All-digital phase shifter handles 5-to-1 bandwidth

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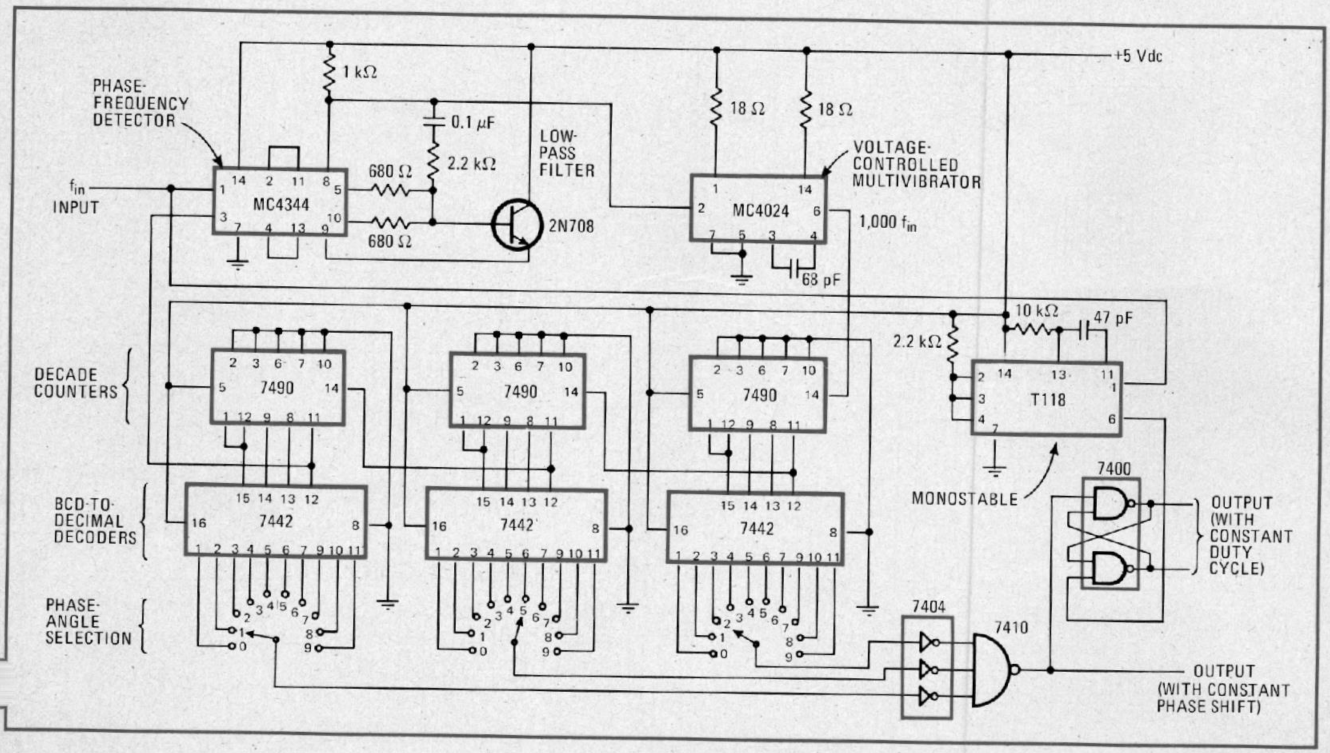
A digitally programable phase-shift network can be made to maintain the phase shift at its output constant, even though the frequency at its input varies by as much as a factor of five. The circuit consists mainly of digital ICs, including its input-detector stage.

The desired phase shift is switch-selectable through a three-stage counter/decoder network. Any phase shift between 0° and 360° can be chosen. Here, the angle selected is divided into 1,000 bits, but a finer resolution can be obtained by increasing the number of decade counters.

For the component values indicated, the circuit's phase angle stays locked for input frequencies from 2 to 10 kilohertz. This operating frequency range can be shifted by changing the values of the low-pass filter components and the value of the timing capacitor for the voltage-controlled multivibrator.

The circuit also produces an output whose duty cycle remains constant. □

Locking phase digitally. Circuit produces the phase shift (between 0° and 360°) selected by the three switches. This digitally programed phase angle does not change, although the input-signal frequency may vary from 2 to 10 kilohertz. The circuit's operating frequency can be changed by adjusting the low-pass filter and the timing of the voltage-controlled multivibrator. There is also a constant-duty-cycle output.



Digital phase shifter covers 0° to 360° range

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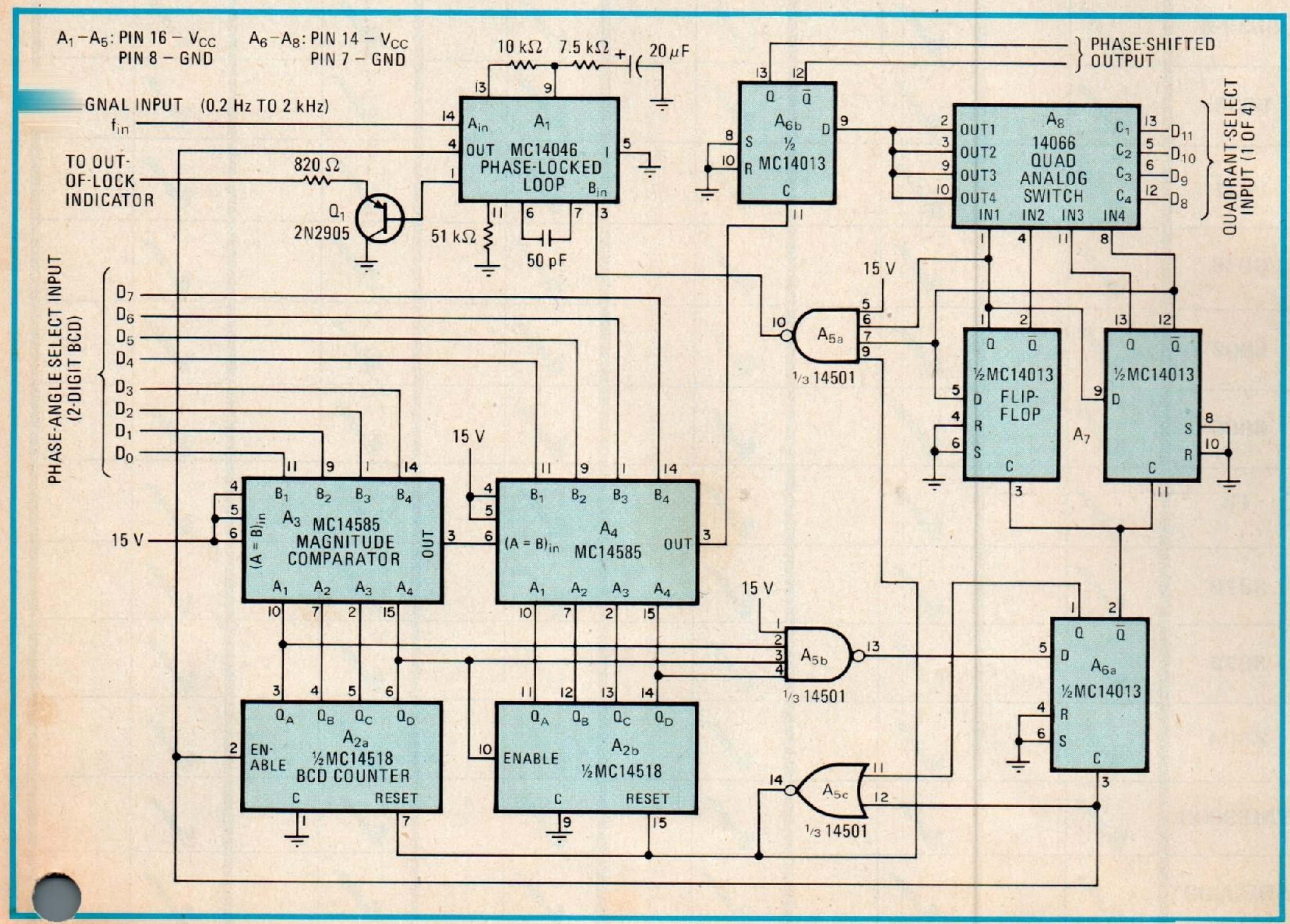
Offsetting the phase of a signal by digital means over the range of 0° to 89° in any quadrant, this low-power circuit is particularly useful in data-recovery systems that employ synchronous detectors. Unlike most RC phase shifters, the value set is independent of the input frequency.

The input reference signal is first introduced to the 14046 phase-locked loop. Its output, which is set to generate a frequency 360 times that of f_{in}, is then applied to the 14518 binary-coded decimal counter, where it is divided by 10. A second, cascaded counter, A_2, divides A_{2a}'s output by 9, the 89th count of a 90-step cycle being detected by A_{5b}. A_2 is then reset to zero on the 90th count by A_{6a} and A_{5c}.

The signal at the output of A_{6a} is thus at a frequency equal to $4f_{in}$. Flip-flop A_7 performs a divide-by-four operation on this signal, at the same time generating four quadrature outputs. Meanwhile, A_{5a}, which generates one pulse per cycle of f_{in}, locks the PLL in phase with the zero count of A_2. Note that the operation of this divider chain is unaffected by the setting of the digital input lines.

The desired phase is selected by applying the appropriate digital signals D_0–D_7 in binary-coded decimal form. Thus, the output from A_3 and A_4 moves high when A_2 counts to that number and clocks flip-flop A_{6b}. This action occurs four times per each cycle of f_{in}. The appropriate quadrant, available at A_7, is selected by digital inputs D_8–D_{11}, the active quadrant corresponding to which one of the lines is high. Flip-flop A_{6b} thus produces a symmetrical square wave at f_{in} having a phase shift equal to the number of degrees specified plus 0°, 90°, 180°, or 270°. There is an additional phase shift of 0.5° at all settings because of the way the PLL is operated to achieve lock. The error can be eliminated by adding an inverter between the output of A_{5a} and the B input of A_1.

With the component values shown and a 15-volt supply, the circuit will operate over the range of 0.2 hertz to 2 kilohertz. Thumbwheel switches with 1-megohm pull-down resistors are used to set the phase-angle input lines. A four-position switch can be used to select the quadrant. With slight modification, the circuit will find application as a digitally controlled ignition timing system for internal-combustion engines. □



Discrete degrees. Circuit sets 0° to 360° phase shift of reference signal by digital means. Digital inputs D_0–D_7 determine displacement over 0° to 89° range, D_8–D_{11} set quadrant. Output is thus 0° to 89° signal shifted by an additional 0°, 90°, 180°, or 270°.