

MP 45E User Manual

M-605 Linear Positioning Stages

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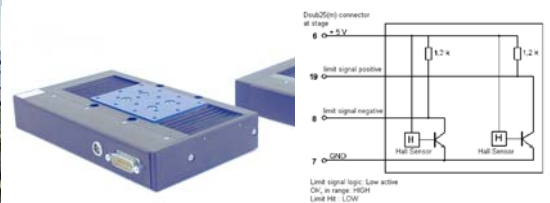
This document describes the following product(s):

■ **M-605.1DD**

Translation Stage, 25 mm, 0.1µm Linear Scale, ActiveDrive™ DC Motor

■ **M-605.2DD**

Translation Stage, 50 mm, 0.1µm Linear Scale, ActiveDrive™ DC Motor



Declaration of Conformity

according to ISO / IEC Guide 22 and EN 45014

Manufacturer: Physik
Instrumente (PI)
GmbH & Co. KG
**Manufacturer's
Address:** Auf der
Römerstrasse 1
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Karlsruhe,
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The manufacturer hereby declares that the product
Product Name: **Linear Positioning Stage**
Model Numbers: **M-605**
Product Options: **all**

conforms to the following EMC Standards and normative documents:

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

August 24, 2004
Karlsruhe, Germany

A handwritten signature in black ink, appearing to read 'K. Spanner', written over a horizontal line.

Dr. Karl Spanner
President

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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-605 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-605 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 via FTP or 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-605 Linear Positioning Stages, 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 M-605 Linear Stages

M-605 linear stages are ultra-compact, high-accuracy linear translation stages designed to meet the most demanding positioning requirements in applications where space is limited. Used in the fields of photonics packaging, semiconductor quality control, metrology test equipment, disk drive test setups and general R&D tasks, M-605 stages are designed to meet demanding positioning requirements.

The stages combine a functional flat design to allow multi-axis combinations, and feature a precision-machined base from high-density, stress-relieved aluminum for exceptional stability and minimum weight. Precision-ground recirculating ballscrews, (more accurate than rolled ballscrews) and preloaded nuts provide low-friction, backlash-free positioning.

Uni-directional and bi-directional repeatability are 0.1 and 0.2 μm respectively with maximum pitch and yaw errors of 50 μrad .

All versions are equipped with non-contact, Hall-effect, direction-sensing origin sensors and limit switches with direction sensing at the origin.



Fig. 1: M-605.1DD Translation Stage

1.1 Model Survey

M-605 stages are available with travel ranges of 25 and 50 mm. All have ActiveDrive™ direct-drive DC motors.

1.2 Safety Precautions

Read This Before Operating M-605 Linear Stages:



CAUTION

M-605 stages are powered by powerful electric motors and can accelerate to high speeds. Be aware that automatic limit switch halt may not be supported by, or activated at, the motor control electronics.

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

When the stage is first connected to the motor controller, be aware that the stage could start an undesired move.



WARNING

To avoid damage or injury, do not put anything on the bellows.

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

1.3 Shipment Contents

M-605 stages are delivered with

- 4 metric screws M4x35 w. hex wrench, (purpose: mounting the stage onto a flat plane or mounting two stages as an XY combination or mounting objects onto the moving platform).
- Power supply, # M-500.PS
- Connecting cable, # C-815.38
- This User Manual



2 Technical Data

Models	M-605.1DD	M-605.2DD	Units	Notes
Travel range	25	50	mm	
Weight	1.5	1.8	kg	
Design resolution		0.1	µm	A3
Min. incremental motion		0.1	µm	A4
Unidirectional repeatability		0.1	µm	
Origin repeatability (reference switch)		0.2	µm	
Bidirectional repeatability		0.2	µm	
Pitch (θ_y)		50	µrad	
Yaw (θ_z)		50	µrad	
Max. velocity		50	mm/sec	
Max. normal load capacity		30	kg	B1
Max. push/pull force		20 / 20	N	B2
Max. lateral force		100	N	
Encoder resolution		0.1	µm	
Ballscrew pitch		1	mm/rev	
Motor Type	DC motor 3557K024CS			
Nominal motor power*	17		W	
Motor voltage range	0 to ±24		V	
PWM amplifier	LMD 18201, 24.5 kHz			
Encoder type	linear encoder			
Signals	A, A/, B, B/			
Transmission	RS-422			
Power supply	external line-power power supply, order # M-500.PS			
Power consumption	Motor power plus 130 mA (supplied by external P/S)			
Body material	Al			
Recommended motor controller	C-843, C-862, C-848			

* ActiveDrive™ (integrated PWM servo-amplifier), 24 V power supply included

NOTES

A3 Design Resolution:

Theoretical minimum movement that can be made, based on characteristics of mechanical drive components selected.

A4 Minimum incremental motion:

The minimum motion that can be repeatably executed for a given input, sometimes called the “practical” or “operational” resolution

B1 Max. Normal Load:

Centered, vertical load on horizontal stage

B2 Max. Push/Pull:

Active and passive force limit in operating direction, at center of stage.

2.1 Motor Controllers

M-605.xDD stages can be used with C-842, C-843, C-844 and C-862 (C-860) Mercury controllers. See the sections that follow for motion parameter settings.



Fig. 2. C-848, C-880 and C-862 Mercury controllers; C-842 (ISA bus) and C-843 (PCI bus) controller cards

3 System Description

3.1 Linear Scale Position Encoder

M-605 stages use linear scale position encoders with 0.1 μm resolution for position detection. Maximum velocities of 50 mm/s can be achieved.

The linear encoder is mounted in the center of the stage, close to the ballscrew drive to prevent possible cosine error. The linear encoder measures the actual position of the moving carriage directly, thus eliminating drivetrain errors such as non-linearity, backlash or elastic deformations.

The encoder is based on an optical grating and a non-contacting read head with integrated signal conditioner and interpolator.

3.2 PWM Amplifiers

For maximum dynamic performance, the DC servo-motors are driven by high-efficiency PWM power amplifiers integrated into the stages. An external line-power power supply (order number: M-500.PS) 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.

3.3 Travel Limit Sensors

M-605 stages are protected against running into the hard stop by double-level magnetic limit sensors (Hall-effect sensors with TTL drivers) at each end of travel.

The **inner limit sensors** (*N1 at the negative-travel end and P1 at the positive-travel end*) work with the controller's limit sense input lines. The TTL output signal is active high.

The **outer limit sensors** (*N2 at the negative and P2 at the positive end*) work locally, opening a relay that cuts the motor current. The second-level limit switches provide for fail-safe operation in case the controller fails to stop the motor when the inner limit sensor is reached.

If the outer limit switch is reached, the stage can not be operated by the controller until the platform is pushed back

manually. Disconnect the motor cable or set the motor into MOTOR OFF state before pushing the platform back into the current-allowed area.

Limit Switch Sensor Specifications:

Type:	magnetic (Hall-effect) sensors, can be used with bipolar CMOS circuits
Power supply:	+5...+24 V / GND, supplied by the motor controller through the motor connector
Voltage output:	TTL level
Sink / Source current:	± 48 mA
Logic (active-high):	Normal motor operation: low, Limit switch reached: high

3.4 Position Reference Signal Sensors

Position Reference Sensors are located approximately in the middle of the operating range and can be used to reference the absolute position of the stage within 0.5 μm accuracy. Always approach the reference sensor from the same side to reach the same position.

The reference sensor in M-605 stages provides a static signal level which depends on the platform position. If the platform is on the "positive side" the reference signal is +5 V, while if the platform is on the "negative side," the signal level is 0 V. Most PI motor controllers and Windows libraries offer the option of starting a search run for the reference point using the current reference sensor signal to determine the appropriate direction.

The "AutoFindReference" function allows for starting a search run for the reference signal. Independent at which side relative to the reference position the stage is located, this function always starts the stage towards the reference position.

4 Operating M-605 Stages

M-605.1DD and M-605.2DD stages have internal linear scales and PWM amplifiers. Individual setting of motion control parameters is required for smooth and optimized movement. Incorrect parameter setting may cause severe spindle vibration. If this occurs set the motor off (MF) and modify the parameter settings.

4.1 Motor Controller Setup

The tables shown in this section give good conservative starting values for the proportional (P), integral (I), differential (D) parameters of the PID servo-control algorithm used by the corresponding controller, as well as the acceleration and velocity limits to use.

The table entries include the command mnemonic to use in the controller command language to set the corresponding value.

4.1.1 Using C-842 Motor Controllers with M-605 Stages

WinMove and WinMoveNT are the standard operating programs for C-842 motor controllers being operated from Windows platforms. WinMove allows configuration of the M-605 stages with a configuration file.

WinMove software automatically handles amplifier mode setting as a function of the stage model number selected.

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.

Sample Configuration File for Use by WinMove (version 3.00 or later) :

```
; File: "WINMOVE.CFG"
; WinMove Configuration File for C-842
; -----
BOARDMODE=9
LIMITMODE=autodetect
STAGE1=M-605.2DD
STAGE2=M-605.2DD
```



C-842 Parameter Settings for		
Parameter	M-605.1DD	M-605.2DD
p- term	DP100 (50 to 120)	DP100 (50 to 120)
i- term	DI100 (0 to 120)	DI100 (0 to 120)
d- term	DD200 (0 to 250)	DD200 (0 to 250)
i- Limit	DL2000	DL2000
vff- term	DF500 (0 to 700)	DF500 (0 to 700)
Acceleration	SA500 (40 to 1000)	SA500 (40 to 1000)
Velocity	SV150000 (1 to 250,000)	SV150000 (1 to 250,000)
Range		485,000 counts

4.1.2 Using C-844 Motor Controllers with M-605 Stages

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:

PWM mode is enabled by the OUP:SIGN PWM command, while analog mode is enabled by the OUP:SIGN DAC command.

C-844 Parameter Settings for M-605 Stages		
	M-605.1DD	M-605.2DD
p-i-d terms	PID 100,100,200 p : 30 to 120 i : 0 to 120 d : 0 to 250	PID 100,100,200 p : 30 to 120 i : 0 to 120 d : 0 to 250
i- Limit	LIM:IERR 2000	LIM:IERR 2000
vff- term	VFF500 (0 to 700)	VFF500 (0 to 700)
Acceleration	ACC 1250000 (100,000 to 1,800,000)	ACC 1250000 (100,000 to 1,800,000)
Velocity	MVEL 180000 (1 to 250,000)	MVEL 180000 (1 to 250,000)



4.1.3 Using Mercury Motor Controllers with M-605 stages

The Windows operating program for the Mercury controller allows choice of M-605 stages as a start option for operation. Mercury always has the PWM mode enabled without any extra command.

Mercury C-862 Parameter Settings for M-605 Stages		
	M-605.1DD	M-605.2DD
p- term	DP120 (50 to 150)	DP120 (50 to 150)
i- term	DI20 (0 to 40)	DI20 (0 to 40)
d- term	DD200 (0 to 350)	DD200 (0 to 350)
i- Limit	DL2000	DL2000
Acceleration	SA1200000 (100,000 to 1,800,000)	SA1200000 (100,000 to 1,800,000)
Velocity	SV150000 (1 to 250,000)	SV150000 (1 to 250,000)

4.2 Mechanical Handling

4.2.1 Mounting

M-605 stages can be mounted in any orientation, horizontally or vertically. To achieve the specified guiding accuracy, the stages must be mounted on a flat surface to avoid torsion of the base.

4.2.2 Operating Environment

M-605 stages require clean environments for operation. Although provided with a flexible bellows to protect against dust and liquids, the unit is not hermetically sealed. Make sure that metal dust and liquid spray do not enter the case.

4.2.3 Maintenance

When operated in a clean environment, no maintenance is required. If the stages are operated in extremely dusty environments, we recommend cleaning and greasing the ballscrew and linear bearings from time to time. The time interval depends of the degree of contamination and can vary from 100 to 800 operating hours.

Recommended lubricant for ballscrews:

KLÜBER Staburags Type NBU 8EP or Beacom 325

5 M-605 Dimensions

Decimal places delimited by commas in drawings

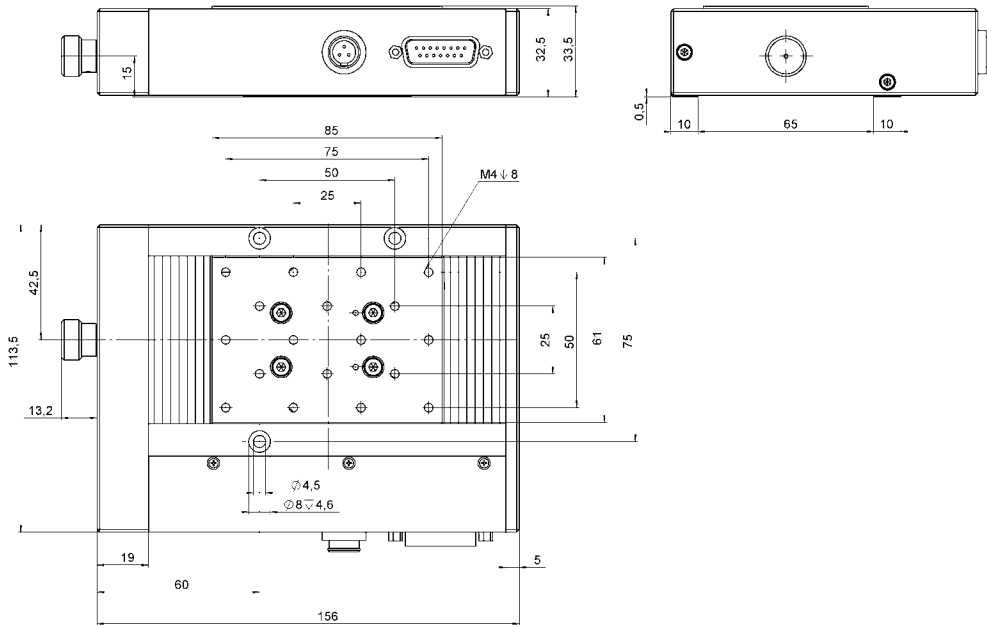


Fig. 3: M-605.1DD

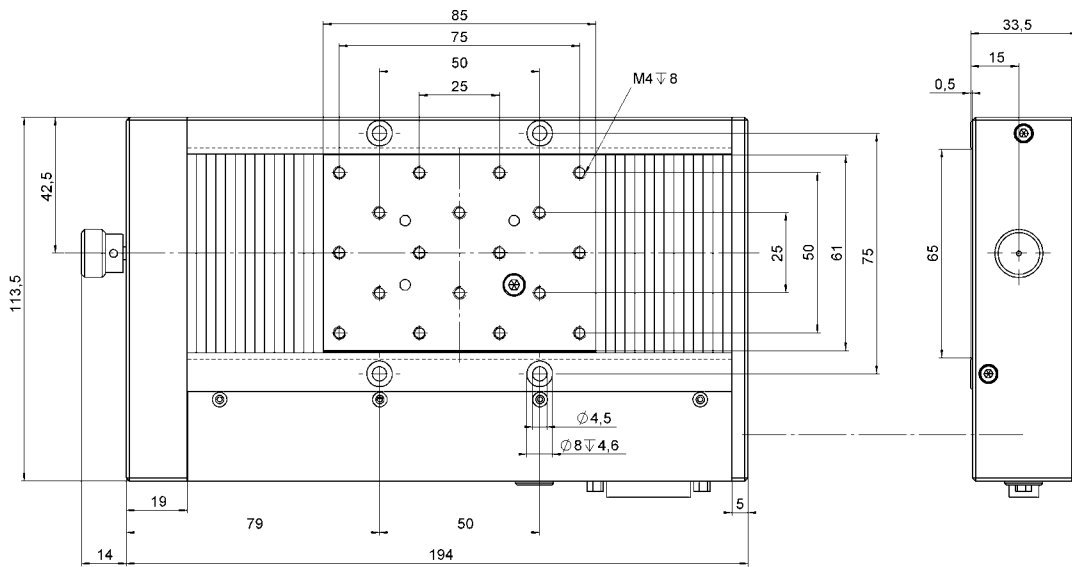


Fig. 4: M-605.2DD

6 Pin Assignments

M-605 stages are equipped with one sub-D15(m) socket for connecting the motor controller and one 3-pin, round connector for the power supply.

Connector J1 (Power Supply)

Type: 3-pin, round socket
Reference No: Switchcraft Tini Q-G

PIN	Signal
1	GND
2	Voltage input
3	n.c.

Connector J2 (Signals, Controller connection)

Type: 15-pin sub-D connector
Reference No.: AMP #9-215594-1

Pin	Signal
1	Control input for optional motor brake (0 to 24 V)
9	n.c.
2	n.c.
10	PGND
3	PWM MAGN input
11	PWM SIGN input
4	+5 V input
12	NLIMIT output (Limit signal of negative side)
5	PLIMIT output (Limit signal of positive side)
13	Reference sensor output
6	GND (Limit)
14	Encoder A(+) output
7	Encoder A(-) output
15	Encoder B(+) output
8	Encoder B(-) output

6.1 Accessories

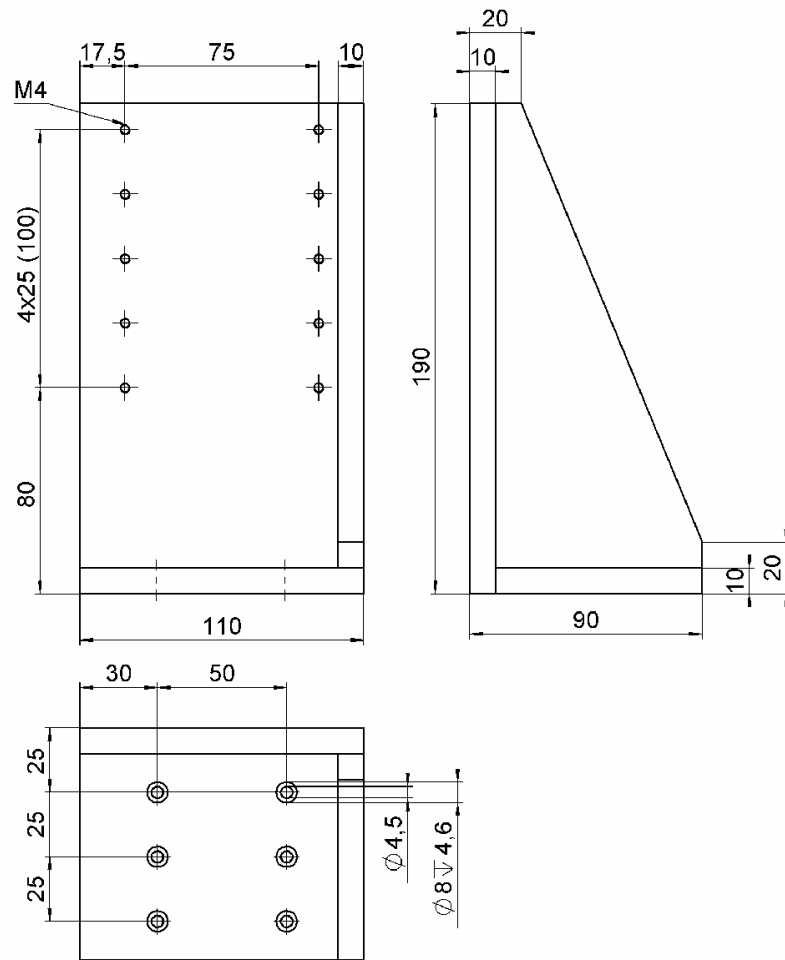


Fig. 5: M-605.AV1 angle bracket for vertical mounting

