between pins 5 and 6 of the flip-flop has one collector/emitter drop and two diode drops to impress on the leds which, at 0.1+1.2 = 1.3V, is insufficient to turn on one of the leds which stays off if the transistor is good and on if the device has one shorted junction to make it behave like a diode; in this case the voltage drop is 1.2 + 0.6 = 1.8V.

Therefore, one led lights if the transistor is good (both p-n-p and n-p-n); both leds are off for a transistor with shorted C/E junction; and both are on if the transistor is bad. Diodes $D_{1,2,3,4}$ prevent false indications of normality when a transistor with a B/C short or a B/E short is connected.

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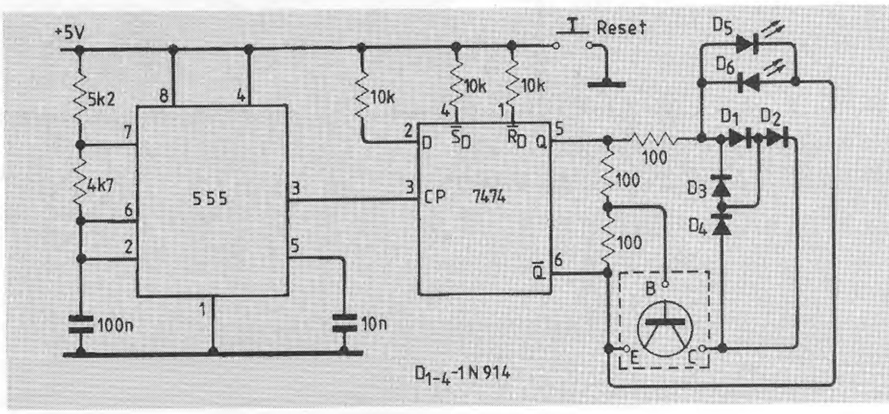
state	D_5	D_6
open C/E	flicker	flicker
short C/E	off	off
good p-n-p	on	off
good n-p-n	off	on



Single-phase to three-phase converter

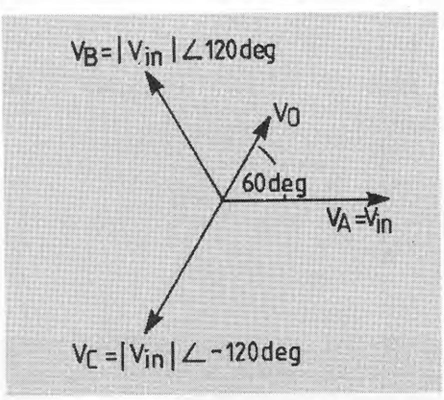
This is a method of deriving a three-phase sine-wave reference using a frequency tracking phase-shift network.

In the diagram, the analogue multiplier IC_1, with R and C, forms a voltage-controlled transfer-function generator, of which the transfer function is

$$(V_o/V_{in})(s) = (V_{CM}RCs)/(10+V_{CM}RCs) \quad (1)$$

where V_{CM} is the multiplier control voltage.

The input signal V_{IN} is half-wave rectified by IC_2 and the multiplier output V_O is half-wave rectified by IC_3 after being



amplified by a factor of 2 in IC_3. Integrator IC_4 forms a low-pass filter and high-gain comparator for these two rectified signals, its output being the control voltage V_{CN} of the multiplier. This feedback loop maintains the magnitude of the transfer function at 0.5 and, under this condition, the phase of the transfer function is exactly 60°.

The phasor diagram shows how the other two phases are derived from the output of the transfer-function generator. If $V_A = V_{IN}$ is the reference phase, V_O has half the amplitude of V_A and leads it by 60°. In conjunction with the transfer-function generator, IC_6 forms an all-pass network which doubles the phase lead of V_O while restoring the amplitude to that of V_A to form the second phase V_B. The third phase V_C is formed by inverting V_O and amplifying it by 2 in instrumentation amplifier IC_5.

Input to the circuit must be sinusoidal with no DC offset, although input amplitude is not important. Operation is from 5Hz to 100Hz, distortion is less than 2%, phase error is better than 0.75degrees and the input should be between 1V and 5V.

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Editorial survey. Use the information card to evaluate this article. Item K.