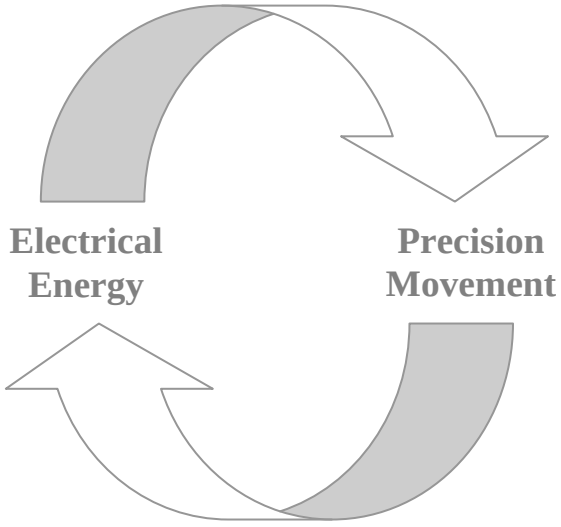
Kinetic Ceramics, Inc.
Products Catalog
January 2009

Piezoelectric Positioning Solutions

From The Most Experienced Company



Kinetic Ceramics Inc.
Pioneers in Piezoelectric Technology

KINETIC CERAMICS, INC.

Pioneers in Piezoelectric Technology

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All parts are proudly made in the U.S.A.

Performance, Reliability and Experience

Kinetic Ceramics, Inc has manufactured piezoelectric stack actuators since 1966 under the trademarked name PIEZOMOTOR®. Our staff has more than 60 years of combined experience making high performance actuators with unmatched reliability.

All piezoelectric manufacturing processes are kept in-house to maintain full control of quality and performance.

- We produce proprietary ceramic powders that optimize strain per volt.
- We form and fire disks and plates that achieve nearly perfect density and maximum strength.
- We process and assemble piezoelectric stacks with highest motion, fastest response and greatest reliability.

The result is PIEZOMOTOR actuators with superior performance and reliability for the most demanding applications.

PIEZOMOTOR stacks are capacitors that change shape when charged with high voltage. Increasing voltage increases the length of the stack up to a maximum strain of approximately 0.1% for typical maximum voltage of 1000V. The relationship between voltage and movement is approximately linear.

To operate PIEZOMOTOR actuators Kinetic Ceramics offers several types of electronic drive amplifiers that are optimized for piezoelectric stacks. To achieve the fastest and most linear response "charge control" amplifiers are available with output power exceeding 1500 watts.

Please take a few minutes to study this catalog and remember if you do not find the exact product to fit your application contact us! Our experienced team loves a challenge and our flexible manufacturing process can readily make special products for your application.

® PIEZOMOTOR is a registered trademark of Kinetic Ceramics Inc.

PIEZOMOTOR System Performance and Applications

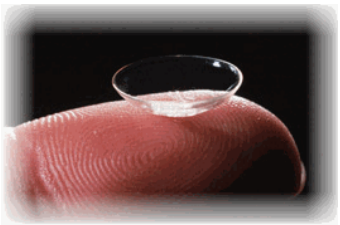
PIEZOMOTOR systems meet the requirements of the toughest positioning applications. They offer superior piezoelectric performance for customers that need:

- Nanometer resolution movement
- Very high rigidity and stiffness
- No magnetic fields or vacuum operation
- More stroke in less space
- Best balance between drive voltage, current and capacitance
- Fastest speed and closed-loop bandwidth
- High-power "charge control" drive amplifiers
- Outstanding reliability that is proven in industrial applications

Kinetic Ceramic's actuators are successfully used in a wide variety of applications. Here are just a few examples:

Industries:	**Applications:**
Aerospace and Defense	Linear and Rotary Motors
Automotive	Diesel Engine Fuel Injectors
Microelectronics	Micro Pumps and Fast Valves
Optics	Fast Beam Steering Mirrors
Telecommunications	Fiber Alignment Stages
Metrology	Vibration Dampers
Precision Machining	Fast Tool Servos
Laboratory/Basic Research	Nano Indentation Instruments
Medical	Ultrasonic Imaging Instruments

Kinetic Ceramic's products use a proprietary composition of PZT material, called PZWT100, with a unique set of properties ideal for high performance actuators. This ceramic composition is pressed and fired to achieve very low porosity and high density (Greater than 99% of the theoretical density). The result is products with high resistance to micro cracking and electrical break down and very long life. In-house tests show that greater than 10 billion operating cycles are routinely achieved without failure.



PIEZOMOTOR Actuators Move Fast Tool Servos to Make More Precise Contact Lens

PIEZOMOTOR Actuators Drive Diesel Fuel Injectors to Improve Engine Efficiency and Emissions

PZT Primer

Pierre and Jacques Curie first observed the piezoelectric phenomenon of "pressure electricity" in the 1880's. They showed that when certain types of crystals are deformed by mechanical pressure they develop electrical charge and, when electric voltage is applied, these same crystals change shape. Many single crystal materials exhibit piezoelectric properties including quartz and Rochelle salt. Modern ceramic technology has produced several polycrystalline piezoelectric compositions including barium titanate and lead zirconate titanate (PZT).

PZT formulations were extensively researched and developed in the 1950's and 1960's, primarily to support Navy sonar development. Kinetic Ceramics extended this research to produce a PZT formula with optimum properties for PIEZOMOTOR actuators for precise positioning applications.

PZT materials must be "poled" to become piezoelectric. Poling is the application of a strong electric field that aligns the electric dipoles. (This is analogous to magnetizing a ferromagnetic material.) After poling the relationship between voltage and movement is approximately linear.

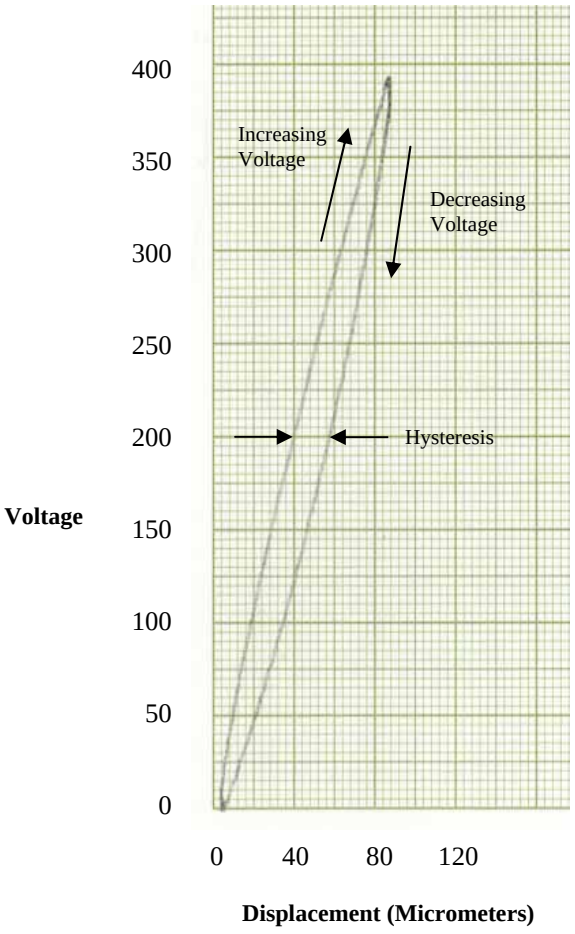
Piezoelectric actuators achieve incredible position resolution approaching Angstroms. However, using voltage to predict position is typically only accurate to about 20 percent of the actuator's total motion. Piezoelectric error sources include non-linearity, hysteresis and creep, which can be corrected using a separate position sensor and closed-loop servo control. For fast response applications a "charge control" amplifier linearizes the piezoelectric response and increases the closed-loop bandwidth.

Please contact Kinetic Ceramics for more information.

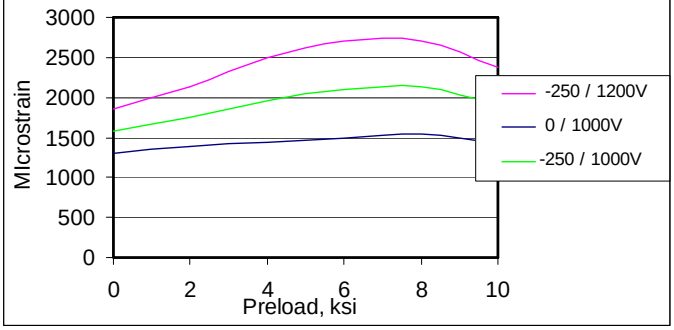
PIEZOMOTOR Material Performance

PZWT 100 Engineering Properties			
Parameter	**Value**	**Parameter**	**Value**
K_p	0.64	Y_{11D}	6.9 X 10^{10} N/m^2
K_{31}	0.37	Tan_δ	0.027
K_t	0.56	ρ	7.8 g/cc
d_{31}	-170 X 10^{-12} m/V	T_{Curie}	> 360 °C
d_{33}	370 X 10^{-12} m/V	Poisson's Ratio	0.3
g_{31}	-13 X 10^{-3} m/N	Dielectric Constant	Krel = 2500
Y_{11E}	6.2 X 10^{10} N/m^2	Strain: (0 to 2 Mv/m)	1500 microstrain
Y_{33E}	4.8 X 10^{10} N/m^2	Strain: (-0.6 to 2.4 Mv/m)	2800 microstrain

Voltage versus Displacement Curve
(Typical for PIEZOMOTOR Actuators)



Typical PIEZOMOTOR Actuator Strain



Some typical engineering properties of PZWT100 material are shown. Strain indicates the amount of movement generated per unit of actuator length. Electric field is the amount of voltage per unit length of electrode spacing (piezoelectric layer thickness). Multiply the strain by the length of the actuator to determine the total movement.

Strain increases with higher preload and when larger electric field changes are applied. The relationship between electric field and strain is not perfectly linear. The chart shows a typical graph of voltage versus displacement. Note that the increasing and decreasing voltage curves are not exactly the same due to hysteresis.

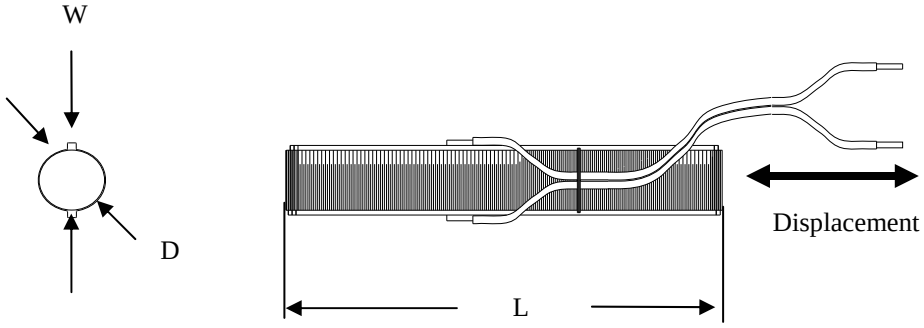
Please contact Kinetic Ceramics for more information.

PIEZOMOTOR Actuators Selection Guide

PIEZOMOTOR actuators are stacks of PZWT100 disks that are bonded together, electrically connected, and packaged for mechanical reliability and electrical safety. Kinetic Ceramics offers several versions and the chart below provide an overview of the standard PIEZOMOTOR actuator choices. More detailed information for each type follows. Should the exact device not be found in the following selector guide, we can provide custom devices. Contact us to learn more.

Model Series	Features	Benefits
D Series PIEZOMOTOR Actuators	• Fully insulated PZT stack without housing • Ceramics stack ends are flat. • Electrical leads. Cable provided for customer assembly and integration.	• Smaller size • More flexible preload and mounting • Lower cost
A Series PIEZOMOTOR Actuators	• Stainless steel housing • Internal preload • Tapped holes on housing and tip • Modular electrical connector	• Highest force and stiffness • Maximum environmental protection • Protects PZT stack from bending forces • Easy installation
HD Series PIEZOMOTOR Actuators	• Mechanically amplified stroke • Stainless steel housing • Internal preload. • Tapped holes on housing and tip • Modular electrical connector.	• More stroke for a shorter length • Lower capacitance • Maximum environmental protection • Protects PZT stack from bending forces • Easy installation • Low cost

D Series PIEZOMOTOR Actuators



Specifications:

Recommended Operating Voltage:	0 to 1000V @ 20°C
Operating Temperature Range:	-20°C to +80°C
Cable Provided:	12 inch nominal length
Recommended Drive Electronics:	Model KC 1000-70 (See page 11.)

Model Number	Blocking Force (Minimum)	Stack Displacement (Minimum movement @ 1000 volts)	Stack Length (L)	Stack Diameter (D) Lead Width (W)	Stack Capacitance	Resonant Frequency
D020010	700N	10 um	0.440”	0.22” (D)	.015 uF	125 kHz
D020020		20 um	0.815”		.030 uF	68 kHz
D020040		40 um	1.530”	0.30” (W)	.06 uF	36 kHz

D Series (Continued)

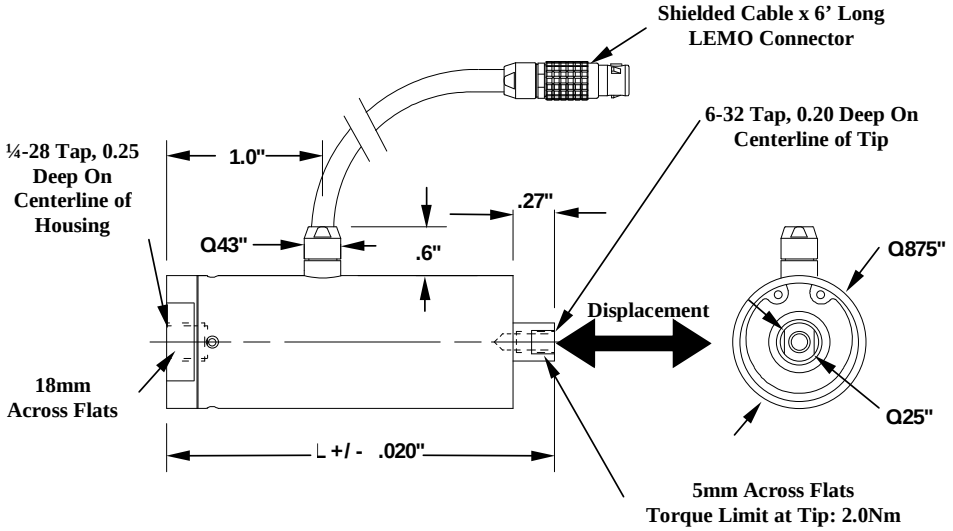
Model Number	Blocking Force (Minimum)	Stack Displacement (Minimum movement @ 1000 volts)	Stack Length (L)	Stack Diameter (D) Lead Width (W)	Stack Capacitance	Resonant Frequency
D02034	1,400N	34 um	0.550”	0.22” (D) 0.30” (W)	.035 uF	100 kHz
D1CM10	2,800N	10 um	0.440”	0.42” (D) 0.58” (W)	.06 uF	125 kHz
D1CM20		20 um	0.815”		.13 uF	68 kHz
D1CM40		40 um	1.530”		.24 uF	36 kHz
D1CM80		80 um	3.070’		.49 uF	18 kHz
D050010	4,500N	10 um	0.440”	0.52” (D) 0.68” (W)	.10 uF	125 kHz
D050020		20 um	0.815”		.20 uF	68 kHz
D050040		40 um	1.530”		.40 uF	36 kHz
D050080		80 um	3.070”		.76 uF	18 kHz
D050120		120 um	4.470”		1.18 uF	12.3 kHz
D075010	10,000N	10um	0.440”	0.77” (D) 0.93” (W)	.23 uF	125 kHz
D075020		20 um	0.815”		.50 uF	68 kHz
D075040		40 um	1.530”		.88 uF	36 kHz
D075080		80 um	3.070”		1.77 uF	18 kHz
D075120		120 um	4.470”		2.65 uF	12.3 kHz
D075160		160 um	5.940”		3.53 uF	9.3 kHz
D075200		200 um	7.410”		4.42 uF	7.4 kHz
D100010	18,000N	10 um	0.440”	1.02” (D) 1.20” (W)	.40 uF	125 kHz
D100020		20 um	0.815”		.81 uF	68 kHz
D100040		40 um	1.530”		1.57 uF	36 kHz
D100080		80 um	3.070”		3.14 uF	18 kHz
D100120		120 um	4.470”		4.72 uF	12.3 kHz
D100160		160 um	5.940”		6.29 uF	9.3 kHz
D100200		200 um	7.410”		7.86 uF	7.4 kHz
D125010	28,500N	10 um	0.440”	1.27” (D) 1.45” (W)	.63 uF	125 kHz
D125020		20 um	0.815”		1.26 uF	68 kHz
D125040		40 um	1.530”		2.46 uF	36 kHz
D125080		80 um	3.070”		4.91 uF	17.9 kHz
D125120		120 um	4.470”		7.37 uF	12.3 kHz
D125160		160 um	5.940”		9.82 uF	9.3 kHz
D125200		200 um	7.410”		12.78 uF	7.4 kHz

A-Series PIEZOMOTOR® Actuators

Specifications:

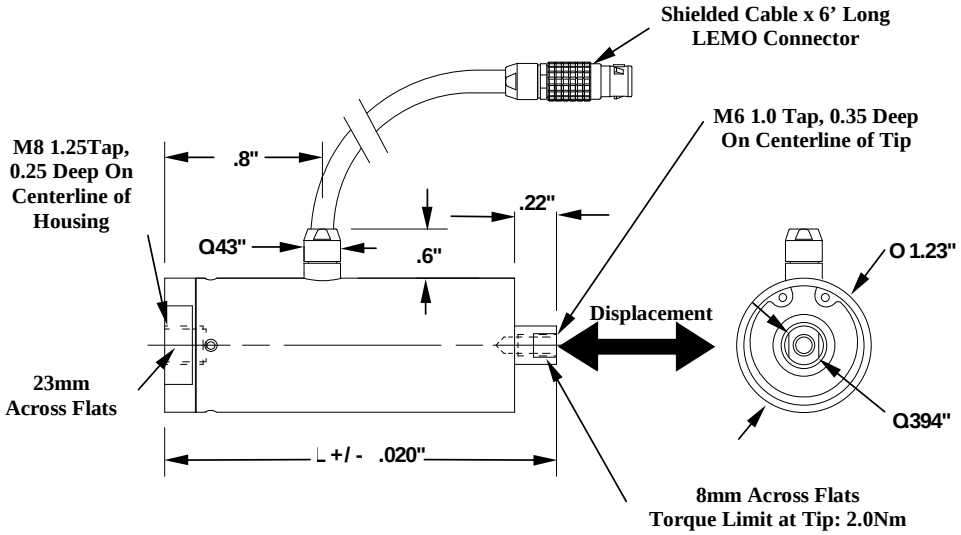
Recommended Operating Voltage:	0 to 1000V @ 20°C
Operating Temperature Range:	-20°C to +80°C
Case Material:	Stainless Steel
Electrical Connection:	Shielded Cable with LEMO FGG.2B Connector
Recommended Drive Electronics:	Model KC 1000-70 (See page 11.)

A-Series, A1CM & A050 Size
(With 0.875 Inch Diameter Housing)



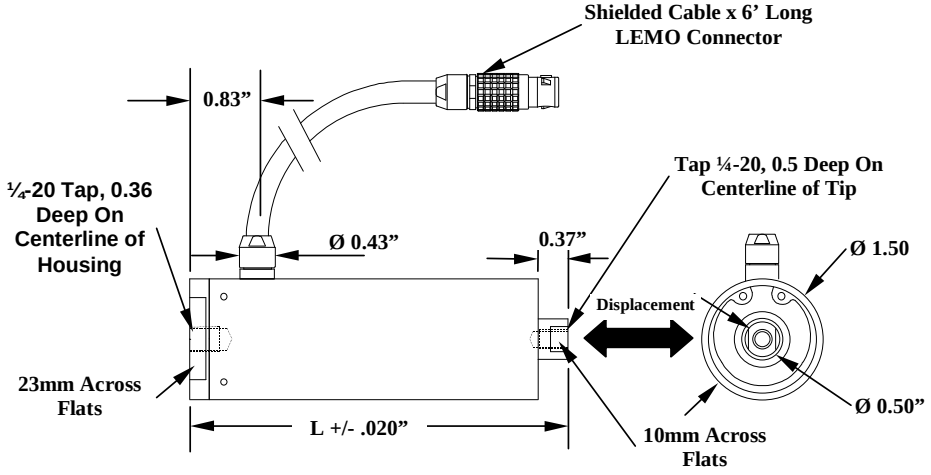
Model Number	Blocking Force (Minimum)	Actuator Displacement (Minimum movement @ 1000 volts)	Stack Length (L)	Stack Capacitance	Resonant Frequency
A1CM10	2,800N	10 um	1.458"	.06 uF	125 kHz
A1CM20		20 um	1.833"	.13 uF	68 kHz
A1CM40		40 um	2.548"	.24 uF	36 kHz
A1CM80		80 um	2.548"	.48 uF	18 kHz
A050010	4,500N	10 um	1.458"	.10 uF	125 kHz
A050020		20 um	1.833"	.20 uF	68 kHz
A050040		40 um	2.548"	.40 uF	36 kHz
A050080		80 um	4.088"	.76 uF	18 kHz
A050120		120 um	5.488"	1.18 uF	12.3 kHz

A-Series, A075 Size (With 1.23 Inch Diameter Housing)



Model Number	Blocking Force (Minimum)	Actuator Displacement (Minimum movement @ 1000 volts)	Stack Length (L)	Stack Capacitance	Resonant Frequency
A075010	10,000N	10 um	1.763"	.23 uF	125 kHz
A075020		20 um	2.138"	.50 uF	68 kHz
A075040		40 um	2.853"	.88 uF	36 kHz
A075080		80 um	4.393"	1.77 uF	18 kHz
A075120		120 um	5.793"	2.65 uF	12.3 kHz
A075160		160 um	7.263"	3.53 uF	9.3 kHz
A075200		200 um	8.733"	4.42 uF	7.4 kHz

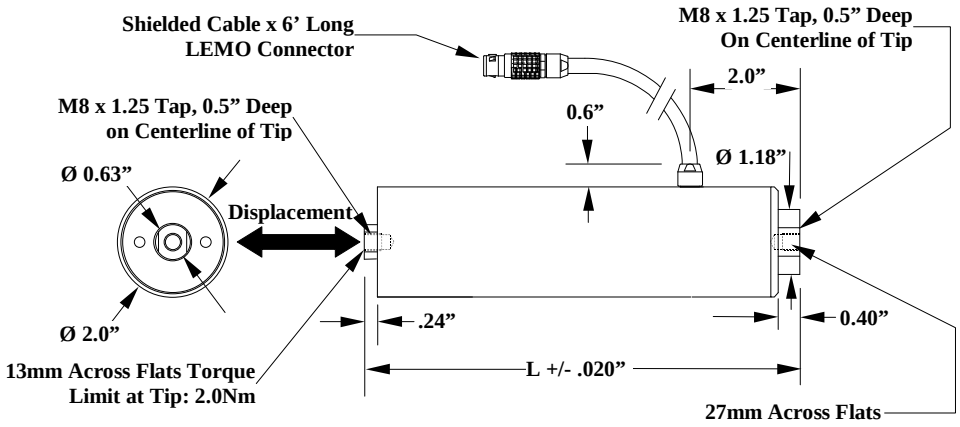
A-Series, A100 Size (With 1.50 Inch Diameter Housing)



A-Series, A100 Size (Continued)

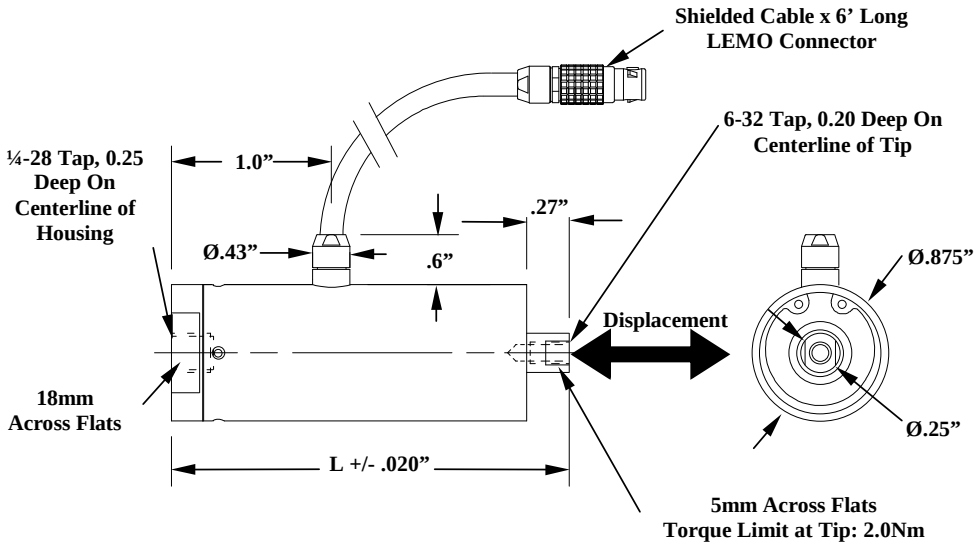
Model Number	Blocking Force (Minimum)	Actuator Displacement (Minimum movement @ 1000 volts)	Stack Length (L)	Stack Capacitance	Resonant Frequency
A100010	18,000N	10 um	1.995”	.40 uF	125 kHz
A100020		20 um	2.331”	.81 uF	68 kHz
A100040		40 um	2.961”	1.57 uF	36 kHz
A100080		80 um	4.263”	3.14 uF	18 kHz
A100120		120 um	5.565”	4.72 uF	12.3 kHz
A100160		160 um	6.825”	6.29 uF	9.3 kHz
A100200		200 um	8.127”	7.86 uF	7.4 kHz

A-Series, A125 Size (With 2.00 Inch Diameter Housing)



Model Number	Blocking Force (Minimum)	Actuator Displacement (Minimum movement @ 1000 volts)	Stack Length (L)	Stack Capacitance	Resonant Frequency
A125010	28,500N	10 um	2.214”	.63 uF	125 kHz
A125020		20 um	2.589”	1.26 uF	68 kHz
A125040		40 um	3.304”	2.46 uF	36 kHz
A125080		80 um	4.844”	4.91 uF	18 kHz
A125120		120 um	6.244”	7.37 uF	12.3 kHz
A125160		160 um	7.714”	9.82 uF	9.3 kHz
A125200		200 um	9.184”	12.78 uF	7.4 kHz

HD-Series, PIEZOMOTOR® Actuators
(With Mechanical Amplification)



Specifications:

Recommended Operating Voltage:	0 to 1000V @ 20°C
Operating Temperature Range:	-20°C to +80°C
Case Material:	Stainless Steel
Electrical Connection:	Shielded Cable with LEMO FGG.2B Connector
Recommended Drive Electronics:	Model KC 1000-70 (See page 11.)

Model Number	Blocking Force (Minimum)	Actuator Displacement (Minimum movement @ 1000 volts)	Stack Length (L)	Stack Capacitance	Maximum Frequency
25HD	445N	25 um	1.37"	0.05 uF	500 Hz
50HD		50 um	1.62"	0.10 uF	
100HD		100 um	2.17"	0.19 uF	
200HD		200 um	3.26"	0.37 uF	
300HD		300 um	4.40"	0.56 uF	

PIEZOMOTOR® Drive Electronics

Kinetic Ceramics Inc. offers a selection of high voltage amplifiers that optimally drive PIEZOMOTOR actuators to achieve maximum displacement, fast response and high precision.

Displacement is proportional to drive voltage (electric field.). PIEZOMOTOR actuators require high activation electric field (typically 1000 volts) to achieve high displacement (greater than 0.15% strain). Under some conditions, strains as high as 0.28% are achieved utilizing special drive techniques. Contact us to learn more.

Fast response (high bandwidth) depends on the amplifier current and power. Rapid mechanical displacement requires fast electrical charging and discharging of the piezoelectric capacitor. The peak current output of the drive amplifier determines the voltage rise time in the capacitor, which determines the motion response.

Note: Mechanical resonance of the PIEZOMOTOR actuator and mechanical system may also limit bandwidth. Physical response is limited by the speed of sound, which determines the system resonant frequency. To fully understand system response both the mechanical and electrical characteristics must be considered. See the analysis at right or contact us to learn more.

Relative Precision (resolution) is determined by the minimum voltage step and noise floor of the drive amplifier. The typical noise contribution from a Kinetic Ceramics amplifier is less than 100 millivolts which corresponds to a typical position noise less than one nanometer.

Absolute Precision requires a position sensor and closed-loop servo. Several options for closed-loop control are available including "charge control" amplifiers for very high bandwidth systems. Contact us to learn more.

Calculating System Frequency Response

Step 1: Calculate the Actuator's "Drive Current Coefficient" (DCC)

DCC is the peak current required drive an actuator in a pure sine wave motion at a frequency of 1 Hz and amplitude of one micrometer. DCC has the units of microamps/(Hz - micrometer).

$$DCC = \frac{2500 * \text{Actuator Capacitance (Farads)}}{\text{Actuator Displacement (Micrometers@1000 Volts)}}$$

Example: For Actuator A1CM20, Capacitance is 0.133 microfarads. Displacement is 20 micrometers.

DCC = 2500 (0.133E-6) /20
= 16.6 microamps / (Hz - micrometer)

Step 2: Calculate Drive Current Required for a Specific Amplitude and Frequency

Peak Drive Current (I_{Peak}) = DCC * Amplitude * Frequency

Example: Amplitude is 20 micrometers.
Frequency is 210 Hertz.

I_{Peak} = DCC * 20 * 210 = 69,720 microamps
= 69.7 milliamps

Step 3: Select Amplifier with Sufficient Drive Current

A KC 1000-70-1 amplifier produces 70 milliamps (70,000 microamps), which is just right to produce 20-micrometer amplitude sine waves at 210 Hertz.

Step 4: Check Other System Constraints

Is the mechanical resonance greater than the drive frequency?
Yes, the A1CM20 actuator has a resonant frequency of 68,000 Hertz, which is much greater than the drive frequency of 140 Hz.

Does the amplifier have sufficient voltage?
Yes, the KC 1000-70-1 amplifier produces 1000 volts.

PIEZOMOTOR Electronics Selection Guide

Model Number	Description	Recommended For:
KC1000-70-1	Piezomotor Driver, 1 channel, 70mA	• Low speed or static positioning to achieve maximum displacement. • Dynamic positioning for PIEZOMOTOR actuators with less than 10 uF capacitance. • One or two actuator systems.
KC1000-70-2	Piezomotor Driver, 2 channel, 70mA	
KC N15-1	Piezo Driver / Linear Amplifier with Offset, 1500 watt	• Larger PIEZOMOTOR actuators operating at the highest possible power and frequency.
KCI FTS 500/450-2	Piezomotor Driver, 2 channel, 1000mA	• Fast response for two and three actuator systems. • Larger PIEZOMOTOR actuators where both fast response and high displacements are required.
KCI FTS 500/450-3	Piezomotor Driver, 3 channel, 1000mA	

Model KC-1000 Series Specifications

Model	Output Voltage	Output Current	Bandwidth	Channels
KC1000-70-1	0 to +1000v	70mA	DC to >12 kHz	One
KC1000-70-2				Two

KC-1000 Series Features and Specifications			
Amplifier Type	Linear		
Output Noise	Less than 100mV (With a 1nF load and 20kHz band-pass filter.)		
Gain	Fixed at 100		
Input Signal	0 to +10v max		
Input Signal Connector	BNC		
Output Connector	LEMO type 2B (Mating plug: Part Number FGG-2B-302-CLL)		
Voltage Monitor	1:100		
Current Monitor	0.1 v/mA		
Line Power	Factory Set:	Range 1: 90 to 126 V.A.C 48 to 63 Hz Range 2: 180 to 250 V.A.C. at 48 to 63 Hz	
	One Channel		**Two Channel**
Size	4.4”H x 8.7”W x 17”D		4.4”H x 17”W x 17”D
Weight	11 lb.		22 lb.

Model KC-N15-1 Specifications

Model	Output Voltage	Output Current	Bandwidth	Channels
KC N15-1	Zero to 353 V rms. or Zero to 1000 V*	2100 mA	1 kHz to 10 kHz	One

*Other ranges available on request

KC-N15-1 Series Features and Specifications	
Amplifier Type	Class AB 1, linear, with complimentary MOSFET output stages to provide clean transient response and high reliability in industrial applications
Continuous Power	1500 Watts
Gain	Adjustable on Front Panel
Input Signal	Zero to 1 V rms (Or zero to 10 V rms. using ten-turn pot on front panel.)
Input Signal Connector	BNC
Output Connection	Terminal Strip
Line Power	110/120V.A.C. 50/60Hz (Power Factor +0.7 to –0.7 for @ full power.)
Short Circuit Protection	Input Circuit Breaker, Automatic Reset Thermostat
Size	12”H x 19”W x 21”D
Weight	Weight 95 lb

Model KCI FTS 500/450 Series Specifications

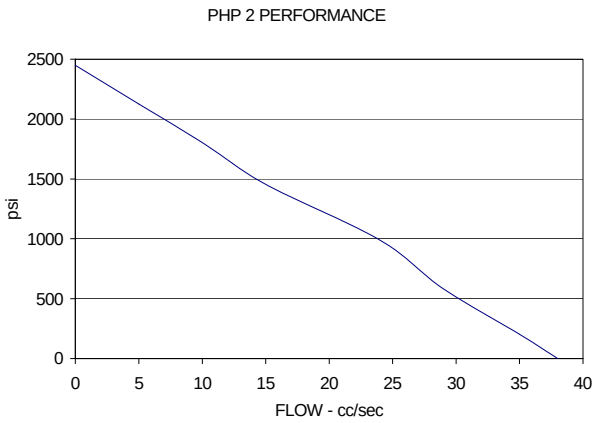
Model	Output Voltage	Output Current	Bandwidth	Channels
KCI FTS 500/450-2	0 to +850 V	1000mA	DC - 6 kHz (-3dB)	Two
KCI FTS 500/450-3				Three

KCI FTS 500/450 Series Features and Specifications		
Amplifier Type	Linear	
Output Noise	Less than 20mV (With a 2uF load and 5kHz band-pass filter)	
Gain	Factory Set at 40	
Input Signal	Zero to +/- 10 Volts (Maximum of +/- 50 mA)	
Input Signal Connector	BNC	
Output Connection	LEMO type 2B (Mating plug: part number FGG-2B-302-CLL)	
Line Power	Factory Set: Range 1: 104 to 120 V.A.C at 48 to 63 Hz Range 2: 208 to 240 V.A.C. at 48 to 63 Hz	
Short Circuit Protection	Output fuses. Amplifier current limiting and voltage transient suppression.	
Agency Certification	All major components and wiring are UL specified. CE compliant	
Size	12”H x 25”W x 21”D	
Weight	Two Channel - 70 lbs.	Three Channel - 90 lbs.

Kinetic Ceramics Inc.
Pioneers in Piezoelectric Technology

Piezo Hydraulic Pumps

*The 2009 SPIE Smart Structures Product Implementation Award Winner**



Product Features:

- Solid-state Piezomotor® Piezoelectric Drive with Direct Electromechanical Energy Conversion
- High Output Pressure and Flow Rates
- High Power Density / High Efficiency
- No Electric Motors or Solenoids
- Robust and Reliable Operation
- Less Space Required
- No Electromagnetic Fields
- Output pressure to 2500 psi
- Flow rate to 40 cc/sec
- Aluminum Housing
- Optional S. Steel Wetted Parts
- Dimensions: ϕ1.5 x 4” L
- Weight 275 – 450 grams
- Compact Electronic Driver
- Metering capability

Call today to discuss your application!

Developed in partnership with DARPA and the US Air Force for high power density actuation

*A panel of independent experts from the SPIE organization selects the product based on its importance, uniqueness, and usefulness to defense and commercial industries.

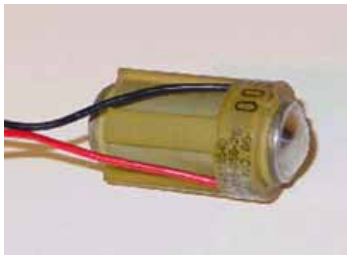
Specialty Piezo Products

Kinetic Ceramics offers many other custom solutions based on PIEZOMOTOR technology. This is a brief overview of our capabilities.

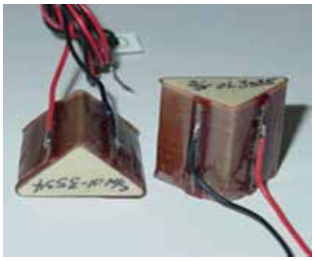
Custom PIEZOMOTOR Actuators and Drive Electronics

Our flexible manufacturing processes and experienced staff can quickly respond to your special requirements. Do you need a special shape, voltage, stiffness or frequency response? Send us your requirements. We love challenges and are confident that our products will exceed your expectations.

Ultra-High Power Drive Electronics



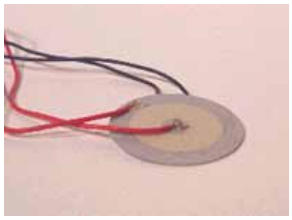
Molded Housings



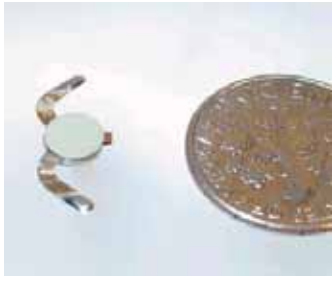
Triangular Stacks

PIEZOMOTOR System Solutions

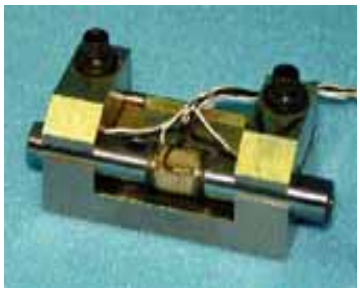
Kinetic Ceramics also produces systems and modules based on PIEZOMOTOR actuators. These integrated solutions offer the highest possible performance in a fully engineered module that is ready for installation in your product or research instrument. Call us to learn more about our system solutions.



Disk Benders



High "G" Accelerometer



Nanopede® Micro Stepper

Ring and Tube Actuators

Kinetic Ceramics Inc.
Pioneers in Piezoelectric Technology

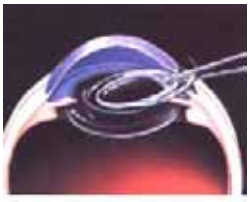
FAST TOOL SERVO

A Way to Quickly Turn Non-Rotationally Symmetric Shapes With Optical Quality Finishes and Tolerances.

Contact Lenses

Oval Pistons

Hydrodynamic Bearings



Intraocular Implants

High Precision Engine Parts

Complex Optical Shapes

Kinetic Ceramics Inc.
Pioneers in Piezoelectric Technology

Fast Tool Servo Module for Precision Lathes

FTS system with tool head and power supply.

12 Nanometer RMS Surface Finish

Up to 600 Micrometer Stroke Available

600 Hz Servo Bandwidth

Industrial Reliability

Cuts Nickel, Brass, Aluminum and Plastics

The Fast Tool Servo (FTS) Module from Kinetic Ceramics, Inc. incorporates the latest piezoelectric positioning technology to achieve optical quality machining performance. When used with a single point diamond turning lathe, the FTS routinely achieves12 nanometer RMS surface finishes on aspheres, toric off-axis spheres and other “free form” optical surfaces with superior dynamic range, speed and reliability.

A World-Leader in Piezo Technology

The model **KC FTS** Fast Tool Servo is a patented* design from the most experienced piezoelectric actuator company in the world. Kinetic Ceramics manufactured their first piezo stacks in 1966, called PIEZOMOTOR® actuators, and today this team has more than 60 years of combined experience. All piezo manufacturing processes are maintained in-house including processing powder, forming disks, firing ceramics, plating electrodes, actuator assembly and final testing. The result is a fast tool servo system with unmatched performance and reliability.

Proven Performance and Reliability

More than two hundred KC FTS systems are in service today as VARIFORM® attachments to Optoform® lathes from Precitech, Inc. These systems operate “ 24 / 7 ” in contact lens manufacturing facilities worldwide providing outstanding surface form and finish with high-throughput. Only Kinetic Ceramics offers this cost-effective combination of precision, throughput and reliability.

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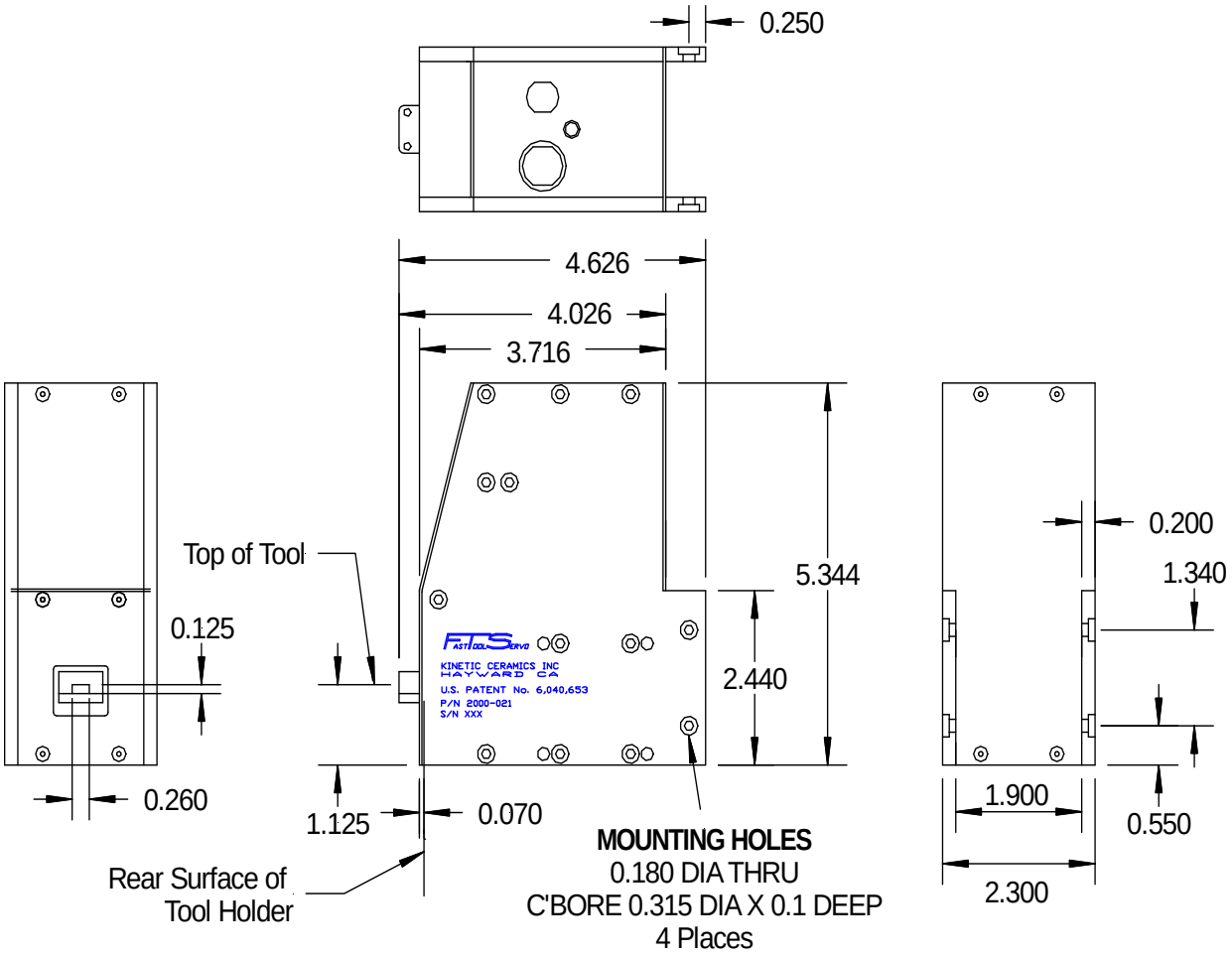
* US Patent 6,040,653
® PIEZOMOTOR is a registered trademark of Kinetic Ceramics Inc.
® VARIFORM and OPTOFORM are registered trademarks of Precitech Inc.

System Specifications for the Fast Tool Servo FTS-400, FTS-600

Tool Travel (under closed loop servo control)	**FTS-400**	400 microns minimum
	FTS-600	600 microns minimum
Linearity		+/-0.25 dB from 0 to 200 Hz
Bandwidth		600 Hz for small signals. (Limited by mechanical resonance/servo gain) 200 Hz for 200 um stroke. (300 um for FTS 600) 100 Hz for 400 um stroke. (600 um for FTS-600)
Tool Stiffness		120 N/um (Closed loop control)
Position Noise Floor		8 nanometers
Surface Finish		12 nanometers RMS typically achieved with Optoform Lathe (6 nanometers RMS contribution compared to lathe without FTS)
Typical Spindle Speed		6000 RPM
Environment		
Operating Temperature		63° F to 77° F (17° C to 25° C)
Storage and Transport Temperature		0° F to 150° F (-18° C to 65° C)
Relative Humidity		25% to 65% (non-condensing)
Open Loop Stroke	**FTS-400**	>400 microns
	FTS-600	>600 microns
Static Stiffness		1.2 Newtons / micrometer (Open Loop)
First Resonant Frequency		1000 Hz nominal
Weight		5 pounds
Size		5.35” H x 4.63” D x 2.3” W
Case Material		Stainless Steel
Internal Protection		Shop air pressurizes housing
Standard Tool Holders	12 degree R:	P/N: 8000-001
	45 degree L:	P/N: 8000-002
	Straight:	P/N: 8000-003

KINETIC CERAMICS FAST TOOL SERVO
Servo Head Mechanical Interface



Ordering information for the
Kinetic Ceramics FTS Fast Tool Servo Module

Please specify 110 or 220 volt factory setting.
This product is CE tested.

Kinetic Ceramics Inc.
Pioneers in Piezoelectric Technology

Rotary Fast Tool Servo Module for Precision Lathes

The Kinetic Ceramics Rotary Fast Tool Servo utilizes a unique piezoelectric shearmotor to produce high frequency angular motion of a lightweight single crystal diamond cutting tool. The shearmotor is mounted in a sealed housing containing a cooling fluid to control the temperature of the high performance piezoelectric driving elements. The housing also contains a temperature sensor to monitor the shearmotor temperature. Fluid ports permit circulation of the coolant. The tool holder is mounted in a titanium flexure that has very high rigidity in the vertical axis as well as in the tool longitudinal axis. Side to side motion of the cutting tool is unrestricted by the flexure.

A high power amplifier drives the shearmotor. A drive signal is synthesized for the amplifier in an oscillator unit and is programmed by two analog input voltages provided by the user. The first input voltage (0 to +10 volts) controls the shearmotor drive amplitude. The second input voltage (0 to +10 volts) represents the desired frequency for the tool oscillation within the range 2 kHz to 24 kHz. An enable input to the oscillator prevents drive signals from being generated when enable contacts are not closed.

Control Amplifier/Oscillator Cabinet and Laptop Computer

Rotary Fast Tool Servo Head

KC FTS-R Preliminary System Specification

Tool Travel :	±10 Microns at tool cutting surface from 2kHz to 7kHz ±4 Microns at tool cutting surface at 20kHz Motion Radius = 1.0cm (Dependant on tool holder design)
Operating Bandwidth :	2 kHz to 24 kHz
Environment:	
Operating Temperature	63° F to 77° F (17° C to 25° C)
Storage and Transport Temperature	0° F to 150° F (-18° C to 65° C)
Relative Humidity	25% to 65 % (non-condensing)
Tool Head weight	4.44 lbs including coolant
Titanium Tool Holder mass (with single crystal diamond cutting tool).	1.4g
Maximum Tool Holder Mass	3.0g
Coolant Type & Quantity	200 DSI-HTF-200 Approximately 24 fl oz.

FTS Control Amplifier with Oscillator

Drive Amplifier

Input Command Signals	
Input 1: Amplitude	0 to +10 Volts
Input 2: Frequency	0 to +10 Volts represents 2kHz to 24kHz
Output Voltage	1000V pk-pk
Maximum Average Continuous Output Power	1000 Watts

Electrical Connectors

Control Signals	BNC
Amplifier Output	Terminal Strip
Input Power	90-120 VAC 50 – 60 Hz

Notes:

Kinetic Ceramics Inc.
Pioneers in Piezoelectric Technology

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Phone: (510)264-2140
Fax: (510)264-2159

All parts are proudly made in the U.S.A.