Scope-triggered register freezes data for display

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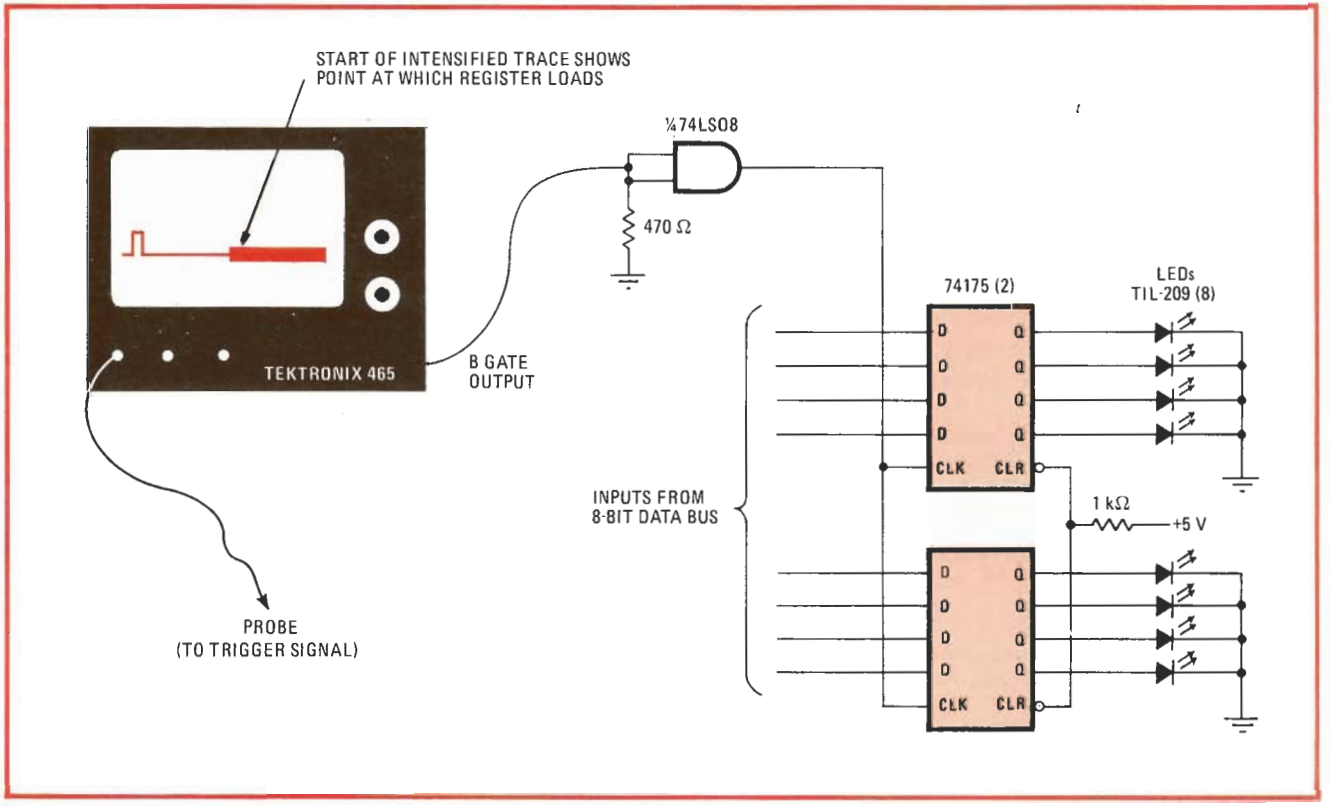
As an aid in logic analysis and program debugging, a standard delaying-sweep oscilloscope, such as the Tektronix 465 or 475, may be augmented with some logic circuitry, to capture and display the data present on a data bus.

The two time bases of the scope perform trigger and trigger-delay functions, the delayed trigger clocks a register to store the data, and light-emitting diodes display the stored levels. The data is not displayed on the face of the scope, which merely shows the timing of operations including a visual indication of the point at which the data state is stored for display by the LEDs.

The scope is operated in a repetitive or nonrepetitive mode, as appropriate. Generally the technique is used to study a repetitive process such as a program loop.

The figure shows a register of two 74175 quad D flip-flops, used to "freeze" the state of a multibit bus, such as a microprocessor's data bus, for examination. The scope trace is triggered by some major timing signal in the program, e.g., an input or output pulse, and its length corresponds to the program's duration.

The scope is operated in its A-intensified-by-B mode. Using the delay-time control of the scope, the bright-



Rudimentary logic analyzer. A lit light-emitting diode shows a logic 1 on the microprocessor data bus and a dark LED shows a logic 0—both at the moment that is determined by the setting of the delay-time knob on the oscilloscope. Scope trace indicates duration of program loop; the trace becomes brighter at the point where the data sample is loaded into the register to light the LEDs.

ened area of the trace that represents the delayed sweep is positioned to begin at the time point of interest.

When the B gate output goes high at the start of the delayed sweep interval, it loads and latches the register, which allows the LEDs to display the data levels that were on the bus at the instant of loading. As the delay time is advanced, the display lights show successive data values.

A 74LS08 AND gate is used as a buffer between the scope and the clock terminals of the quad D flip-flops.

The register, which in this example is eight bits wide, should be as wide as the bus being examined. The ordered array of LED's is easier to interpret as a number than multiple scope traces, and the storage of the register makes it possible to examine nonrepetitive events.

If desired, the LEDs may be replaced by decoders and numeric readouts to present a binary-coded-decimal, octal, or hexadecimal interpretation of the data. □