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MP 35E User Manual

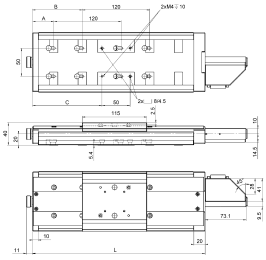
M-405 / M-410 / M-415 Series

Linear Positioning Stages

Release: 3.3.3 Date: 2008-03-17

This document describes the following product(s):

- M-405.DG, M-410.DG, M-415.DG
  Linear Positioning Stages, DC-Motor gearhead
- M-405.CG, M-410.CG, M-415.CG
  Linear Positioning Stages, DC-Motor gearhead
- M-405.PD, M-410.PD, M-415.PD
  Linear Positioning Stages,
  with integrated amplifier (PWM)
- M-405.2S, M-410.2S, M-415.2S
  Linear Positioning Stages, stepper motor
- M-405.M0, M-410.M0, M-415.M0
  Linear Positioning Stages, manual operation



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Declaration of Conformity

according to ISO / IEC Guide 22 and EN 45014

Manufacturer:	**Physik Instrumente (PI) GmbH & Co. KG**	CE
Manufacturer´s Address:	Auf der Römerstrasse 1 D-76228 Karlsruhe, Germany	

The manufacturer hereby declares that the product

Product Name: **M-405/M-410/M-410 Series Translation Stages**
Model Numbers: **M-405, M-410, M-415**
Product Options: **all model types**

complies with the following European directives:
73/23/EEC, Low voltage directive
89/336/EEC, EMC-Directive73/23/EWG, Niederspannungsrichtlinie /
98/37/EG, Maschinenrichtlinie / 98/37/EC, Machinery Directive

The applied standards certifying the conformity are listed below.

Electromagnetic Emission:	EN 61000-6-3, EN 55011
Electromagnetic Immunity:	EN 61000-6-1
Safety (Low Voltage Directive):	EN 61010-1
Safety of Machinery:	EN 12100

October 30, 2006
Karlsruhe, Germany

Dr. Karl Spanner
President

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M-405_M-410_M-415_UserMP35E332.doc

About This Document

Users of This Manual

This manual is designed to help the reader to install and operate the M-405 / M-410 / M-415 Series Linear Positioning Stages. 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-405 / M-410 / M-415 Series Linear Positioning Stages as well as the procedures which are required to put the associated motion system into operation.
This document is available as PDF file. Updated releases are available for download from www.pi.ws or by email: contact your Physik Instrumente Sales Engineer or write info@pi.ws.

Conventions

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

WARNING

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

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-405 / M-410 / M-415 Series Linear Positioning Stages are described in their own manuals. All documents are available as PDF files.. For updated releases visit download section of the PI Website (www.pi.ws), contact your Physik Instrumente Sales Engineer or write info@pi.ws.

Contents

Contents

1 Introduction

Fig. 1: M-415.DG, M-410.DG and M-405.DG Translation Stages (from left to right)

M-405 / M-410 / M-415 Series Linear Positioning Stages are leadscrew driven stages with a travel range of 50, 100 and 150 mm. Precision crossed roller bearings guarantee straightness of travel of better than 2 µm / 100 mm. The stage base is precision machined from high-density, stress relieved aluminum for exceptional stability and minimum weight.

Motorized versions are available with high resolution DC-motors with and without gearhead drives, and with stepper motors.

NOTE

In this manual, the designation “M-4xx” will be used to mean “M-405 / M-410 / M-415”. Note that M-403 and other similarly numbered stage families are covered in other manuals.

Models M-4xx.DG (DC-motor gearhead drive) use closed loop DC motors with shaft mounted position encoders and backlash-free gearheads providing 0.1 µm minimum incremental motion.

Models M-4xx.PD (DC-motor direct drives) are equipped with 30-watt Active Drive DC motors providing 0.25 µm minimum incremental motion and velocity up to 15 mm/sec. The active drive concept features an integrated, high-efficiency power amplifier and reduces overall system cost, because the stage can be driven directly from PI motor controllers.

Models M-4xx.2S use a high-resolution stepper motor allowing for 0.1 µm incremental motion in conjunction with a C-663 stepper motor controller.

All stages are equipped with magnetic origin sensors and end of travel sensors.

M-405 / M-410 / M-415 Series stages can be cross-stacked and combined with the M-592.00 Z-axis mounting bracket to provide multi-axis motion.

Fig. 2: M-400 with stepper motor

M-400 Features

- Travel Ranges to 150 mm
- Stress-Relieved Aluminum Stage Base for Highest Stability
- Crossed Roller Bearings
- High-Resolution DC and Stepper Motor Drives
- ActiveDrive™ Concept
- Manual Knob for Convenient Position Adjustment
- Non-Contact Origin and Limit Switches

1.1 Safety Precautions

Before operating M-400 Series Linear Stages, read this:

CAUTION

M-400 stages are motorized by powerful electrical motors and can generate high forces due to gearhead transmission. Be aware that automatic limit switch halt may not be supported by the motor control electronics.

Be aware that failure of the motor controller may drive the stage into a hard stop with high forces.

When the stage is connected to the motor controller be aware that the stage could start an undesired move due to whatever reason.

Be aware that overlength mounting screws will interfere with motion and may cause permanent damage!

WARNING

To avoid injury, do not put any parts in the gap between the moving stage and the motor cabin.

Never put your finger at a place where the moving platform or any connected object could possibly trap it.

1.2 Prescribed Use

Correct operation of the M-405 / M-410 / M-415 Series Linear Positioning Stages is only possible in combination with a suitable controller/driver (ordered separately) and software.
The controlling device must be able to read out and process the signals from reference and limit switches and the incremental position encoder to ensure proper performance of the servo-control system.

Based on their design and realization, these stages are intended for single-axis positioning, adjusting and shifting of loads at various velocities. M-405 / M-410 / M-415 Series Linear Positioning Stages can be mounted horizontally or vertically. To achieve the specified guiding accuracy, the positioners have to be mounted on a flat surface to avoid torsion of the basic profile.

The positioners may only be used for applications suitably in accordance with the device specifications.

Respect the safety instructions given in this User Manual. The operator is responsible for the correct installation and operation of the stages.

The verification of the technical specifications by the manufacturer does not imply the validation of complete applications. In fact the operator is responsible for the process validation and the appropriate releases.

The M-405 / M-410 / M-415 Series Linear Positioning Stages meet the specifications as defined by DIN EN 61010 for safe operation under normal ambient conditions. See the specifications table for details.

1.3 Model Survey

The following table summarizes the most important characteristics of the M-405 / M-410 / M-415 Series Linear Positioning Stages available:

	Travel Range [mm]	Gearhead Ratio	Design Resolution [µm/count]	Repeatability uni-	Max. Velocity [mm/s]	Motor Power [W]	Mass [kg]
DC motor gearhead							
M-405.CG	50	69.12	0.0035	0.2	0.7	2	2.0
M-410.CG	100	69.12	0.0035	0.2	0.7	2	2.3
M-415.CG	150	69.12	0.0035	0.2	0.7	2	2.7
M-405.DG	50	29.642	0.0085	0.2	1.5	3	2.1
M-410.DG	100	29.642	0.0085	0.2	1.5	3	2.4
M-415.DG	150	29.642	0.0085	0.2	1.5	3	2.8
Integrated PWM amp							
M-405.PD	50		0.125	0.2	15	30	2.1
M-410.PD	100		0.125	0.2	15	30	2.4
M-415.PD	150		0.125	0.2	15	30	2.8
Stepper Motor							
M-405.2S	50	-	0.025	0.2	6		2.1
M-410.2S	100	-	0.025	0.2	6		2.4
M-415.2S	150	-	0.025	0.2	6		2.8
Manual operation							
M-405.M0	50	not applicable					1.9
M-410.M0	100	not applicable					2.2
M-415.M0	150	not applicable					2.5

For complete technical data see the table on p. 4.

1.4 Contents of Delivery

M-400 series stages are delivered with:

- 4 metric screws M4x30, w. hex wrench, (purpose: mounting two stages as an XY combination).
- Connecting cable (motorized stages only)
- This document, MP 35E (User Manual)

1.5 Unpacking

Unpack the stage with care. Compare the contents against the items covered by the contract and against the packing list.

Inspect the contents for signs of damage. If parts are missing or you notice signs of damage, such as loose contacts or hairline cracks, please contact PI immediately.

Save all packing materials in case the product need be shipped again.

2 Installation

2.1 Mechanical Mounting

WARNING—CRUSH HAZARD

When mounting the stage keep in mind that the motor will move with the platform and possibly might trap your finger or any equipment! Make sure that there is sufficient clearance for the motor when it and the platform move.

2.1.1 Cable Connector Position

Before mounting one of the motorized versions, decide whether or not the cable connector is in a suitable position.

To change connector orientation, loosen the 2 set screws which clamp the motor housing with a 2 mm Allen wrench (shown) and rotate the housing and connector to the desired position (arrows). Then retighten the set screws.

NOTE

Motor may be rotated about its axis as desired to change cable connector orientation (Fig. 3).

Fig. 3: Changing connector orientation

2.1.2 Attachment

M-405 / M-410 / M-415 Series Linear Positioning Stages can be mounted in any orientation, horizontally or vertically.

To achieve the specified guiding accuracy, the stages have to be mounted on even surfaces to avoid torsion of the basic profile. If necessary, use the clearance holes in the platform to access the mounting holes in the stage base. The platform can be moved with the knurled knob for this purpose.

Adapter plates and mounting brackets are available for stacking stages to form XY- or XYZ-systems. See p. 19 and the PI catalog at www.pi.ws for more information, or contact your PI Sales Engineer.

To mount an object on the platform, use the threaded mounting holes and M4 screws.

CAUTION

Be aware that overlength mounting screws will interfere with motion and may cause permanent damage!

2.2 Interconnecting the System

Motorized versions of the M-405 / M-410 / M-415 Series can be internetworked other PI micropositioning stages in many different combinations, including:

- Mercury Class devices can be daisy chained off a single RS-232 or USB port, meaning that even stepper and DC motors (PWM and analog) can be networked together (with C-663 and C-863 controllers)
- PWM and DC-motor devices can be mixed on the current models of the multi-axis controllers (with C-843, C-848, C-880).

2.3 Host PC

Most PI controllers are in turn controlled by a host PC provided by the user. The only exceptions are programmable controllers with stand-alone mode (C-862 Mercury), controllers with a joystick port or manual control pad.

The controller is either installed directly in the PC (e.g. C-843) or connected to it over a communications interface. See the controller User Manual for details.

PI generally provides software and/or drivers that run on the host PC to control the system. Typically there will be a control program with a graphic user interface for testing and simple operation, and, in addition, DLL, COM and/or LabView drivers for users who wish to use custom software. If the controller is a PC ISA or PCI card, there will also be hardware drivers to install. See the controller User and Software manuals for installation details.

3 Operational Considerations

3.1 PWM Amplifiers & Brake Signal

The .PD-version stages with the ActiveDrive™, direct, DC-motor drive have the platform connected directly to the 30-watt DC motor by a flexible coupling. For maximum dynamic performance, the DC servo-motors are driven by high-efficiency PWM power amplifiers integrated into the stages. An external plug-in power supply is provided to supply the built-in amplifiers directly. This architecture allows high torque and high velocities while loading the motor controller with control signals only. The actual power is provided by the external supply.

All current PI controllers can drive either analog or PWM stages by operating in the corresponding mode.

NOTE

Be sure your software turns the brake OFF before operation, even though standard M-4xx series stages are not equipped with brakes.

If the signal on the brake line from the motor controller (pin 1) is in the Brake ON state (0 V), the PWM amplifier output to the motor is disabled and no motion is possible.

3.2 Motion Polarity, Limit & Reference Sensors

3.2.1 DC-Motor Versions

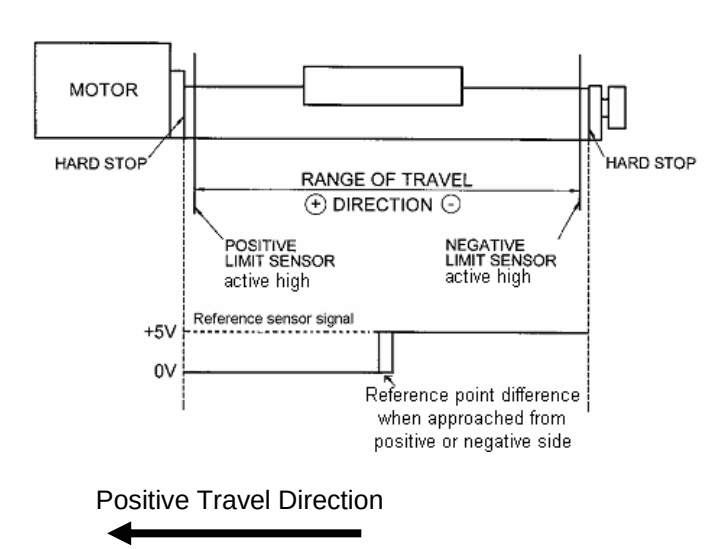


Fig. 4: DC-motor versions

NOTE

Limit and reference signal polarities on DC and stepper motor versions are reversed

3.2.2 Stepper Motor Versions

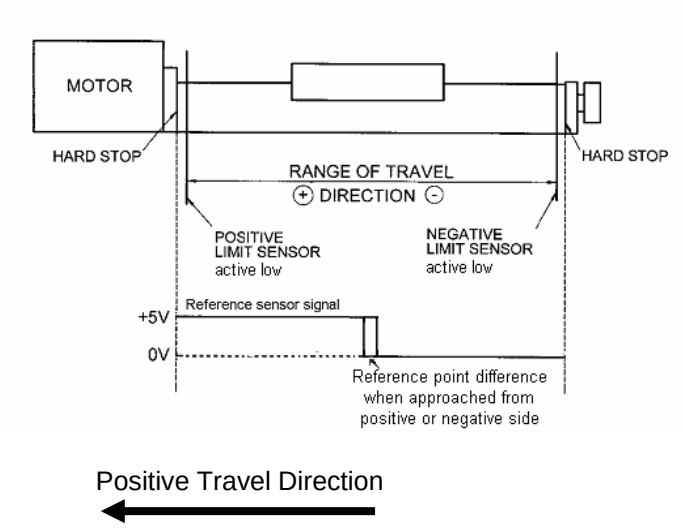


Fig. 5: Stepper motor versions

3.2.3 Limit Switches

All M-405 / M-410 / M-415 Series motorized stages are equipped with non-contacting, Hall-effect limit switches (with TTL drivers). On stepper-motor versions, limit switch outputs are active low, on other versions, active high.

Each limit switch controls an overtravel signal on its own dedicated line to the controller. It is the controller that is then responsible for stopping motion. If it does not do so in time, the stage will run into the hard stop. Should this happen, it may be necessary to push the stage manually out of the end zone.

CAUTION

High-speed crashes can cause irreparable damage. Do not disable limit switches in software. Test limit switch operation at low speeds.

Type:	Magnetic (Hall Effect) sensors
Power supply.	+5V / GND supplied by the motor controller through the motor connector.
Voltage output:	TTL level
Sink / Source capability.	± 48 mA
Logic:	DC-motor versions: Active high, normal motor operation: low, limit switch hit: high Stepper motor versions: Active low, normal motor operation: high, limit switch hit: low

3.2.4 Reference Switch

Motorized versions are equipped with direction-sensing Hall-effect reference switches. These switches provide a TTL signal indicating whether the stage is to the positive or negative side of a fixed point. The rising or falling edge of this signal can be used as to indicate a known reference position (always approach the reference point from the same side to achieve repeatability; the difference in the reference points when approached from the positive side and from the negative side is about 0.3 mm to 0.5 mm). See the controller User Manual and/or associated software manuals for the commands which make use of the reference signal.

See Fig. *4* and Fig. 5 for location details.

Average reference position accuracy: 0.3 µm

Motor controllers with GCS command set (C-843, C-880, C-848, as well as C-862, C-863 and C-663 when used with GCS software) approach the reference sensor always from the "negative" side: The reference move goes from the side with the negative limit switch towards the positive limit switch until the reference signal changes its state. If the moving platform is located between positive limit switch and reference switch when referencing is started, it will first move to the negative side—crossing the reference sensor—and then back until the reference signal changes its state again.

3.3 Maintenance

Operating the stages in clean environments, no maintenance is required. If the stages are operated in extremely dusty environments, we recommend to clean and to grease the ball screw and linear bearings from time to time. The time interval depends of the degree of pollution and can vary from 100 to 800 operating hours.

Recommended lubricant for leadscrews:

KLÜBER Staburags Type NBU 8EP or Beacom 325

4 Technical Data

4.1 Specifications

Models	M-405.CG / M-410.CG / M-415.CG	M-405.DG / M-410.DG / M-415.DG	M-405.PD / M-410.PD / M-415.PD	M-405.2S / M-410.2S / M-415.2S	
Motion and positioning					
Travel range	50 / 100 / 150	50 / 100 / 150	50 / 100 / 150	50 / 100 / 150	mm
Integrated sensor	Rotary encoder	Rotary encoder	Rotary encoder	–	
Sensor resolution	2048	2000	4000		cts./rev.
Encoder bandwidth					
Design resolution	0.0035	0.0085	0.125	0.0781	µm
Min. incremental motion	0.1	0.1	0.25	0.1	µm
Unidirectional repeatability	0.2	0.2	0.2	0.2	µm
Bidirectional repeatability	2	2	2	2	µm
Pitch, yaw	±25 / ±50 / ±75	±25 / ±50 / ±75	±25 / ±50 / ±75	±25 / ±50 / ±75	µrad
Max. velocity	0.7	1.5	15	3	mm/s
Mechanical properties					
Spindle pitch	0.5	0.5	0.5	0.5	mm
Gear ratio	69.12:1	$(28/12)^4$:1 ≈ 29.6:1			
Motor resolution	–	–	–	6400*	steps/rev.
Max. load	200	200	200	200	N
Max. push / pull force	40 / 40	50 / 50	50 / 50	50 / 50	N
Max. lateral force	150	150	150	150	N
Drive properties					
Motor type	DC-motor, gearhead	DC-motor, gearhead	ActiveDrive™ DC Motor	2-phase stepper motor*	
Operating voltage	0 to ±12	0 to ±12	0 to ±24	24	V
Electrical power	2	3	30	—	W
Limit and reference switches	Hall-effect	Hall-effect	Hall-effect	Hall-effect	
Miscellaneous					
Operating temperature range	-20 to +65	-20 to +65	-20 to +65	-20 to +65	°C
Material	Aluminum, steel	Aluminum, steel	Aluminum, steel	Aluminum, steel	
Mass	2.0 / 2.3 / 2.7	2.1 / 2.4 / 2.8	2.1 / 2.4 / 2.8	2.1 / 2.4 / 2.8	kg
Recommended controller/driver	C-863 (single-axis), C-843 PCI board (up to 4 axes)			C-663 (single-axis)	

*2-phase stepper motor, 24 V chopper voltage, max. 0.8 A/phase, 400 full steps/rev., motor resolution with C-663 stepper motor controller, 16x interpolation

NOTES

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).

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. Design resolutions of 1 nm or better can be achieved with many motor, gearbox and leadscrew combinations. In practical applications, however, stiction/friction, windup, and elastic deformation limit resolution to fractions of a micron.

Max. Normal Load Capacity: Centered, vertical load (horizontal installation).

Max. Push/Pull Force: Active and passive force limit in operating direction, at center of stage. Some stages may be able to generate higher forces at the cost of reduced lifetime.

4.2 Dimensions

4.2.1 M-4xx.CG Stages

Dimensions in mm; decimal places separated by commas in drawings

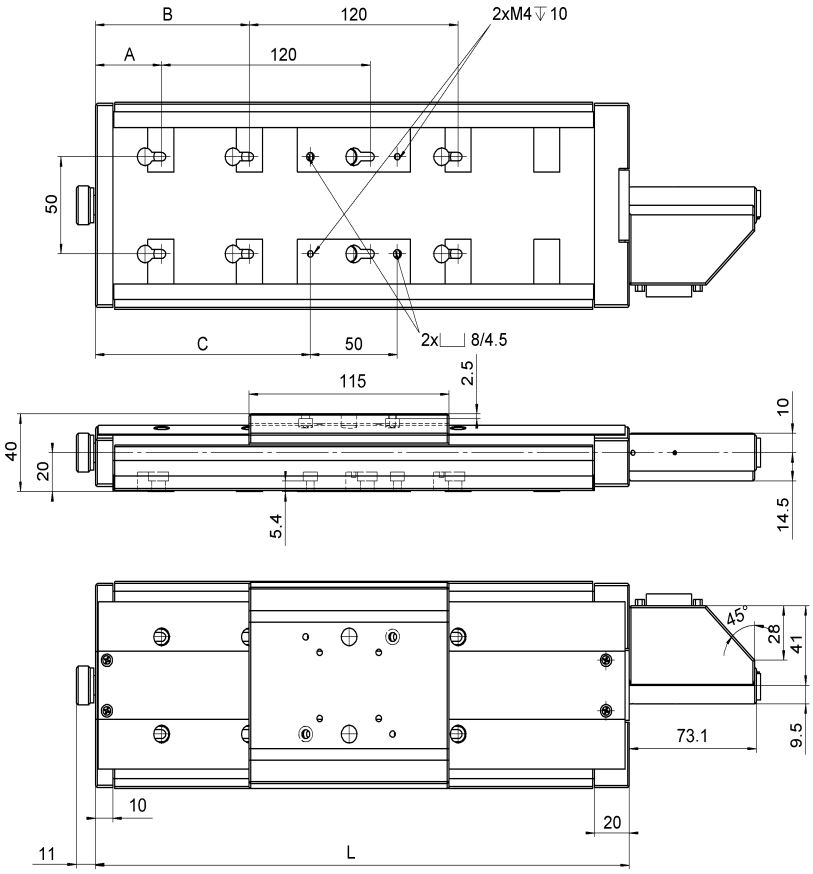


Fig. 6: .CG versions

Length-Related Dimensions

	L	A	B	C
M-405.CG	207	38.5	-	73.5
M-410.CG	257	63.5	-	98.5
M-415.CG	307	38	88.5	123.5

NOTE

Motor on all versions may be rotated about its axis as desired, changing cable connector orientation (Fig. 3). Drawing and current production may differ.

4.2.2 M-4xx.DG Stages

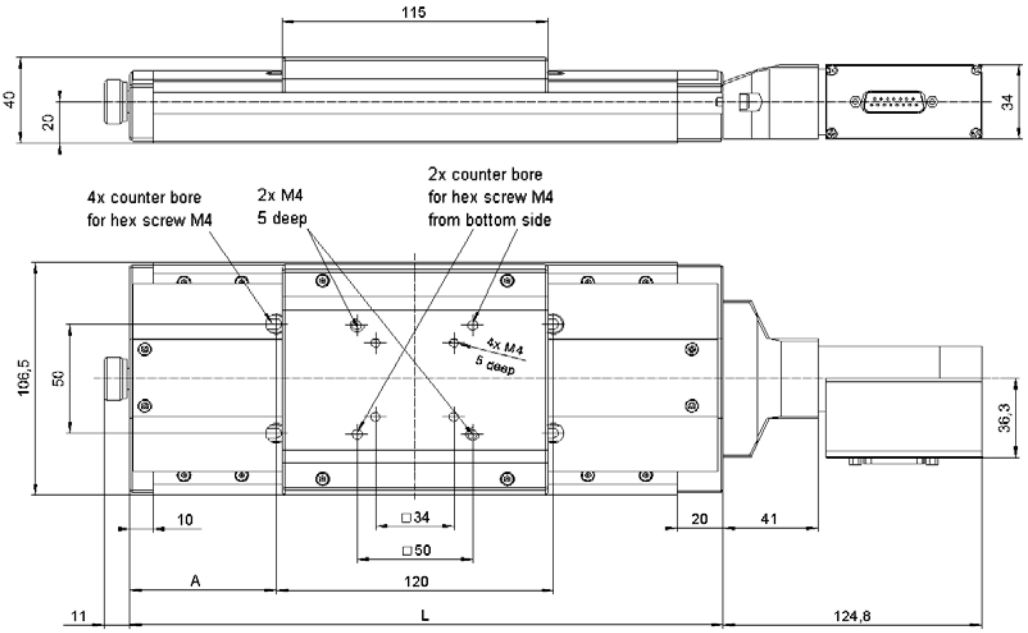


Fig. 7: .DG Stages

Length-Related Dimensions

	L	A
M-405.DG	207	38.5
M-410.DG	257	63.5
M-415.DG	307	88.5

4.2.3 M-xx.PD Stages

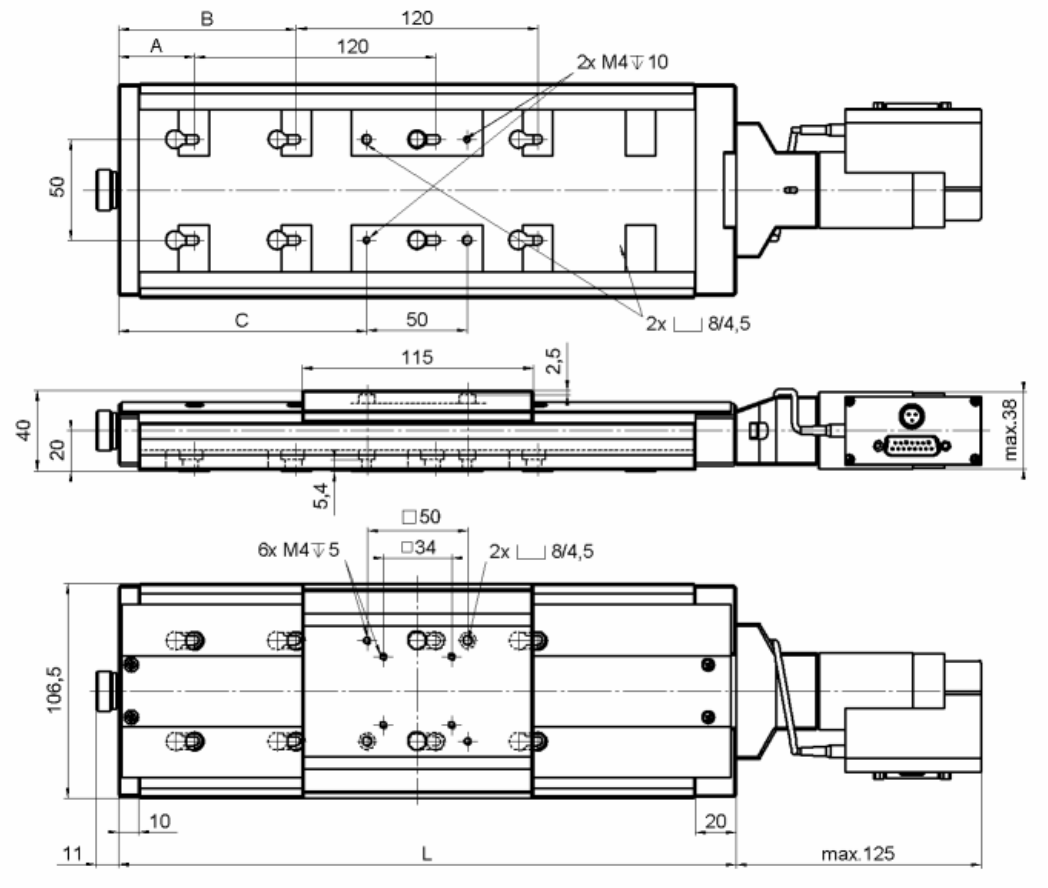


Fig. 8: .PD Stages

Length-Related Dimensions

	L	A	B	C
M-405.PD	207	38.5	-	73.5
M-410.PD	257	63.5	-	98.5
M-415.PD	307	38	88.5	123.5

NOTE

Motor on all versions may be rotated about its axis as desired, changing cable connector orientation (Fig. 3). Drawing and current production may differ.

4.2.4 M-xx.2S Stepper Motor Stages

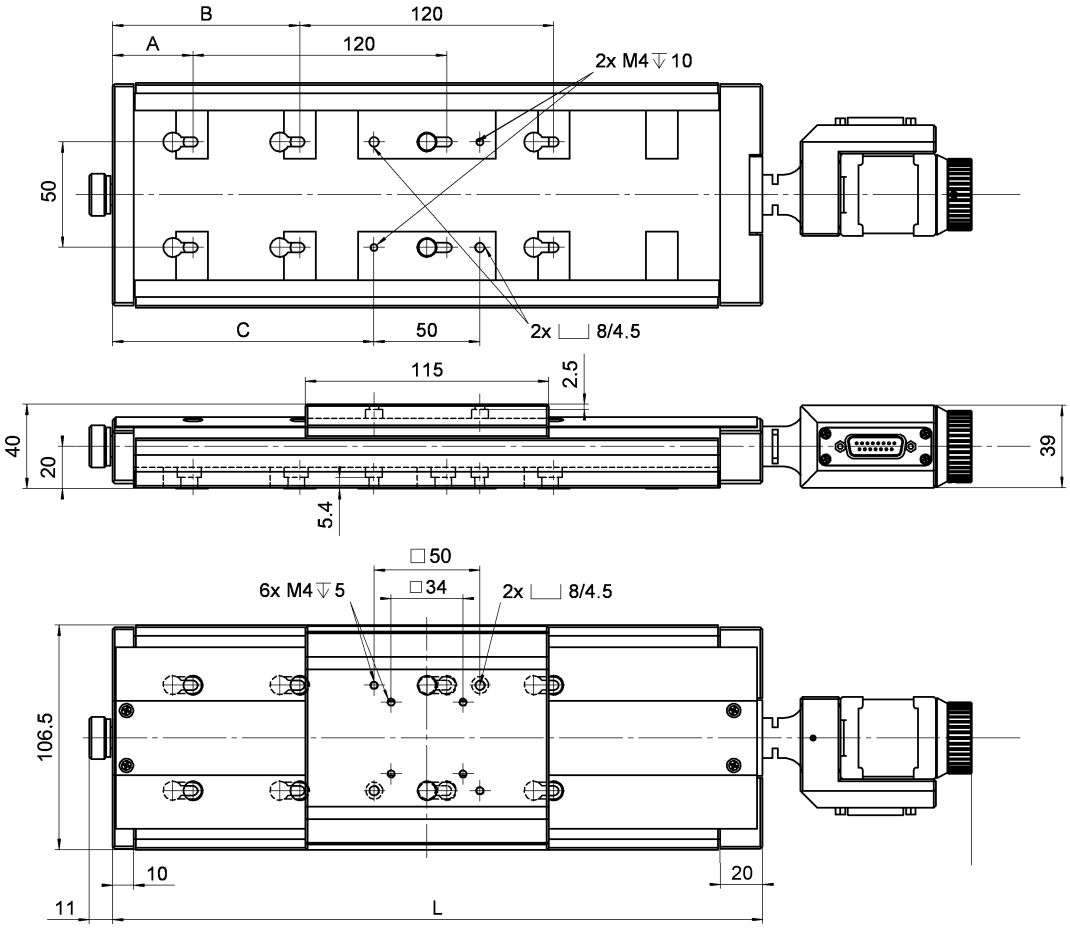


Fig. 9: .2S Stages

Length-Related Dimensions

	L	A	B	C
M-405.2S	207	38.5	-	73.5
M-410.2S	257	63.5	-	98.5
M-415.2S	307	38	88.5	123.5

NOTE

Motor on all versions may be rotated about its axis as desired, changing cable connector orientation (Fig. 3). Drawing and current production may differ.

4.2.5 Z-Axis Mounting Bracket

This bracket is available as an option for assembling stacked systems that include a vertical axis of motion.

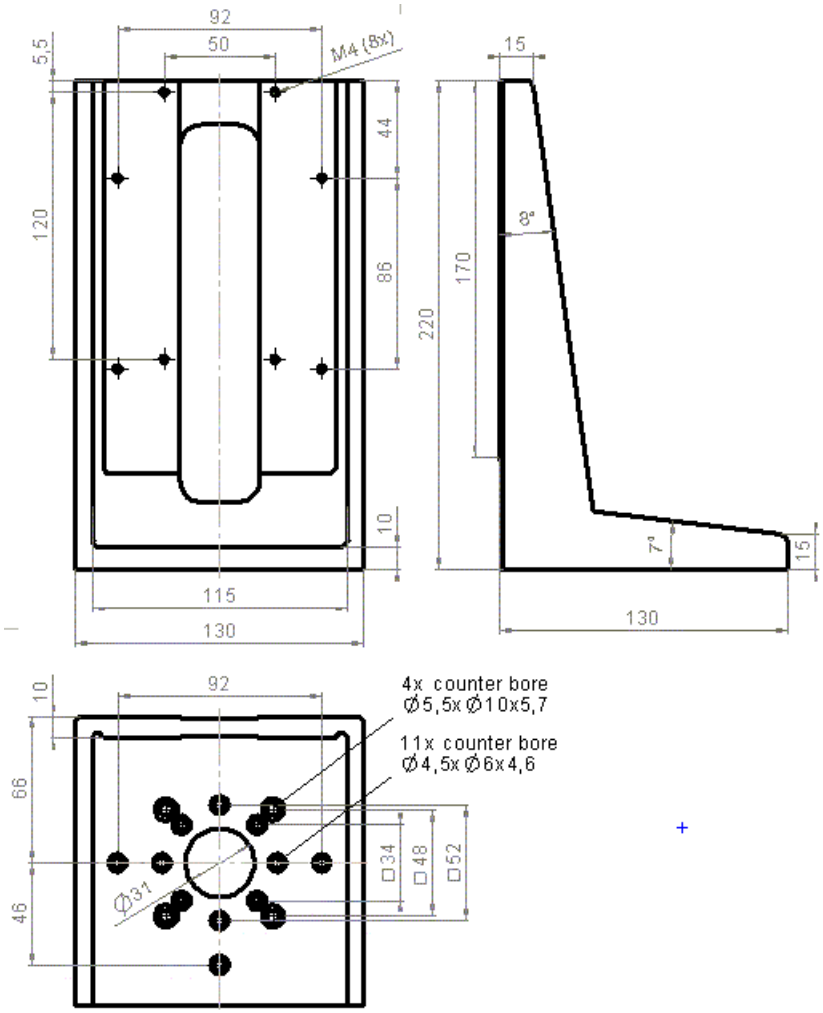
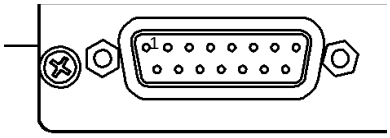


Fig. 10: M-592.00 Z-Axis Mounting Bracket

4.3 PIN Assignments

DC-Motor driven M-400 series stages are equipped with sub-D15(m) socket for connecting the motor controller. The PD versions have a separate motor power connector.

4.3.1 M-4xx.CG, M-4xx.DG

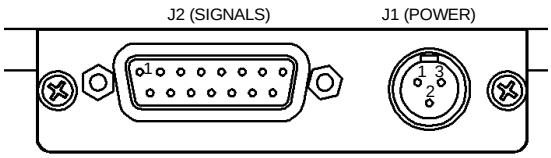


Connector J2 (from controller)

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

Pin		Signal, function
1		not connected
	9	motor connection (-)*
2		motor connection (+)*
	10	ground
3		not connected
	11	not connected
4		+5 V input for encoder and logic
	12	Limit signal for positive side (active high), TTL
5		Limit signal for negative side (active high), TTL
	13	position reference signal, TTL
6		ground (logic)
	14	encoder signal A, TTL
7		encoder signal A-, TTL
	15	encoder signal B, TTL
8		encoder signal B-, TTL

4.3.2 M-4xx.PD PWM



Connector J1 (motor power)

Type: 3-pin, round socket (Switchcraft Tini Q-G); note that pins are numbered counter-clockwise *starting from latch*.

PIN	Function
1	GND
2	Power input
3	n.c.

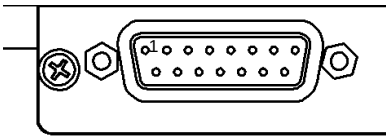
Connector J2 (controller signal)

Type: 15-pin Sub_D
Reference No.: AMP #9-215594-1

Pin		Signal, function
1		Brake ON (0 to 5-12 V) and motor disable signal (active low, input)
	9	n.c.
2		n.c.
	10	PGND (power ground)
3		MAGN signal magnitude (speed, input)
	11	SIGN signal sign (direction, TTL, input)
4		+5 V input for encoder and logic
	12	NLIMIT Limit signal for negative side (active high, TTL, output)
5		PLIMIT Limit signal for positive side (active high, TTL, output)
	13	REFS reference signal (TTL, output)
6		GND (Logic)
	14	A(+) encoder (TTL, output)
7		A(-) encoder (TTL, output)
	15	B(+) encoder (TTL, output)
8		B(-) encoder (TTL, output)

4.3.3 M-4xx.S1 Stepper Motors

Connector type: sub-D15(m)



Pin #	Function
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	input: + 5 V supply from controller
14	output: Limit signal positive side, active low, TTL, output
7	GND
15	output: Reference signal
8	output: Limit signal negative side, active low, TTL, output

4.4 Disposal

In accordance with EU directive 2002 / 96 / EC (WEEE), as of 13 August 2005, electrical and electronic equipment may not be disposed of in the member states of the EU mixed with other wastes. To meet the manufacturer's product responsibility with regard to this product, Physik Instrumente (PI) GmbH & Co. KG will ensure environmentally correct disposal of old PI equipment that was first put into circulation after 13 August 2005, free of charge.

If you have such old equipment from PI, you can send it to the following address postage-free:

Physik Instrumente (PI) GmbH & Co. KG
Auf der Römerstr. 1
76228 Karlsruhe, Germany

5 Appendix I: Current Controllers

Each motorized stage in the motion system must be connected as an axis to a motion controller. The controller is either networked with, or installed in, a PC.

NOTE

This section covers the controllers currently available from PI. If you are using an older controller, see Section 6.

Controller setup and, in most cases, operation is effectuated with software (after being properly set up with a PC, a certain level of stand-alone operation is possible with the controller and stage alone).

With PI user interface software, controller parameter settings specific to the stage are made automatically when the operator indicates which stage type stage is connected to the controller. See the controller User Manual and the software manual for the software you are using for details; they should be on the product CD that came with the controller, but can also be downloaded from www.pi.ws.
If using non-PI software, the software must take care of setting the parameters. The controller CD includes DLLs and LabVIEW drivers to facilitate this task. See the corresponding software manuals for details.

5.1 Stepper Motor Controller

Fig. 11 Single-axis C-663 Mercury™ Step stepper motor controllers are networkable with each other and with C-862 and C-863 DC motor controllers

PI stepper motors do not have position sensors and operate in open-loop mode. The limit or reference switches on the stage can be used to determine absolute position. This is usually done at startup or if confidence in the count is lost.

C-663 Mercury™ Step Parameter Settings	
	M-400.2S
Max. velocity	3 mm/s = 2400 full steps/s = 38400 C-663 microsteps/s (16x interpol.); older controllers p. 27.
Drive (phase) current	Application dependent: 500 mA to 1000 mA
Hold current	Application dependent: 200 mA recommended

5.2 DC-Motor Controllers

The following sections give ranges of numeric parameter settings appropriate for using DC-motor versions with different PI controllers. The values are in encoder counts and should be considered approximate. It may be necessary to fine tune the system for optimum operation.

Fig. 12 Currently available DC-motor controllers from PI: C-848, C-880 benchtop/rackmount (from top), C-843 PCI card (left), and the C-863 Mercury™ (right)

DC-motor versions can be used with C-843, C-848, C-880 and C-863 Mercury™ controllers.

Drive type	**DC Motor**			
Controller	**C-880**	**C-848**	**C-843**	**C-863 Mercury™**
Axes per controller	up to 19*	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)	USB, RS-232 bus or daisy chain
Multiple controllers on same host PC	yes, on separate ports*	yes, on separate ports	yes, in separate slots	yes, all on same port

*Custom configurations possible, with networked controllers controlling hundreds of axes.

5.2.1 Parameter Settings for C-863 Mercury™

The C-863 Mercury™ controller is a compact, palm-size, single-axis controller. The C-863 and other Mercury™ Class controllers like its software- and hardware-compatible predecessor, the C-862, and the C-663 Stepper Motor Controller, are daisy-chain networkable, meaning that a multi-axis system can be controlled from a single PC RS-232 or USB interface.

Both Windows user interface programs that come with the Mercury™ controller allow choice of the stage or drive type as a start option for operation. Mercurys™ always have PWM mode enabled without requiring any extra command.

C-863 Mercury™ Parameter Settings			
Stage Type Parameter	.CG versions	.DG versions	.PD versions
p- term (SPA, DP)*	320 (150 to 400)*	130 (50 to 220)*	140 (100 to 250)*
i- term (SPA, DI)*	130 (0 to 50)*	120 (0 to 50)*	120 (0 to 50)*
d- term (SPA, DD)*	300 (0 to 1000)*	320 (0 to 1000)*	600 (0 to 1200)*
i- Limit (SPA, DL)*	DL2000	DL2000	DL2000
Acceleration (SPA, ACC)*	900000 (1,000–2,500,000)	500000 (1,000–1,500,000)	800000 (1,000–1,200,000)
Velocity (VEL, SV)*	210000 (1 to 280,000)	120000 (1 to 190,000)	70000 (1 to 90,000)

*GCS and MCC native commands, respectively, for setting corresponding parameters. PI GCS software usually loads parameters automatically. The values given can be used directly with native commands. For GCS, some values need to be converted from encoder counts to mm. See GCS and Native Commands manuals for further details.

5.2.2 Parameter Settings for Other DC-Motor Controllers

The C-843 is an add-on card to be installed in a PCI slot of a PC. Two- 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 detailed information on this controller and its software interfaces.

The currently available C-848 and C-880 controllers use C-842.x3 cards (with the same processor as is on the C-843), so the same settings apply for them. For models manufactured before 2007, see Section 6.

C-843, C-848 & C-880 Parameter Settings			
Stage Type: Parameter:	.CG versions	.DG versions	.PD versions
p- term	150	250	200
i- term	240	40	250
d- term	120	800	300
i- Limit	2000	2000	2000
vff- term	0	0	0
Acceleration (max.)	2830000	5930000	2400000
Velocity (max.)	170000	119000	120000

6 Appendix II: Older Controllers

This section covers controllers which are no longer available but which may still be in use in the field.

6.1 Discontinued Stepper Motor Controllers

Fig. 13 Discontinued stepper motor controllers: 3-axis Apollo (foreground), and 4-axis C-600 (background)—both networkable, but not with newer controllers

When controlled with the C-600 or C-630 controllers, the microstepping behavior is different from that of the current C-663, leading to the following divergent specifications:

Models	.2S versions*	Units
Design resolution*	0.025	µm
Max. velocity*	6	mm/sec
Motor resolution*	20,000	steps/rev.
Linear transmission ratio*	40,000	steps/mm

* When controlled with C-600 or C-630

PI stepper motors do not have position sensors and operate in open-loop mode. The limit switches can be used to determine absolute position at startup or if confidence in the count is lost.

Settings for C-600 Apollo and C-600 Controllers	
	M-400.2S
Max. velocity	6 mm/s = 4800 full steps/s = 240000 C-600 / C-630 microsteps/s (50x interpolation)
Drive (phase) current	Application dependent: 500 mA to 1000 mA
Hold current	Application dependent: 200 mA recommended

6.2 Discontinued DC-Motor Controllers

Fig. 14 Discontinued DC-motor controllers: C-844, C-842 ISA bus card and C-862 (black) Mercury®

Covered in this section are the C-844, C-842, C-862 and pre-2007 models of the C-848 and C-880.

Proper operation of the DC-motor controllers requires appropriate setting of the servo-control parameters. The following sections describe the parameter settings appropriate for using DC-motor versions with different older PI controllers. Values for current PI controllers are given in Section 5.

6.2.1 Parameter Settings for C-842 PC ISA-Bus Card

The amplifier mode can also be set by command: PWM mode is enabled by the "SOP" command while analog mode is enabled by the "SOH" command. Use PWM mode with the ActiveDrive™ stages (.PD models). All axes connected to a given card must be in the same mode. Mixing PWM and non-PWM stages on the same card is possible using a PWM converter box (order number C-842.AP1) with analog stages while the card is in PWM mode.

Parameter Settings for C-842 and older C-880/C-848			
Stage Type Parameter	.CG versions	.DG versions	.PD versions
p- term (SPA, DP)	150 (50 to 250)	250 (50 to 300)	140 (50 to 250)
i- term (SPA, DI)	20 (0 to 50)	40 (0 to 50)	20 (0 to 50)
d- term (SPA, DD)	300 (0 to 1000)	800 (0 to 1200)	600 (0 to 1000)
i- Limit (SPA, DL)	DL2000	DL2000	DL2000
Acceleration (SPA, ACC)	350 (1 to 600)	200 (1 to 600)	100 (1 to 400)
Velocity (VEL, SV)	210000 (1 to 280,000)	120000 (1 to 190,000)	70000 (1 to 120,000)

6.2.2 Parameter Settings for Older C-848s & C-880s

C-848 and C-880 controllers manufactured in 2007 and later have C-842.x3 motor controller cards with the same motion processer as the C-843, and are covered in Section 5.2.2.

For models older than 2007, use the settings for the C-842 ISA-bus card given above.

Use PWM mode with the ActiveDrive™ stages (.PD models). All axes connected to older C-848s, or to the same card on an older C-880, must be in the same mode. Mixing PWM and non-PWM stages on the same card is possible only by using a PWM converter box (order number C-842.AP1) with analog stages while the card is in PWM mode.

6.2.3 Parameter Settings for C-844

The C-844 is a 19-inch rackmountable or desktop controller, capable of controlling up to 4 axes.

DCMove is the standard C-844 operating program. This program uses a configuration file to define the motion control parameters. First use the parameter menu to set these values.

Use PWM mode with the M-xxx.PD models. PWM mode is enabled by the OUTP:SIGN PWM command, while analog mode is enabled by the OUTP:SIGN DAC command. All axes connected to a given C-844 must be in the same mode. Mixing PWM and non-PWM stages on the same controller is possible using a PWM converter box (order number C-842.AP1) with analog stages while the card is in PWM mode.

Using C-844 Motor Controllers with

Stage	M-4xx.CG gearhead drive		M-4xx.DG gearhead drive		M-4xx.PD integrated amplifier	
Parameter	Recommended Value Setting*	Operating Range	Recommended Value Setting*	Operating Range	Recommended Value Setting*	Operating Range
p-term	150	P: 150–350	250	P: 150–350	140	P: 50–250
i-term	20	i: 0–50	40	i: 0–50	20	i: 0–50
d-term	300	D: 0–1,200	800	d: 0–1,200	600	d: 0–1,000
i –limit	LIM:IERR 2000	0–2,000	LIM:IERR 2000	0–2,000	LIM:IERR 2000	0–2,000
Velocity	MVEL 210000	1–280,000	MVEL 120000	0–190,000	MVEL 70000	0–120,000
Acceleration (SA)	ACC 900000	0–1,500,000	ACC500000	0–1,500,000	ACC800000	1,000–1,500,000

*Letters are ASCII commands, see the C-844 Motor Controller User Operating Manual (MS52E) for more details

6.2.4 Parameter Settings for C-862 Mercury

C-862s are daisy-chain networkable with each other, with the new C-863 DC motor controller and the C-663 stepper motor controller, meaning a multi-axis system can be controlled from a single PC RS-232 interface.

Using C-862 Mercury™ Controllers with

Stage	M-4xx.CG gearhead drive		M-4xx.DG gearhead drive		M-4xx.PD integrated amplifier	
Parameter	Recommended Value*	Operating Range	Recommended Value*	Operating Range	Recommended Value*	Operating Range
p –term (DP)	DP320	150–400	DP130	50–220	DP140	100–250
i –term (DI)	DI30	0–50	DI20	0–50	DI20	0–50
d –term (DD)	DD300	0–1,000	DD320	0–1,000	DD600	0–1,200
i–Limit (DL)	DL2000	0–2,000	DL2000	0–2,000	DL2000	0–2,000
Velocity (SV)	SV210000	1–260,000	SV120000	1–190,000	SV70000	1–90,000
Acceleration (SA)	SA900000	1,000– 2,500,000	SA500000	1,000–1,500,000	SA800000	1,000–1,200,000

*Letters are ASCII commands, see the C-862 Mercury™ Controller User Manual (MS 74E) for more details