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Simulation and analysis of power flow and stability control using bundle conductor.

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A B S T R A C T

With the expansion of the human population in the 21st century, the demand for quality power has increased in industry, urban and rural areas. A quality power flow is an efficient way to meet the electricity need for human settlement and helps improve the system's stability. Simulation is an integral part of the operation, planning, and design of power systems. In order to research attainable solutions to the challenges exposed by the continual changes in network requirements. In order to research attainable solutions to the challenges expose by the continual changes in network requirements. This enables flexible modeling, testing, and modification methods in an environment close to real-industrial tools. This paper presents simulation results of a power system with a bundle-controlled line-impedance modulator for a stable power system that is MATLAB/simulation module management of power flow under steady-state and dynamic conditions. In addition, much research is focused on increasing the poor efficiency of power processing and improving the power yield of the overall system.

Keywords: Bundle conductors, switching module, line-impedance modulator (LIM), load-flow control, power system stability.

1. Introduction.

In recent years, the challenges of power-flow management in electrical transmission grids have augmented considerably because of the combination of power systems across ever-expanding regions. To improve power-flow management, devices referred to as versatile ac transmission systems (FACTS) are proposed. Some of these devices are put in at transmission-line stations to regulate the ability flow in every conductor in order that the power flow will be safe, stable, and balanced. FACTS devices for high-voltage and dynamic applications are giant items of kit physically erected on the ground. Due to their comparatively high cost, these devices aren't widely enforced in power transmission networks at the current time. Line de-icing (LDI) can be activated prior to or during any severe climatic event, for concentrating the total power line current into one sub-conductor at a time and therefore de-icing by the Joule effect. This distributed flexible AC transmission system (FACTS) provides the opportunity to control the power flow for de-icing applications and dynamic stabilization of the network. Line impedance modulation (LIM) is every other characteristic of the smart power line via way of means by which line energy goes with the drift and balance also managed via way of means of in my view switching inside and out sub-conductors of bundled-conductor lines, thereby enhancing the internet line impedance without delay and dynamically. The combination of LDI and LIM functions with the generalized LMO system led us to a new concept of the power line, the Smart Power Line (SPL) (Fig. 4). The SPL relies on the use of BCL segments, i.e. conventional bundled power lines (e.g. 735 kV line) with insulated line phase sub-conductor segments (e.g. 30 km) to which we hook SMs back-to-back every two segments on the dead-end tower. Line monitoring (LMO) affords real-time records associated with electrical, mechanical, or climatic activities wished for line de-icing, energy going with the drift, or balance control. A range of those switching gadgets should be allotted all through the energy grid and managed in a coordinated manner to manipulate the energy to go with the drift. Transient stability studies are essential for the design and operation of power systems as they aid in analysis of the impact of potential network contingencies and provide information on the dynamic variations in system operation after occurrence of such disturbances. This paper is about a specific application of a new concept of FACTS device, the bundle-controlled line-impedance modulator (LIM), introduced in [2], which is not erected directly on the ground but anchored to a limited number of existing dead-end towers in place of yoke plates. Based on the implementation of switching modules (SMs) in Figure 3 segments of transmission line phase conductors, this new technology involves the use of bundled conductors to modulate the series impedance of high-voltage lines to control power in power grids. It includes how to manage the flow of and made of bundled sub-conductors.

Bundled conductor

Corona leakage occurs in transmission lines when the voltage gradient close to the conductor surface exceeds the dielectric strength of air. Round conductors cannot be used for voltages above 230 kV. Instead of relying on waveguides, it is recommended to use multiple conductors per phase, called conductor bundles. A bundle is a conductor consisting of two or more strands used as phase conductors. It turns out that the increase in transmission capacity justifies, from an economic point of view, in 220 kV transmission lines the uses of two conductor bundles. Its use has the advantages of reduced reactance, reduced voltage gradient, reduced corona losses, reduced radio interference, reduced characteristic impedance, and more power lines.

2.Bundle-controlled line impedance modulation.

The impedance of a line segment is a function of the number of current-carrying sub-conductors. The reactive impedance of a single sub-conductor carrying the current (three switches open) of a bundled line phase is 1.61 times higher than the impedance of a 4-sub-conductor/bundle carrying current; in the case of a 2-subconductor/bundle carrying current, the impedance ratio is 1.21, and for a 3-subconductor/ bundle carrying current, the impedance is 1.07. This distributed flexible AC transmission system (FACTS) provides the opportunity to control the power flow for de-icing applications and dynamic stabilization of the network.

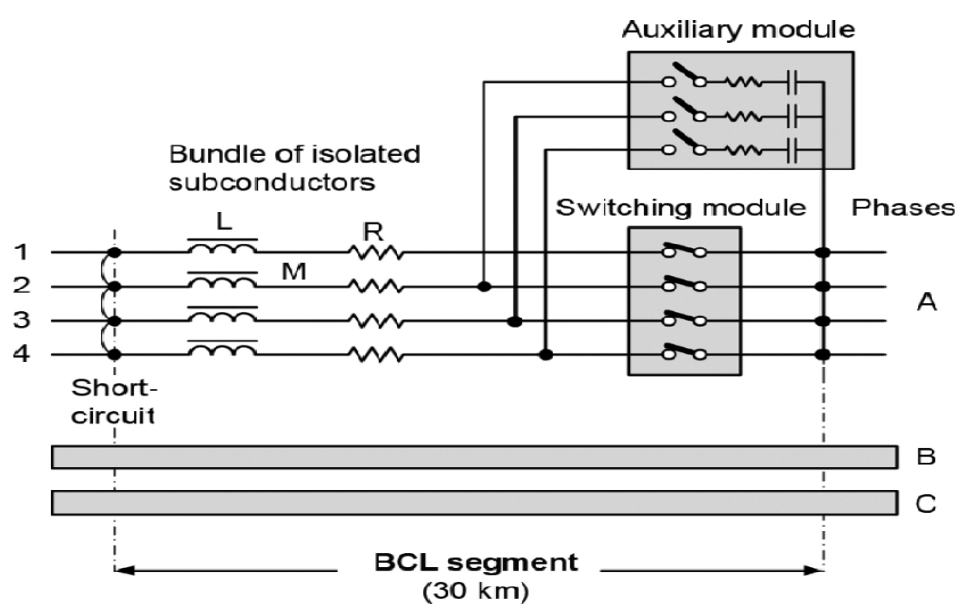


Fig. 1. Schematic of a basic bundle-controlled line (BCL) segment.

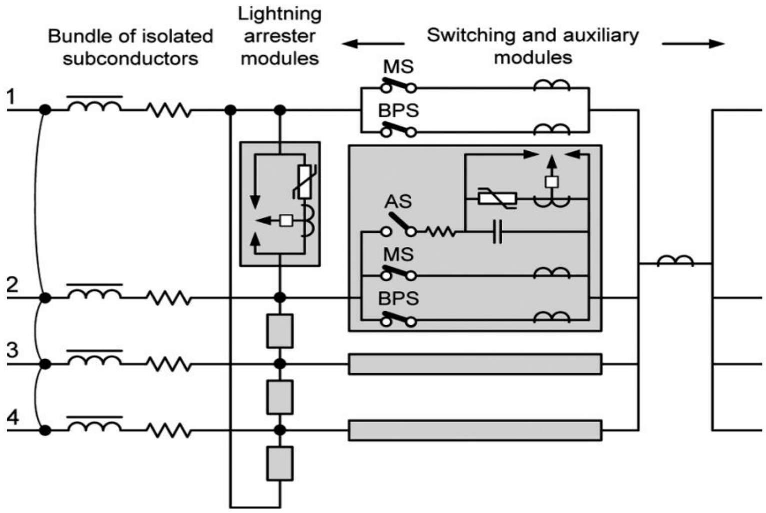


Fig. 2. Switching modules, auxiliary modules, yoke plates, and spacers protection against lightning strikes and over voltages caused by power system faults.

MODELS.

A schematic of line impedance modulation for bundle control in the MATLAB/Simulink environment is shown in Figure 4. It consists of bundle conductors, switching modules, turbines, line impedance modulators (LIMs) and transmission lines.

A power system with two generators, equivalent to 10,000 MVA, connected by three 735 kV transmission lines. Lines L1 and L2 are conventional 30 km and 90 km long transmission lines. L3 is a 60 km line with two switching modules installed at the midpoint in Figure 4. A line L3 containing two line segments forms a back-to-back LIM. The outputs of generators 1 and 2 are set to 2400 MW and 2500 MW respectively. Considering each load connected to 13.8 kV for convenience, it supplies 2000 MW to each of buses B1 and B2. Line L2 is much longer than L3 and its normal power flow is only 1573 MW when all switches in the LIM are closed. The L1 and L3 power flows are 415 MW and 2404 MW respectively. The impedance control commands sent to the LIM are generated by a signal generator within the LIM impedance control block. The Z cmd signal increases from a minimum of 1.0 (using all four strands) to a maximum of 1.642 pu (using only one strand per bundle) in 0.5 to 3 seconds. , which changes stepwise after t as described in Figure 3. As shown in the LIM subsystem, a lookup table 58 maps the 24 switching state combinations to the requested impedance command. These combinations were chosen to keep the reverse and zero-sequence currents at levels below those observed when all switches are closed. The 58 transfer mixtures used in this case represent a very small subset of the 33752 transfer mixtures provided by some of the BCL segment capacitances provided in the power line impedance modulators. A 14x14 impedance and admittance matrix is automatically loaded into the workspace. Table 1 shows the phase resistance, reactance per kilometer (km), and reactance ratio for a 735 kV, 30 km line impedance modulator (LIM).

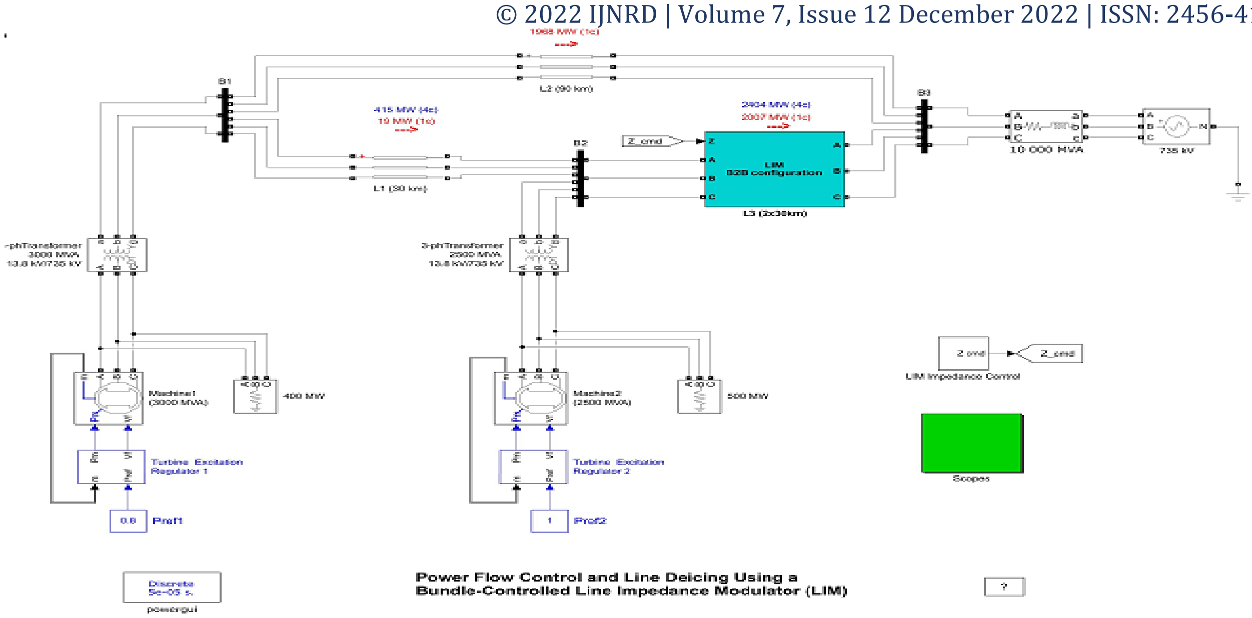


Fig.3 Overview model of power flow control using a bundle-conductor line impedance modulator.

TABLE I
RESISTANCE, REACTANCE, AND REACTANCE RATIO OF 1, 2, 3 AND 4 CURRENT-CARRYING SUBCONDUCTORS OF A 735-kV 30-km LIM SEGMENT

No. of current carrying subconductors/ bundle	Resistance ohms/km	Reactance ohms/km	Reactance ratio
1 out of 4	0.0465	0.512	1.605
2 out of 4	0.0235	0.386	1.21
3 out of 4	0.0165	0.341	1.069
4 out of 4	0.0125	0.319	1.00

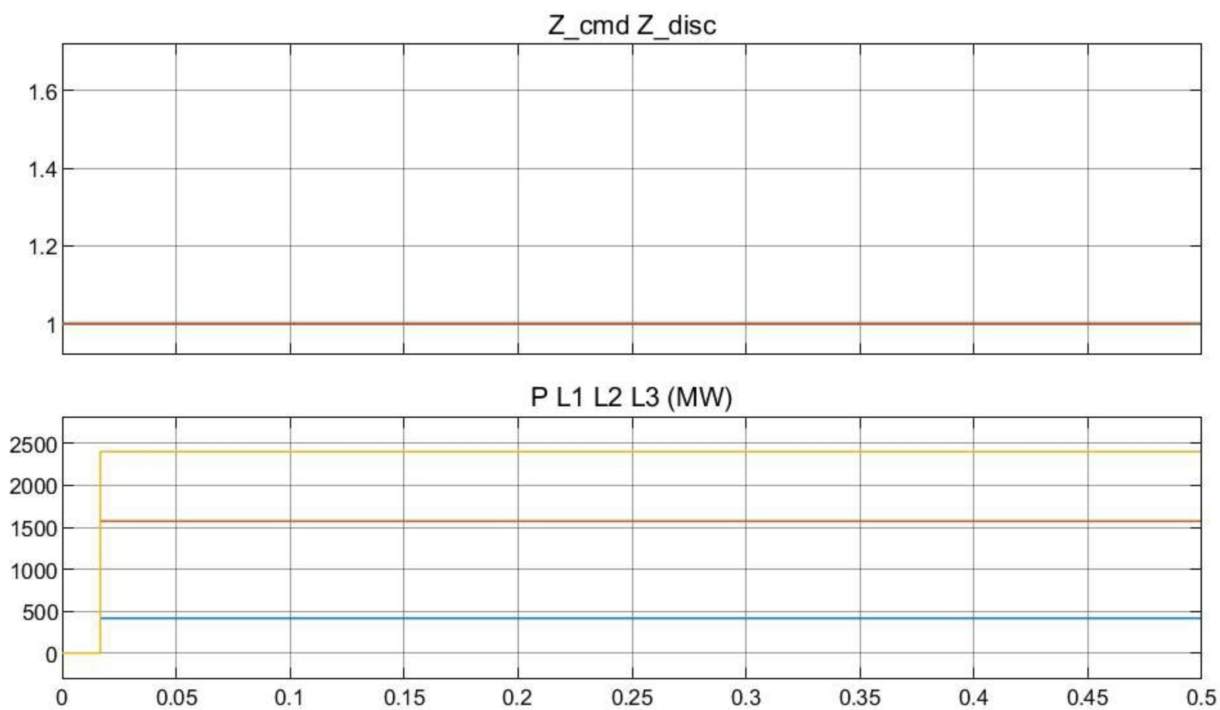


Fig.4 Characteristic of Zcmd, Zdisc (pu) and P L1 L2 L3 (MW)

3.LITERATURE REVIEW

The literature review in this research work is focused on the simulation and analysis of Power flow and stability control using bundle conductors. A bundle is a conductor that consists of two or more strands and is used as a phase conductor. For voltages above 220 kV, it is recommended to use multiple conductors per phase, called bundle conductors. The development of a bundle-controlled line (BCL) technology based on switching modules (SMs) installed in series with bundled conductor transmission lines. The advanced SMs equipped with electronic switches, a response time in the order of 8 ms could be achieved. The SMs are distributed along the transmission lines. SMs are independent of one another and could be mass-produced. Figure 3 shows a switching module with a permanent galvanic link.

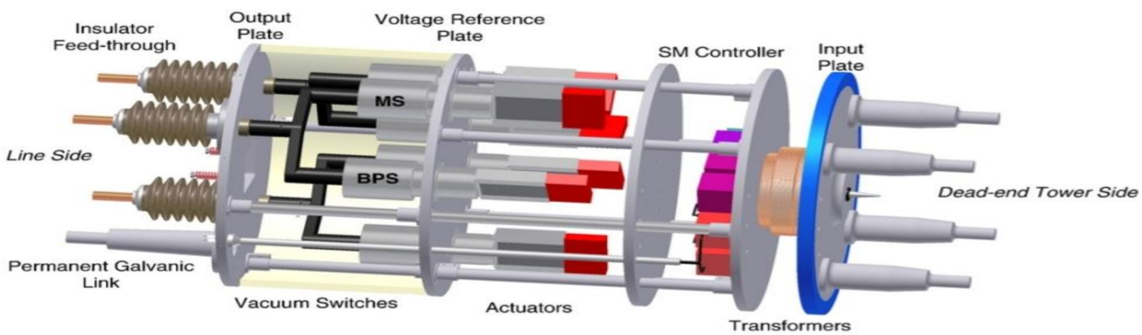
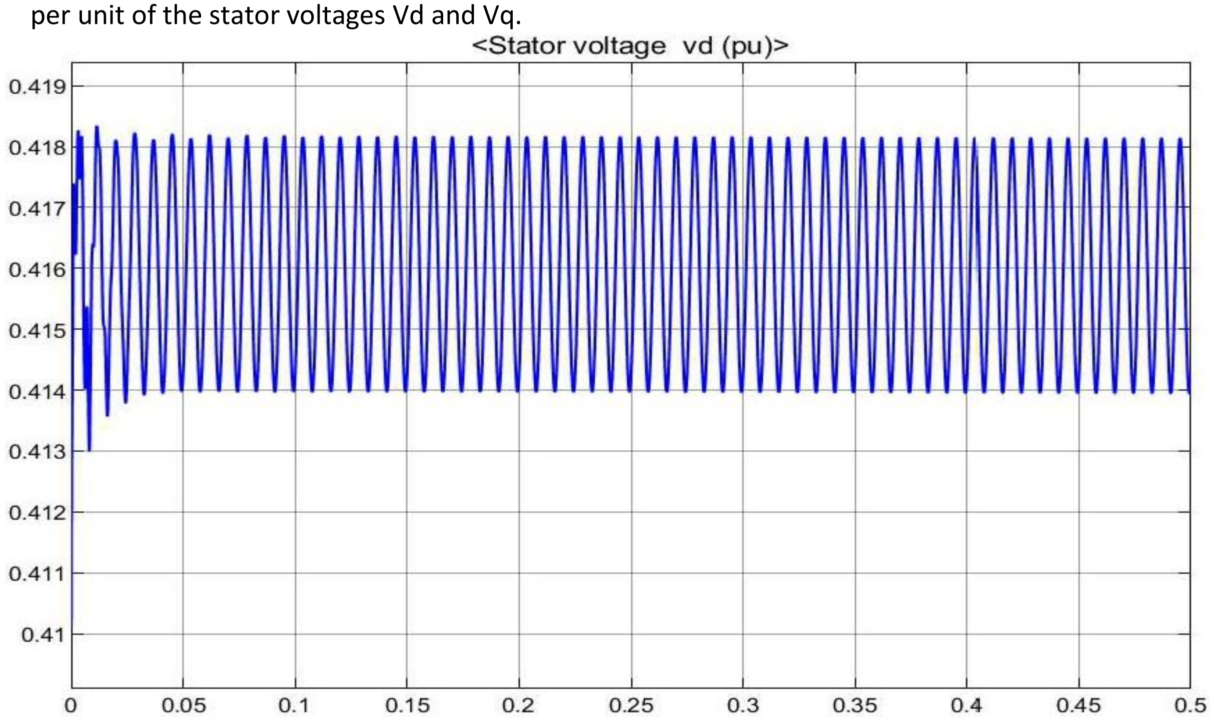


Fig.5 switching module with permanent galvanic link.

Voltage regulation of a synchronous generator is the increase in voltage across the terminals when the load is reduced from the maximum load rating to zero while the speed and field current remain constant. It depends on the power factor of the load. If the power factor is unity and lagging, there will always be a voltage drop with increasing load, but for a given leading power, full load voltage regulation is zero. Figure 1 shows the waveforms per unit of the stator voltages Vd and Vq.



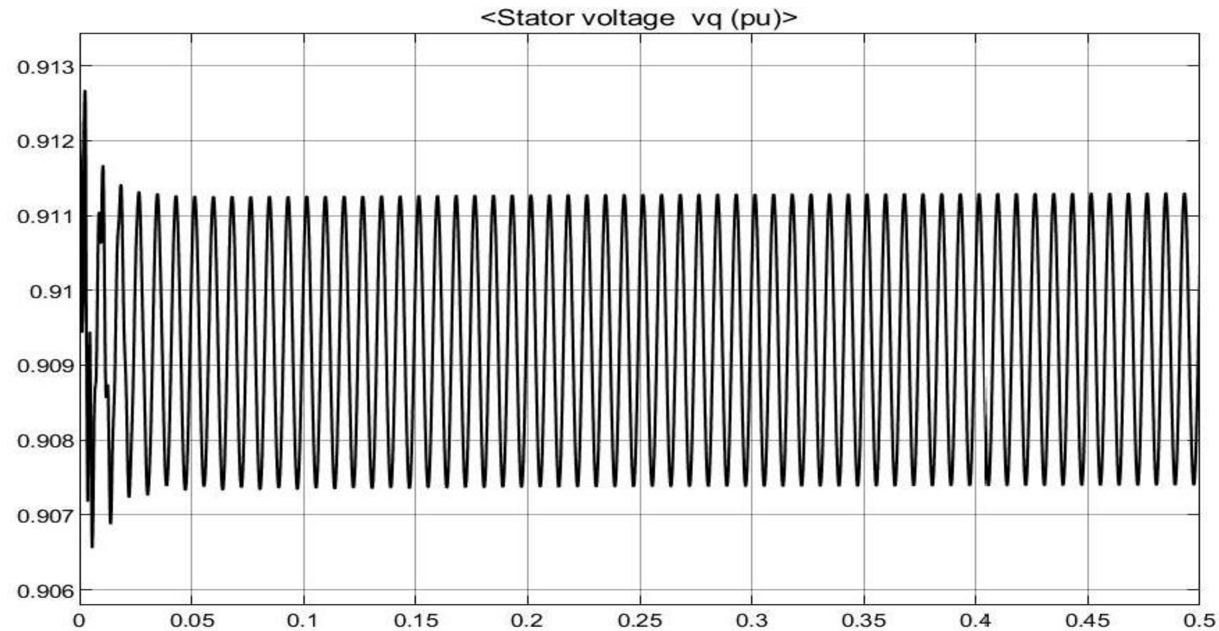


Fig.6 Waveforms of regulator stator voltage Vd and Vq.

4. RESULTS

The simulink model of switching module on a segment of a 735-kV bundled-conductor in power system is shown in Fig. 3, Characteristic of Zcmd, Zdisc (pu) and P L1 L2 L3 (MW) fig.4 and Waveform of rms V's and rms I's Fig.8 which gives a better understanding of voltage .It may be seen that large impedance modulation of a power line using LIMs is feasible either rapidly. This opens the door to real-time power-flow control for stabilization applications with a new type of flexible ac transmission system (FACTS) device solution.

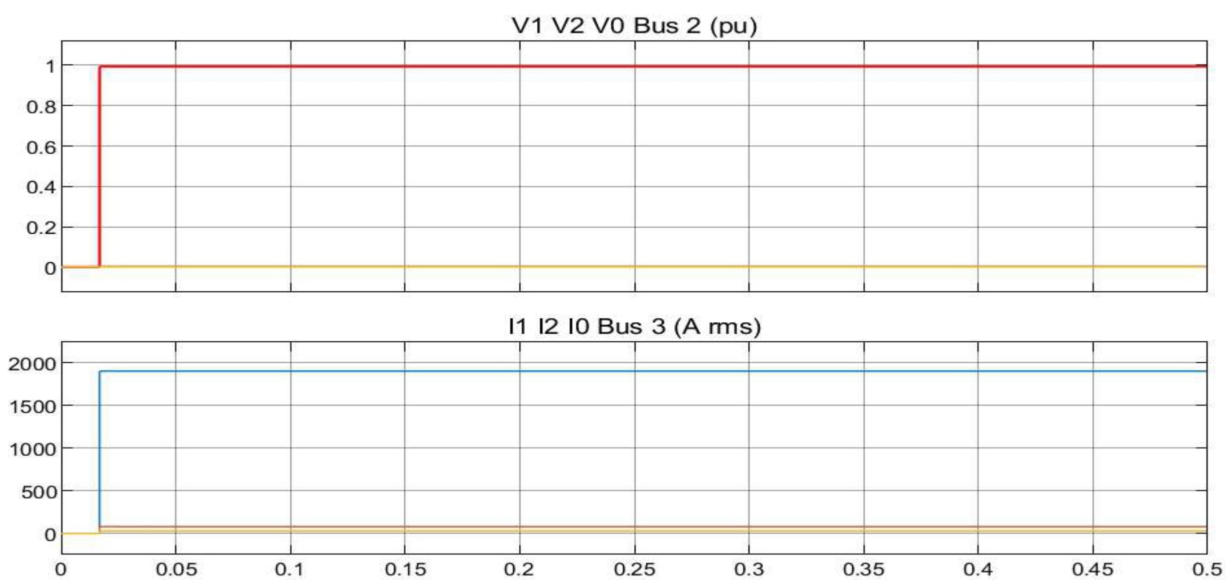
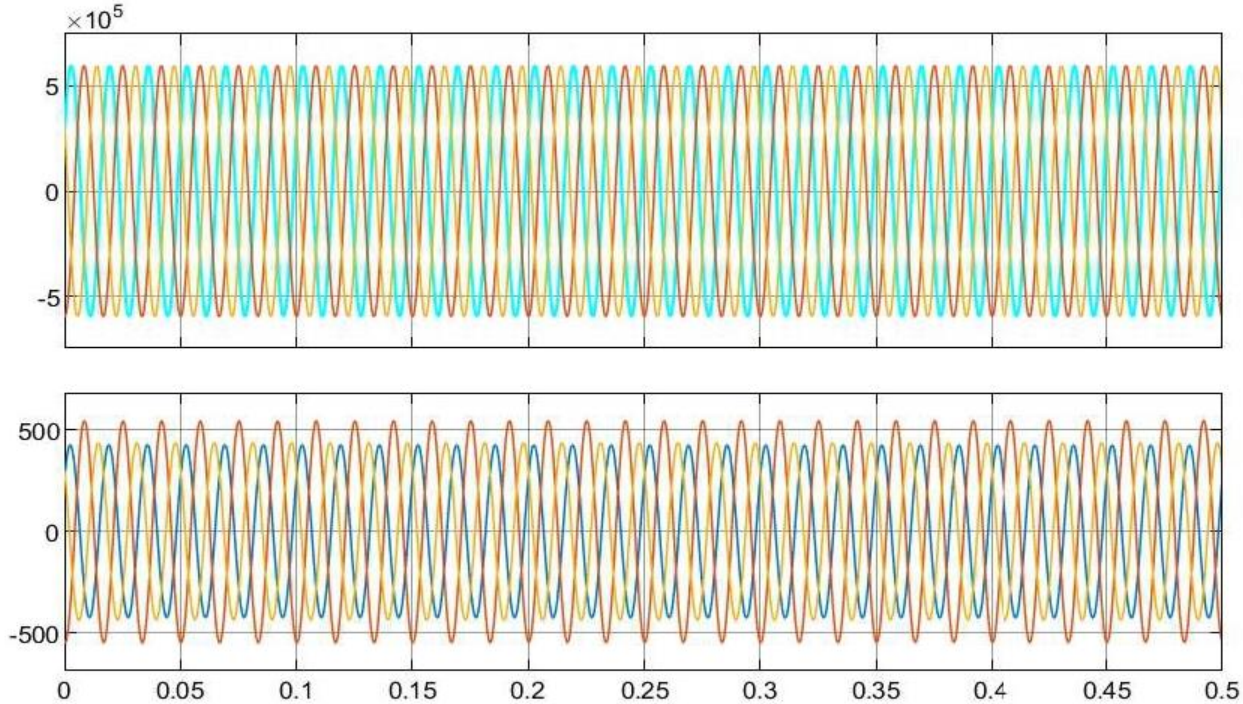
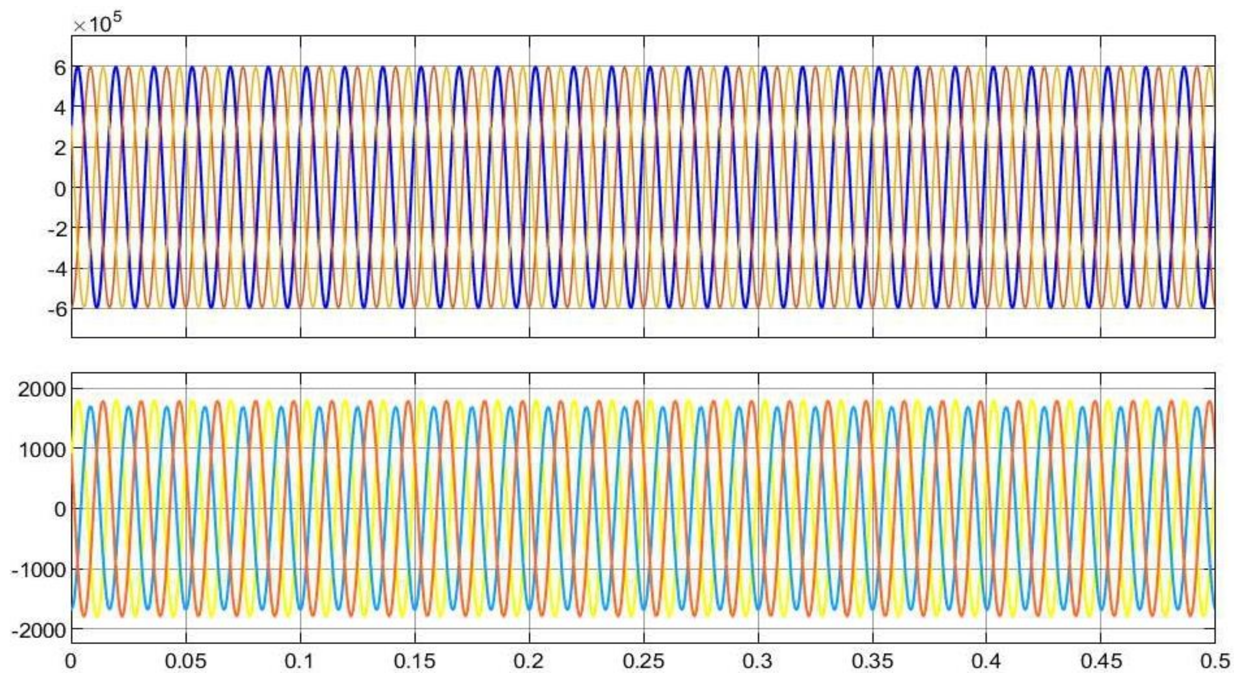


Fig.7 Characteristic of bus 2 seq. rms V's and Line 3 Seq. rms I's.



Bus 2 Seq. rms V's and Line 3 Seq. rms I's 2.



Bus 2 seq. rms V’s and Line 3 Seq. rms I's 3.

Fig.8 Waveform of rms V’s and rms I’s

5. CONCLUSION

Distribute many of these BCL segments in a complex network to reroute power flow to avoid congestion caused by congestion at specific network devices or to meet network stability constraints on specific power lines can do. The transmission-line reliability and longevity should be improved. Utilization of these SMs for performing highly integrated transmission-line functions, such as deicing, power-flow control, stability control, inter area power oscillation damping, and line monitoring has led to a new concept under the development. The model is able to operate at 50 Hz and 60 Hz frequency with deviation. The bundle-controlled line (BCL) technology based on switching modules is helpful in control and stability of the system. It provide better stability to flow quality power.

ACKNOWLEDGMENT

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