

CLEARPATH-SC MOTORS

AC INPUT, INTEGRAL HORSEPOWER

MODELS SCSK AND SCHP

IN NEMA 56, 143/145, AND IEC D100 FRAME SIZES

VERSION 1.39 MAY 24, 2022

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TOP TIPS FOR CLEARPATH-SC USERS

These tips apply to the integral horsepower ClearPath-SC motors covered in this document.

TOP TIPS

- ✓ **Noise at First Enable?** The brief buzzing sound you hear the first time your motor is enabled after power up is the motor initializing itself. This is normal (and necessary).
- ✓ **USB Cables Matter.** Use only Hi-Speed USB data cables to communicate with your ClearPath motor.
- ✓ **USB Connector Damage.** Avoid yanking, twisting, or tripping on a USB cable that is connected to a ClearPath USB port. This can break the physical connector (and your ability to communicate with the motor through the rear USB port).
- ✓ **Motor Blink Code?** To understand what the various motor blink codes mean, 1) look up blink codes in the user manual (see [Appendix A](#)). 2) Connect to your motor's USB port to view exception/shutdown messages using the ClearView software.
- ✓ **Keep it Covered.** Install the motor's watertight junction box cover to prevent liquids and debris from falling into the motor's electronics compartment.
- ✓ **Auto-Tune *Fully Loaded*.** Auto-Tune with your motor connected to the mechanics exactly as it will run during normal operation. The default motor tuning file that comes with your motor is designed for no-load operation.

QUICK START GUIDE

This section was created to help users achieve the following objectives:

- Understand the ClearPath-SC system at a high level
- Connect the ClearPath-SC system components
- Install ClearView setup and configuration software
- Establish communication between a ClearPath-SC motor and PC
- Spin a ClearPath-SC motor using ClearView software

ABOUT CLEARPATH-SC

Thank you for choosing the ClearPath-SC all-in-one servo system with full software control. ClearPath-SC gives you the highest level of flexibility and control over your motors and machine application software, because you write it.

In the ClearPath-SC development model, Teknic provides you with the **sFoundation**, an advanced motion software library. ClearPath-SC is compatible with C++ for Windows/Linux and .NET languages (such as C#) for Windows. You write the machine application using development tools like Microsoft Visual Studio 2015.

The included **ClearView configuration and setup software** allows non-software personnel to tune, test, and exercise the servos right on the machine without coding a single line.

WHO SHOULD USE CLEARPATH-SC MOTORS?

ClearPath-SC users should be proficient in a programming language supported by ClearPath, such as C++ for Windows/Linux and .NET languages (such as C#) for Windows.

If you're not a programmer, consider ClearPath-MC or ClearPath-SD motors for your project. The **ClearPath-MC family** features an assortment of preprogrammed operating modes, simplified digital controls, and *requires no coding*. The **ClearPath-SD family** accepts standard step and direction or quadrature AB control signals from any compatible controller, indexer, or similar device.

PLEASE READ THIS IMPORTANT WARNING!

Always use caution and common sense when handling motion control equipment. Even the smallest ClearPath motor is powerful enough to crush fingers, tear off a shirt sleeve, or pull out a patch of hair, faster than the blink of an eye¹.

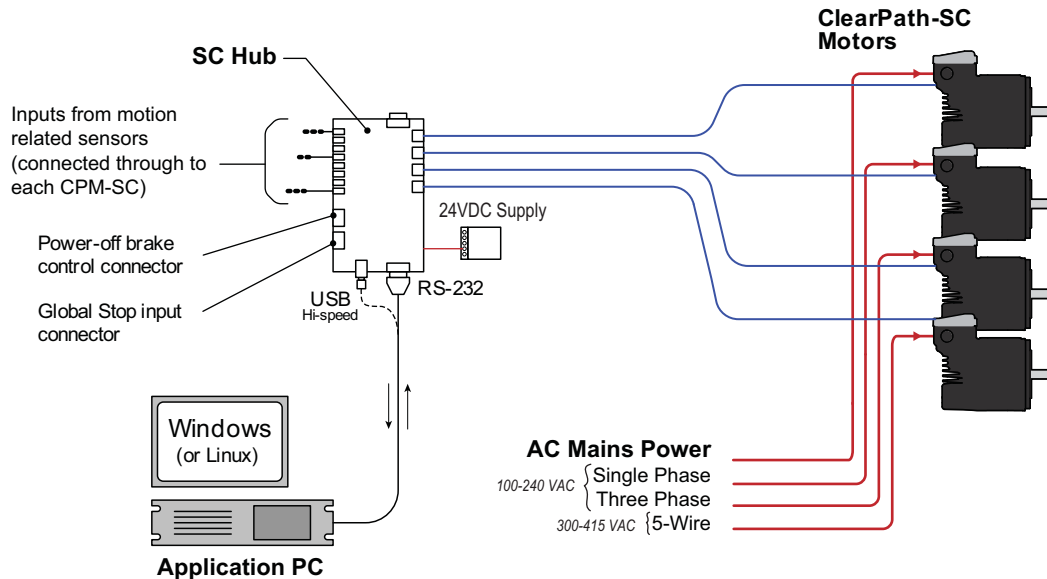
These devices are very powerful and can be extremely dangerous if used carelessly. Misuse can lead to severe injury or death. We want all ClearPath users to be safe and *fully intact* at the end of the day, so please read and understand all safety warnings in the ClearPath User Manual before operating a ClearPath motor.

¹ The average duration for a single blink of the human eye is 100 to 400 milliseconds according to the *Database of Useful Biological Numbers*.

SYSTEM OVERVIEW

This section provides a brief overview and description of the main components of a ClearPath-SC system. See the ClearPath-SC User Manual for more information and specifications on system components.

SYSTEM DIAGRAM



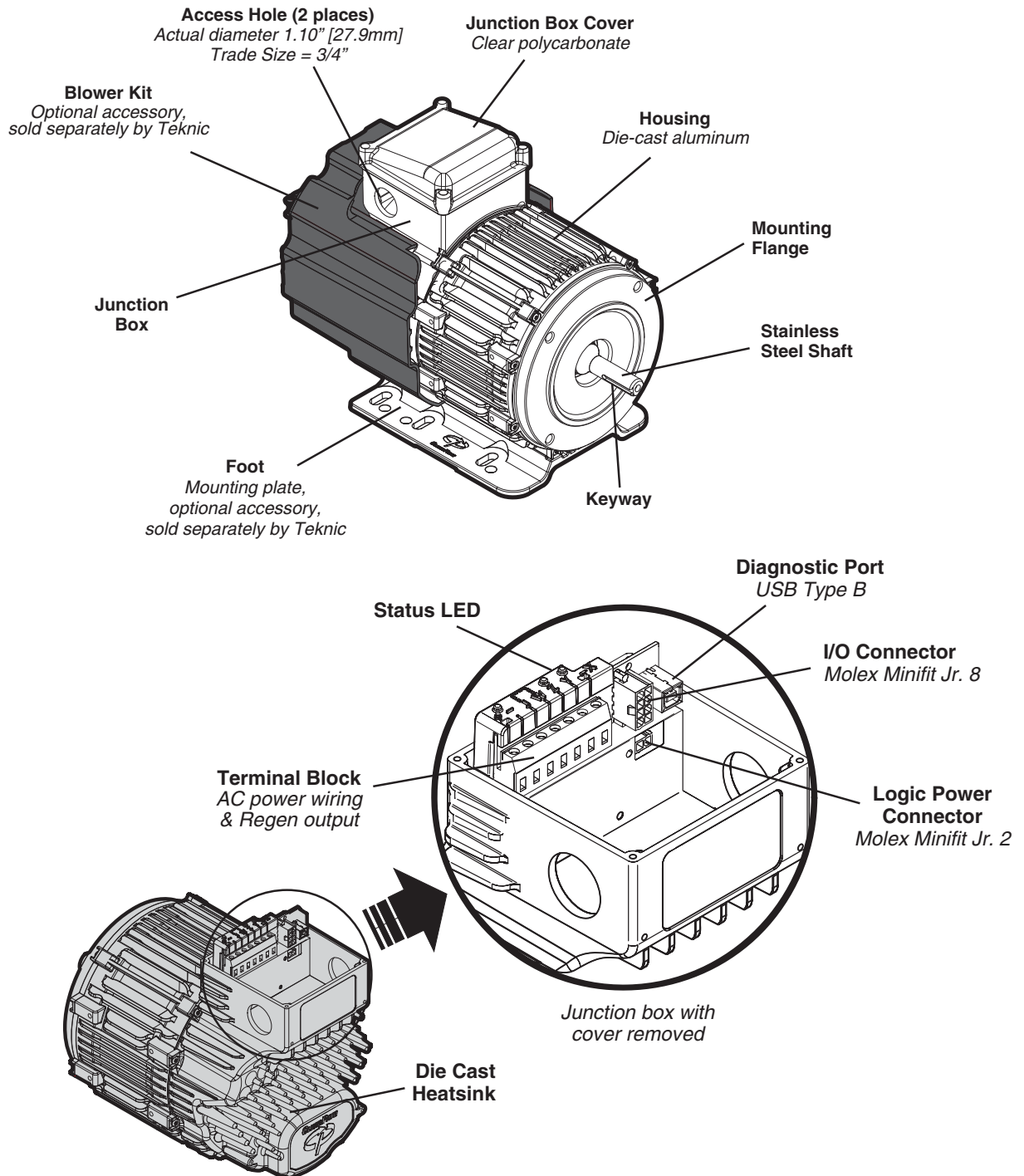
A 4-axis ClearPath-SC System

SC4-HUB NOTE

An SC4-HUB is required in every ClearPath system. It connects your computer and I/O devices to your ClearPath-SC motors. The SC4-HUB routes communication signals, passes sensor/switch inputs to the motors, includes 2 power-off brake outputs, and one Global Stop (e-stop) input. A maximum of 4 SC4-HUBs can be linked together to create systems of up to 16 axes per port, on up to 3 ports per computer, allowing you to create systems with as many as 48 motion axes.

PARTS OF A CLEARPATH-SC MOTOR

Industry-leading, programmable, brushless servo motor with precision optical encoder, built in controller, trajectory generator, servo compensator, and torque drive.



Parts of a ClearPath-SC motor

SYSTEM SETUP

This section describes how to connect ClearPath-SC components, apply power, and establish communication between your motors and PC. We'll show you how to run some basic test moves in the next section.

READ THIS BEFORE POWERING UP A CLEARPATH-SC SYSTEM

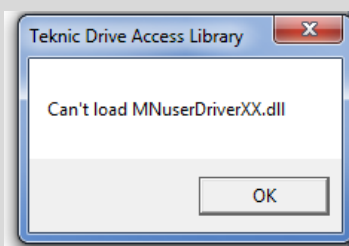
- **Do** secure your motors to a stable work surface.
- **Do** keep loose items such as cables, hair, and clothing away from motor shafts.
- **Do** observe static-safe handling practices when handling the SC4-HUB.
- **Do not** "hot swap" power connectors (i.e. don't connect or disconnect DC power connectors when the DC Bus Supply is powered up). This will cause electrical arcing, carbon scoring, and pitting of the terminals over time.
- **Do** install a protective (finger-safe) guard (or other physical barrier) around the motor shaft.

1. INSTALL CLEARVIEW SOFTWARE

1. Update your Windows installation. See note below for details.
2. Download the ClearView installer from Teknic's website:
<https://www.teknic.com/downloads/>
3. Launch the ClearView Installer. Follow the on-screen prompts.

Important Software Installation Note

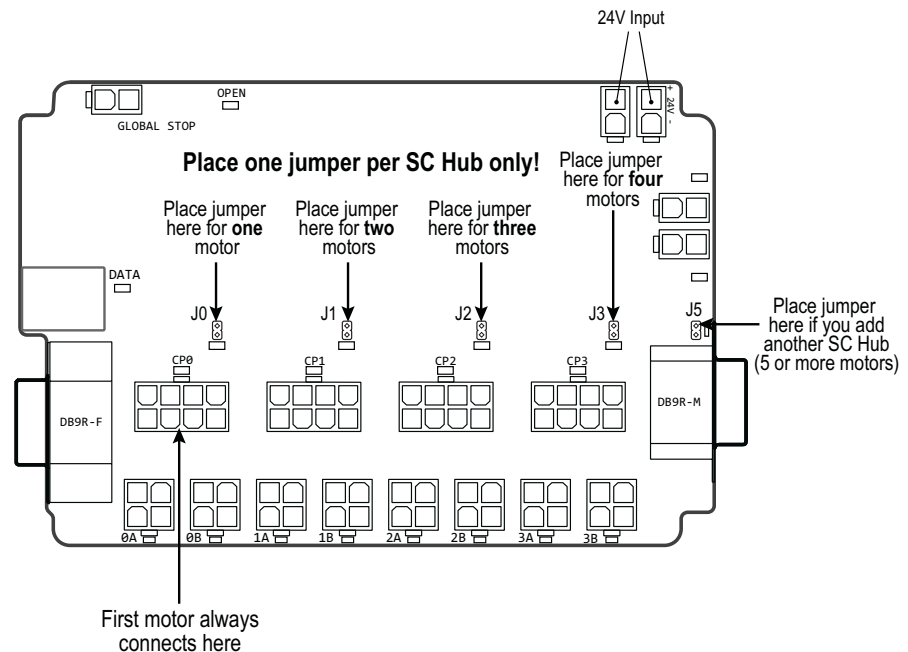
If your Windows installation is not up to date, ClearView may not run properly on your PC. During installation, the ClearView installer needs access to a few specific Windows system files. If these files are not found, Windows Update will attempt to install them. If Windows Update is disabled, and/or you have no internet connection, this may fail.



If you install and attempt to run ClearView and see an error window like the one shown above, close ClearView and install this update:
<https://support.microsoft.com/en-us/kb/2999226>. Then, re-launch ClearView.

2. INSTALL THE SC4-HUB "END-OF-LOOP" JUMPER

Place one (and only one) jumper block on the 2-pin header associated with the last motor connected to your SC4-HUB. Motors must be populated in order from CP0 to CP3 (do not skip motor locations or the system will not communicate properly). Place the jumper on J0 for a single motor, on J1 for two motors, and so forth. See the diagram below for details.



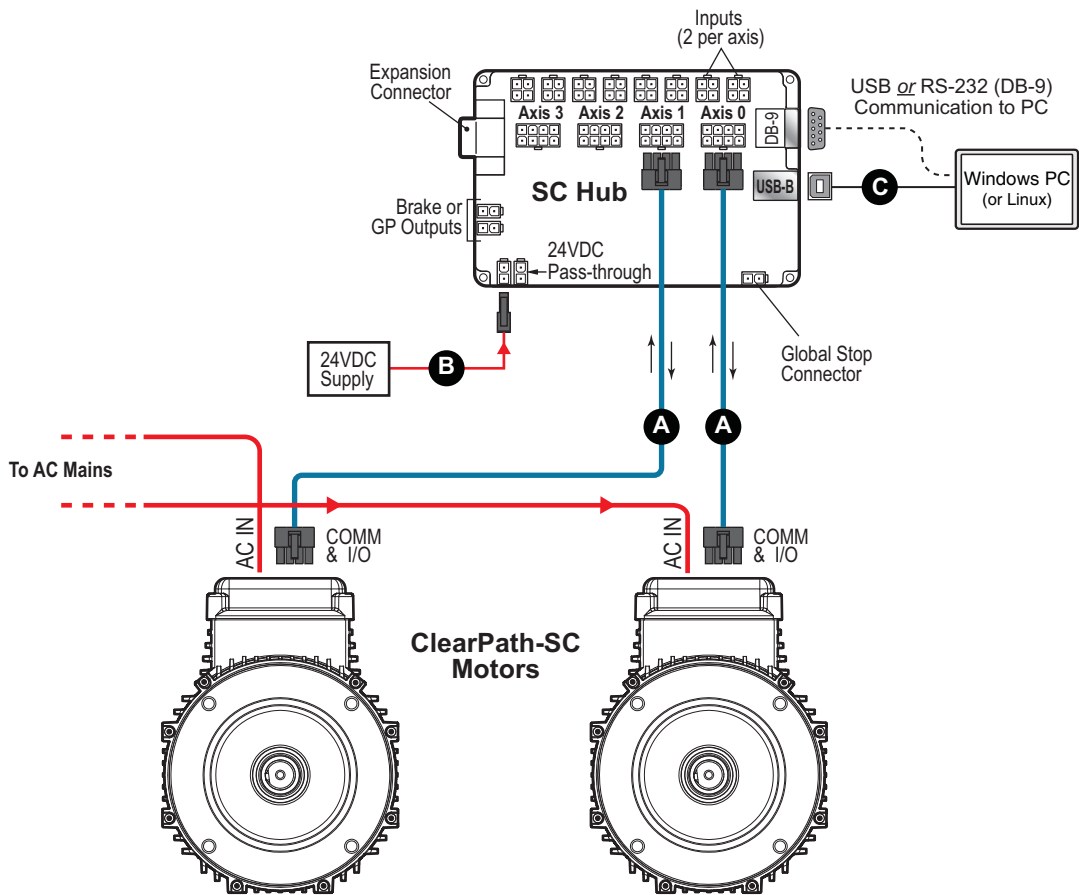
SC4-HUB jumper placement

Note: If you connect a second SC4-HUB, place one jumper at J5 on the first SC4-HUB. Then, on the second SC4-HUB, place one jumper at the last populated motor location.

3. CONNECT CLEARPATH-SC SYSTEM COMPONENTS

Before applying power, connect all ClearPath-SC components as shown in the hookup diagram below.

SYSTEM HOOKUP DIAGRAM



Ref.	Cable Part Number	Description
A	CPM-CABLE-CTRL-MU120	Cable assembly, 120" ClearPath I/O (overmolded Molex Minifit 8-pin to standard Molex Minifit 8-pin).
B	CPM-CABLE-M2P2P-120	2-pin Molex to 2-pin Molex multi-purpose cable, ~10 ft long.
C	CPM-CABLE-USB-120AB	ClearPath USB Cable; A-male to B-male. 120 inches (3.05m) in length

ClearPath-SC Hookup Diagram (for systems without a Power Hub)

4. ESTABLISH COMMUNICATION (USB OR RS-232 / SERIAL)

Next, you'll need to establish communication between your PC and the ClearPath-SC motors you want to control. There are two communication protocols available, USB or RS-232. Each is described in this section.

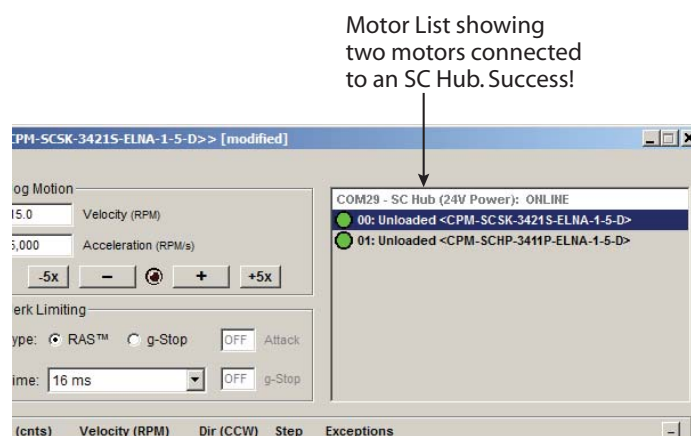
USB COMMUNICATION

1. Power up your ClearPath-SC system.
2. Connect USB cable from the SC4-HUB to your PC. This is a standard USB-A (male) to USB-B (male) cable.



USB-A (male) to USB-B (male)

3. Wait! Allow the drivers to auto-install. This may take a minute.
4. Launch the ClearView software.
5. ClearView will immediately attempt to auto-detect your motors. If all is well, you will see your motor(s) appear in the Motor List in ClearView.



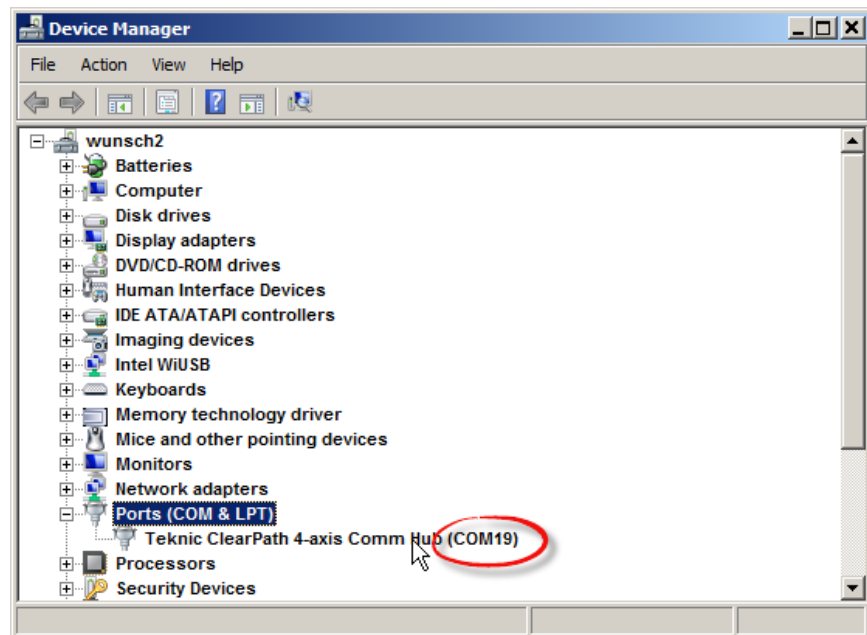
Two ClearPath-SC motors recognized in ClearView

6. If ClearView does not auto-detect your motors. Follow the steps described in *Setting the USB COM Port Manually*, below.

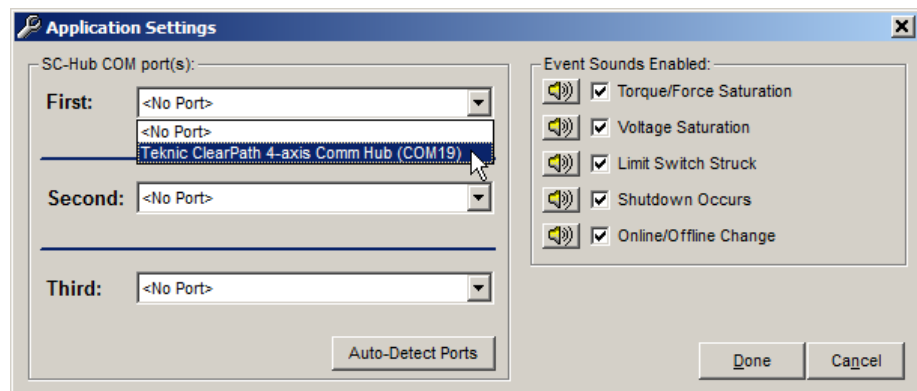
Setting the USB COM Port Manually

1. Open Device Manager (Windows systems).
2. Double-click "Ports (COM & LPT)".

3. Under Ports, locate "Teknic ClearPath 4-Axis Comm Hub (COM[n])". Take note of the value [n]—this is your COM port number.



4. In ClearView software go to File>Preferences.
5. Click the drop down menu in the section labeled "First".
6. Select the COM port [n] you identified above. Click "Done".



Select "Teknic ClearPath 4-axis Comm Hub" for First COM port

RS-232, SERIAL COMMUNICATION

Important: *If you choose serial communication, your serial port must support a **minimum of 230k baud** to run ClearView software.* If you do not know what speeds are supported by your serial port, check Windows Device Manager under Ports, or refer to your computer's documentation. Note: User-developed applications running *without* ClearView will run properly down to 115k baud minimum.

If you want to use serial communication, and your serial ports aren't fast enough, you can find high speed serial port cards online from companies such as Axxon (softio.com) and Perle.

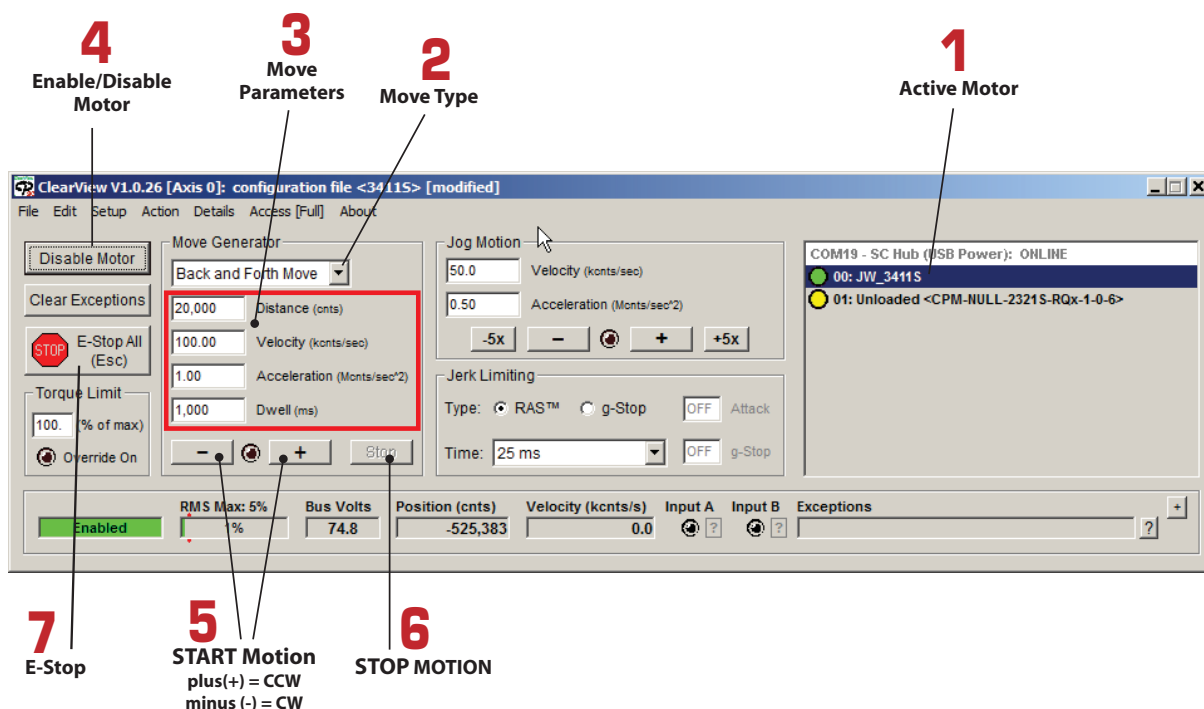
1. Power up your ClearPath-SC system.
2. Connect your serial communication cable (DB-9 to DB-9, straight-through) from the SC4-HUB to your PC.
3. Launch the ClearView application.
4. Click File>Preferences. A dialog box will pop up. In the section labeled "First", select the COM port number assigned to the serial port you are using.
5. Click "Done".

5. TEST SPIN YOUR MOTORS USING CLEARVIEW

Note: This section describes how to spin an unloaded motor (i.e. a motor with nothing attached to the shaft). Important: ClearPath-SC motors ship out pre-configured for *unloaded use only*. **You must run the Auto-Tune application whenever you connect your motor to a different mechanical system.**

Click and spin—no code required! Once your system is powered up and communicating, you can take your motors for a test spin using ClearView's Move Generator or Jog Motion controls. Here's how:

1. Select the motor you'd like to spin from the Motor List.
2. Set the Move Type: Back and Forth, Single, or Repeating.
3. Enter the Move Parameters: Distance, Velocity, Acceleration, and Dwell (Dwell is just the rest period between repeating moves).
4. Click Enable/Disable button once to enable the motor.
5. Click "Start Motion" (+ or -) button. Hit "+" to start motion in the counter clockwise direction; hit "-" to start motion in the clockwise direction
6. Single click the "Stop" button to end motion cycling. Double click the Stop button to stop motion immediately.
7. Click "E-Stop All" or hit your Esc key to stop motion immediately.



ClearView Main UI

End Quick Start Guide

SAFETY WARNINGS

IMPORTANT: Read this manual before attempting to install, power up, or operate a ClearPath motor. Failure to understand and follow the safety information presented in this document could result in property damage, bodily injury, or worse.

PERSONAL SAFETY WARNINGS

- Do not wear loose clothing or unconfined long hair when using ClearPath-SC motors. Remove ties, rings, watches and other jewelry before operating an unguarded motor.
- Do not operate a ClearPath-SC motor if your alertness, cognitive function, or motor skills are impaired.
- Always handle, and carry a ClearPath-SC motor by the housing (don't carry it by the shaft or cable). Be aware that in certain scenarios ClearPath-SC is may spin as soon as main DC power is applied.
- Always understand how to use ClearPath-SC software controls and associated features before attempting to power, enable, or otherwise operate a ClearPath-SC motor.
- Install and test all emergency stop devices and controls before using ClearPath-SC.
- Before applying DC power, secure the ClearPath-SC motor to a stable, solid work surface and install a finger-safe guard or barrier between the user and the motor shaft.
- Provide appropriate space around the ClearPath-SC motor for ventilation and cable clearances.
- Do not allow cables or other loose items to drape over, or rest near the ClearPath-SC motor shaft.
- Never place fingers, hands, or other body parts on or near a powered ClearPath-SC motor.
- Thoroughly test all ClearPath-SC applications at low speed to ensure the motor, controls, and safety equipment operate as expected.

CE COMPLIANCE WARNINGS

- There are no user serviceable parts inside.
- Follow all instructions and use the product only as directed.
- Safety of any system incorporating this equipment is the responsibility of the system designers and builders.
- The machine designers need to recognize and incorporate required warning symbols, guards and shields for ClearPath-SC motors that are used in applications that can result in the

external accessible parts of their machine exceeding a temperature of 65 Celsius. This is required as a method to reduce burns. A tool shall be required to remove any guards and/or shields.

- ClearPath-SC motors require that a path exist between the motor chassis and the Protective Earth (PE) connection of the machine to which it is affixed. (Note: The PE connection is often satisfied by simply bolting the motor to the machine; however it is the users responsibility to verify the PE connection.) If an external grounding wire is required, use the same or larger wire gauge as used between the DC power supply and ClearPath Motor.
- Any maintenance or repair guide created by the user shall state that power shall be removed before the Protective Earth ground conductor is disconnected. When reconnecting power, the Protective Earth ground conductor shall be the first wire reconnected. Main power may be reconnected only after the Safety Ground connection is secure.

GENERAL DISCLAIMER

The User is responsible for determining the suitability of products for their different applications. The User must ensure that Teknic's products are installed and utilized in accordance with all local, state, federal and private governing bodies and meet all applicable health and safety standards.

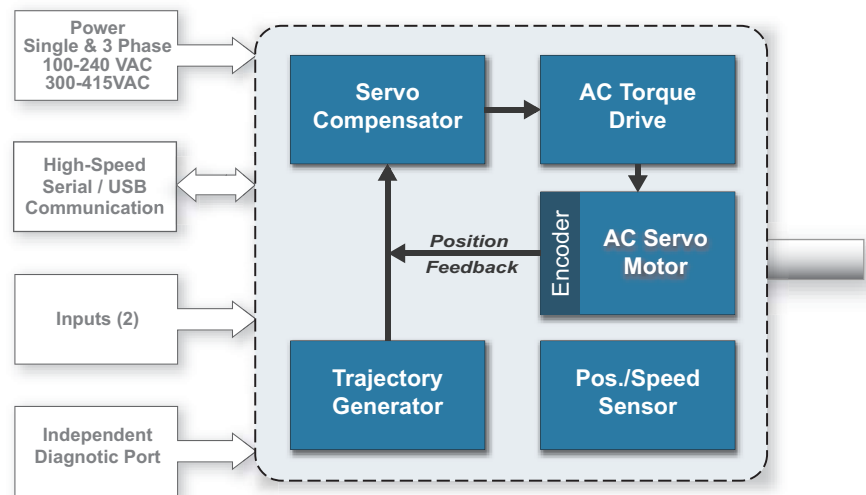
Teknic has made all reasonable efforts to accurately present the information in the published documentation and shall not be responsible for any incorrect information which may result from oversights. Due to continuous product improvements, the product specifications as stated in the documentation are subject to change at any time and without notice. The User is responsible for consulting a representative of Teknic for detailed information and to determine any changes of information in the published documentation.

If Teknic's products are used in an application that is safety critical, the User must provide appropriate safety testing of the products, adequate safety devices, guarding, warning notices and machine-specific training to protect the operator from injury.

INTRODUCTION

WHAT IS CLEARPATH-SC?

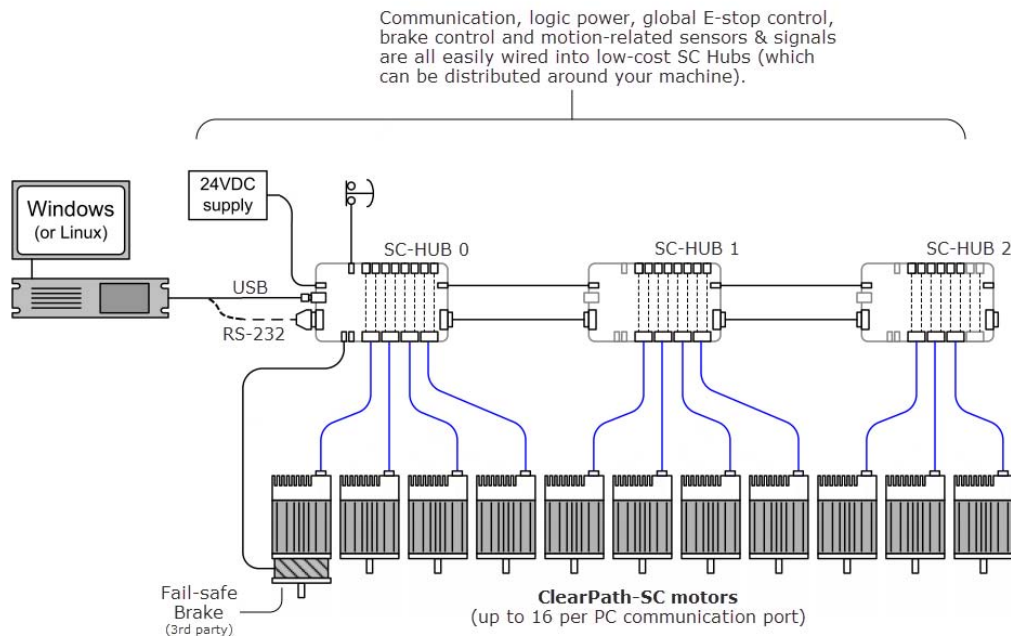
ClearPath-SC is a multi-axis, servo-controlled motion system that allows you to connect up to 16 (or more) integrated servo motors into a tightly coordinated network. Inside each individual ClearPath-SC—in a package about the size of a normal motor—is a rare-earth brushless motor, a powerful servo drive, a motion trajectory generator, and a high-resolution optical encoder. ClearPath-SC's high performance, all-in-one convenience, and low cost makes it practical to use multi-axis servo control in many automated machinery application.



ClearPath-SC all-in-one, software controlled servo system

ClearPath-SC is a rugged, industrial-grade product. The motor subsystem is based on Teknic's [Hudson family](#) of brushless servo motors, with similar instrument grade bearings, stainless steel shaft, windings, rare earth magnets, and encoder technology.

The servo drive electronics and firmware employ the same state-of-the-art technology and advanced motion control algorithms as our high-end, non-integrated servo control products.



Example ClearPath-SC network. (DC bus wiring not shown.)

Tightly coordinate up to 16 or more motion axes per port (or more). ClearPath-SC's free C++ and .NET class library makes it possible to write software for complex multi-axis applications. Simple applications can be written in a single execution thread, and, for more sophisticated systems, ClearPath-SC supports multi-threaded applications as well. Optional advanced firmware allows you to generate user-defined interrupts (attentions) for a variety of system events, allowing you to create highly responsive and deterministic multi-axis systems.

ClearPath-SC features a quick, automatic setup. Install the included ClearView software, connect ClearPath to your PC via USB or high-speed RS-232, and let it auto-tune itself to your mechanical system for optimum servo performance.

ClearView software allows you to get moving quickly. You can set many motor parameters, and exercise your mechanical system and electronics with just a few mouse clicks.

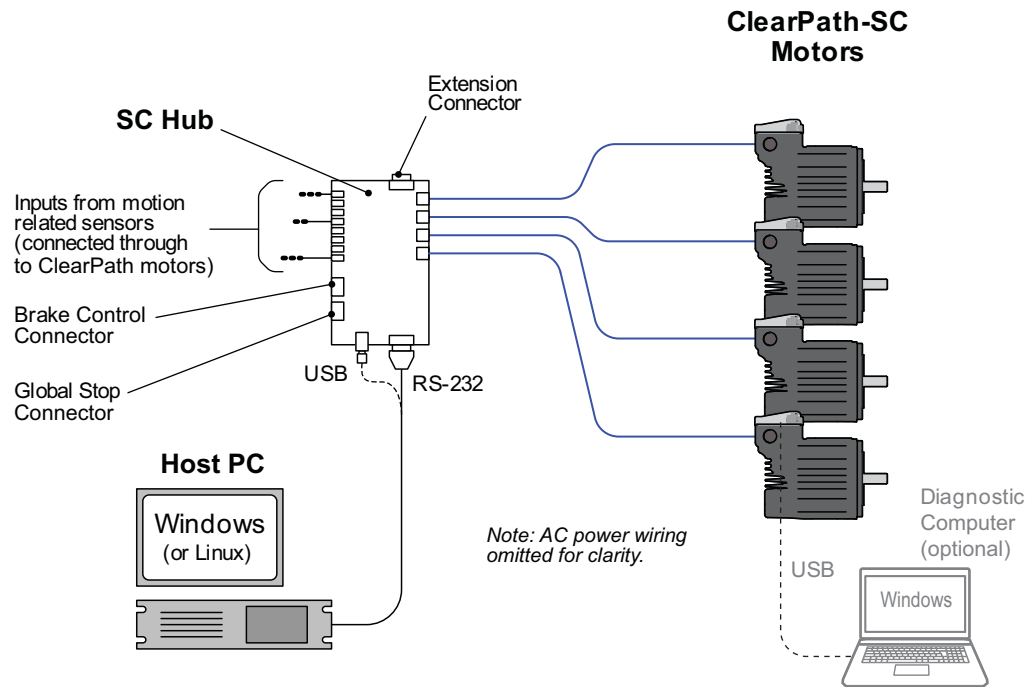
Safety and self-protection features are standard. ClearPath-SC will rapidly shut down if it becomes overloaded, overheated, detects a hard stop, or exceeds any of the safety or motion limits you specify.

Made in USA. Each ClearPath-SC motor is built and tested in our New York manufacturing facility, so you can be certain you're getting a high quality, fully tested motion control product right out of the box. And, Teknic backs up each ClearPath-SC motor with a three year warranty.

EXAMPLE CLEARPATH-SC SYSTEMS

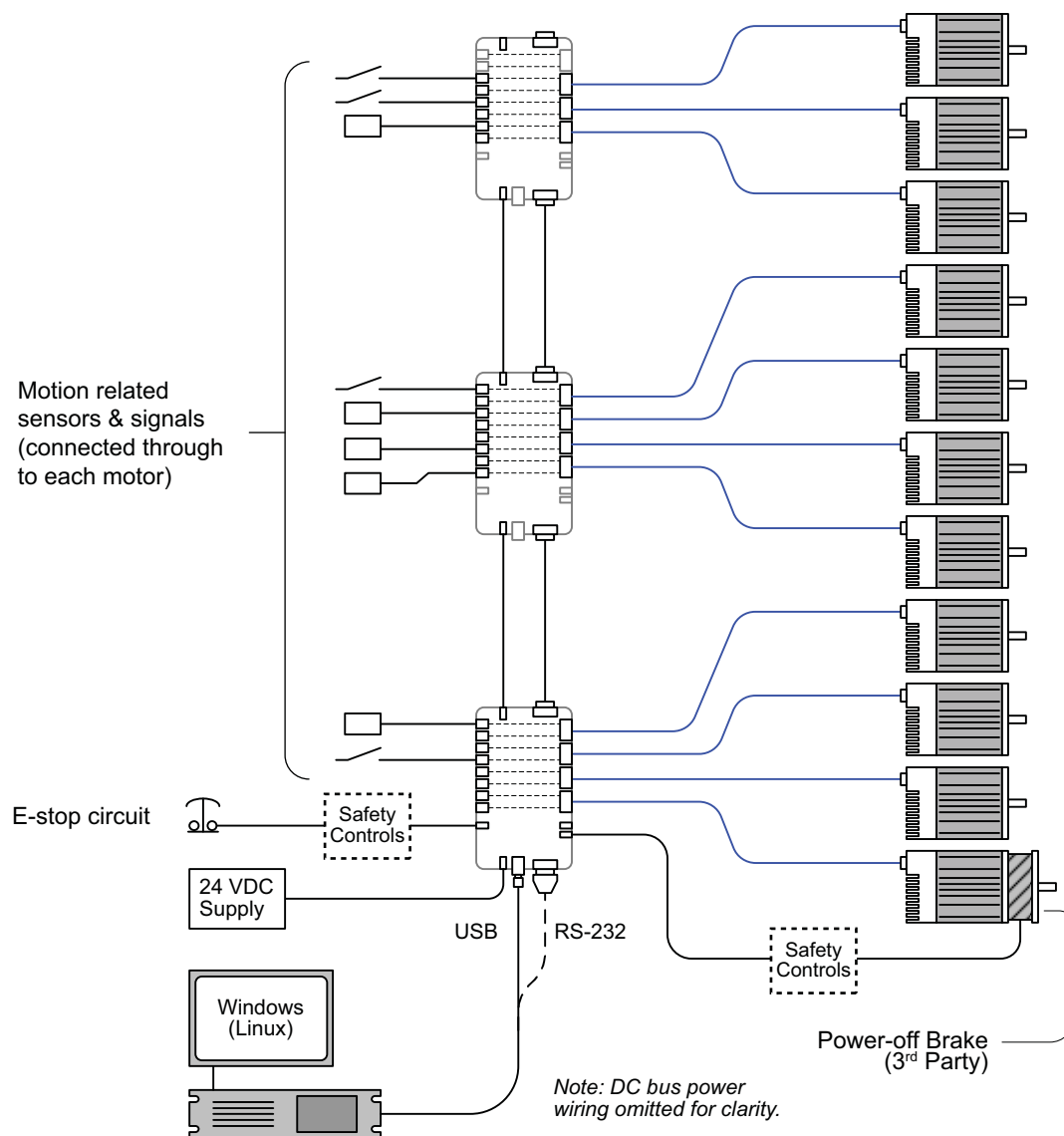
The ClearPath-SC system was created with both design flexibility and expandability in mind. This section shows a few examples of systems that can be built with ClearPath-SC components.

TYPICAL 4-AXIS SYSTEM (SINGLE PORT, 1 SC4-HUB)



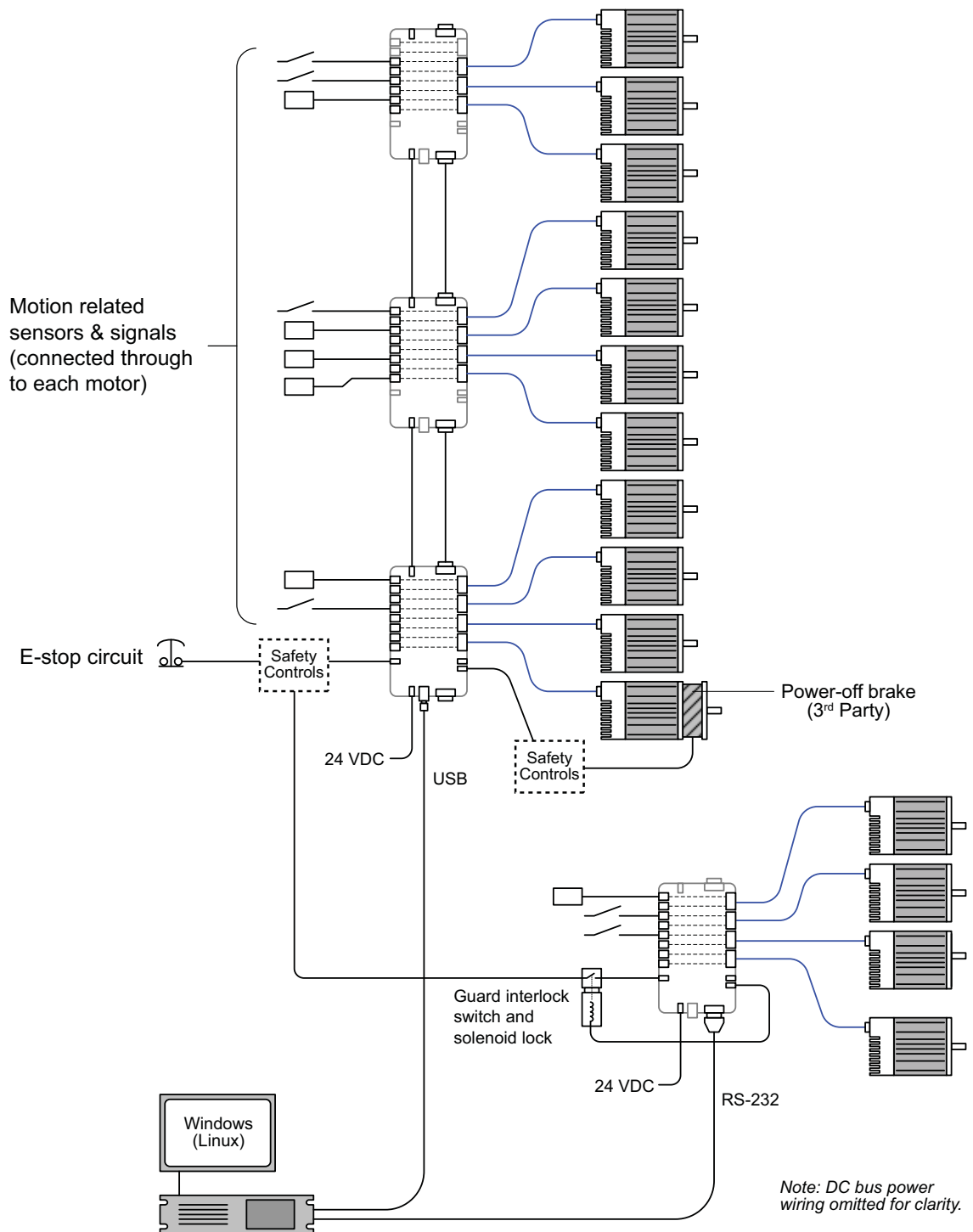
4-axis ClearPath-SC system

MEDIUM SYSTEM (SINGLE PORT, 3 SC4-HUBs)



Medium system with multiple SC-Hubs connected to one computer port
 Active sensors powered through SC-Hub, e.g., proximity, optical, Hall-effect type, etc.
 24V Power-off brake shown wired for axis 0

LARGE SYSTEM (MULTIPLE PORTS AND SC4-HUBS)



Large system with multiple SC-Hubs connected to two ports
 Two area machine with guard lock under software control in one area
 24V Power-off brake shown wired for one axis
 Mix of mechanical switches and active sensors powered from SC-Hub

WIRING AC POWER TO CLEARPATH

BEFORE YOU WIRE AC POWER TO YOUR MOTOR

Verify that you have a compatible AC power source and all of the necessary tools and supplies.

COMPATIBLE AC POWER SOURCES

- Single phase and 3 Phase, 100-240 VAC (common in North America).
- 5-wire (3 Phase with neutral and ground) 300-415 VAC (common in Europe).
- **Important:** Do not connect 3 Phase, 277/480 VAC to your AC ClearPath motor. This will result in an overvoltage condition.

TOOLS AND SUPPLIES REQUIRED

Note: The items listed below are not included with a ClearPath motor.

- T10 (Torx) screwdriver.
- Slotted screwdriver with max. 4mm blade (for terminal block screws).
- Ring terminal sized for a #10 screw, tin plated, crimp style; for connecting AC ground wire to grounding point in motor junction box.
- Wire strippers.
- AC cable and plug rated for your application requirements. **Note: 14-16 AWG wire is appropriate for most installations. The cable's ground conductor must be the same gauge or heavier than the phase conductors. Use cable rated for 80°C or higher.**
- Cord grip, strain relief, or conduit fitting sized for a **3/4" trade size knockout**. Many different types are available from McMaster-Carr, Grainger, MSC, and other industrial supply houses.

CIRCUIT BREAKER REQUIREMENT

AC ClearPath motors should be protected by a circuit breaker with the appropriate current rating, voltage rating, and trip characteristic. **Select a circuit breaker with a “C” trip curve** to help prevent nuisance trips.

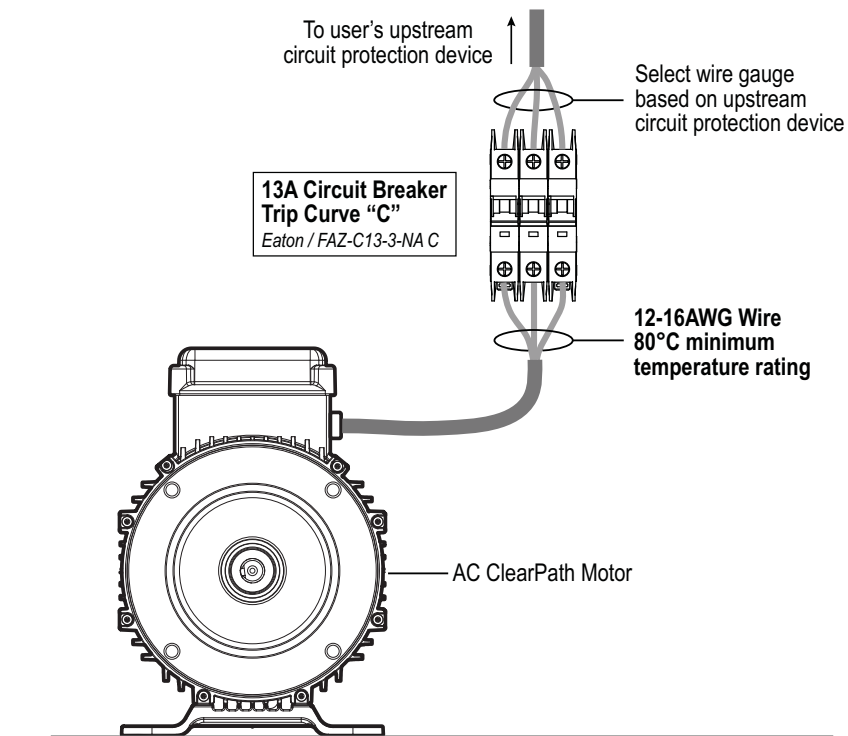
Teknic recommends the following breaker for most AC ClearPath applications. Other circuit breaker manufacturers may offer equivalent products.

Recommended Circuit Breaker

Eaton Part#: FAZ-C13-3-NA C

Description: Eaton miniature circuit breaker, current-limiting, 13 amp, 480Y / 277 VAC / 3-pole, C trip curve, thermal magnetic, 10kA SCCR, 35mm DIN rail mount. This product is UL 489 rated and available at Automation Direct as of this writing.

Important: For US installations, consult the National Electrical Code (NEC) prior to selecting circuit breaker wire. **Use wire rated for 80°C or higher only.** The use of undersized wire and/or wire with temperature rating less than 80°C constitutes a safety and/or fire hazard.



ClearPath with circuit breaker

AC WIRING INSTRUCTIONS

1. Remove the motor's junction box cover (use a Torx T10 driver).
2. Install your choice of cord grip, strain relief, conduit, or plugs in the junction box access holes. The access holes measure 1.1 " in diameter; these are **3/4" trade size knockouts**.

Note: The **red access hole plugs** that shipped with your motor were designed for cosmetic protection only. **Please recycle** these plugs Use a product that is, at a minimum, dust tight.

3. Prepare your AC cable by stripping back the outer jacket approximately 4". Note: Use 12-16 AWG wire.
4. Strip individual wires back 7mm +/- 0.5mm (.275" +/- 0.020").
5. If required, make a 2-3 inch jumper wire. See wiring diagrams below to determine if you need a jumper. **Use the same wire gauge for your jumper as was used for the AC phase wires.** Strip 6-7 mm (~1/4").
6. Crimp a *tin plated ring terminal*² onto the AC cable's grounding wire. See list below for recommended part numbers.

Molex part number: 0190730170 (10-12AWG)

Panduit part number: PV10-10R-D (10-12 AWG)

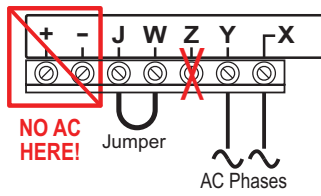
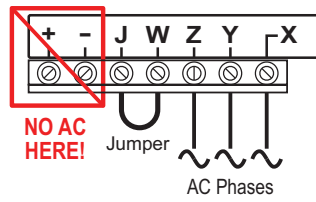
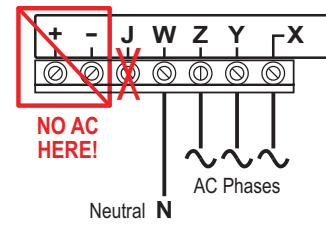
Panduit part number: PV12-10HDB-2K (12-16 AWG)

TE AMP Connectors part number: 40960 (12-14 AWG)

TE AMP Connectors part number: 36160 (16-14 AWG)

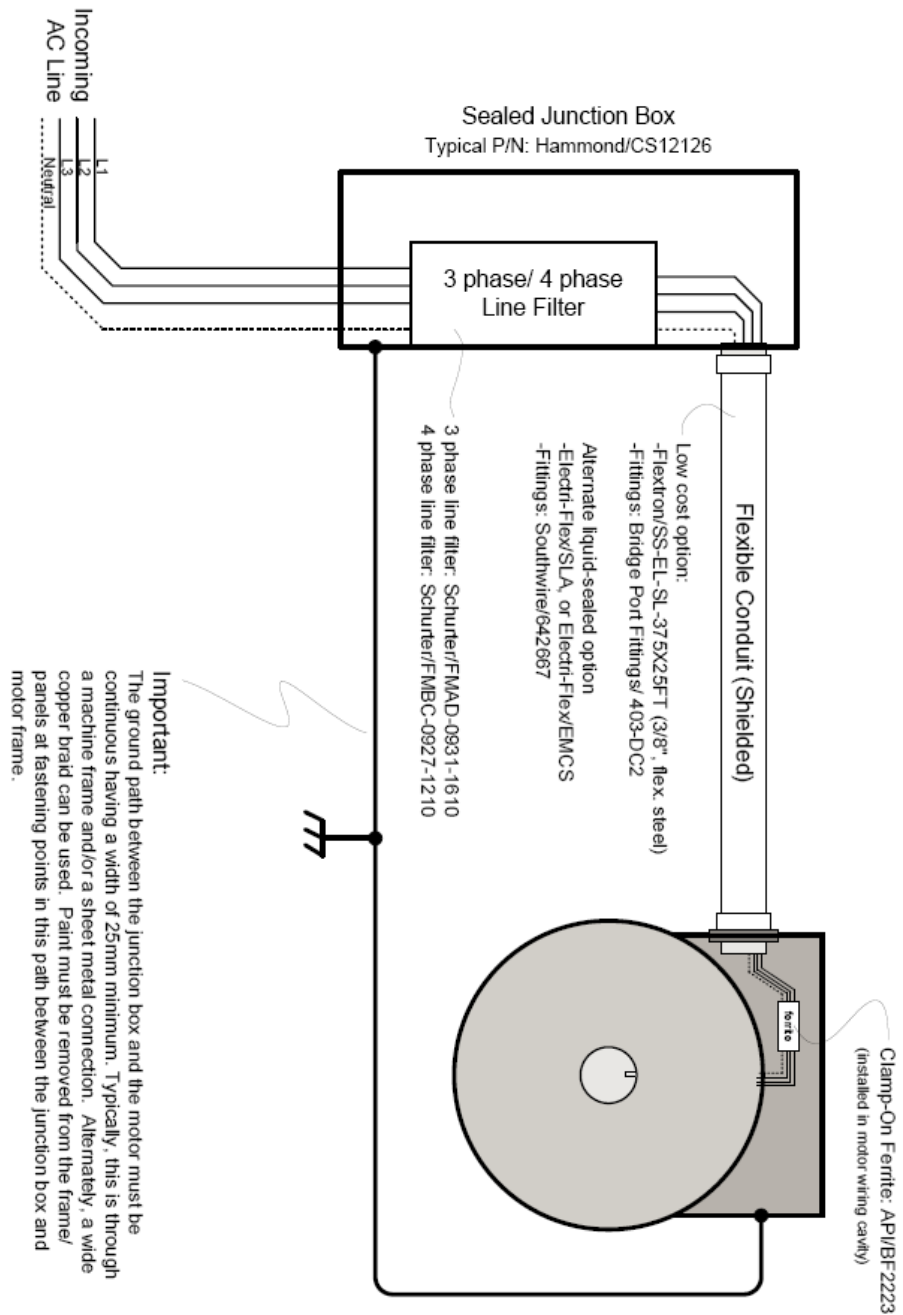
7. With AC power off, feed the AC cable into the motor's junction box. Temporarily secure cable to junction box before installing wires into terminal block.
8. Secure the AC ground wire to the floor of the junction box with a **#10-32 x 3/8"** screw. See instructions inside motor junction box.
9. Determine which wiring diagram below matches your AC power configuration.
10. Insert and screw down wires into the terminal block as indicated by wiring diagram.

² To prevent galvanic corrosion between the copper ground wire and the A380 aluminum alloy die cast housing, a tin plated lug ring must be crimped onto the copper wire prior to installation. The copper wire should not directly touch the aluminum housing.

SINGLE PHASE 100-240 VAC**THREE PHASE 100-240VAC****5-WIRE (3 phase with neutral)
300-415 VAC (common in Europe)**

EMISSIONS FILTER (OPTIONAL) FOR CE COMPLIANCE

The setup below is recommended for users seeking CE certification for their machine. Note: ClearPath conducted and radiated emissions—with no additional filtering—are unlikely to interfere with collocated equipment.



LOGIC POWER BACKUP (OPTIONAL)

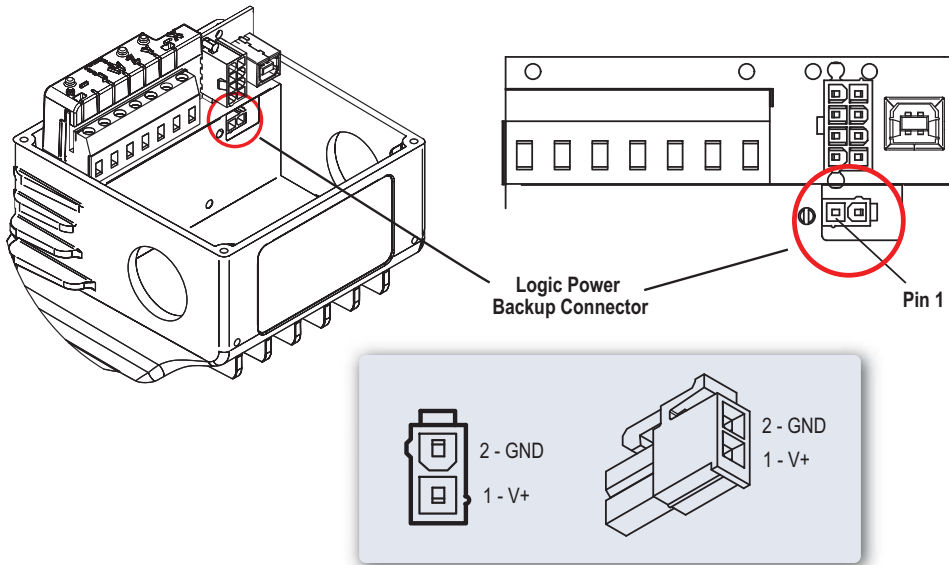
You may optionally connect a logic power backup supply to your ClearPath motor to keep the motor's processor and associated electronics powered up in the event of AC power loss. 24VDC is the most commonly used voltage for logic power backup.

LOGIC POWER BACKUP SUPPLY REQUIREMENTS

- Voltage: 24VDC nominal. Min/max: 20-28VDC
- Power consumption: 5W per motor. See appendix "Logic Power Supply Sizing" for more information.

LOGIC POWER BACKUP CONNECTOR

Connect your logic power backup supply to the 2-pin Molex connector inside the motor junction box. Connector mating parts and tools are listed below. For instructions on how to make an inexpensive logic power backup cable, see next section.

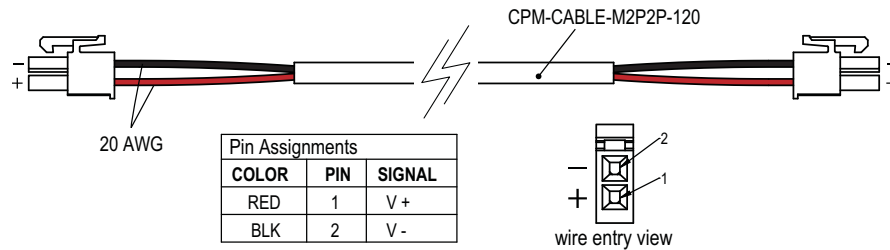


Ref.	Description	Mating Connector PN	Terminal PN	Terminal Desc.	Crimp Tool	Extraction Tool	Recommended Wire Gauge**
A	Molex MiniFit-Jr, Receptacle, 2 circuits	39-01-2020 (natural, UL 94V-2)	39-00-0059 (reel)	Female crimp terminal, tin plate, 18-24 AWG	63819-0900 (16-24AWG)	11-03-0044	20-24 AWG
		39-01-3025 (black, UL 94V-2)	39-00-0060 (loose)				
		39-01-3028 (natural, UL 94V-0)					
		39-03-9022 (black, UL 94V-0)					

HOW TO MAKE AN INEXPENSIVE LOGIC POWER BACKUP CABLE

This section describes how to make an inexpensive, no-crimp cable for use with your optional logic power backup supply.

1. Purchase a Teknic CPM-CABLE-M2P2P-120. This is a, 120" (3 meter), Molex 2-pin to Molex 2-pin cable as shown below.

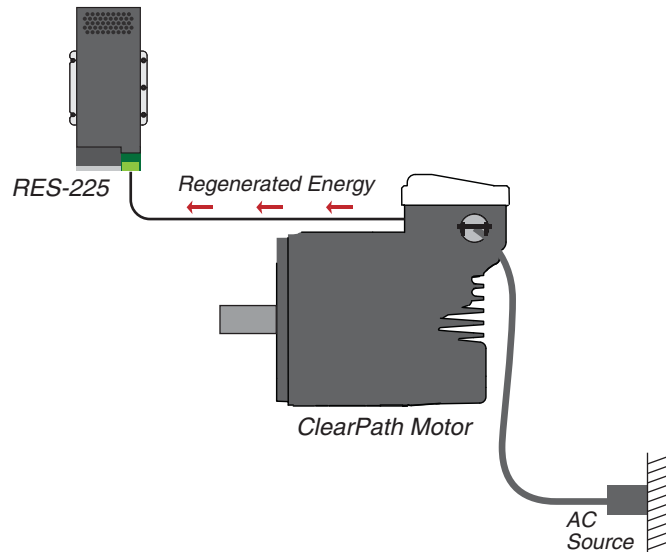


CPM-CABLE-M2P2P-120

2. Cut the cable to the desired length. (If you cut the cable exactly in half, you'll have two 5' (1.52 m) cables.
3. Create flying leads by stripping the outer jacket on the unterminated end of the cable.
4. Strip and connect the flying leads to your logic power backup supply. Insulate any exposed conductors with heat shrinkable tubing, electrical tape or similar.
5. **Test DC output polarity before connecting.** Use a DMM to verify proper polarity at the DC output connector. Use the above diagram as a reference.

RES-225 USE INSTRUCTIONS

This section describes the mounting, wiring, and operation of the optional **RES-225 Regenerated Energy Shunt**. The RES-225 is sold separately by Teknic.



RES-225 and ClearPath motor

RES-225 (REGENERATED ENERGY SHUNT) OVERVIEW

The RES-225 monitors and manages your motor's regenerative energy output to facilitate safe, rapid dissipation of excess energy and to prevent nuisance overvoltage shutdowns.

Background: What is “regen”?

All electric motors (DC brush, brushless, induction, stepper, or servo) generate a reverse voltage when producing torque against the direction of motion, particularly during hard decelerations. This reverse voltage is referred to as back-EMF, regenerated energy, or just “regen” for short. Unmanaged regen will intermittently increase the motor drive's DC bus voltage which can lead to overvoltage shutdowns.

How does the RES-225 work?

Under processor control, the RES-225 detects and channels excess regenerated energy to a large, fan cooled power resistor where it is safely dissipated.

Does my motor need an RES-225?

High regen is commonly seen in axes that rapidly decelerate large inertial or gravitational loads; however, most applications do not generate enough regen to cause shutdowns. For applications that do, ClearPath's built-in VRS feature (Vector Regen Shunt) can usually dissipate enough energy to prevent overvoltage events. VRS is a standard feature of all ClearPath motors. It is turned on or off with a checkbox in ClearView and requires no external hardware.

If the motor's regenerated energy exceeds what the internal VRS can dissipate, the excess energy will temporarily increase the motor drive's DC bus voltage, (particularly during hard decelerations). If the DC bus voltage rises high enough, an overvoltage shutdown will result, indicating that an RES-225 may be needed. *Note: Overvoltage shutdowns are not damaging to the motor. They are an indication that the motor has successfully protected itself.*

If your ClearPath motor generates more regen than the internal VRS (Vector Regen Shunt) can handle, you may need an RES-225 to dissipate the excess energy.

How much regen will my motor produce?

This is a question Teknic engineers hear often (and it's a good one). What we've found over time is that it is impractical to try to accurately calculate motor regen given the number of electromechanical and motion-related variables involved. The most effective approach is to install a motor on fully loaded mechanics and run test moves that emulate normal machine operation.

Tip: ClearPath's built-in diagnostic tools (software scope) can help you determine if and when your motor is experiencing overvoltage shutdowns due to regen.

Additional Information:

- The RES-225 is reverse voltage protected.
- The RES-225 provides up to 250 Watts of continuous energy dissipation, and peak power dissipation in excess of 7 kW.
- RES-225 energy dump turns on when ClearPath's DC bus reaches 417VDC; energy dump turns off below 400VDC.
- Intermittent fan operation is normal.
- In the event of an internal failure (one that prevents the microcontroller from turning off energy flow to the dump resistor) the product is protected by a UL Listed internal fuse.
- The RES-225 uses **LED blink codes** to communicate environmental and internal operating status. See the blink code table later in this section for details.

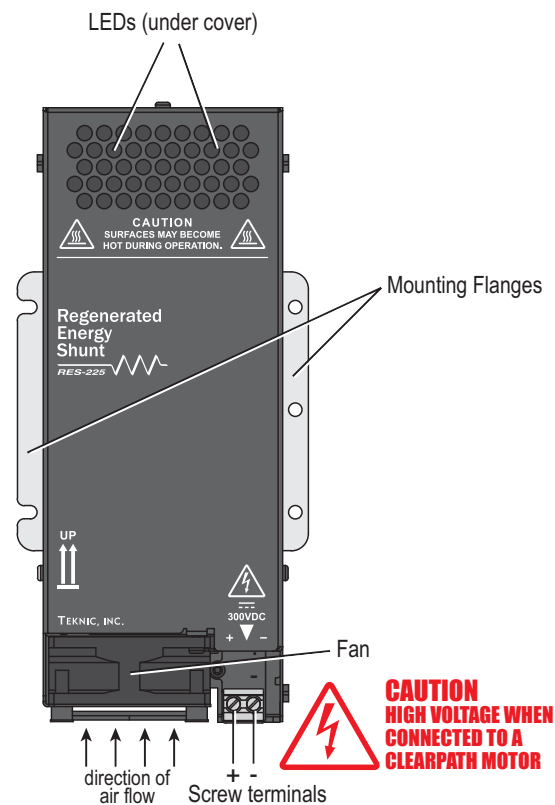
IMPORTANT WARNING

Please read and follow all warnings in this section, and all hazard warnings printed on the device case.

Burn Hazard: This device may present a burn hazard during operation. Always allow RES-225 to cool before handling.

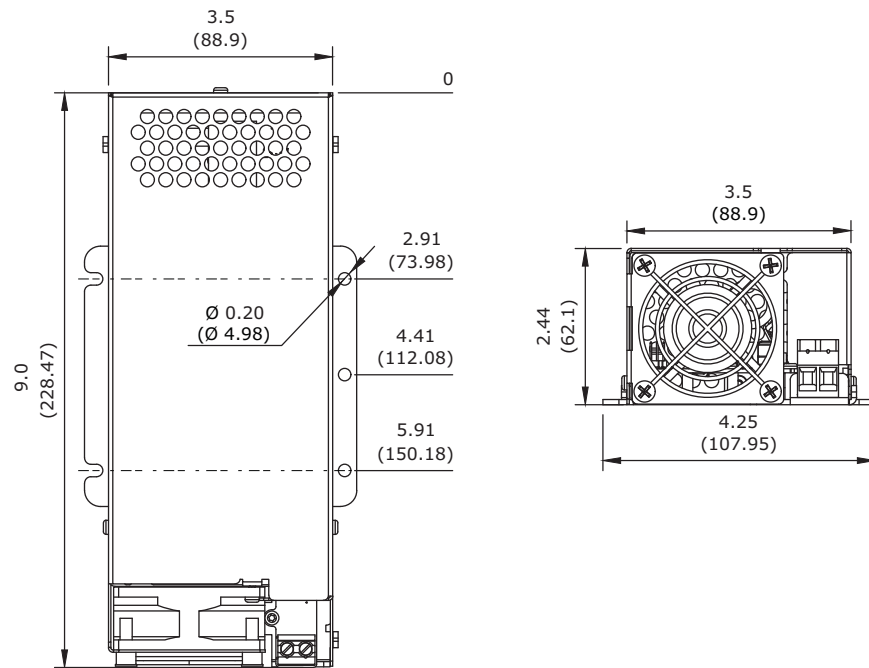
Shock Hazard: RES-225 screw terminals can present a high voltage shock hazard when the unit is connected to a powered ClearPath motor. Never attempt to touch the RES-225 screw terminals unless the unit is completely disconnected from the ClearPath motor.

No user serviceable parts inside. Do not open case or attempt to service this product.

PARTS OF AN RES-225**RES-225 Parts**

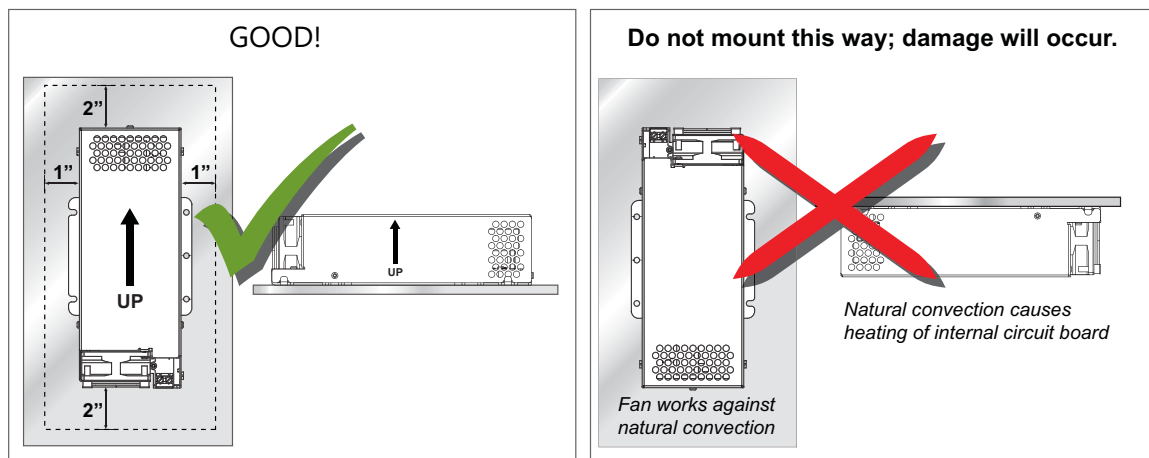
MECHANICAL/MOUNTING INFORMATION

RES-225 MOUNTING DIMENSIONS



RES-225 Dimensions

MOUNTING ORIENTATION AND CLEARANCE REQUIREMENTS



RES-225 mounting orientation and clearance requirements

- Do not mount RES-225 beneath heat sensitive devices such as power supplies or motor drives. *This device will exhaust heat during normal operation.*
- Do not mount RES-225 in unventilated enclosures.
- Do not expose unit to liquids, mist, or splash.
- Do not allow debris to fall into device housing.

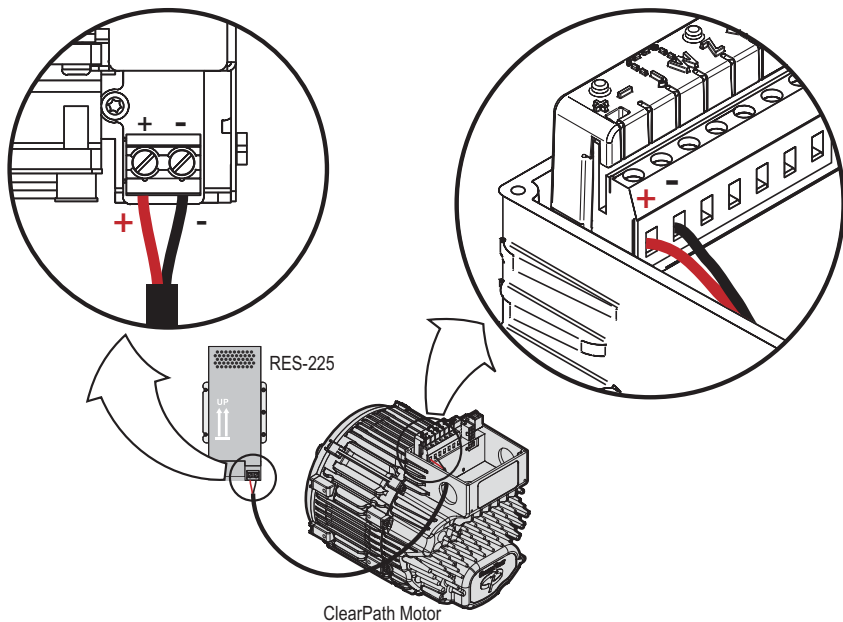
- Leave a minimum of 1" clearance around the unit, 2" clearance at ends.

WIRING RES-225 TO YOUR CLEARPATH MOTOR

Hazardous Voltage Warning

Always disconnect AC mains power from your ClearPath motor before handling or wiring an RES-225.

1. Remove AC mains power from your ClearPath motor.
2. Using 2 conductor, 12-14 AWG wire, connect (+) and (-) terminals from the RES-225 to the (+) and (-) terminals of your ClearPath motor. Follow polarity markings as shown below.



RES-225 wired to AC ClearPath motor

IMPORTANT GROUNDING NOTE (USA)

For applications in most countries, grounding the metal case of the RES-225 is not necessary because the insulation system meets the requirements for Reinforced Insulation per EN 61010. **However, for applications in the USA, the National Electrical Code (NEC) requires that any electrical product with a metal enclosure be bonded to protective earth.** This can be easily accomplished by attaching a grounded lug to one of the RES-225's panel mounting screws or by other means as prescribed by the NEC.

RES-225 LED CODES

LED Color	LED State	Blink Pattern	Description	Notes
Orange	Solid	On for 1 sec. (applies to start up only)	Normal operation. Power-up self test.	
Green	Flicker	16 Hz (16 blinks/sec)	Normal operation. No regen detected since power up.	
Red	Flicker	16 Hz (16 blinks/sec)	Same as above, plus fan failure detected.	Unit is functional, but RMS capability is reduced automatically.
Orange	Blink	3 Hz (3 blinks/sec)	Normal operation: Regen dump is actively occurring.	
Green	Blink	3 Hz (3 blinks/sec)	Normal operation. Regen dump has occurred, regen not actively occurring.	
Red	Blink	3 Hz (3 blinks/sec)	Same as above, plus fan failure detected.	Unit is functional, but RMS capability is reduced automatically.
Orange	Flash	0.5 Hz (1 flash every 2 sec)	Unit in foldback mode. Regen is actively occurring.	
Green	Flash	0.5 Hz (1 flash every 2 sec)	Unit is In foldback mode. Regen is not actively occurring.	
Red	Flash	0.5 Hz (1 flash every 2 sec)	Same as above, plus fan failure detected.	Unit is functional, but RMS capability is reduced automatically.
Orange	Flash	1 Hz	Over temperature condition.	Board temperature is over 90°C.
Red	Flash	On solid with brief off pulse every 3 seconds.	Critical hardware failure.	Unit requires repair. Fuse blown or regen circuit damaged.

COMMUNICATION AND I/O (THE SC4-HUB)

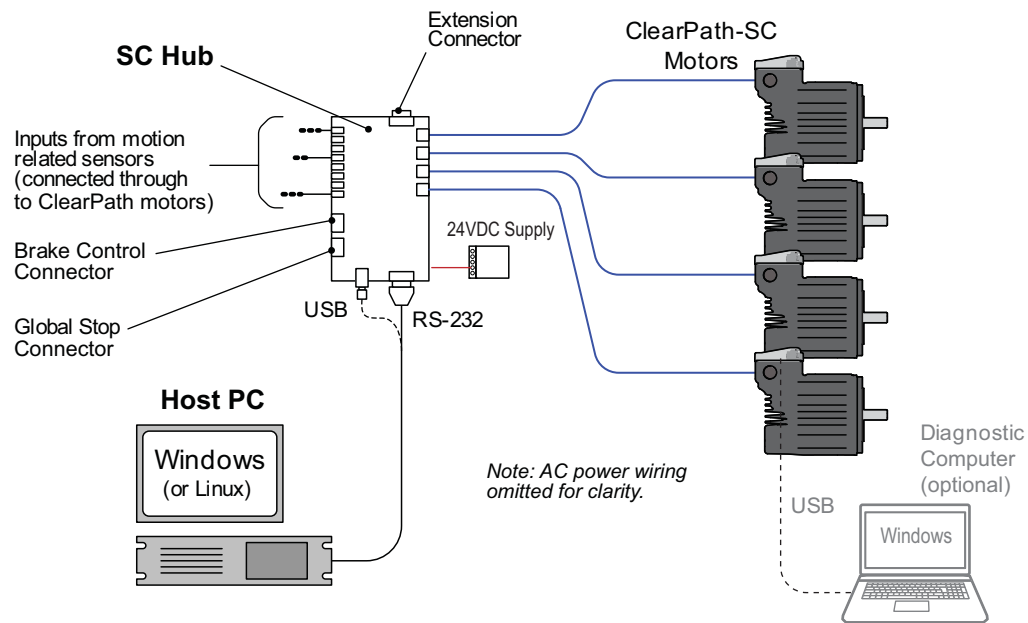
INTRODUCTION

The SC4-HUB (Teknic part number *SC4-HUB*) is the center of communication and I/O routing for all ClearPath-SC systems. The SC4-HUB links the application computer and I/O devices to your ClearPath-SC motors. Up to four SC4-HUBs can be linked together to create systems of 16 motors on a single USB or RS-232 port. ClearPath-SC systems can support up to a maximum of 48 axes³.

SC4-HUB OVERVIEW

The SC4-HUB interfaces with:

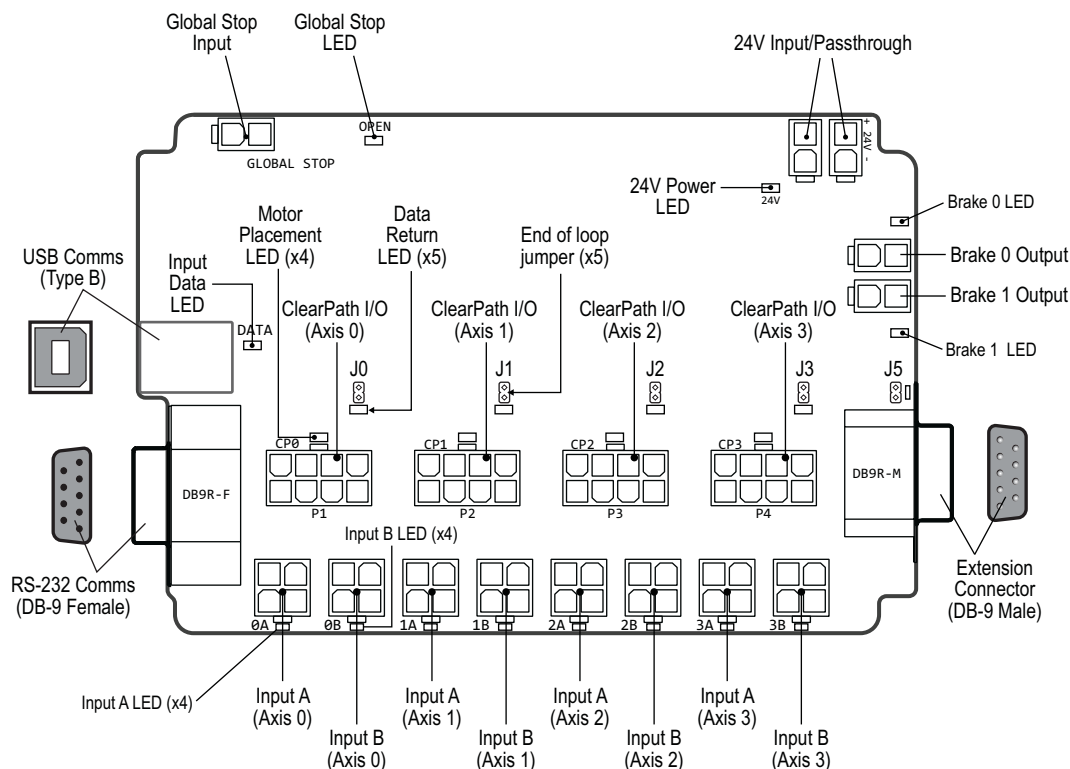
- Application PC
- ClearPath-SC motors
- Input sensors and switches
- Global Stop input
- Brake Control outputs



SC4-HUB in a 4-axis ClearPath-SC system

³ To support a 48 axis system, the application PC must have a minimum of three USB or RS-232 ports.

PARTS OF AN SC4-HUB



SC4-HUB with callouts

SC4-HUB MOUNTING

See [Appendix B](#), *Mechanical Index*, for SC4-HUB mechanical/mounting dimensions.

SC4-HUB OPERATION (CONNECTOR BY CONNECTOR)

USB COMMUNICATION CONNECTOR (USB COMMS)

This is a standard USB type B connector. Connect SC4-HUB to your PC using a readily available cable (USB-A to USB-B).

Important: Never connect a USB and RS-232 connector to the same SC4-HUB. This will cause communication errors.

CLEARPATH I/O CONNECTOR

This connector sends communication and input signals from the SC4-HUB to the ClearPath-SC motor. The required cable is a straight-through, 8-pin to 8-pin Molex MiniFit Jr. cable (Teknic P/N: CPM-CABLE-CTRL-MU120).

24VDC INPUT / PASS-THROUGH POWER CONNECTORS

Connection point for the (required) 24VDC logic power supply. There are a total of two 2-pin Molex connectors wired in parallel; you can supply power to either one. The second connector may be used to daisy chain power to another SC4-HUB or another 24VDC device if desired.

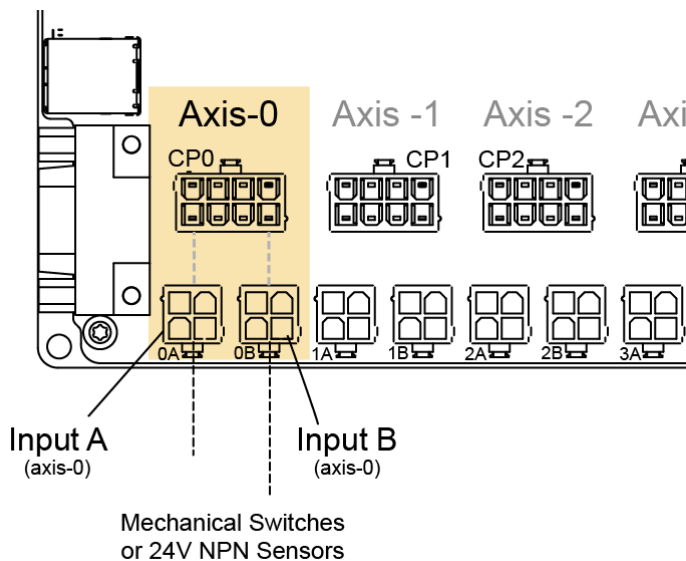
END-OF-LOOP HEADERS

Place a jumper block on the 2-pin header associated with the last motor connected to your SC4-HUB. For example, if you are connecting just one motor to the SC4-HUB, place the jumper on J0. For two motors, place the jumper on J1. If you plan to connect a second SC4-HUB (for systems with five or more motors) place the jumper at J5, then on the second SC4-HUB place a jumper on the appropriate header.

INPUT A AND B CONNECTORS

Each ClearPath I/O connector on the SC4-HUB has two inputs associated with it: *Input A* and *Input B*. Each input has its own 4-pin Molex connector as shown below.

The inputs are designed for use with 24VDC,⁴ NPN type sensors or mechanical switches. The inputs are optically isolated, digitally filtered, current limited, and reverse polarity protected for robust, long-term performance. For more on how the inputs work, see the input circuit schematic (below) and Appendix G, *Wiring Inputs A and B*.



ClearPath-SC Input A and B Connectors

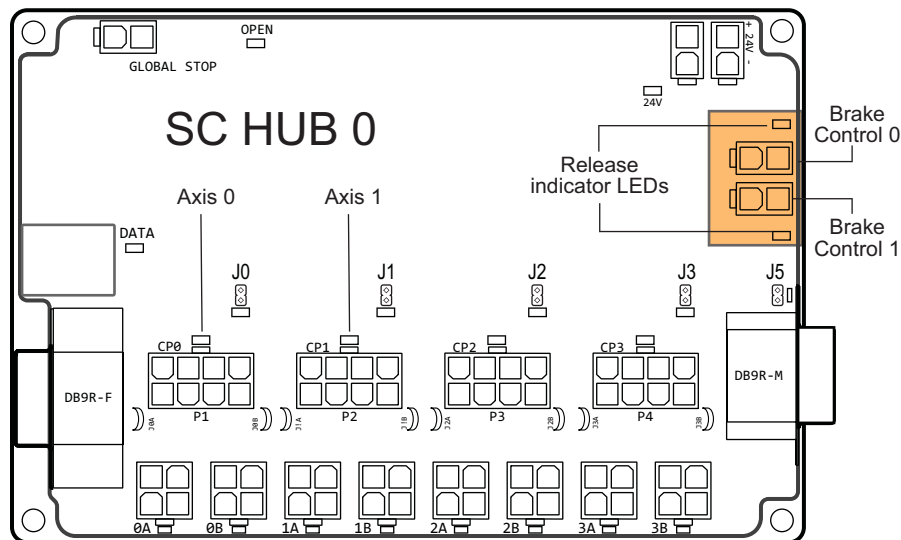
Maximum Input Cable Length

Cables used for SC inputs can be a maximum of 100 feet (30 m) long. However, longer cable runs may be possible if the cable stock is of high quality, low capacitance, twisted pair construction. Contact Teknic if you need input cables longer than 100 feet (30 m).

⁴ ClearPath -SC motors can accept inputs from devices with logic high ranging from 5-24VDC, but the SC Hub, by default, accepts 24VDC NPN type sensors or simple mechanical switches.

BRAKE CONTROL CONNECTORS

These two, 2-pin Molex Minifit Jr. connectors allow you to control "power-off" style 24VDC inline brakes. They can also be used as general purpose outputs (GPOs) to control any 24VDC device through your application code.



Brake Control Connectors

BRAKE NOTES

- Only two Brake Control outputs can be used *per port*. This means, if 4 SC4-HUBs are chained together and connected to a single USB or serial port, only the two brake outputs on the first SC4-HUB in the chain would be useable.
- Brake Control 0 and Brake Control 1 are linked to Axis 0 and Axis 1 respectively. This is a fixed, relationship.
- The Brake Control circuit was designed for use with 24VDC "power-off" type brakes that draw 500mA or less.
- Brakes will not release (allow motion) unless communication with a motor has been established.
- Brakes automatically engage (disallow motion) if communication with the Application PC is interrupted.

Safety/Compliance Note: Ensure this feature is used only with ISO 13849 approved safety controls. Failure to do so could result in serious injury or property damage. See the section "Safety Control Sketch (Brake and Global Stop)" later in this section.

SETTING BRAKE CONTROL BEHAVIOR IN CLEARVIEW

The Brake Control outputs can be toggled manually or set to automatic operation through the ClearView Actions menu: *Actions>Brake 0*, or *Actions>Brake 1*.

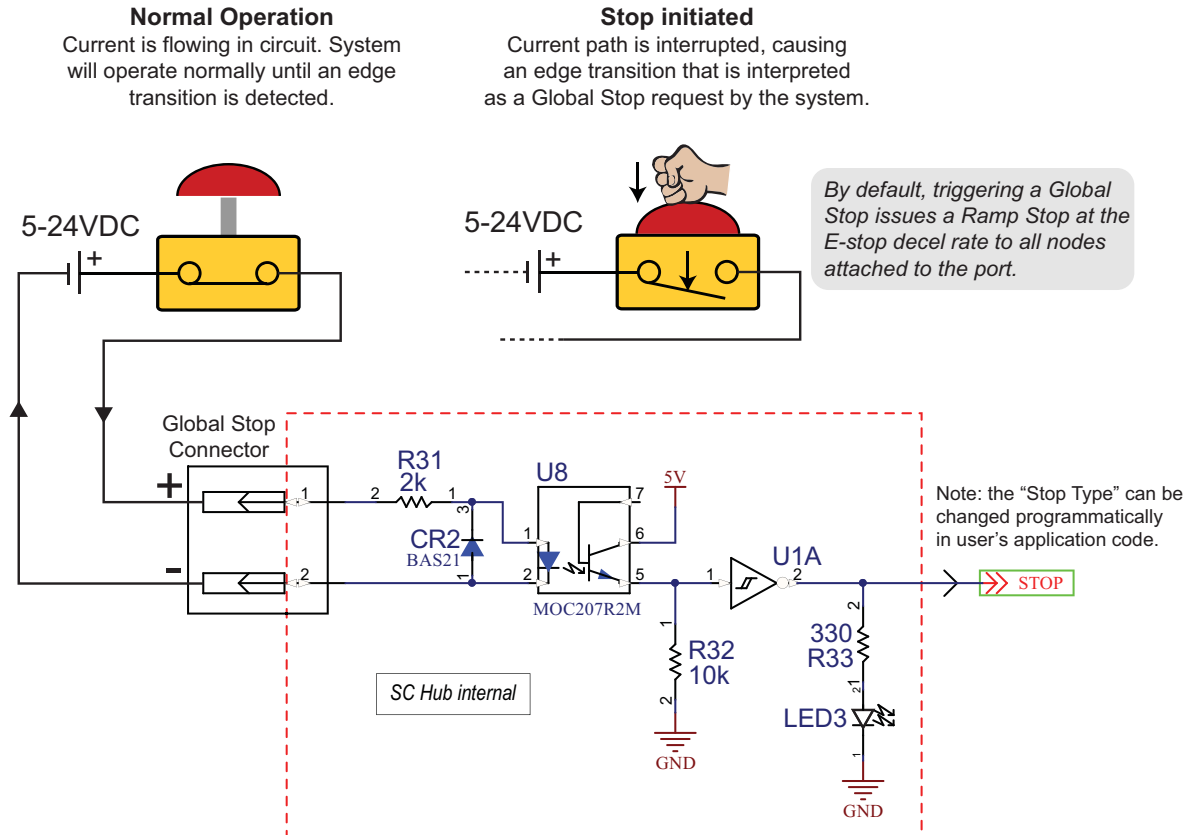
Additional notes:

- Only two brake control outputs can be used per port connection; i.e. if four SC4-HUBs are chained together, only the two brake control outputs on the first SC4-HUB will be controllable.

GLOBAL STOP CONNECTOR

This 2-pin Molex Minifit Jr. connector allows you to connect the E-Stop output from a safety controller to your SC4-HUB.

Important Safety Note: Ensure this feature is used only with ISO 13849 approved safety controls. Failure to do so could result in serious injury or property damage. See the section "Safety Control Sketch (Brake and Global Stop)" later in this section.



Schematic snippet: Global Stop Input

CONFIGURATION SOFTWARE (CLEARVIEW)

ClearView software provides a suite of powerful configuration, analysis, and diagnostic tools to speed machine *and* software development. These tools—the Soft Scope in particular—make it easy to capture valuable motion performance data whether you're in the lab, on the production floor, or in the field.

This section includes the following topics:

- PC system requirements
- Installing ClearView software
- Tour of ClearView software

MINIMUM SYSTEM REQUIREMENTS

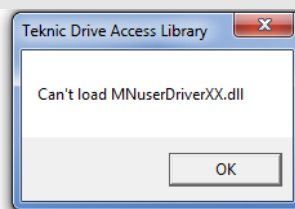
Operating System:	Windows 10, 8.1, 7
Processor:	1.5 GHz or faster
Memory:	1 GB RAM
HD Free Space:	1 GB
Monitor:	1280 x 1024 pixels or higher
Other:	Sound card with speakers (optional)

INSTALLING CLEARVIEW SOFTWARE

- **Run Windows Update.** See note *Windows Update and ClearView* below.
- Download the ClearView installer from <https://www.teknic.com/downloads/>.
- Launch the ClearView installer. Follow on-screen prompts to complete installation.

Windows Update and ClearView Installation

If your Windows installation is not up to date, ClearView may not run properly. During installation, the ClearView installer needs access to a few specific Windows system files. If these files are not found, Windows Update will attempt to install them. If Windows Update is disabled, and/or you have no internet connection, this may fail.



If you install and attempt to run ClearView and see an error window like the one shown above, close ClearView and install this update: <https://support.microsoft.com/en-us/kb/2999226>. Then, re-launch ClearView.

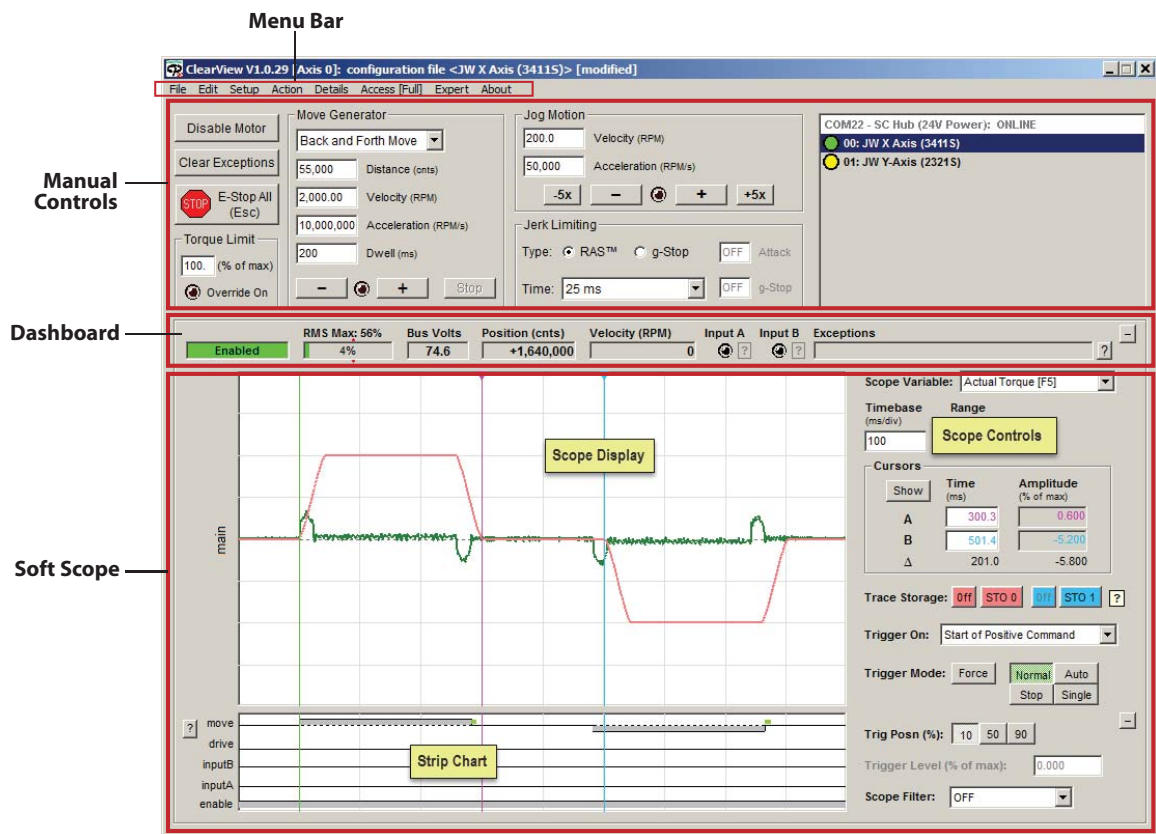
ESTABLISHING COMMUNICATION WITH YOUR SYSTEM

See ClearPath-SC Quick Start Guide.

CLEARVIEW SOFTWARE TOUR

USER INTERFACE OVERVIEW

The ClearView UI is presented in four parts: the *Menu*, *Manual Controls*, *Dashboard*, and *Soft Scope*. Each of these parts is discussed in detail in this section.

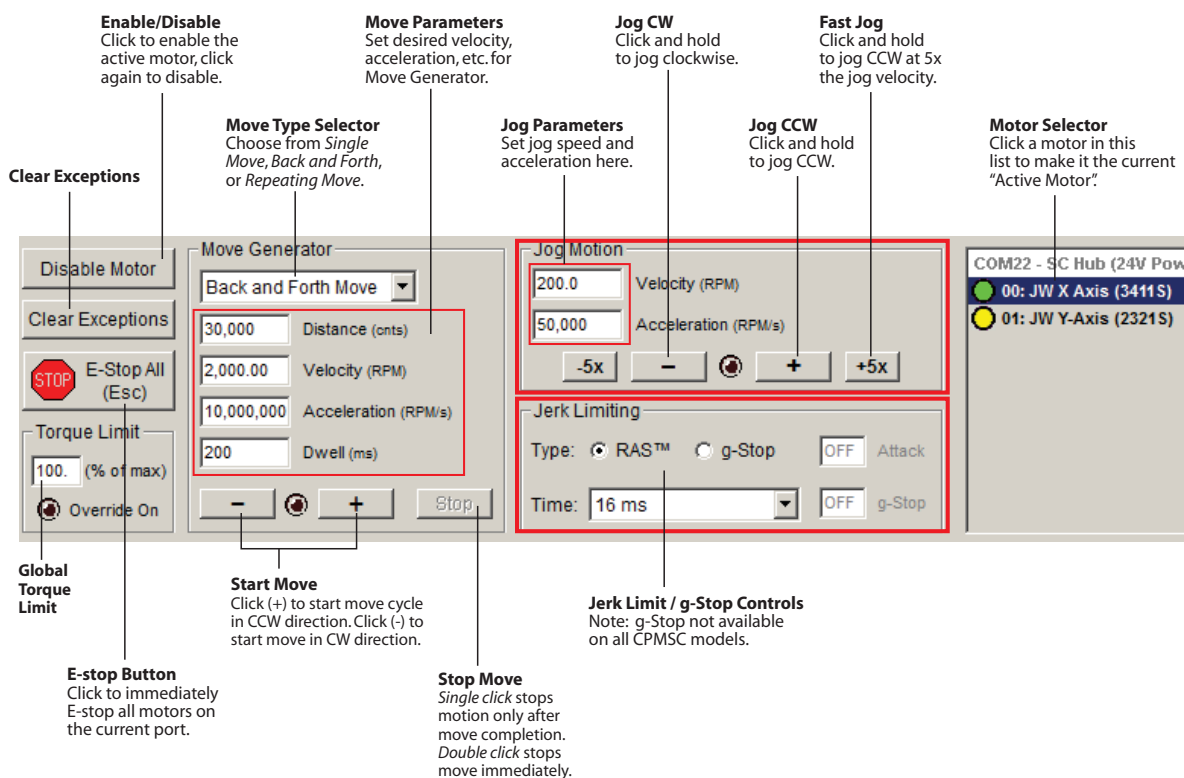


ClearView UI Overview

MANUAL MOTOR CONTROLS

The Manual Motor Controls comprise a set of tools designed to help you test and exercise your ClearPath-SC motors *without writing a single line of code*. Manual Controls give you the ability to:

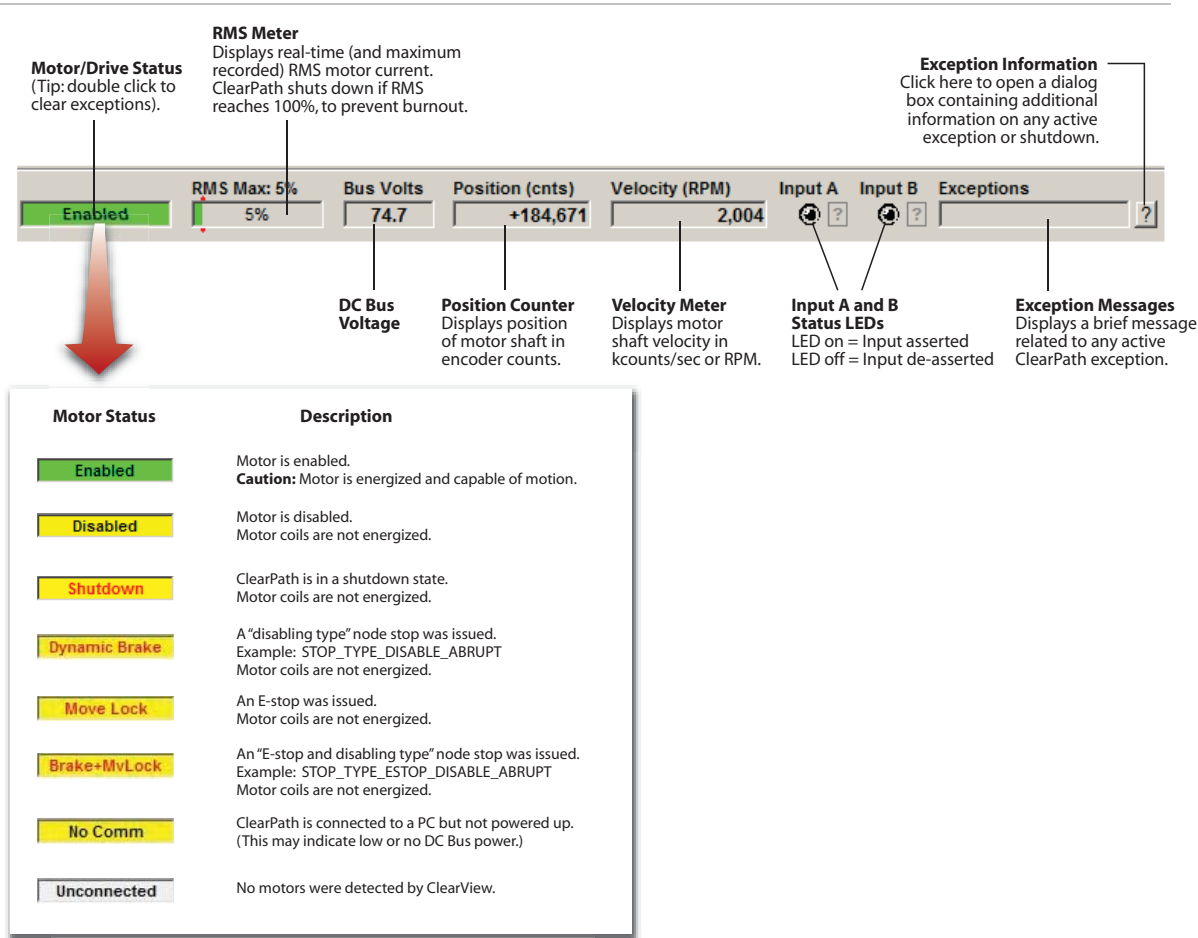
- Enable, disable, and E-stop motors
- Manually jog motors
- Run profiled moves (reciprocating, single, or unidirectional repeating)
- Modify the torque limit setting, and more



Manual Controls section of ClearView UI

DASHBOARD

The Dashboard features virtual indicators and readouts for motor status, encoder position, motor velocity, bus voltage, input states, exception messages, and more.



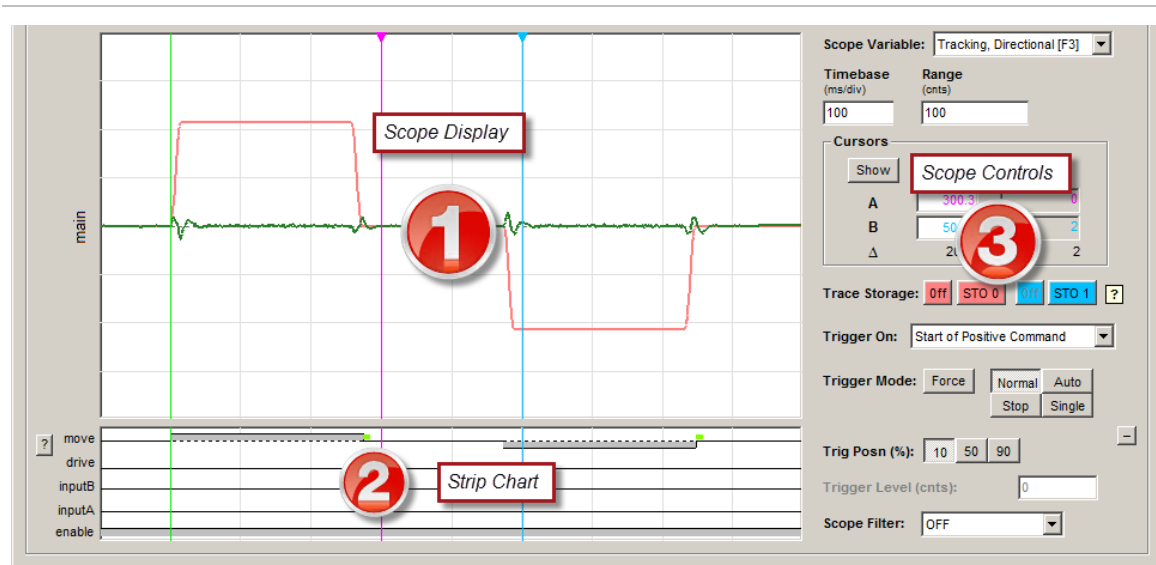
Dashboard section of ClearView UI

SOFT SCOPE

OVERVIEW

The ClearView Soft Scope takes real-time streaming data from your ClearPath-SC motor and plots it on a scope display in an intuitive, easy-to-interpret manner. The Soft Scope can display your motor's *actual torque output, position error, commanded velocity, acceleration, and more*. This is a great tool for engineers, technicians, or maintenance professionals tasked with the analysis or troubleshooting of motors, motion, and mechanical performance.

The Soft Scope consists of three main sections: the **Scope Display (1)**, **Strip Chart (2)**, and **Scope Controls (3)**. Together, these components emulate much of the functionality of a digital storage oscilloscope and data analyzer.



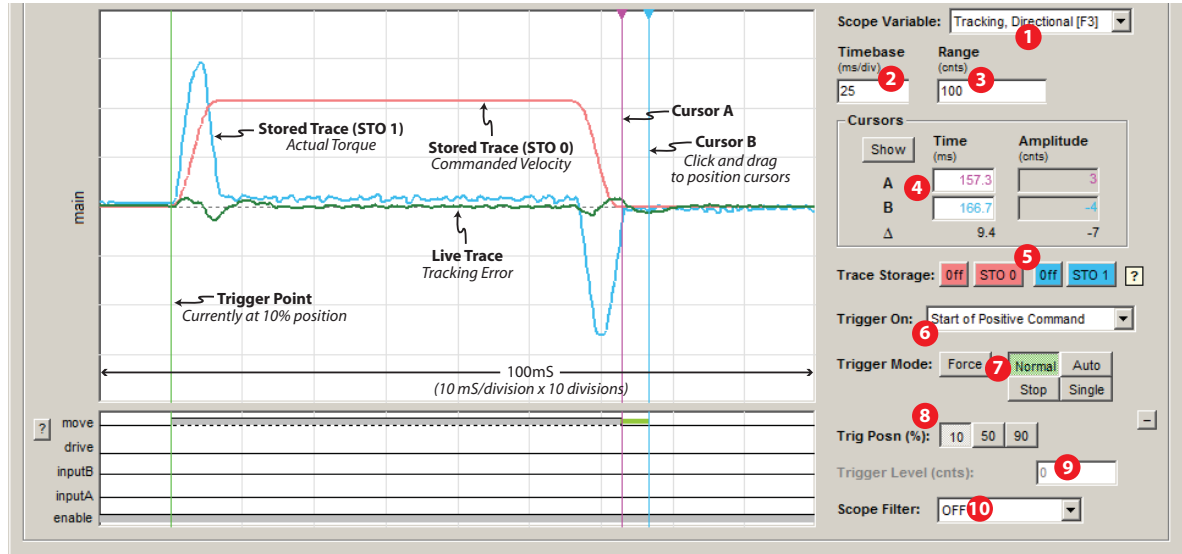
ClearView Soft Scope

SOFT SCOPE FEATURES

- 13 scope variables that can be plotted in real time
- Four trigger modes
- Adjustable timebase, range, and trigger position
- Simultaneously display two stored traces + one live trace
- 13 trigger presets (Example: trigger at end of settled move)
- Interactive cursors for precise timing and amplitude measurements
- Strip Charts for a consolidated view of motor status, input states, and move timing

SCOPE DISPLAY AND SCOPE CONTROLS

The ClearView Scope display is modeled after a typical hardware oscilloscope. It has 10 major vertical divisions (the time axis), and 8 major horizontal divisions (the amplitude axis).



ClearView Soft Scope

1 The Scope Variable drop down menu lets you select any of 13 ClearPath-SC motion control variables to display. These variables are Tracking Error, Commanded Velocity, Actual Torque, Actual Velocity, Velocity Error, Commanded Torque, SGN (sign of velocity), Measured Position, Commanded Jerk, Commanded Acceleration, Max Phase Voltage, Torque Error (peak), and Bus Voltage.

2 The Timebase field lets you adjust the scale of the time axis (think X-axis) in units of mS/division. This allows you to control how a waveform fits horizontally on the Scope Display.

Example: With the Timebase set to 10mS per division (as in the figure above) the full horizontal range of the Scope Display is 100mS (10 divisions x 10mS/division).

3 The Range field lets you adjust the scale of the amplitude axis (think Y-axis). This allows you to control how a waveform fits vertically on the Scope Display.

Example: In the figure above, the green "live" trace represents the motor's tracking error (i.e. how close is the actual motor position to the commanded position). The Range is set to 100 counts.

To interpret the displayed information, you only need to understand a few things: 1) the center horizontal line represents 0 counts of tracking error (perfect tracking), 2) the top of the Scope Display represents +100 counts of tracking error, and 3) the bottom of the scope display represents -100 counts of tracking error. The +/- distinction is necessary because the actual motor position can lead *or* lag the commanded position. By doing a little math you will find that each major horizontal division represents 25 counts of error.

4 Cursor controls display time and amplitude measurements of the live trace. Note: the time readout for the cursors is referenced to the Trigger Point (that's where $t = 0$). Amplitude is measured relative to the horizontal center line. The delta (Δ) function automatically displays the difference between the two cursor values. Click and drag cursors to reposition them. Click the *Show* button to make cursors appear if they are hidden.

5 Trace Storage controls let you save and display two traces on the scope display. Just capture a waveform and click either the STO 0 or STO 1 button (Storage 0 and Storage 1). The selected trace is then stored and displayed in either pink (STO 0) or blue (STO 1). Hide or show either stored trace by clicking its respective On/Off button.

6 The Trigger Source (“Trigger On”) menu lets you choose what conditions must be met before scope data collection begins (is triggered). The following Trigger Source options are available:

If Trigger Source is set to:	MSP Scope will:
Start of Positive Command	Trigger at the start of any positive move; useful for tuning.
Start of Negative Command	Trigger at the start of any negative move; useful for tuning.
Start of Any Command	Trigger at the start of any move (positive or negative); useful for assessing bi-directional tuning performance.
End of Positive Command	Trigger at the end of any positive move; useful for assessing settling performance.
End of Negative Command	Trigger at the end of any negative move; useful for assessing settling performance.
End of Any Command	Trigger at the end of any move (positive or negative); useful for assessing bi-directional settling.
End of Positive Settled Move	Trigger at the end of any positive move after Move Done criteria are met; useful for assessing settling performance.
End of Negative Settled Move	Trigger at the end of any negative move after Move Done criteria are met; useful for assessing settling performance.
End of Any Settled Move	Trigger at the end of any move (positive or negative) after Move Done criteria are met; useful for assessing settling performance.
Voltage/Torque/Speed Limit	Trigger on first occurrence of saturation (voltage or torque) or upon speed limiting; useful for determining which moves (or segments of moves) exceed these thresholds.
Drive Shutdown or Exception	Trigger on the assertion of an exception or safety shutdown; useful for determining the operational status at the time of a fault.
Rising Slope	Trigger on the rising edge of the active waveform.
Falling Slope	Trigger on the falling edge of the active waveform.

7 Trigger Mode settings allow you to select exactly when data acquisition begins and ends. These controls are similar to the trigger modes found on typical digital storage oscilloscopes.

- **Normal** - Causes scope data collection to begin whenever a valid trigger source is detected.
- **Single** - Works the same as *Normal* mode, except it captures only a single data set when a valid trigger source is detected. After the single sweep capture, data collection automatically stops.
- **Auto** - This is the rolling, “always on” setting. Data is continuously collected, refreshed, and displayed regardless of the trigger source settings.
- **Force** - Forces the scope to trigger immediately, regardless of trigger source setting. As with Single mode, only one data set is collected and displayed; then data collection stops.
- **Stop** - Causes scope data collection to stop. It does *not* clear previously captured data from the scope display.

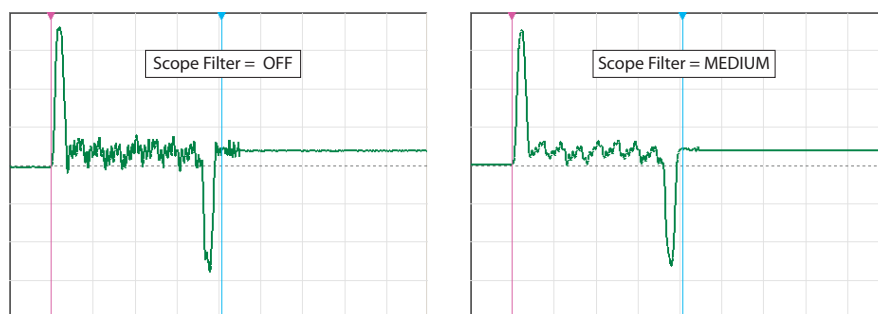
8 Trigger Position buttons allow you to position the trigger point on the left (10% position, as shown in the previous figure), middle (50% position), or on the right side (90% position) of the scope display grid. This is useful for viewing events on the scope that occur before, during, or after the trigger point.

9 The Trigger Level lets you select the amplitude at which the scope will trigger.

Note: Trigger Level can only be used when Trigger Source is set to “Rising Slope” or “Falling Slope”.

Tip: Use Trigger Level when the Trigger Mode is set to “Normal” or “Single” to facilitate waveform display at a fixed trigger point.

10 The Scope Filter “cleans up” or smoothes the appearance of the displayed trace by removing higher frequency data content. This has an averaging effect on the displayed waveform that can help mitigate the effect of noise (or just remove visual clutter) on the displayed signal.



Effect of Scope Filter on trace display

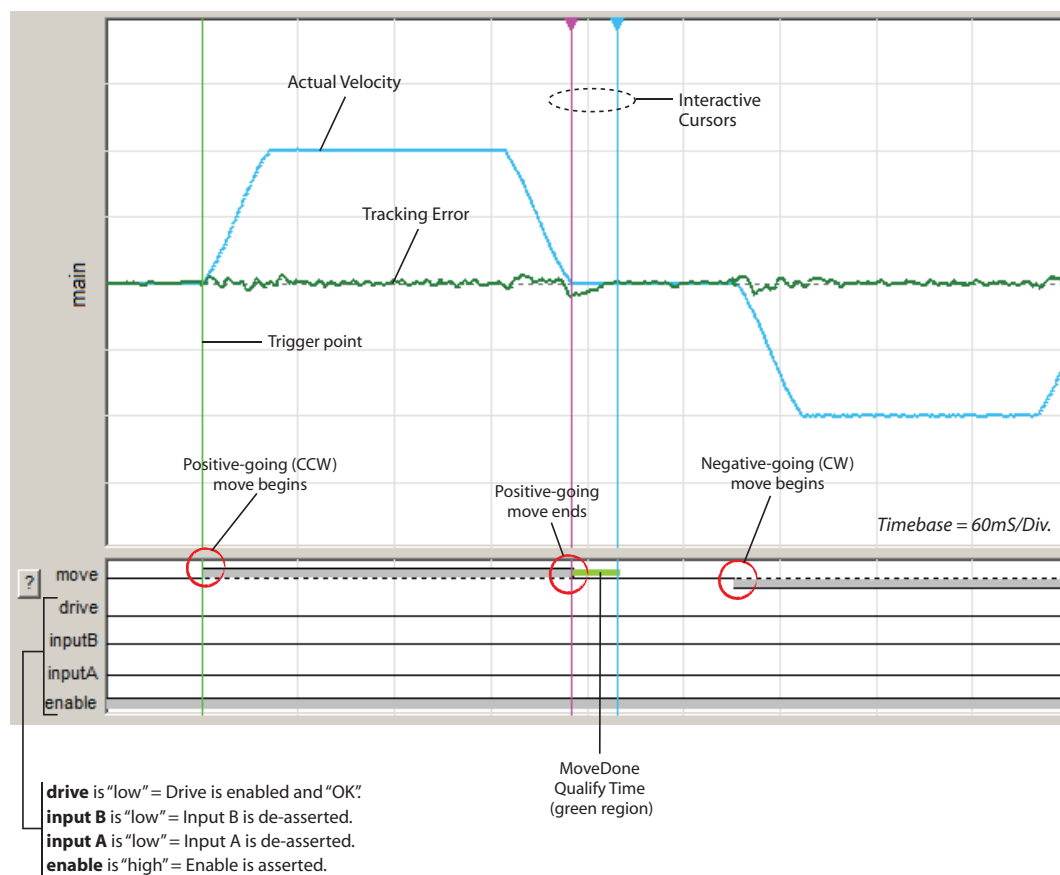
Note: The Scope Filter has no effect on motor performance. *It changes only how scope data is displayed.*

Note: Higher filter setting may filter out meaningful data points from the display (peaks in particular).

Tip: In most cases Scope Filter can be left “OFF” or at the lowest setting.


STRIP CHART

The Strip Chart provides a visual overview of your motor status, input states, and motion performance. A quick look at the strip chart can tell you if the motor is enabled, shut down, hit a limit, whether the inputs are asserted or not. And, because the Strip Chart display is always in sync with the main scope trace, there's no extra setup required.



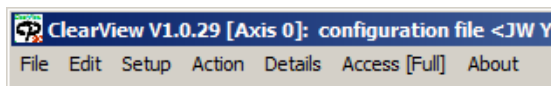
ClearView Strip Chart display

Strip Chart Legend

This key explains the strip chart trace colors and symbols. Click the  symbol to the left of the strip chart display to open.

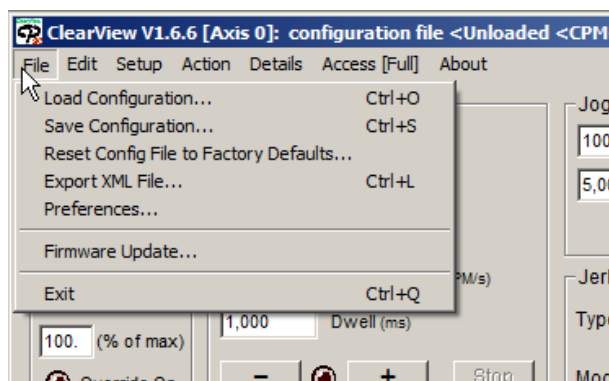
CLEARVIEW MENUS

This section covers the ClearView menu bar and menu items.



ClearView Menu Bar

FILE MENU



ClearView File Menu

Load Configuration (Ctrl+O)

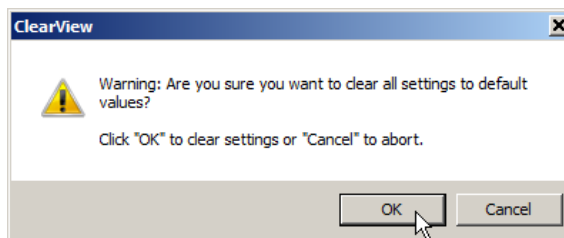
Allows you to load motor configuration files to your ClearPath-SC motors. The file extension is mtr.

Save Configuration (Ctrl+S)

Allows you to save your ClearPath-SC configuration settings to your PC as a .mtr file.

Reset Config File to Factory Defaults

Restores ClearPath-SC to its factory default configuration (i.e., the way it was configured when you received it). All existing settings will be overwritten. Save your current configuration as a .mtr file (described above) if you think you'll need to use it some other time.

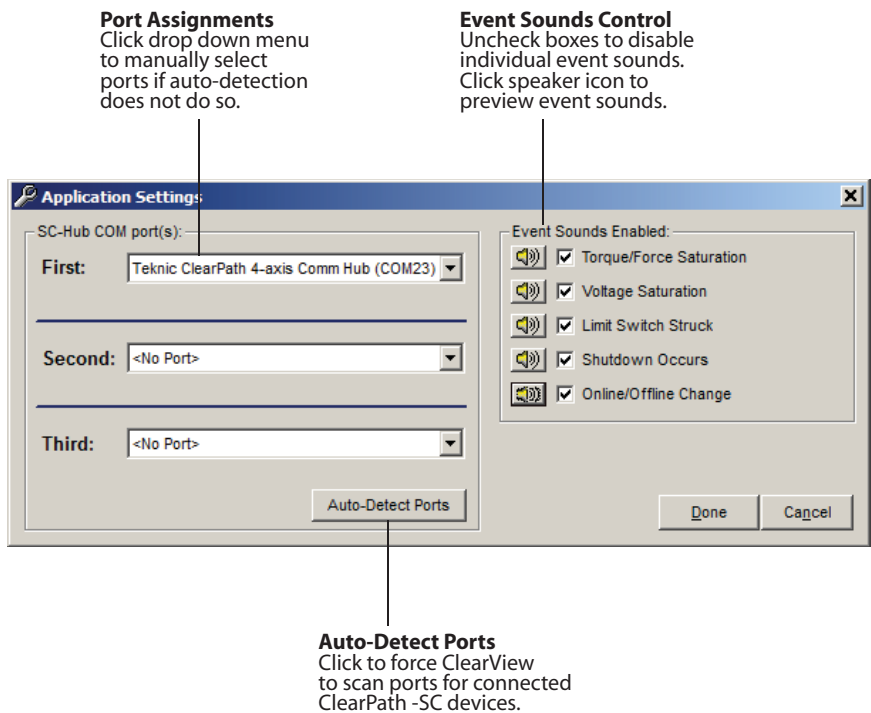


Export XML File

Beta feature for Teknic internal use at this time.

Preferences

Opens a dialog that lets you manage COM port settings and event sounds in ClearView.

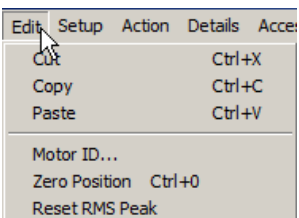


Preferences

Firmware Update

Allows for field update of ClearPath firmware.

EDIT MENU



ClearView Edit Menu

Cut, Copy, Paste

These are just standard Windows commands and keyboard shortcuts.

Motor ID

Select this menu item to open a window as shown below. There you can enter a customized name for your motor. There's also space to enter additional notes on the system. Text entered will remain in your motor's non-volatile memory even when all power is removed.

Motor Identity Setup

Motor Name
This is a user-defined name for the motor (up to 25 characters) that is shown in the main MSP title bar.
For example, "Titan x-axis".
JW X Axis (3411S)

Mechanical System Description
This description identifies what was connected to the motor when it was auto-tuned. This allows you to recognize if the mechanics have been changed since the auto-tuning procedure.
For example, "Ballscrew: 1m long, 15mm dia., 5mm pitch. Load mass, 10kg. Bearing wiper removed. Medium cable track."
Available characters = 95
Enter useful information here

Verify Tuning Upon Connection
By default, upon USB connection, ClearPath MSP will remind you to start the auto-tuning process if the mechanics have changed since the motor was last auto-tuned. To prevent this reminder from appearing for this serial number motor, check the box below.
☒ will remember to re-tune if the mechanical system changes. Do not ask again for this motor.

OK Cancel

ClearView Motor ID Window

Zero Position (Ctrl+0) <-- that's a zero

Click or use keyboard shortcut Ctrl-0 to zero the Position Counter on the ClearView Dashboard.

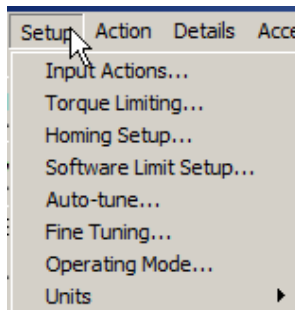
Tip: You can also zero the Position Counter by simply double-clicking it directly on the Dashboard.

Reset RMS Peak

Click to set value of *RMS Max* to the current RMS value. (This applies to the RMS Meter in the Dashboard section of ClearView.)

SETUP MENU

The Setup Menu provides a simple, no code required, way to manage frequently used motion control actions and events such as input behaviors, homing, torque limiting, software limits, Auto-tune, and more.



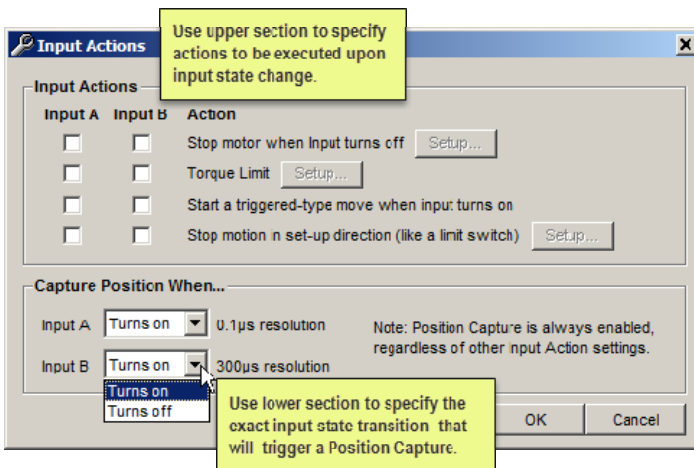
Input Actions

The upper section of the window lets you select one or more actions to execute when a state change is detected at Input A or B.

The lower section of the window lets you specify precisely when to trigger an encoder position capture.

Note: The Position Capture feature is always enabled; it can be simply disregarded if not used.

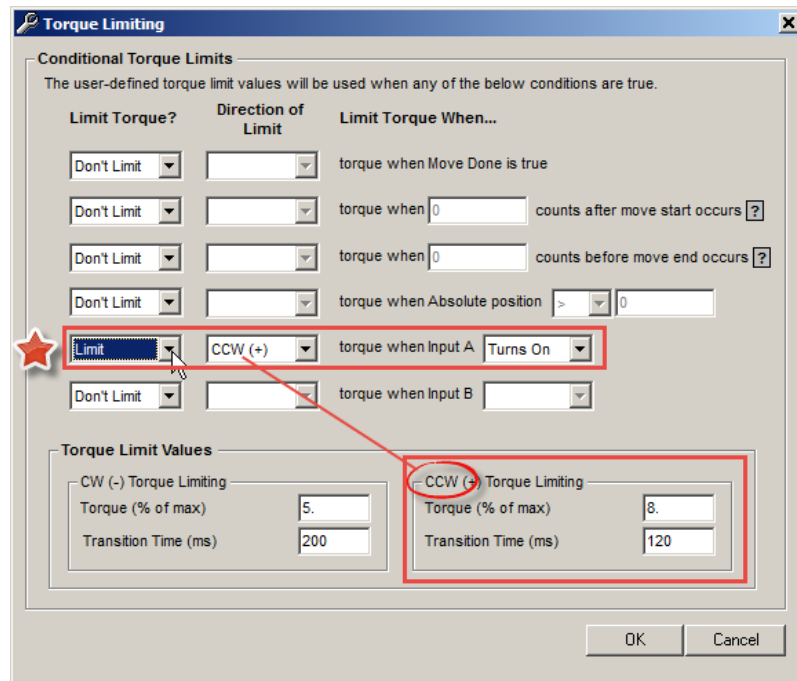
Note: Input A captures encoder positions at 0.1 microsecond resolution; Input B captures at 300 microsecond resolution. These values are not adjustable.



Input Actions Setup

Torque Limiting Setup

This menu item brings up a selection of conditional torque limiting options (see figure below).



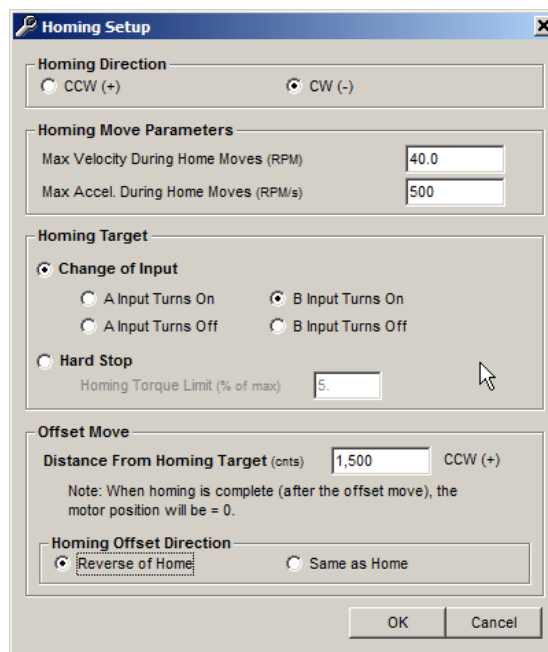
Torque Limiting Setup

Example: the above conditional statement (indicated with a red star) reads: *Limit CCW(+) torque when Input A turns on.*

The "long form" translation is this is: *When Input A turns on, institute a torque limit in the CCW (+) direction of 8% of the motor's maximum peak torque capability. Transition from the current torque limit to the 8% torque limit over 120 mS from the time Input A turns on.*

Homing Setup

The Homing Setup dialog lets you quickly set up frequently used homing parameters without the need to code them into your application software.



Homing Setup

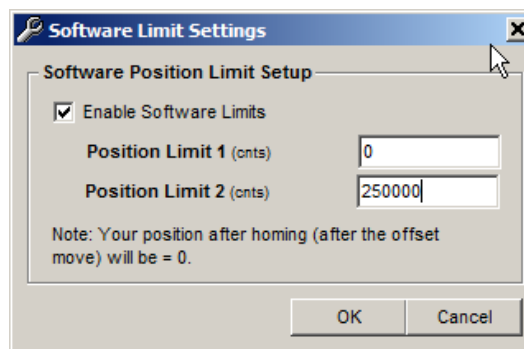
Software Limit Setup

This feature lets you define travel limits in terms of encoder position, with no sensors or switches required.

To use this feature, Check *Enable Software Limits* and set the two encoder positions as desired.

Note: Software Limits do not take effect until the motor is homed.

Note: When Software Limits are activated, the motor will not execute any move that would violate the Software Limit settings.



Software Limit Setup

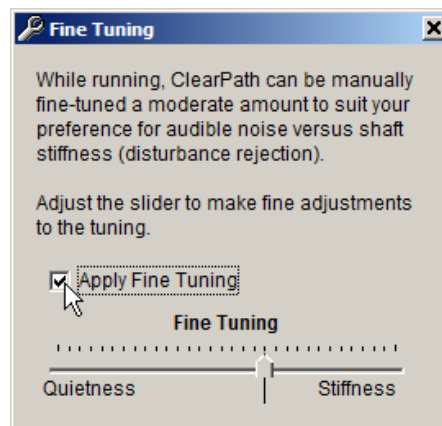
Auto-Tune

Select this menu item to begin an Auto-Tuning session. The software is designed to walk you through the Auto-Tune process in a safe, step-by-step manner.

Important: Avoid personal injuries, crashes and machine damage. Carefully read and follow all instructions presented during the Auto-Tune process.

Fine Tuning

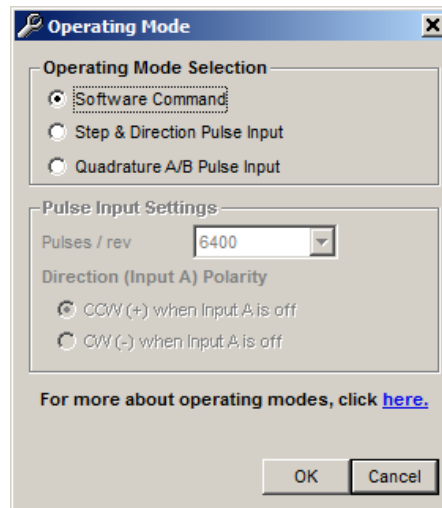
This menu item provides a convenient way to "touch up" tuning performance. Turn on the control by checking *Apply Fine Tuning*. Move the slider left for quieter performance, move it right for increased dynamic stiffness. Uncheck to turn it off.



Fine Tuning Setup

Operating Mode

This dialog lets you choose (from three available options) how you will command motion, whether it's through **software motion commands** (more common), or by using an external **step and direction** pulse source, or by using an external **quadrature A/B** pulse source.



Operating Mode Dialog

Software Command

Select *Software Command* if you intend to command motor motion using only your application software and motion functions in the Teknic sFoundation library. This is the default setting and most common operating mode used with SC family motors.

Step and Direction Pulse Input

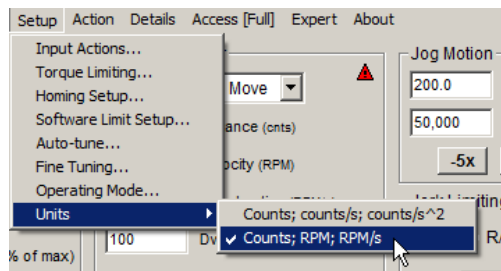
Select *Step and Direction* if you plan to use an external step and direction pulse source (PLC, microcontroller, etc.), and you intend to build a machine application and use other functions in the sFoundation motion library.

Quadrature A/B Pulse Input

Select *Quadrature A/B Pulse Input* if you have an external quadrature A/B pulse source (PLC, microcontroller, etc.) and you intend to build a machine application and use other functions in the sFoundation motion library.

Units

Use this menu item to tell ClearView which units to display for velocity and acceleration. Velocity and acceleration can express in terms of encoder counts or RPM. Distances are always displayed in encoder counts.



Units Setup

ACTION MENU

Action	Details	Access [Full]	Expert	Alt
Homing Actions...				
E-Stop All (Esc)		F12		
Clear E-Stop		Shift+F12		
Clear All Exceptions		Shift+Ctrl+F12		
Enable All		Ctrl+E		
Disable All		Ctrl+D		
Brake 0 (GPO 0)				▶
Brake 1 (GPO 1)				▶
Reset Node		Ctrl+R		
Reset All Nodes		Ctrl+A		

Action Menu

Homing Actions

This menu item provides access to several homing controls, parameters, and homing status indicators. Use these controls to simulate, test, and refine your homing routine without writing code.

Homing Summary
Displays current homing settings.

Starts a simulated homing routine.

Click to simulate hitting a home sensor.

Click to cancel homing simulation.

Virtual LED homing status indicators.

Homing Actions

Homing Setup Summary

- Homing Target: B Input turns on
- Homing Direction: CW (-)
- Homing Speed: 40.0 RPM
- Homing Accel/Decel: 500 RPM/s
- Offset from Homing Target: 6,400 counts CCW (+)

Actions

Start Homing

Go to Home (Posn 0)

Simulate Home Target

Set Current Posn = Home

Cancel Homing

Homing Setup...

Status

Currently Homing

Homing Completed

Home Target True

Close

Click to move motor to current home position at encoder count zero.

Click to make current motor position the home position. This will zero the encoder counter.

Click to open Homing Setup window. Also accessible through the Setup Menu.

Homing Actions

E-Stop All (Esc or F12)

Issues an E-stop (node stop) to all ClearPath-SC motors on the port.

Clear E-Stop (Shift+F12)

Clears E-stop and returns motors to previous operating states.

Clear All Exceptions (Shift+Ctrl+F12)

Clears exception state and messages. Note: The exception condition may recur if the underlying cause of the exception still exists.

Enable All

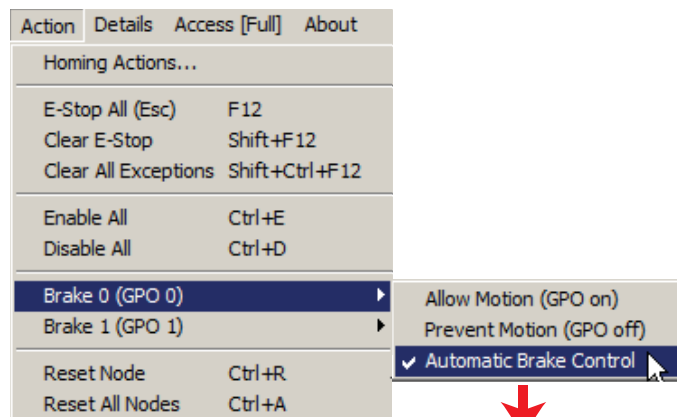
Caution: selecting this control will immediately energize all motors on the port. Always treat an enabled motor as if it can move at any moment.

Disable All

Disables all motors on the port.

Brake 0 and Brake 1

Opens a submenu that lets you manually or automatically control the state of a 24V inline brake (or other compatible device).

**Allow Motion (GPO on)**

Turns on the output. When selected, current is allowed to flow in the brake circuit. This would cause a power-on type brake to release (allow motion). External power required.

Prevent Motion (GPO off)

Turns the output off. When selected, current flow is inhibited in the brake circuit. This would cause a power-on type brake to clamp (disallow motion).

Automatic Brake Control

Automatically turns the output on (allows motion) when motor is enabled, and turns the output off (prevents motion) when the motor is disabled.

Brake Actions**Reset Node (Ctrl+r)**

Resets the currently selected motor.

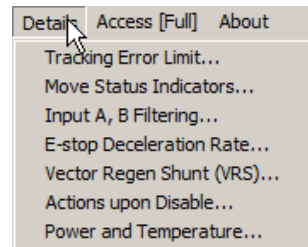
Reset All Nodes (Ctrl+a)

Resets all motors on the port.

DETAILS MENU

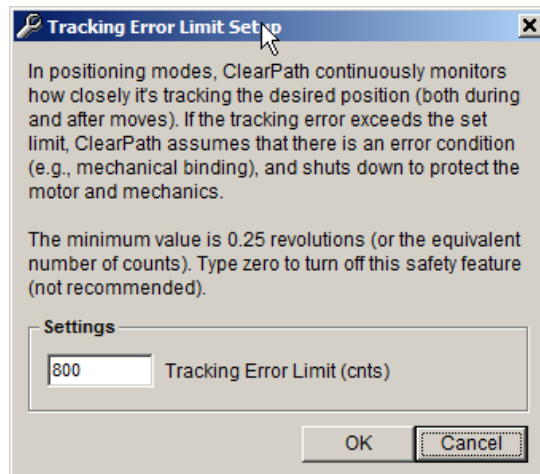
The Details Menu provides access to setup dialogs for the ClearPath-SC features listed below:

- Tracking error limit
- Move status indicators
- Input filtering
- Deceleration rate for E-stops
- Vector Regen Shunt (VRS)
- Actions upon disable
- Power and temperature settings

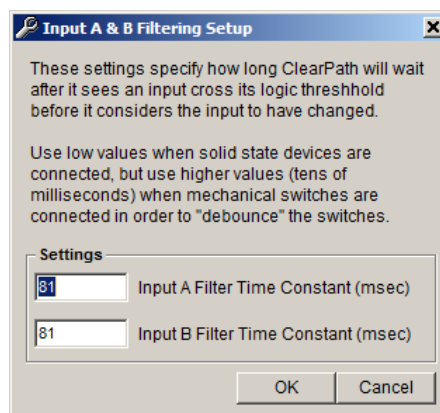


Please read the dialog boxes below to learn more about each feature and its settings.

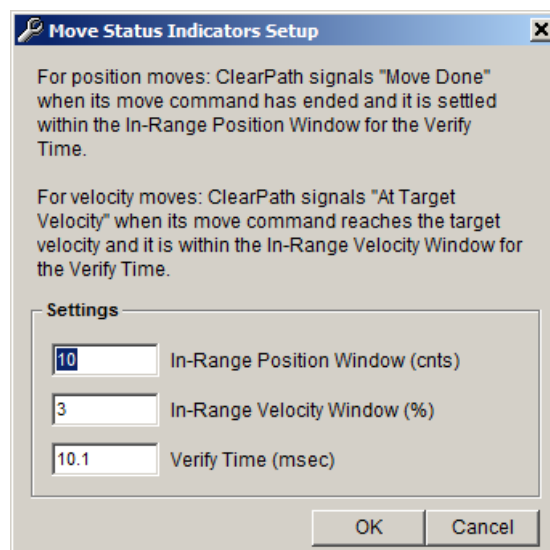
Tracking Error Limit Setup



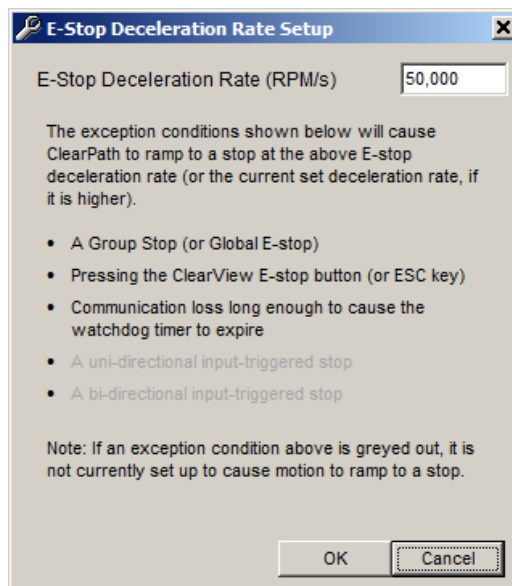
Input A, B Filtering Setup



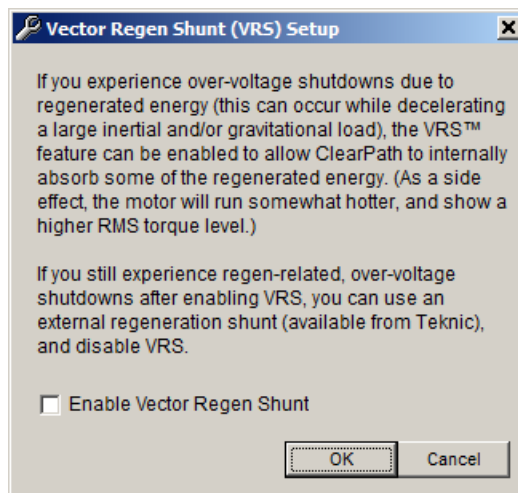
Move Status Indicators Setup



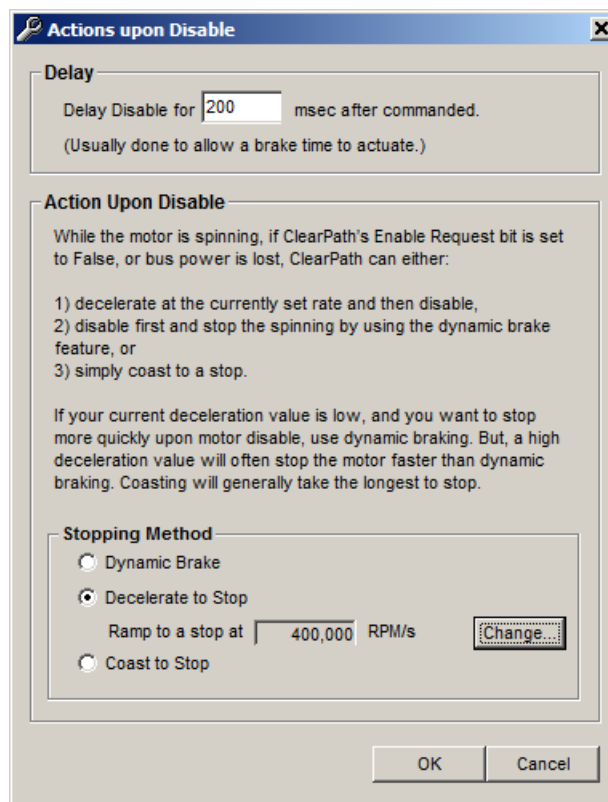
E-Stop Deceleration Rate Setup



Vector Regen Shunt (VRS)



Actions Upon Disable



Power and Temperature

Power and Temperature Settings and Status

Measured Bus Voltage (VDC): 74.9 Power Source: DC

Status	Power Exception	Exception Type
<input checked="" type="radio"/>	Bus went below the minimum operating bus voltage	<input checked="" type="radio"/> Shutdown <input type="radio"/> Warning
<input checked="" type="radio"/>	Bus Voltage Overload	<input checked="" type="radio"/> Shutdown only

Minimum Operating Bus Voltage

Minimum operating bus voltage (VDC)

Drive Temperature (°C)

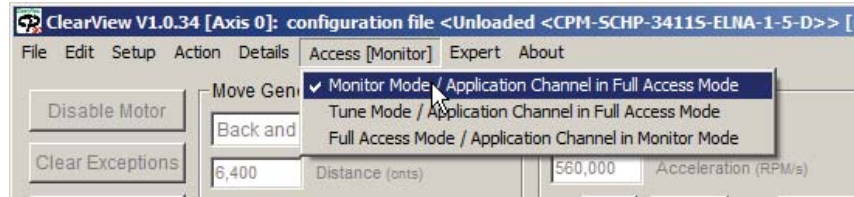
Measured

Maximum

ACCESS MENU

A second computer (or a second port on the same computer) can be connected to your ClearPath-SC via the rear Diagnostic Port. The **Access Menu** lets you specify which of the ports has full control of the motor (only one can).

There are three Access modes. Please see the next section, "Using the Diagnostic Channel", for details on



Access Menu

USING THE DIAGNOSTIC CHANNEL

This section describes how to access and use the Diagnostic Channel of your ClearPath-SC motor. The Diagnostic Channel is accessed via a USB port located in the junction box of your ClearPath motor.

One of the biggest benefits of the Diagnostic Channel is that it allows you to run your machine software on the "main" channel (aka, the Application Channel) while simultaneously monitoring performance on the Diagnostic Channel with a separate computer. This can be very beneficial for quick tuning fixes, configuration changes, and troubleshooting tasks.

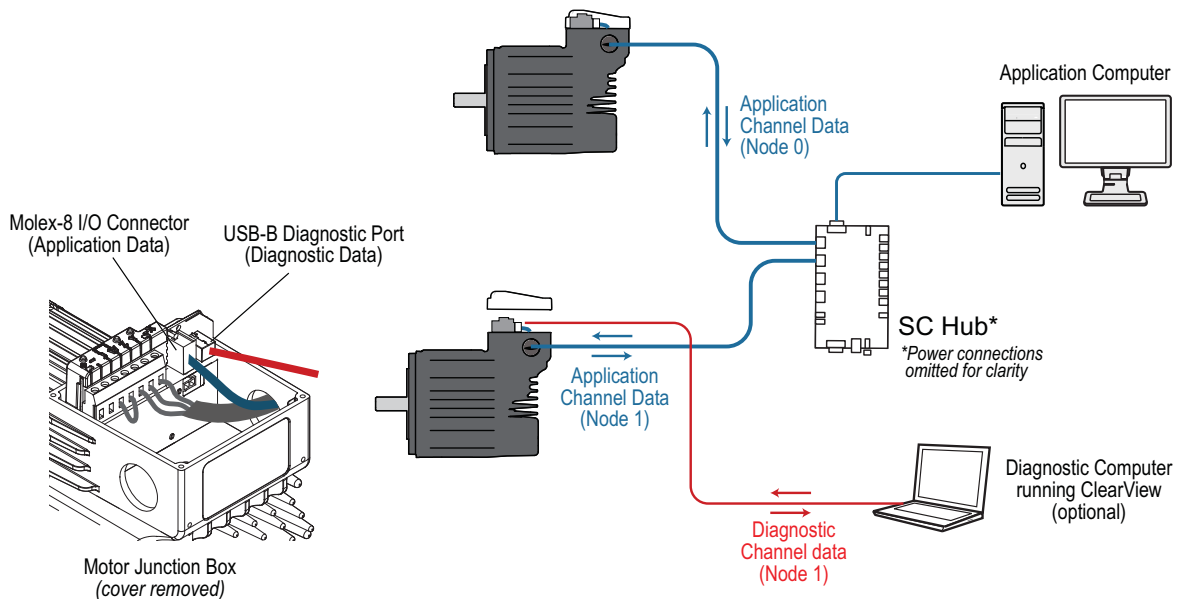
TERMS USED IN THIS SECTION

Application Channel. This is the primary communication channel between the Application Computer and ClearPath-SC motor(s). See blue data path in figure below.

Application Computer. This is the PC that runs the machine application software (written by the user).

Diagnostic Channel. This is a secondary data channel that sends data between the ClearPath-SC and either a different port on the Application Computer or a separate PC altogether. The Diagnostic Channel is accessed via the USB Diagnostic Port located in the motor junction box as shown below.

Note: The ClearView application *and* your machine application software cannot run on the same channel simultaneously. However, you *can* run your machine application software on the Application Channel while simultaneously using ClearView on a separate PC to monitor Diagnostic Channel data. We'll discuss how to do that later in this section.

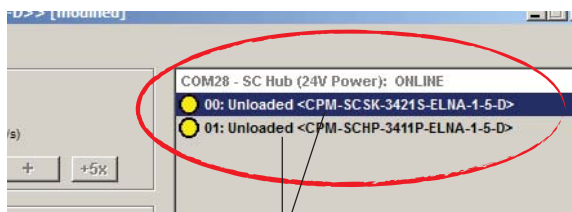


Application and Diagnostic Channels are separate communication paths

CONNECTING TO THE DIAGNOSTIC CHANNEL

This example is based on a system with one SC4-HUB with two ClearPath-SC motors connected.

1. Start with a powered-up, functional ClearPath system that is communicating with ClearView on the Application Channel (ClearView should identify your motors as shown below).

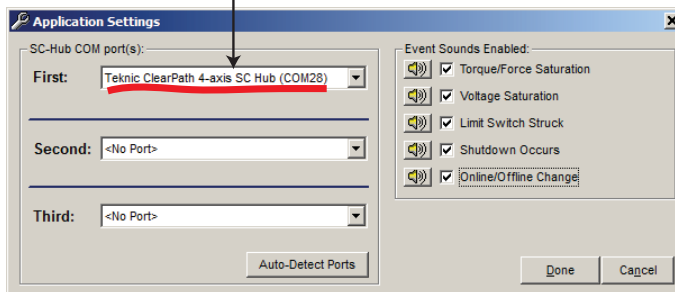


Two ClearPath-SC motors connected to the SC Hub, communicating on the Application Channel using COM 28.

ClearView's Motor List

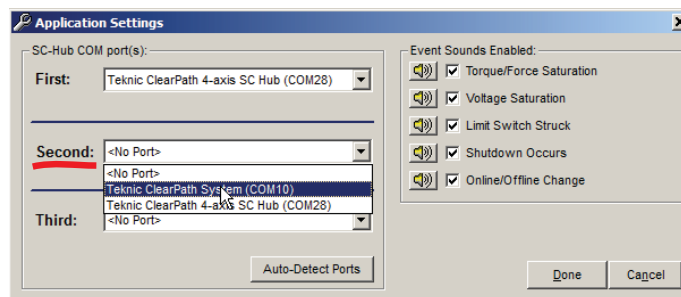
2. Next, connect a USB cable from the motor's Diagnostic Port to a free USB port on the Application PC, or to a USB port on a separate PC if desired. Teknic cable part number CPM-CABLE-USB-120AB is recommended for this.
3. In ClearView, select File>Preferences. An Application Settings window will pop up. The "First" field should show the Application Channel's COM port setting. It is COM 28 in this example.

Application Channel on COM 28
(your COM port number may vary)



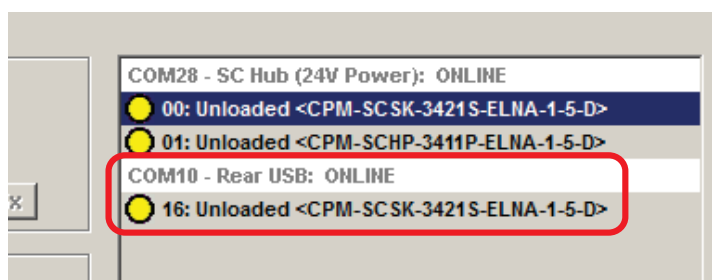
Application Settings window

4. Select the "Second" drop down COM port list. Select Teknic ClearPath System (COMx) and click Done.



Select the Diagnostic COM port as shown

5. The Motor List in ClearView should change to reflect the addition of a motor communicating on the Diagnostic Channel (circled in red below).



Motor "00" now also shows up as "16" on the Diagnostic Channel (COM 10)

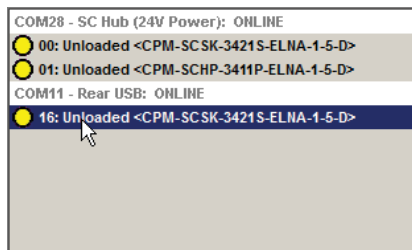
Application Channel vs. Diagnostic Channel

Your ClearPath motor typically communicates with your control PC over the Application Channel. Communication signals on the Application Channel pass through the motor's 8-pin Molex I/O connector, to the SC4-HUB, and finally to the application computer through a USB or serial port.

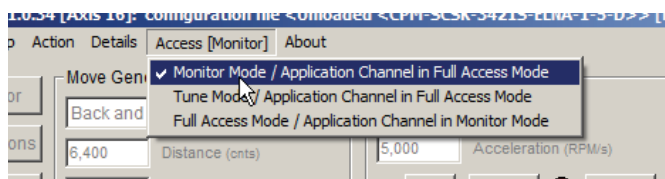
In many scenarios, a second communication channel can be helpful. We refer to this as the **Diagnostic Channel**. Communication signals on the Diagnostic Channel pass through the Diagnostic port located in the junction box on top of your motor. To access the Diagnostic Channel you only need a standard USB cable such as Teknic part# **CPM-CABLE-USB-120AB**.

CHANGING DIAGNOSTIC CHANNEL ACCESS MODES

1. Select the motor of interest from the Motor List (It should appear under the "Rear USB: ONLINE" heading in the UI).



2. Set the access level from the Access menu in ClearView. Users primarily use *Monitor Mode* or *Tune Mode*. Note: Access modes are explained below.



ACCESS MODES EXPLAINED

Monitor Mode

ClearView allows the Diagnostic Channel to access the Soft Scope. ClearView restricts Diagnostic Channel access to most other settings and parameters (restricted items will be grayed out in the UI). The Application Channel has "full access" in this mode.

Tune Mode

ClearView allows the Diagnostic Channel to access the Soft Scope and most of the tuning gains, RAS, and g-Stop settings, tracking error limit, and fine tuning controls. The Application Channel still is considered to have "full access" in this mode.

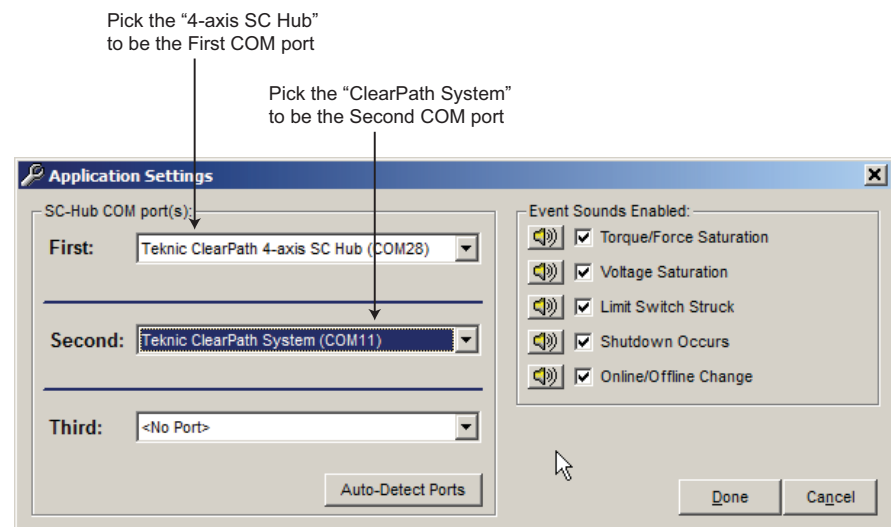
Full Access Mode

The Diagnostic Channel has full control of the motor, including access to all normally available settings and parameters. *The Application Channel is forced into "Monitor Mode" in this case.*

TROUBLESHOOTING DIAGNOSTIC CHANNEL CONNECTIONS

If your motors stop communicating with ClearView on one or both channels, or if you get baud rate errors when connecting or reconnecting to the Diagnostic Port, follow these steps:

1. On the SC4-HUB: Remove the 24V power and the USB connector. Wait 10 seconds.
2. Reconnect 24V power and the USB connector.
3. If you still have problems, close and restart ClearView.
4. If the problem persists, Click File>Preferences and manually select the ports from the drop down list. Then click "Done". You may have to restart ClearView as well.



Manually selecting COM ports

SOFTWARE LIBRARY AND SDK OVERVIEW

INTRODUCTION TO THE sFOUNDATION LIBRARY

The ClearPath-SC software foundation, or "sFoundation", is an object-oriented, motion control class library. The sFoundation has versions for C++ and .NET development. This library includes a large number of functions used to interface with, and control your ClearPath-SC integrated servo motor.

The sFoundation also includes a detailed software development kit (SDK) with all the files you'll need to begin coding immediately. In addition, the SDK includes several example projects and a detailed class reference help document.

WHAT'S COVERED IN THIS SECTION

This section provides a brief overview of the topics listed below. Check out the SDK for the complete programming reference, example programs, header and library files and more.

- sFoundation class hierarchy
- Node level functions
- Port level functions
- System level functions
- Software Development Kit (SDK)

Where do I find the sFoundation SDK on my PC?

64-bit systems

[DRIVE]:\Program Files (x86)\Teknic\ClearView\sdk\

32-bit systems

[DRIVE]:\Program Files\Teknic\ClearView\sdk\

sFOUNDATION CLASS HIERARCHY

The sFoundation libraries are organized into a logical hierarchy (see diagram next page) to help software developers understand class relationships and find relevant functions quickly.

The sFoundation comprises three main levels: a Node level, Port level, and System level. A node is just a ClearPath-SC motor. Most of your application software will interface with Node level objects.

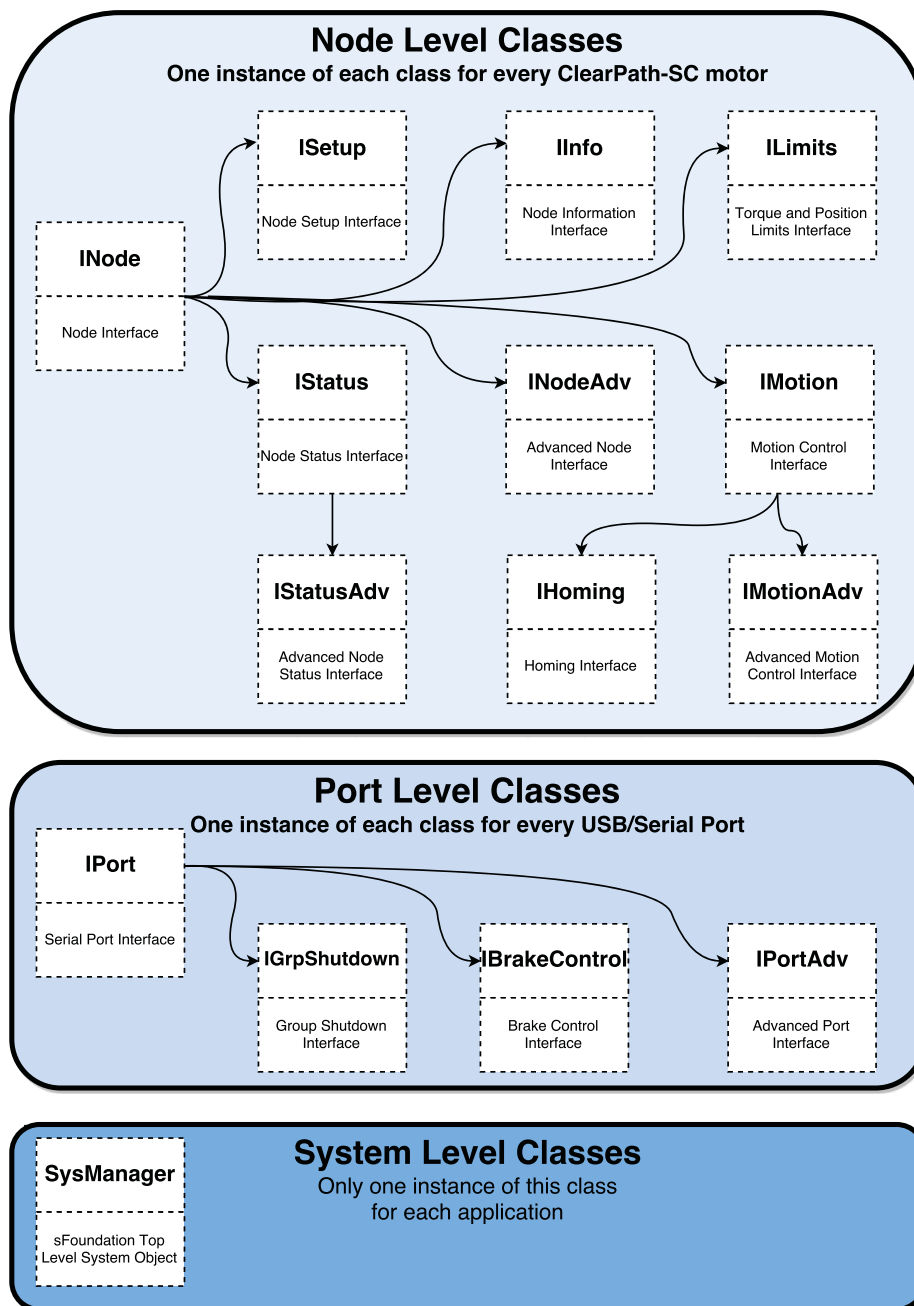
You can think of the sFoundation structure as a hierarchy wherein an instance of a System class object "owns" all of the instances of the Port

class objects (objects which interface with USB or serial ports). Port class objects, in turn, “own” all of the instances of the Node class objects.

You would use **Node class** objects to create and execute positional moves, and to query the node's real-time status (Is the motor enabled? Is the move done?).

Port class objects let you manage individual ports and the collection of all nodes on a given port. Port class objects also provide access to Port level features such as group shutdowns.

Finally, a **System class** defines the manager object used to implement system level functions, things like defining and configuring the USB or serial ports in your system, accessing system timestamps, setting up thread safe delays, and providing a safe thread-locking mechanism.

**sFoundation Class Hierarchy**

INode (Node Level Classes)

The INode class is used to interface with a node in an application (remember, each node is just a motor). Node level functions and structures are defined separately for each node in a system, so your application will have one instance of each of these structures for each node (motor) in your system.

This class defines a "super" Node whose framework exposes the Node level features available to your application by a series of public attribute references. You can think of each instance of the INode class as "owning" all Node level classes linked to the same node.

FEATURES/ACTIONS

- Issue Enable requests to motors
- Assign units for torque, velocity, and acceleration
- Provides a simple and safe mutex mechanism
- Read Node level inputs
- Provide access to all other Node level features

OTHER NODE LEVEL CLASSES

IMotion

This class is used to set up, initiate, and cancel motion on an individual node. This class contains functions to:

- Start moves (positional, velocity)
- Query the MoveDone status (to determine whether a move has completed)
- Query the Ready status (to determine whether a node is ready to initiate a move)
- Set/get the velocity limit for moves
- Set/get the acceleration limit for moves
- Query instantaneous commanded and measured position, velocity, and torque
- Provide access to homing and advanced motion features

IMotionAdv

This class object allows setup and initiation of advanced motion features (available only in advanced models) including:

- Head/tail moves
- Asymmetric moves
- Triggered moves
- A after start/ B before end events

IInfo

This class object provides access to node information including:

- Serial number
- Node type
- Firmware version
- User defined node specific information

IStatus

This class object accesses and manages the node status information in status/alert registers. These registers include information such as:

- In Range status
- Input A/B
- Ready status
- Shutdown state
- In Motion status

IStatusAdv

This class accesses and manages the advanced node status information. It provides access to position capture registers (available on advanced models only).

IHoming

This class object gives you hooks into Teknic's homing engine so you can initiate, and check the status of a homing move.

Note: The IHoming class does not configure homing parameters (homing direction, homing speed, etc.). Homing parameters are set quickly and easily right in the ClearView software UI.

ILimits

This class accesses the global torque limit and positional tracking error limit.

ISetup

This class object accesses and manages node setup features such as loading and saving motor configuration files to and from nodes.

I PORT (PORT LEVEL CLASSES)

The IPort class is used to interface with a port on your computer which, in turn, interfaces to a series of nodes. This class defines a "super" Port whose framework exposes the Port Level features available for your application by a series of public attribute references. You can think of the IPort class as "owning" all other port level classes. Port Level functions and structures are defined separately for each port in a system.

FEATURES/ACTIONS

- Request node counts

- Restart nodes on a port network
- Determine the port network's operational state
- Create command trace files logging the history of the last 4096 commands sent through this port
- Issue high priority stop commands to every node on the port
- Provides access to all other Port level classes

OTHER PORT LEVEL CLASSES

IGrpShutdown

Supports control of the group shutdown feature (which allows an electrical connection on the SC4-HUB board or a change in a node's status to initiate a Group Shutdown).

IBrakeControl

Supports control of the brake control outputs on the SC4-HUB board.

Note: If multiple SC4-HUB boards are chained together on a single port, only the first SC4-HUB board's brake outputs will be controllable.

IPortAdv

Supports control of advanced features such as **Group Triggering** and **attention handling** (available on advanced models only).

SYSMANAGER (SYSTEM LEVEL CLASS)

Sometimes called the "root object" for the sFoundation, this is the main application class used to interface with Teknic nodes attached to serial and/or USB ports. Its purpose is to coordinate actions among the various ports, and, to some extent, within the node environment.

COMMON FEATURES

- Port specification function
- Open and close ports, detect any attached nodes
- Access network maintenance features, such as restarting nodes, or re-enumerating the nodes on the port
- Delay function (to suspend thread execution)
- Includes a thread-locking class

SOFTWARE DEVELOPMENT KIT (SDK)

The sFoundation class libraries come with a detailed software development kit (SDK) to help make your software development as straightforward and efficient as possible.

The SDK includes all of the files a developer will need to begin coding, including:

- Header files
- Library .dll
- Class reference help file
- Fully functional Example C++ projects (written in Visual Studio 2015)

Tip: Before beginning software development, you may want to copy the complete SDK folder into a different working directory on your computer and leave an unmodified copy of the SDK in the default installation location.

WHERE IS THE SDK LOCATED?

The SDK files are copied to your local machine as part of the ClearView installation process, and can be found in one the following directories:

[YOUR_DRIVE]:\Program Files (x86)\Teknic\ClearView\sdk\

or

[YOUR_DRIVE]:\Program Files\Teknic\ClearView\sdk\

APPENDIX A: MOTOR BLINK CODES

Note: The motor LED periodically blinks off to indicate active communication between the motor and the host PC. This communication blinking takes place concurrently with the LED behavior defined in the table below. See examples below for clarification.

Example 1: A motor that is disabled will exhibit a solid green LED, but the LED will periodically blink off and back on during communication with the host PC.

Example 2: An enabled motor will exhibit a rapid green flicker, but the flicker pattern will be interrupted periodically during communication with the host PC. (It will look like a rapid flicker mixed with a slow blink.)

LED Behavior	CPSC State	Description
Green Flicker	Enabled	Operation normal. CAUTION: Motor windings are energized. Motor can move at any time.
Solid Green	Disabled	Operation normal. Motor windings are de-energized.
Yellow Blink	Shutdown	Query drive through application code for exception information, or connect to motor via Diagnostic Port with secondary laptop (running ClearView).
Red Blink	Fatal error	Motor hardware failure possible. Request RMA if condition persists.
Off	No or low DC bus power	Apply DC bus power to motor. Verify power supply meets system power requirements.

APPENDIX B: MECHANICAL INDEX

DIMENSIONAL DRAWINGS



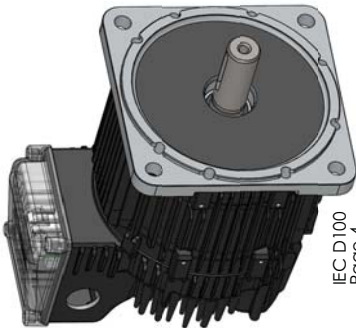
Blower Kit
Page 5



Foot Mount Kit
Page 6



Regenerated
Energy Shunt
Page 7



IEC D100
Page 4



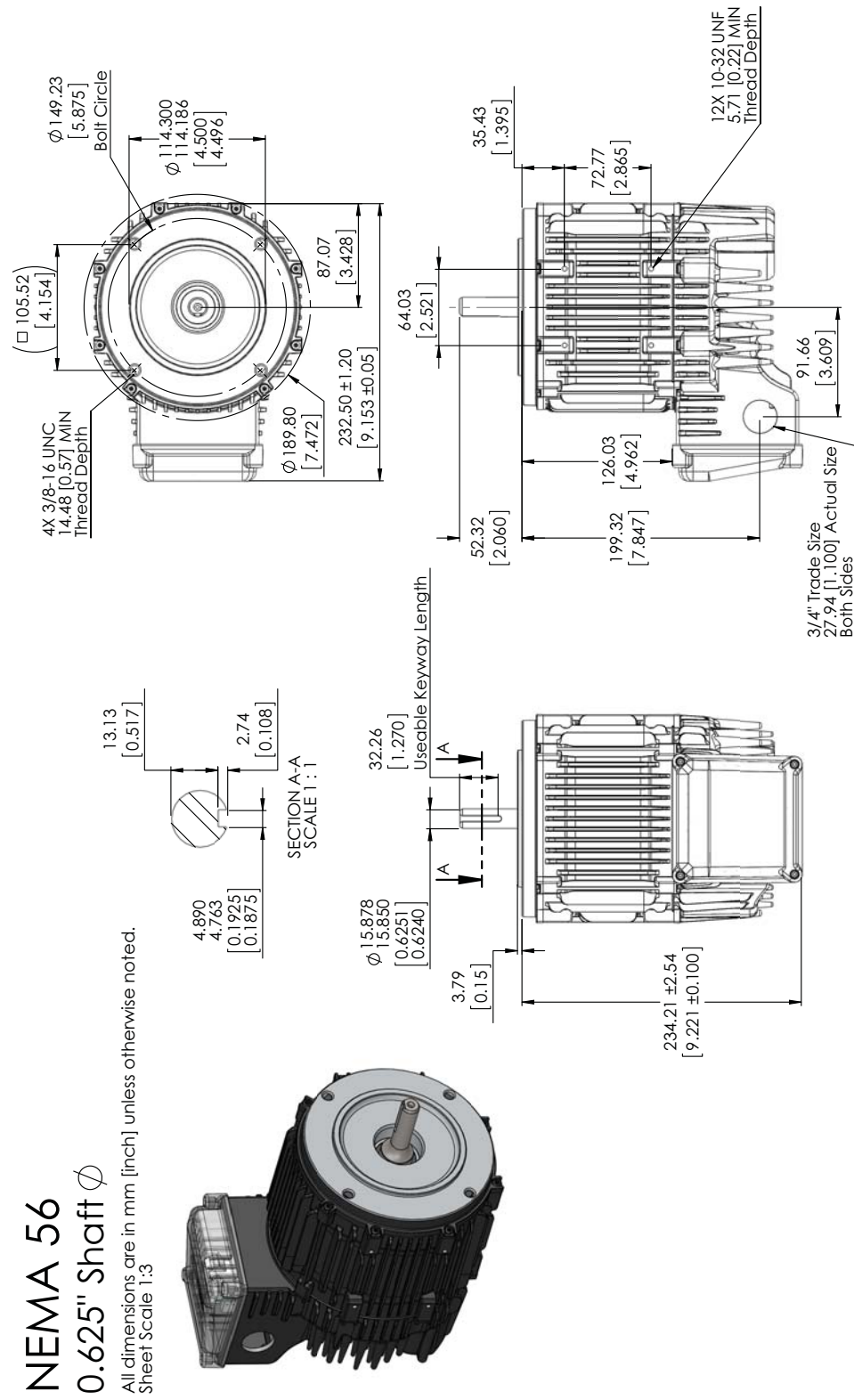
NEMA 143/145
Page 3



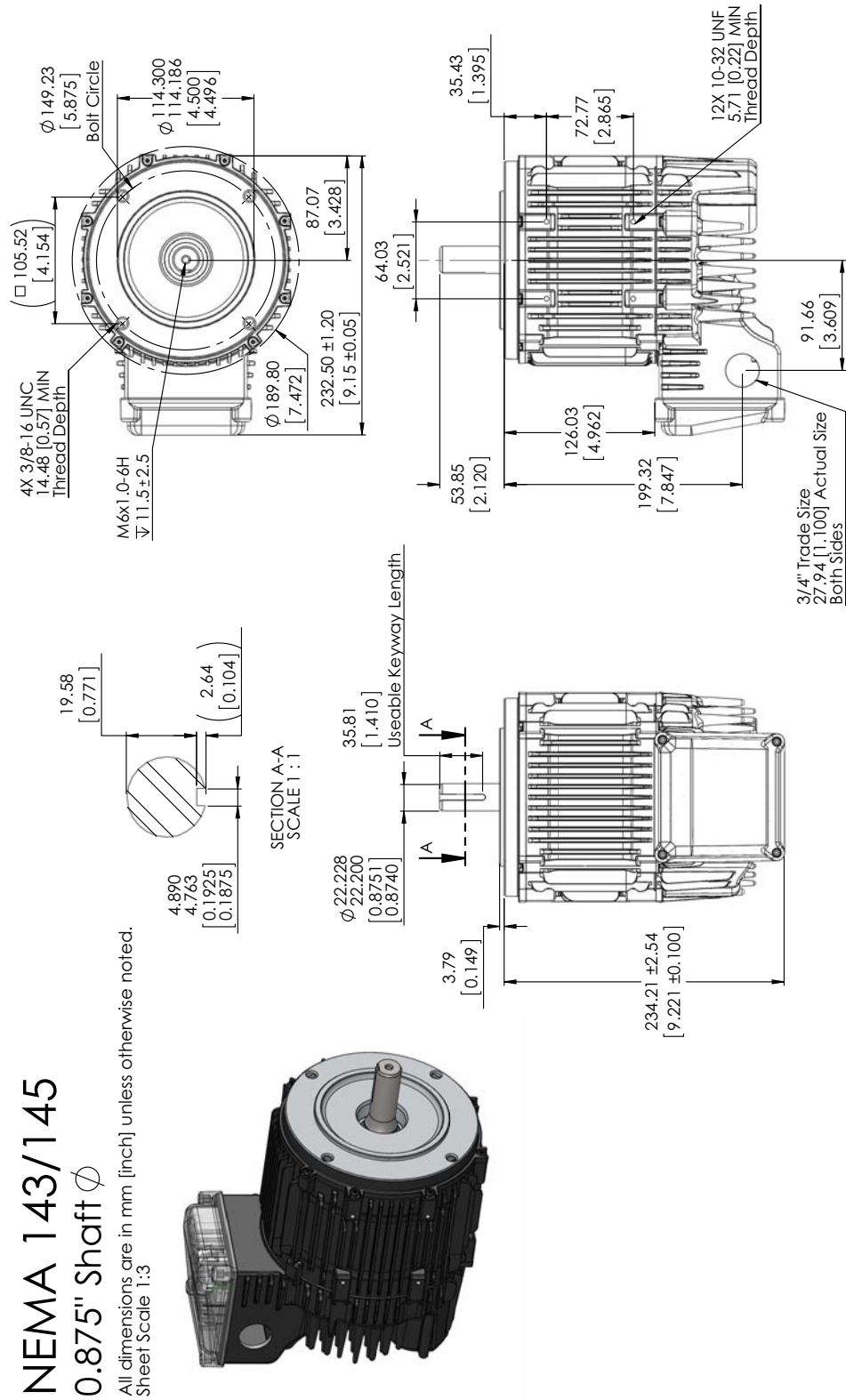
NEMA 56
Page 2

Teknic ClearPath®
Integral Horsepower Motors
& Accessories

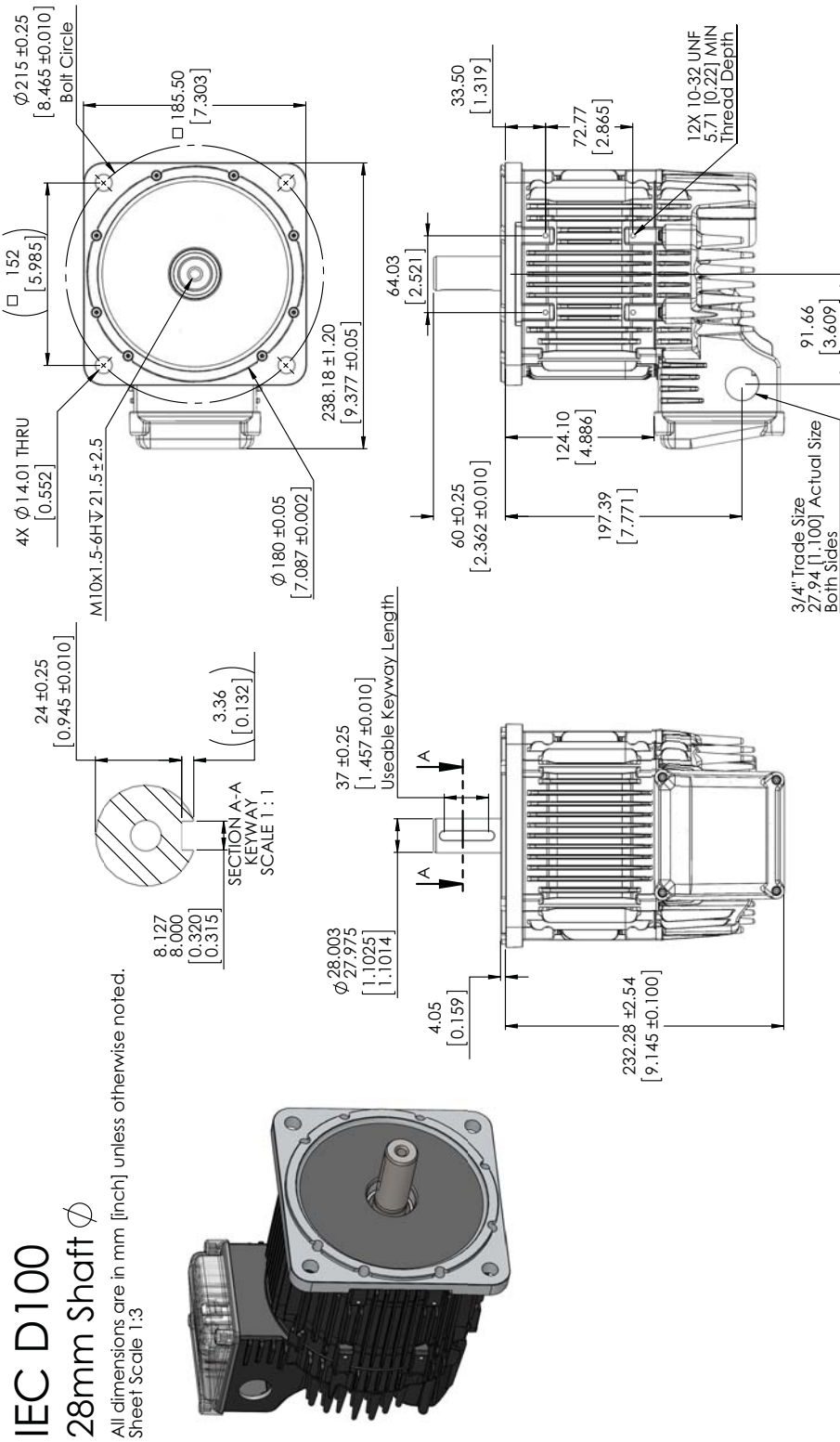
NEMA 56 FRAME MOTORS



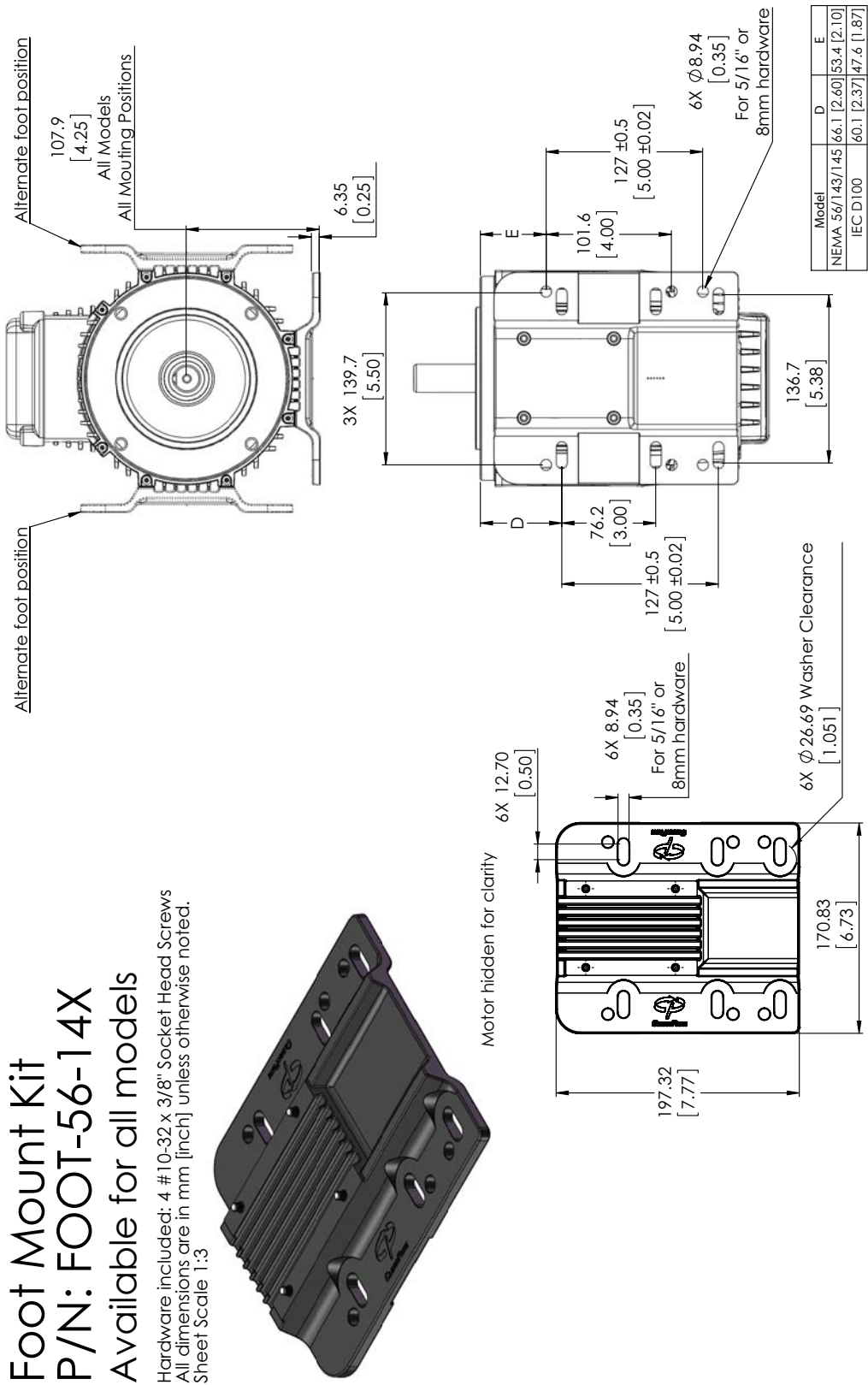
NEMA 143/145 FRAME MOTORS



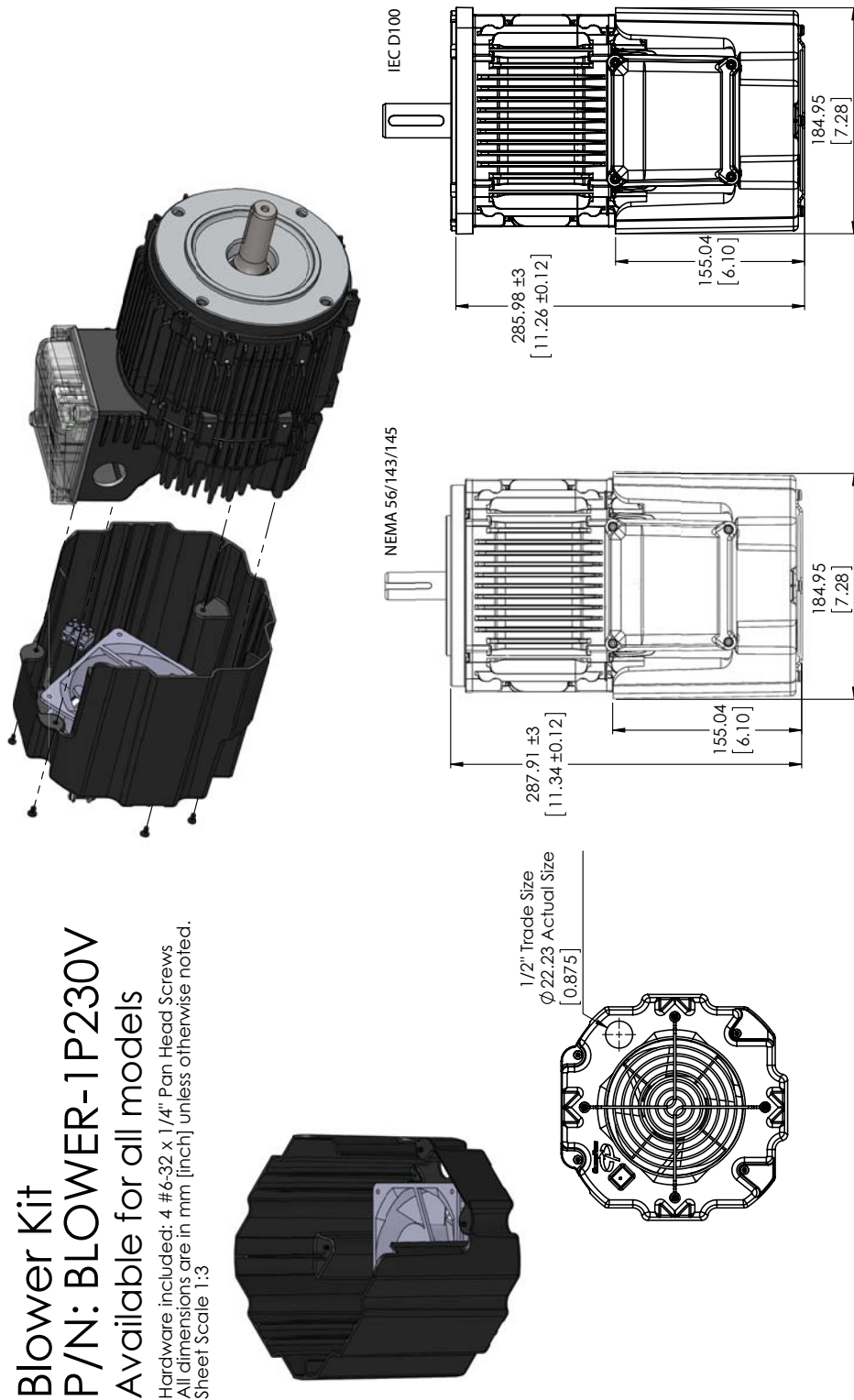
IEC D100 FRAME MOTORS



FOOT (ACCESSORY MOUNTING PLATE)



MOTOR DIMENSIONS WITH BLOWER KIT



CORD GRIPS AND CABLE CLAMPS

Below is a short list of cord grips, clamps, and conduit connectors that will fit the ClearPath motor junction box knockout holes. There are many more options for cord grips, cable clamps, and plugs on the market⁵.

Available from McMaster-Carr

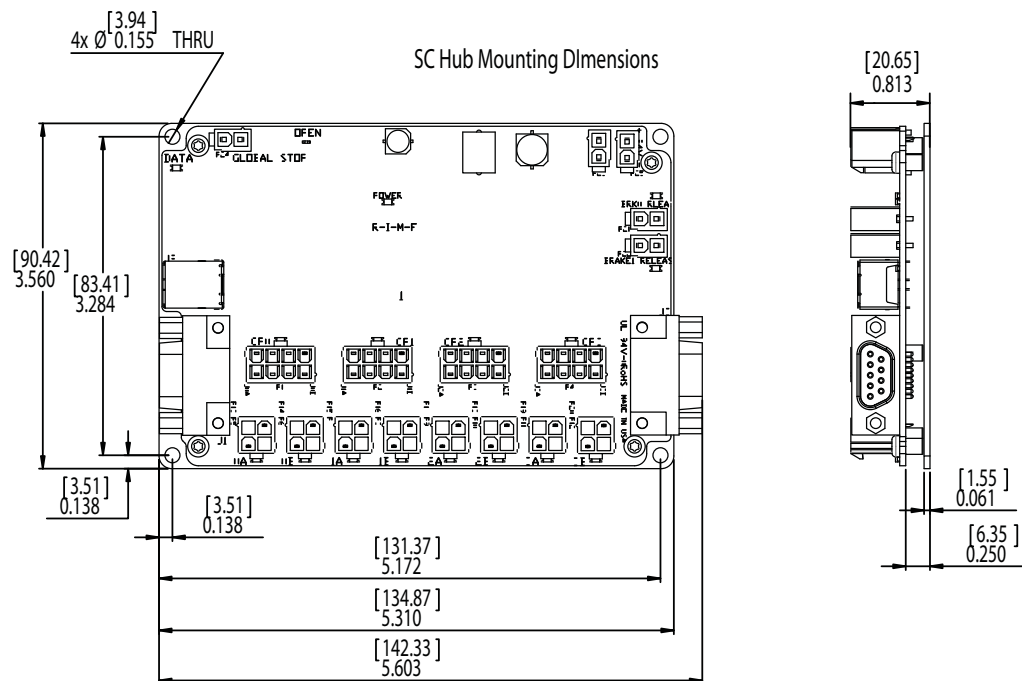
- Screw-down cord grip (Romex connector): M-C Part# 7798K42
- Liquid-tight Conduit (Sealtite): M-C Part# 9082K53 (9082K63 is the 90 degree elbow version)
- EMT connectors (water-tight versions are also available): M-C Part# 7150K12 (Part# 8081K32 is the 90 degree elbow version)
- Metal-Armored cable: M-C Part# 7267K35 (90 degree elbow version)
- Liquid-tight cord grips: M-C Part# 7529K566 (many cord diameters are available, as well as 90 degree angle versions)
- Screw-down cord grip (Romex connector): M-C Part# 7798K41

Available from Mouser.com

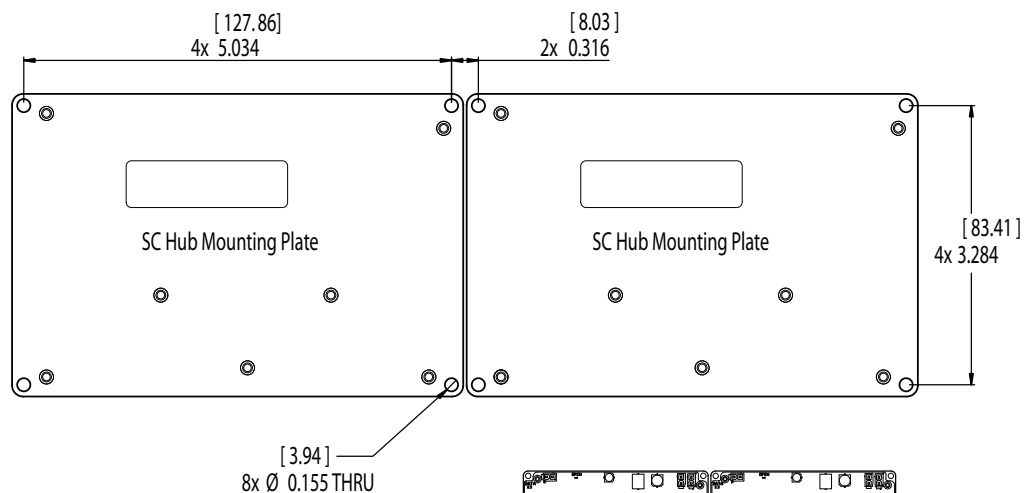
- Liquid tight, 3-cable cord grip with skinned over opening: Mouser Part# 836-M3234GBS-SM (Heyco Part# M3234GBS-SM). *This cord grip is compatible with Teknic's controller cables and 24VDC logic power backup cable.*

⁵ Disclaimer: It is the user's responsibility to evaluate the safety and suitability of third-party accessory items for their application. Part numbers, pricing, and availability of items listed in this section are subject to change without notice.

SC4-HUB DIMENSIONS



Mounting pattern for chaining multiple SC Hubs
end-to-end using onboard DB-9 connectors.



SC4-HUB Mounting Dimensions

CLEARPATH MOUNTING CONSIDERATIONS

Tip: For greater ease of use, consider mounting your motor such that the USB port and status LED are visible and accessible when the motor is mounted to the machine.

- **Do not** mount ClearPath over a heat source such as a power supply, spindle drive, etc. ClearPath will automatically shut down if its internal temperature exceeds specifications.
- **Do not** mount ClearPath in an unventilated enclosure.
- **Do** allow for at least 1" of space around each ClearPath.
- **Note:** ClearPath can be fitted with an external accessory fan if desired See *How to Mount the Blower kit*, later in this section.

CONNECTING CLEARPATH TO A MECHANICAL SYSTEM

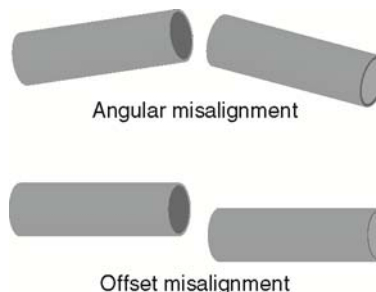
While it's obvious that ClearPath must be connected to a mechanical system to do useful work, it's not always clear just how to connect the motor to the mechanics.

Problems arise when a connecting element (such as a coupling) slips, exhibits excessive backlash, or can not accommodate typical shaft-to-shaft misalignments. Ultimately, the choice of shaft interface or coupling depends on the application, whether a precision positioning stage or a low speed conveyor.

The shaft interface (coupling, pulley, pinion, etc.) must be securely clamped to the shaft with minimum backlash (ideally none). This primary mechanical interface is critical in achieving and maintaining the best possible performance from a servo motion system.

MOTOR CONNECTION: GENERAL TIPS AND GUIDELINES

- **Align with care.** When connecting two shafts—such as a motor shaft to a screw shaft—the rotating centers must be carefully aligned in both the angular and offset sense (including offsets/adjustments for thermal growth) to achieve the best possible motion quality and longest motor/bearing life.



Some couplings are more forgiving of misalignment than others, but in general, misalignment will cause undesired vibration/noise, shortened bearing life, and even broken motor shafts.

- **Use lightweight components.** Aluminum couplings, pinions, and pulleys add significantly less inertia to the motion system than steel parts of the same size. In most applications, lower inertia is preferable because it allows the motor (and attached mechanics) to accelerate harder and move and settle faster.
- **Avoid using set screws.** Coupling devices with set screws are prone to failure and often become the weak link when joining a motor to a load. Set screws deform the metal around the screw's point of contact, often resulting in a raised bur on the shaft that can make it hard to remove and replace the coupling element. Set screws also tend to slip and score the shaft.
- **Tip:** Couplings, pulleys and pinions with circumferential clamping mechanisms tend not to damage motor shaft, hold better, and are easier to replace than those that use set screws.
- **Clamp close to the motor.** For maximum performance, secure pulleys and pinions as close to the motor face as is practical. This effectively reduces the lever arm (and associated bearing load) for applications with a side load.
- **Don't over tighten belts.** Always read the belt manufacturer's guidelines for proper belt tension, but never exceed the ClearPath specification for maximum side load. Overly tight belts put undue stress on the motor shaft and bearing systems that can result in premature bearing and shaft failure.

NOTES ON COUPLING SELECTION

A complete coverage of the topic *Coupling Selection for Servo Applications* is beyond the scope of this document, but many articles and resources can be found on the web for those interested in learning more. Because there are so many different coupling styles and applications, selecting the “right” coupling for a particular application can be challenging.

General Guidelines for Coupling Selection

Teknic has a few guiding principles when it comes to coupling selection for servo applications. Keep in mind that these are rules of thumb and may not apply to every application. In general:

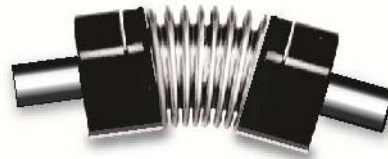
- **Don't** undersize the coupling. Understand how much torque your application requires and stay within the coupling manufacturers specifications. Always leave reasonable engineering margin.
- **Don't** use set screw type couplings. They damage the motor shaft and tend to be less reliable over time than clamp style couplings.
- **Do** use clamp style couplings. These clamp around the circumference of the shaft at one or two points without deforming the shaft surface.
- **Don't** use rigid couplings—they are notoriously intolerant of misalignments.
- **Don't** use beam style (helical) couplings if vibration damping or torsional stiffness is critical to your application. Beam couplings tend to resonate/whine at higher speeds.
- **Don't** use any coupling that requires you to drill into, deform, or “pin” the motor shaft.

Coupling Recommendation

Teknic often recommends **zero-backlash curved jaw couplings** (commonly referred to as “spider couplings”) as a good choice for many servo applications. These couplings are moderately priced and widely available from well established manufacturers such as Ruland.



Curved Jaw (Spider) Coupling



Bellows Coupling

Couplings for servo applications

Note: Curved jaw couplings (also known as spider couplings) are a good choice for many applications, but cannot tolerate a great deal of misalignment or axial motion. Also, never exceed the manufacturer's

rating for “maximum torque with zero backlash” when using jaw couplings.

Bellows couplings are also excellent for high precision positioning applications. Bellows couplings allow for more misalignment than jaw couplings but are generally more expensive.

Both curved jaw and bellows coupling offer excellent positioning accuracy, high speed performance, and vibration damping when installed and operated within the manufacturer’s specifications and guidelines.

Coupling Information on the Web

Ruland’s website has a good collection of technical information on coupling types and coupling selection for servo systems. Click [here](http://www.ruland.com/a_articles.asp) for access to technical articles, videos, and CAD drawings. Or go to http://www.ruland.com/a_articles.asp.

INSTALLING PULLEYS AND PINIONS

PULLEY AND PINION MOUNTING

- Always follow the manufacturers mounting guidelines.
- Mount pulleys and pinions as close to the motor face as possible while still following the manufacturer’s installation guidelines.
- Never drill through, “pin”, or deform the motor shaft when mounting a pulley or pinion.

Application Tip: To prevent loosening/slip, some users bond their pulleys and pinions to the motor shaft with a high strength adhesive such as Loctite #638. While this is very effective in preventing pulley slip, it can be difficult to undo once the adhesive has cured.

HOW TO MOUNT OPTIONAL BLOWER KIT (BLOWER-1P230V)

This document describes how to wire and mount Teknic Part#: **BLOWER-1P230V** to UL Recognized AC ClearPath models.

Please read these important notes before proceeding!

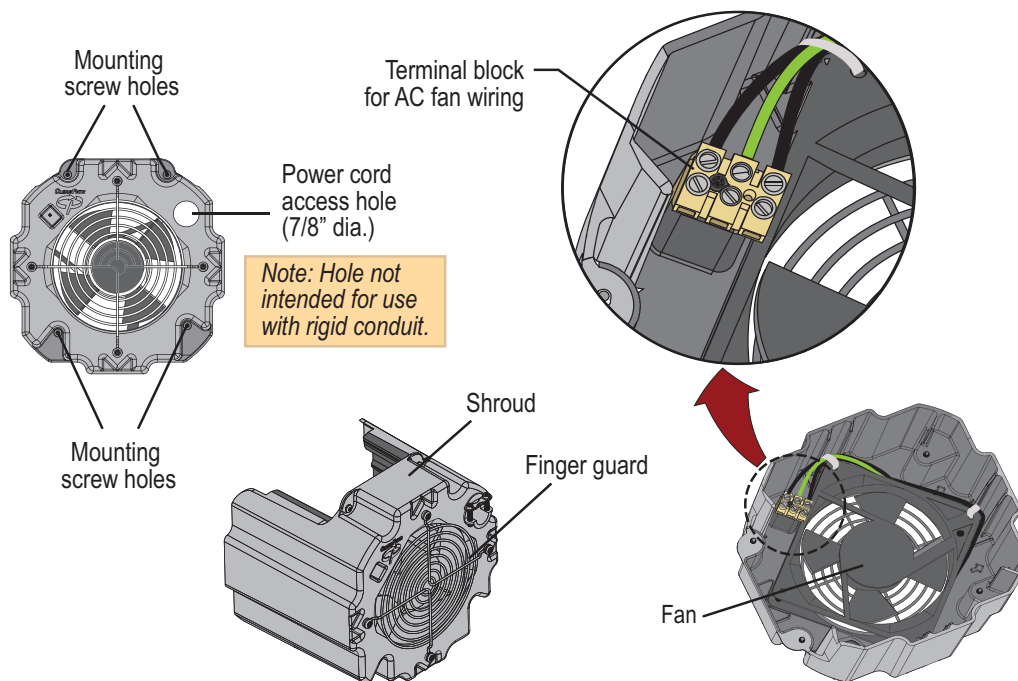
- The fan supplied with this blower kit requires single phase 230VAC nominal mains power with a max. rating of 250 VAC. The fan will not work properly with 120VAC power.
- **Important:** Bond Protective Earth of the blower kit and Protective Earth of the AC ClearPath Motor to the same electrical system in the final installation.
- This device is not intended for connection to rigid metal conduit.

Items included in this kit

- Shroud (heavy-duty plastic)
- Fan (230VAC nominal)
- Finger guard
- AC wiring terminal block, 3 position
- Mounting screws, (qty.4), #6-32, T-10, pre-treated with thread locker

Items not included in this kit

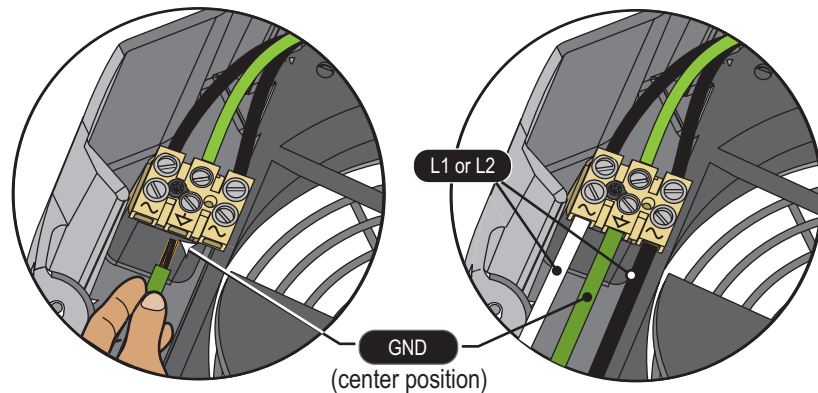
- Screwdriver, Torx, T-10
- Screwdriver, slotted, small
- Suitably Listed line cord with 3 flying leads (L1, L2, and GND) and appropriate (230VAC) Listed plug
- Suitably Listed cord grip or strain relief sized to fit a 1/2" Trade Size knockout. (7/8" hole diameter)
- Tie wrap (1), Panduit PLT1.5i-c (or equivalent)



BLOWER-1P230V

PROCEDURE

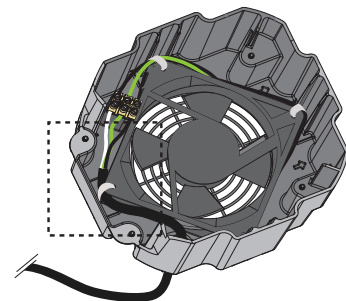
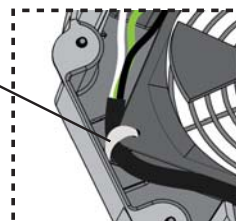
1. Strip 50-75mm (approximately 2-3 inches) of the line cord's outer jacket to expose the 3 inner wires. Be careful not to nick the insulation on any wires.
2. Strip 6-7 mm (approximately 0.25 inches) from each of the 3 inner wires.
3. Attach strain relief or cord grip to the shroud.
4. Feed the line cord through the strain relief and into the blower housing.
5. Insert the line cord wires into the 3 position terminal block as shown below. Connect ground (typically green) to the center terminal. Important: Ensure that GND wire connects to Protective Earth. Connect the AC phase wires (labeled L1 and L2 below) to either of the outer terminals.



6. Tighten screws. Verify that no stray wire strands are protruding from terminal housing.
7. Tighten strain relief or cord grip. Verify that all wires are properly captured and strain relieved.
8. Important: Secure AC line cord to the corner of fan with a tie wrap (see figure below). This is necessary to prevent the line cord from interfering with the fan during operation.

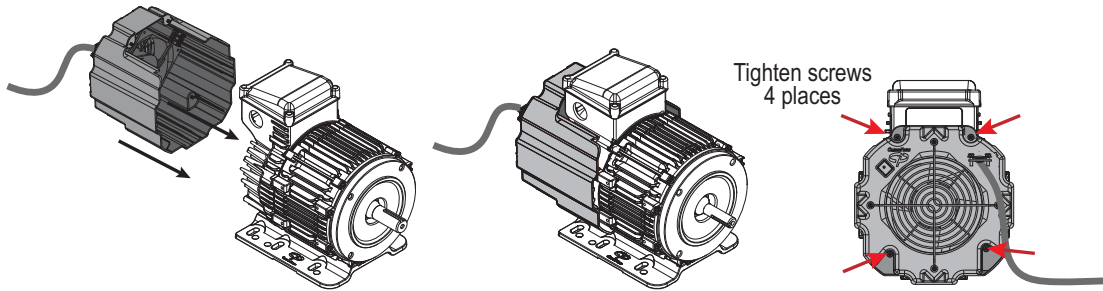
Secure AC line cord to corner of fan

Use tie wrap part #
Panduit PLT1.5I-C
or similar



9. Test fan operation by applying AC mains power. Remove power after test.

10. Slide the blower onto the ClearPath motor as shown below.
11. Secure blower to the motor by tightening 4 screws as shown below. Use Torx (T-10) screwdriver.



Connecting the BLOWER-1P230V to an AC ClearPath Motor

ABOUT END-OF-TRAVEL STOPS

End-of-travel stops are typically installed to prevent the moving element of a linear axis from flying off the machine in the event of a use or control error. There are a few common types of end stop to consider, but the final choice depends on the application objectives and requirements.

HARD BLOCKS

This is usually a solid block of steel, aluminum, or hard plastic secured at one or both ends of travel and positioned in such a way as to make even, repeatable contact with a hard surface on the moving element. Hard blocks are very effective at arresting motion, but can result in mechanical damage when struck at high speeds.

In several modes, ClearPath must home to a hard stop to establish a home reference position before functional positioning can begin.

ELASTOMERIC (RUBBER) STOPS

High durometer rubber stops (hard rubber) can also be used with applications that use HardStop Homing. This type of end stop offers a higher level of shock absorption and axis protection than hard blocks. Spongy, low durometer rubber stops are not recommended in most cases. They offer little benefit over a hard end stop during an axis crash.

PNEUMATIC (DASHPOTS)

Pneumatic hard stops (dashpots) offer excellent shock absorption performance but are considerably more expensive than hard blocks. Examples of specialized dashpots include the hydraulic cylinder in an automobile shock absorber as well as many automatic door closers.

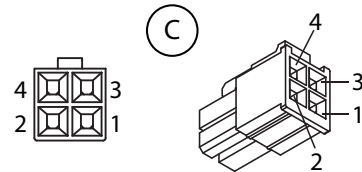
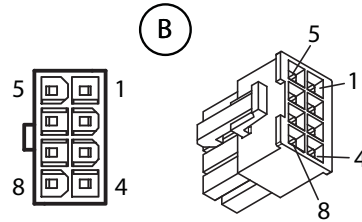
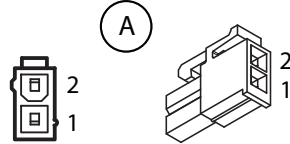
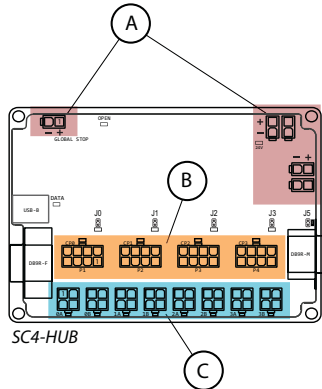
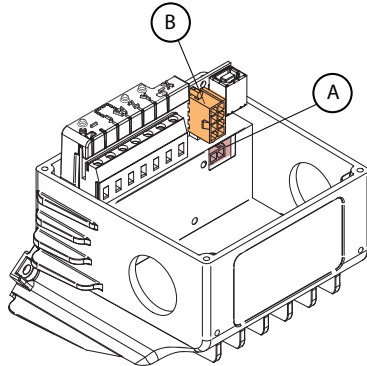
END STOPS AND HARD STOP HOMING

End stops from medium durometer rubber to steel can be used successfully with Hard Stop Homing. When selecting end stops for a Hard Stop Homing application consider the following:

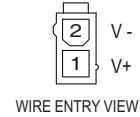
- Axes with low friction that are easily back driven can tolerate “softer” rubber end stops and still achieve good homing performance.
- Higher friction applications and those that cannot be back driven will generally require harder end stop material to achieve best Hard Stop Homing performance.
- Be prepared to test and experiment with different end block materials to ensure proper homing operation with your mechanical system.

APPENDIX C: MATING CONNECTORS AND CABLE PINOUTS

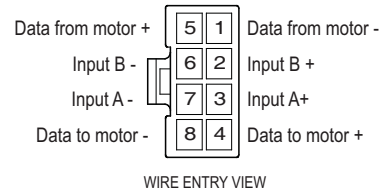
MATING CONNECTORS



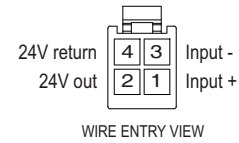
Logic Power Backup Connector



Comm & I/O Connector



Input Connector



All parts listed below are made by Molex Inc. Go to www.molex.com for complete specifications and application information.

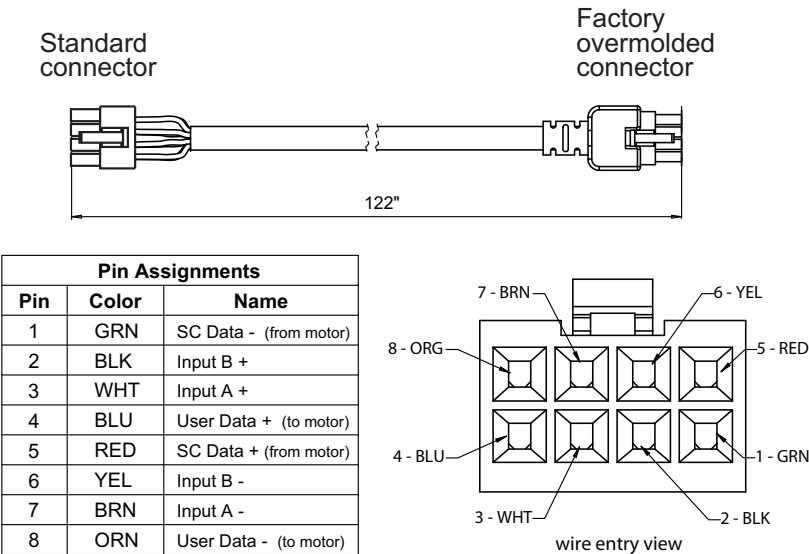
Ref.	Description	Mating Connector PN	Terminal PN	Terminal Desc.	Crimp Tool	Extraction Tool	Recommended Wire Gauge**
A	Molex MiniFit-Jr, Receptacle, 2 circuits	39-01-2020 (natural, UL 94V-2) 39-01-3025 (black, UL 94V-2) 39-01-3028 (natural, UL 94V-0) 39-03-9022 (black, UL 94V-0)	39-00-0059 (reel) 39-00-0060 (loose)	Female crimp terminal, tin plate, 18-24 AWG	63819-0900 (16-24AWG)	11-03-0044	20 AWG
B	Molex MiniFit-Jr, Receptacle, 8 circuits	39-01-2080 (natural, UL 94V-2) 39-01-3085 (black, UL 94V-2) 39-01-2085 (natural, UL 94V-0) 39-03-9082 (black, UL 94V-0)	39-00-0046 (reel) 39-00-0047 (loose)	Female crimp terminal, tin plate, 22-28 AWG	63819-1000 (22-28 AWG)	11-03-0044	22 AWG
C	Molex MiniFit-Jr, Receptacle, 4 circuits	39-01-2040 (natural, UL 94V-2) 39-01-3045 (black, UL 94V-2) 39-01-2045 (natural, UL 94V-0) 39-03-9042 (black, UL 94V-0)	39-00-0046 (reel) 39-00-0047 (loose)	Female crimp terminal, tin plate, 22-28 AWG	63819-1000 (22-28 AWG)	11-03-0044	22 AWG

** AWG values listed are the actual wire gauges used in Teknic-manufactured cables.

CABLE PINOUTS

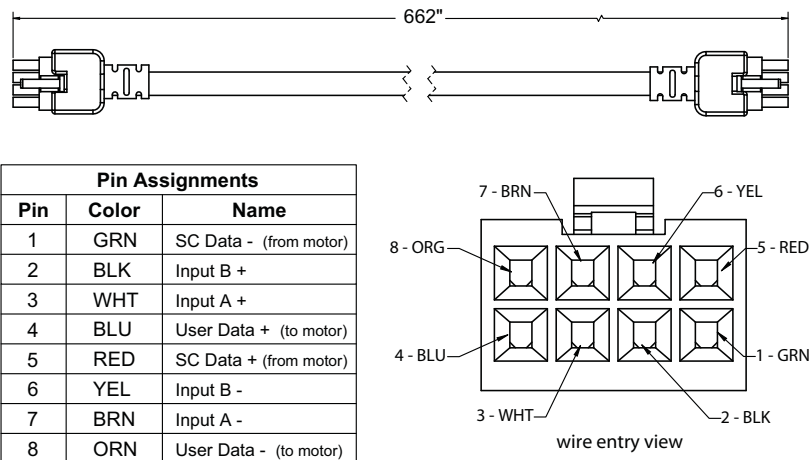
CONTROL CABLE: CPM-CABLE-CTRL-MU120

Cable description: ClearPath I/O connector cable, ~122 inches end-to-end. Overmolded Molex MiniFit Jr. 8-position connector to standard MiniFit Jr. 8-position connector (no overmolding on one end for easy access to wires).



CONTROL CABLE: CPM-CABLE-CTRL-MM660

Cable description: ClearPath I/O connector cable (double-ended), ~662" end-to-end. Overmolded Molex MiniFit Jr. 8-position connector to same. Use "as is" or cut in half to make two cables with flying leads.



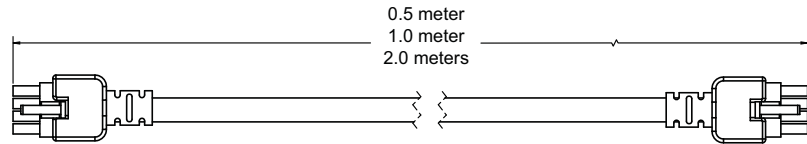
CONTROL CABLE: MOLEX BRAND (2 METERS AND SHORTER)

Molex stocks a few shorter, ClearPath-compatible control cables through their website (see URLs below).

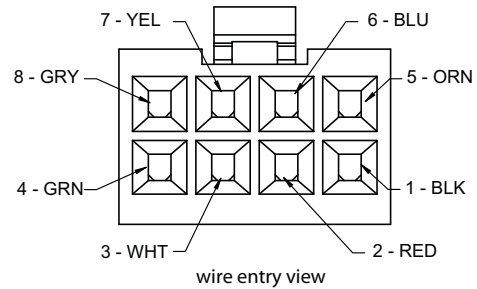
Cable description: These cables are overmolded Molex MiniFit Jr. 8-position connector to same, with 18AWG wires. Available lengths include 0.5 meter, 1 meter, and 2 meters.

Note: The wire colors for the Molex brand cables are not identical to the wire colors used in the Teknic brand cables (listed on the previous page). This will not affect cable operation.

Length	Molex PN	Link
0.5 m	2451350805	https://www.molex.com/molex/products/part-detail/cable_assemblies/2451350805
1.0 m	2451350810	https://www.molex.com/molex/products/part-detail/cable_assemblies/2451350810
2.0 m	2451350820	https://www.molex.com/molex/products/part-detail/cable_assemblies/2451350820



Pin Assignments		
Pin	Color	Name
1	BLK	SC Data - (from motor)
2	RED	Input B +
3	WHT	Input A +
4	GRN	User Data + (to motor)
5	ORN	SC Data + (from motor)
6	BLU	Input B -
7	YEL	Input A -
8	GRY	User Data - (to motor)



APPENDIX D: SPECIFICATIONS

CLEARPATH-SC MOTOR: COMMON SPECIFICATIONS

Motor Common Specifications (All Models)

Input Power

Input voltage range, AC, single and 3 phase	100-240VAC
Input voltage range, AC, 3-phase, 5-wire source	300-415VAC
Typical / Max. quiescent AC input power, enabled	27W / 30W
LVDC Backup power input range	20-28VDC
LVDC Backup power watts, maximum	4.0 W, (15W when temp. < 0° C)

Environmental

Ambient temperature	-40°C to +70°C*
Ambient humidity, junction box closed and ports sealed	0%-95%, condensing
Ambient humidity, junction box open (during commissioning)	10%-85%, non condensing
Environmental Sealing with optional shaft seal	IP65
Environmental Sealing without shaft seal	IP65, exclusive of shaft exit

Electrical Control I/O

Logic Input Voltage Range	4.0VDC to 28VDC
Input Current @ 5V	7.5mA (typical)
Input Current @ 28V	12.0mA (typical)

Bearing/Shaft Ratings:

Rated Radial Load, NEMA56 (lbs./N)	170 lbs (756 N) applied 1.18" (30mm) from user mounting face
Rated Radial Load, NEMA143/145 (lbs./N)	170 lbs (756 N) applied 1.18" (30mm) from user mounting face
Rated Radial Load, IEC D100 (lbs./N)	170 lbs (756 N) applied 1.18" (30mm) from user mounting face
Maximum Axial (Inward-Thrust) Load, all models, all shaft orientations	70 lb (311 N)
Maximum Axial (Outward-Tensile) Load, all models, all shaft orientations	40 lb (178 N)
Bearing Life	2.1 x10 ¹⁰ to 4.4 x10 ¹⁰ revs (typ., load dependent.)

Shock and Vibration

Maximum Shock during transport/storage	10G (applied no more than twice)
Maximum Shock during operation	2G
Maximum Vibration (2-200Hz)	1G or 0.5mm (whichever is less)
Maximum externally applied shaft acceleration (rev/sec ²)	250,000 radians/sec ²

Compliance

Electrical Safety	EN61010, UL61010, UL61800-5-1
EMI (RF emissions and immunity)	EN 61326-1
Conformance Marking	UL recognized for use up to 240VAC CE certified for use up to 415 VAC RoHS

General

Frame sizes available	NEMA 56, NEMA 143/145, IEC D100
Mass	11.5kg
Country of Origin	USA
Warranty	3 Years

*The RMS torque limit on certain motors is derated for operation in ambient temperatures above +40°C. Contact Teknic for derating assistance.

SC4-HUB SPECIFICATIONS

USB

USB Standard	USB 2.0 w/hub, USB 1.1 direct
Power Draw	If 24V is present, 0.4mA max If 24V is not present, 150mA max.
Connector:	USB-B

RS-232 to PC

Compatible baud rates:	Up to 230 kBaud
Connector:	DB-9 female, use DB-9 straight-through cable (male to female) to connect to PC

RS-232 Extension

Compatibility:	Intended for direct connection to another SC4-HUB board only.
Connector:	DB-9 male (can be plugged directly into J1 of another SC4-HUB, or through another straight-through DB-9 cable)

Global Stop Input

Input Type:	Isolated loop
Specified voltage range:	0-24VDC
Current draw:	2mA@4.5V, 12mA@24V
Min. guaranteed on voltage:	3.0VDC
Max. guaranteed off voltage:	2.0VDC
Max. input voltage:	26VDC
Connector:	2-pin MiniFit Jr.

Brake Outputs

Output type:	Powered open collector
Output voltage:	24VDC
Rated current:	500mA per channel, max.
Short circuit protected with built-in inductive clamp	
Connectors:	2-pin MiniFit Jr. (x2)

Power input

Specified voltage range:	20VDC to 30VDC
Max. input voltage	40VDC
Current draw:	300mA (+ up to 500mA per brake)
Connectors:	2-pin MiniFit Jr. (x2)

ClearPath Interface

Compatibility:	Intended for direct connection to a ClearPath-SC motor only
Connectors:	8-pin MiniFit Jr. (x4)

ClearPath Inputs A and B passthrough

Direct passthrough of ClearPath inputs A and B with 24V courtesy power for sensors	
Connectors:	4-pin MiniFit Jr. (x8)

Dimensions:

L x W x H (w/o plate)	5.60" x 3.50" x 0.65"
L x W x H (with plate)	5.60" x 3.56" x 0.82"

Country of Origin:

USA

Warranty:

1 year

APPENDIX E: GROUNDING AND SHIELDING

PROTECTIVE EARTH (PE) CONNECTION

Compliance Note: ClearPath must be properly connected to the machine's Protective Earth terminal to meet EMC emissions specification EN-61000-6-4, and EMC immunity specification EN-61000-6-2, as well as EMC electrical safety specification EN-61010 (for CE/UL compliance).

Connect ClearPath to your machine's Protective Earth terminal (PE) using one of the following methods.

- **If the motor mounting plate is bonded to machine PE (typical)**, most of the work is already done. Simply secure ClearPath to the mounting plate with conductive fasteners (don't use anodized or coated hardware). Ensure direct, bare metal-to-metal contact between the ClearPath motor face and mounting surface.
- **If the motor mounting plate *is not* bonded to machine PE** it's still easy to make a good PE connection. Just install a grounding wire from ClearPath's Auxiliary PE Connection Point (located on the motor's junction box) to a point on the machine that is bonded to machine PE. **Use grounding wire with same AWG number (or heavier) as the ClearPath AC power input wiring.**

Note: In scenarios where ClearPath *is not* connected to a PE (Protective Earth) return path—such as during bench testing or maintenance—temporary grounding measures may be necessary to comply with safety requirements.

GROUNDING AND SHIELDING

- Always maintain separation between isolated control ground and power ground.
- Shielded cable is not required for ClearPath control cables.
- If you choose to use shielded control cable, connect the cable's isolated ground at one point (at the controller only). Do not hook isolated control ground to the machine frame or chassis at any other location.
- Do not ground ClearPath I/O circuits to the machine frame or chassis.

Note: All ClearPath I/O signals are electrically isolated from ClearPath's AC power input and motor output circuits, as well as from the motor case. This design feature helps to ensure that control signals aren't compromised by induced currents from the motor, power supply, or internal PWM.

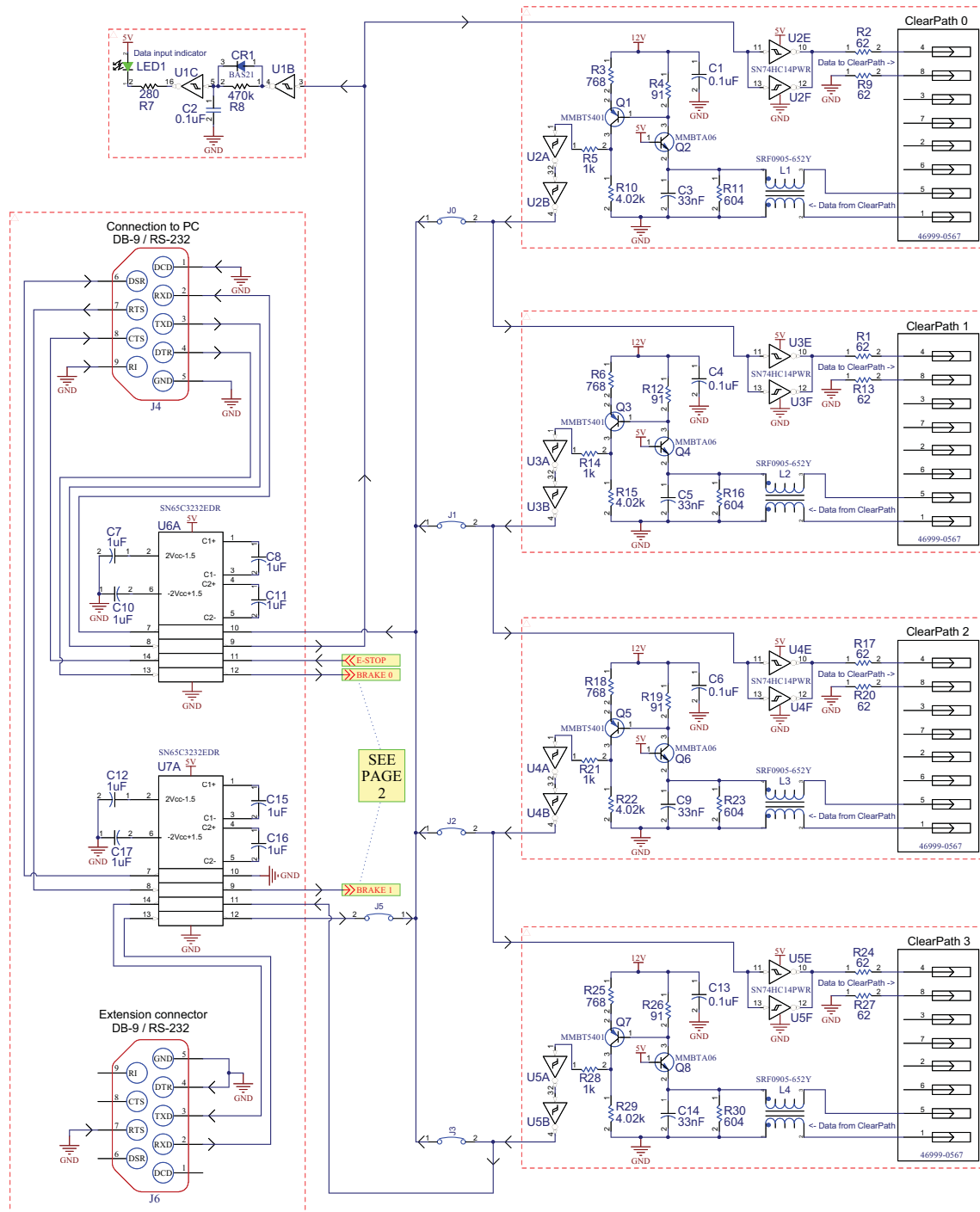
POWER RETURNS

- Never use the machine frame or chassis as a power return. Use discrete cable or wires for all power wiring.
- Use only recommended wire gauge for all ClearPath power wiring. When in doubt, use heavier gauge wire.

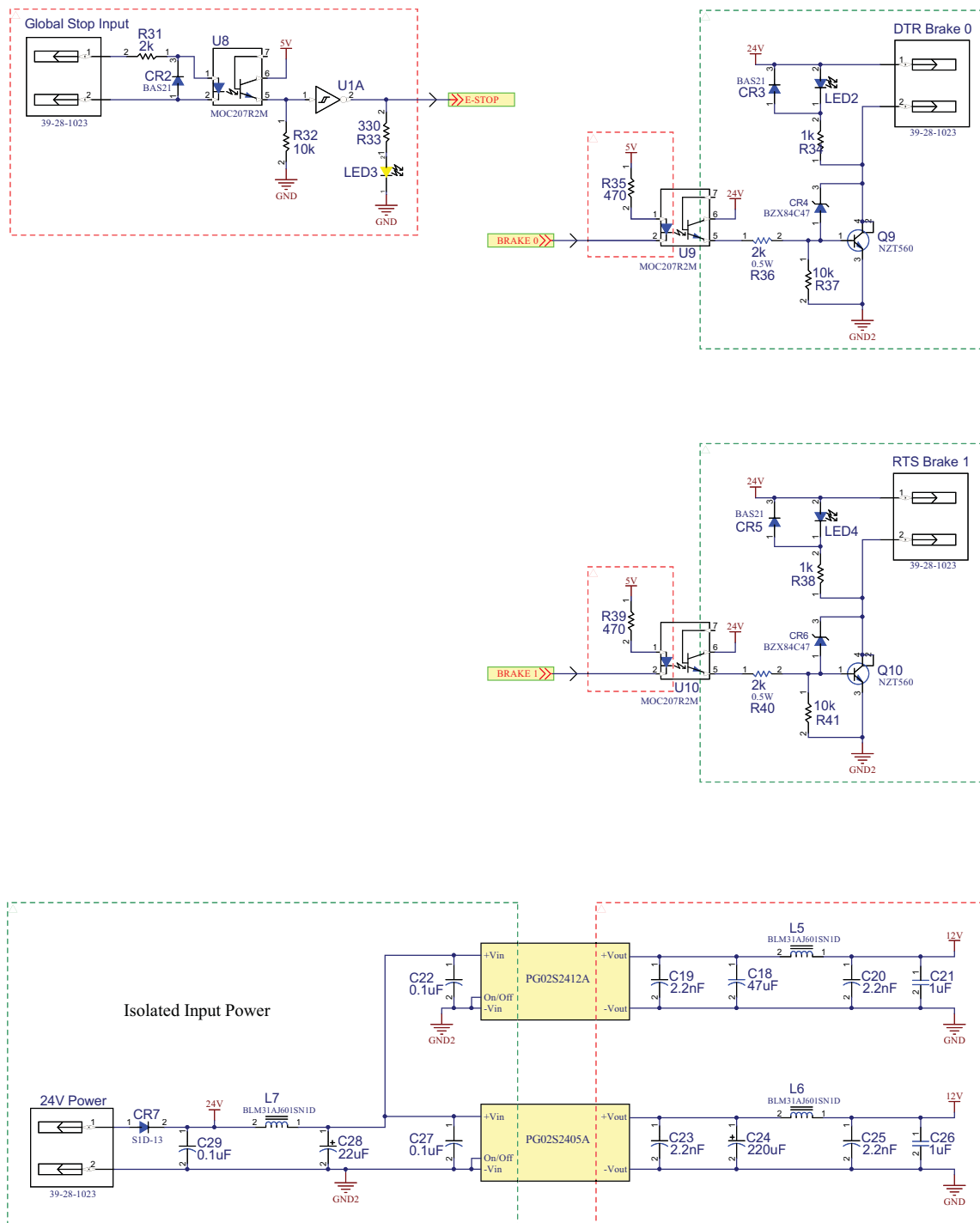
APPENDIX F: CIRCUIT SCHEMATICS

All schematics in this section are functionally accurate. Certain advanced circuit elements have been omitted for clarity.

SC4-HUB SCHEMATIC (SIMPLIFIED)



SC4-HUB simplified schematic page 1

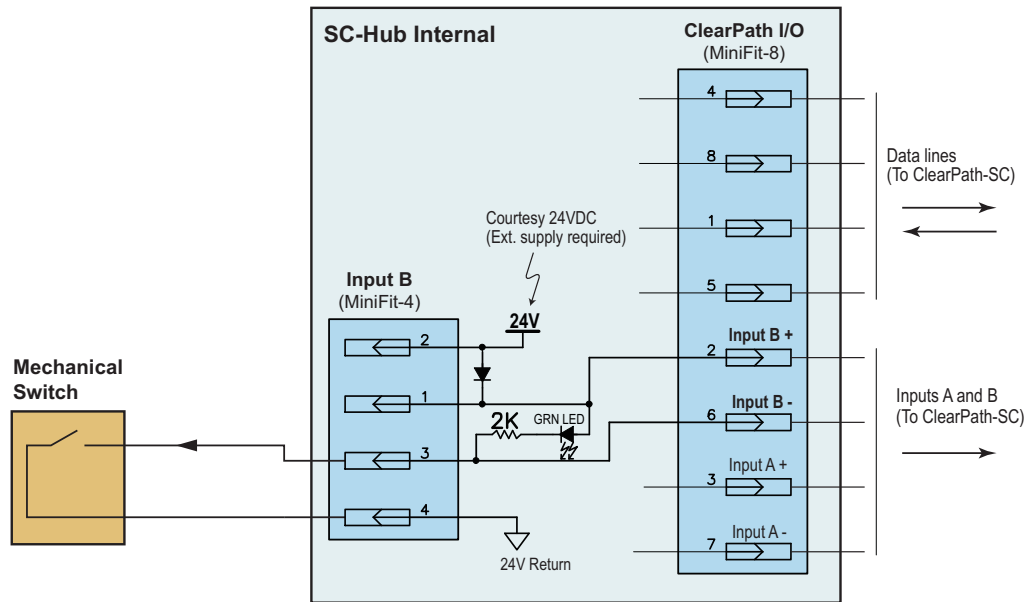


SC4-HUB simplified schematic page 2

APPENDIX G: WIRING THE INPUTS

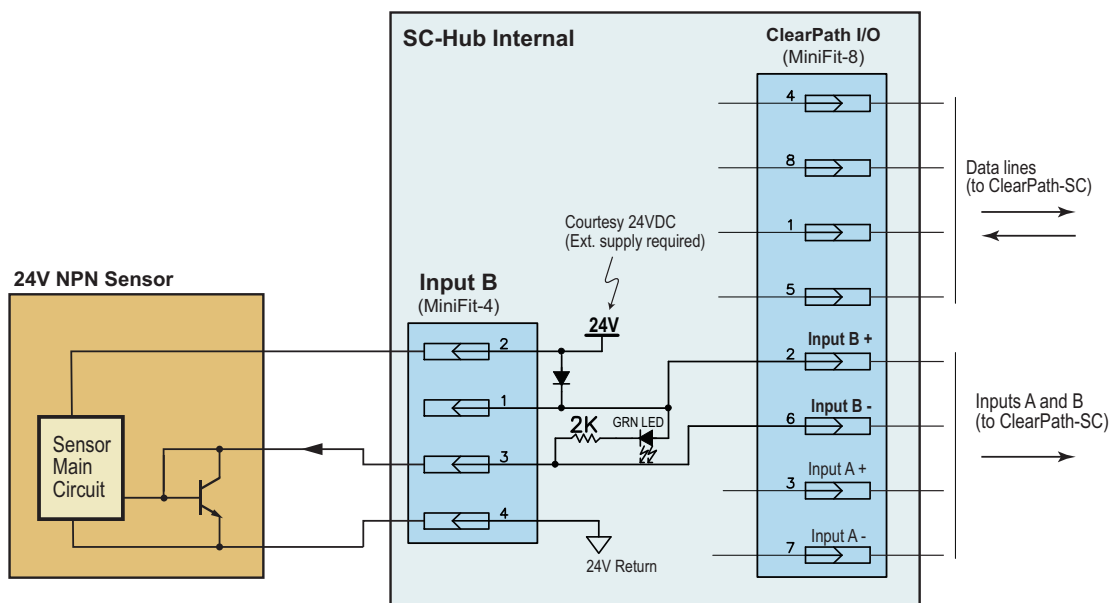
Each ClearPath-SC motor has two available inputs (Input A and B). Inputs are wired to the SC4-HUB and passed to the motor via the ClearPath I/O connector as shown below.

WIRING A MECHANICAL SWITCH TO AN INPUT



A mechanical switch wired to Input B on the SC4-HUB

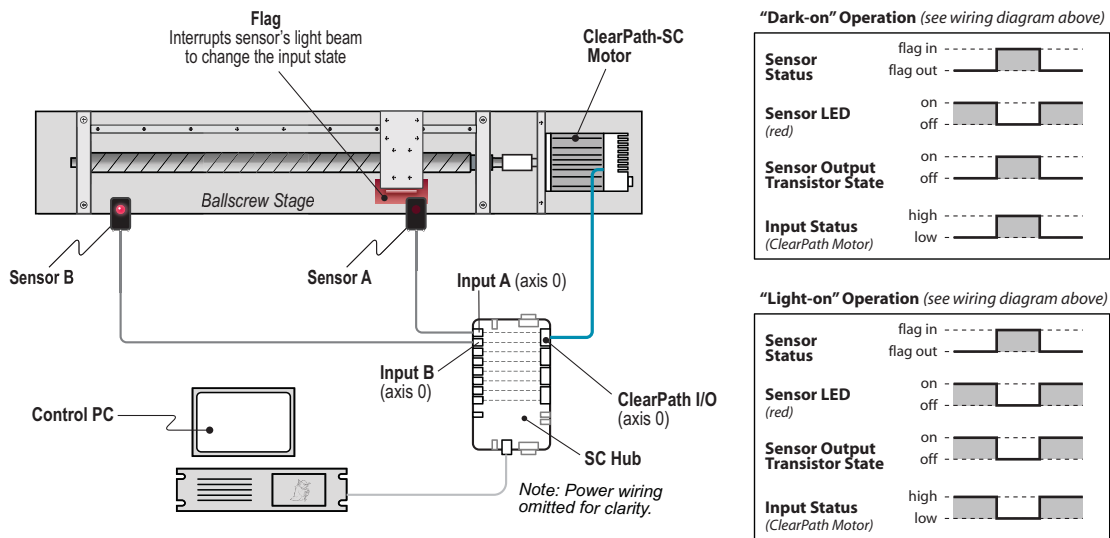
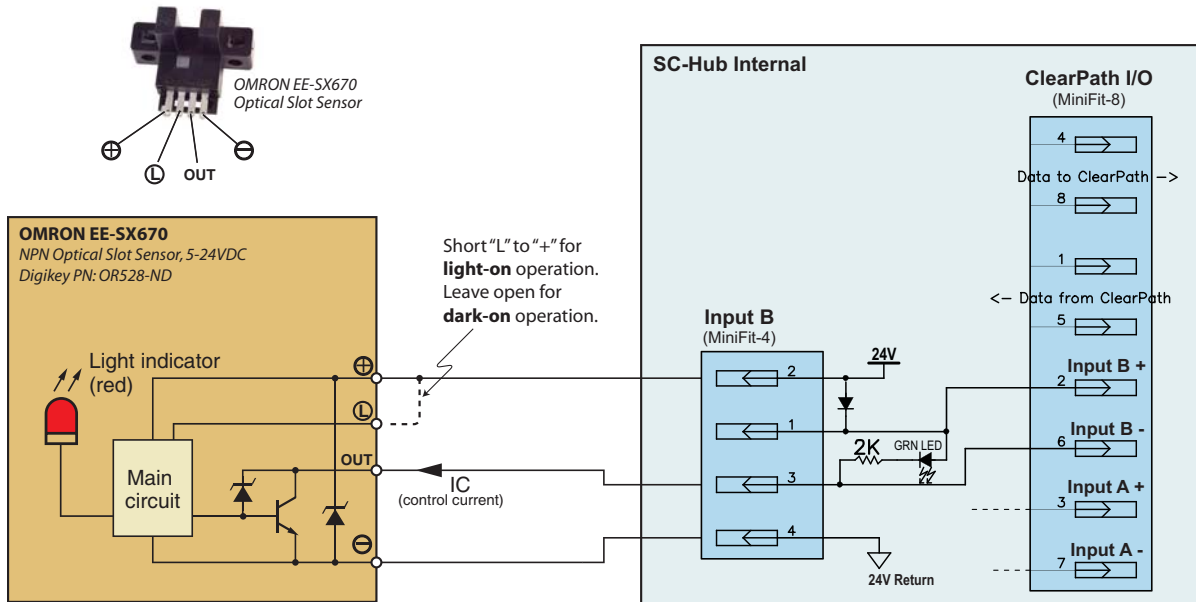
WIRING A 24V NPN SENSOR TO AN INPUT



An 24V sensor wired to one input on the SC4-HUB board

APPLICATION EXAMPLE: WIRING AN OPTICAL SENSOR TO AN INPUT

The example below is based on the Omron EE-SX670 optical slot sensor.



Wiring the Omron EE-SX670 24V optical slot sensor to a CP-SC input

APPENDIX H: MOTOR PART NUMBER KEY

Use the chart below to decode your ClearPath-SC part number, or visit [Teknic's website](#) and enter your motor part number into the search tool for complete information including specifications, torque-speed curves, and links to drawings and documentation.

Example
Part Number

C P M - S C H P - N 1 4 3 1 P - E L N A

1 2 3 4 5 6 7 8 9

1	Product ID	CPM	ClearPath® Motor
2	Family/Model	SDSK	Step & Direction / "Stepper Killer" (2-3x the power of similarly sized steppers)
		SDHP	Step & Direction / High Power model (8-15x the power of similarly sized steppers)
		MCVC	Motion Controller / Velocity, Torque, 2 Position Modes
		MCPV	Motion Controller / Position, Velocity, Torque Modes
		SCSK	Software Control / "Stepper Killer" (3x the power of similarly sized steppers)
		SCHP	Software Control / High Power model (8-15x the power of similarly sized steppers)
3	Frame/Shaft Diameter	N056	NEMA 56 frame with 5/8" shaft diameter
		N143/145	NEMA 143/145 frame with 7/8" shaft diameter
		D100	IEC D100 frame with 28mm shaft diameter, endbell adapter plate
4	Torque-Speed Characteristic	1	Indicates specific winding design. See your motor's torque-speed curve for more information.
		2	
		3	
		4	
		5	
5	Winding	P	Parallel wound
6	Enhanced Options	R	Positioning Resolution = 4000 counts per revolution
		E	Positioning Resolution = 32000 counts per revolution. Note: Encoder resolution is limited to 8000 counts per rev when using Step & Direction in Enhanced Mode.
7	Shaft Option	L	Standard
8	Shaft Seal	N	Standard dust sealing
		S	Extra PTFE infused polyimide seal
9	Feature Set <i>SC Models Only</i>	B	Basic features; see list below.
		A	Advanced features; see list below.

Basic Features-SC models only

Velocity moves
Global torque limit
HardStop foldback (homing)
Trapezoidal moves
Node stops / e-stops
Reading and modifying positions
RAS™ (jerk limiting)
Status register
Warning and alert system
Parameter memory
Safety shutdowns
Soft limits
User defined data
Automatic brake coil control
Group shutdowns

Advanced Features-SC models only (Includes all Basic Features)

RAS™ & q-Stop™ (jerk limiting & vibration suppression)
Positive and Negative torque limiting
Triggered moves (on input or command, including move groups)
Head-tail moves
Asymmetric moves
A-after-start event generation
B-before-end event generation
Conditional torque limiting
Attention generation
Position capture

APPENDIX I: LOGIC POWER SUPPLY SIZING

This section was designed to help users estimate how much power (wattage) to specify when selecting a logic power supply for a ClearPath system. The logic supply is typically 24VDC (nominal).

The worksheet below lists the power rating of ClearPath "logic power" system components. Space is provided for calculation of total estimated power usage for any combination of these components.

Additional Notes

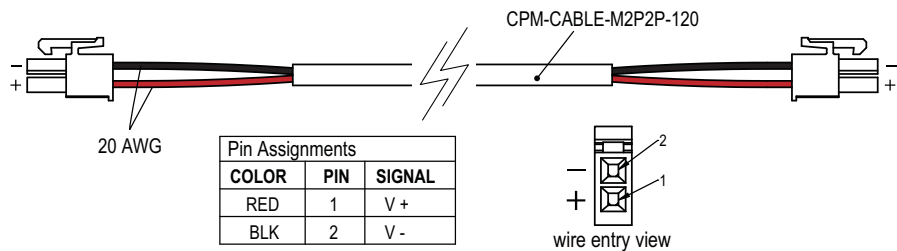
- Your ClearPath system may not include all of the components listed below.
- The topic of main DC bus power is not discussed in this section.

Part	Power Req'd (ea)	x	Qty	=	Line Total (Watts)
SC4-HUB	5W	x		=	
Logic power backup: <i>integral</i> hp ClearPath motors (optional)	5W	x		=	
Logic power backup: <i>fractional</i> hp ClearPath motors (optional, and requires POWER4-HUB accessory)	3W	x		=	
POWER4-HUB (for fractional hp motors only, optional)	2W	x		=	
Brake/GPO (optional)	___ W	x		=	
Input Sensors (optional)	___ W	x		=	
Other	___ W	x		=	
Grand Total (Watts)					

APPENDIX J: HOW TO MAKE A 24V SUPPLY CABLE

All ClearPath-SC systems require a 24VDC supply for the SC4-HUB. The 24 VDC cable must be terminated with a 2-pin Molex connector. This appendix shows a quick, inexpensive, no crimp way to make a cable for use with a 24VDC power supply.

1. Start by acquiring a 24VDC power supply. A unit with screw terminals is easiest to wire, but almost any type of supply will do. A 1.5 amp supply will generally suffice for smaller systems (4 axes or less), but the *actual minimum current rating depends on the current draw of all devices attached to the supply (sensors, brakes, etc.)*. If you plan to provide 24VDC logic power backup to your motors from this supply, add at least 1 amp per motor.
2. Order a Teknic CPM-CABLE-M2P2P-120. This is a 120" (10-ft.), 2-pin Molex to 2-pin Molex cable as shown below.



CPM-CABLE-M2P2P-120

3. Cut the cable to the desired length. If you cut it exactly in half, you can make two five foot long cables.
4. Strip the outer jacket and conductors on the unterminated end of the cable to create flying leads.
5. Connect the flying leads to your 24VDC supply. Insulate any exposed conductors with heat shrinkable tubing, electrical tape or similar.
6. **Test DC output polarity before connecting.** Use a DMM to verify proper polarity at the DC output connector. Use the above diagram as a reference.

Teknic, Incorporated
115 Victor Heights Pkwy
Victor, NY 14564

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