Phase-locked loops go digital

Motorola Semiconductor is marketing two new TTL circuits that expand the world of digital circuits into the area of phase-locked loops (PLL). Fig. 1 shows the basic loop using the new circuits along with Motorola's entry into the Modulo-n divider derby.

A PPL uses feedback techniques to generate an output frequency that is an integral multiple and in phase with a reference frequency. The Frequency-Phase Detector and Voltage Controlled Multivibrator (VCM) could have been put into one package, but Motorola expects to introduce other compatible VCMs, which may have to be shielded at high frequencies.

The MC4044 Digital Frequency-Phase Detector accepts TTL pulse trains on its two inputs, one from a reference oscillator and one from the feedback loop. The circuit achieves zero phase error by locking negative edges of the input pulses, and it is insensitive to duty cycle. A digital phase detector and an analog charge pump circuit convert the inputs into a dc voltage level for use in frequency discrimination and PLL applications. A phase difference between the input waveforms alters the dc voltage to the VCM, which changes its operating frequency until an in-phase condition results.

The MC4024 VCM generates a digital output waveform whose frequency range is linearly dependent upon the variation in dc input voltage between +3 and +5 V. Output frequency is variable over a 3.5 to 1 operating range; the center frequency of which is determined by an external capacitor. See Fig. 2. The VCM will operate between 10 kHz and 30 MHz and dissipates 150 mW.

These units are intended as frequency synthesizers for communication, instrumentation, and computer applications. Digital programming of the VCM output in multiples of the reference frequency is accomplished by changing the value of N in the Divide-by-N package in the feedback loop. Conventional synthesizers comparable to the system in Fig. 1 use 6 to 10 crystals and a lot of functional logic.

Applications are expected in tuners, frequency synthesizers, FM detection, synchronization, timing, and A/D conversion. In aircraft radios, banks of crystals and a mechanical movement costing $80-$100 can be replaced for about $40, and prices could drop to about $20 in a year. In quantities of 100, the two PLL circuits shown cost: MC4044P—$7.00, MC4024P—$5.50. Prices are for DIP plastic packages. DIP ceramic packages and ceramic flat-packs are also available.

Motorola Semiconductor Products Inc., Box 20912, Phoenix, Ariz. 85036.

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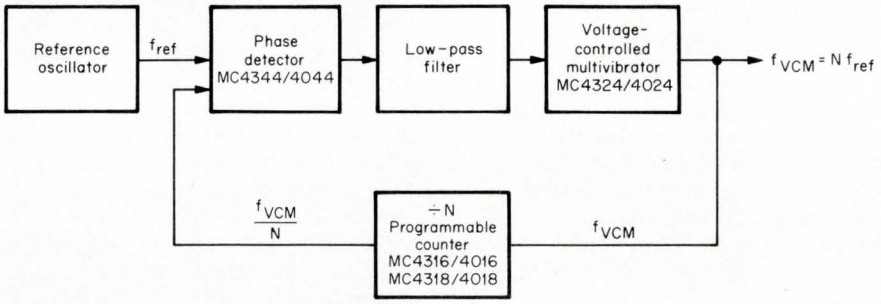

Fig. 1: Digital phase-locked, frequency synthesizer loop. This loop generates output frequencies that are multiples of the reference frequency. When N is changed, or the phase detector senses a phase difference on its inputs, it changes the dc voltage to the VCM which changes its output frequency until an in-phase condition is restored.

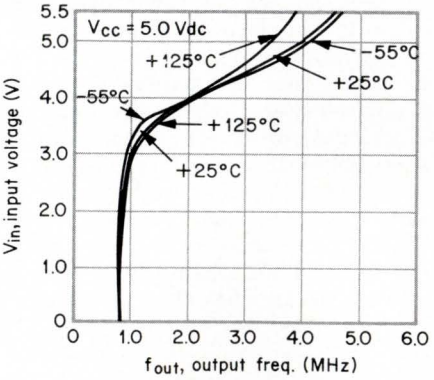

Fig. 2: Operating characteristic of the VCM with a 100 pF feedback capacitor. Output frequency is altered when the input voltage changes between +3 and +5 V. The value of the external control capacitor, C, in μF, can be found from the relationships: $C = 500/f_{max}$ or $C = 100/f_{min}$.

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