Using the MC1648 in Oscillators

The Motorola MC1648 is a specialized LC-oscillator IC that has been manufactured since the early 1970s and is a surviving member of MECL III, a long-obsolete family of emitter-coupled-logic devices. It is still used in military and commercial equipment. It is difficult to obtain, expensive, power hungry, and offers relatively low performance. Its circuitry is complex for an oscillator, with a multi-transistor limiting-amplifier cell controlled by an on-chip ALC system. The MC1648's first problem is that the ECL families use only about a 0.8 V swing between logic levels, and this same limitation applies to the signal in the oscillator tuned circuit. It is possible to improve this situation by using a tapped or transformer-coupled tank circuit to give improved Q, but risks the occurrence of the device's second problem: bandwidth creep.

Periodically, semiconductor manufacturers modernize their plants and scrap old assembly lines used to make old products. Any surviving devices then must undergo some redesign to allow continued production using the newer processes. One common result of this is that devices are shrunk, when possible, to fit more onto a wafer. All this increases the f_T of the transistors in the device, and such evolution has rendered today's MC1648s capable of operation at much higher frequencies than the specified 200-MHz limit. This allows higher-frequency use, of course, but great care is needed in the layout of circuits using it to prevent spurious oscillation. A number of old designs using this part have needed reengineering because the newer parts generate spurious oscillations that the old ones didn't, using PC-board traces as parasitic tuned circuits. Remember the Barkhausen criteria – as long as the gain is greater than 1 when phase shift is zero, there will be oscillation.

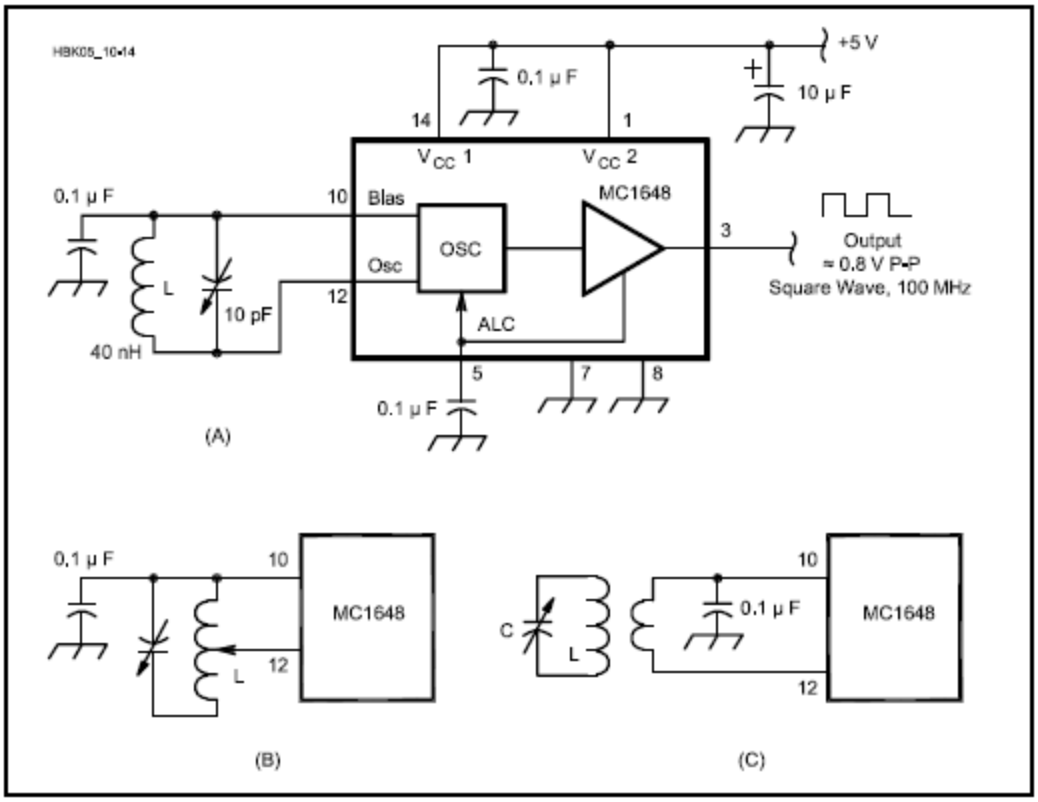

Figure 1 — One of the few ICs ever designed solely for oscillator service, the ECL Motorola MC1648 (A) requires careful design to avoid VHF parasitics when operating at HF. Keeping its tank Q high is another challenge; B and C show means of coupling the IC's low-impedance oscillator terminals to the tank by tapping up on the tank coil (B) or with a link (C).

The moral here is that a UHF-capable device always requires UHF-cognizant design and layout, even if the device is used at far lower frequencies. **Figure 1** shows the MC1648 in a simple circuit and with a tapped resonator. These more complex circuits have a greater risk of presenting a stray resonance within the device's operating range, risking oscillation at an unwanted frequency. This device is not a prime choice for an HF VFO because the physical size of the variable capacitor and the inevitable lead lengths, combined with the need to tap-couple to get sufficient Q for good noise performance, makes spurious oscillation difficult to avoid. The MC1648 is really intended for tuning-diode control in phase-locked loops operating at VHF.

This difficulty is inherent in all wideband devices, especially oscillator circuits connected to their tank by a single "hot" terminal, where there is simply no isolation between the amplifier's input and output paths. Any resonance in the associated circuitry can control the frequency of oscillation.