Use a

TRIPLE-THREAT IC

How a CD4040's 12 flip-flops can be used to make a frequency divider, counter, or meter

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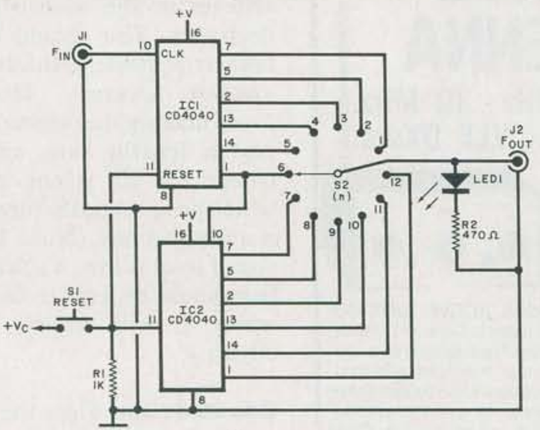
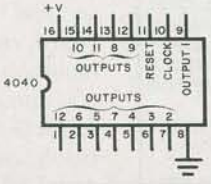
A MAJOR advantage in using state-of-the-art semiconductors is that a number of transistors and several conventional ICs often can be replaced by a single IC. A case in point is the CD4040 CMOS 12-stage ripple binary up-counter. This versatile IC can be used to make a low-cost frequency divider, long-term counter or even a simple frequency meter. In this article, we'll discuss how you can go about doing all three inexpensively and with minimum parts count.

Technical Details. All 12 of the CD4040's cascaded flip-flops are capable of being reset to zero by applying a high (+V) at the RESET input. For normal counting however, the RESET input is held low.

If an input signal is applied to the clock input, each stage will divide the frequency of the signal by 2, the last stage dividing the frequency by 2^{12} (4096). Cascading two counters as shown provides 24 stages that each divide by two, for a grand total of 16,777,216 divisions. In general, stage *n* will divide the input by 2^n, where *n* is the stage number.

Maximum input frequency to the circuit depends upon supply voltage. For example, with 5-, 10-, and 12-volt supplies, maximum input signals are about 4, 10, and 12 MHz, respectively. Since the 4040 is a CMOS device, it has the advantage of low power consumption, wide 1-to-15-volt power supply range and high noise immunity.





PARTS LIST

IC1,IC2—CD4040 12-stage counter
LED1—Any light-emitting diode
J1,J2—Miniature open-circuit phone jack
R1—1-kilohm, ¼-W resistor
R2—470-ohm, ¼-W resistor
S1—Spst normally open pushbutton switch (Radio Shack 275-1547)
S2—Single-pole, 12-position (or 24-position) nonshorting rotary switch (Radio Shack 275-1385 or similar)

Possible Applications. The circuit shown here can be used as a frequency divider, timer, and simple form of frequency meter as follows:

Frequency Divider. Twelve-position switch *S2* permits a selection of every other counting stage. In this configuration, each position permits division by 4 of the input frequency. Thus, for any selected position of *S2*, the circuit will divide the input frequency by 4^n, where *n* is the number of the switch position selected. Of course, a 24-pole switch can be substituted to obtain *every* divide-by capability of the two-chip circuit. In the frequency-divider mode, any signal within the maximum range of the IC can be divided down as desired. One possible application of the frequency-divider mode is to allow an r-f generator to cover the audio range. If an accurate oscillator is used as the input, you will end up with a precision audio source.

Timer. If the power line-frequency of 60 (or 50) Hz is used as the input signal, the circuit can be used as a timer that can be reset using *S1*. A 60-Hz input has a period of 0.016667 second (16.667 ms), which means the first stage will change state every 0.01667 second, the second stage will double this time, and so on to the last stage, which changes state every 139,809.57 seconds (1.618 days). Since the selected position of *S2* will be high after 4^n (0.01667) seconds, *LED1* will turn on to indicate that the output is high. This high can then be used to control other circuits, the only precaution here being that the input voltage of the circuit being controlled must be about equal to the supply voltage for the timer circuit.

Frequency Meter. This mode is just the reverse of the timer mode, because here the input frequency is not known. If we assume the period of the input signal is T, the first stage will change state every 2 × T seconds and, hence, will come back to its state after 4 × T seconds. Therefore, any position of *S2* will yield a period of $4^n \times T$ (*n* being the switch selected). The output is monitored by *LED1*. Hence a period is measured from the time the LED turns off until it turns on again. If you use a stop watch or wristwatch to measure the period, you can calculate the unknown frequency from $f = 4^n/T$, where T is the time measured, for position *n*, to turn off *LED1* and then turn it on again.

Frequency measurement accuracy depends upon time-measurement accuracy. Consequently, accuracy is greater for large values of T since the percentage error due to human reflexes in the measuring process decreases. You should choose the highest possible position for *S2* for greatest accuracy. However, to avoid making the measurement process a lengthy one, an optimum choice for *S2* is the position in which an extinguish/turn-on period is a few seconds. (Note: If the input signal level is low, a suitable amplifier should be used to increase it to where it will reliably drive the circuit.)

Construction. Since the circuit has so few components, perforated-board construction can be conveniently used. Selector switch *S2*'s positions can be numbered from 0 to 11 (or 0-23 if you substitute a 24-position switch as described above). Any LED with the appropriate current-limiting resistor (*R1*) can be used to monitor the output. The board can be installed in almost any metallic or plastic box. Finally, any 3-to-15-volt source can be used to supply power to the circuit. ◊