

# ImplementaionofControl Strategy For Three Phase Grid Connected System With Distributed Generation Inverters

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**ABSTRACT:**Currently distributed generation systems are extensively inhabiting there place in the power generation. Grid codes from the transmission system operators pronounce the behaviour of the energy source, regulating voltage limits and reactive power injection to remain connected and supports the grid under fault. Happening the basis that unlike kinds of voltage sags require different voltage support strategies, a flexible control scheme for three phase grid-connected inverter is proposed here. For the three phase balanced voltage sags, the inverters should inject reactive power in order to raise the voltage in all phases. In one-phase or two-phase faults, the main concern of the DG inverter is to equalize voltages by reducing the negative symmetric sequence and clear the phase jump. Owing to system boundaries, a balance between these two extreme policies is mandatory. Thus, over voltage and under voltage can be avoided, and the proposed control scheme prevents disconnection while achieving the desired voltage support service. The chief contribution of this work is the introduction of a control algorithm for reference current generation that provides flexible voltage support under grid faults.

**KEYWORDS:** -Distributed Generation Inverters Reactive power control, voltage sag, voltage support

## I. INTRODUCTION

Renewable resources are being widely used now a days for power generation. Three phase inverter implemented in the unified control strategy is effective and gives the better inductor current [1]. Distributed generation (DG) is emerging as a viable alternative when renewable or nonconventional energy resources are available, such as wind turbines, photovoltaic arrays, fuel cells, micro turbines [2], [4]. Most of these resources are connected to the utility through power electronic interfacing

converters, i.e., three-phase inverter. Moreover, DG is a suitable form to offer high reliable electrical power supply, as it is able to operate either in the grid-tied mode or in the islanded mode [3]. In the grid-tied operation, DG delivers power to the utility and the local critical load. Upon the occurrence of utility outage, the islanding is formed. Under this circumstance, the DG must be tripped and cease to energize the portion of utility as soon as possible according to IEEE Standard 929-2000 [5]. However, in order to improve the power reliability of some local critical load, the DG should disconnect to the utility and continue to feed the local critical load [6]. The load voltage is key issue of these two operation modes, because it is fixed by the utility in the grid-tied operation, and formed by the DG in the islanded mode, respectively. Therefore, upon the happening of islanding, DG must take over the load voltage as soon as possible, in order to reduce the transient in the load voltage. And this issue brings a challenge for the operation of DG. Droop-based control is used widely for the power sharing of parallel inverters [12], [13], which is called as voltage mode control in this paper, and it can also be applied to DG to realize the power sharing between DG and utility in the grid-tied mode [14]. In this situation, the inverter is always regulated as a voltage source by the voltage loop, and the quality of the load voltage can be guaranteed during the transition of operation modes. However, the limitation of this approach is that the dynamic performance is poor, because the bandwidth of the external power loop, realizing droop control, is much lower than the voltage loop. Moreover, the grid current is not controlled directly, and the issue of the inrush grid current during the transition from the islanded mode to the grid-tied mode always exists, even though phase locked loop (PLL) and the virtual inductance are adopted. In the hybrid voltage and current mode control, there is a need to switch the controller when the operation mode of DG is changed. During the interval from the occurrence of utility outage and

switching the controller to voltage mode, the load voltage is neither fixed by the utility, nor regulated by the DG, and the length of the time interval is determined by the islanding detection process. Therefore, the main issue in this approach is that it makes the quality of the load voltage heavily reliant on the speed and accuracy of the islanding detection method [7]-[11].

This paper proposes a unified control strategy that avoids the aforementioned shortcomings. First, the traditional inductor current loop is employed to control the Neutral point clamped (NPC) inverter with a buck converter which gives neutral point in the dc voltage in DG to act as a current source with a given reference in the synchronous reference frame (SRF). Second, a novel voltage controller is presented to supply reference for the inner inductor current loop, where a proportional-plus-integral (PI) compensator and a proportional (P) compensator are employed in D-axis and Q-axis, respectively. In the grid-tied operation, the load voltage is dominated by the utility, and the voltage compensator in D-axis is saturated, while the output of the voltage compensator in Q-axis is forced to be zero by the PLL. Therefore, the reference of the inner current loop cannot be regulated by the voltage loop, and the DG is controlled as a current source just by the inner current loop. Upon the occurrence of the grid outage, the load voltage is no more determined by the utility, and the voltage controller is automatically activated to regulate the load voltage. These happen naturally, and thus the proposed control strategy does not need a forced switching between two distinct sets of controllers. Further, there is no need to detect the islanding quickly and accurately, and the islanding detection method is no more critical in this approach.

In Fig.1, a block diagram of the controller for DG inverters under grid fault is shown. The inputs of the controller are the measured phase voltages  $v$  at the PCC, the currents  $i$  flowing through  $L_i$  inductor, and the dc-link voltage  $V_{dc}$ . Voltage  $v$  and current  $I$  are transformed into SRF values. Voltages  $v_\alpha$  and  $v_\beta$  are then decomposed into symmetric components using a sequence extractor.

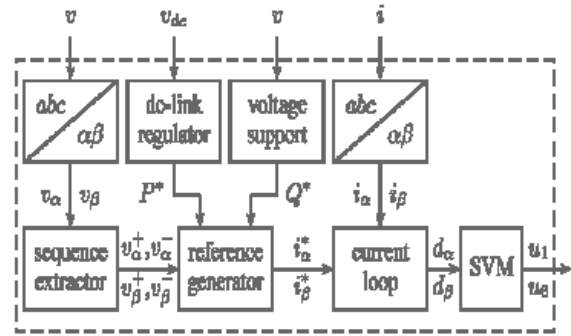


Fig 1. Control diagram of three-phase DG inverter under grid fault

## II. PROPOSED CONTROL STRATEGY

Under grid connected operation DG should be synchronized with the grid. In this mode each DG inverter works for the system by the measured voltage and desired power levels. For unity power factor operation, it is essential that the grid current reference signal is in phases with the grid voltage. Current controller design using Flexible Voltage Support Controller is shown in fig.2

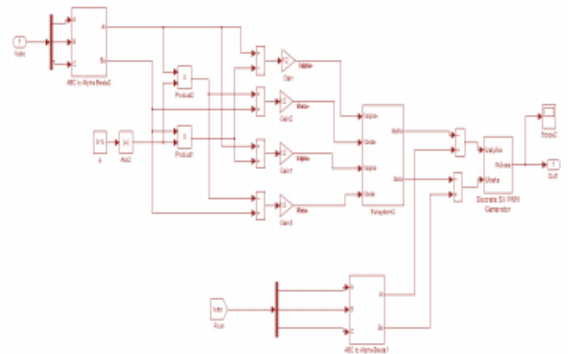


Fig 2 Controller Design

### 2. Point of Common Coupling

The PCC is a point in the electrical system where multiple customers or multiple electrical loads may be connected. According to IEEE-519, this should be a point which is accessible to both the utility and the customer for direct measurement. Although in many cases the PCC is considered at the metering point, service entrance or facility transformer, IEEE-519 states that “within an industrial plant, the PCC is the point between the non-linear load and other loads.” PCC at service entrance, metering point or facility transformer it will generally be easier to meet harmonic distortion limits when the PCC is

considered at the metering point, facility transformer or service entrance.

In most cases, the current flowing at this point represents a combination of pure fundamental current flowing to linear loads and both fundamental and distorted current flowing to non-linear loads. The distortion current will often be a smaller percentage of the total (combined) fundamental current at this point. PCC within the plant and between the non-linear and linear loads. Considering the PCC at the equipment will often meet the IEEE-limits both at this point and also at a PCC near the service entrance. The IEEE-519 limit at this point, which is essentially at the input to the non-linear loads, is often 12%, 15% or even 20% THD-I.

The ratio of short circuit current to load current is typically much larger at this PCC, which typically has less total load, than at the metering point, where the entire plant load is connected. Usually, if the THD limit is met at each non-linear load within the plant, the TDD limits at the service entrance will also

be met. Even though the THD limits are typically lower for the PCC considered near the utility metering point, the overall THD at this PCC may be considerably lower if there are additional linear loads in the plant that share the power source.

**Filter:** The rectifier circuitry takes the initial ac sine wave from the transformer or other source and converts it to pulsating dc. A full-wave rectifier will produce the waveform shown to the right, while a half-wave rectifier will pass only every other half-cycle to its output. This may be good enough for a basic battery charger, although some types of rechargeable batteries still won't like it. In any case, it is nowhere near good enough for most electronic circuitry. We need a way to smooth out the pulsations and provide a much "cleaner" dc power source for the load circuit. To accomplish this, we need to use a circuit called a filter. In general terms, a filter is any circuit that will remove some parts of a signal or power source, while allowing other parts to continue on without significant hindrance. In a power supply, the filter must remove or drastically reduce the ac variations while still making the desired dc available to the load circuitry.

Filter circuits aren't generally very complex, but there are several variations. Any given filter may involve capacitors, inductors, and/or resistors in some combination. Each such combination has both advantages and disadvantages, and its own range of practical application. If we place a capacitor at the output of the full-wave rectifier as shown to the

left, the capacitor will charge to the peak voltage each half cycle, and then will discharge more slowly through the load while the rectified voltage drops back to zero before beginning the next half-cycle. Thus, the capacitor helps to fill in the gaps between the peaks, as shown in red in the first figure to the right. Although we have used straight lines for simplicity, the decay is actually the normal exponential decay of any capacitor discharging through a load resistor. The extent to which the capacitor voltage drops depends on the capacitance of the capacitor and the amount of current drawn by the load; these two factors effectively form the RC time constant for voltage decay. As a result, the actual voltage output from this combination never drops to zero, but rather takes the shape shown in the second figure to the right. The blue portion of the waveform corresponds to the portion of the input cycle where the rectifier provides current to the load, while the red portion shows when the capacitor provides current to the load.

### III. SIMULATION RESULTS

#### 1. Over All Simulation Diagram with Symmetrical Fault

The modelling of the system with flexible voltage support control is designed in simulink. The gain parameters of flexible voltage support controller obtained by proper tuning.

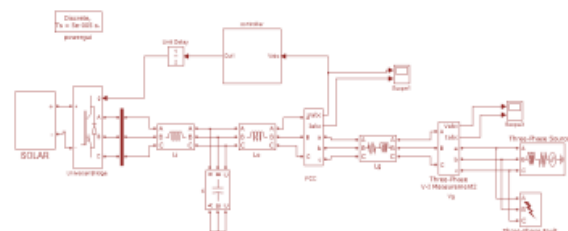


Fig.3 Simulation Diagram with Symmetrical Fault

Flexible voltage support control works as a regulator of the voltage and current during transition from grid connected to Symmetrical Fault.  $\alpha$  and  $\beta$  for flexible voltage support control is chosen proper tuning. The Overall Simulation Diagram with Flexible Voltage Support controller Fig 3.

#### 2. Over all Simulation Diagram with Unsymmetrical Fault

The modelling of the system with flexible voltage support control is designed in simulink. The gain parameters of flexible voltage support controller obtained by proper tuning. Flexible voltage support control works as a regulator of the voltage

and current during transition from grid connected to Unsymmetrical Fault.  $\alpha$  and  $\beta$  for flexible voltage support control is chosen proper tuning. The overall Simulation Diagram with Flexible Voltage Support controller fig.4.

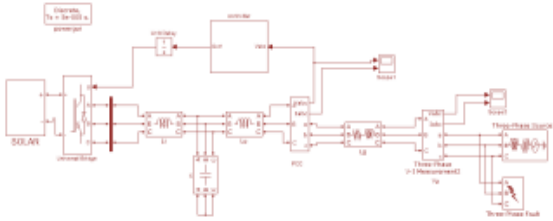


Fig.4 Simulation Diagram with Unsymmetrical Fault

### 3. Grid Voltage and current for symmetrical fault

The grid voltage and current waveforms without fault is shown Fig.6. The grid voltage is 565V and current value is 25A.

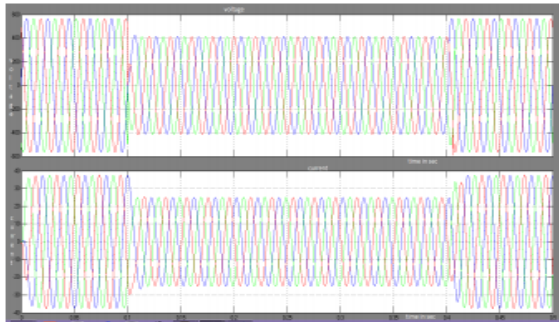


Fig.5 Grid Voltage and Current for symmetrical Fault

The Fig.5 shows the voltage and current value of grid and interconnection of solar power plant and three phase conventional source. In the Fig.5 normal condition the voltage and current values are recalculated by using voltage current measurement. In normal condition with any disturbances grid voltage value 400V and current value is 38A in grid.

### 4. Grid Voltage and current for Unsymmetrical fault

The grid voltage and current waveforms without fault is shown Fig. 6. The grid voltage is 560V and current value is 40A. The Fig.6 shows the voltage and current value of grid and interconnection of solar power plant and three phase conventional source.

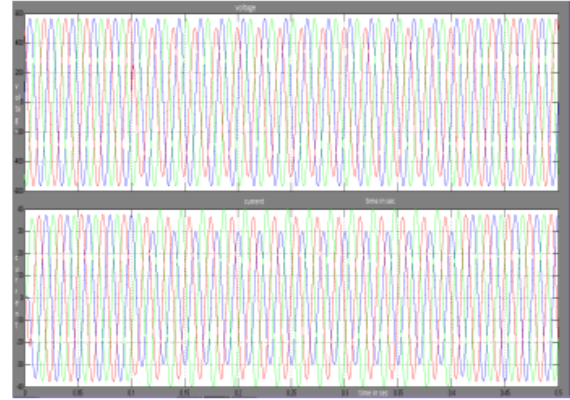


Fig.6 Grid Voltage and Current for symmetrical Fault

In the Fig 6, Unsymmetrical condition the voltage and current values are calculated by using voltage current measurement. Here R&Y phases are fault condition. The grid voltage value in RY&B phases - 565V per phase and grid current value in B phase 40A in R&Y phases 38A. So reduces the fault current values with in limit using reactive power injection in normal condition.

## IV. CONCLUSION

The voltage support strategy can be modified by means of a control parameter according to the type of voltage sag. In three-phase balanced sags, the best solution seems to be to raise the voltage in all phases. In one or two-phase faults, voltage equalization is a preferred choice because conventional strategies can lead to overvoltage and cause disconnection. When the sag is less deep, an abalance between these two extreme policies should be implemented.

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