

LM111,LM321

Microvolt Comparator



Literature Number: SNOA858

Filtering (Continued)

to oscillate during slow transitions. Also, response time to small signals is halved since the positive hysteresis feedback signal is not stored on the filter capacitor.

A higher frequency filter (C_f) is needed to provide a low impedance shunt to any high frequency noise and stray feedback that may be picked up between LM111 terminals 5 and 6. These two terminals have almost the same voltage sensitivity as the normal input terminals. The positive feedback to terminal 5, as described below, is only delayed slightly by this filter.

Feedback

The positive feedback provided by the 5.1k/33 Ω voltage divider with R_H is needed to insure clean, rapid changes of state. It is applied to one of the "balance" terminals (pin 5) of the LM111 to simplify the circuit over a balanced feedback network, and to minimize signal stored on C_S as previously described. The current fed back to terminal 5 is single ended with respect to the balance adjust network between these terminals, and hence injects a dc offset of the desired polarity and amplitude for a few microvolts of latching.

Performance

A tabulation is shown for one of the many possible combinations of input circuits, filters, etc. For large amplitude signals, C_S can be decreased and hysteresis increased for greater speed. Conversely, to obtain hysteresis as low as 1 μ V, trim R_H (to about 300k) use a C_S of 0.01 μ F to 0.1 μ F and have a low impedance source of signals.

For reduced ambient range and drift specifications, an LM321 can be paired with the LM311 for a cost saving while maintaining the same comparison sensitivity.

Design Tips for Microvolt Signals

Even with high performance devices such as the LM121, microvolts of error can occur from thermocouple effects,

common-mode signals, "microphonics," or unbalances in the input or nulling circuits. As pointed out in Application Note AN-79, Kovar lead to copper circuit board thermocouple effects can cause a 3.5 μ V offset voltage for only 0.1°C difference across the input leads. A compact layout of input connections and shielding from air currents will minimize this problem.

Although the LM121A has excellent common-mode rejection (> 120 dB), a 1V change in common-mode voltage can induce up to 1 μ V of error voltage. For this reason common-mode voltage changes should be kept to a minimum. Also, common-mode voltages allow mechanical vibrations in the probe cable to induce "microphonic" noise signals. Short, stiff, low capacitance and symmetrical input shielded wires are recommended.

If it is possible to have a signal source balanced with regard to ground, it will help decrease errors due to bias currents, and noise due to common-mode and microphonic effects. Matched, low temperature coefficient parts should be used in the balance network, and care should be exercised in shielding input circuits and eliminating ground-loops.

Applications

The microvolt comparator is particularly well suited to controllers or test equipment having thermocouples or strain gauges as inputs. This includes wind speed indicators, RMS to dc converters, vacuum gauges, gas analysis equipment, conductivity gauges, and hot wire controls. The strain gauges can be used in materials testing, electronic weighing, pressure transducers, and load limiting sensors for cranes, hoists, and rolling mills.

As a temperature controller, 1/8 degree or less on-off differential can be obtained using thermocouple types E, J, T or K. Other microvolt signals used for control may come from Hall effect sensors, Bolometers, slide-wires, and heat-flow thermopiles. A microvolt comparator will be useful in "Go/No-Go" testing of low resistances such as switch and relay contacts, RTDs, coil and fuse resistances, and pressure-sensitive-plastic conductors.

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