Design Ideas

A Few RF Applications of Digital ICs

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With single-digit nanosecond transition times and clock speeds in the hundreds of MHz, it doesn't take much imagination to see that current digital ICs might be useful in RF applications. We all know about classic RF/digital uses in frequency counters, digital signal processing (DSP) and phase-locked loops (PLLs), but there are other, simpler ways that standard digital ICs can be used.

The main point of this note is that Advanced CMOS (74AC series ICs) will directly drive a 50 ohm load. This is the first logic family to have this performance without exceeding published specifications. ACMOS is a low cost process, another attractive feature.

Square wave mixer drive

50 ohm drive is useful in many ways. For example, most mixers, including the ubiquitous diode double balanced type, have improved intermodulation performance when the driving waveform is a square wave. Of course, digital signals are square waves. Driving a mixer with ACMOS is almost trivial, requiring only a DC blocking capacitor for most mixer transformer connections. The inductive load of a transformer can cause ringing when driven with a square wave, so a small series damping resistor may be needed. The exact value should be determined experimentally, and will be in the tens of ohms range to maintain sufficient drive voltage while minimizing ringing. Figure 1 illustrates these mixer drive options.

If we can provide a push-pull waveform to the mixer, a transformer can be eliminated. The simplest way to do this is with a flip-flop in a divide-by-two circuit. A possible disadvantage is that the local oscillator must operate at twice the desired frequency. This simple technique is illustrated in Figure 2.

Quadrature mixing and demodulation

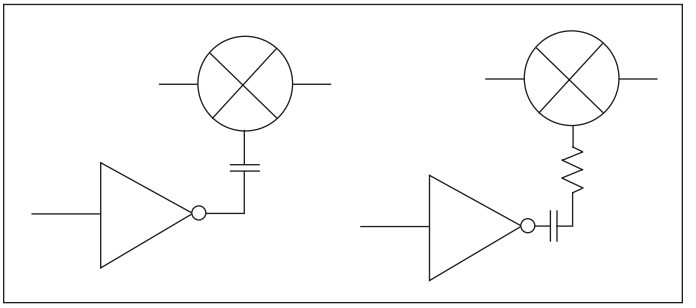
Taking the divider technique one step further, a divide-by-four circuit can produce quadrature square waves with excellent symmetry. A circuit that creates quadrature drive signals from a 4×LO input is shown in Figure 3. This circuit can operate at frequencies up to 30 MHz (120 MHz input) using ACMOS devices.

More ideas

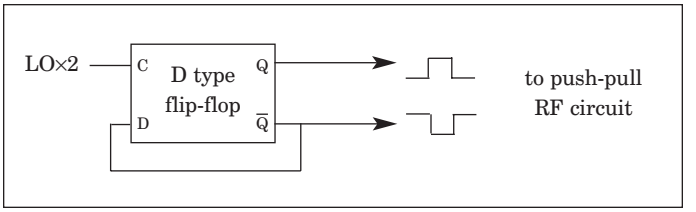
The most common additional way to use digital circuits is in timing and frequency standard distribution. ACMOS can drive a coaxial cable, although you may wish to buffer the output by connecting several gates or inverters in parallel to increase the drive capability.

As a last idea, delay lines (phase shifters) can be implemented with a series of gates or inverters coupled with R-C networks.

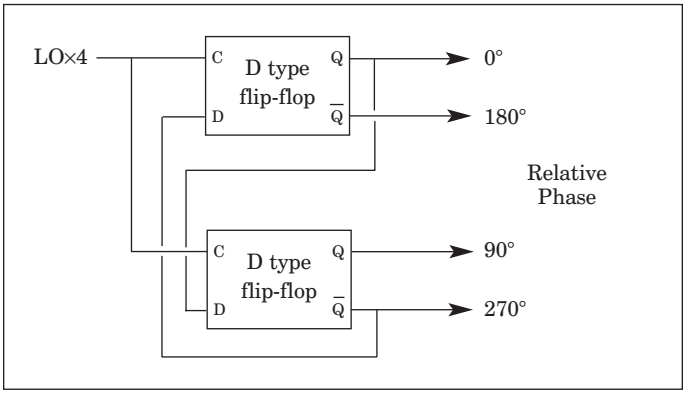
The 100-160 MHz clock rates supported by ACMOS make it a valuable tool for digital *and* RF design. ■



■ **Figure 1. ACMOS digital devices can directly drive 50 ohm loads such as mixers. On the right, a series resistor is used to minimize ringing when the load is inductive.**



■ **Figure 2. A divide-by-two circuit creates a differential output that can replace a transformer in some circuits.**



■ **Figure 3. A divide-by-four circuit can be used to generate quadrature signals for I/Q modulation and demodulation.**