Design Of Supercapacitor Energy Storage System

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Abstract: Reactive power will be essential to deliver the active power with the help of transmission lines to preserve the voltage. If the reactive power is not efficient, the voltage fallsthan the power required to load through the lines is not possible.So in order to deliver this required power in an effective way, we use technologies such asSVCs (Static voltage compensation), FACTS i.e Flexible AC transmission system, STATCOMs(Static VAR compensators),etc for the maintenance of high power factor voltage stability as well as to minimize the transmission losses.

STATCOMs are commonlyhelps to increase thestability of power system. power system, can exchange the reactive power, then which will limited the exchange of gereal power, so that the energy storage devices are may not include. The STATCOMs associate with the energy storage device like batteries which released to increase real power exhange, this kind of batterieshadbarrier in their max deliverable power dueto the chemical process slowneed to release its energy. In recent days, the usage of SCESS as energy storage to STATCOM. We have less energy storage for Super capacitors. Still they have capability of the high level power exchanging than batteries.

The Document represents controland supercapacitor energy storage system analysis i.e SCESS form STATCOM. The controller of current mode wasmainly used for regulating SCESS. The Simulation model of the SCESS is developed and the same simulation results should be presented for the proposed SCESS system.

Keywords: Super capacitor, Energy storage system, Statcom, Ripple voltage

1. Introduction

A STATCON is nothing but static synchronous compensator, it can regulate transmission networks which can have current electricity i.e alternating current. STATCON can works on the voltage source converters which are power electronics as well as they should can behave like as reactive AC power reactive source or may sink of to the networks of electricity. STATCOMs has been mainlyrequired for the voltage support from the last 10 years, to update the stability of voltage as well as power quality, This device work faster in terms of dynamic response compared to thyristor based on the generators i.e conventional synchronous or else static compensators.

STATCOMs can have the wonderful facility of exchange of reactive power by its own via power system, but it contains very controllable capacity to exchangethe real power. This can have wide developments in the technologies of energy storage fromthe decads, such as fuel cells, improved battery technologies as well as magnetic energy storage which is super conducting, flywheel energy storage, the bulk energy storage to the grid systems power balancing and many more.

The applications of STATCOM'sabout to mentioned energy storages and it is feasable for stable voltage control for the outage of power withstand. However, systems have few limitations becauseofitsresponse speed is slow. Supercapacitors can also called as Ultracapacitors are the can able to store necessary energy. It also have fast delivery. They have the main applications to "power boost" and the fast response energy stores and type applications where short term are required.

Thus, now the widely use of the "supercapacitor energy storage systems SCESS" like storage of energy for STATCOMs. it has energy lower storage. Still capability of exchanging of the power can be more compared with the batteries. They are having ahuge area i.e surface that made its higher capacitance its own than the traditional capacitor. In the current mode which is peak, the controller can be helpful for limiting of SCESS. Theexcellent performance of proposed SCESS is here with result of the SCESS system.

2.Objective:

The main aim of the proposed system is for analysing how is a super capacitor required for enhancing the STATCOMs operation capability based on the energy storage technology for themaintenance of a higher quality voltage distribution as well as toincrease system

The objection behind this is, deciding whether it can be used to enhance or improving the dynamic behaviour of the power system during large load changes or faults. The systems of STATCOM with the supercapacitor which is on the basis of energy storage might known as STATCOM with SCESS.

3.Superconducting Magnetic Energy Storage

SMES can preserve energy in terms of magnetic field made from the DC flow in coil which is superconducting itcan be cooled cryogenically at temperature which is below of critical superconducting .

Thus, system of SMES consists 3: Power conditioning system Superconducting coil, and cooled refrigerator which is cryogenically. current will not decay if the superconducting coil is charged, and indefinitely the stored the magnetic energy.

By discharging coil the energy which is stored can given to network. To transform the AC power to DC else to change the DC back to the power i.e AC, the system of power conditioning works arectifier / the inverter.The energy loss in each of the direction in accounts for about 2–3%. when compared to the other methods of storing energy SMES lost the electricity which is very less in energy storage process. Thesesystems are more efficient; efficiency of roundtrip is more than 95%.

As the superconducting wire is more cost as well as for energy requirements of refrigeration, for short duration storage which is energy SMES is used. Hence, we can say thet the widely used system is SMES devoted for increasing the ability of power.

4.Proposed System:

STATCOM along with its equivalent network has been given in below figure.

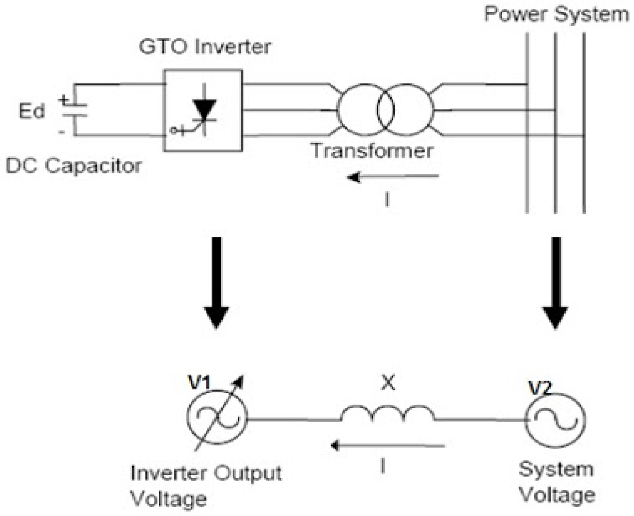

Fig. 1. Design of STATCO

Now we canobserve that how the STATCOM operatesand we shouldsee the operating the STATCOM principle . As itshows in above diagram, the output voltage of STATCOM source V1 can represents. In the same demand for reactive power will be increased in the power system and at the same time V1 and V2 phase difference to zero. STATCOM raises the output voltage to V1. Here V1 > V2, The power which is reactive would go to power system from STATCOM. STATCOM, and acts as a power generatori.e reactive and supplies a power which is reactive

Again, if voltage of the power system raises becauseofthe load throw off, than output voltage V1 reduced. for stabilizing this V1 voltage to the general STATCOM absorbs power which is reactive.

This mode of operation of the “STATCOM” known like "Voltage Regulation Mode”.

But STATCOM may get a littel bit limitation for reactive power absorbing or supplying. Its general. Yes, it done. current carrying capacity imposed for force commutated devices such as GTO, IGBT and many more. Hence when system reaches its limitation, then further output voltage V1 cannot be increase or decreases its and then supplies a reactive power which is fixed and limiting value. This current which is fixed can works like constant current source. This method this STATCOM working is knownas Control Mode VAR.

As per the above details, STATCOM Opeartion divided as two types:

- Voltage Regulation Mode
- VAR Control Mode

These STATCOM 2 mode operation can be expalined in below diagram

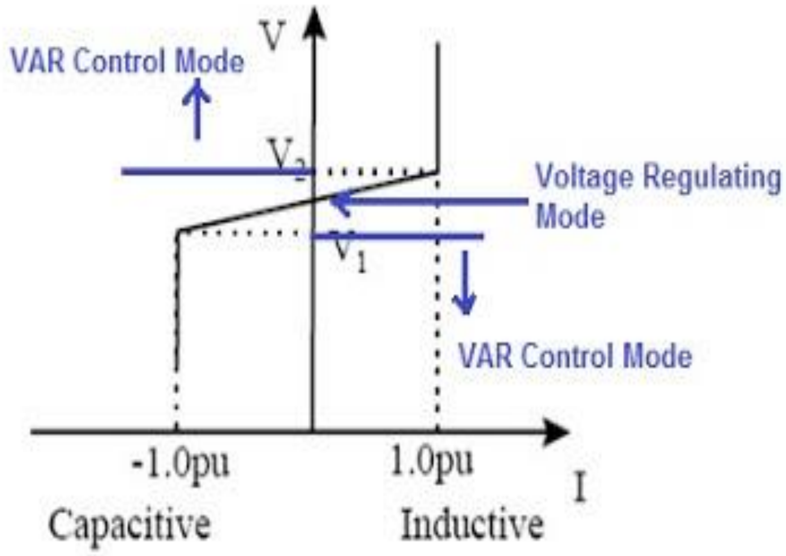

Fig. 2. STATCOM Opeartion Modes

It shows the STATCOM Voltage Current Characteristics. the STATCOM voltage regulation capability from lower side V1 to upper side V2 power system. VAR Control mode existed in STATCOM at power system is less than V1 or greater than V2,. Thus, these are just taken V1 and V2 are example, There is nothing confusion.

5.Design Of Dc Link Capacitor

In previous method, the limited voltage ripple during boost mode the DC link capacitor is smoothing capacitor. in the mode of buck, in supercapacitor modules , the energy stores. DC link capacitor design can focus on the operation of the boost mode.

IGBT2 is ON in boost mode, i.e DC link capacitor delivers energy by using grid supercapacitor, The energy passes to L. if Q Change level will in DC link capacitor decrease, This may supplied real power which is efficient through STATCOM to grid, then voltage drop in DC link. if Capacitor of DC link at IGBT2 is OFF, can be charged which is comes from SCESS and the dc link voltage increases. the cycle of stored and supply charge results V which is ripple voltage in given below.

$$\Delta V = \frac{\Delta Q}{C} = \frac{I_{LOAD}\, dT}{C} = \frac{PdT}{CV_{DC\ Link}}$$

Where

- ΔV - V DC link ripple voltage
- Q denotes the capacitor charge change, coulomb
- T denotes the switching Sec period
- D denotes the IGBT duty cycle
- P denotes the W power rating
- C denotes F DC link capacitor
- iLoad is load current which given to A grid

Here, Maximum ripple voltage as well as power can pases via grid at d = 1.0. With afava rouble 2% ripple voltage. required DC link capacitor commercial inverter of the has useful like dc link capacitor.

5.1.Voltage Controller

Voltage mode controller is the basic method, here output voltage can be backed via feedback loop. Voltage which is different can beacquired for comparing the output voltage on the basis of the voltage ref with help of error amp, it can be matchable to triangular waves via PWM generator. From a result, PWM signal pulse width can be determined for regulating output i.e voltage. This is simplicity use feedback loop which are helpful for solely of voltages, it is efficient for regulating shorter on-time, as well as the higher level of noise tolerance. Possible limitations will be cumbersome design processand phase compensation circuit complaxity.

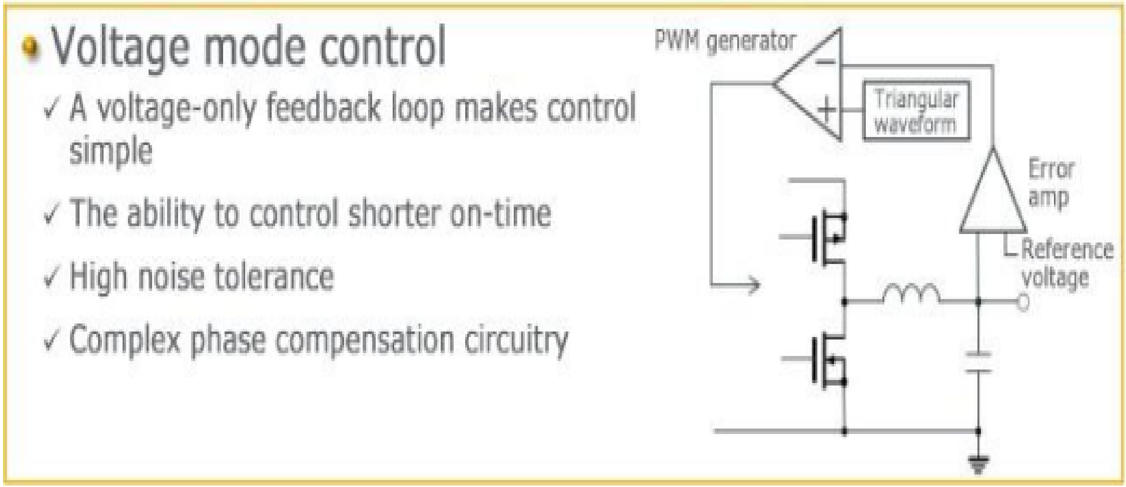

Fig. 25. Voltage mode control for PWM controller

5.2.Boost Mode Controller

The device which is used for controlling and produce the boost level in intake manifold the supercharged/turbocharged engine ie, boost controller. It affects the delivered air pressure to mechanical wastegate actuator and pneumatic wastegate actuator.

Boost controller is used for simple and manual controller and it is easily fabricated. It may also include in engine management computer as a part in an after market electronic booster and turbo charged boost controller.

The boost mode the supercapacitor can be discharged. Theouter loop can control the DC link voltage, whereas the inductor current can be regulated by inner lop in the boost converter Boost mode recieves the power from supercapacitor, where the buck mode recharging the capacitors

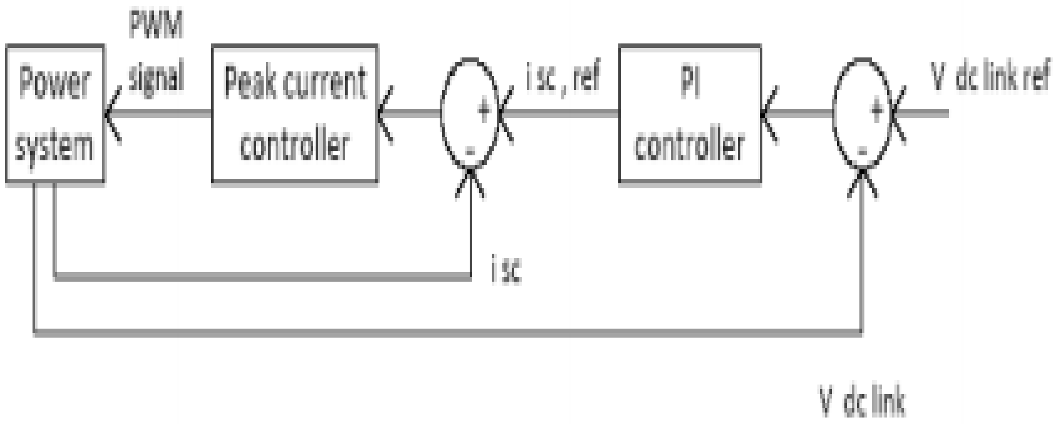

Fig. 3. Boost mode controller

5.3.Buck Mode Controller

The buck converter is known as step down converter. It is also called as DC to DC converter. Here, it reduces input voltage to load. It is just like one of the SMPS. Switch mode power supply i.e SMPS has one diode and transistor. It also having buck converter which is used instead of diode along with transistor. This type of arrangement is for rectification i.e synchronous. along with these, SMPS has one capacitor which stores energy, one inductor / combination of both. For minimizing ripple of the voltage, filters are used. These filters are combined with capatiors. These are usually used for converter s output as well as input.

We can obtain more power efficiency from switching converters like DC to DC converters compared with regulators i.e linear. These are very easy networks which are operated at less voltage, with heat as dissipating power. But it cannot be increase i.e step up output current

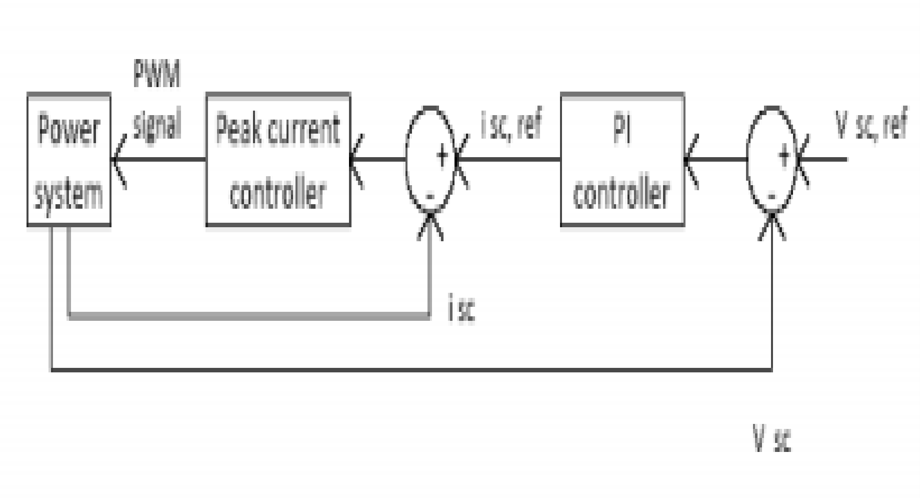

Fig. 4. Buck mode controller

5.4.Dc Link Voltage Controller

DC link voltage was measured as well as compares with 600V voltage referred signal by using DC link voltage controller, as well as comparatoroutput given for PI controller forcontrolling supercapacitor voltages andDC link. Along with the output can be deduced withthe small triangular signal i.e very necessary for eliminating the controllersmall signal instability. current signal is reference for the output for the boost mode.

The parameters are:
V ref = 600VKI = 1 KP = 0.1 and clock frequency = 10KHz

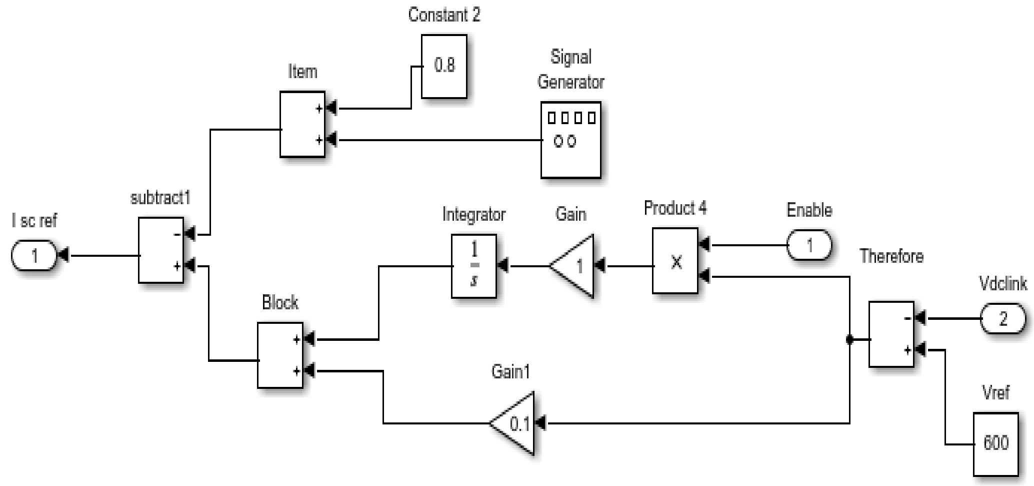

Fig.5. DC link voltage controller model in MATLAB

6.Results:

6.1.Without Scess

without the SCESS system,the simulation was run first.The DC link voltage profile is shown in the Figure andafter 0.4 seconds dc link voltage falls to zero. This is due to no energy storage system to supply the voltage when there is a voltage reduced.

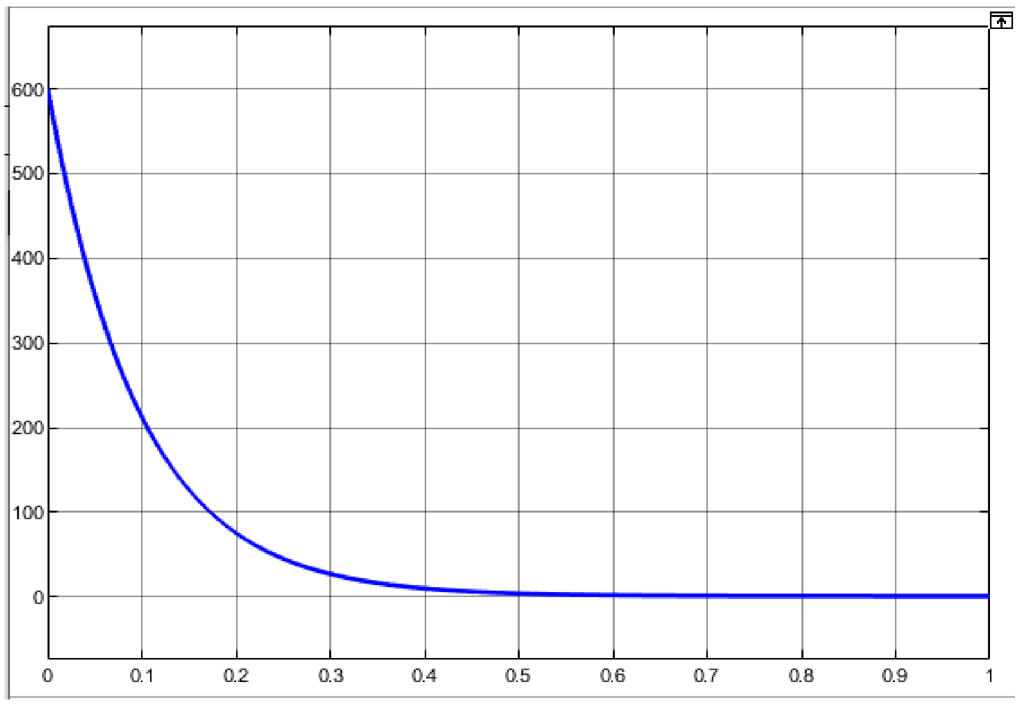

Fig. 6. DC link voltage (V) versus time (seconds) without SCESS

6.2.With Scess

By disconnecting the main DC source for 1 second SCESS system was tested at the DClink. at t=0 the source is disconnected andat t=1is reconnected. If the DC source turn off, capacitor of DC link can be discharging enerygy stored through resistor. Hence to maintain DC link voltage fixed supercapacitor would give energy to DC link. discharged energy by the resistor includes the energy transfer from STATCOM for AC side load. The main objective from the test is for observing SCESS system haveefficient for operating DC link voltage stable at the pre-set value. So,it will a indication for proposed capabilityof SCESS.

Supercapacitor voltage,, the Supercapacitor current and DC link voltage ripple simulation,DC link voltageresultsare shown figure7, figure8, figure9, figure10 equally.

6.3.Dc Link Voltage

During this test theactiveSCESS voltage of DC link profileis shown in the Figure. When the DC link capacitor is discharged,when the DC source is turned ON at t =1sec its voltage is decreased to 300V which is supplied by the supercapacitor and raises to 600V. when the DC source is OFF the voltage of dc link voltage comtrolled using supercapacitor at initial voltage dip i.e 50% rate value i.e 300V. ittells the DC link voltage cam be stabilized that supercapacitor is delivering its energy.

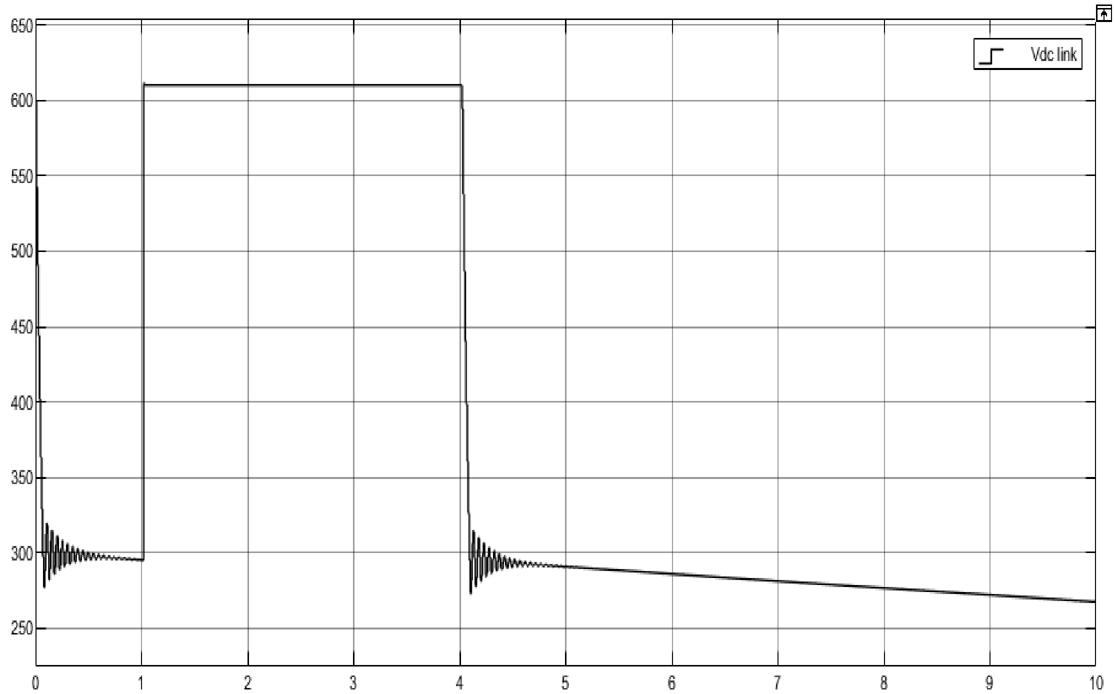

Fig. 7. DC link voltage (V) versus time(s) with SCESS

7.Conclusion

For improve thequalityand power system stability STATCOM-SCESS is a promising technology. Regarding to the benefits of STATCOM-SCESS in various power system applications a brief survey was presented. The simulation model is tested orbuilt to the SCESS system of SIMULINK/ MATLAB. The test also explains that SCESS system shall also having the power of the DC link voltage with the exchanging of real power at stable, itresults the STATCOM-SCESS with the systemwith exchange real power.

Also, a brief study is presented about the superiority of SCESS andvarious energy storage systems over others in terms of performance in various power system applications. The Supercapacitors have a lifetime cyclewhich is higher than the batteries and this may provide wide application temperature i.e (–40 °C to +60 °C) at very fast, same charge as well as at recharge rates. itturns to batteries from from with complementary storage devices in few other application

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