USER'S GUIDE

Closed-Loop Stages and Amplifiers

Models 8101, 8102, 8103, & 8104

U.S. Patent #5,991,249, #5,453,653, #5,714,833, #5,696,421, #5,616,980, #5,682,076

Voltages of up to 260 V are accessible inside the driver chassis, mounts, and motor. While protection circuits are included, DO NOT operate the units with the driver or mount covers removed. If the cable of a mount or motor is frayed or otherwise damaged, discontinue use and return it for repair.

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Warranty

New Focus, Inc. guarantees its products to be free of defects for one year from the date of shipment. This is in lieu of all other guarantees, expressed or implied, and does not cover incidental or consequential loss.

Products described in this document are covered by the following U.S. patents: #5,991,249, #5,453,653, #5,714,833, #5,696,421, #5,616,980, #5,682,076.

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Contents

Introduction

Overview

The New Focus closed-loop translation stages can provide closed-loop operation at resolutions of 100 nanometers or less using the built-in optical encoder. Model 8101 is a linear stage with 44 mm of travel that can move up to 100 mm per second. Model 8102 is a linear "Z-wedge" that can lift more than six pounds. Model 8103 is a rotary stage that can move a full 360 degrees at speeds of 30 RPM or more. Model 8104 is a goniometric stage that can tip or tilt ±10 degrees. All four models use piezo-friction motor technology and high-resolution encoders to provide fast, highly accurate positioning of your parts.

Unpacking the System

Unpack the stage components with care. Compare the contents against the packing slip and inspect them for signs of damage. If parts are missing or you notice signs of damage, such as dented or scratched covers, please contact New Focus immediately. Save all packing materials in the event products need to be shipped elsewhere.

The following components are included in your New Focus system:

1. **Closed-loop stage** with one encoder cable attached. Depending on the model you've ordered, there will also be two or four motor cables attached (see table below).

Model	Description	Motor Configuration
8101	Linear Translation Stage	Two Motors
8102	Z-Axis Wedge	Four Motors
8103	Rotary Stage	Four Small Motors
8104	Goniometer Stage	Two Small Motors

2. **Amplifier:** Each stage comes with a matched amplifier. The amplifiers are not interchangeable between models, so be sure to verify that the correct amplifier type has been shipped with the stage unit (see table below).

Stage	Amplifier
Model 8101 Linear Translation Stage	AB1A-2A-HR-E2
Model 8102 Z-Axis Wedge	AB1A-2A-HR-E4
Model 8103 Rotary Stage	AB1A-4-STM
Model 8104 Goniometer Stage	AB1A-2A-HR-E2

3. **Motor-Splitter Cable:** connects the motor cables to the amplifier.
4. **User's Guide**

Additional Components Required

The following additional components are required to complete a closed-loop motion control system:

1. 5-volt and 48-volt power supplies
2. Power-supply-to-amplifier cable
3. Motion control card, computer, or peripheral device such as a joystick

4. Motion-controller-to-encoder interface cable
5. Motion-controller-to-amplifier interface cable

Note: *Information on selecting a power supply and a motion controller can be found in the "Operation" chapter beginning on page 9.*

User Safety

Care must be taken when connecting the amplifier to a motion controller and power supply. If you are unfamiliar with any of the stage components, please read the entire User's Guide before attempting connection of the stages.

CAUTION! *Voltages of up to 260 V are accessible inside the driver chassis, mounts, and motors. Although protection circuits are included, do not operate the units with the driver or mount covers removed. If the wire of a mount or motor is frayed or otherwise damaged, discontinue use and contact New Focus for information on how to return it for repair.*

Operation

Overview

Before you begin setting up your closed-loop motion control system, you will need to provide an external power supply and motion controller, as well as cables for connecting them to the stage and amplifier. This chapter offers guidelines for selecting these components, followed by instructions on mounting the stages and connecting all of the components together.

Selecting a Power Supply

The amplifier box requires +48 VDC/125 mA and ground from an external power supply to operate. The power requirements for the stages are as follows:

Model	Description	Supply Voltage	Current Consumption
8101	Linear Translation Stage	+48 V ±5%	325 mA
8102	Z-Wedge Translation Stage	+48 V ±5%	525 mA
8103	Rotary Stage	+48 V ±5%	525 mA
8104	Goniometer Stage	+48 V ±5%	325 mA

22 AWG (or lower) wires should be used for the power supplies. In noisy environments, it is recommended that the ground line and power line be twisted together.

Selecting a Motion Controller

The New Focus motion system looks and acts somewhat like a DC-servo motor and can be controlled using several methods, including motion-control cards, joysticks, or other peripheral devices, or even directly through the RS-232 port of a computer. To create a closed-loop system, however, you will need to use a motion-control card with dynamic proportional integral derivative (PID) parameter switching and stiction compensation. The supplied motion system's amplifier electronics require that the card have a minimum servo update rate of 2 kHz and the ability to position and hold to 1 encoder count.

New Focus recommends the following motion-control system:

- Galil DMC-1800 series motion-control card
- Galil CABLE-100 series cable
- Galil ICM1900 Breakout box
- Galil WSDK Servo Tuning Software
- Galil Ceramic Firmware Special

The remainder of this chapter will focus on setting up a closed-loop system using a motion control card and software. For information on setting up the system with other control methods, please refer to "Appendix III: Using the I/O Port" on page 37.

Mounting the Stage

For optimal performance, the stage should be mounted to a flat surface. New Focus recommends that the surface be flat to 0.0003 inches (8 microns).

There are four 8-32 (M4) counter-bored holes in the base of the stage. Use 8-32 (M4) socket-head cap screws tightened to 250 in-oz (18 kgf-cm) to bolt the stage to the table.

Note: *See "Appendix II: Mechanical Drawings" on page 33 to locate the mounting holes for the different stage models.*

Mounting Stages Together

The 810X stages are fully modular: they can be stacked to get any combination from one to six degrees of freedom.

Use the 8-32 UNC- 2B X .18 deep-threaded mounting holes on the top of the stages to mount the units to one another. Torques should not exceed 250 in-oz (18 kgf-cm).

Connecting the Components

The following section takes you through the steps needed to connect the closed-loop stage components together, including:

1. Connecting the closed-loop stage motor cables to the amplifier
2. Connecting your 48-volt power supply to the amplifier
3. Connecting the amplifier to your motion control card
4. Connecting the encoder cable to your motion control card
5. Making the appropriate software settings

Before you begin setting up, you may wish to familiarize yourself with the New Focus components. Figures 1 and 2 show the 810X stages and the cables you will need to connect. The amplifier's front-panel connections are defined in Figure 3.

Figure 1: Models 8101 and 8102 with encoder and motor cables

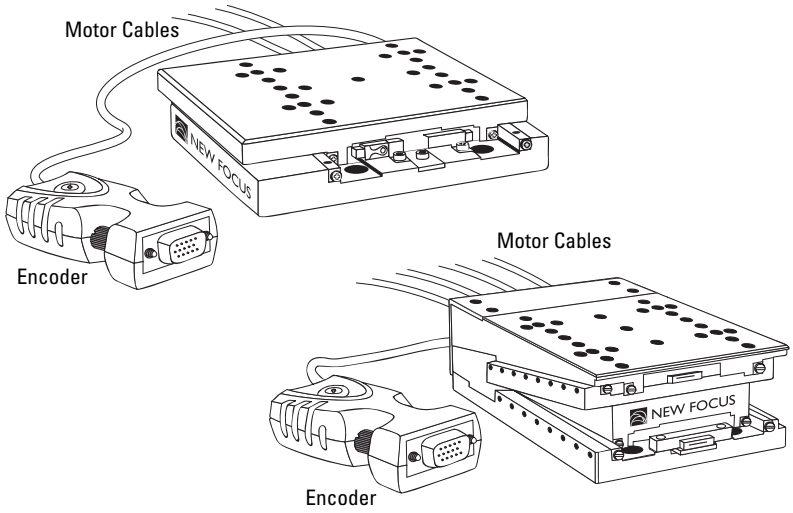


Figure 2: Models 8103 and 8104 with encoder and motor cables

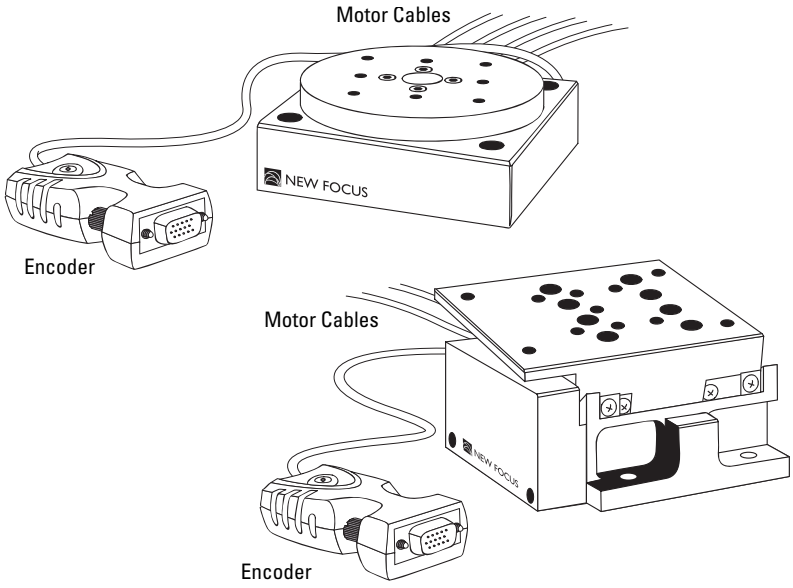
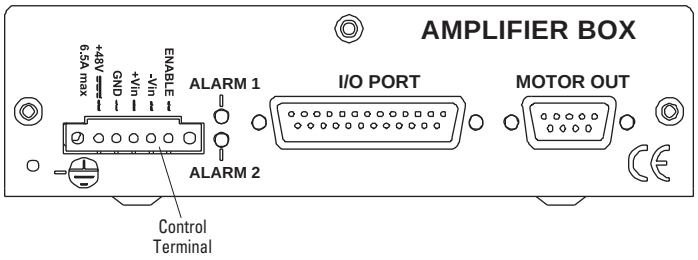


Figure 3: Front panel of the amplifier box



Connector	Description
Control Terminal	5-pin connector—Accepts input from an external +48-VDC power supply (6.5 A max) Provides direct control of the motor ENABLE signal*
I/O Port	D-type 25-pin connector female—Interfaces to the control source (joystick or controller)
Motor Out	D-type 9-pin connector male—Interfaces to the motor

* To operate, the motor requires the following minimum control signals applied to the Control Terminal: +48V, GND, +VIN, -VIN, and ENABLE. The primary voltage (+48V) is supplied from an external source.

Connecting the Stage to the Amplifier

Use the supplied cables to connect the stage's motor cables to the amplifier.

1. Connect the motor-splitter cable to the amplifier connector labeled **Motor Out**.
2. Connect each of the motor cables to any of the splitter cable ends. For the 8101 and 8104 stage models there should be two motor cables; the 8102 and 8103 models have four motor cables.

Note: *If you are experiencing trouble with the motion direction when you begin to use your system, these motor cable connections may need to be reversed. See "Correcting the Motion Direction" on page 23 for details.*

Connecting the Power Supply to the Amplifier

Using 22 AWG (or lower) wires, make the following connections from your power supply to the amplifier's **Control Terminal**:

1. Connect +48 V to the **+48 V** terminal on the left of the **Control Terminal** (see Figure 4).
2. Connect the ground wire to the **GND** terminal.
3. If your surroundings are electrically noisy, be sure to twist the ground line and power line together.

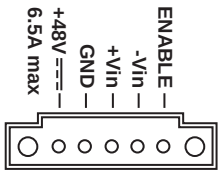
CAUTION!

Do NOT turn on the power supply until all motor and encoder connections are made.

Connecting the Amplifier to the Control Card

The amplifier requires three signals from a motion control card: an analog control signal, analog control return which is usually ground, and motor enable which is active low. Figure 4 shows the **Control Terminal** connectors on the amplifier box.

Figure 4: Control Terminal pin descriptions



Pin	Name	Description
1	+48 V	+ 48 Volts Input
2	GND	Ground
3	+Vin	Analog Drive Voltage Input
4	-Vin	Analog Drive Return
5	ENABLE	Active Low Enable Input

Note:

You will need to refer to the user's manual for your control system to determine the corresponding signal connectors on your control card.

Using a high-quality, shielded 4-conductor cable, make the following connections from your control card to the amplifier:

1. Connect a ±10 V analog output signal to **+VIN** on the **Control Terminal.**
2. Connect an analog return signal to the **-VIN** terminal. On some control cards, this signal will be the same as ground.
3. If your control card's analog return signal is not ground, you will need to run a separate ground wire to the **GND** terminal.

You will need to insert the 48-V power supply ground connection together with the control-card ground to ensure proper grounding of the amplifier box.

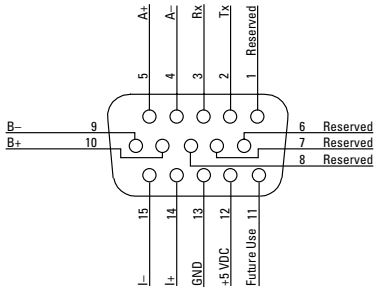
4. Make the motor-enable signal connection to the **ENABLE** terminal.

If you are using a controller other than a control card, refer to "Appendix III: Using the I/O Port" on page 37 for connection information.

Connecting the Encoder to the Control Card

A high density 15-pin male connector is provided for making the necessary connections from the control card to the encoder. The pin descriptors for this connector are shown in Figure 5.

Figure 5: Pin descriptions for the encoder's 15-pin high density 'D' connector



Pin	Function
1	Reserved
2	Serial I/F—Tx
3	Serial I/F—Rx
4	A- quadrature
5	A+ quadrature
6	Reserved

Pin	Function
7	Reserved
8	Reserved
9	B- quadrature
10	B+ quadrature
11	Future Use
12	+5 VDC
13	Ground
14	I+ Index
15	I- Index

Note: *You will need to refer to the user's manual for your control system to determine the corresponding signal connectors on your control card.*

Depending on the control card you are using, the following connections may need to be made:

1. **A+, A-, B+, B- (A/B Quadrature):** Most, if not all, controllers accept A+, A-, B+ and B- differential signals from all of the standard encoders out there, including the one in the 810X models. The encoder's four A/B quadrature signals will need be connected to the controller's corresponding inputs (**A+** to A+, **A-** to A-, etc.).

   Note: *If you are experiencing trouble with the motion direction when you begin to use your system, these cables may need to be reversed. See "Correcting the Motion Direction" on page 23 for details.*

2. **I+, I- (Index Pulse Signals):** The index pulse (differential signal via I+ and I-) is also a standard signal, although this signal is not used in all applications. It is recommended that this signal be connected if the controller accepts it.
3. **+5 VDC, Ground (Power Supply):** The **+5 VDC In** and **Ground** are *required* to power the encoder electronics. Otherwise, the encoder will read zero no matter how much vibration or shock occurs.
4. **Tx, Rx (Serial Interface):** The Tx and Rx signals are for a computer interface that allows New Focus to program the

resolution and output frequency. Normally, the Tx and Rx signals will not be needed. If you would like to access these features for some custom application, please contact New Focus technical support for more information.

Note: *There are four indicator LEDs on the side of the encoder connector. If any of these LEDs glow yellow or red, there is a problem with the encoder alignment. See "Improper Encoder Alignment" on page 24 for more information.*

Software Settings

When setting up your motion control system to control the stage and amplifier, we recommend that you follow the motion-controller manufacturer's recommended procedure as defined in their user manual. However, these are some tips to keep in mind:

- This motion system looks and acts somewhat like a DC-servo motor. The amplifier takes a ±10-VDC proportional signal, where supplied voltage is directly proportional to velocity of the stage.
- PID parameters should generally be set to low values as compared to typical DC-servo motors.

Principles of Operation

Closed-Loop Stages

The piezo-friction motors have a shaped geometry that allows the piezo elements to move a friction strip against the top portion of the motor. The piezo element expands and contracts in both horizontal and vertical directions to move the friction strip. In all closed-loop stages, more than one motor element must work in concert to move the piezo-friction strip simultaneously and achieve maximum force and velocity.

The amplifier causes the motor to be excited at, or very near, the resonant frequency of the piezo elements. This generates the maximum force and moves the piezo elements their maximum distance, allowing maximum speed to be achieved.

Embedded into each stage is an optical-encoder read head and diffraction grating that work together with encoder interface electronics to achieve less than 100-nanometer resolution. In order to protect the optical encoder, New Focus has embedded the entire optical encoder into the stage rather than bolting it to the outside of the unit.

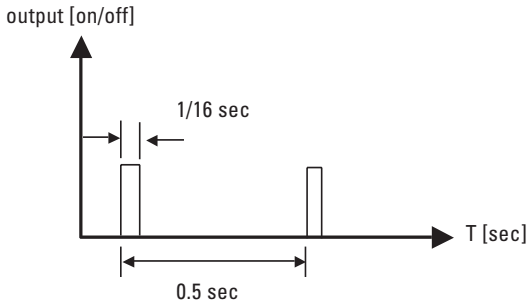
Amplifier

The amplifier box is a single-axis amplifier box designed to drive up to 32 motor elements in parallel.

The amplifier box may be operated in one of two modes: velocity mode in which the motor is driven continuously, or step mode in which the driver output is turned off and on at set intervals in order to drive the motor in discrete steps.

Step-mode operation is illustrated in Figure 6, where the output is ON for 1/16 second at 0.5 second intervals. The amplitude of the output corresponds to the analog input value and thus determines the speed of the motor.

Figure 6: Amplifier output in step mode



The amplifier box features:

- High-precision (11 bits) control of the output-power stage
- Step mode operation
- Interfaces to an analog command
- Indicator LEDs
- Output short-circuit protection
- Minimized sensitivity to cable length

Operating Principles

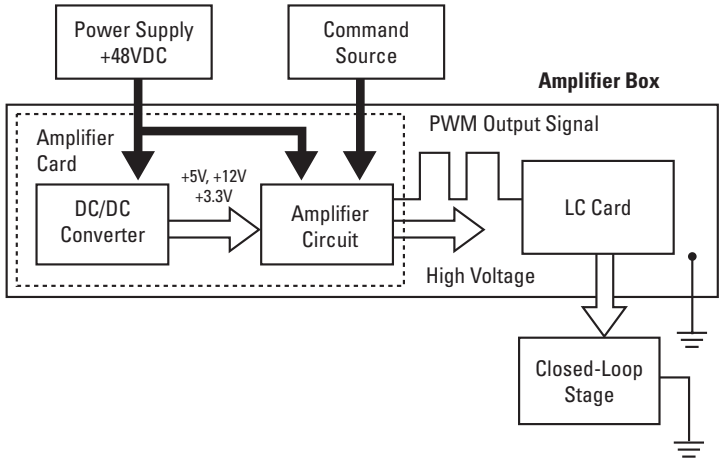
The amplifier box contains the amplifier card and an LC card. The amplifier card converts the analog input command signal into a corresponding PWM square-wave output signal that is fed to the LC card. The LC card filters the signal to produce the output voltage that drives the motor.

The LC card type corresponds to the number of motor elements to be used, and it is integrated into the amplifier box.

The required DC voltages are supplied by an internal DC-to-DC converter that is fed from an external +48-V power supply.

Figure 7 shows a typical application.

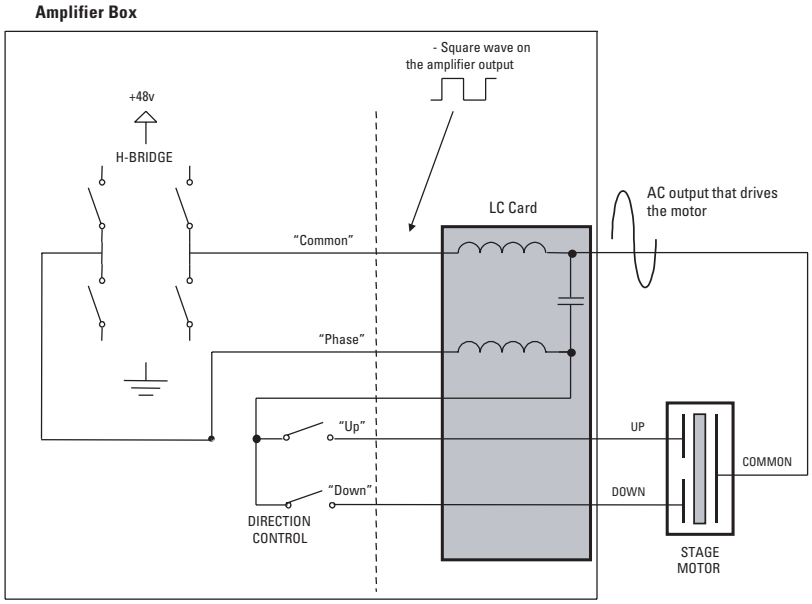
Figure 7: Amplifier block diagram



The motor is a three-terminal component: **Up**, **Down**, and **Common**. Voltage applied between the **Up** and the **Common** terminals causes the motor to move in one direction, while voltage applied between the **Down** and the **Common** terminals causes the motor to move in the opposite direction.

Figure 8 is a schematic drawing of the output stage.

Figure 8: Schematic of the output stage with an internal LC card



Troubleshooting

Correcting the Motion Direction

If you find that the stage holds when the motors are enabled and then runs away when it is disturbed (touched, pushed, etc.), then the encoder signal is probably reporting negative position.

To correct this problem, you will need to change the direction of the encoder signal. There are three ways to do this:

- **Use software:** Most modern controllers provide a mechanism to change the direction of the encoder via software, or to change the polarity of the motor drive signal.
- **Change the encoder connections:** You can change the direction of the A/B quadrature by swapping either the A+ and A- signals *or* the B+ and B- signals, but not both. (See Figure 5 for encoder pin descriptions.)
- **Change the motor connections:** Swap two of the motor connections to the splitter cable.

Amplifier Front-Panel Indicators

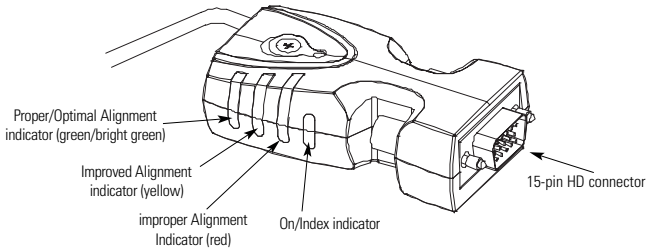
The **Alarm 1** and **Alarm 2** LEDs on the front panel of the amplifier box light to green, orange, or red depending on the status of the system. The table below defines the various status indicators.

Condition	Alarm 1	Alarm 2
VCC < 4.6V	Off	Off
Motor Disconnected	Orange	Off
Motor Disabled	Off	Orange
OK (Motor connected and enabled)	Green	Off
Over-current Protection	Red	Red

Improper Encoder Alignment

The encoder interface box has four LEDs on the side of it: the **On/Index** indicator and three signal and alignment indicators (see Figure 9).

Figure 9: Encoder interface box



The **Proper/Optimal Alignment** indicator should glow green or bright green when the encoder is properly aligned and installed as it was in the factory. If the **Improper Alignment** indicator glows red or the **Improved Alignment** indicator glows yellow, then there is an alignment problem with the encoder head in the stage. You will need to return the unit to New Focus for repair. See "Customer Service" on page 25 for more information.

Customer Service

Technical Support

Information and advice about the operation of any New Focus product is available from our applications engineers. For quickest response, ask for "Technical Support" and know the model and serial numbers for your product.

Hours: 8:00–5:00 PST, Monday through Friday (excluding holidays).

Toll Free: 1-866-NUFOCUS (1-866-683-6287)
(from the USA & Canada only)
Phone: (408) 284-6808

Support is also available by fax and email:

Fax: (408) 980-8883
Email: techsupport@newfocus.com

We typically respond to faxes and email within one business day.

Service

In the event that the closed-loop stage or amplifier malfunctions or becomes damaged, please contact New Focus for a return authorization number and instructions on shipping the unit back for evaluation and repair.

Appendix I: Specifications

Stage with Amplifier Characteristics

Linear Stages

Specification	Model 8101	Model 8102
Accuracy	±3 um	±3 um
Bi-Directional Repeatability	±150 nm	±150 nm
Min. Incremental Motion	100 nm	100 nm
Straightness	4 um	—
Flatness	6 um	—
Operating Temperature	0–50˚ C	0–50˚ C
Maximum Velocity	100 mm/sec	15 mm/sec
Holding Force	5 N	25 N
MTBF*	20,000 hours	20,000 hours
Travel Range	44 mm	6 mm
Encoder Resolution	50 nm	50 nm
Normal Load Capacity	18 N	26 N
Dimensions	3.14 x 3.74 x 0.76 in. (80 x 95 x 19.4 mm)	4.76 x 3.74 x 1.51 in. (121 x 95 x 38.4 mm)
Encoder Output	AB Quadrature and Sine/Cosine	AB Quadrature and Sine/Cosine
Motor Cord Length	3 meters	3 meters
Encoder Cord Length	2 meters	2 meters

* @ 75% rated load, continuous operation, maximum speed, over the operating temperature range

Rotary and Goniometer Stages

Specification	Model 8103	Model 8104
Accuracy	±0.6 mrad	±0.6 mrad
Bi-Directional Repeatability	±9 urad	±9 urad
Min. Incremental Motion	6 urad	6 urad
Operating Temperature	0–50˚ C	0–50˚ C
Maximum Velocity	180 degrees /sec	10 degrees/sec
Holding Torque	9 N-cm	38 N-cm
MTBF*	20,000 hours	20,000 hours
Travel Range	360 degrees continuous	±9 degrees
Encoder Resolution	3 urad	3 urad
Maximum On-Center Load	18 N	18 N
Dimensions	3.15 x 3.15 x 1.18 in (80 x 80 x 30 mm)	3.15 x 4.84 x 1.50 in. (80 x 123 x 38)
Encoder Output	AB Quadrature and Sine/Cosine	AB Quadrature and Sine/Cosine
Motor Cord Length	3 meters	3 meters
Encoder Cord Length	2 meters	2 meters

* @ 75% rated load, continuous operation, maximum speed, over the operating temperature range

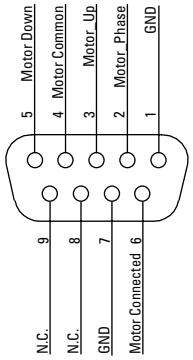
Amplifier Characteristics

Specifications	Amplifier Box
Power Input	+48 VDC ±5%
Maximum Motor Output	250–290 Vrms
Power Consumption without Load	+48 VDC/0.125 A
Power Consumption with Maximum Load	+48 VDC/6.5 A max
Dimensions (W x D x H)	5.87 x 4.67 x 1.61 in. (149 x 118.5 x 41 mm) (without mounting bracket)
Weight	450 gr.
Mounting options	Desktop/Wall Mount
Operating Temperature	0 to 50°C
Storage Temperature	–40 to 70°C
Operating Humidity	Up to 80%

Motor Port Pin Descriptions

We recommend that you use the supplied splitter cable to connect the stage motor cables to the amplifier. For your reference, the motor port pins are described in Figure 10.

Figure 10: Pin descriptions for the amplifier's motor port



Pin	Signal Name	Function	Description
1	GND	Power supply ground	Shorted to shield
2	Motor_Phase	High voltage output	Not connected
3	Motor_Up	High voltage output	Connected to the motor 'UP' terminal
4	Motor Common	High voltage output	Connected to the motor 'COMMON' terminal
5	Motor_Down	High voltage output	Connected to the motor down terminal
6	Motor Connected	Opto-coupled	Safety input, connected to ground via shortage on the motor connector to enable motor operation
7	GND	Power supply ground	Shorted to shield
8	N.C.	NOT IN USE	
9	N.C	NOT INUSE	

CE Compliance

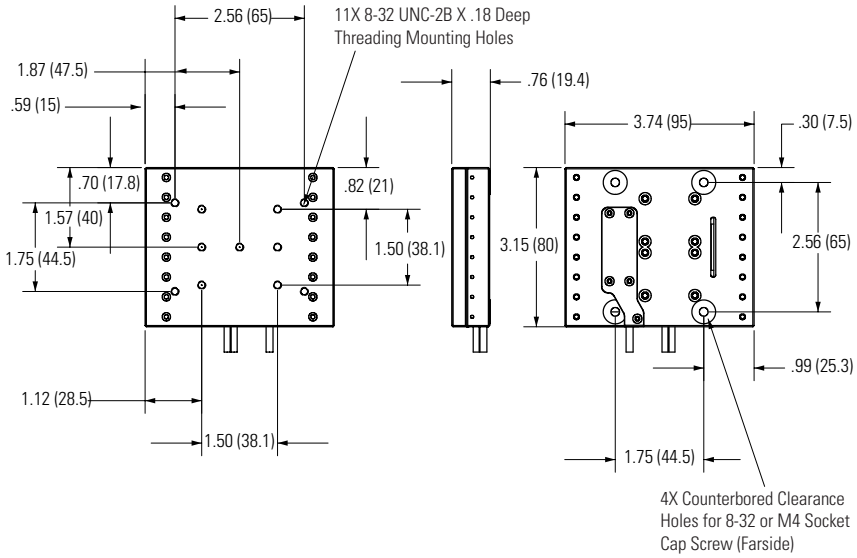
The closed-loop amplifier box and stages comply with the following European council directives:

- EMC: Council directive 89/336/EEC:
- Emissions Standard: EN 50081-2:1993/EN 55011:1991
  - Conducted Emission class A
  - Radiated Emission class A
- Immunity Standard: EN 50082-2:95
- Electro-Static Discharge (ESD) Standard: EN 61000-4-2:95
- Radiated Immunity Standard: EN 61000-4-3:96/ENV 50204:95
- EFT (Electrical Fast Transients) Standard: EN 61000-4-4:95
- Conducted Immunity Standard: EN 61000-4-6:96
- Surges Standard: EN 61000-4-5:95
- Voltage Variations Standard: EN 61000-4-11:94
- SAFETY: council directive 73/23/EEC
- Safety: IEC 61010-1:1990

Appendix II: Mechanical Drawings

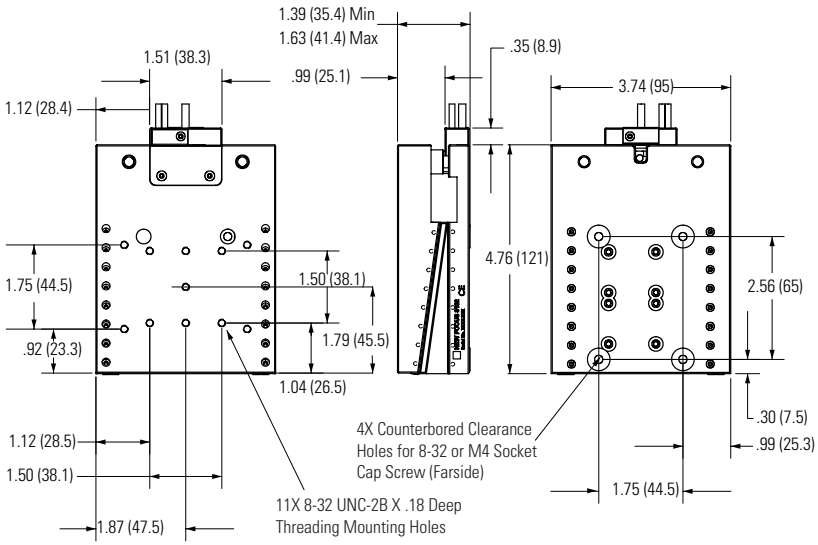
Linear Stages

Figure 11: Top, side, and bottom views of the Model 8101 Closed-Loop Translation Stage



Unless otherwise noted, dimensions are in inches with metric dimensions in mm in parentheses.

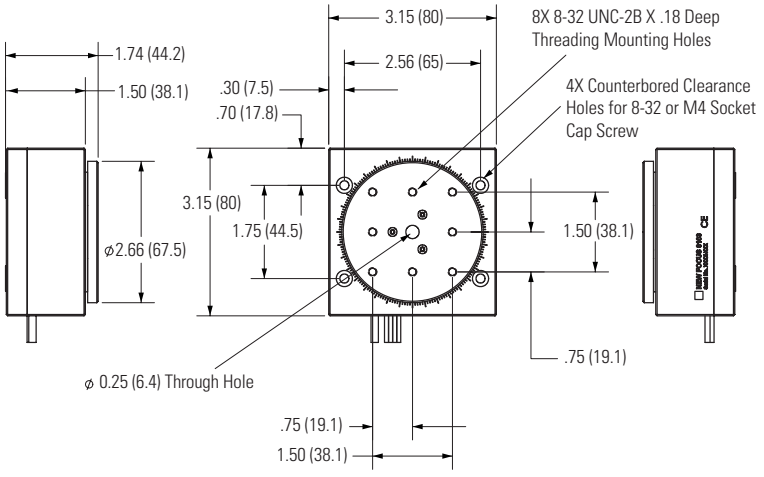
Figure 12: Top, side, and bottom views of the Model 8102 Closed-Loop Z-Axis Wedge



Unless otherwise noted, dimensions are in inches with metric dimensions in mm in parentheses.

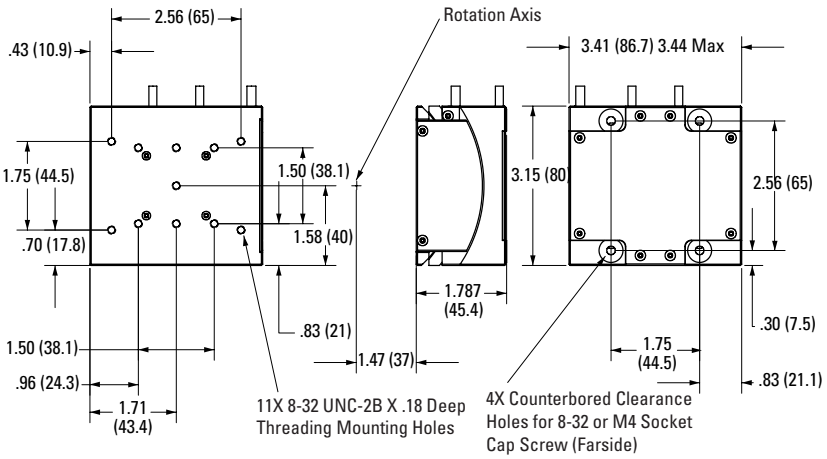
Rotary Stages

Figure 13: Side, top, and side views of the Model 8103 Closed-Loop Rotary Stage



Unless otherwise noted, dimensions are in inches with metric dimensions in mm in parentheses.

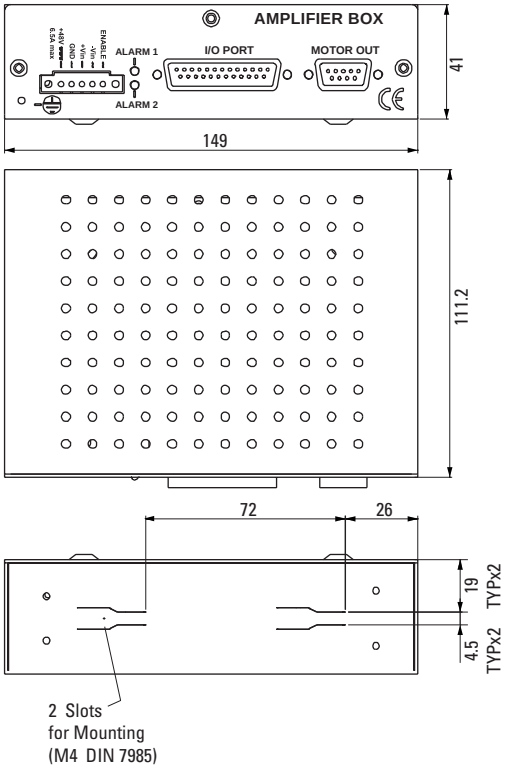
Figure 14: Top, side and bottom views of the Model 8104 Closed-Loop Goniometer



Unless otherwise noted, dimensions are in inches with metric dimensions in mm in parentheses.

Amplifier Box

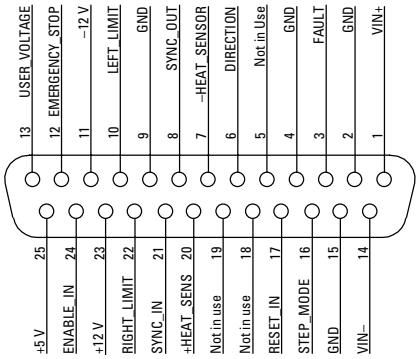
Figure 15: Front, top, and rear views of the Amplifier Box



Appendix III: Using the I/O Port

I/O Port Pin Description

Figure 16: Pin descriptions for the amplifier's I/O Port



Pin	Name	Description
1	VIN+	Positive analog command input
2	GND	Ground
3	FAULT	Open collector output
4	GND	Ground
5	Not in Use	—
6	DIRECTION[1]	TTL input (option)
7	-HEAT_SENSOR	Optional
8	SYNC_OUT	Optional
9	GND	Ground
10	LEFT_LIMIT[1]	Digital Input For Left Limit Switch—Active Low

Pin	Name	Description
11	-12V[1]	-12v Power Supply For External Device
12	EMERGENCY_STOP[1]	Protection Input—Active Low
13	USER_VOLTAGE[1]	External power supply opto-isolated type inputs.
14	VIN-	Negative analog command input
15	GND	Ground
16	STEP_MODE[1]	Mode Selection
17	RESET_IN	System initialization
18	Not in Use	—
19	Not in Use	—
20	+ HEAT_SENSOR	Optional
21	SYNC_IN	Optional
22	RIGHT_LIMIT[1]	Digital Input For Left Limit Switch—Active Low
23	+12 V[1]	+12 V Power Supply For External Device
24	ENABLE_IN[1]	Digital Input—Active Low
25	+5V[1]	+5 V Power Supply For External Device

1. Further explanations for some of these signals are given in the "Signal Descriptions" section below.
2. +VIN, -VIN and ENABLE_IN are identical to the +VIN, -VIN and ENABLE_IN signals in Control Terminal block.

Signal Descriptions

Signal	Description
Limit Switches	The amplifier has two opto-isolated limit switch inputs ('Left_Limit' and 'Right_Limit'). These inputs turn the motor off when the mechanical element driven by the motor reaches the end motion. When the limit switch is active (shorted to ground), the motion in the corresponding direction is disabled, and only motion in the other direction is possible.
Step_Mode	Determines the amplifier's mode of operation (Velocity or Step Mode).

Signal	Description
Emergency_Stop	Safety input. This opto-isolated input disables the card output when activated.
Enable_In	Control input. Enables operation when shorted to ground.
-12V	Accessory voltage used for powering external component Max. 700mW. Ground is at the GND pin.
+12V	Accessory voltage use for powering external component max 700 mW. Ground is at the GND pin.
+5V	Accessory voltage used for powering external component Max. 7.5 W. Ground is at the GND pin.
DIRECTION	TTL input signal—determines the motor direction when using the amplifier box with a specific external controller

Analog Input Specifications

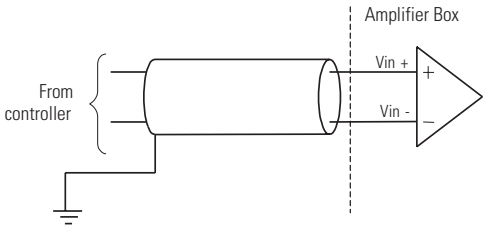
Analog Input Specifications

- Signal type: Differential or Single Ended
- Input voltage range: ±10 V
- Input impedance: 500 kW
- Input low-pass filter: Specific frequencies between 0.8 KHz to 10 KHz, according to configuration

Differential Connection

A differential analog input provides noise immunity. Figure 17 shows how the connection is made.

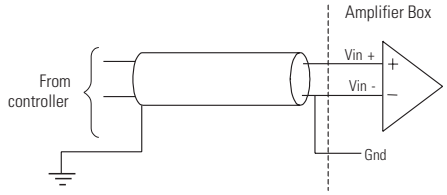
Figure 17: Differential analog input connection



Single-Ended Connection

Figure 18 shows a single-ended analog input connection.

Figure 18: Single-ended analog input connection.



Opto-Isolated Inputs

The following I/O Port input interfaces are opto-isolated and are activated by shorting them to ground:

- **Emergency Stop (ES):** Disables the AMPLIFIER output.
- **Enable:** Should be enabled before the motor is activated.
- **In Mode:** Enables Step Mode operation when activated.
- **Left Limit:** When activated, it disables motor motion to the left.
- **Right Limit:** When activated, it disables motor motion to the right.

Fault Outputs

The **Fault** is an open collector output that is active (shorted to ground) under the following conditions:

- The card is disabled by the Over Current Protection circuit.
- The motor is not connected; the **Motor Disconnect** signal is floating.

Note: *The **Fault** output is capable of sinking a maximum of 20mA, and is not protected from over current.*

Cabling Connections

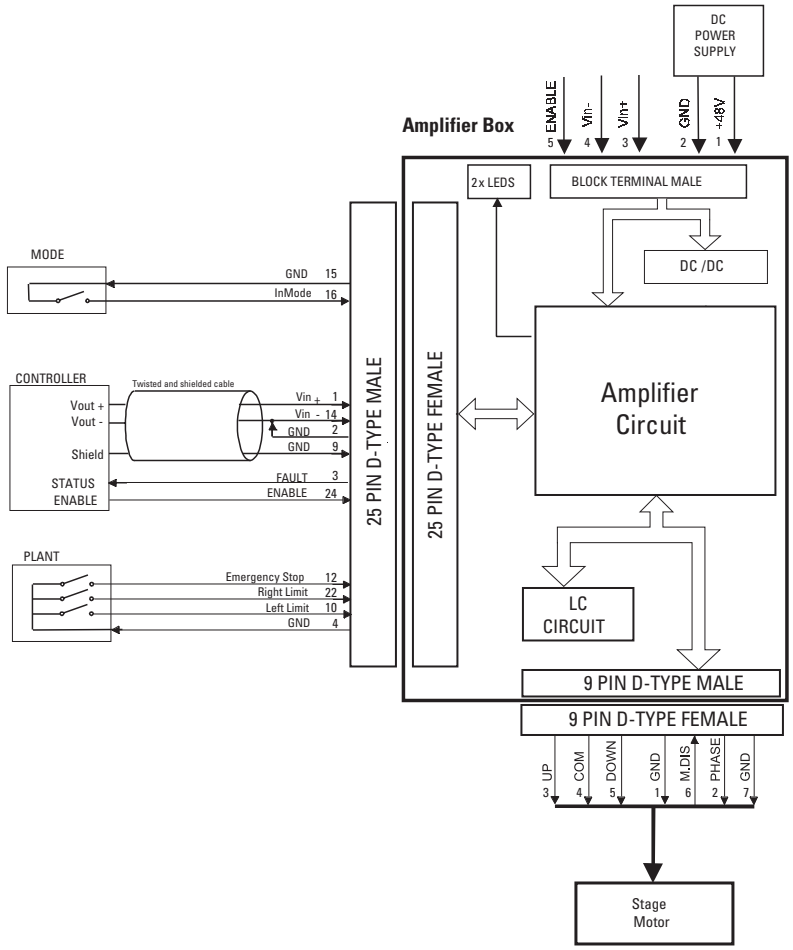
- Analog Command: a twisted shielded cable is recommended.
- Discrete Inputs: These signals are not sensitive to noise and can be grouped together in the same harness with any of the other groups.
- Shielding: Since the high motor voltage is induced placed on the cable shield, it is required to make a good ground connection to the shield on both sides. The driver card and the motor should be grounded to the infrastructure earth.

System Interfaces

This section describes the pin interfaces for single-ended, differential, and joystick inputs.

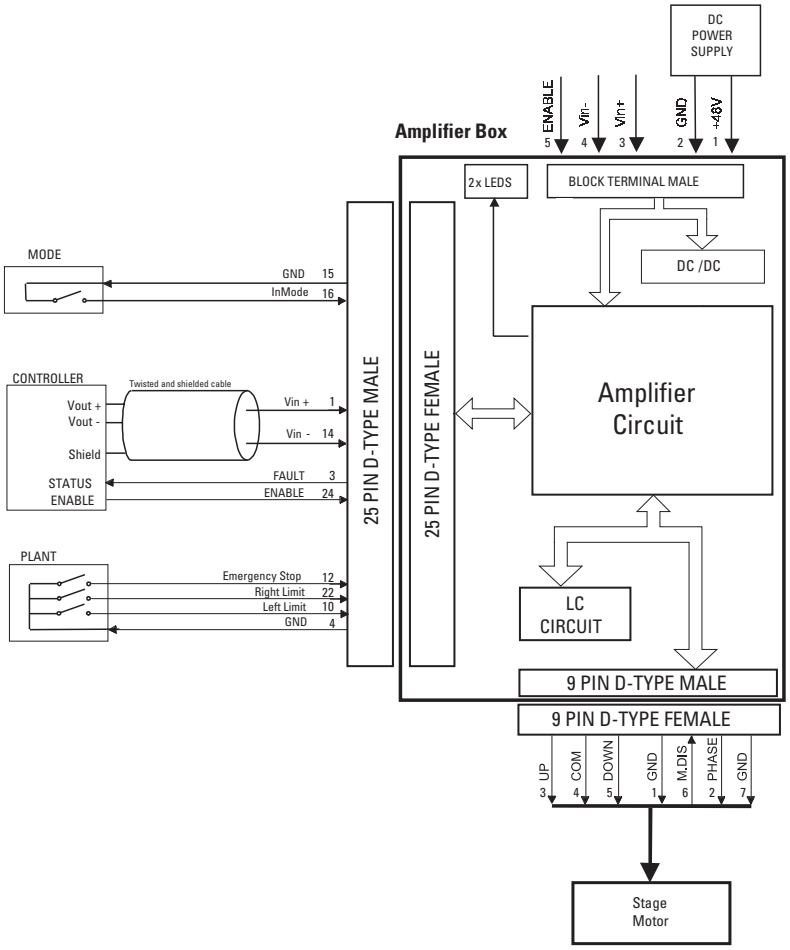
Single-Ended Analog Interface

Figure 19: Non-differential (common) input interface



Differential Analog Interface

Figure 20: Differential interface



Joystick Interface

Figure 21: Joystick Interface