PA07 • PA07A

POWER OPERATIONAL AMPLIFIERS

FEATURES

- MIL-STD-883C VERSION — PA07M
- LOW BIAS CURRENT — FET Input
- PROTECTED OUTPUT STAGE — Thermal Shutoff
- EXCELLENT LINEARITY — Class A/B Output
- WIDE SUPPLY RANGE — ±12V to ±50V
- HIGH OUTPUT CURRENT — ±5A Peak

APPLICATIONS

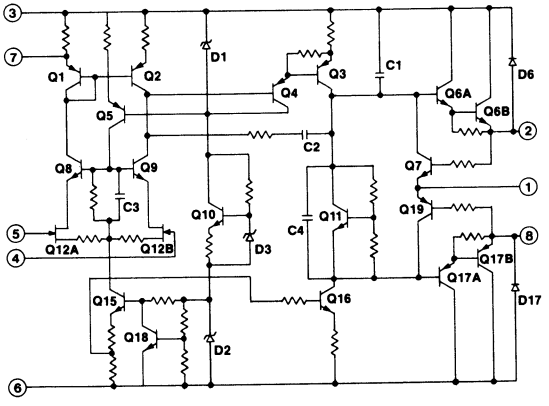
- MOTOR, VALVE AND ACTUATOR CONTROL
- MAGNETIC DEFLECTION CIRCUITS UP TO 4A
- POWER TRANSDUCERS UP TO 100KHz
- TEMPERATURE CONTROL UP TO 180W
- PROGRAMMABLE POWER SUPPLIES UP TO 90V
- AUDIO AMPLIFIERS UP TO 60W RMS

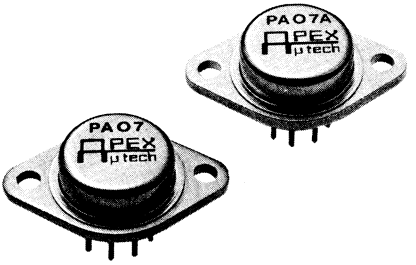
DESCRIPTION

The PA07 is a high voltage, high output current operational amplifier designed to drive resistive, inductive and capacitive loads. Its complimentary darlington emitter follower output stage is protected against inductive kickback or back EMF. For optimum linearity especially at low levels, the output state is biased for class A/B operation using a thermistor compensated base-emitter voltage multiplier circuit. A thermal shutoff circuit protects against overheating and minimizes heatsink requirements for abnormal operating conditions. The safe operating area (SOA) can be observed for all operating conditions by selection of user programmable current limiting resistors. Both amplifiers are internally compensated for all gain settings. For continuous operation under load, a heat sink of proper rating is recommended.

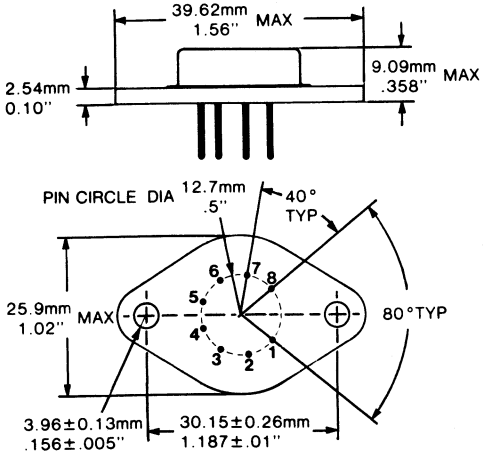
These hybrid integrated circuits utilize thick film (cermet) resistors, ceramic capacitors and semiconductor chips to maximize reliability, minimize size and give top performance. Ultrasonically bonded aluminum wires provide reliable interconnections at all operating temperatures. The 8 pin TO-3 package is hermetically sealed by one shot resistance welding.

EQUIVALENT SCHEMATIC



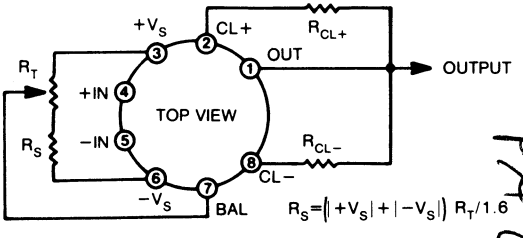


PACKAGE OUTLINE



PIN DIAMETER:	1.01mm or 0.04"
PIN LENGTH:	10.2mm or 0.40" MIN
PIN MATERIAL, STD:	Nickel plated alloy 52, solderable
PIN MATERIAL, MIL:	Gold or nickel plated alloy 52, solderable
PACKAGE:	Hermetic, nickel plated steel
ISOLATION:	300VDC any pin to case
SOCKETS:	APEX PN: MS03
CAGE JACKS:	APEX PN: MS02 (set of 8)
HEATSINKS:	APEX PNs: HS01 thru HS05

EXTERNAL CONNECTIONS



NOTE: Input offset voltage trim optional. R_T=10KΩ MAX

PA07

PA07 ABSOLUTE MAXIMUM RATINGS

SUPPLY VOLTAGE, $+V_S$ to $-V_S$	100V
OUTPUT CURRENT, source	5A
OUTPUT CURRENT, sink	see SOA
POWER DISSIPATION, internal[1]	67W
INPUT VOLTAGE, differential	±50V
INPUT VOLTAGE, common-mode	$\pm V_S$
TEMPERATURE, pin solder-10s	300°C
TEMPERATURE, junction[1]	200°C
TEMPERATURE RANGE, storage	−65 to +150°C
TEMPERATURE RANGE, powered (case)	−55 to +125°C

SPECIFICATIONS

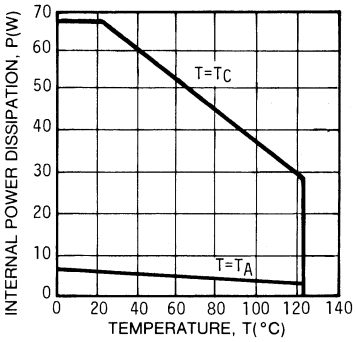
		PA07			PA07A			
PARAMETER	**TEST CONDITIONS[2]**	**MIN**	**TYP**	**MAX**	**MIN**	**TYP**	**MAX**	**UNITS**
INPUT								
OFFSET VOLTAGE, initial	$T_C = 25°C$		.5	±2		±.25	±.5	mV
OFFSET VOLTAGE, vs. temperature	Full temperature range		10	30		5	10	µV/°C
OFFSET VOLTAGE, vs. supply	$T_C = 25°C$		8			*		µV/V
OFFSET VOLTAGE, vs. power	Full temperature range		20			10		µV/W
BIAS CURRENT, initial[3]	$T_C = 25°C$		5	50		3	10	pA
BIAS CURRENT, vs. supply	$T_C = 25°C$		.01			*		pA/V
OFFSET CURRENT, initial[3]	$T_C = 25°C$		2.5	50		1.5	10	pA
INPUT IMPEDANCE, dc	$T_C = 25°C$		10^{11}			*		Ω
INPUT CAPACITANCE	$T_C = 25°C$		4			*		pF
COMMON-MODE VOLTAGE RANGE[4]	Full temperature range	$\pm V_S - 12$			*			V
COMMON-MODE REJECTION, dc	Full temp. range, $V_{CM} = \pm 20V$		120			*		db
GAIN								
OPEN LOOP GAIN at 10Hz	$T_C = 25°C$, $R_L = 15\Omega$	92	98		*	*		db
GAIN BANDWIDTH PRODUCT at 1MHz	$T_C = 25°C$, $R_L = 15\Omega$		1.3			*		MHz
POWER BANDWIDTH	$T_C = 25°C$, $R_L = 15\Omega$		18			*		kHz
PHASE MARGIN	Full temp. range, $R_L = 15\Omega$		70			*		°
OUTPUT								
VOLTAGE SWING[4]	Full temp. range, $I_O = 5A$	$\pm V_S - 5$			*			V
VOLTAGE SWING[4]	Full temp. range, $I_O = 2A$	$\pm V_S - 5$			*			V
VOLTAGE SWING[4]	Full temp. range, $I_O = 90mA$	$\pm V_S - 5$			*			V
CURRENT, peak	$T_C = 25°C$	5			*			A
SETTLING TIME to .1%	$T_C = 25°C$, 2V step		1.5			*		µs
SLEW RATE	$T_C = 25°C$		5			*		V/µs
CAPACITIVE LOAD, unity gain	Full temperature range			10			*	nF
CAPACITIVE LOAD, gain>4	Full temperature range			SOA			*	
POWER SUPPLY								
VOLTAGE	Full temperature range	±12	±35	±50	*	*	*	V
CURRENT, quiescent	$T_C = 25°C$		18	30		*	*	mA
THERMAL								
RESISTANCE, ac[5] junction to case	F>60Hz		1.9	2.1		*	*	°C/W
RESISTANCE, dc junction to case	F<60Hz		2.4	2.6		*	*	°C/W
RESISTANCE, junction to air			30			*		°C/W
TEMPERATURE RANGE, case	Meet full range specification	−25	25	+85	*	*	*	°C

NOTES: * The specification of PA07A is identical to the specification for PA07 in applicable column to the left.

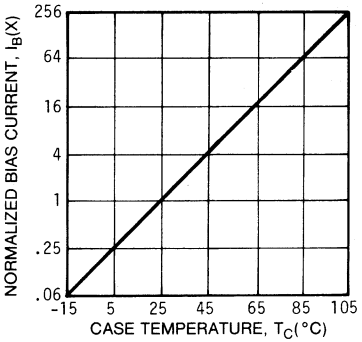
1. Long term operation at the maximum junction temperature will result in reduced product life. Derate internal power dissipation to achieve high MTTF.
2. The power supply voltage for all specifications is the TYP rating unless otherwise noted as a test condition.
3. Doubles for every 10°C of temperature increase.
4. $+V_S$ and $-V_S$ denote the positive and negative supply rail respectively. Total V_S is measured from $+V_S$ to $-V_S$.
5. Rating applies if the output current alternates between both output transistors at a rate faster than 60Hz.
6. 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.
7. The PA07M is screened to MIL-STD-883C Class B Method 5008. See military models.

PA07 TYPICAL PERFORMANCE GRAPHS

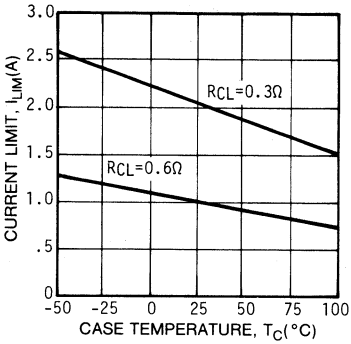
POWER DERATING



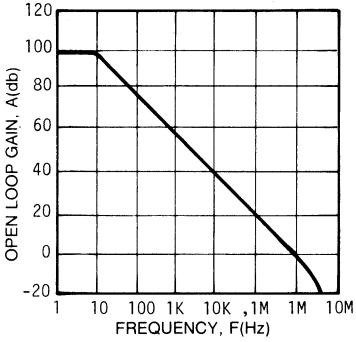
BIAS CURRENT



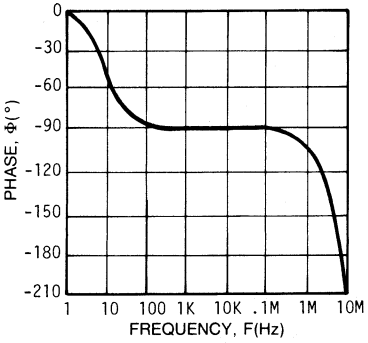
CURRENT LIMIT



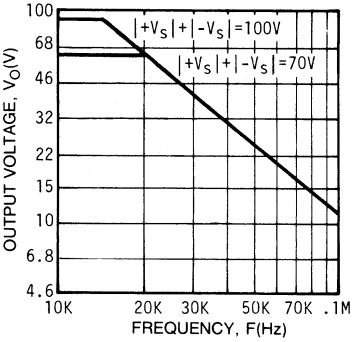
SMALL SIGNAL RESPONSE



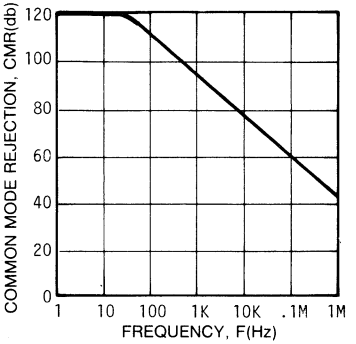
PHASE RESPONSE



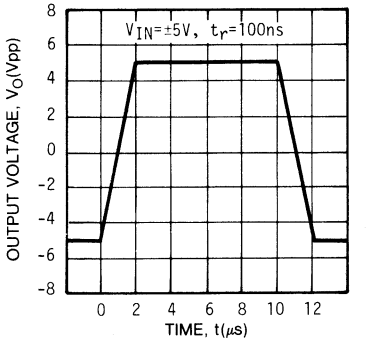
POWER RESPONSE



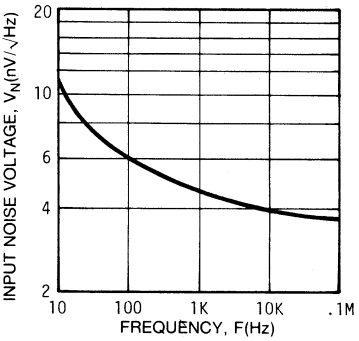
COMMON MODE REJECTION



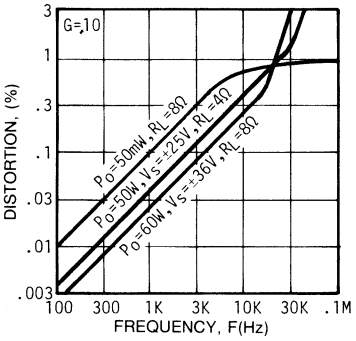
PULSE RESPONSE



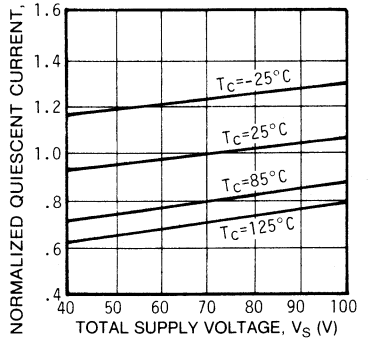
INPUT NOISE



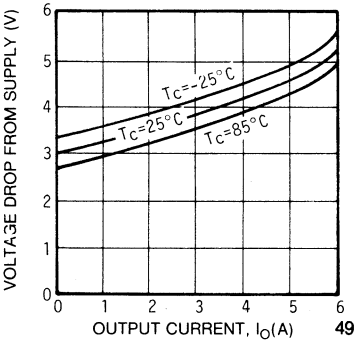
HARMONIC DISTORTION



QUIESCENT CURRENT



OUTPUT VOLTAGE SWING



PA07 OPERATING CONSIDERATIONS

GENERAL

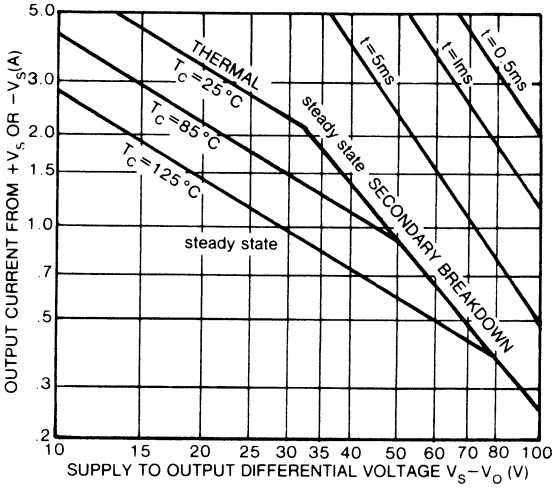
Please consult Power Operational Amplifier Applications, Note 1, "General Operating Considerations", which covers stability, supply, heatsinking, symbols used, and interpretation of specifications. For information on the package outline, heatsinks and mating sockets, see the "Package Outline" and "Accessories"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

SAFE OPERATING AREA (SOA)

The output stage of most power amplifiers has 3 distinct limitations:

1. The current handling capability of the wire bonds.
2. The secondary breakdown effect which occurs whenever the simultaneous collector current and collector-emitter voltage exceeds specified limits.
3. The junction temperature of the output transistors.

SAFE OPERATING AREA CURVES



The SOA curves combine the effect of these limits. For a given application, the direction and magnitude of the output current should be calculated or measured and checked against the SOA curves. This is simple for resistive loads but more complex for reactive and EMF generating loads. However, the following guidelines may save extensive analytical efforts:

1. Under transient conditions, capacitive and dynamic* inductive loads up to the following maximums are safe:

	CAPACITIVE LOAD		INDUCTIVE LOAD	
$\pm V_S$	I_{LIM} = 2A	I_{LIM} = 5A	I_{LIM} = 2A	I_{LIM} = 5A
50V	80μF	75μF	55mH	7.5mH
40V	250μF	150μF	150mH	11mH
30V	1,200μF	500μF	250mH	24mH
20V	20mF	5mF	1.5H	75mH
15V	∞	25mF	∞	100mH

*If the inductive load is driven near steady state conditions, allowing the output voltage to drop more than 12V below the supply rail with I_{LIM} = 5A or 32V below the supply rail with I_{LIM} = 2A while the amplifier is current limiting, the inductor should be capacitively coupled or the current limit must be lowered to meet SOA criteria.

2. The amplifier can handle any EMF generating or reactive load and short circuits to the supply rails or shorts to common if the current limits are set as follows at T_C = 25°C.

$\pm V_S$	SHORT TO $\pm V_S$, C, L OR EMF LOAD	SHORT TO COMMON
50V	.25A	.82A
40V	.37A	1.4A
30V	.65A	2.1A
20V	1.4A	3.3A
15V	2.1A	4.5A

These simplified limits may be exceeded with further analysis using the operating conditions for a specific application.

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.