EXPERIMENTAL INVESTIGATION OF DOUBLY EXCITED SYNCHRONOUS ELECTRIC GENERATOR

Lagudu Maheswara Rao[1], Dr. Pramod Khampariya[2]

[1]Research Scholar, Dept. of Electrical Engineering, Sri Satya Sai University of Technology and Medical Sciences, Sehore Bhopal-Indore Road, Madhya Pradesh, India.

[2]Research Guide, Dept. of Electrical Engineering, Sri Satya Sai University of Technology and Medical Sciences, Sehore Bhopal-Indore Road, Madhya Pradesh, India.

ABSTRACT

The doubly-excited unit can be used as a variable speed generator or engine. The main emphasis of the study is on the facets of electrical power generation (real and reactive) from erratic energy supplies such as water or wind. A single-phase analogous diagram, active and reactive energy and distribution, and steady-state characteristics is provided by a mathematical model of the machine. Detailed experimental work on checking a graphical system to disclose the necessary machine steady-state features to determine the desired generator operating modes is addressed. Next, zero-speed grid syncing and the excitement specifications of the twice-excited unit are studied for the optimum performance of the turbine. In these situations, the input of power to the main mover varies, so the speed of the turbines will be the highest efficiency. One basic principle that can be proven in this study is to provide an electrically regulated and adjustable turbine speed to ensure the optimum efficient functioning of the whole system by using a double-excited generator in a variable speed generation system.

Keywords: Synchronous, Motor, Rotor, Double, Excitation, Generator

INTRODUCTION

The mainframe can be the way back for all the magnetic flows that flow from the poles to the armature. The flow condition specifies that the required magnetic material, generally carbon steel, is cross-sectional. Due to the necessary flow capacity, much more metal is normally needed than for the specifications of structural strength. The most common structure is a rolling ring one with an automatic machine end-closing ass, which leaves a clear solder. This circular shape must be turned around to make it a true cylinders within the surface, and to make the ends of the bord square. The requisite geometric proportions must be maintained such that the finished machine is assembled without needless modification and the pole-shoes are concentrated along the frame. In this frame construction, some kind of mounting feet is always welded. Alternatively, the end clocks are used for bolting surfaces.

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In the automotive starting motors, the easiest structure to be found is the stick sod. These bolts can appear around the center of the frame as hexagonally spaced heads. These fixtures may be counter-sunk where space is crucial. Again, this sinking counter is used on a starting car so the external bolt heads will actually preclude installation of the device as closely as necessary. Depending on the make, scale and application there are other buildings on d.c. mainframes. Some units are made of cast iron or cast steel with integral chamber poles and fitting feet. This makes a very sleek machine, but the necessary machining largely annuls all benefits. The building of a cast iron reduces the flux density, which is mostly obsolete. The mainframe is divided into a top and bottom half on very wide units with a bound flange joint on the horizontal central axis.

That is because the frame is too wide and bulky to be inserted without a hoist. The chamber pole and chamber belt both involve crane handling at larger sizes, and thus two major aims are the separable structure. The mainframe arrangement of the small to medium units can be stacked with punched laminations. This arrangement makes the frame and the field poles an integral unit. It can provide a very good and sound structure; however, the cost of punching die is high. Field poles are normally made of extremely magnetic stainless laminations, but not always. On the inner or polar shoe end of the field poles the laminated construction is used. This is due to the field force pulsations that occur as the corrugated magnetic structure of the armature rotor crosses the polar shoe. Differences in field strength lead to internal currents of eddy in the magnetic structure. These currents of eddy are losers. The laminated magnetic systems can be greatly avoided. Structures laminated to allow magnetic flux to travel through the lamination length but don't permit electric currents to go from one lamination to another through the surface. A suitably positioned rivets house the assembled stack of laminations as a device. In order to match the inner surface of the mainframe, the external part of the laminated pole is curve. A traditional pole and pole laminated area. Any split, in any magnet structure, induces a major reticence, approximately equivalent to the resistance, such that a magnetic flow in the structure as a whole requires more ampere turns. More ampere turns mean more heat, which is a negative, such that the poles on the mainframe joints are always firmly fixed by the bolts of the ground.

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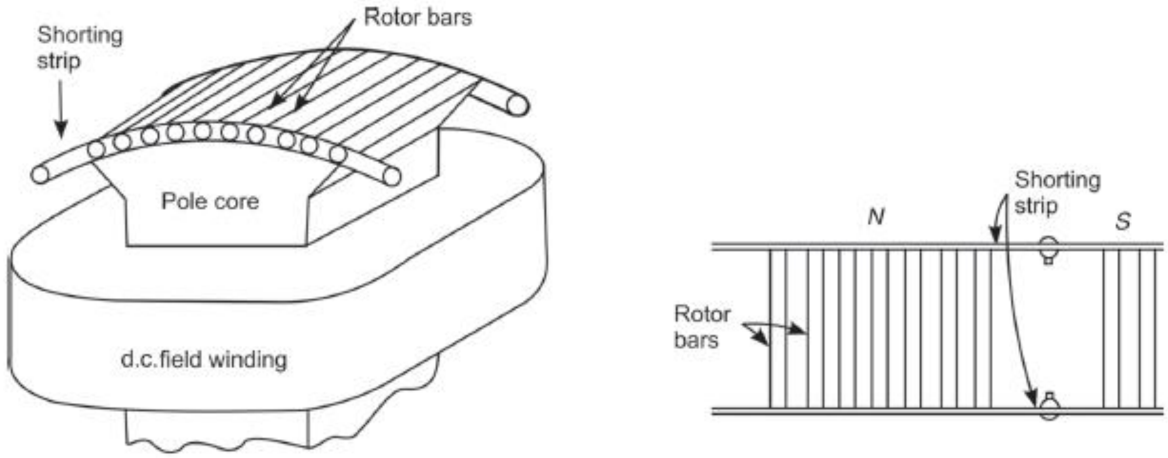

Figure 1 Synchronous Motor winding and Rotor

With regard to chemicals, as with batteries, these processes are reversible so that electricity can be reversed and retained. In proportion to their strength or to both, the procedures are still inefficient or strong. Developments are ongoing. Thermal power can be converted by thermocouples directly into electricity but the voltage is limited, which makes the main application of temperature calculation. The whole area of energy discharge from coal, liquid or solid hydrocarbon fuels through chemical combustion is extremely important. They are not reversible, inasmuch as we normally cannot bring resources into it and get the initial fuel back. The energy that the burning of this fuel releases takes approximately 15 times to produce a fuel at the moment. The theory of thermodynamics is to research the release of chemical energies as heat and to convert heat energy into mechanical energy through the use of intermediate fuels. The last decade has produced a new critical science of atomic energy, the release of heat energy from the fission of heavy elements like uranium or plutonium. More energy release periods are promised to be optimized and regulated by nuclear fusion. There is a hope. There are several practicable ways to generate energy directly by fusion without thermodynamic cycles interfering. Motors and generators are connected by properly positioned and operated magnetic fields with mechanical and electrical energy. The phenomena of electromechanical energy conversion which regulate the operation of instruments other than motors and generators are commonly known and commercially useful. Any of those mentioned below are electrostatic forces that involve very high voltages for comparatively tiny forces between the plates of a capacitor. Piezoelectric transducer effects are the ones that twist a crystal and emit voltages.

The motion here is very limited, while the strengths can be very large. Magnetostrictive effects are those that change their dimension minutely under the influence of a magnetic field in such magnetic materials. Here, as in the piezoelectric transducer, even microscopic motion is weak, but the power can be high. Both three are valuable tools, coordination and power. These are all three. At least in that they function both ways, they are substantially reversible. But either high power or steady motion can't be treated. In the sense that electricity can be distributed and regulated more efficiently than other energy sources, it is an overriding advantage. In wide plant systems, electricity is produced, transformed and transported overland for different distances to the required voltage in the so named transformer units. It is then normally converted into lower voltages and eventually converted in some form.

Mechanical intruding energy supplies and electrical energy converse and electrical energy supplies are known as electromechanical instruments, which absorb and transform electrical energy into sufficient mechanical strength or motion. At the mechanical-to-electric end, turbines and electric-to-mechanical ends motors manage these diverse fields of energy transfer. One of the main reasons for the widespread use of this technology is that it is reasonably reliable and manageable; so that the whole of our modern civilization is in dissociable from it. Because of the characteristic form of the curves, they are called so. There is a synchronous engine to be measured connected to instruments and a variable load. The two Wattmeter methods are shown, but each of the appropriate wattmeter circuits applies, taking into account the balanced three-phase charges. Three voltmeter are shown, but if a balance is seen, only one reading is needed.

LITERATURE REVIEW

Huda (2019): The voltage at the voltage terminal or power terminal can decrease the stability of the device by raising or decreasing the current. Other kinds of machines, including pumps, mills, turbines, solar motors, and heat engines, are used to turn mechanical energy into electricity. The generator can be described as the mover(s) obtained from the first mover is (mechanical energy) (motor, propeller, and diesel). Triple synchronizations are also suitable for operation with larger power stations, particularly those for which a synchronous machine is popular with three-phase rotational generators. Specification 1.030 KVA is an adjective that indicates that the sentence extends into the synchronous. The generator status must be maintained within the best range of operations Charges and the excitement of the generator affect the operating reliability of the generator, whereas the round number generator may have or may have stability. And the circuit's current will shift as the load generator has a different voltage on the circuit. It aims to analyses three main angles of synchronous generator agitation shifts: to collect data for all three processes The estimates were based on studies that showed that the average strength of the EMF was up to 48.68, the current intensity was 124.9, while the EMF's current intensity was down at its maximum, the voltage of the EMF induction (v) and EMF expenditure was down to 470.55, where the arousal current was at its peak. EMF expenses and costs lead at EM intensity at about 46.1.

Kumar (2018): T. Kumar: In different conditions the synchronous generator is simulated to check how much torque is generated during the loading supply shortage, as is done in this article. The DP equation is dq0 when it comes to a Synchronous Generator on an infinite Bus. The Adams fourth-order Runge-Kutta method is used to numerically simulate the torque produced

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using the synchronous MATLAB load-connected generator. Numerical findings revealed that the electromagnetic torque is stronger if a break between ground failure and line-to-fault failures and ground-to-line defects, or line-to-ground defects, is not synchronized or inappropriate. The engine is evaluated in logical steps by adding load and changing the excitement of the ground. At each step, data for all meters is recorded in order to determine volt and power. For each load field current condition, this helps the power factor of the motor to be calculated. Based on the ease of charge control and time available, the curves can be taken over more closely spaced increments, to truly characterize the curve forms. The no- load curve falls at least, but not zero.

PROPOSED METHODOLOGY

The winding of the armature is made of main each polyphaser phase of the synchronous dynamo, ny bands in sequence. The three-phase current in the stator armature drivers creates a consistent spinning magnetic field that rotates at an S-velocity = 120 f/p. The relationship between the stator spinning field and the rotor poles. The north and south poles of the rotor are locked in alignment with the resulting armature synchronous spinning area of the stator, which rotates at a synchronous pace. A rotor N polar is locked with a stators S polar in synchronization and vice versa, each revolving at synchronous speed in a clockwise direction. If a load is loaded on a synchronous loading engine shaft, the loading counter torque causes the rotor to drop down, but it continues to rotation at the same velocity with regard to the filed spinning stator.

The speed of the rotor is still synchronous, in relation to the spinning field, but due to the increased air gap reticence the reciprocal air gap flux is significantly decreased. The synchronous driver is stopped if the counter torque is so high that it approaches the developed optimum torque and the rotor falls out of sync. So a synchronous engine runs at or does not run at any sync level. When the rotor slows down, it slips so quickly through the rotor field poles that it does not lock the spinning stator field synchronously or mesh. At a time, a unit N polar of a rotor is drawn to an approaching S polar, causing torque in the opposite direction of the clock. In the next moment a moving rotor S polar is drawn to an N pole that produces a torque clockwise or a net torque of zero in the opposite direction.

A peculiar feature of the synchronous motor is that it does not auto-start inherently. Like the A.C. alternator, it needs to be quickly attached to the line using a number of auxiliary means. Another particularity of synchronous engines, especially where the loads have abrupt shifts or are not uniform during a single revolution, is their hunting sensitivity, such as punching press shears, compressors and pumps. The use of the rotor structure with the damper windings has solved this problem and at the same time enables the synchronous engine to start itself. The synchronous engine is now commonly used and is never more common. It outsells the poly-phase induction motor in certain horse power sizes and speed ranges. The following special benefits over the polyphaser induction motors apply to synchronous polyphaser motors. In addition to providing torque for drive loads, synchronous engines can be used for power factor adjustment. The motors with the equivalent horse power and voltage rating are more powerful (where run at unity power factor). The field pole rotors of synchronous engines may use broader air gaps, which require lower bearing tolerations and allow higher wearing, than in the squirrel-cage designs used in induction motors. For the same horse power level and voltage ratings, they may be less costly. The synchronous motor works in steps or synchronization with the a.c. line voltage frequency. The real speed of the motor depends on the pole number. The synchronous engine is an alternator used as an engine. Due to their high operating efficiency, reliable power factor and relatively low sensitivity to voltage dips, synchronous motors are primarily used in major power applications.

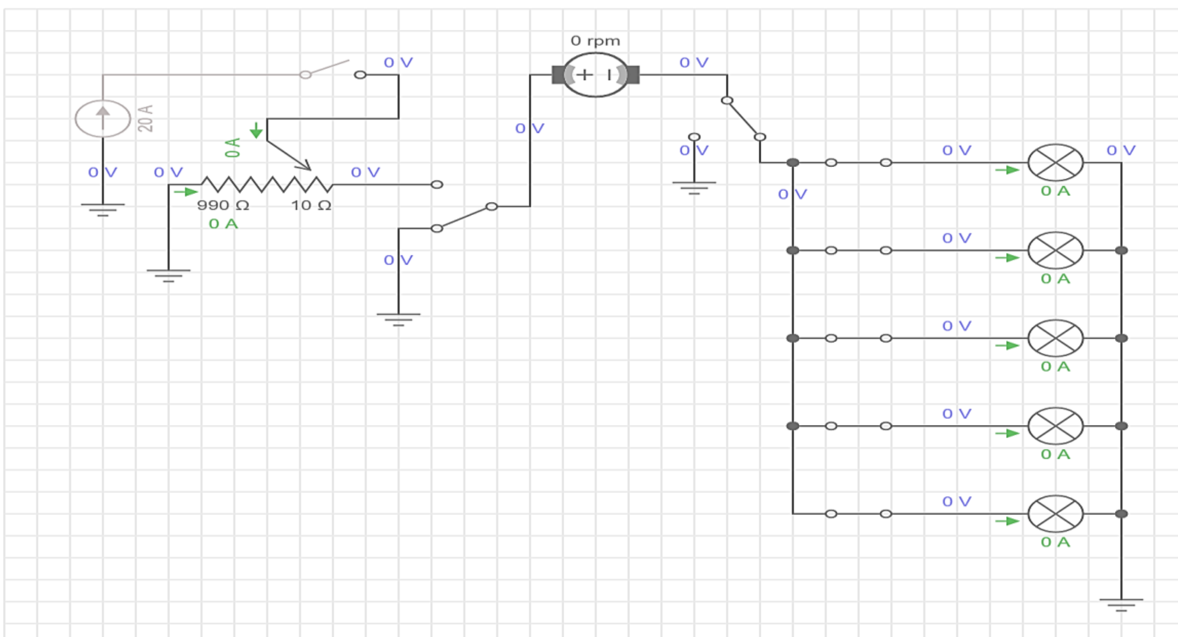

Figure 2 Double Excitation Motor control Circuit

They are constantly operating speed machines for mills, refineries, power plants and so on, which operate and support the power factor correction of pumps, compressors, ventilators, pulverizes or other big loads. Synchronous devices specially designed to monitor the power factor have no external shafts and are called synchronous condensers. They float on the bus, providing the machine with reactive control. By adjusting the field excitation of the unit, the direction of responsiveness and thus the power factor of the device is changed. It is thought that the system is attached to an infinite bus when addressing the action of each motor. The terminal tension and infinite bus frequency are continuous, and no power from or supplied to the infinite bus is affected. Large power systems can be found approximate to infinite bus systems in highly developed countries. The process is actually the same as the first except the sync motor excites, i.e., the shunt generator, is motorized and synchronized with the a.c. dynamo. The third process

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of an auxiliary induction motor with less pole complies with the same a.c. synchronic motor synchronization protocol as an alternator. The induction motor requires at least one pair of pole lower to compensate for the motor slip induction failure. All three strategies require: (1) the synchronous motor has little to no load, and (2) the starting motor output is between 5 and 10 percent of the synchronous motor rating combined with it. However, as a motor induction with damper windings, the most common approach for starting a synchronous motor is by far (fourth method).

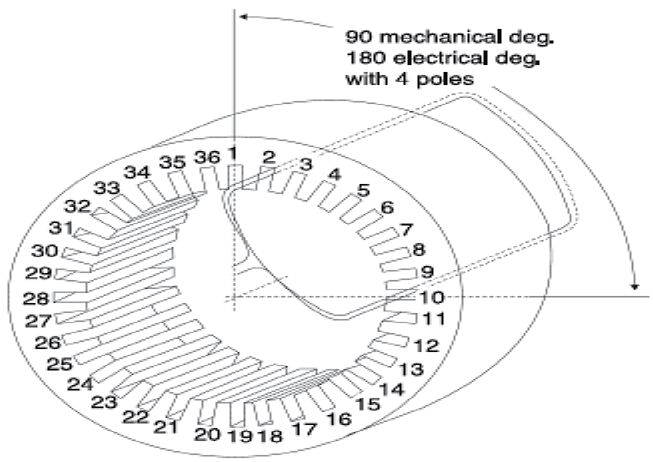

Figure 3 Electric Generator Poles

This is the simplest method and no special auxiliary machines are needed. To lock the spinning field in synchronization, the synchronous motor has to be brought up to a speed equal to its synchronous speed. The method by which speed is raised is: D.c. engine paired with the synchronous engine shaft, Using the exciter field generator as an engine, A small motor with at least one pole lower than the synchronous motor, Use the winders as an induction motor for the squirrel cage. The first approach is often used in laboratories with non-damper-winding synchronous motors. The synchronous drive is generally meant as the d.c. generator's constant speed prime mover. To sync the engine, however, the d.c. generator works as an engine and synchronizes the a.c. synchronous dynamo to the a.c. supply as an alternator.

EXPERIMENT RESULT

The synchronous dynamo works like an engine until in tandem with the delivery. If the field current is raised to be higher than that of the d.c. bus, the D.C. engine can now serve as a generator. If this way, the synchronous engine is modified purposefully, a leading Ia current is drawn from the line by adding an internal Ia sin / reactive current part. The Ia stator current is the same with equivalent lead and lagging power considerations. The advantage is that the component Ia sin is opposite in step with every component Ia sin that exists with the rest of the

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system used by the synchronous engine. The commercially over-excited broad synchronous motors during their work achieve substantial device power factor improvements. If a synchronous engine is used exclusively for the production of a big leading Ia Sin component, it is called a synchronous condenser.

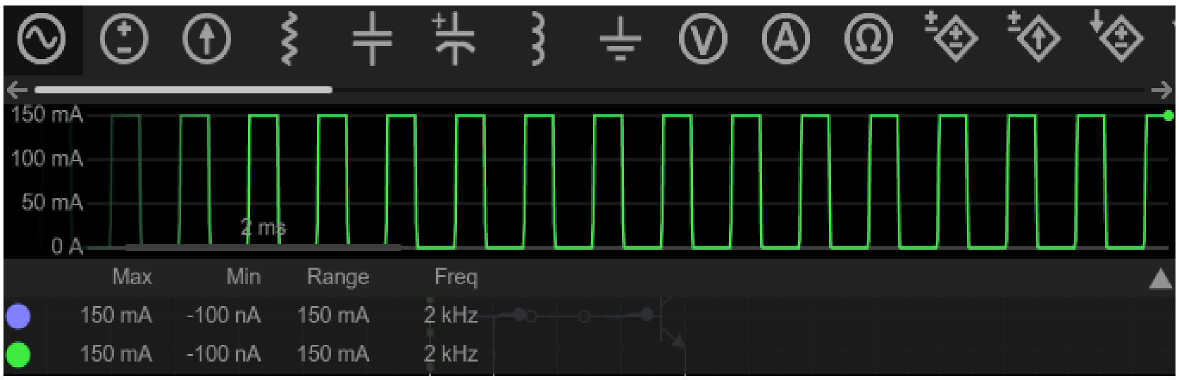

Figure 4 Synchronous signal for double excitation

This name is derived from the impact that a giant condenser is mounted on the axis. The motor is mostly used as a synchronous power factor fixer when it is intentionally exaggerated when a typical mechanical load is present. If the d.c. field excitement is raised, the other situation holds. This results in a larger Egp voltage than Vp, which establishes the phasor relationship. The stator power from the line must be the same as in the same load state, so that Ia cos totally will fit the initial Ia again (a). The relationship of the phases is then modified by the wider Egp. The resulting phasor voltage, Er is rotated in the opposite direction (c). Although Er is rotating, it must still be the Ia phasor, since the winding impedance triangle also determines the angle between them. The effect is a powerful leading load factor with the excessive modification of the ground. Assuming the same engine load, which is the same input power or VpIa cos as needed, the condition occurs with considerably lower d.c. field excitation. Since the amount of phasor sum in regular Vp and lower Egp means less Egp the phasor sum of Er would follow the course of (b). The criterion is that the efficient stator power should have the same value. Ia must be bigger to fit the original value of Ia. Ia must be larger (a). This implies a proportionate growth of the Er phasor. In order for Er to increase with shorter Egp, the angle α2 must be greater than the angle of α1. This angular relation of shift is the only way a small Egp will lead to a larger Er. There will also be the same phase angle between Er and Ia, as the same impedance is effective. Externally, the engine is a lagging energy factor strain on the power supply under these conditions.

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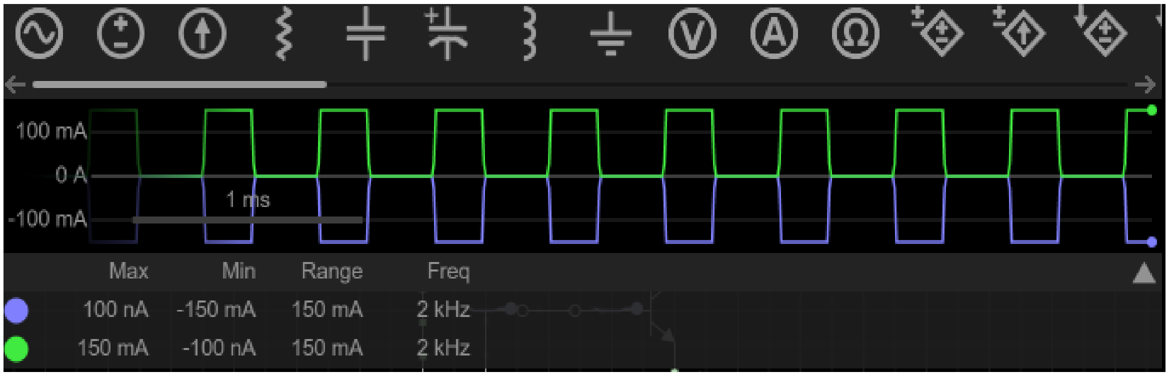

Figure 5 Double Excitation Signal

The lag or cosine percentage of angle depends on how short Egp can be when excitation on the field is decreased. Internally, the phasor relationship formed by the increased magnetization of the field resulting from a delayed current stator of the power factor. The different phase relationships with different values of excitation in the region. Where Egp is of such intensity that the state is called natural field arousal. In such situations, the Egp is simply enough to make it sufficiently high to generate the phasor sum Egp and Vp, the resulting voltage Ev. Present Ia attenuator or stator. The resistance Ra is held as low as possible during the usual stator winding, in order to minimize losses of I2R. The inductive reaction is the main component of the winding impedance. The corner is almost but not quite 90° between the ER and Ia stages. This corner of the phasors contains the whole winding impedance triangle and the pointed line. The armature current Ia can be precisely matched to the supplied voltage Vp by tuning the d.c. excitement to the right level. This is the solidarity element condition a broad range of spinning area, d.c. excitement can run the synchronous motor and hold its load. The relationship between the spinning field and the stator coils is identical to that between a sync generators, which means that the voltage provided by Egp will differ across a broad spectrum. If there are no supply torque requirements and if Egp is set to Vp, the Egp voltage exactly opposes the voltage per step Vp. There is, however, some torque requirement even in running light. With regular load, the maximum standard torque requirement exists, such that the necessary strength of the spinning stator magnet field is developed in full by the stator current. The V-curve measure shows the power response factor of a synchronous motor under different d.c. field excitation currents with constant power.

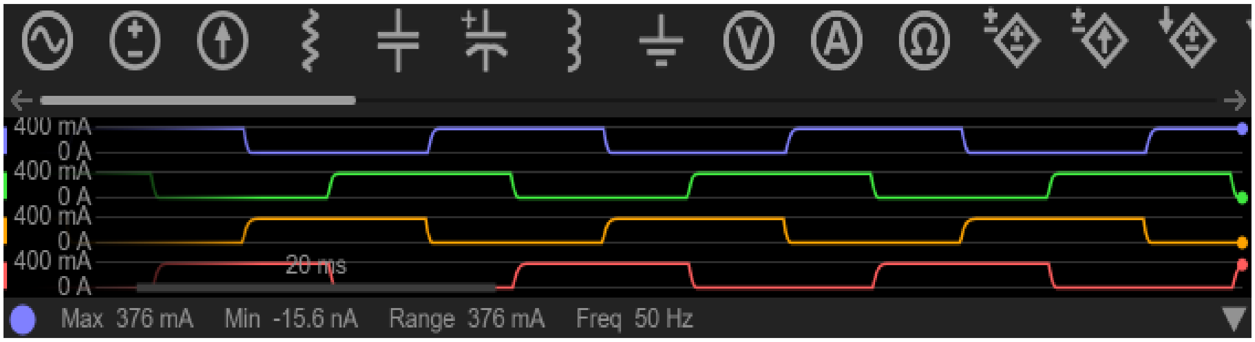

Figure 6 Synchronous and Excitation signal for generator

CONCLUSION

The synchronous motor could be synced quickly and fluently with a power grid by controlling the rotor frequency at any mechanical speed. This has the benefit of remote synchronization which reduces device downtime relative to a synchronous generator in the event where shutdowns take place. The circuit diagram was created as a schematic method to explain the working modes of generator according to the law through the use of a single-stage analogous circuit and assuming that the magnitude and frequency of the stator voltage are both constant. The association of all related system variables can be determined from the circle diagram. This involves the current angle, the active and reactive power outputs, the power factor angle, the winding currents of stators and rotors and the power torque of an operating point. A symmetric-component transition of three phases and the assumption of equilibrium polyphaser terminal voltages achieved the single-phase diagram, a power flow diagram, and a torque equation for the stable state. A comprehensive mathematical model of tension, current, power or torque equations was derived by assuming a symmetrical, balanced machine and ignoring the impact of saturation, hysteresis and eddy currents.

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