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Phase Sequence Measurements

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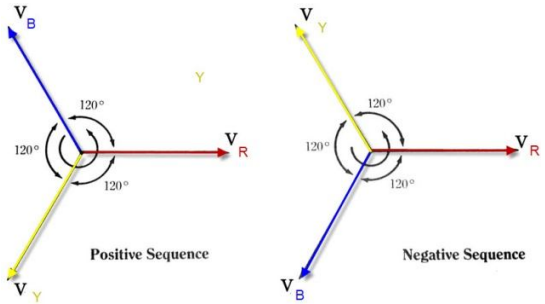
Abstract: ***Now a days with increased productivity and consumption most industrial machines requires high input power. For this, these machines rely on 3 phase input supply. Most of these machines are designed to work on the positive sequence (RYB) of 3 phase supply. However if the phase sequence of the input is reversed the machine may cease to work properly. So the phase sequence of the three phase must be known to the operator***

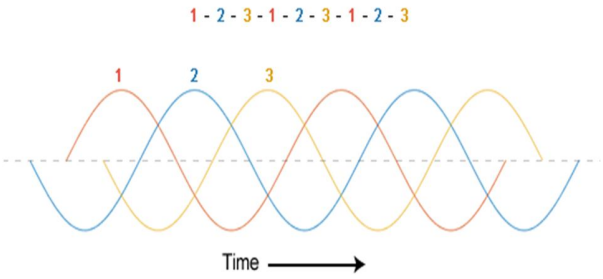
I. WHAT IS PHASE SEQUENCE?



The phase sequence can be taken as RYB if R attains its maximum value first with respect to the reference in anti-clockwise direction followed by Y phase 120° later, and B phase 240° later than the R phase. The phase sequence can be taken as RBY if R followed by B phase is at 120° later and Y phase is at 240° later than the R phase. RYB is considered as a positive sequence, whereas RBY is a negative sequence supply, as shown in the figure.

II. WORKING PRINCIPLE

A 3-phase voltage source on the three wires a, b, and, c. If the voltage waveform of wire a, is the one numbered 1 as shown in Fig. 1, which waveform represents the voltage of wire b? If that waveform is the one numbered 2 in Fig. 1, then the voltage sequence is abc. If on the other hand, the waveform representing the voltage of wire b is waveform 3, then the sequence is acb. You will examine several ways that the phase sequence can be determined.



Three-phase waveforms with the sequence 123, source (1).

The direction of rotation of poly phase induction and synchronous motors depends on the phase sequence of the applied voltages. Also, the two wattcmeters in the two wattmeter method of measuring three-phase power interchange their readings when subjected to a reversal of phase sequence, even though the system is balanced. Magnitudes of the various currents and component voltages in balanced systems are not affected by a reversal of phase sequence. If the phase sequence of the applied voltages is reversed in an unbalanced system, certain branch currents change in magnitudes as well as in time phase, although the total watts and vats generated remain the same.

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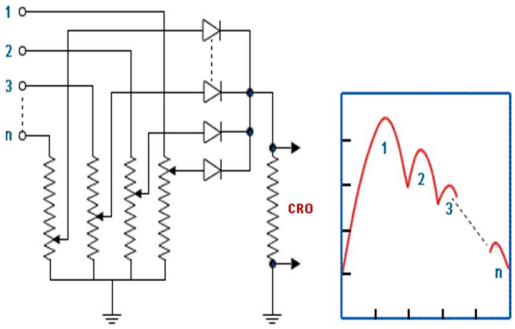
In practice it is desirable, and sometimes necessary, to know the phase sequence of a three- phase power system. For example, when paralleling 2 three-phase transformers, if the wrong sequence is assumed the result could be catastrophic.
One method of determining phase sequence is based on the direction of rotation of induction motors. Another method uses the oscilloscope as in the circuit



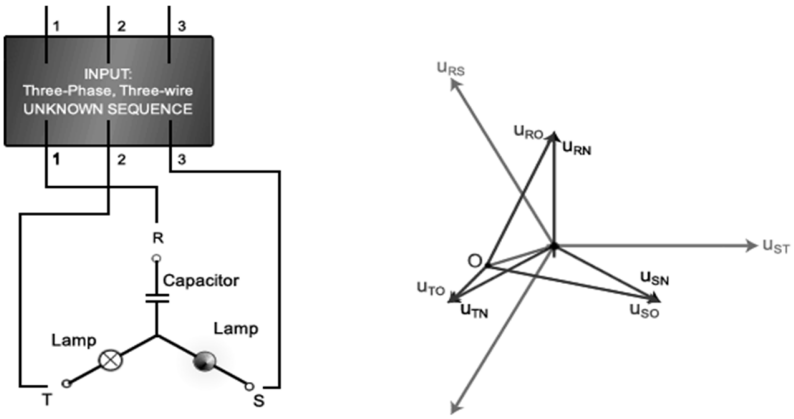
Using the oscilloscope to determine the phase sequence of an n-phase source.

A wattmeter can also be used to determine the phase sequence. A 3-phase inductive load can be connected and a wattmeter is used such that ia is passed through the current coil of the wattmeter, then the reading of the wattmeter will be proportional to either cos(30 + phi) or cos(30 – phi) depending on whether V12 or V13 is applied to the voltage coil. Other methods, discussed below, depend on unbalanced polyphase circuit phenomena.
This set up is designed to test the phase sequence of three phase supply using,

1) Two Lamp Method.
2) RC Method
3) RL Method

A. Two Lamp Method

Generally, any unbalanced set of load impedances may be employed as a voltage phase sequence checker. The effects produced by change in phase sequence can be determined theoretically, and when an effect peculiar to one sequence is noted, that effect can be used to designate the phase sequence of the system.
A circuit for determining the phase sequence using 2 lamps and an inductor.
If lamp a is brighter than lamp b the phase sequence of the line to line voltages is ab, bc, ca. If lamp b is brighter than lamp a, the phase sequence is ab, ca, bc.
The circuit in Fig. 4 (taken from the web, but the source does not exist anymore) uses a capacitor instead of the inductor of Fig



Circuit and phasor diagram to determine the phase sequence of the source wires labeled 123.
If lamp S is brighter than lamp T the phase sequence of the phase voltages is RST.
If Lamp T is brighter than lamp S, the phase sequence is RTS.

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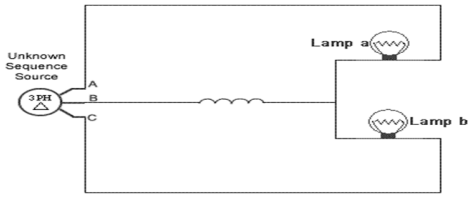
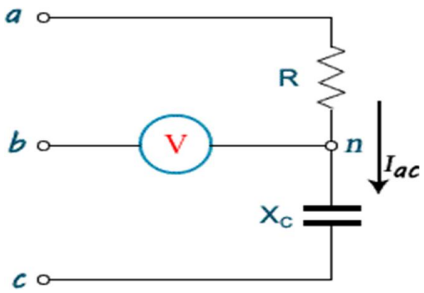
B. RC & RL Method

Another type of circuit for checking phase sequence in 3-phase systems is the unbalanced circuit arrangements shown in Figure 5

RL Circuit



RC Circuit



An RL and an RC circuits for determining the phase sequence.

Calculate the voltage read by the voltmeter for each possible phase sequence. Next, use the circuit to determine the phase sequence from test. Compare watts and vars taken by the above circuits for the two possible phase sequences.

C. Rotating Type Phase Sequence Indicator

(Rotating Type Phase Sequence Indicator)

Similarly, if a three-phase supply is given to the rotating-type phase sequence-checker, then its coils will produce a rotating magnetic field, which further produces eddy EMF in the aluminum disc. A torque is produced by the interaction of the eddy EMF produced on the disc and the rotating magnetic field. Due to this torque, the aluminum disc will rotate, and the direction of rotation of aluminum disc is based on the sequence of supply.

If the supply sequence is RYB, then the disc rotates in clockwise direction and if the supply sequence is changed or altered, then the disc rotates in anticlockwise direction.

III. CONCLUSION

In three-phase equipment such as motors and measuring instruments, the correct phase sequence determines whether the motor will rotate in the right direction, or if the instrument works as expected. ... The two commonly used methods are thephase sequence meter or the static indicator.

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