


PowerAmp Design

INDUSTRIAL INK JET PRINT HEAD DRIVER

PAD149

Rev G

KEY FEATURES

- LOW COST
- HIGH VOLTAGE – 200 VOLTS
- HIGH CURRENT – 10 AMPS
- 125 WATT DISSIPATION CAPABILITY
- 100kHz POWER BANDWIDTH
- SHORT CIRCUIT PROTECTION
- TEMPERATURE MONITORING
-  RoHS COMPLIANT
- CONFORMALLY COATED



PAD149

APPLICATIONS

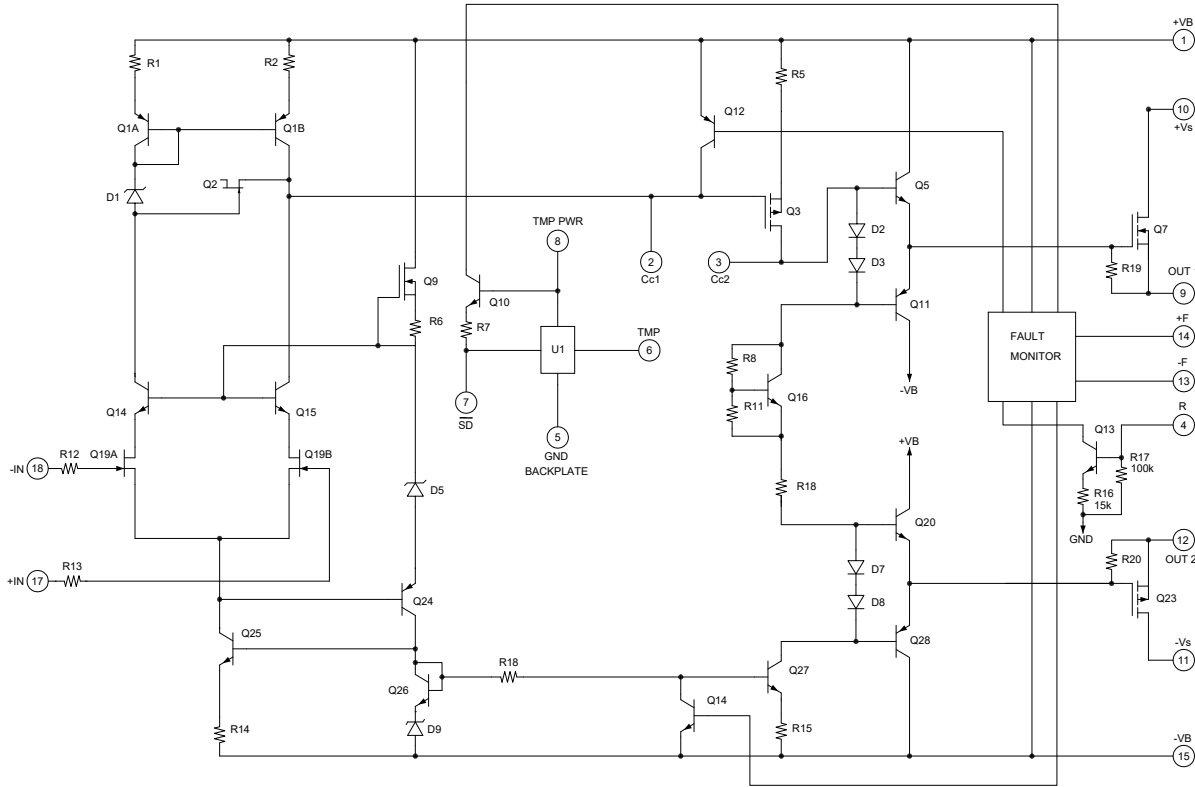
- INKJET PRINTER HEAD DRIVE
- PIEZO TRANSDUCER DRIVE
- INDUSTRIAL INSTRUMENTATION
- RELECTOMETERS

DESCRIPTION

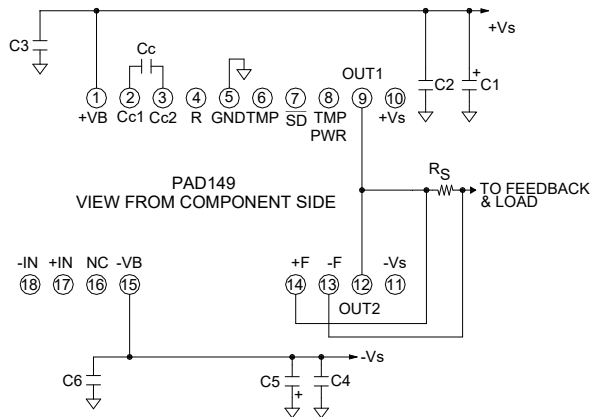
The PAD149 is a high voltage operational amplifier constructed with surface mount components to provide a cost-effective solution for many industrial applications and especially industrial ink jet head drive. With a footprint only 3.1in² the PAD149 offers outstanding performance that rivals more expensive hybrid component amplifiers. User selectable external compensation tailors the amplifier's response to the application requirements. An analog output voltage is provided that is proportional to the substrate temperature. The amplifier's output stage is shut down by pulling the shut down pin low or when the substrate temperature exceeds 110°C. A short circuit or over-current condition also shuts down the output stage. The amplifier circuitry is built on a thermally conductive but electrically insulating substrate. No BeO is used in the PAD149. The resulting module is a small, high-performance solution.

PowerAmp Design ♦ PAD149 ♦ INDUSTRIAL INK JET PRINT HEAD DRIVER

EQUIVALENT CIRCUIT



PINOUT & CONNECTIONS



NOTES:

1. Cc IS NPO (COG) RATED FOR FULL SUPPLY VOLTAGE +Vs TO -Vs
2. PINS 9 & 12 MUST BE TIED TOGETHER.
3. C1 AND C5 ELECTROLYTIC, 10uF PER AMP OUTPUT CURRENT
4. C2,3,4,6 HIGH QUALITY CERAMIC 0.1uF

ABSOLUTE MAXIMUM RATINGS

SUPPLY VOLTAGE, +Vs to -Vs	200V	TEMPERATURE, pin solder, 10s	237°C
BOOST VOLTAGE, V _B	±V _B ±20V	TEMPERATURE, junction ²	150°C
OUTPUT CURRENT, within SOA	12A	TEMPERATURE RANGE, storage	-40 to 105°C
POWER DISSIPATION, internal, DC	125W	OPERATING TEMPERATURE, case	-40 to 105°C
INPUT VOLTAGE, differential	± 20V	TMP PWR + 3.3 - +5V (pin 8)	+5.7V
INPUT VOLTAGE, common mode	±V _B		

PARAMETER	TEST CONDITIONS ¹	MIN	TYP	MAX	UNITS
INPUT					
OFFSET VOLTAGE			1	5	mV
OFFSET VOLTAGE vs. temperature	Full temperature range		20	50	μV/°C
OFFSET VOLTAGE vs. supply				20	μV/V
BIAS CURRENT, initial ³				100	pA
BIAS CURRENT vs. supply				0.1	pA/V
OFFSET CURRENT, initial				50	pA
INPUT RESISTANCE, DC			100		G Ω
INPUT CAPACITANCE			4		pF
COMMON MODE VOLTAGE RANGE				+V _B -12	V
COMMON MODE VOLTAGE RANGE				-V _B +7	V
COMMON MODE REJECTION, DC		98	106		dB
NOISE	100kHz bandwidth, 1kΩ R _s		10		μV RMS
FAULT SENSING INPUTS					
R (RESET), 15μs min width, 2μs max rise	Relative to GND	3.2		5.5	V
+F		-V _s		+V _s	V
-F		-V _s		+V _s	V
+F TO -F	Differential voltage, shutdown		±0.60		V
\overline{SD}	<0.2V to insure shutdown	0		TMP PWR	V
GAIN					
OPEN LOOP	R _L = 10kΩ, C _c =10pF	108			dB
GAIN BANDWIDTH PRODUCT @ 1MHz	C _c =10pF		10		MHz
PHASE MARGIN	Full temperature range	45	60		degree
OUTPUT					
VOLTAGE SWING	I _o = 10A	±Vs-10	+Vs-8.6		V
VOLTAGE SWING	I _o = -10A	-Vs+10	-Vs+7		V
VOLTAGE SWING	+V _B = +Vs+10V, I _o = 10A	+Vs-1.6	+Vs-1.2		
VOLTAGE SWING	-V _B = -Vs-10V, I _o = -10A	-Vs-5.1	+Vs+4.1		
CURRENT, continuous, DC		10			A
SLEW RATE, A _v = -10	C _c = 10pF	65	85		V/μs
SETTLING TIME, to 0.1%	2V Step, C _c = 10pF		1		μs
RESISTANCE, open loop	No load, DC		4		Ω
POWER BANDWIDTH, 180V _{p-p}	C _c = 10pF		150		kHz
POWER SUPPLY					
VOLTAGE ⁴	+/-V _B or +/-VS	± 15	± 75	± 100	V
CURRENT, quiescent			21	25	mA
TMP PWR (quiescent current 40uA)	Pin 8	3.2		5.7	V
THERMAL					
RESISTANCE, AC, junction to case ⁵	Full temperature range, f ≥ 60Hz			0.8	°C/W
RESISTANCE, DC junction to case	Full temperature range			1.0	°C/W
RESISTANCE, DC junction to air	Full temperature range			13	°C/W
TEMPERATURE RANGE, case		-40		105	°C

NOTES:

1. Unless otherwise noted: T_c = 25°C, compensation C_c = 100pF, DC input specifications are ± value given, power supply voltage is typical rating.
2. Derate internal power dissipation to achieve high MTBF.
3. Doubles for every 10°C of case temperature increase.
4. +Vs and -Vs denote the positive and negative supply voltages to the output stage. +V_B and -V_B denote the positive and negative supply voltages to the input stages.
5. Rating applies if the output current alternates between both output transistors at a rate faster than 60Hz.
7. Power supply voltages +V_B and -V_B must not be less than +Vs and -Vs respectively. Total voltage +V_B to -V_B 240V maximum.
8. The PAD149 is constructed with MOSFET transistors and ESD handling procedures must be observed.

SAFETY FIRST

The operating voltages of the PAD149 are potentially deadly. When developing an application circuit, it is wise to begin with power supply voltages as low as possible while checking for circuit functionality. Increase supply voltages slowly as confidence in the application circuit increases. Always use a “hands off” method whereby test equipment probes are attached only when power is off.

OVER-CURRENT FAULT PROTECTION

The output stage of the PAD149 is shut down when an over-current fault is detected. The protection circuit monitors the voltage across an external sense resistor, R_s . The fault condition set point is programmed by:

$$I_F = 0.6V/RS$$

Where I_F is the value of the fault current set point and RS is the value of the sense resistor.

Whenever the programmed current set point is exceeded for more than 10 μ S (typical) the drive to the output stage turns off completely (typically in less than 10 μ S), and remains off until the circuit is reset (pin 4, R) via a 5V momentary pulse $\geq 15\mu$ S (or power recycled). The internal sense voltage is approximately 0.6V and decreases about 2.2mV/ °C of substrate temperature rise. For some loads a start-up current may exceed the normal programmed maximum value. This condition should be considered when setting the programmed fault value. See Figure 1, below, for a typical over-current fault connection diagram.

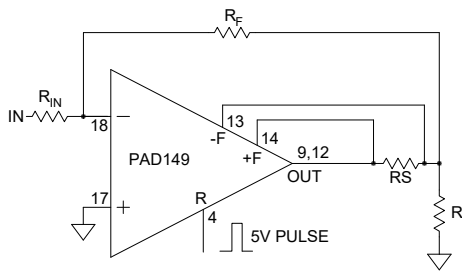


Figure 1

MOUNTING THE AMPLIFIER

In most applications the amplifier must be attached to a heat sink. Spread a thin and even coat of heat sink grease across the back of the PAD149 and also the heat sink where the amplifier is to be mounted. Push the amplifier into the heat sink grease on the heat sink while slightly twisting the amplifier back and forth a few times to bed the amplifier into the heat sink grease. On the final twist align the mounting holes of the amplifier

with the mounting holes in the heat sink and finish the mounting using 4-40 hex male-female spacers. Mount the amplifier to the mother board with 4-40 X 1/4” screws.

PHASE COMPENSATION

The PAD149 **must** be phase compensated. The compensation capacitor, C_C , is connected between pins 2 and 3. The compensation capacitor must be an NPO type capacitor rated for the full supply voltage (200V). On page 2, under *Amplifier Pinout and Connections*, you will find a table that gives recommended compensation capacitance value for various circuit gains and the resulting slew rate for each capacitor value. Consult also the small signal response and phase response plots for the selected compensation value in the Typical Performance Graphs section. Do not use a compensation capacitor less than 10pF.

TEMPERATURE REPORTING

An analog output voltage is provided (pin 6, TMP) relative to ground (PIN 5) and proportional to the temperature in degrees C. The slope is approximately -10.82mV/°C. The output voltage follows the equation:

$$T = (2.127 - V) (92.42)$$

or

$$V = 2.127 - (T/92.42)$$

Where V is the TMP output voltage and T is the substrate temperature in degrees C.

THERMAL SHUTDOWN

The temperature monitoring circuit automatically turns off the output transistors when the substrate temperature reaches 110°C. The output remains disabled until the substrate temperature falls below 100°C and the circuit is reset (R, pin 4). The thermal shutdown feature is activated by amplifier thermal overload such as sustained high power dissipation or inadequate heat sinking.

EXTERNAL SHUTDOWN

When pin 7 (\overline{SD}) is taken low (GND) the output stage is turned off and remains off until reset pulse at pin 4 (R) is applied, or power to the amplifier is restarted. If the \overline{SD} pin is monitored with a high impedance circuit (>100k input impedance) it also gives an indication of the temperature status of the amplifier. A "high" indicates normal temperature operation and a "low" (zero volts, approximately) indicates that the amplifier is shut down due to the occurrence of an over-temp condition. A "high" will be the approximately the same voltage as TEMP PWR (pin 8). See Figure 4 in Applications, page 10, for external shutdown circuits.

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SINGLE HIGH POWER SUPPLY OPERATION

The small signal stages of the PAD149 are connected in such a way that the output stage can be powered by a single high-power supply voltage. $-V_B$ needs to be connected to a negative voltage so that the amplifier's input common mode voltage conditions are satisfied. But the output stage can be connected between ground at $-V_S$ and a high voltage supply at $+V_S$. The amplifier is then biased so that the amplifier's output stage can swing close to ground. This technique is often used to operate the amplifier with only a single high current power supply, thus reducing the system size and cost. See Figure 2 below.

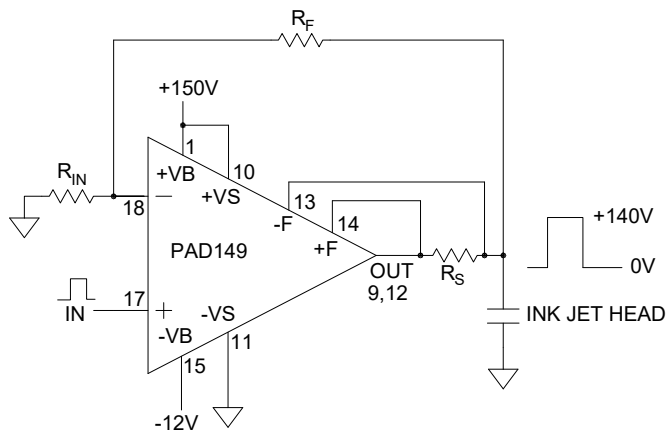
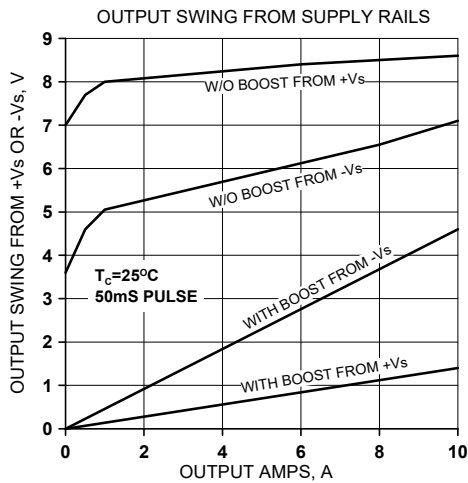
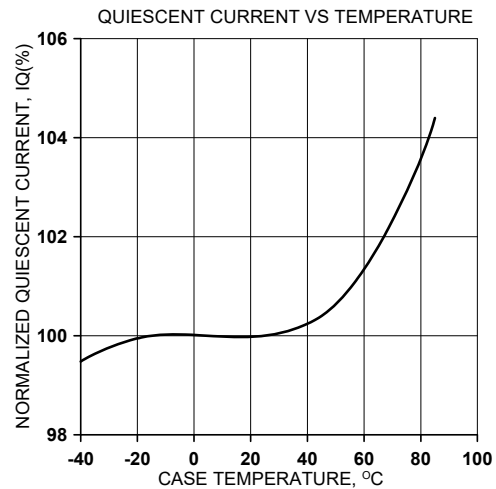
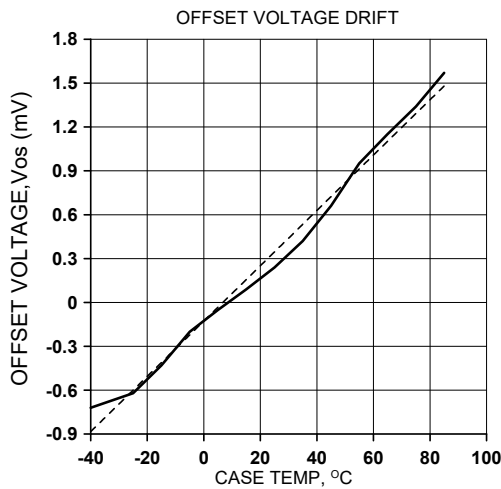
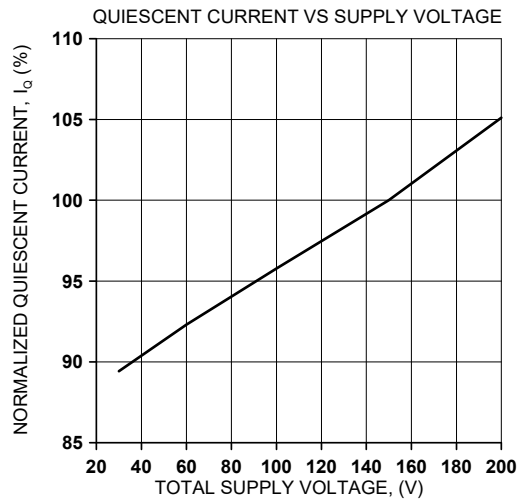
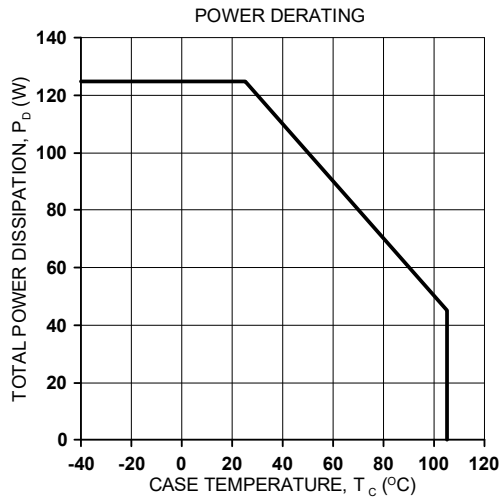
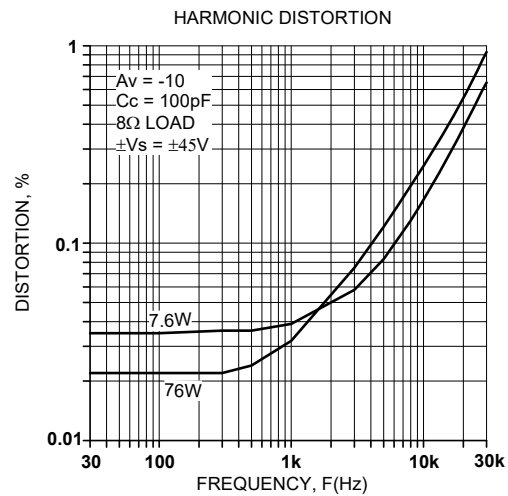
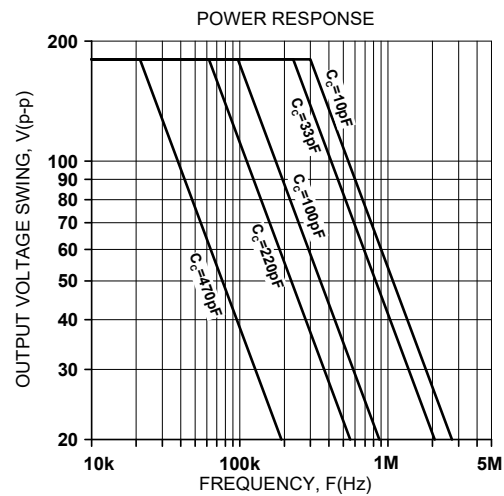
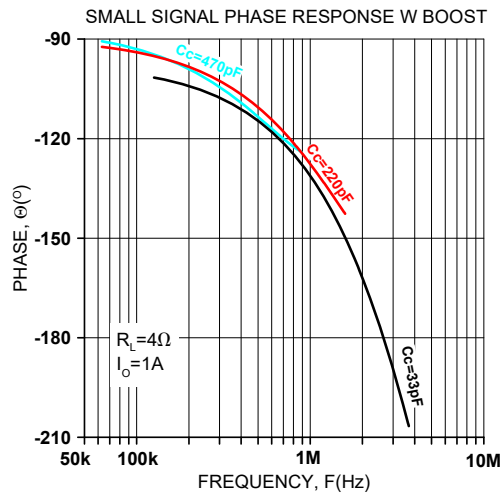
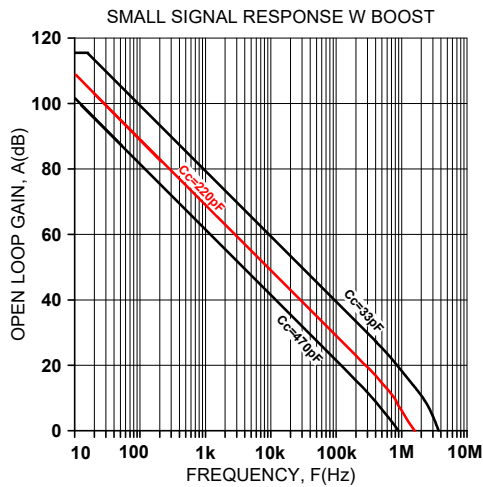
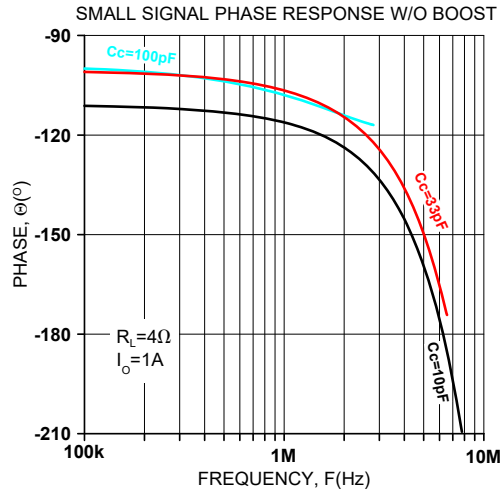
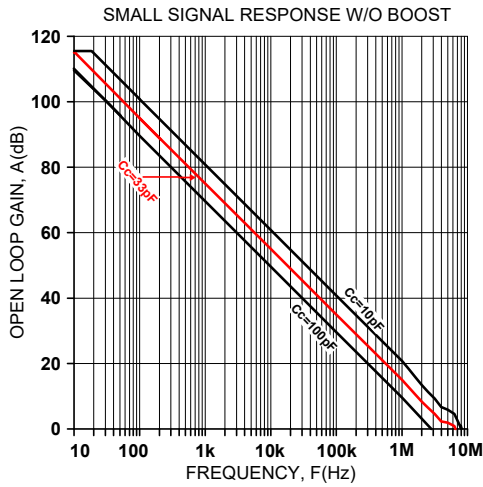
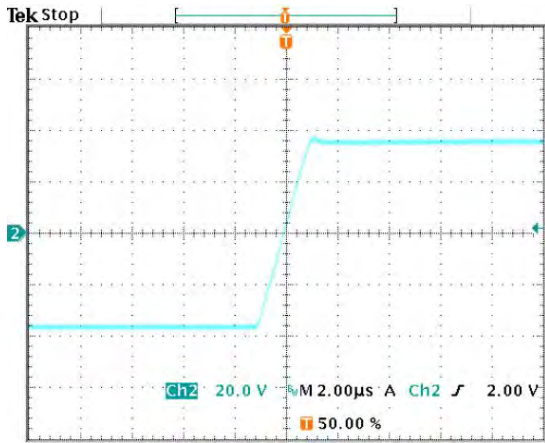


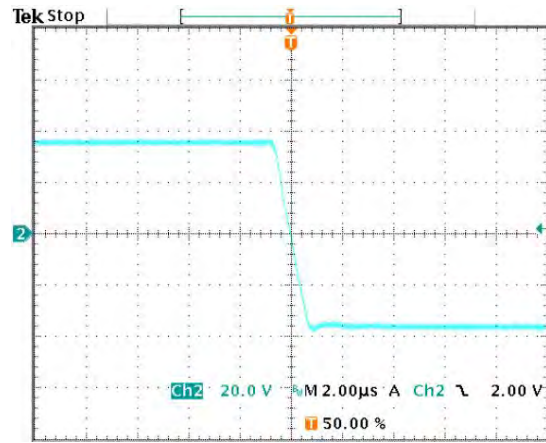
Figure 2
TYPICAL SINGLE HIGH POWER SUPPLY CONNECTION



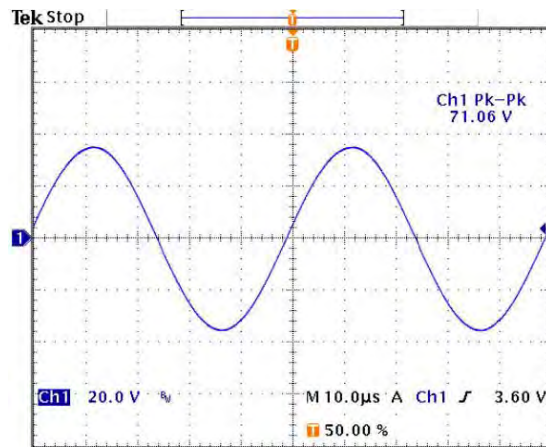




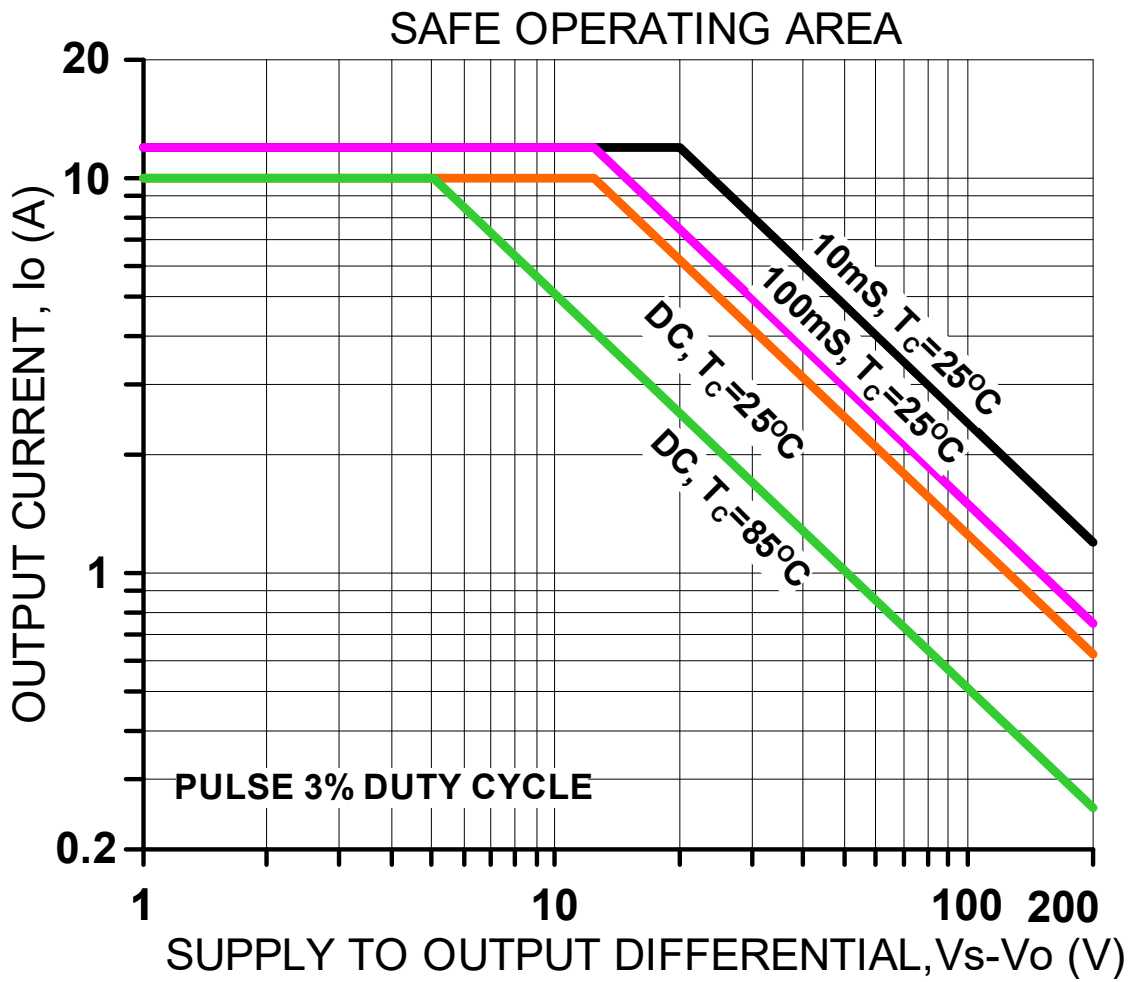
Pos. Pulse response, $G=-10$, $C_c=100\text{pF}$, 47nF load



Neg. Pulse response, $G=-10$, $C_c=100\text{pF}$, 47nF load



20kHz sine into 8Ω load, $G=-10$, $C_c=100\text{pF}$



SAFE OPERATING AREA

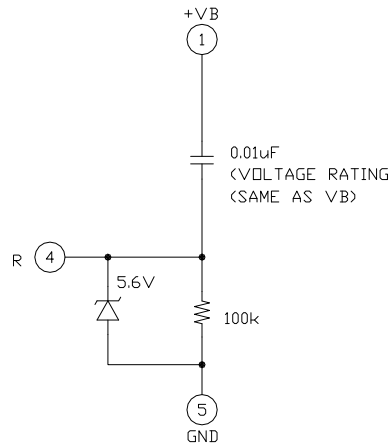


Figure 3
Power-up Reset

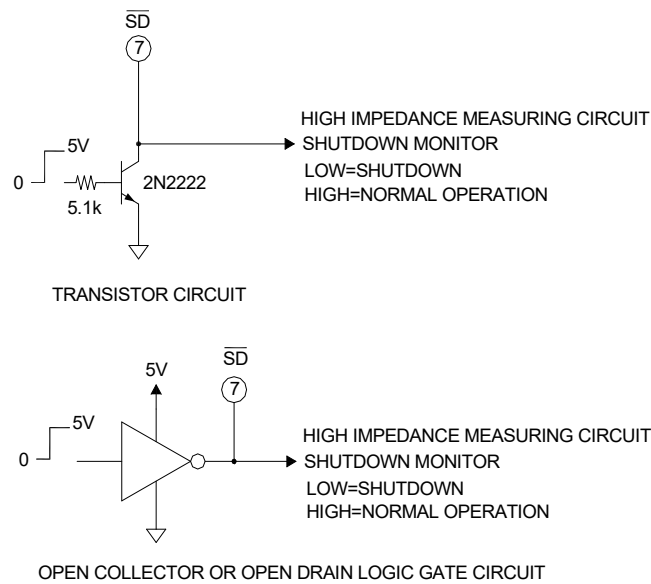
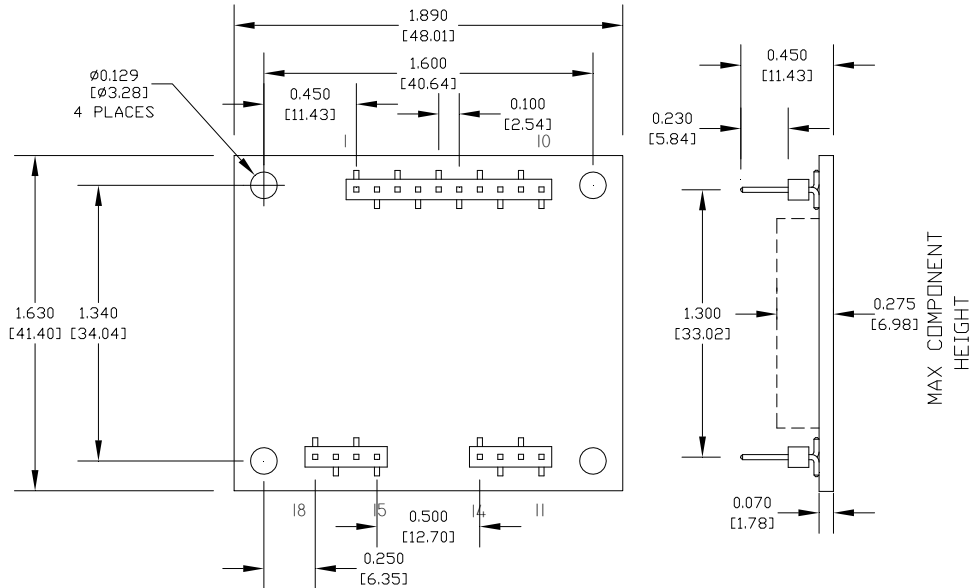


Figure 4
External Shutdown Circuits



- NOTES: 1: DIMENSIONS ARE INCHES, [mm]
 2: PINS 0.025" SQUARE [0.635mm], GOLD PLATED, 0.1" PITCH
 3: RECOMMENDED HOLE FOR MOUNTING 0.129" D. x2 [3.277mm]
 4: RECOMMENDED HOLE FOR PINS 0.052" D. [1.321mm]
 5: HIGHLY RECOMMENDED THAT AMPLIFIER IS MOUNTED INTO CAGE JACKS USING PAD PART NUMBER CJS01. USE 0.062" [1.575mm] HOLE FOR CAGE JACKS.
 6: HIGHLY RECOMMENDED THAT AMPLIFIER IS MOUNTED INTO HEAT SINK WITH 4-40 M/F SPACERS TO PROVIDE STRAIN RELIEF FOR PINS. SEE DRAWING BELOW.

