



Power Booster Amplifier



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FEATURES

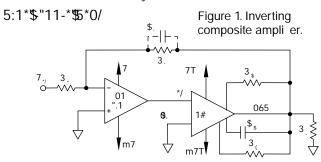
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The PB58 is a high voltage, high current amplifier designed to provide voltage and current gain for a small signal, general purpose op amp. Including the power booster within the feedback loop of the driver amplifier results in a composite amplifier with the accuracy of the driver and the extended output voltage range and current capability of the booster. The PB58 can also be used without a driver in some applications, requiring only an external current limit resistor to function properly.

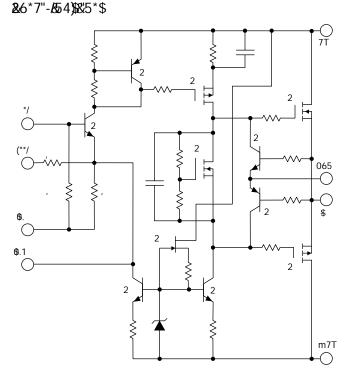
The output stage utilizes complementary MOSFETs, providing symmetrical output impedance and eliminating second breakdown limitations imposed by Bipolar Transistors. Internal feedback and gainset resistors are provided for a pin-strapable gain of 3. Additional gain can be achieved with a single external resistor. Compensation is not required for most driver/gain con gurations, but can be accomplished with a single external capacitor. Enormous exibility is provided through the choice of driver amplifier, current limit, supply voltage, voltage gain, and compensation.

This hybrid circuit utilizes a beryllia (BeO) substrate, thick Im 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 electrically isolated and hermetically sealed using one-shot resistance welding. The use of compressible isolation washers voids the warranty.

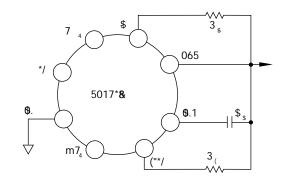




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PB58 • PB58A





-55 to +125°C

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SUPPLY VOLTAGE, $+V_S$ to $-V_S$ OUTPUT CURRENT, within SOA 300V 2.0A POWER DISSIPATION, internal at $T_c = 25^{\circ}C^1$ 83W INPUT VOLTAGE, referred to COM $\pm 15V$ TEMPERATURE, pin solder—10 sec max 300°C TEMPERATURE, junction1 175°C TEMPERATURE, storage -65 to +150°C

OPERATING TEMPERATURE RANGE, case

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PARAMETER	TEST CONDITIONS ²	MIN	PB58 TYP	MAX	MIN	PB58A TYP	MAX	UNITS
INPUT OFFSET VOLTAGE, initial OFFSET VOLTAGE, vs. temperature INPUT IMPEDANCE, DC INPUT CAPACITANCE	Full temperature range ³	25	±.75 -4.5 50 3	±1.75 -7	*	* * * *	±1.0 *	V mV/°C k pF
CLOSED LOOP GAIN RANGE GAIN ACCURACY, internal Rg, Rf GAIN ACCURACY, external Rf PHASE SHIFT	$A_{v} = 3$ $A_{v} = 10$ $f = 10kHz$, $AV_{CL} = 10$, $C_{C} = 22pF$ $f = 200kHz$, $AV_{CL} = 10$, $C_{C} = 22pF$	3	10 ±10 ±15 10 60	25 ±15 ±25	*	* * * * *	* *	% %
OUTPUT VOLTAGE SWING VOLTAGE SWING VOLTAGE SWING CURRENT, continuous SLEW RATE CAPACITIVE LOAD SETTLING TIME to .1% POWER BANDWIDTH SMALL SIGNAL BANDWIDTH SMALL SIGNAL BANDWIDTH	$\label{eq:continuous_problem} \begin{split} &\text{Io} = 1.5\text{A (PB58), 2A (PB58A)} \\ &\text{Io} = 1\text{A} \\ &\text{Io} = .1\text{A} \\ \end{split}$ Full temperature range Full temperature range $R_L = 100$, 2V step $V_C = 100$ Vpp $C_C = 100$ Vpp $C_C = 22$ pF, $A_V = 25$, Vcc = ± 100 $C_C = 22$ pF, $A_V = 3$, Vcc = ± 30	V _s -11 V _s -10 V _s -8 1.5 50	V _s -8 V _s -7 V _s -5 100 2200 2 320 100 1		V _S -15 * 2.0 75	V _S -11 * * * * * * * *		V V V A V/µs pF µs kHz kHz MHz
POWER SUPPLY VOLTAGE, ±V _S ⁴ CURRENT, quiescent	Full temperature range $V_S = \pm 15$ $V_S = \pm 60$ $V_S = \pm 150$	±156	±60 11 12 14	±150	*	* * *	*	V mA mA
THERMAL RESISTANCE, AC junction to case ⁵ RESISTANCE, DC junction to case RESISTANCE, junction to air TEMPERATURE RANGE, case	Full temp. range, f > 60Hz Full temp. range, f < 60Hz Full temperature range Meets full range speci cations	-25	1.2 1.6 30 25	1.3 1.8 85	*	* * * *	* *	°C/W °C/W °C/W

NOTES: *

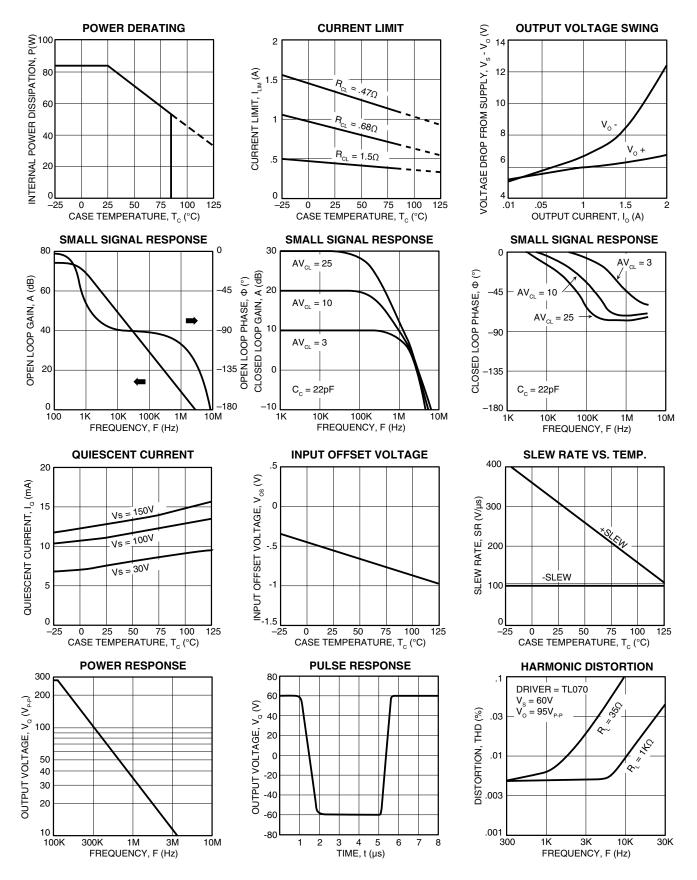
- The speci cation of PB58A is identical to the speci cation for PB58 in applicable column to the left.
- Long term operation at the maximum junction temperature will result in reduced product life. Derate internal power dissipation to achieve high MTTF (Mean Time to Failure).
- The power supply voltage specified under typical (TYP) applies, $T_c = 25$ °C unless otherwise noted.
- Guaranteed by design but not tested.
- 4. +V_s and -V_s denote the positive and negative supply rail respectively.
- 5. Raiting applies if the output current alternates between both output transistors at a rate faster than 60Hz.
- 6. +V_s/-V_s must be at least 15V above/below COM.

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The PB58 is constructed from MOSFET transistors. ESD handling procedures must be observed.

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.

PB58 • PB58A





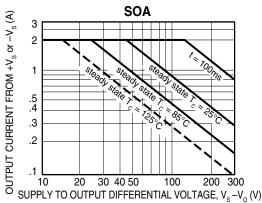


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Please read Application Note 1 "General Operating Considerations" which covers stability, supplies, heat sinking, mounting, current limit, SOA interpretation, and speci cation interpretation. Visit www.Cirrus.com for design tools that help automate 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.

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For proper operation, the current limit resistor ($R_{\rm cl}$) must be connected as shown in the external connection diagram. The minimum value is 0.33 with a maximum practical value of 47 . For optimum reliability the resistor value should be set as high as possible. The value is calculated as follows: $+I_{\rm l}=.65/R_{\rm cl}+.010$, $-I_{\rm l}=.65/R_{\rm cl}$.



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

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Cascading two ampli ers within a feedback loop has many advantages, but also requires careful consideration of several ampli er and system parameters. The most important of these are gain, stability, slew rate, and output swing of the driver. Operating the booster ampli er in higher gains results in a higher slew rate and lower output swing requirement for the driver, but makes stability more difficult to achieve.

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$$R_G = [(Av-1) \cdot 3.1K] - 6.2K$$

$$Av = \frac{R_G + 6.2K}{3.1K} + 1$$

The booster's closed-loop gain is given by the equation above. The composite ampli er's closed loop gain is determined by the feedback network, that is: -Rf/Ri (inverting) or 1+Rf/Ri (non-inverting). The driver ampli er's "effective gain" is equal to the composite gain divided by the booster gain.

Example: Inverting con guration (gure 1) with

R i = 2K, R f = 60K, R g = 0 :
Av (booster) =
$$(6.2K/3.1K) + 1 = 3$$

Av (composite) = $60K/2K = -30$
Av (driver) = $-30/3 = -10$

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Stability can be maximized by observing the following quidelines:

- 1. Operate the booster in the lowest practical gain.
- Operate the driver ampli er in the highest practical effective gain.
- 3. Keep gain-bandwidth product of the driver lower than the closed loop bandwidth of the booster.
- 4. Minimize phase shift within the loop.

A good compromise for (1) and (2) is to set booster gain from 3 to 10 with total (composite) gain at least a factor of 3 times booster gain. Guideline (3) implies compensating the driver as required in low composite gain con gurations. Phase shift within the loop (4) is minimized through use of booster and loop compensation capacitors Cc and Cf when required. Typical values are 5pF to 33pF.

Stability is the most difficult to achieve in a conguration where driver effective gain is unity (ie; total gain = booster gain). For this situation, Table 1 gives compensation values for optimum square wave response with the op amp drivers listed.

DRIVER	Ссн	C _F	C _c	FPBW	SR			
OP07	-	22p	22p	4kHz	1.5			
741	-	18p	10p	20kHz	7			
LF155	-	4.7p	10p	60kHz	>60			
LF156	-	4.7p	10p	80kHz	>60			
TL070	22p	15p	10p	80kHz	>60			
For: R _F = 33K, R _I = 3.3K, R _G = 22K								

Table 1: Typical values for case where op amp effective gain = 1.

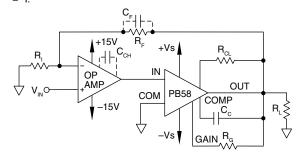


Figure 2. Non-inverting composite ampli er.

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The slew rate of the composite amplier is equal to the slew rate of the driver times the booster gain, with a maximum value equal to the booster slew rate.

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The maximum output voltage swing required from the driver op amp is equal to the maximum output swing from the booster divided by the booster gain. The Vos of the booster must also be supplied by the driver, and should be subtracted from the available swing range of the driver. Note also that effects of Vos drift and booster gain accuracy should be considered when calculating maximum available driver swing.

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For all Apex Precision Power product guestions and inquiries, call toll free 800-546-2739 in North America.

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