Stepnet™ Panel Amplifier User Guide

P/N CC95-00294-000

Revision A
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About This Manual

Overview and Scope

This manual describes the operation and installation of the Stepnet Panel (STP) and Stepnet Panel AC (STX) amplifiers manufactured by Copley Controls. The material in this manual applies to the entire Stepnet amplifier family with the exception of the specifications and wiring diagrams. For specifications and wiring information on the Stepnet Module and Stepnet Micro Module, refer to the appropriate data sheets.

Related Documentation

See the Stepnet data sheets at
http://www.copleycontrols.com/Motion/Downloads/stepnetData.html

Choose the appropriate data sheet.

Related Copley Controls manuals include:

- *CME 2 User Guide*
- *CANopen Programmer's Manual*
- *Copley Motion C++ Libraries (CML) Reference Manual (license purchase required)*
- *Copley Motion Objects (CMO) Programmer's Guide*
- *Copley Camming User Guide*
- *Copley ASCII Interface Programmer's Guide*
- *Copley DeviceNet Programmer's Guide*
- *Copley Amplifier Parameter Dictionary*

Information on Copley Controls Software can be found at:
http://www.copleycontrols.com/Motion/Products/Software/index.html

Comments

Copley Controls welcomes your comments on this manual. See http://www.copleycontrols.com for contact information.

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Document Validity

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Product Warnings

Observe all relevant state, regional, and local safety regulations when installing and using Copley Controls amplifiers. For safety and to assure compliance with documented system data, only Copley Controls should perform repairs to amplifiers.

DANGER

DANGER: Hazardous voltages.

Exercise caution when installing and adjusting Copley Controls amplifiers.

Failure to heed this warning can cause equipment damage, injury, or death.

DANGER: Risk of electric shock.

High-voltage circuits are connected to DC or AC power.

Failure to heed this warning can cause equipment damage, injury, or death.

DANGER: Motor voltage rating.

Be sure that the motor is rated for the voltage provided by the amplifier's outputs.

Failure to heed this warning can cause equipment damage, injury, or death.

DANGER: Risk of unexpected motion with non-latched faults.

After the cause of a non-latched fault is corrected, the amplifier re-enables the PWM output stage without operator intervention. In this case, motion may re-start unexpectedly. Configure faults as latched unless a specific situation calls for non-latched behavior. When using non-latched faults, be sure to safeguard against unexpected motion.

Failure to heed this warning can cause equipment damage, injury, or death.

DANGER: Using CME 2 can affect or suspend amplifier operations.

Use of CME 2 to change amplifier parameters while operating the amplifier can affect operations in progress. Using CME 2 to initiate motion can cause operations to suspend. The operations may restart unexpectedly when the CME 2 move is stopped.

Failure to heed this warning can cause equipment damage, injury, or death.

DANGER: Latching an output does not eliminate the risk of unexpected motion with non-latched faults.

Associating a fault with a latched, custom-configured output does not latch the fault itself. After the cause of a non-latched fault is corrected, the amplifier re-enables without operator intervention. In this case, motion may re-start unexpectedly.
For more information, see Clearing Non-Latched Faults (p. 37).

Failure to heed this warning can cause equipment damage, injury, or death.

WARNING

WARNING: Do not ground mains-connected circuits.

With the exception of the ground pins on the STX connectors J1 and J2, all of the other circuits on these connectors are mains-connected and must never be grounded.

Failure to heed this warning can cause equipment damage.

WARNING: Do not plug or unplug connectors with power applied.

The connecting or disconnecting of cables while the amplifier has 24Vdc and/or mains power applied is not recommended.

Failure to heed this warning may cause equipment damage.

Revision History

Revision	Date	ECO	Comments
1.0	August 2004		Initial publication.
2.0	June 2005		Detent compensation gain feature. See Detent Compensation Gain (p. 181).
3	June 2008	17137	Updated Web page references.
A	June 2009	32822	Updated to include Stepnet Panel AC (STX) amplifiers.

CHAPTER
1: INTRODUCTION

This chapter provides an overview of the Copley Controls Stepnet amplifier.

Contents include:

1.1: Amplifier

Stepnet is a 100% digital stepping motor amplifier which can operate in two control modes, stepper or servo. In stepper mode, conventional microstepping techniques are used. In servo mode, stepping motors fitted with encoders can be operated as DC brushless servo motors in closed loop current, velocity or position modes.

Stepnet can operate as a stand-alone amplifier or as a networked CANopen or DeviceNet node. It can also be controlled using the Copley ASCII interface over a serial connection. The multi-drop feature allows CME 2 or other ASCII serial controller to use an RS-232 serial connection to one amplifier as a gateway to other amplifiers linked together by CAN bus connections. The Stepnet can also be controlled by a Copley Virtual Machine (CVM) program running on the amplifier.

Stepnet amplifiers can be networked with Copley Accelnet and Xenus digital servo amplifiers.

When operating as a stand-alone amplifier, Stepnet can accept incremental position commands from step-motor controllers in Pulse and Direction or Count Up/Count Down formats, as well as A/B quadrature commands from a master-encoder. Pulse to motor position ratio is programmable for electronic gearing. In servo mode Stepnet can also accept PWM torque or velocity commands.

The amplifier features 12 programmable digital inputs and four programmable digital outputs.

The Stepnet amplifier is RoHS compliant.

1.1.1: Stepper and Servo Modes

Stepper Mode

In stepper mode, the amplifier operates as a traditional, open position loop, stepper amplifier. With the addition of optional encoder feedback in stepper mode, the amplifier can monitor and report actual motor position and optionally apply a proportional gain to correct following error. Also, a position-tracking window can be set up along with a programmable following error warning and fault.

Servo Mode

In servo mode with motor encoder feedback, the amplifier operates as a true, closed loop, servo amplifier controlling a stepper motor. Using motor encoder feedback, the amplifier can monitor actual motor position and velocity and correct its output so the motor follows the commanded input precisely. The amplifier can be configured to accept current, velocity, or position commands.

Use of the amplifier in servo mode can result in quieter operation and reduced power consumption.

1.1.2: Amplifier Power

The main power input (+HV) to the Stepnet Panel (STP) amplifier can range from 20 to 75 Vdc. This power can be supplied by an inexpensive, unregulated DC power supply. An auxiliary power input allows the digital processor to stay active when the main +HV supply has been removed.

Mains input voltage to the Stepnet Panel AC (STX) can range from 100 to 120 Vac or 200 to 240 Vac single-phase at 50 to 60 Hz. This allows Stepnet the ability to work in the widest possible range of industrial settings.

<table>
<tr><th>Model</th><th>Continuous Current</th><th>Peak Current</th><th>Voltage</th></tr>
<tr><td>STP-075-07</td><td>5 A</td><td>7 A</td><td rowspan="2">20 - 75 Vdc</td></tr>
<tr><td>STP-075-10</td><td>10 A</td><td>10 A</td></tr>
<tr><td>STX-115-07</td><td>5 A</td><td>7 A</td><td>100 - 120 Vac</td></tr>
<tr><td>STX-230-07</td><td>5 A</td><td>7 A</td><td>100 - 240 Vac</td></tr>
</table>

1.2: Amplifier Commissioning with CME 2

Amplifier commissioning is fast and simple using Copley Controls CME 2 software. All of the operations needed to configure the amplifier are accessible through CME 2. CME 2 communicates with Stepnet via an RS-232 link or CAN. The multi-drop feature allows CME 2 to use a single RS-232 serial connection to one amplifier as a gateway to other amplifiers linked together by CAN bus connections.

The CME 2 Auto Phasing routine eliminates the "wire and try" method of connecting the motor and optional encoder to the amplifier. After wiring the motor and encoder to the amplifier, the Auto Phasing routine determines the correct motor polarity and encoder phasing to match the user's "positive" direction.

The amplifier configuration data can be saved to the PC as a file that contains all the amplifier settings. This file can then be copied to new amplifiers, making it possible to quickly duplicate amplifier/motor configurations.

1.3: CANopen for Distributed Control

CANopen compliance allows the amplifier to take instruction from a master application over a CAN network to perform homing operations, point-to-point motion, and interpolated motion. Multiple drives can be tightly synchronized for high performance coordinated motion.

Copley Motion Libraries (CML) and Copley Motion Objects (CMO) make CANopen system commissioning fast and simple. All network housekeeping is taken care of automatically by a few simple commands linked into your application program. CML provides a suite of C++ libraries, allowing a C++ application program to communicate with and control an amplifier over the CANopen network. CMO provides a similar suite of COM objects that can be used by Visual Basic, .NET, LabVIEW, or any other program supporting the COM object interface.

CHAPTER

2: OPERATIONAL THEORY

This chapter describes the basics of Stepnet operation.

Contents include:

2.1: Amplifier Power: Stepnet Panel (STP)

2.1.1: Stepnet Panel (STP) High Voltage (+HV) Power

A Stepnet Panel (STP) amplifier typically operates from a transformer-isolated, unregulated DC power supply. The supply should be sized such that the maximum output voltage under high-line and no-load conditions does not exceed the amplifier's maximum voltage rating.

Power supply rating depends on the power delivered to the load by the amplifier. In many cases, the continuous power output rating of the amplifier is considerably higher than the actual power required the load. By appropriately selecting the boost, run and hold current levels in stepper mode or by using servo mode, it is often possible to use a smaller power supply then would normally be required.

Operation from regulated switching power supplies is possible if a diode is placed between the power supply and amplifier to prevent regenerative energy from reaching the output of the supply. If this is done, there must be external capacitance between the diode and the amplifier.

2.1.2: Stepnet Panel (STP) Auxiliary Power

Stepnet has an Auxiliary Power input which can keep the amplifier communications and feedback circuits active when the PWM output stage has been disabled by removing the main +HV supply. This can occur during EMO (Emergency Off) conditions where the +HV supply must be removed from the amplifier to ensure operator safety. The Auxiliary Power input operates from any DC voltage that is within the operating voltage range of the amplifier. The higher of the two voltages, +HV or Auxiliary, will power the DC/DC converter that supplies operating voltages to the amplifier DSP and control circuits. As long as the +HV voltage is greater than the auxiliary power voltage it will power the DC/DC converter and the auxiliary power input will draw no current.

Connection of an Auxiliary power supply is optional.

2.2: Amplifier Power: Stepnet Panel AC (STX)

Power distribution within the Stepnet Panel AC (STX) is divided into three sections: +24 Vdc, logic/signal, and high voltage. Each is isolated from the other.

2.2.1: Logic/Signal Power

An internal DC/DC converter operates from the +24 Vdc Logic Supply input and creates the required logic/signal operating voltages, the isolated voltages required for the high-voltage control circuits, and a +5 Vdc supply for powering the motor encoder circuits. All the digital and analog inputs, digital outputs, and encoder inputs are referenced to the same signal common. The CAN interface is optically isolated.

Deriving internal operating voltages from a separate source enables the amplifier to stay on-line when the mains have been disconnected for emergency-stop or operator-intervention conditions. This allows CAN bus and serial communications to remain active so that the amplifier can be monitored by the control system while the mains power is removed.

2.2.2: High Voltage

Mains power drives the high-voltage section. It is rectified and capacitor-filtered to produce the DC bus: the DC “link” power that drives the PWM inverter, where it is converted into the voltages that drive the stepper motor. An internal solid-state switch and power resistor provides dissipation during regeneration when the mechanical energy of the motor is converted back into electrical energy. This prevents charging the internal capacitors to an overvoltage condition.

2.3: Stepper Mode Operation

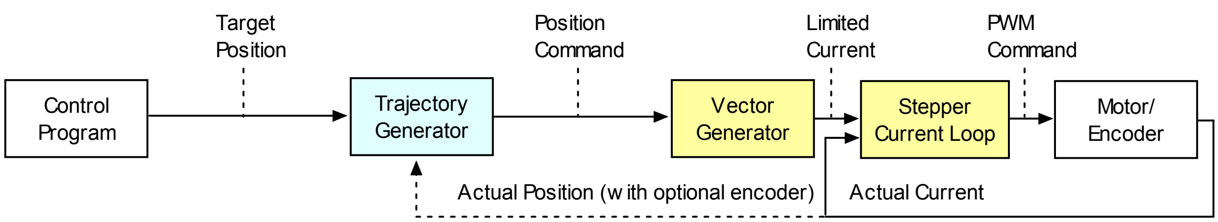
2.3.1: Stepper Mode Control

The amplifier receives target position commands from the digital inputs or over the CAN interface. When using the digital inputs, the amplifier's internal trajectory generator calculates a trapezoidal motion profile based on the trajectory limit parameters. The trajectory generator updates the calculated profile in real time as additional position commands are received. The output of the generator is an instantaneous limited position command. The vector generator accepts this command and calculates a limited current command which is the input to the current loop.

For information on the current loop see Servo Current Mode and Current Loop (p. 19).

Refer to Copley Controls' *CANopen Programmer's Manual* for position loop operation while under CAN control.

In stepper mode, the trajectory generator accepts a target position and provides a current demand to the current limiter. The current limiter provides a limited current to the stepper current loop. The stepper current loop outputs a PWM command to drive the motor. Actual current feedback is used to close the current loop in the amplifier. Position feedback from an optional encoder can be used to provide position maintenance data to the external controller program.



2.3.2: Full Stepping

Full stepping is a traditional and simple approach to driving a step motor. The motor moves when the amplifier stops applying current to one phase and applies it to the other. The amplifier can apply current to either of these two phases in either direction (i.e., positive current into phase A, negative into phase A, positive into B, negative into B). This allows the amplifier to make the motor come to rest in 4 distinct positions for each magnetic poll pair of the motor.

Step motors typically have 50 or 100 poll pairs. This means a full stepping amplifier can make the motor come to rest at 200 or 400 distinct positions or steps. These motors are often described as being 1.8 degree / step, or 0.9 degree / step. (360 degrees/200 steps gives 1.8 degrees/step).

The Stepnet amplifier can be set to full stepping mode by the programming the microsteps/rev value equal to the motors step/rev value.

2.3.3: Microstepping

Through microstepping, Stepnet amplifiers provide a much higher degree of control over a motor's position than does an amplifier that only supports full stepping. The Stepnet amplifier can apply varying amounts of current into both phases of the motor at the same time, making it possible to rest the motor not only at the full step locations, but at points or microsteps between them, and thus allow a high degree of control over the motor's position.

There is virtually no limit on the number of microsteps/rev that can be programmed into the Stepnet amplifier. The practical limit depends on the motor, but a value on the order of 4096 microsteps/electrical cycle is generally reasonable. Programming a very high value will limit the maximum velocity of the motor. When a high resolution encoder is connected to the motor, it is sometimes advantageous to program the number of microsteps to be equal to the number of encoder counts.

Some drive manufacturers require that the number of microsteps/rev be an integer multiple of the number of electrical cycles. The Stepnet amplifiers do not have such a limitation.

2.3.4: Current Control in Stepper Mode

The Stepnet amplifier uses three programmable current settings to control the current applied to the motor: boost, run, and hold.

Boost current is applied to motor while it is accelerating or decelerating. Since it is only applied for a short amount of time, it can typically be set higher then the motor's continuous rated value. Another parameter, time at boost, specifies how long the boost current may be applied to the motor. If acceleration or deceleration time exceeds this limit, the current will decrease to the run value even though the motor is still accelerating/decelerating.

The run current is applied to the motor while it running at a constant velocity.

The hold current is used after the motor has stopped running and after the time specified by the run to hold parameter has expired.

A small amount of jitter can occur when Stepper motors are at rest under hold current. To prevent this, the Stepnet features an optional voltage mode. After the time specified in the hold to voltage parameter has expired, the amplifier enters the voltage mode, locking the duty cycle to prevent jitter.

An I^2T algorithm is used to protect the motor from overheating by basically averaging the amount of current applied to the motor and not allowing it exceed the run current setting. If boost current is used, then the motor must spend time with hold current applied so the average does not exceed the run setting. See I2T Time Limit Algorithm (p. 167).

NOTE: Current loop operation in stepper mode is very similar to current loop operation in servo mode. Reading the description of servo mode operation can be helpful in understanding stepper mode operation. When doing so, make the following substitutions: where stepper mode uses run current, servo mode uses continuous current; where stepper mode uses boost current, servo mode uses peak current. Also, there is no servo mode equivalent to the stepper mode hold current. For more details about current loop operation, see Servo Current Mode and Current Loop (p. 19).

2.4: Servo Mode Operation

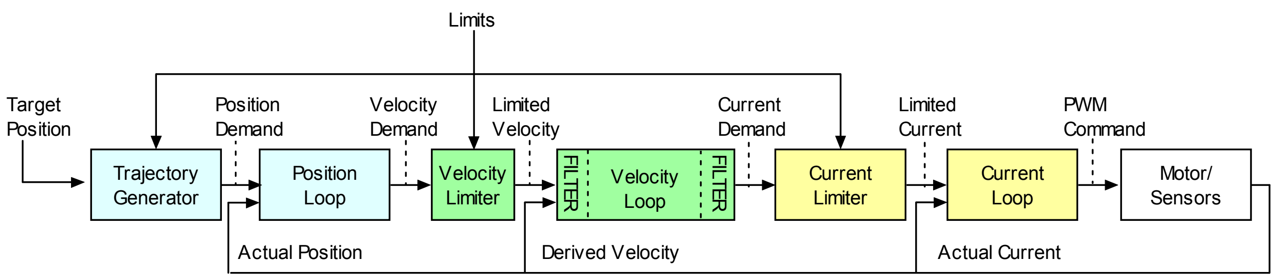
2.4.1: Servo Modes and Control Loops

Nesting of Servo Mode Control Loops and Modes

In servo mode, the Stepnet uses up to three nested control loops - current, velocity, and position - to control a motor in three associated operating modes.

Servo Mode Nested Loops Illustration

In servo position mode, the amplifier uses all three loops, as shown below. The loops are nested: the current loop within the velocity loop, within the position loop. Stated another way: the position loop drives the velocity loop, which drives the current loop.



Servo Control Loops per Operating Mode

The loops are employed in the operating modes as described below.

Operating Mode	Servo Position Loop		Servo Velocity Loop		Servo Current Loop	
	Input	Output	Input	Output	Input	Output
Current	Velocity and position loops not employed in current mode.				External command.	Voltage command (input to the PWM power stage)
Velocity	Position loop not employed in velocity mode.		External command.	Current command (input to current loop).	Current command from velocity loop.	
Position	External command.	Velocity command (input to the velocity loop).	Velocity command from position loop.			

Basic Attributes of All Servo Control Loops

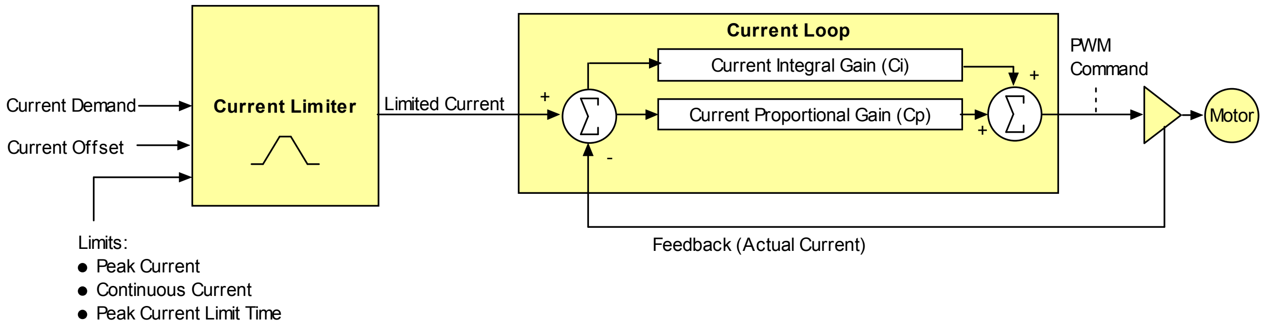
These loops (and servo control loops in general) share several common attributes:

Loop Attribute	Description
Command input	Every loop is given a value to which it will attempt to control. For example, the velocity loop receives a velocity command that is the desired motor speed.
Limits	Limits are set on each loop to protect the motor and/or mechanical system.
Feedback	The nature of servo control loops is that they receive feedback from the device they are controlling. For example, the position loop uses the actual motor position as feedback.
Gains	These are constant values that are used in the mathematical equation of the servo loop. The values of these gains can be adjusted during amplifier setup to improve the loop performance. Adjusting these values is often referred to as *tuning* the loop.
Output	The loop generates a control signal. This signal can be used as the command signal to another control loop or the input to a power amplifier.

2.4.2: Servo Current Mode and Current Loop

Servo Current Loop Diagram

As shown below, the "front end" of the servo current loop is a limiting stage. The limiting stage accepts a current command, applies limits, and passes a limited current command to the summing junction. The summing junction takes the commanded current, subtracts the actual current (represented by the feedback signal), and produces an error signal. This error signal is then processed using the integral and proportional gains to produce a command. This command is then applied to the amplifier's power stage.



Inputs

In servo current mode, the current command comes from external sources such as the amplifier's PWM inputs, or internal sources, such as a Copley Virtual Machine (CVM) program.

See PWM Input (Servo Mode Only) (p. 29).

In servo velocity or position modes, the current command is generated by the velocity loop.

Offset

The servo current loop offset is intended for use in applications where there is a constant force applied to, or required of, the motor and the system must control this force. Typical applications would be a vertical axis holding against gravity, or web tensioning. This offset value is summed with the current command before the limiting stage.

Limits

The current command is limited based on the following parameters:

Limiter	Description
Peak Current Limit	Maximum current that can be generated by the amplifier for a short duration of time. This value cannot exceed the peak current rating of the amplifier.
Continuous Current Limit	Maximum current that can be constantly generated by the amplifier.
I^2T Time Limit	Maximum amount of time that the peak current can be applied to the motor. The amplifier can be programmed to fold back the current to the continuous current setting or generate a latched fault when this time is exceeded. For more details, see I^2T Time Limit Algorithm (p. 167). Note: Although the current limits set by the user may exceed the amplifier's internal limits, the amplifier operates using both sets of limits in parallel, and therefore will not exceed its own internal limits regardless of the values programmed.

Current Loop Gains

The current loop uses these gains:

Gain	Description
Cp - Current loop proportional	The current error (the difference between the actual and the limited commanded current) is multiplied by this value. The primary effect of this gain is to increase bandwidth (or decrease the step-response time) as the gain is increased.
Ci - Current loop integral	The integral of the current error is multiplied by this value. Integral gain reduces the current error to zero over time. It controls the DC accuracy of the loop, or the flatness of the top of a square wave signal. The error integral is the accumulated sum of the current error value over time.

Current Loop Output

The output of the current loop is a command that sets the duty cycle of the PWM output stage of the amplifier.

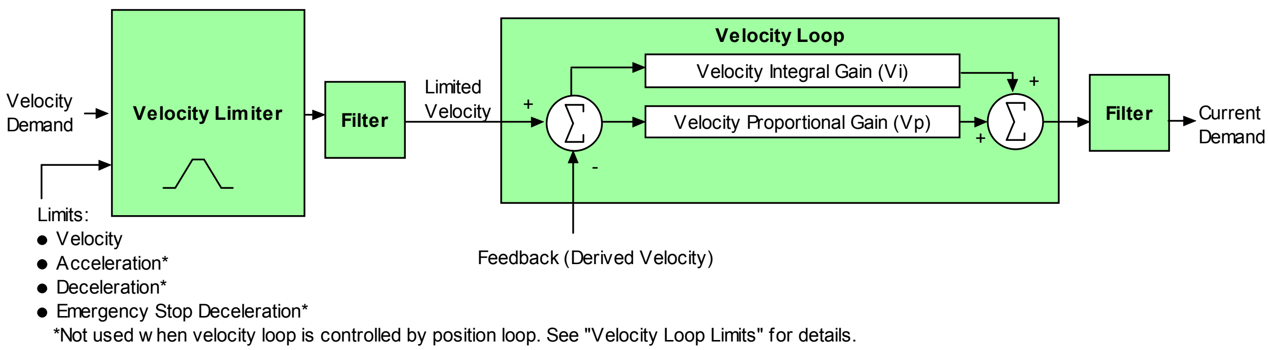
Auto Tune

CME 2 provides a current loop Auto Tune feature, which automatically determines optimal Cp and Ci values for the motor. For more information, see the *CME 2 User Guide*.

2.4.3: Servo Velocity Mode and Velocity Loop

Servo Velocity Loop Diagram

As shown below, the “front end” of the servo velocity loop is a limiting stage. This accepts a velocity command, applies limits, and passes a limited velocity command to the summing junction. The summing junction takes the limited velocity command, subtracts the actual velocity, represented by the feedback signal, and produces an error signal. This error signal is then processed using the integral and proportional gains to produce a current command. Optional filters can be used to reduce the excitation of any resonance in the system. They are available on both the input command and the output current demand, but most typically used on the output only.



Inputs

In servo velocity mode, the velocity command comes from external sources such as the amplifier’s PWM inputs, or internal sources, such as a Copley Virtual Machine (CVM) program.

See PWM Input (Servo Mode Only) (p. 29).

In servo position mode, the velocity command is generated by the position loop.

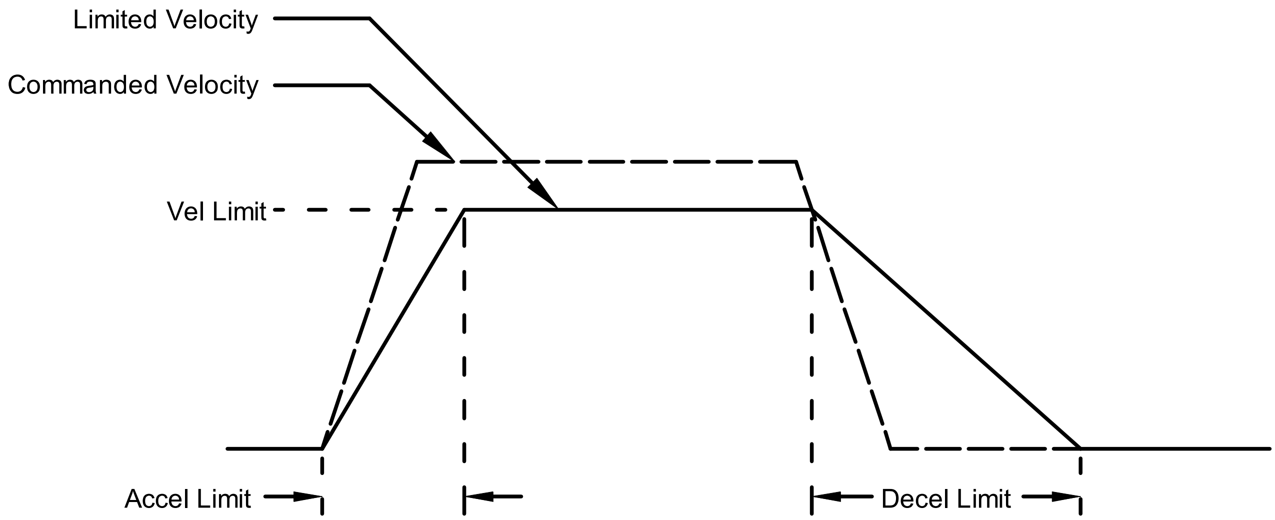
Servo Velocity Loop Limits

The velocity command is limited based on the following set of parameters designed to protect the motor and/or the mechanical system.

Limiter	Description
Velocity Limit	Sets the maximum velocity command input to the servo velocity loop.
Acceleration Limit	Limits the maximum acceleration rate of the commanded velocity input to the servo velocity loop. This limit is used in servo velocity mode only. In servo position mode, the trajectory generator handles acceleration limiting.
Deceleration Limit	Limits the maximum deceleration rate of the commanded velocity input to the servo velocity loop. This limit is used in servo velocity mode only. In servo position mode, the trajectory generator handles deceleration limiting.
Fast Stop Ramp	Specifies the deceleration rate used by the servo velocity loop when the amplifier is hardware disabled. (Fast stop ramp is not used when amplifier is software disabled.) If the brake output is active, the fast stop ramp is used to decelerate the motor before applying the brake. Note that Fast Stop Ramp is used only in servo velocity mode. In servo position mode, the trajectory generator handles controlled stopping of the motor. There is one exception: if a non-latched following error occurs in position mode, then the amplifier goes into velocity mode and the Fast Stop Ramp is used. For more information, see Following Error Fault Details (p. 40).

Diagram: Effects of Limits on Velocity Command

The following diagram illustrates the effects of the servo velocity loop limits.



Servo Velocity Loop Gains

The servo velocity loop uses these gains:

Gain	Description
Vp - Velocity loop proportional	The velocity error (the difference between the actual and the limited commanded velocity) is multiplied by this gain. The primary effect of this gain is to increase bandwidth (or decrease the step-response time) as the gain is increased.
Vi - Velocity loop integral	The integral of the velocity error is multiplied by this value. Integral gain reduces the velocity error to zero over time. It controls the DC accuracy of the loop, or the flatness of the top of a square wave signal. The error integral is the accumulated sum of the velocity error value over time.

Servo Velocity Gains Shift

The *Velocity Gains Shift* feature adjusts the resolution of the units used to express Vp and Vi, providing more precise tuning. If the non-scaled value of Vp or Vi is 64 or less, the Low Gains Shift option is available to increase the gains adjustment resolution. (Such low values are likely to be called for when tuning a linear motor with an encoder resolution finer than a micrometer.) If the non-scaled value of Vp or Vi is 24001 or higher, the High Gains Shift option is available to decrease the gains adjustment resolution.

Servo Velocity Loop Command and Output Filters

The servo velocity loop contains two programmable digital filters. The input filter should be used to reduce the effects of a noisy velocity command signal. The output filter can be used to reduce the excitation of any resonance in the motion system.

Two filter classes can be programmed: the Low-Pass and the Custom Bi-Quadratic. The Low-Pass filter class includes the Single-Pole and the Two-Pole Butterworth filter types. The Custom Bi-Quadratic filter allows advanced users to define their own filters incorporating two poles and two zeros.

For more information, see the *CME 2 User Guide*.

Servo Velocity Loop Outputs

The output of the servo velocity loop is a current command used as the input to the servo current loop.

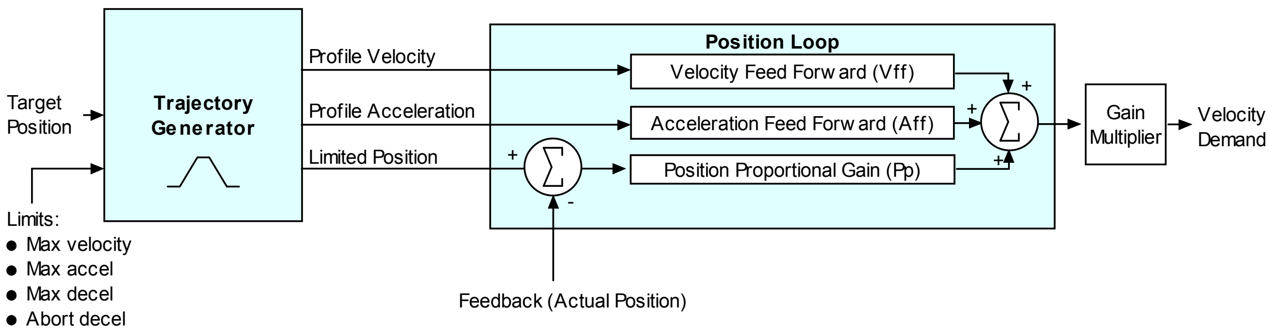
2.4.4: Servo Position Mode and Position Loop

Servo Position Loop Diagram

The amplifier receives position commands from internal sources, such as a Copley Virtual Machine (CVM) program, or external input sources such as the amplifier's digital inputs or a CANopen or DeviceNet network.

When using the digital inputs, the amplifier's internal trajectory generator calculates a trapezoidal motion profile based on the trajectory limit parameters. The trajectory generator updates the calculated profile in real time as additional position commands are received. The output of the generator is an instantaneous position command (limited position). In addition, values for the instantaneous profile velocity and acceleration are generated. These signals, along with the actual position feedback, are processed by the position loop to generate a velocity command.

The following diagram summarizes the servo position loop.



The **Clear Limits** feature is described in Position Loop Settings, p. 141.

Servo Position Mode Inputs

In servo position mode, various input sources can drive the amplifier:

- The amplifier receives position commands directly from the digital inputs. For more information, see Digital Inputs (p. 100).
- The amplifier receives position commands over a CANopen or DeviceNet network via the amplifier's CAN interface. For more information, see Communication (p. 30) and the *Copley DeviceNet Programmer's Guide*.

Trajectory Limits

In servo position mode, the trajectory generator applies the following user-set limits to generate the motion profile.

Limiter	Description
Maximum Velocity*	Limits the maximum speed of the profile.
Maximum Acceleration*	Limits the maximum acceleration rate of the profile.
Maximum Deceleration*	Limits the maximum deceleration rate of the profile.
Abort Deceleration	Specifies the deceleration rate used by the trajectory generator when motion is aborted.
*When the amplifier is driven by pulse and direction commands, Maximum Velocity, Acceleration, and Deceleration function as maximum values. When the amplifier is driven by any other command input, Maximum Velocity, Acceleration, and Deceleration function as commanded values.	

Servo Position Loop Inputs From the Trajectory Generator

The servo position loop receives the following inputs from the trajectory generator.

Input	Description
Profile Velocity	The instantaneous velocity value of the profile. Used to calculate the velocity feed forward value.
Profile Acceleration	The instantaneous acceleration/deceleration value of the profile. Used to calculate the acceleration feed forward value.
Limited Position	The instantaneous commanded position of the profile. Used with the actual position feedback to generate a position error.

Servo Position Loop Gains

The following gains are used by the servo position loop to calculate the velocity command:

Gain	Description
Pp - Position loop proportional	The loop calculates the position error as the difference between the actual and limited position values. This error in turn is multiplied by the proportional gain value. The primary effect of this gain is to reduce the following error.
Vff - Velocity feed forward	The value of the profile velocity is multiplied by this value. The primary effect of this gain is to decrease following error during constant velocity.
Aff - Acceleration feed forward	The value of the profile acceleration is multiplied by this value. The primary effect of this gain is to decrease following error during acceleration and deceleration.
Gain Multiplier	The output of the position loop is multiplied by this value before being passed to the velocity loop.

Servo Position Loop Feedback

The feedback to the loop is the actual motor position, obtained from a quadrature encoder attached to the motor.

Servo Position Loop Output

The output of the servo position loop is a velocity command used as the input to the velocity loop.

2.5: Input Command Types

The amplifier can be controlled by a variety of external sources: analog voltage input (STX only), digital inputs, CAN network (CANopen or DeviceNet), or over an RS-232 serial connection using ASCII commands. The amplifier can also function as a stand-alone motion controller running an internal CVM program or using its internal function generator.

2.5.1: Analog Command Input (STX Servo Mode Only)

Overview

The amplifier can be driven by an analog voltage signal through the analog command input. The amplifier converts the signal to a current, velocity, or position command as appropriate for current, velocity, or position mode operation, respectively.

The analog input signal is conditioned by the scaling, dead band, and offset settings.

A programmable filter is also available on the analog input. See the “Low-Pass and Bi-Quad Filters” appendix in the *CME 2 User’s Guide.*

Scaling

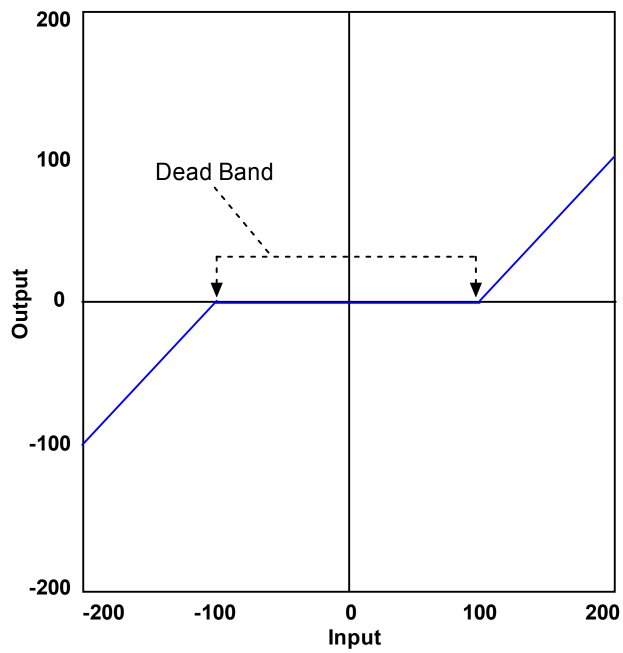
The magnitude of the command generated by an input signal is proportional to the input signal voltage. Scaling controls the input-to-command ratio, allowing the use of an optimal command range for any given input voltage signal range.

For example, in current mode, with default scaling, +10 Vdc of input generates a command equal to the amplifier’s peak current output; +5 Vdc equals half of that.

Scaling could also be useful if, for example, the signal source generates a signal range between 0 and +10 Vdc, but the command range only requires +7.5 Vdc of input. In this case, scaling allows the amplifier to equate +7.5 Vdc with the amplifier’s peak current (in current mode) or maximum velocity (in velocity mode), increasing the resolution of control.

Dead Band

To protect against unintended response to low-level line noise or interference, the amplifier can be programmed with a “dead band” to condition the response to the input signal voltage. The amplifier treats anything within the dead band ranges as zero, and subtracts the dead band value from all other values. For instance, with a dead band of 100 mV, the amplifier ignores signals between –100 mV and +100 mV, and treats 101 mV as 1 mV, 200 mV as 100 mV, and so on.



Offset

To remove the effects of voltage offsets between the controller and the amplifier in open loop systems, CME 2 provides an *Offset* parameter and a *Measure* function. The *Measure* function takes 10 readings of the analog input voltage over a period of approximately 200 ms, averages the readings, and then displays the results. The *Offset* parameter allows the user to enter a corrective offset to be applied to the input voltage.

The offset can also set up the amplifier for bi-directional operation from a uni-polar input voltage. An example of this would be a 0 to +10 Vdc velocity command that had to control 1000 rpm CCW to 1000 rpm CW. Scale would be set to 2000 rpm for a +10 Vdc input and Offset set to -5V. After this, a 0 Vdc input command would be interpreted as -5 Vdc, which would produce 1000 rpm CCW rotation. A +10 Vdc command would be interpreted as +5 Vdc and produce 1000 rpm CW rotation.

Monitoring the Analog Command Voltage

The analog input voltage can be monitored in the CME 2 control panel and oscilloscope. The voltage displayed in both cases is after both offset and deadband have been applied.

Analog Command in Position Mode

The amplifier's Analog Position command operates as a relative motion command. When the amplifier is enabled the voltage on the analog input is read. Then any change in the command voltage will move the axis a relative distance, equal to the change in voltage, from its position when enabled.

To use the analog position command as an absolute position command, the amplifier should be homed every time it is enabled. The Homing sequence may be initiated by CAN, ASCII serial, or CVM Indexer program commands.

2.5.2: Digital Position Inputs

Three Formats

In position mode, the amplifier can accept position commands via two digital inputs, using one of these signal formats: pulse and direction, count up/count down, or quadrature.

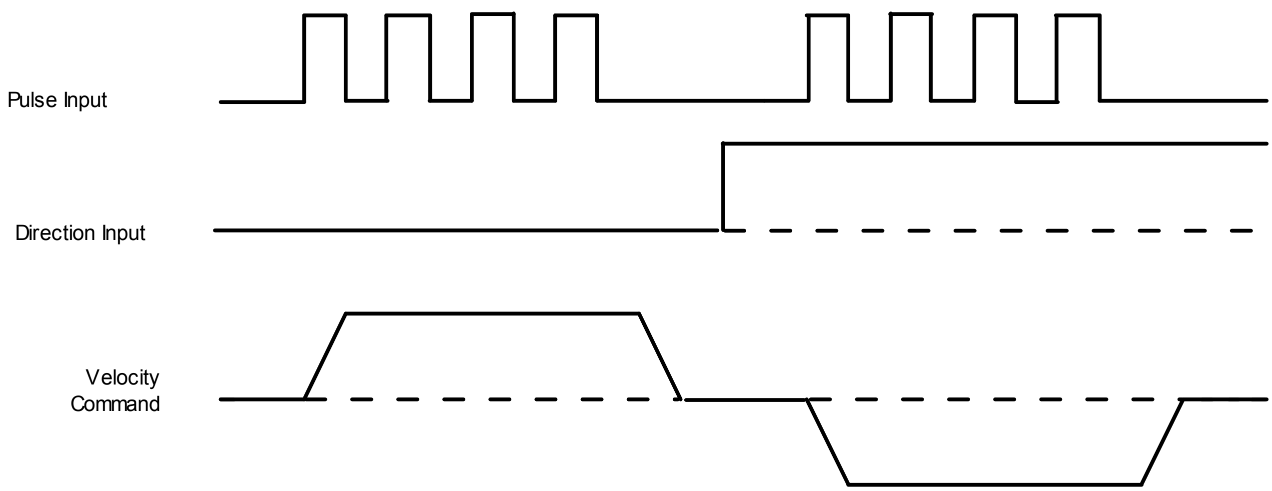
In all three formats, the amplifier can be configured to invert the command.

Pulse Smoothing

In position mode, the amplifier's trajectory generator ensures smooth motion even when the command source cannot control acceleration and deceleration rates.

Pulse and Direction Format

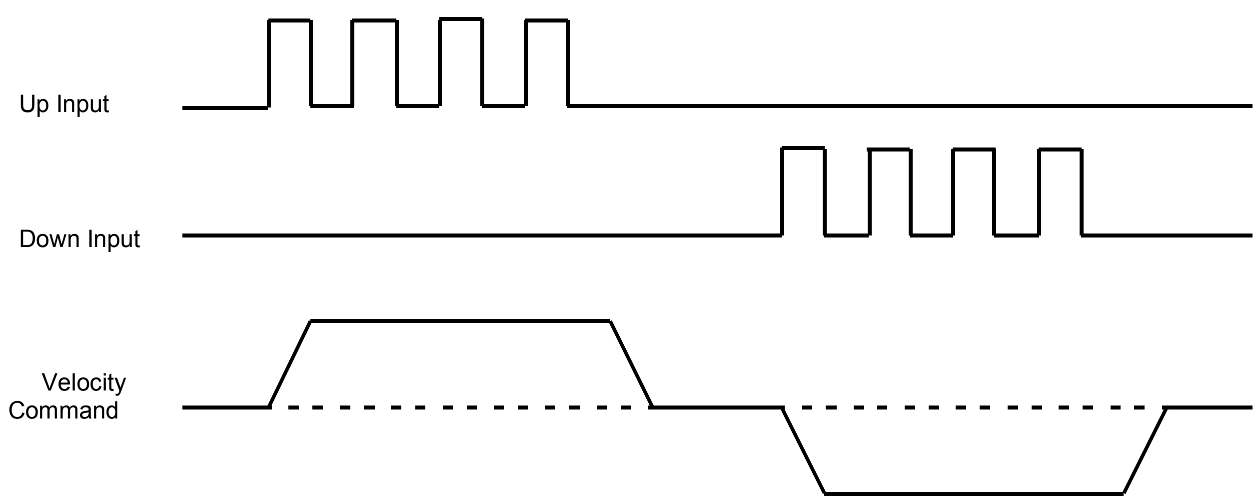
In pulse and direction format, one input takes a series of pulses as motion step commands, and another input takes a high or low signal as a direction command, as shown below.



The amplifier can be set to increment position on the rising or falling edge of the signal. Stepping resolution can be programmed for electronic gearing.

Count Up/Count Down Format

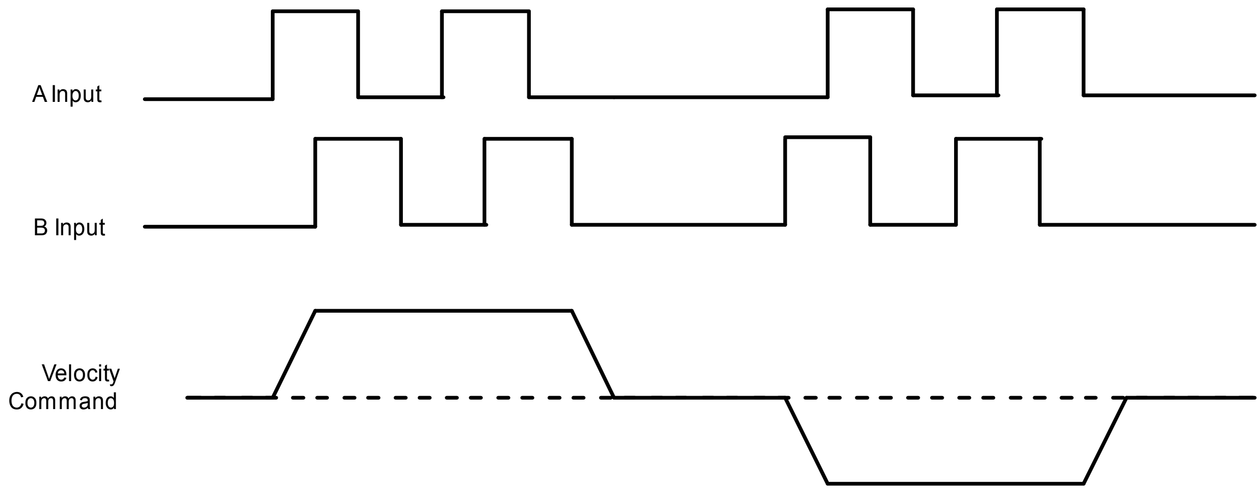
In the count up/count down format, one input takes each pulse as a positive step command, and another takes each pulse as a negative step command, as shown below.



The amplifier can be set to increment position on the rising or falling edge of the signal. Stepping resolution can be programmed for electronic gearing.

Quadrature Format

In quadrature format, A/B quadrature commands from a master encoder (via two inputs) provide velocity and direction commands, as shown below.



The ratio can be programmed for electronic gearing.

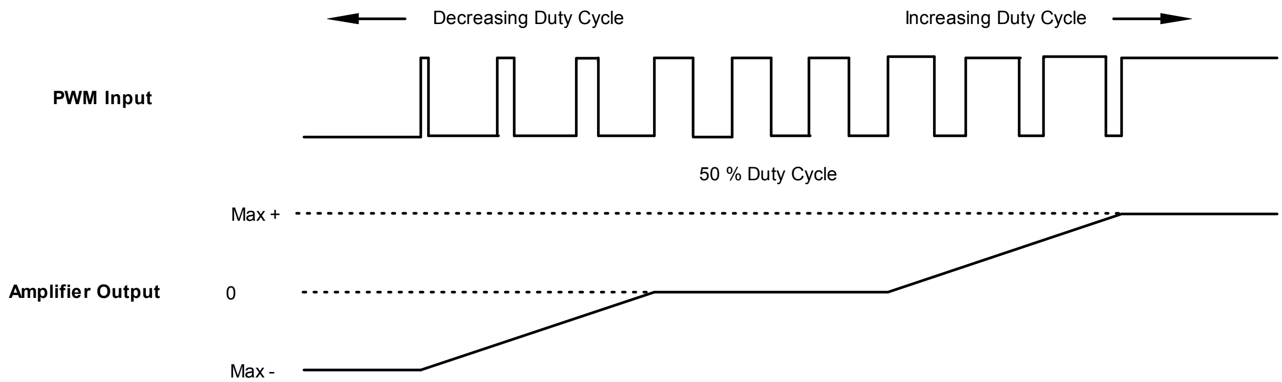
2.5.3: PWM Input (Servo Mode Only)

Two Formats

The amplifier can accept a pulse width modulated signal (PWM) signal to provide a current command in servo current mode or a velocity command in servo velocity mode. The PWM input can be programmed for two formats: 50% duty cycle (one-wire) or 100% duty cycle (two-wire).

50% Duty Cycle Format (One-Wire)

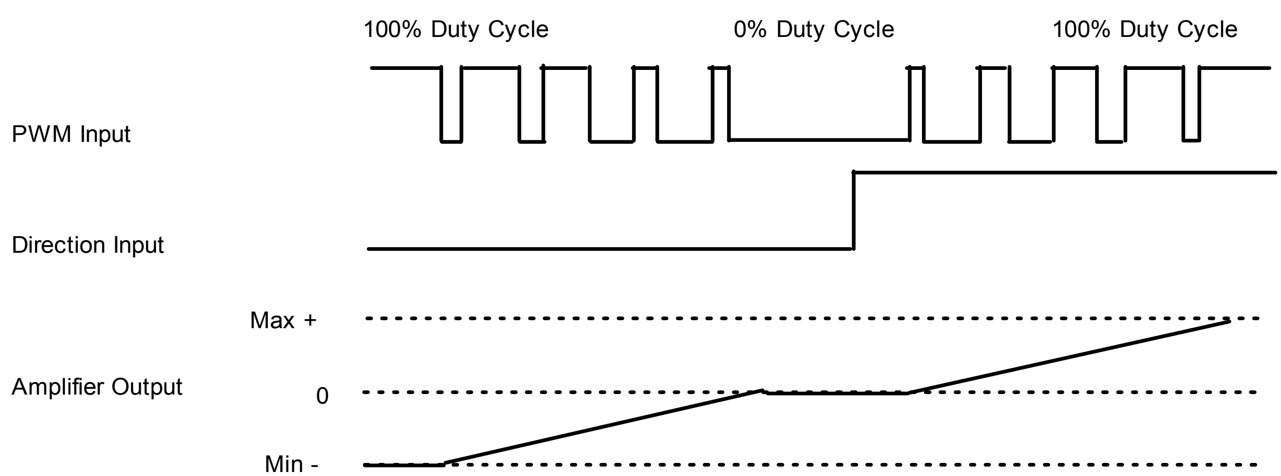
The input takes a PWM waveform of fixed frequency and variable duty cycle. As shown below, a 50% duty cycle produces zero output from the amplifier. Increasing the duty cycle toward 100% commands a positive output; decreasing the duty cycle commands a negative output.



The command can be inverted so that increased duty cycle commands negative.

100% Duty Cycle Format (Two-Wire)

One input takes a PWM waveform of fixed frequency and variable duty cycle, and the other input takes a DC level that controls the polarity of the output. A 0% duty cycle creates a zero command, and a 100% duty cycle creates a maximum command level. The command can be inverted so that increasing the duty cycle decreases the output and vice versa.



Failsafe Protection from 0 or 100% Duty Cycle Commands

In both formats, the amplifier can be programmed to interpret both 0 and 100% duty cycle as a zero command. This provides a measure of safety in case of a controller failure or a cable break.

2.6: Communication

As described below, the amplifier features multiple communication interfaces, each used for different purposes.

Interface	Description
RS-232 port	The amplifier features a three-wire RS-232 port. Control commands can be sent over the RS-232 port using Copley Controls ASCII interface commands. In addition, CME 2 software communicates with the amplifier (using a binary protocol) over this link for amplifier commissioning, adjustments, and diagnostics. For RS-232 port specifications, see Serial Interface (p. 51). For RS-232 port wiring instructions, see Stepnet Panel (STP) RS-232 Serial Communications (J4) (p. 66) or Stepnet Panel AC (STX) RS-232 Serial Communications (J8) (p. 83). Note that CME 2 can be used to make adjustments even when the amplifier is being controlled over the CAN interface or by the digital inputs.
CAN interface	When operating as a CAN node, the amplifier takes command inputs over a CANopen or DeviceNet network. CAN communications are described in the next section.

DANGER

Using CME 2 can affect or suspend CAN operations.

When operating the amplifier as a CANopen or DeviceNet node, use of CME 2 to change amplifier parameters can affect CANopen or DeviceNet operations in progress.

Using CME 2 to initiate motion can cause CANopen or DeviceNet operations to suspend. The operations may restart unexpectedly when the CME 2 move is stopped.

Failure to heed this warning can cause equipment damage, injury, or death.

2.6.1: CAN Network and CANopen Profiles for Motion

In servo or stepper position mode, the amplifier can take instruction over a two-wire Controller Area Network (CAN). CAN specifies the data link and physical connection layers of a fast, reliable network.

CANopen is a set of profiles (specifications) built on a subset of the CAN application layer protocol. These profiles specify how various types of devices, including motion control devices, can use the CAN network in a highly efficient manner. Stepnet supports the relevant CANopen profiles, allowing it to operate in the following modes of operation: profile torque, profile velocity, profile position, interpolated position, and homing.

2.6.2: Supported CANopen Modes

In profile torque mode, the amplifier is programmed with a torque command. When the amplifier is enabled, or the torque command is changed, the motor torque ramps to the new value at a programmable rate. When the amplifier is halted, the torque ramps down at the same rate.

In profile velocity mode, the amplifier is programmed with a velocity, a direction, and acceleration and deceleration rates. When the amplifier is enabled, the motor accelerates to the set velocity and continues at that speed. When the amplifier is halted, the velocity decelerates to zero.

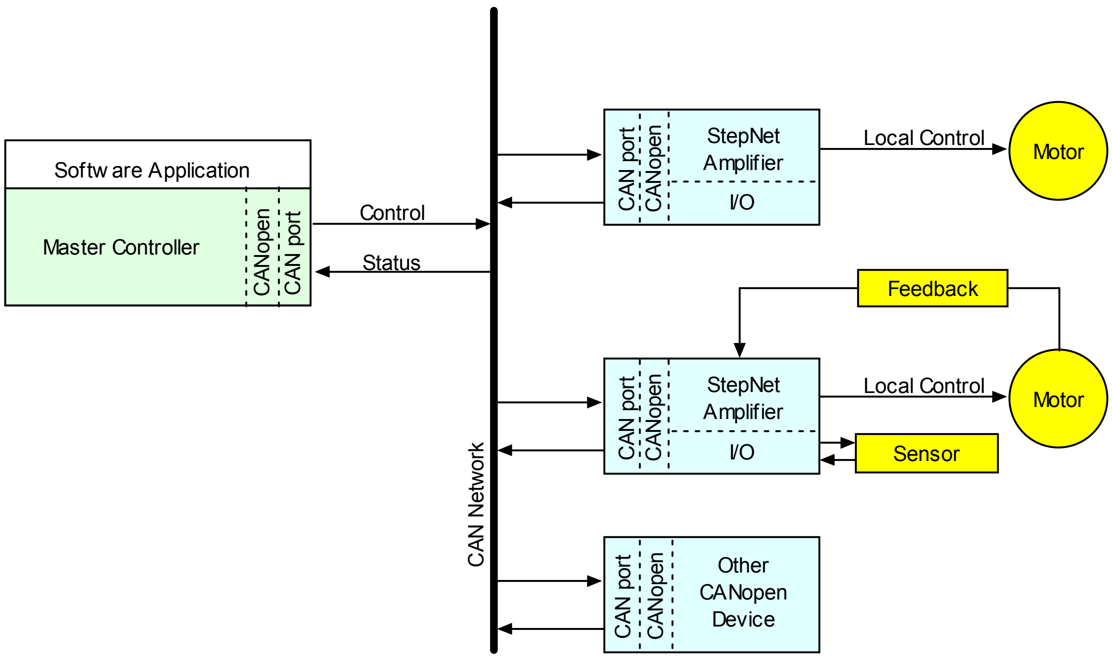
In profile position mode, the amplifier is programmed with a velocity, a relative distance or absolute position, and acceleration and deceleration rates. On command, a complete motion profile is executed, traveling the programmed distance or ending at the programmed position. The amplifier supports both trapezoidal and s-curve profiles.

In interpolated position mode, the controller sends a sequence of points to the amplifier, each of which is a segment of a larger, more complex move, rather than a single index or profile. The amplifier then uses cubic polynomial interpolation to "connect the dots" so that the motor reaches each point at the specified velocity at the programmed time.

Homing mode is used to move the axis from an unknown position to a known reference or zero point with respect to the mechanical system. The homing mode is configurable to work with a variety of combinations of encoder index, home switch, limit switches and mechanical stops.

2.6.3: Architecture

As shown below, in a CANopen motion control system, control loops are closed on the individual amplifiers, not across the network. A master application coordinates multiple devices, using the network to transmit commands and receive status information. Each device can transmit to the master or any other device on the network. CANopen provides the protocol for mapping device and master internal commands to messages that can be shared across the network.



2.6.4: CAN Addressing

A CANopen network can support up to 127 nodes. Each node must have a unique and valid seven-bit address (Node ID) in the range of 1-127. (Address 0 is reserved and should not be used.)

There are several methods for setting the CAN address, using various combinations of the rotary CAN ADDR selector switch, programmed values entered into flash memory, and digital input signals.

Addressing Method	Description
Address selector switch	If the address number <= 16, CAN address can be set using the CAN ADDR switch only.
Use programmed value	Program address into flash only. Ignore switch.
Use address switch with programmed offset value	Use address switch and an offset value programmed into flash memory. Address is the sum of the offset value and the switch setting.
Use inputs with programmed offset value	Use inputs (user selects how many lines, 1-7) and an offset value programmed into flash. This offset value is added to the value set by the inputs to determine the address. Programmed value could be zero so that inputs alone determine address. Ignore the CAN ADDR switch.
Use switch, input lines, and programmed offset value	Use switch, inputs (user selects how many lines, 0-3), and an offset value programmed in to flash memory. Switch provides the lower four bits; inputs provide the next 0 - 3 bits. The offset is added to the value set by the switch and inputs to determine address. If programmed value is zero, switch and inputs alone determine address.

For more information on CAN addressing, see CAN Interface (p. 112).

For more information on CAN communications see Communication (p. 30).

For more information on CANopen operations, see the following Copley Controls documents:

- *CANopen Programmer's Manual*
- *CML Reference Manual*
- *Copley Motion Objects Programmer's Guide*

2.7: Limit Switches

2.7.1: Use Digital Inputs to Connect Limit Switches

Limit switches help protect the motion system from unintended travel to the mechanical limits. Any of the digital inputs 2-12 can be can be programmed as positive or negative limit switch inputs. An input can also be programmed as a home limit switch for homing operations.

The amplifier also supports software limits, as configured in Homing Functions Settings (p. 164).

2.7.2: How the Amplifier Responds to Limit Switch Activation

In all modes, in response to an active limit switch:

- The amplifier status indicator flashes green at fast rate.
- A warning is displayed on CME 2 Control Panel and the CME 2 Control Panel limit indicator turns red.
- (Optional) Appropriately configured digital outputs go active. See Custom Digital Output Settings: Custom Event (p. 104).
- The amplifier stops driving motion in the direction of an active limit switch, with the mode-dependent and configurable variations described below.

Mode	Response to Active Limit Switch
Servo Current Servo Velocity	Amplifier stops driving motion in the direction of the active limit switch. The amplifier will drive motion in the opposite direction if commanded.
Stepper or Servo Position	Responses depend on the setting of Hold position when limit switch is active (p. 101). Hold Position… not set: The amplifier aborts the trajectory in progress and stops the axis, using reverse current only, at the Abort Deceleration rate. After the axis has stopped the amplifier will not drive current in the direction of the activated limit switch. In any command mode other then a digital input mode, the amplifier will respond to commands in the opposite direction. If in digital input mode, the amplifier must be disabled and re-enabled to command motion in the opposite direction. Hold Position… set: The amplifier aborts the trajectory in progress and stops the axis at the Abort Deceleration rate. After the axis stops the amplifier servos to hold that position. The amplifier will respond to commands in the opposite direction.

WARNING

WARNING: Limit switches may be disabled.

If the amplifier is switched back to current or velocity mode with Hold position when limit switch is active (p. 101) set, the limit switches will no longer function.

Failure to heed this warning can cause equipment damage.

2.8: Brake Operation

2.8.1: Digital Output Controls Brake

Many control systems employ a brake to hold the axis when the amplifier is disabled. Any of the digital outputs can be programmed for brake control.

2.8.2: Event- and Mode-Specific Brake/Stop Sequences

Braking sequences vary depending on the amplifier's operating mode.

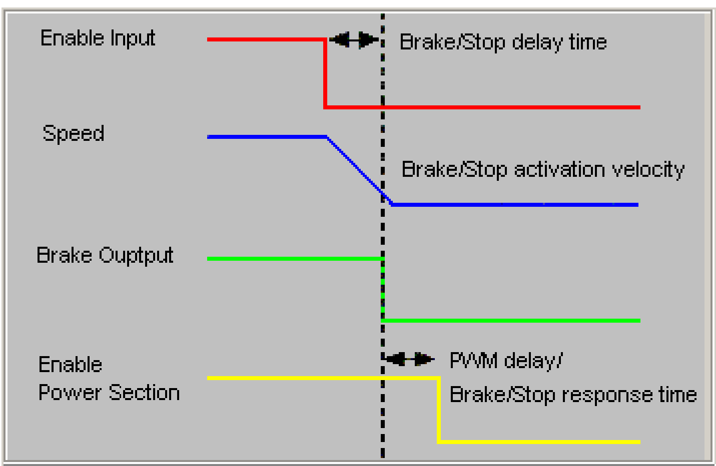
In current mode, disabling the amplifier activates the brake output and disables the amplifier output stages immediately.

In position or velocity mode, a hardware or software disable starts a sequence of events:

- The motor begins to decelerate (at *Abort Deceleration* rate in position mode or *Fast Stop Ramp* rate in velocity mode). At the same time, the *Brake/Stop Delay Time* count begins.
- When the motor slows to *Brake/Stop Activation Velocity* OR the *Brake/Stop Delay Time* expires, the brake output activates and *PWM Delay Brake/Stop Response Time* count begins.
- When response time has passed, the amplifier's output stages are disabled.

2.8.3: Brake Settings

As shown below, the brake settings available in position and velocity mode provide control over the braking sequence.



The pre-braking delay (controlled by the deceleration rate and delay timer) allows the amplifier to slow the motor before applying the brake. *PWM Delay Brake/Stop Response Time* makes it possible to ensure the brake has time to lock in before disabling the power section.

2.9: Status Indicators

2.9.1: Amplifier and CAN Interface Status Indicators

Stepnet Panel (STP): The amplifier's status indicator is a bicolor LED labeled STATUS on the J5 connector. The CAN interface status indicator is a bicolor LED on the J6 connector.

Stepnet Panel AC (STX): The amplifier's status indicator is a bicolor LED labeled STATUS on the front panel. The CAN interface status indicator is a bicolor LED on the J4 connector.

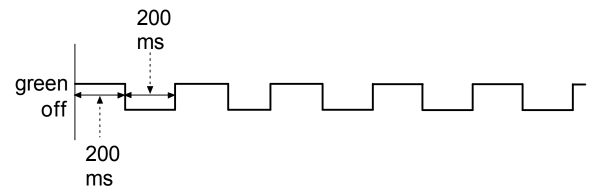
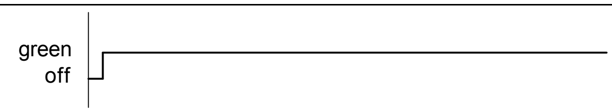
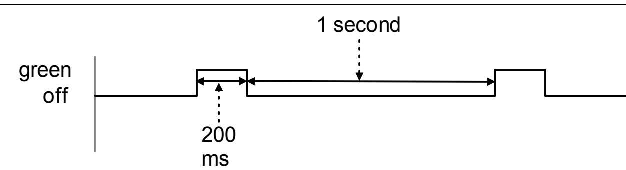
2.9.2: Amplifier Status Indicator Operation

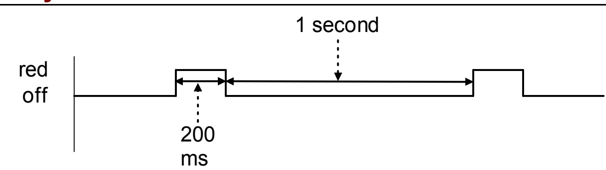
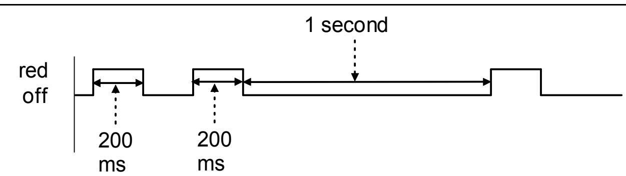
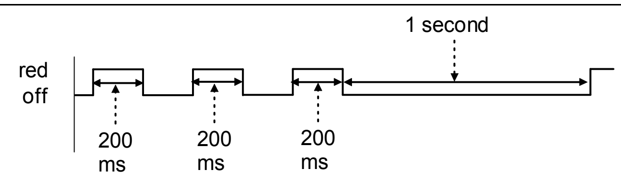
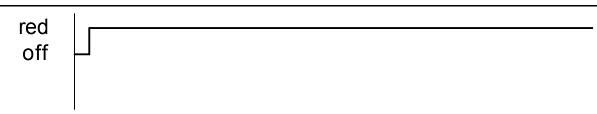
Amplifier status indicator color/blink codes are described below.

Color/Blink Code	Meaning
Not illuminated	No power to amplifier.
Steady green	Amplifier is enabled and operational.
Slow-blinking green	Amplifier is disabled. No faults or warnings are active.
Fast-blinking green	A limit switch is active. The amplifier is enabled.
Steady red	A non-latched fault has occurred.
Blinking red	A latched fault has occurred.

2.9.3: CAN Interface Status Indicator Operation

The amplifier status indicator color/blink codes comply with CAN Indicator Specification 303-3 as described below. Note that green and red codes are often interlaced, each indicating a different set of conditions. The green codes indicate the CANopen state machine mode of operation (pre-operational, operational, or stopped). The red codes indicate the status of the physical bus (warning or error conditions).

CANopen State Machine Mode of Operation		
Indicator	**State**	**Diagram**
Blinking green	Pre-operational.	
Steady green	Operational	
Single flash green	Stopped	

Physical Bus Status		
Single flash red	Warning Limit Reached	
Double flash red	Error Control Event	
Triple flash red	Sync Error	
Steady red	Bus Off	

In addition, the CAN status indicator is turned off when the CAN node ID selector (CAN ADDR) is set to 0. A setting of 0, which is an invalid CAN address, shuts down most operations on the CAN interface, and the light is shut off to indicate this status.

2.10: Protection

2.10.1: Faults

Overview

Stepnet detects and responds to a set of conditions regarded as faults, such as amplifier over temperature and excessive following error. When any fault occurs, with the exception of a following error, the amplifier's PWM output stage is disabled, the fault type is recorded in the amplifier's internal error log (which can be viewed with CME 2), and the status LED changes to indicate a fault condition exists. A digital output can also be programmed to activate on a fault condition. The following error fault behaves with slight differences, as described in Following Error Fault Details (p. 40).

The amplifier's PWM output stage can be re-enabled after the fault condition is corrected and the amplifier faults are cleared. The process for clearing faults varies depending on whether the fault is configured as non-latched or latched.

The fault-clearing descriptions below apply to all faults except for the following error fault, which is described in Following Error Fault Details (p. 40).

Clearing Non-Latched Faults

The amplifier clears a non-latched fault, without operator intervention, as soon as the fault condition is corrected.

DANGER

Risk of unexpected motion with non-latched faults.

After the cause of a non-latched fault is corrected, the amplifier re-enables the PWM output stage without operator intervention. In this case, motion may re-start unexpectedly. Configure faults as latched unless a specific situation calls for non-latched behavior. When using non-latched faults, be sure to safeguard against unexpected motion.

Failure to heed this warning can cause equipment damage, injury, or death.

Clearing Latched Faults

A latched fault is cleared only after the fault has been corrected and at least one of the following actions has been taken:

- power-cycle the amplifier
- cycle (disable and then enable) an enable input that is configured as *Enables with Clear Faults* or *Enables with Reset*
- access the CME 2 *Control Panel* ( ) and press **Clear Faults** or **Reset**
- clear the fault over the CANopen network

Example: Non-Latched vs. Latched Faults

For example, the amplifier temperature reaches the fault temperature level and the amplifier reports the fault and disables the PWM output. Then, the amplifier temperature is brought back into operating range. If the *Amplifier Over Temperature* fault is not latched, the fault is automatically cleared and the amplifier's PWM outputs are enabled. If the fault is latched, the fault remains active and the amplifier's PWM outputs remain disabled until the faults are specifically cleared (as described above).

Fault Descriptions

The set of possible faults is described below. For details on limits and ranges, see Fault Levels (p. 52).

Fault Description	Fault Occurs When…	Fault is Corrected When…
*Amplifier Over Temperature	Amplifier's internal temperature exceeds specified temperature.	Temperature falls below specified temperature.
Motor Phasing Error (in servo mode only)	Motor fails to properly phase initialize.	Amplifier is reset and re-enabled.
*Feedback error (STX only)	Under voltage condition detected on output of the internal +5 Vdc supply used to power the encoder.	Encoder power returns to specified voltage range.
	Differential encoder signal fault.	Line errors are corrected.
*Motor Over Temperature	Motor over-temperature input changes state to indicate an over-temperature condition.	Input changes back to normal operating state.
Under Voltage	+HV voltage falls below specified voltage limit.	+HV voltage returns to specified voltage range.
Over Voltage	+HV voltage exceeds specified voltage limit.	+HV voltage returns to specified voltage range.
*Following Error (with encoder only)	User set following error threshold exceeded.	See Position and Servo Velocity Errors (p. 39).
*Short Circuit Detected	Output to output, output to ground, internal PWM bridge fault.	Short circuit has been removed.
Over Current (Latched)	Output current I^2T limit has been exceeded.	Amplifier is reset and re-enabled.
Command Input Fault	PWM command at 0 or 100% duty cycle with the **Allow 100% Output** option disabled. PWM frequency out of range.	Proper PWM input command is restored.
*Latched by default.		

STX Encoder Loss Detection

The Stepnet Panel AC (STX) amplifier incorporates Encoder Loss Detection circuitry that continuously monitors the integrity of the differential encoder feedback signals. When a fault in any of the differential pairs is detected, a feedback error occurs. To enable or disable this protection, see Enter Motor/Feedback/Brake Settings Manually (p. 96).

In applications where Encoder Loss Detection is enabled and the encoder does not have an index channel or the index channel is not wired to the amplifier, the amplifier’s index channel connector pins must be jumpered as shown in Stepnet Panel AC (STX) J6 Quad A/B Incremental Encoder Wiring Diagram – No Index (p. 76).

2.11: Position and Servo Velocity Errors

2.11.1: Error-Handling Methods

In stepper mode with encoder or servo position mode, any difference between the limited position output of the trajectory generator and the actual motor position is a position error. The servo or stepper position loop uses complementary methods for handling position errors: following error fault, following error warning, and a position-tracking window.

Likewise, in servo velocity or servo position mode, any difference between the limited velocity command and actual velocity is a velocity error. The servo velocity loop uses a velocity tracking window method to handle velocity errors. (There is no velocity error fault.)

2.11.2: Following Error Faults

When the position error reaches the programmed *fault* threshold, the amplifier immediately faults. (The following error fault can be disabled.)
For detailed information, see Following Error Fault Details (p. 40).

2.11.3: Following Error Warnings

When the position error reaches the programmed *warning* threshold, the amplifier immediately sets the *following error warning bit* in the status word. This bit can be read over the CAN network. It can also be used to activate a digital output.

2.11.4: Position and Velocity Tracking Windows

When the position error exceeds the programmed *tracking window* value, a status word bit is set. The bit is not reset until the position error remains within the tracking window for the programmed *tracking time*. This bit can be read over the CAN network. It can also be used to activate a digital output.

In servo mode, a similar method is used to handle velocity errors.

For detailed information, see Tracking Window Details (p. 41).

2.11.5: Following Error Fault Details

Position Error Reaches Fault Level

As described earlier, position error is the difference between the limited position output of the trajectory generator and the actual position. When position error reaches the programmed *Following Error Fault* level, the amplifier faults (unless the following error fault is disabled.) As with a warning, a status bit is set. In addition, the fault is recorded in the error log.

Additional responses and considerations depend on whether the fault is non-latched or latched, as described below.

Amplifier Response to Non-Latched Following Error Fault

In servo mode, when a non-latched following error fault occurs, the amplifier drops into velocity mode and applies the Fast Stop Ramp deceleration rate to bring the motor to a halt. The amplifier PWM output stage remains enabled, and the amplifier holds the velocity at zero, using the velocity loop.

In stepper mode, when a non-latched following error fault occurs, the current move is aborted and the amplifier decelerates at the Trajectory Abort Deceleration rate. The amplifier PWM output stage remains enabled and the Hold current is applied to the motor.

Resuming Operations After a Non-Latched Following Error Fault

The clearing of a non-latched following error depends on the amplifier's mode of operation. If the amplifier is operating as a CAN node, starting a new trajectory, using CANopen commands, will clear the fault and return the amplifier to normal operating condition. If the amplifier is receiving position commands from the digital inputs, then the amplifier must be disabled and then re-enabled using a hardware input or though CME 2 software commands. After re-enabling, the amplifier will operate normally.

Amplifier Response to a Latched Following Error Fault

When a latched following error fault occurs, the amplifier disables the output PWM stage without first attempting to apply a deceleration rate.

Resuming Operations After a Latched Following Error Fault

A latched following error fault can be cleared using the steps used to clear other latched faults:

- power-cycle the amplifier
- cycle (disable and then enable) an enable input that is configured as *Enables with Clear Faults* or *Enables with Reset*
- access the CME 2 *Control Panel* () and press **Clear Faults** or **Reset**
- clear the fault over the CANopen network

2.11.6: Tracking Window Details

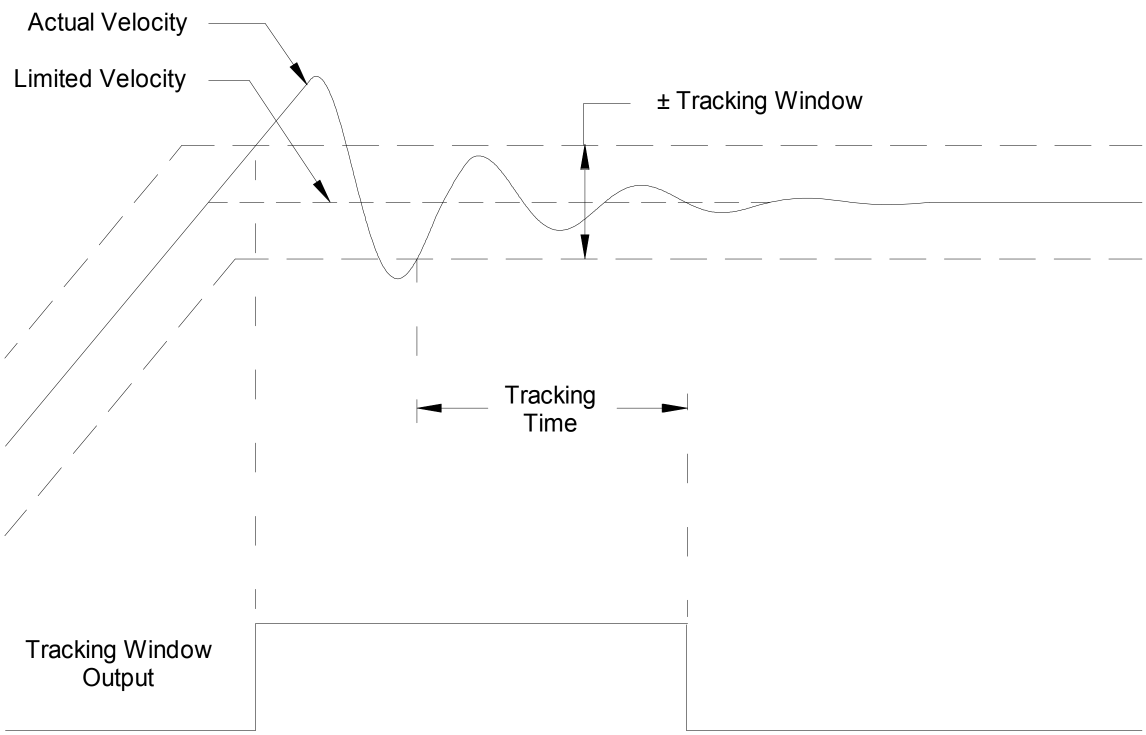
Proper Tracking Over Time

As described earlier, position error is the difference between the limited position output of the trajectory generator and the actual position. In servo mode, velocity error is the difference between commanded and actual velocity.

When the position or velocity error exceeds the programmed *tracking window* value, a status word bit is set. The bit is not reset until the error remains within the tracking window for the programmed *tracking time*.

Servo Mode Velocity Tracking Illustration

The following diagram illustrates the use of tracking window and time settings in servo velocity mode.



2.12: Inputs

2.12.1: Digital Inputs

The amplifier has 12 digital inputs (IN1-IN12). IN1 is always used as an enable input. IN2-IN12 are fully programmable. See Digital Input Functions (p.102).

2.12.2: Input Filters

Two types of input RC filters are used: GP (general-purpose) and HS (high-speed). The digital command inputs, such as Count Up/Count Down and PWM, are wired to inputs having the HS filters. Inputs with the GP filters are used for general-purpose logic functions, limit switches, and the motor temperature sensor.

2.12.3: Debounce Time

To prevent undesired multiple triggering caused by switch bounce upon switch closures, each input can be programmed with a debounce time. The programmed time specifies how long an input must remain stable at a new state before the amplifier recognizes the state.

The programmed debounce time is ignored if the input is programmed as a digital position command, PWM input or encoder input.

2.12.4: Configure for Pull Up/Pull Down Resistors by Groups

Pre-defined groups of inputs can be programmed to have either an internal pull up or pull down resistor. See Stepnet Panel (STP) J3 Pin Description (p. 62)
or Stepnet Panel AC (STX) J7 Pin Description (p. 79) for groupings.

2.13: Outputs

2.13.1: Digital Outputs

The amplifier has four programmable digital outputs. These outputs are open-drain MOSFETs, each with a pull-up resistor, in series with a diode, connected to the amplifier's internal +5 Vdc supply. This design allows the outputs to be directly connected to optically isolated PLC inputs that reference a voltage higher than +5 Vdc, typically +24 Vdc. The diode prevents current flow between the +24 Vdc supply and the internal +5 Vdc supply though the pull-up resistor. This current, if allowed to flow, could turn on the PLC input, giving a false indication of the amplifier's true output state.

The outputs require an external fly-back diode to be installed across any inductive loads, such as relays, that are connected to them.

NOTE: Outputs will remain off (high) after powering up the amplifier, for a maximum delay of 2 seconds. They will then assume their programmed states. The outputs will also turn off during an amplifier reset and return to their programmed state after a maximum delay of 0.5 seconds.

CHAPTER
3: SPECIFICATIONS

This chapter describes the amplifier specifications for the Stepnet Panel (STP) and Stepnet Panel AC (STX) amplifiers. Contents include:

3.1: Agency Approvals

Stepnet Panel (STP) and Stepnet Panel AC (STX) Agency Approvals
CE Compliance: EN 55011, 2007 • CiSPR 11 : 2003/A2 : 2006 • Limits and Methods of Measurement of Radio Disturbance Characteristics of Industrial, Scientific, and Medical (ISM) Radio Frequency equipment EN 61000-6-1 : 2007 • Electromagnetic Compatibility generic immunity Requirements (Following the provisions of EC Directive 2004/108/EC [EMC Directive]) EN 61010-1 : 2001 • Safety Requirements for Electrical Equipment for Measurement, Control, and Laboratory use. (Following the provisions of EC Directive 2006/95/EC [Low Voltage Directive])
UL 508C 3rd Ed.: 2002 UL Standard for Safety for Power Conversion Equipment
UL 61010-1 2nd Ed.: 2004 Safety Requirements for Electrical Equipment for Measurement, Control and Laboratory Use

3.2: Power Input

3.2.1: Stepnet Panel (STP) Power Input

Specification	Model	
	STP-075-07	STP-075-10
HV min to HV max	+20 to +75 Vdc, transformer-isolated	
Peak current	8 Adc (1 Sec)	11 Adc
Continuous current	5.5 Adc	11 Adc
Auxiliary power (optional)	+20 to +75 Vdc 3W typical when auxiliary power > HV 0W when auxiliary power < HV	

3.2.2: Stepnet Panel AC (STX) Power Input

Specification	Model	
	STX-115-07	STX-230-07
Mains voltage	100 – 120 Vac	100 – 240 Vac
Mains frequency	50-60 Hz	
Mains current	8 Arms, continuous	
Logic supply (required)	20-32 Vdc @ 500 mAdc maximum	

3.3: Power Output

3.3.1: Stepnet Panel (STP) Power Output

Specification	Model	
	STP-075-07	STP-075-10
Boost / peak current	7 Adc (5 Arms, sinusoidal) ± 5%	10 Adc (7 Arms, sinusoidal) ± 5%
Boost / peak time	1 Sec	n/a
Run / continuous current	5 Adc (3.54 Arms, sinusoidal)± 5%	10 Adc (7 Arms, sinusoidal) ± 5%
Efficiency	97% @ Full rated voltage and continuous output current.	

3.3.2: Stepnet Panel AC (STX) Power Output

Specification	Model	
	STX-115-07	STX-230-07
Boost / peak current	7 Adc (5 Arms, sinusoidal) ± 5%	7 Adc (5 Arms, sinusoidal) ± 5%
Boost / peak time	1 Sec	1 Sec
Run / continuous current	5 Adc (3.54 Arms, sinusoidal) ± 5%	5 Adc (3.54 Arms, sinusoidal) ± 5% (Note 2)
Efficiency	97% @ Full rated voltage and continuous output current.	

NOTES:

1. Current ratings are for current vector produced by currents flowing in A and B phases (90º phase difference between phases).
2. Mounting to heat sink required for operation at continuous current.

3.3.3: Power Output Configuration (STP and STX)

Type	Dual MOSFET H-bridges, 15 kHz center-weighted PWM, space-vector modulation
PWM ripple frequency	30 kHz
Minimum load inductance	STX > 200 µH per phase STP > 400 µH per phase Note: Contact factory if lower inductance is required.

3.4: Control Loops

Type Servo mode: current Servo mode: velocity Stepper or servo mode: position	100% digital.
Sampling rate (time) Servo mode: current Servo mode: velocity Stepper or servo mode: position	 15 kHz (67 µs) 3 kHz (333 µs) 3 kHz (333 µs)
Current loop small signal bandwidth	> 2 kHz (Tuning and load impedance dependent)
Servo mode velocity loop filters Type Frequency range	 Programmable Low Pass, 1 Pole Low Pass, Butterworth, 2 Poles Bi-Quadratic, 2 Poles & 2 Zeros Programmable 20 - 1500 Hz
Voltage compensation	Changes in HV or Mains voltage does not affect current-loop bandwidth

3.5: Stepnet Panel AC (STX) Internal Regen Circuit

Specification	**Model**	
	STX-115-07	**STX-230-07**
Type	Internal MOSFET dissipater	
Continuous power	40 W	
Peak power	80 W	
Turn on voltage(± 2%)	Bus voltage > 195 Vdc	Bus voltage > 390 Vdc
Turn off voltage(± 2%)	Bus voltage < 190 Vdc	Bus voltage < 380 Vdc

3.6: Digital Command Input

Digital position command Stepper or servo mode	Step and direction, Count up/ count down maximum rate	STP = 1 MHz max pulse rate STX = 1.5 MHz max pulse rate
	Quadrature A/B encoder maximum rate	5 M line/sec (20 M count/sec after quadrature)
Digital current & velocity command Servo mode only	PWM frequency range	1 kHz - 100 kHz
	PWM minimum pulse width	220 nSec

3.7: Stepnet Panel AC (STX) Analog Command Input

Channels	1
Type	Differential, non-isolated
Measurement range	±10 Vdc
Maximum voltage Differential Input to Ground	 ±10 Vdc ±10 Vdc
Input impedance	5 kΩ
Resolution	12 Bit
Accuracy	± 2% of reading, ± 0,5% of range
Bandwidth	7 kHz
Sample period	200 μSec
Function	Current, velocity, or position commands.
Analog input filter Type Frequency range	 Programmable: Low Pass, 1 Pole Low Pass, Butterworth, 2 Poles Bi-Quadratic, 2 Poles & 2 Zeros Programmable: 20 - 1500 Hz

3.8: Digital Inputs

3.8.1: Stepnet Panel (STP) Digital Inputs

Channels	12 5 general-purpose 7 high-speed	
Function	IN1 dedicated to enable input function IN2 - IN12 programmable	
Logic low input voltage	< +1.35 Vdc	
Logic high input voltage	> +3.65 Vdc	
Scan time	333 μSec (pulse and direction, PWM input, and secondary encoder are handled at DSP clock rate of 25 nSec)	
Debounce	Digital, programmable from 0 - 10,000 mSec	
General purpose inputs 1 - 5	Type	74HC14 Schmitt trigger w/ RC filter Inputs 1 – 4, RC time constant = 33uSec Input 5, RC time constant = 22uSec 10 kΩ resistor programmable as pull down or pull up to internal +5 Vdc.
	Input voltage range	0 V - +30 Vdc
High speed inputs 6 - 12	Type	74HC14 Schmitt trigger w/ RC filter RC time constant = 0.1uSec 10 kΩ resistor programmable as pull down or pull up to internal +5 Vdc.
	Input voltage range	0 V - +12 Vdc

3.8.2: Stepnet Panel AC (STX) Digital Inputs

Channels	12 7 general-purpose 5 high-speed	
Function	IN1 dedicated to enable input function IN2 – 11 programmable IN12 motor over temperature, may be reprogrammed	
Scan time	333 µSec (pulse and direction, PWM input, and secondary encoder are handled at DSP clock rate of 25 nSec)	
Debounce	Digital, programmable from 0 - 10,000 mSec	
General purpose inputs 1 – 4, 10 ,11	Type	74HC14 Schmitt trigger w/ RC filter RC time constant = 330uSec 10 kΩ resistor programmable as pull down or pull up to internal +5 Vdc.
	Input voltage range	0 V - +24 Vdc
	Logic low input voltage	< +1.35 Vdc
	Logic high input voltage	> +3.65 Vdc
High speed input 5	Type	74HC14 Schmitt trigger w/ RC filter RC time constant = 0.1uSec 10 kΩ resistor programmable as pull down or pull up to internal +5 Vdc.
	Input voltage range	0 V - +12 Vdc
	Logic low input voltage	< +1.35 Vdc
	Logic high input voltage	> +3.65 Vdc
High speed inputs 6 -9	Type	RS422 line receiver w/ RC Filter RC time constant = 0.1 uSec 10 kΩ resistor programmable as pull down or pull up to internal +5 Vdc. May be programmed as 4 independent inputs or 2 differential inputs
	Input voltage range	0 V - +12 Vdc
	Logic low input voltage	< +2.30 Vdc
	Logic high input voltage	> +2.45 Vdc
General purpose input 12	Type	74HC14 Schmitt trigger w/ RC filter RC time constant = 500uSec 5 kΩ resistor pull up to internal +5 Vdc.
	Input voltage range	0 V - +24 Vdc
	Logic low input voltage	< +1.35 Vdc
	Logic high input voltage	> +3.65 Vdc

3.9: Digital Outputs

Channels	4
Type STP 1 – 4 STX 1 – 3 STX 4 (Brake)	 Current-sinking MOSFET, open-drain with 1 kΩ pullup to internal +5 Vdc through diode Opto-isolated, current sinking MOSFET with flyback diode to 24Vdc
Maximum voltage	+30 Vdc
Low level output resistance	< 0.1 Ω
Function	Programmable
Maximum sink current STP 1 - 4 STX 1 – 3 STX 4	 1A, Total current of outputs 1 – 4 not to exceed 2A 1A, Total current of outputs 1 - 3 not to exceed 1A 1A

3.10: Encoder Power Supply Output

Voltage output	+5 Vdc ±5%
Maximum current output	250 mA
Short circuit protection, STX only	Fold-back current limiting Note: collapsing this supply will put the amplifier in a fault condition.
Function	Provides power for motor encoder.

3.11: Incremental Quadrature Encoder Inputs

3.11.1: Incremental Differential Encoder Inputs

Channels	3
Type	Differential RS-422 line receiver, Non-isolated RC filter
Signals	A, /A, B, /B, X*, /X*
Common mode Vin range	±7 Vdc
Differential input threshold	±0.2 Vdc
Differential input impedance	121 Ω
Maximum frequency	5 MHz Line (20 Mcount/sec)
Function	Incremental encoder required for servo mode of operation or for position monitoring and correction in stepper mode.
* X is equivalent to Marker, Index, or Z channels, depending on the encoder manufacturer. This channel is only required in certain homing modes.	

3.11.2: Stepnet Panel AC (STX) Single Ended Encoder Inputs

Channels	3
Type	Single ended 5V CMOS, Non-isolated RC filter, 2 KΩ pull up to 5V
Signals	A, B, X*
Vin Low	<1.35 V
Vin High	>3.65 V
Vin Maximum	+10 Vdc
Vin Minimum	-7 Vdc
Maximum frequency	1 MHz Line (4 Mcount/sec)
Function	Incremental encoder required for servo mode of operation or for position monitoring and correction in stepper mode.
* X is equivalent to Marker, Index, or Z channels, depending on the encoder manufacturer. This channel is only required in certain homing modes.	

3.12: Stepnet Panel AC (STX) Multi-Mode Port

Channels	3
Type	Bi-Directional, differential RS-422 Non-isolated
Signals	A, /A, B, /B, X, /X
Common mode Vin range	±7 Vdc
Differential input threshold	±0.2 Vdc
Termination resistance	None
Function Programmable	 Output Mode Buffered primary incremental encoder Input Mode Current / velocity mode, PWM input Position mode, digital command input
Maximum frequency Output mode Buffered encoder Input Mode PWM input Digital command	 5 MHz Line (20 Mcount/sec) 100Khz 5 MHz (50% Duty Cycle)

3.13: Serial Interface

Channels	1
Type	RS-232
Signals	Rxd, Txd, Gnd
Baud rate	9,600 to 115,200 (defaults to 9600 on power up or reset)
Data format	N, 8, 1
Protocol	Binary or ASCII format
Function	Amplifier set up, control, and diagnostics

3.14: CAN Interface

Channels	1 (optically isolated from amplifier circuits)
Connectors	2 eight-position modular (RJ-45 style) wired as per CAN Cia DR-303-1, V1.1 One connector for signal input. Second connector for daisy chaining to next node.
Signals	CAN H, CAN L, CAN Gnd (CAN Power Pass though only)
Format	CAN V2.0b physical layer for high-speed connections compliant
Protocol	Motion Control Device Under DSP-402 of the CANopen DS-301 V4.01 (EN 50325-4) Application Layer
Supported modes	Profile Torque, Profile Velocity, Profile Position, Interpolated Position, and Homing
Node address selection	16-position rotary switch on front panel OR programmable digital inputs OR stored in flash memory OR combination of above.
Bus termination	External 121 Ω resistor across CAN-H and CAN-L when termination plug is installed in second connector.
Function	Real-time motion control

3.15: Status Indicators

Amplifier status	Stepnet Panel (STP): LED is integrated in connector J5. Stepnet Panel AC (STX): LED on front panel.
CAN status	Stepnet Panel (STP): LED is integrated in connector J6. Stepnet Panel AC (STX): LED is integrated in connector J4 Conforms to CAN Indicator Specification CiA DR-303-3.

3.16: Fault Levels

Amp over temperature	> 70 °C
DC bus under voltage	Stepnet Panel (STP): < +20 Vdc Stepnet Panel AC (STX): < +60 Vdc
DC bus over voltage	Stepnet Panel (STP): > +90 Vdc Stepnet STX -115-07: > +200 Vdc Stepnet STX-230-07: > +400 Vdc
Encoder power STX only	<4.55 Vdc

3.17: Power Dissipation

3.17.1: Stepnet Panel (STP) Power Dissipation

		STP-075-07	**STP-075-10**
Output Current	**+HV**	**Dissipation**	
0 Adc	75 Vdc	3 W	
Maximum continuous	25 Vdc	6.0 W	
	75 Vdc	7.5 W	

3.17.2: Stepnet Panel AC (STX) Power Dissipation

	STX-115-07	**STX-230-10**
Output Power		
0 Adc	1W	4W
Maximum continuous	30W	40W

3.18: Thermal Impedance

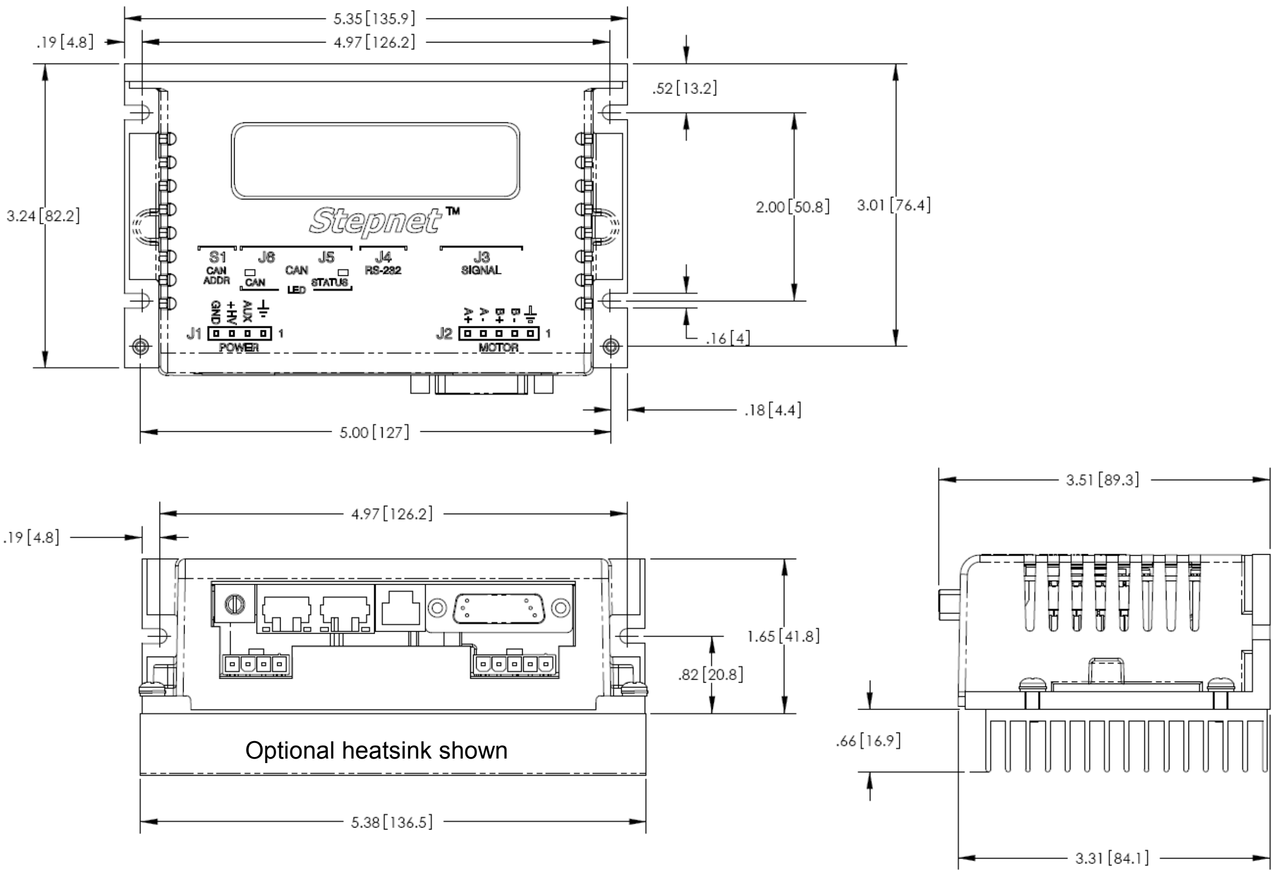
See C: Thermal Considerations (p. 173).

3.19: Mechanical and Environmental

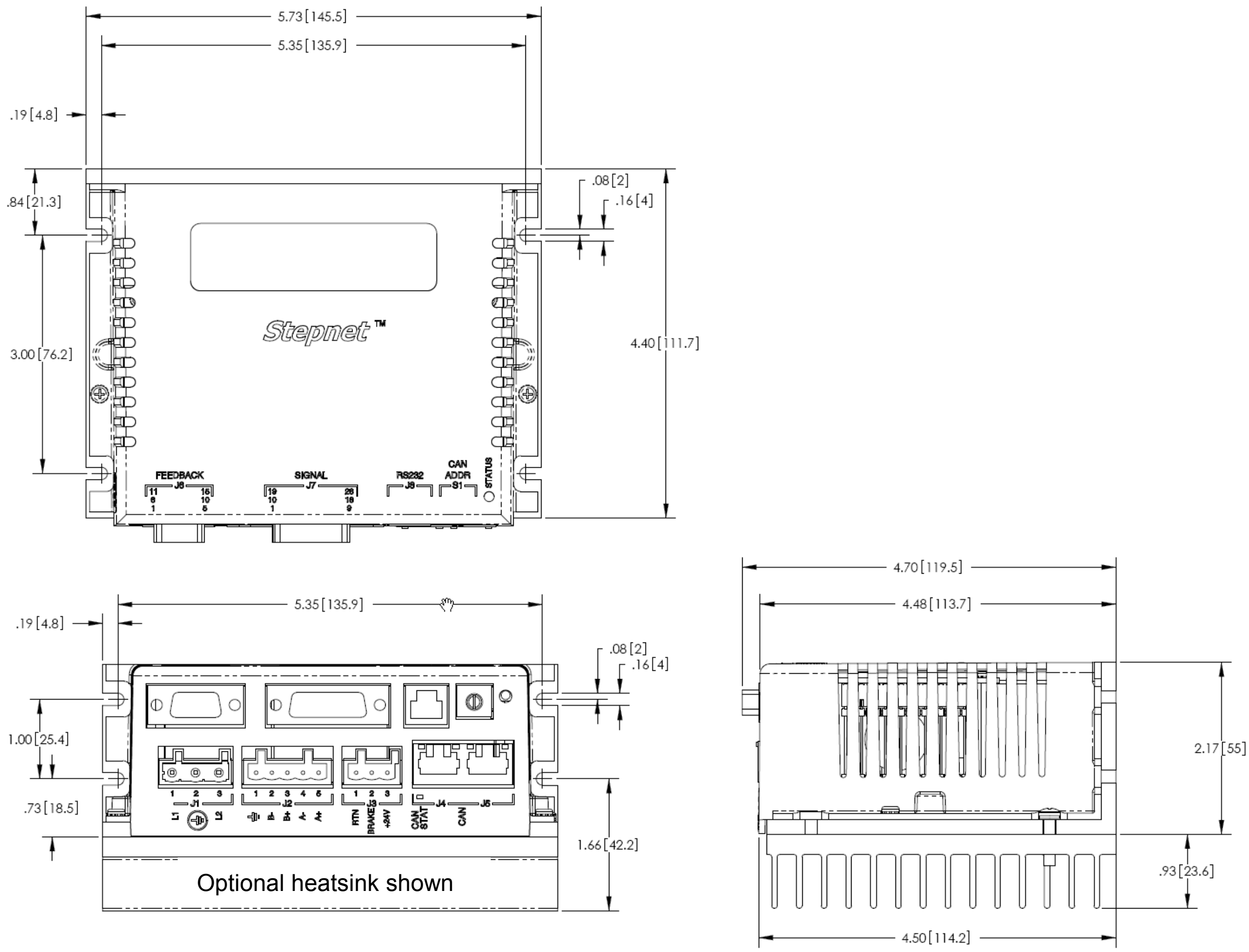
	Stepnet Panel (STP)	Stepnet Panel AC (STX)
Size; inches [mm] (without heatsink)	5.35 x 3.51 x 1.65 [135.9 x 89.3 x 41.8] See Stepnet Panel (STP) Dimensions (p. 54)	5.73 x 4.70 x 2.17 [145.5 x 119.5 x 55.0] See Stepnet Panel AC (STX) Dimensions (p. 55)
Weight Without heat sink With heat sink	 0.94 lb (0.43 kg) 1.34 lb (0.61 kg)	 1.73 lb (0.79 kg) 2.65 lb (1.20 kg)
Ambient temperature Storage Operating	 -40 to +85°C 0 to +50°C	 -40 to +85 °C 0 to 45 °C
Humidity	0% to 95%, non-condensing	
Contaminants	Pollution degree 2	
Environment	IEC68-2: 1990	
Cover material	Meets U.L. Spec 94 V-0 Flammability Rating	

3.20: Dimensions

3.20.1: Stepnet Panel (STP) Dimensions



3.20.2: Stepnet Panel AC (STX) Dimensions



CHAPTER
4: WIRING

This chapter describes the wiring of amplifier and motor connections. Contents include:

4.1: Stepnet Panel (STP) Wiring

4.1.1: Stepnet Panel (STP) General Wiring Instructions

Stepnet Panel (STP) Electrical Codes and Warnings

Be sure that all wiring complies with the National Electrical Code (NEC) or its national equivalent, and all prevailing local codes.

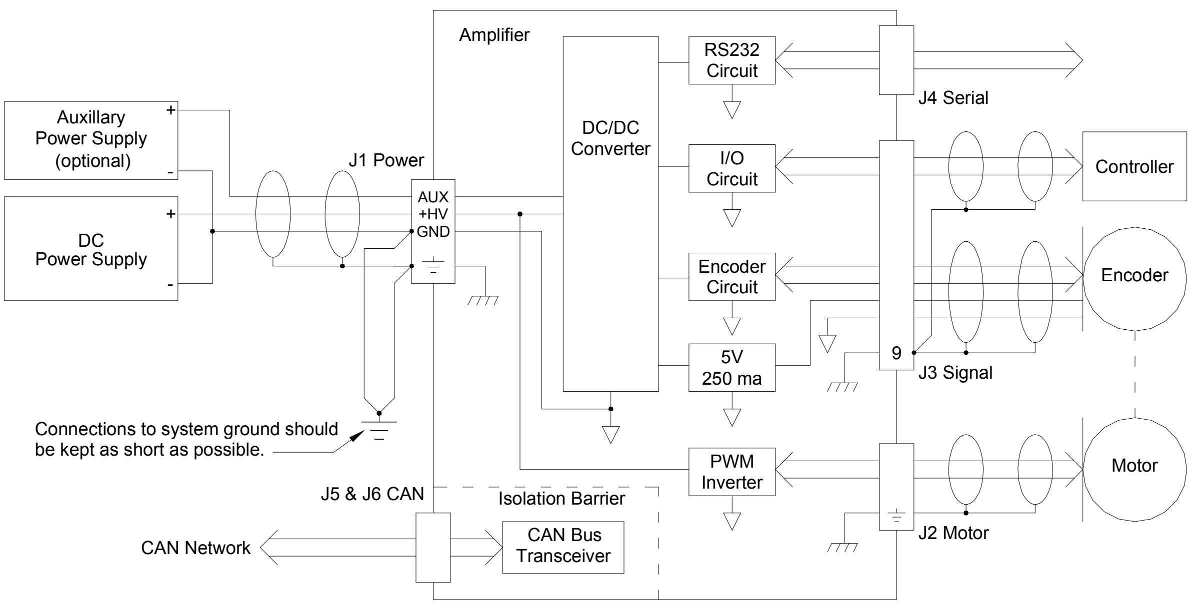
DANGER: Hazardous voltages.

Exercise caution when installing and adjusting.

Failure to heed this warning can cause equipment damage, injury, or death.

DANGER

Stepnet Panel (STP) Shielding and Grounding Considerations



As shown above, power and control circuits in the Stepnet share a common circuit-ground. Digital inputs are referenced to this common circuit-ground, as are the digital outputs, encoder inputs, and serial communications port. The CAN ports are electrically isolated from this common circuit-ground. The Stepnet case (Chassis Ground) is also isolated from any of the internal circuits.

The Stepnet "Gnd" terminal on the power connector (J1-4) should be connected to the users' system common ground, through the shortest path, so that signals between the controller and the Stepnet are at the same common potential, and to minimize noise. The system common ground should, in turn, be connected to an earthing conductor by the shortest wire possible so that the whole system is referenced to "earth."

The HV power supply should be connected to the system common ground only at the Stepnet power connector. In this way, voltage drops across the power conductors due to high motor currents will not appear at the Stepnet ground, but at the HV power supply negative terminal where they will have less effect.

Connection to the case is provided on the Chassis Ground terminal of the power connector (J1-1). This terminal should connect to the system chassis ground, keeping the wire as short as possible.

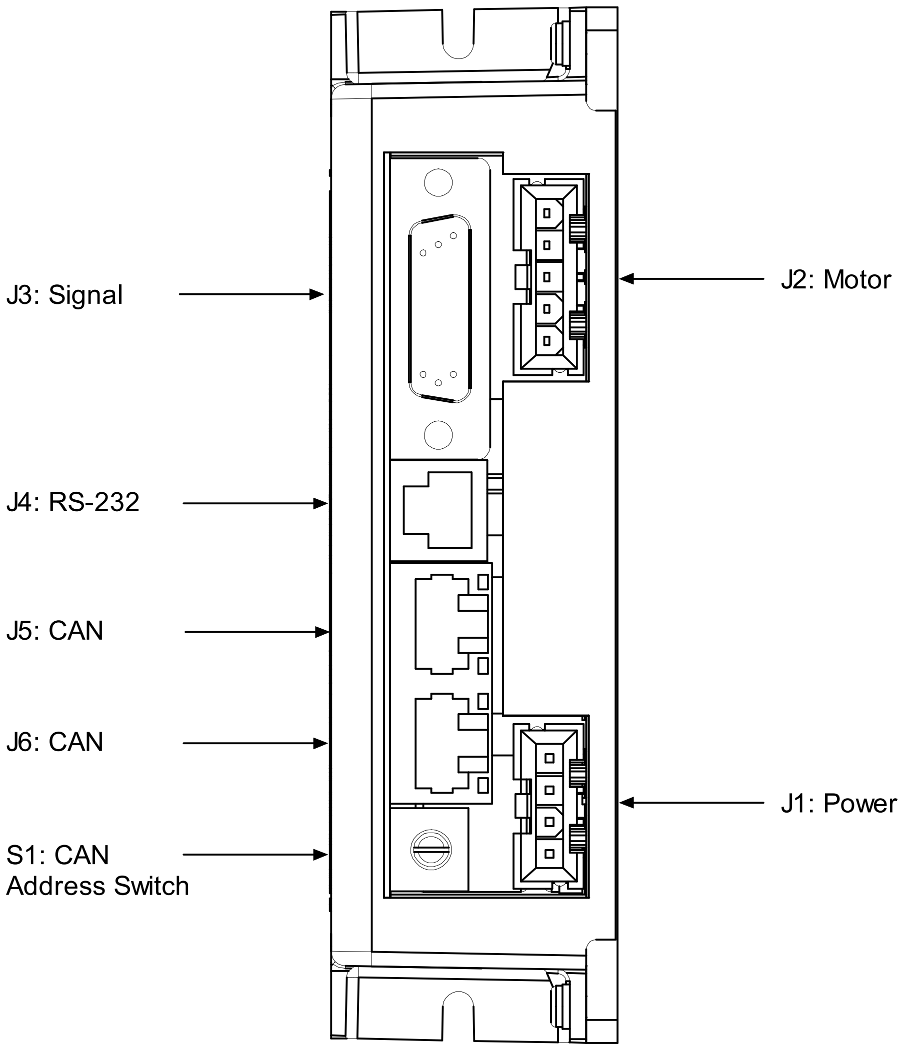
This maximizes the shielding effect of the case, and provides a path to ground for noise currents that may occur in the cable shields.

Stepnet Panel (STP) Shielding

It is recommended that connections to the Stepnet motor, power and signal connectors be made using shielded cables. Shields on cables reduce emissions from the amplifier and help protect internal circuits from interference due to external sources of electrical noise. The shields shown in the wiring diagrams are also required for CE compliance. Cable shields should be tied to earth or system ground. Provisions are made on each Stepnet connector for connecting the shield to the chassis ground of the Stepnet which in turn is connected to the system ground.

4.1.2: Stepnet Panel (STP) Connector Locations

Connector locations are shown below.



4.1.3: Stepnet Panel (STP) Power (J1)

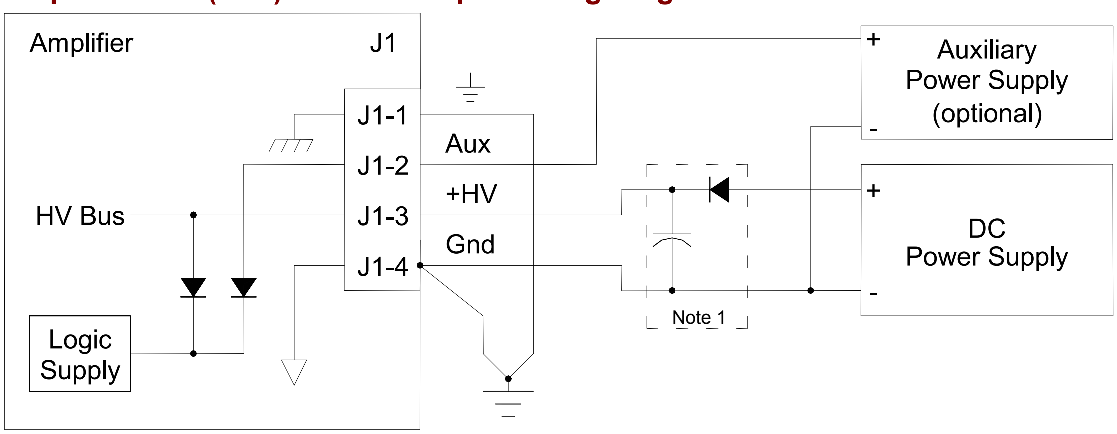
Stepnet Panel (STP) J1 Mating Connector

Description	Receptacle, Single Row 4 Position
Manufacturer part numbers	Housing; Molex 39-01-4041 Crimp Terminal: Molex 39-00-0039 (4 required)
Wire size	18 - 24 AWG
Connector housing and terminals are included in connector kit STP-CK	

Stepnet Panel (STP) J1 Pin Description

Pin	Signal	Function
1	Chassis Ground	Earth ground connection
2	Aux HV	Auxiliary power input
3	+HV	Power input
4	Ground	Power common

Stepnet Panel (STP) J1 Power Input Wiring Diagram



Note 1: Diode and capacitor should be installed if using a switching power supply.

4.1.4: Stepnet Panel (STP) Motor (J2)

Stepnet Panel (STP) J2 Mating Connector

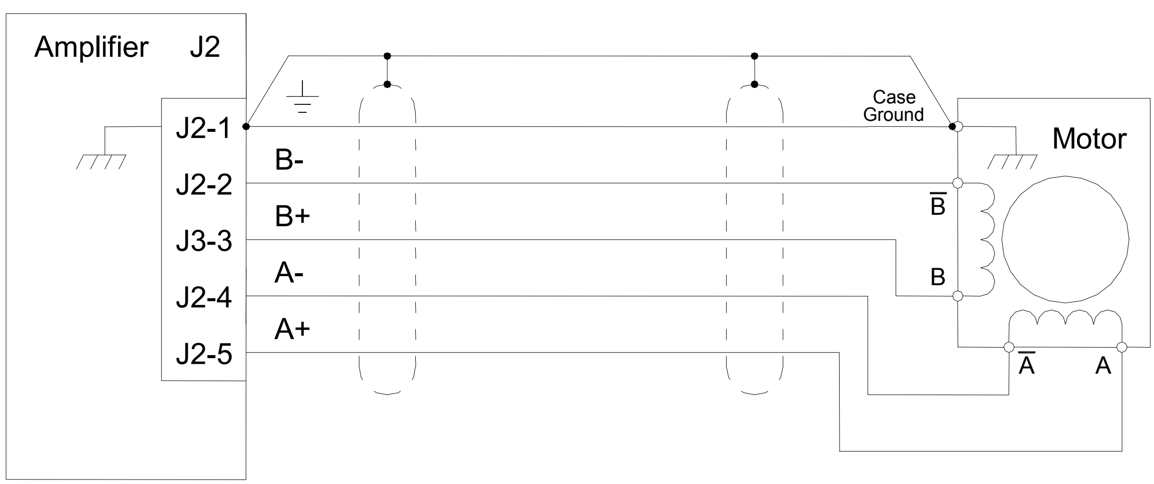
Description	Receptacle, Single Row 5 Position
Manufacturer part numbers	Housing; Molex 39-01-4051 Crimp Terminal: Molex 39-00-0039 (5 required)
Wire Size	18 - 24 AWG
Connector housing and terminals are included in connector kit STP-CK	

Stepnet Panel (STP) J2 Pin Description

Pin	Signal	Function
1	Chassis Ground	Motor frame ground and cable shield
2	Motor B-	Phase B- output of amplifier
3	Motor B+	Phase B+ output of amplifier
4	Motor A-	Phase A- output of amplifier
5	Motor A+	Phase A+ output of amplifier

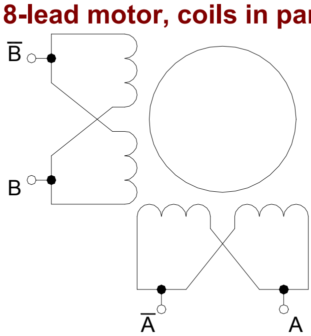
Stepnet Panel (STP) J2 Motor Wiring Diagram

Typical wiring for a 4-lead motor:

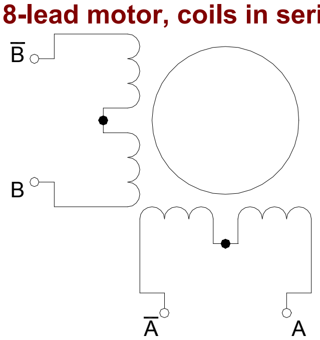


Typical wiring alternatives:

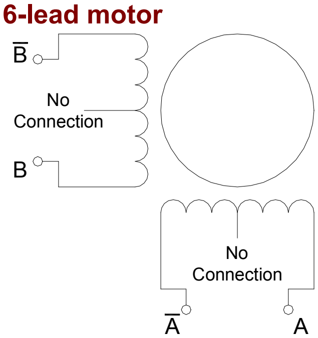
8-lead motor, coils in parallel



8-lead motor, coils in series



6-lead motor

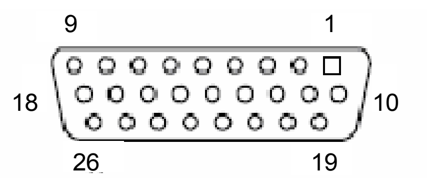


4.1.5: Stepnet Panel (STP) Signal (J3)

Stepnet Panel (STP) J3 Mating Connector

Description	Plug, High Density D-Sub, 26 Position
Manufacturer Part numbers	Connector, solder cup; Norcomp 180-026-102-001 Backshell: Norcomp: 979-015-020R121
Wire Size	22 - 26 AWG, shielded cable
Connector and backshell are included in connector kit STP-CK.	

Amplifier pin locations are shown here:



Stepnet Panel (STP) J3 Pin Description

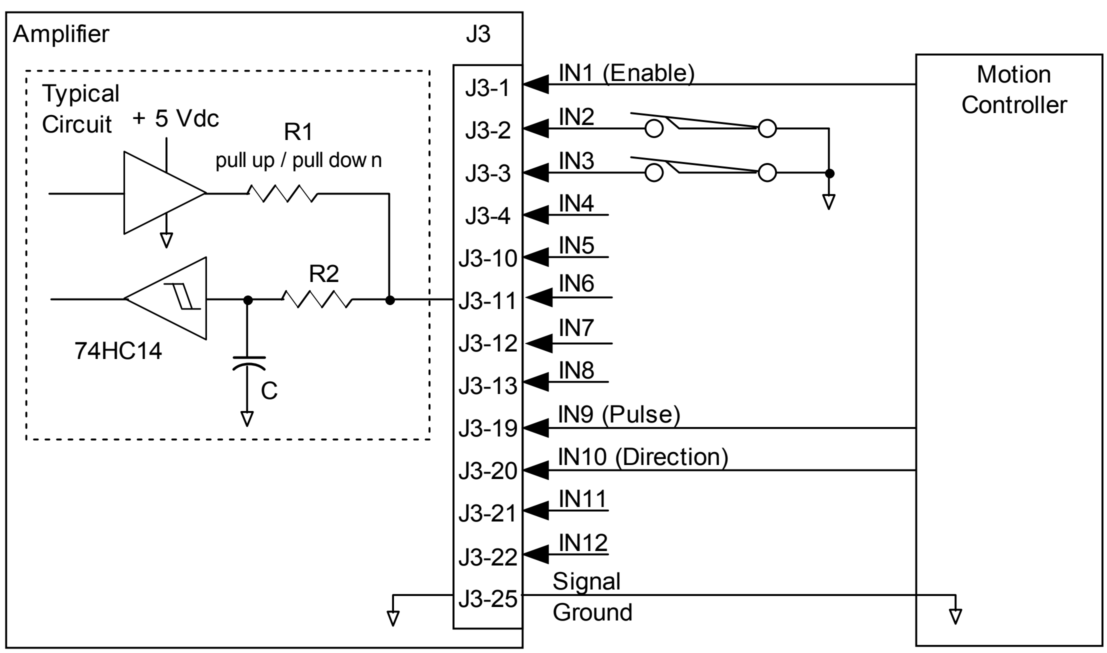
Pin	Signal	Function	Speed	Pull-Up/Pull-Down Group
1	IN1	Enable	Standard	Group 1
2	IN2	Programmable	Standard	Group 1
3	IN3	Programmable	Standard	Group 1
4	IN4	Programmable	Standard	Group 2
5	Encoder A	Motor incremental encoder input		
6	Encoder /A			
7	Signal Ground	Signal ground reference for input, outputs and Encoder +5V		
8	OUT1	General-purpose, programmable output		
9	Frame Ground	Frame Ground		
10	IN5	Programmable	Standard	Group 2
11	IN6	Mode Dependent	High	Group 3
12	IN7	Mode Dependent	High	Group 3
13	IN8	Mode Dependent	High	Group 3
14	Encoder B	Motor incremental encoder input		
15	Encoder /B			
16	+5V OUT	Encoder +5 Vdc power supply output. Total load current not to exceed 250 mA.		
17	OUT2	General-purpose, programmable output		
18	OUT4			
19	IN9	Mode Dependent	High	Group 4
20	IN10	Mode Dependent	High	Group 4
21	IN11	Mode Dependent	High	Group 4
22	IN12	Mode Dependent	High	Group 4
23	Encoder X	Motor incremental encoder input		
24	Encoder /X			
25	Signal Ground	Signal ground reference for input, outputs and encoder +5V		
26	OUT3	General-purpose, programmable output		

Stepnet Panel (STP) J3 Mode-Dependant Dedicated Inputs

These inputs are dedicated to specific functions, depending on operating mode.

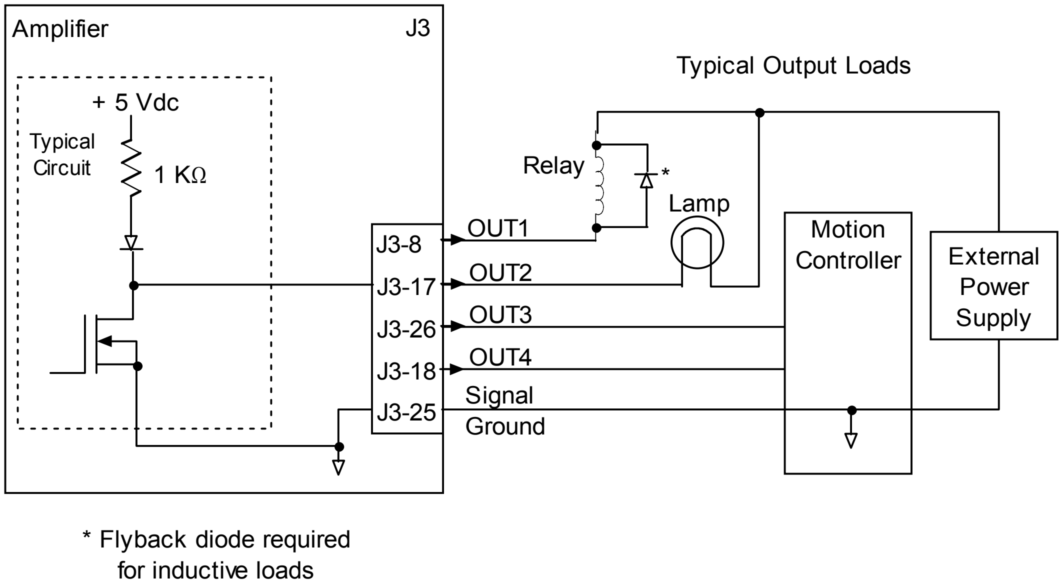
Mode	Input	Function
All	IN1	Enable
Current & Velocity PWM 50%	IN9	PWM Input
Current & Velocity PWM 100%	IN9 IN10	PWM Input Direction Input
Position Pulse & Direction	IN9 IN10	Pulse Input Direction Input
Position Up/Down	IN9 IN10	Count Up Count Down
Position Quadrature	IN9 IN10	Channel B Channel A

Stepnet Panel (STP) J3 Input Wiring Diagram

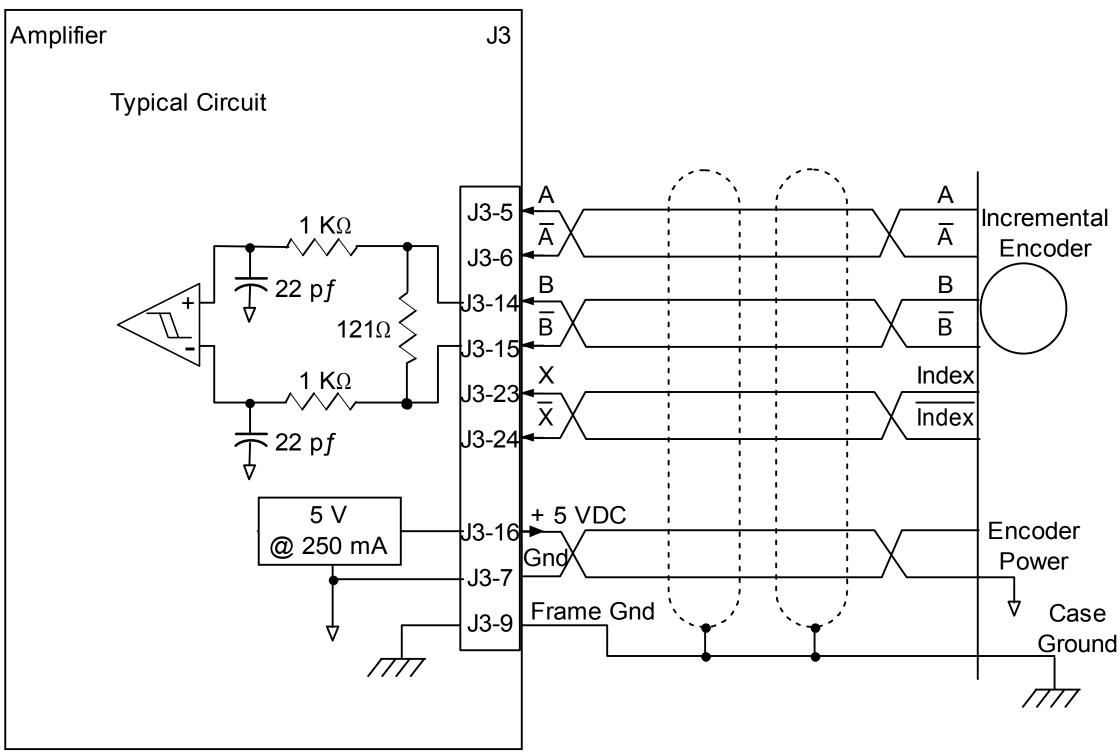


Standard inputs (IN1-IN4): R1 = 10 KΩ, R2 = 10 KΩ, C = 3300 p*f*
High speed input (IN6-IN12): R1 = 10 KΩ, R2 = 1 KΩ, C = 100 p*f*
IN5: R1 = 4.99 KΩ, R2 = 10 KΩ, C = 2200 p*f*

Stepnet Panel (STP) J3 Digital Outputs Wiring Diagram



Stepnet Panel (STP) J3 Incremental Encoder Wiring Diagram



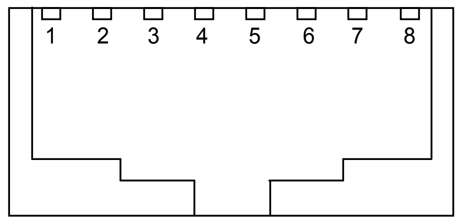
4.1.6: Stepnet Panel (STP) CAN Bus (J5 and J6)

Stepnet Panel (STP) J5 and J6 Mating Connector

8-position, modular connector (RJ-45 style). Copley Controls provides the following assemblies:

- Prefabricated 10 foot cable, PN STP-NC-10
- Prefabricated 1 foot cable, PN STP-NC-01
- Terminator Plug, PN STP-NT

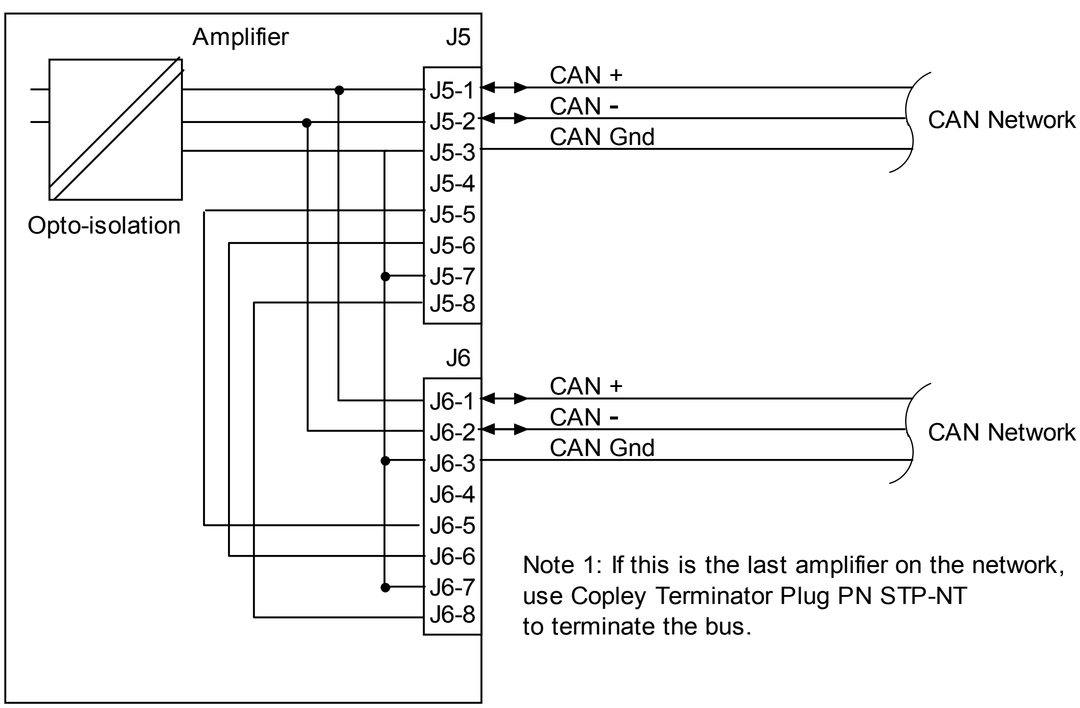
A diagram of the female connector is shown below.



Stepnet Panel (STP) J5 and J6 Pin Description

Pin	Signal	Function
1	CAN_H	CAN_H bus line (dominant high)
2	CAN _L	CAN_L bus line (dominant low)
3	CAN_Gnd	Ground / 0 V / V-
4	--	Pass though to second connector, no internal connection
5	--	Pass though to second connector, no internal connection
6	CAN_SHLD	Pass though to second connector, no internal connection
7	CAN_Gnd	Ground / 0 V / V-
8	CAN V+	Pass through to second connector, no internal connection

Stepnet Panel (STP) CAN Bus Wiring Diagram



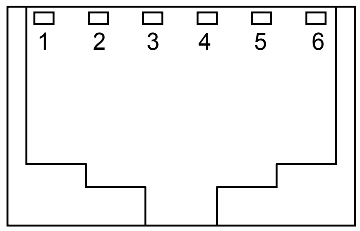
4.1.7: Stepnet Panel (STP) RS-232 Serial Communications (J4)

Stepnet Panel (STP) J4 Mating Connector

6-position, modular connector (RJ-11 style).

Copley Controls provides a prefabricated cable and modular-to-9-pin sub-D adapter in RS-232 Serial Cable Kit, PN SER-CK.

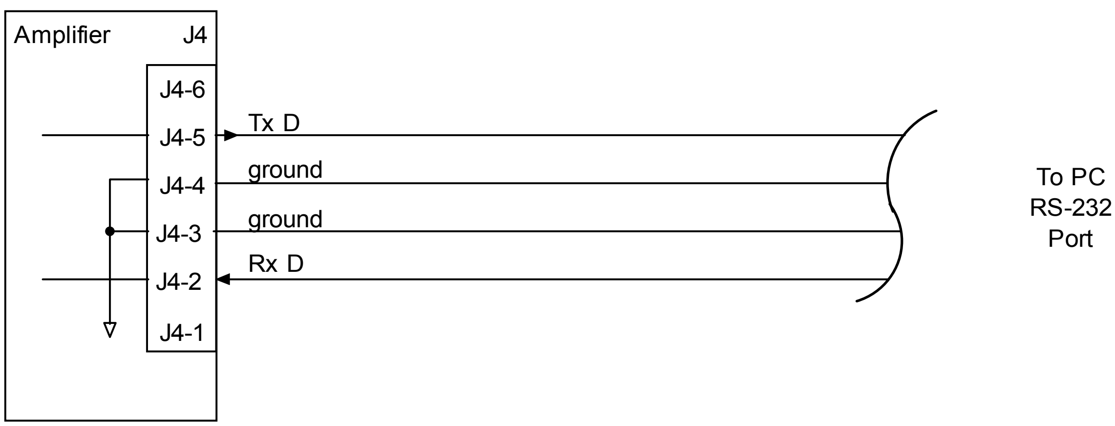
A diagram of the female connector is shown below.



Stepnet Panel (STP) J4 Pin Description

Pin	Signal	Function
1	N/C	No connection
2	RxD	Receive data input from computer
3	Signal ground	Power supply ground
4	Signal ground	Power supply ground
5	TxD	Transmit data output to computer
6	N/C	No connection

Stepnet Panel (STP) J4 RS-232 Serial Communications Wiring Diagram



4.2: Stepnet Panel AC (STX) Wiring

4.2.1: Stepnet Panel AC (STX) General Wiring Instructions

Stepnet Panel AC (STX) Electrical Codes and Warnings

Be sure that all wiring complies with the National Electrical Code (NEC) or its national equivalent, and all prevailing local codes.

DANGER

DANGER: Hazardous voltages.

Exercise caution when installing and adjusting.

Failure to heed this warning can cause equipment damage, injury, or death.

DANGER

Risk of electric shock.

High-voltage circuits on J1 and J2 are connected to mains power.

Failure to heed this warning can cause equipment damage, injury, or death.

WARNING

Do not ground mains-connected circuits.

With the exception of the ground pins on J1 and J2, all of the other circuits on these connectors are mains-connected and must never be grounded.

Failure to heed this warning can cause equipment damage.

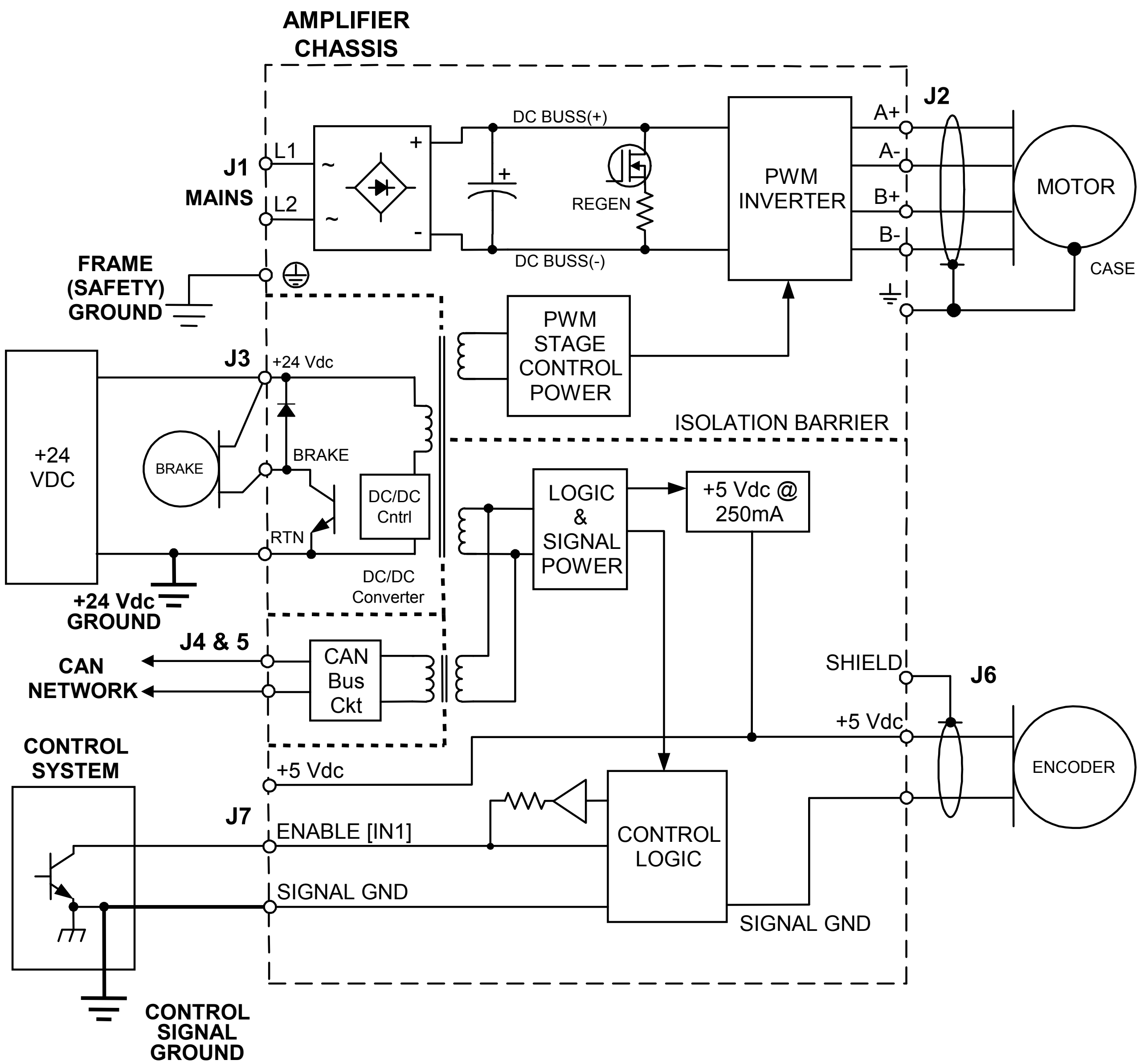
WARNING

Do not plug or unplug connectors with power applied.

The connecting or disconnecting of cables while the amplifier has 24Vdc and/or mains power applied is not recommended.

Failure to heed this warning may cause equipment damage.

Power and Grounding Diagram: Stepnet Panel AC (STX)



Stepnet Panel AC (STX) Primary Grounding Functions

A grounding system has three primary functions: safety, voltage-reference, and shielding.

Stepnet Panel AC (STX) J1-2 Primary Ground

The primary ground at J1-2 is the safety ground and is intended to carry the fault currents from the mains in the case of an internal failure or short-circuit of electronic components. This ground is connected to the amplifier chassis. Wiring to this ground should be done using the same gauge wire as that used for the mains. This wire is a “bonding”’ conductor that should be connected to an earthed ground point and must not pass through any circuit interrupting devices.

The pin on the amplifier at J1-2 is longer than the other pins on J1, giving it a first-make, last-break action so that the amplifier chassis is never ungrounded when the mains power is connected.

Stepnet Panel AC (STX) J2 Ground

The ground terminal at J2-1 also connects to the amplifier chassis.

Motor cases can be safety-grounded in one or optionally both of these ways:

- Direct grounding of the motor frame (assuming the frame of the machine is grounded). Attach the metal motor case to the metal machine frame or connect the ground wire of the motor to the metal frame of the machine.
- Grounding of the motor frame through the motor power cable to amplifier J2-1. The ground wire should be of the same gauge as the power wires.

Cable shields, because of their smaller wire size, must not be used as part of a safety-ground system.

Stepnet Panel AC (STX) Signal Grounding

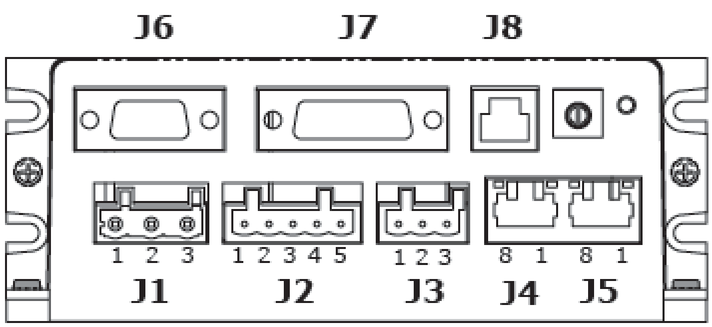
The amplifier signal ground must be connected to the control system signal ground. The amplifier signal ground is not connected to earth ground internal to the amplifier. Therefore, the control system signal ground can be connected to earth ground without introducing a ground loop.

Stepnet Panel AC (STX) Shielding

Shields on cables reduce emissions from the amplifier and help protect internal circuits from interference due to external sources of electrical noise. The shields shown in the wiring diagrams are also required for CE compliance. Cable shields should be tied at both ends to earth or chassis ground. The housing and pin 1 of both J6 and J7 are connected to the amplifier's chassis.

4.2.2: Stepnet Panel AC (STX) Connector Locations

Connector locations are shown below.



4.2.3: Stepnet Panel AC (STX) Power (J1)

Stepnet Panel AC (STX) J1 Mating Connector

Description	Plug, 3 position, 7.5 mm, female
Manufacturer Part numbers	Wago 721-203/026-045/RN01-0000 Insert/extract lever: Wago 231-131
Wire size	12 AWG maximum
Connector housing and terminals are included in connector kit STX-CK	

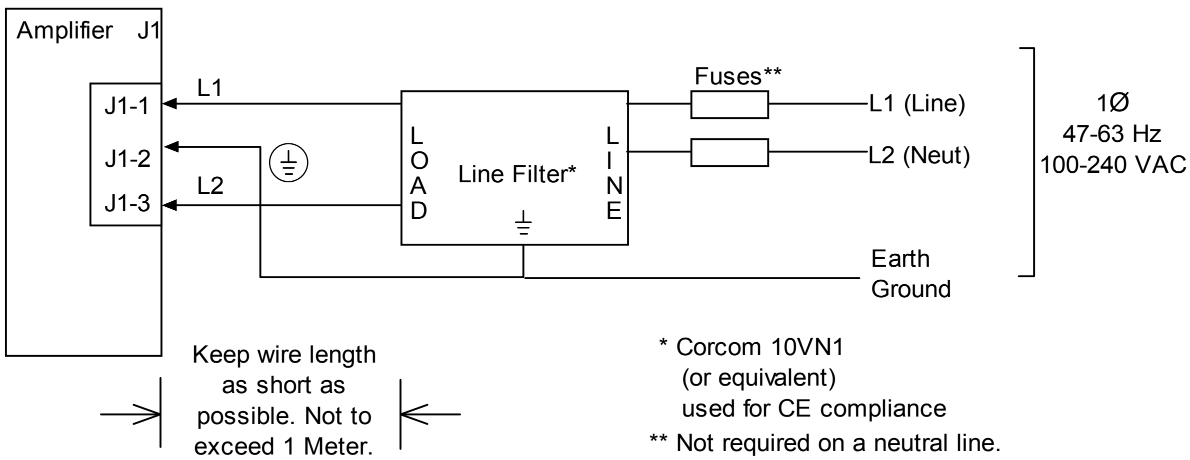
Stepnet Panel AC (STX) J1 Pin Description

Pin	Signal	Function
1	L1	AC power input (hot or L1)
2	Frame ground	Chassis safety ground
3	L2	AC power input (neutral or L2)

Stepnet Panel AC (STX) J1 AC Mains Fuse Recommendation

Recommended fuse type: Class CC, 600 Vac rated, Ferraz-Shawmut ATDR, Littelfuse CCMR, Bussman LP-CC, or equivalent.

Stepnet Panel AC (STX) J1 AC Mains Wiring Diagram (Single-Phase)



Note: A clamp-on ferrite (Fair-Rite PN 0431164951) was used on the AC input cable between the filter and drive (single turn) to meet EMC requirements during qualification testing.

4.2.4: Stepnet Panel AC (STX) Motor (J2)

Stepnet Panel AC (STX) J2 Mating Connector

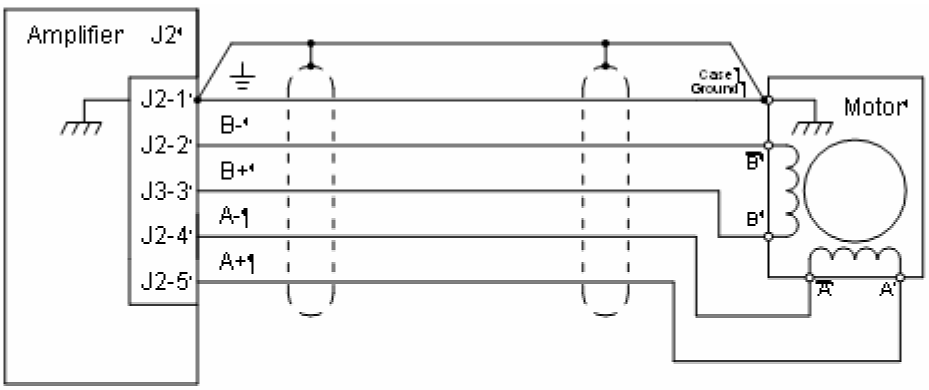
Description	Receptacle, Single Row 5 Position
Manufacturer Part numbers	Wago: 721-605/000-043/RN01-0000 Insert/extract lever: Wago: 231-131
Wire Size	28 - 12 AWG
Connector housing and terminals are included in connector kit STX-CK	

Stepnet Panel AC (STX) J2 Pin Description

Pin	Signal	Function
1	Frame Ground	Motor frame ground and cable shield
2	Motor /B	Phase B- output of amplifier
3	Motor B	Phase B+ output of amplifier
4	Motor /A	Phase A- output of amplifier
5	Motor A	Phase A+ output of amplifier

Stepnet Panel AC (STX) J2 Motor Wiring Diagram

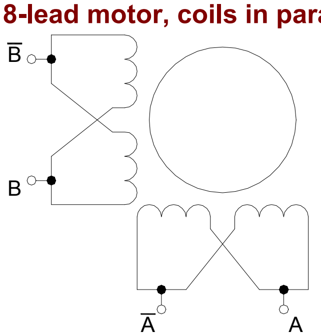
Typical wiring for a 4-lead motor:



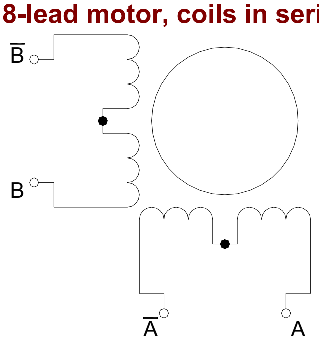
Note: A clamp-on ferrite (Fair-Rite PN 0431164281) was used on the motor cable (single turn), installed close to the amplifier, to meet EMC requirements during qualification testing.

Typical wiring alternatives:

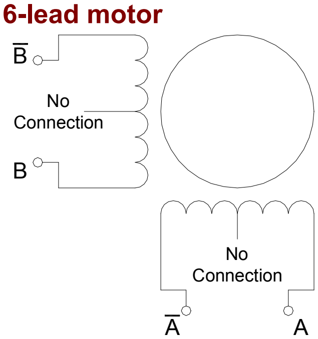
8-lead motor, coils in parallel



8-lead motor, coils in series



6-lead motor



4.2.5: Stepnet Panel AC (STX) Aux HV and Brake (J3)

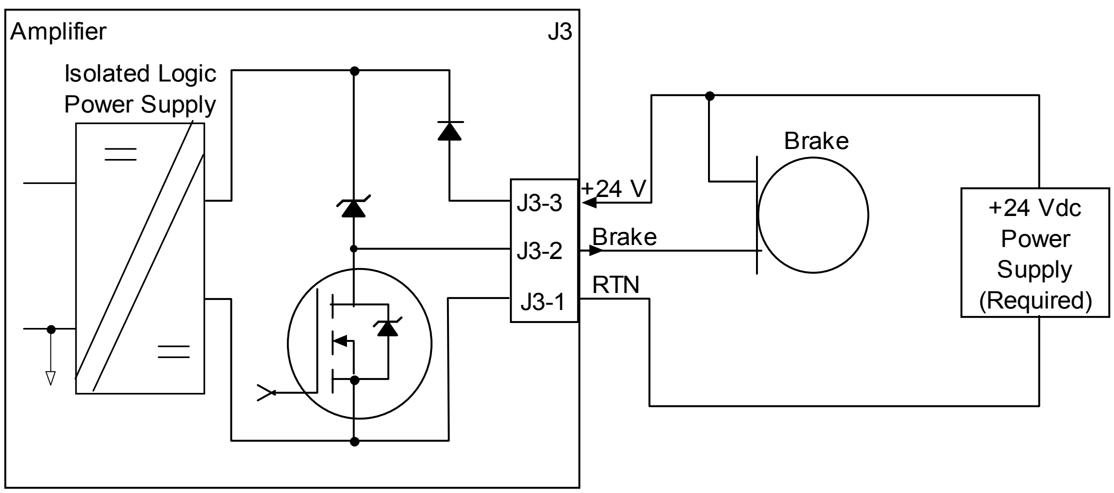
Stepnet Panel AC (STX) J3 Mating Connector

Description	Plug, 3 position, 5.0 mm, female
Manufacturer Part numbers	Wago: 721-103/026-047/RN01-0000 Insert/extract lever: Wago: 231-131
Wire Size	12 AWG maximum
Connector and backshell are included in connector kit STX-CK.	

Stepnet Panel AC (STX) J3 Pin Description

Pin	Signal	Function
1	Return	+24 Vdc return or common
2	Brake Output	Return or low side of motor brake
3	+24 Vdc	+24 Vdc Logic power supply

Stepnet Panel AC (STX) J3 Logic Supply and Brake Wiring Diagram



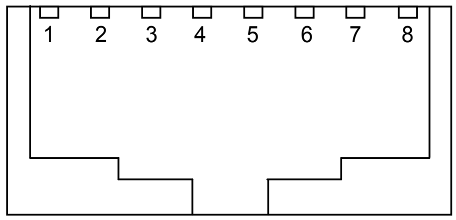
4.2.6: Stepnet Panel AC (STX) CAN Bus (J4 and J5)

Stepnet Panel AC (STX) J4-5 Mating Connector

8-position, modular connector (RJ-45 style). Copley Controls provides the following assemblies:

- Prefabricated 10 foot cable, PN STX-NC-10
- Prefabricated 1 foot cable, PN STX-NC-01
- Terminator Plug, PN STX-NT

A diagram of the female connector is shown below.

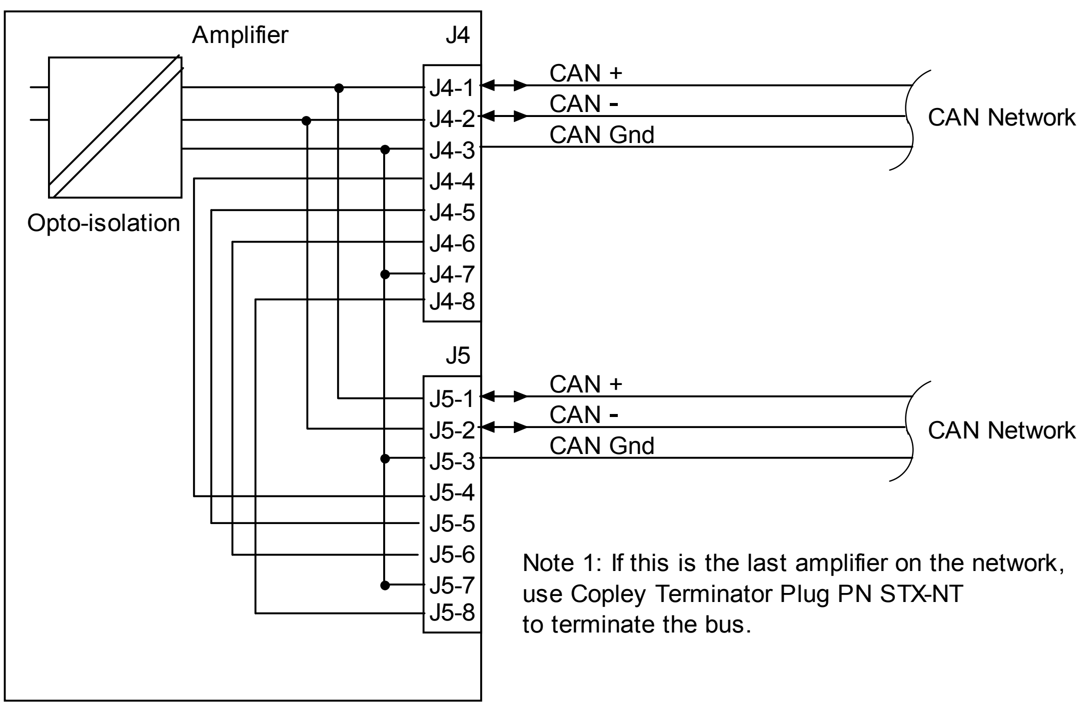


Stepnet Panel AC (STX) J4-5 Pin Description*

Pin	Signal	Function
1	CAN_H	CAN_H bus line (dominant high)
2	CAN _L	CAN_L bus line (dominant low)
3	CAN_Gnd	Ground / 0 V / V-
4	--	Pass though to second connector, no internal connection
5	--	Pass though to second connector, no internal connection
6	CAN_SHLD	Pass though to second connector, no internal connection
7	CAN_Gnd	Ground / 0 V / V-
8	CAN V+	Pass through to second connector, no internal connection

*Table applies to both J4 and J5 CAN connectors

Stepnet Panel AC (STX) J4-5 CAN Bus Wiring Diagram



4.2.7: Stepnet Panel AC (STX) Feedback (J6)

Stepnet Panel AC (STX) J6 Mating Connector

Description	15 Position, High-Density D-Sub Male Solder Style Connector and backshell.
Manufacturer Part numbers	Norcomp: 180-015-103L001 connector Norcomp: 979-009-020R121 backshell
Wire Size	24-30 AWG
Connector and backshell are included in connector kit STX-CK.	

Pin connections are shown here:

1 6 11

5 10 15

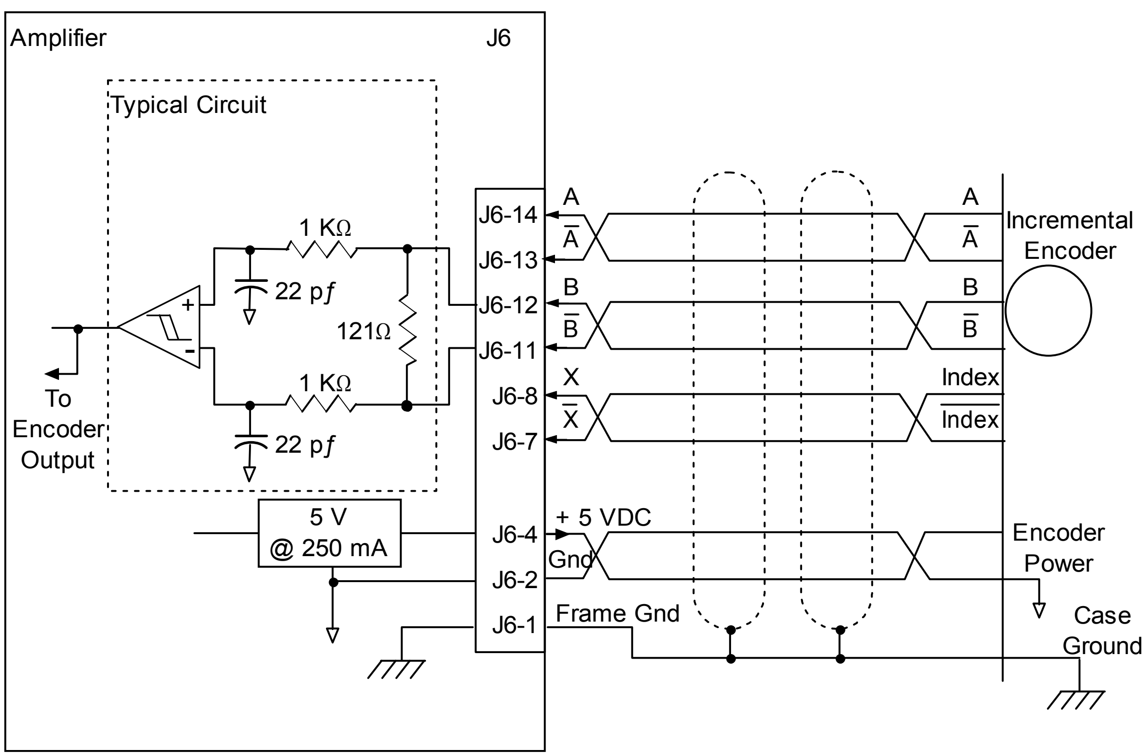
J6 pin connections

Stepnet Panel AC (STX) J6 Pin Description

Pin	Signal	Function		
1	Frame Ground	Cable shield connection		
2	+5 Vdc	Encoder +5 Vdc power supply output. Total load current on J7-20 and J6-4 not to exceed 250 mA.		
3	Encoder B2	Single-ended primary incremental encoder input.		
4	+5 Vdc	Encoder +5 Vdc power supply output. Total load current on J7-20 and J6-4 not to exceed 250 mA.		
5	Signal Ground	Signal and +5 Vdc ground		
6	Encoder X2	Single-ended primary incremental encoder input.		
7	Encoder /X Input	Differential primary incremental encoder inputs		
8	Encoder X Input			
9	Encoder A2	Single-ended primary incremental encoder input.		
10	[IN12] Motemp	Motor over temperature switch May be programmed to other functions	Standard speed	Pull-up/pull-down group 2
11	Encoder /B Input	Differential primary incremental encoder inputs		
12	Encoder B Input			
13	Encoder /A Input			
14	Encoder A Input			
15	Signal Ground	Signal and +5 Vdc ground		

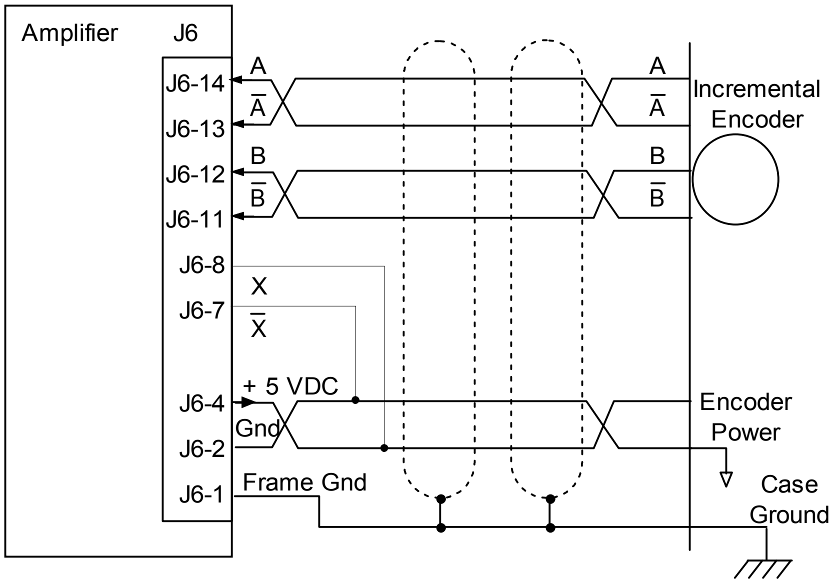
Stepnet Panel AC (STX) J6 Quad A/B Incremental Encoder Wiring Diagram – With Index

When the index pulse is used (as in most applications), wire the connection as shown here.



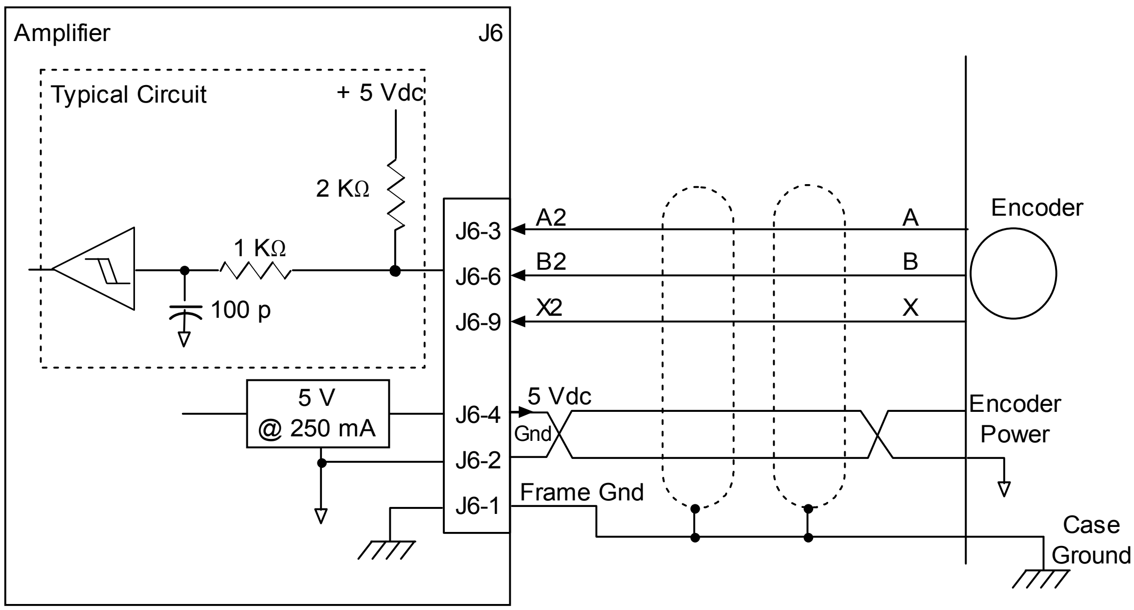
Stepnet Panel AC (STX) J6 Quad A/B Incremental Encoder Wiring Diagram – No Index

In applications where the encoder index pulse is not used, wire the connector as shown here.

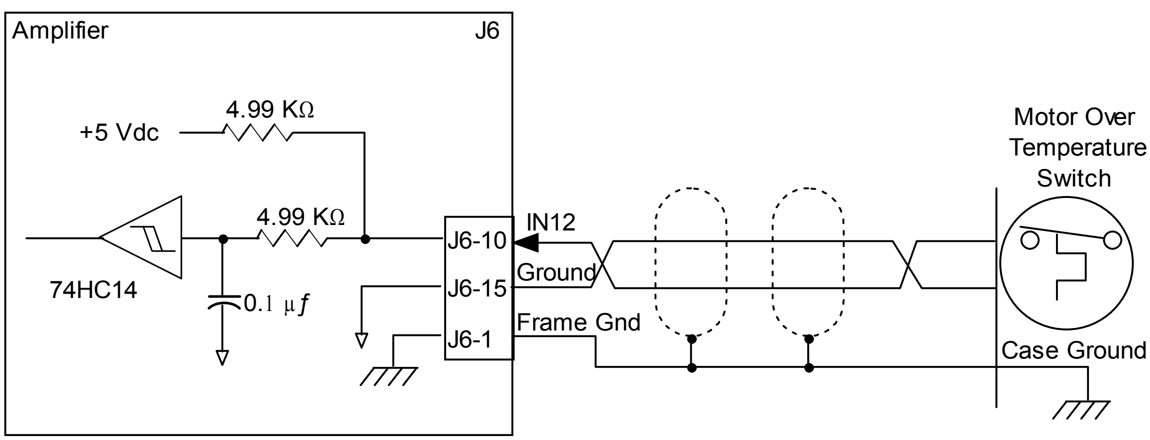


Stepnet Panel AC (STX) J6 Single-Ended Encoder Wiring Diagram

The Stepnet "Gnd" terminal on the feedback connector (J6-1) should be connected to the users' system common ground, through the shortest path, so that signals between the controller and the Stepnet are at the same common potential, and to minimize noise. The system common ground should, in turn, be connected to an earthing conductor by the shortest wire possible so that the whole system is referenced to "earth."



Stepnet Panel AC (STX) J6 Motor Over Temperature Wiring Diagram



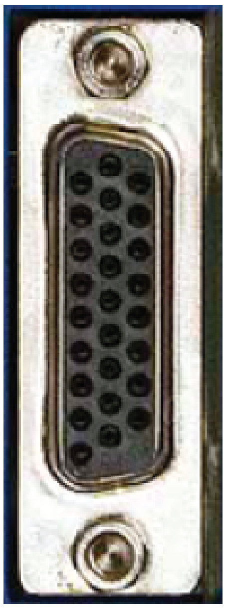
4.2.8: Stepnet Panel AC (STX) Control (J7)

Stepnet Panel AC (STX) J7 Mating Connectors

Description	Manufacturer PN	Wire Size
26 Position, 0.1 x 0.09 High Density D-Sub Male, Solder Style Connector	Norcomp 180-026-103L001	24 - 30 AWG
Back shell	Norcomp 979-015-020R121	
Solder style connector included in Connector Kit PN STX-CK.		

Pin connections are shown here:

1 10 19



9 18 26

J7 pin connections

Stepnet Panel AC (STX) J7 Pin Description

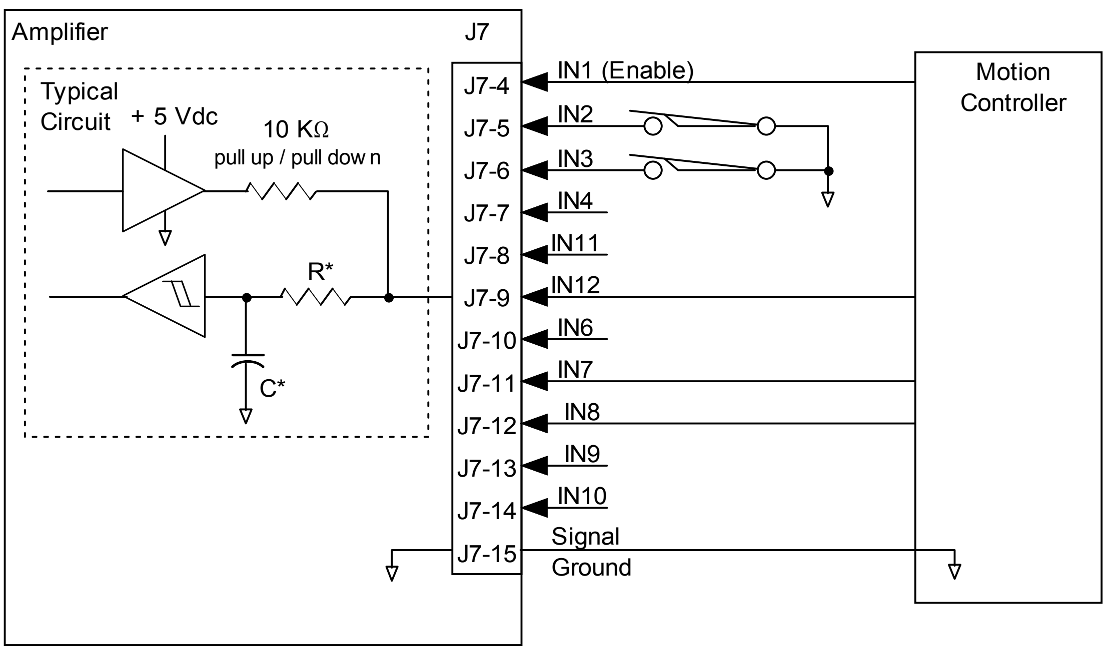
Pin	Signal	Function		
1	Frame Ground	Cable shield connection		
2	Ref - Input	Analog command negative input		
3	Ref + Input	Analog command positive input		
			Speed	**Pull-Up/Pull-Down**
4	IN1	Enable	Standard	Group 1
5	IN2	Programmable inputs	Standard	Group 1
6	IN3		Standard	Group 1
7	IN4		Standard	Group 2
8	IN10		Standard	Group 4
9	IN11		Standard	Group 4
10	IN5	Mode-dependant. See Mode-Dependant Dedicated Inputs (p. 80)	HS	Group 3
11	IN6		HS	Group 3
12	IN7		HS	Group 3
13	IN8		HS	Group 4
14	IN9		HS	Group 4
15	Signal Ground	Signal ground reference for inputs and outputs		
16	OUT1	Programmable outputs		
17	OUT2			
18	OUT3			
19	Signal Ground	Signal ground for +5Vdc, inputs and outputs		
20	+5 Vdc	+5 Vdc output. Total load current on J7-20, J6-2, and J6-4 not to exceed 250 mA.		
21	Multi-Mode Port /X	Programmable differential input/output port. See Mode-Dependant Dedicated Inputs (p. 80)		
22	Multi-Mode Port X			
23	Multi-Mode Port /B			
24	Multi-Mode Port B			
25	Multi-Mode Port /A			
26	Multi-Mode Port A			

Mode-Dependant Dedicated Inputs

These inputs are dedicated to specific functions, depending on operating mode.

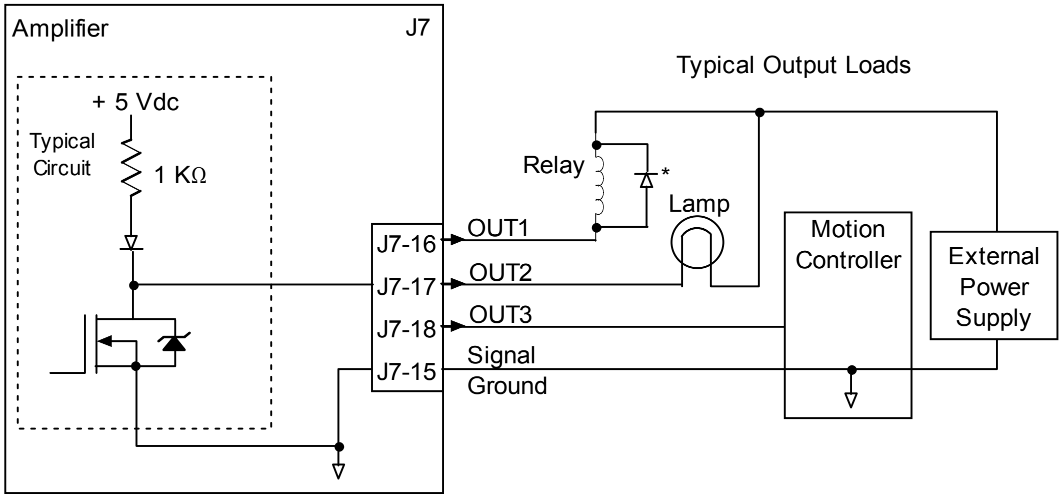
Mode	Selected Command Source			Function
	Digital Input Single Ended	Digital Input Differential	Multi-Mode Port	
Current & Velocity PWM 50%	IN8	IN8(+) & IN6(-)	A & /A	PWM Input
Current & Velocity PWM 100%	IN8 IN9	IN8(+) & IN6(-) IN9(+) & IN7(-)	A & /A B & /B	PWM Input Direction Input
Position Pulse & Direction	IN8 IN9	IN8(+) & IN6(-) IN9(+) & IN7(-)	A & /A B & /B	Pulse Input Direction Input
Position Up/Down	IN8 IN9	IN8(+) & IN6(-) IN9(+) & IN7(-)	A & /A B & /B	Count Up Count Down
Position Quadrature	IN9 IN8	IN8(+) & IN6(-) IN9(+) & IN7(-)	A & /A B & /B	Channel A Channel B

4.2.9: Stepnet Panel AC (STX) J7 Digital Inputs Wiring Diagram



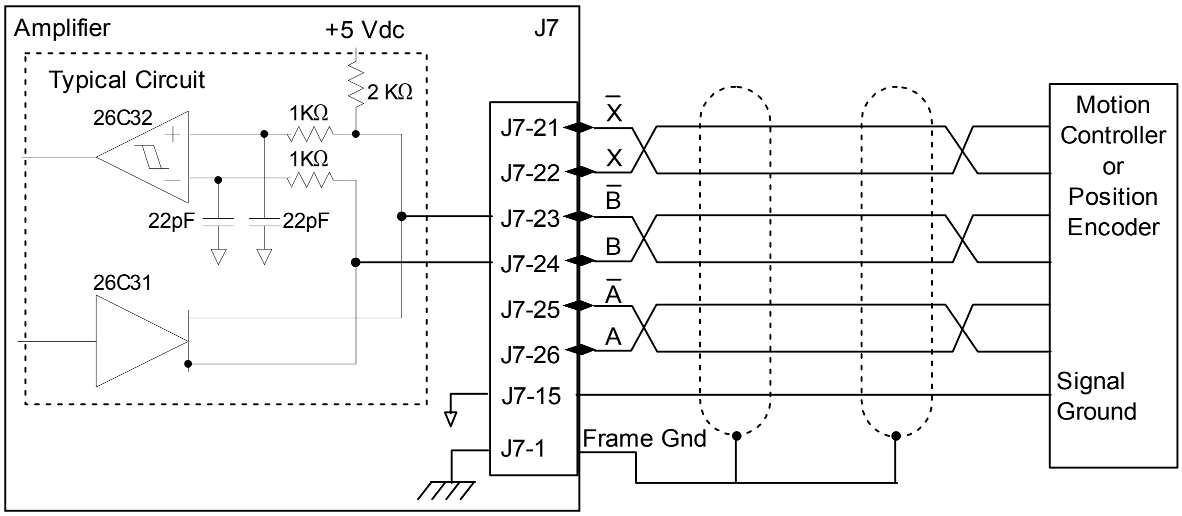
* Standard input R = 10 KΩ C = 0.033 µf
High-speed input R = 1KΩ C = 100 pf

Stepnet Panel AC (STX) J7 Digital Outputs Wiring Diagram

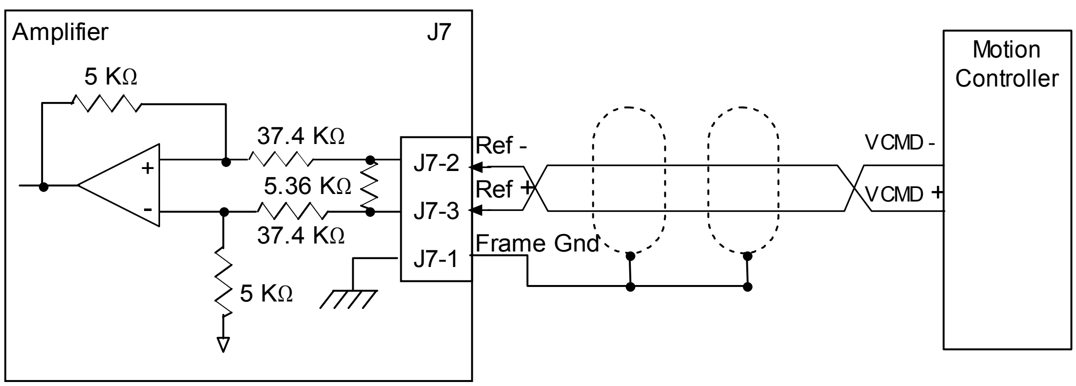


* Flyback diode required
for inductive loads

Stepnet Panel AC (STX) J7 Multi-Mode Port Interface Diagram



Stepnet Panel AC (STX) J7 Analog Input Wiring Diagram



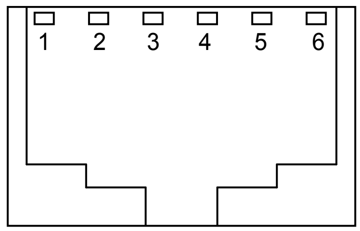
4.2.10: Stepnet Panel AC (STX) RS-232 Serial Communications (J8)

Stepnet Panel AC (STX) J8 Mating Connector

6-position, modular connector (RJ-11 style).

Copley Controls provides a prefabricated cable and modular-to-9-pin sub-D adapter in RS-232 Serial Cable Kit, PN SER-CK.

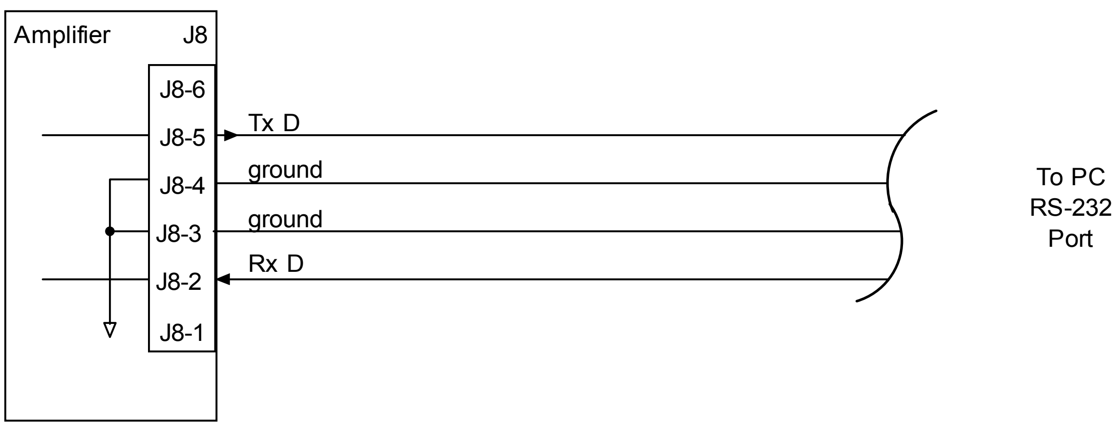
A diagram of the female connector is shown below.



Stepnet Panel AC (STX) J8 Pin Description

Pin	Signal	Function
1	N/C	No connection
2	RxD	Receive data input from computer
3	Signal ground	Power supply ground
4	Signal ground	Power supply ground
5	TxD	Transmit data output to computer
6	N/C	No connection

Stepnet Panel AC (STX) J8 RS-232 Serial Communications Wiring Diagram



CHAPTER

5: MODE SELECTION AND GENERAL SETUP

The Stepnet amplifier can be operated in stepper mode or servo mode, as described below.

Mode	Features
Stepper	Amplifier operates as a traditional, open position loop, stepper drive. With the addition of encoder feedback, the amplifier can monitor and report actual motor position and provide encoder correction. Also a position-tracking window can be set up along with a programmable following error warning and fault.
Servo	Amplifier operates as a true, closed loop, servo amplifier controlling a stepper motor. In this mode, the amplifier can be configured to accept current, velocity, or position commands. Encoder feedback is required for all servo modes of operation.

This chapter contains procedures required for and information relevant to all modes of operation. Start here to begin amplifier set up, and then continue as instructed to the appropriate mode-specific chapter.

To copy setup data from an existing Copley Controls axis file (*.ccx*), skip to Quick Copy Setup Procedure (p. 156).

NOTE: In the procedures described in this chapter, CME 2 uses a serial connection to a single amplifier to set up that amplifier. As an alternative, the multi-drop feature allows CME 2 to use a single RS-232 serial connection to one amplifier as a gateway to other amplifiers linked together by CAN bus connections. For more information, see the *CME 2 User Guide*.

5.1: Warnings

DANGER

DANGER: Hazardous voltages.

Exercise caution when installing and adjusting.

Failure to heed this warning can cause equipment damage, injury, or death.

WARNING

Make connections with power OFF.

Do not make connections to motor or drive with power applied.

Failure to heed this warning can cause equipment damage.

WARNING

Spinning motor with power off may damage amplifier.

Do not spin motors with power off. Voltages generated by a motor can damage an amplifier.

Failure to heed this warning can cause equipment damage.

5.2: CME 2 Installation and Serial Port Setup

5.2.1: Requirements

Computer Requirements

Minimal hardware requirements:

- **CPU**: Minimum: 400 MHZ*
- **RAM**: Minimum: 128 MB*

*Using the minimum requirements will allow CME 2 to run, but performance will be significantly reduced.

Communication Requirements

For serial communications:

- At least one standard RS-232 serial port or a USB port with a USB to RS-232 adapter.
- At least one serial communication cable. Available from Copley Controls. Copley Controls cable part number: SER-CK.

For CAN communications:

- One Copley Controls CAN PCI network card (part number CAN-PCI-02).
  CME 2 also supports CAN network cards made by these manufacturers: KVaser, Vector, and National Instruments.
- One PC-to-amplifier CANopen network cable.

Software Requirements

Copley Controls CME 2 software, Version 5.2 or higher.

Operating System Requirements

Operating Systems Supported: Windows NT, 2000, XP. Vista users see Special Notes for Windows Vista Users.

5.2.2: Special Notes for Windows Vista Users

When the CME 2 installer starts running under Windows Vista, a message will be displayed stating that an unidentified program is trying to access the computer. Click the button to allow the installer to continue, and CME 2 will be installed properly.

On previous versions of Windows, the user data for CME 2 (like ccx, ccm, files, etc.) were stored in C:\Program Files\Copley Motion\CME 2. Because of Windows Vista security, the CME 2 user files are stored on Vista systems in C:\Users\Public\Public Documents\Copley Motion\CME 2.

5.2.3: Downloading CME 2 Software from Web (Optional)

5.2.3.1 Choose or create a folder where you will download the software installation file.

5.2.3.2 In an internet browser, navigate to
http://www.copleycontrols.com/Motion/Downloads/index.html
Under *Software Releases,* click on CME 2.

5.2.3.3 When prompted, save the file to the folder chosen or created in Step 5.2.3.1.
The folder should now contain a file named *CME2.zip*.

5.2.3.4 Extract the contents of the zip file to the same location.
The folder should now contain the files *CME2.zip* and *Setup.exe*.

5.2.3.5 If desired, delete *CME2.zip* to save disk space.

5.2.4: Installing CME 2 Software

5.2.4.1 If installing from a CD, insert the CD (Copley Controls part number *CME2*).

Normally, inserting the CD causes the installation script to launch, and a CME 2 Installation screen appears. If so, skip to Step 5.2.4.3.

5.2.4.2 If the software installation file was downloaded from the Copley Controls website, navigate to the folder chosen or created in Step 5.2.3.1, and then double-click on *Setup.exe*
OR
if you inserted the CD and the CME 2 *Installation* screen did not appear, navigate to the root directory of the installation CD and then double-click on *Setup.exe*.

5.2.4.3 Respond to the prompts on the CME 2 *Installation* screens to complete the installation. We recommend accepting all default installation values.

5.2.5: Serial Port Setup

One or more serial ports on a PC can be used to connect amplifiers. Use the following instructions to add (enable) ports for amplifiers, to choose baud rates for those ports, and to remove (disable) ports for amplifiers.

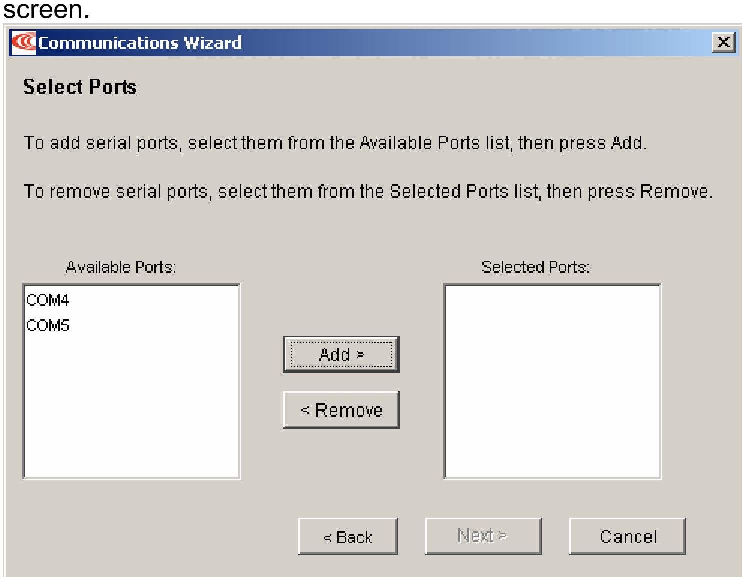
5.2.5.1 

Start CME 2 by double-clicking the CME 2 shortcut icon on the Windows desktop:

If a serial or CAN port has not been selected, the *Communications Wizard Select device* screen appears.

5.2.5.2 If the CME 2 *Main* screen appears instead of *Select Devices*, choose **Tools→Communications Wizard**.

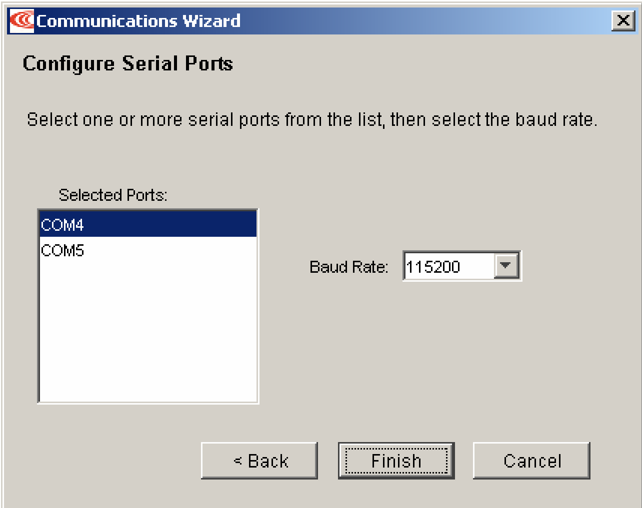
5.2.5.3 Choose **Serial Ports** and click **Next** to open the *Communications Wizard Select Ports* screen.



5.2.5.4 From the *Available Devices* list on the *Select Devices* screen, choose the serial ports that will be used to connect to amplifiers.

1. To allow connection of an amplifier through a port, highlight the port name and click **Add** (or click **Add All** to enable all available ports).
2. To remove a port from the *Selected Devices* list, highlight the port name and click **Remove**.

5.2.5.5 Click **Next** to save the choices and open the *Communications Wizard Configure Serial Ports* screen.



5.2.5.6 Configure the selected ports.

1. Highlight a port in the *Selected Devices* list.
2. Choose a *Baud Rate* for that port.
3. Repeat for each selected port.

5.2.5.7 Click **Finish** to save the choices.

5.3: Prerequisites

5.3.1: Hardware and Equipment

5.3.1.1 Verify that all power is OFF.

5.3.1.2 Verify wiring to all amplifier connectors

5.3.1.3 Secure the motor.

1. Make sure motor is securely fastened.
2. Make sure that no load is connected to the motor.

5.3.1.4 STP: Apply Aux voltage if available. If the Aux supply is not wired, verify that the amplifier enable input (IN1) is in the disabled state and then apply HV power. The factory default setting for the enable input is open or pulled high for disable.

STX: Apply 24 V only.

DANGER

Risk of unexpected or uncontrolled motion.

CME 2 can be used while the amplifier is under other control sources such as CANopen and DeviceNet. However, some changes made with CME 2 could cause unexpected or uncontrolled motion.

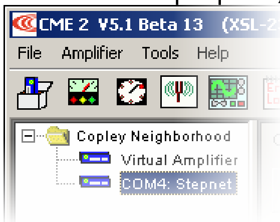
Failure to heed this warning can cause equipment damage, injury, or death.

5.3.2: Starting CME 2 and Choosing an Amplifier

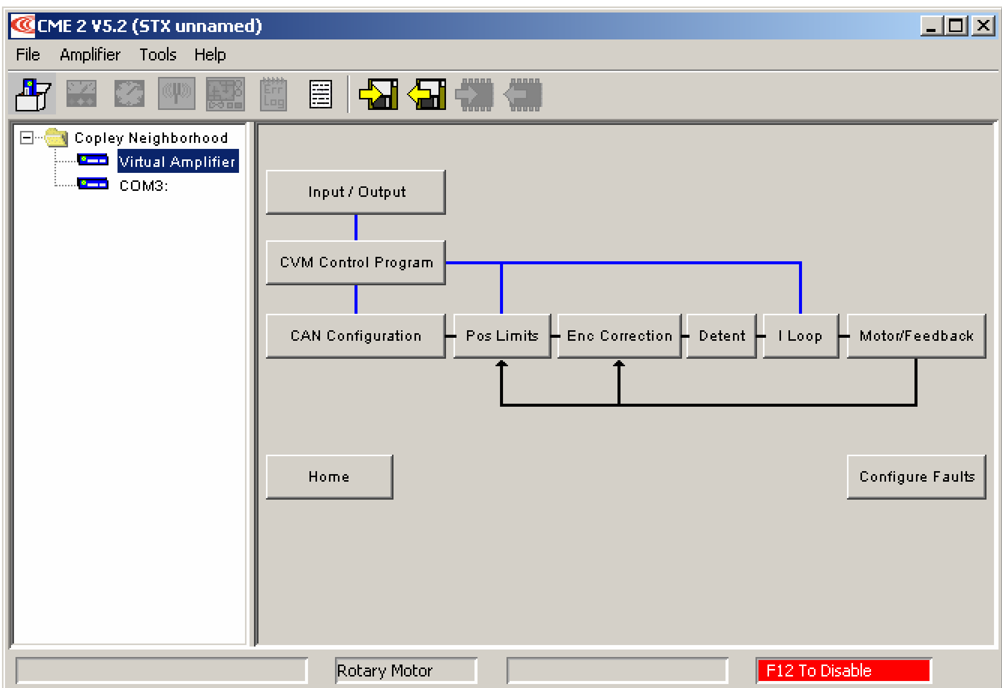
NOTE: Digital input 1 (IN1) must be configured as a hardware disable. It may be used to immediately disable the amplifier. To software disable the amplifier at any time while running CME 2, press function key **F12**.

5.3.2.1 Verify CME 2 installation and serial port configuration.

Start CME 2 by double-clicking the CME 2 shortcut icon on the Windows desktop. If there are multiple ports, the Copley Neighborhood root will be selected:



5.3.2.2 Select the desired amplifier to open the CME 2 Main screen (varies with model and configuration):



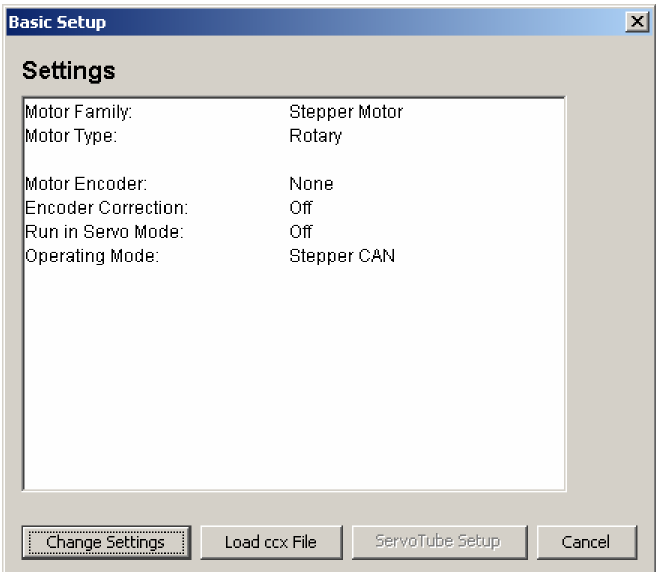
If basic setup settings have not been chosen, the *Basic Setup* screen opens.

5.4: Basic Setup

5.4.1: Basic Setup Screen

5.4.1.1 To load a *.ccx* file that was prepared for the amplifier/motor combination, see Quick Copy Setup Procedure (p. 156).

5.4.1.2  Click the **Basic Setup** button to display the *Basic Setup* screen**.**



5.4.1.3 Click **Change Settings** to start the Basic Setup wizard. Use Back Next to navigate screens. Screen details vary depending on amplifier model and mode selection.

5.4.1.4 Select the **Motor Type** (Rotary or Linear).

5.4.1.5 View or change the Feedback settings described below:

Setting	Options
Motor Encoder	Primary Incremental or none. Encoder is required for servo mode operation. In stepper mode operation, it can provide position maintenance information.
Run in Servo Mode	When checked, amplifier runs in closed loop servo mode. See Stepper and Servo Modes (p. 10).
Enable Encoder Correction	When checked, amplifier runs in stepper mode and uses a programmable proportional gain to correct following errors. See Encoder Correction, p. 128.

5.4.1.6 View or change the Operating Mode settings described below:

Setting	Options
Operating Mode	Stepper mode: Position. See Stepper Mode Operation (p. 16). Servo mode: Current, Velocity, Position. (See Servo Mode Operation (p. 18).
Command Source	PWM Command (current and velocity mode only): Digital pulse-width modulated signal provides command input. See Input Command Types (p. 25). Function Generator (current and velocity mode only): Internal function generator provides command input. Software Programmed: The amplifier is controlled by software commands from either the Copley Virtual Machine (CVM) or an external source. See *Copley Indexer Program User's Guide* or the *Copley ASCII Interface Programmer's Guide.* Digital Input (position mode only): Command input is provided via the Input Source selected from the choices described below. See Digital Position Inputs (p. 27). CAN: (position mode only): Command input is provided over the CANopen network. See Communication (p. 30) and the *CANopen Programmer's Guide.* Camming (position mode only): Amplifier runs in Camming Mode. See *Copley Camming User Guide*.

5.4.1.7 Click **Finish** to close the **Basic Setup** screen.

5.5: Motor Setup

Motor, Feedback, and Brake settings can be loaded from a file or entered manually into the fields. Choose the appropriate method and perform the steps described:

- Load Motor/Feedback/Brake Data File (p. 95)
- Enter Motor/Feedback/Brake Settings Manually (p. 96)

5.5.1: Load Motor/Feedback/Brake Data File

5.5.1.1 To download motor data files from the website:

1. In an internet browser, navigate to http://www.copleycontrols.com/Motion/Downloads/motorData.html
2. Click the appropriate motor name.
   When prompted, save the file to the *MotorData* folder in the CME 2 installation folder.
   (The default installation folder is
   C:\Program Files\Copley Motion\CME 2\MotorData.)
3. Extract the contents of the zip file to the same location.
4. The folder should now contain the new motor data file (with a *.ccm* filename extension).
5. If desired, delete the *.zip* file to save disk space.

5.5.1.2 To load motor data from a motor data file:

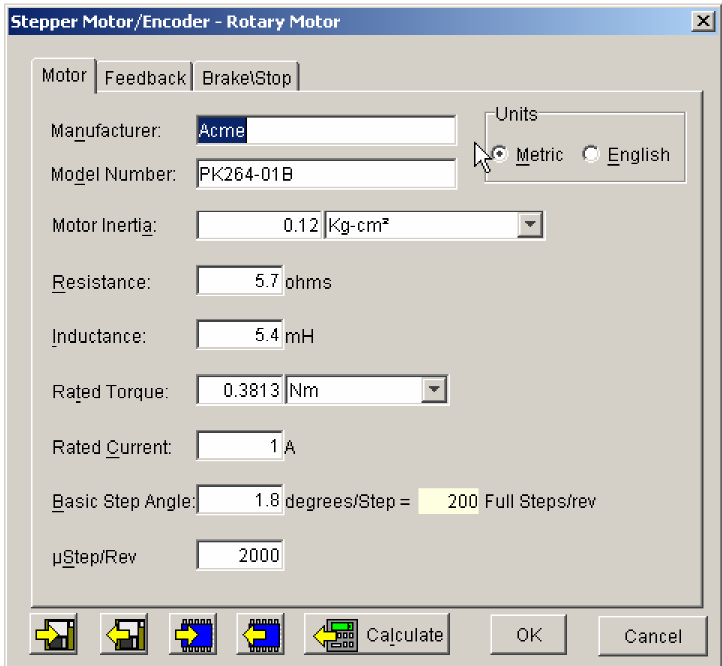
1.

   Click **Motor/Feedback** to open the *Motor/Feedback* screen.
2. On the *Motor/Feedback* screen, click **Restore Motor Data from Disk** ().
   When prompted, navigate to the folder containing the file,
   then click on the file name, and then click **Open**.
3. Verify motor data files against manufacturer's specifications.
4. Proceed to The Calculate Function (p. 99).

5.5.2: Enter Motor/Feedback/Brake Settings Manually

5.5.2.1 

Click **Motor/Feedback** to open the *Motor/Feedback* screen.
A Motor/Feedback screen representing a typical rotary motor is shown below.
Parameters vary with amplifier model.



5.5.2.2 Click the **Motor** tab to view or change Rotary Motor Setup Parameters (p. 97) or Linear Motor Setup Parameters (p. 97).

5.5.2.3 

Click the **Feedback** tab. For rotary motors, enter the number of Encoder Lines. For linear motors, enter the *Encoder Resolution* value and select the units for that value (mm, nm, or um).

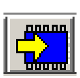
5.5.2.4 (STX only) Verify the *Enable Encoder Loss Detection* setting.
See STX Encoder Loss Detection (p. 38).

5.5.2.5 

Click the **Brake/Stop** tab to view or change Brake/Stop Parameters (p. 98). Read the Brake/Stop Notes (p. 98) for important related information.

5.5.2.6 

Use The Calculate Function (p. *99*) to calculate initial gains and limits.

5.5.2.7  On the Main screen, click **Save to Flash** to avoid losing the changes.

5.5.3: Rotary Motor Setup Parameters

View or change the settings described below. Options vary with amplifier model. Metric units are shown here.

Setting	Description
Manufacturer	Motor manufacturer's name. Saved for reference in the motor data file.
Model Number	Motor model number. Saved for reference in the motor data file.
Units	Selects whether the parameters entered in this screen are in Metric or English units.
Motor Inertia	The rotor inertia of the motor. Used in servo mode for calculating initial velocity loop tuning values. Min: 0.00001 kg-cm^2. Max: 1,000 kg-cm^2. Default: 0.00001 kg-cm^2.
Resistance	Motor resistance line-to-line. Used for calculating the initial current loop tuning values. Min: 0.01Ω. Max: 327Ω. Default: 0.01Ω.
Inductance	Motor inductance line-to-line. Used for calculating the initial current loop tuning values. For inductance range, see Power Output (p. 45).
Rated Torque	Motor's rated operating torque. Min: .001 N m. Max: 1000 N m.
Rated Current	Motor's rated continuous current. Min: 0.001 A. Max: 1000 A.
Basic Step Angle	Fundamental stepper motor step, in degrees. Min: 0.225. Max: 22.5. Default 1.8.
µStep/Rev (stepper mode only)	Number of microsteps per revolution of the motor. Min: 4. Max: 100,000,000. Default 4000. Note: When using encoder feedback, it is desirable to set this value equal to the number of encoder counts per rev.

5.5.4: Linear Motor Setup Parameters

View or change the settings described below. Options vary with amplifier model. Metric units are shown here.

Setting	Description
Manufacturer	Motor manufacturer's name. Saved for reference in the motor data file.
Model Number	Motor model number. Saved for reference in the motor data file.
Units	Selects whether the parameters entered in this screen are in Metric or English units.
Motor Mass	The mass of the moving component of the motor. Used in servo mode for calculating initial velocity loop tuning values. Min: .0001 Kg. Max: 100,000 Kg. Default: .0001 Kg.
Resistance	Motor resistance line to line. Used for calculating the initial current loop tuning values. Min: 0.01. Max: 327 Ω. Default: 0.01 Ω.
Inductance	Motor inductance line to line. Used for calculating the initial current loop tuning values. For inductance range, see Power Output (p. 45).
Rated Force	Motor's rated operating force. Min .001 N. Max 1000 N.
Rated Current	Motor's rated continuous current. Min: 0.01 A. Max 1000 A.
Full Step	Fundamental stepper motor step distance. Min: 0.0001mm. Max: 5000 mm.
µStep/Full Step (stepper mode only)	Number of microsteps per full step. Min: 1. Max: 25,000,000.

5.5.5: Brake/Stop Parameters

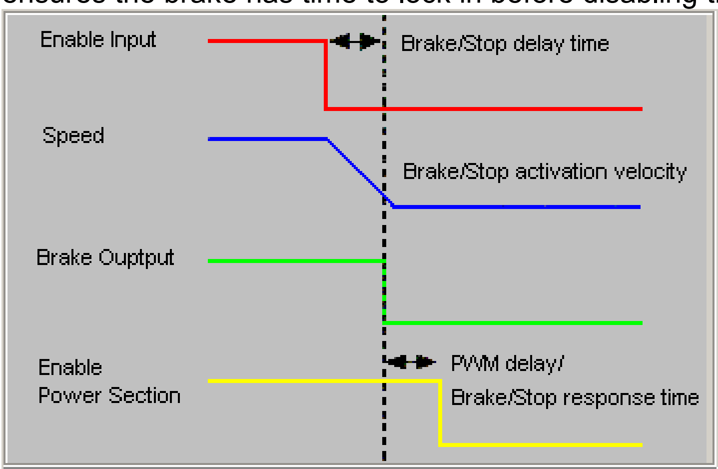
Enter the following parameters as appropriate.

Parameter	Description
Brake/Stop Delay Time	Range of accepted values: 0 to 10,000 mSec.
Brake Activation Velocity	Range of accepted values: motor-dependent.
PWM Delay Brake/Stop Response Time	Range of accepted values: 0 to 10,000 mSec.

Brake/Stop Notes

Many control systems employ a brake to hold the axis when the amplifier is disabled. On brake-equipped systems, disabling the amplifier by a hardware or software command starts the following sequence of events.

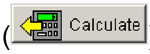
- The motor begins to decelerate (at Abort Deceleration rate in position mode or Fast Stop Ramp rate in velocity mode). At the same time, the Brake/Stop Delay Time count begins. This allows the amplifier to slow the motor before applying the brake.
- When the motor slows to Brake/Stop Activation Velocity OR the Brake/Stop Delay Time expires, the brake output activates and PWM Delay Brake/Stop Response Time count begins.
- When response time has passed, the amplifier's output stages are disabled. This delay ensures the brake has time to lock in before disabling the power section.



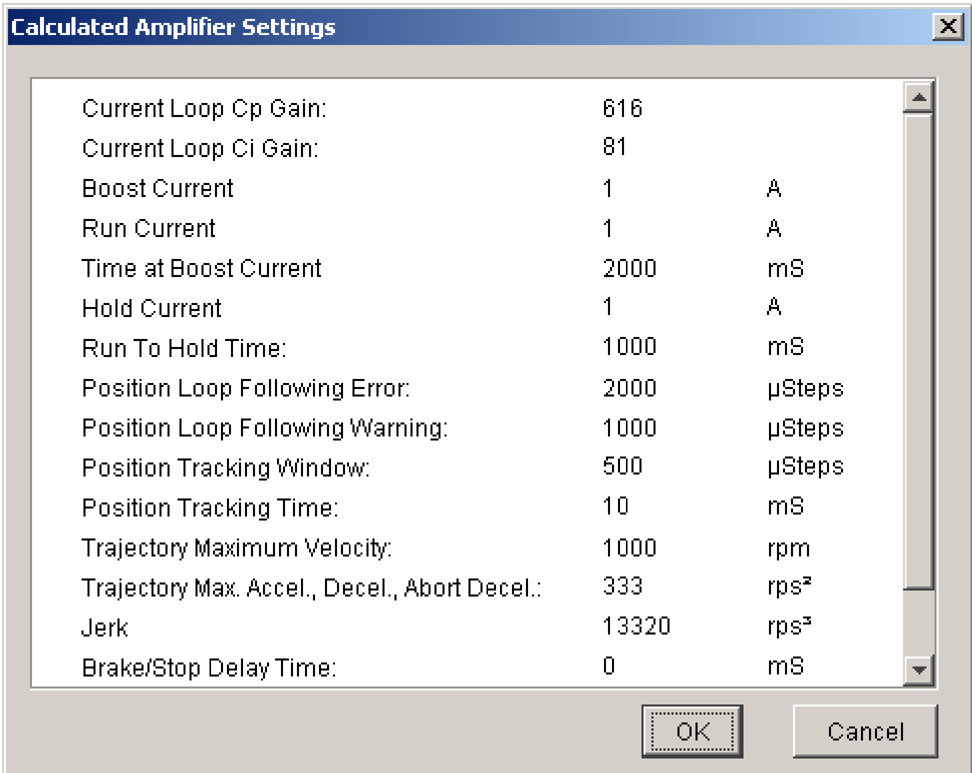
This sequence is not available in the current mode of operation. Instead, in current mode, the amplifier output turns off and the brake output activates immediately when the disable command is received.

5.5.6: The Calculate Function

The *Calculate* function uses the motor and encoder values entered to calculate initial loop gains and limits. These can be modified later to fine-tune the amplifier.

5.5.6.1 Click **Calculate** (

) to calculate and display the settings.



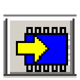
Note that in servo mode, Peak Current and Continuous Current replace the stepper mode Boost Current and Run Current settings.

5.5.6.2 Verify the boost (peak) current limit and Run (Continuous) Current limit.
If one or more of these values seems inappropriate, click **Cancel** and check: Rated Torque (or Force) and Rated Current. Correct them if needed. See Rotary Motor Setup Parameters (p. 97)
or Linear Motor Setup Parameters (p. 97).

If the Motor/Feedback values were correct but the peak current limit, continuous current limit, or velocity loop velocity limit values are not optimal for the application, change these limits during the tuning process.

5.5.6.3 Load the values into amplifier RAM by clicking **OK**.

NOTE: If the motor wiring configuration in the motor file does not match the configuration currently stored in the amplifier, CME prompts for verification on which configuration to use. Select the file configuration by clicking **Yes**. The configuration will be tested during auto phasing.

5.5.6.4  On the Main screen, click **Save to Flash** to avoid losing the changes.

5.6: Amplifier Configuration

5.6.1: Digital Inputs

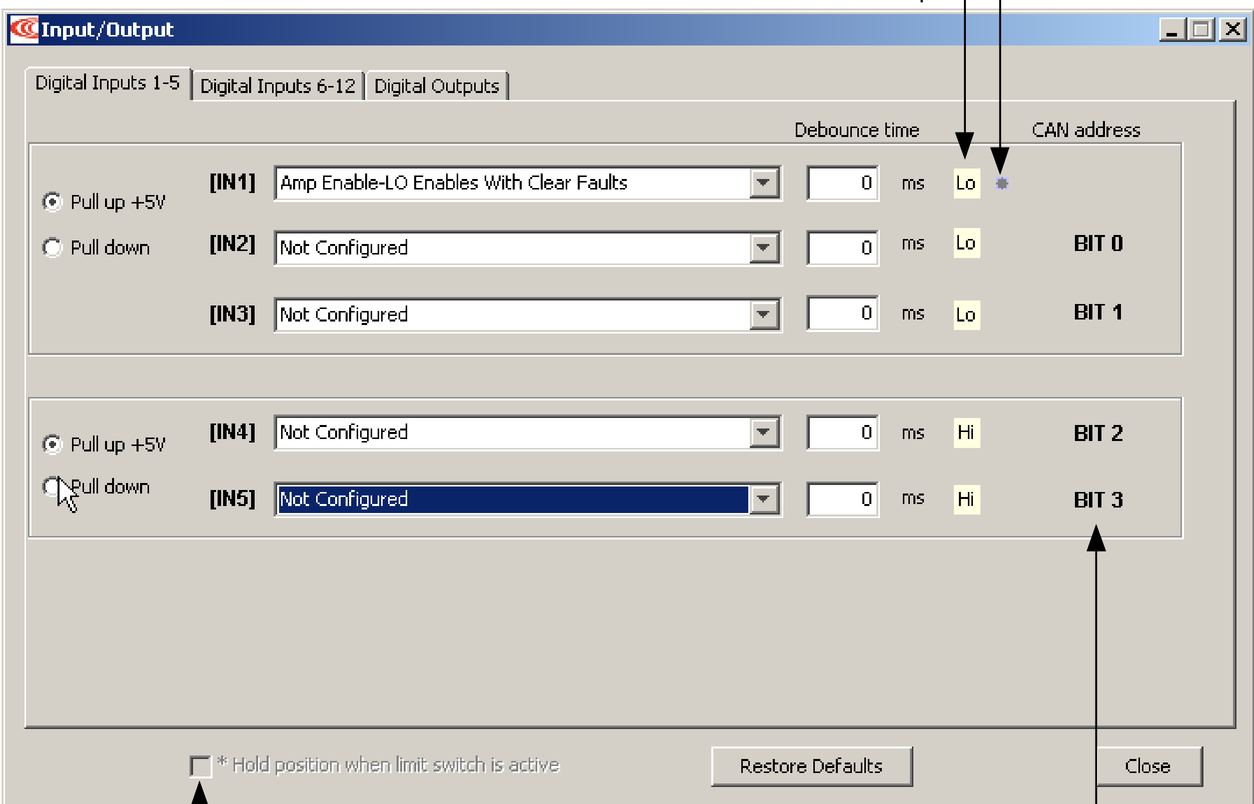
5.6.1.1 

Click **Input/Output** on the *Main* screen to open the *Input/Output* screen.

A typical Input/Output screen is shown below. (Features vary with model and configuration.)

Red: inhibited motion or active input, depending on input function. Grey: motion not inhibited. None: not configured.

Lo/Hi: Indicates state of input.



Hold position setting

Indicates input is used as a CAN address bit.

5.6.1.2 Change or verify the following settings:

Setting	Description
Pull up +5 V	Pulls up the group of inputs up to internal +5 V.
Pull down	Pulls the group of inputs down to internal signal ground.
IN1-IN12	Select the function for the input. See Digital Input Functions (p. 102) for input function descriptions.
Debounce Time	Sets the input debounce time (how long an input must remain stable at a new state before the amplifier recognizes the state). Increase to prevent undesired multiple triggering caused by switch bounce. Debounce time is ignored for digital command inputs such as PWM. Range: 0 to 10,000 mSec. See Debounce Time (p. 42).
*Hold position when limit switch is active	Available in position mode when one or more inputs are configured as a limit switch (NEG Limit-HI Inhibits, NEG Limit-LO Inhibits, POS Limit-HI Inhibits, or POS Limit-LO Inhibits). The *Hold position…* option prevents any motion while a limit switch is active.

WARNING

WARNING: Limit switches may be disabled.

If the amplifier is switched back to current or velocity mode with Hold position when limit switch is active set, the limit switches will no longer function.

Failure to heed this warning can cause equipment damage.

The **Restore Defaults** button restores all inputs and outputs to factory defaults. The **Close** button closes the screen.

5.6.2: Digital Input Functions

Input Function	Description
AMP Enable- LO Enables with clear faults	A low input will enable the amplifier. Any transition will clear latched faults and outputs.
AMP Enable- HI Enables with clear faults	A high input will enable the amplifier. Any transition will clear latched faults and outputs.
AMP Enable- LO Enables with reset	A low input will enable the amplifier. A low to high transition will reset the amplifier.
AMP Enable- HI Enables with reset	A high input will enable the amplifier. A high to low transition will reset the amplifier.
AMP Enable- LO Enables	A low input will enable the amplifier.
AMP Enable- HI Enables	A high input will enable the amplifier.
Not Configured	No function assigned to the input.
NEG Limit-HI Inhibits	A high input will inhibit motion in negative direction.
NEG Limit-LO Inhibits	A low input will inhibit motion in negative direction.
POS Limit-HI Inhibits	A high input will inhibit motion in positive direction.
POS Limit-LO Inhibits	A low input will inhibit motion in positive direction.
Reset on LO-HI Transition	A low to high transition of the input will reset the amplifier.
Reset on HI-LO Transition	A high to low transition of the input will reset the amplifier.
Motor Temp HI Disables	A high input will generate a Motor Over Temperature fault.
Motor Temp LO Disables	A low input will generate a Motor Over Temperature fault.
Home Switch Active HI	A high input indicates the home switch is activated.
Home Switch Active LO	A low input indicates the home switch is activated.
Motion Abort Active HI	A high input stops motion but amplifier remains enabled.
Motion Abort Active LO	A low input stops motion but amplifier remains enabled.
Hi Res Analog Divide Active HI	A high input causes the firmware to divide the level of the analog input signal by 8.
Hi Res Analog Divide Active LO	A low input causes the firmware to divide the level of the analog input signal by 8.
High Speed Position Capture on LO-HI Transition	Position will be captured on the low to high transition of the input.
High Speed Position Capture on HI-LO Transition	Position will be captured on the high to low transition of the input.
PWM Sync Input	PWM synchronization input.

5.6.3: Standard Input Function Assignments

Enable Input: On the Stepnet amplifier, IN1 is dedicated to the enable function.

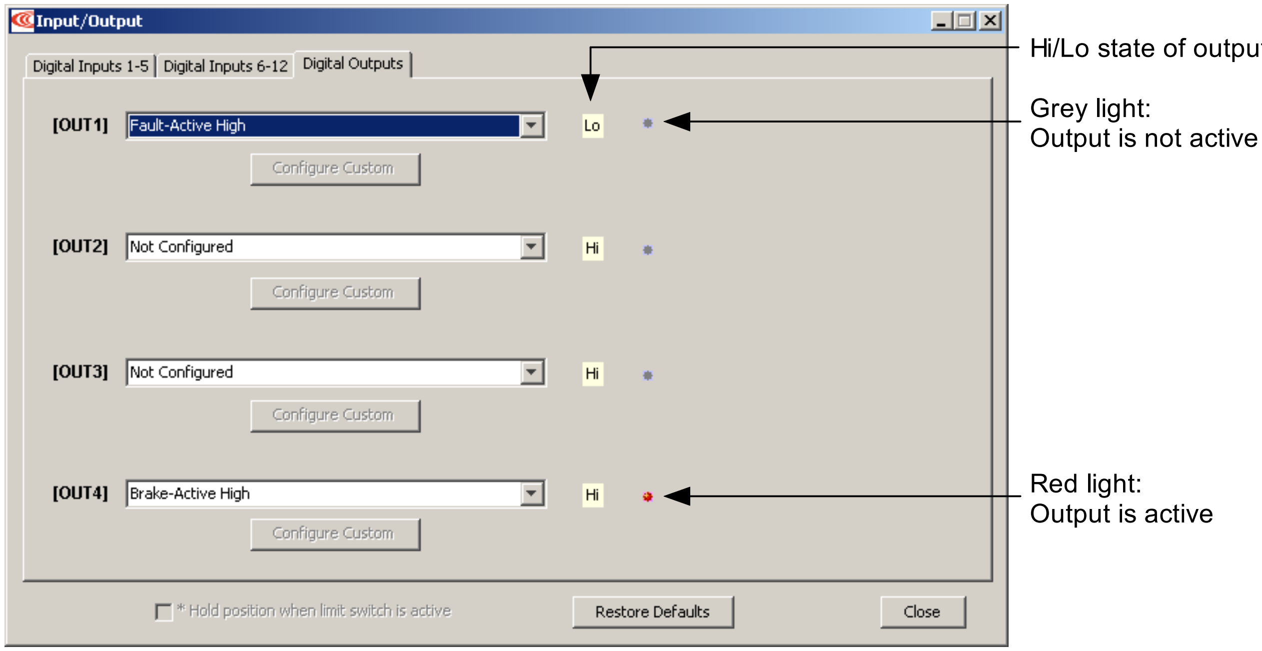
Other inputs can be programmed as additional enables. If there is more than one input programmed as an enable then all the inputs must be in the enabled state before the amplifier PWM output stage will be enabled.

Motor Over Temperature: On the STX amplifier, IN12 is located on the motor feedback connector and is intended to be used for Motor Over Temperature.

Other: Other inputs may have predefined functions depending on mode of operation.

5.6.4: Standard Digital Outputs

5.6.4.1 Click the *Digital Outputs* tab of the *Input/Output* screen. A typical *Digital Outputs* screen is shown below. (Features may vary with amplifier model and configuration.)

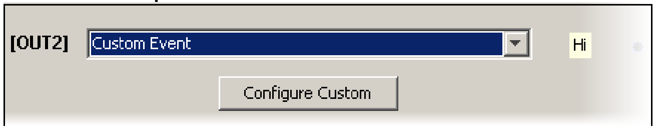


5.6.4.2 Choose any of these functions for any output. OUT4 is recommended for brake function.

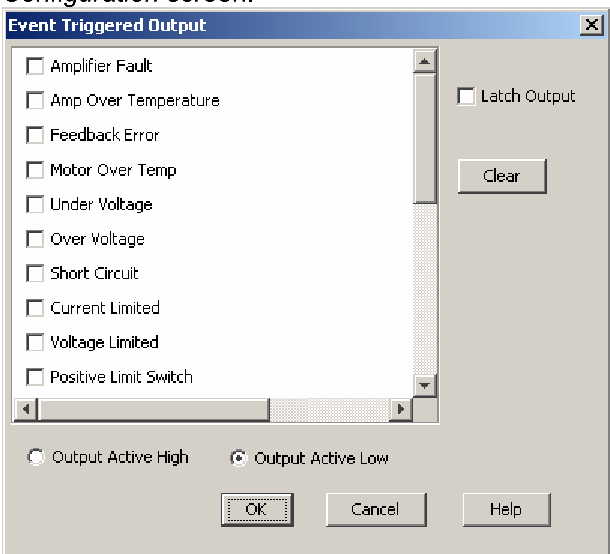
Output Function	Description	For More Information
Not Configured	No function assigned. Output remains high.	
Fault Active High	Output goes high when one or more faults are detected.	Faults (p. 37).
Fault-Active Low	Output goes low when one or more faults are detected.	
Brake-Active High	Output goes high to activate the brake.	Brake Operation (p. 34).
Brake-Active Low	Output goes low to activate the brake.	
PWM Sync Output (OUT1 only)	The PWM synchronization output.	
Custom Event	See Custom Digital Output Settings: Custom Event (p. 104).	
Custom Trajectory Status	See Custom Digital Output Settings: Custom Trajectory Status (p. 106).	
Custom Position Triggered Output	See Custom Digital Output Settings: Position Triggered Output (p. 107).	
Program Control Active High	Output state controlled by CVM or external program.	
Program Control Active Low	Output state controlled by CVM or external program	

5.6.5: Custom Digital Output Settings: Custom Event

Any of the amplifier's digital outputs can be programmed to respond to a combination of events including faults, warnings, and status indications. The output goes active when one or more of the selected events take place.



5.6.5.1 Choose **Custom Event** for an output and then click **Configure Custom** to open the *Event Configuration* screen.

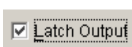


5.6.5.2 Select one or more of the faults described in Fault Descriptions (p. 38) or any of the following warnings or status conditions described below. Note that multiple functions are OR'ed together, so any event activates the output.

Custom Events: Warnings	
Warning	**Description**
Current Limited	The current output is being limited by the I^2T algorithm or a latched current fault has occurred. See I^2T Time Limit Algorithm (p. 167).
Voltage Limited	The current loop is commanding full bus voltage in an attempt to control current. Commonly occurs when motor is running as fast as available bus voltage allows.
Positive Limit Switch	Axis has contacted positive limit switch.
Negative Limit Switch	Axis has contacted negative limit switch.
Positive Software Limit	Actual position has exceeded the positive software limit setting. See Home Function (p. 164).
Negative Software Limit	Actual position has exceeded the negative software limit setting. See Home Function (p. 164).
Following Warning	Following error has reached programmed warning limit. See Following Error Fault Details (p. 40).
Velocity Limit Reached	Velocity command (from analog input, PWM input, or position loop) has exceeded the velocity limit that was set as described in Servo Velocity Loop Limits (p. 21).
Acceleration Limit reached	In velocity mode, motor has reached an acceleration or deceleration limit that was set as described in Servo Velocity Loop Limits (p. 21).
Velocity Outside of Tracking Window	Difference between target and actual velocity has exceeded the window. See Tracking Window Details (p. 41).
Position Outside of Tracking Window	The following error has exceeded the programmed value. See Tracking Window Details (p. 41).
Continued…	

…Continued:	
Custom Events: Status	
Status	**Description**
Amplifier Disabled by Hardware	Amplifier enable input(s) is not active.
Amplifier Disabled by Software	Amplifier is disabled by a software command.
Attempting to Stop Motor	The amplifier, while in velocity or position mode, has been disabled. In velocity mode, amplifier is using the Fast Stop Ramp described in Servo Velocity Loop Limits (p. 21). In position mode, the amplifier is using the Abort Deceleration rate described in Trajectory Limits (p. 23). The output remains active until the amplifier is re-enabled.
Motor Brake Activated	Motor brake activated. See Brake Operation (p. 34) for more information.
PWM Outputs Disabled	The amplifier's PWM outputs are disabled.
Home Switch is Active	Axis has contacted the home limit switch.
Not Settled	The motor is moving, or it has not yet settled after a move. The amplifier is settled when it comes within the position tracking window and stays there for the tracking time at the end of a move. Once settled, it remains settled until a new move is started.

5.6.5.3 Choose Output Active High to have the output go high when active or Output Active Low to have the output go low when active.

5.6.5.4 

To optionally latch the selected events, set **Latch Output**. For more information on latching, see Non-Latched and Latched Custom Outputs (p. 108).

DANGER

Latching an output does not eliminate the risk of unexpected motion with non-latched faults.

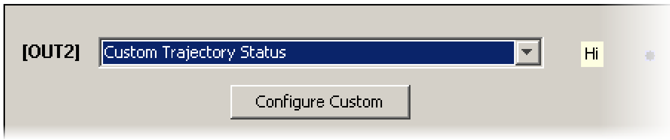
Associating a fault with a latched, custom-configured output does not latch the fault itself. After the cause of a non-latched fault is corrected, the amplifier re-enables without operator intervention. In this case, motion may re-start unexpectedly.

Failure to heed this warning can cause equipment damage, injury, or death.

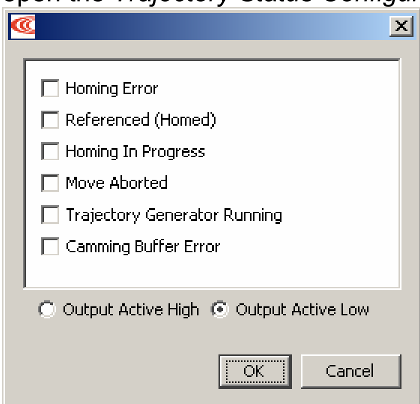
5.6.5.5 Click **OK** to save changes to volatile memory and close the *Custom Output Configuration* screen.

5.6.6: Custom Digital Output Settings: Custom Trajectory Status

Any of the amplifier's digital outputs can be programmed to respond to a combination of amplifier trajectory status conditions. The output goes active when one or more of the conditions is met.



5.6.6.1 Choose **Custom Trajectory Status** for an output and then click **Configure Custom** to open the *Trajectory Status Configuration* screen.



5.6.6.2 Select one or more trajectory status conditions described below. Multiple functions are OR'ed together, so any status match activates the output.

Trajectory Status Functions

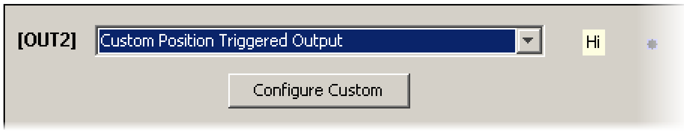
Status	Description
Homing Error	Activate output if an error occurred in the last homing attempt.
Referenced (Homed)	Activate output if the most recent homing attempt was successful.
Homing in Progress	Activate output when a homing move is in progress.
Move Aborted	Activate output if move is aborted.
Trajectory Generator Running	Activate output while trajectory generator is generating a move.
Camming Buffer Error	A camming buffer error has occurred.

5.6.6.3 Choose Output Active High to have the output go high when active or Output Active Low to have the output go low when active.

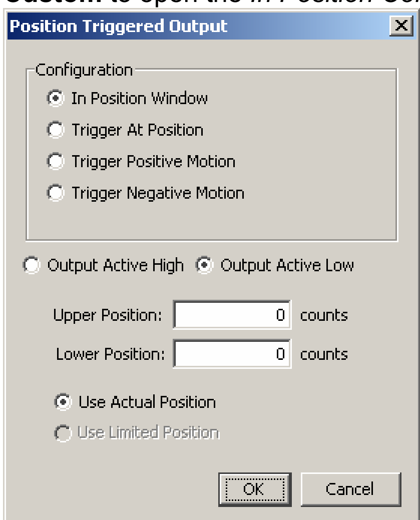
5.6.6.4 Click **OK** to save changes to volatile memory and close the screen.

5.6.7: Custom Digital Output Settings: Position Triggered Output

Any of the amplifier's digital outputs can be programmed to respond in certain ways to the position of the controlled axis. The output goes active when the axis position meets the specified criteria.

5.6.7.1 

5.6.7.2 Choose **Custom Position Triggered Output** for an output and then click **Configure Custom** to open the *In Position Configuration* screen.



5.6.7.3 Select one of the configurations described below and enter appropriate values for the parameters.

Configuration	Description and Parameters
In Position Window	Activates the output while the axis is in the window between the programmed **Upper** and **Lower** positions.
Trigger at Position	Activates the output for the programmed **Time** when the axis travels through the programmed **Position**.
Trigger Positive Motion	Activates the output for the programmed **Time** when the axis travels in the positive direction through the programmed **Position**.
Trigger Negative Motion	Activates the output for the programmed **Time** when the axis travels in the negative direction through the programmed **Position**.

5.6.7.4 Choose Output Active High to have the output go high when active or Output Active Low to have the output go low when active.

5.6.7.5 Choose **Use Actual Position** (with encoder only) or **Use Limited Position**.

5.6.7.6 Click **OK** to save changes to volatile memory and close the *Custom Output Configuration* screen.

5.6.8: Save Input/Output Changes

5.6.8.1 On the *Input/Output* screen, click **Close**.

5.6.8.2  On the *Main* screen, click **Save to Flash**.

5.6.9: Non-Latched and Latched Custom Outputs

Like an amplifier fault, a custom-configured output can be non-latched or latched.

If a non-latched, custom-configured digital output goes active, it goes inactive as soon as the last of the selected events is cleared.

If a latched output goes active, it remains active until at least one of the following actions has been taken:

- power-cycle the amplifier
- cycle (disable and then enable) an enable input that is configured as *Enables with Clear Faults* or *Enables with Reset*
-  access the CME 2 *Control Panel* and press **Clear Faults** or **Reset**
- clear faults over the CANopen network

DANGER

Latching an output does not eliminate the risk of unexpected motion with non-latched faults.

Associating a fault with a latched, custom-configured output does not latch the fault itself. After the cause of a non-latched fault is corrected, the amplifier re-enables without operator intervention. In this case, motion may re-start unexpectedly.

For more information, see Clearing Non-Latched Faults (p. 37).

Failure to heed this warning can cause equipment damage, injury, or death.

Custom Event Output Faults

An output configured for Custom Event can be programmed to go active in response to events, including any of the amplifier faults described in Fault Descriptions (p. 38).

Example: Custom Output Fault Handling vs. Overall Fault Handling

A fault on an output configured for Custom Event is separate from a fault on the amplifier. For instance, suppose:

- OUT3 has a *Custom Event* configuration. Only the *Under Voltage* fault condition is selected, and the output is latched.
- *Under Voltage* is not latched on the *Configure Faults* screen.

An under voltage condition occurs, and the amplifier goes into fault condition, output stages are disabled, and faults are reported. At the same time, OUT3 goes active.

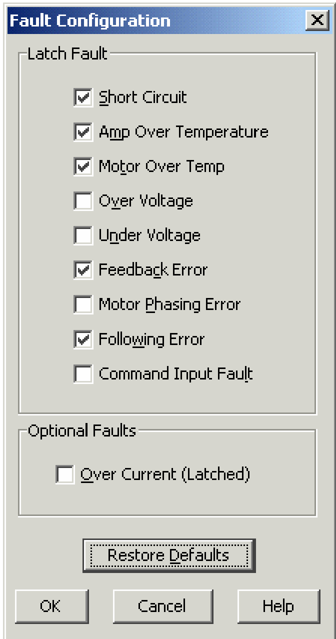
The under voltage condition is corrected, and:

- The amplifier fault is cleared. Output stages are enabled.
- OUT3 remains active.

5.6.10: Fault Latching

5.6.10.1 

Click **Configure Faults** to open the *Fault Configuration* screen.



Note that with no encoder, the Following error fault is not displayed as a choice.

5.6.10.2 To make a fault condition latching, click to put a check mark next to the fault description.

DANGER

Risk of unexpected motion with non-latched faults.

After the cause of a non-latched fault is corrected, the amplifier re-enables the PWM output stage without operator intervention. In this case, motion may re-start unexpectedly. Configure faults as latched unless a specific situation calls for non-latched behavior. When using non-latched faults, be sure to safeguard against unexpected motion.

Failure to heed this warning can cause equipment damage, injury, or death.

For more information on faults, see Faults (p. 37).

5.6.10.3 To restore factory defaults if needed, click **Restore Defaults.**

5.6.10.4 Click **OK** to save fault configuration settings to amplifier RAM and close the *Fault Configuration* screen
OR
click **Cancel** to restore to previous values and close the screen.

5.6.10.5 On the *Main* screen, click **Save to Flash**.

5.7: Command Input

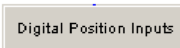
Choose the appropriate step for the input format.

Input Format	Step
Digital Position	Digital Position Input (p. 111)
CAN	CAN Interface (p. 112)
PWM (servo mode only)	PWM Input (p. 113)
Analog	Analog Command Input (STX Servo Mode Only) (p. 114)

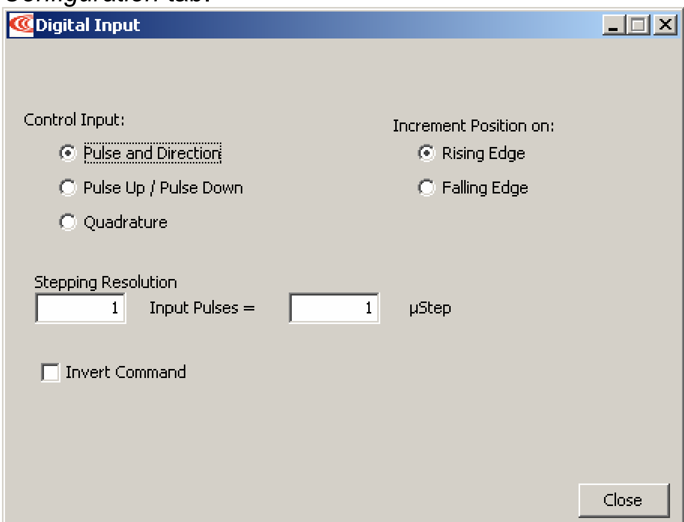
To run the amplifier with Command Input set to *Software Programmed* or *Function Generator*, see the *CME 2 User Guide.* To run the amplifier with Command Input set to *Camming*, see the *Copley Camming User's Guide.*

5.7.1: Digital Position Input

For more information, see Digital Position Inputs (p. 27).

5.7.1.1 

Click **Digital Position Inputs** to open the *Digital Position Input* screen, *Configuration* tab.



5.7.1.2 Set the options described below:

Option	Description
Control Input	**Pulse and Direction:** One input takes a series of pulses as motion step commands, and another input takes a high or low signal as a direction command. **Pulse Up / Pulse Down:** One input takes each pulse as a positive step command, and another takes each pulse as a negative step command. **Quadrature:** A/B quadrature commands from a master encoder (via two inputs) provide velocity and direction commands.
Increment position on	**Rising Edge:** Increment position on the rising edge of the input pulse. **Falling Edge:** Increment position on the falling edge of the input pulse.
Stepping Resolution	**Input Pulses:** Number of Input Pulses required to produce output counts. Range: 1 to 32,767. Default: 1. **Output Counts:** Number of Output Counts per given number of input pulses. Range: 1 to 32,767. Default: 1.
Invert Command	When selected, inverts commanded direction.

5.7.1.3 Click **Close**.

5.7.1.4  On the *Main* screen, click **Save to Flash**.

5.7.1.5 Proceed to Stepper Mode Phase and Tune (p. 115).

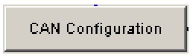
5.7.2: CAN Interface

For more information on CAN see CAN Addressing (p. 32).
For information on DeviceNet, see the *Copley DeviceNet Programmer's Guide.*

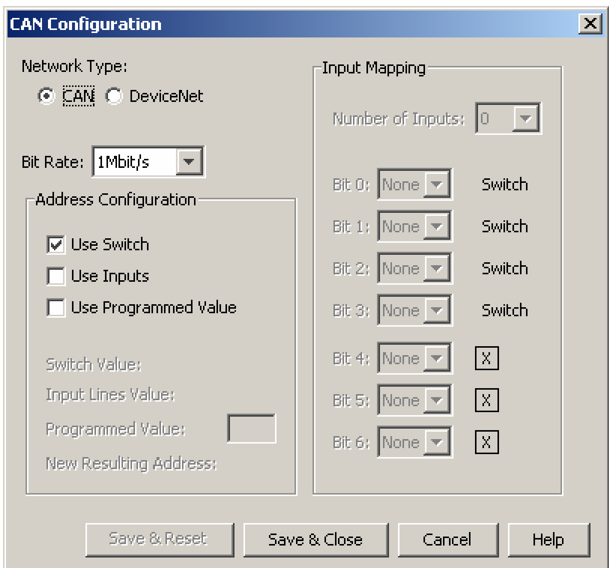
5.7.2.1 Verify that the CAN bus is properly wired and terminated according to the instructions in Stepnet Panel (STP) CAN Bus (J5 and J6) (p. 65).

1. J6 "CAN" CANopen cable

2. J6 "CAN" Termination plug

5.7.2.2 

Click **CAN Configuration** to open the *CAN Configuration* screen. (If CAN is not the Position Loop Input, choose **Amplifier→Network Configuration** instead.)
Here is a typical *CAN Configuration* screen. (Features may vary based on amplifier model and configuration.)



5.7.2.3 Choose a Bit Rate and choose any combination of address sources (Switch, Inputs, and Programmed Value). The address is the sum of the values from these sources.

5.7.2.4 For each source selected, perform the additional steps described below.

Source	Additional Steps
Use Switch	Verify the S1 switch setting. (Assigns values for Bit 0 – Bit 3 of CAN address.)
Use Inputs	Enter the **Number of inputs**. Choose the input that will represent each CAN address bit.
Use Programmed Value	Enter the **Programmed value**.

5.7.2.5 Click **Save & Reset** to save changes to amplifier flash, close the screen, and reset the amplifier. Click **Save & Close** to save changes to amplifier flash without resetting.
NOTE: CAN address and bit rate changes take effect only after power-up or reset.

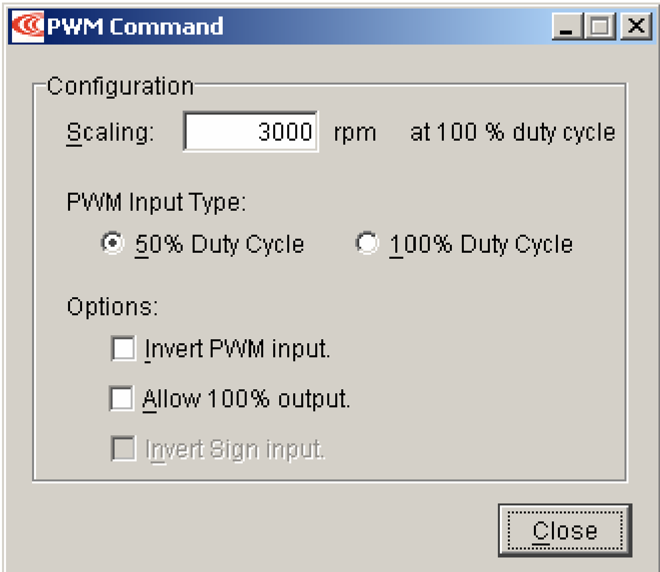
5.7.2.6 Proceed to Stepper Mode Phase and Tune (p. 115) or Servo Mode Phase and Tune (p. 131) as appropriate.

5.7.3: PWM Input (Servo Mode Only)

For more information, see PWM Input (Servo Mode Only) (p. 29).

5.7.3.1 

Click **PWM Command** to open the *PWM Command* screen.



5.7.3.2 Set the input options described below.

Option	Description
Scaling	Current mode: output current at 100% duty cycle. Range: 0 to 10,000,000 A. Default: *Peak Current* value. Velocity mode: output velocity at 100% duty cycle. Range: 0 to 100,000 rpm (mm/sec). Default: *Maximum Velocity* value.
PWM Input Type	One wire 50% or two wire 100% with direction.
Options	Invert PWM input: Inverts the PWM logic. Allow 100% output: Overrides the 100% command safety measure. See Failsafe Protection from 0 or 100% Duty Cycle Commands (p. 29). Invert Sign Input: In 100% duty cycle mode, inverts the polarity of the directional input.

5.7.3.3 Click Close.

5.7.3.4  On the *Main* screen, click **Save to Flash**.

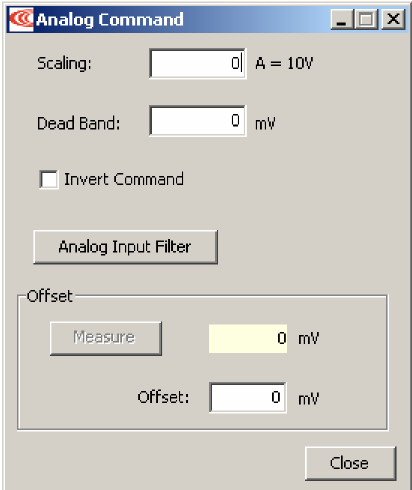
5.7.3.5 Proceed to Servo Mode Phase and Tune (p. 131).

5.7.4: Analog Command Input (STX Servo Mode Only)

For more information, see Analog Command Input (STX Servo Mode Only) (p. 25).

5.7.4.1 

Click **Analog Command** to open the *Analog Command* screen.



5.7.4.2 Set the input options described below.

Option	Description
Scaling	**Current mode:** output current produced by +10 Vdc of input. Range: 0 to 10,000,000 A. Default: *Peak Current* value. **Velocity mode:** output velocity produced by +10 Vdc of input. Range: 0 to 100,000 rpm (mm/sec). Default: *Maximum Velocity* value. **Position mode:** position change (counts or mm) produced by +10 Vdc of input. Range: 0 to 1,000,000,000 counts. Default: 1 Revolution of a rotary motor or 1 pole pair distance for a linear motor. For more information, see Scaling (p. 25).
Dead Band	Sets dead band. Range: -10,000 to 10,000 mV. Default: 0. For more information, see Dead Band (p. 25).
Invert Command	Inverts polarity of amplifier output with respect to input signal.
Offset	(Current and Velocity modes only.) Used to offset input voltage error in an open loop system. Not recommended for use when the amplifier is part of a closed loop system. Range: -10,000 to 10,000 mV. Default: 0. For more information, see Offset (p. 26).
Analog Input Filter	Programmable input filter. Disabled by default. See “Low-Pass and Bi-Quad Filters” in the *CME 2 User’s Guide.*

5.7.4.3 Click Close.

5.7.4.4  On the *Main* screen, click **Save to Flash**.

5.7.4.5 Proceed to Servo Mode Phase and Tune (p. 131).

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CHAPTER

6: STEPPER MODE PHASE AND TUNE

This chapter describes the general procedure for auto phasing and tuning an amplifier with a motor to operate in stepper mode.

6.1: Auto Phase (Stepper Mode)

6.1.1: Auto Phase Warnings and Notes

Warnings

DANGER

Motor Motion

Applying high voltage power to the amplifier before auto phasing may result in motor motion. Be sure that motor motion will not cause injury.

Failure to heed this warning can result in equipment damage, injury, or death.

Danger

High Voltage

Applying AC power to the STX amplifier applies high voltage to the amplifier-motor connections and cabling. Protect personnel against electrical shock.

Failure to heed this warning can result in equipment damage, injury, or death.

Notes

- Do not connect a load to the motor before performing Auto Phase procedure.
- Always connect the motor using the same configuration.
- Wire properly and consistently.
- Connections are actually changed within the DSP, not at the motor terminals, and the results are saved to flash memory. The actual wire configuration should NEVER change.

Phasing a stepper motor establishes positive direction for the motor and (if present) encoder.

6.1.2: Auto Phase Preliminary Steps

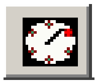
6.1.2.1 Verify that the Enable Input is not activated.

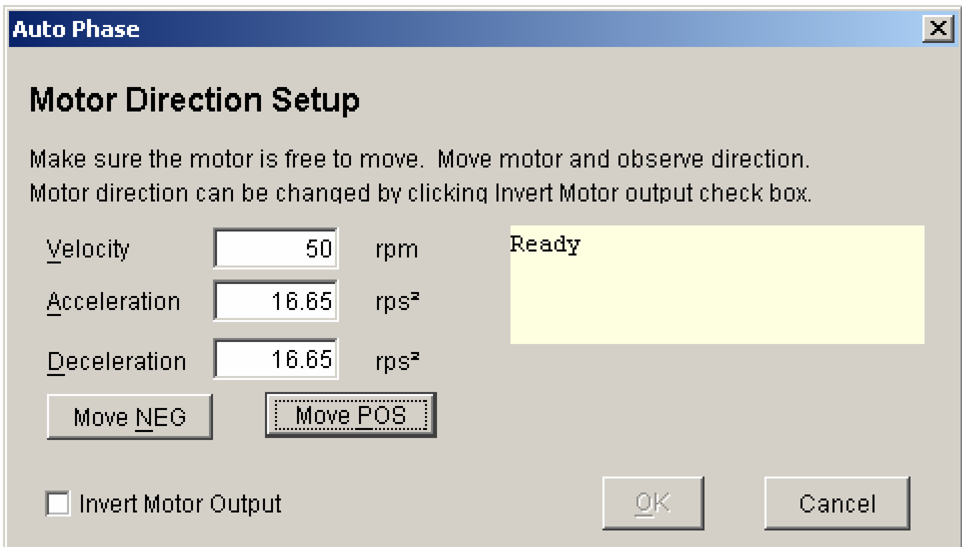
6.1.2.2 Apply power.

6.1.2.3 Choose the appropriate auto phase procedure for the configuration:

Configuration	Procedure
Stepper mode, no encoder	Auto Phase (Stepper Mode, No Encoder (p. 117))
Stepper mode with encoder	Auto Phase Procedure (Stepper Mode with Encoder (p. 118))

6.1.3: Auto Phase (Stepper Mode, No Encoder)

6.1.3.1  Click **Auto Phase** to open the *Auto Phase Motor Direction Setup* screen.



6.1.3.2 Activate the Enable Input.

6.1.3.3 Verify the Velocity, Acceleration, and Deceleration values.

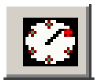
6.1.3.4 Hold down **Move POS** to move the motor in the direction considered positive, and observe the direction of movement.
If the motor does not move, see Trouble Shoot Motor Wiring Setup (p. 119).

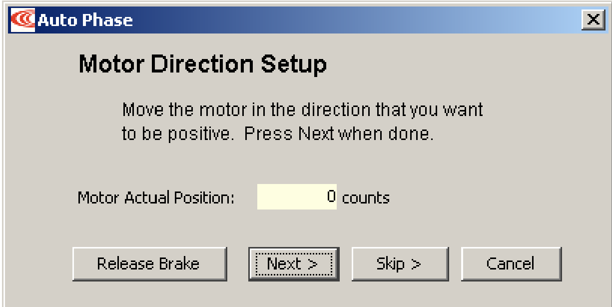
6.1.3.5 If the motor did not move in the direction that you wish to program as the positive direction, click **Invert Motor Output**, and repeat 6.1.3.4.

6.1.3.6 Click **OK** to save the direction setting.

6.1.3.7 Proceed to Current Loop (p. 122).

6.1.4: Auto Phase Procedure (Stepper Mode with Encoder)


Click **Auto Phase** to open the *Auto Phase Motor Direction Setup* screen.

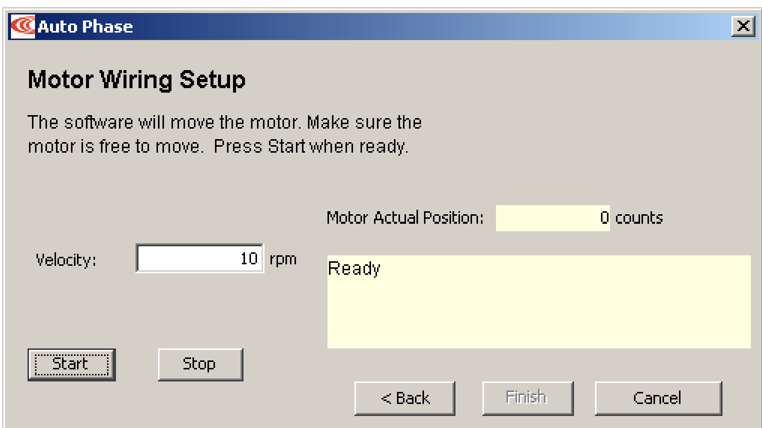


6.1.4.1 Activate the Enable Input.

6.1.4.2 Move the motor at least three counts in the direction considered positive.

6.1.4.3 If the Motor Actual Position count does not change, see Trouble Shoot Motor Direction Setup (p. 119).

6.1.4.4 Click *Next* to open the Motor Wiring Setup screen.



6.1.4.5 Verify the Velocity setting.

6.1.4.6 Click **Start** to begin motor wiring setup.
The software displays messages: Configuring Initial Settings, Microstepping, Test Complete, Motor Wiring has been configured.

During microstepping, a current vector is applied to the motor windings and microstepped through an electrical cycle at a set rate, causing the motor to move.

If you chose to **Skip** the motor direction setup step, Auto Phase will prompt for confirmation of correct motor direction.

If the step fails see Trouble Shoot Motor Wiring Setup (p. 119).

6.1.4.7 Click **Finish** to close the screen and save values to amplifier flash.

6.1.5: Trouble Shoot Motor Direction Setup

If motor direction setup step failed:

6.1.5.1 If an encoder is used, check encoder power and signals.

6.1.5.2 Check shielding for proper grounding.

6.1.6: Trouble Shoot Motor Wiring Setup

If motor wiring setup step failed:

6.1.6.1 Verify that amplifier is disabled.

6.1.6.2 Check for mechanical jamming.

6.1.6.3 Check for good connections to the motor power wires.

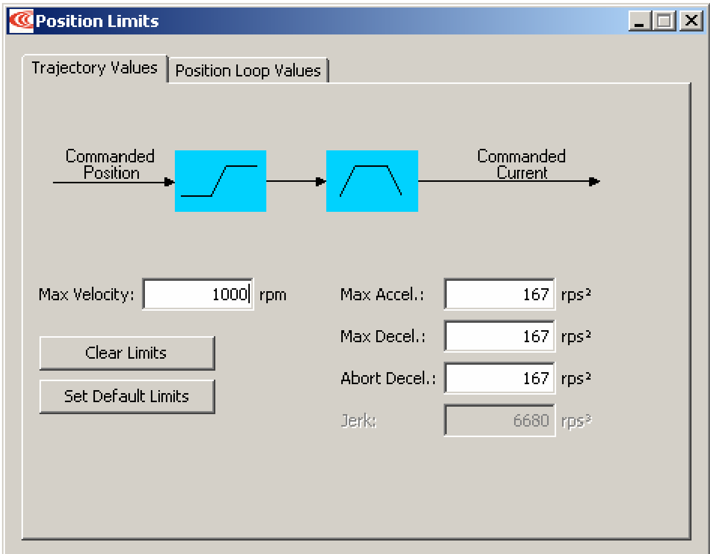
6.1.6.4 Disconnect motor power wires.

6.1.6.5 Measure for proper motor resistance.

6.2: Position Limits (Stepper Mode with Encoder)

6.2.1.1 

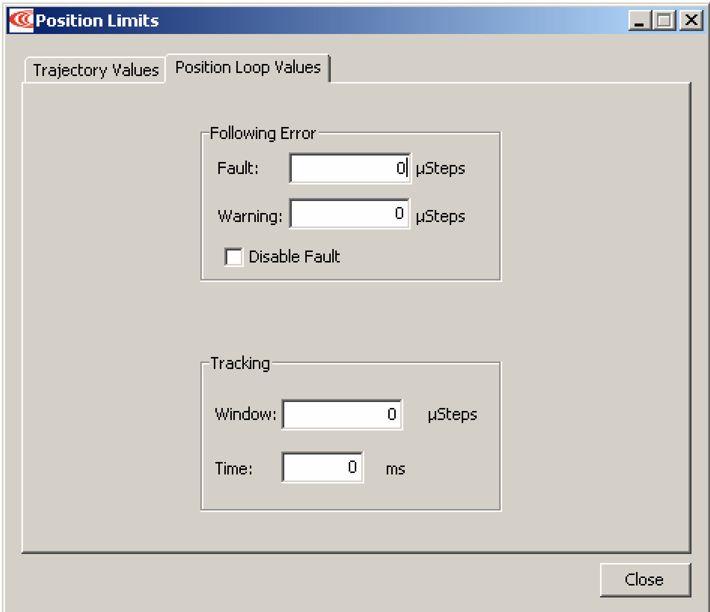
Click **Position Limits** to open the *Position Limits* screen.



6.2.1.2 Set the following Trajectory Values options as needed.

Option	Description	For More Information
Max Velocity	Maximum trajectory velocity. Max value may depend upon the back EMF and the Max feedback count (servo mode) or maximum number of microsteps (stepper mode). Min:0. Default: 0.25 x motor velocity limit.	Servo Position Mode and Position Loop (p. 23).
Max Accel	Maximum trajectory acceleration. Max value may depend upon the load inertia and boost current (stepper mode) or peak current (servo mode). Min:0	
Max Decel	Maximum trajectory deceleration. Max value may depend upon the load inertia and boost current (stepper mode) or peak current (servo mode). Min: 0 (disables limit).	
Abort Decel	Deceleration rate used by the trajectory generator when motion is aborted. Min: 0 (disables limit).	Brake Operation (p. 34).
Clear Limits	Sets Max Velocity, Max Accel, and Max Decel to zero, disabling the trajectory generator.	
Set Default Limits	Restores Max Velocity, Max Accel, and Max Decel to calculated defaults.	

6.2.1.3 Open the **Position Loop Values** tab.



6.2.1.4 Set the following Position Loop Values options as needed.

Option/Description		For More Information
Following Error		
Fault	The level (in µSteps) at which the following error produces a fault. We recommend raising the fault level before tuning the loop.	Following Error Fault Details (p. 40).
Warning	The level (in µSteps) at which the following error produces a warning.	
Disable Fault	Prevents following error from triggering a fault.	
Tracking		
Tracking Window	Width of the tracking window in µSteps.	Tracking Window Details (p. 41).
Tracking Time	Position must remain in the tracking window for this amount of time to be considered tracking.	

6.2.1.5 Click **Close.**

6.2.1.6  On the *Main* screen, click **Save to Flash** to save the changes.

6.3: Current Loop

Initial current loop proportional gain (**Cp**) and current loop integral gain (**Ci**) values were calculated during general amplifier setup. For an introductory overview of the control loops, see Stepper Mode Operation (p. 16).

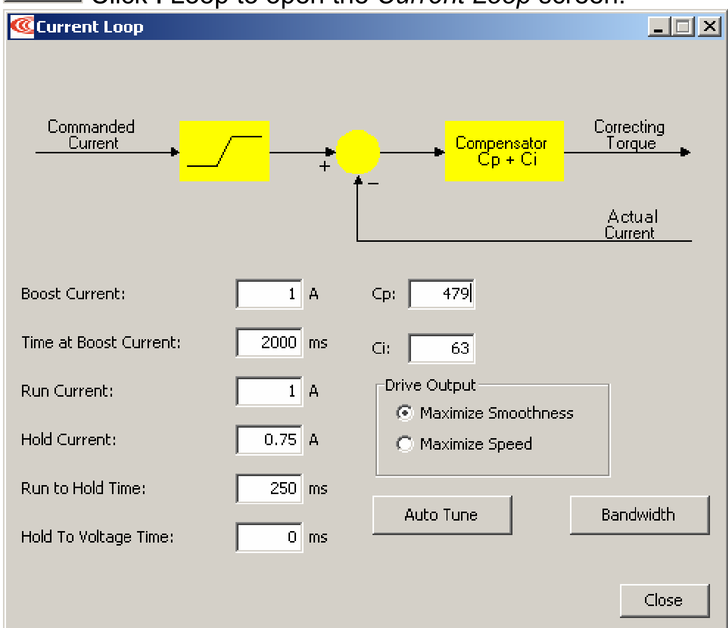
NOTE: For Copley digital amplifiers, current loop gain is independent of power supply voltage.

6.3.1: Current Loop Settings

For more information, see Current Control in Stepper Mode (p. 17).

6.3.1.1 

Click I Loop to open the *Current Loop* screen:

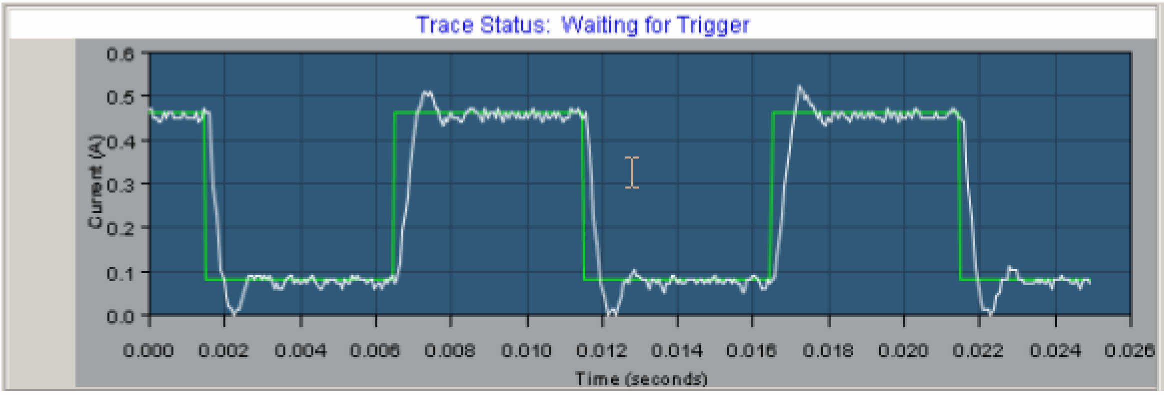


6.3.1.2 Set the following options as needed.

Options	Description
Boost Current	Current used during acceleration and deceleration.
Time at Boost Current.	Maximum time at boost current.
Run Current	Current used during continuous velocity portion of moves.
Hold Current	Current used to hold motor at rest.
Run to Hold Time	The period of time, beginning when a move is completed, during which the output stays at Run Current level before switching to Hold Current level.
Hold to Voltage Time	The period of time, beginning when a move is completed, during which the output stays at Hold Current level before switching to the voltage mode in which the amplifier locks the duty cycle to prevent jitter. Setting to zero disables Voltage Mode.
Cp	Current loop proportional gain. Range 0 – 32,767.
Ci	Current loop integral gain. Range 0 – 32,767.
Drive Output	**Maximize Smoothness:** Amplifier uses circular vector limiting to produce smooth operation even into the voltage limits. **Maximize Speed:** Allows for slightly more of the bus voltage to be used when in the voltage limit. This may produce a small disturbance at top speed.
Auto Tune	See the CME 2 User Guide.
Bandwidth	Measure bandwidth using the Cp and Ci values now in the amplifier.

6.3.2: Manually Tune Current Loop

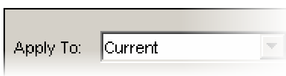
To tune the current loop, apply square-wave excitation to the current loop and adjust current loop proportional gain (**Cp**) and current loop integral gain (**Ci**) to obtain a desired waveform.



NOTE: During tuning, observe any warnings that appear to the left of the trace.

NOTE: For information on the alternate Auto Tune feature, see the *CME 2 User Guide*.

6.3.2.1  Click the Scope Tool.

6.3.2.2 

Choose **Current** from the Function Generator *Apply To:* list.

On the *Settings* tab, make sure **Auto Setup** is selected.

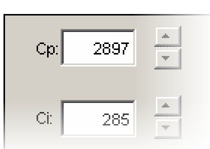
Auto Setup automatically sets the following parameters:

Function Generator Tab	
Function	Square Wave.
Amplitude	50 % of current loop Run Current setting.
Frequency	100 Hz.
Amplitude Offset	10 percent of current loop Run Current setting.
Settings Tab	
Channel 1	Commanded Current (green).
Channel 2	Actual current (white).

6.3.2.3 

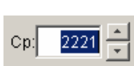
Verify that the Amplitude value is not excessive for the motor.

6.3.2.4 Click **Start**.

6.3.2.5 

On the *Gains* tab, adjust current loop proportional gain (**Cp**).

1. Set current loop integral gain (**Ci**) to zero.
2. Raise or lower Cp until desired step response is obtained. Typically, this means little or no overshoot with a 100 Hz square wave at 50 percent of Run Current. If the Cp value is too large, ringing may occur. If the Cp value is too low, bandwidth decreases. Make sure gain values don't produce excessive ring.

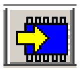
TIP: 

To change a value, highlight the value. Then enter value directly, use mouse and arrow controls, OR use Page Up/Page Down keys to move in increments of 10.

6.3.2.6 Adjust current loop integral gain (**Ci**) until desired settling time is obtained.

6.3.2.7 

Press **Stop** to stop the function generator.

6.3.2.8  On the Main screen, click **Save to Flash** to avoid losing the changes.

6.3.3: Optimize Hold and Run Current Ratings

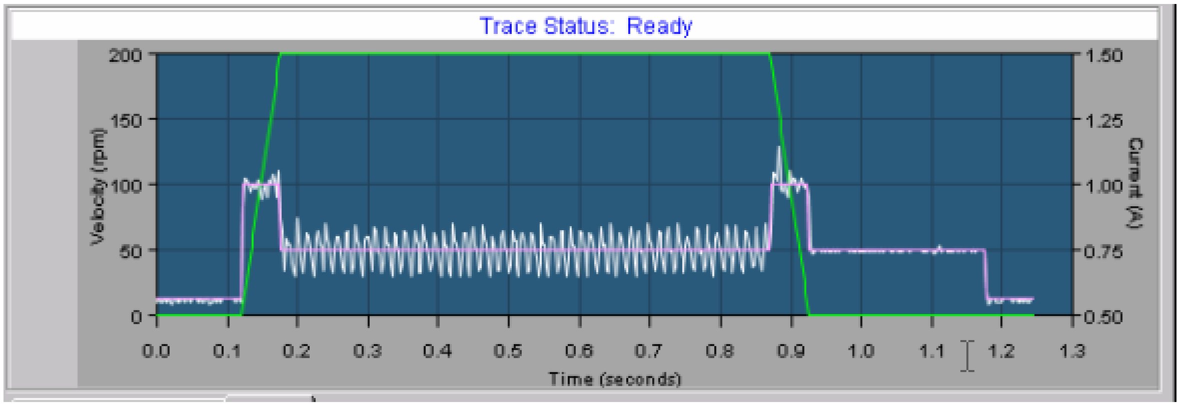
6.3.3.1 Reduce Hold Current if possible, to reduce heat generation.

1. Test with load OR
2. Calculate:
   Hold Current requirement >=
   hold torque x (rated current/rated torque)

6.3.3.2 Reduce Run Current if possible, to reduce heat generation.

6.4: Profile Move Tests

Test the system with various gains, limits, and load conditions.



NOTE: During profile tests, observe any warnings that appear to the left of the trace.

6.4.1.1  Click the Scope Tool.

6.4.1.2 Select the *Profile* tab.

6.4.1.3 

On the *Settings* tab, make sure **Auto Setup** is selected.

Auto Setup automatically sets the following parameters:

Profile Tab	
Move	Relative
Type	Trap
Distance	½ revolution (rotary) or 2 cm (linear)
Reverse and repeat	Not checked
Settings Tab	
Channel 1	Profile velocity (green)
Channel 2	Actual current (white)
Channel 3	Commanded current (purple)

6.4.1.4 Set up a trapezoidal profile by setting the trajectory limits and distance. See table:

Trajectory Limits Tab	
Maximum Velocity	Set values typical of those expected to be used in the application.
Maximum Acceleration	
Maximum Deceleration	
Profile Tab	
Distance	Set the move distance to produce a complete trajectory profile. Be sure that this distance does not exceed mechanical limits of the system.
Move	Relative
Type	Trap

NOTES:

1 The profile may not reach constant velocity during a short move.

2 At higher speeds, motor back EMF may limit Boost and Run currents.

6.4.1.5 Click **Start**. The Profile Generator executes the move.

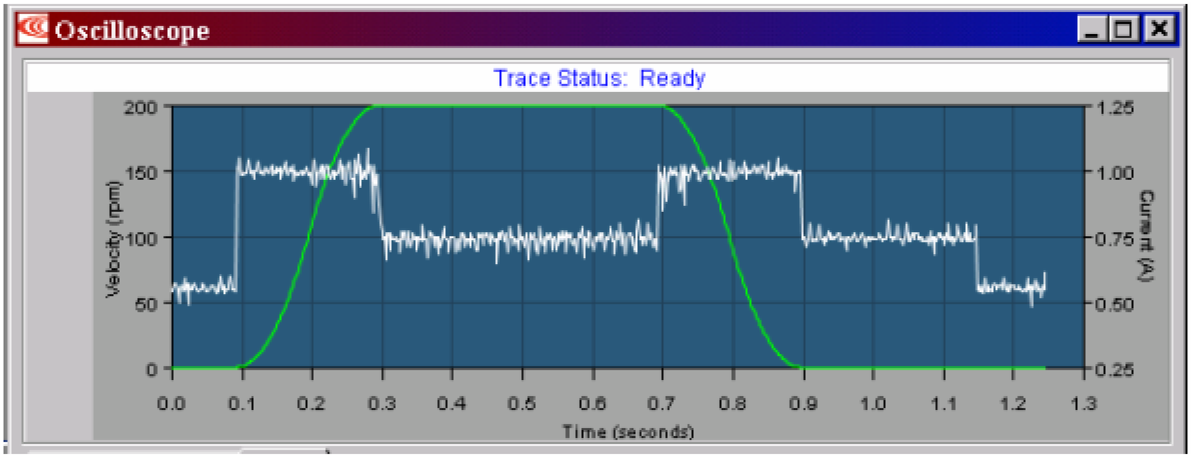
6.4.1.6 Verify that the boost, run, and hold currents are appropriate for the move.

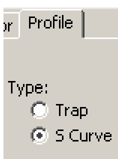
6.4.1.7 Try multiple sets of profiles representing typical moves that might be executed in the application. Starting with Set up a trapezoidal profile, repeat the process as needed.

6.4.2: Test S-Curve Profile

NOTE: Skip this step unless the amplifier will perform CANopen S-Curve profile moves.

Jerk is the rate of change of acceleration. S-Curve moves reduce jerk to provide a smooth profile. To tune the level of jerk, run an S-Curve profile and adjust velocity, acceleration, deceleration, and jerk levels until the desired profile is obtained.



6.4.2.1 

On the *Profile* tab, click the **S-Curve** button.

6.4.2.2 Set up an S Curve profile by adjust the following options. Set values that represent a typical move under normal operation.

Trajectory Limits Tab	
Maximum Velocity	Maximum speed of the profile.
Maximum Acceleration/Deceleration	Top acceleration/deceleration of the profile. Deceleration = acceleration.
Maximum Jerk	The jerk value set by Calculate procedure gives an S-Curve whose maximum slope = the trapezoidal profile slope. This value gives a maximum acceleration no greater than the initial acceleration. Small values produce less jerking but take longer to complete move. Large values produce more jerking and a more trapezoidal profile but complete the move faster.
Profile Tab	
Distance	Increase the move distance to produce a complete trajectory profile. Use an acceptable value the does not exceed mechanical limits of the system.
Move	Relative
Type	S-Curve

6.4.2.3 Verify that the boost, run, and hold currents are appropriate for the move.

6.4.2.4 Try multiple sets of profiles representing typical moves that might be executed in the application. Starting with Set up an S Curve profile, repeat the process as needed.

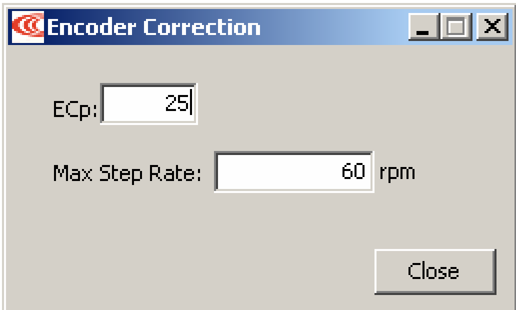
6.5: Encoder Correction

Optionally set encoder correction options:

6.5.1.1 Make sure the Encoder Correction option has been set.
See Basic Setup Screen, p. 93.

6.5.1.2 

On the CME 2 Main screen, click **Encoder Correction** to open the Encoder Correction screen.



6.5.1.3 Set the following options:

Options	Description
ECp	Gain used to correct following error.
Max Step Rate	Controls the maximum rate at which the axis is moved to provide encoder correction.

6.6: Completion Steps

6.6.1: Objective

Save the work and perform additional testing with load and under normal control source.

6.6.2: Steps

6.6.2.1  On the *Main* screen, click **Save to Flash**.

6.6.2.2 Remove power.

6.6.2.3 Attach load.

6.6.2.4 Reconnect power.

6.6.2.5 Re-test profiles.

6.6.2.6  On the *Main* screen, click **Save to Flash**

6.6.2.7  On the *Main* screen, click **Save to Disk** (for backup or duplication).

6.6.2.8  Click **Control Panel** and then click **Reset**
OR
Power-cycle the amplifier.

6.6.2.9 The amplifier stepper mode tuning procedure is complete.

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CHAPTER
7: SERVO MODE PHASE AND TUNE

This chapter describes the general procedure for auto phasing and tuning an amplifier with a motor to operate in servo mode.

7.1: Auto Phase (Servo Mode)

7.1.1: Auto Phase Warnings and Notes

Warnings

DANGER

Motor Motion

Applying high voltage power to the amplifier before auto phasing may result in motor motion. Be sure that motor motion will not cause injury.

Failure to heed this warning can result in equipment damage, injury, or death.

Danger

High Voltage

Applying AC power to the STX amplifier applies high voltage to the amplifier-motor connections and cabling. Protect personnel against electrical shock.

Failure to heed this warning can result in equipment damage, injury, or death.

Notes

- Do not connect a load to the motor before performing Auto Phase procedure.
- Always connect the motor using the same configuration.
- Wire properly and consistently.
- Connections are actually changed within the DSP, not at the motor terminals, and the results are saved to flash memory. The actual wire configuration should NEVER change.

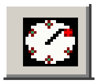
Phasing a stepper motor establishes positive direction for the motor and encoder.

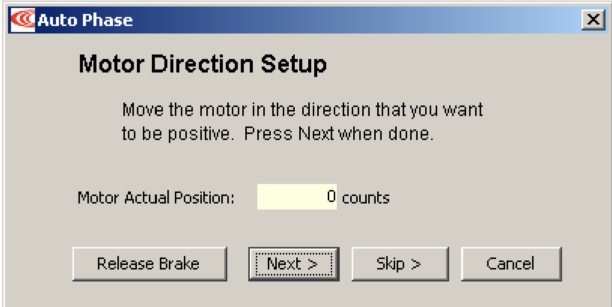
7.1.2: Auto Phase Preliminary Steps

7.1.2.1 Verify that the Enable Input is not activated.

7.1.2.2 Apply power.

7.1.3: Auto Phase Procedure

 Click **Auto Phase** to open the *Auto Phase Motor Direction Setup* screen.

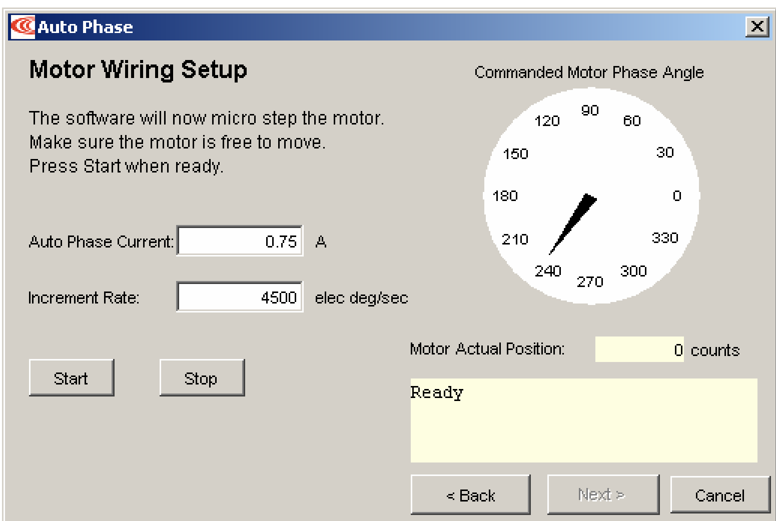


7.1.3.1 Activate the Enable Input.

7.1.3.2 Move the motor in the direction to be considered positive
OR if you cannot move the motor, click **Skip** (you will confirm motor direction later).
NOTE: If an output is configured as a brake you can temporarily release the brake by holding down the **Release Brake** button. The brake will be reactivated when you release the button.

7.1.3.3 The Actual Position value on the screen should change. If it does not change, see Trouble Shoot Motor Direction Setup (p. 119).

7.1.3.4 Click *Next* to open the Motor Wiring Setup screen.



7.1.3.5 Click **Start** to begin the motor wiring setup.

The software displays messages: *Configuring Initial Settings, Microstepping, Test Complete, Motor Wiring has been configured*.

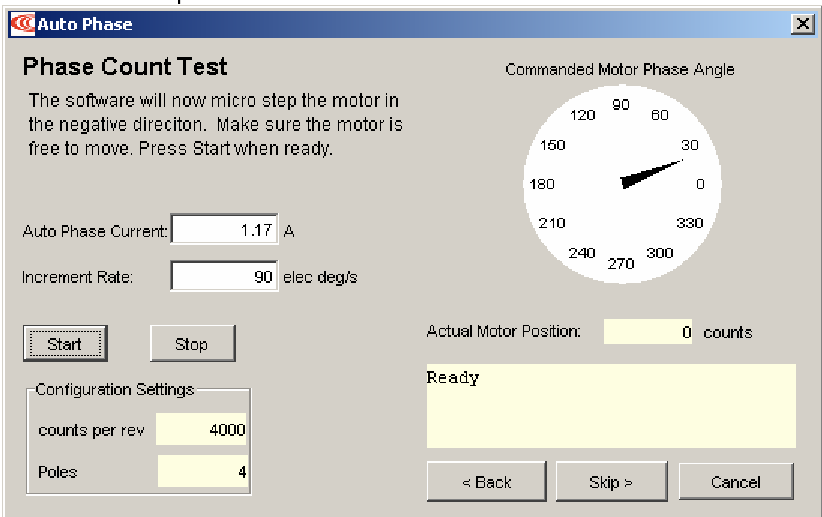
During microstepping, a current vector is applied to the motor windings and microstepped through an electrical cycle at a set rate, causing the motor to move.

If you chose to **Skip** the motor direction setup step, Auto Phase will prompt for confirmation of correct motor direction.

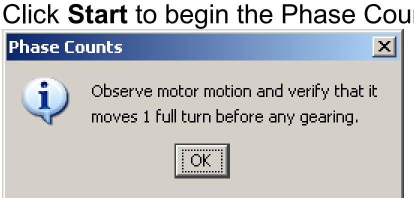
If the step fails see Trouble Shoot Motor Wiring Setup (p. 119).

NOTE: If incorrect values were entered for inductance and resistance, the calculated Cp and Ci values may produce current loop oscillation, evidenced by an audible high frequency squeal during auto phasing.

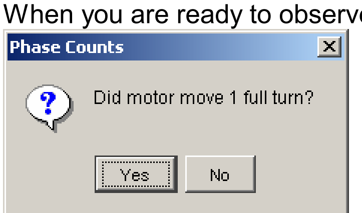
7.1.3.6 Click **Next** to open the *Phase Count Test* screen.



7.1.3.7 Click **Start** to begin the Phase Count Test. Observe status messages. See the prompt:



7.1.3.8 When you are ready to observe motion, click **OK**. See the prompt:

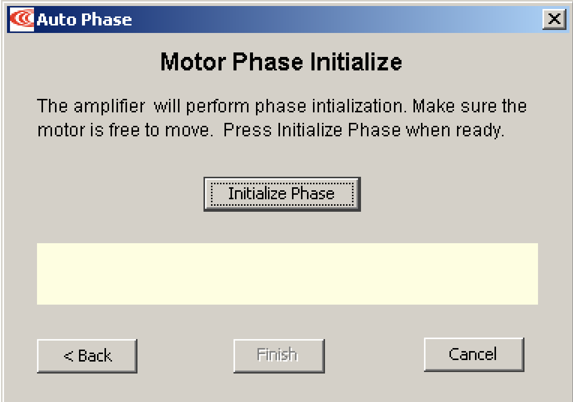


7.1.3.9 If motor did not turn 1 full turn, click **No** and verify that in the Motor/Feedback screen the following parameters have been set correctly:

- Number of Poles for rotary motors.
- Magnetic Pole Pair Length for linear motors
- Encoder Lines or Fundamental Lines for rotary encoders.
- Encoder Resolution for linear encoders.

7.1.3.10 If motor turned 1 full turn, click **Yes**.

7.1.3.11 Click **Next** to open the *Motor Phase Initialize* screen.



7.1.3.12 Click **Initialize Phase**.
The screen will display completion messages: *Test Complete, Phasing has been initialized.*

7.1.3.13 Click **Finish** to close the screen and save values to amplifier flash

7.1.3.14 If the Auto Phase algorithm does not produce desired results, try adjusting the Auto phase Current and Increment Rate values.

7.1.4: Trouble Shoot Motor Direction Setup

If motor direction setup step failed:

7.1.4.1 If an encoder is used, check Encoder power and signals.

7.1.4.2 Check shielding for proper grounding.

7.1.5: Trouble Shoot Motor Wiring Setup

If motor wiring setup step failed:

7.1.5.1 Verify that amplifier is disabled.

7.1.5.2 Check for mechanical jamming.

7.1.5.3 Check for good connections to the motor power wires.

7.1.5.4 Disconnect motor power wires.

7.1.5.5 Measure for proper motor resistance.

7.2: Current Loop

Initial current loop proportional gain (**Cp**) and current loop integral gain (**Ci**) values were calculated during general amplifier setup. For an introductory overview of the control loops, see Servo Modes and Control Loops (p. 19).

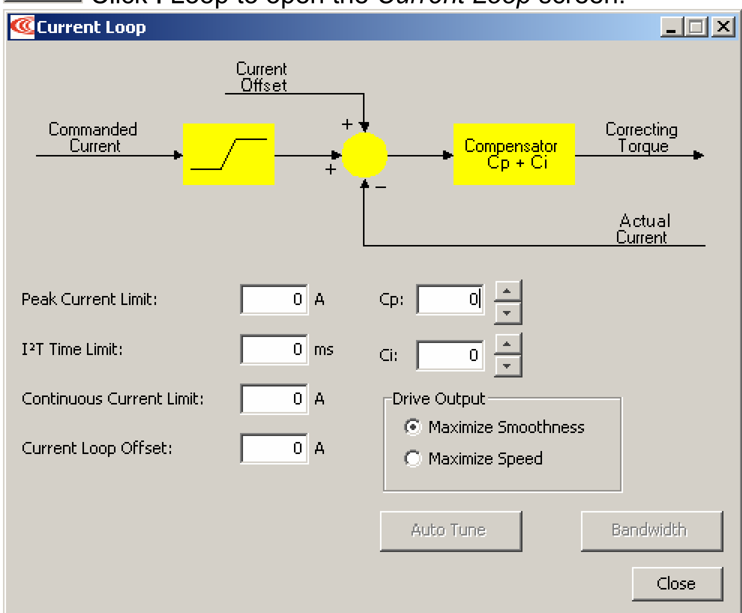
NOTE: For Copley Controls digital amplifiers, the current loop gain is independent of the power supply voltage.

7.2.1: Current Loop Settings

For more information, see Servo Current Mode and Current Loop (p. 19).

7.2.1.1 

Click I Loop to open the *Current Loop* screen:

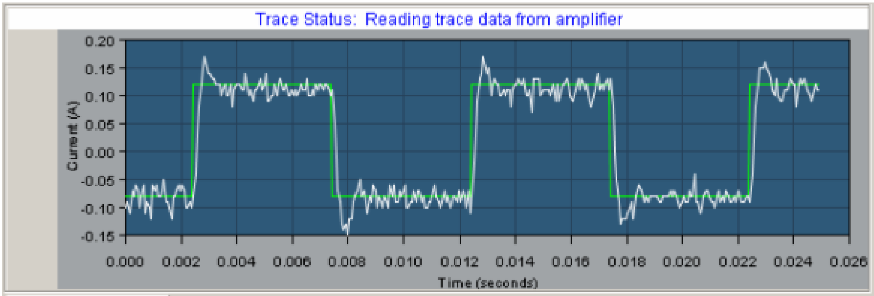


7.2.1.2 Set the following options as needed.

Options	Description
Peak Current Limit	Used to limit the peak phase current to the motor. Max value depends upon the amplifier model. Min value > continuous limit.
I^2T Time Limit	Sets I^2T Time Limit in mSec. For more information, see I2T Time Limit Algorithm (p. 167).
Continuous Current Limit	Used to limit the Phase Current. Max Value is < *Peak Current* and depends upon the amplifier model. Min value: 0
Current Loop Offset	Sets current loop offset. Leave it set to zero until after tuning. For more information, see Offset (p. 19).
Cp	Current loop proportional gain. Range 0 – 32,767.
Ci	Current loop integral gain. Range 0 – 32,767.
Drive Output	**Maximize Smoothness:** Amplifier uses circular vector limiting to produce smooth operation even into the voltage limits. **Maximize Speed:** Allows for slightly more of the bus voltage to be used when in the voltage limit. This may produce a small disturbance at top speed.
Auto Tune	See the CME 2 User Guide..
Bandwidth	Measure bandwidth using the Cp and Ci values now in the amplifier.

7.2.2: Manually Tune Current Loop

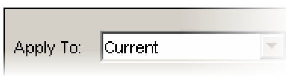
To tune the current loop, apply square-wave excitation to the current loop and adjust current loop proportional gain (**Cp**) and current loop integral gain (**Ci**) to obtain a desired waveform.



NOTE: During tuning, observe any warnings that appear to the left of the trace and take appropriate action.

NOTE: For information on the alternate Auto Tune feature, see the *CME 2 User Guide*.

7.2.2.1  Click the Scope Tool to open the *Oscilloscope* window.

7.2.2.2 

Choose **Current** from the Function Generator *Apply To:* list.

On the *Settings* tab, make sure **Auto Setup** is selected.

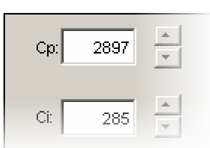
Auto Setup automatically sets the following parameters:

Function Generator Tab	
Function	Square Wave
Amplitude	10 % of current loop Continuous Current Limit setting
Frequency	100 Hz
Settings Tab	
Channel 1	Commanded Current (green)
Channel 2	Actual current (white)

7.2.2.3 

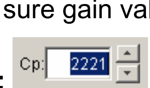
Verify that the Amplitude value is not excessive for the motor.

7.2.2.4 Click **Start**.

7.2.2.5 

On the *Gains* tab, adjust current loop proportional gain (**Cp**).

1. Set current loop integral gain (**Ci**) to zero.
2. Raise or lower Cp until desired step response is obtained. Typically, this means little or no overshoot with a 100 Hz, low-current square wave. If the Cp value is too large, ringing may occur. If the Cp value is too low, bandwidth decreases. Make sure gain values don't produce excessive ring.

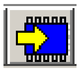
TIP: 

To change a value, highlight the value. Then enter value directly, use mouse and arrow controls, OR use Page Up/Page Down keys to move in increments of 10.

7.2.2.6 Adjust current loop integral gain (**Ci**) until desired settling time is obtained.

7.2.2.7 

Press **Stop** to stop the function generator.

7.2.2.8  On the Main screen, click **Save to Flash** to avoid losing the changes.

7.2.2.9 If the amplifier is to be operated in current mode, skip the velocity and position loop setup procedures and go to Completion Steps (p. 148).

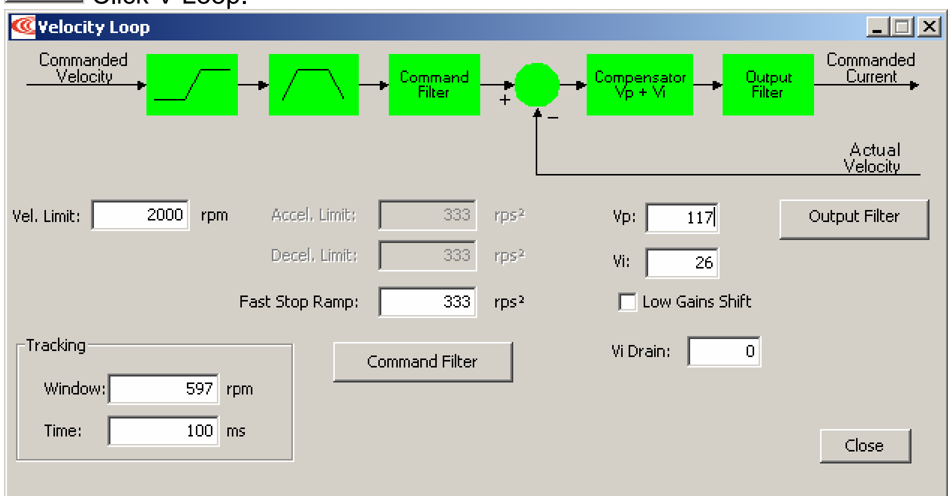
7.3: Velocity Loop

Initial velocity loop proportional gain (**Vp**) and velocity loop integral gain (**Vi**) values were calculated during general amplifier setup.

7.3.1: Velocity Loop Settings

For more information, see Servo Velocity Mode and Velocity Loop (p. 21).

Click V Loop.

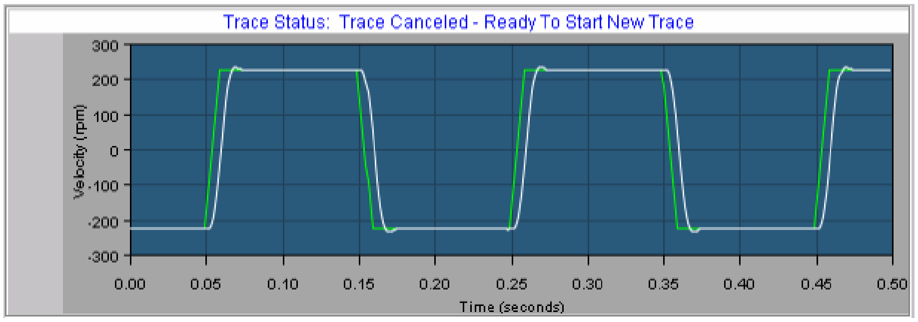


7.3.1.1 Enter the following options as needed.

Option	Description
Velocity Limit	Top speed limit. Max value may depend upon the back EMF & the Encoder resolution. Min value: 0.
Acceleration Limit	Maximum acceleration rate. Max value may depend upon load, inertia, & peak current. Min value: 1. (Does not apply in position mode.)
Deceleration Limit	Maximum deceleration rate. Max value may depend upon load, inertia, & peak current. Min value: 1. (Does not apply in position mode.)
Tracking Window	Width of the tracking window in rpm (or mm/s for linear).
Tracking Time	Position must remain in the tracking window for this amount of time to be considered tracking.
Vp	Velocity loop proportional gain. Range: 0 to 32,767.
Vi	Velocity loop integral gain. Range: 0 to 32,767.
Fast Stop Ramp	Deceleration rate used by the velocity loop when the amplifier is hardware disabled. Range: 0 to 100,000,000. Default: velocity loop *Decel. Limit* value. For more information, see Servo Velocity Loop Limits (p. 21).
Low Gains Shift	Increases the resolution of the units used to express Vp and Vi, providing more precise tuning. For more information, see Servo Velocity Gains Shift (p. 22).
High Gains Shift	Decreases the resolution of the units used to express Vp and Vi, providing more precise tuning. For more information, see Servo Velocity Gains Shift (p. 22).
Vi Drain (integral bleed)	Vi drain modifies the effect of velocity loop integral gain. The higher the Vi Drain value, the faster the integral sum is lowered. Range: 0 to 32,000. Default: 0.
Command Filter/ Output Filter	For more information, see the *CME 2 User Guide.*

7.3.2: Manually Tune the Velocity Loop

To tune the velocity loop, apply square-wave excitation to the velocity loop and adjust velocity loop proportional gain (**Vp**) and velocity loop integral gain (**Vi**) to obtain a desired waveform.



NOTE: During tuning, observe any warnings that appear to the left of the trace.

7.3.2.1  Click the Scope Tool to open the *Oscilloscope* window.

7.3.2.2 

Choose **Velocity** from the Function Generator *Apply To:* list.

On the *Settings* tab, make sure **Auto Setup** is selected.
Auto Setup automatically sets the following parameters:

Function Tab	
Function	Square Wave
Amplitude	10% velocity loop Vel. Limit setting.
Frequency	5 Hz
Settings Tab	
Channel 1	Limited velocity (green)
Channel 2	Actual motor velocity (white)

7.3.2.3 

Verify that the Amplitude value is not excessive for the motor.

7.3.2.4 

Click **Start**.

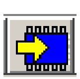
7.3.2.5 On the *Gains* tab, adjust velocity loop proportional gain (**Vp**).

1. Set velocity loop integral gain (**Vi**) to zero.
2. Raise or lower velocity loop proportional gain (**Vp**) until desired step response is obtained. Typically, this means little or no overshoot on a 5 Hz small, slow-speed square wave.

7.3.2.6 Adjust velocity loop integral gain (**Vi**) until desired settling time is obtained.

7.3.2.7 

Press **Stop** to stop the function generator.

7.3.2.8  On the Main screen, click **Save to Flash** to avoid losing the changes.

7.3.2.9 If the amplifier is to be operated in velocity mode, skip the position loop setup procedures and go to Completion Steps (p. 148).

7.4: Position Loop

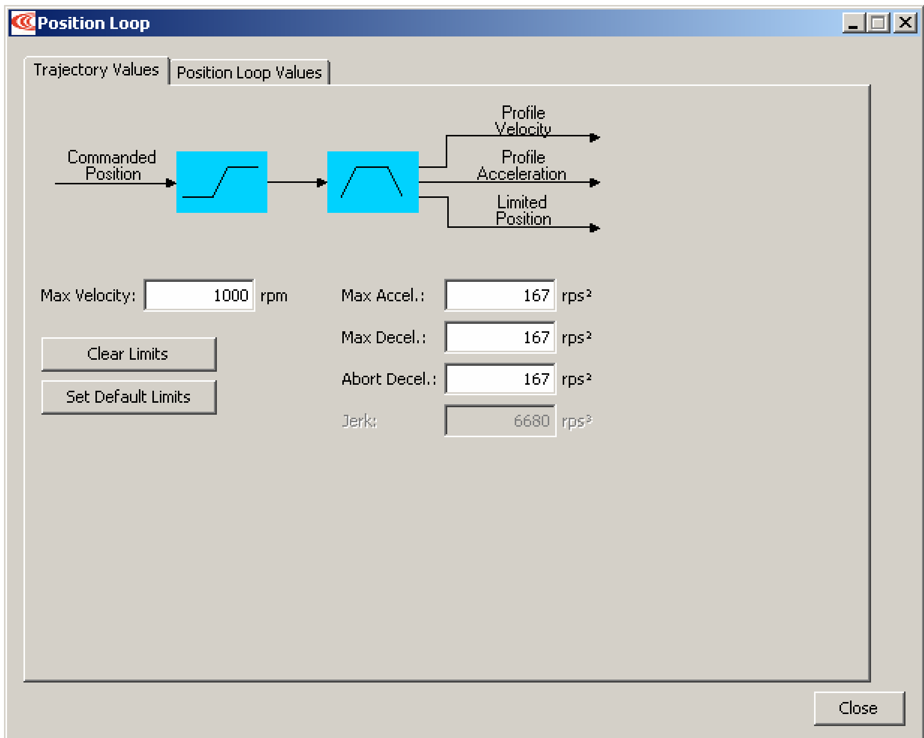
Initial position loop proportional gain (Pp), velocity feed forward (Vff), and acceleration feed forward (Aff) values were calculated during general amplifier setup.

7.4.1: Position Loop Settings

For more information, see Servo Position Mode and Position Loop (p. 23).

7.4.1.1 

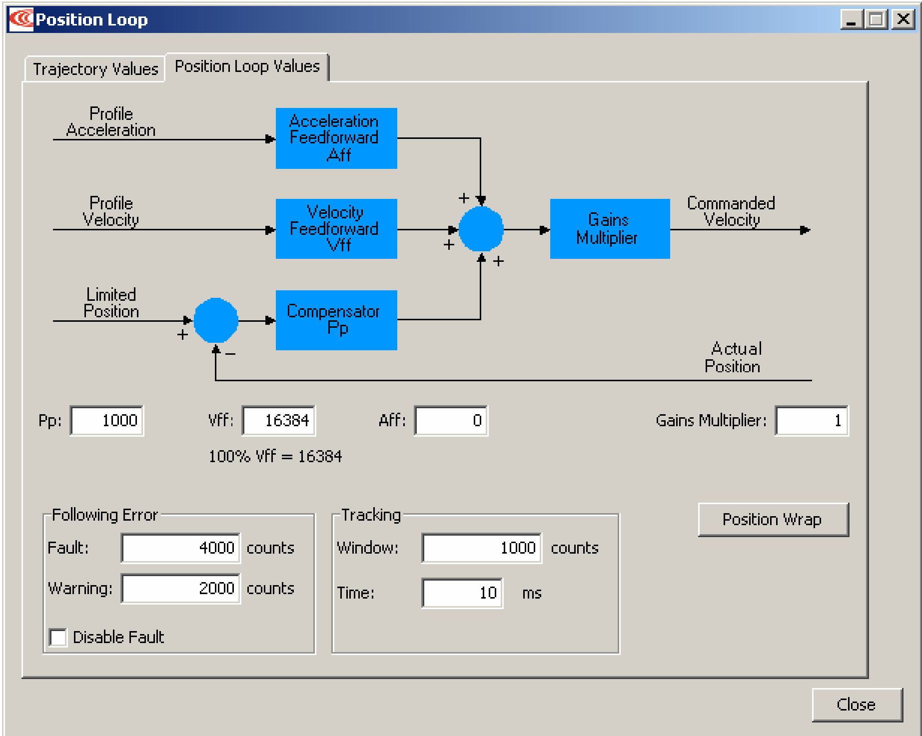
Click P Loop to open the Position Loop screen.



7.4.1.2 Set the following Trajectory Values as needed:

Option	Description	For More Information
Max Velocity	Maximum trajectory velocity. Max value may depend upon the back EMF and the Max feedback count (servo mode) or maximum number of microsteps (stepper mode). Min:0. Default: 0.25 x motor velocity limit.	Servo Position Mode and Position Loop (p. 23).
Max Accel	Maximum trajectory acceleration. Max value may depend upon the load inertia and boost current (stepper mode) or peak current (servo mode). Min:0	
Max Decel	Maximum trajectory deceleration. Max value may depend upon the load inertia and boost current (stepper mode) or peak current (servo mode). Min: 0 (disables limit).	
Abort Decel	Deceleration rate used by the trajectory generator when motion is aborted. Min: 0 (disables limit).	Brake Operation (p. 34).
Jerk	The value of jerk set during the calculate procedure produces an S-Curve whose maximum slope is equal to the trapezoidal profile slope. This value will produce a maximum acceleration that is not more than the initial default value of acceleration. Small values will produce less jerking but will take longer to complete move. Large values will produce more jerking and a more trapezoidal profile but will complete the move faster.	
Clear Limits	Sets Max Velocity, Max Accel, and Max Decel to zero, disabling the trajectory generator.	
Set Default Limits	Restores Max Velocity, Max Accel, and Max Decel to calculated defaults.	

7.4.1.3 Open the **Position Loop Values** tab:

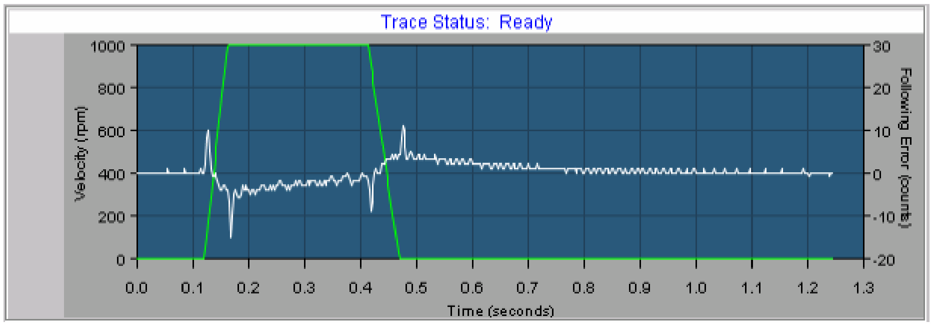


7.4.1.4 Set the following Position Loop Values as needed:

Option	Description	For More Information…
Gains		
Aff	Acceleration feed forward. Range: 0 to 32,767.	Servo Position Loop Gains (p. 24).
Vff	Velocity feed forward. Range: 0 to 32,767. 100% Vff = 16,384.	
Pp	Position loop proportional gain. Range: 0 to 32,767.	
Gains Multiplier	The output of the position loop is multiplied by this value before being passed to the velocity loop.	
Following Error		
Fault	The level (in encoder counts) at which the following error produces a fault. We recommend raising the fault level before tuning the loop.	Following Error Fault Details (p. 40).
Warning	The level (in encoder counts) at which the following error produces a warning.	
Disable Fault	Prevents following error from triggering a fault.	
Tracking		
Tracking Window	Width of the tracking window in counts.	Tracking Window Details (p. 41).
Tracking Time	Position must remain in the tracking window for this amount of time to be considered tracking.	
Position Wrap		
Opens the configuration controls for the Position Wrap feature. This feature causes the amplifier to "wrap back" the reported position value (set it back to zero) at a user-defined position, instead of continually increasing. By default, this feature is disabled.		*CME 2 User Guide.*

7.4.2: Manually Tune the Position Loop

Minimize following error and oscillation by running profiles and adjusting position proportional gain (**Pp**), velocity feed forward (**Vff**), acceleration feed forward (**Aff**) and other settings.



NOTE: During position loop tuning, observe any warnings that appear to the left of the trace.

7.4.2.1 Perform an auto setup test:

1  Click the Scope Tool to open the *Oscilloscope* window.

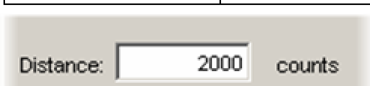
2 

Select the *Profile* tab.

3 

On the *Settings* tab, make sure that **Auto Setup** is checked. Auto Setup automatically sets the following options:

Profile Tab	
Move	Relative
Type	Trap
Distance	½ revolution (rotary) or 2 cm (linear)
Reverse and repeat	Not selected
Settings Tab	
Channel 1	Profile velocity (green)
Channel 2	Following error (white)

4 

If the auto setup default profile distance is not appropriate, enter an appropriate short distance.

5 Set up a trapezoidal profile by setting the trajectory limits and distance on the Trajectory Limits tab. See table:

Trajectory Limits Tab	
Maximum Velocity	Set values typical of those expected to be used in the application.
Maximum Acceleration	
Maximum Deceleration	
Profile Tab	
Distance	Set the move distance to produce a complete trajectory profile. Be sure that this distance does not exceed mechanical limits of the system.
Move	Relative
Type	Trap

6 Start Click **Start**.
The Profile Generator executes a short move.

NOTES:

1 The profile may not reach constant velocity during a short move.

2 If following error occurs, open CME 2 *Control Panel* ( ) and click **Clear Faults**.

7.4.2.2 Adjust position proportional gain (**Pp**) to minimize following error. Note that too much position loop proportional gain (**Pp**) might cause oscillation.

1 On the *Gains* tab, set velocity feed forward (**Vff)** and acceleration feed forward (**Aff)** to zero.

2 On the *Profile* tab, click **Start**. On the *Gains* tab, adjust position loop proportional gain (**Pp**) until best result is obtained.

3 Click **Start** after each adjustment to test the new value on a new profile move.

NOTE: If a following error occurs, open the CME 2 *Control Panel* ( ) and click **Clear Faults**.

7.4.2.3 Adjust velocity feed forward (Vff):

Velocity feed forward (**Vff)** reduces following error in the constant velocity portion of the profile. Often, a velocity feed forward (**Vff)** value of 16384 (100%) provides best results.

1 Click in the *Vff* field and adjust the value.

2 Click **Start** after each adjustment to test the new value on a new profile move.

7.4.2.4 Adjust acceleration feed forward (Aff):

Acceleration feed forward (**Aff**) reduces following error during profile acceleration and deceleration.

1 Click in the *Aff* field and adjust the value.

2 Click **Start** after each adjustment to test the new value on a new profile move.

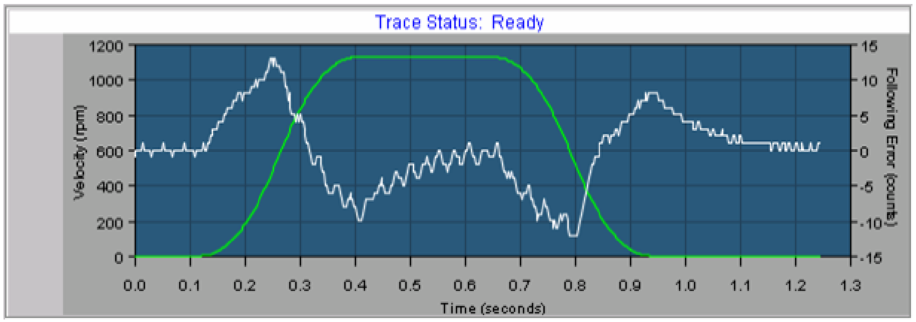
NOTE: If, after tuning the position loop, the motor makes a low frequency audible noise while enabled but not moving, the velocity loop gains (Vp and Vi) may be lowered to reduce the noise. If the gain values are set too low, the response to instantaneous rates of change might be reduced (i.e., slow correction to disturbances or transients).

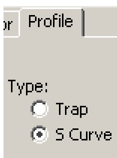
7.4.2.5 Try multiple sets of profiles representing typical moves that might be executed in the application. Starting with Set up a trapezoidal profile, repeat the process as needed.

7.4.3: Test S-Curve Profile

NOTE: Skip this step unless the amplifier will perform S-Curve profile moves.

Jerk is the rate of change of acceleration. S-Curve moves reduce jerk to provide a smooth profile. To tune the level of jerk, run an S-Curve profile and adjust velocity, acceleration, deceleration, and jerk levels until the desired profile is obtained.



7.4.3.1 

On the *Profile* tab, click the **S-Curve** button.

7.4.3.2 Set up an S-curve profile by adjusting the following options. Set values that represent a typical move under normal operation.

Trajectory Limits Tab	
Maximum Velocity	Maximum speed of the profile.
Maximum Acceleration	Maximum acceleration/deceleration of the profile. The deceleration is set to be the same as acceleration.
Maximum Jerk	The value of jerk set during the calculate procedure produces an S-Curve whose maximum slope is equal to the trapezoidal profile slope. This value will produce a maximum acceleration that is not more than the initial default value of acceleration. Small values will produce less jerking but will take longer to complete move. Large values will produce more jerking and a more trapezoidal profile but will complete the move faster.
Profile Tab	
Distance	Increase the move distance to produce a complete trajectory profile. Use an acceptable value the does not exceed mechanical limits of the system.
Move	Relative
Type	S-Curve

7.4.3.3 Click **Start**.

7.4.3.4 Adjust values for desired results.

7.4.3.5 Try multiple sets of profiles representing typical moves that might be executed in the application. Starting with Set up an S-curve profile, repeat the process as needed.

7.5: Completion Steps

7.5.1: Objective

Save the work and perform additional testing with load and under normal control source.

7.5.2: Steps

7.5.2.1 On the *Main* screen, click **Save to Flash**.

7.5.2.2 Remove power.

7.5.2.3 Attach load.

7.5.2.4 Reconnect power.

7.5.2.5 Re-tune velocity and position loops if applicable.

7.5.2.6 On the *Main* screen, click **Save to Flash**.

7.5.2.7 On the *Main* screen, click **Save to Disk** (for backup or duplication).

7.5.2.8 Click **Control Panel** and then click **Reset**
OR
Power-cycle the amplifier.

7.5.2.9 The servo setup procedure is complete.

CHAPTER

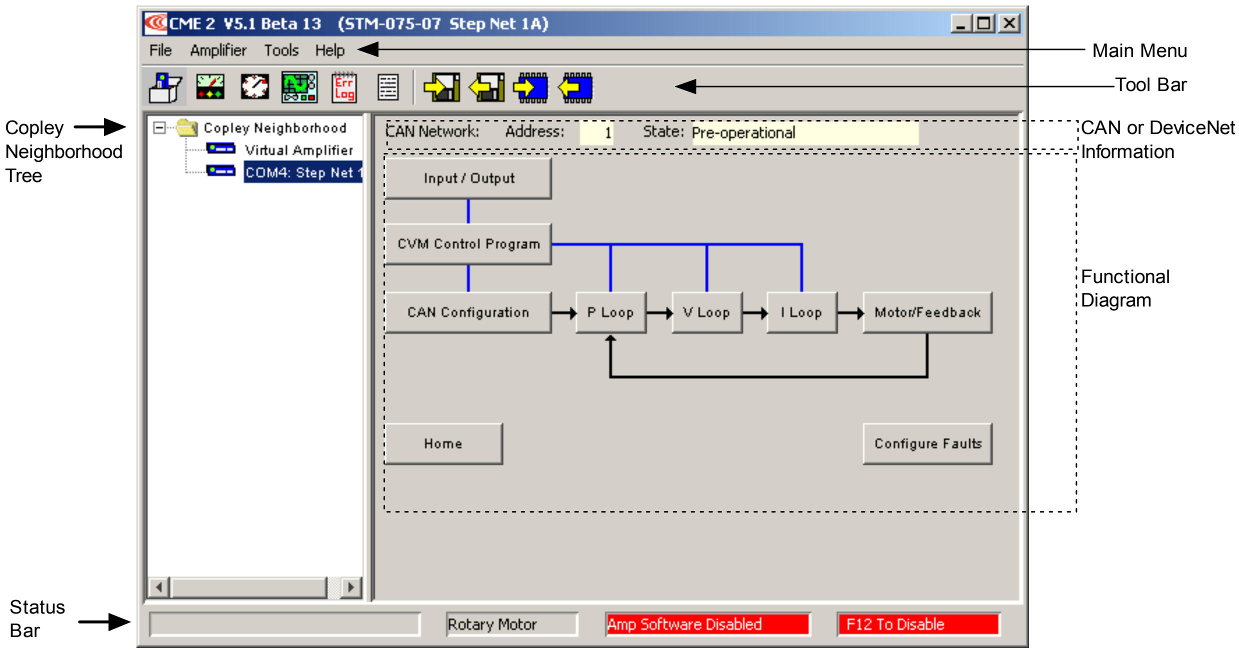
8: USING CME 2 (STEPPER OR SERVO MODE)

This chapter provides an overview of CME 2 software features. Contents are relevant to operation in both stepper and servo modes, and include:

8.1: CME 2 Overview

8.1.1: Main Screen Overview

The CME 2 features called out in the diagram below are described in the following sections.



8.1.2: Tool Bar Overview

Click on any of the tools in the toolbar to access the tools described below.

Icon	Name	Description	For More Information
	Basic Setup	Opens *Basic Setup* screen.	Basic Setup (p. 93).
	Control Panel	Opens Control Panel.	Control Panel (p. 159).
	Auto Phase	Opens *Auto Phase* tool.	Auto Phase (p. 116) and Auto Phase (p. 132).
	Scope	Opens Scope.	*CME 2 User Guide.*
	Error Log	Opens Error Log.	*CME 2 User Guide.*
	Amplifier Properties	Displays basic amplifier properties.	
	Save amplifier data to disk	Saves contents of amplifier RAM to a disk file.	Manage Amplifier and Motor Data (p. 154).
	Restore amplifier data from disk	Restores contents of an amplifier file from disk to amplifier RAM.	
	Save amplifier data to flash	Saves contents of amplifier RAM to amplifier flash.	
	Restore amplifier data from flash	Restores contents of amplifier flash to amplifier RAM.	

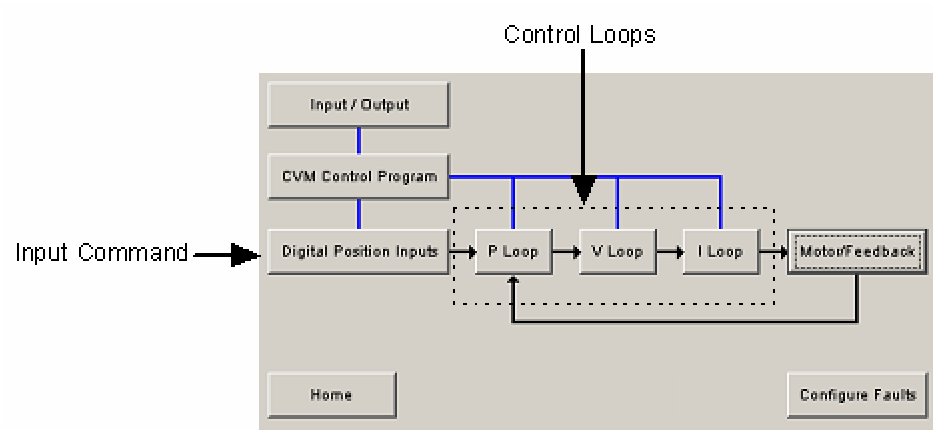
8.1.3: Main Menu Overview

The CME 2 Main Menu choices are described below.

Menu	Selection	Description	For More Information
File	Save Amplifier Data	Saves contents of amplifier's RAM to a disk file.	Manage Amplifier and Motor Data (p. 154).
	Restore Amplifier Data	Restores contents of an amplifier file from disk to amplifier RAM.	
	Restore CVM Control Program	Prompts for a Copley Virtual Machine program file. The program in this file will replace the current program in flash.	Copley Indexer 2 Program User Guide.
	Restore Cam Tables	Prompts for a saved Cam Table file (.cct file). All tables in amplifier flash will be replaced by the ones in this file.	See Copley Camming Users Guide.
	Exit	Closes CME 2. Prompts for data-saving decision.	
Amplifier	Basic Setup	Opens *Basic Setup* screen.	Basic Setup (p. 93).
	Control Panel	Opens Control Panel.	Control Panel (p. 159).
	Auto Phase	Opens *Auto Phase* tool.	Auto Phase (p. 116) and Auto Phase (p. 132).
	Scope	Opens *Scope.*	CME 2 User Guide
	Error Log	Opens Error Log.	CME 2 User Guide
	Amplifier Properties	Displays amplifier properties.	
	Network Configuration	Opens the CAN or DeviceNet Configuration screen.	
	Rename	Prompts for new amplifier name.	Renaming an Amplifier (p. 153).
	Auto Tune	*Auto Tune* for Linear Servo Motors.	
	Gain Scheduling	Opens Gain Scheduling screen.	*CME 2 User Guide.*
Tools	Communications Wizard	Starts sequence of prompts to set up communications.	Serial Port Setup (p. 89).
	Communications Log	Opens Communications Log.	CME 2 User Guide.
	Download Firmware	Starts sequence of prompts to download new firmware image from disk to amplifier.	Downloading Firmware (p. 157).
	View Scope Files	Opens *Trace Viewer* window.	CME 2 User Guide
	I/O Line States	Opens I/O Line States window, showing high/low status of the amplifier's inputs and outputs.	
	CME 2 Lock/Unlock	Opens screen for locking and unlocking CME 2 functionality.	*CME 2 User Guide.*
	ASCII Command Line	Opens screen to accept ASCII format commands.	CME 2 User Guide.
Help	CME 2 User Guide	Opens the CME 2 User Guide.	
	All Documents	Opens the Doc folder in the CME 2 installation folder (typically c://Program Files/Copley Motion/CME 2/Doc). This folder contains all of the related documents that were installed with CME 2.	
	Downloads Web Page	Opens default web browser with relevant pages from Copley Controls' website.	
	Software Web Page		
	View Release Notes	Opens latest CME 2 release notes in a text viewer.	
	About	Displays CME 2 version information.	

8.1.4: Functional Diagram

The functional diagram, shown below, provides button-click access to most of the screens used to configure an amplifier. It also indicates the flow of control from input, across all active control loops, to motor/feedback. Only those control loop buttons that are appropriate to the operational mode appear on the diagram.



The command input button reflects the selected command input.

Name	Description	For More Information
Input/Output	Opens Input/Output screen.	Theory: Inputs (p. *42*) and Outputs (p. *42*). Programming instructions: Amplifier Configuration (p. *100*).
CVM Control Program	Opens Copley Virtual Machine screen.	Copley Indexer Program User Guide.
Input Command	Configure the input command. Button label varies depending on the selected control loop input.	Theory: Input Command Types (p. 25. Programming instructions: Basic Setup Screen (p. *93*).
Control Loops	Each opens a control loop configuration screen.	Theory: Servo Modes and Control Loops (p. *18*). Programming instructions: Stepper Mode Phase and Tune (p. *115*), Servo Mode Phase and Tune (p. *131*).
Motor/Feedback	Opens the Motor/Feedback screen.	Motor Setup (p. 95).
Home	Configure and test homing.	Home Function (p. 164).
Configure Faults	Opens Fault Configuration screen.	Theory: Faults (p. 37). Programming instructions: Non-Latched and Latched Custom Outputs (p. 108).

8.1.5: CAN or DeviceNet Information and Status Bar

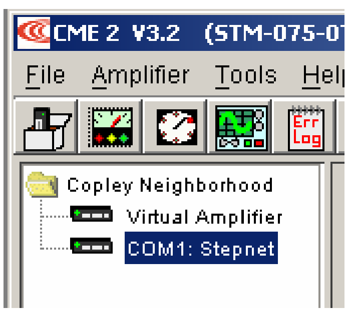
The *Main* screen displays basic CAN or DeviceNet information as shown here:

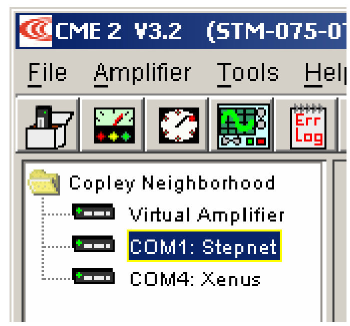
Address shows the amplifier's CAN or DeviceNet address. This value is updated on +24 Vdc power-up or reset only (see CAN Addressing [p.32] or the *Copley DeviceNet Programmer's Guide*). When the Command Source is set to CAN, *State* shows the state of the amplifier's CANopen state machine (see Copley Control's *CANopen Programmer's Manual*).

The status bar describes the present commutation mode, motor type, and amplifier control status as shown below. It also includes a reminder that pressing the F12 function key while CME 2 is running disables the amplifier.

8.1.6: Choosing an Amplifier from a List of Amplifiers

If, as shown at left, below, there is only one serial port set up for communications with an amplifier, CME 2 automatically attempts to connect to the amplifier on that port on CME 2 startup.

One amplifier: 

Multiple amplifiers: 

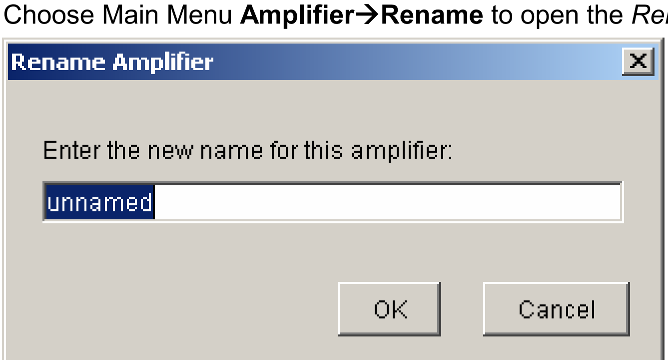
If, as shown at right, above, multiple serial ports have been set up for communications with multiple amplifiers, CME polls all the amplifiers and displays their names in the *Copley Neighborhood*. To choose an amplifier, click on the amplifier name.

8.1.7: Renaming an Amplifier

Each amplifier represented in the *Copley Neighborhood* amplifier tree has a name. The default name for an amplifier is *unnamed*. Use this procedure to rename an amplifier.

8.1.7.1 Select the amplifier from the Copley Neighborhood.

8.1.7.2 Choose Main Menu **Amplifier→Rename** to open the *Rename Amplifier* screen.



8.1.7.3 Enter the new name.

8.1.7.4 Click **OK** to close the screen and save the new name
or click **Cancel** to close the screen without saving the name.

8.2: Manage Amplifier and Motor Data

8.2.1: Memory

To maintain amplifier and motor settings, the amplifier uses volatile RAM memory and non-volatile flash memory. Data can also be saved to disk for backup and distribution.

Amplifier RAM and Amplifier Flash Memory

Amplifier RAM holds status data and certain user-entered information data during operation, whereas flash memory permanently stores the data for loading into amplifier RAM at power-up or reset, as described below.

Amplifier RAM	Amplifier Flash
Contents erased when amplifier is reset or powered off.	Permanent. Contents retained when the amplifier is reset or powered off.
Initial contents read from flash on power-up. Contents then updated in real time to reflect certain operational conditions and changes entered with CME 2 software. At any time, the user can use CME 2 to restore data from flash into amplifier RAM.	Modified only by using a **Save to Flash** tool or by closing certain screens (*Motor/Feedback, Basic Setup*, or *CAN Configuration*), whose contents are automatically saved to flash upon closing of the screen.

How the Amplifier Uses RAM and Flash Memory

As described below, some data resides in flash only, some in RAM only, and some in both.

Data Resides In	Data
Flash only	This category includes all data represented on the *Motor/Feedback* screen, *Basic Setup* screen, and *CAN Configuration* screen. This data is automatically saved to flash as soon as its entry is confirmed (when the user clicks the appropriate **Save to Flash** button, or closes the screen).
Flash and RAM	Includes all user-entered data represented on other screens, such as gains, limits, and I/O, and faults. Initial values for this data are factory-set in flash. They are loaded from flash to RAM with each power-up or amplifier reset. This data is saved to flash only when a user clicks the appropriate **Save to Flash** button. It is flushed from RAM with each power-down or amplifier reset.
RAM only	Includes operating status data such as actual position, actual current, and amplifier temperature. Such data is never stored in flash. It is flushed from RAM with each power-down or amplifier reset.

8.2.2: Disk Storage

Amplifier Data Files and Motor Data Files

At any time, the user can save certain data from RAM and flash memory to a file on disk. From the *Main* screen, the user can save all user-entered data represented on all screens (the data described as Flash only and Flash and on p. 154). This data is saved in a Copley Controls amplifier data file with a *.ccx* filename extension.

From the *Motor/Feedback* screen, the user can save all data represented on the Motor/Feedback screen. This data is saved in a Copley Controls motor data file with a *.ccm* filename extension.

A *.ccx* file can be restored to return the amplifier to a previous state or to copy settings from one amplifier to another, as described in Quick Copy Setup Procedure (p. 156).

8.2.3: Data Management Tools

Amplifier Data Management Tools

Operations performed using the amplifier data management tools at the top of the *Main* screen (shown below) affect all data, including motor/feedback data.

Amplifier Data Management Tools

The amplifier data management tools are described below.

Icon	Name	Description
	Save amplifier data to disk	Saves save all user-entered data represented on all screens from volatile and flash memory to a disk file with a *.ccx* filename extension.
	Restore amplifier data from disk	Restores amplifier and motor data from a *.ccx* file to the amplifier's volatile and flash memory. Note that only certain data is saved to flash by this operation (the data described as Flash only on p. 154). To assure that all data (including the data described as Flash and) is stored in flash, use the *Save amplifier data to flash* tool.
	Save amplifier data to flash	Saves contents of amplifier RAM to amplifier flash memory.
	Restore amplifier data from flash	Restores contents the amplifier's flash memory to amplifier's volatile RAM.

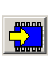
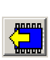
To use a data management tool, click the icon and respond to prompts.

Motor Data Management Tools

Operations performed using the data management tools at the bottom of the *Motor/Feedback* screen (shown below) affect only user-entered data represented on the *Motor/Feedback* screen.

Motor/Feedback
Data Management Tools

The motor data management tools are described below.

Icon	Name	Description
	Save motor data to disk	Saves only motor/feedback data from the PC's RAM to a disk file with a *.ccm* filename extension. Amplifier data that is not represented on the *Motor/Feedback* screen is not saved in this file.
	Restore motor data from disk	Restores only motor data from a disk file with a *.ccm* filename extension to the amplifier's flash memory. Amplifier data that is not represented on the *Motor/Feedback* screen is not affected.
	Save motor data to flash	Saves the contents of the Motor/Feedback screen from a buffer in the PC's RAM to the amplifier's flash memory. Amplifier data that is not represented on the *Motor/Feedback* screen is not saved. Can be used to assure that all changes are saved to flash without closing the *Motor/Feedback* screen.
	Restore motor data from flash	Restores only motor data from amplifier flash to amplifier RAM. Amplifier data that is not represented on the *Motor/Feedback* screen is not affected. Can be used before closing the Motor/Data screen to restore settings to the previously saved values.

To use a data management tool, click the icon and respond to prompts.

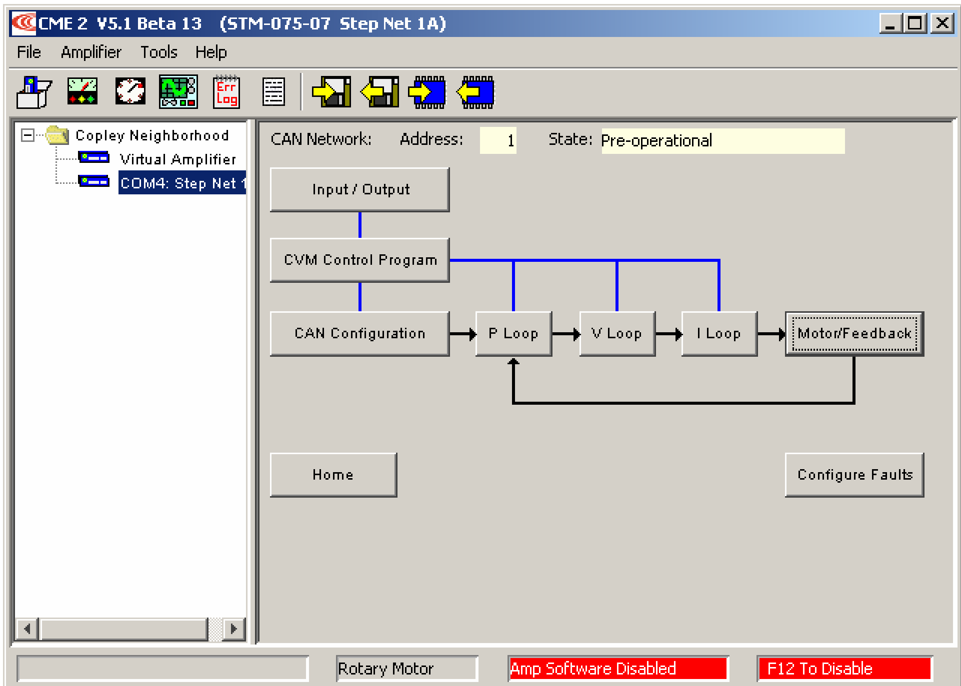
8.2.4: Quick Copy Setup Procedure

Use this procedure to configure an amplifier/motor pair by copying configuration files that were prepared for the amplifier/motor combination.

8.2.4.1 Make sure the amplifier is connected to the PC serial port.

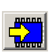
8.2.4.2 

Start CME 2 by double-clicking the CME 2 desktop shortcut icon



8.2.4.3  On the *Main* screen, click **Restore amplifier data from disk**..

8.2.4.4 When prompted, navigate to the folder containing the appropriate *.ccx* file. Highlight the file name and then click **Open** to load the file data into amplifier RAM.

8.2.4.5  On the *Main* screen, click **Save to Flash**.

8.2.4.6 If you do not need to load a CVM Control Program, skip to Step 8.2.4.7.
To load a CVM Control Program, choose **File→Restore CVM Control Program.**
When prompted, navigate to the folder containing the appropriate *.ccp* file.
Highlight the file name and then click **Open** to load the file data into flash memory.

This step also results in the setting of the Indexer 2 Program option Enable Control Program on Startup. This configures the program to auto start when the amplifier is powered up or reset.

8.2.4.7 If you do not need to load a set of Cam Tables, skip to Step 8.2.4.8.
To load a set of Cam Tables, choose **File→Restore Cam Tables.**
When prompted, navigate to the folder containing the appropriate *.cct* file.
Highlight the file name and then click **Open** to load the file data into flash memory.

8.2.4.8 If you do not need to load a Gain Scheduling Table, the process is complete.
To load a Gain Scheduling Table, choose **File→Restore Gain Scheduling Table.**
When prompted, navigate to the folder containing the appropriate *.ccg* file.
Highlight the file name and then click **Open** to load the file data into flash memory.

TIP: When copying amplifier data to multiple amplifiers, consider locking CME 2 to prevent accidental changes to settings. See the *CME 2 User's Guide.*

8.3: Downloading Firmware

8.3.1: Acquiring Firmware Updates from Web Site

8.3.1.1 In an Internet browser, navigate to http://www.copleycontrols.com/Motion/Downloads/firmware.html

8.3.1.2 Click on the appropriate Stepnet firmware icon.

8.3.1.3 When prompted, save the file to the *Firmware Image* folder in the CME 2 installation folder.

(The default installation folder is C:\Program Files\Copley Motion\CME 2\FirmwareImage.)

The folder should now contain a file named *Stepnet_Firmware.zip*.

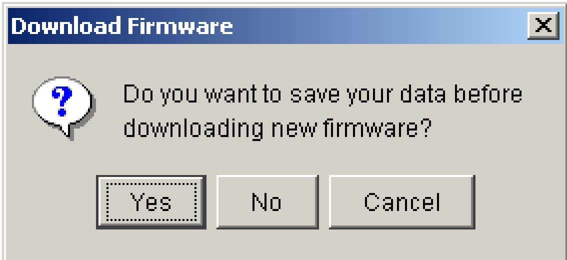
8.3.1.4 Extract the contents of the zip file to the same location.

The folder should now contain the files *Stepnet_Firmware.zip* and the latest *.cff* file.

8.3.1.5 If desired, delete *Stepnet_Firmware.zip* to save disk space.

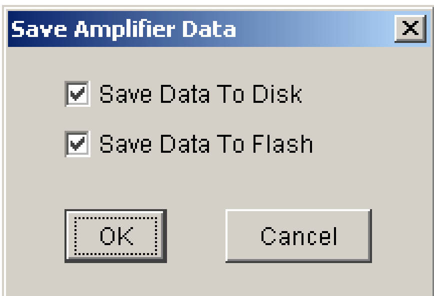
8.3.2: Downloading Firmware to Amplifier

8.3.2.1 On the *Main* screen choose **Tools→Download Firmware** to open the *Download Firmware* window.



8.3.2.2 To download new firmware without saving amplifier and motor data, click **No** and then proceed to Step 8.3.2.4.

8.3.2.3 To back up amplifier and motor data before downloading firmware, click **Yes**.



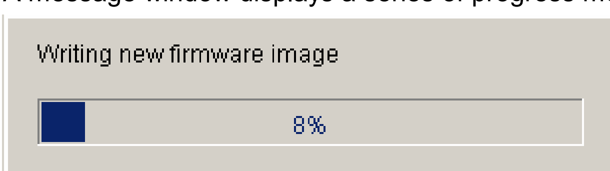
1 Use check marks to select whether to save to disk, flash, both, or neither.

2 Click **OK** to save data and continue to select a firmware image, or click **Cancel** to continue without saving data.

3 If *Save Data to Disk* was checked, use the *Save Amplifier Data to Disk* screen to browse to the folder where you want to save the *.ccx* file. Then enter a name in the *Name* field. Then click **Save**.
When the Firmware Images window appears, proceed to Step 8.3.2.4.

8.3.2.4 Use the *Firmware Images* window to locate and select a firmware image file.

8.3.2.5 Click **Open** to begin the download.
(Or click Cancel to close the screen without downloading new firmware.)
A message window displays a series of progress messages:

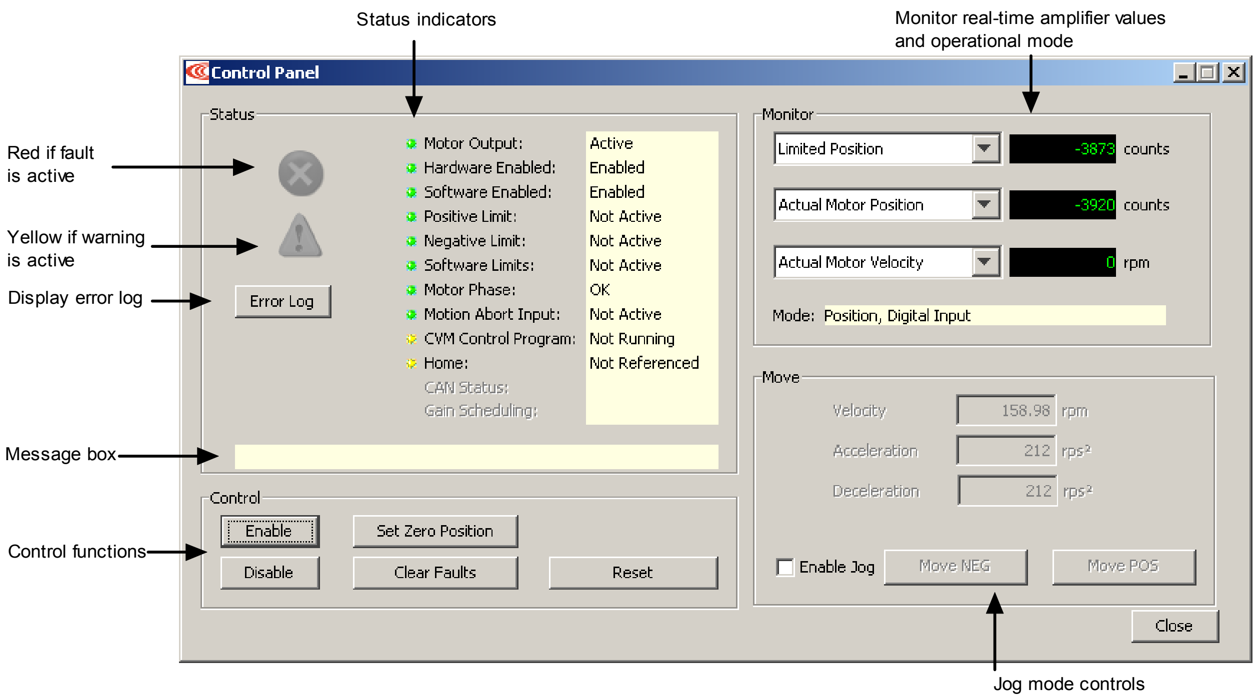


When the message window closes, the firmware download is complete.

8.4: Control Panel

8.4.1: Control Panel Overview

To access the control panel, click the **Control Panel** icon on the *Main* screen.
Each of the features labeled below is described in the following sections.



8.4.2: Status Indicators and Messages

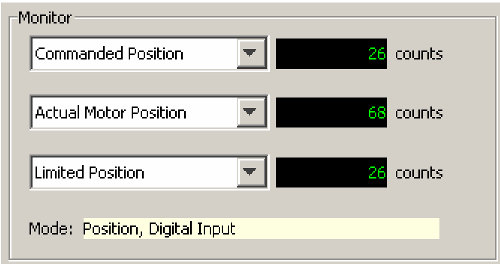
The *Status* area includes status indicator lights (described below) and a message box. All green lights indicate the amplifier is enabled and ready to accept motion commands.

Indicator	States/Description
Motor Output	State of the PWM output stage. Red if the output stage is inactive (disabled)
Hardware Enabled	State of the hardware enable input(s). Red if one or more enable inputs are inactive.
Software Enabled	State of the software enable. Red if the amplifier is disabled by software.
Positive Limit	State of the positive limit switch input. Red indicates an activated positive limit switch.
Negative Limit	State of the negative limit switch input. Red indicates an activated negative limit switch.
Software Limits	State of the software limits. Red indicates an activated software limit.
Motor Phase	Indicates a motor phasing error. Red indicates a motor phasing error exists.
Motion Abort Input	State of the programmed Motion Abort Input. Red indicates the input is active.
CVM Control Program	Status of the CVM Control Program.
Home	Indicates whether the axis has successfully been referenced (homed).
Continued…	

…continued:	
Indicator	**States/Description**
CAN Status	The status of the CAN Bus. Yellow indicates a CAN warning limit reached. Red indicates a bus error detected. (If the CAN Status indicator is replaced by the DeviceNet Status indicator, see the *Copley DeviceNet Programmer's Guide*.)
Gain Scheduling	Indicates whether Gain Scheduling is active. See the *CME 2 User Guide.*
	The fault indicator goes red when a fault is active. Check the status message box for a description of the most recent fault: Fault: Under Voltage. Check the Error Log for a full history of faults and warnings.
	The warning indicator goes yellow when a warning is active. Check the status message box for a description of the most recent: Warning: Pos Outside of Tracking Window. Check the Error Log for a full history of faults and warnings.
Message Box	The message box below the indicators displays the most recent active fault or warning message.

8.4.3: Monitor Functions

The Control Panel Monitor channels can display real-time values on up to three separate variables.



To set up a monitor display box, click in the list box and select a variable from the list.

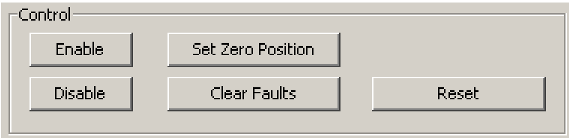
Disabled disables the display. Other options represent the following amplifier variables. Note that some variables are only applicable when an encoder is present (in stepper or servo mode):

Variable	Description
Commanded Current	Command input to the internal current loop.
Actual Current	Actual current output.
Profile Velocity	Instantaneous velocity command output of the trajectory generator.
Profile Acceleration	Instantaneous commanded acceleration / deceleration rate.
Commanded Velocity (Servo mode only)	Command input to the internal velocity loop.
Actual Motor Velocity (With encoder only)	Actual motor velocity derived from the motor encoder.
Velocity Error (With encoder only)	Difference between Profile Velocity and Actual Motor Velocity.
Commanded Position	Position input to the trajectory generator.
Limited Position	Instantaneous position command output of the trajectory generator.
Actual Position (With encoder only)	Actual motor position measured by the motor encoder.
Following Error (With encoder only)	Difference between the Limited Position and the Actual Position.
Bus Voltage	Applied HV voltage
Amplifier Temperature	Internal power stage temperature.

Mode: Displays the amplifier's present operating mode. In camming it also displays the active cam table number.

8.4.4: Control Functions

The *Control* area of the screen provides functions related to overall amplifier control. The screen options vary with model and configuration.



Control the operational state of the amplifier using the controls described below.

Control	Description
Enable	Click to software enable the amplifier.
Disable	Click to software disable the amplifier.
Set Zero Position	Click to set the amplifier's actual position counter to zero.
Clear Faults	Click to clear all amplifier faults and latched outputs.
Reset	Click to reset the amplifier.

DANGER

Risk of unexpected or uncontrolled motion.

Using the CME 2 *Set Zero Position* function while the amplifier is operating under CANopen control or other command sources could cause unexpected or uncontrolled motion.

Failure to heed this warning can cause equipment damage, injury, or death.

8.4.5: Jog Mode

Jog mode provides a simple way to generate forward or reverse commands as described here:

8.4.5.1 To put the amplifier in jog mode, set the **Enable Jog** option.

8.4.5.2 Set up a jog move by setting the following mode-specific parameters:

Mode	Parameter	Description
Current (servo mode only)	Current	Current applied to the motor. Limited by current loop *Continuous Current*. Warning: Unloaded motors may, depending on torque setting, ramp up in speed very quickly.
	Current Ramp	The rate at which the current will increase and decrease.
Velocity (servo mode only)	Jog Speed	Velocity of the jog move. Limited by velocity loop *Vel. Limit*.
Position	Velocity	Velocity of the jog move. Limited by velocity loop *Vel. Limit*.
	Acceleration	Acceleration rate of the jog move.
	Deceleration	Deceleration rate of the jog move.

8.4.5.3 Command the move.

Mode	Steps
Current (servo mode only)	Hold **Pos** to apply positive current to the motor or hold down **Neg** to apply negative current to the motor. Release the button to command zero current.
Velocity (servo mode only)	Hold J**og Pos** to command a forward velocity or hold down **Jog Neg** to command a negative velocity. Release the button to command zero velocity.
Position	Hold Move Pos to generate a forward move profile or hold Move Neg to generate a negative move profile. Release the button to stop movement. NOTE: A position mode jog move continuously updates the commanded position. If a following error develops with Following Error Fault is disabled, motion will not stop on button release. Instead, it stops when actual position = commanded position.

8.5: Home Function

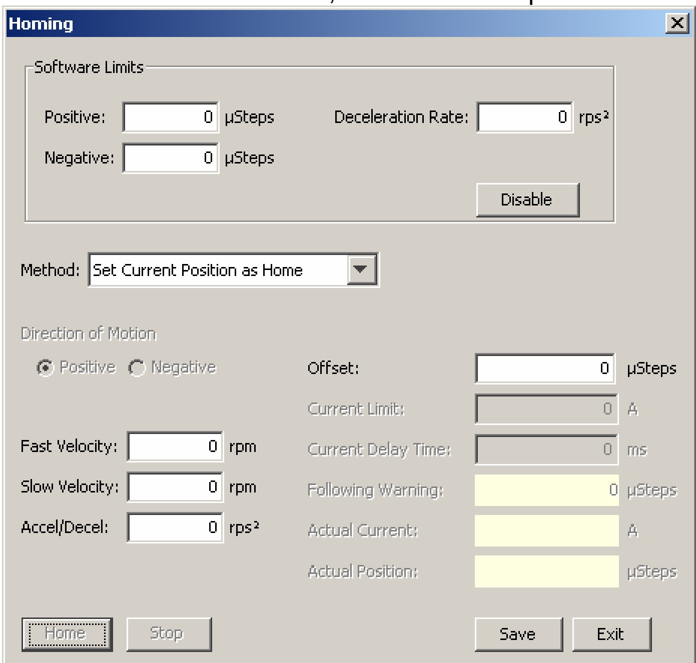
8.5.1: Overview

The CME 2 Home function can be used to set and test homing parameters.

8.5.2: Homing Functions Settings

8.5.2.1

On *Main* screen, click **Home** to open the *Homing* screen**.**



8.5.2.2 Select homing options described below.

Parameter	Description
Software limits: Positive	Position of user-defined travel limits that take effect after homing operation.
Software limits: Negative	
Deceleration Rate	Deceleration rate used to stop a motor when approaching a software limit.
Software limits: Disable	Disables the use of software limits by setting both limits to zero.
Method	Homing method. See *Homing Methods* in the *CME 2 User Guide.*
Direction of Motion	Initial direction of motion for the homing method (Pos or Neg).
Fast Velocity	The velocity used to find a limit or home switch. Also used when moving to an offset position, or a resolver or Servo Tube index position.
Slow Velocity	The velocity used to find a switch edge, incremental or analog encoder index pulse, or hard stop.
Accel/Decel	The acceleration and deceleration rate used during homing.
Offset	Execute a move of this distance after the reference is found. Set actual position to 0 and call the new position home.
Current Limit	Hard stop home is reached when the amplifier outputs the homing Current Limit continuously for the time specified in the Delay Time.
Current Delay Time	
Following Warning	Shows the programmed following warning level.
Actual Current	Shows actual current being applied to windings during homing.
Actual Position	Shows actual position during homing.

8.5.2.3 Optionally click **Home** to begin a homing sequence.

8.5.2.4 To stop the homing sequence before it is completed, click **Stop**.

8.5.2.5 Click **Save** to save the settings to flash memory. Click **Exit** to close the screen.

APPENDIX

A: I^2T Time Limit Algorithm

This chapter describes the algorithm used to implement the I^2T limit.

NOTE: This chapter uses servo mode examples and terminology to describe how the I^2T limit works. It works the same way in stepper mode, with the following exceptions:

- servo mode continuous current = stepper mode run current
- servo mode peak current = stepper mode boost current

A.1: I^2T Algorithm

A.1.1: I^2T Overview

The I^2T current limit algorithm continuously monitors the energy being delivered to the motor using the I^2T Accumulator Variable. The value stored in the I^2T Accumulator Variable is compared with the I^2T setpoint that is calculated from the user-entered Peak Current Limit, I^2T Time Limit, and Continuous Current Limit. Whenever the energy delivered to the motor exceeds the I^2T setpoint, the algorithm protects the motor by limiting the output current.

A.1.2: I^2T Formulas and Algorithm Operation

Calculating the I^2T Setpoint Value

The I^2T setpoint value has units of Amperes^2-seconds (A^2S) and is calculated from programmed motor data. The setpoint is calculated from the Peak Current Limit, the I^2T Time Limit, and the Continuous Current Limit as follows:

I^2T setpoint =
(Peak Current Limit^2 – Continuous Current Limit^2) * I^2T Time Limit

I^2T Algorithm Operation

During amplifier operation, the I^2T algorithm periodically updates the I^2T Accumulator Variable at a rate related to the output current Sampling Frequency. The value of the I^2T Accumulator Variable is incrementally increased for output currents greater than the Continuous Current Limit and is incrementally decreased for output currents less than the Continuous Current Limit. The I^2T Accumulator Variable is not allowed to have a value less than zero and is initialized to zero upon reset or +24 Vdc logic supply power-cycle.

Accumulator Increment Formula

At each update, a new value for the I^2T Accumulator Variable is calculated as follows:

I^2T Accumulator Variable $_{n+1}$ =
I^2T Accumulator Variable $_{n}$
+(Actual Output Current $_{n+1}{}^2$ – Continuous Current Limit^2) * Update period

After each sample, the updated value of the I^2T Accumulator Variable is compared with the I^2T setpoint. If the I^2T Accumulator Variable value is greater than the I^2T Setpoint value, then the amplifier limits the output current to the Continuous Current Limit. When current limiting is active, the output current will be equal to the Continuous Current Limit if the commanded current is greater than the Continuous Current Limit. If instead the commanded current is less than or equal to the Continuous Current Limit, the output current will be equal to the commanded current.

A.1.3: I^2T Current Limit Algorithm – Application Example

I^2T Example: Parameters

Operation of the I^2T current limit algorithm is best understood through an example. For this example, a motor with the following characteristics is used:

- Peak Current Limit – 12 A
- I^2T Time Limit – 1 S
- Continuous Current Limit – 6 A

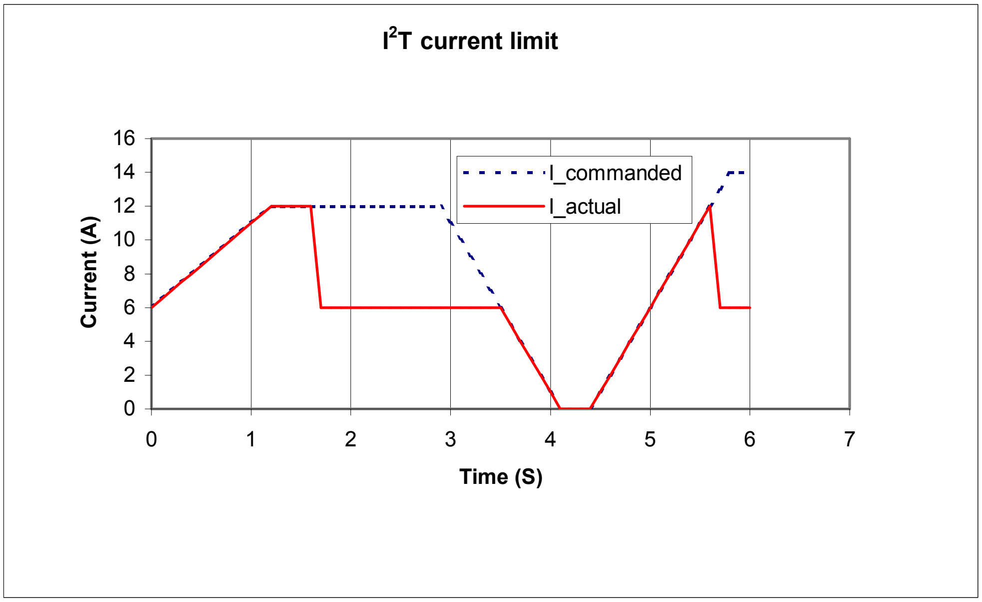
From this information, the I^2T setpoint is:

$$I^2T \text{ setpoint} = (12\ A^2 – 6\ A^2) * 1\ S = 108\ A^2S$$

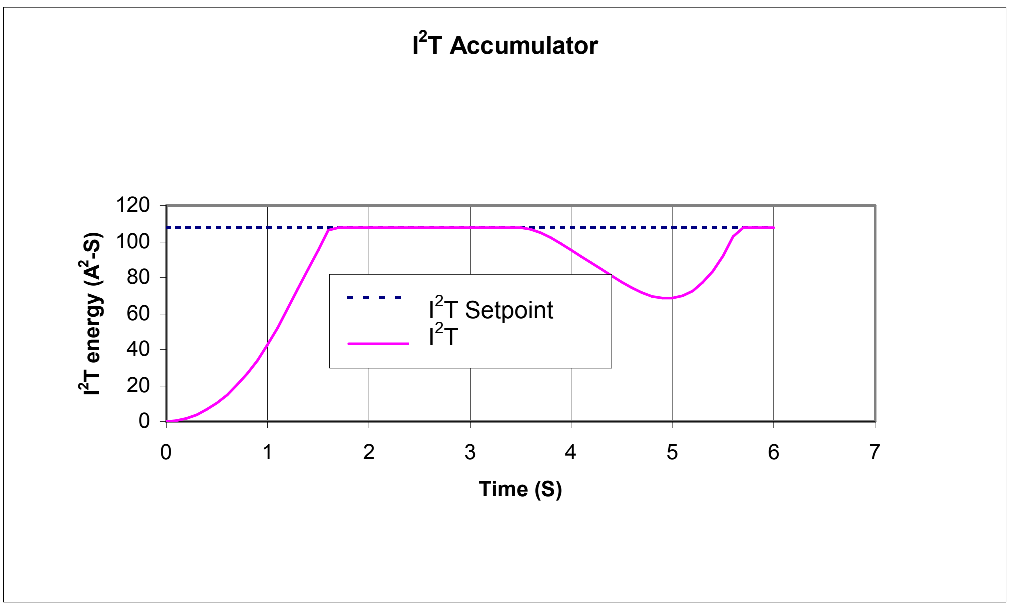
See the example plot diagrams on the next page.

I^2T Example: Plot Diagrams

The plots that follow show the response of an amplifier (configured w/ I^2T setpoint = 108 A^2S) to a given current command. For this example, DC output currents are shown in order to simplify the waveforms. The algorithm essentially calculates the RMS value of the output current, and thus operates the same way regardless of the output current frequency and wave shape.



A)



B)

At time 0, plot diagram A shows that the actual output current follows the commanded current. Note that the current is higher than the continuous current limit setting of 6 A. Under this condition, the I^2T Accumulator Variable begins increasing from its initial value of zero. Initially, the output current linearly increases from 6 A up to 12 A over the course of 1.2 seconds. During this same period, the I^2T Accumulator Variable increases in a non-linear fashion because of its dependence on the square of the current.

At about 1.6 seconds, the I^2T Accumulator Variable reaches a value equal to the I^2T setpoint. At this time, the amplifier limits the output current to the continuous current limit even though the commanded current remains at 12 A. The I^2T Accumulator Variable value remains constant during the next 2 seconds since the difference between the actual output current and the continuous current limit is zero.

At approximately 3.5 seconds, the commanded current falls below the continuous current limit and once again the output current follows the commanded current. Because the actual current is less than the continuous current, the I^2T Accumulator Variable value begins to fall incrementally.

The I^2T Accumulator Variable value continues to fall until at approximately 5.0 seconds when the commanded current goes above the continuous current limit again. The actual output current follows the current command until the I^2T Accumulator Variable value reaches the I^2T setpoint and current limiting is invoked.

A.2: I^2T Scope Trace Variables (STX Only)

Two Scope Tool trace variables are available for monitoring whether the I^2T accumulator is accumulating or discharging.

The I^2T Amplifier Accumulator variable evaluates the accumulator against the factory set current limits of the amplifier.

The I^2T Motor Accumulator variable evaluates the accumulator against the user-programmed current loop values.

The value shown in the scope has been normalized so that 100% equals the I^2T setpoint.

When either trace variable line reaches 100%, current limiting will be invoked.

For instructions on using these variables in the Scope Tool, see the *CME 2 User Guide*.

APPENDIX

C: THERMAL CONSIDERATIONS

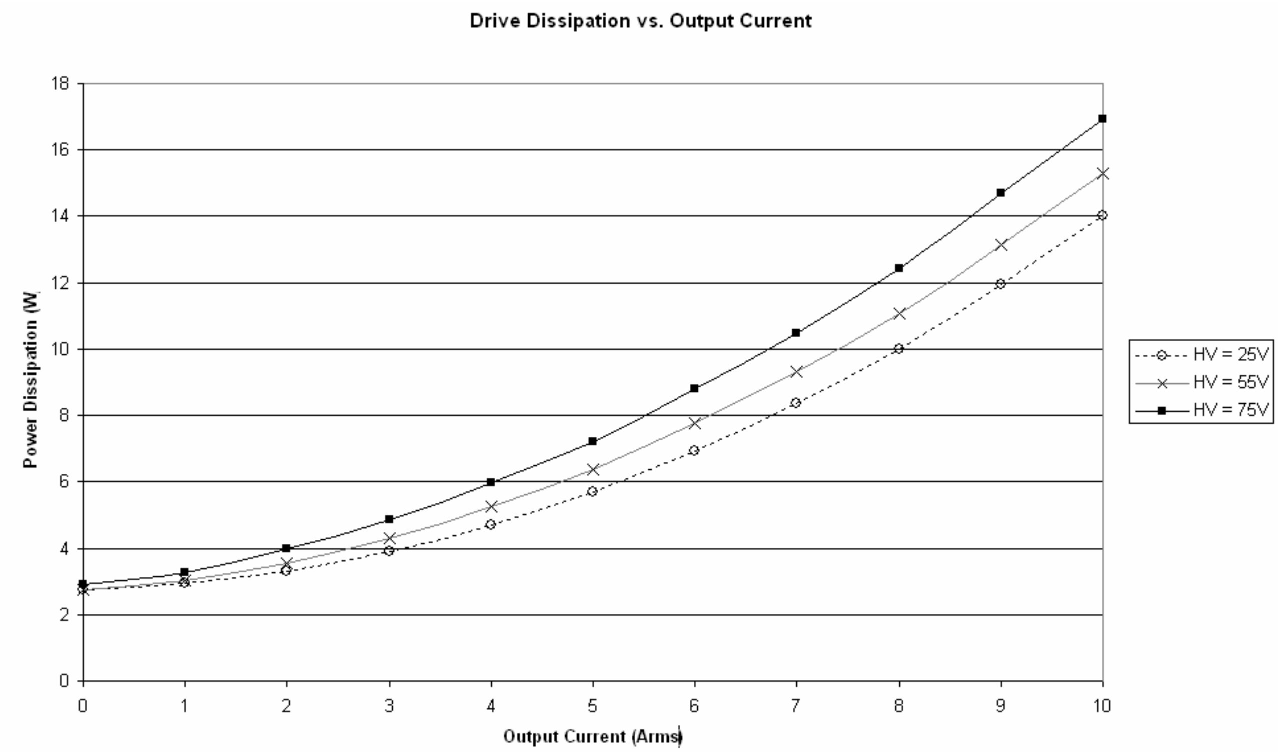
This chapter describes Stepnet Panel (STP) and Stepnet Panel AC (STX) amplifier operating temperature characteristics, heatsink options, and heatsink mounting instructions. Contents include:

C.1: Operating Temperature and Cooling Configurations

C.1.1: Stepnet Panel (STP)

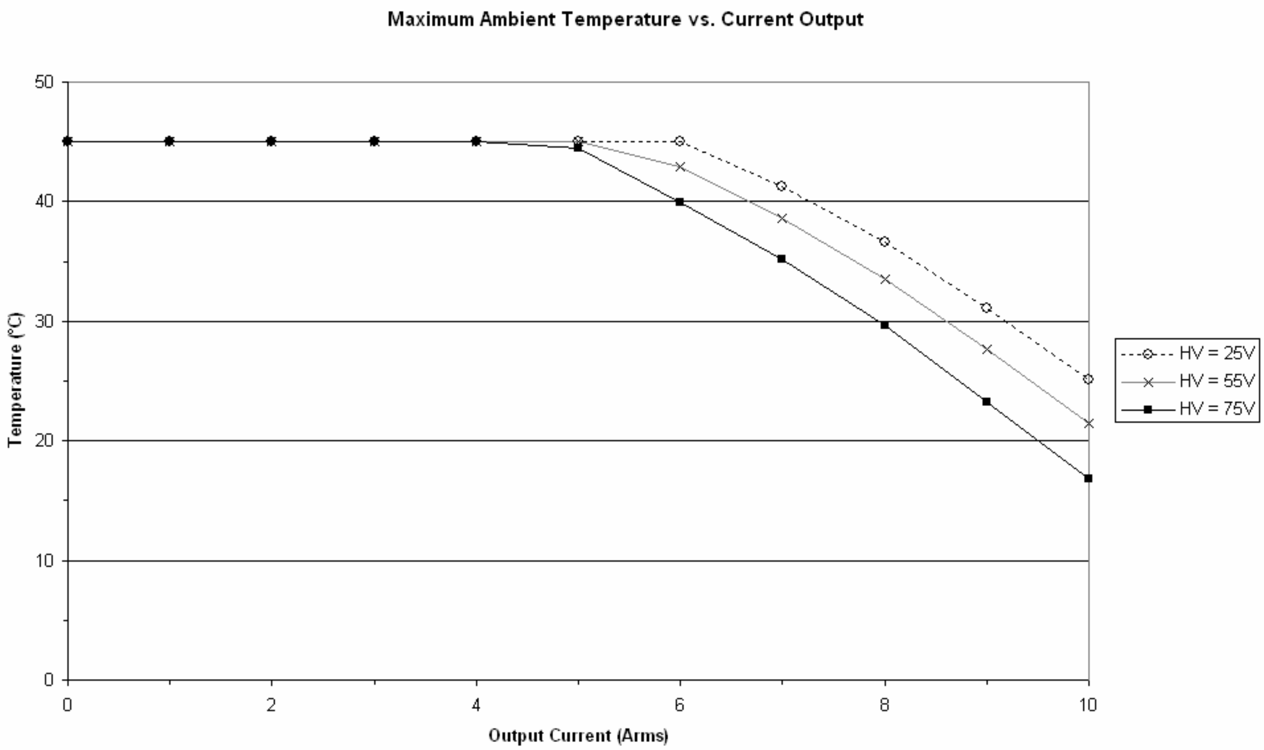
Power Dissipation, Stepnet Panel (STP)

The following chart shows the internal power dissipation for of the Stepnet Panel (STP) amplifier versus output current levels at different +HV voltages. The output current is calculated from the motion profile, motor, and load conditions. The values on the chart represent the rms (root-mean square) current that the amplifier would provide during operation. The +HV values are for the average DC voltage of the power supply.



Max Ambient Temperature vs. Current Output, Stepnet Panel (STP)

The following chart shows the maximum allowable ambient temperature of the Stepnet Panel (STP) amplifier versus output current levels at different +HV voltages. The values shown represent applications where the amplifier is installed without a heatsink and uses natural convection cooling. The addition of forced air (100 lfm minimum) or forced air and a heatsink will allow the Stepnet to operate at maximum voltage and current in a 45°C ambient environment.



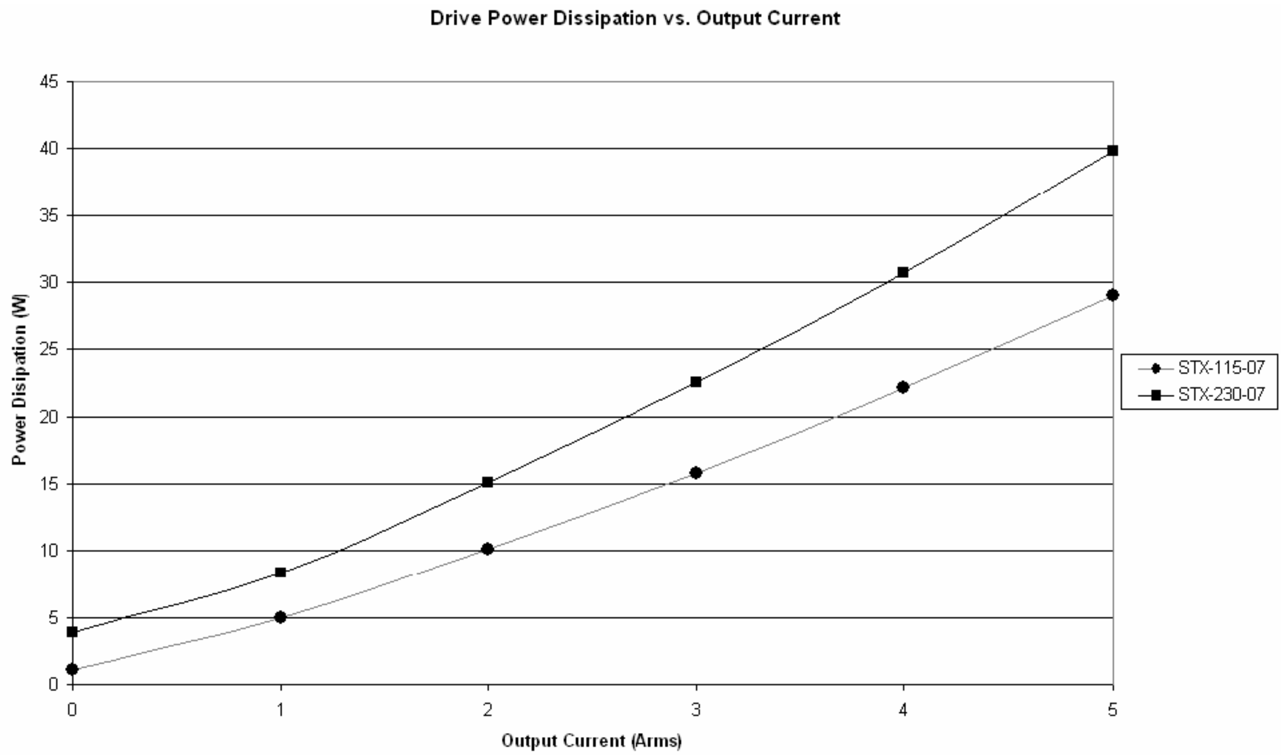
Thermal Resistance Stepnet Panel (STP)

Configuration	Thermal Resistance
No Heat Sink, Convection Cooled	2.8 °C/W
No Heat Sink, Fan Cooled (100 LFM minimum)	1.3 °C/W
With Heat Sink, Fan Cooled (100 LFM minimum)	0.8 °C/W
With Heat Sink, Fan Cooled (200 LFM minimum)	0.6 °C/W

C.1.2: Stepnet Panel AC (STX)

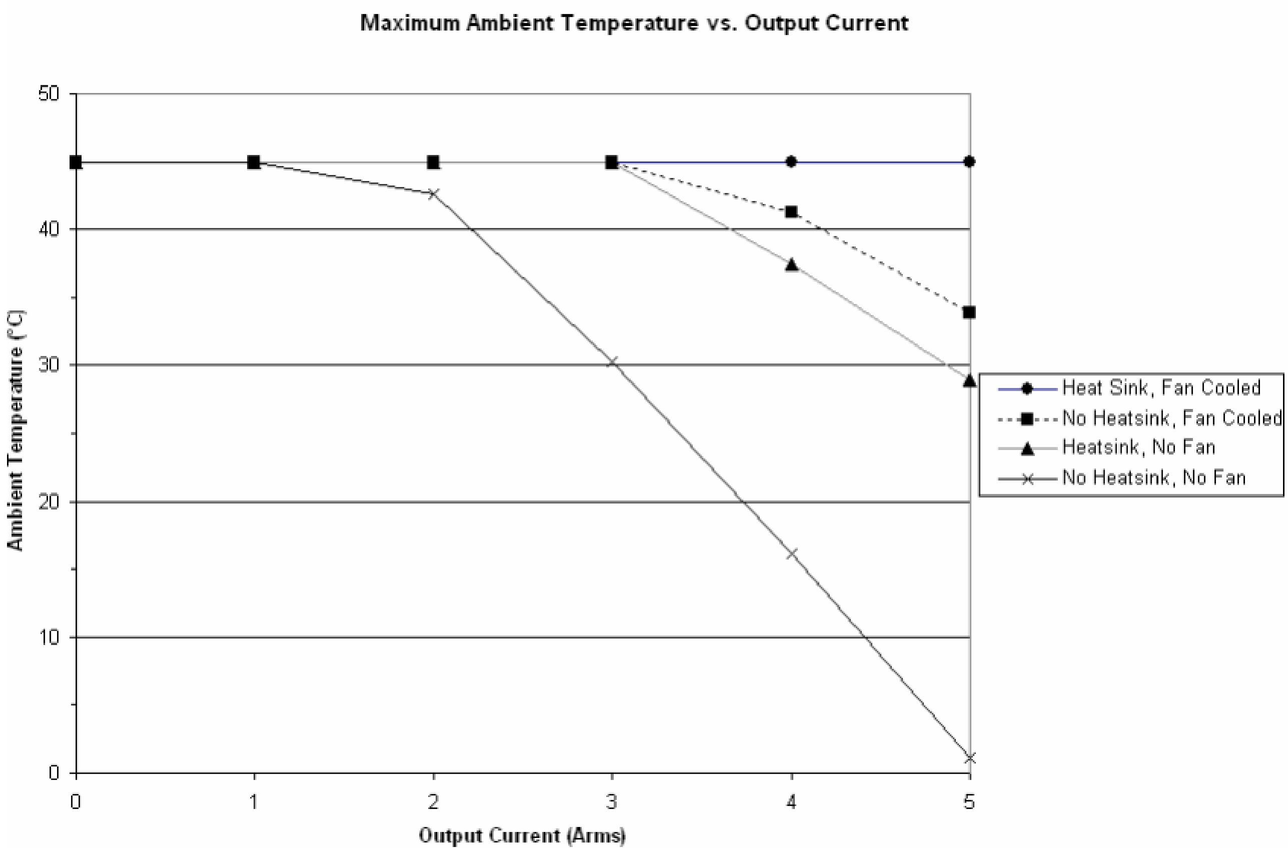
Power Dissipation, Stepnet Panel AC (STX)

The following chart shows the internal power dissipation for of the Stepnet Panel AC (STX) amplifiers versus output current levels at different +HV voltages. The output current is calculated from the motion profile, motor, and load conditions. The values on the chart represent the rms (root-mean square) current that the amplifier would provide during operation.



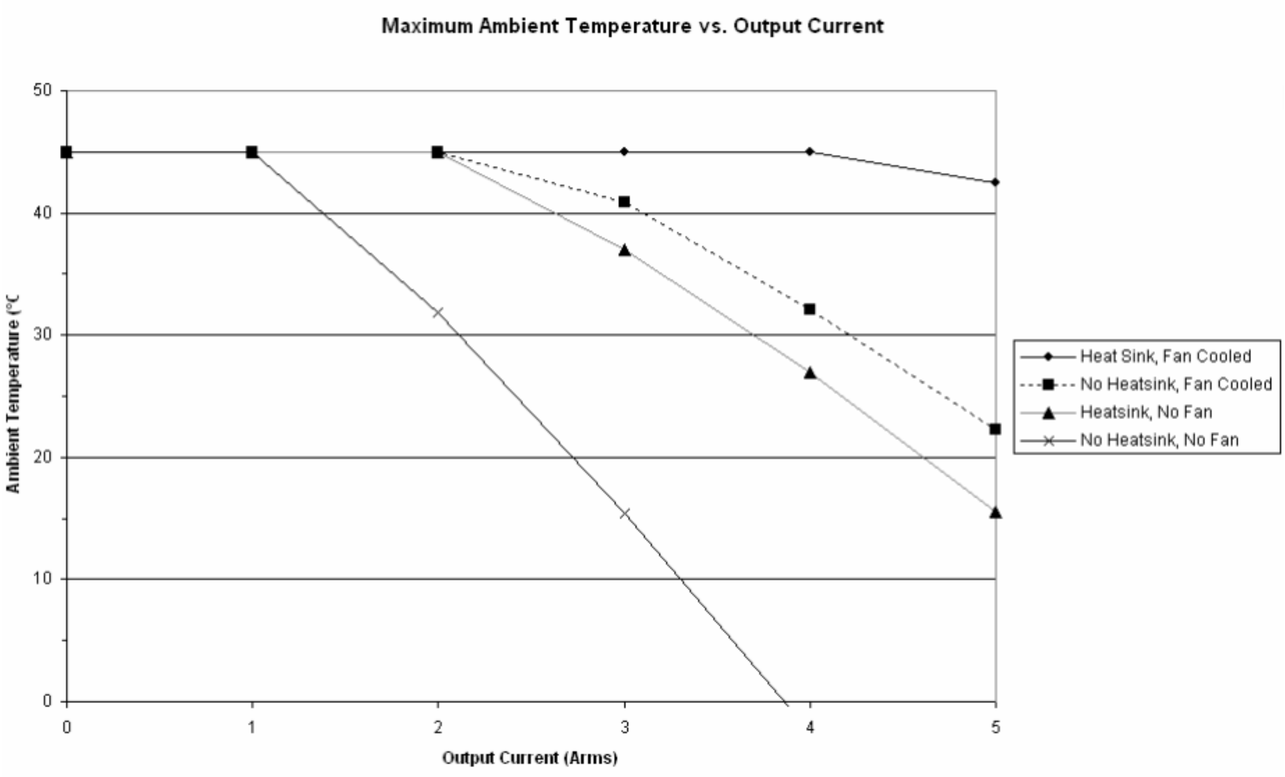
Max Ambient Temperature vs. Current Output, Stepnet Panel AC (STX-120)

The following chart shows the maximum allowable ambient temperature of the Stepnet STX-120-07 amplifier versus output current levels with different cooling feature configurations.



Max Ambient Temperature vs. Current Output, Stepnet Panel AC (STX-230-07)

The following chart shows the maximum allowable ambient temperature of the Stepnet STX-230-07 amplifier versus output current levels with different cooling feature configurations.



Thermal Resistance Stepnet Panel (STX)

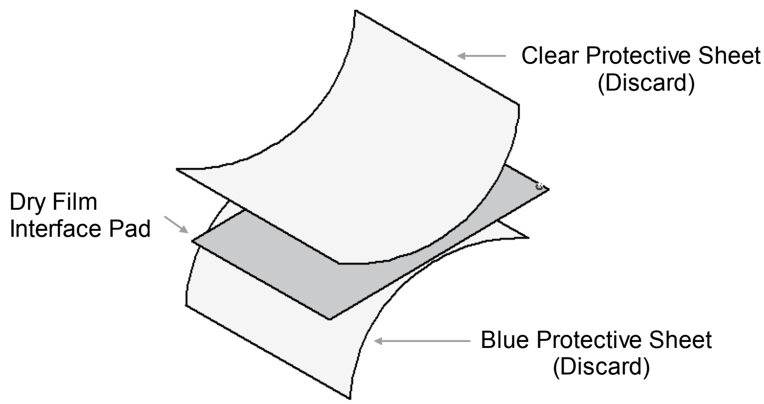
Configuration	Thermal Resistance
No Heat Sink, Convection Cooled	2.2 °C/W
No Heat Sink, Fan Cooled (200 LFM minimum)	1.1 °C/W
With Heat Sink, Convection Cooled	1.2 °C/W
With Heat Sink, Fan Cooled (200 LFM minimum)	0.6 °C/W

*Air flow 200 LFM minimum.

C.2: Heatsink Mounting Instructions

Use the following procedure to mount a heatsink on a Stepnet Panel amplifier. On STP models, the thermal interface between the amplifier and heat sink is a phase change material pad. On STX models, the thermal interface is a dry film interface pad.

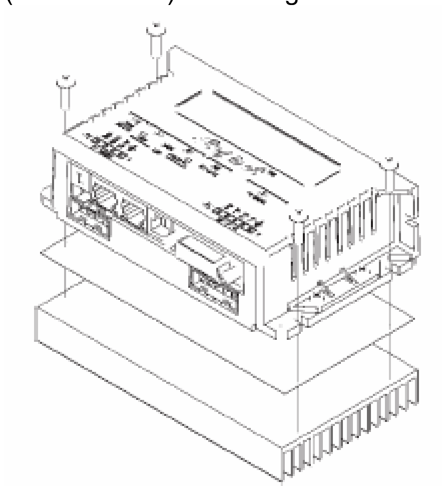
C.2.1 STX: Remove the blue protective sheet from one side of the pad. Place the phase change material on the amplifier, taking care to center the pad holes over the holes in the amplifier. Remove the clear protective sheet from the pad.



C.2.2 STP: Place the phase change material (STP) on the amplifier, taking care to center the pad holes over the holes in the amplifier.

C.2.3 STP and STX: Mount the heatsink onto the amplifier taking care to see that the holes in the heatsink, phase change material or interface pad, and amplifier all line up.

C.2.4 STP and STX: Install and torque the four #6-32 mounting screws to 8~10 lb-in (0.9~1.13 Nm). STP diagram shown here:



APPENDIX
D: DETENT COMPENSATION GAIN

This chapter describes the detent compensation gain feature that can be used in stepper mode to reduce detent noise.

D.1: Detent Gain Tuning

Some stepper motors are susceptible to detent noise. The detent gain tuning feature can be used to reduce that noise.

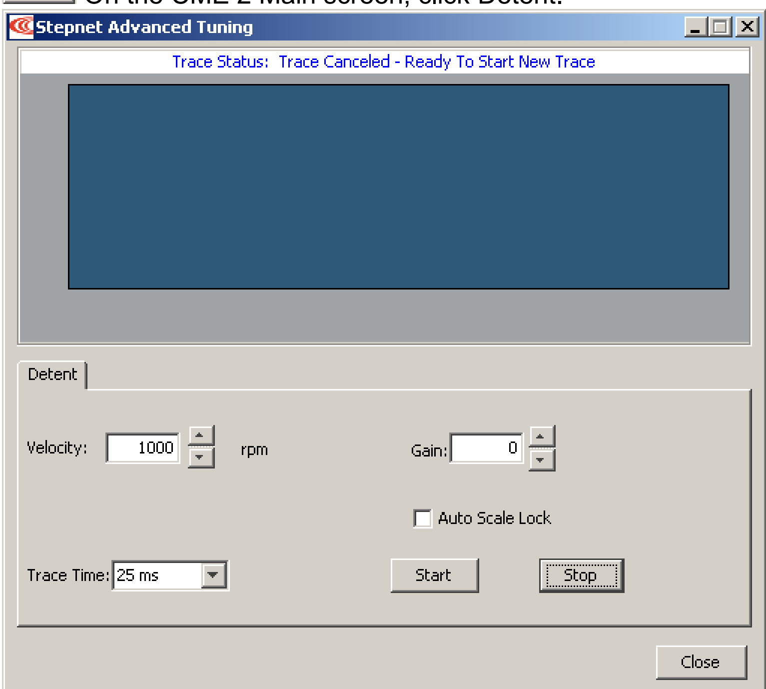
The detent tuning process is different with an encoder than without. With an encoder, actual position is displayed in a trace and used as the primary tuning reference. Without an encoder, actual voltage is shown in the trace. With some motors, voltage changes can be subtle. In these cases, audible noise can be a better tuning reference.

D.1.1: Detent Gain Tuning With Encoder

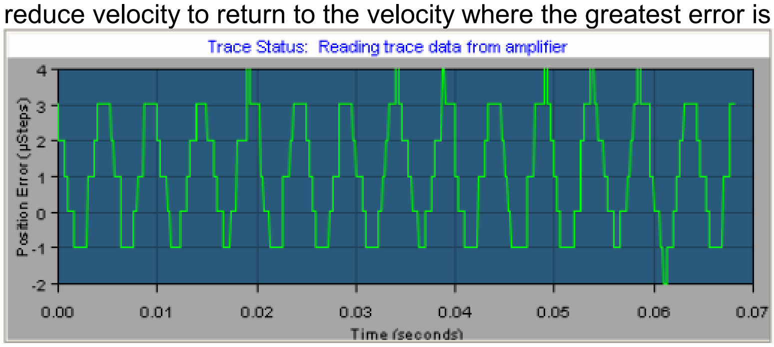
D.1.1.1 Make sure that amplifier and motor have been set up in stepper mode and tuned.

D.1.1.2. 

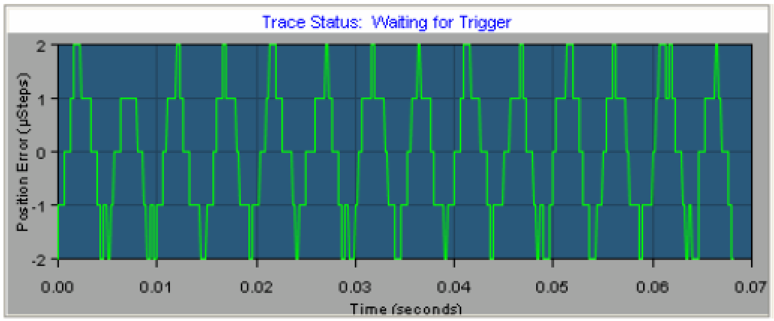
On the CME 2 Main screen, click Detent.



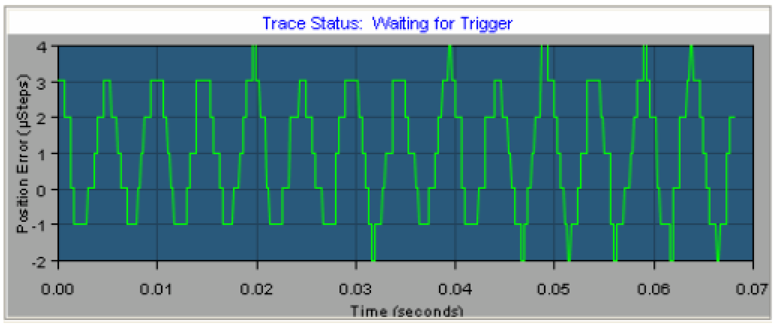
D.1.1.3. With Gain set to 0, adjust the velocity from 0 rpm until the greatest error is seen. Error may peak and then decrease at higher velocities, so it may be necessary to reduce velocity to return to the velocity where the greatest error is seen.



D.1.1.4 At the velocity which exhibits the worst position error, adjust Gain until position error is minimized. See example below.



Note that excessive Gain can introduce more error, as shown below.



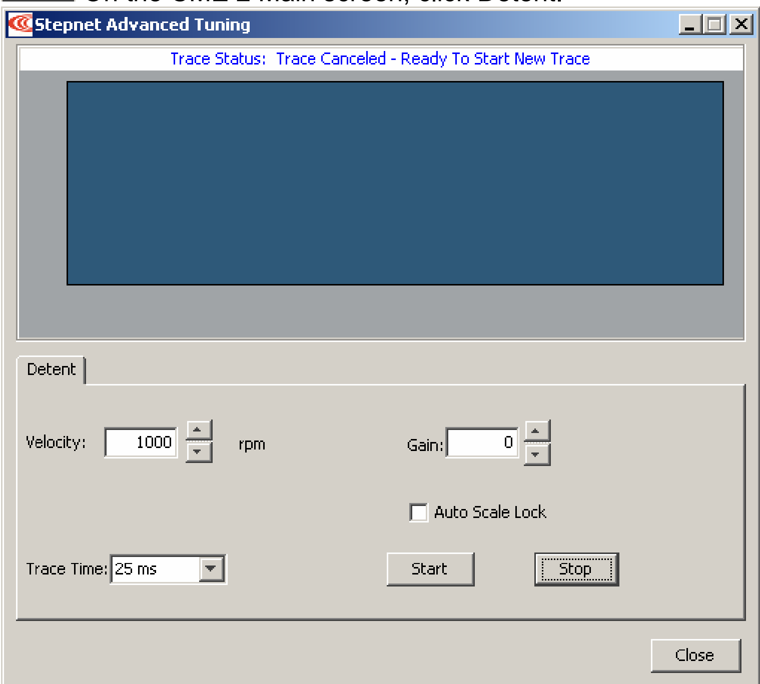
D.1.2: Detent Gain Tuning Without Encoder

With no encoder the trace display shows actual voltage instead of actual position. With most motors, the ouput voltage changes are subtle. In these cases, audible noise provides the best reference for tuning.

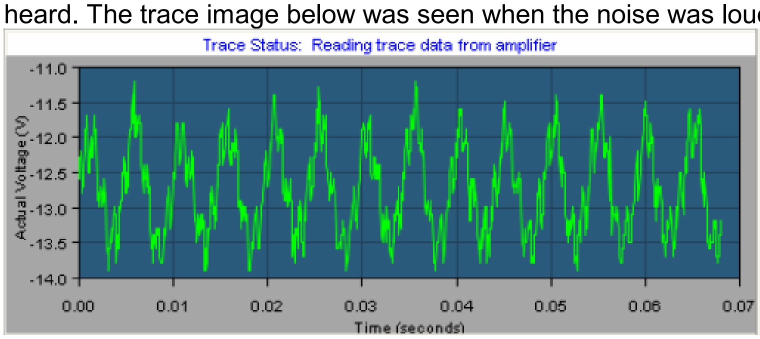
D.1.2.1. Make sure that amplifier and motor have been set up in stepper mode and tuned.

D.1.2.2. 

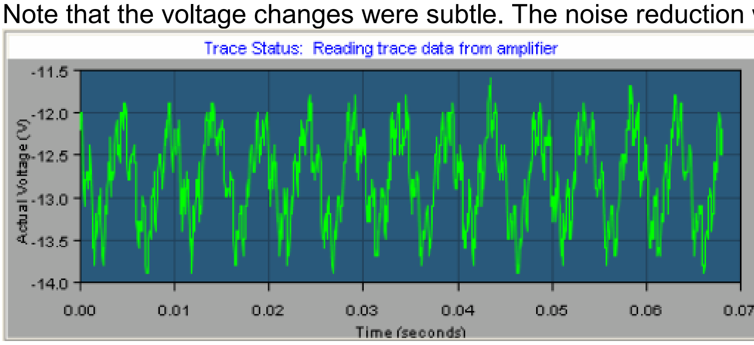
On the CME 2 Main screen, click Detent.



D.1.2.3 With Gain set to zero, adjust velocity from zero until worst noise is heard.
Error may peak at a certain velocity and then decrease at higher velocities, so it may be necessary to reduce velocity to return to the velocity where the greatest noise is heard. The trace image below was seen when the noise was loudest.



D.1.2.2. At the velocity where the worst noise is heard, adjust Gain to find lowest noise level.
Note that the voltage changes were subtle. The noise reduction was obvious.



APPENDIX

E: ORDERING GUIDE AND ACCESSORIES

This chapter lists part numbers for all Stepnet amplifiers and accessories. Contents include:

E.1: Stepnet Panel (STP) Amplifier

Stepnet Panel Model Numbers

Model Number	Description
STP-075-07	Stepnet Panel amplifier 5/7 Adc @ 75 Vdc.
STP-075-10	Stepnet Panel amplifier 10/10 Adc @ 75 Vdc.
NOTE: Add "-H" to order Panel amplifier with factory-mounted heatsink. Heatsink kits may be ordered separately.	

Stepnet Panel (STP) Heatsink Kit

Model	Qty	Description
STP-HK	1	Heatsink
	1	Heatsink thermal material
	1	Heatsink hardware mounting kit

Stepnet Panel (STP) Connector Kit with Solder-Cup Feedback and Control Connectors

Model	Qty	Ref	Description	Mfr. Model No.
STP-CK	1	J1	Housing	Molex 39-01-4041
	4	J1	Crimp terminal	Molex 39-00-0039
	1	J2	Housing	Molex 39-01-4051
	5	J2	Crimp terminal	Molex 39-00-0039
	1	J3	Connector, solder-cup	Norcomp: 180-026-103L001
	1		Back shell	Norcomp: 979-015-020R121

Stepnet Panel (STP) CANopen Network Kit

Model	Qty	Ref	Description	Copley Controls Model No.
STP-NK	1	--	Sub-D 9-position female to RJ-45 adapter	STP-CV
	1	J5/J6	CANopen Network Cable, 10 ft (3 m)	generic Cat5E/Cat6E patch cable
	1		CANopen Network Terminator	STP-NT

Stepnet Panel (STP) Individual Cable Assemblies (and Related Accessories)

Model	Ref	Description	Mfr. Model No.
SER-CK	J4	RS-232 Serial Cable Kit (for connecting PC to amplifier)	
STP-CV	--	Sub-D 9-position female to RJ-45 adapter (PC to CANopen cable adapter)	
STP-NC-10	J5/J6	CANopen Network Cable, 10 ft (3 m)	generic Cat5E/Cat6E patch cable
STP-NC-01		CANopen Network Cable, 1 ft (0.3 m)	
STP-NT		CANopen Network Terminator	

Software

Model	Description
CME2	CME 2 Drive Configuration Software (CD-ROM)
CML	Copley Motion Libraries (CD-ROM)
CMO	Copley Motion Objects (CD-ROM)

Order Example

Order 1 STP-075-07 amplifier with factory-installed heatsink, CME 2 CD, and serial cable kit:

Qty	Item	Description
1	STP-075-07-H	Stepnet Panel (STP) stepper amplifier with heatsink installed
1	STP-CK	Connector kit
1	STP-NK	CANopen network kit
1	CME 2	CME 2 CD
1	SER-CK	Serial Cable Kit for connecting the PC to the amplifier

E.2: Stepnet Panel AC (STX) Amplifier

Stepnet AC Panel Model Numbers

Model Number	Description
STX-115-07	Stepnet Panel AC stepper amplifier 5/7 Adc @ 120 Vac single-phase.
STX-230-07	Stepnet Panel AC stepper amplifier 5/7 Adc @ 240 Vac single-phase.

Stepnet Panel AC (STX) Heatsink Kit

Model	Qty	Description
STX-HK	1	Heatsink, standard
	1	Heatsink thermal material
	1	Heatsink hardware mounting kit

Stepnet Panel AC (STX) Connector Kit

Model	Qty	Ref	Description	Mfr. Model No.
STX-CK	1	J1	Plug, 3 position, 7.5 mm, female	Wago: 721-203/026-045/RN01-0000
	1	J2	Plug, 5 position, 5.0 mm, female	Wago: 721-605/000-043/RN01-0000
	1	J3	3 position, 5.0 mm, female	Wago: 721-103/026-047/RN01-0000
	1	J6	High density D-Sub, male, 15 position, solder-cup	Norcomp: 180-015-103L001
	4		Backshell for J6 plug	Norcomp: 979-009-020R121
	1	J7	High density D-Sub, male, 26 position, solder-cup	Norcomp: 180-026-103L001
	1		Backshell for J7 plug	Norcomp: 979-015-020R121
	2	J1 J2 J3	Wire insertion/extraction tool	Wago: 231-131

Stepnet Panel AC (STX) CANopen Network Kit

Model	Qty	Ref	Description	Copley Controls Model No.
STX-NK	1	J4/J5	Sub-D 9-position female to RJ-45 adapter	STX-CV
	1		CANopen cable assembly, 10 ft (3 m)	STX-NC-10
	1		CANopen network terminator	STX-NT

Stepnet Panel AC (STX) Individual Cable Assemblies (and Related Accessories)

Model	Ref	Description	Mfr. Model No.
SER-CK	J8	RS-232 Serial Cable Kit (for connecting PC to amplifier)	
STX-CV		Sub-D 9-position female to RJ-45 adapter (PC to CANopen cable adapter)	
STX-NC-10	J4/J5	CANopen Network Cable, 10 ft (3 m)	generic Cat5E/Cat6E patch cable
STX-NC-01		CANopen Network Cable, 1 ft (0.3 m)	
STX-NT		CANopen Network Terminator	

Software

Model	Description
CME2	CME 2 Drive Configuration Software (CD-ROM)
CML	Copley Motion Libraries (CD-ROM)
CMO	Copley Motion Objects (CD-ROM)

E.3: Stepnet Module (STM) Amplifier

Stepnet Module Model Number

Model Number	Description
STM-075-07	Stepnet Module amplifier 5/7 Adc @ 75 Vdc. For more information, see data sheet (http://www.copleycontrols.com/Motion/Downloads/stepnetData.html).

Stepnet Module Heatsink Kit

Model	Qty	Description
STM-HS	1	Heatsink, standard
	1	Heatsink thermal material
	1	Heatsink hardware mounting kit
STM-HL	1	Heatsink, low-profile
	1	Heatsink thermal material
	1	Heatsink hardware mounting kit

Stepnet Module Development Kit

Model	Description
TDK-075-01	Stepnet Module Development Kit
TDK-CK	Stepnet Module Development Kit Connector Kit
SER-CK	RS-232 Serial Cable Kit (for connecting PC to development kit)

Software

Model	Description
CME2	CME 2 Drive Configuration Software (CD-ROM)
CML	Copley Motion Libraries (CD-ROM)
CMO	Copley Motion Objects (CD-ROM)

E.4: Stepnet Micro Module (STL) Amplifier

Stepnet Micro Module Model Numbers

Model Number	Description
STL-055-04	Stepnet Micro Module amplifier 3/4.5 Adc @ 55 Vdc. For more information, see data sheet (http://www.copleycontrols.com/Motion/Downloads/stepnetData.html).
STL-075-03	Stepnet Micro Module amplifier 2/3 Adc @ 55 Vdc. For more information, see data sheet (http://www.copleycontrols.com/Motion/Downloads/stepnetData.html).

Stepnet Micro Development Kit (for Stepnet Micro and Stepnet Micro Module)

Model	Description
LDK-075-01	Stepnet Micro Development Kit
LDK-CK	Stepnet Micro Development Kit Connector Kit
SER-CK	RS-232 Serial Cable Kit (for connecting PC to development kit)

Software

Model	Description
CME2	CME 2 Drive Configuration Software (CD-ROM)
CML	Copley Motion Libraries (CD-ROM)
CMO	Copley Motion Objects (CD-ROM)

Stepnet™ User Guide

P/N CC95-00294-000

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