International Journal of Research (IJR)
e-ISSN: 2348-6848, p- ISSN: 2348-795X Volume 2, Issue 05, May 2015
Available at http://internationaljournalofresearch.org

Review Paper on Synchros

Vishakha & Rishabh Sharma

Student (Btech 6 thsem) , Dronacharya college of engineering ,Gurgaon

rishabhsharma.244@gmail.com; vishakha1360@gmail.com

Abstract

*A **synchro** is, in effect, a transformer whose primary-to-secondary coupling may be varied by physically changing the relative orientation of the two windings. Synchros are often used for measuring the angle of a rotating machine such as an antenna platform. In its general physical construction, it is much like an electric motor. The primary winding of the transformer, fixed to the rotor, is excited by an alternating current, which byelectromagneticinduction, causes currents to flow in three Y-connected secondary windings fixed at 120 degrees to each other on the stator. The relative magnitudes of secondary currents are measured and used to determine the angle of the rotor relative to the stator, or the currents can be used to directly drive a receiver synchro that will rotate in unison with the synchro transmitter. In the latter case, the whole device may be called a **selsyn***

Keywords-

Resolver; Control system; Angle servo; Cascade; Mathematical model building; Experiment; Simulation

Introduction

Synchros are used to transmit angular data electrically from one location to another, where a high degree of accuracy is required. They are essentially variable transformers in which the coupling between windings varies with the rotor position relative to the stator. Several different types are produced to suit particular applications and whilst their external appearance is similar, the internal construction varies to optimise the unit's functional requirements. Muirhead's pedigree and capability in the field of Synchros will ensure the most demanding specifications are met. Typical applications include remote positioning of low torque mechanisms, remote control by servo motor driven mechanism, remote digital measurement of angle via a suitable signal converter, remote pointer indication of angular position.

Differential Transmitters

It is sometimes necessary to add or subtract additional information from a Synchro Chain and Differential Transmitters serve this purpose. They are similar in construction to the other elements except for a 3-phase winding on the rotor.

Control Synchros

The design principle of a Control Synchro is to minimise errors in the output signal due to current loading, magnetic non-linearity and temperature rise, by the use of high impedance windings and special attention to the magnetic circuits. The Control Transformer, which provides the error signal to a servo amplifier, can be considered a 'null' detector and it is most often used in this way. However the 'null' is never zero due to residual voltages. This is due to stray couplings within the laminated stator that result in an in-phase voltage, a quadrature voltage, both at fundamental frequency, plus a number of harmonics. These residual voltage levels are quoted in the performance data tables for each unit.

Torque Synchros

The Torque Synchro is designed to provide a light torque output without additional servo components. Current is fed to both the Transmitter and the Receiver from the same source and the winding impedance values are considerably lower than the equivalent control element. Torque is generated as a result of interaction of the stator field and rotor field in the receiver, which drives the rotor of the Receiver into alignment with that of the Transmitter. The torque / misalignment curve takes sinusoidal form through 360 degrees with maximum values of opposite polarity at 90 and 270 degrees.

Resolvers

Resolvers are used to transmit angular data electrically from one location to another, where a high degree of

International Journal of Research
International Journal of Research (IJR)
e-ISSN: 2348-6848, p- ISSN: 2348-795X Volume 2, Issue 05, May 2015
Available at http://internationaljournalofresearch.org

accuracy is required. They are essentially variable transformers in which the coupling between windings varies with the rotor position. Resolvers can be used for the solution of trigonometric problems since their outputs are related by sine and cosine functions to the angular positions being measured. Several different types are produced to suit particular applications and whilst their external appearance is similar, the internal construction varies to optimise performance. Muirhead's pedigree in this critical field of fine wire technology has achieved for the Company a world leading market position. Typical applications include range and elevation calculation for radar equipment and gunnery, remote digital measurement of angle via a suitable signal converter, conversion of geometric co-ordinates and data transmission in engine fuel control units

Resolver to Digital Conversion

Resolvers are generally considered to be the most robust of all angular measurement devices and to provide the best long-term reliability, in a wide range of operating environments. Should a digital signal be required, the output from the Resolver can be converted to make the signal compatible.

Temperature Extremes

For Resolvers in aircraft engine applications where critical components may need to survive limited time exposure to flame in emergency situations Muirhead use special materials and lubricants. Also with close attention to tolerances and expansion rates avoids seizure at extremes of the temperature range. Similar considerations apply for low temperatures as required in space applications.

Operation

On a practical level, synchros resemble motors, in that there is a rotor, stator, and a shaft. Ordinarily, slip rings and brushes connect the rotor to external power. A synchro transmitter's shaft is rotated by the mechanism that sends information, while the synchro receiver's shaft rotates a dial, or operates a light mechanical load. Single and three-phase units are common in use, and will follow the other's rotation when connected properly. One transmitter can turn several receivers; if torque is a factor, the transmitter must be physically larger to source the additional current. In a motion picture interlock system, a large motor-driven distributor can drive as many as 20 machines, sound dubbers, footage counters, and projectors.

Synchros designed for terrestrial use tend to be driven at 50 or 60 hertz (the mains frequency in most countries), while those for marine or aeronautical use tend to operate at 400 hertz (the frequency of the on-board electrical generator driven by the engines).

Single phase units have five wires: two for an exciter winding (typically line voltage) and three for the output/input. These three are bussed to the other synchros in the system, and provide the power and information to align the shafts of all the receivers. Synchro transmitters and receivers must be powered by the same branch circuit, so to speak; the mains excitation voltage sources must match in voltage and phase. The safest approach is to bus the five or six lines from transmitters and receivers at a common point. Different makes of selsyns, used in interlock systems, have different output voltages. In all cases, three-phase systems will handle more power and operate a bit more smoothly. The excitation is often 208/240 V 3-phase mains power. Many synchros operate on 30 to 60 V AC also.

Synchro transmitters are as described, but 50 and 60-Hz synchro receivers require rotary dampers to keep their shafts from oscillating when not loaded (as with dials) or lightly loaded in high-accuracy applications

Applications

Single Resolvers

Muirhead have designed a range of Single Brushless Data Transmission Resolvers with an electrical accuracy of six minutes of arc. The units are a derivative of the Muirhead Aerospace range of Double Resolvers used in many gas turbine fuel metering applications and therefore enjoy the same build standard reliability benefits.

Tandem Resolvers for Engine Fuel Control

This is a size 11 Tandem Resolver with a newly designed housing and cable assembly as the Resolver was relocated to the cockpit area. The Resolver is used to sense the position of the Pilot Lever Angle Unit, which forms part of the throttle control fuel system.

The new unit has a special housing that is sealed against a full range of environmental conditions, together with a newly designed cable assembly for each Resolver lane. These cable assemblies are compliant with the EMC requirements of cockpit mounted equipment.

International Journal of Research
International Journal of Research (IJR)
e-ISSN: 2348-6848, p- ISSN: 2348-795X Volume 2, Issue 05, May 2015
Available at http://internationaljournalofresearch.org

Triple Brushless Resolvers for Flight Control

The unit shown is a Triple Resolver Position Transducer, providing three sets of output information as a function of input rotor shaft position. In operation the unit transmits collective pitch demand on a helicopter, within the aircraft engine FADEC system.

Slab Resolvers

Slab Resolvers can be used in many applications including the Hydraulic Slat Drives for aircraft. The Resolvers can be installed inside a motor casing and fully submerged in a hydraulic fluid, such as "Skydrol". Special processes have been developed to enable this technology to operate reliably in hostile environments. Resolvers can be used to measure the hydraulic motor shaft speed, direction, position and the motor yoke.

Variable Reluctance Resolver

A Variable Reluctance Resolver (VRR) is a Brushless Resolver with no windings on the rotor. The VRR is a type of variable reluctance Resolver, which has high reliability, and is suitable for wide temperature ranges and difficult environmental conditions. This sensor is particularly suitable for brushless motor commutation where the number of pole pairs is equal to the number of output cycles of the VRR. Comparisons between Resolvers and VRRs can be shown below.

Scope

In order to ease the equipment design engineer's problem and at the same time provide a basis for comparing measurements by manufacturer and user this recommended practice sets up standard test procedures for acceptance testing. These conditions and the basic tests to which the characteristics refer are grouped in Section 2 and compose a complete list of defining characteristics of the synchro. Specifications written around synchros have specified certain necessary characteristics for production acceptance testing, such as null voltage and accuracy, under test conditions and techniques that are mainly and properly concerned with accuracy and the shortest possible test time. These characteristics are inherently degraded when the synchro is operating for a period of time at other than room temperature. In synchros this degradation is a factor of high importance

References

[1] Craig, (2013). Design and Implementation on Permanent Magnet Synchronous Motor Servo System, http://www.research-degreethesis.com/showinfo-92-741108-0.html

[2] NEETS, (2013), Principles of Synchros, Servos, and Gyros http://www.rfcafe.com/references/electrical/NEETS%20Modules/NEETS-Module-15-2- 31-2-38.htm

[3] Wang, Xiaohui, Sun, Tao "Fast tool servo system for online compensation of error motion on an ultraprecision lathe" 4th International Symposium on Advanced Optical Manufacturing and Testing Technologies: Advanced Optical Manufacturing Technologies, Proceedings of the SPIE, Vol.7282, pp. 5, 2009.

[4] Tim Wescott, (2013), designing a Control System, http://www.eetimes.com/document.asp?doc_id=1274122-1

[5] Li, Zhu-Lian, Xiong, Yao-Heng "The research on property of servo-control and drive system for 1.2 m Alt-Az telescope" Journal of Astronomical Research and Technology, Publications of National Astronomical Observatories of China, Vol. 2, pp. 130 – 136, 2005.

[6] SongbinLiu,Mingyan Wang, Kai Tian, Yiwei Wang "Research on loading simulation of DC torque motor for electrical load simulator" 3rd IEEE Conference on Industrial Electronics and Applications, PP.1146-1150, June, 3-5, 2008

[7] Yeh, A., Chou, J., Lin, M. "An economical, precise and limited access In-Circuit Test method for pulse-width modulation (PWM) circuits" IEEE International Test Conference, (ITC) PP.1-9, NOV, 1-6, 2009.