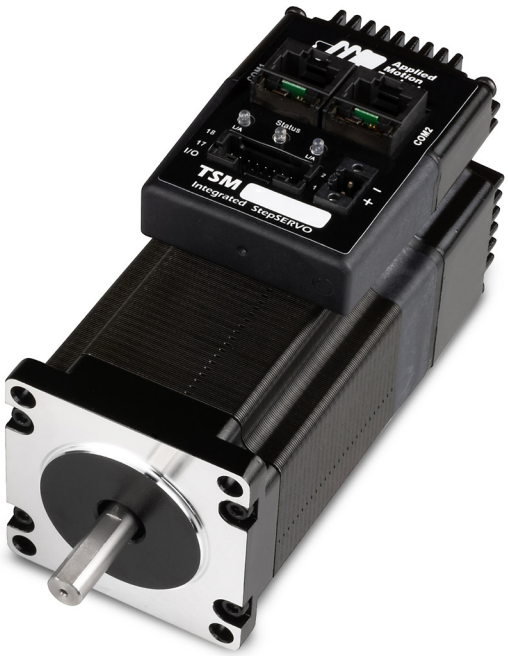
TSM23X-IP

Integrated StepSERVO™ Motor with TruCount™ Absolute Encoder



Hardware Manual

Applied Motion Products
A MOONS' COMPANY

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Contents

Model	Communications		
	Ethernet	Ethernet/IP	Modbus/TCP
TSM23X2B-IP	✓	✓	✓
TSM23X3B-IP	✓	✓	✓
TSM23X4B-IP	✓	✓	✓

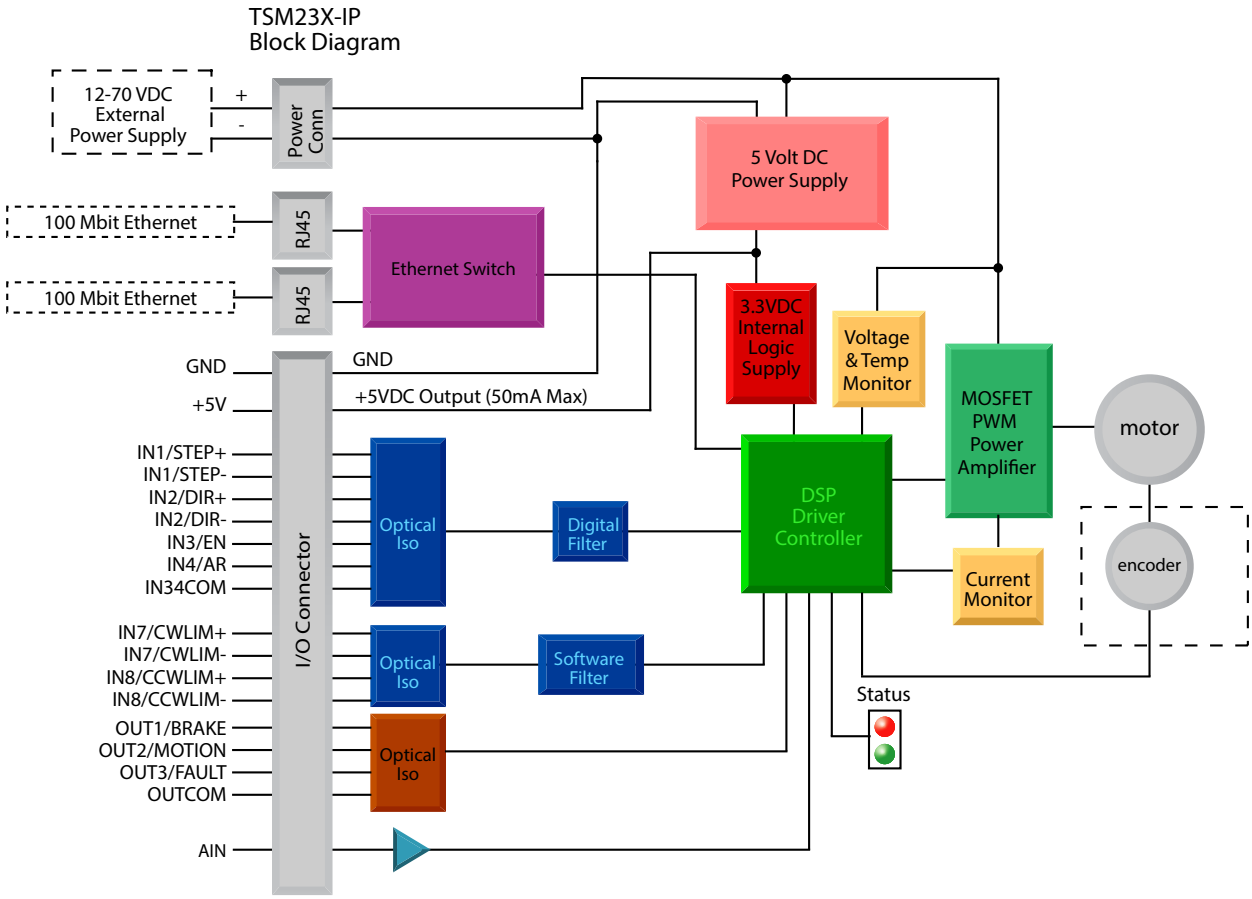
1 Introduction

Thank you for selecting the Applied Motion Products TSM23X-IP Integrated Motor.The TSM line of integrated StepSERVO™ motors combines servo technology with an integrated motor to create a product with exceptional feature and broad capability. TruCount™ encoders provide the ultimate in hassle-free positioning of rotary and linear axes. TruCount Encoders are multi-turn, absolute encoders that don't require batteries or external power to track encoder position while the motor is powered off. We hope our commitment to performance, quality and economy will result in a successful motion control project.

1.1 Features

- Programmable, Digital servo driver and motor in an integrated package
- Operates from a 12 to 70 volt DC power supply
- Control Modes:
  - Torque Control
    - Analog input
    - SCL commanded
  - Velocity Control
    - Digital input control
    - Analog velocity
    - SCL Commanded Velocity (Jogging)
  - Position Control
    - Digital input control
    - Analog Position
    - SCL Commanded Position
  - Q Programming, stand alone operation
- Communications:
  - Dual port Ethernet, Ethernet/IP, Modbus/TCP
- TruCount™ absolute multi-turn encoder
  - 20,000 counts single turn
  - 65,536 turns multi-turn
- Available torque:
  - TSM23X2B: Up to 1.0N•m Continuous(1.3 N•m Boost)
  - TSM23X3B: Up to 1.5N•m Continuous(2.0 N•m Boost)
  - TSM23X4B: Up to 1.9N•m Continuous(2.4 N•m Boost)
- I/O:
  - 6 optically isolated digital inputs, with adjustable bandwidth digital noise rejection filter, 5 to 24 volts
  - 3 optically isolated digital output, 30V/100 mA max.
  - 1 analog input for speed, position and torque control, 0 to 5 volts
- Technological advances:
  - Full servo control, Closed loop
  - Efficient, Accurate, Fast, Smooth
  - Intelligent, Compact

1.2 Block Diagram



1.3 Safety Instructions

Only qualified personnel should transport, assemble, install, operate, or maintain this equipment. Properly qualified personnel are persons who are familiar with the transport, assembly, installation, operation, and maintenance of motors, and who meet the appropriate qualifications for their jobs.

To minimize the risk of potential safety problems, all applicable local and national codes regulating the installation and operation of equipment should be followed. These codes may vary from area to area and it is the responsibility of the operating personnel to determine which codes should be followed, and to verify that the equipment, installation, and operation are in compliance with the latest revision of these codes.

Equipment damage or serious injury to personnel can result from the failure to follow all applicable codes and standards. Applied Motion Products does not guarantee the products described in this publication are suitable for a particular application, nor do they assume any responsibility for product design, installation, or operation.

- Read all available documentation before assembly and operation. Incorrect handling of the products referenced in this manual can result in injury and damage to persons and machinery. All technical information concerning the installation requirements must be strictly adhered to.
- It is vital to ensure that all system components are connected to earth ground. Electrical safety is impossible without a low-resistance earth connection.
- This product contains electrostatically sensitive components that can be damaged by incorrect handling. Follow qualified anti-static procedures before touching the product.
- During operation keep all covers and cabinet doors shut to avoid any hazards that could possibly cause severe damage to the product or personal health.
- During operation, the product may have components that are live or have hot surfaces.
- Never plug in or unplug the Integrated Motor while the system is live. The possibility of electric arcing can cause damage.

Be alert to the potential for personal injury. Follow recommended precautions and safe operating practices emphasized with alert symbols. Safety notices in this manual provide important information. Read and be familiar with these instructions before attempting installation, operation, or maintenance. The purpose of this section is to alert users to the possible safety hazards associated with this equipment and the precautions necessary to reduce the risk of personal injury and damage to equipment. Failure to observe these precautions could result in serious bodily injury, damage to the equipment, or operational difficulty.

2 Getting Started

The following items are needed:

- a 12 - 70 Volt DC power supply, see the section below entitled “Choosing a Power Supply” for help in choosing the right one
- a small flat blade screwdriver for tightening the connectors (included)
- a PC running Microsoft Windows XP, Vista, or Windows 7, 8, 10
- RJ45 Ethernet cable for communication

2.1 Installing Software

Before utilizing the TSM23XIP Integrated StepSERVO™ Motor and StepServo Quick Tuner Software in an application, the following steps are necessary:

- Install the Step-Servo Quick Tuner software from the Applied Motion Products website.
- Connect the drive to the power supply. See instructions below.
- Launch the software by clicking Start...Programs...Applied Motion Products.
- Apply power to the drive.
- The software will recognize the drive and display the model and firmware version. At this point, it is ready for use.

2.2 Mounting the Hardware

As with any step motor, the TSM23 must be mounted so as to provide maximum heat sinking and airflow. Keep enough space around the Integrated Motor to allow for airflow.

- Never use the drive where there is no airflow or where other devices cause the surrounding air to be more than 40°C (104°F).
- Never put the drive where it can get wet.
- Never use the drive where metal or other electrically conductive particles can infiltrate the drive.
- Always provide airflow around the drive.

2.3 Choosing a Power Supply

The main considerations when choosing a power supply are the voltage and current requirements for the application.

2.3.1 Voltage

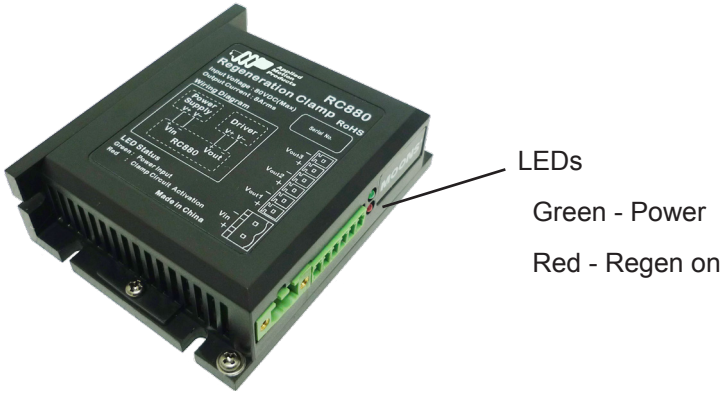
The TSM23X is designed to give optimum performance between 24 and 48 Volts DC. Choosing the voltage depends on the performance needed and motor/drive heating that is acceptable and/or does not cause a drive over-temperature. Higher voltages will give higher speed performance but will cause the TSM23X to produce higher temperatures. Using power supplies with voltage outputs that are near the drive maximum may significantly reduce the operational duty-cycle.

The extended range of operation can be as low as 10 VDC minimum to as high as 75 VDC maximum. When operating below 18 VDC, the power supply input may require larger capacitance to prevent under-voltage and internal-supply alarms. Current spikes may make supply readings erratic. The supply input cannot go below 10 VDC for reliable operation. Absolute minimum power supply input is 10 VDC. If the Input supply drops below 10 VDC the low voltage alarm will be triggered. This will not fault the drive.

Absolute maximum power supply input is 75 VDC at which point an over-voltage alarm and fault will occur. When using a power supply that is regulated and is near the drive maximum voltage of 75 VDC, a voltage clamp may be required to prevent over-voltage when regeneration occurs. When using an unregulated power supply, make sure the no-load voltage of the supply does not exceed the drive's maximum input voltage of 75 VDC.

2.3.2 Regeneration Clamp

If a regulated power supply is being used, there may be a problem with regeneration. When a load decelerates rapidly from a high speed, some of the kinetic energy of the load is transferred back to the power supply, possibly tripping the over-voltage protection of a regulated power supply, causing it to shut down. This problem can be solved with the use of an Applied Motion Products RC880 Regeneration Clamp. It is recommended that an RC880 initially be installed in an application. If the "regen" LED on the RC880 never flashes, the clamp is not necessary.

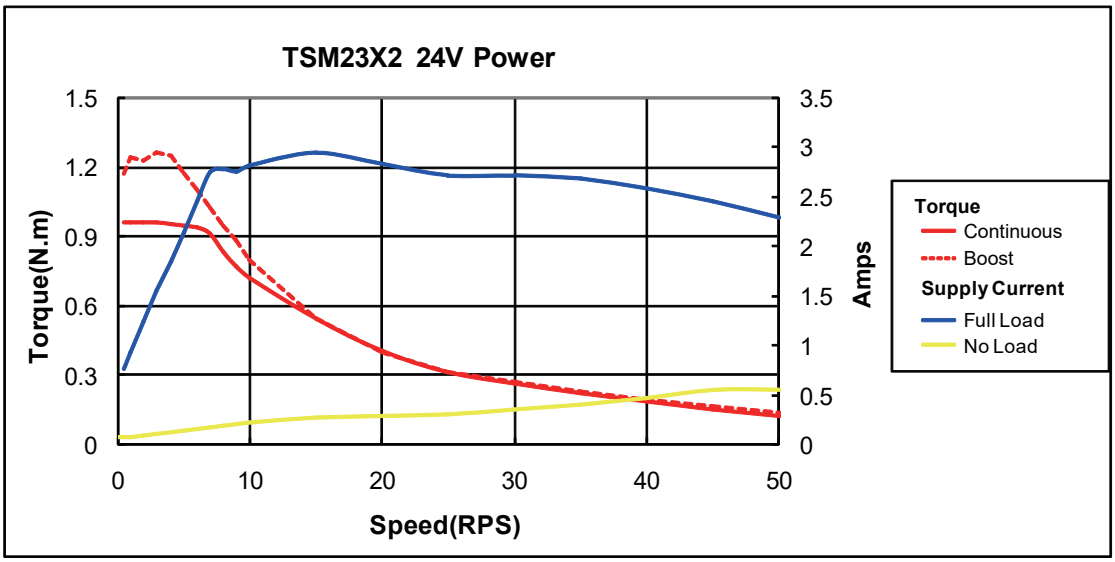


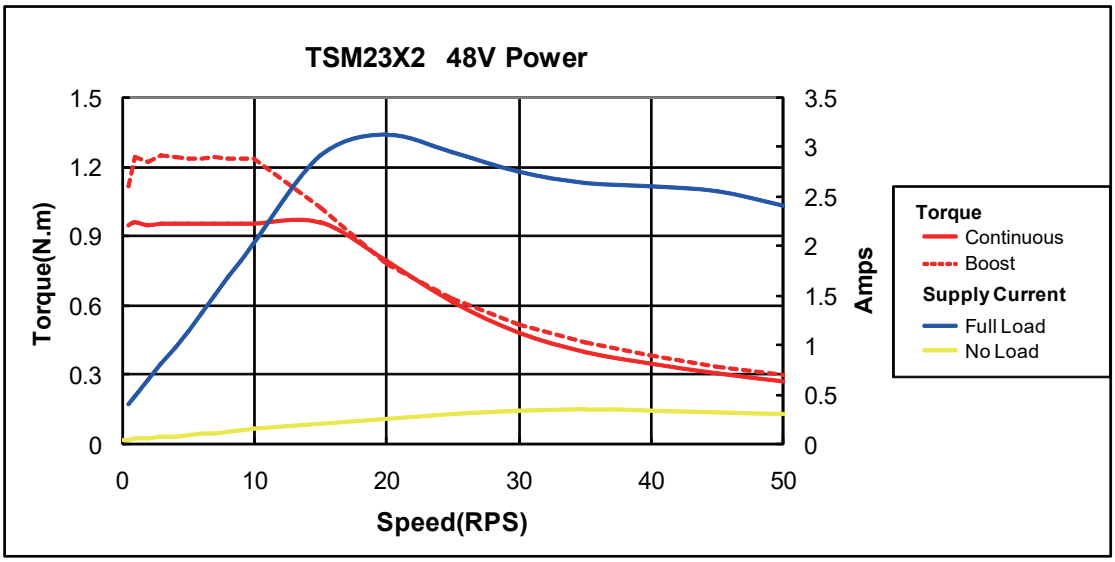
RC880 Regen Clamp

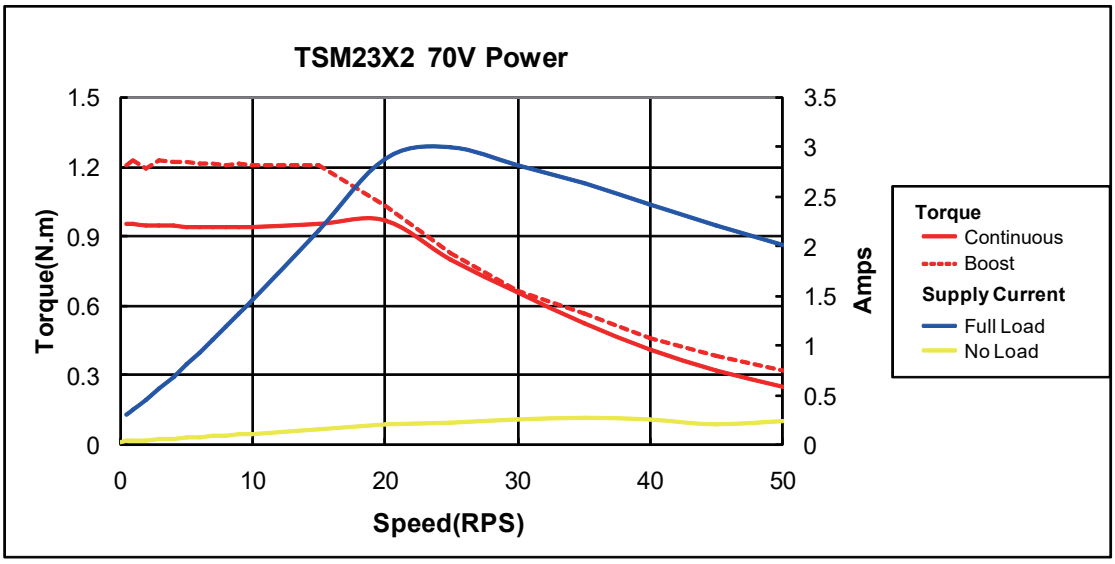
2.3.3 Current

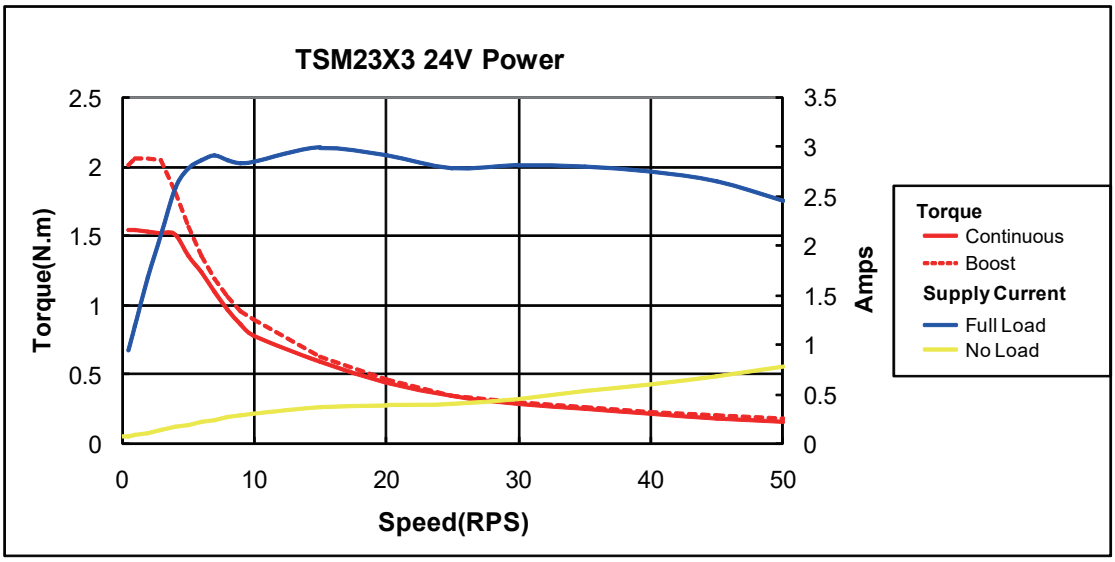
The maximum supply currents required by the TSM23X are shown in the charts below at different power supply voltage inputs. The TSM23X power supply current is lower than the winding currents because it uses switching amplifiers to convert a high voltage and low current into lower voltage and higher current. The more the power supply voltage exceeds the motor voltage, the less current will be required from the power supply.

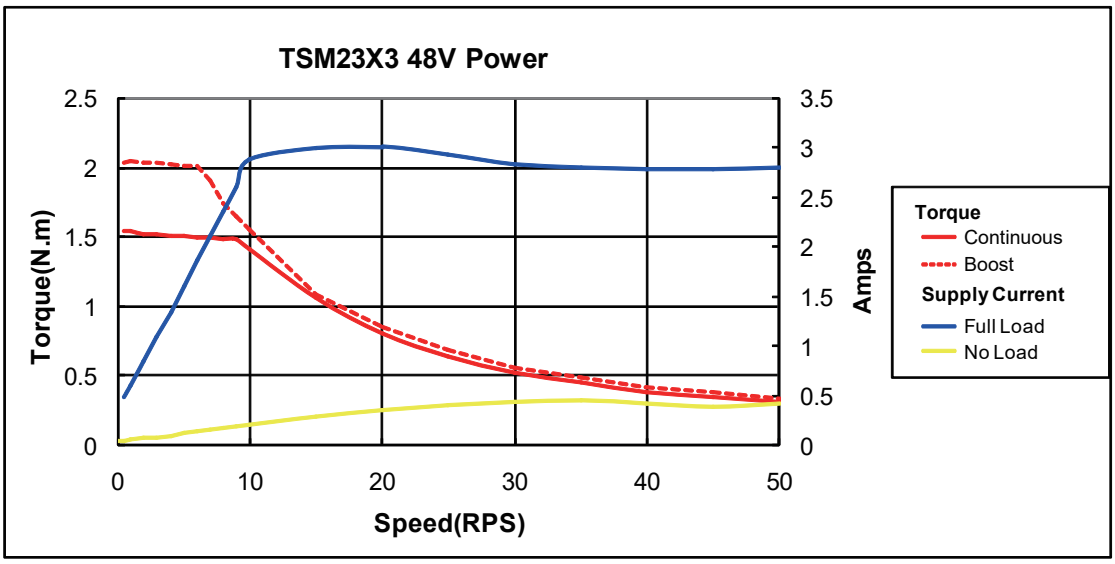
It is important to note that the current draw is significantly different at higher speeds depending on the torque load to the motor. Estimating how much current is necessary may require a good analysis of the load the motor will encounter.

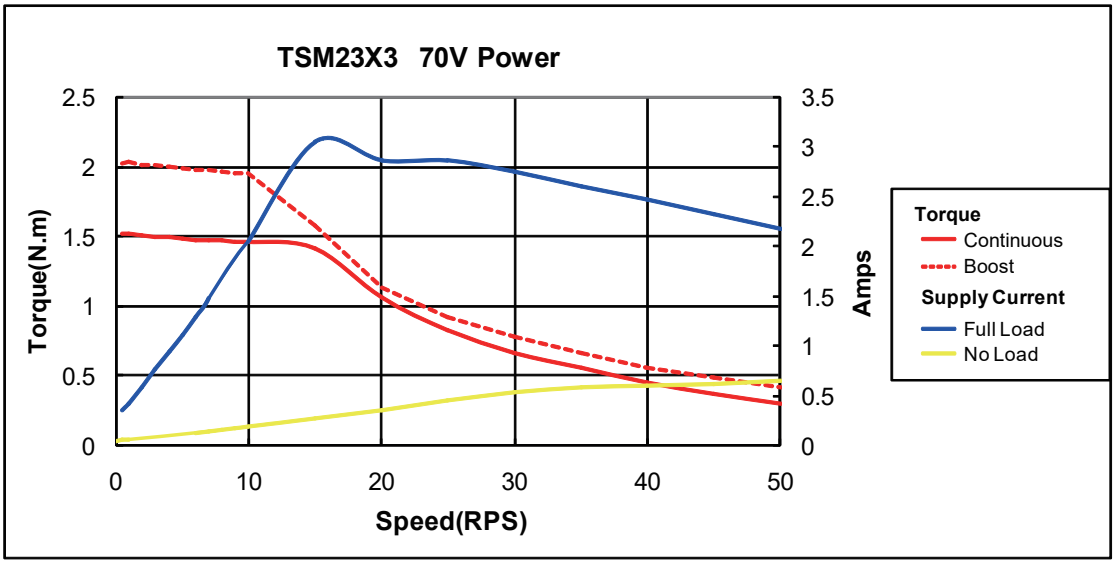





TSM23X2 70V Power
Torque(N.m)
1.5
1.2
0.9
0.6
0.3
0
3.5
3
2.5
2
1.5
1
0.5
0
Amps
0
10
20
30
40
50
Speed(RPS)
Torque
Continuous
Boost
Supply Current
Full Load
No Load


TSM23X3 24V Power
Torque(N.m)
2.5
2
1.5
1
0.5
0
3.5
3
2.5
2
1.5
1
0.5
0
Amps
0
10
20
30
40
50
Speed(RPS)
Torque
Continuous
Boost
Supply Current
Full Load
No Load


TSM23X3 48V Power
Torque(N.m)
2.5
2
1.5
1
0.5
0
3.5
3
2.5
2
1.5
1
0.5
0
Amps
0
10
20
30
40
50
Speed(RPS)
Torque
Continuous
Boost
Supply Current
Full Load
No Load

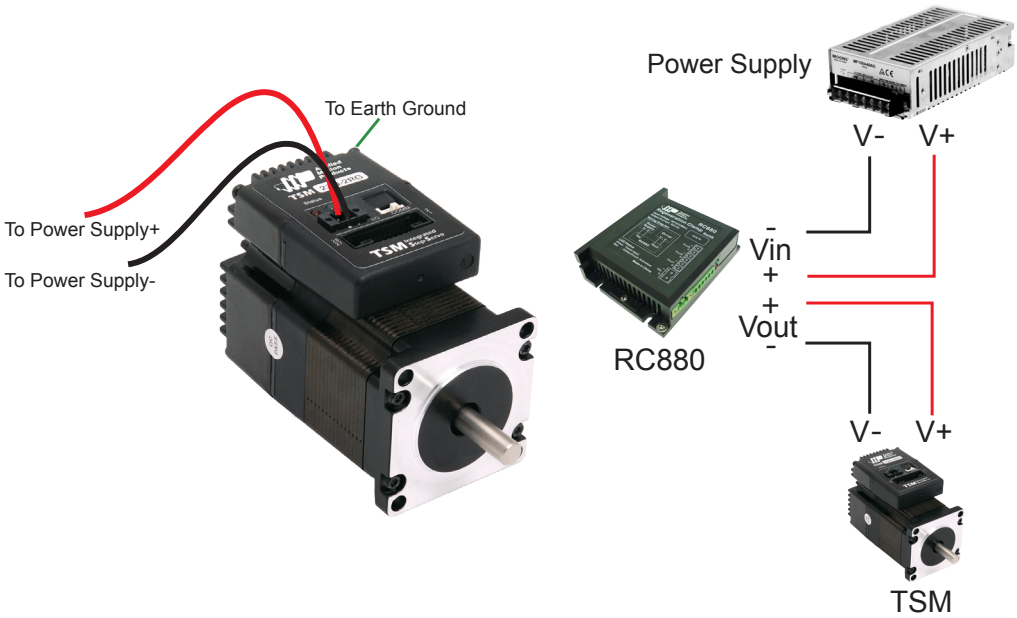

TSM23X3 70V Power
Torque(N.m)
2.5
2
1.5
1
0.5
0
3.5
3
2.5
2
1.5
1
0.5
0
Amps
0
10
20
30
40
50
Speed(RPS)
Torque
Continuous
Boost
Supply Current
Full Load
No Load

3 Installation/Connections

3.1 Connecting the Power Supply

Use 16 to 20-gauge wire to connect the TSM23 to a power supply. It contains an internal fuse connected to the “+” terminal that is not user replaceable. If a user serviceable fuse is desired, install a 6.3 amp fast acting fuse in line with the “+” power supply lead.

Be careful not to reverse the wires. Reversing the connection may open the internal fuse on the drive and void the warranty.



Applied Motion Products offers two matched power supplies for use with the TSM23X.

(To use with a switch power supplier, a RC880 regen must be connected in system)

The RC880 regeneration clamp is for use where regeneration from the motor may cause damage to the drive. In these cases the RC880 is connected between the drive and power supply and absorbs regenerated energy.

3.2 Connecting the TSM23X Communications

Connecting to a PC using Ethernet

This process requires three steps:
Physically connect the drive to the network (or directly to the PC). There are 2 RJ45 connectors on the drive labeled COM1 and COM2.

- For Ethernet Motor configuration and programming, Please use port "COM1 " on the motor only.
- If the Ethernet network is connected in a daisy-chain fashion, the connection should be from Motor#1 COM2 to Motor#2 COM1, Motor#2 COM2 to Motor#3 COM1 and so on.
- If using a router or hub on the network, the connection should be from the router or hub to the drive. Only COM1 port on the drive can be used, but take care to not connect to both COM ports as this may cause the communication to work incorrectly.
- Set the drive's IP address
- Set the appropriate networking properties on the PC

Note: The following sections are taken from the "Host Command Reference - Appendix G: eSCL (SCL over Ethernet) Reference". For more information, please read the rest of the guide. It can be downloaded from Applied Motion Products website.

Setting the IP Address

Your TSM23 stores two IP addresses: the "normal"address" and the "recovery" address. Once you've connected your TSM23 to a PC, you can set the "normal" address to a value that is best for your network. If you don't know the IP address of your TSM23, you must connect using the "recovery" address. To do this, power up the TSM23 with the network cable unplugged. Wait five seconds, then plug in the network cable. The TSM23 will then communicate using the "recovery" address, which is always 10.10.10.10. Once you are connected to a PC that' running the Step Servo Quick Tuner software, you can click "IP Table" on the top menu bar and set the normal IP address.

If you later connect the TSM23 to your network and it doesn't communicate, it might be do to a slow network component that is fooling the TSM23 into using the recovery address. In that case, you should change the recovery delay to a long time period. That is also done by clicking "IP Table" in Step Servo Quick Tuner.

Addresses, Subnets, and Ports

Every device on an Ethernet network must have a unique IP address. In order for two devices to communicate with each other, they must both be connected to the network and they must have IP addresses that are on the same subnet. A subnet is a logical division of a larger network. Members of one subnet are generally not able to communicate with members of another unless they are connected through special network equipment (e.g. router). Subnets are defined by the choices of IP addresses and subnet masks.
If you want to know the IP address and subnet mask of your PC, select Start…All Programs… Accessories…Command Prompt. Then type "ipconfig" and press Enter. You should see something like this:

```
Windows IP Configuration

Ethernet adapter Local Area Connection:

        Connection-specific DNS Suffix  . :
        IP Address. . . . . . . . . . . . : 192.168.0.22
        Subnet Mask . . . . . . . . . . . : 255.255.255.0
        Default Gateway . . . . . . . . . : 192.168.0.254
```

If your PC's subnet mask is set to 255.255.255.0, a common setting known as a Class C subnet mask, then your machine can only talk to another network device whose IP address matches yours in the first three octets. (The numbers between the dots in an IP address are called octets.) For example, if your PC is on a Class C subnet and has an IP address of 192.168.0.20, it can talk to a device at 192.168.0.40, but not one at 192.168.1.40. If you change your subnet mask to 255.255.0.0 (Class B) you can talk to any device whose first two octets match yours. Be sure to ask your system administrator before doing this. Your network may be segmented for a reason.

Your drive IP address can be set by using StepServo Quick Tuner Software. The default or “recovery” address is “10.10.10.10”.

Your TSM23 stores two IP addresses: the “normal”address” and the “recovery” address.

Once you’ve connected your TSM23 to a PC, you can set the “normal” address to a value that is best for your network. If you don’t know the IP address of your TSM23, you must connect using the “recovery” address. To do this, power up the TSM23 with the network cable unplugged. Wait five seconds, then plug in the network cable. The TSM23 will then communicate using the “recovery” address, which is always 10.10.10.10. Once you are connected to a PC that’ running the Step Servo Quick Tuner software, you can click “IP Table” on the top menu bar and set the normal IP address.

If you later connect the TSM23 to your network and it doesn’t communicate, it might be do to a slow network component that is fooling the TSM23 into using the recovery address. In that case, you should change the recovery delay to a long time period. That is also done by clicking “IP Table” in Step Servo Quick Tuner.

If someone were to change the other settings and not write it down or tell anyone then you will not be able to communicate with your drive. The only way to “recover” it is to use the recovery address.
Setting the address to “0.0.0.0”, means using the “DHCP” function. It commands the drive to get an IP address from a DHCP server on the network. The IP address automatically assigned by the DHCP server may be “dynamic” or “static” depending on how the administrator has configured DHCP. The DHCP setting is reserved for advanced users.

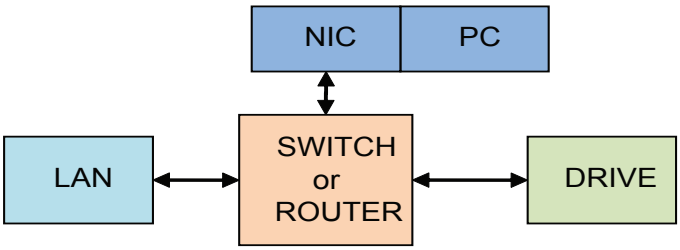
Your PC, or any other device that you use to communicate with the drive, will also have a unique address.

One of the great features of Ethernet is the ability for many applications to share the network at the same time. Ports are used to direct traffic to the right application once it gets to the right IP address. The UDP eSCL port in our drives is 7775. To send and receive commands using TCP, use port number 7776. You’ll need to know this when you begin to write your own application. You will also need to choose an open (unused) port number for your application. Our drive doesn’t care what that is; when the first command is sent to the drive, the drive will make note of the IP address and port number from which it originated and direct any responses there. The drive will also refuse traffic from other IP addresses that is headed for the eSCL port. The first application to talk to a drive “owns” the drive. This lock is only reset when the drive powers down.
If you need help choosing a port number for your application, you can find a list of commonly used port numbers at http://www.iana.org/assignments/port-numbers.

One final note: Ethernet communication can use one or both of two “transport protocols”: UDP and TCP. eSCL commands can be sent and received using either protocol. UDP is simpler and more efficient than TCP, but TCP is more reliable on large or very busy networks where UDP packets might occasionally be dropped.

Option 1: Connect a Drive to Your Local Area Network

If you have a spare port on a switch or router and if you are able to set your drive to an IP address that is compatible with your network, and not used by anything else, this is a simple way to get connected. This technique also allows you to connect multiple drives to your PC. If you are on a corporate network, check with the system administrator before connecting anything new to the network. They should be able assign a suitable address and help you get going.
If you are not sure which addresses are already used on your network, you can find out using "Angry IP scanner", which can be downloaded free from http://www.angryip.org/w/Download. But be careful: an address might appear to be unused because a computer or other device is currently turned off. And many networks use dynamic addressing where a DHCP server assigns addresses "on demand". The address you choose for your drive might get assigned to something else by the DHCP server at another time.



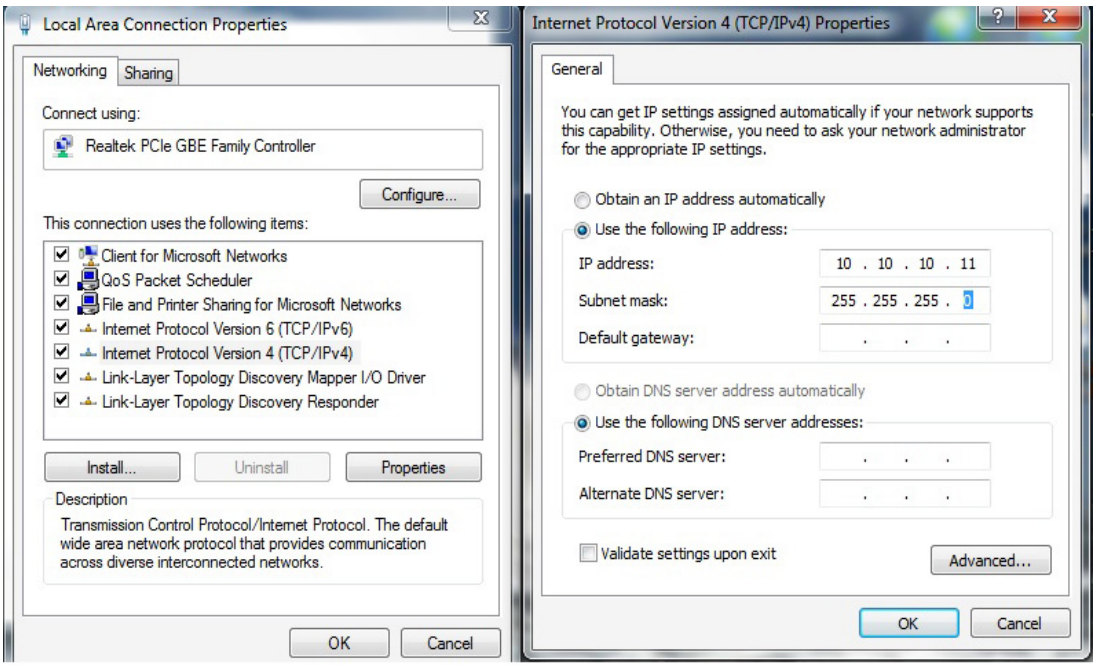
If the PC's address is not in one of the configured drive subnets, you will have to change your subnet mask to 255.255.0.0 in order to talk to your drive. To change your subnet mask:
1. On Windows XP, right click on "My Network Places" and select properties. On Windows 7, click Computer.
Scroll down the left pane until you see "Network". Right click and select properties. Select "Change adapter settings"

2. You should see an icon for your network interface card (NIC). Right click and select properties

3. Scroll down until you see "Internet Properties (TCP/IP)". Select this item and click the Properties button. On Windows 7/8/Vista, look for "(TCP/IPv4)"

4. If the option "Obtain an IP address automatically" is selected, your PC is getting an IP address and a subnet mask from the DHCP server. Please cancel this dialog and proceed to the next section of this manual: "Using DHCP".

5. If the option "Use the following IP address" is selected, life is good. Change the subnet mask to "255.255.0.0" and click OK.



Using DHCP (not recommended)

If you want to use your drive on a network where all or most of the devices use dynamic IP addresses supplied by a DHCP server, set the IP address to “0.0.0.0”. When the drive is connected to the network and powered on, it will obtain an IP address and a subnet mask from the server that is compatible with your PC. The only catch is that you won’t know what address the server assigns to your drive. As it may be difficult to resolve addresses with DHCP, this method is not recommended.

Option 2: Connect a Drive Directly to Your PC

1. Connect one end of a CAT5e STP cable into the LAN card (NIC) on your PC and the other to the drive.
You don’t need a special “crossover cable”; the drive will automatically detect the direct connection and make the necessary physical layer changes.

2. The default IP address is “10.10.10.10”.

3. To set the IP address of your PC:
    a. On Windows XP, right click on “My Network Places” and select properties.
    b. On Windows 7, click Computer. Scroll down the left pane until you see “Network”. Right click and select properties. Select “Change adapter settings”

4. You should see an icon for your network interface card (NIC). Right click and select properties.
    a. Scroll down until you see “Internet Properties (TCP/IP)”. Select this item and click the Properties button.
    b. On Windows 7 and Vista, look for “(TCP/IPv4)”

5. Select the option “Use the following IP address”. Then enter the address “10.10.10.10”. This will give your PC an IP address that is on the same subnet as the drive. Windows will know to direct any traffic intended for the drive’s IP address to this interface card.

6. Next, enter the subnet mask as “255.255.255.0”.

7. Be sure to leave “Default gateway” blank. This will prevent your PC from looking for a router on this subnet.

8. Because you are connected directly to the drive, anytime the drive is not powered on, your PC will annoy you with a small message bubble in the corner of your screen saying “The network cable is unplugged.”

Option 3: Use Two Network Interface Cards (NICs)

This technique allows you to keep your PC connected to your LAN, but keeps the drive off the LAN, preventing possible IP conflicts or excessive traffic.

1. If you use a desktop PC and have a spare card slot, install a second NIC and connect it directly to the drive using a CAT5e cable. You don't need a special "crossover cable"; the drive will automatically detect the direct connection and make the necessary physical layer changes.

2. If you use a laptop and only connect to your LAN using wireless networking, you can use the built-in RJ45 Ethernet connection as your second NIC.

3. The default IP address is "10.10.10.10".

4. To set the IP address of the second NIC:

    a. On Windows XP, right click on "My Network Places" and select properties.

    b. On Windows 7, click Computer. Scroll down the left pane until you see "Network". Right click and select properties. Select "Change adapter settings"

5. You should see an icon for your newly instated NIC. Right click again and select properties.

    a. Scroll down until you see "Internet Properties (TCP/IP)". Select this item and click the Properties button.

    b. On Windows 7 and Vista, look for "(TCP/IPv4)"

6. Select the option "Use the following IP address". Then enter the address "10.10.10.10". This will give your PC an IP address that is on the same subnet as the drive. Windows will know to direct any traffic intended for the drive's IP address to this interface card.

7. Next, enter the subnet mask as "255.255.255.0". Be sure to leave "Default gateway" blank. This will prevent your PC from looking for a router on this subnet.

8. Because you are connected directly to the drive, anytime the drive is not powered on your PC will annoy you with a small message bubble in the corner of your screen saying "The network cable is unplugged."

3.3 Inputs and Outputs

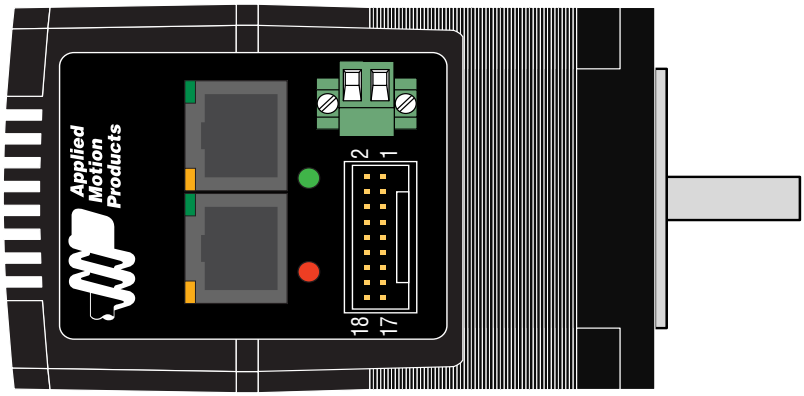
The TSM23X has three types of inputs:

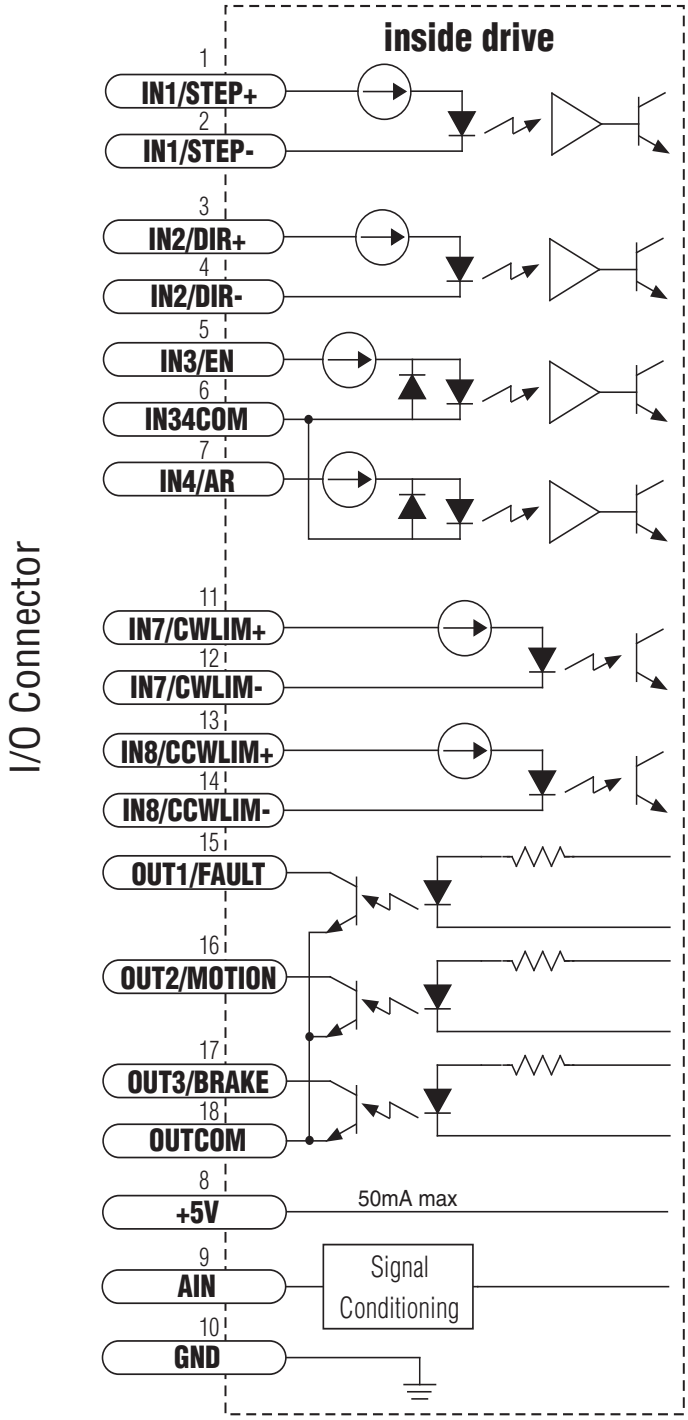
- High speed digital inputs for step & direction commands or encoder following, 5 to 24 volt logic
- Low speed digital input for other signals, 5 to 24 volt logic
- Analog input for analog speed and positioning modes

All drives include 6 digital inputs and 1 analog input

- Two high speed digital inputs, 5-24 volt logic, labeled IN1, IN2 can be used for commanding position. Pulse & direction or CW/CCW pulses can be fed to these IN1 and IN2 from a motion controller. A/B quadrature encoder signals can be used to follow a master encoder.
- Inputs 3, 4 can be connected to sensors, switches and other devices for use with streaming SCL and Q programming commands such as Wait Input (WI), Seek Home (SH), Feed to Sensor (FS), etc. IN3 can also be used as a motor enable input. IN4 can be used as an alarm reset input. IN3 and IN4 share a common terminal, but can be used as sinking or sourcing inputs.
- Two lower bandwidth inputs, IN7 and IN8, also with 5-24V input range, can be used for CW/CCW end-of-travel limits.
- Three digital outputs can be used to connect the TSM23X to other electronic equipment. OUT1 can be dedicated to signaling a fault condition. OUT2 can be used to automatically indicate when the motor is moving. OUT3 can be used to control a failsafe brake. The three outputs can also be used with streaming SCL and Q programming commands such as Set Output (SO), Feed and Set Output (FO). All three inputs share a common terminal and can be used only as sinking outputs.
- One analog input, 0-5 volt logic, labeled AIN, which can be used as an analog velocity or position command. It can also be used with streaming SCL and Q programming commands such as Wait Input, Seek Home, Feed to Sensor, etc.

3.3.1 Connector Pin Diagram

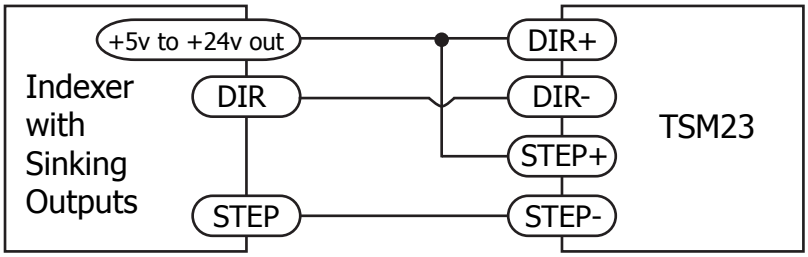



inside drive
I/O Connector
1
IN1/STEP+
2
IN1/STEP-
3
IN2/DIR+
4
IN2/DIR-
5
IN3/EN
6
IN34COM
7
IN4/AR
11
IN7/CWLIM+
12
IN7/CWLIM-
13
IN8/CCWLIM+
14
IN8/CCWLIM-
15
OUT1/FAULT
16
OUT2/MOTION
17
OUT3/BRAKE
18
OUTCOM
8
+5V
50mA max
9
AIN
Signal Conditioning
10
GND

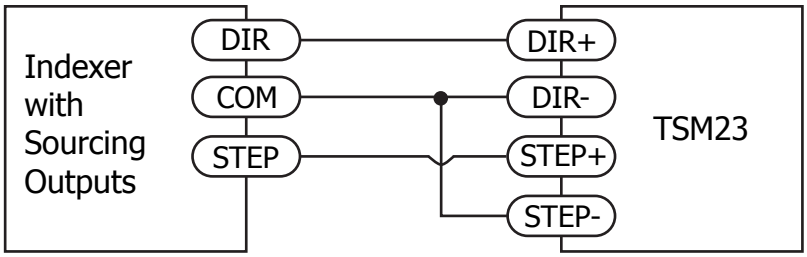
3.3.2 X1 & X2 Digital Inputs

The TSM23 drives include two high-speed inputs: X1/STEP and X2/DIR. They accept 5 to 24 volt single-ended or differential signals, up to 2 MHz. Typically these inputs connect to an external controller that provides step & direction command signals. You can also connect a master encoder to the high-speed inputs for "following" applications. Or you can use these inputs with Wait Input(WI), Feed to Sensor(FS), Seek Home(SH) and other SCL or Q commands.

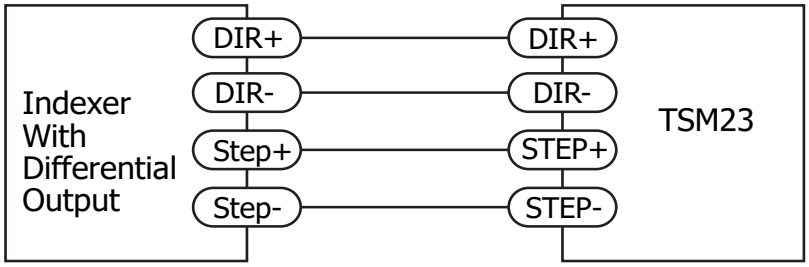
The diagrams below show how to connect the STEP & DIR Inputs to various commonly used devices.



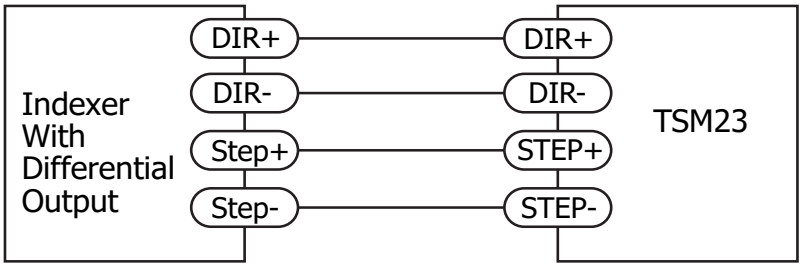
Connecting to Indexer with Sinking Outputs



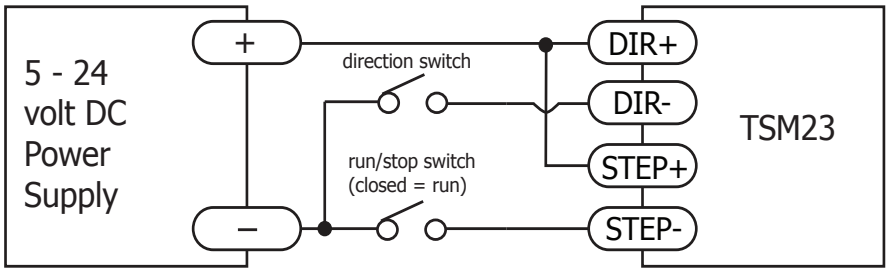
Connecting to Indexer with Sourcing Outputs



Connecting to Indexer with Differential Outputs



Connecting to Indexer with Differential Outputs



Using Mechanical Switches

3.3.3 X3/X4 Digital Input

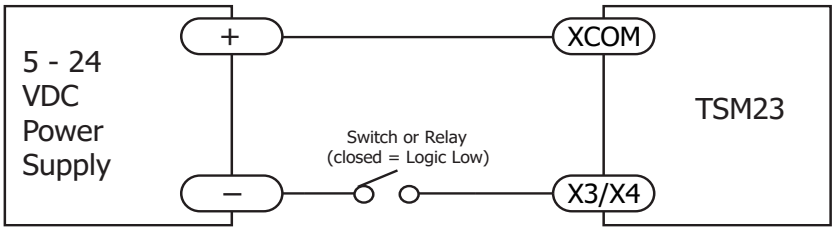
While the STEP and DIR inputs are designed for high-speed digital input operation, the X3/X4 input are designed for low speed digital input operation between 5 and 24 volts optically Isolated Single-ended input. They can be used with sourcing or sinking signals, 5 to 24 volts. This allows connection to PLCs, sensors, relays and mechanical switches. Because the input circuits are isolated, they require a source of power. If you are connecting to a PLC, you should be able to get power from the PLC power supply. If you are using relays or mechanical switches, you will need a 5-24 V power supply.

What is COM?

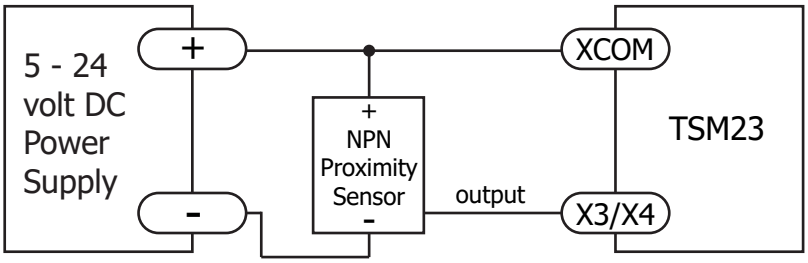
"Common" is an electronics term for an electrical connection to a common voltage. Sometimes "common" means the same thing as "ground", but not always. In the case of the TSM23 drives, if you are using sourcing (PNP) input signals, then you will want to connect COM to ground (power supply -). If you are using sinking (NPN) signals, then COM must connect to power supply +.

Note: If current is flowing into or out of an input, the logic state of that input is low or closed. If no current is flowing, or the input is not connected, the logic state is high or open.

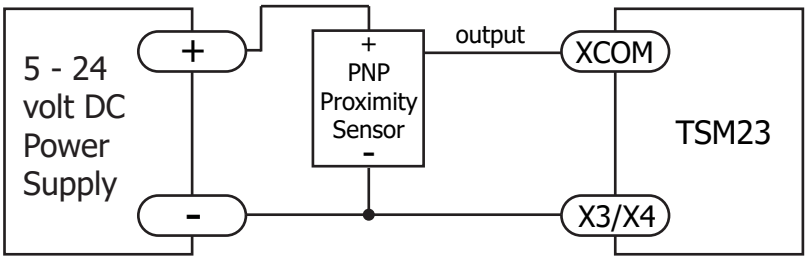
The diagrams below show how to connect X3/X4 input to various commonly used devices.



Connecting the input to a Switch or Relay



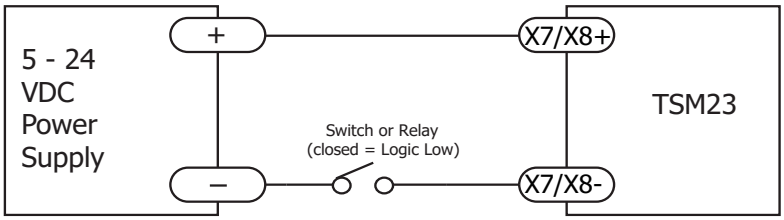
Connecting an NPN type Proximity Sensor to an Input
(when prox sensor activates, input goes low)



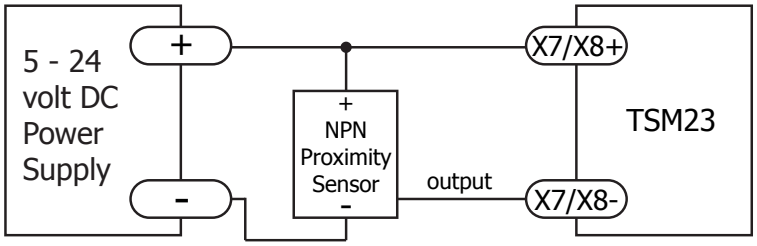
Connecting a PNP type Proximity Sensor to an Input
(when prox sensor activates, input goes low)

3.3.4 X7/X8 Digital Input

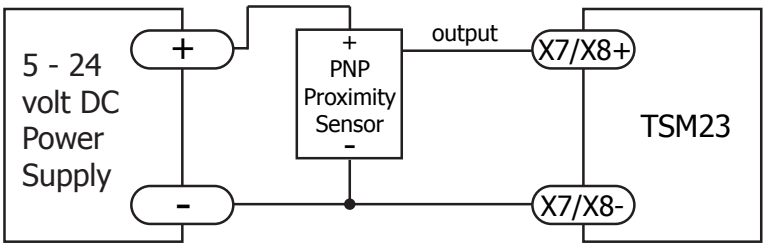
The X7/X8 input are designed for low speed digital input operation between 5 and 24 volts optically Isolated differential input. They are normally used for end of travel limit switches. The diagrams below show how to connect the X7/X8 Inputs to various commonly used devices



Connecting the input to a Switch or Relay



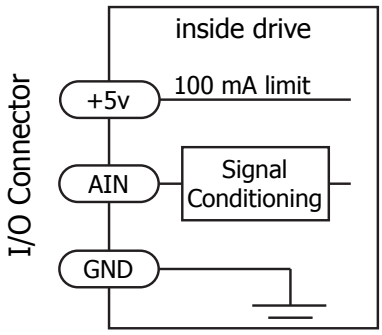
Connecting an NPN type Proximity Sensor to an Input
(when prox sensor activates, input goes low)

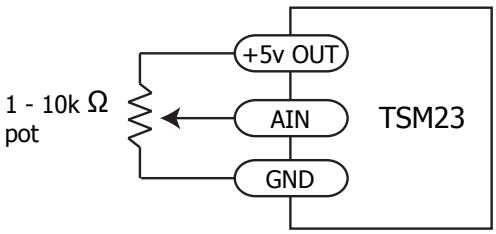


Connecting a PNP type Proximity Sensor to an Input
(when prox sensor activates, input goes low)

3.3.5 AIN Input

The TSM23X drives have an analog input (AIN) which can accept a signal range of 0 to 5 volts. The drive can be configured to operate at a speed, position or torque that is proportional to the analog signal. Use the Step-Servo Quick Tuner software to set the signal range, offset, dead-band and filter frequency. The TSM23X provides a +5 volt/100mA limit voltage supply that can be used to power external devices such as potentiometers. It is not the most accurate supply for reference, for more precise readings use an external supply that can provide the desired accuracy.





Connecting a Potentiometer
to the Analog Input

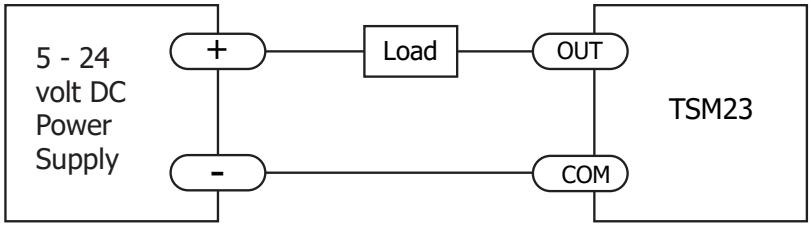
3.3.6 Programmable Output Y1/Y2/Y3

The TSM23X drives feature three optically isolated digital outputs (Y1 to Y3). Y1, Y2 and Y3 share a common terminal YCOM.

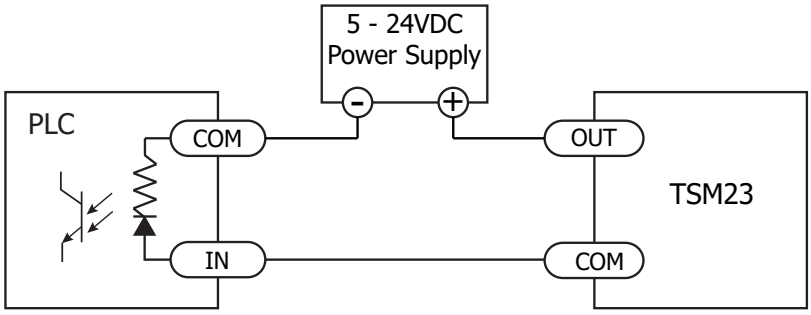
- Y1 can be set to signal a fault condition.
- Y2 can be set to indicate whether the motor is in position(dynamic).
- Y3 can be set to control a motor brake.

These outputs can also be turned on and off by program instructions like Set Output (SO). The output can be used to drive LEDs, relays and the inputs of other electronic devices like PLCs and counters. Diagrams of various connection types follow.

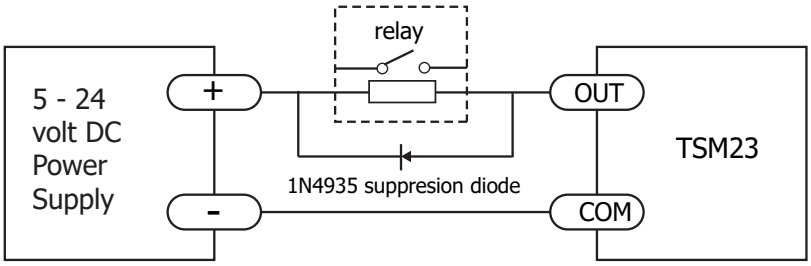
Do not connect the outputs to more than 30 volts. The current through each output terminal must not exceed 100mA.



Connecting a Sinking Output



Connecting a Sourcing Output



Driving a Relay

Do not connect the output to more than 30 volts. The current through the output terminal must not exceed 100mA.

4 Troubleshooting

LED Error Codes

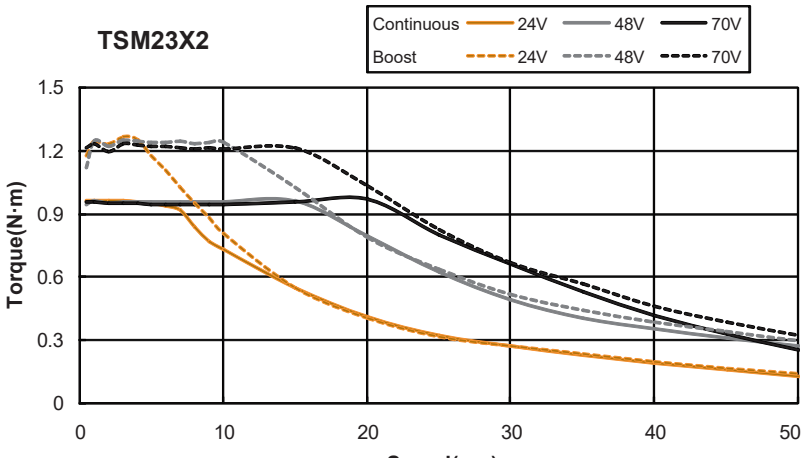
The TSM23X uses red and green LEDs to indicate status. When the motor is enabled, the green LED flashes slowly. When the green LED is solid, the motor is disabled. Errors are indicated by combinations of red and green flashes as shown below. This feature can be disabled for certain warnings but not for alarms. See software manual for information on how to do this and which warnings may be masked.

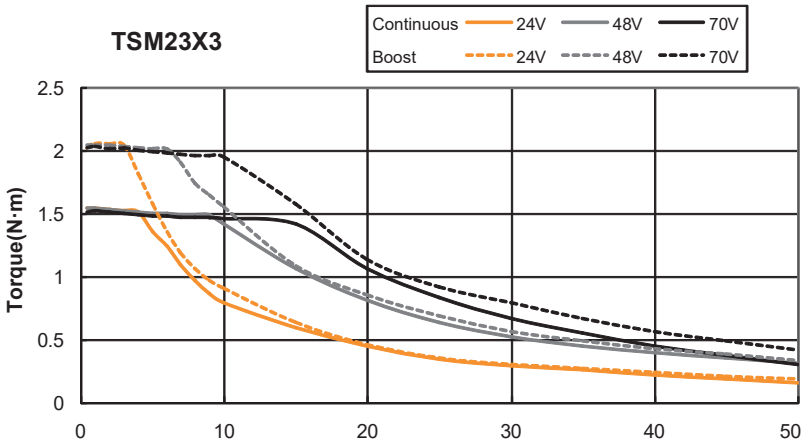
Code		Error
🟢	Solid green	no alarm,motor disabled
🟢🟢	Flashing green	no alarm,motor enabled
🔴🟢	1 red,1 green	motor stall (optional encoder only)
🔴🔴🟢	2 red,1 green	ccw limit
🔴🔴🟢🟢	2 red,2 green	cw limit
🔴🔴🔴🟢	3 red,1 green	drive overheating
🔴🔴🔴🟢🟢	3 red,2 green	internal voltage out of range
🔴🔴🔴🟢🟢🟢	3 red,3 green	blank Q segment
🔴🔴🔴🔴🟢	4 red,1 green	power supply overvoltage or excess regen
🔴🔴🔴🔴🟢🟢	4 red,2 green	power supply undervoltage
🔴🔴🔴🔴🟢🟢🟢	4 red,3 green	flash memory backup error
🔴🔴🔴🔴🔴🟢🟢🟢🟢	5 red, 4 green	Encoder Multiturn counts over flow
🔴🔴🔴🔴🔴🟢	5 red,1 green	Over current/short circuit
🔴🔴🔴🔴🔴🔴🟢	6 red,1 green	Open motor winding
🔴🔴🔴🔴🔴🔴🟢🟢	6 red,2 green	bad encoder signal (optional encoder only)
🔴🔴🔴🔴🔴🔴🔴🟢	7 red,1 green	communication error
🔴🔴🔴🔴🔴🔴🔴🟢🟢	7 red,2 green	flash memory error

5 Reference Materials

5.1 Torque-Speed Curves

Note: all torque curves were measured at 20,000 steps/rev.





5.2 Technical Specifications

Power Amplifier	
Amplifier Type	Dual H-Bridge, 4 Quadrant
Current Control	4 state PWM at 20 KHz
Output Torque	TSM23X2x: Up to 1.0N•m Continuous(1.3 N•m Boost) TSM23X3x: Up to 1.5N•m Continuous(2.0 N•m Boost)
Power Supply	External 12 - 70 VDC power supply required
Protection	Over-voltage, under-voltage, over-temp, motor/wiring shorts (phase-to-phase, phase-to-ground)
Controller	
Electronic Gearing	Software selectable from 200 to 51200 steps/rev in increments of 2 steps/rev
Encoder Resolution	20,000 counts/rev single turn, 65,536 turns multi-turn
Speed Range	Up to 3600rpm
Filters	Digital input noise filter, Analog input noise filter, Smoothing filter, PID filter, Notch filter
Non-Volatile Storage	Configurations are saved in FLASH memory on-board the DSP
Digital Inputs	Digital Inputs Adjustable bandwidth digital noise rejection filter on all inputs **X1/X2**: Optically isolated, 5-24 volt. Minimum pulse width = 250 ns, Maximum pulse frequency = 2 MHz Function: Pulse/Direction, CW/CCW Pulse, A/B quadrature (encoder following), (start/stop)/direction (oscillator mode), or general purpose input **X3/X4** : Optically isolated, 5-24 volt. Minimum pulse width = 100 µs, Maximum pulse frequency = 5 KHz Function: Servo on/off, Alarm/Fault Reset, or general purpose input **X7/X8**: Optically isolated, 5-24 volt. Minimum pulse width = 100 µs, Maximum pulse frequency = 5 KHz Function: CW/CCW Limit, or general purpose input
Digital Outputs	Y1/Y2/Y3: Optically isolated, 30V/100mA max Open Collector Output. Function: Alarm/Fault, In Position(dynamic/static), Brake Control, Tach out, Timing out, or general purpose usage
Analog Input	AIN referenced to GND. Range = 0 to 5 VDC. Resolution = 12 bits
Communication Interface	Ethernet , Ethernet/IP or Modbus/TCP
Physical	
Ambilent Temperature	0 to 40°C (32 to 104°F) When mounted to a suitable heatsink
Humdity	90% Max., non-condensing
Mass	TSM23X2x: 850 g TSM23X3x: 1200 g
Rotor Inertia	TSM23X2x:260 g•cm^2 TSM23X3x:460 g•cm^2

5.3 TruCount™ Absolute Encoder Homing Setup

The TruCount™ series encoder allows the motor to track the motor shaft position even when power is off. TruCount™ encoder does not need an external battery for encoder position tracking while the motor is power off.

For more detail please refer to APPN0052 for details

5.4 SCL Command Reference

The Serial Command Language (SCL) was developed to give users a simple way to control a motor drive via a serial port. This eliminates the need for separate motion controllers or indexers to supply Pulse and Direction signals to the drive. It also provides an easy way to interface to a variety of other industrial devices such as PLCs and HMIs, which often have standard or optional serial ports for communicating to other devices. Some examples of typical host devices might be:

A Windows based PC running Applied Motion Products software

An industrial PC running a custom or other proprietary software application

A PLC with an ASCII module/serial port for sending text strings

An HMI with a serial connection for sending text strings

SCL commands control the motion of the step motor, use of the inputs and outputs, and configure aspects of the drive such as motor current and microstep resolution.

In SCL mode, the TSM23X receives commands from the host, executing them immediately or sending them to a command buffer and then executing them directly from the buffer. It cannot, however, create a stored program for stand-alone operation. For that function, the TSM23Q is needed.

The communications protocol of SCL is simple in that the host initiates all communication, with one exception. The only time the drive will initiate communication is at power-up. At that time, the drive will send an identifier to tell the software which drive is connected and what the firmware version is.

There are two types of SCL commands: buffered and immediate. Buffered commands are loaded into and then executed out of the drive's command buffer. Buffered commands are executed one at a time and in sequential order. The buffer can be filled with commands without the host controller needing to wait for a specific command to execute before sending the next command. Special buffer commands enable the buffer to be loaded and to pause for a desired time.

Immediate commands are not buffered, but are executed immediately, running in parallel with a buffered command if necessary. Immediate commands are designed to access the drive at any time and can be sent as often as needed. This allows a host controller to get information from the drive at a high rate, most often for checking drive status or motor position.

The basic structure of a command packet from the host to the drive is always a text string followed by a carriage return. The text string is composed of the command itself, followed by any required parameters. A carriage return denotes the end of transmission to the drive.

The syntax of the command is

XXAB<cr>

where **XX** designates the command (always composed of 2 uppercase letters), and **A** and **B** define the possible parameters. These parameters can vary in length, can be letters or numbers, and are often optional. Once a drive receives the **<cr>** (carriage return), it will determine whether or not it understood the command-if it did, it will either execute or buffer the command. The drive can also be programmed ahead of time to send a response as to whether or not it understood the command as well as any error code.

Some SCL commands transfer data to the drive for immediate or later use. These data values are stored in data registers and remain there until new commands change the values or power is removed from the drive. Some data registers in a drive are Read-Only and contain predefined information about the drive which can also be read through SCL commands.

Because of the intense nature of serial communications required in host mode applications, there is a serial communication Protocol (PR) command available that will adjust a drive's serial communications protocol to best fit an application. Typically this command is used when configuring a drive and saved as part of the startup parameters. But it can be used at any time to dynamically alter the serial communications.

The Host Command Reference contains the complete command listing as well as instructions on connecting and configuring the TSM23X for use in SCL mode, using the Data Registers and the Protocol command. It also contains detailed information on:

Host Serial Communications

Host Serial Connections

Alarm and Status Codes

Working with Inputs and Outputs

The Host Command Reference is available from the Applied Motion Products website at http://www.applied-motion.com under the SCL Utility download section.

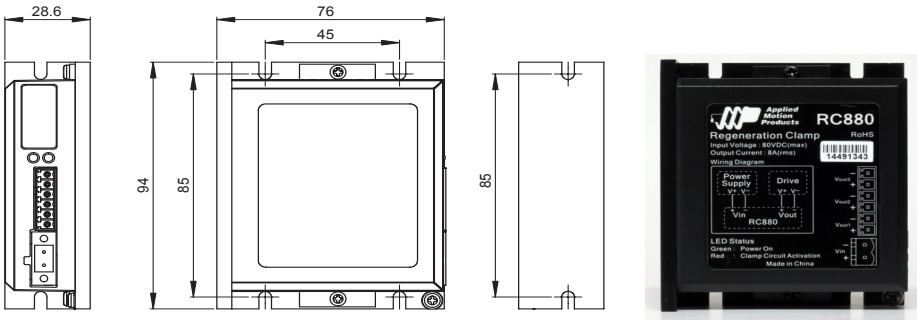
5.4 Accessories

Mating Connectors

Description	Model	Supplier
Power		
Connector	1615780000	Weidmuller
I/O		
Housing	PUDP-18V-S	JST
Pin, Connector	SPUD-001T-P0.5	JST

Regeneration Clamp

P/N: RC880

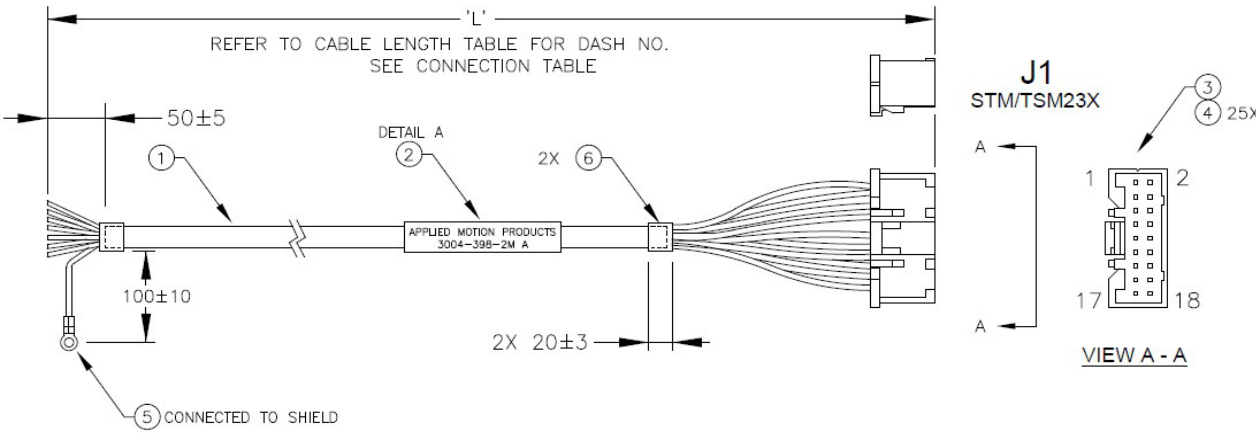


When using a regulated power supply you may encounter a problem with regeneration. The kinetic energy caused by regeneration is transferred back to the power supply. This can trip the overvoltage protection of a switching power supply, causing it to shut down.

Applied Motion Products offers the RC880 “regeneration clamp” to solve this problem. If in doubt, use an RC880 for the first installation. If the “regen” LED on the RC880 never flashes, you don’t need the clamp.

Cables

I/O P/N: 3004-398-3M



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