

MP 54E User Manual

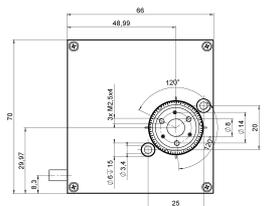
M-116 Precision Rotary Stage

Release: 1.2.2 Date: 2005-09-19



This document describes the following product(s):

- M-116.DG
Rotary Stage, DC-Motor with Gearhead and Encoder
- M-116.DGH
Rotary Stage, DC-Motor with Gearhead and Encoder, Zero-Backlash
- M-116.2S
Rotary Stage, Stepper Motor with Gearhead
- M-116.2SH
Rotary Stage, Stepper Motor with Gearhead, Zero-Backlash



© Physik Instrumente (PI) GmbH & Co. KG
 Auf der Römerstr. 1 · 76228 Karlsruhe, Germany
 Tel. +49-721-4846-0 · Fax: +49-721-4846-299
 info@pi.ws · www.pi.ws

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This manual has been provided for information only and product specifications are subject to change without notice.

About this Document

Users of this Manual

This manual is designed to help the reader to install and operate the M-116 Precision Rotary Stage. It assumes that the reader has a fundamental understanding of basic servo systems, as well as motion control concepts and applicable safety procedures.

The manual describes the physical specifications and dimensions of the M-116 Precision Rotary Stage as well as the procedures which are required to put the associated motion system into operation.

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Conventions

The notes and symbols used in this manual have the following meanings:



CAUTION

Calls attention to a procedure, practice, or condition which, if not correctly performed or adhered to, could result in damage to equipment.

NOTE

Provides additional information or application hints.

Related Documents

The motion controller and the software tools, which might be delivered with M-116 Precision Rotary Stage, are described in their own manuals. All documents are available as PDF files on the Motion CD or special product CD. Updated releases are available via FTP or email: contact your Physik Instrumente sales engineer or write info@pi.ws

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1 Introduction

The M-116 rotary stages all feature high-precision, preloaded worm-gear drives (zero-backlash gear-head with M-116.xxH versions) that allow unlimited rotation in either direction. All versions have a non-contact optical reference switch and/or optional custom limit switch outputs (with some limitation on travel range, if present). The DC motor versions are equipped with optical encoders whereas the stepper motor versions are designed to operate in open-loop mode only.

The DC motor/gearhead versions are equipped with shaft-mounted encoders. The gear ratio of 29.6 to 1 is used for increased resolution.

The stepper motor versions use microstepped 2-phase stepper motors with 1200 microsteps/revolution. Because stepper motors are driven to specific positions with known accuracy, these units are open-loop only.

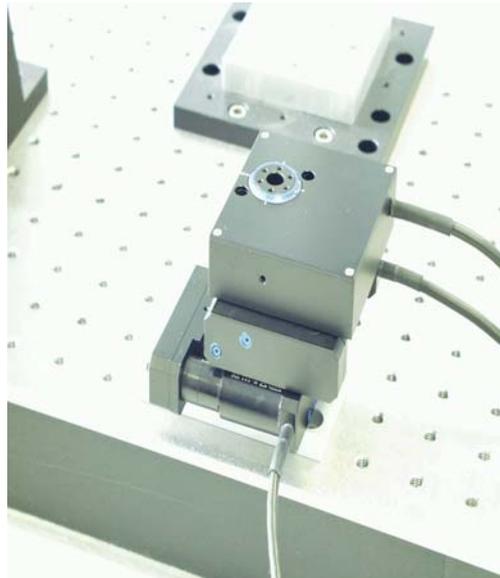


Fig. 1: M-116 mounted on two M-111 linear stages to make an X-Y-θZ stack

1.1 Safety Precautions

CAUTION— Torque Limit

Be careful not to exceed the platform’s maximum torque specifications of 1.5 Nm (1.1 ft-lb). Special attention is necessary when tightening or loosening the attachment screws. Permanent damage to the device will otherwise result.



1.2 Model Survey

The following models are available:

DC motor/gearhead ¹	M-116.DG
DC motor/zero-backlash gearhead ¹	M-116.DGH
Stepper motor ²	M-116.2S
Stepper motor, zero-backlash gearhead	M-116.2SH

Special order options: Custom limit switches

M-116 rotary stages can be connected to the same multi-axis controllers as other PI micropositioning stages, with the restriction that stepper motor devices must all be connected to / networked with other stepper-motor devices (see Section 3.3 for controller recommendations).

¹ closed-loop

² open-loop

2 Quick Start



CAUTION— Torque Limit

Be careful not to exceed the platform's maximum torque specifications of 1.5 Nm (1.1 ft-lb). Special attention is necessary when tightening or loosening the attachment screws. Permanent damage to the device will otherwise result.

Set up the controller following the instructions in the controller manual. If you are going to connect a host computer to the controller for computer-controlled operation, install the host software in the host computer. That procedure is described in the controller and or software manual or manuals.

Connect the rotary stage to the controller. With multi-axis controllers, be sure to note the axis designation of the connection selected.

Command a few test moves to make sure everything is working properly. If your controller comes with graphic-user-interface software, use it for such testing.

3 Operational Considerations

3.1 Limit Switches

M-116 stages are optionally available with two optical limit sensors with TTL drivers. Limit switch outputs are active-high for the DC-motor version, and active-low for the stepper motor version. Models without the optional limit switches put the TTL level indicating “no overtravel” on the limit switch lines. The distance between the limit switches must be specified with the order. If no reference switch is required, the limit switches may be anywhere between 0° and 330°; if the reference is installed, then the lower limit switch must be at $\geq 30^\circ$. Limit switch installation is accurate to $\pm 2^\circ$, limit switch repeatability is 0.004° .

3.2 Position Reference Signal Sensors

A position reference sensor is located approximately in the middle of the operating range and can be used to reference the absolute position of the stage within 0.004° accuracy. Always approach the reference sensor from the same side to reach the same position.

The reference sensor provides a static signal level which depends on the platform position. If the platform position is less than a half-turn counterclockwise from the reference switch position, the reference signal is +5 V, while if the platform is less than a half-turn clockwise from the reference switch, the signal level is 0 V.

3.3 Recommended Motor Controllers

M-116.DG and M-116.DGH stages can be used with C-842, C-843, C-844, C-848 and Mercury (C-860, C-862) controllers, the M-116.2S and M-116.2SH with the C-600 and C-630 stepper-motor controllers.



Fig. 2: DC-motor controllers: C-848 and C-880 benchtop/rackmount (background, top to bottom), C-843 PCI bus and C-842 ISA bus cards and Mercury controllers, alone and networked (foreground, left to right)



Fig. 3: Stepper motor controllers: 3-axis Apollo (foreground), and 4-axis C-600 (background)—both networkable

Controller Summary

Drive type	DC Motor				
Controller	C-880	C-848	C-843	C-842	Mercury
Axes per controller	up to 19 ³	2 or 4	2 or 4	2 or 4	1
Host PC interface	RS-232, RS-422 or IEEE (GPIB)	RS-232, RS-422 or IEEE (GPIB)	Internal (PCI bus)	Internal (ISA bus)	RS-232, bus or daisy chain
Multiple controllers on same host PC	yes, separate ports*	yes, separate ports	yes, separate slots	yes, separate slots	yes, same port

Drive type	Stepper Motor	
Controller	C-600	C-630
Axes per controller	4	3
Host PC interface	RS-232, daisy chain	RS-232, daisy chain
Multiple controllers on same host PC	yes, same port	yes, same port

³ Custom configurations possible with networked controllers controlling hundreds of axes

4 DC-Motor Controller Setup

Individual setting of servo-control parameters is required for smooth and optimized movement of the DC-motor versions. Incorrect parameter settings may cause severe vibration. If this occurs, set the motor to OFF and modify the parameter settings.

4.1 Using C-842 Motor Controllers with M-116.DG Stages

The C-842 is an add-on card which is installed in an ISA slot of a PC. Two-axis and 4-axis versions are available, and multiple cards can be installed in the same PC. DLL, COM Server and LabView™ software interfaces are provided, as well as a graphical user interface, *WinMove*, in versions for Windows9x and NT, 2000 and XP.

WinMove allows configuration of the M-116 stages from a configuration file.

Note that it is not possible to operate PWM devices on the same C-842 card as a (non-PWM) M-116.DG unless you use the C-842.AP1 PWM converter box.

Recommended initial settings with the C-842 are as follows:

p-term (DP)	300
i-term (DI)	65
d-term (DD)	100
Velocity (SV)	16 °/s
Acceleration (SA)	70 °/s ²

NOTE

The gear ratio is 29.6:1; See the C-842 Controller User Manual (MS 45E) for more details.

4.2 Using C-843 Motor Controllers with M-116.DG Stages

The C-843 is an add-on card to be installed in a PCI slot of a PC; 2- and 4-axis versions are available, and more than one card can be installed in the same PC. PWM and analog stages can be run off the same card without using a converter box.

See the C-843 user and software manuals for information on this controller and its software interfaces. Suitable control settings are provided in the controller software.

4.3 Using C-848 Motor Controllers with M-116.DG Stages

The C-848 is a benchtop/rackmount unit. It is actually an industrial PC with C-842 cards installed. See the C-842 section above and the C-848 manuals for more information. Settings suitable for the M-116 are included in the stage database integrated with the *C-848Control* software.

4.4 Using Mercury Motor Controllers with M-116.DG Stages

The Windows™ operating program for the Mercury controller allows choice of M-116 stages as a start option for operation.

Parameter	Recommended Value ⁴	Operating Range
p-term (DP)	320	100-400
i-term (DI)	20	0-50
d-term (DD)	280	0-400
i-Limit (DL)	2000	0-2000
Velocity (SV)	100,000	1-180,000
Acceleration (SA)	500,000	1000-1,000,000

⁴ see the C-862 Mercury Controller User Manual (MS 74E) for more details

5 Stepper Motor Controller Setup

Controller setup (and multi-axis networking) for the stepper motor versions is fully described in the controller documentation. All PI stepper-motor devices can be networked together and up to 9 axes controlled off of single RS-232 port of a host PC.

6 Technical Data

Models	M-116.DG	M-116.DGH	M-116.2S	M-116.2SH	Units	Notes
Rotation range	continuous	continuous	continuous	continuous		
Design resolution	2.45	3.16	4.18	5.40	μrad	A3
	0.00014	0.00018	0.00024	0.00031	deg	
Min. incremental motion	50	25	50	25	μrad	A4
Unidirectional repeatability	12	10	12	10	μrad	
Backlash	1000	<500	1000	<500	μrad	
Max. velocity	20	20	20	20	deg/ sec.	
Maximum axial force	15	15	15	15	N	
Max. output torque (θ_z : CW/CCW)	0.4/0.8	0.4/0.8	0.4/0.8	0.4/0.8	Nm	
Maximum (off-axis) torque (θ_x, θ_y)**	±1.5	±1.5	±1.5	±1.5	Nm	
Encoder resolution	2048	2048	–	–	counts / rev.	
Motor resolution	–		1200 ^{††}	1200 ^{††}	microsteps / rev.	
Gear ratio	28.444:1	22.0335:1	28.444:1	22.0335:1		
Worm gear ratio	44:1	44:1	44:1	44:1		
Nominal motor power	1.75	1.75	–	–	W	
Motor voltage range	0 to ±12	0 to ±12	24 ^{††}	24 ^{††}	V	
Weight	0.4	0.4	0.4	0.4	kg	
Body material	Al	Al	Al	Al		

** Exceeding this value will cause permanent damage, be careful when tightening/loosening attachment screws.

†† 2-phase stepper, 24 V chopper voltage, max. 0.25 A / phase, 1200 microsteps with C-600 or C-630 controller

NOTES**A3 Design Resolution:**

The theoretical minimum movement that can be made based on the selection of the mechanical drive components (drive screw pitch, gear ratio, angular motor resolution etc.). Design resolution is usually higher than the practical position resolution (minimum incremental motion).

A4 Minimum Incremental Motion:

The minimum motion that can be repeatedly executed for a given input, which is sometimes referred to as practical or operational resolution. Design resolution and practical resolution have to be distinguished. In practical applications stiction/friction, windup, and elastic deformation severely limit operational resolution.

7 Dimensions

Dimensions in millimeters, decimal places separated by commas in drawings.

7.1 All M-116 Versions

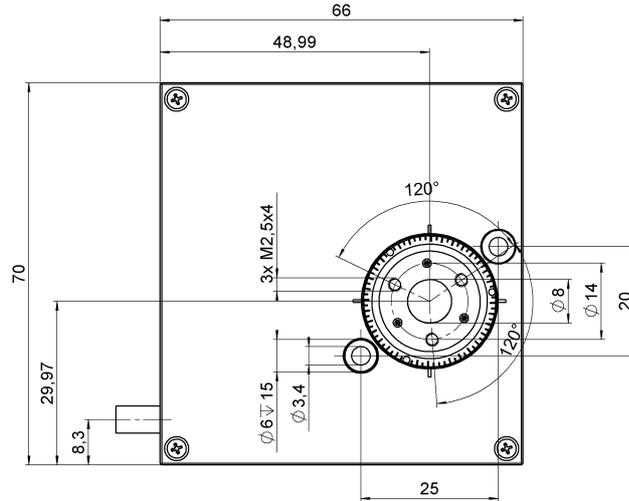


Fig. 4: All M-116 Versions

7.2 M-116.AL1 Optics Adapter

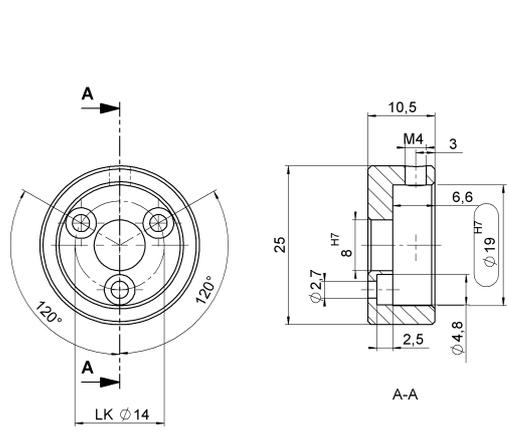
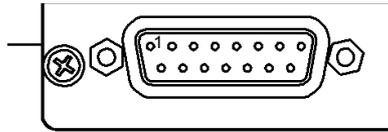


Fig. 5: M-116.AL1 Optics Adapter; Unmarked roundings of edges 0.5 mm x 45°

8 Connectors and Pin Assignments

Motor-driven M-116 series stages are equipped with sub-D15(m) sockets for connecting to the motor controller.

8.1 M-116.DG / M-116.DGH



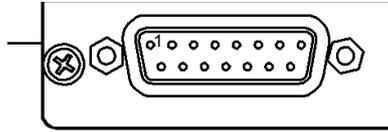
Connector (from controller)

Type: 15-pin sub-D(m)
Reference No.: AMP #9-215594-1

Pin	Signal
1	unused
9	motor (-) (input)
2	motor(+)(input)
10	PGND (power ground)
3	not used
11	not used
4	+5 V (input)
12	NLIMIT ⁷ (Limit signal for negative side) (output)
5	PLIMIT ⁷ (Limit signal for positive side) (output)
13	REFS (position origin signal) (output)
6	GND (logic signal ground)
14	A(+) (output)
7	A(-) (output)
15	B(+) (output)
8	B(-) (output)

⁷ Limit switches are optional; models without limit switches output a TTL “low” signifying “no overtravel” on these lines.

8.2 M-116.2S / M-116.2SH (Stepper Motor)



Connector (from controller)

Type: sub-D 15(m)
Reference No.: AMP #9-215594-1

Pin	Signal
1	Phase 1a
9	Phase 1b
2	Phase 2a
10	Phase 2b
3	n.c.
11	n.c.
4	n.c.
12	n.c.
5	n.c.
13	n.c.
6	+ 5 V supply from controller
14	Positive limit signal ⁸
7	GND
15	Reference Signal
8	Negative limit signal ⁸



⁸ Limit switches are optional; models without limit switches output a TTL “high” signifying “no overtravel” on these lines.