raduated-scale generator calibrates data display

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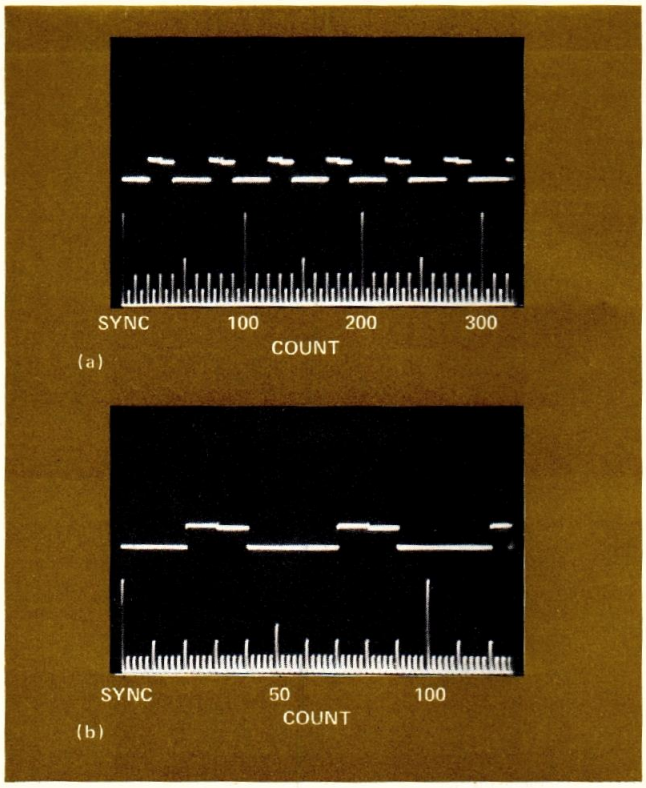
Scope and chart displays may require reference signals to indicate timing or counting scales. The circuit shown here is added to the display portion of a real-time digital data correlator at a cost of $3 or $4 to provide a graduated scale below the correlation display on a two-channel scope. Although it lacks the precision of a cursor, the continuous scale offers greater versatility and speed of operation. It also references the display data when stored on hard copy.

The photographs in Fig. 1 show two scales that can be generated to aid the observer in determining the pulse count or time at which a wave form rises or falls. In the lower trace of Fig. 1(a), every fifth clock pulse is indicated, and in Fig. 1(b), every second clock pulse is indicated. The upper trace in each photo shows a wave form that goes high at count 20, low at 40, high again at 70, low again at 90, and so forth. These counts can be read easily and accurately from the reference scales.

As shown in Fig. 2, the scale generator is remarkably simple. For two decades of unique graduations, two decade counters (7490) and one package of open-collector AND gates (7409) are required. These gates switch a crude voltage-divider digital-to-analog converter, generating the various pulse heights. Gate A in Fig. 2 ANDs the system clock with the basic scale unit—five in Fig. 2(a) or two in Fig. 2(b)—enabling the voltage-divider output to rise. Low gates B, C, or D (or combinations) clamp the output to appropriate levels as determined by R_1, R_2, R_3, and R_4. As higher-order counters progres-

1. Measurement aids. Graduated scales are generated on dual-trace scope or chart to facilitate probing of displayed data. In lower trace (a), every fifth clock pulse has a spike; in lower trace (b), every second clock has one. From these scales, observer sees that upper trace rises at count 20 and falls at count 40. Circuits for generating scales are shown in Fig. 2.

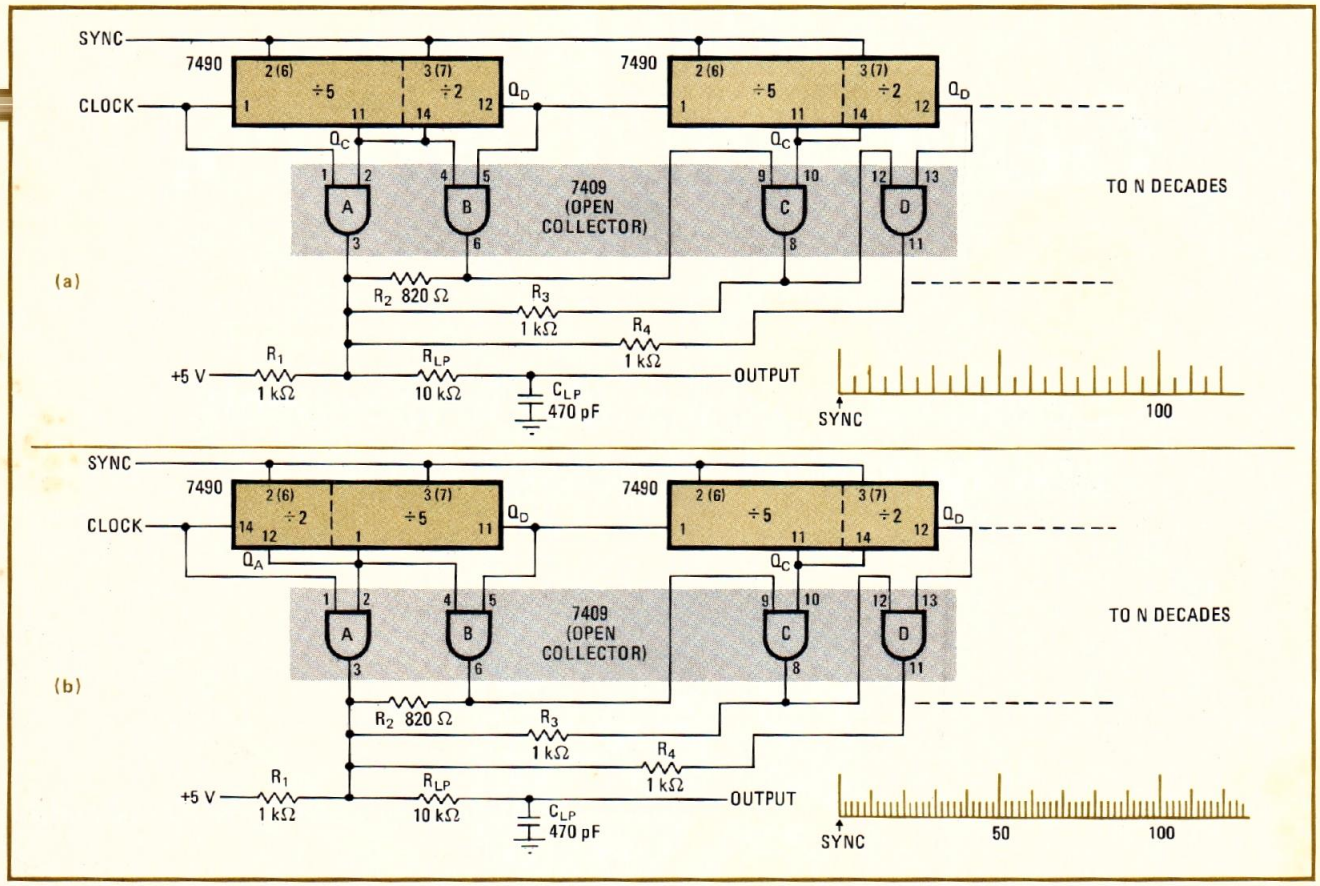


sively flip high, taller graduations are created.

Use of the 7490's quinary and binary counters obviates the need for extensive decoding. For example, the output of gate A in Fig. 2(a) goes high on the clock high of count 4, (9, 14, 19, etc); gate B ANDs this high signal with counts 5–9 (15–19, 25–29), thus decoding count 9 (19, 29). The cascaded decade circuit decodes counts 49 and 99. For display on a scope, a low-pass filter or integrator consisting of R_{LP} and C_{LP} is added to improve the appearance of the scale by increasing the rise and fall times of the pulses. Relative pulse heights may be altered via resistor ratios of R_1, R_2, R_3, and R_4. However, to ensure adequate noise margin at inputs of gates C and D, R_1 must not be greater than R_3 or R_4.

Synchronization of the scale generator to the scope and system output is accomplished by providing a pulse to reset the counters to zero (pins 2, 3) for graduations on counts 4, 9, 14, 19, etc. or to maximum (pins 6, 7) for graduations on counts 5, 10, 15, 20. . . .

The use of this graduated-scale generator can ensure



Here's how. Circuits for generating graduated scales of incoming clock pulses use decade counters. Two AND gates per decade switch voltage-divider d-a converter to produce various pulse heights; the AND gates have open collector outputs. Each counter in (a) divides by 5 and then by 2 to provide scale with a basic unit of 5 counts. In (b), first counter divides by 2 and then by 5 to provide a basic unit of 2. Second counter divides by 5 and then 2 to enhance pulses at 50 and 100. Values of R_{LP} and C_{LP} shown here are chosen for use with a 10-kHz clock.

precise tagging of displayed data even when the scope is being operated in the magnify, delayed-sweep, and uncalibrated-sweep modes. Other applications include generation of a time scale for sweep calibration of scopes (when clocked by a high-precision source) and generation of a clock-pulse scale for troubleshooting cyclic sequences. The latter application is illustrated by the upper traces in the two photographs; this waveform is actually the output of the second bit of the second quinary counter (pin 8 of the second 7490). □