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FEATURES

- HIGH POWER BANDWIDTH 350kHz
- HIGH SLEW RATE 20V/μs
- FAST SETTLING TIME 600ns
- LOW CROSSOVER DISTORTION Class A/B
- LOW INTERNAL LOSSES 1.2V at 2A
- HIGH OUTPUT CURRENT ±5A PEAK
- LOW INPUT BIAS CURRENT FET Input
- ISOLATED CASE 300 VDC

APPLICATIONS

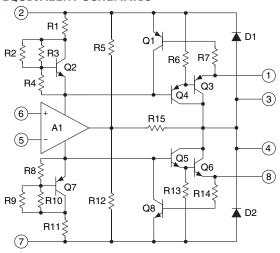
- MOTOR, VALVE AND ACTUATOR CONTROL
- MAGNETIC DEFLECTION CIRCUITS UP TO 5A
- POWER TRANSDUCERS UP TO 350 kHz
- AUDIO AMPLIFIERS UP TO 30W RMS

DESCRIPTION

The PA02 and PA02A are wideband, high output current operational amplifiers designed to drive resistive, inductive and capacitive loads. Their complementary "collector output" stage can swing close to the supply rails and is protected against inductive kickback. For optimum linearity, the output stage is biased for class A/B operation. The safe operating area (SOA) can be observed for all operating conditions by selection of user programmable, current limiting resistors (down to 10mA). Both amplifiers are internally compensated but are not recommended for use as unity gain followers. For continuous operation under load, mounting on a heatsink 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 and electrically isolated. Isolation washers are not recommended. The use of compressible thermal washers and/or improper mounting torque will void the product warranty. Please see "General Operating Considerations".

EQUIVALENT SCHEMATIC

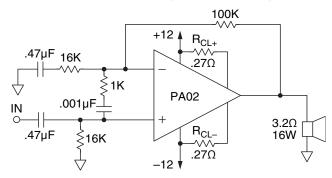




8-PIN TO-3 PACKAGE STYLE CE

TYPICAL APPLICATION

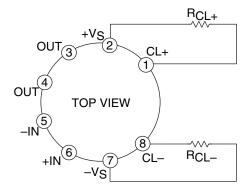
Vehicular Sound System Power Stage



LOW INTERNAL LOSS MAXIMIZES EFFICIENCY

When system voltages are low and power is at a premium, the PA02 is a natural choice. The circuit above utilizes not only the feature of low internal loss of the PA02, but also its very low distortion level to implement a crystal clear audio amplifier suitable even for airborne applications. This circuit uses AC coupling of both the input signal and the gain circuit to render DC voltage across the speaker insignificant. The resistor and capacitor across the inputs form a stability enhancement network. The 0.27 ohm current limit resistors provide protection in the event of an output short circuit.

EXTERNAL CONNECTIONS



ABSOLUTE MAXIMUM RATINGS

SUPPLY VOLTAGE, +V to -V 38V OUTPUT CURRENT, within SOA 5A POWER DISSIPATION, internal¹ 48W $\pm V_s$ -5V $\pm V_s$ -2V 300°C INPUT VOLTAGE, differential INPUT VOLTAGE, common mode TEMPERATURE, pin solder - 10s TEMPERATURE, junction¹ 150°C TEMPERATURE RANGE, storage -65 to +150°C OPERATING TEMPERATURE RANGE, case -55 to +125°C

SPECIFICATIONS

PA02 PA02A								
PARAMETER	TEST CONDITIONS 2, 6	MIN	TYP	MAX	MIN	TYP	MAX	UNITS
INPUT OFFSET VOLTAGE, initial OFFSET VOLTAGE, vs. temperature OFFSET VOLTAGE, vs. supply OFFSET VOLTAGE, vs. power BIAS CURRENT, initial BIAS CURRENT, vs. temperature BIAS CURRENT, vs. supply OFFSET CURRENT, vs. temperature INPUT IMPEDANCE, DC INPUT CAPACITANCE COMMON MODE VOLT. RANGE ⁵ , Pos. COMMON MODE VOLT. RANGE ⁵ , Neg. COMMON MODE REJECTION, DC	$T_c = 25^{\circ}\text{C}$ Full temperature range $T_c = 25^{\circ}\text{C}$ $T_c = 25^{\circ}\text{C}$ $T_c = 25^{\circ}\text{C}$ $T_c = 85^{\circ}\text{C}$ $T_c = 85^{\circ}\text{C}$ $T_c = 25^{\circ}\text{C}$ $T_c = 25^{\circ}\text{C}$ $T_c = 25^{\circ}\text{C}$ $T_c = 25^{\circ}\text{C}$ $T_c = 85^{\circ}\text{C}$ $T_c = 25^{\circ}\text{C}$ $T_c = 25^{\circ}\text{C}$ $T_c = 25^{\circ}\text{C}$ Full temperature range Full temperature range Full temperature range	+V _s -6 -V _s +6 70	±5 ±10 ±10 ±6 50 .01 25 1000 3 +V _s -3 -V _s +5 100	±10 ±50 200 200 100 100	* *	±1 * * 25 * 15 * * * * * * * * * * * * *	±3 ±25 100 * 50 *	mV μV/°C μV/V μV/W pA pA/°C pA/°C pA pA/°C GΩ pF V V dB
GAIN OPEN LOOP GAIN at 10Hz OPEN LOOP GAIN at 10Hz GAIN BANDWIDTH PRODUCT at 1MHz POWER BANDWIDTH PHASE MARGIN	T_c = 25°C, 1kΩ load Full temp. range, 10kΩ load T_c = 25°C, 10Ω load T_c = 25°C, 10Ω load Full temp. range, 10Ω load	86	103 100 4.5 350 30		*	* * * *		dB dB MHz kHz
OUTPUT VOLTAGE SWING³ VOLTAGE SWING³ CURRENT, peak SETTLING TIME to .1% SLEW RATE CAPACITIVE LOAD HARMONIC DISTORTION SMALL SIGNAL rise/fall time SMALL SIGNAL overshoot	$T_{\rm c}=25^{\circ}{\rm C},\ I_{\rm o}=5{\rm A},\ R_{\rm cl}=.08\Omega$ Full temp. range, $I_{\rm o}=2{\rm A}$ $T_{\rm c}=25^{\circ}{\rm C}$ $T_{\rm c}=25^{\circ}{\rm C}$ $T_{\rm c}=25^{\circ}{\rm C},\ 2{\rm V}\ {\rm step}$ $T_{\rm c}=25^{\circ}{\rm C}$ Full temp. range, $A_{\rm v}>10$ $P_{\rm o}=.5{\rm W},\ F=1{\rm kHz},\ R_{\rm l}=10\Omega$ $R_{\rm l}=10\Omega,\ A_{\rm v}=1$ $R_{\rm l}=10\Omega,\ A_{\rm v}=1$	±V _s -4 ±V _s -2 5	±V _s -3 ±V _s -1.2 .6 20 SOA .004 100		* * *	* * * * * * *		V V A µs V/µs % ns
POWER SUPPLY VOLTAGE CURRENT, quiescent	Full temperature range T _c = 25°C	±7	±15 27	±19 40	*	*	*	V mA
THERMAL RESISTANCE, AC junction to case ⁴ RESISTANCE, DC junction to case RESISTANCE, junction to air TEMPERATURE RANGE, case	F > 60Hz F < 60Hz Meets full range specifications	-25	1.9 2.4 30	2.1 2.6 +85	-55	* *	* * +125	°C/W °C/W °C/W

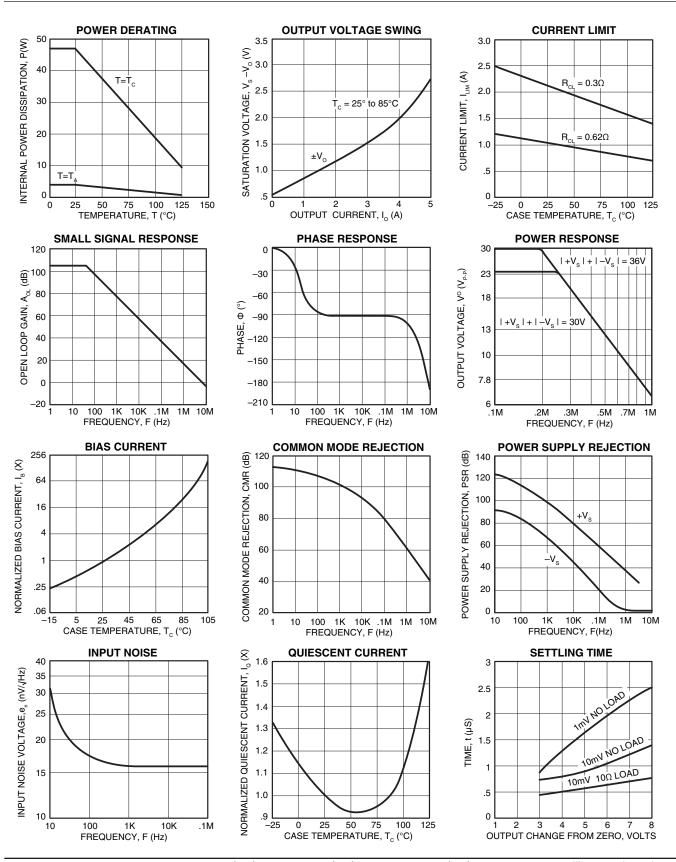
NOTES: *

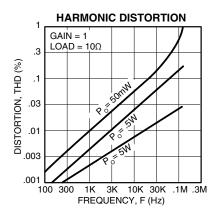
- The specification of PA02A is identical to the specification for PA02 in applicable column to the left.
- 1. Long term operation at the maximum junction temperature will result in reduced product life. Derate internal power dissipation to achieve high MTTF.
- The power supply voltage for all specifications is the TYP rating unless otherwise noted as a test condition.
- +V_s and -V_s denote the positive and negative supply rail respectively. Total V_s is measured from +V_s to -V_s.
 Rating applies if the output current alternates between both output transistors at a rate faster than 60Hz.
 Exceeding CMV range can cause the output to latch.

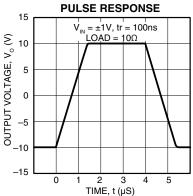
- 6. Full temperature specifications are guaranteed but not 100% tested.

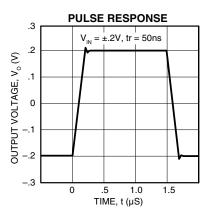
CAUTION

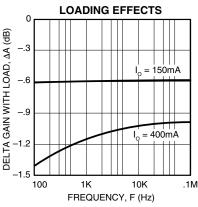
The internal substrate contains beryllia (BeO). Do not break the seal. If accidentally broken, do not crush, machine, or subject to temperatures in excess of 850°C to avoid generating toxic fumes.











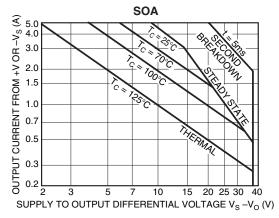
GENERAL

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

SAFE OPERATING AREA

The SOA curves combine the effect of all limits for this Power Op Amp. 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. The following guidelines may save extensive analytical efforts:

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



CAPACITIVE LOAD		INDUCTIVE LOAD		
$\pm V_s$	$I_{LIM} = 2A$	$I_{LIM} = 5A$	$I_{LIM} = 2A$	$I_{LIM} = 5A$
18V	2mF	0.7mF	.2H	10mH
15V	10mF	2.2mF	.7H	25mH
10V	25mF	10mF	5H	50mH

- If the inductive load is driven near steady state conditions, allowing the output voltage to drop more than 8V below the supply rail with I, IM = 5A, or 17V below the supply rail with I, M = 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 $T_{c} = 85^{\circ}C.$

±V _s 18V	SHORT TO ±V _s C, L OR EMF LOAD	SHORT TO COMMON		
18Ÿ	.5A	1.7A		
15V	.7A	2.8A		
10V	1.6A	4.2A		

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

CURRENT LIMIT

Proper operation requires the use of two current limit resistors, connected as shown in the external connection diagram. The minimum value for \mathbf{R}_{CL} is 0.12 ohm, however for optimum reliability it should be set as high as possible. Refer to the "General Operating Considerations" section of the handbook for current limit adjust details.

DEVICE MOUNTING

The case (mounting flange) is electrically isolated and should be mounted directly to a heatsink with thermal compound. Screws with Belville spring washers are recommended to maintain positive clamping pressure on heatsink mounting surfaces. Long periods of thermal cycling can loosen mounting screws and increase thermal resistance.

Since the case is electrically isolated (floating) with respect to the internal circuits it is recommended to connect it to common or other convenient AC ground potential.