


PowerAmp Design

COMPACT SINGLE SUPPLY POWER OP AMP

PAD141

Rev D

KEY FEATURES

- LOW COST
- SINGLE SUPPLY OPERATION
- SMALL SIZE 40mm SQUARE
- HIGH VOLTAGE – 100 VOLTS
- HIGH OUTPUT CURRENT – 10A
- 75 WATT DISSIPATION - PAD141
- 125 WATT DISSIPATION – PAD141-1
- 7V/ μ S SLEW RATE
- PROGRAMMABLE CURRENT LIMIT
-  RoHS COMPLIANT

APPLICATIONS

- HIGH VOLTAGE INSTRUMENTATION
- BRUSH MOTOR DRIVE
- SINGLE SUPPLY APPLICATIONS

DESCRIPTION

The PAD141 compact single supply power op amp is constructed with surface mount components to provide a cost effective solution for many industrial applications. With a footprint only 40mm square the PAD141 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 input common mode range includes ground making the PAD141 suitable for applications with a single supply voltage. The output voltage can swing to within 1V of the negative supply voltage (usually ground) at 10A output. The PAD141 is built on a thermally conductive but electrically insulating substrate. No BeO is used in the PAD141. For custom applications the PAD141-1 version of the amplifier is available without the integrated heat sink and fan. RoHS Compliant.



PAD141



PAD141-1



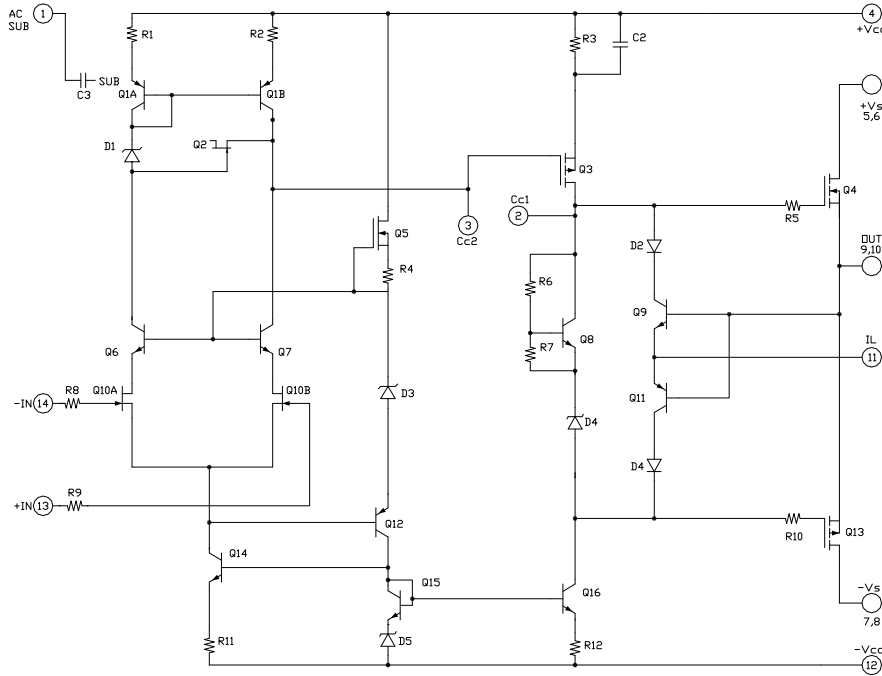
PAD141 MOUNTED IN EVAL138 EVALUATION KIT

A NEW CONCEPT

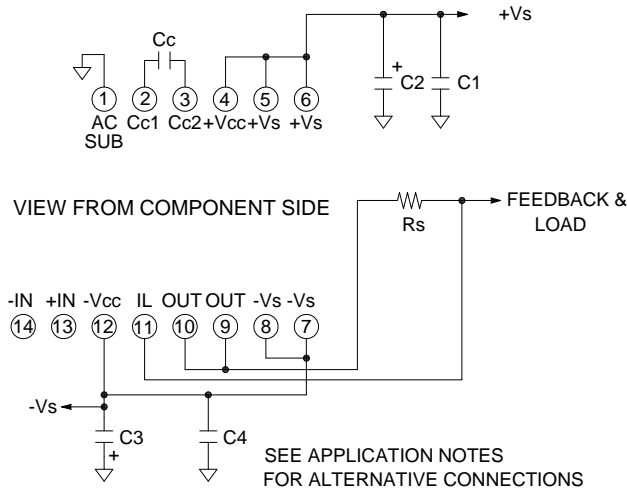
A critical task in any power amplifier application is cooling the amplifier. Until now component amplifier manufacturers often treated this task as an after-thought, left for the user to figure out. At **Power Amp Design** the best heat sink and fan is chosen at the start and becomes an integral part 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.

PowerAmp Design ♦ PAD141 ♦ COMPACT SINGLE SUPPLY POWER OP AMP

EQUIVALENT CIRCUIT



PINOUT & CONNECTIONS



PHASE COMPENSATION		SLEW RATE
GAIN	Cc	
1	100pF	3V/uS
≥ 3	47pF	7V/uS

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ABSOLUTE MAXIMUM RATINGS			
SUPPLY VOLTAGE, +Vs to -Vs ⁴	100V	TEMPERATURE, pin solder,	10s, 300°C
SUPPLY VOLTAGE, +Vcc to -Vcc ⁴	100V	TEMPERATURE, junction ²	150°C
INPUT VOLTAGE +Vcc to -Vcc		TEMPERATURE RANGE, storage	-40 to 80°C ⁵
DIFFERENTIAL INPUT VOLTAGE	± 20V	TEMPERATURE RANGE, storage, PAD141-1	105C
OUTPUT CURRENT, peak, within SOA	15A	OPERATING TEMPERATURE, substrate	-40 to 85°C
POWER DISSIPATION, internal, DC, PAD141	75W	POWER DISSIPATION, internal, DC, PAD141-1	125W

PARAMETER	TEST CONDITIONS ¹	MIN	TYP	MAX	PAD141-1 ⁹	UNITS
INPUT						
OFFSET VOLTAGE			1	3		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-10		V
COMMON MODE VOLTAGE RANGE			-Vs	-Vs-4		V
COMMON MODE REJECTION, DC		110	118			dB
NOISE	100kHz bandwidth, 1kΩ R _s		1			mVp-p
GAIN						
OPEN LOOP	R _L = 10kΩ, C _C =100pF	108				dB
GAIN BANDWIDTH PRODUCT @ 1MHz	C _C =100pF		2			MHz
PHASE MARGIN	Full temperature range	60				degree
OUTPUT						
VOLTAGE SWING	I _O = 10A		+Vs-6.5	+Vs-8		V
VOLTAGE SWING	I _O = -10A		-Vs+0.8	-Vs+1		V
VOLTAGE SWING	I _O = -0.5A		-Vs+0.2	-Vs+0.25		V
CURRENT, continuous, DC				10		A
CURRENT, pulse, ≤10mS, within SOA				15		A
SLEW RATE, A _v = -10	C _C = 100pF	3.8	5			V/μS
SETTLING TIME, to 0.1%	2V Step, C _C = 100pF		4			μS
RESISTANCE	No load, DC		4			Ω
POWER SUPPLY						
VOLTAGE, total supply voltage +Vs to -Vs		12	48	100		V
CURRENT, quiescent			16	20		mA
THERMAL						
RESISTANCE, AC, junction to air or case ⁶	Full temperature range, f ≥ 60Hz			1.20 to air	0.75 to case	°C/W
RESISTANCE, DC junction to air or case	Full temperature range			1.67 to air	1.0 to case	°C/W
TEMPERATURE RANGE, substrate		-40		105	105	°C
TEMPERATURE RANGE, ambient ⁵		-40		80	NA	°C
FAN, 40mm 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 C_c = 470pF, 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 100V 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 PAD141-1 are the same as for the PAD141 except as shown in this column.

SAFETY FIRST

The operating voltages of the PAD141 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.

SINGLE SUPPLY OPERATION

Although the PAD141 easily operates with dual power supplies, as is usually the case with operational amplifiers, it is designed to operate just as easily with a single positive supply voltage. The input common mode range actually extends 4V beyond the negative supply voltage and the output can swing within 1V of the negative supply voltage (usually ground) at 10A of output current and will actually reach 0V at zero output current. See Figure 2 in **Application Circuits** on page 10 for a typical connection.

COOLING FAN

The PAD141 relies on its fan for proper cooling of the amplifier. Make sure that air flow to the fan and away from the heat sink remains unobstructed. The cooling method used is impingement cooling, which means that cool air is pushed into the heat sink and warm air is exhausted through the spaces between the heat sink fins. 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 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.

MOUNTING THE PAD141-1 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 PAD141 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. For all mounting hardware torque to 4.7 in lb [53 N cm] max.

CURRENT LIMIT

The current limiting function is connected as shown in Figure 1. It is best to connect R_s directly to OUT to avoid any significant parasitic resistance, R_p , as shown in Figure 1. The sense voltage for current limit is approximately 0.65V. Thus:

$$I_L = \frac{0.65V}{R_s}$$

Where I_L is the value of the limited current and R_s is the value of the current limit sense resistor.

In addition, the sense voltage has a temperature coefficient approximately equal to $-2.2\text{mV}/^\circ\text{C}$.

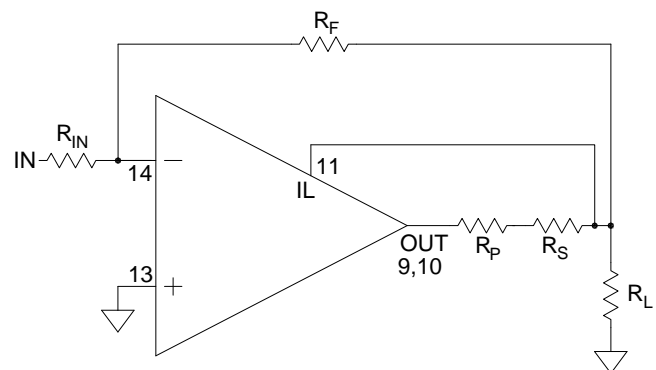
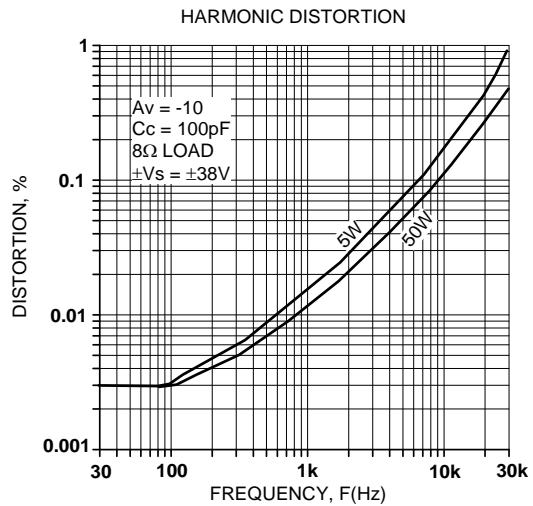
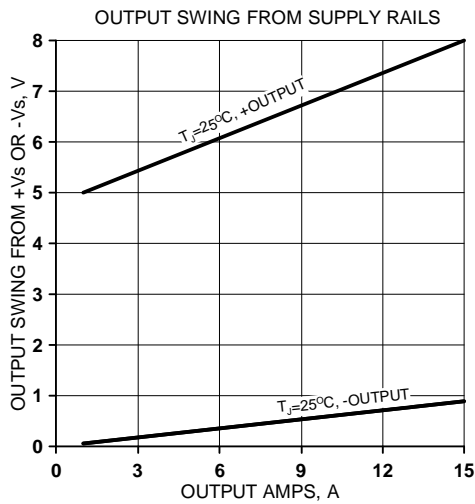
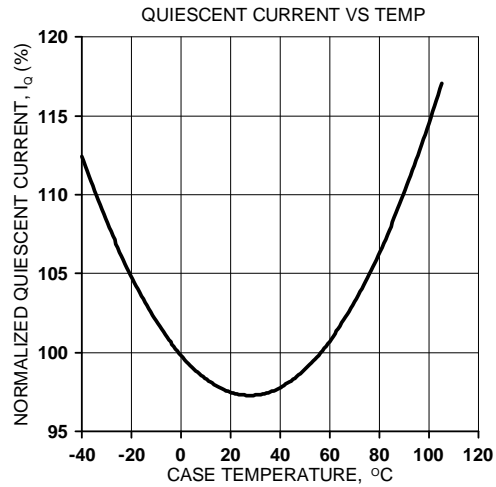
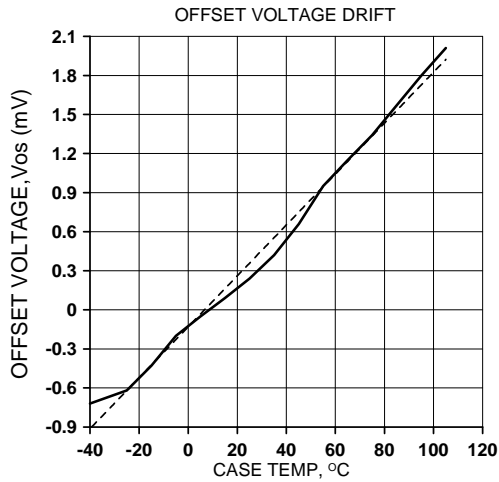
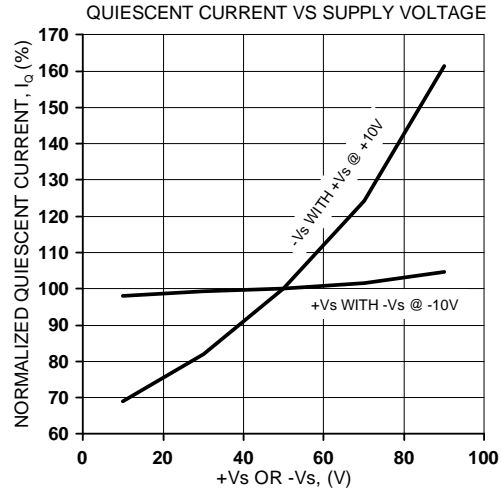
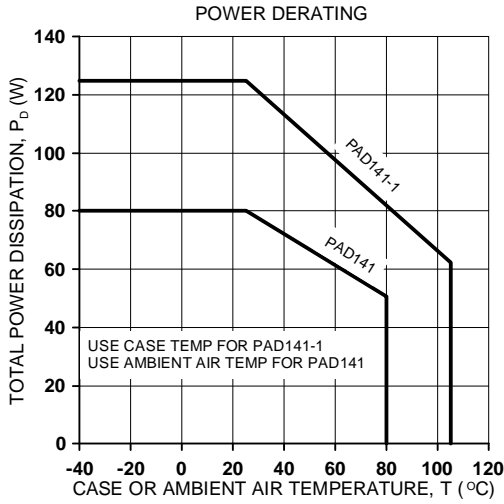
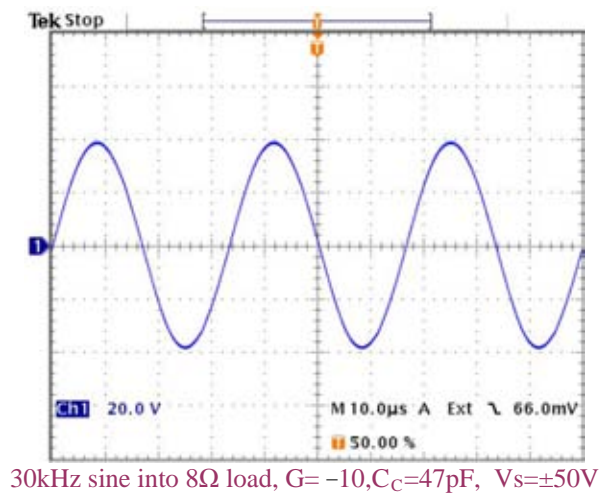
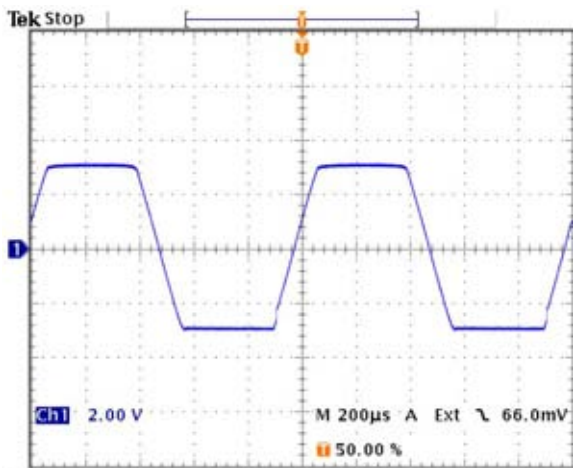
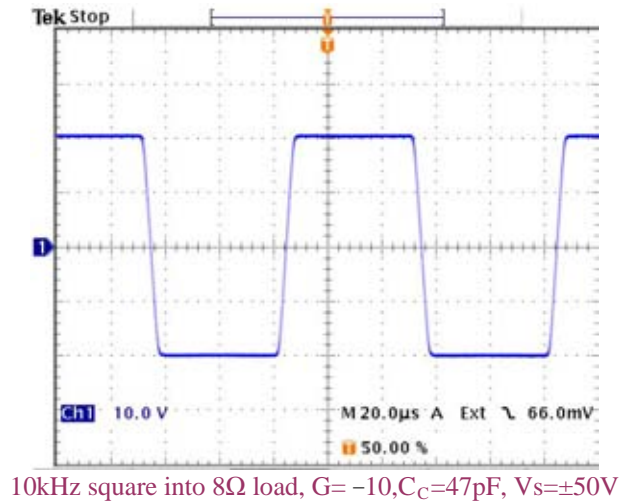
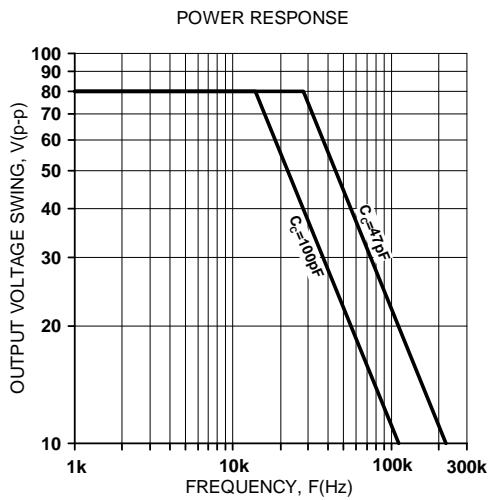
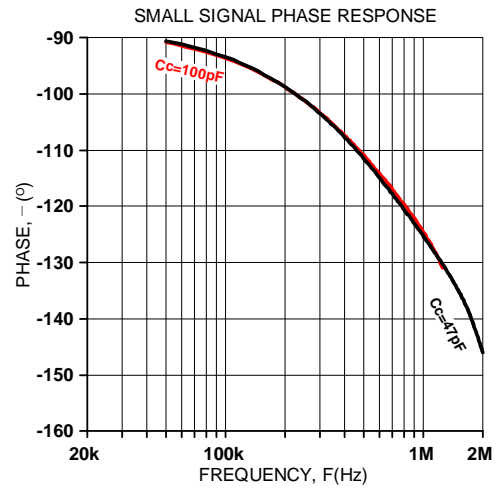
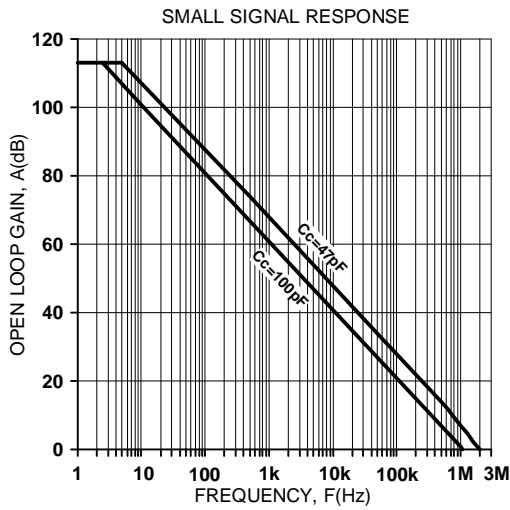


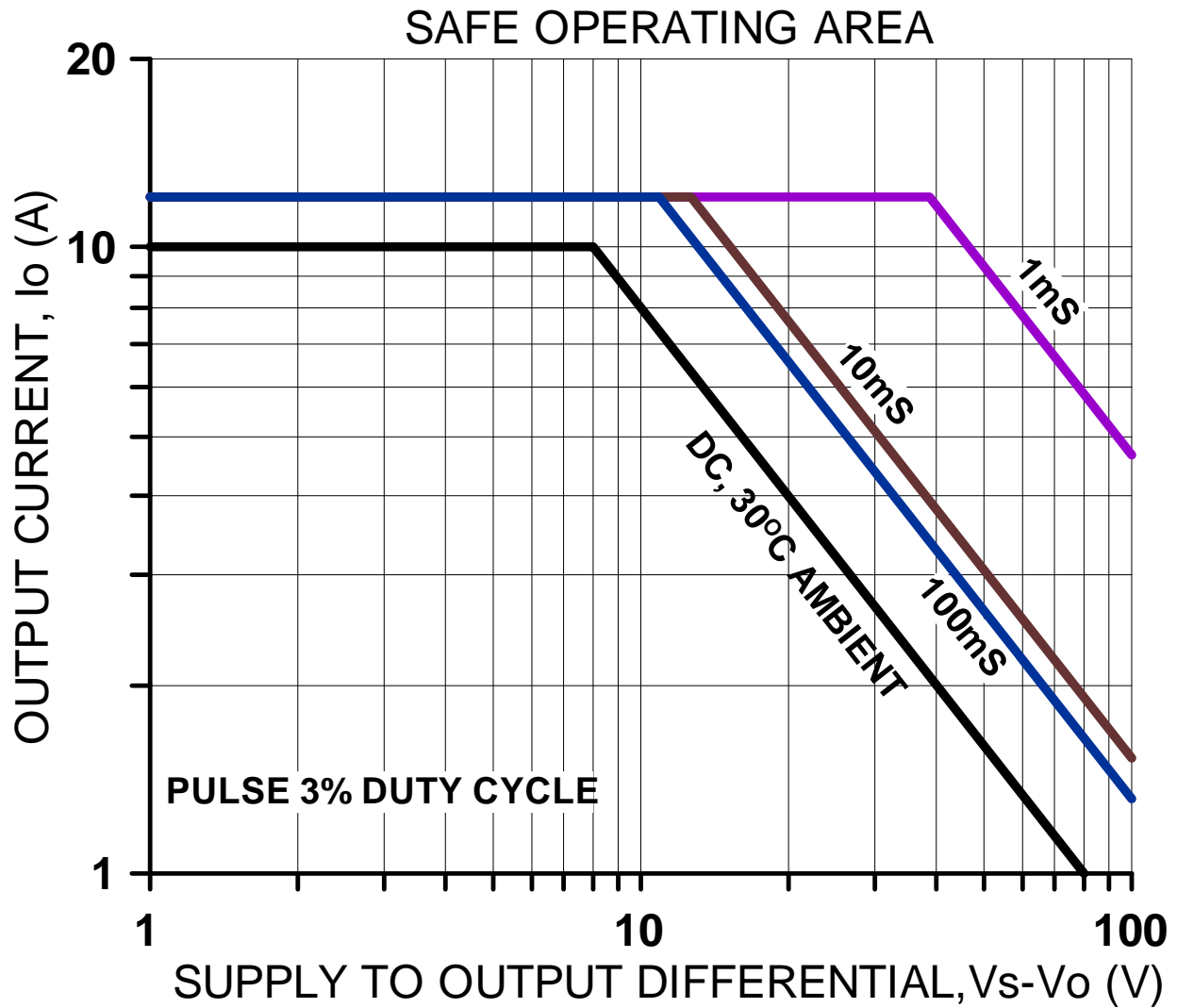
Figure 1

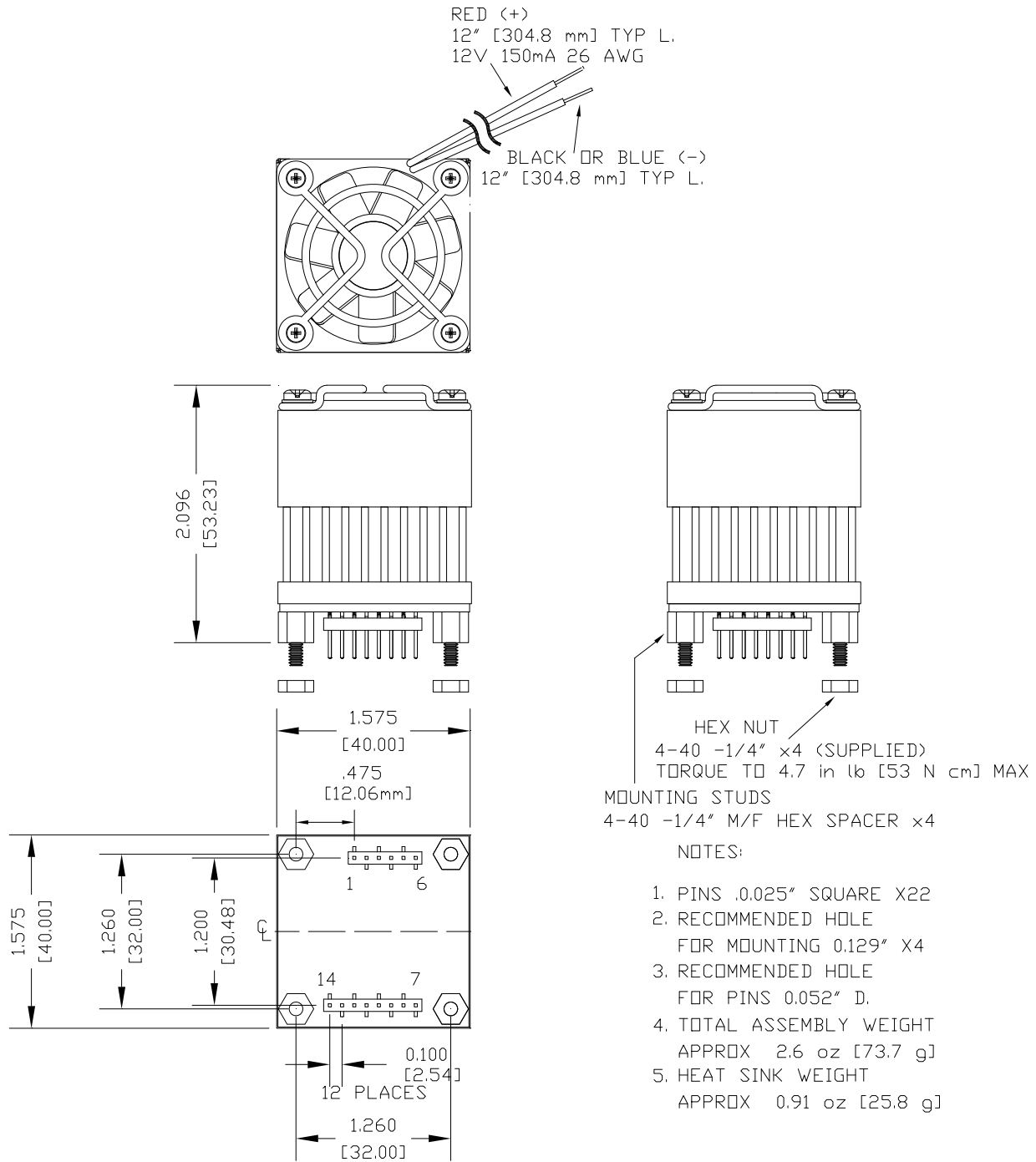
PHASE COMPENSATION

The PAD141 **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 (100V). 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 47pF is not recommended.









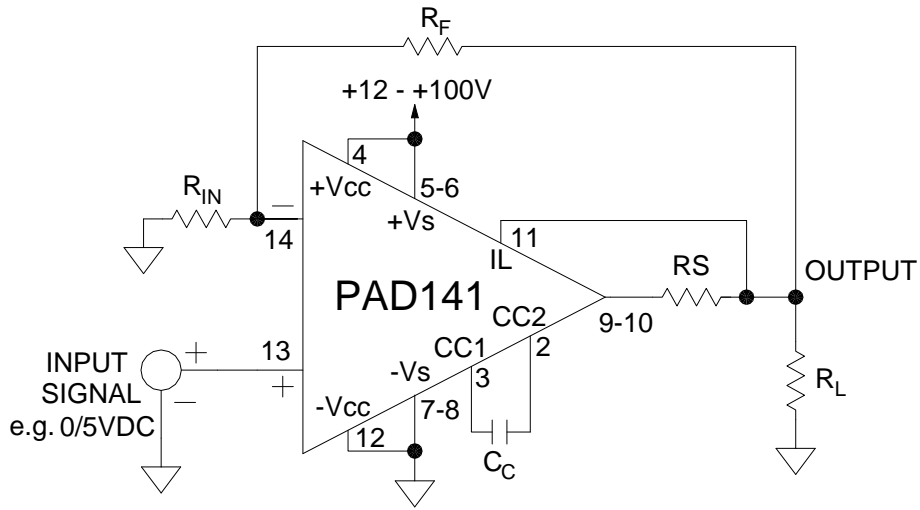


FIGURE 2.
TYPICAL SINGLE SUPPLY CONNECTIONS