Originally published in the August 6, 1992, issue of *EDN*

Dual op amp takes absolute difference

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A traditional implementation of an absolute-difference function comprises a difference circuit followed by an absolute-value circuit; the entire circuit requires at least three op amps. The design problem is complicated in single-supply-only systems, which usually require an artificial ground, typically one-half of the supply. The circuit in **Figure 1** takes the absolute value of the difference of two voltages using only two single-supply, ground-referenced op amps. The circuit is designed for dc or low-speed operation.

For the case where $V_1>V_2$, IC_{1A} is disabled because diode D_1 is off. IC_{1B} and its associated resistors form a classic difference circuit where $V_{OUT}=(R_2/R_1)(V_1-V_2)$.

For the case where $V_2>V_1$, diode D_1 conducts, producing the composite amplifier system made up of both IC_{1A} and IC_{1B}, where $V_{OUT}=(R_2/R_1)(V_2-V_1)$. Using these two **equations**, the overall function of the circuit for V_1 and V_2 greater than zero is as follows: $V_{OUT}=(R_2/R_1)|(V_1-V_2)|$.

The circuit was built and tested with R_1=10 kΩ and R_2=220 kΩ. For $V_2>V_1$, the composite amplifier system has poor phase margin and is unstable. Thus, the circuit compensates the loop with the dominant pole formed by R_3 and C_1. At a gain of 22 and a desired response time of about 300 µsec (the 10 to 90% rise time when V_2 becomes 0.1V greater than V_1), values of R_3=56 kΩ and C_1=850 pF produced the best empirical results. R_3 and C_1 will vary, depending on the required speed of the response and the closed-loop gain.

Also, when $V_2>V_1$, the output of IC_{1A} becomes a function of the factor $2V_2-V_1$. Thus, IC_{1A} may saturate for large values of V_2. The factor's upper limit is as follows, where V_{SAT} is the saturation voltage for IC_{1A}: $(2V_2-V_1)<V_{SAT}(R_1+R_2)/R_2$. For the LM2902 operating from 5V, V_{SAT} is approximately 3.5V. This last **equation** also implicitly sets a common-mode voltage (V_{CM}) limitation. You can see this limitation by setting $V_1=V_2=V_{CM}$ and allowing the factor $(2V_2-V_1)$ to reduce to V_{CM}. EDN

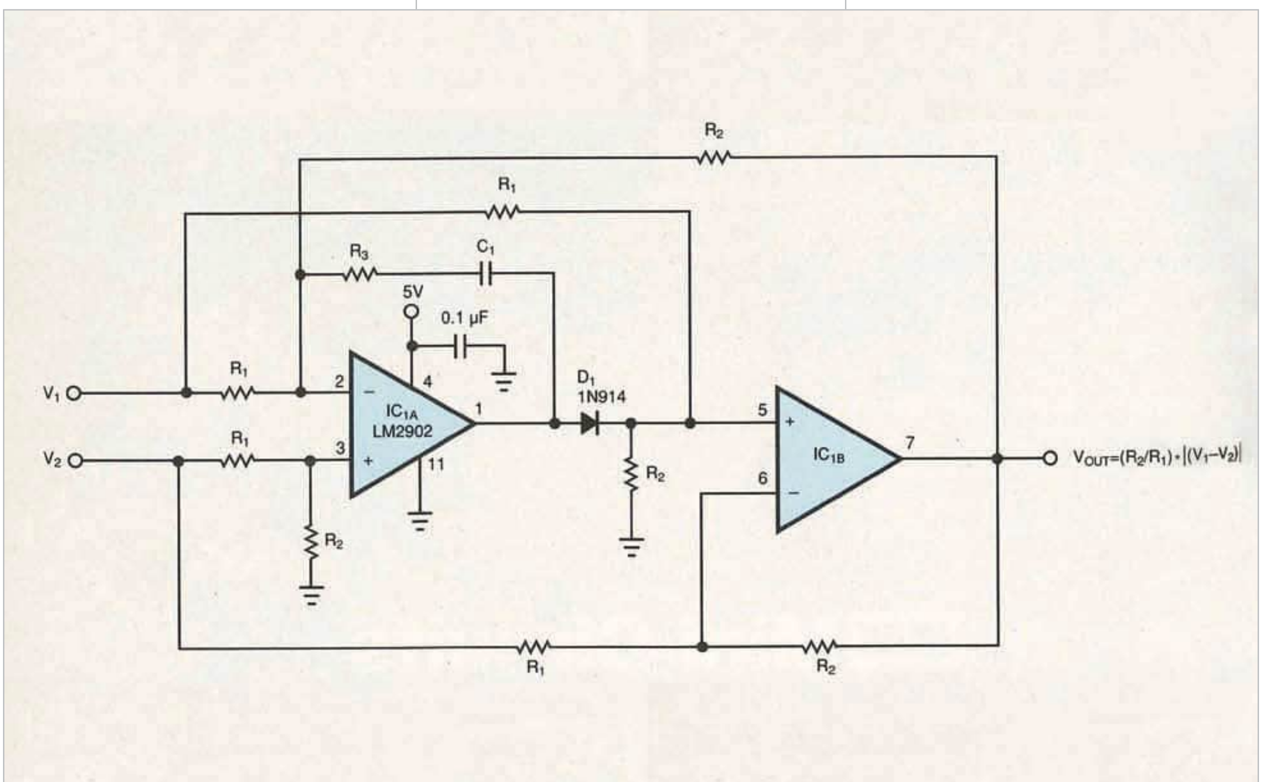

Figure 1 Using single-supply, ground-referenced op amps, this circuit accomplishes an absolute-difference function.