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# Technical Review On LVRT Feature For Grid Connected PV System Using MPPT Technique

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***Abstract*— As we know nowadays wind and solar become more and more widely spread. As a consequence to grid operating companies demand system services. We have connect it to the grid for commercialize & utilize solar energy properly. The work presented in this paper describes an improvement of a photovoltaic grid connected system. It consists of PV panel,boost dc- dc converter for stepping up the PV panel voltage, an inverter for converting dc to ac and finally to the grid. For operating the PV panel at maximum power point, perturb & observation algorithm is used & the system also works under various changing environmental conditions. This paper mainly deals with LVRT capability using voltage difference method. All results are simulated and checked in matlab Simulink**.

**Keywords— Photovoltaic system(Pv system), inverter, boost converter, MPPT control, LVRT feature , grid, PCC point,PLL loop, d&q reference control.**

## I. INTRODUCTION

With increasing penetration of renewable energies more and more getting participating in power quality which are required in countries like USA, Canada, France, Spain, Germany and Denmark. There is a vast increase in the exploitation of solar energy which needs research and development of higher efficiency. There are some issues which should be concerned when PV source is connected to grid. Firstly, the power qualities of fluctuating PV power. Secondly, during grid faults a voltage dip occurs at the point of connection of PV source, which causes an increase in current at grid which can disconnect electrical appliances from each other.

The impacts of PV systems on the grid are becoming increasingly apparent in the rapid development. They bring serious challenges to the stable operation of the grid especially under the fault conditions because of the characteristics of random and intermittent with the increasing capacity of PV systems.

Apart from stand-alone PV systems, grid connected megawatt class PV plants are being installed. Present statistics says that over 150 PV parks exist with 10MW or more capacity [3]. Due to increasing penetration of PV power in recent years, German grid codes has recently adopted low voltage ride through (LVRT) requirement for PV plants.

For purposely of grid stability, Low Voltage Ride Through (LVRT) has been proposed and applied widely. The introduction of LVRT brings benefits to the grid while it also increases the design difficulty of PV inverters. When the grid has faults or the voltage drops, there may be a series of problems such as overvoltage, overcurrent and the surge of the imbalance of the two sides.

New-generation photovoltaic production processes must produce more and be in compliance with the grid codes . The work presented in this paper is in this framework. The objective is the compliance of a photovoltaic generation system, based on Perturb & observation MPPT technique, with the LVRT (Low Voltage Ride Through) feature. The expected contribution is the design of a photovoltaic generation system that can satisfy the LVRT requirement without the support of an auxiliary device. Adopted methodology exploits the voltage difference at PCC. In this paper, LVRT feature is taken as algorithm logic in matlab function. All results are simulated and checked in matlab software.

| Parameters | Value |
|---|---|
| Short circuit current | 8.5 A |
| Open circuit voltage | 45.5V |
| PV panel | Trina solar TSM-300PD14.08 |
| Irradiation | 1000 w/m$^2$ |
| Number of cells | 72 |

| | |
|---|---|
| Boost converter(input voltage) | 266.7 V |
| Boost converter(output voltage) | 440v |
| Transformer | 20 MVA |
| Three phase source(grid) | 66KV |
| Grid frequency | 50 hz |
| Switching frequency | 20khz |

Table 1 specifications of electrical appliances

## II. LVRT FEATURE

LVRT requirement Voltage dip or sags put the generation systems under stress as well as grid. Disconnection protects them, but creates the difficulties of Transmission / Distribution System Operators to find solutions to ensure correct power system operation in system. However, the continued connection can involve their destruction without saving power system. The spirit of LVRT requirement is to establish a reasonable solidarity between producers and operators. The generation system remains connected when voltage sags occur. LVRT is short for Low Voltage Ride-Through and describes the requirement that generating plants must continue to operate through short periods of low grid voltage and not Disconnect from the grid.

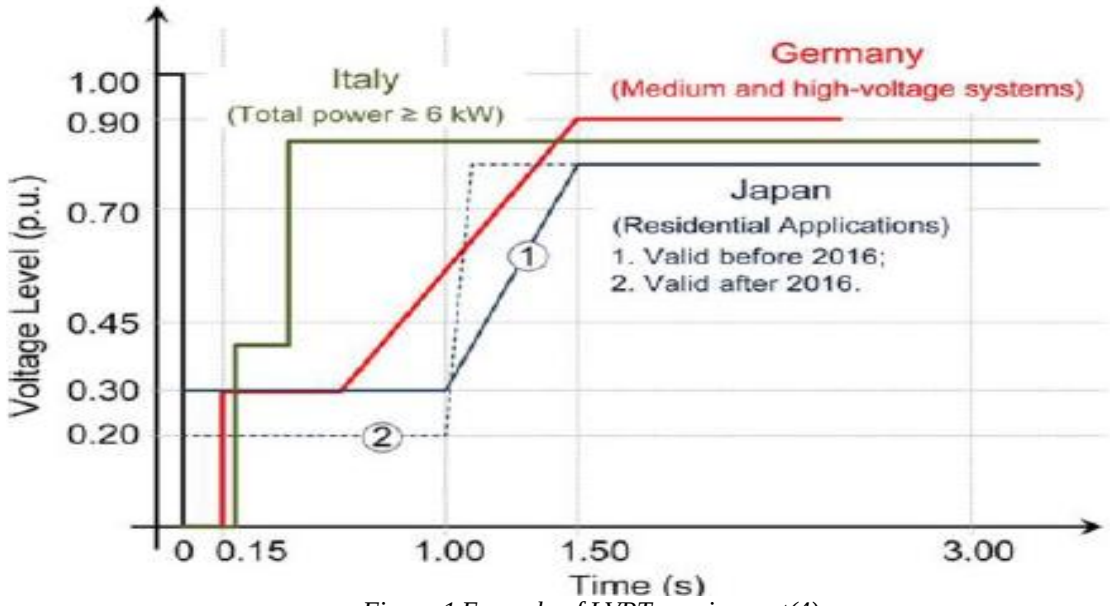


*Figure 1 Example of LVRT requirement(4)*

An area where the generator has to stay connected and another one where it can be disconnected. Each country is sovereign to delimit these areas.

An example of LVRT requirements adopted in some countries is shown in Fig. 1. Research says that, in many countries, the photovoltaic generation is still exempted from this LVRT requirement. But this scenario will not last a long time. Already countries like Germany and Italy impose a LVRT requirement for PV Generation to connect to the grid when power exceeds 6 kW[4].

## III MODELLING OF PV SYSTEM UNDER STUDY

### A. PV plant modelling

PV systems are manufactured to withstand the most rugged conditions. Modules are designed to endure extreme temperatures, at any elevation, in high winds, and with any degree of moisture or salt in the atmosphere. Systems can be designed with storage capabilities to provide consistent, high-quality power even when the sun isn't shining.

As we can show in fig 2, that PV array is getting irradiation 1000w/m2 and 25 degree temperature.output of PV array is connected to boost converter which increases voltage from 366 to 440 v.

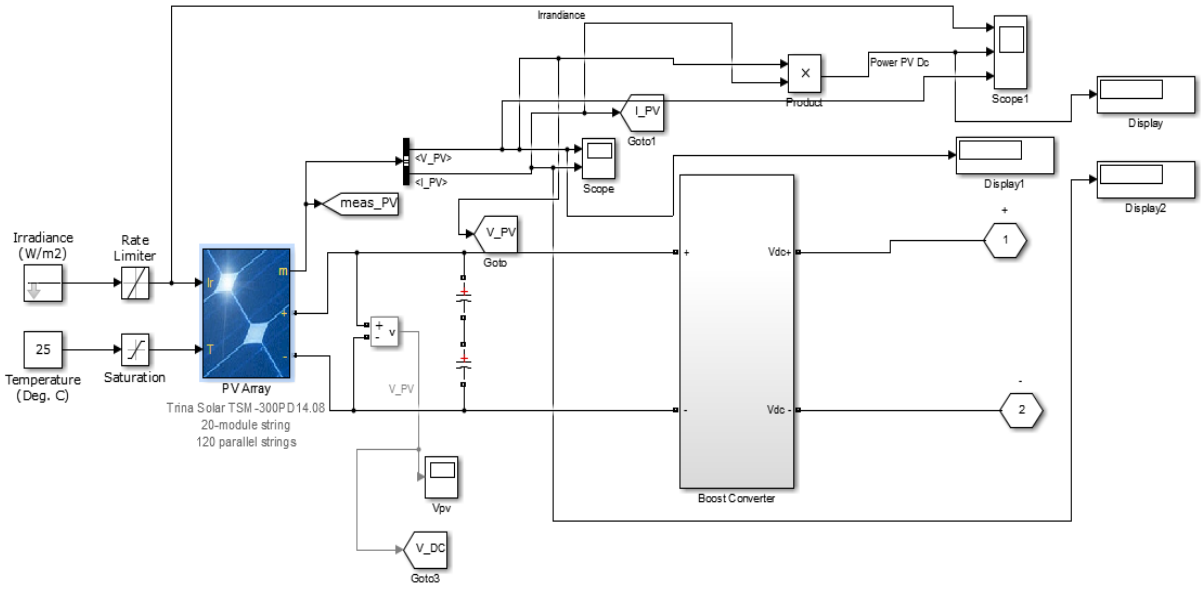


*Figure 2 PV connected to boost converter*

## B. Modelling of grid connected PV system

Fig. 3 represents the schematic diagram of 4.6 MW pv plant connected to 66 KV. PV plant is followed by the DC/DC boost converter and then a DC/AC inverter is employed to dispatch the AC power to the grid. The inverter is capable of maintaining constant 350V DC voltage at the DC link. Finally a 350V/ 66kV transformer (delta-way) is employed to integrate the generated PV power to the grid.

Figure 3 represents the responses of the PV power, input irradiance and voltage measured at the PV terminal, and duty cycle applied to boost converter with MPPT control . It is seen from fig.3 that when the irradiance level is 1000 w/m2, the PV plant delivers 4.6 MW power to the grid. However, when the irradiance level goes down to 250 w/m2, it is capable of generating about 3.4 MW power. Duty cycle is varied by the MPPT technique to extract maximum power at different irradiance level. From fig.3 it also evident that, MPPT forces the PV plant to operate different voltage level at different irradiance.

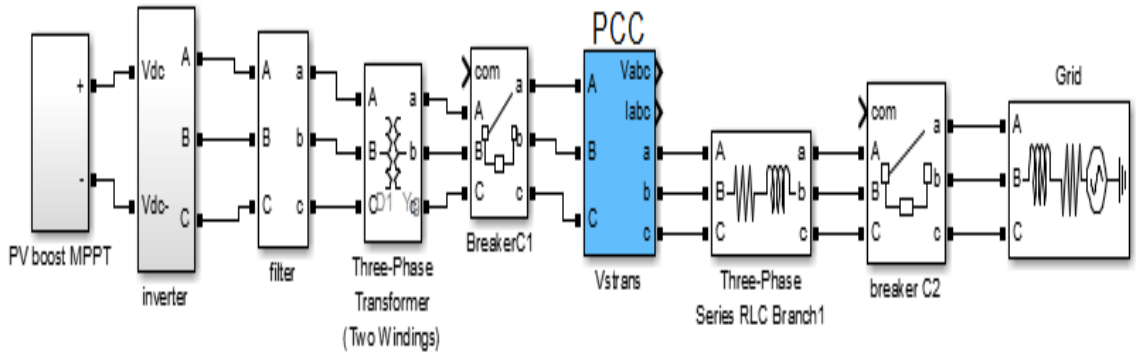


*Figure 3 grid connected pv system*

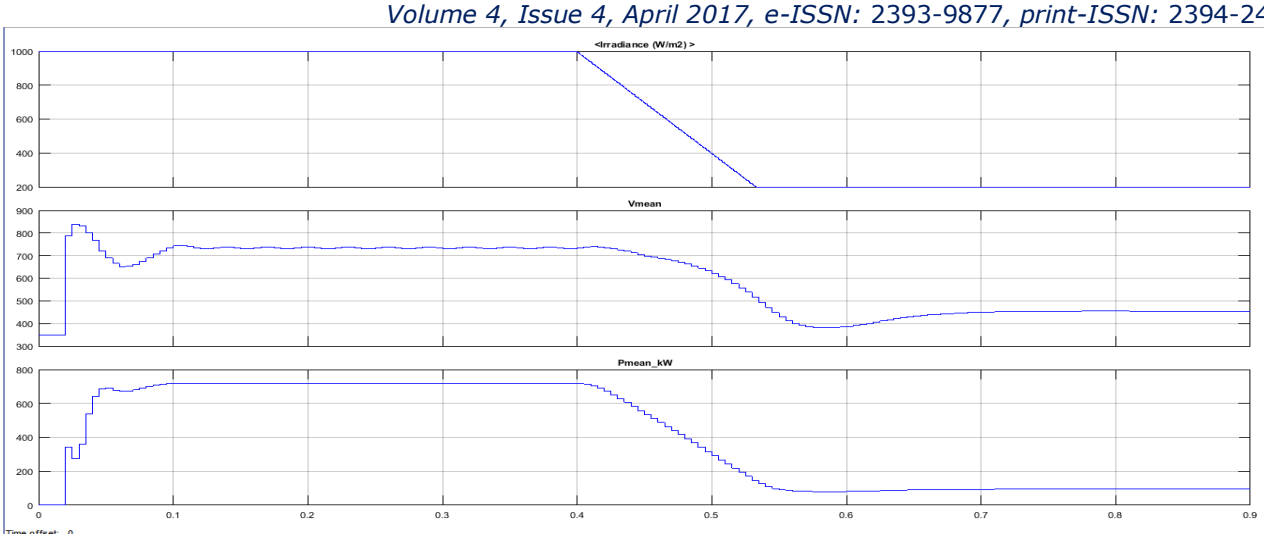


*Figure 4 PV output*

### C. Modelling of Boost converter

Boost converter is a DC-to-DC power converter that steps up voltage (while stepping down current) from its input to its output. It is a class of switched-mode power supply containing at two semiconductors capacitor and inductors which smoothes and filters output taken from inverter. Boost converter is placed between inverter and PV array Here, we given duty cycle from MPPT control to switch used in boost converter.

There are so many techniques are used for MPPT control which gives the maximum output from PV array. We have used Perturb &Observation MPPT technique for boost converter. Because it is easily implemented and less complicated from other techniques. We used duty cycle generated from this MPPT technique given to DC-DC boost converter and it converts to AC at inverter next to it.

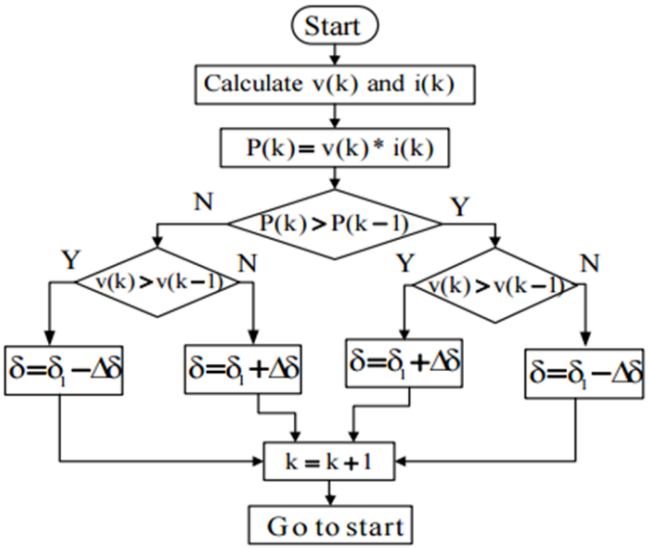


*Figure 5 MPPT controller (p & O)(8)*

### D. Controlling of Inverter from grid

We presented in simple way the modelling and the control strategy using *dq0* transformation of a three- phase PWM inverter to be employed in a grid-connected photovoltaic generation system. The inverter used in this work is a three-phase bidirectional DC-AC converter with PWM modulation using six power switches.

The simplified diagram of the inverter is shown in Fig. 5. The inverter modelling is quit simple and is accomplished through *dq0* transformation which gives id,vd,iq and vq. The modelling for the inverter control is obtained considering the AC output.

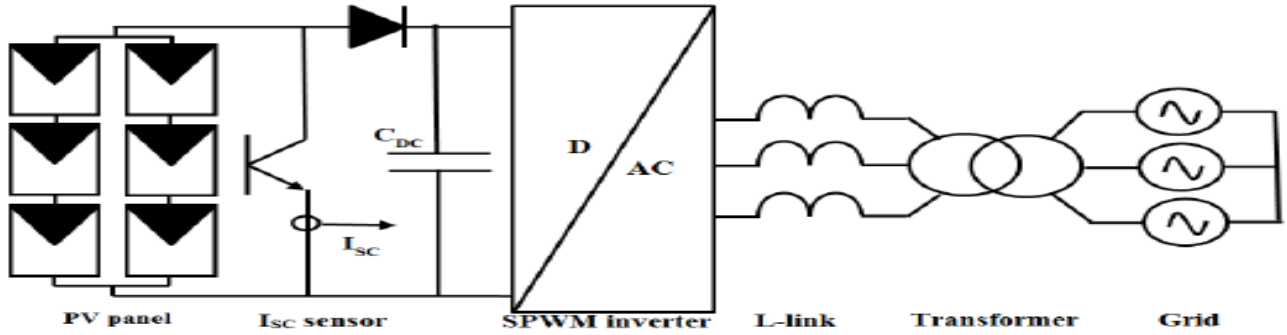


*Figure 6 bidirectional inverter in grid connected pv system(5)*

**E. Protection strategy for PV and grid under fault**

For protection of PV source the protection scheme recommended by the IEEE standard 929 for such systems.[9,10] It indicates that, the protection device disconnects the PV from the grid when it detects grid abnormal voltage or frequency. the time taken for the protection scheme to disconnect the PV depends on how low the terminal voltage will be during a fault [9]. For good protection, we have used two circuit breakers from which one is placed at PCC and another is connected at grid. Thus both circuit breakers will trip by getting signal from relay in faulty conditions.

According to our proposed method, during fault period, circuit breaker will be trip which connected at PV and grid.so, that PV source and grid should feed independently.

## IV. LVRT CONTROL STRATEGY

In this paper, LVRT is employed to improve the voltage profile during the fault period. The fault created at the grid side makes the inverter incapable of delivering power generated by the PV source due to drop in the grid voltage. This excess power causes the DC link voltage to go high due to the power imbalance between grid side and PV side.

The LVRT concept is employed to contribute directly to the balance of voltage during a fault. It can be done by making the voltage difference between PCC received voltage and rated voltage. Fig 6 shows the steps for LVRT algorithm or logic created by Simulink matlab function. Fig 6 describes that when voltage difference in healthy condition is equal to voltage received at PCC the circuit breaker will be open and displays no fault. but when voltage difference in LLLG or LG fault is more than voltage received at PCC circuit breakers will be trip and displays LLLG fault or LG fault. From this method, inverter remain connected in low voltage at healthy condition and in faulty condition PV source and grid can work independently. In this process, the PV needs not disconnect immediately from the grid at the occurrence of the fault.

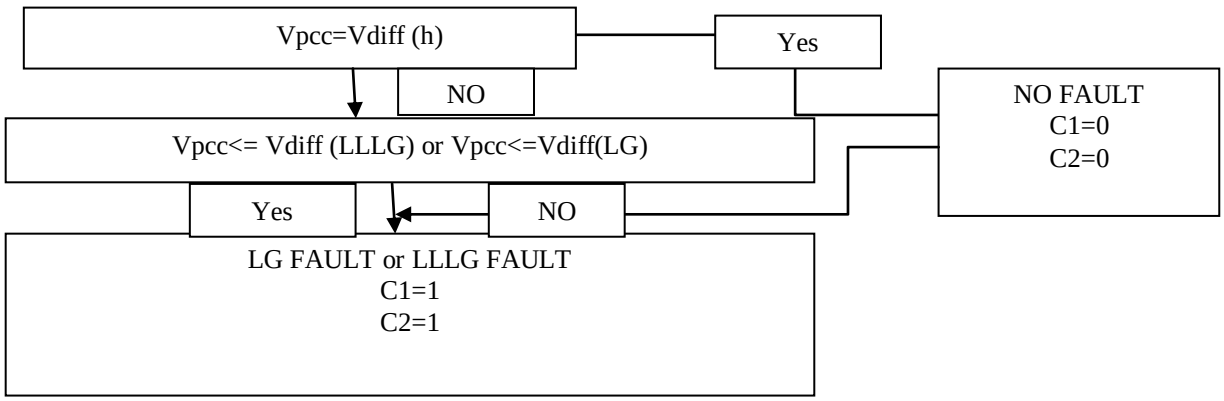


Figure 7 LVRT feature

## V. SIMULATION RESULTS AND DISCUSSIONS

In this paper, all the simulations are performed through Matlab/Simulink software. Simulations have been carried out considering most seviour fault LLLG at line bus located after transformer. The fault is considered at 0.04 sec. A simulation time is of 0.1 sec. switching frequency is 20khz taken. All the simulations are carried out under variable irradiance and constant temperature (250 C).The major contribution of this work is twofold: DC link overvoltage protection and enhancement of LVRT of PV plant by improving the voltage sag at the point of common coupling. The LVRT feature has not applied to my model till now. So its output is my future plan.

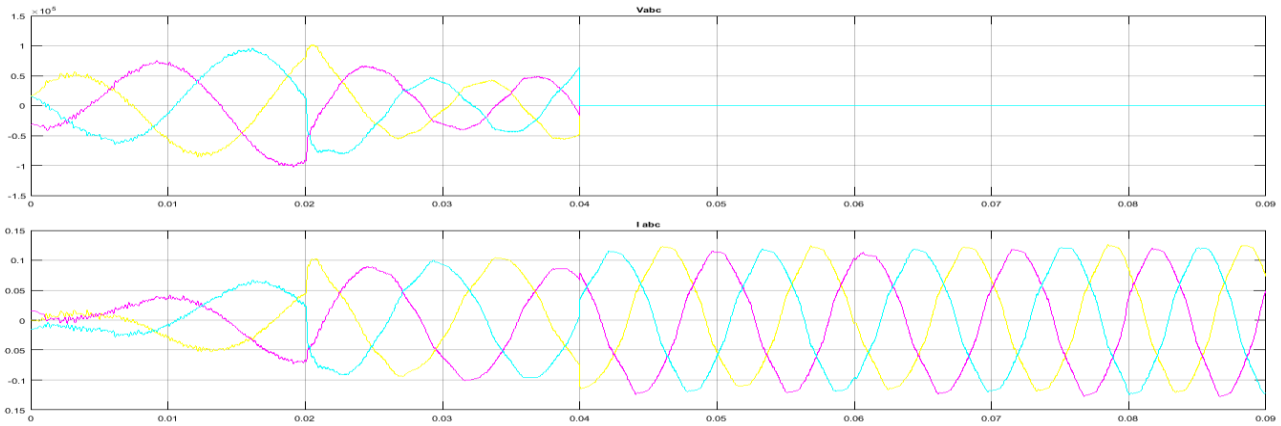


*Figure 7 PCC output in LLLG fault condition*

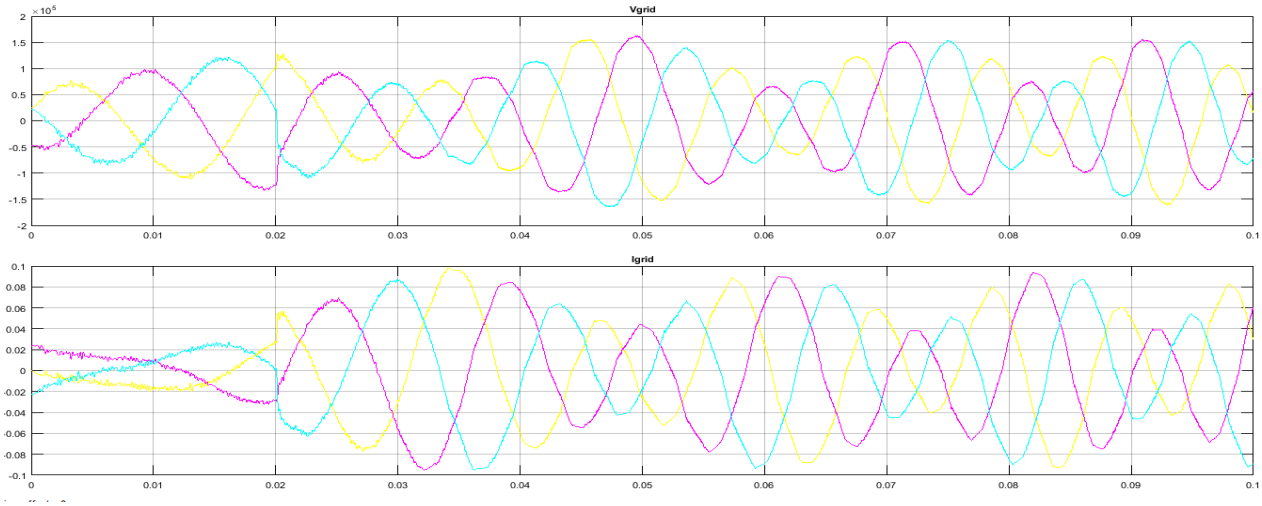


*Figure 8 grid voltage and current in healthy condition*

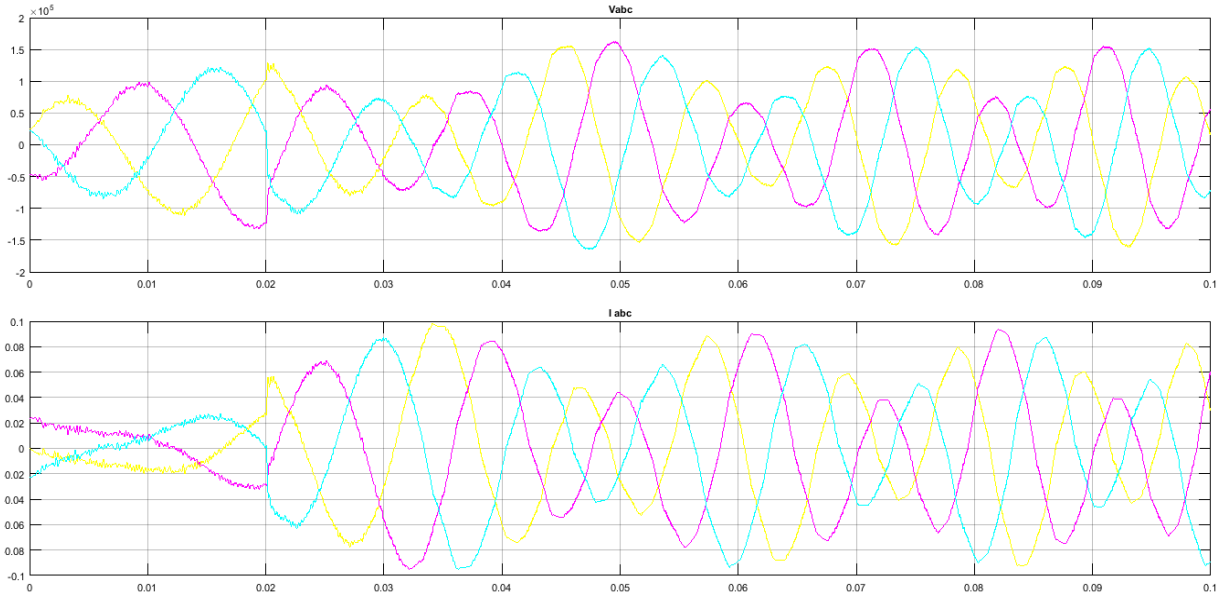


*Figure 9 PCC voltage and current in healthy condition*

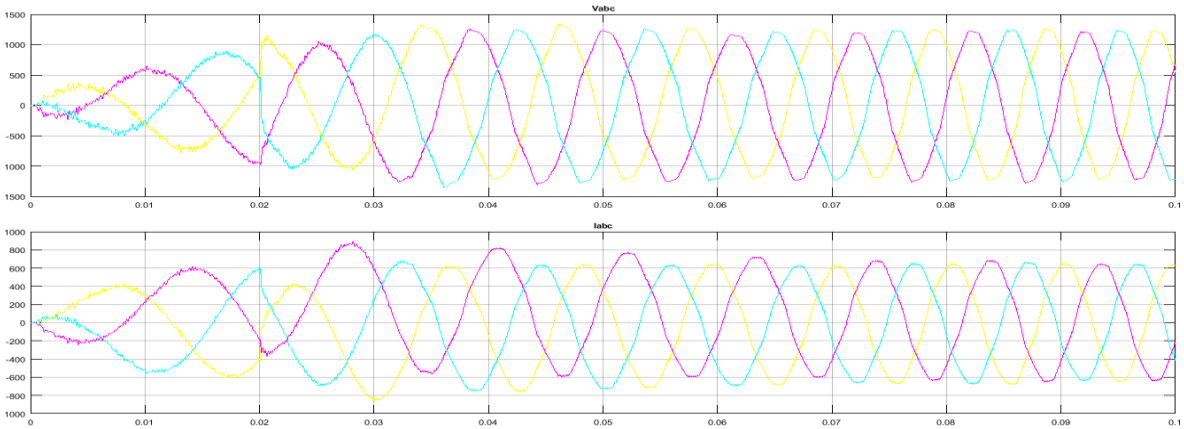


*Figure 10 inverter output in healthy condition*

## VI CONCLUSION

In this paper, we presented a new PV grid-connected system with LVRT capability. This paper analyzes the application of voltage difference for enhancing the LVRT capability and inverter DC link protection of grid connected PV system. MPPT technique is also applied to boost converter. A complete modeling of grid connected PV system is presented. Based on simulations, the following points are noteworthy.

From this paper we concluded that

1) to maintain voltage sag, voltage difference technique will be better then other methods.
2) The DC link overvoltage protection is possible with this protection scheme.
3) The proposed methodology is capable of enhancing the LVRT capabilities of grid connected PV system.
4) The undervoltage tripping of the big PV plant can be prevented with the proposed scheme as required by the recent grid code.

Penetration of PV power on distribution level is gradually increasing, and the proposed protection scheme for grid connected PV systems might play an important role to grid integration of PV power. In our future work, we will look LVRT methods comparison with other methods.

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