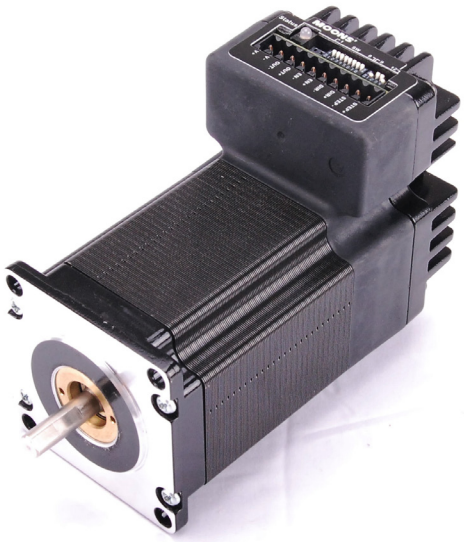
STM23R

Integrated Motor



User Manual

Rev. 1

AMP & MOONS' Automation

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The information in this manual applies to the following products:

Model	Standard	Rear Shaft	Optional Encoder
STM23R-2	✓		
STM23R-2D		✓	
STM23R-2E			✓
STM23R-3	✓		
STM23R-3D		✓	
STM23R-3E			✓

1 Introduction

Thank you for selecting the MOONS' STM23R Integrated Motor. We hope our commitment to performance, quality and economy will make a successful motion control project.

1.1 Overview

The STM23R Integrated Motor is a cost-effective, high performance, step motor with the drive and controller built in. The design is based on advanced digital current control technology, and features high torque, low noise and low vibration. Running current, microstep resolution, and other parameters are switch selectable so software configuration is not required. As an integrated motor, it is less expensive than a separate motor and drive combination, while providing better performance.

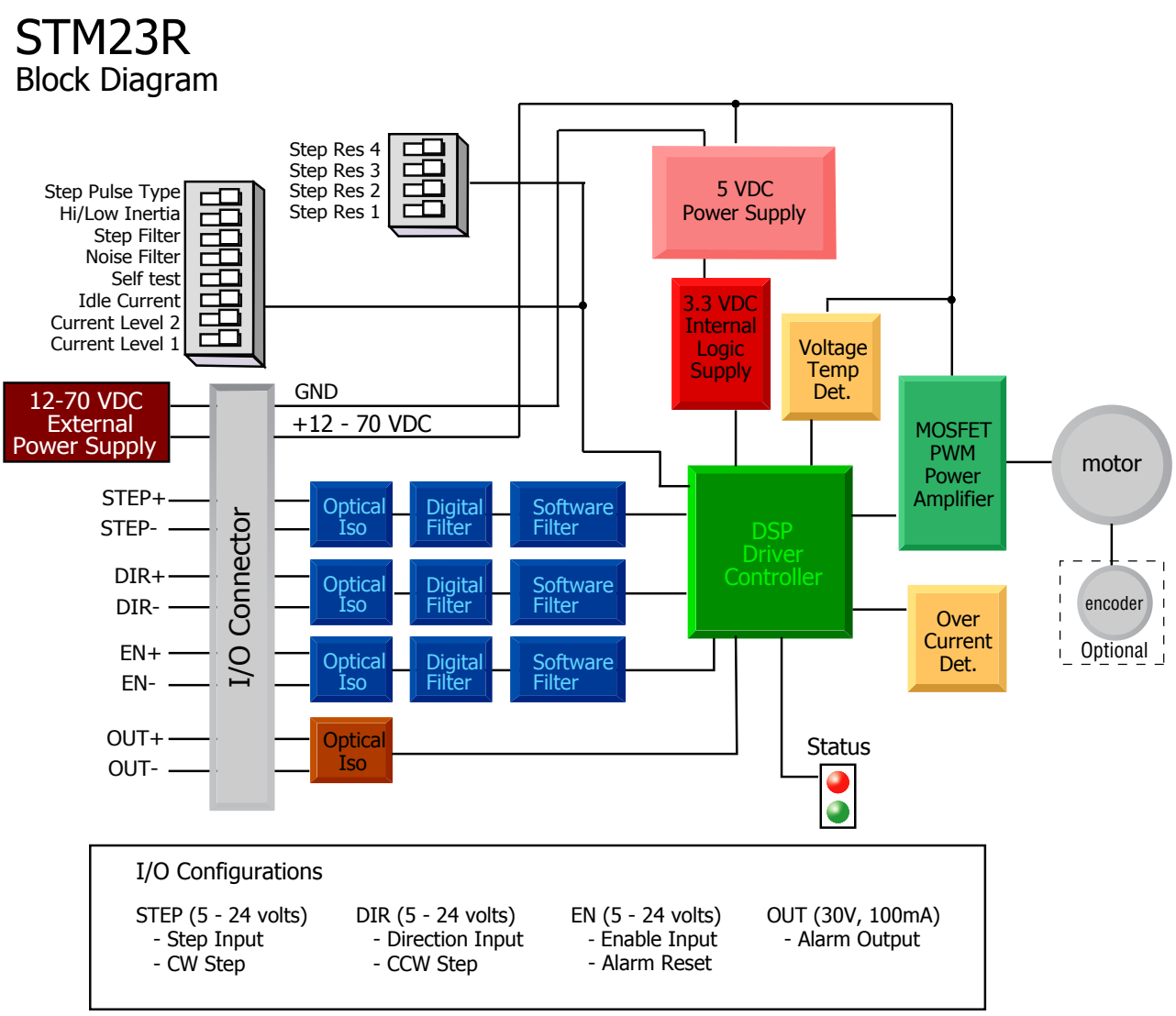
1.2 Features

- Power Supply - Operates from a 12 to 70 volt DC power supply
- Ouput Power - 5 amps peak maximum
- Available Torque

  STM23R-2 up to 0.9 N.m
  STM23R-3 up to 1.5 N.m
- Inputs & Outputs

  3 optically isolated digital inputs, 5 to 24 volts
  1 optically isolated digital output, 30V 100mA
- Speed Range - up to 60 rps
- Current Control - Advanced digital current control provides excellent high speed torque, switch selectable, 4 settings, 50%, 70%, 90%, 100%
- Idle Current - Switch selectable for reduction to 50% or 90% of running current 1 second after the motor stops
- Self Test - Performs a 2 rev, 1 rps, CW/CCW move test, switch selectable: ON or OFF
- Input Noise Filter - Filters out unwanted noise that can cause extra steps, switch selectable, 2 settings: 150KHz,2MHz
- Step Smoothing Filter (Microstep Emulation) - Performs high resolution stepping by synthesizing coarse steps into fine micro-steps, switch selectable, ON or OFF
- Anti-resonance/Electronic Damping - Improves motor performance, switch selectable, 2 settings: ON (for high inertia loads), or OFF (for low inertia loads)
- Control Mode - Accepts input signals in 2 formats, switch selectable: OFF for Step & Direction input, ON for CW/CCW input
- Microstep Resolution - Switch selectable, 16 settings: 200, 400, 800, 1600, 3200, 6400, 12800, 25600, 1000, 2000, 4000, 5000, 8000, 10000, 20000 and 25000 steps/rev

1.3 Block Diagram



1.4 Safety Instructions

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

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

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

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

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

2 Getting Started

To use the STM23R integrated motor, the following items are needed:

- A 12 - 70 volt DC power supply, see the section below entitled “Choosing a Power Supply” for help in choosing the right one
- Step & Direction signals
- a small flat blade screwdriver for configuring the switches (included)

2.1 Mounting Hardware

As with any step motor, the STM23R must be mounted so as to provide maximum heat sinking and airflow. Keep enough space around the Integrated Motor to allow for airflow.



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

2.2 Choosing a Power Supply

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

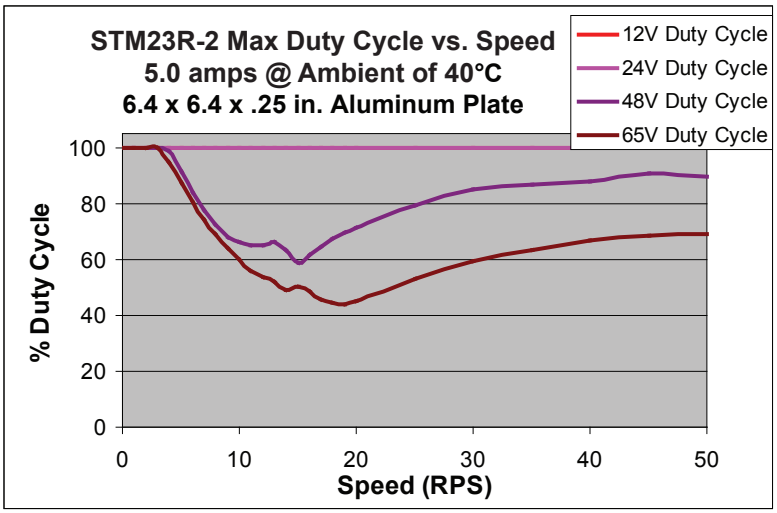
2.2.1 Voltage Selection

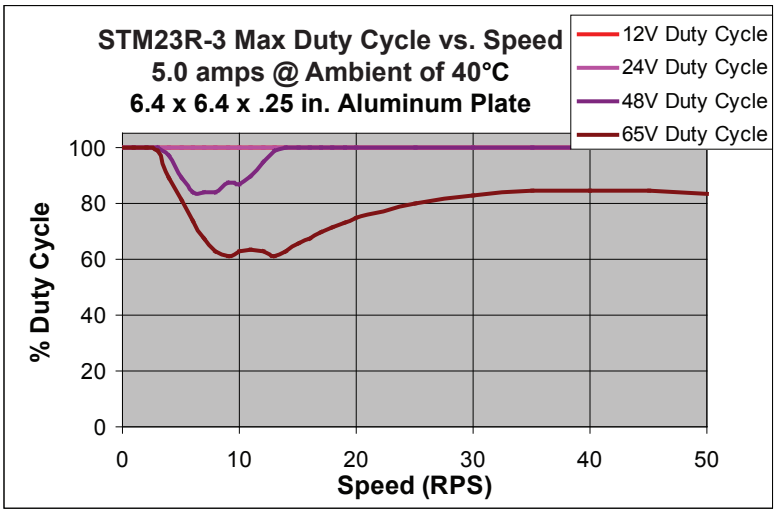
The STM23R is designed to give optimum performance between 12 and 70 volts DC. Choosing the voltage depends on the performance needed and motor/drive heating that is acceptable and/or does not cause a drive over-temperature. Higher voltages will give higher speed performance but will cause the STM23R to produce higher temperatures. Using power supplies with voltage outputs that are near the drive maximum may significantly reduce the operational duty-cycle.

The extended range of operation can be as low as 10 VDC minimum to as high as 75 VDC maximum. When operating below 12 VDC, the power supply input may require larger capacitance to prevent under-voltage and internal-supply alarms. Current spikes may make supply readings erratic. The supply input cannot go below 12 VDC for reliable operation. Absolute minimum power supply input is 10 VDC. If the Input supply drops below 10 VDC the low voltage alarm will be triggered. This will not fault the drive.

Absolute maximum power supply input is 75 VDC at which point an over-voltage alarm and fault will occur. When using a power supply that is regulated and is near the drive maximum voltage of 75 VDC, a voltage clamp may be required to prevent over-voltage when regeneration occurs. The RC050 Regeneration Clamp is recommended for the STM23R in this situation (see 3.1 “Connecting the Power Supply” below). When using an unregulated power supply, make sure the no-load voltage of the supply does not exceed the drive’s maximum input voltage of 75 VDC.

The charts below show the heat output, in watts, of the drive at various speeds and voltages. See section 6.4 on Drive/Motor Heating for more information.

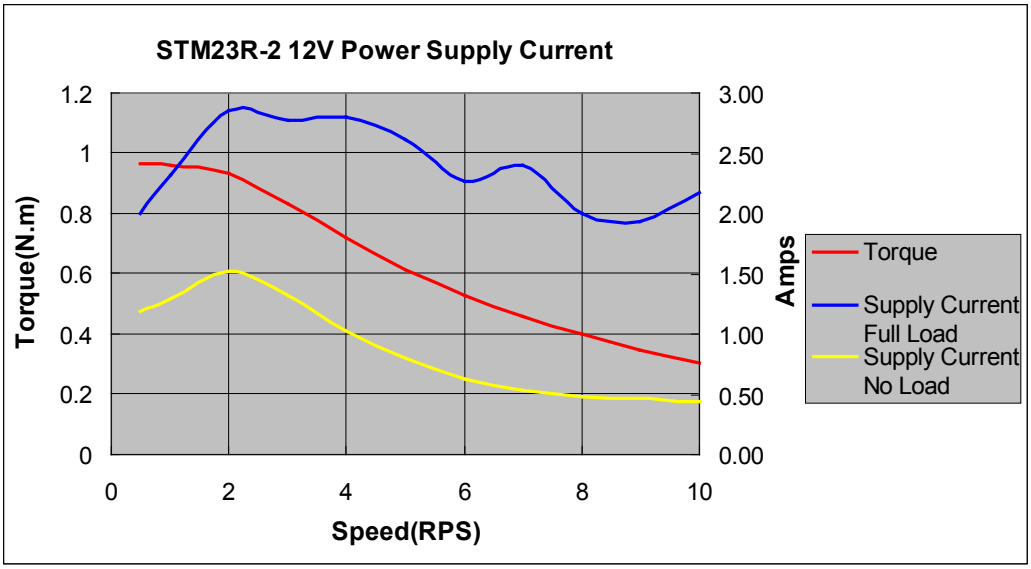


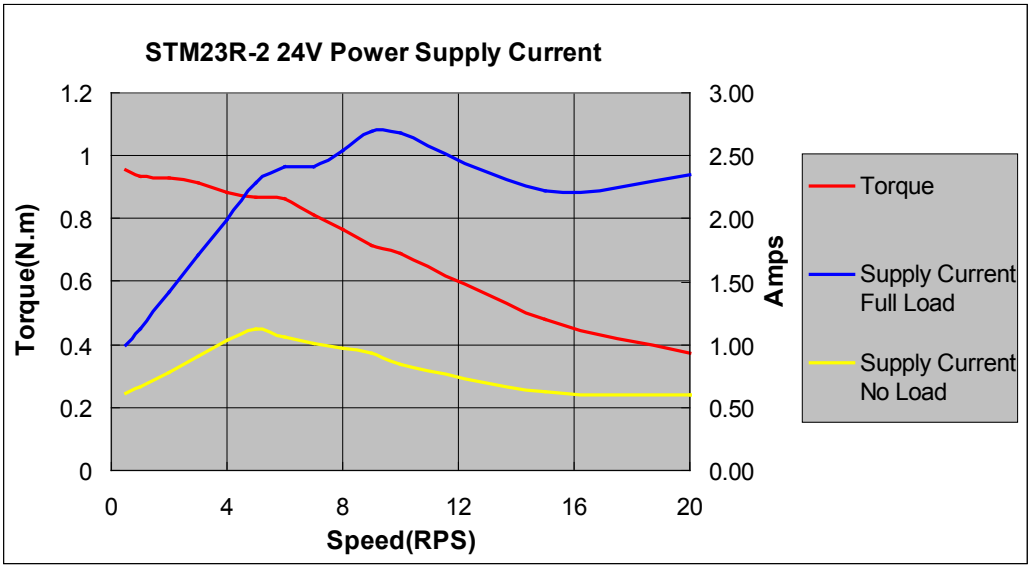


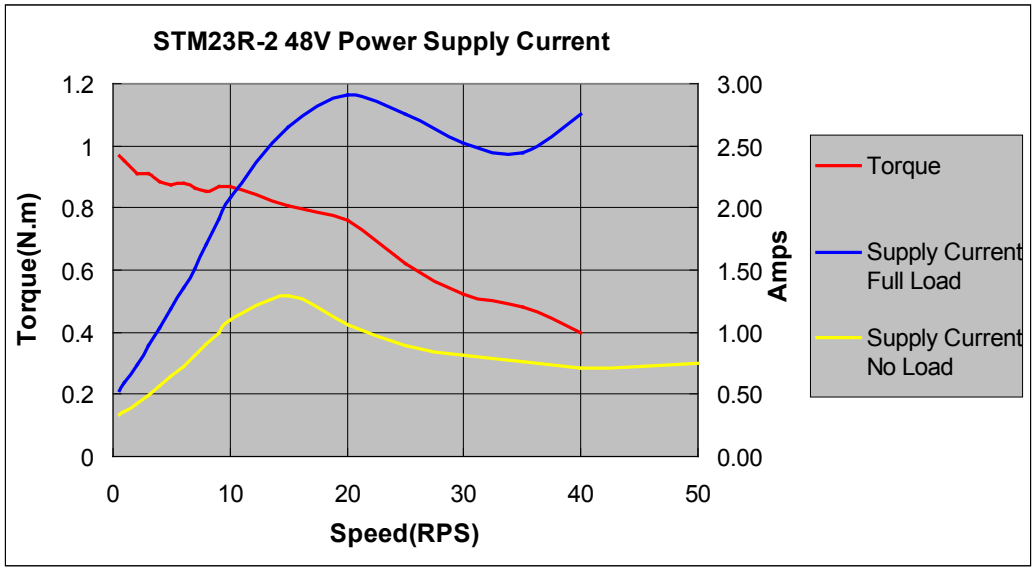
2.2.2 Current

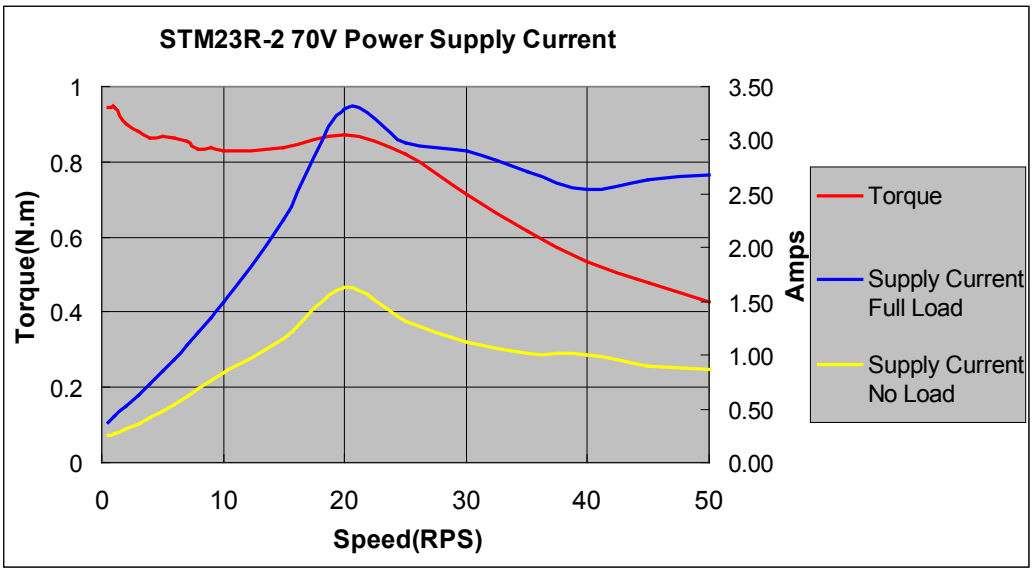
The maximum supply currents required by the STM23R are shown in the charts below at different power supply voltage inputs. The STM23R power supply current is lower than the winding currents because it uses switching amplifiers to convert a high voltage and low current into lower voltage and higher current. The more the power supply voltage exceeds the motor voltage, the less current will be required from the power supply.

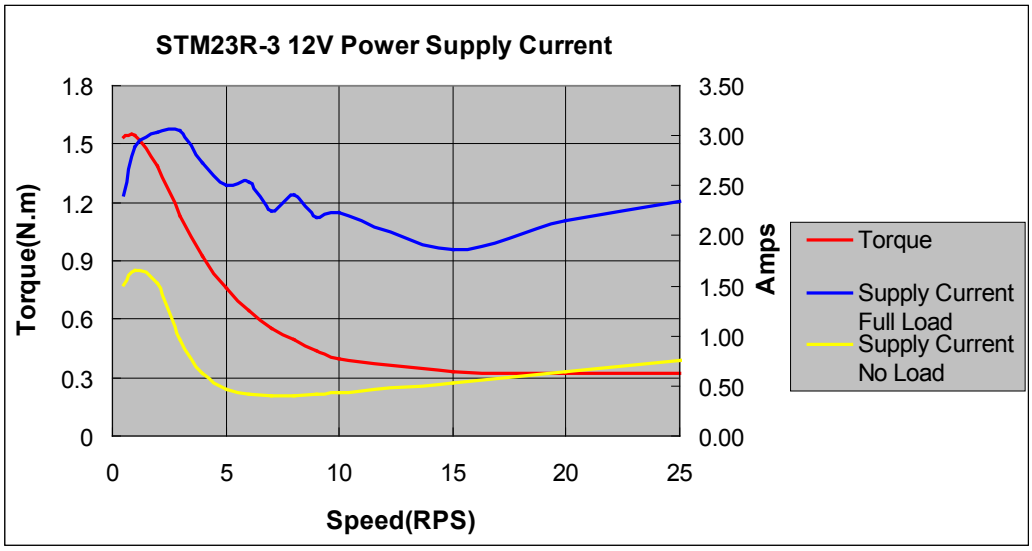
It is important to note that the current draw is significantly different at higher speeds depending on the torque load to the motor. Estimating how much current is necessary may require a good analysis of the load the motor will encounter.

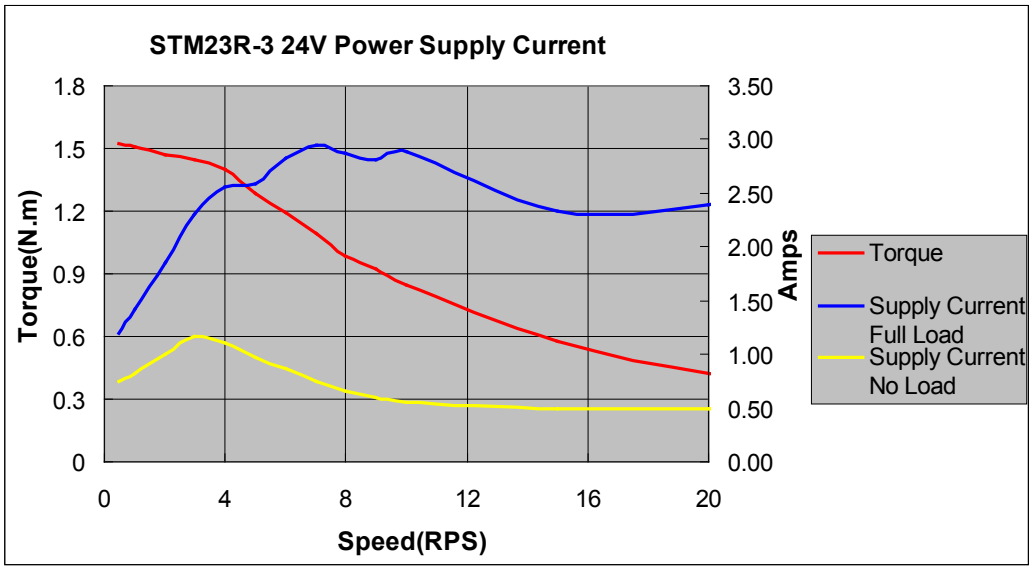


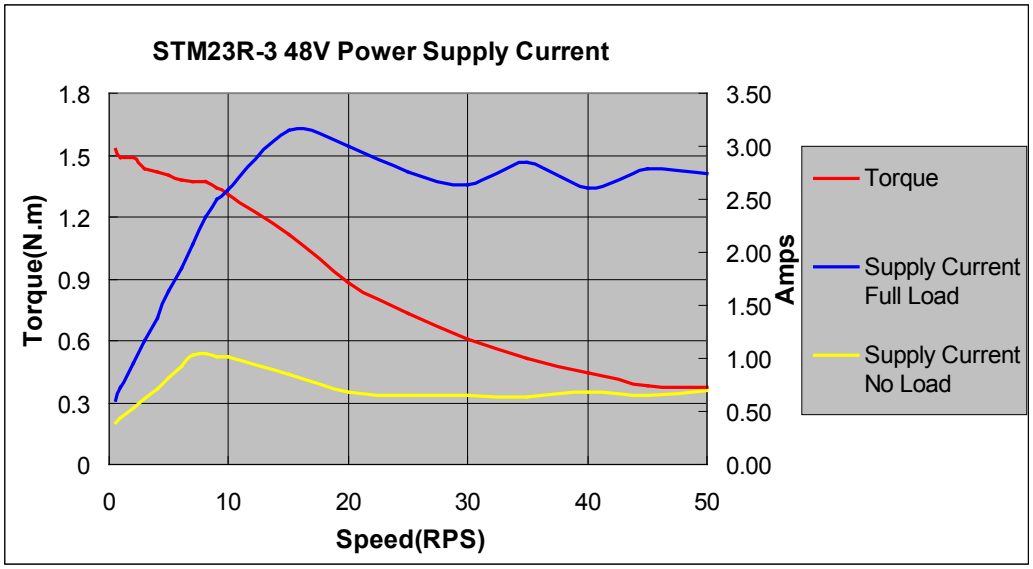


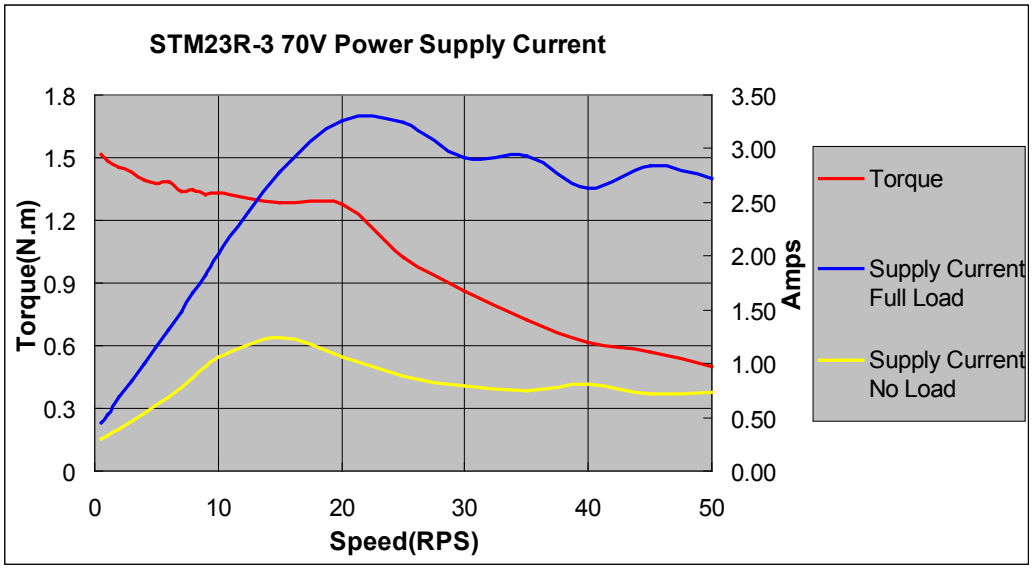

STM23R-2 48V Power Supply Current
Torque(N.m)
Amps
Speed(RPS)
1.2
1
0.8
0.6
0.4
0.2
0
3.00
2.50
2.00
1.50
1.00
0.50
0.00
0
10
20
30
40
50
Torque
Supply Current Full Load
Supply Current No Load


STM23R-2 70V Power Supply Current
Torque(N.m)
Amps
Speed(RPS)
1
0.8
0.6
0.4
0.2
0
3.50
3.00
2.50
2.00
1.50
1.00
0.50
0.00
0
10
20
30
40
50
Torque
Supply Current Full Load
Supply Current No Load


STM23R-3 12V Power Supply Current
Torque(N.m)
Amps
Speed(RPS)
1.8
1.5
1.2
0.9
0.6
0.3
0
3.50
3.00
2.50
2.00
1.50
1.00
0.50
0.00
0
5
10
15
20
25
Torque
Supply Current Full Load
Supply Current No Load


STM23R-3 24V Power Supply Current
Torque(N.m)
Amps
Speed(RPS)
Torque
Supply Current Full Load
Supply Current No Load


STM23R-3 48V Power Supply Current
Torque(N.m)
Amps
Speed(RPS)
Torque
Supply Current Full Load
Supply Current No Load

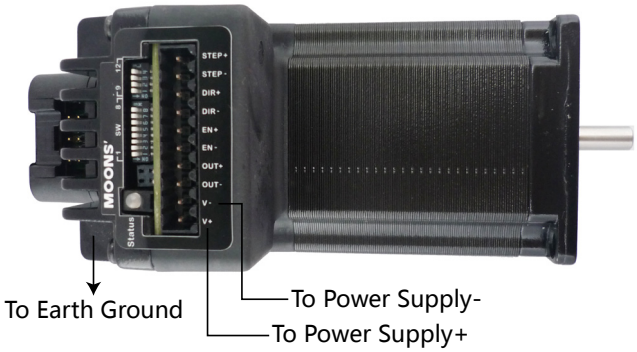

STM23R-3 70V Power Supply Current
Torque(N.m)
Amps
Speed(RPS)
Torque
Supply Current Full Load
Supply Current No Load

3 Connections

3.1 Connecting the Power Supply

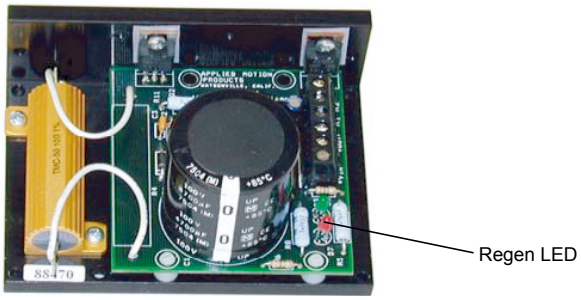
If the power supply does not have a fuse on the output or some kind of short circuit current limiting device a fast acting fuse is required. A 5 amp fast acting fuse should be installed in line with the "+" power supply lead.

Connect the power supply "+" terminal to the drive " V+" terminal. Connect the power supply "-" terminal to the drive " V-" terminal.



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

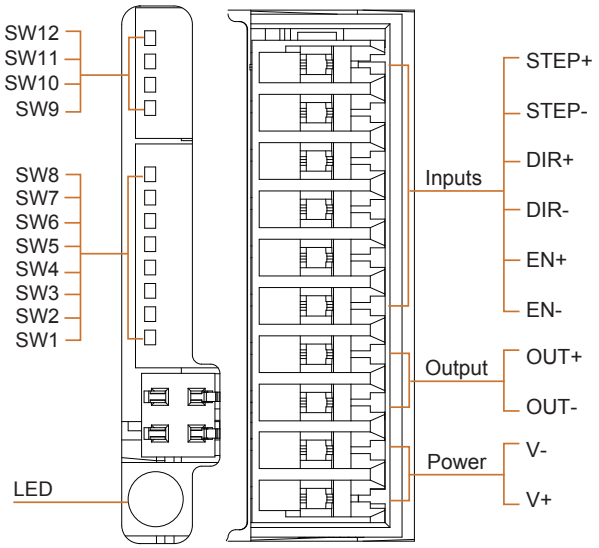
If a regulated power supply is being used, there may be a problem with regeneration. When a load decelerates rapidly from a high speed, some of the kinetic energy of the load is transferred back to the power supply, possibly tripping the over-voltage protection of a regulated power supply, causing it to shut down. This problem can be solved with the use of a MOONS' RC050 Regeneration Clamp. It is recommended that an RC050 initially be installed in an application. If the "regen" LED on the RC050 never flashes, the clamp is not necessary.

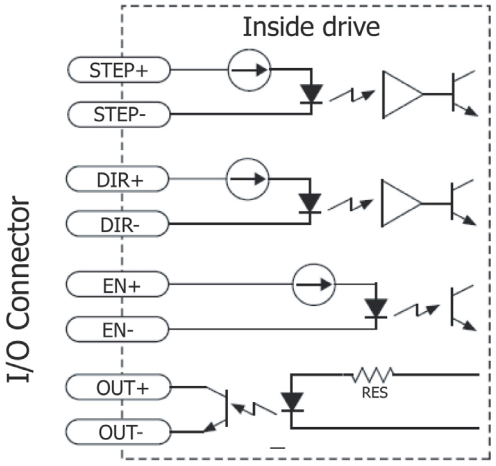


RC050 Regen Clamp

3.2 Connecting the Inputs & Outputs

3.2.1 Connector Pin Diagram



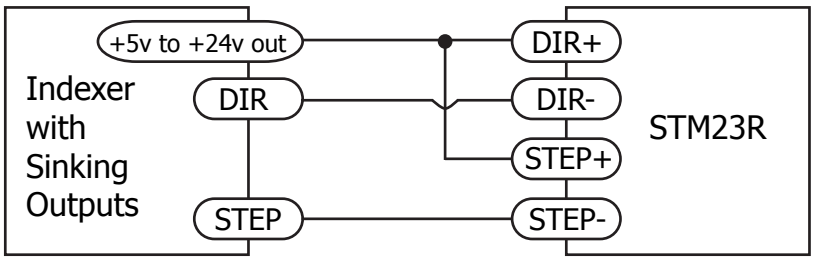


3.2.2 STEP & DIR Inputs

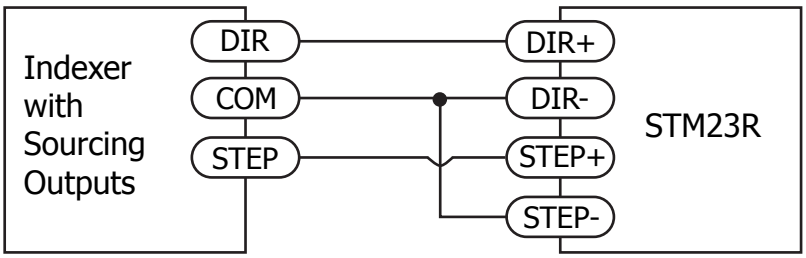
The STM23R integrated motor has two high speed optically isolated inputs called STEP and DIR. They accept 5 to 24 volt single-ended or differential signals, up to 2MHz. The maximum voltage that can be applied to the input is 28V.

The motor executes one step when the STEP input closes.

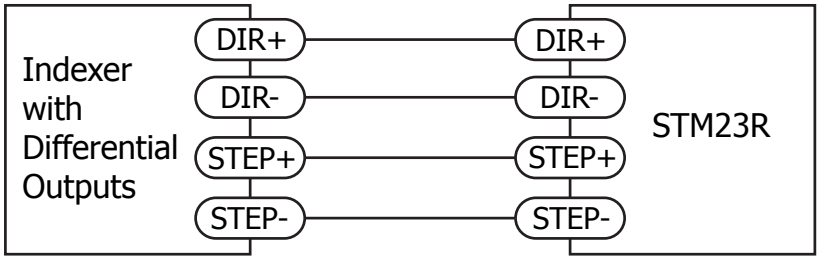
The direction of rotation is controlled by the DIR input state. A closed input (logic “0”) will result in clockwise rotation, and an open input (logic “1”) will result in counterclockwise rotation.



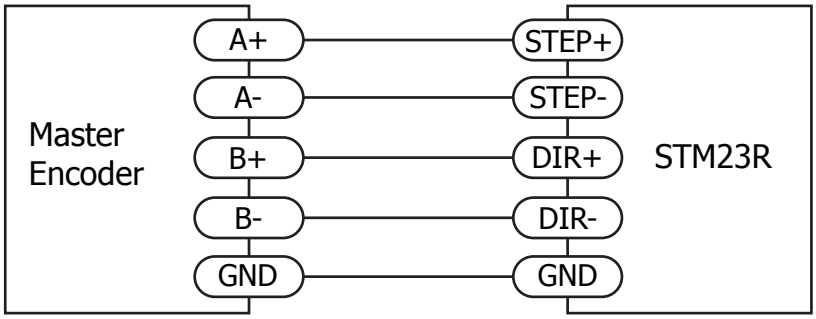
Connecting to Indexer with Sinking Outputs



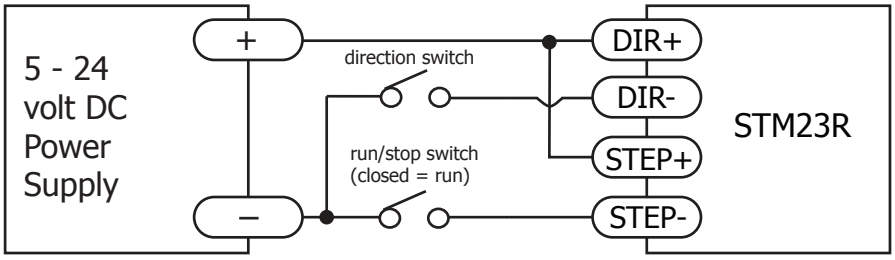
Connecting to Indexer with Sourcing Outputs



Connecting to Indexer with Differential Outputs
Many high-speed indexers have differential outputs



Wiring for Encoder Following



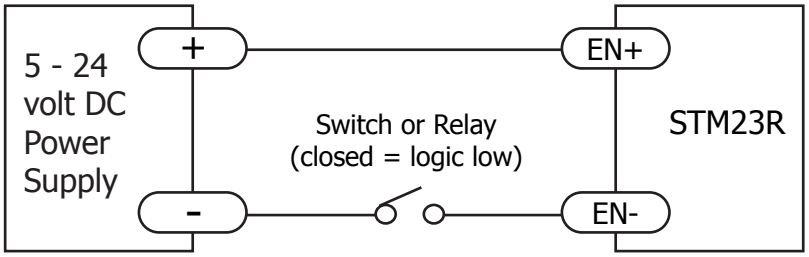
Using Mechanical Switches

3.2.3 EN Input

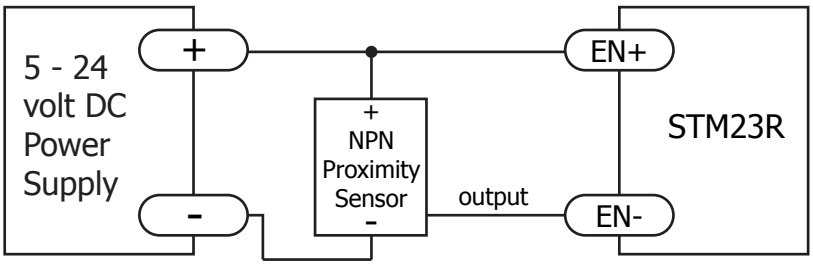
The EN input enables or disables the drive amplifier. It is an optically isolated input that accepts a 5 to 24 volt single-ended or differential signal. The maximum voltage that can be applied to the input is 28V.

When EN input is closed, the drive amplifier is deactivated. All the MOSFETs will shutdown, and the motor is free. When EN input is open, the drive is activated.

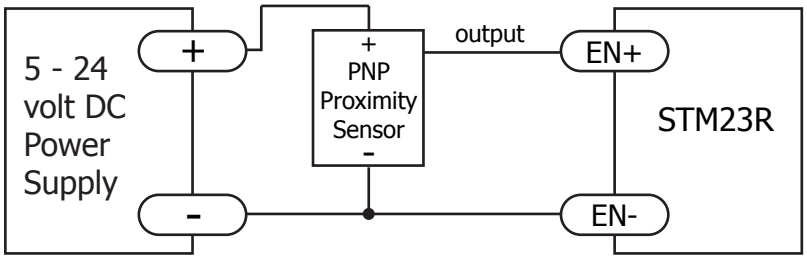
When the drive has encountered an error and the fault is removed from system, a falling signal into the EN input will reset the error status and activate the drive amplifier again.



Connecting the Input to a Switch or Relay



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

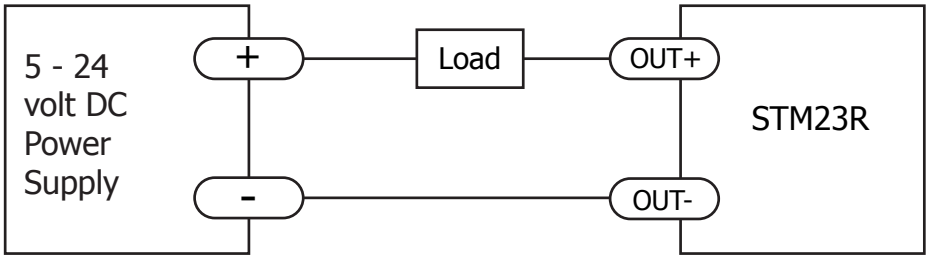


Connecting a PNP type Proximity Sensor to an Input
(when prox sensor activates, input goes low)

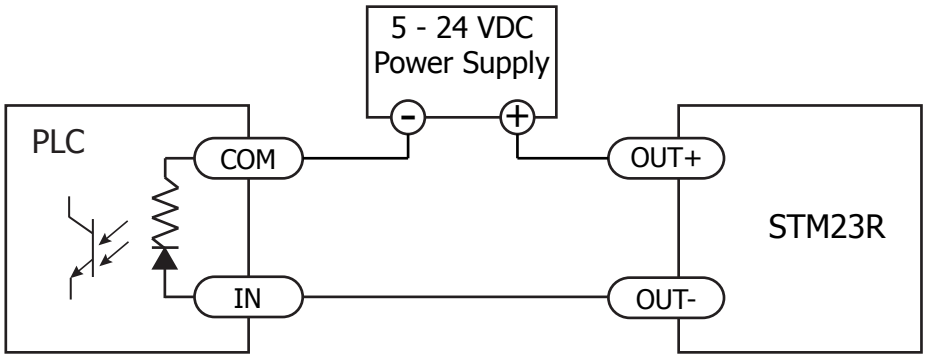
3.2.4 FAULT Output

The FAULT Output is also optically isolated. The maximum collector current is 100mA, and the maximum collector to emitter voltage is 30 volts. This output can be wired to sink or source current.

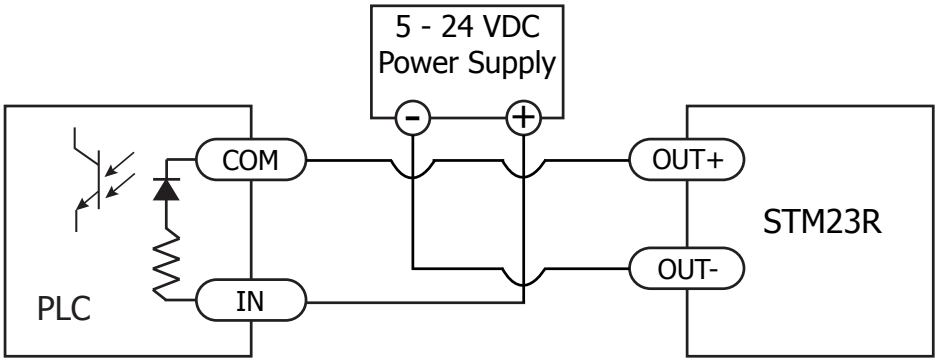
When the drive is working normally, the output is open. When the drive encounters an error, the output closes.



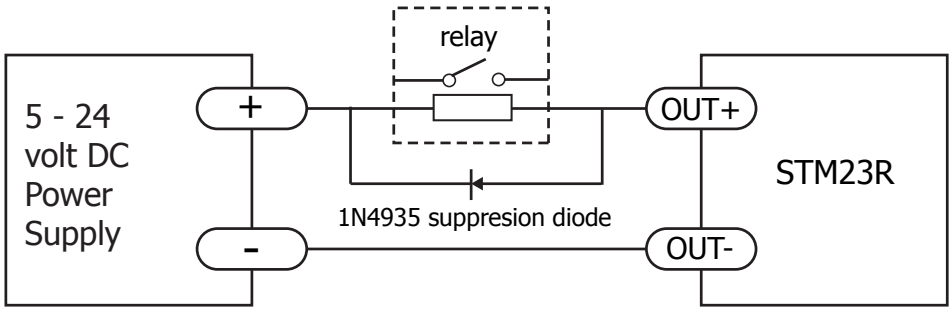
Connecting a Sinking Output



Connecting a Sourcing Output

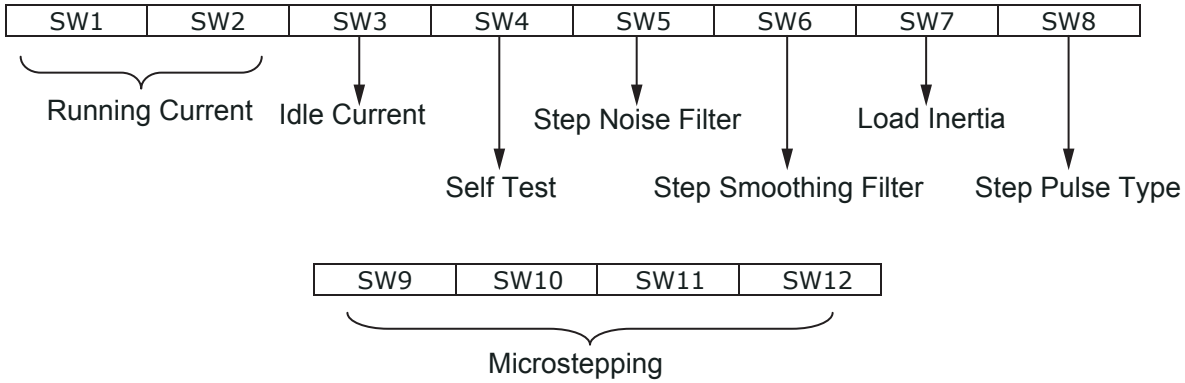


Connecting a Sourcing Output again



Driving a Relay

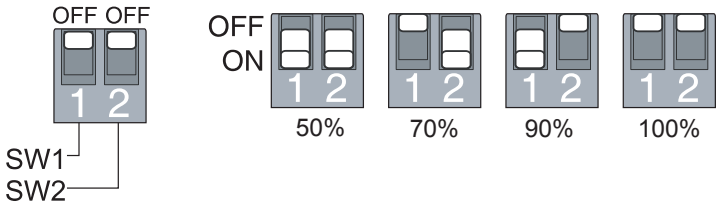
4 Switch Selecting



4.1 Running Current

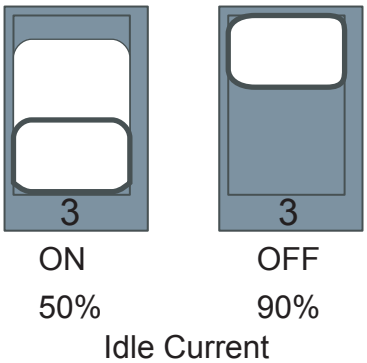
The output current of the STM23R integrated motor is set by the SW1 and SW2 switches and can be changed as necessary. There are 4 settings available according to the ON/OFF combination of the switches.

Peak	SW1	SW2
50%	ON	ON
70%	OFF	ON
90%	ON	OFF
100%	OFF	OFF



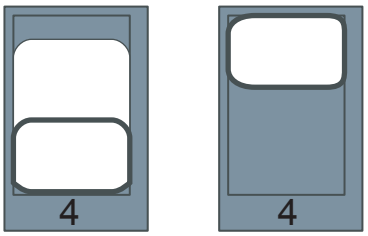
4.2 Idle Current

The running current of the STM23R is automatically reduced whenever the motor isn't moving. Setting the SW3 switch to ON maintains 50% of the running current. Setting this switch to OFF maintains 90% of the running current. This 90% setting is useful when a high holding torque is required. To minimize motor and drive heating it is highly recommended that the idle current reduction feature be set to 50% unless the application requires the higher setting.



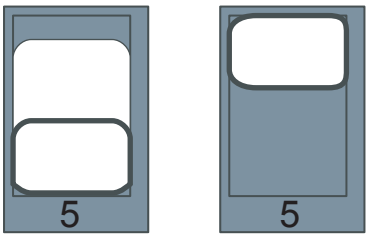
4.3 Self Test

A built-in self-test feature is available on the STM23R to check the physical operation of the motor. Setting switch SW4 to ON after the drive is powered up will cause the drive to perform a self test move of 2 revolutions both CW and CCW at 1rps. Setting switch SW4 to OFF disables this feature.



Self Test

4.4 Input Noise Filter



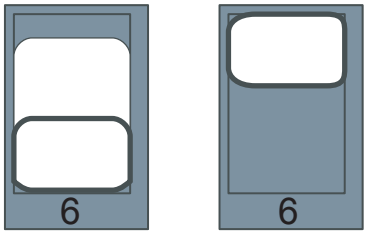
The digital inputs used for the STEP & DIR signals are very high speed and can be sensitive to external electrical noise. The Input Noise Filter sets a hardware circuit to filter out unwanted noise that can cause extra steps. Setting switch SW5 to ON will set this filter frequency at 150 KHz, enough for most applications.

However, if the STM23R is being operated at a high number of steps/rev and at high motor speeds, the drive is being commanded at step rates above 150 KHz. When this is the case, the switch should be set to OFF which will set this filter frequency at 2 MHz.

The necessary setting can be determined by multiplying the highest motor speed by the steps/rev. For example, 40 revs/second at 20,000 steps/rev is 40 x 20,000 = 800 KHz. This application would require the higher setting of 2 MHz and so the switch should be set to OFF.

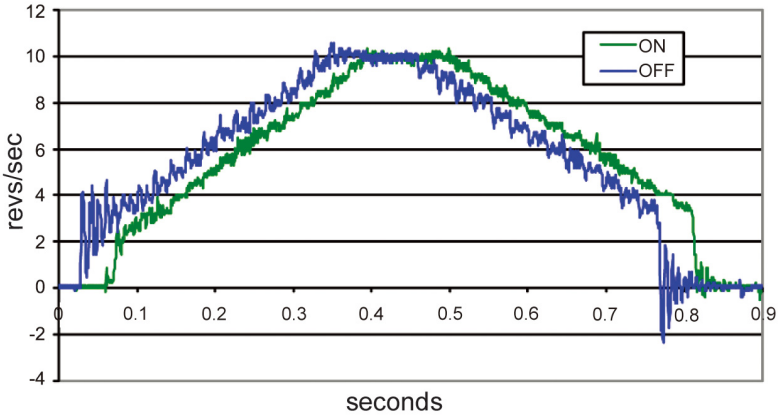
4.5 Step Smoothing Filter

Lower step resolutions such as 200 steps/ rev (full step) or 400 steps/rev (half step) may cause a motor to run rough and produce more audible noise than if it were being microstepped (20,000 steps/rev and beyond). The STM23R includes a step smoothing feature, also called microstep emulation, that can provide smooth motion from coarse command signals. When switch SW6 is set to ON this feature is automatically enabled to provide the smoothest possible motion.



Step Smoothing Filter

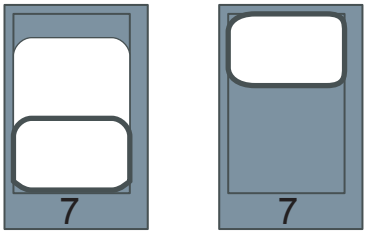
Motion Profile with Step Smoothing Filter



Because a command filter is used as part of the step smoothing process there will be a slight delay in the motion. If the filter lag causes undesirable results, the SW6 switch may be set to OFF to disable this feature. The chart to the left shows an example of the delay that can occur from using the step smoothing filter.

4.6 Anti Resonance Inertia

The anti-resonance and electronic damping features of the STM23R can greatly improve motor performance. For optimum performance, the drive must understand the electromechanical characteristics of the motor and load. It is important to have a good estimate of the load intertia for this feature to work properly. The motor table below lists the rotor inertia of each motor. Divide the load inertia by the rotor inertia to determine the inertia ratio of the load and motor. Switch SW7 should be set to ON for a high load inertia (5x to 10x) and to OFF for a low load inertia (0x to 4x).



ON
5 - 10X

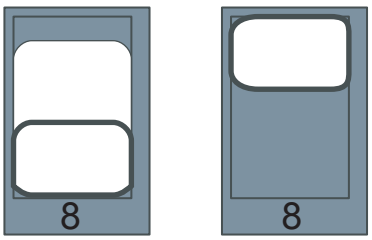
OFF
0 - 4X

Integrated Motor	Rotor Inertia (g-cm2)
STM23R-2	260
STM23R-3	460

4.7 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. Setting SW8 to OFF will enable the step and direction control mode.

Some PLCs use a different type of command signal: one signal pulses once for each desired step in the clockwise direction (CW Step), while a second signal pulses for counterclockwise motion (CCW Step). Setting SW8 to ON will enable the CW/CCW control mode. In CW/CCW control mode, the CW signal should be connected to the STEP input and the CCW signal to the DIR input.



ON
CW/CCW

OFF
Step/Dir

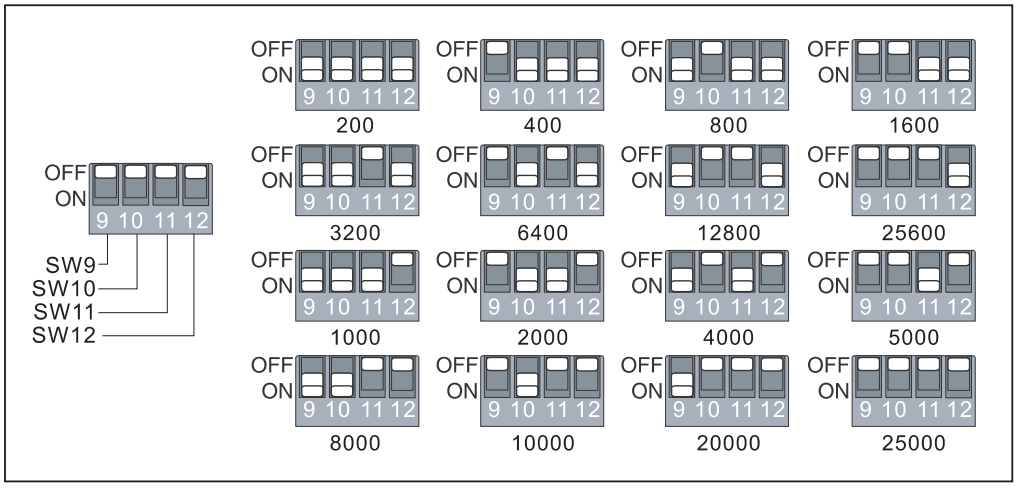
Pulse Type

Note: The power must be cycled if this switch setting is changed.

4.8 Microstep Resolution

The microstep resolution of the STM23R is set by the SW9, SW10, SW11 and SW12 switches. There are 16 settings.

Steps/Rev	SW9	SW10	SW11	SW12
200	ON	ON	ON	ON
400	OFF	ON	ON	ON
800	ON	OFF	ON	ON
1600	OFF	OFF	ON	ON
3200	ON	ON	OFF	ON
6400	OFF	ON	OFF	ON
12800	ON	OFF	OFF	ON
25600	OFF	OFF	OFF	ON
1000	ON	ON	ON	OFF
2000	OFF	ON	ON	OFF
4000	ON	OFF	ON	OFF
5000	OFF	OFF	ON	OFF
8000	ON	ON	OFF	OFF
10000	OFF	ON	OFF	OFF
20000	ON	OFF	OFF	OFF
25000	OFF	OFF	OFF	OFF



5 Troubleshooting

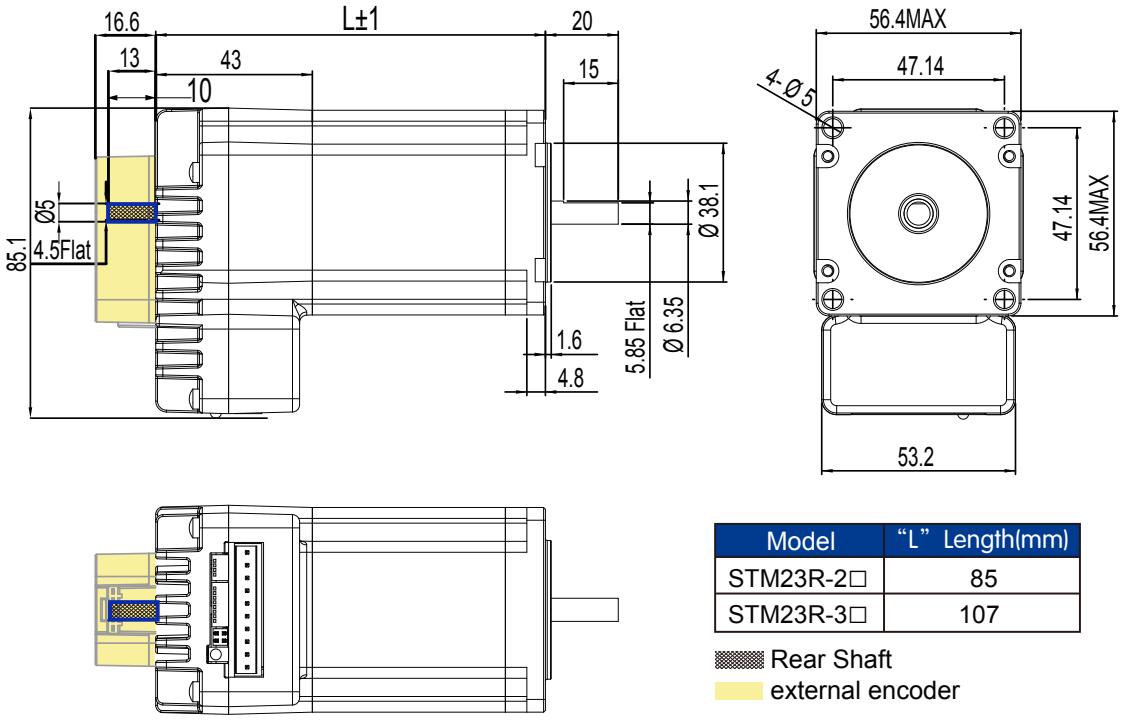
LED Error Codes

The STM23R has one bicolor (red/green) LED to indicate status and errors. When the motor is enabled, the LED slowly flashes green. When the LED is solid green, the motor is disabled. If the LED flashes red, an error has occurred. Errors are indicated by a combination of red and green flashes as follows:

Code		Error
🟢	Solid	Motor Disabled
🟢🟢	Flashing	Motor Enabled
🔴🔴🔴🟢	3 red, 1 green	Over Temperature
🔴🔴🔴🟢🟢	3 red, 2 green	Bad Internal Voltage
🔴🔴🔴🔴🟢	4 red, 1 green	Power Supply Over Voltage
🔴🔴🔴🔴🟢🟢	4 red, 2 green	Power Supply Under Voltage
🔴🔴🔴🔴🔴🟢	5 red, 1 green	Over Current/Short Circuit

6 Reference Materials

6.1 Mechanical Outline



Model	"L" Length(mm)
STM23R-2□	85
STM23R-3□	107

Rear Shaft
external encoder

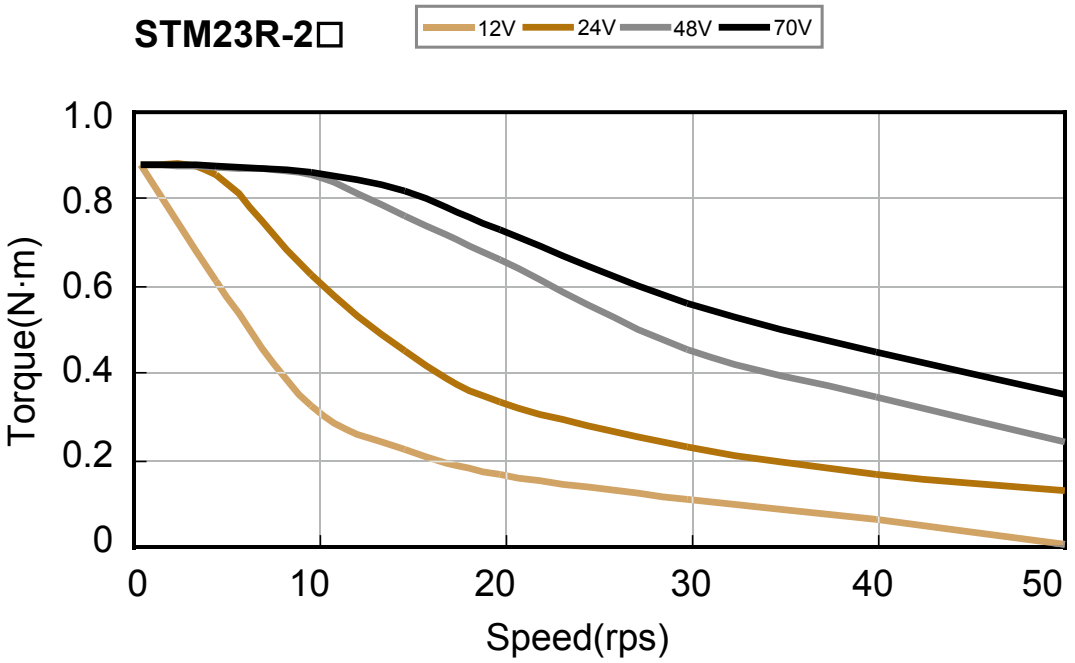
6.2 Technical Specifications

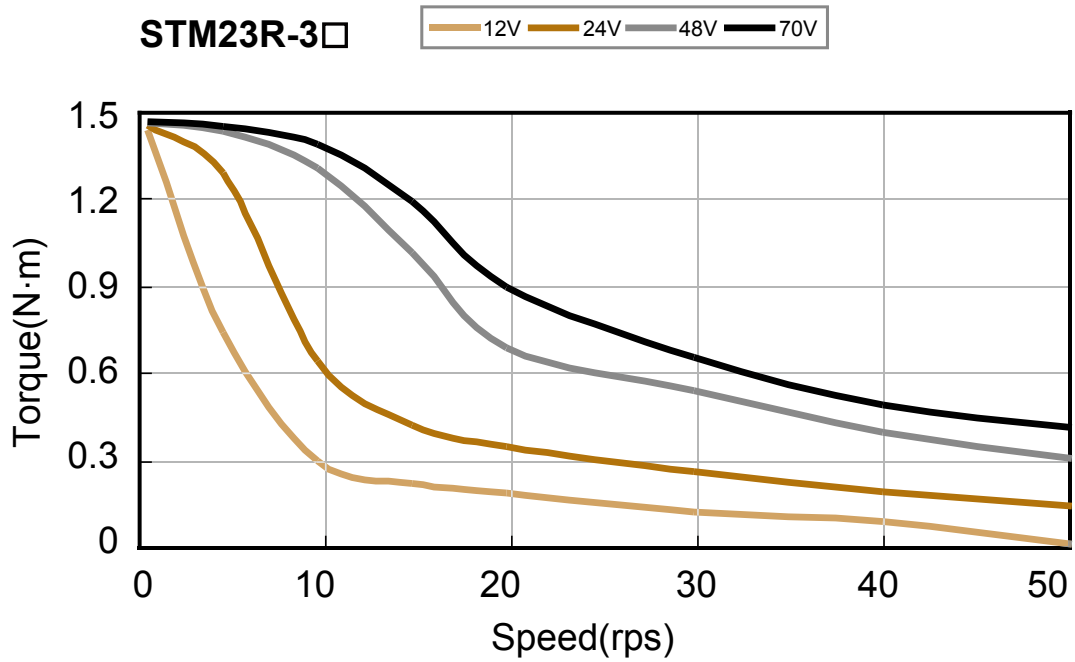
Power Amplifier	
Amplifier Type	Dual H-Bridge, 4 Quadrant
Current Control	4 state PWM at 16 KHz
Output Torque	STM23R-2 Series to 0.9 N.m with suitable power supply STM23R-3 Series to 1.5 N.m with suitable power supply
Power Supply	External 12 - 70 volt power supply required
Input Voltage Range	10 - 75 volts min/max (nominal 12 - 70 volts), voltages outside this range will cause driver faults and/or may damage the drive
Protection	Over-voltage, over-current, under-voltage, over-temp, internal motor shorts (phase-to-phase, phase-to-ground)
Ambient Temperature	0 - 40°C (32 - 104°F) when mounted to a suitable heatsink
Humidity	90% non-condensing

Controller	
Current Control	Advanced digital current control provides excellent high speed torque
Speed Range	Speeds up to 3000 rpm
Auto Setup	Measures motor parameters to configure current control and anti-resonance gain settings
Encoder Feedback	Optional 1000 line external encoder
Step Input STEP+/-	Inputs: optically isolated, 5 - 24 volts, min. pulse width 250 ns., max. pulse frequency 2 MHz; motor executes one step when the STEP input closes
Direction Input DIR+/-	Inputs: optically isolated, 5 - 24 volts, min. pulse width 250 ns., max. pulse frequency 2 MHz; direction of rotation is controlled by the DIR input state
Enable Input EN+/-	Inputs: optically isolated, 5 - 24 volts, min. pulse width 100 us., max. pulse frequency 10 KHz; enables or disables the drive amplifier
Output OUT+/-	Open Collector, 30 volts, 100 mA max, max. pulse frequency 10 KHz; closes when the drive encounters an error, open when the drive is operating normally
Running Current	Switch selectable, 4 settings: 50%, 70%, 90%, 100%
Idle Current Reduction	Automatically reduces the current 1 second after the motor stops; switch selectable, 2 settings: 50% or 90% of the running current
Microstep Resolution	Switch selectable, 16 settings: 200, 400, 800, 1600, 3200, 6400, 12800, 25600, 1000, 2000, 4000, 5000, 8000, 10000, 20000 and 25000 steps/rev
Anti Resonance (Electronic Damping)	Raises the system-damping ratio to eliminate midrange instability and allow stable operation throughout the speed range of the motor, switch selectable, low or high load inertia
Self Test	Checks internal and external power supply voltages, 2 rev move both CW and CCW at 1rps, switch selectable, ON or OFF
Microstep Emulation	Performs high resolution stepping by synthesizing coarse steps into fine micro-steps, switch selectable, ON or OFF
Modes Of Control	Step & Direction
Step Input Pulse	Switch selectable for Step & Direction or CW/CCW
Noise Filtering	Hardware digital noise filter, software noise filter, switch selectable, 2 settings: 150KHz, 2MHz

6.3 Torque Curves

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



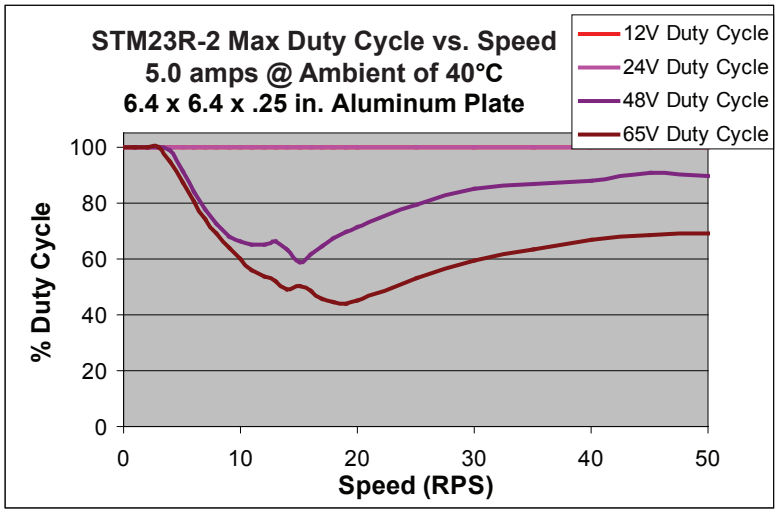


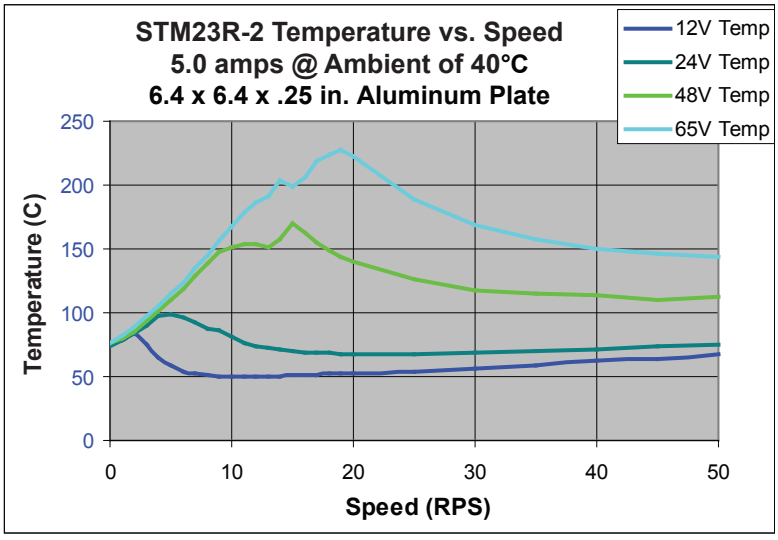
6.4 Drive/Motor Heating

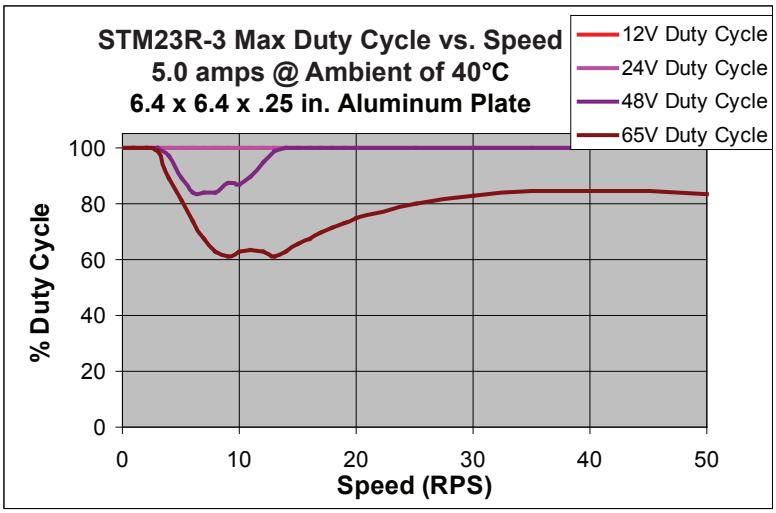
Step motors convert electrical power from the driver into mechanical power to move a load. Because step motors are not 100% efficient, some of the electrical power turns into heat as it passes through the motor. The amount of heating is not so much dependent on the load being driven as on the motor speed and power supply voltage. There are certain combinations of speed and voltage at which a motor cannot be continuously operated without damage occurring to the motor.

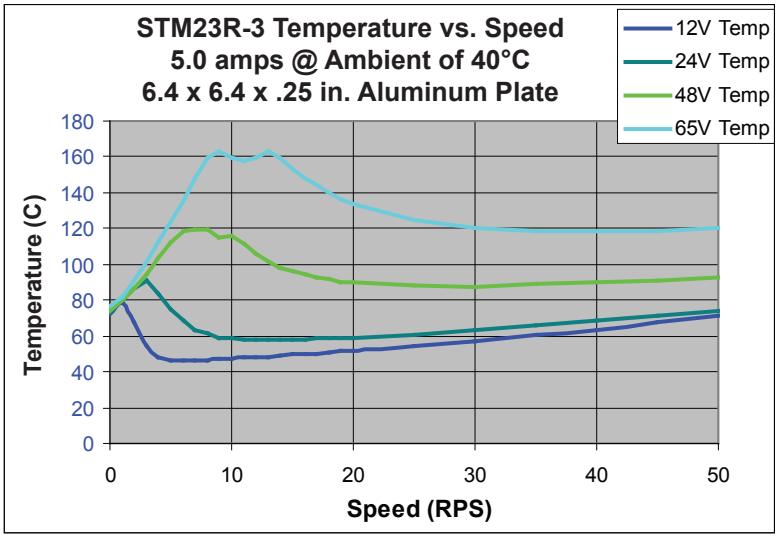
A step motor typically reaches its maximum temperature after 30 to 45 minutes of operation. A motor that runs for one minute and then rests for one minute is said to have a duty cycle of 50%. Five minutes of running and five minutes of rest is also a 50% duty cycle. However, one hour of running and one hour of rest has the effect of 100% duty cycle as the motor will reach full and possible excessive temperature during the first hour. The actual temperature of the motor depends on how much heat is conducted, convected or radiated out of it.

The curves below result from measurements 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. Results may vary.






STM23R-3 Max Duty Cycle vs. Speed
5.0 amps @ Ambient of 40°C
6.4 x 6.4 x .25 in. 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)


STM23R-3 Temperature vs. Speed
5.0 amps @ Ambient of 40°C
6.4 x 6.4 x .25 in. Aluminum Plate
12V Temp
24V Temp
48V Temp
65V Temp
Temperature (C)
180
160
140
120
100
80
60
40
20
0
0
10
20
30
40
50
Speed (RPS)

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