

## Amplified Actuators



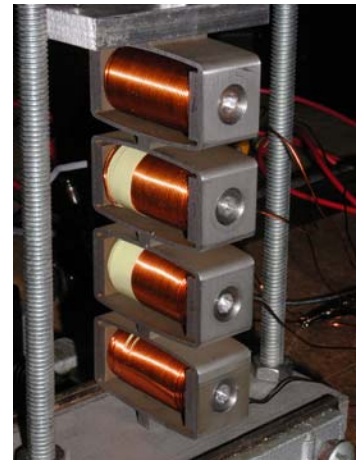
Mechanically amplified (MA) actuators deliver a range of motion that cannot be accessed by direct linear actuators. Through an innovative mechanical design, Energen’s MA actuators feature high stiffness combined with higher displacements than direct actuators, resulting in an actuator with high bandwidth for dynamic applications.

### Applications:

- high resolution adjustment of segmented telescope
- adaptive optics (>1 kHz)
- active vibration control
- valve actuation

Specifications	MA5	MA5 XL
Displacement (µm)	50	200
Force (N)	535	535
Stiffness (N/µm)	1.375	0.3975
Resonance frequency (Hz)	390	105
Response time (ms)	8	10
Max. Voltage (V)	5.5 V	22
Max. Current (A)	5	5
Inductance (mH)	2.66	10.6
Resolution (nm)	100	100
Thermal expansion (10 <sup>-6</sup> /K)	12	12
Height H (mm)	33	142
Length (mm)	58	58
Width (mm)	25	25
Mass (g)	232	910
Mechanical interface	#6-40 UNF	#6-40 UNF
Electrical interface	21 AWG leads	21 AWG leads

The four-cell amplified actuator MA5 XL shown was used to actuate a hydraulic valve in a down-hole drilling tool. The drilling tool has a rotary head as well as a reciprocating mud hammer. The amplified actuator was used to operate a hydraulic valve to drive the reciprocation. The operating fluid of the drill is high-pressure mud, which precludes the use of all conventional actuators. The MA5 XL performed reliably under extreme conditions of temperature, pressure, shock and impact loading. The use of Energen’s actuators increased the penetration rate and tool life.



Energen’s expertise in magnetic “smart” materials (MSM) has enabled innovative positioning, vibration control, and shape control solutions. MSM-based solutions span a size scale of six orders of magnitude, from microvalves enabling microfluidic and sensing applications to elevator brakes and jet blast deflectors with tens of thousands of pounds of force capability. Energen actuators and linear motors are being applied successfully to diverse applications such as precision positioning of telescope optics, active vibration and jitter control of weapons platforms, and tuning of particle accelerator cavities.

Energen’s current development thrust aims to exploit the commercial potential of magnetic smart materials in thin film form. Thin film MSM actuators have the potential to enable more robust drug delivery systems, disposable chemical and biological sensors, lightweight large-scale optics, and many other applications not yet envisioned.

Energen’s success in delivering high value-added solutions to its customers derives from its collaborative business model. The Company partners with academic institutions, national laboratories, government agencies, and industry to pursue application-specific opportunities in its customer’s market niche. Through these partnerships, our customers leverage their resources by accessing a broader range of technology than that in which they invest directly.

Since its founding in 1996, Energen has developed a proven track record of successful cross-disciplinary collaboration, having delivered state-of-the-art solutions to commercial customers and the Federal Government, funded in part through 15 SBIR awards. Energen has assembled a team of recognized experts and has a reputation for quality.