POWER QUALITY IMPROVEMENT WITH SAPF AND DVR USING MATLAB

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ABSTRACT: At the side of the increasing demand on up power quality i.e. typically outlined as any amendment in power (voltage, current, frequency) that interferes with the conventional operation of electrical instrumentality, the foremost in style technique that has been employed in Active Power Filter (APF). This {can be} as a result of passive filters performances is proscribed to many harmonics and that they can introduce resonance within the power grid. Passive filters square measure larger element sizes and thus prices high. therefore APF will simply eliminate unwanted harmonics, improve power issue and overcome voltage sags and eliminate any harmonic frequencies. This paper can discuss and analyse these simulation result for a 3- phase three wire Shunt Active Power Filter(SAPF) using MATLAB program. This simulation can implement a non linear load, to compensate line current harmonics below balanced and unbalanced masses. As a results of the simulation, it's found that a lively power filter is that the higher thanks to cut back the whole Harmonic Distortion (THD).
Voltage sags square measure a very important power quality downside that the DYNAMIC VOLTAGE RESTORER (DVR) is thought as effective device to mitigate them. The DVR has become in style as price effective answer for the protection of sensitive load from voltage sag. it's shown that the planned technique improves the performance of DVR.

Keywords: SAPF, PWM converter, d-q theorem, THD, Power Quality, DVR.

1.INTRODUCTION

A harmonic may be a element of a periodic wave having a frequency that's AN integral multiple of the elemental transmission line frequency of sixty cps. Harmonics area unit the multiple of the elemental frequency. Total harmonic distortion is that the contribution of all the harmonic frequency currents to the elemental.

1.1 HOW HARMONICS ARE PRODUCED

Harmonics area unit the by-products of recent physical science. They occur often once there area unit giant numbers of private computers (single part loads), uninterruptible power provides (UPSs), variable frequency drives (AC and DC) or any device mistreatment solid state power change provides to convert incoming AC to DC. Non-linear masses produce harmonics by drawing current in abrupt short pulses, instead of in a very sleek curved manner.

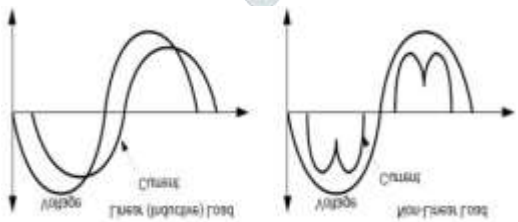


Fig:Linear load Non-Linear load

The terms “linear” and “non-linear” outline the connection of current to the voltage wave shape. A linear relationship exists between the voltage and current, that is typical of associate degree across-the-line load. A non-linear load contains a discontinuous current relationship that doesn't correspond to the applied voltage wave shape.

h = (n x p) ±1 where: n = associate degree number (1, 2, 3, 4, 5…) p = variety of pulses or rectifiers
For example, employing a six pulse rectifier, the characteristic harmonics can be:

h = (1 x 6) ±1	5th &7th harmonics
h = (2 x 6) ±1	11th &13th harmonics
h = (3 x 6) ±1	17th &19th harmonics

Harmonic is outlined as "a curving element of a periodic wave or amount having a frequency that's associate degree integral multiple of the basic frequency". Harmonic is prove of many of frequency current or voltage multiply by the basic voltage or current within the system. Previous technique accustomed compensate load current harmonics is L-C passive filter; as a result the filter cannot adapt for varied range of load current a n d typically manufacture unwanted resonance.

Efficiency and controllability is increasing the priority for harmonic distortion levels in user facilities and on the power system". The harmonic commonplace was invigilated with the target of this commonplace is to produce general harmonic analysis procedures for various categories of client like industrial, business and residential. Illustrated strategies for evaluating of harmonics management at the client level and therefore the utility system. skilled devices like ovens that manufacture heat ar ordinarily sensitive to harmonics. There ar several issues caused by harmonics within the facility and electrical hundreds like a Disturbance to Electrical and physics Devices, Higher Losses, additional Neutral Current, Improper operating of Metering Devices, De-Rating of Distribution.

1.2.ACTIVE POWER FILTERS

Active power filters are essentially of 2 varieties i.e. shunt active power filter and series active power filters. Here we have a tendency to principally think about the shunt active filters.

2.SHUNT ACTIVE FILTERS

The conception of shunt active filtering was 1st introduced by Gyugyi and Strycula in 1976. Nowadays, a shunt active filter isn't a dream however a reality, and lots of shunt active filters ar in business operation everywhere the planet. Their controllers verify in real time the compensating current reference, and force an influence convertor to synthesize it accurately. during this method, the active filtering will be selective and accommodative. In alternative words, a shunt active filter will compensate just for the harmonic current of a specific nonlinear load, and might incessantly track changes in its harmonic content

The shunt active power filter, with a self-controlled dc bus, contains a topology kind of like that of a static compensator (STATCOM) used for reactive power compensation in power transmission systems. Shunt active power filters compensate load current harmonics by injecting equal however opposite harmonic compensating current. during this case the shunt active power filter operates as a current supply injecting the harmonic elements generated by the load however section shifted by 180^0.

Active filter are designed, improved, and commercial in past 3 decades. they're applicable to compensate current-based distortions like current harmonics, reactive power and neutral current. they're conjointly used for voltage-based distortion like voltage harmonics, voltage glints, voltage sags and swells, voltage imbalances.

They are 2 classes of active filter like single- phase and three-phase. Three-phase active filters could also be with or while not neutral association and single section active filters are accustomed compensate power quality issues caused by single-phase hundreds like DC power provides. Three-phase active filters are used for prime power nonlinear hundreds like adjustable speed drive (ASD) and Ac to DC converters.

Based on topologies, they're 2 forms of active filter like current supply and voltage supply active filters. Current supply active filters (CSAF) use associate degree inductance because the DC energy memory device. In voltage supply active filter (VSAF), a electrical device acts because the storage component .VSAF are cheap, lighter, and easier to manage as compared to CSAF . There are forms of association that may be used for active filter like shunt active filter, series active filter, parallel active filter.

Harmonic currents ar generated principally thanks to the presence of:

1.Nonlinear hundreds

2.Harmonic voltages within the facility

A nonlinear load attracts a basic current element I_{LF} and a harmonic current I_{Lh} from the facility system. The harmonic current I_{Sh}, is evoked by the supply harmonic voltage V_{Sh}. A shunt active filter will compensate each harmonic currents I_{Sh} and I_{Lh} , but the principal operate of a shunt active filter is compensation of the load harmonic current I_{Lh} , this implies that the active filter ambit the load harmonic current at the load terminals, obstructive its penetration into the facility system. For simplicity the facility system is painted solely by constant ohmic resistance X_L in Fig. If the load harmonic current I_{Lh}, flows through the facility system, it produces a further harmonic free fall adequate to $V_t = X_L * I_{Lh}$, that additional degenerates the load terminal voltage V_T.

The principle of shunt current compensation shown in Fig. is extremely effective in compensating harmonic currents of hundreds. However, a shunt active filter that realizes this principle of shunt current compensation ought to conjointly draw a further harmonic current so as to stay the load terminal voltage curving and adequate to $V_T = V_{SF} – X_L * I_{LF}$. The harmonic free fall showing across the equivalent ohmic resistance becomes adequate to the supply harmonic voltage if $V_{Sh} = X_L * I_{Sh}$. during this case, the harmonic voltage elements cancel one another, in order that the terminal voltage V_T ,is unbroken curving.

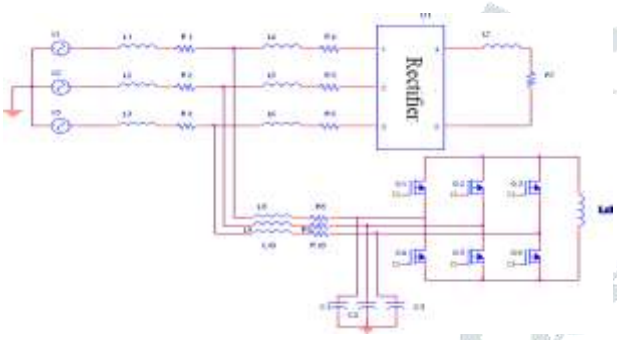


Fig: A typical three- phase current source active filter(CSAF)

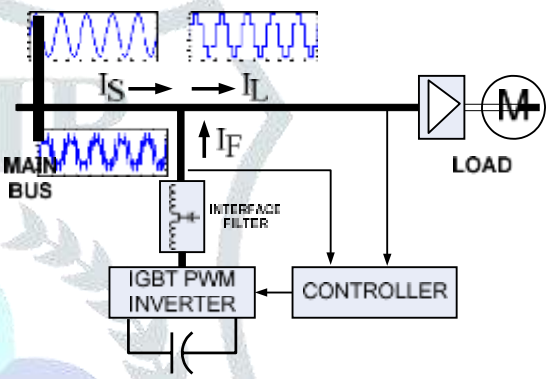


Fig:A typical three phase voltage source active filter (VASF)

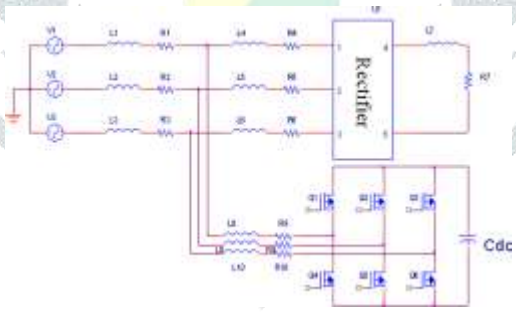


Fig: Shunt connected active filter

3. PROPOSED CINTROL STRATEGY

3.2 The p-q theory in three phase, three wire system

This concept is incredibly fashionable and, primarily consists of a variable transformation from a, b, c, system of the instant power, voltage, and current signals to the α, β system. The transformation equation from the a, b, c, system to the α, β,0 coordinates may be derived from the phasor diagram .

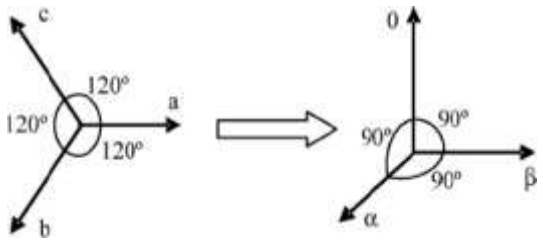


Fig:Transformation from the part reference system(a, b, c) to (α, β, 0) system

The instant values of voltages and currents within the α, β coordinates may be obtained from the subsequent equations, the Clarke transformation and inverse Clarke transformation of 3 part generic voltage given by, equally 3 part generic instant line currents Iowa, ib, ic may be rework on the αβ axis by This transformation is valid if and provided that $V_a(t)+ V_b(t)+ V_c(t)$ is up to zero, and conjointly if the voltages ar balanced and curved . The instant active and reactive power within the within the ar calculated with the subsequent expressions.

The instant complicated power is feasible mistreatment the instant vectors of voltage and current. The instant complicated power is outlined because the product of the voltage V and therefore the conjugate of this vector i*, given within the style of complicated numbers

3.2 Instantaneous Power Theory

1..This theory takes under consideration the reactive power arises from oscillation of power between supply and cargo.

2. It primarily three part system as one unit and performs Clarke's transformation (a-b-c coordinates to the α-β-0 coordinates) over load current and voltage.

3.The harmonic elimination from the network happen with none time delay as compared to alternative detection methodology.

4. SIMULINK MODELS

4.1 THREE PHASE SYSTEM FEEDING A NON-LINEAR LOAD with SAPF

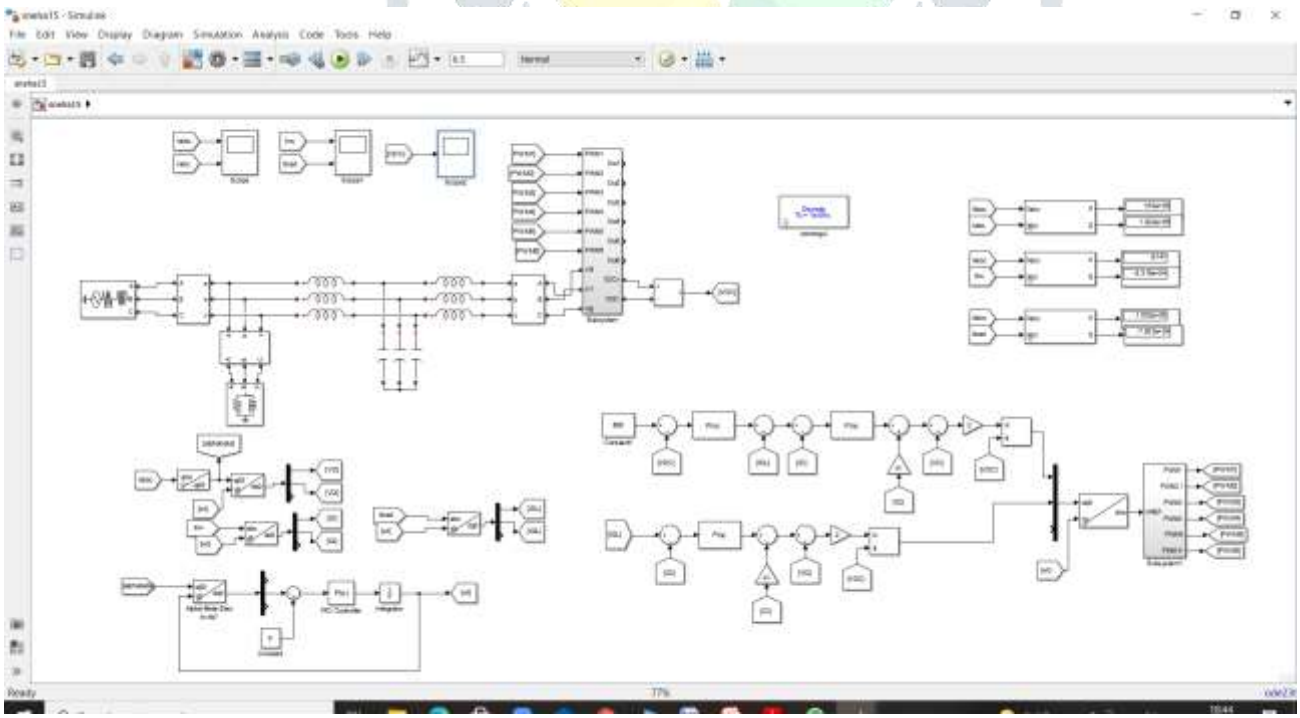


Fig: 3 phase statcom for reactive power compensation with SAPF

4.2 OUTPUT WAVEFORM

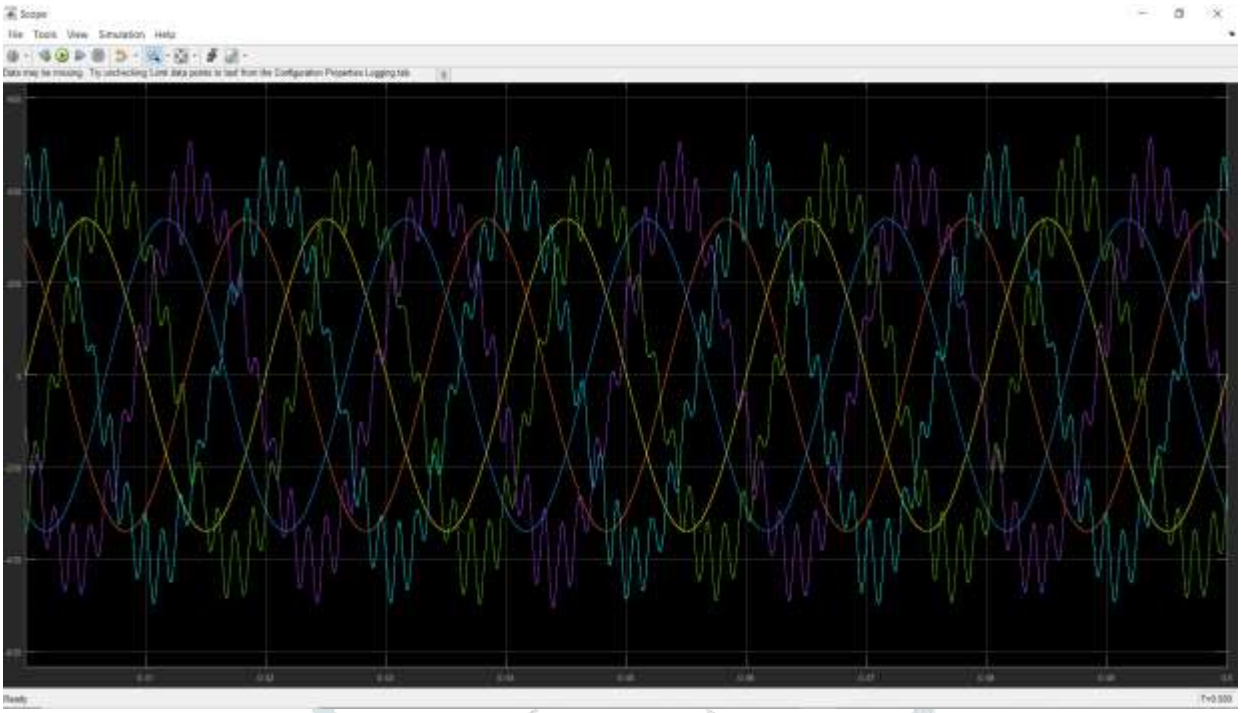


Fig: Voltage and current

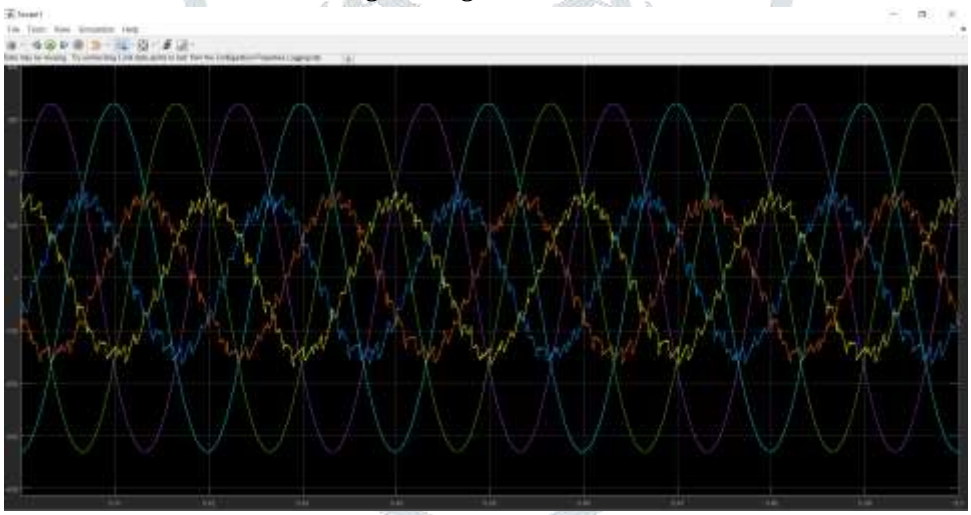


Fig: Inverter and Load current

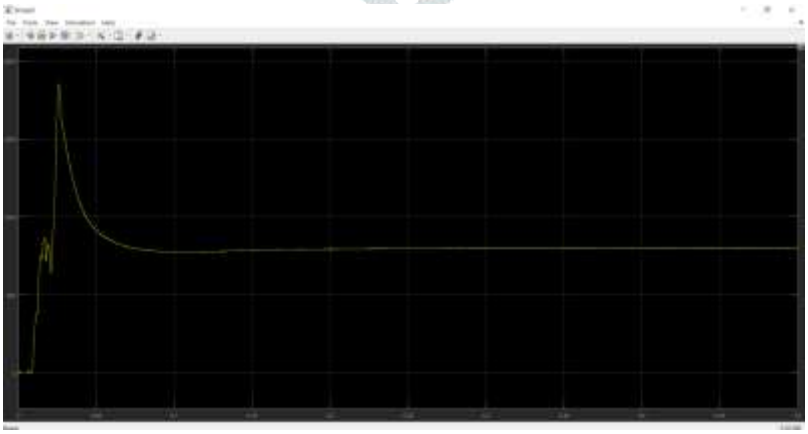
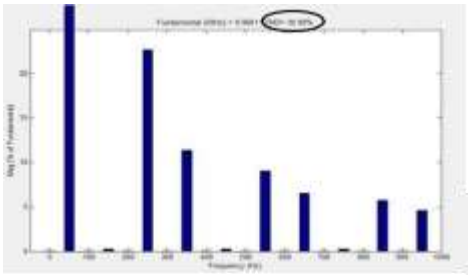
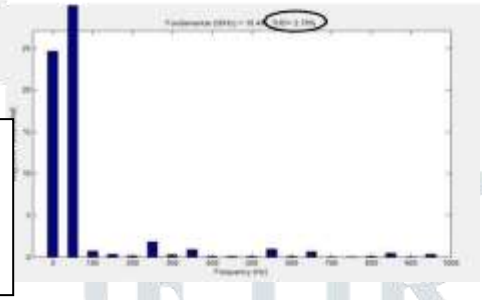


Fig: Reference voltage

5. ANALYSIS OF THD



The left side graph shows the THD calculated Using the currents on Load side. THD is around 30.90%



The right side graph shows the THD calculated Using the currents on Source side. THD is around 2.79%

6. VOLTAGE SAG

A decrease in RMS voltage at the power frequency for duration from 0.5 cycles to 1 minute, reported as the remaining voltage.

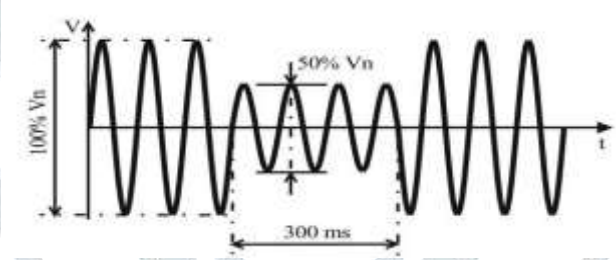


Fig: voltage sag

6.1 INTRODUCTION

The power system is split into the subsequent elements as generation, transmission, distribution, and by victimisation alternative conductor power systems is fed to completely different masses on the distribution aspect. Power quality plays an important role within the grid once variable power is provided to the load. later, the domestic and industrial customers with delicate masses ar full of the poor quality of power. Even there's varied form of load on the distribution aspect, however poor power quality affects the sensitive masses quite others. There ar several applications wherever the sensitive load has Associate in Nursing increasing demand, like in hospital's operation theatres, semiconductor systems in process plants, information systems, instruments to manage pollution in crowded areas, precise and correct instrumentality ar needed by processing, and repair suppliers. If the facility system causes the dips and distorted voltages, these devices could fail, and such a device's failure ends up in wastage of a big quantity of cash. Therefore, the distribution aspect depends on power quality. Electrical characteristics ar set by the facility system that doesn't disturb the system's performance and perform its operate during a controlled manner. during this article, voltage swell and distorted voltage with high harmonics in it are mentioned.

When the load voltage being disturbed, it causes voltage sag, transient, swell, and high distorted voltage with harmonics and Total Harmonic Distortion (THD) because of the prevalence of the faults. The vulnerability of voltage sags and

harmonics issues is generally to the fragile instruments. Few issues occur within the results of voltage sag which will conjointly cause disturbance of torques within the motors, device burning, misfiring within the device, etc. The harmonic is an important issue for power quality to be resolved effectively.

When the faults occur within the grid that causes an oversized current drawn from the facility system, a brief period reduction RMS voltage seems, unremarkably called voltage sag or Dips [7]. for instance, once somebody starts Associate in Nursing cooling or a significant motor, the startup of the load and remote fault clearance done by utility instrument, ar the basic explanation for sag production. once the motor starts, it causes sixfold a lot of current than actual current. whereas the motor's startup, a considerable quantity of reactive power is absorbed which will cause the introduction of voltage sag.

6.2. DYNAMIC VOLTAGE RESTORER (DVR)

A DVR is consists of GTO or IGBT primarily based Voltage Source Inverter (VSI), Associate in Nursing energy storage instrument, a electrical condenser bank, Associate in Nursingd an injection electrical device. The DVR is additionally referred to as solid-state power electronic change device. A DVR connected to a distribution bus is illustrated in Figure three. the sensible guideline of the DVR because it works by strategies for Associate in Nursing injecting transformer; a sway voltage is made by a forced commuted device, that is in arrangement to the bus voltage. Completely different device management topologies for droop-controlled device are given .

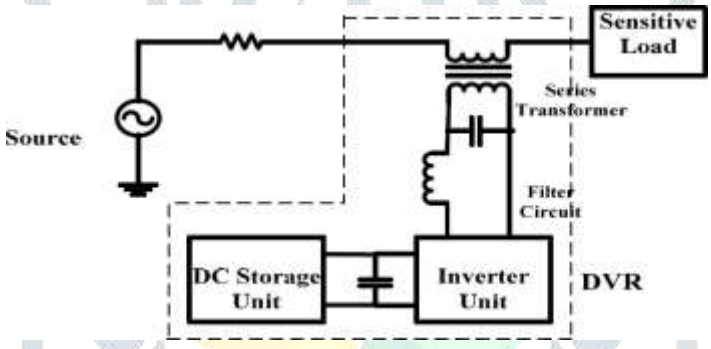


Fig: Basic model of DVR

6.3 SIMULINK MODEL OF DVR

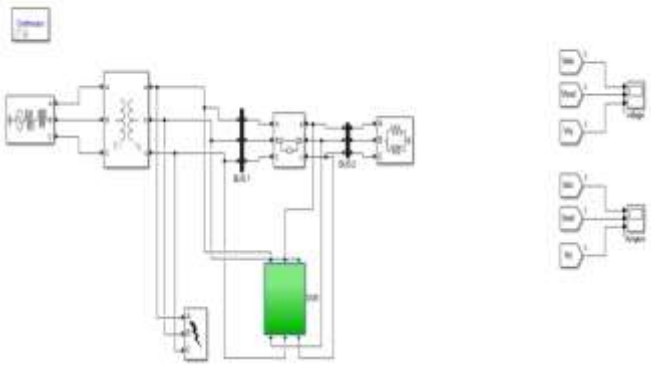


Fig: Voltage sag using DVR with PI controller

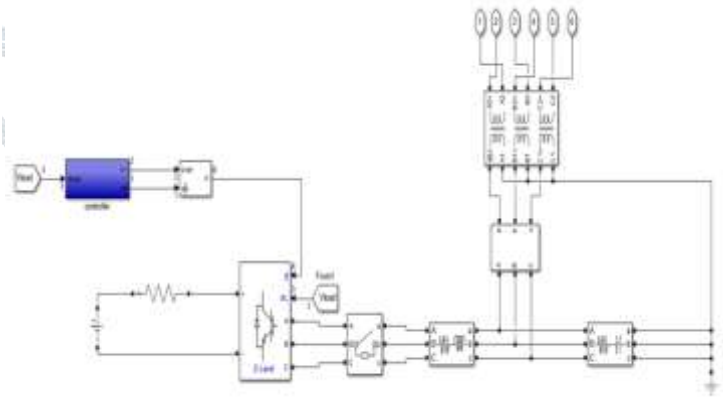


Fig: DVR model

6.4 OUTPUT WAVEFORMS

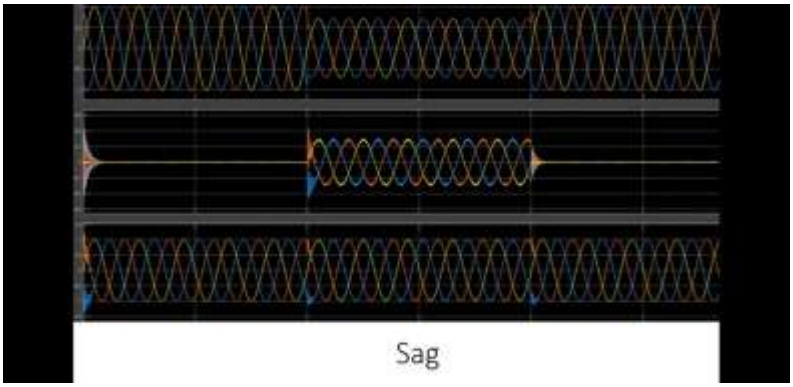


Fig: a) source voltage, b) DVR voltage, c) load voltage

7. CONCLUSION

1. From the MATLAB/SIMULINK simulation method, we've designed an influence system that consists of supply ,non-linear load and SAPF that is connected to the particular line once zero.1 seconds.
2. The initial peaks within the doctorate amount once the SAPF has not been connected to the facility system.
3. The minimum allowable limit of Total Harmonic Distortion as per IEEE 519_1992 laws is below five-hitter for bus voltage but 69KV
4. Using SAPF ,we have reduced the doctorate remarkably from half-hour to a pair of.97% on the simulated power grid circuits.
5. The very fact devices like DVR is useful in overcoming the voltage unbalance issues in power grid.
6. These devices even have different blessings like harmonic reduction, power issue correction.
7. DVR needs a lot of variety of power electronic switches and storage devices for his or her operation. to beat this drawback, PWM switched auto-transformer is employed for mitigating the voltage sag.

8. REFERENCE

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