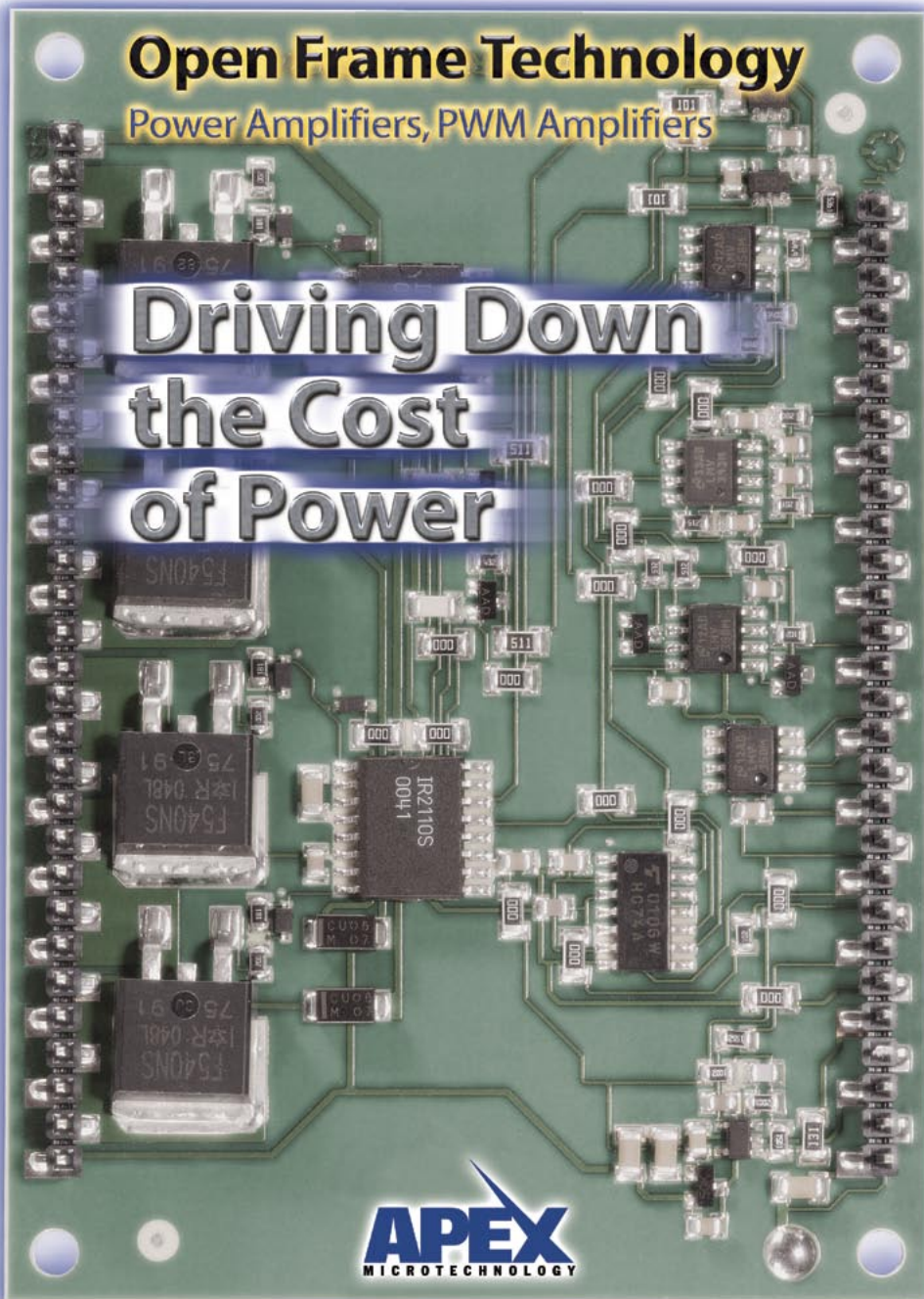




# Open Frame Technology

Power Amplifiers, PWM Amplifiers

## Driving Down the Cost of Power



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Apex is driving down the cost of high power analog. For those applications with slightly more relaxed operating environments, the new Apex “Open Frame” product design delivers the power and thermal performance of a hybrid, but at a cost that is significantly less.

### Cost savings of up to 75%

The open frame concept uses low-cost SMT (surface mount technology) construction to deliver the power analog performance you seek at a cost that makes selecting these off-the-shelf power solutions an easy choice over a discrete solution.

This new open frame product design is being integrated into the Apex linear power operational amplifier and PWM amplifier product lines to achieve per unit cost reductions of up to 75%. When decreasing overall system costs and time-to-market are paramount, this new open frame product design deserves serious consideration.

### High Power Delivery

For more than 30 years, hybrid design techniques have been virtually the only approach to designing off-

the-shelf high power analog amplifier solutions. Working with high power in ranges above 5 amps or voltage supplies greater than 100 volts, comes with a difficult set of thermal management issues. A watt is a watt no matter how the amplifier is designed.

For example, a 5 amp, 100 volt amplifier may have to dissipate hundreds of watts while driving the load. No matter how the amplifier is designed, how large it is, or how it is packaged, the one constant is heat dissipation. And the primary task is to get the heat out of the amplifier’s package.

### Thermal Management

Traditional hybrid designs achieve exceptional thermal management by soldering unpackaged power transistors (die) to a thick film metalized BeO (beryllium oxide) substrate. The power transistors take the brunt of the heat generated when driving the load. The use of BeO provides the hybrid design with superior heat conductance, while keeping the temperature of the power transistors under control. The BeO also has excellent electrical isolation properties for the other components on the substrate. The BeO is then mounted on a metal package

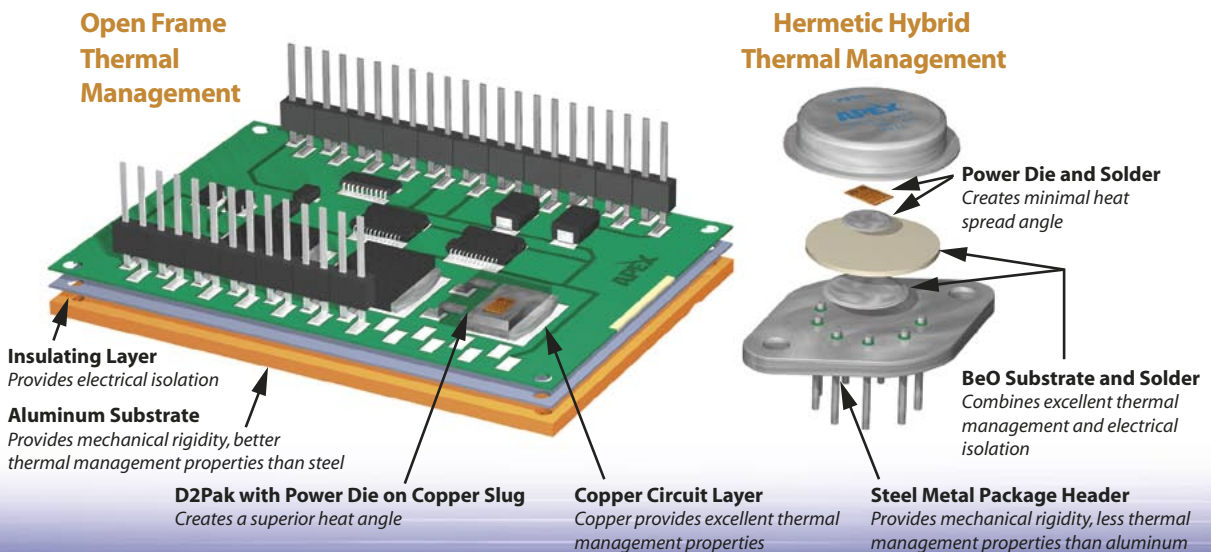


Figure 1.



to provide the substrate with a mechanically ridged base and pins for thru-hole mounting to a heatsink.

With the open frame approach, thermal management actually begins with the individually packaged components. The surface mount power transistors are packaged in the industry-standard D2Pak with a copper slug on the back (the D2Pak is the surface mount version of the TO-220 package).

The power transistor inside the D2Pak is soldered to the copper slug to provide a very low thermal resistance and an exceptionally wide heat spread angle (see Figure 1). When the D2Pak is soldered to the copper circuit layer of the open frame's insulated metal substrate (IMS), the thermal resistance is actually superior to that of the hybrid design.

### Create More Board Space

Although its footprint can be slightly larger than a hybrid design, an open frame amplifier actually allows you to create a smaller and less costly system. The open frame design incorporates the pins and circuitry on the same side of the substrate. When the open frame is mounted on a PCB, a 1/4 inch of space is created

between the amplifier and the board. With this mounting arrangement, power supply bypass capacitors can be placed very closely to the amplifier's power supply pins while freeing-up valuable board space. This configuration also makes room for other required system components.

Open frame products save additional board space by allowing the heatsink to be mounted on top of the device (see Figure 2). This is in sharp contrast to a hybrid design that requires through-hole mounting of the hybrid and the heatsink. The latter places the heatsink on the board, thus occupying valuable board space close to the amplifier.

### Why Roll Your Own?

By achieving the performance of a traditional power hybrid, but at a significantly lower cost, Apex's new open frame product technology is making high power analog affordable for a very broad spectrum of applications. If you have considered an off-the-shelf power amplifier solution in the past, but you ended up "rolling your own" because you couldn't justify the price tag, a new lower-cost option is finally here.

#### Open Frame Amplifier

##### Heat sinking and board mounting

*Heatsink flush mounts to open frame above board to free up board space*

#### Hermetic Hybrid Amplifier

##### Heat sinking and board mounting

*Metal packaged hybrid is thru-hole mounted to the heatsink and board, with heatsink occupying valuable board space*

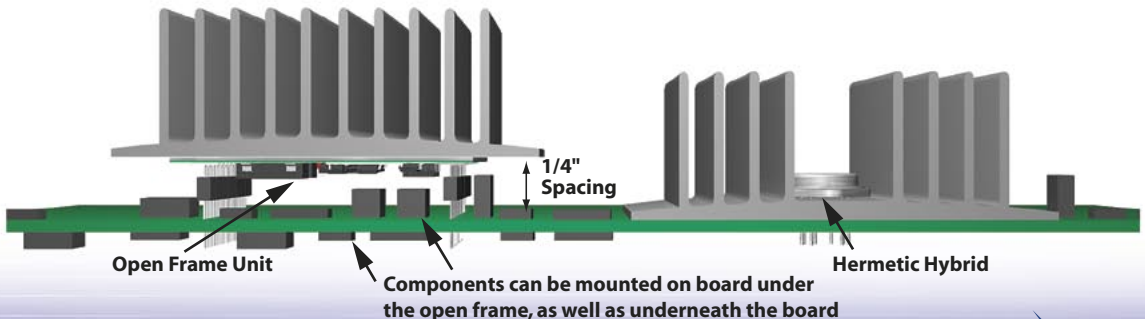


Figure 2.



## Pair of 20A PWM Amplifiers Feature Onboard Smart Controller, Oscillator, Comparator, and Full Bridge Output To Provide A Complete, Cost Effective High Power Driver Solution For Motor Control Applications

As customers continue to streamline their motor control designs, Apex is meeting this design challenge by providing increased levels of integration in the company's next generation of high power motor control drivers.

The MSA240 and MSA260 are complete PWM solutions that include an onboard oscillator, comparator, error amplifier, current limit comparator, and full bridge output. The error amplifier also can be used as a differential amplifier on the input to allow interface with most motor control chip sets. The MSA240 and MSA260 also are designed as full bridge, 4-quadrant PWM amplifiers to allow the amplifier to transition smoothly through 0 Volts for applications requiring deceleration and position control.

Rated at 20A output on motor voltage supplies of up to 100V, the MSA240 can deliver up to 2000W of continuous power to the load. The MSA260 also is a 20A device, but capable of operating on supplies up to 450V. The result is a very impressive power delivery of up to 9000W to the load.

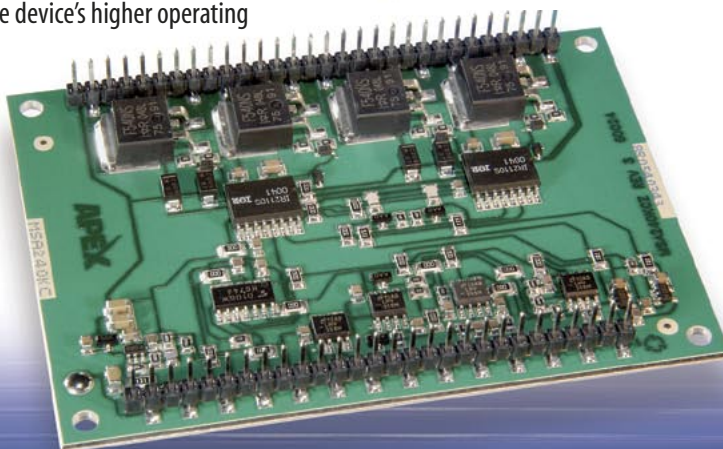
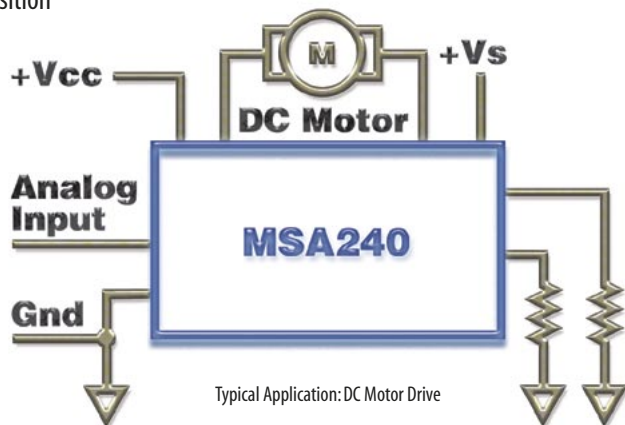
Additional features for both the MSA240 and MSA260 include a variable, user defined switching frequency up to 50KHz. The MSA260 also includes IGBTs on the outputs to provide great efficiency at the device's higher operating voltages.

### MSA240, MSA260 Performance:

- Full bridge, 4-quadrant PWM
- Switching frequency up to 50 KHz
- Power delivery up to 9000W
- High voltage up to 450V
- High current up to 20A

### Typical Applications:

- DC brush motor drive
- Magnetic bearings
- MRI
- Class D Switchmode Amplifier (MSA240)





## 10A High Power Amplifiers Drive Linear And Rotary Motors, Capable Of Dissipating 125W On Supplies Of 100V, 200V

Both the MP38 and MP39 are excellent choices in motor drive applications because of their high output current and high voltage supply operation. Both devices feature continuous output current of 10A within the SOA. Voltage supply operation varies from  $\pm 100V$  with the MP38 and  $\pm 50V$  with the MP39. By combining high voltage output with up to 40 KHz of power bandwidth, both devices are ideal for driving ultra-sonic transducers using a resonant circuit that includes the transducer and a matching transformer.

For applications where crossover distortion is not important, an Iq pin is available on the MP38 to shut off the quiescent current in the output stage. The output stage then operates as a Class C amplifier, lowering the quiescent power dissipation. The MP39 operation is similar with a lower supply voltage of 100 volts at 10 amps.

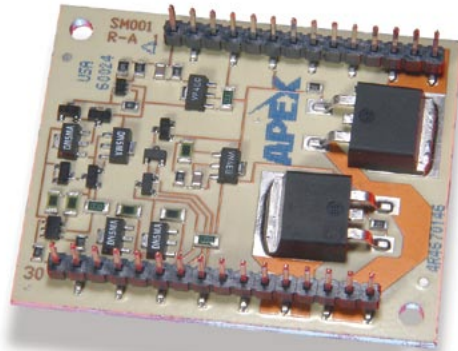
Additional performance features offered by the MP38 and MP39 include an optional boost voltage input to allow the small signal portion of the amplifier to operate at higher supply voltages than the high current output stage. For extra efficient operation, the amplifiers are biased to achieve close linear swings to the supply rails at high current. The MP38 and MP39 can be tailored to the user needs for external compensation. A four wire sense technique allows current limiting without the need to consider internal or external mil-ohm parasitic resistance in the output line.

### MP38, MP39 Performance:

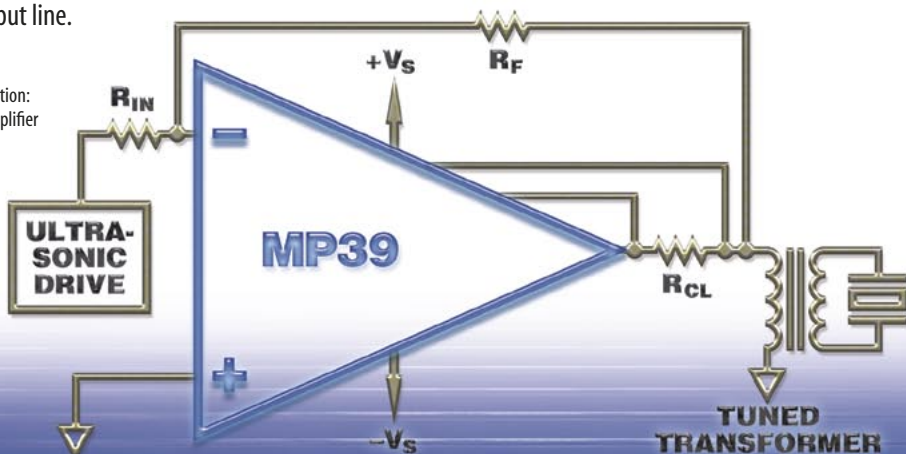
- High voltage up to 200V
- High current up to 10A
- High slew rate 10V/ $\mu$ s
- Four-wire current limit sensing
- Optional boost voltage inputs
- High internal dissipation up to 125W

### Typical Applications:

- Linear and rotary motor drives
- Programmable power supplies
- Yoke and magnetic excitation
- Industrial audio



Typical Application:  
Ultra Sonic Amplifier





## Pair of Power Amplifiers Deliver Up To 40A Of PEAK Output Current For Programmable Power Supplies, Motor Drive Applications

High output current capabilities makes both the MP230 and MP240 excellent choices in programmable power supply and motor drive applications. The MP230 is a 30A device and can dissipate up to 250W. The MP240 provides 20A of continuous output current and 200W of power dissipation capability. At PEAK operation, the MP230 is capable of 40A within the SOA and the MP240 can deliver 25A.

Both models offer four-wire programmable current limit sensing and external compensation, and they can be directly mounted to a heat sink. In terms of operational efficiency, a boost feature on both devices biases the output stage for close linear swings to the supply rail. V-boost is accomplished by operating the amplifiers' small signal stages at a higher voltage supply than the amplifiers' high current output stage. An additional +10V is sufficient for the small signal stages to drive the output stage into

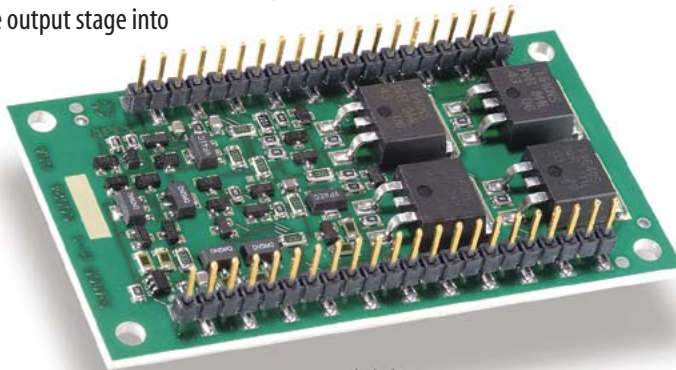
saturation and improve the output voltage swing for extended efficiency when needed.

### MP230, MP240 Performance:

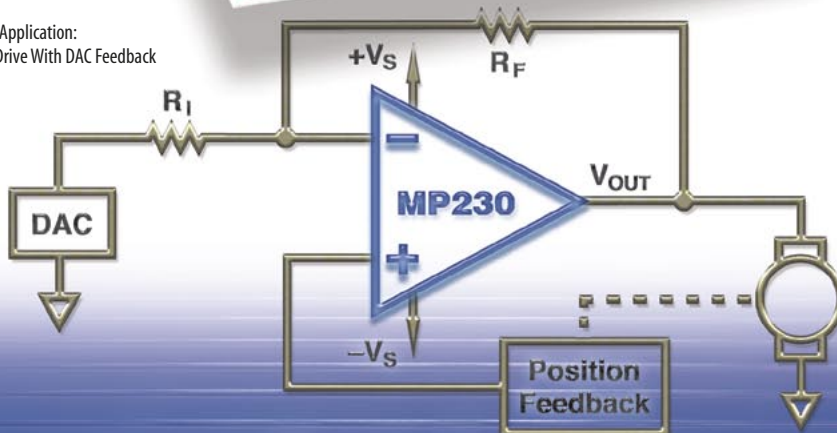
- High voltage up to 200V
- High current up to 40A PEAK
- High slew rate 15V/ $\mu$ s
- Four-wire current limit sensing
- Optional boost voltage inputs
- High internal dissipation up to 250W

### Typical Applications:

- Programmable power supplies
- Motor drive
- Magnetic deflection
- Industrial audio amplifier



Typical Application:  
Motor Drive With DAC Feedback





## Power Amplifier Uses 200V Supply, 170V/ $\mu$ s Slew Rate And 300 KHz Of Power Bandwidth To Drive Inkjet Printer Heads

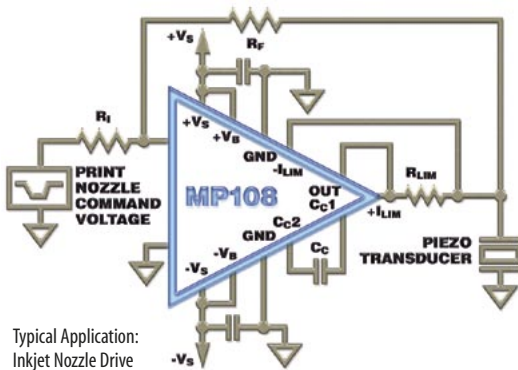
The MP108 provides a unique combination of high voltage operation, very fast slew rate and wide power bandwidth for driving industrial inkjet printers. With 10A of output current capability, the MP108 can drive up to 512 nozzles simultaneously. These performance features also make the MP108 ideally suited to a number of challenging piezo transducer drive applications. Capable of  $\pm 15V$  to  $\pm 100V$  voltage supply operation, the MP108 features a very high 170V/ $\mu$ s slew rate and 300 KHz of power bandwidth.

### MP108 Performance:

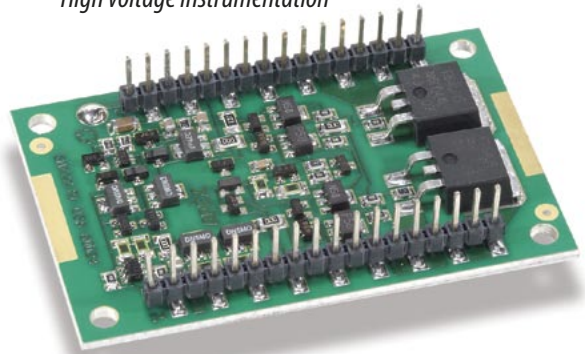
- High voltage up to 200V
- High slew rate 170V/ $\mu$ s
- Power bandwidth up to 300 KHz
- Four-wire current limit sensing
- External compensation

### Typical Applications:

- Inkjet printer head drive
- Piezo transducer drive
- Ultra-sound transducer drive
- Reflectometers
- High voltage instrumentation



Typical Application:  
Inkjet Nozzle Drive



## UNDER DEVELOPMENT

## Power Amplifier Features 12A and 1.8 MHz Of Power Bandwidth For Use In Magnetic Deflection And Piezo Transducer Applications

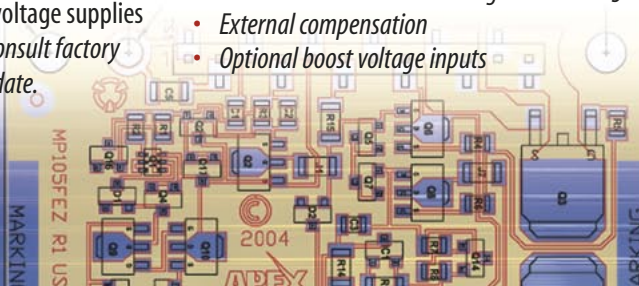
Currently in development, the MP105 is being designed as a high current power amplifier with one of the highest power bandwidth ratings in the industry. The MP105 offers 1.8 MHz of power bandwidth with 12A of output current on voltage supplies of  $\pm 15V$  to  $\pm 27.5V$ . Consult factory for scheduled release date.

### MP105 Performance:

- Power bandwidth up to 1.8 MHz
- High voltage up to 55V
- High output current up to 12A
- High slew rate of up to 200V/ $\mu$ s
- Four-wire current limit sensing
- External compensation
- Optional boost voltage inputs

### Typical Applications:

- Magnetic deflection
- Piezo transducer drive
- Ultra-sound transducer drive
- Reflectometers
- High voltage instrumentation





# Driving Down the Cost of Power

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