Temperature Compensation Stabilizes LCD Contrast

The variation of LCD contrast with temperature can be a problem in some applications. Working in a meat-packing plant, for instance, you might go from scanning sides of beef in a refrigerated locker to downloading data from your LCD bar-code reader in a heated office. That temperature change would definitely require an LCD-bias adjustment.

Combining automatic bias adjustment with manual-adjust capability lets the user compensate for LCD viewing angles and manufacturing differences (**Figure 1**). This circuit provides a linear bias change with temperature, from -10V at 50°C to -15V at -20°C (**Figure 2**). (IC_1 is a power-supply chip for portable systems that includes two other switching-regulator controllers and four linear-regulator controllers, plus circuitry for backup-battery switchover, low-voltage warning, and power-fail reset.)

The automatic compensation is provided by a negative-temperature-coefficient resistor (R5) that affects the feedback for the V6 regulator in IC_1. Decreasing temperature, for instance, causes an increase in R5's resistance and a consequent increase in the LCD bias voltage (V6). R_4 linearizes the effect of R5, and R3 adjusts the temperature coefficient of R5 to that of the LCD. (Other tempcos require different values for R_2 and R_3.)

To calculate R2 and R3, note that V6 is a function of $V_{D/A}$ and RT. $V_{D/A}$ is the output of the internal 5-bit D/A converter, which allows the user to digitally adjust the LCD bias voltage, and RT is the sum of R3 and the parallel combination of R4 and R5:

$$V6 = V_{D/A} - \frac{(5V-V_{D/A})RT}{R2}$$

$$\text{therefore } R_T = \frac{R2(V_{D/A}-V_6)}{(5V-V_{D/A})}$$

Solve for R_T at the extremes of V6 (-10V and -15V) using the midrange value for $V_{D/A}$ (0.625V):

V6 = -10V: $R_T = 2.43R2$
V6 = -15V: $R_T = 3.57R2$

Equivalent expressions for R_T are based on its definition:

V6 = -10V: $R_T = R3 + (R5\ @50°C) \parallel R4$
V6 = -15V: $R_T = R3 + (R5\ @{-20}°C) \parallel R4$

From the R5 data sheet, R4 = 277kΩ (choose 280k, 1%), R5 @50°C = 52.7kΩ, and R5 @-20°C = 250.1kΩ. Substitute these values above, equate corresponding expressions for R_T, and solve for R2 and R3:

R2 = 172kΩ (use 169kΩ, 1%).
R3 = 365kΩ (use 365kΩ, 1%).

(Circle 5)

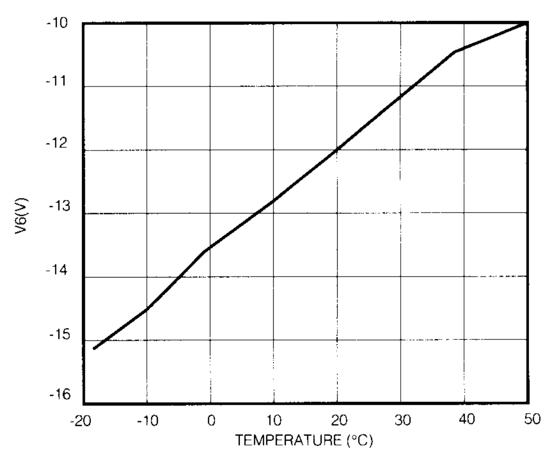

Figure 2. *The regulator output in Figure 1 serves as a temperature-compensated bias voltage for LCDs.*

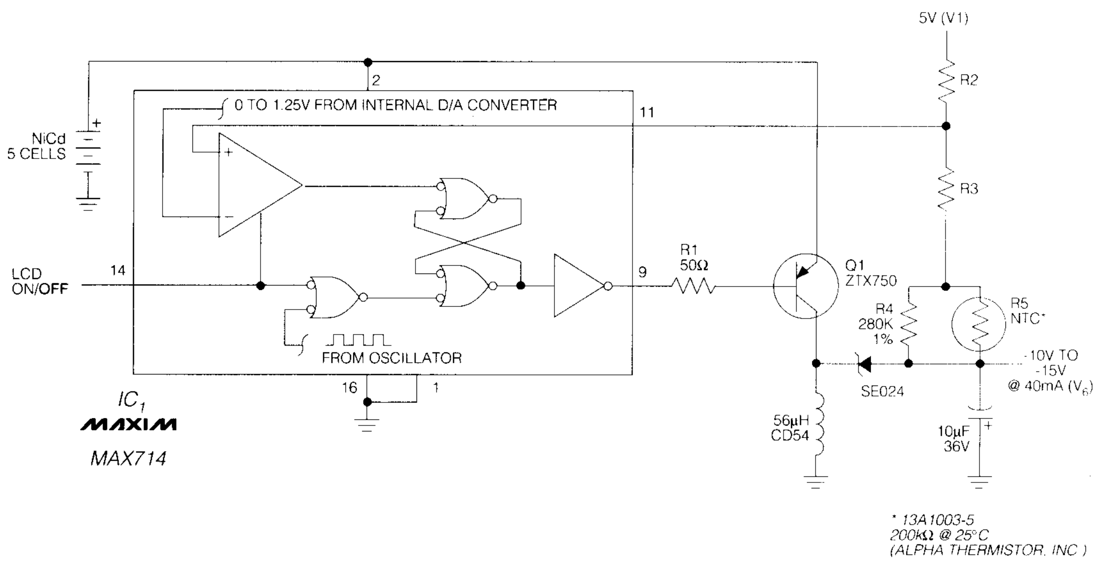

Figure 1. *The negative-tempco resistor R5 modifies feedback in this switching regulator, resulting in a negative output voltage that varies with temperature. With properly chosen resistor values (see text) the circuit produces a temperature-compensated bias voltage that assures constant contrast in an LCD.*