E-616 Controller for Multi-Axis Piezo Tip/Tilt Mirrors and Platforms
Flexible Multi Channel OEM Electronics with Coordinate Transformation

E-616 OEM controller and
S-334 tip/tilt mirror system
with a tilt range of 60 mrad

- **Three Integrated Amplifiers Provide up to 10 W Peak Power**
- **Closed-Loop and Open-Loop Versions**
- **Internal Coordinate Transformation Simplifies Control of Parallel Kinematics Designs (Tripod & Differential Drive)**
- **Compact and Cost-Effective Design for OEMs or Bench-Top**

Simple Setup and Operation

To facilitate integration, setup and operation the E-616 features both front and rear panel connections. The 25-pin sub-D piezo & sensor connector is located on the front, along with offset trim pots and LEDs for Power and Overflow. Commanding and reading the sensor and amplifier monitor outputs is realized via a 32-pin rear connector (OEM version) or via a combination of SMB and a 15-pin sub-D connector (stand-alone device).

E-616: operating limits with various PZT loads (open-loop), capacitance is measured in µF

E-616 is a special controller for piezo based tip/tilt mirrors and tip/tilt platforms containing two servo controllers, amplifiers and sensor channels in a compact unit. High-resolution SGS position sensors within the piezo mechanics provide optimum position stability and fast response in nanometer respectively µrad-range. A high output power of 10 W per channel allows dynamic operation of the tip/tilt mirrors for applications such as (laser) beam steering or stabilization.

Tripod or Differential Piezo Drive—One for All!

All multi-axis piezo tip/tilt mirrors of PI are designed as parallel-kinematics: all actuators affect the same movable platform. PI basically distinguishes two kinds of designs of piezo tip/tilt mirrors that can be operated both by the E-616 controller. With the triple drive design (e.g. S-325, see p. 2-92) the platform is driven of three piezo actuators that are located in 120° angles to one another. With the differential drive design (S-330, see p. 2-88 or S-334, see p. 2-90) the actuators operate in pairs in a push / pull-mode. Two orthogonal rotation axes share a common pivot point. For position controlled tip/tilt mirrors the differential evaluation of two sensors per axis provides an improved linearity and resolution.

Internal Coordinate Transformation Simplifies Control
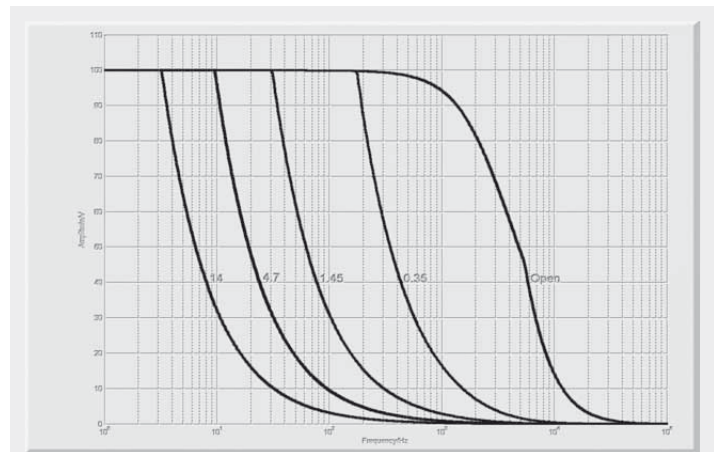
Parallel-kinematics require a transformation of the tilt angle to the motion of the single actuators. In the E-616.S0, this is taken care of by an integrated circuit, eliminating the need of additional external hardware or software. Additionally with the E-616.S0 all actuators can be commanded by an offset-voltage simultaneously. As a result a vertical motion, for example for optical path tuning, is obtained.

E-616 bench-top versions facilitate
start-up and allow stand-alone operation

Technical Data

Model	E-616.S0/S0G	E-616.SS0/SS0G
Function	E-616.S0: Controller for parallel-kinematics piezo tip/tilt mirror systems with strain gauge sensors, tripod design E-616.S0G: E-616.S0 with casing	E-616.S0: Controller for parallel-kinematics piezo tip/tilt mirror systems with strain gauge sensors, differential design E-616.SS0G: E-616.SS0 with casing
Tilt axes	2	2
Sensor		
Servo characteristics	P-I (analog), notch filter	P-I (analog), notch filter
Sensor type	SGS	SGS
Sensor channels	3	2
External synchronization	200 kHz TTL	200 kHz TTL
Amplifier		
Control input voltage range	X-, Y-tilt axes: -7 V to +7 V Z-Offset: -3.5 V to +3.5 V	-2 V to +12 V
Output voltage	-20 V to +120 V	-20 V to +120 V
Amplifier channels	3	3
Peak output power per channel	10 W	10 W
Average output power per channel	5 W	5 W
Peak current	100 mA	100 mA
Average current per channel	50 mA	50 mA
Current limitation	Short-circuit-proof	Short-circuit-proof
Voltage gain	X-, Y- tilt axes: 10 Z-Offset: 20	10
Amplifier bandwidth, small signal	3 kHz	3 kHz
Ripple, noise, 0 to 100 kHz	<20 mV$_{pp}$ <2 mV$_{rms}$	<20 mV$_{pp}$ <2 mV$_{rms}$
Amplifier resolution	<1 mV	<1 mV
Interfaces and operation		
Piezo / sensor connector	25-pin sub-D connector	25-pin sub-D connector
Analog input	E-616.S0: 32-pin connector E-616.S0G: SMB-connector	E-616.SS0: 32-pin connector E-616.SS0G: SMB-connector
Sensor monitor signal	0 to +10 V for nominal displacement	0 to +10 V for nominal displacement
Sensor monitor output	E-616.S0: 32-pin connector E-616.S0G: 15-pin sub-D connector	E-616.SS0: 32-pin connector E-616.SS0G: 15-pin sub-D connector
Display	Power-LED and sensor OFL display	Power-LED and sensor OFL display
Miscellaneous		
Operating temperature range	5 °C to 50 °C	5 °C to 50 °C
Overheat protection	Max. 75 °C, deactivation of the piezo voltage output	Max. 75 °C, deactivation of the piezo voltage output
Dimensions	E-616.S0: 186 mm x 128.4 mm x 10 HP (incl. handle, 32-pin connector & front panel; Euro card format 3U/10HP) E-616.S0G: 205 mm x 105 mm x 54.1 mm, without feet	E-616.SS0: 186 mm x 128.4 mm x 10 HP (incl. handle, 32-pin connector & front panel; Euro card format 3U/10HP) E-616.SS0G: 205 mm x 105 mm x 54.1 mm, without feet
Mass	E-616.S0: 950 g E-616.S0G: 1200 g	E-616.SS0: 950 g E-616.SS0G: 1200 g
Operating voltage	E-616.S0: 12 to 30 V DC E-616.S0G: 23 to 26 V DC	E-616.SS0: 12 to 30 V DC E-616.SS0G: 23 to 26 V DC
Power consumption	30 W	30 W