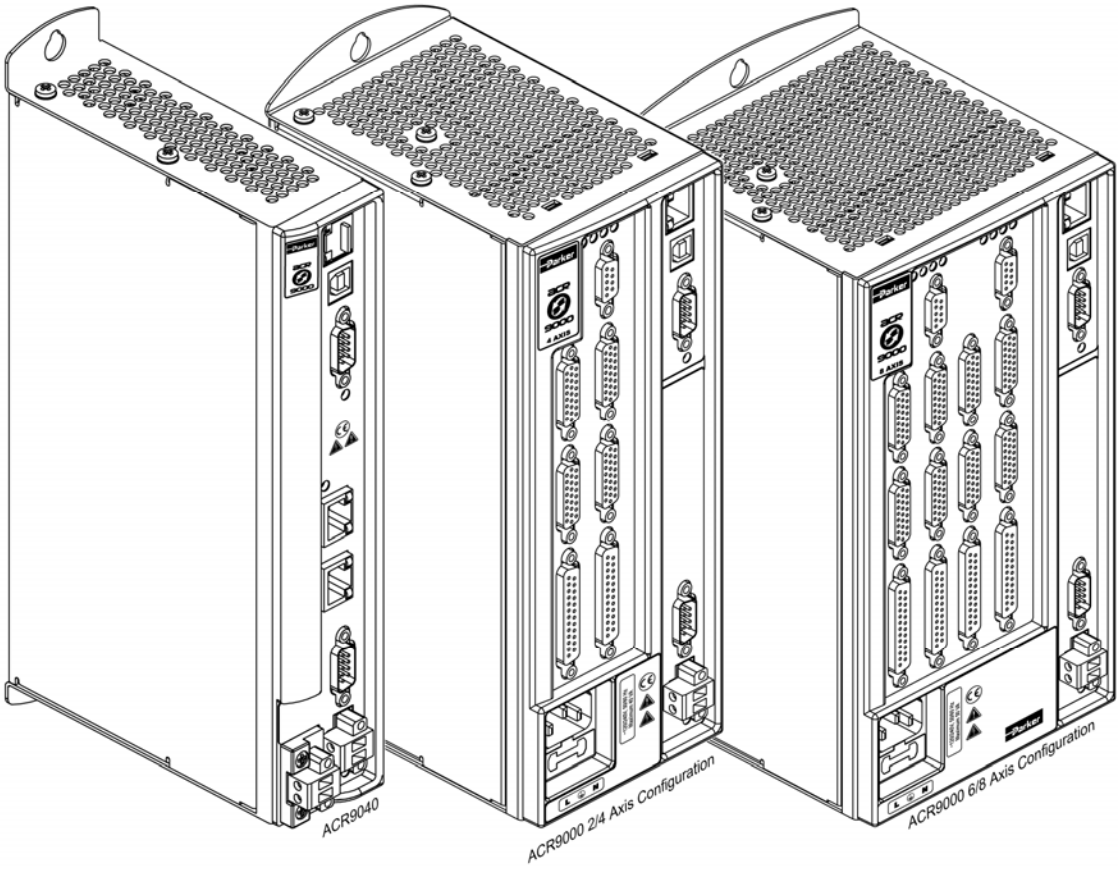
ACR Motion Controllers

88-022337-01H

ACR9000 Series
Hardware Installation Guide

Effective: September 2010



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Important User Information

It is important that motion control equipment is installed and operated in such a way that all applicable safety requirements are met. It is your responsibility as an installer to ensure that you identify the relevant safety standards and comply with them; failure to do so may result in damage to equipment and personal injury. In particular, you should study the contents of this user guide carefully before installing or operating the equipment.

The installation, setup, test, and maintenance procedures given in this guide should only be carried out by competent personnel trained in the installation of electronic equipment. Such personnel should be aware of the potential electrical and mechanical hazards associated with mains-powered motion control equipment—please see the safety warnings below. The individual or group having overall responsibility for this equipment must ensure that operators are adequately trained.

Under no circumstances will the suppliers of the equipment be liable for any incidental, consequential or special damages of any kind whatsoever, including but not limited to lost profits arising from or in any way connected with the use of the equipment or this guide.

Warning — High-performance motion control equipment is capable of producing rapid movement and very high forces. Unexpected motion may occur especially during the development of controller programs. KEEP WELL CLEAR of any machinery driven by stepper or servo motors. Never touch any part of the equipment while it is in operation.

This product is sold as a motion control component to be installed in a complete system using good engineering practice. Care must be taken to ensure that the product is installed and used in a safe manner according to local safety laws and regulations. In particular, the product must be positioned such that no part is accessible while power may be applied.

This and other information from Parker Hannifin Corporation, its subsidiaries, and authorized distributors provides product or system options for further investigation by users having technical expertise. Before you select or use any product or system, it is important that you analyze all aspects of your application and review the information concerning the product in the current product catalog. The user, through its own analysis and testing, is solely responsible for making the final selection of the system and components and assuring that all performance, safety, and warning requirements of the application are met.

If the equipment is used in any manner that does not conform to the instructions given in this user guide, then the protection provided by the equipment may be impaired.

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Product Type..... ACR9000 Series Controllers, including ACR9030 and ACR9040

The above product complies with the requirements of directives:

- EMC Directive 89/336/EEC
- Low Voltage Directive 73/23/EEC
- CE Marking Directive 93/68/EEC.

Provided the installation requirements described in this guide are met, and there are no special requirements of the installation and operating environment so that the application may be considered typical.

The above equipment conforms with the protection requirements of Council Directive 89/336/EEC as amended by Directive 92/31/EEC on the approximation of the laws of the Member States relating to Electromagnetic Compatibility when installed, operated and maintained as intended. Also, the above equipment conforms with the requirements of Council Directive 73/23/EEC (Low Voltage Directive) as amended by Directive 93/68/EEC (CE Marking Directive), when installed, operated, and maintained as intended.

In accordance with IEC 61800-3:1997 (Adjustable speed electrical power drive systems) this product is of the restricted sales distribution class which meets the needs of an industrial environment when installed as directed. However, further measures may need to be taken for use of the product in a domestic environment.

The installation requirements are detailed in the Information supplied with the equipment. The equipment is sold only to competent system builders.

Compliance is demonstrated by the application of the following standards:

- BS EN 50081-2 (1994) Electromagnetic compatibility—Generic emission standard Part 2. Industrial Environment.
- BS EN 61000-6-2 (1999) Electromagnetic compatibility Part 6-2: Generic Standards – Immunity for industrial environments.
- BS EN 61010-1 (1993) including Amendment A2. Safety requirements for electrical equipment for measurement, control, and laboratory use. Part 1 General Requirements.

Important Safety Information

NOTE: The ACR90x0 designates the ACR9000, ACR9030, and ACR9040.

Warning — Risk of damage and/or personal injury

The ACR90x0 controllers described in this guide contain no user-serviceable parts. Attempting to open the case of any unit, or to replace any internal component, may result in damage to the unit and/or personal injury. This may also void the warranty.

The following symbols appear in this guide:

Symbols	Description
	Protective Earth Ground
	Functional Earth (Ground) Terminal
	Shield, Frame, or Chassis Terminal
	Digital Ground
	Isolated Ground
	Caution Risk of Electrical Shock
	Caution, Refer to Accompanying Documentation

Change Summary

Revision H Changes

This document, 88-022337-01H, supersedes 88-022337-01G. Additions, clarifications and corrections are as follows:

Topic	Description
Ch 2—Analog Inputs Electrical / Timing Characteristics	Corrected sample rate at 8 inputs to 86.5µs, and added footnote.
Ch 3—Cable Installation section, Aries I/O pinout	Added Drive Step and Drive Direction pins for Aries Drives in Table 40 Connection to Aries Pinout.

Revision G Changes

This document, 88-022337-01G, supersedes 88-022337-01F. Additions, clarifications and corrections are as follows:

Topic	Description
Title	Changed title of document from “ACR9000 Hardware Installation Guide” to “ACR9000 Series Hardware Installation Guide” to indicate that this document applies to several models of the controller.
Important Safety Information; Ch 1 – Overview	Added note that “ACR90x0” designates the ACR9000, ACR9030, and ACR9040.
ACR9000 throughout	Specified ACR9030 and/or ACR9040 in addition to or instead of ACR9000, as appropriate.
Ch 1 – Compatible Parker Hannifin Products	Refined section to include ACR9030 and ACR9040 and their compatible products; added note that the ACR9040 is not compatible with stepper drives.
Ch 1 - Controller Options	Added options for ACR9030 and ACR9040.
Ch 2 – External I/O Interface	Corrected Analog Inputs quantities from “0 or 1” to “0 or 2” in Table 9 Controller I/O Interface Configurations.
Ch 2 – GP Input/Output Connector	Labeled GP input schematic resistor value 2.7 KΩ (1W), and labeled chip ILD213 (Figure 15).
Ch 2 – GP Outputs	Labeled GP equivalent circuit for outputs chip AQY210KS.
Ch 3 – Axis Connection	Replaced Dynaserv G2 cable with Dynaserv G3 cable in Drive Connection Cables (Table 39) and in Connection to Dynaserv Pinout (Table 42).
Ch 3 – Ethernet Connection	Removed incorrect statement that the Ethernet port is an optional feature.
Ch 3 – USB Connection	Removed incorrect statement that the USB port is an optional feature.
Ch 3 – USB Connection	Added information regarding ACR9040 intermittent USB communication.

Topic	Description
App H – general	Removed statements that “ACR90x0” refers to ACR9030 and ACR9040 only. (“ACR90x0” now designates the ACR9000, ACR9030, and ACR9040.)
App H – Communications	Corrected color (added Amber) on Ethernet Status LEDs drawing (Figure 46).
App H – Hall Sensors	Corrected Figure 49 by switching motor wire labels V and W.

Revision F Changes

This document, 88-022337-01F, supersedes 88-022337-01E. Additions, clarifications and corrections are as follows:

Topic	Description
ACR User's Guide title change	Updated all references to the *ACR User's Guide* to the new title, *ACR Command Language Reference*.
Compatible Parker Hannifin Products	Clarified that ACR9000 is not compatible with EPL drives; added ACR9030 and ACR9040.
Enable Connector (Specifications chapter)	Redesigned section; added warning regarding sharing power supply between Motion Enable function and inductive loads such as brakes, solenoids, contactors, relays; added polarity to Equivalent Circuit for Enable Connector schematic.
Enable Connection (Installation chapter)	Expanded section; added warning regarding sharing power supply between Motion Enable function and inductive loads; added schematic with loop-back diode for shared power supply; added information regarding Parker- and Parker Daedal-build equipment from Tech Bulletin (TB421).
Motion-Related Error Messages (Troubleshooting chapter)	Added information regarding Motion Enable Input Open to Table 61 (error messages); added section Motion Enable Input Open.

Revision E Changes

This document, 88-022337-01E, supersedes 88-022337-01D. Additions, clarifications and corrections are as follows:

Topic	Description
ACR9040	Added dimensional drawing, and electrical and mechanical specifications to Chapter 2 Specifications. Added mounting and clearance drawings to Chapter 3 Installation.
ACR9030	Drawings and electrical/mechanical specifications were included in those for ACR9000.
ETHERNET Powerlink	Added Appendix H—ETHERNET Powerlink description, specifications, instructions, and troubleshooting.
Table 39	Added box surrounding pins for Drive Enable – and + for Compax3 pinouts to indicate requirement for twisted pair.
Table 42	Added box surrounding pins for Drive Enable – and +, and for Drive Reset – and +, for Gemini Stepper pinouts to indicate requirement for twisted pair.
Tables 47 and 49	Corrected cable colors for CANopen pins 2, 7, and 3 to white, blue, and black, respectively, (from white-blue, blue-white, and white-orange, respectively.)

Topic	Description
Table 55	Changed shading for clarification.
Drive Input Fault	Added information regarding adjusting the polarity and response to Drive Fault Input in Appendix D.
Drive Control Parameters and Bits Table	Added pertinent control flags, and changed column heading from *Master* Number to *Axis* Number in the Drive Control Parameters and Bits table in Appendix D.
Encoder Error Detection	Added a method for inhibiting the default response to an encoder error in the Encoder Error Detection section in Appendix D.
Health Period and Node Health	Added information on Health Type parameter, and on Heartbeating and Node Guarding in Health Period and Node Health section in Appendix E.

Revision D Changes

This document, 88-022337-01D, supersedes 88-022337-01C. Changes associated with ACR9000 User Guide revisions, and document clarifications and corrections are as follows:

Topic	Description
Analog Inputs	Added cable specifications and pinout. See Analog Inputs Connector.
VM26 Breakout Module	Added Appendix C describing the VM26 Breakout Module.
Drive I/O	Added Appendix D Drive I/O—from ACR9000 Software Addendum Chapter 1. The ACR9000 Software Addendum p/n88-023737 is no longer a valid document.
CANopen	Added Appendix E CANopen—from ACR9000 Software Addendum Chapter 2. The ACR9000 Software Addendum p/n88-023737 is no longer a valid document.
Drive Talk	Added Appendix F Drive Talk—from ACR9000 Software Addendum Chapter 3. The ACR9000 Software Addendum p/n88-023737 is no longer a valid document.
Battery Backup	Added specifications for Battery Backup option. See Battery Backup.
Aries Cable Pinout	Corrected pinout for Axis Connection.
USB Specifications	Added cable specifications and pinout. See USB Connector.
USB Connection	Added procedures for connecting controller to a USB network. See USB Connection.

Revision C Changes

This document, 88-022337-01C, supersedes 88-022337-01B. Changes associated with ACR9000 User Guide revisions, and document clarifications and corrections are as follows:

Topic	Description
Controller Options	Added connectivity options P1 and P3.
Accessories	Added Ethernet cable.
Ethernet Specifications	Added cable specifications and pinout. See Ethernet Connector.
Ethernet Connection	Added procedures for connecting controller to an Ethernet network. See Ethernet Connection.
Ethernet Troubleshooting	Added table describing LED status indicators. See Ethernet Status LED.

Revision B Changes

This document, 88-022337-01B, supersedes 88-022337-01A. Changes associated with ACR9000 User Guide revisions, and document clarifications and corrections are as follows:

Topic	Description
AC Power Fuse	Removed Parker Hannifin part (no longer stocked), and added Wickmann part number. See AC Power Fuse Requirements.

CHAPTER ONE

1 Introduction

IN THIS CHAPTER

ACR90x0 Controllers—Overview

The ACR90x0 controllers are a series of motion controllers for controlling servo and stepper drives. Their compact form factor permits direct panel-mounting, and is configurable for a variety of connectivity options. Note that "ACR90x0" designates the ACR9000, ACR9030, and ACR9040.

Checking Your Shipment

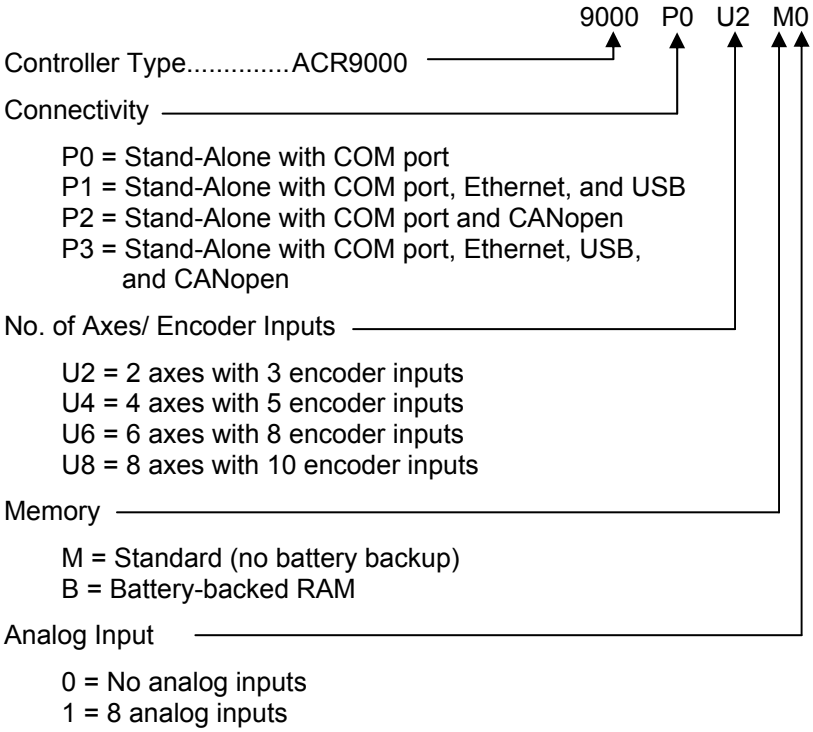
Confirm that you have received all items in Table 1. These items ship with the ACR90x0 controller. If you are missing an item, call the factory. For contact information, see "Technical Assistance" on the inside cover, page 3.

Controller Ship Kit	
Part Name	**Part Number**
ACR SDK CD	95-021500-01
AC Power cord, IEC-320 (120 VAC only) (Not supplied with the ACR9040)	44-000054-01

Table 1 Ship Kit for ACR90x0 Stand-Alone Controller

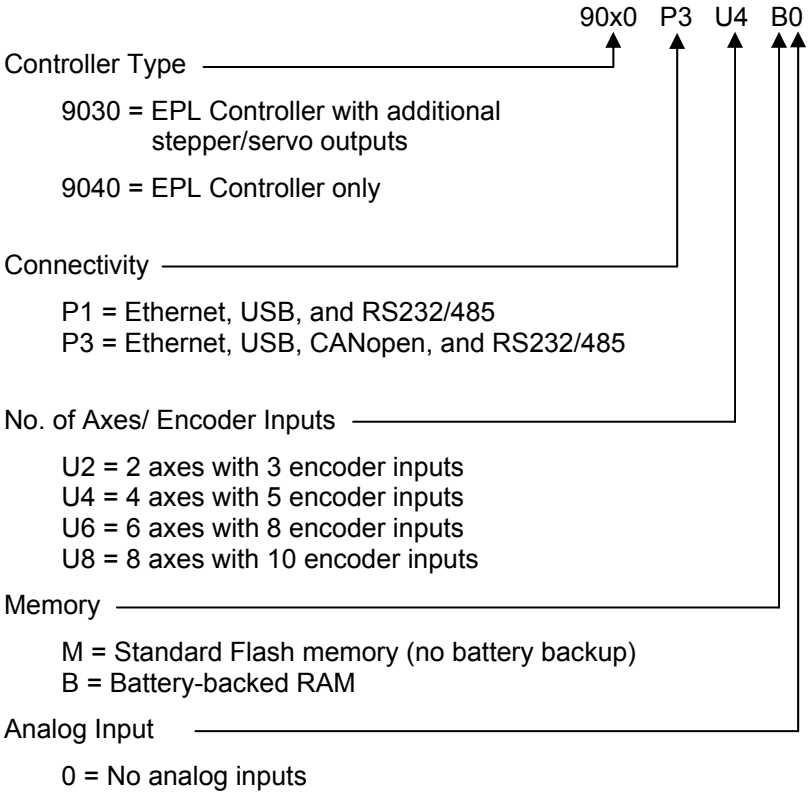
Controller Options

ACR9000 This section contains a list of the options for the ACR9000 Stand-Alone Controller and an explanation of the controller part number. The part number of your ACR9000 controller reflects the options ordered.



Example
9000P0U2M0 = ACR9000 with COM port, 2 axes, standard memory, and no analog inputs.

ACR9030 and ACR9040 This section contains a list of the options for the ACR9030 and ACR9040 Stand-Alone Controllers and an explanation of the controller part number. The part number of your ACR9030 or ACR9040 controller reflects the options ordered.



Example
9030P1U6B0 = ACR9030 with COM port, Ethernet, and USB, 6 axes with 8 encoder inputs with EPL, battery-backed RAM

9040P3U0B0 = ACR9040 with COM port, Ethernet, USB, and CANopen, EPL only, battery-backed RAM

For the latest additions, see our website at www.parkermotion.com.

Accessories

Shown below are products used with the ACR90x0 controllers. To order, contact your local automation technology center (ATC) or distributor. See page 3.

ACR9000 and ACR9030 Controller Accessories	
Description	**Part Number**
Drive Cables[1]	
Aries drive cable	71-021599-xx
Compax3 drive cable	71-021108-xx
Dynaserv G3 drive cable	71-023715-xx
Flying leads cable	71-022344-xx

ACR9000 and ACR9030 Controller Accessories	
Description	**Part Number**
Gemini Servo drive cable	71-021112-xx
Gemini Stepper drive cable	71-022316-xx
Parker Stepper drive cable (E-AC, E-DC, Zeta, etc.)	71-021113-xx
SLVD and HPD drive cable	71-021109-xx
ViX drive cable	71-021110-xx
Communications Cable	
Standard cable for RS-232 operation, 10 ft (3,048 mm) (COM1 port 9-pin to PC 9-pin, D-sub connectors)	71-016939-10
Ethernet crossover cable, 5 ft (1524 mm), unshielded CAT 5E	71-017635-01
Expansion I/O	
25-pin D-sub to screw terminal breakout board with 2 ft cable	VM25
Expansion I/O cable	71-022338-xx[2]
PIO 337, Buscoupler, CANopen STD	01-022317-01
PIO 347, Buscoupler, CANopen ECO	01-022318-01
PIO 400, Input, 2-channel, 24 VDC, 3.0 ms	01-022325-01
PIO 402, Input, 4-channel, 24 VDC, 3.0 ms	01-022324-01
PIO 430, Input, 8-channel, 24 VDC, 3.0 ms	01-022323-01
PIO 468, Input, 4-channel, 0-10 VDC, analog	01-022329-01
PIO 480, Input, 2-channel, 0-20 mA, differential isolated	01-022330-01
PIO 501, Output, 2-channel, 24 VDC, 0.5 A	01-022328-01
PIO 504, Output, 4-channel, 24 VDC, 0.5 A	01-022327-01
PIO 530, Output, 8-channel, 24 VDC, 0.5 A	01-022326-01
PIO 550, Output, 2-channel, 0-10 VDC, analog	01-022331-01
PIO 552, Output, 2-channel, 0-20 mA	01-022332-01
PIO 600, end module	01-022333-01
AC Power	
AC Power	
AC power plug (mating-connector only), 3-pin, female (240 VAC)	43-011905-01

1. Each cable comes in a 4-foot (1,219 mm) or 10-foot length (3,048 mm) in the part number -xx (-04 or -10).
2. The cable comes in a 2-foot (609.6 mm) or 4-foot length (1,219 mm) in the part number -xx (-02 or -04).

Table 2 ACR9000 and ACR9030 Controller Accessories

ACR9040 Controller Accessories[1]	
Description	**Part Number**
Drive Cables [2]	
EPL controller to drive Ethernet cable, SFTP	71-028656-xx
Communications Cable	
Standard cable for RS-232 operation, 10 ft (3,048 mm) (COM1 port 9-pin to PC 9-pin, D-sub connectors)	71-016939-10
Ethernet crossover cable, 5 ft (1524 mm), unshielded CAT 5E	71-017635-01
Expansion I/O	
25-pin D-sub to screw terminal breakout board with 2 ft cable	VM25
Expansion I/O cable	71-022338-xx[3]
PIO 337, Buscoupler, CANopen STD	01-022317-01
PIO 347, Buscoupler, CANopen ECO	01-022318-01
PIO 400, Input, 2-channel, 24 VDC, 3.0 ms	01-022325-01
PIO 402, Input, 4-channel, 24 VDC, 3.0 ms	01-022324-01
PIO 430, Input, 8-channel, 24 VDC, 3.0 ms	01-022323-01
PIO 468, Input, 4-channel, 0-10 VDC, analog	01-022329-01
PIO 480, Input, 2-channel, 0-20 mA, differential isolated	01-022330-01
PIO 501, Output, 2-channel, 24 VDC, 0.5 A	01-022328-01
PIO 504, Output, 4-channel, 24 VDC, 0.5 A	01-022327-01
PIO 530, Output, 8-channel, 24 VDC, 0.5 A	01-022326-01
PIO 550, Output, 2-channel, 0-10 VDC, analog	01-022331-01
PIO 552, Output, 2-channel, 0-20 mA	01-022332-01
PIO 600, end module	01-022333-01

1. A power cord does not ship with the unit.
2. Each cable comes in a 1-foot (304.8 mm), 3-foot (914.1 mm), 5-foot (1,524mm), 10-foot (3,048 mm), or 25-foot length (7,620 mm) in the part number -xx (-01, -03, -05, -10, or -25).
3. The cable comes in a 2-foot (609.6 mm) or 4-foot length (1,219 mm) in the part number –xx (-02 or -04).

Table 3 ACR9040 Controller Accessories

Compatible Parker Hannifin Products

Servo Drives

(±10V torque, step/direction, CW and CCW) ..... **ACR9000:** Aries, Compax3, Dynaserv, ViX, Gemini GV, OEM770T series, or other Parker Hannifin drives except Aries EPL or Compax3 EPL

ACR9030: Aries, Aries EPL, Compax3, Compax3 EPL, Dynaserv, ViX, Gemini GV, OEM770T series, or other Parker Hannifin drives

ACR9040: Aries EPL, Compax3 EPL

Stepper Drives

(step/direction, CW and CCW) ..... **ACR9000 and ACR9030:** E-AC, E-DC, Zeta, OEMZL, OEM750, Gemini GT series, or other Parker Hannifin drives

NOTE: The ACR9040 is not compatible with stepper drives

Software ..... ACROLOOP SDK CD

For information about cables, see Chapter 3 Installation, beginning on page 62.

About This Guide

This purpose of this guide is to help you install the ACR90x0 Stand-Alone Controllers for use with a variety of Parker Hannifin drives.

The ACR9000 and ACR9030 controllers come in two models of housing, distinguished primarily by their width, and each model supports two configurations of I/O interfaces. In this guide, these models are identified by the number of Axis I/O interfaces that they provide—the 2/4 Axis Configuration and the 6/8 Axis Configuration.

Typically, the illustrations in this guide show the 2/4 Axis Configuration of the ACR9000 and ACR9030 controllers with all four Axis interfaces present, or the 6/8 Axis Configuration with all eight Axis interfaces present.

The ACR9040 comes in one model of housing where all I/O is conducted through the Ethernet connector and the ETHERNET Powerlink connectors. Where applicable, the ACR9040 is also illustrated.

Assumptions of Technical Experience

To install and troubleshoot the ACR90x0 Stand-Alone Controller, you should have a fundamental understanding of the following:

- Electronic concepts such as voltage, current, and switches.
- Mechanical motion control concepts such as inertia, torque, velocity, distance, and force.

Technical Support

For solutions to your questions about implementing the ACR90x0 Stand-Alone Controllers, refer to the following documents:

- *ACR9000 Series Hardware Installation Guide* (this document)
- *ACR Command Language Reference (*formerly the *ACR User's Guide) (Online Help System in the ACR-View software)*

If you cannot find the answer in these documents, contact your local Automation Technology Center (ATC) or distributor for assistance.

If you need to talk to our in-house Application Engineers, please contact us at the numbers listed in "Technical Assistance" section on page 3.

CHAPTER TWO

2 Specifications

IN THIS CHAPTER

Environmental Specifications

The controller operates in an ambient temperature range of 0°C (32°F) to 50°C (122°F). The unit can tolerate atmospheric pollution degree 2: only dry, non-conductive pollution is acceptable. Therefore, we recommend that you mount the controller in a suitable enclosure as described in “Installation Safety Requirements” on page 63.

Still Air Operating Temperature ..... Maximum ..... 50°C (122°F)
Minimum ..... 0°C (32°F)

Storage Temperature ..... –40°C to 75°C (–40°F to 167°F)

Humidity ..... 0-95%, non-condensing

Shock ..... 15g, 11 ms half-sine

Vibration ..... 10-2000 Hz at 2g

Pollution Degree ..... 2 (per IEC 61010)

Installation Category ..... 2 (per IEC 61010)

Cooling

The environment in which you operate the controller must meet the cooling requirements listed below and shown in Table 4.

- For proper cooling, install the controller vertically. (Chapter 3 provides installation guidelines, starting on page 63.)
- Avoid installing heat-producing equipment directly below the controller.
- Make sure the ambient air temperature entering the controller, or rising up to the controller, is within acceptable ambient temperature limits. Under normal use, the temperature of air leaving the controller may be 25°C (45°F) above ambient temperature.
- After installation, verify that the ambient air temperature directly below the top-most controller does not exceed the Still Air maximum (see “Operating Temperature” above). In addition, make sure that nothing obstructs the circulating airflow.

Controller	Power Consumption	Minimum Top/Bottom Clearance	Minimum Side Clearance
ACR9000, ACR9030 2/4 Axis	40 Watts	4.0 in (101.6 cm)	2.0 in (50.8 cm)
ACR9000, ACR9030 6/8 Axis	50 Watts	4.0 in (101.6 cm)	2.0 in (50.8 cm)
ACR9040	20 Watts	4.0 in (101.6 cm)	2.0 in (50.8 cm)

Table 4 Controller Cooling Requirements

Mechanical Specifications

The ACR90x0 Series controller housings are vented, metal enclosures. Two models of controller housing, those for the ACR9000 and ACR9030, are distinguished primarily by their width and are identified in this guide by the number of Axis I/O interfaces that they provide—the 2/4 Axis Configuration and the 6/8 Axis Configuration. The third model, the ACR9040, serves axes connected through Ethernet and ETHERNET Powerlink connectors, and therefore is not as wide as the other models. This section contains details of the weight and dimensions of the three models of the controller. (For information about the I/O interfaces provided by each configuration, see “External I/O Interface Connectors” on page 29.)

Weight

The weight of each controller is specified in Table 5.

Controller	Weight
ACR9000, ACR9030 2/4 Axis	4.8 lbs (2.2 kg)
ACR9000, ACR9030 6/8 Axis	5.9 lbs (2.7 kg)
ACR9040	2.5 lbs (1.1 kg)

Table 5 Controller Weight

Dimensions

Table 6 contains the dimensions of each controller. The dimensions are illustrated in Figure 1, Figure 2 and Figure 3.

Controller	Outside Width	Unit Height	Overall Height	Depth
ACR9000, ACR9030 2/4 Axis	3.58 in (90.9 mm)	9.25 in (234.9 mm)	10.50 in (266.7 mm)	5.30 in (134.6 mm)
ACR9000, ACR9030 6/8 Axis	5.00 in (127 mm)	9.25 in (234.9 mm)	10.50 in (266.7 mm)	5.30 in (134.6 mm)
ACR9040	1.75 in. (44.5 mm)	9.25 in (234.9 mm)	10.50 in (266.7 mm)	5.30 in (134.6 mm)

Table 6 Controller Dimensions

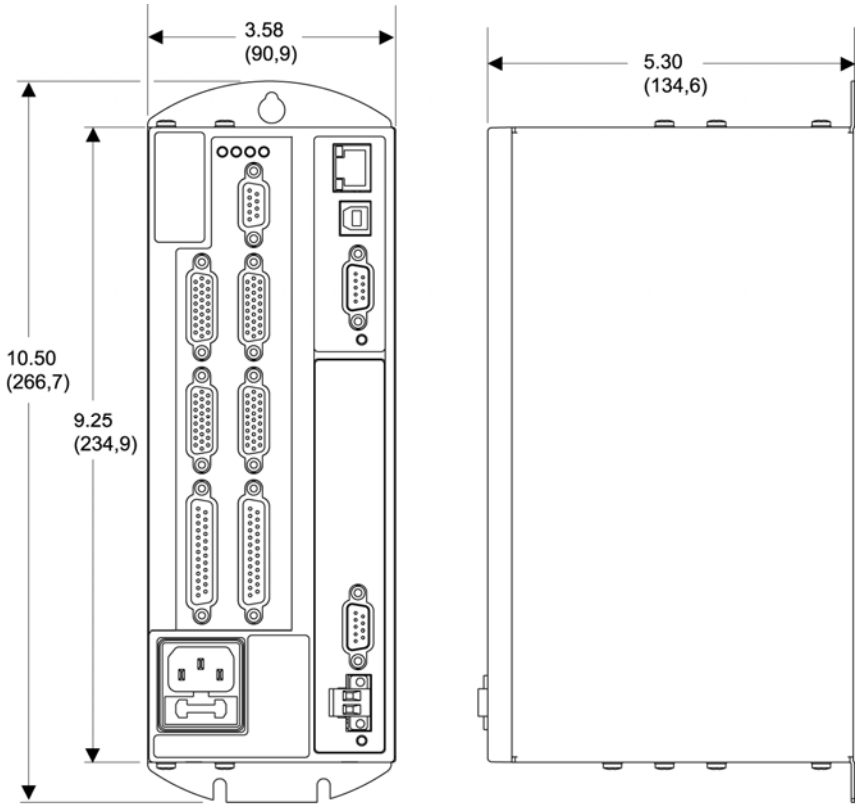


Figure 1 ACR9000 and ACR9030 2/4 Axis Dimensions

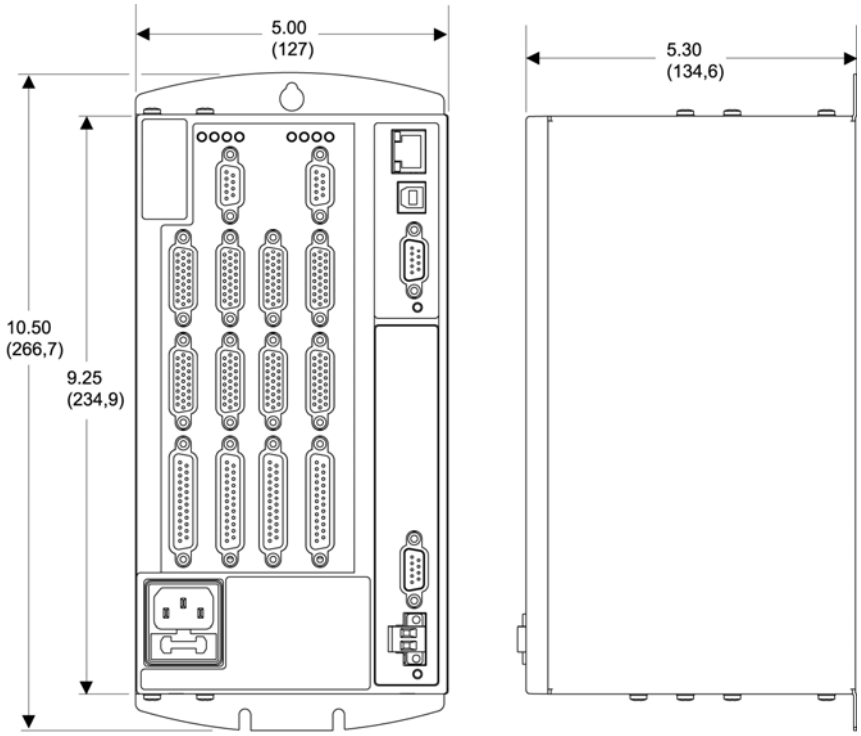


Figure 2 ACR9000 and ACR9030 6/8 Axis Dimensions

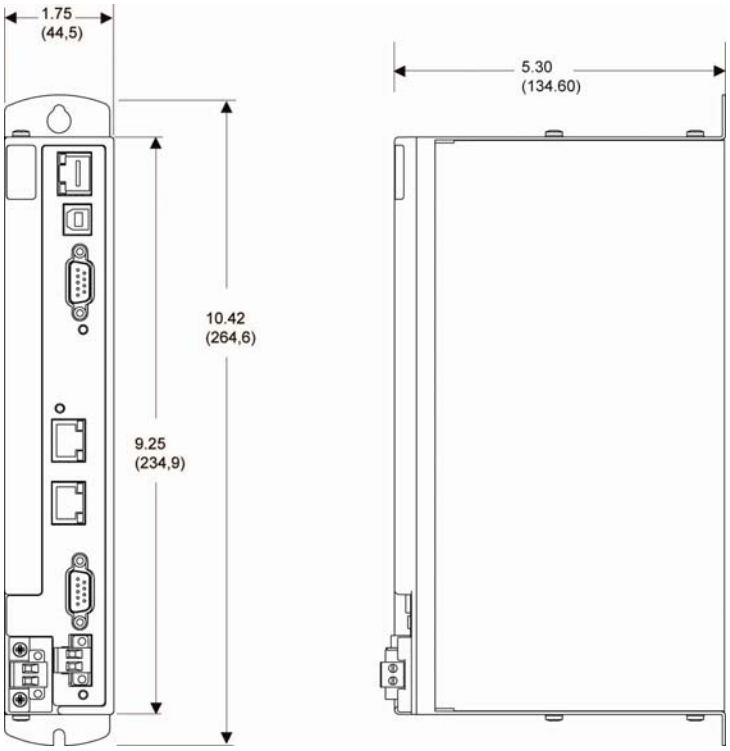


Figure 3 ACR9040 Dimensions

Electrical Specifications

All configurations of the ACR9000 and ACR9030 controllers have a universal AC power supply, and the ACR9040 is designed to be powered by a DC supply. The electrical requirements are listed in Table 7.

Controller	Voltage	Frequency	Maximum Power
ACR9000, ACR9030 2/4 Axis	120/240 VAC	50-60 Hz	40 VA
ACR9000, ACR9030 6/8 Axis	120/240 VAC	50-60 Hz	50 VA
ACR9040	24 VDC	n/a	20 VA

Table 7 Controller Power Requirements

AC Power Supply Connector (ACR9000 and ACR9030)

A standard IEC-320 male connector resides on the front panel of the controller. For its location, see Figure 4 and Figure 5.

Connector Specification—AC Power

Manufacturer ..... Adam Tech or equivalent (www.adam-tech.com)

Connector Type..... IEC-320, 3-pin (male connector)

Manufacturer Part Number IECG3

Connector Specification— AC Power Mating

Parker Hannifin cables are available with mating connectors attached for 120 VAC installations (Parker Hannifin P/N: 44-000054-01 supplied with product). Mating connectors for 240 VAC are not provided with the ACR9000 or ACR9030 Stand-Alone Controllers.

Manufacturer ..... Schurter or equivalent (www.schurterinc.com)

Connector Type..... 3-pin, removable (female socket)

Manufacturer Part Number 4782.0000

Parker Hannifin Part Number..... 43-011905-01

AC Power Fuse (ACR9000 and ACR9030)

The ACR9000 and ACR9030 have one accessible fuse located by the AC power connector. For the ACR9000 and ACR9030 to maintain UL Recognition, you must use one of the approved vendor part numbers listed below.

AC Power Fuse Requirements

Voltage Rating..... 250 VAC

Current Rating..... 2.5 A

Type ..... Time-delay fuse (do not use fast blow fuse)

Size ..... 5 x 20 mm cartridge

Part numbers..... Wickmann ..... 1951250000 (www.wichmannusa.com)
Littelfuse.....218 02.5 (www.littelfuse.com)

The ACR9040 does not have a fuse that is accessible by the user.

DC Power Connector (ACR9040)

The ACR9040 accepts a DC power input through a 2-pin [positive (+) and negative (–)], removable screw terminal on the front panel of the controller. This connector is labeled 24 VDC, 20 VA MAX. A mating connector is provided and is shipped connected to the DC power connector.

DC Power Connector Specification

Manufacturer ..... Amphenol PCD or equivalent (www.amphenol.com)

Connector Type..... 2-pin removable screw terminal (male connector), UL class 2

Manufacturer Part Number ELFH02210E

DC Power Mating-Connector Specification

Manufacturer ..... Amphenol PCD or equivalent (www.amphenol.com)

Connector Type..... 2-pin, removable (female socket)

Manufacturer Part Number ELFP02210E

Parker Hannifin Part Number..... 43-021606-01

Pitch ..... 0.200 in (5.03 mm)

Wire range..... 12-26 AWG, 14-27 SWG, (0.12 - 3.30 mm^2)

Wire Strip Length ..... 0.310 in (0.787 mm)

Tightening Torque..... 7.0 in-lbs nom (0.79 N-m)

DC Power Connector Pinout

Signal	Pin
DC Input –	1
DC Input +	2

Table 8 DC Power Connector Pinout

Battery Backup for RAM

The controller has an optional battery backup. With this option, the controller retains everything stored in RAM when power is cycled.

Note: When using battery backup for RAM, do not use the `FLASH IMAGE` or `FLASH SAVE` commands. The `FLASH IMAGE` command writes a copy of the RAM to the flash memory; the `FLASH SAVE` command writes a copy of user programs to the flash memory. On cycling power, the controller restores the flash memory to RAM, wiping out the data otherwise retained by battery backup.

Note: The controller does not save certain system parameters in the battery backed RAM (user RAM). Instead, you can save them in the system RAM using the `ESAVE` command. For more information about which commands are stored in system and user RAM, see the section titled “AcroBASIC Commands & Memory Organization” in the ACR Command Language Reference (Online Help System in the ACR-View software).

Battery Backup

Battery Life..... 5 years at 25°C

Part numbers..... Tadiran TL-5242/W 2100 mAh (www.tadiranbat.com)

External I/O Interface Connectors

This section contains details of the I/O interface connectors provided by each configuration of the ACR9000 and ACR9030 Stand-Alone Controllers. The 2/4 Axis Configuration and 6/8 Axis Configuration differ primarily in width and the number of Axis interface connectors they provide. The 2/4 Axis Configuration provides either two or four Axis interfaces; the 6/8 Axis Configuration supplies six or eight. (For more information on housing and dimensions, see “Mechanical Specifications” on page 24.)

The number of General-Purpose-I/O and Auxiliary-Encoder interface connectors also differs between the two models. Table 9 shows the quantity of each type of I/O interface connector on each configuration of the controller.

Interface Connectors	Quantity on 2/4 Axis Configuration	Quantity on 6/8 Axis Configuration
Axis	2 or 4	6 or 8
General Purpose I/O	2	4
Auxiliary Encoder	1	2
User Enable	1	1
COM1	1	1
CANopen[1]	0 or 1	0 or 1
Ethernet	0 or 1	0 or 1
USB	0 or 1	0 or 1
Analog Inputs[2]	0 or 2	0 or 2

1. This interface is an option on the ACR9000 and ACR9030 controller.

2. This interface option is only available on the ACR9000.

For more information, see Controller Options on page 16.

Table 9 Controller I/O Interface Configurations

On all configurations of the controller, the I/O interface connectors are on the front panel. The front panel diagrams in Figure 4 and Figure 5 starting on page 30 show the interface connector locations for the 2/4 axis and 6/8 axis configurations, respectively. Figure 6 shows the interface connector locations for the 2/4 axis for the ACR9030. (Figure 7 shows the interface connectors for the ACR9040.)

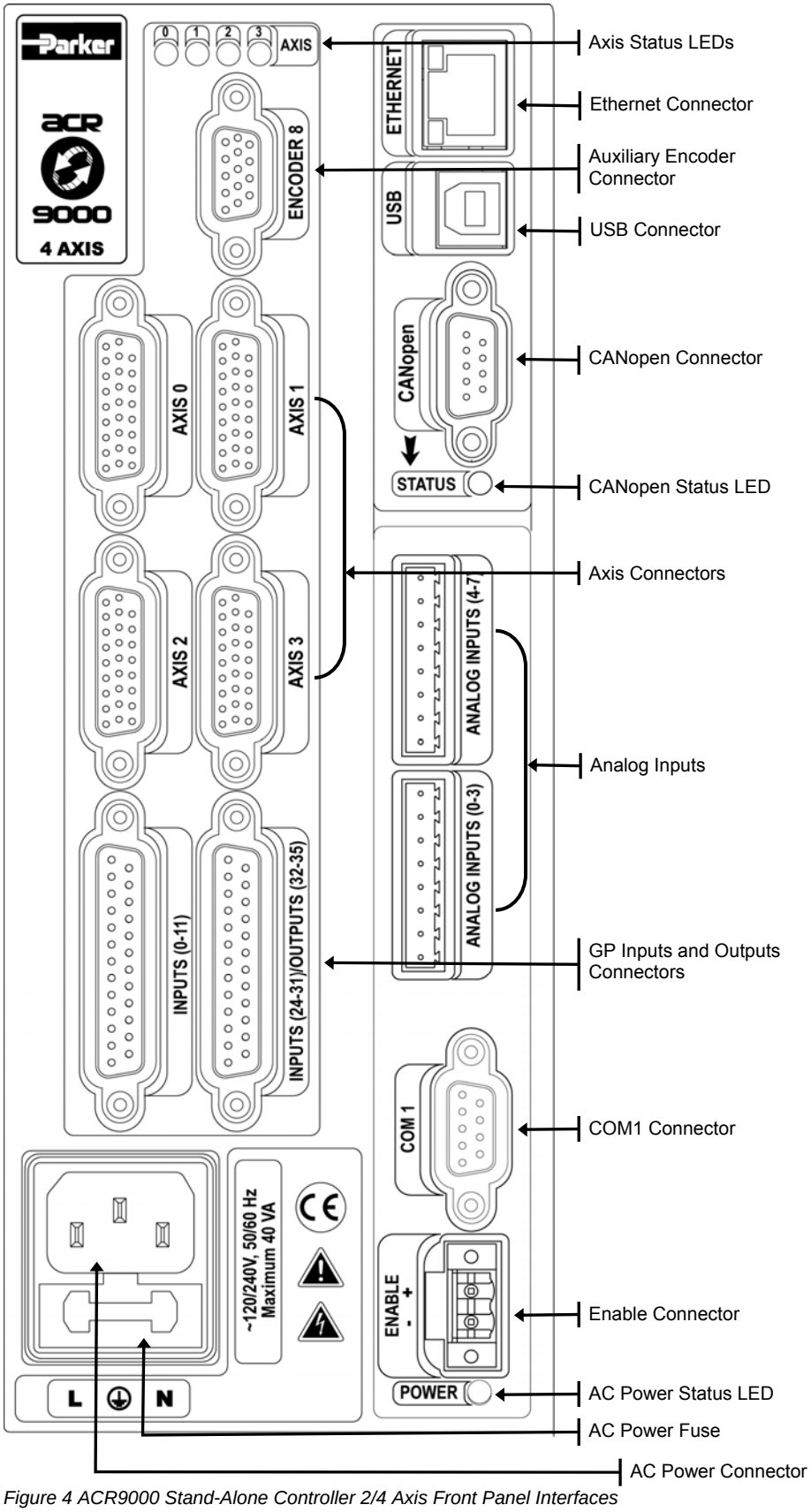


Figure 4 ACR9000 Stand-Alone Controller 2/4 Axis Front Panel Interfaces

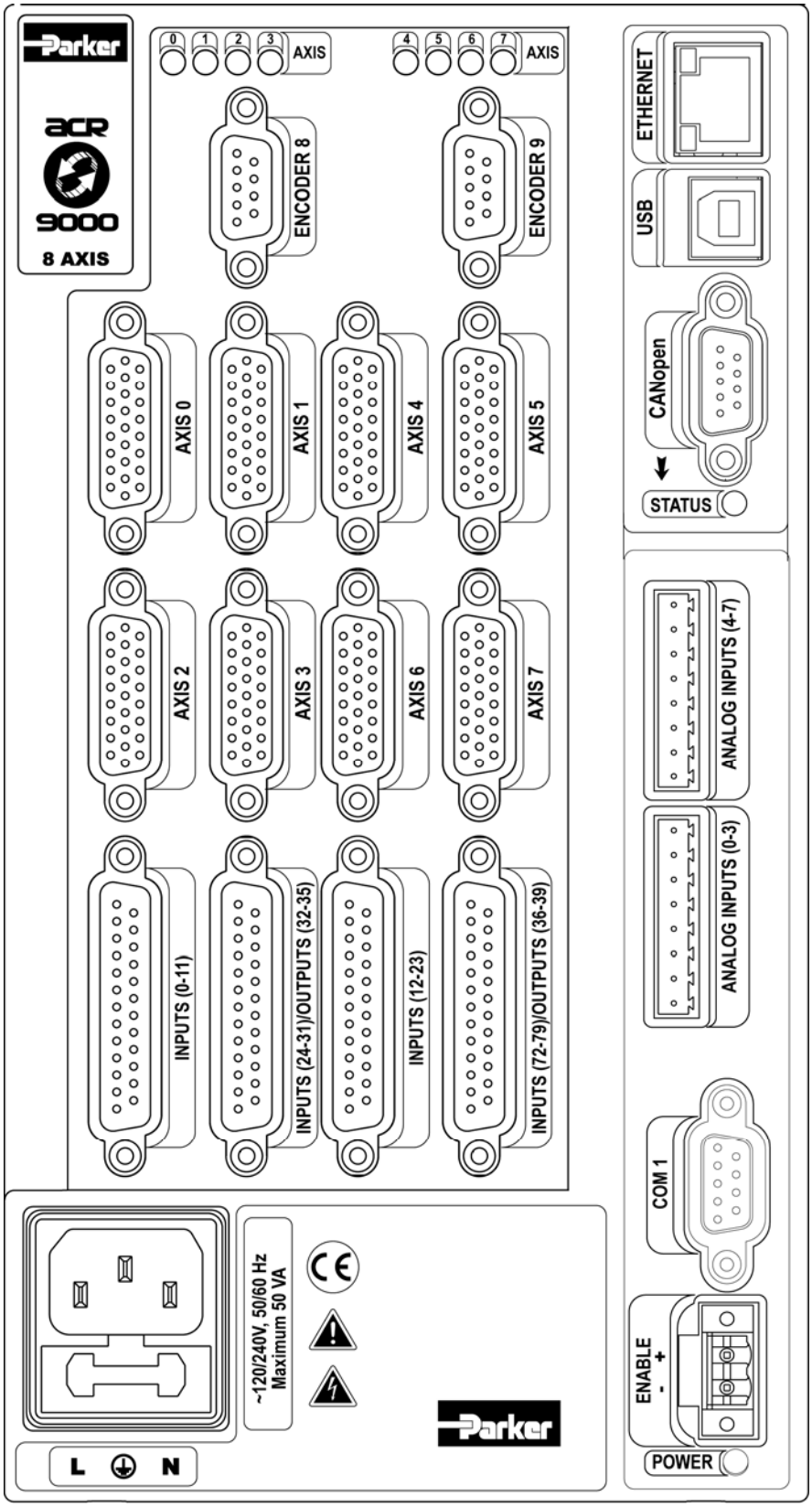


Figure 5 ACR9000 Stand-Alone Controller 6/8 Axis Front Panel Interfaces

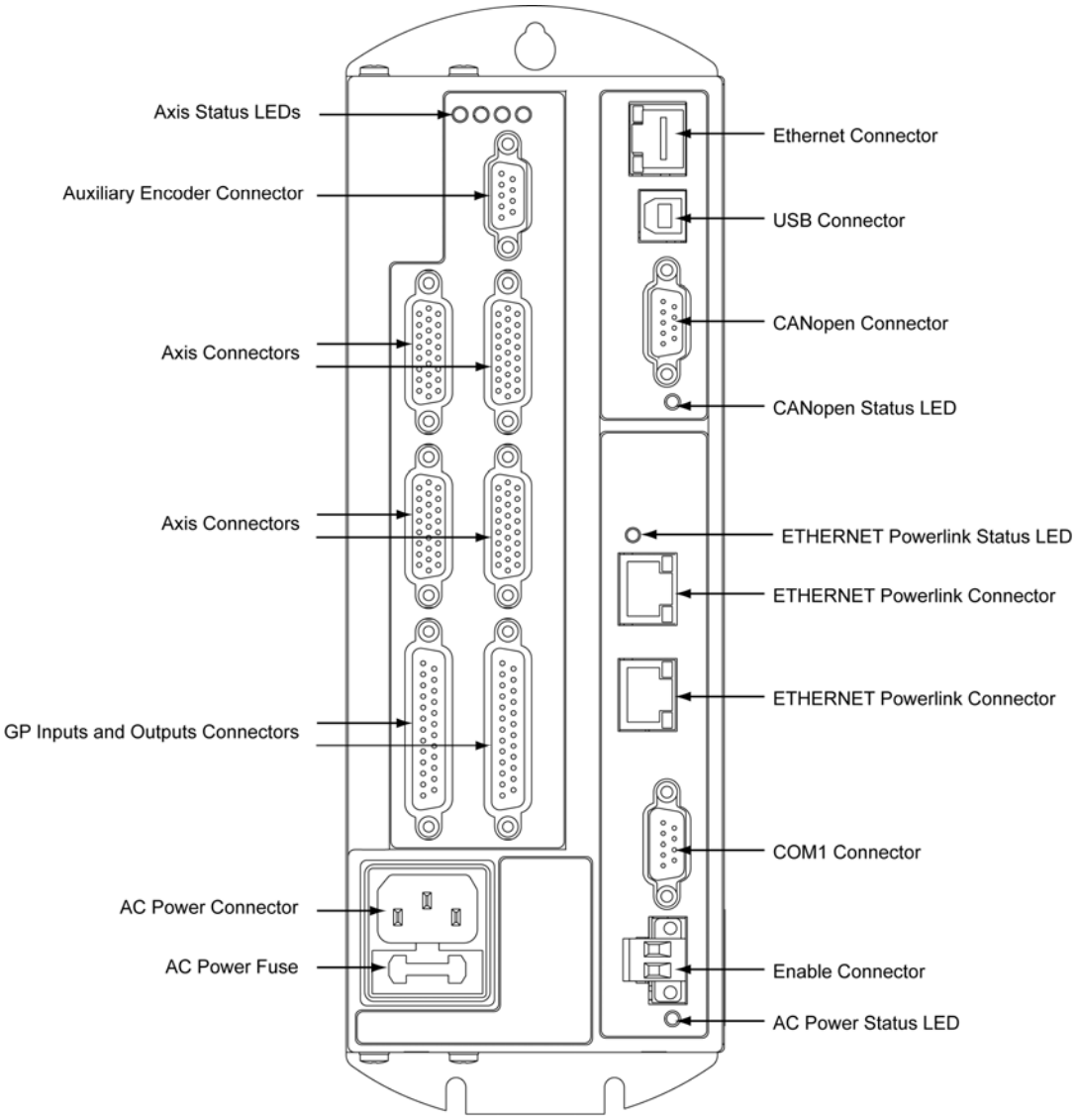


Figure 6 ACR9030 Front Panel Interfaces (2/4 Axis)

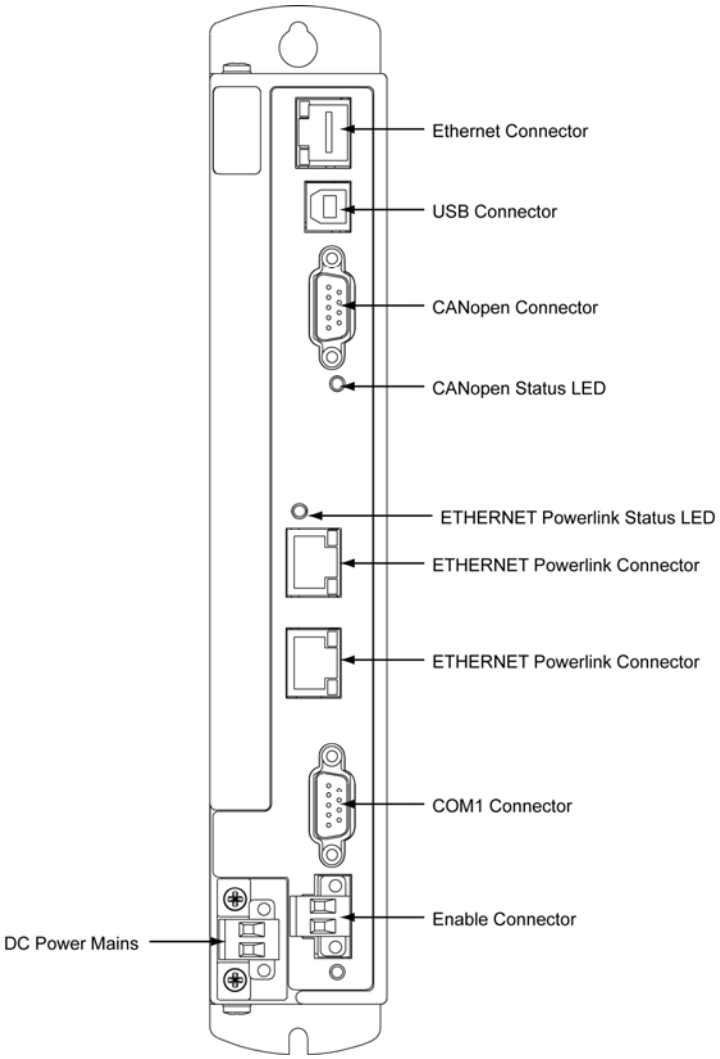


Figure 7 ACR9040 Front Panel Interfaces

The following sections contain a description and specifications for each of the ACR9000 and ACR9030 controller I/O interface connectors, including (as appropriate):

- Connector specification
- Mating-Connector specification
- Connector pinout
- Signal assignments
- Electrical/Timing characteristics
- Internal circuit schematics

Axis Connectors, 0-7

The ACR9000 and ACR9030 controllers employ a single connector that handles both the encoder and drive signals—the Axis connector. Therefore, each axis of motion has its own integrated encoder/drive connector. This section contains connector specifications, a connector pinout, and information about the drive and encoder functions of the Axis connectors.

Depending on the configuration of your ACR9000 or ACR9030 controller, there are two, four, six, or eight axis connectors on the front panel. They are labeled AXIS 0 through AXIS 7. For connector locations, see Figure 4 on page 30 or Figure 5 on page 31. (The figures show both controller models with all axis connectors populated. Not all connectors may be populated on your configuration of the controller.) The axis connector is a 26-pin, female D-sub, high-density connector. The connector pinout for Axes 0 through 3 follows in Table 10 on page 35. Table 11 on page 36 provides the connector pinout for Axes 4 through 7.

Axis Connector Specification

Manufacturer	KYCON or equivalent (www.kycon.com)
Connector Type	26-pin high density D-sub, 3-row (female socket)
Manufacturer Part Number	K42-A26S/S-A4NR

Axis Mating-Connector Specification

Parker Hannifin does not provide mating connectors with the ACR9000 or ACR9030 controllers. However, you may order Parker Hannifin cables with mating connectors attached.

Manufacturer	AMP or equivalent (www.amp.com)
Connector Type	26-pin, high density D-sub, 3-row (male connector)
Connector Kit	AMP Part Number 748474-1 Includes: 748365-1 connector, shield, enclosure, and two jack screws (does not include contacts or ferrules)

Contacts ..... 30µ" Gold—AMP Part Number 748333-4
Gold Flash—Amp Part Number 748333-7

Axis Connector Pinout, Axis 0–3

Axis Connector		AcroBASIC Direct I/O Reference			
Signal	**Pin**	**Axis 0**	**Axis 1**	**Axis 2**	**Axis 3**
5 VDC PWR	1	Not Applicable			
DC RETURN	2				
Encoder CHA+	3				
Encoder CHA–	4				
Encoder CHB+	5				
Encoder CHB–	6				
Encoder CHZ+	7	MRK 0	MRK 1	MRK 2	MRK 3
Encoder CHZ–	8				
5VDC PWR	9	Not Applicable			
Drive Step+	10				
Drive Step–	11				
Drive Direction+	12				
Drive Direction–	13				
Drive AOUT+	14				
Drive AOUT–	15				
Drive Fault+	16	INP 64	INP 65	INP 66	INP 67
Drive Fault–	17				
5VDC PWR	18	Not Applicable			
Drive GND	19				
Drive Enable–	20	OUT 40	OUT 41	OUT 42	OUT 43
Drive Enable+	21				
Drive Reset–	22	OUT 48	OUT 49	OUT 50	OUT 51
Drive Reset+	23				
Drive GND	24	Not Applicable			
Drive Talk+	25				
Drive Talk–	26				

Note: If the Enable Drive I/O flag is set, then the AcroBASIC direct I/O commands can only report the output status and cannot set or clear the output state.

The ACR9000 and ACR9030 controllers ship with a default state for all axes—Enable Drive I/O flag set.

Table 10 Connector Pinout, Axes 0–3

Axis Connector Pinout, Axis 4–7

Axis Connector		AcroBASIC Direct I/O Reference			
Signal	**Pin**	**Axis 4**	**Axis 5**	**Axis 6**	**Axis 7**
5 VDC PWR	1	Not Applicable			
DC RETURN	2				
Encoder CHA+	3				
Encoder CHA–	4				
Encoder CHB+	5				
Encoder CHB–	6				
Encoder CHZ+	7	MRK 4	MRK 5	MRK 6	MRK 7
Encoder CHZ–	8				
5VDC PWR	9	Not Applicable			
Drive Step+	10				
Drive Step–	11				
Drive Direction+	12				
Drive Direction–	13				
Drive AOUT+	14				
Drive AOUT–	15				
Drive Fault+	16	INP 68	INP 69	INP 70	INP 71
Drive Fault–	17				
5VDC PWR	18	Not Applicable			
Drive GND	19				
Drive Enable–	20	OUT 44	OUT 45	OUT 46	OUT 47
Drive Enable+	21				
Drive Reset–	22	OUT 52	OUT 53	OUT 54	OUT 55
Drive Reset+	23				
Drive GND	24	Not Applicable			
Drive Talk+	25				
Drive Talk–	26				

Note: If the Enable Drive I/O flag is set, then the AcroBASIC direct I/O commands can only report the output status and not set or clear the output state.

The ACR9000 and ACR9030 controllers ship with a default state for all axes of—Enable Drive I/O flag set.

Table 11 Connector Pinout, Axes 4–7

Axis Connector Power Source

Each Axis (and Auxiliary Encoder) connector has a nominal +5 VDC power source to aid application installations. The power source typically is used to power:

- An external encoder, and
- Optical inputs and/or outputs between the ACR9000/ACR9030 and an external drive.

Table 12 contains the electrical characteristics for the Axis-Connector power source. Figure 1 provides a schematic of its circuit.

Description	Min	Max	Units
Continuous current, +5V	--	150[1]	mA
Trip current, +5V	700	1200	mA
Voltage tolerance from +5V (@ 150 mA or less)	4.9	5.5	VDC
1. Maximum current draw per Axis/Encoder Connector is 250 mA, not to exceed a combined 1500 mA for eight axis connectors and two auxiliary encoder connectors.			
Note: All parameters are at the connector pin.			

Table 12 Axis Power Electrical Characteristics

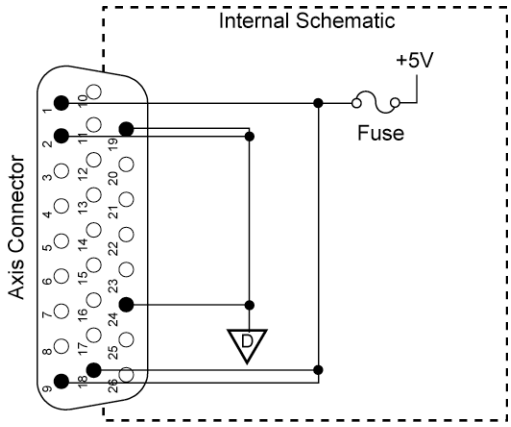


Figure 8 Equivalent Circuit for Axis Power Source

Axis-Connector Fuse

The Axis connector has a +5V voltage source for powering an encoder and/or drive I/O, and includes a fuse, as shown in Figure 8 above. In the event the +5V source shorts to ground, the internal reset-able fuse disables the +5V source. When the short-circuit condition is removed and the fuse cools, the fuse automatically resets.

Drive Function

This section describes the drive function of the Axis interface, as well as an AcroBASIC command reference, signal assignments, electrical/timing characteristics, and internal circuit schematics.

Modes of Operation

The Drive Step and Drive Direction output feature of the drive interface has two modes of operation:

- Step and Direction
- CW and CCW Mode

Step and Direction Mode
In Step and Direction mode, two differential output signals are driven to an external drive: STEP and DIR. A high DIR signal and a positive edge of the STEP signal indicates a request for positive motion while a low DIR signal and a positive edge of the STEP signal indicates a request for negative direction. On the connector, Drive Step and STEP use the same pins and Drive Direction and DIR use the same pins.

CW and CCW Mode
In CW and CCW mode, two differential output signals are driven to an external drive: CW and CCW. A low CCW signal and a positive edge of the CW signal indicates a request for positive motion, while a low CW signal and a positive edge of the CCW signal indicates a request for negative direction. Only one output will transition at a time. On the connector, Drive Step and CW use the same pins and Drive Direction and CCW use the same pins.

Drive Signal Assignments

Table 13 summarizes the drive signal assignments.

Mode	Axis Connector	
	Drive Step	Drive Direction
Step and Direction	STEP	DIR
CW and CCW	CW	CCW
Note: The drive signals will support either a servo drive or stepper drive on the same connector.		

Table 13 Drive Signal Assignments

Drive Commands

Table 14 provides drive signal information and the associated AcroBASIC commands.

Signal	Description	AcroBASIC Reference
Drive Step and Drive Direction Output +/–	The step and direction outputs provide the commanded motion outputs between the ACR9000/ACR9030 and an external stepper drive amplifier, such as the E-AC series from Parker. For more information, see “Modes of Operation” on page 38.	Enable Drive I/O flag, `ATTACH`
Drive AOUT Output +/–	The Drive AOUT output provides the analog +/– 10V commanded motion output between the ACR9000/ACR9030 and an external servo drive amplifier, such as the Aries series from Parker.	`ATTACH`, `DAC GAIN`, Enable Drive I/O flag,
Drive Fault Input +/–	The Drive Fault input is commonly used to monitor the state of an external drive amplifier. For the ACR9000/ACR9030, this typically means that the external drive amplifier has disabled or shutdown due to an error between the drive and motor.	Enable Drive I/O flag,
Drive Enable Output +/–	The Drive Enable output is commonly used to enable an external drive amplifier for commanded motion. When the ACR9000/ACR9030 asserts the output, the drive amplifier responds to commanded motion on either the Drive Step and Drive Direction outputs or the Drive AOUT output. When the ACR9000/ACR9030 de-asserts the output, the drive amplifier does not respond to the Drive Step and Drive Direction outputs or the Drive AOUT output.	Enable Drive I/O flag, `DRIVE OFF`, `DRIVE ON`
Drive Reset Output +/–	The Drive Reset output is commonly used to re-initialize an external drive amplifier to a known state.	Enable Drive I/O flag, `DRIVE RES`
Drive Talk +/–	The Drive Talk signals are reserved for compatibility with Parker drives and are not available for general use.	`OPEN DTALK`, `OPEN`
Note: For more information on these and additional AcroBASIC commands, refer to the ACR Command Language Reference (Online Help System in the ACR-View software).		

Table 14 Drive Commands

Drive Electrical/Timing Characteristics

Table 15 through Table 18, on pages 40 and 41, contain the electrical timing/characteristics for the following drive functions:

- Outputs—Drive Step and Drive Direction
- Outputs—Drive AOUT
- Inputs—Drive Fault
- Outputs—Drive Enable and Drive Reset

Important!

These electrical/timing characteristics only apply to the Axis connectors.

Outputs—Drive Step and Drive Direction

Description	Min	Max	Units
Output voltage low at –30 mA	--	1	VDC
Output voltage high at +10 mA	3.7	--	
Output voltage high at +30 mA	3.5	--	VDC
Step output frequency	0	2.5	MHz
Note: All parameters are at the connector pin.			

Table 15 Outputs—Drive Step and Drive Direction Electrical/Timing Characteristics

Outputs—Drive AOUT

Description	Min	Max	Units
Output voltage	-10	+10	VDC
DAC resolution	--	16	bits
Load impedance	2k	--	ohms
Note: All parameters are at the connector pin.			

Table 16 Outputs—Drive AOUT Electrical/Timing Characteristics

Inputs—Drive Fault

The Drive Fault input is an optically isolated input. Current is limited internally for input voltage control of 5 to 24 volt logic. The Anode (+) and Cathode (–) are on separate connector pins to allow significant flexibility in wiring to different styles of interface.

Description	Min	Max	Units
Turn-on time	–	1	ms
Turn-off time	–	1	ms
Guaranteed on voltage	4	–	VDC
Guaranteed off voltage	–	2	VDC
Maximum forward voltage	–	30	VDC
Maximum reverse voltage	-30	–	VDC
Forward current	3	12	mA
Note: All parameters are at the connector pin.			

Table 17 Inputs—Drive Fault Electrical/Timing Characteristics

Outputs—Drive Enable and Drive Reset

The Drive Enable and Drive Reset outputs are not polarity sensitive, and can be controlled regardless of polarity.

The Drive Enable and Drive Reset outputs are optically isolated outputs. The drain and source are on separate connector pins to allow significant flexibility in wiring to different styles of interface.

Description	Min	Typical	Max	Units
Turn-on time	—	—	2	ms
Turn-off time	—	—	1	ms
Working Voltage	–30	—	30	VDC
On-time voltage drop ($I_L \leq 10$ mA)	—	—	0.4	VDC
On-time voltage drop ($10\ mA < I_L \leq 100\ mA$)	—	—	4.0	VDC
Load current ($T_A \leq 35\ °C$)	—	—	100	mA
Load current, I_L ($35\ °C < T_A \leq 50\ °C$)	—	—	80	mA
Short-circuit trip current	—	200	—	mA
Note: All parameters are at the connector pin.				

Table 18 Outputs—Drive Enable and Drive Reset Electrical/Timing Characteristics

Drive Internal Circuit Schematics

Figure 9 through Figure 13 show the internal circuit for the following drive functions:

- Outputs—Drive Step and Drive Direction
- Outputs—Drive AOUT
- Inputs—Drive Fault
- Outputs—Drive Enable and Drive Reset
- Drive Talk Signals

Outputs—Drive Step and Drive Direction

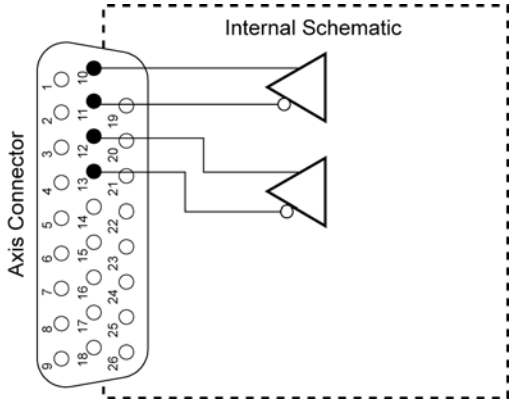


Figure 9 Equivalent Circuit for Drive Step and Drive Direction Outputs

Drive AOUT Outputs

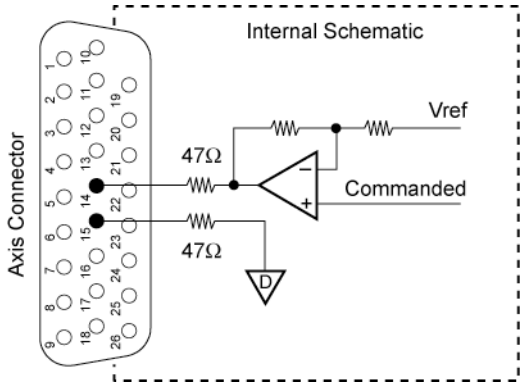


Figure 10 Equivalent Circuit for Drive AOUT Outputs

Drive Fault Inputs

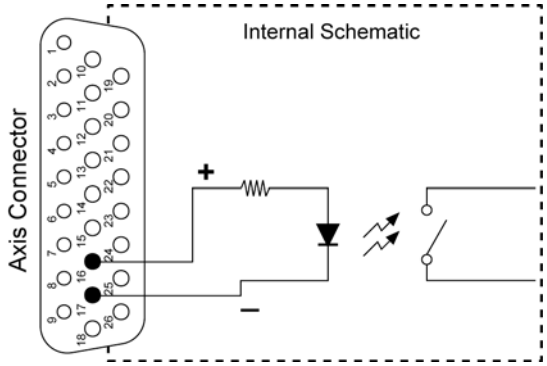


Figure 11 Equivalent Circuit for Drive Fault Inputs

Drive Enable and Drive Reset Outputs

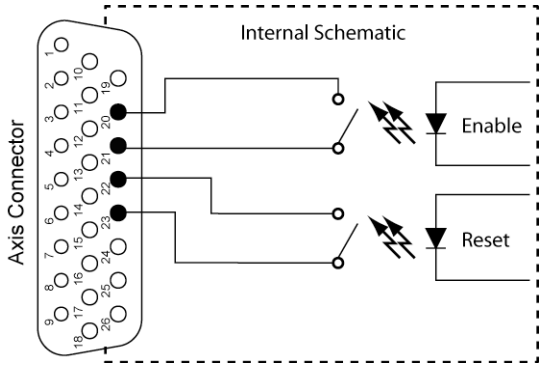


Figure 12 Equivalent Circuit for Drive Enable and Drive Reset Outputs

Drive Talk

Drive Talk signals are reserved for compatibility with Parker Hannifin drives and are not available for general use. Figure 13 illustrates the Drive Talk signal path.

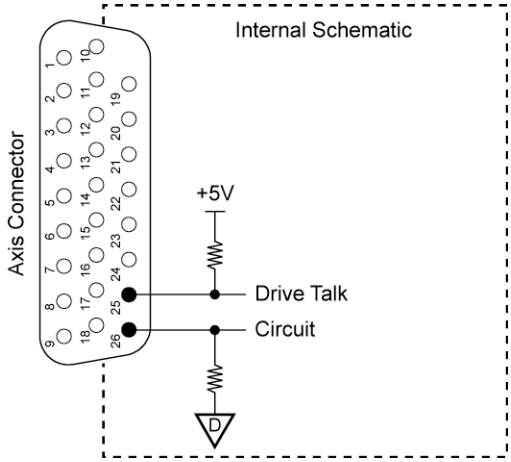


Figure 13 Equivalent Circuit for Drive Talk Signals

Encoder Function

This section describes the encoder function of the Axis interface, as well as signal assignments, electrical/timing characteristics, and internal circuit schematics.

Modes of Operation

The encoder feature has four modes of operation:

- Quadrature
- Step and Direction
- CW and CCW
- SSI (Synchronous Serial Interface)

Quadrature Mode
In Quadrature mode, two differential signals drive the onboard circuits: Encoder CHA and Encoder CHB. When Encoder CHA leads Encoder CHB, (usually by 90 degrees) the motion is positive by convention. When Encoder CHA lags Encoder CHB, the motion is negative by convention.

Step and Direction Mode
In Step and Direction mode, two differential signals drive the onboard circuits: STEP and DIR. A high DIR signal and a positive edge of the STEP signal indicates a positive count, while a low DIR signal and a positive edge of the STEP signal indicates a negative count. On the connector, Encoder CHA and STEP use the same pins and Encoder CHB and DIR use the same pins.

CW and CCW Mode
In CW and CCW mode, two differential signals drive the onboard circuits: CW or CCW. A low CCW signal and a positive edge of the CW signal indicates a positive count. A low CW signal and a positive edge of the CCW signal indicates a negative count. On the connector, Encoder CHA and CW use the same pins and Encoder CHB and CCW use the same pins.

SSI Mode
In SSI mode, one differential signal is driven out to a device, and one differential signal is received from the device: SCLK (clock out) and SDATA (data in). The first falling edge on SCLK causes the remote device to latch its current position value. The device then responds by synchronously shifting the data out using the SCLK rising edge to qualify SDATA. On the connector, Encoder CHA and SCLK use the same pins, and Encoder CHB and SDATA use the same pins. For more information on SSI encoders, see Appendix A on page 109. For more information on SSI mode commands, refer to `ENC CLOCK`, `ENC DST`, `ENC SRC`, and `ENC WIDTH` in the ACR Command Language Reference (Online Help System in the ACR-View software).

For more information on encoder modes of operation, refer to the `ENC SRC` command in the ACR Command Language Reference (Online Help System in the ACR-View software).

Encoder Signal Assignments

Table 19 summarizes signal assignments and supported features of the encoder interface.

Mode	Axis Connector Signal		Supported Features
	Encoder CHA	Encoder CHB	Position Capture[1]
Quadrature	CHA	CHB	Yes
Step and Direction	STEP	DIR	Yes
CW and CCW	CW	CCW	Yes
SSI	SCLK	SDATA	No

1. For more information on position capture, refer to the `INTCAP` command in the ACR Command Language Reference (Online Help System in the ACR-View software).

Table 19 Encoder Signal Assignments and Supported Features

Encoder Cable Disconnect

To improve reliability, the controller detects if the axis/encoder cable is absent on a given axis by monitoring the Encoder CHA and Encoder CHB signals. The feature does not distinguish between the causes, but identifies which axis is experiencing the event. The controller does not monitor the Encoder CHZ signal because the controller does not use it to close the servo loop, and Encoder CHZ is not connected to an SSI device.

For more information on the encoder-cable-disconnect feature, refer to the Encoder Flags section and “Bit Encoder Signal Lost” message in the ACR Command Language Reference (Online Help System in the ACR-View software).

Notes

- The encoder-cable-disconnect feature is not available for single-ended encoders.
- For SSI devices, the controller monitors only the Encoder CHB signal.

Encoder Electrical/Timing Characteristics

Description	Min	Max	Units
Pre-Quadrature frequency	0	5.0	MHz
Post-Quadrature frequency	0	20.0	MHz
Duty cycle (pre-quad frequency ≤ 2.5 MHz)	30	70	%
Duty cycle (pre-quad frequency > 2.5 MHz)	40	60	%
Receiver Differential Threshold, V_{TH}	–200	+200	mV
Common mode range, V_{CM}	–10	13.2	VDC
Note: All parameters are at the connector pin.			

Table 20 Encoder Electrical/Timing Characteristics

Encoder Circuit Schematic

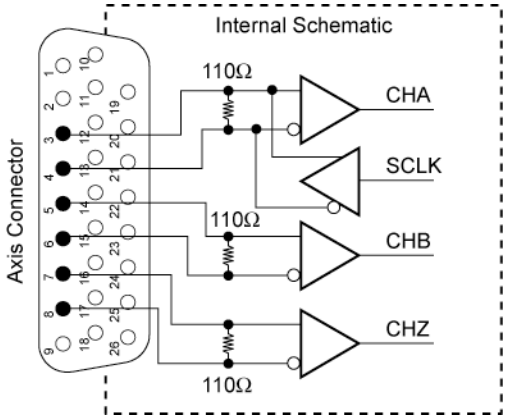


Figure 14. Equivalent Circuit for Encoder

Auxiliary Encoder Connector

The 2/4 Axis Configuration of the ACR9000 and ACR9030 controllers provide one Auxiliary Encoder connector, labeled ENCODER 8. The 6/8 Axis Configuration provides two, which are labeled ENCODER 8 and ENCODER 9. The Auxiliary Encoder interface includes the same features as the encoders found on the Axis connectors described in the previous section, starting on page 45. This section contains the Auxiliary Encoder connector specifications and a connector pinout. The connector is a 9-pin female, D-sub connector on the front panel of the unit.

Auxiliary Encoder Connector Specifications

Manufacturer	KYCON or equivalent (www.kycon.com)
Connector Type	9-pin D-sub, 2-row (female socket)
Manufacturer Part Number	K22HT-E9S-NVR30

Auxiliary Encoder Mating-Connector Specifications

Parker Hannifin does not provide mating connectors with the ACR9000 or ACR9030. However, you can order Parker Hannifin cables with mating connectors attached.

Manufacturer	AMP or equivalent (www.amp.com)
Connector Type	9-pin, D-sub, 2-row (male connector)
Connector Kit	AMP Part Number 747952-1 Includes: 205204-3 connector, shield, enclosure, and two jack screws (does not include contacts or ferrules)
Contacts	Crimp style 30µ" Gold—AMP Part Number 1-745254-6 Gold Flash—Amp Part Number 1-745254-3

Auxiliary Encoder Pinout

Signal	Pin	Signal	Pin
5 VDC PWR	1	Encoder CHB +	6
DC RETURN	2	Encoder CHB –	7
Encoder CHA +	3	Encoder CHZ +	8
Encoder CHA –	4	Encoder CHZ –	9
No connect	5		

Table 21 Auxiliary Encoder Connector Pinout

General Purpose Inputs/Outputs

The 2/4 Axis Configuration provides 20 general purpose (GP) digital inputs and four digital outputs through two connections. They are labeled INPUTS (0-11) and INPUTS (24-31) / OUTPUTS (32-35). The 6/8 Axis Configuration provides 40 inputs and eight outputs through four connections. The four connectors are labeled INPUTS (0-11), INPUTS (24-31) / OUTPUTS (32-35), INPUTS (12-23), and INPUTS (72-79) / OUTPUTS (36-39). Figure 22 on page 66 shows the connectors and labels for the 2/4 Axis Configuration. Figure 23 on page 67 shows the connectors and labels for the 6/8 Axis Configuration.

The digital inputs and digital outputs are optically isolated from the digital logic. For inputs, current is limited internally for input voltage control of 24 volt logic. The connector is a 25-pin female, D-sub connector.

General Purpose Inputs/Outputs Connector Specification

Manufacturer ..... KYCON or equivalent (www.kycon.com)

Connector Type..... 25-pin D-sub, 2-row (female socket)

Manufacturer Part Number K42-B25S/S-A4NR

General Purpose Inputs/Outputs Mating-Connector Specification

Parker Hannifin does not provide mating connectors with the ACR9000 or ACR9030 controllers. However, you can order Parker Hannifin cables with mating connectors attached.

Manufacturer ..... AMP or equivalent (www.amp.com)

Connector Type..... 25-pin, D-sub, 2-row (male connector)

Connector Kit ..... AMP Part Number 747956-1
Includes: 207464-1 connector, shield, enclosure, and two jack screws (does not include contacts or ferrules)

Contacts ..... Crimp style
30µ" Gold—AMP Part Number 1-745254-6
Gold Flash—Amp Part Number 1-745254-3

General Purpose Inputs/Outputs Connector Pinouts

Table 22 contains the General Purpose (GP) Inputs/Outputs and Trigger Inputs connector pinouts for the 2/4 Axis Configuration controller. Table 23 on page 49 contains the pinout for the additional GP Inputs/Outputs connectors on the 6/8 Axis Configuration.

Use only Trigger Inputs 24 through 31 to capture position on AXIS 0 through AXIS 3, and ENCODER 8.

General Purpose Inputs 0–11		General Purpose (Trigger) Inputs 24–31/ Outputs 32–35	
AcroBASIC Bit	**Pin**	**AcroBASIC Bit**	**Pin**
Input 5–	25	Trigger Input 29–	25
Input 0–	24	Trigger Input 24–	24
Input 0+	23	Trigger Input 24+	23
Input 1–	22	Trigger Input 25–	22
Input 1+	21	Trigger Input 25+	21
Input 2–	20	Trigger Input 26–	20
Input 2+	19	Trigger Input 26+	19
Input 3–	18	Trigger Input 27–	18
Input 3+	17	Trigger Input 27+	17
Input 4–	16	Trigger Input 28–	16
Input 4+	15	Trigger Input 28+	15
No connect	14	No connect	14
Input 5+	13	Trigger Input 29+	13
Input 6–	12	Trigger Input 30–	12
Input 6+	11	Trigger Input 30+	11
Input 7–	10	Trigger Input 31–	10
Input 7+	9	Trigger Input 31+	9
Input 8–	8	Output 32–	8
Input 8+	7	Output 32+	7
Input 9–	6	Output 33–	6
Input 9+	5	Output 33+	5
Input 10–	4	Output 34–	4
Input 10+	3	Output 34+	3
Input 11–	2	Output 35–	2
Input 11+	1	Output 35+	1

Note: Input 5 and Trigger Input 29 are paired on pins 13 and 25 to ease cable assembly.

Table 22 GP Input/Output Connector Pinout (2/4/6/8 Axis Configuration)

On the 6/8 Axis Configuration, use only Trigger Inputs 72 through 79 to capture position on AXIS 4 through AXIS 7, and ENCODER 9.

General Purpose Inputs 12–23		General Purpose (Trigger) Inputs 72–79/ Outputs 36–39	
AcroBASIC Bit	**Pin**	**AcroBASIC Bit**	**Pin**
Input 17–	25	Trigger Input 77–	25
Input 12–	24	Trigger Input 72–	24
Input 12+	23	Trigger Input 72+	23
Input 13–	22	Trigger Input 73–	22
Input 13+	21	Trigger Input 73+	21
Input 14–	20	Trigger Input 74–	20
Input 14+	19	Trigger Input 74+	19
Input 15–	18	Trigger Input 75–	18
Input 15+	17	Trigger Input 75+	17
Input 16–	16	Trigger Input 76–	16
Input 16+	15	Trigger Input 76+	15
No connect	14	No connect	14
Input 17+	13	Trigger Input 77+	13
Input 18–	12	Trigger Input 78–	12
Input 18+	11	Trigger Input 78+	11
Input 19–	10	Trigger Input 79–	10
Input 19+	9	Trigger Input 79+	9
Input 20–	8	Output 36–	8
Input 20+	7	Output 36+	7
Input 21–	6	Output 37–	6
Input 21+	5	Output 37+	5
Input 22–	4	Output 38–	4
Input 22+	3	Output 38+	3
Input 23–	2	Output 39–	2
Input 23+	1	Output 39+	1

Note: Input 17 and Trigger Input 77 are paired on pins 13 and 25 to ease cable assembly.

Table 23 GP Input/Output Connector Pinout (6/8 Axis Configuration)

GP Trigger Input/Output Electrical/Timing Characteristics

GP Inputs 0–11, 12–23			
Description	**Min**	**Max**	**Units**
Turn-on time	--	1	ms
Turn-off time	--	1	ms
Guaranteed on voltage	21	--	VDC
Guaranteed off voltage	--	3	VDC
Maximum forward voltage	--	30	VDC
Maximum reverse voltage	–30	--	VDC
Forward current	6.3	15	mA
Note: All parameters are at the connector pin.			

Table 24 GP Inputs 0–11 & 12–23 Connector Electrical/Timing Characteristics

GP Inputs 24–31, 72–79			
Description	**Min**	**Max**	**Units**
Turn-on time	--	400	ns
Turn-off time	--	400	ns
Guaranteed on voltage	21	--	VDC
Guaranteed off voltage	--	3	VDC
Maximum forward voltage	--	30	VDC
Maximum reverse voltage	–30	--	VDC
Forward current	6.3	15	mA
Note: All parameters are at the connector pin. Propagation delay due to filtering and isolation is ~400 ns, or encoder capture resolution of +/– 5 counts at 10 MHz.			

Table 25 Trigger Inputs 24–31, 72–79 Connector Electrical/Timing Characteristics

GP Outputs 32–39				
Description	**Min**	**Typical**	**Max**	**Units**
Turn-on time	--	--	2	ms
Turn-off time	--	--	1	ms
Working voltage	-30[1]	--	30	VDC
On-Time voltage drop ($I_L \leq 10$ mA)	--	--	0.4	VDC
On-time voltage drop (10 mA < $I_L \leq 100$ mA)	--	--	4.0	VDC
Load current ($T_A \leq 35$ °C)	--	--	100	mA
Load current, I_L (35 °C < $T_A \leq 50$ °C)	--	--	80	mA
Short-Circuit trip current	--	200	--	mA
1. The output is not polarity sensitivity, and can be controlled regardless of polarity. **Note**: All parameters are at the connector pin.				

Table 26 GP Outputs 32–39 Connector Electrical/Timing Characteristics

GP Input/Output Connector Circuit Schematics

This section contains schematics of the input and output circuits of the ACR9000 and ACR9030 controllers. All inputs have the same circuit schematic and all outputs have the same circuit schematic.

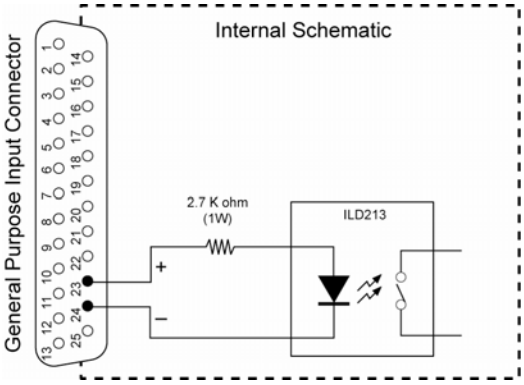


Figure 15 Equivalent Circuit for GP Inputs/Trigger Inputs Connector

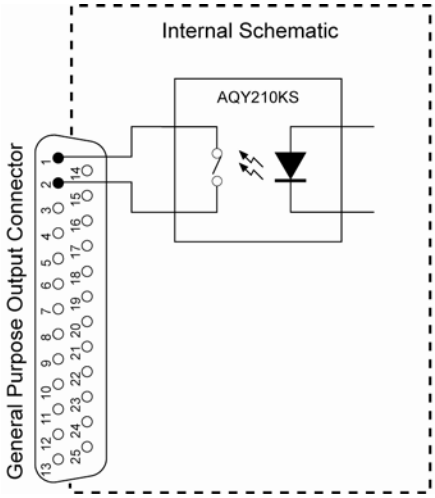


Figure 16 Equivalent Circuit for Outputs

Enable Connector

The Motion Enable input connector (labeled "ENABLE" on the front of the unit) is a two-pin, removable screw terminal on an optically isolated circuit. Current is limited internally for input voltage control of 5 to 24 volt logic. The Anode (+) and Cathode (–) are available on separate connector pins to allow significant flexibility in wiring to different styles of interface.

Current must flow through the Motion Enable input for motion to occur on any axis. When you *de-assert* the Motion Enable input, an immediate kill of all motion without de-acceleration occurs. If current flow does not assert the input, motion does not occur when you command it, and the error message "Motion Enable Input Open" appears on the terminal emulator.

Warning — Damage to the ACR90x0 will result if the 24 Volt supply used on the Motion Enable input is shared with an inductive load (such as brakes, solenoids, contactors, or relays).

Use a separate 24 VDC power supply for inductive loads, or use loop-back diodes or rectifiers across the inductive loads. See the section "Enable Connection" on page 71 for information on how to set up connections for a Motion Enable input.

NOTE: You do not interrupt program executions when you de-assert the Motion Enable input.

Write your user programs to monitor and control the following AcroBASIC commands and flags:

- Misc. Control Group 1 Flags (P4272)
- Kill All Motion Request

For more information on the commands, flags, and parameters, refer to the ACR Command Language Reference (Online Help System in the ACR-View software).

Enable Connector Specification

Manufacturer ..... Amphenol PCD or equivalent (www.amphenol.com)

Connector Type..... 2-pin removable screw terminal (male connector), UL class 2

Manufacturer Part Number ELFH02210E

Enable Mating-Connector Specification

An Enable mating connector ships with the ACR90x0 Stand-Alone Controller

Manufacturer ..... Amphenol PCD or equivalent (www.amphenol.com)

Connector Type..... 2-pin, removable (female socket)

Manufacturer Part Number ELFP02210E

Parker Hannifin Part Number..... 43-021606-01

Pitch ..... 0.200 in. (5.03 mm)

Wire Range ..... 12-26 AWG, 14-27 SWG, (0.12 – 3.30 $mm^{2)}$

Wire Strip Length ..... 0.310 in. (0.787 mm)

Tightening Torque..... 7.0 in-lbs nom (0.79 N-m)

Enable Connector Pinout

Signal	Pin
ENABLE–	1
ENABLE+	2

Table 27 Motion Enable Connector Pinout

Enable Connector Electrical Timing/Characteristics

Description	Min	Max	Units
Turn-on time	--	1	ms
Turn-off time	--	1	ms
Guaranteed on voltage	4	--	VDC
Guaranteed off voltage	--	2	VDC
Maximum forward voltage	--	30	VDC
Maximum reverse voltage	–30	--	VDC
Forward current	3	12	mA
Note: All parameters are at the connector pin.			

Table 28 Motion Enable Connector Electrical Timing/Characteristics

Enable Circuit Schematic

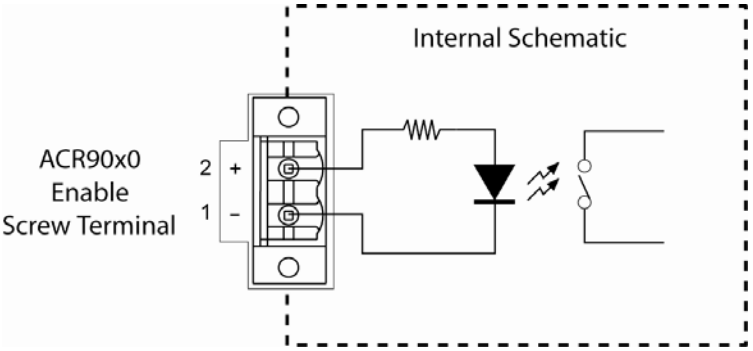


Figure 17 Equivalent Circuit for Motion Enable Connector

COM1 Connector

The COM 1 port on the ACR90x0 controller supports the following transmission characteristics:

- 1200, 2400, 4800, 9600, 19200, 38400 baud (The controller automatically detects baud upon start-up.)
- 8 data bits
- 1 stop bit
- No parity
- Xon/Xoff flow control

The controller supports RS-232 full-duplex and RS-485 full-duplex operation. Hardware configuration determines the mode of data transmission. (For information on configuring the hardware, see COM1 Connection on page 72.) The controller does not support half-duplex operation.

COM1 Connector Specification

Manufacturer ..... KYCON or equivalent (www.kycon.com)

Connector Type..... 9-pin D-sub, 2-row (male connector)

Manufacturer Part Number K202HT-E9P-NJ

COM1 Mating-Connector Specification

Mating connectors are not provided with the ACR90x0 Stand-Alone Controller. Parker Hannifin cables are available with mating connectors attached.

Manufacturer ..... AMP or equivalent (www.amp.com)

Connector Type..... 9-pin, D-sub, 2-row (female socket)

Connector Kit ..... AMP Part Number 747951-1
Includes: 205203-3 connector, shield, enclosure, and two jack screws (does not include contacts or ferrules)

Contacts ..... Crimp style
30µ" Gold—AMP Part Number 1-745253-6
Gold Flash—Amp Part Number 1-745253-3

COM1 Pinout

Table 29 contains the COM1 connector pinout.

COM1 Connector Pinout				
Signal	**Pin**		**Signal**	**Pin**
RX485–	1		No connect	6
RX232/RX485+	2		Mode 0	7
TX232/TX485–	3		No connect	8
TX485+	4		Mode 1	9
GND	5			
Note: Some RS-485 ports designate the "–" terminal as "A" and the "+" terminal as "B."				

Table 29 COM1 Connector Pinout

Analog Inputs Connector (ACR9000 only)

The two screw terminals provide eight single-ended analog inputs, all referencing ground. You can also configure the analog inputs to provide four differential inputs by connecting the input signals in pairs (connect to the inputs; do not connect to the grounds.)

Analog Inputs Connector Specification

Manufacturer ..... Amphenol PCD or equivalent

Connector Type..... 8-pin screw terminal

Manufacturer Par Number ELVP08100

Parker Hannifin Part Number..... 43-021048-01

Pitch ..... 0.150 in (3.81 mm)

Wire range..... 16-28 AWG, 18-29 SWG, (0.08 – 1.3 mm2)

Wire Strip Length ..... 0.25 in (6.35 mm)

Tightening Torque ..... 2.2 in-lbs (0.25 N-m)

Analog Inputs Connector Pinouts

Analog Inputs (0-3) Connector Pinout		
Pin	**Signal***	**Description**
1	AIN0	Analog input 0
2	AGND	Analog ground
3	AIN1	Analog input 1
4	AGND	Analog ground
5	AIN2	Analog input 2
6	AGND	Analog ground
7	AIN3	Analog input 3
8	AGND	Analog ground

Table 30 Analog Inputs (0-3) Connector Pinout

Analog Input (4-7) Connector Pinout		
Pin	**Signal***	**Description**
1	AIN4	Analog input 4
2	AGND	Analog ground
3	AIN5	Analog input 5
4	AGND	Analog ground
5	AIN5	Analog input 6
6	AGND	Analog ground
7	AIN7	Analog input 7
8	AGND	Analog ground

Table 31 Analog Inputs (4-7) Connector Pinout

Analog Inputs Electrical/Timing Characteristics

Input Voltage ..... 16-bit A/D converter, ±10 VDC; bipolar range selectable `ADC GAIN` command; ±10V (default), ±5V, ±2.5V, ±1.25V

Voltage Limit ..... ±15 VDC (referenced to AGND)

Input Current (worst case load)..... ±160 µA

Fault Tolerance ..... ±16.5V

Input Impedance ..... 10^{13} Ω

Sample Rate* (8 inputs)..... 86.5 µs

* ADC parameter update rate is based upon servo period (PERIOD) setting.

Analog Inputs Circuit Schematics

This section contains schematics of the optional analog input circuits of the ACR9000 controller. All inputs have the same circuit schematic.

Differential Inputs

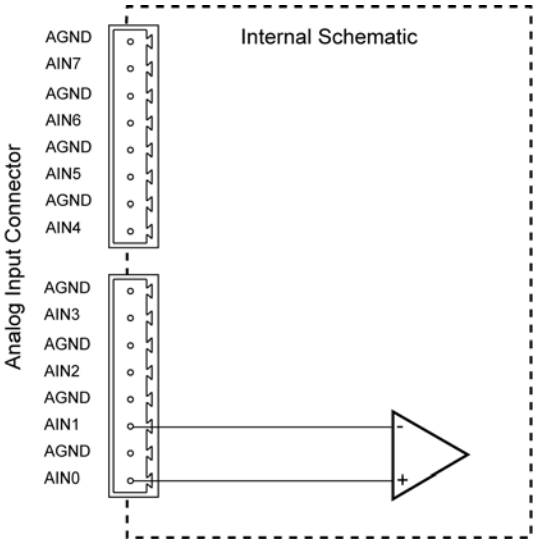


Figure 18 Equivalent Circuit for Differential Analog Inputs Connector

Single-Ended Inputs

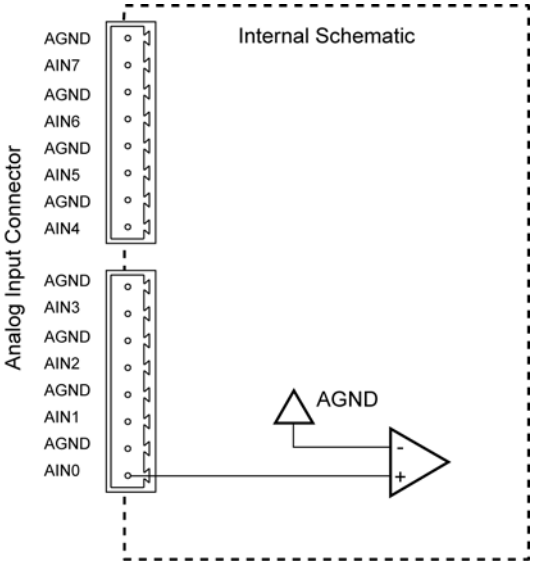


Figure 19 Equivalent Circuit for Single-Ended Analog Inputs

CANopen Connector

The CANopen network interface is fully isolated from the controller's digital reference. The CANopen connector is on the front panel of the unit and is a 9-pin, male D-sub connector.

CANopen Connector Specification

Manufacturer .....KYCON or equivalent (www.kycon.com)

Connector Type.....9-pin D-sub, 2-row (male connector)

Manufacturer Part Number K202HT-E9P-NJ

CANopen Mating-Connector Specification

The ACR90x0 Stand-Alone Controller does not ship with a mating connector. However, you may order a Parker Hannifin cable with a mating connector attached.

Manufacturer .....AMP or equivalent (www.amp.com)

Connector Type.....9-pin, D-sub, 2-row (female socket)

Connector Kit .....AMP Part Number 747951-1
Includes: connector, shield, enclosure, and two jack screws (does not include contacts or ferrules)

Contacts .....Crimp style
30µ" Gold—AMP Part Number 1-745253-4
Gold Flash—Amp Part Number 1-745253-1

CANopen Connector Pinout

Table 32 contains the CANopen connector pinout and Figure 20 on page 59 illustrates its circuit.

Signal	Pin	Description
NC	1	No connect
CAN_L	2	CAN_L bus line (dominant low)
CAN_GND	3	CAN isolated digital ground
NC	4	No connect
CAN_SHLD	5	Optional CAN shield, connected to earth
GND	6	Optional CAN isolated digital ground
CAN_H	7	CAN_H bus line (dominant high)
NC	8	No connect
CAN_V+	9	Not used
Note: The controller does not provide internal termination resistors for CANopen operation. If you require termination, you must add it externally. For more information, see "Selecting CANopen Cables" on page 88.		

Table 32 CANopen Connector Pinout

CANopen Circuit Schematic

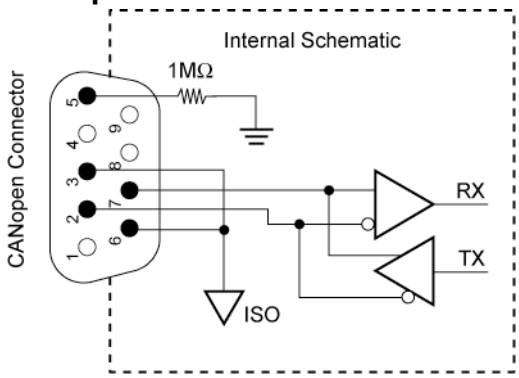


Figure 20 Equivalent Circuit for CANopen

The ACR90x0 controller implements a CANopen master with the following features:

- 10k, 20k, 50k, 125k, 250k, 500k, 800k, and 1M programmable bit-rate
- Up to four slave nodes
- Full network isolation
- DS-301 v4.02 communication profile

In addition, the ACR90x0 CANopen master node supports the following external slave node types:

- DS-401 digital/analog input/output modules

For the latest information on supported CANopen features, see our website, www.parkermotion.com.

Note: The ACR90x0 does not support multi-master networks. There can be only one master, an ACR90x0 controller. For information on connecting the controller to a CANopen network, see “CANopen Connection” on pages 86 through 90.

Ethernet Connector

The ACR90x0 controllers implement a single Ethernet network interface with the following features:

- 10/100 Mbps (self-configuring), full-duplex capable connection
- TCP/IP version 4
- UDP protocols

Ethernet Connector Pinout

Table 33 contains the connector pinout for the Ethernet connector:

Signal	Pin	Wire Color
TX+	1	White with orange
TX-	2	Orange
RX+	3	White with green
*	4	Blue
*	5	White with blue
RX-	6	Green
*	7	White with brown
*	8	Brown
* Terminated internally: 4x75-ohm, 1000pF (2kV) to shield		

Table 33 Ethernet Connector Pinout

ETHERNET Powerlink Connectors

The ACR9030 and ACR9040 controllers implement two ETHERNET Powerlink interfaces with the following features:

- 100 Mbps, full-duplex capable connection
- ETHERNET Powerlink protocols

ETHERNET Powerlink Connector Pinout

Table 34 contains the connector pinout for the ETHERNET Powerlink connector:

Signal	Pin	Wire Color
RX+	1	White with orange
RX-	2	Orange
TX+	3	White with green
*	4	Blue
*	5	White with blue
TX-	6	Green
*	7	White with brown
*	8	Brown
* Terminated internally: 4x75-ohm, 1000pF (2kV) to shield		

Table 34 ETHERNET Powerlink Connector Pinout

USB Connector

The ACR90x0 controller implements the USB interface with the following features:

- USB 2.0 full-speed device, 12 Mbps
- Self-powered— it does not draw power through the USB interface

USB Connector Pinout

The USB connector is a Series B receptacle. The connector pin-out follows:

Signal	Pin	Wire Color (typical)
Vbus	1	Red
D-	2	White
D+	3	Green
GND	4	Black
Shield	Shell	—

Table 35 USB Connector Pinout

CHAPTER THREE

3 Installation

IN THIS CHAPTER

Before You Begin

Electrical Noise Guidelines

- Ensure that all components are properly grounded.
- Ensure that all wiring is properly shielded.

Warning — The ACR90x0 Stand-Alone Controller connects to your system's other mechanical and electrical components. Be sure to test your system for safety under all potential conditions. Failure to do so may result in damage to equipment and serious injury to personnel.

ALWAYS REMOVE POWER TO THE ACR90X0 CONTROLLER BEFORE CONNECTING ELECTRICAL DEVICES (for example, drive, encoder, I/O brick, inputs, and outputs).

Installation Safety Requirements

The ACR90x0 Stand-Alone Controller meets the requirements of both the European LVD (Low Voltage Directive) and EMC (Electromagnetic Compliance) directives when installed according to the instructions provided in this chapter and the specifications in Chapter 2.

The ACR90x0 Stand-Alone Controller is a vented product. As a rule, Parker Hannifin recommends that you install the controller in an enclosure to protect it from atmospheric contaminants, accidental spills and damage, and to prevent operator access while it has power applied. A metal equipment cabinet is ideally suited for housing the equipment because it provides operator protection, EMC screening, and can be fitted with interlocks arranged to remove all hazardous power when the cabinet door is opened.

ACR90x0 products are made available under "Restricted Distribution" for use in the "Second Environment" as described in *EN 61800-3 1996*, on page 9.

Precautions

During installation, take the normal precautions against damage caused by electrostatic discharges.

- Wear earth wrist straps.
- Include a mains power switch or circuit breaker within easy reach of the machine operator. Label clearly the switch or breaker as the disconnecting device.

Installation Overview

Figure 21 illustrates the components necessary for installation of the ACR9000 Stand-Alone Controller. It shows the ACR9000 connected to an Aries drive and a personal computer (PC), and it is also applicable to the ACR9030 installation. The recommended installation process, mounting guidelines, and cable installation procedures follow.

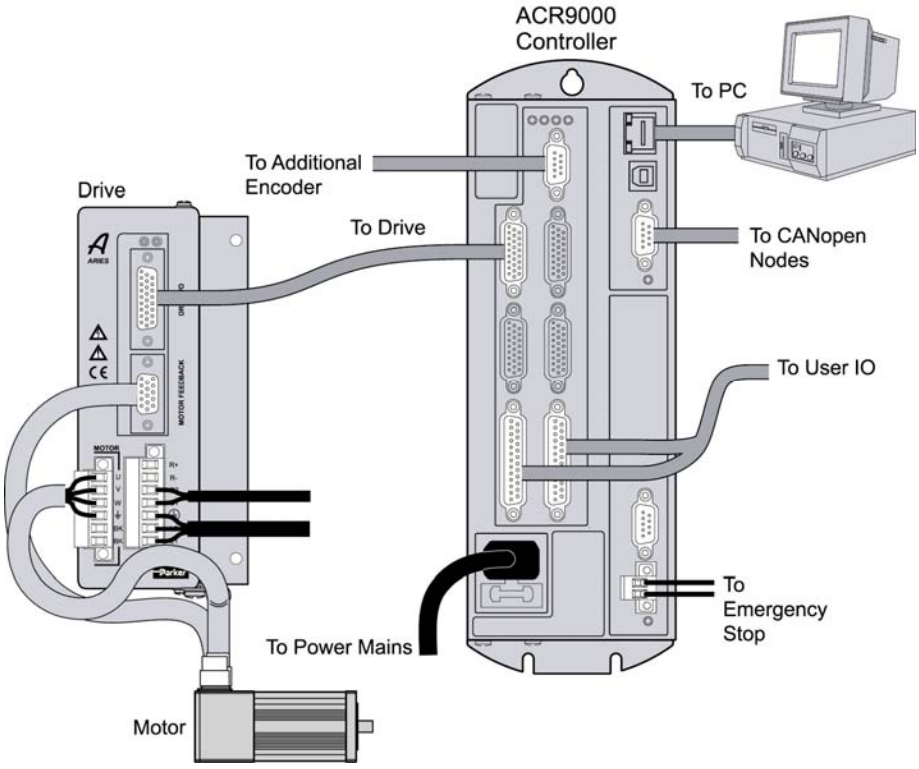


Figure 21 Overview of System Installation

Recommended Installation Process

1. Check the ship kit to make sure you have all items. (For the ship kit contents, see Table 1 Ship Kit for ACR90x0 Stand-Alone Controller on page 16).
2. Review the specifications tables in Chapter 2.
3. If you require RS-485 operation, configure the COM1 port connecting cable as specified in “COM1 Connection” on page 72.
4. Mount the ACR90x0 controller following the guidelines on page 65.
5. Connect all cables and electrical components, *except* the AC power cord.
6. If you desire VM25 expansion I/O connectivity, install the module following the guidelines in Appendix B VM25 .
7. Install the power cord.
8. Apply power to the controller and confirm that all LED status indicators are illuminated green. Use the procedures in Chapter 4 Troubleshooting to solve any installation problems.

Mounting Guidelines

Mount the ACR90x0 Stand-Alone Controller before making any electrical connections or applying power. The figures on the following pages illustrate mounting specifications for the 2/4 Axis Configuration and the 6/8 Axis Configuration of the controller. Figure 22 and Figure 23 on pages 66 and 67 provide the measurements. Figure 24 and Figure 25 on pages 68 and 69 show the clearance requirements. Use the following guidelines for mounting the controller.

- Mount the controller in proximity to the drive amplifiers and power mains connection or terminal bus.
- Mount the controller in a suitable metal enclosure, or under an overhang, to prevent possible damage or injury. (See “Installation Safety Requirements” on page 63.)
- Mount it on an **unpainted metal surface** (preferably zinc-plated), using three No. 8 or M4 mounting screws. For mounting measurements, see Figure 22 on page 66 and Figure 23 on page 67.
- For proper cooling, mount the controller vertically and with required clearance. (See Table 4 on page 23 for cooling requirements. Figure 24 and Figure 25 on pages 68 and 69 illustrate mounting clearance requirements.)
- Avoid installing heat-producing equipment directly below the controller.
- Make sure the ambient air temperature entering the controller, or rising up to the controller, is within acceptable ambient temperature limits. Under normal use, the temperature of air leaving the controller may be 25°C (45°F) above ambient temperature.
- After installation, verify that the ambient air temperature directly below the top-most controller does not exceed the Still Air maximum. For ambient air temperature specifications, see Environmental Specifications on page 23. In addition, make sure that nothing obstructs the circulating airflow.

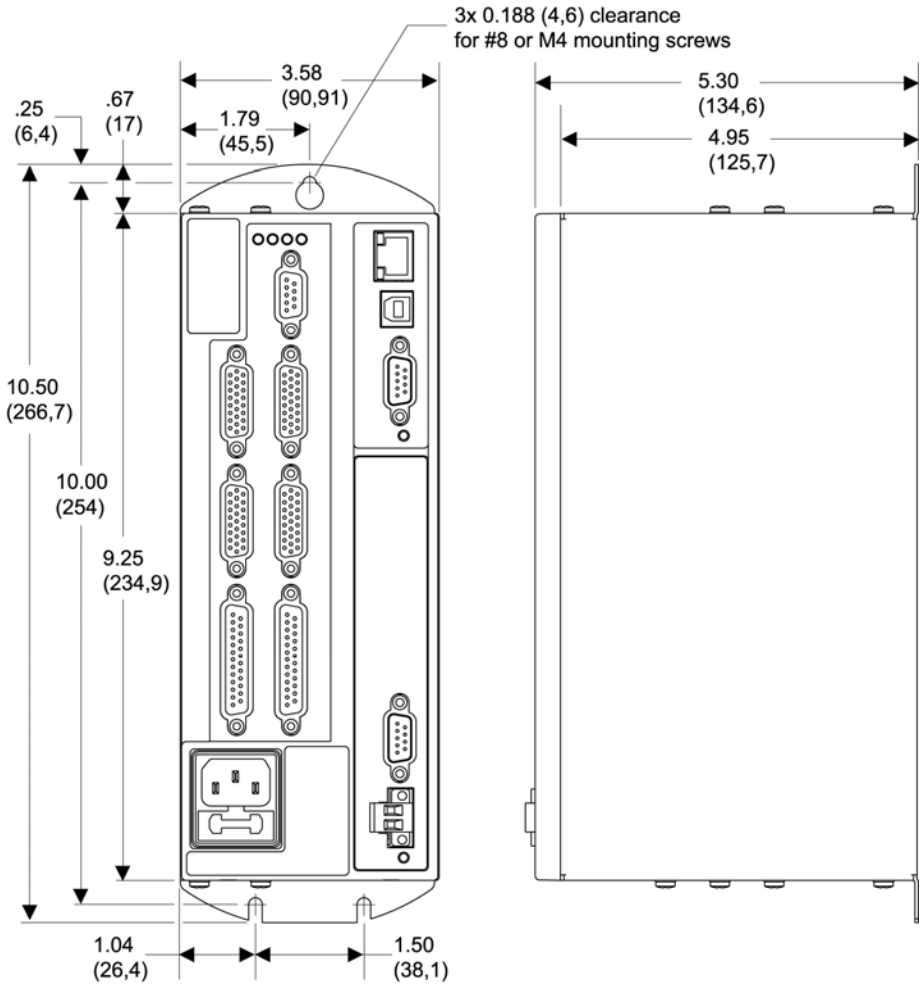


Figure 22 Mounting Specifications for ACR9000 and ACR9030 2/4 Axis Configuration

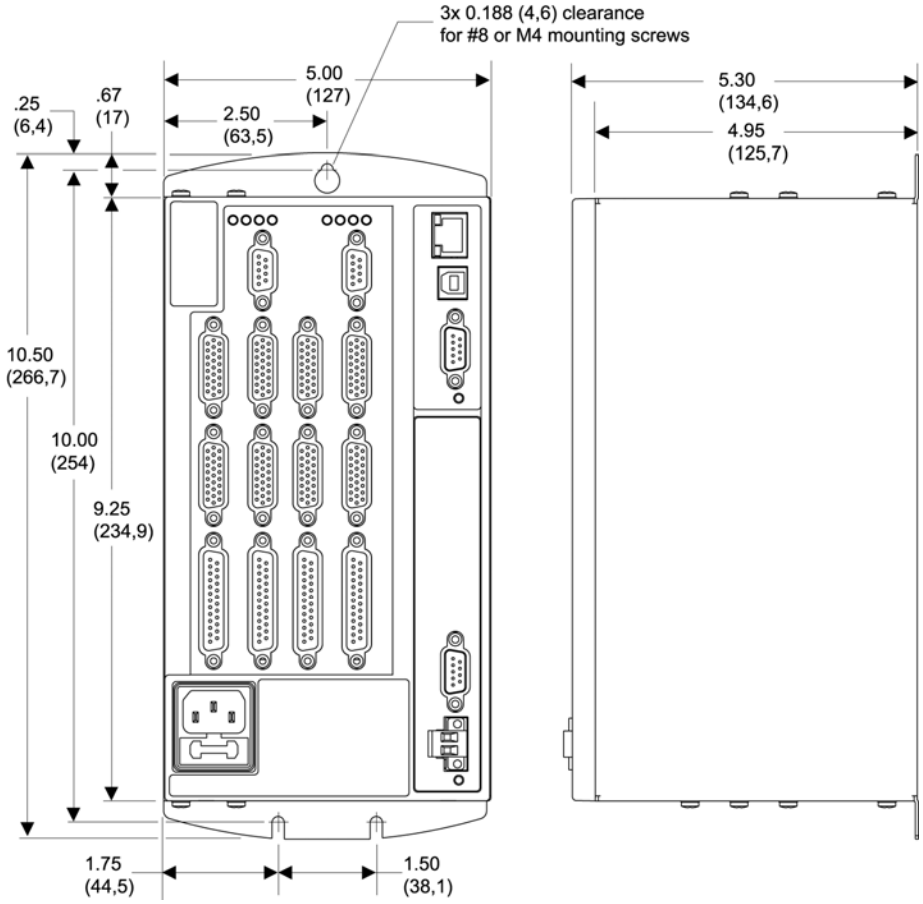


Figure 23 Mounting Specifications for ACR9000 and ACR9030 6/8 Axis Configuration

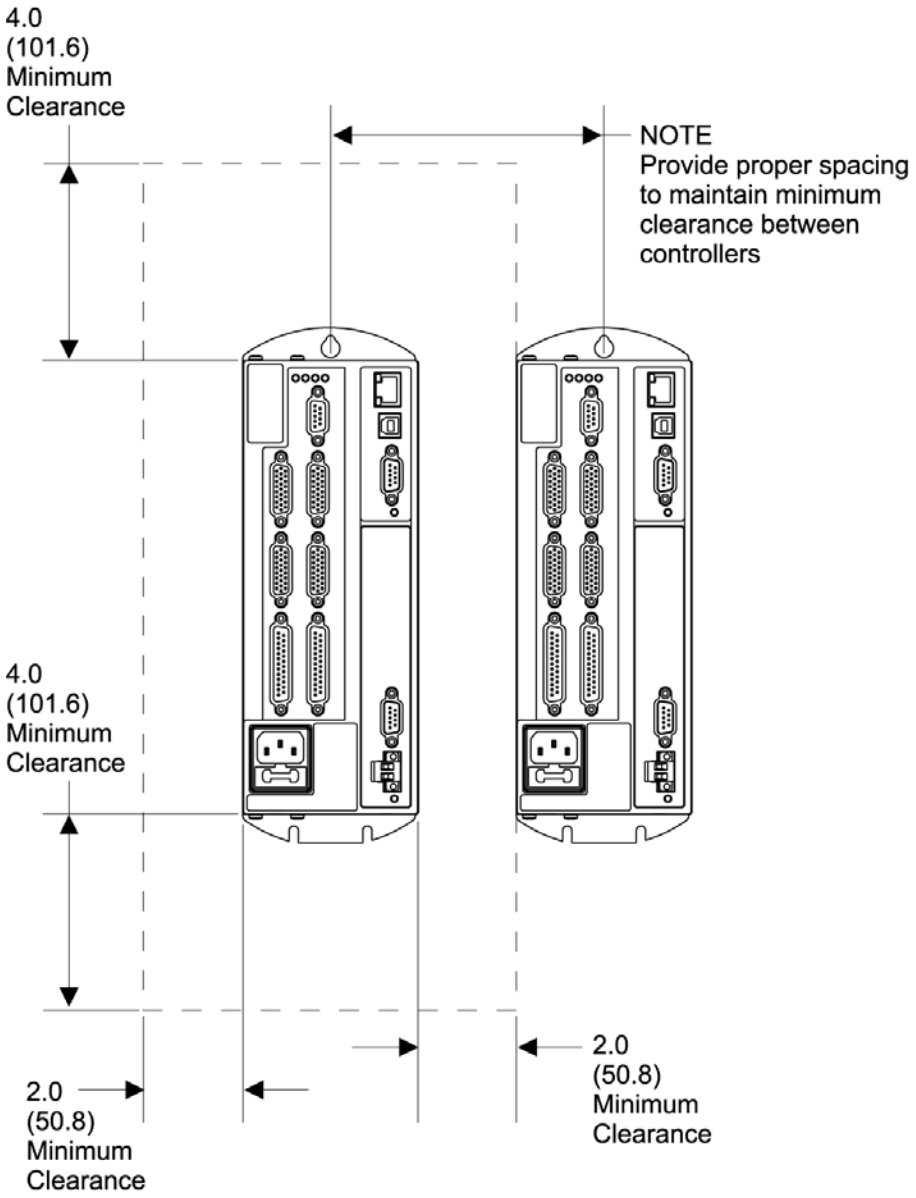


Figure 24 Mounting Clearance for ACR9000 and ACR9030 2/4 Axis Configuration

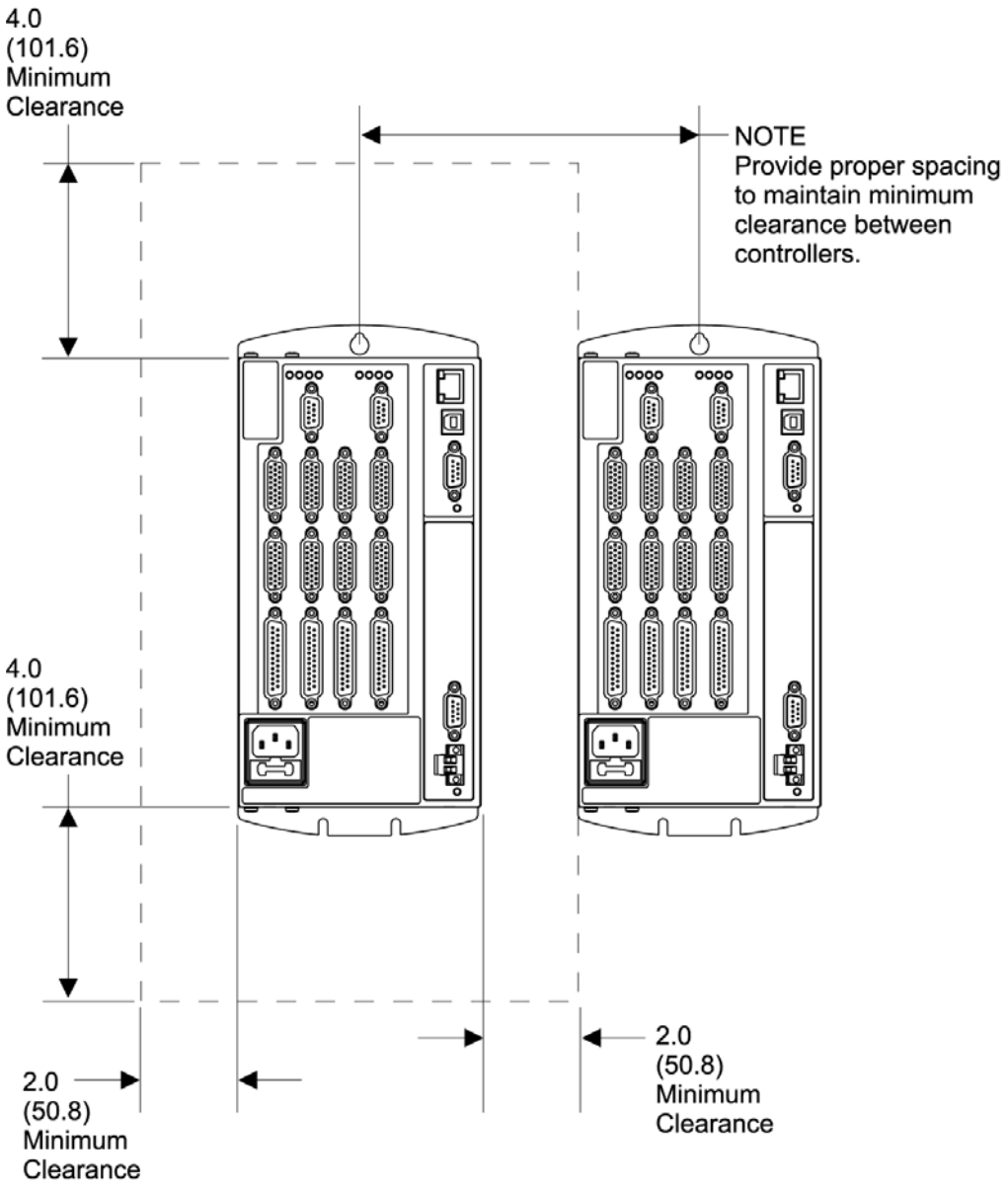


Figure 25 Mounting Clearance for ACR9000 and ACR9030 6/8 Axis Configuration

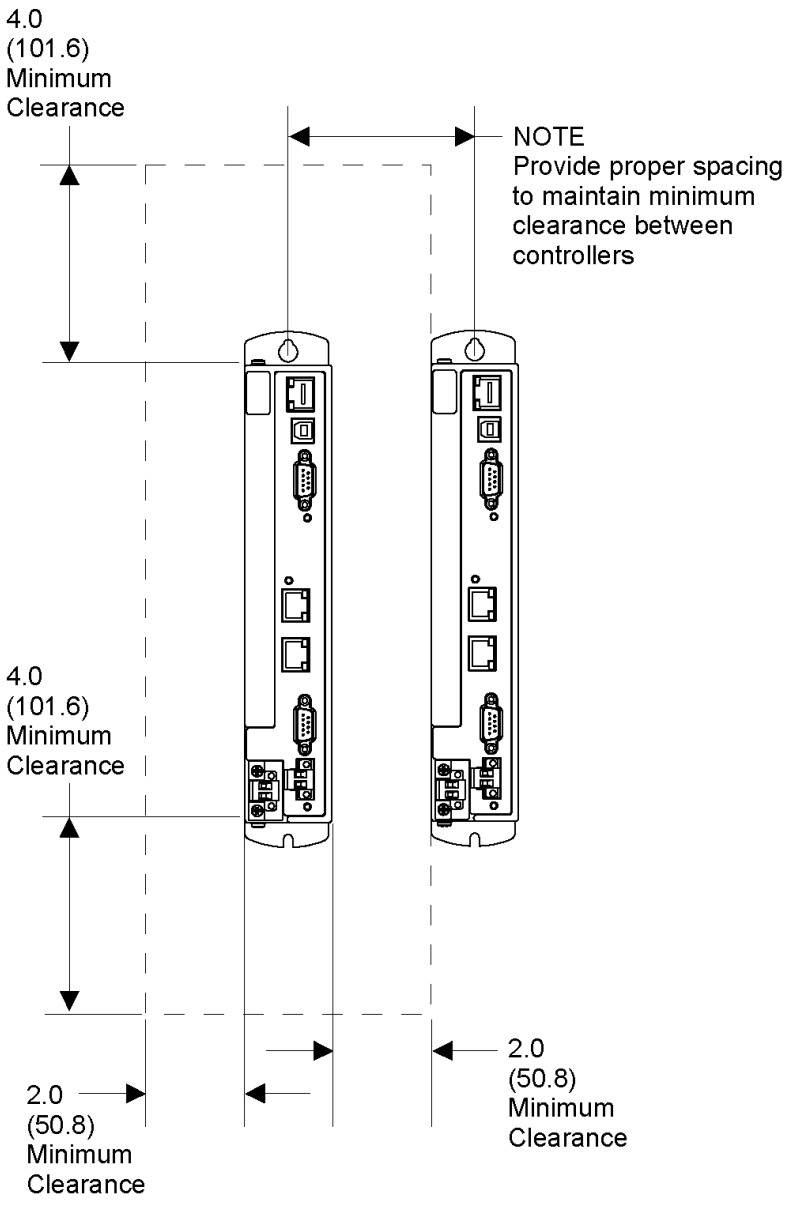


Figure 26 Mounting Clearance for ACR9040

Cable Installation

All connectors are on the front panel of the ACR90x0 controller. You may install cables in any order; however, make sure to install the power cord *last*. For convenience, we recommend starting with the connections at the bottom of the front panel. Refer to Chapter 2 Specifications for connector locations, specifications, and pinouts.

As with any D-sub connector, make sure the securing screws are sufficiently tightened to secure the cable connection to the controller.

Cable Routing

Route the high power cable (AC mains) at a right angle to low power cables (communications and inputs/outputs). **Never route high and low power cables parallel to each other.**

Cable EMC Requirements

EMC Ready Cables

Many Parker Hannifin cables are EMC installation ready. If installed according to the instructions in **Error! Reference source not found.** on page **Error! Bookmark not defined.**, these cables aid the user in gaining European Compliance, and therefore are an integral part of a CE-system solution. EMC cables add RF screening and bonding to reduce emissions, increase immunity, and provide high-integrity safety-Earth bonding. They also help to reduce problems in environments with high electrical noise.

Non-EMC Cables

Parker Hannifin also offers non-EMC cables, for applications in which CE compliance is not required or ambient electrical noise does not cause problems. Because these cables are either unshielded, or contain simple-foil shielding terminated by a drain wire, they do not provide significant shielding of electrical noise at high frequencies.

Enable Connection

The ACR90x0 provides one user-enabled interface for emergency stop purposes. The Motion Enable connector (labeled "ENABLE" on the front of the unit) is a two-pin removable screw terminal located on the front panel of the unit. The Anode (+) and Cathode (–) are on separate connector pins to allow flexibility in wiring to different styles of interface. A current must flow through the Motion Enable input for motion to occur on any axis.

Warning — Damage to the ACR90x0 will result if the 24 Volt supply used on the Motion Enable input is shared with an inductive load (such as brakes, solenoids, contactors, or relays).

Do not use the same power supply as your inductive loads unless you place a loop-back diode as shown in Figure 27. (Place the diode as close as possible to the inductive load to reduce the possibility of emitted electrical noise.)

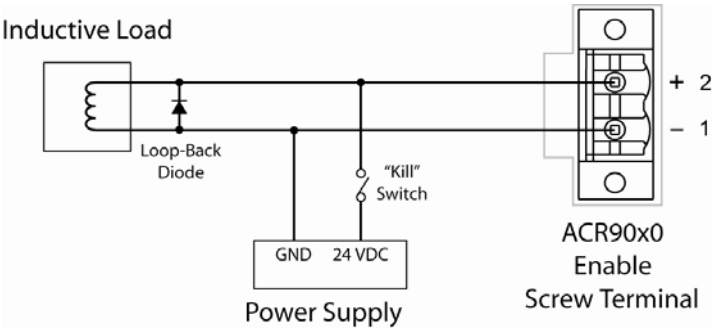


Figure 27 Loop-Back Diode with Shared Power Supply

For more information, see “Enable Connector” on page 52.

NOTE: Parker-built servo motors include protection with their internal brakes. These are in the form of full-wave rectifiers for the BE, J, M/SMN (serial number 050801nnnnn and up), MPP, Neo and SM series motors and loop-back diodes for M/SMN (before serial number 050801nnnnn), and MPM series motors. Be sure to observe polarity for brake connections for motors equipped with loop-back diodes.

Some Parker Daedal-built positioners with external brakes do not have protection diodes installed. For these positioners with external brakes, the diode would go between the brown (+24VDC) and blue (24V RTN) wires.

COM1 Connection

Connect the ACR90x0 controller directly to a personal computer (PC) or similar serial device through the COM1 port, *only* after properly configuring your cable and connectors. (For mating-connector specifications, see COM1 Mating-Connector Specification on page 55.) The COM1 port is located on the front panel of the unit. The unit does not provide a COM2 port.

Note: Do not connect the ACR90x0 controller in an RS-232 or RS-485 daisy chain or multi-drop network; it will not function properly.

The COM1 port is hardware configurable for either an RS-232 or RS-485 full-duplex operation. (It does not support half-duplex operation.) Use the information in this section to configure your cable and connectors for RS-232 or RS-485 operation. The controller does not provide internal termination resistors for RS-485 operation. If termination is required, you must add it externally. Figure 28 shows the pin assignments for RS-232 and RS-485 operation.

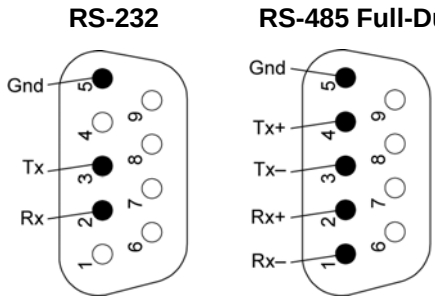


Figure 28 RS-232/485 Connector Pin Assignments

Transmission Modes

The COM1 connector contains two mode pins, 7 and 9. Figure 29 shows the location of the pins. Table 36 shows the mode pin assignments for establishing RS-232 or RS-485 operation. (For example, to establish RS-485 full-duplex operation, connect pins 7 and 9 to ground.)

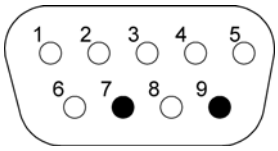


Figure 29 COM1 Mode Pins (7 and 9)

Operation	COM1 Modes	
	Pin 9 (Mode1)	Pin 7 (Mode 0)
RS-232 full-duplex	Open	Open
RS-485 full-duplex	GND	GND
Reserved	Open	GND
Reserved	GND	Open
Note: The controller defaults to RS-232 operation—pins 7 and 9 are not connected to ground (Open).		

Table 36 COM1 Transmission Modes

The COM 1 port supports the following characteristics for RS-232 and RS-485 transmission:

- 1200, 2400, 4800, 9600, 19200, 38400 baud (The controller automatically detects baud upon start-up.)
- 8 data bits
- 1 stop bit
- No parity
- Xon/Xoff flow control

RS-232 Communications

The ACR90x0 controller's COM1 port default configuration is for RS-232 transmission with a standard cable. For information on cables available from Parker Hannifin, see Table 2 ACR9000 and ACR9030 Controller Accessories on page 18 and Table 3 ACR9040 Controller Accessories on page 19.

Before installing a cable, verify that the pin connections between the PC and the controller are configured as shown in Table 37. (Table 37 shows the pinout for both a 9-pin and 25-pin PC connector.)

Note: *Do not* connect the controller in an RS-232 daisy chain; it will not function properly.

Pinout for RS-232 Full-Duplex Communication			
PC 9-Pin Connector	**PC 25-Pin Connector**		**ACR90x0 COM1 9-Pin Connector**
Pin 3, Tx	Pin 2, Tx	to	Pin 2, Rx
Pin 2, Rx	Pin 3, Rx	to	Pin 3, Tx
Pin 5, Gnd	Pin 7, Gnd	to	Pin 5, Gnd[1]

1. Many PC COM ports connect RS-232 ground to chassis ground.

Notes:

Maximum RS-232 cable length is 50 feet (15.25 meters).

For details on connector configuration, see Transmission Modes on page 73.

Table 37 COM1 RS-232 Pinout

RS-485 Communications

The ACR90x0 supports RS-485 full-duplex (four-wire) communication. No internal termination resistors are provided for RS-485 operation, however. If termination is required for RS-485 operation, you must add it externally.

Note: Do not connect the controller in an RS-485 daisy chain or multi-drop network; it will not function properly.

Table 38 on page 75 contains the COM1 connector pinout.

Pinout for RS-485 Full-Duplex (Four-Wire) Communication	
Pin	**Description**
1 & 2	Rx (receive). Connect to Tx on your computer.
3 & 4	Tx (transmit). Connect to Rx on your computer.
5	DGND[1] (logic ground). Connect to DGND on your computer.
1. Many PC COM ports connect RS-485 ground to chassis ground.	
Notes:	
Maximum RS-485 cable length is 1000 feet (305 meters).	
Keep wires as short as possible. Termination resistors may be required on long cable runs.	
The recommended cable is Belden 9842 with a termination resistor value of 120Ω.	
For details on connector configuration, see Transmission Modes on page 73.	

Table 38 RS-485, Four-Wire Connector Pinout

General Purpose Input/Output Connection

Depending upon the configuration of your ACR9000 or ACR9030 controller, there are either two or four connectors for general-purpose inputs and outputs on the front panel. The 2/4 Axis Configuration provides twenty digital inputs and four digital outputs through two connections. The 6/8 Axis Configuration provides forty inputs and eight outputs through four connections. (See Chapter 2, “External I/O Interface,” pages 47 through 51 for specifications, illustration, and labeling of the connectors.)

To aid installation, Parker Hannifin offers the VM25 expansion I/O module to adapt the controller’s 25-pin D-sub connector(s) to screw terminals. For more information, see Appendix B VM25 Breakout Module on page 112.

Axis Connection

Your ACR9000 or ACR9030 controller may be configured with two, four, six, or eight Axis connectors depending on your requirements. Each connector functions as an integrated drive/encoder interface for one axis of motion. Make one connection for each required axis of motion. The connectors are on the front panel of the unit and are 26-pin, female D-sub, high-density connectors. For the Axis connector specifications and pinout, see “Axis Connectors, 0-7” on pages 34 through 43.

The following section contains specifications and information for connecting the Axis interface to various compatible drives and encoders.

Drive Connections

Table 39 contains the drive cables for connecting the Axis interface to the specific drives shown. Pinouts of the drive cables follow.

Drive	Drive Cable Part Number
Aries EPL and Compax3 EPL [1]	71-028656-xx
Aries	71-021599-xx
Compax3	71-021108-xx
Dynaserv G3	71-023715-xx
Gemini Servo	71-021112-xx
Gemini Stepper	71-022316-xx
Parker Steppers (E-AC, E-DC, Zeta, etc.)	71-021113-xx
SLVD and HPD	71-021109-xx
ViX	71-021110-xx
Other (flying leads)	71-022344-xx

1. Each cable comes in a 1-foot (304.8 mm), 3-foot (914.1 mm), 5-foot (1,524mm), 10-foot (3,048 mm), or 25-foot length (7,620 mm) in the part number -xx (-01, -03, -05, -10, or -25).

Note: Each (non-EPL) cable comes in a 4-foot (1,219 mm) or 10-foot length (3,048 mm) in the part number -xx (-04 or -10).

Table 39 Drive Connection Cables

Aries Drives

The following pinout is for the Aries drive's 26-pin Drive I/O connector.

Part number 71-021599-xx

Note: A box surrounding pins indicates a requirement for twisted-pair wiring.

ACR9000 and ACR9030 Controller		Wire Color	Aries
Signal	**Pin**		**Pin**
5 VDC PWR	1	Black	1
Drive Enable+	21	Red	21
DC RETURN	2	Orange	2
Drive GND	19	Violet	19
Encoder CHA+	3	Green	3
Encoder CHA–	4	White	4
Encoder CHB+	5	Yellow	5
Encoder CHB–	6	Orange	6
Encoder CHZ+	7	Blue	7
Encoder CHZ–	8	Violet	8
Drive Step+	10	Red	10
Drive Step–	11	Green	11
Drive Direction+	12	Yellow	12
Drive Direction–	13	Blue	13
Drive AOUT+	14	Gray	14
Drive AOUT–	15	Brown	15
Drive Fault–	17	Pink	9
5 VDC PWR	18	Wht-Blu	18
Drive Reset+	23	Blu-Wht	23
Drive Enable–	20	Black	20
Drive Reset–	22	White	22
Drive Talk+	25	Red	25
Drive Talk–	26	White	26

Note: In the controller connector, pins 9 & 16 are jumpered. In the Aries connector, pins 16 & 24 are jumpered.

Table 40 Connection to Aries Pinout

Compax3 Drives

The following pinout is for the Compax3 drive connectors.

Part number 71-021108-xx

Note: A box surrounding pins indicates a requirement for twisted-pair wiring.

ACR9000 and ACR9030 Controller		Wire Color	Compax3 X11	Compax3 X12
Signal	**Pin**		**Pin**	**Pin**
Encoder CHA+	3	Black	7	—
Encoder CHA–	4	Red	6	—
Encoder CHB+	5	Green	8	—
Encoder CHB–	6	White	12	—
Encoder CHZ+	7	Yellow	14	—
Encoder CHZ–	8	Orange	13	—
Drive AOUT+	14	Blue	9	—
Drive AOUT–	15	Violet	11	—
Drive Fault+	16	Gray	—	2
Drive Enable–	20	Brown	—	6 & 8
Drive Enable+	21	Blue	—	1, 7, & 11
Drive GND	24	Violet	—	15
NOTE: In the controller connector, pins 17 & 19 are jumpered. In the Compax3 X12 connector, pins 1, 7, & 11 are jumpered.				

Table 41 Connection to Compax3 Pinout

Dynaserv G3 Drives

The following pinout is for the Dynaserv drive's CN4 connector.

Part number 71-023715-xx

Note: A box surrounding pins indicates a requirement for twisted-pair wiring.

ACR9000 and ACR9030 Controller		Wire Color	Dynaserv
Signal	**Pin**		**Pin**
5 VDC PWR	1	Black	1
DC RETURN	2	Red	2
Encoder CHA+	3	Green	9
Encoder CHA–	4	White	10
Encoder CHB+	5	Yellow	11
Encoder CHB–	6	Orange	12
Encoder CHZ+	7	Blue	13
Encoder CHZ–	8	Violet	14
Drive Step+	10	Gray	15
Drive Step–	11	Brown	16
Drive Direction+	12	Tan	17
Drive Direction–	13	Pink	18
Drive AOUT+	14	Wht-Blu	35
Drive AOUT-	15	Blu-Wht	36
Drive Fault–	17	Black	3
Drive Enable+	21	Yellow	20
Drive Reset+	23	Gray	19
Note: In the controller connector, the following pins are jumpered: 16 & 18 19 & 20 22 & 24			

Table 42 Connection to Dynaserv Pinout

Gemini Servo Drives

The following pinout is for the Gemini Servo drive's 50-pin Drive I/O connector.

Part number 71-021112-xx

Note: A box surrounding pins indicates a requirement for twisted-pair wiring.

ACR9000 and ACR9030 Controller		Wire Color	Servo
Signal	**Pin**		**Pin**
5 VDC PWR	1	Pink	26
DC RETURN	2	Tan	7
Encoder CHA+	3	Black	14
Encoder CHA–	4	Red	15
Encoder CHB+	5	Green	16
Encoder CHB–	6	White	17
Encoder CHZ+	7	Yellow	18
Encoder CHZ–	8	Orange	19
Drive AOUT+	14	Blue	23
Drive AOUT–	15	Violet	24
Drive Fault–	17	Brown	43
Drive Enable–	20	Gray	2
Drive Enable+	21	Blu-Wht	1
Drive Reset–	22	Wht-Blu	6
Drive Reset+	23	Orange	3
Note: In the controller connector, pins 16 & 18 are jumpered.			

Table 43 Connection to Gemini Servo Pinout

Gemini Stepper Drives

The following pinout is for the Gemini Stepper drive's 50-pin Drive I/O connector.

Part number 71-022316-xx

Note: A box surrounding pins indicates a requirement for twisted-pair wiring.

ACR9000 and ACR9030 Controller		Wire Color	Stepper
Signal	**Pin**		**Pin**
DC RETURN	2	Pink	7
Encoder CHA+	3	Black	14
Encoder CHA–	4	Red	15
Encoder CHB+	5	Green	16
Encoder CHB–	6	White	17
Encoder CHZ+	7	Yellow	18
Encoder CHZ–	8	Orange	19
Drive Step+	10	Violet	8
Drive Step–	11	Blue	9
Drive Direction+	12	Gray	10
Drive Direction–	13	Brown	11
Drive Fault–	17	Blu-Wht	43
Drive Enable–	20	Wht-Blu	2
Drive Enable+	21	Yellow	1
Drive Reset–	22	Blue	6
Drive Reset+	23	Red	3

Note: In the controller connector, pins 16 & 18 are jumpered. In the Gemini Stepper connector, pins 4 & 26 are jumpered.

Table 44 Connection to Gemini Stepper Pinout

Parker Stepper Drives: E-AC, E-DC, Zeta, etc.

The following pinout is for all Parker Stepper drive Indexer connectors.

Part number 71-021113-xx

Note: A box surrounding pins indicates a requirement for twisted-pair wiring.

ACR9000 and ACR9030 Controller		Wire Color	Stepper
Signal	**Pin**		**Pin**
DC RETURN	2	Yellow	21
5 VDC PWR	9	Orange	11
Drive Step+	10	Black	1
Drive Step–	11	Red	14
Drive Direction+	12	Green	2
Drive Direction–	13	White	15
Drive Fault+	17	Blue	9
5 VDC PWR	18	Violet	16
Drive Enable+	21	Gray	17
Drive Reset+	23	Brown	23
Note: In the controller connector, the following pins are jumpered: 19 & 20, 1 & 16, 22 & 24			

Table 45 Connection to Parker Stepper Pinout

SLVD and HPD Drives
The following pinout is for the SVLD drive's X3 connector, and the HPD drive's X7 connector.

Part number 71-021109-xx

Note: A box surrounding pins indicates a requirement for twisted-pair wiring.

ACR9000 and ACR9030 Controller		Wire Color	SLVD & HPD
Signal	**Pin**		**Pin**
DC RETURN	2	Tan	Flying lead
Encoder CHA+	3	Black	1
Encoder CHA–	4	Red	2
Encoder CHB+	5	Green	3
Encoder CHB–	6	White	4
Encoder CHZ+	7	Yellow	5
Encoder CHZ–	8	Orange	6
Drive AOUT+	14	Blue	Flying lead
Drive AOUT–	15	Violet	Flying lead
Drive Fault+	16	Pink	Flying lead
Drive Fault–	17	Gray	Flying lead
Drive Enable–	20	Brown	Flying lead
Drive Enable+	21	Blu-Wht	Flying lead

Table 46 Connection to SLVD and HPD Pinout

ViX Drives

The following pinout is for the ViX drive's X4 connector.

Part number 71-021110-xx

Note: A box surrounding pins indicates a requirement for twisted-pair wiring.

ACR9000 and ACR9030 Controller		Wire Color	ViX
Signal	**Pin**		**Pin**
DC RETURN	2	Tan	3
Encoder CHA+	3	Black	14
Encoder CHA–	4	Red	9
Encoder CHB+	5	Green	15
Encoder CHB–	6	White	10
Encoder CHZ+	7	Yellow	5
Encoder CHZ–	8	Orange	4
Drive AOUT+	14	Blue	1
Drive AOUT–	15	Violet	2
DRV FAULT IN–	17	Gray	6
DRV ENABLE+	21	Brown	11
Note: In the controller connector, pins 9 & 16, and 20 & 24 are jumpered.			

Table 47 Connection to ViX Pinout

Other Drives

The following pinout is for connection to a drive with a flying leads assembly.

Part number 71-022344-xx

Note: A box surrounding pins indicates a requirement for twisted-pair wiring.

ACR9000 and ACR9030 Controller		Wire Color	Other
Signal	**Pin**		**Pin**
5 VDC PWR	1	Black	Flying lead
DC RETURN	2	Red	Flying lead
Encoder CHA+	3	Green	Flying lead
Encoder CHA–	4	White	Flying lead
Encoder CHB+	5	Yellow	Flying lead
Encoder CHB–	6	Orange	Flying lead
Encoder CHZ+	7	Blue	Flying lead
Encoder CHZ–	8	Violet	Flying lead
5 VDC PWR	9	Blue	Flying lead
Drive Step+	10	Orange	Flying lead
Drive Step–	11	Violet	Flying lead
Drive Direction+	12	Tan	Flying lead
Drive Direction–	13	Pink	Flying lead
Drive AOUT+	14	Gray	Flying lead
Drive AOUT–	15	Brown	Flying lead
Drive Fault+	16	Yellow	Flying lead
Drive Fault–	17	Blue	Flying lead
5 VDC PWR	18	Orange	Flying lead
Drive GND	19	Blu-Wht	Flying lead
Drive Enable–	20	Black	Flying lead
Drive Enable+	21	White	Flying lead
Drive Reset–	22	Red	Flying lead
Drive Reset+	23	Green	Flying lead
Drive GND	24	Wht-Blu	Flying lead
Drive Talk+	25	Red	Flying lead
Drive Talk–	26	White	Flying lead

Table 48 Connection to Drive with Flying Leads

Differential and Single-Ended Encoders

Differential encoders may be connected without hardware modification. To connect a line driven, single-ended encoder, connect the encoder signal to the “+” terminal while providing a common ground between the encoder and controller. Then attach a resistor divider network across the “–” terminal, with one resistor (681 ohms) pulled to +5V, and the other resistor (681 ohms) pulled to ground.

CANopen Connection

This section contains guidelines and cable specifications for connecting a CANopen network with multiple slave nodes or a single slave node to the ACR90x0 master node. The CANopen connector is on the front panel of the controller. (For specifications, see “CANopen Connector” on page 58.)

Use the following guidelines for installing a CANopen network with the ACR90x0 controller.

- Route a main trunk line near the point of use.
- Connect drop lines between the trunk line and the CANopen nodes.
- Install termination resistors (120 ohms) at both ends of the trunk line.

Figure 30 on page 87 shows a typical CANopen network for the ACR9000 (ACR90x0) controller, with a main trunk line and drop lines to the CANopen nodes.

Table 49, also on page 87, contains a minimum CANopen connector pinout for the installation.

“Selecting CANopen Cables” on page 88, provides information on proper cable types and lengths, and termination values for the network.

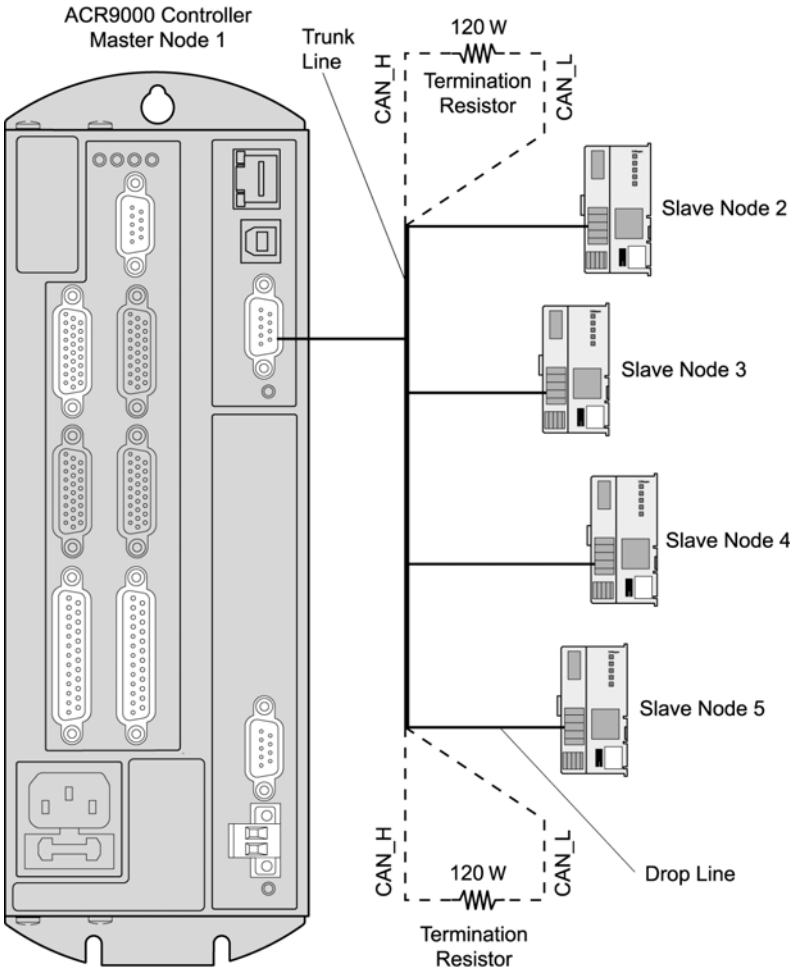


Figure 30 CANopen Network for ACR90x0

ACR90x0 CANopen Pinout (Minimum)		
Pin	**Description**	**Wire Color**
2	Connect to CAN_L on slave node(s)	White
7	Connect to CAN_H on slave node(s)	Blue
3	Connect to CAN_GND on slave node(s)	Black

Notes

CANopen recommends that all nine wires on the connector be routed to support future network enhancements. The signals listed above are the minimum required for the ACR90x0.

CAN_H and CAN_L should be a twisted-cable pair with a third wire run as a common ground between nodes. If all network nodes implement isolation, CAN_GND is optional. Connection is recommended if the network contains non-isolated nodes.

Use shielded cabling to improve network noise immunity. See Appendix on page **Error! Bookmark not defined.**.

The conductor shield of the cable may be routed to pin 5, CAN_SHLD, which is terminated with 1MΩ resistor to protective earth. If required, make a low ohmic connection of the shield to the protective earth through the metal D-sub back shell.

Table 49 CANopen Pinout (Minimum)

Selecting CANopen Cables

The cables, connectors, and termination resistors in CANopen networks must meet the requirements defined in ISO 11898.

For point-to-point connection between a single CANopen slave node and the ACR90x0 master node, Parker Hannifin provides the cable assembly in Table 50. Table 51 contains the cable's connector pinout.

CANopen Point-To-Point Cable	
Part Number	**Description**
71-022338-xx[1]	ACR90x0 CANopen master node to single slave node, 9-pin female D-sub to flying leads

1. The cable comes in 2-foot (609.6 mm) or 4-foot length (1,219 mm) in the part number -xx (-02 or -04).

Notes:

The connector on one end is a 9-pin female D-sub connector; the other end has flying leads for connecting to screw terminals.

The above cable assembly includes a termination resistor (120Ω) within the D-sub connector. Parker Hannifin recommends installing another resistor at the screw terminal (120Ω).

Table 50 CANopen Point-To-Point Cable

Note: A box surrounding pins indicates a requirement for twisted-pair wiring.

ACR Controller CANopen Master Node			Single CANopen Slave Node
Signal	**Pin**	**Wire Color**	**Pin**
No connect	1	NC	
CAN_L	2	White	Flying lead
CAN_H	7	Blue	Flying lead
CAN_GND	3	Black	Flying lead
No connect	4	NC	
CAN_SHLD	5	Shield drain	Flying lead
No connect	6	NC	
No connect	8	NC	
CAN_V+	9	NC	

Table 51 CANopen Point-To-Point-Cable Connector Pinout

For multiple CANopen slave nodes, you must fabricate your own cable network. Parker Hannifin recommends the cables provided in Table 52.

CANopen Cables for Multiple-Node Networks	
Part Number	**Description**
Belden 7895A or equivalent	Short to moderate cable runs[1]
Belden 7896A or equivalent	Long cable runs[1]
1. See Table 53 for bit-rate de-rating and cable lengths.	
Notes	
Maximum slave node count is ≤ 4.	
Parker Hannifin recommends installing a termination resistor (120Ω) at both ends of the CANopen trunk line.	
The blue/white twisted pair is for signal transmission, and the black/red pair is for ground and power.	

Table 52 CANopen Cables for Multiple-Node Networks

Table 53 contains estimated cable and drop-line lengths to serve as a guideline for installing a CANopen network.

Bit Rate (bits/ second)	Maximum Bus Length (m)	Maximum Drop Length (m)	Maximum Cumulative Drop Length (m)	Recommended Cable
1M	30	2	10	Belden 7895A
800k	50	3	15	
500k	100	5	25	
250k	250	10	50	
125k	500	20	100	
50k	1000	48	240	Belden 7896A
20k	1000	120	600	
10k	1000	120	600	
Notes				
Maximum bus length includes the length of the main trunk line plus the length of all the drop lines.				
Maximum drop length is for a single drop line.				
Maximum cumulative drop length is the total length of all drop lines.				
Keep wires as short as possible, especially drop lines.				
Parker Hannifin recommends installing a termination resistor (120Ω) at both ends of the CANopen trunk line.				
System noise, improper cable routing, incorrect cable type, and number of CANopen nodes can all degrade network performance. Reliable operation may require shorter cable lengths. See noise-related issues in **Error! Reference source not found.** on page **Error! Bookmark not defined.**.				

Table 53 Estimated Cable and Drop-Line Lengths

Use the information in Table 54 to select a cable and/or vendor other than those described previously.

	Bus Cable	
Bus length [m]	**Length-Related Resistance [mΩ/m]**	**Wire Gauge (mm2)**
0 to 40	< 70	24 AWG (0.25 to 0.34)
40 to 300	< 60	22 AWG (0.34 to 0.6)
300 to 600	< 40	20 AWG (0.5 to 0.6)
600 to 1000	< 26	18 AWG (0.75 to 0.8)

Note

Recommended cable AC parameters: 120 Ω impedance and 5-ns/m specific line delay.

Termination resistor value should match the cable impedance value, typically 120Ω impedance.

See Table 53 for bit-rate de-rating and cable lengths.

For proper shielding requirements, see **Error! Reference source not found.** on page **Error! Bookmark not defined.**.

For more information on selecting cables, see the CANopen spec DR303 – "CANopen Cabling and Connector Pin Assignment", www.canopen.org/canopen.

Table 54 CANopen Bus-Cable Specifications

CANopen Electrical Installation Test

Before testing, verify that you have installed proper cable shielding and earth drains for your application. (For more information, see **Error! Reference source not found.** on page **Error! Bookmark not defined.**.)

Perform the installation test in Table 55 on page 90 prior to connecting any nodes (slave or master) to the CANopen network. This test verifies that you have properly connected the data lines and termination resistors.

For more information about the location and value of termination resistors, see pages 87 and 89. Use an ohmmeter to perform all measurements in Table 55.

Measurement (between)	Value	What It Means
CAN_L and CAN_GND	Infinite	Normal
	0Ω (ohms)	CAN_L and CAN_GND are shorted together in the wiring harness. Correct this before proceeding.
CAN_H to CAN_GND	Infinite	Normal
	0Ω	CAN_H and CAN_GND are shorted together in the wiring harness. Correct this before proceeding.
CAN_L to CAN_H	~ 60Ω	Normal
	~ 120Ω	Only 1 termination resistor is installed. You must install a second termination resistor.
	< 50Ω	More than 2 termination resistors are installed, or the resistors have incorrect values. Install the correct number or value of termination resistors before proceeding.

Table 55 CANopen Network Installation Test

CANopen Functional Installation Test

Having performed the electrical installation test, you can proceed with a functional test.

Single Node Network

1. Power up the ACR90x0.

   The controller should have a green, blinking CANopen Status LED, and the I/O node should have a green blinking Run LED.

2. Start the ACR-View software, and then open a terminal emulator session.

3 After all nodes and connections are set up, set these parameters for ACR90x0:

   a. P32769 = bit rate

   b. P32770 = number of nodes on the bus

   c. P33024 = node0 ID

   d. P33040 = node1 ID

   e. P33056 = node2 ID

   f. P33072 = node3 ID

   g. P32772 = cyclic period (ms)

4. To start the network, send the `SET11265` command to set bit 11265.

   Both the controller and I/O node should have a steady green LED.

Multiple Node Network

1. Power up the ACR90x0.

   The controller should have a green, blinking CANopen Status LED, and the I/O nodes should have green blinking Run LEDs.

2. Start the ACR-View software, and then open a terminal emulator session.

3. Set the number of I/O nodes in the network. Send `P32770=n` where `n` equals the number of nodes (range =0-4). The factory default is set to 1.

4. Assign a unique address to each I/O node.

   a. On each I/O node, configure the dip switch to assign a hardware address. For more information, see Hardware Address (Module ID) in the Parker I/O System manual.

   b. In the terminal emulator, set the corresponding parameters for the addresses assigned to the I/O nodes.

ACR90x0 Node Number	Parameter	Default ID Value
0	33024	1
1	33040	0
2	33056	0
3	33072	0

Example

Suppose you are installing a three node network. To set the number of nodes in the network, the following parameter is set:

```
P32770=3
```

Next, the hardware addresses are assigned. The first node requires no configuration—the factory default hardware ID is set to 1, and the ACR90x0 is factory configured to recognize hardware ID 1. The hardware of the second and third nodes are configured, then the following parameters are set:

```
P33040=2
```

```
P33056=3
```

5. To start the network, send the `SET11265` command to set bit 11265.

   The controller and I/O nodes should have steady green LEDs

6. Send the `ESAVE` command.

Ethernet Cable Specification

Cable.....RJ-45 Ethernet, unshielded CAT 5E

Ethernet Connection

The Ethernet port is located on the front panel of the ACR90x0. (For specifications, see Ethernet Connector on page 60.)

Before connecting to an Ethernet port, you must configure the ACR90x0 to use an IP address and subnet mask that is valid for your network. The factory assigns an IP address of 192.168.10.40 and a subnet mask of 255.255.255.0 to each controller. Before adding the controller to your network, assign it an IP address and subnet mask appropriate for your network.

Important!

Talk with your Network Administrators before assigning an IP address or subnet mask to a controller. They can provide you with an available IP address, as well as which subnet mask is appropriate for your particular network configuration.

Isolate the ACR90x0 controller and related devices on their own subnet. The high-volume traffic on networks can affect the ACR90x0 controller's performance. A closed network restricts the flow of traffic to only the controller and related devices.

Assigning an IP Address and Subnet Mask

The following procedure is for configuring an ACR90x0 controller using a Serial connection.

1. Using a standard RS-232 cable, connect the COM1 serial connector on the ACR90x0 to a serial port on your PC. For information about COM1, see pages 54 and 72.
2. Using an Ethernet crossover cable, connect the ACR90x0 to your PC.
3. Start the ACR-View software, and set up a basic project:
   a. In the **New/Open Project** dialog box, select **Create New Project**. Then enter a title in the box, and click **OK**.
   b. Select your specific ACR90x0 controller model and then click **Next**.
   c. Enter the part number for the controller and then click **Next**.
   d. In the **Controller Alias** box, type your ACR90x0 model (ACR9000, ACR9030, or ACR9040) and then click **Next**.
   e. In the dialog box under **Communications**, click **Serial**. Then select the COM port (on the personal computer) you want to use from the left-most list. Then select the Baud for communications from the right-most list.
   f. Click **Connect**.
4. In the **Project Workspace** (to the left), select **Terminal Emulator**.
5. In the Terminal Emulator, do the following:
   a. To set the IP address, type `IP "xxx.xxx.xxx.xxx"` where x is the IP address. Quotation marks must surround the IP address.
   b. To set the subnet mask, type `IP MASK "xxx.xxx.xxx.xxx"` where x is the subnet mask. Quotation marks must surround the subnet mask.
   c. To save the settings, enter `ESAVE`.
   d. For the new settings to take effect, enter `REBOOT`.

Verifying the IP Address and Subnet Mask, and Communication

This procedure assumes you have completed Assigning an IP Address and Subnet Mask (above), you have not disconnected the ACR90x0, and the ACR-View software is still open.

1. In the **Project Workspace** (to the left), click on your ACR90x0 model (ACR9000, ACR9030, or ACR9040).
2. In the dialog box, click **Disconnect**.
3. Under **Communications**, click **Ethernet**. Then enter the IP address in the box to the right.
4. In the dialog box, click **Connect**.

5. In the Terminal Emulator, type VER. If the Ethernet is set up correctly, the terminal emulator reports the firmware version information for the ACR90x0. For troubleshooting Ethernet connections, see page 99.

USB Cable Specification

The ACR90x0 USB configuration uses a “standard detachable cable” (twisted-pair shielded) with a Series A connector at one end, and a Series B connector at the other end.

USB Connection

The USB (Universal Serial Bus) port is located on the front panel of the ACR90x0. (For specifications, see USB Connector on page 61.)

NOTE: Parker Hannifin does not provide USB cables.

Windows 98SE, Windows 2000 or Windows XP

To connect the ACR90x0 USB port to Windows 98SE, 2000, or XP follow these steps:

1. Connect the ACR90x0 to your PC using a standard USB cable.
2. The PC should find the new hardware. Run the **New Hardware Wizard**.
3. Select **Search for a suitable driver for my device (recommended)**, and click **Next**.
4. Select the **Specify Location** check box, and click **Next**.
5. Insert the ACR SDK disc into the CD-ROM drive.
6. Click **Browse**. Navigate to the following subdirectory on the ACR SDK—\Drivers\USB Win98-2K-XP. Click **OK**, and complete the **New Hardware Wizard**.

NOTE: The ACR9040 can experience intermittent USB communications that are caused by ground loops, or by power surges occurring when connecting the USB cable. (This occurs with certain combinations of power supplies and computers.)

If this occurs:

- When using an isolated 24 VDC power supply, such as Parker’s PS-60W, jumper the 24 V return/ground to Earth ground, and
- Use a USB hub between the host PC and the ACR9040.

Auxiliary Encoder Connection

The ACR9000 and ACR9030 controllers provide an interface for additional, non-drive-related encoder signals. The 2/4 Axis Configuration provides one auxiliary encoder interface; the 6/8 Axis Configuration provides two. The connector is on the front panel of the unit, labeled ENCODER 8 and/or 9. For the specifications of ENCODER 8 and ENCODER 9 connectors, see “Auxiliary Encoder Connector” on pages 46 and 47.

For information on single-ended encoders, see page 86.

AC Power Connection

After securely installing all other cables on the ACR9000 or ACR9030 controller, connect the device to an external 120/240 VAC mains power source. For more information on power requirements and the AC power connector, see Electrical Specifications on page 26.

DC Power Connection

The ACR9040 must be powered by a non-isolated 24 VDC power supply. Parker's PS-60W is an isolating DC power supply which can be converted to non-isolated by connecting an 18 AWG jumper between the DC return and Earth ground.

After securely installing all other cables on the ACR9040, connect the device to the non-isolated 24 VDC power supply. See Figure 31. For more information on power requirements and the DC power connector, see Electrical Specifications on page 26, and DC Power Connector (ACR9040) on page 27.

Warning — Damage to the ACR9040 will result if the 24 Volt supply used on the DC Power connection is shared with an inductive load (such as brakes, solenoids, contactors, or relays).

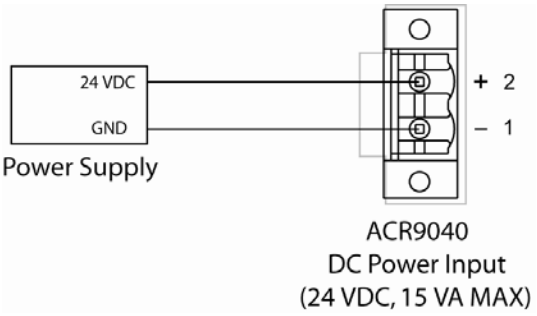


Figure 31 ACR9040 DC Power Connection

CHAPTER FOUR

4 Troubleshooting

IN THIS CHAPTER

Troubleshooting Guidelines

The ACR90x0 Stand-Alone Controller design features easy connectivity, auto-detect functions, and reliability. In addition, LEDs on the front panel of the unit provide quick identification of power, axis, and CANopen status. If, after following the installation guidelines in Chapter 3, your controller does not function properly, use the guidelines and procedures in this chapter to troubleshoot. These guidelines also apply to troubleshooting a malfunction during normal operation of the controller.

First Troubleshooting Steps

The first step in troubleshooting is to check the power-status LED on the front panel of the controller. It is next to the ENABLE connector on the ACR90x0 and is labeled POWER (OR PWR ON THE ACR9040). Table 56 describes the states of the power-status LED and troubleshooting actions.

Power-Status LED	What It Means
Off	No power Verify that the power source meets the requirements in Table 7 on page 26. Check for disconnected power cable, blown fuse, etc.
Green	Normal operation
Steady Red	Inadequate power 1. Verify that the power source meets the requirements in Table 7 on page 26. 2. Remove all cables except power. If the LED does not turn green, contact Parker Hannifin Technical Assistance.[1] If the LED turns green after removing the cables, re-attach the cables one at a time to determine which cable or device is causing the problem.
Alternating Red/Green	Contact Parker Hannifin Technical Assistance. [1]
1. For Parker Hannifin Technical Assistance contact information, see page 3.	

Table 56 Power-Status LED

General Troubleshooting

Use the following list as a guideline for troubleshooting. The balance of this chapter provides procedures for each of the guidelines in the list.

- Check the status-indicator LEDs for power, axis interface, and CANopen interface.
- Launch the ACR-View.
- Verify that RS-232/485 communications are functioning correctly.
- In the ACR-View, look in the Status panel to identify problems.
- Check for problems with system components other than the controller.
- Check our website's FAQs at www.parkermotion.com.

LED Status Indicators

Axis Status LEDs

Each axis of motion interface on the ACR9000 and ACR9030 (except ENCODER 8 and ENCODER 9) is assigned one bi-color LED by default. The LEDs are on the front panel above the ENCODER 8 and ENCODER 9 connectors. They are labeled AXIS and numbered 0 through 3 on the 2/4 Axis ACR9000 as shown in Figure 4 on page 30, and labeled 0 through 7 on the 6/8 Axis ACR9000 as shown in Figure 5; and labeled 0 through 3 on the ACR9030 as shown Figure 6. Table 57 describes the default LED illumination states and the conditions that they indicate.

Note: Use AcroBASIC commands to disable or reassign the purpose of the Axis-Status LEDs. The Enable Drive I/O flag command removes the assignment of the LED to axis "n." This makes it possible to change the LED using flags 56 through 63 and 96 through 103. For additional information, refer to the *ACR Parameter and Bit Reference* (formerly *AcroBASIC Command User Guide, Part 2*).

Axis Status LED	What It Means
Off	Axis disabled with no fault
Green	Axis enabled with no fault
Red	Axis fault; motion on this axis is disabled during a fault state. **Note:** The LED illuminates red whenever the drive fault input is activated (drive faulted, no axis cable connected, etc.).

Table 57 Axis Status LEDs

CANopen Status LED

The controller employs a bi-color LED that indicates the status of the CANopen network state machine and the CAN physical layer. It also indicates errors due to missing CAN messages (SYNC, GUARD, or HEARTBEAT). The LED is next to the CANopen interface on the front panel and is labeled STATUS, as shown in Figure 4 on page 30 and Figure 5 on page 31. Table 58 on page 99 provides the CANopen-Status-LED states and descriptions.

CANopen Status LED[1]		State	What It Means
Green	Flickering	AutoBaud/LSS	AutoBaud detection is in progress, or LSS services are in progress (alternately flickering with red LED).
	Single flash	Stopped	The device is in the stopped state.
	Blinking	Pre-Operational	The device is in the pre-operational state.
	On	Operational	The device is in the operational state.
Red	Single flash	Warning Limit Reached	At least one of the error counters of the CAN controller has reached or exceeded the warning level (too many error frames).
	Flickering	AutoBaud/LSS	AutoBaud detection is in progress or LSS services are in progress.
	Double flash	Error Control Event	A guard event (NMT-slave or NMT-master) or a heartbeat event (heartbeat consumer) has occurred.
	Triple flash	Sync Error	The SYNC message has not been received within the configured communication cycle period time out (see Object Dictionary Entry 0x1006)[2].
	On	Bus Off	The CAN controller is bus off.
Off	Off	Reset	The ACR90x0 is executing a reset.

1. LED Intervals:
   Flickering = on for ~50 ms and off for ~50 ms
   Blinking = on for ~200 ms and off for ~200 ms
   Single flash = on for ~200 ms and off for ~1000 ms
   Double flash = sequence of 2 flashes ~200 ms, separated by an off phase ~1000 ms
   Triple flash = sequence of 3 flashes ~200 ms, separated by an off phase ~1000 ms.

2. Object 0x1006 contains the sync cycle period in ms. The sync cycle period time out is the configured sync cycle period multiplied by 1.5.

Table 58 CANopen Status LED

Ethernet Status LEDs

The Ethernet status LEDs are located on the Ethernet connector.

LED	Steady	Flash	Description
Ethernet Link/Activity	Off	—	No Ethernet link detected
	Yellow	—	Ethernet link established, no activity
	—	Yellow	Ethernet link established and active
Ethernet Speed	Off	—	Ethernet 10Mbps
	Green	—	Ethernet 100Mbps

Table 59 Ethernet Status LED

CANopen Connection

Perform the following steps to resolve CANopen network problems.

- Confirm completion of the installation test on page 90.
- Verify that each node employs the correct pinout. For the ACR90x0 CANopen connector pinout, see Table 32 on page 58.
- The ACR90x0 controller provides a network-status LED, which indicates the state of the CANopen network interface. Use Table 58 on page 99 to resolve issues indicated by the LED states.
- CANopen slave nodes typically have a network-status LED; refer to the device's documentation for an explanation of the LED states and resolution of the issues indicated.

Ethernet Connection

Perform the following steps to resolve Ethernet network problems.

1. Verify that you are using the correct type of cable. See Ethernet Cable Specification on page 92.
2. Verify the cable pin out matches the ACR90x0. See Ethernet Cable Specification on page 92.
3. The ACR90x0 controller provides a network-status LED, which indicates the state of the Ethernet connection. See Table 59 on page 99.

   Do not proceed until the status LED indicates an Ethernet Link has been established.
4. Verify a valid IP and subnet mask has been assigned to the ACR90x0. See Ethernet Cable Specification on page 92.
5. Test the IP and subnet assignment. At a DOS or command prompt type `ping xxx.xxx.xxx.xxx` where xxx.xxx.xxx.xxx represents the IP address. Compare the response to the following:
   a. If you receive a "reply from" message, do the following:

      Disconnect the ACR90x0 Ethernet cable and type the `ping` command again.

      1. If you see "reply from" message, then another device or computer has already been assigned the same IP address. You can change IP address you assigned to the ACR90x0 or change the IP address of the conflicting device.
      2. If you see a "timeout" message, then the ACR90x0 is properly configured and is network accessible. Re-attach the ACR90x0 Ethernet cable.

   b. If a "timeout" message is seen, then the ACR90x0 has an invalid IP address or subnet mask setting. Determine the correct setting and update the ACR90x0.

RS-232/RS-485 Communication Problems

If you cannot establish serial communication with the ACR90x0 controller, use the information and procedures in this section to help isolate and resolve problems. For more information, see “COM1 Connector” on pages 54 and 55 and “COM1 Connection” on pages 72 through 75.

COM1 Port Settings (RS-232 and RS-485)

The COM1 port supports the following characteristics for RS-232 and RS-485 transmission:

- 1200, 2400, 4800, 9600, 19200, 38400 baud (The controller automatically detects baud upon start-up.)
- 8 data bits
- 1 stop bit
- No parity
- Xon/Xoff flow control

Physical Settings

Verify the physical settings for the COM1 port by following the steps in this section.

1. Use the connector pinout in Table 60 to confirm that your cable and mating connector are configured accurately for the COM1 port.

Signal	Pin	Signal	Pin
RX485–	1	No connect	6
RX232/RX485+	2	Mode 0	7
TX232/TX485–	3	No connect	8
TX485+	4	Mode 1	9
GND	5		

Table 60 COM1 Connector Pinout

2. Confirm that mode pins 7 and 9 are assigned as indicated in Table 61 for proper RS-232 or RS-485 full-duplex operation.

Interface	COM1 Connector Pin	
	Pin 9 (Mode1)	Pin 7 (Mode 0)
RS-232	Open	Open
Reserved	Open	GND
Reserved	GND	Open
RS-485 full-duplex	GND	GND
Note: The controller defaults to RS-232 operation—pins 7 and 9 set to Open.		

Table 61 COM1 Transmission Modes

3. Ensure that the RS-232 or RS-485 cabling is connected prior to applying power to the controller. Upon power-up, the controller detects physical settings on the COM1 connector and configures the connection accordingly.

Testing the COM Port

Test COM1 port communications using the ACR-View.

1. Cycle power on the ACR90x0; this puts the controller in AutoBaud.
2. On the ACR-View **Project Tree**:
    1. Select your ACR90x0 model.
    2. Under the **Communications** box, select **Serial**.
    3. Specify your COM port settings.
    4. Click the **Connect** button.
    5. Select the **Terminal Emulator**.
    6. Type *VER* and press the ENTER key. You should see a response.

Table 62 contains the COM-port-test error messages and their resolutions. For more information, see “COM1 Connection” on pages 72 through 75.

COM Port Error Message	Resolution
Invalid COM port number	Select a different COM port.
Unable to open COM port	No COM port has been specified, or the COM port is being used by other software. Select a different COM port.
No response from ACR90x0 controller	Power is not supplied to the controller, the controller is not powered up, the power connection is wired incorrectly, or the RS-232/RS-485 cable is wired incorrectly. Check the controller to verify that the power supply is connected, wired correctly. Then apply power to the controller. Verify the wiring on the RS-232/RS-485 cable.
Incorrect response from ACR90x0 controller	Verify that an ACR90x0 controller is connected to the selected COM port.
OS needs to be downloaded	Download the operating system to the ACR90x0 controller.
Cycle power and download OS	The ACR90x0 controller has encountered an error while downloading an operating system. Cycle power to the controller and download the operating system again.

Table 62 Communications Port Error Messages and Resolutions

Feedback Device Problems

Several controller parameters may need additional configuration to work with different types of feedback devices. The MULT command affects feedback polarity; the ENC SRC command selects the interpretation of encoder inputs.

If the feedback position does not change correctly, check the following:

- Confirm that the feedback cables are wired correctly.
- If the ACR9000 (or ACR9030) +5 VDC powers the feedback device, verify that the device is designed to be powered from +5 VDC and meets the current rating in Table 12 Axis Power Electrical Characteristics, on page 37.
- If the ACR9000 (or ACR9030) +5 VDC powers the feedback device and/or drive I/O, verify that a short circuit in the feedback device and/or cabling has not tripped the internal protection circuit. When the short-circuit event is removed, the internal protection circuit will automatically reset and apply power.
- The ACR9000 (or ACR9030) directly supports feedback devices with differential signaling (RS-422/RS-485). Single-ended feedback devices require external circuitry to be compatible with the ACR9000 (or ACR9030). For more information, see “Differential and Single-Ended Encoders” on page 86.
- Noise in the system can cause missed and/or false position values. Try to isolate the cause by removing one component at a time.
- Exceeding the maximum feedback frequency can cause wrong position values at high speeds. Peak frequency must account for velocity ripple. For more information, see Table 20 Encoder Electrical/Timing Characteristics on page 45.
- SSI feedback—confirm that the servo period is correctly configured to accommodate SSI setup and transfer time. For specifics, see Table 64 SSI Transfer-Cycle Timing Data, on page 111.
- For a stepper axis with feedback, you must set the Stepper Feedback flag in the Secondary Axis flags. For more information, refer to the ACR Command Language Reference (Online Help System in the ACR-View software).
- The feedback device is counting backwards. Use either:

  AcroBASIC remedy: Change the MULT command setting to either +4 or –4 to reverse feedback polarity (not applicable for SSI feedback devices).

  Hardware remedy: Depending on the feedback device used, take one of the following actions.

  If your application can change how the feedback device is mounted, you may be able to affect the count direction with it.

  For Quadrature feedback, switch Encoder CHB+ and Encoder CHB– between the controller and the feedback device.

  For Step and Direction feedback, switch Encoder CHB+ and Encoder CHB– between the controller and the feedback device.

For CW and CCW feedback, switch both the CW and CCW signal pairs between the controller and the feedback device.

For SSI feedback, switch the Drive AOUT+ and Drive AOUT– connection between the controller and the drive. (If the drive does not support differential outputs, switching the connections will not work.) **Note:** Some SSI encoders may have a polarity input that can be set to change the count direction.

Motion-Related Error Messages

Table 63 explains motion-related error messages you might encounter during installation of the controller.

Error Message	Description
Drive I/O Not Enabled	A `DRIVE` command was issued while Enable Drive I/O flag, was not set for that axis.
Not Valid While In Motion	A `DRIVE` command (any) was issued while that axis was in motion.
Drive I/O Enabled	An attempt was made to set or clear a flag that controls one of the physical drive I/Os while the Enable Drive I/O flag was set for that axis. The physical drive I/Os are drive enable output, drive reset output, drive fault input, red LED, and green LED.
Drive I/O Status Bit	An attempt was made to set or clear a flag that reflects drive status for an axis. These flags are controlled exclusively by firmware.
Associated Slave Kill Motion Request Active	An attempt was made to initiate motion on an axis whose Kill Motion Request flag was active. This affects all axes attached to a given master. Motion includes jog, cam, and gear motion.
Drive Output Enabled	An attempt was made to change the state of the Enable Drive I/O flag, while the axis' drive output was enabled.
Motion Enable Input Open	An attempt was made to execute a `DRIVE ON` while the controller's Motion Enable input was open. Resolution: Close the Motion Enable input circuit. If the Motion Enable input is not open, the ACR90x0 may be damaged. See the section "Motion Enable Input" below for more information.

Table 63 Motion-Related Error Messages

Motion Enable Input Open

Bit 5646 (Unlatched Motion Enable Input) is used to indicate when the Motion Enable input circuit is open. See Figure 32.

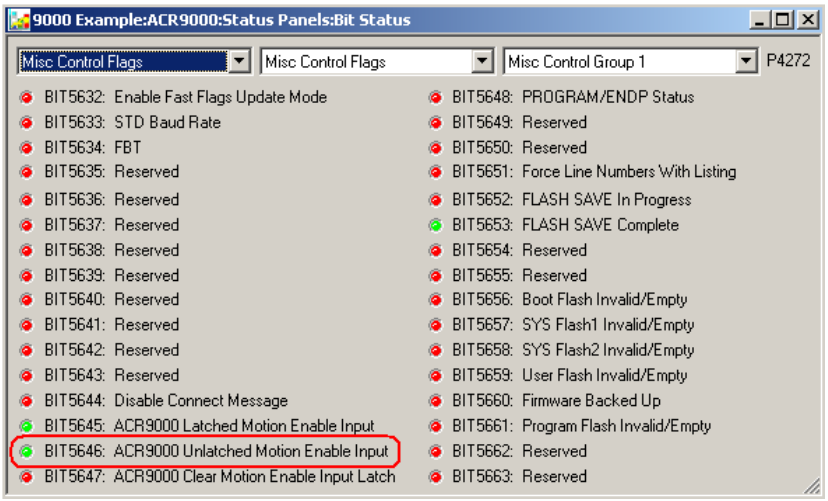


Figure 32 Motion Enable Input Fault

If the Motion Enable input circuit is closed and Bit 5646 still shows active, it indicates that the ACR90x0 may have been damaged by a large reverse current through the Motion Enable input connector. A large reverse current can be caused by using the Motion Enable's 24 V supply to also power inductive loads—such as brakes, solenoids, contactors, and relays—without loop-back protection diodes.

If you suspect your ACR90x0 has been damaged, see "Technical Assistance" on page 3 for information on how to contact the automation technology center.

See the section "Enable Connection" on page 71 for information on Motion Enable input connections.

Axis I/O Troubleshooting

Several controller parameters may need additional configuration to work with different types of drives.

If motion does not occur:

- Enable input is not connected; see "Enable Connection" on page 71 and "Enable Connector" on pages 52 and 54.
- The load is jammed; remove power and clear jam.
- Use the information in the section "Axis Status LED" on page 98 to determine LED states and methods of resolution.
- See "General Drive I/O" below for drive-function specifics.

General Drive I/O

For problems with the drive function of the Axis I/O, check the following configurations.

1. If the drive will not enable, verify that the drive's fault output configuration is correct (Gemini command, `OUTLVLx1`, etc.). See also AcroBASIC flag, Enable Drive I/O.
2. If the axis status LED turns red when the drive is disabled, verify that the drive's fault output configuration is correct (Aries command, `FLTDSB0`, etc.). **Note:** Some drives will indicate a drive fault when disabled, and cause the axis status LED to illuminate red.

Servo Axes

For problems with the servo axes, use the following procedures.

1. If the servo is stable, but the direction of motion is reversed, both the feedback cabling and commanded Drive AOUT signals are reversed. Use either:

   AcroBASIC remedy (not applicable for SSI feedback devices): Change the polarity of both the `DAC GAIN` and `MULT` settings. This reverses both the polarity of the commanded direction and the feedback direction so that servo stability is maintained.

   Hardware remedy: Switch the Drive AOUT+ and Drive AOUT– connection to the drive. (If the drive does not support differential outputs, this will not work.) You must also change the feedback wiring or mounting so that it counts in the same direction as the commanded direction. Depending on the feedback device used, do one of the following:

   If your application can change how the feedback device is mounted, you may be able to affect the count direction with it.

   For Quadrature feedback, switch Encoder CHB+ and Encoder CHB– between the controller and the feedback device.

   For Step and Direction feedback, switch Encoder CHB+ and Encoder CHB– between the controller and the feedback device.

   For CW and CCW feedback, switch both the CW and CCW signal pairs between the controller and the feedback device.

   For SSI feedback, switch the Drive AOUT+ and Drive AOUT– connection between the controller and the drive. (If the drive does not support differential outputs, switching the connections will not work.) **Note:** Some SSI encoders may have a polarity input that can be set to change the count direction.

2. If the servo is unstable, check for the conditions listed below and follow the recommended steps.

   The drive and motor combination are not properly tuned; refer to the drive installation manual for proper tuning.

   Verify that you have attached the axis as a servo and not a stepper. For more information, see the `ATTACH` command in the ACR

Command Language Reference (Online Help System in the ACR-View software).

The feedback device is counting backwards. Use either:

AcroBASIC remedy: Change the MULT command setting to either +4 or –4 to reverse feedback polarity (not applicable for SSI feedback devices).

Hardware remedy: Depending on the feedback device used, do one of the following:

If your application can change how the feedback device is mounted, you may be able to affect the count direction with it.

For Quadrature feedback, switch Encoder CHB+ and Encoder CHB– between the controller and the feedback device.

For Step and Direction feedback, switch Encoder CHB+ and Encoder CHB– between the controller and the feedback device.

For CW and CCW feedback, switch both the CW and CCW signal pairs between the controller and the feedback device.

For SSI feedback, switch the Drive AOUT+ and Drive AOUT– connection between the controller and the drive. (If the drive does not support differential outputs, switching the connections will not work.) **Note:** Some SSI encoders may have a polarity input that can be set to change the count direction.

3. If the drive holds torque when you disable the axis, and loses torque when you enable the axis, check the value of the Drive Enable Output Shuts Down Drive flag. Some drives implement reverse functionality of the disable and enable settings.

Stepper Axes

For problems with the stepper axes, check the conditions listed below and follow the recommended steps.

1. If the direction of motion is reversed, take one of the following actions.

   AcroBASIC remedy: Change both the `STEPPER GAIN` and `MULT` settings (`MULT` is not applicable for SSI feedback devices, nor required if no feedback device is used). This reverses both the polarity of the commanded direction and the feedback direction.

   Hardware remedy:

   For Step and Direction mode, switch the Drive Direction+ and Drive Direction– connection between the controller and the drive.

   For CW and CCW mode, switch the CW and CCW signal pairs between the controller and the drive.

   Swap the A+ and A– connections between the drive and the motor.

2. If the stepper is unstable, follow these steps.

   Verify that you have attached the axis as a stepper and not as a servo. For more information, see the `ATTACH` command in the ACR

Command Language Reference (Online Help System in the ACR-View software).

Although a stepper does not require tuning, you must set PGAIN equal to 0.00244141 and all other gains equal to 0.

3. If the drive is enabled, but you cannot command motion, check and remedy the following condition.

   If you have attached the axis of motion to a master axis with one or more slave axes faulted, motion stops on all slave axes until you clear the flags. For more information on the ATTACH command, Kill All Motion Request axis flag and Kill All Motion master flag, refer to the ACR Command Language Reference (Online Help System in the ACR-View software).

4. If the drive holds torque when you disable the axis, and loses torque when you enable the axis, check the value of the Drive Enable Output Shuts Down Drive flag. Some drives implement reverse functionality of the disable and enable settings.

APPENDIX A

SSI Encoders

IN THIS CHAPTER

Overview

SSI (Synchronous Serial Interface) is a unidirectional synchronous serial link for retrieving predefined data from a slave device. The ACR9000 (or ACR9030) Stand-Alone Controller drives one differential signal out to a slave device, and receives one differential signal from the slave device: SCLK (clock out) and SDATA (data in). The slave device latches new data on the first falling edge of SCLK. The slave responds by synchronously shifting the data out using the SCLK rising edge to assert SDATA.

As implemented in the ACR9000 (or ACR9030) controller, the general characteristics of the SSI are:

- Physical layer is RS-485.
- Network topology is point-to-point, single master/slave.
- Data rate is 97.6 KHz to 1.56 MHz.
- Message frame size is 1 to 32-bits.
- Selectable data modes are gray code to binary conversion or pass-thru mode.

Protocol

Slave Device

When not transmitting, the SCLK and SDATA lines are high. The slave device latches a new data value on the first falling edge of SCLK. It then transfers the latched data value out on the subsequent rising edges of SCLK (MSB first). After the transfer completes, the SDATA line remains logic low for a period defined by the slave device. If the slave device detects a falling edge SCLK before the SDATA line is high, the slave device retransmits the same data value on the subsequent rising edge SCLK.

Master Device (ACR9000 and ACR9030 Controllers)

The ACR9000 and ACR9030 controllers initiate a new SSI transfer at the beginning of a servo period by generating SCLK. The controller then qualifies subsequent data values on SDATA using the rising edge of SCLK.

Timing

This section describes the SSI transfer cycle timing for the ACR9000 and ACR9030 controllers. Figure 33 illustrates the cycle timing and Table 64 contains the timing data.

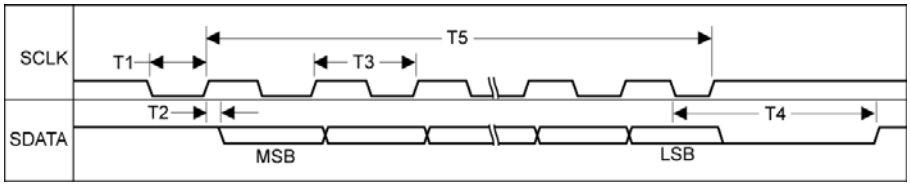


Figure 33 SSI Transfer-Cycle Timing

SSI Transfer-Cycle Timing Data			
Symbol	**Description**	**Min**	**Max**
T1	SCLK falling edge to first rising edge	0.5 x T3	--
--	Data setup time before SCLK rising edge	80 ns	--
T2	Data hold time after SCLK rising edge	0	--
T3	Programmable SCLK period	641 ns	10.2 µs
T4	Re-transmission timeout period is specified by slave device	--	--
T5	The number of data bits times SCLK period	641 ns	327.9 µs

Table 64 SSI Transfer-Cycle Timing Data

For example, if:

- Device data word size equals 25-bits
- SSI clock rate equals 781.2 KHz
- Device parameter for T4 equals 20 µs

Then total transfer time equals:

$$T1 + T4 + T5 = (0.5 \times \frac{1}{781.2\text{KHz}}) + 20\,\mu s + (25 \times \frac{1}{781.2\text{KHz}}) = 53.28\,\mu s$$

When selecting the SSI clock rate, the total transfer time cannot exceed one servo period. If it does, the following error(s) may occur:

- SSI encoder values may never change, since the re-transmission time-out period never expires.
- Data is corrupted because the SCLK is being re-synced at the beginning of each servo period. The SCLK is re-synced to minimize jitter.

APPENDIX B

VM25 Breakout Module

IN THIS CHAPTER

Overview

The VM25 module provides screw-terminal connections for the General Purpose I/O connectors on the ACR9000 and ACR9030 Stand-Alone Controllers. The VM25 comes with a 2-foot cable (609.6 mm) that provides easy connection between the VM25 and the controller's 25-pin I/O connectors. The VM25 expansion I/O module is ordered separately (part number "VM25").

Notes

- The VM25 module ships with DIN-rail mounting clips installed.
- The overall cabinet depth with cable-bend radius is 5 inches (127 mm).

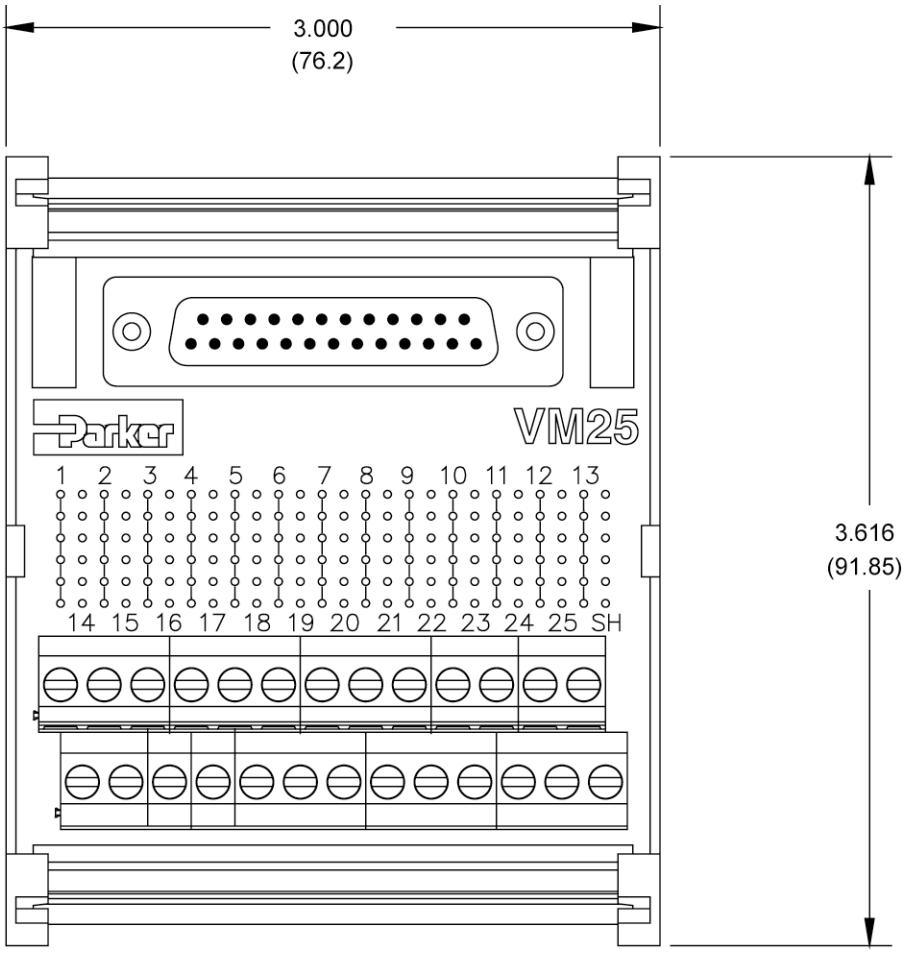


Figure 34 VM25 Breakout Module

APPENDIX C

VM26 Breakout Module

IN THIS CHAPTER

Overview

The VM26 expansion module provides screw-terminal connections for the axis connections on the ACR9000 and ACR9030. The VM26 comes with a 2-foot cable (609.6 mm) that provides easy connection between the VM26 module and the axis 26-pin connector. The VM26 expansion module is ordered separately (part number “VM26-PM”).

Notes

- The VM26 module ships with DIN-rail mounting clips installed.
- The overall cabinet depth with cable-bend radius is 5 inches (127 mm).

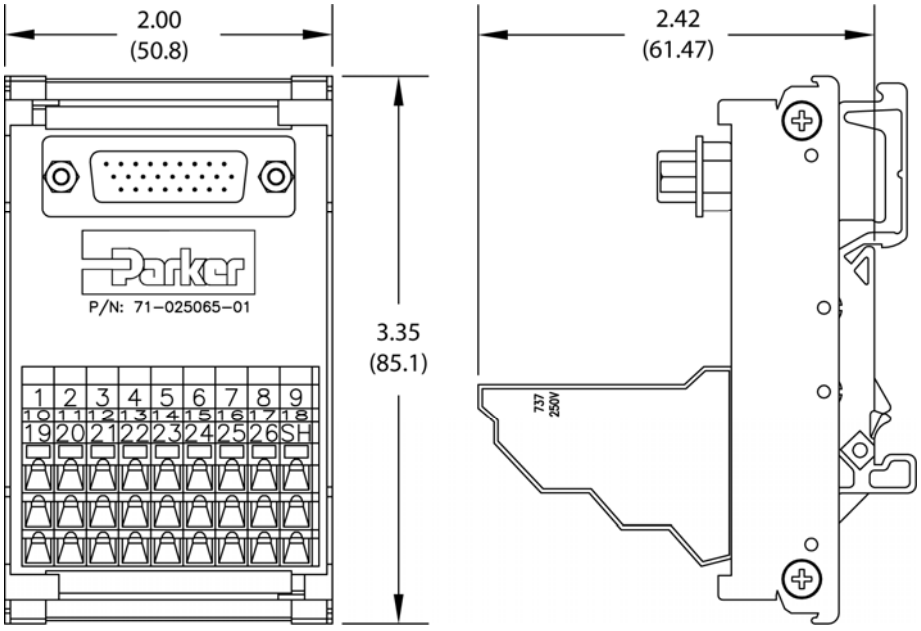


Figure 35 VM26 Breakout Module

APPENDIX D

Drive I/O

IN THIS CHAPTER

Drive I/O

We have pre-configured the standard drive functionality used with stepper and servo drives. These functions will allow users to enable, reset, and monitor position error on each of the drive connectors.

Basic Setup

As in other ACR controllers, the first step is to attach the axes to the master trajectory generator. There are several important changes to setup:

- The CONFIG command has been eliminated for the ACR90x0, as the hardware is not field-installable. The CONFIG command provides a report back, but the ACR90x0 configuration does not use it.
- The MULT command is latched at +/-4. Modes 0, +/-1 and +/-2 are not valid.
- The DAC GAIN command is inverted internally from the other ACR products. For the ACR90x0, a positive final output signal produces a positive voltage output. This does not apply to other ACR products.

Attach Axis

The ATTACH AXIS command is now used to configure the controller for servo or stepper control. Each axis can be setup as servo or stepper. Since each axis connector includes the analog, digital, and drive I/O, it is logical to attach ENC1 to DAC1 and so fourth.

Example axis attachments

```
P00>ATTACH AXIS0 STEPPER0 STEPPER0
P00>ATTACH AXIS1 ENC1 DAC1 ENC1
P00>ATTACH AXIS2 STEPPER2 STEPPER2
P00>ATTACH AXIS3 ENC3 DAC3 ENC3
```

The ATTACH command functions the same as other ACR controllers.

Example attachments

```
P00>ATTACH MASTER0
P00>ATTACH SLAVE0 AXIS0 "X"
P00>ATTACH SLAVE1 AXIS1 "Y"
P00>ATTACH SLAVE2 AXIS2 "Z"
P00>ATTACH SLAVE3 AXIS3 "A"
P00>ESAVE
```

Drive I/O Functionality
The drive I/O on the ACR90x0 now monitors drive faults and encoder faults. If these conditions exist, the drive will not be enabled. The drive I/O can be modified, or monitored, using the drive control flags shown below.

Three new commands have been added for enabling, disabling, and resetting drives connected to the ACR90x0 controller. These commands can be enabled and disabled using the Enable Drive I/O bits shown on the next page. The commands are as follows:

- `DRIVE ON` – This command automatically performs a `REN` command before enabling the drive and delays for 50-100 ms before looking at the drive fault input. It also checks for drive and encoder faults. This command will also clear the kill all motion flag. If the flag is set after the `DRIVE ON` command, the drive is disabled.
- `DRIVE OFF` – Disables the drive
- `DRIVE RES` – Resets drive using the drive reset input, if applicable

Here is an example of their use

```
P00>DRIVE ON X Y Z A
P00>DRIVE OFF X Y Z A
P00>DRIVE RES X Y Z A
```

Drive Input Fault

By default, the ACR9000 and ACR9030 check for a drive fault input. The input is active when no current is flowing through the drive fault input.

If no drive fault input is attached to an axis, the user must do the following to enable the drive: clear the Enable Drive I/O flag, then enable the drive with the specific drive enable bit (bits 40-47). Alternatively, the polarity and response to the Drive Fault Input may be adjusted with some Drive Control flags described below.

Drive Control Flags

New drive control flags have been added for the ACR90x0's dedicated drive functionality. These parameters and bits allow users to modify the actions of the `DRIVE` command. As with other ACR controllers, `SET` will set the bit, and `CLR` will clear the bit. See Table 10 and Table 11 in the section "External I/O Interface Connectors" for more information on the physical I/O structure.

Here are the drive control parameters and bits.

	Mask	0x01	0x02	0x04	0x08	0x10	0x20	0x40	0x80
Flag Parameter code=0x10; index=0x14		4360	4361	4362	4363	4364	4365	4366	4367

Control Flags	Bit	AXIS Number							
	Index	0	1	2	3	4	5	6	7
Disable Encoder Fault Response	3	8451	8483	8515	8547	8579	8611	8643	8675
Disable Drive Fault Response	4	8452	8484	8516	8548	8580	8612	8644	8676
Invert Drive Fault Input Level	5	8453	8485	8517	8549	8581	8613	8645	8677
Invert Motion Direction	7	8455	8487	8519	8551	8583	8615	8647	8679
Enable CW/CCW (versus Step/Dir)	16	8464	8496	8528	8560	8592	8624	8656	8688
Drive Enable Output (DEO)	17	8465	8497	8529	8561	8593	8625	8657	8689
Drive Reset Output (DRO)	18	8466	8498	8530	8562	8594	8626	8658	8690
Kill All Motion Request (KAMR)	19	8467	8499	8531	8563	8595	8627	8659	8691
Enable Drive I/O (EDIO)	20	8468	8500	8532	8564	8596	8628	8660	8692
Enable EXC Response (EER)	21	8469	8501	8533	8565	8597	8629	8661	8693
DEO serves shutdown function	22	8470	8502	8534	8566	8598	8630	8662	8694
Disable Drive on Kill	23	8471	8503	8535	8567	8599	8631	8663	8695
Drive Fault Input (DFI)	24	8472	8504	8536	8568	8600	8632	8664	8696
Reserved	25	8473	8505	8537	8569	8601	8633	8665	8697
DFI Response Inhibit	26	8474	8506	8538	8570	8602	8634	8666	8698
Completing Drive Reset	27	8475	8507	8539	8571	8603	8635	8667	8699
Physical Drive Enable State (PDES)	28	8476	8508	8540	8572	8604	8636	8668	8700
Drive Fault Latched	29	8477	8509	8541	8573	8605	8637	8669	8701
EPL Axis	30	8478	8510	8542	8574	8606	8638	8670	8702
Latched Excess Position Error	31	8479	8511	8543	8575	8607	8639	8671	8703

Field Description	Read/ Write	Description
Disable Encoder Fault Response	R/W	The user can select whether or not the controller responds to the Encoder fault flags of attached encoders by setting or clearing the Disable Encoder Fault Response Flag. This is clear by default, which means that the controller will respond to encoder faults in the same way as drive faults, as described in Disable Drive Fault Response.
Disable Drive Fault Response	R/W	The user can select whether or not the controller responds to the Drive Fault Input (DFI) flag by setting or clearing the Disable Drive Fault Response flag. This is clear by default, which means that the controller will respond to changes in the DFI flag. (See Drive Fault Input).
Invert Drive Fault Input Level	R/W	The value of the Drive Fault Input (DFI) flag (described in this table) will depend on the actual physical input and the value of the Invert Drive Fault Input Level (IDFIL) flag. If no current is flowing to the input and the IDFIL flag is clear (the default), then the DFI flag will be set. This would be the case if no drive were attached to the connector on power up, or if a cable fell off, or if a standard drive actually faulted. For some drives, however, the presence of current, not the absence, indicates a fault. In this case, the user would wish to set the IDFIL flag, so DFI would be set if current were flowing to the input.
Invert Motion Direction	R/W	By convention, default wiring, gains, and MULT values will result in clockwise shaft motion (viewed from the motor face) when the count is becoming more positive. But some applications require that some axes be opposite of this. The Invert Motion Direction bit will implement this by inverting the polarity of the signal and feedback objects attached to the axis. Note that changing this bit (on or off) on an axis that has an attached ENC, DAC, or ADC will simply invert the polarity of those objects by inverting the current MULT or gain values. This allows the MULT and gain values to accommodate “unconventional” wiring but still allow the Invert Motion Direction bit to change the physical direction. The Invert Motion Direction bit is saved by **ESAVE**.
Enable CW/CCW	R/W	This flag will change the output of the axis when configured as a stepper. A setting of 0 means that step and direction signals are sent to that drive and a setting of 1 means that CW and CCW signals are sent to the drive.
Drive Enable Output	R/W	This flag is set by the `DRIVE ON` command and is cleared by the `DRIVE OFF` command. Can be used to manually enable/disable the drive.
Drive Reset Output	R/W	This flag is the same as the `DRIVE RES` command and is automatically cleared. Can be used to manually reset the drive.

Field Description	Read/ Write	Description
Kill All Motion Request	R/W	When set, this flag will stop all motion, including gear, cam, jog and master motion (Kill All Moves Request), on the axis selected. All axes attached to the same master as the selected axis will also have all motion stopped. This flag is automatically set by a Drive Fault Input activation or a position error window exceeded event if the Position Error On bit is set. It can be manually set by the user to kill or prevent motion. To recover from this, clear this flag or issue a `DRIVE ON` command. To make master motion again all Kill All Motion Request flags must be cleared for all axes attached to the master. Otherwise the Kill all Move Request for the master are set every 50 ms, stopping any commanded master motion.
Enable Drive I/O	R/W	When this flag is set (default) the `DRIVE` commands function as stated. The drive must be disabled to set or clear this flag. When this flag is cleared the `DRIVE ON/OFF` commands do not function and will generate the error “Drive I/O Not Enabled.” The user must use the I/O to enable and disable the drive when this flag is cleared.
Enable EXC Response	R/W	The ACR controllers will always test for excess position error, as defined by the **EXC** command (Axis Parameters indices 0x20 and 0x21). When Enable EXC Response is enabled (bit set to 1), the controller will respond to excess position error by killing all motion and disabling the drive. If the bit is not set, position error will be monitored, but not responded to. The default is set to disabled (bit set to 0). For more information, see the **EXC** command; or Axis Parameters, indices 0x20 and 0x21.
DEO Serves Shutdown Function	R/W	When enabled (bit set to 1), the Drive Enable Output Serves Shutdown Function reverses the behavior of the Drive Enable Output bit.
Disable Drive on Kill	R/W	Normally, **`CTRL-Z`** will kill motion and disable all axes, and **`CTRL-X`** will only kill motion. If the Disable Drive on Kill bit is set on an axis, then **`CTRL-X`** will also disable that axis.
Drive Fault Input	R	This flag indicates the status of the drive fault input. When this bit is set, the drive is telling the controller it is faulted. If the Enable Drive I/O bit is on, the controller will react to the drive fault input by disabling the drive and setting the kill all motion request flag for that axis. If this bit is not set, then the drive is not faulted.
Drive Fault Input Response Inhibit	R	This flag is set during a period of time (50 to 100 ms) immediately after a `DRIVE ON` command is issued. During this time the controller will not use the drive fault input to determine if the axis is faulted. This delay is required for drives that delay turning off their fault output for a short time after the drive enable is set.

Field Description	Read/ Write	Description
Completing Drive Reset	R	This flag is set when the drive is being reset by a `DRIVE RES` command. The flag is cleared when the reset is complete.
Physical Drive Enable State	R	This flag indicates the status of the drive enable output. The bit is set when the drive enable output is on and cleared with the drive enable is off.
Drive Fault Latched	R	Indicates a drive fault has been detected. Stays latched until cleared with a **DRIVE ON** command.
EPL Axis	R	Indicates an **EPLD** is attached to this axis.
Latched Excess Position Error	R	Indicates that excess position error has been detected, and that motion has been killed and the drive disabled as a result. Stays latched until cleared with a **DRIVE ON** command.

Encoder Input Mode

The ACR9000 and ACR9030 can be set to any one of six encoder modes. The new command `ENCm SRCn` has been added to support the new modes, and is directly equivalent to setting or clearing the flags. The table below summarizes the choices for the flags and the corresponding valid values of "n" for SRC. These values are saved with the `ESAVE` command and read from flash on power up.

The encoder source can be changed with the following command, where m is the encoder number and n is the mode number.

```
ENCm SRCn
```

The following example sets encoder one's source to a quadrature encoder.

```
P00>ENC1 SRC0
```

The following table can be used for setup of the different encoder modes for the ACR9000 and ACR9030.

SRC	Input Configuration	Channel A use	Channel B use
0	Quadrature Encoder	Channel A	Channel B
1	Step and Direction	Step	Direction
2	CW/CCW steps	CW step	CCW step
3	SSI Encoder	SCLK	SDATA
-	RESERVED		
5	Step and Direction (Int.)	Step	Direction
6	CW/CCW steps (Int.)	CW step	CCW step
-	RESERVED		

Encoder Error Detection

The ACR FPGAs have a phase error detection enable bit (PEEN), which will normally always be set, enabling detection of erroneous transitions on channel A and B. If the error is detected, no counts are recorded for that transition, and a latched bit in the FPGA is set to record the event. When firmware detects that bit, it sets the "encoder signal fault" flag. In the `RES` command, the PEEN is toggled (1 to 0 to 1) to clear the latch fault bit. The FPGAs also have a bit that reflects the state of encoder cable disconnect detection circuitry on the boards. That bit is not latched. When firmware detects that bit, it sets the "encoder signal lost" flag. In the `RES` command, the flag is cleared, but if the cable is still disconnected, the flag will be set again.

The ACR9000 and ACR9030 controllers support two encoder error flags. These are the first two bits in the encoder flags parameter, "encoder signal fault" and "encoder signal lost." When using the `DRIVE IO` (Enable Drive I/O =1) and an encoder error is detected, by default, the drive disables and the Kill All Motion bit is set for the axis to which the fault encoder is attached. Both bits are cleared by the `RES` or `ENC RES`, or `DRIVE` command. If an encoder error is detected, the controller will cease reading the encoder until the error is cleared. This default response to an encoder error can be inhibited by setting the Disable Encoder Fault Response flag, bit index 3 in the Drive Control flags.

General Purpose and Extended I/O

The drive connectors on the ACR9000 and ACR9030 have dedicated I/O purposes. The extended I/O on these units are not necessarily in groups of 32 digital inputs and 32 digital outputs, and can include analog inputs. Despite these differences, the user control of general purpose and extended I/O fits well into the other ACR system of flags, parameters, and commands.

For a two or four axis controller, there are 12 general-purpose inputs (mapped to bits 0-11), four general purpose outputs (mapped to bits 0-3), and eight high-speed inputs (mapped to bits 24-31).

For an eight axis controller, there are a total of 24 general purpose inputs (mapped to bits 0-23), eight general purpose outputs (mapped to bits 0-7) and 16 high-speed inputs (mapped to bits 24-31 and 72-79).

Bits 40-63 are mapped to physical drive outputs. You can use the `CONFIG IO` command to redirect the parameter for digital outputs—the upper 24 bits of that parameter are mapped to physical drive outputs.

Note: If the Enable Drive I/O is set to 0, setting the Drive Enable Output will not change the state of the LED for that axis. In addition, the controller does not perform a `REN` command.

Opto-Isolated Outputs (P4097)	Flag number
Drive Enable Output 0	40
Drive Enable Output 1	41
Drive Enable Output 2	42
Drive Enable Output 3	43
Drive Enable Output 4	44
Drive Enable Output 5	45
Drive Enable Output 6	46
Drive Enable Output 7	47
Drive Reset Output 0	48
Drive Reset Output 1	49
Drive Reset Output 2	50
Drive Reset Output 3	51
Drive Reset Output 4	52
Drive Reset Output 5	53
Drive Reset Output 6	54
Drive Reset Output 7	55
LED 0 Green	56
LED 0 Red	57
LED 1 Green	58
LED 1 Red	59
LED 2 Green	60
LED 2 Red	61
LED 3 Green	62
LED 3 Red	63

Miscellaneous Inputs (P4098)	Flag number
Drive Fault Input 0	64
Drive Fault Input 1	65
Drive Fault Input 2	66
Drive Fault Input 3	67
Drive Fault Input 4	68
Drive Fault Input 5	69
Drive Fault Input 6	70
Drive Fault Input 7	71
Opto-Isolated High Speed Input INP72	72
Opto-Isolated High Speed Input INP73	73
Opto-Isolated High Speed Input INP74	74
Opto-Isolated High Speed Input INP75	75
Opto-Isolated High Speed Input INP76	76
Opto-Isolated High Speed Input INP77	77
Opto-Isolated High Speed Input INP78	78
Opto-Isolated High Speed Input INP79	79

Miscellaneous Outputs (P4099)	Flag number
LED 4 Green	96
LED 4 Red	97
LED 5 Green	98
LED 5 Red	99
LED 6 Green	100
LED 6 Red	101
LED 7 Red	102
LED 7 Red	103

Example

The following example sets up 2 axes, and creates basic motion. The first, axis0, is an Aries servo drive and the second, axis1, is a E-AC stepper drive.

```
ATTACH AXIS0 ENC0 DAC0 ENC0          :REM CONFIGURE AXIS0 FOR A SERVO
ATTACH AXIS1 STEPPER1 STEPPER1       :REM CONFIGURE AXIS1 FOR A
STEPPER

10 ATTACH MASTER0      :REM ATTACH A MASTER TRAJECTORY
                       :REM GENERATOR
20 ATTACH SLAVE0 AXIS0 "X"           :REM ATTACH AXIS0
30 ATTACH SLAVE1 AXIS1 "Y"           :REM ATTACH AXIS1
35 DRIVE OFF X Y       :REM MAKE SURE THE DRIVES IS DISABLED
                       :REM BEFORE CONFIGURING THEM
40 PPU X8000 Y25000    :REM SET UNITS FOR REVOLUTIONS, AXIS0
                       :REM 8000 COUNTS/REV, AXIS1 25000
                       :REM STEPS/REV
50 CLR 8496            :REM MAKE SURE AXIS1'S OUTPUT IS STEP AND
                       :REM DIRECTION NOT CW/CCW
60 SET 8502            :REM SETUP AXIS1'S ENABLE TO ACT LIKE A
                       :REM SHUTDOWN OUTPUT SINCE THE E-AC HAS
                       :REM SHUTDOWN CIRCUITRY
70 SET 8468 SET 8500   :REM MAKE SURE DRIVE I/O IS ENABLED
80 SET 8469 CLR 8501   :REM TURN ON POSITION ERROR CHECKING FOR
                       :REM AXIS0 AND TURN IT OFF FOR AXIS1
90 EXC X1              :REM SET THE POSTIION ERROR WINDOW FOR 1
                       :REM REV FOR AXIS0

100 DRIVE ON X Y       :REM ENABLE AXIS0 AND 1
110 DWL0.5             :REM DWELL FOR 500 ms TO ALLOW THE DRIVES
                       :REM TO ENABLE

120 IF ((NOT BIT 8476) OR (NOT BIT 8508)) THEN GOTO 500
                       :REM IF AXIS0 OR AXIS1 DID NOT ENABLE THEN
                       :REM GOTO LINE 500

130 ACC 100 DEC 100 STP 100 VEL 5
                       :REM SET VELOCITY, ACCEL AND DECEL RATES
140 X1 Y-10            :REM MOVE AXIS0 ONE REV AND AXIS1 10 REVS IN
                       :REM THE NEGATIVE DIRECTION
150 DWL1               :REM DWELL FOR A SECOND
160 X0 Y0              :REM GO BACK TO 0 POSITION
170 GOTO 600           :REM GO TO LINE 600

500 :REM THIS IS WHERE CODE TO HANDLE DRIVES NOT ENABLING SHOULD GO
600 END
```

Motion Enable Input

The motion enable input is designed to halt motion even in the absence of firmware control. The input is directly connected to the CPU and the drive enable circuits in the ACR90x0.

The input is considered active when 5-24 VDC are across the two pins. If the input goes inactive, that inactive state is latched and the ACR90x0 reacts by doing the following:

- Forcing the DAC outputs to zero.
- Blocking the step generation output.

The status of the motion enable input is shown in bit 5646, where active is a cleared or 0 state, and inactive is a set or 1 state.

When the enable input goes inactive, bit 5645 is set and latched until voltage is present again on the enable input and the `DRIVE ON` command is sent.

Example
A typical recovery routine for this event would need to wait until the enable input is active, state 0, clear the kill all motion request bits for axes attached to the master, clear the kill all move request for master0 and re-enable all needed drives. The following is for a 2 axis recovery routine.

```
100 IF (NOT BIT 5646) THEN GOTO 200   REM IF THE ENABLE INPUT IS
                      REM ACTIVE, STATE 0 THEN GO ON
110 GOTO 100          REM LOOP BACK TO LINE 100
200 CLR 8467 CLR 8499 REM CLEAR THE KILL ALL MOTION FLAG
205 CLR522            REM CLEAR THE KILL ALL MOTION FLAG
                      REM FOR MASTER
210 DRIVE ON X Y      REM REENABLE THE DRIVES
```

Appendix E

CANopen

IN THIS CHAPTER

Limited Amounts of Nodes and I/O

- 4 external I/O nodes
- 64 bytes (512 bits) of digital inputs total for 4 nodes
- 64 bytes (512 bits) of digital outputs total for 4 nodes
- 32 analog inputs total for 4 nodes
- 32 analog outputs total for 4 nodes

Semi-Automatic Network Configuration

The network configuration is as automatic as possible, but the user must adjust some settings. The ACR90x0 controller automatically sets other configuration parameters required for CANopen, including the global analog data enable (For more information, see the Parker I/O manual). The table below gives the parameters the user must set, along with their default values. The default values apply on power up if user supplied values have not been saved with the `ESAVE` command. Each parameter is described in further detail in subsequent paragraphs.

Parameter	P number	Default value
Master Node Id	P32768	5
Bit Rate (kilobits/second)	P32769	125
Number of slave nodes	P32770	1 (valid range 0-4)
Cyclic Period (milliseconds)	P32772	50
Node 0 ID (required if P32770 > 0)	P33024	1
Node 1 ID (required if P32770 > 1)	P33040	0
Node 2 ID (required if P32770 > 2)	P33056	0
Node 3 ID (required if P32770 = 4)	P33072	0

Bit Rate and Node Addresses

Every node on a CANopen bus must have a unique ID number, and must use the same bit rate. The slave I/O nodes have DIP switches that allow the user to set bit rate and node ID number. ACR90x0 will have a default node ID number of 5, but this may be changed by modifying parameter P32768. The user must set an ACR90x0 parameter (P32769) to allow the master to know and set its bit rate to match the nodes on the bus. The bit rate may only be set as high as allowed by the bus length and the existing nodes. This will usually be 1 megabit/second.

For available bit rates and constraints of bus length, see the CiA Draft standard 301, version 4.02, table 2. The default bit rate is 125Kbit/second. Bit rate and master node numbers are saved with the `ESAVE` command.

Transmission Cycle Period

ACR90x0 uses a periodic cyclic transmission protocol between the master and the nodes for digital and analog outputs, and for analog inputs. Digital inputs transmit to the ACR90x0 only when their input state has changed. Each cycle, the master sends a synchronization message to all slave nodes. The slave nodes respond by latching and transmitting back their analog inputs, and by asserting the output states commanded by the master before the synchronization message. The cycle period should be calculated to be as fast as possible, and is dependent on the bit rate, the node types, and the number I/O bits on the nodes. Two factors limit the speed of the transmission cycle. One is the total amount data that needs to be transmitted at the selected bit rate. The other is the processing load of the slowest node on the bus.

For the former constraint, the number of bits is divided by the bit rate for the required time. Bits are sent in messages of 125 bits each. Each node has messages for its data, plus one to report health. The ACR90x0 also sends a sync message. In the formulas below, digital inputs are ignored, since these will not transmit periodically.

Node messages = (node analog inputs +3)/4 + (node digital outputs +63)/64 + (node analog outputs +3)/4 + 1

Total messages = Sum of Node messages +1

Required time (milliseconds) = (Total messages * 125) /bit rate in Kilobits/s

This time should be rounded up to the next higher integer number of milliseconds. For example, suppose there are two nodes. One node has 100 digital outputs and 10 each analog inputs and outputs. The second node has 20 digital outputs and 5 each analog inputs and outputs. The first node has nine messages, and the second has six messages. The total is 16 messages. At the 1-megabit rate, 2 milliseconds are required. At the 125K rate, 16 milliseconds are required.

(16 * 125)/1000 = 2

(16 * 125)/125 = 16

The second constraint is individual node speed. Parker offers the PIO-337 and PIO-347 fieldbus couplers, and these have been characterized for speed. The time required depends on the coupler and the amount and type of I/O on the coupler. There is a base time required just to respond to the ACR90x0's sync signal, plus additional time per point. The sum represents minimum type required by the node. Using the first node of the example above, and the timing in the table below, the time using a PIO-347 would be 31 milliseconds, and using a PIO-337 would be five milliseconds. Using the second node of the example above, and the timing in the table below, the time using a PIO-347 would be 12 milliseconds, and using a PIO-337 would be two milliseconds.

Node Type	Base time (milliseconds)	time/digital point (microseconds)	time/analog point (microseconds)
PIO-347	5	100	270
PIO-337	1	15	40

Health Period and Node Health

Node health is a way for the master to periodically (known as the Health Period) ascertain that all nodes are still alive, and to respond appropriately if one goes “off line.”

There are two health checking protocols, called “Heartbeating” and “Node Guarding.” Node guarding requires slightly more bandwidth on the CANbus, but allows disconnected nodes to revert to safe output states. For each node, there is a Health Type parameter (P33029 for node 0) that serves to request a certain protocol, and to report the actual protocol used when the network is started. The default value for this parameter is zero, which instructs the ACR90x0 to choose the protocol. ACR90x0 uses the Node Guarding protocol for nodes that support it, and Heart Beating protocol for other nodes. These are standard CANopen features.

Compatibility is determined automatically when the network is started. The Health period is set to 10 times the Cycle Period.

Starting and Configuring the Network

An ACR90x0 network master may start and reset the network at any time. When the network is started via bit 11265, the ACR90x0 initially places all slaves’ nodes into the “pre-operational” state. During this state, the ACR90x0 interrogates and configures the slaves as required. The slaves are then placed into the “operational” state, and automatic transfer between the slave’s physical I/O and the ACR90x0’s I/O parameters and bits takes place.

Before the network may become in the “operational” state, the master must know how many slave nodes there are, what the node numbers are, and how many and what type of I/O are on each node.

In some applications, the external nodes may be powered after ACR90x0, and hence not available for configuration on ACR90x0’s power up. For this reason, the ACR90x0 user is required to explicitly request network start via a control flag. The flag (bit 11265) is used for starting the network. The flag is self-clearing, i.e., cleared automatically by ACR90x0 when the attempt to start the network has completed. There are also status bits and parameters to indicate the results of starting the network. Examples would be error bits, bit rate, cycle period, node status, etc. A typical application scenario would be as follows.

- Perform application initialization, and dwell or otherwise determine that external nodes are powered up.
- Write to any required parameters if the values are not yet correct.
- Assert bit 11265 requesting I/O network start.
- Check for success and any other status of interest. For example, application operation may depend on I/O present, or expected I/O may be verified.
- Proceed with application that depends on external I/O

AcroBASIC Language Access to CANopen I/O

All “objects” (for example steppers, encoders, axes, and masters) in an ACR controller may be accessed via bits and parameters as well as commands. In many cases, (for example, ADC inputs) the values may be accessed only through bits or parameters. An external digital input or output is the same in function and use as an on board digital input or output, and are used in the same way in the language. This is true not just for `SET` and `CLR`, but for `IF`, `WHILE`, `INH`, `LD`, and any other command that has a flag as an argument. This also applies to using parameters with analog I/O. To be consistent with the current language, extend all existing on board I/O functionality to external I/O, and facilitate backward compatibility with existing applications, external I/O are represented with bits and parameters in exactly the same way onboard I/O is.

Network and Node Information Parameters and Flags

After the ACR90x0 has started the CANopen network, and discovered and characterized nodes on the network, it fills in an information parameter block for the network and each discovered node. It also updates the Extended I/O Control/Status flags shown below.

Extended I/O Control/Status (P4448)	Flag Number
Control Flags	
Start Network	11265
Reset Network	11266
Reserved	11267
Status Flags	
CANopen controller installed	11268
Network Operational	11269
Network Start Failed	11270
Node Failure	11271
SW Rx Overflow	11272
HW Rx Overflow	11273

Field Description	Read/ Write	Description
Start Network	R/W	When set, this flag will attempt to communicate with the CANopen network. This flag is automatically cleared by the controller when the attempt to start the network has completed. See the section on “Starting and Configuring the Network” for more details.
Reset Network	R/W	When set this flag will reset all of the Extended I/O nodes. This may be needed if there is a baud rate, node ID, wiring change, unrecoverable error or a loss in communications.
CANopen Controller Installed	R	This flag is set if the controller has the CANopen hardware and cleared if it does not.
Network Operational	R	This flag is set when the CANopen network is in the “operational” state and communicating. It is cleared if there is no communication or some other error. Check the below flags for more information on the error, the CANopen LED or the `DIAG` command.
Network Start Failed	R	This flag is set when a request to start the network was issued and there was a failure. Check the below flags for more information, the CANopen LED and the `DIAG` command.
Node Failure	R	This flag is set when one, more nodes are lost, or not responding while the network is operational. Check the below flags for more information, the CANopen LED and the `DIAG` command.
SW Rx Overflow	R	A flag indicating that the software receive buffer has overflowed.
HW Rx Overflow	R	A flag indicating that the hardware receive buffer has overflowed.

The description and parameter numbers are shown in the following table. The control parameters are those that should be set before attempting to start the network. The status parameters are those that the controller will set because of attempting to start the network.

Extended I/O Control/Status	
Control Parameters	
Master node ID	P32768
Bit Rate (Kb)	P32769
Number of slave nodes	P32770
Alt Digital I/O Mapping	P32771
Cyclic Period (milliseconds)	P32772
Status Parameters	
Health Period (milliseconds)	P32773
Reserved	P32774
Number of digital inputs bytes	P32775
Number of digital outputs bytes	P32776
Number of analog inputs	P32777
Number of analog outputs	P32778
Bus state (see table below)	P32779
Reserved	P32782
Reserved	P32783

Field Description	Read/ Write	Description
Master Node ID	R/W	The controller's ID in the CANopen Network
Bit Rate	R/W	The bit rate in Kb for the CANopen Network
Number of Slave Nodes	R/W	The number of slave nodes not including the controller/master.
Alternate Mapping of Digital I/O	R/W	Remap CANopen Digital Inputs and Outputs to lower XIO bits. See Alternate Mapping of Digital I/O section.
Cyclic Period	R/W	The time between updating data on the network.
Health Period	R	The Health period this is always set to 10 times the Cyclic Period. See the "Health Period and Node Health" section for more detail.
Number of Digital Input Bytes	R	The total number of bytes (1 byte = 8 bits) taken for digital inputs on the network.
Number of Digital Output Bytes	R	The total number of bytes (1 byte = 8 bits) taken for digital outputs on the network.
Number of Analog inputs	R	The total number of analog inputs on the network.
Number of Analog Outputs	R	The total number of analog outputs on the network.
Bus State	R	Indicates the current bus state. See the next page for more detail on what this value means.

The CANopen STATUS LED table below gives the possible LED indicator states and the corresponding CAN state and controller. The only normal states are “PRE-OPERATIONAL” and “OPERATIONAL.” Any red in the CAN LED indicates a problem. All states listed below are consistent with CiA DR-303-3 “Indicator Specification”, although not all possible states listed in that document can occur in the ACR90x0. In addition, the ”off” and “blinking red” indications are unique to the ACR90x0, not included and not conflicting with the states listed in CiA DR-303-3 “Indicator Specification.”

The CANopen status LED is located just below the CANopen connector on the ACR90x0.

CANopen STATUS LED	CiA DR 303-3 CAN state	Description	Possible ACR90x0 state(s)
OFF	N/A	No CAN controller detected	0
Blinking Green	Pre-Operational	CANopen is in the pre-operational state.	1,3,4,5
Solid Green	Operational	The network is now exchanging data	2
One Red blink inside blinking Green	Warning limit reached	At least one of the error counters of the CAN controller chip has reached or exceeded the warning level (too many error frames)	6
Two Red blinks inside blinking Green	Error control event (Health event)	A guard event or heartbeat event has occurred.	7
Solid Red	Bus Off	The CAN controller is bus off	10
Blinking Red	N/A	ACR internal error or transmission overrun	8,9

The **Bus State Description** table below gives the possible bus states and the corresponding CAN LED indicator state. The only normal states are “READY TO START” and “NETWORK STARTED.” Any red in the CAN LED indicates a problem.

Bus State Description (parameter P32779)	Bus State	CAN LED State
PRE-INITIALIZED. The network has not been initialized yet. This should only happen during power up or reset. If the CAN LED stays OFF, it indicates that the ACR90x0 did not detect its internal CAN controller chip.	0	off
PRE_OPERATIONAL. The user’s node information and bit rate have been verified and the CAN controller is ready to accept the “start network” bit. (11265)	1	Blinking Green
NETWORK STARTED. Successful network start.	2	Solid Green
INVALID MASTER NODE ID. The ACR90x0 node ID must be between 1 and 127 inclusive.	3	Solid Red
INVALID MODULE NODE INFORMATION. The module node IDs must be between 1 and 127 inclusive, must be unique, and not the same as the master node ID. A maximum of 4 module nodes is allowed.	4	Solid Red
CHARACTERIZATION ERROR. An expected external node has not responded to interrogation during attempt to start network. Will occur if a stated node ID does not match the actual node ID, or if the node is missing or at the wrong bit rate or not operational. The network is still ready to start once the external node problem is resolved.	5	Blinking Green
EXCESS BUS ERRORS. The controller chip has too many bus errors. One possible reason would be incorrect bit rate on one or more modules.	6	One Red blink inside blinking Green
HEALTH EVENT. A node has stopped sending heartbeat or node guard responses. The errant node will have a node state of 0 (dead). See table below. One possible reason would be node receive overrun caused by a cyclic period that is too fast for the node.	7	Two Red blinks inside blinking Green
INTERNAL ERROR. A firmware or hardware internal error has occurred on power up or after an attempt to start the network. Requires factory consultation	8	Blinking Red
TRANSMISSION OVERFLOW. The amount of data that must be transferred each cyclic update is greater than the bit rate allows. Increase the bit rate or decrease the cyclic rate.	9	Blinking Red
BUS OFF. The CAN controller is bus off, and the network must be re-started.	10	Solid Red

The Node ID must be set by the user to match the node ID settings on the actual nodes. All other node information is filled in by the controller after the network is started. The node information is saved with the ESAVE command, and user applications may use it to verify expected network configuration, or make run time application decisions.

This information could serve as a source for a front-end software GUI that displays bus and node status, although no configuration would be possible. Another possibility would be to implement a sort of “Network Configuration Verify” command that would allow the application to easily verify that the configuration is the same every time.

In the table below, nodes are numbered 0-3, like all other ACR objects. This is the node number, from the ACR90x0 point of view. The node ID is the setting on that node’s DIP switch, and must be between 1 and 127, but may not conflict with the chosen Master node ID.

Description/Node number	0	1	2	3
Node Id	33024	33040	33056	33072
Number of Digital Inputs (bytes)	33025	33041	33057	33073
Number of Digital Outputs (bytes)	33026	33042	33058	33074
Number of Analog Inputs	33027	33043	33059	33075
Number of Analog Outputs	33028	33044	33060	33076
Health Type (0=not present, 1=heartbeat, 2= lifeguarding)	33029	33045	33061	33077
Node state (0=dead, 1=live)	33030	33046	33062	33078

Flags for Extended Digital I/O

Each possible node will have two blocks of flag parameters, each 16 parameters in length, to accommodate the possible 512 bits each of extended digital inputs and outputs. Flag parameter numbers are shown the table below.

32 bit block type	Starting parameter	Ending parameter
Node 0 digital inputs	4456	4471
Node 0 digital outputs	4472	4487
Node 1 digital inputs	4488	4503
Node 1 digital outputs	4504	4519
Node 2 digital inputs	4520	4535
Node 2 digital outputs	4536	4551
Node 3 digital inputs	4552	4567
Node 3 digital outputs	4568	4583

For each node, the lowest bit number for extended digital inputs block of that node will correspond the lowest numbered digital input on that node on the network. Numbering will proceed upward for all the digital inputs on that numbered node. The same process occurs for the Digital Outputs. This continues until the actual number of digital inputs and outputs on the network

or maximum number (512) of digital I/O is reached. For example, the first digital input on node 0 is bit 11520, and the first digital input on node 2 is bit 13568.

Each node will have an information parameter block, described later in this text. This block will contain, among other things, the number of bytes of digital inputs and outputs. Digital I/O are assigned in blocks of eight, so the number of bits assigned to each node is a multiple of eight. For example, suppose node 2 has 12 digital inputs. Node 2's inputs would be bits 13568-13579, even though the node status parameter indicates that it has two bytes of inputs. The same numbering rules apply to digital outputs.

Analog Inputs and Outputs

Analog inputs and outputs are implemented by ADCs and DACs respectively, and unlike digital I/O, the analog values represent something with units and a range. For example, a DAC might assert –5V to 5V, or 0-20 mA, or some range of pressure, force, or speed. The ADCs and DACs also have variable binary resolution, e.g., 10, 12, 14 or 16 bits. All CANopen values are left shifted to occupy the entire 16 bits as a two's complement signed number, even if the actual ADC or DAC is less than 16 bits. This does not increase the analog resolution. In addition, the sign of the resulting 16-bit number is the same as the sign of the physical quantity it represents instead of being offset. A value of 32767 represents full scale positive for the device, and -32768 represents full scale negative for the device.

For example a 0-10V DAC would take values of 0-32767, and a ±10V device would take values of –32768 to 32767. However, a ±5V device would also take values of –32768 to 32767. To translate from this raw binary number to the range and units being controlled or measured, the ACR90x0 employs entered offsets and gains.

An offset has the same units as the user units of the analog value, for example volts or milliamps, and translates the center of the analog range to a value that allows a gain to be applied. A DAC gain has the units of full-scale binary resolution per user unit. The DAC range is 16-bit or 65536 DAC counts, regardless of the actual DAC resolution.

For example, suppose a 12-bit DAC asserts –10V to +10V, where a value of 32768 will assert –10V and 32767 will assert +10V. In this case, the offset is 0V, and the gain is (65536/20 = 3276.8). If the user wants to assert 7.5V, a value of 7.5 *3276.8 = 24576 must be written to the DAC.

The process is different for an ADC. An ADC gain has the units of full-scale user units. For example, if the input of the analog device were a maximum of +/- 10V, then the gain would be 10. Alternatively, if the input of the analog device were a maximum of +/- 20ma, then the gain would be 20. Internally the raw analog count value is normalized such that +/-1.0 represents full scale positive and negative before the user gain is applied, and user offset added.

The ACR90x0 automatically performs this arithmetic so that the analog values appear to the user as user units, not raw DAC or ADC counts. The user must know the analog range of the DAC or ADC in order to calculate the appropriate gain for entry into the ACR90x0 parameter structure. Offset values will usually be zero unless an actual physical offset is required. The ACR90x0 uses default values for gains and offsets if the user does not overwrite the defaults. All default-offset values are zero. All default ADC gains are ten (10.0), and all default DAC gains are 3276.8.

The DAC and ADC values, gains, and offsets are accessed in blocks of eight parameters each, as shown in the table below. Since each node may accommodate all 32 analog inputs and outputs, a range of 512 bits is reserved for each node. The parameter numbers correspond to a range of 33280-33791 for the lowest numbered node, 33792-34303 for the next node, and so on. The table below shows the parameter mapping for the lowest number node. For each higher number node, add 512.

DAC Parameter/DAC number	0	1	…	31
DAC Output Value	P33280	P33296	…	P33776
Reserved	P33281	P33297	…	P33777
DAC Gain	P33282	P33298	…	P33778
DAC Offset	P33283	P33299	…	P33779
Reserved	P33284	P33300	…	P33780
Reserved	P33285	P33301	…	P33781
Reserved	P33286	P33302	…	P33782
Reserved	P33287	P33303	…	P33783

ADC Parameter/ADC number	0	1	…	31
ADC Input Value	P33288	P33304	…	P33784
Reserved	P33289	P33305	…	P33785
ADC Gain	P33290	P33306	…	P33786
ADC Offset	P33291	P33307	…	P33787
Reserved	P33292	P33308	…	P33788
Reserved	P33293	P33309	…	P33789
Reserved	P33294	P33310	…	P33790
Reserved	P33295	P33311	…	P33791

These tables appear similar to the other parameter tables for ACR DACs and ADC's, but there is no relationship in function. Nor do the other DAC and ADC commands have any function for ACR9000 extended analog I/O. The DAC commands assume their use as command outputs for drives, and the ACR90x0 does not have the type of ADCs that are assumed by other ADC commands.

Saved Parameters

All the parameters required to set up the extended I/O network are saved with the ESAVE command, and automatically recalled on power up. In addition, some of the parameters determined by the controller, such as the total number of analog and digital I/O, are also saved with the ESAVE command. This allows an application to compare the total I/O expected before the network is started with the actual amount found when the network is started. The exact parameters saved and recalled are P32768 through P32778, the node IDs for each node, and the gains and offsets for all DAC and ADC parameter blocks of each node.

Example

The following example uses two Parker I/O nodes. The first, configured as node 3, has a PIO-337, four digital inputs, four digital outputs, four analog inputs (0 to 10 VDC) and two analog outputs (0 to 10 VDC). The second, configured as node 4, has a PIO-347, four digital inputs, four digital outputs, four analog inputs (0 to 10 VDC) and two analog outputs (0 to 10 VDC). They are both configured at a bit rate of 1 Mb. The example shows the required setup, and how to use the data in a very basic program.

```
10 P32768 = 5               :REM SET THE CONTROLLER ID TO 5
20 P32769 = 1000            :REM SET THE BIT RATE TO 1 Mb
30 P32770 = 2               :REM TELL THE CONTROLLER THERE
                            :REM ARE 2 SLAVES ON THE NETWORK
40 P33024 = 3               :REM SET NODE 0 TO PHYSICAL NODE 3
50 P33040 = 4               :REM SET NODE 1 TO PHYSICAL NODE 4
60 P33056 = 0               :REM SET NODE 2 TO NOTHING
70 P33072 = 0               :REM SET NODE 2 TO NOTHING
80 P32772 = 50              :REM SET THE CYCLIC PERIOD TO 50 ms
100 SET11265                :REM START THE NETWORK
110 DWL1                    :REM DWELL FOR A SECOND TO ALLOW THE
                            :REM NETWORK TO BECOME OPERATIONAL

120 IF (NOT BIT 11269) THEN SET 11266
                            :REM IF THE NETWORK IS NOT OPERATIONAL AT
                            :REM THIS POINT THEN TRY TO RESET IT

:REM MORE CODE MAY BE NEEDED HERE TO ENSURE THE NETWORK IS OPERATIONAL

200 INH 11520               :REM WAIT UNTIL THE FIRST DIGITAL INPUT ON
                            :REM NODE 0 IS ON

210 SET 12033               :REM TURN ON DIGITAL OUTPUT 2 ON NODE 0
220 SET 13057               :REM TURN ON DIGITAL OUTPUT 2 ON NODE 1
230 IF (P33288 > 5.0) THEN P33792 = 2.5
                            :REM IF ANALOG INPUT 1 FROM NODE 0 IS
                            :REM GREATER THAN 5 VDC THEN SET ANALOG
                            :REM OUTPUT 1 ON NODE 1 TO 2.5 VDC
240 INH -11520              :REM WAIT UNTIL THE FIRST DIGITAL INPUT ON
                            :REM NODE 0 IS OFF
250 CLR 12033               :REM TURN OFF DIGITAL OUTPUT 2 ON NODE 0
260 CLR 13057               :REM TURN OFF DIGITAL OUTPUT 2 ON NODE 1
270 P33792 = 0              :REM RESET ANALOG OUTPUT 1 ON NODE 1 TO 0
```

Alternate Mapping of Digital I/O

The current version of ACR90x0 firmware does not allow flags numbered higher than 8191 to be accessed by the PLC programs. The digital I/O mapping option (P32771) allows the first I/O bits of one or more nodes to appear at the flags that had been used for the XIO boards of other ACR products, i.e., P4104-P4111.

The value of P32771 is evaluated and implemented each time the network is started (via bit 11265). Values of P32771 less than or equal to zero do not result in any re-mapping, so CANopen digital I/O appears at the original location. Values of 1, 2, or 3 will result in the equal re-mapping of node 0 only, node 0 and 1 only, or all 4 nodes respectively. The meaning of P4104-P4111 is given below for the various values of P32771.

XIO Flags Parameters	P32771 = 1	P32771 = 2	P32771 >=3
4104	Node0 DI 0-31	Node0 DI 0-31	Node0 DI 0-31
4105	Node0 DO 0-31	Node0 DO 0-31	Node0 DO 0-31
4106	Node0 DI 32-63	Node0 DI 32-63	Node1 DI 0-31
4107	Node0 DO 32-63	Node0 DO 32-63	Node1 DO 0-31
4108	Node0 DI 64-95	Node1 DI 0-31	Node2 DI 0-31
4109	Node0 DO 64-95	Node1 DO 0-31	Node2 DO 0-31
4110	Node0 DI 96-127	Node1 DI 32-63	Node3 DI 0-31
4111	Node0 DO 96-127	Node1 DO 32-63	Node3 DO 0-31

Any digital input or output of any node that appears in this table will not appear in the standard mapping of CANopen digital I/O. In other words, each I/O bit is controlled by only one flag. In addition, this table represents the maximum amounts of I/O that can appear at XIO flag parameters 4104-4111. For example, if P32771= 1 and Node 0 only has 32 physical inputs and outputs, only flag parameters 4104 and 4105 have meaning.

Appendix F

Drive Talk

IN THIS CHAPTER

Quick Startup (ACR9000 and ACR9030)

1. Make sure the drives are connected to the controller before they are powered on. The Aries drives auto detects RS232/485 communications on power up. If they are not connected to the controller when the drive is powered up, they will default to RS232 and Drive Talk will not function.
2. Open the second COM port which is located in the axis connectors. The Aries drive operates on 9600 baud, no parity.

   OPEN DTALK “COM2:9600,N,8,1” AS #1
3. Set the device number for each drive (base +256 per axis). This device number must match the number given with the `OPEN` command.

   `P28672=1` for axis0

   `P28928=1` for axis1

   `P29184=1` for axis2

   `P29440=1` for axis3

   `P29696=1` for axis4

   `P29952=1` for axis5

   `P30208=1` for axis6

   `P30464=1` for axis7
4. Set the type of drive you are talking to for each drive (base +256 per axis) (Aries=0)

   `P28673=0` for axis0

   `P28929=0` for axis1

   `P29185=0` for axis2

   `P29441=0` for axis3

   `P29697=0` for axis4

   `P29953=0` for axis5

   `P30209=0` for axis6

   `P30465=0` for axis7
5. Make sure bits 11122, 11123, and 11124 are all set to 0 (Timeouts)
6. Set the auto address request flag for each drive. You should see the drives reset.

   `SET 10496` for axis0

   `SET 10528` for axis1

   `SET 10560` for axis2

   `SET 10592` for axis3

   `SET 10624` for axis4

   `SET 10656` for axis5

`SET 10688` for axis6

`SET 10720` for axis7

7. Using the Drive Talk Control Parameters, set the bits of the parameters you would like to query.
8. Set the update bit for the type of parameters you have set using the drive talk control for the parameters you have selected. Your options include:

   `GET_CONFIG`

   `SEND_CONFIG`

   `SEND_ERRORL`

   `GET_DRIVE_DATA.`

   Note: For more information about commands, see the Command Reference.

9. Read the parameter or flag for the information you have queried. These parameters are supplied on the following pages. These parameters include:

   Drive Data Parameters

   Drive Status (1&2)

   Drive Configuration

   Error Log

For more information on these commands, please see the Aries User Guide.

Example 1
The following example is for two-axis operation:

```
OPEN DTALK "COM2:9600,N,8,1" AS #1 REM OPEN PORT
P28672=1       REM SET DEVICE NUMBER FOR DRIVE 1
P28928=1       REM SET DEVICE NUMBER FOR DRIVE 2
P28673=0       REM SET DRIVE TALK AXIS1 TO ARIES DRIVES
P28929=0       REM SET DRIVE TALK AXIS2 TO ARIES DRIVES
CLR 11122      REM RESET TIMEOUT
CLR 11123      REM RESET TIMEOUT
CLR 11124      REM RESET TIMEOUT
SET 10505      REM GET TPE AXIS0 USING GET DRIVE DATA
SET 10500      REM UPDATE DATA AXIS0 USING
               REM GET_DRIVE_DATA_REQUEST
SET 10537      REM GET TPE AXIS1 USING GET DRIVE DATA
SET 10532      REM UPDATE DATA AXIS1 USING
               REM GET_DRIVE_DATA_REQUEST
?P28693        REM SHOW TPE AXIS0 ON TERMINAL
?P28949        REM SHOW TPE AXIS1 ON TERMINAL

SET 10500      REM GET TPE AXIS1 USING GET DRIVE DATA
SET 10532      REM UPDATE DATA AXIS1 USING
               REM GET_DRIVE_DATA_REQUEST
?P28693        REM SHOW TPE AXIS0 ON TERMINAL
?P28949        REM SHOW TPE AXIS1 ON TERMINAL
```

Example 2
Another way to talk to the drive is using the DTALK command. You communicate directly with the drive, where the controller acts as a bypass. To end the direct communications, you must send an escape character.

Use this method of communication for troubleshooting drive and controller problems. The following example shows how to open the communications with an Aries drive and talk directly to it.

```
P00>OPEN DTALK "COM2:9600,N,8,1" AS #1       REM OPEN A DRIVE TALK PORT
WITH           REM DEVICE NUMBER 1
P00>P28672=1   REM SET AXIS0'S DEVICE NUMBER FOR DTALK
               REM TO 1, MUST MATCH THE OPEN COMMAND ABOVE
P00>P28673=0           REM SET AXIS0 TO AN ARIES DRIVE
P00>CLR11122 CLR11123 CLR11124               REM CLEAR ALL TIMEOUT BITS
P00>SET11104           REM START AUTO ADDRESS
P00>DTALK X            REM START TALKING DIRECTLY TO THE DRIVE
                       REM HIT ESCAPE TO EXIT
TPE
*0
TPE
*2576
TREV

*Aries OS Revision 2.00
DMODE
*2

P00>
```

Configuration Parameters

Mask			0x01	0x02	0x04	0x08	0x10	0x20	0x40	0x80
Index	Drive Talk Configuration Parameters Code=0x70		Axis Number							
			0	1	2	3	4	5	6	7
0x00	Communication Device	LONG	28672	28928	29184	29440	29696	29952	30208	30464
0x01	Drive Type	LONG	28673	28929	29185	29441	29697	29953	30209	30465

Field Description	Read/ Write	Description
Communication Device	R/W	This specifies the device number to use for drive talk. This must be the same device number used in the OPEN DTALK command.
Drive Type	R/W	This specifies what drive type to talk to (Aries = 0)

	Mask=0x08
Flag Parameter Code=0x10; Index=0x2B	4443

COM2 Stream Drive Talk Control Flags	Bit Index	Flag Number
AUTO_ADDRESS Request	0	11104
Reserved	1	11105
Reserved	2	11106
Reserved	3	11107
Reserved	4	11108
Reserved	5	11109
Reserved	6	11110
Reserved	7	11111

COM2 Stream Drive Talk Status Flags	Bit Index	Flag Number
Reserved	8	11112
Reserved	9	11113
Reserved	10	11114
Reserved	11	11115
Reserved	12	11116
Reserved	13	11117
Reserved	14	11118
Reserved	15	11119
STREAM_DTALK_ACTIVE	16	11120
STREAM_DRIVE_FOUND	17	11121
STREAM_DRIVE_LOST	18	11122
STREAM_DRIVE_TIMEOUT	19	11123
STREAM_ADDR_ERROR	20	11124
Reserved	21	11125
Reserved	22	11126
Reserved	23	11127

COM2 Stream TALKTO/DTALK Status Flags	Bit Index	Flag Number
Reserved	24	11128
Reserved	25	11129
Reserved	26	11130
Reserved	27	11131
STREAM_FORWARD to STREAM_	28	11132
STREAM_FORWARD to DRIVE_	29	11133
STREAM_RESPONSE_PENDING	30	11134
STREAM_FORWARD_REQUEST	31	11135

Field Description	Read/ Write	Description
Auto Address All Drives Request	R/W	When this flag is set the controller will start the auto address process for all axes with a non-zero Drive Talk Device Number. This process will hold drives in the reset state and issue addressing commands until all axes are addressed in the order that the axes are attached with the ATTACH command. The flag is automatically cleared when the process is finished.
Drive Talk Active	R	Indicates whether drive talk is active or not. Drive Talk becomes active after the OPEN DTALK command is issued. Drive talk is deactivated with the CLOSE command and any of the errors below.
Drive Found	R	This flag is set each time a successful response from the drive has been read by the controller.
Drive Lost	R	This flag is set if at any time the controller requests data from the drive and the drive does not respond. The controller never clears only sets this flag.
Drive Timeout	R/W	This flag is the same as the Drive Lost flag, but when this flag is set the controller will not send another query to the drive until this flag is cleared.
Address Error	R	This flag is set when an individual axis auto address request was made, but the drive's reported address did not match the sent address.

APPENDIX G

Regulatory Compliance —UL, EMC and CE

IN THIS CHAPTER

System Installation Overview

This appendix contains information related to installation methods and practices that can be used to aid the systems integrator or machine builder in designing a compliant installation, meeting the needs of Global Regulatory Agencies.

The installation overview is divided in to two sections—“Safety” and “Electromagnetic Compatibility (or EMC).”

It is recommended that the installer read this entire overview, prior to taking any action, as some of the required installation methods can be leveraged across both Safety and EMC installations.

Although the ACR90x0 Stand-Alone Controller is technically considered a motion control component and is therefore not within the scope of the European Union’s CE (Conformité Européenne) directives, Parker Hannifin has taken the initiative to provide its customers with easy to integrate motion control products that meet global requirements.

The following constitutes what is typically required to install the ACR90x0 controller into a CE compliant system. Additional installation measures may be required at some locations. The machine builder has ultimate responsibility for machine compliance.

General Safety Considerations

These products are intended for installation according to the appropriate safety procedures including those laid down by the local supply authority regulations. The recommendations provided are based on the requirements of the Low Voltage Directive and specifically on EN61010. Remember, never compromise safety to achieve EMC compliance. Therefore, in the event of a conflict between safety regulations and the following EMC recommendations, safety regulations always take precedence.

General EMC Considerations

The ACR90x0 product is a Motion Control Component and as such will be built in to another machine that will in turn be required to comply with the relevant directives of the marketplace.

It is important to remember that for specific installations, the full protection requirements of the EMC directive 89/336/EEC need to be met before the system is taken in to service. This must be verified either by inspection or by testing. The following EMC installation recommendations are intended to assist in ensuring that the requirements of the EMC directive are met. It may be necessary to take additional measures in certain circumstances and at specific locations.

It should be stressed that although these recommendations are based on the expertise acquired during the design and development of the ACR90x0 products, and on tests carried out on similar products, it is impossible for Parker Hannifin to guarantee compliance of any particular installation. This will be strongly influenced by the physical and electrical details of the installation and the performance of other system components. Nevertheless, it is important to follow all the installation recommendations if an adequate level of compliance is to be achieved.

Installing the ACR90x0 Controller

Only qualified, skilled electrical technicians familiar with local safety requirements should install this product. For service, the controller must be returned to an authorized service center. There are no user serviceable parts inside the chassis. In certain circumstances, opening the cover may void the product warranty.

The ACR90x0 controller is a vented product. To prevent material spilling into the controller, mount it under an overhang or in a suitable enclosure.

ACR90x0 products are made available under “Restricted Distribution” for use in the “Second Environment” as described in EN 61800-3 1996, page 9. This means only those individuals familiar with the EMC requirements of motion control systems should install this product and that this product is designed for connection to mains distribution networks other than low-voltage networks, which may supply domestic premises. The controller can tolerate atmospheric pollution degree 2, which means only dry, non-conductive pollution is acceptable.

The ACR90x0 Stand-Alone Controller has been shown to meet the requirements of both the European LVD & EMC directives when installed according to the recommendations given within this section. It is recommended the controller be installed in an enclosure to protect it from atmospheric and industrial process contaminants, to prevent operator access while it has power applied, and to provide the necessary EMC screening. Metal equipment cabinets are ideally suited for housing the equipment since they can provide operator protection, EMC screening, and can be fitted with interlocks arranged to remove all hazardous voltages when the cabinet door is opened. Do not arrange interlocks to open circuit inductive loads, such as motor phase connections, while the system is still powered, as this could cause damage to the controller.

Precautions

During installation, take the normal precautions against damage caused by electrostatic discharges. Wear earth wrist straps. A switch or circuit breaker must be included in the installation, which must be clearly marked as the disconnecting device and should be within easy reach of the machine operator.

A Safe Installation – Meeting the Requirements of the Low Voltage Directive (LVD)

In order to comply with the requirements of the European Union’s Low Voltage Directive, the proper AC power fuse type and size must meet all of the requirements under AC Power Fuse Requirements on page 27.

The ACR9000 and ACR9030 controllers receive its protective earth (PE) connection through its 3-pin power connector. The mains socket on the ACR9000 and ACR9030 incorporate a mains fuse in the Line (hot) leg of the AC mains. For portable equipment, the use of a standard IEC approved power cord is allowed. For permanent installations, local safety requirements may dictate that both the Line and Neutral conductors be fused. *Never* fuse the protective earth (PE) conductor; serious injury may result.

Additional safety measures may be required within your particular market, please consult you local Regulatory Agency for additional requirements.

A Highly-Immune, Low-Emission Installation—Meeting the Requirements of the Electromagnetic Compatibility (EMC) Directive

The following information was compiled to aid the machine builder or systems integrator in gaining EMC compliance. For effective control of Conducted and Radiated Emissions, along with maximizing the ACR90x0 Controller's inherent noise immunity, the following recommendations should be followed.

- For EMC compliance, the ACR90x0 controller must be installed within an earth-bonded metallic enclosure. The enclosure must provide at least 10 dB of shielding effectiveness for a Class A (industrial) installation. For ESD purposes, the enclosure also must restrict user access to discrete input and output conductors, which are located on the front of the ACR90x0 enclosure.
- Mount the controller and all components to a clean (unpainted), earthed, metal panel.

Important!

To reduce the risk of electrical noise entering your system you must properly earth ground the enclosure, and remove all paint and other non-conductive surface coatings from the panel mounting surface and RF earth bonding locations.

If you mount the ACR90x0 controller in an equipment cabinet, terminate cable braids (screens) at the entrance of the enclosure. This can be easily accomplished using the additional EMC installation hardware shown below.

The shields of all cables that enter or exit the enclosure must be RF bonded to the enclosure entrance point using an R-Clamp, bulkhead clamshell clamp, or other 360° bonding technique. This ensures that no stray noise will enter or exit the enclosure. Figure 36 illustrates 360° bonding techniques.

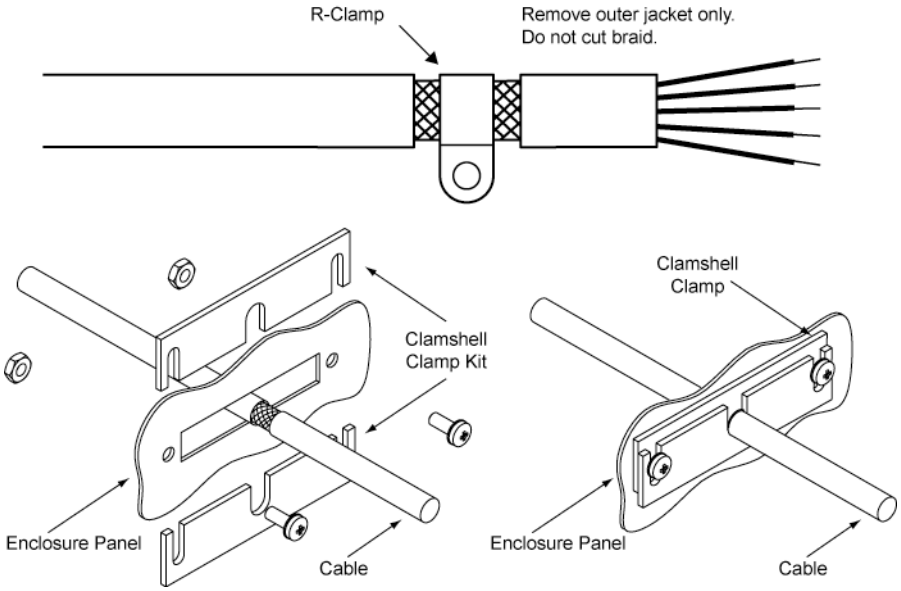


Figure 36 360° Bonding Techniques

All braid termination connections must remain secure. For small diameter cables, it may be necessary to fold back the braid to increase the effective diameter of the cable so that R-Clamps are secure.

Within the cabinet itself, all high-voltage cables should lie in the same trunking as far as possible. Keep the cables separate from any low-level control signal cables. This applies particularly where the control cables run close to the cables providing power to motor drives, contactors, relays, etc.

There must be no break in the 360° coverage that the screen provides around the cable conductors.

A steel equipment cabinet will screen radiated emissions provided all panels are bonded to a central earth point. Separate earth circuits are commonly used within equipment cabinets to minimize the interaction between independent circuits. A circuit switching large currents and sharing a common earth return with another low-level signal circuit could conduct electrical noise into the low level circuit, thereby possibly interfering with its operation. For this reason, so called ‘dirty earth’ and ‘clean earth’ circuits may be formed within the same cabinet, but all such circuits will eventually need to be returned to the cabinet’s main star earth point.

Mount the individual controllers and the EMC filter (if your system requires filters, see Table 65 on page 154) on a metal earth plane. The earth plane will have its own individual star point earth that should be hard wired (using an insulated copper conductor) back to the cabinet’s ‘clean earth’ connection point.

Panel mounting can provide a similar measure of EMC performance if strict attention is paid to cable screen termination and cable layout.

Again, the machine builder’s primary focus should be on ensuring operators are kept safe from all hazards.

- Install a Mains filter. Installing with multiple ACR9000 and ACR9030 controllers require an EMC mains supply filter to meet EMC emission requirements. It is recommended that the controllers are mounted on a conductive panel which is shared with the EMC filters. If the panel has a paint finish, it will be necessary to remove the paint in certain areas to ensure filters and controller make a good large-area metal to metal contact between filter case and panel.

  Use Table 65 on page 154 to determine the correct filter for your specific application.

Filter	Filter Rating: Continuous Current (Amps)	Number of ACR9000 and/or ACR9030 Controllers
6EP1 (160937-5)[1]	5 at 240VAC	2
10EP1 (160937-7)[1, 3]	8 at 240VAC	3
FN2070-10/06[2]	10 at 240VAC	3
FN2070-12/06[2]	12 at 240VAC	4
FN2070-16/06[2, 3]	16 at 240VAC	5

1. Corcom (a division of Tyco Electronics)
2. Schaffner
3. Available filters from Parker Hannifin:
   10 Amp filter—part number 47-016140-01
   16 Amp filter—part number 47-017900-01

Table 65 Mains Filter Selection

- Install transient suppressors. You must install varistors or other voltage surge limiting devices in order to meet the requirements of EN61000-4-5. Place a Littelfuse V275LA2ØC, or an equivalent varistor, from line to line and from lines to earth before the mains filter, as shown in the EMC Installation drawings. (Intersil, General Electric, and Littelfuse manufacture equivalent varistors.)
- Use shielded cabling with braided and bonded headshells.

  Parker Hannifin EMC cabling—requires no additional cable preparation. The design of the ACR90x0 controller D-sub connectors provides a reliable earth bond when used with Parker EMC cabling. It requires no additional cable screen earth bond if the chassis of the ACR90x0 is adequately bonded to the system earth.

  For maximum immunity, both ends of each cable must be earth-bonded. All connections must be made using a high quality braided-screen cable (with minimum of 85% coverage). Cables using a metalized plastic bandage for an earth screen are unsuitable and in fact provide very little screening. Care must be taken when terminating the cable screen, as the screen itself is comparatively fragile; bending it round a tight radius can seriously affect the screening performance. The selected cable must have a temperature rating which is adequate for the expected operating temperature of the motor case.

  All cables must maintain high integrity 360-degree shielding. Parker Hannifin CE cables are fully shielded and provide the necessary screening. For differential signals (inputs and outputs), shielded, twisted-pair wiring (with 3 turns per inch (TPI)) is recommended. When you install limit switches and other inputs/outputs, you must observe these noise immunity procedures and practices.
- Route cables as shown in the EMC Installation drawing, Figure 37 on page 156.

  Route high power cables (motor and mains) at right angles to low power cables (communications and inputs/outputs). Never route high and low power cables parallel to each other.

If filters are required, mount them close to the controller and keep the supply wiring as short as practical. Attempt to layout the wiring in a way that minimizes cross coupling between filtered and non-filtered conductors. This means avoiding running wires from the output of a filter close to those connected to its input. Where you wish to minimize the cross coupling between wires avoid running them side-by-side one another, if they must cross, cross them at 90° to each other. Keep wiring supported and close to cabinet metalwork.

- Cables may require the use of ferrite core suppressors.

  Some installations may require that you take additional EMC measures. To further increase product immunity and reduce product emissions, you may add clip-on ferrite absorbers to all cables. Parker Hannifin recommends ferrites with at least 200 ohm impedance at 100 MHz, such as the following:

Steward Ferrite	Part number 28A2024
Fair-Rite	Part number 0443164151

  (These ferrites are available from Parker Hannifin, part number 47-015956-01)

  Ferrite absorbers also are recommended for cable runs longer than 5 meters.

- Take care that the power supply providing the pull-up voltage to the controller's high-speed inputs and outputs is free from electrical noise. Short-Duration transient events, such as those caused by electrical relays, can induce sufficient voltage disturbance on unfiltered DC power lines to affect I/O performance. One method of reducing the amplitude of transient disturbances on DC power lines is to add ferrite suppressors (3 turns) to the conductors as shown in Figure 37 on page 156.
- Your Installation may require additional EMC installation hardware (as shown in illustrations).

  The following clamp kits (earth-bonding kits) are available from Parker Hannifin:

Clamp Type	Parker Hannifin Part Number
R-Clamp Kit (10 per)	AR CLAMP KIT
Clamshell Clamp Kit*	CLAMSHELL KIT
* The Clamshell kit consists of two clamshell clamps.	

Table 66 Enclosure Mounting Clamps

Panel Installation in an Earth-Bonded Metallic Enclosure

The following diagram shows a typical ACR9000 installation, and is also applicable to the ACR9030 and ACR9040.

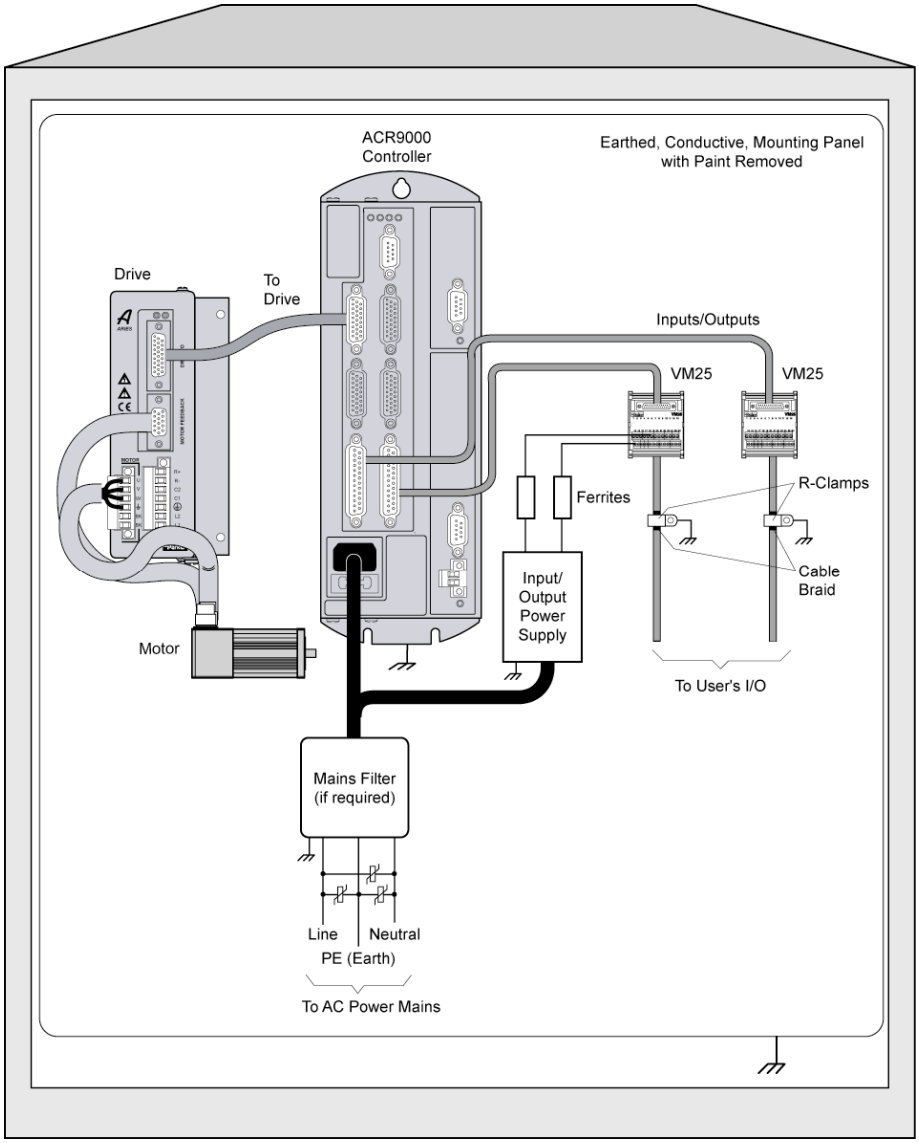


Figure 37 Typical LVD/EMC Installation

Warning — These products have been developed for industrial environments. Due to exposed high voltage terminals, these products must not be accessible to users while under normal operation.

Panel Layout

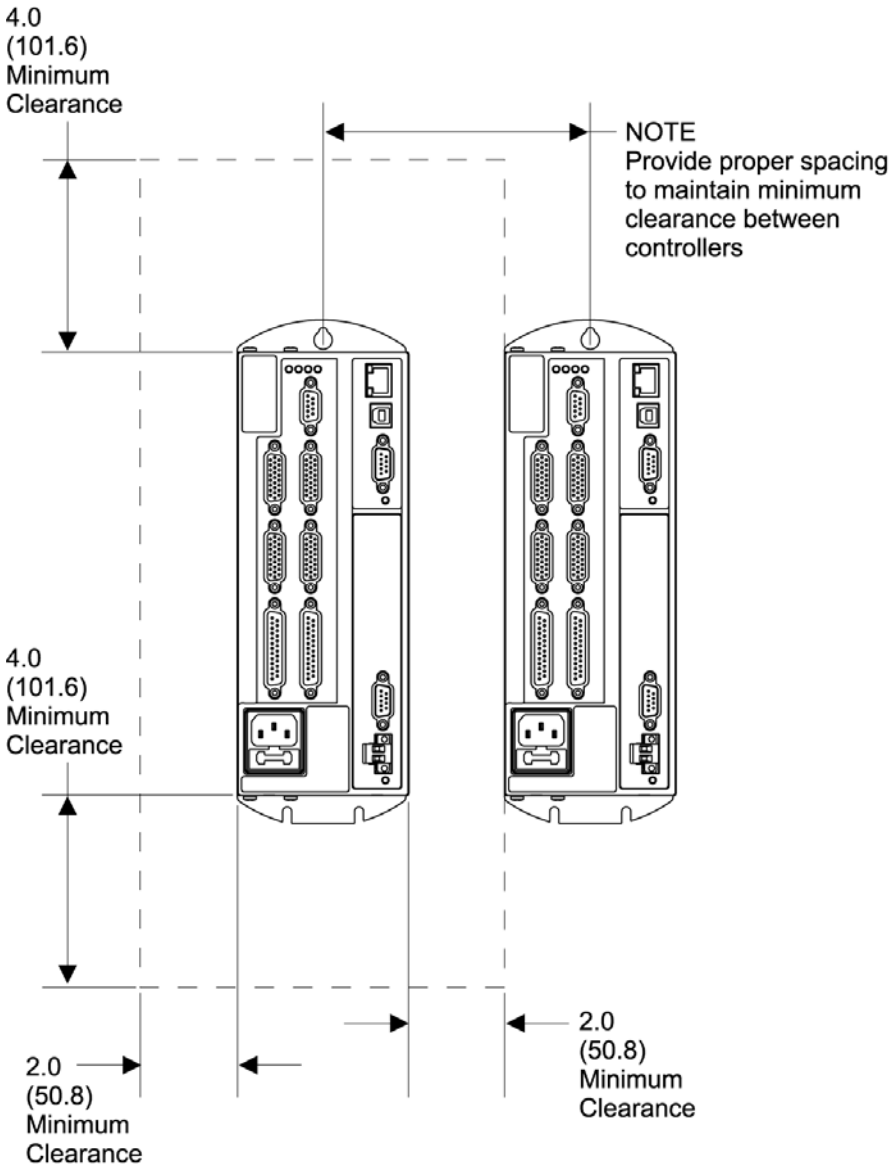


Figure 38 ACR9000 and ACR9030 2/4 Axis Configuration Panel Layout Dimensions

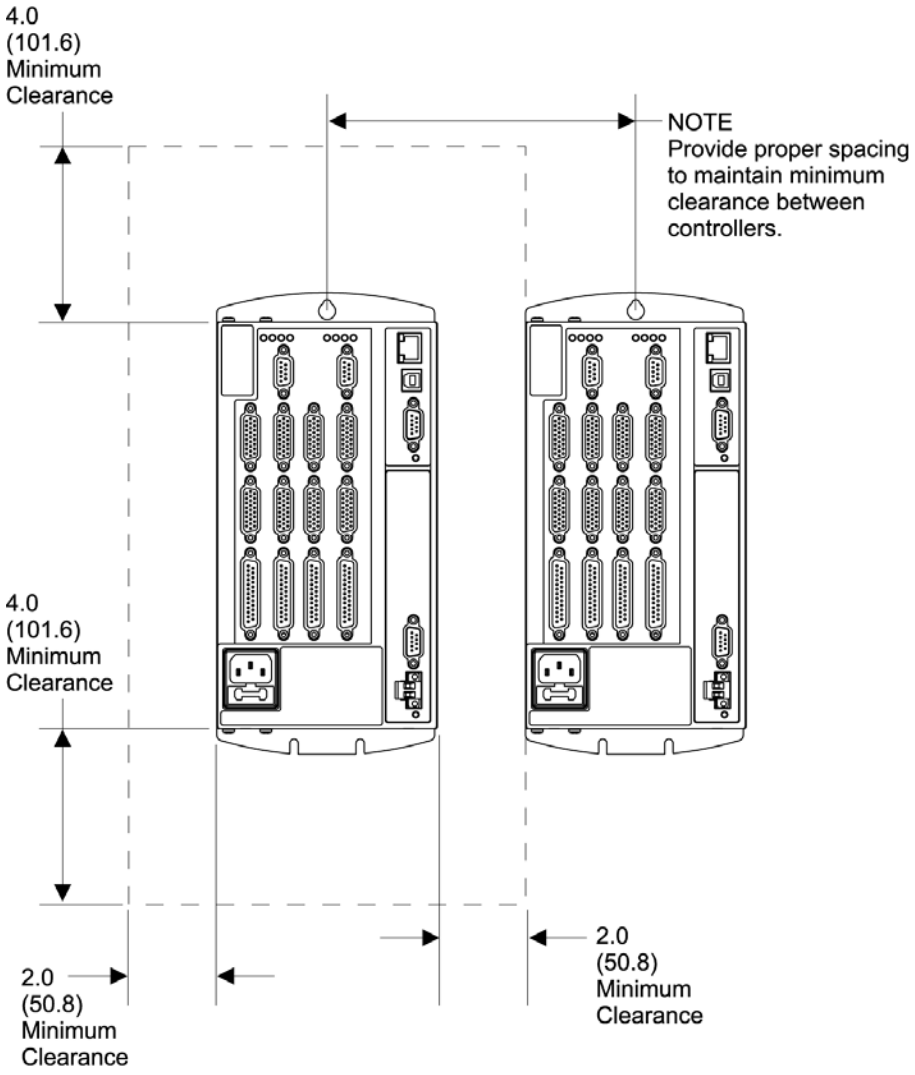


Figure 39 ACR9000 and ACR9030 6/8 Axis Configuration Panel Layout Dimensions

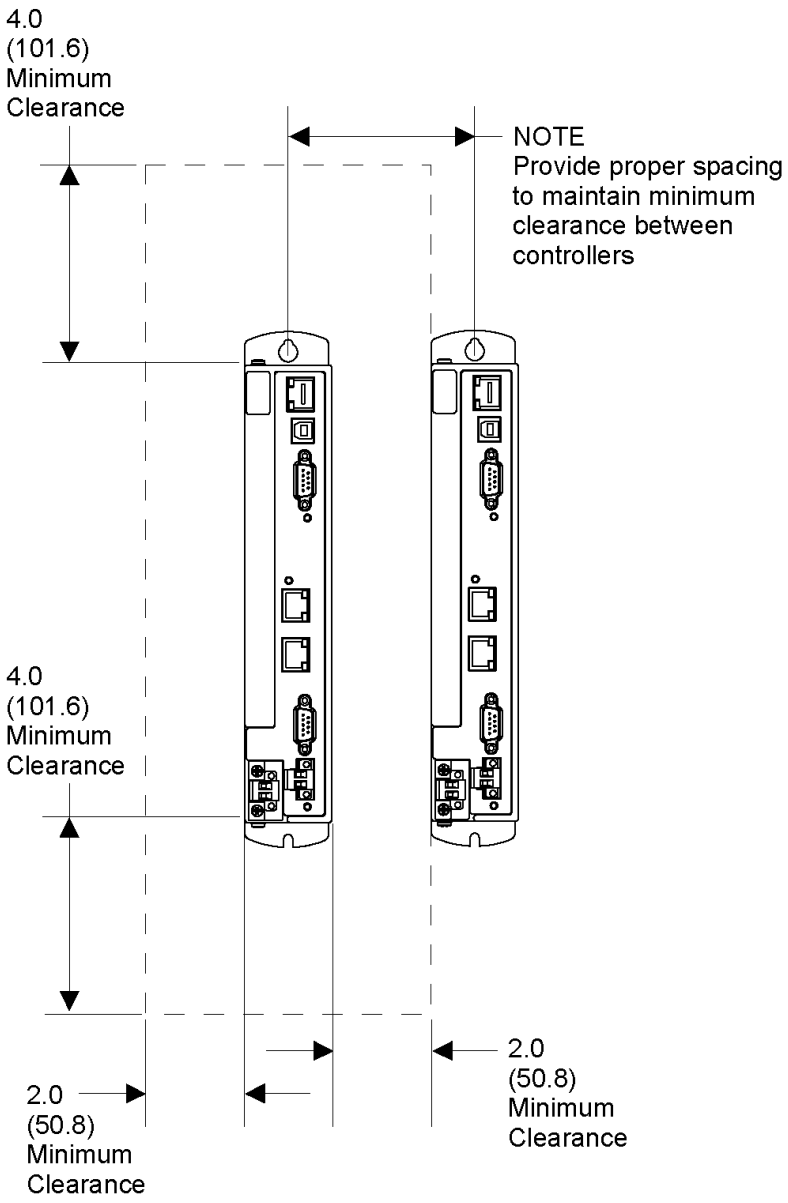


Figure 40 ACR9040 Panel Layout Dimensions

Regulatory Agencies

The ACR90x0 family of products is designed to meet the requirements of global regulatory agencies.

ACR90x0 products have shown compliance with the regulatory agencies in the following list. The list also shows additional steps users must take to ensure compliance.

Agency	Additional Steps User Must Take
UL, cUL	Mains fuses, as dictated by the local safety authority.
CE (LVD)	Mains fuses, as dictated by the local safety authority.
CE (EMC)	Varistors, mains filter (if required), EMC cabling, EMC ready motor, proper installation

Table 67 Regulatory Agencies

Standards of Compliance

UL, cUL	508C	
CE for LVD	72/23/EEC	
	BS EN 61010-1 (1993) including Amendment A2.	Safety requirements for electrical equipment for measurement, control, and laboratory use. Part 1. General Requirements.
CE for EMC	89/336/EEC	
	BS EN 50081-2 (1994) Electromagnetic compatibility	Generic emission standard Part 2. Industrial Environment.
	BS EN 61000-6-2 (1999) Electromagnetic compatibility Part 6-2: Generic Standards	Immunity for industrial environments.

Appendix H

ETHERNET Powerlink

IN THIS CHAPTER

ACR9030 and ACR9040

The ACR series includes two ACR9000-based ETHERNET Powerlink (EPL) motion controllers—the ACR9030 and ACR9040. They are each equipped with an EPL daughter card, two EPL connectors, and an EPL Status LED. They use standard EPL technology without altering existing ACR9000 features.

The ACR9030 is based on the ACR9000 hardware. It will support up to 16 axes total. Some or all of the axes may be EPL Nodes, and a maximum of 8 may be traditional axes. The ACR9040 is a DC-powered EPL controller, and will support up to 16 EPL nodes.

Introduction to ETHERNET Powerlink (EPL)

ETHERNET Powerlink (EPL) is an open standard communication profile for real time Ethernet. It was developed to achieve the timing and performance required in automation and motion control applications while reducing cabling costs and complexity. EPL uses standard Ethernet for the data link layer, but imposes timing rules for all members of an EPL network, rules that prevent collisions and ensure precise periodic data exchange.

EPL Cycles and Nodes

A member of an EPL network is called a node. There may be only one managing node (MN) and up to 16 controlled nodes (CN). As the names imply, the MN starts and stops the network, and initiates all communication. Controlled nodes respond to requests from the MN. All communication takes place periodically within an EPL cycle. See Figure 41.

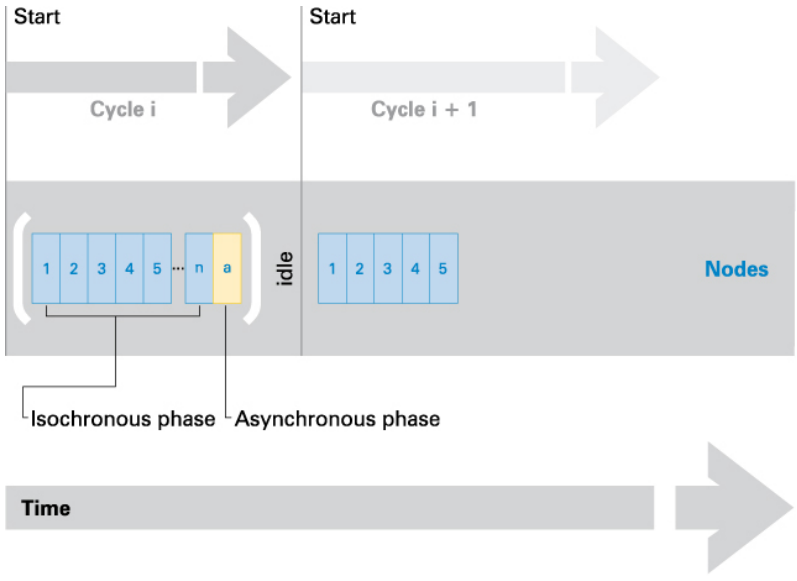


Illustration courtesy of ETHERNET Powerlink Standardization Group (EPSG)

Figure 41 EPL Network Communication

An EPL cycle has two phases, the isochronous and the asynchronous. The isochronous phase consists of request/response pairs between the MN and each CN. All periodic data transfer takes place during this portion. See Figure 42 for details included in this phase.

Using the isochronous time slot procedure to assign the send authorization avoids data packet collisions on the network, allowing ultra precise timing (jitter < 1µs).

The asynchronous phase is devoted to other types of communication between nodes, including standard TCP/IP and UDP. This phase allows non-EPL related communication to take place during the EPL cycle.

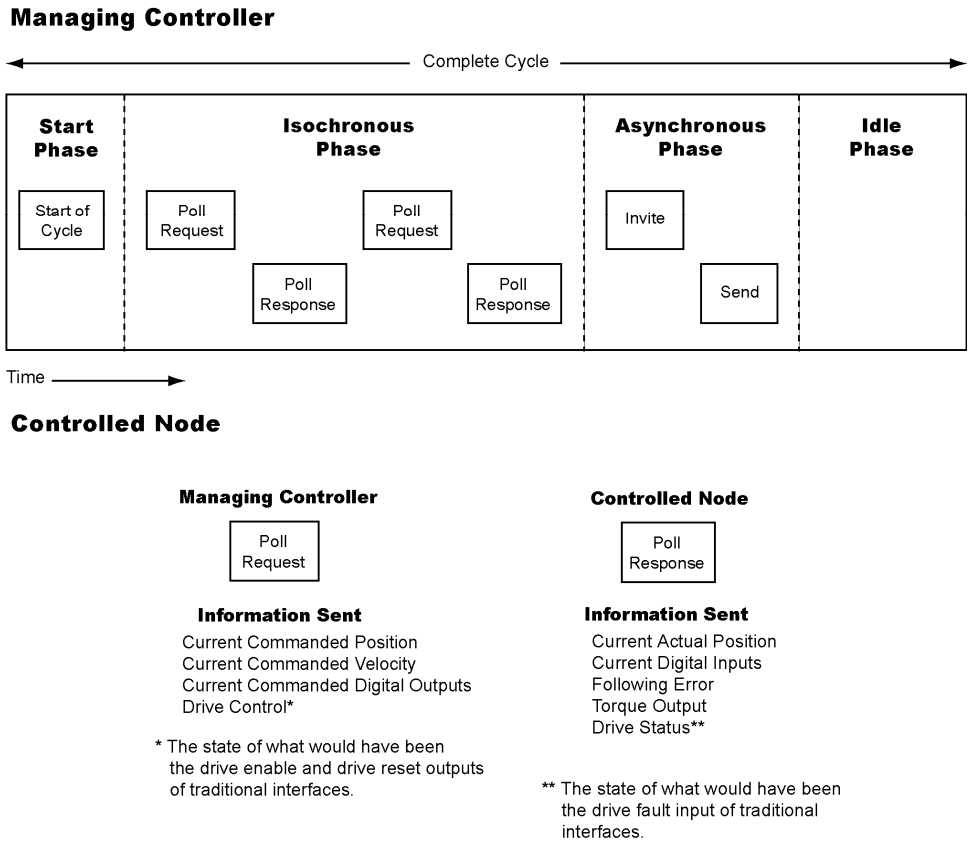


Figure 42 EPL Cycle

EPL Node IDs

Each node on an EPL network has a unique node ID. The MN always has the ID 240, whereas the CN nodes IDs may be between 1 and 239. It is the node ID that allows the internal EPL firmware to identify whether a node is an MN or CN. In general, a node that can be a CN will have external switches to set the node ID.

NOTE: Do not confuse the node ID with the axis number in AcroBASIC. Node IDs start at one, while axis numbers always start at zero.

EPL IP Addresses

An EPL network is a private Class C network with Net ID 192.168.100.0. The first 3 octets will always be 192.168.100 for all EPL nodes. The node ID of an individual node will be the last octet of the EPL IP address of that node. For example, if an EPL drive has the address of 97 on its switch settings, its IP address will be 192.168.100.97. The correlation of node ID with network IP is required because EPL uses TCP/IP as part of the protocol.

The EPL IP address is not related in any way to the standard Ethernet IP address given with the IP command. There is no need to change any part of the EPL IP address other than the last octet.

EPL and CANopen Standards

The ETHERNET Powerlink V2.0 draft standard calls for the use of CANopen as the data exchange protocol. In this case, CANopen describes the use of object dictionaries, device profiles, data exchange methods, and network control. Ethernet is used as the physical medium, not CANbus.

Both EPL and CANopen device profiles are open standards, so all vendors' equipment will work together to the extent that they support the standards. The CANopen device profile for drives and motion control is CiA DSP-402. EPL drives must conform to this standard, and EPL controllers such as the ACR9030 and ACR9040 expect to find drives that conform to CiA DSP-402. To ensure product compatibility, please contact Parker Electromechanical Division before specifying a multi-vendor EPL solution.

Cabling and SETUP

ACR9030, ACR9040, and Aries EPL devices are equipped with dual ETHERNET Powerlink ports which can handle lines and branches. Therefore, any topology such as line, tree, star, or mixed structures can be realized. Inside each device, a repeating hub forwards the data stream to its intended destination. In addition to greater flexibility, this reduces the need for external infrastructure components such as switching or repeating hubs.

With ETHERNET Powerlink, the physical and the logical topology of the network are separated. It is possible to connect a device to any port on the network without having to reconfigure it. This achieves a higher degree of freedom with designing and upgrading modular machine systems and prevents cabling errors.

Two EPL connectors are located on the ACR9030 and ACR9040 front panel and are labeled ETHERNET POWERLINK. (This is not to be confused with the LAN communications port labeled ETHERNET.) See Figure 43 for the ACR9030 front panel and Figure 44 for the ACR9040 front panel. Both EPL ports are available to the user. An internal hub allows the use of either or both of the connectors for wiring the EPL network, allowing for cabling simplification.

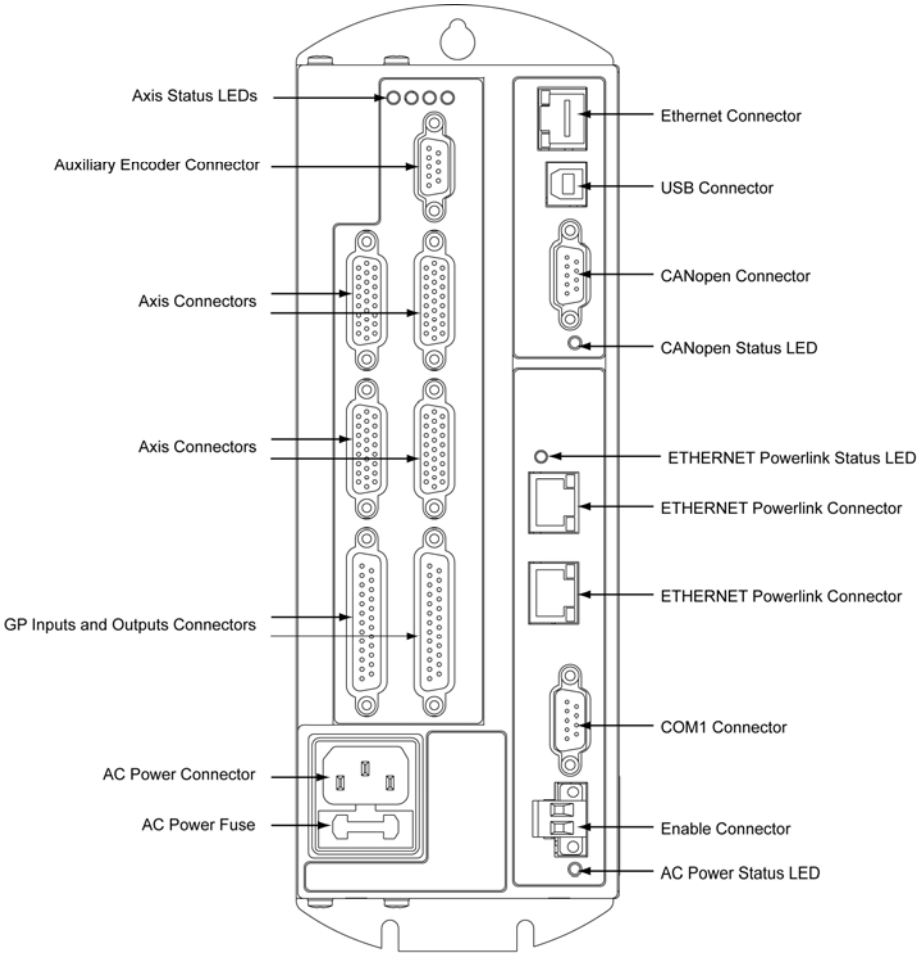


Figure 43 ACR9030 Front Panel

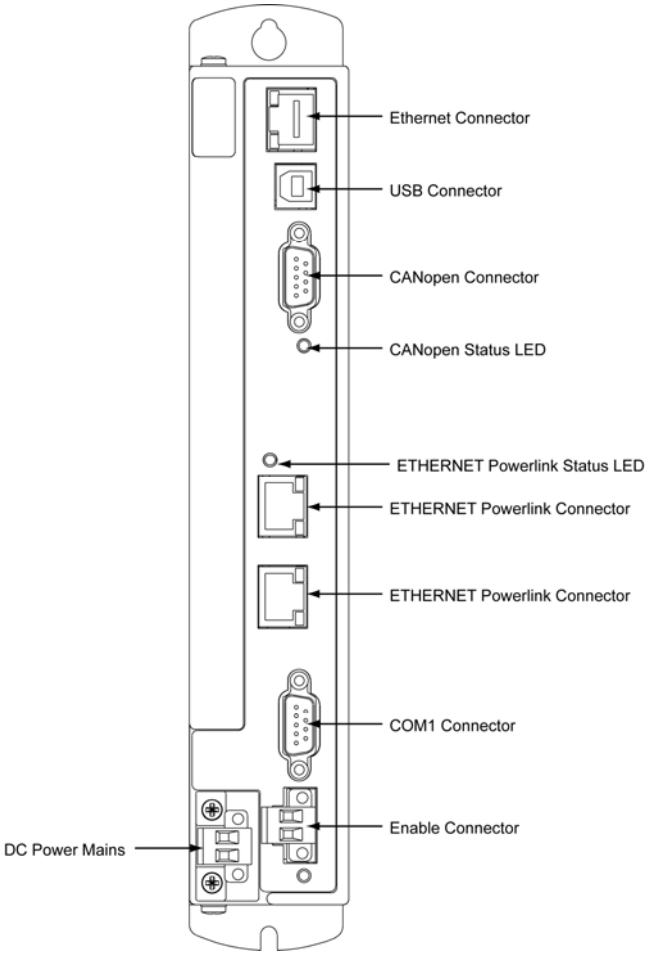


Figure 44 ACR9040 Front Panel

EPL Ethernet Cable Specification

Use a braid over foil, twisted-pair cable (straight or crossover) for connection to the Aries EPL drive. An example of this type of cable is L-COM TRD855SIG-XX. (Although the EPL guidelines call for crossover cables between EPL devices, the ACR9030, ACR9040, and Aries EPL drive can autodetect, and as such, either a crossover cable or a straight cable may be used.)

The maximum cable length is 100m, as defined by Ethernet 100Base-TX standards.

NOTE: Due to its lack of noise immunity, unshielded Ethernet cable will not work in an ETHERNET Powerlink system.

ETHERNET Powerlink Connector Specifications

See Ethernet Connector on page 60 for specifications for the two ETHERNET Powerlink connectors.

Connections

See Figure 45 for connections between the ACR9030 and the Aries EPL drive. (Connections to the ACR9040 are identical.)

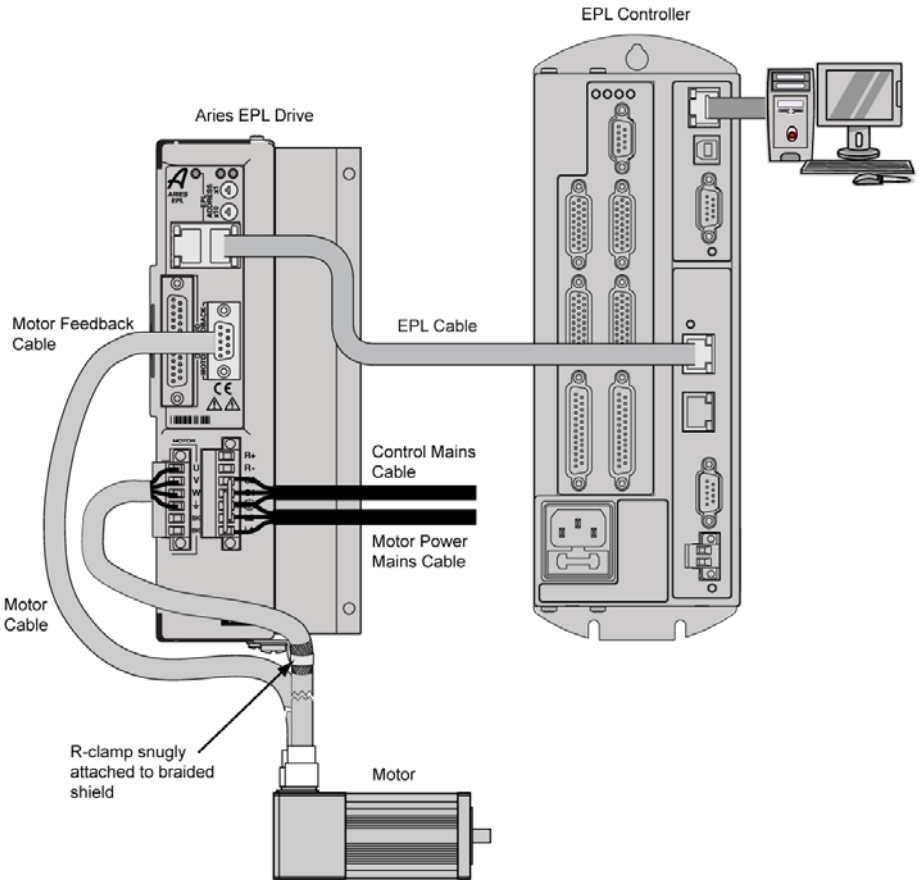


Figure 45 ACR9030 and connections to the Aries EPL drive

ACR9030 and ACR9040 Utilization of EPL

The ACR9030 and ACR9040 use an EPL network card to control EPL drives (EPLD). The EPL network is an alternative to the DACs, encoders, connectors, and cabling associated with the traditional interface drives, as in the case of the ACR9040, or it may be used in combination with them, as with the ACR9030. EPL nodes are represented via parameters in the ACR9030 and ACR9040 as objects (EPLDs) to be attached to an axis, just as the ENC and DAC objects are. They range from EPLD0 to EPLD15. A complete description of the network with EPLD parameters and the use of the `ATTACH EPLD` command are given later in this appendix.

ACR9030 and ACR9040 as Managing Node

The ACR9030 or ACR9040 is the managing node (MN) and the drives are the controlled nodes (CN). The ACR9030 and ACR9040 will support up to 16 axes total. In the case of the ACR9030, some or all of the axes may be EPL nodes, and a maximum of 8 may be traditional axes. The ACR9030 and ACR9040 only support EPL nodes that adhere to device profile DSP-402.

EPL vs. Traditional Drive Interface

A traditional drive interface on an ACR9000 or ACR9030 controller is contained on the drive connector. It consists of the DAC (or step and direction) signals out, the encoder feedback in, the drive enable and reset outputs, and the drive fault input. The position loop is closed in the controller, meaning the commanded and actual positions of an axis are combined to result in a torque command to the DAC.

In an EPL drive interface, the position loop is closed in the drive. There is one EPL cycle synchronized with every ACR9030 and ACR9040 trajectory period, so the EPL cycle time is automatically established with the `PERIOD` command.

For every EPL cycle, the drive receives the current commanded position, the current commanded velocity, the current commanded digital outputs, and the state of what would have been the drive enable and drive reset outputs of traditional interfaces. See Figure 42. The drive closes its own position loop, controlling torque by directly controlling current to the motor. Also, for every EPL cycle, the drive sends the current actual position, the current digital inputs, the following error, the torque output, and the state of what would have been the drive fault input of traditional interfaces.

The ACR9030 and ACR9040 generate position set points, and drive enable and drive reset output states for an EPL axis in exactly the same way it does for a traditional axis. This means drive I/O commands, jogging, gearing, cams, and all moves can be used with an EPL axis. Similarly, the ACR9030 and ACR9040 respond to drive fault input states exactly the same way it does for a traditional axis. The ACR9030 and ACR9040 only use the feedback information from the drive to update the actual position, following error, and output signal axis parameters.

Network Failsafe Assurances

Several measures help to ensure failsafe behavior in the event of any kind of network problem. In an EPL cycle, the controller and drive exchange data, and each tests for a loss of EPL cycles or unexpected network state.

A loss of EPL cycles could be caused by a disconnected cable or a problem with the controller. The controller will respond to a disconnected EPL cable or node error by disabling that axis, just as with a traditional drive. The Aries EPL drive will detect any loss of EPL cycles within 20 milliseconds and treats this as a fault. If the drive was enabled, it will disable itself and record the fault.

An EPL drive axis is treated just the same as any other axis in the event that the motion enable input on the ACR9030 or ACR9040 is lost. Although there are no DACs or stepper outputs to clamp, the motion is killed and axes are commanded to be disabled.

EPL Network Cycle Times

The EPL cycle time is automatically established with the ACR9030 or ACR9040 `PERIOD` command, and is exactly the same as their trajectory period.

The ACR9030 and ACR9040 firmware uses the following formula with some restrictions:

Minimum period in microseconds = 125 x (number of nodes)

The restrictions on allowable values for ACR9030 or ACR9040 `PERIOD` when an EPL controller card is installed are as follows:

- The minimum period is 500 microseconds. This accommodates the minimum overhead involved with EPL cycle creation, reporting, and error handling.
- The period must be a multiple of 125 microseconds, allowing the Aries EPL drive to synchronize its servo periods with trajectory data received over the EPL network.
- The period must be long enough to accommodate the added overhead of adding nodes on the EPL network.

Support for CiA DSP-402

Drives controlled by the ACR9030 or ACR9040 must adhere to the CANopen device profile for motion control, CiA DSP-402 V2.0, in order to ensure interoperability with EPL motion products from other vendors. DSP-402 specifies object dictionary entries that correspond to drive setup as well as periodic data transfer. In addition, DSP-402 specifies six different modes of operation. All of these modes require some type of trajectory generator in the drive whose function depends on the mode.

Interpolated Position Mode

The ACR9030 and ACR9040 generate trajectories for the drive, and only expects the drive to close the position loop at each update. It does not want the drive to generate its own trajectory.

ACR9030 and ACR9040 EPL Commands, Parameters and Flags

A new user command related to EPL is the `ATTACH AXIS ELPD` command, which will be described later in this appendix. The EPL network configuration requires the user to set some of the parameters, and the rest of the configuration is automatically done by the ACR9030 and ACR9040. The ACR9030 and ACR9040 report the status of the EPL network and nodes in parameters and flags.

NOTE: ACR-View utilizes a wizard-based configuration tool to set all required parameters.

EPL Network and Node Control Parameters

The tables below list the network and drive parameters the user must set, and their default values. (The default values are applied on power up if user-supplied values have not been saved with the ESAVE command.)

The parameter for the EPL network must be set for any network operation:

EPL Network Parameter	P Number	Default Value
Number of controlled nodes (CN)	P37376	1 (valid range 0-15)

Table 69 User-Set Network Parameter

The parameter for the EPL drives must be set for each EPL drive implied by P37376. The following shows the parameter for EPLD0, where “Node ID” refers to the external device setting, established by a switch on the device:

EPLD0 Parameter	P Number	Default Value
Node ID	P37632	1 (valid range 1-99)

Table 70 User-Set Node Parameter

The entire list of network and node control and status parameters is given later in this appendix.

Starting, Configuring and Resetting the Network

NOTE: The following procedure is stated for reference only. If using ACR-View, the configuration wizard automatically accomplishes this procedure for you.

The user may command the ACR9030 or ACR9040 (MN) to start or reset the network at any time using the `EPLC ON` and `EPLC OFF` commands, respectively, or by setting control bits in the EPL Network Control/Status flag parameter (P4616). The `EPLC ON` and `EPLC OFF` commands work by internally setting the control bits discussed below.

When the network is started via `EPLC ON` or bit 16640, the ACR9030 or ACR9040 initially places all controlled nodes (CN) into the “pre-operational” state. During this state, the MN interrogates and configures the CNs as required. The CNs are then placed into the “operational” state, and the automatic data transfer between the CNs and the MN takes place.

Before the network may become “operational,” the ACR9030 or ACR9040 must know the number of CNs, and the Node ID for each. In some applications, the external nodes may be powered after the MN, and hence not available for configuration on ACR9030 or ACR9040 power up. For this reason, the user will be required to explicitly request network start via a control flag.

The flag (bit 16640) is used for starting the network. The flag is self-clearing (cleared automatically by the MN when the attempt to start the network has completed). There are also status bits and parameters—such as error bits, network state, cycle period, and drive states—to indicate the results of starting the network.

There may be occasions when errors on the EPL network require that the network be reset. The flag (bit 16641) is used for resetting the network. The flag is self-clearing (cleared automatically by the MN when the attempt to reset the network has completed). The status bits and parameters will also indicate the results of resetting the network.

For safety reasons, the user may not start or reset the EPL network while any EPLD axes are enabled. Also, the network may not be started if the trajectory period (as specified with the `PERIOD` command) is too low for the number of nodes on the network. The MN response to these conditions depends on whether the start or reset attempt was made via the `EPLC` command or by explicitly setting bit 16640 or 16641. If the attempt is made by using the EPLC command, an appropriate error message will appear, and the control bit will not get set internally. If the attempt is made by explicitly setting bit 16640 or 16641, then the bit will self-clear, and an additional diagnostic status bit will appear. These bits are detailed below.

The terms “operational” and “reset” in this section correspond to the network states given in the table in the section “EPL Network States, LED Indications, Error Codes” on page 173. The network can be “operational” even if one or more nodes are not responding. This simply means the MN is sending poll requests to those nodes that it has found, and requesting identity packets from those nodes it is trying to find. If the user resets the network using bit 16641, then the network state goes from operational to reset, and stays that way until it is restarted.

Diagnostic Reports (`DIAG EPLD` and `EPLC`)

Two commands allow different levels of diagnostic reporting. The `DIAG EPLD` command reports a comprehensive list of the current values of network and node status bits and parameters, along with brief descriptions of each. These include all setup vales as well as current status.

A more abbreviated report is available with the `EPLC` command, issued without the `ON` or `OFF` modifiers. This command reports only network and node status, and is very compact on the screen.

Network Information Parameters and Flags

After the MN starts the EPL network and characterizes nodes, it fills in an information parameter block for the network and each EPL drive. It also updates the EPL Network Control/Status flags shown in Table 71. The control flags are requests to the controller. These are self-clearing flags, and will be cleared automatically when the request has been completed. The

status flags will indicate the results of the requests. A “Start Network” request will result in “Network Operational” if everything is okay, or “Network Start Failed” if there was some problem. It is unsafe and not allowed to start or reset the network if any EPL drives are enabled. Any attempt to do so will fail, and result in the “EPL Drive(s) enabled” status flag (bit 16654) being set. The network will also not start if the MN period is too low. This state will result in the “Insufficient Period” status flag (bit 16655) being set.

EPL Network Control/Status (P4616)	Flag Number
Control Flags	
Start Network	16640
Reset Network	16641
Reserved	16642-16647
Status Flags	
EPL Controller Installed	16648
Network Operational	16649
Network Start Failed	16650
EPL Node Failure	16651
EPLD Stream OPEN	16652
EPLD Stream Disconnected	16653
EPL Drive(s) Enabled	16654
Insufficient Period	16655
Starting Network	16656
Resetting Network	16657
Reserved	16658
Reserved	16659
Opening EPLD Stream	16660

Table 71 Auto-Populated Network Control and Status Flags

The descriptions and parameter numbers for the EPL network are shown in Table 72. The control parameters are those that should be set before attempting to start the network. The status parameters are those that the controller will set as a result of attempting to start the network. The parameter denoted with an asterisk (*) is saved with the ESAVE command.

EPL Network Control Parameters	P Number
Number of Controlled Nodes (CN)*	P37376
Reserved	P37377-P37383
EPL Network Status Parameters	**P Number**
Network State	P37384
Non-Operating Nodes Bit Reports	P37385
EPL Operation Error Code (0 means no error)	P37386
EPLD Object OPENed (-1 means none)	P37387
OPENed EPLD Device Number	P37388
Operational Duration in Seconds	P37389
Downloading or resetting nodes bits (started)	P37390
Downloading or resetting nodes bits (current)	P37391

* Saved with the ESAVE command

Table 72 Control and Status Parameters

The value in P37385, P37390, and P37391 are a bit-oriented reports. Bit zero represents EPLD0, bit 1 represents EPLD1, and so on. If the bit in P37385 is set, it means that node is not operating as expected. This could be because the node ID was not set correctly, or the node has become disconnected, or the node simply has failed in some way.

Parameters P37390 and P37391 indicate the nodes that are the targets of either a controlled node OS download or a controlled node reset operation. These events are initiated by ACR-View either over the Ethernet or USB interfaces, and ACR-View monitors these parameters during the progress of the operation. P37390 indicates all the nodes that were or are involved, and P37391 indicates all the nodes that have not yet finished. The progress or final state for each individual node is reflected in a parameter in the drive information parameters described in EPL Drive Information Parameters and I/O Flags on page 175.

EPL Network States, LED Indications, Error Codes

Table 73 indicates the possible values for the EPL network state (P37384), and the corresponding green states of the bicolor EPL indicator LED on the ACR9030 and ACR9040's EPL card. Any red in the bicolor EPL indicator LED indicates an error state, but may co-exist with the flickering or flashing green. The only normal steady states for the ACR9030 and ACR9040 are "reset" and "operational." The only normal steady states for Aries EPL are "BASIC ETHERNET" and "OPERATIONAL." All other states are transitional and may not be observable, especially for a small number of nodes. All states listed below are consistent with EPL V2.0 WSP V0.1.2 chapter 10, "Indicators."

EPL Status LED (Green)	EPL Network State	Description	P37384 Value
OFF	Reset or Not Active	The MN is off, initializing, or in the reset state	0
Flickering	Basic Ethernet	The node is operating as a basic Ethernet device, not EPL	1
Single flash	Pre-Operational 1	The MN is asking for node status and is configuring CNs, but the full EPL cycles have not started.	2
Double flash	Pre-Operational 2	The full EPL cycles have started, but not all node configuration has finished. The exchanged data is ignored.	3
Triple flash	Ready to Operate	The CN has responded to a request from MN to enter this state, but exchanged data is still ignored.	4
ON	Operational	The network is now exchanging valid data	5
Blinking	Stopped	The network has stopped	6

Table 73 EPL Network States and Corresponding Status LEDs

Table 74 indicates the possible values for the EPL operational errors, along with a description of the error. If these errors occur, the error code is stored in P37386 of network parameters. In some cases, the errors related to a specific node. In those cases, the code is also stored in the EPL operation error code parameter for the affected node. For EPLD0, this is P37637. The most recently detected error will overwrite previous error codes in these parameters. These parameter values are set to zero (no error) when the network start is attempted.

EPL Operational Error Description	P37386 Value
No errors	0
Management node Object Dictionary error during start	1
Invalid user supplied node count	2
Error in user supplied external node data	3
External node Object Dictionary error during start	4
Unexpected external node found during start	5
Error in SDO transfer	6
Internal Error in EPL cycle start	7

Table 74 EPL Operational Errors

EPL Drive Information Parameters and I/O Flags

Table 75 gives all the user-set control parameters for EPLD0. For higher numbered ETHERNET Powerlink drives (EPLD), work from EPLD0 and add **n x 16** to each parameter number. For example, for EPLD1 Node ID, add **1 x 16** to the parameter number for EPLD0 Node ID (P37632) to get P37648.

The control parameters must be set by the user before the network is started. Save the parameters denoted with an asterisk (*) with the `ESAVE` command.

Control Parameters for EPLD0	P Number
Node ID *	P37632
Reserved	P37633
Drive mode *	P37634
TCP/IP Port number *	P37635

* Saved with the ESAVE command

Table 75 Control Parameters for EPLD0

The “Drive Mode” parameter is derived from the DSP-402 specification, and takes a value of 7 for Interpolated Position Mode, the only supported mode. It is included as a parameter to accommodate a possible future expansion in supported modes. The TCP/IP Port number (P37635) is required for TCP/IP connection to a drive, discussed in the section “Basic Ethernet Connections” on page 179.

Table 76 gives all the status parameters for EPLD0. The controller automatically updates the status parameters, and the user should not modify them.

Status Parameters for EPLD0	P Number
OS download or reset progress or status	P37636
EPL Operation Error Code (0 means no error)	P37637
Attached Axis Number (Established by the ATTACH AXIS command)	P37638
Node Status (0=never found, 1=found, 2=found then lost)	P37639
Operational Duration in Seconds	P37640
Node Failure Count	P37641
Reserved	P37642-P37647

Table 76 Status Parameters for EPLD0

P37636 indicates the current progress, or final status of an OS download or reset initiated by ACR-View. The potential values and their meanings are listed in Table 77 in the order that would occur during the process. The status values persist after the operation is complete.

Progress or State	Value
Operation pending (this node has not started yet)	-1
Percentage download complete (downloads only)	1-100
Download or reset successful	0
CRC failure at drive (downloads only)	-5
Flash save failure at drive (downloads only)	-6
Failure with TCP connection to drive	-8

Table 77 P37636 (OS download or reset progress or status control parameter for EPLD0)

The EPL operation error code (P37637) values are the same as P37386. The attached axis number (P37638) is -1 if no axis is attached, otherwise it is the axis number (0-15). Node status (P37639) is updated each time the network is started, stopped, or a node is lost.

If for any reason a controlled node stops being operational, the controller will automatically try to restart it. The Node Failure Count (P37641) indicates the number of times this has happened since the overall network became operational. The Operational Duration in Seconds (P37640) indicates how long this node has been operating, either from the start time of the original network operation, or since being restarted by the controller.

Table 78 and Table 79 give all the digital I/O definitions and where they appear for EPLD0 through EPLD3 in the ACR9030 and ACR9040. For the next group of 4 EPLDs, add 32 to the bit number, and 1 to the flag parameter number. For example, the digital inputs for EPLD4 are contained in P4201, starting with bit 3360. (The second column of the tables contains information useful for understanding how to use the ACR9030 and ACR9040 with an EPL drive other than the Aries EPL. In that case, consult that drive's user guide to know how to interpret those bits.)

Digital Input on Aries EPL Drive	DSP-402 Object 60FD Bit Position	Bit Number
EPLD0 Input 0	EPLD0 3	3328
EPLD0 Input 1	EPLD0 0	3329
EPLD0 Input 2	EPLD0 1	3330
EPLD0 Input 3	EPLD0 18	3331
EPLD0 High Speed Input 4	EPLD0 2	3332
EPLD0 High Speed Input 5	EPLD0 16	3333
EPLD0 High Speed Input 6	EPLD0 17	3334
No function	EPLD0 19	3335
EPLD1 Input 0	EPLD1 3	3336
EPLD1 Input 1	EPLD1 0	3337
EPLD1 Input 2	EPLD1 1	3338
EPLD1 Input 3	EPLD1 18	3339
EPLD1 High Speed Input 4	EPLD1 2	3340
EPLD1 High Speed Input 5	EPLD1 16	3341
EPLD1 High Speed Input 6	EPLD1 17	3342
No function	EPLD1 19	3343
EPLD2 Input 0	EPLD2 3	3344
EPLD2 Input 1	EPLD2 0	3345
EPLD2 Input 2	EPLD2 1	3346
EPLD2 Input 3	EPLD2 18	3347
EPLD2 High Speed Input 4	EPLD2 2	3348
EPLD2 High Speed Input 5	EPLD2 16	3349
EPLD2 High Speed Input 6	EPLD2 17	3350
No function	EPLD2 19	3351
EPLD3 Input 0	EPLD3 3	3352
EPLD3 Input 1	EPLD3 0	3353
EPLD3 Input 2	EPLD3 1	3354
EPLD3 Input 3	EPLD3 18	3355
EPLD3 High Speed Input 4	EPLD3 2	3356
EPLD3 High Speed Input 5	EPLD3 16	3357
EPLD3 High Speed Input 6	EPLD3 17	3358
No function	EPLD3 19	3359

Table 78 P4200 (EPLD0 – EPLD3 Digital Inputs)

Digital Output on Aries EPL Drive	DSP-402 Object 60FE Bit Position	Bit Number
EPLD0 Output 1	EPLD0 16	3840
EPLD0 Output 2	EPLD0 17	3841
EPLD0 Output 3	EPLD0 18	3842
EPLD0 Output 4	EPLD0 19	3843
No function	EPLD0 20	3844
No function	EPLD0 21	3845
No function	EPLD0 22	3846
No function	EPLD0 23	3847
EPLD1 Output 1	EPLD1 16	3848
EPLD1 Output 2	EPLD1 17	3849
EPLD1 Output 3	EPLD1 18	3850
EPLD1 Output 4	EPLD1 19	3851
No function	EPLD1 20	3852
No function	EPLD1 21	3853
No function	EPLD1 22	3854
No function	EPLD1 23	3855
EPLD2 Output 1	EPLD2 16	3856
EPLD2 Output 2	EPLD2 17	3857
EPLD2 Output 3	EPLD2 18	3858
EPLD2 Output 4	EPLD2 19	3859
No function	EPLD2 20	3860
No function	EPLD2 21	3861
No function	EPLD2 22	3862
No function	EPLD2 23	3863
EPLD3 Output 1	EPLD3 16	3864
EPLD3 Output 2	EPLD3 17	3865
EPLD3 Output 3	EPLD3 18	3866
EPLD3 Output 4	EPLD3 19	3867
No function	EPLD3 20	3868
No function	EPLD3 21	3869
No function	EPLD3 22	3870
No function	EPLD3 23	3871

Table 79 P4216 (EPLD0 – EPLD3 Digital Outputs)

EPLD Objects

There are 16 EPLD objects. The primary nature of an EPLD object is as an actual position, but EPLDn can also function as a stream name for use in communicating with an external EPL drive. (See the section “EPLD Pseudo-Stream” on page 180.)

The EPLD position and EPLD velocity are available as object parameters, starting at P38144. These objects are organized and spaced in the same way that ENC (encoder) objects are. For example, EPLD0 position and EPLD0 velocity are at P38144 and P38145 respectively. The next EPLD object starts 16 away from the previous one, so EPLD1 position and EPLD1

velocity are at P38160 and P38161 respectively. Similarly, EPLD position is the actual EPLD position, updated every servo period, and EPLD velocity is the change in EPLD position each servo period.

In addition to their use in the ATTACH and OPEN commands described later, EPLD objects may be used as SRC (source) objects anywhere that ENC may be used, such as cams and gears. It is also possible to reset or offset the EPLD position using EPLDn RES. But an EPLD is more like an absolute encoder than an incremental encoder, because the count value is received by the ACR9030 and ACR9040 as an absolute value, not incrementally. For this reason, the EPLDn RES value will simply be added as an offset to the absolute raw value provided by the drive, just as is done with an absolute encoder.

ATTACH AXIS EPLD Command

The ATTACH AXIS EPLD command is a new AcroBASIC command needed for use with EPL drives. This command is used in the same way as, but in place of, the ATTACH AXIS ENC DAC command. In other words, an EPLD object takes the place of both an encoder and a DAC. When EPLD is the first token following ATTACH AXIS, no other tokens are accepted. When this command is executed, the controller knows to use the EPL network as described above instead of closing the position loop on that axis.

Just as any AXIS can be attached to any ENC or DAC, any AXIS can be attached to any EPLD. For example, suppose a 2 axis ACR9030 also has an EPL card and three EPL drives. The following commands would be valid.

```
ATTACH AXIS0 ENC0 DAC0

ATTACH AXIS1 ENC1 DAC1

ATTACH AXIS2 EPLD0

ATTACH AXIS3 EPLD1

ATTACH AXIS4 EPLD2
```

See the ACR Command Language Reference for information on other EPL commands (DIAG EPLD, OPEN EPLD, EPLC, EPLC OFF, EPLC ON).

Access to EPL Drives' Native Command Language

It may be necessary to communicate with an EPL drive in its native language in order to fully set up the drive, or take advantage of features not covered by ACR9030 or ACR9040 functions. The Aries EPL has a TCP server that listens on Port 5002 for connections to its native command language parser. The ACR9030 and ACR9040 provide a way of communicating with EPL drives using their own command language, while the drives remain connected to the EPL network. This capability can also be accessed easily via the terminal emulator in ACR-View.

Basic Ethernet Connections

Part of the EPL specification requires that an EPL device be able operate in "basic Ethernet" mode (as a standard Ethernet device). This means that the Aries EPL drive, for example, will accept commands over TCP/IP connections. When a drive is not part of an EPL network, its Ethernet connection is strictly devoted to TCP/IP.

Even when it is part of an operational EPL network, the drive must still be able to accept a connection from a TCP/IP client, in this case, the ACR9030 or ACR9040. The ACR9030 and ACR9040 are single TCP/IP clients that can make a connection to one EPL drive at a time. This communication takes place during the asynchronous portion of the EPL cycle (see the section “EPL Cycles and Nodes” on page 162) and so will not affect motion performance. The connection is made on the port specified in the EPLD parameter “TCP/IP Port number.”

EPLD Pseudo-Stream

Although the ACR9030 or ACR9040 TCP/IP client can make a connection to an EPL drive, this is internal, and there must be a way for user programs and external hosts to connect to this client. The EPLD Pseudo-Stream provides this link. This is not a true stream like COM1 and the Ethernet and USB streams, because there is no way to enter commands on this stream. Also, the flags associated with normal streams are not available with the EPLD stream. It is possible to use this stream in the `OPEN` command, which allows the `PRINT`, `INPUT` and `TALKTO` commands access to the ACR9030 or ACR9040’s TCP/IP client connection to an EPL drive.

The name of the Pseudo-Stream is ”EPLDn,” where “n” is the EPLD object number, with a possible range of 0-15. When this is used with the `OPEN` command, “n” is first tested to be sure it is less than the number of external nodes given by P37376. The ACR9030 or ACR9040’s TCP/IP client then makes a connection to the corresponding EPL drive and links all input and output from that connection to this Pseudo-Stream. The `CLOSE` command will close the Pseudo-Stream and the connection to the drive.

Status flags and parameters, described in the section “Network Information Parameters and Flags” on page 171, indicate the state of the `OPEN EPLD`. Unlike other OPEN streams, the EPLD stream must maintain a TCP connection with the corresponding EPLD drive. The `OPEN` command will not finish until this connection is made. If the connection fails, the `OPEN` command results in an error message. If the connection is not made, or is broken for any reason other than a user `CLOSE` command, then bit 16653 will indicate the unexpected disconnect, and the ACR9030 or ACR9040 will automatically close the stream. Bit 16653 will remain set until it is cleared by the user, or by another `OPEN EPLD` command.

Application Scenario

A typical application may have a mix of traditional as well as EPL axes. This application scenario is designed to focus on the setup and operation of an EPL network, and to illustrate the differences between EPL and traditional axes. In this three-axis system, X and Y are EPL axes, and Z is traditional. The following program might be part of a program downloaded by ACR-View.

NOTE: This application scenario illustrates the direct use of the parameters and control bits to be set for an EPL network. ACR-View will do this automatically via the configuration wizard.

```
PROG0
PROGRAM
REM: Setup the network update rate
PERIOD = 0.0005
REM: Setup the number of controlled nodes
P37376 = 2
REM: Setup node ID for EPLD0
P37632 = 100
REM: Setup node ID for EPLD1
P37648 = 101
REM: Start the EPL network, wait for completion, then test
state for errors
SET 16640
INH -16640
IF (P37384 <>5)
PRINT "Network Start Failed"
GOTO ApplicationEnd
ENDIF
REM: Create attachments for X, Y, Z
ATTACH MASTER 0
ATTACH SLAVE0 AXIS0 "X"
ATTACH SLAVE1 AXIS1 "Y"
ATTACH SLAVE2 AXIS2 "Z"
ATTACH AXIS0 EPLD0
ATTACH AXIS1 EPLD1
ATTACH AXIS2 ENC0 DAC0
REM: Set up gains, for X, Y, Z
PGAIN X0.001 Y0.001 Z.0.001
DGAIN X0.0003 Y0.0003 Z0.0003
IGAIN X0.01 Y0.01 Z0.01
REM: All drive I/O and motion is the same for EPLD as for
traditional
DRIVE ON X Y Z
JOG HOME X1 Y1 Z1
REM: Wait for jog moves to finish, then go to an XYZ
position
INH 16134
INH 16166
INH 16198
MOVE X5 Y-2 Z8
_ApplicationEnd
ENDP
```

Troubleshooting

The Aries EPL drive design features easy connectivity, auto-detect functions, and reliability. In addition, LEDs on the front panel of the unit provide quick identification of AC power, drive, and EPL/Ethernet status. If, after following the installation guidelines in The Aries EPL Hardware Installation Guide, your drive does not function properly, use the guidelines and procedures in this section to troubleshoot. These guidelines also apply to troubleshooting a malfunction during normal operation of the drive.

A problem with the drive typically can be traced to one of four areas: power, power-up sequence, communications, and motor control. If your system is not functioning properly, follow the steps indicated for each of these areas.

Power

If none of the LEDs are illuminated, do the following:

1. Look for problems with AC power. Check the AC power source. Also check connections at the L1, L2, and ⏚ earth ground terminals of the motor mains connector, and at the C1 and C2 terminals of the control mains connector.
2. If the AC wiring is correct but no LEDs illuminate, remove all connections to the drive (Drive I/O, Motor, Motor Feedback, and Ethernet cables), leaving the Mains control power C1, C2, and ⏚ earth ground terminals connected. Apply power to the drive. If any LEDs illuminate, then a short exists in one of the disconnected cables.

Power-Up Sequence

Observing the power-up sequence may help identify defective hardware or software issues. Any deviation from the following power-up sequence may indicate the need for additional technical resources. Please see “Technical Assistance” on page 3 for contact information.

1. Cycle power to the drive and observe the drive and EPL status LEDs.
2. When power is first applied, the right drive status LED turns RED. This is the default hardware state and simply indicates that power is applied.
3. After approximately 8 seconds, the right drive status LED turns off and the left drive status LED changes from off to yellow. This indicates the Ethernet processor has booted and is now in the process of booting the motor control processor.
4. After approximately 4 more seconds, the right drive status LED changes from off to RED again, indicating that the motor control processor has completed the boot process.
5. The left drive status LED changes states depending on conditions described in the section “Motor Control” on Page 186.
6. The EPL status LED changes states depending on the status of the Ethernet or EPL network as described in the section “Communications” on page 183.

Communications

All drive communications are based on Ethernet or EPL. When the drive is attached to the ACR9030 or ACR9040 EPL controller, and the EPL network is established, all communications takes place through the ACR9030 or ACR9040 EPL controller. Each Aries EPL drive attached to the EPL network can be accessed through the ACR9030 or ACR9040 EPL controller.

Alternatively, an Aries EPL drive may be connected directly to any appropriately configured Ethernet port. The drive IP address will be 192.168.100.xx, where xx is defined by the address selection switches on the drive's front panel.

EPL Drive Ethernet Status LEDs

The first step in troubleshooting communications is to observe the state of the Ethernet status LEDs. (Figure 46 shows their location on the drive's EPL RJ-45 socket.) These LEDs indicate any Ethernet or EPL connection, as described in Table 80. Note that for an EPL connection or a standard 100Mbps connection, both the yellow and green LED should be illuminated. For a 10Mbps Ethernet connection, the Yellow LED should be illuminated and the Green LED off.

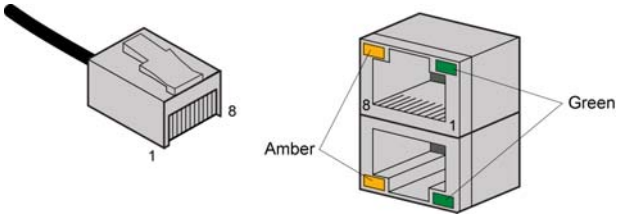


Figure 46 Ethernet Status LEDs

LED	Steady	Flash	Description
Ethernet Link/Activity	Off	—	No Ethernet link detected
	Yellow	—	Ethernet link established, no activity
	—	Yellow	Ethernet link established and active
Ethernet Speed	Off	—	Ethernet 10Mbps
	Green	—	Ethernet 100Mbps

Table 80 Aries EPL Drive Ethernet Status LED Descriptions

If neither Ethernet Status LED is illuminated, the physical Ethernet connection is faulty.

1. Verify that you are using the correct type of cable. See “EPL Ethernet Cable Specification“ on page 166.
2. Verify that the cable pin out matches the drive’s connector pin out. See Table 81.

Signal	Pin	Wire Color	Description
RX+	1	White/orange	Differential Receive positive side
RX–	2	Orange	Differential Receive negative side
TX+	3	White/green	Differential Transmit positive side
	4	Blue	Not used
	5	White/blue	Not used
TX–	6	Green	Differential Transmit negative side
	7	White/brown	Not used
	8	Brown	Not used
Note: Pin assignment follows EIA/TIA T568B guidelines.			

Table 81 RJ-45 Connector Pinout

Connector Specification

Manufacturer ..... Bel or equivalent

Connector Type..... 8-Pin, RJ45 (female socket)

Bel Part Number..... 0845-2D1T-H5

3. Try swapping cables with Ethernet cables you know to be good. Even cables that do not meet the EPL specification should cause the LEDs to illuminate.
4. If the LEDs still do not illuminate, look for Ethernet hardware problems.

Aries EPL Drive EPL Status LEDs

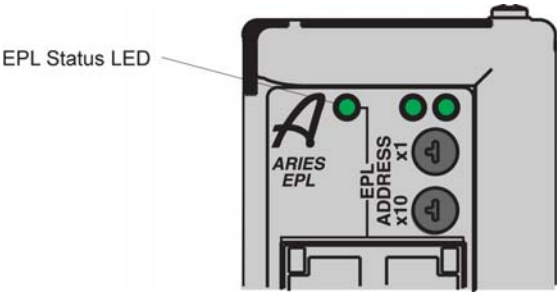


Figure 47 Aries EPL Drive EPL Status LEDs

EPL Status LED Illumination States	
LED State	**Description**
Off	Powering up, searching for Ethernet
Off/Green, flickering (alternating 50 ms at 10 Hz)	Standard Ethernet mode (no error)
Red/Green, flickering (alternating 50 ms at 10 Hz)	Standard Ethernet mode, EPL error
Green, 1 flash	Waiting for configuration (followed by Start of Cycle frame)
Green, 2 flashes	Waiting for configuration to complete
Green, 3 flashes	Ready to operate in EPL mode
Green, constant	EPL mode
Red/Green, flashing (alternating 200 ms at 2.5 Hz)	Not participating in frame exchange, but observing EPL communications

Table 82 Aries EPL Drive EPL Status Indicator LED Descriptions

If the Aries EPL drive EPL Status LED is off, there is no valid Ethernet communication.

1. Check the network-status LEDs located on the drive's Ethernet/EPL connector to determine the state of the Ethernet connection. See "EPL Ethernet Cable Specification" on page 166. Do not proceed until the network status LED indicates that an Ethernet Link has been established.
2. Verify that no two drives on the network have the same IP address/Node ID. The Node ID is determined by the rotary switch settings on the front panel of the drive. See "Assigning the Drive Node ID " in the Aries EPL Hardware Installation Guide.
3. Temporarily disconnect all CNs, except for the one Aries EPL drive you are troubleshooting, to ensure there is no conflict with other CNs.
4. If you are connecting to an EPL network, try connecting to a standard Ethernet network instead.
5. Using a standard Ethernet connection, test the Aries EPL drive IP assignment. At a DOS or command prompt, type "ping 192.168.100.xx", where xx is the setting of the drive address switches on the front panel.
    a. If you receive a "reply from" message, do the following: disconnect the drive Ethernet/EPL cable and type the ping command again.
        1. If you see "reply from" message, then another device or computer has already been assigned the same IP address. Change the node ID of the drive to one that is unique in the network.
        2. If you see a "timeout" message, then the drive is properly configured and is network accessible. Re-attach the Ethernet/EPL cable.
    b. If a "timeout" message is seen, the drive has an invalid IP address. Determine the correct setting and assign it to the drive.

ACR-View

The ACR-View software is a user-friendly interface for verifying status of and commanding the ACR EPL controller and the EPL network it manages. Use ACR-View to perform additional troubleshooting of your network and drive. Refer to the ACR EPL controller user's guide for details of using the ACR-View software.

Once you have established an EPL connection as indicated by the Aries EPL drive EPL Status LED, launch ACR-View on the computer system connected to your EPL network.

1. Open the Configuration Wizard. Select Axes, then select the desired axis (drive/CN).
2. Set the drive motor combination used, then check the box next to "I want to edit the mechanical/electrical parameters for my motor (Advanced)."
3. Click Next and verify that the motor parameters are correct.
4. Continue through the configuration wizard and verify that all the parameters for the axis are correct.

Terminal Emulator (Hyper Terminal)

A terminal emulator such as Hyper Terminal will allow basic access to the drive's native commands. This may be connected directly to the drive via a standard Ethernet port, using TCP/IP and the IP address of the drive. The drive IP address is 192.168.100.xx, where xx is the front panel switch setting.

The terminal emulator may also connect to the drive through the ACR EPL controller while EPL is running. After the terminal emulator is connected to and communicating with the ACR9030 or ACR9040 via an available communications port, the following command sequence is an example of how that connection can be extended to the drive.

OPEN "EPLD0:" AS #1	(open a connection to the drive)
TALKTO #1	(invoke the **TALKTO** function)

At this point the terminal emulator should be communicating directly with the drive, and all native drive commands should function. For example, the following command should elicit a response:

TDTEMP	(drive temperature query)
26.000	(drive will respond with the temperature)

To disconnect use the following sequence:

<ESC>	(escape key, to exit from **TALKTO** function)
CLOSE #1	(close the connection to the drive)

Motor Control

The first step in troubleshooting motor-control issues is to examine the drive status LEDs. Use Table 83 to determine the condition they indicate. Use the additional information in this section to take corrective action.

Drive Status LEDs

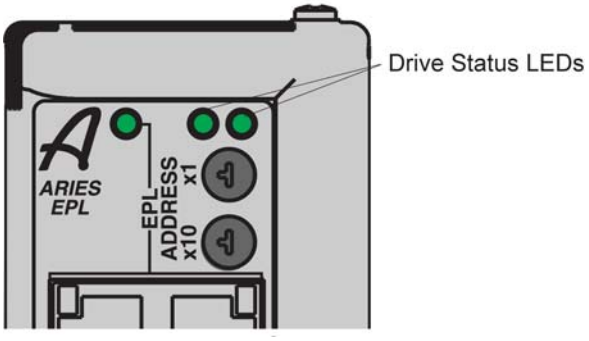


Figure 48 Drive Status LEDs

Drive Status LED Illumination States		
LED Left	**LED Right**	**Description**
Drive Enabled		
Off	Green	Enabled
Yellow (flashes during Regeneration)	Green	Enabled, Regeneration active
Yellow/Green (alternating)	Green	Enabled, Autorun mode
Drive Disabled		
Off	Red	Disabled, no faults or Ethernet boot, 8-second process
Yellow	Off	Motor control boot, 4-second process
Yellow	Red	Disabled, no bridge power
Yellow & 1 Green (flashing)	Red	Disabled, Bridge fault
Yellow & 2 Green (flashing)	Red	Disabled, Feedback fault
Yellow & 3 Green (flashing)	Red	Disabled, Thermal fault
Yellow & 4 Green (flashing)	Red	Disabled, other fault

Table 83 Aries EPL Drive Status Indicator LED Descriptions

Fault Correction

If examining the LED states and conditions indicated has not solved the problem, launch the Aries Support Tool and establish communication with the drive. If you are unable to establish communication, see the section “Communications” on page 183.

To access further information on the drive status and fault conditions, use ACR-View on the computer system connected to your EPL network. (See the ACR Programmer’s Guide for details on using ACR-View software.)

1. Open a terminal connection to the drive using one of the methods described under “Terminal Emulator (Hyper Terminal)” on page 186.
2. Enter the **CONFIG** command to see a list of drive configuration editors.
3. Enter the **ERROR** command to see a list of drive error messages.

Pay particular attention to faults that need to be fixed. Refer to Table 84 for corrective action suggestions.

Error Codes

Table 84 contains a list of error messages and a brief description of corrective action.

Error Code	Resolution
EØ—Motor Configuration Warning	The motor rating is too high for the drive, and the drive is using its own limits for safety reasons.
E1—Motor Configuration Error	One of the motor parameters is set to zero (Ø). Look at the additional errors to find which parameters are set at zero (Ø). Refer to your motor specifications for the correct value.
E3—Max Inductance = Ø	This parameter is set to zero (Ø). To correct the error, you must set a non-zero (Ø) value. Refer to your motor specifications for the correct value. (**DMTIND**)
E4—Rated Speed = Ø	This parameter is set to zero (Ø). To correct the error, you must set a non-zero (Ø) value. Refer to your motor specifications for the correct value. (**DMTW**)
E5—DPOLE = Ø	This parameter is set to zero (Ø). To correct the error, you must set a non-zero (Ø) value. Refer to your motor specifications for the correct value. (**DPOLE**)
E6—Resistance = Ø	This parameter is set to zero (Ø). To correct the error, you must set a non-zero (Ø) value. Refer to your motor specifications for the correct value. (**DMTRES**)
E7—Ke = Ø	This parameter is set to zero (Ø). To correct the error, you must set a non-zero (Ø) value. Refer to your motor specifications for the correct value. (**DMKE**)
E8—Continuous Current = Ø	This parameter is set to zero (Ø). To correct the error, you must set a non-zero (Ø) value. Refer to your motor specifications for the correct value. (**DMTIC**)
E9—Peak Current = Ø	This parameter is set to zero (Ø). To correct the error, you must set a non-zero (Ø) value. Refer to your motor specifications for the correct value. (**DMTIP**)
E1Ø—Continuous Current Too High	The continuous current of the motor is higher than the continuous current rating of the drive. Use the continuous current rating for the drive.
E11—Torque Rating Is Greater than Peak Power Rating	The motor's torque rating is too high for the power level of the drive. Use the drive's torque rating.
E12—Peak Current Too High	The peak current of the motor is higher than the peak current rating of the drive. Use the drive's value for peak current.
E13—Inertia = Ø	This parameter is set to zero (Ø). The drive will not enable Velocity or Position Modes. To correct the error, you must set to a non-zero value. Refer to your motor specifications for the correct value. (**DMTJ**)
E14—Damping = Ø	This parameter is set to zero (Ø). The drive will not enable Velocity or Position Modes. To correct the

Error Code	Resolution
	error, you must set to a non-zero value. Refer to your motor specifications for the correct value. (**DMTD**)
E15—Notch Filter Calc Error	The notch filter settings caused an internal calculation error. The last valid value was used. Try different values for the notch filter parameters. (**DNOTAF, DNOTAQ, DNOTBF, DNOTBQ**)
E16—Lead < Lag Freq	The lead filter setting (**DNOTLD**) must be greater than or equal to the lag filter setting. (**DNOTLG**)
E17—Lead ≥ 4* Lag Freq	The lead filter setting (**DNOTLD**) must be less than or equal to 4 times the lag filter setting. (**DNOTLG**)
E18—Lag Freq < 2Ø Hz	The lag filter setting (**DNOTLG**) must be greater than or equal to 2Ø Hz.
E19—E24	RESERVED
E25—Excessive Command Voltage at Enable	The command voltage (at the ANI+ terminal) was too high when the drive was enabled. Lower the voltage at the ANI+ terminal.
E26—Drive Faulted	The drive is faulted.
E27—Bridge Hardware Fault	Excessive current or short on the H-bridge.
E29—Drive Over-voltage	The bus voltage is too high (>41Ø VDC). Lower the AC Mains voltage and check for excessive regeneration power.
E3Ø—Drive Under-voltage	The bus voltage is too low (<85 VDC) or there is overly aggressive acceleration or deceleration. Raise the AC Mains voltage.
E31—Bridge Foldback	Drive current was limited to prevent overheating (warning only). See **DIFOLD**.
E32—Power Regeneration Fault	Check the Regeneration resistor for a short.
E34—Drive Temperature Fault	Wait for the drive to cool down.
E35—Motor Thermal Model Fault	The motor thermal model has determined the motor is too hot. Wait for the motor to cool, and then re-enable the drive.
E36—Motor Temperature Fault	Motor thermal switch has tripped. Wait for the motor to cool, and then re-enable the drive.
E37—Bad Hall State	A problem with the Hall sensors exists. Check the Hall state wiring.
E38-Feedback Failure	Feedback not present or the signal level is incorrect.
E39—Drive Disabled	The drive is disabled.
E4Ø—PWM Not Active	The H-bridge is not switching.
E41—Power Regeneration Warning	The drive regenerated (warning only).
E42—Shaft Power Limited Warning	Shaft power is limited to the rated output to protect the drive (warning only).
E43—Excessive Speed at Enable	The motor was turning too fast when the drive was enabled.
E44—Excessive Position Error	Commanded position. Actual Position is greater than the value set by **SMPER**.
E45—Excessive Velocity Error	Commanded velocity. Actual Velocity is greater than the value set by **SMVER**.
E46—Hardware Enable	Ø = Hardware Enable (Drive I/O Pin 1 and 21) 1 = No Hardware Enable
E47—Low Voltage Enable	No motor power was present when the drive was enabled.

Error Code	Resolution
E48—Control Power Active	The drive is in Control power mode. No motor power is present.
E49—Alignment Error	The **ALIGN** command did not complete successfully.
E52—Encoder Read Fault	The drive could not successfully read the motor parameters from the encoder. Check motor wiring.
E-53—User Fault	The drive user fault input was triggered.
E-54—Encoder Loss Fault	The drive could no longer detect the encoder. Check the encoder connections. Check/modify the value of **ENCFT** or set to zero (Ø) to disable this error.
E55— Network Loss Fault	No update was sent by the EPL network in more than 2 seconds. Check the network cable and controller status.

Table 84 Error Messages

Drive Configuration

Some fault conditions or incorrect motor operation may require changes to the drive configuration. Change the configuration of the drive using ACR-View. (See the ACR Programmer's Guide for details on using ACR-View.)

1. Open a terminal connection to the drive using one of the methods described under "Terminal Emulator (Hyper Terminal)" on page 186.
2. Enter the **CONFIG** command to see a list of drive configuration editors.
3. Enter the **ERROR** command to see a list of drive error messages.

***Important!* —** Further troubleshooting steps can change the drive configuration. Upload the current configuration file and save it as a backup before proceeding.

Smart Encoders

This troubleshooting procedure assumes a terminal emulator connection is established with the drive.

If the drive does not initialize correctly when connected to a Smart Encoder (Parker motors only), check the following:

1. Verify the motor phases are wired correctly. Incorrectly wired motor phases can produce any combination of the following symptoms in the motor: runs backwards; produces low torque, or gets warm.
2. Check that the feedback cables are wired correctly.
3. Apply power to the drive.
    a. Send the **SFB** command. It should report 4. If the response is not **<*>4**, then check the feedback cable (if using a non-Parker cable, check that it is correctly wired). If the cable is correctly wired and connected, the problem might be the encoder.

b. Send the **THALL** command. It should report a number in the range of 1–6, which indicates the phase wires are connected correctly. If the response is **Ø** or **7**, a fault exists. Check the motor phase wiring

c. Send the **TPE** command and turn the motor shaft. Verify the encoder is counting in the correct direction. Turning the shaft clockwise results in positive encoder counts when **CMDDIR** is set to zero (Ø). If not, check the encoder feedback wires and reset the drive.

Hall Sensors

The troubleshooting procedures in this section assume that a terminal emulator connection is established with the drive. The procedures assist you in resolving a Hall fault (**ERROR** bit **E37-Bad Hall State**). Several problems can cause a Hall fault; the following checklist will help identify these problems.

Troubleshooting Checklist

1. Does **THALL** report either 0 or 7?
   If yes, see Problem 1 or 2, below.
2. Does **THALL** change if you move the motor by hand?
   If no, see Problem 2, below.
3. Does **THALL** have six distinct Hall states from 1 to 6? (No numerical order is necessary.)
   If no, see Problem 2, below.
4. Does **THALL** report the six distinct Hall states *n* times as the rotor turns one revolution, where *n* is equal to the number of pole-pairs (**DPOLE**)? (Linear motors: *n* = pitch)
   If no, see Problem 2 or 3, below.
5. Does **THALL** report the Hall state sequence [1, 5, 4, 6, 2, 3, 1...] as the motor turns clockwise? (Clockwise means **TPE** is increasing when **CMDIR** set to zero (Ø); it is also the direction the motor turns in **DMODE1**.)
   If no, see Problem 4, below.
6. Does **ERROR** report a Hall fault each time the drive is enabled (**DRIVE1**), even though the Hall state sequence is correct?
   If yes, see Problem 4, below.
7. Does the Hall fault occur irregularly?
   If yes, see Problem 6, below.

Possible Problems

1. No Hall states are seen by the drive.
2. The cable is not connected, or is connected incorrectly (incorrectly wired).
3. **DPOLE** or **DMEPIT** is not set correctly.
4. Either the motor wires or the Hall wires are connected incorrectly.

   Use Procedure 1 to fix this problem by changing the motor wires.

   Use Procedure 2 to fix this problem by changing the Hall wires.
5. The Hall wires or the encoder wires may have loose connections, causing intermittent faults.

6. Noise induced on the Hall signals from routing the motor feedback cable next to high-voltage cables (for example, strapped to motor power cables).

Procedure 1—Motor Wires

Use this procedure to connect your *motor wires* to the drive.

1. With the motor's feedback cable connected to the drive, randomly connect two motor power wires and slowly apply a positive voltage with respect to the third. See Figure 49 on page 192.

   Note: A variable low voltage (5 to 24V) current limiting (less than continuous current rating of motor) power supply is preferred.

Warning — This procedure could damage the motor. Slowly increase the voltage until the motor moves. Do not exceed the rated current.

Safety Warning — High-performance motion control equipment is capable of producing rapid movement and very high forces. Unexpected motion may occur especially during the development of controller programs. **KEEP WELL CLEAR** of any machinery driven by stepper or servo motors. Never touch any part of the equipment while it is in operation.

2. If **THALL** reports a 1, 2, or 4, change **SHALL** from either 0 to 1 or from 1 to 0. After you change **SHALL**, reset the drive.
3. Repeat step 1 until **THALL** reports a value of 6.
4. The wire on the negative voltage or ground is motor wire W. The two wires at the positive voltage are U and V.

   Now there are two possibilities:

   a. Connect the motor wires to the terminals. Operate the drive in **DMODE1**. If the motor does not turn in the clockwise direction, exchange motor wires U and V. Verify that the **CMDDIR** command is set to zero (Ø).

   b. Put positive voltage on motor wire W together with either U or V and put negative voltage or ground on the remaining wire. If **THALL** reports a value of 3, the wire at the negative voltage is V. If **THALL** reports a value of 5, the wire at the negative voltage is U.

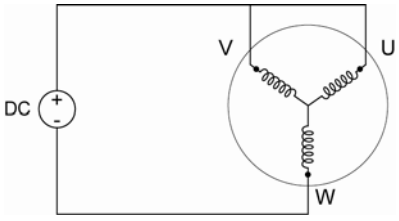


Figure 49 Hall Connection Diagram

Procedure 2—Hall Wires

Use this procedure to connect your *Hall wires* to the drive.

1. First operate the drive in **DMODE1** and verify that the motor turns clockwise. If not, swap any two motor wires.
2. Remove the motor power leads, leaving the feedback cable connected to the drive. Connect motor power wires U and V and slowly apply a positive voltage with respect to W. (See Figure 49.)

   Note: A variable low voltage (5-24V) current limiting (less than continuous current rating of motor) power supply is preferred.

Warning — This procedure could damage the motor. Slowly increase the voltage until the motor moves. Do not exceed the rated current.

Safety Warning — High-performance motion control equipment is capable of producing rapid movement and very high forces. Unexpected motion may occur especially during the development of controller programs. **KEEP WELL CLEAR** of any machinery driven by stepper or servo motors. Never touch any part of the equipment while it is in operation.

3. If **THALL** reports a value of 1, 2 or 4, change **SHALL** from either 0 to 1 or from 1 to 0. After you change **SHALL**, reset the drive.
4. Change the Hall wires until **THALL** reports a value of 6.
5. Connect motor wires U and W and slowly apply a positive voltage with respect to V.
6. If **THALL** does not report a value of 3, change Hall wires B and C.
   If **THALL** reports a value of 3, the wires are connected correctly.

Table 85 on page 193 summarizes phase voltages and their corresponding Hall states. Starting with **SHALLØ** and the phase voltages as shown, the **THALL** command should report the Hall states that match the “Correct” column. If instead **THALL** reports Hall states that match the “Use **SHALL1**” column, enter **SHALL1** and reset the drive. The Hall states should now match the “Correct” column. For more information, see Figure 50 on page 194.

Phase			**Hall State**	
U	**V**	**W**	**Correct**	**Use** SHALL1
–	–	+	1	6
–	+	+	5	2
–	+	–	4	3
+	+	–	6	1
+	–	–	2	5
+	–	+	3	4

Table 85 Configuring Hall Sensors

Figure 50 illustrates the alignment of phases U, V, and W with Halls 1, 2, and 3 as viewed from the front of the shaft. The illustration assumes the following:

Hall signals that are High equal TRUE signals.

Hall 1 is the least significant bit (LSB).

Hall 3 is the most significant bit (MSB).

There is one hall cycle and one electrical cycle per pole pair on the motor.

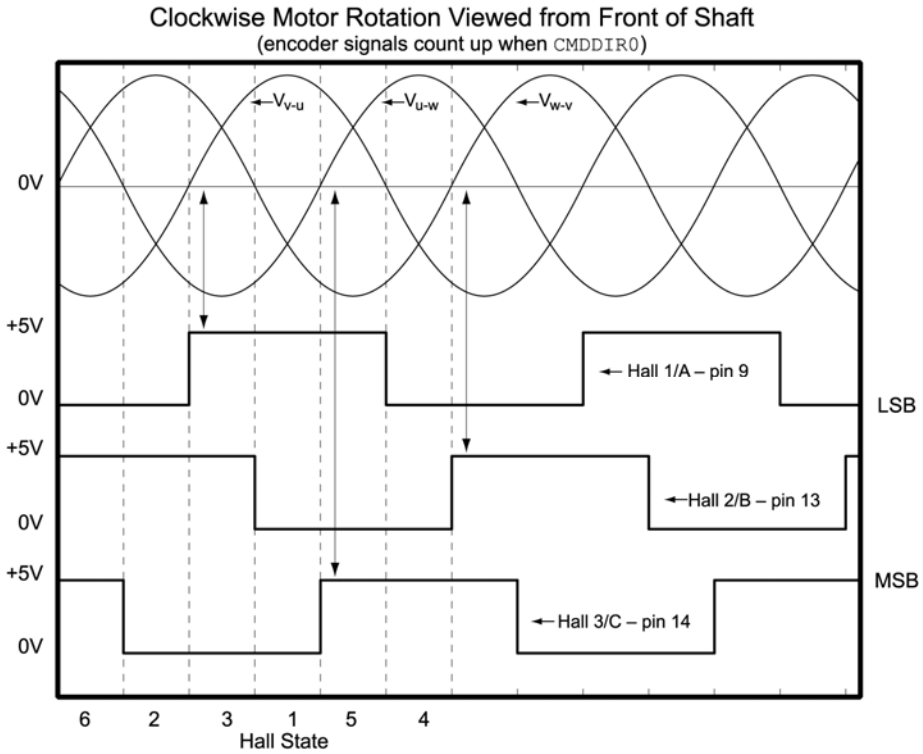


Figure 50 Motor Terminal Voltages (back EMF) and Hall Sensor Signals

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