ICs' hidden features enhance counter-based designs

ICs designed expressly for counter applications appear in most digital-device data books but might not offer the features you need. Chips dedicated to other applications, however, often include counter functions that you can access.

John Hatchett and **William Morgan,**
Motorola Semiconductor Products Sector

When looking for a digital counter, don't limit your search to dedicated ICs, which might require the "wrong" supply voltage, take too much power, operate too slowly or perhaps not be readily available. The function you need might be hidden within other devices aimed at different applications.

For example, frequency-synthesizer/phase-locked-loop ICs generally contain on-chip counters—often more than one. And CMOS-based versions of these devices tolerate wide supply-voltage variations, operate at low current levels and function at input frequencies in the tens-of-megahertz range.

Three devices provide the options

Three devices that meet these requirements, the MC145146, -151 and -157, each contain at least one 10-, 12- or 14-bit counter (**Table 1**) and operate over a 3 to 9V supply range. The counters' programming methods differ, suiting them to a variety of applications.

Table 2 shows the devices' counting ranges and counter-programming requirements: The 14-bit MC145151 accepts parallel counter loading; a 4-bit data bus programs the 10- and 12-bit -146 counters; and the -157's dual 14-bit counters load via a clocked, serial data stream.

You parallel-load **Fig 1a**'s MC145151 via inputs N_0 through N_{13} using **Table 2**'s code sequence. (Note that all three devices achieve full count value for an all-ZERO input and are nonresponsive for inputs of 00...01 and 00...10.) By comparision, the -146's 10- and 12-bit counters require three 4-bit inputs at D_0 through D_3 (**Fig 1b**). Address bits A_0 through A_2 direct these 4-bit nibbles to the appropriate counter locations. The indicated strobe/chip-select signal (ST) allows the data and address lines to share a common bus with other system functions because they achieve an inactive high-impedance state when ST is LOW.

The MC145157's dual 14-bit counters employ only three programming interface controls: the Data, Clock and Enable functions (**Fig 1c**). You accomplish a count-loading operation by clocking the data into the on-chip shift registers, then transfering the information into the latches by taking Enable HIGH. (Conversely, keeping Enable LOW allows you to enter new data into the registers without disturbing what's already in the counters.) The first 14 bits are the count value; the 15th bit selects which counter gets loaded—a ONE loads ÷R, a ZERO loads ÷N.

Other than these programming differences, the counters are sufficiently similar to permit one functional description, and an example application demonstrates their advantages.

A CMOS counter's current consumption generally depends on its supply voltage and the input's frequency

TABLE 1—COUNTER CHARACTERISTICS

OPERATING VOLTAGE	3 TO 9V DC
OPERATING TEMPERATURE	– 40 TO + 85°C
COUNTERS AVAILABLE:	
MC145146	ONE 12-BIT, ONE 10-BIT
MC145151	ONE 14-BIT
MC145157	TWO 14-BIT
TYPICAL CURRENT DRAIN AT 25°C FOR f_{IN} = 10 MHz, V_{DD} = 5V	
V_{IN} = 2V p-p	2.0 mA DC
V_{IN} = 0.5V p-p	2.4 mA DC
MAXIMUM F_{IN} WITH 500 mV P-P SINE-WAVE INPUT AND V_{DD} = 5V	15 MHz MIN
PACKAGE SIZE (DUAL IN-LINE):	
MC145146	20 PIN, 0.3-IN. WIDE
MC145151	28 PIN, 0.6-IN. WIDE
MC145157	16 PIN, 0.3-IN. WIDE