Circuit Ideas

Op-amp power output stage

This circuit overcomes the difficulty in setting quiescent current by using R_2 for adjustment and R_3, within the feedback loop of the op-amp, for stabilization.

Positive signals are handled by Tr_1 with base current flowing down L_1. Negative signals are handled by Tr_2 with base current initially via R_1. For large negative signals D_1 becomes forward biased and base current for Tr_2 is then drawn through the load and D_1. Resistor R_1 must be large enough to forward bias D_1 for negative excursions in order to prevent Tr_1 from being turned on. It is possible to omit R_1, C_4 and R_4, but the crossovers are then less smooth. The op-amp may be used in the virtual earth mode if desired.

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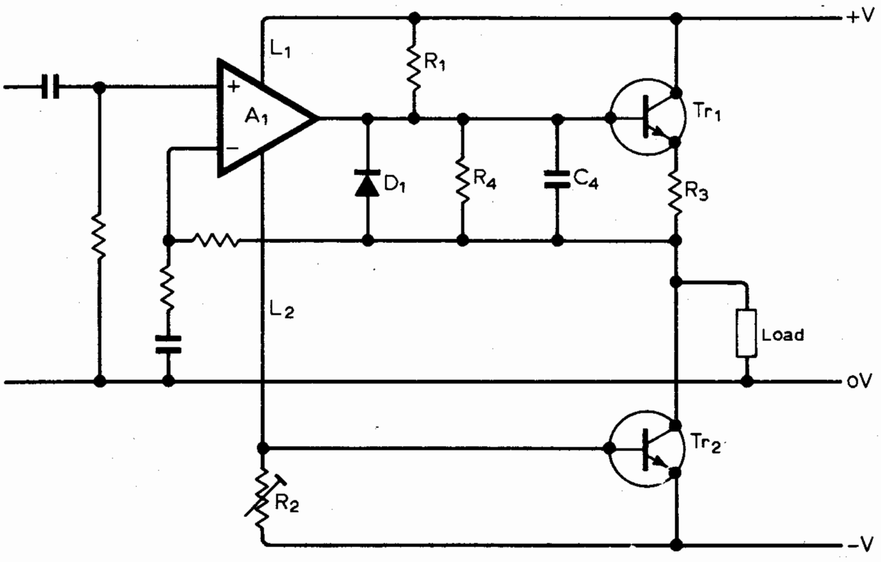

Zero crossing detection with exponentially decaying hysteresis

It is well known that a zero detector may be constructed as shown in Fig. 1. Assuming that the output V_0 of the operational amplifier is at its positive limit V_1, then the voltage V_+ on the non-inverting input is $V_1R_2/(R_1+R_2)$, and the amplifier output will not change unless $V_i > V_+$. Once V_0 starts to fall, V_+ decreases and the switching process is accelerated due to positive feedback through R_1. The penalty for this sharp switching is that when V_0 is at its negative limit $-V_2$, the amplifier will not start to switch unless $V_i < -V_2R_2/(R_1+R_2)$ and thus exhibits a hysteresis band of width $(V_1+V_2)R_2/(R_1+R_2)$ as shown in Fig. 2. This hysteresis is often valuable because it avoids multiple switching of the detector when the input consists of a low frequency signal corrupted with high frequency noise. It does, however, reduce detector sensitivity for small inputs.

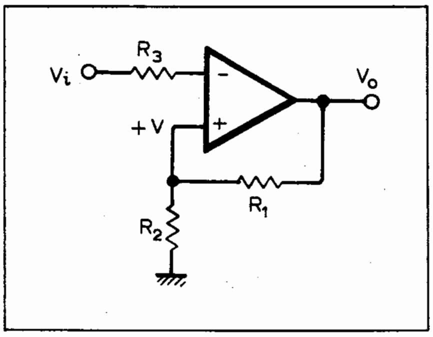

Fig 1

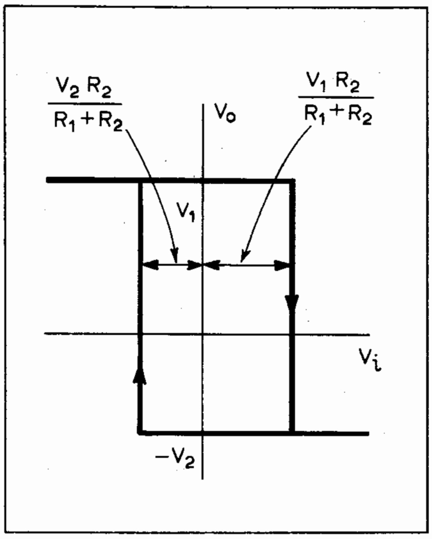

Fig 2

The modified circuit shown in Fig. 3 gives improved zero detection. When the circuit changes state, V_0 changes by an amount (V_1+V_2) and thus V_+ immediately changes by $(V_1+V_2)R_2/(R_1+R_2)$, because the charge on the capacitor cannot change instantaneously. Subsequently, V_+ decays exponentially to zero with time constant $(R_1+R_2)C$. Since V_0 only changes when $V_i = V_+$ the hysteresis in the detector is large just after a change of state has occurred, but later decays to zero. Therefore, there is sharp switching between the limits and when noise is present multiple switching is avoided. If the time constant is significantly shorter than the average time separation of the zero crossings the zero detection is very accurate.

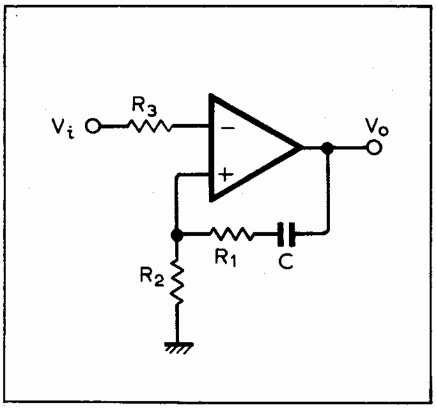

Fig 3

To avoid error with the input bias currents of the amplifier, $R_3 = R_1R_2/(R_1+R_2)$ in Fig. 1 and $R_3 = R_2$ in Fig. 3. Also in Fig. 3 $R_1 > R_2$ so that the input-voltage limits of the operational amplifier are not exceeded.

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Contributors to Circuit Ideas are urged to say what is new or improved about their circuit early in the item, preferably in the first sentence.