C-702 Hybrid System Controller

High Velocity-Constancy for Nanometer-Precision Hybrid DC/Piezo Nanopositioning Systems

C-702 Hybrid Controller

- **Motion Controller & Driver for Simultaneous Operation of Closed-Loop DC Servo Motors and Piezo Actuators**
- **2 Channels**
- **Sample Rate 10 kHz**
- **Piezo Resolution 24-bit**
- **Fast Serial Bus for Incremental High-Resolution Sensor**
- **Realtime Operating System**
- **Interfaces: TCP/IP Ethernet, RS-232, VGA, Keyboard**

The C-702 digital hybrid motion controller has been designed for precision control of the M-511.HD (see p. 4-46) and M-714 (see p. 4-62) nanopositioning stages. Both are based upon the PI hybrid drive technology integrating piezoelectric and motorized drive components to form one motion and servo-control system. The result is a nanopositioning system for high loads that can follow a motion profile with nanometer position accuracy and high constancy of velocity over several millimeters of travel.

Application Examples

- Surface Inspection
- Microscopy
- Laser technology
- Interferometry
- Metrology

Highly Effective Servo-Control for a Complex Drive Technology

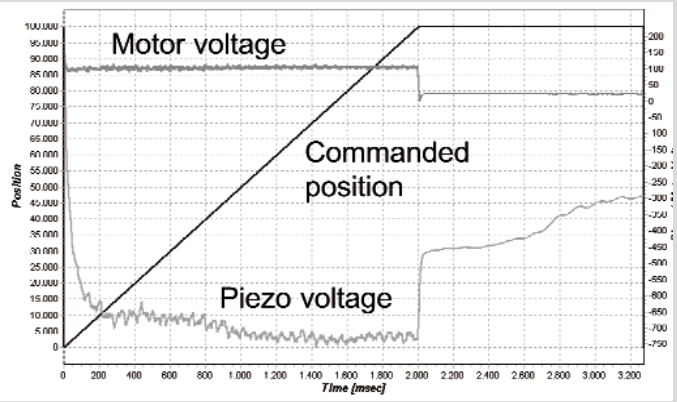
The optimized interaction between the piezoelectric and motorized drive components to make them a single motion unit requires a high-speed sensor as well as powerful control algorithms. The digital, 2-channel, C-702 controller, based on modern CPU technology with a real time operating system, has been designed for this task. It is able to read the position signals with virtually no delay and process the data immediately. The integrated piezo amplifiers use a high-resolution 24-bit DAC to fully support the high position resolution of the piezo actuators. The new ultra-fast broadband SSI interface for the optical linear encoder supports stage velocities of 300 mm/s at a resolution of 2 nm. With special cabling, external sensor signals, like those from an interferometer, can be used for servo-control via an SSI interface.

One Controller for One Motion System

In PI hybrid systems, the motor-leadscrew and piezo actuator are fully integrated to form one motion system. The motor and piezo act together at all times. The result is far more than a coarse-adjust/fine-adjust system: effects like startup stick/slip and backlash can be completely compensated and a motion profile with high constancy of velocity can be followed. Because of the high-piezo stiffness, setting to a few nanometers only takes a few milliseconds, significantly faster than with conventional, higher-inertia, linear-motor-driven stages. Furthermore minimal increments in the range of the sensor resolution can be reliably executed. To allow high velocities beyond 100 mm/sec and nanometer-range incremental resolution, position information must be transmitted and processed very rapidly and a complex control algorithm is required.

Ordering Information

C-702.00
Ultra-High-Precision
Hybrid Controller, 2 Channels



PI hybrid servo-controller output during a positioning command. The controller reads the system position off a high-resolution encoder and actuates both the motor and piezoelectric actuator at the same time giving a system with the advantages of both drives

10 nm steps of an M-714 stage, as measured by an interferometer

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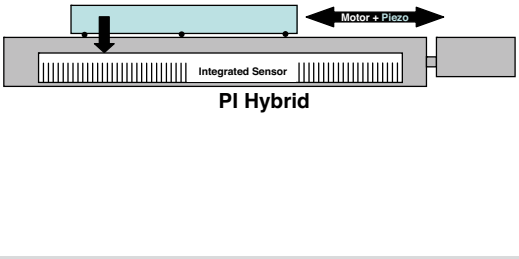
The newest release for data sheets is available for download at www.pi.ws. Cat120E Inspirations2009 08/10.18

M-511.HD hybrid stage (left),
M-714.00 (right front) and the C-702 controller (rear)



6PI Hybrid drive combines DC motor and piezo actuator with integrated, internal, high-resolution sensor in one servo loop

Technical Data

Model	C-702.00
Function	Motion Controller for Hybrid Nanopositioning Systems
Drive type	DC motor (PWM)/piezo
Channels	2
Motion and control	
Servo characteristics	PID V-ff filter, notch filter, hysteresis setting (motor); proportional-integral (P-I) algorithm with notch filter (piezo)
Sampling rate	10 kHz
Trajectory profile modes	Trapezoidal, S-curve
Processor	32-bit Intel Celeron
Position range	32 bit
Limit switches	2 lines per axis
Reference switch	1 line per axis
Motor brake	Software programmable
Electrical properties	
Operating voltage	24 VDC (via M-500.PS wide range power supply*)
Output power/channel	PWM: 19.5 kHz, 10-bit resolution
Piezo voltage	±36 V (24-bit resolution)
Power consumption	< 25 W
Interfaces and operation	
Communication interfaces	TCP/IP, RS-232, VGA, Keyboard
Motor connector	Sub-D connector, 26-pin**
Encoder input	Serial SSI interface for incremental encoder
Controller network	via TCP/IP
I/O ports	8 TTL inputs, 8 TTL outputs
Command set	ASCII, PI General Command Set (GCS)
User software	PIMikroMove®
Software drivers	GCS (PI General Command Set)-DLL, LabVIEW™ drivers
Supported functionality	Autostart macro, user-programmable macro
Miscellaneous	
Operating temperature range	+10 to +50 °C
Mass	1.35 kg
Dimensions	130 x 205 x 76 mm

*M-500.PS: wide range power supply, 100 to 250 VAC, 50 to 60 Hz
**Sub-D 26 contains connection for motor, piezo, reference and limit switches and sensor, Internal heat sink with very silent fan