CLEARPATH-IP USER MANUAL

AC INPUT, INTEGRAL HORSEPOWER

MODELS IPVC, IPHP, AND IPSK

NEMA 56, 143, AND IEC D100 FRAME SIZES

VERSION 1.11 DECEMBER 10, 2025

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TOP TIPS FOR CLEARPATH-IP USERS

These tips apply to the fractional horsepower ClearPath-IP motors covered in this document.

- ✓ **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 high-speed USB data cables to communicate with your ClearPath-IP motor and I/O HUB.
- ✓ **USB Connector Damage.** Avoid yanking, twisting, or tripping on a USB cable that is connected to a ClearPath-IP 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, see Appendix A, or connect to your motor's USB port to view exception/shutdown messages using the ClearView 3.0 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.

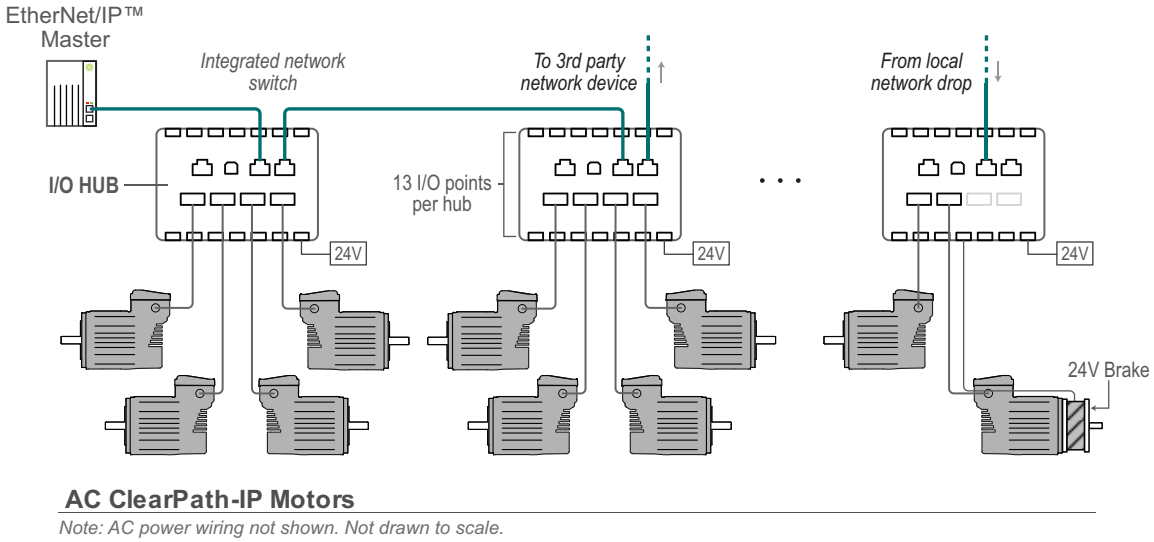
INTRODUCTION

WHAT IS CLEARPATH-IP?

ClearPath-IP is a multi-axis servo motion control and I/O system that is fully compliant with the EtherNet/IP™ communication protocol[1].

ClearPath-IP motors are brushless DC servomotors with custom rare-earth magnets, a powerful servo drive, and a high-resolution optical encoder, featuring advanced EtherNet/IP™ firmware, all in a package about the size of a typical non-integrated motor.

The I/O HUB serves as the interface between your EtherNet/IP™ network and ClearPath-IP motors. It supports up to 4 axes of motion and up to 13 points of configurable I/O. The I/O complement can include NPN and PNP limit switches, home sensors, stop sensors, analog I/O, spring-applied brakes, relays, GPIO, external encoder input and more. See your model's product information for full details.



Example ClearPath-IP network

ClearPath-IP 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 drive electronics and advanced motion control firmware bring smooth, accurate, and responsive motion to EtherNet/IP™-based automation projects.

Easy setup. Install ClearView 3.0 software, connect ClearPath to your PC via USB, and run the included auto-tune software to optimize servo performance for your mechanical system. I/O Hub setup and network configuration typically take just a few minutes. Once you're up and running, Teknic's motion AOIs (Add-On Instructions) simplify and streamline application development.

ClearView 3.0 software features an intuitive user interface that allows users to quickly change motor settings, assign I/O functions, and test

[1] EtherNet/IP™ is a trademark of ODVA, Inc.

motors and mechanics using only ClearView's built-in Move Generator and Software Scope.

Teknic's IP-Sync™ technology provides exceptionally tight motor-to-motor synchronization. Most EtherNet/IP™ networks update in the millisecond range. ClearPath-IP motors can now achieve synchronization in the 200 nanosecond range as a result of Teknic's IP-Sync technology. This feature can give machine builders a noteworthy performance advantage on high-speed, coordinated multi-axis systems.

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

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

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 a serious injury to humans and property.

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 eye[2]. These devices are extremely powerful and **dangerous if used carelessly**.

PERSONAL SAFETY WARNINGS

- Do not wear loose clothing or unconfined long hair when using ClearPath-IP motors. Remove ties, rings, watches and other jewelry before operating an unguarded motor.
- Do not operate a ClearPath-IP motor if your alertness, cognitive function, or motor skills are impaired.
- Avoid carrying a ClearPath-IP motor by its cable.
- Always understand how to use ClearPath-IP software controls and associated features before attempting to power, enable, or otherwise operate a ClearPath-IP motor.
- Install and test all emergency stop devices and controls before using ClearPath-IP.
- Before applying DC power, secure the ClearPath-IP 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-IP motor for ventilation and cable clearances.
- Do not allow cables or other loose items to drape over, or rest near the ClearPath-IP motor shaft.
- Never place fingers, hands, or other body parts on or near a powered ClearPath-IP motor.
- Thoroughly test all ClearPath-IP 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.
- The safety of any system incorporating this equipment is the responsibility of the system designers and builders.

[2] A single blink of the human eye takes between 100 and 400 milliseconds according to the *Harvard Database of Useful Biological Numbers*.

- The machine designers need to recognize and incorporate required warning symbols, guards and shields for ClearPath-IP motors that are used in applications that can result in the externally accessible parts of their machine exceeding a temperature of 65 Celsius. This is required to reduce the possibility of burns. A tool shall be required to remove any guards and/or shields.
- ClearPath-IP 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.

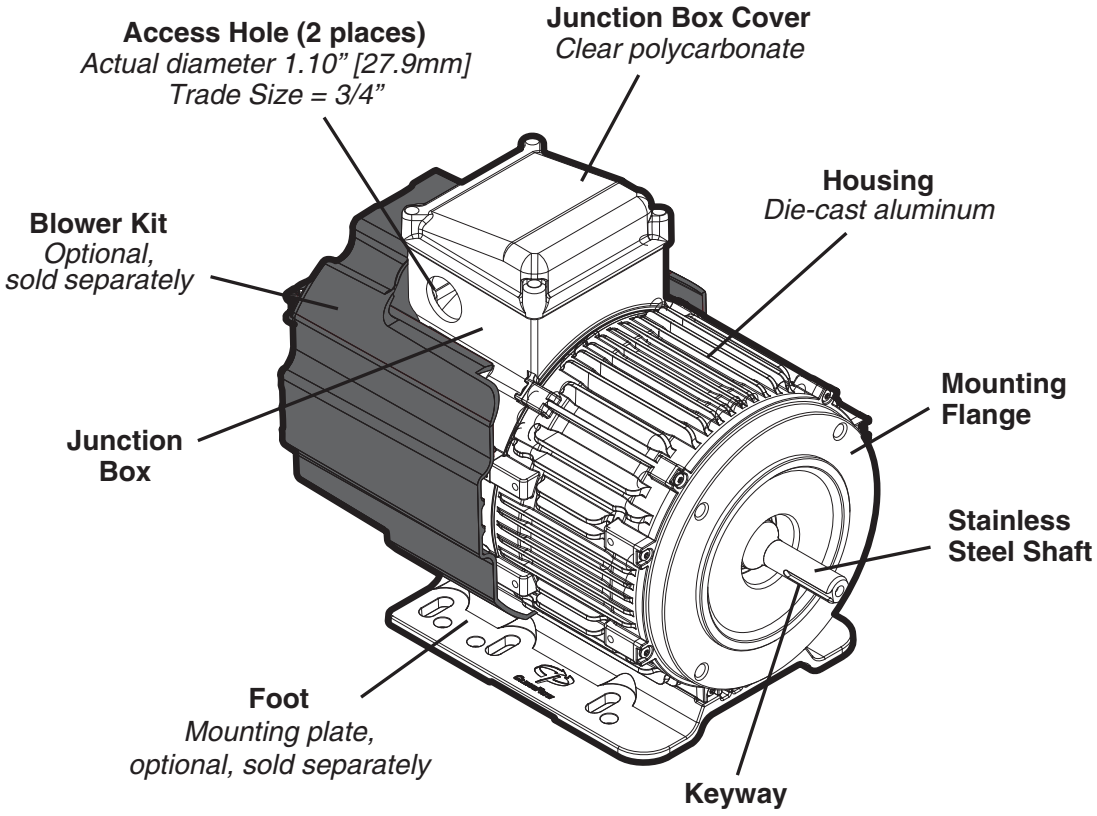
If Teknic's products are used in an application that is safety critical, the User must provide appropriate safety testing of the products, adequate safety devices, guarding, warning notices and machine-specific training to protect the operator from injury.

QUICK START GUIDE

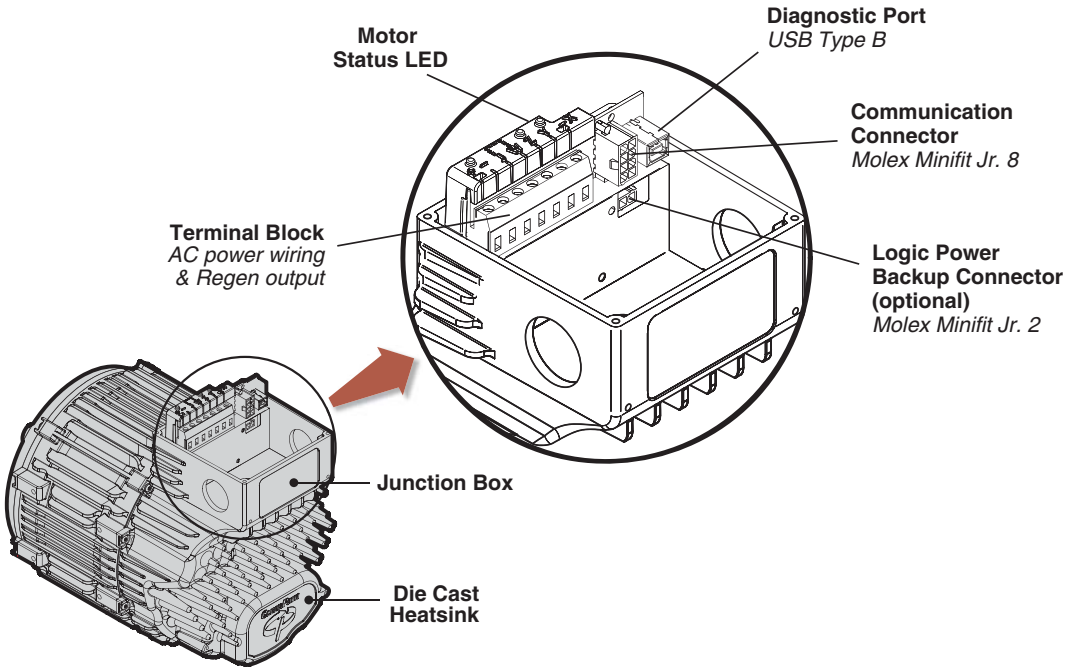
This section describes:

- Parts of a ClearPath-IP motor and I/O HUB
- ClearView 3.0 software installation
- How to establish a USB connection between a ClearPath-IP motor and PC running ClearView 3.0
- How to spin a ClearPath-IP motor using ClearView 3.0. I/O HUB setup is not discussed in this section.

PARTS OF A CLEARPATH-IP MOTOR

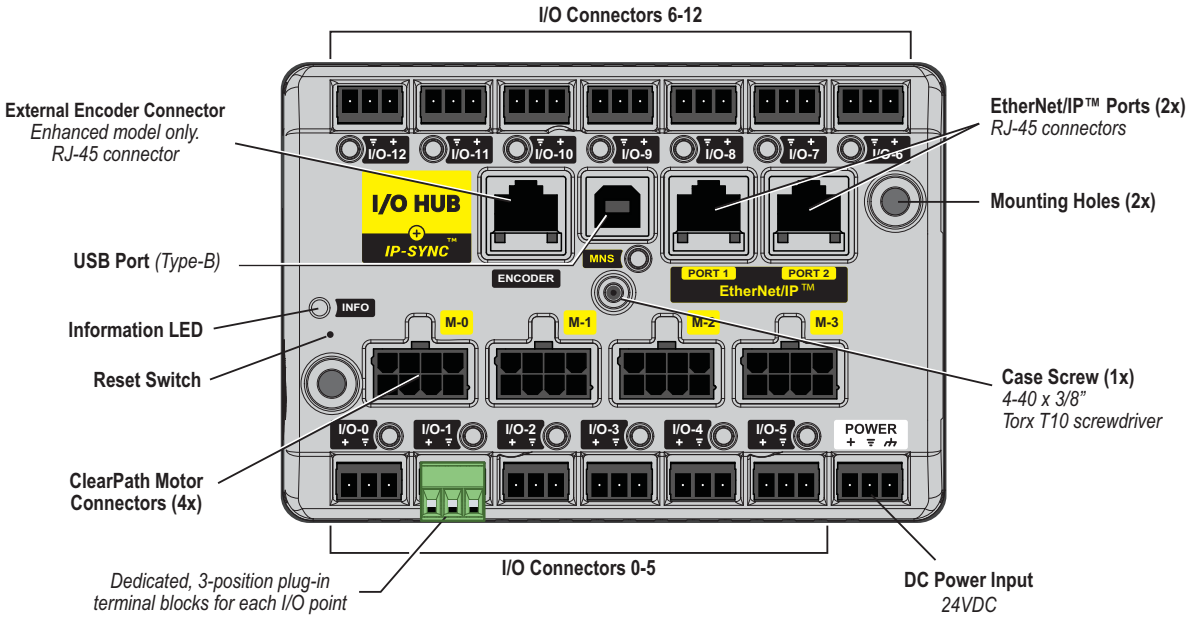


ClearPath-IP motor parts



ClearPath-IP motor junction box

PARTS OF AN I/O HUB



SYSTEM SETUP

This section describes how to bench-test a ClearPath-IP motor with ClearView 3.0 using minimal components. This includes how to apply power, establish USB communication, and spin the motor. This section *does not* describe how to set up a Master PLC or I/O HUB.

WIRE AC POWER TO THE CLEARPATH MOTOR

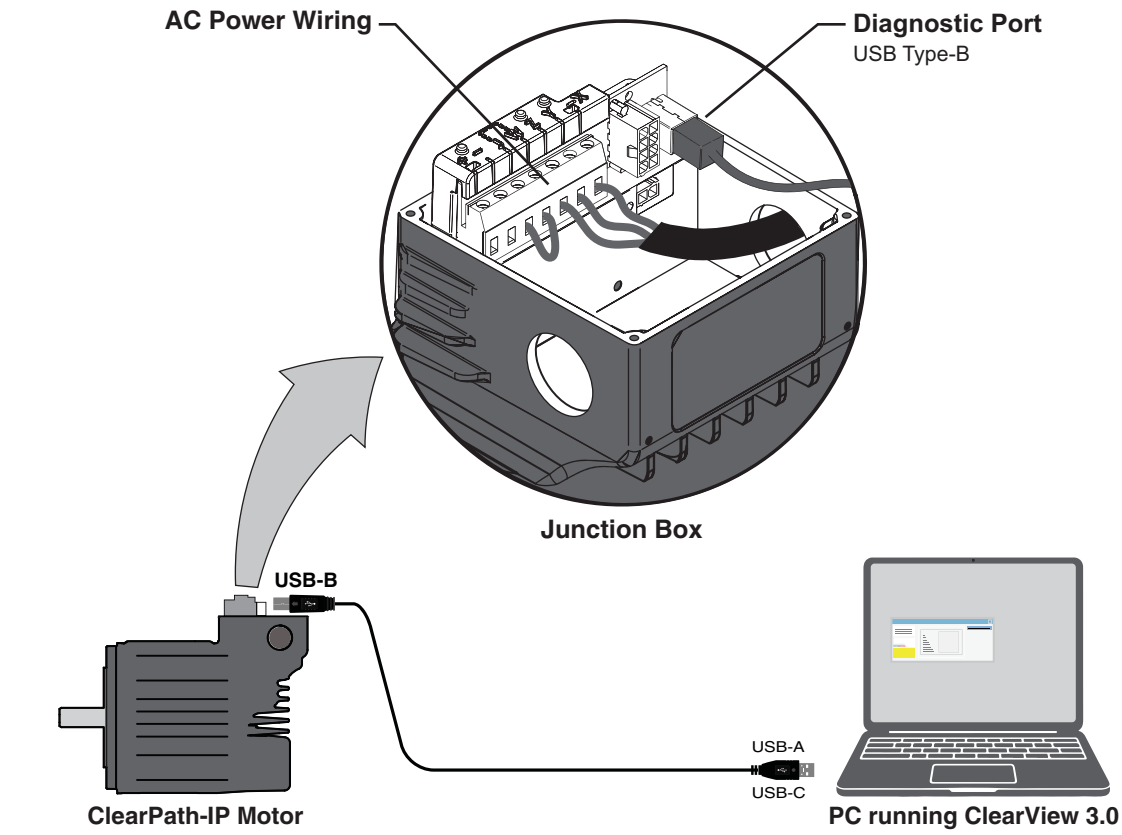
See *Wiring AC Power To ClearPath* later in this document.

INSTALL CLEARVIEW 3.0 SOFTWARE

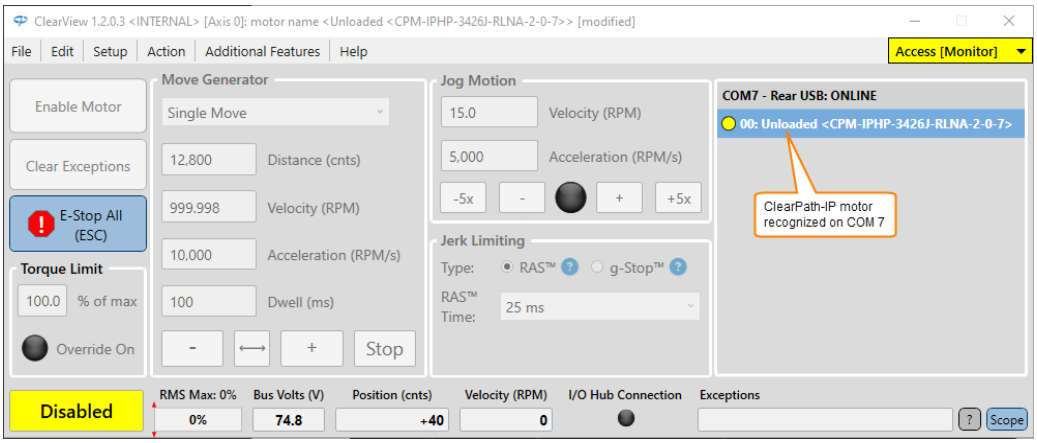
To download and install ClearView 3.0, click here, or visit https://teknic.com/downloads/.

SET UP USB COMMUNICATION

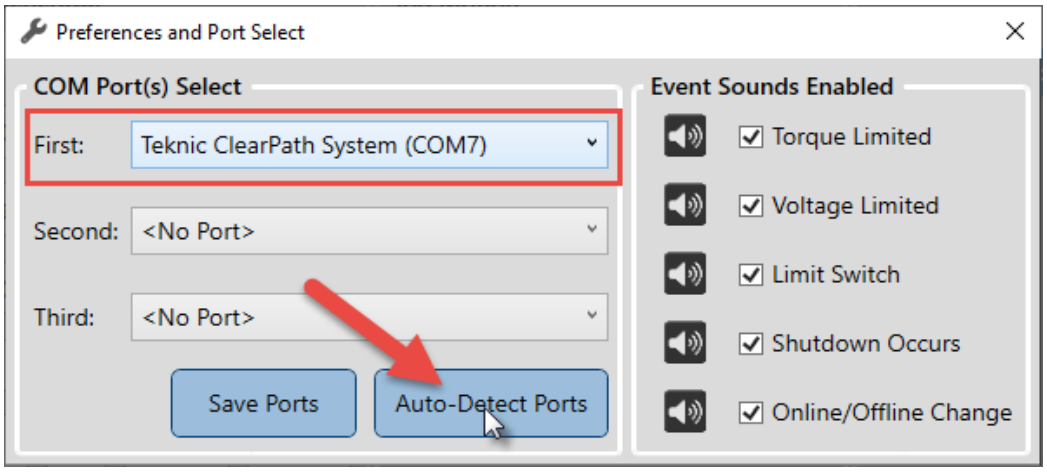
1. Connect a high-speed USB cable to the USB Diagnostic Port in the motor's junction box. Use a USB Type-B to Type-A (or Type-B to C , depending on your PC's hardware.



2. Open ClearView 3.0 software.
3. ClearView 3.0 will attempt to auto-detect your motor. Once detected, your motor will appear in the device list at right in the UI.



4. If ClearView 3.0 ***does not*** find your motor, choose *File>Preferences and Port Select* and click "Auto-Detect Ports", or use the drop down menu labeled "First" to select your motor from the list.



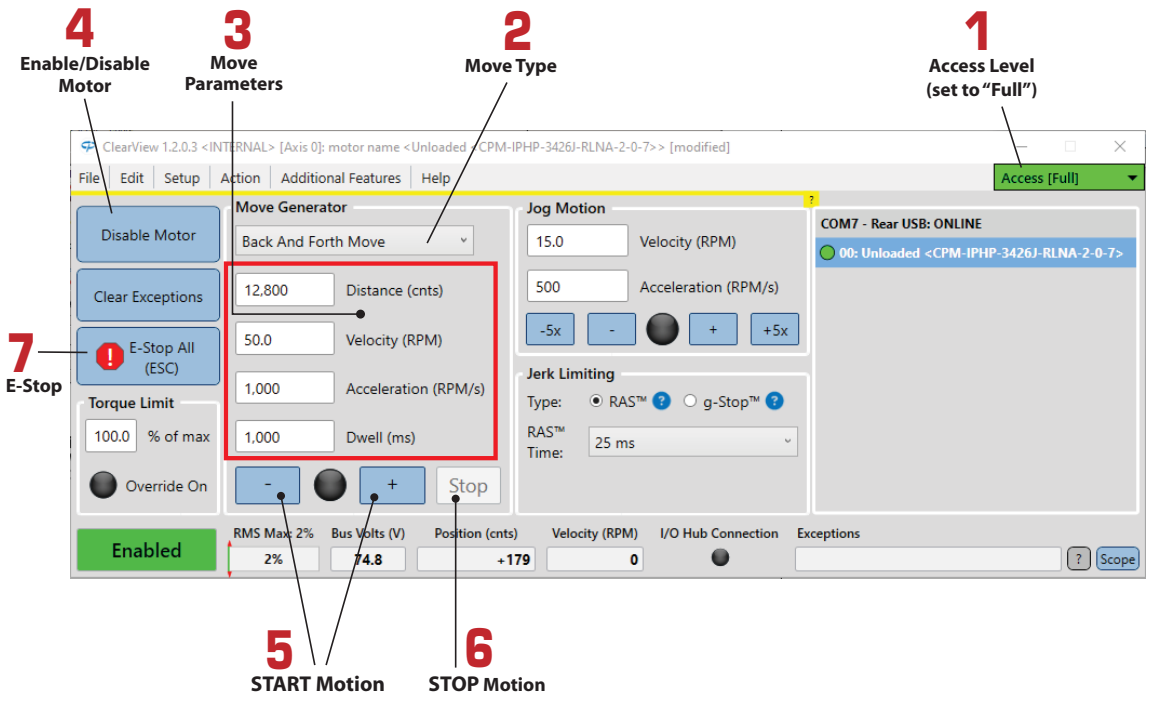
TEST SPIN YOUR CLEARPATH-IP MOTOR

Note: *This section describes how to spin an unloaded motor only.* ClearPath-IP motors ship pre-configured for *unloaded use*. **Always run the Auto-Tune application whenever you connect your motor to a different mechanical system.**

Click and spin—no PLC required. Once your system is powered up and communicating, you can take your motor for a test spin using the Move Generator controls in ClearView 3.0. Here's how:

Important: Before proceeding to #2, be sure to set the motor's AC source to single-phase or three-phase based on your actual AC wiring. In MSP, go to (***Setup > AC Source Type***).

1. Set the Access Level to "Full". The controls won't work otherwise. Tip: Remember to set the Access Level back to "Monitor" before commanding motion through a Master/Scanner.
2. Select a Move Type. Choose from: Back and Forth, Single, or Repeating Moves.
3. Enter the Move Parameters: Distance, Velocity, Acceleration, and Dwell (Dwell is the rest period between repeating moves).
4. Click Enable/Disable button once to enable the motor.
5. Click "Start Motion" (+ or -) button. Use "+" to start motion in the CCW direction (looking into the motor shaft). Use "-" to start motion in the CW 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 Esc key to stop motion immediately.



ClearView 3.0 Main UI

POWERING CLEARPATH-IP MOTORS

BEFORE WIRING 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 (more common in Europe).
- **277/480 VAC is not compatible with ClearPath-IP motors.** Wiring this voltage to the motor will result in a motor overvoltage shutdown.

TOOLS AND SUPPLIES

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).
- #10 ring terminal, 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. For most installations, 14–16 AWG wire is appropriate; 12 AWG is the largest size that fits in the terminal block. The ground conductor must be the same gauge or larger 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.

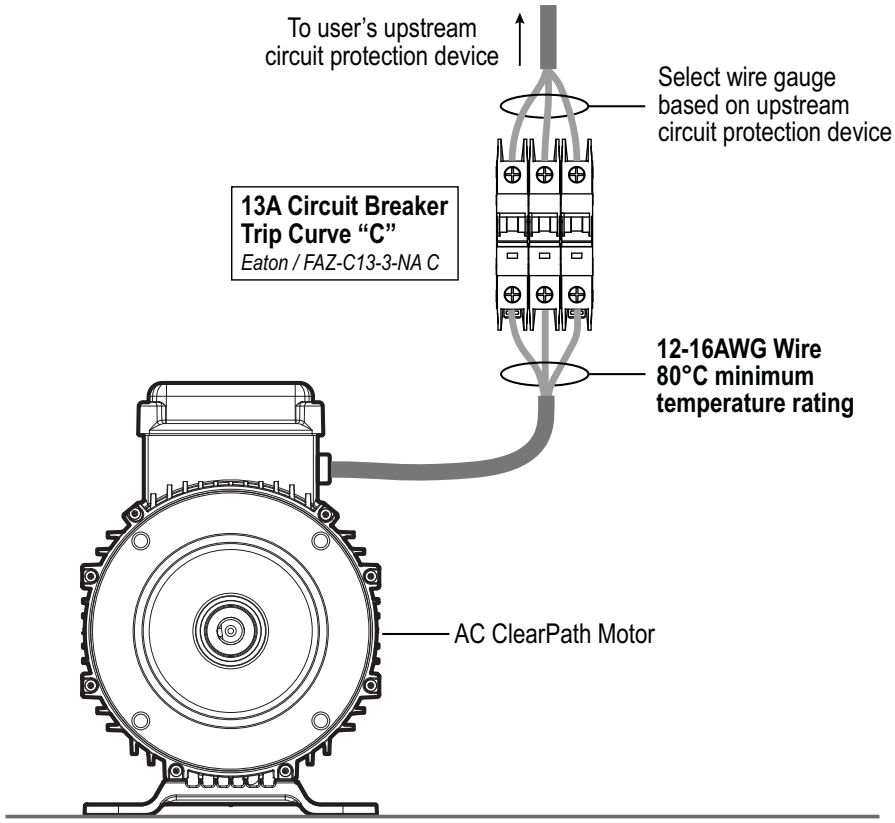
Teknic recommends the following breaker for most AC ClearPath applications. Other circuit breaker manufacturers may offer equivalent products.

Recommended Circuit Breaker

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

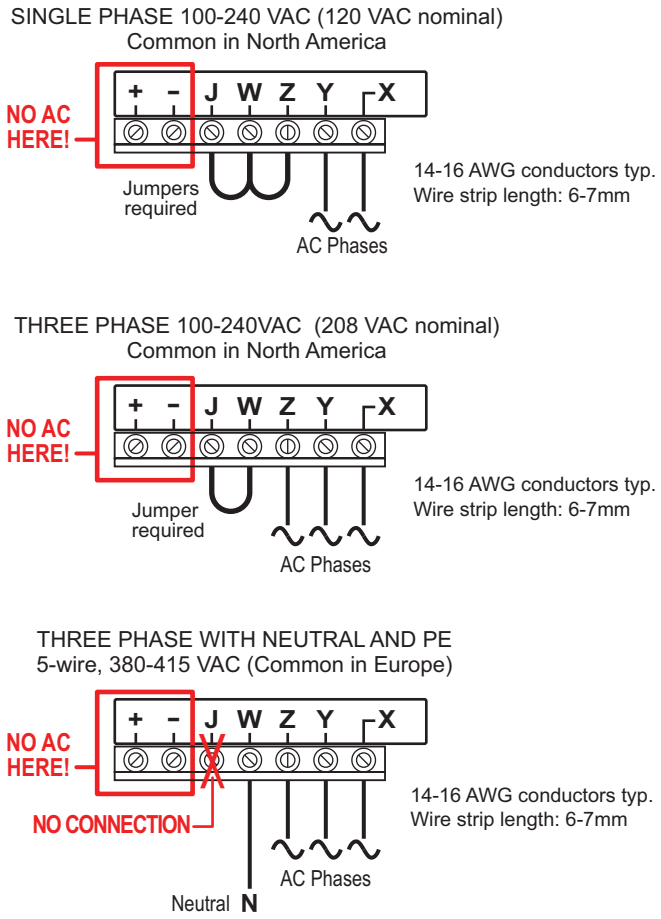
Description: Eaton miniature circuit breaker, current-limiting, 13 amp, 480Y / 277 VAC / 3-pole, C trip curve, thermal magnetic, 10kA SCCR, 35mm DIN rail mount. This product is UL 489 rated and available at Automation Direct as of this writing.

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



AC ClearPath Wiring Diagrams

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 cord grip that is dust tight at minimum.
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 jumper wire(s). See wiring diagrams to determine if you need jumpers. **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*[3] 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: PV12-10HDRB-2K (12-16 AWG)

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

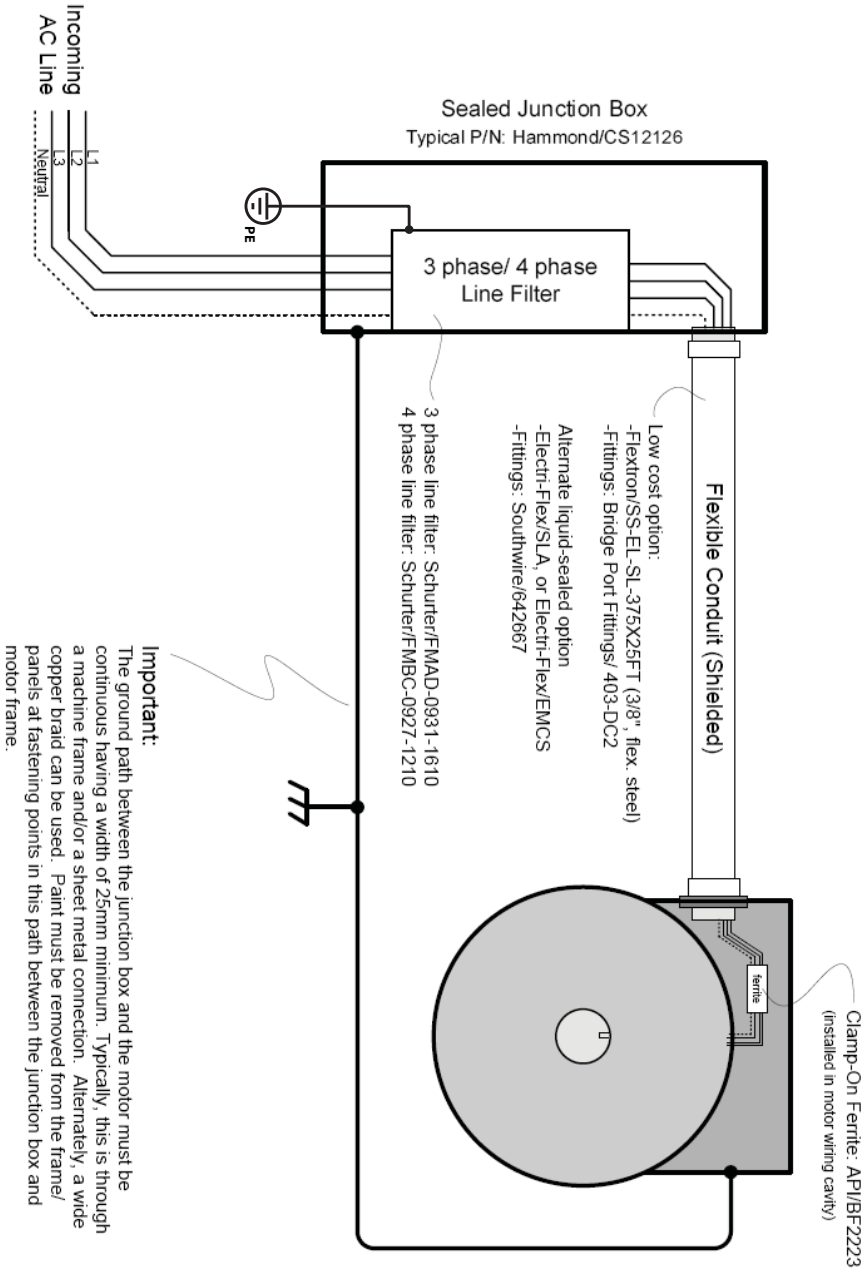
   TE AMP Connectors part number: 36160 (16-14 AWG)

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.

[3] 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. Copper wire should not directly touch the aluminum housing.

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 connect a 24 VDC logic power backup supply to your ClearPath motor to keep its processor and control electronics powered during an AC power loss.

LOGIC POWER BACKUP SUPPLY REQUIREMENTS

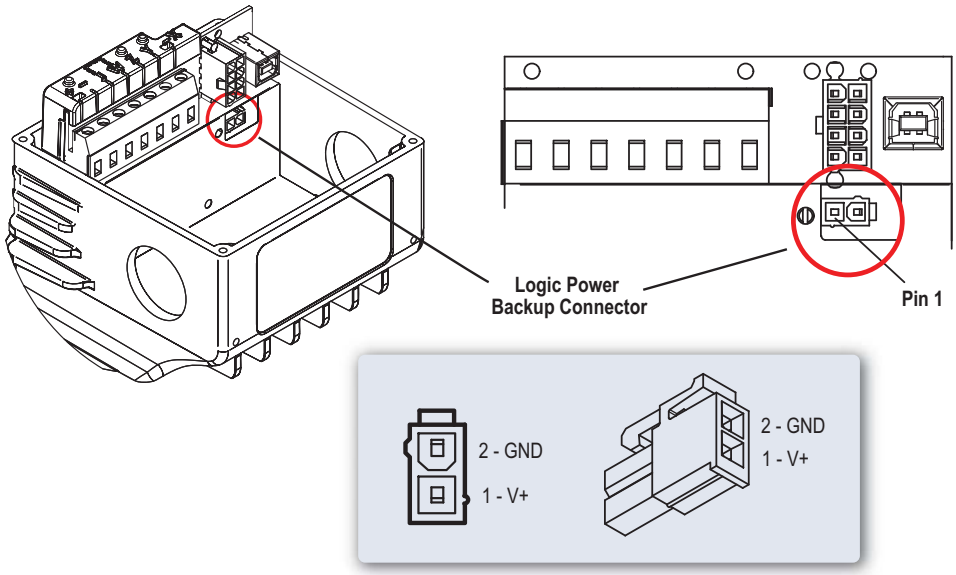
- Voltage: 24VDC nominal. Min/max: 20-28VDC
- Power consumption: 5W per motor.

LOGIC POWER BACKUP CONNECTOR

Connect the logic power backup supply to the 2-pin Molex connector inside the motor junction box.

Connector part numbers and recommended tools are listed below.

For instructions on how to make an inexpensive logic power backup cable, see *How to Make an Inexpensive Logic Power Backup Cable*.

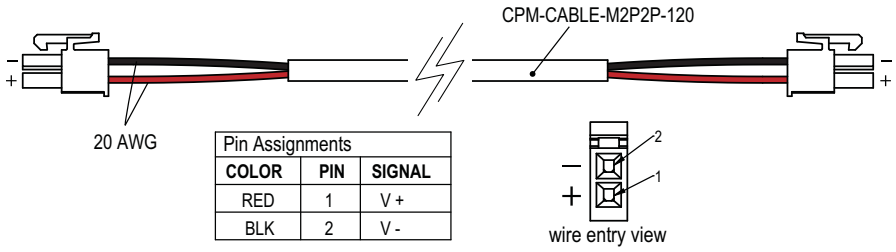


Ref.	Description	Mating Connector PN	Terminal PN	Terminal Desc.	Crimp Tool	Extraction Tool	Recommended Wire Gauge **
A	Molex MiniFit-Jr, Receptacle, 2 circuits	39-01-2020 (natural, UL 94V-2) 39-01-3025 (black, UL 94V-2) 39-01-3028 (natural, UL 94V-0) 39-03-9022 (black, UL 94V-0)	39-00-0059 (reel) 39-00-0060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

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.

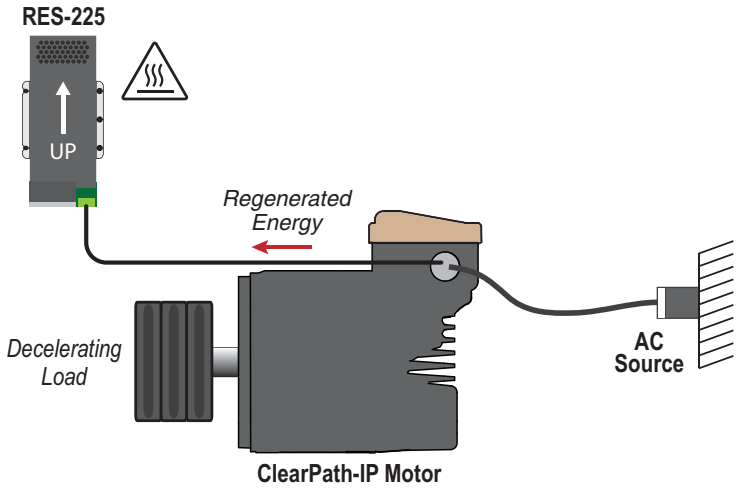


CPM-CABLE-M2P2P-120

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 REGENERATED ENERGY SHUNT

The optional **RES-225** (Regenerated Energy Shunt) monitors and manages regenerated energy at the motor, safely dissipating excess energy through a controlled resistor to prevent DC bus overvoltage shutdowns.



RES-225 and ClearPath-IP motor

SAFETY INFORMATION

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 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.

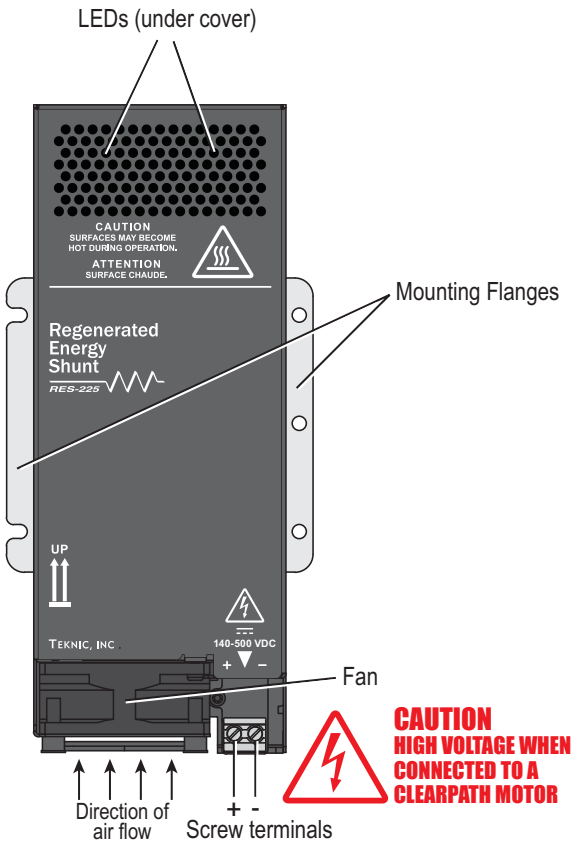
No user serviceable parts inside. Do not open case or attempt to service this product. Contact Teknic for service.

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 417 VDC; energy dump turns off below 400 VDC.
- 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.
- 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) this product is protected by a UL Listed internal fuse.

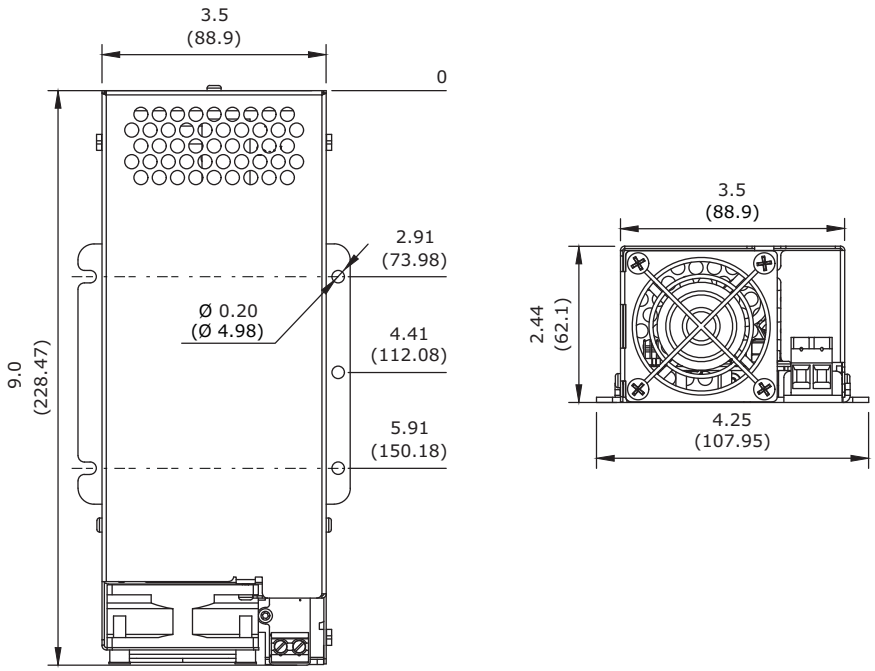
PARTS OF AN RES-225



RES-225 Parts

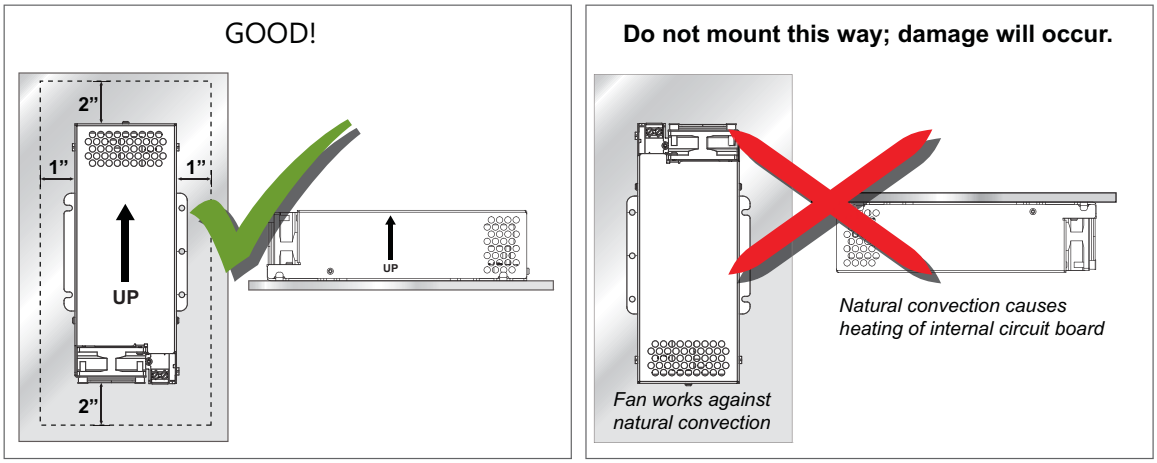
MECHANICAL/MOUNTING INFORMATION

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.

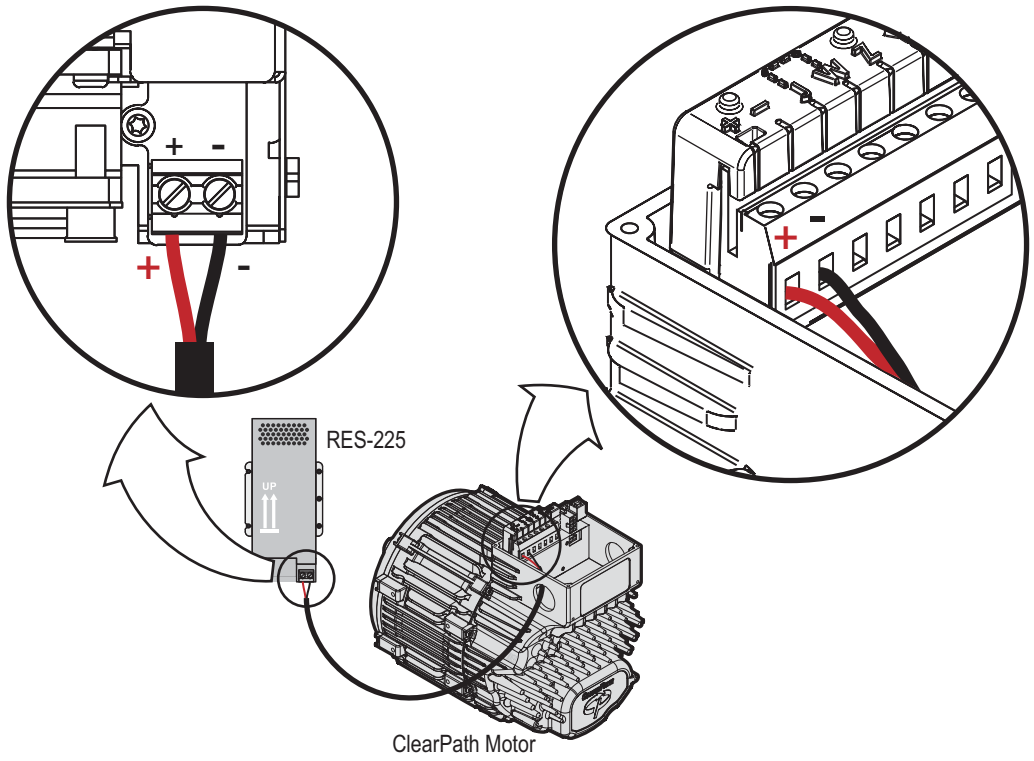
- Leave a minimum of 1" clearance around the unit, 2" clearance at ends.

WIRING RES-225 TO A 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 FAQ

What is “regen”?

All electric motors—DC brush, brushless, induction, stepper, and servo—generate a reverse voltage when producing torque opposite the direction of motion, especially during rapid deceleration. This reverse voltage is called back-EMF, regenerated energy, or simply “regen.”

Unmanaged, regenerated energy may raise the drive’s DC bus voltage enough to trigger an overvoltage shutdown.

How does the RES-225 work?

Under microprocessor control, the RES-225 detects excess regenerated energy and diverts it to a fan-cooled power resistor, where it is safely dissipated as heat.

At what voltage will the RES-225 turn on and turn off?

The RES-225 will turn on at 417 VDC and turn off at 400VDC.

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 often dissipate enough energy to prevent overvoltage events. VRS is a standard feature of all ClearPath motors. It is turned on or off via a checkbox in ClearView.

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

How much regen will my motor produce?

We get this question a lot, and it's a good one. Because there are many electromechanical and motion-related factors, accurately predicting how regenerated energy will affect a given motion system is impractical.

The quickest way to figure out how much regen your motor will produce is to install it on the actual machine, fully loaded, and run test moves that mirror real life operation. If during test moves, the motor experiences overvoltage shutdowns you may need an RES-225.

Tip: ClearView's built-in software scope, set to display Bus Voltage, can help you determine if your motor is experiencing overvoltage shutdowns due to regen.

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.

I/O HUB

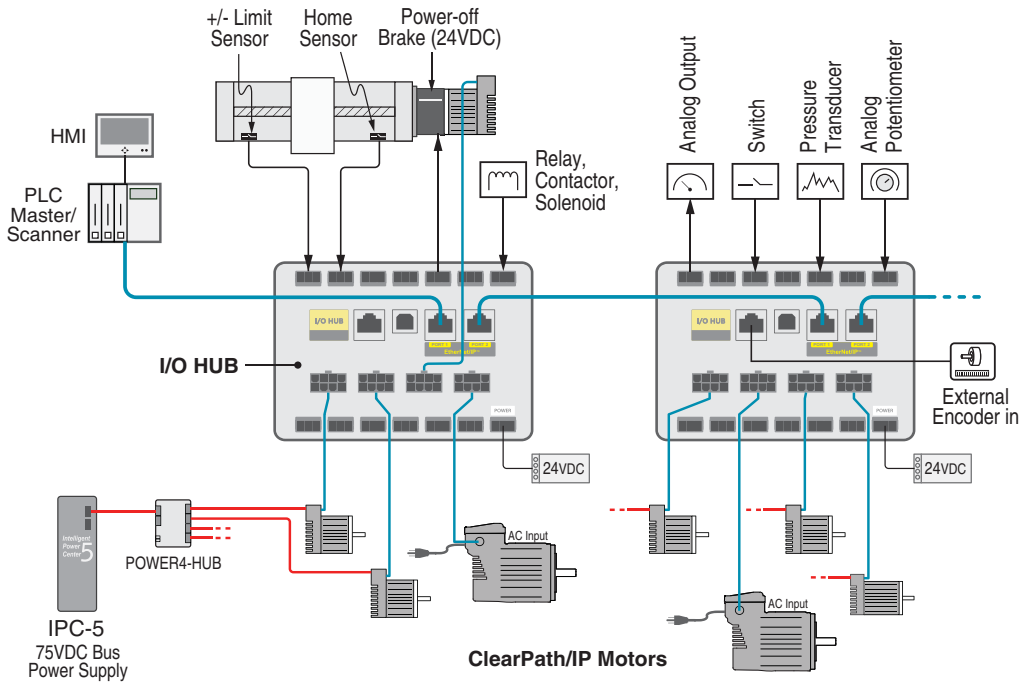
INTRODUCTION

The **I/O HUB** serves as both the EtherNet/IP™ communication interface and the I/O and motor connection hub for ClearPath-IP systems. Each hub appears as a single device on the EtherNet/IP™ network and can support two or four ClearPath-IP motors, depending on the model.

Each I/O HUB has a built-in two-port Ethernet switch. This enables multiple hubs to be daisy-chained or connected directly to existing network drops and switches.

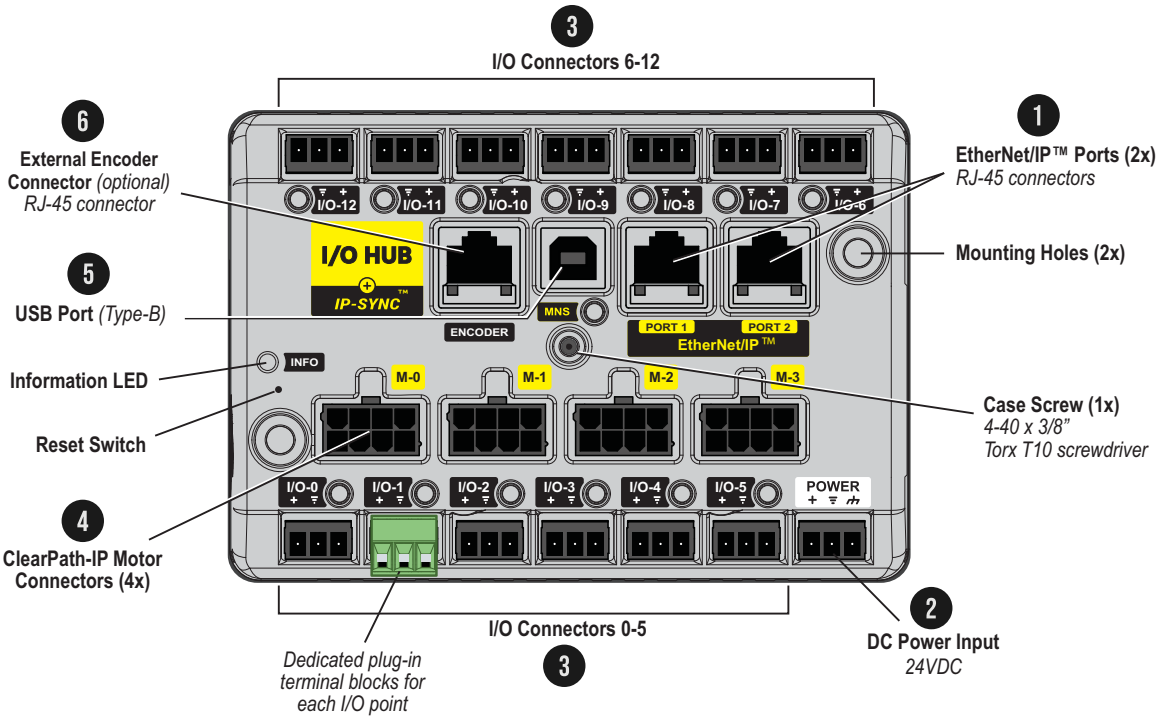
The I/O HUB directly interfaces with:

- EtherNet/IP™ Master/Scanner
- ClearPath-IP motors (2 or 4 depending on model)
- Input devices, such as sensors, switches, brakes, potentiometers, etc.
- Output devices, such as brakes, LED indicators, etc.
- A PC, via USB, for setup and configuration tasks



I/O HUBs in a ClearPath-IP system

PARTS OF AN I/O HUB



I/O HUB with callouts

MAIN CONNECTORS

1) EtherNet/IP™ Ports (2x) - Connect your EtherNet/IP™ network to either of these RJ-45 connectors, or make use of the built-in switch feature to daisy-chain I/O HUBs or to connect other network devices. **Note:** always use CAT-5e cable or better.

2) Power Input Connector - Connect 24VDC power to this 3-position connector. See *Powering an I/O HUB* later in this section. Note: I/O HUBs can be powered from lower voltages (down to 12VDC), but 24VDC is the most common supply voltage used for this product.

3) I/O Connectors - There are 13 3-position I/O connectors that can support simple switches, NPN and PNP sensors, analog I/O, spring-applied brakes, relays, GPIO, external encoder input and more[4].

4) ClearPath-IP Motor Connectors - Connect your ClearPath-IP motors here. The required cable is a straight-through, 8-pin to 8-pin Molex MiniFit Jr. cable.

5) USB Port - Connect your PC running ClearView 3.0 to this USB-B connector for I/O HUB setup and configuration tasks. Use only high quality, data-rated USB cables.

6) External Encoder Connector - *(Applies to IO-HUB-4-E only)* Connect an optional third-party 5V differential encoder to this standard RJ-45 connector. Courtesy 5V power is provided at connector.

[4] Check your I/O HUB model for supported features.

I/O HUB MODELS AND FEATURES

Teknic offers three I/O HUB models with different motor and I/O capabilities. See model descriptions and features by model for details.

Note: The last two characters in an I/O HUB model number indicate the number of motors the model supports, 2 or 4, and the type of I/O available, -E or -R.

I/O HUB MODEL NUMBERS

IO-HUB-2-R supports up to 2 CPM-IP motors, and R ***(Motor I/O)*** functionality.

IO-HUB-4-R supports up to 4 CPM-IP motors and R ***(Motor I/O)*** functionality.

IO-HUB-4-E supports all features. This includes R ***(Motor I/O)*** and E ***(Enhanced I/O)*** functionality.

TABLE OF I/O HUB FEATURES BY MODEL

Note: Model IO-HUB-4-E supports four motors and all I/O HUB features.

Table Key

ALL = Feature available on **ALL** I/O HUB models.

2R = Feature available on IO-HUB-2-R.

4R = Feature available on IO-HUB-4-R.

4E = Feature available on IO-HUB-4-E.

Connector Name	Digital Inputs		Digital Outputs		Analog Inputs	Analog Output	ClearPath-IP Motors	Encoder Input
	Motor I/O	GPIO	Motor I/O	GPIO PWM Capable				
I/O-0	ALL	4E	ALL	4E	4E			
I/O-1	ALL	4E	ALL	4E	4E			
I/O-2	ALL	4E	ALL	4E	4E			
I/O-3	ALL	4E	ALL	4E	4E			
I/O-4	ALL	4E	ALL	4E	4E			
I/O-5	ALL	4E	ALL	4E	4E			
I/O-6	ALL	4E	ALL	4E	4E			
I/O-7	ALL	4E	ALL	4E	4E			
I/O-8	ALL	4E	ALL	4E	4E			
I/O-9	ALL	4E	ALL	4E	4E			
I/O-10	ALL	4E	ALL	4E	4E			
I/O-11	ALL	4E	ALL	4E	4E			
I/O-12	ALL	4E			4E	4E		
M-0							ALL	
M-1							ALL	
M-2							4R, 4E	
M-3							4R, 4E	
ENCODER								4E

"MOTOR I/O" (ALL MODELS)

The Motor I/O type lets you assign I/O devices such as sensors, switches, or brakes to predefined motion-related functions.

Each Motor I/O function can be assigned to any available I/O point and then mapped to a specific motor connected to the I/O HUB. Motor and I/O configuration is done using either ClearView 3.0 or programmatically through the Master controller.

Motor I/O points may be assigned to any of these predefined functions:

- Positive Limit Input
- Negative Limit Input
- Home Switch Input
- Stop Switch Input
- Position Capture Input
- Brake Output

Note: *Motor I/O is not general-purpose I/O (GPIO).* The Master/Scanner cannot directly read or write to Motor I/O points. Only the Enhanced I/O HUB model supports GPIO functionality.

How to configure Motor I/O in ClearView 3.0

1. Connect the I/O HUB to your PC running ClearView 3.0 via the USB port.
2. Set the I/O HUB to **Full Access** mode.
3. Click on the desired motor connector from the UI graphic (**M-0, or M-1** for example).
4. Click **Configure** to open the Motor Configuration window.
5. Decide which Motor I/O function you want to configure (for example, **Positive Limit**).
6. Next to the [Positive Limit] function, select the desired I/O connector from the I/O Point dropdown list (**I/O-1** for example).
7. Select the device type from the **Configuration** dropdown list (e.g., Switch, NPN, PNP).
8. Select the Trigger On behavior. This defines the condition under which the I/O point is considered asserted.

"ENHANCED I/O" (-E)

The Enhanced I/O Model (IO-HUB-4-E):

- Supports all -R (Motor I/O) functions.
- Supports general-purpose I/O (GPIO) in any combination up to:
  - 13 digital inputs
  - 12 digital outputs (PWM capable)
  - 13 analog inputs
  - 1 analog output on I/O-12 only (4-20mA or 0-20mA)
- **External Encoder Input** - The I/O HUB features one dedicated RJ-45 encoder input port.

  Note: To be compatible, third-party encoders must support differential RS-422 quadrature signals to channels A and B; an optional index channel is also supported. The Encoder port provides 5VDC@300mA courtesy power.

Enhanced I/O points can be read and written by the Master controller. Configuration is performed through ClearView 3.0, or programmatically through the Master/Scanner.

How to configure Enhanced I/O in ClearView 3.0

1. Connect the I/O HUB to your PC running ClearView 3.0 via the USB port.
2. Set the I/O HUB to **Full Access** mode.
3. Click on the desired I/O connector from the UI graphic (**I/O-0, or I/O-1,** for example).
4. From the center drop-down list, select an I/O configuration (for example, Digital Input).
5. Select the appropriate Input or Output Wiring Option from the drop-down list (for example Switch, NPN, or PNP device).
6. Configure any additional settings in the setup dialog to complete the configuration process.

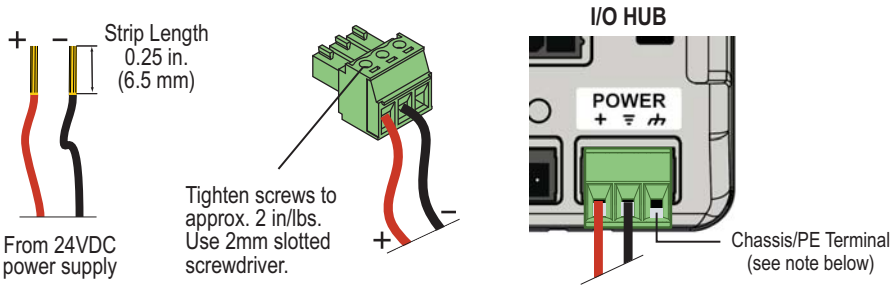
POWERING AN I/O HUB

TOOLS AND PARTS REQUIRED:

- **Power supply (24VDC[5]).** The minimum required wattage depends on the total power draw of all connected devices. See the I/O HUB specifications for details.
- **Slotted screwdriver.** A 2 mm blade is recommended.
- **Wire cutter/stripper.**
- **Connectors:** Three-position Molex P/N 0395105003. These connectors are available at Teknic.com. Order PN CC-3TERM-PLUG-10PC.

WIRING INSTRUCTIONS

1. Turn off power supply.
2. Strip positive and negative wires coming from the power supply. Strip length: 0.25" (6.5 mm).
3. Insert wires into terminal block as shown below.
4. Tighten terminal screws.
5. Visually inspect the connector for good wire capture. Verify that no wire insulation is captured in the closure, and that no loose wire strands are present.
6. Recommended: Before connecting the terminal block to the I/O HUB, test for correct voltage polarity between "+" and ground terminals.



Chassis Connection: If direct mounting to a PE-bonded chassis is not possible, connect the chassis terminal to a nearby PE-bonded point on the machine. Use uncoated, conductive hardware, and ensure the connection is made to an uncoated, conductive part of the chassis close to the I/O HUB.

[5] The recommended supply voltage for the I/O HUB is 24VDC. The hub can also operate with supply voltages as low as 12VDC; however, when using a lower voltage supply (e.g., 12VDC), use only I/O devices rated for that voltage.

TEKNIC 24VDC POWER SUPPLY

The **PWR-IO-24VDC power supply** (Mean Well PN LRS-150-24) is an inexpensive, 24VDC, 6.5A (156W) switching supply capable of powering most ClearPath-IP and I/O HUB applications.

Product Datasheet

Installation Information

Application Note: A higher-current power supply may seem excessive for an I/O HUB application, but it helps ensure that the processor remains powered under adverse conditions, such as overloads or shorts. It also provides overhead for future expansion if additional I/O devices are added. Lower-current supplies, in some cases, may experience shutdowns or brownouts when the I/O HUB is overloaded or shorted.

SETTING THE I/O HUB'S IP ADDRESS

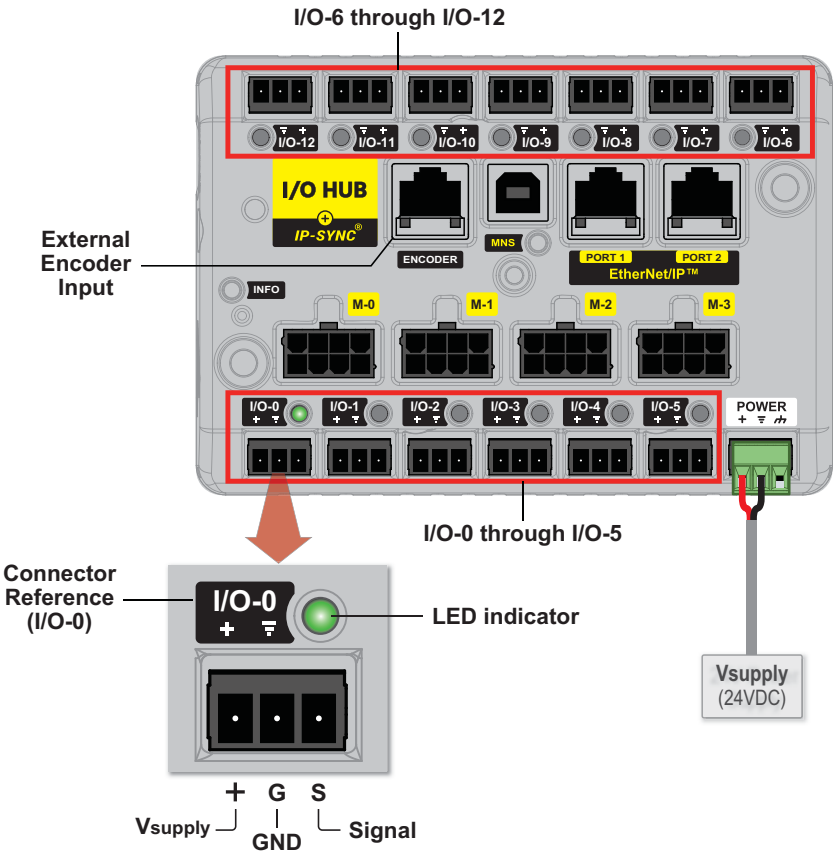
1. Apply power to the I/O HUB.
2. Open ClearView 3.0.
3. Connect a USB cable from your computer to the USB port on the I/O HUB. The I/O HUB will show up in ClearView's Device List. **Note:** Use a high speed, data-rated USB cable.
4. Set the I/O HUB Access Level to "Full". Access Level settings are located at upper right of the ClearView 3.0 UI.
5. Plug your network cable into Port 1 or Port 2 of the I/O HUB.
6. Click the "Edit Network Settings..." button at bottom of UI; or, choose *Setup>Edit Network Settings...* from the main menu.
7. Follow the instructions in the Network Settings dialog window to configure for DHCP or Static IP settings.

I/O WIRING

This section contains hookup diagrams and wiring details for connecting common I/O devices to an I/O HUB.

Note: 24VDC is the recommended supply voltage for an I/O HUB; however, I/O HUBs will operate properly at lower voltages; 12VDC is the practical minimum.

DAMAGE WARNING: Never apply an external voltage higher than your chosen V_{supply} to any I/O point on the I/O HUB. Doing so will damage the hub's circuitry.

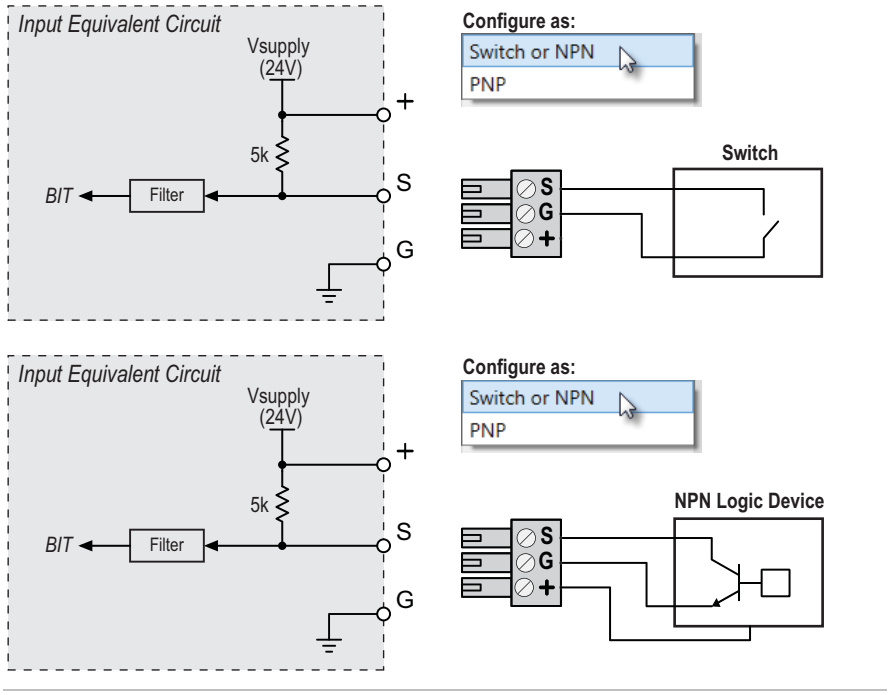


I/O HUB with enlarged view of I/O-0

DIGITAL INPUTS: SWITCHES, NPN LOGIC DEVICES

Supported I/O HUB models

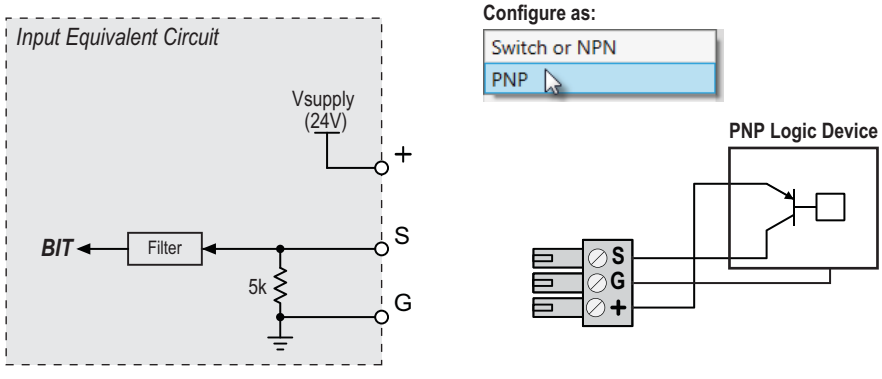
- IO-HUB-2-R
- IO-HUB-4-R
- IO-HUB-4-E



DIGITAL INPUTS: PNP LOGIC DEVICES

Supported I/O HUB models

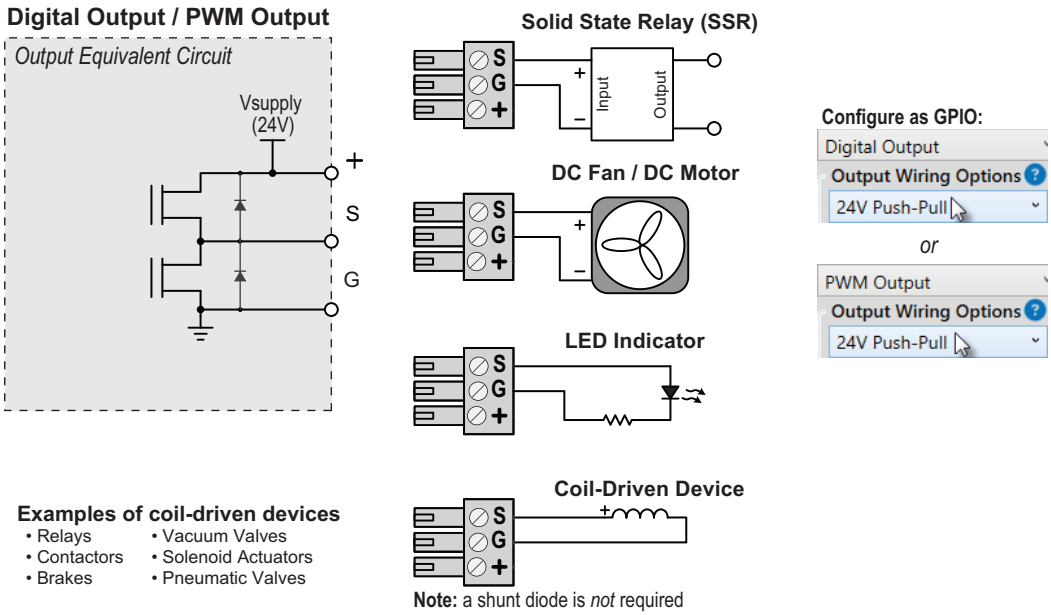
- IO-HUB-2-R
- IO-HUB-4-R
- IO-HUB-4-E



DIGITAL OUTPUTS: GPIO (PUSH-PULL, PWM)

Supported models:

- IO-HUB-4-E

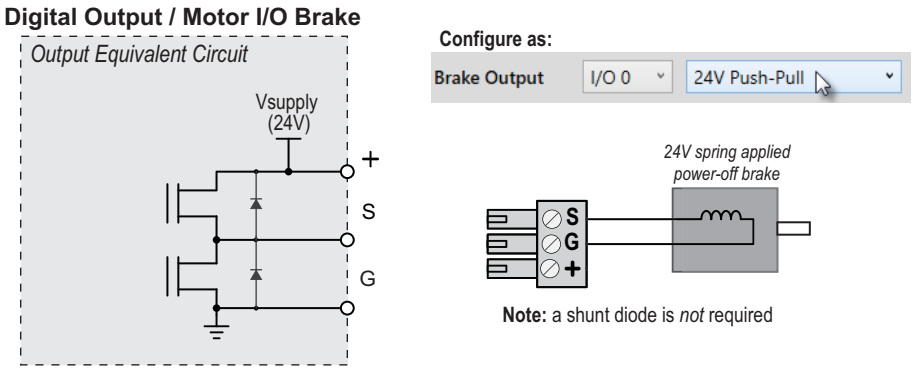


DIGITAL OUTPUTS: MOTOR I/O (BRAKE OUTPUT)

When configured as *Motor I/O*, this output serves as a pre-programmed brake output.

Supported models

- IO-HUB-2-R
- IO-HUB-4-R
- IO-HUB-4-E



DIGITAL OUTPUTS: OPEN-COLLECTOR (3.3V AND 5V INPUTS)

Supported I/O HUB models:

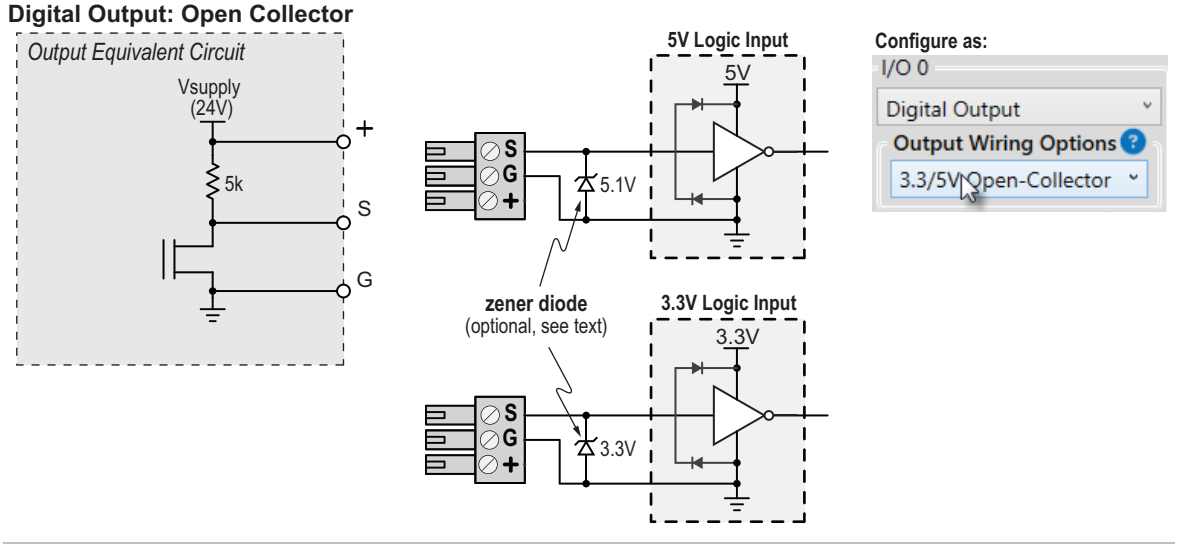
- IO-HUB-4-E

Digital Output Open-Collector mode allows you to connect I/O HUB outputs directly to lower voltage logic inputs, such as a 5V or 3.3V logic inputs.

Damage Warning: Use 3.3/5V Open Collector Output mode only. Do not use *Push-Pull mode*.

Application Notes

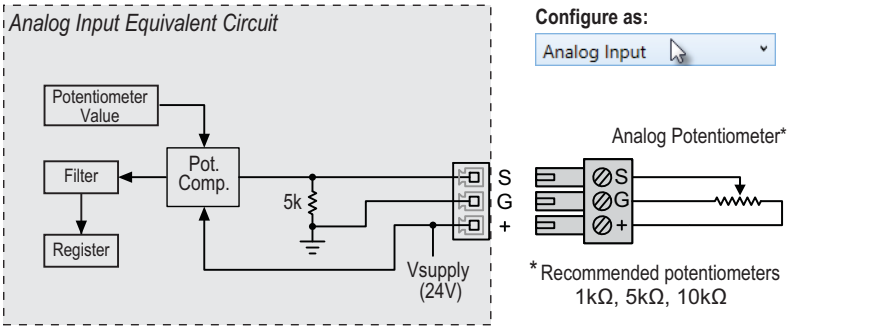
- Lower-voltage inputs may include internal protection circuitry to clamp the signal voltage to a safe level. If such protection is not present, the input can be damaged by direct connection to 24V. Check the manufacturer's documentation if you are unsure.
- Install a **zener diode** if the logic input cannot safely tolerate a 24V open-collector output (or if you aren't sure). Select a standard zener diode with zener voltage close to the input's nominal logic level. Use a 5.1V zener for 5V logic inputs; use a 3.3V zener for 3.3V inputs. See figure below for zener placement information.
- Even with a zener diode installed for voltage limiting, the I/O HUB output **must be configured for Open-Collector mode**.

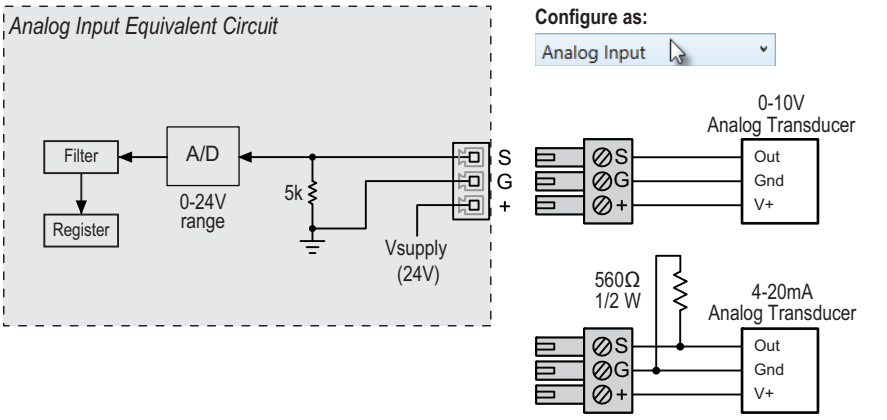


ANALOG INPUTS: POTENTIOMETER, TRANSDUCER

Supported I/O HUB models

- IO-HUB-4-E



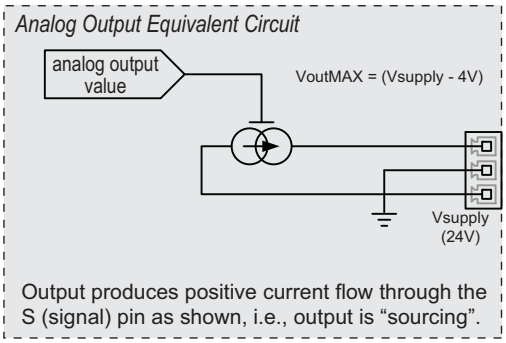


Note: *Place shunt resistor close to terminal block.*

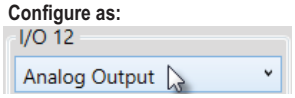
ANALOG OUTPUT (I/O-12 ONLY)

Supported I/O HUB models

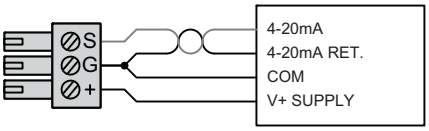
- IO-HUB-4-E ***(applies to I/O-12 only)***



Configure as:



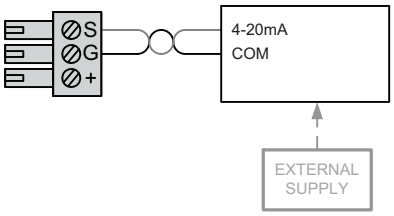
4-wire Actuator



Notes:

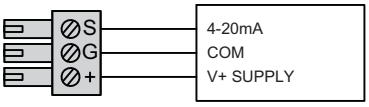
- Connect signal and supply return wires close to output terminal block
- Use twisted pair as shown for best noise immunity

2-wire Control

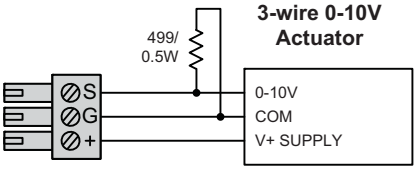


May be required depending on device

3-wire Actuator



3-wire 0-10V Actuator



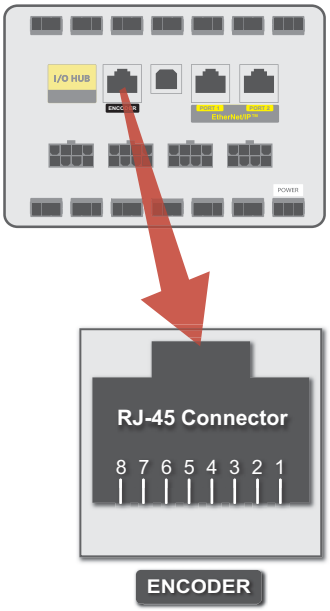
Note:
Place 499 Ohm shunt resistor close to actuator

ENCODER INPUT

Connect an external encoder to the I/O Hub for encoder-following or external position reference functions. Refer to the *ClearPath-IP Software Reference Manual* for programming information.

Supported I/O HUB models:

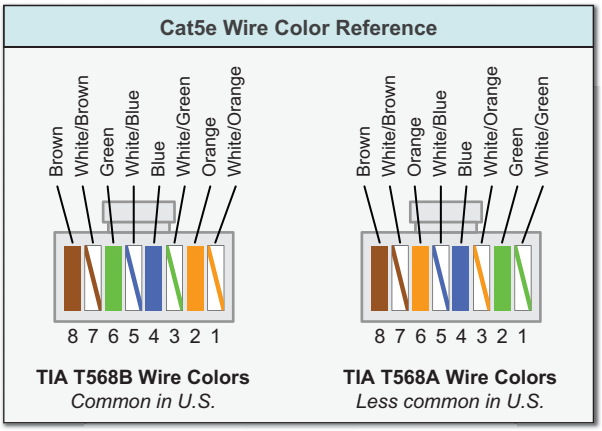
- IO-HUB-4-E



External Encoder Requirements

- Differential, quadrature A/B/I
- RS-422 signal levels
- 5VDC@300mA courtesy power at jack
- Max.10 Mhz quadrature count rate

Pin#	Signal
1	ENC A
2	ENC A~
3	GND
4	ENC B
5	ENC B~
6	5V (out)
7	ENC I
8	ENC I~



Notes:

- Use high quality CAT5e cable or better.
- External encoders are not sold or supplied by Teknic.
- 5VDC encoder power and ground provided at pins 3 and 6. Maximum current: 300mA.

SOFTWARE (CLEARVIEW 3.0)

ClearView 3.0 is the configuration and diagnostic application for ClearPath-IP systems. ClearView 3.0 allows you to:

- View and interact with the ClearPath-IP motors and I/O HUBs on the network.
- Load motor configuration files and I/O HUB configuration files.
- Configure motor settings and I/O HUB network settings.
- Assign functions to the I/O points on the I/O HUB.
- Auto-Tune ClearPath-IP motors.
- Use the Move Generator and Jog Motion controls to test, refine, and troubleshoot motion and mechanical performance (without a controller present).
- Access the software oscilloscope to analyze motor variables in real time. Variables include Measured Torque, Position Error, Measured Velocity, Bus Voltage, and several more.

MINIMUM SYSTEM REQUIREMENTS

Operating System:	Windows 10, 11
Processor:	1.5 GHz or faster. ARM-based processors not supported.
Memory:	1 GB RAM
HD Free Space:	1 GB
Monitor:	1280 x 1024 pixels or higher
Other:	Sound card with speakers (optional)

DOWNLOAD LINK

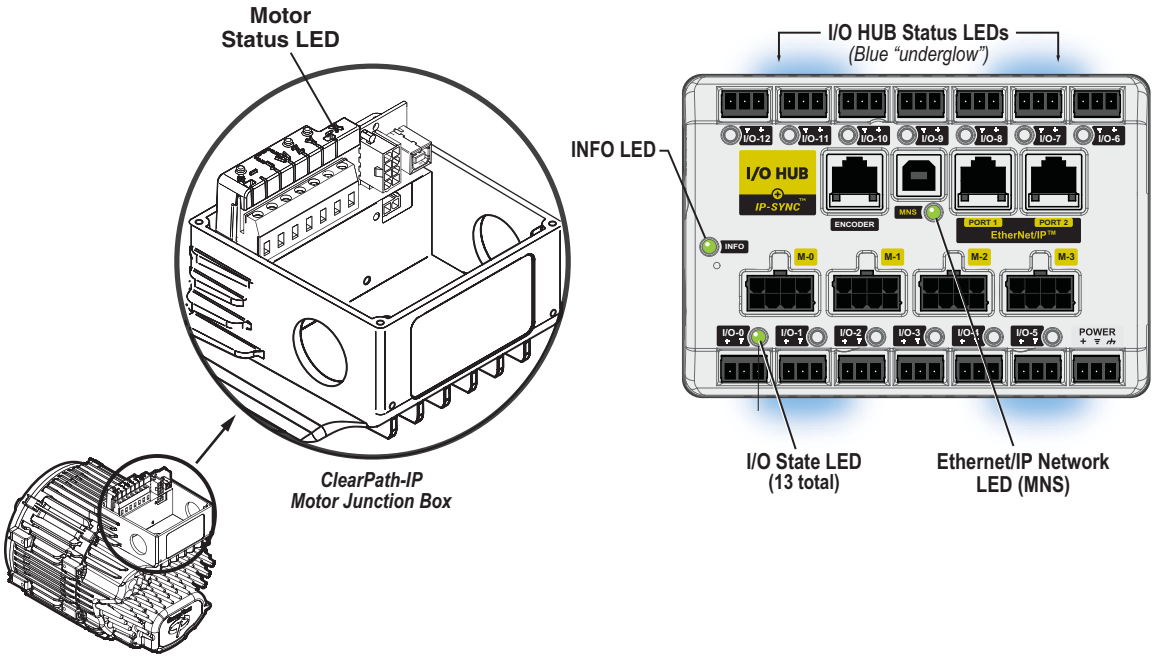
Download the ClearView 3.0 installer from https://www.teknic.com/downloads/.

APPENDIX A: TROUBLESHOOTING

The ClearPath-IP motor and I/O Hub each include LED indicators that provide visual feedback on system operating status.

This section describes:

- The names and physical locations of each LED indicator.
- The meaning of each LED color and flash pattern.



- **Motor Status LED:** Indicates whether the motor is enabled, disabled, or in a shutdown.
- **I/O HUB Status LED:** These LEDs, seen as a blue underglow around the base of the I/O HUB, indicate the ongoing operational state of the I/O HUB. During normal operation, the LEDs fade in and out at a regular interval. When an I/O HUB warning is triggered, the normal breathing pattern is replaced with a blink code corresponding to the specific warning.
- **Info LED:** Mirrors the behavior of the I/O HUB Status LED when an I/O HUB warning is present.
- **I/O State LEDs:** These LEDs (13 in all) show the logical state of each I/O point on the I/O HUB.
- **MNS LED (EtherNet/IP™ Network):** Displays the device's connection and communication status on the EtherNet/IP™ network.

LED CODES: CLEARPATH-IP MOTOR

The Motor Status LED indicates the motor's current operational state (enabled, disabled, shutdown etc.). Refer to the table below for more information. For more detailed information on motor shutdowns, connect to the motor using ClearView 3.0.

LED Behavior	Motor State	Description
Green, rapid flicker	Enabled	Operation normal. **CAUTION:** Motor windings are energized. Motor can move at any time.
Green, solid	Disabled	Operation normal. Motor windings are de-energized.
Yellow, blink	Shutdown	Query drive through application code for exception information, or connect to motor via it's USB Diagnostic Port with secondary laptop running ClearView 3.0.
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.

Note: The Motor LED will periodically blink off to indicate active communication with the network. This brief blink occurs alongside the standard LED behavior described above. See the examples below.

Example 1: A motor that is *disabled* will show a solid green LED, but the LED will blink off and on during periods of active communication.

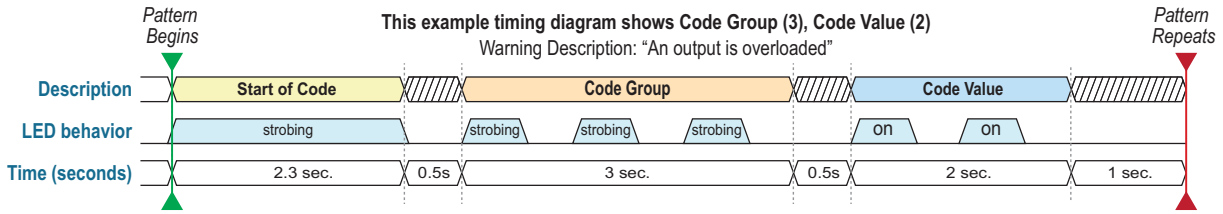
Example 2: A motor that is *enabled* will exhibit a rapid green flickering LED, but the flicker pattern will be interrupted during periods of active network communication.

LED CODES: I/O HUB STATUS LED AND INFO LED

The I/O HUB Status LED is the blue "underglow" at the base of the I/O HUB. During normal operation this LED fades in and out in a slow breathing pattern. **The Info LED** (top left of the device) mirrors the behavior of the I/O HUB Status LED when (and only when) a warning is present.

I/O HUB Status codes are divided into three segments. Refer to the description and timing table below.

- **The Start-of-Code** segment is indicated by a 2.3 second strobing pulse, followed by a 1/2 second off period.
- **The Code Group** segment follows the Start-of-Code segment and indicates the general category of the warning (e.g., 'Device Error'). It is defined by the number of strobing pulses. Each strobing pulse is 1/2 second on, followed by 1/2 second off.
- **The Code Value** follows the Code Group and indicates the specific warning within the designated Code Group. One pulse is defined as 1/2 second solid on, followed by 1/2 second off.



Note: *If multiple I/O HUB warnings are present simultaneously, the codes will be displayed sequentially with a brief pause between codes.*

Code Group	Code Value	Description
1 Strobe: **HW Failure**	1 Blink: **Unit Requires Repair**	Hardware problem. Return unit to Teknic.
2 Strobes: **Device Error**	1 Blink: **IP Address Conflict**	The I/O HUB's configured IP Address is the same as another device on the network. Make sure the I/O HUB has a unique IP Address configured in ClearView 3.0.
	2 Blinks: **Config Load Required**	Configuration file load failed. Try loading the file again, or reset the I/O HUB.
	3 Blinks: **Encoder Noise**	The I/O HUB detected noise on the external encoder input.
	4 Blinks: **ADC Over-voltage**	An analog input's voltage was too high. Check the I/O State LEDs to determine which analog input was overloaded.
3 Strobes: **Power Error**	1 Blink: **5V Supply Overloaded**	The 5-volt supply for the Encoder Input has been overloaded.
	2 Blinks: **Output Overloaded**	An output on the I/O HUB has been overloaded. Check the I/O State LEDs to determine which output was overloaded.
	3 Blinks: **Supply Voltage Too Low**	The supply voltage dropped below 10 VDC. Check the I/O HUB's power supply.
	4 Blinks: **Supply Voltage Too High**	The supply voltage rose above 29 VDC. Check the I/O HUB's power supply.

LED CODES: MNS LED

The MNS (Module and Network Status) LED conveys information such as I/O HUB power status, IP Address status, and EtherNet/IP™ connection status.

LED State	Description
Steady Off	The I/O HUB is powered off, or is powered on but an IP Address has not been configured.
Flashing Green and Red	Startup sequence in progress.
Flashing Green	The I/O HUB's IP Address has been configured, but a communication link has not been established, and a connection timeout between the I/O HUB and PLC has not occurred.
Steady Green	The I/O HUB's IP Address has been configured, a connection has been established with at least one other Ethernet/IP™ device, and a connection timeout between the I/O HUB and PLC has not occurred.
Flashing Red	The I/O HUB's IP Address has been configured, and a timeout between the I/O HUB and PLC has occurred.

APPENDIX B: MECHANICAL INDEX

DIMENSIONAL DRAWINGS

CLEARPATH-IP MOTORS

56xx CPM Dimensional Drawing

143/145xx CPM Dimensional Drawing

D100xx CPM Dimensional Drawing

CLEARPATH-IP ACCESSORIES

I/O HUB Communication and I/O interface

DIN-MNT Optional DIN rail mounting plate for I/O HUB

FOOT-56-14X Optional mounting baseplate (foot) for ClearPath motor

BLOWER-1P230V Optional blower kit for ClearPath motor

RES-225 Optional regenerated energy shunt for ClearPath motor

MOTOR MOUNTING: THERMAL CONSIDERATIONS

- Do not mount ClearPath-IP motors over a heat source such as a power supply, spindle drive, etc.
- Do not mount ClearPath-IP motors in an unventilated enclosure.
- Do allow for at least 1" of space around each ClearPath-IP motor.
- ClearPath-IP motors can be fitted with an external accessory fan if desired. See part number BLOWER-1P230V
- ClearPath-IP motors will perform a protective shutdown when its internal temperature sensor threshold is exceeded.

MOUNTING BLOWER KIT P/N BLOWER-1P230V

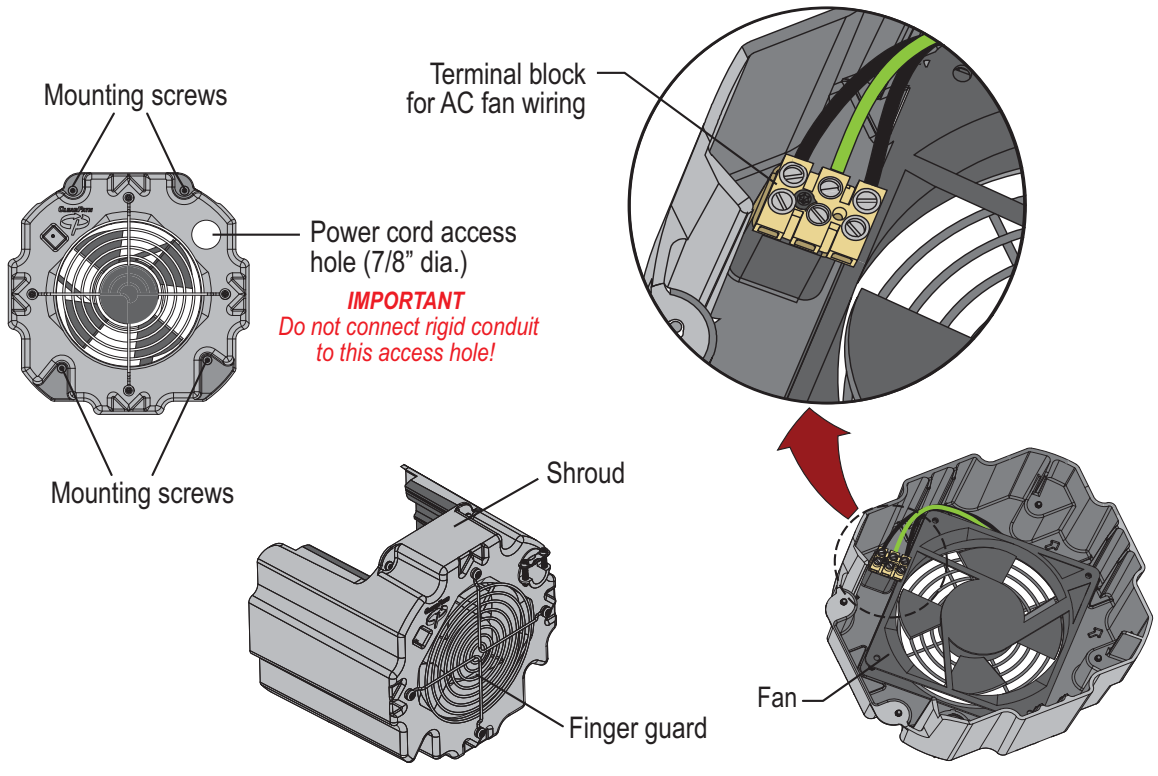
This document describes how to wire and mount the optional blower kit (Teknic Part#: ***BLOWER-1P230V***) to UL Recognized AC ClearPath models.

IMPORTANT PRODUCT NOTES

- The fan supplied with this blower kit requires single phase 230VAC nominal mains power with a maximum 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.
- Do not connect rigid metal conduit to this product.

BLOWER KIT CONTENTS

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



BLOWER-1P230V

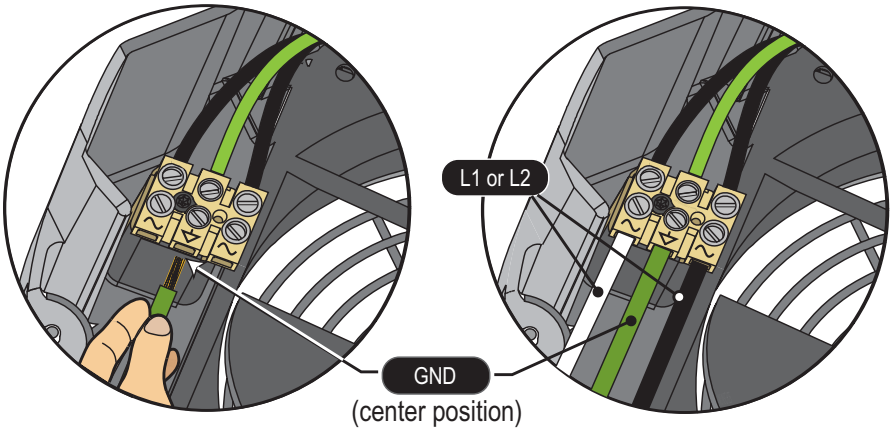
WIRING INSTRUCTIONS

TOOLS AND MATERIALS (NOT PROVIDED IN KIT)

- Screwdriver, Torx T-10
- Screwdriver, small slotted
- Line cord (UL Listed) with 3 flying leads (L1, L2, and GND) and UL Listed plug
- 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)

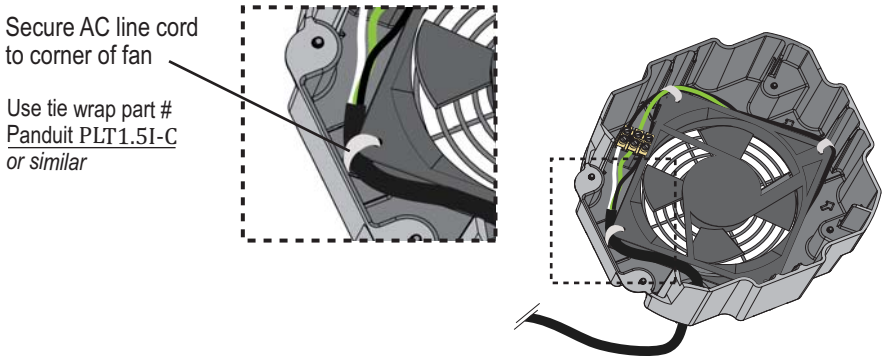
DIRECTIONS

1. Strip 50–75 mm (2–3 in.) of the line-cord jacket to expose the three inner conductors. **Caution:** Avoid nicking the insulation on any conductor.
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.

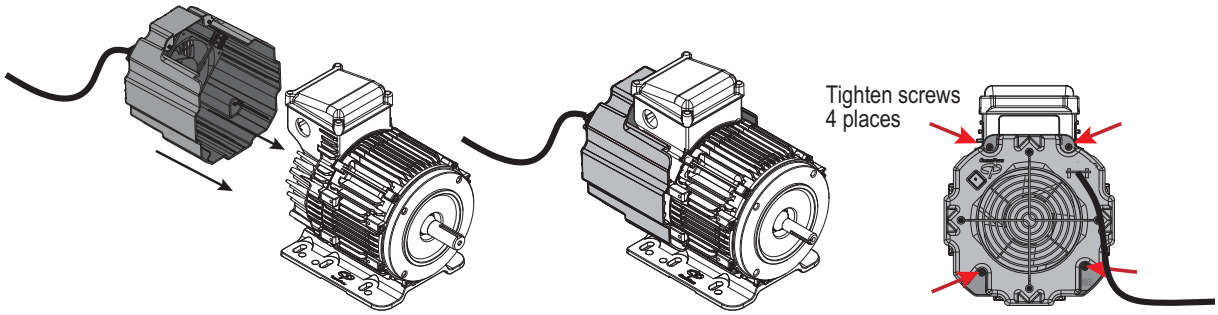


6. Tighten screws. Check for loose wire strands.
7. Tighten strain relief or cord grip. Verify that all wires are properly captured and strain relieved.

8. **Important:** Secure AC line cord to the corner of the fan with a tie wrap (see figure below). This is necessary to prevent the line cord from interfering with the fan during operation.



9. Test fan operation by applying AC power. Remove AC power after testing.
10. Slide the blower onto the ClearPath motor as shown below.
11. Secure the blower to the motor by tightening 4 screws as shown below. Use Torx (T-10) screwdriver.



CONNECTING CLEARPATH-IP TO A MECHANICAL SYSTEM

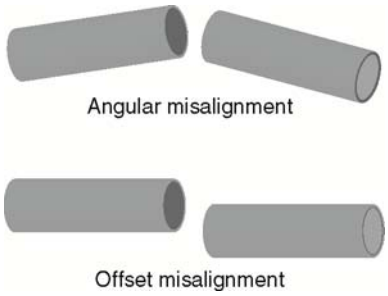
ClearPath-IP motor must be connected to a mechanical system to do any useful work, but it's not always clear just how to connect the motor to the rest of the machine.

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 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-IP 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.
- **Avoid using shaft keys when possible.** Although ClearPath-IP includes a keyway feature on the shaft, Teknic does not generally recommend the use of keys. Keys tend to cause run-out and backlash errors, particularly in reciprocating, precision positioning motion applications.
- **Note:** Keys *should be* considered for use in applications where coupling slip could result in a dangerous or hazardous condition. Also, key use may be appropriate for unidirectional applications (where the motor always spins in the same direction) as these applications are less prone to key-related lash problems.
- **Avoid direct loads.** In general, ClearPath-IP motors are not designed for connection to direct loads (e.g. direct connection to a grinding wheel). However, direct connection may make sense if the load is of low-mass and balanced, as with small mirrors for laser applications.

NOTES ON COUPLING SELECTION.

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.

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.

Information on the Web

For technical articles on coupling types and coupling selection, see links below.

https://teknic.com/securing-mechanics-motor-shafts/

https://www.ruland.com/technical-resources/technical-articles

https://www.ruland.com/technical-resources/technical-articles/5-reasons-to-consider-using-jaw-couplings

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.

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-IP 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

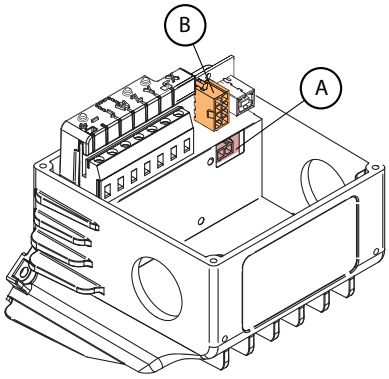
End stops from medium durometer rubber to steel can be used successfully with Hard Stop Homing. When selecting end stops for a Hard Stop Homing application consider the following:

- 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.

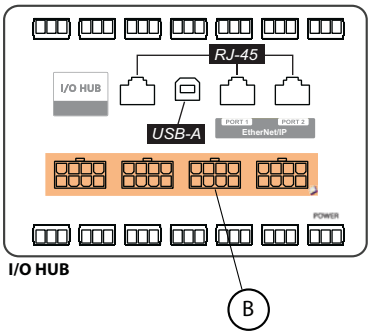
APPENDIX C: MATING CONNECTORS AND CABLES

MATING CONNECTORS

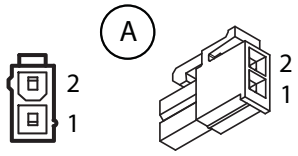
This section contains a list of mating connectors, terminals, and hand tools needed for making ClearPath-IP cables.



ClearPath-IP Motor Junction Box

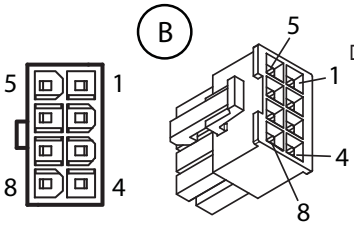


I/O HUB

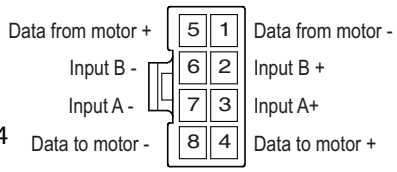


Logic Power Backup Connector

WIRE ENTRY VIEW



Communication Connector



WIRE ENTRY VIEW

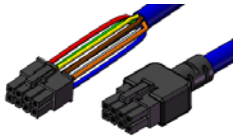
All parts listed below are made by Molex Inc. Go to www.molex.com for complete specifications and application information.

Ref.	Description	Mating Connector PN	Terminal PN	Terminal Desc.	Crimp Tool	Extraction Tool	Recommended
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	22-24 AWG

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

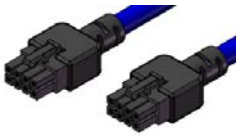
CABLE DRAWINGS

CONTROL CABLE: CPM-CABLE-CTRL-MU120



Cable description: ClearPath control 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). Link

CONTROL CABLE: CPM-CABLE-CTRL-MM660



ClearPath control 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. Link

NETWORK CABLE: CABLE-CAT5-120

Cat5e cable, 10 ft. end-to-end. Flexible, snag-free, cable boot protects the plug while making it easy to depress the locking clip. 24AWG stranded, pure bare copper conductors. 50µm gold-plated contacts. Link

APPENDIX D: SPECIFICATIONS

CLEARPATH-IP 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
Environmental	
Ambient temperature	-40°C to +70°C*
Ambient humidity, junction box open (during commissioning)	10%-85%, non condensing
Environmental Sealing with optional shaft seal	IP66K/IP67**
Environmental Sealing without shaft seal	IP53**
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/sec2)	250,000 radians/sec2
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.*

*** To achieve the stated IP rating, user must install junction box cord grips or plugs that meet or exceed the specified IP ratings.*

I/O HUB

Mechanical

Dimensions	5.0" x 3.5" x 1.0" (127mm x 88.9mm x 25.4mm)
Weight (with cover)	6.66 oz (189 g)
Material	3mm thick polycarbonate cover, aluminum baseplate

Electrical

Voltage Input	10-28VDC (24VDC nominal)
Output Current Capability	I/O 0,1,2,3,4,5,6,7,8,9,10,11 - 750mA RMS (1000mA peak) each Group total for each 0/1/2/3, 4/5/6/7, 8/9/10/11 - 1.5A RMS (2A peak) Total continuous for all outputs - 4A RMS (7A peak for 10mS Max)
Power Consumption (I/O HUB only)	300mA @ 24VDC
Protection features	Overcurrent protection on all outputs Inductive clamping on all outputs Board master overvoltage and overcurrent protection ESD protection features on all I/O circuits
Capacitive load (max.)	Capacitance on I/O power pins collectively may not exceed 250uF.

Motion Axes by Model

IO-HUB-2-R	2 motion axes available per I/O HUB; with Regular (R) axis I/O only
IO-HUB-4-R	4 motion axes available per I/O HUB; with Regular (R) axis I/O only
IO-HUB-4-E	4 motion axes available per I/O HUB; with Enhanced (E) general purpose I/O (GPIO) and axis I/O

I/O Points by Model

Total I/O Points (all models)	13 built-in I/O points. I/O points each have an individual LED indicator.
IO-HUB-2-R	Software configurable I/O can serve as motion axis Home Switch Input, +/- Limit Switch Inputs, Stop Sensor Input, Position Capture Input, or Brake Output. I/O is not general purpose (i.e., the master/scanner cannot directly read or write this I/O). Analog I/O is not supported.
IO-HUB-4-R	Software configurable I/O can serve as motion axis Home Switch Input, +/- Limit Switch Inputs, Stop Sensor Input, Position Capture Input, or Brake Output. I/O is not general purpose (i.e., the master/scanner cannot directly read or write this I/O). Analog I/O is not supported.
IO-HUB-4-E	Supports all motion axis functions of the IO-HUB-2-R and IO-HUB-4-R (Home Switch Input, +/- Limit Switch Inputs, Stop Sensor Input, Position Capture Input, and Brake Output). In addition, this model supports software configurable GPIO in any combination of up to 13 digital inputs, 12 digital outputs (PWM capable), 13 analog inputs, and 1 analog output (4-20mA or 0-20mA). The master/scanner can directly read/write the GPIO.

External Encoder Input by Model

IO-HUB-2-R	No external encoder support
IO-HUB-4-R	No external encoder support
IO-HUB-4-E	1 RJ-45 port configured for optional external encoder input. Encoder requirements: 5V differential, quadrature A/B/I supported, index not required RS-422 levels, Max. count rate 10Mhz 5V @ 300mA courtesy power available on this port.

Communications

Ethernet	EtherNet/IP™ in/out switching capability. Accessed via 2 standard RJ-45 ports. 10Base-T/100Base-TX Ethernet. Use CAT5e cable or better.
USB	USB 2.0, for configuration only

Environmental

IP rating	IP20
Operating Temperature/Humidity	-20°C to 50°C / 0-90% non-condensing
Storage Temperature	-40°C to 85°C

Compliance

CE (pending), RoHS

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.
- 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.

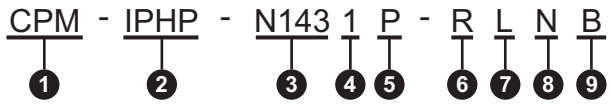
POWER RETURNS

- 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.

APPENDIX F: MOTOR PART NUMBER KEY

Visit teknic.com and enter your motor part number into the search bar for complete information including specifications, torque-speed curves, and links to drawings and documentation.

Example Part Number



1	Product ID	CPM	ClearPath Motor
2	Family/Model	IPVC	Ethernet/IP™ Controlled / Velocity Control
		IPSK	Ethernet/IP™ Controlled / Stepper Killer
		IPHP	Ethernet/IP™ Controlled / High Power
3	Motor Frame Size	N056	NEMA 56 frame with 5/8" shaft diameter
		N143/N145	NEMA 143/145 frame with 7/8" shaft diameter
		D100	IEC D100 frame with 28mm shaft diameter, end bell 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 Type	P	Parallel wound
6	Options	R	Positioning Resolution = 64000 counts per revolution
		E	Not used (for future expansion)
7	Shaft Diameter	L	Standard
8	Shaft Seal	N	Standard dust sealing
		S	Extra Viton™ seal.
9	Feature Set	B	Basic firmware

APPENDIX G: MISCELLANEOUS TOPICS

PRODUCT NOTES

RE: ELECTRICAL FAST TRANSIENT (EFT) TESTING

Electrical fast transient testing might induce a motor communication error. In such an event, the motor will come to a controlled stop. The communication error can be cleared by a node reset, after which motion can be resumed on command.

CLEARPATH EMC INSTRUCTIONS

ClearPath motors can meet EMC requirements as defined in IEC 61326-1. In general, ClearPath motors are electrically quiet and immune devices; however, certain machine design factors can affect motor-related RF emissions and immunity. These factors include cable routing, motor mounting, grounding practices, number of motors running simultaneously, and how aggressively the commanded moves are.

The recommendations in this document (see link below) will help machine manufacturers achieve IEC 61326-1 compliance.

https://teknic.com/files/downloads/ClearPath EMC Instructions.pdf

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