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AC SYNCHROUS TRANSMITTER AND RECEIVER CONTROLLER

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Abstract:

Synchronal are specially wound rotary transformers with the stator windings typically fixed, Synchronal transmitter and receiver is widely used where remote indication of some angular reading is required. The rotor connections are brought out via slip rings. With the proposed control, the communication between the transmitter and receiver side is not required. The simple converter topology has reduced number of switches on the secondary side as compared to typical inductive energy transfer secondary-side dc/dc converter topologies. The transfer function of the converter is also derived analytically. Conduction losses, switching losses, and efficiency estimation are provided considering the transmitter and receiver side of the wireless converter. The proposed control strategy adjusts the output voltage of the system by phase-shift tuning of the active switches in the receiver. The proposed receiver topology utilization can also be facilitated for the impedance matching protection by adjusting reflected equivalent resistance value. The system performance is confirmed with theoretical and experimental results at various coupling coefficient factors. To verify the proposed phase-shifted S-BAR converter, it is designed for 1-kW maximum power at 120-V input. The laboratory prototype achieved a 94.4% maximum efficiency.

Keywords: **Synchronous; Transmitter; Receiver; Transformer.**

I. INTRODUCTION

The term synchro is a generic name for a family of inductive devices which works on the principle of a rotating transformer (Induction motor). The trade names for synchronous are Autosyn and Telesyn. Basically they are electro mechanical devices or electromagnetic transducer which produces an output voltage depending upon angular position of the rotor. A Synchro system is formed by interconnection of the devices called the synchro transmitter and the synchro control transformer. They are also called as synchro pair. The synchro pair measures and compares two angular displacements and its output voltage is approximately linear with angular difference of the axis of both the shafts.

II. SYNCHRO TRANSMITTER

The constructional features, electrical circuit and a schematic symbol of synchro transmitter are shown in figure-2. The two major parts of synchro transmitters are stator and rotor. The stators identical to the stator of three phase alternator. It is made of laminated silicon steel and slotted on the inner periphery to accommodate a balance three phase winding. The stator winding is concentric type with the axis of the three coil 120° apart. The rotor is of dumb bell construction with a single winding. The ends of the rotor winding are terminated on two slip rings. A single phase AC excitation voltage is applied to the rotor through the slip rings.

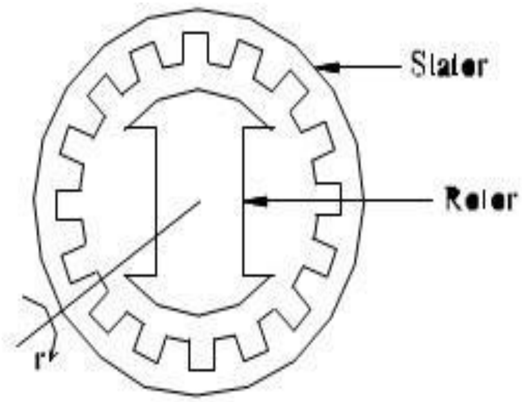

Figure.1 Constructional Features of Synchronous Transmitter

A. Synchronous Control Transformer

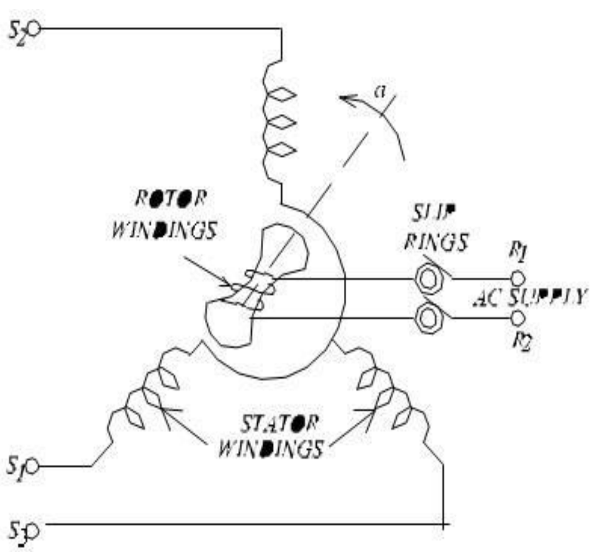

Fig.1 Electrical Circuit of synchronous control transformer

The constructional features of synchronous control transformer are similar to that of synchronous transmitter, except the shape of rotor. The rotor of the control transformer is made cylindrical so that the air gap is practically uniform. This feature of the control transformer minimizes the changes in the rotor impedance with the rotation of the shaft. The constructional features, electrical circuit and a schematic symbol of control transformer are shown in figure 4.

II. CONSTRUCTION

The generated emf of the synchro transmitter is applied as input to the stator coils of control transformer. The rotor shaft is connected to the load whose position has to be maintained at the desired value. Depending on the current position of the rotor and the applied emf on the stator, an emf is induced on the rotor winding. This emf can be measured and used to drive a motor so that the position of the load is corrected.

SYNCHRO TRANSMITTER / RECEIVER

Let e be reference vector. With reference to figure 2, when 2 = 0, the flux linkage of coil s i. Zero. Hence the flux linkage of coil S is function of cos22 (K = K) Cos c1 2 for coil S). The flux2 linkage of coil S will be maximum after a rotation of 120°in anti-clock wise direction and that3 of S after a rotation of 240°.1 Coupling coefficient, K for coil – S1 Coupling coefficient, K for coil – S2 Coupling coefficient, K for coil – S3

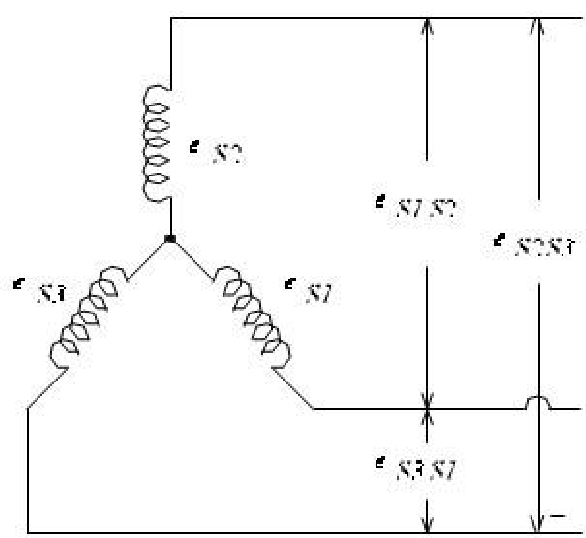

Fig.2 Induced emf in stator coils

$$e_{S2S3} = e_{S2} - e_{S3} = K E_r \cos\theta \sin\omega t - KE_r \cos(\theta - 120^\circ) \sin\omega t$$

$$e_{S3S1} = e_{S2} - e_{S3} = KE_r \cos(\theta - 120^\circ) \sin\omega t - K E_r \cos(\theta - 240^\circ) \sin\omega t$$

$$= KE_r [\cos\theta - \cos\theta \cos 120^\circ - Sin\,\theta\, Sin\, 120^\circ] \sin\omega t$$

$$= \sqrt{3}\, KE_r [\sin\theta \cos 120^\circ + \cos\theta\, Sin\, 120^\circ] \sin\omega t$$

$$= \sqrt{3}\, KE_r \left[\sin\theta\left(-\frac{1}{2}\right) + \cos\theta\left(\frac{\sqrt{3}}{2}\right)\right] \sin\omega t$$

$$= \sqrt{3}\, KE_r \sin(\theta + 120^\circ) \sin\omega t$$

When 2 = 0, from equation 3 we can say that maximum emf is induced in coil S. But from2 equation 8, it is observed that the coil - to coil voltage ES3S1 is zero. This position of the rotor is defined as the electrical zero of the transmitter.

III.WORKING

The generated emf of the synchro transmitter is applied as input to the stator coils of control transformer. The rotor shaft is connected to the load whose position has to be maintained at the desired value. Depending on the current position of the rotor and the applied emf on the stator, an emf is induced on the rotor winding. This emf can be measured and used to drive a motor so that the position of the load is corrected.

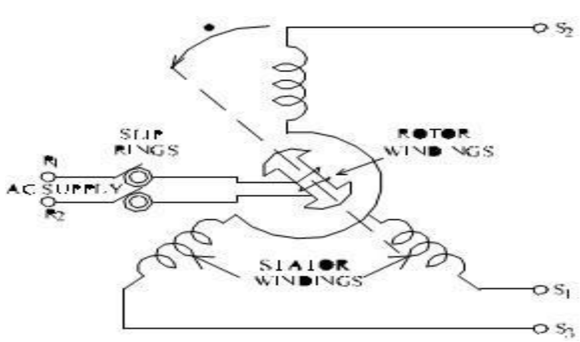

Figure – 3 Electrical Circuit (Synchronous Transmitter)

a. Working Principles

When the rotor is excited by AC voltage, the rotor current flows, and a magnetic field is produced. The rotor magnetic field induces an emf in the stator coil by transformer action. The effective voltage induced in any stator coil depends upon the angular position of the coils axis with respect to rotor axis.

IV.EXPERIMENTAL RESULTS

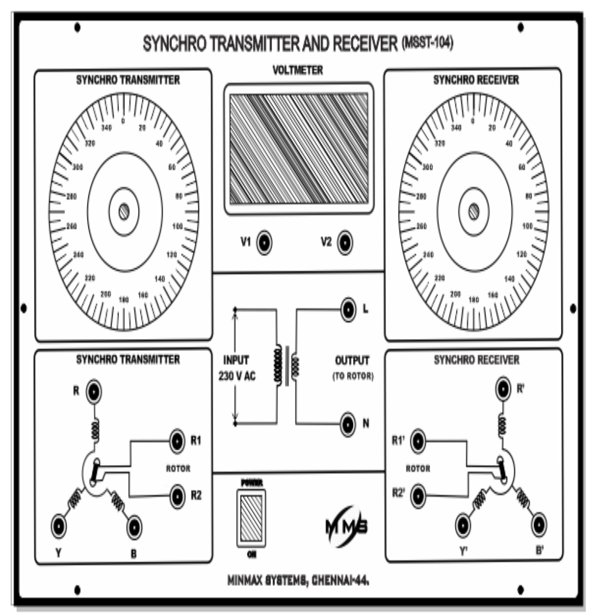

Fig.4 Front Panel Diagram

Front Panel Description:

1. Power ON - To switch on/off the trainer kit.
2. R1, R2 - To connect transformer output to transmitter rotor.
3. R - First stator coil of transmitter.
4. Y - Second stator coil of transmitter.

5. B - Third stator coil of transmitter.
6. R1', R2' - To connect transformer output to receiver rotor.
7. R' - First stator coil of receiver.
8. Y' - Second stator coil of receiver.
9. B' - Third stator coil of receiver.
10. L, N - Transformer output voltage (115V AC).
11. V1, V2 - Input terminals of digital voltmeter.

i. SYSTEM CONSTRUCTION

This system consists of a synchronal transmitter and receiver. The rotors of transmitter and receiver are excited using a step down transformer (115 V AC). Due to rotation of rotor, magnetic field is induced on the stator coils and hence emf are generated in the stator coils.

The stator coils of synchronal receiver are excited by the corresponding stator coils of synchronous transmitter. The voltages across any two stator coils of receiver will be same as the voltages across corresponding two stator coils of synchronous transmitter.

The angle made by the transmitter rotor with respect to the transmitter stator coils will be equal to the angle made by the receiver rotor with respect to the receiver stator coils due to synchronization.

V. CONCLUSION

The proposed control strategy use only minimum measurement like loads and mains voltage measurements for S-D device. The instantaneous reactive power theory is used by measuring mains voltage, current and capacitor voltage. But the conventional methods require measurements of the load, source and filter voltages and currents. The simulation results show that, when unbalanced and Nonlinear load current or unbalanced and distorted mains voltage conditions, the above control algorithms eliminate the impact of distortion and unbalance of load current on the power line, making the power factor unity.

This paper deals with the case study of power quality control with the STATCOM-DVR Controller (SDC) that is used to maintain and improve power system operation and stability.

This paper presents the power quality operation of power systems and its limitations, different devices to control the power quality with the existing transmission lines, types of FACTS controllers used in the power system, basic characteristics and operation of SDC, Newton Raphson quality chart and algorithm with SDC and a case study of power quality control with SDC.

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