Synchronous-motor phase control

The requirement was for accurate phasing of a 51 pole pair phonic/synchronous motor in a facsimile transmitter. This circuit can be readily adapted for similar applications. A sixteen stage shift register loaded with one bit and connected as a ring counter is clocked at sixteen times the required motor drive frequency. Thus, the output of any one stage is a pulse train with a 1:15 mark/space ratio and a repetition rate equal to the drive frequency. A single pole, sixteen way switch can select the output from any stage of the shift register. For every clockwise step of the switch there will be a 360/16 degree phase retard of the output. Similarly for every anticlockwise step there will be a 360/16 degree phase advance. Smaller steps may be achieved by extra stages in the shift register. In terms of shaft rotation each step is $360/16\times51=0.44°$. In the circuit shown a sixteen line-to-one multiplexer acts as the sixteen-way switch. The position of the switch is determined by the data select input. To make the switch rotate uniformly either clockwise or anticlockwise, the data select is connected to a four-bit binary up/down counter. The clock drive for the counter is derived from a gated multivibrator, the rate of which determines the rate at which the phase advances or retards. If necessary another counter can be used to monitor the number of pulses from the multivibrator.

The 1:15 mark/space ratio at the multiplexer output can be improved by a monostable with a period set at half the period of the drive frequency. This puts less demand on the bandpass filter if a sinusoidal output is required. Sixteen clock pulses to the up/down counter produce one complete rotation of the sixteen way switch which means one complete cycle subtracted from or added to the motor drive. In terms of shaft rotation in a 51 pole pair machine, the phase is retarded or advanced 360/51 (7.05°) in sixteen 0.44° steps. In other words, if the gated multivibrator output frequency is N pulses/s, the motor speed alters by $N/7.05$ degrees/second.

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