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DATASHEET

Kit version 1.0

xL741

Discrete Operational Amplifier

Re-create one of the most classic, popular, and all-around useful chips of all time.

The xL741 Discrete Operational Amplifier is a faithful and functional transistor-scale replica of the classic µa741 op-amp integrated circuit.

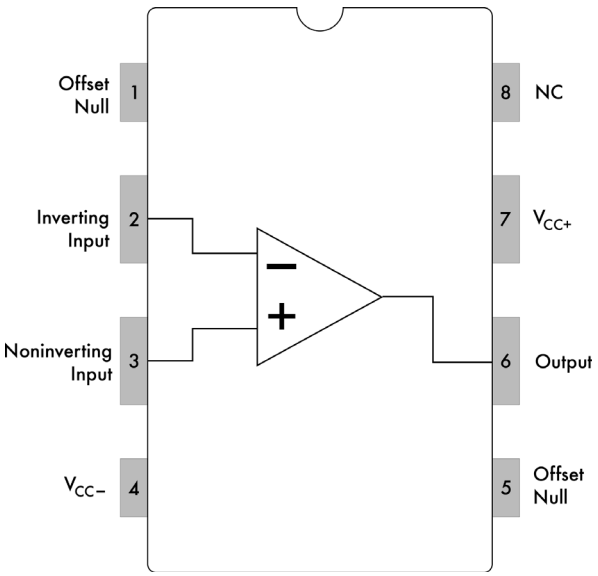
Designed by Eric Schlaepfer (tubetime.us), in collaboration with Evil Mad Scientist Laboratories.

The latest version of this document and additional resources about 741 op-amps are available at: http://wiki.evilmadscientist.com/XL741

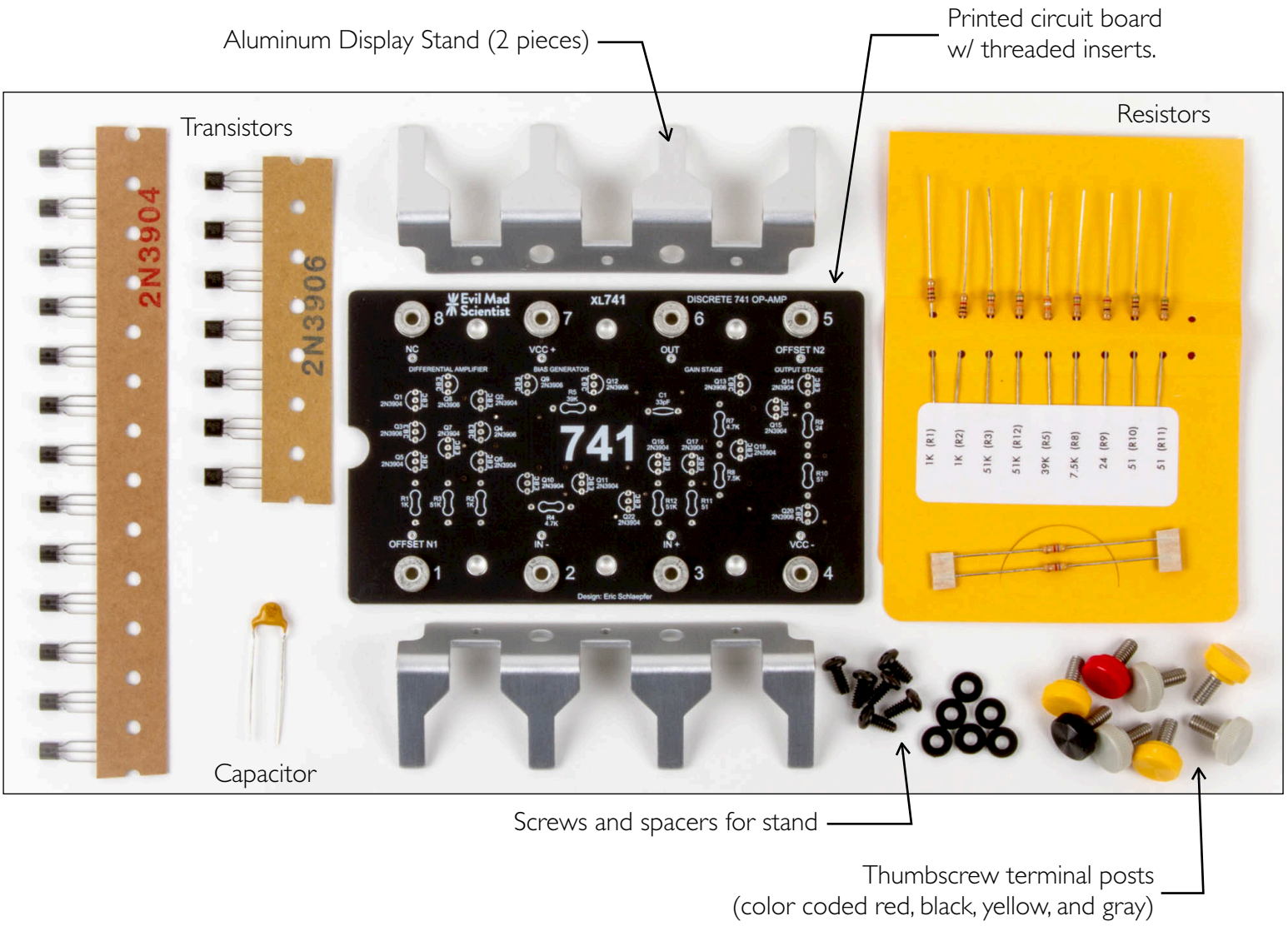
Main Specifications

- Kit type: Through-hole soldering kit
- Assembly instructions: Printed, included with kit
- Assembly time: 30-60 minutes (typical)
- Function: Equivalent circuit to µa741 IC. Some performance characteristics differ; Refer to Abs. Maximum ratings and Electrical Characteristics
- RoHS compliance: All kit components are RoHS compliant (lead free)
- Connection methods: Terminal posts (bare wire, lug, or alligator clip) or solder

Connection Diagram / Pinout



Kit Contents



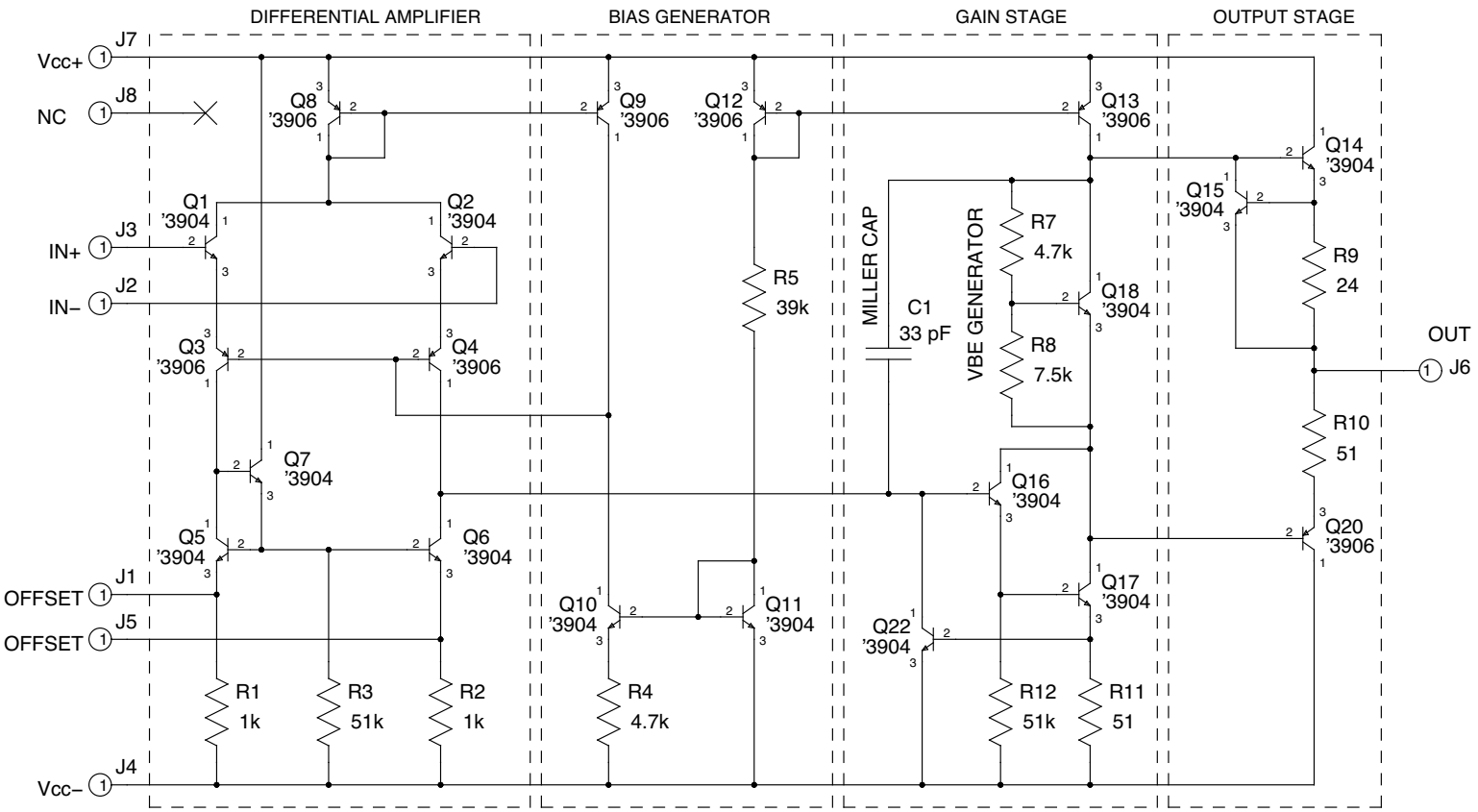
Contents of the XL741 kit:

- The XL741 printed circuit board (extra thick 0.100"), pre-fitted with eight 8-32 threaded inserts
- The transistors, resistors, and capacitor required to assemble the kit
- Eight thumbscrews (terminal posts) with color-coded caps (1 red, 1 black, 3 yellow, 3 gray)
- Two-piece "IC Legs" stand, anodized aluminum
- Mounting screws and spacers for attaching the "IC Legs" stand
- Printed assembly instructions (not shown)

Tools and materials required for assembly (not included with kit):

- Soldering iron
- Solder
- Wire clippers
- Phillips head screwdriver (#2 size recommended).

Schematic Diagram



Electrical Components

Reference	Qty	Type	Value
Q1,2,5,6,7,10,11,14-18,22	13	NPN Transistor	2N3904
Q3,4,8,9,12,13,20	7	PNP Transistor	2N3906
R1,R2	2	Resistor, ¼ W	1 kΩ
R3,R12	2	Resistor, ¼ W	51 kΩ
R4,R7	2	Resistor, ¼ W	4.7 kΩ
R5	1	Resistor, ¼ W	39 kΩ
R8	1	Resistor, ¼ W	7.5 kΩ
R9	1	Resistor, ¼ W	24 Ω
R10,R11	2	Resistor, ¼ W	51 Ω
C1	13	Cap., Ceramic	33 pF

Absolute Maximum Ratings[1]

Parameter	Symbol	Value	Unit
Supply Voltage, Positive[2]	V_{CC+}	+18	V
Supply Voltage, Negative	V_{CC-}	-18	V
Differential Input Voltage[3,4]	V_{ID}	±11	V
Input Voltage (any input) [5]	V_{IN}	Lesser of V_{CC} or ±15	V

Notes:

1. Exceeding Absolute Maximum Ratings may cause permanent damage to the device. Please refer to Electrical Characteristics for recommended operating parameters.
2. Input voltages are measured with respect to the midpoint between V_{CC+} and V_{CC-} .
3. Differential Input Voltage is the voltage at pin IN+ with respect to the voltage at pin IN-.
4. Note that this value differs significantly from the μA741 integrated circuit.
5. Input voltages must not exceed V_{cc} nor 15 V in magnitude.

Electrical Characteristics

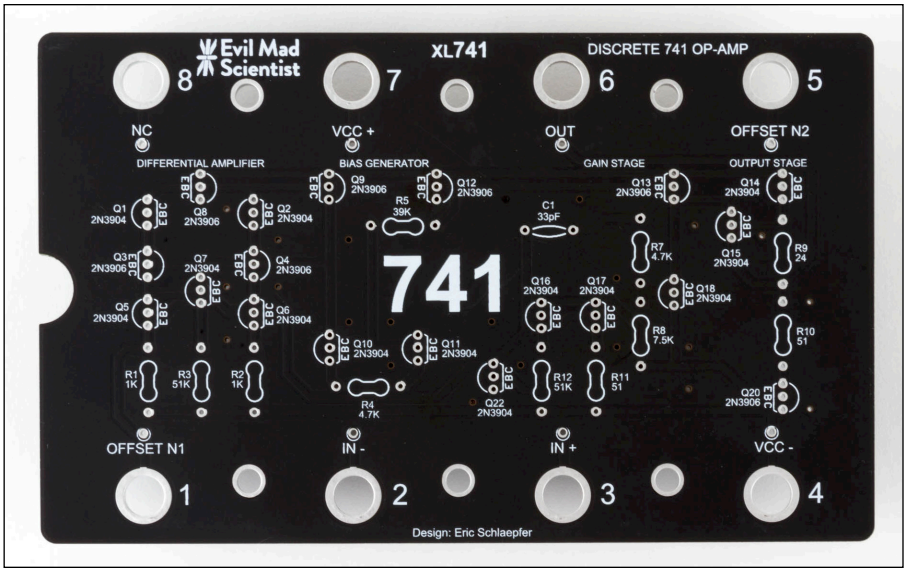
At V_{CC} = ± 15 V, T_A = 25 °C (unless otherwise specified)

Parameter	Symbol	Conditions	Typ	Unit
Input Offset Voltage	V_{IO}	$R_S \leq 10$ kΩ	2.0	mV
Input Offset Current	I_{IO}		20	nA
Input Bias Current	I_{IB}		80	nA
Input Resistance	r_i		2.0	MΩ
Input Capacitance[1]	C_i		10	pF
Offset Voltage Adjustment Range	$\Delta V_{IO(ADJ)}$		±15	mV
Input Voltage Range (Common Mode)	V_{IR}		±13	V
Common Mode Rejection Ratio[1]	CMRR	$R_S \leq 10$ kΩ	43	dB
Supply Voltage Sensitivity	$\Delta V_{IO}/\Delta V_{CC}$	$R_S \leq 10$ kΩ	30	µV/V
Large-Signal Differential Voltage Gain	A_{VD}	$R_L \geq 2$ kΩ, V_{OUT} = ±10 V	200	V/mV
Output Voltage Swing	V_{OM}	$R_L \geq 10$ kΩ	±14	V
		$R_L \geq 2$ kΩ	±13	V
Output Resistance	r_O		75	Ω
Output Short-Circuit Current	I_{OS}		25	mA
Supply Current	I_{CC}	V_O = 0 V, No load	1.7	mA
Power Consumption	P_D	V_O = 0 V, No load	50	mW
Transient Response (unity gain)		V_{in} = 20 mV R_L = 2 kΩ, $C_L \leq$ 100 pF		
Risetime	t_r	V_{CC} = 5 V	0.3	µs
Overshoot			5	%
Slew Rate	SR	$R_L \geq 2$ kΩ	0.5	V/µs

Notes:

1. Note that this value differs significantly from the µA741 integrated circuit.

Additional Photos

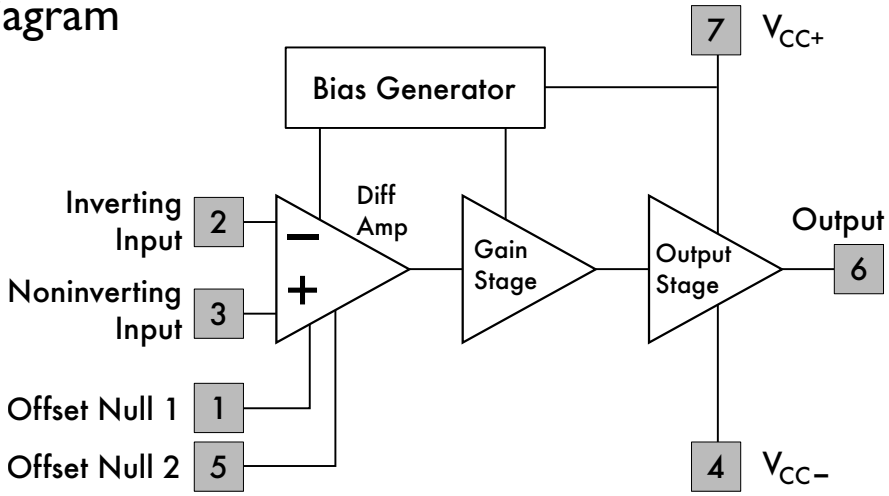


Bare PCB

Assembled PCB with stand
(Terminal posts removed)

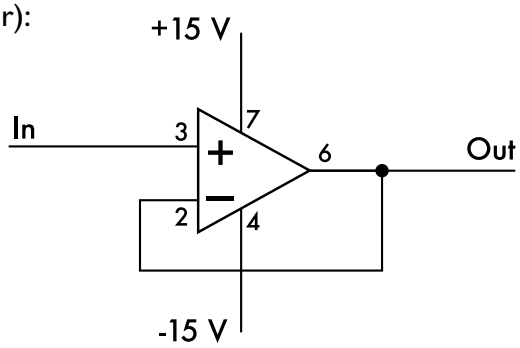
Assembled kit with stand and
terminal posts (top view)

Block Diagram



Example Circuits

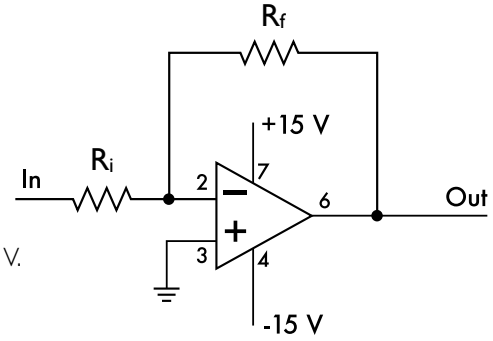
Voltage Follower (analog buffer):



$V_{out} = V_{in}$

V_{in} should be in range ±13 V.

Inverting Amplifier

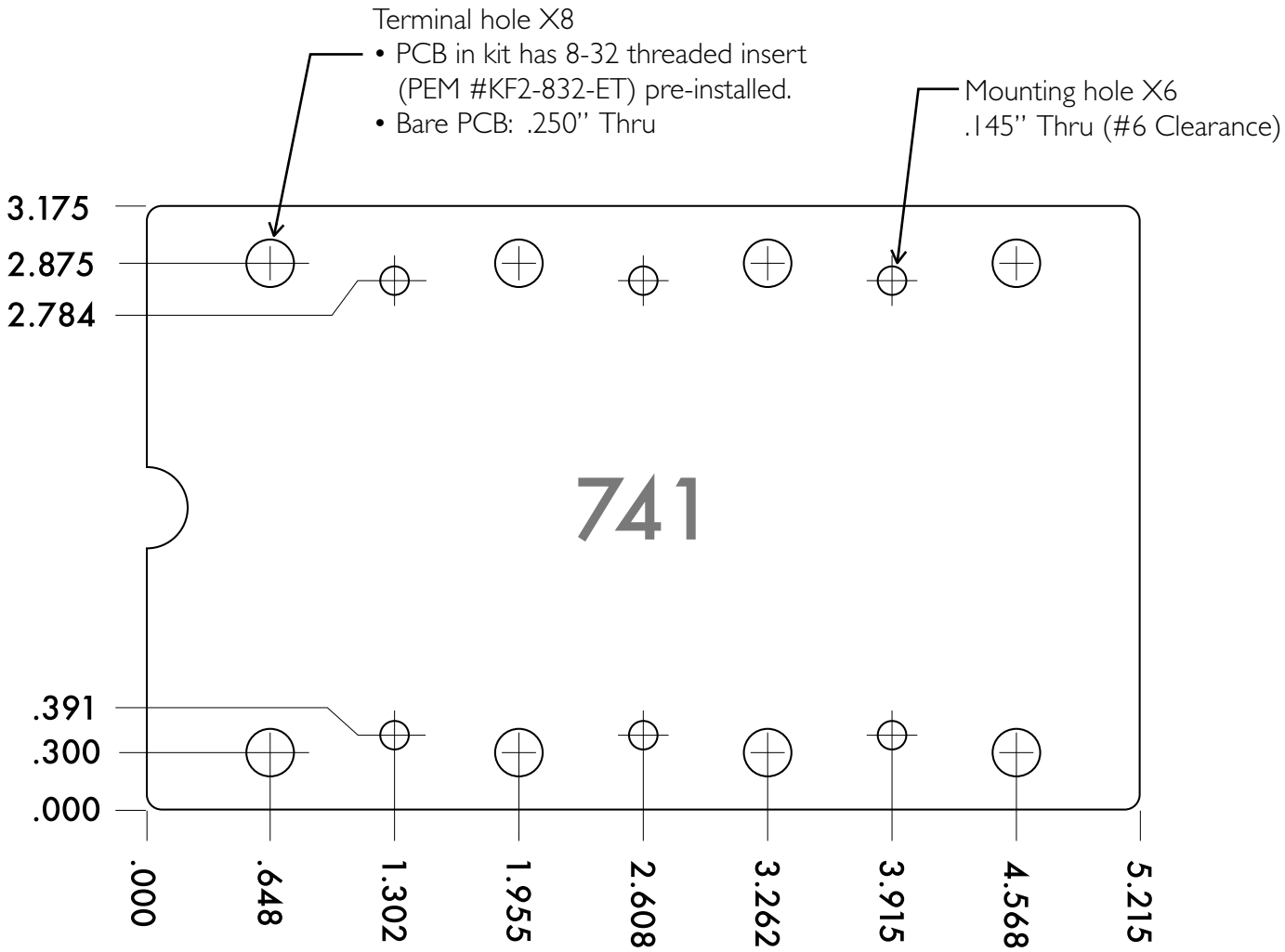


$$V_{out} = -V_{in} \frac{R_f}{R_i}$$

V_{in} should be in range ±13 V.

- If $R_i = R_f = 10\ k\Omega$, then Gain = -1.
- If $R_i = 10\ k\Omega$, and $R_f = 20\ k\Omega$ then Gain = -2.

Printed Circuit Board:
Physical layout and mounting holes



Note: All dimensions are in INCHES.

Additional physical specifications:

- Printed Circuit Board size: 5.215 X 3.175 inches (13.25 X 8.06 cm) wide
- PCB thickness: 0.100" (2.54 mm) nominal, not including threaded inserts
- PCB thickness: 0.196" (4.98 mm) nominal, including threaded inserts
- Overall thickness: Allow 0.5" min. clearance above and below circuit board
- Mounting holes: Six #6 clearance holes provided. See drawing for locations.
- Nominal height of "IC legs" stand: 1.25 inches (3.175 cm), not including spacers
- Nominal height of "IC legs" stand: 1.31 inches (3.33 cm), including spacers, to bottom of PCB.