'Dithering' Display Expands Bar Graph's Resolution

National Semiconductor
Application Brief 25
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Commercially available bar-graph chips such as National's LM3914 offer an inexpensive and generally attractive way of discerning 10 levels of signal. If 20, 30, or more steps of resolution are required, however, bar-graph displays must be stacked, and with that, the circuit's power drain, cost and complexity all rise. But the techniques used here for creating a scanning-type "dithering" or modulated display will expand the resolution to 20 levels with only one 3914 or, alternately, make it possible to implement fine-tuning control so that performance approaching infinite resolution can be achieved.

The light-emitting-diode display arrangement for simply distinguishing 20 levels is achieved with a rudimentary square-wave oscillator, as shown in *Figure 1*. Here, the LM324 oscillator, running at 1 kHz, drives a 60 mV peak-to-peak signal into pin 8 of the 3914.

Now, the internal reference circuitry of the 3914 acts to force pin 7 to be 1.26V above pin 8, so that pins 4 and 8 are at an instantaneous potential of 4.0 mV plus a 60 mV p-p square wave, while pins 6 and 7 will be at 1.264V plus a 60 mV p-p square wave. Normally, the first LED at pin 1 would turn on when V_{IN} exceeded 130 mV, but because of the dither caused by the AC component of the oscillator's output, the first LED now turns on at half intensity when V_{IN} rises above the aforementioned value. Full intensity is achieved when V_{IN} = 190 mV.

When V_{IN} rises another 70 mV or so, the first LED will fall off to half brightness and the second one will begin to glow. When V_{IN} reaches 320 mV, the first LED will go off and the second will turn on fully, and so on. Thus 20 levels of brightness are easily obtained.

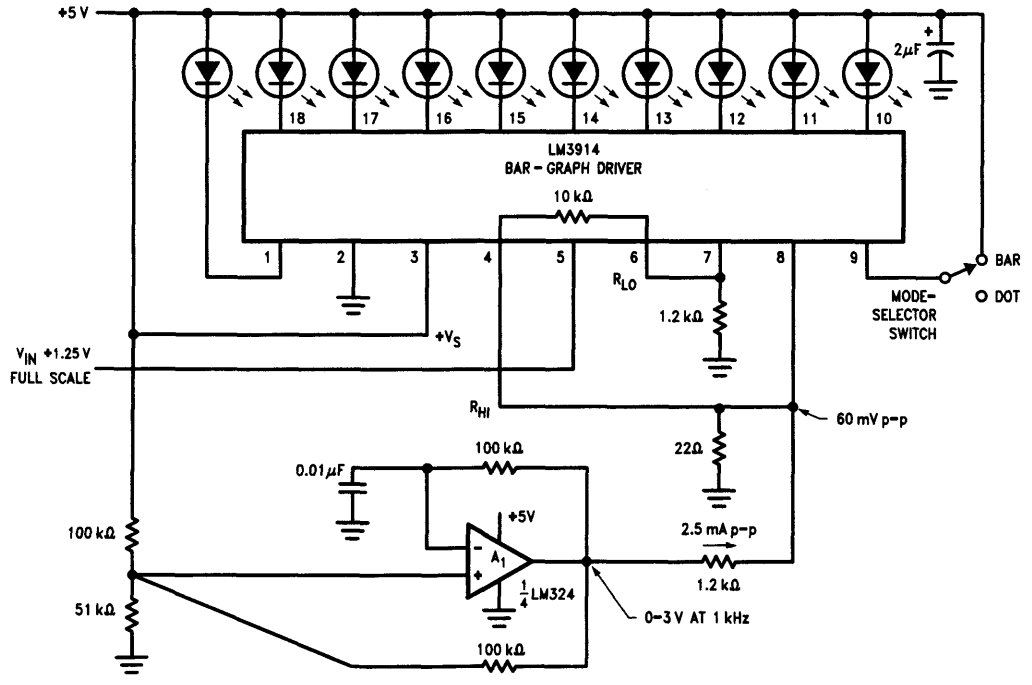

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FIGURE 1. Half tones. Input-signal biasing on LM3914 bar-graph chip is set by the instantaneous output of a low-amplitude square-wave oscillator so that bar-graph resolution can be doubled. Each of 10 LEDs now has a fully-on and a partially-on mode, making 20 states discernible.

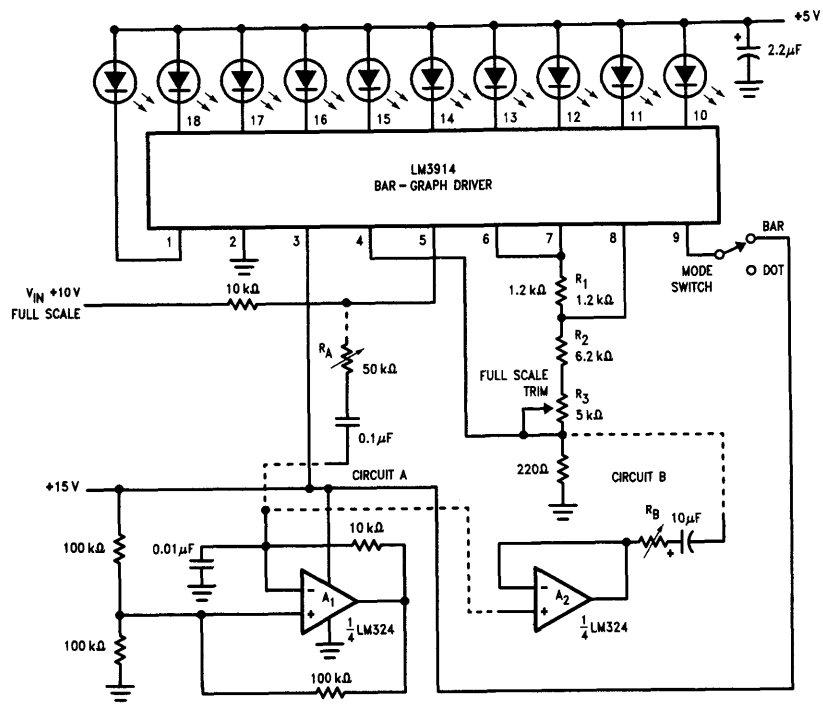

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FIGURE 2. Spectrum. Greater resolution, limited only by the ability of the user to discern relative brightness, is achieved by employing a triangular-wave oscillator and more sensitive control circuitry to set the voltage levels and thus light levels of corresponding LEDs. Two RC networks, circuits A and B, provide required oscillator coupling and attenuation. B replaces A if oscillator cannot suffer heavy loading.

Similarly, greater resolution can be achieved by employing a triangular-wave oscillator and two simple RC networks as seen in *Figure 2*. Here, by means of circuit A, this voltage is capacitively coupled, attenuated, and superimposed on the input voltage at pin 5 of the LM3914. With appropriate setting of the 50 kΩ potentiometer, each incremental change in V_{IN} can be detected because the glow from each LED can be made to spread gradually from one device to the next.

Of course, if the signal-source impedance is not low or linear, the AC signals coupled into the input circuit can cause false readings at the output. In this case, the circuit in block B should be used to buffer the output of the triangular-wave oscillator.

The display is most effective in the dot mode, where supply voltages can be brought up to 15V. If the circuit's bar mode is used, the potentials applied to the LEDs should be made no greater than 5V to avoid overheating.

To trim the circuit, set the LM3914's output to full scale with R_3. R_A or R_B should then be trimmed so that when one LED is lit, any small measured change of V_{IN} will cause one of the adjacent LEDs in the chain to turn on.