High Voltage Power Operational Amplifiers

RoHS COMPLIANT

FEATURES

- HIGH VOLTAGE — 400V (±200V)
- LOW QUIESCENT CURRENT — 10mA
- HIGH OUTPUT CURRENT — 200mA
- PROGRAMMABLE CURRENT LIMIT
- HIGH SLEW RATE — 300V/µs

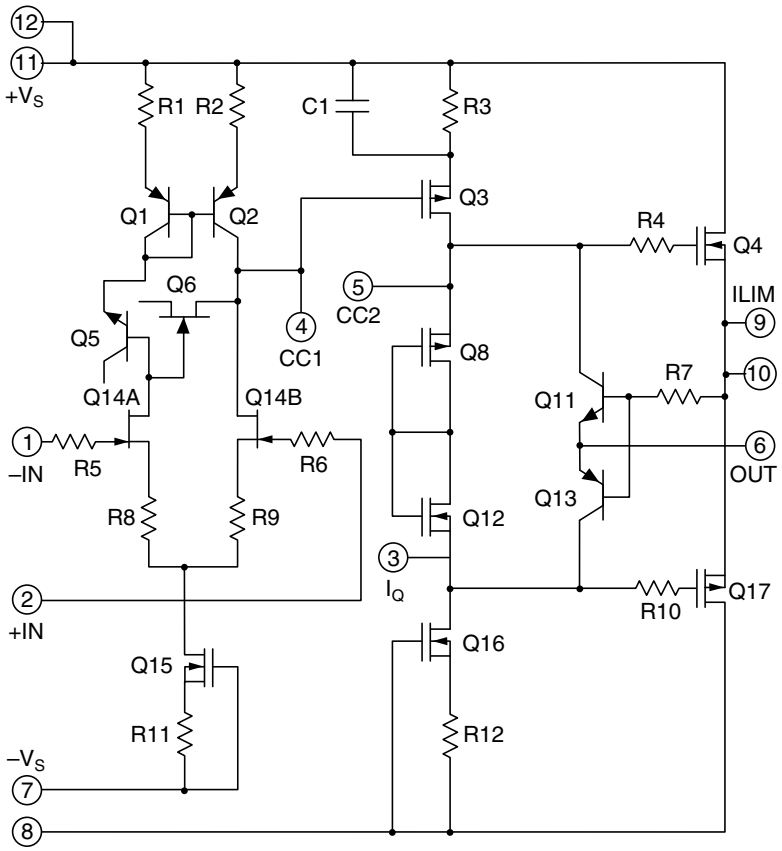
APPLICATIONS

- PIEZOELECTRIC POSITIONING
- HIGH VOLTAGE INSTRUMENTATION
- ELECTROSTATIC TRANSDUCERS
- PROGRAMMABLE POWER SUPPLIES UP TO 390V

DESCRIPTION

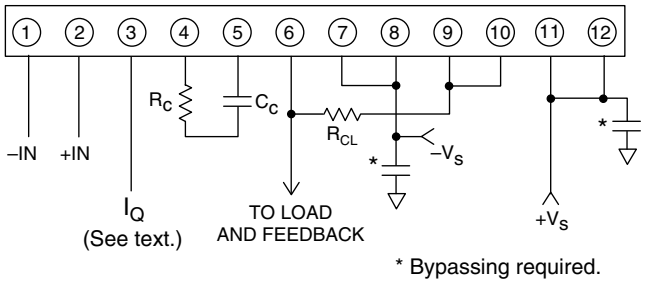
The PA90 is a high voltage, low quiescent current MOSFET operational amplifier designed as a low cost solution for driving continuous output currents up to 200mA and pulse currents up to 350mA. The safe operating area (SOA) has no second breakdown limitations and can be observed for all type loads by choosing an appropriate current limiting resistor. The MOSFET output stage is biased AB for linear operation. External compensation provides flexibility in choosing bandwidth and slew rate for the application. Apex Precision Power's Power SIP package uses a minimum of board space allowing for high density circuit boards. The 12-pin PowerSIP package is electrically isolated.

EQUIVALENT SCHEMATIC



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EXTERNAL CONNECTIONS



* Bypassing required.



12-pin SIP
PACKAGE
STYLE DP
Formed leads available
See package EE

1. CHARACTERISTICS AND SPECIFICATIONS

ABSOLUTE MAXIMUM RATINGS

Parameter	Symbol	Min	Max	Units
SUPPLY VOLTAGE, +V_S to -V_S			400	V
OUTPUT CURRENT, source, sink, peak, within SOA			350	mA
POWER DISSIPATION, continuous @ T_C = 25°C			30	W
INPUT VOLTAGE, differential		-20	20	V
INPUT VOLTAGE, common mode		-V_S	V_S	V
TEMPERATURE, pin solder, 10s max.			260	°C
TEMPERATURE, junction (Note 2)			150	°C
TEMPERATURE RANGE, storage		−40	85	°C
OPERATING TEMPERATURE RANGE, case		−25	85	°C

CAUTION The PA90 is constructed from MOSFET transistors. ESD handling procedures must be observed. The exposed substrate contains beryllia (BeO). Do not crush, machine, or subject to temperatures in excess of 850°C to avoid generating toxic fumes.

SPECIFICATIONS

Parameter	Test Conditions[1]	Min	Typ	Max	Units
AMPLIFIER INPUT					
OFFSET VOLTAGE, initial			0.5	2	mV
OFFSET VOLTAGE vs. temperature	Full temperature range		15	50	µV/°C
OFFSET VOLTAGE vs. supply			10	25	µV/V
OFFSET VOLTAGE vs. time			75		µV/kHz
BIAS CURRENT, initial			200	2000	pA
BIAS CURRENT vs. supply			4		pA/V
OFFSET CURRENT, initial			50	500	pA
INPUT IMPEDANCE, DC			10^{11}		Ω
INPUT CAPACITANCE			4		pF
COMMON MODE VOLTAGE RANGE (Note 3)		±V_S ∓ 15			V
COMMON MODE REJECTION, DC	V_{CM} = ±90V	80	98		dB
NOISE	100KHz bandwidth, R_S = 1KΩ, C_C = OPEN		1		µV RMS

Parameter	Test Conditions[1]	Min	Typ	Max	Units
GAIN					
OPEN LOOP @ 15Hz	R_L = 2KΩ, C_C = OPEN	94	111		dB
GAIN BANDWIDTH PRODUCT @ 1MHz	R_L = 2KΩ, C_C = OPEN		100		MHz
POWER BANDWIDTH	R_L = 2KΩ, C_C = OPEN		470		kHz
PHASE MARGIN	Full temperature range		60		°
OUTPUT					
VOLTAGE SWING (Note 3)	I_O = 200mA	$\pm V_S$ ∓ 12	$\pm V_S$ ∓ 10		V
CURRENT, continuous		200			mA
SLEW RATE, A_V = 100	C_C = OPEN	240	300		V/µS
CAPACITIVE LOAD, A_V = +1	Full temperature range	470			pF
SETTLING TIME to 0.1%	C_C = OPEN, 2V step		1		µS
RESISTANCE, no load			50		Ω
POWER SUPPLY					
VOLTAGE (Note 5)		±40	±150	±200	V
CURRENT, quiescent			10	14	mA
THERMAL					
RESISTANCE, AC, junction to case (Note 4)	Full temp range, F > 60Hz			2.5	°C/W
RESISTANCE, DC, junction to case	Full temp range, F < 60Hz			4.2	°C/W
RESISTANCE, junction to air	Full temp range		30		°C/W
TEMPERATURE RANGE, case	Meets full range specifications	-25		+85	°C

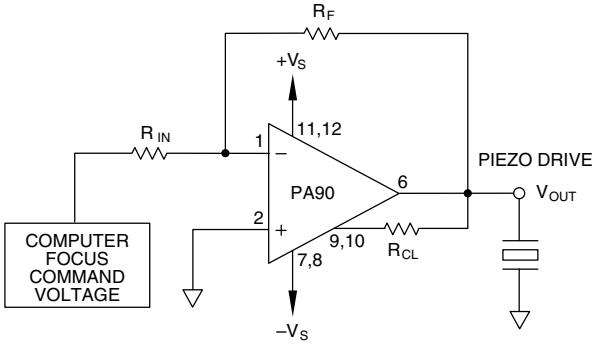
NOTES:

1. (All Min/Max characteristics and specifications are guaranteed over the Specified Operating Conditions. Typical performance characteristics and specifications are derived from measurements taken at typical supply voltages and T_C = 25°C).
2. Long term operation at the maximum junction temperature will result in reduced product life. Derate power dissipation to achieve high MTTF.
3. $+V_S$ and $-V_S$ denote the positive and negative power supply rail respectively.
4. Rating applies if the output current alternates between both output transistors at a rate faster than 60Hz.
5. Derate max supply rating .625 V/°C below 25°C case. No derating needed above 25°C case.

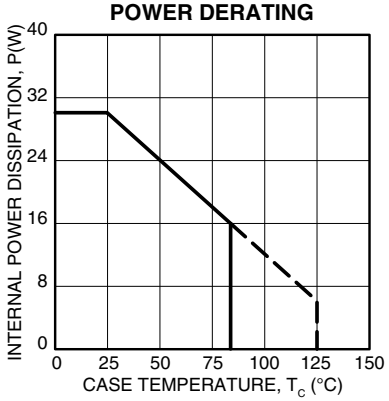
TYPICAL APPLICATION

LOW POWER, PIEZOELECTRIC POSITIONING

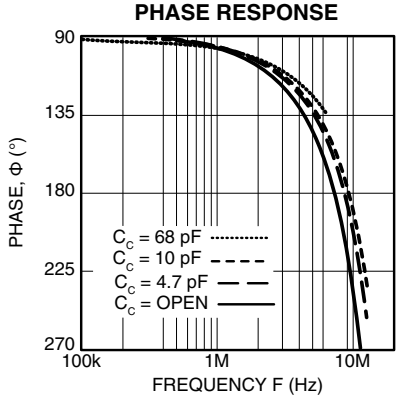
Piezo positioning may be applied to the focusing of segmented mirror systems. The composite mirror may be composed of hundreds of elements, each requiring focusing under computer control. In such complex systems the PA90 reduces the costs of power supplies and cooling with its advantages of low cost and low quiescent power consumption while increasing circuit density with the SIP package.



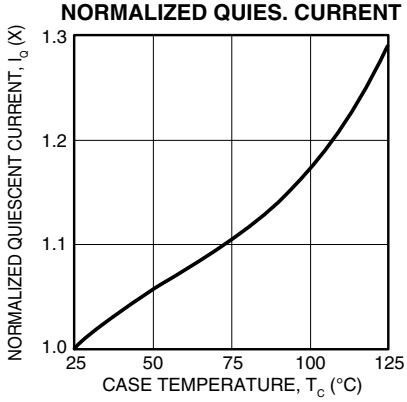
POWER DERATING



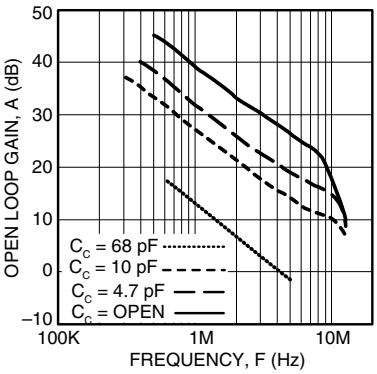
PHASE RESPONSE



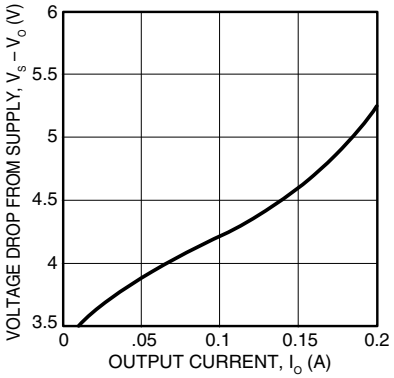
NORMALIZED QUIES. CURRENT



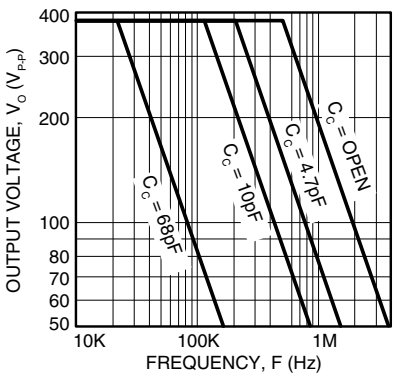
SMALL SIGNAL RESPONSE



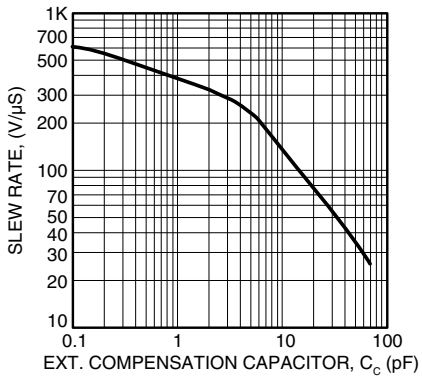
OUTPUT VOLTAGE SWING



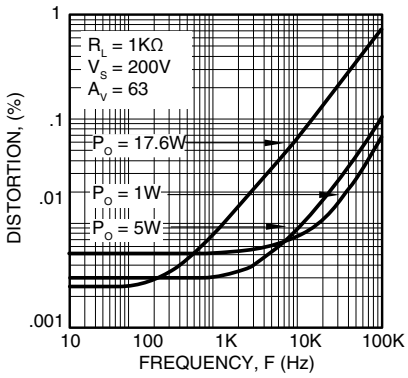
POWER RESPONSE



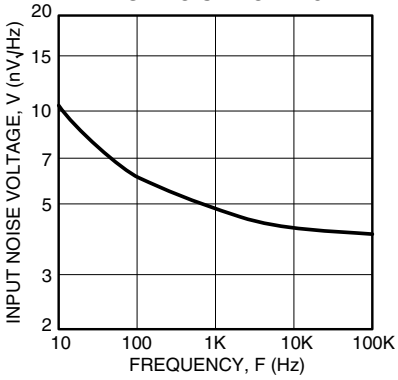
SLEW RATE



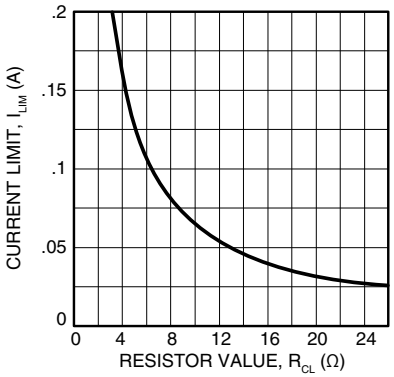
HARMONIC DISTORTION



INPUT NOISE VOLTAGE



CURRENT LIMIT



PHASE COMPENSATION

GAIN	C_C*	R_C
≥1	68pF	100Ω
≥5	10pF	100Ω
≥10	4.7pF	0Ω
≥30	NONE	0Ω

*C_C To be rated for the full supply voltage $+V_S$ to $-V_S$. Use NPO ceramic (COG) type.

GENERAL

Please read Application Note 1 "General Operating Considerations" which covers stability, supplies, heat sinking, mounting, current limit, SOA interpretation, and specification interpretation. Visit www.cirrus.com for design tools that help automate tasks such as calculations for stability, internal power dissipation, current limit; heat sink selection; Apex Precision Power's complete Application Notes library; Technical Seminar Workbook; and Evaluation Kits.

CURRENT LIMIT

For proper operation, the current limit resistor (R_{CL}) must be connected as shown in the external connection diagram. For optimum reliability the resistor value should be set as high as possible. The value is calculated as follows; with the maximum practical value of 32 ohms.

$$R_{CL} = \frac{.65}{I_{LIM}}$$

SAFE OPERATING AREA (SOA)

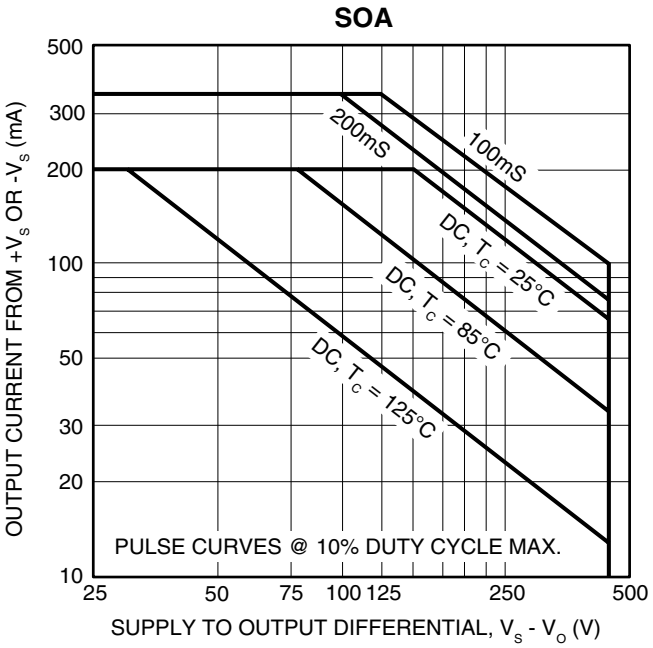
The MOSFET output stage of this power operational amplifier has two distinct limitations:

1. The current handling capability of the MOSFET geometry and the wire bonds.
2. The junction temperature of the output MOSFETs.

NOTE: The output stage is protected against transient flyback. However, for protection against sustained, high energy flyback, external fast-recovery diodes should be used.

SAFE OPERATING CURVES

The safe operating area curves define the maximum additional internal power dissipation the amplifier can tolerate when it produces the necessary output to drive an external load.



INPUT PROTECTION

Although the PA90 can withstand differential voltages up to ±20V, additional external protection is recommended. Low leakage, low capacitance JFETs connected as diodes are recommended (e.g. 2N4416, Q1-Q4 in Figure 2). The differential input voltage will be clamped to ±1.4V. This is sufficient overdrive to produce maximum power bandwidth.

POWER SUPPLY PROTECTION

Unidirectional zener diode transient suppressors are recommended as protection on the supply pins. See Figure 2. The zeners clamp transients to voltages within the power supply rating and also clamp power supply reversals to ground. Whether the zeners are used or not, the system power supply should be evaluated for transient performance including power-on overshoot and power-off polarity reversals as well as line regulation.

Conditions which can cause open circuits or polarity reversals on either power supply rail should be avoided or protected against. Reversals or opens on the negative supply rail is known to induce input stage failure. Unidirectional transzorbs prevent this, and it is desirable that they be both electrically and physically as close to the amplifier as possible.

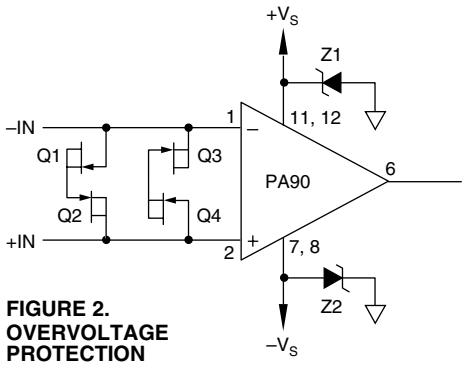


FIGURE 2. OVERVOLTAGE PROTECTION

STABILITY

The PA90 is externally compensated and performance can be tailored to the application. Use the graphs of small signal response and power response as a guide. The compensation capacitor C_C must be rated at 500V working voltage. An NPO capacitor is recommended. The compensation network C_CR_C must be mounted closely to the amplifier pins 4 and 5 to avoid spurious oscillation.

QUIESCENT CURRENT REDUCTION

When pin 3 (I_Q) is shorted to pin 5 (CC2) the AB biasing of the output stage is disabled. This raises distortion since the output stage is then class C biased, but reduces the quiescent current by 1mA for a power dissipation savings of 0.4W. Pin 3 may be left open if not used.

CONTACTING CIRRUS LOGIC SUPPORT

For all Apex Precision Power product questions and inquiries, call toll free 800-546-2739 in North America.
For inquiries via email, please contact tucson.support@cirrus.com.
International customers can also request support by contacting their local Cirrus Logic Sales Representative.
To find the one nearest to you, go to www.cirrus.com

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