ECL tuned oscillators are voltage-stable

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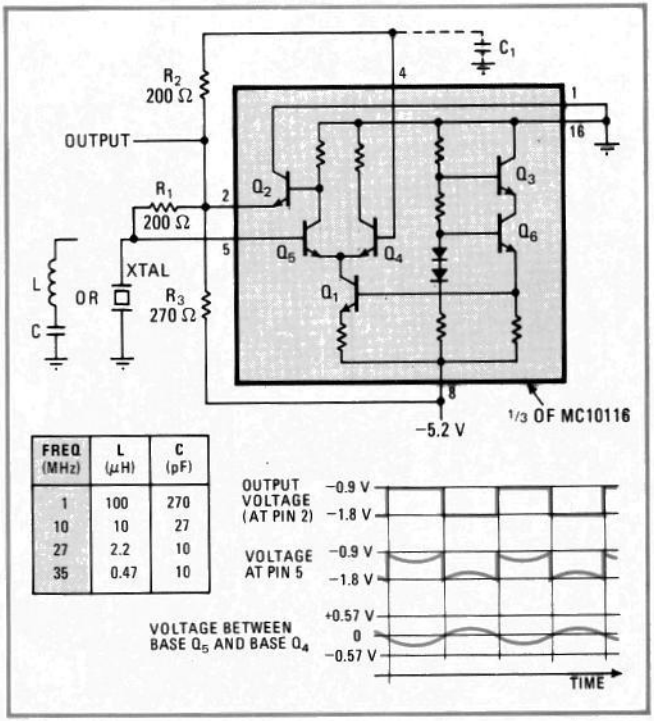
A simple square-wave crystal oscillator or LC oscillator can be built by using one third of an MC10116 integrated circuit, which is a triple differential amplifier in the MECL 10,000 series. It has better frequency stability than a similar oscillator that uses a resistor and capacitor as the frequency-determining elements [*Electronics*, May 29, p. 106]. A 1-volt variation in supply voltage to the RC oscillator caused fractional frequency changes ranging from 0.09 at 10 megahertz to 0.02 at 50 MHz. The same voltage variation changes LC oscillator frequencies of 1, 10, 27, and 35 MHz by less than 0.003; and crystal oscillator frequencies of 10 and 20 MHz are changed less than 5×10^{-6}.

Details of the tuned oscillators are shown in the figure. Transistors Q_1, Q_4, and Q_5 form a differential amplifier. The output signal supplied by emitter follower Q_2 is fed back via resistors R_1 and R_2 to the bases of Q_4 (positive feedback) and Q_5 (negative feedback). If no crystal or LC combination is connected to the bases of Q_4 and Q_5, the feedback signals cancel each other because of the high common-mode rejection of the differential amplifier, and the circuit is thus quiescent.

When an LC circuit or a crystal is connected between the base of Q_5 and ground, the negative-feedback signal is attenuated by the divider consisting of R_1 and the low impedance of the LC circuit or crystal at the series-resonant frequency. Because positive feedback dominates, the circuit oscillates.

The top waveform represents the oscillator's output voltage, i.e. a square wave alternating between ECL logic levels. The middle waveform displays the idealized signal on the base of Q_5, i.e. the output square wave with its fundamental frequency component attenuated by the divider. The bottom waveform represents the difference between the other two waveforms, which is the voltage acting between the bases of Q_5 and Q_4. This voltage, clipped and amplified by the differential amplifier, constitutes the oscillator output voltage. □



Stable. ECL-oscillator frequency, determined by crystal or LC tank circuit, is insensitive to variations in supply voltage. Capacitor C_1 balances stray capacitances (e.g. from crystal holder) that might cause parasitic oscillations; its value is $(R_1/R_2)C_{stray}$.