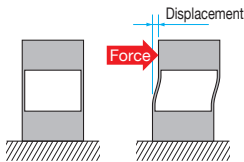# Piezo Guide

For the guide mechanism, Sigma fine stages adopted a guide system that utilizes elastic deformation of metals and a mechanism to increase deformation of piezo elements. These originally designed stages achieved readable resolution of 10nm during closed loop control, ideal for uses that require high-speed high-precision positioning.
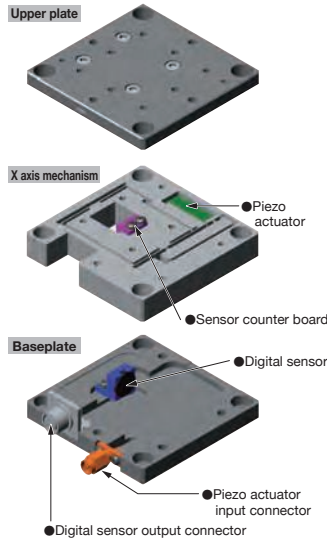
Structure of Sigma Fine Stage

■Displacement Magnification Method

Piezo actuator and displacement magnification mechanism offer a large operating range.

■Digital Sensor

Closed loop control is possible with a digital sensor that does not require any high precision analog amplifier or AD conversion circuit.

■SFS-H Internal Structural Drawing

Upper plate

X axis mechanism
●Piezo actuator

●Sensor counter board

Baseplate
●Digital sensor

●Piezo actuator input connector

●Digital sensor output connector
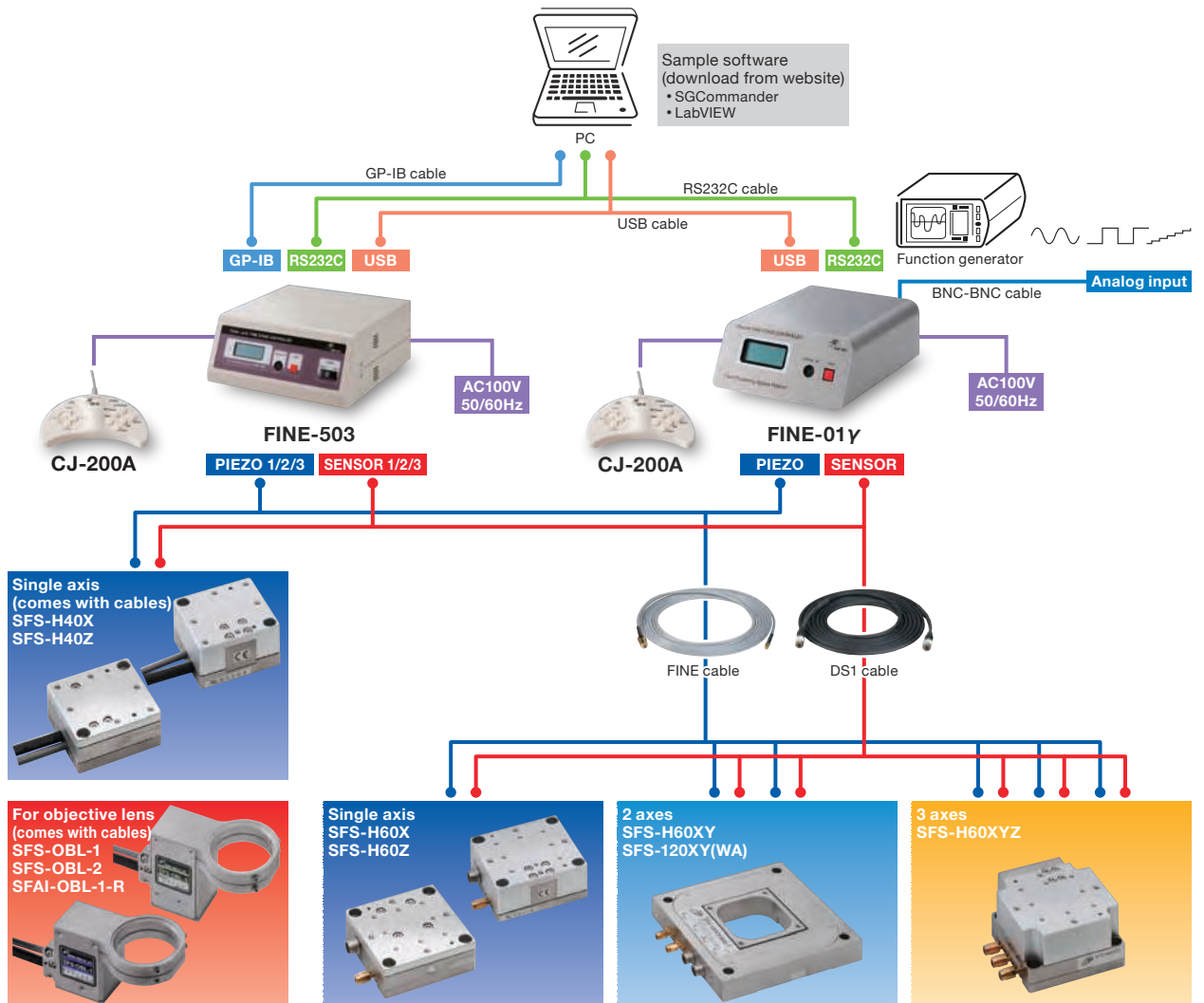
Operating Environment of Sigma Fine Stage

Use fine stages within the following operating environment temperature range. Contact us separately if you desire to use the stages outside the operating environment temperature range.

*Operating environment	*Recommended environment
Temperature: 10°C – 30°C	Temperature: 20°C ±1°C
Humidity: 20% – 60%	Humidity: 40% or lower
(without condensation)	

Since durability of piezo elements used in the SFS/SFS-H stage series will deteriorate in high humidity environments, use them in the above environments.

Sigma Fine System Chart

Sample software (download from website)
• SGCommander
• LabVIEW

PC

GP-IB cable

RS232C cable

USB cable

GP-IB | RS232C | USB | USB | RS232C | Function generator

BNC-BNC cable | Analog input

AC100V 50/60Hz

FINE-503

CJ-200A | PIEZO 1/2/3 | SENSOR 1/2/3

AC100V 50/60Hz

FINE-01γ

CJ-200A | PIEZO | SENSOR

FINE cable | DS1 cable

Single axis (comes with cables)
SFS-H40X
SFS-H40Z

For objective lens (comes with cables)
SFS-OBL-1
SFS-OBL-2
SFAI-OBL-1-R

Single axis
SFS-H60X
SFS-H60Z

2 axes
SFS-H60XY
SFS-120XY(WA)

3 axes
SFS-H60XYZ

Accuracy Measurement Example: Sigma Fine Stage System SFS-H (Linear Stage)

High Speed Convergence Data

SFS-H60X
0μm⇔75μm
150g load

M100ms A Ch1 ∫ 10.8mV
CH1 200mV ↓   (Reference)
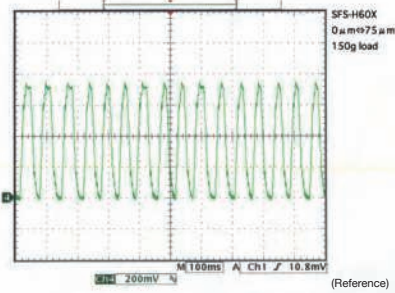
0⇔75μm pulse rate (16Hz)
Closed loop control
by SFS-H60X at 150g load

△: 9.80mV
@: 11.9mV
△: 15.0ms
@: 13.2ms

SFS-H60X
1μm
150g load

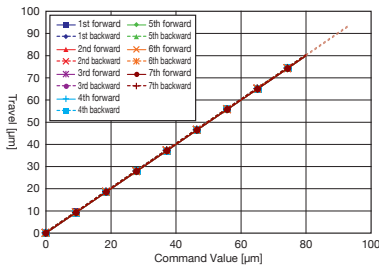M10.0ms A Ch4 ∫ 9.70mV
CH4 5.00mV ↓   (Reference)
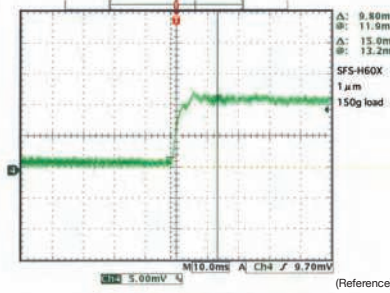
0⇒1μm step convergence data (15msec)
Closed loop control
by SFS-H60X at 150g load

Travel

The following graph shows the hysteresis curve unique to piezo actuators during open loop control travel.


Displacement (μm) vs Voltage (V)
- 1st time
- 2nd time
(Reference)

Linearity

Travel [μm] vs Command Value [μm]
- 1st forward
- 1st backward
- 2nd forward
- 2nd backward
- 3rd forward
- 3rd backward
- 4th forward
- 4th backward
- 5th forward
- 5th backward
- 6th forward
- 6th backward
- 7th forward
- 7th backward
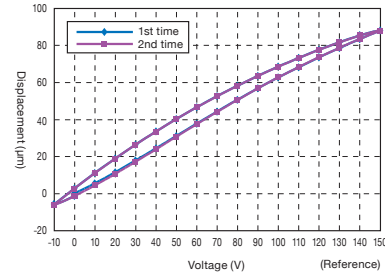
0⇔80μm linearity within 0.3%
Closed loop control
by SFS-H60X at 150g load

Positional Repeatability

Measured Value [μm] vs Command Position [μm]
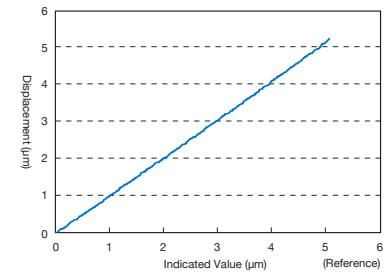- Positional Repeatability (Forward)
- Positional Repeatability (Backward)
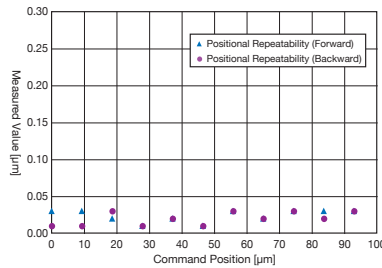
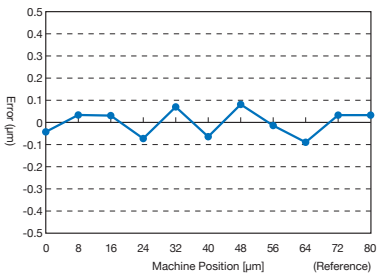0⇔80μm positional repeatability 50nm or lower
by SFS-H60X at 150g load

Characteristics of Fine Feed

Characteristics when feed amount is small in closed loop control. Hysteresis disappears in open loop control.
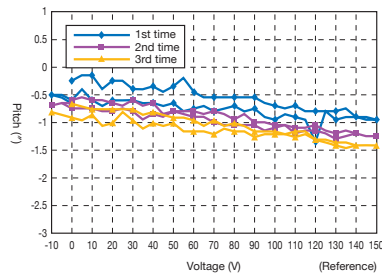

Displacement (μm) vs Indicated Value (μm)
(Reference)

Straightness

Deviation from the straight line in the direction of travel.

Error (μm) vs Machine Position [μm]
(Reference)

Pitch

Tilt around the axis in the horizontal plane perpendicular to the direction of travel.

Pitch (°) vs Voltage (V)
- 1st time
- 2nd time
- 3rd time
(Reference)

Characteristics of Yaw

Rotation around the axis in the vertical plane perpendicular to the direction of travel.

Yaw (°) vs Voltage (V)
- 1st time
- 2nd time
- 3rd time
(Reference)
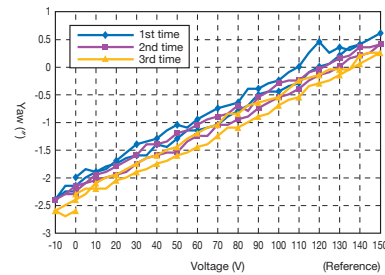
Follow-up example with Respect to Analog Input: SFS-H (Linear Stage) *Controlled by FINE-01γ

High Speed Convergence Data

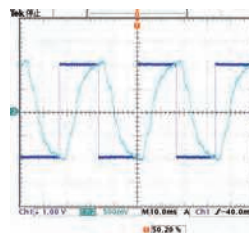Input waveform: Navy／Output waveform: Light blue

Displacement (μm) vs Time (sec)
- Capacitive sensor (user machine)
- Position command value
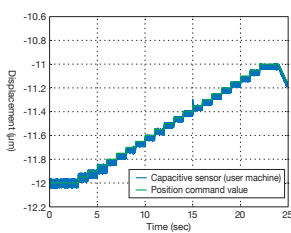
SFS-H40X
Staircase wave input/output waveforms
(Step 50nm 20-step staircase wave)

Displacement (μm) vs Time (sec)
- Capacitive sensor (user machine)
- Position command value
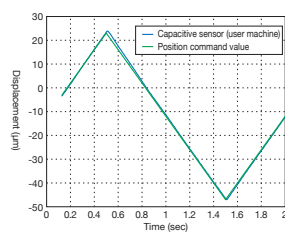
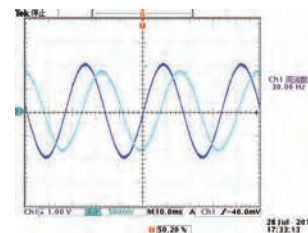SFS-H40X
Saw-tooth wave input/output waveforms
(Uniform motion 35μm1Hz)

SFS-H40X
Rectangular wave input/output (30Hz)

SFS-H40X
Sine wave input/output (30Hz)

Application Systems

Optics & Optical Coatings

Holders

Bases

Manual Stages

Actuators

Motoeized Stages

Light Sources

Index

Guide

Controllers/Drivers

Softwares

Stepping Motor

AC Servo Motor

Cables

Piezo

X Translation

Theta Rotation

Goniometer

Vacuum

Options

□40mm
□60mm
□80mm
□85mm
□100mm
□120mm
Others

Sigma Fine (Piezo) Stages (high stiffness type)
XY Piezo Stages Aperture Type

SFS-H
SFS-120XY(WA)

CE
CE

These piezo stages achieved fine movement of theoretical resolution of 1nm, offering high precision, high stiffness and high speed with adoption of digital sensors.
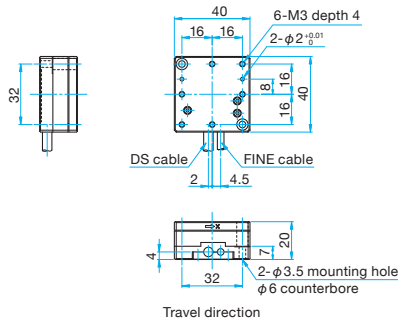
SFS-H

- These piezo stages offer high precision and high resolution positioning because full closed loop control is possible with digital sensors.
- With piezo elements used as actuators, travel between 90μm – 100μm in open loop control, and fine movement of theoretical resolution of 1nm are possible.
- Readable resolution of 10nm is achieved during full closed loop control with adoption of a digital sensor (micro-displacement sensor based on the frequency digital conversion method) used as position detection sensors.
- Sigma Koki controller FINE series offers high speed. Reference G117 Regarding pulse rate, SFS-H (linear) achieved 10 – 15Hz, or 25Hz when the current FINE-01γ analog input is used.
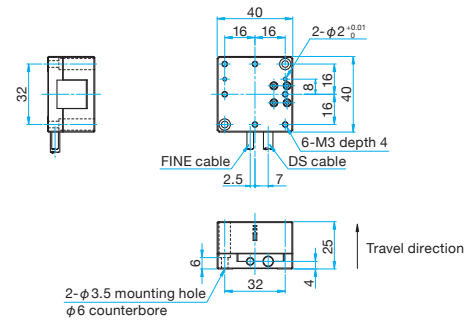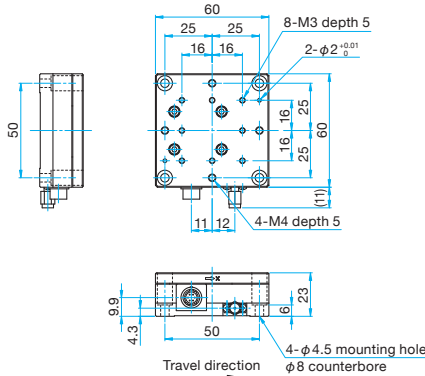
2D CAD 3D CAD

Outline Drawing

SFS-H40X(CL) Hexagon socket head cap screw M3×10…2 screws
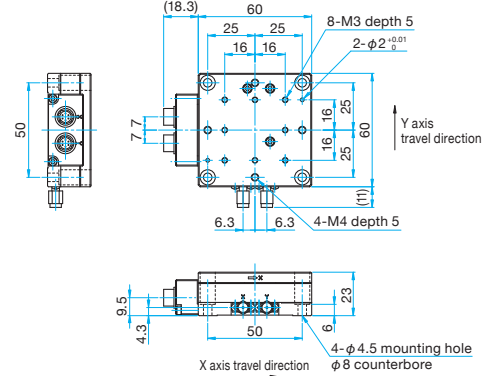

SFS-H40Z(CL) Hexagon socket head cap screw M3×10…2 screws

SFS-H60X(CL) Hexagon socket head cap screw M4×10…4 screws

SFS-H60XY(CL) Hexagon socket head cap screw M4×10…4 screws

Specifications

Part Number	SFS-H40X(CL)	SFS-H40Z(CL)	SFS-H60X(CL)	SFS-H60XY(CL)
Travel	90μm±15%	100μm±15%	100μm±15%	100μm±15%
Table Size [mm]	40×40	40×40	60×60	60×60
Actuator	Piezo actuator	Piezo actuator	Piezo actuator	Piezo actuator
Weight [kg]	0.28	0.28	0.4	0.43
Theoretical Resolution (open-loop) [nm]	1	1	1	1
Resolution (closed-loop) [nm]	10	10	10	10
Linearity [%]	0.3 or lower	0.3 or lower	0.3 or lower	0.3 or lower
Perpendicularity (Horizontal Direction) [μm]	1	1	1	1
Positional Repeatability [μm]	0.1 or lower	0.1 or lower	0.1 or lower	0.1 or lower
Load Capacity [N]	9.8 (1.0kgf)	6.7 (0.7kgf)	19.6 (2.0kgf)	14.7 (1.5kgf)
Micro-displacement Sensor	Digital Sensor	Digital Sensor	Digital Sensor	Digital Sensor
Compatible Cable	Attached cable (2m)	Attached cable (2m)	FINE-CA-3: For piezo DS1-CA-3: For digital sensor	FINE-CA-3: For piezo DS1-CA-3: For digital sensor

2D CAD 3D CAD

Outline Drawing

SFS-H60Z(CL) 🔧 Hexagon socket head cap screw M4×10...4 screws
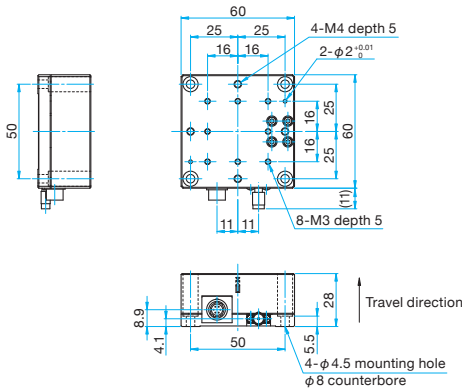
SFS-H60XYZ(CL) 🔧 Hexagon socket head cap screw M4×10...4 screws
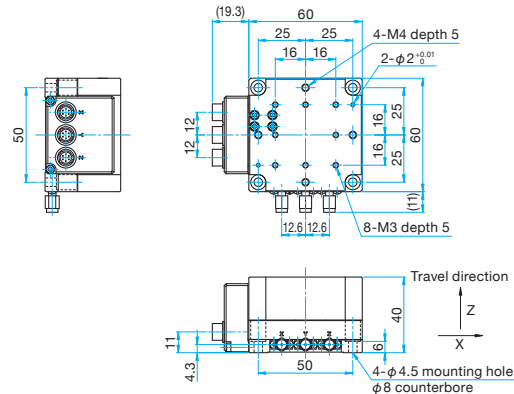
SFS-120XY(WA)

- A high precision positioning XY axis stage with 50×50mm aperture fitted with a piezo element as an actuator and digital sensor for position feedback, suitable for fine movement of samples under a microscope.
- Can be driven with the Sigma fine stage controller FINE-503. Since the controller supports RS232C, GP-IB (FINE-503 only) and USB interfaces, position control can be performed easily from a PC using the software for positioning & measurement SGEMCSE, SGTERME and SGSFSXE.
- Ideal for applications such as incorporation into various types of microscopes, precision measurement, semiconductor test equipment, high-precision mask alignment, scanning interferometer, image processor, and biotechnology systems.
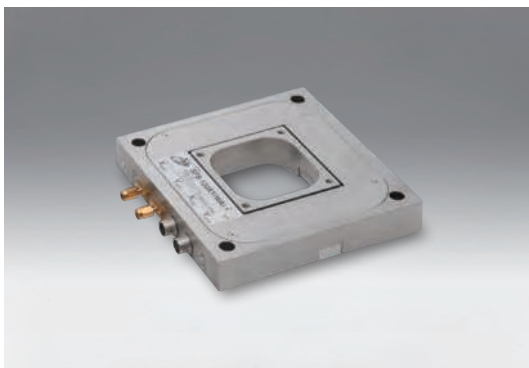
Outline Drawing

SFS-120XY(WA) 🔧 Hexagon socket head cap screw M4×8...4 screws

2D CAD 3D CAD
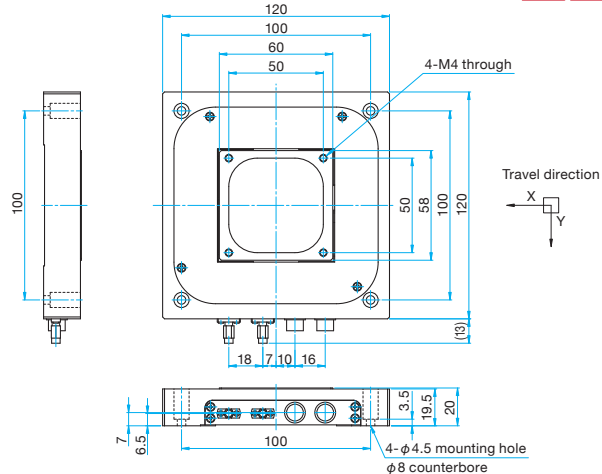
Specifications

Part Number	SFS-H60Z(CL)	SFS-H60XYZ(CL)	SFS-120XY(WA)
Travel	100µm±15%	100µm±15%	100µm±10%
Table Size [mm]	60×60	60×60	120×120
Actuator	Piezo actuator	Piezo actuator	Piezo actuator
Weight [kg]	0.33	0.63	1.2
Theoretical Resolution (open-loop) [nm]	1	1	1
Resolution (closed-loop) [nm]	10	10	10
Linearity [%]	0.3 or lower	0.5 or lower	—
Perpendicularity (Horizontal Direction) [µm]	1	1	1 or lower
Positional Repeatability [µm]	0.1 or lower	0.15 or lower	0.1 or lower
Load Capacity [N]	9.8 (1.0kgf)	9.8 (1.0kgf)	19.6 (2.0kgf)
Micro-displacement Sensor	Digital sensor	Digital sensor	Digital sensor
Compatible Cable	FINE-CA-3: For piezo DS1-CA-3: For digital sensor	FINE-CA-3: For piezo DS1-CA-3: For digital sensor	FINE-CA-3: For piezo DS1-CA-3: For digital sensor

Application Systems
Optics & Optical Coatings
Holders
Bases
Manual Stages
Actuators
Motoeized Stages
Light Sources
Index
Guide
Controllers/Drivers
Softwares
Stepping Motor
AC Servo Motor
Cables
Piezo
X Translation
Theta Rotation
Goniometer
Vacuum
Options
□40mm
□60mm
□80mm
□85mm
□100mm
□120mm
Others

Piezo Actuator for Objective Lens | SFS-OBL (Upright)/SFAI-OBL (Inverted)

CE (SFS-OBL-1 only)   Catalog Code W9056

Objective lens actuator for inverted microscope employing a piezo element as actuator and digital sensor for feedback.


- Compact, and enabling high-speed high-resolution positioning.
- Travel is 100μm at open loop.
- Two types of erected model and inverted model are available for incorporation into various types of microscopes.
- In the case of the Sigma fine stage series, these actuators can be driven with the controller (FINE-01γ/503(CL)). Since RS232C, GP-IB (FINE-503 only) and USB interfaces are supported, position control can be performed easily from a PC using the software for positioning & measurement SGEMCSE, SGTERME and SGSFSXE.

Guide

▶ Adapters compatible with screw sizes of other manufacturers' objective lenses are also available.
▶ SFS-OBL-2 uses a metal enclosure type piezo actuator to improve environment resistance such as humidity compared to SFS-OBL-1.

Outline Drawing

SFS-OBL-1

SFS-OBL-2

SFAI-OBL-1R

2D CAD 3D CAD

[Accessory] Special adapter
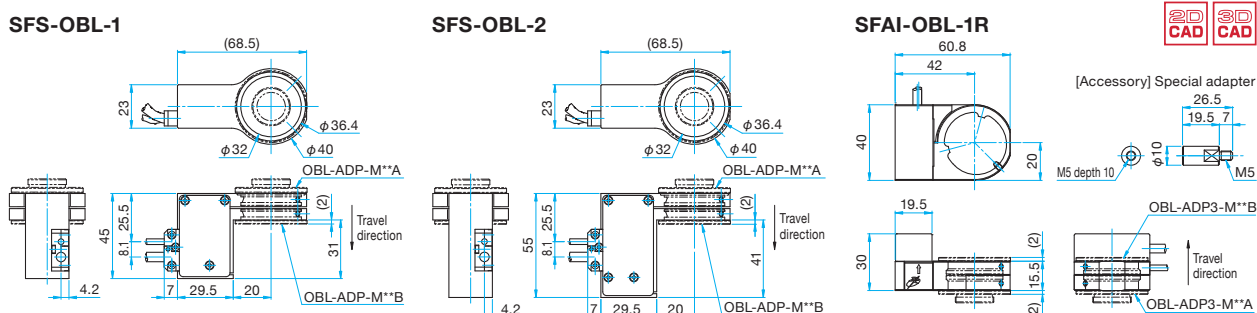
Specifications

Part Number	CE SFS-OBL-1	SFS-OBL-2	SFAI-OBL-1R
Travel	100μm±15%	100μm±15%	100μm±15%
Objective Lens Diameter [mm]	Diameter φ39 or less	Diameter φ39 or less	Diameter φ39 or less
Dimensions [mm]	(W)75.5 × (H)45 × (D)40	(W)75.5 × (H)55 × (D)40	(W)60.8 × (H)30 × (D)40
Actuator	Piezo element	Piezo element	Piezo element
Weight [kg]	0.15	0.24	0.15
Theoretical Resolution (open-loop) [nm]	1	1	about 0.8
Resolution (closed-loop) [nm]	10	10	10
Straightness (Xy Xz Yx Yz) [μm]	1 or lower	1 or lower	0.2 or lower
Positional Repeatability [μm]	0.1 or lower	0.1 or lower	0.1 or lower
Load Capacity [N]	—	—	4.9 (0.5kgf)
Micro-displacement Sensor	Digital sensor	Digital sensor	Digital sensor
Compatible Adapter	OBL-ADP-**	OBL-ADP-**	OBL-ADP3-**
Accessories	Cable (2m)	Cable (2m)	Cable (2m), four special lift spacers

Objective Lens Adapters

OBL-ADP-MA**

OBL-ADP-MB**

OBL-ADP3-MA**

OBL-ADP3-MB**
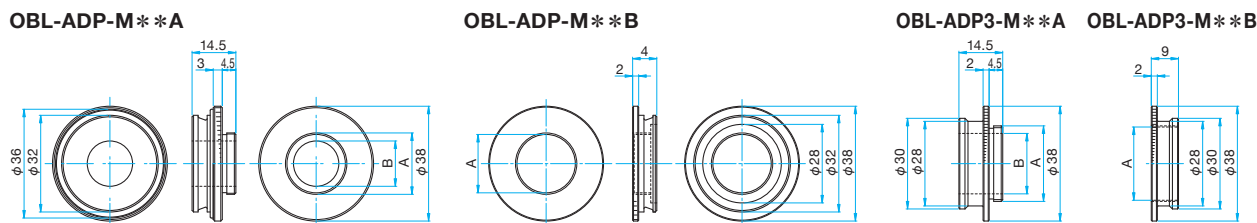
SFS-OBL Compatible Adapters

Part Number	Mounting Screw Size [mm]		A [mm]	B [mm]
OBL-ADP-M20.32A	Microscope side M20.32	M20.32 P=0.706 (W0.8×1/36)	15	
OBL-ADP-M20.32B	Objective lens side M20.32	M20.32 P=0.706 (W0.8×1/36)	—	
OBL-ADP-M25.0A	Microscope side M25.0	M25.0 P=0.75	20	
OBL-ADP-M25.0B	Objective lens side M25.0	M25.0 P=0.75	—	
OBL-ADP-M26.0A	Microscope side M26.0	M26.0 P=0.706 (W26.0×1/36)	21	
OBL-ADP-M26.0B	Objective lens side M26.0	M26.0 P=0.706 (W26.0×1/36)	—	

SFAI-OBL Compatible Adapters

Part Number	Mounting Screw Size [mm]		A [mm]	B [mm]
OBL-ADP3-M20.32A	Microscope side M20.32	M20.32 P=0.706 (W0.8×1/36)	15	
OBL-ADP3-M20.32B	Objective lens side M20.32	M20.32 P=0.706 (W0.8×1/36)	—	
OBL-ADP3-M25.0A	Microscope side M25.0	M25.0 P=0.75	20	
OBL-ADP3-M25.0B	Objective lens side M25.0	M25.0 P=0.75	—	
OBL-ADP3-M26.0A	Microscope side M26.0	M26.0 P=0.706 (W26.0×1/36)	21	
OBL-ADP3-M26.0B	Objective lens side M26.0	M26.0 P=0.706 (W26.0×1/36)	—	

SFS Controllers | **FINE**

Controllers with built-in piezo drivers for single axis / 3 axes.

FINE-01γ

FINE-503(CL)

- These controllers are fitted with digital sensor input for each axis, enabling closed loop control by correcting hysteresis curve unique to piezo.
- Being connected to a PC via RS232C, GP-IB, or USB interface, the FINE-503(CL) allows control of a fine stage by simple commands sent from a PC.
- In addition to PC control via RS232C or USB interface, the FINE-01γ enables high-speed control synchronized with analog signal input.

Part Name	Part Number
1 axis SFS Controller with Analog Input Function	**FINE-01γ**
3 axes SFS Controller	**FINE-503(CL)**
Control Pad	**CJ-200A**
FINE Cable	**FINE-CA-3**
DS Cable	**DS1-CA-3**
BNC-BNC Cable	**SKBNC-BNC-3.0**

■Primary Functions

Part Number	FINE-01γ	FINE-503(CL)
Controller Function	○	
Number of Control Axes	1	3
Stored Program Control	○	
Feedback Control	Digital sensor	

■General Specifications

Power Voltage	AC100V ±10% 50/60Hz	
Power Consumption	50VA	
Operating Temperature	10 – 30°C	
Storage Temperature	–20 – 60°C	
Ambient Humidity	20 – 80%RH	
External Dimensions (W×H×Dmm)	225×118×250	270×118×297
Weight (kg)	3.5	5.3

■Interface

GP-IB	—	○
RS232C	○	
USB	○	
Analog input	○	—

■Optional

CJ-200A	○	
SKBNC-BNC-3.0	○	—

■Performance Specifications

Coordinate Indication Range	±999,999nm
Max. Travel to Set	±999,999nm

■Control Command

| Machine Origin Return	○
Theoretical Origin Setting	○
Relative Position Drive	○
Absolute Position Drive	○
Jog Operation	○
Position Appointment	—
Circular Interpolation Control	—
Linear Interpolation Control	—
Drive	○
Deceleration Stop	—
Emergency Stop	—
Speed Setting	○
Motor Free/Hold	—
Port Input	—
Port Output	—

SFS Software

Free Software | SGCommander (for RS232C) Windows® Version

Free software is available to operate your controller easily from a PC. Each axis of a connected motorized stage can be moved using buttons on the screen. The software can be downloaded from our website.

(1) Jog operation   (2) Speed specification
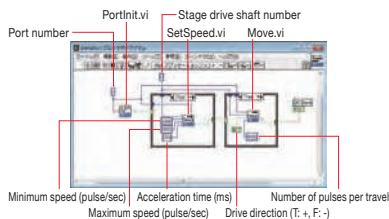
(3) Homing control   (4) Travel control
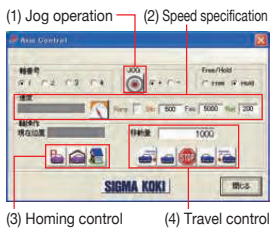
Simple operations are possible such as travel by specifying an axis, homing or jog operation.
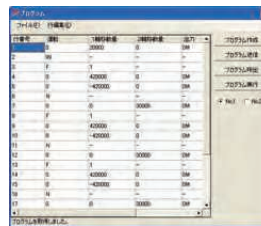
Controllers such as SHOT-30*/702 and FINE-**, which have a built-in program function, allow editing of programs from a PC. Since data can be downloaded/uploaded from/to Excel sheets, it is easy to edit programs. In addition, upload of memory switch or download mode is available.

Free Application LabVIEW (for v.5.1/v.6i/v.7.1/v.8.6/v.2010) RS232C/GP-IB

LabVIEW application is available for LabVIEW users.

PortInit.vi
Port number   Stage drive shaft number
SetSpeed.vi   Move.vi

Minimum speed (pulse/sec)   Acceleration time (ms)   Number of pulses per travel
Maximum speed (pulse/sec)   Drive direction (T: +, F: -)

Other: 30 Day Trial Version (SGEMCSE/SGTERME)

Trial Version

SGEMCSE.....SGEMCSE is software for collecting data or measuring using automatic positioning equipment, measuring instrument or controller, and is offered 30 days for free.
Reference ▶ G025

SGTERME.....It allows command input using Excel for easy program making. SGTERME is ideal software to link with various devices, and is offered 30 days for free.
Reference ▶ G024

Side navigation:

- Application Systems
- Optics & Optical Coatings
- Holders
- Bases
- Manual Stages
- Actuators
- Motoeized Stages
- Light Sources
- Index
- Guide
- Controllers/Drivers
- Softwares
- Stepping Motor
- AC Servo Motor
- Cables
- Piezo
- X Translation
- Theta Rotation
- Goniometer
- Vacuum
- Options
- □40mm
- □60mm
- □80mm
- □85mm
- □100mm
- □120mm
- Others

ECS Positioners | ECS series

attocube
pioneers of precision

With Industrial Line positioners, attocube has genuinely combined highest precision piezodrive technology with extremely rugged, yet cost effective design.

- All ECS positioners of the Industrial Line are dedicated for operation at ambient temperature and depending on the model for pressures ranging from atmospheric to UHV.
- The ECS drive series features implemented crossed roller bearings and is thus specified for high loads of up to several kilograms and guiding errors of less than 0.1mrad in pitch, yaw, and roll.
- This powerful performance is supplemented by travel ranges up to 50mm, step sizes as small as 50nm, and optional position sensor for closed loop operation with 1nm resolution. Attocube's Industrial Line positioners are available in a wide variety of designs, sizes, and travel ranges and can be stacked directly on top of each other for multi axis operation.

Specifications

Exterior			X axis positioner	X axis positioner	X axis positioner	Goniometer	Goniometer	Rotator	Rotator
Products Name			X axis positioner	X axis positioner	X axis positioner	Goniometer	Goniometer	Rotator	Rotator
Part Number			**ECS3030**	**ECS3080**	**ECS5050**	**ECGt5050**	**ECGp5050**	**ECR3030**	**ECR5050**
Closed-loop travel properties	Position Resolution		1nm	1nm	1nm	0.000001°	0.000001°	0.00001°	—
	Position Repeatability		50nm	50nm	50nm	±0.00005°	±0.00005°	±0.0005°	—
	Accuracy		< 0.01% of travel range	< 0.01% of travel range	< 0.01% of travel range	≒0.001°	≒0.001°	≒0.002°	—
Open-loop travel properties	Minimum step size		50nm	50nm	50nm	0.0001°	0.0001°	0.0004°	0.0002°
	Fine positioning range		1.6µm	1.6µm	1.6µm	0.0014°	0.0011°	0.012°	0.006°
Travel Range			20mm	50mm	30mm	10°	10°	360°	360°
Table Dimensions [mm]			30×30	30×80	50×50	50×50	50×50	30×30	50×50
Positioning Slide			Crossed Roller Bearing	Crossed Roller Bearing	Crossed Roller Bearing	Crossed Roller Bearing	Crossed Roller Bearing	Ball Bearing	Ball Bearing
Weight [kg]	Aluminum		0.029	0.078	0.070	0.137	0.137	0.28	0.1
	Stainless steel		0.051	0.147	0.247	0.247	0.247	0.66	0.215
Maximum Travel Speed			4.5mm/sec	4.5mm/sec	4.5mm/sec	≒1°/sec	≒1°/sec	≒10°/sec	≒5°/sec
Load Capacity (horizontal mounting)			9kg	24kg	15kg	1kg	1kg	2kg	2kg

* Closed-loop properties are available if "encoder option" is selected. For ordering, add suffix "/NUM" after the model number.

Control of Industrial Line Positioners | ECC100

The three axes controller ECC100 is used for driving all ECS positioners either in open loop or closed loop mode, depending on the corresponding positioner model.

Software features

The ECC100 is delivered with a basic software package providing windows based software including LabView driver set and DLL. A dedicated software package /PRO providing enhanced controller functionality can be upgraded at any time. The /SYNC option offers the use of an Ethernet interface and allows for using the controller with Epics drivers.

Controller Hardware

Part Number	**ECC100**
Chassis [mm]	about (W)210 × (H)50 × (D)210
Weight [kg]	1.9
Power supply	100/115/230V, 50–60Hz
Power consumption	max. 100W

Output Signals

Stepping - voltage range	0 – 45V
Stepping - frequency range	0 – 5kHz (1 axis) 0 – 2kHz (3 axes simultaneously)
Stepping - maximum current	>5A Peak
Resolution of signal generation	680µV (16 bit)
Output connectors	SubD 15 connectors