APPLICATIONS INFORMATION

BATTERY-POWERED APPLICATIONS

The OP-290 can be operated on a minimum supply voltage of +1.6V, or with dual supplies of ±0.8V, and draws only 19μA of supply current. In many battery-powered circuits, the OP-290 can be continuously operated for thousands of hours before requiring battery replacement, reducing equipment downtime and operating cost.

High-performance portable equipment and instruments frequently use lithium cells because of their long shelf-life, light weight, and high energy density relative to older primary cells. Most lithium cells have a nominal output voltage of 3V and are noted for a flat discharge characteristic. The low supply voltage requirement of the OP-290, combined with the flat discharge characteristic of the lithium cell, indicates that the OP-290 can be operated over the entire useful life of the cell. Figure 1 shows the typical discharge characteristic of a 1Ah lithium cell powering an OP-290 with each amplifier, in turn, driving full output swing into a 100kΩ load.

INPUT VOLTAGE PROTECTION

The OP-290 uses a PNP input stage with protection resistors in series with the inverting and noninverting inputs. The high breakdown of the PNP transistors coupled with the protection resistors provides a large amount of input protection, allowing the inputs to be taken 20V beyond either supply without damaging the amplifier.

SINGLE-SUPPLY OUTPUT VOLTAGE RANGE

In single-supply operation the OP-290's input and output ranges include ground. This allows true "zero-in, zero-out" operation. The output stage provides an active pull-down to around 0.8V above ground. Below this level, a load resistance of up to 1MΩ to ground is required to pull the output down to zero.

In the region from ground to 0.8V the OP-290 has voltage gain equal to the data sheet specification. Output current source capability is maintained over the entire voltage range including ground.

APPLICATIONS

TEMPERATURE TO 4-20mA TRANSMITTER

A simple temperature to 4-20mA transmitter is shown in Figure 2. After calibration, the transmitter is accurate to ±0.5°C over the −50°C to +150°C temperature range. The transmitter operates from +8V to +40V with supply rejection better than 3ppm/V. One half of the OP-290 is used to buffer the V_{TEMP} pin, while the other half regulates the output current to satisfy the current summation at its noninverting input:

$$I_{OUT} = \frac{V_{TEMP}\,(R_6 + R_7)}{R_2\,R_{10}} - V_{SET}\left(\frac{R_2 + R_6 + R_7}{R_2\,R_{10}}\right)$$

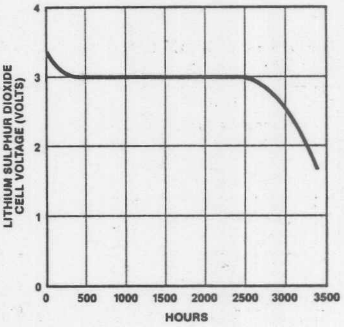


FIGURE 1: *Lithium Sulphur Dioxide Cell Discharge Characteristic With OP-290 and 100kΩ Loads*

The change in output current with temperature is the derivative of the transfer function:

$$\frac{\Delta I_{OUT}}{\Delta T} = \frac{\frac{\Delta V_{TEMP}}{\Delta T}(R_6 + R_7)}{R_2\,R_{10}}$$

From the formulas, it can be seen that if the span trim is adjusted before the zero trim, the two trims are not interactive, which greatly simplifies the calibration procedure.

Calibration of the transmitter is simple. First, the slope of the output current versus temperature is calibrated by adjusting the span trim, R_7. A couple of iterations may be required to be sure the slope is correct.

Once the span trim has been completed, the zero trim can be made. Remember, that adjusting the offset trim will not affect the gain.

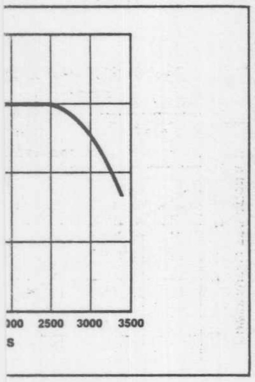
The offset trim can be set at any known temperature by adjusting R_5 until the output current equals:

$$I_{OUT} = \left(\frac{\Delta I_{FS}}{\Delta T_{OPERATING}}\right)(T_{AMBIENT} - T_{MIN}) + 4mA$$

Table 1 shows the values of R_6 required for various temperature ranges.

TABLE 1

TEMP RANGE	R_6
0°C to +70°C	10k
−40°C to +85°C	6.2k
−55°C to +150°C	3k



ide Cell Discharge
'00kΩ Loads

ı temperature is the deriva-

$_6 + R_7)$

$^{}R_{10}$

en that if the span trim is
wo trims are not interactive,
ration procedure.

mple. the slope of the
e is ca... ated by adjusting
tions may be required to be

pleted, the zero trim can be
he offset trim will not affect

ıy known temperature by
ent equals:

MBIENT − TMIN) + 4mA

required for various tem-

R_6
10k
6.2k
3k

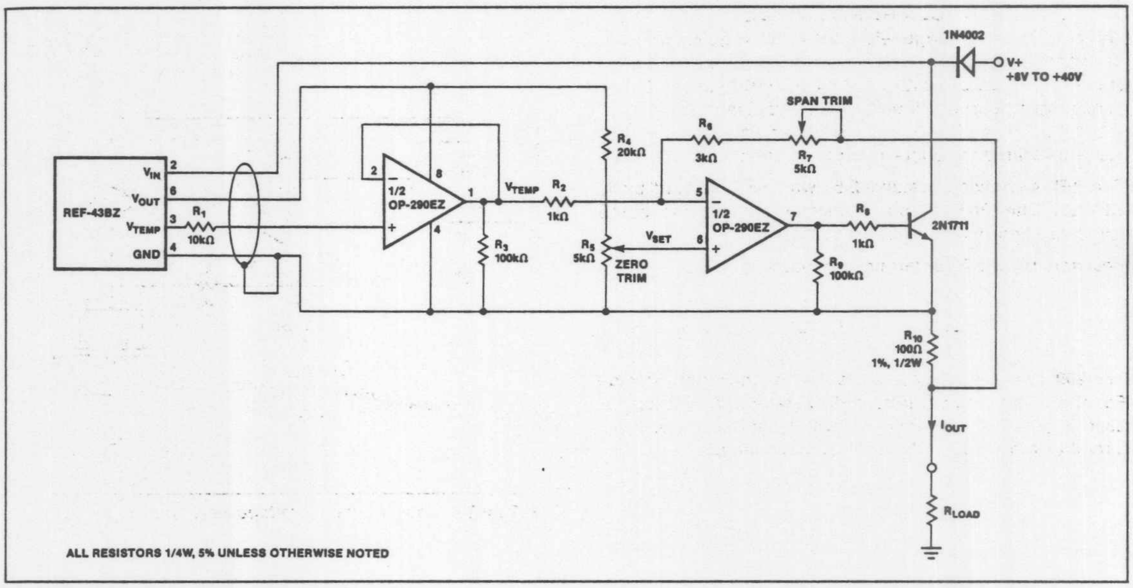


FIGURE 2: *Temperature to 4-20mA Transmitter*

VARIABLE SLEW RATE FILTER

The circuit shown in Figure 3 can be used to remove pulse noise from an input signal without limiting the response rate to a genuine signal. The non-linear filter has use in applications where the input signal of interest is known to have physical limitations. An example of this is a transducer output where a change of temperature or pressure cannot exceed a certain rate due to physical limitations of the environment. The filter consists of a comparator which drives an integrator. The comparator compares the input voltage to the output voltage and forces the integrator output to equal the input voltage. A_1 acts as a comparator with its output high or low. Diodes D_1 and D_2 clamp the voltage across R_3 forcing a constant current to flow in or out of C_2. R_3, C_2 and A_2 form an integrator with A_2's output slewing at a maximum rate of:

$$\text{Maximum slew rate} = \frac{V_D}{R_3C_2} \approx \frac{0.6V}{R_3C_2}$$

For an input voltage slewing at a rate under this maximum slew rate, the output simply follows the input with A_1 operating in its linear region.

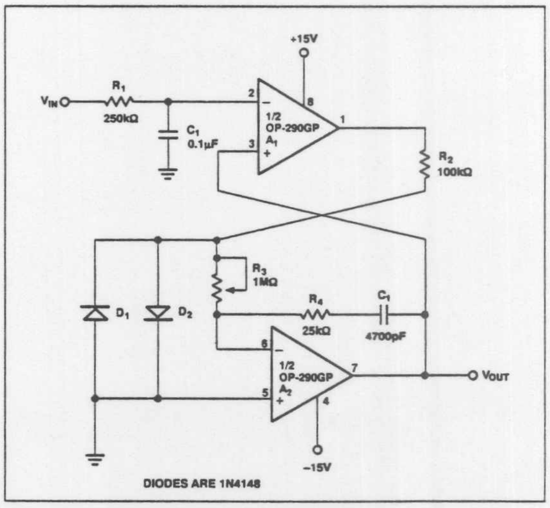


FIGURE 3: *Variable Slew Rate Filter*