PERFORMANCE IMROVEMENT OF GRID TIED PV SYSTEM WITH VSC BASED DVR FOR VOLTAGE SAG

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Abstract: In this proposed paper, Performance Improvement of Grid Tied PV System with VSC Based DVR for Voltage Sag. The world's sole ideal desire to supply unpracticed energy is to use renewable energy sources that are abundant in nature. The problem with most long-term energy sources, especially photovoltaic PV, is that they are discontinuous in nature, relying on sun-powered irradiative forcing separately, which causes power fluctuations. The DVR (Dynamic Voltage Restorer) is most often used to correct and protect critical masses from power appropriation angle fluctuations and conflicts. The aim of this question is to confront and insulate the effect of voltage shift in a lattice-connected crossover photovoltaic power system. To do so, will have to get a lot of energy and a lot of fabulous attractive powers. In order to do so, a DVR dependent on battery and fantastic attractive force stockpiling (SMES) is used as a remunerating system if a voltage list condition occurs. It was replaced with a VSC-based DVR to compensate system used is a pre-droop pay, which bolts the moment real time three portion voltage size and perspective in a conventional situation at the factor of successive coupling (PCC) and stores freely so that it can be used for pay for the span of an aggravation. The situation of even and unbalanced voltage lists is valued, and remuneration is completed by the use of the Power System. The simulation results are compared with all the features of power profile smoothing capability validated using MATLAB Simulink.

***Keywords*: Solar PV Arrays, Grid, Boost converter, IC (Incremental Conductance) MPPT, DVR (Dynamic Voltage Restorer).**

1. Introduction

According to the new research, solar, wind, and biomass would be sufficient to meet all of our energy needs. However, the increased use of biomass has resulted in an unnatural weather shift and dramatically increased food prices by redirecting woodlands and harvests into biofuel production. As a result of the erratic nature of properties such as solar and wind, various problems arise [2].

In today's world, the demand for electrical energy is steadily increasing; however, sun-oriented PV energy, Ozone depleting material discharge problems, limited quantities in its sustainable power existence, and instable charge, non-environmentally friendly power assets aren't better than feeding this energy demand [3]. As a result, the appropriate use of assets (RES) as well as wind and solar-based photovoltaic (PV) capacity should be the fate strategy to satisfy energy consumption demands [8].

Heat motors and photovoltaic are used to monitor the electrical age of the sun. The uses of sunlight-based resources are solely limited by human imagination. At the upper environment, the Earth receives 174 pet watts (PW) of approaching sun-powered radiation (insulation). The remainder is absorbed by mists, oceans, and land masses, with about 30% reflected back to space. At the Earth's surface, sunlight-based illumination is mostly scattered through the visible and near-infrared reaches, with a small portion in the close bright.

Renewable energy sources are becoming increasingly important as a result of the widespread use and decline of fossil fuels. Solar energy is also one of the most fundamental sources of energy since it is renewable [8]. In addition, unlike other renewable energy sources, A PV system generates energy without the use of moving parts and has a long lifetime. Despite the fact that PV systems have many tremendous advantages, they have a number of disadvantages that preclude them from replacing conventional sources, such as the capacity to only produce direct current (DC) power, which is inadequate for most electricity applications (AC). Other drawbacks include high costs, limited capacity compared to other renewable energy sources, poor energy conversion performance (LECE), and dependency on weather conditions. It is important to operate the PV system at its full power point at all times in order to mitigate the drawback of PV LECE to some degree. Maximum Power Point can be extracted in a variety of ways. ICA (Incremental conductance algorithm) is used for the maximum power point from the

ISSN (Print): 2204-0595
ISSN (Online): 2203-1731

solar PV Arrays and it is the faster solution of maximum power point is extracted using the tracking method [1],[7].

Photovoltaic (PV) cells use semiconductor technology to convert sunlight-based radiation directly into an electric flow that can be used right away or stored for later use. PV cells are often mounted as "modules" to form clusters capable of supplying power to orbiting satellites and other rockets. With the steady decrease in assembling costs (down 3% to 5% per year as of late), PV innovation applications have grown to integrate home force age and network related power age.

PV framework establishments have also been expanding to a large degree as a result of robust incentive schemes that help lower the cost of these frameworks while also allowing clients to sell surplus power back to the public grid (feed-in).

Sun-powered boards generate electricity using devices that are identical to synthetic batteries or regular plugs. It's all about the free flow of electrons through a circuit of sun-oriented circuit boards.

The fundamental component of solar-powered boards is the same component that aided in the creation of pure silicon for the PC revolution. As silicon is depleted, everything else being equal, it creates an ideal unbiased system. Silicon also has certain nuclear level properties that make it more appealing for the development of solar-powered circuit boards. If there is additional energy available in the matrix, it could be used as power if PV is needed, and it will reduce the weight and structure of the heap. PV board yield has energy agreeable issues as well, and these are held under passable cutoff with the use of unmistakable control methods. The two are on the fragile strain weight side, and dynamic voltage restorer (DVR) is the most cost-effective and comprehensive CPD (Custom energy contraptions) course of action. A DVR is used to mitigate major power fine (PQ) issues caused by voltage list, swell, impedances, sounds, and sparkles, which account for more than 80% of PQ issues, by protecting simple consumer hundreds from staggering and emerging incidents [5],[9]. Hang is the most notable voltage agitating effect, which is frequently caused by a lack at the distant vehicle, the trading of substantial weight loads, the beginning of titanic motors, and the enabling of a stream of parts. After that, there's a partial perspective bounce. Despite the above-mentioned factors, rundown can occur in PV-blow strength systems as a result of assets that are intermittent.

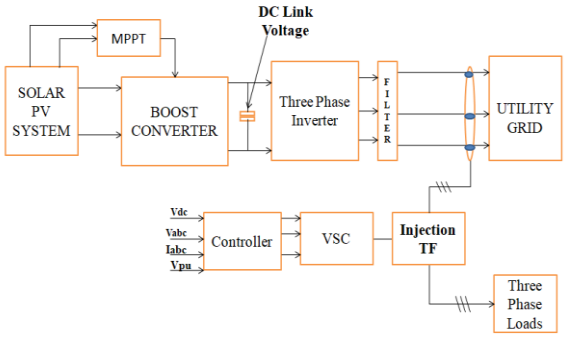

Figure 1: Block Diagram of Grid tied Solar PV with DVR

2. Related work:

DVR topographies of exceptional quality, control, and reimbursement execution that is rational. The DVR imbuement stream of segments assessments (in-territory repayment) and the DC hyperlink capacitor accumulating Capacity are directly limited by the reimbursement astute execution. The DVR topographies, handle, and pay techniques are exceptional, reducing stage bob in the stack voltage and improving overall rundown compensation time. The proposed scheme essentially fabricates the DVR hang maintain time (over half) separated and the current stage bob compensation methods, according to a logical analysis. This development can also be seen as a major reduction in the size of the dc associate capacitor for new base [12], [14]. The proposed procedure's show is evaluated using amusement focus, and the results are likely to be confirmed on a scaled lab model. MATLAB simulation is used to set up the overall display of the approach protocol. The DVR's fuel supply can be derived directly from the fundamental source unbounded component working pattern of self-hoarding capacitors and working collaboration with external limit contraptions such as battery energy storage (BES) and, in particular, engaging energy accumulation (SMES) [4]. It can be realized with Voltage Source Converter based DVR with the help of dq Control theory.

3. Experimental approach:

Discription Of Dynamic Voltage Restorer(DVR)

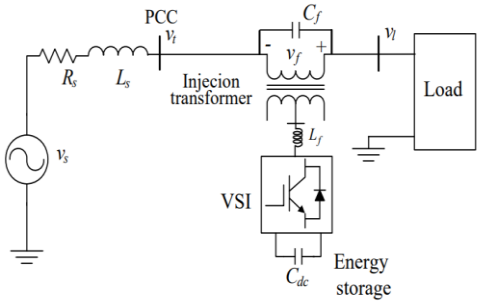

Figure 2: DVR schematic diagram

The Dynamic Voltage Restorer is a custom control device that is used in the delivery system to keep the load voltage steady

ISSN (Print): 2204-0595
ISSN (Online): 2203-1731

[12]. DVR has two modes of operation. It is in standby mode in regular operating mode, with no voltage injection by the DVR. DVR's primary purpose is to compensate for voltage sags and swells, but it can also perform tasks including harmonic correction, transient voltage reduction [14], and fault current limitation. Injection transformer, harmonic filter, and voltage source are the key components of DVR.

The injection transformer, Voltage Source Converter (VSC), harmonic filter, storage unit, and DVR's basic setup and operation of DVR.

Solar cell (photo voltaic):

A lattice creamer device is demonstrated, which requires solar PV. A photovoltaic cell, also known as a sun-based cell, is a device that uses the photovoltaic effect to transform solar energy into electricity. In certain circumstances, the term sun centred cell is used to identify devices that are primarily designed to collect energy from sunlight, while photovoltaic cell is used where the source is unclear. Sun-based boards, sun-powered modules, and photovoltaic clusters are all made up of groups of cells. Photovoltaic is an area of research and development dealing with the use of sun-based cells to produce solar energy [1].

Sun-oriented cell efficiencies range from 6% with indistinct silicon-dependent sun-based cells to 40.7 % for different intersection research lab cells and 42.8 % for a crossover bundle with several kicks the bucket. For economically accessible multi glasslike Si sun focused cells, solar energy conversion efficiencies range from 14 to 19 percent [6].

Sun-based cells can also be used to power other hardware devices, allowing for self-sufficiency in the sun. Individuals may use sun-oriented PDA chargers, bicycle lights powered by the sun, and outdoor lamps powered by the sun on a daily basis.

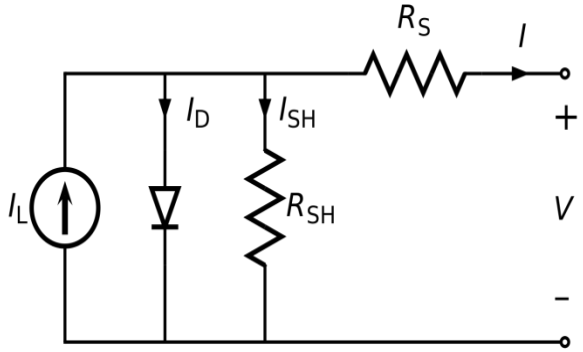

Figure 3: Equivalent of Solar Cell

Modeling of PV array:

$$I = I_p - I_0\left[e^{\left[\frac{V+R_sI}{u_t a}\right]} - 1\right] - \frac{V+R_sI}{R_{sh}}$$

Where Ip/0 is the photovoltaic (PV)/submersion current and Ut = nskT/q is the warm voltage of the PV monitor. PV cells are connected in series/shunt to produce more voltage/current. If the display is composed of np equivalent blends, PV and inundation streams are transmitted as IP = IP, cell np, I0 = I0, cell np. PV cell with indistinguishable series/shunt resistances Rs/sh

Incremental Conductance algorithm:

Owing to sudden changes in environmental conditions, irradiation and temperature fluctuate. As a consequence, the PV system's output power is variable. PV panels with MPPT methods have higher conversion efficiency. Many algorithms exist to monitor it, with IC MPPT being one of the most common [7].

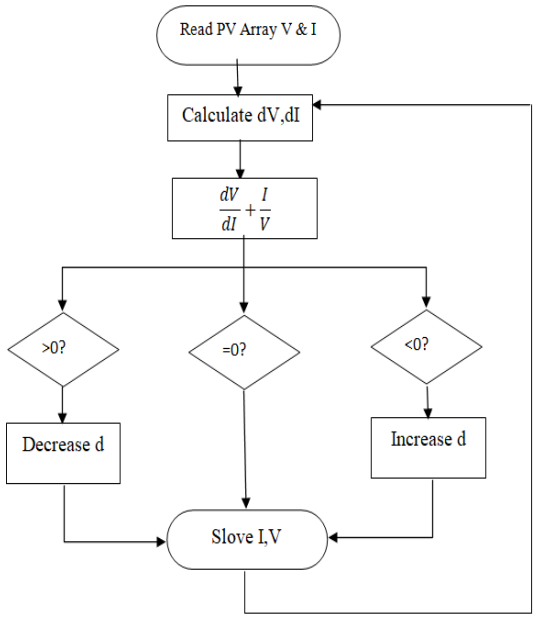

Figure 4: Flow Chart of Incremental Algorithm Conductance

The equations for tracking MPP are as follows:

$$\frac{dp}{dV} = \frac{d(VI)}{dV} = I + V\frac{dI}{dV} = I + V\frac{\Delta I}{\Delta V} = 0$$

By reorganizing the above equation

$$\frac{\Delta I}{\Delta V} = \frac{-I}{V} \; at\; MPP$$

$$\frac{\Delta I}{\Delta V} > \frac{-I}{V} \; at\; the\; left\; side\; of\; MPP$$

$$\frac{\Delta I}{\Delta V} < \frac{-I}{V} \; at\; the\; right\; side\; of\; MPP.$$

Boost Converter:

In most cases, a boost converter is the best converter [7]. Because of the lower voltage provided by the PV system due to low irradiation, a boost converter can be used to scale it up to meet the load requirements. The boost converter's basic topology, consists of an inductor, a diode, a condenser, and a relay, as seen in Fig. 5. Furthermore, the input's interim output voltage is written as.

ISSN (Print): 2204-0595
ISSN (Online): 2203-1731

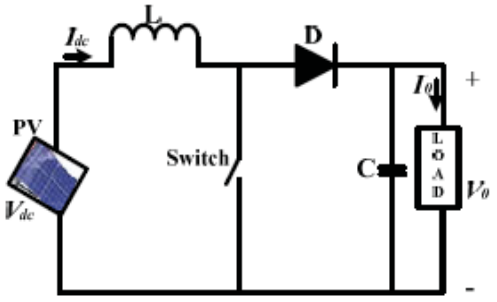

Figure 5: Boost Converter

The Boost Converter's Average Output Voltage is as follows:

$$V0 = (\frac{1}{1-D})Vdc$$

Here V0 /dc is output voltage /input Voltage of converter, D is duty cycle.

Voltage Source Converter (VSC):

VSC is a power electronic device composed of a storage device and switching devices that generate a compensating sinusoidal voltage of the required magnitude, duration, phase, and instantaneous phase with the system. The DVR voltage source converter supplies the missing voltage during voltage sag.

Harmonic Filter:

The VSC's output has a high harmonic content. To hold this harmonic content within the Permissible limit, a harmonic filter is used**.**

4. Prinpice And Control Stratage Of Vsc Based DVR

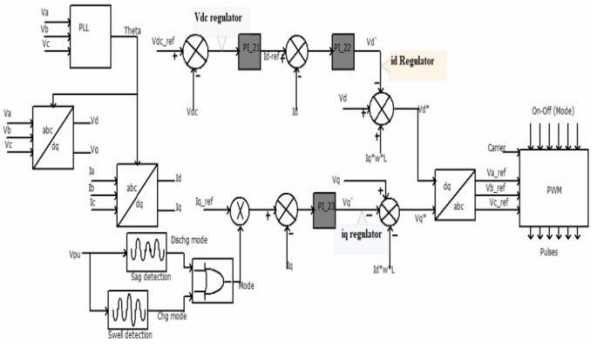

Figure 6: Controller strategy of VSC based DVR

The power of the feed is regularly monitored by the control region. The function of the control system is to detect interference in the supply volume, compare them with the fixed reference value, and then produce a switch in the VSC to produce DVR output values that pay for voltage sag / inflammation [9].

we propose various forms of energy compensation for DVR VSCs, including pre-sag compensation, phase compensation, and energy use compensation. The pre-sag correction method, also used in this analysis, aims to restore the magnitude of the sagged and swollen energy and phase angle to their original values. It incorporates active energy during sag conditions and active energy during inflammation. This is achieved by locking and recording the magnitude of the real-time voltage and the power of the three-phase power line before any power disturbance, so that it can be used to properly compensate in the event of a disturbance [9],[10]and [11].

Pre-sag compensation is more beneficial than compensated and used compensation because it can compensate for cross-sectional compounds even though we need to control more operating power from DC-link [13]. Since the escape phase is a critical problem for critical loads that produce past and present current, it allows for special consideration. Figure 7 shows these compensation procedures in detail. Before and after the interruption, the three-line step voltages in the PCC are Vabc and Vabc, respectively. Vlabc, Vlabc, and VDVR are three-line load voltages, before, during, and after the voltage applied by the DVR during the disturbance.

Similarly, Ilabc and Ilabc are three heavy-duty lines before and after the disruption, respectively. The PWM converter is currently controlled, with a direct current axis (id) that controls DC-link voltage and a quadrature axis current (iq) that controls active power [9]. The current AC VSC (Iabc) is controlled in this analysis using a process controlled by current hysteresis.

5. Modeling & Simulation Results In Matlab

Model of DVR:

The DVR is modelled and simulated using MATLAB and its Simulink and Sim Power System toolboxes. Figure depicts the MATLAB model of the DVR-connected system.

DVR is completely fabricated of a PWM inverter circuit and a DC Voltage source that is connected to the VSI's DC Connection. The Universal Bridge Block from the Power Electronics subset of the Power System Block-set is used to model the IGBT-based VSI.

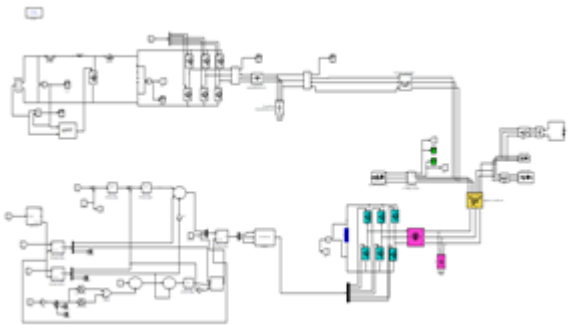

Figure 7: Simulation diagram of Grid tied PV with VSI based DVR

6. Results and conversations:

The entertainment is finished working cycle of MATLAB Simulation to test the implementation of the methodology VSC based DVR structure for PV-sources as seen with its limits. For this generation test, an inadequacy is applied at the PCC transport for 50 milliseconds for even and unbalanced conditions, resulting in even and hilter kilter voltage hangs.

ISSN (Print): 2204-0595
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Simulation Results of DVR while Grid connected Solar PV System as shown below figures.

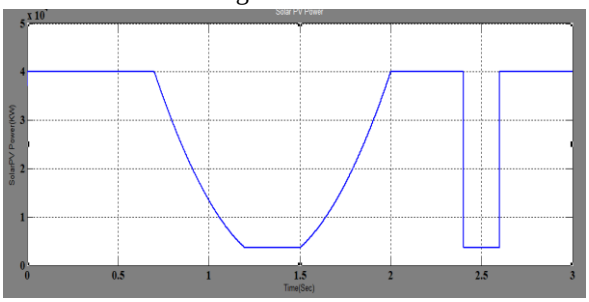

Figure 8: Solar PV Array Output Powe

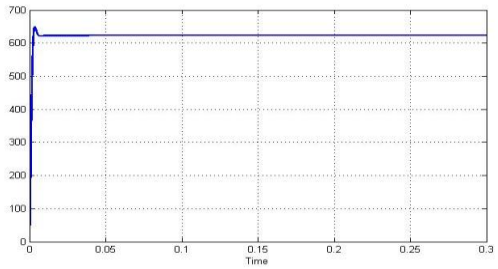

Figure 9: PV Output Voltage at DC link

Figure 8 and Figure 9 shows the Solar PV Array output power and DC link Voltages respectively, The DC link Voltage is settles10ms.

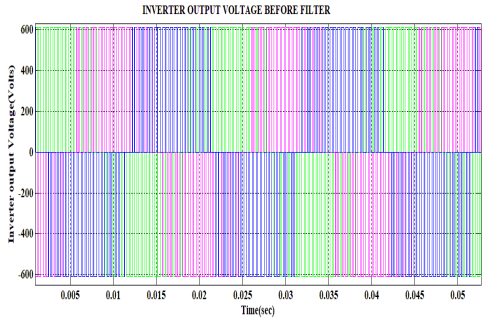

Figure 10: Inverter Output Voltage without Filter

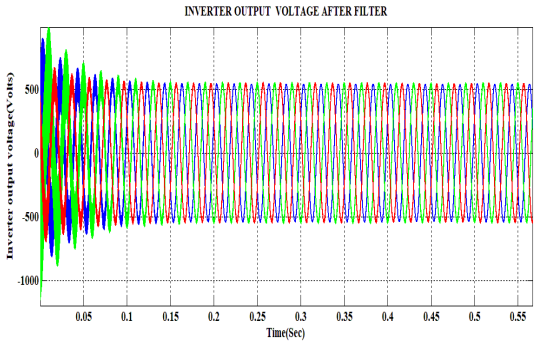

Figure11: Inverter Output Voltage after Filter

Figures 10 and 11 depict the nature of the inverter output voltage waveforms before and after filtering to minimize the portion of DC harmonics content from the voltages.

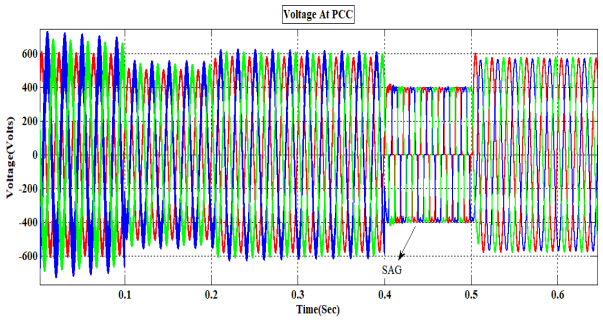

Figure 12: Voltage at PCC without DVR

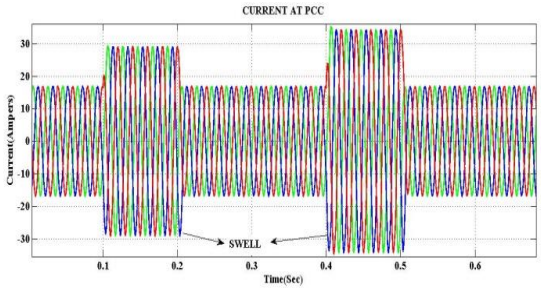

Figure 13: Current at PCC without DVR

Figure 12 and Figure 13 indicates the disturbances or sudden interruption of equipments on the system during these intervals (0-0.1) Sec is transient nature of system, (0.1-0.2) Sec and (0.4-0.5) Sec SAG in Voltage waveform and Swell in Current wave form are Shown.

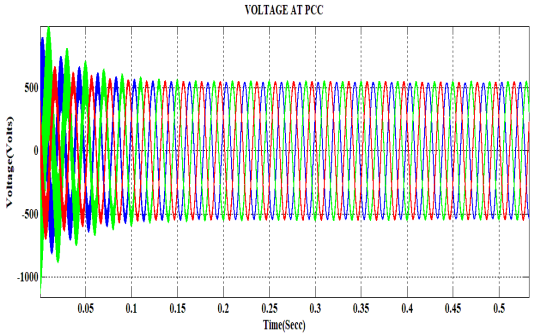

Figure 14: Grid Voltage with DVR

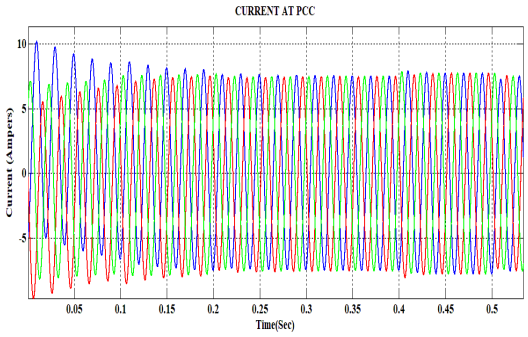

Figure 15: Grid Current with DVR

Figure 14 and Figure 15 are boost the voltage of system with the help of VSC based DVR connecting during the disturbances in the System.

ISSN (Print): 2204-0595
ISSN (Online): 2203-1731

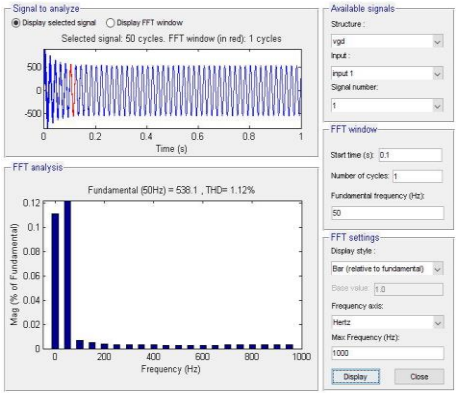

Figure 16: %THD in Voltage waveform without DVR

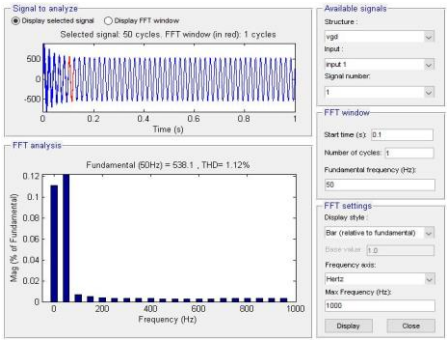

Figure 17: %THD in Voltage wave form with DVR

Figure 16 and Figure 17 are FFT analysis of the system can be improved in Total Harmonic Distortion by implementing the VSC Based DVR controlled scheme shown.

7. Conclusion:

A voltage list improvement of sensitive weight that gets energy from network related sun power/energy dependent DVR is presented in this paper. The DVR technique focuses on preventing the sensitive weight from being influenced by any voltage fluctuation caused by a defect condition or a PV-sun structure with a low energy yield. The Voltage state of the company at the PCC. Similarly, the monitoring and operation of the VSC is rendered by looking at the voltage level at the PCC for complete confirmation of the technique DVR system. The pre-hang pay system is chosen based on the degree and stage jump changing limits. The working states of the VSC-dependent DVR, which are customary (inert state), charging state, and delivering state, are depicted based on the conditions. In realistic situations, the methodology's working states have been shown to be rational. Different voltage hang importance situations for both adjusted and strayed voltage unpredictable attributes are considered in the reenactment, and the VSC-based DVR performs admirably

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ISSN (Print): 2204-0595
ISSN (Online): 2203-1731