Compensation of Negative Sequence Components in an Induction Machine

Ms.Vinida Ranjan

Considering a three-phase system, symmetrical components (positive sequence, negative sequence, and zero sequence) allow one to analyze power system operation during unbalanced conditions such as those caused by faults between phases and/or ground, open phases, unbalanced impedances, and so on.

The positive sequence set consists of the balanced three-phase currents and line-to-neutral voltages supplied by the system generator. They are always equal in magnitude and phase displaced by 120 degrees rotating at the system frequency with a phase sequence of normally a, b, c.

The negative sequence set is also balanced with three equal magnitude quantities at 120 degrees apart but with the phase rotation or sequence reversed, or a, c, b. (If the positive sequence is a, c, b as in some power systems, then negative sequence will be a, b, c.) The members of the zero-sequence set of rotating phasors are always equal in magnitude and always in phase.

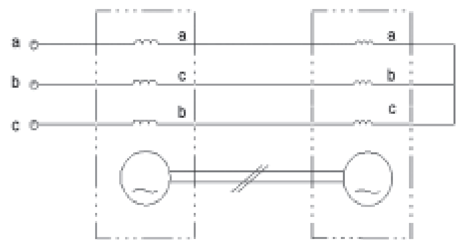
Effect of negative sequence current on an induction motor

Use of 3-ϕ induction motor (IM) in various industries is almost 80% of their total drive requirements. Performance of these induction motors is affected by the unbalance in bus voltage caused by negative sequence currents, which produces an air gap flux rotating opposite to the direction of rotor thereby heats up the rotor and generates a breaking torque. Due to the very low value of negative sequence impedance offered by the induction motor as compared to its positive sequence impedance, a very small negative sequence voltage component in the input may give rise to considerable negative sequence current causing significant deterioration in the performance of induction motor.

Therefore even low unbalance factor (ratio of negative sequence to positive sequence) in input voltage has to be carefully looked into. Voltage unbalances occur quite often in distribution systems.

Electromagnetic compensator

Fig 1 shows the schematic connection diagram for this system. It requires another 3-ϕ squirrel cage motor (much smaller in capacity) whose rotor is mounted on the same shaft and whose stator windings are connected with reverse phase sequence. Stator windings of both the motors are electrically connected in series with the system voltage.



Compensator Main motor

Fig 1: Schematic connection diagram

The theory behind this method is that the second motor with negative sequence winding connection will offer large impedance to the negative sequence currents in the input lines (caused by the mains voltage unbalance) and low impedance to the positive sequence currents. Thus this connection will reduce the magnitude of negative sequence currents in the stator of the main motor for the same input voltage unbalance factor.

Drawbacks

In addition to the cost of another motor is that the stator winding of the second motor which is connected in series with the stator of the main motor while reducing the magnitude of negative sequence current also reduces the positive sequence voltage applied to the main motor since the series winding has some impedance offered to the flow of positive sequence currents. Since the output of induction motor is approximately proportional to the square of the voltage applied, this method results in reduced output of the motor

Degenerate Circuits

Prof. K R Varmah

An electric circuit is said to be degenerate if there exists an all capacitor circuit when the voltage sources, if any, are short-circuited. This is called C-v loop. Similarly an electric circuit is said to be degenerate if there exists an all inductor cut set when the current sources, if any, are open circuited. This is known as L-i cut set.

In deriving a state model for any dynamic physical system, the number of state variables to be selected, in general, is equal to the number of energy storing elements. In an electrical network the energy storing elements are inductors and capacitors. In a mechanical translational system the energy storing elements are mass and spring and that in a mechanical rotational system are moment of inertia and torsion spring. For a degenerate network, the number of state variables required to get a state model is equal to one less than the number of energy storing elements. Such a network is also called an imperfect network.

For a non-degenerate electric circuit the voltage across a capacitor cannot change instantaneously and so also the current through an inductor. In a degenerate loop of capacitors the voltage across a capacitor must change instantaneously in order to satisfy the KVL equation, just after switching, say, at time $t = 0^+$. This happens only when there is a change in charge across a capacitor during the time interval from $t = 0^-$ to $t = 0^+$. Similarly in a degenerate cut set of inductors, the current through an inductor must change instantaneously in order to satisfy the constraint imposed by the KCL equation at $t = 0^+$ and this takes place only when there is an instantaneous change in flux linkage from $t = 0^-$ to $t = 0^+$.

The principle of conservation of charges states that the sum of all the charges that flow to a node is zero. The principle of conservation of flux linkages states that the sum of flux linkages at any time in a loop is zero.

In a C-v loop, to determine the initial voltage across a capacitor, open all elements, which do not have any charge transfer capability. Hence remove all resistors, inductors, current sources and those capacitors, which are not in the degenerate loop. The reduced network will have only capacitors and voltage sources. Now apply the KVL equation, in terms of change in charge, to each mesh and also the principle of conservation of charges. From this the change in charge on every capacitor can be determined and hence the initial condition at $t = 0^+$.

In an L-i cut set, to determine the initial condition at $t = 0^+$, short-circuit all elements that do not have any flux linkage capability. Hence short-circuit all resistors, capacitors, voltage sources and those inductors, which are not in the L-i cut set. The reduced network, obtained to simulate the condition at $t = 0^+$, will have only inductors and current sources. Now apply the KCL equation, in terms of change in flux linkage, to every such L-i cut set and also the principle of conservation of flux linkages. From this the change in flux linkage in each inductor can be determined and hence the initial conditions.

Do you know?	
WIND ENERGY IN KERALA	
Wind Farm, Kanjikode, Palghat	2.03 MW (9 x 0.225 MW)
Ramakkalmedu, Idukki (Private Sector)	10.50 MW (14 x 0.75 MW)
Agali, Palghat (Private Sector)	6.00 MW (10 x 0.6 MW)
WIND TOTAL	**18.53 MW**

Courtesy: KSEB

INDUCTION MACHINE ON-LINE CONDITION MONITORING AND FAULT DIAGNOSIS – MEMS BASED

Ms. Jayasri R. Nair

Condition monitoring techniques have been researched and developed for several years. Through the monitoring of the health of running electric motors, severe economic losses resulting from unexpected motor failures can be avoided and tooling system reliability and maintainability can be improved. Identifying mechanical and electrical maintenance problems with sensor feedback data and correcting them will reduce unplanned production shutdowns and significantly increase profits.

As the induction machine is highly symmetrical, the presence of any kind of fault in it affects its symmetry. This leads to a corresponding change in the interaction of flux between the stator and rotor, resulting in changes to the stator currents, voltages, magnetic field and machine vibration. Thus these signals can be used for on-line condition monitoring.

Wireless communication techniques enable a new class of low cost and flexible condition monitoring systems. Traditional monitoring systems in industrial plants are realized through wired systems, formed by communication cables and sensors . The installation and maintenance of these cables and sensors is much more expensive than the cost of the sensors themselves. Integration of electronics, sensors and wireless communications has enabled the easy installation of these sensor networks, which saves the cost of the deployment of large numbers of sensors and actuators. ***The flexibility and rapid deployment characteristics of a wireless sensor network (WSN) form an ideal platform for condition monitoring systems.*** Although wireless communication has enabled WSN with applications for condition monitoring, sensing nodes still require an electric power supply for operations and their power line distribution conflicts with ease of installation and retrofit into industrial plants. Furthermore, the sensor cables are easily damaged, which affects the reliability of the monitoring system deployed to assure the machine is reliable. In this case, a sensing node is developed to achieve wireless and powerless operation for implementing an easily mounted sensor networks for monitoring motor conditions.

The ***design of the wireless and powerless sensing node*** provides a solution that can work independently inside a motor. A specially designed communication module transmits electromagnetic (EM) pulses in response to a sensor output, and the pulses are able to pass through the motor casing to deliver the signal to the data acquisition terminal. No signal cable passing through the motor case is required, and as induction power is generated from the motor shaft rotation, the resulting sensing system is self-sustaining and no power lines are required. *Figure 1 shows the schematic view of the sensing node*. A **MEMS sensor**, a signal processor, a communication module, and a magnetic self-powered generator are integrated into the spacer ring. The spacer is fit into the shaft, located between two bearing sets in the motor. Four planar coils, distributed around the ring generate power by the induction of the coils and soft magnets are attached to the shaft as the motor starts. The induction power drives the sensor, a signal processor, and the communication module.

Through coil arrangements and circuit design, the sensing node on the ring is self-sustaining. The communication module antenna, fitted tightly into the spacer ring inside the motor, is in direct contact with the inner surface of the motor case. EM pulses, transmitted from the module delivery sensor signal, go to the outside data acquisition center through the motor casing. The signal cable attached on the motor's surface works as a receiver antenna and transmits the signal to the data acquisition center. The special wireless signal transfer uses the metal wall as the media to transmit data between sensors and the data center. No physical signal cable enters through the metal casing of the motor. Only one signal cable, which is attached on the outside motor wall, is required for data collection.

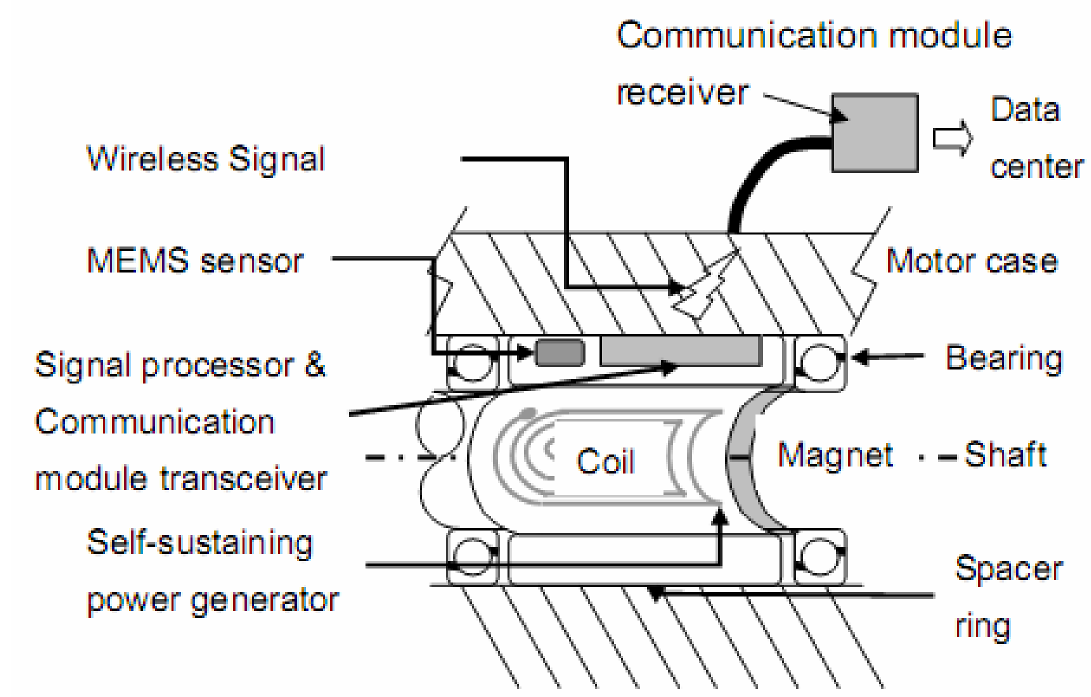


Fig 1: Sensing node (Schematic view)

The MEMS accelerometer element functions on the principle of the differential capacitance of the micro machined structure of the silicon chip. Acceleration causes the displacement of a silicon structure resulting in capacitance changes, which can provide tri-axial vibration detection of a variety of upper frequencies. The chip embedded signal processor, using a standard CMOS manufacturing process, detects and transforms changes of capacitance into an analog output voltage, which is proportional to acceleration. An 8051-core microprocessor, with a build-in AD converter, is employed to track analog input from the sensor and determine the mean value of the acceleration. The acceleration signal from the MEMS accelerometer is analyzed and encoded by the signal processor, which consists of an 8051-core microprocessor and its related circuits. The transceiver of the EM pulse communication module converts the digitized measurement data into sequential electronic pulses, and then transmits to the receiver, which is outside the motor. The receiver decodes the high/low duty of the pulses in order to decode the measurement data and send it to the data center through a serial communication port. The receiver acquires sequential pulses and decodes the pulses into a ***time-domain vibration signal***. Digital filters process digitized signals to reject noise. For vibration measurements, a Hanning window function can be applied and the anti-aliasing filter could pass all frequencies up to half of sampling frequency. The 512-point fast Fourier transform (FFT) processor is used to generate the power spectrum for identification of vibration sources.

HOD's DESK

Advancement in technology has helped to expand the scope and depth of education across borders. Innovations in technology have enabled students to have access to more information and knowledge.

In spite of rapid advances in technology, we are still stuck in the industrial era model of education. Creating a more visual interactive and personalized education with the use of new technology would help education an enjoyable experience to both teachers and students.

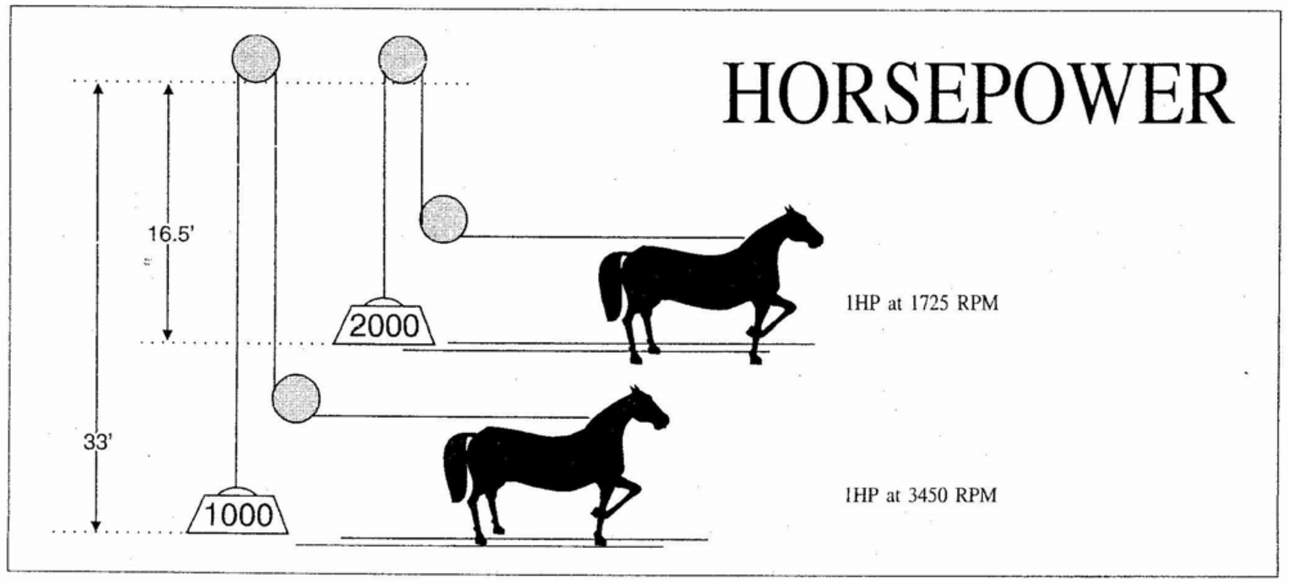
It is true that a few students may have to be taken, occasionally, out of the classroom to impart individualized teaching. What is required is that teachers and students create some sort of an environment conducive to collaborative learning.

Engineering technology education of the future may face significant challenges because of rapidly evolving technologies and changing attitudes and demands of students. These challenges may profoundly affect the employment patterns and the professional life of engineering technology graduates.

Teachers should accept these challenges and take to innovative approaches in teaching and guiding the students in projects and research. They should involve and empower everybody in the process of continuous improvement. They should help the students to develop problem solving and analytical skills so that they excel in their future career.

K.R.Varmah

DO YOU KNOW ?



'orespower is a measure of the rate at which motors and other drives can produce work. This unit was actually derived by testing. It was found that an average work horse could move 33,000 1bs through one foot in one minute. This would be equal to lifting one ton (2,0001bs) 16.5 feet in one minute, or 1,000 1bs,., 33 feet in one minute. Motors are rated in horsepower according to the amount of power they're designed to deliver.

Contributed by **Prof. Dominic Mathew**

while improving its efficiency due to reduction in negative sequence torque.

Electronic Compensator

This above problem can be solved by the use of electronic compensator connected in series with the stator of main motor, which will compensate only the negative sequence voltage in the mains, and the positive sequence voltage remains unaffected.

An electronic negative sequence compensator is a voltage source inverter whose output is changed through pulse width modulation (PWM). PWM method utilizes a reference signal (one for each phase), which is compared with a high frequency triangular wave and the points of intersection of both these signals decide the time of switching on and off the devices connected to that particular phase. The output of PWM inverter follows the reference signal used. If the reference signal is derived from the negative sequence voltage with opposite polarity, then the negative sequence compensator voltages obtained from the PWM inverter, which are connected in series with the main motor windings, will cancel the negative sequence component voltages presents in the mains applied voltage.

Revenue Improvement From Automatic Meter Reading Systems

Ms. A. Anntonet Daffodil

The importance of measuring the energy sold by a power supply organization is well known. In order to achieve revenue improvement, it is essential to measure the energy consumed accurately, render the bills quickly and collect the amount promptly. Energy losses are inevitable consequences of the transfer of energy across networks. The commercial losses are widely due to pilferage, defective metering, wrong meter reading, unmetered supply and malpractice in usage of energy. The meter being the equipment for energy consumed, is the target for tampering. This paper describes the implementation of automatic meter reading systems in which the meter reading and management processes are free from human involvement, which makes theft of energy more difficult and easily detectable in order to crub commercial losses thereby, improving the revenue.

Implementation of Automatic Meter Systems : AMR System Architecture

Automatic Meter reading is the collection of data at a remote central location from energy meter and other devices at consumer premises through wire and wireless. The AMR consists of Remote Reading Units (RRU) and Communication Front End (CFE). The Remote Reading Unit is an intelligent end-user premises device that constantly monitors and accumulates utility usage. It reports to the Communication Front End through the telephone network either according to a predetermined schedule or on demand. The CFE collects information sent from the RRUs, and then assembles and transmits it to the utility host administrative processing and billing. The RRU incorporates the network termination functions to prevent from implementing the No Ringing Trunk (NRT) in the telephone network which may require additional efforts to request the network provider to implement such functions. The RRU and CFE communicate with each other through this public switched telephone networks (PSTN). The RRU in each subscriber's premises is equivalent to a pulse-dial telephone with the existing telephone set.

Revenue Protection from Illegal Usage

The RRU reports meter readings, meter status, internal time-of-day/calendar, to the CFE. The RRU implements a communication protocol that not only guarantees the correctness and integrity of the information exchange with the CFE, but also protects the RRU database from unauthorized accesses and modifications.

It has high degree of tamper protection and electronic facility because no-dial up network is involved. Any tampering through disconnection or shorting of wires will be recorded in the corresponding meter status register and reported to the CFE during the RRU-CFE communication.

The meter can be accessed through cell phone. The system detects tamper and sends alerts to control room as well as field official's cell phones with tamper details.

DEE organized a three day workshop on Innovative Approaches in Power Electronics Drives and Control from 4th to 6th May 2009

Classes were handled by eminent professors from leading educational institutions and resource persons from related industries.

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25. SPIN BATTERY
26. LARGE HADRON COLLIDOR

impulse

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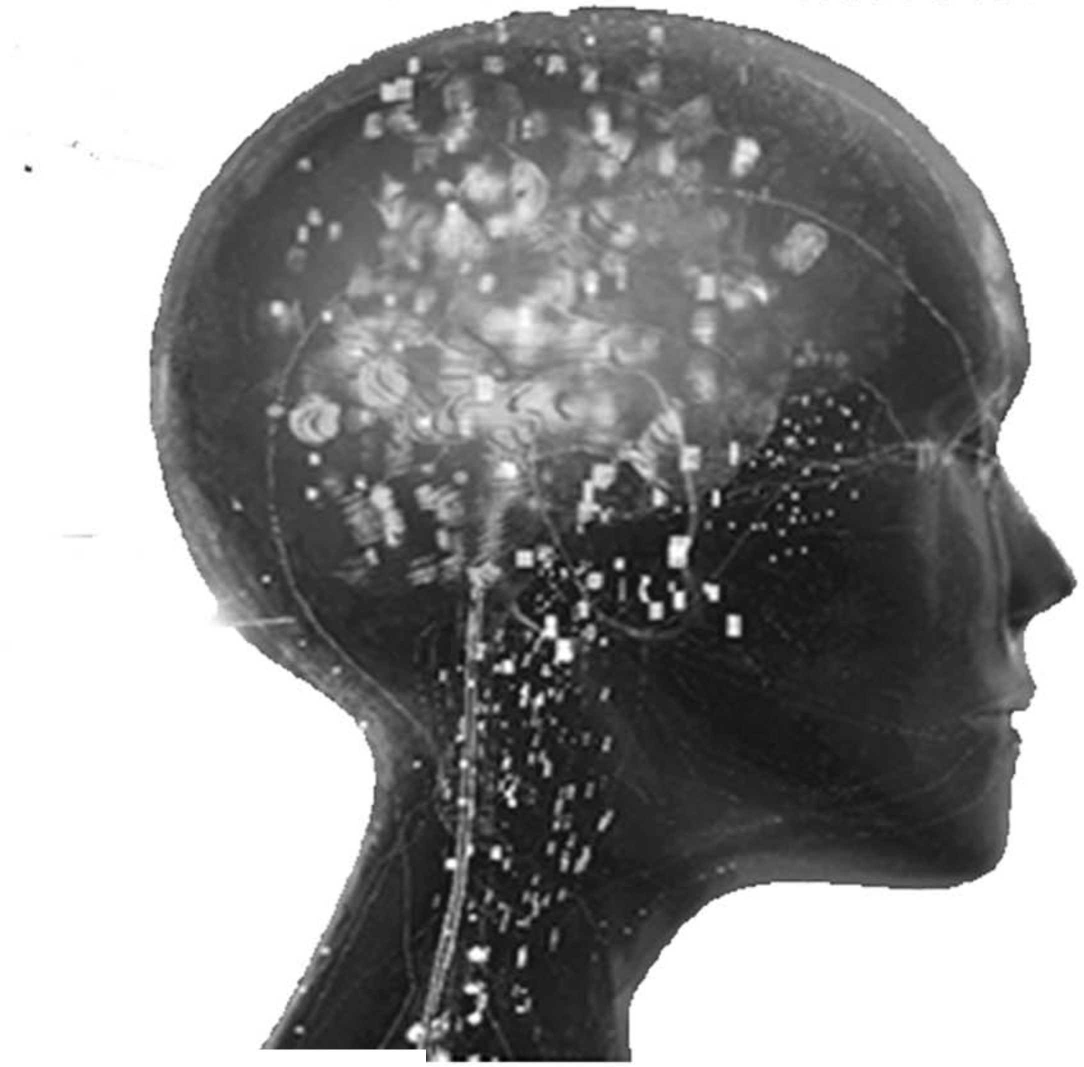

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