PA80 SERIES
POWER OPERATIONAL AMPLIFIERS

FEATURES

- HIGH VOLTAGE OPERATION - ±150V (PA82J)
- HIGH OUTPUT CURRENT - ±60mA (PA80J)
- PROTECTED OUTPUT - Thermal Shutoff
- LOW BIAS CURRENT, LOW NOISE - FET Input
- SECOND SOURCEABLE - BB3580J, 81J, 82J

APPLICATIONS

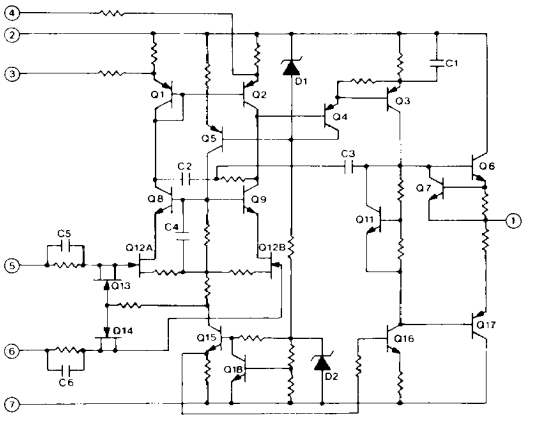
- HIGH IMPEDANCE BUFFERS UP TO ±140V
- ELECTROSTATIC TRANSDUCER & DEFLECTION
- PROGRAMMABLE POWER SUPPLIES TO ±145V
- BIOCHEMISTRY STIMULATORS
- COMPUTER TO VACUUM TUBE INTERFACE

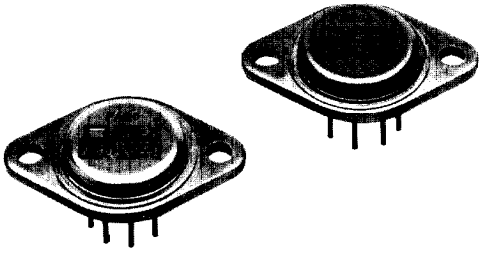
DESCRIPTION

The PA80 series of high voltage operation amplifiers provides an extremely wide range of supply capability with three overlapping products. High accuracy is achieved with a cascode input circuit configuration. All internal biasing is referenced to a zener diode. As a result these models offer outstanding common mode and power supply rejection. The output stage operates in the class A/B mode for best linearity. Internal phase compensation assures stability at all gain settings without external components. Fixed internal current limits protect these amplifiers against a short circuit to common at most supply voltages. For operation into inductive loads, two external flyback pulse protection diodes are recommended. A built-in thermal shutoff circuit prevents destructive overheating under most abnormal operating conditions. However, a heatsink may be necessary to maintain the proper case temperature under normal operating conditions.

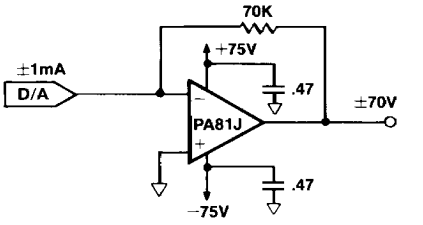
These hybrid integrated circuits utilize thick film conductors, ceramic capacitors and silicon semiconductors to maximize reliability, minimize size and give top performance. Ultrasonically bonded aluminum wires provide reliable interconnections at all operating temperatures. The 8 pin TO-3 package (see Package Outlines) is hermetically sealed and isolated from the internal circuits. Insulating washers are not recommended.

EQUIVALENT SCHEMATIC





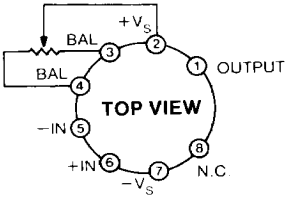
TYPICAL APPLICATION



HIGH VOLTAGE PROGRAMMABLE POWER SUPPLY

The PA81 and 70K ohm resistor form a current to voltage converter, accepting ±1mA from a 12 bit current output digital to analog converter. The power op amp contribution to the error budget is insignificant. At a case temperature of 70°C, the combination of voltage offset and bias errors amounts to less than 31 ppm of full scale range. Incorporation of the optional offset trim can further reduce these errors to under 9 ppm.

EXTERNAL CONNECTIONS



NOTES:
1. Input offset trimpot optional. Recommended value 100KΩ.

PA80 SERIES ABSOLUTE MAXIMUM RATINGS

	PA80J	PA81J	PA82J
SUPPLY VOLTAGE, $+V_S$ to $-V_S$	100V	200V	300V
OUTPUT CURRENT, source		Internally Limited	
POWER DISSIPATION, internal		11.5W	
INPUT VOLTAGE, differential	±50V	±150V	±300V
INPUT VOLTAGE, common mode		$\pm V_S$	
TEMPERATURE, pin solder-10sec		300°C	
TEMPERATURE, storage		−65 to 125°C	
TEMPERATURE RANGE, powered (case)		−55 to 125°C	

SPECIFICATIONS

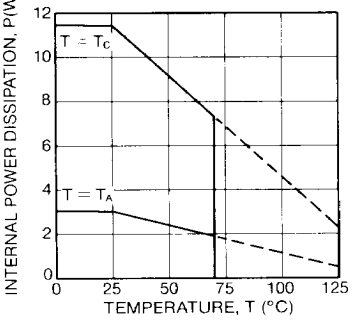
		PA80J			PA81J			PA82J			
PARAMETER	**TEST COND.**	**MIN**	**TYP**	**MAX**	**MIN**	**TYP**	**MAX**	**MIN**	**TYP**	**MAX**	**UNITS**
INPUT											
Offset Voltage, initial	$T_C = 25°C$		±5	±10		±1.5	±3		±1.5	±3	mV
vs. temp.	Full temp. range		10	30		10	25		10	25	µV/°C
vs. supply	$T_C = 25°C$		100			20			*		µV/V
vs. time	$T_C = 25°C$		150			75			*		$\mu V\sqrt{kh}$
Bias Current, initial	$T_C = 25°C$		5	50		*	*		*	*	pA
vs. supply	$T_C = 25°C$		.5			.2			*		pA/V
Offset Current, initial	$T_C = 25°C$		2.5	50		*	*		*	*	pA
Input Impedance, dc	$T_C = 25°C$		10^{11}			*			*	*	Ω
Input Capacitance	$T_C = 25°C$		10			*			*	*	pF
Common Mode											
Voltage Range[2]	Full temp. range	$\pm V_S - 10$			*			*			V
Rejection, dc	$V_{CM} = \pm 20V$		86			110		*	*		db
GAIN											
Open Loop at 10Hz	Full load	86	104		94	116		100	118		db
Unity Gain Bandwidth	$T_C = 25°C$		5			*			*		MHz
Power Bandwidth	$T_C = 25°C$, full load		100			60			30		kHz
Phase Margin	Full temp. range		45			*			*		°
OUTPUT											
Voltage Swing[2]	$T_C = 25°C$, I_{PK}	$\pm V_S - 5$			*			*			V
Current, peak	$T_C = 25°C$	60			30			15			mA
Current, limit	$T_C = 25°C$		100			50			25		mA
Settling Time to .1%	$T_C = 25°C$, 10V step		12			*			*		µs
Slew Rate	$T_C = 25°C$		15			20			*		V/µs
Capacitive Load	G = 1		10			*			*		nF
POWER SUPPLY											
Voltage	Full temp. range	±15	±35	±35	±32	±75	±75	±70	±150	±150	V
Current, quiescent	$T_C = 25°C$		8.5	10	*	6.5	8.5		6.5	8.5	mA
THERMAL											
Resistance, ac[3], junction to case	F>60Hz		6			*			*		°C/W
Resistance, dc, junction to case	F<60Hz		9	10		*	*		*	*	°C/W
Resistance, case to air	Full temp. range		30			*			*		°C/W
Temp., shutdown			150								°C
Temp. Range, case	Full range spec.	0		70	*		*	*		*	°C

NOTES: * The specification is identical to the specification for the model in applicable column to the left.

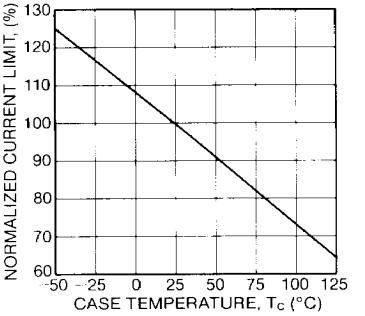
1. The power supply voltage for all specifications is the TYP rating unless noted as a test condition.
2. $+V_S$ and $-V_S$ denote the positive and negative supply rail respectively. Total V_S is measured from $+V_S$ to $-V_S$.
3. Rating applies if the output current alternates between both output transistors at a rate faster than 60Hz.
4. The internal substrate contains beryllia (BeO). Do not break the seal. If accidently broken, do not crush, machine, or subject to temperatures in excess of 850°C to avoid generating toxic fumes.
5. On the PA81J and PA82J, signal slew rates at pins 5 and 6 must be limited to less than 1V/ns to avoid damage. When faster waveforms are unavoidable, resistors in series with those pins, limiting current to 150mA will protect the amplifier from damage.

PA80 SERIES TYPICAL PERFORMANCE CURVES

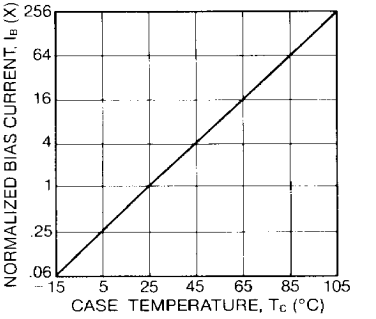
POWER DERATING



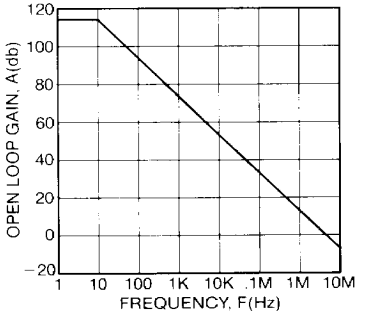
CURRENT LIMIT



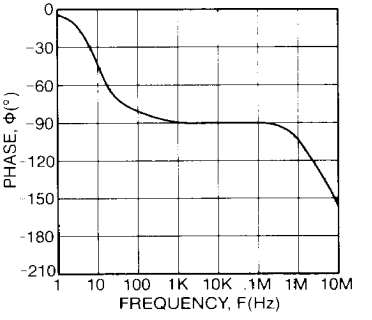
BIAS CURRENT



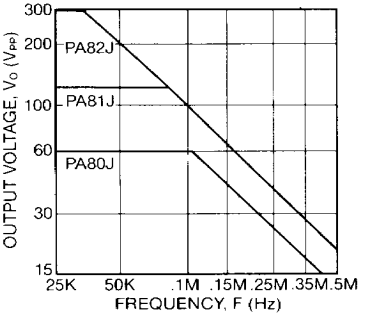
SMALL SIGNAL RESPONSE



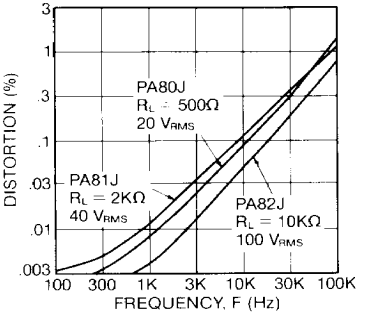
PHASE RESPONSE



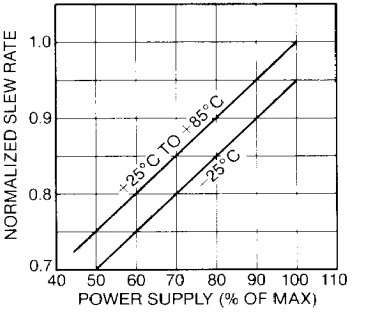
POWER RESPONSE



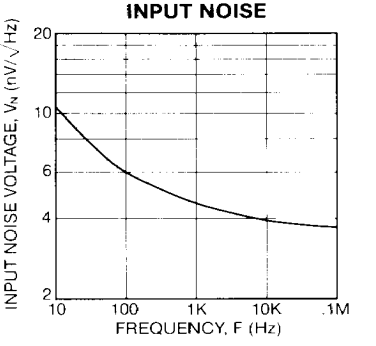
HARMONIC DISTORTION



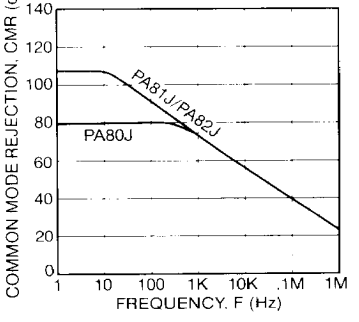
SLEW RATE



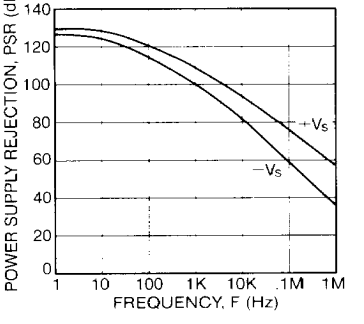
INPUT NOISE



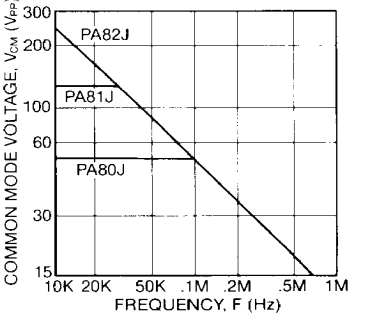
COMMON MODE REJECTION



POWER SUPPLY REJECTION



COMMON MODE VOLTAGE



PA80 SERIES OPERATING CONSIDERATIONS

GENERAL

Please consult Power Operational Amplifier Applications, Note 1, "General Operating Considerations", which covers stability, supply, heatsinking, interpretation of specifications, and symbols used. The information given here cover specific considerations for the PA80J, 81J and 82J. For information on the package outline, heatsinks, and mating sockets, see the "Package Outlines" and "Accessories" sections of the APEX Amplifier Handbook.

SAFE OPERATING AREA (SOA)

For PA80J and PA81J, the combination of voltage capability and internal current limits mandate that the devices are safe for all combinations of supply voltage and load. On the PA82J, any load combination is safe up to a total supply of 250 volts. When total supply voltage equals 300 volts, the device will be safe if the output current is limited to 10 milliamps or less. This means that the PA82J used on supplies up to ±125 volts will sustain a short to common or either supply without danger. When using supplies above ±125 volts, a short to one of the supplies will be potentially destructive. When using single supply above 250 volts, a short to common will be potentially destructive.

Safe supply voltages do not imply disregard for heatsinking. The thermal calculations and the use of a heatsink are required in many applications to maintain the case temperature within the specified operating range of 0 to 70°C. Exceeding this case temperature range can result in an inoperative circuit due to excessive input errors or activation of the thermal shutdown.

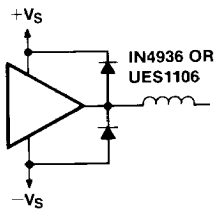


FIGURE 2. PROTECTION, INDUCTIVE LOAD.

INDUCTIVE LOADS

Two external diodes as shown in figure 2, are required to protect these amplifiers against flyback (kickback) pulses exceeding the supply voltage of the amplifier when driving inductive loads. For component selection, these external diodes must be very quick, such as ultra fast recovery diodes with no more than 200 nanoseconds of reverse recovery time. The diode will turn on to divert the flyback energy into the supply rails thus protecting the output transistors from destruction due to reverse bias.

A note of caution about the supply. The energy of the flyback pulse must be absorbed by the power supply. As a result, a transient will be superimposed on the supply voltage, the magnitude of the transient being a function of its transient impedance and current sinking capability. If the supply voltage plus transient exceeds the maximum supply rating or if the AC impedance of the supply is unknown, it is best to clamp the output and the supply with a zener diode to absorb the transient.

THERMAL SHUTDOWN

The thermal protection circuit shuts off the amplifier when the substrate temperature exceeds safe limits. This allows the heatsink design to be based solely on normal conditions but prevents excessive temperatures during abnormal high power conditions without overdesigning the heatsink.

Under abnormal operating conditions, activation of the thermal shutdown is a sign that the internal temperatures have reached approximately 150°. Continued operation in this temperature range will reduce the life of the product. Also, in this operating mode the device may oscillate in and out of thermal shutoff destroying useful signals.

SINGLE SUPPLY OPERATION

These amplifiers are suitable for operation from a single supply voltage. The operating requirements do however, impose the limitation that the input voltages do not approach closer than 10 volts to either supply rail. Referring to the simplified schematics, this is due to the operating voltage requirements of the current sources, the half-dynamic loads and the cascode stage. Thus, single supply operation requires the input signals to be biased at least 10 volts from either supply rail. Figure 3 illustrates one bias technique to achieve this.

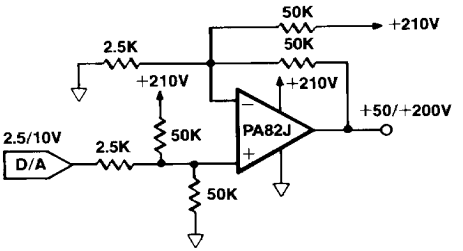


FIGURE 3. TRUE SINGLE SUPPLY OPERATION.

Figure 4 illustrates a very common deviation from true single supply operation. The availability of two supplies still allows ground (common) referenced signals but also maximizes the high voltage capability of the unipolar output. This technique can utilize an existing low voltage system power supply and does not place large current demands on that supply. The 12 volt supply in this case must supply only the quiescent current of the PA81J, which is 8.5mA maximum. If the load is reactive or EMF producing, the low voltage supply must also be able to absorb the reverse currents generated by the load.

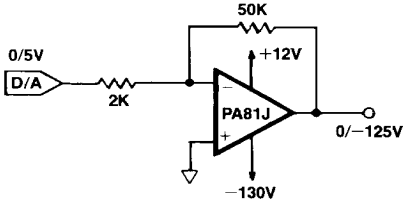


FIGURE 4. NON-SYMMETRIC SUPPLIES.