Controller selects mode for multiphase stepping motor

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Offering a selection of the most common stepping modes, these circuits are an inexpensive solution to the problem of torque control in four- and five-phase motors. The mode can be changed simply by the flip of a switch.

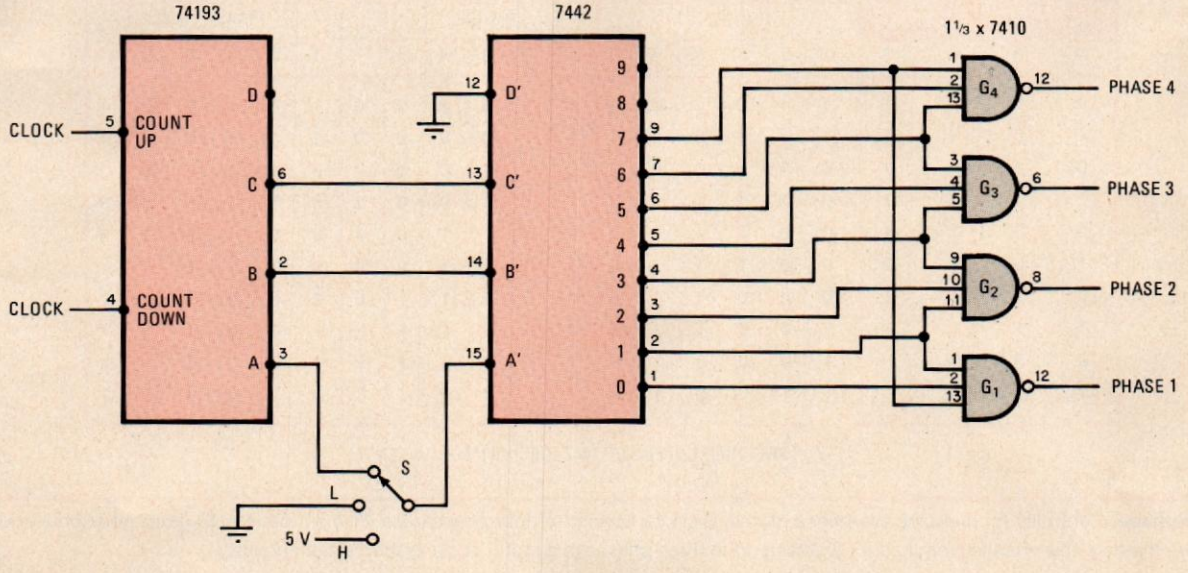
The basic circuit is the same for either stepping motor. It consists of a 4-bit binary-coded-decimal counter, a BCD-to-decimal converter, and several gates that serve as phase detectors.

The four-phase controller is shown below. The 74193 counter advances with each input-clock pulse at a frequency determined by individual requirements. Note that the 74193 can count up or down and so may be used to step the motor in the opposite direction if desired.

As the counter increments or decrements, the output of the 7442 4-to-10-line decoder switches in a manner dependent on switch S. If S connects port A′ of the 7442 to the A port of the 74193, the decoder's output will move from 0 to 7 in sequence. Otherwise, the output will switch to even values every other count (S connected to logic 0) or switch to odd values (S connected to logic 1).

A combinational logic circuit using gates G_1–G_4 converts the 7442's output to phase information in order to drive the motor. As can be seen in the truth table, either one or two windings of the motor will be active at any given time.

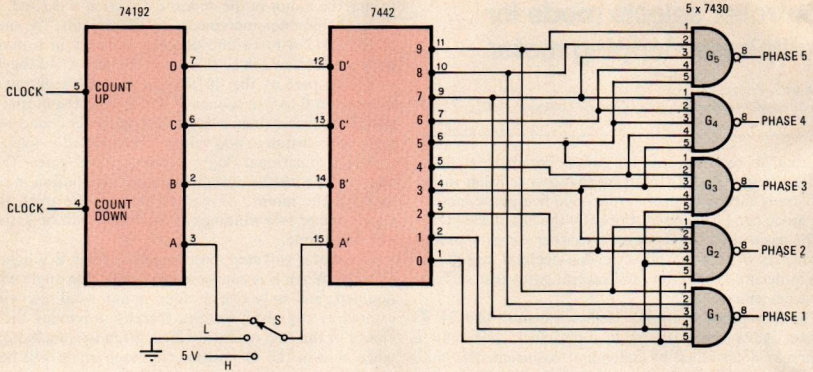
The motor will step most smoothly when S is connected to A. When S is connected to L, the step angle will be doubled, and only one of four motor windings will be excited at any given instant, thereby improving the efficiency of the step operation for a given torque. Note that when S is in the H position, the step angle will be the



COUNTER OUTPUT				A					L					H				
				PHASE				Z	PHASE				Z	PHASE				Z
A	B	C	D	1	2	3	4		1	2	3	4		1	2	3	4	
0	0	0	0 OR 1	1	0	0	0	0	1	0	0	0	0	1	1	0	0	1
1	0	0	0 OR 1	1	1	0	0	1	1	0	0	0	0	1	1	0	0	1
0	1	0	0 OR 1	0	1	0	0	2	0	1	0	0	2	0	1	1	0	3
1	1	0	0 OR 1	0	1	1	0	3	0	1	0	0	2	0	1	1	0	3
0	0	1	0 OR 1	0	0	1	0	4	0	0	1	0	4	0	0	1	1	5
1	0	1	0 OR 1	0	0	1	1	5	0	0	1	0	4	0	0	1	1	5
0	1	1	0 OR 1	0	0	0	1	6	0	0	0	1	6	1	0	0	1	7
1	1	1	0 OR 1	1	0	0	1	7	0	0	0	1	6	1	0	0	1	7

Z = SWITCHED OUTPUT OF 7442 (DECIMAL EQUIVALENT)

1. Multimode. Step controller uses up-down counter, decoder, and logic to control excitation of four-phase motor windings. Switch S selects one of three possible operating modes, ranging from smooth-stepping to high-torque.



COUNTER OUTPUT				A						L						H					
				PHASE					Z	PHASE					Z	PHASE					Z
A	B	C	D	1	2	3	4	5		1	2	3	4	5		1	2	3	4	5	
0	0	0	0	1	1	0	0	0	0	1	1	0	0	0	0	1	1	1	0	0	1
1	0	0	0	1	1	1	0	0	1	1	1	0	0	0	0	1	1	1	0	0	1
0	1	0	0	0	1	1	0	0	2	0	1	1	0	0	2	0	1	1	1	0	3
1	1	0	0	0	1	1	1	0	3	0	1	1	0	0	2	0	1	1	1	0	3
0	0	1	0	0	0	1	1	0	4	0	0	1	1	0	4	0	0	1	1	1	5
1	0	1	0	0	0	1	1	1	5	0	0	1	1	0	4	0	0	1	1	1	5
0	1	1	0	0	0	0	1	1	6	0	0	0	1	1	6	1	0	0	1	1	7
1	1	1	0	1	0	0	1	1	7	0	0	0	1	1	6	1	0	0	1	1	7
0	0	0	1	1	0	0	0	1	8	1	0	0	0	1	8	1	1	0	0	1	9
1	0	0	1	1	1	0	0	1	9	1	0	0	0	1	8	1	1	0	0	1	9

Z = SWITCHED OUTPUT OF 7442 (DECIMAL EQUIVALENT)

2. Multiphase. Controller for stepping five-phase motors is similar to that for four-phase case. Five 5-input NAND gates and some additional wiring are the only new changes required for enabling up to three phases of a motor to be excited simultaneously.

same as in the preceding case, but two motor windings will be active at any time, power input will be doubled, and 41% greater torque will be obtained.

A similar circuit suitable for stepping five-phase motors is shown above. In this case, either two or three phases of the motor are excited simultaneously. This circuit can be extended to solve a general m-phase motor problem. □