USER MANUAL

NI ISM-7401/7402

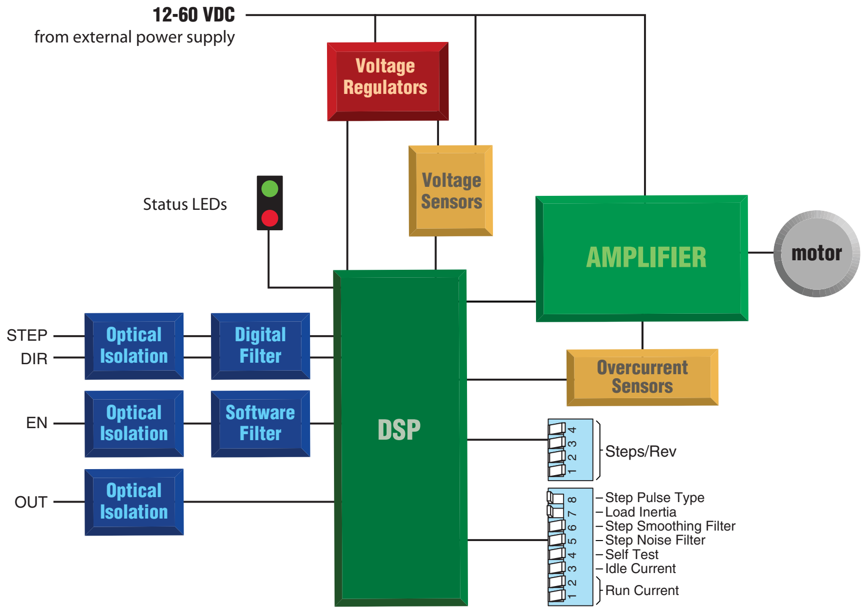
Integrated Stepper

This manual describes the NI ISM-7401 and the NI ISM-7402 integrated steppers. It describes electrical and mechanical characteristics of the devices, as well as I/O functionality.

Contents

NATIONAL INSTRUMENTS™

Figure 1. Block Diagram



Getting Started

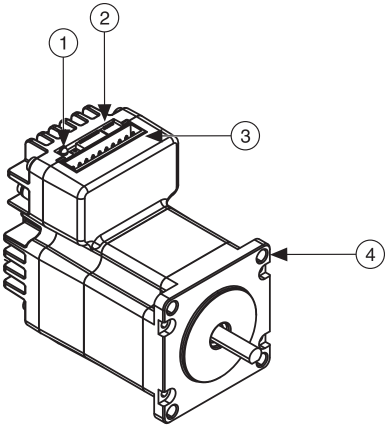
You will need the following items to get started with your NI ISM-7401/7402:

- ☐ 12 VDC to 60 VDC power supply. NI PS-12 (NI part number 748906-01) or NI PS-13 (NI part number 748907-01) recommended.
- ☐ Tool for inserting wires into the connector
- ☐ Source of step signals, such as a PLC or motion controller

Refer to *Choosing a Power Supply* for more information.

Figure 2 shows an overview of the connectors on the NI ISM-7401/7402 integrated stepper.

Figure 2. NI ISM-7401/7402 Integrated Stepper Connectors



1	Status LED	3	Power and I/O Connector
2	DIP Switches (current, idle current, steps/rev, load inertia)	4	Mounting Holes (x4)

Mounting the NI ISM-7401/7402

Mount your NI ISM-7401/7402 using four #6 or #8 screws. Securely fasten the NI ISM-7401/7402 to a smooth, flat metal surface to conduct heat away from the motor. To prevent overheating, forced airflow from a fan may be required. Refer to the *Heating* section for more information.

Caution Never use your NI ISM-7401/7402 in a space where there is no airflow or where other devices cause the surrounding air to be higher than 40 °C.

Caution Never put the NI ISM-7401/7402 where it can get wet or where metal or other electrically conductive particles can contact the circuitry.

Caution Always provide air flow around the drive. When mounting multiple NI ISM-7401/7402 integrated steppers near each other, maintain at least one half inch of space between devices.

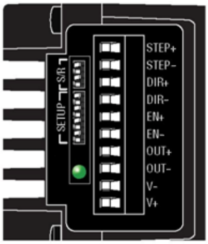
Connecting the Power Supply

Refer to *Choosing a Power Supply* for more information.

1. Use 1.02 mm to 0.81 mm diameter (18-20 AWG) gauge stranded wire for connections.
2. Connect the power supply positive (+) terminal to the connector terminal labeled V+.
3. Connect power supply negative (-) terminal to the connector terminal labeled V-

The NI ISM-7401/7402 contains an internal fuse that connects to the power supply positive (+) terminal. This fuse is not user-replaceable. If you want to install a user-replaceable fuse in your system, install a fast-acting 4 A fuse in line with the positive (+) power supply lead. Figure 3 shows the NI ISM-7400 connections.

Figure 3. NI ISM-7401/7402 Connector



Caution Do not reverse the wires. Reverse connection will damage your drive and void your warranty.

When you rapidly decelerate a load from a high speed, much of the kinetic energy of that load transfers back to the power supply. This transfer can trigger the overvoltage protection of a switching power supply, causing it to shut down. Unregulated power supplies generally do not have overvoltage protection and have large capacitors for storing energy coming back from the drive. NI offers the SMD-7700 regeneration clamp, part number 748908-01, to solve this problem.

Choosing a Power Supply

NI offers two power supplies for the NI ISM-7400:

- NI PS-12 (24 V, 6.3 A)
- NI PS-13 (48 V, 6.7 A)

Voltage

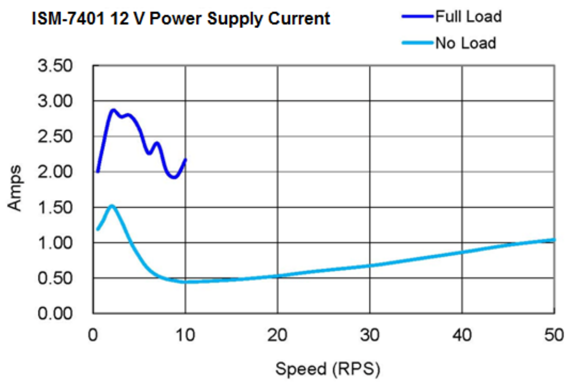
Your motor can provide more torque at higher speeds if you use a higher power supply voltage. Refer to the speed-torque curves for more information.

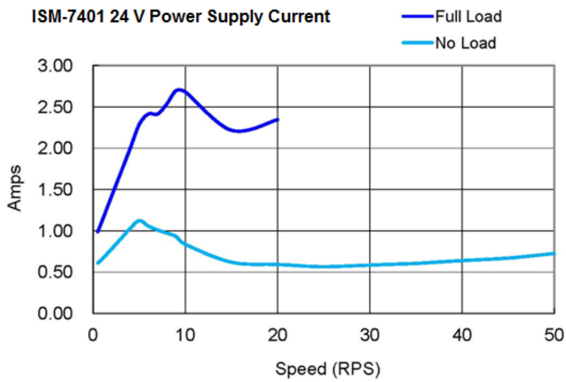
Note If you choose an unregulated power supply, ensure the no-load voltage of the supply does not exceed 60 VDC.

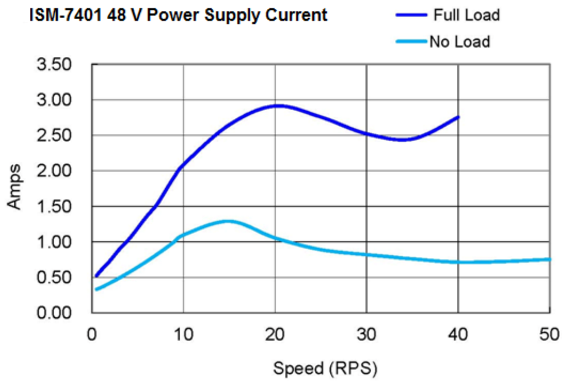
Current

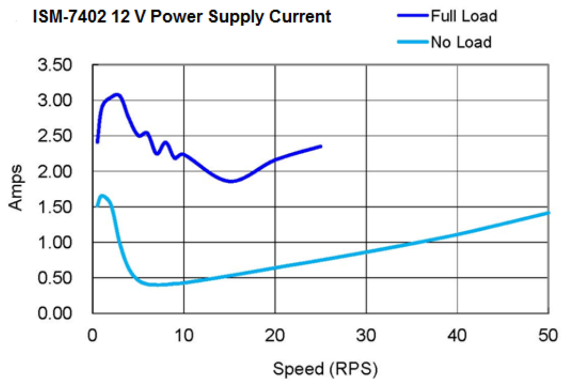
The following charts list the maximum current required for each motor at several common power supply voltages.

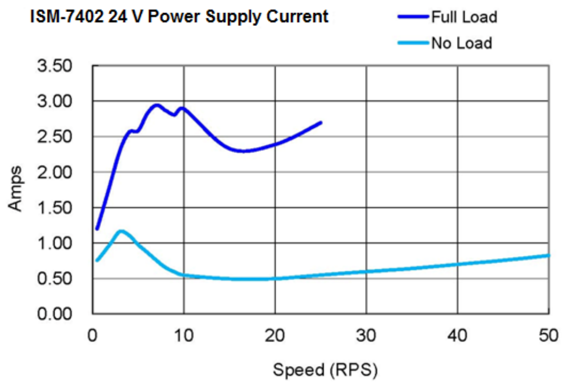
Note Full load curves are abbreviated because of the speed limitation at lower voltages.

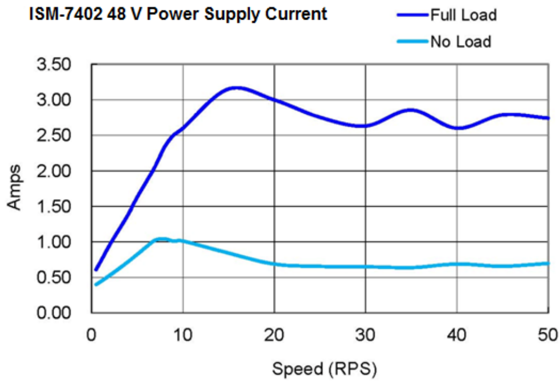





ISM-7401 48 V Power Supply Current
Full Load
No Load
3.50
3.00
2.50
2.00
1.50
1.00
0.50
0.00
Amps
0
10
20
30
40
50
Speed (RPS)


ISM-7402 12 V Power Supply Current
Full Load
No Load
3.50
3.00
2.50
2.00
1.50
1.00
0.50
0.00
Amps
0
10
20
30
40
50
Speed (RPS)


ISM-7402 24 V Power Supply Current
Full Load
No Load
3.50
3.00
2.50
2.00
1.50
1.00
0.50
0.00
Amps
0
10
20
30
40
50
Speed (RPS)



Regeneration

If you plan to use a regulated power supply, you may encounter a problem with regeneration. If you rapidly decelerate a load from a high speed, much of the kinetic energy of that load is transferred back to the power supply. This can trip the overvoltage protection of a switching power supply, causing it to shut down. Unregulated power supplies are better suited for applications with significant regeneration as they generally do not have overvoltage protection and have large capacitors for storing energy coming back from the drive. Refer to *Connecting the Power Supply* for more information.

Connecting Input Signals

The NI ISM-7401/7402 has three inputs:

- **STEP**—High-speed digital input for step pulse commands, 5 V to 24 V logic
- **DIR**— High-speed digital input for the direction signal, 5 V to 24 V logic
- **EN**—5 V to 24 V input for commanding the removal of power from the motor

Note To convert STEP and DIR inputs to STEP CW and STEP CCW, move switch #8 to the ON position. Refer to *Step Pulse Type* for more information.

Figure 4. Connector Pin Diagram

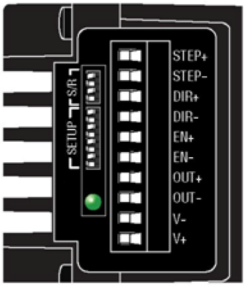
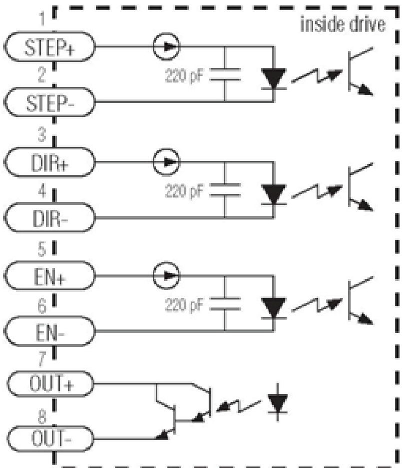


Figure 5. Internal Circuit Diagram



Connection Examples: STEP & DIR

Figure 6. Connecting to Indexer with Sourcing Outputs

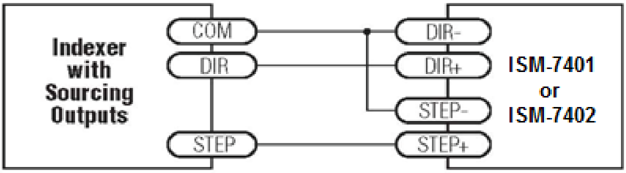


Figure 7. Connecting to Indexer with Sinking Outputs

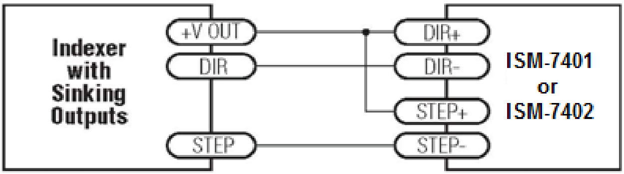
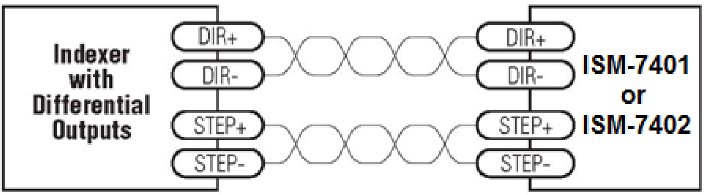


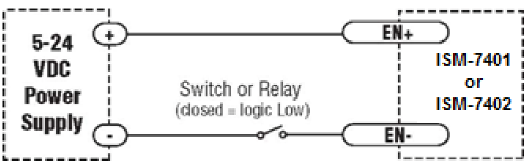
Figure 8. Connecting to Indexer with Differential Outputs



Connection Examples: EN

Connecting the Enable input as shown in Figure 9 causes the drive to disable when the relay is closed and enable when the relay is open.

Figure 9. Connecting an Input to a Switch or Relay



Connecting the Enable signal as shown in Figures 10 and 11 causes the drive to disable when the proximity sensor activates.

Figure 10. Connecting an NPN Type Proximity Sensor to an Input

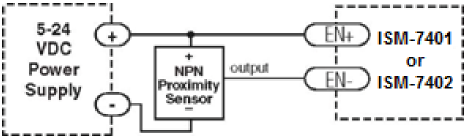
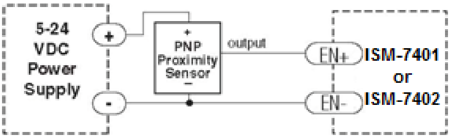


Figure 11. Connecting a PNP Type Proximity Sensor to an Input

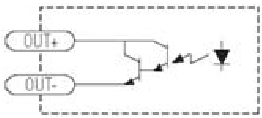


Note When the proximity sensor activates, the input closes.

Connecting the Digital Output

The NI ISM-7401/7402 has a digital output labeled OUT. This output closes to signal a fault condition.

Figure 12. Internal Circuit Diagram



Use this output to drive LEDs, relays, and the inputs of other electronic devices like PLCs. The positive collector and negative emitter terminals of the output transistor are available at the connector. This allows you to configure the output for current sourcing or sinking.

Diagrams of each type of connection follow.

Caution Do not connect the output to more than 30 VDC. The current through the output terminal must not exceed 80 mA.

Figure 13. Sinking Output

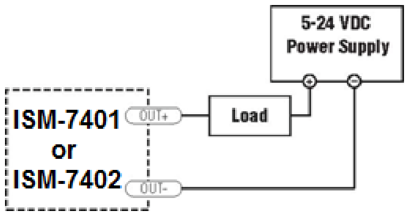


Figure 14. Sourcing Output

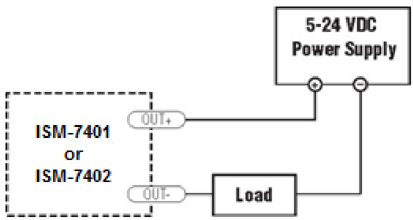
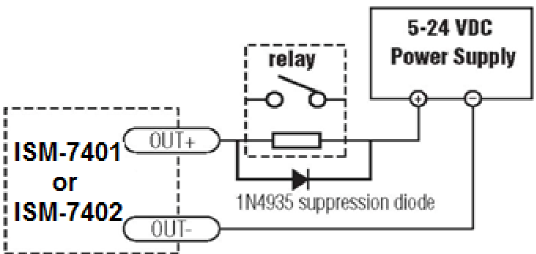


Figure 15. Driving a Relay

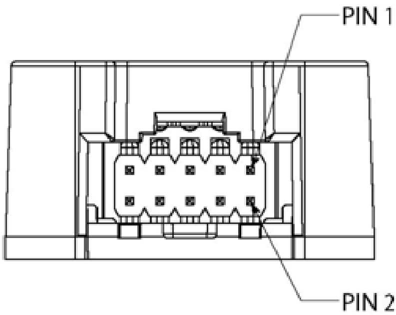


Using the Optional Encoder

There are three versions of the NI ISM-7401 and NI ISM-7402: the NI ISM-7401/7402 has a single shaft, the ISM-7401D/7402D has a dual shaft, and the ISM-7401E/7402E has a dual shaft with a 1000-line, incremental encoder assembled to the rear shaft of the unit. You can connect the A, B, and Index (Z) channel signals of this encoder 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 748995-01.

Note If you are making your own cable to connect the encoder signals to your controller, NI recommends using a shielded cable with four or five twisted pairs for improved noise immunity.

Figure 16. NI ISM-7401/7402 Encoder Connector



Configuring the NI ISM-7401/7402

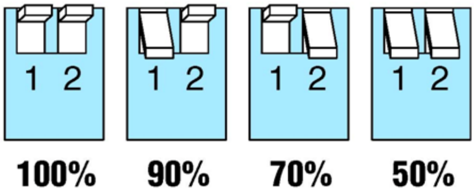
Setting the Current

Set the current to 100% to achieve maximum torque. However, under some conditions you might 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 conduct heat away or if you expect the ambient temperature 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, the motor provides 90% of the rated torque and approximately 81% as much heat. At 70% current, the torque is reduced to 70% and the heating to about 50%.

Switches 1 and 2 on the front of the NI ISM-7401/7402 control the percent of rated current that is applied to the motor. Set them according to the illustration below.

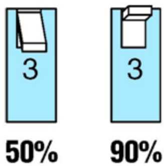
Figure 17. Configuring Current on Switches 1 and 2



Setting Idle Current

You can also reduce motor heating and power consumption by lowering the motor current when it is not moving. The NI ISM-7401/7402 automatically lowers the motor current when it is idle to either 50% or 90% of the running current. The 50% idle current setting lowers the holding torque to 50%, which is enough to prevent the load from moving in most applications. This reduces motor heating by 75%. Some applications, such as those supporting a vertical load, require a high holding torque. In such cases, set the idle current to 90% as shown in the following figure.

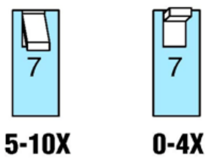
Figure 18. Configuring Idle Current on Switch 3



Load Inertia

The NI ISM-7401/7402 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 completed automatically in the factory during motor and drive assembly. 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. Divide your load inertia by the NI ISM-7401/7402 rotor inertia (82 g-cm2) to determine the ratio, then set switch 7 accordingly, as shown below.

Figure 19. Configuring Load Inertia on Switch 7



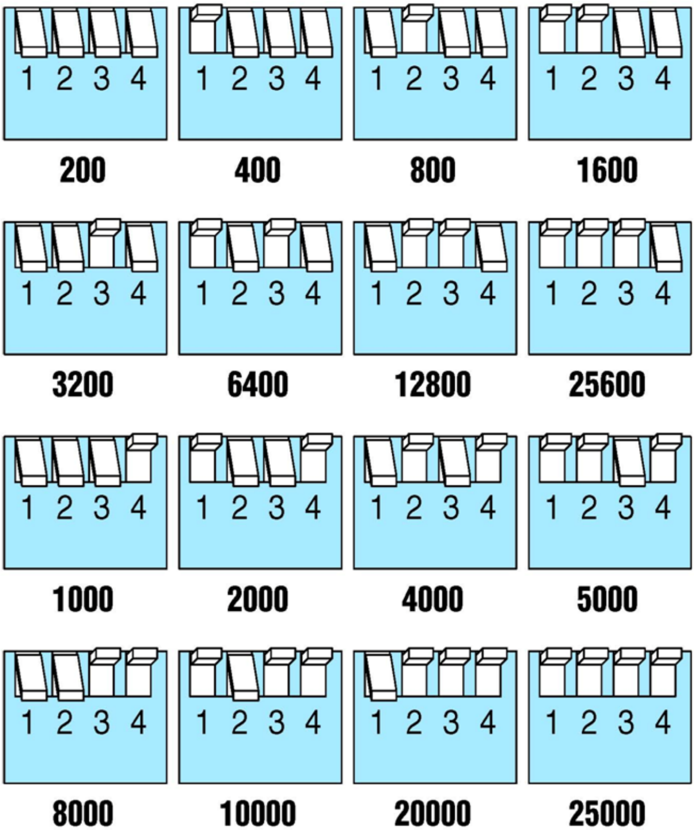
Step Size

The NI ISM-7401/7402 requires a source of step pulses to command motion. This source can be a PLC, an indexer, a motion controller, or another type of device that can produce step pulses with a frequency proportional to the desired motor speed. The source must also 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 pulse frequency must be 50 × 25,000 = 1.25 MHz. The NI ISM-7401/7402 provides sixteen different settings for steps per revolution as illustrated in the following figure.

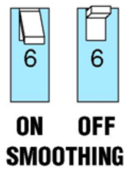
Select the steps per revolution setting that best suits your system capabilities.

Figure 20. Configuring Step Size on Switches 1, 2, 3, and 4



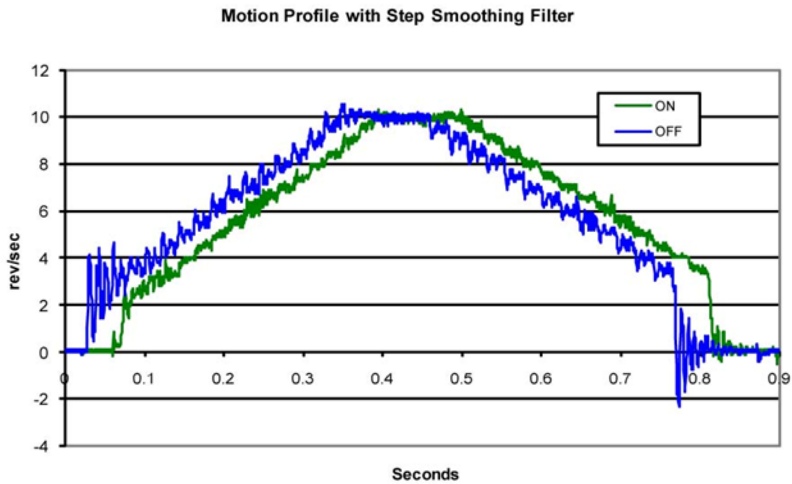
At lower step resolutions such as 200 steps per revolution (full step) and 400 steps per revolution (half step) motors produce more audible noise than when they are microstepped (2000 steps per revolution and beyond). The NI ISM-7401/7402 includes a feature called microstep emulation, also called step smoothing, that can provide smooth motion when using full and half steps. Set switch 6 to the ON position, as shown in the figure below, to provide the smoothest possible motion when using full and half steps.

Figure 21. Configuring Step Smoothing on Switch 6



The step smoothing process uses a command filter which causes a slight delay, or lag in the motion. The following figure shows an example of the delay that can occur from using the step smoothing filter.

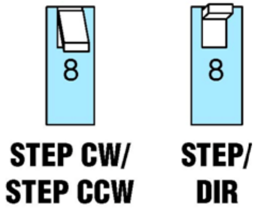
Figure 22. Delay Due to Filtering



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 where one signal pulses once for each desired step in the clockwise direction (STEP CW), while a second signal pulses for counterclockwise motion (STEP CCW). Set switch 8 as shown in the following figure to allow the NI ISM-7400 to accept this type of signal. In STEP CW/STEP CCW mode, connect the CW signal to the STEP input and connect the CCW signal to the DIR input.

Figure 23. Configuring Step Pulse Type on Switch 8

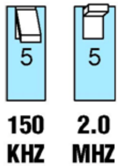


Step Pulse Noise Filter

Electrical noise can negatively affect the STEP signal by causing the drive to interpret one step pulse as two or more pulses. This results in extra motion and inaccurate motor and load positioning. To solve this problem, the NI ISM-7401/7402 includes a digital noise filter on the STEP and DIR inputs. The default factory setting of this filter is 150 kHz, which is suitable for most applications. This is set by moving switch 5 to the ON position.

Note If you are operating the NI ISM-7401/7402 at a high number of steps per revolution in combination with high motor speeds, you may be commanding the drive at step rates above 150 kHz. In such cases, you should set switch 5 to the OFF position as shown below.

Figure 24. Configuring Step Noise Filter on Switch 5



Your maximum pulse rate equals the highest motor speed multiplied by the number of steps per revolution. For example:

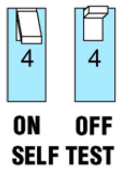
$$40\frac{revs}{second} \times 20,000\frac{steps}{revs} = 800kHz$$

Consider the maximum pulse rate when deciding whether you must increase the filter frequency.

Self Test

If you are having trouble getting your motor to turn, use the built-in self test. When you set switch 4 to the ON position, the drive automatically rotates the motor back and forth, two and a half turns in each direction. Use this feature to confirm that the motor is wired correctly, selected, and otherwise operational.

Figure 25. Configuring Self Test on Switch 4



Reference Materials

Torque-Speed Curves

Figure 26. Torque Curve for NI ISM-7401

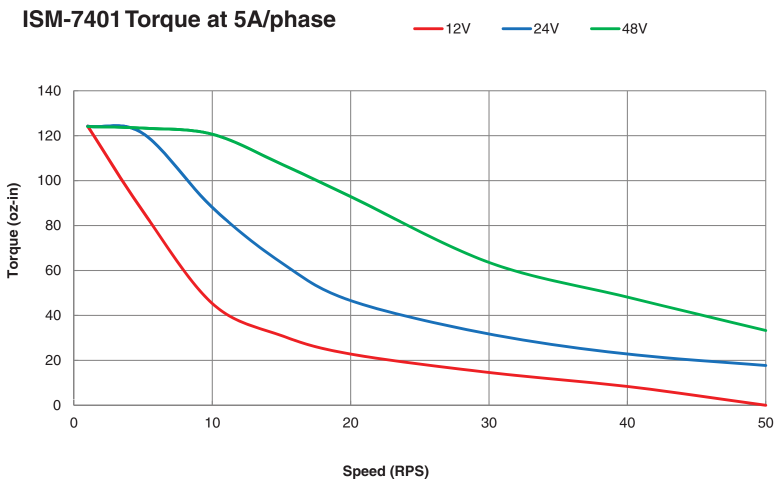
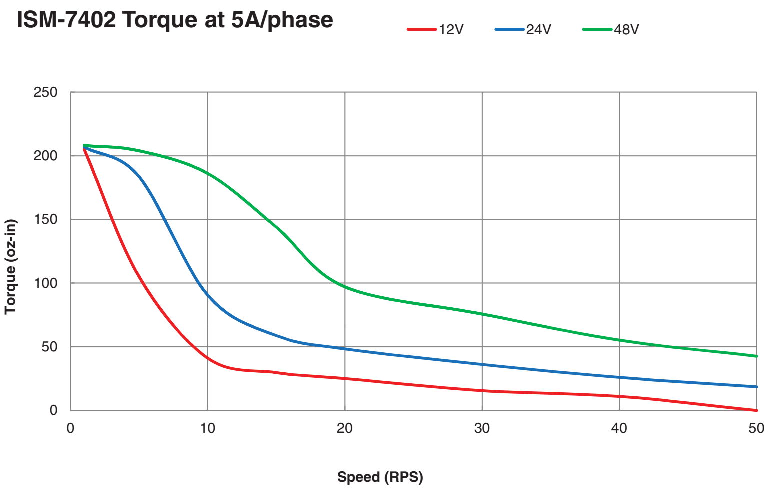


Figure 27. Torque Curve for NI ISM-7402



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 depends on the motor speed and power supply voltage rather than load. There are certain combinations of speed and voltage at which you can continuously operate a motor without damage.

The drive electronics of the NI ISM-7401/7402 also dissipate power. The heat produced by the electronics is dependent on power supply voltage and motor speed.

The following figures show the maximum duty cycle versus speed for the NI ISM-7401/7402 at commonly used power supply voltages. Refer to these curves when planning your application. Use the charts depicting typical power dissipation when planning the thermal design of your application.

A step motor typically reaches maximum temperature after 30 to 45 min of operation. Running the motor for one minute and then idling for one minute results in a 50% duty cycle. Running the motor for five minutes on and five minutes off also results in 50% duty. One hour on and one hour off results in 100% duty because the motor will reach full and possibly excessive temperature during the first hour of use.

Note National Instruments tested the NI ISM-7401/7402 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 might vary.

Maximum Duty Cycle

Figure 28. Duty Cycle for the ISM-7401

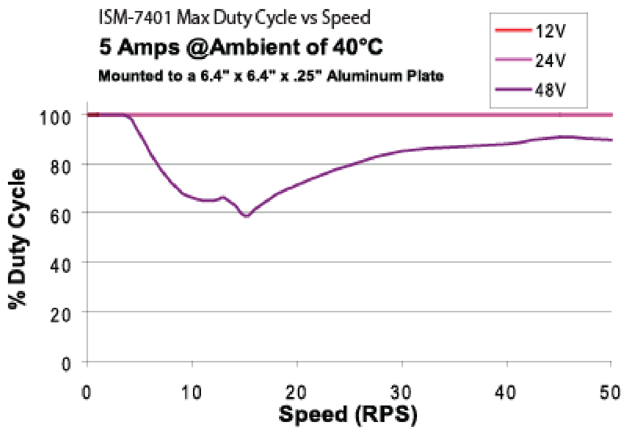
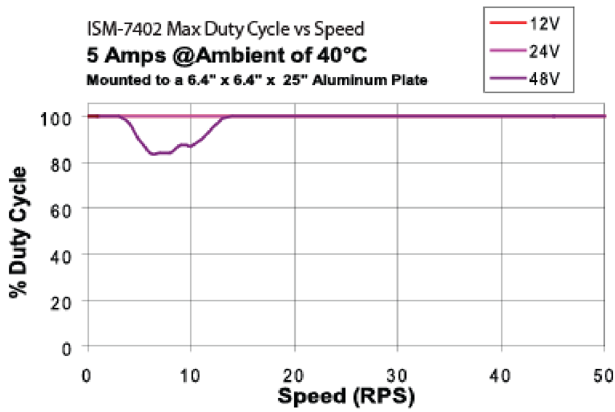


Figure 29. Duty Cycle for the ISM-7402



Temperature

Figure 30. Temperature vs. Speed for the NI ISM-7401

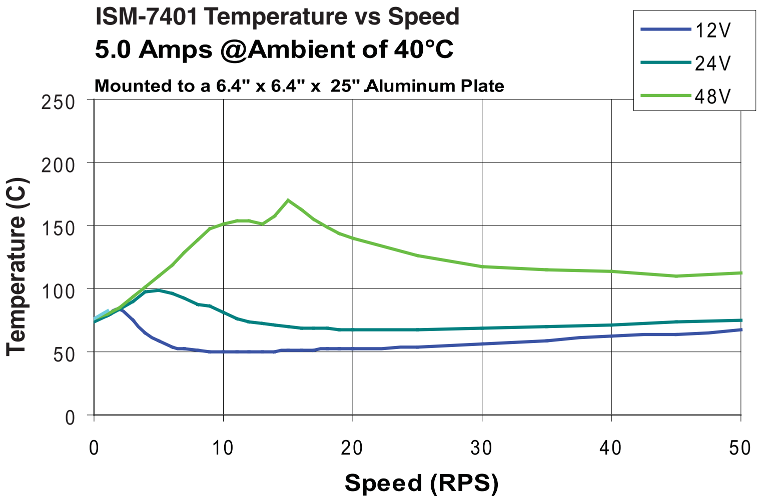
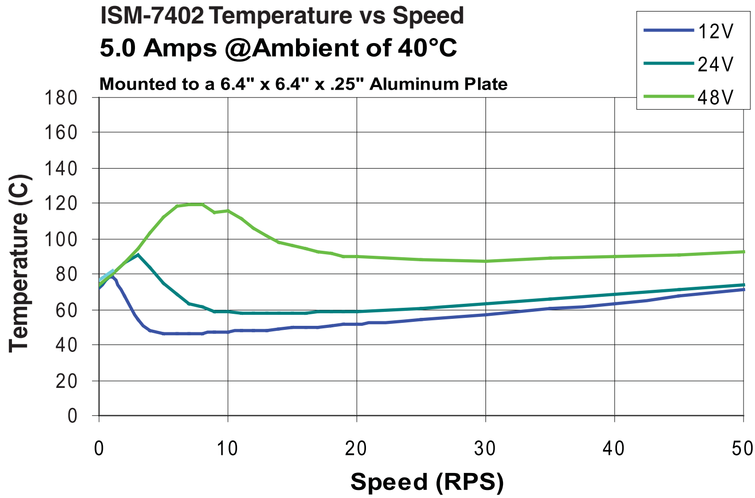


Figure 31. Temperature vs. Speed for the NI ISM-7402



Power Consumption

Figure 32. Power Consumption for the NI ISM-7401

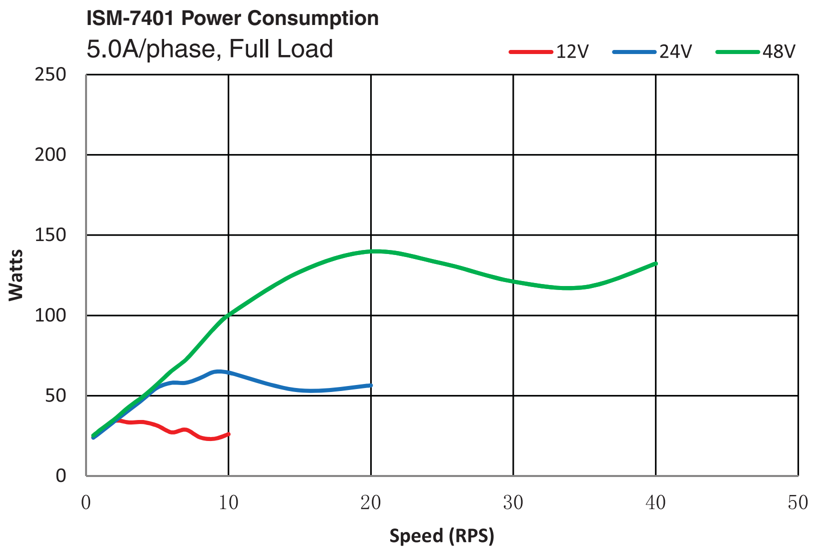
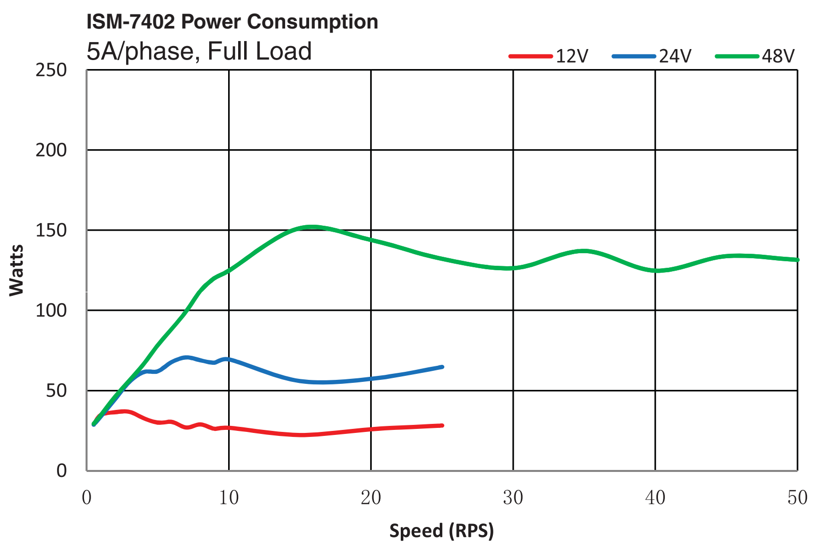


Figure 33. Power Consumption for the NI ISM-7402



Power Dissipation

Figure 34. Power Dissipation for the NI ISM-7401

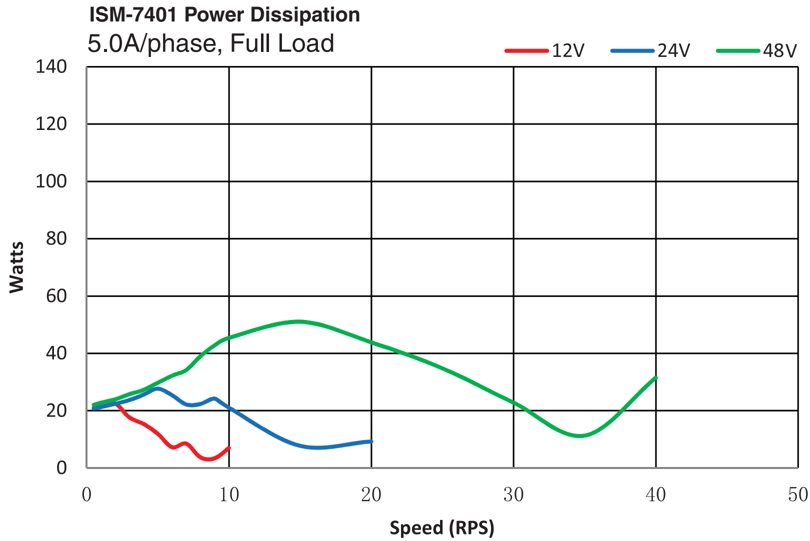
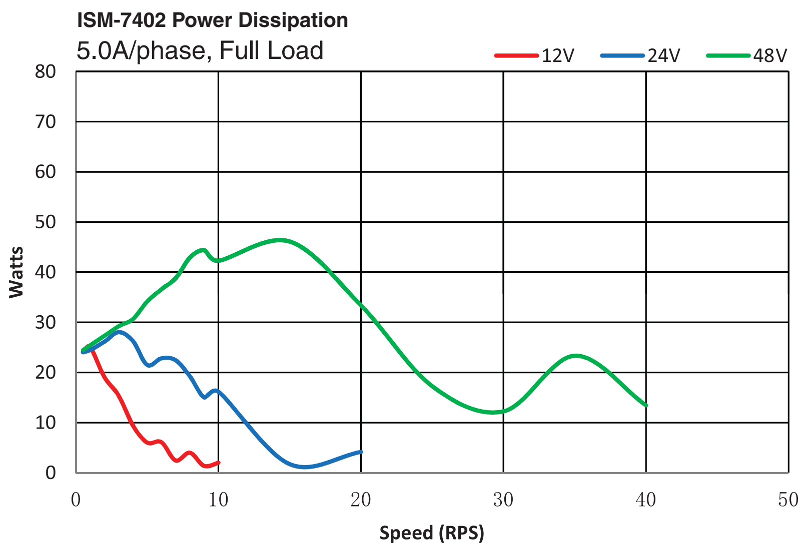


Figure 35. Power Dissipation for the NI ISM-7402



Mechanical Outlines

Figure 36. Mechanical Outline for the NI ISM-7401

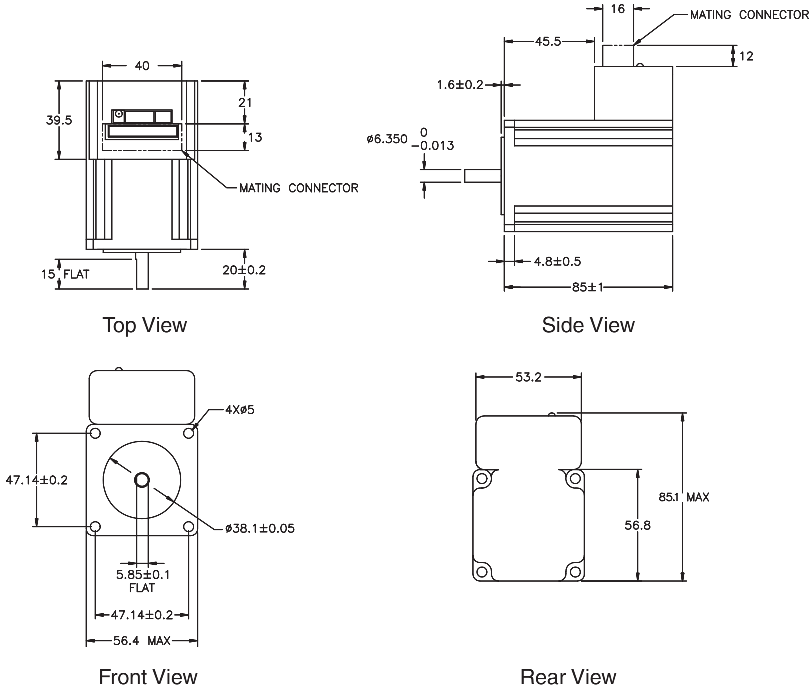


Figure 37. Mechanical Outline for the NI ISM-7401D

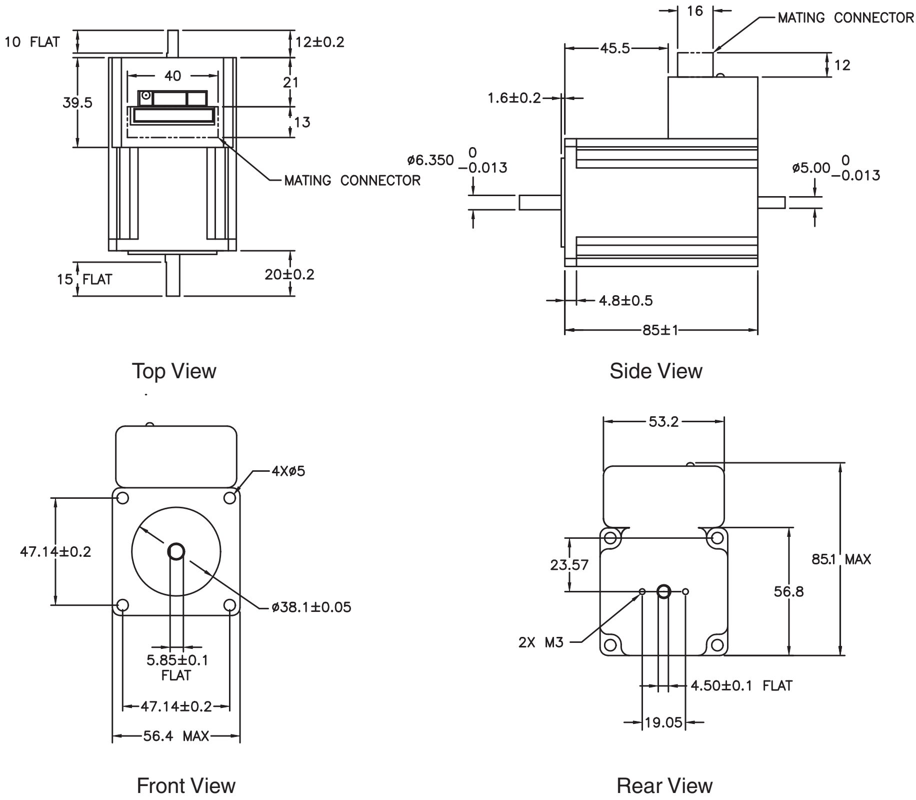


Figure 38. Mechanical Outline for the NI ISM-7401E

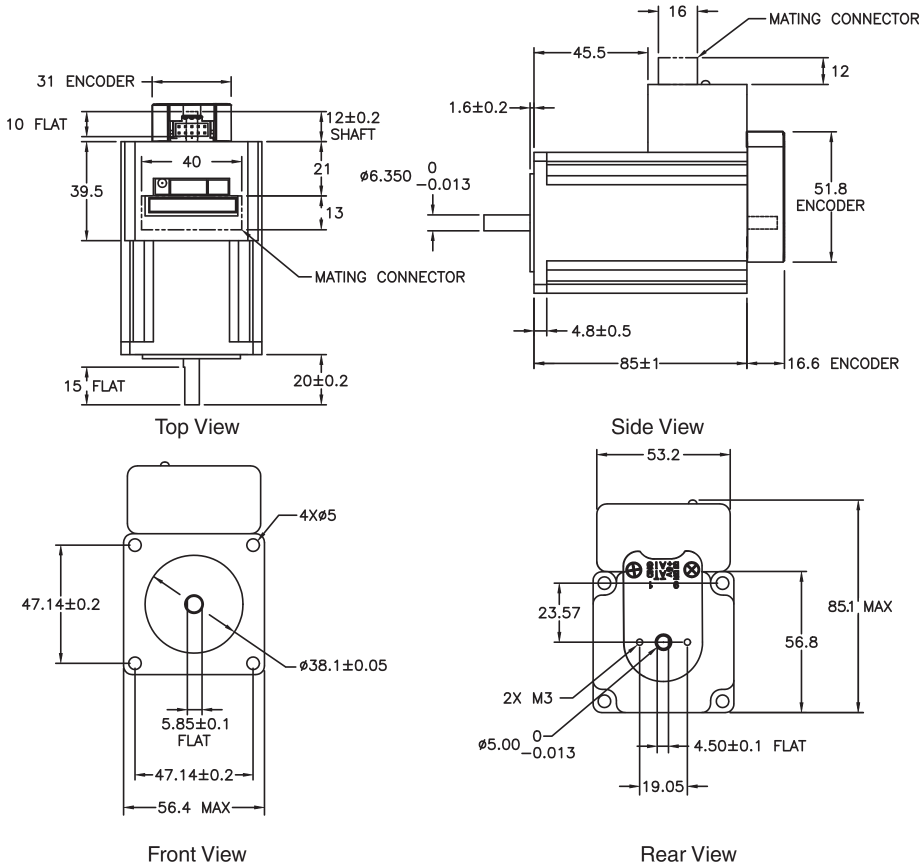


Figure 39. Mechanical Outline for the NI ISM-7402

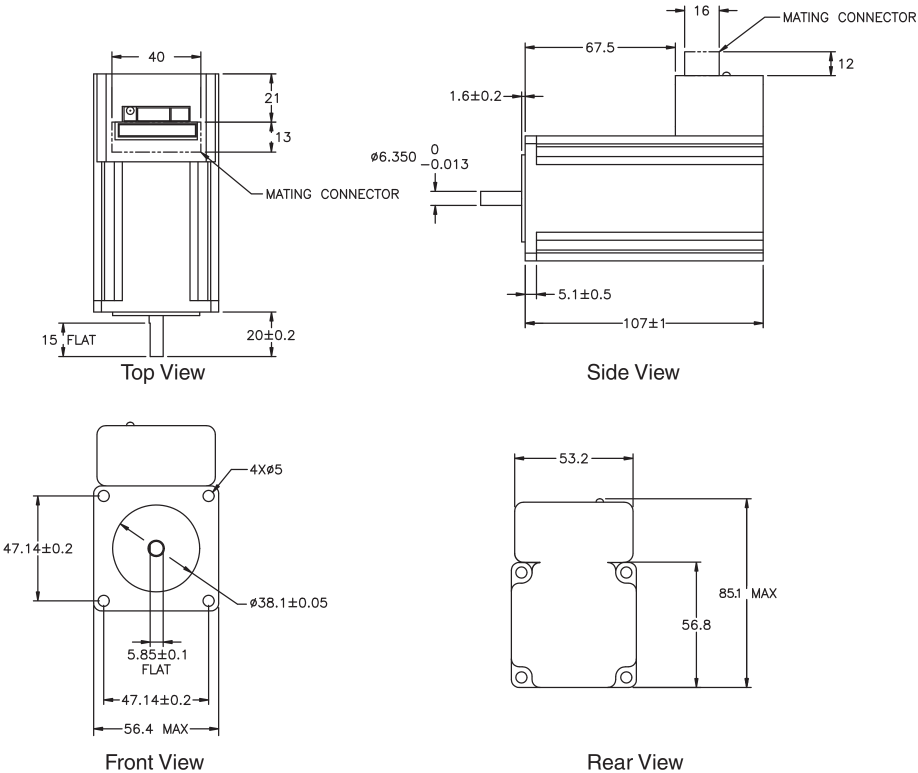
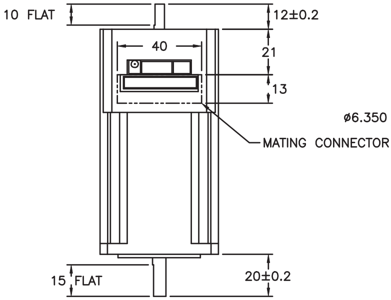
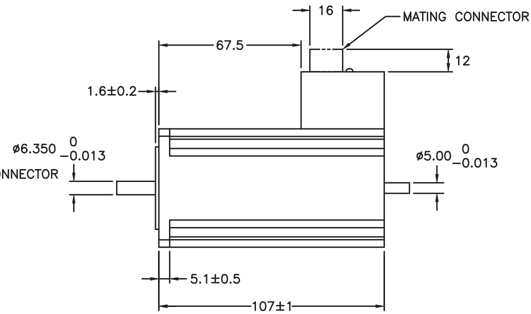


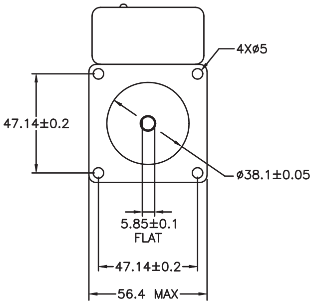
Figure 40. Mechanical Outline for the NI ISM-7402D



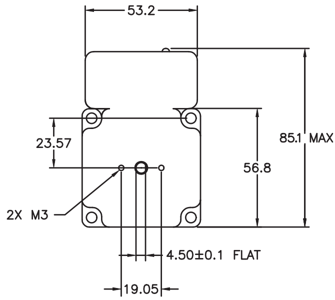
Top View



Side View

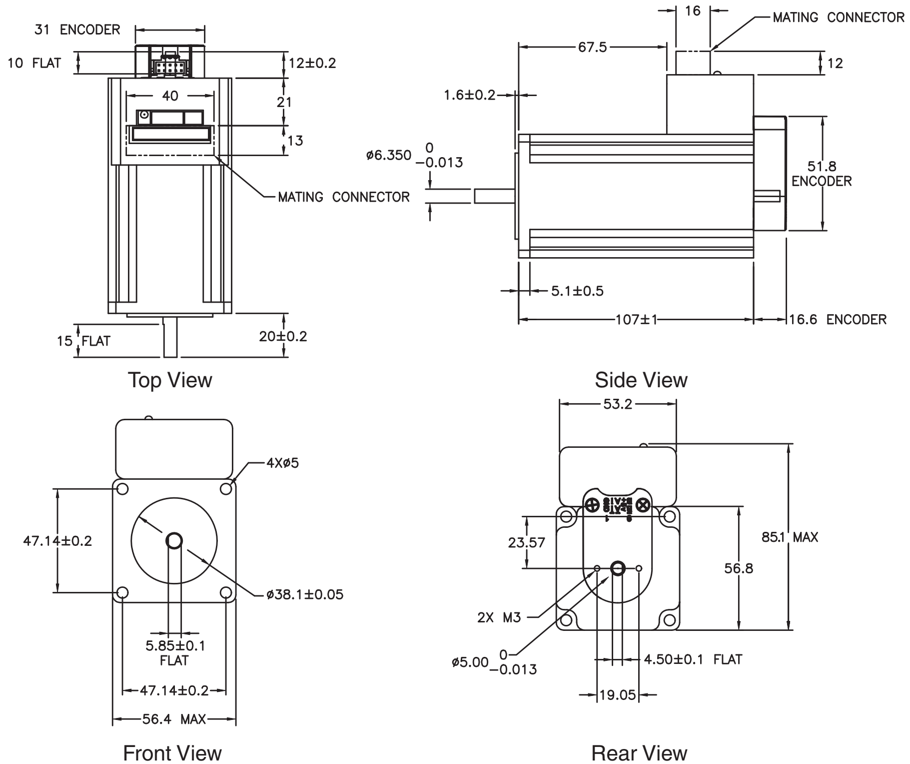


Front View



Rear View

Figure 41. Mechanical Outline for the NI ISM-7402E



Technical Specifications

Amplifier

Digital MOSFET..16 kHz PWM

Protection...Over-voltage, under-voltage, over-current, over-temperature

Supply voltage...12 VDC to 60 VDC

Under-voltage alarm................................10 VDC

Over-voltage shutdown............................75 VDC

Over-temp shutdown..85 °C

Motor current...2.5 to 5.0 A/phase peak of sine

Motor

Torque .... Refer to *Torque-Speed Curves*

Digital Inputs

Optically isolated, 5 V to 24 V logic. Sourcing, sinking, or differential signals can be used. Drive steps on falling edge of STEP+ input.

Minimum on voltage .... 4 VDC

Maximum voltage... 30 VDC

Input current .... 5 mA typ at 4 V,
15 mA typ at 30 V

Maximum pulse frequency: .... 150 kHz or 2 MHz (switch selectable)

Minimum pulse width...................................... 3 µs (at 150 kHz setting)
0.25 µs (at 2 MHz setting)

Fault Output

Photodarlington .... 80 mA, 30 VDC max

Voltage drop... 1.2 V max at 80 mA

Physical

NI ISM-7401

Size .... 2.22 in. × 3.35 in.× 3.35 in.
(56.4 mm × 85 mm × 85 mm), not including pilot or shaft. 0.25 in. shaft with flat.

Weight... 30 oz (850 g)

Rotor inertia .... 3.68×10^{-3} oz-in.-sec^2 (260 g-cm^2)

NI ISM-7402

Size .... 2.22 in. × 3.35 in. × 4.21 in.
(56.4 mm × 85 mm × 107 mm), not including pilot or shaft. 0.25 in. shaft with flat.

Weight... 42 oz (1200 g)

Rotor inertia .... 6.52×10^{-3} oz-in.-sec^2 (460 g-cm^2)

Operating temperature range .... 0 °C to 40 °C

Incremental Encoder Specifications

10-pin connector signals (pin assignments)

Ground 1, 2

Index- 3

Index+ 4

A- 5

A+ 6
+5VDC power 7, 8
B- 9
B+ 10

Power supply requirements...............................5 VDC at 56 mA typical, 59 mA max

Encoder internal differential line driver (26C31)
Source ....20 mA at TTL levels
Sink ....20 mA at TTL levels

Maximum encoder frequency ....100,000 cycles per second

Mating Connectors and Accessories

Mating Connector

11-pin screw terminal connector, 3.5 mm pitch, included with drive.

Connector part number ....Weidmuller 1610200000

Wire gauge ....1.02 mm to 0.81 mm in diameter (18 to 20 AWG)

Accessories

Regeneration clamp ....NI SMD-7700, NI part number 748908-01

Power Supply
NI PS-12 ....24 VDC, 6.3 A, NI part number 748906-01
NI PS-13 ....48VDC, 6.7A, NI part number 748907-01

Alarm Codes

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

Table 1. Status LED Blink Code Definitions

Blink sequence	Code	Error
G	Solid green	No alarm, motor disabled
GG	Flashing green	No alarm, motor enabled
RR	Flashing red	Configuration or memory error
RRRG	3 red, 1 green	Over temperature
RRRGG	3 red, 2 green	Internal voltage out of range
RRRRG	4 red, 1 green	Power supply voltage too high
RRRRGG	4 red, 2 green	Power supply voltage too low

Table 1. Status LED Blink Code Definitions (Continued)

Blink sequence	Code	Error
RRRRRG	5 red, 1 green	Over current/short circuit
RRRRRRG	6 reds, 1 green	Open motor winding

Worldwide Support and Services

The NI website is your complete resource for technical support. At ni.com/support you have access to everything from troubleshooting and application development self-help resources to email and phone assistance from NI Application Engineers.

Visit ni.com/services for NI Factory Installation Services, repairs, extended warranty, and other services.

Visit ni.com/register to register your NI product. Product registration facilitates technical support and ensures that you receive important information updates from NI.

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