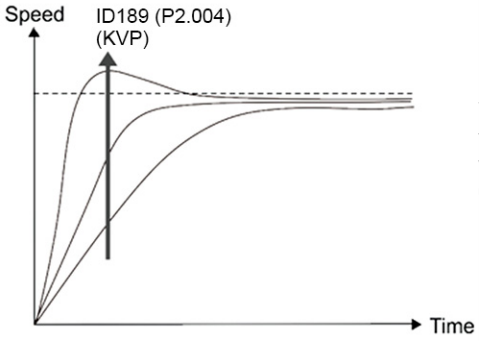
- Speed loop gain: The higher the gain, the bigger bandwidth of speed loop response is.
- Integral gain: Increasing this gain will increase the low frequency rigidity and reduce the steady-state error. However, phase margin will be smaller. If this gain is set too high, the system stability will be reduced.
- Feed forward gain: Diminish the deviation of phase delay.

Table 87 - Relevant Parameters

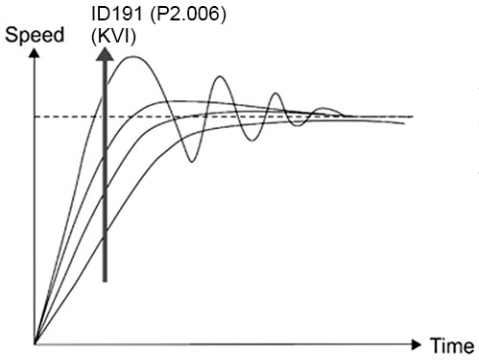
Parameter	Name
ID189 (P2.004)	VelocityProportionalGain (KVP)
ID190 (P2.006)	VelocityIntegralGain (KVI)
ID191 (P2.007)	AccelFeedForwardGain (KVF)

Theoretically, a stepping response can be used to explain proportional gain (KVP), integral gain (KVI), and feed forward gain (KVF). Speed over time diagrams are shown below to illustrate the basic principle.

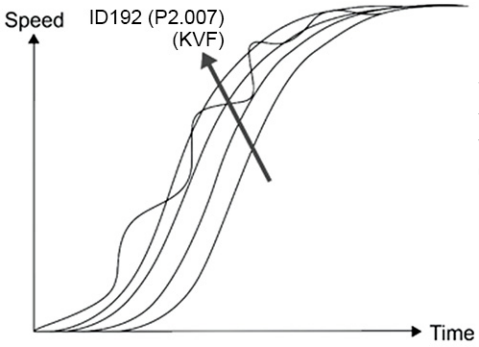
Timing Diagrams



Impact of Speed Proportional Gain (KVP) Setting
The higher the KVP value, the larger the bandwidth, and the speed increase time also shortens. However, if the value is set too high, the phase margin is too small. The effect is not as good as KVI for the steady-state error but is better for the effect on following.



Impact of Speed Integral Gain (KVI) Setting
The higher the KVI value, the larger the low frequency gain. It shortens the time for the steady-state error to reduce to zero. However, it does not significantly reduce the following error.



Impact of Acceleration Feedforward Gain (KVF) Setting
The closer the KVF value is to 1, the more complete the forward compensation. The following error becomes very small. But a KVF value that is set too high also causes vibration.

Resonance Suppression (Notch Filter)

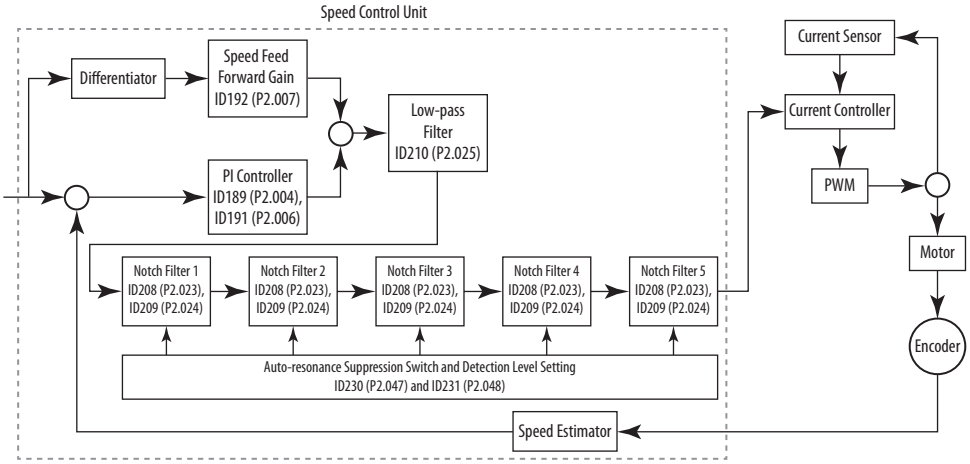
When resonance occurs, it is probably because the stiffness of the control system is too high or the response is too fast. Mitigating these two factors can improve the situation. In addition, parameter ID210 (P2.023), Low-pass Filter, and 15 notch filter parameters (see Table 88 on page 217) are provided to suppress the resonance if the control parameters remain unchanged.

Table 88 - Relevant Parameters

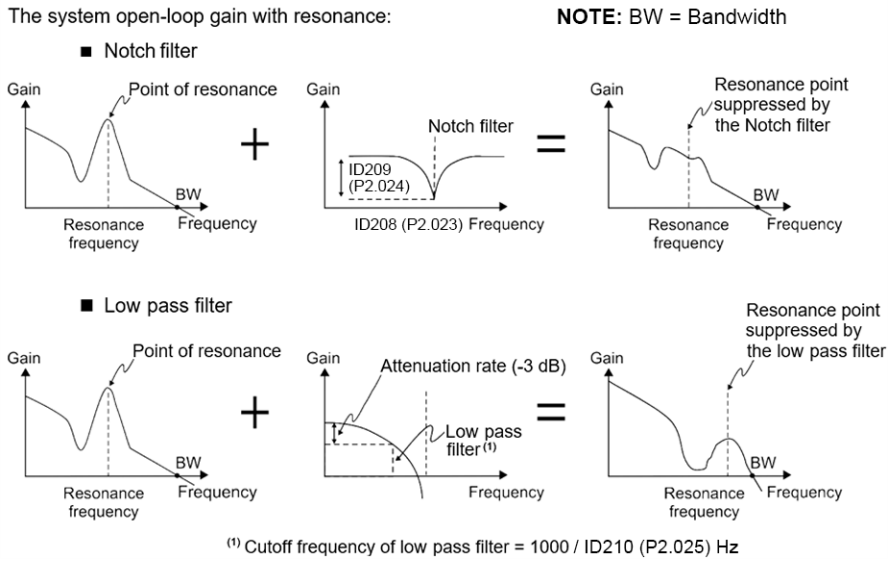
Parameter	Name
ID208 (P2.023)	NotchFilter1Frequency
ID209 (P2.024)	NotchFilter1Depth
ID226 (P2.043)	NotchFilter2Frequency
ID227 (P2.044)	NotchFilter2Depth
ID228 (P2.045)	NotchFilter3Frequency
ID229 (P2.046)	NotchFilter3Depth
ID254 (P2.095)	NotchFilter1QValue
ID255 (P2.096)	NotchFilter2QValue
ID256 (P2.097)	NotchFilter3QValue

Table 88 - Relevant Parameters (Continued)

Parameter	Name
ID257 (P2.098)	NotchFilter4Frequency
ID258 (P2.099)	NotchFilter4Depth
ID259 (P2.100)	NotchFilter4QValue
ID260 (P2.101)	NotchFilter5Frequency
ID261 (P2.102)	NotchFilter5Depth
ID262 (P2.103)	NotchFilter5QValue
ID210 (P2.025)	ResonanceSuppressionLowPassFilterTime



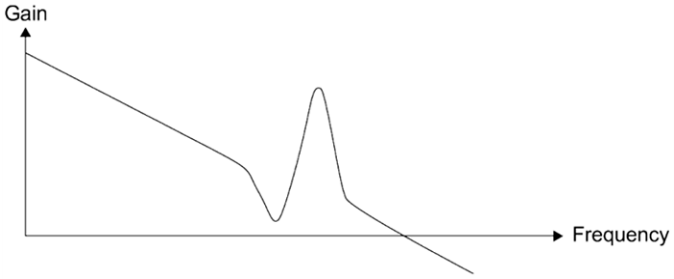
The drive provides two types of resonance suppression, one is a notch filter and the other is a low pass filter. See the following diagrams for the results of suppression by each type.



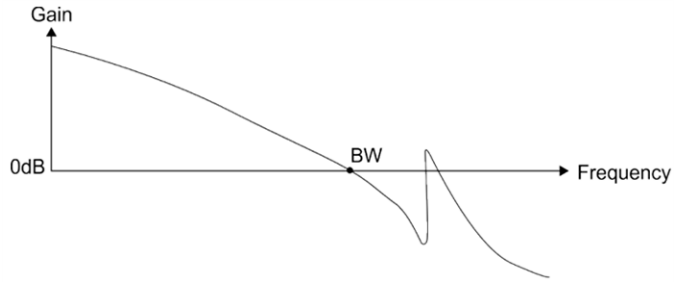
As shown in the previous two examples, if the value of parameter ID210 (P2.025) ResonanceSuppressionLowPassFilterTime is increased from 0, the bandwidth (BW) becomes smaller. Although it solves the problem of resonance, it also reduces the response bandwidth and phase margin, and thus the system becomes unstable.

If the resonance frequency is known, you can mitigate the suppression by using the Notch filter, which is better than the low pass filter in this case. If the resonance frequency drifts along with time or other causes and the drifting amount is too great, using notch filter is not recommended.

The following figure shows the system open-loop gain with resonance suppression.



When the value of parameter ID210 (P2.025) is increased from 0, BW becomes smaller. Although it solves the problem of resonance frequency, the response bandwidth and phase margin are reduced. Also, the system becomes unstable.



If the resonance frequency is given, the notch filter can mitigate the resonance directly. Frequency of notch filter is 50...5000 Hz and the suppression strength is 0...40 dB. If the frequency meets this condition, using low pass filter to reduce the resonance is suggested.

Auto-resonance Suppression Mode

Table 89 - Relevant Parameter

Parameter	Name
ID230 (P2.047)	ResonanceSuppressionConfig

Settings:



	X = Auto-resonance Suppression Function	Y = Fixed Resonance Suppression Parameter	Z = Fixed Resonance Suppression Parameter	U = Reserved
Where:	See below	See below	See below	

- X: Auto-resonance Suppression Function

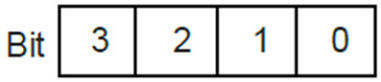
  0 = Disable auto resonance suppression. After the function is disabled, the existing resonance suppression parameter values are fixed.

1 = Auto resonance suppression. The servo must determine the following:

If	Then
• The servo is stable and resonance is suppressed • No other resonance is present • No other interference source is present	The servo automatically saves the data of resonance suppression, and the value returns to 0. If the servo is unstable, re-power on or set to 1 again for the servo to re-estimate.

- Y: Fixed Resonance Suppression Parameter

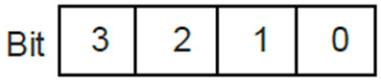
In auto resonance suppression, you can set the notch filters that require manual resonance suppression.



Bit	Function	Description
0	Notch 1 auto/manual setting	• 0: Auto resonance suppression • 1: Manually set the first set of resonance suppression
1	Notch 2 auto/manual setting	• 0: Auto resonance suppression • 1: Manually set the second set of resonance suppression
2	Notch 3 auto/manual setting	• 0: Auto resonance suppression • 1: Manually set the third set of resonance suppression
3	Notch 4 auto/manual setting	• 0: Auto resonance suppression • 1: Manually set the fourth set of resonance suppression

- Z: Fixed Resonance Suppression Parameter

In auto resonance suppression, you can set the notch filters that require manual resonance suppression.



Bit	Function	Description
0	Notch 5 auto/manual setting	• 0: Auto resonance suppression • 1: Manually set the fifth set of resonance suppression

For example:
If the user sets the ID230 (P2.047) parameter to 0x0021 with the auto resonance suppression enabled, then the servo searches for the point of resonance and suppresses it. When Y is set to 2, the user can manually set the second set of resonance suppression. Thus, if the servo finds two resonance points, then the servo writes data of the first point to the first set of resonance suppression parameters. Then, data of the second point is written to the third set of resonance suppression parameters. Therefore, the second set is skipped.

Auto-resonance Detection Level

Table 90 - Relevant Parameter

Parameter	Name
ID231 (P2.048)	ResonanceDiagnosticLevel

The smaller the parameter value is, the more sensitive to resonance. If the set value of the ID231 (P2.048) parameter is bigger, then the resonance sensitivity becomes lower; on the other hand, if the set value of the ID231 (P2.048) parameter is smaller, then the resonance sensitivity becomes higher.

ZCLAMP Function

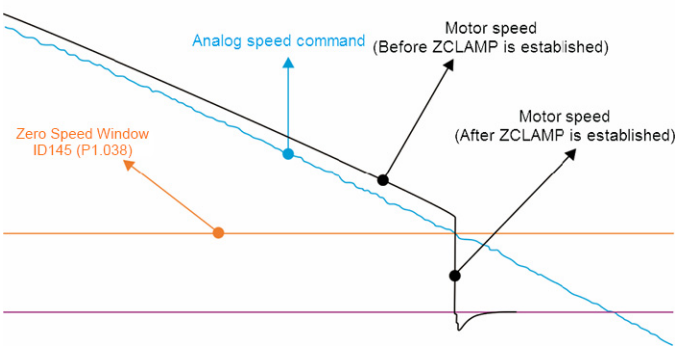
Table 91 - Relevant Parameter

Parameter	Name
ID145 (P1.038)	ZeroSpeedWindow

The ZCLAMP function is enabled when the following conditions are met:

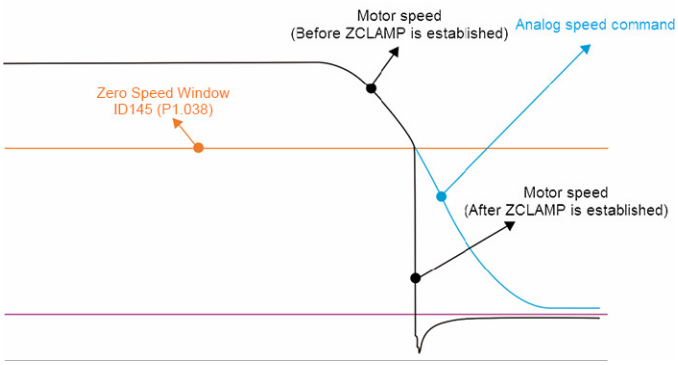
- Condition 1: Speed mode
- Condition 2: DI.ZCLAMP signal is on
- Condition 3: Motor speed is slower than the value of the ID145 (P1.038) parameter
- 0: Command source is analog voltage.

  ZCLAMP function uses the analog speed command without acceleration/deceleration to determine if this function should be enabled. The motor is clamped at the position where ZCLAMP conditions are met.



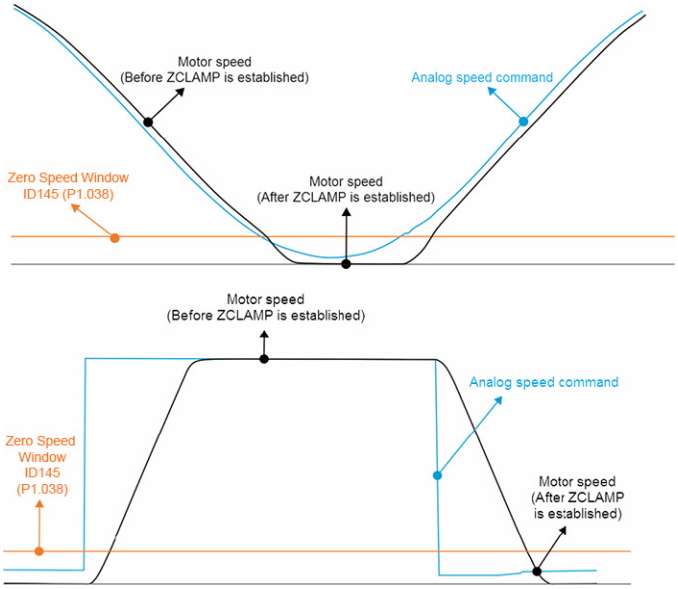
- 0: Command source is register.

  ZCLAMP function uses the register speed command without acceleration/deceleration to determine if this function should be enabled. The motor is clamped at the position where ZCLAMP conditions are met.



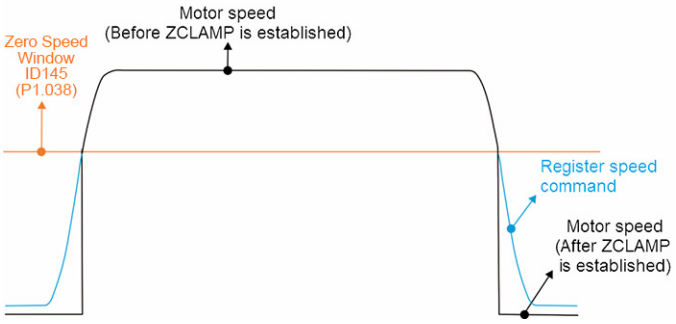
- 1: Command source is analog voltage.

  ZCLAMP function uses the analog speed command without acceleration/deceleration to determine if this function is enabled. When ZCLAMP conditions are met, the motor speed decelerates to 0 rpm by S-curve deceleration. If not, the motor follows the analog speed command through S-curve.



- 1: Command source is register.

  ZCLAMP function uses the register speed command with acceleration/deceleration to determine if this function should be enabled. When ZCLAMP conditions are met, the motor speed is set to 0 rpm.



For more information on the ZCLAMP function, see the Description of Digital Input Functions on page 405.

Torque Mode

Torque control mode (T or Tz) is suitable for torque control applications, such as printing machine, winding machine, etc. There are three kinds of command source: analog input, register, and I/O mode. Analog command input uses external voltage to control the torque of the motor while register uses the internal parameters ID128...130 (P1.012...P1.014) as the torque command.

The torque command can also come from the controller when parameter ID117 (P1.001) is set to 0xC (I/O mode). The command name is Target Torque. For more details, see I/O Mode - Torque on page 243.

Selection of Torque Command

External analog voltage and parameters are the two types of torque command source. They are selected by the DI signal from the I/O connector of the drive.

The following table shows the torque command source selection when the operating mode is T or Tz.

Torque Command	DI Signal		Command Source			Content	Range
	TCM1	TCM0					
T1	0	0	Mode	Torque (T)	External analog command	Voltage difference between T-REF and GND	-10V...+10V
				Torque without analog command (Tz)	—	Torque command is 0	0
T2	0	1	Parameters			ID128 (P1.012) PresetTorqueCmd_Limit_1	-300%...+300%
T3	1	0				ID129 (P1.013) PresetTorqueCmd_Limit_2	
T4	1	1				ID130 (P1.014) PresetTorqueCmd_Limit_3	

- State of DI.TCM0 and DI.TCM1 signals: 0 signifies that the circuit is open (digital input [DI] is off); 1 signifies that the circuit is closed (DI is on).
- When DI.TCM0 signal = DI.TCM1 signal = 0 in Tz mode, then the command is 0. Thus, if there is no need to use analog voltage as torque command, Tz mode is applicable and can avoid the problem of zero drift.

  If it is in T mode, the command will be the voltage difference between T-REF and GND. Its input voltage range is -10V...+10V, which means the corresponding torque is adjustable via ID148 (P1.041) AnalogToTorqueScale.
- When either the DI.TCM0 or DI.TCM1 signal is not 0, parameters become the source of torque command. The command will be executed after the DI.TCM0 and DI.TCM1 signals are changed. There is no need to use the DI.CTRG signal for triggering.

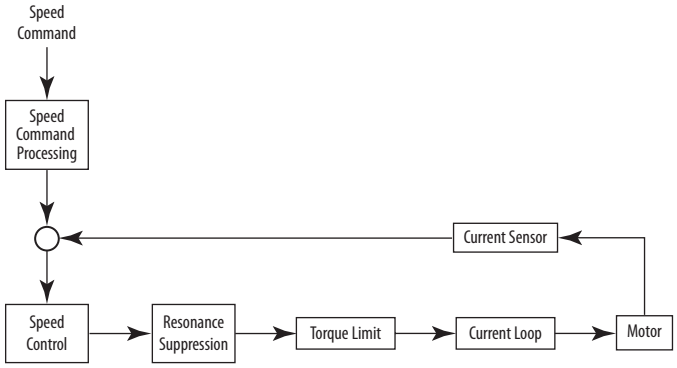
The torque command can be used in torque mode (T or Tz) and speed mode (S or Sz). When it is in speed mode, it can be regarded as the command input of torque limit.

Control Structure of Torque Mode

Table 92 - Relevant Parameters

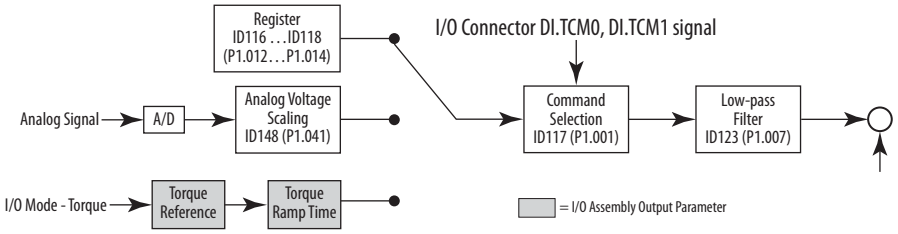
Parameter	Name
ID117 (P1.001)	ControlMode
ID123 (P1.007)	TorqueCmdLowPassFilterTime
ID148 (P1.041)	AnalogToTorqueScale

The following diagram shows the basic control structure of torque mode:



The torque command unit is to specify the torque command source, including the ID148 (P1.041) parameter and S-curve setting. The current control unit manages the gain parameters of the servo drive and calculates the current for servo motor in time; this can only set by commands.

The structure of a torque command unit is as follows.



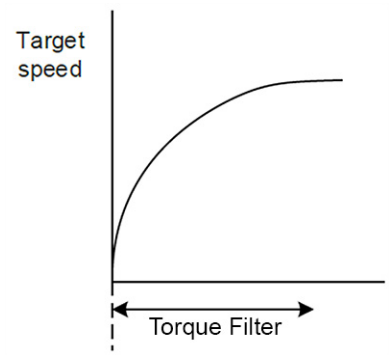
The upper path is the command from register, while the lower one is the external analog command. The command is selected according to the status of the DI.TCM0 and DI.TCM1 signals, and with the ID117 (P1.001) parameter set to T or Tz.

The torque can be adjusted by the ID148 (P1.041) parameter, and the response can be smoothed by the ID123 (P1.007) parameter.

Low Pass Filter for Torque Command

Table 93 - Relevant Parameter

Parameter	Name
ID123 (P1.007)	TorqueCmdLowPassFilterTime



Scaling of Analog Command (Torque Mode)

The motor torque command is controlled by the analog voltage difference between the T_REF and GND analog signals. The torque slope and its range can be adjusted by the Analog to Torque Scale parameter.

Table 94 - Relevant Parameter

Parameter	Name
ID148 (P1.041)	AnalogToTorqueScale

Motor torque command is based on the following equation:

$$\text{Torque control command} = \frac{\text{External analog input voltage x ID148 (P1.041) setting value}}{10} = \text{Unit \%}$$

If the ID148 (P1.041) parameter is set at its default setting of 100 and the external analog input voltage is 10V, the torque command is 100% of the rated torque.

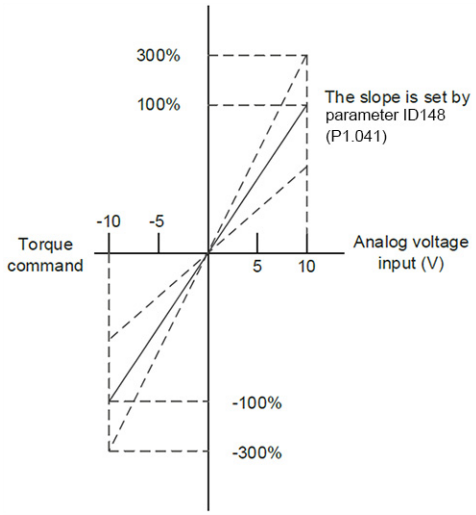
$$\text{Torque control command} = \frac{10\text{V x } 100}{10} = 100\%$$

If the ID148 (P1.041) parameter is set to 300 and the external analog input voltage is 10V, the torque command is 300% of the rated torque.

$$\text{Torque control command} = \frac{10\text{V x } 300}{10} = 300\%$$

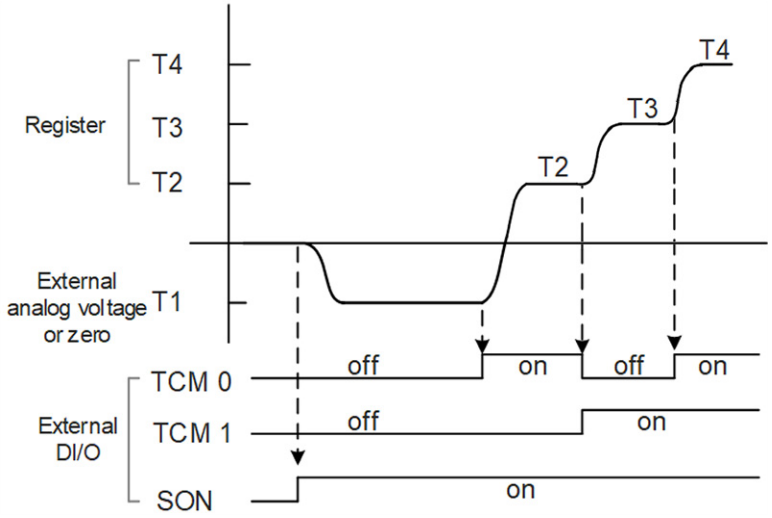
If the ID148 (P1.041) parameter is set at its default setting of 100 and the external analog input voltage is 5V, the torque command is 50% of the rated torque.

$$\text{Torque control command} = \frac{5\text{V x } 100}{10} = 50\%$$



In Speed, PT and PR modes set the torque limit corresponding to 10V (max. voltage) for analog torque limit.

Torque Mode Timing



- Off signifies the contact is open while on signifies the contact is closed.
- When it is in Tz mode, the torque command T1 equals 0; when it is in T mode, the torque command T1 is the external analog voltage input.
- In servo-on state, the command is selected according to the state of DI.TCM0 and DI.TCM1 inputs.

Dual and Multi-modes

Eight dual/multiple modes are provided for operation in addition to the single mode for position, speed, and torque control.

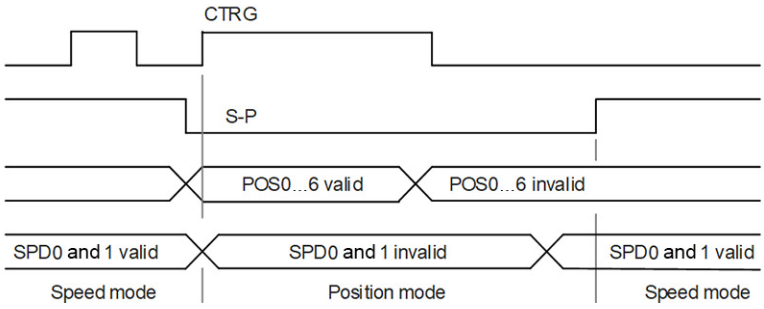
Mode	Short Name	Setting Code	Description
Dual	PT-S	06	PT and S can be switched by using the DI signal, S_P.
	PT-T	07	PT and T can be switched by using the DI signal, T_P.
	PR-S	08	PR and S can be switched by using the DI signal, S_P.
	PR-T	09	PR and T can be switched by using the DI signal, T_P.
	S-T	0A	S and T can be switched by using the DI signal, S_T.
	PT-PR	0D	PT and PR can be switched by using the DI signal, PT_PR.
Multi-mode(1)	PT-PR-S	0E	PT, PR, and S can be switched by using the DI signal, S_P and PT_PR.
	PT-PR-T	0F	PT, PR, and T can be switched by using the DI signal, T_P and PT_PR.

(1) Multiple (multi-) modes are a combination of a dual mode and a single mode.

Sz and Tz dual mode are not provided. To avoid using too many digital inputs in a dual mode, speed and torque (S-T) mode can apply external analog voltage as the command source so as to reduce the use of DI points (SPD0, SPD1 or TCM0, and TCM1). In addition, position mode can use pulse input to help reduce the use of DI points (POS0...POS6).

Speed/Position Dual Mode

There are PT-S and PR-S in speed/position dual mode. The command source of PT-S comes from external pulse while PR-S comes from internal parameters ID397…ID524 (P6.000…P7.027). The Speed command can be issued by external analog voltage or internal parameters ID125…ID127 (P1.009…P1.011, internal speed commands 1…3). The switch of speed/position mode is controlled by the DI.S-P (0x18) signal; switch of PT and PR for position mode is controlled by the DI.PT-PR (0x2B) signal. Thus, both position and speed commands in PR-S mode are selected by DI signal. The timing diagram is as follows.

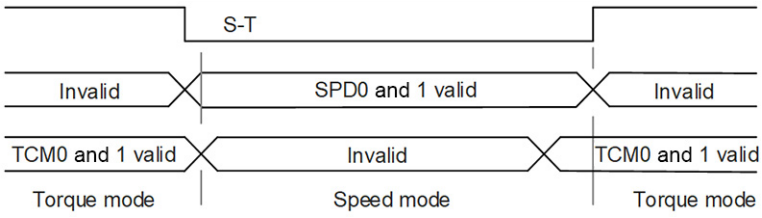


In Speed mode (the DI.S-P signal is on), the speed command is selected via the DI.SPD0 and DI.SPD1 signals. The DI.CTRG signal is not working at the moment. When switching to Position mode (DI.S-P signal is off), since position command has not been issued (needs to wait for the rising edge of the DI.CTRG signal), the motor stops. The position command is determined by the DI.POS0…DI.POS6 signals, and triggered by the rising edge of the DI.CTRG signal. When the DI.S-P signal is on, it resumes to the Speed mode.

For more information, see Position Control on page 197 and Speed Mode on page 211.

Speed/Torque Dual Mode

Speed/torque dual mode includes only the S-T mode. The speed command comes from the external analog voltage and internal parameters ID125…ID127 (P1.009…P1.011) internal speed commands 1…3, which are selected via the DI.SPD0 and DI.SPD1 signals. Similarly, the source of torque command could be external analog voltage or internal parameters ID128…ID130 (P1.012…P1.014) internal torque limits 1…3 and is selected via the DI.TCM0 and DI.TCM1 signals. The switch of speed/torque mode is controlled by the DI.S-T (0x19) signal. The timing diagram is as follows.

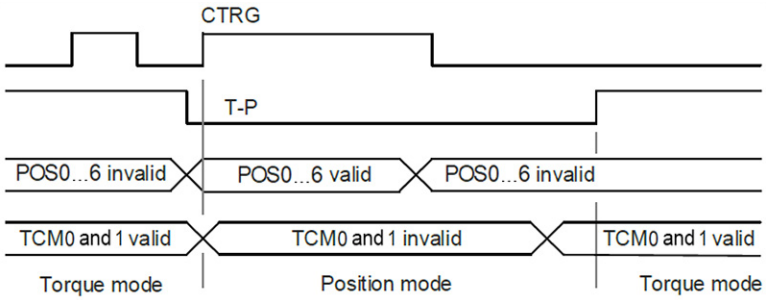


In torque mode (the DI.S-T signal is on), the torque command is selected via the DI.TCM0 and DI.TCM1 signals. When switching to speed mode (the DI.S-T signal is off), the torque command is selected via the DI.SPD0 and DI.SPD1 signals. The motor operates according to the speed command. When the DI.S-T signal is on, it resumes to the torque mode.

For more information, see Speed Mode on page 211 and Torque Mode on page 222.

Torque/Position Dual Mode

In torque/position dual mode, there are PT-T and PR-T. The command source of PT-T comes from external pulse while PR-T comes from internal parameters ID397…ID524 (P6.000…P7.027), which define the Homing settings and PR commands. Torque command could be issued by external analog voltage or internal parameters ID128…ID130 (P1.012…P1.014) internal torque limits 1…3. The switch of torque/position mode is controlled by the DI.T-P (0x20) signal. PT and PR in position mode are selected by the DI.PT-PR (0x2B) signal. Thus, both position and torque commands in PR-T mode are selected by a DI signal. The timing diagram is as follows.



In torque mode (DI.T-P signal is on), the torque command is selected via the DI.TCM0 and DI.TCM1 signals. The DI.CTRG signal is not working at the moment. When switching to position mode (the DI.T-P signal is off), since position command has not been issued (needs to wait for the rising edge of the DI.CTRG signal), the motor stops. The position command is determined by the DI.POS0…DI.POS6 signals and triggered by rising edge of the DI.CTRG signal. When the DI.T-P signal is on, it resumes to torque mode.

For more information, see Position Control on page 197 and Torque Mode on page 222.

I/O Mode

The Kinetix 5100 drive is working in I/O mode when the Control Mode parameter ID117 (P1.001) is set to 0x0C. In this mode, commands come from the programmable controller through the I/O assembly.

Three assembly instances, Output 104, Output 106, and Input 154 are supported only with Class 1 I/O mode communication with the Kinetix 5100 drive. No configuration assembly is supported by the Kinetix 5100 drive.

Instance	Assembly Type	Description
104	Output	Extended position, speed, torque, and miscellaneous output
106	Output	Extended position, speed, torque, cam, and miscellaneous output
154	Input	Extended position, speed, torque, and miscellaneous input

No configuration assembly is supported by the Kinetix 5100 drive.

Table 95 - Kinetix 5100 Output Assembly Data (Instance 104)

Byte	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
0	Operating Mode							
1				Start Motion	Fault Reset	Stop Motion	Servo Off	Servo On
2								
3	Homing Method							
4	Speed Reference (DINT)							
5								
6								
7								
8	Accel Reference (DINT)							
9								
10								
11								
12	Decel Reference (DINT)							
13								
14								
15								
16	Position Reference (DINT)							
17								
18								
19								
20	Home Return Speed (DINT)							
21								
22								
23								
24	Non-cyclic Move Type							
25	Cyclic Move Type							
26	Travel Mode							
27						Captured Position Select	Position Command Overlap	Position Command Override
28	Torque Reference (DINT)							
29								
30								
31								
32	Torque Ramp Time (DINT)							
33								
34								
35								
36	Starting Index							
37								
38								
39								

Table 96 - Kinetix 5100 Output Assembly Data (Instance 106)

Instance	Byte	Bit7	Bit6	Bit5	Bit4	Bit3	Bit2	Bit1	Bit0
106	0	OperatingMode							
	1				Start Motion	Fault Reset	Stop Motion	ServoOff	ServoOn
	2								
	3	HomingMethod							
	4	SpeedReference (DINT)							
	5								
	6								
	7								
	8	AccelReference (DINT)							
	9								
	10								
	11								
	12	DecelReference (DINT)							
	13								
	14								
	15								
	16	PositionReference (DINT)							
	17								
	18								
	19								
	20	HomeReturnSpeed (DINT)							
	21								
	22								
	23								
	24	NonCyclicMoveType							
	25	CyclicMoveType							
	26	TravelMode							
	27						Captured Position Select	Position Command Overlap	Position Command Override
	28	TorqueReference (DINT)							
	29								
	30								
	31								
	32	TorqueRampTime (DINT)							
	33								
	34								
	35								
	36	StartingIndex							
	37								
	38								
	39								
	40					CamStop Mode		CamUnlocMode	
	41	CamMasterReference							
	42	CamExecutionMode							
	43	CamExecutionSchedule							
	44	CamSlaveScaling (DINT)							
	45								
	46								
	47								

Table 96 - Kinetix 5100 Output Assembly Data (Instance 106) (Continued)

Instance	Byte	Bit7	Bit6	Bit5	Bit4	Bit3	Bit2	Bit1	Bit0
106	48	Reserved							
	49								
	50								
	51								
	52	CamLockPosition (DINT)							
	53								
	54								
	55								
	56	CamMasterLockPosition (DINT)							
	57								
	58								
	59								
	60	CamMasterLeadingCounts							
	61								
	62								
	63								
	64	CamMasterUnlockCounts							
	65								
	66								
	67								
	68	CamMasterCyclicLeadingCounts							
	69								
	70								
	71								
	72	Reserved							
	73								
	74								
	75								
	76	GearRatioSlaveCounts							
	77								
	78								
	79								
	80	GearRatioMasterCounts							
	81								
	82								
	83								
	84								
	85								
	86								

Table 97 - Kinetix 5100 Drive Output Assembly Data Description

Name	Data Type	Description	Semantics of Values
Operating mode (output)	SINT	Indicate which output assembly parameters will have effect when 'Start Motion' has a zero-to-one transition.	• -128...-1: Reserved • 0: Mode not specified • 1: Position mode • 2: Speed mode • 3: Home mode • 4: Torque mode • 5: Gear mode • 6: Index mode • 7...127: Reserved
Servo on	BOOL	A 0-to-1 transition servos on the drive.	–
Servo off		A 0-to-1 transition servos off the drive.	–
Stop motion		A 0-to-1 transition stops the drive.	–
Fault reset		A 0-to-1 transition tried to clear the drive fault.	–
Start motion		A 0-to-1 transition means the motion command is issued from the external controller.	–
Homing method	SINT	Homing method.	See Table 102 on page 239.
Speed reference	DINT	For a rotary motor, the speed reference is 0.1 rpm/sec.	• -80000...+80000 • 1...20000 (home mode)
Acceleration reference		For a rotary motor, the acceleration reference is 0.1 rpm/sec.	_
Deceleration reference		For a rotary motor, the deceleration reference is 0.1 rpm/sec.	_
Position reference		The relationship between user unit and motor encoder counts is defined by position factor numerator/denominator.	–
Home return speed		The return speed when home mode is the operating mode. For a rotary motor, the return speed is 0.1 rpm/sec.	1...5000
Non-cyclic move type	SINT	Enumerated attribute used to determine the noncyclic move type.	• -128...-1: Reserved • 0: Absolute • 1: Relative • 2: Incremental • 3: High-speed capture • 4...127: Reserved
Cyclic move type		Enumerated attribute used to determine the cyclic move type.	• -128...-1: Reserved • 0: Rotary positive • 1: Rotary negative • 2: Rotary shortest path • 3...127: Reserved
Travel mode		Enumerated attribute used to determine the travel constraints of the axis.	• -128...+1: Reserved • 2: Non-cyclic move • 3...9: Reserved • 10: Cyclic move • 11...127: Reserved
Position command override	BOOL	When executing this movement, it overrides previous movement.	• 0: Does not override previous movement • 1: Can override previous movement
Position command overlap		Permits overlapping of the next movement	• 0: Does not overlap the next movement • 1: Overlaps the next movement
Captured position select	BOOL	Captured position selection.	Vendor specific. 0: DI9 is selected 1: DI10 is selected

Table 97 - Kinetix 5100 Drive Output Assembly Data Description (Continued)

Name	Data Type	Description	Semantics of Values
Torque reference	DINT	When method of operation is 3–Torque mode. Its unit is percentage of the rated torque for the rotary motor.	-4000…4000
Torque ramp time		Its unit is milliseconds (ms) from 0…100% of the rated torque.	1…65500
Starting index	SINT	The first index (position routine) that the drive should execute.	• -128…-1: Reserved • 0: PR 0 • 1…99: PR1…PR99 • 100…127: Vendor specific

Table 98 - CAM Parameters

Name	Data Type	Description	Semantics of Values
CamMaster Reference	SINT	Sets the master position reference	• 0 - Reserved • 1 - Auxiliary encoder • 2 - Pulse Command (I/O terminal) • 3 - Reserved • 4 - Virtual Pulse from Time Axis (1K Hz)
CamStopMode	BOOL	Sets CAM stop mode	• 0 - stop immediately • 1 - decelerate and stop
CamExecutionSchedule	SINT	Selects the method used to execute the cam profile.	• 0 = Immediate - The slave axis is immediately locked to the master axis and the position camming process begins. • 1 = Reserved • 2 = Forward only - the cam profile starts when the master position crosses the Master Lock Position in the forward direction. If the setting of CamMasterLockPosition is less than the Master Axis Position, the slave axis is immediately locked to the master axis. • 3 = Reverse only - the cam profile starts when the master position crosses the Master Lock Position in the reverse direction. If the setting of CamMasterLockPosition is larger than the Master Axis Position, the slave axis is immediately locked to the master axis. • 4 = Bi-directional - the cam profile starts when the master position crosses the Master Lock Position in either direction.
CamExecutionMode	SINT	Determines if the cam profile is executed only one time or repeatedly:	• 0 = Once - cam motion of slave axis is executed one time according to the value of CamMasterUnlockCounts, and then the Process Complete bit is set. • 1 = Continuous - Once started the cam profile is executed indefinitely. This feature is useful in rotary applications where it is necessary that the cam position run continuously in a rotary or reciprocating fashion.
CamSlaveScaling	DINT	Scales the total distance covered by the slave axis through the cam profile. same as ID311 (P5.019)	Unit is 0.000001 times,
CamLockPosition	DINT	This determines the starting location in the cam profile. Similar as ECAM Macro#C	
CamMasterLeadingCounts	DINT	This determines the leading counts (master axis) before the cam profile is executed. Same as ID375 (P5.087)	
CamMasterUnlockCounts	DINT	This determines the unlock counts (master axis) when the cam profile is executed. Valid only when CamExecutionMode = 0 (Once) Same as ID377 (P5.089)	
CamMasterCyclicLeadingCounts	DINT	This determines the cyclic leading counts (master axis) during the cam profile is executed. Valid only when CamExecutionMode = 1 (Continous) Same as ID380 (P5.092)	

Table 98 - CAM Parameters (Continued)

Name	Data Type	Description	Semantics of Values
GearRatioSlaveCounts	DINT	Integer value representing slave counts used in specifying a Fractional gear ratio. Same as ID151 (P1.044).	
GearRatioMasterCounts	DINT	Integer value representing master counts used in specifying a Fractional gear ratio. Same as ID152 (P1.045)	
CamMasterLockPosition	DINT	This determines the master location where the slave axis locks to the master axis. Valid only when CamExecutionSchedule = 2, 3, 4	See Figure 86.

Figure 86 - CAM Execution

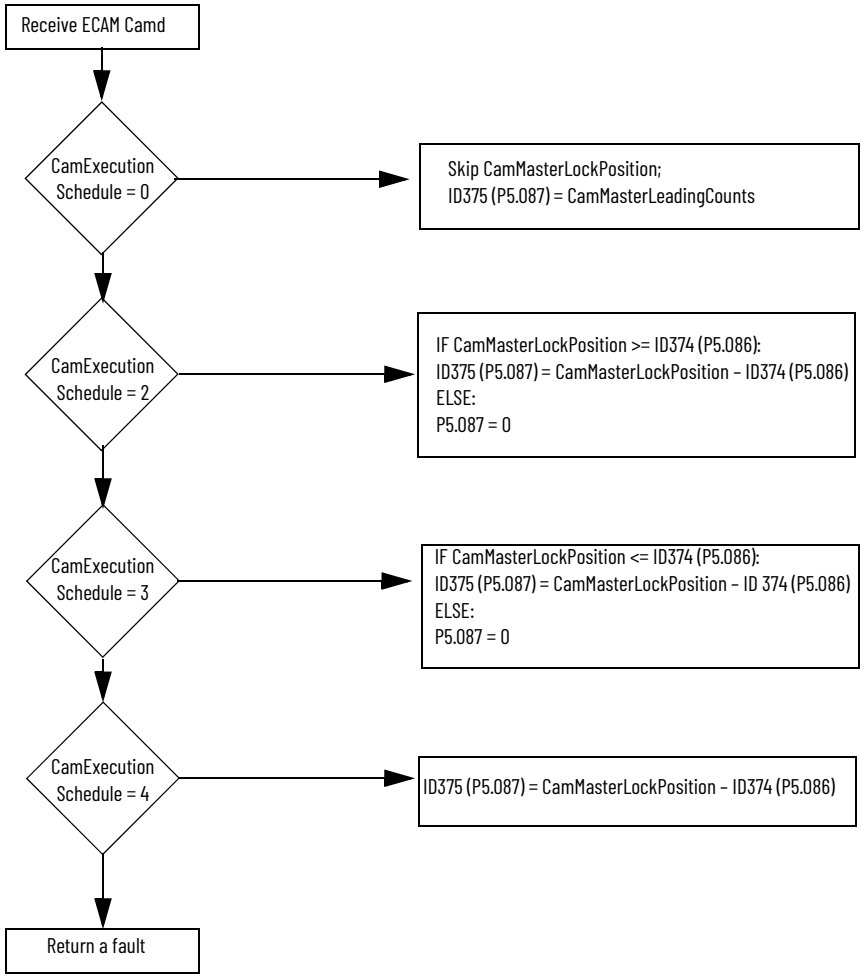


Table 99 - Kinetix 5100 Input Assembly Data (Instance 154)

Byte	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
0						Diagnostic Active	Connection Faulted	Run Mode
1	Diagnostic sequence count							
2	Pad bytes for LINT alignment							
3								
4								
5								
6								
7								
8						Uncertain	Fault	
9	At Reference	Stopped	Homed Status	Command in Progress	Ready	Active	Warning Present	
10	Reserved							
11	Operating Mode							
12	Active Index							
13	Reserved							
14								
15	Motor Type							
16	Actual Speed (DINT)							
17								
18								
19								
20	Fault Code (UINT)							
21								
22	Warning Code (UINT)							
23								
24	Actual Position (DINT)							
25								
26								
27								
28	Actual Torque (DINT)							
29								
30								
31								
32	Parameter Monitor 1 Value (DINT)							
33								
34								
35								
36	Parameter Monitor 2 Value (DINT)							
37								
38								
39								
40	Parameter Monitor 3 Value (DINT)							
41								
42								
43								
44	Parameter Monitor 4 Value (DINT)							
45								
46								
47								

Table 99 - Kinetix 5100 Input Assembly Data (Instance 154) (Continued)

Byte	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
48	Parameter Monitor 5 Value (DINT)							
49								
50								
51								

Table 100 - Kinetix 5100 Drive Input Assembly Data Description

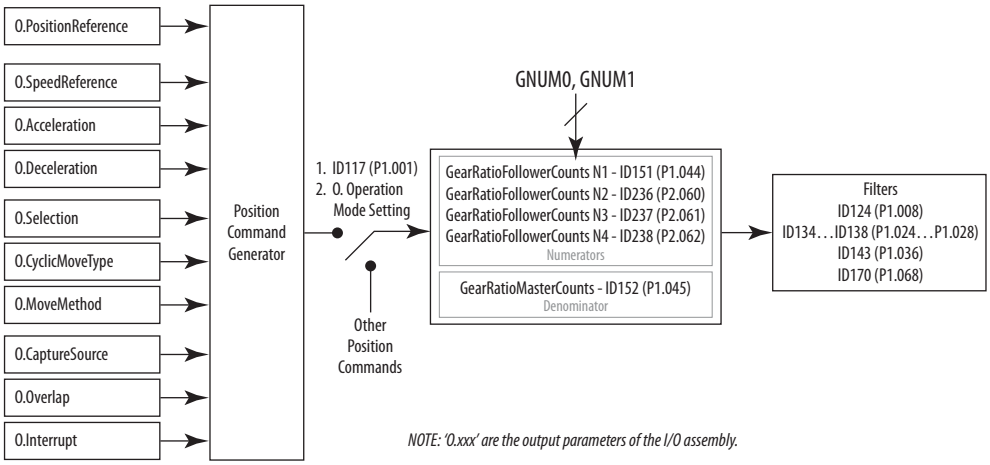
Name	Data Type	Description	Semantics of Values
Run mode	BOOL	Indicates whether the drive is in run mode	• 0: Drive is idle • 1: Drive is in run mode
Connection faulted		Indicates whether the connection is faulted	• 0: Connection is not faulted • 1: Connection is faulted
Diagnostic active		Indicates whether the diagnostic is active	• 0: Diagnostic is not active • 1: Diagnostic is active
Diagnostic sequence count	SINT	The sequence count for the diagnostic	–
Fault	BOOL	Indicates whether the drive is in a faulted state	• 0: Drive is not in a faulted state • 1: Drive is in a faulted state
Uncertain		Indicates whether the data validity is questionable	• 0: No question about data validity • 1: Data validity is questionable
Warning present		Indicates whether the drive is in a warning state	• 0: Drive is not in a warning state • 1: Drive is in a warning state
Active	BOOL	Indicates whether the drive has been servo on	• 0: Drive is not enabled • 1: Drive is enabled
Ready		Indicates whether the drive is ready for servo on	• 0: Drive is not ready • 1: Drive is ready
Command in progress		Indicates whether the drive received the command from the controller	Indicates the new command has been received by the K5100 drive. It toggles between 0 and 1 after a new command has been received by the K5100 drive.
Homed status		Indicates whether the drive completed the home operation	1: Drive completed the home operation
Stopped		Indicates whether the motor is stopped	1: Drive is stopped
At reference		Drive actual at reference (position, speed, torque) based on mode	1: Drive actual at reference (position, speed, torque) based on mode
Operating mode (input)	SINT	Indicates at which state the drive stays	Its value may be: • -128...+1: Reserved • 0: Mode not specified • 1: Position mode • 2: Speed mode • 3: Home mode • 4: Torque mode • 5: Gear mode • 6: Index mode • 7...127: Reserved
Active index		Indicates the currently executing index	Currently executing index: • -128...+1: Reserved • 0: PR 0 • 1...99: PPR 1...PR 99 • 100...127: Reserved
Motor type		Indicates which type of motor is connected to the drive	• 0: No motor connected • 1: Rotary motor connected • 2: Linear motor connected
Actual speed	DINT	Speed actual value; its unit is rpm for the rotary motor	–
Fault code	UINT	Fault code	See View Status and Faults on page 422
Warning code		Warning code	

Table 100 - Kinetix 5100 Drive Input Assembly Data Description (Continued)

Name	Data Type	Description	Semantics of Values
Actual position	DINT	Position actual value; its unit is user unit.	–
Actual torque		Torque actual value; its unit is a percentage of the rated torque for the rotary motor	–
Parameter monitor 1 value		Parameter monitor selection 0 - no parameter is selected 0x0001...0xFFFF parameter instance ID is selected	–
Parameter monitor 2 value		Parameter monitor selection 0 - no parameter is selected 0x0001...0xFFFF parameter instance ID is selected	–
Parameter monitor 3 value		Parameter monitor selection 0 - no parameter is selected 0x0001...0xFFFF parameter instance ID is selected	–
Parameter monitor 4 value		Parameter monitor selection 0 - no parameter is selected 0x0001...0xFFFF parameter instance ID is selected	–
Parameter monitor 5 value		Parameter monitor selection 0 - no parameter is selected 0x0001...0xFFFF parameter instance ID is selected	–

I/O Mode - Position

The Kinetix 5100 drive receives position commands from the controller, then commands the motor to run to the target position. The control structure of position mode is as follows.



The I/O assembly data for position mode is as follows.

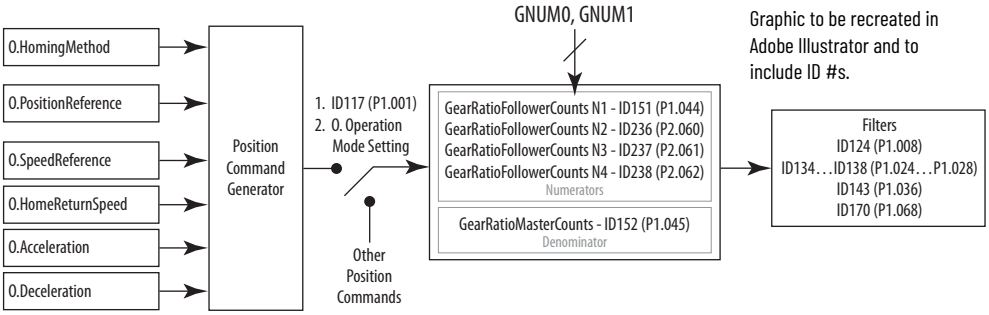
Table 101 - Position Mode Data Description

Name	Data Type	Description	Semantics of Values
Operation mode setting	SINT	Indicates what output assembly parameters have effect when 'Start Motion' has a 0-to-1 transition.	Must be 1 - position mode
Selection		Move type	• -128...+1: Reserved • 2: Positioning/move type • 3...9: Reserved • 10: Index positioning/ move method • 11...127: Reserved
Cyclic move type		Position command selection, when selection is 2.	• -128...+1: Reserved • 0: Absolute positioning • 1: Relative positioning • 2: Incremental positioning • 3: High-speed position capturing • 4...127: Reserved
Move method		Movement directions when selection is 10.	• -128...+1: Reserved • 0: Rotary positive • 1: Rotary negative • 2: Rotary shortest path • 3...127: Reserved
Interrupt	BOOL	When this movement is executed, it interrupts the previous movement.	• 0: Does not interrupt previous movement • 1: Can interrupt previous movement
Overlap		Permits overlapping of the next movement.	• 0: Does not permit overlapping of the next movement • 1: Permits overlapping of the next movement
Capture source		Captures move source.	0 = DI9, 1 = DI10
Speed reference	DINT	For a rotary motor, the speed reference is 0.1 rpm/sec.	–
Acceleration reference		For a rotary motor, the acceleration reference is 0.1 rpm/sec.	–
Deceleration reference		For a rotary motor, the deceleration reference is 0.1 rpm/sec.	–
Position reference		The relationship between user unit and motor encoder counts is defined by position factor numerator/denominator.	–

I/O Mode - Home

The Kinetix 5100 drive receives home commands from the controller, then commands the motor to home position per the homing method.

The control structure of home mode is as follows.



NOTE: '0.xxx' are the output parameters of the I/O assembly.

The I/O assembly data for the home mode is as follows.

Name	Data Type	Description	Semantics of Values
Operation mode setting	SINT	Indicates what output assembly parameters have effect when 'Start Motion' has a 0-to-1 transition.	Must be 3 - home mode
Homing method		Homing method.	See Table 102.
Speed reference	DINT	For a rotary motor, the speed reference is 0.1 rpm/sec.	–
Acceleration reference		For a rotary motor, the acceleration reference is 0.1 rpm/sec.	–
Deceleration reference		For a rotary motor, the deceleration reference is 0.1 rpm/sec.	–
Position reference		The relationship between user unit and motor encoder counts is defined by position factor numerator/denominator.	–
Home return speed		When operation mode is the home mode, then the creep speed for the rotary motor is 0.1 rpm/sec.	–

Table 102 - Homing Method Values

Value	Description
0	Homing in forward direction and regard PL as homing origin. Return to Z pulse.
1	Homing in forward direction and regard PL as homing origin. Go forward to Z pulse.
2	Homing in forward direction and regard PL as homing origin. Do not look for Z pulse.
3	Homing in reverse direction and regard NL as homing origin. Return to Z pulse.
4	Homing in reverse direction and regard NL as homing origin. Go forward to Z pulse.
5	Homing in reverse direction and regard NL as homing origin. Do not look for Z pulse.
6	Homing in forward direction, ORG: OFF→ON as homing origin. Return to Z pulse. Shows error when encounter limit.
7	Homing in forward direction, ORG: OFF→ON as homing origin. Return to Z pulse. Reverse direction when encounter limit.
8	Homing in forward direction, ORG: OFF→ON as homing origin. Go forward to Z pulse. Shows error when encounter limit.
9	Homing in forward direction, ORG: OFF→ON as homing origin. Go forward to Z pulse. Reverse direction when encounter limit.
10	Homing in forward direction, ORG: OFF→ON as homing origin. Do not look for Z pulse. Shows error when encounter limit.
11	Homing in forward direction, ORG: OFF→ON as homing origin. Do not look for Z pulse. Reverse direction when encounter limit.
12	Homing in reverse direction, ORG: OFF→ON as homing origin. Return to Z pulse. Shows error when encounter limit.
13	Homing in reverse direction, ORG: OFF→ON as homing origin. Return to Z pulse. Reverse direction when encounter limit.
14	Homing in reverse direction, ORG: OFF→ON as homing origin. Go forward to Z pulse. Shows error when encounter limit.

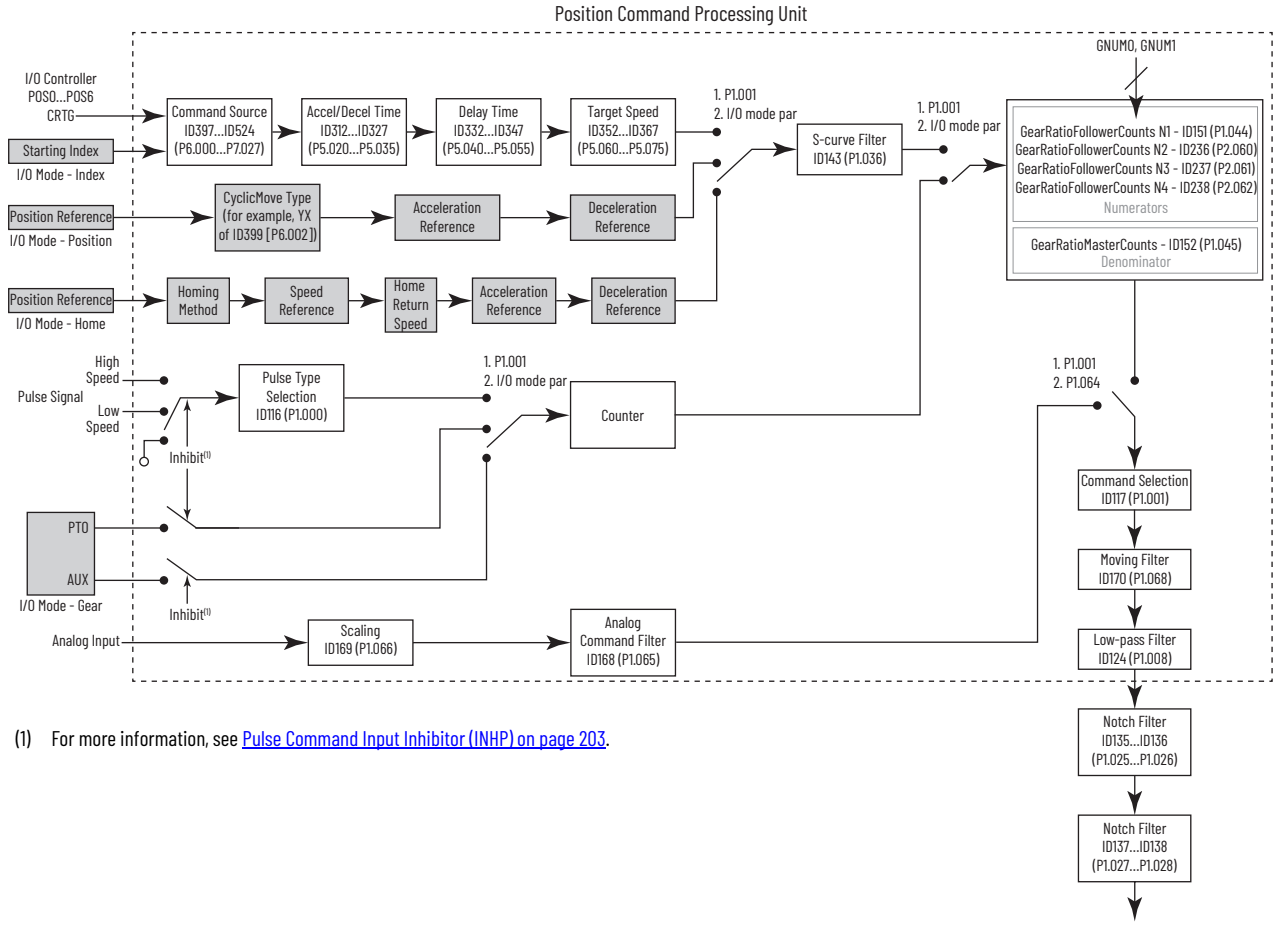
Table 102 - Homing Method Values (Continued)

15	Homing in reverse direction, ORG: OFF→ON as homing origin. Go forward to Z pulse. Reverse direction when encounter limit.
16	Homing in reverse direction, ORG: OFF→ON as homing origin. Do not look for Z pulse. Shows error when encounter limit.
17	Homing in reverse direction, ORG: OFF→ON as homing origin. Do not look for Z pulse. Reverse direction when encounter limit.
18	Look for Z pulse in forward direction and regard it as homing origin. Shows error when encounter limit.
19	Look for Z pulse in forward direction and regard it as homing origin. Reverse direction when encounter limit.
20	Look for Z pulse in reverse direction and regard it as homing origin. Shows error when encounter limit.
21	Look for Z pulse in reverse direction and regard it as homing origin. Reverse direction when encounter limit.
22	Homing in forward direction, ORG: ON→OFF as homing origin. Return to Z pulse. Shows error when encounter limit.
23	Homing in forward direction, ORG: ON→OFF as homing origin. Return to Z pulse. Reverse direction when encounter limit.
24	Homing in forward direction, ORG: ON→OFF as homing origin. Go forward to Z pulse. Shows error when encounter limit.
25	Homing in forward direction, ORG: ON→OFF as homing origin. Go forward to Z pulse. Reverse direction when encounter limit.
26	Homing in forward direction, ORG: ON→OFF as homing origin. Do not look for Z pulse. Shows error when encounter limit.
27	Homing in forward direction, ORG: ON→OFF as homing origin. Do not look for Z pulse. Reverse direction when encounter limit.
28	Homing in reverse direction, ORG: ON→OFF as homing origin. Return to Z pulse. Shows error when encounter limit.
29	Homing in reverse direction, ORG: ON→OFF as homing origin. Return to Z pulse. Reverse direction when encounter limit.
30	Homing in reverse direction, ORG: ON→OFF as homing origin. Go forward to Z pulse. Shows error when encounter limit.
31	Homing in reverse direction, ORG: ON→OFF as homing origin. Go forward to Z pulse. Reverse direction when encounter limit.
32	Homing in reverse direction, ORG: ON→OFF as homing origin. Do not look for Z pulse. Shows error when encounter limit.
33	Homing in reverse direction, ORG: ON→OFF as homing origin. Do not look for Z pulse. Reverse direction when encounter limit.
34	Define current position as the origin.
35	Look for the collision point in forward direction and regard it as the origin. Return to Z pulse. Shows error when encounter negative limit.
36	Look for the collision point in forward direction and regard it as the origin. Do not look for Z pulse.
37	Look for the collision point in reverse direction and regard it as the origin. Return to Z pulse. Shows error when encounter positive limit.
38	Look for the collision point in reverse direction and regard it as the origin. Do not look for Z pulse.

I/O Mode - Gear

The Kinetix 5100 drive receives gear commands from controller, then triggers the motor to run per the pulse train input or AUX feedback.

The control structure of gear mode is as follows.



(1) For more information, see Pulse Command Input Inhibitor (INHP) on page 203.

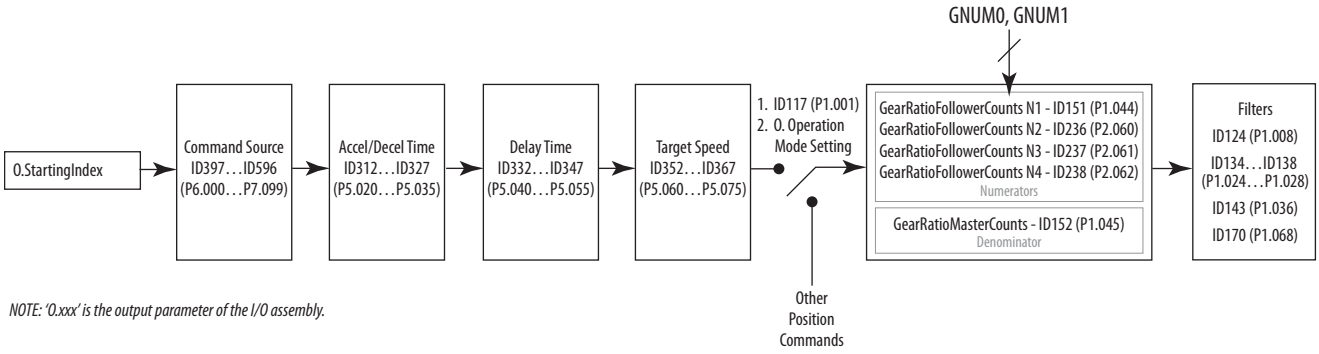
The I/O assembly data for the gear mode is as follows.

Name	Data Type	Description	Semantics of Values
Operation mode setting	SINT	Indicates what output assembly parameters have effect when 'Start Motion' has a 0-to-1 transition.	Must be 5 (Inst 104) or 8 (Inst 106) - gear mode
Gear ratio slave counts	DINT	Set the value of ID151 (P1.044).	Only valid when Operation mode Setting is 8
Gear ratio master counts	DINT	Set the value of ID152 (P1.045).	Only valid when Operation mode Setting is 8
Acceleration reference	DINT	For a rotary motor, the acceleration reference is 0.1 rpm/sec	Only valid when Operation mode Setting is 8

I/O Mode - Index

The Kinetix 5100 drive receives index commands from controller, then executes the index (PR command). For more about PR mode, see Chapter 11, Motion Control in PR Mode.

The control structure of the index mode is as follows.



NOTE: '0.xxx' is the output parameter of the I/O assembly.

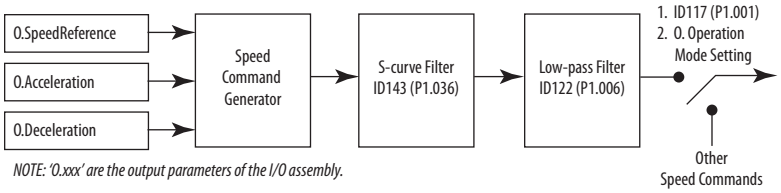
The I/O assembly data for the index mode is as follows.

Name	Data Type	Description	Semantics of Values
Operation mode setting	SINT	Indicates what output assembly parameters have effect when 'Start Motion' has a 0-to-1 transition.	Must be 6 - index mode
Starting index		The first index that the Kinetix 5100 drive should execute.	• -128...+1: Reserved • 0: PR 0 • 1...99: PR 1...PR 99 • 100...127: Vendor specific

I/O Mode - Speed

The Kinetix 5100 drive receives speed commands from the controller, then commands the motor to run to the target speed.

The control structure of speed mode is as follows.



NOTE: '0.xxx' are the output parameters of the I/O assembly.

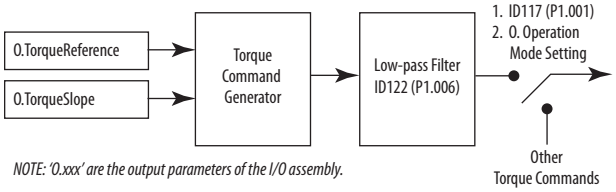
The I/O assembly data for speed mode is as follows.

Name	Data Type	Description	Semantics of Values
Operation mode setting	SINT	Indicates what output assembly parameters have effect when 'Start Motion' has a 0-to-1 transition.	Must be 2 - speed mode
Speed reference	DINT	For a rotary motor, the speed reference is 0.1 rpm/sec.	
Acceleration reference		For a rotary motor, the acceleration reference is 0.1 rpm/sec.	
Deceleration reference		For a rotary motor, the deceleration reference is 0.1 rpm/sec.	

I/O Mode - Torque

The Kinetix 5100 drive receives torque commands from the controller, then commands the motor to output target torque.

The control structure of torque mode is as follows.



NOTE: 'O.xxx' are the output parameters of the I/O assembly.

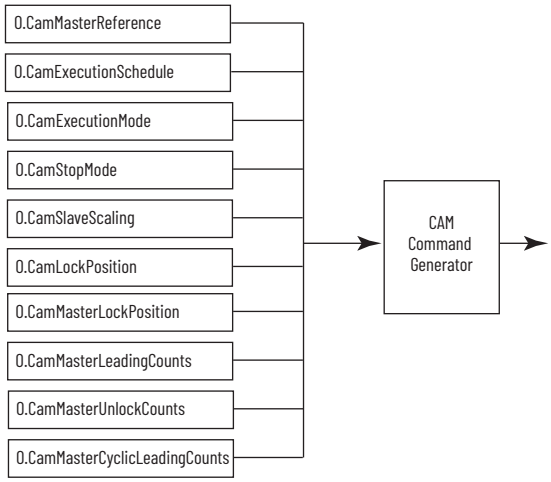
The I/O assembly date for torque mode is as follows.

Name	Data Type	Description	Semantics of Values
Operation mode setting	SINT	Indicates what output assembly parameters have effect when 'Start Motion' has a 0-to-1 transition.	Must be 4 (Inst 104) or 9 (Inst 106) - torque mode
Torque reference	DINT	Torque reference when the operation method is 3 - torque mode. Its unit is a percentage of the rated torque for the rotary motor.	
Torque slope		Its unit is milliseconds from 0...100% of the rated torque for the rotary motor.	
Speed reference	DINT	For a rotary motor, the speed limit is 0.1 rpm/sec and range is from -8000rpm to 8000rpm.	Only valid when Operation mode Setting is 9

I/O Mode - CAM

The Kinetix 5100 drive receives CAM commands from the controller, then commands the motor to run at electronic camming.

The control structure of cam mode is as follows.



NOTE: 'O.xxx' are the output parameters of the I/O assembly.

The I/O assembly date for torque mode is as follows.

Name	Data Type	Description	Semantics of Values
Operation mode setting	SINT	Indicates what output assembly parameters have effect when 'Start Motion' has a 0 to 1 transition.	Must be 7 - cam mode
CamMasterReference	SINT	Sets the master position reference	• 0 - Reserved • 1 - Auxiliary encoder • 2 - Pulse Command (I/O terminal) • 3 - Reserved • 4 - Virtual Pulse from Time Axis (1K Hz)
CamStopMode	BOOL	Sets CAM stop mode	• 0 - stop immediately • 1 - decelerate and stop
CamExecutionSchedule	SINT	Selects the method used to execute the cam profile.	• 0 - Immediate - The slave axis is immediately locked to the master axis and the position camming process begins. • 1 - Reserved • 2 - Forward only - the cam profile starts when the master position crosses the Master Lock Position in the forward direction. If the setting of CamMasterLockPosition is less than the Master Axis Position, the slave axis is immediately locked to the master axis. • 3 - Reverse only - the cam profile starts when the master position crosses the Master Lock Position in the reverse direction. If the setting of CamMasterLockPosition is larger than the Master Axis Position, the slave axis is immediately locked to the master axis. • 4 - Bi-directional - the cam profile starts when the master position crosses the Master Lock Position in either direction.

Name	Data Type	Description	Semantics of Values
CamExecutionMode	SINT	Determines if the cam profile is executed only one time or repeatedly.	0 - Once - cam motion of slave axis is executed one time according to the value of CamMasterUnlockCounts, and then the Process Complete bit is set. 1 - Continuous - Once started the cam profile is executed indefinitely. This feature is useful in rotary applications where it is necessary that the cam position run continuously in a rotary or reciprocating fashion.
CamSlaveScaling	DINT	Scales the total distance covered by the slave axis through the cam profile. same as ID311 (P5.019).	Unit is 0.000001 times,
CamLockPosition	DINT	This determines the starting location in the cam profile. Similar as ECAM Macro#C.	
CamMasterLeadingCounts	DINT	This determines the leading counts (master axis) before the cam profile is executed. Same as ID375 (P5.087).	
CamMasterUnlockCounts	DINT	This determines the unlock counts (master axis) when the cam profile is executed. Valid only when CamExecutionMode = 0 (Once) Same as ID377 (P5.089).	
CamMasterCyclicLeadingCounts	DINT	This determines the cyclic leading counts (master axis) during the cam profile is executed. Valid only when CamExecutionMode = 1 (Continous) Same as ID380 (P5.092).	
GearRatioSlaveCounts	DINT	Integer value representing slave counts used in specifying a Fractional gear ratio. Same as ID151 (P1.044).	
GearRatioMasterCounts	DINT	Integer value representing master counts used in specifying a Fractional gear ratio. Same as ID152 (P1.045).	
CamMasterLockPosition	DINT	This determines the master location where the slave axis locks to the mater axis. Valid only when CamExecutionSchedule = 2, 3, 4.	

Speed and Torque Limit Functions

The Kinetix 5100 drive provides speed and torque limits determined by internal parameters for speed limit and either internal parameters or analog inputs for torque limit.

Enable or Disable the Limit Functions

Table 103 - Relevant Parameter

Parameter	Name
ID118 (P1.002)	VelocityTorqueLimitAction

When using torque limit function, users can use this parameter to set its value to 1 to limit the torque permanently without occupying one DI setting. Additionally, users can enable or disable the limit function via the DI.TRQLM signal, which is more flexible, but would need to occupy one DI setting. Torque limit function can be enabled by either parameter ID118 (P1.002) or the digital input (DI).

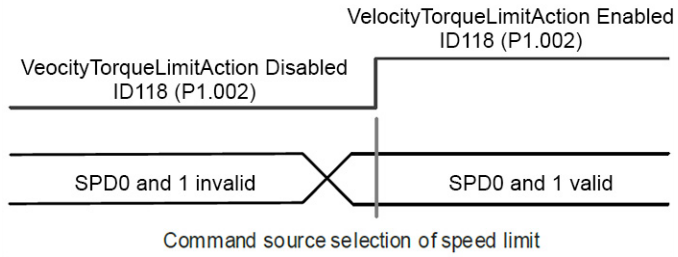
Apply Speed Limit

Table 104 - Relevant Parameters

Parameter	Name
ID118 (P1.002)	VelocityTorqueLimitAction
ID125 (P1.009)	PresetVelocityCmd_Limit_1
ID126 (P1.010)	PresetVelocityCmd_Limit_2
ID127 (P1.011)	PresetVelocityCmd_Limit_3
ID160 (P1.055)	MaximumSpeed

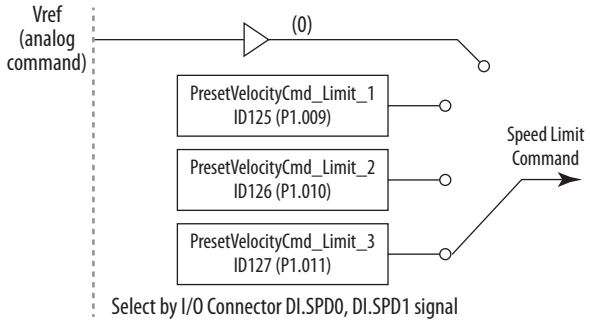
The maximum speed in each mode is determined by the internal parameter ID160 (P1.055), no matter if it is in position, speed, or torque mode. The issuing method of speed limit command and speed command is identical. The command source can be the external analog voltage or internal parameters ID125...ID127 (P1.009...P1.011).

Speed limit is applicable only in torque mode (T) for controlling the motor's maximum speed. If using external analog voltage in torque mode, DI signals will be available and can be set to SPD0...SPD1 for motor speed limit selection (internal parameters). If not, users can use analog voltage input as the speed limit command. When parameter ID118 (P1.002) is set to 1, the speed limit function is enabled. See the following timing diagram.



Command source selection of speed limit

To set the speed limit, see the following diagram.



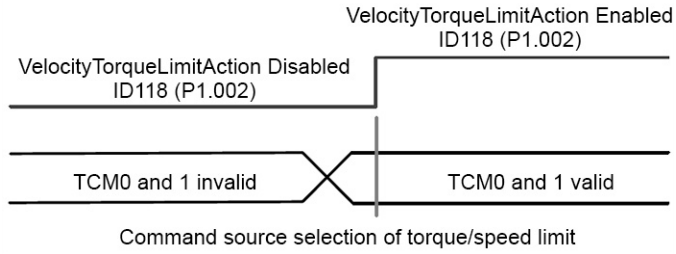
Apply Torque Limit

Table 105 - Relevant Parameters

Parameter	Name
ID118 (P1.002)	VelocityTorqueLimitAction
ID128 (P1.012)	PresetTorqueCmd_Limit_1
ID128 (P1.013)	PresetTorqueCmd_Limit_2
ID130 (P1.014)	PresetTorqueCmd_Limit_3

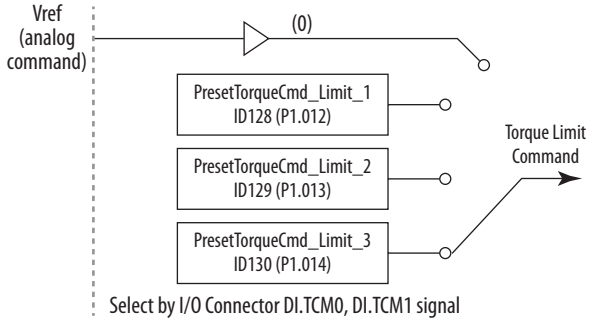
The issuing method of torque limit command and torque command are identical. The command source can be external analog voltage or internal parameters ID128…ID130 (P1.012…P1.014).

Torque limit can be used in position mode (PT, PR) or speed mode (S). It is used for limiting the motor torque output. When the command in position mode is issued by external pulse or the command in speed mode is issued by external analog voltage, DI signals are available and can be set to TCM0…TCM1 to determine the torque limit command (internal parameters). If not enough DI signal is available, torque limit command can be issued by analog voltage. When the parameter ID118 (P1.002) is set to 1, the torque limit function is enabled. See the timing diagram below.



Command source selection of torque/speed limit

To set the torque limit, see the following diagram.



Analog Monitoring

You can observe the needed voltage signal via analog monitoring. Two analog channels are provided by the servo drive and are located in terminals 15 and 16 of the I/O connector.

Table 106 - Relevant Parameters

Parameter	Name
ID103 (P0.003)	AOMonitorSelection
ID119 (P1.003)	EncoderOutputPolarity
ID120 (P1.004)	AnalogOutput1Scale
ID121 (P1.005)	AnalogOutput2Scale
ID290 (P4.020)	AnalogOuput1Offset
ID291 (P4.021)	AnalogOuput2Offset

For example:
To specify a motor speed of 1000 rpm to correspond to an analog output of 8V and a maximum speed of 5000 rpm, use the following equation:

$$\text{ID120 (1.004)} = \frac{\text{Required speed}}{\text{Max speed}} \times 100\% = \frac{1000\ \text{rpm}}{5000\ \text{rpm}} \times 100\% = 20\%$$

To acquire the corresponding voltage output for the current motor speed, use the following equations:

For a motor current speed of 300 rpm:

$$\text{MON1} = 8\text{V} \times \frac{\text{Current speed}}{\text{Max speed} \times \frac{\text{P1.004}}{100}} \times 100\% = 8\text{V} \times \frac{300\ \text{rpm}}{5000\ \text{rpm} \times \frac{20}{100}} \times 100\% = 2.4\text{V}$$

For a motor current speed of 900 rpm:

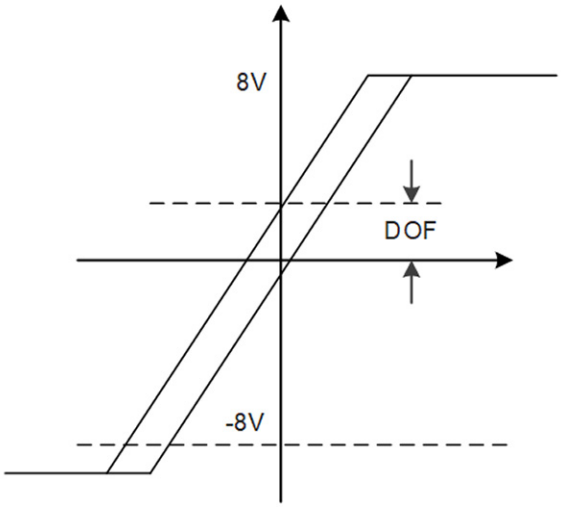
$$\text{MON1} = 8\text{V} \times \frac{\text{Current speed}}{\text{Max speed} \times \frac{\text{P1.004}}{100}} \times 100\% = 8\text{V} \times \frac{900\ \text{rpm}}{5000\ \text{rpm} \times \frac{20}{100}} \times 100\% = 7.2\text{V}$$

Voltage Drift

Table 107 - Relevant Parameters

Parameter	Name
ID290 (P4.020)	AnalogOuput1Offset
ID291 (P4.021)	AnalogOuput2Offset

When voltage drift occurs, the voltage level defined as zero voltage is different from the set zero point. To tackle this problem, DOF1 (ID290, P4.020) AnalogOutput1Offset and DOF2 (ID291, P4.021) AnalogOutput2Offset can be used to calibrate the offset voltage output.



Notes:

Motion Control in PR Mode

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Position Control Command	272
Jump Command	275
Write Command	276
Index Position Command	278
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PR Mode Setup in KNX5100C Software	282
Display of PR Procedure in KNX5100C Software	291
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This chapter provides information about how to use the PR mode. In this mode, motion commands are generated based on the internal register commands of the servo drive. Various motion commands are available, including Homing, Speed, Position, Jump, Write, Index Position, and Arithmetic operation. This chapter contains detailed description of each motion command.



For Kinetix® 5100 fault code descriptions and parameters, see Knowledgebase Technote: Kinetix 5100 Servo Drive Parameter Data and Fault Codes. You can download the spreadsheet from this public article.

You will be asked to log in to your Rockwell Automation web account or create an account if you do not have one. You do not need a support contract to access this article.

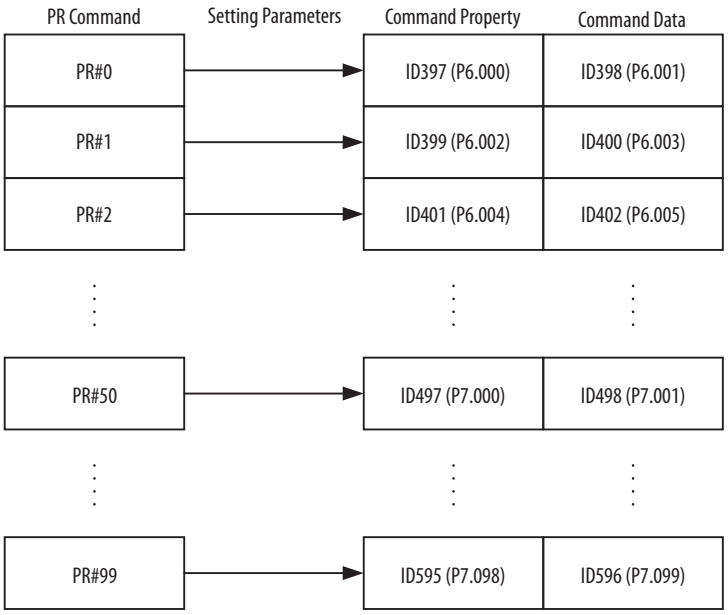
Detailed Operation in PR Mode

In PR mode, the internal registers of the servo drive generate motion commands. Except for the basic arithmetic operation commands, all settings are saved in the parameter file of the servo drive. Thus, changing parameter values changes the PR commands simultaneously. The drive provides 100 PR commands, which let you configure the following:

- homing method
- position command
- speed command
- jump command
- write command
- index positioning command
- arithmetic operation commands

With the exception of arithmetic operations, the properties and corresponding data of each PR command are set by parameters. For example, PR#1 is defined by two parameters, ID399 (P6.002) PRCmd1Setting and ID400 (P6.003) PRCmd1Data. ID399 (P6.002) is for specifying the properties of PR#1, such as the PR command type, and whether to interrupt or auto-execute the next PR. ID400 (P6.003) is subject to change based on the property set by ID399 (P6.002). If ID399 (P6.002) is set to a speed command, then ID400 (P6.003) is used to specify the target speed. If ID399 (P6.002) is set to a jump command, then ID400 (P6.003) specifies the target PR to jump to. For the remaining PR commands, the PRCmdXSetting and PRCmdXData parameters are grouped in pairs as shown in Figure 87.

Figure 87 - Setting Parameters for Each PR Command



PR Command Setting and Data Definitions

The Command setting defines the type of command (Speed, Position, Jump, Write, Index, Arithmetic/Statement).

- CMD is the position command selection.

  00: ABS, Absolute Position, CMD = DATA;

  01: REL, Relative Position, CMD = Current Position + DATA

  10: INC, Incremental Position, CMD = Previous CMD + DATA

  11: CAP, High Speed Position Capturing, CMD = Captured Position + DATA
- UNIT is the speed unit selection; 0 signifies 0.1 rpm and 1 signifies pulse per second (PPS).
- DIR sets the rotation direction

  00: Forward

  01: Backward

  10: Shortest distance

  11: Reserved
- ROM lets the drive write parameters to both RAM and EEPROM at the same time. This function can only write parameters.
- INS: executing this PR command interrupts the previous PR command.
- OVLP: allow overlapping of the next PR command. Overlapping is not allowed in Speed mode. When overlapping in Position mode, DLY has no function.
- AUTO: once current PR command is finished, automatically load the next command.
- DLY is the delay time index.
- SPD is the target speed index.
- ACC is the acceleration time index.
- DEC is the deceleration time index.

PR Command Setting

The PRCmd*X*Setting parameters define how the PR commands (PR#01…PR#99) function. ID399 (P6.002) PRCmd1Setting is described below, but the description applies to all PRCmd*X*Setting parameters.

Settings:

Format of this parameter: (High word h) DCBA: (Low word L) UZYX



A	SPD, Target speed index	**X**	TYPE, Command type
B	DLY, Delay time index	**Y**	OPT, Option
C	AUTO	**Z**	ACC, Acceleration time index
D	Reserved	**U**	DEC, Deceleration time index

Definitions are as follows:

- YX: option; command type

Y: OPT, Option				**X: TYPE, Command Type**
Bit 3	**Bit 2**	**Bit 1**	**Bit 0**	
-	UNIT	AUTO	INS	1: Constant speed control
CMD		OVLP	INS	2: Point-to-point command
				3: Point-to-point command (Proceed to the next command when completed)
-	-	-	INS	7: Jump to the specified PR command
-	ROM	AUTO	INS	8: Write to parameter or Data Array
DIR		OVLP	INS	A: Index position control
-	-	-	-	B: Statement / arithmetic operation

TYPE command type: when executing 1...3, it can be interrupted and stopped by DI.STP and software limits.

- UZ: DEC, deceleration time; ACC, acceleration time

U: DEC, Deceleration Time	**Z: ACC, Acceleration Time**	**Corresponding Parameter**	**Default Value (ms)**
0	0	ID312 (P5.020)	200
1	1	ID313 (P5.021)	300
2	2	ID314 (P5.022)	500
3	3	ID315 (P5.023)	600
4	4	ID316 (P5.024)	800
5	5	ID317 (P5.025)	900
6	6	ID318 (P5.026)	1000
7	7	ID319 (P5.027)	1200
8	8	ID320 (P5.028)	1500
9	9	ID321 (P5.029)	2000
10	10	ID322 (P5.030)	2500
11	11	ID323 (P5.031)	3000
12	12	ID324 (P5.032)	5000
13	13	ID325 (P5.033)	8000
14	14	ID326 (P5.034)	50
15	15	ID327 (P5.035)	30

- A: SPD, target speed index

A	Corresponding parameter	Default value (ms)
0	ID352 (P5.060)	20
1	ID353 (P5.061)	50
2	ID354 (P5.062)	100
3	ID355 (P5.063)	200
4	ID356 (P5.064)	300
5	ID357 (P5.065)	500
6	ID358 (P5.066)	600
7	ID359 (P5.067)	800
8	ID360 (P5.068)	1000
9	ID361 (P5.069)	1300
10	ID362 (P5.070)	1500
11	ID363 (P5.071)	1800
12	ID364 (P5.072)	2000
13	ID365 (P5.073)	2300
14	ID366 (P5.074)	2500
15	ID367 (P5.075)	3000

- B: DLY, delay time index

B	Corresponding parameter	Default value (ms)
0	ID332 (P5.040)	0
1	ID333 (P5.041)	100
2	ID334 (P5.042)	200
3	ID335 (P5.043)	400
4	ID336 (P5.044)	500
5	ID337 (P5.045)	800
6	ID338 (P5.046)	1000
7	ID339 (P5.047)	1500
8	ID340 (P5.048)	2000
9	ID341 (P5.049)	2500
10	ID342 (P5.050)	3000
11	ID343 (P5.051)	3500
12	ID344 (P5.052)	4000
13	ID345 (P5.053)	4500
14	ID346 (P5.054)	5000
15	ID347 (P5.055)	5500

- C: AUTO: once current PR command is finished, automatically load the next command. This function is only enabled when X = A indexing position control.

  Description of each bit:

Bit 2	AUTO	0: disable auto function 1: once current PR command is finished, automatically load the next command
Bit 0, Bit 1	Reserved	-

IMPORTANT The parameter format definition [C, A, U, Z] is different from the above table when the command type is [8]: write the specified parameter to the specified command, and [B]: statement / arithmetic operation. See Write Command on page 276 for more information.

PR Command Data Setting

The PRCmdXData parameters define either the target position of the related PR command or the target PR command for the jump command.

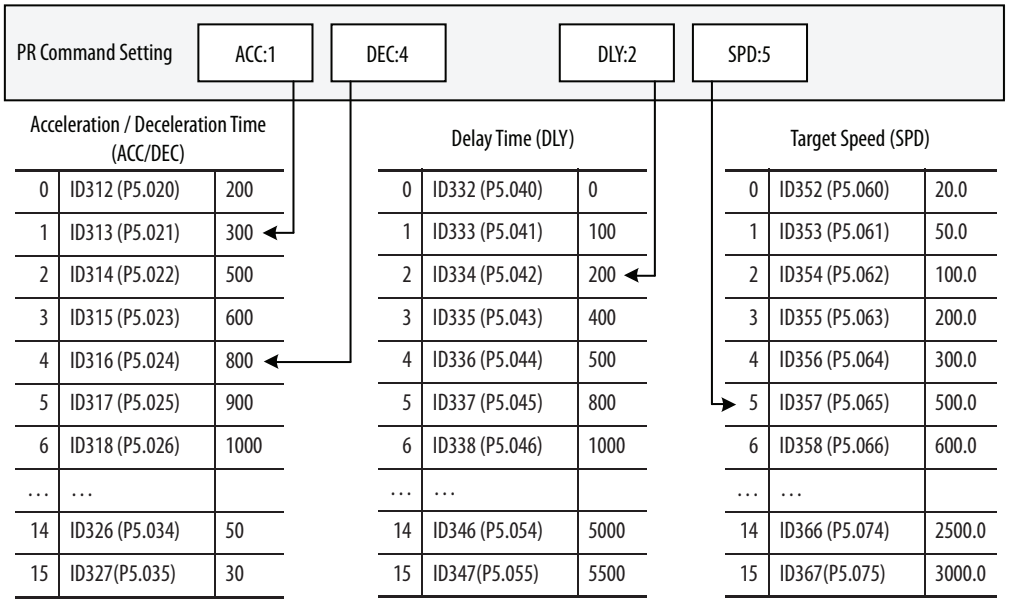
Shared PR Parameters

The drive provides 16 acceleration / deceleration time settings ID312 (P5.020)…ID327 (P5.035), 16 delay time settings ID332 (P5.040)…ID347 (P5.055), and 16 target speed settings ID352 (P5.060)…ID367 (P5.075) for users to set the PR commands as shown in Figure 88. If a given setting that is used by multiple PR commands is changed, then all PR commands applying this setting are changed as well.

ATTENTION: Damage to machine can occur. Changing a setting that is used by multiple PR commands will affect all PR commands using that setting.

For example, if multiple PR commands apply the target speed setting of ID352 (P5.060) PresetVelocity0, when value of ID352 (P5.060) is changed, those PR commands' target speed is also modified. In these data, the acceleration / deceleration time is set based on the duration for motor to accelerate from 0… 3000 rpm or decelerate from 3000 rpm to 0. For example, if acceleration time is set to 50 ms, when the target speed of motion command is 3000 rpm, then the required duration is 50 ms. If target speed of the motion command is 1500 rpm, then the acceleration time will be 25 ms. The acceleration / deceleration time is a fixed slope, and the slope does not change with the modification of target speed.

Figure 88 - Shared Parameter Data of PR Commands



See Speed and Time Settings on page 282 for information about configuring the speed and time settings for these shared parameters.

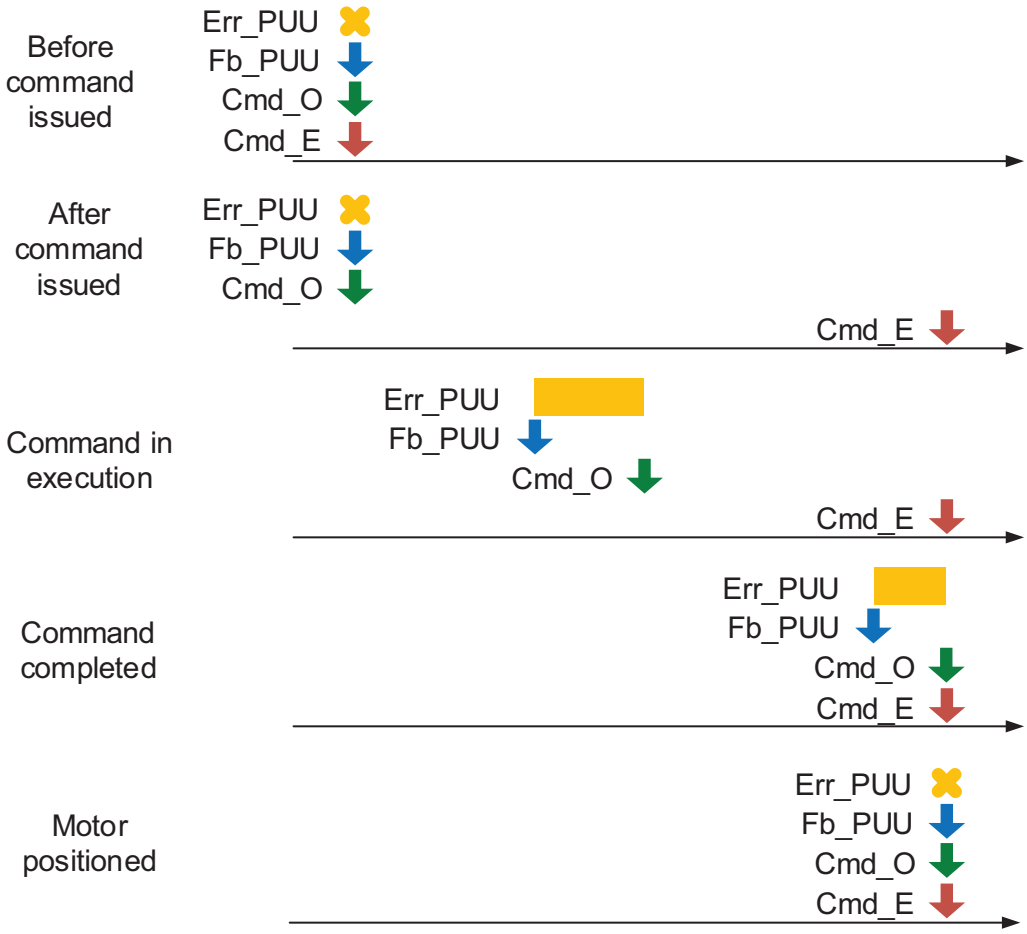
Monitoring Variables in PR Mode

PR mode provides the following four monitoring variables for servo command and feedback.

- Command position (PUU): monitoring variable code 001. The target position of the motion command generated per scan cycle during servo operation (updated every 1 ms), simplified as Cmd_O (Command Operation).
- PR command end register: monitoring variable code 064. The target position of the PR command, simplified as Cmd_E (Command End). When a command is triggered, the servo drive calculates the target position and then updates the PR command end register.
- Feedback position (PUU): monitoring variable code 000. The feedback position (coordinates) for the motor, simplified as Fb_PUU (Feedback PUU).
- Position error (PUU): monitoring variable code 002. The deviation between the command position (PUU) and the feedback position (PUU), simplified as Err_PUU (Error PUU).

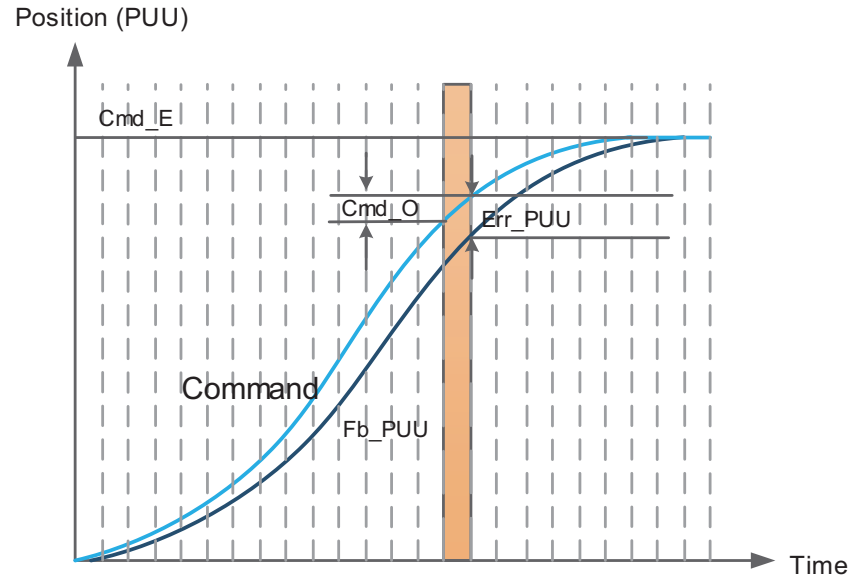
How these four monitoring variables work is shown in Figure 89. After the servo issues a Position command, the servo sets the position of Cmd_E once the target position data is acquired. The motor operates to the target position based on the PR command setting. Cmd_O calculates the amount of command deviation in each fixed cycle and sends it to the servo drive, where it is treated as a dynamic command. Fb_PUU is the motor feedback position and Err_PUU is the deviation of Cmd_O minus Fb_PUU.

Figure 89 - Timing Diagram of PR Mode Monitoring Variables



The detailed command behavior of each stage is illustrated in Figure 90. Cmd_E is the endpoint specified by the command; its setting is completed once the PR command is triggered. Fb_PUU is the feedback position, which is the motor actual position. For example, Cmd_O is the target of this command section and Err_PUU is the deviation between target position and feedback position.

Figure 90 - Monitoring Variables' Status When Executing a Command IN PR Mode



Use digital input (DI) and digital output (DO) signals to monitor PR commands as shown in Figure 91. When the motion command is triggered by DI.CTRG [0x08], the servo drive operates based on the command from the internal register. Once the execution is completed, DO.Cmd_OK [0x15] turns on. And when motor reaches its target position range, which is set by ID159 (P1.054) InPositionWindow, DO.TPOS [0x05] is on. Once the PR position command completes and the motor reaches the target position, both DO signals are on and the servo drives outputs the MC_OK [0x17] signal to signify that this PR command is completed.

Figure 91 - Operation of DI and DO Signals in PR Mode

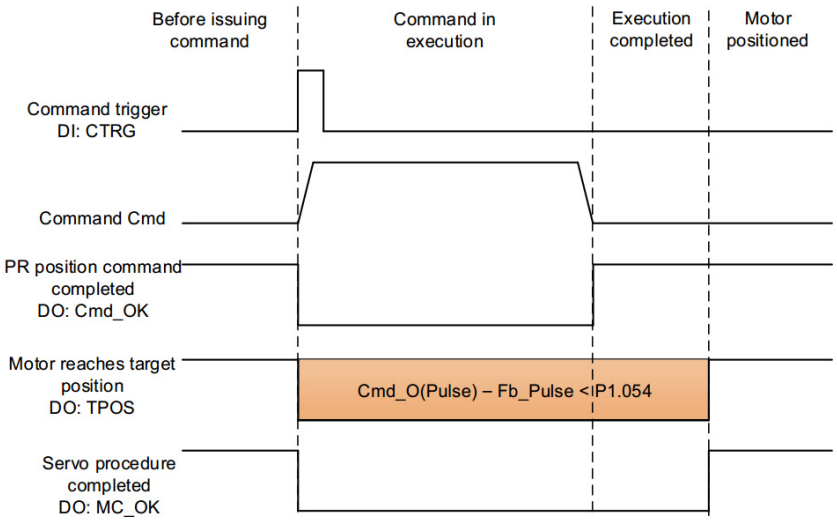
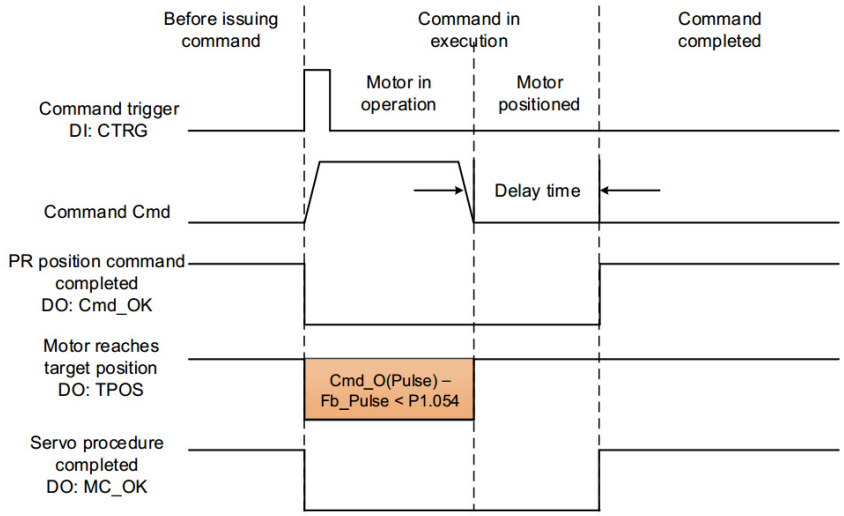


Figure 92 - Operation of DI and DO Signals in PR Mode(including delay time)



See Description of System Variable Monitoring on page 414 for more information.

Homing

The drive provides 11 homing methods in PR mode. They include home sensor, limit, or collision point and come with sub-selections such as whether to refer to Z pulse and limit signal as the trigger. Homing method is specified by ID297 (P5.004) HomingMode and the homing definition is determined by ID397 (P6.000) HomingSetting.

Setting Homing Mode ID297 (P5.004)

Settings:



X	Homing method	**Z**	Limit setting
Y	Z pulse setting	**U**	Reserved

Definition of each setting value:

Z	Y	X
Limit setting	**Z pulse setting**	**Homing method**
-	Y = 0: return to Z pulse Y = 1: go forward to Z pulse Y = 2: do not look for Z pulse	X = 0: homing in forward direction and define PL as homing origin
		X = 1: homing in reverse direction and define NL as homing origin
When encounter limit: Z = 0: show error Z = 1: reverse direction		X = 2: homing in forward direction, ORG: OFF→ON as homing origin
		X = 3: homing in reverse direction, ORG: OFF→ON as homing origin
	-	X = 4: look for Z pulse in forward direction and define it as homing origin
		X = 5: look for Z pulse in reverse direction and define it as homing origin
	Y = 0: return to Z pulse Y = 1: go forward to Z pulse Y = 2: do not look for Z pulse	X = 6: homing in forward direction, ORG: ON→OFF as homing origin
		X = 7: homing in reverse direction, ORG: ON→OFF as homing origin
-	-	X = 8: define current position as the origin
	Y = 0: return to Z pulse Y = 2: do not look for Z pulse	X = 9: look for the collision point in forward direction and define it as the origin
		X = A: look for the collision point in reverse direction and define it as the origin

Configuring Homing Setting ID397 (P6.000)

Settings:



A	DEC2: deceleration time selection of second homing	**YX**	CMD: command type
B	DLY: select 0...F for delay time	**Z**	ACC: select 0...F for acceleration time
C	N/A	**U**	DEC1: deceleration time selection of first homing
D	BOOT	**-**	-

- YX: CMD: command type

  0x0: Stop: homing complete and stop.

  0x1...0x63: Auto: homing complete and execute the specified PR command (PR#01...PR#99).
- Z: ACC: select 0...F for acceleration time

  0...F: corresponds to ID312 (P5.020)...ID327 (P5.035)

- U: DEC1: deceleration time selection of first homing

  0...F: corresponds to ID312 (P5.020)...ID327 (P5.035)
- A: DEC2: deceleration time selection of second homing

  0...F: corresponds to ID312 (P5.020)...ID327 (P5.035)
- B: DLY: select 0...F for delay time

  0...F: corresponds to ID332 (P5.040)...ID347 (P5.055)
- D: BOOT: when the drive is powered on, whether to search for the origin.

  0: do not execute homing
- 1: execute homing automatically (servo switches to Servo On status for the first time after applying power)

Note:

1. After the origin is found (sensor or Z), it has to decelerate to a stop. The stop position exceeds the origin by a short distance:

   If returning to the origin is not needed, set CMD to 0;

   If returning to the origin is needed, set CMD to a non-zero value and set PABS = ORG_DEF.

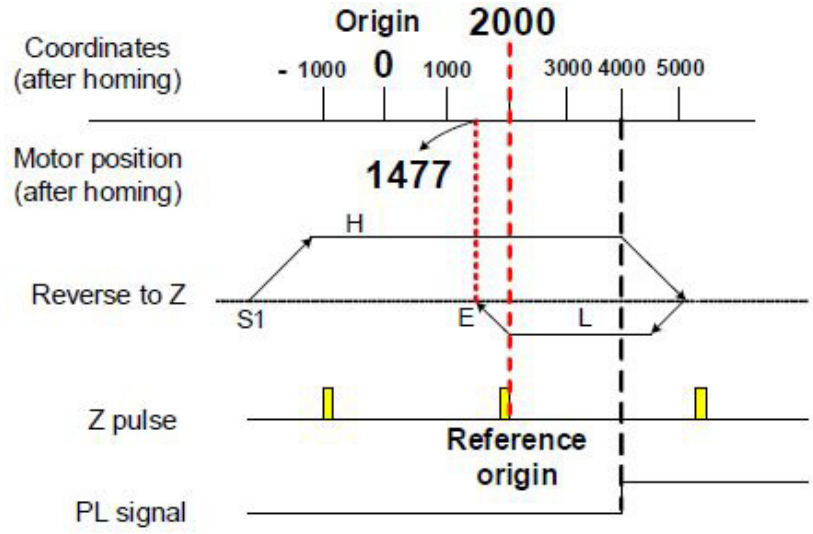
   Example:

   0x0001 to execute PR#01 automatically upon the completion of homing.

   Set PR#01 to run absolute position to 0 (ID399(P6.002)=0x0002, ID400(P6.003)=0x0000).
2. If the origin is found (sensor or Z), and you want it to move an offset S and define the coordinate as P after moving, then CMD = non-zero and set ORG_DEF = P - S, and this absolute Position command = P.

The PR Homing mode includes the function for setting the origin offset. You can define any point on the coordinate axis as the reference origin, which does not have to be 0. Once you define the reference origin, the system can create the coordinate system for the motion axis. See Figure 93. The coordinate for the reference origin is 2000 (P6.001 = 2000). The motor passes by the reference origin and then stops at coordinate 1477. From the coordinate system that it created, the system automatically calculates the position of the 0 point. As soon as the PR motion command is issued, the motor moves to the specified position.

Figure 93 - Reference Origin

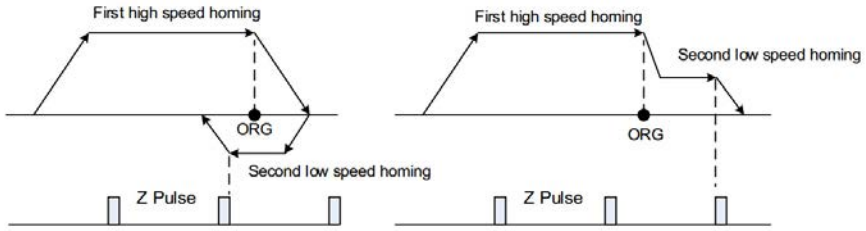


Origin and Speed Settings for Homing

Parameter ID398 (P6.001) HomePosition defines the origin. The range is -2147483648...2147483647.

The homing procedure goes through two stages: high speed and low speed. Homing starts in high speed, seeking the reference point (such as the limit switch and ORG signal). Once the servo detects the reference point, the motor runs at low speed to find the reference point accurately (such as the Z pulse). The speeds for the two stages are defined by ID298 (P5.005) HomingSpeed and ID299 (P5.006) HomingCreepSpeed.

Figure 94 - Speed Settings for Homing



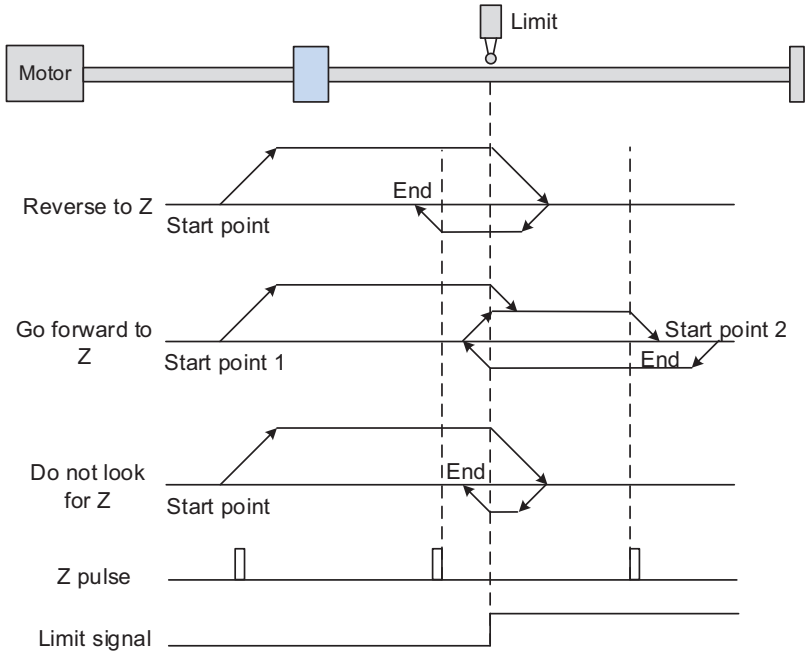
Operation of Homing Types

The following describes the homing methods supported by the drive. They can be categorized into six types based on their reference points.

Referencing the Limit

This homing method uses the positive or negative limit as the reference point. When the limit is detected, you can choose to look for the Z pulse and use it as the homing reference point. Changing the starting position does not change the searching result. The drive always looks for the setting reference point to correctly reset the coordinates.

Figure 95 - Positive or Negative Limit as Reference Point



In the Figure 95 example (looking for the Z pulse), the servo motor operates at high speed (first speed value) and then decelerates once it reaches the limit (rising-edge triggers the signal). Then the motor switches to low speed (second speed value) to look for the Z pulse. When the motor finds the Z pulse, it decelerates and stops, completing the homing procedure.

If you set the motor to look for the Z pulse and the limit signal remains un-triggered (low, Start point 1), the servo motor operates at high speed (first speed setting) and then decelerates once it reaches the limit (rising-edge triggers the signal). Then the motor switches to low speed (second speed setting) to look for the Z pulse. When the motor finds the Z pulse, it decelerates and stops, completing the homing procedure. If the setting is to look for the Z pulse and the limit signal is triggered (high, Start point 2), the servo motor returns to look for the rising-edge trigger signal at low speed (second speed setting). Once it is found, the servo motor starts to look for the Z pulse and decelerates to stop when it finds the Z pulse, completing the homing. In conclusion, the origin is at the same position after homing with the same condition regardless of the location of the starting point.

If you set the motor to not look for the Z pulse, the servo motor first operates at high speed (first speed setting) and then decelerates to a stop once rising-edge limit signal is triggered. Then the motor changes to low speed (second speed setting) to look for rising-edge signal. Once it finds the rising-edge signal, the motor decelerates to a stop, completing the homing.

Referencing the Rising-edge Signal of the Home Sensor (ORG)

This method uses the rising-edge of the home sensor (ORG) signal as the reference point. You have the option of using the Z pulse as the reference point of the origin when the home sensor detects the signal.

Figure 96 - ORG Signal (rising edge) as Reference Point

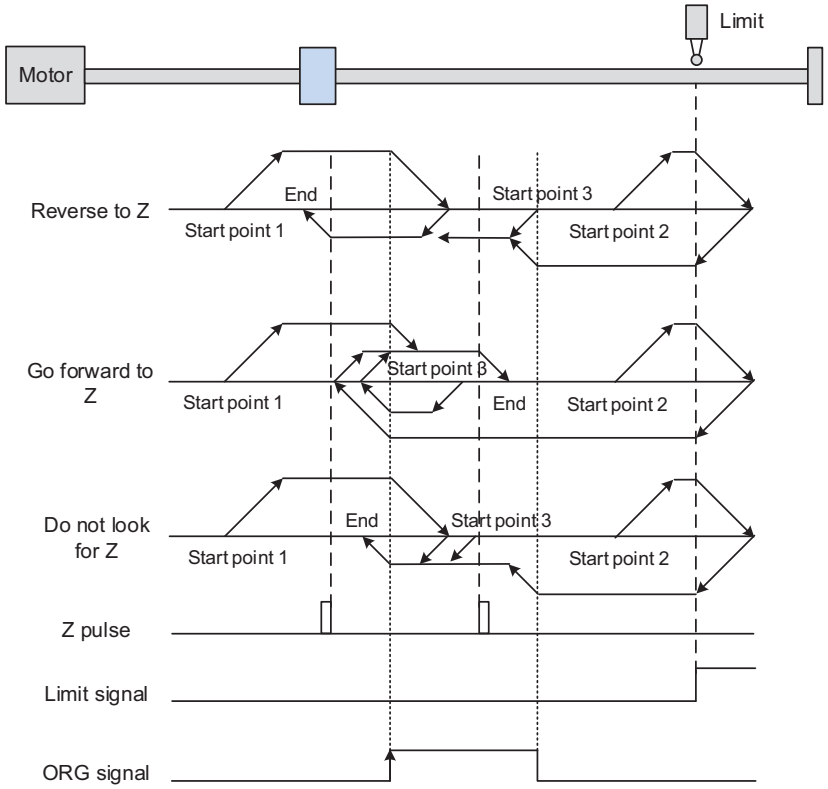


Figure 96 shows an example of reversing to look for the Z pulse. If the home sensor signal for the start position is un-triggered (low, Start point 1), the servo motor operates at high speed (first speed setting) until it reaches the rising-edge of ORG signal. Then it decelerates, switching to low speed (second speed setting) and reverses to look for the Z pulse. When the motor finds the Z pulse, it decelerates to a stop, completing the homing.

If the ORG signal at the start point is un-triggered and the current position is relatively closer to the limit switch (Start point 2), then the servo motor operates at high speed (first speed setting). You can choose whether to show an error or reverse the running direction when it reaches the limit switch. If you choose to reverse the rotation direction, the servo motor keeps rotating in reverse direction. Once the motor reaches the limit switch, it changes to low speed (second speed setting) and operates until the ORG signal switches to low. Next, it starts to look for the Z pulse. When the motor finds the Z pulse, it decelerates to a stop, completing the homing.

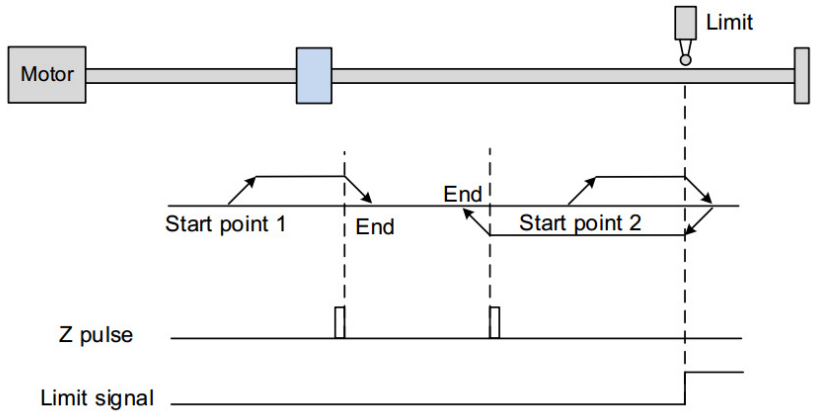
If the ORG signal is triggered (high, Start point 3), the motor reverses with low speed (second speed setting) and after the ORG signal switches to low, the motor returns to look for the Z pulse. Once the Z pulse is found, homing is complete.

If you set the servo motor to look for the Z pulse, or not to look for the Z pulse in the forward direction (this is similar to the first method mentioned above, (going in the reverse direction or not to look for the pulse Z).

Referencing the Z Pulse

This method uses the Z pulse as the reference origin. One Z pulse is generated per rotation of the motor. This method is only suitable when the operation is kept within one motor rotation.

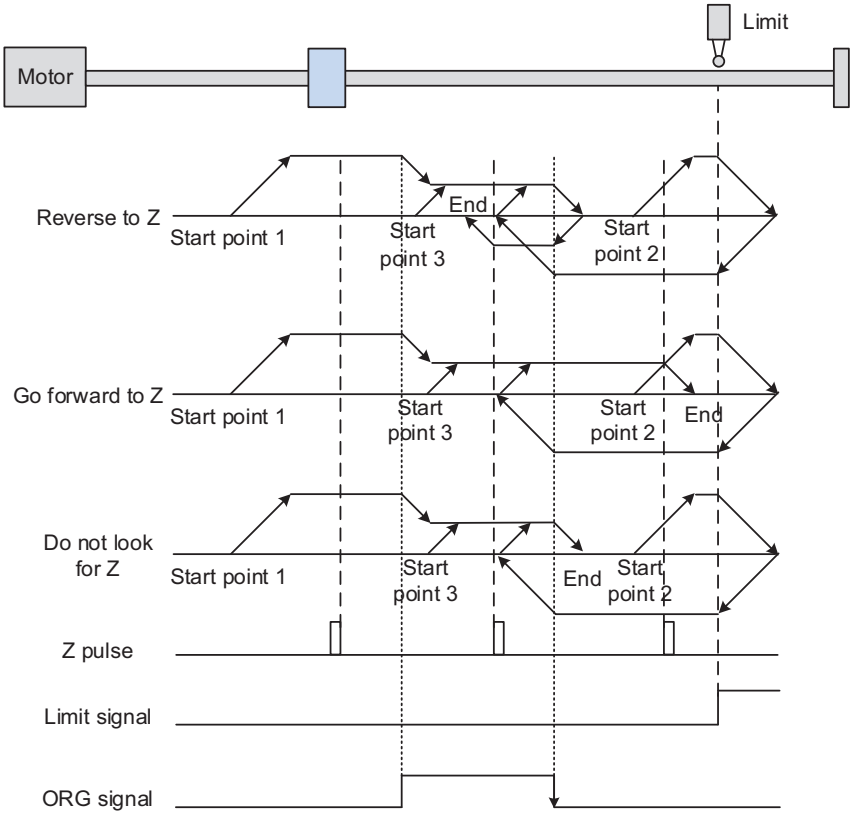
Figure 97 - Z Pulse as Reference Point



Referencing the falling-edge of the ORG signal.

This method uses the falling-edge signal of the home sensor as the reference origin. You can choose whether or not to use Z pulse as the reference origin after the ORG signal is detected.

Figure 98 - ORG Signal (falling edge) as Reference Point



If ORG signal is un-triggered at the start point (low, Start point 1), the servo motor runs at high speed (first speed setting) until reaching the rising edge of the ORG signal. Then it decelerates and switches to low speed until the ORG signal is off (low). Next, it reverses to look for the Z pulse and decelerates to a stop once it finds the Z pulse, completing the homing.

If ORG signal is un-triggered at the start point and is closer to the limit switch (Start point 2), the motor runs at high speed (first speed setting). You can set whether to show an error or reverse the running direction when it reaches the limit switch. If you set it to reverse direction, the motor operates in reverse to reach the ORG signal. Once it reaches the ORG signal, it decelerates and runs at low speed (second speed setting) until it reaches the falling edge of ORG signal. Then it reverses to look for Z pulse. When found, the servo decelerates to a stop, completing the homing.

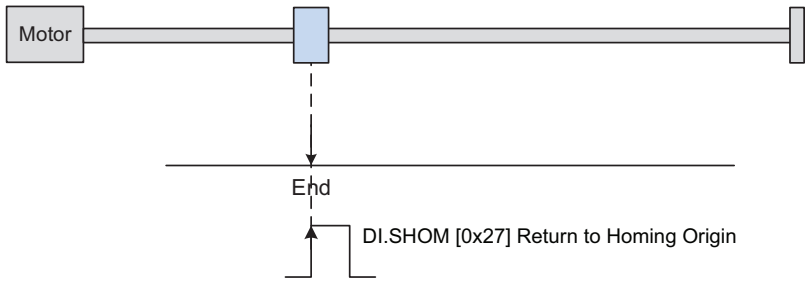
If the ORG signal is triggered at the start point (high, Start point 3), the servo motor operates at low speed (second speed setting) in the forward direction until the ORG signal switches to low. Finally, the motor reverses to look for the Z pulse and decelerates to a stop, completing the homing.

If you set it to look for the Z pulse or to not to look for the Z pulse in the forward direction, which is similar to the first setting mentioned previously (going in the reverse direction or not to look for the Z pulse).

Referencing the Current Position as the Origin

This method uses the current position of the motor as the reference origin. As long as the homing procedure is triggered and the motor remains still, then coordinate positioning is completed.

Figure 99 - Referencing Current Position as the Origin

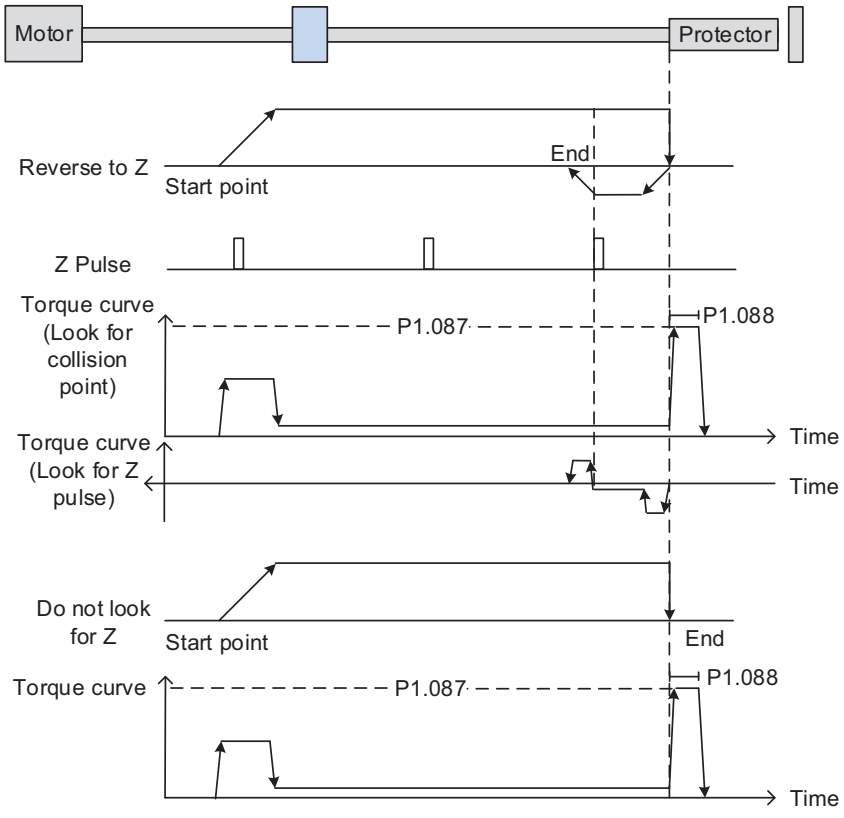


See Description of Digital Input Functions in Chapter 15 for details about the DI:SHOM signal.

Referencing the Torque Limit

This method uses the stop position of the motor as the origin by referring to: the limit on the mechanism, ID177 (P1.087)HomingCollisionTorqueLimit and ID178 (P1.088) HomingCollisionTorqueLimitTime. You can also choose whether to use the Z pulse as the origin.

Figure 100 - Torque Limit as Reference Point

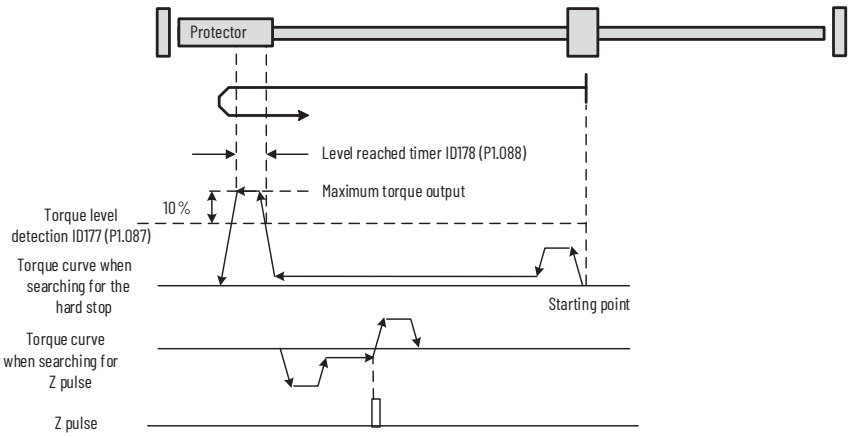


In Figure 100, which uses looking for the Z pulse, the motor runs at the high speed (first speed setting). Then the servo outputs a greater current to resist the external force once the motor touches the collision protector. When the motor torque reaches the set limit ID177 (P1.087) HomingCollisionTorqueLimit and the output duration is longer than the time setting ID178 (P1.088) HomingCollisionTorqueLimitTime, the motor runs in the reverse direction to look for the Z pulse at low speed (second speed setting). Once the motor finds the Z pulse, it decelerates to a stop, completing the homing.

If you set it not to look for the Z pulse, the servo motor runs at high speed (first speed setting) until it touches the collision protector. Then the servo outputs a greater current to resist the external force. When the motor torque reaches the set limit ID177 (P1.087) and the output duration is longer than the time setting ID178 (P1.088), the motor stop stops, completing the homing.

The Torque limit (setting range 1...300%) is only for Torque limit homing mode. As shown in Figure 101, when the homing command is triggered, the motor runs in one direction until it reaches the collision protector. After reaching the collision protector, the servo drive outputs a larger motor current to counter the external force from the collision protector. The servo drive uses the motor current and the Torque limit, ID178 (P1.088) time to determine homing, and then it runs in the opposite direction to find the Z pulse.The valid range for ID178 (P1.088) is 2...2000ms.

Figure 101 - Motor Actions After Homing Command is Triggered

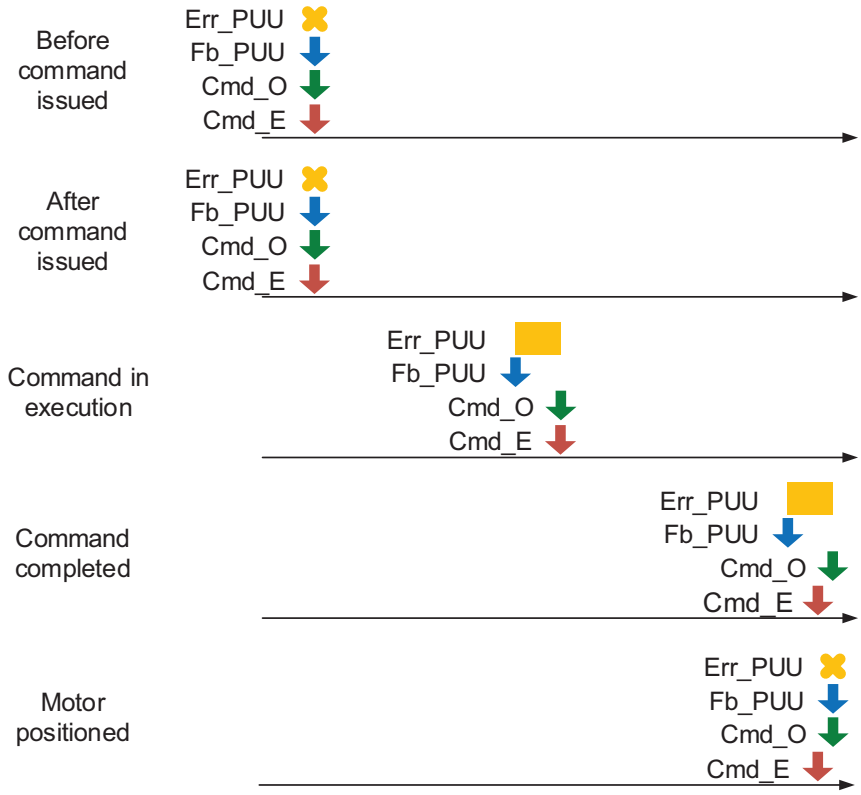


Use Monitoring Variables While Homing

PR mode provides four monitoring variables for you to monitor the servo commands and feedback status. These are Command position PUU (Cmd_O), PR command end register (Cmd_E), Feedback position PUU (Fb_PUU), and Position error PUU (Err_PUU). Before homing completes, the command end register (Cmd_E) cannot be calculated because the coordinate system can only be created after homing is completed, and the target position remains unknown after the Homing command is issued. This is why the status of each monitoring variables is different during homing. In the Homing command's default setting, the contents of Cmd_E and Cmd_O are identical. After it finds the reference origin in the coordinate system, it sets the content of Cmd_E to the coordinate of the reference origin. However, once it finds the reference origin, it still requires some distance for motor to decelerate to a stop. Meanwhile, Cmd_O continues to issue commands. If no other PR commands are issued after homing (other than the Position command), the contents of the final command position (Cmd_O) and command end position (Cmd_E) will be different. See Figure 102.

See Description of System Variable Monitoring on page 414 for more information.

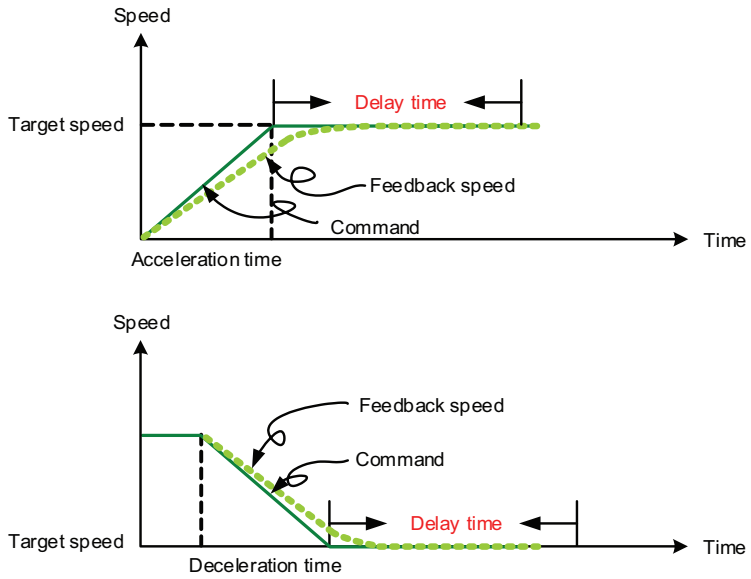
Figure 102 - Homing Mode and Monitoring Variables



Speed Control Command

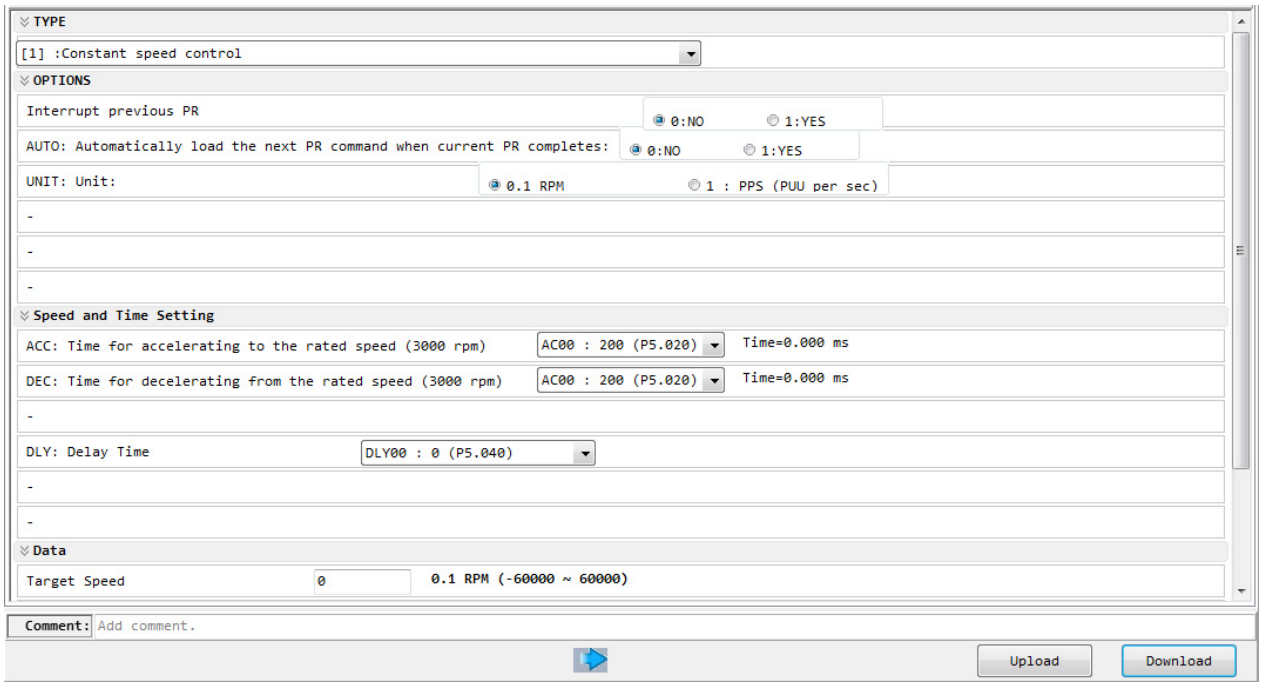
PR mode of the drive provides speed control function. The parameters available for PR mode with speed control are acceleration/deceleration time, delay time, and target speed.

Figure 103 - Parameter for PR Mode Speed Control



When configuring speed control, INS is an interrupt command which can interrupt the previous motion command. AUTO is the command for automatically loading the next PR command. It executes the next PR command immediately after the current command completes. In addition, the target speed can be set with two unit options, which are 0.1 rpm and 1 PPS ranging from -6000 rpm...6000 rpm. ACC/DEC acceleration/deceleration time are configured by shared PR parameters ID312 (P5.020)...ID327 (P5.035) AccelDecelTime*X*. The required duration for accelerating from 0 to the target speed is calculated and shown by the software. DLY is the delay time command that is determined by the shared PR parameters ID332 (P5.040)...ID347 (P5.055) PositionCompletedDelay*X*; it is used to delay the command. In other words, the delay time starts counting when the target speed is reached.

Figure 104 - PR Mode Speed Screen



Below are the functions of each bit when a speed command is applied using the ID339...ID595 (P6.002...P7.098) PRCmdXSetting.

PR parameters	D	C	B	A	U	Z	Y	X
Command type	-	-	DLY	-	DEC	ACC	OPT	1
Data Content	Target speed [0.1 rpm / PPS]							

Y OPT: option

BIT	3	2	1	0
Command type	-	UNIT	AUTO	INS

See PR Mode Setting on page 285, where you can configure the PR mode for speed and control in KNX5100C Software.

Position Control Command

Position control function is also available in PR mode of the drive. There are two command types: Mode 2 and Mode 3. Mode 2 command signifies that execution stops once the command is completed. Mode 3 command signifies that the next PR command is automatically executed. Their setting methods are identical.

When configuring position control, the X value determines the Mode. INS is the interrupt command, which interrupts the previous motion command. OVLP is the overlap command, which allows the next PR command to overlap the command that is currently being executed when decelerating. If this function is applied, setting the delay time to 0 is suggested. ACC / DEC is the acceleration/deceleration time configured by the shared PR parameters ID312 (P5.020)...ID327 (P5.035). The required duration to accelerate from 0 to the target speed is calculated and shown by the software. SPD is the target speed specified by the shared PR parameters ID352 (P5.060)...ID367 (P5.075). You can set whether it should times 0.1. DLY is the delay time specified by the shared PR parametersID332 (P5.040)...ID347 (P5.055). It is defined by the command. In other words, once the target position is reached, the delay time starts counting. The position command is user-defined and its unit is PUU.

See PR Command Setting on page 253 on for details on the PR commands.

Figure 105 - PR Mode Position Interface of the Configuration Software

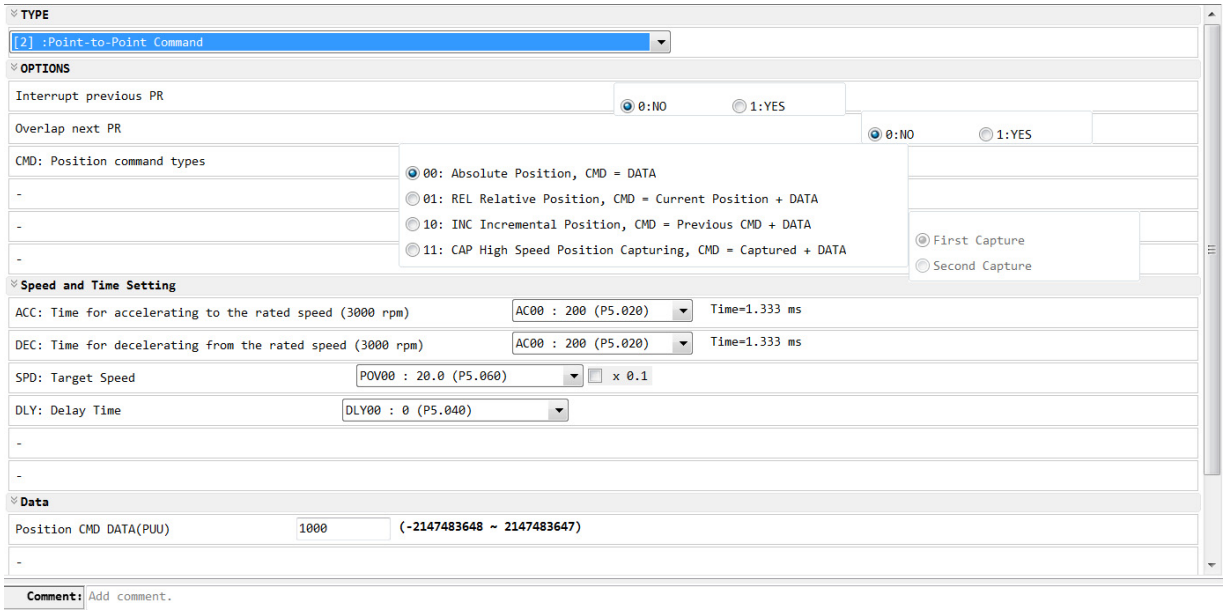
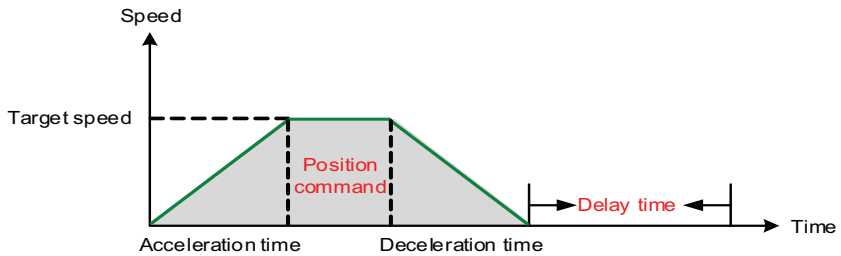


Figure 106 - Parameters for PR Mode Position Settings



Below are the functions of each bit when a position command is applied.

PR parameters	D	C	B	A	U	Z	Y	X
Command type	-	-	DLY	SPD	DEC	ACC	OPT	2 or 3
Data content	Target position [PUU]							

Note:

1. OPT: option

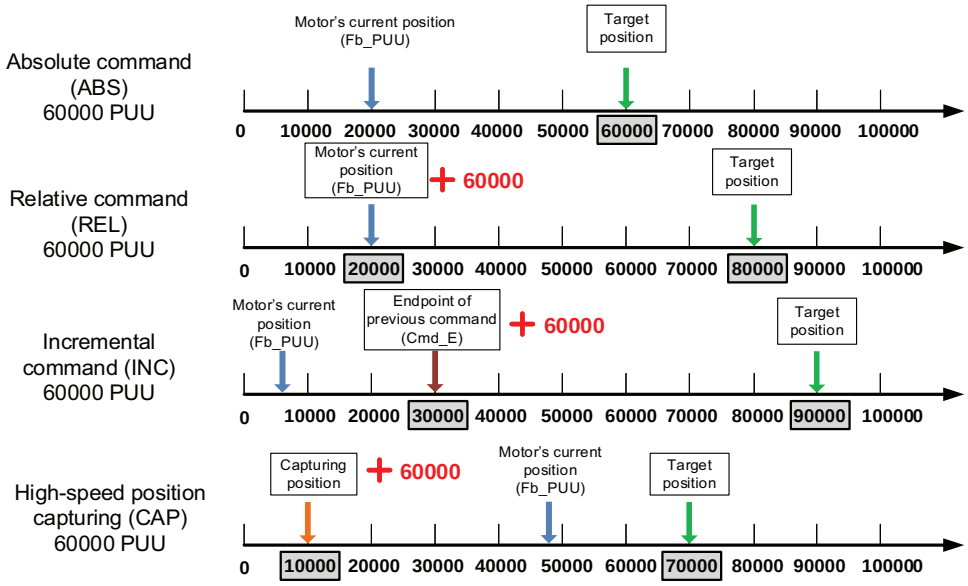
BIT	3	2	1	0	Description
Command type	CMD		OVLP	INS	-
Data content	0	0	-	-	ABS (absolute positioning)
	0	1			REL (relative positioning)
	1	0			INC (incremental positioning)
	1	1			CAP (high-speed position capturing)

Position Command Types

There are four types of position commands for the PR mode. You can choose the position command according to the application requirements. The functions of each type are described in the examples below. The condition in these examples is that a position command is still being executed and another type of command is inserted. To see how the position commands are combined, see Figure 107.

1. Absolute position command (ABS): when executed, the target position value equals the absolute command value. In Figure 107, an ABS command with the value of 60000 PUU is inserted in the previous PR command with setting target position of 60000 PUU on the coordinate axis.
2. Relative position command (REL): when executed, the target position value is the motor's current position value plus the position command value. In the figure, a REL command with the value on 60000 PUU is inserted in the previous PR command. The target position is the motor's current position (20000 PUU) plus the relative position command (60000 PUU), which equals 80000 PUU in the coordinate system. The target position specified by the original command is omitted.
3. Incremental command (INC): when executed, the target position is the previous target position value plus the current position command value. In the example below, an INC command with the value of 60000 PUU is inserted in the previous PR command. The target position is the previous target position value 30000 PUU plus the relative position command 60000 PUU, which equals 90000 PUU. The previous destination specified by the previous command is combined to define the new one.
4. High-speed position capturing command (CAP): when executed, the target position is the last position acquired by the Capture function plus the position command value. In the following example, a high-speed capturing command with the value of 60000 PUU is inserted in the previous PR command. The target position value is the captured position value of 10000 PUU plus the relative command of 60000 PUU, which equals 70000 PUU. The target position specified by the original command is omitted.

Figure 107 - Four Types of Position Command



See PR Mode Setup in KNX5100C Software on page 282, where you can configure the PR mode for one of two position control modes:

- Mode 2 = Point-to-Point Command
- Mode 3 = Point-to-Point Command (Proceed to next command when complete)

Jump Command

The drive provides a jump function in PR mode. It can call any PR commands or form PR commands into a loop, as shown in Figure 108. You can specify the PR command number to be jumped to by using PR mode setting screen in the configuration software. Among the options, INS stands for an interrupt command which interrupts the previous motion command. DLY is the delay time determined by shared PR parameters ID332...ID347 (P5.040...P5.055). Once a jump command is issued, the servo drive will start counting the delay time.

Figure 108 - Jump Command in PR Mode

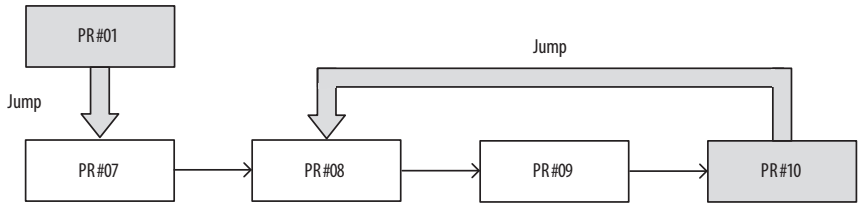
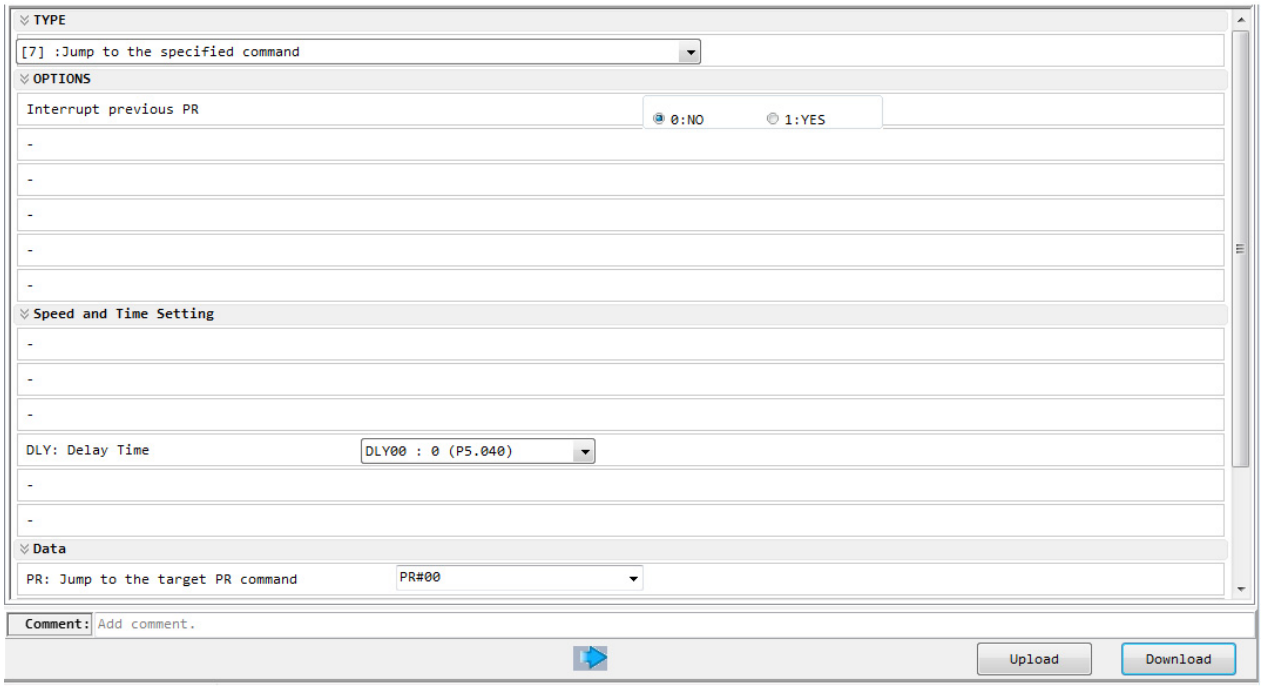


Figure 109 - Using PR Mode Jump Command



Below are the functions of each bit when a jump command is applied using the ID399...ID595 (P6.002...P7.098) PRCmdXSetting.

PR parameters	D	C	B	A	U	Z	Y	X
Command type	-	-	DLY	-	-	-	OPT	7
Data content	Jump to target PR command(0...99)							

Note:

1. Y: OPT: option

BIT	3	2	1	0
Command type	-	-	-	INS

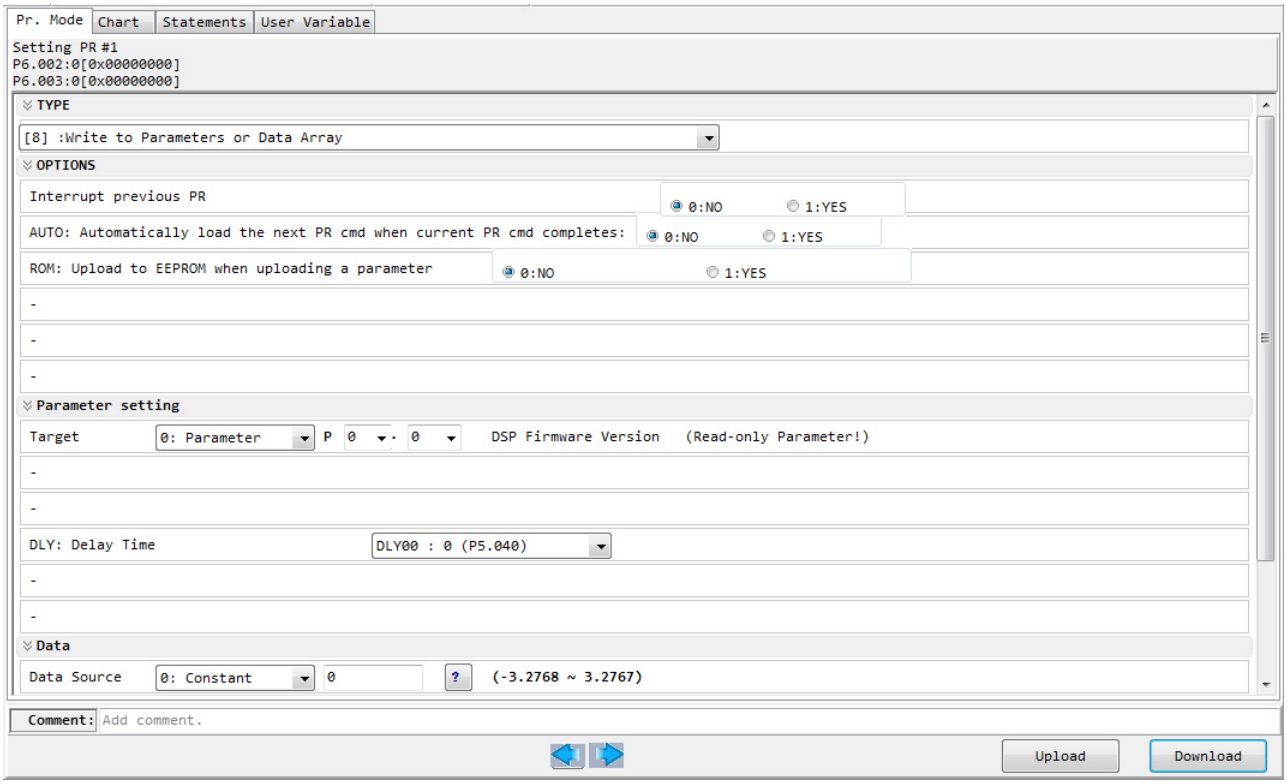
See PR Mode Setup in KNX5100C Software on page 282, where you can configure the PR Mode as Jump to specified command.

Write Command

The write command in PR mode can write constants, parameters, data arrays, and monitoring variables to the specified parameters or data arrays. Users can write the parameter by using the PR mode setting screen of the configuration software. INS is an interrupt command, which can interrupt the previous motion command. AUTO command signifies that the next PR will be loaded automatically; once current PR completes, the next one will be automatically executed. The ROM command lets the drive write parameters to both RAM and EEPROM at the same time. However, frequent usage will shorten the life of EEPROM. DLY is the delay time selected by shared PR parameters ID332...ID347 (P5.040...P5.055). Once a jump command is issued, the servo drive will start calculating the delay time. The table below shows the bit function when a write command is used.

Writing Target	Data Source
Parameter	Constant
Data array	Parameter
-	Data array
-	Monitoring variables

Figure 110 - Using PR Write Command



Below are the functions of each bit when a write command is applied using the ID399...ID595 (P6.002...P7.098)PRCmdXSetting.

PR parameters	D	C	B	A	U	Z	Y	X
Command type	0	SOUR_DEST	DLY	DESTINATION			OPT	8
Data content	SOURCE							

Note:

1. Y: OPT: option

BIT	3	2	1	0
Command type	-	ROM	AUTO	INS

2. C: SOUR_DEST: data source and data format to be written.

BIT	3	2	1	0	Description	
Command type	SOUR		-	DEST	Data source	Writing target
Data content	0	0	0	0	Constant	Parameter
	0	1		0	Parameter	Parameter
	1	0		0	Data array	Parameter
	1	1		0	Monitoring variable	Parameter
	0	0		1	Constant	Data array
	0	1		1	Parameter	Data array
	1	0		1	Data array	Data array
	1	1		1	Monitoring variable	Data array

3. Z,U,A: DESTINATION: destination

	A	U	Z
Target: Parameter	Parameter group	Parameter number	
Target: Data array	Data array number		

4. SOURCE: data source setting

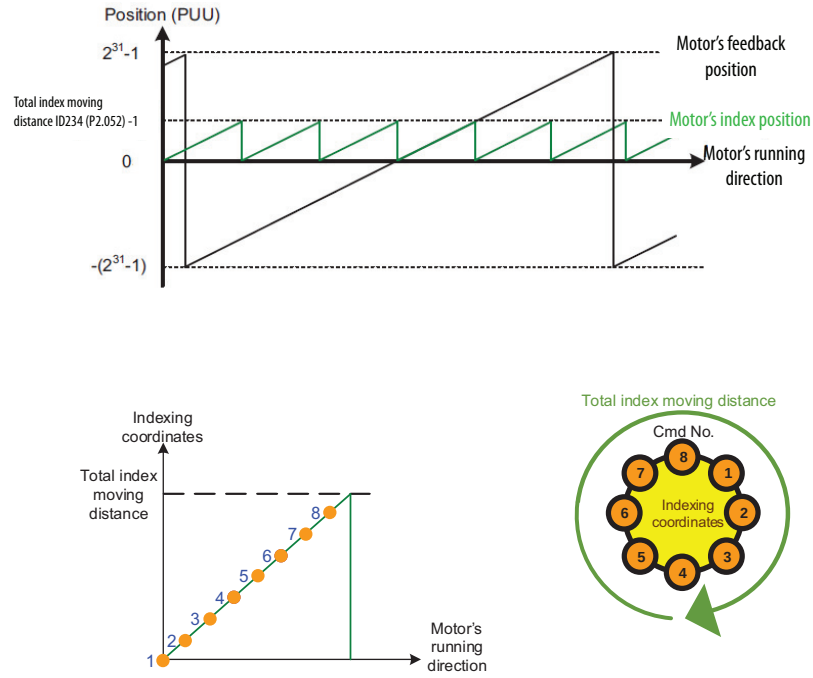
	D	C	B	A	U	Z	Y	X
Data source: Constant	Constant data							
Data source: Parameter	-					Parameter group	Parameter number	
Data source: Data array	-					Data array number		
Data source: Monitoring variable	-						Monitoring variable number	

See PR Mode Setup in KNX5100C Software on page 282 to configure the PR Mode as Write to Parameters or Data Array.

Index Position Command

PR mode also provides an index position command, which creates an index coordinate system. Unlike the feedback position in global coordinate system, the index position command positions the motor within the range of indexing coordinate. Using the index coordinate system, users are able to divide a total moving distance into several equal moving distances.

Figure 111 - PR Mode Indexing Coordinates



ID234 (P2.052) IndexingCoordinatesScale sets the scale of the indexing coordinates, indexing command position, and indexing feedback position. If the value is too small, it can cause errors in the indexing coordinates. The ranges of values for ID234 (P2.052) are:

P2.052 > (PM.004 * P1.045 / P1.044) * (PM.032 / 60) * (1 / 1000) * 1.05

P2.052 > (PM.004 * P1.045 / P1.044) * PM.032 / 57142

Where 1/1000 means 1μs (position update time), 1.05 is a safe factor for calculation.

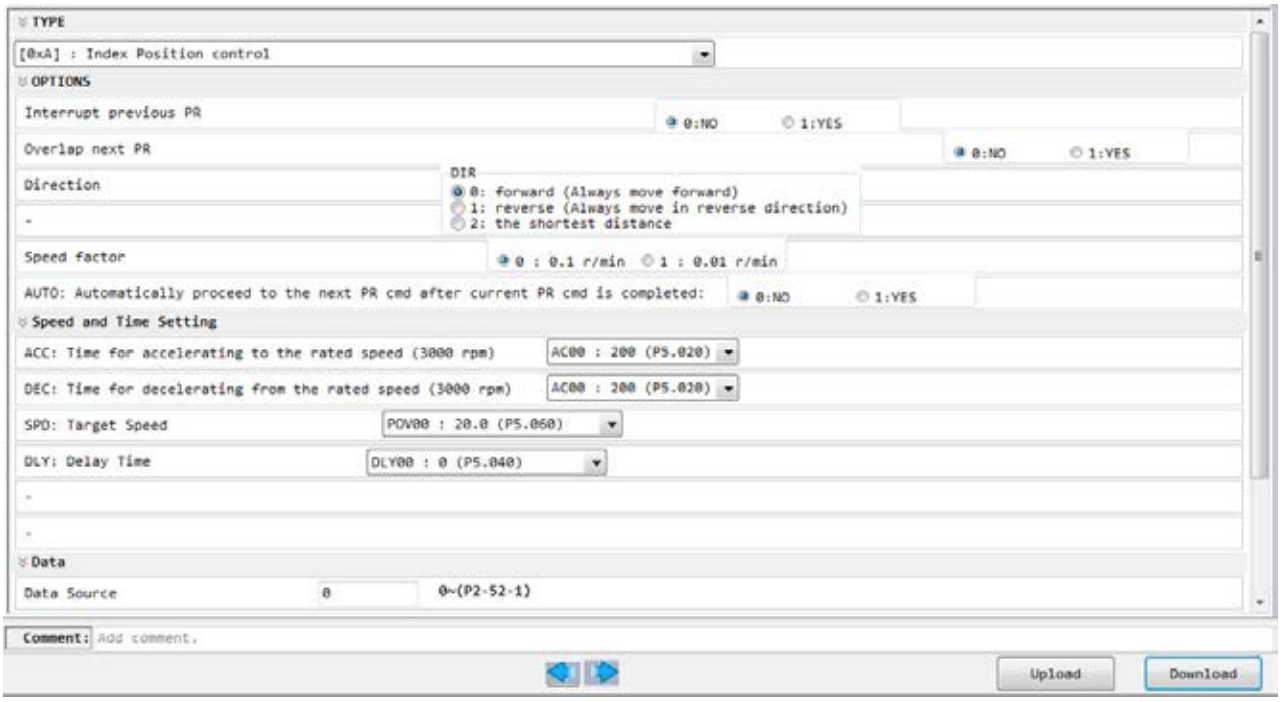
Table 108 - Relevant Parameters

Parameter	Name
ID8 (PM.032)	MotorMaxSpeed
ID151 (P1.044)	GearRatioslaveCountsN1
ID152 (P1.045)	GearRatioMasterCounts
ID234 (P2.052)	IndexingCoordinatesScale
ID600 (PM.004)	EncoderResolution

If using the index function, execute homing to create the coordinate system. Then the origin of the motor's feedback position and that of the motor's index position can be identical. If homing is not executed, E 237 (Indexing mode cannot start) occurs.

Among the options, INS is the interrupt command, which interrupts the previous motion command. OVLP is the overlap command, which allows the next PR command to overlap the current one during deceleration. If this OVLP is used, setting the delay time to 0 is suggested. DIR sets the rotation direction with options of forward (always runs forward), backward (always runs backward), and shortest distance. S_LOW is the speed unit with available options of 0.1 rpm or 0.01 rpm. The option AUTO automatically loads the next PR command. When current PR command completes, the next PR command will be auto-executed. ACC / DEC is the acceleration / deceleration time setting determined by shared PR parameters ID312...ID327(P5.020... P5.035). SPD is the target speed set by the PR shared parameters ID352...ID367 (P5.060...P5.075). DLY is the delay time. When motor reaches the target position, the servo drive will start counting the delay time. Position command is the target position of each index segment.

Figure 112 - PR Mode Index Position Screen



Below are the functions of each bit when a index command is applied using the ID339...ID595 (P6.002...P7.098) PRCmdXSetting.

PR parameters	D	C	B	A	U	Z	Y	X
Command type	-	OPT2	DLY	SPD	DEC	ACC	OPT	0xA
Data content	Index Position command [PUU](0 – P2.052-1)							

Note:

1. Y: OPT: option

BIT	3	2	1	0	Description
Command type	DIR		OVLP	INS	-
Data content	0	0	-	-	Always goes forward (Forward)
	0	1			Always goes backward (Backward)
	1	0			Shortest distance
	1	1			-

2. C: OPT2: Option 2

BIT	3	2	1	0
Command type	-	AUTO	-	S_LOW

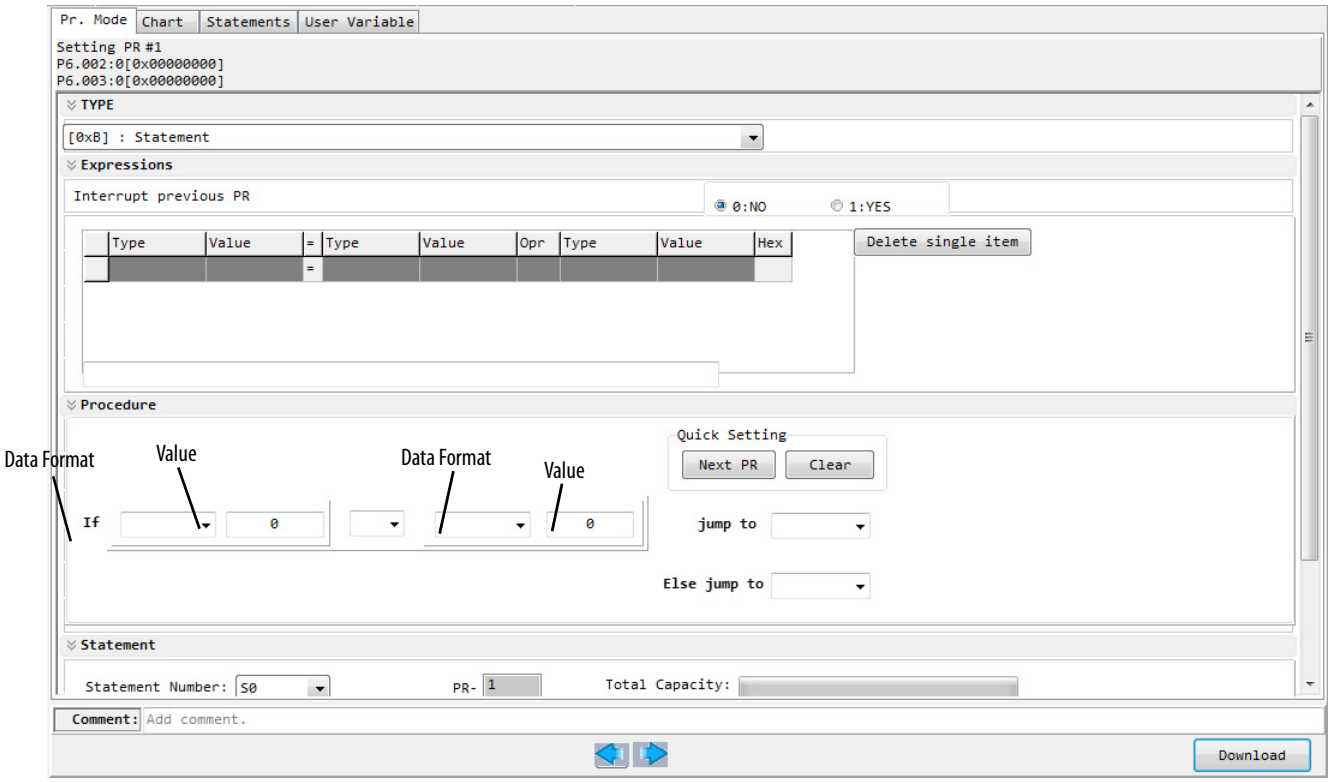
See Index Coordinates Settings Wizard on page 287 for Index position control and use the Index Coordinates Setting Wizard.

Arithmetic Operations Commands

In PR mode, the drive provides arithmetic operations commands, including addition, subtraction, multiplication, division, OR, AND, MOD, and logic condition. Available operands are user variable, parameter, data array, monitoring variable, and constant. Among them, a user variable is the register only for four arithmetic operations. It is user-defined, offering 64 sets of user variables with each data size of 32 bits. And data size of each constant is also 32-bit. After all arithmetic operation commands are executed, you can set a jump condition in the PR command so that it jumps to different PR command and then carry on the next one or stop once operation is done and it can also serve as a loop function. The arithmetic operation commands support negative numbers operations but not floating points. Negative numbers are calculated by Two's compliment.

Arithmetic operations must be set via the Arithmetic Operations dialog box in KNX5100C software. See Arithmetic Operations in KNX5100C Software on page 288. To avoid error occurrences, do not use the panel or a Message instruction to do the setting.

Figure 113 - PR Arithmetic Operations Screen



PR Mode Setup in KNX5100C Software

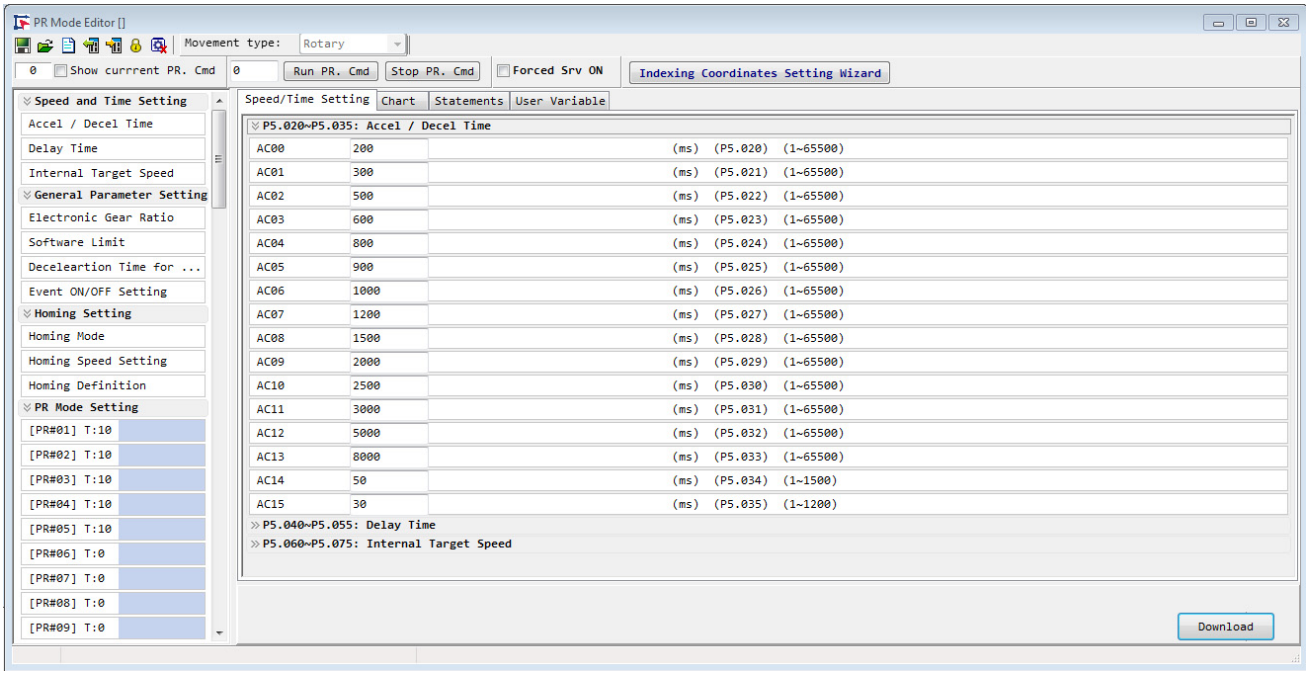
This function provides a quick and easy way to set all the relevant parameters in PR mode. Choose PR Mode Editor from the Function List to configure the following: Speed and Time Settings, General Parameter Settings, Homing Settings, and PR Mode Settings for the PR commands.

Speed and Time Settings

You can use KNX5100C software to configure the shared PR parameters for these Speed and Time Settings:

- Accel/Decel Time (shown in Figure 114)
- Delay Time
- Internal Target Speed

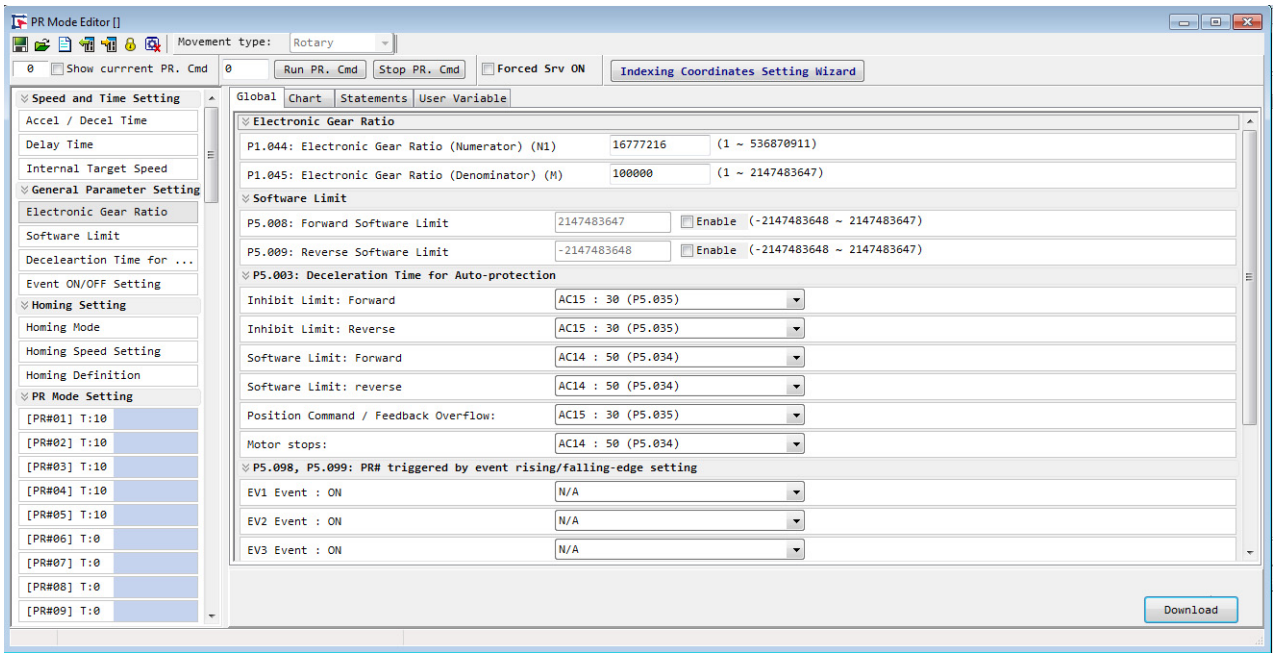
Figure 114 - Speed/Time Setting Tab



General Parameter Settings

You can set the general parameters, such as electronic gear ratio, software limit, Deceleration time, and Event On/Off. See Configure E-gear Ratio on page 150, Configure Limits on page 153, and Event Trigger on page 298 for more information.

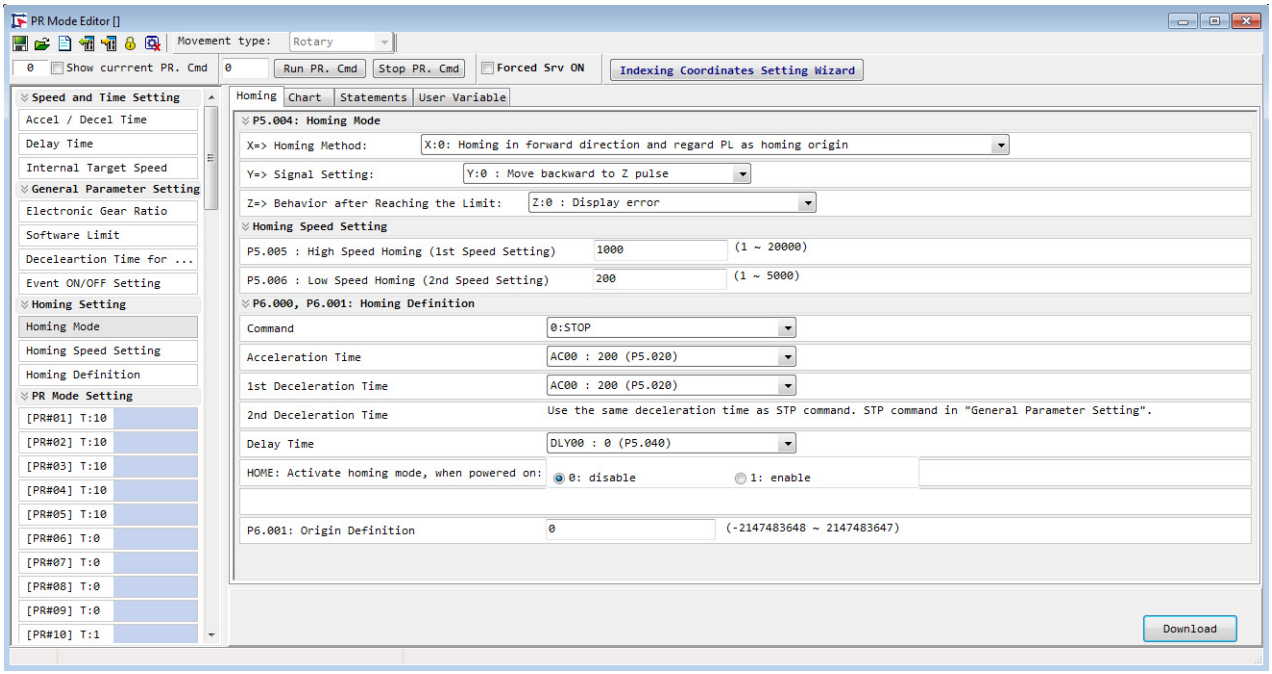
Figure 115 - General Parameter Settings



Homing Setting

The Homing tab lets you configure the Homing mode, speed settings, and Homing Definition parameters. See Homing on page 260 for more information.

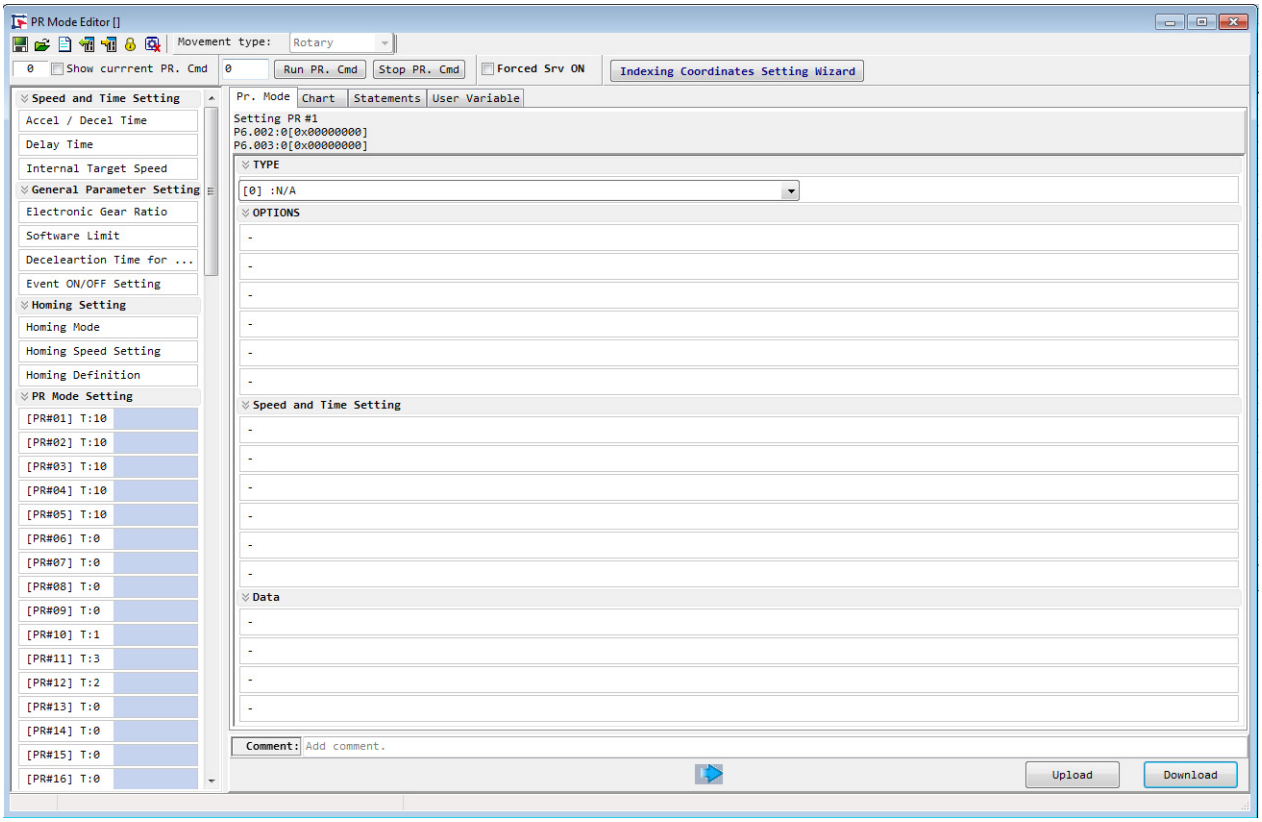
Figure 116 - Homing Tab



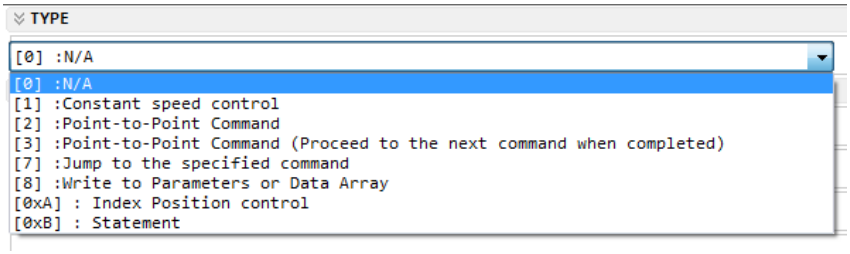
PR Mode Setting

PR Mode Setting part of the dialog lets you configure the PR commands.

Figure 117 - PR Mode Tab



The Type menu lets you select the PR command type and corresponds to the X value in the PRCmdXSetting parameters, for example ID399 (P6.002) PRCmd1Setting



X:TYPE, Command Type
1: Constant speed control
2: Point-to-point command
3: Point-to-point command (Proceed to the next command when completed)
7: Jump to the specified PR command
8: Write to parameter or Data Array.
A: Index position control
B: Statement / arithmetic operation

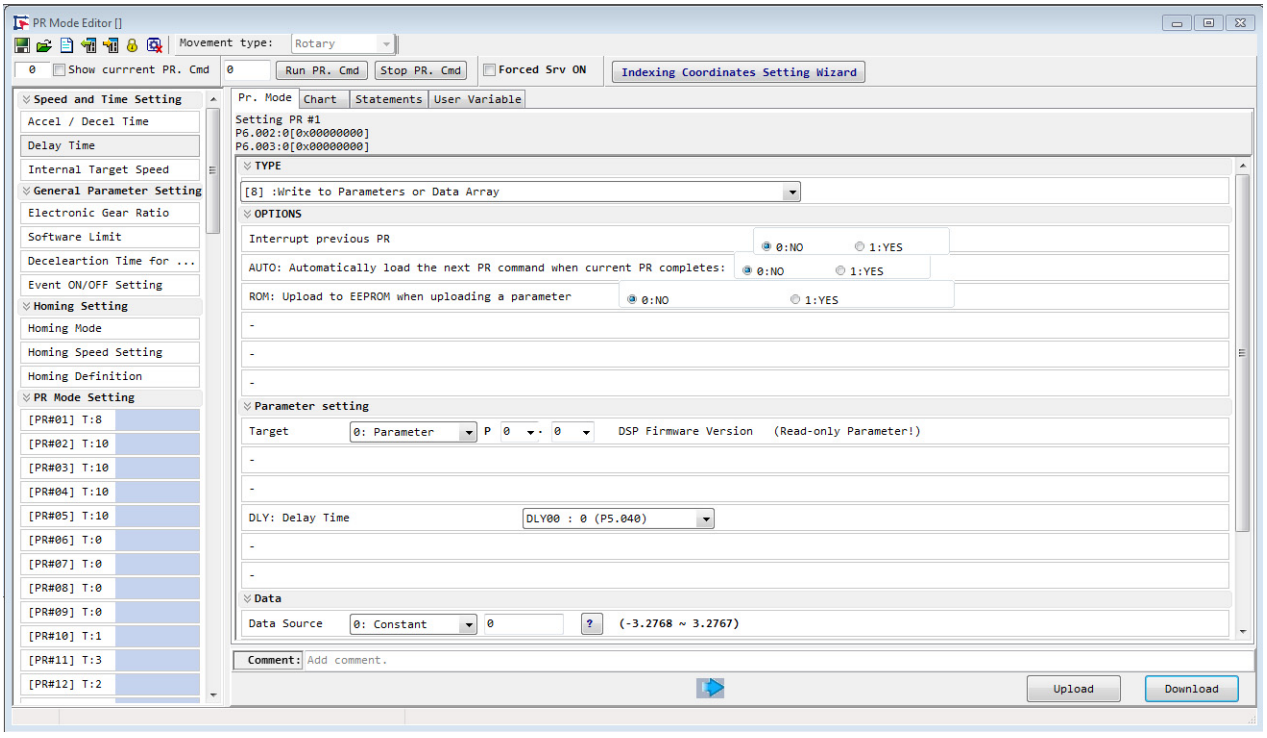
Each command type, except for (B) Arithmetic/Statement, let you configure the Options and the Speed and Time Setting for the PR command. The options differ depending on the command type. These settings correspond to the Y, A, U, A, B, and C values of the PRCmd*X*Setting parameters, for example ID399 (P6.002) PRCmd1Setting.

See PR Command Setting and Data Definitions on page 253 for more information.

For (7) Jump to the specified PR command, you can configure a PR command number to jump to. For (8) Write to Parameter or Data Array, you can configure a Target parameter or data array and a Data Source. The data source can be any of the following:

- 0: Constant
- 1: Parameter
- 2: Data Array
- 3: Monitor Variable

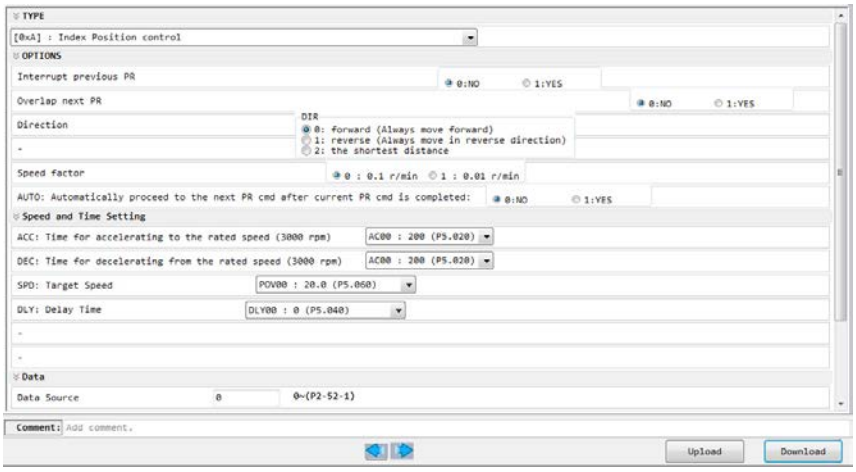
Figure 118 - PR Command Settings



Index Coordinates Settings Wizard

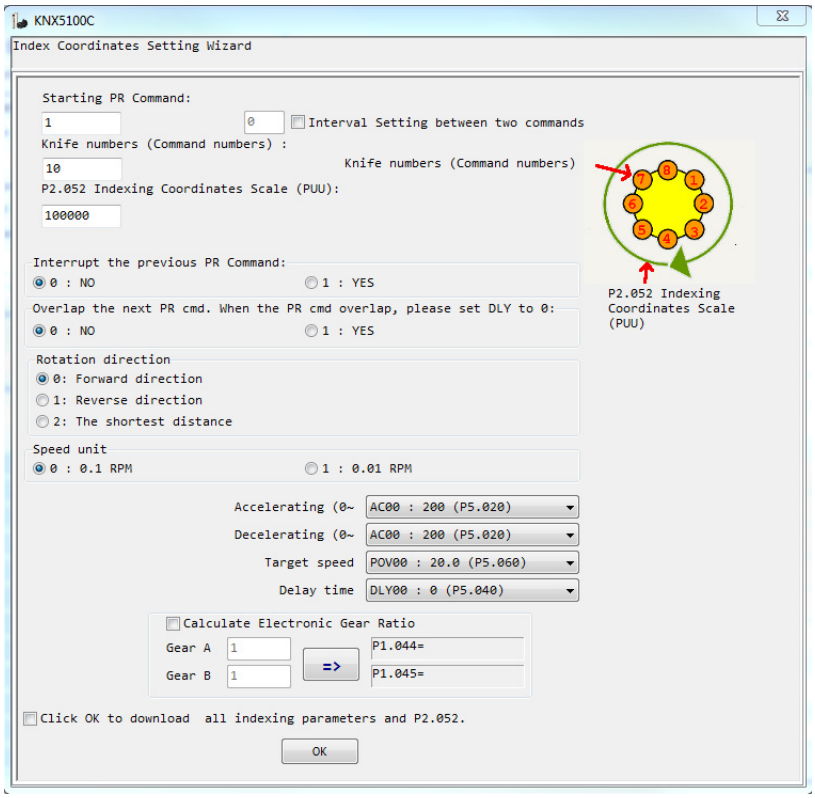
If you choose a command type of [0xA]: Index Position Control, you can configure the OPTIONS and the Speed and Time Setting on the PR Mode tab.

Figure 119 - PR Mode Editor for Index Position Command



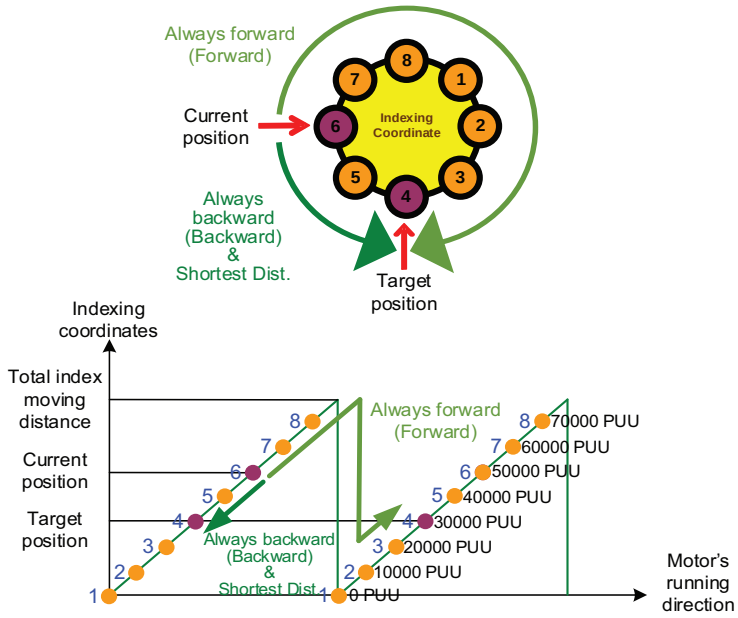
You can use the Index Coordinates Setting Wizard in the PR screen of the configuration software to help you configure the Index Position command. Click Index Coordinates Setting Wizard in the PR screen of the configuration software to launch the wizard.

Figure 120 - Indexing Coordinates Setting Wizard in PR Mode



As shown in Figure 121, the start PR command is set to 1 and command number is set to 8 and total moving distance is 80000 PUU. Clicking on OK, the software will automatically write position command 0 PUU to PR#01 and 10000 PUU to PR#02 and 20000 PUU to PR#03 and so on to PR#08. When index position reaches 80000 PUU, it auto restores to 0 PUU.

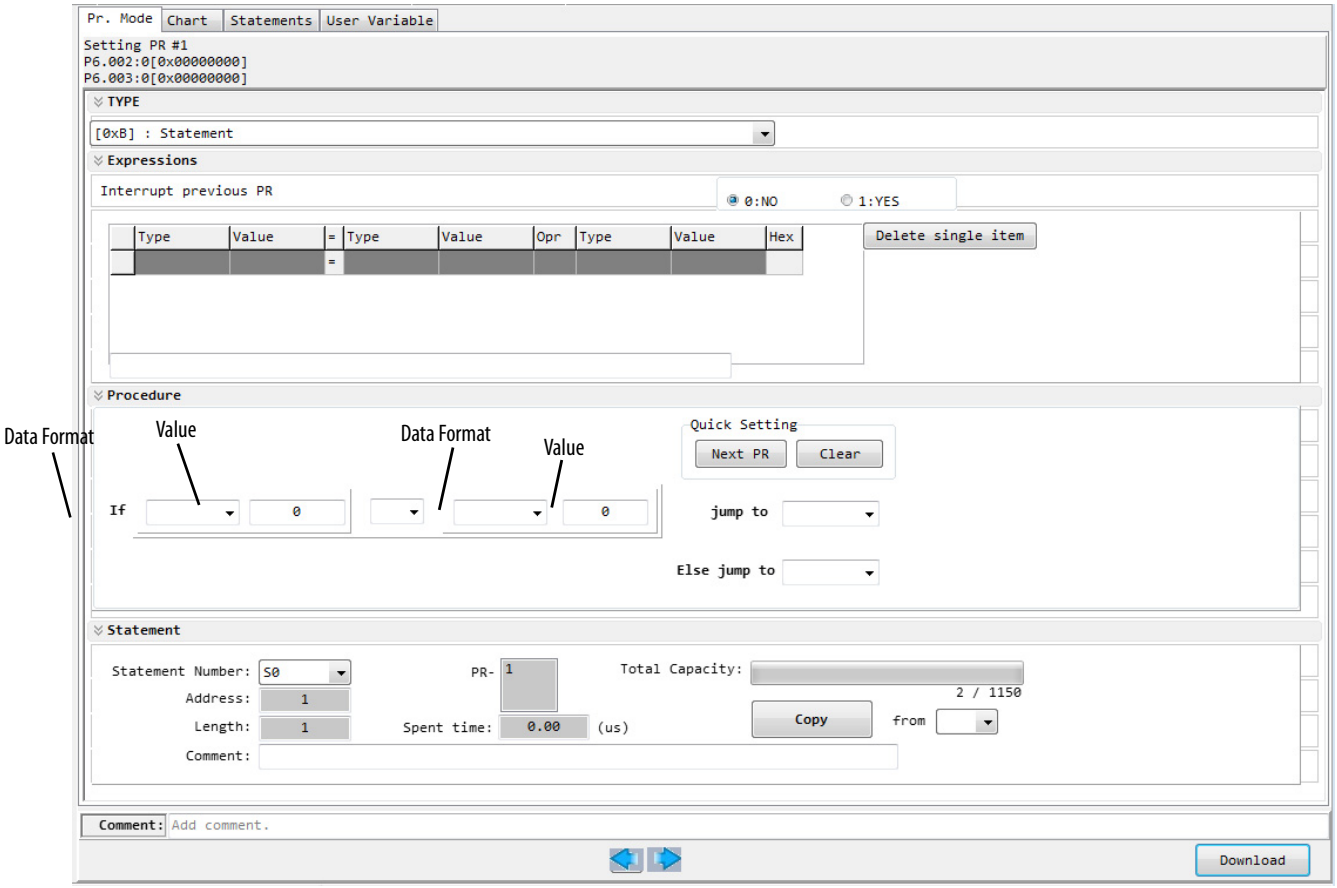
Figure 121 - PR Mode Index Position Example



Arithmetic Operations in KNX5100C Software

When you configure a PR command type as [0xB] Statement, you must use the Arithmetic Operations dialog box in KNX5100C software to define the commands, including addition, subtraction, multiplication, division, and logic conditions. The configuration dialog box has three sections: Expressions, Procedure, and Statement.

Figure 122 - PR Arithmetic Operations Screen



Expressions Section

This section supports addition, subtraction, multiplication, division, AND, OR, and MOD operation as well as logical operations for multiple data. Table 109 shows the supported operators and calculation data with data format in DEC and HEX.

Table 109 - Description of Each Field in the Expressions Section

Data to be Written	=	Calculation Data	Operator	Calculation Data
User variable (User[0...63])		User variable (User[0...63])	Addition (+) Subtraction (-) Multiplication (*) Division (/) Obtain remainder (%) And (&) Or (|)	User variable (User[0...63])
		Constant (Constant)		
Parameter (PX.XXX)		Data array (Arr[0...799])		Constant (Constant)
Data array (Arr[0...799])		Parameter (PX.XXX)		Data array (Arr[0...799])
		Monitoring variable (Mon[*])		

Procedure Section

This section uses the IF statement to determine whether the user-defined condition is fulfilled. If it is true, jump to the specified PR command. If false, jump to the other specified PR command. If you click Next PR in Quick Setting, the software automatically inputs the condition and then jumps to the next PR command. If you leave this section blank, then the PR procedure stops once the basic operation is done. See Table 110 for data formats and operators.

Table 110 - Field Description for the Procedure Setting Section

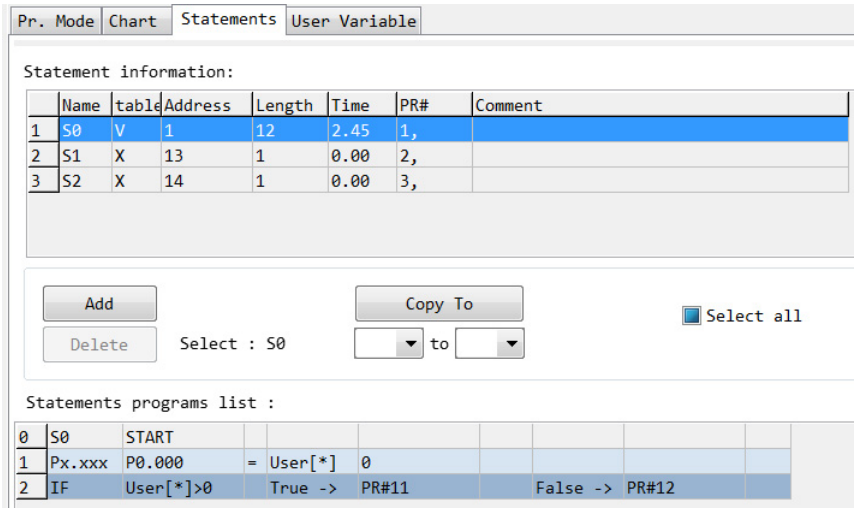
Data format	Operator	Data format
User variable (User[0...63])	Greater than (>) Greater than or equal to(≥) Less than (<) Less than or equal to (≤) Equal to (=) Not equal to (≠)	User variable (User[0...63])
Constant (Constant)		
Data array (Arr[0...799])		Constant (Constant)
Parameter (PX.XXX)		Data array (Arr[0...799])
Monitoring variable (Mon[*])		

Statement Section

This section includes statements and memory capacity. Statements save the data from the expression and procedure sections. Data in the expression and procedure sections of the same statement always remain identical and can be shared by multiple PR commands. If data in those two sections are different, then the data is saved to another statement. The time required to execute the statement is shown in the Spend Time field. Total Capacity shows the servo drive's memory capacity. Basic operations cannot be performed if there is no memory space available.

The Statements tab is shown in Figure 123. The upper section displays all the statements and the lower section displays the operations in each statement and the values.

Figure 123 - PR Procedure



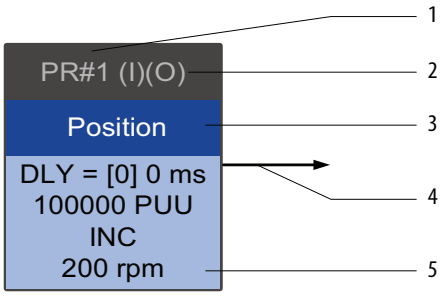
Display of PR Procedure in KNX5100C Software

This section describes how the software displays information related to each of the seven types of PR mode commands. This display is on the Chart tab of the PR Mode Editor in KNX5100C software. To help you understand how PR procedure works, the configuration software presents the execution order and calling sequence of all PR procedures.

Parts of the PR Display

The PR display includes five parts: number, execution property, command type, next PR command, and command data.

Figure 124 - PR Display



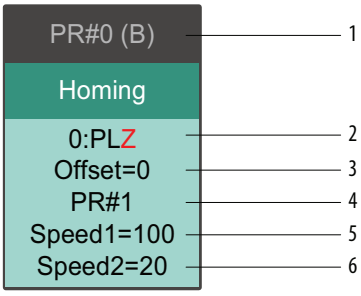
1. Number: the PR number, ranging from PR#0...PR#99 (100 sets of PR commands).
2. Execution property: (B) Execute homing when power on; (O) Command overlap; (R) write data to EEPROM; (I) command interrupt.
3. Command type: there are six types of PR commands: homing, speed, position, writing, jumping, and arithmetic operations. The color displayed in this section depends on the command type.
4. Next PR command: if followed by a PR command, the arrow points to the specified PR command.
5. Command information: displays the details of this PR command. The color depends on the information types.

The following sections describe the display.

Homing PR Display

In the display of homing methods, PR#0 always signifies the homing procedure, which is identified or indicated as "Homing". See Figure 125 below.

Figure 125 - Homing Methods Display



1. Command execution type: to execute homing when the drive is in Servo On state, it displays (B); if homing is not required, then no information is displayed.
2. Method selection: homing methods and Z pulse setting are shown in the table below. Characters in red (see Figure 125) indicate the motor's position after homing; F signifies running forward; R signifies running in reverse; ORG signifies origin; CUR signifies current position; BUMP represents the collision point.

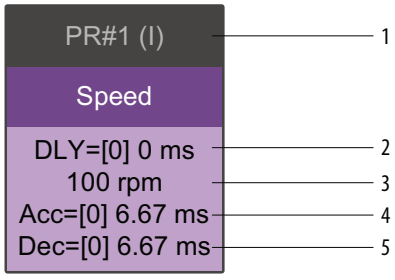
Homing methods	Y = 0: reverse to look for Z pulse Y = 1: go forward to look for Z pulse	Y = 2: do not look for Z pulse
X = 0: homing in forward direction with PL as the homing origin	0: PLZ	0: PL
X = 1: homing in reverse direction with NL as the homing origin	1: NLZ	1: NL
X = 2: homing in forward direction with ORG (when it switches from off to on state) as the homing origin	2: F_ORGZ	2: F_ORG
X = 3: homing in reverse direction with ORG (when it switches from off to on state) as the homing origin	3: R_ORGZ	3: R_ORG
X = 4: look for the Z pulse in forward direction with it as the homing origin	4: F_Z	
X = 5: look for the Z pulse in reverse direction with it as the homing origin	5: R_Z	
X = 6: homing in forward direction with ORG (when it switches from on to off state) as the homing origin	6: F_ORGZ	6: F_ORG
X = 7: homing in reverse direction with ORG (when it switches from on to off state) as the homing origin	7: R_ORGZ	7: R_ORG
X = 8: use the current point as the origin	8: CUR	
X = 9: look for collision point in forward direction and use it as the origin	9: F_BUMPZ	9: F_BUMP
X = A: look for collision point in reverse direction and use it as the origin	A: R_BUMPZ	A: R_BUMP

3. Offset: origin offset, ID398 (P6.001)
4. Command: next PR command to be executed after homing
5. Homing at high speed: first homing speed, ID298 (P5.005) HomingSpeed.
6. Homing at low speed: second homing speed, ID299 (P5.006) HomingCreepSpeed.

Speed Command PR Display

You can use the Speed command in any PR command (PR#1...PR#99). It is identified or indicated as "Speed". See Figure 126.

Figure 126 - Speed Command Display

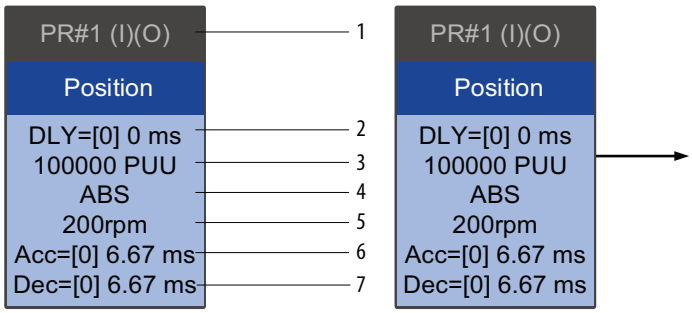


1. Command execution type: a Speed command can interrupt (INS) the previous PR command. If the Interrupt function is enabled, it displays (I); if not, no information is displayed.
2. Delay time (DLY): determined by shared PR parameters. It is defined by a command from the controller; the servo drive starts counting the delay time once it reaches the target speed.
3. Target speed: the set target speed.
4. Acceleration time (ACC): determined by shared PR parameters; length of time to reach the 3000 rpm speed from stopped.
5. Deceleration time (DEC): determined by shared PR parameters; length of time to decelerate from 3000 rpm speed to stopped.

Position Command PR Display

You can use the Position command in any PR command (PR#1...PR#99). It is marked as 'Position', and includes the options to 'Stop once position control completed' and 'Load the next command once position control completed'. The only difference is that 'Load the next command once position control completed' shows an arrow pointing to the next PR. See Figure 127.

Figure 127 - Position Command Display

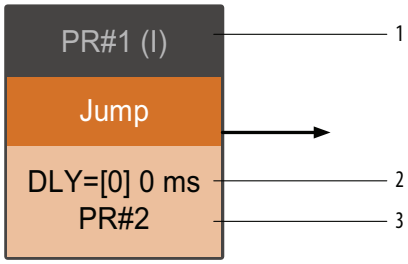


1. Command execution type: a Position command can interrupt (INS) the previous PR command. If the Interrupt function is enabled, it displays (I); if not, no information is displayed. The Position command can overlap (OVLP) the next PR command. If delay time is set to 0 when this function is enabled, it displays (O). If the Overlap function is not used, no information is displayed.
2. Delay time (DLY): determined by shared PR parameters. It is defined by a command from the controller. The servo drive starts counting the delay time once it reaches the target position.
3. Target position: the set target position.
4. Position command type: 'ABS' means an absolute positioning command; 'REL' means relative positioning; "INC" means incremental positioning; 'CAP' means high speed position capture.
5. Target speed: determined by shared PR parameters.
6. Acceleration time (ACC): determined by shared PR parameters; the length of time to reach the 3000 rpm speed from stopped.
7. Deceleration time (DEC): determined by shared PR parameters; the length of time to decelerate from 3000 rpm speed to stopped.

Jump Command PR Display

You can use the Jump command in any PR command (PR#1...PR#99). It is identified or indicated as 'Jump' and followed by an arrow pointing to the next PR command. See Figure 128.

Figure 128 - Jump Command Display

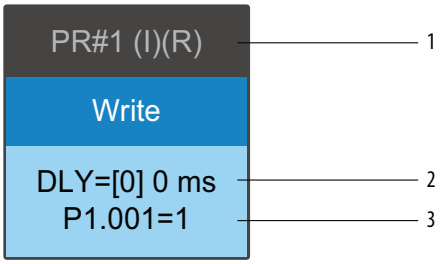


1. Command execution type: the Jump command can interrupt (INS) the previous PR command. If the Interrupt function is enabled, it displays (I); if not, no information is displayed.
2. Delay time (DLY): determined by shared PR parameters.
3. Target PR number: the target PR number.

Write Command PR Display

You can use the Write command in any PR command (PR#1 - PR#99). It is identified or indicated as 'Write'. See Figure 129.

Figure 129 - Write Command Display



1. Command execution type: a write command can interrupt (INS) the previous PR command. If the Interrupt function is enabled, it displays (I); if not, no information is displayed. You can determine whether to write the data to EEPROM. If writing data to EEPROM is required, it shows (R); if not, no information is displayed.
2. Delay time (DLY): determined by shared PR parameters.

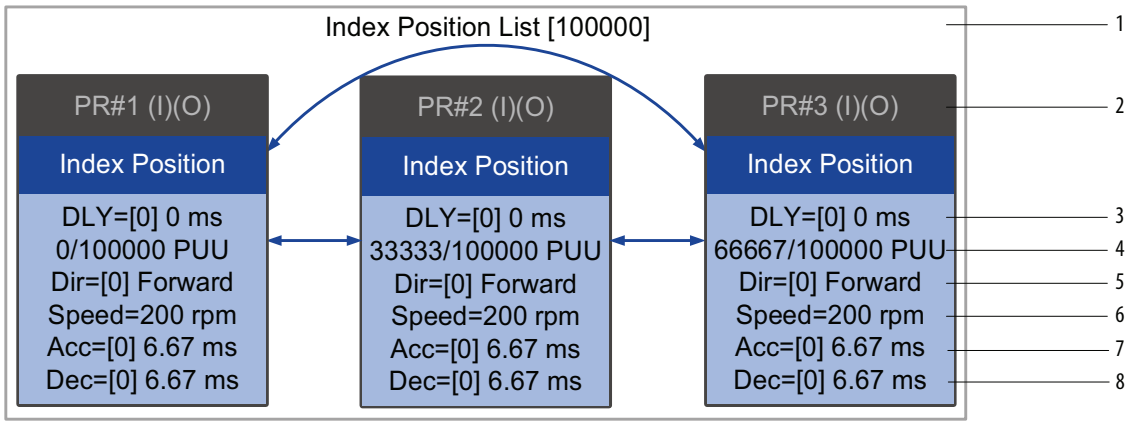
3. Writing target and data source: the corresponding target and data sources are shown in the table below. Note that constants can be written in DEC or HEX format.

Writing Target	Data Source
Parameter (PX.XXX)	Constant
Data array (Arr[#])	Parameter (PX.XXX)
-	Data array (Arr[#])
-	Monitoring variable (Mon[#])

Index Position Command PR Display

You can use the Indexing Position command in any PR command (PR#1...PR#99). The number of PR commands is determined by the index number. It is identified or indicated as "Index Position". See Figure 130.

Figure 130 - Indexing Position Command Display

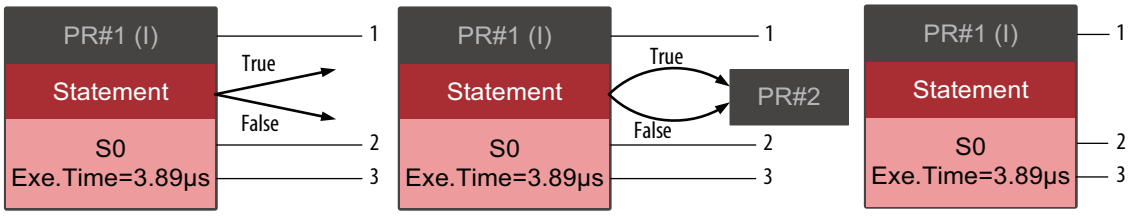


1. Indexing Position command section: the number of the index position. It shows the total moving distance at the top using double arrows to show that the motor can run reciprocally between each target position in each PR command.
2. Command execution type: a position command can interrupt (INS) the previous PR command. If the Interrupt function is enabled, it displays (I). If not, no information is displayed. The Position command can overlap (OVLP) the next PR command. If delay time is set to 0 when this function is enabled, it displays (O). If the Overlap function is not used, no information is displayed.
3. Delay time (DLY): determined by shared PR parameters. It is defined by a command from the controller. The servo drive starts counting the delay time once it reaches the target position.
4. Position command: the numerator is the position of this PR command; the denominator is the total moving distance of this indexing Position command, which is set by ID234 (P2.052) IndexingCcoordinatesScale.
5. Rotation direction (Dir): available options are 'Rotation forward (Forward)', 'Rotation in reverse (Reverse)' and 'Rotation with the shortest distance (Shortest)'.
6. Target speed: determined by shared PR parameters.
7. Acceleration time (ACC): determined by shared PR parameters; the length of time to reach the 3000 rpm speed from stopped.
8. Deceleration time (DEC): determined by shared PR parameters; the length of time to decelerate from 3000 rpm speed to stopped.

Arithmetic Operation PR Display

You can use arithmetic operations and statements in any PR command (PR#1...PR#99). It is identified or indicated as 'Statement'. When the condition is fulfilled, an arrow pointing to the next PR command appears with a solid line. If the condition is unfulfilled, an arrow pointing to the next PR appears with a dotted line. You can choose to execute the next PR command and stop once the execution is completed. See Figure 131.

Figure 131 - Arithmetic Operation Display



1. Command execution type: an arithmetic operation command can interrupt (INS) the previous PR command. If the Interrupt function is enabled, it displays (I); if not, no information is displayed.
2. Statement number: displays the statement number used in the PR command.
3. Execution time (Exe.Time): the time required to execute the arithmetic operation.

Trigger Method for PR Commands

This section describes the four trigger methods for PR commands.

Digital Input (DI) Trigger

You can choose the PR command to be executed by using internal registers (position command Bit 0...Bit 6) and use a command to trigger the selected PR command. Before using DI-triggering commands, you will have to define the 8 sets of DI functions, which are POS0 [0x11], POS1[0x12], POS2 [0x13], POS3 [0x1A], POS4 [0x1B], POS5 [0x1C], POS6 [0x1E], and CTRG [0x08].

See Description of Digital Input Functions on page 405 for more information. Select the PR number to be executed based on the on/off status of DI.POS0 – 6 and use DI.CTRG to trigger the specified PR command.

This can also be set in the Digital I/O and Jog Function dialog box in KNX5100C software, as shown in Figure 132.

Figure 132 - I/O Setting Screen

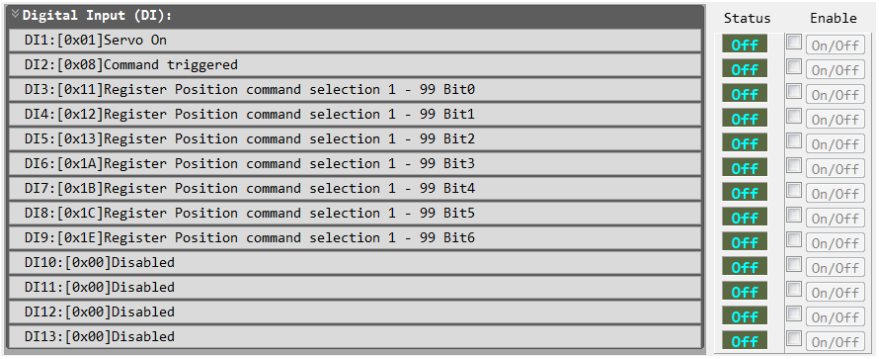


Table 111 - Use DI to Select the PR Command to be Triggered

Position Command	POS 6	POS 5	POS 4	POS 3	POS 2	POS 1	POS 0	CTRG	Parameter
Homing	0	0	0	0	0	0	0	↑	ID397 (P6.000
									ID398 (P6.001)
PR#1	0	0	0	0	0	0	1	↑	ID399 (P6.002)
									ID400 (P6.003)
~									
PR#49	0	1	1	0	0	1	0	↑	ID495 (P6.098)
									ID496 (P6.099)
PR#50	0	1	1	0	0	1	1	↑	ID497 (P7.000)
									ID498 (P7.001)
~									
PR#99	1	1	0	0	0	1	1	↑	ID595 (P7.098)
									ID596 (P7.099)

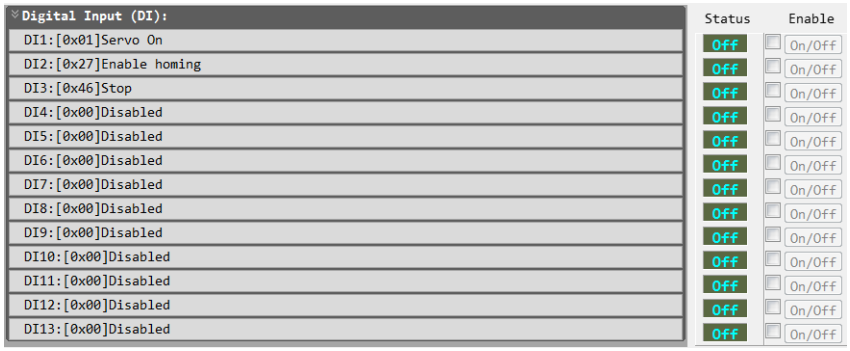
Status of DI.POS0...DI.POS6 signals: 0= On; 1= Off

DI.CTRG (up arrow): This signifies the moment that the digital input is switched from off to on.

In addition, there are two sets of DI for special functions, DI.SHOM[0x27] return to homing origin and DI.STP[0x46] motor stop. If the former is triggered, the servo drive will execute homing based on the homing setting. If the latter is triggered, the servo drive will stop the motor.

You can use the Digital I/O and Jog Function dialog box in KNX5100C software to complete the setting, as shown in Figure 133.

Figure 133 - I/O Setting Screen

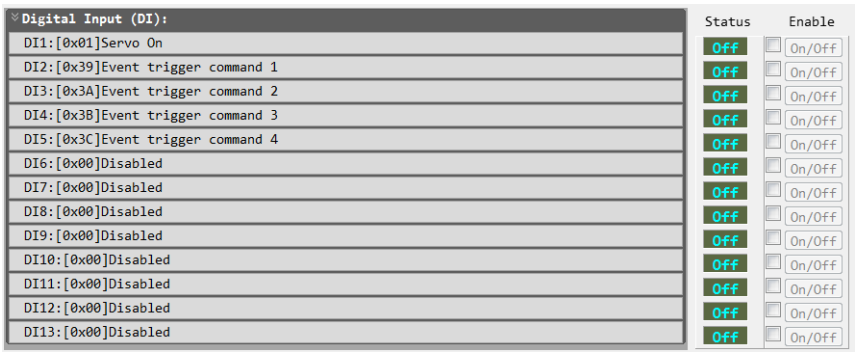


See Digital I/O and Jog Function in KNX5100C Software on page 160 for more information.

Event Trigger

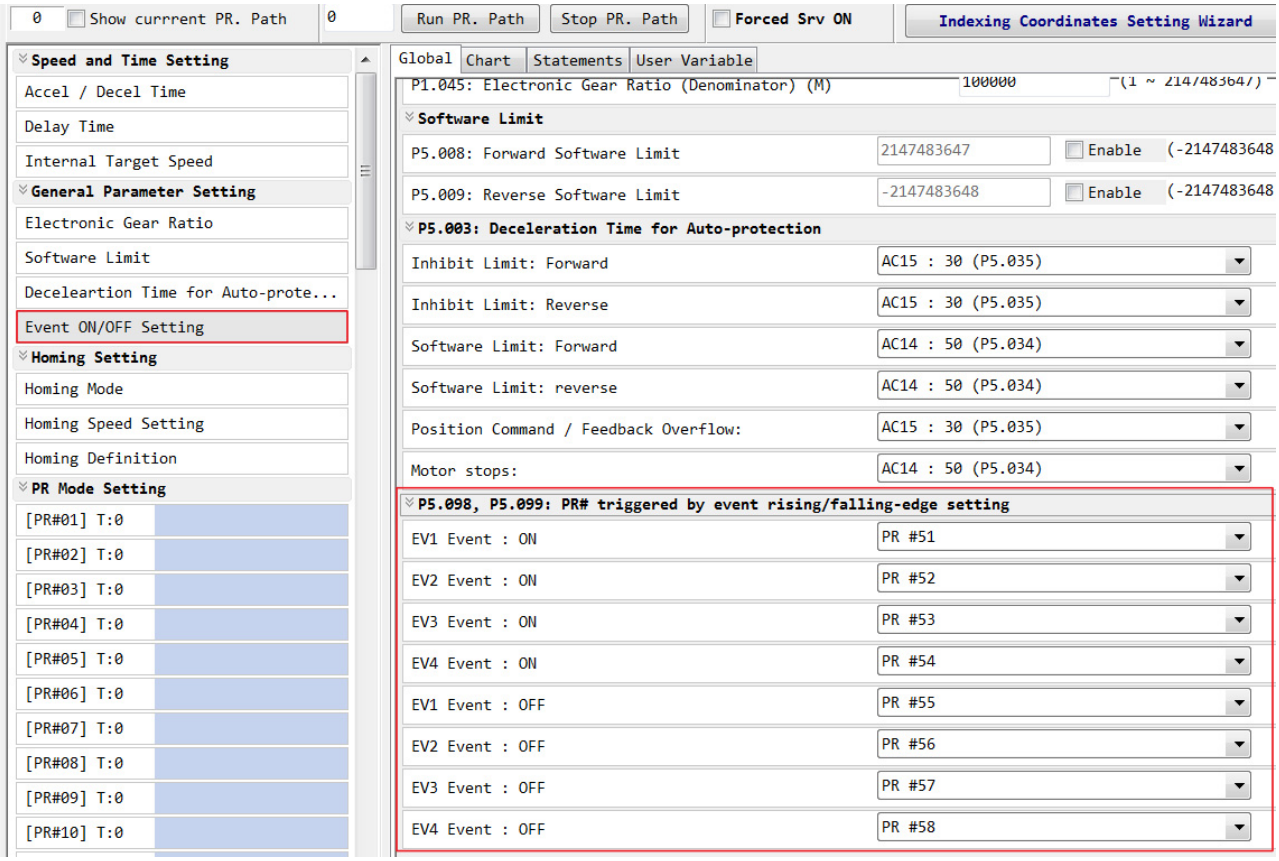
You can use event-triggered commands 1...4 to execute the specified PR command. Two types of event triggering are selectable: rising-edge trigger and falling-edge trigger. Range of PR numbers that can be specified is from 51...63. Before using event-trigger for PR commands, you have to define the related DI functions, which are DI.EV1 [0x39] event-trigger command 1, DI.EV2 [0x3A] event-trigger command2, DI.EV3 [0x3B] event-trigger command 3, and DI.EV4[0x3C] event-trigger command 4. See Description of Digital Input Functions on page 405 for more information.

Figure 134 - I/O Setting Screen



You can use the Digital I/O and Jog Function dialog box in KNX5100C software to complete the setting, as shown in Figure 134. You also can use the Event ON/OFF Setting of PR Mode Editor dialog box in KNX5100C software to complete the setting, as shown in Figure 135.

Figure 135 - Event Setting for Event Trigger



The following information describes the functions of ID386 (P5.098) EventRisingEdgePRNumber.

Settings:



X	PR triggered by EV1 rising-edge	**Z**	PR triggered by EV3 rising-edge
Y	PR triggered by EV2 rising-edge	**U**	PR triggered by EV4 rising-edge

- X: PR triggered when EV1 is on

  0: no action

  1-D: execute PR#51...63
- Y: PR triggered when EV2 is on

  0: no action

  1-D: execute PR#51...63

- Z: PR triggered when EV3 is on

  0: no action

  1-D: execute PR#51...63
- U: PR triggered when EV4 is on

  0: no action

  1-D: execute PR#51...63

The following information describes the functions of ID387 (P5.099) EventFallingEdgePRNumber

Settings



X	PR triggered by EV1 rising-edge	**Z**	PR triggered by EV3 rising-edge
Y	PR triggered by EV2 rising-edge	**U**	PR triggered by EV4 rising-edge

- X: PR triggered when EV1 is off

  0: no action

  1-D: execute PR#51...63
- Y: PR triggered when EV2 is off

  0: no action

  1-D: execute PR#51...63
- Z: PR triggered when EV3 is off

  0: no action

  1-D: execute PR#51...63
- U: PR triggered when EV4 is off

  0: no action

  1-D: execute PR#51...63

Trigger Position Command ID300 (P5.007)

Write the PR number to be executed in ID300 (P5.007) PRCmdTrigger and the servo drive executes the specified PR command.

- If you write 0 to the PR command trigger register, the servo drive executes homing.
- If you write1...99 to PR command trigger register, the servo drive executes the specified PR command (1...99).
- If you write 1000, the servo drive stops executing PR commands. which is the same function as DI.STP [0x46] motor stop. Values 100...999 are not valid.

When reading ID300 (P5.007) PRCmdTrigger, if the command is incomplete, the drive reads the current command (1...99).

If the command is complete, the drive reads the current command +10000. If the command is complete, DO.TPOS [0x05] target position reached is on, and motor position is reached, the drive reads the current command +20000.

For example:If the value read is 3, it means PR#3 is incomplete. If the value read is 10003, it means PR#3 completed, but the motor has not reached the target position yet. If the value read is 20003, it means PR#3 completed and the motor reached the target position.

Special Trigger (Capture, Compare, E-Cam)

You can use high-speed position capturing (Capture), high-speed position comparing (Compare), and E-Cam function to trigger the specified PR command. While the capturing completes, you can set Bit3 of ID331 (P5.039).X or ID395 (P5.110).X to determine whether to trigger PR#50, or set Bit 0 of ID351 (P5.059).U to determine whether to trigger PR#45 once the last data is compared. If E-Cam disengagement setting is 2, 4, or 6, use ID376 (P5.088).BA to write the PR command number.

See features of High-speed Position Capture Function (CAP) on page 317, High-speed Position Compare Function (CMP) on page 324, and E-Cam on page 335 for more information.

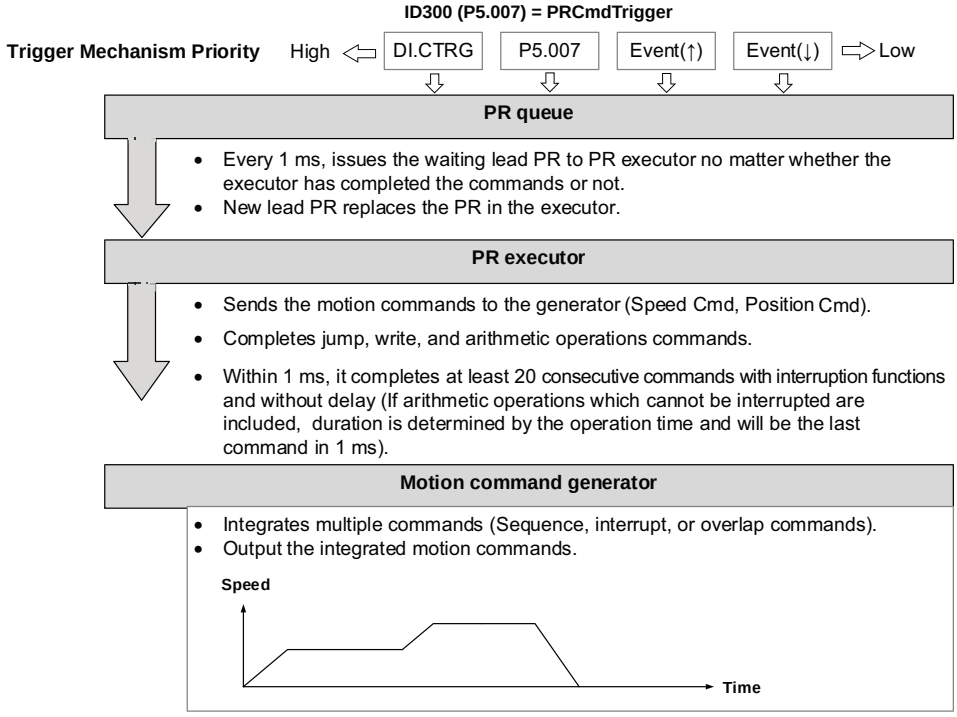
Triggering method	Setting bit	Default Trigger PR Command
ID331 (P5.039) DI9CaptureControl	ID331 (P5.039).X Bit 3	PR#50
ID395 (P5.110) DI10CaptureControl	ID395 (P5.110).X Bit 3	PR#60
ID351 (P5.059) CompareControl	ID351 (P5.059).U Bit 0	PR#45
ID376 (P5.088) ECamControl	ID376 (P5.088).BA	User-defined

The total number of Capture, Compare, or E-Cam cannot exceed 800 (the limit of the data array). See Chapter 12 for more information about these applications.

PR Execution Process

The drive updates the command status every 1 ms. Figure 136 illustrates the PR procedure execution flow and how the servo drive deals with PR commands. Once a PR procedure is triggered, it goes through three units, which are PR queue, PR executor, and motion command generator.

Figure 136 - PR Arrangement Procedure of the Drive



- Trigger mechanism: There are three trigger methods. A PR procedure will be executed as long as a trigger signal is received. When two different trigger methods are used for one PR procedure within the same ms, the priority is as follows: (1) DI trigger (DI.CTRG); (2) ID300 (P5.007) PRCmdTrigger; (3) ID386 (P5.098) EventRisingEdgePRNumber; (4) ID387 (P5.099) EventFallingEdgePRNumber. Within this ms, commands with higher priority is executed first and then the lower priority commands in order. If three trigger commands are generated in the same ms, the third is not be issued to the PR queue.
- PR Queue: The triggered PR command is the lead PR. The PR group it leads goes into the PR queue to wait for the arrangement. In each ms, the servo drive sends the lead PR and the PR group it leads to the PR executor no matter whether a PR command is being executed. Therefore, as long as a PR command is triggered, the PR queue collects it and sends it to the executor.

- PR executor: Once the PR executor receives the lead PR and its PR group, the PR group in execution is replaced immediately. If a PR group includes motion commands, such as speed commands and position commands, then the PR executor will send them to the motion command generator. PR commands with write or jump commands are completed at the moment when PR executor is read, thus they do not enter the generator. The arithmetic operations commands are executed when entering the PR executor; however, the execution time varies with the computing duration and the next command cannot interrupt. The PR executor can consecutively complete at least 20 PR commands with interrupt commands (INS) and without delay time setting within 1 ms. If there is a PR command that hasn't been completed within 1 ms and a new PR group has been sent to the executor by the queue, the new PR group will then replace the previous one. In other words, instead of executing the PR group that hasn't been completed, the executor starts executing the new ones. However, if a new PR group hasn't been sent to the executor yet, the executor continues to execute the unfinished PR command.
- Motion Command Generator: Motion commands include speed command and position command. The PR executor sends this type of command to the motion command generator. This generator has a buffer for temporarily storing the next motion command and all motion commands are integrated here.

  Motion commands can be executed as soon as they enter the generator. If other motion command (with interrupt setting) also enters the generator, it is integrated with the current command in the generator and the integration is based on the setting. The setting includes whether multiple motion commands are sequence commands and whether it is set with overlap or interrupt function; all integration varies with each PR command setting.

Sequence Command Execution

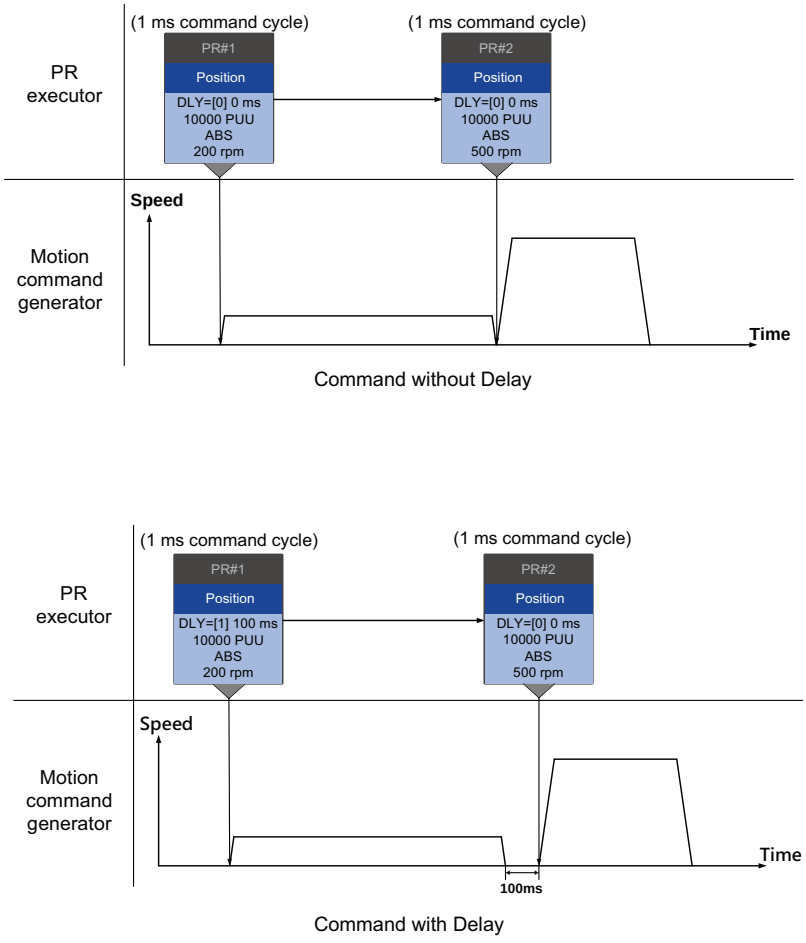
Configurable commands in PR command are motion commands, which are position and speed commands. A sequence command is a motion command without an overlap or interrupt function. The following command starts executing only after the delay set in the previous command is over. For position commands, the delay time starts to count after the target position is reached. For speed commands, the delay time counting starts after the target speed is reached.

Consecutive Position Commands

When the PR executor receives two position commands consecutively, as they are not set with interrupt or overlap functions, the PR executor issues the first position command to the motion command generator and the generator starts the first part of position control. After the first position command completes, if no delay time is set, the PR executor issues the second position command for the generator to start the second part of position control.

If the first position command is set with a delay, the PR executor starts counting the delay time right after the motor reaches the target position. Then, it issues the second position command to the generator for the second part of position control as shown in Figure 137.

Figure 137 - Position Command

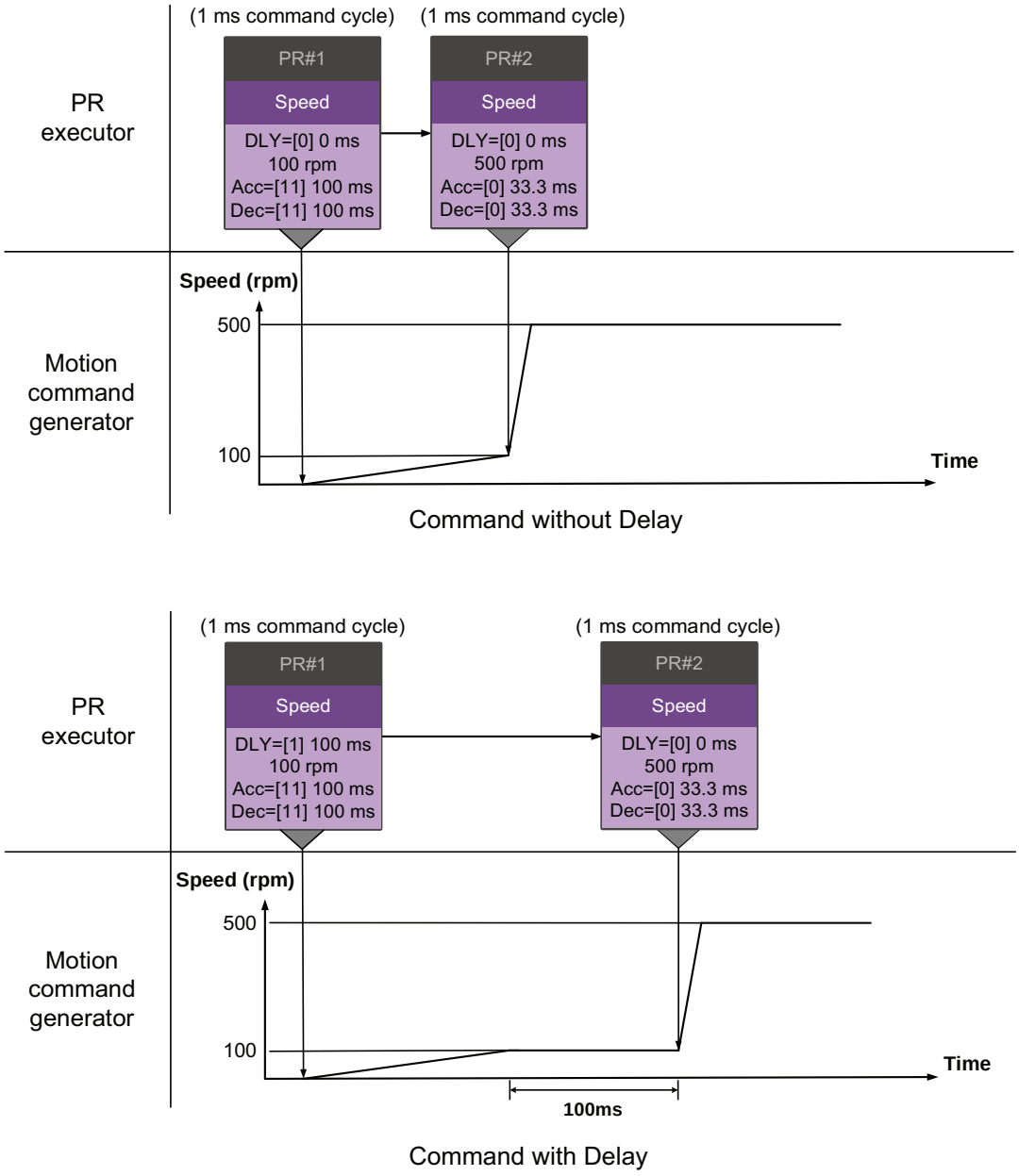


Consecutive Speed Commands

When the PR executor receives two speed commands consecutively, as they are not set with interrupt or overlap functions, the PR executor issues the first speed command to the motion command generator and the generator starts the first part of speed control. After the first speed command completes, if no delay time is set, the PR executor issues the second speed command to the generator to start the second part of speed control (see Figure 138).

If the first speed command is set with a delay, the PR executor starts counting the delay time right after the motor reaches the target speed. Then, it issues the second speed command to the generator for the second part of speed control as shown in Figure 138.

Figure 138 - Speed Command



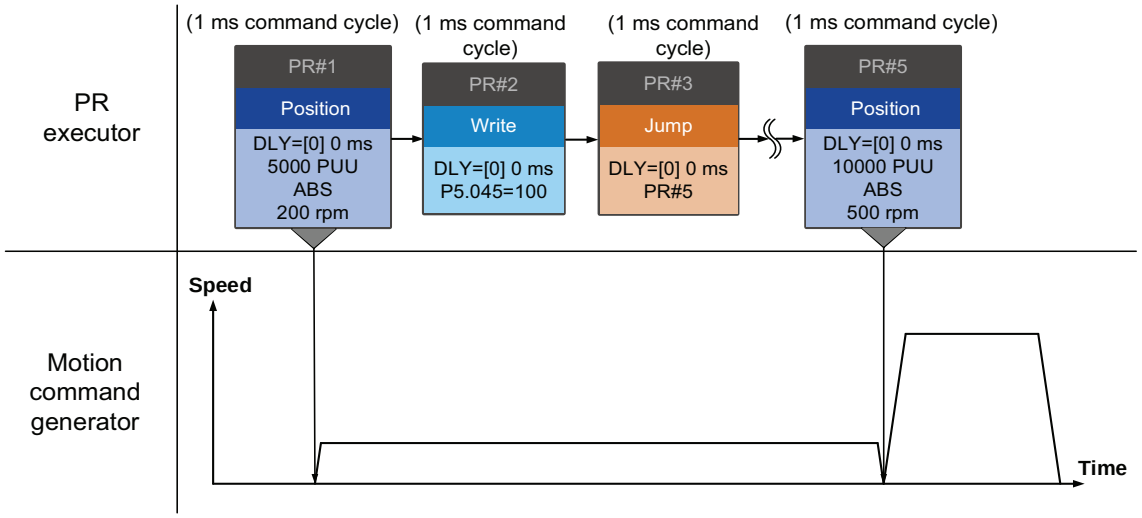
Multiple Commands

The PR queue updates commands every 1 ms. If it is a motion command, the PR queue issues the next command to the generator only after the previous completes. For jump or write commands, they are executed in the PR queue immediately.

As shown in Figure 139, in the first ms, the PR queue receives a position command and it issues this command to the motion command generator, allowing the generator to execute it. In the second ms, the PR queue receives a write command and executes it immediately. In the third ms, the PR queue receives a jump command and executes it right away as well. So, these two commands are not sent to the motion command generator; the PR queue and the generator can execute commands individually. In the fourth ms, the PR queue receives a position command.

After the first position command is completed, the PR executor issues it to the generator and the generator starts executing it promptly.

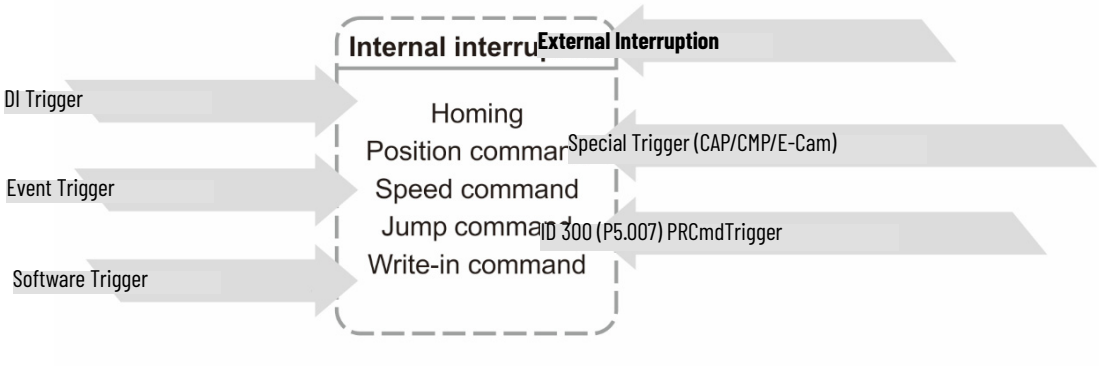
Figure 139 - Sequence Command - Multiple Commands



Command Interrupts Execution

Interruption (INS) is an action that results in a command in execution being replaced or integrated. Results of interruption differ based on the command types. With INS, the latter command replaces the previous. There are two types of interruption: internal and external, as shown in Figure 140.

Figure 140 - Internal and External Interruption



Internal Interrupts

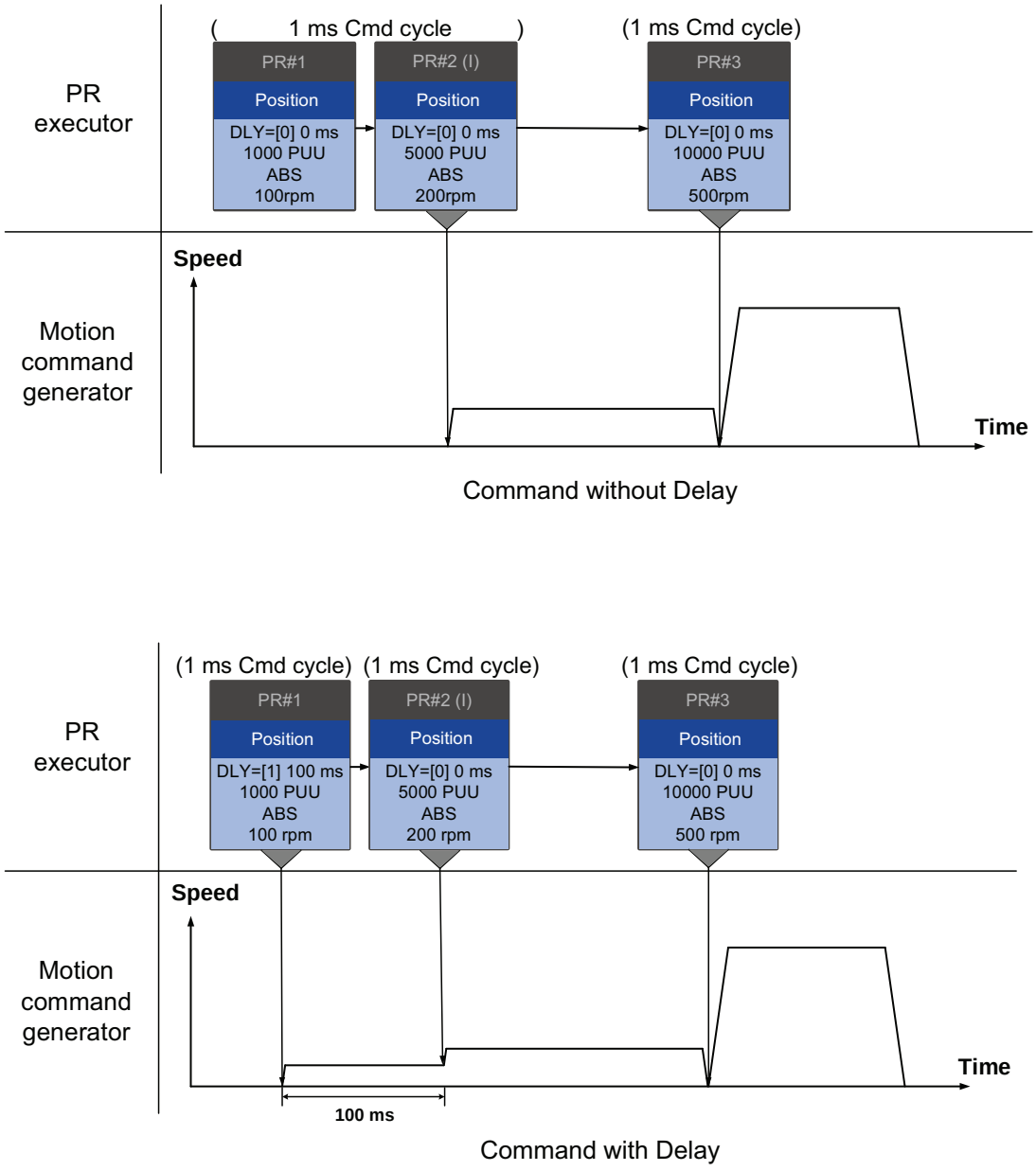
For a series of PR commands, if one PR command is set with AUTO (auto-execute the next command), the system carries on to the next command after the current command is read. (If the current is set with a delay, the next command is read after delay time is over.) Meanwhile, if the next command is set with an interrupt function, which has a higher execution priority, the servo drive immediately executes the interrupt command. It replaces the un-executed part in the previous command with the latter or integrates the commands in execution of the previous.

Position Commands

When the PR executor receives three consecutive position commands and the second command has an interrupt configured (Position command > Position Command (I) > Position Command), the executor treats the first and second commands as one PR group. As the first position command is unexecuted, the executor replaces the first with the second. It only issues the second to the motion command generator for execution. After the second is completed, the executor issues the third to the generator.

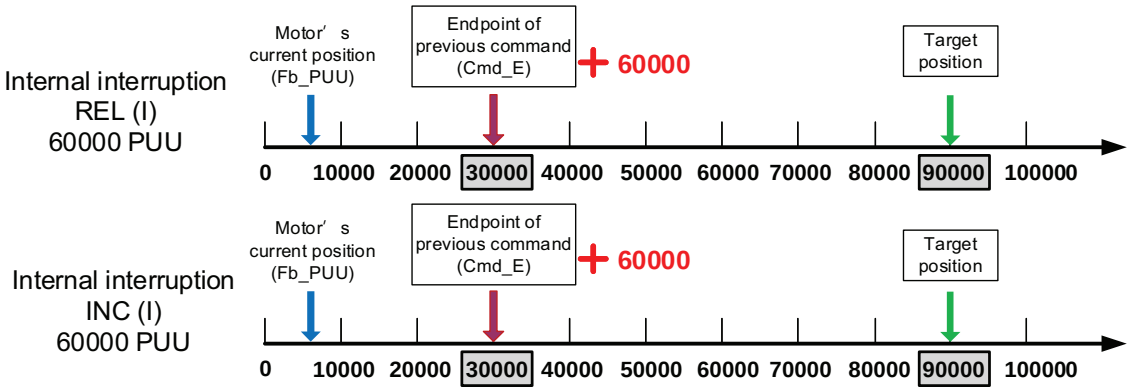
If the first is set with a delay, then the PR executor issues the first to the generator and then start counting the delay time. After the delay is over, it then issues the second and the generator starts the second part of position control. While the first is still being executed, it is integrated with the second. Once the second is completed, the executor issues the third to the generator for execution.

Figure 141 - Internal Interruption - Position Command



Integration for internal interrupt of an absolute position command (ABS) is slightly different from what described in Position Control Command on page 272. The way REL and INC commands work is the identical. The target position is the previous target position plus the current. See the example below.

Figure 142 - Example of Relative and Incremental Position Command for Internal Interruption

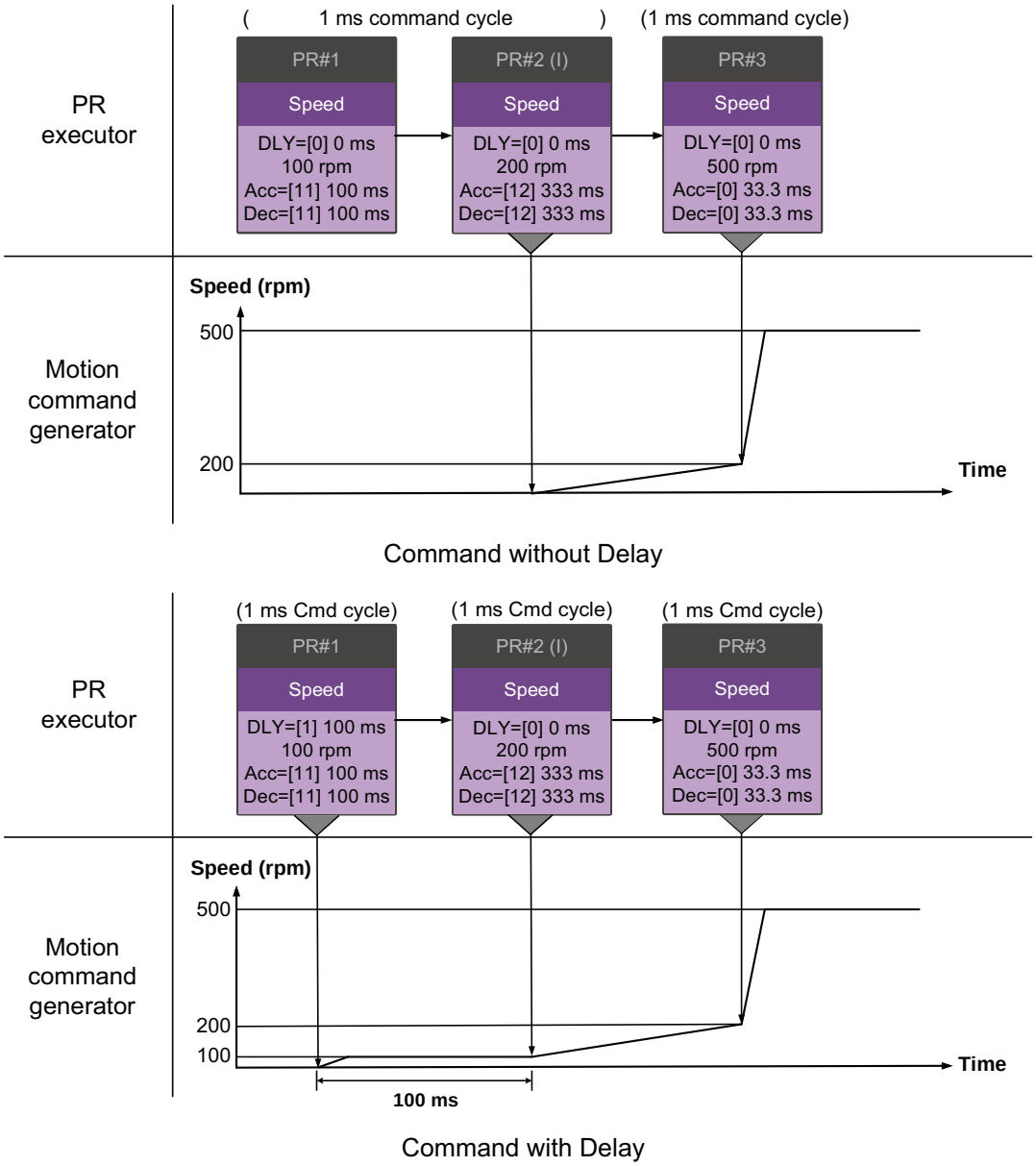


Speed Commands

When the PR executor receives three consecutive speed commands and the second command has an interrupt configured (Speed command > Speed Command (I) > Speed Command), the executor treats the first and second commands as one PR group. As the first speed command is unexecuted, the executor replaces the first with the second. It only issues the second command to the motion command generator for execution. After the second is completed, the executor issues the third to the generator (see Figure 143).

If the first command is set with a delay, then the PR executor issues the first to the generator and then start counting the delay time. After the delay is over, it then issues the second command and the generator starts the second part of speed control. While the first command is still being executed, it is integrated with the second command. Once the second is completed, the executor issues the third to the generator for execution (see Figure 143).

Figure 143 - Internal Interruption - Speed Command



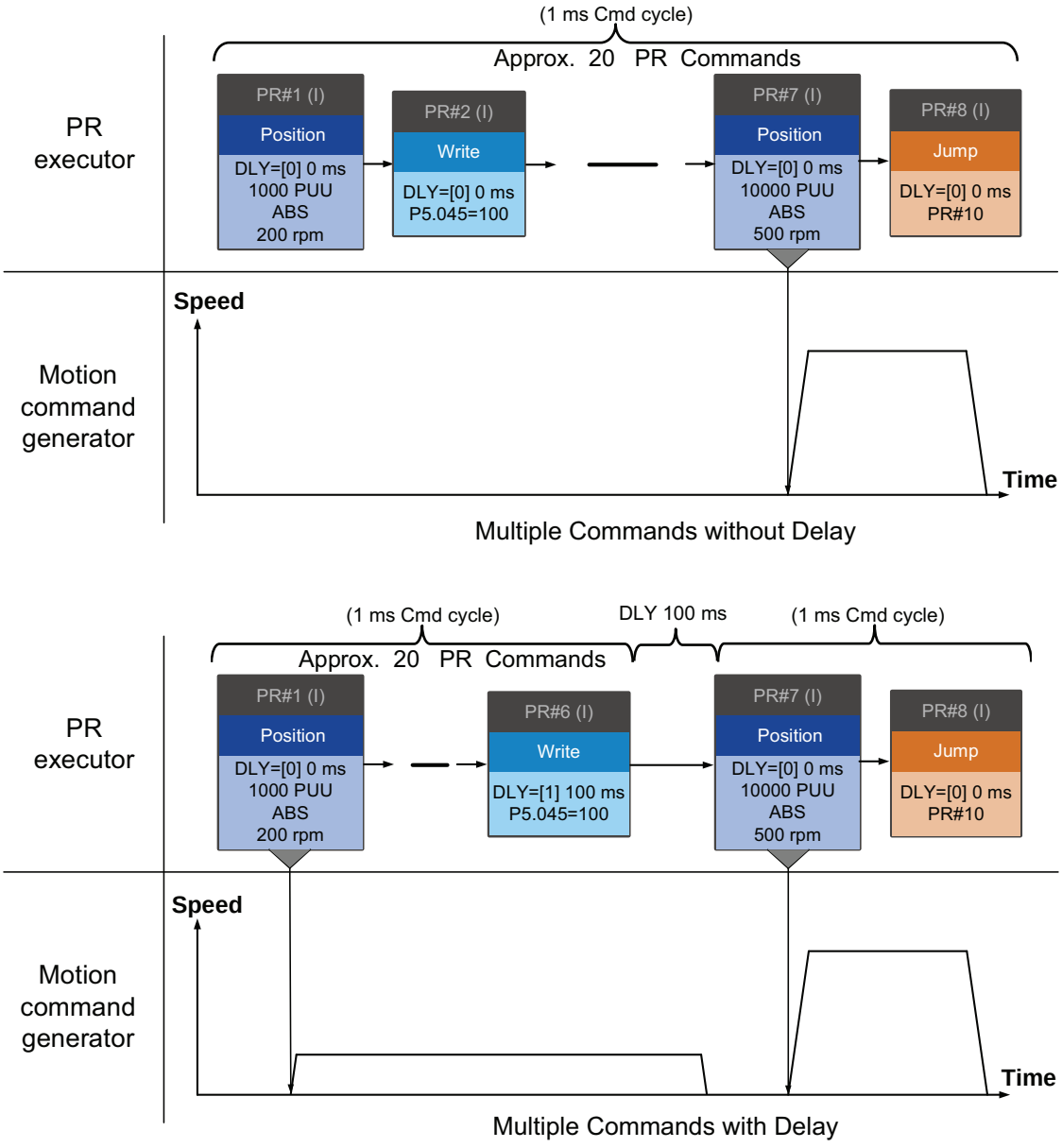
Multiple Commands

The PR queue updates once every 1 ms Command cycle. If all PR commands are set with interrupt function, the queue can read at least 20 PR commands in 1 ms and these commands are called a PR group.

If this PR group has multiple motion commands, the PR queue only issues the last command it receives to the motion command generator for execution. Therefore, in the same PR group, only one PR command with motion command is executed. The latter motion command directly replaces the former, whereas jump and write commands are executed once received by the PR queue (see Figure 144).

If one of the PR command is set with a delay, the PR queue schedules all commands on the basis of this PR command. The prior commands set with a delay are regarded as the first PR group and what follows is regarded as the second PR group. Thus, this PR procedure can execute up to two PR commands with motion commands, as shown in Figure 144.

Figure 144 - Internal Interruption - Multiple Commands

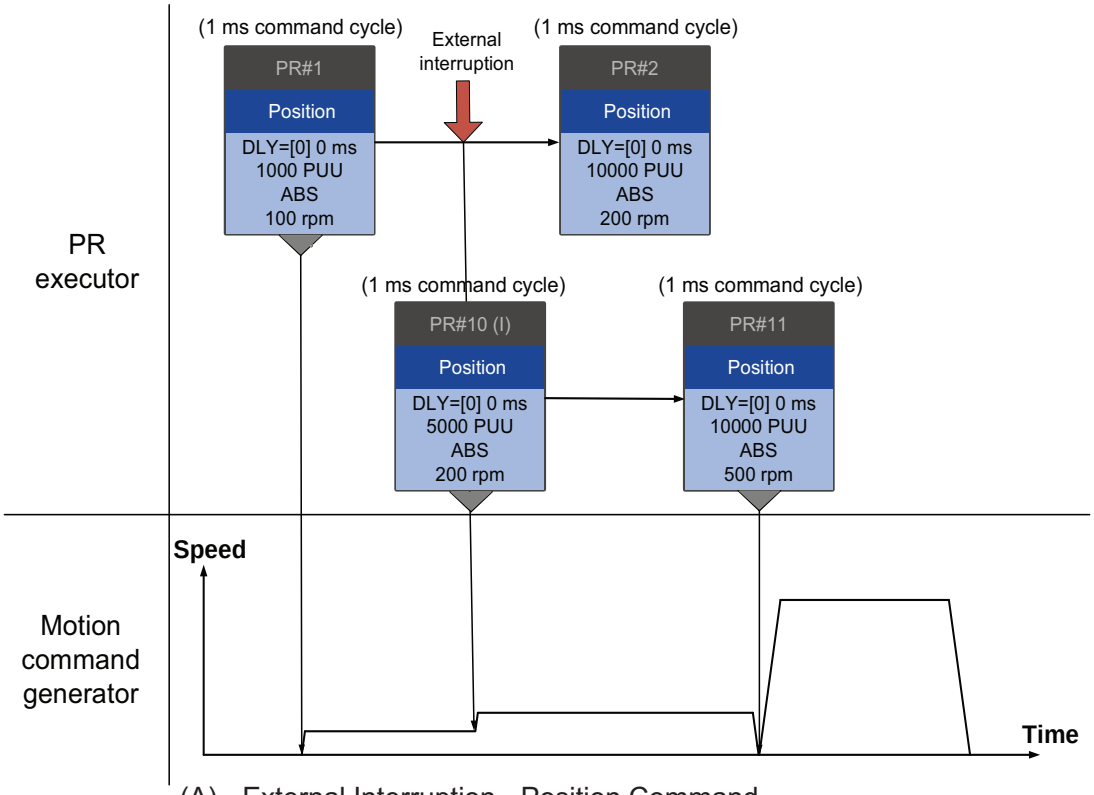


External Interrupts

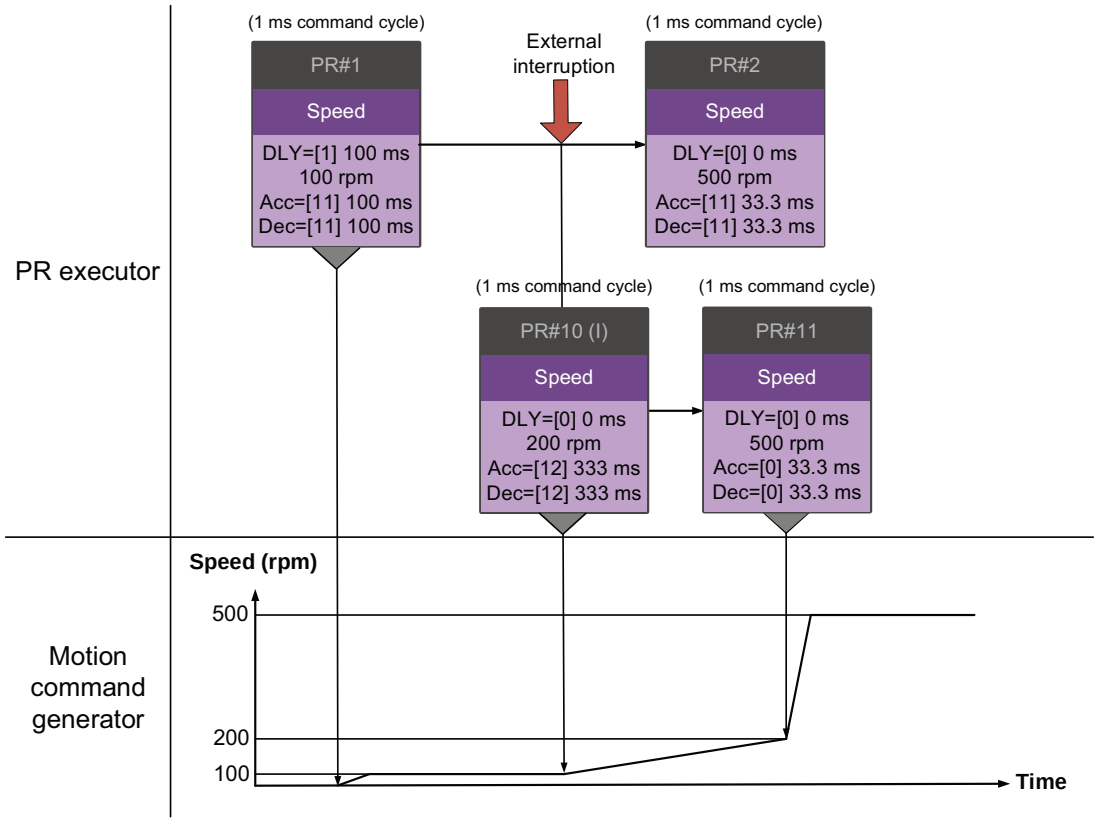
If external interruption is applied, it uses the PR command trigger method to execute another PR command. When the PR queue receives a PR command with interrupt function, this command is issued to the motion command generator immediately and change the command in execution. Whether a delay is set does not change the result of external interruption. That is, once the PR queue receives an external interruption command, the motion commands in the latter part is executed by the generator and integrated with the previous. Procedure of external interruption is as shown in Figure 145.

If a PR command with external interruption enters the PR executor, the executor issues this position command promptly to the generator so that the motor can run in accordance. The motor refers to the setting that integrates with the former motion commands when running. Similarly, external interruption with application of speed commands and position commands work the same way and so do the applications of multiple commands. See Figure 145 for example.

Figure 145 - External Interruption



(A) - External Interruption - Position Command



(B) - External Interruption - Speed Command

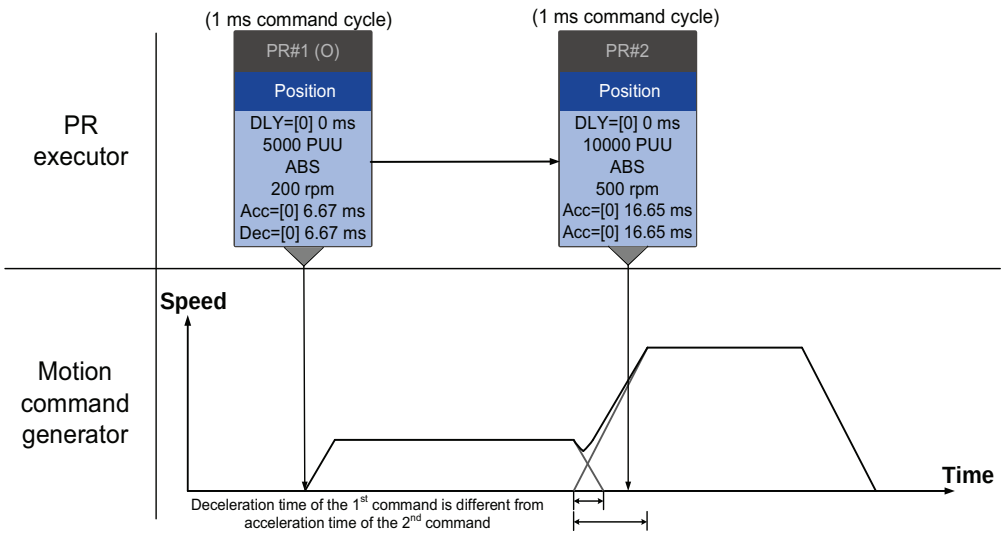
Overlap Command Execution

If an overlap function is set in the previous position command, it allows the next command to be executed while the previous is decelerating thus achieving a continuous motion. When an overlap command is used, the set delay time is still effective. The delay time starts to count from command's start point; however, in order to have the commands transit smoothly, setting the delay time of the previous to 0 is suggested. In addition, if deceleration time of the previous is identical to acceleration time of the next, the transition between commands can be very smooth and discontinuous speed during transition can be avoided (see Figure 146). The calculation is as follows.

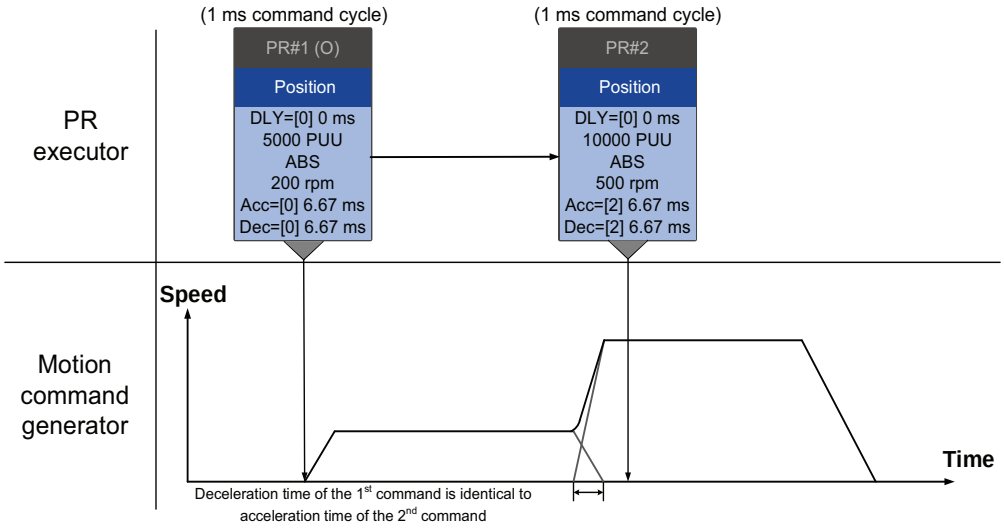
$$\frac{\text{1st target speed (Spd1)}}{3000} \times \text{Deceleration time (Dec)} = \frac{\text{2nd target speed (Spd2)}}{3000} \times \text{Acceleration time (Acc)}$$

An interrupt command has a higher priority over an overlap command. Thus, when overlap function is set in the current position command and the next motion command is set to apply the interrupt function, only interrupt function will be carried out.

Figure 146 - Overlap Command



Overlap Command - Acceleration and Deceleration Time are Different



Command with Delay - Acceleration and Deceleration Time are Identical

Arithmetic Operation Command Execution

Arithmetic operations commands are regarded as combinations of write commands and jump commands. Thus, the execution priority is the same as these two types of commands, which are executed by PR executor. Arithmetic operations commands can interrupt the previous command but cannot be interrupted by the latter. This is for ensuring that all arithmetic operations are completed before the PR commands enter the PR queue. In other words, for a series of PR commands with both arithmetic operations and interrupt functions, only the arithmetic operations commands of this PR command is executed in the first ms. And the rest is arranged to the PR queue in the next ms.

Therefore, the target jump PR number specified by the command with arithmetic operations is executed in the next ms. If users have input the triggering parameter in Statement section, such as ID300 (P5.007) PRCmdTrigger, which has the highest execution priority (regarded as external interruption), after the arithmetic operations are done, the command specified by PR command trigger register is executed in the next ms. And logic condition commands are not executed (see Figure 147).

Figure 147 - Multiple Commands with Arithmetic Operations

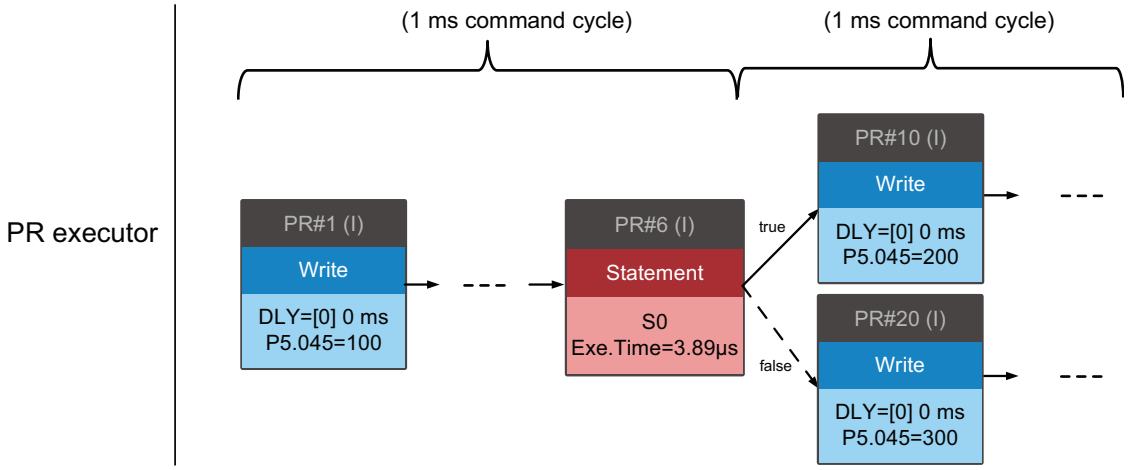
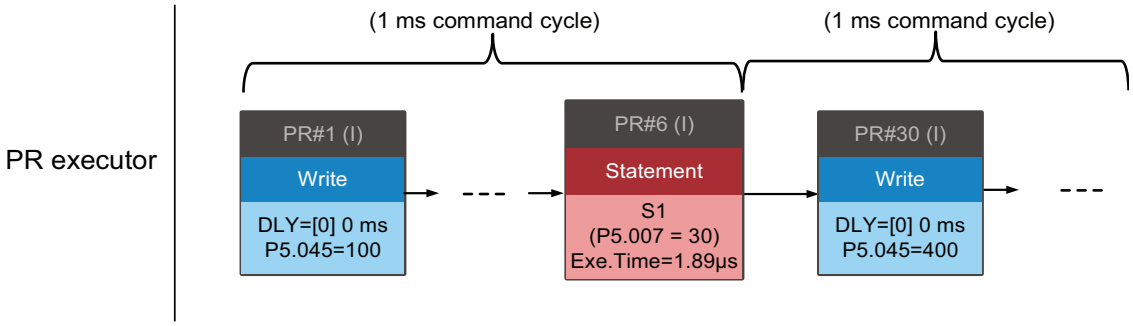


Figure 148 - Writing Trigger Command in Statement Section



Motion Control Applications

Topic	Page
High-speed Position Capture Function (CAP)	317
High-speed Position Compare Function (CMP)	324
E-Cam	335
Macro Commands	368

Motion control applications include high-speed position capture applications, high-speed position compare applications, and E-Cam applications.



For Kinetix® 5100 fault code descriptions and parameters, see Knowledgebase Technote: Kinetix 5100 Servo Drive Parameter Data and Fault Codes. You can download the spreadsheet from this public article.

You will be asked to log in to your Rockwell Automation web account or create an account if you do not have one. You do not need a support contract to access this article.

High-speed Position Capture Function (CAP)

The High-speed Position Capture function uses the externally-triggered high speed digital inputs DI9 and DI10 to capture the position data of the motion axis and store it in the data array for further motion control. As the Capture function is carried out by the hardware, the KNX5100C software captures the motion axis' position accurately. While the Capture function is enabled, the servo drive inputs the DI9 or DI10 signal as capture signal, which is not user-defined.

The following parameters define the function.

Table 112 - High-speed Capture Related Parameters

Parameter	Name
ID328 (P5.036)	DI9CaptureStartAddress
ID392 (P5.107)	DI10CaptureStartAddress
ID330 (P5.038)	DI9CaptureRemainedCount
ID394 (P5.109)	DI10CaptureRemainedCount
ID131 (P1.019)	DI9ExtraConfiguration
ID183 (P1.103)	DI10ExtraConfiguration
ID331 (P5.039)	DI9CaptureControl
ID395 (P5.110)	DI10CaptureControl
ID329 (P5.037)	DI9CaptureAxisPosition
ID393 (P5.108)	DI10CaptureAxisPosition
ID132 (P1.020)	DI9CaptureMaskRange

Table 112 - High-speed Capture Related Parameters (Continued)

Parameter	Name
ID184 (P1.104)	DI10CaptureMaskRange
ID368 (P5.076)	DI9FirstCaptureResetPosition
ID396 (P5.110)	DI10FirstCaptureResetPosition

To configure the Capture function, you need to:

- Define and enable the operation of the capture function, including definition of the axis source and trigger logic
- Define the start position for data capture in the data array
- Set the amount of data to be captured
- Enable the cyclic mode

The following explanation of the function uses DI9 as the example and is illustrated in Figure 149.

Use ID331 (P5.039) (corresponding to DI9, or ID395 (P5.110) corresponding to DI10) to enable or disable the Capture function and to define the axis source and trigger logic. See Table 113.

The amount of data to capture is set via ID330 (P5.038) DI9CaptureRemainedCount and must be greater than 0 otherwise the Capture function is invalid.

When the Capture function is executing, the ID330 (P5.038) DI9CaptureRemainedCount parameter indicates the remaining number of data that has not been captured (read-only). With each instance where data is captured, this value decrements by 1 until the value is 0, which indicates that the Capture function has completed. Then, the next cycle automatically begins referring to the configured capture amount.

However, the start position is still determined by ID328 (P5.036) DI9CaptureStartAddress, which means that the data captured in the previous cycle is replaced by the data captured in the following cycle.

To prevent the same position data (or position data within a small deviation) from being captured repeatedly, you can configure the drive to capture multiple data sets by defining a masking range for data capture. Capturing data more than once is not allowed within the masked area. Use ID132 (P1.020) DI9CaptureMaskRange to define a masking range.

Set ID131.X (P1.019.X) DI9ExtraConfiguration bit 0 to 1 to enable the cycle mode for the function.

Table 113 - High-speed Position Capture, Additional Information

P5.039 (for DI9) DI9CaptureControl	Bit	Function	Description
X	0	Enable capture function	When bit 0 = 1, and ID330 (P5.038) > 0, data capturing starts and DO.CAP_OK signal is off. The value of ID330 (P5.038) decrements as data capture continues. When ID330 (P5.038) = 0 it means that data capture is complete. The DO.CAP_OK signal is on, and bit 0 is cleared to 0. If bit 0 is already 1, the written value must not be 1; you have to write 0 to disable the Capture function.
	1	Reset the axis position when first data is captured	If bit 1 = 1, after the first data is captured, the Capture axis position is set to the value of ID368 (P5.076) DI9FirstCaptureResetPosition.
	2	Enable Compare function after the first data is captured(1)	If bit 2 = 1, when the first data is captured, the Compare function is enabled. (ID351.X (P5.059.X) CompareControl bit 0 = 1 and ID350 (P5.058) CompareRemainedCount resets to the previous setting amount). If the Compare function is already enabled, then this bit function is ignored.
	3	Execute specific PR after the last data is captured	If bit 3 = 1, the drive executes the specific PR once data capture is complete (2).
Y	–	Source of capture axis	0: Disabled 1: Auxiliary encoder (Aux) 2: Pulse command (I/O) 3: Main encoder of motor (MFB)
Z	–	Trigger logic	0: N.O. (normally open) 1: N.C. (normally closed)
U	–	Minimum trigger interval	–
DC		The specific PR#1...PR#99	–

(1) Compare function only supported in first capture.
(2) See Special Trigger (Capture, Compare, E-Cam) on page 301.

Figure 149 - High-speed Position Capture Flowchart (DI9 example)

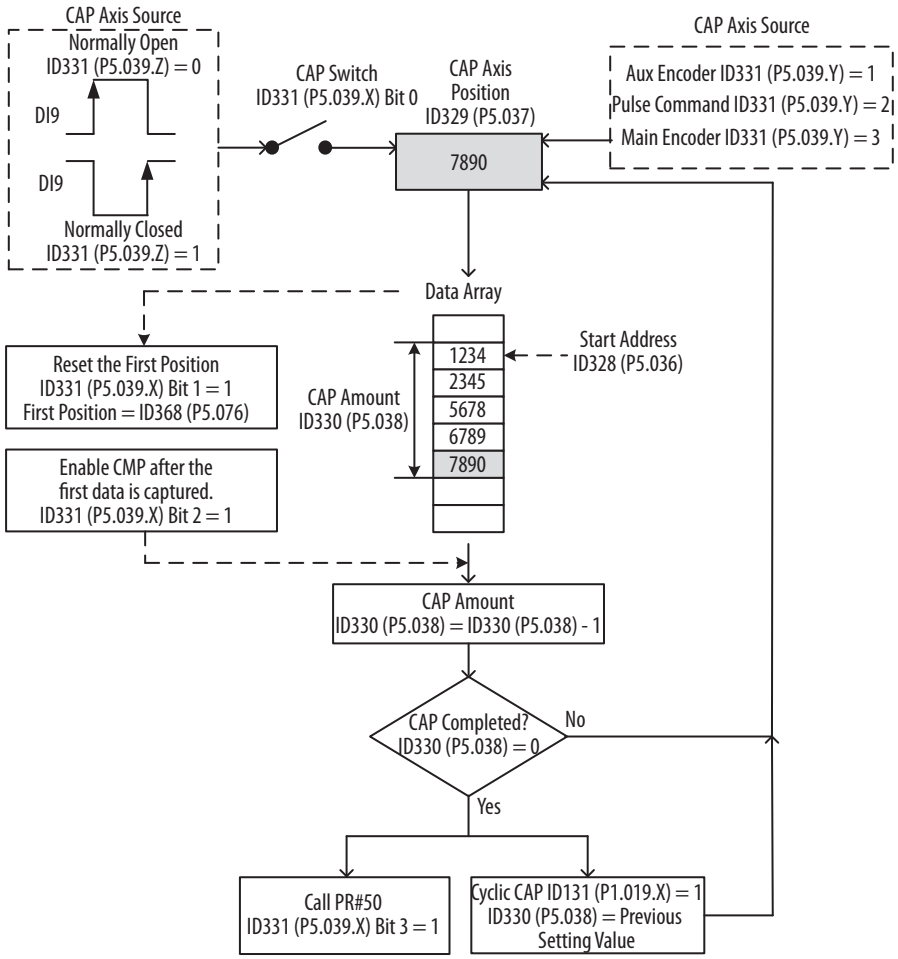
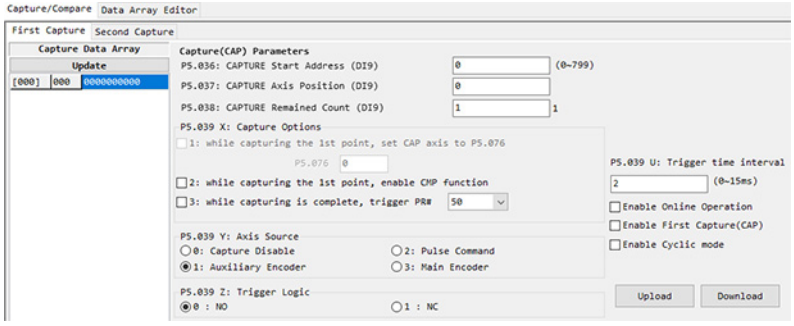


Figure 150 - Capture Function Screen



See Set Up Capture and Compare in KNX5100C Software on page 332.

Using PR Command Programming with the Capture Function (H3)

To use motion commands with the Capture function, we recommend using PR command programming.

With PR command programming, write commands configure the high-speed position capture function, as well as execute the motion commands once configuration is complete. See Chapter 11 for details on PR command programming.

The following example describes how the PR command works and is illustrated in Figure 151.

1. PR#1 confirms that the Capture function is disabled, with ID331.X (P5.039.X) NAME Bit 0 = 0.
2. PR#2 sets the start position of data array to #100.
3. PR#3 sets the capturing amount as 3.
4. PR#4 sets the capturing axis' position to 0 for the first capture point.
5. PR#5 sets the cyclic capture mode and then delay 1 ms to execute the next PR command.
6. PR#6 enables the capture function and resets the first point. Once the data capture is complete, the drive executes PR#50. It selects motor's encoder as the capturing axis, applying 'normally closed' contact as trigger logic with trigger interval of 2 ms.
7. PR#7 sets the speed command at 50 rpm.
8. PR#50 sets the move command (50000 PUU) per the last capturing position. Once the CAP (selects motor's main encoder as the capturing axis, applying 'normally closed' contact as trigger logic with trigger interval of 2 ms) is completed, carry on executing PR#50.
9. PR#51 sets the speed command at 50 rpm.

Figure 151 - PR Command with Application of High-speed Capture (DI9 example)

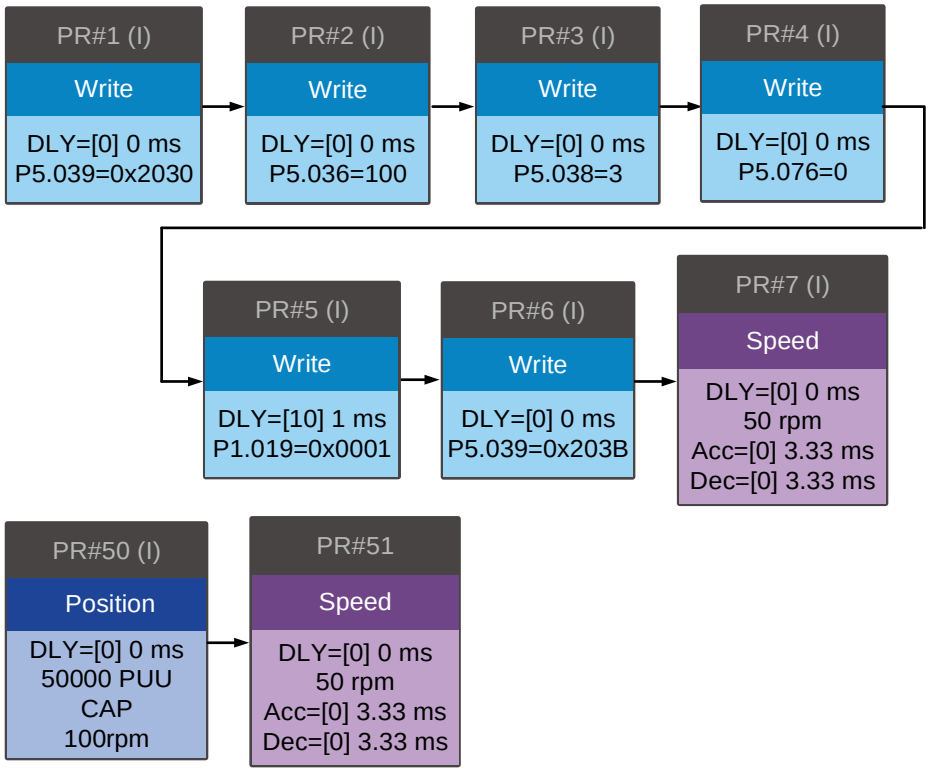
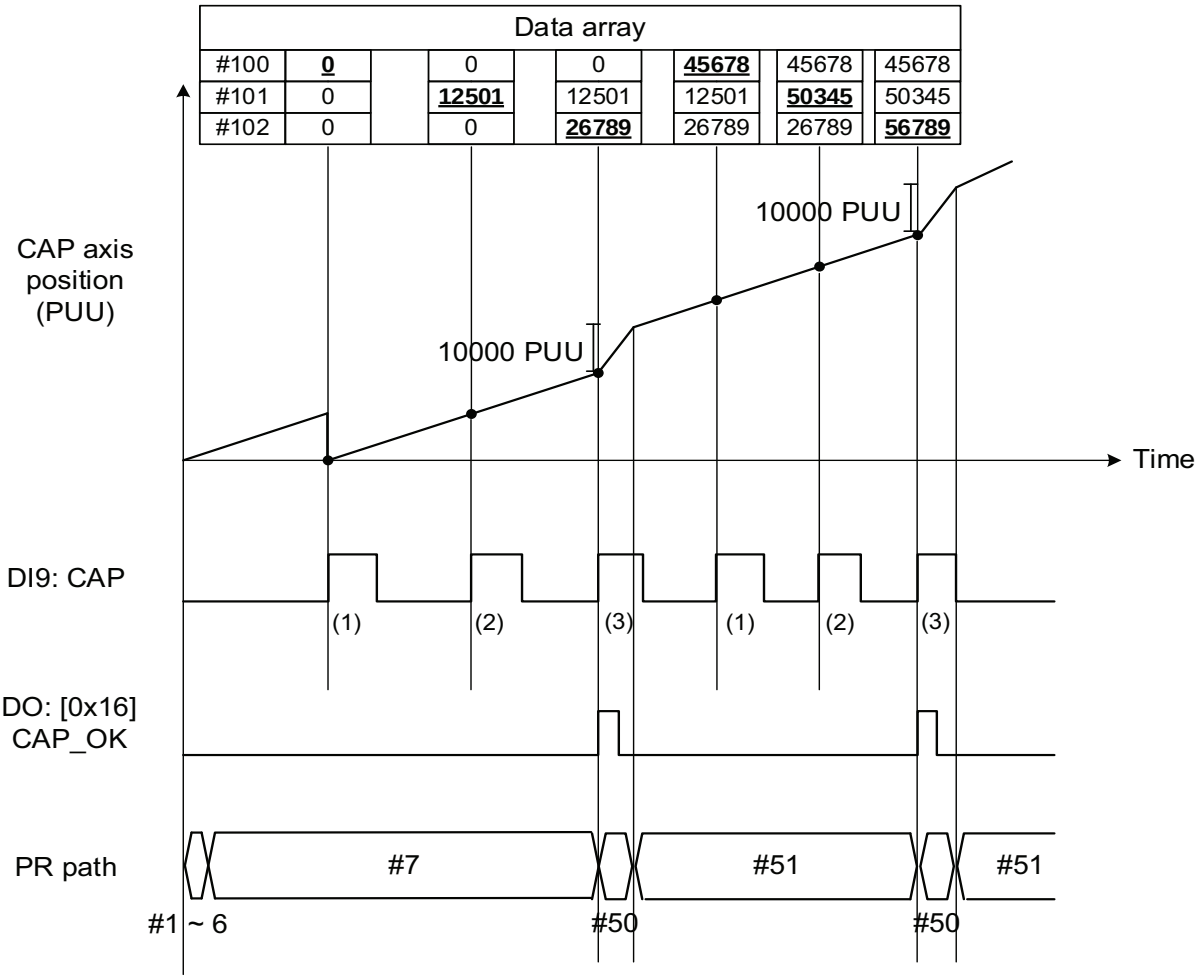


Figure 152 shows how the data is captured in the data array when the capture function is executed. At (1) after DI9 is triggered, the capturing axis is reset to 0 and the data is stored in data array #100 because the reset function of the first point is enabled and ID368 (P5.076) DI9FirstCaptureResetPosition is set to 0. At the moment DI9 is triggered the second (2) and third (3) times, the position data is written to the data arrays #101 and #102, respectively. Once the first capture cycle is completed, the DO:CAP_OK [0x16] signal turns on and then PR#50 (high speed position capture command) and PR#51 (motion with fixed speed) are executed. The servo drive will execute the next cycle. The DO:CAP_OK signal is off when procedure is completed and the capturing amount is set to 3.

When DI9 is triggered for the fourth (1) time, the capture axis' position is not reset and the position data of the capturing axis is written to data array #100 again. Therefore, the data written in the previous cycle is replaced. At the moment DI9 is triggered for the fifth and sixth times, the position of capturing axis is written to data arrays #101 and #102, respectively. As soon as the second capture cycle is finished, DO:CAP_OK [0x16] CAP turns on and then PR#50 (high speed position capture command) and PR#51 (motion with fixed speed) are executed.

When applying cyclic capture mode (P1.019.X = 1), the reset function is only valid for the first cycle. Every time a cycle ends, PR#50 is executed. The first position data that is captured in every cycle is written to the data array set by ID328 (P5.036) NAME and then other data is written in sequence. Position data written in the previous cycle is always replaced by that of the next cycle.

Figure 152 - High-speed Capture Application Example



High-speed Position Compare Function (CMP)

The high-speed position compare function compares the actual position of the motion axis with the value saved in data array. When the compare condition is fulfilled, a high-speed digital signal (DO4)[1] is output immediately for motion control. As this function is carried out by the hardware, KNX5100C software compares the data accurately on high speed motion axes. When the CMP function is enabled, the servo drive employs DO4 to force an output signal, which is not user-defined.

The following parameters define the function.

Table 114 - High-speed Capture Related Parameters

Parameter	Name
ID348 (P5.056)	CompareStartAddress
ID349 (P5.057)	CompareAxisPosition
ID350 (P5.058)	CompareRemainedCount
ID351 (P5.059)	CompareControl
ID330 (P5.038)	DI9CaptureRemainedCount
ID331 (P5.039)	DI9CaptureControl
ID131 (P1.019)	DI9ExtraConfiguration
ID133 (P1.023)	NonVolatileCompareDataOffset
ID134 (P1.024)	VolatileCompareDataOffset
ID153 (P1.046)	EncoderOutputResolution
ID176 (P1.097)	EncoderOutputDenominator

To configure the Compare function, you need to:

- Define and enable the operation of the compare function, including definition of the axis source and trigger logic
- Define the start position for data compare in the data array
- Set the amount of data to be compared
- Enable the cyclic mode

Figure 153 describes the compare function.

Use parameter ID351 (P5.059) CompareControl to enable or disable the Capture function and to define the axis source and trigger logic. See Table 115.

Table 115 - High-speed Position Compare, Additional Information

ID351 P5.059 CompareControl	Bit	Function	Description
X	1	Cycle mode	If bit 1 is set to 1 and all compare procedure is completed, ID350 (P5.058) resets to the setting value and then compare procedure starts again.
	2	Enable Capture function after data compared	If bit 2 is 1, after all comparing is done, enable the Capture function (Set ID331 (P5.039.X) bit 0 to 1, and set the previous value to ID330 (P5.038) as the data size to be captured); if Capture function has been enabled, then this function is invalid.
	3	Reset position of the comparing axis to 0	If bit 3 is 1, set ID349 (P5.057) to 1 once comparing is completed, the position of comparing axis will be cleared to 0.
Y	–	Source setting of comparing axis	0: Capturing axis 1: Auxiliary encoder (AUX) 2: Pulse command (I/O) 3: Main encoder (MFB) If capturing axis is selected, source of the capturing axis ID331 (P5.039.Y) cannot be changed. If encoder of the motor is selected, pulse resolution is determined by ID153 (P1.046) (Encoder pulse number output setting) and ID176 (P1.097).

(1) With execution time 5 µs only.

Table 115 - High-speed Position Compare, Additional Information (Continued)

ID351 P5.059 CompareControl	Bit	Function	Description
Z	–	Trigger logic	0: N.O. (normally open) 1: N.C. (normally closed)
U	–	Trigger PR command	If bit 0 is set to 1, PR#45 is triggered once the last data is compared.
CBA	–	Pulse output duration (ms)	–

See Set Up Capture and Compare in KNX5100C Software on page 332.

Using the Motor Encoder as the Compare Source

If the capturing axis is selected, the source of the capturing axis ID331 (P5.039.Y) cannot be changed. If the encoder of the motor is selected, the pulse resolution is determined by ID153 (P1.046) (Encoder pulse number output setting) and ID176 (P1.097).

When ID176 (P1.097) = 0, OA/OB pulse output only refers to the setting of ID153 (P1.046).

Example 1:

When ID176 (P1.097) = 0; ID153 (P1.046) = 2500

OA/OB output is P1.046 multiplied by 4 times the frequency, which is 10,000 pulse.

When ID176 (P1.097) has been set (value is not 0), OA/OB pulse output needs to be calculated via the numerator and denominator of ID153 (P1.046) and ID176 (P1.097), then convert into 4 times the frequency.

Example 1:

When ID176 (P1.097) = 5; ID153 (P1.046) = 2500

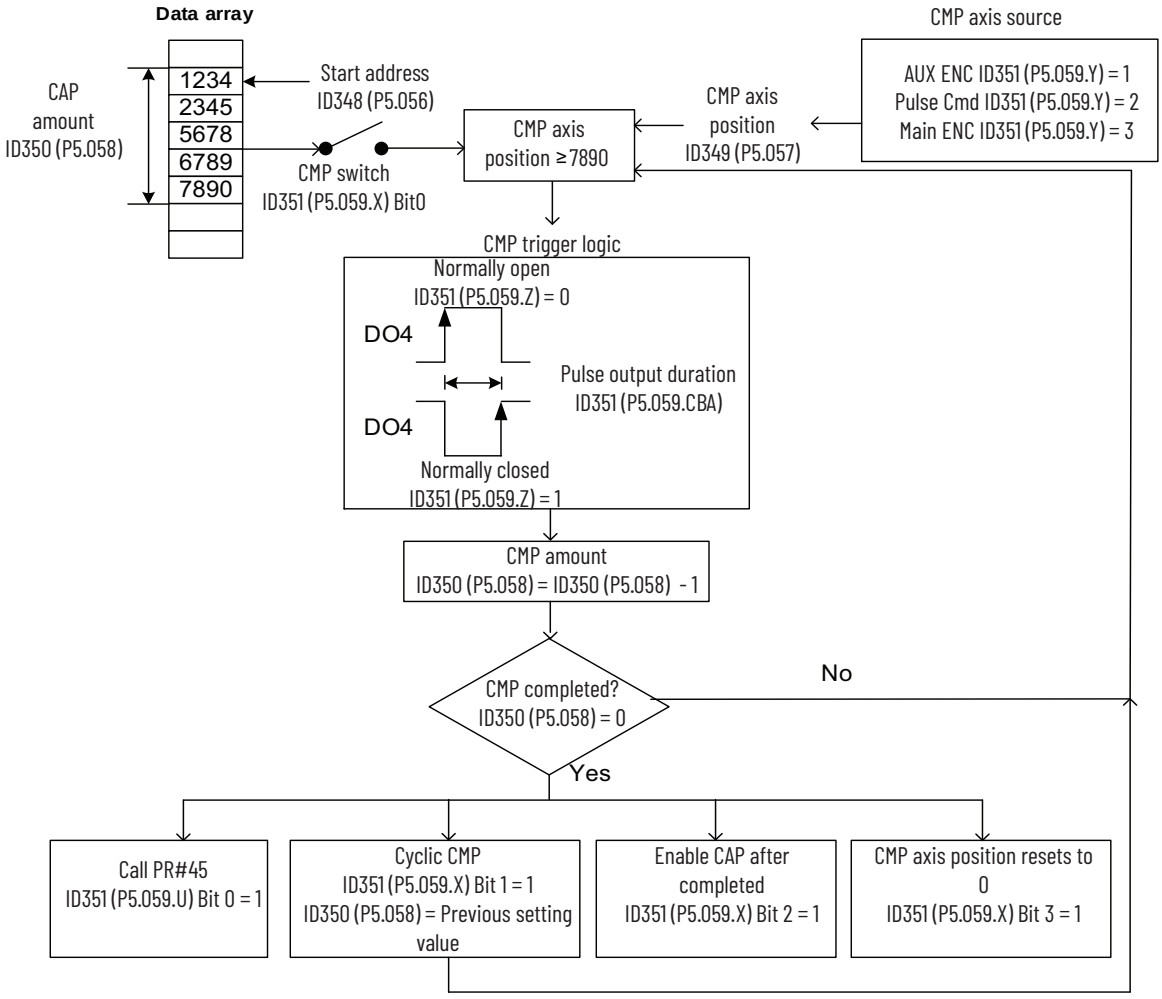
$$\text{OA/OB output} = \frac{2500}{5} = 500 \text{ pulse}$$

Example 2:

When ID176 (P1.097) = 7; ID153 (P1.046) = 2500

$$\text{OA/OB output} = \frac{2500}{7} = 357.142857 \text{ pulse}$$

Figure 153 - High Speed Position Compare Flowchart



Using PR Command Programming with the Compare Function

To use motion commands with the Compare function, we recommend using PR command programming.

With PR command programming, write commands configure the high-speed position compare function, as well as execute the motion commands once configuration is complete. See Chapter 11 for details on PR command programming.

The following example describes how the PR command works and is illustrated in Figure 155. Set the numerator ID153 (P1.046) EncoderOutputResolution and denominator ID176 (P1.097) EncoderOutputDenominator of the encoder's pulse output, whose default is based on the comparing axis runs 10000 pulses per rotation of motor.

1. PR#1 use write commands to edit data array #50.
2. PR#2 use write commands to edit data array #51.
3. PR#3 use write commands to edit data array #52.
4. PR#4 confirms that the Compare function is disabled (ID331.X (P5.039.X) Bit 0 = 0).
5. PR#5 sets the start position to #50.

6. PR#6 sets the compare amount to 3, with a delay of 1 ms to allow the PR command with the use of Compare function to be executed.
7. PR#7 enables the Compare function in cycle mode which clears the compare axis to 0 after compare is complete and executes PR#45. It selects encoder of the motor as the capturing axis, setting 'normally closed' as the trigger logic with pulse output duration of 100 ms.
8. PR#8 sets the speed command to 50 rpm.
9. PR#45 sets the incremental command to 50000 PUU and then carries on to PR#46, keeping the speed command setting of 50 rpm.

Figure 154 - PR Command with Application of Compare Function

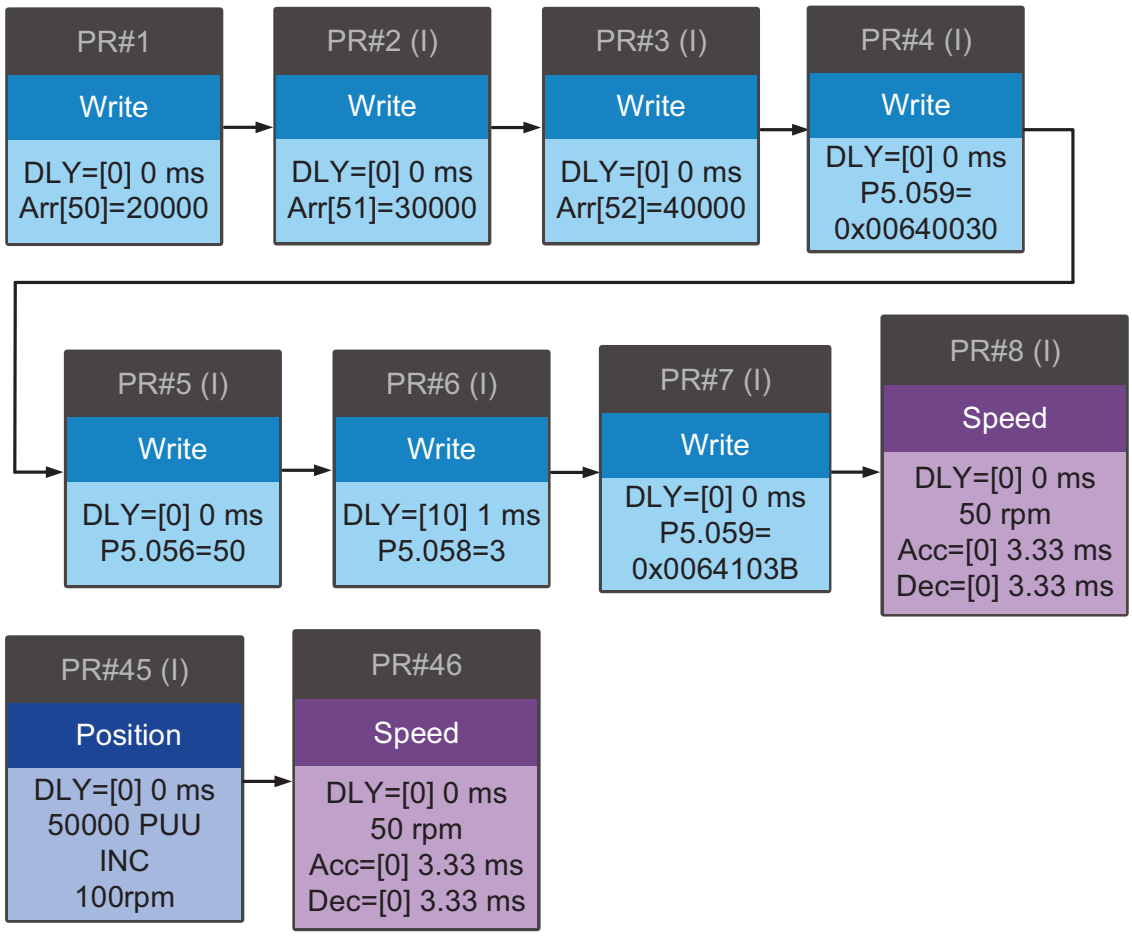
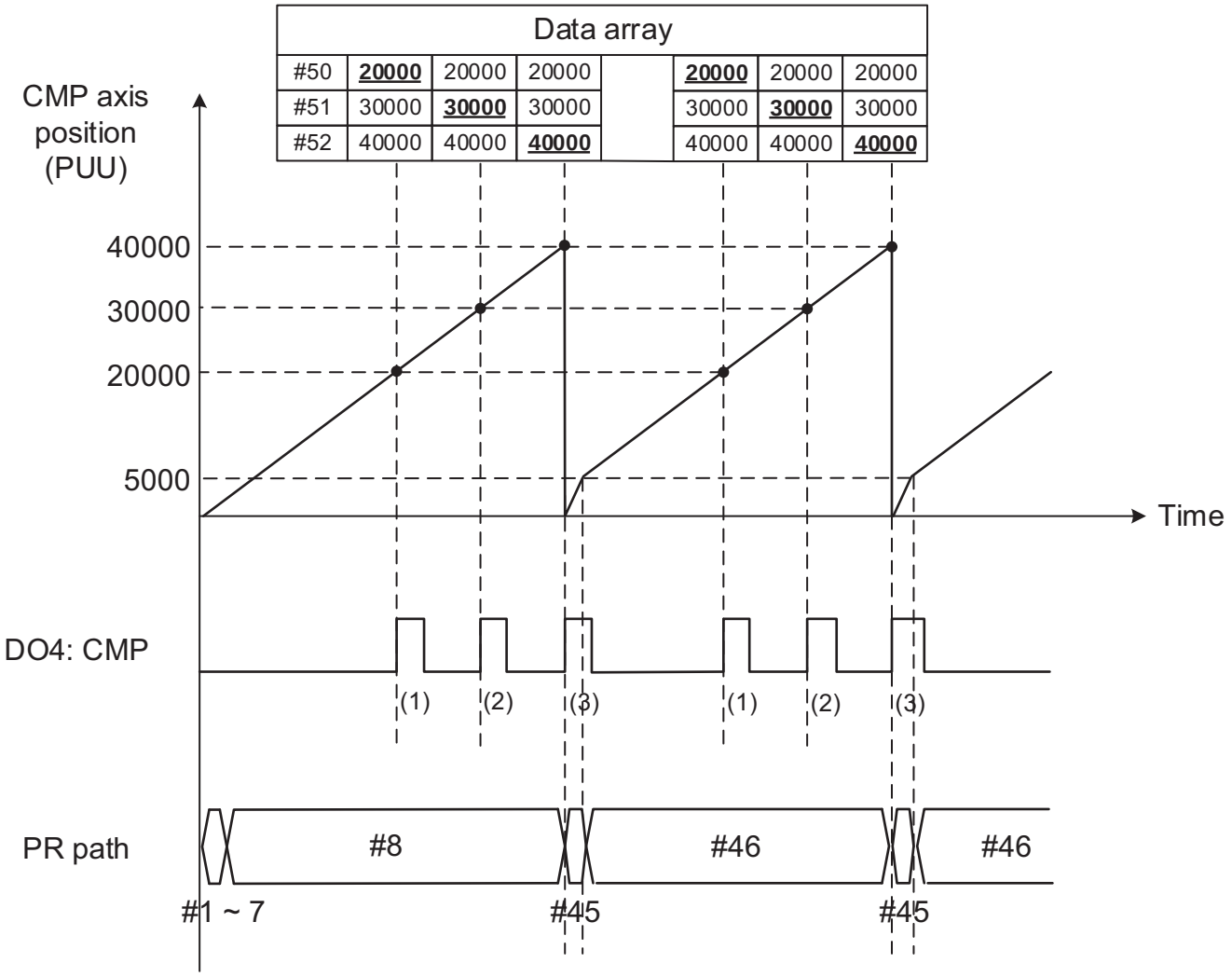


Figure 155 shows how the data is compared in the data array when the compare function is executed.

Figure 155 - Application Example of High-speed Compare



Data Array

Data array can store up to 800 data (0...799) with each data size of 32-bit. It can be used to store the high-speed captured data and high-speed compared data as well as E-Cam curves. Users have to segment the space for these three functions as their individual spaces are not restricted in the default setting. This way data being overwritten or changed incorrectly can be avoided. You can set ID193 (P2.008) to 30 and then 35 or use the KNX5100C configuration software to write the data to EEPROM, otherwise, the data does not remain after power off. A user-friendly setting screen is also provided in the configuration software for reading / writing the data array. See Set Up Capture and Compare in KNX5100C Software on page 332.

With two channels provided, users can use panel, communication, or the configuration software to read data from or write data to the data array. Channel 1 can be set by ID304 (P5.011), ID305 (P5.012), and ID306 (P5.013).

ID304 (P5.011) specifies the address for reading / writing of data array. ID305 (P5.012), and ID306 (P5.013) are the windows of reading / writing. Both can be used to read / write, but the behaviors after reading / writing differ. See Table 116. Channel 2 can be set by ID304 (P5.011), ID388...ID391 (P5.100...103).

ID304 (P5.011) sets the address for reading / writing of data array. ID388 (P5.100) can read data from or write data to the data array address following the address set by ID304 (P5.011). ID305 (P5.012), and ID391 (P5.103) work the same way. If the address number has reached the max. 799, then the address remains 799 instead of adding up. You can find more details in Table 116.

Table 116 - Channel 1 - Reading or Writing of Data Array

Parameter	Description		
ID304 (P5.011) Address of reading / writing	Specify the address for reading from or writing to the data array		
Window for reading or writing	Configured by	Behavior after reading	Behavior after writing
ID305 (P5.012) Window #1 for reading or writing	Panel	Value of ID304 (P5.011) does not add 1	Value of ID304 (P5.011) adds 1
	Communication or configuration software	Value of ID304 (P5.011) adds 1	Value of ID304 (P5.011) adds 1
ID306 (P5.013) Window #2 for reading or writing	Panel	Value of ID304 (P5.011) adds 1	Cannot be written via drive panel
	Communication or configuration software	Value of ID304 (P5.011) adds 1	Value of ID304 (P5.011) adds 1

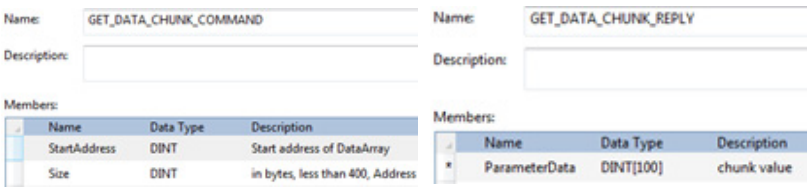
Example: When using the drive panel or communication for reading from or writing to the data array, add values to the data array address in this order:

- Data array #11 = 100
- Data array #12 = 200
- Data array #13 = 300

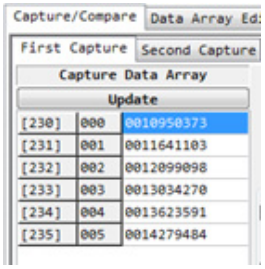
Message Service - Get/Set Chunk data (service code 0x33, 0x34) is used to access the data array or PR statement.

- Get Chunk data service (0x33)

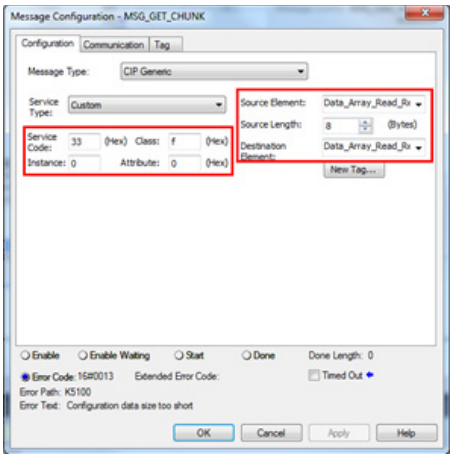
  This service defines the data structure of the command: Address 0x0000...0x0C7F for DataArray; Address 0x8000...0x08FB for PR Statements. The units of both StartAddress and Size are in bytes. Each data in the data array and PR statement are stored in four bytes, and the StartAddress and Size are a multiple of four. Also, this service defines the data structure of the reply.



The captured data array is shown. The stored capture data starts at 230, the StartAddress of the Get Chunk service is 230 × 4=920. The size is 6 × 4=24.



Use the MSG instruction to send the Get Chunk data service.

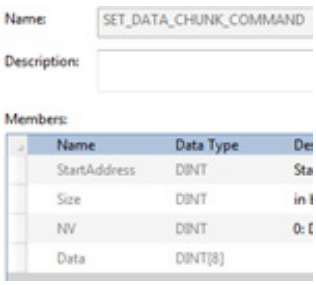


The read data is shown here.

Name	Value	Force	Style	Data Type
Data_Array_Read_Request	{...}	{...}		GET_DATA_CHUNK_COMMAND
Data_Array_Read_Request.StartAddress	920		Decimal	DINT
Data_Array_Read_Request.Size	24		Decimal	DINT
Data_Array_Read_Response	{...}	{...}		GET_DATA_CHUNK_REPLY
Data_Array_Read_Response.ParameterData	{...}	{...}	Decimal	DINT[100]
Data_Array_Read_Response.ParameterData[0]	10950373		Decimal	DINT
Data_Array_Read_Response.ParameterData[1]	11641103		Decimal	DINT
Data_Array_Read_Response.ParameterData[2]	12099098		Decimal	DINT
Data_Array_Read_Response.ParameterData[3]	13034270		Decimal	DINT
Data_Array_Read_Response.ParameterData[4]	13623591		Decimal	DINT
Data_Array_Read_Response.ParameterData[5]	14279484		Decimal	DINT
Data_Array_Read_Response.ParameterData[6]	0		Decimal	DINT

- Set Chunk data service (0x34)

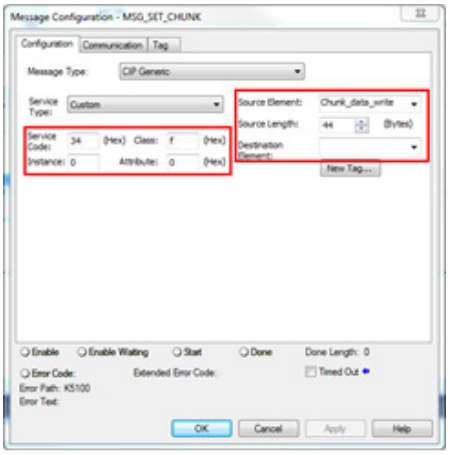
  This service defines the data structure of the command. If NV is 1, the data is also saved into EEPROM. The size is the byte numbers of the Data parameter.



Set the Data Chunk Command.

Chunk_data_write	{...}	{...}		SET_DATA_CHUNK_COMMAND
Chunk_data_write.StartAddress	292		Decimal	DINT
Chunk_data_write.Size	32		Decimal	DINT
Chunk_data_write.NV	1		Decimal	DINT
Chunk_data_write.Data	{...}	{...}	Decimal	DINT[8]
Chunk_data_write.Data[0]	888888		Decimal	DINT
Chunk_data_write.Data[1]	777777		Decimal	DINT
Chunk_data_write.Data[2]	666666		Decimal	DINT
Chunk_data_write.Data[3]	555555		Decimal	DINT
Chunk_data_write.Data[4]	444444		Decimal	DINT
Chunk_data_write.Data[5]	333333		Decimal	DINT
Chunk_data_write.Data[6]	222222		Decimal	DINT
Chunk_data_write.Data[7]	111111		Decimal	DINT

Use a MSG instruction to send the Set Chunk data service.

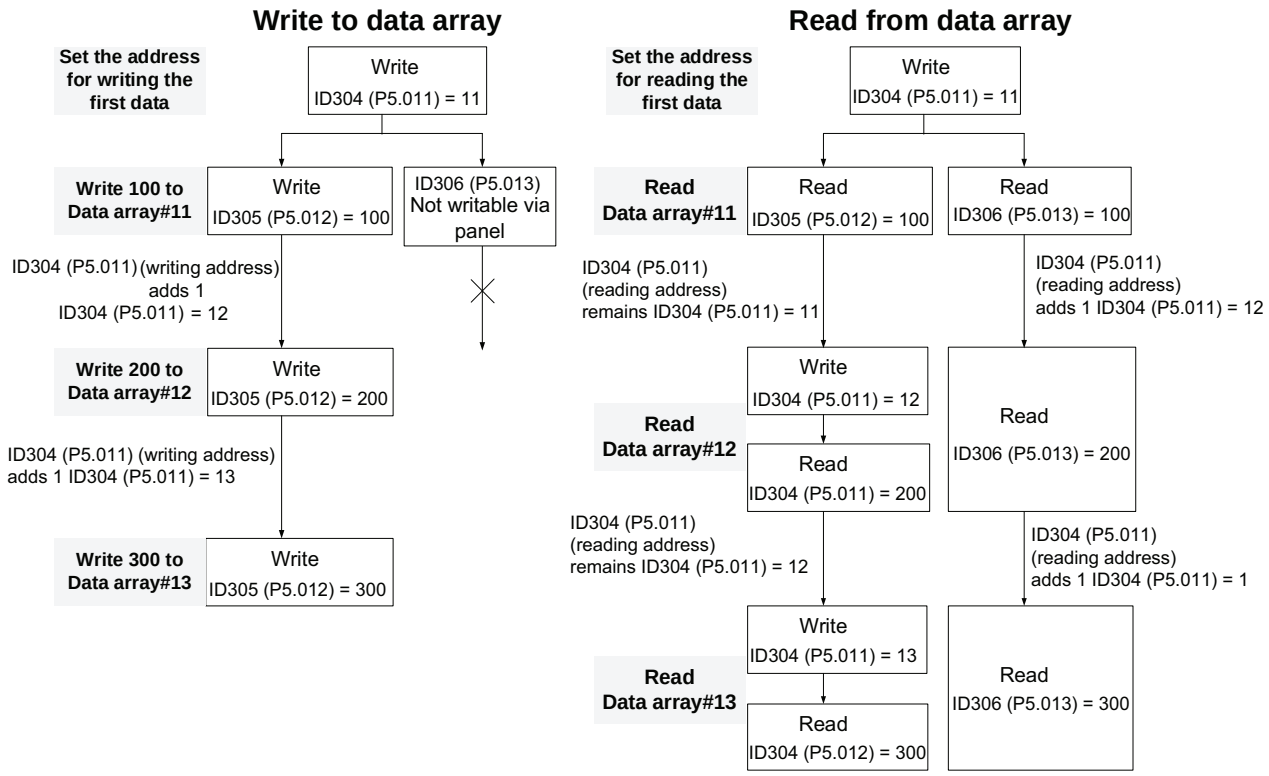


The data is read in the 'Data Array Editor' of KNX5100C software on the Capture (CAP)/Compare (CMP) page.

[072]	0000000000
[073]	0000888888
[074]	0000777777
[075]	0000666666
[076]	0000555555
[077]	0000444444
[078]	0000333333
[079]	0000222222
[080]	0000111111
[081]	0000000000

Then, the data is read in sequence.

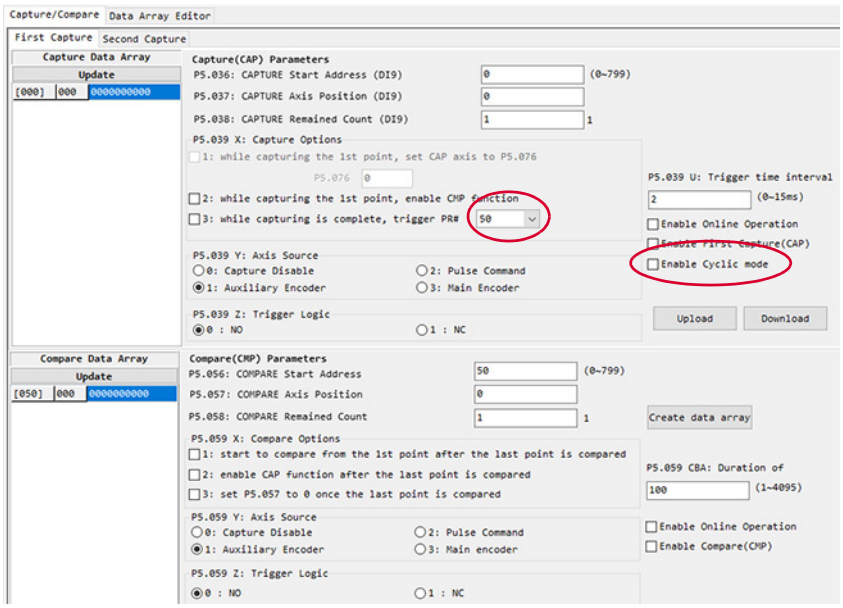
Figure 156 - Read or Write Via Panel



Set Up Capture and Compare in KNX5100C Software

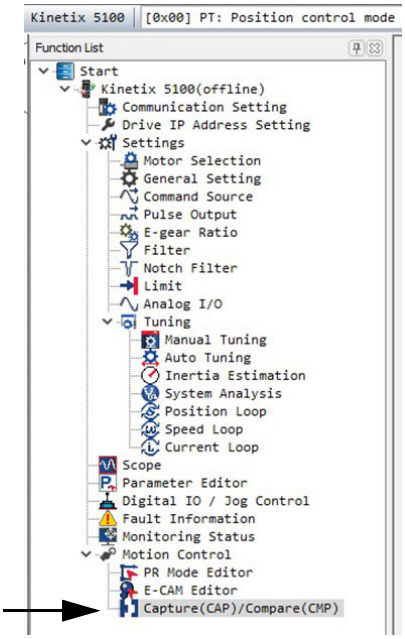
This user interface lets you use high-speed Capture and Compare functions quickly and change the data stored in Data Array easily.

Figure 157 - Capture or Compare User Interface



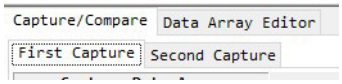
Click Capture(CAP) / Compare(CMP) node from the project tree to open Capture / Compare.

Figure 158 - Project Tree - Capture/Compare



KNX5100C software provides two channels of Capture including First Capture and Second Capture.

Figure 159 - Capture/Compare Channels



High-speed Capture Function

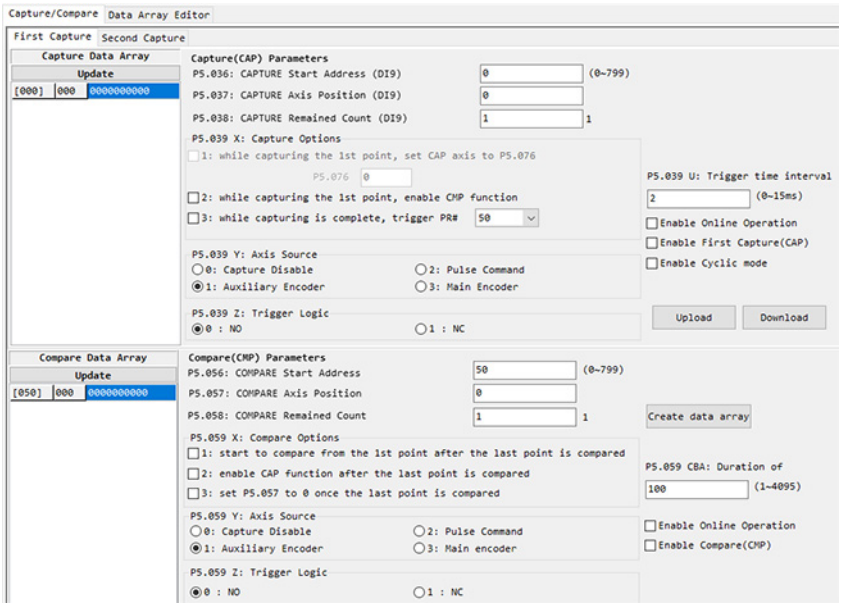
The High-speed Capture Function can be applied to latch a reference position which could be the signal of main encoder, linear encoder, or pulse train. It is possible to record 800 items with maximum length of Data Array.

Under Capture (CAP) Parameters, you can determine the setting values of the relevant Capture parameters and enable On-Line operation directly.

The High-speed Capture Function can change the data in Data Array.

Press Update to display the data stored in Data Array.

Figure 160 - Capture Data Array



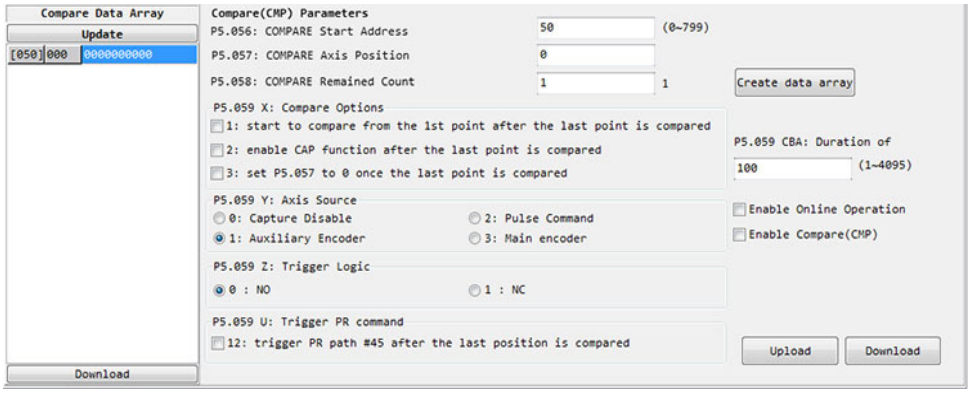
High-speed Compare Function

The High-speed Compare Function is a reverse process of the High-speed Capture Function. The items stored in Data Array are compared to the signal of a physical axis.

Under Compare (CMP) Parameters, you can determine the setting values of the relevant Compare parameters and enable On-Line operation directly.

The High-speed Compare Function cannot change the data in Data Array. It only can read the data in it.

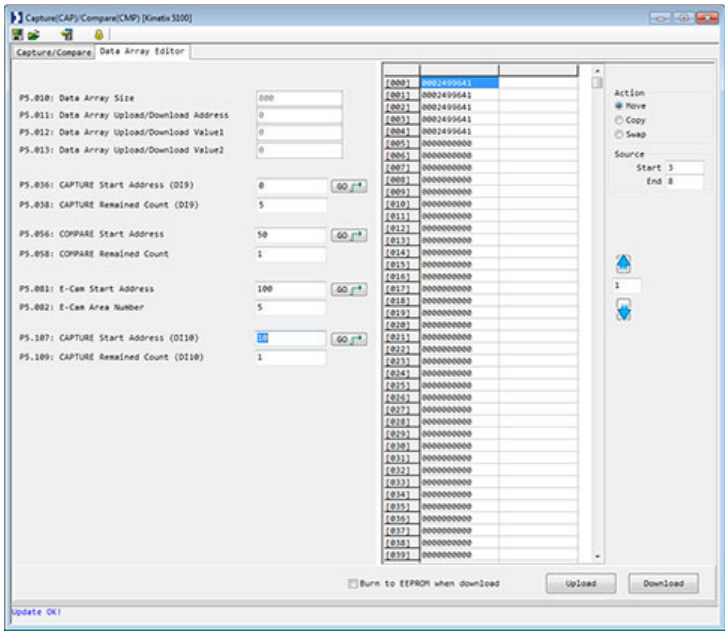
Figure 161 - Compare Data Array



Data Array

KNX5100C software provides the convenient functions for reading and editing the data in Data Array.

Figure 162 - Data Array Editor



The Data Array is a place to keep the data for the functions of Capture, Compare, and E-Cam. Up to 800 records (all together to max. 800 records) can be stored in the Data Array. Ensure not to overwrite the data stored in Data Array.

Use the Update Array Address button to update the parameter setting values of the Capture, Compare, and E-Cam functions.

Select the Burn to EEPROM check box to put the data into EEPROM for permanently keeping the data even when the drive is powered off.

Click the Upload button to load the data from the drive to the data array.

E-Cam

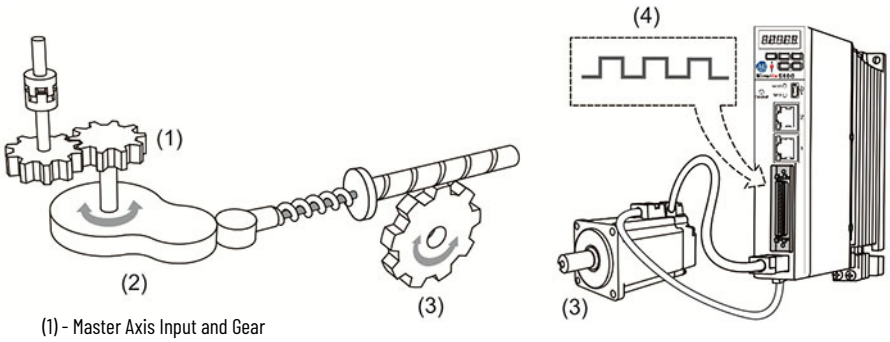
E-Cam is the built-in function in Kinetix 5100 series servo drive. Its advantages are the following:

- Increase the power efficiency - Without the friction among machinery parts, it reduces the power consumption.
- E-Cam shape is easy to change - E-Cam shape can be changed simply by modifying the E-Cam curve.
- Machinery maintenance - It is simulated by software.
- Wide range of application - E-Cam software is applicable to any application which is required to use E-Cam curve.
- Flexibility - One master axis can command several slave axes. It would be more difficult when doing it by machine cam.

With built-in E-Cam function, the configuration software stabilizes the control system and enables the servo drive to complete motion control command, such as synchronous conveyor, flying shear and rotary cut.

The E-Cam uses the mathematical equations to plan the motion path between Master Axis and Slave Axis. It cannot only replace the mechanical cam, but also break the shape limit of mechanical cam. The electronic cams can be used as long as they are master-slave control and can find the mathematical equations of the master-slave position relationship. The mechanical cam and electric cam are illustrated in Figure 163.

Figure 163 - Mechanical Cam and E-Cam



(1) - Master Axis Input and Gear
(2) - Mechanical Cam
(3) - Slave Axis Output
(4) - Master Axis Input for E-Cam

The E-Cam function can be used only in PR mode (ID117 (P1.001.YX) = 1). The slave axis operates according to the cam curve, and the position of the slave axis is a function of the position of the master axis. The master axis transmits pulses to the slave axis, and the slave axis operates according to the cam curve corresponding to the received master axis pulses, shown in Figure 164. The E-Cam function can be enabled or disable by setting parameter ID376 (P5.088.X). When the E-Cam function is turned on, the drive judges the time to engage the clutch. Figure 165 uses the mechanical cam concept to illustrate the E-Cam parameter settings.

Figure 164 - E-Cam Curve

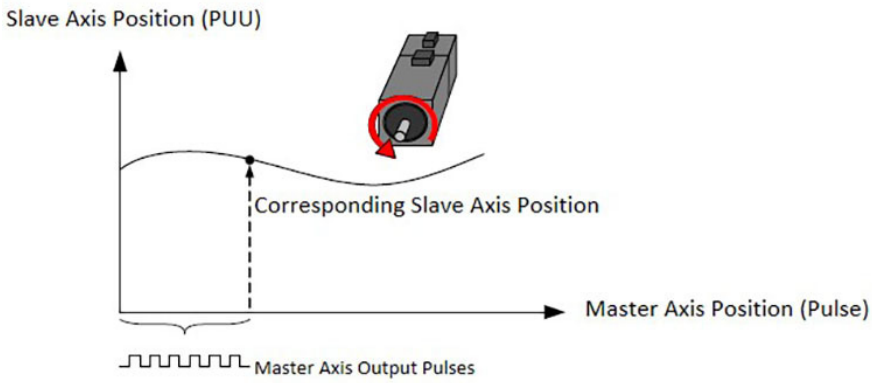
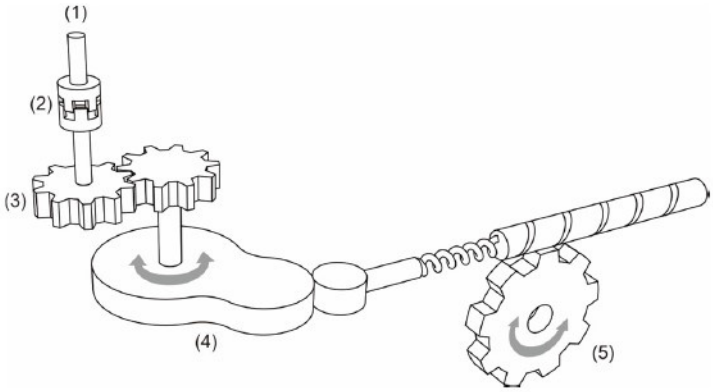


Figure 165 - Electronic cam simulates mechanical cam assembly with servo drive parameters



(1) Master Axis: master axis signal source is set by ID376 (P5.088.Y)
(2) Clutch: time to engage or disengage is set by ID376 (P5.088.UZ), ID375 (P5.087), ID377 (P5.089)
(3) Master Axis Gear Ratio: pulse input resolution is set by ID371 (P5.083), ID372 (P5.084)
(4) E-Cam Curve: curve is set by ID369 (P5.081), ID370 (P5.082), ID373 (P5.085), scale is set by ID311 (P5.019)
(5) Slave Axis Gear Ratio: output signal resolution is set by ID151 (P1.044), ID152 (P1.045)

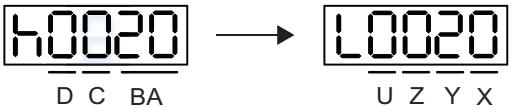
Table 117 - E-Cam General Settings

Parameter	Name
ID245 (P2.073)	ECamConfiguration
ID246 (P2.074)	ECamDIDelayTimeCompenation
ID247 (P2.075)	ECamAlignementTargetPosition
ID248 (P2.076)	ECamControlConfiguration
ID249 (P2.078)	ECamAreaNumPositive
ID250 (P2.079)	ECamAreaNumNegative

E-Cam Control Settings

The format of ID376 (5.088) ECamControl is: (High word h) DCBA: (Low word L) UZYX

Figure 166 - Parameter Format



BA	PR command to execute	X	Activation setting of E-Cam function
C	Reserved	Y	Command source
D	Reserved	Z	Engaging condition
-	-	U	Disengaging condition

Definition as follows:

- X: E-Cam command

Bit	Function	Description
0	E-Cam activation	0: E-Cam is disabled 1: E-Cam is enabled (relevant parameters cannot be modified once E-Cam is enabled)
1	E-Cam does not disengage when servo is off	0: when the servo is stopped by alarm or servo is off, the clutch disengages 1: when the servo stops because of alarm or servo is off, the clutch can remain engaged. When the servo switches to on again, E-Cam can operate directly. It can return to the correct E-Cam position by macro #D.
2	ID311 (P5.019) is effective immediately	0: ID311 (P5.019) is effective after next engagement 1: ID311 (P5.019) is effective immediately
3	Reserved	-

- Y: command source

  1: auxiliary encoder

  2: pulse command

  4: time axis (1 ms)
- Z: engaging time

  0: immediately

  1: trigger DI.CAM
- U: disengaging condition (2, 4, and 6 cannot be selected at the same time)

U	Disengagement condition	Action after disengaged
0	Never disengage	-
1	DI.CAM OFF	In stop status
2	Master axis reaches the setting value of ID377 (P5.089) (Sign indicates the direction)	In stop status
6	Same as 2, but the speed remains when disengaging and the engaged length slightly exceeds ID377 (P5.089) ECamMasterPositionToDisengage. This is suitable for when calling the next PR Position command right after disengaging.	
4	Master axis exceeds the value of ID377 (P5.089) (sign indicates the direction)	Return to pre-engaged status Lead pulse is ID380 (P5.092) ECamSkippedMasterPulses
8	When U = 1, 2, or 6: disable E-Cam after disengaging	Set X to 0
	When U = 4: Avoid jittering when it returns to pre-enagaged status	N/A

- BA: auto execute the specified PR command

  When disengaging condition (ID376 (P5.088.U: 2, 4, 6)) is met, a PR 00...3F (hexadecimal; 00 means no action) is executed automatically.
- C: reserved
- D: reserved

Master Axis Signal Source

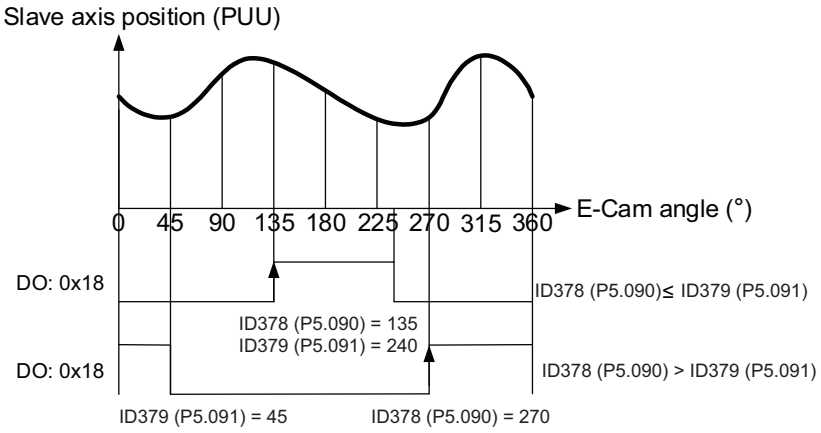
When using an electronic cam, you must first determine the source of the master axis, which can be an encoder, a host controller, a servo drive, and so on. The Kinetix 5100 drive provides three signal sources for master axis as follows. The signal source is determined by parameter ID376 (P5.088.Y) ECamControl. The master axis position can be observed by parameter ID374 (P5.086).

- Auxiliary Encoder - when ID376 (P5.088.Y) = 1, the external encoder signal from the motor feedback connector (MFB) is used as the source of the master axis signal. And the master axis position can be obtained by reading ID309 (P5.017) AuxEncoderPosition.
- Pulse Input - when ID376 (P5.088.Y) = 2, the pulse input from the I/O connector is used as the source of the master axis signal. And the master axis position can be obtained by reading ID310 (P5.018) PulseCmdPosition.
- Time Axis (1ms) - when ID376 (P5.088.Y) = 4, the 1ms pulse generated internally by the servo drive is used as the source of the master axis signal.

Digital Output CAM_Area Settings

The Kinetix 5100 drive provides two sets of digital outputs [0x18]CAM_AREA and [0x1A]CAM_AREA2 to indicate the current master axis position of E-Cam. The first area is determined by parameter ID378 (P5.090) and ID379 (P5.091), as illustrated in Figure 167. The second area is determined by parameter ID249 (P2.078) and ID250 (P2.079), as illustrated in Figure 168.

Figure 167 - Digital Outputs of Clutch Engagement



The following parameters define the function.

Table 118 - Relevant Parameters

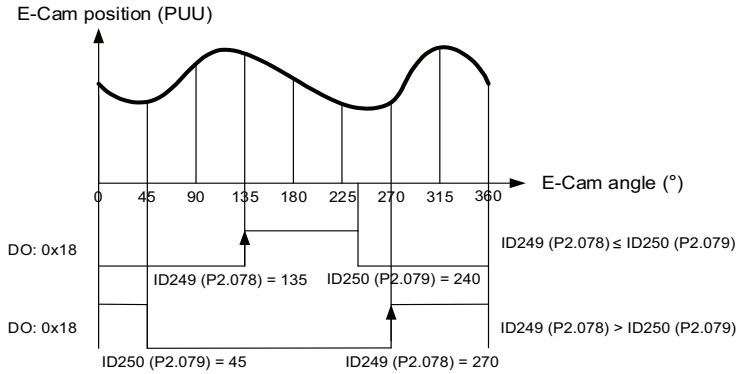
Parameter	Name
ID378 (P5.090)	ECamDOCamArea1RisingEdgeAngle
ID379 (P5.091)	ECamDOCamArea1FallingEdgeAngle
ID249 (P2.078)	ECamDOCamArea2RisingEdgeAngle
ID250 (P2.079)	ECamDOCamArea2FallingEdgeAngle

ID378 (P5.090)>=ID379 (P5.091): DO.CAM_AREA1 (0x18) is on when the master axis position angle is bigger than ID379 (P5.091) but not bigger than ID378 (P5.090).

Master ID378 P5.090<ID379 (P5.091): DO.CAM_AREA1 (0x18) is on when the master axis position angle is bigger than ID378 (P5.090) but not bigger than ID379 (P5.091).

The relationship between DO.CAM_Area2 and the parameter values is shown in Figure 168. When E-Cam is not engaged, this signal is always off.

Figure 168 - Digital Outputs of Clutch Engagement, Area 2



1. ID249 (P2.078)>=ID250 (P2.079): DO.CAM_AREA2 (0x1A) is on when the master axis position angle is bigger than ID250 (P2.079) but not bigger than ID249 (P2.078).

2.ID249 (P2.078)<ID250 (P2.079): DO.CAM_AREA2 (0x1A) is on when the master axis position angle is bigger than ID249 (P2.078) but not bigger than ID250 (P2.079.

System Variables for Master Access Monitoring

The Kinetix 5100 drive also provides four system variables to monitor the master axis:

- Cumulative Pulse of Master Axis - system variable 059(3Bh): the cumulative number of pulses of the E-Cam master axis, equivalent to P5.086.
- Incremental Pulse of Master Axis - system variable 060(3Ch): the incremental number of pulses of the E-Cam master axis in 1ms.
- Lead Pulse of Master Axis - system variable 061(3Dh): when the clutch is engaged, the lead pulse of E-Cam master axis before disengaged ID377 (P5.089) decreases to zero will trigger the clutch disengaged. When the clutch is disengaged, the lead pulse of E-Cam master axis before engaged ID375 (P5.087) decreases to zero will trigger the clutch engaged.
- Position of Master Axis - system variable 062(3Eh): the position of the E-Cam master axis.

When using the E-Cam, the pulse bypass function lets the servo drive transmit the received pulse signal to the next servo drive, so that multiple slave axes can refer to the same master axis signal. The signal strength of the drive is not attenuated because the drive has the function as a strong wave device. The signal strength returns to its input intensity when outputting. For example, when the signal input is 4.5V, the output is adjusted to 5V. Because of the resistance on the cable, consider the signal attenuation. Use the twisted pair of isolated wire. If the input signal attenuated to a pulse signal which can't be recognized by the servo drive, then the wire diameter must be increased or the signal line shortened. If the signal delay time caused by the wire is not considered, the delay time between each servo drive to transmit the signal is 50 nanoseconds (ns).

The Kinetix 5100 drive only provides four pulse output pins OA, /OA, OB, /OB respectively. The pulse can be input to the drive through the I/O connector or AUX connector. The servo drive output signal source is determined by ID173 (P1.074.Y). If the AUX connector is used as the pulse input channel, as shown in Figure 169, then the value of ID173 (P1.074.Y) of each drive shall be set to 1. If the I/O connector is used as the pulse input channel, as shown in Figure 170, then the value of ID173 (P1.074.Y) of each drive is set to 2.

Figure 169 - Pulse By-pass Function - Auxiliary Feedback (AUX) Connector

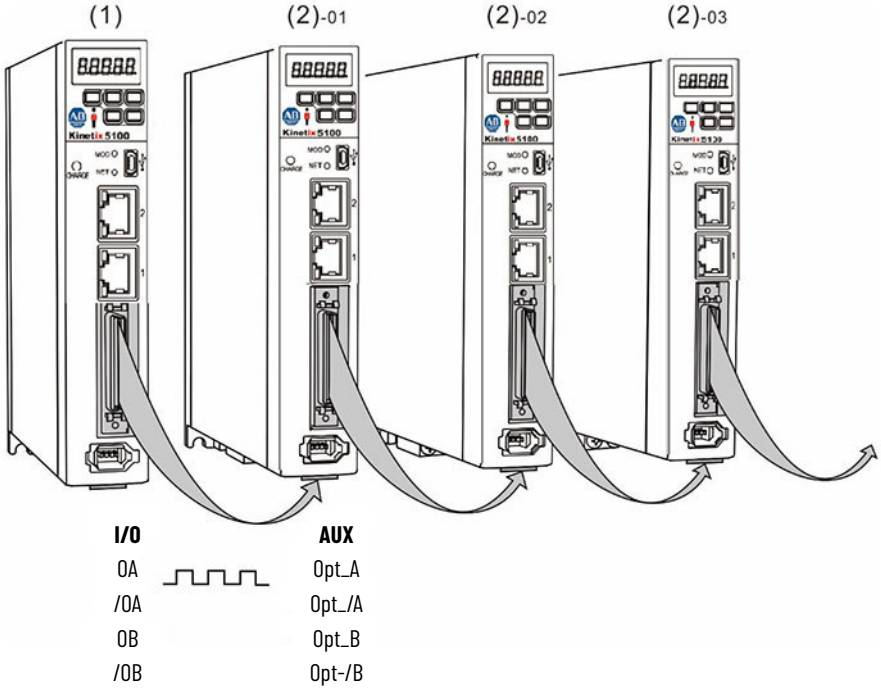
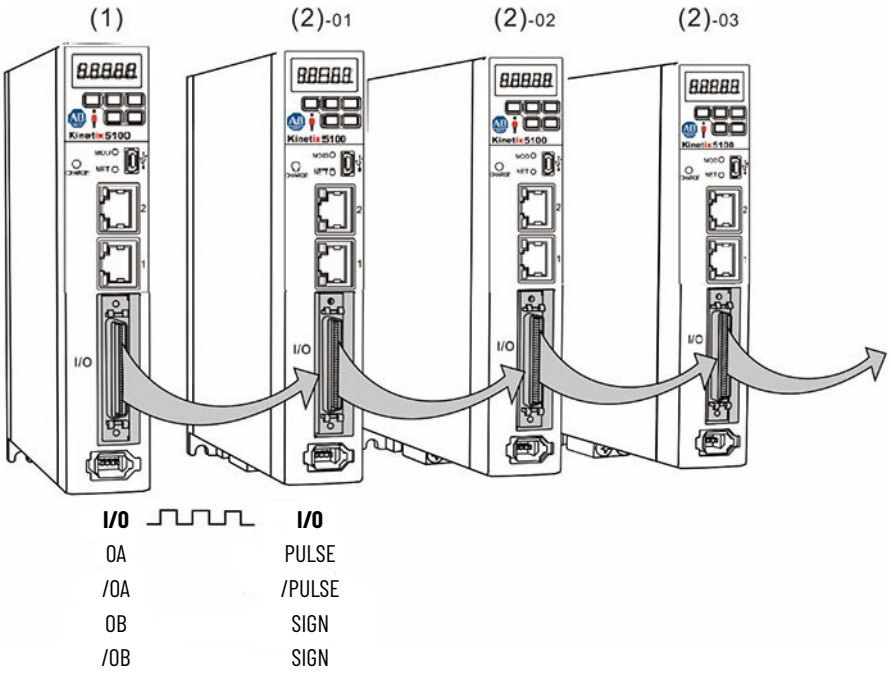


Figure 170 - Pulse By-pass Function - I/O Connector



Clutch Engagement and Disengagement

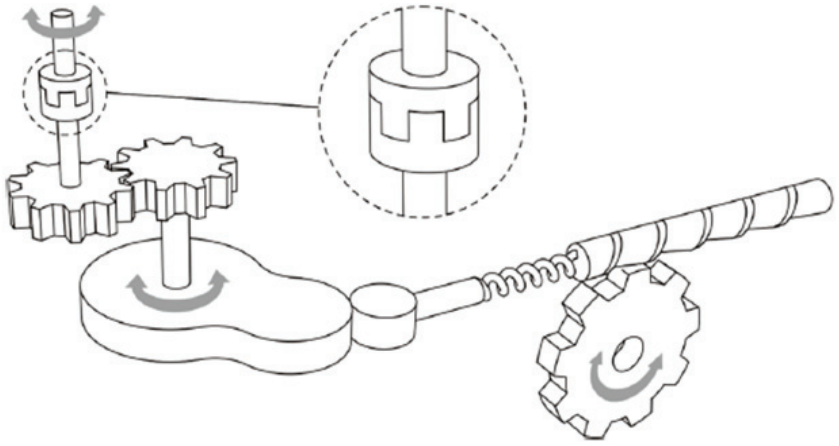
When the E-Cam function is enabled, the state of the clutch determines whether the slave axis start operates according to the received master axis signal or not. When the clutch is engaged, the slave axis operates according to the received master axis pulse and the cam curve. When the cam is disengaged, the slave axis does not operate according to the cam curve even if the slave axis receives the master axis pulse.

Condition for Engagement

When the E-Cam function is enabled, the slave axis can only be operated according to the master axis signal and the cam curve when the clutch is in the engaged state, as shown in Figure 171. The timing condition of the clutch engagement can be set by parameter ID376 (P5.088.Z). Kinetix 5100 provides two kinds of timing conditions for users to choose.

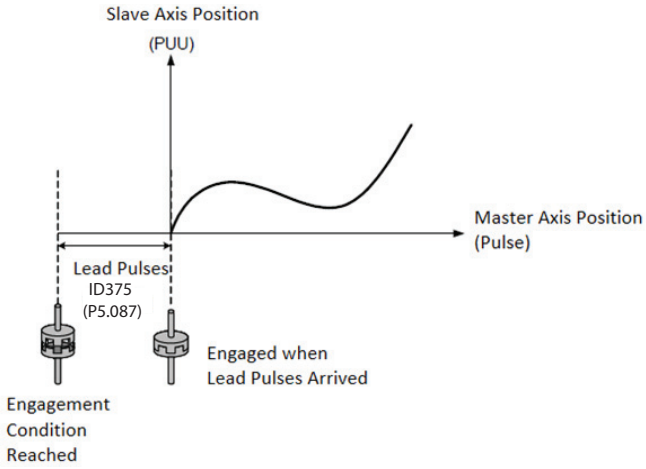
- Immediate engagement (ID376 (P5.088.Z) = 0) — The clutch is engaged immediately after the E-Cam function is activated, and the slave axis immediately operates according to the master axis signal and the electronic cam curve.
- Engagement controlled by Digital Input (ID376 (P5.088.Z) = 1) — The clutch is engaged when the digital input DI:CAM [0x036] is triggered. When this DI is triggered, the clutch remains engaged until a disengagement condition is reached.

Figure 171 - Clutch Engagement Diagram



In addition, the initial lead pulse number of the master axis before engagement can be set by parameter ID375 (P5.087) ECamLeadPulseBeforeEngaged. That means when the engagement condition is reached, the clutch is still waiting. It is engaged until the lead pulse is reached, as shown in Figure 172.

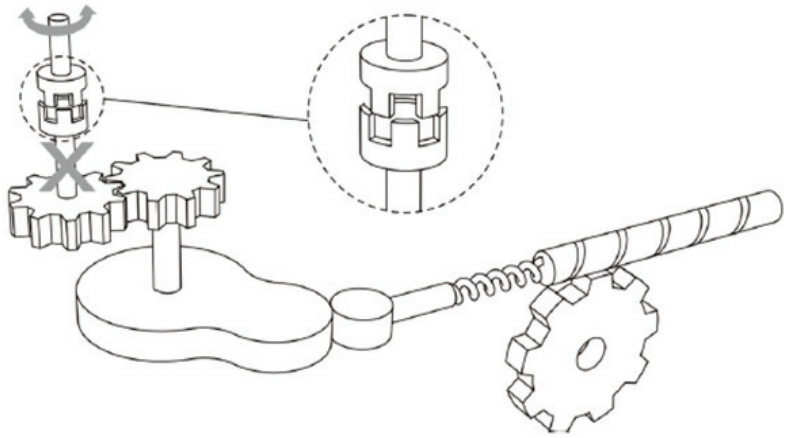
Figure 172 - Clutch Engagement Lead Pulses



Condition for Disengagement

When the E-Cam function is enabled and the clutch is engaged, the slave axis operates according to the master axis signal and the cam curve. When the slave axis completes its motion, it is stopped either by disabling the E-Cam function or disengaging the clutch. As shown in Figure 173, if the clutch is in the disengaged state, the slave axis always remains stationary regardless of the action of the master axis.

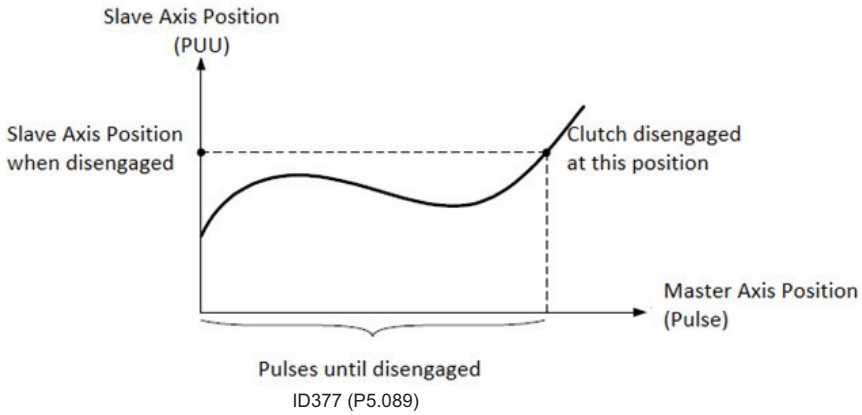
Figure 173 - Clutch Disengagement Diagram



You can choose the proper disengagement condition based on different applications by setting ID376 (P5.088). The Kinetix 5100 drive provides five disengagement timing conditions:

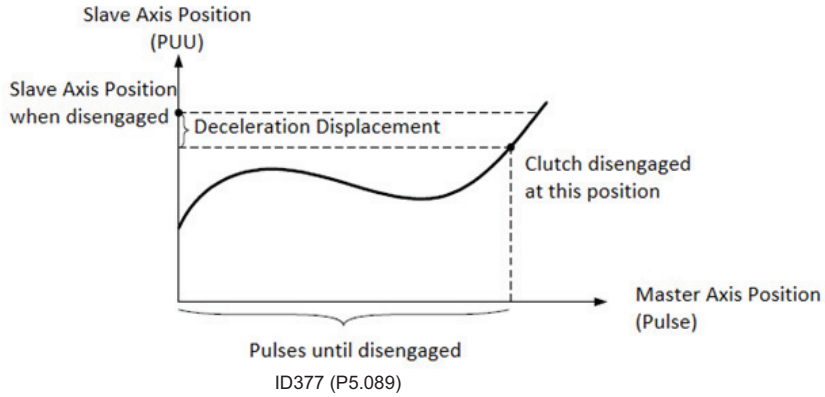
- Never disengagement (ID376 (P5.088.U) = 0) — The clutch does not disengage until the E-Cam function is disabled.
- Disengagement controlled by Digital Input (ID376 (P5.088.U) = 1) — The clutch is disengaged when the digital input (DI:CAM [0x036]) is triggered to OFF. It remains in disengaged state when this DI is OFF; the E-Cam system is in the stop state.
- Immediate stop after disengagement ID376 (P5.088.U) = 2) — The clutch is disengaged and stops immediately when the number of pulses of the master axis reaches the value set by ID377 (P5.089). Then the E-Cam system enters the stop state, as shown in Figure 174. This disengagement condition is suitable for the application where the slave axis must be accurately stopped.

Figure 174 - Immediate Stop After Disengagement



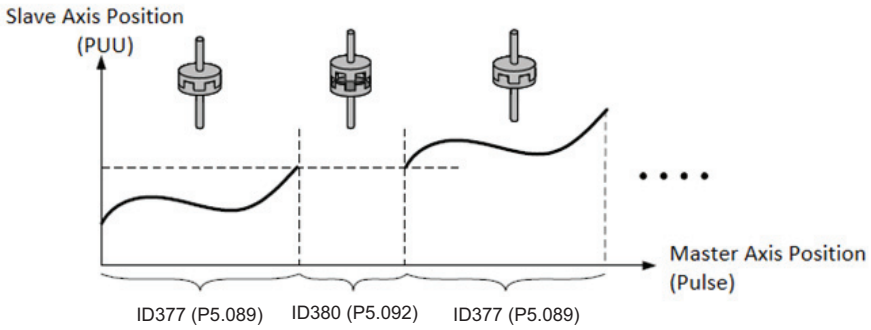
- Deceleration stop after disengagement (ID376 (P5.088.U) = 6) — The clutch is disengaged and decelerates smoothly to stop when the number of pulses of master axis reached the value set by ID377 (P5.089). Then the E-Cam system enters the stop state, as shown in Figure 175. This disengagement condition is suitable for the application where the slave axis must be slowly decelerated to a stop.

Figure 175 - Deceleration Stop After Disengagement



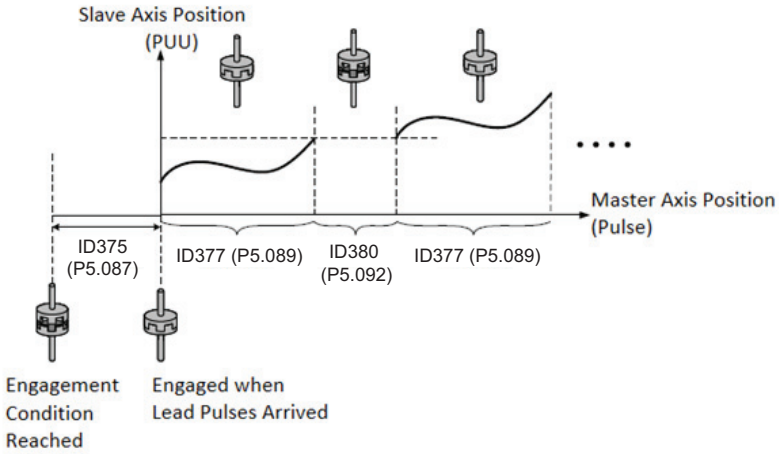
- Entering loop mode after disengagement (ID376 (P5.088.U) = 4) — The clutch enters the loop mode when the number of pulses of master axis reached the value set by instance ID377 (P5.089) ECamMasterPositionToDisengage. Then the E-Cam system enters the pre-engage state, as shown in Figure 176. The clutch engages again and operates the next motion cycle when the number of skipped master position pulses before re-engage reached the value set by ID380 (P5.092) ECamSkippedMasterPulses.

Figure 176 - Loop Mode After Disengagement



Pay attention to the difference between the lead pulses before engaged (ID375 (P5.087)) and the skipped master position pulses before re-engage (ID380 (P5.092)). ID375 (P5.087) takes effect only before the first engagement, however, ID380 (P5.092) takes effect each time in a motion cycle before engagement. Figure 177 shows the schematic diagram of the combination of these two.

Figure 177 - Lead pulses before engaged and Skipped master position pulses before re-engage



You can only choose one from these three disengagement conditions.

- immediate stop after disengagement
- deceleration stop after disengagement
- entering loop mode after disengagement (ID376 (P5.088.U) = 2, 6, 4)

If you select these conditions:

Disengagement controlled by DI, immediate stop after disengagement, or deceleration stop after disengagement (ID376 (P5.088.U) = 1, 2, 6), the function of disabling the E-Cam function after clutch disengagement is available. That means ID376 (P5.088.X) =0, however, this value can't be set independently. It must be used with on of the above three conditions. Both the clutch disengagement and disabled E-Cam function results in the slave axis no longer operating. But the E-Cam system is in different states (stop, engaged, pre-engaged). The E-Cam function is completely shut down when the E-Cam function is disabled. When the clutch is disengaged, the slave axis is stopped, but the E-Cam system is still operating. And the slave axis is still monitoring the pulse input signal from master axis.

You can set the PR command after the condition of immediate stop after disengagement, or deceleration stop after disengagement, or entering loop mode after disengagement (ID376 (P5.088.U) = 2, 6, 4). The followed PR command number is stored in instance ID376 (P5.088.BA). If the value is 0, then there will be no PR command after. If there is PR command designated in the condition of entering loop mode after disengagement (ID376 (P5.088.U) = 4), the slave axis continues in the next motion cycle after PR command complete. That is because the E-Cam function doesn't support interrupt.

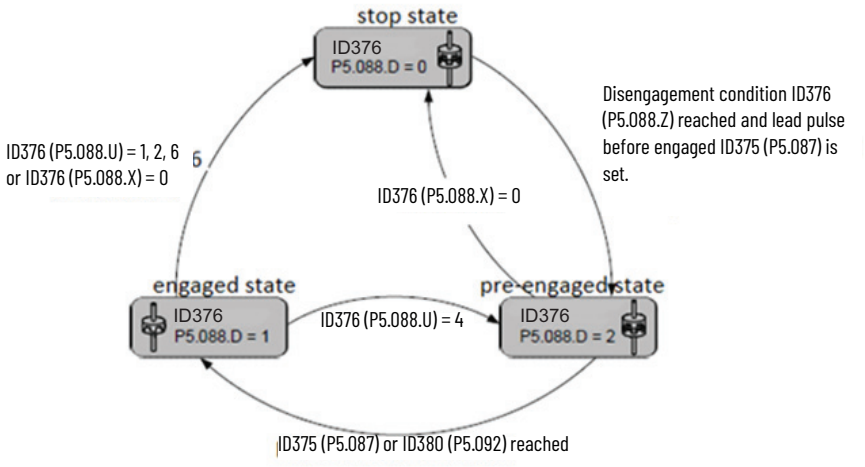
E-Cam System State

The electronic cam system has three states: stop, engaged, and pre-engaged. When the E-Cam function is enabled, the current state of the system can be observed in real time by parameter instance ID376 (P5.088.D). The following describes each state in detail. The schematic diagram is shown in Figure 178.

- Stop state (ID376 (P5.088.D) = 0) — In this state, the clutch is disengaged, and the system continuously checks the engagement condition (instance P5.088.Z, (376)). When the engagement condition is reached, it enters into the engaged state if instance ID375 (P5.087) equals 0. And it enters the engaged state if the lead pulses before engagement is set and reached. The clutch also enters into the stop state if the E-Cam function is disabled.
- Engaged state (ID376 (P5.088.D) = 1) — In this state, the clutch is engaged, and the system continuously checks the disengagement condition (ID376 (P5.088.U)). The system enters into the stop state if on of the following conditions is reached:
  - digital input (DI) controlled disengagement
  - stop immediately after disengagement
  - decelerate stop after disengagement (ID376 (P5.088.D)= 1, 2, 6).

  If the disengagement condition of entering loop mode after disengagement (ID376 (P5.088.U)=4) reached, the system will enter into the pre-engaged state.
- Pre-engaged state (ID376 (P5.088.D) = 2) — In this state, the clutch is disengaged, and the system continuously checks lead pulses before engagement (ID375 (P5.087)) and the skipped master position pulses before re-engagement (ID380 P5.092)). If the condition reached, the clutch engages and the system enters into the engaged state.

Figure 178 - E-Cam System State



E-Cam Gear Ratio and Curve Scaling

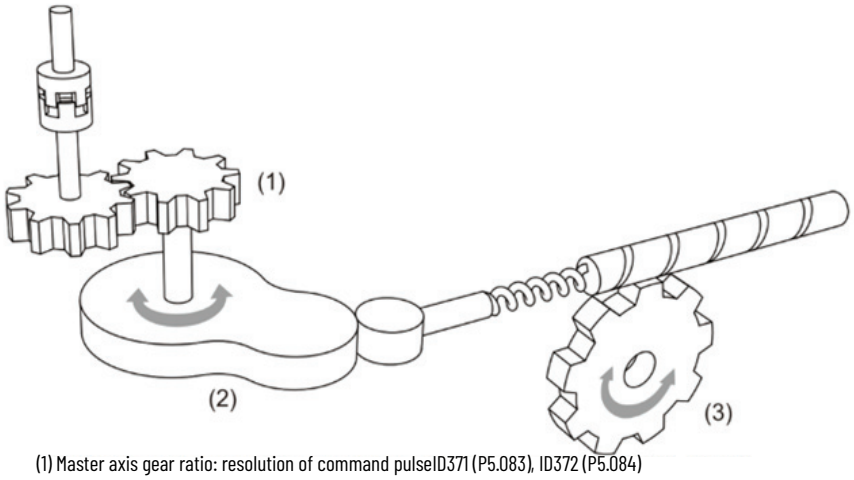
In the E-Cam system, there are two kinds of electronic gear ratios that can determine the motion performance:

- Master axis electronic gear ratio
- Slave axis electronic gear ratio

The slave axis electronic gear ratio is determined by ID151 (P1.044) and ID152 (P1.045) which is also the electronic gear ratio of the overall servo system. Once this electronic gear ratio is changed, the motion behavior changes not only in the E-Cam function, but also in other control modes (PT/PR). Therefore, if you simply adjust the electronic cam gear ratio, it is not recommended to adjust this gear ratio parameter.

The master axis electronic gear ratio is dedicated to the electronic cam system and can change the resolution of the master axis pulse command. The setting parameters are ID371 (P5.083) ECamSlaveCycleNumberM and ID372 (P5.084) ECamMasterPulseNumberP. When the slave axis receives the number of master axis pulses defined by ID372 (P5.084), the electronic cam runs the number of cycles defined by ID371 (P5.083) (one cycle means the cam curve running from 0...360 degrees).

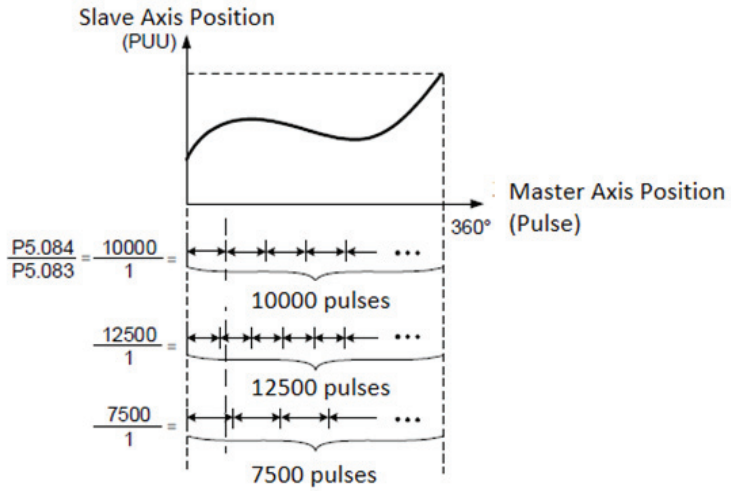
Figure 179 - E-Cam Gear Ratio



(1) Master axis gear ratio: resolution of command pulseID371 (P5.083), ID372 (P5.084)
(2) E-Cam curve: scaling ID311 (P5.019)
(3) Slave axis gear ratio: resolution of output signal ID151 (P1.044), ID152 (P1.045)

The following example explains the resolution adjustment method of the master axis. As shown in Figure 180, the original setting is 10000 master axis pulses for one cycle. When the ratio becomes larger (ID372 (P5.084) increases or ID371 (P5.083) decreases), the phase interval, which corresponds to one master axis pulse is narrowed. As a result, the resolution of the master axis pulse command becomes higher. When the ratio becomes smaller (ID372 (P5.084) decreases or ID371 (P5.083) increases), the phase interval, which corresponding to one master axis pulse, is wider. As a result, the resolution of the master axis pulse command becomes lower. In general, ID371 (P5.083) is set to 1, and ID372 (P5.084) is set to the number of master axis pulses required for one cycle. If the number of pulses required for one cycle is a number with decimal point, then it is recommended to adjust the value of ID371 (P5.083) appropriately. For example, if the number of pulses required to run one cycle is 517.5, then set ID371 (P5.083) = 2, and ID372 (P5.084) = 1035.

Figure 180 - E-Cam Gear Ratio and Resolution

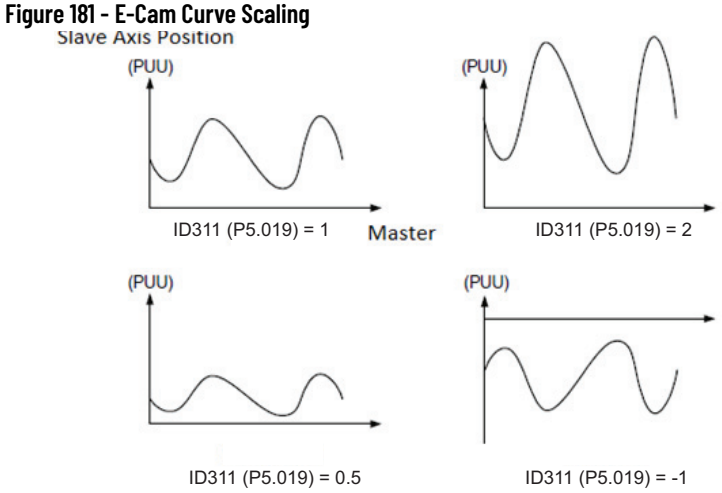


In the application of the E-Cam function, if you want to change motion curve of the slave axis in a multiplying manner, use the ID311 (P5.019) ECamCurveScale to scale the E-Cam curve. This parameter only takes effect in the electronic cam system, and does not affect the motion behavior in other servo systems. As shown in Figure 181,

- If ID311 (P5.019) = 2, the output curve of the slave axis becomes twice the original curve.
- If ID311 (P5.019) = 0.5, the output curve of the slave axis becomes half of the original curve.
- If ID311 (P5.019) = -1 is set, the output curve of the slave axis is opposite of the original curve.

The effective condition of the scaled electronic cam curve can be set by parameter instance ID376 (P5.088.X Bit2). The condition can be effective immediately or effective after the clutch is re-engaged. For example, in the application of flying shear, the cutting length can be adjusted by this parameter. If the clutch is continuously engaged, and the cutting length needs to be corrected, then this parameter must be set to take effect immediately. But it must be noted that this parameter is not allowed to be modified during shearing to avoid damaging the machine.

Figure 181 - E-Cam Curve Scaling



E-Cam Alignment

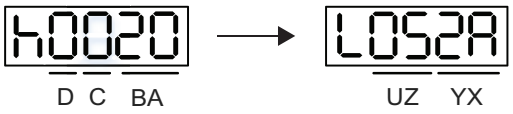
E-Cam phase alignment is a cam compensation method provided by the servo drive. You must first set the phase of the cam alignment and the position of the external sensor. Each time the cam runs to the position of the external sensor, the drive compares the difference between the actual phase and the correct phase. The difference is stored in the PR program. You can choose to compensate immediately or later.

Table 119 - E-Cam Alignment Settings

Parameter	Name
ID245 (P2.073)	ECamConfiguration
ID246 (P2.074)	ECamDIDelayTimeCompenation
ID247 (P2.075)	ECamAlignementTargetPosition

E-Cam Alignment Operation Setting

The settings for ID245 (P2.073)ECamConfiguration are described below.



BA	PR number	YX	Range of filter (0...95%)
DC	Masking range (0 ... 95%)	UZ	Maximum allowable correction rate (0...100%)
h	High bit	L	Low bit

- YX - range of filter (0...95%)

  When the DI.ALGN signal is triggered, the E-Cam alignment function is enabled. The system detects the current E-Cam position. When the difference between the current E-Cam position and its previous alignment position is less than the parameter's range as a percentage, the filter function is enabled. Otherwise, the system uses the new position to do the alignment.

YX	00	01...5F
Function	Filter disabled	| Error | <= (1 to YX)%: filter enabled

Using the filter allows the alignment to be more stable and reduces any position errors caused by DI noise and results in smoother operation.

- UZ - maximum allowable correction rate (0...100%)

  When alignment correction is enabled, the limitation of the maximum allowable correction rate (C) is defined as follows:

  |C|<= [(ID372) (P5.084) / ID371 (P5.083)] x ID245 (P2.073.UZ) %

  When the alignment error is too large, correcting this error once may cause motor vibration or overloading. Using this parameter can divide the alignment correction into several stages to smooth the process, but it may need more time to complete the alignment correction.

- BA: PR number (PR#0...PR#99)

  After each alignment, any shortage of pulse numbers from the slave axis is stored in a specified PR. This PR can compensate for the slave position at the appropriate timing point. If BA is set to 0, any shortage of pulse numbers is not stored in PR.

The format of this parameter is HEX. Thus, to set PR#11, write 0B to BA.

- DC: masking range (0...95%)

  When the DI.ALGN signal is triggered, the next alignment action is allowed only after the increasing pulses of the master axis are greater than the distance (M) masking.

  M >= ((ID372) (P5.084) / ID371 (P5.083)) x ID245 (P2.073.DC) %

IMPORTANT This masking function only allows increasing pulse input, and does not work for decreasing pulse input.

E-Cam Alignment Control Switch

The settings for ID248 (P2.076)ECamControlConfiguration are described below.



X	E-Cam alignment control	UZ	Alignment forward direction allowable rate (0...100%)
Y	Filter intensity (0 - F)	-	-

- X: E-Cam alignment control

Bit	3	2	1	0

Bit	Function	Description
0	Enable alignment	Set this bit to 0 to disable this function; set this bit to 1 to enable this function. If enabled, the E-Cam alignment correction is executed when DI.ALGN is on.
1	Trigger PR immediately	Set this bit to 1 to enable this function. When the E-Cam alignment is executing, the correction is stored in the PR data location specified by ID245 (P2.073), which triggers the PR immediately. Set this bit to 0 to disable this function. When the E-Cam alignment is executing, it does not trigger PR immediately to compensate the correction. You must use the PR ID376 (P5.088.BA) when E-Cam disengages in order to execute it.
2	Position of the mark	0: if the mark is on the master axis, the position of the mark is not affected when aligning. 1: if the mark is on the slave axis, the position of the mark is affected when aligning.
3	Reserved	-

- Y: filter intensity (0...F)

  Indicates average of 2^(value). Set to 0 to disable the filter. When the value of Y increases, the correction is slower which can avoid large amounts of correction during E-Cam adjustment.

  This can also avoid disturbances caused by sensor noise for a smoother operation. Setting ID248 (P2.076) too high causes the alignment to not work properly. The recommended value is 3.

  Example: when the filter intensity value is 3, the actual filter intensity = 2^3 = 8.

- UZ: alignment forward direction allowable rate (0...100%)

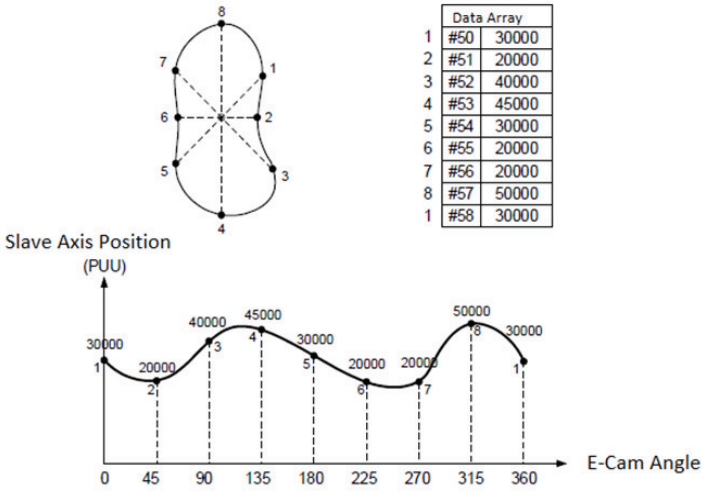
Value	Alignment direction	Value	Alignment direction
0	Backward alignment only	80	Forward 80%, backward 20%
30	Forward 30%, backward 70%	>= 100	Forward alignment only
50	Alignment with the shortest distance	-	-

E-Cam Curve

The electronic cam curve is a function between the position of the master axis and the slave axis. The electronic cam is built in a variety of ways and can be built using other mathematical software tools. Several commonly used construction methods are also provided in KNX5100C software. Regardless of the tool construction method, the equation is eventually converted into position points stored in the data array. A single electronic cam curve can have up to 721 data (720 segments), meaning that the highest resolution is 0.5 degrees. Multiple sets of E-Cam curves can be stored at the same time, as long as the total number of points does not exceed the upper limit of the data array (800). The slave axis curve between the two data points is interpolated with a cubic curve to smooth the motion at the endpoint.

Take Figure 182 as an example, if a mechanical cam is to be replaced by an electronic cam, the mechanical cam must be divided into several equal parts. The greater the division, the higher the accuracy. This example divides it into 8 equal parts. Each part is separated by 45 degrees (this is an example, the actual application must be fine-cut, otherwise the path is seriously distorted), and each distance between cam shaft and edge is filled into the data array. The starting point of 0 degrees and the last point of 360 degrees is the same point, but all must be filled in the data array to complete the mechanical cam curve in one cycle. Therefore, a total of 9 pieces of data must be filled in to create the table of the electronic cam curve.

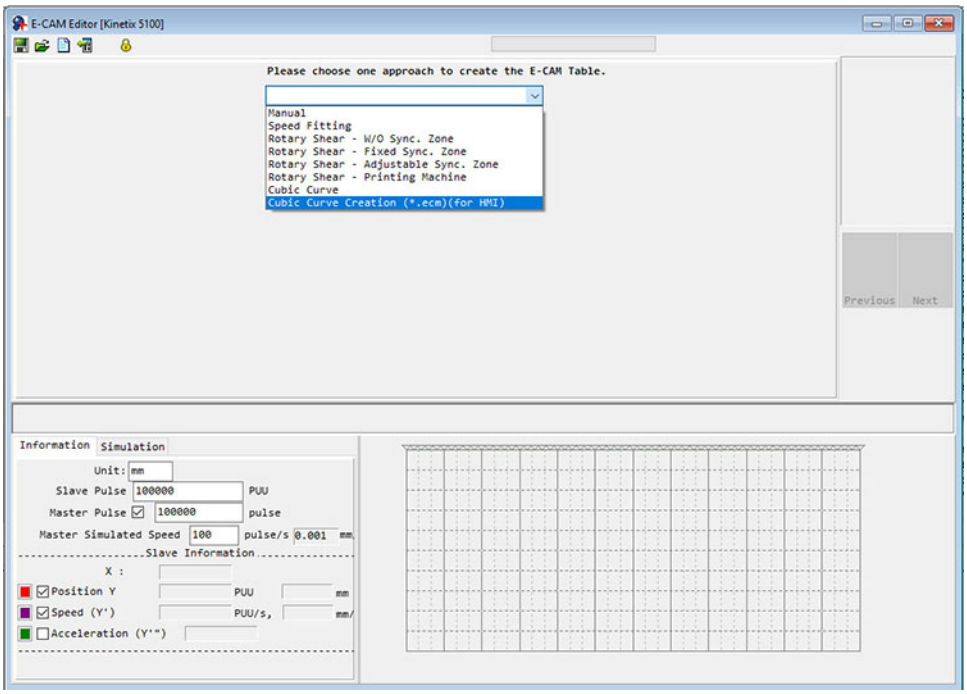
Figure 182 - E-Cam Curve Table Creation



You can use KNX5100C software to create electronic cam curves. Click on the E-Cam in the software toolbar to open the electronic cam editing window, shown in Figure 183.

The first page of the edit window lets you choose the approach to create the E-Cam table. Currently, there are seven methods, including: manual, speed fitting, cubic curve, automatic rotary shear, automatic rotary shear with fixed sync zone, automatic rotary shear with adjustable sync zone, and automatic rotary shear with intermittent printing machine.

Figure 183 - E-Cam Edit Window



Manual

If the E-Cam table is created with other software, it is also presented in the form of points and be imported into the table to complete the cam curve. As shown in Figure 182, the E-Cam curve is created based on the cam curve-to-edge distance corresponding to each angle of the mechanical cam, which means the relationship between the angle and the slave axis position. The KNX5100C E-Cam table manual creation interface is shown in Figure 184. The following are the steps to manually create the table:

1. Set the number of E-Cam segments.

   A single cam can be divided into up to 720 segments (721 points). For a period of 360 degrees, that means every 0.5 degrees corresponds to a slave axis position. The more points, the higher the resolution and more accurate the curve. To select the most suitable number of segments, measure the resolution of the curve and the resource usage of the data array.

2. When the number of E-Cam segments is set, click Create Table.

   The software automatically divides 360 degrees into the table by dividing the number of segments. When the number of segments is set to n points, the table generates n+1 splits.

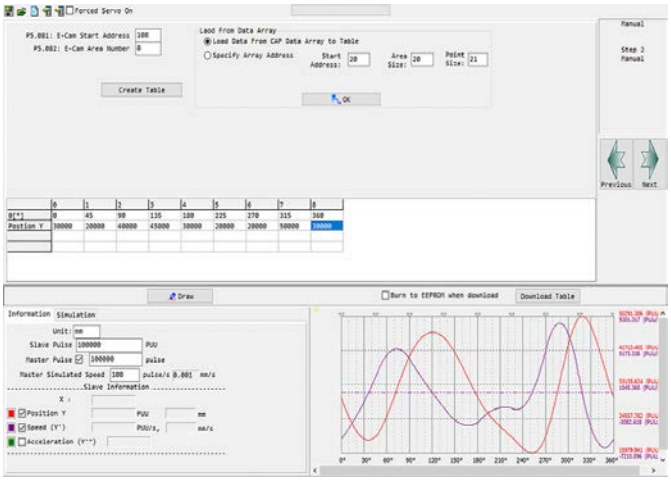
3. Fill in the position of the slave axis.

   The position corresponding to each segment angle is filled in the table in units of PUU. When you click Draw, the software automatically plots the E-Cam simulation curve and the position, velocity and acceleration curves. Pay special attention to the continuity of the slave axis speed in manual creation to avoid the machine vibration or overloading the motor.

4. After confirming that the curve is correct, click Download Table, to write the E-Cam curve to the data array.

   If you have selected 'Burn to EEPROM when download', when you click the Download, the data array is written to the EEPROM that can be held after the power is turned off.

Figure 184 - E-Cam Table Manual Creation



Import Points

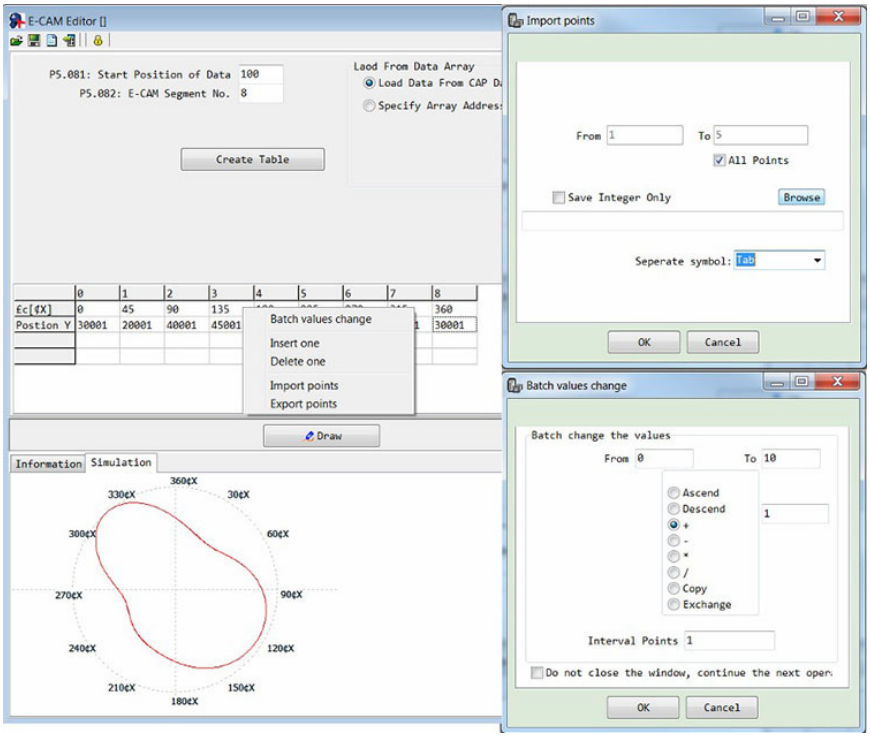
If you use the third-party software (such as: Excel) to create the table, you must save the position of each point as a text file (.txt). Separator symbol between each point should be indicated by Space, Tab, Enter, '|' or comma. Figure 185 illustrates the following steps.

1. Open the E-Cam editor in KNX5100C software, selecting the manual table and specify the number of E-Cam segments (ID370 (P5.082)).
2. Click Create Table, the table displays the E-Cam phase corresponding to each E-Cam segment.
3. Right-click the form and select Import Points.

   The import points dialog box appears.
4. Click Browse to open the stored text file, and select the separator symbol you used in the text file.
5. Click OK, to import the data points in the text file.
6. Click Draw and the software draws the designed E-Cam curve according to the data points.

You can also export the data points to text files by selecting 'Export Points'. The KNX5100C software provides a Batch Values Change feature, which includes functions of increment, decrement, add, subtract, multiply, divide, copy and exchange for you to quickly adjust the E-Cam curve. You can also right-click to insert and delete single-position positions.

Figure 185 - E-Cam Import or Export Points



Speed Fitting

If the application requires the same or associated motion speed of the master and slave axes, then use the Speed Fitting creation method to create the E-Cam table. This method divides an E-Cam cycle into five zones: waiting zone, acceleration zone, constant speed zone, deceleration zone, and stop zone, as shown in Figure 186. The proportion of each zone can be adjusted. The E-Cam curve is designed from the position point of view. The corresponding speed to the master-slave axis is determined by the position change per time unit. The KNX5100C E-Cam table creation by using the speed fitting method is shown in Figure 187.

1. To plan the E-Cam curve, determine the proportion of waiting zone, acceleration zone, constant speed zone, deceleration zone, and stop zone in one cycle according to the required distribution.
2. Set the motion distance.

   The total travel distance of the slave axis in one cycle, the unit is PUU.
3. Set the smoothness of the position curve at the turning point.

   The larger the set value, the smoother the motor change during acceleration and deceleration. A smoother curve extends the running time in one cycle. The value of the S curve is usually the same as the number of data points in the stop zone or less than the number of data points in the stop zone.
4. After confirming that the curve is correct, click Download Table, then the E-Cam curve is written to the data array.

   If you have selected 'Burn to EEPROM when download', when you click Download, the data array is written to the EEPROM that can be held after the power is turned off.

Figure 186 - Speed Zone Definition

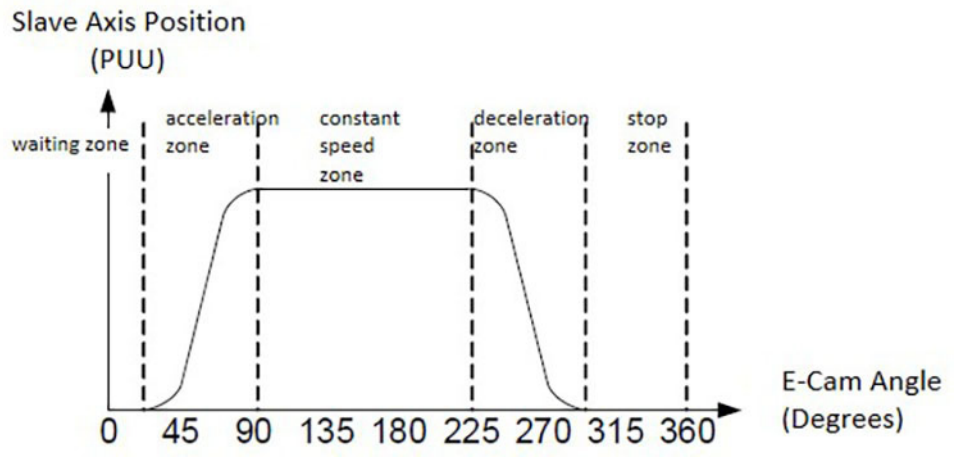
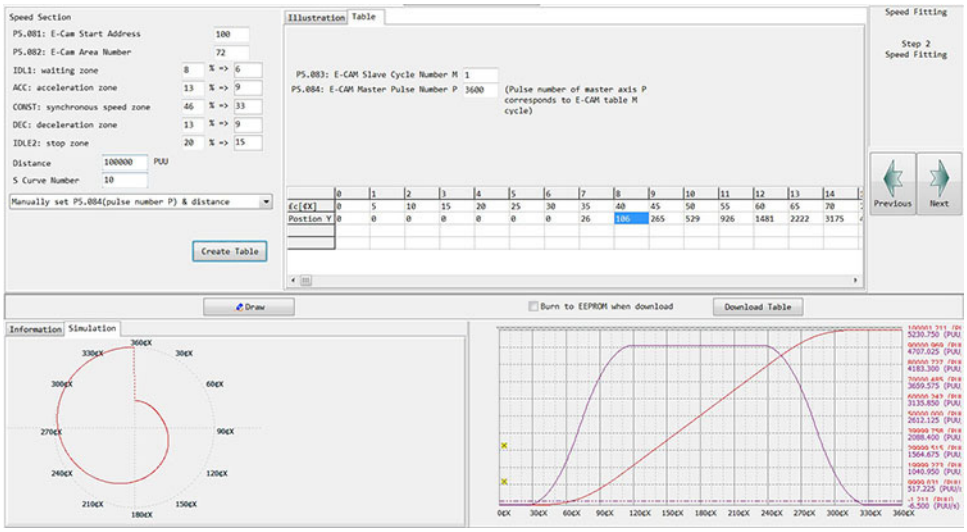


Figure 187 - E-Cam Speed Fitting Table



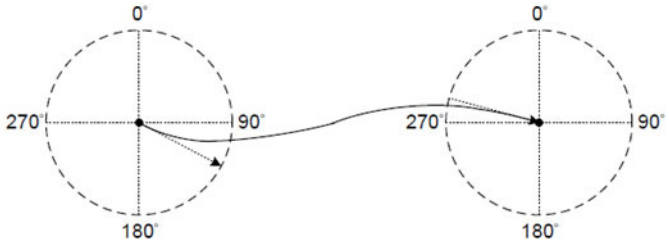
Cubic Curve

When the master-slave axis only has position correspondence, such as point-to-point correspondence, then the cubic curve can be used to create an electronic cam curve. When using the cubic curve to create a table, you only need to fill in the phase angle with the corresponding slave axis position. The software automatically draws and optimizes the curve. Some applications require a point-to-point motion trajectory, such as a straight line or a curve. The E-Cam curve creation is simplified by the cubic curve creation method. As shown in Figure 188, the starting angle N1 (the angle from the starting point) and the ending angle N2 (the angle of entering the target point) can be set according to the application requirements. There are three different types of curve:

- Straight line — There is a straight line between the two data points of the cam. The starting angle and the ending angle are not adjustable.
- Constant acceleration — A unidirectional increasing or decreasing curve with an equal acceleration and deceleration. Only the starting angle can be adjusted.

- Cubic curve — Both the starting angle and the ending angle can be adjusted. The change of the angle will affect the speed change when leaving the starting point and entering the target point. Improper angle setting causes the speed to change sharply which causes the machine to oscillate.

Figure 188 - Starting and Ending Angle



The KNX5100C software E-Cam table creation by cubic curve method is shown in Figure 189. The following is the operation steps of the cubic curve table creation:

5. Set E-Cam curve.

   The cubic curve table data includes angle, slave axis position, curve type, starting angle and ending angle. You can change the data corresponding to each point by dragging the turning point in the Cubic Curve Simulation diagram, and can also insert or delete a specific turning point. When dragging, inserting, or deleting a turning point, the data content in the Cubic Data changes accordingly. However, when directly inputting the desired content into Cubic Data, click Create Cubic Curve to see the cubic curve simulation.

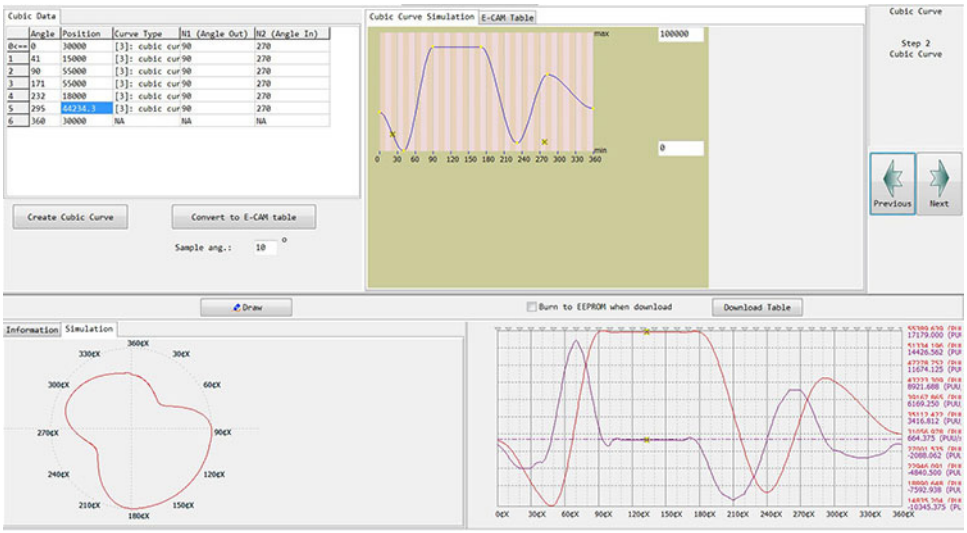
6. After completing the setting of the turning point, set the sample angle (Sample ang.) and click Convert to E-CAM table.

   The software automatically fills the data of each sampling point into the E-Cam table according to the curve. The more points, the more precise the E-Cam curve. If the position of the slave axis is too small, that can cause the speed jitter. You can adjust the parameter instance ID311 (P5.019) ECamCurveScale to enlarge the value in the table to improve the speed jitter.

7. After confirming that the curve is correct, click Download Table.

   The E-Cam curve is written to the data array. If you have selected 'Burn to EEPROM when download', when you click the download button, the data array is written to the EEPROM that can be held after the power is turned off.

Figure 189 - E-Cam Cubic Curve Table



Automatic Rotary Shear

In the application of rotary shears, KNX5100C software provides four methods to build rotary shear curves:

- Rotary shear - without sync zone
- Rotary shear - fixed sync zone
- Rotary shear - adjustable sync zone
- Rotary shear - printing machine

The difference between methods is in the phase interval of the master axis and the slave axis in the same speed zone. Select different speed zones depending on the machined tool type and the required motion behavior. The automatic rotary shear with intermittent printing machine is a curve-specific creation method for printing presses. Alternatively, application macros #6 and #7 can be used to create the electronic cam curve of the flying shear.

Rotary Shear - Without Sync Zone

This method of creating E-Cam curve is only applicable to the sharp knife application and is created by using KNX5100C software.

1. Set the gear number (A) of the motor and the gear number (B) of the cutter.
2. Set the number of cutters based on the application.
3. Set the diameter of cutter based on the application.

   This value does not change if the number of cutters changed. The KNX5100C software automatically calculates the perimeter.
4. Set the diameter and single-turn pulse number of the master axis encoder.

   Based on these two parameters, you can calculate the command resolution. If the gear ratio of the master axis is known, then the diameter and single-turn pulse number of encoder is no longer needed. You must directly input the value of ID371 (P5.083) and ID372 (P5.084).

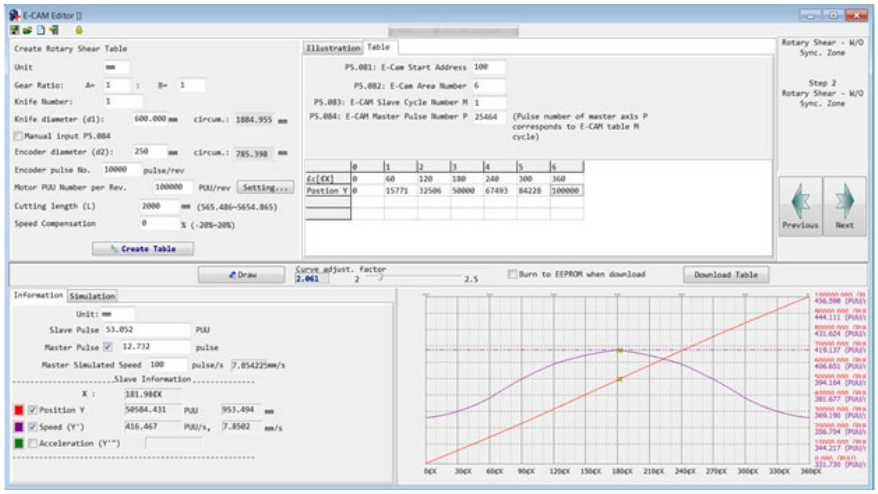
5. Set the number of PUUs that the motor runs one revolution with the electronic gear ratio (ID151 (P1.044) / ID152 (P1.045)).
6. Set the length of cutting.

   To prevent creating unreasonable rotary shear curves, the software automatically limits the length by the ratio of the cutting length (L) to the edge spacing (a): (R = L / a), R = 0.3…3.



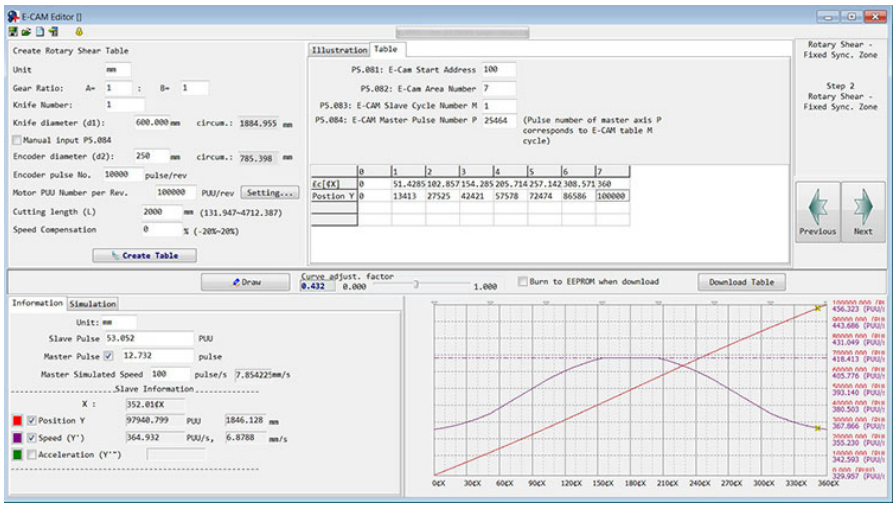
7. Set the speed compensation (Vc).

   In some applications, the master axis and the cutter axis cannot be the same speed. The speed compensation is used to change the speed of the cutter axis. In the cutting zone, if the speed compensation is positive that means the cutter axis is faster than the master axis. If the speed compensation is negative that means the cutter axis is slower than the master axis.



Rotary Shear - Fixed Sync Zone

This method can create the E-Cam curve with a fixed sync zone of 51 degrees. Use KNX5100 software to create this E-Cam curve. The parameter settings are similar to the rotary shear without sync zone. The software automatically limits the cutting length by the ratio of cutting length and arc length between cutters (R=L/a), here, R = 0.07...2.5.



You can also use macro #6 of the drive to build the same E-Cam curve as KNX5100C software. The advantage of using a macro to build a cam curve is that when the cutting length needs to be changed, you only need to change the parameters to generate a new curve. This method is very convenient for users who change the cutting length frequently.

1. Set the E-Cam storage start address by using ID369 (P5.081).

   Parameter ID373 (P5.085) sets the E-Cam engaged area. When using macro #6, parameter ID370 (P5.082) (the number of E-Cam area) is 7, that means the curve resolution is 51 degrees, and the sync zone is also 51 degrees.

2. Set the system gear ratio in parameters ID151 (P1.044) and ID152 (P1.045).
3. Set the E-Cam gear ratio and the E-Cam scale.
   a. Set ID371 (P5.083) slave cycle number to 1.
   b. Set the master pulse numbers: ID372 (P5.084) $= \frac{N}{\pi \times d2} \times L$.
   c. Set the E-Cam scale ID311 (P5.019).
4. Set the E-Cam table parameters.
   a. ID382 (P5.094) = Gear number of motor side × Cutter number (A × C)
   b. ID383 (P5.095) = Gear number of cutter (B)
   c. ID384 (P5.096) = $\frac{L}{\pi \times d1} \times C \times Vc \times 1000000$.
   - Vc = 1 means there is no speed compensation.
   - Vc = 0.9 means the speed of the cutter axis in the sync zone is 0.9 times of the speed of master axis.
   - Vc = 1.1 means the speed of the cutter axis in the sync zone is 1.1 times of the speed of master axis.

5. Write parameter ID385 (P5.097) = 0x0006 to create the E-Cam curve by macro #6.
6. Then, read parameter ID385 (P5.097).

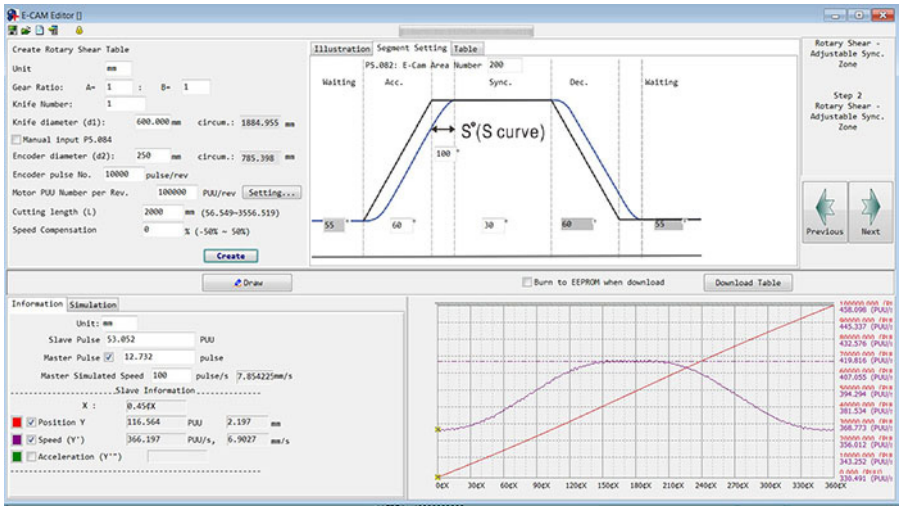
   If it equals to 0x1006, the macro table was successfully created.

   If these error codes appear, correct the setting according to the instructions:

Error Codes	Error Instructions
0xF061	Cannot make a watch when the clutch is engaged
0xF062	ID382 (P5.094) is out of range
0xF063	ID383 (P5.095) is out of range
0xF064	ID384 (P5.096) is out of range
0xF065	ID369 (P5.081) E-Cam start address exceeds the data array length
0xF066	ID370 (P5.082) must be 7
0xF067	Gear ration ID151 (P1.044)/ID152 (P1.045) too big. For example, 167772160:1000000 changes to 16777216:100000

Rotary Shear - Adjustable Sync Zone

This method can create the E-Cam curve with adjustable sync zone. You can use the KNX5100 software to create this E-Cam curve. The parameters setting is similar to the rotary shear without sync zone. The software automatically limits the cutting length by the ratio of cutting length and arc length between cutters (R=L/a), here, 1.88 > R × Vc. This method is different than the rotary shear curve without sync zone because you can plan the acceleration zone, sync zone, and S-curve zone according to your application requirements. The size of the deceleration zone is the same as the acceleration zone. And the remaining zone is planned as the waiting zone by the KNX5100 software.



You can also use the macro #7 of the drive to build the same E-Cam curve as the KNX5100C software. The advantage of using a macro to build a cam curve is that when the cutting length needs to be changed, you just change the parameters to generate a new curve. This method is convenient for users who change the cutting length frequently.

1. Set the E-Cam storage start address by parameter ID369 (P5.081).

Parameter ID373 (P5.085) sets the E-Cam engaged area. When using macro #7, parameter ID370 (P5.082) (the number of E-Cam area) can be set between 30…72. We recommend 72 to get the highest resolution of 5 degrees.

2. Set the system gear ratio in parameters ID151 (P1.044) and ID152 (P1.045).
3. Set the E-Cam gear ratio and the E-Cam scale.
   a. Set ID371 (P5.083) slave cycle number to 1.
   b. Set the master pulse numbers: ID372 (P5.084) $= \frac{N}{\pi \times d2} \times L$.
   c. Set the E-Cam scale (ID311 (P5.019)).
4. Set the E-Cam curve parameters: area size of the waiting zone, acceleration zone, sync zone, and S-curve zone.

- ID381 (P5.093) sets the S-curve smoothing level (S, 1 to 4), its corresponding S-curve zone angle (S°) is calculated by these equations.
- The waiting zone angle (W, -1° to 170°) is also set by ID381 (P5.093). If you enter -1 (0xFFFF), it means that the speed of the cutter axis in the waiting zone is zero, and the waiting zone angle is calculated by the drive automatically.
- Parameter ID382 (P5.094) sets the sync zone angle (Y), its range is 0°…330 °.
- The acceleration zone (Acc) is automatically calculated by the drive, as shown in these equations:

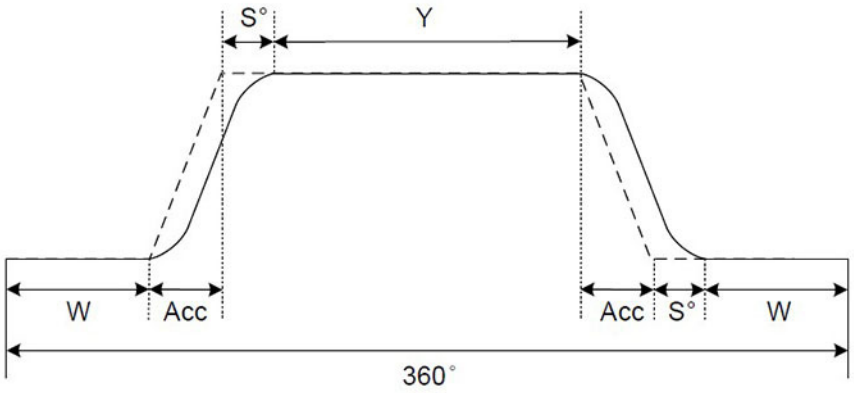
$$S^{\circ} = \frac{2^{S} \times 360^{\circ}}{ID370(P5.082)}$$

$$360° = 2W + 2Acc + 2S° + Y$$

Since the sync zone can be adjusted, Macro #7 has a limitation on the waiting zone for building the E-Cam curve. The restrictions are as follows:

$$Wmin = 180^{\circ} + \frac{360^{\circ}}{ID370(P5.082)} - \frac{360^{\circ}}{R} + \frac{Y}{2}$$

- When waiting zone W < Wmin, error code 0xF07A occurs. This error code indicates that the waiting zone should be larger or the sync zone should be smaller.
- When waiting zone W = Wmin, the speed of cutter axis in the waiting zone is zero.
- When waiting zone W > Wmin, the speed of cutter axis in the waiting zone is bigger than zero.



5. Set the E-Cam table parameters.

- ID383 (P5.095) MacroCmdParameter2 (highest 2 bytes) = Gear number of motor side × Cutter number (A × C).
- ID383 (P5.095) MacroCmdParameter2 (lowest 2 bytes) = Gear number of cutter (B).
- ID384 (P5.096) MacroCmdParameter1 = $\frac{L}{\pi \times d1} \times C \times Vc \times 1000000$.
  - Vc = 1 means there is no speed compensation.
  - Vc = 0.9 means the speed of the cutter axis in the sync zone is 0.9 times of the speed of master axis.
  - Vc = 1.1 means the speed of the cutter axis in the sync zone is 1.1 times of the speed of master axis.

6. To enable macro #7, write parameter ID385 (P5.097) MacroCmdIssue&Result = 0x0007 to create the E-Cam curve by macro #7.
7. Read parameter ID385 (P5.097), if it equals to 0x1007 that means the macro table is successfully created.

   If these error codes appear, correct the setting according to the instructions.

Error Codes	Error Instructions
0xF071	Cannot make a watch when the clutch is engaged
0xF072	ID382 (P5.094) MacroCmdParameter3 is out of range (0°...330°)
0xF073	ID381 (P5.093) MacroCmdParameter4 (higher 2 bytes) S-curve smoothing level S is out of range (1...4)
0xF074	ID381 (P5.093) (lower 2 bytes) waiting zone is out of range (-1°...+170°)
0xF075	ID384 (P5.096)MacroCmdParameter1 is out of range
0xF076	ID370 (P5.082) ECamAreaNumber is out of range (30...72)
0xF077	ID 369 (P5.081) E-Cam start address exceeds the data array length
0xF078	Gear ratio ID151 (P1.044)/ID152 (P1.045) too big, For example:167772160:1000000 changes to 16777216:100000
0xF079	Acceleration zone not enough, make smaller the waiting zone, sync zone, or S-curve zone
0xF07A	Waiting zone should be larger or the sync zone should be smaller

Rotary Shear - Printing Machine

This type of E-Cam curve is applied to a reciprocating printing machine. When the printing plate is separated from the material, the material is retracted, so that the printed pattern can be closely connected to save material. Taking paper printing as an example, the printing axis runs at a constant speed in one direction. As shown in Figure 190, when the printing plate makes contact with the paper, the printing is started at the same line speed as the printing axis. When the printing operation is finished and the printing plate is separated from the paper, the dragging axis starts to decelerate and stop, then runs to the specific area in the opposite direction. Then the previous steps repeat to perform the next printing cycle. For this type of E-Cam curve, the corresponding relationship between the required parameters and the mechanical structure of the printing press is shown in Figure 191.

Figure 190 - Printing Machine Diagram

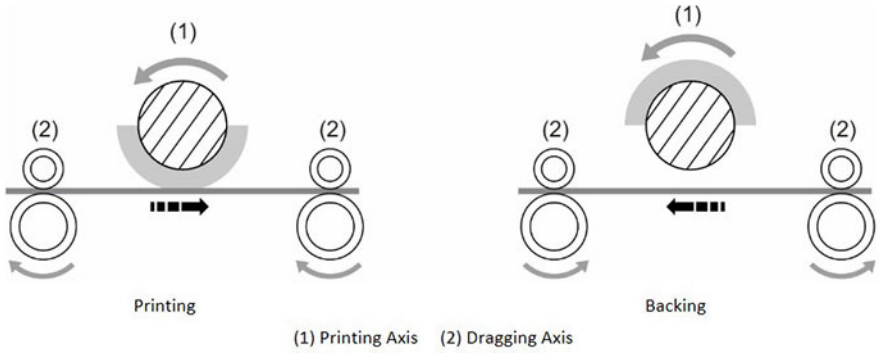
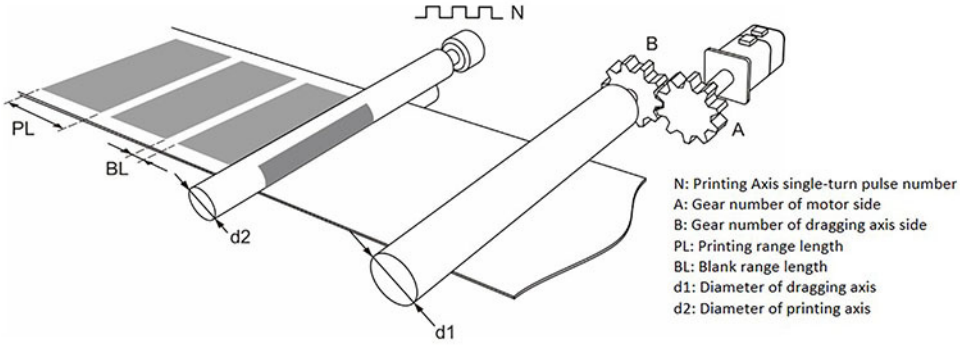


Figure 191 - Printing Machine Mechanical Structure



This type of E-Cam curve can be created by KNX5100C software.

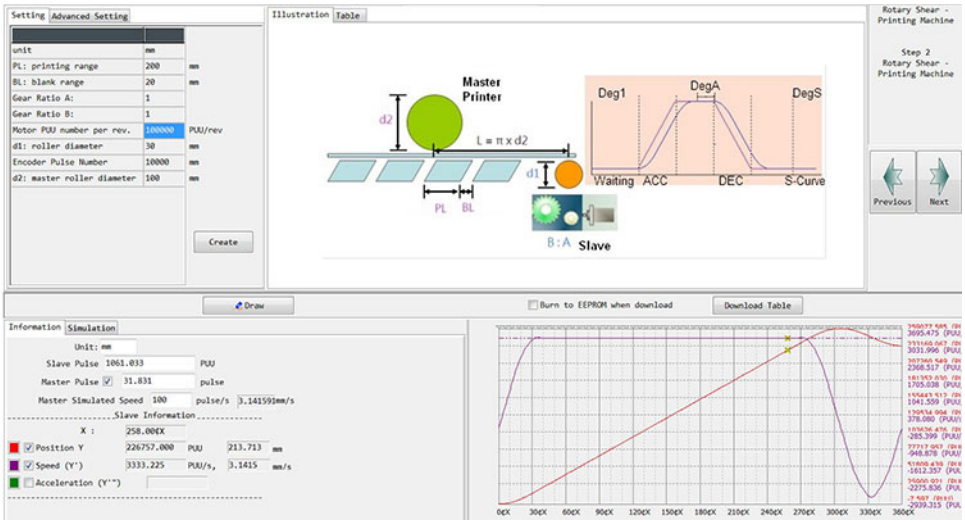
1. To set the gear ratio, set the gear number (A) of the motor side and gear number (B) of the dragging axis side.
2. To set PL and BL, set the length of printing range and blank range.
3. For d1, set the diameter of dragging axis.
4. For d2 and N, set the diameter of printing axis and its single-turn pulse number.
5. Set the PUU numbers per revolution of the motor in one cycle by using ID151 (P1.044) GearRatioslaveCountsN1 and ID152 (P1.045) GearRatioMasterCounts.

In this application, the ratio of the circumference length of the printing axis to the length of the printing zone ($R = (\pi \times d2)/(PL + BL)$) must be greater than 1 to save material.

The sync zone is obtained by software using the equation:

$$Y = PL \times \pi \times d2 \times 360^{\circ}$$

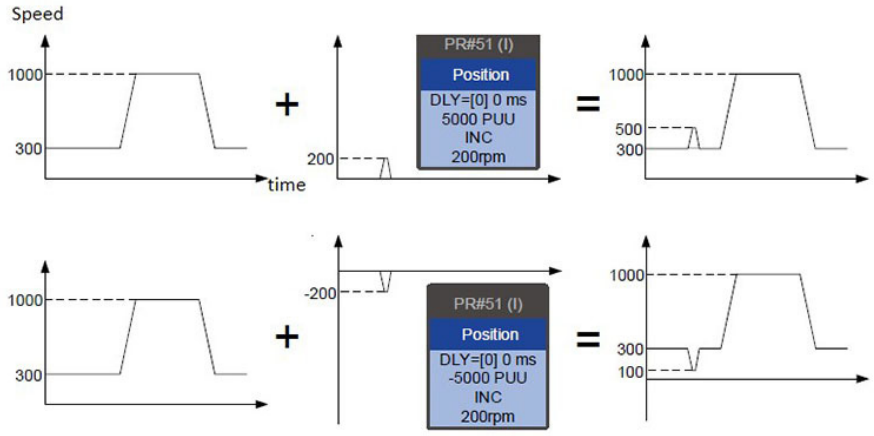
In the advanced settings tab, you can adjust the angle of the waiting zone and the angle of the S-curve. Increase the sync zone so that the printing axis and the dragging axis have a stable constant velocity motion when the printing operation is performed, which can improve the printing quality.



E-Cam and PR Command Operation

When the electronic cam is operating, if the PR program of a position increment command is triggered, the electronic cam and the PR command overlap at the same time. As shown in the example in Figure 192, if the slave axis displacement is in the same direction as the position increment command, the slave axis speed is 300 rpm. At the same time, if a co-directional position increment command with a target speed of 200 rpm triggered, then the target speed changes to 500 rpm. The slave axis superimposes the PR position increment command with the E-Cam command during the PR command operation, and completes the 5000 PUU position increment command at a target speed of 500 rpm. If the slave axis displacement and the position increment command are in the opposite direction, the slave axis speed is 100 rpm when a reverse position increment command with a target speed of 200 rpm is triggered. The E-Cam command is executed at a target speed of 100 rpm until the position increment command of the -5000 PUU is executed and then it returns to the original speed.

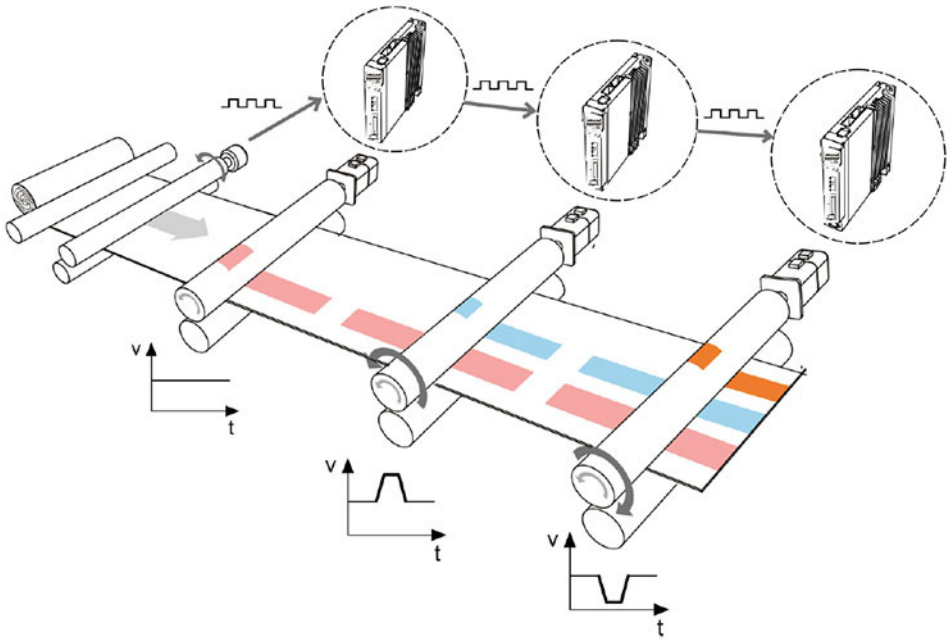
Figure 192 - E-Cam Command and PR Command Overlap



When the electronic cam is operating, if you want to change the slave axis speed or cam phase, you can use the PR position increment command. The cam phase alignment function and macro application of the rotary shear are used to correct the phase position of the slave axis.

Taking the three-axis synchronous printing machine in Figure 193 as an example, the feeding axis is used as the master axis. The master axis pulse signals are transmitted to the three slave axes whose E-Cam curve are the same. In general, the phases of these three servo drives must be the same. If phases differ during the application, you can use this phase correction function to perform the cam phase alignment. Generate a positive offset phase by setting the forward incremental command and generate a reverse offset phase by setting the reverse incremental command.

Figure 193 - E-Cam Phase Correction



E-Cam Troubleshooting

If the E-Cam does not work properly, you can check the following points for detection:

- Control Mode — Make sure that the control mode is PR mode and the servo drive is actually activated (Servo On).
- Pulse Source of Master Axis — Make sure that the pulse source of the master axis (ID376 (P5.088.Y)) is set properly. The count of the number of master axis pulses can be read by ID374 (P5.086) ECamMasterAxisPosition or by monitor variable 059. When the input is from terminal I/O connector, the count of the pulse command can be observed by ID310 (P5.018) PulseCmdPosition. When the input is from MFB terminal connector, the count of the auxiliary encoder pulses can be observed by ID309 (P5.017) AuxEncoderPosition.
- E-Cam Curve — Read the E-Cam curve data from the data array to make sure that this curve is correct. Check the starting position of the E-Cam data array ID369 (P5.081) and the E-Cam segment numbers ID370 (P5.082).
- E-Cam Gear Ratio and Curve Scaling — Check the master axis gear ratio (ID372 (P5.084)/ ID371 (P5.083)) and the slave axis gear ratio (ID151 (P1.044)/ ID152 (P1.045)). Check the E-Cam curve scale ID311 (P5.019). If the scale setting is too small, it is difficult to observe the motor movement. You can use the software oscilloscope in KNX5100C software to check if the motor rotates slightly.
- Clutch State — Read the value of ID376 (P5.088.D) to know the current state of the clutch.

  ID376 (P5.088.D) = 0 means that the clutch is in the disengaged state. Check the setting of the engagement condition ID376 (P5.088.D).

  ID376 (P5.088.D) = 1 means that the clutch is in the engaged state and the slave axis operates according to the master axis. Check the time of DI trigger if the disengagement condition is controlled by digital input (ID376 (P5.088.D) = 1). Check the setting of the number of pulses before disengagement (ID377 (P5.089.D)) if the disengagement condition is stopped immediately after disengagement (ID376 (P5.088.D) = 2) or deceleration stop after disengagement (ID376 (P5.088.D) = 6).
- ID376 (P5.088.D) = 2 means that the clutch is in the pre-engaged state. Check the value of lead pulse number ID375 (P5.087.D). The clutch is engaged only if sufficient pulses from the positive direction are received. If received pulses are from the reversed direction, correct it by following one of these steps:
  - Check the pulse source of master axis: Modify the polarity of the encoder output pulse (ID119 (P1.003).
  - The master axis pulse input is from the MFB connector: Modify the auxiliary encoder feedback direction (ID173 (P1.074.Z).
  - The master axis pulse input is from the I/O connector: correct the wiring by interchanging the A/B phase wiring.

Macro Commands

ID385 (P5.097) MacroCmdIssue&Result is used to issue a macro command (write this parameter) or get the execution result of a macro command (read this parameter).

If the command issues 0001, 1001h is returned if successful and Fxxxh if unsuccessful (depending on the command description). If you execute a command that is not supported, the failure code F001h is returned.

Motion Parameter Protection - Set Password and Activate Protection (code 0003h)

You can only set the password prior to activating the parameter protection function.

Command code 0003h	Motion parameter protection: password setting, protection activation.
Macro parameters	ID381 (P5.093) = parameter write-protected level (0...1) (0: no protection, 1: enable protection) ID382 (P5.094) = protection level of data array (-1... 7) 0 - password protection of all data array 1 - password protection of data array #100... #799 2 - password protection of data array #200...#799 3 - password protection of data array #300...#799 4 - password protection of data array #400...#799 5 - password protection of data array #500...#799 6 - password protection of data array #600...#799 7 - no password protection of data array ID383 (P5.095) = set new password (1...16777215)(1) ID384 (P5.096) = confirm new password (1...16777215)

(1) ID383 (P5.095) must equal to ID384 (P5.096) to be successfully set and the password must be set within the allowable range.

When the protection function has been activated, these are the potential failure codes.

Code	Description
Failure code F031h	Protection function has been activated and cannot be set repeatedly
Failure code F032h	Wrong password: ID383 (P5.095) does not equal to ID384 (P5.096)
Failure code F033h	Password value exceeds the allowable range (1...16777215)
Failure code F034h	Protection level ID382 (P5.094) exceeds the allowable range (-1...7)
Failure code F035h	Protection level ID381 (P5.093) exceeds the allowable range (0...1)
Success code 1003h	-

Motion Parameter Protection - Unlock Protection (code 0004h)

This function can only be executed when the parameter protection function has been activated.

Command code 0004h	Motion parameter protection: unlock protection
Macro parameters	ID384 (P5.096) = enter password (1...16777215)

When the protection function has been unlocked, the failure code is returned if this function is executed repeatedly. If the wrong password is entered, failure code Ennn is returned, where nnn indicates the remaining attempts to enter the password. The number decrements by one after each failed attempt. When the number displays 0, the maximum number of failed password attempts has been reached and the system is locked.

Code	Description
Failure code F041h	Protection function is unlocked and cannot be unlocked repeatedly
Failure code F043h	Password value exceeds the allowable range (1...16777215)
Failure code F044h	Exceeded maximum failed password attempts: locked. Can only be unlocked by resettingID193 (P2.008) ForceFunction = 10, but this also resets all parameters to the default values.
Failure code Ennnh	Incorrect password setting: failed to unlock nnn: remaining attempts to enter the password. The number decrements by one after each failed attempt. When the number displays 0, it is locked and does not allow further attempts.
Success code 1004h	-

Build Up the E-Cam Table - Rotary Shear, Including Synchronous Area (code 0006h)

This macro calculates the data for the E-Cam table according to these parameters and stores them in the data array specified by ID369 (P5.081) ECamStartAddress. Parameters listed are relevant to the E-Cam table calculation. Verify that the parameters are correctly set up prior to execution.

Command code 0006h	Build up the E-Cam table: rotary shear, including synchronous area (7 areas)
General parameters	ID369 (P5.081) = Address of table (data array) ID370 (P5.082) = 7 (This macro is fixed to 7 areas, 8 points) ID151 (P1.044) and ID152 (P1.045) = E-Gear ratio (must be set up in advance)
Macro parameters	ID382 (P5.094) = A (deceleration ratio: numerator) x C (cutting count) ID383 (P5.095) = B (deceleration ratio: denominator) ID384 (P5.096) = 1000000 x R x V • R (cutting ratio) = L (target cutting length) / ℓ (perimeter of cutter) Allowable cutting ratio: (0.3...2.5) times V (speed factor) = target cutting speed / speed of delivered product V = 1.0: when cutting, the speed of cutter is same as the delivered product V = 1.1: when cutting, the speed of cutter is 10% faster than the delivered product V = 0.9: when cutting, the speed of cutter is 10% slower than the delivered product

After this macro is executed, if the above parameters have been modified, the E-Cam table must be recreated and you must execute this macro again. Data in the E-Cam table is changed after executing this macro. Do not execute the macro when E-Cam is engaged.

In E-Cam applications, parameters (such as ID371 (P5.083) and ID372 (P5.084)) that are irrelevant to this macro are not listed here. Set up the parameters according to the actual application. See E-Cam on page 335. After executing this macro, the E-Cam table is not saved to EEPROM automatically.

Code	Description
Failure code F061h	When creating the table, E-Cam is in engaged status. To issue this command, E-Cam needs to disengage first.
Failure code F062h	Value of ID382 (P5.094) MacroCmdParameter3 exceeds the range: (1...65535)
Failure code F063h	Value of ID383 (P5.095)MacroCmdParameter2 exceeds the range: (1...65535)
Failure code F064h	Value of ID384 (P5.096) MacroCmdParameter4 exceeds the range: (300000...2500000)
Failure code F065h	Address specified by ID369 (P5.081) ECamStartAddress is too long and the space of data array is insufficient.
Failure code F066h	Value of ID370 (P5.082) ECamAreaNumber must be set to 7. Otherwise the command cannot be executed.
Failure code F067h	Data calculation error. Decrease the value of ID151 (P1.044) and ID152 (P1.045), but maintain the same proportions.

Build Up the E-Cam Table - Rotary Shear, Multi-dimensional Control

This macro calculates the data for the E-Cam table according to these parameters and stores them in the data array specified by ID369 (P5.081) ECamStartAddress. Parameters listed are relevant to the E-Cam table calculation. Verify that the parameters are correctly set up prior to execution.

Command code 0007h	Build up the E-Cam table: rotary shear (multi-dimensional control)
General parameters	ID369 (P5.081) = address of table (data array) ID370 (P5.082) = N (30 - 72) (area number of E-Cam) ID151 (P1.044) and ID152 (P1.045) = E-Gear ratio (must be set up in advance).
Macro parameters	ID381 (P5.093.H16) (high 16-bit) = S ID381 (P5.093L16) (low 16-bit) = W • S (curve level) = 1 - 4 levels; W (degree of waiting area) = -1 to +170 degrees (W = -1 is available in firmware version V1.038 (sub29) or later versions) ID382 (P5.094) = Y (degree of synchronous area) = 0 - 330 degrees ID383 (P5.095.H16) (high 16-bit) = A x C ID383 (P5.095.L16) (low 16-bit) = B • A (deceleration ratio: numerator), C (cutting count) B (deceleration ratio: denominator) ID384 (P5.096) = 1000000 x R x V • R (cutting ratio) = L (target cutting length) / ℓ (length of cutter) Allowable cutting ratio: (0.05...5.0) times V (speed factor) = target cutting speed / speed of delivered product V = 1.0: when cutting, the speed of cutter is same as the delivered product V = 1.1: when cutting, the speed of cutter is 10% faster than the delivered product V = 0.9: when cutting, the speed of cutter is 10% slower than the delivered product
	ID381 (P5.093.L16) < W′, E-Cam table is in error (failure code F07Ah) ID381 (P5.093.L16) = W′, initial speed is 0 in E-Cam table ID381 (P5.093.L16) > W′, initial speed > 0 in E-Cam table • W′ = 180 + 360/N - 360/R + Y/2

After this macro is executed, if the above parameters have been modified, the E-Cam table must be recreated and you must execute this macro again. Data in E-Cam table is changed after executing this macro. Do not execute when E-Cam is in engaged status. In E-Cam applications, parameters (such as ID371 (P5.083) and ID372 (P5.084)) that are irrelevant to this macro are not listed here. Set up the parameters according to the actual application. See E-Cam on page 335. After executing this macro, the E-Cam table is not saved to EEPROM automatically.

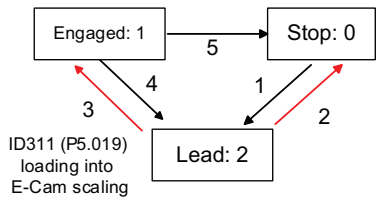
Code	Description
Failure code F071h	When creating the table, E-Cam is in engaged status. To issue this command, E-Cam must disengage first.
Failure code F072h	Degree of synchronous area of ID382 (P5.094) exceeds the range: (0...330)
Failure code F073h	Curve level of ID381 (P5.093.H16) exceeds the range: (1...4)
Failure code F074h	Degree of waiting area of ID381 (P5.093.L16) exceeds the range: (0 ...170)
Failure code F075h	Value of ID384 (P5.096) exceeds the range: (50000 ...5000000)
Failure code F076h	Area number of E-Cam of ID370 (P5.082) exceeds the range: (30 ...72)
Failure code F077h	Address specified by ID369 (P5.081) is too long and the space of data array is insufficient.
Failure code F078h	Data calculation error. Decrease the setting value of ID151 (P1.044) and ID152 (P1.045), but maintain the same proportions.
Failure code F079h	Acceleration degree is too small; decrease the value for waiting area (W), synchronous area (Y), or curve level (S).
Failure code F07Ah	Waiting area is too small; increase the value for waiting area (W) or decrease the value for synchronous area (Y).

E-Cam Curve Scaling (code 0008h)

This macro is triggered when E-Cam is engaged, and ID311 (P5.019) ECamCurveScale becomes effective immediately.

Command code 0008h	E-Cam curve scaling ID311 (P5.019) is effective immediately.
Macro parameters	N/A

Normally, E-Cam scaling is only loaded into the system by ID311 (P5.019) at the point when the E-Cam engages (see transition 3 in the graphic). It cannot be changed in the engaged condition. E-Cam scaling can only be changed after one E-Cam cycle so that the E-Cam can return to the original position without accumulative error.



If necessary in the application, there are two ways to change the setting of E-Cam curve scaling immediately:

- ID376 (P5.088.X2) ECamControl = 1: when E-Cam is engaged, set up this bit at the same time, which causes each change in ID311 (P5.019) to be enabled immediately.
- Use macro #8: each time that this macro command is triggered, the function of ID311 (P5.019) is enabled immediately. However, if the value of ID311 (P5.019) is changed and this macro is not triggered, then the function of ID311 (P5.019) is not enabled immediately. This macro command has to be triggered again to enable the function of ID311 (P5.019).

There are no failure codes with this command code.

Change Position X Where E-Cam is Engaged (code 000Ch)

This macro command can change the engaged position immediately even when the E-Cam is engaged.

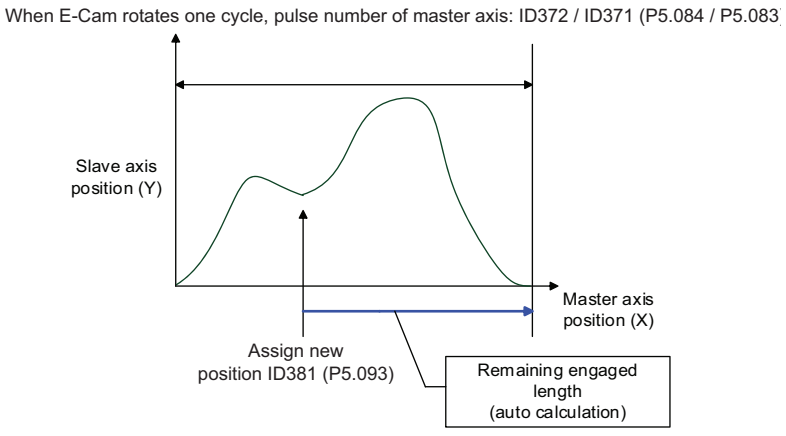
Command code 000Ch	Change position X where E-Cam is engaged: E-Cam disengages after rotating one cycle in the forward direction.
General parameters	N/A
Macro parameters	ID381 (P5.093) = new engaged position X, Unit: pulse number of master axis. Monitoring variable 062(3Eh): displays the current engaged position (X) of master axis.

This macro command automatically calculates the remaining engaged length so that the E-Cam disengages after rotating one cycle (360°) in the forward direction. However, you must set ID376 (P5.088.U) to 2, 4, or 6; otherwise, the E-Cam does not disengage.

The E-Cam disengages when an alarm occurs or the power supply is cut off. If you want the E-Cam to re-engage at the last disengaged position and continue its remaining cycle, we recommend that you record the last disengaged position (X) and then resume the operation of this macro command.

IMPORTANT When the E-Cam is disengaged, the servo position might shift slightly, which can cause a position error when the E-Cam re-engages.

The engaged direction is in the forward direction (master axis operates in forward direction).



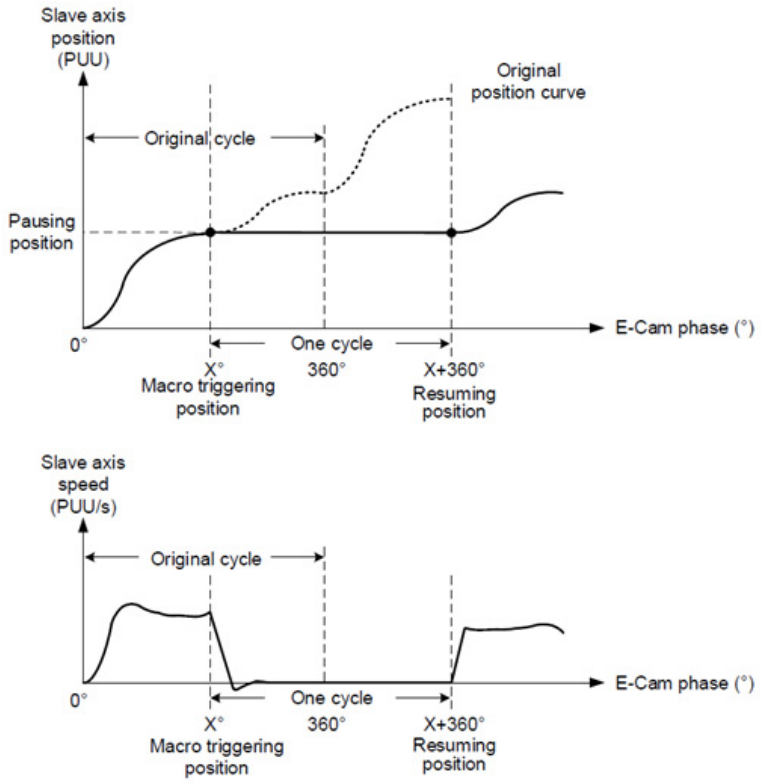
IMPORTANT When using this macro command, we recommend that you execute the macro command before operating the master axis.

Code	Description
Failure code FOC1h	When executing this macro command, E-Cam is not in engaged status. Engaged position can only be modified when E-Cam is engaged.
Failure code FOC2h	Value of ID381 (P5.093) is in error. The value cannot be less than 0.
Failure code FOC3h	Value of ID381 (P5.093) is in error. The value has to be less than the value of (ID372 (P5.084) / ID371 (P5.083)).

The Slave Axis Immediately Pauses For One Cycle

When the clutch is engaged and the slave axis operates in forward direction, this macro can stop one cycle of the slave axis operation and then the operation resumes. To stop for multiple cycles, consecutively trigger Macro #10 for a number of times. The servo drive records the number of times Macro #10 is triggered and the slave axis will stop for the number of cycles accordingly. This macro is usually used for the empty pack prevention function on the packing machine. The operation is shown in Figure 194.

Figure 194 - Macro #10 Operation Diagram



1. Engage the clutch.
2. Set ID385 (P5.097) = 0x0010 to enable Macro #10.
3. Read ID385 (P5.097) and if it returns 0x1010, it means the macro execution is successful.

4. If any of the following failure codes shows, modify the setting according to the description.

Error Codes	Error Instruction
0xF101	When executing this macro command, the clutch is not in the engaged status.
0xF102	Set ID381 (P5.093) to 0.
0xF103	The slave axis must operate in forward direction. Check the E-Cam curve and ID311 (P5.019) E-Cam curve scaling.
0xF104	Accumulated pause distance exceeds 231. Do not execute this macro command consecutively.

IMPORTANT This function is accumulative. If the command is triggered for N times consecutively, it pauses the E-Cam for N cycles. The accumulated pause distance cannot exceed the range. When the pause cycle is complete, the slave axis continues to operate and the accumulated pause distance is cleared to 0.

Notes:

Kinetix 5100 Safe Torque Off (STO) Feature

The 2198-E*xxxx*-ERS servo drives are equipped for hardwired Safe Torque Off (STO). The hardwired STO function meets the requirements of Performance Level d (PLd) and safety category 3 (CAT 3) per ISO 13849-1 and SIL 2 per IEC 61508, IEC 61800-5-2 and IEC 62061.

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Wire the Safe Torque Off Circuit	383
Safe Torque Off Feature	384
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The 2198-E*xxxx*-ERS servo drives use the STO connector for wiring external safety devices and cascading hardwired safety connections from one drive to another.

Certification

The TÜV Rheinland group has approved 2198-E*xxxx*-ERS servo drives with hardwired safe torque-off for use in safety-related applications up to ISO 13849-1, Performance Level d (PL d) and Category 3, SIL CL 2 per IEC 61508, IEC 61800-5-2, and IEC 62061, in which removing the motion producing power is considered to be the safe state.

For product certifications currently available from Rockwell Automation, go to website rok.auto/certifications.

Important Safety Considerations

The system user is responsible for the following:

- Validation of any sensors or actuators connected to the system
- Completing a machine-level risk assessment
- Certification of the machine to the desired ISO 13849-1 performance level or IEC 62061 SIL level
- Project management and proof testing in accordance with ISO 13849

Category 3 Requirements According to ISO 13849-1

Safety-related parts are designed with these attributes:

- A single fault in any of these parts does not lead to the loss of the safety function.
- A single fault is detected whenever reasonably practicable.
- Accumulation of undetected faults can lead to the loss of the safety function and a failure to remove motion producing power from the motor.

Stop Category Definition

Stop Category 0 as defined in IEC 60204 or Safe Torque Off (STO) as defined by IEC 61800-5-2 is achieved with immediate removal of motion producing power to the actuator.

IMPORTANT In the event of a malfunction, the most likely stop category is Stop Category 0. When designing the machine application, timing and distance must be considered for a coast to stop. For more information regarding stop categories, refer to IEC 60204-1.

Performance Level (PL) and Safety Integrity Level (SIL)

For safety-related control systems, Performance Level (PL), according to ISO 13849-1, and SIL levels, according to IEC 61508 and IEC 62061, include a rating of the systems ability to perform its safety functions. All of the safety-related components of the control system must be included in both a risk assessment and the determination of the achieved levels.

Refer to the ISO 13849-1, IEC 61508, and IEC 62061 standards for complete information on requirements for PL and SIL determination.

Description of Operation

The Safe Torque Off (STO) feature provides a method, with sufficiently low probability of failure, to force the power-transistor control signals to a disabled state. When disabled, or any time power is removed from the safety enable inputs, all of the drive output-power transistors are released from the ON-state. This results in a condition where the drive performs a Category 0 Stop. Disabling the power transistor output does not provide mechanical isolation of the electrical output that is required for some applications.

For hardwired control of the safe torque-off function, the appropriate wiring must be connected to the Safety connector plug. Refer to Safe Torque Off Specifications on page 386 for more information on the safety inputs.

Under normal operation, the safe torque-off inputs are energized. If an STO fault is detected, then all of the output power transistors turn off. The safe torque-off response time is less then 20 ms.

ATTENTION: Permanent magnet motors can, in the event of two simultaneous faults in the IGBT circuit, result in a rotation of up to 180 electrical degrees.

ATTENTION: If either of the safety enable inputs are de-energized for more than 1 second, or both inputs are in the OFF state simultaneously for more than 10 ms, a fault condition results.

The ServoOutputStatus parameter represents various drive status values. Bit 0 (Servo Ready) is used to indicate the status of the Safe Torque Off inputs. This bit can be monitored in KNX5100C software.

Figure 195 - ServoOutputStatus Parameter Setting

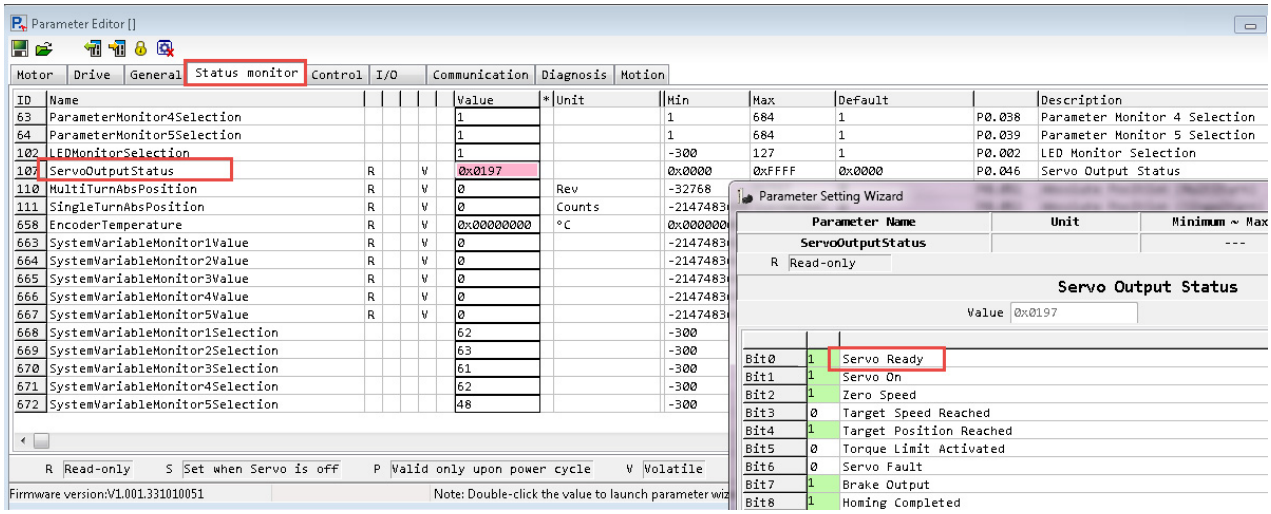
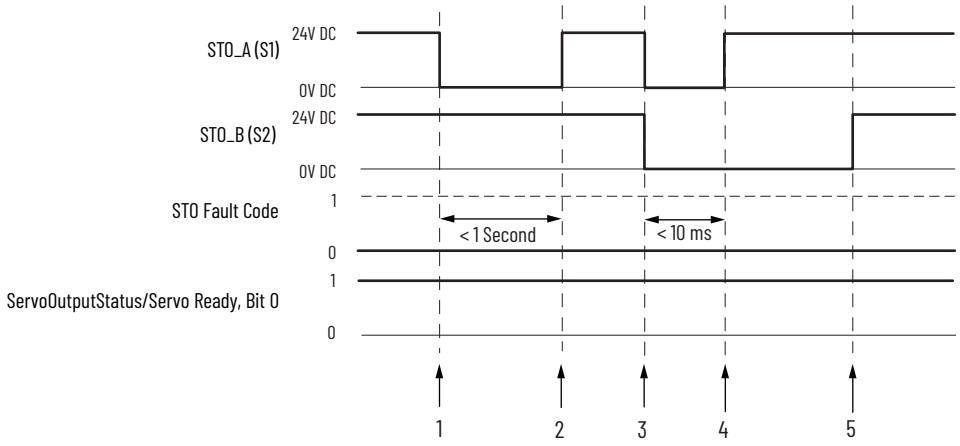


Table 120 - ID107 (P0.046) ServoOutputStatus

Channel	Status of Output (1)			
STO_A	ON	ON	OFF	OFF
STO_B	ON	OFF	ON	OFF
Status	Ready (2)	Torque off (3)	Torque off (4)	Torque off (5)

(1) ServoOutputStatus is located in KNX5100C software>Parameter Editor>Status Monitor.
(2) Kinetix® 5100 drive is Ready and able to produce torque (current) to the motor. ServoOutputStatus/Servo Ready (Bit 0) = 1.
(3) When STO_B is lost for more than 1 second, with STO_A high, the Kinetix 5100 drive faults (E 502) and has no motor torque (current). ServoOutputStatus/Servo Ready (Bit 0) = 0.
(4) When STO_A is lost for more than 1 second, with STO_B high, the Kinetix 5100 drive faults (E 501) and has no motor torque (current). ServoOutputStatus/Servo Ready (Bit 0) = 0.
(5) When both STO_A and STO_B are lost for more than 10 ms, the Kinetix 5100 drive faults (E 500) and has no motor torque (current). ServoOutputStatus/Servo Ready (Bit 0) = 0.

Figure 196 - System Operation when Inputs are Meeting Timing Requirements



Event	Description
1	One input is switched-off and second input is on.
2	First input is switched-on within 1 second.
3	Both inputs are switched-off.
4	Both inputs are in OFF state simultaneously within 10 ms.
5	Second input is switched-on within 1 second of event 4.

STO-related Fault Codes

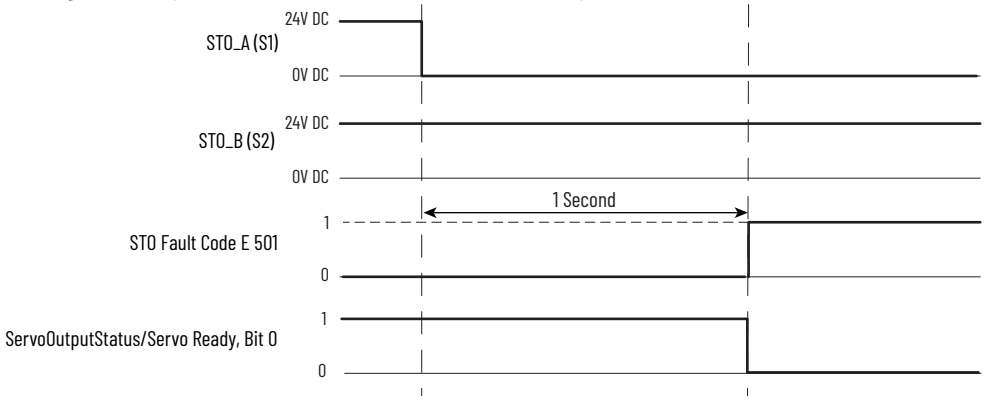
For Kinetix® 5100 fault code descriptions and parameters, see Knowledgebase Technote: Kinetix 5100 Servo Drive Parameter Data and Fault Codes. You can download the spreadsheet from this public article.

You will be asked to log in to your Rockwell Automation web account or create an account if you do not have one. You do not need a support contract to access this article.

For information on how to clear faults, see Clear Faults on page 426.

Figure 197 demonstrates when the safe torque-off mismatch is detected and fault E 501 (STO_A signal loss) or E 502 (STO_B signal loss) is posted.

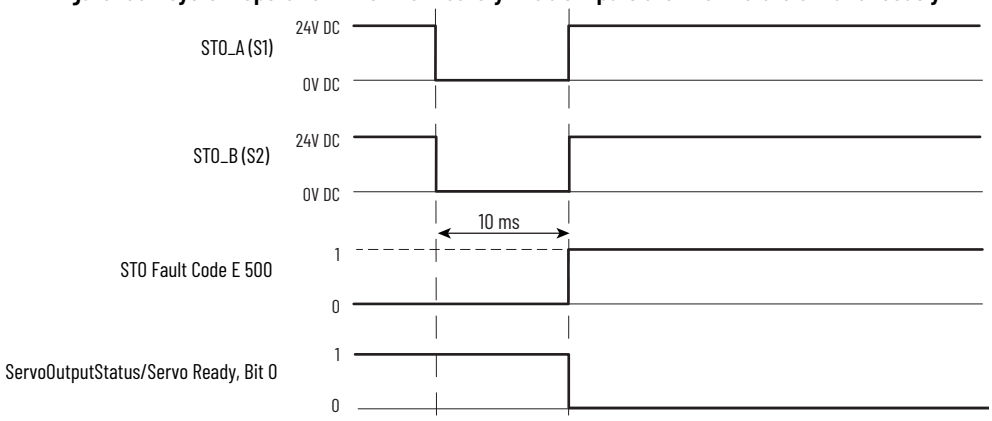
Figure 197 - System Operation in the Event that the Safety Enable Inputs Mismatch



When the STO self-diagnostic (STO circuit and wiring, for example) fails, fault E 503 is posted.

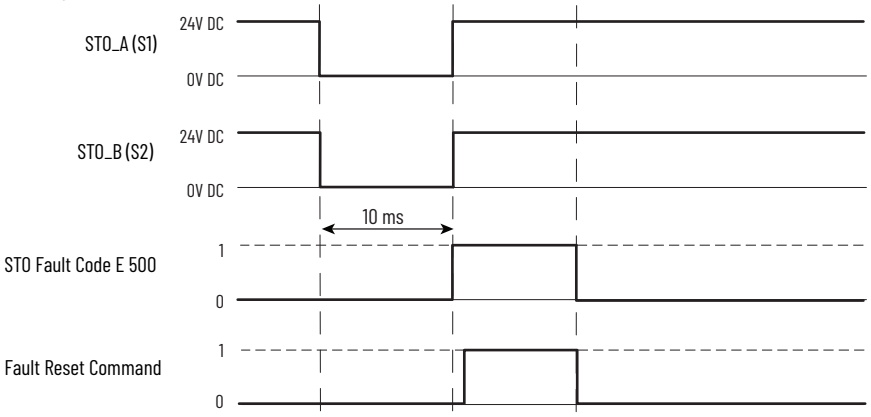
Figure 198 demonstrates when both inputs in the OFF state are detected and fault E 500 (STO enabled) is posted.

Figure 198 - System Operation When Both Safety Enable Inputs are in OFF State Simultaneously



ATTENTION: The safe torque-off fault is detected upon demand of the Safe Torque Off (STO) function. After troubleshooting the STO function or performing maintenance that might affect the STO function, the STO function must be executed to verify correct operation.

Figure 199 - Typical Fault Reset Sequence



IMPORTANT The STO fault (E 500) can be reset only if both inputs are in the ON state. After the fault reset requirement is satisfied, a Fault Reset command in the application software or DI.ARST (physical input) must be issued to reset the E 500 fault. You can reset faults E 501, E 502, and E 503 with power cycle.

For Safety Status (SS), you can configure one parameter/attribute, ID252 (P2.093) STOFeedbackConfiguration and determine whether SS will latch, if an STO fault occurs. If SS signal is latched when STO fault occurs, the status of SS signal remains even when the fault has been cleared.

Figure 200 - Parameter Format Legend

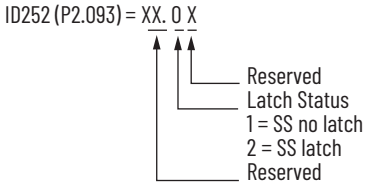


Table 121 - SS Signal Status/Behavior for STO Faults

Servo Drive Status		SS Signal Status (1)	
Parameter ID252 (P2.093)		XX1X	XX2X
SS signal behavior		No latch	Latch
No STO fault occurs		Open	
STO fault occurs	E 500	Close	
	E 501	Open	
	E 502	Open	
	E 503	Open	

(1) Open indicates continuity between SS+ and SS– is open circuit. Close indicates continuity between SS+ and SS– is short circuit.

Average Frequency of a Dangerous Failure per Hour

Safety-related systems are classified as operating in a High-demand/continuous mode. The SIL value for a High-demand/continuous mode safety-related system is directly related to the probability of a dangerous failure occurring per hour (PFH).

PFH calculation is based on the equations from IEC 61508 and show worst-case values. Table 122 provides data for a 20-year proof test interval and demonstrates the worst-case effect of various configuration changes on the data.

IMPORTANT Determination of safety parameters is based on the assumptions that the system operates in High-demand mode and that the safety function is requested at least once every three months.

Table 122 - PFH for 20-year Proof Test Interval

Attribute	Value
PFH (1e-9)	0.96
Proof test (years)	20

Safe Torque Off Connector Data

The Kinetix 5100 drive ships with the (8-pin) wiring-plug header that connects your safety circuit to the Kinetix 5100 drive Safe Torque Off (STO) connector. The header includes jumper wires that by-pass the safety function for drives that do not use the Safe Torque Off feature. Remove the jumper wires when the Safe Torque Off feature is used.

Figure 201 - Pin Orientation for 8-pin Safe Torque-off Connector

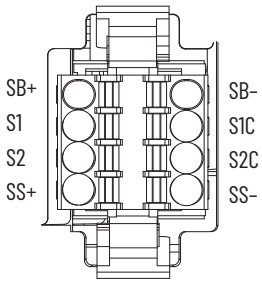


Table 123 - Kinetix 5100 Drive Safe Torque Off Connector Pinout

Description	Signal
Used for safety jumper +	SB+
Used for safety jumper –	SB–
STO_A+	S1
STO_A–	S1C
STO_B+	S2
STO_B–	S2C
Safety status or feedback	SS+
Safety status or feedback	SS–

IMPORTANT Use pins SB+ and SB– only for the by-pass jumpers to defeat the Safe Torque Off function. When the Safe Torque-off function is in operation, the 24V supply must come from an external source.

Wire the Safe Torque Off Circuit

This section provides guidelines for wiring your Kinetix 5100 Safe Torque Off (STO) drive connections.

IMPORTANT The National Electrical Code and local electrical codes take precedence over the values and methods provided.

IMPORTANT To improve system performance, run wires and cables in the wireways as established in Establish Noise Zones beginning on page 34.

IMPORTANT Pins SB+ and SB– are used to disable the safe torque-off function. When wiring to the STO connector, use an external 24V supply for the external safety device that triggers the safe torque-off request. To avoid jeopardizing system performance, do not use pin SB+ as a power supply for the external safety device.

Safe Torque Off Wiring Requirements

The Safe Torque Off (STO) connector uses spring tension to secure the wire. Depress the orange tab along side each pin to insert or release the wire. Wire must be copper with 75 °C (167 °F) minimum rating.

IMPORTANT Stranded wires must terminate with ferrules to prevent short circuits, per table D.4 of ISO 13849-2:2012.

Figure 202 - Safe Torque Off Terminal Plug

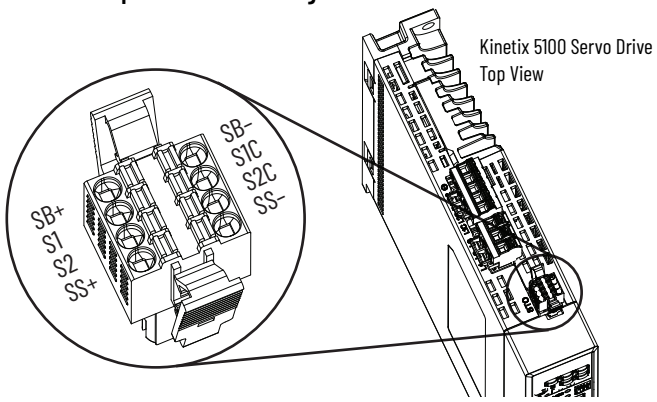


Table 124 - Safe Torque Off Terminal Plug Wiring

Signal	Recommended Wire Size mm^2 (AWG)	Strip Length mm (in.)	Torque Value N•m (lb•in)
SB+ SB- S1 S1C S2 S2C SS+ SS-	0.75 (18)) (stranded wire with ferrule) 1.5 (16) (solid wire)	8.0 (0.31)	N/A (1)

(1) This connector uses spring tension to hold the wires in place.

Safe Torque Off Feature

The Safe Torque Off (STO) circuit, when used with suitable safety components, provides protection according to ISO 13849-1 (PLd), Category 3 or according to IEC 61508, IEC 61800-5-2, and IEC 62061 (SIL CL2). All components in the system must be chosen and applied correctly to achieve the desired level of operator safeguarding.

The Safe Torque Off circuit is designed to safely turn off all of the output-power transistors. You can use the Safe Torque Off circuit in combination with other safety devices to achieve Stop Category 0 and protection-against-restart as specified in IEC 60204-1.

ATTENTION: This option is suitable only for performing mechanical work on the drive system or affected area of a machine. It does not provide electrical safety.

SHOCK HAZARD: In Safe Torque Off mode, hazardous voltages can still be present at the drive. To avoid an electric shock hazard, disconnect power to the system and verify that the voltage is zero before performing any work on the drive.

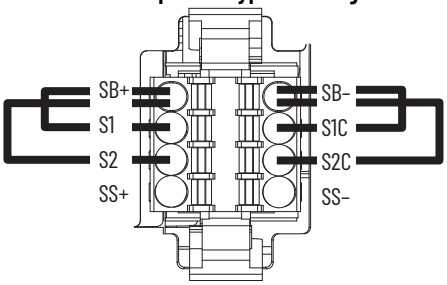
ATTENTION: Personnel responsible for the application of safety-related programmable electronic systems (PES) shall be aware of the safety requirements in the application of the system and shall be trained in using the system.

Safe Torque Off Feature Bypass

The 2198-E*xxxx*-ERS drives do not operate without a safety circuit or safety bypass wiring. For applications that do not require the Safe Torque Off (STO) feature you must install jumper wires (included with the drive) to bypass the safe torque-off circuitry.

Each 2198-E*xxxx*-ERS drive includes one 8-pin wiring plug for wiring to safety devices. Jumper wires are installed by default to bypass the safety function, as shown in Figure 203. With the jumper wires installed, the Safe Torque Off feature is not used.

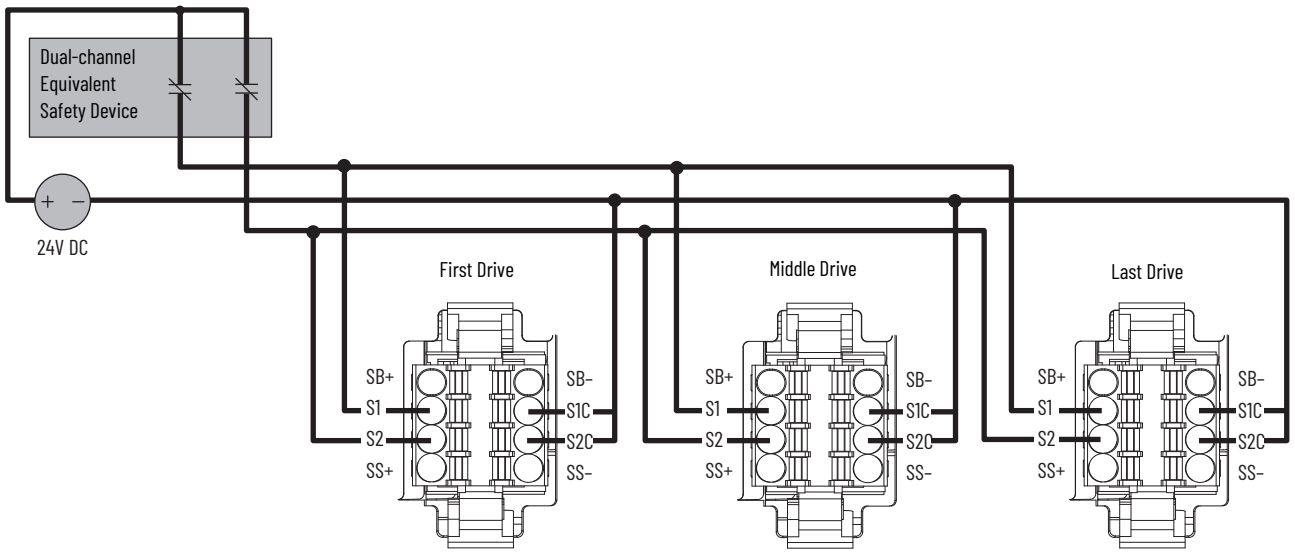
Figure 203 - Safe Torque Off Bypass Wiring



Cascade the Safe Torque Off Signal

The total number of drives in a single cascaded safety circuit is limited by the current carrying capacity of the cascaded safety circuit. Refer to Table 125 for current rating per channel, per drive.

Figure 204 - Cascaded Safe Torque Off Wiring



Safe Torque Off Specifications

To maintain the safety rating, Kinetix 5100 drives must be installed inside protected control panels or cabinets appropriate for the environmental conditions of the industrial location. The protection class of the panel or cabinet must be IP54 or higher.

Table 125 - Safe Torque Off Signal Specifications

Attribute		Value
Safety inputs (per channel)	Input ON voltage	11...30V DC
	Input OFF voltage, max	5V DC
	Input ON current, per input, max	7.34 mA
	Input OFF current, max (@ V in < 5V DC)	2.9 mA
	Pulse rejection width	60 µs
	Feedback output OFF current, max	100 µA
	Feedback output ON current, max	40 mA
	Feedback output OFF voltage, max	30V DC
	Feedback output ON voltage, max	1.5 V @ 40 mA
	External power supply	SELV/PELV
	Input type	Optically isolated and reverse voltage protected

Safe Torque Off Wiring Diagrams

This section provides a typical wiring diagram for the Kinetix 5100 Safe Torque Off (STO) feature with other Allen-Bradley safety products.

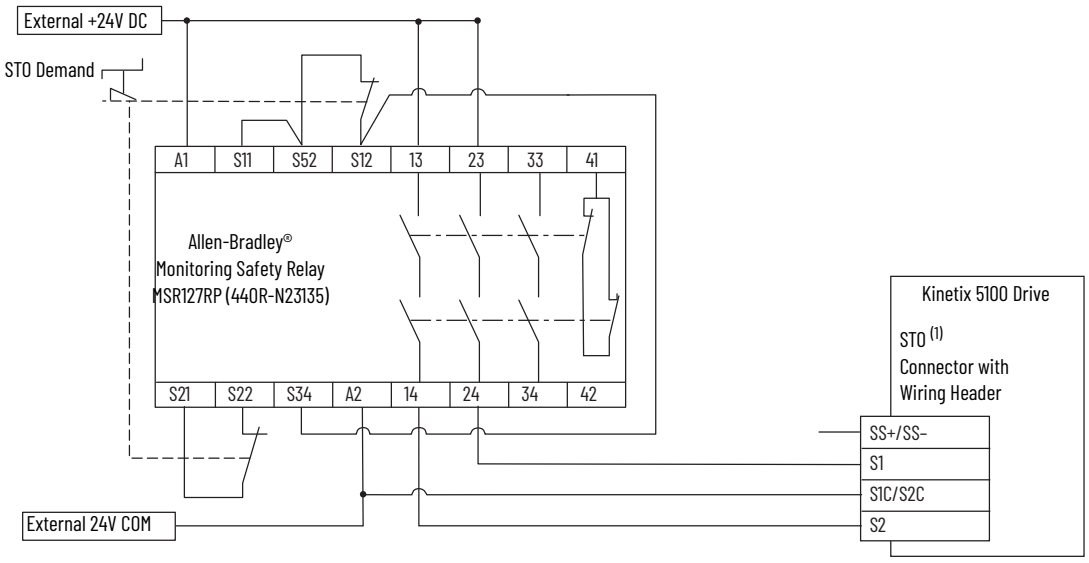
For additional information regarding Allen-Bradley safety products, including safety relays, light curtain, and gate interlock applications, see the Safety Components, webpage https://www.rockwellautomation.com/en_NA/products/safety-components/overview.page.

The drive is shown in a single-axis relay configuration for Stop Category 0 per IEC-60204-1 Safety of Machinery Directive. This is an example, however, and your application can differ based on the required overall machine performance level requirements.

IMPORTANT The Kinetix 5100 drive has been qualified and rated as a component to meet ISO 13849-1 performance level d (PLd), category 3.

It is suggested to evaluate the entire machine performance level required with a risk assessment and circuit analysis. Contact your local distributor or Rockwell Automation Sales for more information.

Figure 205 - Single-axis Relay Configuration (Stop Category 0)

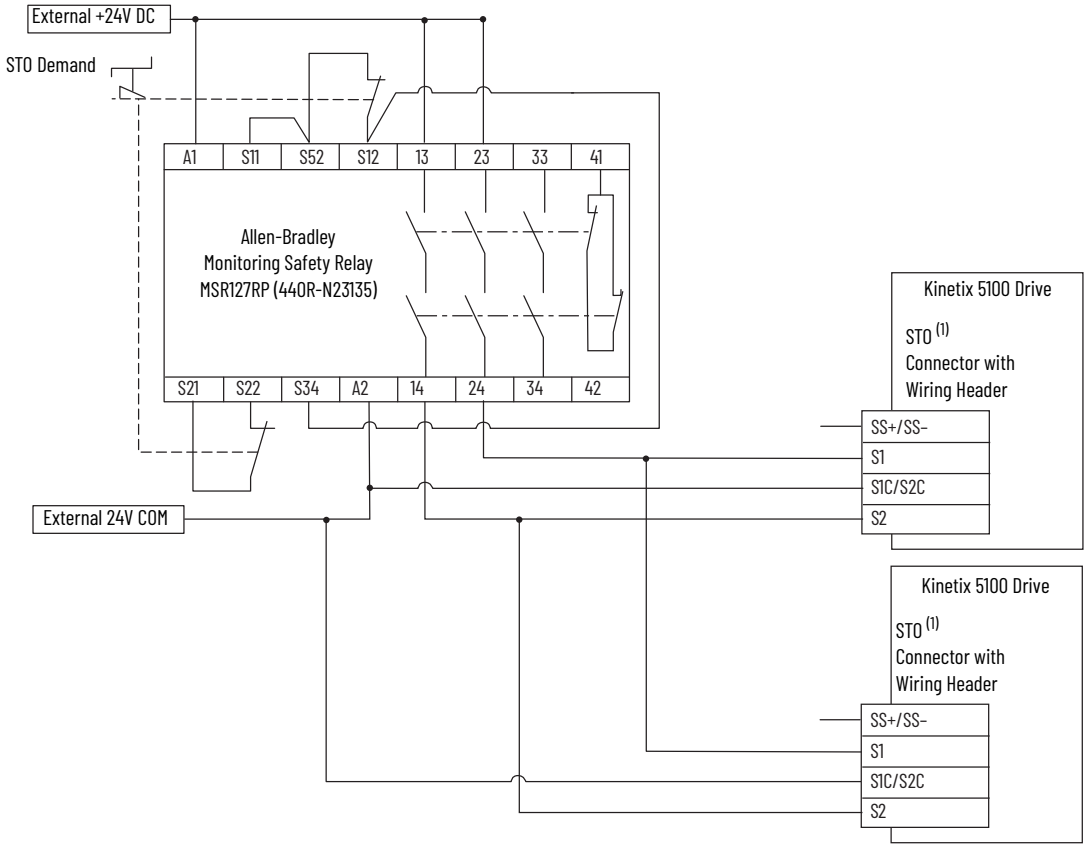


(1) Bypass Jumper is removed from SB+ and SB-.
Sinking output status is true (=1) when the drive displays E 500 status (SS+ and SS- are closed).

IMPORTANT Reset of the STO fault is required via digital input DI.ARST or raC_Dvc_5100_MAFR instruction.

In this example, the drive is shown with two axes configuration in a relay configuration for Stop Category 0 per IEC-60204-1 Safety of Machinery Directive.

Figure 206 - Multiple-axis Relay Configuration (Stop Category 0)

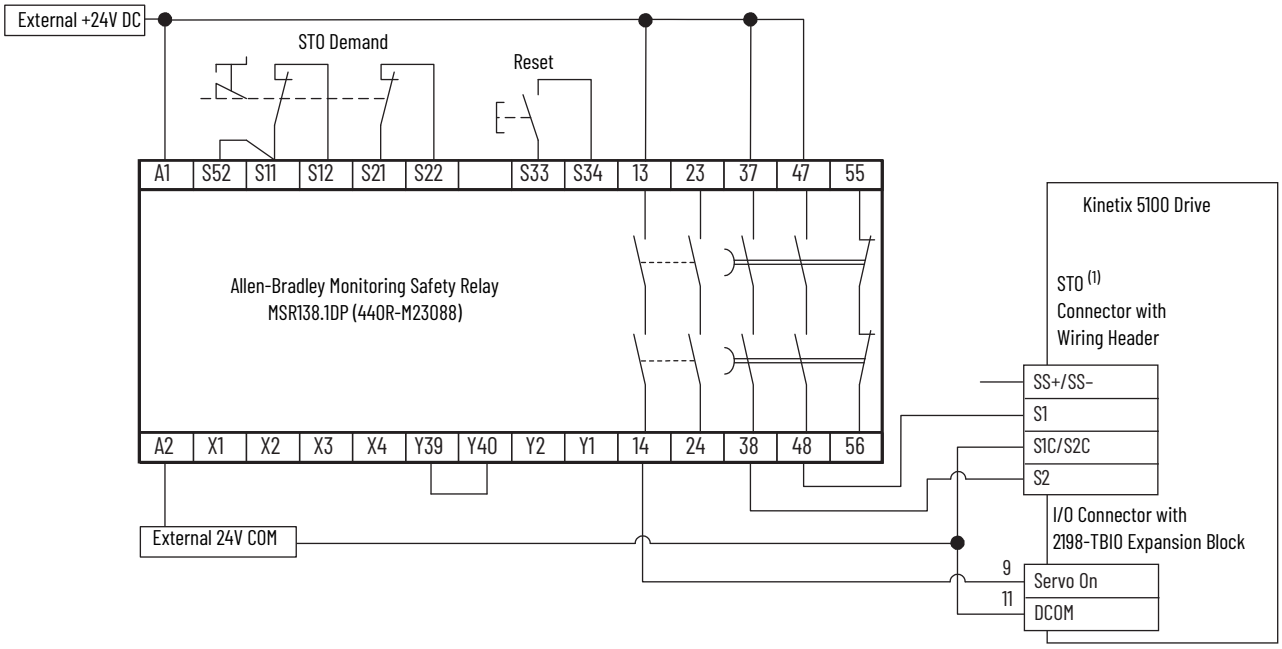


(1) Bypass Jumper is removed from SB+ and SB-.
Sinking output status is true (=1) when the drive displays E 500 status (SS+ and SS- are closed)

IMPORTANT Reset of the STO fault is required via digital input DI.ARST or raC_Dvc_5100_MAFR instruction.

In this example, the drive is shown in a single-axis relay configuration for Stop Category 1 per IEC-60204-1 Safety of Machinery Directive.

Figure 207 - Single-axis Relay Configuration (Stop Category 1)



(1) Bypass Jumper is removed from SB+ and SB-.
Sinking output status is true (=1) when the drive displays E 500 status (SS+ and SS- are closed).

IMPORTANT Reset of the STO fault is required via digital input DI.ARST or raC_Dvc_5100_MAFR instruction.

The MotorStopMode parameter is used to determine the type of stop in the drive. Upon removal of digital input Servo On, the drive behavior in Table 126 executes.

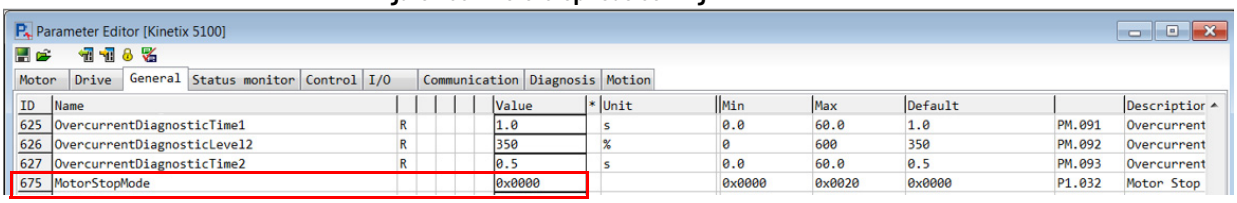
Table 126 - MotorStopMode Settings in Drive Firmware

ID675 (P1.032) MotorStopMode Setting	Drive Behavior
0000 (default)	Dynamic brake stop
0010	Disable and coast
0020	Dynamic brake stop first, when motor speed is slower than ID145 (P1.038), then coast stop
0030	Ramped decel

Figure 208 - Digital Input Servo On



Figure 209 - MotorStopMode Setting



Absolute Position Recovery

This section introduces the absolute servo system, the steps to set up the system, and the procedures for initializing and operating the system for the first time.

Topic	Page
System Requirements	389
Compatible Servo Motors	389
Install the Battery	391
System Initialization	392



For Kinetix® 5100 fault code descriptions and parameters, see Knowledgebase Technote: Kinetix 5100 Servo Drive Parameter Data and Fault Codes. You can download the spreadsheet from this public article.

You will be asked to log in to your Rockwell Automation web account or create an account if you do not have one. You do not need a support contract to access this article.

System Requirements

A complete absolute servo system should include a Kinetix® 5100 servo drive, absolute motor, and when a Kinetix TLP motor is present, a backup battery box. When the battery supplies power to the system, the encoder is able to work even when power is off. Moreover, an absolute type encoder can continuously record the motor's actual position anytime, even when the motor shaft is rotated after the power is off. The absolute servo system must work with an absolute motor. If it is arranged with an incremental type motor and the related parameters of an absolute system are enabled, E 069 Wrong motor encoder type occurs.

Compatible Servo Motors

Following motors are compatible with Kinetix 5100 drives. They are listed with variables, but include the appropriate encoder (V/E/M/S/D) types. See the Motor and Auxiliary Feedback Configurations on page 14 for information about encoder types.

Kinetix TL Servo Motor[1]
TL-A1xxx-B
TL-A2xxx-B
TL-A25xxx-B
TL-A4xxx-B

(1) Battery backup is required for -B encoders.

Kinetix TLY Servo Motor[1] [2]
TLY-A1xxx-B
TLY-A2xxx-B
TLY-A25xxx-B
TLY-A3xxx-B

(1) Battery backup is required for -B encoders.
(2) Also available with -H (incremental) encoders.

Kinetix TLP Servo Motor [1]
TLP-A046-*xxx*-D
TLP-A/B070-*xxx*-D
TLP-A/B090-*xxx*-D
TLP-A100-*xxx*-D
TLP-A/B115-*xxx*-D
TLP-A/B145-*xxx*-D
TLP-A/B200-*xxx*-D
TLP-A/B235-*xxx*-D

(1) The 24-bit absolute multi-turn, 65536 revolution option is available, but requires battery backup.

Kinetix MPL Low Inertia Motors (200V-class)
MPL-A15*xxx*-V/E [1]
MPL-A2*xxx*-V/E [1]
MPL-A3*xxx*-M/S [1]
MPL-A4*xxx*-M/S [1]
MPL-A45*xxx*-M/S [1]
MPL-A5*xxx*-M/S

(1) Also available with -H (incremental) encoders.

Kinetix MPL Low Inertia Motors (400V-class)
MPL-B15xxx-V/E[1]
MPL-B2xxx-V/E[1]
MPL-B3xxx-M/S[1]
MPL-B4xxx-M/S[1]
MPL-B45xxx-M/S[1]
MPL-B5xxx-M/S
MPL-B6xxx-M/S
MPL-B8xxx-M/S
MPL-B9xxx-M/S

(1) xxxxxAlso available with -H (incremental) encoders.

Kinetix MPM Medium Inertia Motors (200V-class)
MPM-A115*xx*-M/S
MPM-A130*xx*-M/S
MPM-A165*xx*-M/S
MPM-A215*xx*-M/S

Kinetix MPM Medium Inertia Motors (400V-class)
MPM-B115x-M/S
MPM-B130x-M/S
MPM-B165x-M/S
MPM-B215x-M/S

Kinetix MPF Food Grade Motors (200V-class)
MPF-A3*xxx*-M/S
MPF-A4*xxx*-M/S
MPF-A45*xxx*-M/S
MPF-A5*xxx*-M/S

Kinetix MPF Food Grade Motors (400V-class)
MPF-B3xxx-M/S
MPF-B4xxx-M/S
MPF-B45xxx-M/S
MPF-B5xxx-M/S

Kinetix MPS Stainless Steel Motors (200V-class)
MPS-A3*xxx*-M/S
MPS-A45*xxx*-M/S

Kinetix MPS Stainless Steel Motors (400V-class)
MPS-B3xxx-M/S
MPS-B45xxx-M/S
MPS-B5xxx-M/S

Install the Battery

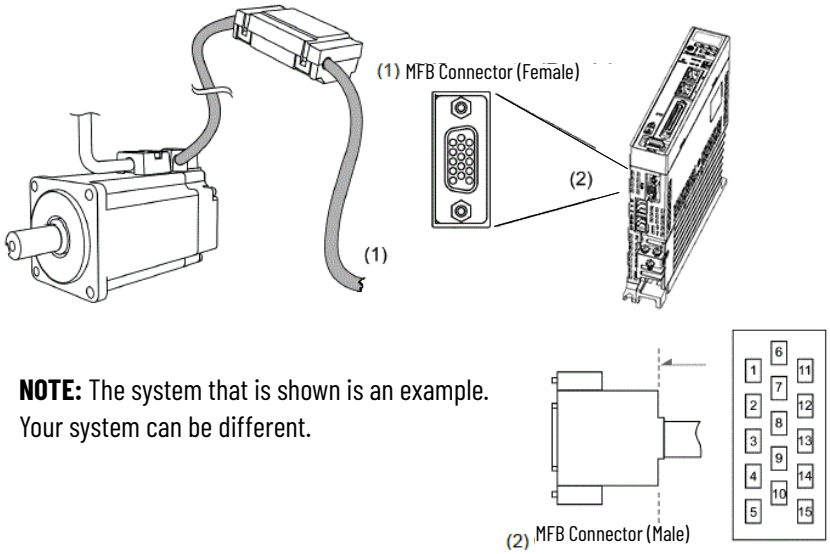
For instructions on the motor feedback cable preparation, see Wire the Motor Feedback Connector on page 89.

Installation of a battery box is required for Kinetix TLP.

If you are using the pre-assembled TLP motor feedback cables, see the Kinetix 5100 Feedback Battery Box Installation Instruction, publication 2198-IN022, for information to install or replace a battery box, install a battery, and prepare a feedback cable for a battery box installation.

For information on wiring flying-lead feedback cables, see Chapter 4. That chapter provides information on motor feedback cables and provides wire terminations for encoder signals to the motor feedback (MFB) connector on Kinetix 5100 drives.

Figure 210 - Battery box that is connected to Kinetix 5100 system



NOTE: The system that is shown is an example. Your system can be different.

System Initialization

When you initialize the absolute system for the first time, a fault (A 060 Absolute Position Lost) occurs because the coordinate system has not been created. Clear the fault by configuring the coordinate system. Insufficient battery power or the failure of the main power supply also causes loss of the coordinate system and the reoccurrence of A 060. In the absolute system, when the PUU position value goes outside the range -2147483648 … 2147483647, A 289 (Feedback position [PUU] counter overflow) occurs.

Except for the faults mentioned above, you can use Bit 2, Overflow warning setting of ID243 (P2.070) DataReadUnitSelection to set up the absolute servo system. You can choose not to show A 289 if the absolute coordinate system overflows when the PUU exceeds the range -2147483648 … 2147483647. For example, you might do this on a system that uses incremental commands to operate in one direction.

ID243 (P2.070) setting:

1. Initialize the absolute coordinates.

   When the coordinate setting is complete, A 06A (or A 060) is automatically cleared. There are three ways for you to initialize the host controller coordinates: using the digital input signals (DI), setting the parameters below, or using the Homing Command (raC_Dvc_K5100_MAH AOI).

Homing Parameters	Name
ID269 (P5.004)	HomingMode
ID298 (P5.005)	HomingSpeed
ID299 (P5.006)	HomingCreepSpeed
ID397 (P6.000)	HomingSetting
ID398 (P6.001)	HomePosition

2. When the system is powered on again, you can access the host controller's absolute position either with DI/DO signals or through Ethernet communication.

   Based on the setting of ID243 (P2.070), the host controller can select the requested value, either the PUU or the pulse value, within one turn.

Pulse Number

With the default setting in ID117 (P1.001.Z = 0), when the motor is running in the clockwise direction, the cycle number is expressed as a positive value. When the motor runs in the counterclockwise direction, the cycle number is expressed as a negative value.

Table 127 - Relevant Parameters and Faults

Fault code	Name
A 060	Absolute Position Lost
A 06A	Absolute Position is not Initialized
A 289	Feedback Position [PUU] Counter Overflow

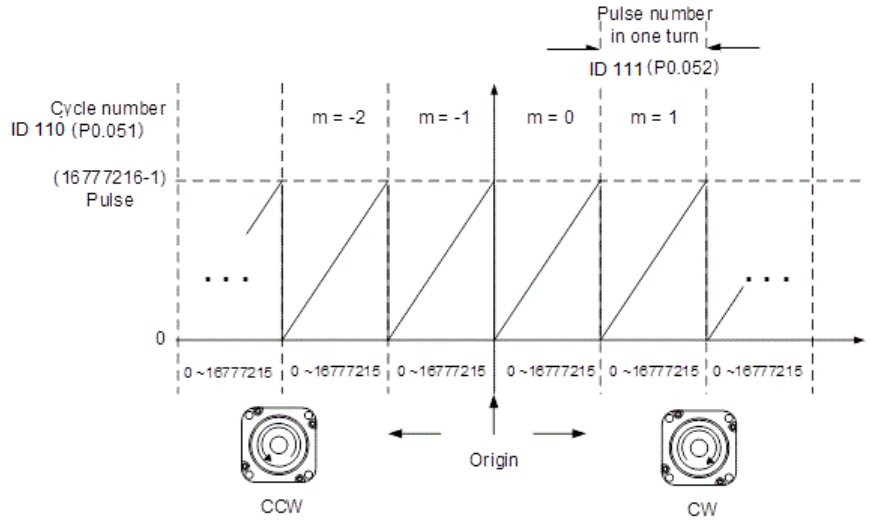
Parameters	Name
ID117 (P1.001)	ControlMode
ID151 (P1.044)	GearRatioSlaveN1
ID152 (P1.045)	GearRatioMasterCounts
ID194 (P2.009)	DIDebounceTime
ID243 (P2.070)	DataReadUnitSelection
ID398 (P6.001)	HomePosition

In the examples below, the encoder resolution of 16777216 (single turn) is used. In addition to the cycle counter, there are 16,777,216 pulses (0 ... 16777215) in one rotation. Pay attention to the motor's running direction. You can read the cycle number and the pulse number either with communication or DI/DO.

Pulse number = m (cycle number) x 16777216 + pulse number (0 ... 16777215). The conversions between pulse number and PUU are as follows:

When the rotation direction is defined as clockwise (CW) in ID117 (P1.001.Z=0), then the PUU number =
pulse number × [ID152 (P1.045) / ID151 (P1.044)] + ID398 (P6.001).

When the rotation direction is defined as counter-clockwise (CCW) in ID117 (P1.001.Z=1), then the PUU number =
(-1) × pulse number × [ID152 (P1.045) / ID151 (P1.044)] + ID398 (P6.001).

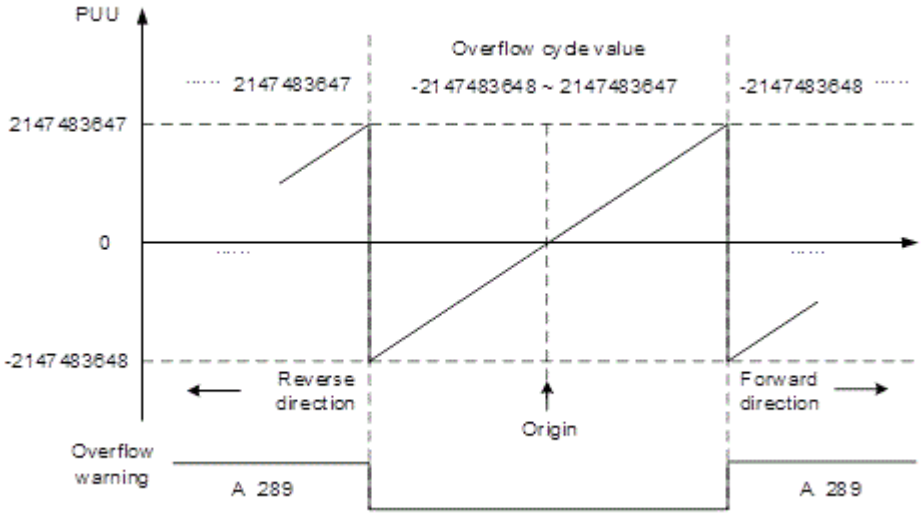


PUU Number

The PUU number is a 32-bit absolute value with positive and negative signs. When the motor is running in the forward direction, the PUU number increases; when it is running in the reverse direction, the PUU number decreases. The forward direction does not mean that the motor is running clockwise; the direction is defined by ID117 (P1.001.Z). If the PUU number exceeds the range -2147483648 ... 2147483647, the position counter overflows and A 289 occurs. Reinitialize the system to clear the fault A 289. You can determine A 289 when the position overflows through ID243 (P2.070). When reaching the maximum PUU number in the forward direction, the value changes from
2147483647 to -2147483648, -2147483647, until 2147483647, and so on. The value changes the other way when the motor operates in the reverse direction. See the following examples:

Example:

When ID151 (P1.044) = 16777216 and ID152 (P1.045) = 100000, the motor needs 100,000 PUU to run a cycle. 2,147,483,647 ÷ 100,000 = 21,474.8, so after the motor runs over 21,474.8 cycles in the forward direction, A 289 occurs.

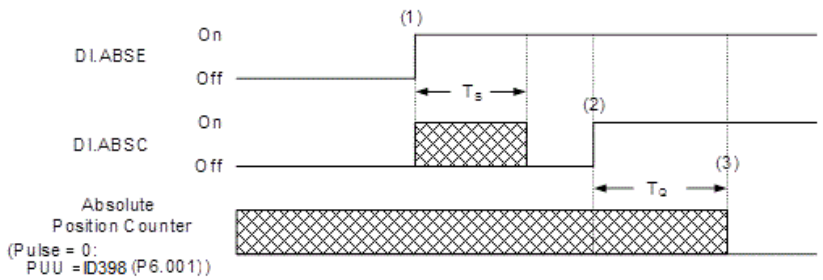


After initializing the absolute coordinate system, any change to ID117 (P1.001.Z) or E-Gear ratio [ID151 (P1.044) and ID152 (P1.045)] changes the original setting of the absolute coordinate system. If the parameters are changed, reinitialize the coordinate system.

Initializing Coordinates with Digital Input and Digital Output Signals

When the servo system is controlled by the host controller, you can reset the absolute coordinate system with DI/DO signals. To initialize the coordinate system, set the DI.ABSE signal to on and switch the DI.ABSC signal from off to on. At that point, the pulse number is set to 0 and the PUU number is the value of ID398 (P6.001) HomePosition. See to the following diagram for detailed descriptions.

IMPORTANT (1), (2), and (3) represent the required delay time between triggering the DI.ABSE and the DI.ABSC signals to enable the function.



This table describes the T_S and T_Q delay time after triggering the DI.ABSE and the DI. ABSC signals.

	$T_{S(ms)}$	$T_{Q(ms)}$
Min (T_S, T_Q)	Value of ID194 (P2.009) + 2	
Max	ID194 (P2.009) + 2	ID194 (P2.009) + 250

Description:

1. When the DI.ABSE signal turns on, it has to wait for T_S(ms) before proceeding to the next step.
2. After reaching T_S the host controller starts to reset the coordinate system. When the DI.ABSC signal turns on and remains on for T_Q ms, the pulse number is set to zero and the PUU number is set to the value of ID398 (P6.001).

Table 128 - Relevant Faults

Parameter	Name
ID102 (P0.002)	LEDMonitorSelection
ID108 (P0.049)	EncoderDataUpdateConfiguration
ID109 (P0.050)	AbsSysStatus
ID110 (P0.051)	MultiTurnAbsPosition
ID111 (P0.052)	SingleTurnAbsPosition
ID193 (P2.008)	ForceFunction
ID194 (P2.009)	DIDebounceTime
ID197 (P2.012)	DI3Configuration
ID198 (P2.013)	DI4Configuration
ID204 (P2.019)	DO2Configuration
ID242 (P2.069)	AbsoluteSystemSetting
ID243 (P2.070)	DataReadUnitSelection
ID244 (P2.071)	PositionErrorToleranceTime
ID398 (P6.001)	HomePosition

The setting of ID243 (P2.070) determines the value of ID110 (P0.051) and ID111 (P0.052).

Table 129 - Relevant DI/DO Signals

Value	DI name	Value	DO name
0x1D	DI.ABSE signal	When the DI.ABSE signal is on, the DO.ABSR signal is output by DO2, which is no longer configured by ID204 (P2.019).	The DO.ABSR signal always output by DO2
When the DI.ABSE signal is on, the DI.ABSQ signal is input by DI4, which is no longer configured by ID198 (P2.013).	The DI.ABSQ signal always input by DI4	When the DI.ABSE signal is on, the DO.ABSD signal is output by DO3, which is no longer configured by ID197 (P2.012).	The DO.ABSD signal always output by DO3
0x1F	DI.ABSC signal	0x0D	DO.ABSW signal

Table 130 - Relevant Faults

Fault Code	Fault Name
A 060	Absolute position is lost
A 061	Encoder under-voltage (battery under-voltage)
E 069	Wrong motor encoder type
E 072	Encoder over-speed
E 073	Encoder memory error
E 074	Absolute encoder single-turn position error
E 075	Absolute encoder position error
E 077	Encoder computing error
E 07B	Encoder memory is busy
A 07C	Clearing absolute position is issued when motor speed is over 200 rpm
E 07D	A 07C fault not cleared
E 07E	Encoder clearing procedure error
A 289	Feedback position [PUU] counter overflows

Initializing the Absolute Coordinates with Parameters

Set ID244 (P2.071) to 1 to initialize the coordinates through the display panel or with communication. As soon as ID244 (P2.071) is set to 1, the absolute coordinate system resets. Because the write-protect function of ID244 (P2.071) is protected by ID193 (P2.008), you must set ID193 (P2.008) to 271 first. In other words, the sequence is: set ID193 (P2.008) to 271, then set ID244 (P2.071) to 1.

Reading the Absolute Position with DI/DO

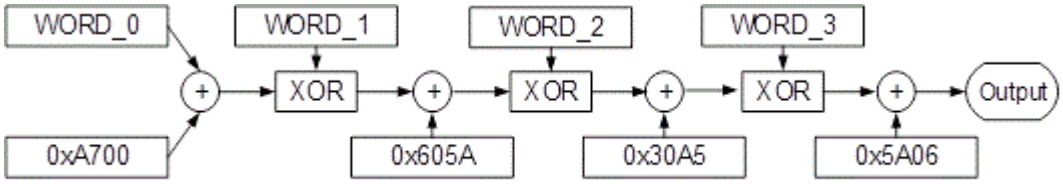
Set ID243 (P2.070) Bit 0 to 0 so that you can read the PUU number with DI/DO. See the following descriptions:

Bit 79 ... Bit 64	Bit 63 ... Bit 32	Bit 31 ... Bit 16	Bit 15 ... Bit 0
Check Sum	PUU -2147483648 ... +2147483647	0	Encoder status ID109 (P0.050)

Set ID243 (P2.070) to 1 so that you can read the pulse number with DI/DO. In this example, the encoder resolution of 16777216 (single-turn) and 65536 (multi-turn) are used. See the following descriptions:

Bit 79 ... Bit 64	Bit 63 ... Bit 32	Bit 31 ... Bit 16	Bit 15 ... Bit 0
Check Sum	Pulse number in one rotation 0 ... 16777215 (=16777216-1)	Encoder turn -32768 ... +32767	Encoder status

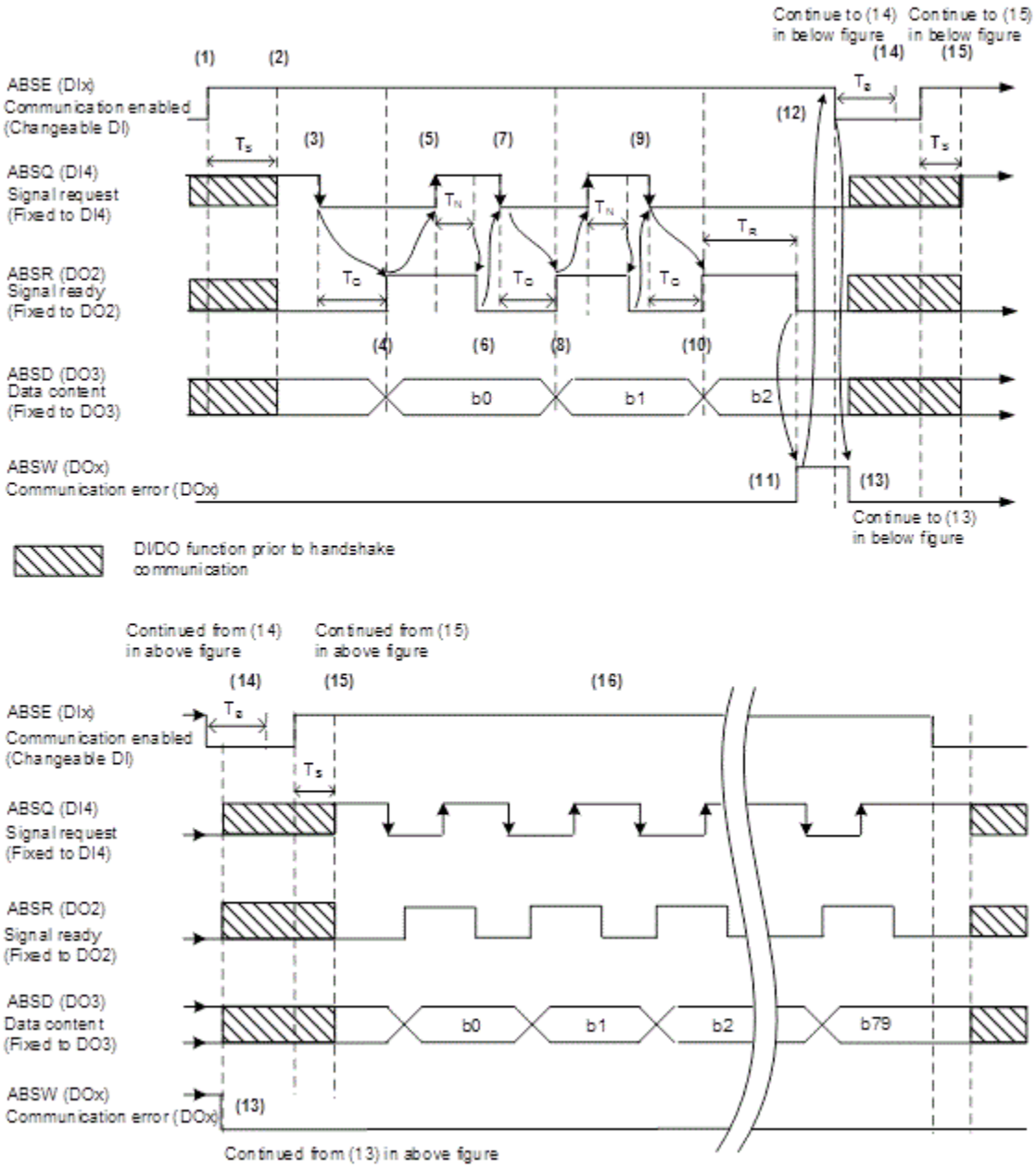
Description:
Check Sum = (((((((WORD_0+0xA700) XOR WORD_1)+0x605A) XOR WORD_2)+0x30A5) XOR WORD_3)+0x5A06)



NOTES:

1. This algorithm has no positive or negative sign.
2. 0xA700, 0x605A, 0x30A5, and 0x5A06 are the constants for hexadecimal format.
3. WORD_0: encoder status (Bit 15 ... 0)
   WORD_1: encoder turn (Bit 31 ... 16)
   WORD_2: encoder pulse number (Bit 47 ... 32)
   WORD_3: encoder pulse number (Bit 63 ... 48)

You can read the pulse number or PUU number with DI/DO and ID243 (P2.070). See the following timing diagram:



See Description of Digital Input Functions on page 405 and Description of Digital Output Functions on page 409 for information about the DI and DO signals in the timing diagram.

This table explains the delay time when reading the absolute position with DI/DO.

	T_R (ms)	T_S (ms)	T_Q (ms)	T_N (ms)	T_B (ms)
Min	-	ID194 (P2.009) + 2			
Max	200	ID194 (P2.009) + 10			

Descriptions:

1. When handshake communication starts, the DI.ABSE signal is triggered.
2. After the T_S delay time (make sure that the signal is on), the functions for DI4, DO2, and DO3 are switched to the DI.ABSQ, the DO.ABSR, and the DO.ABSD signals, respectively. If DI4 was in the high-level state before, it remains in the high-level state when switched to the DI.ABSQ signal (logic high-level signal). DI4, DO2, and DO3 are dual-function DI/DO, which means DI4, DO2, and DO3 share the same digital input with the DI.ABSQ signal, the DO.ABSR signal, and the DO.ABSD signal. Use care when switching functions or setting the DI/DO to 0 to disable the dual-function of DI/DO.
3. If DI4 is set to high and switched to the DI.ABSQ signal after the T_S delay time, when the host controller resets this signal to low, the new signal is interpreted as the data access command.
4. After the T_Q time, the handshake data is ready and the absolute position is sent to the DO.ABSD signal. Now the servo drive turns on the DO.ABSR signal, and the host controller can access the data. If the host controller still cannot detect the DO.ABSR signal status while it is changing to high after the maximum T_Q time, there may be a communication error.
5. After the DO.ABSR signal is set high, the host controller accesses the data, and the DI.ABSQ signal is set high to notify the servo drive that data was read.
6. When the DI.ABSQ signal is high, the DO.ABSR signal is set low after the T_N time, to send the data for the next bit.
7. When the DO.ABSR signal is low, the DI.ABSQ signal is also set low and the servo drive needs to send the data for the next bit.
8. Repeat step 3 ... 4. Send the absolute position to the DO.ABSD signal for the next bit communication.
9. Repeat step 5 ... 7. The host controller has read and received the data.
10. The third bit data is ready.
11. After the T_R waiting time, if the host controller has not read the data and turned on the DI.ABSQ signal, the servo drive sends the DO.ABSW signal (communication error) and stops the handshake communication.
12. When the host controller receives the communication error signal, the DI.ABSE signal is set low and prepares to restart the handshake communication.
13. The DO.ABSW signal resumes at low after the servo drive receives the DI.ABSE signal.
14. The host controller resumes communication after T_B time.
15. Repeat step 1.
16. If no error occurs, the host controller completes 80 bits (0 ... 79) of the handshake communication with the servo drive. DI4, DO2, and DO3 then resume their original functions.

IMPORTANT	If the DI.ABSE signal is set low first, and then changed to high, but the DO.ABSW signal does not return to high, it means that some other errors exist. Check for the following possible warnings: A 060 absolute position lost, low battery voltage level, or absolute position overflows. Restart a new communication cycle after those errors have been cleared.

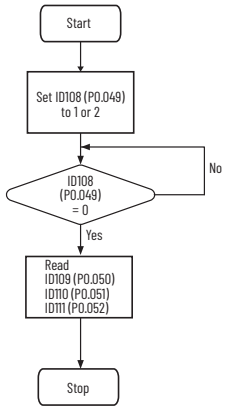
Reading the Absolute Position with Communication

You can access the data of the absolute encoder through two communication methods: instant access or parameter access.

Instant access refers to reading the motor feedback position as soon as the servo is powered on. When you set the status monitoring register 1 to the motor's feedback pulse number [ID668 (P0.017) SystemVariableMonitor1Selection = 0], you can access the motor's current position by reading ID663 (P0.009) SystemVariableMonitor1Value.

Parameter access means the motor's position is temporarily stored in parameters. Once you set ID108 (P0.049) EncoderDataUpdateConfiguration with communication, the encoder's status, absolute position (cycle number), and pulse number (or PUU) are stored in ID109 (P0.050) AbsSysStatus, ID110 (P0.051) MultiTurnAbsPosition, and ID111 (P0.052) SingleTurnAbsPosition respectively.

You can choose to read the pulse number or PUU through ID243 (P2.070) Bit 1. Even when the motor is stopped, it still moves slightly forward and backward. When you set ID108 (P0.049) to 1, the encoder continues to read the exact position of where the motor stops, without changing anything else. However, when you set ID108 (P0.049) to 2, the encoder updates the motor's current position on the servo drive, which clears the position error.



For example, the motor's current position is 20000, but it varies from 19999 to 20001.

If you send the command to read the motor's position when it stops at 20001, the motor's position is updated to 20001. After all positions are updated in ID109 (P0.050)...ID111 (P0.052), ID108 (P0.049) is automatically reset to 0. At that point, the controller can access the values of ID109 (P0.050)...ID111 (P0.052).

ID109 (P0.050) shows the status of the absolute encoder. When absolute position lost or absolute position overflow is shown, this is an indication that the absolute position is invalid. You must redo the homing procedure and reinitialize the absolute coordinates.

Notes:

Programming via Drive Parameters

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Organization of Parameters	403
Description of Digital Input Functions	405
Description of Digital Output Functions	409
Description of System Variable Monitoring	414
Description of Parameter Monitoring	418
Use a MSG Instruction to Set Parameters	419

Organization of Parameters



For Kinetix® 5100 fault code descriptions and parameters, see Knowledgebase Technote: Kinetix 5100 Servo Drive Parameter Data and Fault Codes. You can download the spreadsheet from this public article.

You will be asked to log in to your Rockwell Automation web account or create an account if you do not have one. You do not need a support contract to access this article.

Parameter Groups

Parameters are listed across 26 functional groups. Some parameters have dual functions and appear in multiple groups. The primary groups are listed in the parameter spreadsheet in the Knowledgebase Technote. The additional groups to which the parameters belong are listed in the Additional Groups column of that spreadsheet and are identified in the table.

Table 131 - Parameters and the Functional Groups

Primary Group Number	Group Name	Additional Group Number	Group Name
1	Motor	11	System
2	Drive	12	BRK_RegResistor
3	General	13	Pulse Setting
4	Status Monitor	14	Gear Ratio
5	Control	15	Filter
6	I/O	16	Limit
7	Communication	17	Position Loop
8	Diagnosis	18	Velocity Loop
9	Motion_1	19	Current Loop
10	Motion_2	20	Tuning

Table 131 - Parameters and the Functional Groups (Continued)

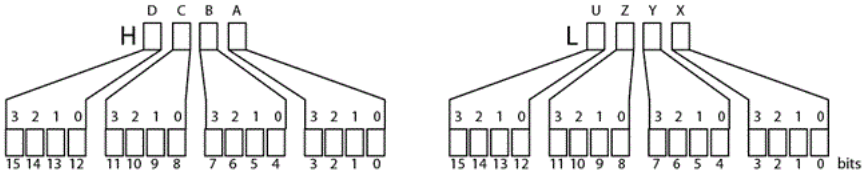
Primary Group Number	Group Name	Additional Group Number	Group Name
		21	Speed Setting
		22	Event Setting
		23	Homing
		24	E-cam
		25	Capture
		26	Compare

Numeric/Decimal Parameters

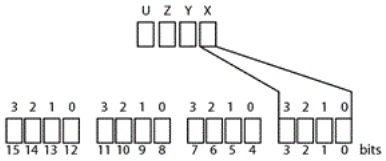
These parameters have a single numeric value. For example, ID123 (P1.007) (Torque Command Low Pass Filter Time Constant) supports values in ms, with a default value of 0 ms.

Parameters in Hexadecimal Format

The drive has some parameters that are 16-bits or 32-bits in size and are represented in hexadecimal format. The settings for these parameters are defined either by the value of each bit or by the value of each hexadecimal digit, represented by D, C, B, A (high) and U, Z, Y, X (low).



For example, ID230 (P2.047) is a 16-bit parameter that translates to one hexadecimal number with four digits. This settings for this parameter are defined both by the actual value of the X hexadecimal digit and by the values of the individual bits in the Y and Z digits.



ID230 (P2.047) Auto resonance suppression mode setting			
X	Auto resonance suppression function	Z	Fixed resonance suppression parameter
Y	Fixed resonance suppression parameter	U	Reserved

The setting for Auto resonance suppression is defined by the value of X as follows:

- X = 0: Disable auto resonance suppression
- X = 1: Enable auto resonance suppression

The fixed resonance suppression parameter is defined by the value of the bits that make up the Y digit, as follows:

Y(1)	Function	Description
Bit 0	Notch 1 auto / manual setting	0: Auto resonance suppression 1: Manually set the first set of resonance suppression
Bit 1	Notch 2 auto / manual setting	0: Auto resonance suppression 1: Manually set the second set of resonance suppression
Bit 2	Notch 3 auto / manual setting	0: Auto resonance suppression 1: Manually set the third set of resonance suppression
Bit 3	Notch 4 auto / manual setting	0: Auto resonance suppression 1: Manually set the fourth set of resonance suppression

(1) Bit 0...3 of digit Y correspond to Bits 4...7 of the 16-bit parameter.

Description of Digital Input Functions

The drive provides user-defined input functions for the 10 digital inputs and three virtual digital inputs. When the following parameters are set to 0, digital input functions are disabled:

Table 132 - Relevant Parameters

Parameter	Name
ID195 (P2.010)	DI1Configuration
ID196 (P2.011)	DI2Configuration
ID197 (P2.012)	DI3Configuration
ID198 (P2.013)	DI4Configuration
ID199 (P2.014)	DI5Configuration
ID200 (P2.015)	DI6Configuration
ID201 (P2.016)	DI7Configuration
ID202 (P2.017)	DI8Configuration
ID220 (P2.036)	DI9Configuration
ID221 (P2.037)	DI10Configuration
ID222 (P2.038)	VirtualDI11Configuration
ID223 (P2.039)	VirtualDI12Configuration
ID224 (P2.040)	VirtualDI13Configuration

The available digital input functions are listed in the following table.

Table 133 - Digital Inputs

Setting	DI Name	DI Description	Trigger Method	Control Mode
0x01	SON	Servo On When this DI is on, servo is activated (Servo On).	Level triggered	All except I/O
0x02	ARST	Fault Reset After the fault has been cleared, the drive will show that the fault has been cleared when this DI is on.	Rising-edge triggered	All
0x03	GAINUP	Gain Switching In speed and position mode, when this DI is on (ID212 (P2.027) GainSwitchingSelection set to 1), the gain will switch to the original gain multiply the switching rate.	Level triggered	PT, PR, S, I/O (Position, Index, Gear, Speed)
0x04	CCLR	Pulse Clear Clear pulse counter and setting of parameter ID233 (P2.050) PulseClearMode. Set the DI.CCLR signal to 0 to clear position pulse deviation (applicable to PT mode). When this DI is on, the accumulative pulse deviation of the drive will be cleared to 0.	Rising-edge triggered, level triggered	PT, PR, I/O (Position, Index, Gear)

Table 133 - Digital Inputs (Continued)

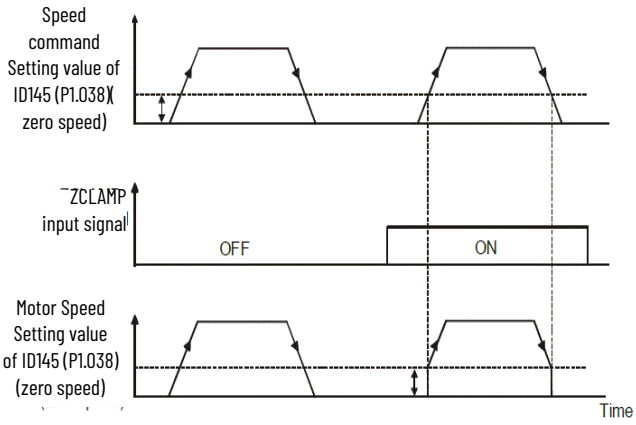
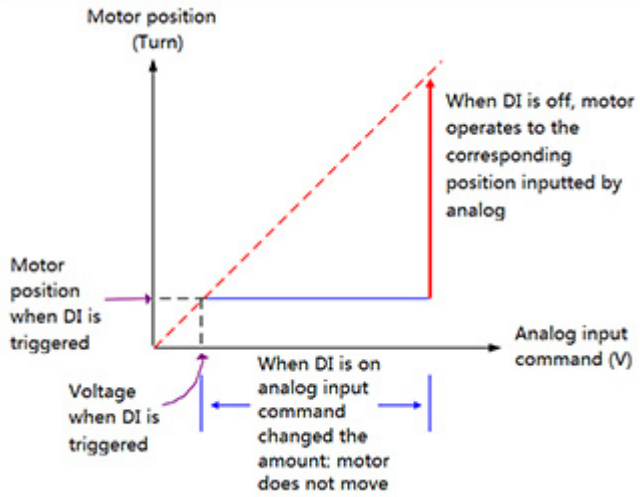
Setting	DI Name	DI Description	Trigger Method	Control Mode
0x05	ZCLAMP	Zero Speed Clamp When the speed is slower than the setting of zero speed ID145 (P1.038) ZeroSpeedWindow, motor stops operating when this DI is on.  See ZCLAMP Function on page 221 for additional information.	Level triggered	S, I/O (Speed)
0x06	CMDINV	Command Input Reverse Control In speed mode, the input command will be set to reverse direction when this DI is on.	Level triggered	S, Sz, T, I/O (Speed, Gear Mode)
0x08	CTRG	Command Triggered In PR mode, after selecting the PR command (POS0...POS6), the motor operates according to the command issued by the register when this DI is on.	Rising-edge triggered	PR
0x09	TRQLM	Torque Limit In speed and position mode, the motor torque will be limited when this DI is on, and the source of the torque limit command will be the internal register or analog voltage.	Level triggered	PT, PR, S, I/O (Position, Index, Gear, Speed)
0x0C	VPL	Latch Function of Analog Position Command If this DI is on, position of the motor will be held at the current position when DI is triggered. During DI on, the motor will not operate even when there is a change of analog command. When this DI is off, the motor completes the command that is changed during the time when DI is on. 	Level triggered	PT, I/O (Gear)
0x10	SPDLM	Speed Limit Enable In torque mode, the motor speed will be limited when this DI is on, and the limited speed command will be the internal register or analog voltage command.	Level triggered	T, I/O (Torque)
0x11	POS0	Position Command Internal Position Command Selection 1...99 Bit 0. See Digital Input (DI) Trigger on page 296 for more information.	Level triggered	PR
0x12	POS1	Position Command Internal Position Command Selection 1...99 Bit 1. See section Digital Input (DI) Trigger on page 296 for more information.	Level triggered	PR
0x13	POS2	Position Command Internal Position Command Selection 1...99 Bit 2. See section Digital Input (DI) Trigger on page 296 for more information.	Level triggered	PR

Table 133 - Digital Inputs (Continued)

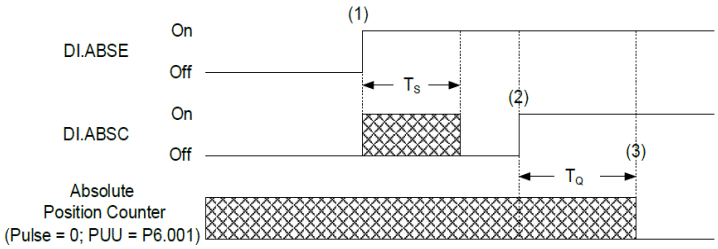
Setting	DI Name	DI Description	Trigger Method	Control Mode
0x1A	POS3	Position Command Internal Position Command Selection 1...99 Bit 3. See section Digital Input (DI) Trigger on page 296 for more information.	Level triggered	PR
0x1B	POS4	Position Command Internal Position Command Selection 1...99 Bit 4. See section Digital Input (DI) Trigger on page 296 for more information.	Level triggered	PR
0x1C	POS5	Position Command Internal Position Command Selection 1...99 Bit 5. See section Digital Input (DI) Trigger on page 296 for more information.	Level triggered	PR
0x1E	POS6	Position Command Internal Position Command Selection 1...99 Bit 6. See section Digital Input (DI) Trigger on page 296 for more information.	Level triggered	PR
0x1D	ABSE	When the DI.ABSE signal is on, it is in absolute mode and can enable the functions of the DI.ABSQ, DI.ABSC, DI.ABSR, DI.ABSD, and DI.ABSC signals at the same time. When the DI.ABSE signal is on, the functions of DI4, DO2, and DO3 no longer are the ones assigned by the parameter. Function of DI4 is the DI.ASDQ signal, DO2 is the DI.ABSR signal, and DO3 is the DI.ABSD signal. In addition, DI pins of the DI.ABSC signal can be assigned by parameters.	Level triggered	All
0x1F	ABSC	Set Up or Clear Absolute System Coordinates When the DI.ABSC signal is on, the number of turns data stored in absolute encoder will be cleared. But this DI is only valid when the DI.ABSE signal is on.	Rising-edge triggered	All
—	ABSQ	ABSQ Always Input by DI4 Setting Setting Value: When the DI.ABSE signal is on, the DI.ABSQ signal that is input by DI4 replaces the DI4 function assigned by ID198 (P2.013) DI4Configuration. During I/O transmission, a handshaking signal is sent by the controller. When the DI.ABSQ signal is off, it indicates the controller issues the request; when the DI.ABSQ signal is on, it indicates the controller has processed the ABSD signal. This DI is only valid when the DI.ABSE signal is on.  See Initializing Coordinates with Digital Input and Digital Output Signals on page 395 for additional information.	Rising- and falling-edge triggered	All
0x14	SPD0	Internal Speed Command Selection 1...4 Bit 0. See Selection of Speed Command on page 211 for more information.	Level triggered	S T, I/O (Torque) for speed limit function
0x15	SPD1	Internal Speed Command Selection 1...4 Bit 1. See Selection of Speed Command on page 211 for more information.	Level triggered	S T, I/O (Torque) for speed limit function
0x16	TCM0	Internal Torque Command Selection 1...4 Bit 0. See Selection of Speed Command on page 211 for more information.	Level triggered	T PR, PT, S, I/O (Position, Index, Gear, Speed) for torque limit function
0x17	TCM1	Internal Torque Command Selection 1...4 Bit 1. See Selection of Speed Command on page 211 for more information.	Level triggered	T PR, PT, S, I/O (Position, Index, Gear, Speed) for torque limit function

Table 133 - Digital Inputs (Continued)

Setting	DI Name	DI Description	Trigger Method	Control Mode
0x18	S-P	Speed and Position Mode Switching In position and speed mode, if DI is off, it is in speed mode; if DI is on, it is in position mode. (In PT/PR/S mode, PT or PR are selected via DI.PT-PR (0x2B).	Level triggered	Dual Mode
0x19	S-T	Speed and Torque Mode Switching In speed and torque mode, if DI is off, it is in speed mode; if DI is on, it is in torque mode.	Level triggered	Dual Mode
0x20	T-P	Torque and Position Mode In position and torque mode, if DI is off, it is in torque mode; if DI is on, it is in position mode. (In PT/PR/T mode, PT or PR are selected via DI.PT-PR (0x2B).	Level triggered	Dual Mode
0x21	EMGS	Emergency Stop When this DI is on, the motor executes an emergency stop.	Level triggered	All
0x22	NL (CWL)	Reverse Inhibit Limit - Clockwise (normally closed, N.C.)	Level triggered	All
0x23	PL (CCWL)	Forward Inhibit Limit - Counterclockwise (normally closed, N.C.)	Level triggered	All
0x24	ORGP	Homing Origin During homing, the servo regards the position when this DI is triggered as the homing origin. Refer to the setting of ID297 (P5.004) =HomingMode See Setting Homing Mode ID297 (P5.004) on page 260 for additional information.	Rising- and falling-edge triggered	PR, I/O (Index)
0x27	SHOM	Return to Homing Origin During homing, the function of searching the origin will be activated when this DI is on. Refer to the setting of ID297 (P5.004) =HomingMode See section Setting Homing Method for more information.	Rising-edge triggered	PR
0x2B	PT-PR	PT and PR Mode Switching When selecting PT-PR dual mode or PT/PR/S multiple mode, the command source can be selected via this DI. If this DI is off, it is in PT mode; if this DI is on, it is in PR mode.	Level triggered	Dual Mode
0x35	ALGN	E-Cam Alignment When the E-Cam alignment function is enabled ID248 (P2.076) ECamControlConfiguration bit0 = 1and bit1 = 1, it will execute an alignment correction after this DI is on.	Rising-edge triggered	PR, I/O (Position, Index)
0x36	CAM	E-Cam Engaging Control Refer to the setting of ID376 (P5.088 U, Z.value) = ECamControl See E-Cam on page 335.	Rising- and falling-edge triggered	PR, I/O (Position, Index)
0x37	JOGU	Forward Jog Input When this DI is on, the motor will jog in a forward direction.	Level triggered	All except I/O
0x38	JOGD	Reverse Jog Input When this DI is on, the motor will jog in a reverse direction.	Level triggered	All except I/O
0x39	EV1	Event Trigger Command 1 Refer to the ID386 (P5.098) EventRisingEdgePRNumber and ID387 (P5.099) EventFallingEdgePRNumber descriptions in the spreadsheet.	Rising- and falling-edge triggered	PR, I/O (Index)
0x3A	EV2	Event Trigger Command 2 Refer to the ID386 (P5.098) EventRisingEdgePRNumber and ID387 (P5.099) EventFallingEdgePRNumber descriptions in the spreadsheet.	Rising- and falling-edge triggered	PR, I/O (Index)
0x3B	EV3	Event Trigger Command 3 Refer to the ID386 (P5.098) EventRisingEdgePRNumber and ID387 (P5.099) EventFallingEdgePRNumber descriptions in the spreadsheet.	Rising- and falling-edge triggered	PR, I/O (Index)
0x3C	EV4	Event Trigger Command 4 Refer to the ID386 (P5.098) EventRisingEdgePRNumber and ID387 (P5.099) EventFallingEdgePRNumber descriptions in the spreadsheet.	Rising- and falling-edge triggered	PR, I/O (Index)
0x43	GNUM0	E-Gear Ratio (Numerator) Selection 0 See E-Cam Gear Ratio and Curve Scaling on page 347 for additional information.	Level triggered	PT, I/O (Gear)
0x44	GNUM1	E-Gear Ratio (Numerator) Selection 1 See E-Cam Gear Ratio and Curve Scaling on page 347 for additional information.	Level triggered	PT, I/O (Gear)
0x45	INHP	External Pulse Inhibit In position mode, the external pulse input command has no function when this DI is on. (Note: This function has to be set to DI8 to ensure the instantaneity of pulse inhibition) set DI8 ID202 (P2.017) DI8Configuration. See section Pulse Command Input Inhibitor (INHP) on page 203 for more information.	Level triggered	PT, I/O (Gear)

Table 133 - Digital Inputs (Continued)

Setting	DI Name	DI Description	Trigger Method	Control Mode
0x46	STP	Motor Stop Trigger method of STP can be configured by ID241 (P2.068.Z). Rising-edge triggered when ID241 (P2.068.Z) is 0. Level triggered when ID241 (P2.068.Z) is 1.	Rising-edge triggered, level triggered	PR
0x47	PFQS	Profile Quick Stop This DI is used to set the emergency stop of deceleration time. The setting of deceleration time is the same as ID236 (P5.003) AutoProtectionDecelTime. If this DI is triggered, A 35F occurs and the motor will start decelerating. When the speed reaches 0, A 3CF occurs and the servo is off. Reset the fault to switch the drive to the servo on state.	Rising-edge triggered	PT, PR, T, S
0x48	DSO	Servo On with holding brake When this DI is on, servo is activated (Servo On). When this DI is off, the motor will start to decelerate, and the deceleration time is according to the setting value of parameter ID236 (P5.003.C). This DI is only available when ID675 (P1.032.Y) is 3 (enable vertical load control).	Level triggered	All except I/O

Description of Digital Output Functions

The drive provides user-defined output functions for the six digital outputs. When the following parameters are set to 0, digital output functions are disabled.

Table 134 - Relevant Parameters

Parameter	Name
ID203 (P2.018)	DO1Configuration
ID204 (P2.019)	DO2Configuration
ID205 (P2.020)	DO3Configuration
ID206 (P2.021)	DO4Configuration
ID207 (P2.022)	DO5Configuration
ID225 (P2.041)	DO6Configuration

The available digital output functions are listed in the following table.

Table 135 - Digital Outputs

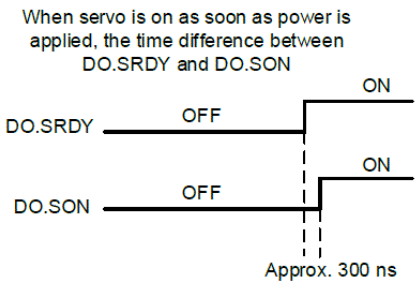
Setting	DO Name	DO Description	Triggering Method	Control Mode
0x01	SRDY	Servo Ready When the control and main circuit power is applied to the drive, this DO is on if no fault occurs.	Level triggered	All
0x02	SON	Servo On When the servo is activated (Servo On), this DO is on if no fault occurs. 	Level triggered	All
0x03	ZSPD	Zero Speed Reached When the motor speed is slower than the setting of zero speed ID145 (P1.038) ZeroSpeedWindow, this DO is on.	Level triggered	All
0x04	TSPD	Target Speed Reached When the motor speed is faster than the target speed setting ID146 (P1.039) UpToSpeedLimit, this DO is on.	Level triggered	All
0x05	TPOS	Target Position Reached When the deviation pulse number is smaller than the position range setting value of ID159 (P1.054) InPositionWindow, this DO is on.	Level triggered	PT, PR, I/O (Position, Gear)
0x06	TQL	Torque Limit When it is in torque limit, this DO is on.	Level triggered	All (Except for T and Tz)

Table 135 - Digital Outputs (Continued)

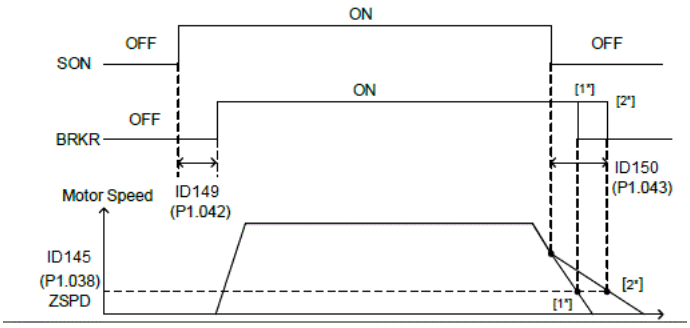
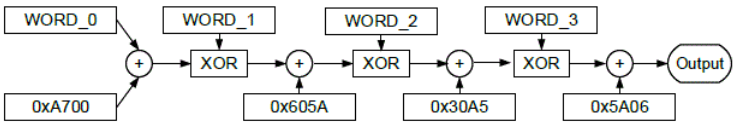
Setting	DO Name	DO Description	Triggering Method	Control Mode
0x07	ALRM	Servo Warning When an fault occurs, this DO is on. (Except for forward / reverse limit, communication error, undervoltage, and fan error.)	Level triggered	All
0x08	BRKR	Brake Control When the signal of magnetic brake control is outputted, adjust the settings of ID149 (P1.042) BrakeOnDelay and ID150 (P1.043) BrakeOffDelay.  See Motor Brake Circuit on page 57.	Level triggered	All
0x09	HOME	Homing Completed When homing is completed, it means the position coordinate system and position counter are defined and this DO is on. When applying to power, this DO is off; when homing is completed, this DO is on. During operation, this DO is on until the position counter overflows (including command or feedback). Then, this DO turns off. When homing command is triggered, this DO is off; after homing is completed, this DO is on.	Level triggered	PR
0x0B	TPHM	At Home Position This DO is on when homing is completed, position command is equal to home position and the deviation between position feedback and home position is smaller than ID 159 (P1.054),	Level triggered	PR, IO position
0x0D	ABSW	Absolute Type System Error When there are faults regarding the absolute encoder, this DO is on.	Level triggered	All
0x0E	IDXD	Definition of Index Coordinates Indexing coordinate is defined. When homing is completed, indexing coordinate is defined as well.	—	PR
0x10	OLW	Early Warning for Overload This DO is on when the overload level setting is reached. t_{OL} = Overload allowable time of the servo x Setting of overload warning level ID161 (P1.056) OverloadWarningUserThreshold. When the overload accumulative time exceeds t_{OL}, it will output overload pre-warning (OLW). However, if the overload accumulative time exceeds the overload allowable time of the servo, it will output overload error (ALRM). For example: The setting value of overload pre-warning is 60%. ID161 (P1.056) OverloadWarningUserThreshold= 60. When the output average load of the servo drive is 200% and the output-time exceeds 8 seconds, the overload fault A 006 Motor overload will occur. t_{OL} = Duration of the output average load of the servo is 200% x Parameter setting of overload warning level = 8 sec x 60% = 4.8 sec Result: When the output average load of the servo drive is 200% for over t_{OL} = 4.8 seconds, this overload warning DO is on (DO code is set to 10). If the duration exceeds 8 seconds, then the overload fault A 006 Motor overload occurs and will output overload error (ALRM).	Level triggered	All
0x11	WARN	Warning Output Warning outputs (forward / reverse limit, communication error, undervoltage, and fan error).	Level triggered	All
0x12	OVF	Position Command Overflows Position command / feedback overflows.	Level triggered	PT, PR, I/O (Position, Index, Gear)
0x13	SNL (SCWL)	Reverse Software Limit Software limit (reverse limit).	Level triggered	PR, I/O (All I/O modes, but will stop under Position or Index mode)
0x14	SPL (SCCWL)	Forward Software Limit Software limit (forward limit).	Level triggered	PR, I/O (All I/O modes, but will stop under Position or Index mode)

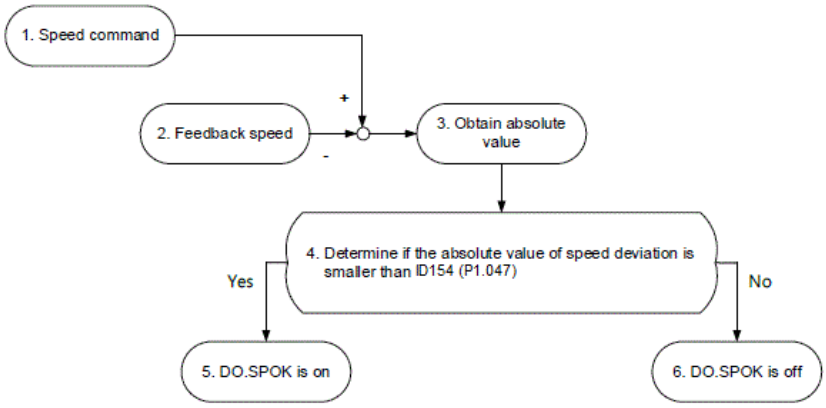
Table 135 - Digital Outputs (Continued)

Setting	DO Name	DO Description	Triggering Method	Control Mode
0x15	Cmd_OK	Command Completed When the command is completed or entered I/O mode from another mode, this DO is on. When the command is executing, this DO is off; after the command is completed, this DO is on. This DO only indicates the command is completed, but the motor positioning may not be completed yet. Refer to DO.TPOS.	Level triggered	PR, I/O (Position, Home, Index)
0x16	CAP_OK	CAP Procedure Completed Capture procedure is completed.	Level triggered	All
0x17	MC_OK	Servo Procedure Completed When DO.Cmd_OK and DO.TPOS are both on, then this DO is on. Refer to ID155 (P1.048) ToSpeedAction.	Level triggered	PR, I/O (Index when the PR command type is not Speed)
0x18	CAM_ AREA1	E-Cam area 1 When the master axis position angle is between ID378 (P5.090) and ID379 (P5.091), this DO is on.	Level triggered	PR, I/O (Position, Index)
0x19	SP_OK	Speed Reached Output Motor speed reaches target speed: In speed mode, when the deviation between the speed feedback and the command is smaller than the setting value of ID154 (P1.047) SpeedWindow**,** this DO is on.	Level triggered	S, Sz, I/O (Speed
0x1A	CAM_ AREA2	E-Cam area 2 When the master axis position angle is between ID249(P2.078) and ID250(P2.079), this DO is on.	Level triggered	PR
0x2C	Zon_1	Zone Activated When the value of the item monitored by ID663 (P0.009) SystemVariableMonitor1Value ranges between the setting value of ID113 (P0.054) SystemVeriableMonitorLowerLimit, ID114 (P0.055) SystemVeriableMonitorUpperLimit, and after the filter time set in ID112(P0.053).X, then this DO is on.	Level triggered	All
0x30	SPO_0	Output Bit 00 of ID283 (P4.006) DOOverride	Level triggered	All
0x31	SPO_1	Output Bit 01 of ID283 (P4.006) DOOverride	Level triggered	All
0x32	SPO_2	Output Bit 02 of ID283 (P4.006) DOOverride	Level triggered	All
0x33	SPO_3	Output Bit 03 of ID283 (P4.006) DOOverride	Level triggered	All
0x34	SPO_4	Output Bit 04 of ID283 (P4.006) DOOverride	Level triggered	All
0x35	SPO_5	Output Bit 05 of ID283 (P4.006) DOOverride	Level triggered	All
0x36	SPO_6	Output Bit 06 of ID283 (P4.006) DOOverride	Level triggered	All
0x37	SPO_7	Output Bit 07 of ID283 (P4.006) DOOverride	Level triggered	All
0x38	SPO_8	Output Bit 08 of ID283 (P4.006) DOOverride	Level triggered	All
0x39	SPO_9	Output Bit 09 of ID283 (P4.006) DOOverride	Level triggered	All
0x3A	SPO_A	Output Bit 10 of ID283 (P4.006) DOOverride	Level triggered	All
0x3B	SPO_B	Output Bit 11 of ID283 (P4.006) DOOverride	Level triggered	All
0x3C	SPO_C	Output Bit 12 of ID283 (P4.006) DOOverride	Level triggered	All
0x3D	SPO_D	Output Bit 13 of ID283 (P4.006) DOOverride	Level triggered	All
0x3E	SPO_E	Output Bit 14 of ID283 (P4.006) DOOverride	Level triggered	All
0x3F	SPO_F	Output Bit 15 of ID283 (P4.006) DOOverride	Level triggered	All
ABSR always outputted by DO2	ABSR	ABSR Always Output by DO2 Setting Value When the DI.ABSE signal is on, the DO.ABSR signal triggered by DO2 replaces the DO2 assigned by ID204 (P2.019) DO2Configuration. When the DI.ABSE signal is on, the DO.ABSD signal triggered by DO3 will replace the DO3 assigned by ID205 (P2.020) DO3Configuration. When the DO.ABSR signal is off, it indicates the servo drive can receive request issued by the DI.ABSQ signal; when the DO.ABSR signal is on, it indicates after receiving the request, the data has been prepared and the ABSD signal data is valid so that the controller can access the ABSD signal data. This output is only valid when the DI.ABSE signal is on.  See Reading the Absolute Position with DI/DO on page 397 for additional information.	Level triggered	All
ABSD always outputted by DO3	ABSD	ABSD Always Output by DO3 Setting Value When the DI.ABSE signal is on, the DO.ABSD signal triggered by DO3 replaces the DO3 assigned by ID205 (P2.020) DO3Configuration. The data is valid when the DO.ABSR signal is on. This output is only valid when the DI.ABSE signal is on. See Reading the Absolute Position with DI/DO on page 397 for additional information.	Level triggered	All

DO.SP_OK (Digital Output: speed reached output)

When the error between the speed command and the motor feedback speed is less than this parameter, the digital output DO.SP_OK (DO code 0x19) is on.

Diagram:



1. Speed command: Command inputted by the user (without acceleration / deceleration), not the command from the front end speed circuit. Its source is from the register.
2. Feedback speed: The actual speed of the motor which has been filtered.
3. Obtain the absolute value.
4. Determine whether the absolute value of speed error is smaller than the parameter value: If the parameter is set to 0, the output is always off. If smaller, the DO output is on, otherwise off.

DO.MC_OK (Digital Output: servo procedure completed)

ID155 (P1.048) ToSpeedAction controls the operation of the digital output DO.MC_OK.



X	DO output hold option	Y	Position deviation fault A 380 option	UZ	Reserved

- X: DO output hold option

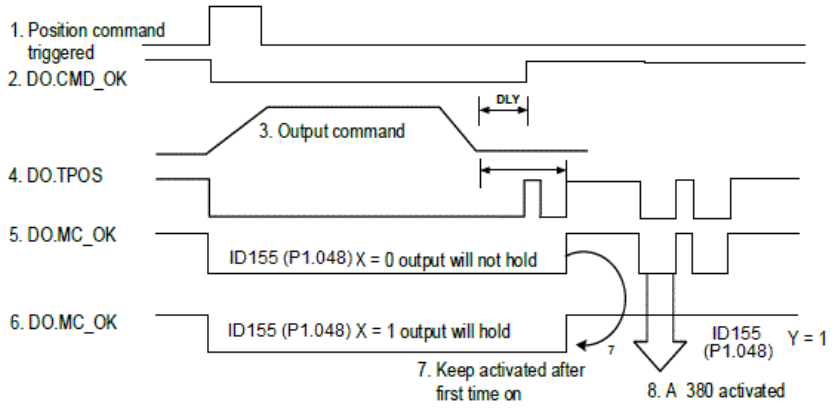
  0: Output status will not hold

  1: Output status will hold
- Y: Position deviation fault A 380 option

  0: A 380 not functioning

  1: A 380 functioning

Diagram:



Description:

1. Command triggered: New PR command is effective. Command 3 starts to output and clear signals 2, 4, 5, and 6 simultaneously. Command triggering source: DI.CTRG, DI.EV1/EV2, ID300 (P5.007) PRCmdTrigger (triggered via software), etc.
2. DO.CMD_OK: Command 3 is completely outputted and can set the delay time (DLY).
3. Command output: Output the profile of position command according to the setting of acceleration / deceleration.
4. DO.TPOS: Position error of the servo drive is within the range set by ID159 (P1.054) InPositionWindow.
5. DO.MC_OK: Position command output and servo positioning completed which is DO.CMD_OK and DO.TPOS are both on.
6. DO.MC_OK (remains digital output status): Same as 5.
However, after this DO is on, its status will hold regardless of the signal 4 status.
7. Can only select one of the signal 5 or signal 6 to output and it is specified by ID155 (P1.048.X) ToSpeedAction.
8. Position deviation: When number 7 happens, if signal 4 (or 5) is off, it means the position is deviated and A 380 Position deviation fault of DO:MC_OK can be triggered. This fault may be set via ID155 (P1.048.Y) ToSpeedAction.

DO.Zon_1 (Digital Output: system variable in range)

When the value of the item monitored by ID663 (P0.009) SystemVariableMonitor1Value ranges between the setting value of ID113 (P0.054) ParameterMonitorLowerLimit and ID114 (P0.055) ParameterMonitorUpperLimit, and after the time set by ID112(P0.053).X, then DO.Zon_1[0x2C is on.

Table 136 - Relevant Parameters

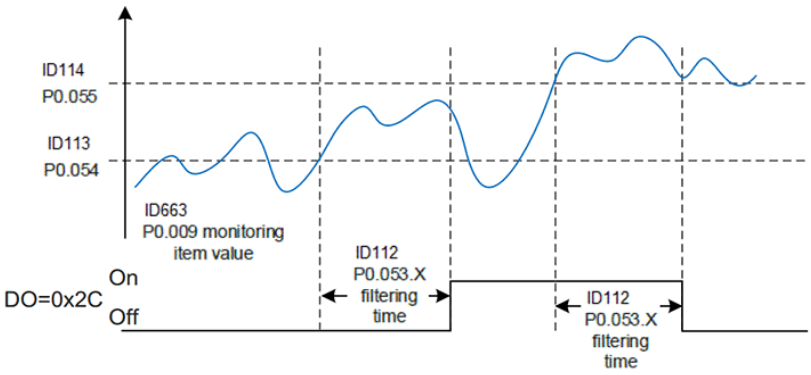
Parameter	Name
ID112 (P0.053)	SystemVariableMonitorFilterTime
ID113 (P0.054)	SystemVariableMonitorLimit
ID114 (P0.055)	SystemVariableMonitorUpperLimit

Use the X position of the ID112 (P0.053) parameter to set the filter time. This figure provides an example.



- X: First filter time
- Y...U: Reserved

Example of the first filter:



Description of System Variable Monitoring

Each system variable has a code, and users can use ID668...ID672 (P0.017...P0.021) to set the code and monitor the system variable. Each system variable is stored in the 32-bit format (long integer) of the drive.

There are two ways to monitor the system variables. You can monitor via the panel display or you can monitor via the system variable monitoring parameters.

Panel Display

When the panel is in Real Time Data Display mode, press the UP / DOWN keys to select the variable to be monitored. See Chapter 6, Use the Keypad Interface.

System Variable Monitoring Parameters

The following parameters are used to support system variable monitoring.

Table 137 - System Variable Monitoring Parameters

Parameter	Name	Description
ID663 (P0.009)	SystemVariableMonitor1Value	The value to be monitored can be set by using ID668 (P0.017) SystemVariableMonitor1Selection. For example, if ID668 (P0.017) is set to 3, when accessing ID663 (P0.009), it obtains the total feedback pulse number of the motor encoder. When the panel displays VAR-1, it indicates the content value of ID663 (P0.009). Set ID102 (P0.002) LEDMonitorSelection to 23 to display the value of this parameter on the panel display.
ID664 (P0.010)	SystemVariableMonitor2Value	System Variable Monitor 2 Value The value to be monitored can be set by ID 669 (P0.018). Set ID102 (P0.002) to 24 to display the value of this parameter on the panel display.
ID665 (P0.011)	SystemVariableMonitor3Value	System Variable Monitor 3 Value The value to be monitored can be set by (P0.019). Set ID102 (P0.002) to 25 to display the value of this parameter on the panel display.
ID666 (P0.012)	SystemVariableMonitor4Value	System Variable Monitor 4 Value The value to be monitored can be set by ID670 (P0.020). Set ID102 (P0.002) to 26 to display the value of this parameter on the panel display.
ID667 (P0.013)	SystemVariableMonitor5Value	System Variable Monitor 5 Value The value to be monitored can be set by ID672 (P0.021). Set ID102 (P0.002) to 27 to display the value of this parameter on the panel display.
ID668 (P0.017)	SystemVariableMonitor1Selection	System Variable Monitor 1 Selection Selects the content displayed by the System Variable Monitor 1 Value.
ID669 (P0.018)	SystemVariableMonitor2Selection	System Variable Monitor 2 Selection Selects the content displayed by the System Variable Monitor 2 Value.
ID670 (P0.019)	SystemVariableMonitor3Selection	System Variable Monitor 3 Selection Selects the content displayed by the System Variable Monitor 3 Value.
ID671 (P0.020)	SystemVariableMonitor4Selection	System Variable Monitor 4 Selection Selects the content displayed by the System Variable Monitor 4 Value.
ID672 (P0.021)	SystemVariableMonitor5Selection	System Variable Monitor 5 Selection Selects the content displayed by the System Variable Monitor 5 Value.

System Variables List

The property code of each system variable is described as follows:

Property	Description
B	BASE: Basic variables, can be selected via the UP / DOWN keys on the panel.
Dec, Hex	Display format on panel. Dec indicated Decimal, Hex indicates Hexadecimal. Currently all the system variables are displayed in the Dec format.

Monitoring variables are described in the following table according to the code sequence:

Table 138 - System Variables Code

Code	Variable name	Property	Description	User Unit[1]
000 (00h)	Feedback position (PUU)	B, DEC	Current feedback position of the motor encoder.	PUU
001 (01h)	Position command (PUU)	B, DEC	Current coordinate of the position command. PT mode: Number of pulse commands received by the drive. PR mode: Absolute coordinates of the position command.	PUU
002 (02h)	Position deviation (PUU)	B, DEC	Deviation between the position command and the feedback position.	PUU
003 (03h)	Feedback position (count)	B, DEC	Current feedback position of the motor encoder.	count
004 (04h)	Position command (count)	B, DEC	Current coordinate of the Position command. This is the command after the E-Gear ratio conversion.	count
005 (05h)	Position deviation (count)	B, DEC	Deviation between position command and feedback position.	count
006 (06h)	Pulse command frequency	B, DEC	Frequency of the pulse command received by the drive. Applicable to PT, PR and I/O (Gear) modes	Kpps
007 (07h)	Speed feedback	B, DEC	Current motor speed. This is the speed after applying the low-pass filter, which makes it more stable.	0.1 rpm
008 (08h)	Speed command (analog)	B, DEC	Speed command from the analog channel.	0.01 Volt
009 (09h)	Speed command (integrated)	B, DEC	Integrated Speed command. Source includes analog, register, or position loop.	0.1 rpm
010 (0Ah)	Torque command (analog)	B, DEC	Torque command from the analog channel.	0.01 Volt
011 (0Bh)	Torque command (integrated)	B, DEC	Integrated Torque command. Source includes analog, register, or speed loop.	percentage (%)
012 (0Ch)	Average load rate	B, DEC	Average load rate (moving average every 20 ms) from the servo drive.	percentage (%)
013 (0Dh)	Peak load rate	B , DEC	Maximum load rate from the drive.	percentage (%)
014 (0Eh)	DC Bus voltage	B, DEC	Rectified capacitor voltage.	Volt
015 (0Fh)	Load inertia ratio	B, DEC	Ratio of the load inertia to the motor inertia.	0.1 times
016 (10h)	IGBT temperature	B, DEC	Temperature of IGBT.	°C
017 (11h)	Resonance frequency	B, DEC	Resonance frequency of the system consists of two groups of frequencies: F1 and F2. The low word is frequency F2, when the high word is frequency F1.	Hz
018 (12h)	Z phase offset	B, DEC	Offset value between motor position and Z phase; range: -4999...+5000 (-180 degrees to 180 degrees). Where it overlaps with Z phase, the value is 0; the greater the value, the greater the offset.	180/5000 degree
019 (13h)	Mapping parameter content #1	B, DEC	Returns the value of P0.025, which is mapped by P0.035.	—
020 (14h)	Mapping parameter content #2	B, DEC	Returns the value of P0.026, which is mapped by P0.036.	—
021 (15h)	Mapping parameter content #3	B, DEC	Returns the value of P0.027, which is mapped by P0.037.	—
022 (16h)	Mapping parameter content #4	B, DEC	Returns the value of P0.028, which is mapped by P0.038.	—
023 (17h)	Mapping monitoring variable #1	B, DEC	Returns the value of P0.009, which is mapped by P0.017.	—
024 (18h)	Mapping monitoring variable #2	B, DEC	Returns the value of P0.020, which is mapped by P0.018.	—
025 (19h)	Mapping monitoring variable #3	B, DEC	Returns the value of P0.011, which is mapped by P0.019.	—
026 (1Ah)	Mapping monitoring variable #4	B, DEC	Returns the value of P0.012, which is mapped by P0.020.	—
027 (1Bh)	Z phase offset (PUU Unit)	B, DEC	Offset value between motor position and Z phase (Panel only)	PUU
028 (1Ch)	Alarm code	B, DEC	The Error Code (Reserved for future release).	—
029 (1Dh)	Auxiliary encoder feedback	DEC	Position feedback from the auxiliary encoder.	PUU

Table 138 - System Variables Code (Continued)

Code	Variable name	Property	Description	User Unit[1]
030 (1Eh)	Position deviation (PUU)	DEC	Position deviation between the position command and the feedback position of the auxiliary encoder.	PUU
031 (1Fh)	Main / auxiliary encoder position deviation (PUU)	DEC	Feedback position deviation between the main encoder and auxiliary encoder.	PUU
035 (23h)	Indexing coordinate command	DEC	Current command for the indexing coordinates.	PUU
037 (25h)	Compare data of COMPARE	DEC	The actual Compare data is the Compare data plus a specified value: CMP_DATA = DATA_ARRAY[*] + P1.023 + P1.024.	PUU
039 (27h)	DI status (integrated)	DEC	Integrated DI status of the drive. Each bit corresponds to one DI channel. Source includes Hardware channel / ID281 (P4.007), which is determined by ID268 (P3.006).	—
040 (28h)	DO status (hardware)	DEC	Actual status from the DO hardware. Each bit corresponds to one DO channel.	—
041 (29h)	Status of the drive	DEC	Returns ID280 (P4.006) Refer to the description of this parameter.	—
043 (2Bh)	Latest capture data	DEC	The latest data captured by CAP hardware. CAP can continuously capture multiple points.	PUU
048 (30h)	Auxiliary encoder CNT	DEC	Pulse counts from the auxiliary encoder.	count
049 (31h)	Pulse command CNT	DEC	Pulse counts from the pulse command (Terminal block input)..	count
050 (32h)	Speed command (integrated)	DEC	Integrated Speed command. Source includes analog, register, or position loop.	0.1 rpm
051 (33h)	Speed feedback (immediate)	DEC	Current actual motor speed.	0.1 rpm
053 (35h)	Torque command (integrated)	DEC	Integrated Torque command. Source includes analog, register, or speed loop.	0.1%
054 (36h)	Torque feedback	DEC	Current actual motor torque.	0.1%
055 (37h)	Current feedback	DEC	Current actual motor current.	0.01 A (ampere)
056 (38h)	DC Bus voltage	DEC	Rectified capacitor voltage.	0.1 Volt
057(39h)	ECAM engage status	DEC	0-stop, 1-engaged, 2-pre-engaged	—
059 (3Bh)	Pulse from E-Cam master axis (accumulative)	DEC	Accumulative pulse number of the E-Cam master axis. Same as ID374 (P5.086).	Same as the master axis pulse
060 (3Ch)	Pulse from E-Cam master axis (incremental)	DEC	Incremental pulse number of the E-Cam master axis. The increment per ms.	Same as the master axis pulse
061 (3Dh)	Pulse from E-Cam master axis (lead pulse)	DEC	The lead pulse of the E-Cam master axis which determines the engagement condition.When disengaged: lead pulse = ID375 (P5.087) or ID380 (P5.092); when the value is 0, E-Cam engages.When engaged: lead pulse = ID377 (P5.089); when the value is 0, it disengages.	Same as the master axis pulse
062 (3Eh)	Position of E-Cam master axis	DEC	Position of the E-Cam which corresponds to the master axis pulse, and can be used to find the phase of the E-Cam. when the incremental pulse number of the master axis is P, E-Cam rotates M cycles, where ID371 (P5.083) = M, ID372(P5.084) = P.	Same as the master axis pulse
063 (3Fh)	Position of E-Cam slave axis	DEC	Position of the E-Cam slave axis and can be found from the E-Cam table.Unit: unit used in the E-Cam table.	PUU
064 (40h)	Endpoint register of PR command	DEC	In PR mode, the endpoint of the Position command (Cmd_E).	PUU
065 (41h)	Output register of PR command	DEC	In PR mode, the accumulative output of the Position command.	PUU
067 (43h)	PR target speed	DEC	Target speed specified in the PR command.	0.1 RPM or PPS (pulse per second)
068 (44h)	S-curve (input)	DEC	Input data of the S-curve filter.Effective in PR mode, E-Cam, and register Speed command.	PUU
069 (45h)	S-curve (output)	DEC	Output data of the S-curve filter.Effective in PR mode, E-Cam, and register Speed command.	PUU
072 (48h)	Speed command (analog)	DEC	Speed command from the analog channel.	0.1 rpm
085 (55h)	E-Cam alignment deviation percentage	DEC	The alignment error rate after filtering. 10 indicates 1% and the angle conversion is 360° × 1% = 3.6°.	0.1%
091 (5Bh)	Indexing coordinate feedback	DEC	Immediate feedback position of the indexing coordinates.	PUU
096 (60h)	Drive firmware version	DEC	Includes 2 versions: DSP and CPLD. • Low word returns the DSP version number • High word returns the CPLD version number	—

Table 138 - System Variables Code (Continued)

Code	Variable name	Property	Description	User Unit[1]
111 (6Fh)	Error code of the servo drive	DEC	Error code from the servo drive: control loop of the servo only, not including the motion controller.	—
112 (70h)	Encoder communication error rate	DEC	When this value continues to increase, it indicates that there is communication interference. In an interference-free environment, this value should not increase.	—
113 (71h)	Overload (E006) protection counter	DEC	Displays the motor load during operation. When the value reaches 100%, E006 occurs.	—
114 (72h)	Encoder temperature	DEC	Monitor the encoder temperature.	°C
115 (73h)	Encoder type	DEC	Displays the encoder type.	—
116 (74h)	Deviation between position and Z phase of auxiliary encoder (pulse)	DEC	Deviation between the current position of the auxiliary encoder and the Z phase position of the auxiliary encoder.	count
117 (75h)	Hall sensor phase sequence and Z pulse data from auxiliary encoder feedback	DEC	Use the bit to determine the UVW phase sequence of the Hall sensor and Z pulse from auxiliary encoder feedback. Bit 0: Z pulse, Bit 1: U phase, Bit 2: V phase, Bit 3: W phase.	
118 (76h)	Hall sensor phase sequence and Z pulse data from main encoder feedback	DEC	Use the bit to determine the UVW phase sequence of the Hall sensor and Z pulse from main encoder feedback. Bit 0: Z pulse, Bit 1: U phase, Bit 2: V phase, Bit 3: W phase.	
123 (7Bh)	Value returned when monitoring by panel	—	Monitoring value displayed when returned to the monitoring panel.	—

(1) PUU is Position of User Unit; count is encoder unit.

Description of Parameter Monitoring

Parameters can be monitored by using ID55(P0.025)...ID59(P0.029), which contents are specified by ID60(P0.035)...ID64(P0.039).

Table 139 - Relevant Parameters

Parameter	Name	Description
ID55 (P0.025)	ParameterMonitor1Value	Parameter Monitor 1 Value ID60 (P0.035) can be used to specify the mapping parameter instance ID number. The content of the parameter that is specified by ID60 (P0.035) is shown in ID55 (P0.025).
ID56 (P0.026)	ParameterMonitor2Value	Parameter Monitor 2 Value ID61 (P0.036) can be used to specify the mapping parameter instance ID number. The content of the parameter that is specified by ID61 (P0.036) is shown in ID56 (P0.026).
ID57 (P0.027)	ParameterMonitor3Value	Parameter Monitor 3 Value ID62 (P0.037) can be used to specify the mapping parameter instance ID number. The content of the parameter that is specified by ID62 (P0.037) is shown in ID56 (P0.027).
ID58 (P0.028)	ParameterMonitor4Value	Parameter Monitor 4 Value ID63 (P0.038) can be used to specify the mapping parameter instance ID number. The content of the parameter that is specified by ID63 (P0.038) is shown in ID57 (P0.028).
ID59 (P0.029)	ParameterMonitor5Value	Parameter Monitor 5 Value ID64 (P0.039) can be used to specify the mapping parameter instance ID number. The content of the parameter that is specified by ID64 (P0.039) is shown in ID57 (P0.028).
ID60 (P0.035)	ParameterMonitor1Selection	The content of the parameter that is specified by ID60 (P0.035) is shown in ID55 (P0.025).

Table 139 - Relevant Parameters (Continued)

Parameter	Name	Description
ID61 (P0.036)	ParameterMonitor2Selection	The content of the parameter that is specified by ID61 (P0.036) is shown in ID56 (P0.026).
ID62 (P0.037)	ParameterMonitor3Selection	The content of the parameter that is specified by ID62 (P0.037) is shown in ID57 (P0.027).
ID63 (P0.038)	ParameterMonitor4Selection	The content of the parameter that is specified by ID63 (P0.038) is shown in ID58 (P0.028).
ID64 (P0.039)	ParameterMonitor5Selection	The content of the parameter that is specified by ID64 (P0.039) is shown in ID59 (P0.029).

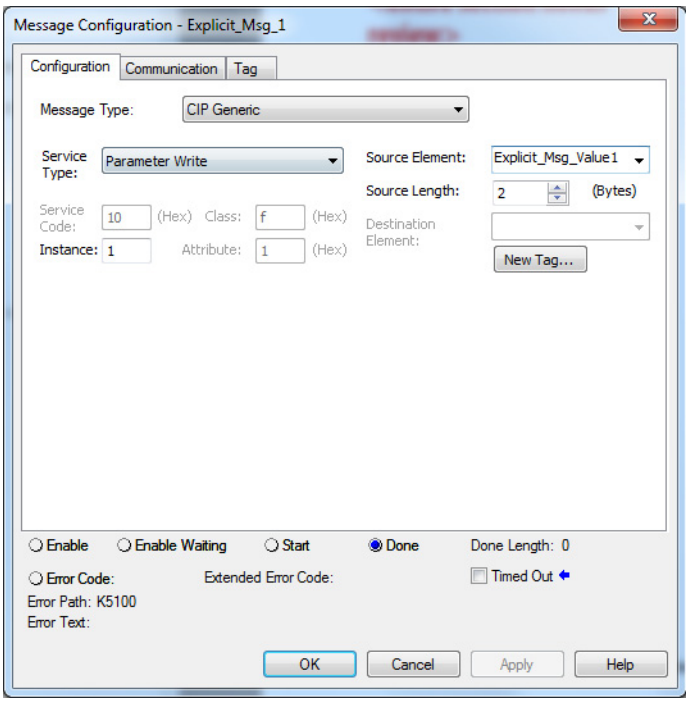
When ID60(P0.035) is 1, then the value of ID55 (P0.025) is equal to ID1 (PM.000).

When ID60(P0.035) is 4, then the value of ID55 (P0.025) is equal to ID4 (PM.029).

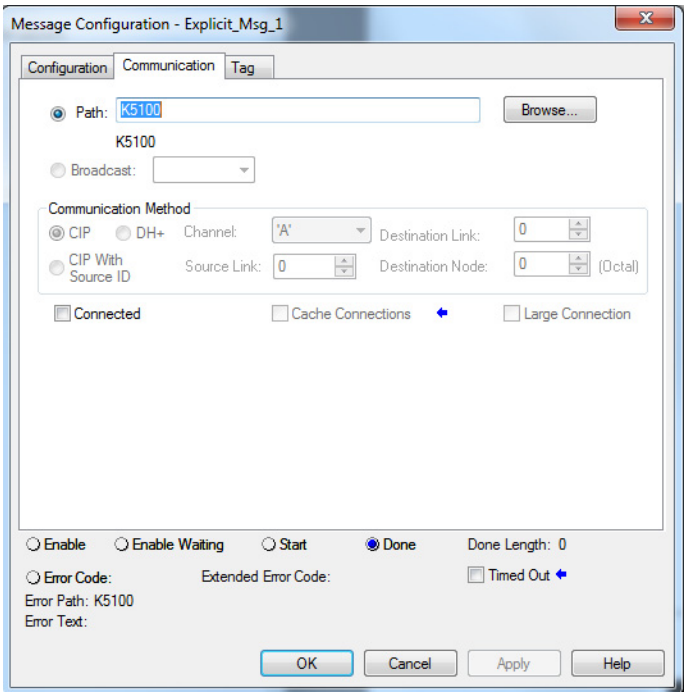
Use a MSG Instruction to Set Parameters

Some parameters can be set by using the Logix Designer Application. Alternately, you can use a MSG instruction to set parameters by following these steps.

1. Create a Parameter Write MSG instruction in the ladder logic program..



2. Use the ID of the parameter for the instance.
3. Select or create a Source Element, and specify the length of it.
4. Configure the communication path.


Message Configuration - Explicit_Msg_1
Configuration
Communication
Tag
Path: K5100
Browse...
K5100
Broadcast:
Communication Method
CIP
DH+
Channel: 'A'
Destination Link: 0
CIP With Source ID
Source Link: 0
Destination Node: 0 (Octal)
Connected
Cache Connections
Large Connection
Enable
Enable Waiting
Start
Done
Done Length: 0
Error Code:
Extended Error Code:
Timed Out
Error Path: K5100
Error Text:
OK
Cancel
Apply
Help

Troubleshoot the Kinetix 5100 Drive System

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Safety Precautions

Observe the following safety precautions when you troubleshoot your Kinetix® 5100 drive.



ATTENTION: DC bus capacitors may retain hazardous voltages after input power has been removed. Before working on the drive, measure the DC bus voltage to verify it has reached a safe level or wait the full time interval listed on the drive warning label. When the DC bus voltage is above 50V DC, the charge LED light on the drive must be on. Failure to observe this precaution could result in severe bodily injury or loss of life.
Do not attempt to defeat or override the drive fault circuits. You must determine the cause of a fault and correct it before you attempt to operate the system. If you do not correct a drive or system malfunction, it could result in personal injury and/or damage to the equipment as a result of uncontrolled machine system operation.

Test equipment (such as an oscilloscope or chart recorder) must be properly grounded. Failure to include an earth ground connection could result in a potentially fatal voltage on the oscilloscope chassis.

Status Indicators

There are three status indicators on front of the Kinetix 5100 drive: module (MOD), network (NET), and CHARGE.

Table 140 - MOD LED Status Indicators

Operation Mode	LED Color	Status	Description
I/O	Steady off	No power	If no power is supplied to the device, the module status indicator shall be steady off.
	Steady green	Device operational	If the device is operating correctly (IO connection is established successfully), the module status indicator shall be steady green.
	Flashing green	Standby	If the device has not been configured, the module status indicator shall be flashing green.
	Flashing red	Major recoverable fault or Minor recoverable fault	If the device has detected a major or minor recoverable fault, the module status indicator shall be flashing red. **NOTE:** An incorrect or inconsistent configuration could be considered a major recoverable fault.
	Steady red	Major unrecoverable fault	If the device has detected a major unrecoverable fault, the module status indicator shall be steady red.
	Flashing green/red	Self-test	While the device is performing its power up testing, the module status indicator shall be flashing green/red.

Table 140 - MOD LED Status Indicators (Continued)

Operation Mode	LED Color	Status	Description
Standalone	Steady off	No power	If no power is supplied to the device, the module status indicator shall be steady off.
	Steady green	Device operational	If the device is operating correctly (after the drive boots successfully), the module status indicator shall be steady green.
	Flashing red	Major recoverable fault or Minor recoverable fault	If the device has detected a major or minor recoverable fault, the module status indicator shall be flashing red. **NOTE:** An incorrect or inconsistent configuration could be considered a major recoverable fault.
	Steady red	Major unrecoverable fault	If the device has detected a major unrecoverable fault, the module status indicator shall be steady red.
	Flashing green/red	Self-test	While the device is performing its power up testing, the module status indicator shall be flashing green/red.

Table 141 - NET LED Status Indicators

LED Color	Status	Description
Steady off	No power or no IP address	The device is powered off, or is powered on but with no IP address configured.
Steady green	Connected	An IP address is configured, at least one CIP™ connection (any transport class) is established, and an Exclusive Owner connection has not timed out.
Flashing green	Not connected	An IP address is configured but no CIP connections are established, and an Exclusive Owner connection has not timed out.
Flashing red	Connection timeout	An IP address is configured, and an Exclusive Owner connection where this device is the target has timed out.
Steady red	A duplicate IP address has been identified	The device has detected that (at least one of) its IP address is already in use.
Flashing green/red	Self-test	While the device performs its power up testing.

Table 142 - CHARGE LED Status Indicators

LED Color	Status	Description
Steady off	No power	When no power is supplied to the device.
Steady orange	DC bus voltage operational	When the DC bus voltage is above 50V DC.

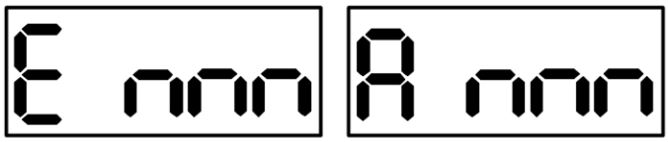
View Status and Faults

For Kinetix® 5100 fault code descriptions and parameters, see Knowledgebase Technote: Kinetix 5100 Servo Drive Parameter Data and Fault Codes. You can download the spreadsheet from this public article.

You will be asked to log in to your Rockwell Automation web account or create an account if you do not have one. You do not need a support contract to access this article.

Drive Fault Code Display

The drive display panel indicates a fault or warning on the display.



Fault Warning

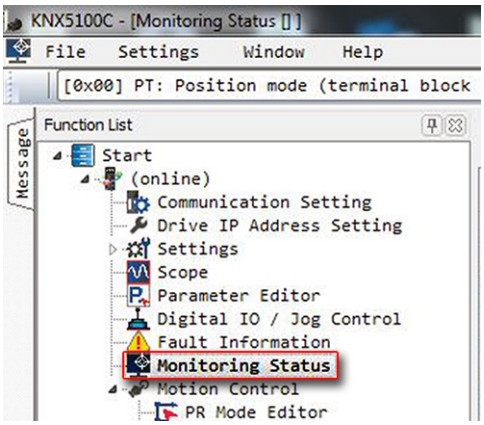
For more information on faults and warnings, see Clear Faults on page 426.

Monitoring Status in KNX5100C Software

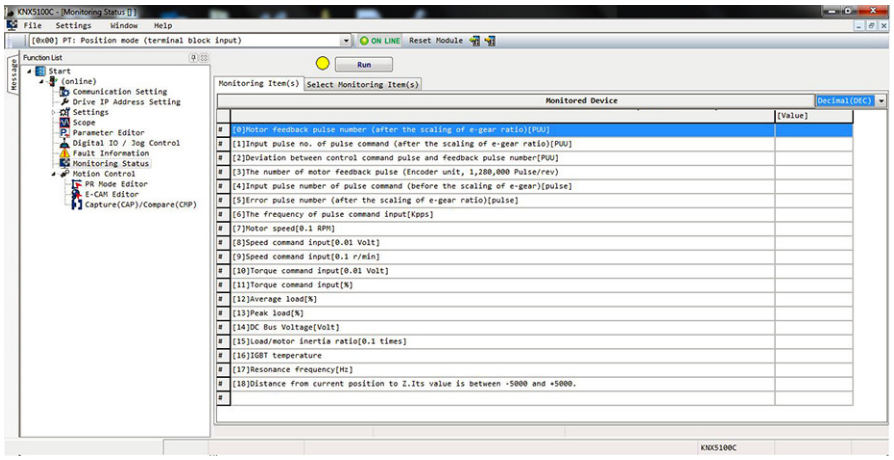
In KNX5100C software, you can monitor the status of the servo drive.

To monitor the servo drive, perform the following steps.

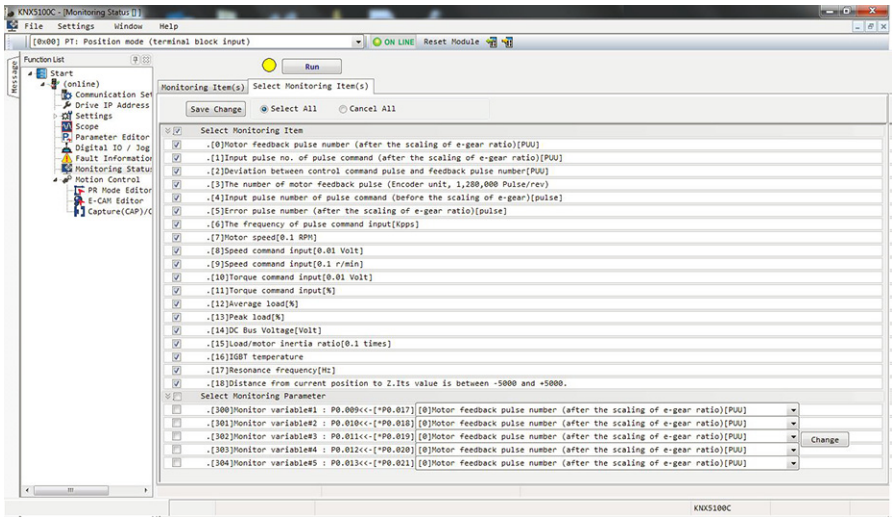
1. In the Function List of the KNX5100C software, click Monitoring Status.



On the Monitoring Items tab, the monitored items and their setting values are shown.



On the Select Monitoring Items tab, you can select what items to monitor.



2. Click Save Changes if any changes are made, which are shown subsequently on the Monitoring Items tab.

IMPORTANT Click Run to run the Monitoring Status function. If you do, the same button toggles to Stop, which you then click when you want to stop the monitoring status.

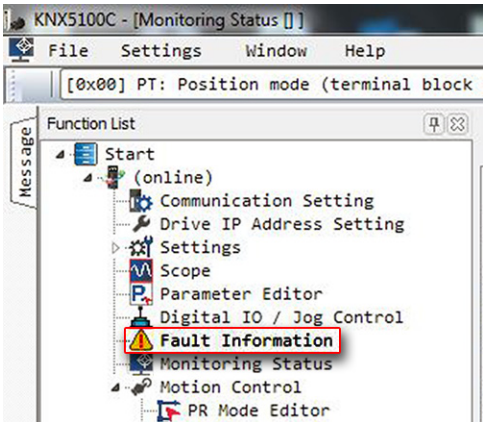


Fault Information in the KNX5100C Software

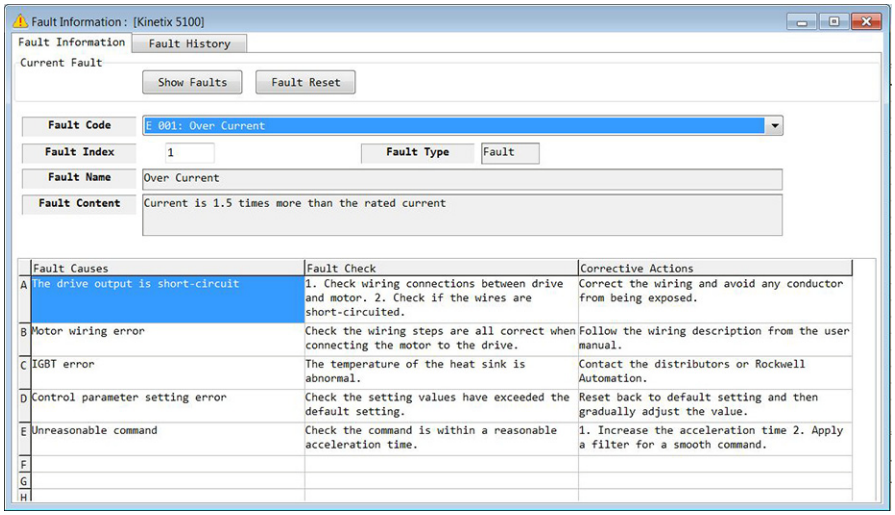
In the KNX5100C software, you can use Fault Information to identify any faults of the servo drive.

To identify any faults, perform the following steps.

1. In the Function List of the KNX5100C software, click Fault Information.

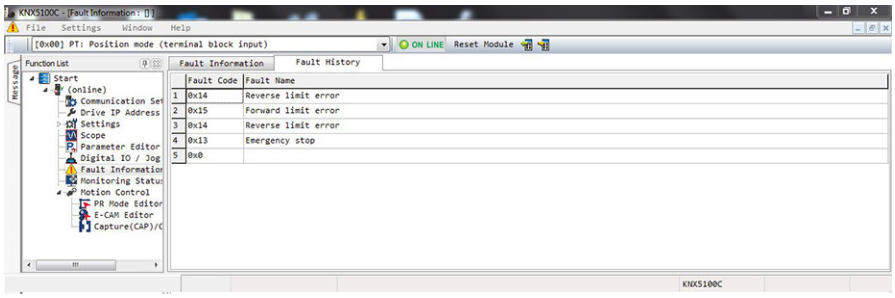


On the Fault Information tab, the most current fault is shown with detailed information, including possible causes and subsequent corrective actions.



2. Click either available button for the following reasons:
   - Click Show Faults to refresh the current fault information.
   - Click Fault Reset to reset fault and remove the current list of fault information if fault is cleared.

   Click the Fault History tab to see the latest fault codes recorded in the servo drive.



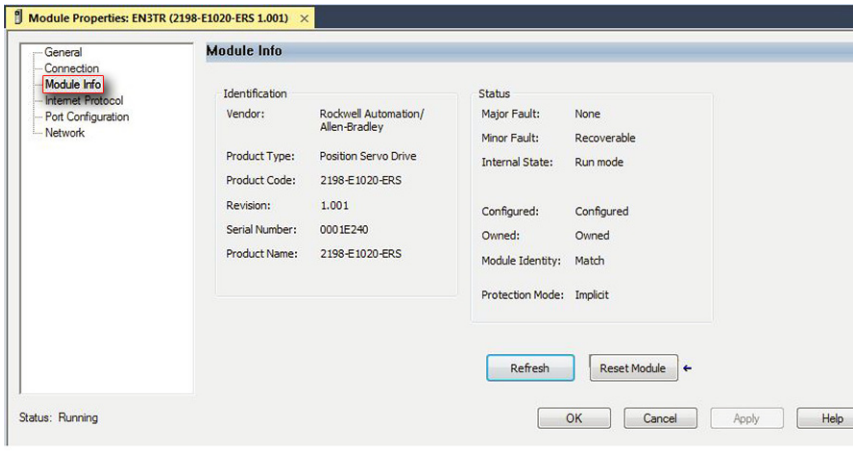
Fault and Status Information in Studio 5000 Application

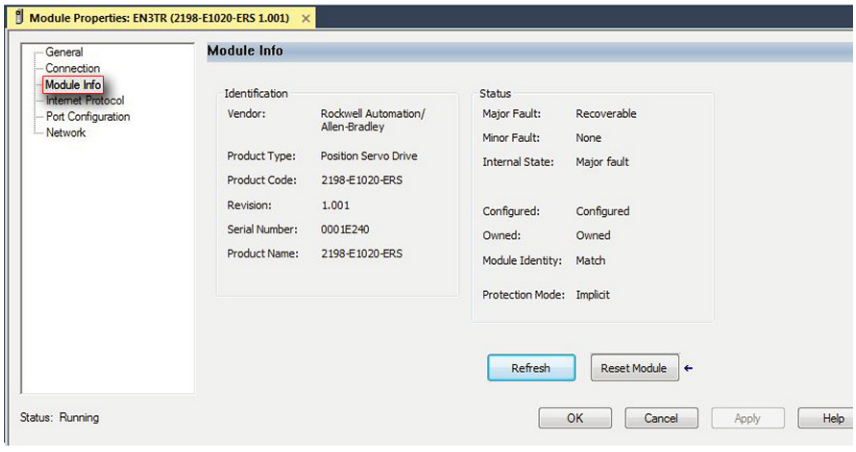
Major faults and minor faults (warnings) are shown on the Module Info tab in the Studio 5000 Logix Designer® application.

To view faults the Studio 5000 Logix Designer application, perform the following steps.

1. Under the hierarchy, click Module Info.

   Any fault is shown in the Status field.





2. If the fault is recoverable, click Reset Module to clear the fault.

Drive Stopping Behavior

A fault (code E *nnn*) triggers the shutdown (servo off) behavior of the drive.

Parameter ID675 (P1.032), MotorStopMode, configures the drive stopping behavior.

MotorStopMode Setting	Drive Behavior
0000 (default)	Dynamic brake stop
0010	Disable and coast
0020	Use dynamic brake first, then let the motor run freely once the speed is slower than the value of parameter ID145 (P1.038), ZeroSpeedWindow.
0030	Enable vertical load control

Clear Faults

The two methods for clearing faults depends on the type.

Warnings (A *nnn*): When the condition that caused the warning is corrected, the warning clears automatically.

Faults (E *nnn*): Clear the fault by one of the following methods:

- For a major unrecoverable fault, cycle power to clear the fault. If the issue persists, contact your distributor or Rockwell Automation representative.
- For a major recoverable fault:
  - Click Reset Module in the Studio 5000 Logix Designer software. For more information, see Fault and Status Information in Studio 5000 Application on page 425.
  - By using the DI.ARST signal.
  - By clicking Fault Reset in the Fault Information dialog of the KNX5100C software (see Fault Information in the KNX5100C Software on page 424).
  - Set ID101 (P0.001) FltWarnCode to 0.
  - By using the raC_Dvc_K5100_MAFR add-on instruction in the Studio 5000 Logix Designer software (for more information on add-on instructions, see Appendix C, Use Add-On Instructions).

General Troubleshooting

The following conditions do not always result in a fault code, but can require troubleshooting to improve performance.

Table 143 - Troubleshooting

Condition	Potential Cause	Possible Resolution
Axis or system is unstable.	The position feedback device is incorrect or open.	Check wiring.
	Unintentionally in torque mode.	Check to see what primary operation mode was programmed.
	Motor tuning limits are set too high.	Run Tune by using KNX5100C software or the LED panel. See Tuning Process on page 173.
	Position loop gain or position controller acceleration/deceleration rate is improperly set.	Run Tune by using KNX5100C software or the LED panel. See Tuning Process on page 173.
	Improper grounding or shielding techniques are causing noise to be transmitted into the position feedback or velocity command lines, causing erratic axis movement.	Check wiring and ground.
	Motor select limit is incorrectly set (servo motor is not matched to axis module).	• Check setups. • Run Tune in the Logix Designer application.
	Mechanical resonance.	Notch filter or output filter can be required.
You cannot obtain the motor acceleration/ deceleration that you want.	Torque Limit limits are set too low.	Verify that torque limits are set properly.
	Incorrect motor selected in configuration.	Select the correct motor. Run Tune by using KNX5100C software or LED panel.
	The system inertia is excessive.	• Check motor size versus application need. • Review servo system sizing.
	The system friction torque is excessive.	Check motor size versus application need.
	Available current is insufficient to supply the correct acceleration/ deceleration rate.	• Check motor size versus application need. • Review servo system sizing.
	Acceleration limit is incorrect.	Verify limit settings and correct them, as necessary.
	Velocity limits are incorrect.	Verify limit settings and correct them, as necessary.
	The motor is operating in the field-weakening range of operation.	Reduce the commanded acceleration or deceleration.
Motor does not respond to a command.	The axis cannot be enabled until stopping time has expired.	Disable the axis, wait for 1.5 seconds, and then enable the axis.
	The motor wiring is open.	Check the wiring.
	The motor cable shield connection is improper.	• Check feedback connections. • Check cable shield connections.
	The motor has malfunctioned.	Repair or replace the motor.
	The coupling between motor and machine has broken (for example, the motor moves but the load/machine does not).	Check and correct the mechanics.
	Primary operation mode is set incorrectly.	Check and properly set the limit.
	Velocity or torque limits are set incorrectly.	Check and properly set the limits.
	Brake connector not wired.	Check the brake wiring.
Presence of noise on command or motor feedback signal wires.	Recommended grounding per installation instructions have not been followed.	• Verify grounding. • Route wire away from noise sources. • Refer to System Design for Control of Electrical Noise, publication GMC-RM001.
	Line frequency can be present.	• Verify grounding. • Route wire away from noise sources.
	Variable frequency can be velocity feedback ripple or a disturbance caused by gear teeth or ball screw. The frequency can be a multiple of the motor power transmission components or ball screw speeds, resulting in velocity disturbance.	• Decouple the motor for verification. • Check and improve mechanical performance, for example, the gearbox or the ball screw mechanism.

Table 143 - Troubleshooting (Continued)

Condition	Potential Cause	Possible Resolution
No rotation	The motor connections are loose or open.	Check motor wiring and connections.
	Foreign matter is lodged in the motor.	Foreign matter is lodged in the motor. Remove foreign matter.
	The motor load is excessive.	The motor load is excessive. Verify the servo system sizing.
	The bearings are worn.	The bearings are worn. Return the motor for repair.
	The motor brake is engaged (if supplied).	• Check brake wiring and function. • Return the motor for repair.
	The motor is not connect to the load.	Check the coupling.
Motor overheating	The duty cycle is excessive.	Change the command profile to reduce acceleration/deceleration, or increase time.
	The rotor is partially demagnetized causing excessive motor current.	Return the motor for repair.
Abnormal noise	Motor tuning limits are set too high.	Run Tune by using KNX5100C software or the LED panel. See Tuning Process on page 173.
	Loose parts are present in the motor.	• Remove the loose parts. • Return motor for repair. • Replace motor.
	Through bolts or coupling is loose.	Tighten bolts.
	The bearings are worn.	Return motor for repair.
	Mechanical resonance.	Notch filter can be required.
Erratic operation–Motor locks into position, runs without control, or with reduced torque.	Motor power phases U and V, U and W, or V and W reversed.	Check and correct motor power wiring.

Interconnect Diagrams

This appendix provides wiring examples to assist you in wiring the Kinetix® 5100 drive system.

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Power Wiring Examples	430
Digital I/O Wiring	435
Passive Shunt Wiring Examples	437
Kinetix 5100 Drive/Rotary Motor Wiring Examples	438
System Block Diagram	444

Interconnect Diagram Notes

These notes apply to the wiring examples on the pages that follow.

Table 144 - Interconnect Diagram Notes

Note	Information
1	For power wiring specifications, see Wiring Requirements on page 76.
2	DC–, and P1, P2 terminals are not used. Do not remove the jumper between P1 and P2.
3	Single-phase control power is not phase limited. You can choose any two inputs (L1, L2, or L3), unless a fan or other item is powered on the AC line bus.
4	Only the 2198-E1*xxxx*-ERS, 2198-E2030-ERS, 2198-E4004-ERS, 2198-E4007-ERS, and 2198-E4015-ERS drives have an internal IGBT and resistor for shunt purposes. A jumper connects the internal shunt resistor, see Passive Shunt Wiring Examples on page 437. Remove jumper only when wiring to an external shunt resistor.
5	For input fuse and circuit breaker sizes, see Circuit Breaker/Fuse Selection on page 25.
6	Place the AC (EMC) line filters as close to the drive as possible and do not route very dirty wires in the same wireway. If routing in same wireway is unavoidable, use shielded cable with shields grounded to the drive chassis and filter case. For AC line filter specifications, see Kinetix Servo Drives Specifications Technical Data, publication KNX-TD003.
7	2198-TBIO I/O terminal block is required to make connections. Configure a digital output (OUTPUT1...OUTPUT6) as Brake Control in KNX5100C software. For digital output specifications, see Digital Outputs on page 51.
8	The M1 contactor is optional - customer supplied. It is recommended when independent control of control power and main AC power is desired. Contactor coil (M1) requires integrated surge suppressors for AC coil operation. See Kinetix Servo Drives Specifications Technical Data, publication KNX-TD003.
9	See Brake Control Circuit Example on page 58 to size the customer-supplied interposing relay for your application. See Figure 217 on page 436 for the diode or MOV suppression device for your application.
10	Servo On input must be removed when main power is removed or a drive fault occurs. A delay of at least 6.0 seconds must be observed before attempting to enable the drive after main power is restored. The Kinetix 5100 drives are limited to 1 main power cycle per minute.
11	Ground plate connection must be used to meet CE requirements. The motor ground termination has a direct path to the Kinetix 5100 drive for control of common mode and EMI interference. However, we recommend this grounding practice regardless of CE requirements. No external connection to ground is required.
12	PE ground point is a mounting screw (see Connect the Braided Ground Strap Example on page 75).
13	For motor cable specifications, see the Kinetix Motion Accessories Technical Data, publication KNX-TD004.

Table 144 - Interconnect Diagram Notes (Continued)

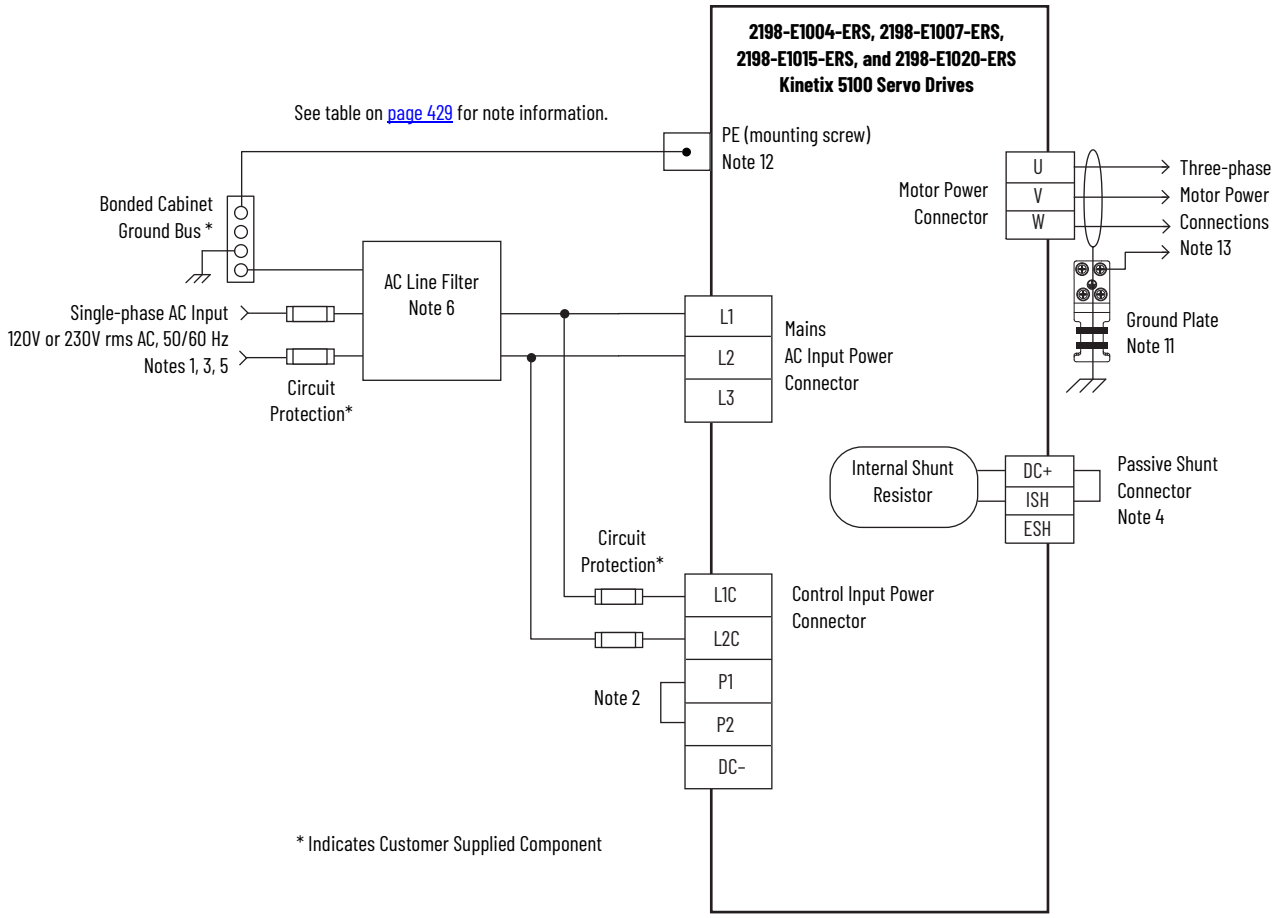
Note	Information
14	MPL-B15*xx*-V/E...MPL-B2*xx*-V/E, MPL-B3*xx*-S/M...MPL-B9*xx*-S/M, MPL-A5*xx*, MPM-B*xx*, MPM-A165*xx*...MPM-A215*xx*, MPF-B*xx*, MPF-A5*xx*, and MPS-B*xxx* encoders use the +9V DC supply.
15	MPL-A/B15*xx*-H...MPL-A/B45*xx*-H, MPL-A15*xx*-V/E...MPL-A2*xx*-V/E, MPL-A3*xx*-S/M...MPL-A5*xx*-S/M, MPM-A115*xx*...MPM-A130*xx*, MPF-A3*xx*...MPF-A45*xx*, and MPS-A*xxx* encoders use the +5V DC supply.
16	Motor brake connector pins are labeled plus (+) and minus (-) or F and G, respectively. Motor power connector pins are labeled U, V, W, and GND or A, B, C, and D, respectively.

Power Wiring Examples

You must supply input power components. The following diagrams illustrate single-phase and three-phase input power and connections for control power, motor power, AC line filters, and passive shunts.

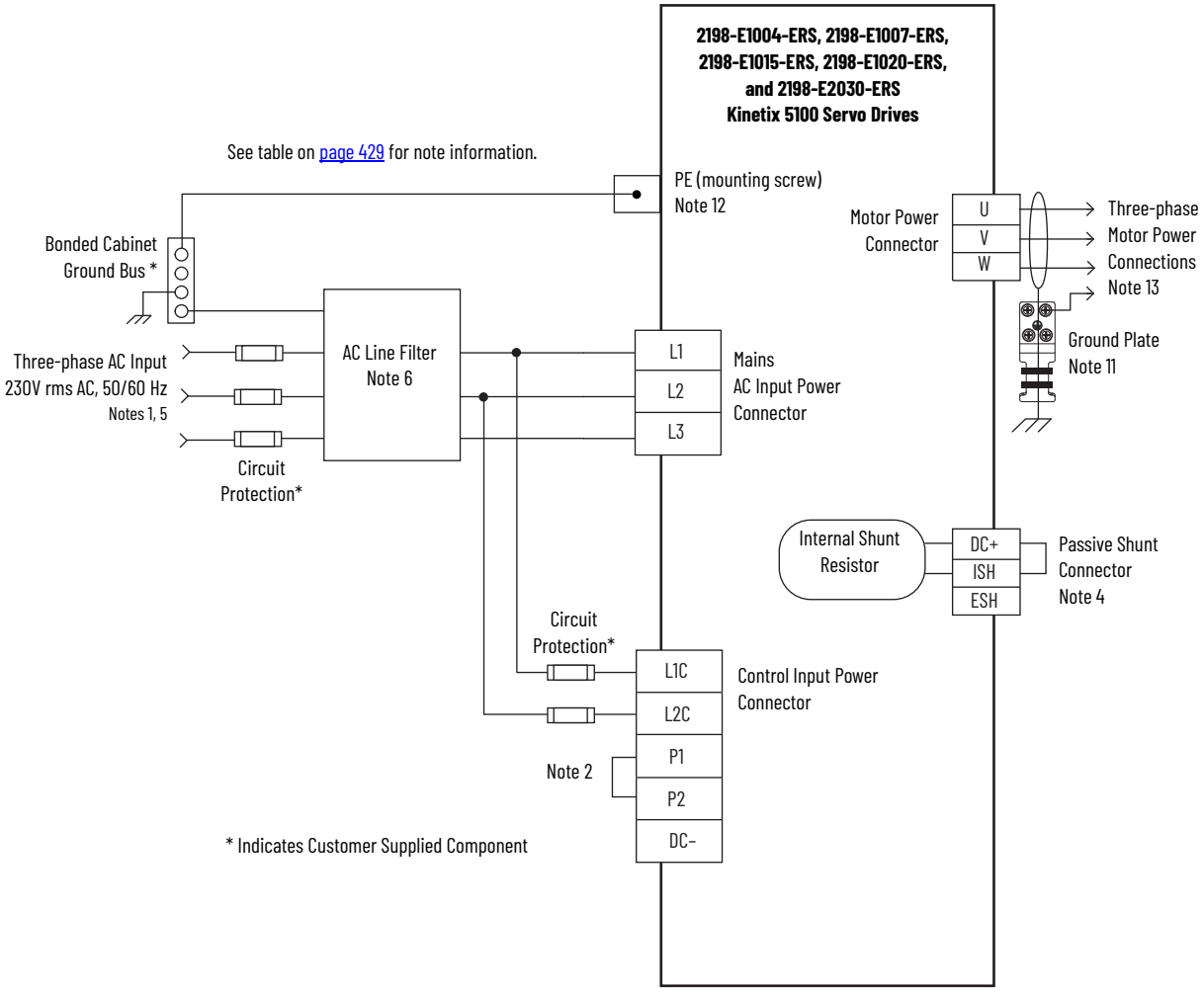
In this example, the 2198-E1004-ERS, 2198-E1007-ERS, 2198-E1015-ERS, and 2198-E1020-ERS drives are wired for 120V or 230V single-phase operation.

Figure 211 - Kinetix 5100 Drive (120V or 230V Single-phase Input Power)



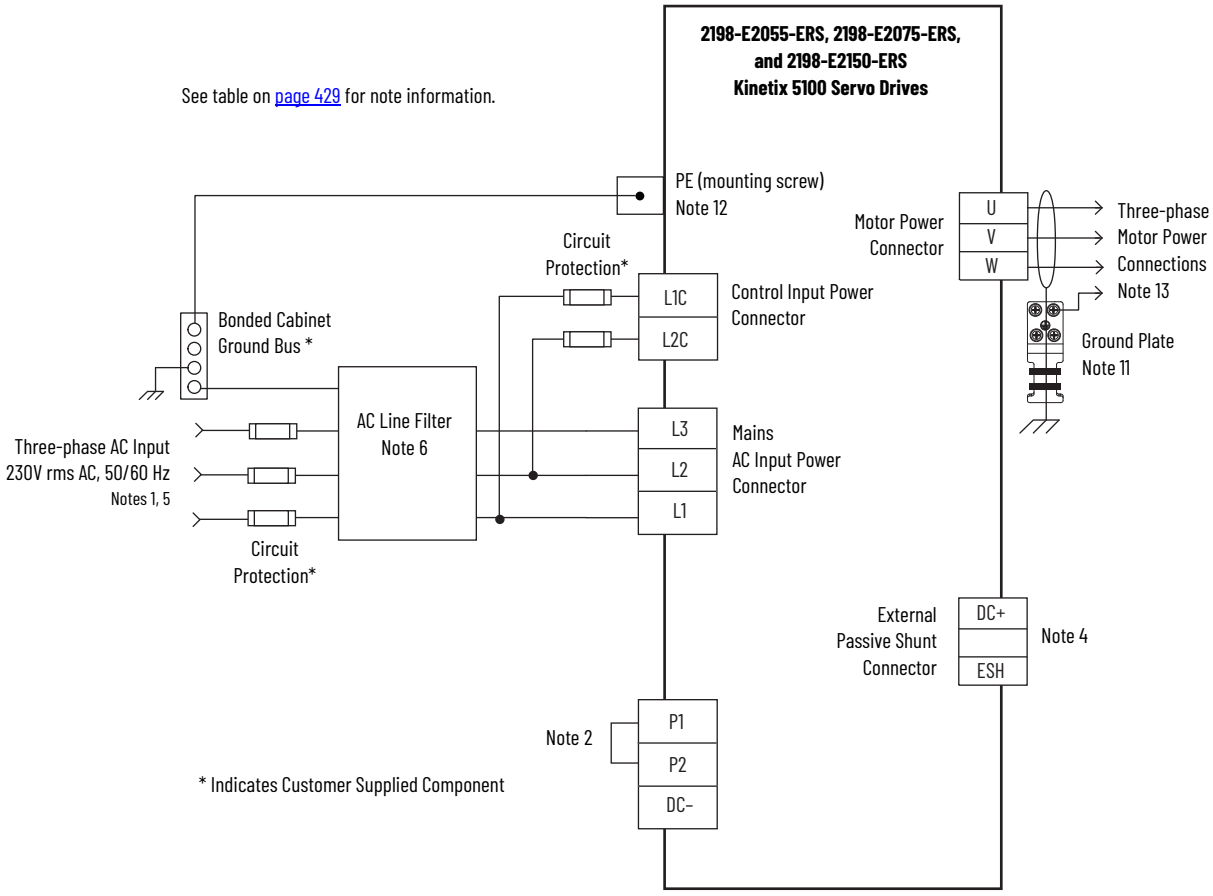
In this example, the 2198-E1004-ERS, 2198-E1007-ERS, 2198-E1015-ERS, 2198-E1020-ERS, and 2198-E2030-ERS drives are wired for 230V three-phase operation.

Figure 212 - Kinetix 5100 Drive (230V three-phase input power)



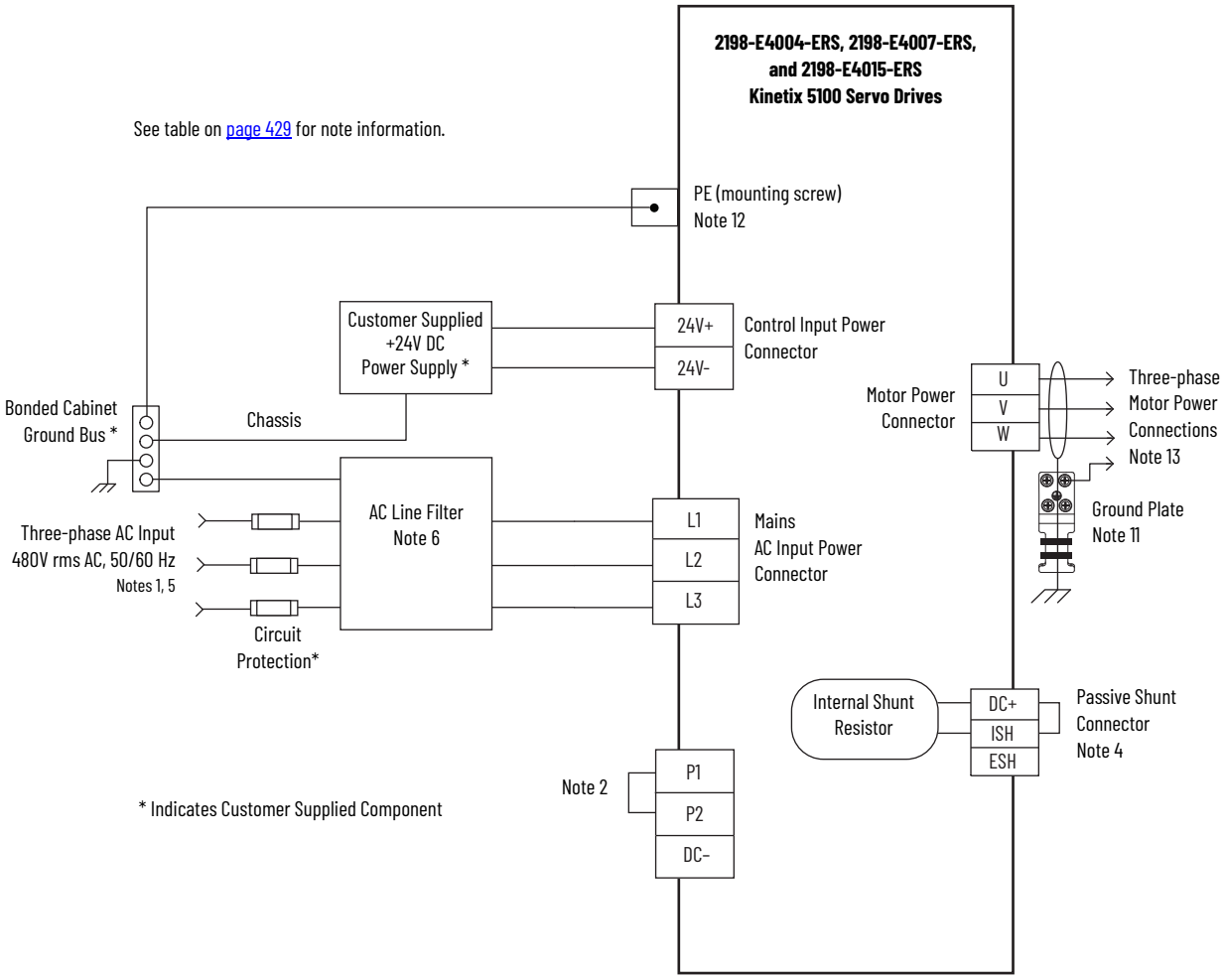
In this example, the 2198-E2055-ERS, 2198-E2075-ERS, and 2198-E2150-ERS drives are wired for 230V three-phase operation.

Figure 213 - Kinetix 5100 Drive (230V three-phase input power)



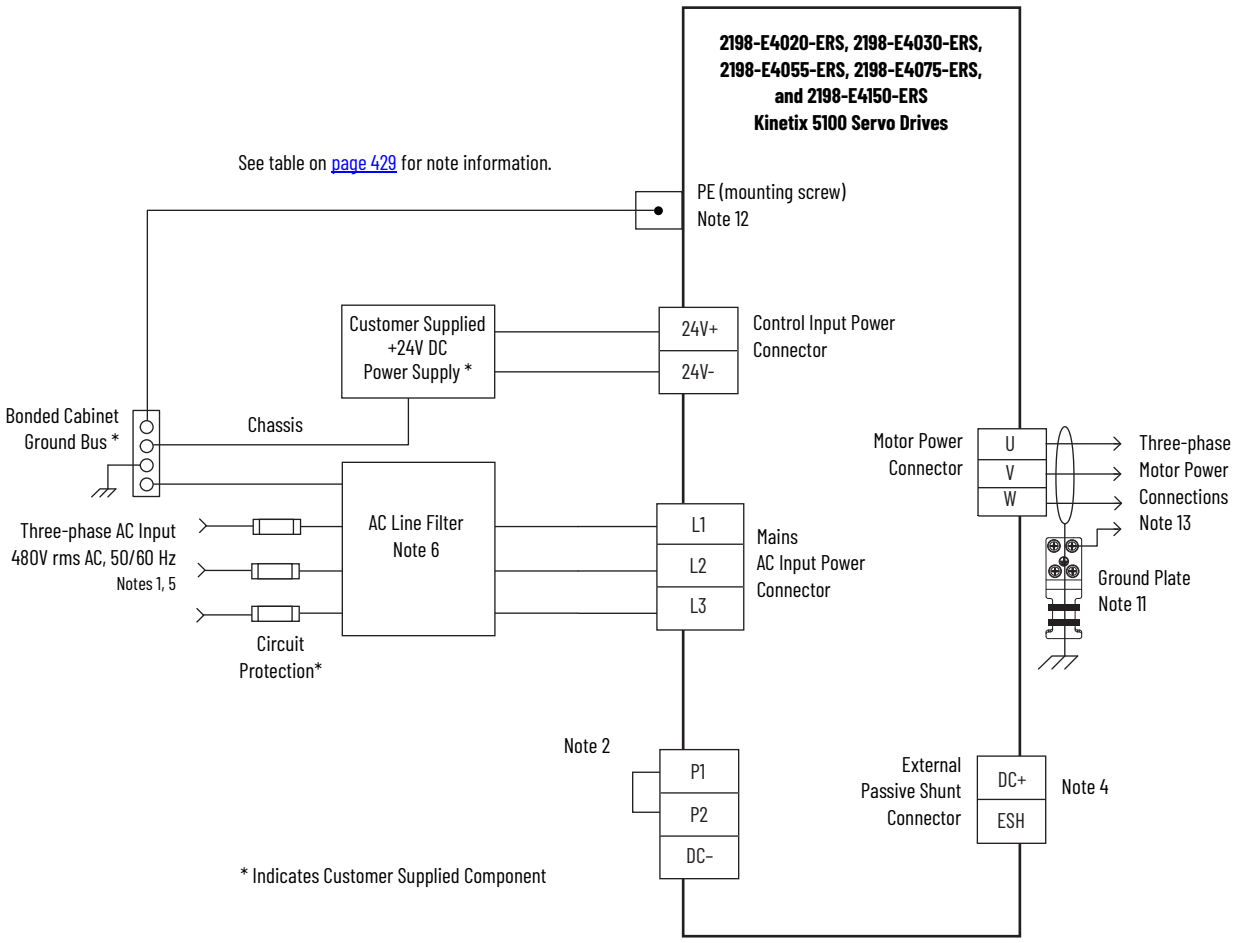
In this example, the 2198-E4004-ERS,2198-E4007-ERS, and 2198-E4015-ERS, drives are wired for 480V three-phase operation.

Figure 214 - Kinetix 5100 Drive (480V three-phase input power)



In this example, the 2198-E4020-ERS,2198-E4030-ERS, 2198-E4055-ERS, 2198-E4075-ERS, and 2198-E4150-ERS drives are wired for 480V three-phase operation.

Figure 215 - Kinetix 5100 Drive (480V three-phase input power)



Digital I/O Wiring

This section contains wiring configuration examples for digital inputs and digital outputs.

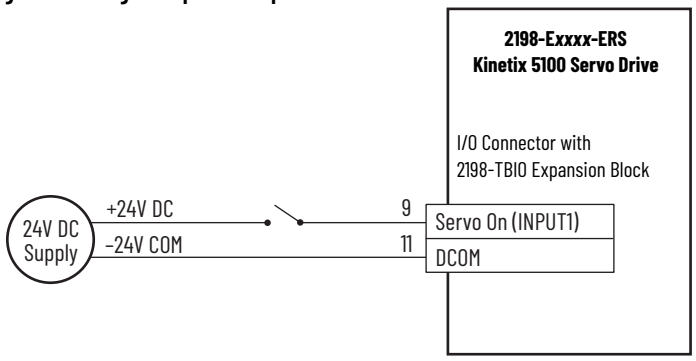
Digital Input Wiring

The I/O connector provides up to ten digital inputs. Eight digital inputs are configured with default settings and two are disabled. All the inputs are configurable with KNX5100C software.

See Digital Inputs on page 49 for the default digital input assignments for Kinetix 5100 drives.

In this example, Servo On is assigned to digital input 1 as a sinking type input.

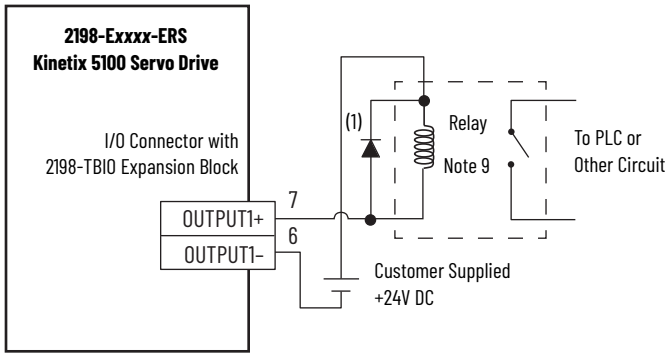
Figure 216 - Digital Input Example



Digital Output Wiring

In this example, digital output 1 (pin 7+, pin 6–) is connected to an output relay that changes a contact state used in a PLC or other circuit as shown.

Figure 217 - Digital Output Example



(1) Customer-supplied diode or MOV suppression device.

The I/O connector provides up to six digital outputs. Digital outputs are open-collector type and are configurable with KNX5100C software.

An example brake circuit contains the following components:

- Digital output 40 mA (max) continuous current.

Choose relay rated for 40 mA continuous current or less.

- Relay 700-HK36Z24 with DIN mount 700-HN121 or equivalent
- Choose from these suppression devices:
  - 1N4004 diodes or equivalent
  - Bulletin 199-MSMV1 MOV or equivalent

See Digital Inputs on page 49 for the default digital output assignments for Kinetix 5100 drives.

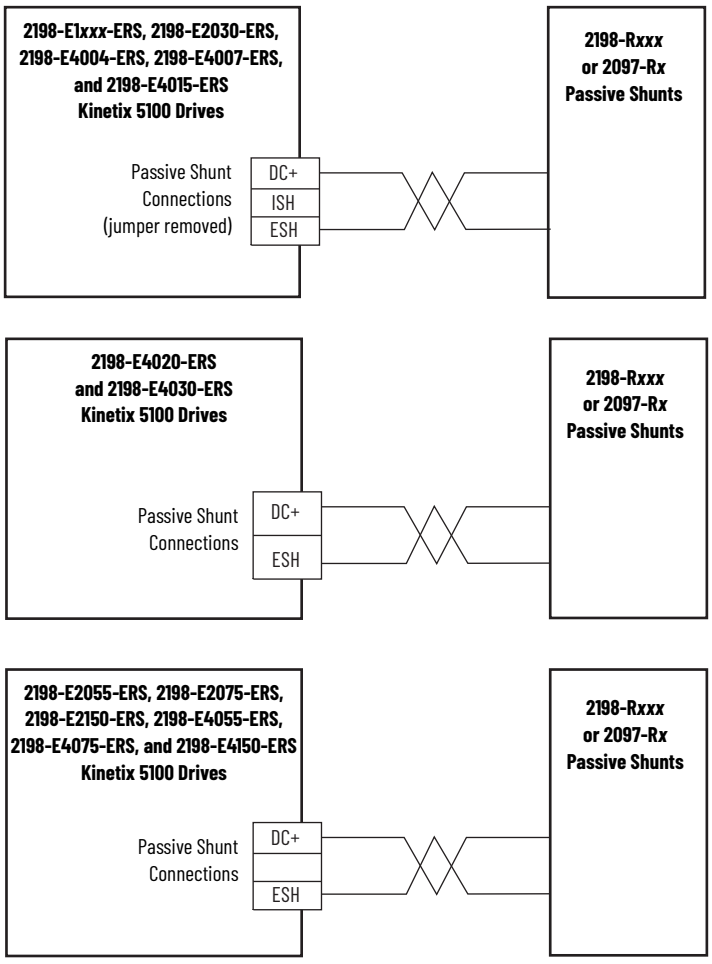
Passive Shunt Wiring Examples

Bulletin 2198-R*xxx* shunts and 2097-R*x* shunt resistors are available for the Kinetix 5100 drives. See the Kinetix Servo Drives Specifications Technical Data, publication KNX-TD003, for shunt specifications. See Passive Shunt Considerations on page 27 for specifications specific to your Kinetix 5100 drive application.

See the Bulletin 2097 Shunt Resistor Installation Instructions, publication 2097-IN002, and Kinetix 5700 Passive Shunt Modules Installation Instructions, publication 2198-IN011, for installation information.

IMPORTANT When wiring an external shunt to the 2198-E1*xxx*-ERS, 2198-E2030-ERS, 2198-E4004-ERS, 2198-E4007-ERS, and 2198-E4015-ERS drives you must remove the jumper between terminals DC+ and ISH. Set the ID157 (P1.052) ShuntResistorValue and ID158 (P1.053) ShuntResistorPower accordingly to make the external shunt resistor take effect.

Figure 218 - Passive Shunt Wiring Examples



ATTENTION: Kinetix 5100 drives are rated for minimum external regenerative resistance. Shunt resistor used must have a rating above this value. See Table 8 on page 27 for these ratings. Using an external shunt resistor below the rated value can result in damage to the drive shunt circuitry.

Kinetix 5100 Drive/Rotary Motor Wiring Examples

These wiring diagrams apply to Kinetix 5100 drives with compatible rotary motors.

In this example, the Kinetix TLP servo-motor with rectangular connectors uses a power/brake cable and the motor brake is wired to a digital output. Flying-lead feedback connections to the 2198-K51CK-D15M feedback connector kit are made by using bulk cable and building your own cables. See Build Your Own Kinetix TLP Motor Cables Installation Instructions, publication 2090-IN048, for more information.

Figure 219 - Kinetix 5100 Drives with Kinetix TLP-A/B046...TLP-A/B100 Servo Motors

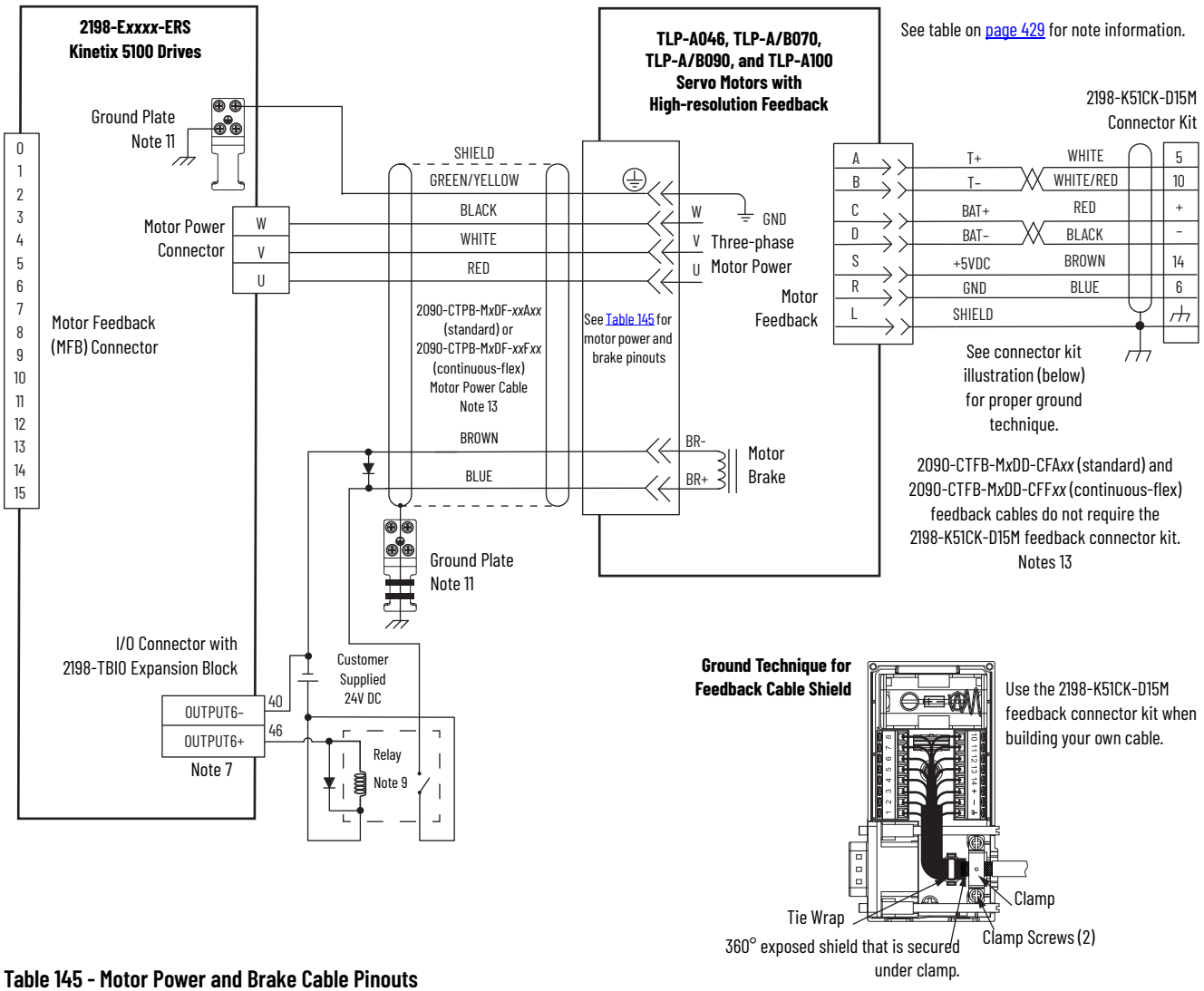


Table 145 - Motor Power and Brake Cable Pinouts

Motor Power/Brake Cable Cat. No.	Motor Power			Motor Brake		
	Signal	Wire Color	Pin	Signal	Wire Color	Pin
2090-CTPx-MADF-16	U V W PE	RED WHITE BLACK GREEN/YELLOW	1 2 4 5	BR+ BR–	BROWN BLUE	3 6
2090-CTPx-MADF-18						5 6

Refer to Kinetix 5100 Feedback Connector Kit Installation Instructions, publication 2198-IN019, for connector kit specifications.

In this example, the Kinetix TLP servo-motor with military-style connectors uses a power/brake cable and the motor brake is wired to a digital output. Flying-lead feedback connections to the 2198-K51CK-D15M feedback connector kit are made by using bulk cable and building your own cables. See Build Your Own Kinetix TLP Motor Cables Installation Instructions, publication 2090-IN048, for more information.

Figure 220 - Kinetix 5100 Drives with Kinetix TLP-A/B115...TLP-A/B200 Servo Motors

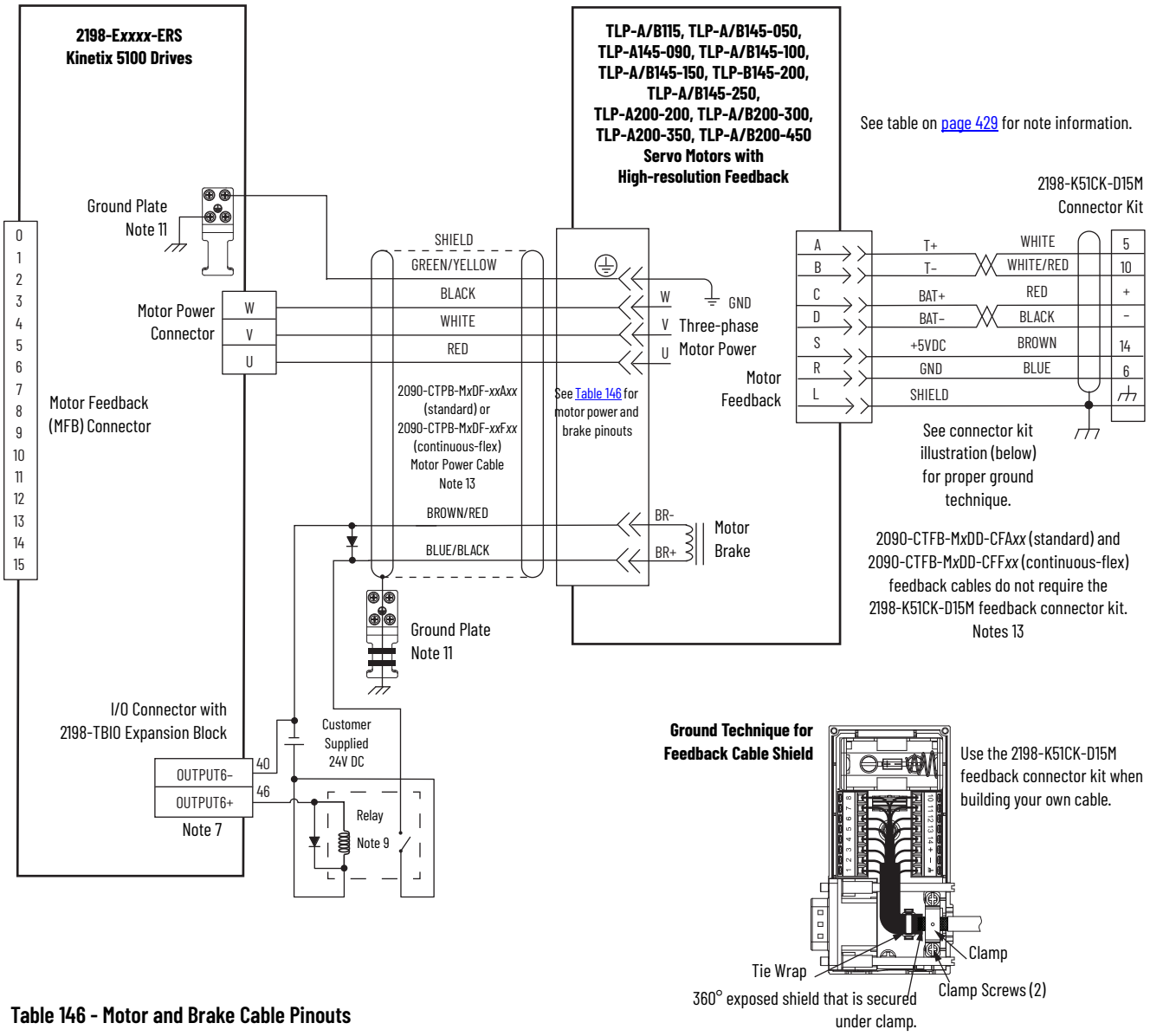
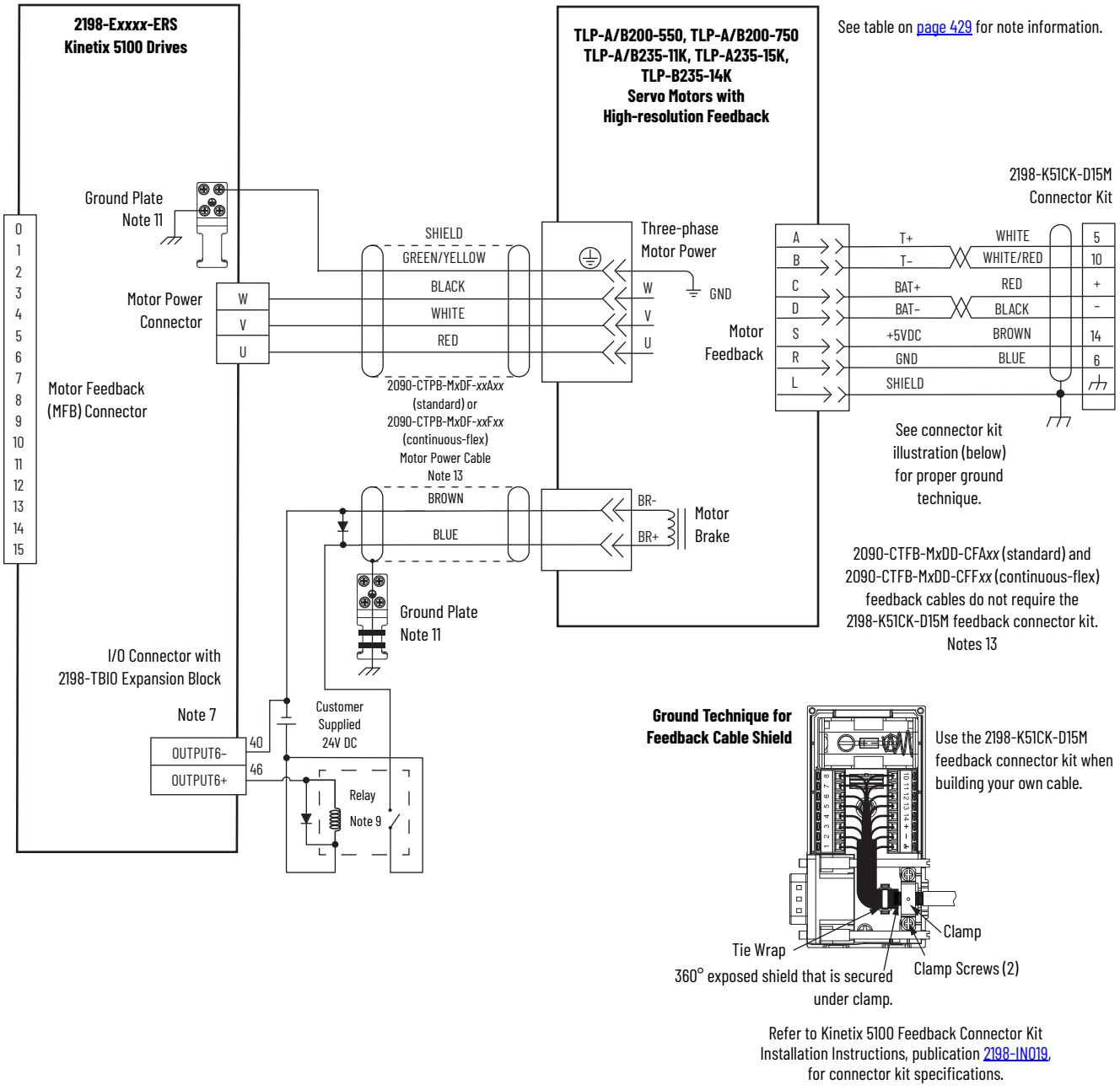


Table 146 - Motor and Brake Cable Pinouts

Motor Power/Brake Cable Cat. No.	Motor Power			Motor Brake		
	Signal	Wire Color	Pin	Signal	Wire Color	Pin
2090-CTPx-MCDF-12	U V W PE	RED WHITE BLACK GREEN/YELLOW	F I B E	BR+ BR–	RED BLACK	G H
2090-CTPx-MCDF-16				BR+ BR–	BROWN BLUE	
2090-CTPx-MDDF-08	U V W PE	RED WHITE BLACK GREEN/YELLOW	D E F G	BR+ BR–	RED BLACK	A B
2090-CTPx-MDDF-12						

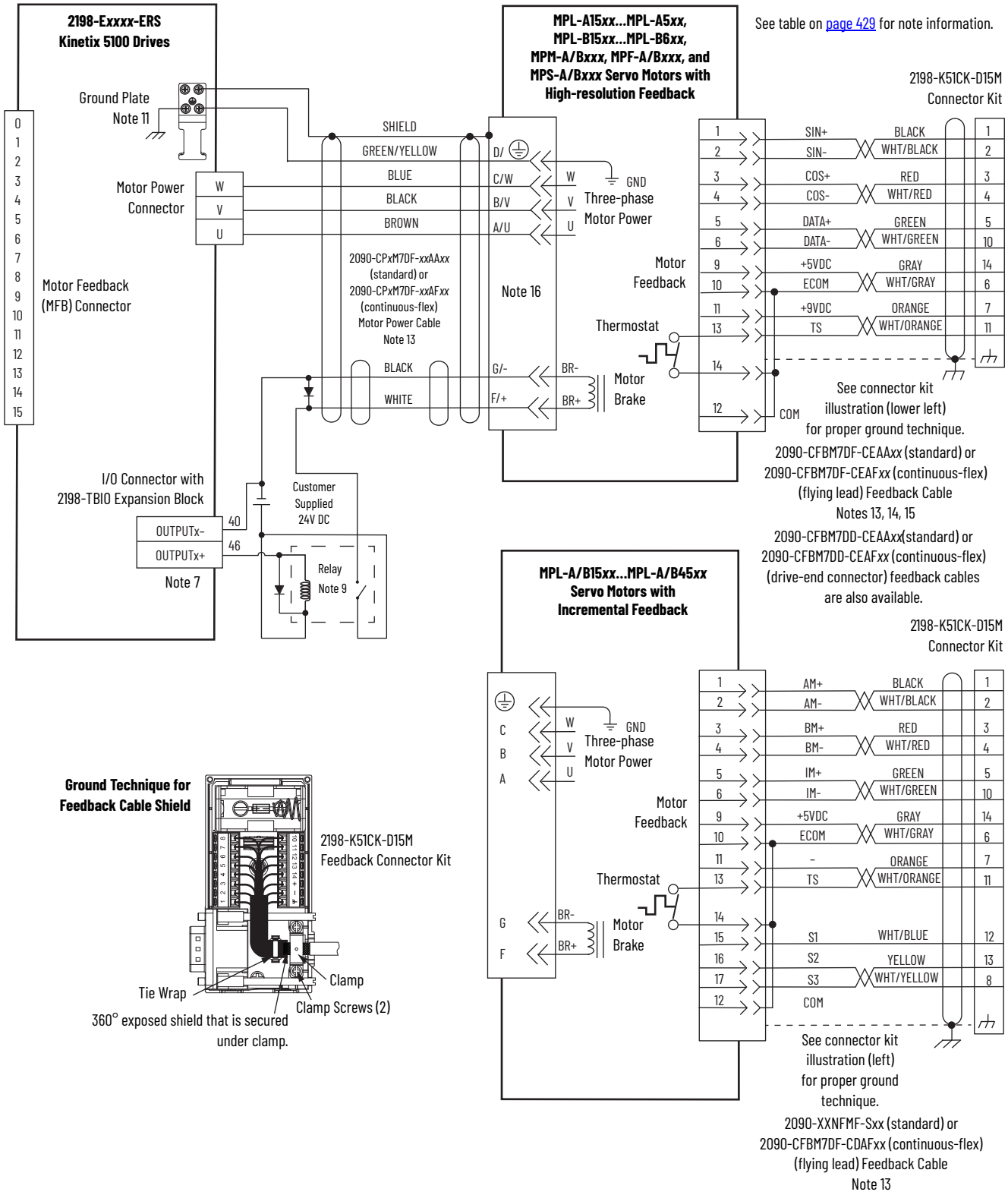
In this example, the Kinetix TLP servo motors have a separate brake (military style) connector and brake cable. The motor brake is wired to a digital output. Flying-lead feedback connections to the 2198-K51CK-D15M feedback connector kit are made by using bulk cable and building your own cables. See Build Your Own Kinetix TLP Motor Cables Installation Instructions, publication 2090-IN048, for more information.

Figure 221 - Kinetix 5100 Drives with Kinetix TLP-A/B200-550, TLP-A/B200-750, and TLP-A/B235 Servo Motors



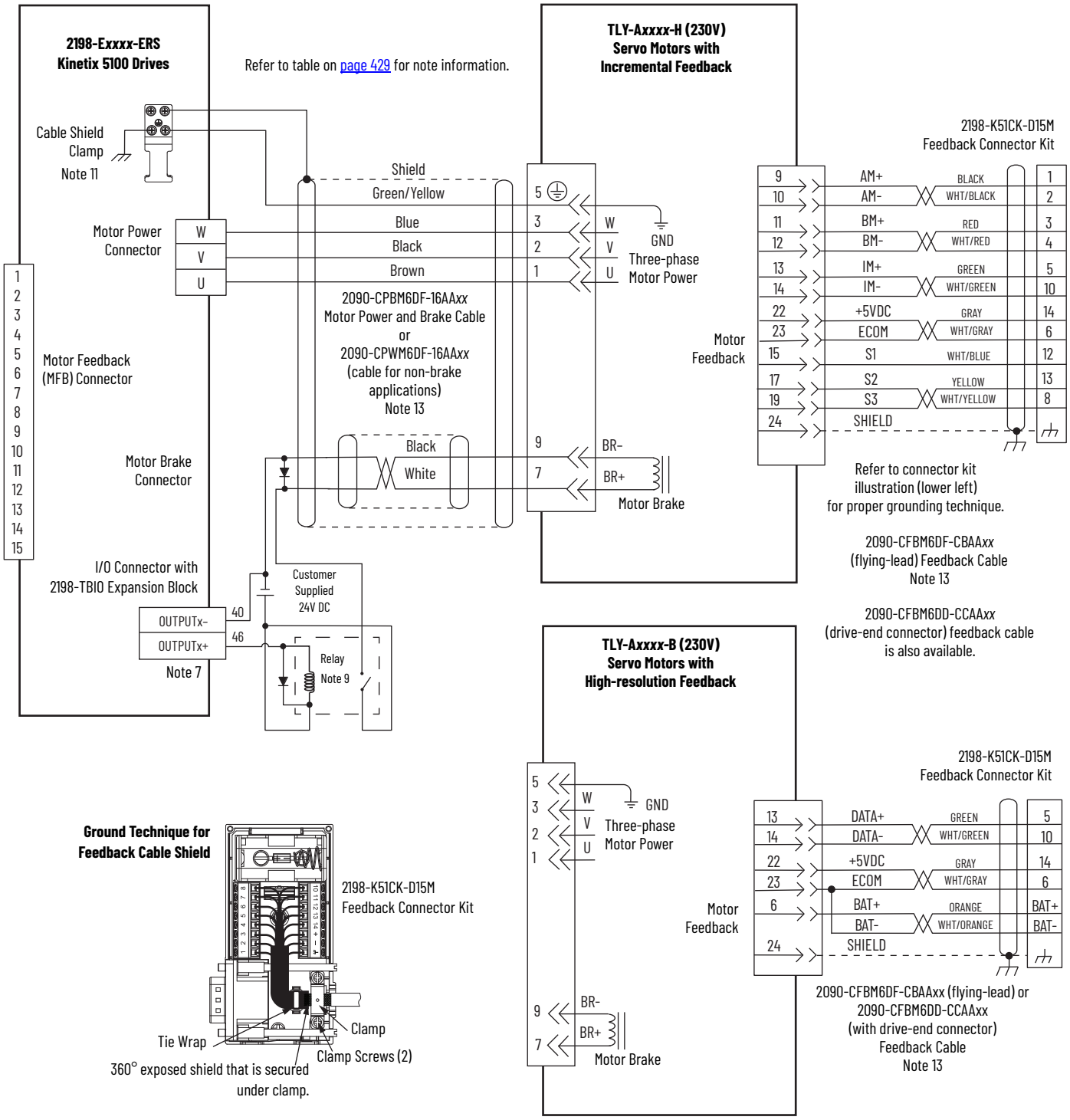
In this example, the Kinetix MP motor brake is wired to a digital output. 2090-CFBM7DD feedback cables with premolded drive-end connector are available. Flying-lead feedback connections are made with 2090-CFBM7DF cables to the 2198-K51CK-D15M feedback connector kit. See Cable Preparation for Kinetix MP Servo Motors on page 85 for more information.

Figure 222 - Kinetix 5100 Drives with Kinetix MP Rotary Servo Motors



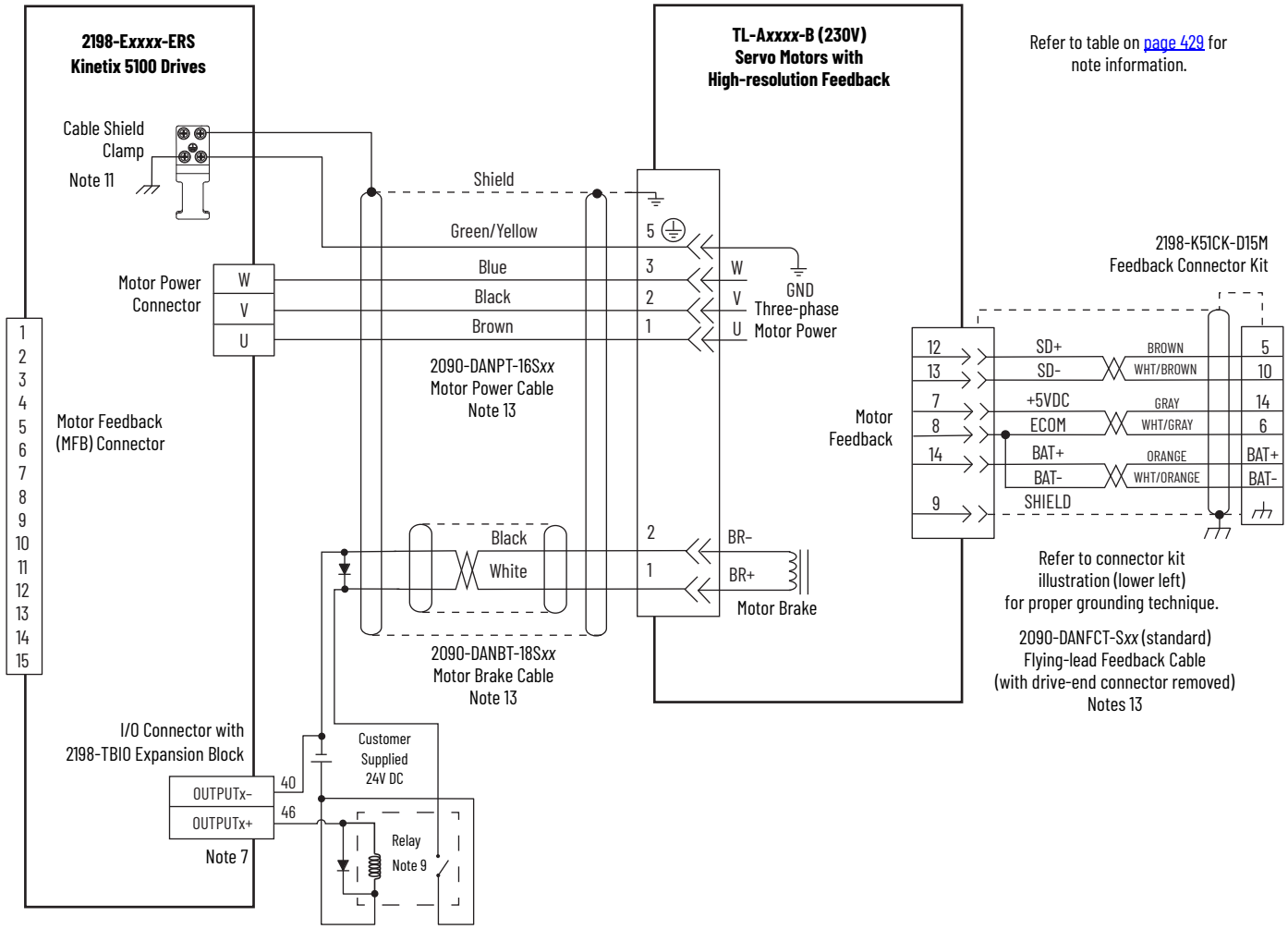
These compatible Kinetix TL and TLY rotary motors have separate connectors and cables for power/brake and feedback connections. See Cable Preparation for Kinetix TL and TLY Motor Power Cables on page 86 for more information.

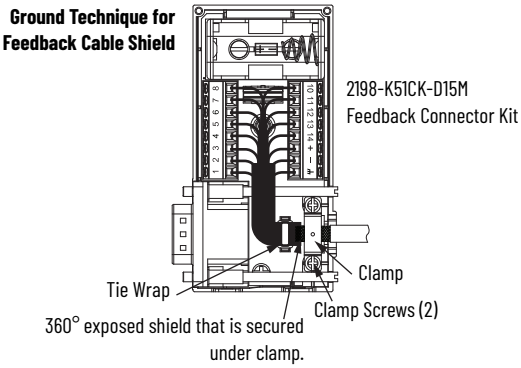
Figure 223 - Kinetix 5100 with Kinetix TLY Rotary Motors



The 2090-DANFCT-S*xx* feedback cable is equipped with a drive-end connector that is not compatible with the 15-pin (MFB) feedback connector. To provide battery backup to the encoder, you can remove the drive-end connector and prepare the cable shield and conductors for wiring to the 2198-K51CK-D15M feedback connector kit. See Cable Preparation for Kinetix TL and TLY Motor Power Cables on page 86 for more information.

Figure 224 - Kinetix 5100 with Kinetix TL Rotary Motors

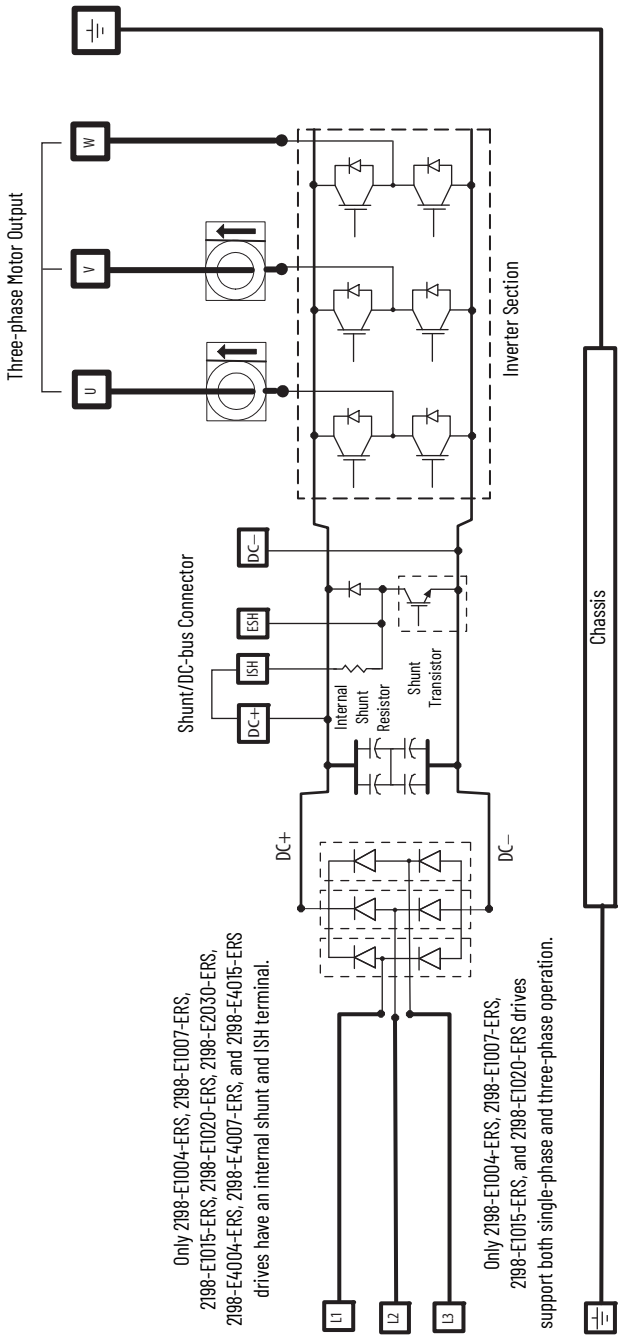




System Block Diagram

This power block diagram applies to all 2198-E*xxxx*-ERS servo drives.

Figure 225 - Power Block Diagram



Upgrade Kinetix 5100 Drive Firmware

This appendix provides procedures for upgrading your Kinetix® 5100 firmware.

Topic	Page
Before You Begin	445
Upgrade the Firmware	446
Verify the Firmware Upgrade	455

You can upgrade your Kinetix 5100 drive firmware by using either of these two methods:

- ControlFLASH Plus™ software
- ControlFLASH™ software

To upgrade drive firmware, you must configure a path to your drive, select the drive module to upgrade, and complete the firmware upgrade procedure.

We recommend that you use ControlFLASH Plus software for firmware upgrades. See the ControlFLASH Plus Quick Start Guide, publication CFP-QS001, for more information.

Before You Begin

The firmware revision for software must be as shown for EtherNet/IP™ networks.

Table 147 - Kinetix 5100 System Requirements

Description	Firmware Revision
Logix Designer application	30.00.00 or later
RSLinx® software (1)	3.60.00 or later
FactoryTalk® Linx software (2)	6.20.00 or later
ControlFLASH software kit (3)	14.01.00 or later
ControlFLASH Plus software kit (3)	3.01 or later

(1) Only required when using ControlFLASH software.
(2) Only required when using ControlFLASH Plus software.
(3) Download the ControlFLASH software kit from the Product Compatibility and Download Center at: rok.auto/pcdc. For more ControlFLASH software information (not Kinetix 5100 specific), refer to the ControlFLASH Firmware Upgrade Kit User Manual, publication 1756-UM105.

Gather this information before you begin your firmware upgrade.

- Network path to the targeted Kinetix 5100 drives you want to upgrade.
- Catalog numbers of the targeted Kinetix 5100 drives you want to upgrade.

IMPORTANT Control power at L1C and L2C (200V drives) and 24V+ and 24V- (400V drives) must be present prior to upgrading your target module.

IMPORTANT The state on the display must be STDBY (STANDBY) in IO mode before upgrading your target module.

The state on the display must be STOP (STOPPED) in other modes before upgrading your target module.

ATTENTION: To avoid personal injury or damage to equipment during the firmware upgrade due to unpredictable motor activity, do not apply the main power to the drive. Do apply the control power to the drive.

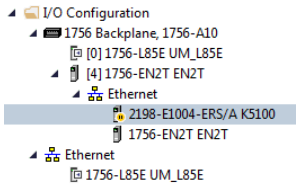
Inhibit the Module

If the drive is configured as IO mode, you must inhibit the connection before performing the firmware upgrade.

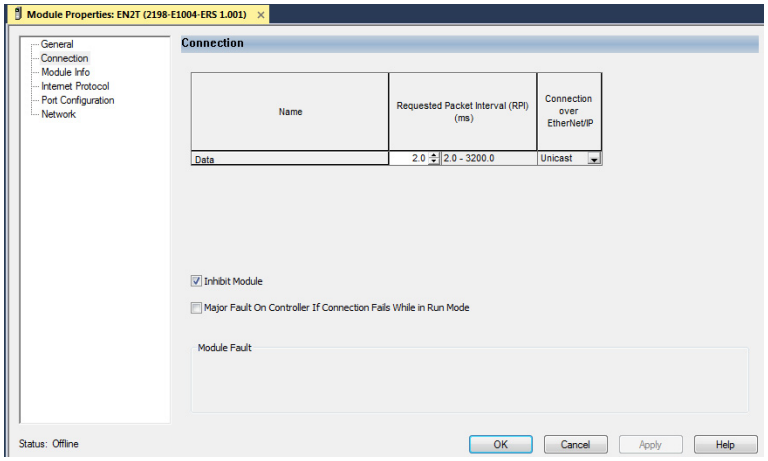
Follow these steps to inhibit the connection.

1. Open your Logix Designer application.
2. Right-click the 2198-E*xxxx*-ERS drive and choose Properties.

   The Module Properties dialog box appears.



3. Select the Connection category.



4. Check Inhibit Module.
5. Click OK.
6. Save your file and download the program to the controller.

Upgrade Your Firmware

Use either ControlFLASH Plus software or ControlFLASH software to upgrade your firmware.

- To use ControlFLASH Plus software, see Use ControlFLASH Plus Software to Upgrade Your Drive Firmware on page 447.
- To use ControlFLASH software, see Use ControlFLASH Software to Upgrade Your Drive Firmware on page 450.

Use ControlFLASH Plus Software to Upgrade Your Drive Firmware

Follow these steps to select the Kinetix 5100 drive to upgrade.

1. Start ControlFLASH Plus software.

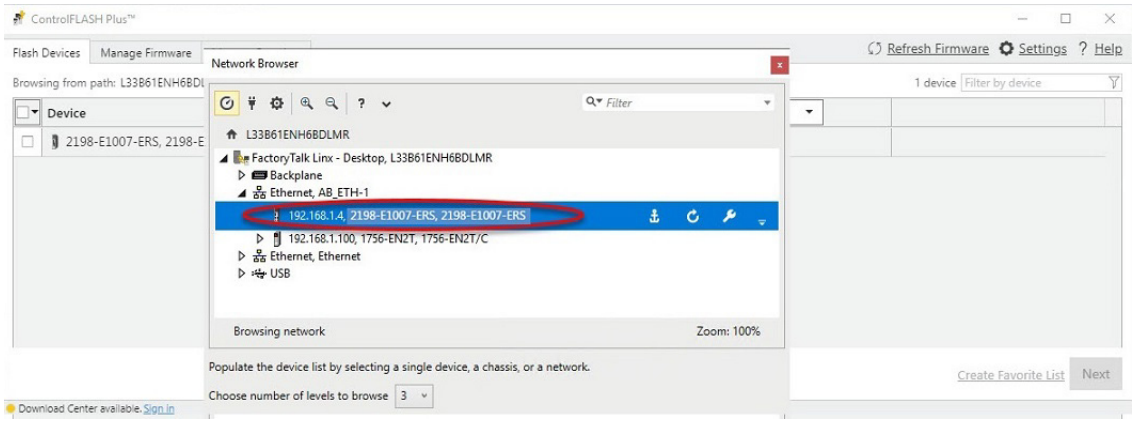
   You can choose to select and upgrade the firmware for all drive modules in your system. However, in this procedure only one drive is selected for a firmware upgrade.

2. Click the Flash Devices tab. If the device is not already present in Browsing from path:, complete these steps:

   a. Click .

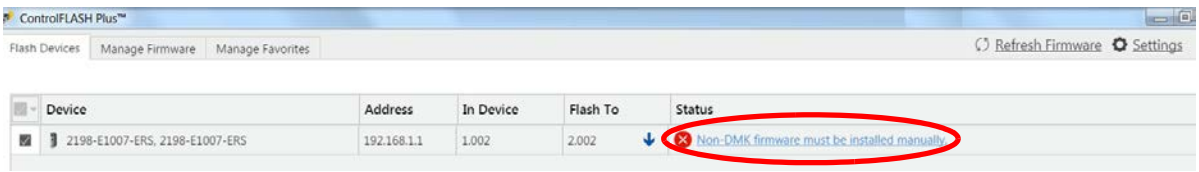


   b. In the Network Browser dialog box, locate and select the device to upgrade.

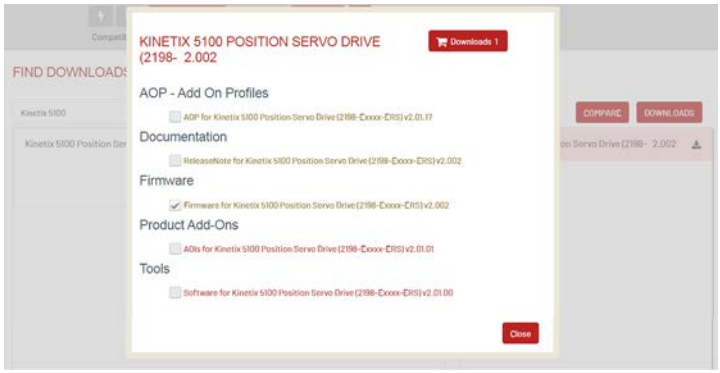


   c. Click OK.

   The Status field displays Non-DMK Firmware must be installed manually. This is accomplished with the ControlFLASH MSI file.

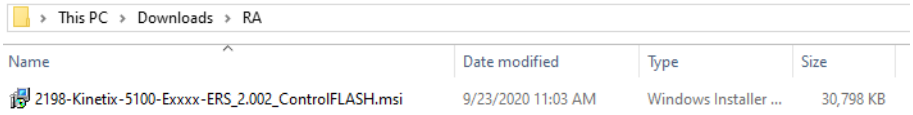


3. To download the ControlFLASH MSI file, go to the Product Compatibility and Download Center (PCDC).



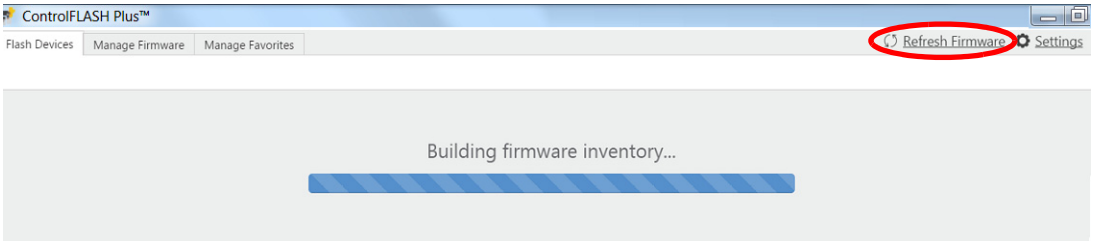
   a. Check Firmware, click Downloads, and follow the prompts to download the ControlFLASH MSI file.

   b. Install the Kinetix 5100 ControlFLASH MSI file.



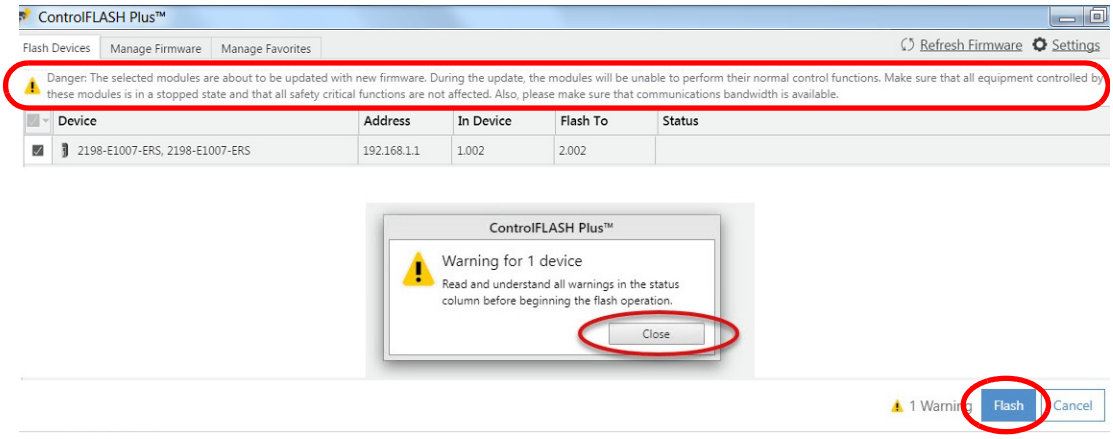
   c. Click Refresh Firmware.

      The Building firmware inventory dialog box opens and the firmware inventory installs.



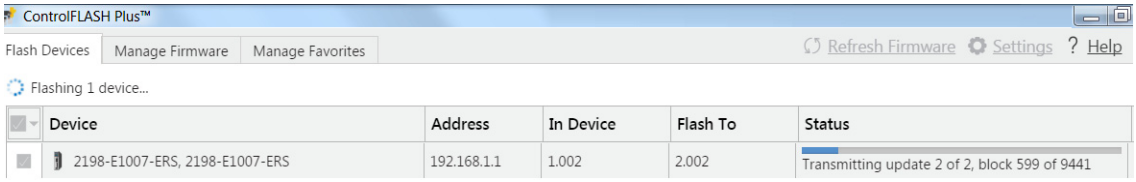
      When the refresh is complete, the Status field is empty.

4. If a warning dialog box appears, read the warning, complete any recommendations, and click Close.



5. After acknowledging all warnings and confirming the desired revisions, click Flash to begin the firmware upgrade.

The Status bar appears to show the progress of the firmware update. Also, the status display scrolls 'Updating. Do Not Turn Off', which indicates that the upgrade is in progress.

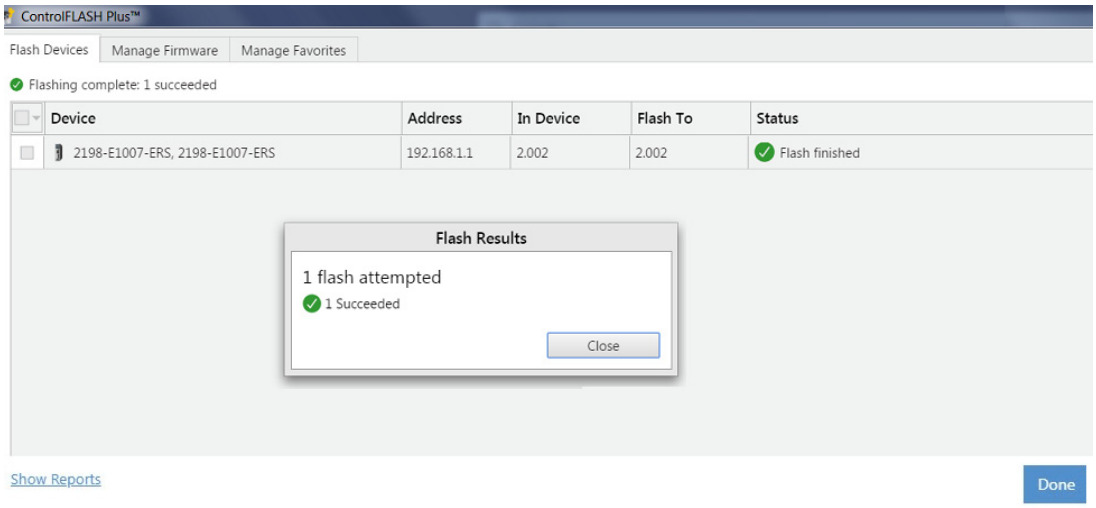


After the upgrade information is sent to the drive, the drive resets and performs diagnostic checking.

After the download, the drive applies the new firmware and reboots. This can take several minutes.

IMPORTANT Do not cycle power to the drive during this process. A power cycle results in an unsuccessful firmware upgrade and an inoperable module.

After the drive reboots, ControlFlash Plus software indicates success or failure of the update.



6. When the upgrade has completed, click Close.
7. To complete the process and close the application, click Done.

IMPORTANT You must return to the drive Module Properties>Connection category to clear the Inhibit Module checkbox before resuming normal operation.

Use ControlFLASH Software to Upgrade Your Drive Firmware

Before using ControlFLASH software you need to configure the communication path by using RSLinx software.

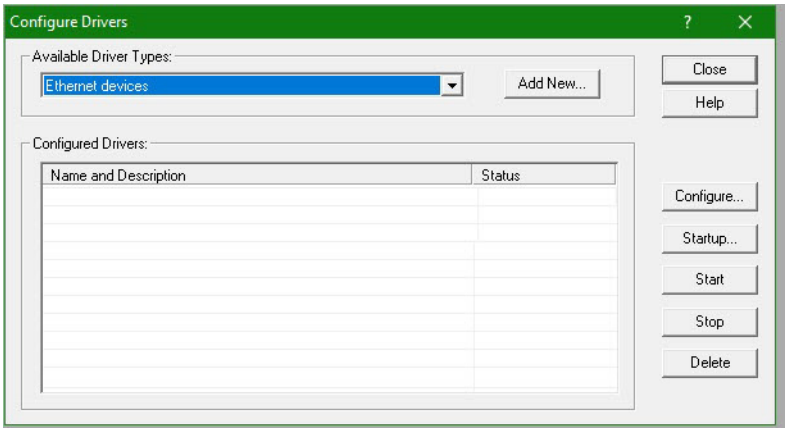
Configure Your Communication Path with RSLinx Software

This procedure assumes that your communication method to the target device is the Ethernet network. It also assumes that any Ethernet communication module or Logix 5000™ controller in the communication path has already been configured.

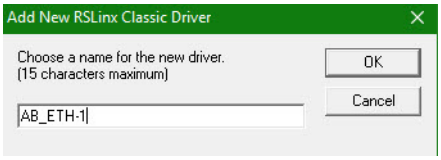
For more controller information, see Additional Resources on page 8.

Follow these steps to configure the communication path to the target device.

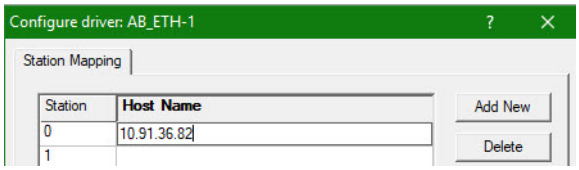
1. Open your RSLinx Classic software.
2. From the Communications menu, choose Configure Drivers.
   The Configure Drivers dialog box appears.



3. From the Available Driver Types pull-down menu, choose Ethernet devices.
4. Click Add New.
   The Add New RSLinx Classic Driver dialog box appears.
5. Type the new driver name.

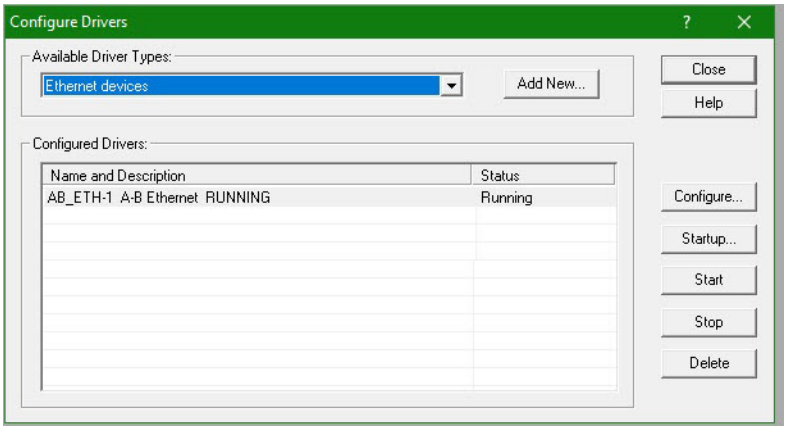


6. Click OK.
   The Configure driver dialog box appears.



7. Type the IP address of your Ethernet Module or Controller that bridges between the Ethernet network and the EtherNet/IP network.
8. Click OK.

The new Ethernet driver appears under Configured Drivers.



9. Click Close.
10. Minimize the RSLinx application dialog box.

Start the ControlFLASH Software

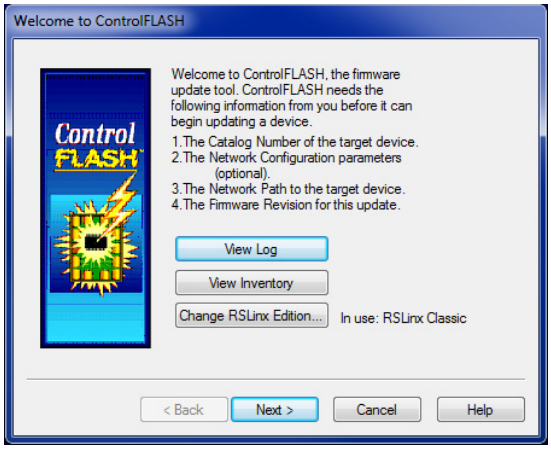
Follow these steps to start ControlFLASH software and begin your firmware upgrade.

1. In the Logix Designer application, from the Tools menu, choose ControlFLASH.

   You can also open ControlFLASH software by choosing Start>Programs>FLASH Programming Tools>ControlFLASH.

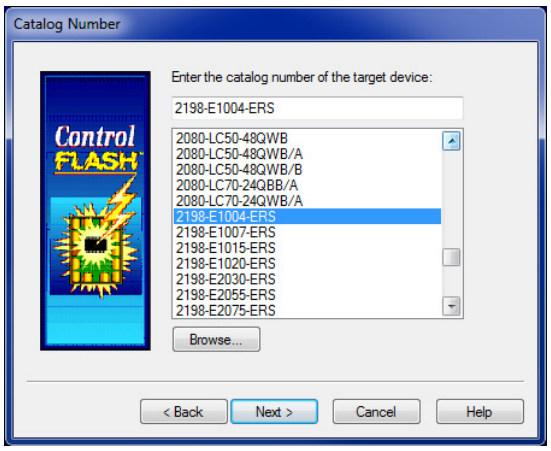
2. In the Logix Designer application, from the Tools menu, choose ControlFLASH.

   The Welcome to ControlFLASH dialog box appears.



3. Click Next.

The Catalog Number dialog box appears.



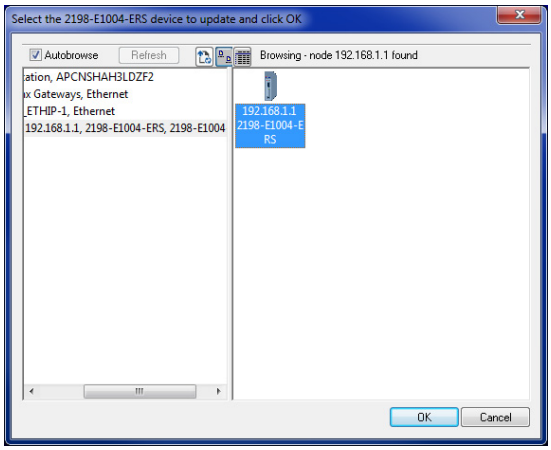
If your catalog number does not appear, click Browse, select the monitored folder where the firmware kit (DMK files) is located. Click Add and OK.

4. Select your drive module.

   In this example, the 2198-E1004-ERS drive is selected.

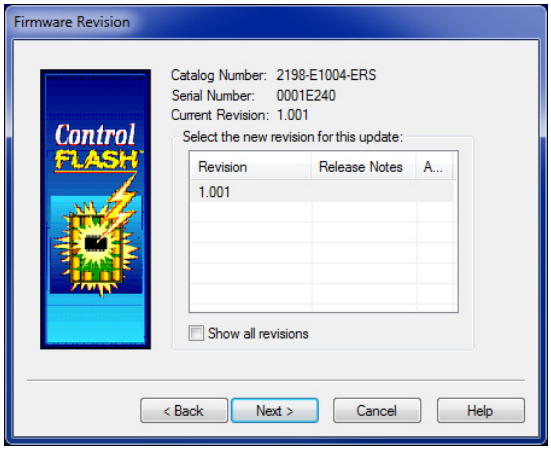
5. Click Next.

   The Select Device to Update dialog box appears.



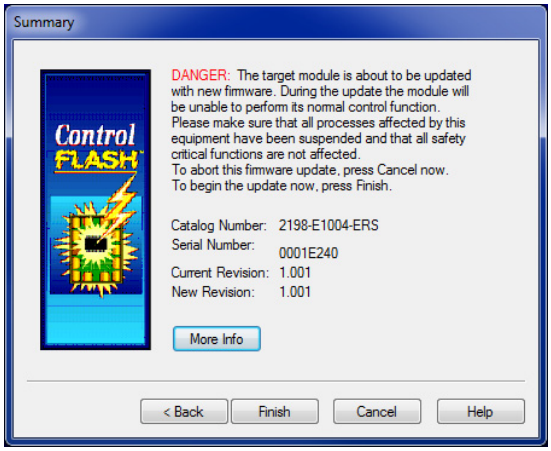
6. Expand your Ethernet node, Logix backplane, and EtherNet/IP network module.
7. Select the servo drive to upgrade.
8. Click OK.

The Firmware Revision dialog box appears.



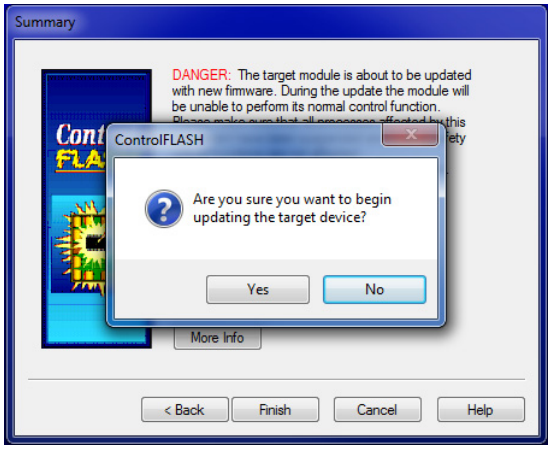
9. Select the firmware revision to upgrade.
10. Click Next.

The Summary dialog box appears.



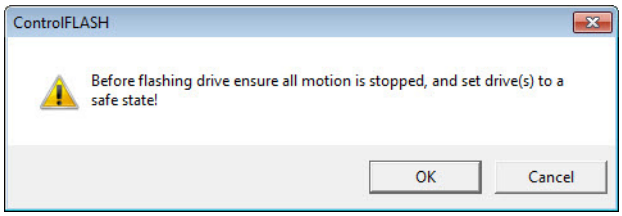
11. Confirm the drive catalog number and firmware revision.
12. Click Finish.

This ControlFLASH warning dialog box appears.



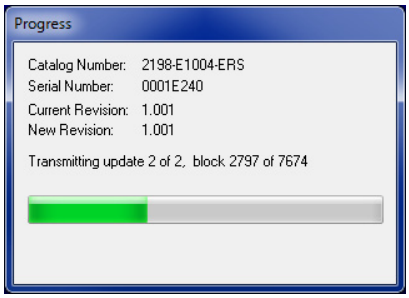
13. To complete the update now, click Yes.

This ControlFLASH warning dialog box appears.

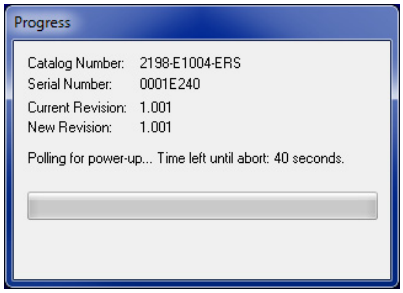


14. Acknowledge the warning and click OK.

    The Progress dialog box appears and the update begins.



    The state on the display changes from STDBY (STANDBY), or STOP (STOPPED) to F_UPD (FIRMWARE UPDATE), which indicates that the upgrade is in progress.



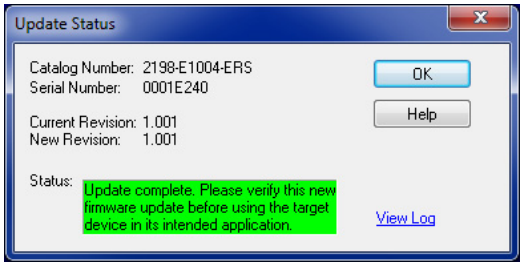
    After the upgrade information is sent to the drive, the drive resets and performs diagnostic checking.

15. Wait for the Progress dialog box to time out.

    It is normal for this process to take several minutes.

IMPORTANT	Do not cycle power to the drive during this process. A power cycle results in an unsuccessful firmware upgrade and an inoperable module.

16. Verify that the Update Status dialog box appears and indicates success or failure as described below.



Upgrade Status	If
Success	Update complete appears in a GREEN Status dialog box, then go to step 17.
Failure	Update failure appears in a RED Status dialog box, then see the ControlFLASH Firmware Upgrade Software User Manual, publication 1756-UM105 for troubleshooting information. IMPORTANT: If the power is lost during the firmware upgrade, the update fails. When the power is restored, three different situations happen depending on when the power went off. • Panel display shows UPt 1: Update the firmware again. • Panel display is blank:, The drive automatically finishes the last firmware update in 20 seconds, then it resets to complete the update. • Panel display shows UPt 3: Update the firmware again.

17. Click OK.

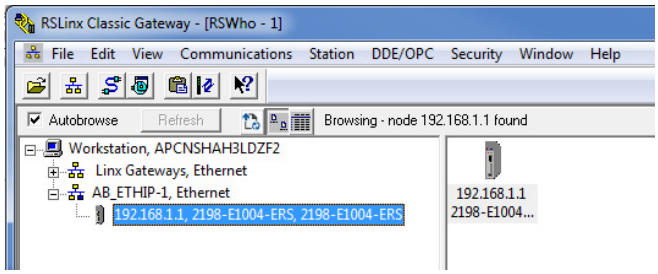
IMPORTANT If you checked Inhibit Module on the Connection tab in Module Properties, you must clear the Inhibit Module check box before resuming normal operation.

Verify the Firmware Upgrade

Follow these steps to verify that your firmware upgrade was successful.

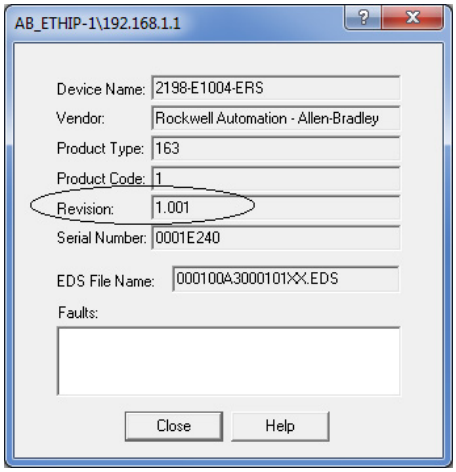
Verifying the firmware upgrade is optional.

1. Open your RSLinx software.
2. From the Communications menu, choose RSWho.



3. Expand your Ethernet node, Logix backplane, and EtherNet/IP network module.
4. Right-click the drive module and choose Device Properties.

   The Device Properties dialog box appears.



5. Verify the new firmware revision level.
6. Click Close.

Notes:

Use Add-On Instructions

Topic	Page
Download the Add-On Instruction Files and Data Types	458
Import the Add-On Instruction Files and Data Types	458
Create an Application	459
Add-On Instruction Configuration	461
Error Codes	464
Add-On Instruction Details	465

The Kinetix® 5100 drive Add-On Instructions are aimed to provide necessary function block. Table 148 lists the Kinetix 5100 drive Add-On Instructions.

Table 148 - Add-On Instruction List for Kinetix 5100 Drives

Name	Description
raC_Dvc_K5100_MSO	Motion Axis Servo On. Use the Motion Servo On (raC_Dvc_K5100_MSO) instruction to activate the drive amplifier for the specified axis and to activate the axis servo control loop.
raC_Dvc_K5100_MSF	Motion Axis Servo Off. Use the Motion Servo Off (raC_Dvc_K5100_MSF) instruction to deactivate the drive output for the specified axis and to deactivate the axis servo loop.
raC_Dvc_K5100_MAJ	Motion Axis Jog Use the Motion Axis Jog (raC_Dvc_K5100_MAJ) instruction to move an axis at a constant speed until you tell it to stop.
raC_Dvc_K5100_MAT	Motion Axis Torque Use the Motion Axis Torque (RAMAT) instruction to move an axis at a constant torque with the speed limit.
raC_Dvc_K5100_MAM	Motion Axis Move Use the Motion Axis Move (raC_Dvc_K5100_MAM) instruction to move an axis to a specified position.
raC_Dvc_K5100_MAH	Motion Axis Home Use the Motion Axis Home (raC_Dvc_K5100_MAH) instruction to home an axis.
raC_Dvc_K5100_MAG	Motion Axis Gear Use the Motion Axis Gear (MAG) instruction to set the gear ratio between the PUU (Position of User Unit) and encoder counts, and specify the acceleration rate during gear ratio change for the position control in the Kinetix 5100 drive.
raC_Dvc_K5100_MAS	Motion Axis Stop Use the Motion Axis Stop (raC_Dvc_K5100_MAS) instruction to stop a specific motion process on an axis or to stop the axis completely.
raC_Dvc_K5100_MAFR	Motion Axis Fault Reset. Use the Motion Axis Fault Reset (raC_Dvc_K5100_MAFR) instruction to clear some motion faults for an axis. Other faults cannot be cleared until you power cycle the drive. The faults, which can be cleared by raC_Dvc_K5100_MAFR, are listed in Fault list section.
raC_Dvc_K5100_MAI	Motion Axis Index Use the Motion Axis Index (raC_Dvc_K5100_MAI) instruction to execute the index (PR) function of the drive. Use configuration software or explicit message to set the index parameters. The raC_Dvc_K5100_MAI instruction specifies the index number to be executed.
raC_Dvc_K5100_MAPC	Motion Axis Position Cam Use the Motion Axis Position Cam (MAPC) instruction to provide electronic camming according to the specified cam profile.

Download the Add-On Instruction Files and Data Types

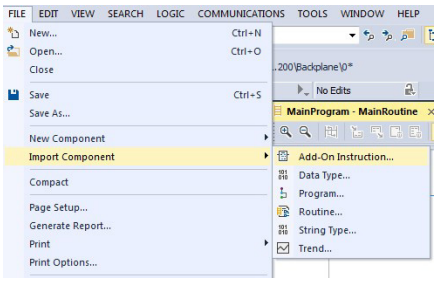
The Add-On Instructions files and Data Types for the Kinetix 5100 drive are available for download at the Rockwell Automation Product Compatibility Download Center (PCDC) website. Follow these steps to download the Add-On Instruction files and Data Types from the PCDC website.

1. Go to http://compatibility.rockwellautomation.com/Pages/home.aspx and enter 2198-E*xxxx*-ERS in the Search PCDC window.
2. Download the Add-On Instruction files and Data Types, and save them to your personal computer.

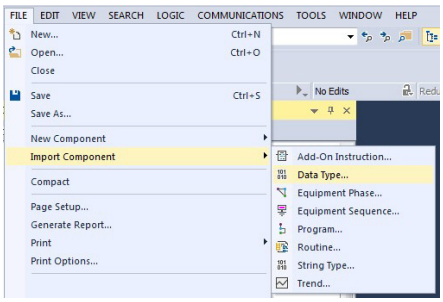
Import the Add-On Instruction Files and Data Types

Follow these steps to import the Add-On Instruction files and Data Types to your Studio 5000 Logix Designer® application.

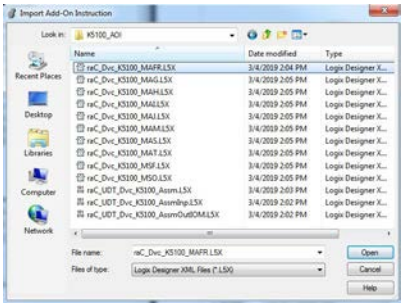
1. From the File menu, click Import Component>Add-On Instruction to import Add-On Instruction Files.

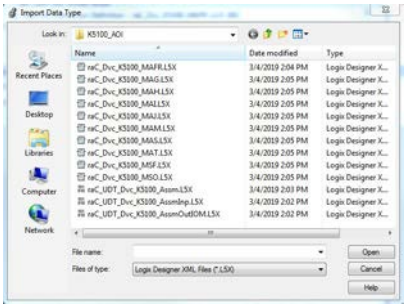


Or, click Import Component>Data Type to import Data Types.



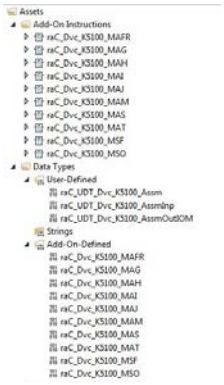
The Import Add-On Instruction/Data Types dialog box appears.





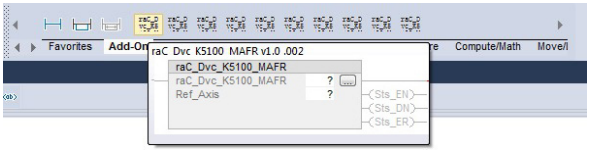
2. Browse to the Add-On Instruction files/Data Types you downloaded and select a file to add to your Logix Designer application and click Open.
3. Repeat step 1 and step 2 for the other Add-On Instruction file/Data Types.

Your Add-On Instruction files appear in the Controller Organizer under the Add-On Instructions folder, along with the Add-On-Defined Data Types, which appear in the Controller Organizer under Data Types> Add-On-Defined folder. Your Data Types appear in the Controller Organizer under Data Types>User-Defined folder.



There are eleven Add-On Instruction files and five user-defined data types for the Kinetix 5100 drive firmware version 2 or later to provide a necessary function block with assembly output instance 106 or 'Connection' is 'Data with Camming' of AOP version 2 or later. If the assembly output instance 104 is configured or 'Connection' is 'Data' of AOP version 2 or later, MAG and MAT need use the files in 'Version 1' and MAPC cannot be used.

The Add-On Instruction files also appear in the ladder logic toolbox.

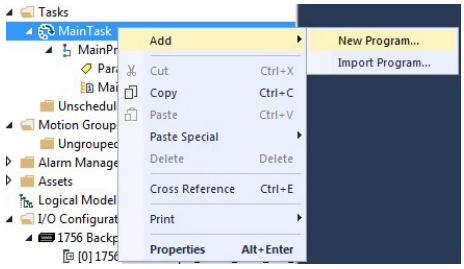


Create an Application

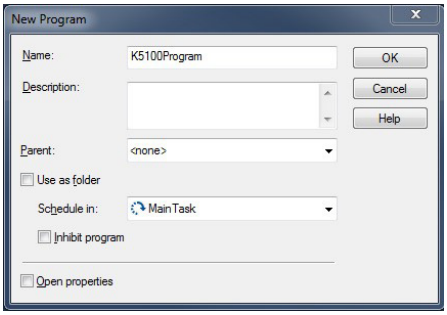
Follow these steps to create an application for using the Add-On Instruction.

Add a New Program

1. Right-click MainTask, select Add, and click New Program.



The New Program dialog box appears.

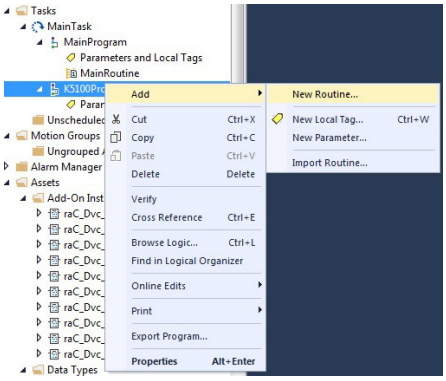


2. Enter a name (for example, K5100Program) for your new program and click OK.

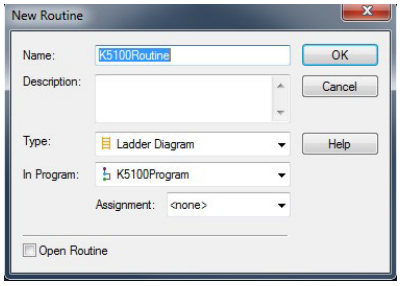
The new K5100Program that you created appears in the controller organizer, under MainTask.

Add a New Routine

1. Right-click the new K5100Program, select Add, and click New Routine.



The New Routine dialog box appears.

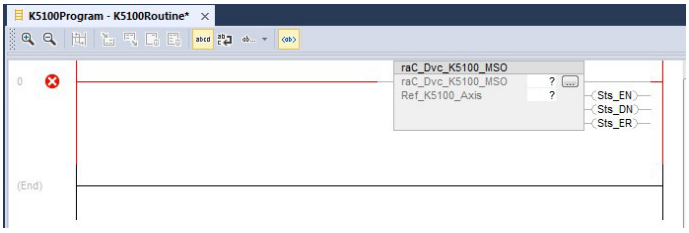


2. Enter a name (for example, K5100Routine) for your new routine and click OK.

   The new K5100Routine that you created appears in the Controller Organizer, under the K5100Program.

Add Add-On Instruction to your Routine

Double-click the K5100Routine, and add the Add-On Instructions into your new routine.



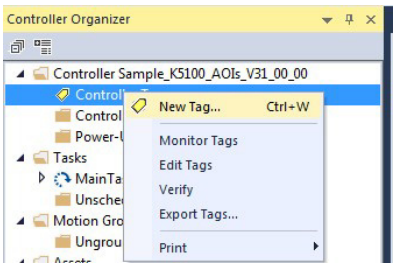
An error shows in the rung before you configure the Add-On Instruction arguments.

Add-On Instruction Configuration

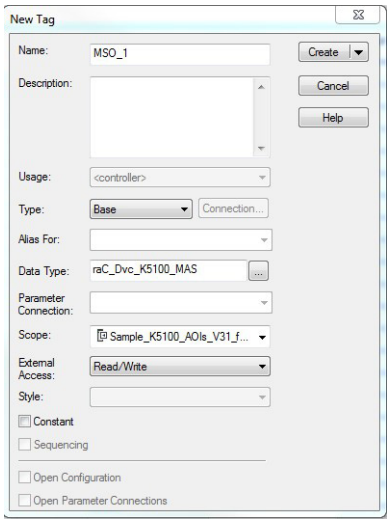
Follow these steps to configure your Add-On Instruction.

Create the Add-On Instruction Tag

1. In the Controller Organizer, right-click Controller Tags and click New Tag.

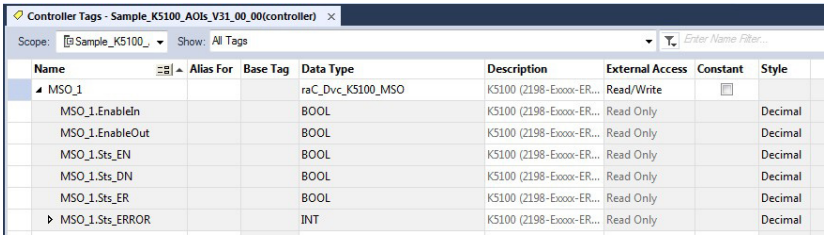


The New Tag dialog box appears.



2. Type a name (for example, MSO_1) for the Tag.
3. In the Data Type field, click Browse and choose an Add-On Instruction (for example, raC_Dvc_K5100_MSO).
4. Click OK.

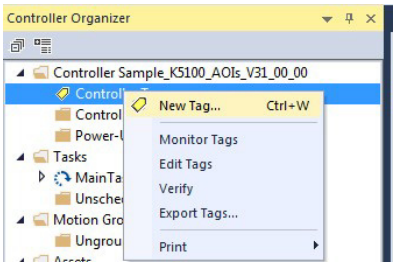
The Add-On Instruction tag that you created, with the module-defined data types, populates in the Controller Tags group.



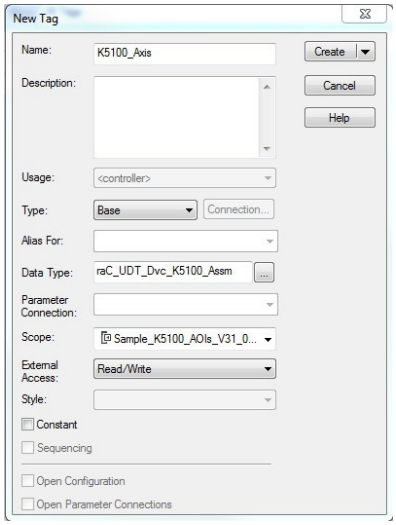
Create the Ref_Axis Tag

To use the Kinetix 5100 drive Add-On Instructions, you must create a tag Ref_Axis whose type is raC_UDT_Dvc_K5100_Assm. Follow these steps to create a Ref_Axis tag.

1. In the Controller Organizer, right-click Controller Tags and click New Tag.

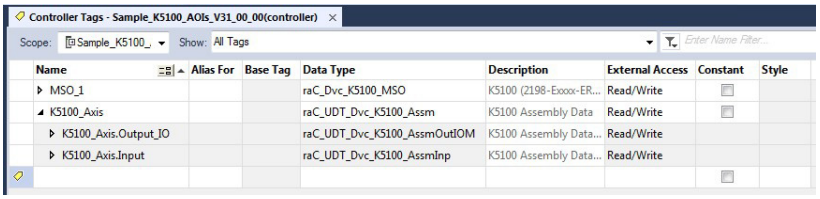


The New Tag dialog box appears.



2. Type a name (for example, K5100_Axis) for the Tag.
3. In the Data Type field, click Browse and choose an Add-On Instruction (for example, raC_UDT_Dvc_K5100_Assm).
4. Click OK.

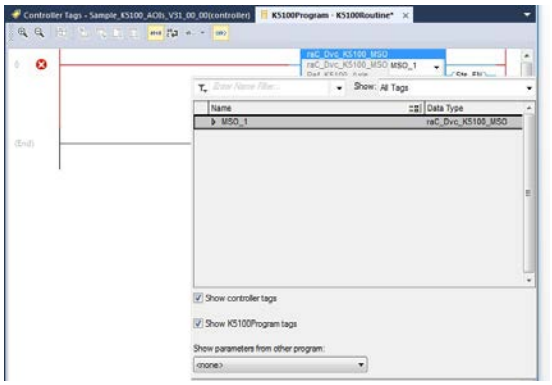
The Add-On Instruction tag that you created, with the module-defined data types, populates in the Controller Tags group.



IMPORTANT All Add-On Instructions use the K5100_Axis as the operation object.

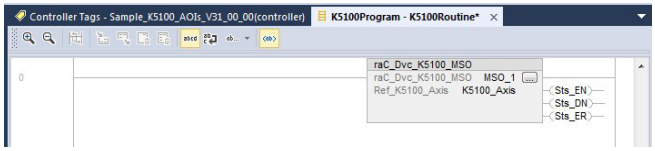
Configure the Add-On Instruction

1. Double-click the entry of raC_Dvc_K5100_MSO argument and choose the MSO_1 Tag created earlier.



2. Double-click the entry of Ref_Axis argument and choose the K5100_Axis tag that you created earlier.

   The error disappears after you configured the Add-On Instruction arguments.

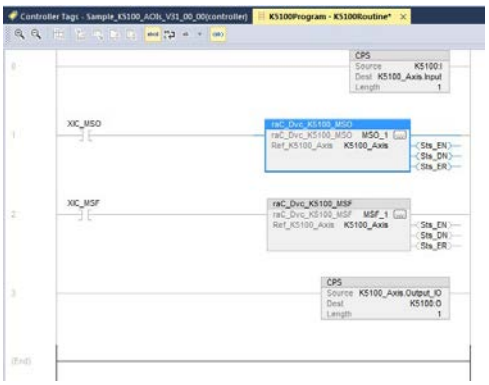


General Execution Rule for Add-On Instruction

See I/O Mode on page 228 for the input assembly data for the Kinetix 5100 drive.

To map the K5100_Axis to the Kinetix 5100 drive, before any K5100 RA motion Add-On Instruction is used, you must use the CPS function to copy all input assembly data of the Kinetix 5100 drive to the Input element of K5100_Axis. After all of the K5100 RA motion Add-On Instructions are used, you must use the CPS function to copy the Output element of K5100_Axis to the output assembly data of the Kinetix 5100 drive. This figure shows an example for mapping the K5100_Axis to the Kinetix 5100 drive.

CommandInProcess in the input assembly indicates the new motion command has been received by the K5100 drive. It toggles between 0 and 1 after a new motion command has been received by the K5100 drive.



Error Codes

Motion Error Codes (Sts_ERR) describes the error for Logix Designer. Table 149 lists the error codes for Logix Designer application motion instructions for the Kinetix 5100 drive.

Table 149 - Kinetix 5100 Drive Add-On Instruction Error Codes

Error	Corrective Action or Cause	Macro Name	Used in Which Add-On Instruction
100	Drive is not ready	_ERR_DriveNotReady	raC_Dvc_K5100_MSO, raC_Dvc_K5100_MSF, raC_Dvc_K5100_MAFR, raC_Dvc_K5100_MAS, raC_Dvc_K5100_MAJ, raC_Dvc_K5100_MAPC, raC_Dvc_K5100_MAT, raC_Dvc_K5100_MAI, raC_Dvc_K5100_MAM, raC_Dvc_K5100_MAH, raC_Dvc_K5100_MAG
101	Drive is faulted	_ERR_DriveFaulted	raC_Dvc_K5100_MSO, raC_Dvc_K5100_MSF, raC_Dvc_K5100_MAS, raC_Dvc_K5100_MAPC, raC_Dvc_K5100_MAJ, raC_Dvc_K5100_MAT, raC_Dvc_K5100_MAI, raC_Dvc_K5100_MAM, raC_Dvc_K5100_MAH, raC_Dvc_K5100_MAG
102	Another raC_Dvc_K5100_MSO is executing	_ERR_AnotherMSOExecuting	raC_Dvc_K5100_MSO
103	raC_Dvc_K5100_MSF is executing	_ERR_MSFExecuting	raC_Dvc_K5100_MSO, raC_Dvc_K5100_MAG, raC_Dvc_K5100_MAH, raC_Dvc_K5100_MAI, raC_Dvc_K5100_MAJ, raC_Dvc_K5100_MAM, raC_Dvc_K5100_MAPC, raC_Dvc_K5100_MAT, raC_Dvc_K5100_MAS
104	Another raC_Dvc_K5100_MSF is executing	_ERR_AnotherMSFExecuting	raC_Dvc_K5100_MSF
105	Drive is disabled	_ERR_DriveDisable	raC_Dvc_K5100_MAM, raC_Dvc_K5100_MAH, raC_Dvc_K5100_MAS, raC_Dvc_K5100_MAI, raC_Dvc_K5100_MAG, raC_Dvc_K5100_MAPC, raC_Dvc_K5100_MAT, raC_Dvc_K5100_MAJ
106	Another raC_Dvc_K5100_MAFR message is executing	_ERR_AnotherMAFRExecuting	raC_Dvc_K5100_MAFR
107	raC_Dvc_K5100_MAS is executing	_ERR_MASIsExecuting	raC_Dvc_K5100_MAS, raC_Dvc_K5100_MAG, raC_Dvc_K5100_MAH, raC_Dvc_K5100_MAI, raC_Dvc_K5100_MAJ, raC_Dvc_K5100_MAM, raC_Dvc_K5100_MAPC, raC_Dvc_K5100_MAT
108	Another RA motion Add-On Instructions is sending the command.	_ERR_OtherMotionAOISendingCommand	raC_Dvc_K5100_MAJ. raC_Dvc_K5100_MAG, raC_Dvc_K5100_MAH, raC_Dvc_K5100_MAI, raC_Dvc_K5100_MAM, raC_Dvc_K5100_MAPC, raC_Dvc_K5100_MAT
111	SpeedReference is out of range	_ERR_SpeedReferenceOutOfRange	raC_Dvc_K5100_MAJ, raC_Dvc_K5100_MAM, raC_Dvc_K5100_MAH
112	AccelReference is out of range	_ERR_AccelReferenceOutOfRange	raC_Dvc_K5100_MAJ, raC_Dvc_K5100_MAM, raC_Dvc_K5100_MAH
113	DecelReference is out of range	_ERR_DecelReferenceOutOfRange	raC_Dvc_K5100_MAS, raC_Dvc_K5100_MAJ. raC_Dvc_K5100_MAM, raC_Dvc_K5100_MAH
115	StartingIndex is higher than 99	_ERR_StartingIndexOutOfRange	raC_Dvc_K5100_MAI
116	Torque is out of range	_ERR_TorqueOutOfRange	raC_Dvc_K5100_MAT
117	NonCyclicMoveType is higher than 3	_ERR_NonCyclicMoveTypeOutOfRange	raC_Dvc_K5100_MAM
118	CyclicMoveType is higher than 2	_ERR_CyclicMoveTypeOutOfRange	raC_Dvc_K5100_MAM
119	TravelMode is not either 2 or 10	_ERR_TravelModeOutOfRange	raC_Dvc_K5100_MAM
122	HomingMethod is out of range	_ERR_HomingMethodOutOfRange	raC_Dvc_K5100_MAH
125	TorqueRampTime is out of range	_ERR_TorqueRampTimeOutOfRange	raC_Dvc_K5100_MAT
126	Homing is not completed	_ERR_HomeNotCompleted	raC_Dvc_K5100_MAM
129	Motor is not connected	_ERR_MotorNotConnected	raC_Dvc_K5100_MSO, raC_Dvc_K5100_MSF, raC_Dvc_K5100_MAS, raC_Dvc_K5100_MAJ, raC_Dvc_K5100_MAT, raC_Dvc_K5100_MAI, raC_Dvc_K5100_MAM, raC_Dvc_K5100_MAH, raC_Dvc_K5100_MAG, raC_Dvc_K5100_MAPC
131	Gear slave counts is out of range	_ERR_SlaveCountsOutOfRange	raC_Dvc_K5100_MAG (v2)
132	Gear master count is out of range	_ERR_MasterCountsOutOfRange	raC_Dvc_K5100_MAG (v2)

Table 149 - Kinetix 5100 Drive Add-On Instruction Error Codes (Continued)

Error	Corrective Action or Cause	Macro Name	Used in Which Add-On Instruction
133	Gear ratio is out of range	_ERR_GearRatioOutOfRange	raC_Dvc_K5100_MAG (v2)
134	CAM Master Reference is out of range (0...4)	_ERR_MasterReferenceOutOfRange	raC_Dvc_K5100_MAPC
135	CAM Execution mode is out of range (0...1)	_ERR_ExecutionModeOutOfRange	raC_Dvc_K5100_MAPC
136	CAM Execution schedule is out of range (0...4)	_ERR_ExecutionScheduleOutOfRange	raC_Dvc_K5100_MAPC
137	CAM Master Leading counts are out of range (-1073741824...+1073741823	_ERR_MasterLeadingCountsOutOfRange	raC_Dvc_K5100_MAPC
138	CAM Master unlock counts are out of range (-1073741824...+1073741823)	_ERR_MasterUnlockCountsOutOfRange	raC_Dvc_K5100_MAPC
139	CAM Slave Scaling is out of range (-2147000000...+2147000000)	_ERR_SlaveScalingOutOfRange	raC_Dvc_K5100_MAPC

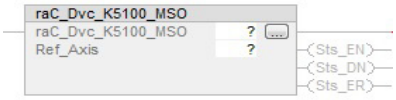
Add-On Instruction Details

This section provides details for each instruction.

raC_Dvc_K5100_MSO

Use the Motion Servo On (raC_Dvc_K5100_MSO) instruction to activate the drive amplifier for the specified axis and to activate the axis servo control loop.

Figure 226 - MSO Ladder Diagram



Operands

Operand	Type	Format	Description
Instance	raC_Dvc_K5100_MSO	Tag	Instance of raC_Dvc_K5100_MSO
Ref_Axis	raC_UDT_Dvc_K5100_Assm	Tag	Name of the axis to perform operation on

Mnemonic	Description
Sts_EN (Enable)	This bit is set when the rung makes a false-to-true transition and remains set until the servo message transaction is completed and the rung goes false.
Sts_DN (Done)	This bit is set when the axis servo action has been successfully enabled and the drive enable bit has been set.
Sts_ER (Error)	This bit is set to indicate that the instruction detected an error.

Description

The raC_Dvc_K5100_MSO instruction automatically enables the specified axis by activating the Kinetix 5100 drive and by activating the associated servo loop. The resulting state of the axis is referred to as Ref_Axis.Input.Active.

IMPORTANT The instruction execution can take multiple scans to execute because it requires multiple course updates to complete the request. The Done (Sts_DN) bit is not set immediately, but only after the request is completed.

In this transitional instruction, the relay ladder, toggle the Rung-condition-in from cleared to set each time that the instruction executes.

Execution

Condition/State	Action Taken
Prescan	The Sts_EN, Sts_DN, Sts_ER and Ref_Axis.Output_IO.ServoOn are cleared to false.
Rung-condition-in is false	The Sts_EN bit is cleared to false if the Sts_DN or Sts_ER bit is true.
Rung-condition-in is true	The Sts_EN bit is set to true and the instruction executes. If the EN bit is set to false, there is no action taken,
Postscan	–

Error Codes

- 100 - Kinetix 5100 drive is not ready
- 101 - Kinetix 5100 drive is faulted
- 102 - Another raC_Dvc_K5100_MSO message is executing
- 103 - raC_Dvc_K5100_MSF is executing
- 129 - Motor not connected

See Error Codes on page 464 for details.

raC_Dvc_K5100_MSF

Use the Motion Servo Off (raC_Dvc_K5100_MSF) instruction to deactivate the drive output for the specified axis and to deactivate the axis servo loop.

Figure 227 - MSF Ladder Diagram



Operands

Operand	Type	Format	Description
Instance	raC_Dvc_K5100_MSF	Tag	Instance of raC_Dvc_K5100_MSF
Ref_Axis	raC_UDT_Dvc_K5100_Assm	Tag	Name of the axis to perform operation on

Mnemonic	Description
Sts_EN (Enable)	This bit is set when the rung makes a false-to-true transition and remains set until the servo message transaction is completed and the rung goes false.
Sts_DN (Done)	This bit is set when the axis servo action has been successfully disabled and the drive enable bit have been cleared.
Sts_ER (Error)	This bit is set to indicate that the instruction detected an error.

Description

The raC_Dvc_K5100_MSF instruction directly and immediately turns off drive output and disables the servo loop on any physical servo axis. The resulting state of the axis is referred to as Ref_Axis.Input.Active.

IMPORTANT	The instruction execution can take multiple scans to execute because it requires multiple course updates to complete the request. The Done (Sts_DN) bit is not set immediately, but only after the request is completed.

In this transitional instruction, the relay ladder, toggle the Rung-condition-in from cleared to set each time that the instruction executes.

Execution

Condition	Ladder Diagram Action
Prescan	The Sts_EN, Sts_DN, Sts_ER and Ref_Axis.Output_IO.ServoOff bits are cleared. The rung-condition-out is set to false.
Rung-condition-in is false	The Sts_EN bit is cleared if the Sts_DN or Sts_ER bit is true.
Rung-condition-in is true	The Sts_EN bit is cleared to false if the Sts_DN or Sts_ER bit is true.
Postscan	–

Error Codes

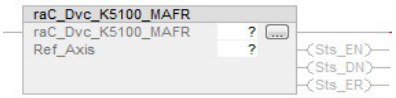
- 100 - Kinetix 5100 drive is not ready
- 101 - Kinetix 5100 drive is faulted
- 104 - Another raC_Dvc_K5100_MSF message is executing
- 129 - Motor not connected

See Error Codes on page 464 for details.

raC_Dvc_K5100_MAFR

Use the Motion Axis Fault Reset (raC_Dvc_K5100_MAFR) instruction to clear some motion faults for an axis. Other faults cannot be cleared until you power cycle the drive. The faults that are cleared by raC_Dvc_K5100_MAFR are listed in Fault list section.

Figure 228 - MAFR Ladder Diagram



Operands

Operand	Type	Format	Description
Instance	raC_Dvc_K5100_MAFR	Tag	Instance of raC_Dvc_K5100_MAFR
Ref_Axis	raC_UDT_Dvc_K5100_Assm	Tag	Name of the axis to perform operation on

Mnemonic	Description
Sts_EN (Enable)	This bit is set when the rung makes a false-to-true transition and remains set until the servo message transaction is completed and the rung goes false.
Sts_DN (Done)	This bit is set when fault clear has been executed.
Sts_ER (Error)	This bit is set to indicate that the instruction detected an error.

Description

The raC_Dvc_K5100_MAFR instruction directly clears fault status on the specified axis. It does not correct the condition that caused the error. If the condition is not corrected before executing this instruction, the axis could immediately fault again giving the appearance that the fault status was not reset.

This instruction is most commonly used as part of a fault handler program. Once the appropriate fault action is taken, the raC_Dvc_K5100_MAFR instruction is used to clear some motion faults for an axis. Other faults cannot be cleared until you power cycle the drive.

IMPORTANT The instruction execution can take multiple scans to execute because it requires multiple course updates to complete the request. The Done (Sts_DN) bit is not set immediately, but only after the request is completed.

In this transitional instruction, the relay ladder, toggle the Rung-condition-in from cleared to set each time that the instruction executes.

Execution

Condition/State	Action Taken
Prescan	The Sts_EN, Sts_DN, and Sts_ER bits are cleared. The rung-condition-out is set to false.
Rung-condition-in is false	The Sts_EN bit is cleared if the Sts_DN or Sts_ER bit is true.
Rung-condition-in is true	The Sts_EN bit is cleared to false if the Sts_DN or Sts_ER bit is true.
Postscan	–

Error Codes

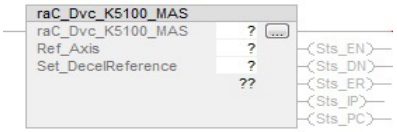
- 100 - Kinetix 5100 drive is not ready
- 106 - Another raC_Dvc_K5100_MAFR message is executing

See Error Codes on page 464 for details.

raC_Dvc_K5100_MAS

Use the Motion Axis Stop (raC_Dvc_K5100_MAS) instruction to stop a specific motion process on an axis or to stop the axis completely.

Figure 229 - MAS Ladder Diagram



Operands

Operand	Type	Format	Description
Instance	raC_Dvc_K5100_MAS	Tag	Instance of raC_Dvc_K5100_MAS
Ref_Axis	raC_UDT_Dvc_K5100_Assm	Tag	Name of the axis to perform operation on
Set_DecelReference	DINT	Tag	The Deceleration Rate in 0.1 RPM/s for rotary motor. Range: 458...30,000,000

Mnemonic	Description
Sts_EN (Enable)	This bit is set when the rung makes a false-to-true transition and remains set until the servo message transaction is completed and the rung goes false.
Sts_DN (Done)	This bit is set when the stop process is initiated.
Sts_ER (Error)	This bit is set to indicate that the instruction detected an error.
Sts_IP (In Progress)	This bit is to indicate that the operation is in progress.
Sts_PC (Process Completed)	This bit is set to indicate that the process is completed (axis is stopped).

Description

Use the raC_Dvc_K5100_MAS instruction when you want a decelerated stop for any controlled motion in process for the axis. The instruction stops the motion without disabling the servo loop. Use the instruction to do the following:

- Stop a specific motion process such as jogging, moving, gearing, indexing, or outputting a torque.
- Stop the axis completely.

Execution

Condition/State	Action Taken
Prescan	The Sts_EN, Sts_DN, Sts_ER Sts_IP, Sts_PC, and Ref_Axis.Output_IO.StopMotion bits are cleared. The rung-condition-out is set to false.
Rung-condition-in is false	The Sts_EN bit is cleared if the Sts_DN or Sts_ER bit is true.
Rung-condition-in is true	The Sts_EN bit is cleared to false if the Sts_DN or Sts_ER bit is true.
Postscan	–

Error Codes

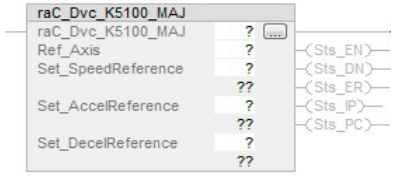
- 100 - Kinetix 5100 drive is not ready
- 101 - Kinetix 5100 drive is faulted
- 103 - MSF is executing
- 105 - Drive is disabled
- 107 - Another raC_Dvc_K5100_MAS message is executing
- 113 - Decel_Rate is out of range
- 129 - Motor is not connected to drive

See Error Codes on page 464 for details.

raC_Dvc_K5100_MAJ

Use the Motion Axis Jog (MAJ) instruction to move an axis at a constant speed without regard to position.

Figure 230 - MAJ Ladder Diagram



Operands

Operand	Type	Format	Description
Instance	raC_Dvc_K5100_MAJ	Tag	Instance of raC_Dvc_K5100_MAJ
Ref_Axis	raC_UDT_Dvc_K5100_Assm	Tag	Name of the axis to jog
Set_SpeedReference	DINT	Immediate or Tag	Speed to move the axis in 0.1 RPM for rotary motor. Range: -80,000...+80,000
Set_AccelReference	DINT	Immediate or Tag	Acceleration rate in 0.1 RPM/s for rotary. Range: 458...30,000,000
Set_DecelReference	DINT	Immediate or Tag	Deceleration rate in 0.1 RPM/s for rotary motor. Range: 458...30,000,000

Mnemonic	Description
Sts_EN (Enable)	This bit is set when the rung makes a false to true transition. The EN bit stays set until the process is complete and the rung goes false.
Sts_DN (Done)	This bit is set when the jog command is successfully initiated.
Sts_ER (Error)	This bit is set to indicate that the instruction detected an error.
Sts_IP (In Process)	This bit is set when the axis is jogging.
Sts_PC (Process Complete)	This bit is set when the axis has reached the target speed.

Description

Use the MAJ instruction to move an axis at a constant speed without regard to position.

Guidelines	Details
In the ladder diagram, toggle the rung condition each time you want to execute the instruction.	This instruction is transitional: In ladder diagram, toggle the rung-condition-in from cleared to set each time you want to execute the instruction.
Use raC_Dvc_K5100_MAS instruction to stop the jog.	

Execution

Condition/State	Action Taken
Prescan	The Sts_EN, Sts_DN, Sts_ER, Sts_IP, Sts_PC bits and Ref_Axis.Output_IO.StartMotion are cleared. The rung-condition-out is set to false.
Rung-condition-in is false	The Sts_EN bit is cleared if the Sts_DN or Sts_ER bit is true.
Rung-condition-in is true	The Sts_EN bit is cleared to false if the Sts_DN or Sts_ER bit is true.
Postscan	–

Error Codes

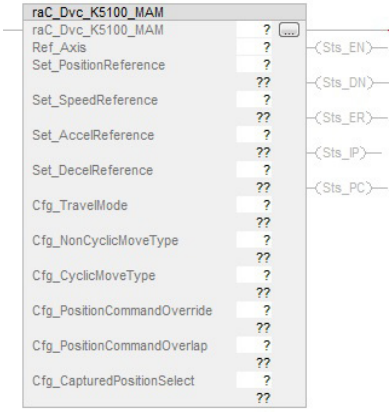
- 100 - Kinetix 5100 drive is not ready
- 101 - Kinetix 5100 drive is faulted
- 103 - raC_Dvc_K5100_MSF is running
- 105 - Drive is disabled
- 107 - raC_Dvc_K5100_MAS is executing
- 108 - Other RA motion Add-On Instruction is sending the command
- 111 - Input speed is out of range
- 112 - Accel_rate is out of range
- 113 - Decel_rate is out of range
- 129 - Motor is not connected to drive

See Error Codes on page 464 for details.

raC_Dvc_K5100_MAM

Use the Motion Axis Move (raC_Dvc_K5100_MAM) instruction to move an axis to a specified position.

Figure 231 - MAM Ladder Diagram



Operands

Operand	Type	Format	Description
Instance	raC_Dvc_K5100_MAM	Tag	Instance of raC_Dvc_K5100_MAM
Ref_Axis	raC_UDT_Dvc_K5100_Assm	Tag	Name of the axis to perform operation on
Set_PositionReference	DINT	Immediate or Tag	Position Reference (PUU) Range: -2,147,483,648...+2,147,483,647
Set_SpeedReference	DINT	Immediate or Tag	Speed to move the axis in 0.1 RPM for rotary motor. Range: -80,000...+80,000
Set_AccelReference	DINT	Immediate or Tag	Acceleration Rate for the Axis to move in 0.1 RPM/s for rotary. Range: 458...30,000,000
Set_DecelReference	DINT	Immediate or Tag	Deceleration Rate for the Axis to move in 0.1 RPM/s for rotary. Range: 458 ...30,000,000
Cfg_TravelMode	USINT	Tag	2 (0b0010) - NonCyclic Move Type 10 (0b1010) - Cyclic Move Type
Cfg_NonCyclicMoveType	USINT	Tag	This operand is effective only when the Cfg_TravelMode = 0b0010 00- absolute positioning 01- relative positioning 10- incremental positioning 11- high-speed position capturing
Cfg_CapturedPositionSelect	BOOL	Tag	This operand is effective only when the Cfg_TravelMode = 0b0010 and Cfg_NonCyclicMoveType = 0b11 0 - DI9 1 - DI10
Cfg_CyclicMoveType	USINT	Tag	This operand is effective only when the Cfg_TravelMode = 0b1010 00 - Rotary Positive 01 - Rotary Negative 10 - Rotary shortest path
Cfg_PositionCommandOverride	BOOL	Tag	0 - NA 1 - When executing this movement, it interrupts previous movement
Cfg_PositionCommandOverlap	BOOL	Tag	0 - NA 1 - Current movement can be overlapped by the next movement

Mnemonic	Description
Sts_EN (Enable)	This bit is set when the rung makes a false-to-true transition and remains set until the process is completed and the rung goes false.
Sts_DN (Done)	The move was successfully initiated.
Sts_ER (Error)	This bit is set to indicate that the instruction detected an error.
Sts_IP (In Progress)	The axis is moving to the end position.
Sts_PC (Process Completed)	The axis is at the end Position and remains set until the rung makes a false-to-true transition or if some other action stops the move before the axis gets to the end position.

Description

The raC_Dvc_K5100_MAM instruction moves an axis to either a specified absolute position or by a specified incremental distance. The raC_Dvc_K5100_MAM instruction can also produce other special types of moves.

Execution

Condition/State	Action Taken
Prescan	The Sts_EN, Sts_DN, Sts_ER, Sts_IP, Sts_PC bits and Ref_Axis.Output_IO.StartMotion are cleared. The rung-condition-out is set to false.
Rung-condition-in is false	The Sts_EN bit is cleared if the Sts_DN or Sts_ER bit is true.
Rung-condition-in is true	The Sts_EN bit is cleared to false if the Sts_DN or Sts_ER bit is true.
Postscan	–

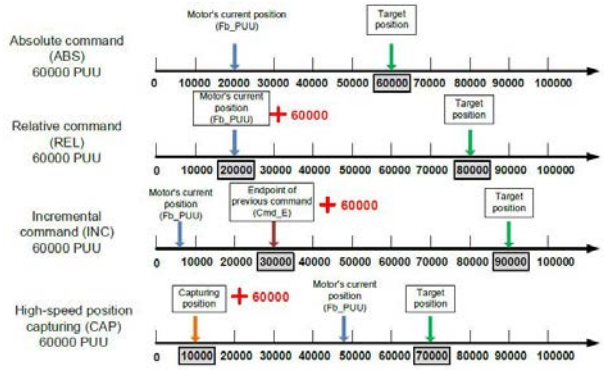
Error Codes

- 100 - Kinetix 5100 drive is not ready
- 101 - Kinetix 5100 drive is faulted
- 103 - MSF is executing
- 105 - Drive is disabled
- 107 - raC_Dvc_K5100_MAS is executing
- 108 - Other RA motion Add-On Instruction is sending the command
- 112 - AccelReference is out of range
- 113 - DecelReference is out of range
- 111 - SpeedReference is out of range
- 117 - NonCyclicMoveType is out of range
- 118 - CyclicMoveType is out of range
- 119 - TravelMode is out of range
- 126 - Homing not completed
- 129 - Motor is not connected to drive

See Error Codes on page 464 for details.

See Also

- Positioning Operation (Cfg_Selection is set to 2 (0b0010)): Four types of move operations (Cfg_MoveType) are executed as shown.



- Positioning Operation (Cfg_Selection is set to 10 (0b1010)): Three types of move operations (Cfg_MoveMethod) are executed as shown.
  - Define 'Indexing Coordinate':

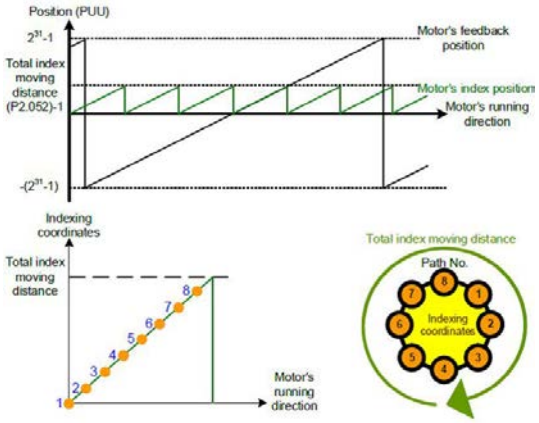


Figure 7.1.3.12 PR mode indexing coordinates

  - Rotate Positive or Rotate Negative or Rotate Shortest Path

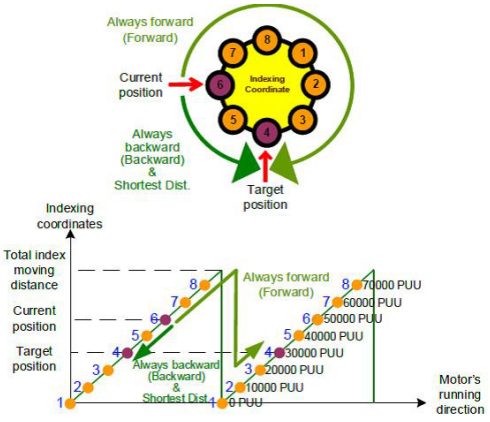
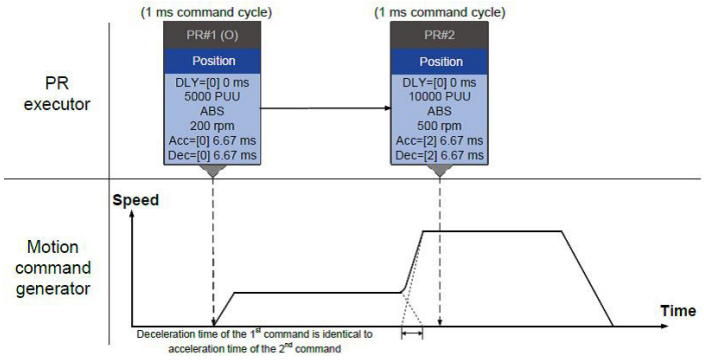
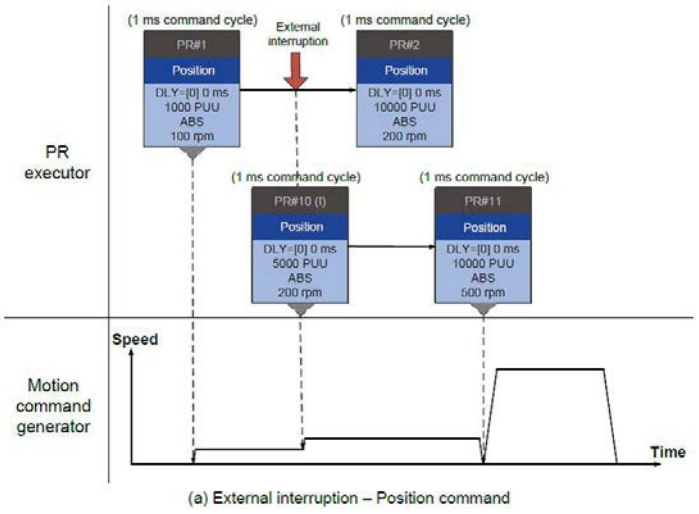


Figure 7.1.3.15 Motor's operation direction and indexing coordinates

- Position Command with Overlap option



- Position Command with Interrupt option



(a) External interruption – Position command

raC_Dvc_K5100_MAI

Use the Motion Axis Index (raC_Dvc_K5100_MAI) instruction to execute motion control by internal register (PR) in Kinetix 5100 drives. The 99 built-in command registers selects the PR command source.

Figure 232 - MAI Ladder Diagram



Operands

Operand	Type	Format	Description
Instance	raC_Dvc_K5100_MAI	Tag	Instance of raC_Dvc_K5100_MAI
Ref_Axis	raC_UDT_Dvc_K5100_Assm	Tag	Name of the axis to perform operation on.
Cfg_StartingIndex	USINT	Tag	The first index the drive SHOULD execute. Range: 1...99
Sts_ActiveIndex	USINT	Tag	The active index the drive executing.

Mnemonic	Description
Sts_EN (Enable)	This bit is set when the rung makes a false-to-true transition and remains set until the process is completed and the rung goes false.
Sts_DN (Done)	This bit is set when the command is issued successfully.
Sts_ER (Error)	This bit is set to indicate that the instruction detected an error.
Sts_IP (In Progress)	The axis is executing the index.
Sts_PC (Process Completed)	The index has been completed.

Description

Use the Motion Axis Index (raC_Dvc_K5100_MAI) instruction to execute motion control by internal register (PR) in Kinetix 5100 drives. The 99 built-in command registers selects the PR command source. See Chapter 11, Motion Control in PR Mode on page 251 for details.

Execution

Condition/State	Action Taken
Prescan	The Sts_EN, Sts_DN, Sts_ER, Sts_IP, Sts_PC bits and Ref_Axis.Output_IO.StartMotion are cleared. The rung-condition-out is set to false.
Rung-condition-in is false	The Sts_EN bit is cleared if the Sts_DN or Sts_ER bit is true.
Rung-condition-in is true	The Sts_EN bit is cleared to false if the Sts_DN or Sts_ER bit is true.
Postscan	–

Error Codes

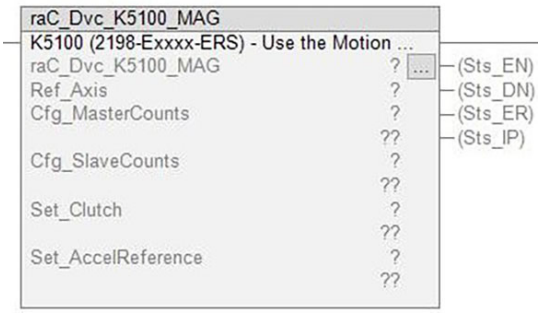
- 100 - Kinetix 5100 drive is not ready
- 101 - Kinetix 5100 drive is faulted
- 103 - MSF is executing
- 105 - Drive is disabled
- 107 - raC_Dvc_K5100_MAS is executing
- 108 - Other RA motion Add-On Instruction is sending the command
- 115 - StartingIndex is out of range
- 129 - Motor is not connected to drive

See Error Codes on page 464 for details.

raC_Dvc_K5100_MAG

Use the Motion Axis Gear (raC_Dvc_K5100_MAG) instruction to set the gear ratio between the PUU (Position of User Unit) and encoder counts on the fly (at drive servo on), and specify the acceleration rate during the gear ratio change for the position control in the Kinetix 5100 drive.

Figure 233 - MAG Ladder Diagram



Operands

Operand	Type	Format	Description
Instance	raC_Dvc_K5100_MAG	Tag	Instance of raC_Dvc_K5100_MAG
Ref_Axis	raC_UDT_Dvc_K5100_Assm	Tag	Name of the axis to perform operation on
Cfg_GearRatioSlaveCounts	DINT	Immediate or Tag	Set the value of ID151 (P1.044)
Cfg_GearRatioMasterCounts	DINT	Immediate or Tag	Set the value of ID152 (P1.045)
Set_Clutch	BOOL	Tag	When the clutch is enabled, motion control ramps up the slave axis to gearing speed at the instruction defined acceleration value. If not enabled, the slave axis immediately locks onto the master axis. If the master axis is currently moving, this condition results in an abrupt uncontrolled acceleration event of the slave axis, which can cause the axis to fault. Select either: 0 = enabled 1 = disabled
Set_AccelReference	DINT	Immediate or Tag	Acceleration rate in 0.1 RPM/s for rotary motor.

Mnemonic	Description
Sts_EN (Enable)	This bit is set when the rung makes a false-to-true transition and remains set until the process is completed and the rung goes false.
Sts_DN (Done)	This bit is set when the axis gear has been successfully initiated.
Sts_ER (Error)	This bit is set to indicate that the instruction detected an error.
Sts_IP (In Progress)	This bit is set when the axis is accepting the external pulse input and cleared if terminated by a stop command or servo fault.

Description

The raC_Dvc_K5100_MAG instruction works similar as the PT mode of standalone mode, where it accepts the external pulse input and rotates the motor. The gear ratio defines the relationship between the external pulse and encoder counts. You can set the gear ratio while in operation when the drive is servo on. You can use DI.INHP to inhibit the external pulse.

Execution

Condition/State	Action Taken
Prescan	The Sts_EN, Sts_DN, Sts_ER, Sts_IP bits and Ref_Axis.Output_IO.StartMotion are cleared. The rung-condition-out is set to false.
Rung-condition-in is false	The Sts_EN bit is cleared if the Sts_DN or Sts_ER bit is true.
Rung-condition-in is true	The Sts_EN bit is cleared to false if the Sts_DN or Sts_ER bit is true.
Postscan	–

Error Codes

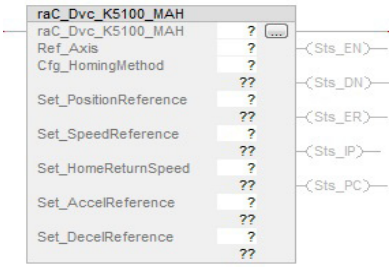
- 100 - Kinetix 5100 drive is not ready
- 101 - Kinetix 5100 drive is faulted
- 103 - MSF is executing
- 105 - Drive is disabled
- 107 - raC_Dvc_K5100_MAS is executing
- 108 - Other RA motion Add-On Instruction is sending the command
- 129 - Motor is not connected to drive
- 131 - Slave count is out of range 1 to (2^{29}...1)
- 132 - Master counts is out of range 1 to (2^{31}...1)
- 133 - Gear ratio is out of range (262144...1)

See Error Codes on page 464 for details.

raC_Dvc_K5100_MAH

Use the Motion Axis Home (raC_Dvc_K5100_MAH) instruction to home an axis.

Figure 234 - MAH Ladder Diagram



Operands

Operand	Type	Format	Description
Instance	raC_Dvc_K5100_MAH	Tag	Instance of raC_Dvc_K5100_MAH
Ref_Axis	raC_UDT_Dvc_K5100_Assm	Tag	Name of the axis to perform operation on
Cfg_ HomingMethod	SINT	Tag	0 - Homing in forward direction and regard PL as homing origin, Return to Z pulse. 1 - Homing in forward direction and regard PL as homing origin, Go forward to Z pulse. 2 - Homing in forward direction and regard PL as homing origin, Do not look for Z pulse. 3 - Homing in reverse direction and regard NL as homing origin, Return to Z pulse. 4 - Homing in reverse direction and regard NL as homing origin, Go forward to Z pulse. 5 - Homing in reverse direction and regard NL as homing origin, Do not look for Z pulse. 6 - Homing in forward direction, ORG: OFF to ON as homing origin, Return to Z pulse, Shows error when encounter limit. 7 - Homing in forward direction, ORG: OFF to ON as homing origin, Return to Z pulse, Reverse direction when encounter limit. 8 - Homing in forward direction, ORG: OFF to ON as homing origin, Go forward to Z pulse, Shows error when encounter limit. 9 - Homing in forward direction, ORG: OFF to ON as homing origin, Go forward to Z pulse, Reverse direction when encounter limit. 10 - Homing in forward direction, ORG: OFF to ON as homing origin, Do not look for Z pulse, Shows error when encounter limit. 11 - Homing in forward direction, ORG: OFF to ON as homing origin, Do not look for Z pulse, Reverse direction when encounter limit. 12 - Homing in reverse direction, ORG: OFF to ON as homing origin, Return to Z pulse, Shows error when encounter limit. 13 - Homing in reverse direction, ORG: OFF to ON as homing origin, Return to Z pulse, Reverse direction when encounter limit. 14 - Homing in reverse direction, ORG: OFF to ON as homing origin, Go forward to Z pulse, Shows error when encounter limit. 15 - Homing in reverse direction, ORG: OFF to ON as homing origin, Go forward to Z pulse, Reverse direction when encounter limit. 16 - Homing in reverse direction, ORG: OFF to ON as homing origin, Do not look for Z pulse, Shows error when encounter limit. 17 - Homing in reverse direction, ORG: OFF to ON as homing origin, Do not look for Z pulse, Reverse direction when encounter limit.
Cfg_ HomingMethod (continued)	SINT	Tag	18 - Look for Z pulse in forward direction and regard it as homing origin, Shows error when encounter limit. 19 - Look for Z pulse in forward direction and regard it as homing origin, Reverse direction when encounter limit. 20 - Look for Z pulse in reverse direction and regard it as homing origin, Shows error when encounter limit. 21 - Look for Z pulse in reverse direction and regard it as homing origin, Reverse direction when encounter limit. 22 - Homing in forward direction, ORG: ON to OFF as homing origin, Return to Z pulse, Shows error when encounter limit. 23 - Homing in forward direction, ORG: ON to OFF as homing origin, Return to Z pulse, Reverse direction when encounter limit. 24 - Homing in forward direction, ORG: ON to OFF as homing origin, Go forward to Z pulse, Shows error when encounter limit. 25 - Homing in forward direction, ORG: ON to OFF as homing origin, Go forward to Z pulse, Reverse direction when encounter limit. 26 - Homing in forward direction, ORG: ON to OFF as homing origin, Do not look for Z pulse, Shows error when encounter limit. 27 - Homing in forward direction, ORG: ON to OFF as homing origin, Do not look for Z pulse, Reverse direction when encounter limit. 28 - Homing in reverse direction, ORG: ON to OFF as homing origin, Return to Z pulse, Shows error when encounter limit. 29 - Homing in reverse direction, ORG: ON to OFF as homing origin, Return to Z pulse, Reverse direction when encounter limit. 30 - Homing in reverse direction, ORG: ON to OFF as homing origin, Go forward to Z pulse, Shows error when encounter limit. 31 - Homing in reverse direction, ORG: ON to OFF as homing origin, Go forward to Z pulse, Reverse direction when encounter limit. 32 - Homing in reverse direction, ORG: ON to OFF as homing origin, Do not look for Z pulse, Shows error when encounter limit. 33 - Homing in reverse direction, ORG: ON to OFF as homing origin, Do not look for Z pulse, Reverse direction when encounter limit. 34 - Define current position as the origin. 35 - Look for the collision point in forward direction and regard it as the origin, Return to Z pulse. 36 - Look for the collision point in forward direction and regard it as the origin, Do not look for Z pulse. 37 - Look for the collision point in reverse direction and regard it as the origin, Return to Z pulse. 38 - Look for the collision point in reverse direction and regard it as the origin, Do not look for Z pulse.
Set_ PositionReference	DINT	Tag	The home position when a homing procedure is completed Range: -2,147,483,648...+2,147,483,647
Set_ SpeedReference	DINT	Tag	First speed setting of high speed. Its unit is 0.1 RPM for rotary motor. Range: 1...20,000

Operand	Type	Format	Description
Set_ HomeReturnSpeed	DINT	Tag	Second speed setting of low speed homing. Its unit is 0.1 RPM for rotary motor. Range: 1...5000
Set_AccelReference	DINT	Tag	Its unit is 0.1 RPM/s for rotary motor. Range: 458...30,000,000
Set_DecelReference	DINT	Tag	Its unit is 0.1 RPM/s for rotary motor. Range: 458 ...30,000,000

Mnemonic	Description
Sts_EN (Enable)	This bit is set when the rung makes a false to true transition. The EN bit stays set until the process is complete and the rung goes false.
Sts_DN (Done)	This bit is set when the Home command is successfully initiated.
Sts_ER (Error)	This bit is set to indicate that the instruction detected an error.
Sts_IP (In Process)	This bit is set when the Home command is successfully initiated.
Sts_PC(Process Complete)	This bit is set when axis home is successfully completed.(If Input.HomeCompleted == TRUE).

Description

The raC_Dvc_K5100_MAH instruction is used to calibrate the absolute position of the specified axis.

Execution

Condition/State	Action Taken
Prescan	The Sts_EN, Sts_DN, Sts_ER, Sts_IP, Sts_PC bits and Ref_Axis.Output_IO.StartMotion are cleared. The rung-condition-out is set to false.
Rung-condition-in is false	The Sts_EN bit is cleared if the Sts_DN or Sts_ER bit is true.
Rung-condition-in is true	The Sts_EN bit is cleared to false if the Sts_DN or Sts_ER bit is true.
Postscan	–

Error Codes

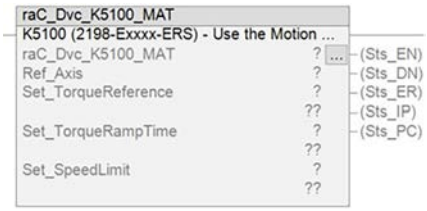
- 100 - Kinetix 5100 drive is not ready
- 101 - Kinetix 5100 drive is faulted
- 103 - raC_Dvc_K5100_MSF is running
- 105 - Drive is disabled
- 107 - raC_Dvc_K5100_MAS is executing
- 108 - Other RA motion Add-On Instruction is sending the command
- 111 - SpeedReference is out of range
- 112 - AccelReference is out of range
- 113 - DecelReference is out of range
- 122 - HomingMethod is out of range
- 129 - Motor is not connected to drive

See Error Codes on page 464 for details.

raC_Dvc_K5100_MAT

Use the Motion Axis Torque (raC_Dvc_K5100_MAT) instruction to move an axis at a constant torque with the speed limit.

Figure 235 - MAT Ladder Diagram



Operands

Operand	Type	Format	Description
Instance	raC_Dvc_K5100_MAT	Tag	Instance of raC_Dvc_K5100_MAT
Ref_Axis	raC_UDT_Dvc_K5100_Assm	Tag	Name of the axis to perform operation on
Set_TorqueReference	DINT	Immediate or Tag	Torque Reference, in the unit of 0.1% of the motor rated torque, Range: -4000...+4000
Set_TorqueRampTime	DINT	Immediate or Tag	Torque Ramp Time, the time it takes to ramp up from 0% to 100% rated torque, Range: 1...65500
Set_Speedlimit	DINT	Immediate or Tag	Speed limit during the torque: output, unit is 0.1 RPM for rotary motor. Range: -80,000...+80,000

Mnemonic	Description
Sts_EN (Enable)	This bit is set when the rung makes a false-to-true transition and remains set until the process is completed and the rung goes false.
Sts_DN (Done)	The torque command is successfully initiated.
Sts_ER (Error)	This bit is set to indicate that the instruction detected an error.
Sts_IP (In Progress)	The axis is outputting the torque.
Sts_PC (Process Completed)	The output torque has reached the torque.

Description

Use the Motion Axis Torque (raC_Dvc_K5100_MAT) instruction to move an axis at a constant torque without regard to position or speed.

Table 150 - Programming Guidelines

Guidelines	Details
In ladder diagram, toggle the rung condition each time you want to execute the instruction.	This instruction is transitional: In ladder diagram, toggle the rung-condition-in from cleared to set each time you want to execute the instruction.
Use raC_Dvc_K5100_MAS instruction to stop the torque output.	

Execution

Condition/State	Action Taken
Prescan	The Sts_EN, Sts_DN, Sts_ER, Sts_IP, Sts_PC bits and Ref_Axis.Output_IO.StartMotion are cleared. The rung-condition-out is set to false.
Rung-condition-in is false	The Sts_EN bit is cleared if the Sts_DN or Sts_ER bit is true.
Rung-condition-in is true	The Sts_EN bit is cleared to false if the Sts_DN or Sts_ER bit is true.
Postscan	–

Error Codes

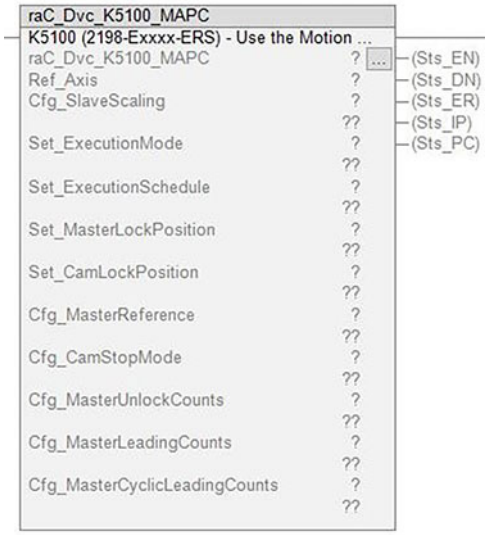
- 100 - Kinetix 5100 drive is not ready
- 101 - Kinetix 5100 drive is faulted
- 103 - raC_Dvc_K5100_MSF is executing
- 105 - Drive is disabled
- 107 - raC_Dvc_K5100_MAS is executing
- 108 - Other RA motion Add-On Instruction is sending the command
- 111 - Speed limit is > 80000 or < -80000
- 116 - TorqueReference is out of range
- 125 - TorqueRampTime is out of range
- 129 - Motor is not connected to drive

See Error Codes on page 464 for details.

raC_Dvc_K5100_MAPC

Use the Motion Axis Position Cam (MAPC) instruction to provides electronic camming according to the specified Cam Profile.

Figure 236 - MAPC Ladder Diagram



Operands

Operand	Type	Format	Description
Instance	raC_Dvc_K5100_MAT	Tag	Instance of raC_Dvc_K5100_MAT
Ref_Axis	raC_UDT_Dvc_K5100_Assm	Tag	Name of the axis to perform operation on
Cfg_SlaveScaling	SINT	Tag	Scales the total distance covered by the slave axis through the cam profile.
Set_ExecutionMode	SINT	Tag	Selects the method used to execute the cam profile. 0 = Immediate - The slave axis is immediately locked to the master axis and the position camming process begins. 1 = Reserved 2 = Forward only - the cam profile starts when the master position crosses the Master Lock Position in the forward direction. 3 = Reverse only - the cam profile starts when the master position crosses the Master Lock Position in the reverse direction. 4 = Shorteset Path - the cam profile starts when the master position crosses the Master Lock Position in the shortest path.
Set_ExecutionSchedule	SINT	Tag	Determines if the cam profile is executed only one time or repeatedly: 0 = Once - cam motion of slave axis is executed one time according to the value of CamMasterUnlockCounts, and then the Process Complete bit is set. 1 = Continuous - Once started the cam profile is executed indefinitely. This feature is useful in rotary applications where it is necessary that the cam position run continuously in a rotary or reciprocating fashion.

Operand	Type	Format	Description
Set_MasterLockPosition	DINT	Tag	This determines the master location where the slave axis locks to the mater axis.Valid only when CamExecutionSchedule = 2, 3, 4
Set_CamLockPosition	DINT	Tag	This determines the starting location in the cam profile.
Cfg_MasterReference	SINT	Tag	Sets the master position reference 0 - Reserved 1 - Auxiliary encoder 2 - Pulse Command (I/O terminal) 3 - Reserved 4 - Virtual Pulse from Timeline (1K Hz)
Cfg_CamStopMode	BOOL	Tag	Sets CAM stop mode 0 - stop immediately 1 - decelerate and stop
Cfg_CamMasterUnlockCounts	DINT	Tag	This determines the unlock counts (master axis) when the cam profile is executed. Valid only when CamExecutionMode = 0 (Once)
Cfg_CamMasterLeadingCounts	DINT	Tag	This determines the leading counts (master axis) before the cam profile is executed.
Cfg_MasterCyclicLeadingCounts	DINT	Tag	This determines the cyclic leading counts (master axis) during the cam profile is executed. Valid only when CamExecutionMode = 1 (Continous)

Mnemonic	Description
Sts_EN (Enable)	This bit is set when the rung makes a false-to-true transition and remains set until the process is completed and the rung goes false.
Sts_DN (Done)	The cam operation is successfully initiated.
Sts_ER (Error)	This bit is set to indicate that the instruction detected an error.
Sts_IP (In Progress)	It is set on positive rung transition and cleared if either superseded by another Motion Axis Position Cam command, or terminated by a stop command.
Sts_PC (Process Completed)	It is set when the position of the master axis leaves the master position range defined by the currently active cam profile if Execution Mode = Once.

Description

Use the Motion Axis Position Cam (MAPC) instruction to provides electronic camming according to the specified Cam Profile.

ID375 (P5.087) EcamLeadPulseBeforeEngaged is decided

- When CamExecutionSchedule is 0, skip CamMasterLockPosition, ID375 (P5.087) = CamMasterLeadingCounts.
- When CamExecutionSchedule is 2, if CamMasterLockPosition >= (P5.086), then ID375 (P5.087) = CamMasterLockPosition - ID374 (P5.086), otherwise ID375 (P5.087) = 0.
- When CamExecutionSchedule is 3, if CamMasterLockPosition <= ID374 (P5.086), then ID375 (P5.087) = CamMasterLockPosition - (P5.086), otherwise ID375 (P5.087) = 0.
- When CamExecutionSchedule is 4, ID375 (P5.087) = CamMasterLockPosition - ID374 (P5.086)

Table 151 - Programming Guidelines

Guidelines	Details
In ladder diagram, toggle the rung condition each time you want to execute the instruction.	This instruction is transitional: In ladder diagram, toggle the rung-condition-in from cleared to set each time you want to execute the instruction.
Use raC_Dvc_K5100_MAS instruction to stop the CAM operation.	

Execution

Condition/State	Action Taken
Prescan	The Sts_EN, Sts_DN, Sts_ER bits and Ref_Axis.Output_IO.StartMotion are cleared. The rung- condition-out is set to false.
Rung-condition-in is false	The Sts_EN bit is cleared if the Sts_DN or Sts_ER bit is true.
Rung-condition-in is true	The Sts_EN bit is cleared to false if the Sts_DN or Sts_ER bit is true.
Postscan	–

Error Codes

- 100 - Kinetix 5100 drive is not ready
- 101 - Kinetix 5100 drive is faulted
- 103 - raC_Dvc_K5100_MSF is executing
- 105 - Drive is disabled
- 107 - raC_Dvc_K5100_MAS is executing
- 108 - Other RA motion Add-On Instruction is sending the command
- 129 - Motor is not connected to drive
- 134 - Master reference is out of range
- 135 - Execution mode is out of range
- 136 - Execution schedule is out of range
- 137 - Master leading counts is out of range
- 138 - Master unlock counts is out of range
- 139 - Slave Scaling is out of range

Notes:

Full Closed Loop Control

Topic	Page
Full Closed-loop Control	488

The full closed-loop control can be useful when some level of compliance exists due to mechanical coupling between the motor and the load (like gear transmission or belt transmission). Due to the gear backlash or belt slip of mechanical transmission, it may cause the bigger position error/offset between the motor and the load if only the encoder of the motor end is used (even if the motor has high precision and fast response time).

The full closed-loop control function acts to reduce the position error/offset and improve the positioning accuracy.

IMPORTANT This function applies to PT: Position mode (terminal block input), PR: Position mode (register input), and I/O gear and position mode.

Figure 237 - Wiring Diagram

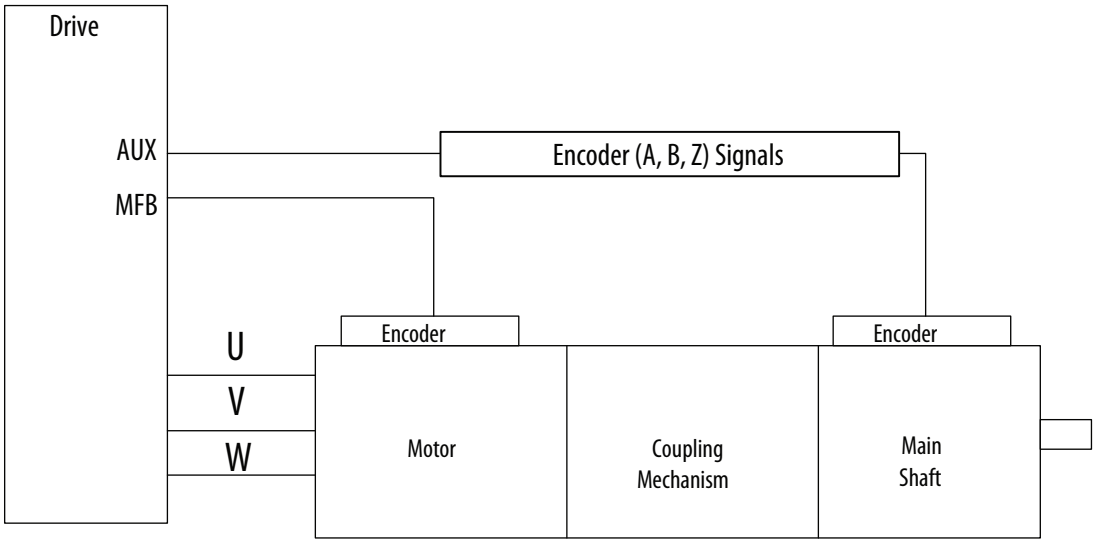
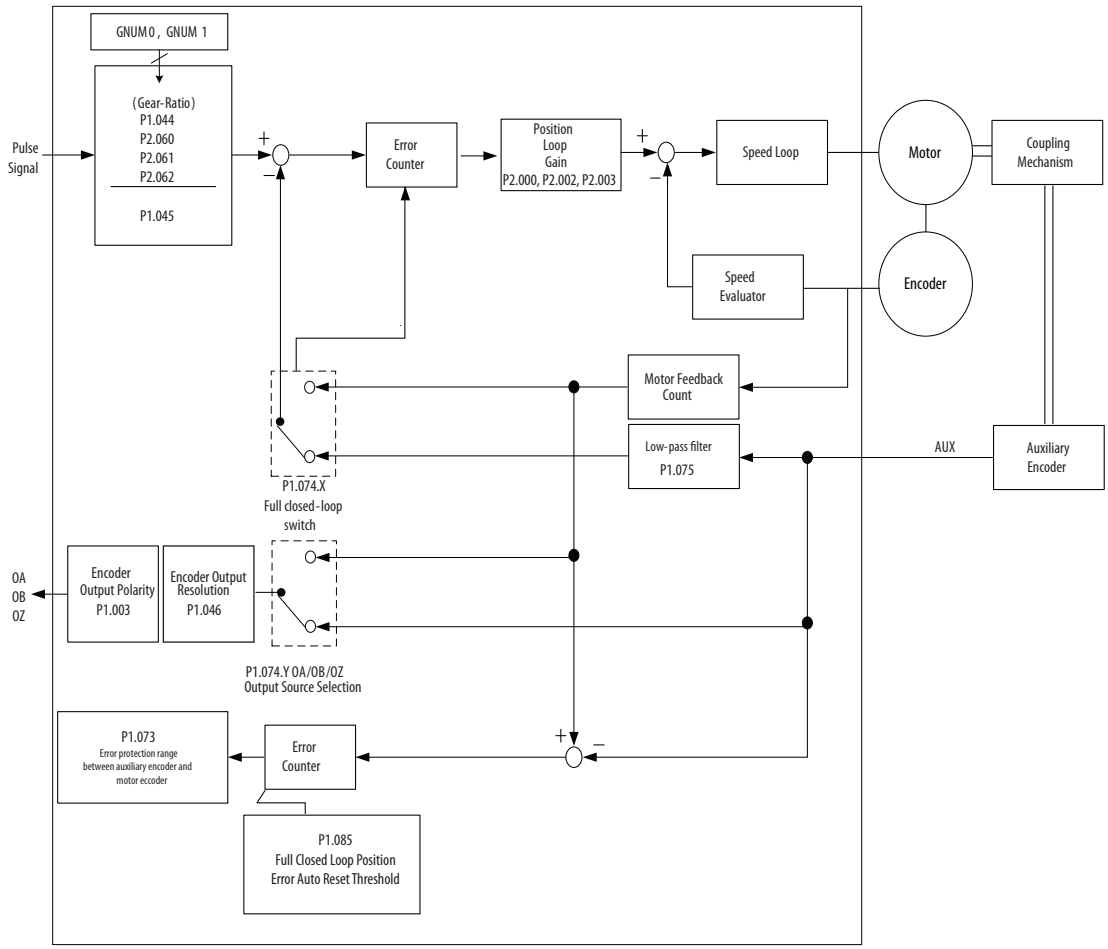


Figure 238 - Control Structure



Full Closed-loop Control

To execute the full closed-loop control, follow these steps.

1. To check wiring, connect auxiliary encoder (OA, OB, OZ) and AUX port to create full closed-loop.
2. Select the auxiliary encoder feedback polarity ID173 (P1.074.Z) FullClosedLoopControlConfiguration.
3. Configure the auxiliary encoder resolution ID171 (P1.072) AuxFeedbackResolution.
4. Set the appropriate gear ratio ID151 (P1.044), ID152 (P1.045).
5. Configure the error protection range between auxiliary encoder and motor encoder ID172 (P1.073) MotorAndAuxFeedbackErrorLimit.

   When commissioning, set (ID172 (P1.073)) with a smaller value to avoid the motor runaway due to auxiliary encoder disconnection or polarity configuration issue.
6. Configure Low-pass filter time constant ID174 (P1.075) FullHalfClosedLoopLowPassFilterTime.
7. Configure the error auto-reset condition ID677 (P1.085) FullClosedLoopPositionErrorAutoResetThreshold.
8. Configure encoder output parameters, if necessary ID119 (P1.003.Y), ID173 (P1.074.Y), ID153 (P1.046), ID175 (P1.076), ID179 (P1.097)).
9. Start full closed-loop control function ID173 (P1.074.X) FullClosedLoopControlConfiguration.

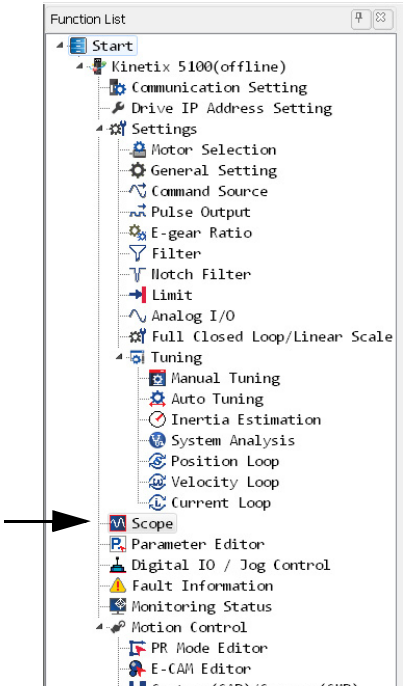
Use the Scope Function in KNX5100C Software

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Select Communication Channels	491
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Set Preferences	497
Use Popup Menu for Save Options	498

The Scope option provides you with a personal computer-based digital oscilloscope function for real-time monitoring. You can use two scope modes (8K and 16K) to measure and monitor many signals quickly without oscilloscope equipment.

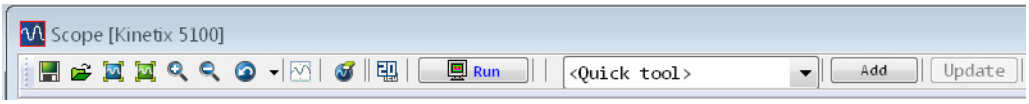
Get Started

To open the Scope dialog box, select Scope from the Function list.



Scope Functions

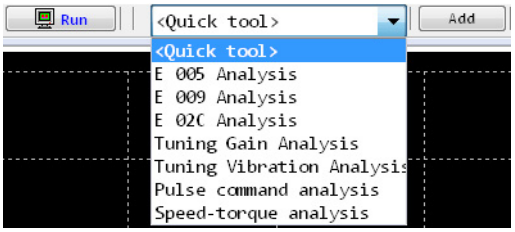
To execute Scope functions, click icons on the toolbar.



- Save File (*.scp): Save the waveform displays on the screen as a scope file (*.scp) or other files in several kinds of format.
- Open File (*.scp): Open and read the scope file (*.scp) and display the waveform displays on the screen.
- Show all channels with same scaling: Display the channel data with the same scaling/axis on the screen.
- Show all channels with different scaling: Display the channel data with different scaling/axis on the screen.
- Zoom in (F5). Zoom in to the waveform displays on the current screen.
- Zoom out (F6). Zoom out of the waveform displays on the current screen.
- Previous screen (F7). Display the previous screen.
- Optimize the current view: Optimize the display in the current screen.
- Clear Screen. Clear the waveform displays on the current screen.
- Screen second switch (20 <-> 120). It is used to select the data buffer (X-axis) that the screen can display one time. When selecting 20, it indicates that the screen can display 20 seconds of data buffer for one time.
- Run: start to execute the Scope.
- Quick tool: select the Quick Setup from the Quick tool template.
- Add: add the current channel setting to Quick tool template.
- Update: update the current channel setting to Quick tool template.
- Delete: delete the selected Quick Setup from Quick tool template.

Quick Setup of Communication Channels

Use the pull-down menu to select monitor option from Quick tool template and do the quick setup of Communication Channels.



- E005 Analysis - Quick setup for E005 (Regeneration Error) Analysis.
- E009 Analysis - Quick setup for E009 (Excessive deviation of Position Command) Analysis.
- E02C Analysis - Quick setup for E02C (Drive Overload) Analysis.
- Tuning Gain Analysis - Quick setup for Gain Analysis.
- Tuning Vibration Analysis - Quick setup for Vibration Analysis.
- Pulse command analysis - Quick setup for Pulse command analysis.
- Speed-torque Analysis - Quick setup for Speed-torque Analysis.

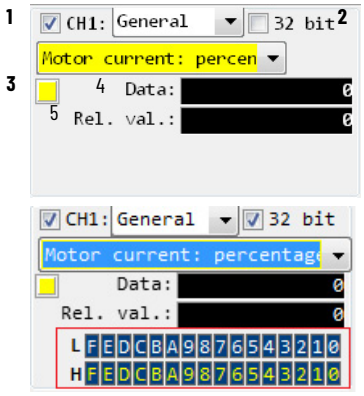
Select Communication Channels

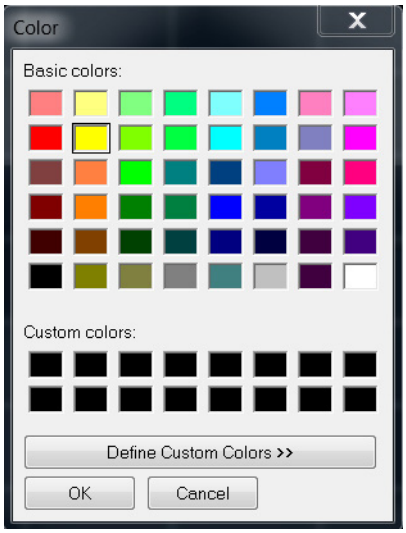
The scope speed determines the available channels. After you choose the communication speed, the system disables the unavailable channels automatically.

- CH (Channel) (1) - To display data on the screen, check the channel that you want to view.
- 32 bit (2) - This option is used to select the data length of the channel.
  - When the checkbox is checked, it indicates that it is a 32-bit data. At this time, two 16-bit data (the data of CH1 and CH3) is combined into a 32-bit data and CH3 is disabled. By the same logic, the data of CH2 and CH4 is combined into a 32-bit data channel and CH4 is disabled.
  - When the checkbox is not checked, it indicates it is 16-bit data. You can enable each channel.
- Color Selection (3) - You can choose the channel display color by preference. When you click, a color selection dialog box appears and you can choose your favorite color.
- Data (4) - If there is data on the screen, when you move your mouse over the data, the current data value of the point where the mouse is located is shown.

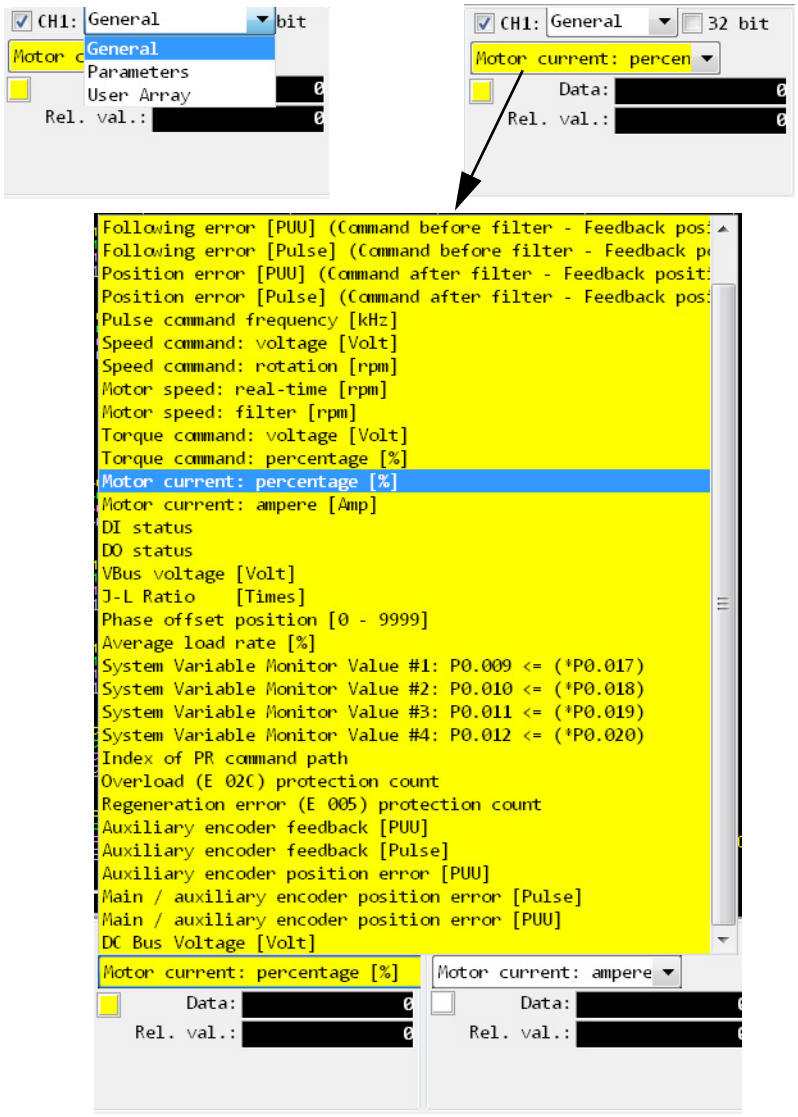
Double click the Data field to display the data with BIT or HEX format.

- Relative Value (Rel. val.) (5) - If there is data on the screen, when you move your mouse over the data, the data value relative to the value of the starting point is shown.

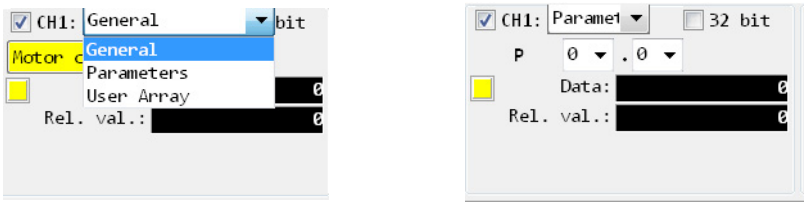




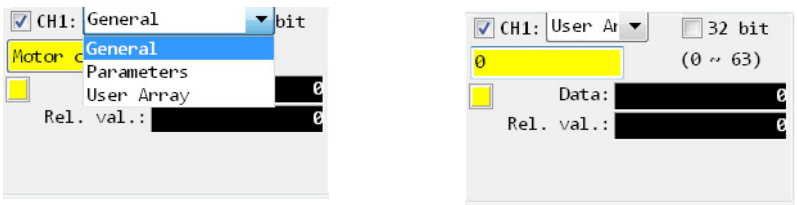
- General - From the pull-down menu, choose General. The General setting lets you choose what to monitor.



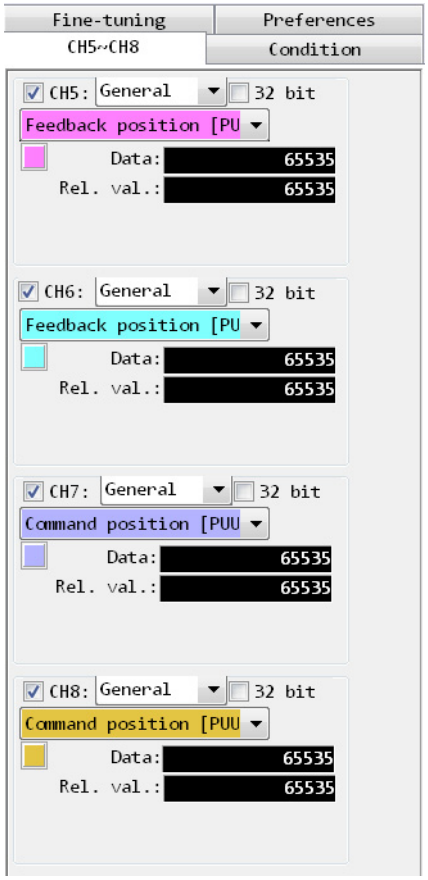
- Parameters - From the pull-down menu, choose Parameters.



- User Array - From the pull-down menu, choose User Array. Set the array between 0...63 for the array you want to monitor.

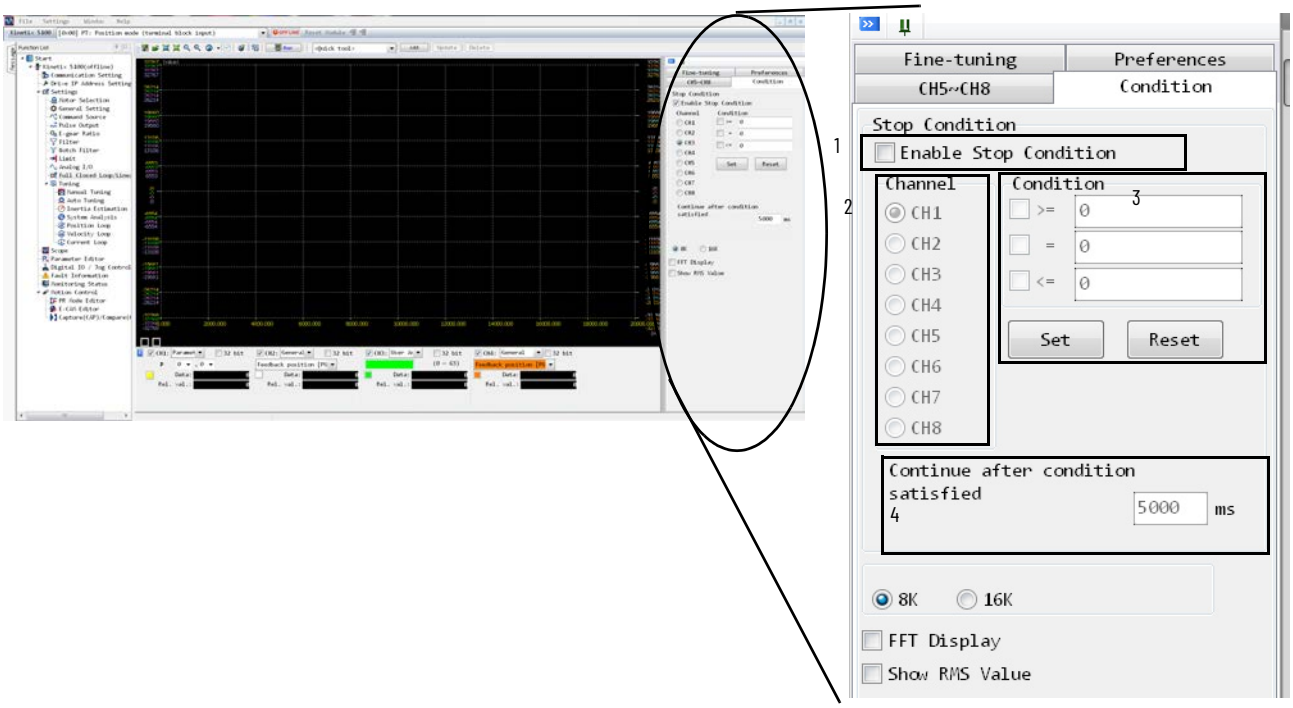


- CH 5…8: This function is only available for 8K baud-rate enabled. You can observe all eight channels of data. Channels 5…8 function just as Channels 1…4.



Enable Stop Condition

When Enable Stop Condition option is selected, after Run is pressed, you can select one channel and stop its monitoring operation after a period.



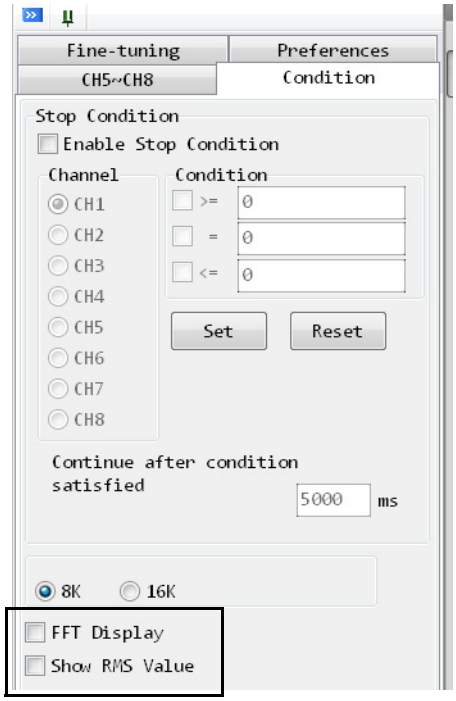
1. Check Enable Stop Condition.
2. Select the channel.
3. Select the logical condition (>=, =, and <=), add a value that determines the threshold for when the monitoring operation is to stop, and click Set.
4. Add a value for 'Continue after condition satisfied'.

   This option is used to set the time (lasting time) for which the digital scope collects data after the stop conditions are met.

   For example, select CH2, select '=' and set the value to 1000, then set the continue time to 2000 ms. Once the value reaches 1000, data is collected for another 2000 ms.

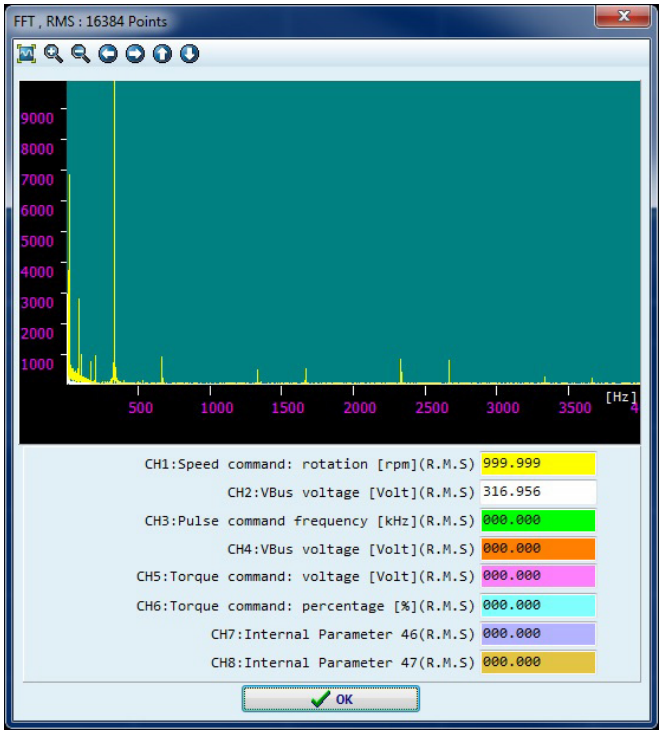
FFT Display and Show RMS Value

This option is used to display the frequency spectrum of the waveforms. From the Condition tab, you can select FFT Display and Show RMS Value.



When you check FFT Display, use the zoom in/zoom out tools or use the mouse to drag a rectangle area and drop it on the screen to display the frequency spectrum of the waveforms.

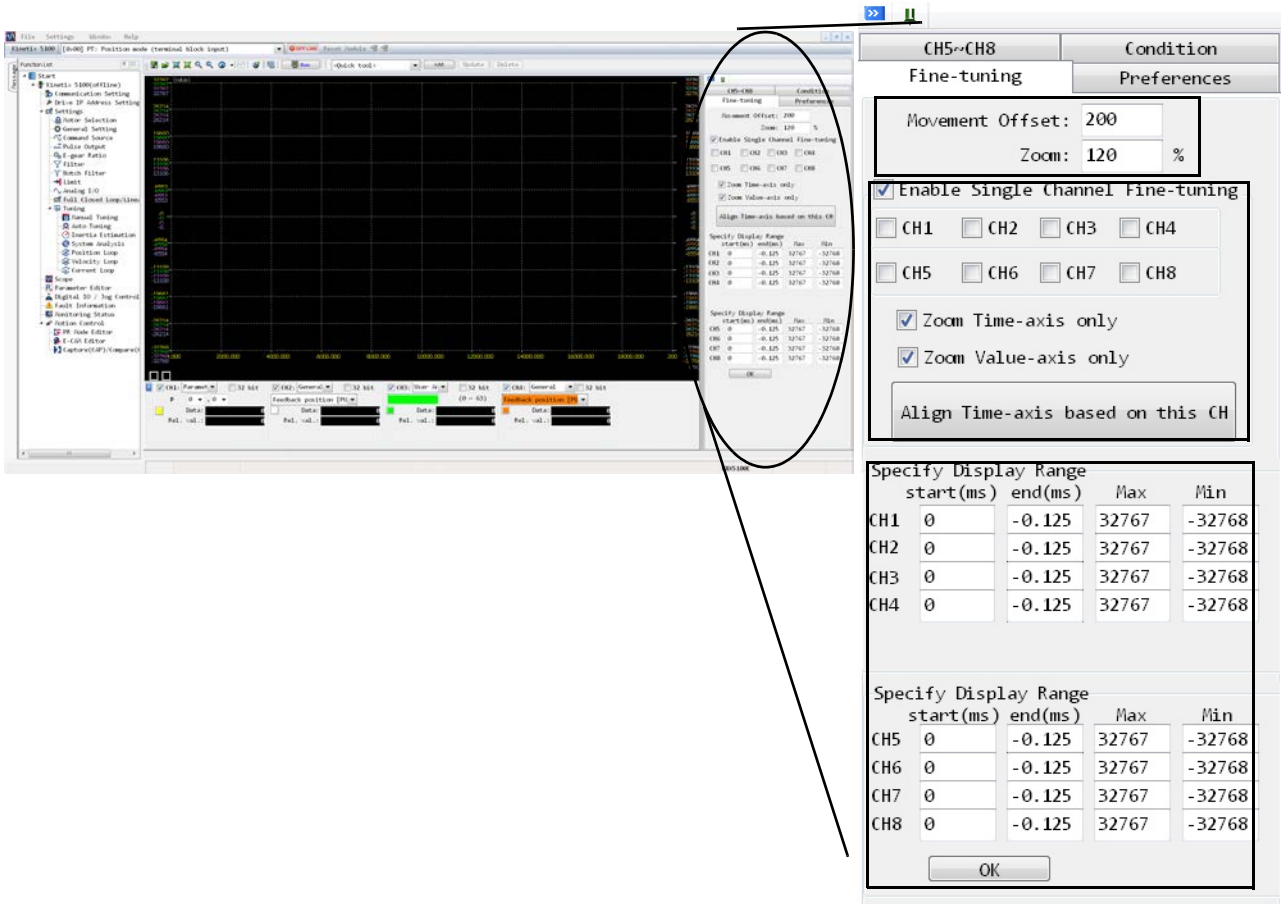
When you check Show RMS Value, the RMS value of each channel is also displayed.



- The X-axis represents the frequency and the unit is Hz.
- The Y-axis represents the strength of the signal, which has no absolute unit but is a relative value.
- The icons on the FFT Display toolbar function the same as the icons on the Scope toolbar.
- Double-click any point of the FFT Display screen and all points display.
- You can also use the mouse to drag a rectangle and drop it on the screen to display the frequency spectrum of the waveforms.
- The title bar of FFT Display window, such as FFT: 32768 Pts, indicates the data number of the selected area. The larger the number, the better the resolution (DPI™). We recommended a value of at least 512 or higher.
- The image of the FFT Display screen can also be saved as a picture (*.bmp file). Place the cursor on the FFT Display screen, right-click the mouse, and choose 'Save as picture (*.bmp)'.

Fine-Tune the Scope

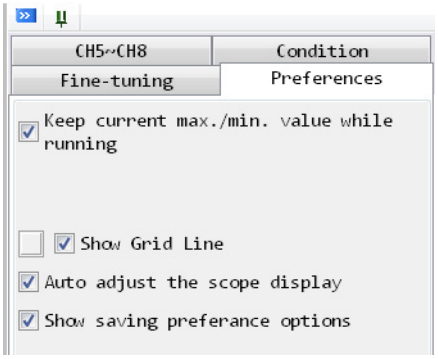
When the other functions cannot meet your requirements, you can enable the Fine-Tuning function.



- When the Enable Single Channel checkbox is checked, it indicates that Fine-Tuning function is enabled.
- When the Channel checkboxes are checked, only the waveform displays of the selected channels can be zoomed in/out and moved.
- When all Channel checkboxes are checked, the waveform displays of all channels can be zoomed in/out and moved.
- Zoom Time-axis only - If this option is not selected, the values of Time axis do not change when you zoom in/out and move the waveform displays.
- Zoom Value-axis only - If this option is not selected, the values of Value axis do not change when you zoom in/out and move the waveform displays.
- Align Time axis based on this CH - When this button is clicked, the system changes the time of other channels and make it the same as the time of the selected channel.
- Specify Display Range - The start and end values are the start and end points of the data. To convert these values into time, multiply by the time unit. For example:
  - Time unit is 0.125 ms
  - Start point is 100, therefore, 100 * 0.125 = 12.5 ms
  - Endpoint is 2000, therefore 2000 * 0.125 = 250 ms

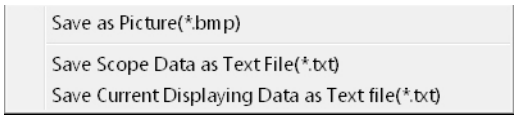
Set Preferences

- Keep current Max/Min while running - The scope remains the current Max/Min value after the user pressing RUN if this setting is checked. The system uses the default Max/Min value if this option is not checked.
- Show Grid Line - The scope screen shows the grid line when selecting this option. The square button on left is to select the color of the grid line.
- Auto adjust the scope display - The system adjusts the size of scope automatically according to screen resolution and selected condition.
- Show saving preference options - The options that appear when you right-click on the screen.



Use Popup Menu for Save Options

When you right-click the mouse on the screen, the following popup menu appears.

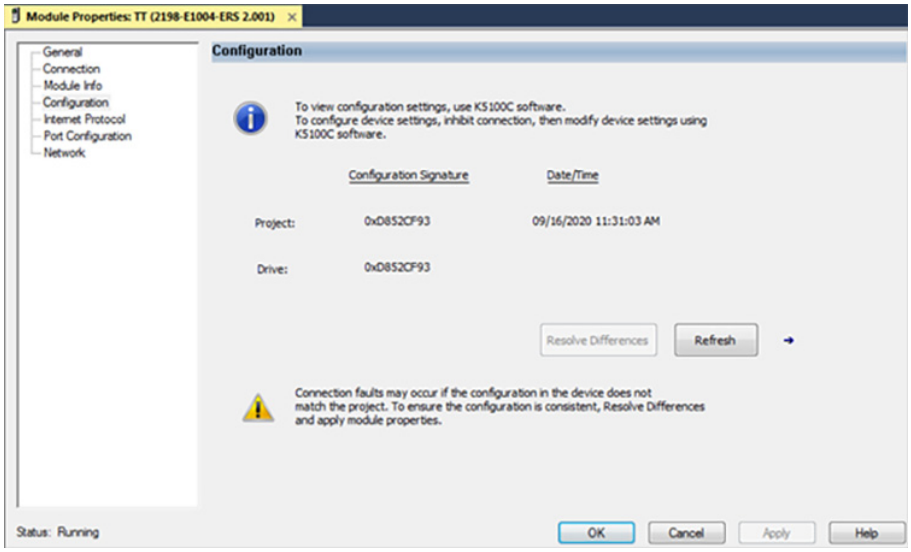


- Save as a picture(*.bmp) Save the signal data as a picture (*.bmp file).
- Save Scope Data as Text File (*.txt) Save all signal data as a text file (*.txt file).
- Save Data of Current Display as Text (*.txt) Save the signal data on the current display as a text file (*.txt file).

Automatic Device Configuration

Automatic Device Configuration (ADC) function is supported in Kinetix 5100 firmware revision 2 and later. You can download the configuration data from one Kinetix 5100 drive to another Kinetix 5100 drive through the ADC function. AOP version 2 and later adds the 'Configuration' page to resolve the difference between the configuration data stored in the controller and the Kinetix 5100 drive.

Figure 239 - Configuration Screen

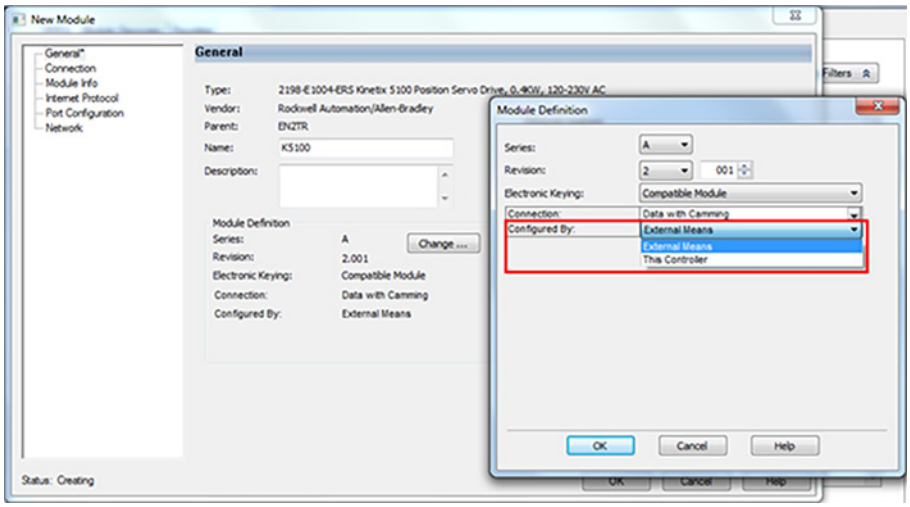


Get Started

Version 2 of the AOP and the Kinetix 5100 drive firmware lets you choose either ‘Configured By External Means’ or ‘Configured By This Controller’. When you choose ‘Configured By This Controller’, the controller delivers a K5100 configuration via a scripted connection.

While an I/O connection exists between the controller and the Kinetix 5100 drive, configuration of the Kinetix 5100 drive parameters is not permitted. An I/O connection is only established when the drive configuration and the controller configuration are kept in-sync. The ADC function is only supported for I/O mode when the control mode parameter ID 117 (P1.001) value is 0X0C.

Figure 240 - Module Configuration



The default configuration data in the AOP matches the data in the Kinetix 5100 drive after the following:

- reset the Kinetix 5100 drive parameters (write 30, 39 to ID193 (P2.008))
- connect the default motor and set the control mode to 0X0C

Table 152 shows the combination of drive and motor in default configuration data.

Table 152 - Drive and Motor Default

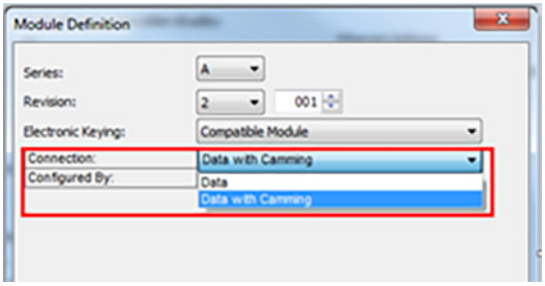
Drive Catalog Number	Motor Catalog Number
2198-E1004-ERS	TLP-A070-040
2198-E1007-ERS	TLP-A090-075
2198-E1015-ERS	TLP-A145-150
2198-E1020-ERS	TLP-A200-200
2198-E2030-ERS	TLP-A200-300
2198-E2055-ERS	TLP-A200-550
2198-E2075-ERS	TLP-A200-750
2198-E2150-ERS	TLP-A235-15K
2198-E4004-ERS	TLP-B070-040
2198-E4007-ERS	TLP-B090-075
2198-E4015-ERS	TLP-B145-150
2198-E4020-ERS	TLP-B145-200
2198-E4030-ERS	TLP-B200-300
2198-E4055-ERS	TLP-B200-550
2198-E4075-ERS	TLP-B200-750
2198-E4150-ERS	TLP-B235-14K

'Configured By External Means' lets you use external KNX5100C software to create the configuration and download it to the Kinetix 5100 drive via the Kinetix 5100 drive USB port.

The different values in the 'Connection' field determines the assembly output instance and motion function.

- Data with Camming in the AOP; configure assembly output instance 106; in the AOI folder, use the AOI with the name prefix 'rac_Dvc_' .
- Data in the AOP; configure assembly output instance 104; in the Version 1 folder, use AOI MAG, MAT, and structure AssemblyOutIOM; in the AOI folder, you can use any AOI other than MAPC

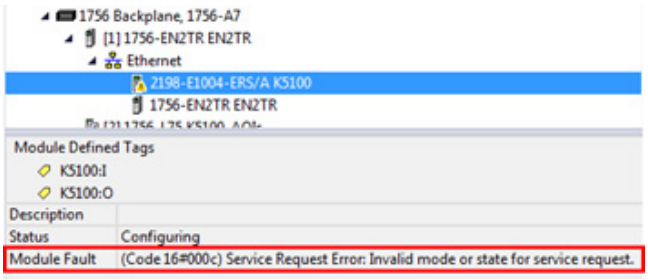
Figure 241 - Module Definition



Compare the Configuration Data

If the configuration data in the controller and the Kinetix 5100 drive are different, the I/O connection cannot be established. The Kinetix 5100 drive shows 0x0c Service Request Error: Invalid mode or state for service request.

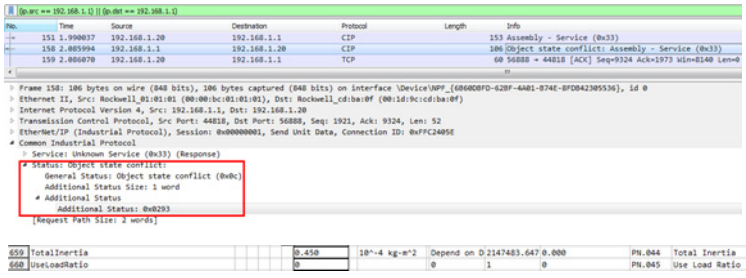
Figure 242 - Configuration Compare Error



The additional status of this error code identifies the root cause, which could be 0x1000 (the Kinetix 5100 drive has the newer configuration data than the data in the controller) or the specific parameter instance ID.

For example, in the packets recorded from Wireshark, the additional status is 0x293, which is the Inst 659 Total Inertia. The reason is that Inst 659 has different values in the controller and Kinetix 5100 drive. Inst 660, UseLoadRatio, is 0, which doesn't allow the controller to download the value of Inst 659 to the Kinetix 5100 drive.

Figure 243 - Object State Conflict

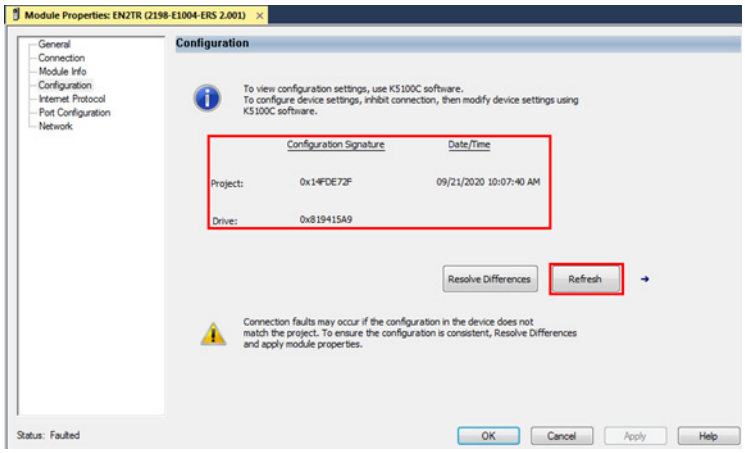


You can check the signature in the Configuration dialog box to determine whether the configuration data in the controller and the Kinetix 5100 drive are different. The signature and date/time in the controller are stored when one of the following occurs:

- The AOP is created
- When you click 'Upload' in the 'Resolve Differences' dialog box to upload the configuration data
- When you click 'Overwrite' in the 'Resolve Differences' dialog box

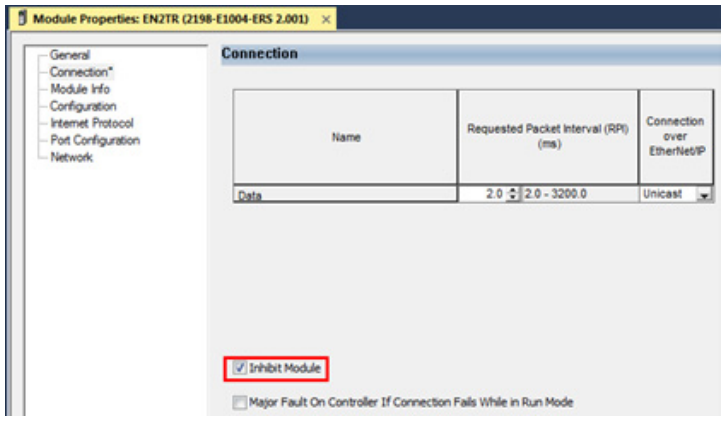
The signature of the drive is automatically read from the Kinetix 5100 drive when you click 'Refresh'. If the signature in the controller and the Kinetix 5100 drive are different, the I/O connection cannot be established.

Figure 244 - Configuration Signature



If the ADC function is enabled, KNX5100C software cannot be used until the I/O connection is established or the I/O connection is inhibited. To inhibit the I/O connection, check 'Inhibit Module' in the 'Connection' dialog box or disconnect the network cable from the Kinetix 5100 drive.

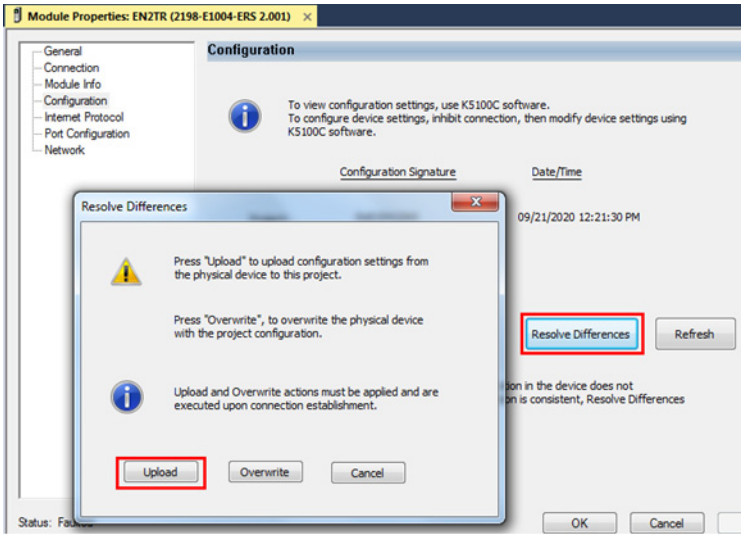
Figure 245 - Inhibit Module



Upload the Configuration Data

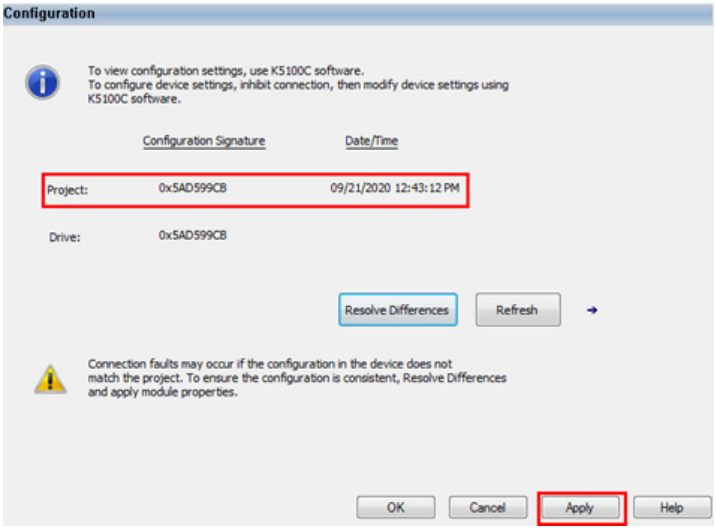
Click 'Upload' in the 'Resolve Differences' dialog box to upload the configuration data from the Kinetix 5100 drive and stored the data in the controller.

Figure 246 - Upload Configuration Data

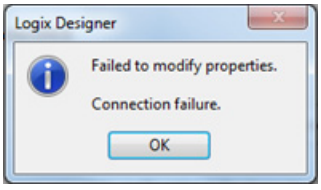


After the upload is complete, the Configuration Signature and Date/Time in the controller is updated. The Signature is the same as the one in the Drive, and the Date/Time is the time that Upload is clicked. After you click 'Apply', the Configuration data is saved in the controller and the controller establishes the I/O connection with the Kinetix 5100 drive.

Figure 247 - Apply Configuration Data



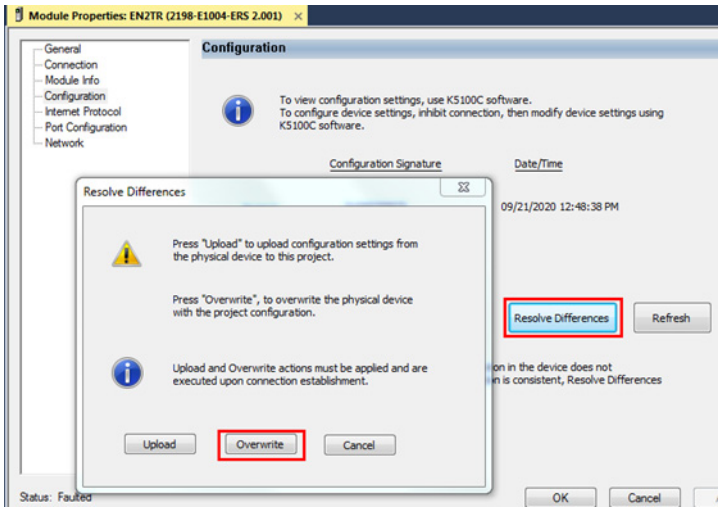
This message can occur when you click 'Apply'. Click OK and the I/O connection is established.



Overwrite the Configuration Data

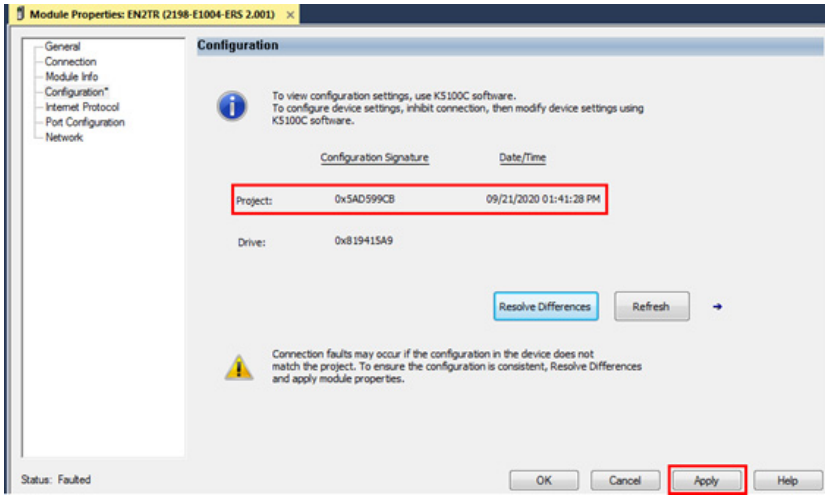
To overwrite the configuration data from the controller to the Kinetix 5100 drive, click 'Overwrite' in the 'Resolve Differences' dialog box.

Figure 248 - Overwrite the Configuration Data

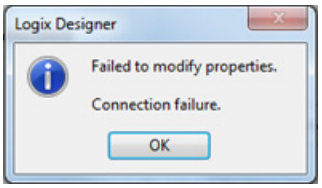


After you click 'Overwrite', the Date/Time of the configuration data is updated, which means the newer configuration data in the controller is created. After you click 'Apply', the Configuration data with the newer date in the controller is downloaded to the Kinetix 5100 drive. If all parameters are downloaded successfully, the Kinetix 5100 drive performs the power cycle automatically and the I/O connection is established.

Figure 249 - Apply Controller Configuration Data



This message can occur when you click 'Apply'. Click OK and the I/O connection is established.



Numerics

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2090-CxxM6Dx 12
2090-DANxx 12
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