

±200V DIFFERENCE AMPLIFIER WITH COMMON-MODE VOLTAGE MONITOR

By Art Gass and R. Mark Stitt (602) 746-7445

The INA117 is a monolithic difference amplifier with the unique ability to accept up to ±200V common-mode input signals while operating on standard ±15V power supplies. Using on-chip high-voltage resistor dividers, the INA117 rejects common-mode signals up to ±200V and translates a 0V to ±10V differential input signal to a 0V to ±10V ground-referenced output signal.

In some applications it is also necessary to monitor the common-mode level of the input signal. A common-mode level monitor can be implemented with the addition of an external op amp or two. Even though standard signal level op amps are used, the circuit remains protected for momentary common-mode or differential overloads up to ±500V.

If precision is not required, the circuit shown in Figure 1 can be used to monitor the common-mode voltage with a maximum error of about ±5V. This implementation actually monitors the common-mode level of the INA117 noninverting input (pin 3). The circuit works by measuring the current in reference pins 1 and 5, which are normally connected to ground. Amplifier A₁ forces the reference pins to a virtual ground through feedback resistors R₆ + R₇. The

normal operation of the INA117 is unaffected since its reference pins are connected to virtual ground. Resistors R₃ and R₄ in the INA117 form a voltage divider so that the top of R₄ is at V₃/20. Feedback of the op amp in the INA117 forces the voltage of its inverting input to be equal to its noninverting input so that the top of resistor R₅ is also at V₃/20. The common mode level of V₃ is therefore related to the current flowing out of pins 1 and 5.

$$I_{1+5} = (V_3/20)/(R_4 \parallel R_5)$$

If

$$R_6 + R_7 = R_4 \parallel R_5$$

then

$$A_1 \text{ OUT} = -V_3/20.$$

Where

I₁₊₅ = total current flowing out of INA117 pins 1 and 5 [A]

R₄ ∥ R₅ = parallel combination of R₄ and R₅ [Ω]

R₄ ∥ R₅ = (R₄ • R₅)/(R₄ + R₅), nominally 10.27kΩ

A₁ OUT = A₁ output voltage [V]

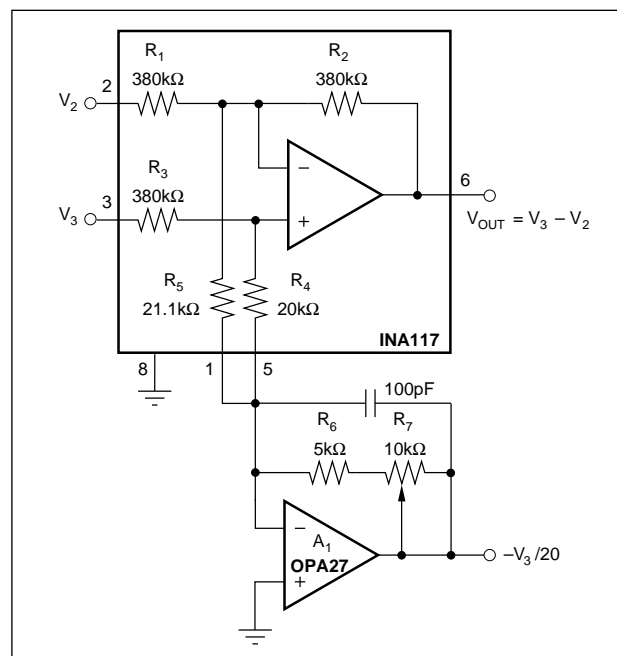


FIGURE 1. INA117 with V₃ Common-Mode Voltage Monitor.

The signal is scaled by 1/20 so the output of A₁ does not exceed its maximum of ±10V with common-mode inputs of ±200V. If smaller maximum common-mode voltages are to be monitored, the value of R₆ + R₇ can be increased for more gain.

Although the resistor ratios in the INA117 are accurately laser trimmed, the absolute resistor values can vary by as much as ±25%. For better accuracy, the circuit must be calibrated. To calibrate the gain, short pins 2 and 3 of the INA117 to ground, offset adjust A₁ for 0V at its output, connect pins 2 and 3 to a known V_{REF} (such as +10V or +100V), and adjust R₇ for an A₁ output of -V_{REF}/20.

By definition, the true common-mode input voltage of the INA117 is (V₂ + V₃)/2. The actual common-mode voltage can be monitored with the addition of a second op amp as shown in Figure 2. The second op amp is connected to sum the -V₃/20 output of A₁ at a gain of -1V/V with the V₃ - V₂ output of the INA117 at a gain of -1/40V/V to produce an output of V_{CM}/20.

Calibrate the Figure 2 circuit as before, adjusting R_7 for an A_2 output of $V_{REF}/20$. Then, ground pin 3 of the INA117, connect pin 2 to +10V and trim R_9 for 0.025V at the output of A_2 . If resistors R_8 , R_9 , and R_{10} accurately ratio match, adjustment of R_9 is unnecessary.

Of course, if connection of additional components to the INA117 inputs is acceptable, the circuits shown in Figures

3 and 4 can be used to monitor the common-mode input voltage. With these circuits, calibration is not required if accuracy commensurate with the tolerance of R_6 , R_7 , and R_8 is acceptable. As before, either R_7 or R_8 can be omitted to monitor the common-mode voltage of just one input. If R_7 or R_8 is omitted, double the value of R_6 .

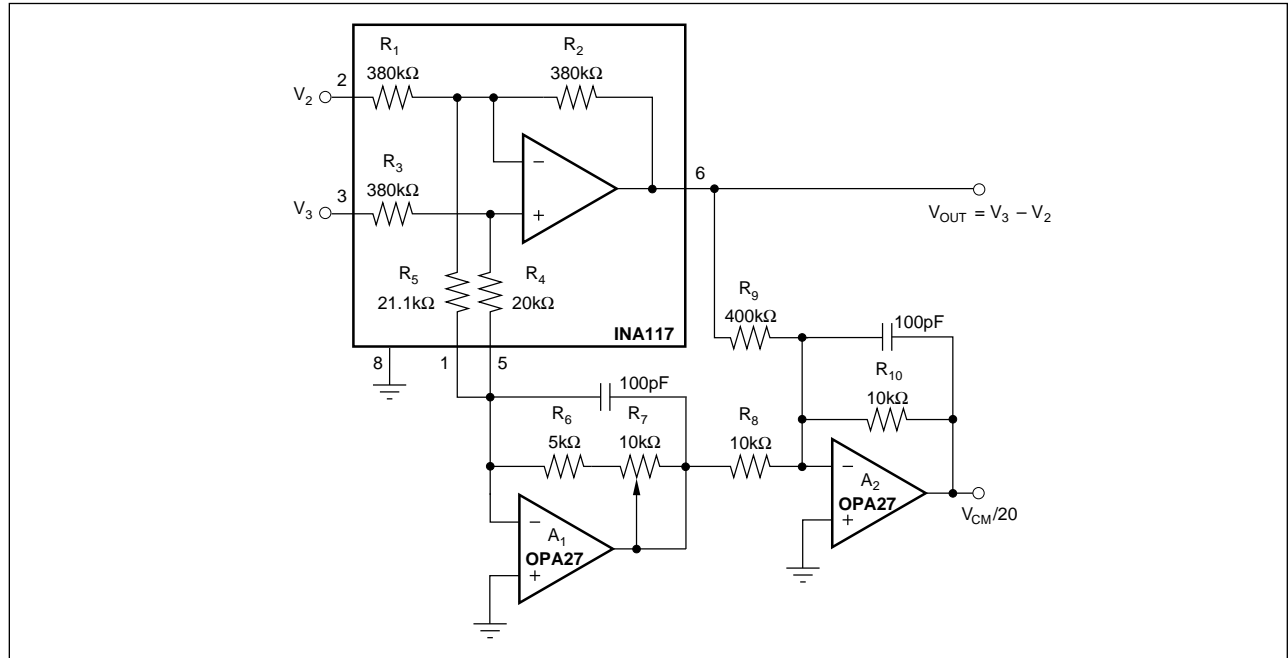


FIGURE 2. INA117 with True Common-Mode Voltage Monitor.

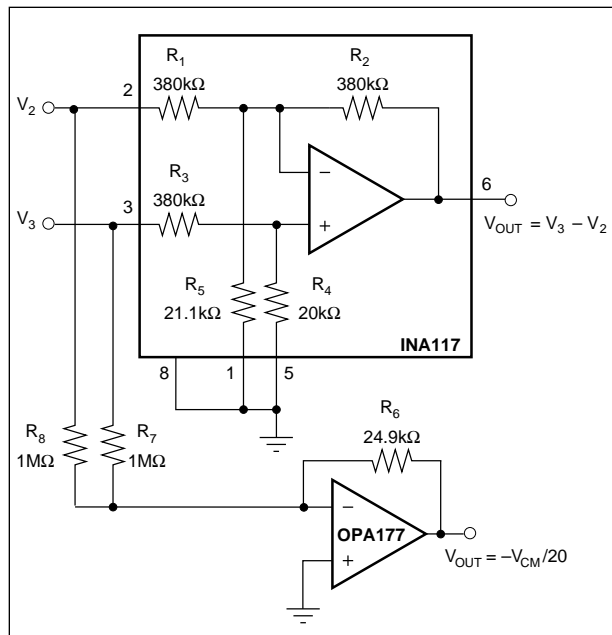


FIGURE 3. External CMV Monitor, Inverting.

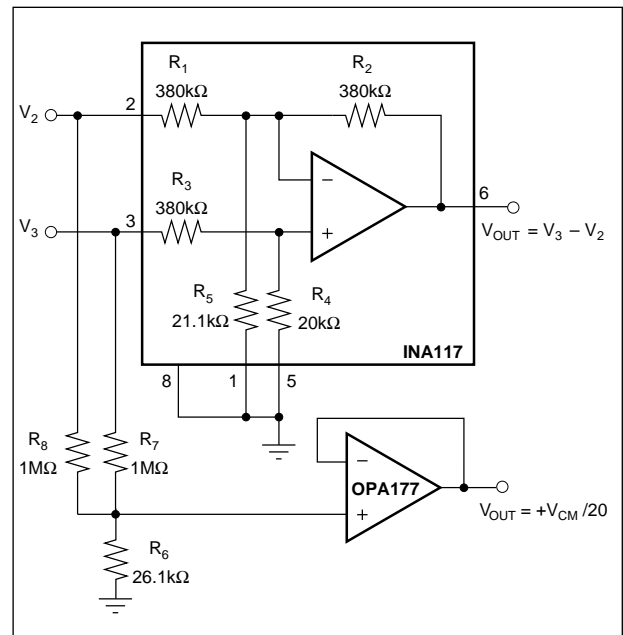


FIGURE 4. External CMV Monitor, Noninverting.

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