POWER ANALOG SOLUTIONS

Aerospace & Defense Guide

APEX® MICROTECHNOLOGY

PRECISION • POWER • ANALOG

AEROSPACE & DEFENSE GUIDE

Precision Power Analog Applications

Our Value

- Broad product portfolio of fully-certified “M/883” and M/883-equivalent amplifier solutions (“M” Grade)
- Commercial/Industrial Grade suited for COTS level circuits
- Family of rad tolerant “R” grade devices
- All devices are standard catalog products to deliver high reliability and trim design time
- Dedicated power analog applications engineering technical support to guide product selection, review schematics, and de-bug circuits
- DLA MIL-PRF-38534 Certified and ISO 9001:2015 Registration
- Certified and Qualified MIL-PRF-38534 manufacturing facility since 1990

A Comprehensive Portfolio of Precision Power Analog Products for Aerospace and Defense Applications.

Precision control in any type of application requires high power analog to generate movement. As a system’s power level increases above 100mA, or greater than 24V, so do the complexities of designing power circuitry that is highly reliable and highly stable. The precision control of high current or high voltage also generates a complex set of electrical and thermal management issues. Apex Microtechnology mitigates and solves these challenges by offering commercial (COTS) solutions reducing complexities for the end customer.

For more than 40 years, customers working in the defense and aerospace industries have relied upon Apex Microtechnology linear operational amplifiers, switching (PWM) amplifiers and precision voltage references to meet the rigorous demands of their operating environments. Apex products are offered in a commercial/industrial grade, with select models also made available in either a M/883-equivalent (“M” grade) or full “M/883” compliant grade.

Apex has an extensive flight heritage in space applications. Apex continues to develop a line of operational amplifiers that are manufactured and tested to meet the requirements for operation in space. Devices that are optimized for tolerating radiation are identified as the new “R” grade.

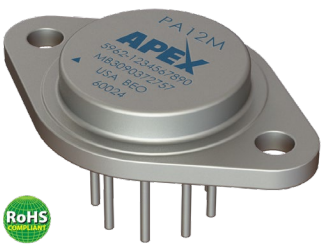
The information provided in this brochure outlines specific space, defense, and aerospace applications with suggested compatible products. Additional product selection assistance, design suggestions, schematic review, and circuit debugging are available by contacting the Apex Microtechnology Applications Engineering Team.

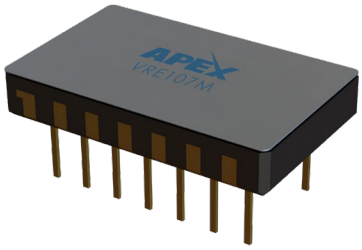
For product selection assistance and technical support, call the Apex Microtechnology applications engineering team.

800-546-2739 (toll free in the USA and Canada)

“M” AND “M/883” GRADE PRODUCTS

The listing below captures the complete Apex Microtechnology product offerings that are available as either M/883-equivalent (“M” grade), or full-compliant “M/883” with Standard Military Drawing (SMD) numbers. Please refer to www.apexanalog.com for the current technical product data sheets for each of these models.





Power Operational Amplifiers	M/883-equivalent (“M”)	Full-Compliant “M/883”	Stocked SMD #
PA02M/883		x	5962-9067901HXA
PA07M/883		x	5962-9063801HXA
PA08M/883		x	5962-9072301HXA
PA09M/883		x	5962-9170001HXA
PA10M/883		x	5962-9082801HXA
PA12M/883		x	5962-9065901HXA
PA51M/883		x	5962-8762001,02YA
PA61M/883		x	
PA73M/883		x	
PA74M	x		
PA83M/883		x	5962-9162101HXA
PA84M/883		x	5962-9073601HXA
PA85M	x		

Precision Voltage References	M/883-equivalent (“M”)	Full-Compliant “M/883”	Stocked SMD #
VRE102M	x		
VRE104M	x		
VRE107M	x		
VRE204M	x		
VRE210M	x		

PRECISION VOLTAGE REFERENCES

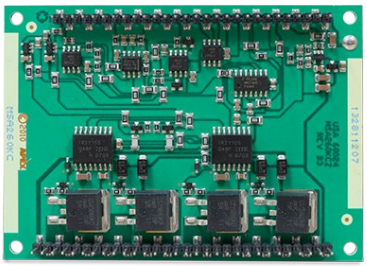
The 100 and 200 series of precision voltage references are zener-based references that offer either a single or dual output voltage. These are popular in systems where positive and negative reference voltages are required. Packaged in 14-pin DIPs and 20-pin LCCs, many are available with military process options (class H).

Model	Output (V)	Initial Error (mV)	TempCo (ppm/ °C)	Noise (µVp-p)	Package	Feature
VRE102*	±10	1.0, 1.2, 1.5, 1.7	1.09, 1.11, 1.33, 1.45	6	DIP14 (HC)	High Temp Range
VRE104*	4.5	0.8	1.48, 1.62, 1.70, 1.98	3	DIP14 (HC)	High Temp Range
VRE107*	±5	0.8, 0.9	1.33, 1.56	3	DIP14 (HC)	High Rel Military
VRE204*	4.5	0.8	1.48, 1.70	3	LCC20 (HD)	Small Pkg, High Rel Military
VRE205	5	0.8	1.33, 1.45, 1.56, 1.82	3	LCC20 (HD)	Small Pkg, High Rel Military
VRE210*	10	0.5, 0.8, 1.0	1.09, 1.11, 1.33, 1.45	6	LCC20 (HD)	Small Pkg, High Rel Military

*Available in M/883-equivalent "M" or fully-certified M/883 product grade
** Available as radiation tolerant "R" product grade.

Model	Sine Wave Output (Vrms)	Initial Error (mV)	Temperature Coefficient (ppm/ °C)	Distortion (%THD)	Package
SWR200	7.071	0.5	20	0.1	DIP14 (HC)

OPERATING TEMPERATURE RANGES



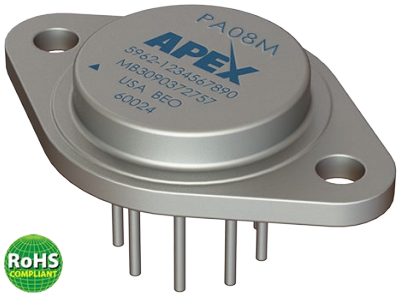
Apex products are graded across four specific operating temperature ranges: commercial, industrial, M/883-equivalent ("M" grade), and fully-compliant "M/883". Depending on the application, a commercial grade product may be a suitable solution if the operating environment is less rigorous. Commercial grade Apex products are routinely used in commercial and industrial level circuits; however, for applications that are more demanding, customers can opt for M/883-equivalent amplifier solutions ("M" grade) or a fully compliant, fully certified "M/883" device that is capable of guaranteed operation over the military temperature range.

Package type is another variable to be considered during the product selection process. Apex offers a number of packaging options suited to a wide spectrum of operating conditions. Taking the time to make the right packaging choice can also deliver cost savings. For less rigorous environments, a low-cost, non-hermetic package such as a plastic PowerSIP, or an open frame module, can be suitable choices that are also very cost-effective. However, a hermetically sealed, metal package may be the best option to provide long-term reliability in the most rigorous operating conditions.

Operating Temperature Range (°C)	Product Grade	Packaging Options
0°C to +70°C	Commercial	PowerSIP, TO-220, LCC, Open Frame Modules, PowerDIP
-40°C to +125°C	Industrial	PowerSIP, TO-220, LCC, Open Frame Modules, PowerDIP
-55°C to +125°C	M/883-equivalent ("M")	QFPs, TO-3, LCC, CERDIP
-55°C to +125°C	M/883 Compliant Military	TO-3

SCREENING PROCESSES

The chart below outlines the static and dynamic test operations performed for the commercial, industrial, M/883-equivalent ("M" grade) and fully-certified "M/883" compliant grades. In addition, the M/883-equivalent ("M" grade) and fully-certified "M/883" are distinguished further by the DLA certification which substantiates the level of quality screening required. In addition, all devices are subject to 100% electrical parametric testing, ensuring all datasheet specifications are met.



Radiation tolerant products ("R" grade) go through screening processes beyond what is shown for the M/883-equivalent ("M" grade) products. Apex has the ability to tailor the screening process based on agreed requirements with our customers. Please reach out to our sales or application team members to discuss further details.

Operation	Commercial/Industrial	M/883-equivalent ("M" grade)	M/883 Compliant Military
Clean Room Processing	Yes	Yes	Yes
Clean Room Testing	Yes	Yes	Yes
Solder Integrity Testing	Yes	Yes	Yes
Wire Bond Integrity	Yes	Yes	Yes
All Processing Under Document Control	Yes	Yes	Yes
High Power Die Inspection	No	Yes	Yes
Processed on Military Line	Yes	Yes	Yes
Pre-cap Visual	Sample	100%	100%
Pre-seal Vacuum Bake	Yes	Yes	Yes
Welded in Controlled Atmosphere[1]	Yes	Yes	Yes
Checked for Hermeticity[1]	No	100%	100%
Temperature Cycle: – 65°C to +150°C for 10 Cycles	No	Yes	Yes
Constant Acceleration Condition 5000G	No	Yes	Yes
Burn-in: 160 hours @ TC = 125°C	No	Yes	Yes
Dynamic Testing	+25°C	-55°C, +25°C, +125°C	-55°C, +25°C, +125°C
External Visual Inspection	Yes	Yes	Yes
Pin Finish	Ni or Sn	Solder	Solder

Maximum Number of Re-work Cycles Specified

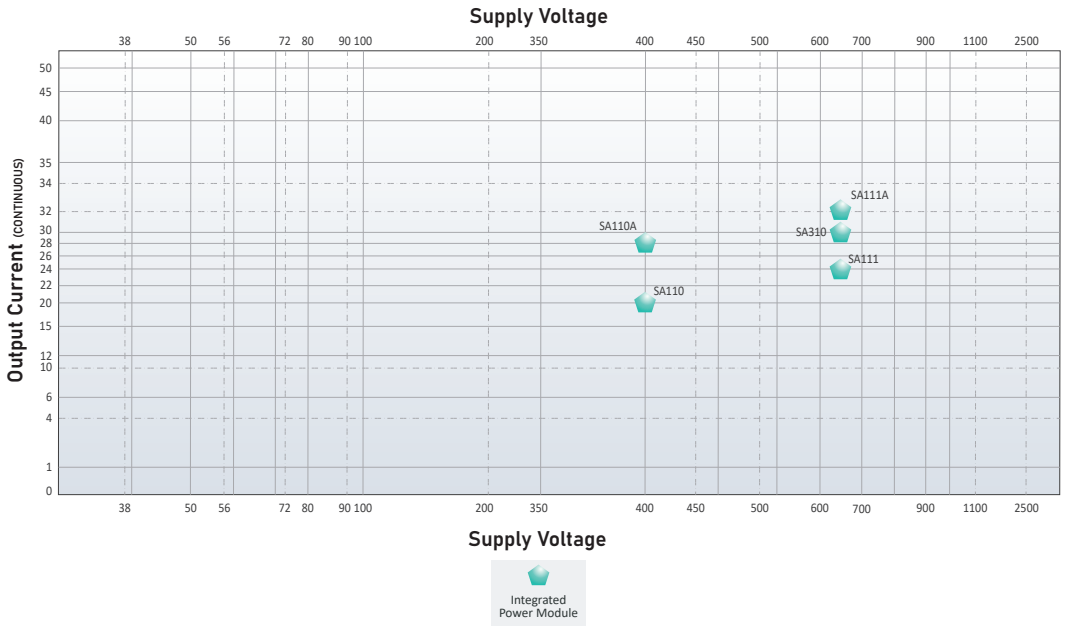
Solder	**Yes**	**Yes**	**Yes**
Epoxy	**No**	**Yes**	**Yes**
Wirebond	**Yes**	**Yes**	**Yes**

[1]Metal Packaged Hybrid Models

SIC INTEGRATED POWER MODULES

In addition to its amplifiers based on CMOS technology, Apex offers a dedicated range of integrated power modules with integrated gate drivers based on Silicon Carbide (SiC). These products offer high efficiency, reduced temperature dependency, and are available at expanded case temperature ranges of 125°C and beyond. The table below shows available Apex SiC devices. As this is a growing product line, information on products with higher voltage and current capabilities is available through the Apex sales team.

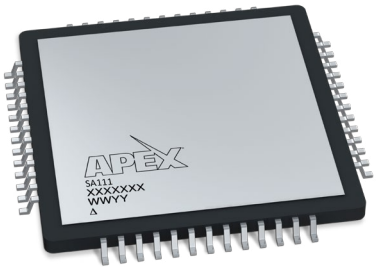
Model	Supply Voltage max (V)	Output Architecture	Output Current continuous (peak) (A)	Switching Frequency max (kHz)	Power Delivery max (W)	Power Dissipation max (W)	Package
SA111A	650	Single Phase	32 (80)	1000	20800	56	52-pin QFP Power Quad (PQ)
SA111	650	Single Phase	24 (50)	1000	15600	56	52-pin QFP Power Quad (PQ)
SA310	600	3-Phase	30 (80)	400	18000	111	16-pin PowerDIP (KR)
SA110A	400	Single Phase	28 (40)	400	11200	89	12-pin PowerSIP (DP)
SA110	400	Single Phase	20 (40)	400	8000	89	12-pin PowerSIP (DP)

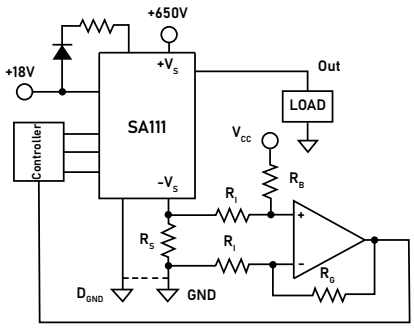


Silicon Carbide Half-Bridge Power Module

SA111

PWM Amplifier
50 A Peak, 650 V Supply Voltage
52-Pin QFP style package
Integrated Gate Driver

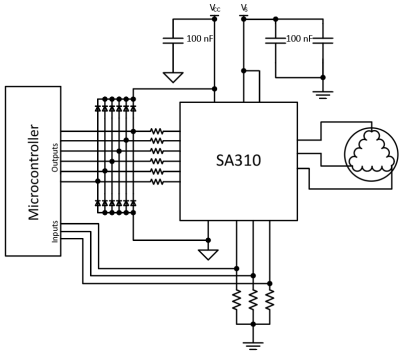


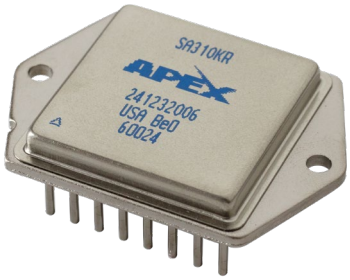


Silicon Carbide 3-Phase Integrated Power Module

SA310

PWM Amplifier
80 A Peak, 650 V Supply Voltage
16-pin PowerDIP Package
Integrated Gate Driver





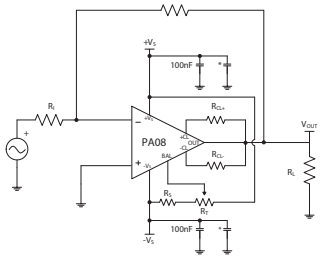
RADIATION TOLERANT PRODUCTS

Model	Supply Voltage max (V)	Output Current continuous (peak) (A)	Slew Rate typical (V/µs)	Quiescent Current max (mA)	Power Dissipation max (W)	Package
PA08R	300	0.15 (0.2)	30	8.5	17.5	8-pin TO-3 (CE)
PA07R	100	5	5	30	67	8-pin TO-3 (CE)
PA12R	100	10 (15)	4	50	125	8-pin TO-3 (CE)
PA74R	40	3 (x2 channels)	1.4	40	36 per channel/60	8-pin TO-3 (CE)
PA02R	38	5	20	40	48	8-pin TO-3 (CE)

High Voltage Power Amplifier with Programmable Current Limit

PA08R

±15V to ±150V Voltage Supply Operation
150 mA High Output Current
Low Bias Current - FET Input



APEX FLIGHT HERITAGE

MARS ROVER

JAMES WEBB TELESCOPE

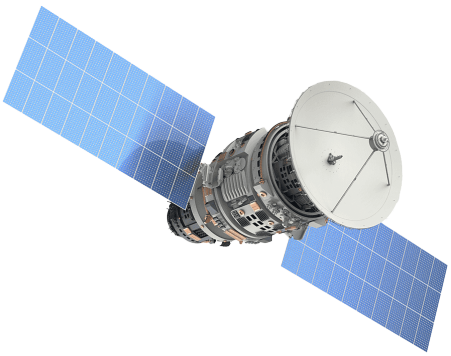
INTERNATIONAL SPACE STATION

OSIRIS-REx

With a stellar flight heritage that spans across renowned space missions, our rad-tolerant devices have proven their reliability and resilience in the most demanding space environments. Our devices have been an integral part of various space missions, including the Mars Rover, James Webb Telescope, the International Space Station, and OSIRIS-REx. Beyond our past achievements, we remain committed to innovation, continuing to expand our rad-tolerant portfolio to include additional solutions for the evolving demands of space exploration.

RAD-TOL TESTING CAPABILITIES

Apex Microtechnology's Radiation Tolerant "R" grade devices are specifically built and tested to maintain operability after exposure to certain levels of radiation. Apex Radiation Tolerant devices include HDR, ELDRS, and SEE radiation test reports, Class H military grade screening, and lot traceability for TID testing.

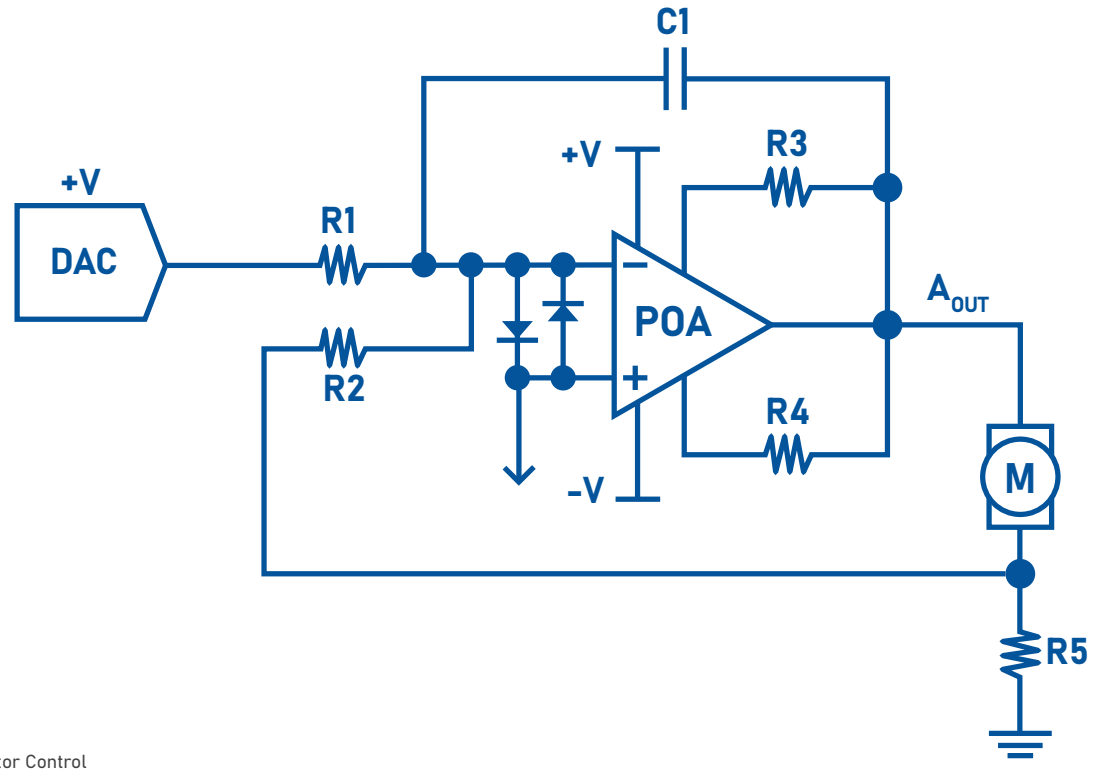


For more information about Apex Radiation Tolerant "R" grade devices or for additional radiation testing options & capabilities offered by Apex please submit our Radiation-Tolerant Inquiry Form by scanning the QR code.

MOTOR DRIVERS

Application	Product Type	Suggested Apex Solutions
Flight Control Actuators, Gimbal Positioning	Power Operational Amplifiers	PA02*,**, PA04, PA05, PA07*,**, PA10*, PA12*,**, PA73*, PA74*,**, PA75, PA76, MP38, MP39
	PWM Amplifiers	SA03, SA53, SA57, SA110, SA160, SA303, SA306, SA310**, MSA240, MSA260

*Available in M/883-equivalent "M" or fully-certified M/883 product grade
** Available as radiation tolerant "R" product grade.



Fin Actuators DC Motor Control

Motor drive applications represent the most common application within the defense and aerospace industries. Apex high current operational and PWM amplifiers are popular choices for motor control applications because of their high reliability and their ability to perform as promised. Choosing between a power op amp or a switching (PWM) amplifier typically comes down to the power requirements of the application circuit. A project can become unmanageable when internal power dissipation requirements are significant, thus indicating a PWM solution may be the best option. These amplifiers also offer varying levels of integration, including cycle-by-cycle current limiting and integrated gate driver logic in the most sophisticated models.

In addition to its amplifiers based on CMOS technology, Apex offers a dedicated range of PWM amplifiers with integrated gate drivers based on Silicon Carbide (SiC). These products offer high efficiency and reduced temperature dependency. Please see Page 6 for more information.

AUDIO, NOISE CANCELLATION

Application	Product Type	Suggested Apex Solutions
Flight Control Actuators, Gimbal Positioning	Power Operational Amplifiers	MP38, MP39, MP103, MP108, MP111, MP118, PA01, PA02*,**, PA03, PA04, PA05, PA07*,**, PA09*, PA10*, PA12*,**, PA13, PA16, PA50, PA51*, PA52, PA61*, PA73*, PA74*,**, PA75, PA76, PA92, PA93, PA96, PA107, PA162, PA164/PA165, PA166, PA119
	PWM Amplifiers	SA01, SA03, SA09, SA12, SA53, SA57, SA110, SA160, SA303, SA306, SA10, MSA240, MSA260
	Power Boosters	PB50, PB51, PB58, PB63, PB64
Guidance and Systems Calibration	Precision Voltage References	VRE102*, VRE204*, VRE205, VRE210*

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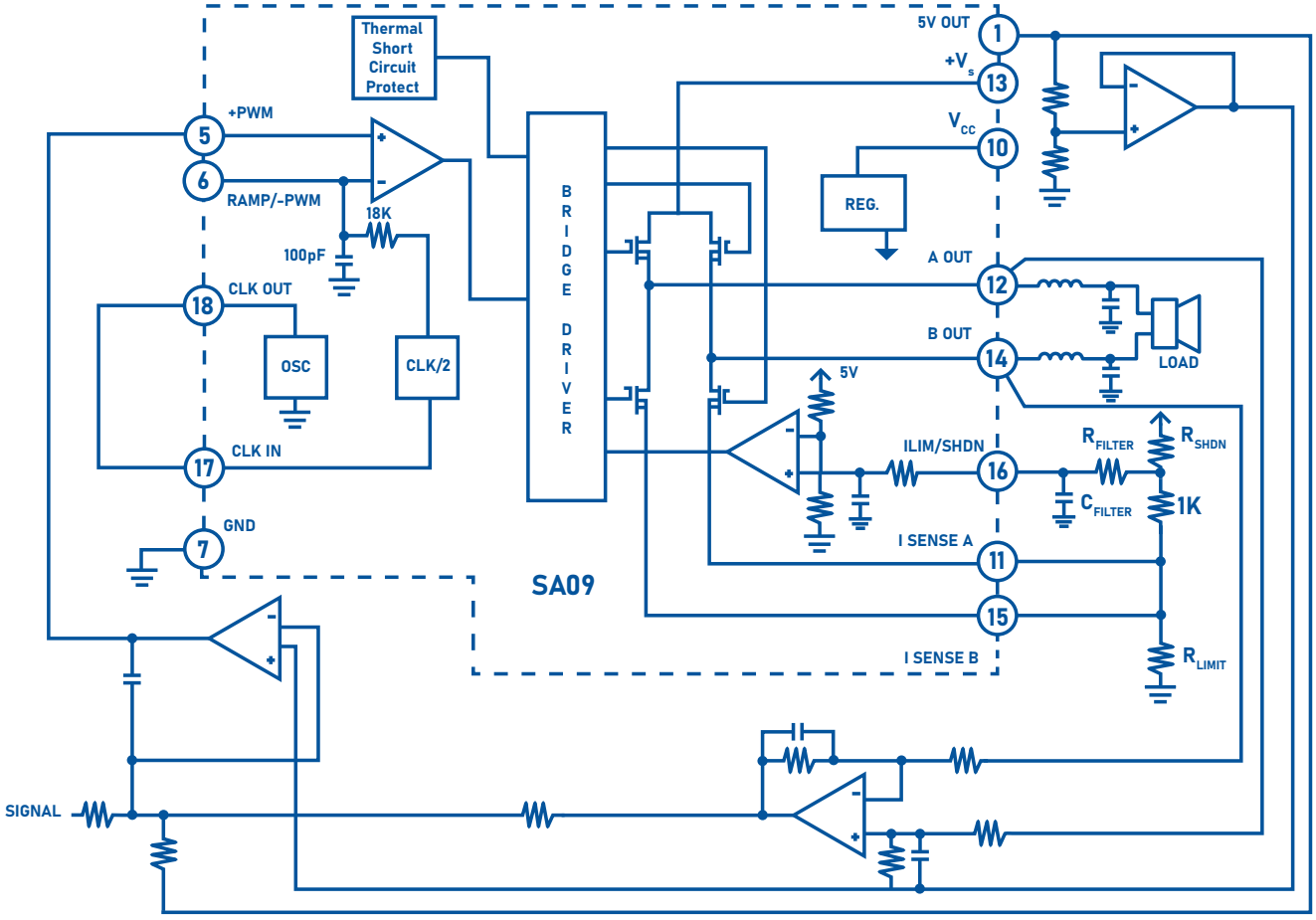
** Available as radiation tolerant "R" product grade.

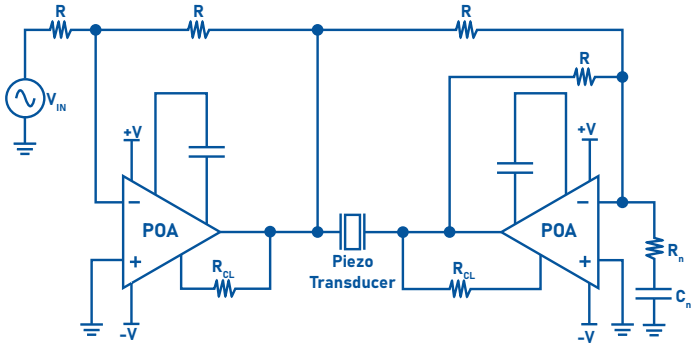


Reducing the size and weight of aircraft electrical systems is of paramount importance. Even the slightest reduction in the number of system components can provide a benefit. System reliability is also a critical factor in avoiding costly down time. Because of their reputation for high reliability, Apex products are designed into aircraft audio and noise cancelation systems, as well as for the high level of integration they provide inside a single, space-saving package. These off-the-shelf solutions can be the best choice to reduce a system's overall component count and simplify heat sinking requirements.

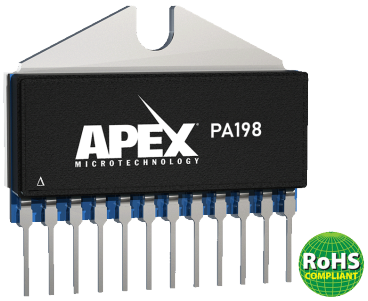
PIEZO TRANSDUCERS, DEFLECTION

Application	Product Type	Suggested Apex Solutions
Sonar	Power Operational Amplifiers	MP38, MP39, MP103, MP108, MP111, MP118, MP400, PA02*,**, PA03, PA04, PA05, PA07*,**, PA08*, PA09*, PA10*, PA12*,**, PA15, PA73*, PA78, PA79, PA81, PA82, PA83*, PA84*, PA85*, PA88, PA89, PA90, PA91, PA92, PA93, PA94, PA95, PA96, PA97, PA98, PA107, PA119, PA198, PA441, PA443
	Power Boosters	PB50, PB51, PB58, PB63, PB64

*Available in M/883-equivalent "M" or fully-certified M/883 product grade
** Available as radiation tolerant "R" product grade.



Sonar Transducer Driver



Apex power operational amplifiers are designed into a wide range of piezo and deflection applications for their exceptional linearity, high slew rates, high voltage output, fast settling times, low crossover distortion and low internal losses. Typical applications include sonar transducer drivers and mirror positioning, which require random beam positioning. For high current applications, Apex power boosters are selected for their slew rates and power bandwidth.

HIGH VOLTAGE DRIVES

Application	Product Type	Suggested Apex Solutions
Heads-Up Displays	Power Operational Amplifiers	MP38, MP39, MP103, MP108, MP111, MP118, PA03, PA04, PA05, PA07*,**, PA08*,**, PA15, PA78, PA79, PA81, PA82, PA83*, PA84*, PA85*, PA88, PA89, PA90, PA91, PA92, PA93, PA94, PA95, PA97, PA98, PA107, PA164/PA165, PA166, PA198, PA194, PA198, PA441, PA443
	Power Boosters	PB50, PB51, PB58, PB63, PB64

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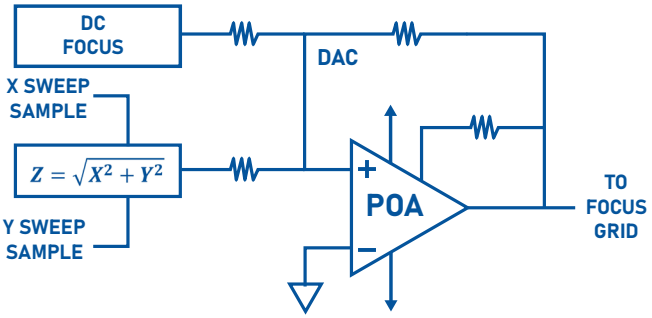


By offering multiple combinations of high speed and high voltage power amplifiers, Apex can drive the rapid correction of focus in high resolution displays. Dynamic focusing is the active correction of focusing voltage as a beam moves from the center to the edges of a CRT. Power operational amplifiers lend themselves well to this application with their ability to be connected as a summing amplifier with inputs from the nominal focus potential and the dynamic correction.

DLA AND ISO CERTIFICATIONS

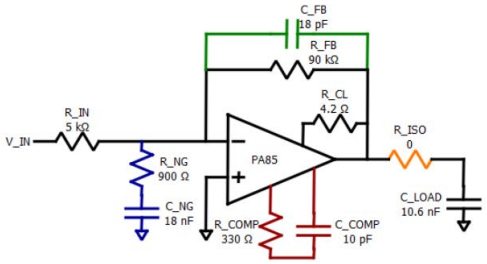
Apex Microtechnology products deliver high quality and reliability by using the same DLA MIL-PRF-38534 certification, ISO 9001:2015 registration and qualified manufacturing systems and processes across all product grades. Apex operates a DLA certified and qualified QML-38534 manufacturing facility with our certification maintained since November 8, 1989, and a QML listing as of May 31, 1990. All products are screened to MIL-PRF-38534 and Class H.

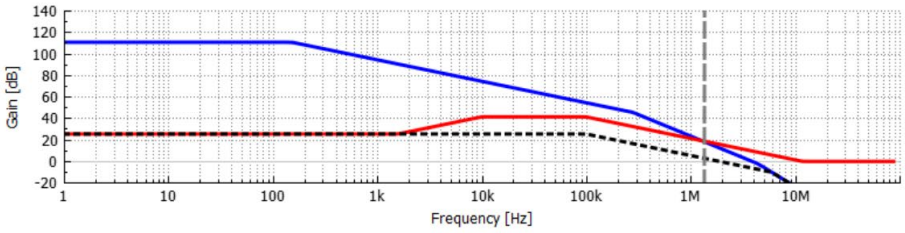
The only point at which variables occur is during electrical testing. The M/883 equivalent ("M" grade) products are tested over a wider temperature range, in addition to certain environmental screenings and internal visual inspection criteria. Commercial and industrial grade products are 100% static and dynamic tested at +25°C. Military level products are 100% tested over their respective full temperature ranges. For complete product and quality information, including complete technical datasheets and supporting design documentation, or to request product samples, visit www.apexanalog.com.

POWER DESIGN SOFTWARE TOOL

POWER DESIGN

Need help with selecting the best product that suits your application needs? How about resolving key design challenges and calculations associated with your power analog circuit? Apex's Power Design software tool helps automate many of the calculations required when working with high power linear and PWM amplifiers. It has multiple modules that provide the ability to plot load-lines and current limits directly onto the Safe Operating Area to ensure circuit stability; calculate internal power dissipation and heatsink requirements; dynamically select a part and assist with other key tasks involved with designing high power analog circuits.





APEX VALUE ADDED

Applications Engineering Staff
Dedicated team of analog experts to assist in design optimization

Design Engineering Team
Powering next-gen innovation in high voltage, high current analog components

Dedicated Account Management and Customer Support Staff
Overall quality and customer satisfaction are our top priorities

Manufacturing Capabilities
Equipped to produce integrated COTS solutions at large volumes

Reduced Lead Times
Best-In-Class lead times to ensure your design stays on schedule

In-House Obsolescence Management
Ensuring long-term product availability and manufacturing support

APEX®
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PRECISION • POWER • ANALOG

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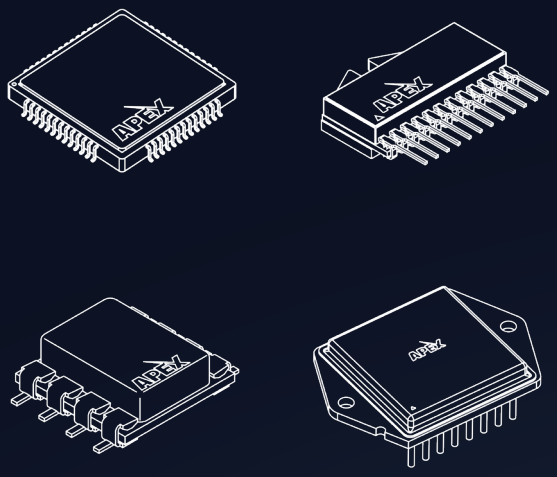

For Technical Support:

Call Toll Free +1 (800) 546-2739
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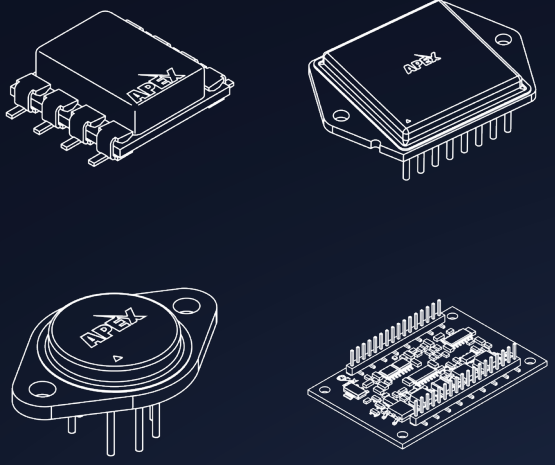
Fax: +1 (520) 888-7003
email: apex.support@apexanalog.com



For Customer Service:

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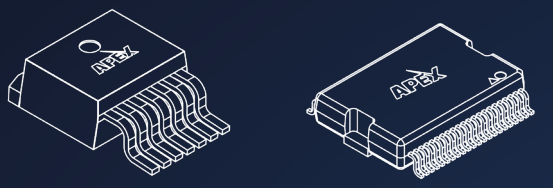

Please visit www.apexanalog.com for a current listing of authorized distributors and sales representatives.

apexanalog.com

January 2024