PowerAmp Design

COMPACT HIGH VOLTAGE OP AMP — PAD04

Advance Information — ***Rev A***

KEY FEATURES

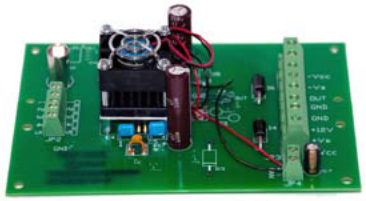
- **LOW COST**
- **SMALL SIZE – 30mm SQUARE**
- **HIGH VOLTAGE – 200 VOLTS**
- **HIGH OUTPUT CURRENT – 10A PEAK**
- **30 WATT DISSIPATION CAPABILITY**
- **200V/µS SLEW RATE**
- **Pb RoHS COMPLIANT**

PAD04

PAD04-1

APPLICATIONS

- **INDUSTRIAL INK JET PRINT HEADS**
- **HIGH VOLTAGE INSTRUMENTATION**
- **PIEZO TRANSDUCER DRIVE**
- **LCD PANEL TESTING**



PAD04 MOUNTED IN EVAL04 EVALUATION KIT

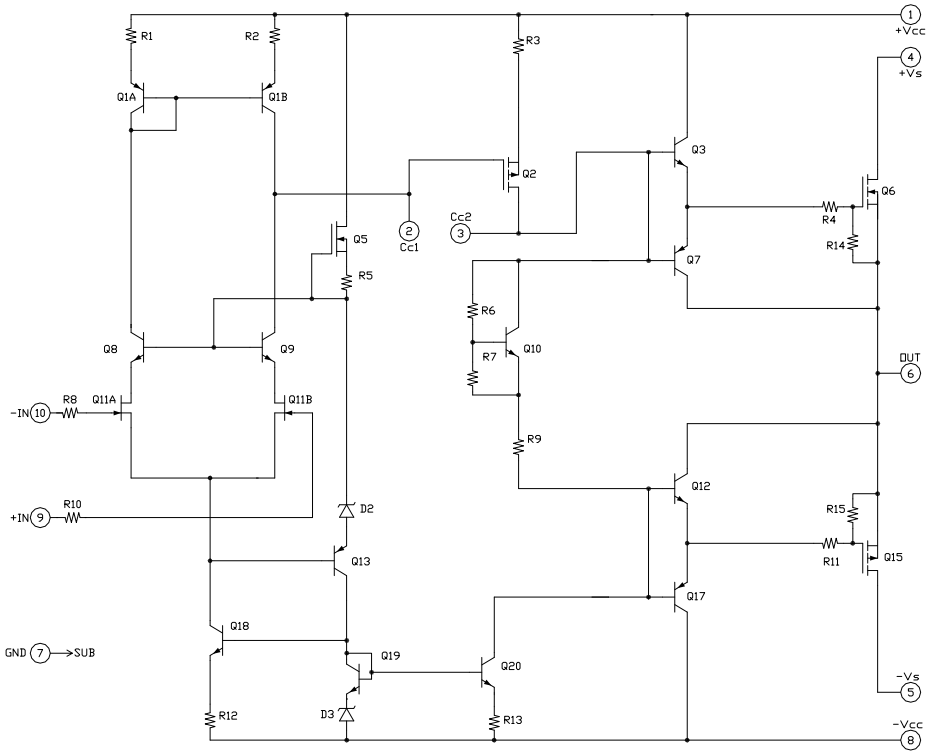
DESCRIPTION

The PAD04 compact high voltage op amp is constructed with surface mount components to provide a cost-effective solution for many industrial applications such as an ink jet print head driver. With a footprint only 30mm square the PAD04 offers outstanding performance that rivals more expensive hybrid components. An integrated heat sink and fan cooling are included. User selectable external compensation tailors the amplifier's response to the application requirements. The PAD04 is capable of driving 150V pulses into 47nF at 50 kHz with a duty cycle of 40% and a slew rate of 200V/µS. The PAD04 is built on a thermally conductive but electrically insulating substrate. No BeO is used in the PAD04. For custom applications the PAD04-1 version of the amplifier is available without the integrated heat sink and fan capable of higher power dissipation with a properly rated heat sink.

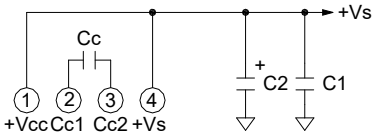
A NEW CONCEPT

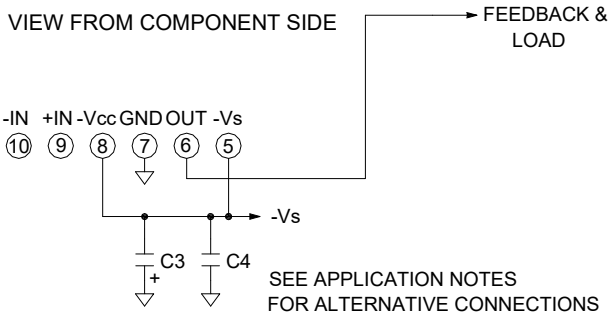
A critical task in any power amplifier application is cooling the amplifier. Until now component amplifier manufacturers often treated this task as an after-thought, left for the user to figure out. At **Power Amp Design** the best heat sink and fan is chosen at the start and becomes an integral part of the overall amplifier design. The result is the most compact and volumetric efficient design combination at the lowest cost. In addition, this integrated solution concept offers an achievable real-world power dissipation rating, not the ideal rating usually cited when the amplifier case is somehow kept at 25°C. The user no longer needs to specify, procure or assemble separate components.

EQUIVALENT CIRCUIT



PINOUT & CONNECTIONS





PHASE COMPENSATION		SLEW RATE
GAIN	Cc	
≥20	10pF	200V/uS
≥10	22pF	150V/uS
≥6	47pF	80V/uS
≥1	150pF	25V/uS

ABSOLUTE MAXIMUM RATINGS

SUPPLY VOLTAGE, +Vs to −Vs[4]	200V	TEMPERATURE, pin solder	10s, 300°C
SUPPLY VOLTAGE, +Vcc to −Vcc[4]	200V	TEMPERATURE, junction[2]	150°C
INPUT VOLTAGE	+Vcc to −Vcc	TEMPERATURE RANGE, storage	−40 to 70°C[5]
DIFFERENTIAL INPUT VOLTAGE	± 20V	TEMPERATURE RANGE, storage, PAD04-1	105C
OUTPUT CURRENT, peak, within SOA	10A	OPERATING TEMPERATURE, substrate	−40 to 85°C
POWER DISSIPATION, internal, DC	30W		

PARAMETER	TEST CONDITIONS[1]	MIN	TYP	MAX	PAD04-1[9]	UNITS
INPUT						
OFFSET VOLTAGE			1	5		mV
OFFSET VOLTAGE vs. temperature	Full temperature range		20	50		µV/°C
OFFSET VOLTAGE vs. supply				3		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				+Vs−15		V
COMMON MODE VOLTAGE RANGE				−Vs+8		V
COMMON MODE REJECTION, DC		110	118			dB
NOISE	100kHz bandwidth, 1kΩ R_S		10			µV RMS
GAIN						
OPEN LOOP	R_L= 10kΩ, C_C=10pF	108				dB
GAIN BANDWIDTH PRODUCT @ 1MHz	C_C=10pF		4			MHz
PHASE MARGIN	Full temperature range	60				degree
OUTPUT						
VOLTAGE SWING	I_O = 5A	+Vs−8	+Vs−6.5			V
VOLTAGE SWING	I_O = −5A	−Vs+8	−Vs+6.5			V
CURRENT, continuous, DC				5		A
CURRENT, pulse, ≤10mS, within SOA				10		A
SLEW RATE, A_V = +65	C_C = 10pF		200			V/µS
SETTLING TIME, to 0.1%	2V Step, C_C = 10pF		4			µS
RESISTANCE	No load, DC, OPEN LOOP		8			Ω
POWER SUPPLY						
VOLTAGE		± 15	± 75	± 100		V
CURRENT, quiescent			29	32		mA
THERMAL						
RESISTANCE, AC, junction to air or case[6]	Full temperature range, f ≥ 60Hz			2.1 to air	1.7 to case	°C/W
RESISTANCE, DC junction to air or case	Full temperature range			3.1 to air	2.5 to case	°C/W
TEMPERATURE RANGE, substrate		−40		85	85	°C
TEMPERATURE RANGE, ambient[5]		−40		70	NA	°C
FAN, 30mm dc brushless, ball bearing						
OPERATING VOLTAGE			12		NA	V
OPERATING CURRENT			50		NA	mA
AIR FLOW			7.5		NA	CFM
RPM			7000		NA	RPM
NOISE			30		NA	dB
L10, life expectancy, 50°C[8]			45		NA	kHrs
L10, life expectancy, 25°C[8]			60		NA	kHrs

NOTES:
1. Unless otherwise noted: T_C = 25°C, compensation Cc = 150pF, 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. +Vcc and –Vcc denote the positive and negative supply voltages to the small signal stages. +Vcc and –Vcc may not be more than + and – 20V greater than +Vs and –Vs respectively.
5. Limited by fan characteristics. During operation, even though the heat sink may be at 85°C the fan will be at a lower temperature.
6. Rating applies if the output current alternates between both output transistors at a rate faster than 60Hz.
7. Power supply voltages +Vcc and −Vcc must not be less than +Vs and −Vs respectively. Total voltage +Vcc to −Vcc 200V maximum.
8. L10 refers to the time it takes for 10% of a population of fans to fail. Lower ambient temperature increases fan life.
9. Specifications for the PAD04-1 are the same as for the PAD04 except as shown in this column.

SAFETY FIRST

The operating voltages of the PAD04 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.

COOLING FAN

The PAD04 relies on its fan for proper cooling of the amplifier. Make sure that air flow from the fan and to the heat sink remains unobstructed. Air is drawn into the heat sink fin area and exhausted via the fan out of the top of the amplifier assembly. To eliminate electrical noise created by the cooling fan we recommend a 47µF capacitor placed directly at the point where the fan wires connect to the PCB. See application note AN-24 for further details.

MOUNTING THE PAD04 AMPLIFIER

The amplifier is supplied with four 4-40 M/F hex spacers at the four corners of the amplifier. Once the amplifier is seated, secure the module with the provided 4-40 nuts and torque to 4.7 in lb [53 N cm] max. See "**Dimensional Information**" for a detailed drawing. It is recommended that the heat sink be grounded to the system ground. This can easily be done by providing a grounded circuit board pad around any of the holes for the mounting studs. In addition, it is important that the ground at pin 7 of the PAD04 be connected to the ground plane with a very short wide trace.

MOUNTING THE PAD04-1 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 PAD04-1 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 X 3/16" hex male-female spacers and torque to 4.7 in oz [3.8 N cm] max. Mount the amplifier to the mother board with 4-40 X 1/4" screws. See Dimensional Information for additional recommendations.

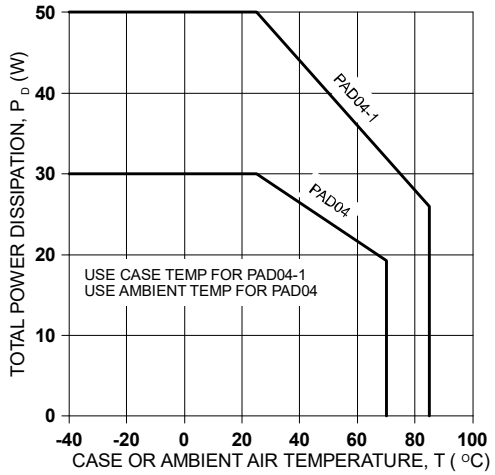
PHASE COMPENSATION

The PAD04 **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. A compensation capacitor less than 10pF is not recommended.

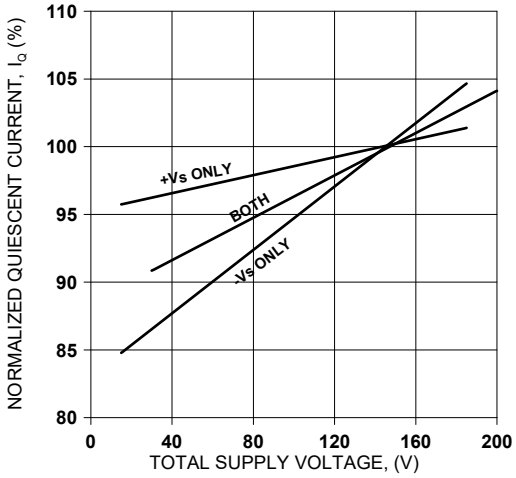
SINGLE HIGH-CURRENT SUPPLY OPERATION

It is often desirable to operate the PAD04 with a single high-current power supply as this reduces system cost. Figure 2 in the application circuits section shows one way to do this. See also application note AN-46 which details an application for driving ink jet print heads.

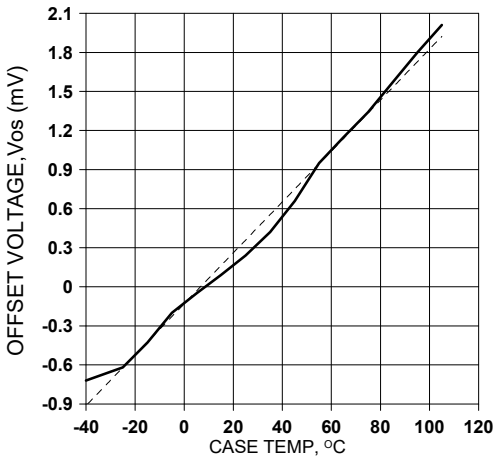
POWER DERATING



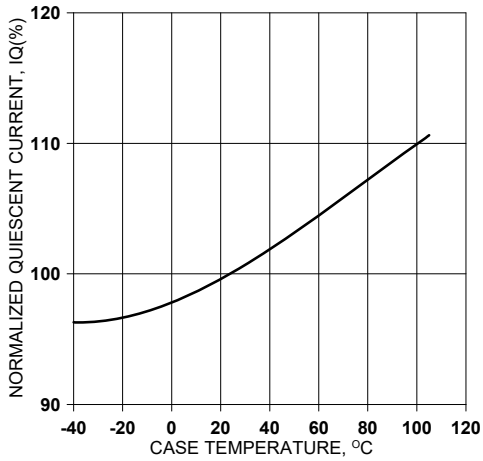
QUIESCENT CURRENT VS SUPPLY VOLTAGE



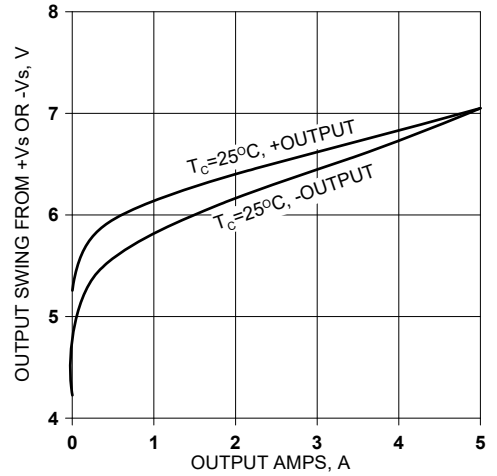
OFFSET VOLTAGE DRIFT



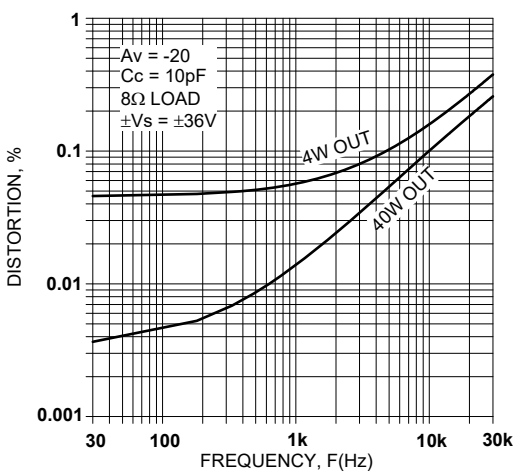
QUIESCENT CURRENT VS TEMPERATURE



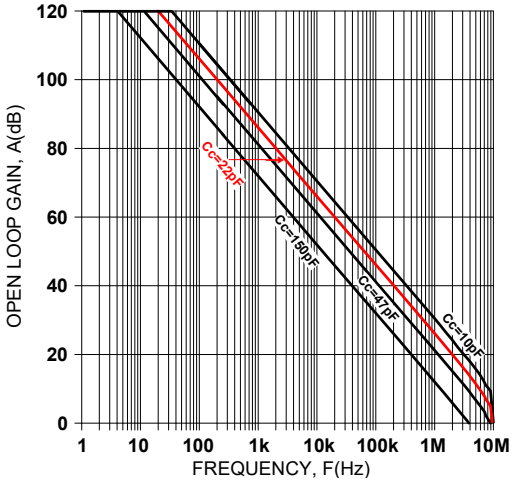
OUTPUT SWING FROM SUPPLY RAILS



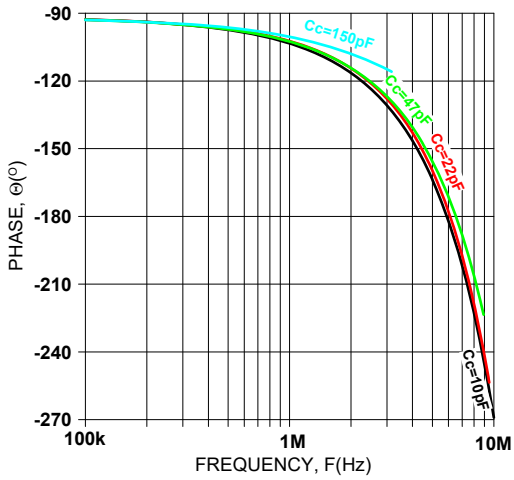
HARMONIC DISTORTION



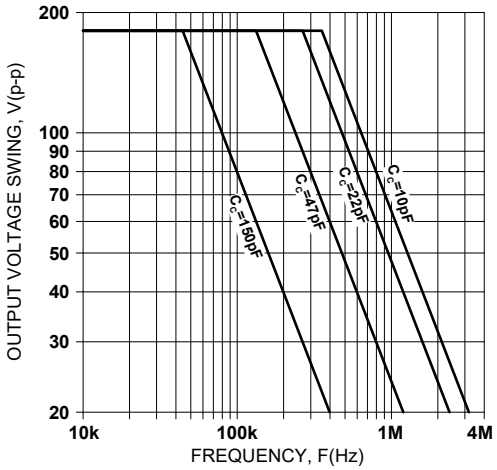
SMALL SIGNAL RESPONSE



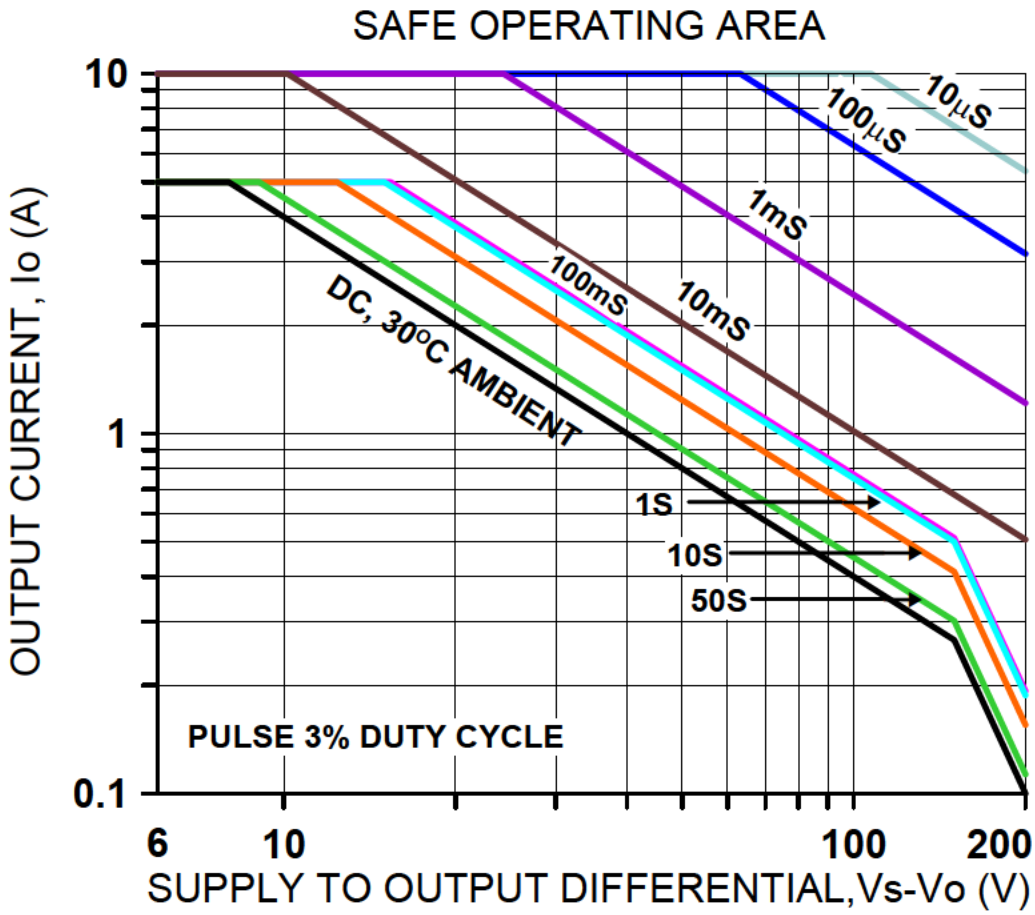
SMALL SIGNAL PHASE RESPONSE



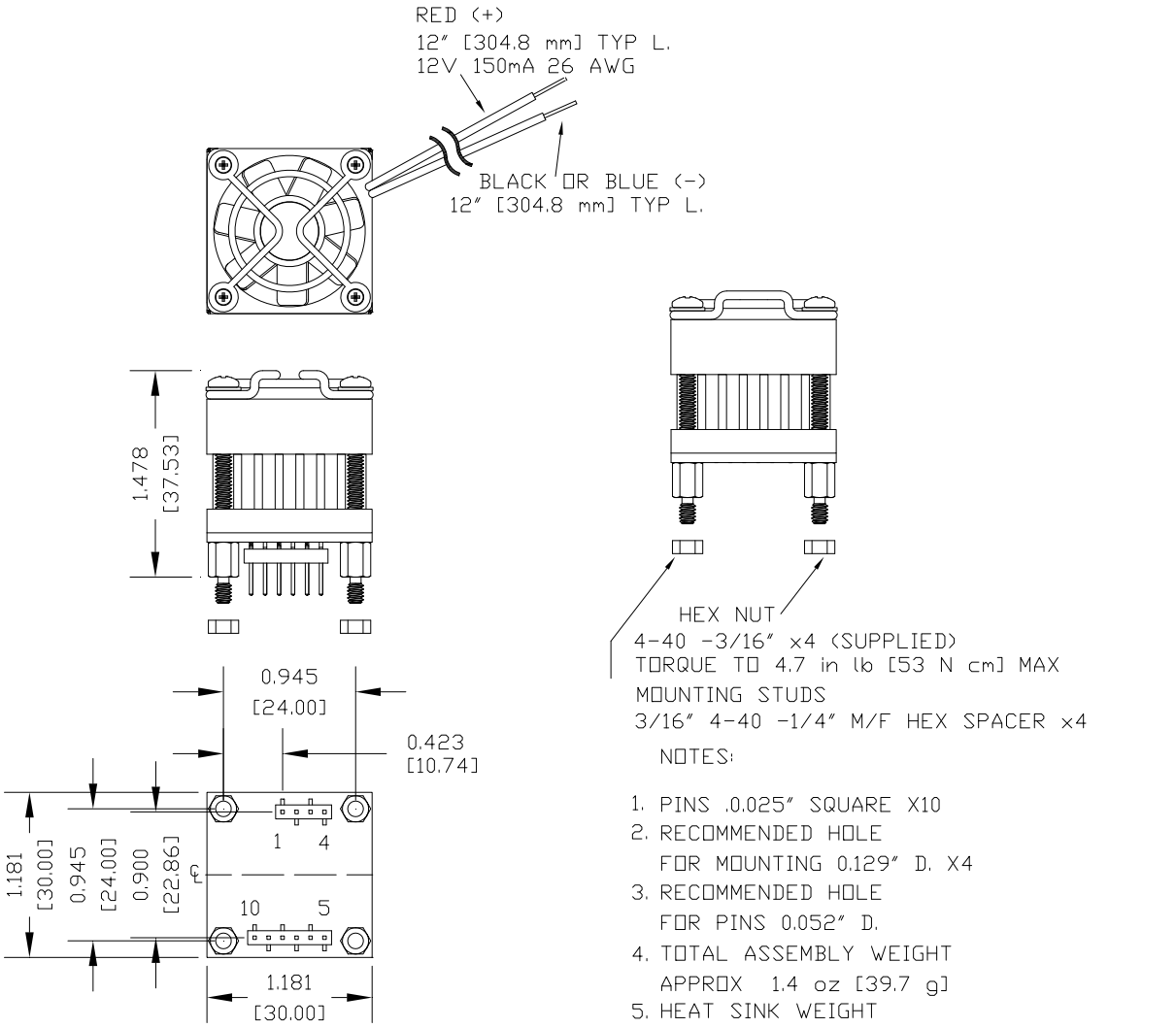
POWER RESPONSE



PowerAmp Design ♦ PAD04 ♦ COMPACT HIGH VOLTAGE OP AMP

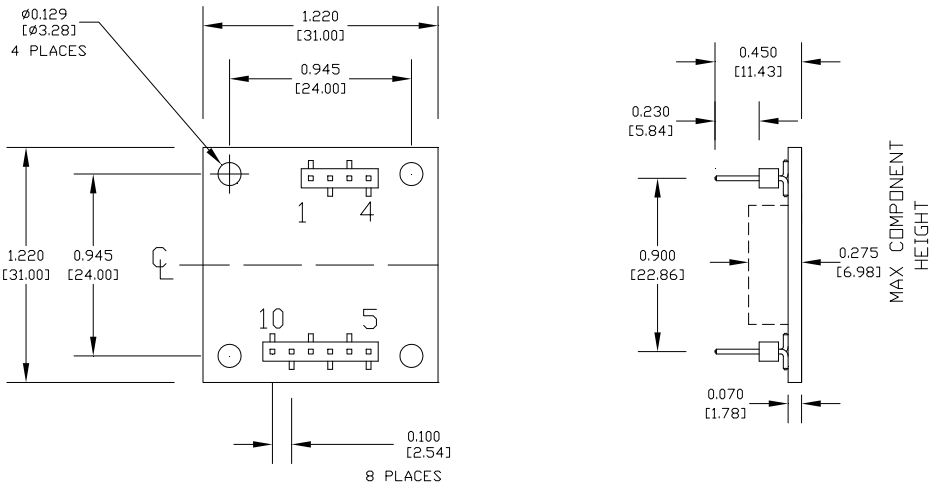


SAFE OPERATING AREA

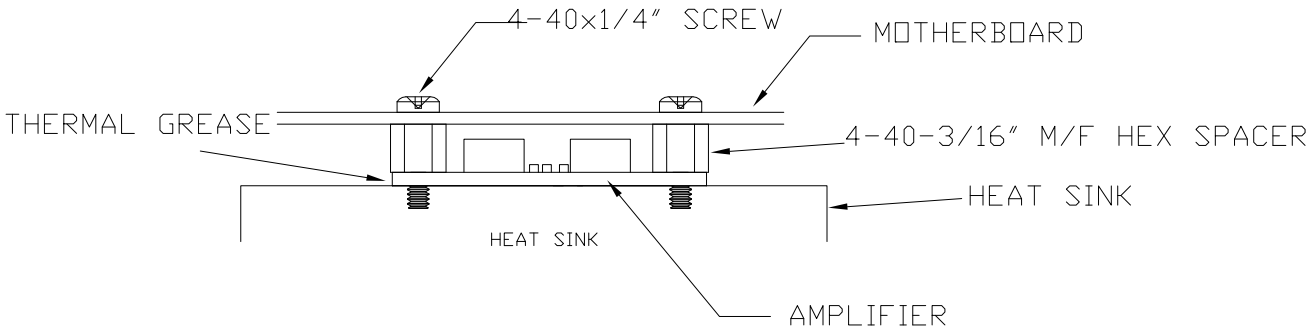


NOTES:

1. PINS .0.025" SQUARE X10
2. RECOMMENDED HOLE FOR MOUNTING 0.129" D. X4
3. RECOMMENDED HOLE FOR PINS 0.052" D.
4. TOTAL ASSEMBLY WEIGHT APPROX 1.4 oz [39.7 g]
5. HEAT SINK WEIGHT APPROX 0.26 oz [7.4 g]
6. SEE ALSO CAGE JACK ACCESSORY CJS01 FOR A SOCKET ALTERNATIVE FOR MOUNTING



NOTES: 1: DIMENSIONS ARE INCHES, [mm]
2: PINS 0.025" SQUARE [0.635mm], GOLD PLATED
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.
7: PRODUCT WEIGHT APPROXIMATELY 6g



PAD04-1

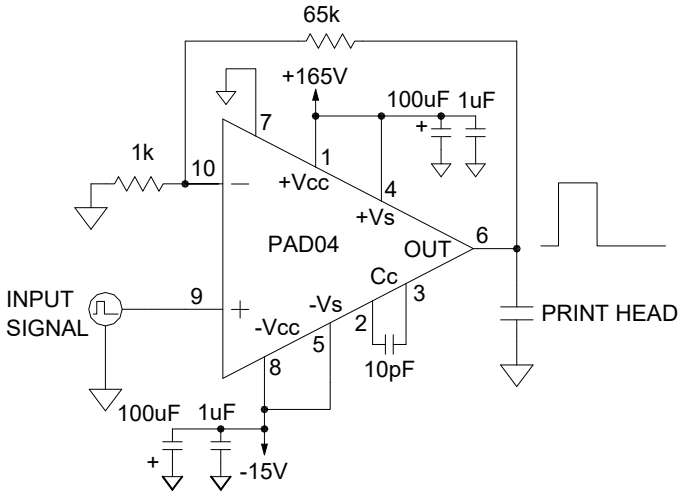


FIGURE 1.
TYPICAL DUAL SUPPLY PRINT HEAD DRIVE CIRCUIT

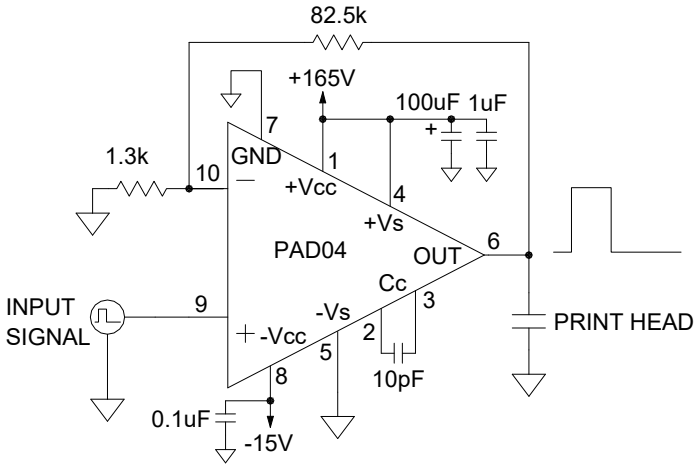


FIGURE 2.
SINGLE HIGH-CURRENT POWER SUPPLY PRINT HEAD DRIVE CIRCUIT