

Models 152 & 155 Operational Amplifiers

Description

The Model 152 is an economical, general purpose operational amplifier featuring very low input bias current and high input impedance. It is designed for applications involving high source resistances. The Model 155 has all these same features but is better suited for applications requiring low voltage drift.

A versatile circuit building kit, the Model MK150, is available. It makes it easy to connect an amplifier in a wide variety of standard op-amp circuits. These include inverting and non-inverting amplifier, integrator, summer, etc. A potentiometer for nulling the input offset and test jacks are provided.

Inverting/Filter Amplifier

The basic inverting amplifier shown in Figure 1 is useful where a signal inversion or a simple low/high pass filter function is required. The basic inverting amplifiers are used where high slew rate and or high linearity is needed.

Basic Design Equations:

GAIN $G = R_6 / (R_1 + R_{14})$
 $0.1 < G < 100$
 $R_6 + R_{LOAD} > 2 \text{ kohms}$
Either R_1 or R_{14} can be zero ohms
(jumper) for convenience

INPUT IMPEDANCE ... $Z_{in} = R_1 + R_{14}$

BANDWIDTH $bw = 3 \text{ MHz}/(1+G)$ in Hz

Value For R_5 $R_5 = Z_{in} \parallel R_6$

For a low pass filter function add C_2 by the following equation,

$$F_c = 1 / (2 \times \pi \times R_6 \times C_2) \quad 100 \text{ pF} < C_2 < 1 \text{ }\mu\text{F}$$

Where F_c is the -3 dB frequency in Hz of the low pass function. The roll off is 6 dB per octave or -20 dB per decade of frequency.

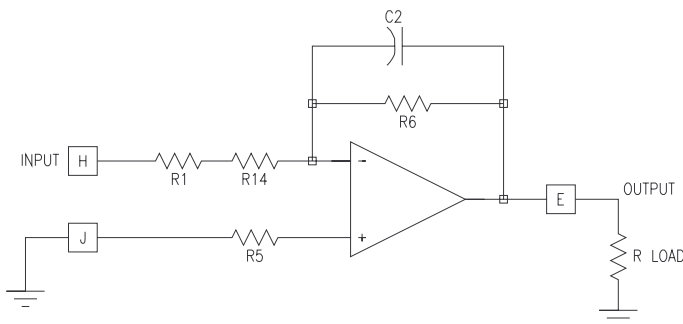


FIGURE 1. Inverting Amplifier

Inverting Summing Amplifier

Figure 2 shows the basic inverting summing amplifier configuration. This amplifier provides the function of summing inputs and providing gain. The summed output can be low pass filtered to reduce high frequency noise if required.

Basic Design Equations:

GAIN $G_1 = R_6/(R_1 + R_{14})$ Input to Pin H
 $G_2 = R_6/R_2$ Input to Pin K
 $G_3 = R_6/R_3$ Input to Pin L
 $G_4 = R_6/R_4$ Input to Pin M
 $0.1 < G < 100$ for any input
 $R_6 \parallel R_{LOAD} > 2 \text{ k ohms}$
Either R_1 or R_{14} can be zero ohms
(jumper) for convenience.

INPUT IMPEDANCE ... $Z_{in} = (R_1 + R_{14})$ or R_2 or R_3 or R_4

BANDWIDTH $bw = 3 \text{ MHz}/(1+R_6/Z_{in})$ in Hz

Value For R_5 $R_5 = Z_{in} \parallel R_6$

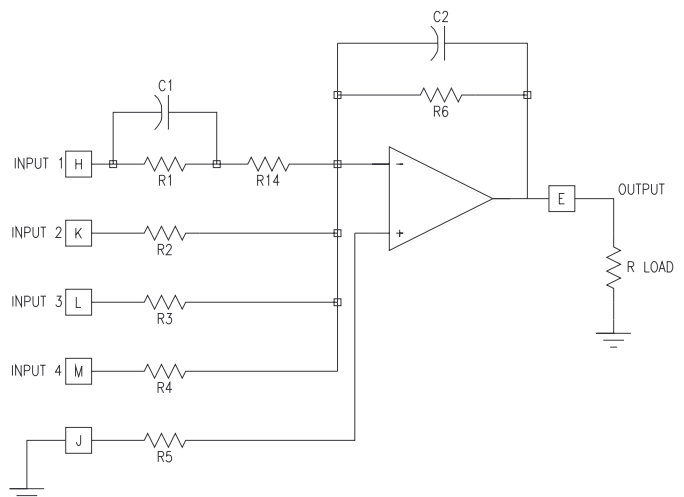


FIGURE 2. Inverting Summing Amplifier

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AC Coupled Inverting Amplifier

An AC coupled amplifier or high pass filter amplifier (Figure 3) is also easy to construct with MK 150. This amplifier is useful for audio and other applications where the DC content of the signal is not important.

Basic Design Equations:

GAIN $G = R6 / R14$
 $0.1 < G < 100$
 $R6 \parallel R_{Load} > 2 \text{ kohms}$

INPUT IMPEDANCE ... $Z_{in} = R14$,
Midband: DC $Z_{in} = \text{Infinity}$

BANDWIDTH $bw = 3 \text{ MHz} / (1+G)$ in Hz

Value For $R5$ $R5 = R6$

Value For $C1$ $C1 = 1 / (2 \times \pi \times F_c \times R14)$ in Hz, where
 F_c is the lower -3 dB cutoff of the amplifier.

The low frequency roll off is +6 dB or +20 dB per decade of increasing frequency. Pick $C2$ to minimize overshoot or ringing with a small square wave input. Increasing $C2$ will reduce overshoot and ringing at the output.

Non-inverting Amplifier

Figure 4. Shows the basic non-inverting amplifier circuit. The non-inverting amplifier or voltage follower is useful where high input impedance is required and or an in phase output voltage is required.

Basic Design Equations:

GAIN $G = 1 + R6 / (R14 + R1)$
 $0.1 < G < 100$
Either $R14$ or $R1$ can be zero ohms for convenience
 $R6 \parallel R_{Load} > 2 \text{ kohms}$
if $R1 + R14$ are not used the gain is a precision +1 (voltage follower mode).

INPUT IMPEDANCE ... $Z_{in} = > 10 \text{ Meg}$

BANDWIDTH $bw = 3 \text{ MHz} / G$ in Hz

Value For $R5$ $R5 = R6 \parallel (R1 + R14)$

The gain can be rolled off to a minimum gain of +1 by using $C2$ in the circuit.

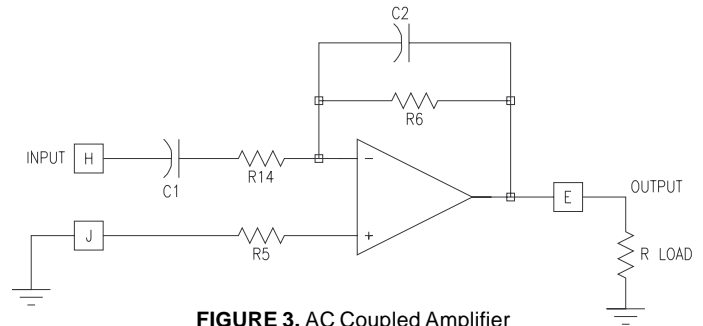


FIGURE 3. AC Coupled Amplifier

The Differentiator

The differentiator (also Figure 3) is basically a high pass filter that has the useful property of producing an output voltage that is proportional to the instantaneous derivative of the input waveform.

Basic Design Equations:

Voltage Output $V_o = -R6 \times C1 \times dV_i/dt$
 V_o should be as low as possible for maximum dynamic range.

Utility Gain Frequency $F_c = 1 / (2 \times \pi \times R6 \times C1)$

Value for $R5$ $R5 = R6$

Value for $R14$ and $C2$ Select for minimum overshoot and ringing on the output with a step input. Increase $R14$ and or $C2$ to reduce overshoot.

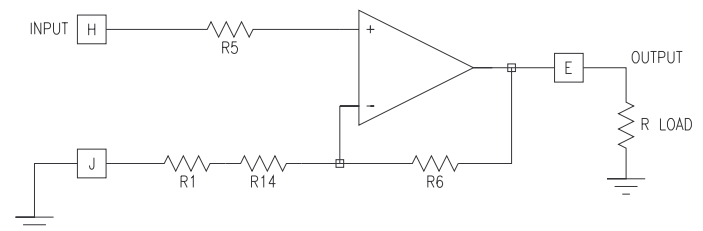


FIGURE 4. Non-inverting Amplifier Circuit

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Specifications

Model	152	155
Open Loop Gain	90 dB	100 dB
Rated Output ($R_L = 2k$)	$\pm 10V$	$\pm 10V$
Input Offset Voltage		
Initial 25°C	6 mV	1 mV
Vs. Temperature	20 $\mu V/^\circ C$	3 $\mu V/^\circ C$
Input Bias Current		
Initial 25°C	200 pA	50 nA
Vs. Temperature	10 pA/ $^\circ C$	0.2 nA/ $^\circ C$
Differential Input Impedance	10 ¹² ohm	4 megohm
Input Signal Range		
Common Mode	$\pm 12V$	$\pm 10V$
Differential	$\pm 12V$	$\pm 10V$
Frequency Response		
Small Signal Unity Gain Frequency	3 MHz	3 MHz
Full Power Bandwidth	5 kHz	5 kHz
Slew Rate, min.	10V/ μs	10V/ μs
Power Required		
Voltage	$\pm 15V$	$\pm 15V$
Current	± 3 mA	± 5 mA
Temperature Range		
Operating	0 - 70°C	0 - 70°C

General Notes

When driving capacitive loads or shielded cables of greater than 50pF remove the jumper for R11 and insert a 470 ohm resistor. This will prevent oscillation that will appear as an unstable DC offset to most measuring equipment.

The minimum value of load resistance is 2k ohms for a rated output swing of ± 10 Volts. The external load must be considered along with the feedback resistance for the total load. For reduced swings the output load can be increased up to a maximum of 5 mA peak.

For optimum DC stability use single point "Star" grounds to Pin B. This will prevent unwanted ground loops or "unexplained" DC offsets.

When the MK150 is wired in a system and it appears that something is wrong, remove the MK150 and test it individually to make sure that it functions as expected. Then troubleshoot the system from the transducer to the end, a function block at a time.

If a high precision amplifier is required with a gain of 100 or more, the 176/178 Instrumentation amplifiers are a much better choice for most systems.

If all else fails please feel free to call our applications engineers; we spend time trouble shooting our own systems and can sometimes spot trouble right away. We even learn new tricks from our customers!

To order the MK150 for use with the 152, specify the MK150 as MK150-152. For use with the 155, specify the MK150 as MK150-155.

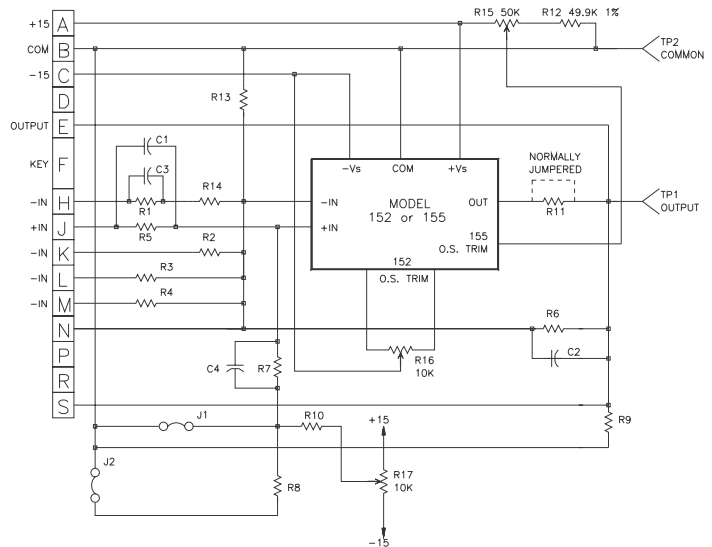


FIGURE 5. MK150 Mounting Kit Schematic

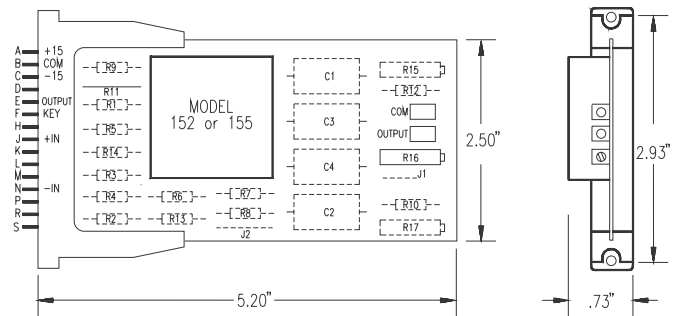


FIGURE 6. MK150 Mounting Kit Dimensions

For Model 155-TP1, TP2, R12, R15 and Jumper for R11 are factory installed.

For Model 152-TP1, TP2, R16, and Jumper for R11 are factory installed.

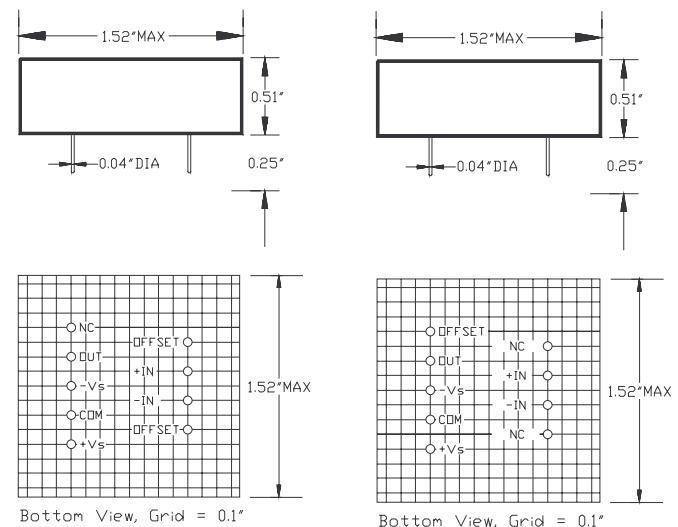


FIGURE 7. Outline Dimensions