SureStep™ Stepping Systems

User Manual

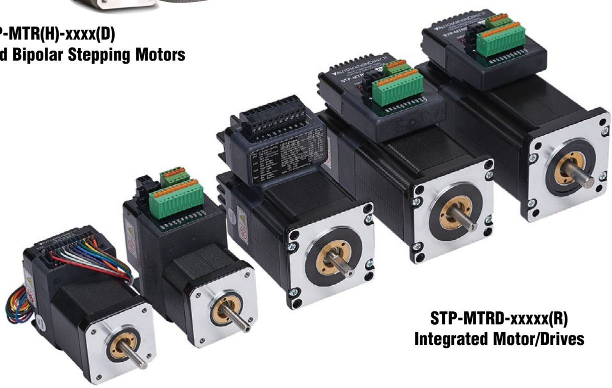
Manual #: STP-SYS-M-WO
5th Edition

STP-DRV-xxxx
Microstepping Drives

STP-PWR-xxxxx
Stepping System
Power Supplies

STP-MTR(H)-xxxx(D)
Connectorized Bipolar Stepping Motors

STP-EXT(H)-020
Step Motor Extension Cable



STP-MTRD-xxxxx(R)
Integrated Motor/Drives

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~ WARNING ~

WARNING: Read this manual thoroughly before using *Sure*Step™ Stepping System drives, motors, and power supplies.

WARNING: AC input power must be disconnected before performing any maintenance. Do not connect or disconnect wires or connectors while power is applied to the circuit. Maintenance must be performed only by a qualified technician.

WARNING: There are highly sensitive MOS components on the printed circuit boards, and these components are highly sensitive to static electricity. To avoid damage to these components, do not touch the components or the circuit boards with metal objects or with your bare hands.

WARNING: Ground the *Sure*Step™ power supply using the ground terminal. The grounding method must comply with the laws of the country where the equipment is to be installed. Refer to "Power Supply Terminal & Component Layout" in the Power Supply chapter.

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SureStep™ Stepping Systems

User Manual

Please include the Manual Number and the Manual Issue, both shown below, when communicating with Technical Support regarding this publication.

Manual Number:	**STP-SYS-M-WO**
Issue:	**Fifth Edition**
Issue Date:	**07/03/2018**

Publication History		
Issue	**Date**	**Description of Changes**
First Edition	7/28/04	Original
1st Ed, Rev A	8/26/04	AC power fuse changed from 2A slow blow to 3A fast acting, plus other minor changes and corrections.
1st Ed, Rev B	3/28/07	Added wiring diagrams for both sink and source for indexers and PLCs with 12-24 VDC outputs. Also corrected value for r^4 from 64 to 1296 in formula under Step 4 on page 15 of Appendix A.
Second Edition	11/2008	Changed name of user manual (was STP-SYS-M). Added new components: 3 new power supplies: STP-PWR-4805, -4810, -7005 2 new drives: STP-DRV-4850, -80100 5 new motors: STP-MTR-17040, STP-MTRH-23079, -34066, -34097, -34127 2 new cables: STP-EXTH-020, STP-232RJ11-CBL Other minor changes throughout.
2nd Ed, Rev A	06/2009	Advanced drives RS-232 communication port pin-out; pages 3-4 & B-7
2nd Ed, Rev B	09/2009	Advanced drives Digital Output max current rating; page 3-10
2nd Ed, Rev C	02/2011	Ch 2,3: drive storage temperature specs Ch 4: motor storage temperature specs; motor Torque vs Speed curves Ch 5: power supply Watt loss specs
2nd Ed, Rev D	11/2011	Ch 2: RoHS, Wiring for Encoder Following Ch 3: Connection Locations & Pin-out; Wiring for Encoder Following Appx B: PLC connection diagrams
2nd Ed, Rev E	02/2012	Appx B: PLC connection diagrams
Third Edition	09/2012	Ch 1,4: Added new STP-MTR(H)-xxxxx(D) dual-shaft motors
Fourth Edition	12/2012	Added new drive STP-DRV-6575 & accessories; chapter renumberings
Fifth Edition	07/2018	Manual update throughout for Integrated Motors/Drives additions. New Chapter 5, 8, and 9 added.

SureStep™ Stepping Systems User Manual Table of Contents

GETTING STARTED

CHAPTER 1

In This Chapter...

Manual Overview

Overview of this Publication

Thank you for selecting the SureStep™ Stepping System components. This user manual describes the selection, installation, configuration, and methods of operation of the SureStep™ Stepping System. We hope our dedication to performance, quality and economy will make your motion control project successful.

Who Should Read this Manual

This manual contains important information for those who will install, maintain, and/or operate any of the SureStep™ Stepping System devices.

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When you see the "exclamation mark" icon in the left-hand margin, the paragraph to its immediate right will be a WARNING. This information could prevent injury, loss of property, or even death (in extreme cases).

SureStep™ System Introduction

SureStep open-loop and inclusive position verification (semi-closed loop) stepping systems provide simple and accurate control of position and speed where lower power and cost are considerations. The SureStep family of stepping components includes power supplies, drives, motors, and cables. The AutomationDirect family of PLCs or other indexers and motion controllers can be used to provide the signals that are "translated" by the microstepping drives into precise movement of the stepping motor shaft.

SureStep™ Part Number Explanation

Drives

STP - DRV - 6575

Component Capacity
2-digit max nominal voltage followed by
max current with 1 implied decimal place
4035: 40V, 3.5A
4850: 48V, 5.0A
6575: 65V, 7.5A
80100: 80V, 10.0A

Component Type
DRV: stepper drive
DRVA: drive accessory

***Sure*Step Series Designation:** STP

Motors

STP - MTRx - 23079 x

Motor Shaft Type/Variant
blank: single shaft
D: dual shaft

Component Capacity
2-digit NEMA frame size followed by
approximate stack* length in mm

Component Type
MTR: stepper motor
MTRA: motor accessory
MTRH: high-power stepper motor

***Sure*Step Series Designation:** STP

* The length of the motor that produces torque

Power Supplies

STP- PWR - 3204

Component Capacity
2-digit output voltage followed by output current

Component Type
PWR: power supply

***Sure*Step Series Designation:** STP

Integrated Motors/Drives

STP- MTRD - 23042 x

Integrated Drive Type
blank: Standard
R: Advanced
V: Variable I/O
E: Encoder included

Component Capacity
2-digit NEMA frame size followed by approximate stack* length in mm

Component Type
MTRD: integrated motor/drive

***Sure*Step Series Designation:** STP

* The length of the motor that produces torque

Cables and Accessories

*Sure*Step Cables & Accessories	
Part Number	**Description**
STP-EXTx-xx	Motor extension cable, xx = cable length in feet, x=H for high-power
STP-DRVA-xx	Drive accessory, xx= accessory descriptor
STP-MTRA-xx	Motor accessory, xx = accessory descriptor
STP-CBL-xx	Cable (other), xx = cable descriptor
STP-CON-x	Connector kit, x = kit number
STP-485DB9-x	MTRD programming cable, x = length in meters
STP-USB485-xx	USB to RS-485 adapter, xx = type

SureStep™ System Recommended Component Compatibility

*Sure*Step Power Supply / Drive Compatibility				
Drive (1)(2)	Recommended Linear Power Supply (1)(2)			
Model Number	STP-PWR -3024	STP-PWR -4805	STP-PWR -4810	STP-PWR -7005(3)
STP-DRV-4035 12-32 VDC input (40V max)	√	No	No	No
STP-DRV-4850 24-48 VDC input (48V max)	√	√	√	No
STP-DRV-6575 24-65 VDC input (65V max)	√	√	√	No
STP-DRV-80100 24-80 VDC input (80V max)	√	√	√	√
STP-MTRD-17 12-48 VDC input	√	√	√	No
STP-MTRD-23, -24 12-70 VDC input	√	√	√	√

1) Do NOT use a power supply that exceeds the drive's input voltage range. If using a non-STP linear power supply, ensure that the unloaded voltage does not float above the drive's maximum input range.

2) For best performance, use the lowest voltage power supply that supplies the required speed and torque.

3) An unloaded STP-PWR-7005 can float above the allowable input voltages of some drives if it is fed with a high AC input voltage (greater than 120VAC).

*Sure*Step Power Supply / Drive Compatibility			
Drive (1)(2)	Recommended Switching Power Supply (1)(2)		
Model Number	PSB12-xxxS	PSB24-xxxS	PSB48-xxxS
STP-DRV-4035 12-32 VDC input (40V max)	√	√	No
STP-DRV-4850 24-48 VDC input (48V max)	No	√	√
STP-DRV-6575 24-65 VDC input (65V max)	No	√	√
STP-DRV-80100 24-80 VDC input (80V max)	No	√	√
STP-MTRD-17 12-48 VDC input	√	√	√
STP-MTRD-23, -24 12-70 VDC input	√	√	√

1) Do NOT use a power supply that exceeds the drive's input voltage range.

2) For best performance, use the lowest voltage power supply that supplies the required speed and torque.

*Sure*Step Drive / Motor Compatibility						
Motor (1)(2)			Recommended Drive (1)			
Model Number (1)(2)	Rated Amps	Extension Cable(2)	STP-DRV-4035(1) (3.5A max output)	STP-DRV-4850(1) (5.0A max output)	STP-DRV-6575(1) (7.5A max output)	STP-DRV-80100(1) (10.0A max output)
STP-MTR-17040x	1.7	STP-EXT-020	√	√	√	–
STP-MTR-17048x	2.0		√	√	√	
STP-MTR-17060x	2.0		√	√	√	
STP-MTR-23055x	2.8		√	√	√	
STP-MTR-23079x	2.8		√	√	√	
STP-MTR-34066x	2.8		√	√	√	
STP-MTR*H*-23079x	5.6	STP-EXT***H***-020	–		√	√
STP-MTR*H*-34066x	6.3				√	√
STP-MTR*H*-34097x	6.3				√	√
STP-MTR*H*-34127x	6.3				√	√

1) The combinations above will perform according to the published speed/torque curves. However, any STP motor can be used with any STP drive. Using a motor with a current rating higher than the drive's output rating will proportionally limit the motor torque.

2) MTR motors have connectors compatible with the EXT extension cables. MTRH motors have connectors compatible with the EXTH extension cables.

Microstepping Drives Introduction

There are two different basic types of microstepping drives offered in the SureStep™ series. Two DIP-switch configurable models with pulse inputs are available, as well as two software configurable advanced models with multiple operating modes. Descriptions of integrated motor/drives (a drive integrally attached to the motor) follow the drive-only section.

Standard Microstepping Drives

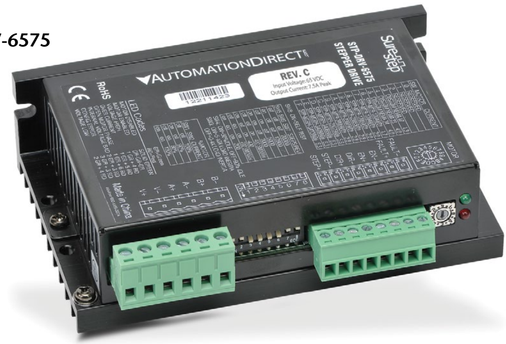
STP-DRV-6575

The SureStep™ STP-DRV-6575 standard microstepping drive uses pulse input signals, and is configured with DIP switches on the drive. To use this drive in a step motor control system, you will need the following:

- A 24–65 VDC power supply for the motor drive. SureStep STP-PWR-3204 or STP-PWR-48xx linear power supplies from AutomationDirect are good choices. If you decide not to use one of these recommended power supplies, then please read the section entitled “Choosing a Power Supply” in Chapter 7, “SureStep System Power Supplies.”
- A source of step pulses. Signal may be sinking (NPN), sourcing (PNP), or differential.
- The step inputs can be CW/CCW or Step & Direction. CW and CCW are viewed from the end opposite the drive end of the motor (looking out of the shaft).
- A compatible step motor, such as an AutomationDirect SureStep STP-MTRx. (Motor extension cables STP-EXTx are also available.)
- A small flat blade screwdriver for tightening the connectors.

The STP-DRV-6575 standard microstepping drive is an enclosed design.

STP-DRV-6575



Refer to the “SureStep STP-DRV-6575 Microstepping Drive” chapter of this user manual for complete details on the installation, configuration, and wiring of this drive.

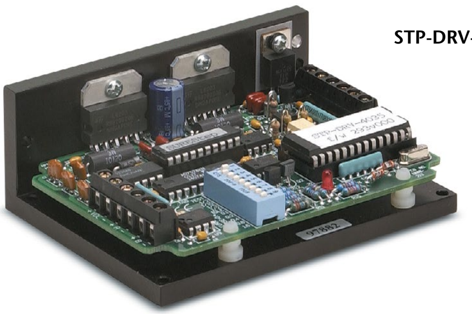
Standard Microstepping Drives (continued)

STP-DRV-4035

The SureStep™ STP-DRV-4035 standard microstepping drive uses pulse input signals, and is configured with DIP switches on the drive. To use this drive in a step motor control system, you will need the following:

- 12-42 volt DC power supply for the motor drive. The SureStep STP-PWR-3204 linear power supply from AutomationDirect is the best choice. If you decide not to use the STP-PWR-3204, please read the section entitled “Choosing a Power Supply” in Chapter 7, “SureStep System Power Supplies.”
- A source of step pulses. Signal may be sinking (NPN), sourcing (PNP), or differential.
- The step inputs can be CW/CCW, step and direction, or quadrature.
- A compatible step motor, such as an AutomationDirect SureStep STP-MTRx. (Motor extension cables STP-EXTx are also available.)
- A small flat blade or phillips screwdriver for tightening the connectors.

The STP-DRV-4035 standard microstepping drive is an open frame design.



STP-DRV-4035

Refer to the “SureStep STP-DRV-4035 Microstepping Drive” chapter of this user manual for complete details on the installation, configuration, and wiring of this drive.

Advanced Microstepping Drive

The SureStep™ advanced microstepping drives (STP-DRV-4850 & -80100) are capable of accepting several different forms of input signals for control: pulse, analog, serial communication, or internal indexing. These drives are configured by computer with software which is included with the drive. To use one of these drives in a step motor control system, you will need the following:

- A DC power supply for the motor drive. A compatible SureStep STP-PWR-xxxx linear power supply from AutomationDirect is the best choice.
- A source of input control signals, such as a PLC from AutomationDirect.
- A compatible step motor, such as an AutomationDirect SureStep STP-MTRx. (Motor extension cables STP-EXTx are also available.)
- A small flat blade screwdriver for tightening the connectors.

The SureStep advanced microstepping drives are enclosed with removable wiring terminal blocks.

STP-DRV-80100

Refer to the "SureStep™ Advanced Microstepping Drives" chapter of this user manual for complete details on the installation, configuration, and wiring of this drive.

Standard Integrated Motors/Drives

The SureStep™ STP-MTRD standard series integrated motors/drives (STP-MTRD-17 and -23) use pulse input signals, and are configured with DIP switches on the drive. To use this motor/drive in a step motor control system, you will need the following:

- 12-48 volt (for 17 series) or 12-70 volt (for 23 series) DC power supply for the motor/drive. The SureStep linear power supplies from AutomationDirect are the best choice. If you decide not to use a STP-PWR-xxxx, please read the section entitled "Choosing a Power Supply" in Chapter 7, "SureStep System Power Supplies."
- A source of step pulses. Signal may be sinking (NPN), sourcing (PNP), or differential.
- The step inputs can be CW/CCW, step and direction, or quadrature.
- A small flat blade screwdriver (3/32") for tightening the connectors.

The SureStep standard integrated motors/drives are enclosed with removable wiring terminal blocks. Models with external encoders (for position feedback to a PLC, motion controller, etc.) are available.

STP-MTRD-23042

Refer to Chapter 5: "SureStep Integrated Motors/Drives" for complete details on the installation, configuration, and wiring of this motor/drive.

Advanced Integrated Motors/Drives

The SureStep™ STP-MTRD advanced series integrated motors/drives (STP-MTRD-17R, -23R, and -24R) are capable of accepting several different forms of input signals for control: pulse, analog, serial communication, or internal indexing (via serial communications). These motors/drives are configured with software which is included with the drive. To use one of these motors/drives in a step motor control system, you will need the following:

- A DC power supply for the motor drive (12-48 volt for 17 series, 12-70 volt for 23 and 24 series). A compatible SureStep STP-PWR-xxxx linear power supply from AutomationDirect is the best choice.
- A source of input control signals, such as a PLC from AutomationDirect.
- A small flat blade screwdriver for tightening the connectors.

The SureStep advanced integrated motors/drives are enclosed with removable wiring terminal blocks. Models with internal encoders (for position verification and stall prevention inside the motor/drive) are available.

STP-MTRD-17038RE

Refer to Chapter 5: "SureStep Integrated Motors/Drives" for complete details on the installation, configuration, and wiring of this motor/drive.

Bipolar Step Motor Introduction

AutomationDirect offers many different models of bipolar step motors with mounting flanges in two different shaft configurations (single and dual-shaft), and in three different NEMA frame sizes (17, 23, and 34). There are standard torque (STP-MTR), and several high torque (STP-MTRH) motors available. All of which have a “D” variant representing a dual shaft option. All of the motors have a 12 inch connectorized pigtail cable, and optional matching 20 ft connectorized extension cables (STP-EXTx) are also available.

Refer to Chapter 6: “SureStep™ Stepping Motors” in this user manual for complete details on the specifications, installation, mounting, dimensions, and wiring of the SureStep step motors.

STP-MTRx
NEMA 17, 23, 34
Frame Sizes

STP-MTRx Motors Available in Single-shaft and Double-shaft Models

Stepping System Power Supply Introduction

The SureStep stepping system power supplies are designed to work with SureStep microstepping drives and motors. The different power supply models can provide unregulated DC power at the applicable voltage and current levels for various SureStep drives and motors. The power supplies also provide a regulated 5VDC, 500 mA logic supply output for indexer and PLC logic outputs to control the SureStep drives. Automation Direct switching power supplies PSB12-xxxS, PSB24-xxxS, and PSB48-xxxS are good non-linear supplies. A regen clamp may be needed if using these supplies. For more information on using the power supplies please see Chapter 7: “SureStep System Power Supplies”.

Linear Power Supplies

Switching Power Supplies

The stepping system power supplies can supply power for multiple SureStep STP-DRV-xxxx microstepping motor drives, depending on step motor size and application requirements.

Refer to the Power Supply chapter of this user manual for complete details on the specifications, installation, mounting, dimensions, and wiring of the SureStep stepping system power supplies.

Further information about braking accessories and regeneration clamping can be found in Appendix A: “SureStep Accessories” and the STP-DRVA-RC-050 REGENERATION CLAMP datasheet.

Selecting the Stepping System

Refer to Appendix C: Selecting the SureStep™ Stepping System for detailed information on how to calculate requirements for various applications using stepping motors for motion control.

Use with AutomationDirect PLCs

Refer to Appendix B: Using SureStep™ with AutomationDirect PLCs for detailed information on wiring the SureStep Stepping System components to AutomationDirect PLCs and high-speed counter modules.

The following is a summary of the AutomationDirect PLCs and module part numbers that are suitable to work with the SureStep Stepping Systems:

High-Speed Pulse Output Control (Standard Drives)

Any AutomationDirect PLC with high speed pulse output can control the SureStep Standard and Advanced stepper drives and integrated motor/drives. Certain high-speed PLC outputs are 24VDC and may require dropping resistors to work with 5VDC stepper inputs. See Appendix B in this manual and the appropriate PLC User Manual for more detailed information.

AutomationDirect PLCs that can use pulse train outputs with SureStep drives:

BRX Series (all models with DC outputs on the CPU module)

Productivity Series (all P2 and P3 CPUs - with the P2-HSO/P3-HSO modules)

Do-More Series (all models that can use the H2-CTRIO2)

DirectLogic Series

- All CPU models that can use the H2-CTRIO2 (and other CTRIO models)
- Models with built-in high speed outputs (DL05, DL06)

Serial Communication Control (Advanced Drives)

AutomationDirect PLCs with an RS-232 port can control an Advanced stepper drive (STP-DRV-4850, STP-DRV-80100) with serial communication (one drive per PLC communication port). A PLC with an RS-485 port can control multiple Advanced integrated stepper motor/drives.

The **Click Series**, **BRX Series**, **Productivity Series**, and **Do-More Series** of PLCs allow for simple ASCII control of the Advanced drives and motor/drives. Of the DirectLogic Series of PLCs, we recommend only using the DL06 and D2-260 CPUs due to their advanced ASCII instruction set which includes PRINTV and VPRINT commands.

See Appendix B and the appropriate PLC User Manual for more detailed information.

SureStep™ STP-DRV-6575 Microstepping Drive

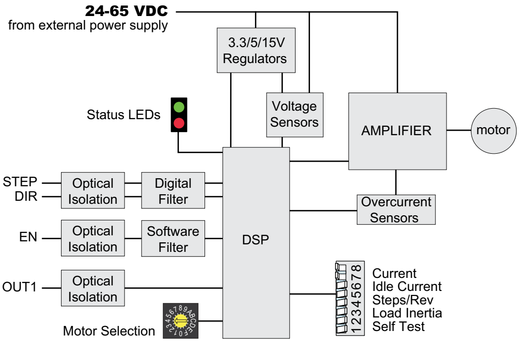
Chapter 2

In This Chapter...

Features

- Low cost, digital step motor driver in compact package
- Operates from Step & Direction signals, or Step CW & Step CCW (jumper selectable). CW and CCW are viewed from the end opposite the drive end of the motor (looking out of the shaft)
- Enable input & Fault output
- Optically isolated I/O
- Digital filters prevent position error from electrical noise on command signals; jumper selectable: 150 kHz or 2MHz
- Rotary switch easily selects from many popular motors
- Electronic damping and anti-resonance
- Automatic idle current reduction to reduce heat when motor is not moving; switch selectable: 50% or 90% of running current
- Switch-selectable step resolution: 200 (full-step); 400 (half-step); 2,000; 5,000; 12,800; or 20,000 steps per revolution
- Switch selectable microstep emulation provides smoother, more reliable motion in full and half step modes
- Automatic self test (switch selectable)
- Operates from a 24 to 65 VDC power supply
- Running current from 0.5 to 7.5A

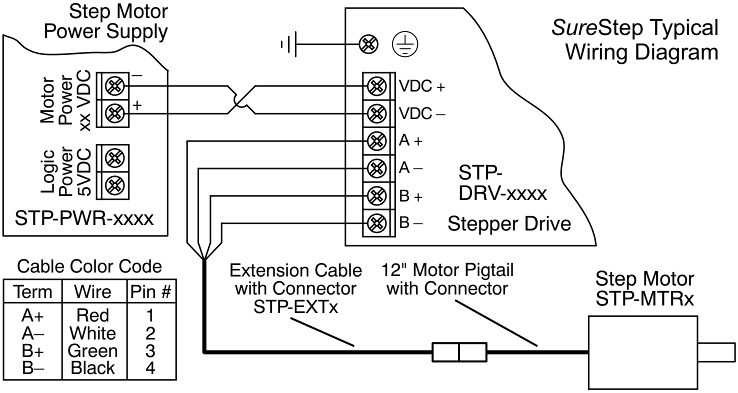
Block Diagram



Specifications

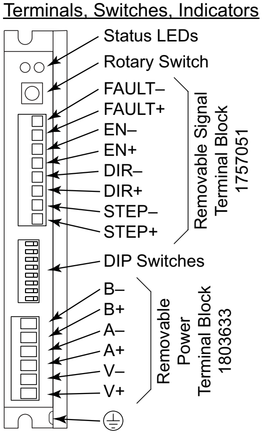
SureStep™ Microstepping Drive Specifications		
Part Number		***STP-DRV-6575***
Input Power		24–65 VDC (external power supply required; fuse at 7A fast-acting)
Output Current		1.0–7.5 A/phase (peak of sine)
Current Controller		Dual H-bridge digital MOSFET, 4-quadrant PWM at 20 kHz
Input Signals	***Step***	5–24 VDC nominal (range: 4–30 VDC); (5mA @ 4V; 15 mA @ 30V); Optically isolated, differential. Minimum pulse width = 0.5µs. Maximum pulse frequency = 150 kHz or 2MHz (user selectable). Function = Step or Step CW pulse.
	Direction	5–24 VDC nominal (range: 4–30 VDC); (5mA @ 4V; 15 mA @ 30V); Optically isolated, differential. Minimum pulse width = 0.5µs. Maximum pulse frequency = 150 kHz or 2MHz (user selectable). Function = Direction or Step CCW pulse.
	Enable	5–24 VDC nominal (range: 4–30 VDC); (5mA @ 4V; 15 mA @ 30V); Optically isolated, differential. Function = disable motor when closed.
Output Signal	***Fault***	30 VDC / 80mA max, optically isolated photodarlington, sinking or sourcing. Function = closes on drive fault.
Rotary Switch Selectable Function		Select motor based on part number, or by motor current.
Jumper Selectable Functions	***Step Pulse Type***	Step and Direction: Step signal = step/pulse; Direction signal = direction. Step CW & CCW: Step signal = CW step; Direction signal = CCW step.
	Step Pulse Noise Filter	Select 150 kHz or 2MHz
DIP Switch Selectable Functions	***Current Reduction***	Reduce power consumption and heat generation by limiting motor running current to 100%, 90%, or 80% of maximum. Current should be increased to 120% if microstepping. (Torque is reduced/increased by the same %.)
	Idle Current Reduction	Reduce power consumption and heat generation by limiting motor idle current to 90% or 50% of running current. (Holding torque is reduced by the same %.)
	Load Inertia	Anti-resonance and damping feature improves motor performance. Set motor and load inertia range to 0–4x or 5–10x.
	Step Resolution	For smoother motion and more precise speed, set the pulse step resolution to 20000, 12800, 5000, 2000, 400 smooth, 400, 200 smooth, or 200 steps/rev.
	Self Test	Automatically rotate the motor back and forth two turns in each direction in order to confirm that the motor is operational.
Drive Cooling Method		Natural convection (mount drive to metal surface)
Mounting		Use (2) #6 screws to mount wide or narrow side to metal surface
Removable Connectors		Motor & Power Supply: Screw term blocks Phoenix Contact 1757051 (30–12AWG) Signals: Screw terminal blocks Phoenix Contact 1803633 (30–14 AWG) AutomationDirect part number STP-CON-1 contains these replacement connectors.
Weight		10.8 oz [306g] – (including mating connectors)
Operating Temperature		0 to 85 °C [32 to 185 °F] – (interior of electronics section)
Ambient Temperature		0 to 50 °C [32 to 122 °F] – (drive must be mounted to suitable heat sink)
Humidity		Maximum 90% non-condensing
Agency Approvals		CE

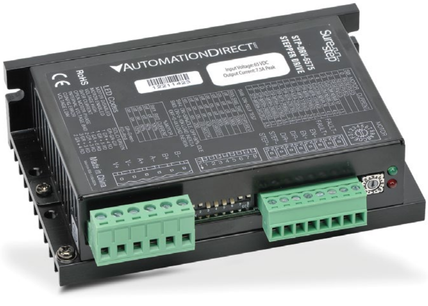
Typical Wiring Diagram



Term	Wire	Pin #
A+	Red	1
A–	White	2
B+	Green	3
B–	Black	4

Wiring Connections and Configuration Switches





Terminal block part #s (shown) are
Phoenix Contact (www.phoenixcontact.com)

External wiring is connected using two separate pluggable screw terminal connectors. The power connections share a six-position connector, and the digital inputs and output share an eight-position connector.

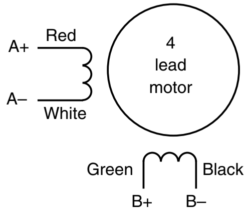
Connecting the Motor

Warning: When connecting a step motor to a *Sure*Step™ STP-DRV-6575 microstepping drive, be sure that the motor power supply is switched off. When using a motor not supplied by AutomationDirect, secure any unused motor leads so that they can't short out to anything. Never disconnect the motor while the drive is powered up. Never connect motor leads to ground or to a power supply. (See the Typical Wiring Diagram shown in this chapter for the step motor lead color code of AutomationDirect supplied motors.)

CW and CCW are viewed from the end opposite the drive end of the motor (looking out of the shaft).

Four Lead Motors

Four lead motors can only be connected one way, as shown below.

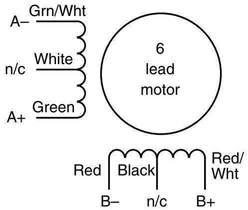


4 Leads

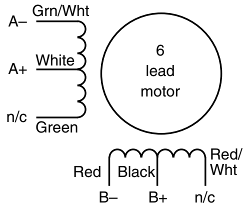
All AutomationDirect SureStep™ motors are four lead bipolar step motors.

Six Lead Motors

Six lead motors can be connected in series or center tap. Motors produce more torque at low speeds in series configuration, but cannot run as fast as in the center tap configuration. In series operation, the motor should be operated at 30% less than rated current to prevent overheating.



6 Leads Series Connected

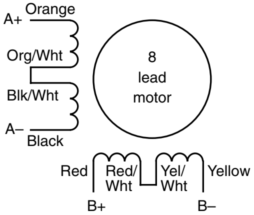


6 Leads Center Tap Connected

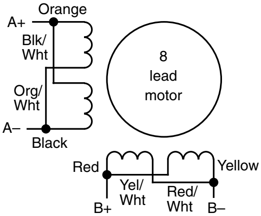
Step motor wire lead colors vary from one manufacturer to another.

Eight Lead Motors

Eight lead motors can also be connected in two ways: series or parallel. Series operation gives you more torque at low speeds, but less torque at high speeds. When using series connection, the motor should be operated at 30% less than the rated current to prevent over heating. Parallel operation allows greater torque at high speeds. When using parallel connection, the current can be increased by 40% above rated current. Care should be taken in either case to assure that the motor does not overheat.



8 Leads Series Connected



8 Leads Parallel Connected

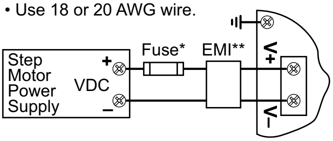
Step motor wire lead colors vary from one manufacturer to another.

Connecting the Power Supply

An STP-PWR-xxxx power supply from AutomationDirect is the best choice to power the step motor drive. If you need information about choosing a different power supply, refer to the section entitled "Choosing a Power Supply" in Chapter 7 of this manual.

If your power supply does not have a fuse on the output or some kind of short circuit current limiting feature, you need a fuse between the drive and the power supply. Install the fuse on the + power supply lead.

- Connect the green ground screw to earth ground
- Use 18 or 20 AWG wire.



* External fuse not required when using an STP-PWR-xxxx P/S; fuse is internal.
** CE use requires an EMI line filter.

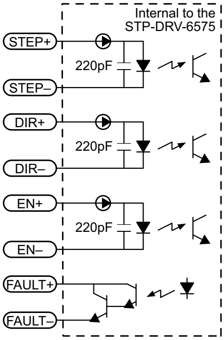
Further information about braking accessories and regeneration clamping can be found in Appendix A: "SureStep Accessories" and the STP-DRVA-RC-050 REGENERATION CLAMP datasheet.

Do NOT use STP-PWR-70xx power supplies with an STP-DRV-6575 drive, because those power supplies exceed the voltage limit of this drive.

Connecting the I/O

SureStep™ Drive Digital Inputs and Outputs

The *Sure*Step STP-DRV-6575 drive includes two high-speed 5–24 VDC digital inputs (STEP & DIR), one standard-speed 5–24 VDC digital input (EN), and one 30 VDC digital output (Fault).



Drive Digital Input Circuit

The digital inputs are optically isolated to reduce electrical noise problems. There is no electrical connection between the control and power circuits within the drive, and input signal communication between the two circuits is achieved by infrared light. Externally, the drive's motor power and control circuits should be supplied from separate sources, such as from a step motor power supply with separate power and logic outputs.

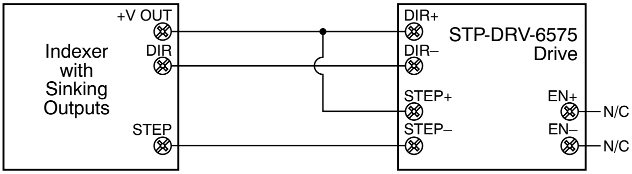
For bidirectional rotation, supply a source of step pulses to the drive at the STEP+ and STEP– terminals, and a directional signal at the DIR+ and DIR– terminals.

The ENABLE input allows the logic to turn off the current to the step motor by providing a signal to the EN+ and EN– terminals. The EN+ and EN– terminal can be left unconnected if the enable function is not required.

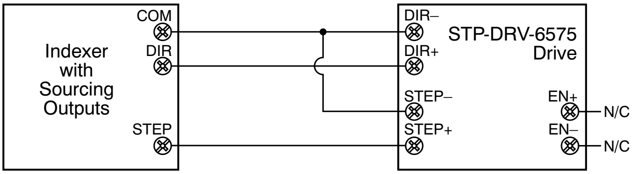
All logic inputs can be controlled by a DC output signal that is either sinking (NPN), sourcing (PNP), or differential.

Connecting the Input Signals – STEP and DIR

Connecting Inputs to an Indexer with Sinking Outputs

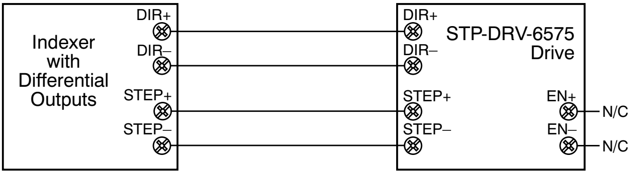


Connecting Inputs to an Indexer with Sourcing Outputs



Connecting the Input Signals – STEP and DIR (continued)

Connecting Inputs to an Indexer with Differential Outputs



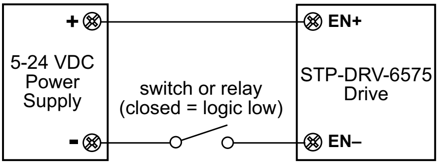
Many high speed indexers have differential (also known as line-driver) outputs.

Connecting the Input Signals – EN Input

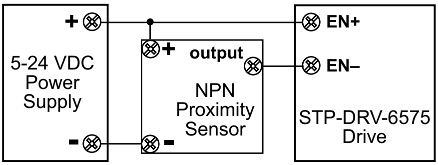
The ENABLE input allows the user to turn off the current to the motor by providing a 5–24 VDC positive voltage between EN+ and EN-. The logic circuitry continues to operate, so the drive "remembers" the step position even when the amplifiers are disabled. However, the motor may move slightly when the current is removed depending on the exact motor and load characteristics.

Warning: 24VDC is the maximum voltage that can be applied directly to the standard speed EN input. If using a higher voltage power source, install resistors to reduce the voltage at the input. Do NOT apply an AC voltage to an input terminal.

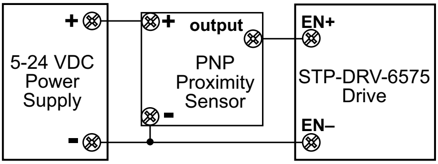
Connecting ENABLE Input to Relay or Switch



Connecting ENABLE Input to NPN Proximity Sensor



Connecting ENABLE Input to PNP Proximity Sensor

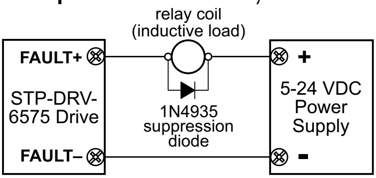


Leave the ENABLE input unconnected if you do not need to disable the amplifiers.

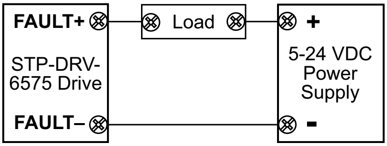
Connecting the Fault Output

The *Sure*Step advanced drives have one digital output that has separate positive (+) and negative (-) terminals, and can be used to sink or source current.

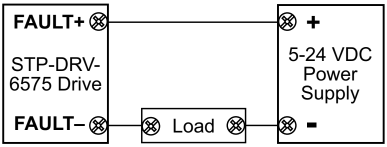
Connecting FAULT Output to Inductive Relay



Connecting FAULT Output as Sinking Output



Connecting FAULT Output as Sourcing Output



Do not connect more than 30 VDC. Current must not exceed 80 mA.

Drive Configuration

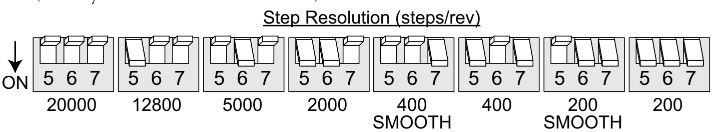
You need to configure your drive for your particular application before using the drive for the first time. The *Sure*Step STP-DRV-6575 microstepping drive offers several features and configuration settings, including:

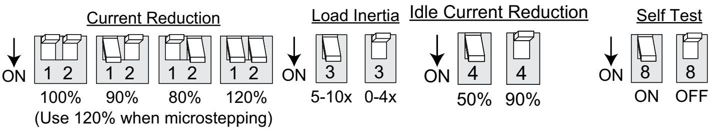
Drive Configurations Settings

STP-DRV-6575 Configuration Settings		
Feature	***Description***	***Configuration Method***
Motor Phase Current	Select motor based on part number, or set by motor current.	Rotary Switch
Mode of Operation (Step Pulse Type)	Step and Direction (default): Step signal = step/pulse; Direction signal = direction. Step CW & CCW: Step signal = CW step; Direction signal = CCW step.	Jumper S3
Step Pulse Noise Filter	Select 150 kHz, or 2MHz (default)	Jumper S4
Current Reduction	Reduce power consumption and heat generation by limiting motor running current to 100%, 90%, or 80% of maximum. Current should be increased to 120% if microstepping. (Torque is reduced/increased by the same %.)	DIP Switches
Idle Current Reduction	Reduce power consumption and heat generation by limiting motor idle current to 90% or 50% of running current. (Holding torque is reduced by the same %.)	
Load Inertia	Anti-resonance and damping feature improve motor performance. Set motor and load inertia range to 0–4x or 5–10x.	
Step Resolution	For smoother motion and more precise speed, set the pulse step resolution to 20000, 12800, 5000, 2000, 400 smooth, 400, 200 smooth, or 200 steps/rev.	
Self Test	Automatically rotates the motor back and forth two turns in each direction in order to confirm that the motor is operational.	

DIP Switch Settings

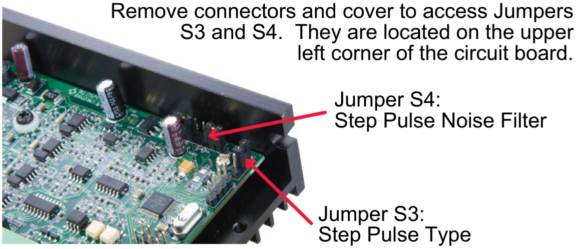
(Factory default = all switches OFF)





Jumper Settings

Jumpers S3 and S4 are located on the internal circuit board, and they can be accessed by removing the drive's front cover.



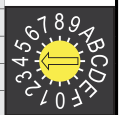
Jumper S3 – Step Pulse Type

- Jumper in "1-2" position – Step & Direction (factory default)
- Jumper in "1-3" position – Step CW / Step CCW

Jumper S4 – Step Pulse Noise Filter

- Jumper in "1-2" position – 2MHz
- Jumper in "1-3" position – 150 kHz (factory default)

Rotary Switch Settings – Motor/Current Settings

STP-DRV-6575 Motor Selection Table										
Motor Data						*Drive Configuration Data*			*Rotary Switch Position*	
Motor STP-MTR -xxxx(D)	*Motor Current (Arms/phase)*	*Holding Torque (oz·in)*	*Rotor Inertia (oz·in²)*	*Inductance (mH)*	*Resistance (Ω)*	*Torque (mN·m)*	*Inertia (g·cm²)*	*Drive Current (peak sine A)*		
n/a	reserved								***0–2***	
n/a	1.3	custom NEMA 17							***3***	
n/a	4.0	custom NEMA 23							***4***	
n/a	4.0	custom NEMA 34							***5***	
-17040	1.7	61	0.28	3.03	1.60	434	51	2.04	***6***	
-17048	2.0	83	0.37	2.65	1.40	586	82	2.40	***7***	
-17060	2.0	125	0.56	3.30	2.00	883	37	2.40	***8***	
-23055	2.8	166	1.46	2.36	0.08	1172	271	3.36	***9***	
-23079	2.8	276	2.60	3.82	1.10	1949	475	3.36	***A***	
-34066	2.8	434	7.66	7.70	1.11	3065	1402	3.36	***B***	
H-23079	5.6	287	2.60	1.18	0.40	2025	371	6.72	***C***	
H-34066	6.3	428	7.66	1.52	0.25	3021	1402	7.56	***D***	
H-34097	6.3	803	14.80	2.07	0.03	5668	2708	7.56	***E***	
H-34127	6.3	1292	21.90	4.14	0.49	9123	4008	7.56	***F***	

Alarm Codes

In the event of a drive fault or alarm, the green LED will flash one or two times, followed by a series of red flashes. The pattern repeats until the alarm is cleared.

STP-DRV-6575 Alarm Codes

Code	Error
solid green	no alarm, motor disabled
flashing green	no alarm, motor enabled
flashing red	configuration or memory error*
fast green	program running
1 red, 1 green	motor stall (optional encoder only)
1 red, 2 green	move attempted while drive disabled
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 prog segment
4 red, 1 green	power supply overvoltage**
4 red, 2 green	power supply undervoltage*
4 red, 3 green	flash memory backup error
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	serial communication error
7 red, 2 green	flash memory error

* *Does not disable the motor.*
The alarm will clear about 30 seconds after the fault is corrected.

** *Disables the motor. Cannot be cleared until power is cycled.*

† *The over-current/short-circuit alarm typically indicates that an electrical fault exists somewhere in the system external to the drive. This alarm does not serve as motor overload protection.*

Alarm Code Definitions

No alarm, motor disabled	No faults active, Circuit is closed between EN+ and EN-.	N/A
No alarm, motor enabled	No faults active, Circuit is open between EN+ and EN-.	N/A
Configuration or memory error	Memory error detected when trying to load config from flash on powerup.	Restart device. No fix if restart doesn't work.
Program running	No faults active.	N/A
Motor stall (optional encoder only)	Motor torque demand exceeded capability and the motor skipped steps. This is configured in SureMotion Pro.	Increase torque utilization if it's not already maxed out, otherwise decrease the torque demand by modifying the move profile, or put in a larger motor.

Error	Description	Corrective Action
Move attempted while drive disabled	Drive is disabled and move attempted.	Reset alarm, enable motor, and move again.
CCW limit	CCW limit is reached. The digital input that has been assigned CCW limit has been activated.	Unblock the CCW sensor (open the circuit) or redifine the input with SureMotion Pro.
CW limit	CW limit is reached. The digital input that has been assigned CW limit has been activated.	Unblock the CCW sensor (open the circuit) or redefine the input with SureMotion Pro.
Drive overheating	The drive's internal temperature is too high.	If the drive is operating within its standard range (input voltage and output current are OK), more heat must be removed from the drive during operation. For Advanced drives (see "Mounting the Drive" on page 4-14), ensure the drive is mounted to a metal surface that can dissipate the drive's heat. For Integrated motor/drives, see "Mounting" on page 5-13. For both types of drives: If the mounting surface cannot pull enough heat away from the drive, forced airflow (from a fan) may be required to cool the drive.
Internal voltage out of range	Gate voltage, 5V rail, or 3V rail are out of spec.	Ensure adequate supply voltage (in very rare cases, low input voltages combined with fast accelerations can draw down the gate voltage) and try again. If persistant, RMA is required.
Blank prog segment	Attempt to execute a blank programming segment.	Ensure program is downloaded and try again.

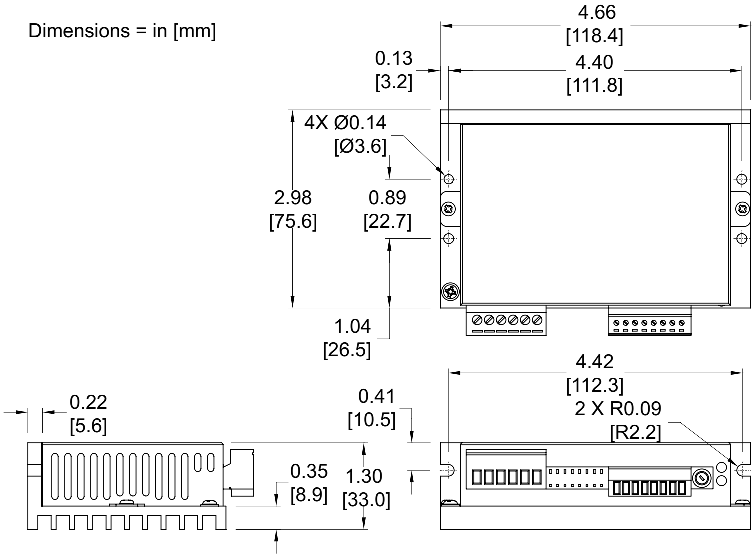
Error	Description	Corrective Action
Power supply overvoltage	The DC voltage feeding the drive is above the allowable level.	Decrease the input voltage. Linear power supplies do not output a fixed voltage: the lighter the output current, the higher the output voltage will float. If a linear supply's voltage floats above the drive's max voltage, you can install a small power resistor across the linear power supply's output to provide some load that will help pull down the floating voltage. Consider using a switching power supply such as the Rhino PSB power supply series. Overvoltage can also be fed back into a system by regeneration (when an overhauling load pushes energy back into the motor). In an application with regen problems, install an STP-DRVA-RC-050 regen clamp to help dissipate the extra energy. (The regen clamp will not help with the floating linear power supply that floats too high, but it will help with excess voltage generated from an overhauling load.)
Power supply undervoltage	The DC voltage feeding the drive is below the allowable level.	Correct the power supply. If this error occurs during operation, the power supply is most likely undersized. A sudden high current demand can cause an undersized power supply to dip in output voltage.
Flash memory backup error	Memory error detected when trying to load config from flash on powerup.	Restart device. No fix if restart doesn't work.
Over current / short circuit	Motor leads shorted - only checked on powerup.	Check and fix motor wiring.
Open motor winding	Motor leads not connected - only checked on powerup.	Check and fix motor wiring.
Bad encoder signal (optional encoder only)	Noisy or otherwise incorrectly formatted encoder signal (lack of A or B, lack of differential signal).	Check encoder wiring, always use differential encoders (or use checkbox in SureMotion Pro to disable this error when using single ended).
Serial communication error	Catch-all error for something wrong with serial communications. See CE command in HCR for details.	If drive can communicate, CE can give a precise diagnosis. If not, refer to the Serial Communications part of the HCR for troubleshooting.
Flash memory error	Memory error detected when trying to load config from flash on powerup.	Restart device. No fix if restart doesn't work.

Mounting the Drive

You can mount your drive on the wide or the narrow side of the chassis using (2) #6 screws. Since the drive amplifiers generate heat, the drive should be securely fastened to a smooth, flat metal surface that will help conduct heat away from the chassis. If this is not possible, then forced airflow from a fan may be required to prevent the drive from overheating.

- Never use your drive in a space where there is no air flow or where the ambient temperature exceeds 50 °C (122 °F).
- When mouting multiple STP-DRV-xxxx drives near each other, maintain at least one half inch of space between drives.
- Never put the drive where it can get wet.
- Never allow metal or other conductive particles near the drive.

Dimensions and Mounting Slot Locations



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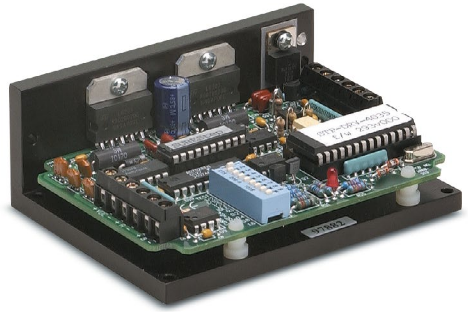
SureStep™ STP-DRV-4035 Microstepping Drive

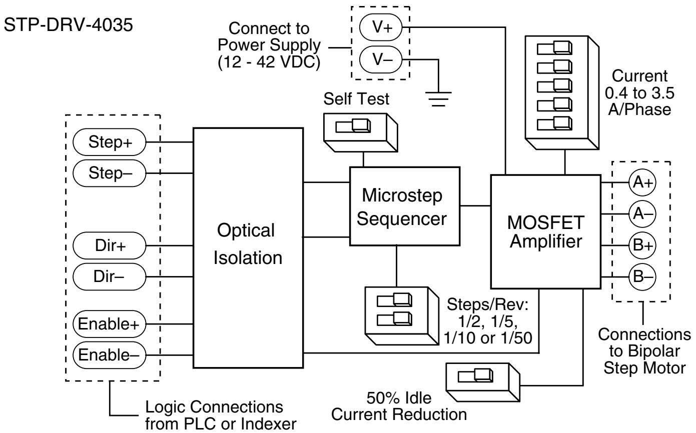
Chapter 3

In This Chapter...

Features

- Drives sizes 17 through 34 step motors
- Pulse width modulation, MOSFET 3 state switching amplifiers
- Phase current from 0.4 to 3.5 amps (switch selectable, 32 settings)
- Optically isolated step, direction and enable inputs
- Half, 1/5, 1/10, 1/50 step (switch selectable)
- Automatic 50% idle current reduction (can be switched off)



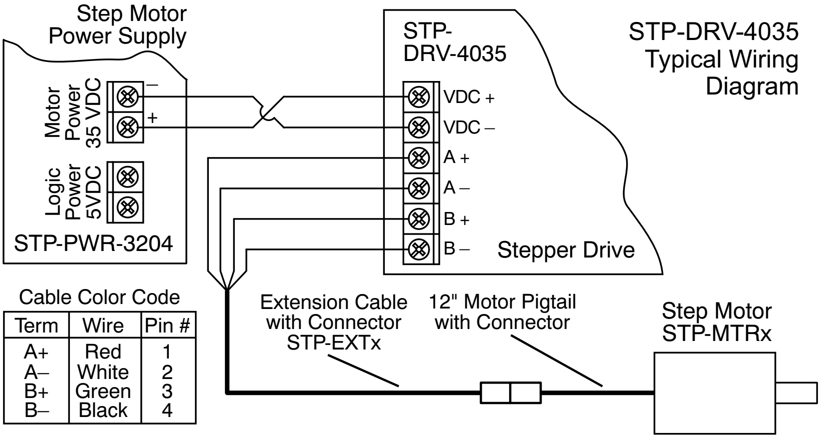


Specifications

SureStep™ Microstepping Drives Specifications		
Part Number		**STP-DRV-4035**
Input Power (with red Power On LED)		12-42 VDC (including ripple voltage)
Output Power		Output current selectable from 0.4 to 3.5 Amps/phase motor current (maximum output power is 140 W)
Current Controller		Dual H-bridge Bipolar Chopper (4-state 20 kHz PWM with MOSFET switches)
Input Signals	**Input Signal Circuit**	Opto-coupler input with 440 Ohm resistance (5 to 15 mA input current), Logic Low is input pulled to 0.8 VDC or less, Logic High is input 4VDC or higher (see page 3-9 for using input voltages higher than 5VDC)
	Pulse Signal	Motor steps on falling edge of pulse and minimum pulse width is 0.5 microseconds
	Direction Signal	Needs to change at least 2 microseconds before a step pulse is sent. CW and CCW are viewed from the end opposite the drive end of the motor (looking out of the shaft).
	Enable Signal	Logic 1 will disable current to the motor (current is enabled with no hook-up or logic 0)
DIP Switch Selectable Functions	**Self Test**	Off or On (uses half-step to rotate 1/2 revolution in each direction at 100 steps/second)
	Microstepping	400 (200x2), 1,000 (200x5), 2,000 (200x10), or 10,000 (200x50) steps/rev
	Idle Current Reduction	0% or 50% reduction (idle current setting is active if motor is at rest for 1 second or more)
	Phase Current Setting	0.4 to 3.5 Amps/phase with 32 selectable levels
Drive Cooling Method		Natural convection (mount drive to metal surface if possible)
Dimensions		3 x 4 x 1.5 inches [76.2 x 101.6 x 38.1 mm]
Mounting		Use #4 screws to mount on wide side (4 screws) or narrow side (2 screws)
Connectors		Screw terminal blocks with AWG 18 maximum wire size
Weight		9.3 oz. [264g]
Storage Temperature		-20–80 °C [-4–176 °F]
Chassis Operating Temperature		0–55 °C [32–131 °F] recommended; 70 °C [158 °F] maximum (use fan cooling if necessary); 90% non-condensing maximum humidity
Agency Approvals		CE

Note: The STP-DRV-4035 Microstepping Drive works with 4, 6, and 8 lead bipolar step motors. All **AutomationDirect** SureStep™ *motors are four-lead bipolar step motors.*

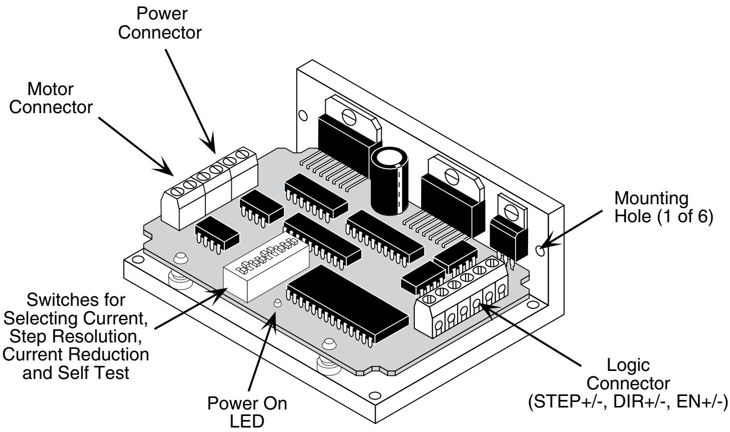
Typical Wiring Diagram



Term	Wire	Pin #
A+	Red	1
A–	White	2
B+	Green	3
B–	Black	4

Connection and Adjustment Locations

The diagram below shows where to find the important connection and adjustment points.



Connecting the Motor

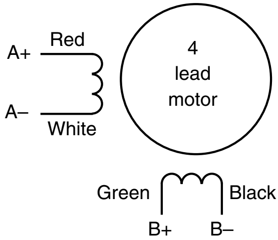
WARNING: When connecting a step motor to the *Sure*Step™ STP-DRV-4035 microstepping drive, be sure that the motor power supply is switched off. When using a motor not supplied by AUTOMATIONDIRECT, secure any unused motor leads so that they can't short out to anything. Never disconnect the motor while the drive is powered up. Never connect motor leads to ground or to a power supply. (See the Typical Wiring Diagram shown on page 2-4 of this chapter for the step motor lead color code of AUTOMATIONDIRECT supplied motors.)

You must now decide how to connect your stepping motor to the SureStep™ STP-DRV-4035 microstepping drive.

Four Lead Motors

Four lead motors can only be connected one way. Please follow the wiring diagram shown to the right.

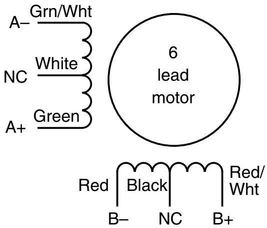
Note: All AUTOMATIONDIRECT Sure*Step™ motors are four lead bipolar step motors.*



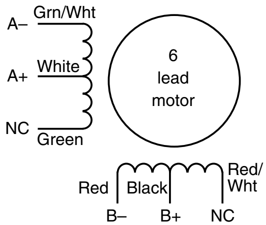
4 Leads

Six Lead Motors

Six lead motors can be connected in series or center tap. In series mode, motors produce more torque at low speeds, but cannot run as fast as in the center tap configuration. In series operation, the motor should be operated at 30% less than rated current to prevent overheating. Wiring diagrams for both connection methods are shown below. **NC** means not connected to anything.



6 Leads Series Connected

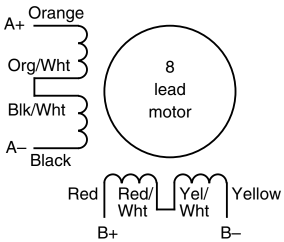


6 Leads Center Tap Connected

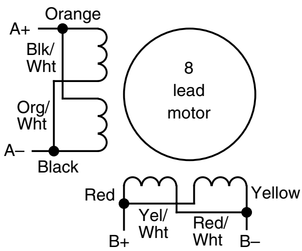
Note: Be aware that step motor wire lead colors vary from one manufacturer to another.

Eight Lead Motors

Eight lead motors can also be connected in two ways: series or parallel. Series operation gives you more torque at low speeds and less torque at high speeds. When using series connection, the motor should be operated at 30% less than the rated current to prevent over heating. Parallel operation allows a greater torque at high speed. When using parallel connection, the current can be increased by 30% above rated current. Care should be taken in either case to assure the motor is not being overheated. The wiring diagrams for eight lead motors are shown below.



8 Leads Series Connected



8 Leads Parallel Connected

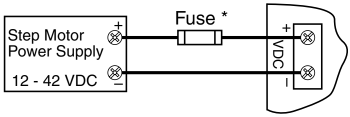
Note: Be aware that step motor wire lead colors vary from one manufacturer to another.

Connecting the Power Supply

The STP-PWR-3204 power supply from AUTOMATIONDIRECT is the best choice to power the step motor drive. If you need information about choosing a different power supply, please read the section titled "Choosing a Power Supply" in Chapter 7: "SureStep System Power Supplies".

If your power supply does not have a fuse on the output or some kind of short circuit current limiting feature you need to put a 4 amp fast acting fuse between the drive and power supply. Install the fuse on the + power supply lead.

Connect the motor power supply "+" terminal to the driver terminal labeled "+ VDC". Connect power supply "-" to the drive terminal labeled "VDC-". Use no smaller than 18 gauge wire. **Be careful not to reverse the wires.** Reverse connection will destroy your drive and void the warranty.



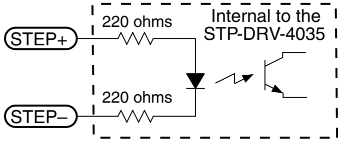
* External fuse not required when using an STP-PWR-3204 P/S; fuse is internal.

Do NOT use STP-PWR-48xx or -70xx power supplies with an STP-DRV-4035 drive, because those power supplies exceed the voltage limit of this drive.

Further information about braking accessories and regeneration clamping can be found in Appendix A and the STP-DRVA-RC-050 REGENERATION CLAMP datasheet.

Connecting the Logic

The SureStep drive contains optical isolation circuitry to prevent the electrical noise inherent in switching amplifiers from interfering with your circuits. Optical isolation is accomplished by powering the motor driver from a different supply source than your control circuits. There is no electrical connection between the two; signal communication is achieved by infrared light. When your circuit turns on or turns off, an infrared LED (built into the drive), signals a logic state to the phototransistors that are wired to the brains of the drive. A schematic diagram input circuit is shown to the right.



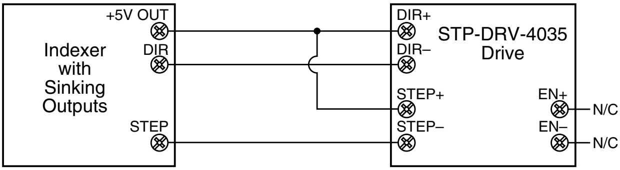
Drive Input Circuit

You will need to supply a source of step pulses to the drive at the STEP+ and STEP– terminals and a direction signal at the DIR+ and DIR– terminals, if bidirectional rotation is required. You will also need to determine if the **ENABLE** input terminals will be used in your application. Operation, voltage levels and wiring on the **ENABLE** terminals is the same as the **STEP** and **DIRECTION** terminals. The EN+ and EN– terminal can be left not connected if the enable function is not required.

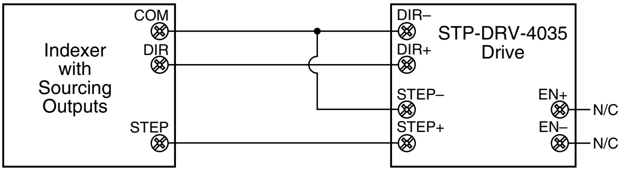
All logic inputs can be controlled by a DC output signal that is either sinking (NPN), sourcing (PNP), or differential.

On the next couple of pages are examples for connecting various forms of outputs from both indexers and PLCs.

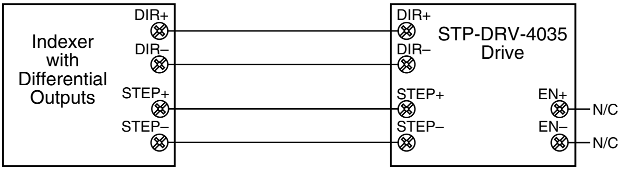
Connecting to an Indexer with Sinking Outputs



Connecting to an Indexer with Sourcing Outputs



Connecting to an Indexer with Differential Outputs



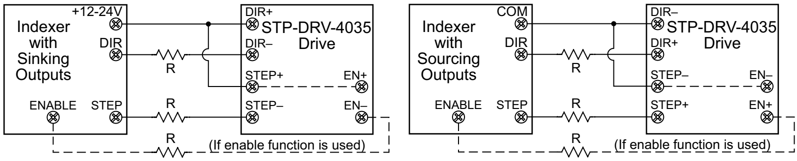
Note: Many high speed indexers have differential outputs.

Using Logic That is Not 5 volt TTL Level

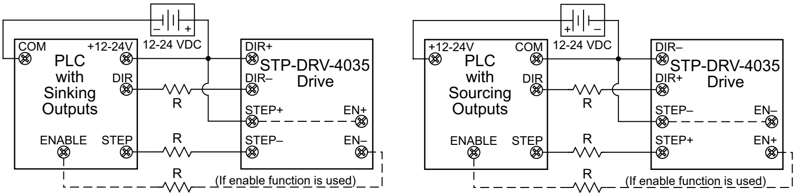
Some step and direction signals, especially those of PLCs, don't use 5 volt logic. You can connect signal levels as high as 24 volts to the SureStep drive if you add external dropping resistors to the STEP, DIR and EN inputs, as shown below.

- For 12 volt logic, add 820 ohm, 1/4 watt resistors
- For 24 volt logic, use 2200 ohm, 1/4 watt resistors

Connecting to an Indexer with Sink or Source 12-24 VDC Outputs



Connecting to a PLC with Sink or Source 12-24 VDC Outputs



Note: Most PLCs can use 24 VDC Logic.

The Enable Input

The **ENABLE** input allows the user to turn off the current to the motor by providing a positive voltage between EN+ and EN-. The logic circuitry continues to operate, so the drive "remembers" the step position even when the amplifiers are disabled. However, the motor may move slightly when the current is removed depending on the exact motor and load characteristics.

*Note: If you have no need to disable the amplifiers, you don't need to connect anything to the **ENABLE** input.*

Step Table
(half stepping)

DIR=1 cw (Step 0 → 8); DIR=0 ccw (Step 8 → 0)

Step	A+	A–	B+	B–
0	open	open	+	–
1	+	–	+	–
2	+	–	open	open
3	+	–	–	+
4	open	open	–	+
5	–	+	–	+
6	–	+	open	open
7	–	+	+	–
8	open	open	+	–

Step 0 is the Power Up State

Setting Phase Current

Before you turn on the power supply the first time, you need to set the drive for the proper motor phase current. The rated current is usually printed on the motor label. The SureStep drive current is easy to set. If you wish, you can learn a simple formula for setting current and never need the manual again. Or you can skip to the table on the next page, find the current setting you want, and set the DIP switches according to the picture.

Current Setting Formula

Locate the bank of tiny switches near the motor connector. Five of the switches, DIP switch positions 5-9, have a value of current printed next to them, such as 0.1, 0.2, 0.4, 0.8 and 1.6. Each switch controls the amount of current, in amperes (A), that its label indicates in addition to the minimum current value of 0.4 Amps. **There is always a base current of 0.4 Amps, even with all five DIP switches set to the "off" position (away from their labels).** To add to that, slide the appropriate switches toward their labels on the PC board. You may need a small screwdriver for this.

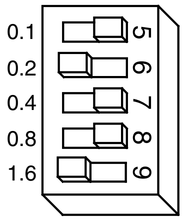
DIP switch current total settings =
step motor required phase current – 0.4 Amps always present base current

Example

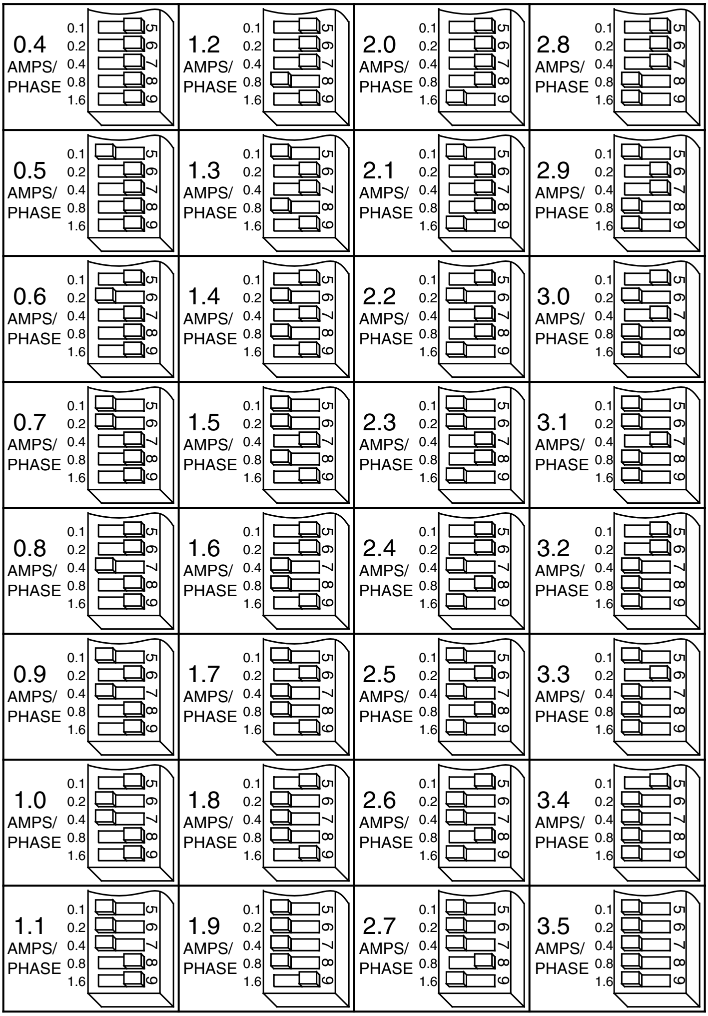
Suppose you want to set the drive for 2.2 Amps per phase based on the step motor showing a phase current of 2.2 Amps. You need the base current of 0.4 Amps plus another 1.6 and 0.2 Amps.

2.2 = 0.4 + 1.6 + 0.2

Slide the 1.6 and 0.2 Amp DIP switches toward the labels as shown in the figure to the right.



Current Setting Table



Factory Default

Microstepping

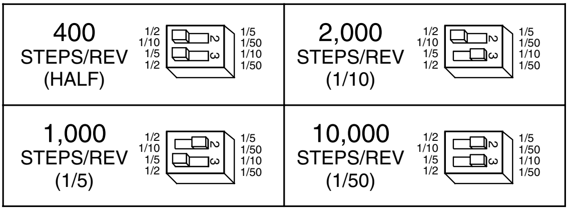
Most step motor drives offer a choice between full step and half step resolutions. In most full step drives, both motor phases are used all the time. Half stepping divides each step into two smaller steps by alternating between both phases on and one phase on. Microstepping drives like the SureStep drive precisely control the amount of current in each phase at each step position as a means of electronically subdividing the steps even further. The SureStep drive offers a choice of half step and three microstep resolutions. The highest setting divides each full step into 50 microsteps, providing 10,000 steps per revolution when using a 1.8° motor.

In addition to providing precise positioning and smooth motion, microstep drives can be used to provide motion in convenient units. When the drive is set to 2,000 steps/rev (1/10 step) and used with a 5 pitch lead screw, you get .0001 inches/step.

Setting the step resolution is easy. Look at the dip switch on the SureStep drive. Next to switches 2 and 3, there are labels on the printed circuit board. Each switch has two markings on each end. Switch 2 is marked 1/5, 1/10 at one end and 1/5, 1/50 at the other. Switch 3 is labeled 1/2, 1/5 and 1/10, 1/50. To set the drive for a resolution, push both switches toward the proper label. For example, if you want 1/10 step, push switch 2 toward the 1/10 label (to the left) and push switch 3 toward 1/10 (on the right).

Please refer to the table below and set the switches for the resolution you want.

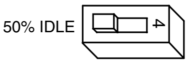
Factory Default



Idle Current Reduction

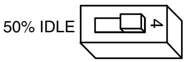
Your drive is equipped with a feature that automatically reduces the motor current by 50% anytime the motor is not moving. This reduces drive heating by about 50% and lowers motor heating by 75%. This feature can be disabled if desired so that full current is maintained at all times. This is useful when a high holding torque is required. To minimize motor and drive heating we highly recommend that you enable the idle current reduction feature unless your application strictly forbids it.

Idle current reduction is enabled by sliding switch #4 toward the ***50% IDLE*** label, as shown in the sketch below. Sliding the switch away from the ***50% IDLE*** label disables the reduction feature.



Idle Current Reduction Selected

(Factory Default)

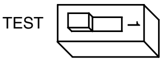


No Current Reduction

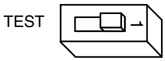
Self Test

The SureStep drive includes a self test feature. This is used for trouble shooting. If you are unsure about the motor or signal connections to the drive, or if the SureStep drive isn't responding to your step pulses, you can turn on the self test.

To activate the self test, slide switch #1 toward the ***TEST*** label. The drive will slowly rotate the motor, 1/2 revolution forward, then 1/2 rev backward. The pattern repeats until you slide the switch away from the ***TEST*** label. The SureStep drive always uses half step mode during the self test, no matter how you set switches 2 and 3. The self test ignores the ***STEP*** and ***DIRECTION*** inputs while operating. The ***ENABLE*** input continues to function normally.



Self Test ON

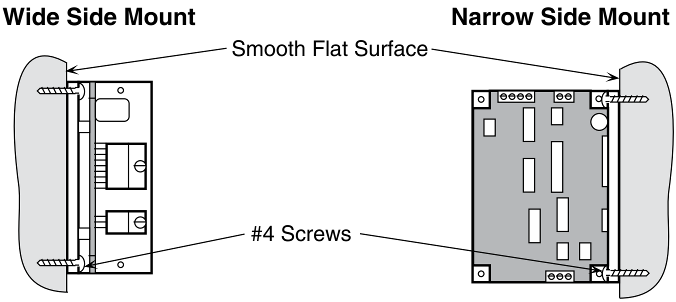


Self Test OFF

(Factory Default)

Mounting the Drive

You can mount your drive on the wide or the narrow side of the chassis. If you mount the drive on the wide side, use #4 screws through the four corner holes. For narrow side mounting applications, you can use #4 screws in the two side holes.

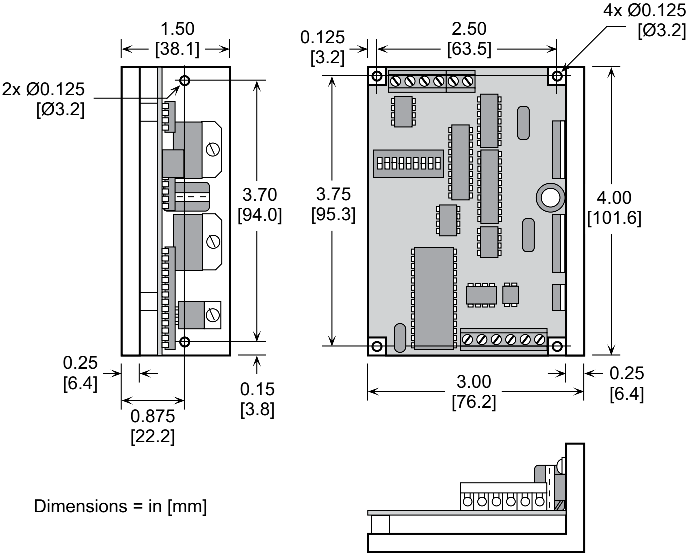


Unless you are running at 1 Amp/phase motor current or below, you may need a heat sink. Often, the metal subpanel being used for the control system will make an effective heat sink.

The amplifiers in the drive generate heat. Unless you are running at 1 amp or below, you may need a heat sink. To operate the drive continuously at maximum power you must properly mount it on a heat sinking surface with a thermal constant of no more than 4°C/Watt. Often, the metal enclosure of your system will make an effective heat sink.

Never use your drive in a space where there is no air flow or where other devices cause the surrounding air to be more than 70 °C. Never put the drive where it can get wet or where metal particles can get on it.

Dimensions


1.50
[38.1]
2x Ø0.125
[Ø3.2]
3.70
[94.0]
0.25
[6.4]
0.875
[22.2]
0.15
[3.8]
0.125
[3.2]
2.50
[63.5]
4x Ø0.125
[Ø3.2]
3.75
[95.3]
4.00
[101.6]
3.00
[76.2]
0.25
[6.4]
Dimensions = in [mm]

BLANK
PAGE

SureStep™ Advanced Microstepping Drives

Chapter 4

In This Chapter...

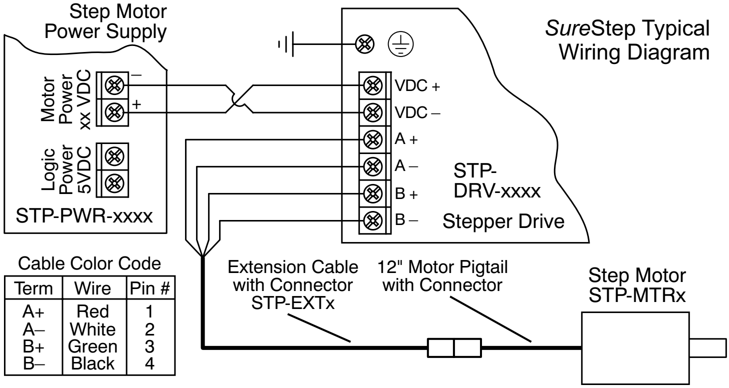
Features

- Max 5A, 48V and max 10A, 80V models available
- Software configurable
- Programmable microsteps
- Internal indexer (via ASCII commands)
- Self test feature
- Idle current reduction
- Anti-resonance
- Torque ripple smoothing
- Step, analog, and serial communication inputs

Specifications

SureStep™ Series Specifications – Microstepping Drives			
Microstepping Drive		**STP-DRV-4850**	**STP-DRV-80100**
Drive Type		Advanced microstepping drive with pulse or analog input, serial communication, & indexing capability	
Output Current		0.1–5.0 A/phase (in 0.01A increments)	0.1–10.0 A/phase (in 0.01A increments)
Input Voltage (external p/s required)		24–48 VDC (nominal) (range: 18-53 VDC)	24–80 VDC (nominal) (range: 18-88 VDC)
Configuration Method		SureMotion Pro software	
Amplifier Type		MOSFET, dual H-bridge, 4-quadrant	
Current Control		4-state PWM @ 20 kHz	
Protection		Over-voltage, under-voltage, over-temperature, external output faults (phase-to-phase & phase-to-ground), inter-amplifier shorts	
Recommended Input Fusing		Fuse: 4A 3AG delay (ADC #MDL4) Fuse Holder: ADC #DN-F6L110	Fuse: 6.25A 3AG delay (ADC #MDL6-25) Fuse Holder: ADC #DN-F6L110
Input Signals	**Input Circuit**	Opto-coupler input with 5 to 15 mA input current; Logic Low is input pulled to 0.8 VDC or less; Logic High is input 4 VDC or higher (see pages 4-8 and 4-9 for how to use input voltages higher than 5VDC)	
	Step/Pulse	Optically isolated, differential, 5V, 330Ω; Min pulse width = 250 ns, Max pulse frequency = 2MHz Adjustable bandwidth digital noise rejection feature	
	Direction	FUNCTIONS: step & direction, CW/CCW step, A/B quadrature, run/stop & direction, jog CW/CCW, CW/CCW limits	
	Enable	Optically isolated, 5–12V, 680Ω; FUNCTIONS: motor enable, alarm reset, speed select (oscillator mode)	
	Analog	Range: 0–5 VDC; Resolution: 12 bit; FUNCTION: speed control	
Output Signal		Optically isolated, 24V, 100mA max; FUNCTIONS: fault, motion, tach (3kHz max)	
Communication Interface		RS-232; RJ11 (6P4C) receptacle	
Non-volatile Memory Storage		Configurations are saved in FLASH memory on-board the DSP	
Features	**Idle Current Reduction**	Reduction range of 0–90% of running current after delay selectable in ms	
	Microstep Resolution	Software selectable from 200 to 51200 steps/rev in increments of 2 steps/rev	
	Modes of Operation	Pulse (step) & direction, CW/CCW, A/B quadrature, velocity (oscillator), SCL serial commands	
	Phase Current Setting	0.1–5.0 A/phase (in 0.01A increments)	0.1–10.0 A/phase (in 0.01A increments)
	Self Test	Checks internal & external power supply voltages, diagnoses open motor phases	
	Additional Features	Anti-resonance (Electronic Damping) Auto setup Serial Command Language (SCL) Host Control Step Smoothing Filter (Command Signal Smoothing & Microstep Emulation) Waveform (Torque Ripple) Smoothing	
Connectors		Communication: RJ11 (6P4C); Other: removable screw terminal blocks	
Maximum Humidity		90% non-condensing	
Storage Temperature		-20–80 °C [-4–176 °F] (mount to suitable heat sink)	
Operating Temperature		0–55 °C [32–158 °F] (mount to suitable heat sink)	
Drive Cooling Method		Natural convection (mount to suitable heat sink)	
Mounting		#6 mounting screws (mount to suitable heat sink)	
Dimensions		3.0 x 3.65 x 1.125 inches [76.2 x 92.7 x 28.6 mm]	
Weight		8 oz [227g] (approximate)	
Agency Approvals		CE	

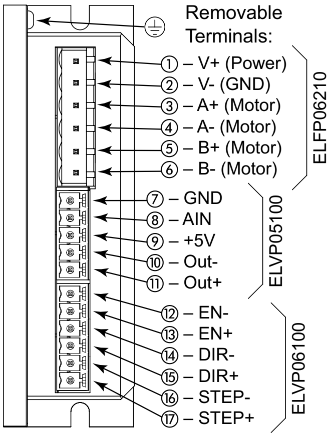
Typical Wiring Diagram

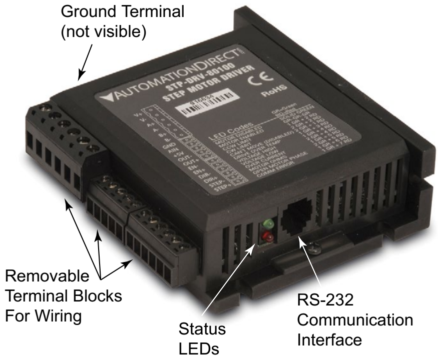


Cable Color Code

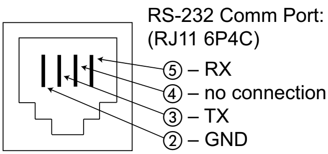
Term	Wire	Pin #
A+	Red	1
A–	White	2
B+	Green	3
B–	Black	4

Connection Locations & Pin-out





Terminal block part #s (shown) are
Amphenol PCD (www.amphenolpcd.com)



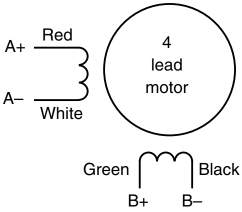
External wiring is connected using three separate pluggable screw terminal connectors. The power connections share a six position connector, the digital inputs share another six position connector, and the analog input and digital output share a five position connector.

Connecting the Motor

Warning: When connecting a step motor to a *Sure*Step™ advanced microstepping drive, be sure that the motor power supply is switched off. When using a motor not supplied by AutomationDirect, secure any unused motor leads so that they can't short out to anything. Never disconnect the motor while the drive is powered up. Never connect motor leads to ground or to a power supply. (See the Typical Wiring Diagram shown in this chapter for the step motor lead color code of AutomationDirect supplied motors.)

Four lead motors

Four lead motors can only be connected one way, as shown below.

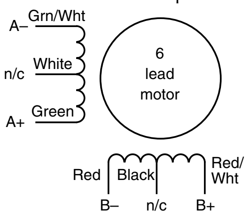


4 Leads

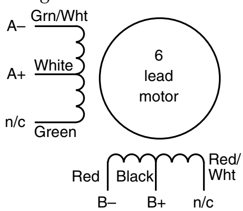
All AutomationDirect Sure*Step™ motors are four lead bipolar step motors.*

Six Lead Motors

Six lead motors can be connected in series or center tap. Motors produce more torque at low speeds in series configuration, but cannot run as fast as in the center tap configuration. In series operation, the motor should be operated at 30% less than rated current to prevent overheating.



6 Leads Series Connected

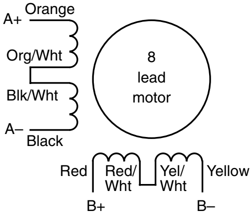


6 Leads Center Tap Connected

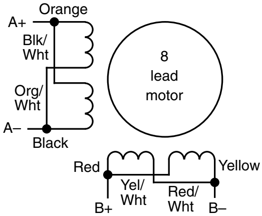
Step motor wire lead colors vary from one manufacturer to another.

Eight Lead Motors

Eight lead motors can also be connected in two ways: series or parallel. Series operation gives you more torque at low speeds, but less torque at high speeds. When using series connection, the motor should be operated at 30% less than the rated current to prevent over heating. Parallel operation allows greater torque at high speeds. When using parallel connection, the current can be increased by 30% above rated current. Care should be taken in either case to assure the motor does not overheat.



8 Leads Series Connected



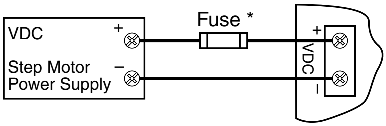
8 Leads Parallel Connected

Step motor wire lead colors vary from one manufacturer to another.

Connecting the Power Supply

An STP-PWR-xxxx power supply from AutomationDirect is the best choice to power the step motor drive. If you need information about choosing a different power supply, refer to the section entitled "Choosing a Power Supply" in Chapter 7: "SureStep System Power Supplies."

If your power supply does not have a fuse on the output or some kind of short circuit current limiting feature, you need a fuse between the drive and the power supply. Install the fuse on the + power supply lead.



* External fuse not required when using an STP-PWR-xxxx P/S; fuse is internal.

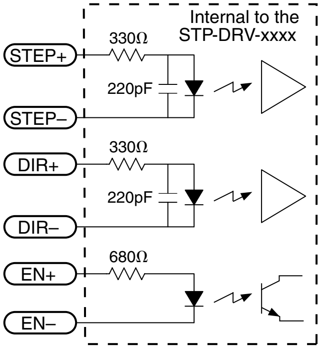
Further information about braking accessories and regeneration clamping can be found in Appendix A: "SureStep Accessories" and the STP-DRVA-RC-050 REGENERATION CLAMP datasheet.

Warning: Connect the motor power supply "+" terminal to the drive "+ VDC" terminal, and connect the power supply "–" terminal to the drive "VDC–" terminal. Use wire no smaller than 18 gauge, and be careful not to reverse the wires. Reverse connection will destroy your drive and void the warranty.

Connecting the I/O

SureStep™ Drive Digital Inputs

The SureStep advanced drives include two high speed 5V digital inputs (STEP and DIR), and one standard speed 5-12V input (EN).



Drive Digital Input Circuit

The digital inputs are optically isolated to reduce electrical noise problems. There is no electrical connection between the control and power circuits within the drive, and input signal communication between the two circuits is achieved by infrared light. Externally, the drive's motor power and control circuits should be supplied from separate sources, such as from a step motor power supply with separate power and logic outputs.

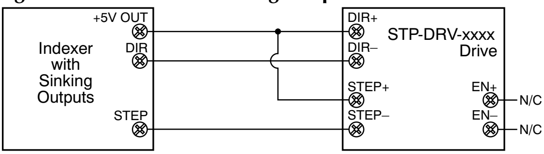
For bidirectional rotation, supply a source of step pulses to the drive at the STEP+ and STEP– terminals, and a directional signal at the DIR+ and DIR– terminals.

The ENABLE input allows the logic to turn off the current to the step motor by providing a signal to the EN+ and EN– terminals. The EN+ and EN– terminal can be left unconnected if the enable function is not required.

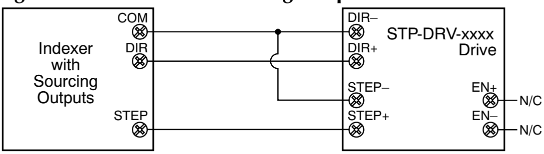
All logic inputs can be controlled by a DC output signal that is either sinking (NPN), sourcing (PNP), or differential.

Connecting STEP and DIR to 5V TTL Logic

Connecting to an Indexer with Sinking Outputs



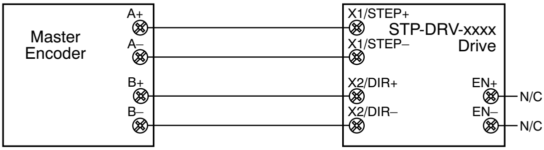
Connecting to an Indexer with Sourcing Outputs



Connecting to an Indexer with Differential Outputs

Many high speed indexers have differential outputs.

Wiring for Encoder Following



Connecting STEP and DIR to Logic Other Than 5V TTL Level

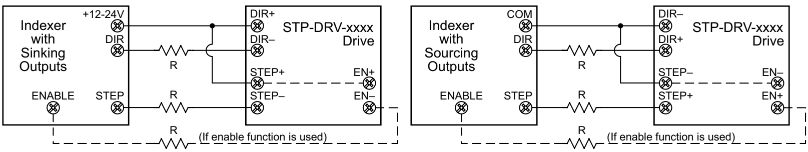
Some step and direction signals, especially those of PLCs, don't use 5 volt logic. You can connect signal levels as high as 24 volts to a SureStep advanced drive if you add external dropping resistors to the STEP, DIR and EN inputs.

- For 12V logic, use 820Ω, 1/4W resistors
- For 24V logic, use 2200Ω, 1/4W resistors

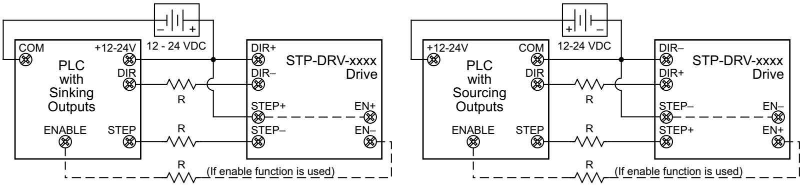
Most PLCs can use 24 VDC Logic.

Warning: 5VDC is the maximum voltage that can be applied directly to a high speed input (STEP and DIR). If using a higher voltage power source, install resistors to reduce the voltage at the inputs. Do NOT apply an AC voltage to an input terminal.

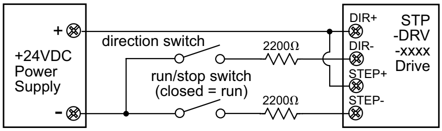
Connecting to an Indexer with Sink or Source 12-24 VDC Outputs



Connecting to a PLC with Sink or Source 12-24 VDC Outputs



Connecting to Mechanical Switches at 24 VDC

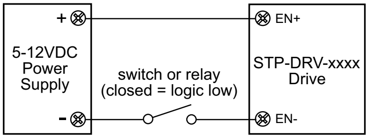


Connections to the EN Input

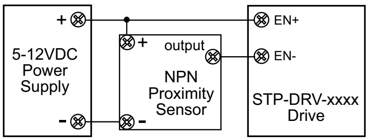
The ENABLE input allows the user to turn off the current to the motor by providing a 5-12 VDC positive voltage between EN+ and EN-. The logic circuitry continues to operate, so the drive "remembers" the step position even when the amplifiers are disabled. However, the motor may move slightly when the current is removed depending on the exact motor and load characteristics.

Warning: 12VDC is the maximum voltage that can be applied directly to the standard speed EN input. If using a higher voltage power source, install resistors to reduce the voltage at the input. Do NOT apply an AC voltage to an input terminal.

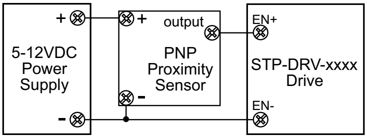
Connecting ENABLE Input to Relay or Switch



Connecting ENABLE Input to NPN Proximity Sensor



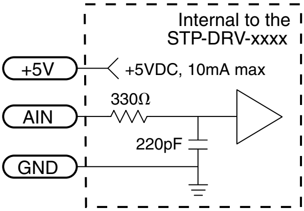
Connecting ENABLE Input to PNP Proximity Sensor



Leave the ENABLE input unconnected if you do not need to disable the amplifiers.

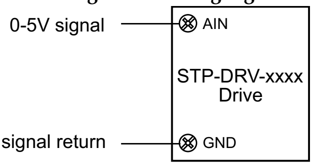
Connecting the Analog Input

The SureStep advanced drives have one 0-5 VDC analog input.

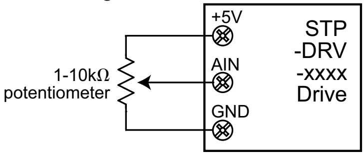


Drive Analog Input Circuit

Connecting AI to Analog Signal



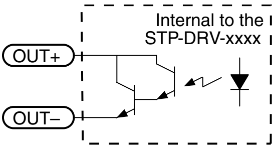
Connecting AI to Potentiometer



Warning: The analog input is NOT optically isolated, and must be used with care. It may operate improperly and it can be damaged if the system grounds are not compatible.

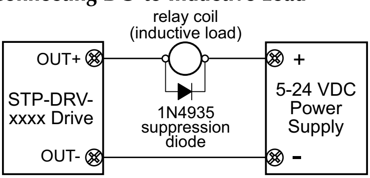
Connecting the Digital Output

The SureStep advanced drives have one digital output (DO) that has separate positive (+) and negative (-) terminals, and can be used to sink or source current.

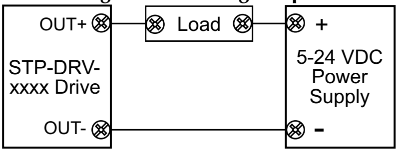


Drive Digital Output Circuit

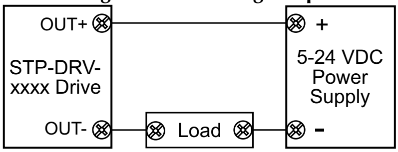
Connecting DO to Inductive Load



Connecting DO as Sinking Output



Connecting DO as Sourcing Output



Warning: Do NOT connect the digital output to a voltage greater than 30VDC. The current through each DO terminal must not exceed 100mA.

LED Display Codes

The LEDs on the Surestep advanced drives flash in the sequences shown in the table below to denote various alarm states.

STP-DRV-4850 and 810100 Alarm Codes	
Status LED Alarm Code	**Error**
solid green	no alarm, motor disabled
flashing green	no alarm, motor enabled
flashing red	configuration or memory error*
fast green	program running
1 red, 1 green	motor stall (optional encoder only)
1 red, 2 green	move attempted while drive disabled
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 prog segment
4 red, 1 green	power supply overvoltage**
4 red, 2 green	power supply undervoltage*
4 red, 3 green	flash memory backup error
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	serial communication error
7 red, 2 green	flash memory error

** Does not disable the motor.*
The alarm will clear about 30 seconds after the fault is corrected.

*** Disables the motor. Cannot be cleared until power is cycled.*

† The over-current/short-circuit alarm typically indicates that an electrical fault exists somewhere in the system external to the drive. This alarm does not serve as motor overload protection.

Alarm Code Definitions

Error	Description	Corrective Action
No alarm, motor disabled	No faults active, Circuit is closed between EN+ and EN-.	N/A
No alarm, motor enabled	No faults active, Circuit is open between EN+ and EN-.	N/A
Configuration or memory error	Memory error detected when trying to load config from flash on powerup.	Restart device. No fix if restart doesn't work.
Program running	No faults active.	N/A
Motor stall (optional encoder only)	Motor torque demand exceeded capability and the motor skipped steps. This is configured in SureMotion Pro.	Increase torque utilization if it's not already maxed out, otherwise decrease the torque demand by modifying the move profile, or put in a larger motor.
Move attempted while drive disabled	Drive is disabled and move attempted.	Reset alarm, enable motor, and move again.
CCW limit	CCW limit is reached. The digital input that has been assigned CCW limit has been activated.	Unblock the CCW sensor (open the circuit) or redifine the input with SureMotion Pro.
CW limit	CW limit is reached. The digital input that has been assigned CW limit has been activated.	Unblock the CCW sensor (open the circuit) or redefine the input with SureMotion Pro.
Drive overheating	The drive's internal temperature is too high.	If the drive is operating within its standard range (input voltage and output current are OK), more heat must be removed from the drive during operation. For Advanced drives (see "Mounting the Drive" on page 4-14), ensure the drive is mounted to a metal surface that can dissipate the drive's heat. For Integrated motor/drives, see "Mounting" on page 5-13. For both types of drives: If the mounting surface cannot pull enough heat away from the drive, forced airflow (from a fan) may be required to cool the drive.
Internal voltage out of range	Gate voltage, 5V rail, or 3V rail are out of spec.	Ensure adequate supply voltage (in very rare cases, low input voltages combined with fast accelerations can draw down the gate voltage) and try again. If persistant, RMA is required.
Blank prog segment	Attempt to execute a blank programming segment.	Ensure program is downloaded and try again.

Error	Description	Corrective Action
Power supply overvoltage	The DC voltage feeding the drive is above the allowable level.	Decrease the input voltage. Linear power supplies do not output a fixed voltage: the lighter the output current, the higher the output voltage will float. If a linear supply's voltage floats above the drive's max voltage, you can install a small power resistor across the linear power supply's output to provide some load that will help pull down the floating voltage. Consider using a switching power supply such as the Rhino PSB power supply series. Overvoltage can also be fed back into a system by regeneration (when an overhauling load pushes energy back into the motor). In an application with regen problems, install an STP-DRVA-RC-050 regen clamp to help dissipate the extra energy. (The regen clamp will not help with the floating linear power supply that floats too high, but it will help with excess voltage generated from an overhauling load.)
Power supply undervoltage	The DC voltage feeding the drive is below the allowable level.	Correct the power supply. If this error occurs during operation, the power supply is most likely undersized. A sudden high current demand can cause an undersized power supply to dip in output voltage.
Flash memory backup error	Memory error detected when trying to load config from flash on powerup.	Restart device. No fix if restart doesn't work.
Over current / short circuit	Motor leads shorted - only checked on powerup.	Check and fix motor wiring.
Open motor winding	Motor leads not connected - only checked on powerup.	Check and fix motor wiring.
Bad encoder signal (optional encoder only)	Noisy or otherwise incorrectly formatted encoder signal (lack of A or B, lack of differential signal).	Check encoder wiring, always use differential encoders (or use checkbox in SureMotion Pro to disable this error when using single ended).
Serial communication error	Catch-all error for something wrong with serial communications. See CE command in HCR for details.	If drive can communicate, CE can give a precise diagnosis. If not, refer to the Serial Communications part of the HCR for troubleshooting.
Flash memory error	Memory error detected when trying to load config from flash on powerup.	Restart device. No fix if restart doesn't work.

Drive Configuration

You need to configure your drive for your particular application before using the drive for the first time. The SureStep advanced microstepping drives require SureMotion Pro (part number SM-PRO, free download at Automationdirect.com) drive configuration software for this purpose. Please refer to Chapter 8: "SureMotion Pro Configuration Software" or the software's help file for more detailed information on configuring the drive. The software contains instructions for installation on a PC, and instructions for configuring the drives. Configuration settings include:

- drive model
- motor characteristics
- motion control mode
- I/O configuration

Anti-Resonance / Electronic Damping

Step motor systems have a tendency to resonate at certain speeds. SureStep advanced drives automatically calculate the system's natural resonate frequency, and apply damping to the control algorithm. This greatly improves midrange stability, allows higher speeds and greater torque utilization, and improves settling times.

This feature is on by default, but it can be turned off using the "Motor..." icon of the SureMotion Pro software.

Idle Current Reduction

This feature reduces current consumption while the system is idle, and subsequently reduces drive and motor heating. However, reducing the idle current also reduces the holding torque.

The percent and delay time of the idle current reduction can be adjusted using the "Motor..." icon of the SureMotion Pro software.

Microstep Resolution

The microstep resolution (steps/rev) can be selected using the "Motion & I/O..." icon of the SureMotion Pro software, and selecting "Pulse and Direction Mode".

Modes of Operation

Modes of operation are selectable via the SureMotion Pro software "Motion & I/O..." icon.

- Pulse & Direction Mode
  - Pulse & Direction
  - CW & CCW Pulse
  - A/B Quadrature
- Velocity (Oscillator) Mode
- Serial Command Language (SCL)

Phase Current Setting

Motor phase current settings are available through the SureMotion Pro software "Motor..." icon and the "Running Current" settings.

Serial Command Language (SCL) Host Control

SureStep advanced drives can accept serial commands from a host PC or PLC.

This feature can be selected using the "Motion & I/O..." icon of the SureMotion Pro software, and selecting Serial Command Language.

Step Smoothing Filter (Command Signal Smoothing & Microstep Emulation)

The Step Smoothing Filter setting is effective only in the Step (Pulse) & Direction mode. It includes command signal smoothing and microstep emulation to soften the effect of immediate changes in velocity and direction, therefore making the motion of the motor less jerky. An added advantage is that it can reduce the wear on mechanical components.

This feature can be modified by using the "Motion & I/O..." icon of the SureMotion Pro software, and selecting "Pulse and Direction Mode".

Waveform (Torque Ripple) Smoothing

All step motors have an inherent low speed torque ripple that can affect the motion of the motor. SureStep advanced drives can analyze this torque ripple and apply a negative harmonic to negate this effect. This feature gives the motor much smoother motion at low speeds.

This feature is on by default, and is factory preset for standard motors. It can be turned off or on using the "Motor..." icon of the SureMotion Pro software. To set Waveform Smoothing for custom motors, select "Define Custom Motor..." and the "Waveform Smoothing" "Wizard...".

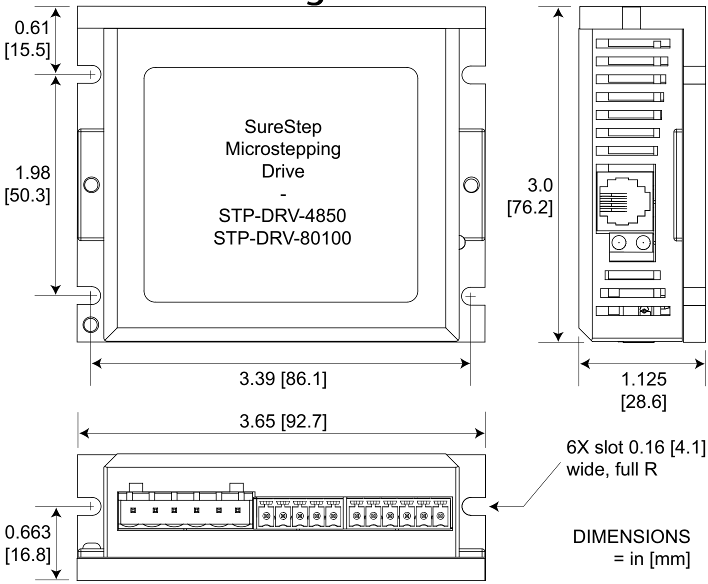
CAUTION: Power down the SureStep drive before plugging a communication cable into the comm port of the drive. Failure to do so may result in damage to the drive comm port!

Mounting the Drive

You can mount your drive on the wide or the narrow side of the chassis using #6 screws. Since the drive amplifiers generate heat, the drive should be securely fastened to a smooth, flat metal surface that will help conduct heat away from the chassis. If this is not possible, then forced airflow from a fan may be required to prevent the drive from overheating.

- Never use your drive in a space where there is no air flow or where the ambient temperature exceeds 40 °C (104 °F).
- When mouting multiple STP-DRV-xxxx drives near each other, maintain at least one half inch of space between drives.
- Never put the drive where it can get wet.
- Never allow metal or other conductive particles near the drive.

Dimensions and Mounting Slot Locations



SureStep™ Integrated Motors/Drives

Chapter 5

In This Chapter...

Features

General Features:

- NEMA 17, NEMA 23, and NEMA 24 frame sizes available
- DC power supply required: 12-48 VDC or 12-70 VDC
- Pulse/Direction or CW Pulse/CCW Pulse
- Digital input filtering
- Three optically isolated digital inputs, 5 to 24 volts
- One isolated digital input, 30V 100mA
- Step input signal smoothing (microstep emulation), performs high resolution stepping by synthesizing coarse steps into fine microsteps
- Dynamic smoothing, software configurable filtering for use in removing spectral components from command sequence, reduces jerk, limiting excitation of system resonance
- Anti-resonance (electronic damping): raises the system-damping ratio to eliminate midrange instability and allow stable operation throughout the speed range of the motor
- Idle current reduction range of 0-90% of running current after a delay selectable in milliseconds
- Configurable hardware digital noise filter, software noise filter
- Non-volatile storage, configurations are saved in FLASH memory on-board the DSP
- Dynamic current control, software configurable for running current, accel current, idle current, to make motion smoother and the motor run cooler

Standard Drive Features

- Optional, external encoder feedback
- Configurable via DIP switches
- Available torque from 60 oz-in to 210 oz-in

Advanced Drive Features

- AB Quadrature/Encoder Following
- Velocity (Oscillator) and position mode
- Streaming SCL commands
- RS-485 communications
- Optional, internal encoder feedback
- Four “Variable I/O” points, 5 to 24 volts (available on NEMA 24 only)
- 12-bit analog input for speed and position, 0 to 5 VDC
- Configurable via SureMotion Pro software
- Available torque from 68 oz-in to 340 oz-in

Features Comparison

Features Comparison – Integrated Motor/Drives					
Motor/Drive Series	STP-MTRD-17xxxxR(E)	STP-MTRD-23xxxxR(E)	STP-MTRD-24xxxxRV(E)	STP-MTRD-17xxxx(E)	STP-MTRD-23xxxx(E)
Motor/Drive Type	Advanced (w/RS-485 Serial/ASCII)			Standard (Pulse/Direction only)	
DC Power Supply	12-48 VDC	12-70 VDC	12-70 VDC	12-48 VDC	12-70 VDC
Pulse/Direction or CW Pulse/CCW Pulse	✓	✓	✓	✓	✓
AB Quadrature/ Encoder Following	✓	✓	✓	-	-
Velocity (Oscillator) and Position Mode	✓	✓	✓	-	-
Serial ASCII (SCL) Commands	✓	✓	✓	-	-
RS-485 ASCII Communications	✓	✓	✓	-	-
Optional, Internal Encoder Feedback (Position Verification)	✓	✓	✓	-	-
Optional, External Encoder Feedback (Open Loop)	-	-	-	✓	✓
Available Torque	Up to 68 oz-in	Up to 210 oz-in	Up to 340 oz-in	Up to 68 oz-in	Up to 210 oz-in
Digital Input Filtering	✓	✓	✓	✓	✓
Three Optically Isolated Digital Inputs, 5-24 Volts	✓	✓	-	✓	✓
One Optically Isolated Digital Output, 30V 100mA	✓	✓	-	✓	✓
Four, 5-24 Volt digital "Variable I/O" points	-	-	✓	-	-
12-bit Analog Input	✓	✓	✓	-	-
Step Input Signal Smoothing (Microstep Emulation)	✓	✓	✓	✓	✓
Anti-resonance	✓	✓	✓	✓	✓
Electronic Damping	✓	✓	✓	✓	✓
Idle Current Reduction	✓	✓	✓	✓	✓
Configuration Method	SureMotion Pro software			Dip Switch	

Specifications

General Specifications – All Integrated Motor/Drives	
Drive Cooling Method	Natural convection (mount to suitable heat sink)
Step Resolution	Full, Half, Microstepping, Microstep Emulation
Step Angle	1.8 degrees
Supply Output	+4.8 - 5 volts @ 50mA maximum
Circuit Protection	Short circuit, over-voltage, under-voltage, over-temp
Operating Temperature	0-85°C (32-185°F) 0-70°C (0-158°F) for NEMA 24 systems
Ambient Temperature	0-40°C (32-104°F)
Over-temp Shutdown	85°C (185°F)
Humidity	90% max, non-condensing
Insulation Class	Class B (130°C)
Agency Approvals	CE*

**For NEMA 24 motors, an EMI filter (RES10F03) is needed on the power supply for CE compliance.*

*Sure*Step™ Standard Integrated Motor/Drive Specifications			
Integrated Motor/ Drive	**STP-MTRD-17038 / STP-MTRD-17038E**	**STP-MTRD-23042 / STP-MTRD-23042E**	**STP-MTRD-23065 / STP-MTRD-23065E**
Frame Size	NEMA 17	NEMA 23	
Input Power	12-48 VDC (nominal) (Range: 11-52 VDC) (fuse at V+)	12-70 VDC (nominal) (Range: 11-74 VDC) (fuse at V+)	
Current Controller	Digital MOSFET, PWM at 16kHz		
Encoder Feedback	"E" models only. External encoder must be wired to external feedback device.		
Configuration Method	Dip Switches		
Input Signals – Step	5-24 VDC nominal (range 4-30VDC); (5mA @ 4V; 15 mA @ 30V); Optically isolated. Minimum pulse width = 3µs (at 2 MHz), 0.25µs (at 150kHZ) Maximum pulse frequency = 150kHz or 2MHz (switch selectable) Function = Step Input, Limit CW		
Input Signals – Direction	5-24 VDC nominal (range 4-30VDC); (5mA @ 4V; 15 mA @ 30V); Optically isolated. Minimum pulse width = 3µs (at 2 MHz), 0.25µs (at 150kHZ) Maximum pulse frequency = 150kHz or 2MHz (switch selectable) Function = Direction Input, Limit CCW		
Input Signals – Enable	5-24 VDC nominal (range 4-30VDC); (5mA @ 4V; 15 mA @ 30V); Optically isolated. Minimum pulse width = 3µs (at 2 MHz), 0.25µs (at 150kHZ) Maximum pulse frequency = 150kHz or 2MHz (switch selectable) Function = Enable Input		
Output Signal – Output	30 VDC / 100mA max, photodarlington, voltage drop = 1.2V max at 100mA Function = Alarm Output		
Jumper Selectable Functions – Step Pulse Type	Step and Direction: Step signal = step/pulse; Direction signal = direction. Step CW & CCW: Step signal = CW step; Direction signal = CCW step.		
Jumper Selectable Functions – Step Pulse Noise Filter	Selectable 150 kHz or 2MHz		
DIP Switch Selectable Functions – Current Reduction	This is the percentage of full current that the motor will use when the shaft is rotating. 100%, 90%, 70%, and 50% current selections.		
DIP Switch Selectable Functions – Idle Current Reduction	Reduce power consumption and heat generation by limiting motor idle current to 90% or 50% of running current. (Holding torque is reduced by the same %.)		
DIP Switch Selectable Functions – Load Inertia	Anti-resonance and damping feature improves motor performance. Set motor and load inertia range to 0–4x or 5–10x.		
DIP Switch Selectable Functions – Step Resolution	200-25600 (dip switch selectable)		
DIP Switch Selectable Functions – Self Test	Automatically rotate the motor back and forth two turns in each direction in order to confirm that the motor is operational.		
Max Holding Torque	4.25 lb·in / 68 oz·in / 0.480189 N·m	7.8125 lb·in / 125 oz·in / 0.8827 N·m	13.125 lb·in / 210 oz·in / 1.482936 N·m
Mounting	Four M3 screws	Four #6 screws	
Removable Connector – Control	Housing: Tyco 4-643498-1 Cover: Tyco 1-643075-1	Connector part number: Weidmuller 1610200000, included in STP-CON-3	
Removable Connector – Encoder	Two 5 pin inserts (Molex# 14-60-0058), one housing Molex# 15-04-5104		
Rotor Inertia	0.448 oz-in^2 (0.082 kg-cm^2)	1.420 oz-in^2 (0.260 kg-cm^2)	2.515 oz-in^2 (0.460 kg-cm^2)
Status LEDs	1 red/green		
Weight	14.7 oz	30 oz (850g)	42 oz (1200g)

*Sure*Step™ Advanced Integrated Motor/Drive Specifications			
Integrated Motor/Drive		**STP-MTRD-17030R / STP-MTRD-17030RE**	**STP-MTRD-17038R / STP-MTRD-17038RE**
Frame Size		NEMA 17	
Input Power		12-48 VDC (nominal) (Range: 11-52 VDC) (fuse at V+)	
Current Controller		Dual H-Bridge, 4 Quadrant, 4 state PWM @ 16kHz	
Encoder Feedback		"E" models only. Encoder is internal and provides position verification and stall prevention control by default.	
Configuration Method		SureMotion Pro software (SM-PRO: Free download)	
Input Signals	***Step/Pulse***	5-24 VDC nominal. Optically isolated. Minimum pulse width = 250ns (at 3 MHz). Maximum pulse frequency = 3MHz, max current draw = 12mA Function = Step Input, Jog CW, Limit CW, Start/Stop, General Purpose	
	Direction	5-24 VDC nominal. Optically isolated. Minimum pulse width = 250ns (at 3 MHz). Maximum pulse frequency = 3MHz, max current draw = 12mA Function = Direction Input, Jog CCW, Limit CCW, General Purpose	
	Enable	5-24 VDC nominal. Optically isolated. Minimum pulse width = 250ns (at 3 MHz). Maximum pulse frequency = 3MHz, max current draw = 12mA Function = Enable Input, Reset Input, Change Speed, General Purpose	
	Analog	0-5 VDC nominal (AIN referenced to GND). Input impedance: 30K ohms minimum, resolution = 12 bits Function = analog control modes and general purpose analog usage; programmable for signal range, offset, dead band, and filtering	
Output Signal		30VDC, 40mA maximum. Optically isoalted, open collector. Maximum pulse frequency 10kHz. Functions = Brake Output, Alarm Output, Motion Output, Tach Output, General Purpose	
Communication Interface		RS-485 ASCII/SCL (2- or 4-wire network for PLC control; SureMotion Pro software requires 4-wire)	
Non-volatile Memory Storage		Configurations are saved in FLASH memory on-board the DSP	
Features	***Current Reduction***	Selectable in SureMotion Pro software	
	Idle Current Reduction	Reduction range of 0–90% of running current after delay selectable in ms	
	Microstep Resolution	Software selectable from 200 to 51200 steps/rev in increments of 2 steps/rev	
	Modes of Operation	Pulse (step) & direction, CW/CCW, A/B quadrature, velocity (oscillator), SCL streaming commands via RS-485 ASCII/SCL (2- or 4-wire)	
	Self Test	Checks internal and external power supply voltages, diagnoses open motor phases	
Max Holding Torque		3.375 lb·in / 54 oz·in / 0.381326 N·m	4.25 lb·in / 68 oz·in / 0.480189 N·m
Mounting		Four M3 screws	
Removable Connector (included in STP-CON-3)	**DC Power**	2-position screw terminal: Weidmuller 1615780000	
	I/O	11-position spring cage: Phoenix 1881419	
	Comm	5-position spring cage: Phoenix 1881354	
Rotor Inertia		0.310 oz-in^2 (0.057 kg-cm^2)	0.448 oz-in^2 (0.082 kg-cm^2)
Status LEDs		1 red, 1 green	
Weight		12.7 oz (360g)	15.6 oz (441g)

*Sure*Step™ Advanced Integrated Motor/Drive Specifications			
Integrated Motor/Drive		**STP-MTRD-23042R / STP-MTRD-23042RE**	**STP-MTRD-23065R / STP-MTRD-23065RE**
Frame Size		NEMA 23	
Input Power		12-70 VDC (nominal) (Range: 11-74 VDC) (fuse at V+)	
Current Controller		Dual H-Bridge, 4 Quadrant, 4 state PWM @ 20kHz	
Encoder Feedback		"E" models only. Encoder is internal and provides closed loop control by default.	
Configuration Method		SureMotion Pro software (SM-PRO: Free download)	
Input Signals	***Step/Pulse***	5-24 VDC nominal. Optically isolated. Minimum pulse width = 250ns (at 2 MHz). Maximum pulse frequency = 2MHz, max current draw = 12mA Function = Step Input, Jog CW, Limit CW, Start/Stop, General Purpose	
	Direction	5-24 VDC nominal. Optically isolated. Minimum pulse width = 250ns (at 2 MHz). Maximum pulse frequency = 2MHz, max current draw = 12mA Function = Direction Input, Jog CCW, Limit CCW, General Purpose	
	Enable	5-24 VDC nominal. Optically isolated. Minimum pulse width = 250ns (at 2MHz). Maximum pulse frequency = 2MHz, max current draw = 12mA Function = Enable Input, Reset Input, Change Speed, General Purpose	
	Analog	0-5 VDC nominal (AIN referenced to GND). Input impedance: 30K ohms minimum, resolution = 12 bits Function = analog control modes and general purpose analog usage; programmable for signal range, offset, dead band, and filtering	
Output Signal		30VDC, 40mA maximum. Optically isolated, open collector. Maximum pulse frequency 10kHz. Functions = Brake Output, Alarm Output, Motion Output, Tach Output, General Purpose	
Communication Interface		RS-485 ASCII/SCL (2- or 4-wire network for PLC control; SureMotion Pro software requires 4-wire)	
Non-volatile Memory Storage		Configurations are saved in FLASH memory on-board the DSP	
Features	***Current Reduction***	Selectable in SureMotion Pro software	
	Idle Current Reduction	Reduction range of 0–90% of running current after delay selectable in ms	
	Microstep Resolution	Software selectable from 200 to 51200 steps/rev in increments of 2 steps/rev	
	Modes of Operation	Pulse (step) & direction, CW/CCW, A/B quadrature, velocity (oscillator), SCL streaming commands	
	Self Test	Checks internal and external power supply voltages. Diagnoses open motor phases and motor resistance changes > 40%	
Max Holding Torque		7.8125 lb·in / 125 oz·in / 0.8827 N·m	13.125 lb·in / 210 oz·in / 1.482936 N·m
Mounting		Four #6 screws	
Removable Connector (included in STP-CON-3)	**DC Power**	2-position screw terminal: Weidmuller 1615780000	
	I/O	11-position spring cage: Phoenix 1881419	
	Comm	5-position spring cage: Phoenix 1881354	
Rotor Inertia		1.420 oz-in^2 (0.260 kg-cm^2)	2.515 oz-in^2 (0.460 kg-cm^2)
Status LEDs		1 red, 1 green	
Weight		30 oz (850g)	42 oz (1191g)

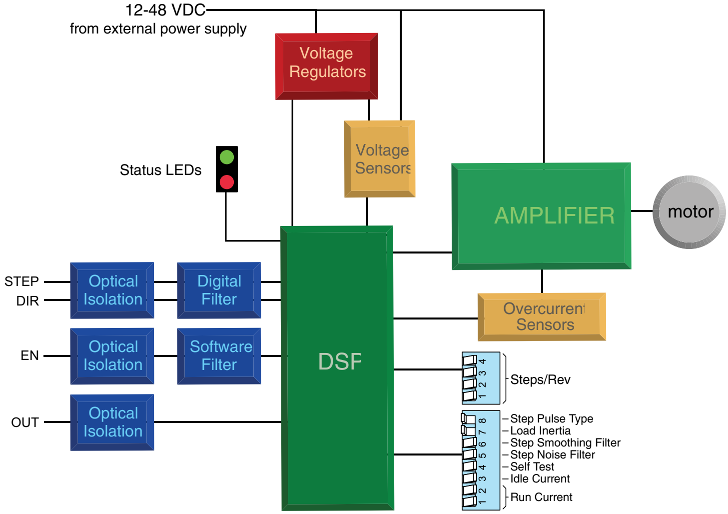
*Sure*Step™ Advanced Integrated Motor/Drive Specifications		
Integrated Motor/ Drive		**STP-MTRD-24075RV / STP-MTRD-24075RVE**
Frame Size		NEMA 24
Input Power		12-70* VDC (nominal) (Range: 11-74 VDC) (fuse at V+)
Current Controller		Dual H-Bridge, 4 Quadrant, 4 state PWM @ 20kHz
Encoder Feedback		"E" models only. Encoder is internal and provides position verification and stall prevention control by default.
Configuration Method		SureMotion Pro software (SM-PRO: free download)
Variable I/O	**I/O 1*(Step/Pulse)***	INPUT: 5-24 VDC nominal. Optically isolated. Minimum pulse width = 250ns (at 3MHz). Maximum pulse frequency = 3MHz, max current draw = 12mA, Function = Step Input, Jog CW, Enable Input, Start/Stop, General Purpose OUTPUT: 30VDC, 40mA maximum. Optically isolated, open collector. Maximum pulse frequency 10kHz. Functions = Brake Output, Fault Output, Motion Output, Tach Output, General Purpose
	I/O 2 *(Direction)*	INPUT: 5-24 VDC nominal. Optically isolated. Minimum pulse width = 250ns (at 3MHz). Maximum pulse frequency = 3MHz, max current draw = 12mA, Function = Direction Input, Jog CCW, Alarm Reset Input, General Purpose OUTPUT: 30VDC, 40mA maximum. Optically isolated, open collector. Maximum pulse frequency 10kHz. Functions = Brake Output, Fault Output, Motion Output, Tach Output, General Purpose
	I/O 3	INPUT: 5-24 VDC nominal. Optically isolated. Minimum pulse width = 250ns (at 3MHz). Maximum pulse frequency = 3MHz, max current draw = 12mA, Function = Limit CW Input, Enable Input, Change Speed Input, General Purpose OUTPUT: 30VDC, 40mA maximum. Optically isolated, open collector. Maximum pulse frequency 10kHz. Functions = Brake Output, Fault Output, Motion Output, Tach Output, General Purpose
	I/O 4	INPUT: 5-24 VDC nominal. Optically isolated. Minimum pulse width = 250ns (at 2 MHz). Maximum pulse frequency = 2MHz, max current draw = 12mA, Function = Limit CCW Input, Alarm Reset Input, General Purpose OUTPUT: 30VDC, 40mA maximum. Optically isolated, open collector. Maximum pulse frequency 10kHz. Functions = Brake Output, Fault Output, Motion Output, Tach Output, General Purpose
Analog		0-5 VDC nominal (AIN referenced to GND). Input impedance: 30K ohms minimum, resolution = 12 bits, Function = analog control modes and general purpose analog usage; programmable for signal range, offset, dead band, and filtering
Communication Interface		RS-485 ASCII/SCL (2- or 4-wire network for PLC control; SureMotion Pro software requires 4-wire)
Features	***Current Reduction***	Selectable in SureMotion Pro software
	Idle Current Reduction	Reduction range of 0–90% of running current after delay selectable in ms
	Microstep Resolution	Software selectable from 200 to 51200 steps/rev in increments of 2 steps/rev
	Modes of Operation	Pulse (step) & direction, CW/CCW, A/B quadrature, velocity (oscillator), SCL streaming commands
	Self Test	Checks internal and external power supply voltages. Diagnoses open motor phases and motor resistance changes > 40%.

** If using the STP-PWR-7005, the power supply (when unloaded) may float above the drive's maximum alowable DC voltage if the power supply is fed with greater than 120VAC input. Either ensure that the incoming AC voltage is less than 120V or supply a burden resistor to pull the unloaded DC voltage level down.*

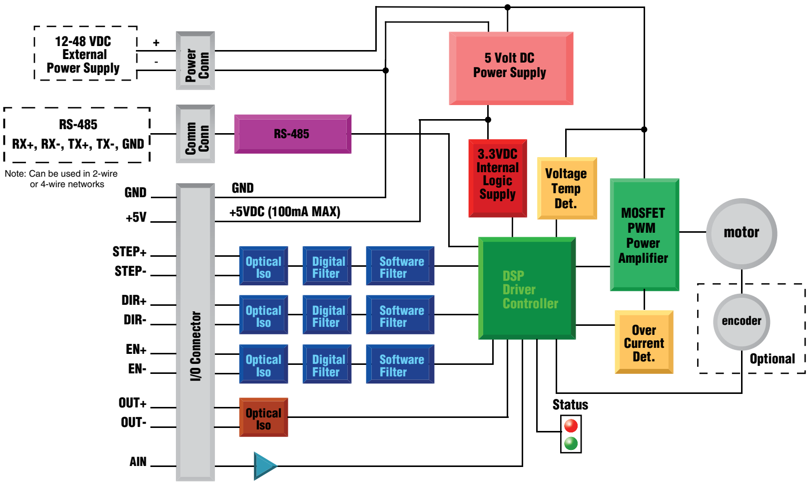
*Sure*Step™ Advanced Integrated Motor/Drive Specifications (continued)		
Integrated Motor/ Drive		**STP-MTRD-24075RV / STP-MTRD-24075RVE**
Max Holding Torque		21.25 lb·in / 340 oz·in / 2.400944 N·m
Mounting		Four #6 screws
Removable Connector (included in STP-CON-3)	**DC Power**	2-position screw terminal: Weidmuller 1615780000
	I/O	11-position spring cage: Phoenix 1881419
	Comm	5-position spring cage: Phoenix 1881354
Rotor Inertia		4.900 oz-in^2 (0.897 kg-cm^2)
Status LEDs		1 red, 1 green
Weight		56 oz (1580g)

Block Diagrams

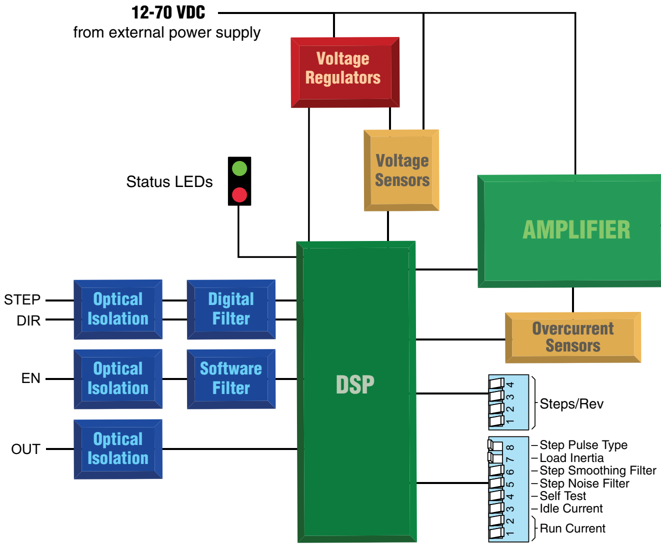
STP-MTRD-17 Standard Series



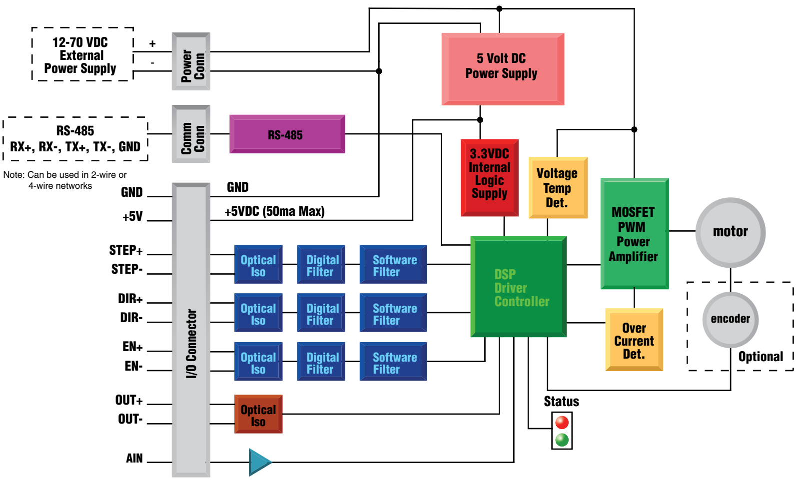
STP-MTRD-17 Advanced Series



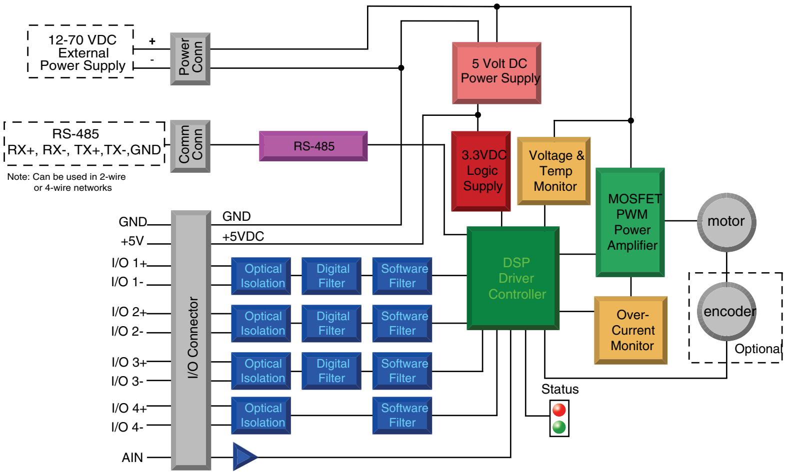
STP-MTRD-23 Standard Series



STP-MTRD-23 Advanced Series



STP-MTRD-24 Advanced Series



Getting Started

The following items are needed for the Standard and Advanced integrated motors/drives (STP-MTRD):

- DC power supply (see the Chapter 8, "Choosing a Power Supply") for help in choosing one.
- A small, flat blade screwdriver for inserting wires into the connector.
- A source of step signals, such as a PLC or motion controller.

Additional items needed for Advanced integrated motors/drives (STP-MTRD-xxxxR):

- A PC running Microsoft Windows software.
- A configuration cable and suitable USB to four wire RS-485 converter. ADC part numbers STP-USB485-4W and STP-485DB9-CLB-2 are recommended.

Installing Software

Before using the STP-MTRD-xxxxR Advanced integrated motor and SureMotion Pro software in an application, the following steps are necessary:

- Install the SureMotion Pro software.
- Launch the software by clicking Programs -> AutomationDirect -> SureMotion Pro
- Connect the drive to the PC using the programming cable. STP-USB485-4W in 4-wire configuration is recommended (see "Chapter 9: Communications" for detailed info).
- Connect the drive to the power supply.
- Apply power to the drive. (When first powered-up, the drive sends out a "power-up packet" to identify itself. See the SCL Manual for more details.)
- The software will recognize the drive and display the model and firmware version. At this point, it is ready for use.

Mounting

As with any step motor, the STP-MTRD must be mounted so as to provide maximum heat sinking and airflow. Keep enough space around the unit 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 STP-MTRD.

Use the following to mount the motors:

- STP-MTRD-17 series: four M3 screws
- STP-MTRD-23 and -24 series: four #6 or #8 screws

Additional Reading

To learn more about SureMotion Pro™, please refer to the software's built-in help.

To learn more about the SCL language, please read the Serial Command Language User Manual.

Mating Connectors and Accessories

Advanced Drive Mating Connectors & Accessories			
Mating Connector (Type)	**Part Number**	**Terminal Tightening Torque**	**Acceptable Wire AWG**
DC Power (2-position, screw terminal)	Weidmuller 1615780000	0.25 Nm	16-20 AWG, ferrules allowed
I/O (11-position, spring cage)	Phoenix 1881419	N/A	20-22 AWG, no ferrules allowed
Comm (5-position, spring cage)	Phoenix 1881354		

Note: ADC's STP-CON-3 connector kit contains all three above parts.

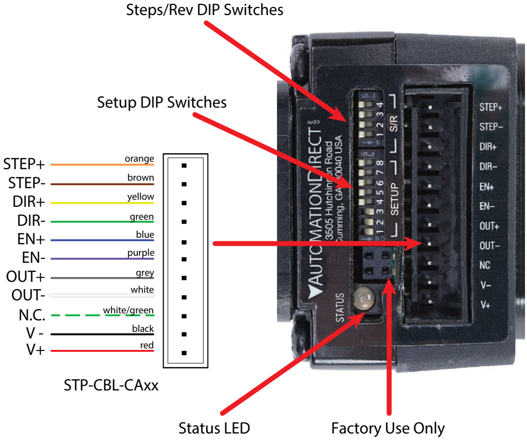
Standard Drive Mating Connectors & Accessories			
Mating Connector (Type)	**Part Number**	**Terminal Tightening Torque**	**Acceptable Wire AWG**
NEMA 17: 11-pin insulation displacement style connector	Housing: Tyco 4-643498-1 Cover: Tyco 1643075-1	N/A	22 AWG
NEMA 23: 11-pin screw terminal connector	Weidmuller 1610200000	0.25 Nm	18-20 AWG, ferrules allowed

Note: See STP-CON-3 connector kit and STP-CBL-CAxx for replacement options.

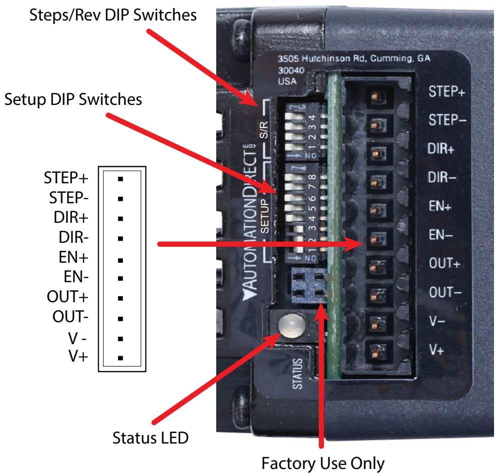
General Accessories	
Part	**Part Number**
USB to RS485 Adapter	STP-USB485-4W
Regeneration Clamp and/or breaking resistor for applications with high inertial loads	STP-DRVA-RC-050 STP-DRVA-BR-100
SureStep communication cable, 9-pin	STP-485DB9-CBL-2
Replacement SureStep incremental (quadrature) encoder	STP-MTRA-ENC1

Installation and Connections

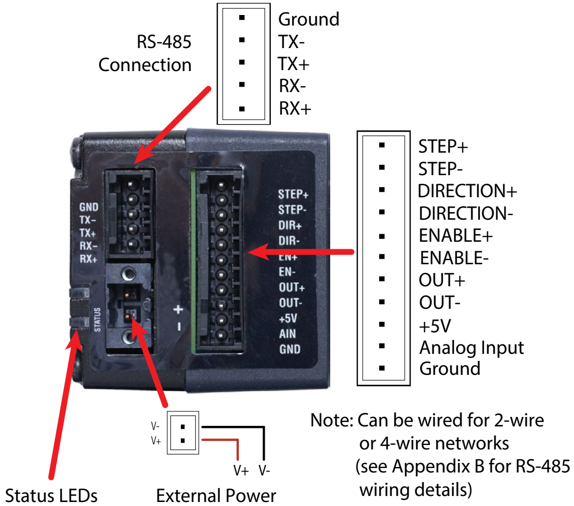
STP-MTRD-17 Standard Series



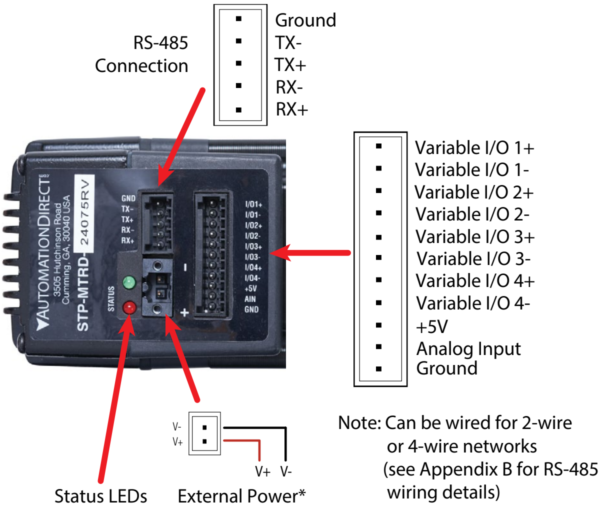
STP-MTRD-23 Standard Series



STP-MTRD-17 / STP-MTRD-23 Advanced Series



STP-MTRD-24 Advanced Series

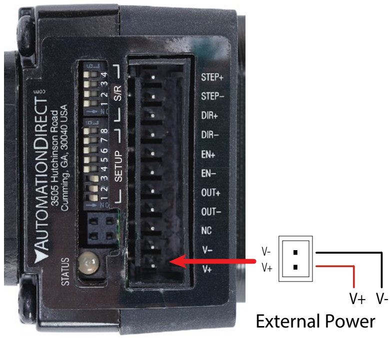


**** an EMI filter (RES10F03) is needed on the power supply for CE compliance***

Connecting a Power Supply to the Standard STP-MTRD-17

For information on choosing a power supply, please see the “Choosing a Power Supply” section of Chapter 7, “SureStep System Power Supplies.”

Connect the power supply “+” terminal to connector terminal V+, then connect power supply “-” to connector terminal V-. Use 22 gauge stranded wire if supplying your own connector and cable.



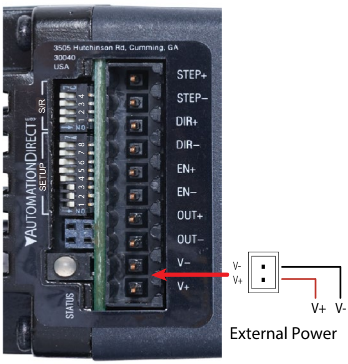
The STP-MTRD-17 contains an internal fuse that connects to the power supply + terminal. This fuse is not user replaceable. If you want to install a user serviceable fuse in your system, install a fast acting 2 amp fuse in line with the + power supply lead.

Be careful not to reverse the wires. Reverse connection will open the internal fuse on your drive and void your warranty. Fuse is not user-replaceable.

Connecting a Power Supply to the Standard STP-MTRD-23

For information on choosing a power supply, please see the “Choosing a Power Supply” section of Chapter 7, “SureStep System Power Supplies.”

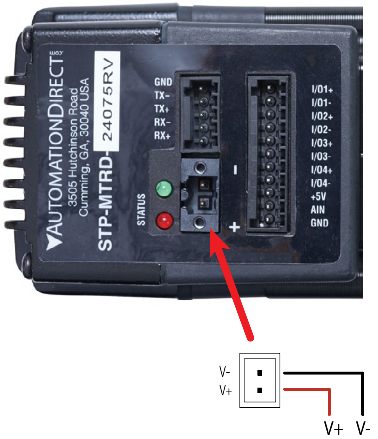
Connect the power supply “+” terminal to the connector terminal labeled “V+”, then connect the power supply “-” to the connector terminal labeled “V-”. Use 14-20 gauge stranded wire.



The STP-MTRD-23 contains an internal fuse that connects to the power supply + terminal. This fuse is not user replaceable. If you want to install a user serviceable fuse in your system, install a fast acting 4 amp fuse in line with the + power supply lead.

Be careful not to reverse the wires. Reverse connection will open the internal fuse on your drive and void your warranty. Fuse is not user-replaceable.

Connecting a Power Supply to the Advanced STP-MTRD-xxxxxR



External Power

For information on choosing a power supply, please see the “Choosing a Power Supply” section of Chapter 7, “SureStep System Power Supplies.”

Connect the power supply “+” terminal to the drive “+” terminal and the power supply “-” terminal to the drive “-” terminal using 16 to 22 gauge wire. The STP-MTRD contains an internal fuse connected to the “+” terminal. This fuse is not user replaceable. If a user serviceable fuse is desired, install a fast acting fuse in line with the “+” power supply lead.

Suitable fuses are:

- STP-MTRD-17 series: 2 amp
- STP-MTRD-23 series: 4 amp
- STP-MTRD-24 series: 5 amp

It is important that the motor frame be electrically connected to ground. When the motor is mounted on an insulated surface, a ground wire is required. Also, in applications where multiple integrated motors are used on a machine, individual ground wires may reduce the overall electrical noise level.

Be careful not to reverse the wires. Reverse connection will open the internal fuse on your drive and void your warranty. Fuse is not user-replaceable.

To maintain CE compliance with the STP-MTRD-24, EMI filter RES10F03 must be wired in series with the V+ power supply to the motor/drive.

Using a Regulated Power Supply

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 STP-DRVA-RC-050 regeneration clamp. It is recommended that an STP-DRVA-RC-050 initially be installed in an application. If the "regen" LED on the STP-DRVA-RC-050 never flashes, the clamp is not necessary. For additional regen clamping capacity, STP-DRVA-BR-100 resistor can be added to the regen clamp. See Appendix A: "SureStep Accessories."

STP-DRVA-RC-050 Regen Clamp

LED Error Codes

STP-MTRD Alarm Codes

Code	Error
solid green	no alarm, motor disabled
flashing green	no alarm, motor enabled
flashing red	configuration or memory error*
fast green	program running
1 red, 1 green	motor stall (optional encoder only)
1 red, 2 green	move attempted while drive disabled
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 prog segment
4 red, 1 green	power supply overvoltage**
4 red, 2 green	power supply undervoltage*
4 red, 3 green	flash memory backup error
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	serial communication error
7 red, 2 green	flash memory error

* *Does not disable the motor.*
The alarm will clear about 30 seconds after the fault is corrected.

** *Disables the motor. Cannot be cleared until power is cycled.*

† *The over-current/short-circuit alarm typically indicates that an electrical fault exists somewhere in the system external to the drive. This alarm does not serve as motor overload protection.*

Alarm Code Definitions

Error	Description	Corrective Action
No alarm, motor disabled	No faults active, Circuit is closed between EN+ and EN-.	N/A
No alarm, motor enabled	No faults active, Circuit is open between EN+ and EN-.	N/A
Configuration or memory error	Memory error detected when trying to load config from flash on powerup.	Restart device. No fix if restart doesn't work.
Program running	No faults active.	N/A
Motor stall (optional encoder only)	Motor torque demand exceeded capability and the motor skipped steps. This is configured in SureMotion Pro.	Increase torque utilization if it's not already maxed out, otherwise decrease the torque demand by modifying the move profile, or put in a larger motor.
Move attempted while drive disabled	Drive is disabled and move attempted.	Reset alarm, enable motor, and move again.

Error	Description	Corrective Action
CCW limit	CCW limit is reached. The digital input that has been assigned CCW limit has been activated.	Unblock the CCW sensor (open the circuit) or redifine the input with SureMotion Pro.
CW limit	CW limit is reached. The digital input that has been assigned CW limit has been activated.	Unblock the CCW sensor (open the circuit) or redefine the input with SureMotion Pro.
Drive overheating	The drive's internal temperature is too high.	If the drive is operating within its standard range (input voltage and output current are OK), more heat must be removed from the drive during operation. For Advanced drives (see "Mounting the Drive" on page 4-14), ensure the drive is mounted to a metal surface that can dissipate the drive's heat. For Integrated motor/drives, see "Mounting" on page 5-13. For both types of drives: If the mounting surface cannot pull enough heat away from the drive, forced airflow (from a fan) may be required to cool the drive.
Internal voltage out of range	Gate voltage, 5V rail, or 3V rail are out of spec.	Ensure adequate supply voltage (in very rare cases, low input voltages combined with fast accelerations can draw down the gate voltage) and try again. If persistant, RMA is required.
Blank prog segment	Attempt to execute a blank programming segment.	Ensure program is downloaded and try again.

Error	Description	Corrective Action
Power supply overvoltage	The DC voltage feeding the drive is above the allowable level.	Decrease the input voltage. Linear power supplies do not output a fixed voltage: the lighter the output current, the higher the output voltage will float. If a linear supply's voltage floats above the drive's max voltage, you can install a small power resistor across the linear power supply's output to provide some load that will help pull down the floating voltage. Consider using a switching power supply such as the Rhino PSB power supply series. Overvoltage can also be fed back into a system by regeneration (when an overhauling load pushes energy back into the motor). In an application with regen problems, install an STP-DRVA-RC-050 regen clamp to help dissipate the extra energy. (The regen clamp will not help with the floating linear power supply that floats too high, but it will help with excess voltage generated from an overhauling load.)
Power supply undervoltage	The DC voltage feeding the drive is below the allowable level.	Correct the power supply. If this error occurs during operation, the power supply is most likely undersized. A sudden high current demand can cause an undersized power supply to dip in output voltage.
Flash memory backup error	Memory error detected when trying to load config from flash on powerup.	Restart device. No fix if restart doesn't work.
Over current / short circuit	Motor leads shorted - only checked on powerup.	Check and fix motor wiring.
Open motor winding	Motor leads not connected - only checked on powerup.	Check and fix motor wiring.
Bad encoder signal (optional encoder only)	Noisy or otherwise incorrectly formatted encoder signal (lack of A or B, lack of differential signal).	Check encoder wiring, always use differential encoders (or use checkbox in SureMotion Pro to disable this error when using single ended).
Serial communication error	Catch-all error for something wrong with serial communications. See CE command in HCR for details.	If drive can communicate, CE can give a precise diagnosis. If not, refer to the Serial Communications part of the HCR for troubleshooting.
Flash memory error	Memory error detected when trying to load config from flash on powerup.	Restart device. No fix if restart doesn't work.

STP-MTRD Inputs and Outputs

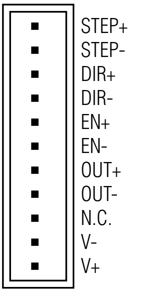
The standard drives (STP-MTRD-xxxx) have three inputs:

- STEP: a high speed digital input for step pulse commands, 5-24 volt logic
- DIR: a high speed digital input for the direction signal, 5-24 volt logic
- EN: a 5-24 volt input for commanding the removal of power from the motor

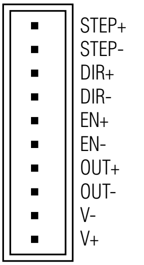
NOTE: STEP and DIR inputs can be converted to STEP CW and STEP CCW by moving switch #8 to the ON position.

The standard drives have a single digital output labeled OUT. This output closes to signal a fault condition. The output can be used to drive LEDs, relays, and the inputs of other electronic devices like PLCs. The "+" (collector) and "-" (emitter) terminals of the output are available at the connector - this allows you to configure the output for current sourcing or sinking.

Connector Pin Diagrams

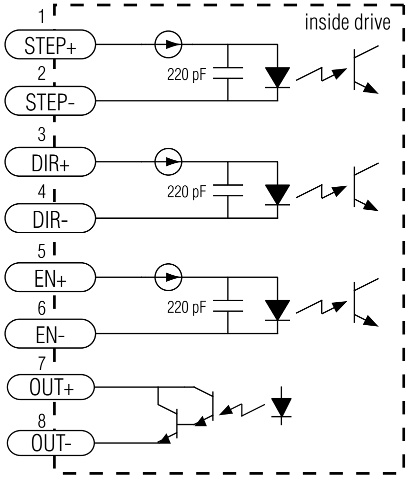


STP-MTRD-17 series

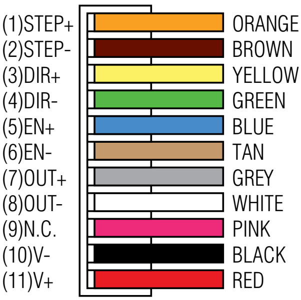


STP-MTRD-23 series

Internal Circuit Diagram



Mating Cable STP-CBL-CAx
(for STP-MTRD-17038/17038E)



The advanced STP-MTRD-17xxxxxR and -23xxxxxR drives include 3 digital inputs and 1 analog input:

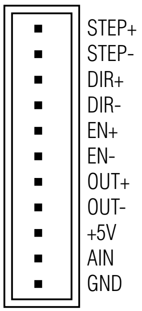
- Two high speed digital inputs, 5-24 volt logic, labeled STEP (or IN1) and DIR (or IN2), for commanding position. Pulse & direction, CW/CCW pulse, and A/B quadrature encoder signals can be used as position commands with these inputs. The STEP/IN1 and DIR/IN2 inputs can also be connected to sensors, switches and other devices for use with streaming SCL commands such as Wait Input (WI), Seek Home (SH), Feed to Sensor (FS), etc. When not being used for commanding position, these inputs can also be used for CW/CCW end-of-travel limits, CW/CCW jog inputs, or Run/stop & direction velocity-mode inputs.

NOTE: the available functionality of these inputs is determined by the STP-MTRD control option (R) as well as the motion control mode selected in SureMotion Pro.

- One digital input, 5-24 volt logic, labeled EN (or IN3), which can be used for motor enable/disable and/or alarm reset. It can also be connected to a sensor, switch or other device for use with streaming SCL commands such as Wait Input, Seek Home, Feed to Sensor, etc.
- 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 commands such as Wait Input, Seek Home, Feed to Sensor, etc.

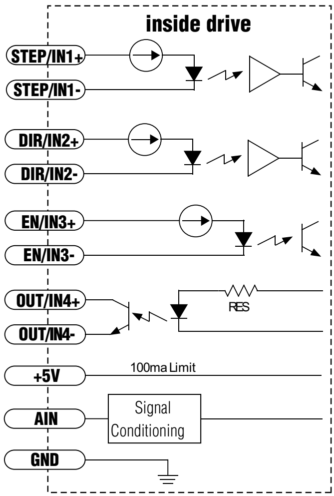
NOTE: On the advanced drives, the green 5 and 11 position spring clip terminal blocks do not accept ferrules, either use bare stranded copper or tinned leads.

Connector Pin Diagram



STP-MTRD-xxxxR series

I/O Connector

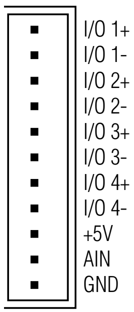


STP-MTRD-xxxxR series

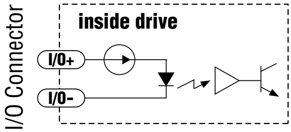
The STP-MTRD-24 models have four "Variable I/O" points. Each can be configured as a digital input or a digital output. In addition, pre-defined functions such as motor enable or fault output can be assigned, providing the flexibility to handle a diverse range of applications.

SureMotion Pro™ is used to set each Variable I/O point as an input or output. SureMotion Pro™ can also be used to assign functions to each I/O point, or functions can be assigned "on the fly" from SCL streaming commands.

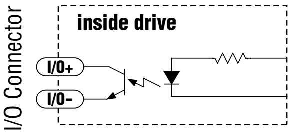
Connector Pin Diagram



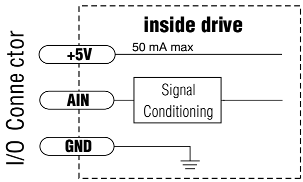
STP-MTRD-24xxR series



Equivalent Circuit: Variable I/O Point Set as Input



Equivalent Circuit: Variable I/O Point Set as Output



Equivalent Circuit: Analog Input

Input/Output Functions

Basic STP-MTRD-x I/O Functions (configure with dip switches)				
Terminal	**STEP (5-24 Volts)**	**DIR (5-24 Volts)**	**EN (5-24 Volts)**	**OUT (30V, 80mA)**
Function	Step Input	Dir Input	Enable Input	Alarm Output
	Limit CW	Limit CCW	-	-

Advanced STP-MTRD-17xR (23xR) I/O Functions (configure in software)				
Terminal	**STEP (5-24 Volts)**	**DIR (5-24 Volts)**	**EN (5-24 Volts)**	**OUT (30V, 80mA)**
Function	Step Input	Dir Input	Enable Input	Brake Output
	Jog CW	Jog CCW	Reset Input	Alarm Output
	Limit CW	Limit CCW	Change Speed	Motion Output
	Start/Stop	General Purpose	General Purpose	Tach Output
	General Purpose	-	-	General Purpose

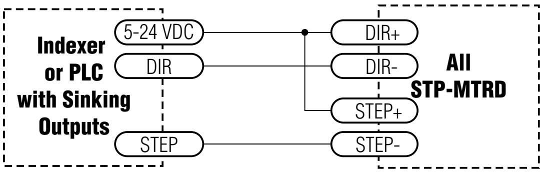
Advanced STP-MTRD-24xR I/O Functions (configure in software)				
Terminal	**I/O 1**	**I/O 2**	**I/O 3**	**I/O 4**
Input Function	Step/CW Pulse/AB Quad Input	DIR/CCW Pulse/AB Quad Input	Limit CW Input	Limit CCW Input
	Jog CW Input	Jog CCW Input	Enable Input	Alarm Reset Input
	Enable Input	Alarm Reset Input	Change Speed Input	General Purpose Input
	Start/Stop Input	General Purpose Input	General Purpose Input	-
	General Purpose Input	-	-	-
Output Function	Brake Output	Brake Output	Brake Output	Brake Output
	Fault Output	Fault Output	Fault Output	Fault Output
	Motion Output	Motion Output	Motion Output	Motion Output
	Tach Output	Tach Output	Tach Output	Tach Output
	General Purpose Output	-	General Purpose Output	General Purpose Output

The Step (STEP) and Direction (DIR) Inputs

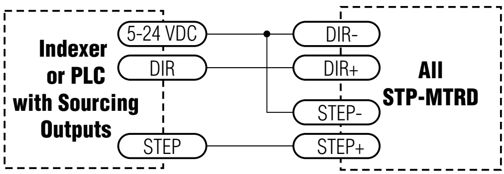
The STP-MTRD motor/drives include two high-speed inputs called STEP (or IN1) and DIR (or IN2). They accept 5 to 24 volt single-ended or differential signals, up to 2 MHz. Typically these inputs connect to an external controller that provides step and direction command signals. With the Advanced models you can also connect a master encoder to the high-speed inputs for "encoder following" applications. Or you can use these inputs with Wait Input, If Input, Feed to Sensor, Seek Home, and other SCL commands.

If the 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.

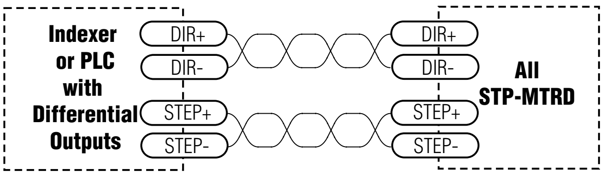
Example connection diagrams:



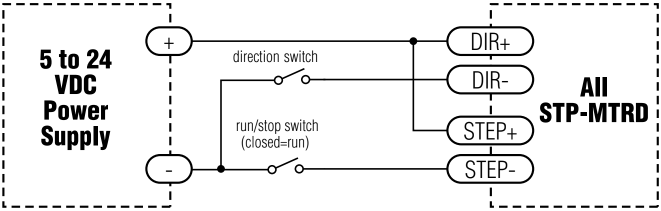
Connecting to indexer with Sinking Outputs



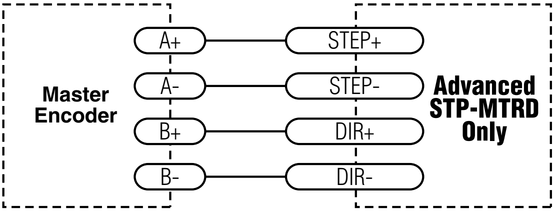
Connecting to indexer with Sourcing Outputs



Connecting to indexer with Differential Outputs



Using Mechanical Switches
(The switches can also be placed on the + line)



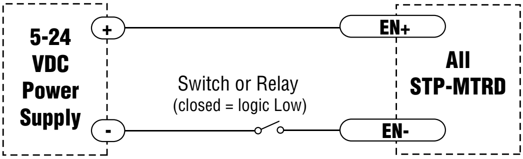
Wiring for Encoder Following

The Enable (EN/IN3) Digital Input

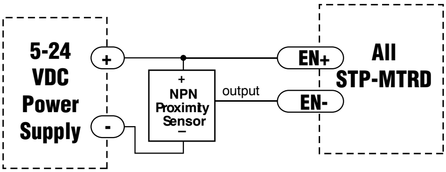
As mentioned in the previous section, the high-speed STEP and DIR inputs are designed for high speed operation. The Enable digital input is designed for low speed digital input operation between 5 and 24 volts DC.

If the current is flowing into or out of an input, the logic state of that input is low or closed (active). If no current is flowing, or the input is not connected, the logic state is high or open. Using a switch (see the first image below) to activate the "Enable" circuit will actually disable the drive. The switch in the image below could be considered a "Disable" switch.

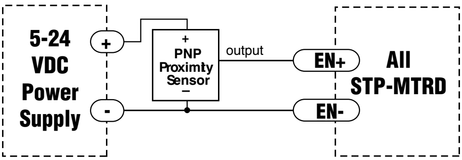
Example connection diagrams:



Connecting the Input to a Switch or Relay



Connecting an NPN Type Proximity Sensor to an input
(When proximity sensor activates, input goes low).

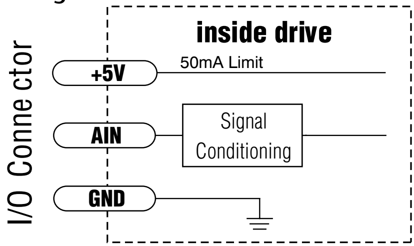


Connecting an PNP Type Proximity Sensor to an input
(When prox sensor activates, input goes low).

The Analog (AIN) Input

The Advanced STP-MTRD drives feature an analog input. The input can accept a signal range of 0 to 5 VDC. The drive can be configured to operate at a speed or position that is proportional to the analog signal. Use the SureMotion Pro software to set the signal range, offset, dead-band and filter frequency. For some SCL commands the analog input can be used as an emulated digital input by just using the full analog scale as the on/off condition. The Advanced STP-MTRD also provides a +5VDC 50mA output 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.

Example connection diagram:



Connecting a Potentiometer to the Analog Input

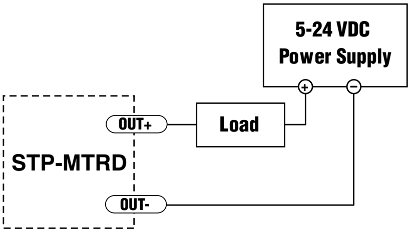
The Digital Output

The STP-MTRD drives feature one configurable optically isolated digital output. In the units with RS-485 communication this output can be set to automatically control a motor brake, to signal a fault condition, to indicate when the motor is moving, or to provide an output frequency proportional to motor speed (tach signal). The output can also be turned on and off by program instructions like Set Output. The output can be used to drive LEDs, relays, and the inputs of other electronic devices like PLCs and counters. The “OUT+” (collector) and “OUT-” (emitter) terminals of the transistor are available at the connector. This allows you to configure the output for current sourcing or sinking. The STP-MTRD-24 has four variable I/O points. Each one can be either an output or an input.

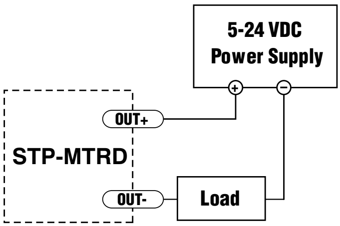
If current is flowing into or out of an output, the logic state of that output is low or closed (active). If no current is flowing, or the output is not connected, the logic state is high or open.

Do not connect the output to more than 30VDC.
The current through the output terminal must not exceed 40mA.

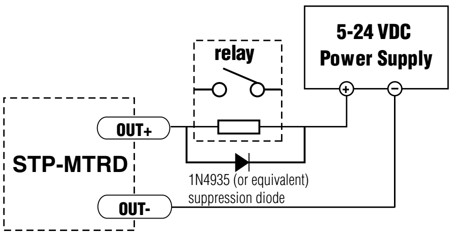
Example connection diagrams:



Connecting as a Sinking Output



Connecting as a Sourcing Output



Driving a Relay

Using the Optional Encoder

(STP-MTRD-17038E, 23042E, 23065E)

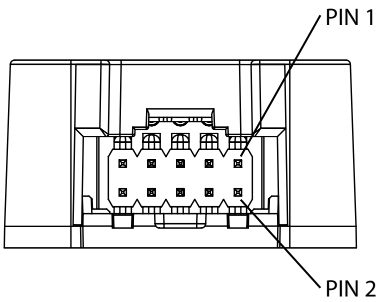
This optional encoder is a differential line driver 1000 ppr incremental encoder assembled to the rear shaft of the unit. The A, B, and Index (Z) channel signals of this encoder can be connected back to the external controller for position verification and enhanced performance, depending on the features of the controller. To facilitate connecting the encoder signals to your external controller you should purchase cable part number STP-CBL-EAx.

For more information on the encoder, please see the Accessories appendix. Replacement encoder part number is STP-MTRA-ENC1.

Incremental encoder specifications:

- 10-pin connector provides the following signals (pin assignments): Ground (1,2), Index- (3), Index+ (4), A- (5), A+ (6), +5VDC power (7,8), B- (9) and B+ (10).
- Power supply requirements: 5 VDC at 56mA typical, 59 mA max.
- The encoder's internal differential line driver (26C31) can source and sink 20mA at TTL levels. the recommended receiver is industry standard 26C32.
- Maximum noise immunity is achieved when the differential receiver is terminated with a 110-ohm resistor in series with a .0047 microfarad capacitor placed across each differential pair. The capacitor simply conserves power; otherwise power consumption would increase by approximately 20mA per pair, or 60mA for three pairs.
- If making your own cable to connect the encoder signals to your controller, we recommend using a shielded cable with four or five twisted pairs for improved noise immunity.
- Max encoder frequency is 100,000 pulses per second.

CONN	CONNECTION TABLE	
PIN	LEAD COLOR	SIGNAL
2	GREEN/WHITE	GROUND
7	GREEN	POWER+
3	ORANGE/WHITE	Z–
4	ORANGE	Z+
5	BLUE/WHITE	A–
6	BLUE	A+
9	BROWN/WHITE	B–
10	BROWN	B+
1	N/C	GROUND
8	N/C	POWER+



Note: Pin 1 and Pin 2 are internally connected. Pin 7 and Pin 8 are internally connected inside the encoder.

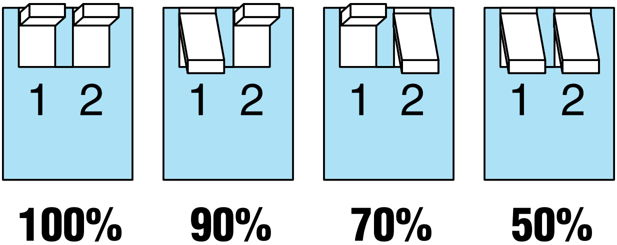
Configuring the Standard STP-MTRD

Step 1: Setting the Current

To achieve maximum torque, you should set the current to 100%. But under some conditions you may want to reduce the current to save power or lower motor temperature. This is important if the motor is not mounted to a surface that will help it dissipate heat or if the ambient temperature is expected to be high.

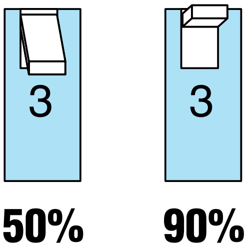
Step motors produce torque in direct proportion to current, but the amount of heat generated is roughly proportional to the square of the current. If you operate the motor at 90% of rated current, you'll get 90% of the rated torque. But the motor will produce approximately 81% as much heat. At 70% current, the torque is reduced to 70% and the heating to about 50%.

Two of the small switches on the front of the STP-MTRD are used to set the percent of rated current that will be applied to the motor: SW1 and SW2. Please set them according to the illustration below.



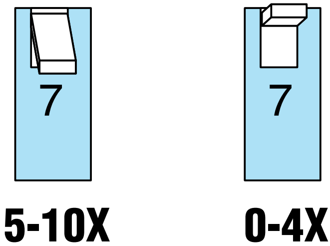
Step 2: Setting Idle Current

Motor heating and power consumption can also be reduced by lowering the motor current when it is not moving. The STP-MTRD will automatically lower the motor current when it is idle to either 50% or 90% of the running current. The 50% idle current setting will lower the holding torque to 50%, which is enough to prevent the load from moving in most applications. This reduces motor heating by 75%. In some applications, such as those supporting a vertical load, it is necessary to provide a high holding torque. In such cases, the idle current can be set to 90% as shown.



Step 3: Load Inertia

The Standard STP-MTRD includes anti-resonance and electronic damping features which greatly improve motor performance. To perform optimally, the drive must understand the electromechanical characteristics of the motor and load. Most of this is done automatically when the motor and drive are assembled at the factory. To further enhance performance, you must set a switch to indicate the approximate inertia ratio of the load and motor. The ranges are 0 to 4X and 5 to 10X. Please divide your load inertia by the STP-MTRD rotor inertia (82 g-cm2) to determine the ratio, then set switch 7 accordingly, as shown.

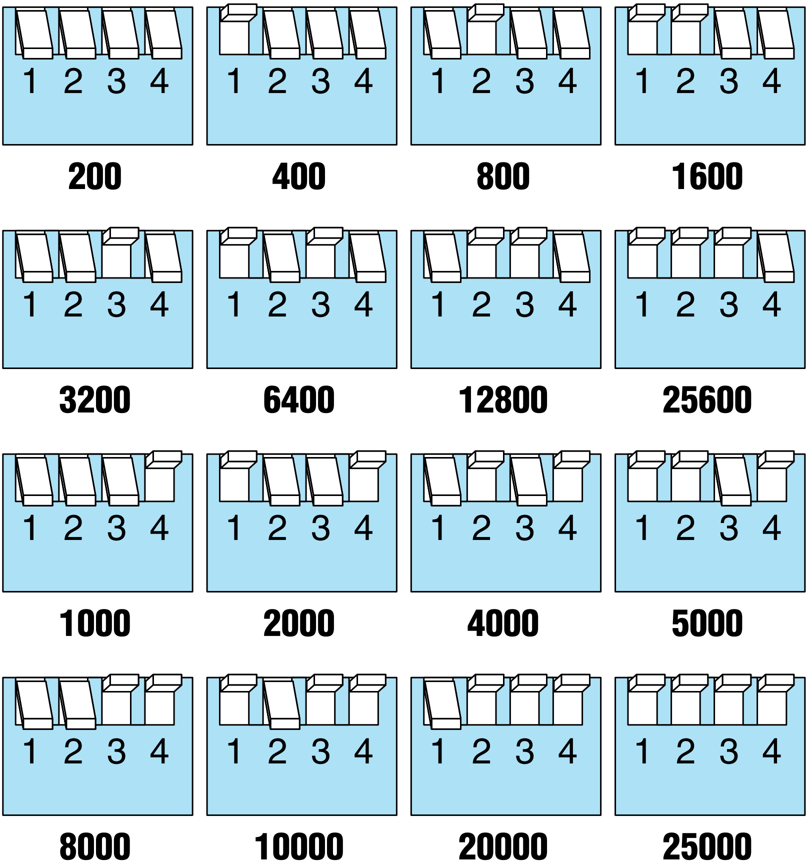


Step 4: Step Size

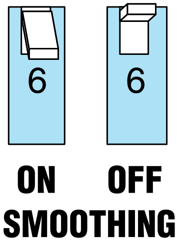
The Standard STP-MTRD requires a source of step pulses to command motion. This may be a PLC, an indexer, a motion controller or another type of device. The only requirement is that the device be able to produce step pulses whose frequency is in proportion to the desired motor speed, and be able to smoothly ramp the step speed up and down to produce smooth motor acceleration and deceleration.

Smaller step sizes result in smoother motion and more precise speed, but also require a higher step pulse frequency to achieve maximum speed. The smallest step size is 1/25,600th of a motor turn. To command a motor speed of 50 revolutions per second (3000 rpm) the step pulses frequency must be 50 x 25,600 = 1.28 MHz. Many motion devices, especially PLCs cannot provide step pulses at such a high speed. If so, the drive must be set for a lower number of steps per revolution. Sixteen different settings are provided, as shown in the diagrams on the next page.

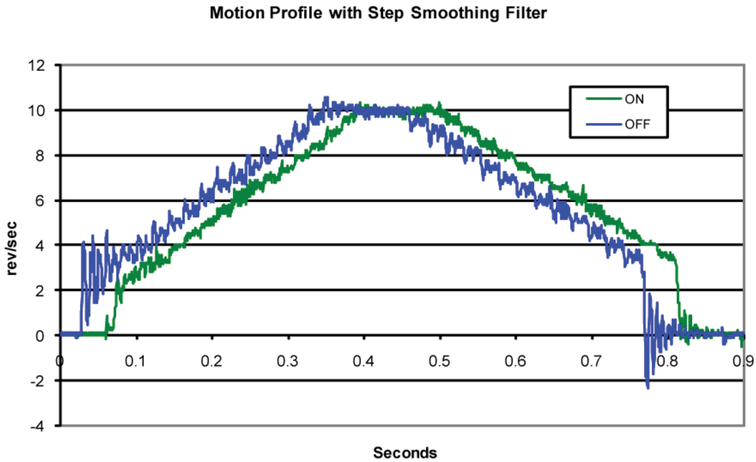
Please choose the one that best matches the capability of your system.


1 2 3 4
200
400
800
1600
3200
6400
12800
25600
1000
2000
4000
5000
8000
10000
20000
25000

At lower step resolutions such as 200 steps/rev (full step) and 400 steps/rev (half step), motors run a little rough and produce more audible noise than when they are microstepped. The STP-MTRD includes a feature called "microstep emulation", also called "step smoothing", that can provide smooth motion from coarse command signals. If you set switch 6 to the ON position, this feature is automatically employed to provide the smoothest possible motion from a less than ideal signal source.



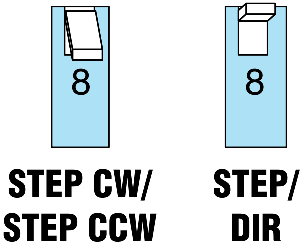
Because a command filter is used as part of the step smoothing process, there will be a slight delay, or "lag", in the motion. The graph below shows an example of the delay that can occur from using the step smoothing filter.



Step 5: Step Pulse Type

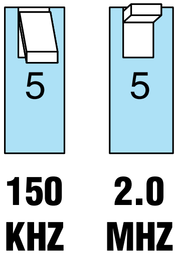
Most indexers and motion controllers provide motion commands in the "Step and Direction" format. The step signal pulses once for each motor step and the direction signal commands direction. However, a few PLCs use a different type of command signal: one signal pulses once for each desired step in the clockwise direction (called STEP CW), while a second signal pulses for counterclockwise motion (STEP CCW). The Standard STP-MTRD can accept this type of signal if you adjust switch 8 as shown in the diagram on the next page.

In STEP CW/STEP CCW mode, the CW signal should be connected to the STEP input and the CCW signal to the DIR input.



Step 6: Step Pulse Noise Filter

Electrical noise can affect the STEP signal in a negative way, causing the drive to think that one step pulse is two or more pulses. This results in extra motion and inaccurate motor and load positioning. To combat this problem, the Standard STP-MTRD includes a digital noise filter on the STEP and DIR inputs. The default factory setting of this filter is 150 kHz, which works well for most applications. This is set by moving switch 5 to the ON position.

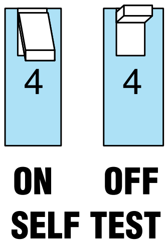


However, as discussed in Step 4, if you are operating the STP-MTRD at a high number of steps/rev and at high motor speeds, you will be commanding the drive at step rates above 150 kHz. In such cases, you should set switch 5 to the OFF position as shown.

Your maximum pulse rate will be the highest motor speed times the steps/rev. For example, 40 revs/second at 20,000 steps/rev is 40 x 20,000 = 800 kHz. Please consider this when deciding if you must increase the filter frequency.

Self Test

If you are having trouble getting your motor to turn, you may want to try the built-in self-test. Any time switch 4 is moved to the ON position, the drive will automatically rotate the motor back and forth, two and a half turns each direction. This feature can be used to confirm that the motor is correctly wired and otherwise operational.



Drive/Motor Heating

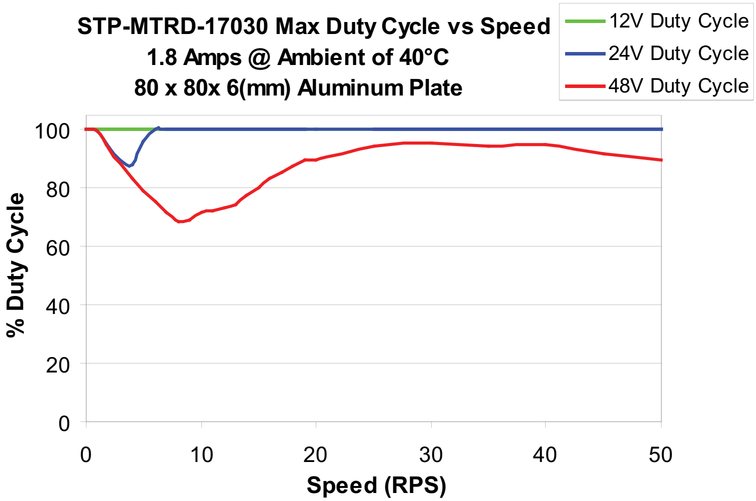
Step motors convert electrical power from the driver into mechanical power to move a load. Because step motors are not perfectly efficient, some of the electrical power turns into heat on its way through the motor. This heating is not dependent on the load being driven but rather the motor speed and power supply voltage. There are certain combinations of speed and voltage at which a motor cannot be continously operated without damage.

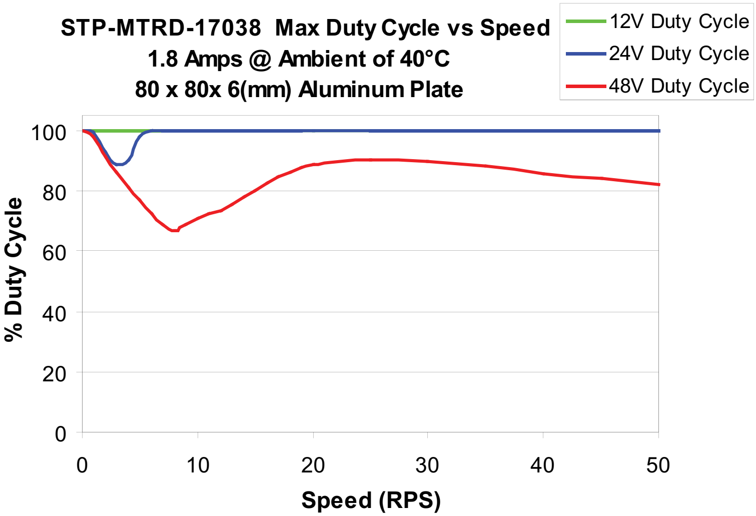
Provided below are curves showing the maximum duty cycle versus speed for each size at commonly used power supply voltages. Please refer to these curves when planning your application.

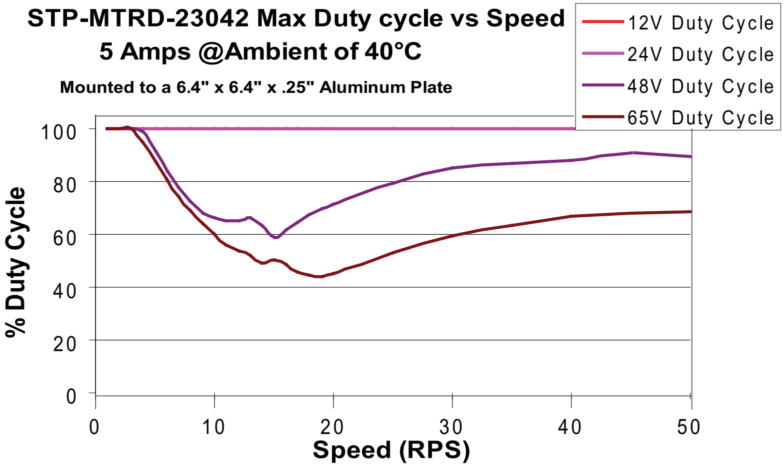
Also keep in mind that a step motor typically reaches maximum temperature after 30 to 45 minutes of operation. If you run the motor for one minute then let it sit idle for one minute, that is a 50% duty cycle. Five minutes on and five minutes off is also a 50% duty. However, one hour on and one hour off has the effect of 100% duty because during the first hour the motor will reach full (and possibly excessive) temperature.

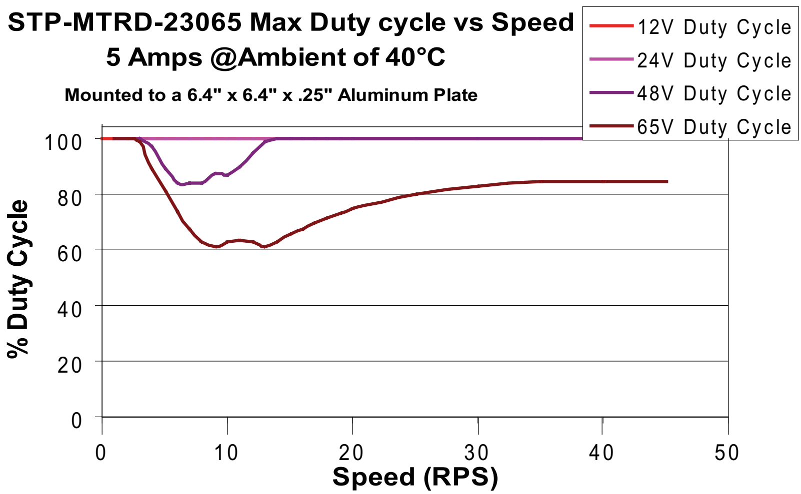
The actual temperature of the motor depends on how much heat is conducted, convected, or radiated out of it. The measurements below were made in a 40°C (104°F) environment with the motor mounted to an aluminum plate sized to provide a surface area consistent with the motor power dissipation. Your results may vary.

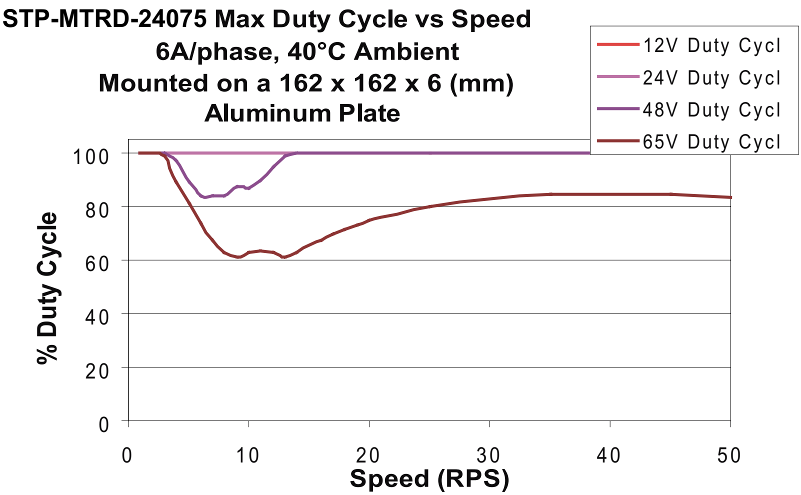
Please use the motor body temperature curves below to determine the maximum duty cycle of the drive/motor under various conditions.



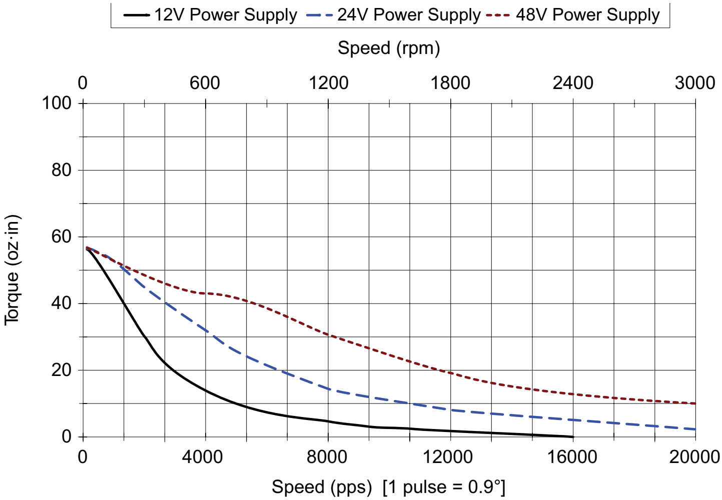

STP-MTRD-17038 Max Duty Cycle vs Speed
1.8 Amps @ Ambient of 40°C
80 x 80x 6(mm) Aluminum Plate
12V Duty Cycle
24V Duty Cycle
48V Duty Cycle
% Duty Cycle
100
80
60
40
20
0
0
10
20
30
40
50
Speed (RPS)


STP-MTRD-23042 Max Duty cycle vs Speed
5 Amps @Ambient of 40°C
Mounted to a 6.4" x 6.4" x .25" Aluminum Plate
12V Duty Cycle
24V Duty Cycle
48V Duty Cycle
65V Duty Cycle
% Duty Cycle
100
80
60
40
20
0
0
10
20
30
40
50
Speed (RPS)

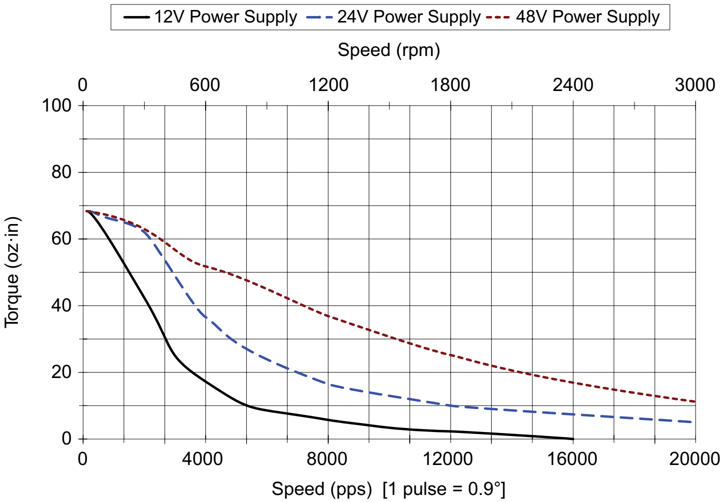

STP-MTRD-23065 Max Duty cycle vs Speed
5 Amps @Ambient of 40°C
Mounted to a 6.4" x 6.4" x .25" Aluminum Plate
12V Duty Cycle
24V Duty Cycle
48V Duty Cycle
65V Duty Cycle
% Duty Cycle
100
80
60
40
20
0
0
10
20
30
40
50
Speed (RPS)

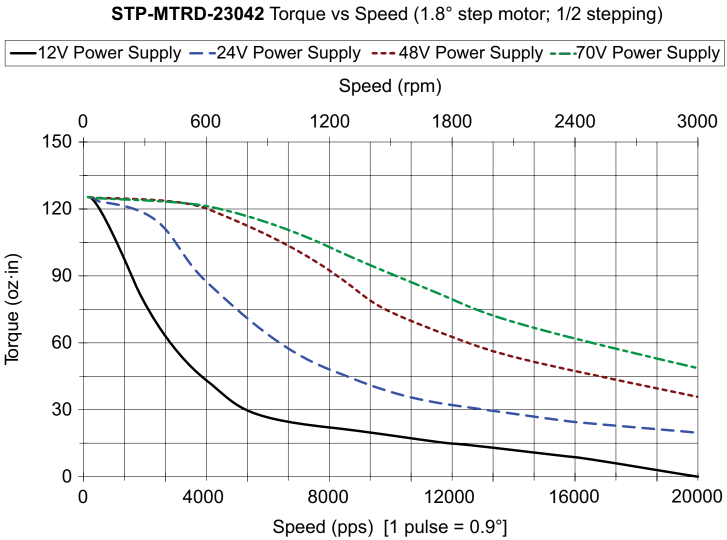

STP-MTRD-24075 Max Duty Cycle vs Speed
6A/phase, 40°C Ambient
Mounted on a 162 x 162 x 6 (mm)
Aluminum Plate
12V Duty Cycl
24V Duty Cycl
48V Duty Cycl
65V Duty Cycl
% Duty Cycle
100
80
60
40
20
0
0
10
20
30
40
50
Speed (RPS)

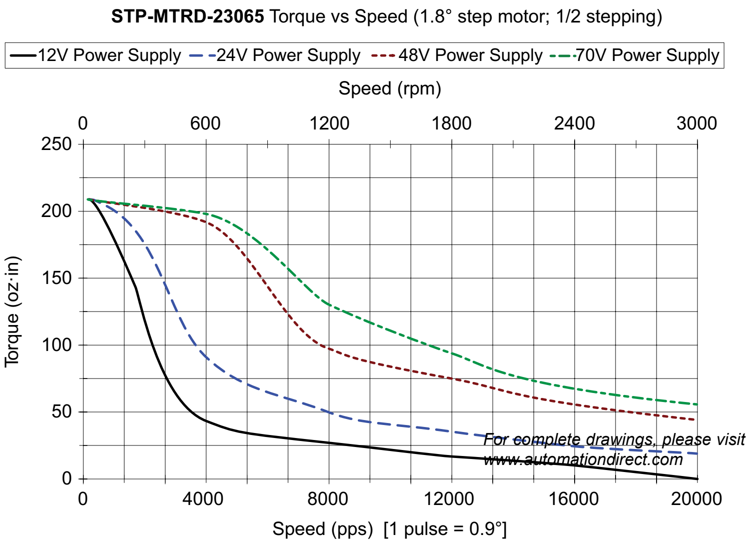
Torque Speed Graphs



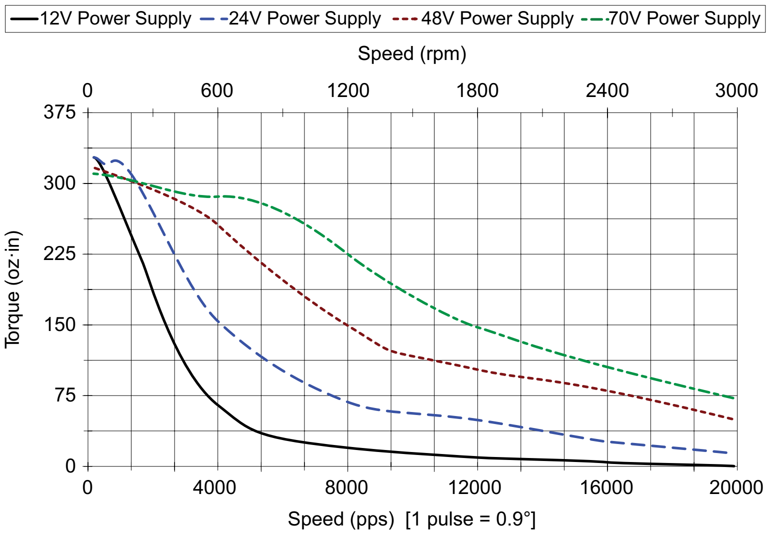
STP-MTRD-17038 Torque vs Speed (1.8° step motor; 1/2 stepping)




STP-MTRD-23042 Torque vs Speed (1.8° step motor; 1/2 stepping)
12V Power Supply
24V Power Supply
48V Power Supply
70V Power Supply
Speed (rpm)
0
600
1200
1800
2400
3000
150
120
90
60
30
0
Torque (oz·in)
0
4000
8000
12000
16000
20000
Speed (pps) [1 pulse = 0.9°]


STP-MTRD-23065 Torque vs Speed (1.8° step motor; 1/2 stepping)
12V Power Supply
24V Power Supply
48V Power Supply
70V Power Supply
Speed (rpm)
0
600
1200
1800
2400
3000
250
200
150
100
50
0
Torque (oz·in)
0
4000
8000
12000
16000
20000
Speed (pps) [1 pulse = 0.9°]
For complete drawings, please visit www.automationdirect.com

STP-MTRD-24075 Torque vs Speed (1.8° step motor; 1/2 stepping)

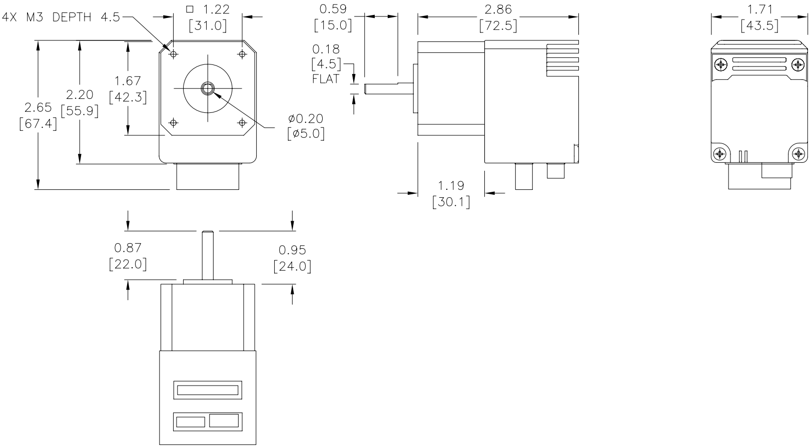


For complete drawings, please visit www.automationdirect.com

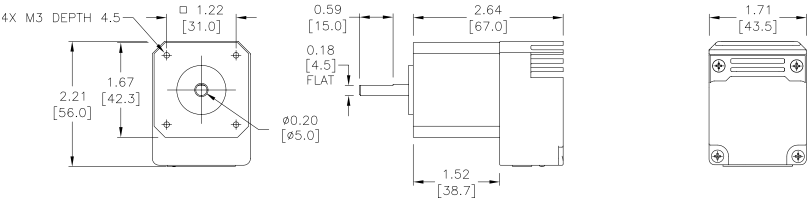
Dimensions and Mounting Slot Locations

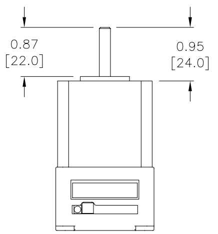
Dimensions = inches [mm]

STP-MTRD-17030R / STP-MTRD-17030RE



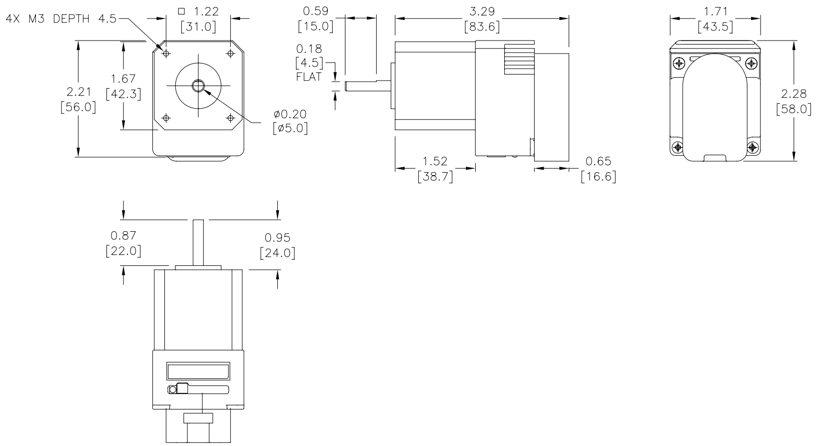
STP-MTRD-17038



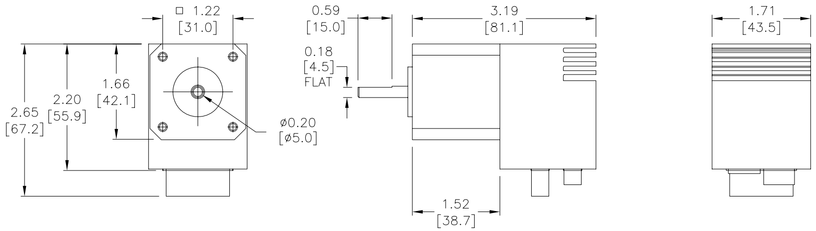


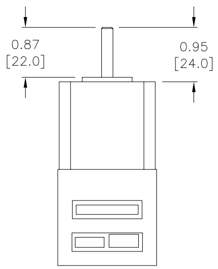
For complete drawings, please visit
www.automationdirect.com

STP-MTRD-17038E



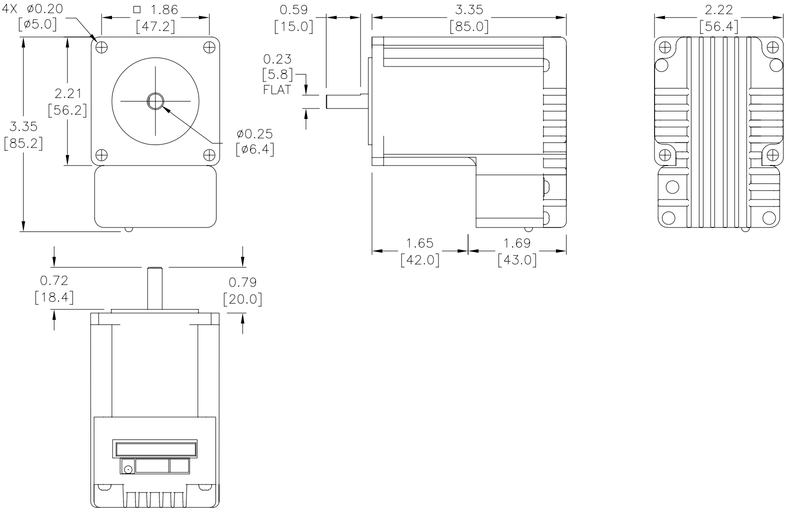
STP-MTRD-17038R / STP-MTRD-17038RE



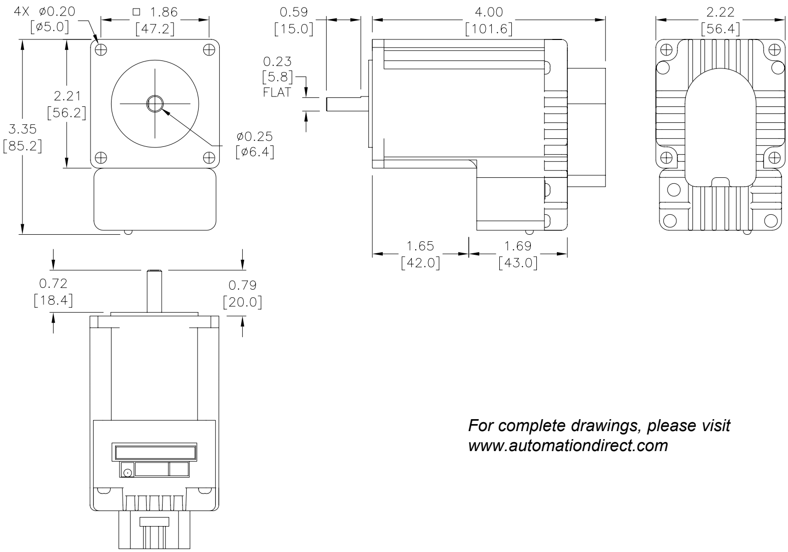


For complete drawings, please visit
www.automationdirect.com

STP-MTRD-23042

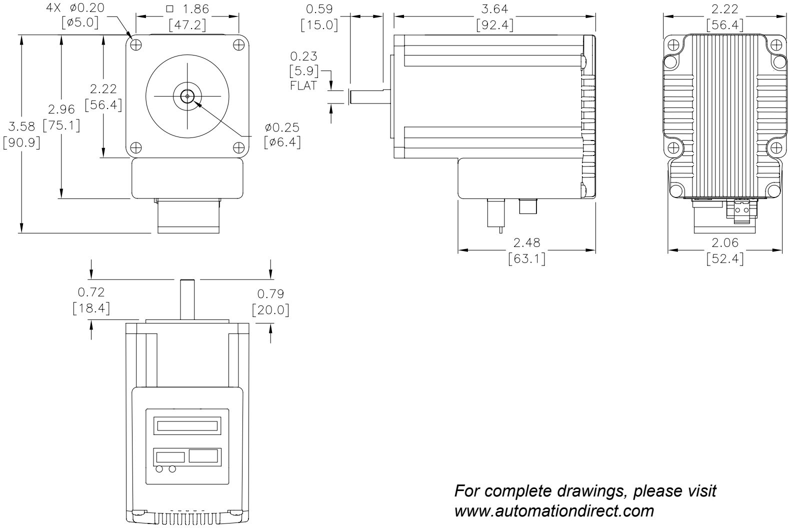


STP-MTRD-23042E



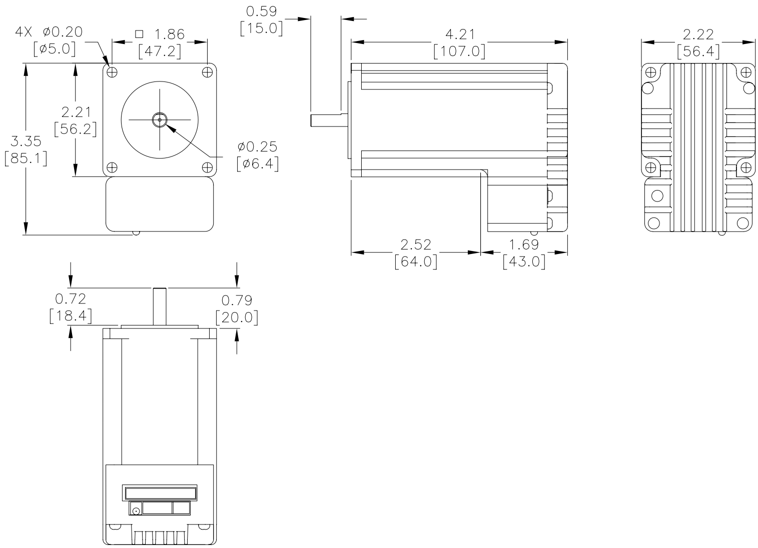
For complete drawings, please visit www.automationdirect.com

STP-MTRD-23042R / STP-MTRD-23042RE

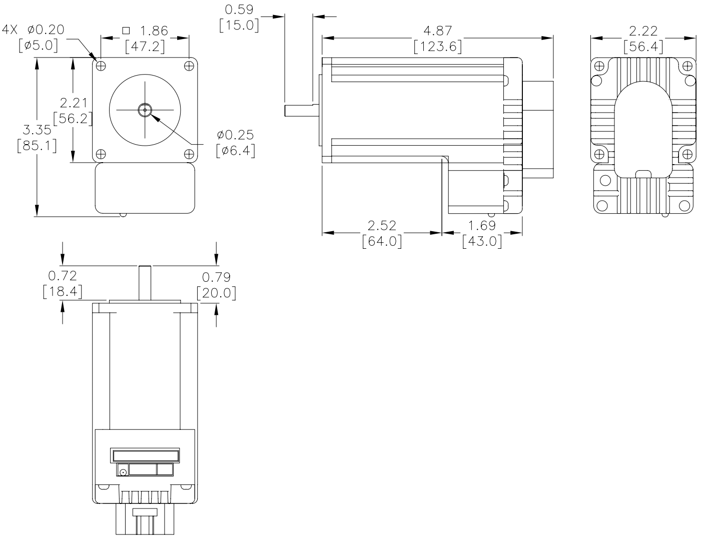


For complete drawings, please visit www.automationdirect.com

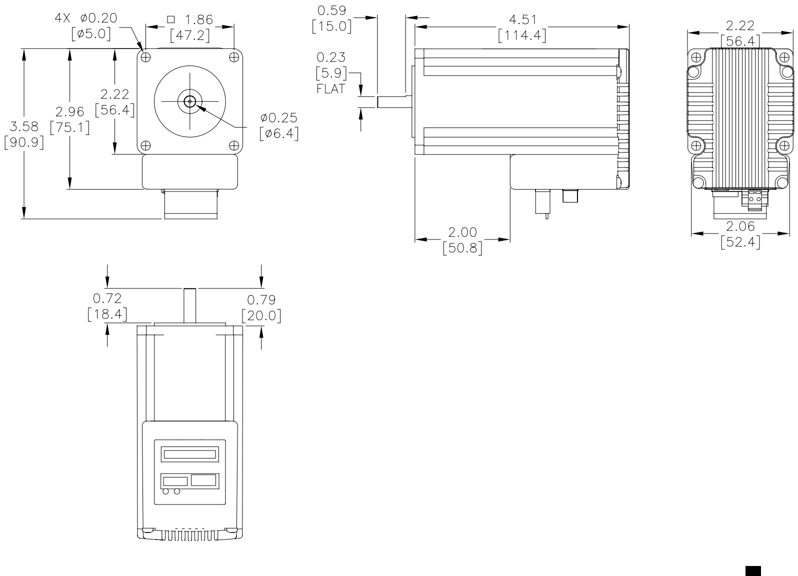
STP-MTRD-23065



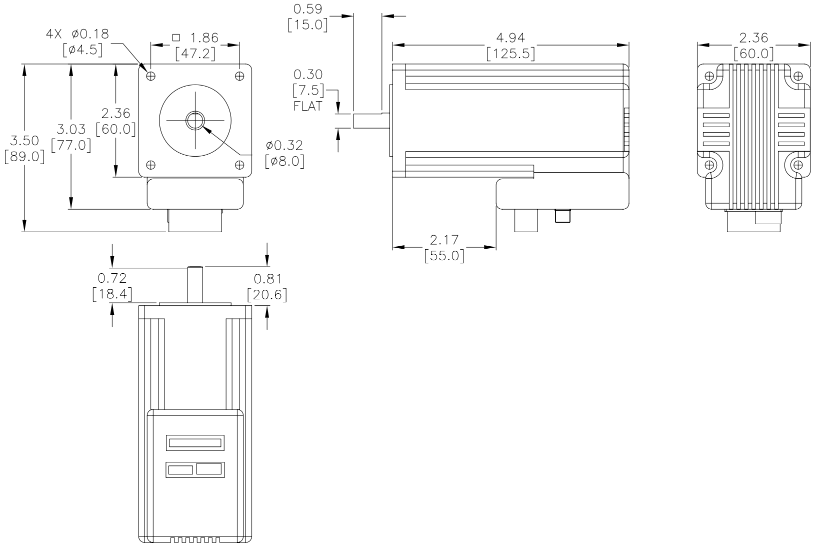
STP-MTRD-23065E



STP-MTRD-23065R / STP-MTRD-23065RE



STP-MTRD-24075RV / STP-MTRD-24075RVE



SureStep™ Stepping Motors

Chapter 6

In This Chapter...

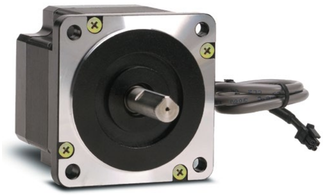
Features

- Step motors available in NEMA 17, NEMA 23, and NEMA 34 frame sizes
- Square frame style produces high torque and achieves best torque to volume ratio
- Holding torque ranges from 63 to 1288 oz·in
- Available in single-shaft and dual-shaft configurations
- NEMA 17, 23, and 34 mounting flange frame sizes
- 4-wire, 12″ long connectorized pigtail
- Optional 20 foot extension cable with locking connector available

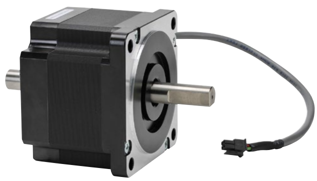
NEMA 17

NEMA 23

NEMA 34



Dual-shaft Versions Available



Design and Installation Tips

Allow sufficient time to accelerate the load and size the step motor with a 100% torque safety factor (i.e.: design the system using a maximum of 50% of the motor's torque). DO NOT disassemble step motors because motor performance will be reduced and the warranty will be voided. DO NOT connect or disconnect the step motor during operation. The motor can be mounted in any orientation (horizontal or vertical). Mount it to a surface with good thermal conductivity, such as steel or aluminum, to allow heat dissipation. Use a flexible coupling with "clamp-on" connections to both the motor shaft and the load shaft to prevent thrust and radial loading on bearings from minor misalignment.

Specifications

*Sure*Step™ Series Specifications – Connectorized Bipolar Stepping Motors							
Bipolar Stepping Motors		High Torque Motors					
		STP-MTR-17040x	STP-MTR-17048x	STP-MTR-17060x	STP-MTR-23055x	STP-MTR-23079x	STP-MTR-34066x
NEMA Frame Size		17	17	17	23	23	34
Optional Encoder		Y	Y	Y	Y	Y	N
* Max Holding Torque	(lb·in)	3.81	5.19	7.19	10.37	17.25	27.12
	(oz·in)	61	83	115	166	276	434
	(N·m)	0.43	0.59	0.81	1.17	1.95	3.06
Rotor Inertia	($oz \cdot in^2$)	0.28	0.37	0.56	1.46	2.60	7.66
	($kg \cdot cm^2$)	0.05	0.07	0.10	0.27	0.48	1.40
Rated Current (A/phase)		1.7	2.0	2.0	2.8	2.8	2.8
Resistance (Ω/phase)		1.6	1.4	2.0	0.8	1.1	1.1
Inductance (mH/phase)		3.0	2.7	3.3	2.4	3.8	6.6
Insulation Class		130°C [266°F] Class B; 300V rms					
Basic Step Angle		1.8°					
Shaft Runout		0.002 in [0.051 mm]					
Max Shaft Radial Play @ 1lb load		0.001 in [0.025 mm]					
Perpendicularity		0.003 in [0.076 mm]					
Concentricity		0.002 in [0.051 mm]					
* Max Radial Load (lb [kg])		6.0 [2.7]			15.0 [6.8]		39.0 [17.7]
* Max Thrust Load (lb [kg])		6.0 [2.7]			13.0 [5.9]		25.0 [11.3]
Storage Temperature		-20°C to 100°C [-4°F to 212°F]					
Operating Temperature		-20°C to 50°C [-4°F to 122°F] (motor case temperature should be kept below 100°C [212°F])					
Operating Humidity		55% to 85% non-condensing					
Product Material		steel motor case; stainless steel shaft(s)					
Environmental Rating		IP40					
Weight (lb [kg])		0.6 [0.3]	0.7 [0.3]	0.9 [0.4]	1.5 [0.7]	2.2 [1.0]	3.9 [1.7]
Agency Approval		CE (complies with EN55014-1 (1993) and EN60034-1.5.11)					
Accessory Extension Cable		STP-EXT-020					

** For dual-shaft motors (STP-MTR-xxxxxD): The sum of the front and rear Torque Loads, Radial Loads, and Thrust Loads must not exceed the applicable Torque, Radial, and Thrust load ratings of the motor.*

Specifications (continued)

Table continued from previous page					
***Sure*Step™ Series Specifications – Connectorized Bipolar Stepping Motors**					
Bipolar Stepping Motors		**Higher Torque Motors**			
		STP-MTR*H*-23079x	**STP-MTR*H*-34066x**	**STP-MTR*H*-34097x**	**STP-MTR*H*-34127x**
NEMA Frame Size		23	34	34	34
Optional Encoder		Y	N	N	N
Max Holding Torque	**(lb·in)**	17.87	27.12	50.00	80.50
	(oz·in)	286	434	800	1288
	(N·m)	2.02	3.06	5.65	9.12
Rotor Inertia	**(oz·in²)**	2.60	7.66	14.80	21.90
	(kg·cm²)	0.48	1.40	2.71	4.01
Rated Current (A/phase)		5.6	6.3	6.3	6.3
Resistance (Ω/phase)		0.4	0.3	0.3	0.5
Inductance (mH/phase)		1.2	1.5	2.1	4.1
Insulation Class		130°C [266°F] Class B; 300V rms			
Basic Step Angle		1.8°			
Shaft Runout		0.002 in [0.051 mm]			
Max Shaft Radial Play @ 1lb load		0.001 in [0.025 mm]			
Perpendicularity		0.003 in [0.076 mm]			
Concentricity		0.002 in [0.051 mm]			
Maximum Radial Load (lb [kg])		15.0 [6.8]	39.0 [17.7]		
Maximum Thrust Load (lb [kg])		13.0 [5.9]	25.0 [11.3]		
Storage Temperature		-20°C to 100°C [-4°F to 212°F]			
Operating Temperature		-20°C to 50°C [-4°F to 122°F] (motor case temperature should be kept below 100°C [212°F])			
Operating Humidity		55% to 85% non-condensing			
Product Material		steel motor case; stainless steel shaft(s)			
Environmental Rating		IP40			
Weight (lb [kg])		2.4 [1.1]	3.9 [1.7]	5.9 [2.7]	8.4 [3.8]
Agency Approval		CE (complies with EN55014-1 (1993) and EN60034-1.5.11)			
Accessory Extension Cable		STP-EXT**H**--020			

Power Supply and Step Motor Drive

An STP-PWR-xxxx linear power supply from AutomationDirect is the best choice to power AutomationDirect and other step motors. These power supplies were designed to work with the AutomationDirect SureStep™ STP-DRV-xxxx series bipolar microstepping motor drives. PSBxx switching power supplies are also available from AutomationDirect.

Mounting the Motor

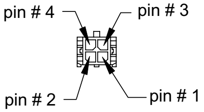
We recommend mounting the motor to a metallic surface to help dissipate heat generated by the motor.

Connecting the Motor

WARNING: When connecting a step motor to a drive or indexer, be sure that the motor power supply is switched off. Never disconnect the motor while the drive is powered up. Never connect the motor leads to ground or directly to the power supply.

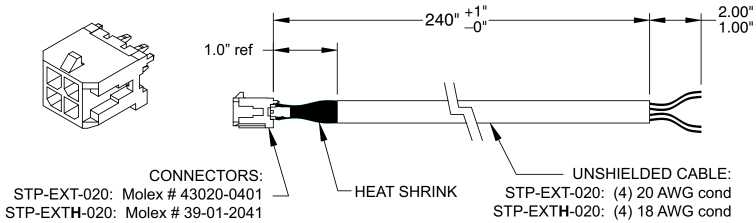
All SureStep step motors have four-wire connectorized pigtail cables which connect directly to available SureStep 20″ extension cables. Due to the different current ranges of the two motor torque classes, two different ampacity rated cables are available. The ...MTR... motors use ...EXT... cables and the ...MTR*H*... motors use ...EXT*H*... cables. The extension cables have the same wire color coding as the motor pigtail cables, as shown in the extension cable wiring diagram and in the motor dimension and cabling diagram.

Extension Cable Wiring Diagram



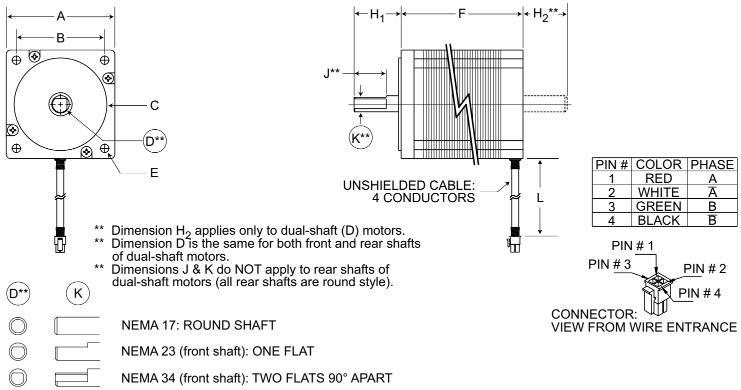
PIN #	COLOR
1	red
2	white
3	green
4	black

STP-EXTx-020
MOTOR EXTENSION CABLES



Motor Dimensions and Cabling

Typical Dimension & Cable Diagram for STP-MTRx Step Motors



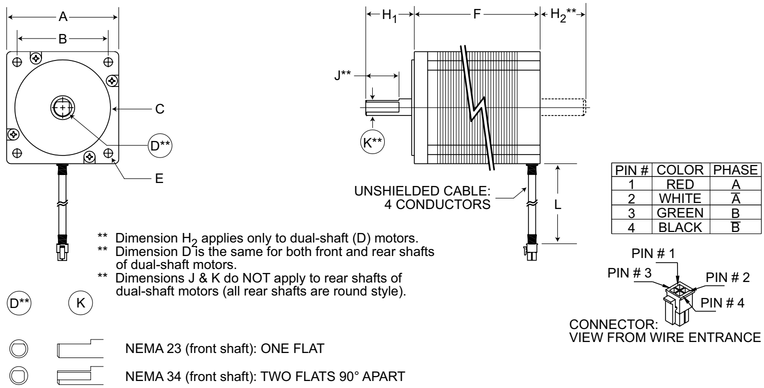
SureStep™ Series Dimensions & Cabling – STP-MTRx*** Step Motors						
Dimensions (in [mm])*	**High Torque Motors STP-MTR-x**					
	STP-MTR -17040x	**STP-MTR -17048x**	**STP-MTR -17060x**	**STP-MTR -23055x**	**STP-MTR -23079x**	**STP-MTR -34066**
A	1.67 [42.3]			2.25 [57.2]		3.39 [86.1]
B	1.22 [31.0]			1.86 [47.2]		2.74 [69.6]
C	Ø 0.87 [22.1]			Ø 1.50 [38.1]		Ø 2.88 [73.0]
D**	Ø 0.20 [5.0]			Ø 0.25 [6.4]		Ø 0.50 [12.7]
E	M3 x 0.5 thread 0.15 [3.8] min depth			Ø 0.20 [5.1] through		Ø 0.26 [6.6] through
F	1.58 [40.1]	1.89 [48.0]	2.34 [59.5]	2.22 [56.4]	3.10 [78.7]	2.64 [67.1]
H_1	0.94 [24.0]			0.81 [20.6]		1.46 [37.1]
H_2**	0.39 [9.9]			0.63 [16.0]		1.13 [28.7]
J**	n/a			0.59 [15.0]		0.98 [25.0]
K**	n/a			0.23 [5.8]		0.45 [11.4]
L	12 [305]					
Conductor	(4) #20 AWG					
Connector	Molex # 43025-0400					
Pin	Molex # 43030-0007					

** *mm dimensions are for reference purposes only.*

** *Dimension D (shaft diameter) is the same for both front and rear shafts of dual-shaft motors. Dimension H_2 applies only to dual-shaft (D) motors. Dimensions J & K do NOT apply to rear shafts of dual-shaft motors (all rear shafts are round style).*

*** *Higher Torque STP-MTRH motors are shown in a separate table.*

Typical Dimension & Cable Diagram for STP-MTRH Step Motors



PIN #	COLOR	PHASE
1	RED	A
2	WHITE	$\overline{A}$
3	GREEN	B
4	BLACK	$\overline{B}$

SureStep™ Series Dimensions & Cabling – STP-MTR*H*-x*** Step Motors				
Dimensions (in [mm])*	Higher Torque Motors STP-MTR*H*-x			
	STP-MTR*H*-23079x	STP-MTR*H*-34066x	STP-MTR*H*-34097x	STP-MTR*H*-34127x
A	2.25 [57.2]	3.39 [86.1]		
B	1.86 [47.2]	2.74 [69.6]		
C	Ø 1.50 [38.1]	Ø 2.88 [73.0]		
D**	Ø 0.25 [6.4]	Ø 0.50 [12.7]		
E	Ø 0.20 [5.1] through	Ø 0.26 [6.6] through		
F	3.10 [78.7]	2.64 [67.1]	3.82 [97.0]	5.00 [127.0]
H_1	0.81 [20.6]	1.46 [37.1]		
H_2**	0.63 [16.0]	1.13 [28.7]		
J**	0.59 [15.0]	0.98 [25.0]		
K**	0.23 [5.8]	0.45 [11.4]		
L	12 [305]			
Conductor	(4) #18 AWG			
Connector	Molex # 39-01-3042			
Pin	Molex # 39-00-0039			

** *mm dimensions are for reference purposes only.*

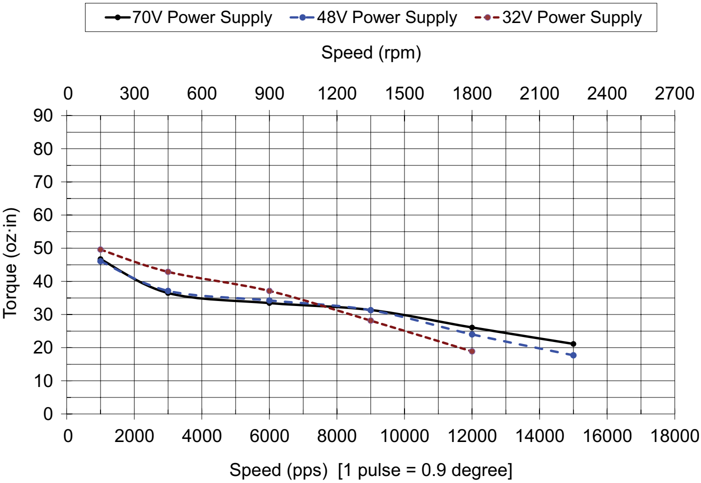
** *Dimension D (shaft diameter) is the same for both front and rear shafts of dual-shaft motors. Dimension H_2 applies only to dual-shaft (D). Dimensions J & K do NOT apply to rear shafts of dual-shaft motors (all rear shafts are round style).*

*** *High Torque STP-MTR motors are shown in a separate table.*

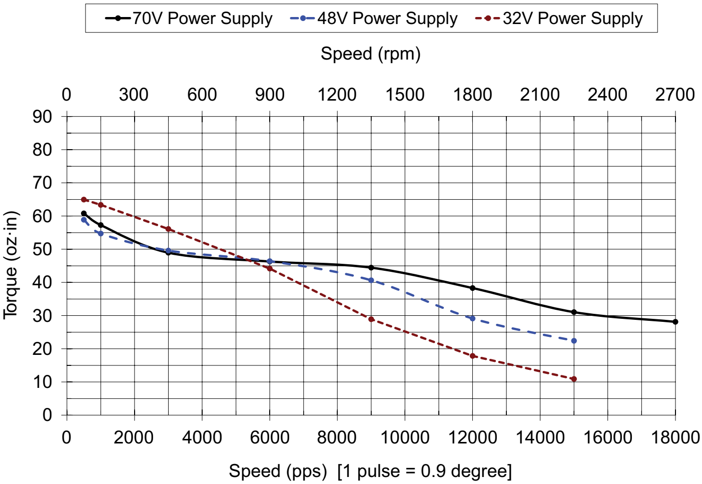
Torque vs. Speed Charts

STP-MTR-17xxx(D) NEMA 17 Step Motors

STP-MTR-17040x Torque vs Speed (1.8° step motor; 1/2 stepping)



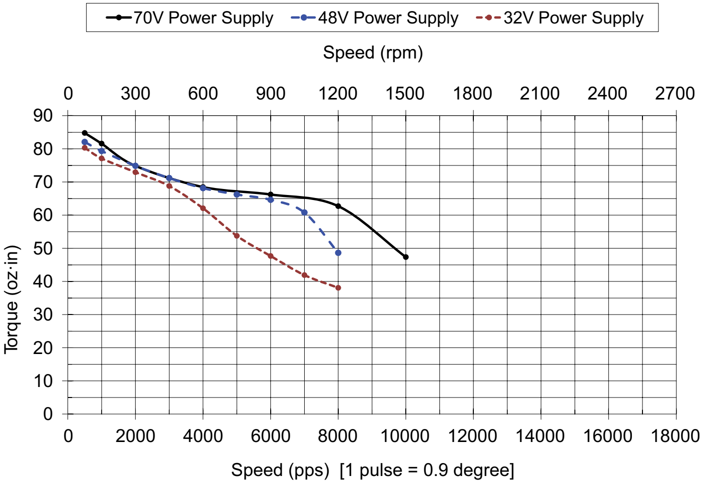
STP-MTR-17048x Torque vs Speed (1.8° step motor; 1/2 stepping)



Torque vs. Speed Charts (continued)

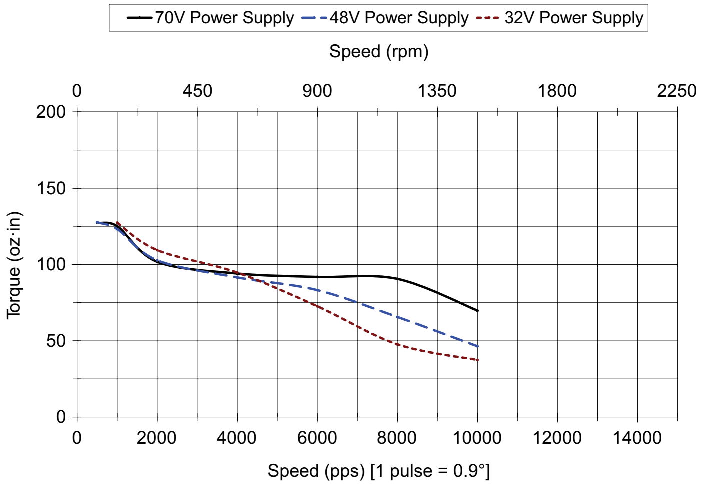
STP-MTR-17xxx(D) NEMA 17 Step Motors (continued)

STP-MTR-17060x Torque vs Speed (1.8° step motor; 1/2 stepping)



STP-MTR(H)-23xxx(D) NEMA 23 Step Motors

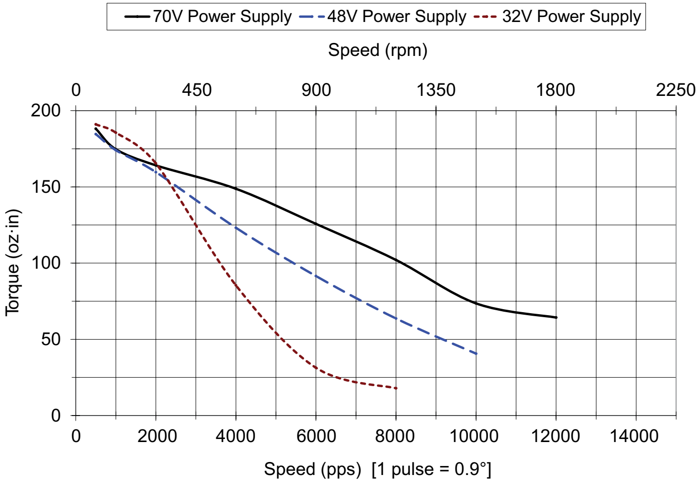
STP-MTR-23055x Torque vs Speed (1.8° step motor; 1/2 stepping)



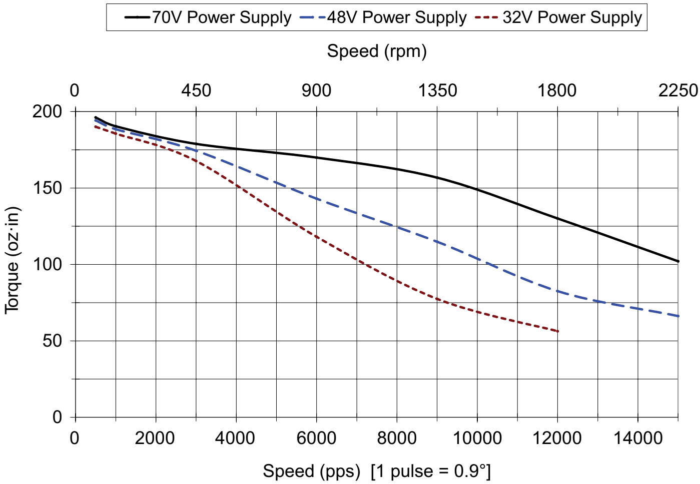
Torque vs. Speed Charts (continued)

STP-MTR(H)-23xxx(D) NEMA 23 Step Motors (continued)

STP-MTR-23079x Torque vs Speed (1.8° step motor; 1/2 stepping)



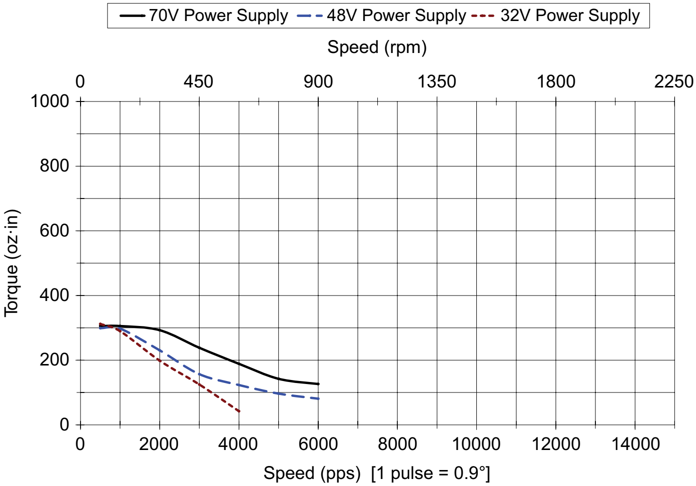
STP-MTR*H*-23079x Torque vs Speed (1.8° step motor; 1/2 stepping)



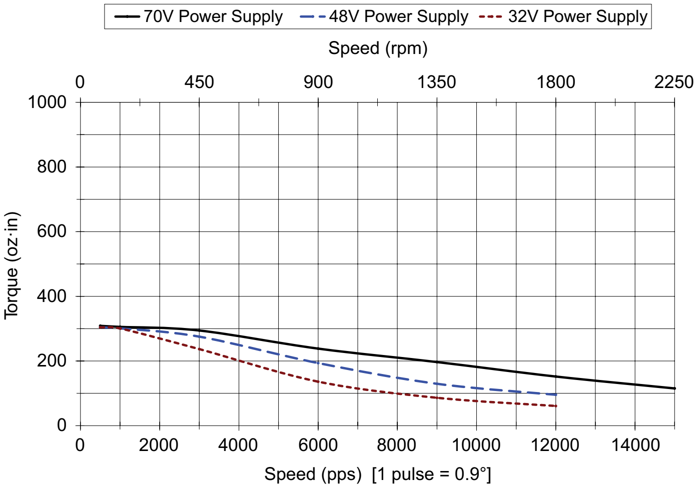
Torque vs. Speed Charts (continued)

STP-MTR(H)-34xxx(D) NEMA 34 Step Motors

STP-MTR-34066x Torque vs Speed (1.8° step motor; 1/2 stepping)



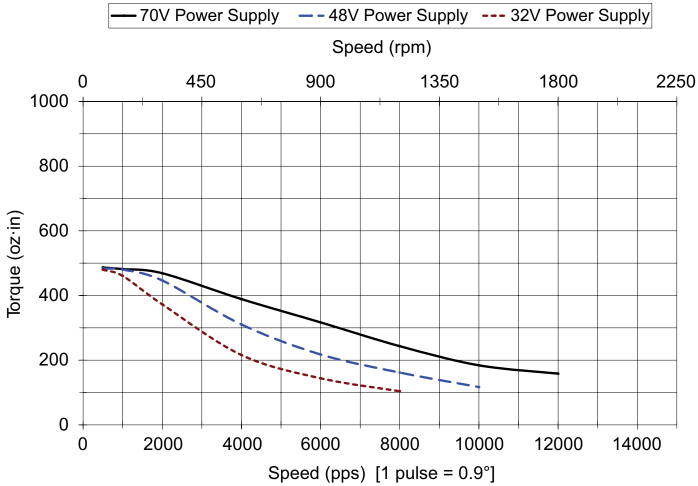
STP-MTR*H*-34066x Torque vs Speed (1.8° motor; 1/2 stepping)



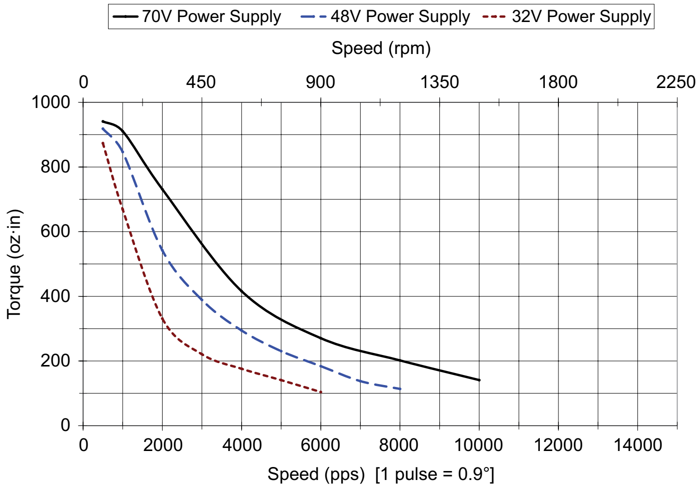
Torque vs. Speed Charts (continued)

STP-MTR(H)-34xxx(D) NEMA 34 Step Motors (continued)

STP-MTR*H*-34097x Torque vs Speed (1.8° step motor; 1/2 stepping)



STP-MTR*H*-34127x Torque vs Speed (1.8° step motor; 1/2 stepping)



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SureStep™ System Power Supplies

Chapter 7

In This Chapter...

Features

- Linear models available with 32V@4A, 48V@5A, 48V@10A, & 70V@5A DC unregulated step motor power
    - 5VDC ±5% at 500 mA regulated logic power (electronic overload)
    - Screw terminal AC input and DC output connectors
    - 120 or 240 VAC, 50/60 Hz power input, switch selectable
    - Power ON LEDs
    - Integrated input and output fusing
    - Matched to SureStep drives for maximum voltage
- Switching models also available

Linear Power Supplies

Switching Power Supplies

The stepping system power supplies can supply power for multiple SureStep STP-DRV-xxxx *microstepping motor drives, depending on step motor size and application requirements. To select a power supply for multiple drives, use the following formula:*

I(ps) ≥ 0.66 x (I_motor1 + I_motor2 + I_motor3 + . . .)

Further information about braking accessories and regeneration clamping can be found in Appendix A and the STP-DRVA-RC-050 REGENERATION CLAMP datasheet.

Specifications

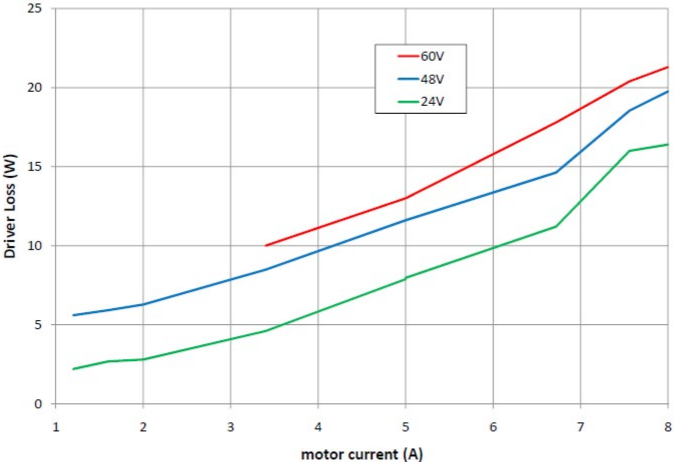
*Sure*Step™ Linear Power Supply Specifications				
Part Number	**STP-PWR-3204**	**STP-PWR-4805**	**STP-PWR-4810**	**STP-PWR-7005**
Input Power (fuse protected)[1]	1-phase, 120/240 VAC, 50/60 Hz, 150 VA Fuse[1]: 3A	1-phase, 120/240 VAC, 50/60 Hz, 350 VA Fuse[1]: 5A	1-phase, 120/240 VAC, 50/60 Hz, 650 VA Fuse[1]: 8A	1-phase, 120/240 VAC, 50/60 Hz, 500 VA Fuse[1]: 7A
Input Voltage	120/240 VAC ±10% [3] (switch selectable; voltage range switch is set to 240 VAC from factory)			
Inrush Current	120 VAC < 12A 240 VAC < 14A	120 VAC < 20A 240 VAC < 24A	120 VAC < 40A 240 VAC < 50A	
Motor Supply Output (linear unregulated, fuse protected[1], power on LED indicator)	32 VDC @ 4A (full load) 35 VDC @ 1A load 41 VDC @ no load Fuse[1]: 6A	46.5 VDC @ 5A (full load) 52 VDC @ 1A load 57.5 VDC @ no load Fuse[1]: 8A	46.5 VDC @ 10A (full load) 50 VDC @ 1A load 57.5 VDC @ no load Fuse[1]: 15A	70 VDC @ 5A (full load) 79 VDC @ 1A load 86.5 VDC @ no load [3] Fuse[1]: 8A
SureStep Drive Compatibility [2]	STP-DRV-4035 (STP-DRV-4850) (STP-DRV-80100)	STP-DRV-4850 (STP-DRV-80100)		STP-DRV-80100
Logic Supply Output	5VDC ±5% @ 500 mA (regulated, electronically overload protected, power on LED indicator)			
Watt Loss	13W	25W	51W	42W
Storage Temperature	-55 to 85 °C -67 to 185 °F			
Operating Temperature	0 to 50 °C (32 to 122 °F) full rated; 70 °C (158 °F) maximum Derate current 1.1% per degree above 50 °C			
Humidity	95% (non-condensing) relative humidity maximum			
Cooling Method	Natural convection (mount power supply to metal surface if possible)			
Dimensions (in [mm])	4.00 x 7.00 x 3.25 [101.6x177.8x82.6]	5.00 x 8.10 x 3.88 [127.0x205.7x98.6]	5.62 x 9.00 x 4.62 [142.7 x 228.6 x 117.3]	
Mounting	Use four (4) #10 screws to mount on either wide or narrow side.			
Weight (lb [kg])	6.5 [2.9]	11 [4.9]	18 [8.3]	16 [7.2]
Connections	Screw Terminals, tightening torque of 4.5 in·lbs			
Agency Approvals	UL (file # E181899), CSA, CE			

1) Fuses to be replaced by qualified service personnel only. Use (1-1/4 x 1/4 in) ceramic fast-acting fuses (Edison type ABC from AutomationDirect, or equivalent).

2) Caution: Do not use a power supply that exceeds the input voltage range of the drive. Using a lower voltage power supply with a higher voltage drive is acceptable, but will not provide full system performance.

3) An unloaded STP-PWR-7005 can float above the allowable input voltages of some drives if it is fed with a high AC input voltage (greater than 120VAC). Either ensure that the incoming AC supply is less than 120V, or supply a burden resistor to pull the unloaded linear DC voltage level down.

Drive Watt Loss



Choosing a Power Supply

Voltage

Chopper drives work by switching the voltage to the motor terminals on and off while monitoring current to achieve a precise level of phase current. To do this efficiently and silently, you'll want to have a power supply with a voltage rating at least five times that of the motor. SureStep Drives are designed to work well with SureStep motors so choosing the proper voltage of the supply is made easy when using all AutomationDirect products. A compatibility chart for AutomationDirect power supplies and drives is located below.

SureStep™ Power Supply Compatibility				
Drive	**Linear Power Supply**			
	STP-PWR-3024	**STP-PWR-4805**	**STP-PWR-4810**	**STP-PWR-7005***
STP-DRV-4035	✓	No	No	No
STP-DRV-4850	✓	✓	✓	No
STP-DRV-6575	✓	✓	✓	No
STP-DRV-80100	✓	✓	✓	✓
STP-MTRD-17	✓	✓	✓	No
STP-MTRD-23, -24	✓	✓	✓	✓
Drive	**Switching Power Supply**			
	PSB12-xxxS	**PSB24-xxxS**	**PSB48-xxxS**	
STP-DRV-4035	✓	✓	No	
STP-DRV-4850	No	✓	✓	
STP-DRV-6575	No	✓	✓	
STP-DRV-80100	No	✓	✓	
STP-MTRD-17	✓	✓	✓	
STP-MTRD-23, -24	✓	✓	✓	

**An unloaded STP-PWR-7005 can float above the allowable input voltages of some drives if it is fed with a high AC input voltage (greater than 120VAC). Either ensure that the incoming AC supply is less than 120V, or supply a burden resistor to pull the unloaded liner DC voltage level down.*

Depending on how fast you want to run the motor, you may need even more voltage. Generally, more is better; the upper limit being the maximum voltage rating of the drive itself. With voltage, there is a trade-off between higher voltage and increased heating.

Voltage determines max speed. A higher voltage power supply equals higher top-end motor speed. But higher voltages also mean higher temperatures (drive and motor), so the lowest voltage that will satisfy your required speed should be used.

Linear (Unregulated) vs Switching (Regulated) Power Supplies

If you choose an unregulated power supply, do not allow the "no load" voltage to exceed the maximum voltage rating of the drive. Unregulated supplies are rated at full load current. At lesser loads, such as when the motor is not moving, the actual voltage can be up to 25% greater than the voltage listed on the power supply label. Some applications may have regeneration (the motor tries to decelerate a large load quickly and becomes a generator). The motor tries to dump the excess energy back into the drive (and supply). This can sometimes boost the DC voltage up higher than the regulated supply would normally output which can turn into an overvoltage situation, causing the power supply to shut down. Regeneration clamp STP-DRVA-RC-050 can help in these situations. It is installed between the power supply and drive, where it monitors incoming power supply voltage and the voltage on the drive side. If the drive side goes higher than the incoming (the motor is regenerating power), the clamp "dumps" energy out to its resistor. Linear supplies don't care (they will just float higher), but regulated supplies might trip. STP-DRVA-BR-100 allows the regeneration clamp to "dump" even more energy from the system.

Current

The maximum supply current you will need is the sum of the two phase currents. However, you will generally need a lot less than that, depending on the motor type, voltage, speed and load conditions. That's because the SureStep drives use switching amplifiers, converting 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 you'll need from the power supply.

We recommend the following selection procedure:

1. If you plan to use only a small number of drives, choose a power supply using the following formula:

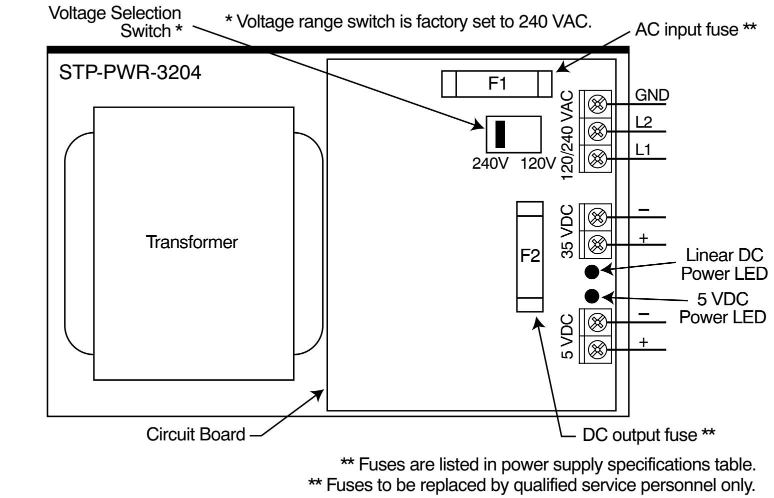
   I(ps) ≥ 0.66 x (I_motor1 + I_motor2 + I_motor3 + . . .)

2. If you are designing for mass production and must minimize cost, get one power supply with more than twice the rated current of the motor. Install the motor in the application and monitor the current coming out of the power supply and into the drive at various motor loads. This test will tell you how much current you really need so you can design in a lower cost power supply.

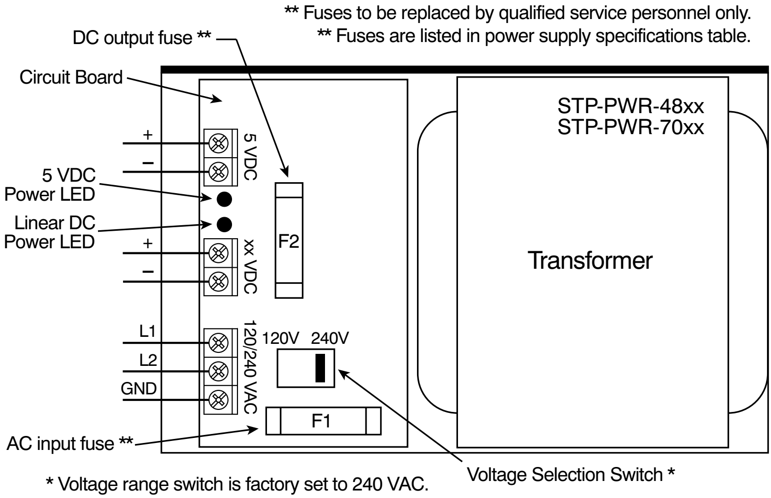
If you plan to use a regulated or switching power supply, you may encounter a problem with current foldback. When you first power up your drive, the full current of both motor phases will be drawn for a few milliseconds while the stator field is being established. After that, the amplifiers start chopping and much less current is drawn from the power supply. If your power supply thinks this initial surge is a short circuit it may "foldback" to a lower voltage. With many foldback schemes the voltage returns to normal only after the first motor step and is fine thereafter. In that sense, unregulated power supplies are better.

Power Supply Terminal & Component Layout

STP-PWR-3204



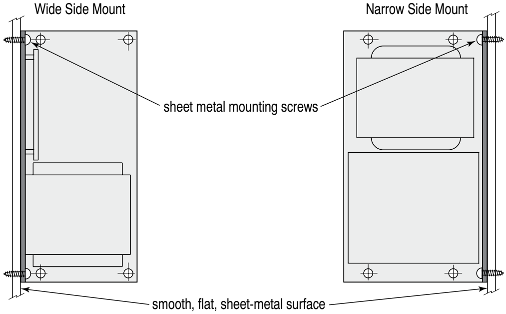
STP-PWR-4805, STP-PWR-4810, STP-PWR-7005



Mounting the Power Supply

STP-PWR-xxxx power supplies can be mounted on either the bottom (wide) side, or the back (narrow) side of the chassis. Either orientation contains mounting holes for machine screws. Use #10 screws for STP-PWR-3204 and -4805, or 1/4″ screws for STP-PWR-4810 and -7005.

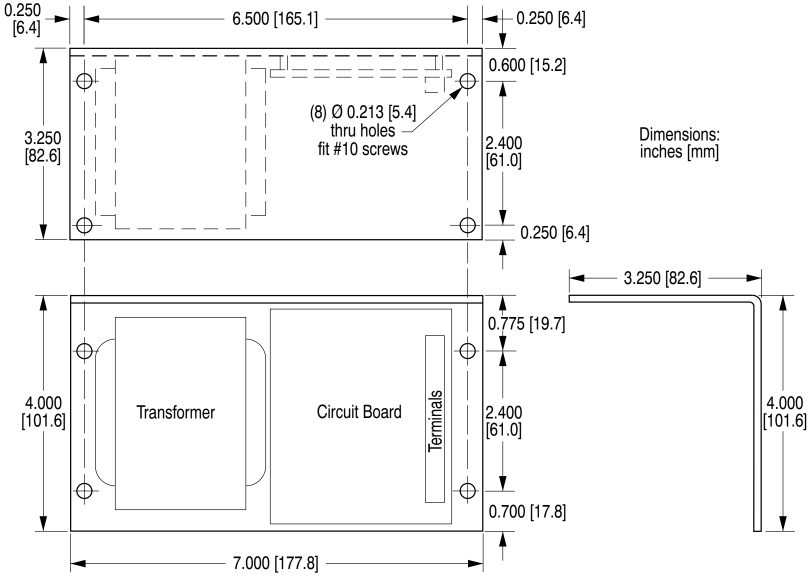
Since power supplies generate heat, they should be mounted in a location that allows air flow. They also should be securely fastened to a smooth, flat metal surface that will dissipate heat.



Warning: Never use the power supply in a space where there is no air flow, or where the surrounding air temperature is greater than 70 °C.

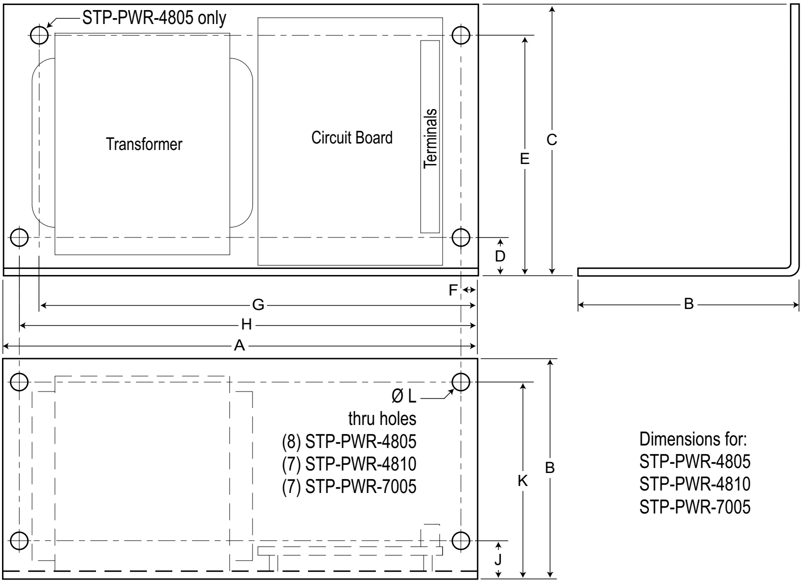
Dimensions

STP-PWR-3204



Dimensions (continued)

STP-PWR-4805, -4810, -7005



SureStep™ Series Dimensions – 48V & 70V Power Supplies			
Dimensions* (in [mm]*)	Power Supply Part Number		
	STP-PWR-4805	STP-PWR-4810	STP-PWR-7005
A	8.10 [205.7]	9.00 [228.6]	
B	3.88 [98.6]	4.62 [117.3]	
C	5.00 [127.0]	5.62 [142.7]	
D	0.87 [22.1]	1.56 [39.6]	
E	4.67 [118.6]	4.06 [103.1]	
F	0.25 [6.4]	0.35 [8.9]	
G	7.15 [181.6]	n/a	
H	7.75 [196.9]	8.59 [218.2]	
J	0.50 [12.7]	0.50 [12.7]	
K	3.53 [89.7]	4.27 [108.5]	
L	0.200 [5.1]	9/32 [7.1]	
Mtg Screw	#10	1/4	
** mm dimensions are for reference purposes only.*			

SureMotion Pro Configuration Software

Chapter 8

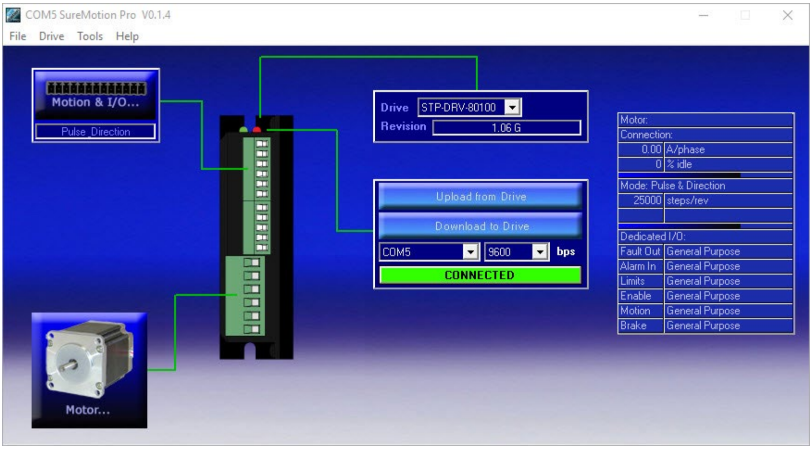
In This Chapter...

SureMotion™ Pro Software

The *Sure*Step advanced drives STP-DRV-4850 & -80100 and advanced integrated motor/drives (STP-MTRD-17R, -23R, and -24R) are configured using *Sure*Motion Pro™ configuration software, which is available for download from the Automationdirect.com website.

Note: SureMotion Pro is the successor to SureStep Pro. Anything that could be done with SureStep Pro can still be done with SureMotion Pro.

The software is divided into two major sections, "Motion and I/O" and "Motor" configuration. There are also communication settings, drive selection, and drive status features.



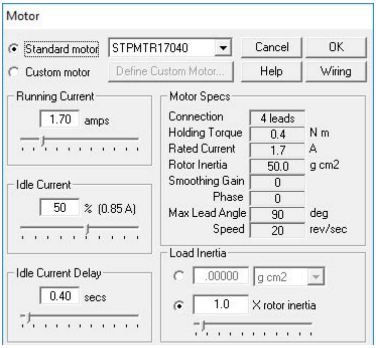
Complete software instructions are included in the "Help" files within the software.

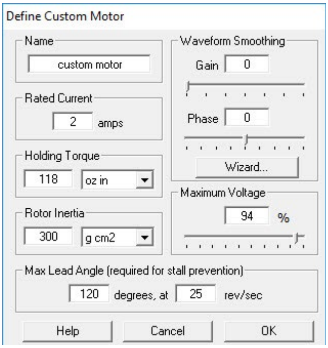
Communication

Upload and Download from/to the drive. When you connect to a drive, the Motor, Motion Mode, and Dedicated I/O settings that are currently in the drive will appear on the right of the screen (as will the Drive and Revision at the top of the screen). "Upload from Drive" to get all the configuration settings from the drive or "Download to Drive" to apply all the settings on the PC to the drive.

Motor Configuration

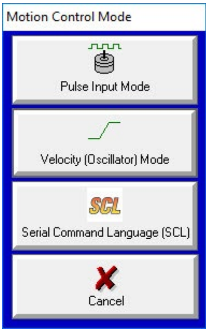
Clicking on the "Motor.." icon will bring up the motor configuration screen. You can choose a motor from the pull-down menu or enter a custom motor (you will need to enter that motor's specific information). If you know the inertia mismatch of the load, you should enter it. If the inertia mismatch is unknown, this entry can be left at 1. The idle current is default at 50%. Idle current should be used unless the application will require a constant high holding torque





Motion and I/O

Selecting this tab will allow you to set the drive's mode of operation.



- Pulse and Direction:
  Used with high-speed pulse inputs (CW/CCW, Pulse/Direction, Quadrature) generated from a PLC, encoder, etc.
- Velocity (Oscillator):
  Allows the drive to be speed controlled by an analog signal. The input is 0 – 5V and can be scaled to the desired maximum speed. Bidirectional motion can be attained by changing the Offset (under "Advanced Analog Settings") to a non-zero value. EX: Setting this value to 2500mV will command the drive to be at zero speed when 2.5V are present.
- Serial Command Language (SCL):
  Causes the drive to respond to serial commands. A PLC or PC can issue a variety of commands to enable simple motion, gearing/following, turn on the output, wait for an input, etc. See the "SCL Manual" under the *Sure*Motion Pro Help menu. Serial commands can be tested by selecting the "Drive" pull-down menu from the menu bar, and then selecting "SCL Terminal".

Drive Pull-down Menu

This software menu gives you several features to monitor and test the drive.

- Self-Test – Rotates the motor clockwise and counterclockwise. (Tests motor and cabling)
- Status Monitor – Shows the current Drive and I/O status.
- SCL Terminal – Allows SCL commands to be tested by typing them in. (HyperTerminal is NOT a good tool for serial commands, because the drive will "time-out" if you use HyperTerminal to enter strings. SCL Terminal will send the entire string at once.)
- Alarm History – Will read back the most recent drive faults
- Clear Alarm – Will clear the current drive fault.
- Restore Factory Defaults – resets the drive to "out of the box" status.
- Set Quick Decel Rate – Used when the drive encounters faults or overtravel limits.

If using SCL mode, and if testing is done with SCL terminal, make sure to disconnect software and turn power off to the drive for at least 10 seconds to clear the drive's communication buffer.

SCL terminal can be used to test SCL strings before programming your PLC. However, PLC communications will fail after using SCL Terminal unless the drive is powered down for at least 10 seconds before attempting PLC-to-drive communication.

SureStep™ Communications

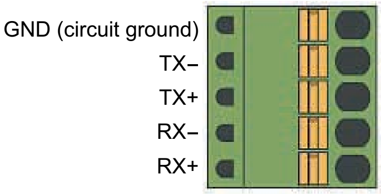
Chapter 9

In This Chapter...

Connecting to a Host Using RS-485

The Advanced integrated motor/drives (STP-MTRD-xxxxxR) support RS-485 ASCII/SCL serial communication. RS-485 communication allows connection of more than one drive to a single host PC, PLC, HMI or other computer. It also allows the communication cable to be long (more than 300 meters or 1000 feet). The use of Category 5 cable is recommended as it is widely used for computer networks, inexpensive, easily obtained, and certified for quality and data integrity.

For electrically noisy environments we recommend twisted pair cable with an overall shield and drain wire. Connect the drain wire at one end of the cable to earth ground.



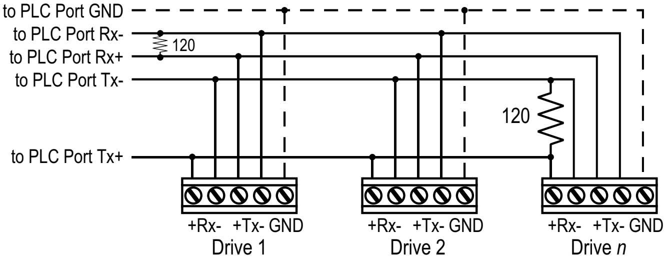
RS-485 Connector Diagram

RS-485 can be used with either four-wire or two-wire configurations. Both types of configurations can be used for point-to-point (i.e. one drive and one host) or multi-drop networks (one host and up to 32 drives).

To use the STP-MTRD-xxxxxR RS-485 with SureMotion Pro, the STP-MTRD-xxxxxR must be connected to the PC in the four-wire "point-to-point" configuration and configured one axis at a time. The DA command is useful in setting up multiple drives.

Four-Wire Configuration

Four-wire systems utilitize separate transmit and receive wires. One pair of wires must connect the host's transmit signals to each drives RX+ and RX- terminals. The other pair connects the drive's TX+ and TX- terminals to the host's receive



RS-485 4-wire System

signals. A logic ground terminal is provided on each drive and can be used to keep all drives at the same ground potential. This terminal connects internally to the DC power supply return (V-), so if all the drives on the RS-485 network are powered from the same supply it is not necessary to connect the logic grounds. One drive's GND terminal should still be connected to the host computer ground.

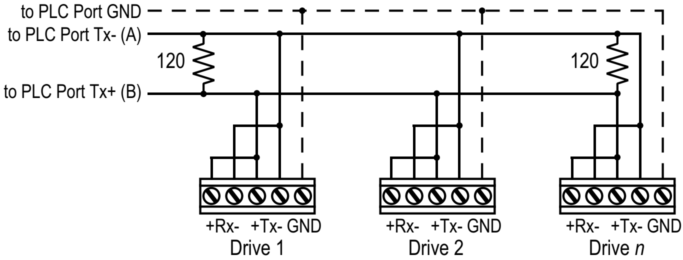
A 120 ohm terminating resistor is required at the end of a four-wire network.

If the PC does not have an RS-485 serial port, a converter will be required. ADC part number STP-USB485-4W is recommended.

Two-Wire Configuration

Two-wire systems use the same pair of wires to transmit and receive. This can lead to trouble as the host must not only disable its transmitter before it can receive data, it must do so quickly before a drive begins to answer a query. The STP-MTRD-xxxxR includes a "transmit delay" parameter that can be adjusted to compensate for a host that is slow to disable its transmitter. This adjustment can be made over the network using the TD command, or it can be set using the SureMotion Pro software. It is not necessary to set the transmit delay in a four-wire system.

2-wire communication is not recommended for STP-MTRD-xxxxxR systems. Some SureMotion Pro features (firmware upgrade, etc.) may not work correctly. Use a 4-wire configuration for best results.



RS-485 2-wire System

A 120 ohm terminating resistor is required at both ends of a 2-wire network.

Assigning RS-485 Addresses

Before wiring the entire system, you'll need to connect each drive individually to the host computer so that a unique address can be assigned to each drive using SureMotion Pro if you want to assign addresses to the drives. This is required if you plan to talk to multiple drives that are on the same network. See the "DA" SCL command. Use the programming cable and the SureMotion Pro software that came with your drive for this purpose.

Connect the drive to your PC and then launch the SureMotion Pro software. Select the com port that is connected to the drive. Finally, apply power to your drive. If you have already configured your drive, then you should click the Upload button so that the SureMotion Pro settings match those of your drive. Click on the Motion & I/O button, then select the "SCL" operating mode. The RS-485 Address panel should appear. If you would like to assign the drive a unique address, just click on the address character of your choice. You can use the numerals 0-9, or any of the following special characters: ! " # $ % & ' () * + , - . / : ; < = > ? @. Just make sure that each drive on your network has a unique address. If you are using a 2-wire network, you may need to set the Transmit Delay too. 10 milliseconds works on most adapters. Once you've made your configuration choices, click Download to save the settings to your drive.

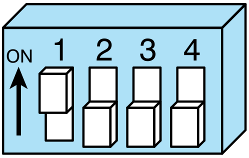
Connecting to an STP-MTRD-xxxxR using the STP-USB485-4W Adapter

The STP-USB485-4W is an excellent chocie for USB to serial conversion. It can be used for all RS-232 and RS-485 applications.

For RS-485 two-wire systems, set the switches and make the connections to the STP-MTRD-xxxxR according to the diagrams below:

Note: 2-wire is used by some AutomationDirect PLCs.

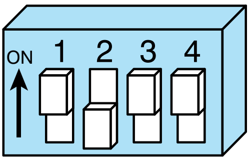
RS-485 Two-wire Settings	
STP-USB485-4W 6-pin screw terminal connector	**STP-MTRD-xxxxR 5-pin connector**
1	RX-, TX-
2	RX+, TX+
6	GND



RS-485 2-wire Switch Settings

For RS-485 four-wire systems, set the switches and make the connections to the STP-MTRD-xxxxR according to the diagrams below:

RS-485 Four-wire Settings	
STP-USB485-4W 6-pin screw terminal connector	**STP-MTRD-xxxxR 5-pin connector**
1	RX-
2	RX+
3	TX+
4	TX-
6	GND



RS-485 4-wire Switch Settings

Note: 4-wire is needed for communications to SureMotion Pro.

Connecting to a drive using RJ12

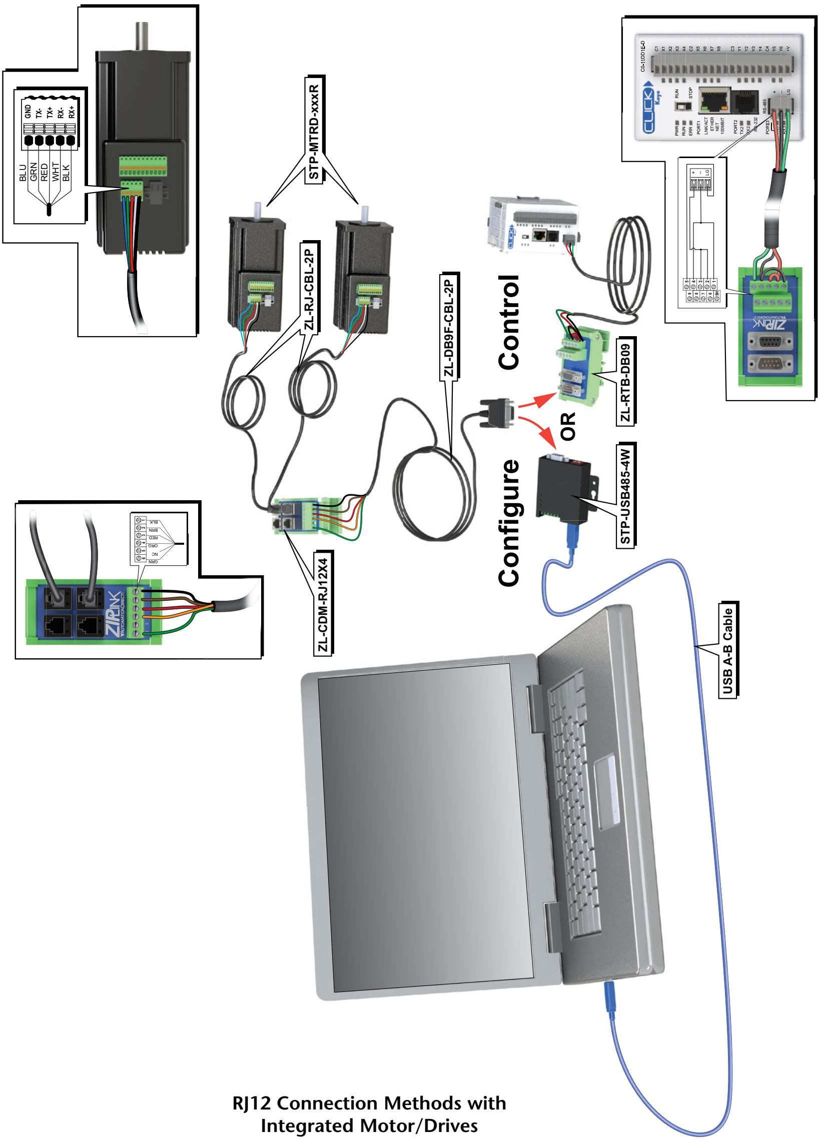
Multiple drives can easily be configured by connecting them using the ZL-CDM-RJ12X4 or ZL-CDM-RJ12X10 RJ12 feedthrough modules. Use SureMotion Pro to assign unique addresses to each drive, then use the feedthrough module to network them together. The diagram on the next page shows a very convenient way to configure (PC) and control (PLC) multiple RS-485 integrated stepper motor/drives. This diagram uses a 2-wire RS-485 connection (CLICK and several other AutomationDirect PLCs only support 2-wire RS-485).

Drive configuration using SureMotion Pro:

The drives must be configured one at a time using SureMotion Pro (they all have the same network address out-of-the-box). Disconnect all but one drive from the ZL-CDM-RJ12X4 or ZL-CDM-RJ12X10 breakout board. That drive can now be configured by the PC. Plug the cable with the DB9 connector into the USB/RS-485 converter (the "Configure" option in the diagram on the next page). Configure each drive (connect only one at a time to the network) with SureMotion Pro. Remember that the PLC cannot be connected to the network while the PC is configuring drives, as there can only be one master on the network at a time.

Controlling the network of drives from a PLC using SCL commands:

Once all the drives are uniquely addressed, plug all the RJ12 cables back into the ZL-CDM-RJ12X4 or ZL-CDM-RJ12X10 feedthrough module. Unplug the USB/RS-485 converter from the RS-485 network and plug the DB9 connector into the ZL-RTB-DB09 feedthrough module (the "Control" option in the diagram). Pins 1 & 4 need to be tied together and pins 2 and 3 need to be tied together for 2-wire RS-485 communications (Most AutomationDirect PLCs only support 2-wire RS-485. Only the 06 and 260 CPU support 4-wire RS-485). See "Two-Wire Configuration" on page 9-3 for an example diagram.



RJ12 Connection Methods with Integrated Motor/Drives

SureStep™ Accessories

Appendix A

In This Appendix...

Braking Accessories

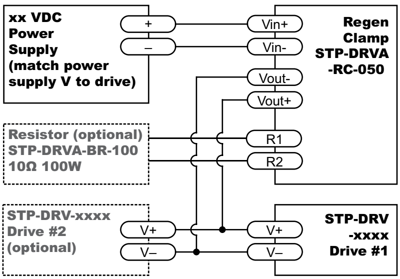
If you plan to use a regulated or switching power supply, you might encounter problems from power regeneration. As a load rapidly decelerates from a high speed, much of the kinetic energy of that load is transferred back to the motor. This energy is then pushed back to the drive and power supply, resulting in increased system voltage. If there is enough overhauling load on the motor, the DC voltage will go above the drive and/or power supply limits.

This can trip the overvoltage protection of a switching power supply or a drive, and cause it to shut down.

To solve this problem, AutomationDirect offers a regeneration clamp and a braking resistor as optional accessories. The regeneration clamp has a built-in 50W braking resistor. For additional braking power (larger overhauling loads), an optional 100W braking resistor is also available.

Further information about braking accessories and regeneration clamping can be found in the STP-DRVA-RC-050 REGENERATION CLAMP datasheet.

Block Diagram – STP-DRV-xxxx STP-DRVA-RC-050 & STP-DRVA-BR-100



Regeneration Clamp Features

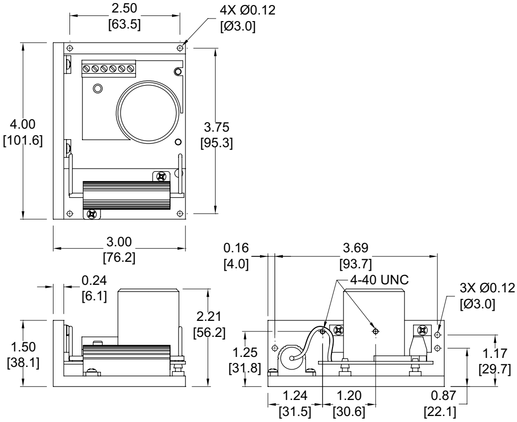
(STP-DRVA-RC-050)

- Built-in 50W power resistor (optional 100W resistor also available)
- Mounted on a heat sink
- Voltage range: 24–80 VDC; no user adjustments required
- Power: 50W continuous; 800W peak
- Wire connection: 6-pin screw terminal block; 12–18 AWG wire
- Indicators (LED):
  Green = power supply voltage is present
  Red = clamp is operating (usually when stepper is decelerating)
- Protection: The external power supply is internally connected to an “Input Diode” in the regen clamp that protects the power supply from high regeneration voltages. This diode protects the system from connecting the power supply in reverse. If the clamp circuit fails, the diode will continue to protect the power supply from over-voltage.
- RoHS

SureStep™ Microstepping Drives – Optional Accessories	
Part Number	***Description***
STP-DRVA-RC-050 *	Regeneration Clamp: use with DC-powered stepper & servo drives; 50W, 24–80 VDC
STP-DRVA-BR-100	Braking Resistor: use with STP-DRV-RC-050 regen clamp; 100W, 10 ohms
** Do not use the regeneration clamp in an atmosphere containing corrosive gases.*	

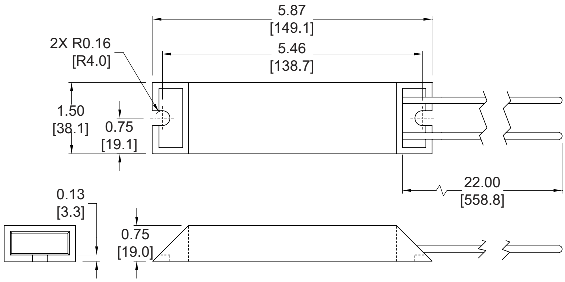
Dimensions – STP-DRVA-RC-050

Dimensions = in [mm]



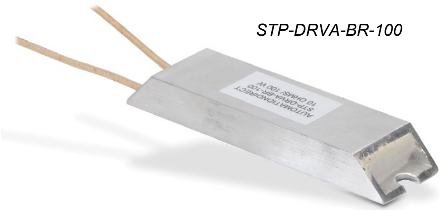
Dimensions – STP-DRVA-BR-100

Dimensions = in [mm]



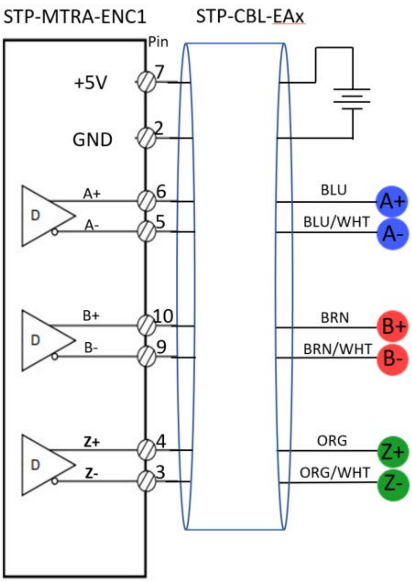
STP-DRVA-RC-050

STP-DRVA-BR-100

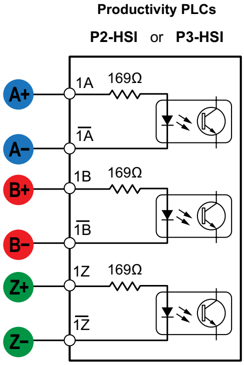


Optional Encoder

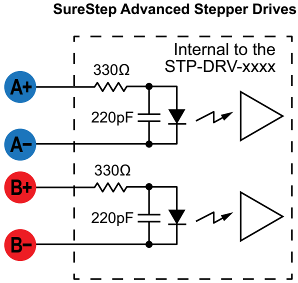
The optional external line driver encoder that comes with the standard integrated motors (STP-MTRA-ENC1) is compatible for encoder following for the SureServo SVA servo drives and the SureStep Advanced stepper drives. The encoder is also compatible with the Productivity 2000 and 3000 series PLCs. The Productivity high speed input modules (P2-HSI and P3-HSI) will accept the encoder signal directly. Other AutomationDirect PLCs with high-speed inputs (BRX, Do-More, DirectLogic) will accept the input signal only after they have been converted to an open collector using the FC-ISO-C signal conditioner. Please see below and following pages for wiring examples:



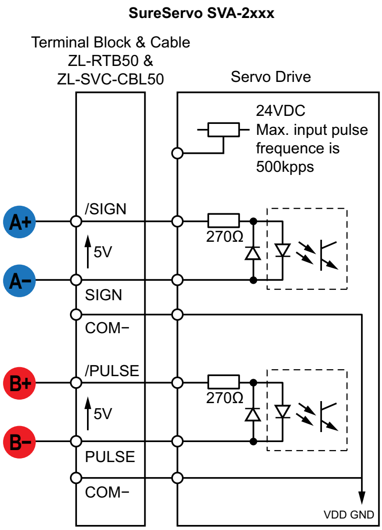
STP-MTRA-ENC1 Wiring Diagram



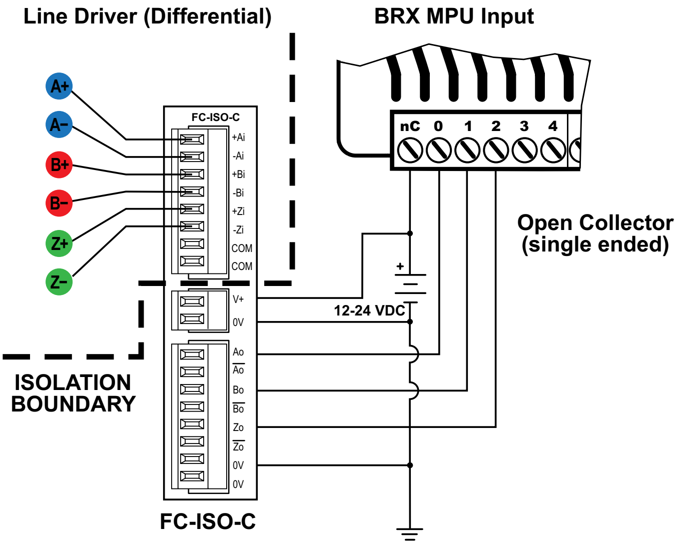
Productivity PLC Wiring Diagram



SureStep Advanced Stepper Drive Wiring Diagram



SureServo Wiring Diagram



BRX PLC Wiring Diagram

Encoder Specifications

Encoder General Specifications	
Encoder	**STP-MTRA-ENC1**
Operating Temperature, CPR < 2000	-40 to 100°C (xx to xx°F)
Operating Temperature, CPR ≥ 2000	-25 to 100°C (xx to xx°F)
Vibration (5Hz to 20kHz)	20G
Electrostatic Discharge, Human Body Model	±2kV
Max. Shaft Axial Play	±0.010 inches
Max Shaft Eccentricity plus Radial Play	0.004 inches
Max Accleration	250000 rad/sec^2
Typical Product Weight	0.91 oz.
Hub Set Screw	#4-48
Hex Wrench Size	0.050 inches
Encoder Base Plate Thickness	0.135 inches
Phase Relationship	A leads B for clockwise shaft rotation, and B leads A for counterclockwise rotation as viewed from the cover side of the encoder.

Differential Electrical Specifications

The following specifications apply over the entire operating temperature range. Typical values are specified at Vcc = 5.0VDC and 25°C.

Encoder Electrical Specifications			
STP-MTRA-ENC1	**Min.**	**Typical**	**Max.**
Supply Voltage (V)	4.5	5.0	5.5
Supply Current (mA)	-	56	65
Low-level Output[1] (V)	-	0.2	0.4
High-level Output[2] (V)	2.4	3.4	-
Differential Output Rise/Fall Time (nS)	-	-	15
1: IOL = 20mA max.			
2: IOH = 20mA max.			

USING SureStep™ WITH AUTOMATIONDIRECT PLCs

APPENDIX B

In This Appendix...

Compatible AutomationDirect PLCs and Modules

The following tables show which high-speed pulse-output PLCs and modules can be used with the *Sure*Step Microstepping Motor Drives.

Productivity PLCs/Modules for Use with *Sure*Step Drive	
Productivity Series High Speed Counter I/O Modules	
P3-HSO	Productivity3000 high-speed pulse output module, 1MHz maximum switching frequency, 2-channel, 4 general purpose output points, 5-24 VDC, sinking/sourcing, 6 general purpose input points, external 24 VDC required.
P2-HSO	Productivity2000 high-speed pulse output module, 1MHz maximum switching frequency, 2-channel, 4 general purpose output points, 5-24 VDC, sinking/sourcing, 6 general purpose input points, external 24 VDC required.

BRX Series PLCs/Modules for Use with *Sure*Step Drive	
BRX Series High Speed Counter I/O Modules	
BX-DM1-10ED1-D	BRX Do-more PLC, 12-24 VDC required, serial port, microSD card slot, Discrete Input: 6-point, AC/DC, Discrete Output: 4-point, sinking.
BX-DM1-10ED2-D	BRX Do-more PLC, 12-24 VDC required, serial port, microSD card slot, Discrete Input: 6-point, AC/DC, Discrete Output: 4-point, sourcing.
BX-DM1E-10ED13-D	BRX Do-more PLC, 12-24 VDC required, Ethernet and serial ports, microSD card slot, Discrete Input: 6-point, AC/DC, Analog Input: 1-channel, current/voltage, Discrete Output: 4-point, sinking, Analog Output: 1-channel, current/voltage.
BX-DM1E-10ED23-D	BRX Do-more PLC, 12-24 VDC required, Ethernet and serial ports, microSD card slot, Discrete Input: 6-point, AC/DC, Analog Input: 1-channel, current/voltage, Discrete Output: 4-point, sourcing, Analog Output: 1-channel, current/voltage.
BX-DM1-18ED2-D	BRX Do-more PLC, 12-24 VDC required, serial port, microSD card slot, Discrete Input: 10-point, AC/DC, Discrete Output: 8-point, sourcing.
BX-DM1-18ED1-D	BRX Do-more PLC, 12-24 VDC required, serial port, microSD card slot, Discrete Input: 10-point, AC/DC, Discrete Output: 8-point, sinking.
BX-DM1E-18ED23-D	BRX Do-more PLC, 12-24 VDC required, Ethernet and serial ports, microSD card slot, Discrete Input: 10-point, AC/DC, Analog Input: 1-channel, current/voltage, Discrete Output: 8-point, sourcing, Analog Output: 1-channel, current/voltage.
BX-DM1E-18ED13-D	BRX Do-more PLC, 12-24 VDC required, Ethernet and serial ports, microSD card slot, Discrete Input: 10-point, AC/DC, Analog Input: 1-channel, current/voltage, Discrete Output: 8-point, sinking, Analog Output: 1-channel, current/voltage.
BX-DM1-18ED2	BRX Do-more PLC, 120-240 VAC required, serial port, microSD card slot, Discrete Input: 10-point, AC/DC, Discrete Output: 8-point, sourcing.
BX-DM1-18ED1	BRX Do-more PLC, 120-240 VAC required, serial port, microSD card slot, Discrete Input: 10-point, AC/DC, Discrete Output: 8-point, sinking.
Table continued next page.	

BRX Series PLCs/Modules for Use with *Sure*Step Drive	
BX-DM1E-18ED23	BRX Do-more PLC, 120-240 VAC required, Ethernet and serial ports, microSD card slot, Discrete Input: 10-point, AC/DC, Analog Input: 1-channel, current/voltage, Discrete Output: 8-point, sourcing, Analog Output: 1-channel, current/voltage.
BX-DM1E-18ED13	BRX Do-more PLC, 120-240 VAC required, Ethernet and serial ports, microSD card slot, Discrete Input: 10-point, AC/DC, Analog Input: 1-channel, current/voltage, Discrete Output: 8-point, sinking, Analog Output: 1-channel, current/voltage.
BX-DM1-36ED2-D	BRX Do-more PLC, 12-24 VDC required, serial port, microSD card slot, Discrete Input: 20-point, AC/DC, Discrete Output: 16-point, sourcing.
BX-DM1-36ED1-D	BRX Do-more PLC, 12-24 VDC required, serial port, microSD card slot, Discrete Input: 20-point, AC/DC, Discrete Output: 16-point, sinking.
BX-DM1E-36ED23-D	BRX Do-more PLC, 12-24 VDC required, Ethernet and serial ports, microSD card slot, Discrete Input: 20-point, AC/DC, Analog Input: 4-channel, current/voltage, Discrete Output: 16-point, sourcing, Analog Output: 2-channel, current/voltage.
BX-DM1E-36ED13-D	BRX Do-more PLC, 12-24 VDC required, Ethernet and serial ports, microSD card slot, Discrete Input: 20-point, AC/DC, Analog Input: 4-channel, current/voltage, Discrete Output: 16-point, sinking, Analog Output: 2-channel, current/voltage.
BX-DM1-36ED2	BRX Do-more PLC, 120-240 VAC required, serial port, microSD card slot, Discrete Input: 20-point, AC/DC, Discrete Output: 16-point, sourcing.
BX-DM1-36ED1	BRX Do-more PLC, 120-240 VAC required, serial port, microSD card slot, Discrete Input: 20-point, AC/DC, Discrete Output: 16-point, sinking.
BX-DM1E-36ED23	BRX Do-more PLC, 120-240 VAC required, Ethernet and serial ports, microSD card slot, Discrete Input: 20-point, AC/DC, Analog Input: 4-channel, current/voltage, Discrete Output: 16-point, sourcing, Analog Output: 2-channel, current/voltage.
BX-DM1E-36ED13	BRX Do-more PLC, 120-240 VAC required, Ethernet and serial ports, microSD card slot, Discrete Input: 20-point, AC/DC, Analog Input: 4-channel, current/voltage, Discrete Output: 16-point, sinking, Analog Output: 2-channel, current/voltage.
Table continued next page.	

*Direct*LOGIC PLCs/Modules for Use with *Sure*Step Drive (1)	
DL05 PLCs	
D0-05AD	DL05 CPU, 8 AC in / 6 DC out, 110/220 VAC power supply. Inputs: 8 AC inputs, 90-120 VAC, 2 isolated commons. Outputs: 6 DC outputs, 6-27 VDC current sinking, 1.0 A/pt max, 1 common. Two outputs are configurable for independent CW/CCW pulse train output or step and direction pulse output up to 7kHz (0.5 A/pt.).
D0-05DD	DL05 CPU, 8 DC in / 6 DC out, 110/220 VAC power supply. Inputs: 8 DC inputs, 12-24 VDC current sinking/sourcing, 2 isolated commons. Outputs: 6 DC outputs, 6-27 VDC current sinking, 1.0 A/pt max, 1 common. Two outputs are configurable for independent CW/CCW pulse train output or step and direction pulse output up to 7kHz (0.5 A/pt) (not available when using high-speed inputs).
D0-05DD-D	DL05 CPU, 8 DC in / 6 DC out, 12/24 VDC power supply. Inputs: 8 DC inputs, 12-24 VDC current sinking/sourcing, 2 isolated commons. Outputs: 6 DC outputs, 6-27 VDC current sinking, 1.0 A/pt max, 1 common. Two outputs are configurable for independent CW/CCW pulse train output or step and direction pulse output up to 7kHz (0.5 A/pt.) (not available when using high-speed inputs).
DL06 PLCs	
D0-06DD1	DL06 CPU, 20 DC in / 16 DC out, 110/220 VAC power supply, with 0.3A 24 VDC auxiliary device power supply. Inputs: 20 DC inputs, 12-24 VDC current sinking/sourcing, 5 isolated commons (4 inputs per common). Outputs: 16 DC outputs, 12-24 VDC current sinking, 1.0A/pt max, 4 commons non-isolated (4 points per common). Two outputs are configurable for independent CW/CCW pulse train output or step and direction pulse output up to 10 kHz (0.5 A/pt) (not available when using high-speed inputs).
D0-06DD2	DL06 CPU, 20 DC in / 16 DC out, 110/220 VAC power supply, with 0.3A 24 VDC auxiliary device power supply. Inputs: 20 DC inputs, 12-24 VDC current sinking/sourcing, 5 isolated commons (4 inputs per common). Outputs: 16 DC outputs, 12-24 VDC current sourcing 1.0A/pt max, 4 commons non-isolated (4 points per common). Two outputs are configurable for independent CW/CCW pulse train output or step and direction pulse output up to 10 kHz (0.5 A/pt) (not available when using high-speed inputs).
D0-06DD1-D	DL06 CPU, 20 DC in / 16 DC out, 12/24 VDC power supply. Inputs: 20 DC inputs, 12-24 VDC current sinking/sourcing, 5 isolated commons (4 inputs per common). Outputs: 16 DC outputs, 12-24 VDC current sinking, 1.0 A/pt max, 4 commons non-isolated (4 pts/common). Two outputs are configurable for independent CW/CCW pulse train output or step and direction pulse output up to 10 kHz (0.5 A/pt) (not available when using high-speed inputs).
D0-06DD2-D	DL06 CPU, 20 DC in / 16 DC out, 12/24 VDC power supply. Inputs: 20 DC inputs, 12-24 VDC current sinking/sourcing, 5 isolated commons (4 inputs per common). Outputs: 16 DC outputs, 12-24VDC current sourcing, 1.0A/pt max, 4 commons non-isolated (4 pts/common). Two outputs are configurable for independent CW/CCW pulse train output or step and direction pulse output up to 10 kHz (0.5 A/pt) (not available when using high-speed inputs).
DL05/DL06 High Speed Counter I/O Module	
H0-CTRIO	DL05/06 High Speed Counter I/O Interface Module, 4 DC sink/source inputs 9-30 VDC, 2 isolated sink/source DC outputs, 5-30 VDC, 1A per point. Inputs supported: 1 quadrature encoder counters up to 100 kHz, or 2 single channel counters up to 100 kHz, and 2 high speed discrete inputs for Reset, Inhibit, or Capture. Outputs supported: 2 independently configurable high speed discrete outputs or 1 channel pulse output control, 20Hz-25kHz per channel, pulse and direction or CW/CCW pulses.
Table continued next page.	

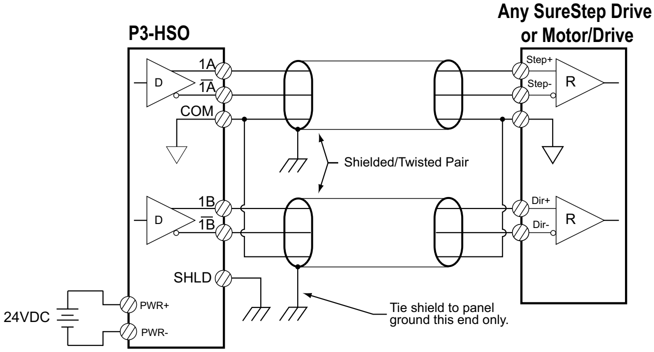
*Direct*LOGIC PLCs/Modules for Use with *Sure*Step Drive (1) (continued)	
DL105 PLCs	
F1-130AD	DL130 CPU, 10 AC in / 8 DC out, 110/220 VAC power supply. Inputs: 10 AC inputs, 80-132 VAC, 3 isolated commons. Outputs: 8 DC outputs, 5-30 VDC current sinking, 0.5A/pt max, 3 internally connected commons. Two outputs are configurable for independent CW/CCW pulse train output or step and direction pulse output up to 7kHz (@ 0.25 A/pt max).
F1-130DD	DL130 CPU, 10 DC in / 8 DC out, 110/220 VAC power supply. Inputs: 10 DC inputs, 12-24 VDC current sinking/sourcing, 3 isolated commons. Outputs: 8 DC outputs, 5-30 VDC current sinking, 0.5 A/pt max, 3 internally connected commons. Two outputs are configurable for independent CW/CCW pulse train output or step and direction pulse output up to 7kHz (@ 0.25 A/pt max) (not available when using high-speed inputs).
F1-130DD-D	DL130 CPU, 10 DC in / 8 DC out, 12/24 VDC power supply. Inputs: 10 DC inputs, 12-24 VDC current sinking/sourcing, 3 isolated commons. Outputs: 8 DC outputs, 5-30 VDC current sinking, 0.5 A/pt max, 3 internally connected commons. Two outputs are configurable for independent CW/CCW pulse train output or step and direction pulse output up to 7kHz (@ 0.25 A/pt max) (not available when using high-speed inputs).
DL205 and Do-More High Speed Counter I/O Modules	
H2-CTRIO2	DL205 High Speed Counter I/O Interface Module, 8 DC sink/source inputs 9-30 VDC, 4 isolated sink/source DC outputs, 5-30 VDC, 1A per point. Inputs supported: 2 quadrature encoder counters up to 100 kHz, or 4 single channel counters up to 100 kHz, and 4 high speed discrete inputs for Reset, Inhibit, or Capture. Outputs supported: 4 independently configurable high speed discrete outputs or 2 channels pulse output control, 20 Hz - 25 kHz per channel, pulse and direction or CW/CCW pulses.
D2-CTRINT	Counter Interface Module, 4 isolated DC inputs, 1 pulse train output (CW) or 2 pulse train outputs (CW/CCW) with DC input restrictions, accepts two up-counters when used with D2-240 or D2-250(-1) (one only with D2-230), or one up/down counter. (not available when using high-speed inputs).
Terminator I/O High Speed Counter I/O Module	
T1H-CTRIO	Terminator I/O High Speed Counter I/O Interface Module, 8 DC sink/source inputs 9-30 VDC, 4 isolated sink/source DC outputs, 5-30 VDC, 1A per point. Inputs supported: 2 quadrature encoder counters up to 100 kHz, or 4 single channel counters up to 100 kHz, and 4 high speed discrete inputs for Reset, Inhibit, or Capture. Outputs supported: 4 independently configurable high speed discrete outputs or 2 channels pulse output control, 20 Hz - 25 kHz per channel, pulse and direction or CW/CCW pulses. (Use with T1K-16B or T1K-16B-1 terminal base.)
DL405 High Speed Counter I/O Module	
H4-CTRIO	DL405 High Speed Counter I/O Interface Module, 8 DC sink/source inputs 9-30 VDC, 4 isolated sink/source DC outputs, 5-30 VDC, 1A per point. Inputs supported: 2 quadrature encoder counters up to 100 kHz, or 4 single channel counters up to 100 kHz, and 4 high speed discrete inputs for Reset, Inhibit, or Capture. Outputs supported: 4 independently configurable high speed discrete outputs or 2 channels pulse output control, 20 Hz - 25 kHz per channel, pulse and direction or CW/CCW pulses.

(1) Any DirectLOGIC PLC capable of RS-232 ASCII communication can write serial commands to the SureStep Advanced Microstepping Drives (STP-DRV-4850 & -80100). These PLCs include DL 05, 06, 250-1, 260, 350, and 450/454. However, we strongly recommend using DL06 or DL260 PLCs for serial commands due to their more advanced ASCII instruction set which includes PRINTV and VPRINT commands.

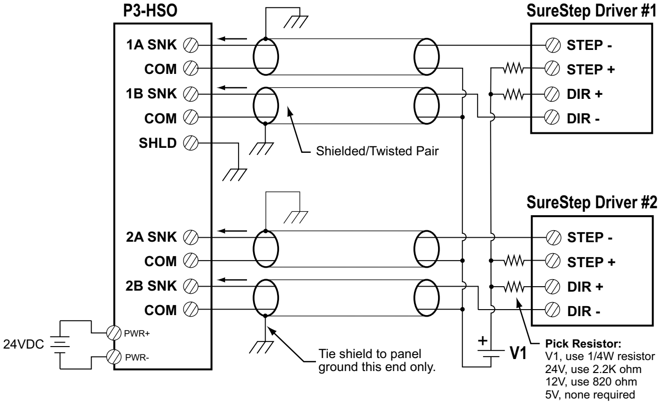
Typical Connections to a Productivity PLC

The following wiring diagrams show typical connections between any SureStep Drive or Integrated motor/drive and a Productivity P3-HSO or P2-HSO (wiring is identical). All SureStep drives can be wired for Line Driver signals (preferred for noise immunity) or Open Collector. Refer to the Productivity User Manual for detailed programming instructions when using the HSO module.

Line Driver/Differential Wiring (preferred)



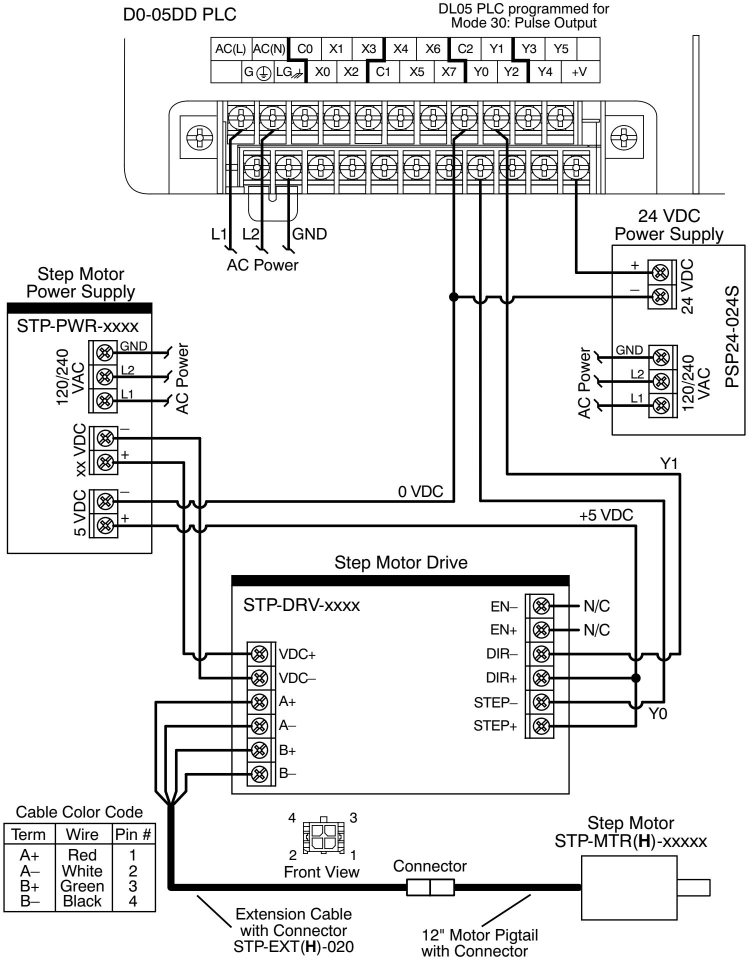
Open Collector/Single-ended wiring



A voltage dropping resistor is only needed if the PLC cannot generate 5VDC high speed pulses and the drive can only accept 5VDC pulses. These resistor values result in a 10mA signal [Amps = Volts/(internal drive R + external R)]. Other values can be used, but ensure that [5mA < signal current < 15mA]. See the individual drive chapters for more information.

Typical Connections to a DL05 PLC

The following wiring diagram shows typical connections between the *Sure*Step Stepping System components and a *Direct*LOGIC DL05 PLC. Refer to the DL05 Micro PLC User Manual, p/n D0-USER-M, High-Speed Input and Pulse Output Features chapter, for detailed programming instructions when using the PLC for the Mode 30: Pulse Output function.

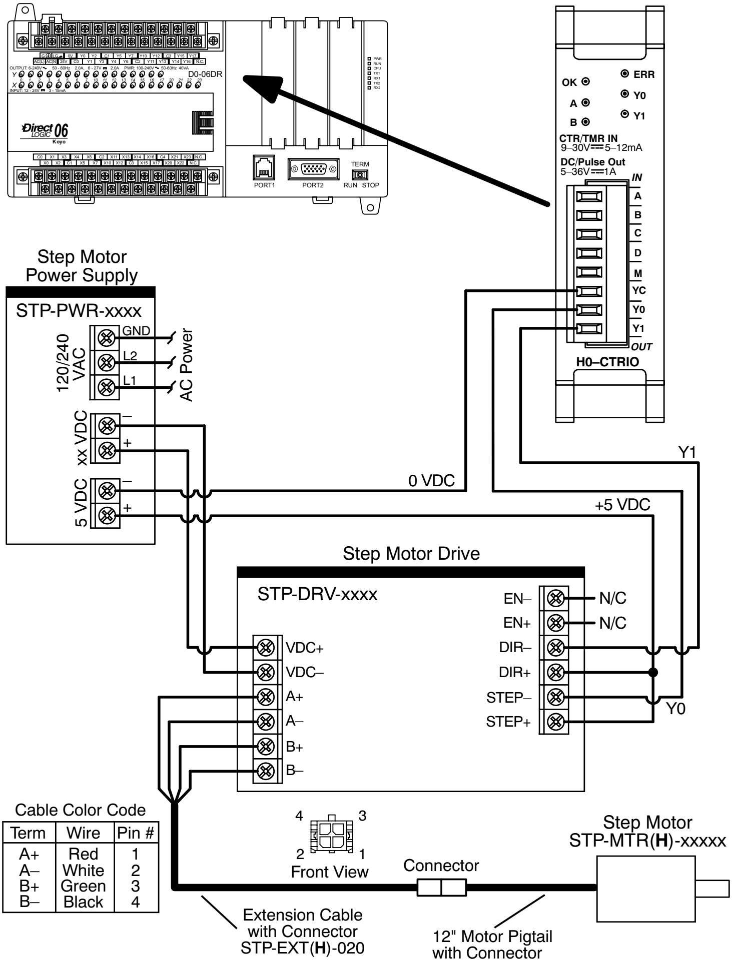


Cable Color Code

Term	Wire	Pin #
A+	Red	1
A–	White	2
B+	Green	3
B–	Black	4

Typical Connections to an H0-CTRIO

The following wiring diagram shows typical connections between the *Sure*Step Stepping System components and a *Direct*LOGIC H0-CTRIO High Speed Counter I/O Interface Module installed in either a DL05 or DL06 PLC option slot. Refer to the CTRIO High-Speed Counter Module User Manual, p/n Hx-CTRIO-M, for detailed programming instructions when using the H0-CTRIO module.

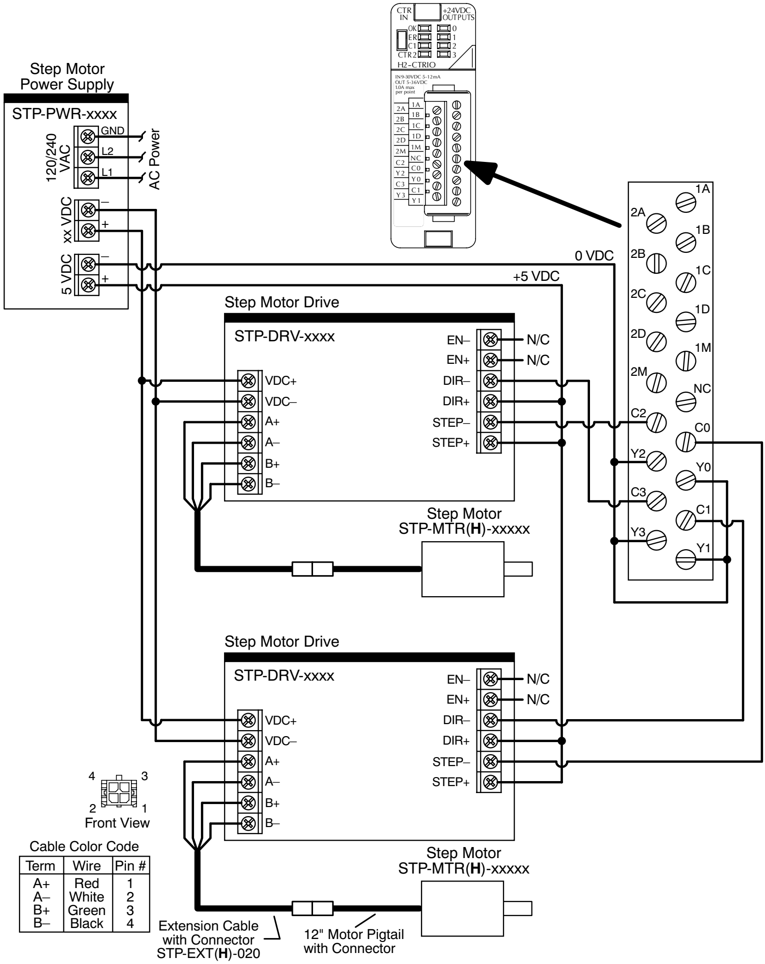


Cable Color Code

Term	Wire	Pin #
A+	Red	1
A–	White	2
B+	Green	3
B–	Black	4

Typical Connections – Multiple Drives/Motors

The following wiring diagram shows typical connections between the *Sure*Step Stepping System components and a *Direct*LOGIC H2-CTRIO(2) High Speed Counter I/O Interface Module installed in a DL205 PLC. Refer to the CTRIO High-Speed Counter Module User Manual, p/n Hx-CTRIO-M, for detailed programming instructions when using the H2-CTRIO module.



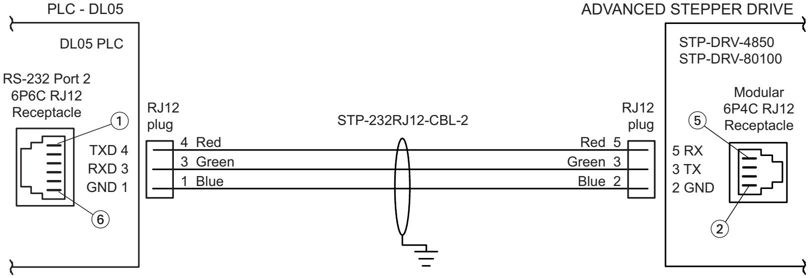
Cable Color Code

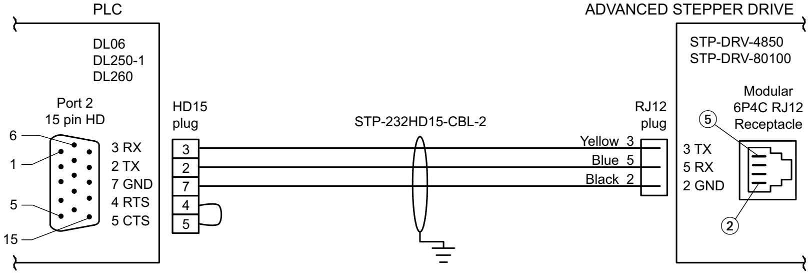
Term	Wire	Pin #
A+	Red	1
A–	White	2
B+	Green	3
B–	Black	4

Typical *Direct*LOGIC PLC RS-232 Serial Connections to an Advanced SureStep Drive

The following wiring diagrams show typical serial connections between a *Sure*Step Advanced Microstepping Drive and a *Direct*LOGIC PLC capable of RS-232 ASCII communication. Refer to the particular PLC user manual for instructions for writing ASCII serial commands.

Serial Connection Using Automation Direct Cables





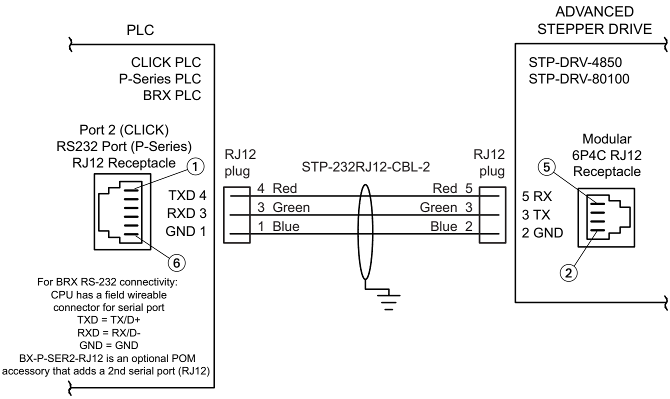
Serial Connection Using Custom Cables

Use Belden 9841 or equivalent cable, and wire according to the Automation Direct cable diagrams shown above (including RTS/CTS jumper for DL06, DL250-1, and DL260).

Typical CLICK, P-Series, & BRX PLC RS-232 Serial Connections to an Advanced SureStep Drive

The following wiring diagrams show typical serial connections between a *Sure*Step Advanced Microstepping Drive and a CLICK, BRX, or P1/P2/P3 PLC capable of RS-232 ASCII communication. Refer to the particular PLC user manual for instructions for writing ASCII serial commands.

Serial Connection Using Automation Direct Cables



Serial Connection Using Custom Cables

Use Belden 9841 or equivalent cable, and wire according to the Automation Direct STP-232RJ12-CBL-2 diagram shown above.

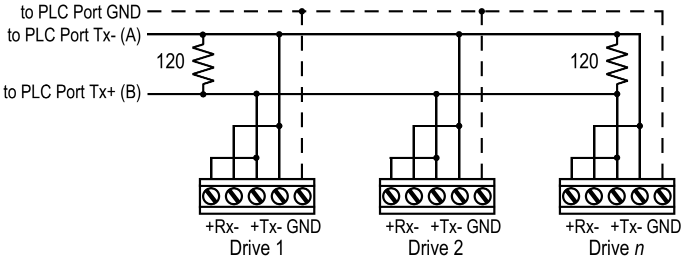
Typical RS-485 Connections to Integrated Motor/Drives

Most AutomationDirect PLCs support 2-wire RS-485 serial communication (3 wires on the connector: Transmit (+), Receive (-), and Ground). For 2-wire communication, the integrated motor/drive must have its Tx+ and Rx+ connected; and Tx- and Rx- connected.

The drive's Tx+/Rx+ signal should be connected to the "+" connection of the PLC's RS-485 port.

The drive's Tx-/Rx- signal should be connected to the "-" connection of the PLC's RS-485 port.

The drive's RS-485 ground terminal should be connected to the PLC's serial port ground terminal.



RS-485 2-wire System

Terminal Connections per PLC			
Drive Connection	**CLICK**	**P-Series**	**BRX**
Tx+, Rx+	+	+	TX/D+
Tx-, Rx-	–	–	RX/D-
GND	LG	G	GND

SELECTING THE SureStep™ STEPPING SYSTEM

APPENDIX C

In This Appendix...

Selecting the SureStep™ Stepping System

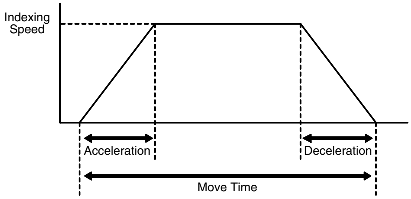
The selection of your SureStep™ stepping system follows a defined process. Let's go through the process and define some useful relationships and equations. We will use this information to work some typical examples along the way.

The Selection Procedure

The motor provides for the required motion of the load through the actuator (mechanics that are between the motor shaft and the load or workpiece). Key information to accomplish the required motion is:

- total number of pulses from the PLC
- positioning resolution of the load
- indexing speed (or PLC pulse frequency) to achieve the move time
- required motor torque (including the 100% safety factor)
- load to motor inertia ratio

In



the final analysis, we need to achieve the required motion with acceptable positioning accuracy.

How many pulses from the PLC to make the move?

The total number of pulses to make the entire move is expressed with the equation:

Equation ①: P_{total} = total pulses = $(D_{total} \div (d_{load} \div i)) \times \theta_{step}$

D_{total} = total move distance

d_{load} = lead or distance the load moves per revolution of the actuator's drive shaft
(P = pitch = $1/d_{load}$)

θ_{step} = driver step resolution ($steps/rev_{motor}$)

i = gear reduction ratio ($rev_{motor}/rev_{gearshaft}$)

Example 1: The motor is directly attached to a disk, the stepping driver is set at 400 steps per revolution and we need to move the disk 5.5 revolutions. How many pulses does the PLC need to send the driver?

P_{total} = $(5.5\ rev_{disk} \div (1\ rev_{disk}/rev_{driveshaft} \div 1\ rev_{motor}/rev_{driveshaft}))$
$\times\ 400\ steps/rev_{motor}$
= 2200 pulses

Example 2: The motor is directly attached to a ballscrew where one turn of the ballscrew results in 10 mm of linear motion, the stepping driver is set for 1000 steps per revolution, and we need to move 45 mm. How many pulses do we need to send the driver?

$\mathbf{P_{total}}$ = (45 mm ÷ (10 mm/rev$_{screw}$ ÷ 1 rev$_{motor}$/rev$_{screw}$)) x 1000 steps/rev$_{motor}$
= 4500 pulses

Example 3: Let's add a 2:1 belt reduction between the motor and ballscrew in example 2. Now how many pulses do we need to make the 45 mm move?

$\mathbf{P_{total}}$ = (45 mm ÷ (10mm/rev$_{screw}$ ÷ 2 rev$_{motor}$/rev$_{screw}$)) x 1000 steps/rev$_{motor}$
= 9000 pulses

What is the positioning resolution of the load?

We want to know how far the load will move for one pulse or step of the motor shaft. The equation to determine the positioning resolution is:

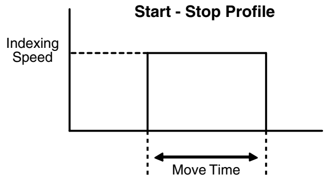
Equation ②: L_θ = load positioning resolution = (d_{load} ÷ i) ÷ θ_{step}

Example 4: What is the positioning resolution for the system in example 3?

$L_\theta = (\mathbf{d_{load}} \div \mathbf{i}) \div \theta_{step}$
= (10 mm/rev$_{screw}$ ÷ 2 rev$_{motor}$/rev$_{screw}$) ÷ 1000 steps/rev$_{motor}$
= 0.005mm/step
≈ 0.0002in/step

What is the indexing speed to accomplish the move time?

The most basic type of motion profile is a "start-stop" profile where there is no acceleration or deceleration period. This type of motion profile is only used for low speed applications because the load is "jerked" from one speed to another and the stepping motor will stall or drop pulses if excessive speed changes are attempted. The equation to find indexing speed for "start-stop" motion is:



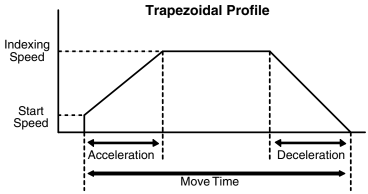
Equation ③: f_{SS} = indexing speed for start-stop profiles = P_{total} ÷ t_{total}

$\mathbf{t_{total}}$ = move time

Example 5: What is the indexing speed to make a "start-stop" move with 10,000 pulses in 800 ms?

$\mathbf{f_{SS}}$ = indexing speed = $\mathbf{P_{total}} \div \mathbf{t_{total}}$ = 10,000 pulses ÷ 0.8 seconds
= 12,500 Hz

For higher speed operation, the "trapezoidal" motion profile includes controlled acceleration & deceleration and an initial non-zero starting speed. With the acceleration and deceleration periods equally set, the indexing speed can be found using the equation:



Equation ④: $\mathbf{f_{TRAP} = (P_{total} - (f_{start} \times t_{ramp})) \div (t_{total} - t_{ramp})}$
for trapezoidal motion profiles

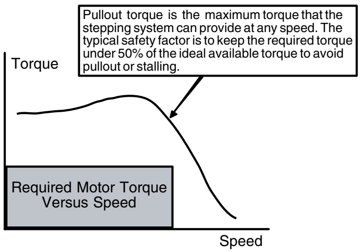
$\mathbf{f_{start}}$ = starting speed
$\mathbf{t_{ramp}}$ = acceleration or deceleration time

Example 6: What is the required indexing speed to make a "trapezoidal" move in 800ms, accel/decel time of 200 ms each, 10,000 total pulses, and a starting speed of 40 Hz?

$\mathbf{f_{TRAP}}$ = (10,000 pulses - (40 pulses/sec x 0.2 sec)) ÷ (0.8 sec - 0.2 sec)
≈ 16,653 Hz

Calculating the Required Torque

The required torque from the stepping system is the sum of acceleration torque and the running torque. The equation for required motor torque is:



Equation ⑤: $\mathbf{T_{motor} = T_{accel} + T_{run}}$

$\mathbf{T_{accel}}$ = motor torque required to accelerate and decelerate the total system inertia (including motor inertia)

$\mathbf{T_{run}}$ = constant motor torque requirement to run the mechanism due to friction, external load forces, etc.

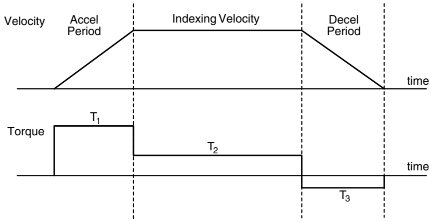
In **Table 1** we show how to calculate torque required to accelerate or decelerate an inertia from one speed to another and the calculation of running torque for common mechanical actuators.

Table 1 – Calculate the Torque for "Acceleration" and "Running"

The torque required to accelerate or decelerate an inertia with a linear change in velocity is:

Equation ⑥: $T_{accel} = J_{total} \times (\Delta speed \div \Delta time) \times (2\pi \div 60)$

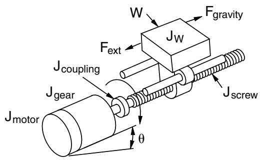
J_{total} is the motor inertia, plus load inertia ("reflected" to the motor shaft). The $(2\pi \div 60)$ is a factor used to convert "change in speed" expressed in RPM into angular speed (radians/ second). Refer to information in this table to calculate "reflected" load inertia for several common shapes and mechanical mechanisms.



Example 7: What is the required torque to accelerate an inertia of 0.002 lb·in·sec^2 (motor inertia is 0.0004 lb·in·sec^2 and "reflected" load inertia is 0.0016 lb·in·sec^2) from zero to 600 RPM in 50 ms?

T_{accel} = 0.002 lb·in·sec^2 x (600 RPM ÷ 0.05 seconds) x $(2\pi \div 60)$
≈ 2.5 lb·in

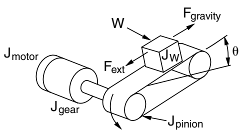
Leadscrew Equations

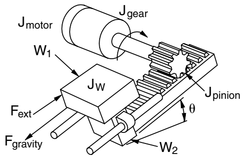


Description:	Equations:
Motor RPM	$n_{motor} = (v_{load} \times P) \times i$, n_{motor} (RPM), v_{load} (in/min)
Torque required to accelerate and decelerate the load	$T_{accel} \approx J_{total} \times (\Delta speed \div \Delta time) \times 0.1$
Motor total inertia	$J_{total} = J_{motor} + J_{gear} + ((J_{coupling} + J_{screw} + J_W) \div i^2)$
Inertia of the load	$J_W = (W \div (g \times e)) \times (1 \div 2 \pi P)^2$
Pitch and Efficiency	P = pitch = revs/inch of travel, e = efficiency
Running torque	$T_{run} = ((F_{total} \div (2 \pi P)) + T_{preload}) \div i$
Torque due to preload on the ballscrew	$T_{preload}$ = ballscrew nut preload to minimize backlash
Force total	$F_{total} = F_{ext} + F_{friction} + F_{gravity}$
Force of gravity and Force of friction	$F_{gravity} = W\sin\theta$, $F_{friction} = \mu W\cos\theta$
Incline angle and Coefficient of friction	θ = incline angle, μ = coefficient of friction

Table 1 (cont'd)			
Typical Leadscrew Data			
Material:	**e = efficiency**	**Material:**	**μ = coef. of friction**
ball nut	0.90	steel on steel	0.580
acme with plastic nut	0.65	steel on steel (lubricated)	0.150
acme with metal nut	0.40	teflon on steel	0.040
		ball bushing	0.003

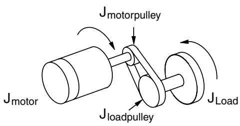
Belt Drive (or Rack & Pinion) Equations

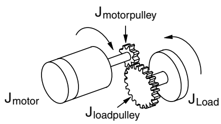




Description:	Equations:
Motor RPM	$n_{motor} = (v_{load} \times 2\pi r) \times i$
Torque required to accelerate and decelerate the load	$T_{accel} \approx J_{total} \times (\Delta speed \div \Delta time) \times 0.1$
Inertia of the load	$J_{total} = J_{motor} + J_{gear} + ((J_{pinion} + J_W) \div i^2)$
Inertia of the load	$J_W = (W \div (g \times e)) \times r^2$; $J_W = ((W_1 + W_2) \div (g \times e)) \times r^2$
Radius of pulleys	r = radius of pinion or pulleys (inch)
Running torque	$T_{run} = (F_{total} \times r) \div i$
Force total	$F_{total} = F_{ext} + F_{friction} + F_{gravity}$
Force of gravity and Force of friction	$F_{gravity} = W\sin\theta$; $F_{friction} = \mu W\cos\theta$

Belt (or Gear) Reducer Equations

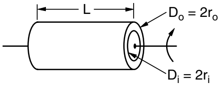




Description:	Equations:
Motor RPM	$n_{motor} = n_{load} \times i$
Torque required to accelerate and decelerate the load	$T_{accel} \approx J_{total} \times (\Delta speed \div \Delta time) \times 0.1$
Inertia of the load	$J_{total} = J_{motor} + J_{motorpulley} + ((J_{loadpulley} + J_{Load}) \div i^2)$
Motor torque	$T_{motor} \times i = T_{Load}$

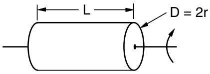
Table 1 (cont'd)

Inertia of Hollow Cylinder Equations



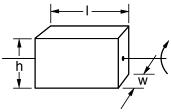
Description:	Equations:
Inertia	$J = (W \times (r_o^2 + r_i^2)) \div (2g)$
Inertia	$J = (\pi \times L \times \rho \times (r_o^4 - r_i^4)) \div (2g)$
Volume	$\text{volume} = \pi/4 \times (D_o^2 - D_i^2) \times L$

Inertia of Solid Cylinder Equations



Description:	Equations:
Inertia	$J = (W \times r^2) \div (2g)$
Inertia	$J = (\pi \times L \times \rho \times r^4) \div (2g)$
Volume	$\text{volume} = \pi \times r^2 \times L$

Inertia of Rectangular Block Equations



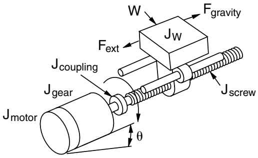
Description:	Equations:
Inertia	$J = (W \div 12g) \times (h^2 + w^2)$
Volume	$\text{volume} = l \times h \times w$

Symbol Definitions

J = inertia	ρ = density
L = Length	ρ = 0.098 lb/in^3 (aluminum)
h = height	ρ = 0.28 lb/in^3 (steel)
w = width	ρ = 0.04 lb/in^3 (plastic)
W = weight	ρ = 0.31 lb/in^3 (brass)
D = diameter	ρ = 0.322 lb/in^3 (copper)
r = radius	
g = gravity = 386 in/sec^2	$\pi \approx 3.14$

Leadscrew – Example Calculations

Step 1 – Define the Actuator and Motion Requirements



Weight of table and workpiece = 200 lb, where W = 200 lb
Angle of inclination = 0°
Friction coefficient of sliding surfaces = 0.05, where μ = 0.05
External load force = 0
Ball screw shaft diameter = 0.6 inch
Ball screw length = 23.6 inch
Ball screw material = steel
Ball screw lead = 0.6 inch/rev, where P = 1/0.6 = 1.67 rev/in
Desired Resolution = 0.001 inch/step
Gear reducer = 2:1, where i = 2, preliminary (for the 3:1 example, i = 3)
Stroke = 4.5 inch
Move time = 1.7 seconds
Acceleration time = Deceleration time = 0.425 sec / 2 = 212.5 ms
Lead screw efficiency = 0.9, where e = 0.9
Coupling and gear reducer inertias are negligible, which are considered to be 0

Definitions
d_{load} = lead or distance the load moves per revolution of the actuator's drive shaft (P = pitch = 1/d_{load})
D_{total} = total move distance
θ_{step} = driver step resolution (steps/rev_{motor})
i = gear reduction ratio (rev_{motor}/$rev_{gearshaft}$)
T_{accel} = motor torque required to accelerate and decelerate the total system inertia (including motor inertia)
T_{run} = constant motor torque requirement to run the mechanism due to friction, external load forces, etc.
t_{total} = move time
Start frequency = 20 Hz (as defined with a Module H0-CTRIO

Step 2 – Determine the Positioning Resolution of the Load

One revolution of the lead screw shaft advances 0.6 inches. We are looking for a 0.001 inch per step precision.

Check to see if 400 pulses/rev will achieve the desired precision:

With a reduction of 2:1, there will be two motor shaft revolutions to get a displacement of 0.6 inches.

(2 rev) x (400 pulses/rev) = 800 pulses for every 0.6 inches of displacement.

Therefore, (0.6 in) / (800 pulses) = 0.00075 in/pulse.

This is within the desired 0.001 in/step.

How many pulses are needed for the displacement?

With the 2:1 gear reduction, the stepping system can be set at 400 steps/rev to exceed the required load positioning resolution.

Since the lead screw advances 0.6 inches / rev, in the required stroke of 4.5 inches we will need:
(4.5 in) / (0.6 rev/in) = 7.5 revolutions on the lead screw

Since we have a reduction of 2:1, the motor shaft shall rotate 15 revolutions.

Step 3 – Determine the Motion Profile

Since we know that 400 pulses gets one revolution on the motor and we need 15 revolutions, then 400 x 15 = 6,000 pulses to move 4.5 inches.

From **Equation** ④, the indexing frequency for a trapezoidal move is:

$$f_{TRAP} = (P_{total} - (f_{start} \times t_{ramp})) \div (t_{total} - t_{ramp})$$
$$= (6{,}000 - (20 \times 0.425s)) \div (1.7 - 0.425) = 4{,}699 \text{ Hz},$$

where the starting speed is 20 Hz

(4,699 Hz) / (400 steps/rev) = 11.7475 rev/s

To get it in rpm, (11.7475 rev/s) x (60 s/min) = 704.85 rpm.

Step 4 – Determine the Required Motor Torque

Using the equations in **Table 1**:
(Total inertia seen by the motor is the sum of all inertias)

$$J_{total} = J_{motor} + J_{gear} + ((J_{coupling} + J_{screw} + J_W) \div i^2)$$

For this example, we assume the gearbox and coupling inertias are zero.

Load inertia:

$$J_W = (W \div (g \times e)) \times (1 \div 2\pi P)^2$$
$$= (200 \div (386 \times 0.9)) \times (1 \div 2 \times 3.1416 \times 1.67)^2$$
$$= 0.00523 \text{ lb·in·sec}^2$$

Lead screw inertia:

$$J_{screw} = (\pi \times L \times \rho \times r^4) \div (2g)$$
$$= (3.1416 \times 23.6 \times 0.28 \times 0.3^4) \div (2 \times 386)$$
$$= 0.0002178 \text{ lb·in·sec}^2$$

The inertia of the load and screw reflected to the motor is the sum of both values divided by the square of the reduction ratio

$$J_{(screw + load)\ referred\ to\ motor} = ((J_{screw} + J_W) \div i^2)$$

$$J_{total\ less\ the\ motor\ inertia} = ((0.0002178 + 0.00523) \div 2^2) = 0.001362 \text{ lb·in·sec}^2$$

The dynamic torque required to accelerate the inertia (without the motor rotor inertia) is:

$T_{accel} = J_{total} \times ((\Delta_{rpm} \div \Delta_{time}) \times (2\pi \div 60))$
$= 0.001362 \times ((704.85 \div 0.2125) \times (2 \times 3.1416 \div 60))$
$= 0.474309$ lb·in

Determine the running torque, or in this case the friction torque:

The forces are:

$F_{total} = F_{ext} + F_{friction} + F_{gravity}$ [External forces and gravity are zero in this case.]
$= 0 + (\mu \times W \times \cos\theta) + 0$
$= 0.05 \times 200 = 10$ lb

And the formula to be used is:

$T_{run} = ((F_{total} \div (2\pi P)) + T_{preload}) \div i$
$= (10 \div (2 \times 3.1416 \times 1.67)) \div 2$ [related to the motor side]
$= 0.4765$ lb·in [where, we have assumed the preload torque to be zero]

From **Equation** ⑤, the minimum required motor torque @ 704.85 rpm is:

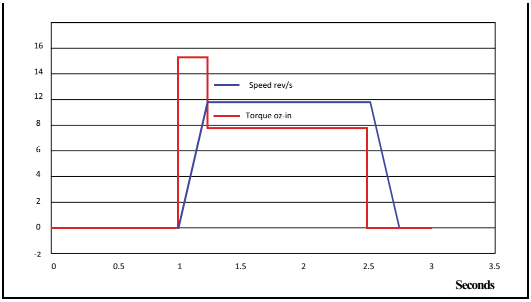
$T_{motor} = T_{accel} + T_{run}$
$= (0.474309$ lb·in$) + (0.4765$ lb·in$)$
$= 0.9508$ lb·in, or 15.21 oz·in

However, this is the required motor torque before we have picked a motor and included the motor inertia.

Step 5 – Select & Confirm the Stepping Motor & Driver System

There are two commonly used criteria to select a motor and drive:

- Take into account the calcluated torque. From step 4, we find we need 15.21 oz·in.
- Per a rule of thumb, the load to motor inertia ratio should be kept below 10.
- In step 4 we calculated that the $J_{(screw + load)} = 0.001362$ lb·in·sec^2. To find the ratio, we use the formula: $J_{(screw + load)} \div J_{motor}$ The inertia of the motor is found in the motor specifications sheet.



We will check the criteria with 2 motors:

Figure 2 shows the Torque vs. Speed curves for STP-MTR-17040 and figure 3 shows STP-MTR-17048. We use this as an example to observe how different power supply voltages affect the torque output of a motor.

Consider STP-MTR-17040:

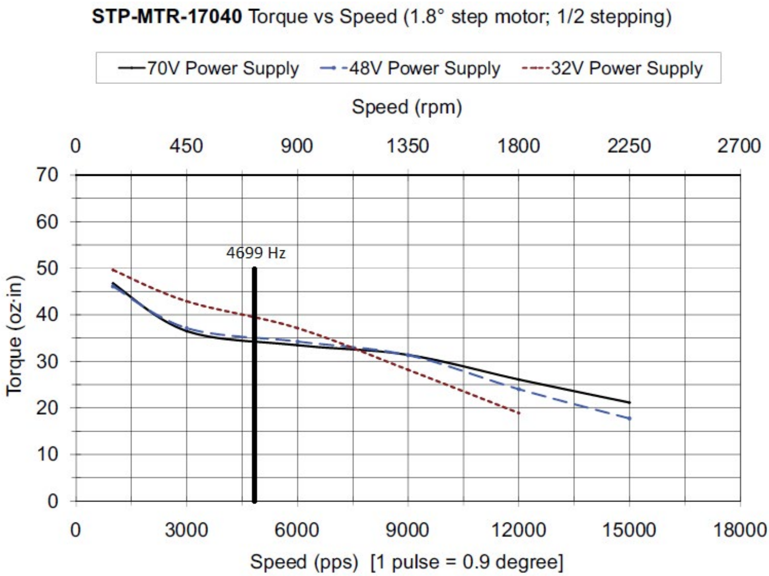


Figure 2: Torque for STP-MTR-17040 at 4.7 kHz

According to the torque/speed curves for this motor, the torque at 4.7 kHz is approximately 39 oz·in at 48VDC and 34 oz·in at 70VDC. Based on the torque, this motor meets the desired 15.21 oz·in with any power supply.

The rotor intertia, per the motor specification is 0.28 oz·in^2 or 0.0000454 lb·in·sec^2.

Load/Motor inertia ratio:

$\mathbf{J_{(screw\ +\ load)} \div J_{motor}}$ = 0.001362 lb·in·sec^2 ÷ 0.0000454 lb·in·sec^2

= 30

The ratio of 30 is well above the desired ratio of 10, so the STP-MTR-17040 motor is not suitable.

Consider STP-MTR-17048:

STP-MTR-17048 Torque vs Speed (1.8° step motor; 1/2 stepping)

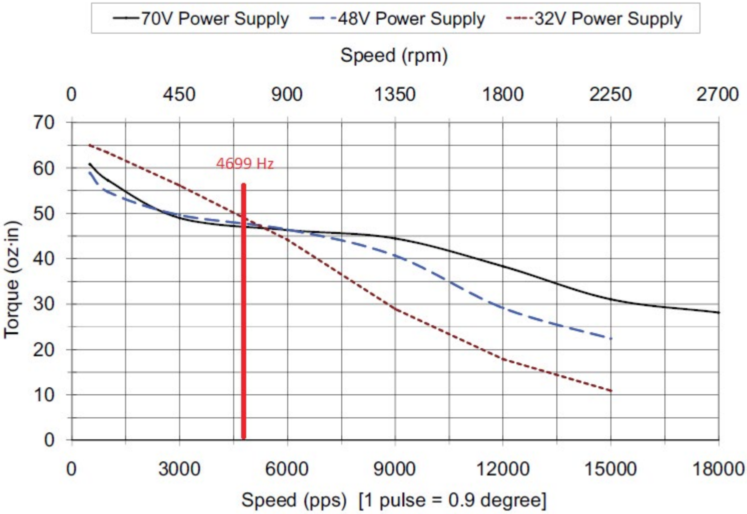


Figure 3: Torque for STP-MTR-17048 at 4.7 kHz

For the purpose of this example, the torque vs. speed curves for this motor at 4.7 kHz will be approximately 48 oz·in at 48VDC, and 46 oz·in at 70VDC. This motor also meets the desired 15.21 oz·in requirement.

The rotor intertia, per the motor specification is 0.45 oz·in^2 or 0.000024 lb·in·sec^2.

Load/Motor inertia ratio:

$\mathbf{J_{(screw\ +\ load)} \div J_{motor}} = 0.001362$ lb·in·sec^2 $\div$ 0.000024 lb·in·sec^2

= 18.683

The ratio of 18.683 is still above the desired ratio of 10, so the STP-MTR-17048 motor is not suitable.

We can keep increasing the motor size, or maybe change the reflected load inertia by changing the reduction ratio from 2:1 to 3:1.

Reduction Ratio 3:1 (Step 2 revisited) – Determine the Positioning Resolution of the Load

One revolution of the lead screw shaft advances 0.6 inches. We are looking for a 0.001 inch per step precision.

Check to see if 400 pulses/rev will achieve the desired precision:

With a reduction of 3:1, there will be three motor shaft revolutions to get a displacement of 0.6 inches.

(3 rev) x (400 pulses/rev) = 1200 pulses for every 0.6 inches of displacement.

Therefore, (0.6 in) / (1200 pulses) = 0.0005 in/pulse.

This is within the desired 0.001 in/step.

How many pulses are needed for the displacement?

With the 3:1 gear reduction, the stepping system can be set at 400 steps/rev to exceed the required load positioning resolution.

Since the lead screw advances 0.6 inches / rev, in the required stroke of 4.5 inches we will need:

(4.5 in) / (0.6 rev/in) = 7.5 revolutions on the lead screw

Since we have a reduction of 3:1, the motor shaft shall rotate 22.5 revolutions.

Reduction Ratio 3:1 (Step 3 revisited) – Determine the Motion Profile

Since we know that 400 pulses gets one revolution on the motor and we need 22.5 revolutions, then 400 x 22.5 = 9,000 pulses to move 4.5 inches.

From **Equation** ④, the indexing frequency for a trapezoidal move is:

$$\mathbf{f_{TRAP} = (P_{total} - (f_{start} \times t_{ramp})) \div (t_{total} - t_{ramp})}$$
$$= (9{,}000 - (20 \times 0.425s)) \div (1.7 - 0.425) = 8{,}991.5 \text{ Hz},$$

where the starting speed is 20Hz

(8,991.5 Hz) / (400 steps/rev) = 22.48 rev/s

To get it in rpm, (22.48 rev/s) x (60 s/min) = 1349 rpm.

Reduction Ratio 3:1 (Step 4 revisited) – Determine the Required Motor Torque

Using the equations in **Table 1**:
(Total inertia seen by the motor is the sum of all inertias)

$$J_{total} = J_{motor} + J_{gear} + ((J_{coupling} + J_{screw} + J_W) \div i^2)$$

For this example, we assume the gearbox and coupling inertias are zero.

Load inertia:

$$\mathbf{J_W = (W \div (g \times e)) \times (1 \div 2\pi P)^2}$$
$$= (200 \div (386 \times 0.9)) \times (1 \div 2 \times 3.1416 \times 1.67)^2$$
$$= 0.00523 \text{ lb·in·sec}^2$$

Lead screw inertia:

$$\mathbf{J_{screw} = (\pi \times L \times \rho \times r^4) \div (2g)}$$
$$= (3.1416 \times 23.6 \times 0.28 \times 0.3^4) \div (2 \times 386)$$
$$= 0.0002178 \text{ lb·in·sec}^2$$

The inertia of the load and screw reflected to the motor is the sum of both values divided by the square of the reduction ratio

$$\mathbf{J_{(screw + load)\ referred\ to\ motor} = ((J_{screw} + J_W) \div i^2)}$$

$$J_{total\ less\ the\ motor\ inertia} = ((0.0002178 + 0.00523) \div 3^2) = 0.000605 \text{ lb·in·sec}^2$$

The dynamic torque required to accelerate the inertia (without the motor rotor inertia) is:

$$\mathbf{T_{accel} = J_{total} \times ((\Delta_{rpm} \div \Delta_{time}) \times (2\pi \div 60))}$$
$$= 0.000605 \times ((1349 \div 0.2125) \times (2 \times 3.1416 \div 60))$$
$$= 0.4022 \text{ lb·in}$$

Determine the running torque, or in this case the friction torque:

The forces are:

$\mathbf{F_{total} = F_{ext} + F_{friction} + F_{gravity}}$ [External forces and gravity are zero in this case.]

$= 0 + (\mu \times W \times \cos\theta) + 0$

$= 0.05 \times 200 = 10$ lb

And the formula to be used is:

$\mathbf{T_{run} = ((F_{total} \div (2\pi P)) + T_{preload}) \div i}$

$= (10 \div (2 \times 3.1416 \times 1.67)) \div 3$ [related to the motor side]

$= 0.3177$ lb·in [where, we have assumed the preload torque to be zero]

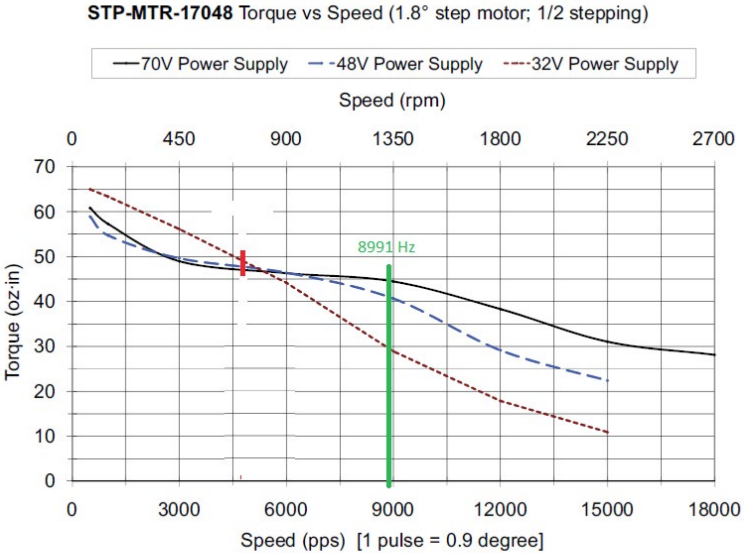
From **Equation** ⑤, the minimum required motor torque @ 1349 rpm is:

$\mathbf{T_{motor} = T_{accel} + T_{run}}$

$= (0.4022$ lb·in$) + (0.3177$ lb·in$)$

$= 0.7199$ lb·in, or 11.51 oz·in

Consider STP-MTR-17048 with the new values:



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kHz will be approximately 26 oz·in at 32VDC and 44 oz·in at 70VDC. Based on the torque, this motor meets the desired 11.51 oz·in requirement.

The rotor intertia, per the motor specification is 0.45 oz·in^2 or 0.000024 lb·in·sec^2.

Load/Motor inertia ratio:

$\mathbf{J_{(screw\ +\ load)}} \div \mathbf{J_{motor}}$ = 0.00605 lb·in·sec^2 ÷ 0.000024 lb·in·sec^2

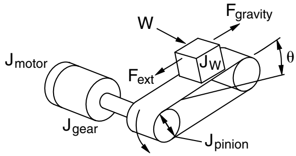
= 2.52

The ratio of 2.52 is below the desired ratio of 10, so the STP-MTR-17048 motor is suitable.

A small change in the mechanical design allowed us to use the motor STP-MTR-17048. The torque in the point of operation is more than enough, and the ratio of intertia criteria is fulfilled with any level of voltage in the drive. To be sure the safety factor is high, it would be better to select a 48V power supply and drive.

Belt Drive – Example Calculations

Step 1 – Define the Actuator and Motion Requirements



Weight of table and workpiece = 3 lb
External force = 0 lb
Friction coefficient of sliding surfaces = 0.05
Angle of table = 0º
Belt and pulley efficiency = 0.8
Pulley diameter = 1.5 inch
Pulley thickness = 0.75 inch
Pulley material = aluminum
Desired Resolution = 0.001 inch/step
Gear Reducer = 5:1
Stroke = 50 inch
Move time = 4.0 seconds
Accel and decel time = 1.0 seconds

Definitions
d_{load} = lead or distance the load moves per revolution of the actuator's drive shaft (P = pitch = $1/d_{load}$)
D_{total} = total move distance
θ_{step} = driver step resolution ($steps/rev_{motor}$)
i = gear reduction ratio ($rev_{motor}/rev_{gearshaft}$)
T_{accel} = motor torque required to accelerate and decelerate the total system inertia (including motor inertia)
T_{run} = constant motor torque requirement to run the mechanism due to friction, external load forces, etc.
t_{total} = move time

Step 2 – Determine the Positioning Resolution of the Load

Rearranging **Equation** ④ to calculate the required stepping drive resolution:

$$\begin{aligned}\theta_{step} &= (\mathbf{d_{load}} \div \mathbf{i}) \div \mathbf{L_\theta}\\ &= ((3.14 \times 1.5) \div 5) \div 0.001\\ &= 942 \text{ steps/rev}\end{aligned}$$

where $\mathbf{d_{load}} = \pi \times$ Pulley Diameter.

With the 5:1 gear reduction, the stepping system can be set at 1000 steps/rev to slightly exceed the required load positioning resolution.

Reduction is almost always required with a belt drive, and a 5:1 planetary gearhead is common.

Step 3 – Determine the Motion Profile

From **Equation** ①, the total pulses to make the required move is:

$$\begin{aligned}\mathbf{P_{total}} &= (\mathbf{D_{total}} \div (\mathbf{d_{load}} \div \mathbf{i})) \times \theta_{step}\\ &= 50 \div ((3.14 \times 1.5) \div 5) \times 1000\\ &\approx 53{,}079 \text{ pulses}\end{aligned}$$

From **Equation** ④, the running frequency for a trapezoidal move is:

$$\begin{aligned}\mathbf{f_{TRAP}} &= (\mathbf{P_{total}} - (\mathbf{f_{start}} \times \mathbf{t_{ramp}})) \div (\mathbf{t_{total}} - \mathbf{t_{ramp}})\\ &= 53{,}079 \div (4 - 1)\\ &\approx 17{,}693 \text{ Hz}\end{aligned}$$

where accel time is 25% of total move time and starting speed is zero.

$$\begin{aligned}&= 17{,}693 \text{ Hz} \times (60 \text{ sec}/1 \text{ min}) \div 1000 \text{ steps/rev}\\ &\approx 1{,}062 \text{ RPM motor speed}\end{aligned}$$

Step 4 – Determine the Required Motor Torque

Using the equations in **Table 1**:

$$\mathbf{J_{total}} = \mathbf{J_{motor}} + \mathbf{J_{gear}} + ((\mathbf{J_{pulleys}} + \mathbf{J_W}) \div \mathbf{i}^2)$$

For this example, let's assume the gearbox inertia is zero.

$$\begin{aligned}\mathbf{J_W} &= (\mathbf{W} \div (g \times e)) \times r^2\\ &= (3 \div (386 \times 0.8)) \times 0.75^2\\ &\approx 0.0055 \text{ lb·in·sec}^2\end{aligned}$$

Pulley inertia (remember there are two pulleys) can be calculated as:

$$\mathbf{J_{pulleys}} \approx ((\pi \times L \times \rho \times r^4) \div (2g)) \times 2$$

$\approx ((3.14 \times 0.75 \times 0.098 \times 0.754) \div (2 \times 386)) \times 2$
≈ 0.00019 lb·in·sec²

The inertia of the load and pulleys reflected to the motor is:

$\mathbf{J}_{\mathbf{(pulleys + load) \ to \ motor}} = ((\mathbf{J}_{\mathbf{pulleys}} + \mathbf{J}_{\mathbf{W}}) \div \mathbf{i}^2)$
$\approx ((0.0055 + 0.00019) \div 52) \approx 0.00023$ lb·in·sec²

The torque required to accelerate the inertia is:

$\mathbf{T}_{\mathbf{acc}} \approx \mathbf{J}_{\mathbf{total}} \times (\Delta\text{speed} \div \Delta\text{time}) \times 0.1$
$= 0.00023 \times (1062 \div 1) \times 0.1$
$= 0.025$ lb·in

$\mathbf{T}_{\mathbf{run}} = (\mathbf{F}_{\mathbf{total}} \times \mathbf{r}) \div \mathbf{i}$

$\mathbf{F}_{\mathbf{total}} = \mathbf{F}_{\mathbf{ext}} + \mathbf{F}_{\mathbf{friction}} + \mathbf{F}_{\mathbf{gravity}}$
$= 0 + \mu W\cos\theta + 0 = 0.05 \times 3 = 0.15$ lb

$\mathbf{T}_{\mathbf{run}} = (0.15 \times 0.75) \div 5$
≈ 0.0225 lb·in

From **Equation** ⑤, the required motor torque is:

$\mathbf{T}_{\mathbf{motor}} = \mathbf{T}_{\mathbf{accel}} + \mathbf{T}_{\mathbf{run}} = 0.025 + 0.0225 \approx 0.05$ lb·in

However, this is the required motor torque before we have picked a motor and included the motor inertia.

Step 5 – Select & Confirm the Stepping Motor & Driver System

It looks like a reasonable choice for a motor would be the STP-MTR-17048 or NEMA 17 motor. This motor has an inertia of:

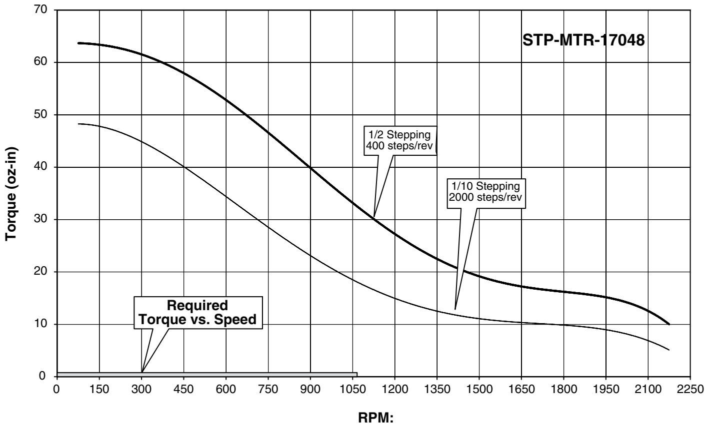
$\mathbf{J}_{\mathbf{motor}} = 0.00006$ lb·in·sec²

The actual motor torque would be modified:

$\mathbf{T}_{\mathbf{accel}} = \mathbf{J}_{\mathbf{total}} \times (\Delta\text{speed} \div \Delta\text{time}) \times 0.1$
$= (0.00023 + \mathbf{0.00006}) \times (1062 \div 1) \times 0.1 \approx 0.03$ lb·in

so that:

$\mathbf{T}_{\mathbf{motor}} = \mathbf{T}_{\mathbf{accel}} + \mathbf{T}_{\mathbf{run}}$
$= 0.03 + 0.0225 \approx 0.0525$ lb·in ≈ 0.84 oz·in



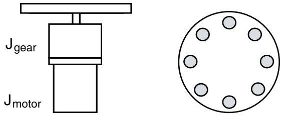
It looks like the STP-MTR-17048 stepping motor will work. However, we still need to check the load to motor inertia ratio:

Ratio = $\mathbf{J_{(pulleys\ +\ load)\ to\ motor}} \div \mathbf{J_{motor}}$
= 0.00023 ÷ 0.00006 = 3.8

It is best to keep the load-to-motor inertia ratio below 10, so 3.8 is within an acceptable range.

Index Table – Example Calculations

Step 1 – Define the Actuator and Motion Requirements



Diameter of index table = 12 inch
Thickness of index table = 2 inch
Table material = steel
Number of workpieces = 8
Desired Resolution = 0.036º
Gear Reducer = 25:1
Index angle = 45º
Index time = 0.7 seconds

Definitions
d_{load} = lead or distance the load moves per revolution of the actuator's drive shaft (P = pitch = $1/d_{load}$)
D_{total} = total move distance
θ_{step} = driver step resolution (steps/rev_{motor})
i = gear reduction ratio (rev_{motor}/$rev_{gearshaft}$)
T_{accel} = motor torque required to accelerate and decelerate the total system inertia (including motor inertia)
T_{run} = constant motor torque requirement to run the mechanism due to friction, external load forces, etc.
t_{total} = move time

Step 2 – Determine the Positioning Resolution of the Load

Rearranging **Equation** ④ to calculate the required stepping drive resolution:

$$\theta_{step} = (\mathbf{d_{load}} \div \mathbf{i}) \div \mathbf{L_\theta}$$
$$= (360^\circ \div 25) \div 0.036^\circ$$
$$= 400 \text{ steps/rev}$$

With the 25:1 gear reduction, the stepping system can be set at 400 steps/rev to equal the required load positioning resolution.

It is almost always necessary to use significant gear reduction when controlling a large inertia disk.

Step 3 – Determine the Motion Profile

From **Equation** ①, the total pulses to make the required move is:

$$\mathbf{P}_{total} = (\mathbf{D}_{total} \div (\mathbf{d}_{load} \div \mathbf{i})) \times \theta_{step}$$
$$= (45^{o} \div (360^{o} \div 25) \times 400$$
$$= 1250 \text{ pulses}$$

From **Equation** ④, the running frequency for a trapezoidal move is:

$$\mathbf{f}_{TRAP} = (\mathbf{P}_{total} - (\mathbf{f}_{start} \times \mathbf{t}_{ramp})) \div (\mathbf{t}_{total} - \mathbf{t}_{ramp})$$
$$= 1{,}250 \div (0.7 - 0.17) \approx 2{,}360 \text{ Hz}$$

where accel time is 25% of total move time and starting speed is zero.

$$= 2{,}360 \text{ Hz} \times (60 \text{ sec/1 min}) \div 400 \text{ steps/rev}$$
$$\approx 354 \text{ RPM}$$

Step 4 – Determine the Required Motor Torque

Using the equations in **Table 1**:

$$\mathbf{J}_{total} = \mathbf{J}_{motor} + \mathbf{J}_{gear} + (\mathbf{J}_{table} \div \mathbf{i}^2)$$

For this example, let's assume the gearbox inertia is zero.

$$\mathbf{J}_{table} \approx (\pi \times L \times \rho \times r^4) \div (2g)$$
$$\approx (3.14 \times 2 \times 0.28 \times 1296) \div (2 \times 386)$$
$$\approx 2.95 \text{ lb·in·sec}^2$$

The inertia of the indexing table reflected to the motor is:

$$\mathbf{J}_{table\ to\ motor} = \mathbf{J}_{table} \div \mathbf{i}^2$$
$$\approx 0.0047 \text{ lb·in·sec}^2$$

The torque required to accelerate the inertia is:

$$\mathbf{T}_{accel} \approx \mathbf{J}_{total} \times (\Delta\text{speed} \div \Delta\text{time}) \times 0.1$$
$$= 0.0047 \times (354 \div 0.17) \times 0.1$$
$$\approx 1.0 \text{ lb·in}$$

From **Equation** ⑤, the required motor torque is:

$$\mathbf{T}_{motor} = \mathbf{T}_{accel} + \mathbf{T}_{run}$$
$$= 1.0 + 0 = 1.0 \text{ lb·in}$$

However, this is the required motor torque before we have picked a motor and included the motor inertia.

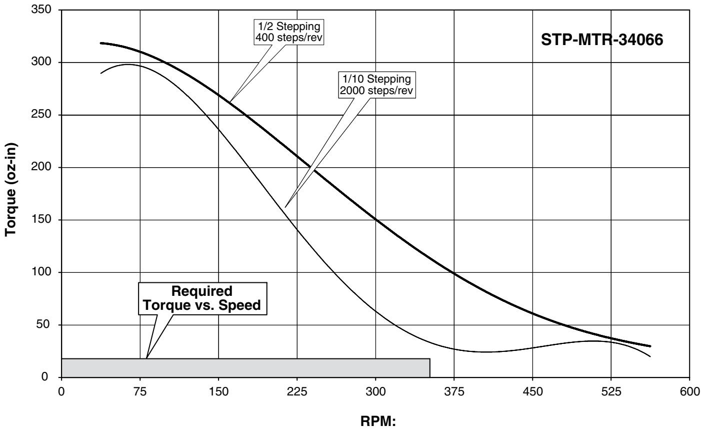
Step 5 – Select & Confirm the Stepping Motor & Driver System

It looks like a reasonable choice for a motor would be the STP-MTR-34066, or NEMA 34 motor. This motor has an inertia of:

$\mathbf{J_{motor}}$ = 0.0012 lb·in·sec²

The actual motor torque would be modified:

$\mathbf{T_{accel}} = \mathbf{J_{total}} \times (\Delta speed \div \Delta time) \times 0.1$
$= (0.0047 + \mathbf{0.0012}) \times (354 \div 0.17) \times 0.1$
≈ 1.22 lb·in
so that:
$\mathbf{T_{motor}} = \mathbf{T_{accel}} + \mathbf{T_{run}}$
$= 1.22 + 0$
$= 1.22$ lb·in $= 19.52$ oz·in



It looks like the STP-MTR-34066 stepping motor will work. However, we still need to check the load to motor inertia ratio:

Ratio = $\mathbf{J_{table\ to\ motor}} \div \mathbf{J_{motor}}$
$= 0.0047 \div 0.0012 = 3.9$

It is best to keep the load-to-motor inertia ratio below 10, so 3.9 is within an acceptable range.

Engineering Unit Conversion Tables, Formulae, & Definitions:

Conversion of Length

To convert A to B, multiply A by the entry in the table.		B					
		µm	mm	m	mil	in	ft
A	µm	1	1.000E–03	1.000E–06	3.937E–02	3.937E–05	3.281E–06
	mm	1.000E+03	1	1.000E–03	3.937E+01	3.937E–02	3.281E–03
	m	1.000E+06	1.000E+03	1	3.937E+04	3.937E+01	3.281E+00
	mil	2.540E+01	2.540E–02	2.540E–05	1	1.000E–03	8.330E–05
	in	2.540E+04	2.540E+01	2.540E–02	1.000E+03	1	8.330E–02
	ft	3.048E+05	3.048E+02	3.048E–01	1.200E+04	1.200E+01	1

Conversion of Torque

To convert A to B, multiply A by the entry in the table.		B					
		N·m	kg·m	kg·cm	oz·in	lb·in	lb·ft
A	N·m	1	1.020E–01	1.020E+01	1.416E+02	8.850E+00	7.380E-01
	kg·m	9.810E+00	1	1.000E+02	1.390E+03	8.680E+01	7.230E+00
	kg·cm		1.000E–02	1	1.390E+01	8.680E–01	7.230E–02
	oz·in	7.060E–03	7.200E–04	7.200E–02	1	6.250E–02	5.200E–03
	lb·in	1.130E–01	1.150E–02	1.150E+00	1.600E+01	1	8.330E–02
	lb·ft	1.356E+00	1.380E–01	1.383E+01	1.920E+02	1.200E+01	1

Conversion of Moment of Inertia

To convert A to B, multiply A by the entry in the table.		B						
		kg·m²	kg·cm·s²	oz·in·s²	lb·in·s²	oz·in²	lb·in²	lb·ft²
A	kg·m²	1	1.020E+01	1.416E+02	8.850E+00	5.470E+04	3.420E+03	2.373E+01
	kg·cm·s²	9.800E–02	1	1.388E+01	8.680E–01	5.360E+03	3.350+02	2.320E+00
	oz·in·s²	7.060E–03	7.190E–02	1	6.250E–02	3.861E+02	2.413E+01	1.676E–01
	lb·in·s²	1.130E–01	1.152E+00	1.600E+01	1	6.180E+03	3.861E+02	2.681E+00
	oz·in²	1.830E–05	1.870E–04	2.590E–03	1.620E–04	1	6.250E–02	4.340E–04
	lb·in²	2.930E–04	2.985E–03	4.140E–02	2.590E–03	1.600E+01	1	6.940E–03
	lb·ft²	4.210E–02	4.290E–01	5.968E+00	3.730E–01	2.304E+03	1.440E+02	1

Engineering Unit Conversion Tables, Formulae, & Definitions (cont'd):

General Formulae & Definitions	
Description:	**Equations:**
Gravity	gravity = 9.8 m/s^2; 386 in/s^2
Torque	$T = J \cdot \alpha$; $\alpha = rad/s^2$
Power (Watts)	P (W) = T (N·m) · ω (rad/s)
Power (Horsepower)	P (hp) = T (lb·in) · ν (rpm) / 63,024
Horsepower	1 hp = 746W
Revolutions	1 rev = 1,296,000 arc·sec / 21,600 arc·min

Equations for Straight-Line Velocity & Constant Acceleration	
Description:	**Equations:**
Final velocity	$v_f = v_i + at$ final velocity = (initial velocity) + (acceleration)(time)
Final position	$x_f = x_i + ½(v_i + v_f)t$ final position = initial position + [(1/2)(initial velocity + final velocity)(time)]
Final position	$x_f = x_i + v_i t + ½at^2$ final position = initial position + (initial velocity)(time) + (1/2)(acceleration)(time squared)
Final velocity squared	$v_f^2 = v_i^2 + 2a(x_f - x_i)$ final velocity squared = initial velocity squared + [(2)(acceleration)(final position – initial position)]