

CHAPTER TWO

# Installation

---

## IN THIS CHAPTER

---

- Product Ship Kit List
  - Installation Procedure
-

## What You Should have (*ship kit*)

---

If you ordered a TQ10X, you should have

<b>Part</b>	<b>Part Number</b>
TQ10X Drive	TQ10X
includes 10-pin plug (four included)	43-013891-01
includes 7-pin plug (one included)	43-013575-01
Power Cable – 6 feet (1.8 m) in length	44-000054-01
Thermally Conductive Strip	58-014871-01
TQ10 Torque Servo Drive User Guide	88-015115-02

### **Accessories**

External Heatsink/Fan Unit	TQ-HS3
Top & Bottom Covers (to enclose drive)	TQ-ENCL

NOTE: If you ordered a TQ10X-EHS, the External Fan/Heatsink Unit and the Top & Bottom Covers are installed at the factory.

### **SM Motor Information**

<b><u>SM with</u></b> <b><u>500 Line Encoder</u></b>	<b><u>SM with</u></b> <b><u>1000 Line Encoder</u></b>	<b><u>SM Motor Cables</u></b>
SM161AD-N10N	SM161AE-N10N	23TQ Cable-10
SM162AD-N10N	SM162AE-N10N	(1 set/10' cables)
SM161AD-NTQN	SM161AE-NTQN	23TQ Cable-25
SM162AD-NTQN	SM162AE-NTQN	(1 set/25' cables)
SM231AD-NTQN	SM231AE-NTQN	Above cables are for
SM232AD-NTQN	SM232AE-NTQN	Size 16 and 23 motors
SM232BD-NTQN	SM232BE-NTQN	
SM233AD-NTQN	SM233AE-NTQN	
SM233BD-NTQN	SM233BE-NTQN	

### **NeoMetric Motor Information**

<b><u>NeoMetric with</u></b> <b><u>500 Line Encoder</u></b>	<b><u>NeoMetric with</u></b> <b><u>1000 Line Encoder</u></b>	<b><u>NeoMetric</u></b> <b><u>Motor Cables</u></b>
N0701DD-NTQN	N0701DE-NTQN	70TQ Cable-10
N0701FD-NTQN	N0701FE-NTQN	(1 set/10' cables)
N0702ED-NTQN	N0702EE-NTQN	70TQ Cable-25
N0702FD-NTQN	N0702FE-NTQN	(1 set/25' cables)
N0703FD-NTQN	N0703FE-NTQN	92MS Cable-10
N0703GD-NTQN	N0703GE-NTQN	(1 set/10' cables)
N0704FD-NTQN	N0704FE-NTQN	92MS Cable-25
N0704GD-NTQN	N0704GE-NTQN	(1 set/25' cables)
	N0921FE-NMSN	
	N0921GE-NMSN	
	N0922GE-NMSN	

## Precautions

---

The TQ10X Drive has an open-frame style of construction. The top and bottom of the sheet metal enclosure is open, and internal components are exposed. Hazardous voltages are present inside the drive and on many of its terminals. Therefore, observe the following precautions:

- Do not reach inside the drive
- Do not probe inside the drive
- Do not touch the drive's motor terminals while power is applied to the drive
- Do not touch **MOTOR TEMP+** or **MOTOR TEMP-** while power is applied to the drive
- Configure the drive's DIP switches for your application before you apply power to the drive

## Installation Overview

---

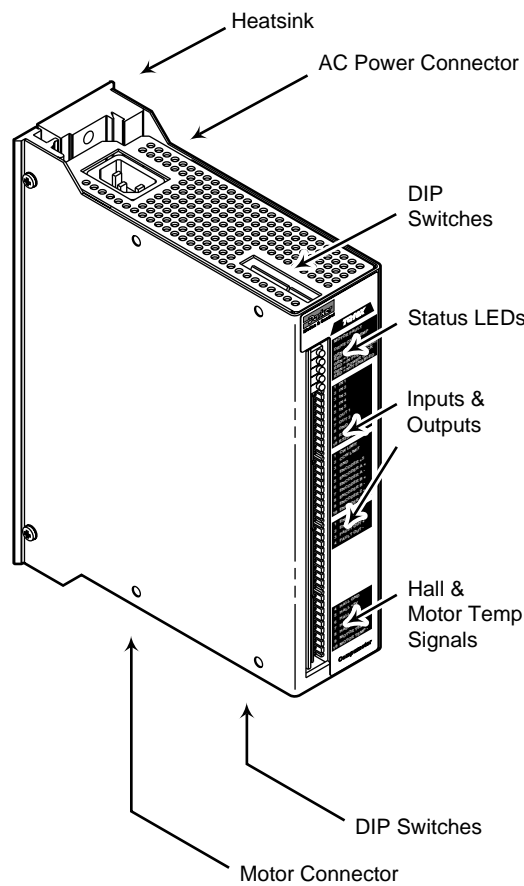
The order of topics in the installation procedure is:

- Quick Test
- DIP Switch Configuration
- Drive Mounting & Heatsinking
- Motor Mounting
- Connecting the Motor to the Drive
- Connecting AC Power
- Testing the System Installation
- Connecting the Motor to the Load

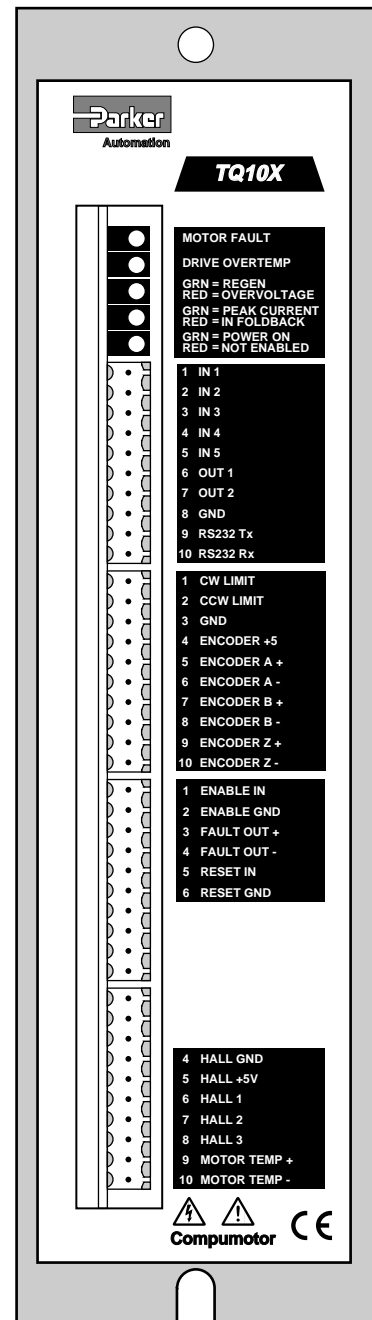
# Installation Procedure

Topics in this chapter are arranged to lead you through the installation process in a step-by-step manner. Complete each step before proceeding to the next.

The next drawing shows locations and names of the various connectors, switches, and components that you will encounter during the installation procedure.



TQ10X – Component Locations



TQ10X Servo Controller/Drive

## Quick Test

---

The steps in the following installation procedure will lead you through the permanent installation process. However, if you wish to familiarize yourself with the drive before you install it, you can perform a bench top *quick test*. To do so, complete the following sections, in the order given below:

- Set configuration DIP switches (on top of drive)
- Set peak current at twice the motor's continuous rated current, or less
- Set compensation DIP switches (on bottom of drive)
- Connect RS-232C signals
- Connect the Motor to the Drive
- Connect AC Power
- Test your system

During your permanent installation, complete the other sections in this chapter—drive mounting, motor mounting, and connecting the load—and review *Chapter 4 Tuning*.

## Installation

---

The following procedures will lead you through the steps required to permanently install your TQ10X Drive and motor.

### 1. Set DIP Switches (Top of Drive)

Configure the TQ10X Drive's DIP switches for your motor and application. Two 6-position DIP switches—Switch 1 (SW1) and Switch 2 (SW2)—are located on top of the drive. The table below summarizes their settings. A three-position DIP switch—Switch 3 (SW3)—is located on the bottom of the drive. See the section after this for instructions on setting SW3.

#### Default Settings

The factory default position is *off* for all switches. You must set the DIP switches appropriately for your application.

#### Peak Current

Set DIP switches SW1-#1 — SW1-#3 for the *peak current* that you want your drive to produce. If you use a high performance motor (peak current rating greater than three times the continuous current rating), such as Compumotor's SM or NeoMetric Series servo motors, see the caution note below.

---

#### CAUTION

**Peak current settings for initial drive tuning with SM and NeoMetric Motors:** Set peak current at twice the motor's continuous rated current, or less. Otherwise, motor damage due to excessive heating may result from high peak currents and improper tuning values. See *Chapter 4, Tuning* for a procedure to iteratively raise peak current during tuning.

---

## Time at Peak Current

Set DIP switches SW1-#4 — SW1-#6 to control the length of time the drive can produce peak current, before it goes into current foldback.

# TQ10X DIP SWITCH SETTINGS

off ↑

1 2 3 4 5 6

1 6

1 2 3 4 5 6

↑ off

Shown Configured for SM161A Motor\* →

PEAK CURRENT (amps)			
	1	2	3
0	off	off	off
1.5	on	off	off
3.0	off	on	off
4.4	on	on	off
6.0	off	off	on
7.4	on	off	on
8.9	off	on	on
10.0	on	on	on

TIME AT PEAK (seconds)			
	4	5	6
1.0	on	on	on
1.2	on	on	off
1.4	on	off	on
1.6	on	off	off
3.3	off	on	on
5.0	off	on	off
10.0	off	off	on

LOOP GAIN			
	4	5	6
0	off	off	off
1	on	off	off
2	off	on	off
3	on	on	off
4	off	off	on
5	on	off	on
6	off	on	on
7	on	on	on

↑ Less Gain (use with lower inductance motors)  
↓ More Gain (use with higher inductance motors)

FOLDBACK	
3	Foldback Disabled
on	Foldback Enabled

FOLDBACK FAULT	
2	High Threshold
on	Low Threshold

FOLDBACK FAULT	
1	Fault on Foldback
off	No Fault on Foldback

### DIP Switch Settings for Compumotor SM and NeoMetric Motors\* (with foldback enabled)

<p>SM161A</p>	<p>N0702E</p>
<p>SM162A</p>	<p>N0702F</p>
<p>SM231A</p>	<p>N0703F</p>
<p>SM232A</p>	<p>N0703G</p>
<p>SM232B</p>	<p>N0704F</p>
<p>SM233A</p>	<p>N0704G</p>
<p>SM233B</p>	<p>N0921F</p>
<p>N0701D</p>	<p>N0921G</p>
<p>N0701F</p>	<p>N0922G</p>

\*Switches shown configured for initial tuning, with peak current approx. twice motor's continuous current rating. See Tuning for procedure to raise current. For SW 3 settings, see next page.

## Foldback Fault Enable

If DIP switch SW2-#1 is in the *off* position, the drive can go in and out of current foldback without causing a fault condition. If DIP switch SW2-#1 is in the *on* position, then going into foldback will cause a latched fault condition; this setting can aid in troubleshooting your system.

## Foldback Threshold

DIP switch SW2-2 sets the current threshold for the foldback circuit. During initial tuning, this switch should be ON (low threshold) for all SM motors, and for NeoMetric motors with “D” and “E” windings. After tuning is completed, this switch should be ON for “A” winding SM motors. It should be OFF (high threshold) for “B” winding motors, NeoMetric (70mm and 92mm) motors, and for most motors with continuous current ratings above 4 amps.

## Foldback Enable

DIP switch SW2-3 enables foldback. When this switch is ON (the default) foldback is enabled.

## Loop Gain

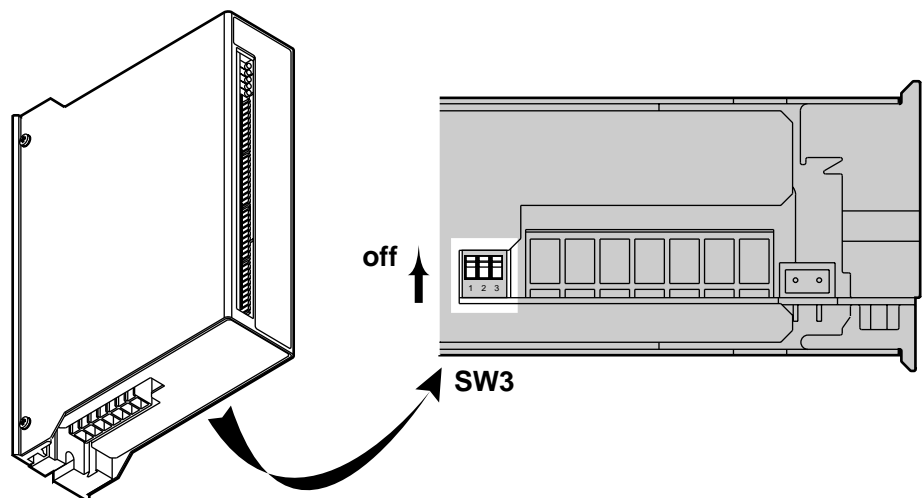
Set DIP switches SW2-#4 — SW2-#6 to control the gain of the drive’s internal current control loop. Properly setting this switch will match the drive to your motor’s parameters (inductance and resistance). The suggested settings provide wide current-loop bandwidth. In some applications, lower bandwidth may allow easier position-loop tuning. To reduce bandwidth, set the loop gain DIP switch for lower gain by one or two settings. *Do not set loop gain higher than the suggested setting.*

## DIP Switch Settings for SM and NeoMetric Motors

DIP switch settings for Compumotor SM and NeoMetric motors are shown above. If you use a non-Compumotor motor, see the *Appendix* at the end of this user guide for information about setting DIP switches for your motor.

## 2. Set DIP Switches (Bottom of Drive)

Switch 3 (SW3) is a three-position DIP switch located on the bottom of the drive, near the motor connector.



DIP Switch 3 – Location

Set it to control the drive’s motor pole compensation, based upon your motor’s

electrical time constant. The following table shows switch settings for Compumotor SM and NeoMetric Series servo motors.

## TQ10X DIP SWITCH #3\*

\*Located on Bottom of Drive

off ↑

1	2	3

MOTOR POLE COMPENSATION	1	2	3
SM161A, SM162A	off	off	off
Reserved	on	off	off
SM231A, SM232A+B, SM233A+B	off	on	off
Reserved	on	on	off
N0701D, N0701F	off	off	on
N0702E, N0702F	on	off	on
Reserved	off	on	on
N0703F, N0703G, N0704F, N0704G, N0921F, N0921G, N0922G	on	on	on

If you use a non-Compumotor motor, see the *Appendix* at the end of this user guide for information about setting DIP switches for your motor.

### Offset Potentiometer – Do Not Adjust

Located next to DIP SW3 is a small potentiometer that controls the drive’s offset. It was adjusted at the factory, and requires no further adjustment.

#### **WARNING**

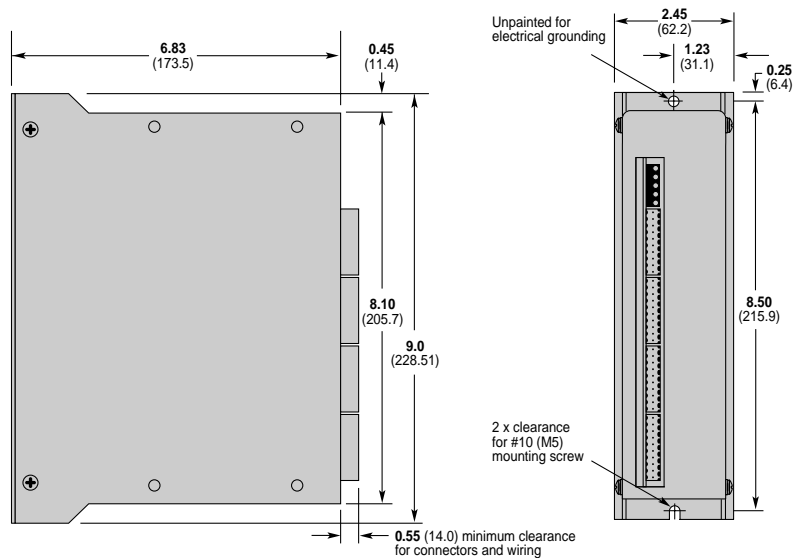
Do not adjust the offset potentiometer. Lethal voltages are present inside the drive. Adjusting the potentiometer with AC power applied can be hazardous to personnel.

## 3. Mount the Drive

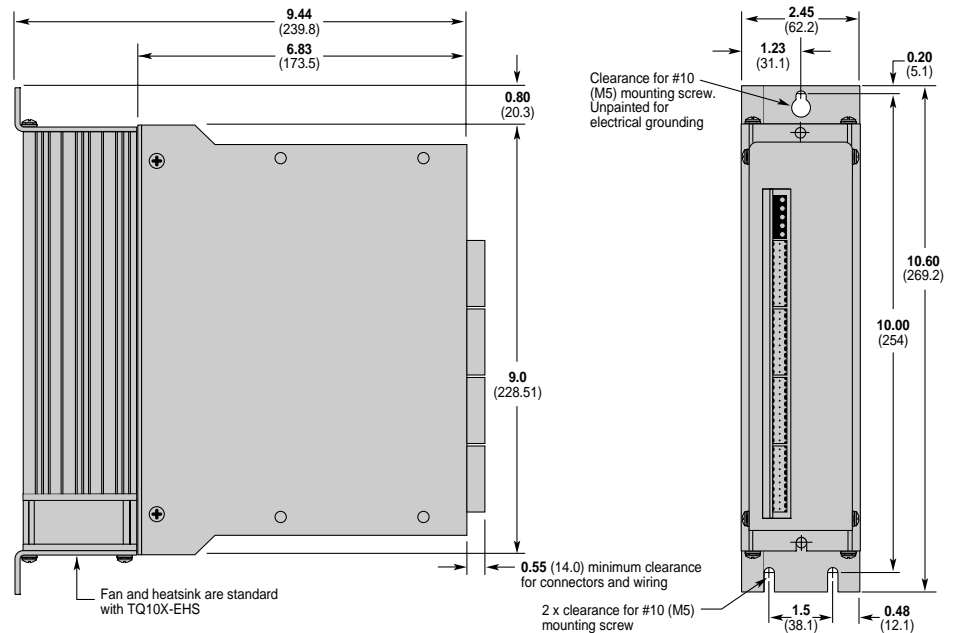
The TQ10X has an “open frame” enclosure—sheet metal encloses the front and sides, but the top and bottom are open. A TQ10X-EHS drive has top and bottom covers, and an attached heatsink and fan. You can purchase the heatsink or covers separately, and install them on your drive.

Dimensions for each version of the drive are shown below.

### Drive Dimensions



*Dimensions — TQ10X Drive*



*Dimensions — TQ10X With Heatsink Attached*

## Environmental Considerations

### TEMPERATURE SPECIFICATIONS

Maximum Ambient Temperature:	50°C	(122°F)
Minimum Ambient Temperature:	0°C	(32°F)
Maximum Temperature of Mounting Surface:	45°C	(113°F) (for non -EHS version)

**HUMIDITY** Keep the relative humidity below 95%, non-condensing.

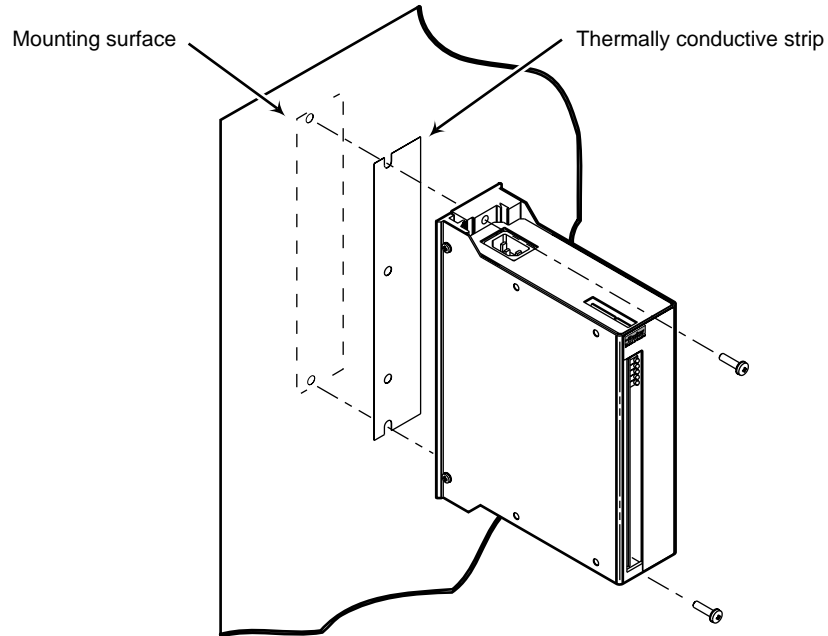
**LIQUIDS** Do not allow liquids or fluids to come into contact with the TQ10X Drive or its cables.

**AIRBORNE CONTAMINANTS** Particulate contaminants, especially electrically conductive material such as metal shavings or grinding dust, can damage the TQ10X Drive and motor. Do not allow contaminants to come into contact with the drive or motor.

## Mounting the Drive to a Heat Sinking Surface

Mounting profiles and loads affect the amount of heat dissipated by the TQ10X Drive. If yours is a low power application with moderate ambient temperature, the drive may not need a large heatsink. The mounting surface may be adequate as a heatsink, provided it has sufficient mass and surface area.

The mounting plate at the rear of the drive is a *heatplate*—it is a thermal pathway through which the drive can dissipate its excess heat. Mount the drive to a suitable heat sinking surface. A thermally conductive strip is provided with the drive. When you mount the drive, install the strip between the drive's heatplate and the mounting surface, as the next drawing shows. Do not fold or wrinkle the strip.



*Mounting with Thermally Conductive Strip*

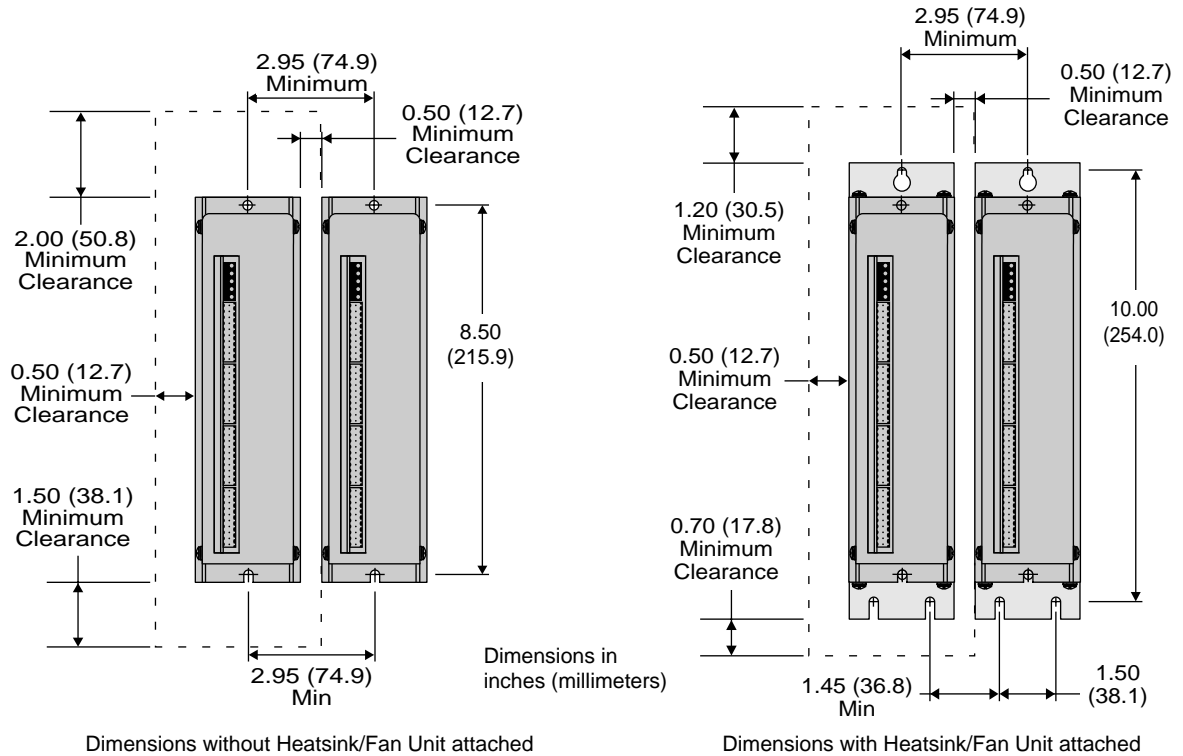
While the drive is operating, ensure that the temperature of the mounting surface is no higher than 45°C (113°F), and that the temperature of the ambient air is no higher than 50°C (122°F).

Do not mount equipment that produces substantial heat below the drive. Avoid mounting heat sensitive equipment directly above the drive.

## Panel Layout

High power applications may require a heatsink. A heatsink/fan unit for the TQ10X Drive is available from Compumotor (part number TQ-HS3). If you purchased a TQ10X-EHS, the heatsink/fan unit was installed at the factory.

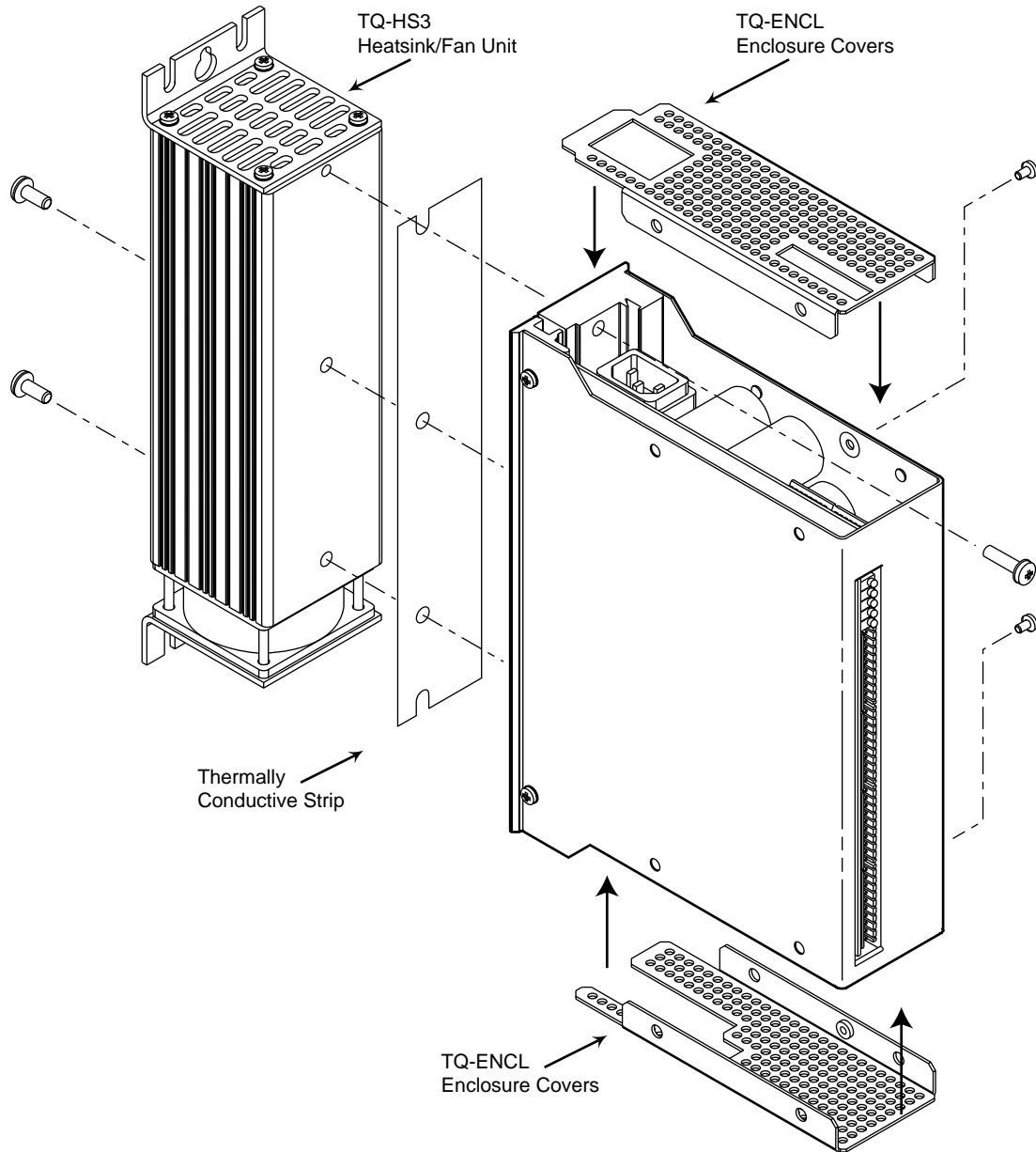
The next drawing shows minimum spacing and clearance requirements you should follow when you mount TQ10X Drives. Dimensions are shown with and without heatsink/fan units attached to the drive.



Panel Layout Dimensions

## Attaching Heatsink/Fan Unit and Enclosure Covers

The next drawing shows how to attach Compumotor's optional TQ-HS3 Heatsink/Fan Unit to your TQ10X Drive.

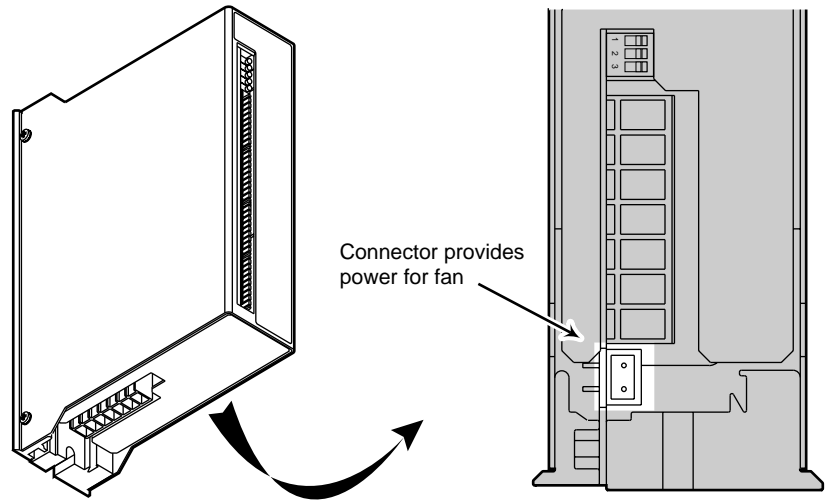


### *Heatsink/Fan Unit and Covers – Attaching to Drive*

Perforated sheet metal covers that enclose the top and bottom of the drive are available from Compumotor (part number TQ-ENCL). The drawing above shows how to attach these optional parts to your TQ10X Drive.

Because the covers will reduce convection available for cooling internal components, drive temperature may increase. You may need to reduce ambient temperature or provide forced air cooling to cool the drive. You may also need to install an external regeneration resistor (power dump), if regenerated energy causes drive overheating with the covers installed.

The heatsink/fan unit has a cable with connector attached. Plug the connector into the TQ10X's fan power connector.

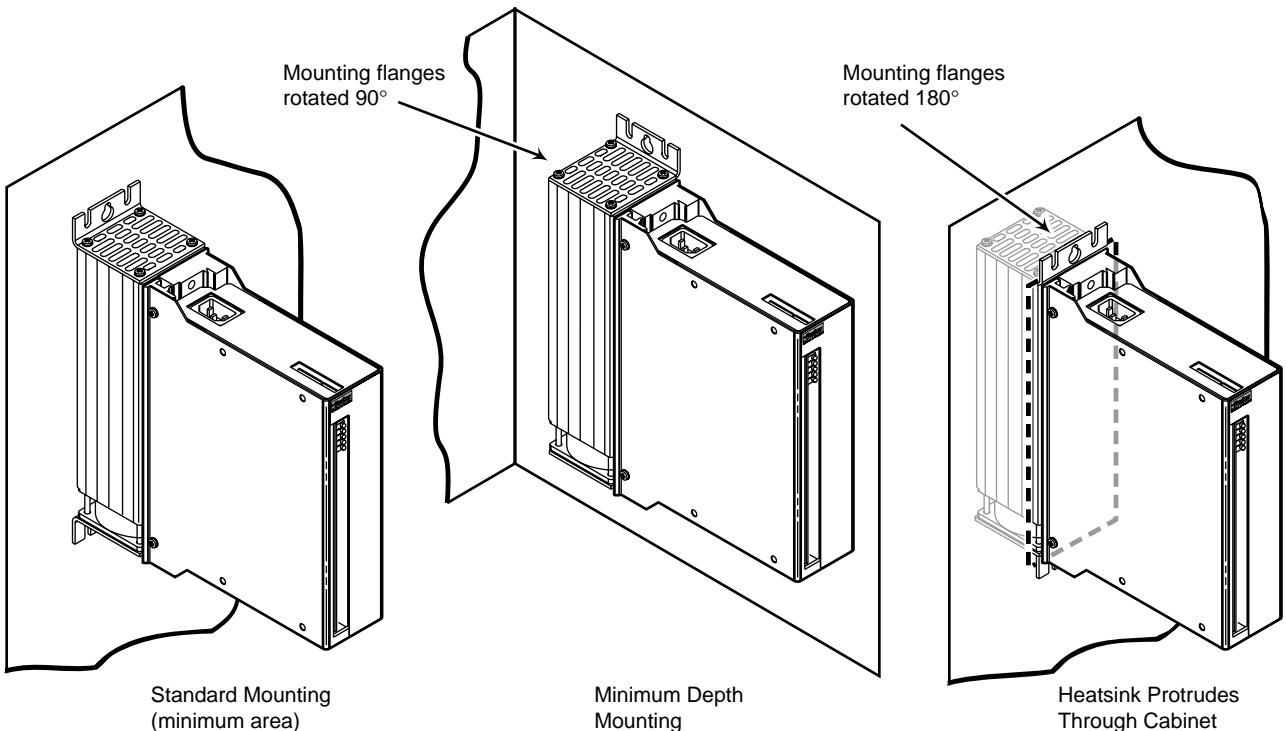


*Fan Power Connector*

### Mounting Options with Heatsink/Fan Unit

If your drive has a TQ-HS3 Heatsink/Fan Unit attached, you have several options for mounting the drive, as the next drawing shows.

You can mount the drive in a “minimum area” configuration, as shown on the left, below. Or, you can mount the drive in a “minimum depth” configuration by rotating the mounting flanges 90° (located at the top and bottom of the heatsink), as shown in the center. If you rotate the mounting flanges 180°, as shown on the right, you can mount the drive with the heatsink protruding through an opening in your equipment cabinet. This configuration may help to remove heat from the interior of your cabinet.



*Mounting Options*

## 4. Mount the Motor

The following guidelines present important points about motor mounting and its effect on performance.

For mechanical drawings of SM and NeoMetric Series servo motors, see *Chapter ③—Specifications*.

---

---

### **WARNING**

Improper motor mounting can limit system performance and jeopardize safety of personnel.

---

---

Servo motors should be mounted by bolting the motor's face flange to a suitable support. Foot mount or cradle configurations are not recommended because the motor's torque is not evenly distributed around the motor case. Any radial load on the motor shaft is multiplied by a much longer lever arm when a foot mount is used rather than a face flange.

Servo motors used with the TQ10X can produce large torques and high accelerations. These forces can shear shafts and mounting hardware if the mounting is not adequate. High accelerations can produce shocks and vibrations that require much heavier hardware than would be expected for static loads of the same magnitude.

Under certain move profiles, the motor can produce low-frequency vibrations in the mounting structure. If harmonic resonances are induced by the move profiles you are using, these vibrations can cause metal fatigue in structural members. A mechanical engineer should check the machine design to ensure that the mounting structure is adequate.

---

---

### **CAUTION**

Modifying or machining the motor shaft will void the motor warranty. Call Compumotor's Application Engineers (800-358-9070) about shaft modifications as a custom product.

---

---

### **Motor Heatsinking**

Performance of a servo motor is limited by the amount of current that can flow in the motor's coils without causing the motor to overheat. Most of the heat in a brushless servo motor is dissipated in the stator—the outer shell of the motor. Performance specifications usually state the maximum allowable winding or case temperature. Exceeding this temperature can permanently damage the motor. The maximum case temperature for Compumotor SM and NeoMetric motors is 70°C (158°F).

If yours is a demanding application, your motor may become quite hot. The primary pathway through which you can remove the heat is through the motor's mounting flange. Therefore, mount the motor with its flange in contact with a suitable heatsink.

---

---

### **CAUTION**

In temporary "bench top" setups, often used for prototyping or demonstrations, motors are very vulnerable to overheating if they are not mounted to a heatsink. Limit peak current to the motor's continuous current rating if you operate your motor without a heatsink.

---

---

Specifications for Compumotor SM and NeoMetric Series servo motors apply when the motor is mounted to a ten inch by ten inch aluminum plate, ¼ inch thick. To get rated performance in your application, you must mount the motor to a heatsink of at least the same thermal capability. Mounting the motor to a smaller heatsink may result in decreased performance and a shorter service life. Conversely, mounting the motor to a larger heatsink can result in enhanced performance.

## 5. Connect the Motor to the Drive

The TQ10X Drive works with three-phase brushless motors equipped with Hall effect sensors. The typical motor has a permanent-magnet rotor with four poles (two pole pairs). Higher pole-count motors may also be used.

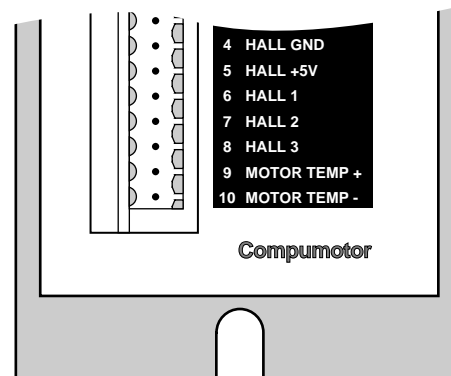
In the following installation procedure, we assume you are using a Compumotor SM or NeoMetric Series Motor with your TQ10X Drive. If you are using a non-Compumotor motor, consult the *Appendix* at the end of this user guide for information you may need during the following installation steps.

### Connect Hall Effect Wires

The TQ10X Drive is designed to be used with motors that have single-ended, open collector Hall outputs. Internally, the drive pulls these signals up to +15V.

For best performance and reliability, the drive should be used with motors having no more than six electrical degrees of commutation error in either direction. Motors with greater commutation error may cause increased torque ripple and motor heating, reduced average torque, and greater stresses on the drive output stage.

Connect your motor's Hall effect wires to the 10-pin screw terminal on the front of the TQ10X. Each terminal is labeled with the name of the wire you should connect.



*Hall Effect and Motor Temperature Connections – Front of Drive*

14 AWG (2.5 mm<sup>2</sup>) is the maximum wire size that can fit in the connector.

### Connect Motor Thermostat Wires

Connect your motor's thermostat wires to **MOTOR TEMP+** and **MOTOR TEMP-**.

If your motor does not have a thermostat, short **MOTOR TEMP+** and **MOTOR TEMP-** together by connecting an insulated jumper wire between them. The drive will experience a motor fault if neither a thermostat nor a jumper wire is attached to the **MOTOR TEMP** terminals.

---

---

**WARNING**

Hazardous voltages are present on **MOTOR TEMP+** and **MOTOR TEMP-** when the drive is powered up. Use insulated wires for connections. Protect personnel from contacting these terminals or any attached wires. Do not short these terminals to earth ground.

---

---

The TQ10X's motor overtemperature fault can, in many cases, protect the motor against overheating. Through its **MOTOR TEMP+** and **MOTOR TEMP-** terminals, the drive checks for electrical continuity provided by a normally-closed thermostat mounted on the motor. If the motor overheats and the thermostat opens, the loss of continuity triggers protection circuitry in the TQ10X. It will turn off power output to the motor, and illuminate the LED labeled **MOTOR FAULT**.

This is a latched fault. Wait for the motor to cool, then cycle power to resume operations. A motor overtemperature fault indicates improper motor sizing, or improper installation of your application.

This circuit may not protect the motor in every possible application. It works best in cases where the temperature rise occurs slowly over a long period of time. In this situation, the thermal sensor and motor windings will be at the same temperature. When the windings and sensor reach the sensor's threshold temperature, the sensor can trigger the overtemperature circuit.

In cases where the temperature rise is caused by continuous peak current flowing—such as a mechanical jam—the winding temperature may rise much more quickly than the sensor temperature does. In this situation, the windings may be damaged from overheating *before* the sensor can trigger the overtemperature circuit.

Be careful not to overheat your motor during system tuning. Allow the motor to cool for several seconds between test moves. Instability while tuning can cause rapid motor heating and possible motor damage. A thermal switch may not protect the motor if the motor heats up too quickly. Do not allow oscillations to persist longer than a few seconds. Allow the motor to cool for several minutes after each incident of instability.

### Connect Motor Phase Wires

Connect your motor's phase wires and ground wire to the removable 7-pin **MOTOR** connector located on the bottom of the drive. The next drawing shows the location of each terminal.

---

---

**WARNING**

Potentially hazardous voltages are present on motor connector terminals when power is applied to the drive.

---

---

Ensure the connector is aligned correctly when inserted—and not misaligned by one position.

The terminal labeled **MOTOR GROUND** is connected internally to the **EARTH** terminal on the drive's AC power connector.

---

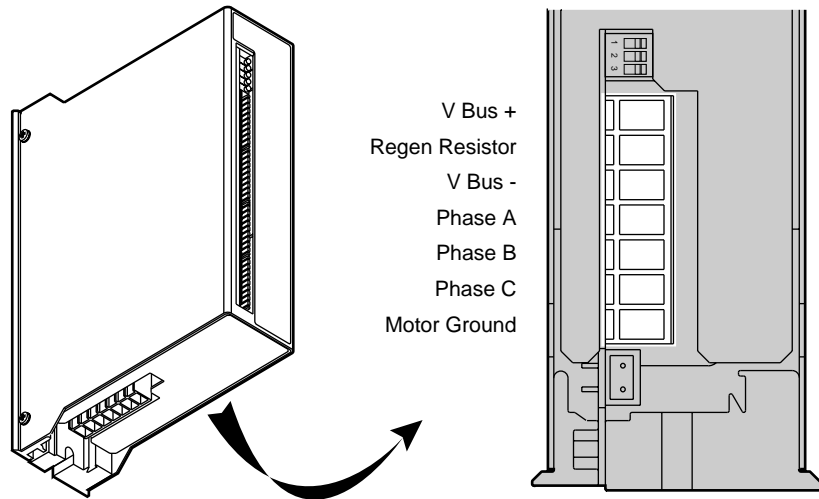
---

**WARNING**

DO NOT OMIT the **Motor Ground** connection. Internal failure of motor insulation can place the motor frame at deadly potential if it is not properly grounded.

---

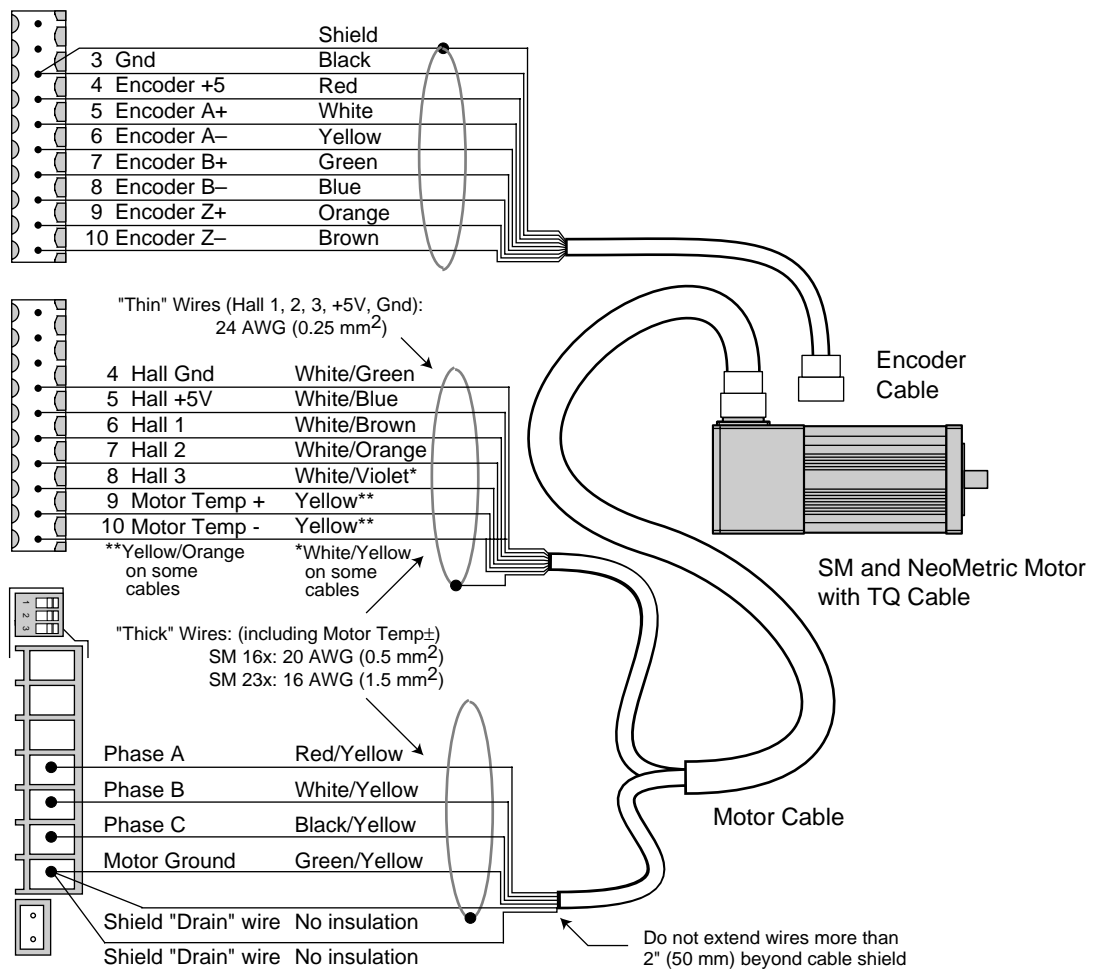
---



Motor Connector

### Connecting Compumotor SM or NeoMetric Series Motors

To connect a Compumotor SM or NeoMetric Series servo motor to the TQ10X, follow the color code shown in the next drawing.



Motor Cable Connections for SM or NeoMetric Series Motors

Inside the motor cable, there are two sets of wires. One contains Hall effect and motor thermostat wires; the other contains motor phase wires. Each set of wires has its own shield and shield drain wire. As shown in the drawing, you should connect both drain wires and the green/yellow ground wire to the **MOTOR GROUND** connector.

## Optional – Connect an External Regeneration Resistor

The TQ10X Drive can dissipate regenerated energy in its internal *regeneration resistor*. If your system regenerates more energy than the internal resistor can dissipate, you can connect an external resistor between two terminals called **V Bus+** and **Regen Resistor**, located on the motor connector. The external resistor doubles the TQ10X's dissipation capabilities.

---

---

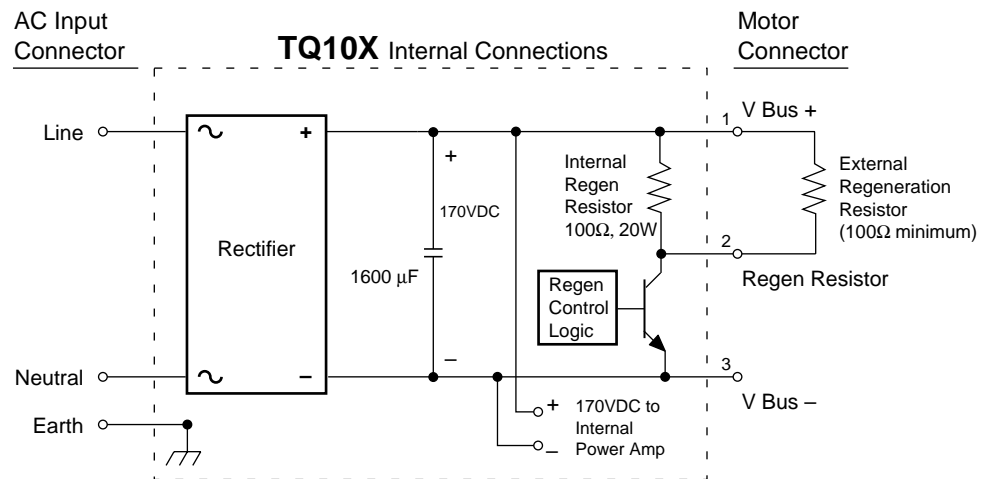
### WARNING

Potentially hazardous voltages are present on **V Bus+** and **Regen Resistor** terminals when power is applied to the drive.

---

---

The next drawing shows the internal regeneration resistor, terminals for an external regeneration resistor, and the DC power bus.



Regeneration Circuit

The TQ10X's regeneration circuit works automatically—there are no adjustments to make. The circuit monitors the voltage on the power bus. If regenerated energy from the motor causes the bus voltage to rise above a threshold value, the circuit closes a switch, thus connecting the regeneration resistor between the positive and negative sides of the power bus, **V Bus+** and **V Bus-**. The energy is then dissipated in the resistor—its power capacity is 1KW for one second, or 10 watts on a continuous basis. During the regeneration event, the bicolor LED labeled **REGEN/OVERVOLTAGE** will be illuminated *green*.

The TQ10X also has an *overvoltage* circuit; it protects the drive from excessive regeneration. If the motor regenerates more energy than the internal resistor can dissipate, voltage on the power bus will rise and trigger an overvoltage fault. The drive will shut down power output to the motor. The bicolor LED labeled **REGEN/OVERVOLTAGE** will be illuminated *red*. This is a latched fault—cycle power to resume operations.

If excessive regeneration causes overvoltage faults in your system, you can install an external regeneration resistor. Ensure that the external resistor is adequately mounted and cooled. Excessive heating can cause the resistor to fail.

---

---

**CAUTION**

---

---

Adequately cool the external resistor. Forced air cooling may be required. Maintain resistor temperature below its rated temperature limit.

---

---

The internal resistor is a 100Ω, 10% non-inductive resistor. It is intended to dissipate no more than 10 watts. (For safety margins, a 20W resistor was designed into the circuit.) For an external resistor, we suggest:

- Manufacturer Name: Dale
- Manufacturer Part Number: NHL-55-16N-100Ω (5% – 20% is suitable)

This resistor has “faston” mounting tabs, and can be mounted with two screws. You can order this resistor, with two 18 inch (457 mm) cables, as a kit from Compumotor. The part number is:

**TQ-REGEN-KIT**

Or, you may use an equivalently rated 100Ω 55W *non-inductive* resistor for your external resistor.

To connect the external resistor, follow these steps:

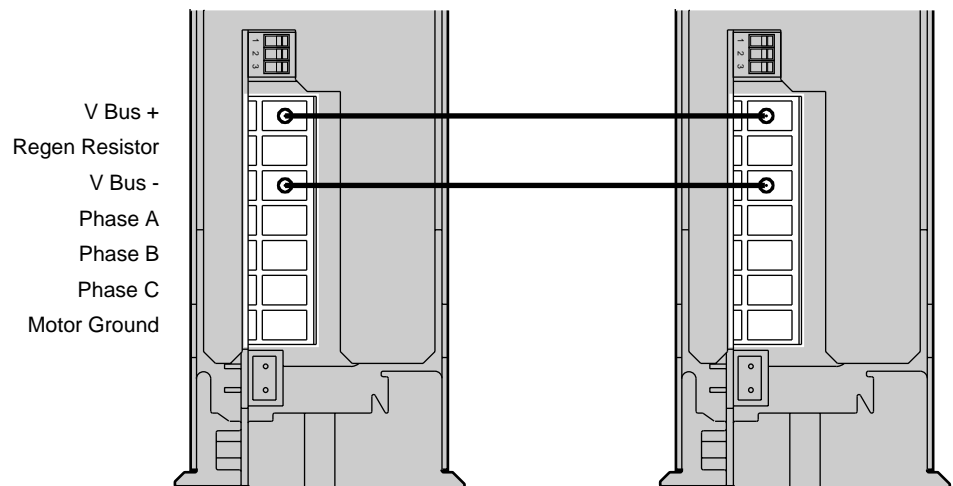
- ① Connect the resistor’s two terminals to **V BUS+** and **REGEN RESISTOR**, located on the motor connector.
- ② Keep wires as short as possible, and twist them together.

The circuit will automatically dissipate half the regenerated energy in the external resistor. Total dissipation with the external resistor installed is 2KW peak, 20W continuous.

### Optional – Sharing the Power Bus

In some applications with multiple drives, one or more drives may continuously receive regenerated power from their loads. For example, in a tensioning application, two TQ10Xs apply tension (opposite torques) to a single moving load. In this situation, one TQ10X could receive substantial regenerated power from its motor.

In such applications, you can connect the power buses for the TQ10Xs in parallel, through the **V BUS+** and **V BUS-** terminals, located on the motor connector, as shown below. (See the previous drawing, *Regeneration Circuit*, for an internal schematic.)



*Sharing the Power Bus*

With the buses connected in parallel, the regenerated power from one TQ10X is dissipated by the power consumption of the other.

In standard multi-axis applications, where regeneration occurs when one axis decelerates, the energy can be used by other axes if the power bus is shared. This improves system efficiency by using energy that would otherwise be wasted.

## Connecting Motors from Other Vendors

Before connecting a motor from another vendor, you must determine which motor phase wires correspond to Phase A, Phase B, and Phase C inputs on the TQ10X. Similarly, you must determine which Hall effect wires correspond to Hall 1, Hall 2, and Hall 3.

Connect each wire to its appropriate terminal on the TQ10X. Ensure that the Hall effect sensors accurately transmit information about rotor position, and that motor current is commutated to the correct motor phases. See the *Appendix* at the end of this user guide for more information about using a motor from a vendor other than Compumotor.

## Connecting a Brushed DC Servo Motor

You can use the TQ10X as a drive for brushed DC servo motors. To do this, follow these steps:

- ① Connect drive terminals **HALL 1** and **HALL 2** to **HALL GND**
- ② Make no connections to drive terminal **HALL 3**
- ③ Connect the drive's **PHASE A** to your motor's positive input.
- ④ Connect the drive's **PHASE C** to your motor's negative input.

Under these conditions (**HALL 1** and **HALL 2** connected to ground; **HALL 3** unconnected), the drive's internal logic determines that a brushed motor is connected. The drive will send DC current out of Phase A, through the motor, and back into the drive through Phase C. The amount and polarity of the current will be determined by the command input signal.

## Shielded Motor Cables

Keep electrical noise from interfering with the signals that the Hall effect sensors send to the drive. Position the motor as close as possible to the drive. If you need to connect a long cable between the drive and motor, we recommend you use a shielded cable for the Hall wires (Hall 1, Hall 2, Hall 3, +5V, Hall Gnd). Run the power wires (phase A, B, and C) separately from the Hall wires.

## Motor Grounding

For safety reasons, the motor case should be grounded. Often, the motor can be grounded through the equipment to which it is mounted. This requires a good electrical connection between the motor's mounting flange and the equipment, and that the equipment be connected to ground. Check with the National Electrical Code (NEC) and your local electrical code to ensure you use proper grounding methods.

Proper grounding can also reduce electrical noise.

---

---

### **GROUND THE MOTOR CASE!**

The motor case must be grounded, to reduce electrical noise. An ungrounded motor can cause electrical noise problems throughout the system, particularly in encoder wiring and circuitry. This noise may cause the encoder to output erroneous information, such as missing encoder pulses. To avoid electrical noise problems, ground the motor case.

---

---

## 6. Connect Inputs and Outputs

This section describes how to connect inputs and outputs to the TQ10X.

---

---

### CAUTION

I/O is not OPTO isolated. For greater noise immunity, we recommend the use of optical isolation modules. For added noise immunity, this controller has a digital filter; each input must be true for three successive clock cycles before recognizing a given state.

---

---

### Enable Input

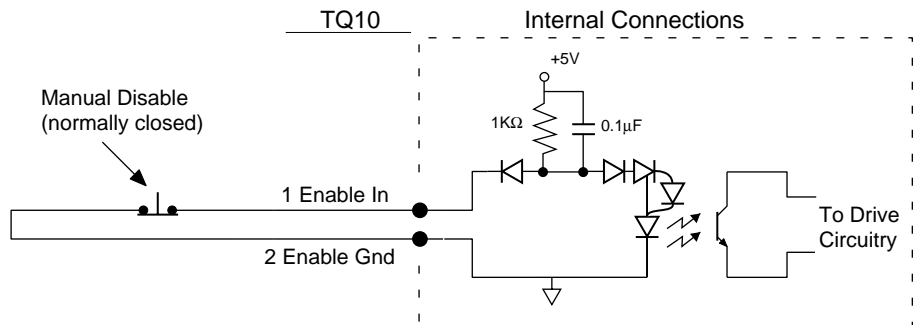
To enable the drive, you must connect the enable input to ground. If you break the connection to ground while the drive is on, the TQ10X's fault circuitry will activate, with the following results:

- The drive will shut down power output to the motor.
- The motor will freewheel (it may not stop immediately).
- The bicolor LED labeled **GRN = POWER ON, RED = NOT ENABLED** will be illuminated red.
- The fault output will become active (no current will flow through it).

To re-enable the drive, establish the connection between enable and ground, and cycle power.

In most applications, you can permanently wire the enable input to ground. This input is internally pulled up to +5V. If your equipment requires, you can connect the input to an external voltage as high as +24V. You can also connect it to a dry contact closure to ground.

If you need to disable the drive in an emergency, use the enable input. Connect a *manual disable* switch to the enable input, as the next drawing shows. The switch is normally closed. When it is opened, the drive will be disabled. The load can freewheel—therefore, you should use a brake to stop the motor immediately in applications where a freewheeling motor can cause injury or damage.



Enable Input Connected to a Switch

---

---

### WARNING

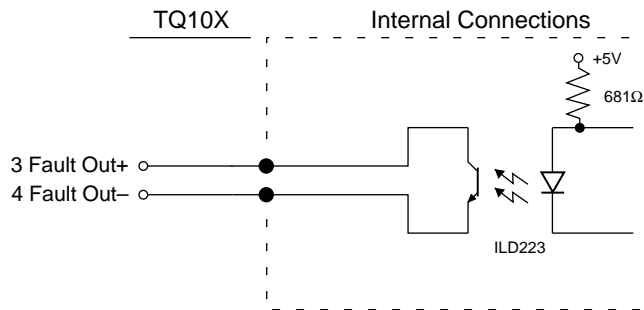
Do not use the ENABLE INPUT by itself as an emergency stop. The motor can freewheel when the drive is disabled and may not stop immediately. Use a mechanical brake or some other method to stop the motor quickly.

---

---

## Fault Output (Optional)

When the TQ10X is operating normally, its fault output's internal transistor is in the "on" state, and conducts current. If the TQ10X detects a fault, it turns off the transistor, and current stops flowing.



### Fault Output

#### Specifications

Maximum Applied Voltage	50 V
Maximum Current	10 mA
Active Level	No Fault: Transistor <i>on</i> , current flows Fault: Transistor <i>off</i> , no current flows

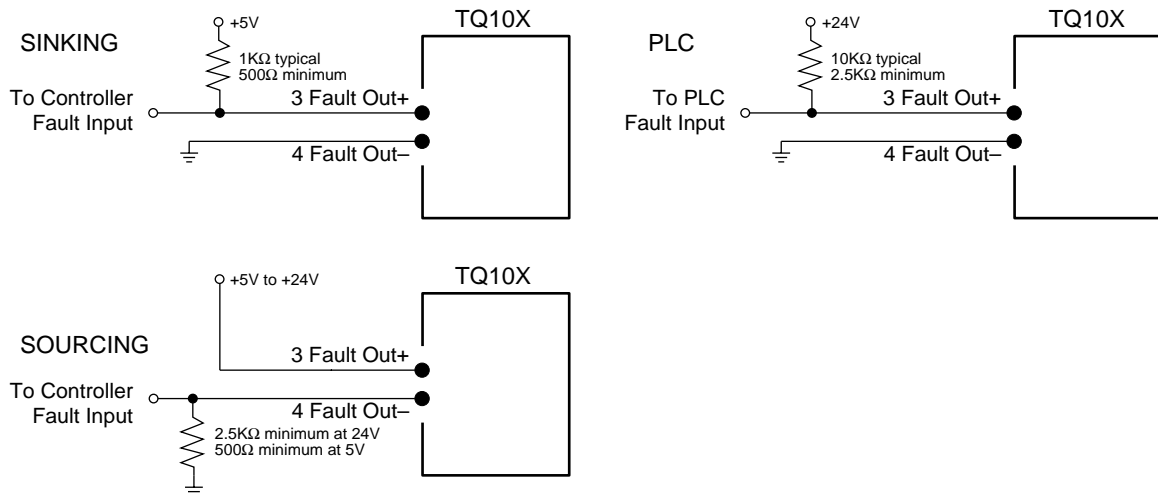
The following conditions will activate the fault output.

#### Fault Condition

Drive Not Enabled	
Over Temperature	<i>latched</i>
Overvoltage	<i>latched</i>
Undervoltage	<i>latched</i>
Excess Position Error	<i>latched</i>
Short Circuit	<i>latched</i>
Power Supply Fault	<i>latched</i>
Foldback	<i>foldback causes fault if DIP SW2, Position#1 is set to ON</i>

*Latched* means you must cycle power before the drive will operate again.

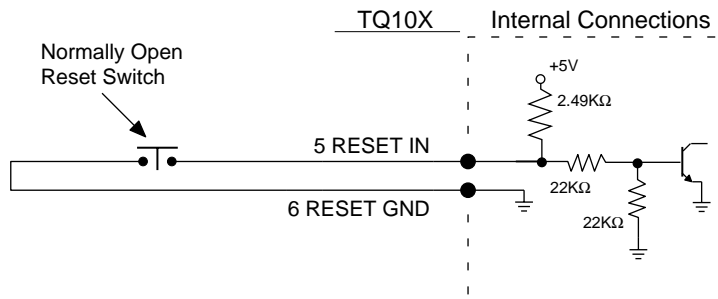
You can use the TQ10X's fault output as a signal to a PLC or other equipment that a fault has occurred. The following drawing shows several ways to connect external devices to the TQ10X's fault output.



Fault Output – Typical Applications.

## Reset Input (Optional)

You can use the reset input to reset the drive and the controller. The effect of a reset is identical to cycling power. The reset input is internally pulled up to +5V. If your equipment requires, you can connect the input to an external voltage as high as +24V. You can also connect it to a dry contact closure to ground.



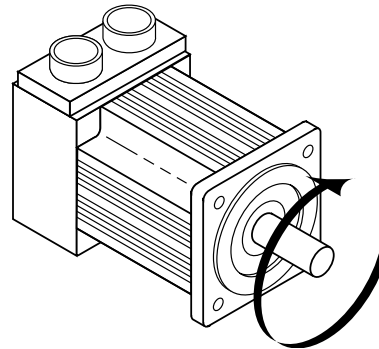
*Reset Input*

### Specifications

Maximum Applied Voltage	30 V
Maximum Current	5 mA
Active Level	Low to reset

## Rotation Direction

In the following sections, we will refer to clockwise and counterclockwise directions. As the next drawing shows, shaft rotation is defined as the direction the shaft rotates, as viewed from the mounting flange end of the motor.



*Clockwise Shaft Rotation*

## Maximum Voltage Level on I/O Signal Inputs

---

---

### **CAUTION**

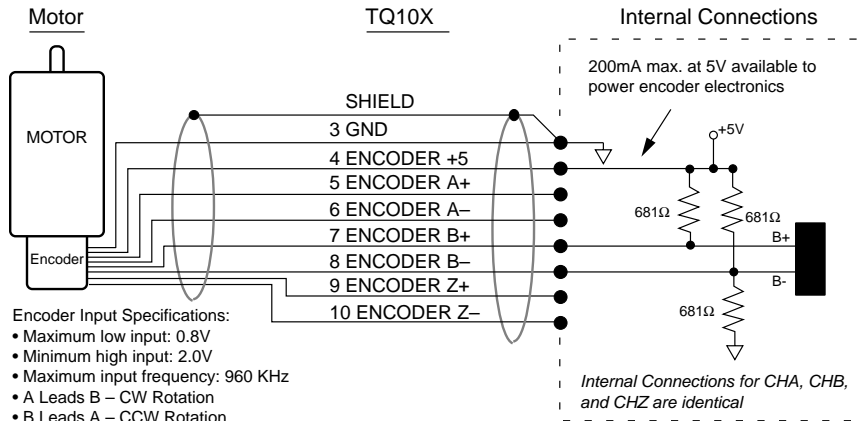
Do not apply more than 5V maximum to inputs described in the following sections.

---

---

## Encoder Input Connections

The TQ10X has six dedicated inputs for use with a differential incremental encoder. These inputs provide position information for the servo loop.



### Encoder Input

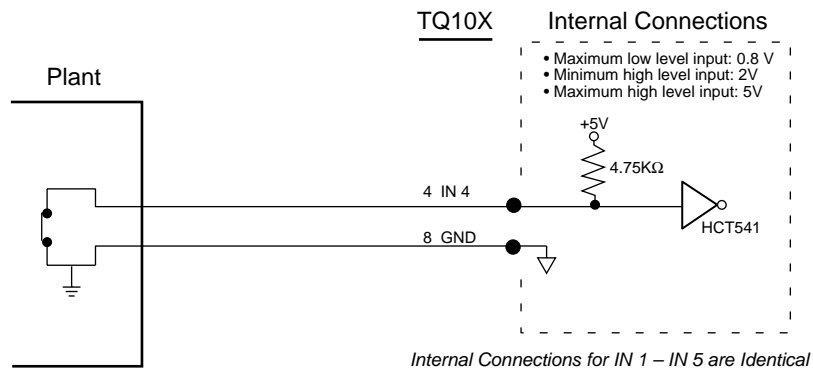
The color code for encoder wires was shown earlier for Compumotor SM and NeoMetric Series servo motors. Connect the cable's shield wire to the encoder ground terminal (pin 3).

### CAUTION

If you do not connect an encoder Z-channel output to the TQ10X, then you must ground the Z+ input on the TQ10X. To do this, connect a jumper wire between the Z+ input and the nearest available ground terminal (labeled GND).

## General Purpose Inputs (IN 1 – IN 5)

The TQ10X has five general purpose inputs. Each of these inputs may be configured to match the application needs. The figure represents a typical configuration of one of these inputs.



### General Purpose Input Connected to a Switch

The **IN** command is used to configure the inputs to the following functions:

**TRIGGER INPUT** – The TQ10X can dedicate up to five Trigger inputs. These inputs are pulled up internally. These inputs are used with the Trigger (**TR**) command to control the TQ10X's trigger function. Minimum pulse width is 1 ms.

**HOME POSITION INPUT** – The TQ10X can dedicate up to one Home input. The Home input allows you to establish a home reference position. This input is not active during power-up. Refer to the Go Home (**GH**) command for more information on setting up and using this function. Minimum pulse width is 1 ms.

**SEQUENCE SELECT INPUT** – The TQ10X can dedicate up to three Sequence Select inputs that allow you to control seven different sequences. Sequences are executed remotely by using one of the following logic patterns in conjunction with the **XP** command.

Sequence #	Ø	1	2	3	4	5	6	7
SEQ Input #1	Ø	1	Ø	1	Ø	1	Ø	1
SEQ Input #2	Ø	Ø	1	1	Ø	Ø	1	1
SEQ Input #3	Ø	Ø	Ø	Ø	1	1	1	1

Ø = low, pulled to ground  
1 = high, 5VDC

**STOP or KILL INPUT** – The TQ10X can dedicate up to one Stop and one Kill input. The active state is high. The Stop or Kill input is identical in function to the effect of the **S** or **K** command respectively.

**GO INPUT** – The TQ10X can dedicate up to one Go input. The active state is high. The Go input is identical in function to the effect of the **GO (G)** command.

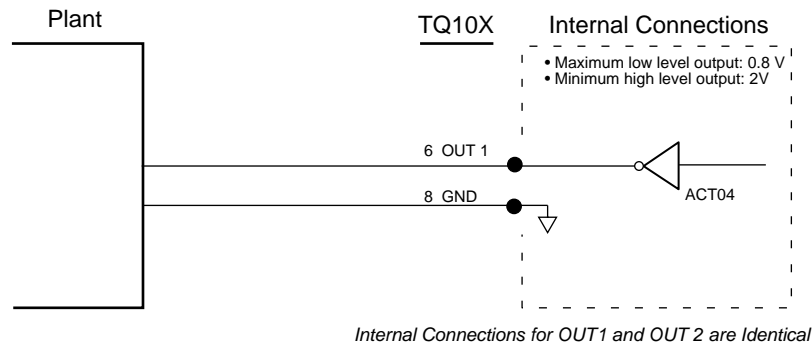
**NOTE**

Unless configured otherwise (**SSH** command), the controller will dump the commands following the **IN** command in the buffer. Please pay special attention to the state of the inputs before entering the **IN** command.

**Output #1 (OUT 1) and Output #2 (OUT 2)**

The TQ10X has two dedicated programmable +5 volt outputs. They may be used to signal peripheral devices upon the start or completion of a move. The default state for Outputs #1 and #2 is logic low. Refer to the Output (**O**) command for information on using these outputs.

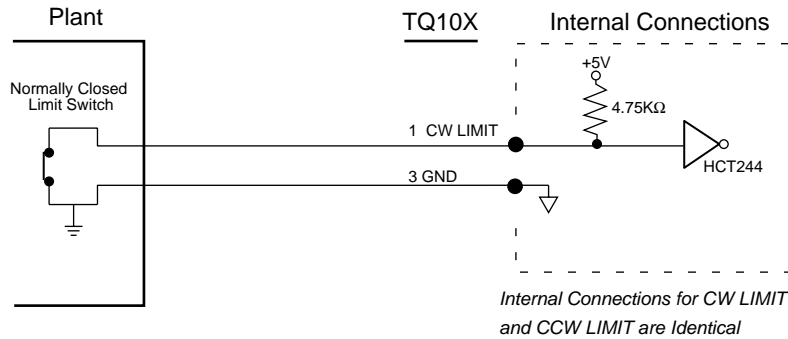
The next drawing shows the schematic for one of the outputs.



General Purpose Outputs

## CW LIMIT & CCW LIMIT Inputs

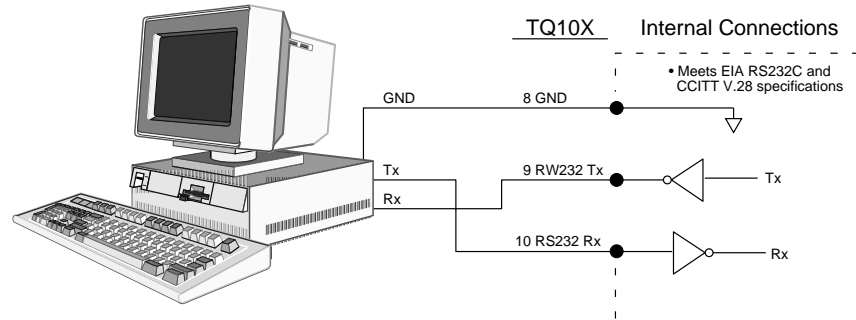
The TQ10X has two dedicated hardware end-of-travel limits (**CW LIMIT** and **CCW LIMIT**). When you power up the TQ10X, these inputs are enabled (high). To test the TQ10X without connecting the CCW and CW limits, you must disable the limits with the **LD3** command. You can use the Limit Switch Status Report (**RA**) and Input Status (**IS**) commands to monitor the limits' status. The following figure represents a typical configuration of these inputs. Minimum pulse width is 1 ms.



Hardware Limit Switch Inputs

## Connecting RS232-C Communications

The TQ10X uses RS-232C as its communication medium. The controller does not support handshaking. A typical three-wire (Rx, Tx, and Signal Ground) configuration is used. The figure represents a typical RS-232C configuration.

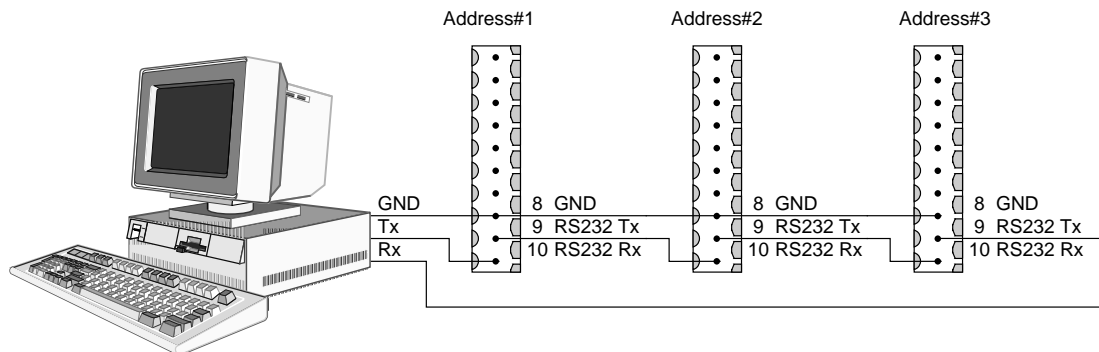


RS232-C Connections

## Daisy Chaining

You may daisy chain up to 255 TQ10Xs. Individual drive addresses are set with the **#** (Address Numbering) command. When daisy chained, the units may be addressed individually or simultaneously. You should establish a unique device address for each TQ10X.

Refer to the figure below for TQ10X daisy chain wiring.



RS232-C Daisy Chain of Three TQ10Xs

Commands prefixed with a device address control only the unit specified. Commands without a device address control all units on the daisy chain. The general rule is: *Any command that causes the drive to transmit information from the RS-232C port (such as a status or report command), must be prefixed with a device address.* This prevents daisy chained units from all transmitting at the same time.

Attach device identifiers to the front of the command. The Go (**G**) command instructs all units on the daisy chain to go, while **1G** tells only unit 1 to go.

When you use a single communications port to control more than one TQ10X, all units in a daisy chain receive and echo the same commands. Each device executes these commands, unless this command is preceded with an address that differs from the units on the daisy chain. This becomes critical if you instruct any TQ10X to transmit information. To prevent all of the units on the line from responding to a command, you must precede the command with the device address of the designated unit.

## 7. Connect AC Power

At this point in your installation procedure, you should have mounted your drive and motor, and connected motor cables and encoder cables to the drive.

The TQ10X does not have an *on/off* switch. When you plug the power cord into the drive, the system will turn on. Therefore, before you apply power to the TQ10X, verify the following:

- Motor should be properly secured
- Load should not yet be connected to motor shaft
- Motor cable should be connected to drive
- Drive should be properly mounted
- Encoder cable should be connected to drive
- Encoder cable should not be located close to motor cable

### Apply Power

Apply power to the TQ10X by plugging one end of the molded power cord into the drive's AC Power connector. The cord is 6 feet (1.8 m) long. Plug the other end of the power cord into an AC power source that meets the following specifications:

#### Specifications – AC Power Input

Input Power:	120VAC	nominal
	95VAC	minimum
	132VAC	maximum
	50 – 60 Hz	
Fuses:	No user serviceable fuses	
Grounding:	You must provide a proper AC power ground	

---

---

#### **WARNING**

The motor case and drive are grounded through the AC power connector ground pin. You must provide a proper AC power ground for safety purposes.

---

---

### Peak Power Ratings

The amount of power the TQ10X draws from your AC power source depends upon the motor you use and upon your specific application. For high power applications, we suggest you use a dedicated 20 amp service for the TQ10X. Even applications that use low *average* power may require 20 amp service if the *peak* power is high. Inadequate AC power can cause various problems that are difficult to diagnose.

## 8. Test Your System

Except for connecting the motor to the load, system installation should be complete at this point. Perform the test procedure below to verify that your system is functioning properly.

In the test procedure, you will command single revolution moves in the clockwise and counterclockwise direction. If your mechanics do not permit such moves, choose a move that allows you to easily verify correct system response.

---

---

### CAUTION

If you have an SM or NeoMetric Motor, use the drive's DIP switches to set the peak current at twice the motor's continuous current rating, or less. Motor damage due to excessive heating may result from the combination of high peak current and improper tuning values.

---

---

### Test Procedure

- ① Apply 120VAC power. The bicolor LED labeled GRN = POWER ON should be illuminated green.
- ② Command a slow move of one revolution in the clockwise direction. Verify that the motor turns as commanded. (If you have not connected hardware limit switches, send the command LD3 to disable limits, before you send a GO command.)
- ③ Command a slow move of one revolution in the counterclockwise direction. Verify that the motor turns as commanded.
- ④ Test any of the optional inputs and outputs that you have connected.

You may need to tune your system before you can obtain motion from the motor. See *Chapter 4 Tuning* for tuning instructions.

Successful completion of this procedure will verify that your motor and encoder are correctly connected to the TQ10X, and that the drive is functioning properly.

If the test was unsuccessful, observe the LEDs on the front panel of the TQ10X while you try the test procedure—they may indicate the cause of the problem. (*Chapter 6 Troubleshooting* has a complete description of LED functions.) Review earlier sections of this user guide, verify that you have completed each step, and try this test procedure again.

If the test is still unsuccessful, proceed to *Chapter 6 Troubleshooting* for problem identification and solution procedures.

## 9. Connect the Motor to the Load – Couplers

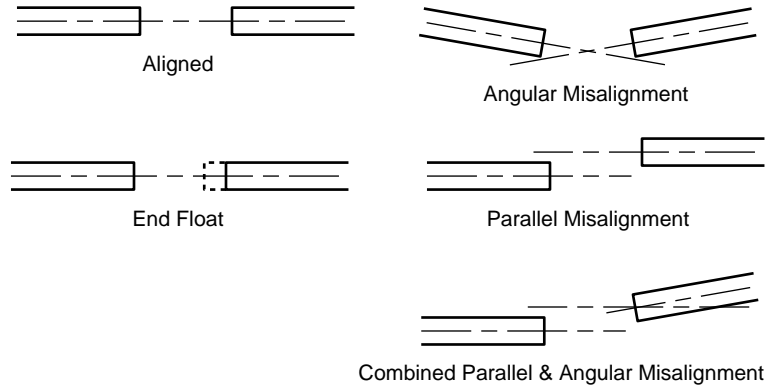
Your mechanical system should be as stiff as possible. Because of the high torques and accelerations of servo systems, the ideal coupling between a motor and load would be completely rigid. Rigid couplings require perfect alignment, however, which can be difficult or impossible to achieve. In real systems, some misalignment is inevitable. Therefore, a certain amount of flexibility may be required in the system. Too much flexibility can cause resonance problems, however. These conflicting requirements are summarized below.

- Maximum Stiffness (in the mechanical system)
- Flexibility (to accommodate misalignments)
- Minimum Resonance (to avoid oscillations)

The best design may be a compromise between these requirements.

## Misalignment & Couplers

Align the motor shaft and load as accurately as possible. In most applications, some misalignment is unavoidable, due to tolerance variations in components. However, excessive misalignment may degrade your system's performance. The three misalignment conditions, which can exist in any combination, are illustrated and described in the next drawing.



### Misalignment Conditions

- Angular Misalignment: The center lines of two shafts intersect at an angle other than zero degrees.
- Parallel Misalignment: The offset of two mating shaft center lines, although the center lines remain parallel to each other.
- End Float: A change in the relative distance between the ends of two shafts.

The type of misalignment in your system will affect your choice of coupler.

### Single-Flex Coupling

Use a single-flex coupling when you have angular misalignment only. Because a single-flex coupling is like a hinge, one and only one of the shafts must be free to move in the radial direction without constraint. **Do not use a double-flex coupling in this situation:** it will allow too much freedom and the shaft will rotate eccentrically, which will cause large vibrations and catastrophic failure. **Do not use a single-flex coupling with a parallel misalignment:** this will bend the shafts, causing excessive bearing loads and premature failure.

### Double-Flex Coupling

Use a double-flex coupling whenever two shafts are joined with parallel misalignment, or a combination of angular and parallel misalignment (the most common situation).

Single-flex and double-flex couplings may or may not accept end play, depending on their design.

### Rigid Coupling

Rigid couplings are generally not recommended, because they cannot compensate for any misalignment. They should be used only if the motor or load is on some form of floating mounts that allow for alignment compensation. Rigid couplings can also be used when the load is supported entirely by the motor's bearings. A small mirror connected to a motor shaft is an example of such an application.

## Coupling Manufacturers

HUCO

70 Mitchell Blvd, Suite 201

San Rafael, CA 94903

(415) 492-0278

ROCOM CORP.

5957 Engineer Drive

Huntington Beach, CA 92649

(714) 891-9922

HELI-CAL

P.O. Box 1460

Santa Maria, CA 93456

(805) 928-3851

## Resonance Issues

A coupler that is too flexible may cause a motor to overshoot its commanded position. When the encoder sends a position feedback signal, the controller will command a correction move in the opposite direction. If the resonant frequency of the system is too low (too flexible), the motor may overshoot again and again. In extreme cases, the system could become an oscillator.

To solve resonance problems, increase the mechanical stiffness of the system to raise the resonant frequency so that it no longer causes a problem.

If you use a servo as a direct replacement for a step motor, you may need to modify your mechanical coupling system to reduce resonance. For example, we recommend using a bellows-style coupler with servo motors, rather than the helical-style coupler that is often used with step motors. Helical couplers are often too flexible, with resonant frequencies that can cause problems. Bellows couplers are stiffer, and perform better in servo systems.

## What's Next

---

This completes the system installation procedure. Proceed to *Chapter 4, Tuning* for instructions about tuning the TQ10X Drive.