LED bar-graph display represents two digits

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This circuit uses two National Semiconductor (www.national.com) LM3914 dot/bar-display-driver ICs to implement a two-digit, 0 to 5V LED voltmeter that mimics a subranging flash ADC. An LED bar graph comprising five LEDs, each representing 1V of input signal, represents the MSD (most-significant digit). Nine LEDs in dot mode, in which only one LED lights, represent the LSD (least-significant digit). The circuit senses the operation of the MSD LEDs and uses them to change the input reference ladder of the chip that drives the LSD. The input signal ranges from 0 to 5V, and accuracy is better than ±50 mV. The circuit operates over a supply voltage range of 5 to 8V.

R_1 and R_2 divide the input voltage in half, such that a 5V maximum input is 2.5V at the LM3914s, IC_1 and IC_2 (**Figure 1**). You strap the mode pin of IC_1 high, so it operates as a bar graph, and use V_{R1} to adjust the REFOUT pin of IC_1 to 2.5V. Thus, each of the IC_1 output pins lights successively in 0.5V increments. Because this IC makes the MSD, you wire in only five LEDs on every other output, starting at output D_2, meaning that the five LEDs will light at 1V intervals from 1 to 5V. The LM3914's data sheet explains how you can use R_3 to set a constant-current output on the LED pins (**Reference 1**). The current in each LED is approximately 10 times the current that you draw from the REFOUT output pin. The part maintains 1.25V between the REFADJ and REFOUT pins. The $V_{R2}/R_{10}/R_{13}$ voltage divider causes a load, which, along with the 1.5-kΩ value of R_3, sets a fixed output current in LEDs D_1 through D_5. You should select these LEDs from the same batch so that their forward voltage drops match.

You then wire a resistor and a transistor around each of the four LEDs. The voltage across the LED also presses across the resistors, so these LEDs form four constant-current sources that operate in conjunction with the LEDs. Adjust V_{R3} such that each LED when on

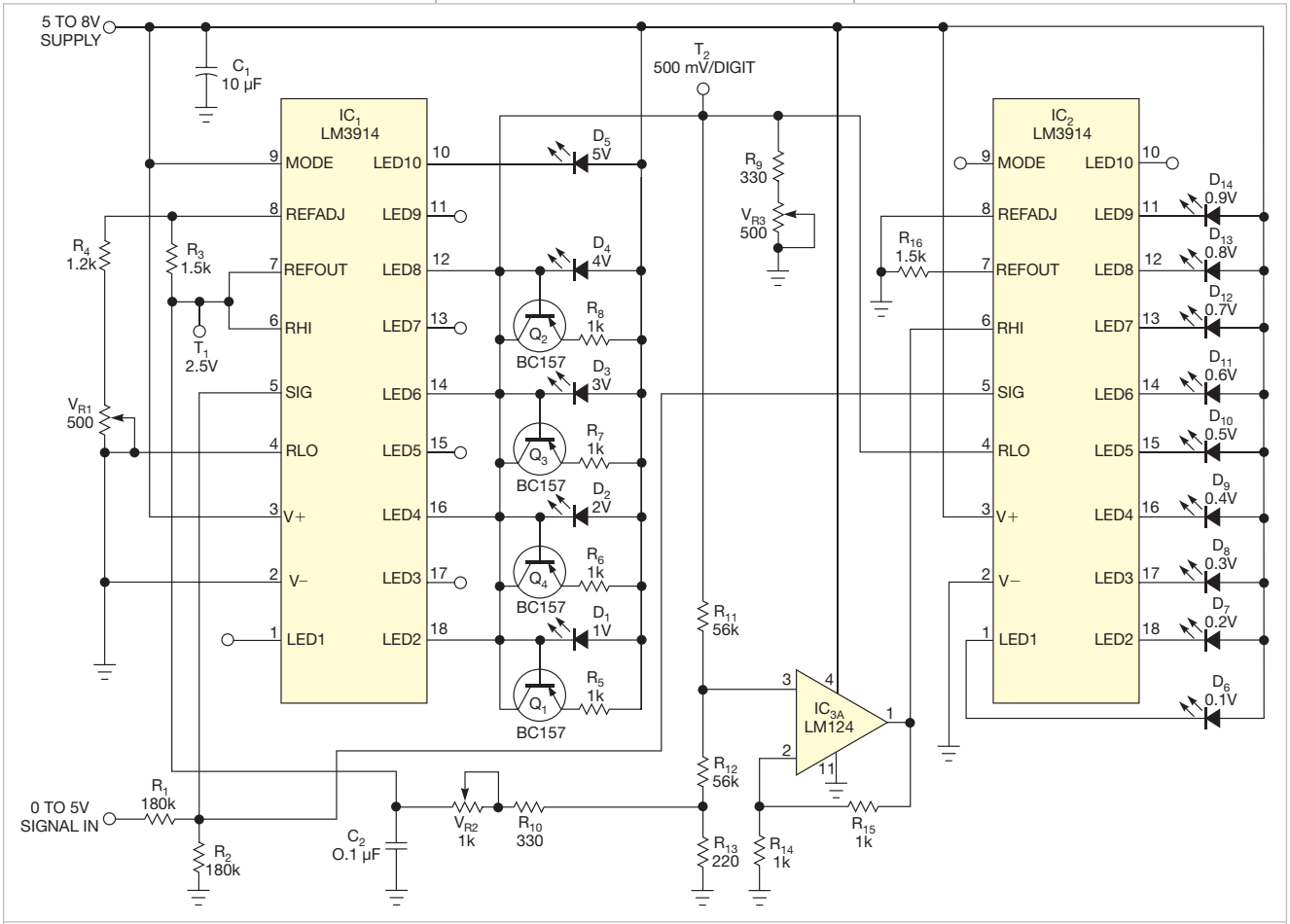

Figure 1 This voltmeter displays 1 to 5V as a bar graph from IC_1. A dot display from IC_2 represents the least-significant digit, with the LEDs representing 0.1 to 0.9V.

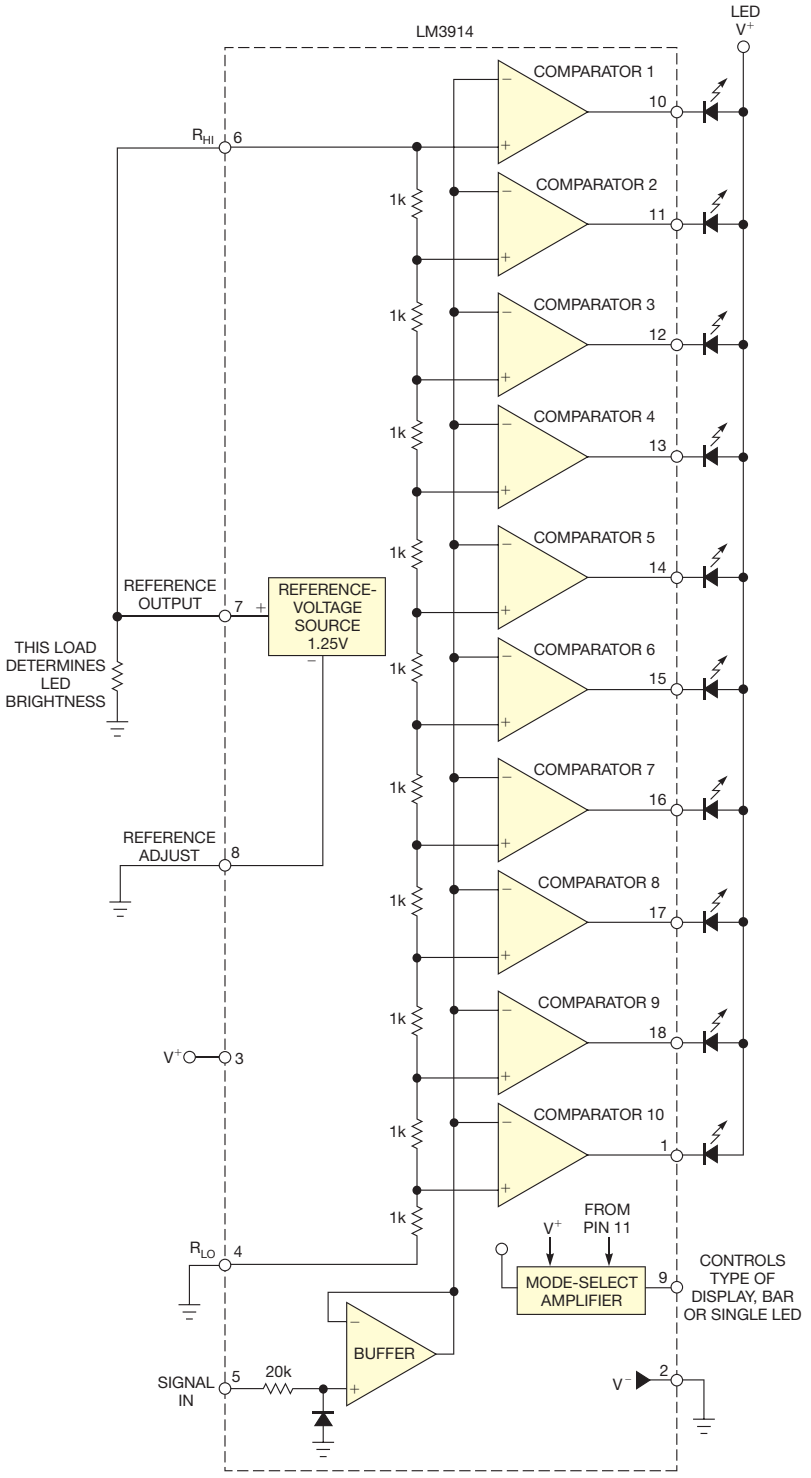

Figure 2 The LM3914 IC has an internal reference and a resistor ladder you can configure to make bar or dot LED displays (courtesy National Semiconductor).

adds 500 mV to their summed output. You send this signal to R_{LO}, the bottom of the internal resistor string in the second LM3914 (**Figure 2**). You then send the 50%-divided input signal to the SIG Pin of IC_2. Use an op amp, IC_3, to add a fixed 500-mV offset plus the summed-current signal from the outputs of IC_1. R_1 and R_2 reduce the input signal to the circuit by 50%, so a 500-mV excursion at IC_2's SIG Pin input represents 1V of the input excursion.

LEAVE THE MODE PIN ON IC_2 FLOATING SO THAT THE PART OPERATES IN DOT MODE, NOT BAR MODE.

As the input to the circuit goes from 0 to 1V, the SIG inputs to both bar-graph ICs go from 0 to 0.5V. No LEDs light on IC_1, meaning that IC_2 has R_{LO} at 0V and R_{HI} at the 500-mV offset you adjusted with V_{R2}. The LED outputs of IC_2 now light in sequence as the input to the chip goes from 0 to 0.45V, corresponding to a 0 to 0.9V input at the Signal-in Port. When the input signal is high enough to light LED D_1, the value at IC_2's R_{LO} jumps to 500 mV, and the input at R_{HI} jumps to just 500 mV higher than R_{LO}, or 1V. Because IC_2's internal resistor ladder is now biased between 0.5 and 1V, IC_2 indicates 0.1V steps between 1 and 2V at the Signal-in Port. Leave the Mode Pin on IC_2 floating so that the part operates in dot mode instead of bar-graph mode.

At a 4.9V input to the Signal-in Port, LEDs D_1 through D_4 illuminate, resulting in 2V at the R_{LO} input of IC_2. The op amp adds 500 mV to that value and presents it to the R_{HI} input of IC_2 for a total of 2.5V. The input to IC_2 is 2.45V, so the D_9 output of IC_2 lights D_{14}, correctly indicating the LSB (least-significant bit) of the measurement as nine-tenths. EDN

REFERENCE

1 "LM3914 Dot/Bar Display Driver," National Semiconductor, February 2003, http://bit.ly/naDCRG.