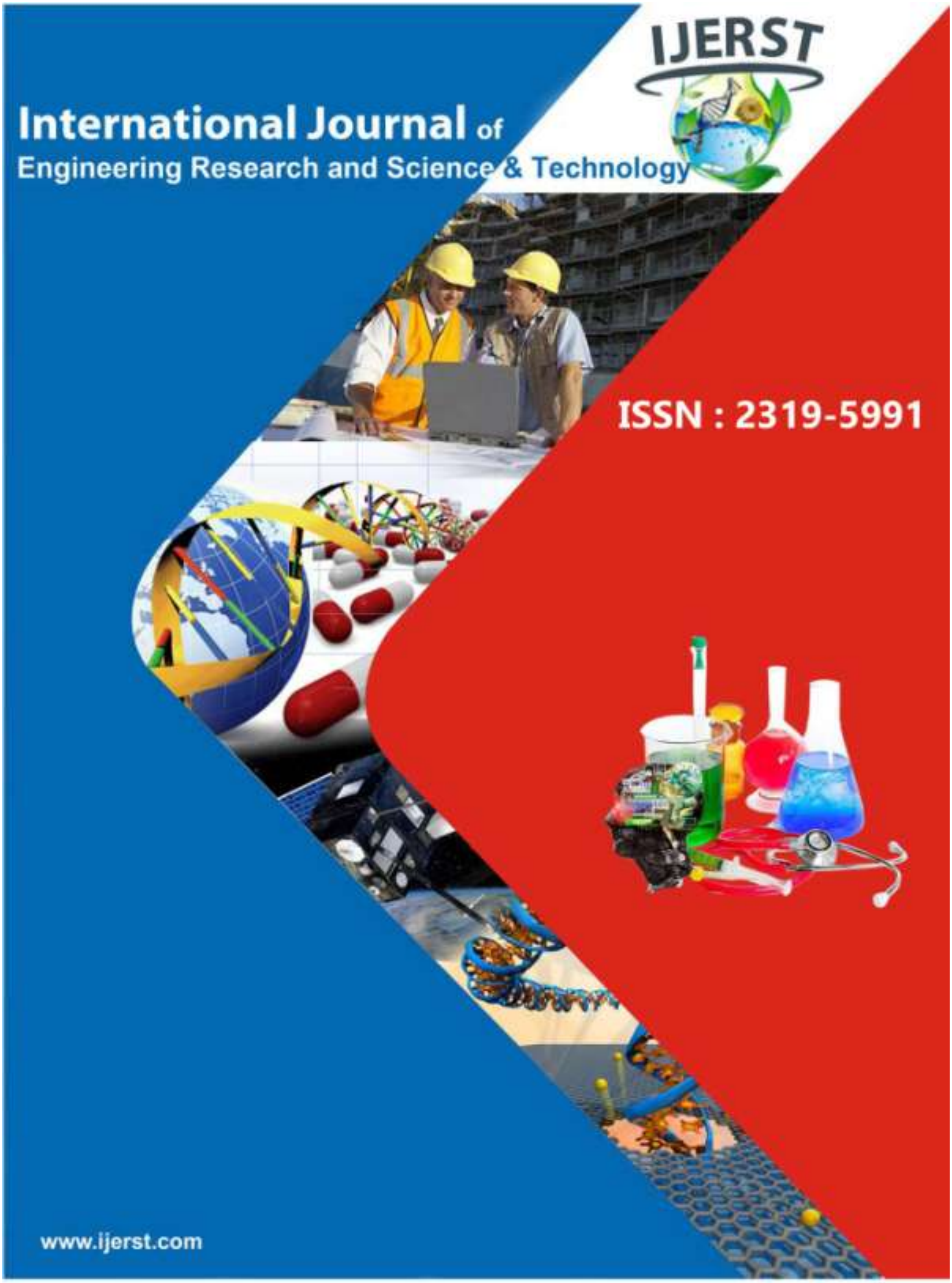

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AnAnalysisofaTwo-stageGrid-ConnectedPhotovoltaicSystemunderGridFaults Conditions

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ABSTRACT

There are three reasons why grid-connected distributed generation with VSI-interfaced interface should be isolated from the grid: 1) excessive dc-interface voltage, 2) over-top air cooling streams, and 3) loss of grid voltage synchronization. Inverter disengagement under various grid deficiencies is addressed in this work by the control of single- and two-arrange system associated VSIs in photovoltaic (PV) control plants. Receptive power support is included into inverter control to deal with voltage dips in light of the network codes' (GCs) requirements to keep the grid voltage stable. A contextual investigation of a 1-MW system reenacted in MATLAB/Simulink programming is used to clarify the proposed control. Issues that may happen during system blames alongside relevant remedies are dealt about. The results demonstrate the system's resilience in the face of a variety of grid flaws.

IndexTerms—DC–DCconverter,fault-ride-through,photovoltaic(PV)systems,powersystemfaults,reactivepowersupport.

I.**INTRODUCTION**

The need for F AULT STUDIES in large-scale, grid-connected sustainable power source systems has been publicized in the academic literature. According to [1] and [2], the majority of these ideas focused on grid-connected wind control plants. GCPPPs (GCPPPs) are matrix-related photovoltaic (PV) control plants (GCPPPs) that have previously been focused on FRT capacity. When a three-phase current source inverter (CSI) is used, the yield streams remain confined under a wide range of fault conditions due to the implementation of a present source show for the inverter. [5] and [6] are examples of this. However, dynamic situations may cause this design to become unstable. [7] Matrix related control change systems use three-phase voltage source inverters (VSIs). The increasing number of these systems necessitates the control of VSIs in order to keep the grid stable under voltage perturbations and unequal conditions, as specified by grid codes (GCs). Among a number of tests for unfair treatment.

As reported in [8], a PV system with a 4.5-kVA output and a non-faulty phase voltage hang was used to alleviate the peak yield streams in non-faulty phases. One more test has been conducted.

As shown in [9], a resonant (PR) current controller was developed for the present limiter in order to ensure sinusoidal yield current waveforms and keep a strategic distance from excessive current. In

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any event, the response power bolster was not considered in the above-mentioned considerations. A study on how to keep the good guys in charge and the bad guys in their places may be found in [10]. Each group had its own controller, which was run in simultaneously. Using this control system was found to have dynamic obstacles because of the postponements in the current control rings. The dc side of the inverter was investigated in [11] to demonstrate the effect of several difficulties on the voltage and current of the PV exhibit.

According to FRT methods, some research has been done on wind turbine applications and VSI-based high-voltage direct current systems [5]. A

1.2 Inactive control, such as crowbar and chopper resistors, is used in some of these experiments, while dynamic control plans are used in others. Both classes can provide FRT, but inactive techniques require more segments and disperse essential power during voltage list formations, therefore they have drawbacks. Many studies have been done to examine the effects of uneven voltages on the inverter's ac and dc FRT on GCPPPs with single-arrange change setups [8] and [9], in which the PV source is guided to be connected to the dc side of the inverter. Regardless, no paper so far has proposed a comprehensive technique for securing the inverter during voltage hangs while providing receptive power support to the matrix in the application of a two-arrange change (which means a dc–dc transformation or pre regulator unit exists between the PV source and VSI). All of the inverter plans and modifications, whether for a single or two-organization system, must address various flaws and concerns about FRT capacity in light of the GCs. In the event of a malfunctioning system, a PV inverter may get detached from its mounting bracket. One or more of the following may occur: 1) over the top dc-interface voltage, 2) intemperate air conditioning streams, or three) loss of network voltage synchronization.

1.3 **Existingsystem**

1.3.1 VSI-based high-voltage direct current (HVDC) systems and wind turbine applications have both been studied in terms of FRT techniques for grid-connected VSIs. Passive controls, such as crowbars and chopper resistors, are used in several of these investigations. When voltage sags occur, the passive technique loses significant power and requires more components to do so, but it can still give FRT capabilities. Grid faults cause PV inverter disconnection due to three main factors: Insufficient DC-link voltage, too much ac current, and a breakdown in grid voltage synchronization are the three main problems.

1.3.2 Disadvantages

1. NoProperrequirementsarenotavailabl e
2. Lesspower
3. Noalternativesolution

1.4 Proposedsystem

Wind and PV power are being added to the grid as an alternative method for powering loads in this system. Single and two-stage grid-connected inverters have been designed to meet the performance requirements of grid-connected renewable energy sources under fault situations. When solar power isn't available, the system relies on wind or battery power to keep everything running. As part of these adjustments, current limiters were installed and the dc-link voltage was lowered bya variety of approaches The dc-link voltage is inherently limited in the single-stage system, whereas it is not in the two-stage configuration. The two-stage setup may endure any form of fault according to the GCs without being disconnected by using three different approaches. The first two ways rely on the PV arrays and wind turbines not producing any power when the voltage drops, while the third method alters the power point of the PV arrays and wind turbines such that they inject less power into the grid than they did prior to the failure.Advantages

1. Morepower
2. AlternativesolutionwhenisPVnotavaila ble

1.5 ProblemIdentification

2. VSI-based high-voltage direct current (HVDC) systems and wind turbine applications have both been studied in terms of FRT techniques for grid-connected VSIs. In certain cases, passive control, such as crowbar and chopper resistors, is used, whereas in others active control strategies are employed. When voltage sags occur, the passive technique loses significant power and requires more components to do so, but it can still give FRT capabilities.

3. An evaluation of the FRT concerns of both AC and dc sides of the inverter under unbalanced voltage conditions was done for GCPPPs with single-stage designs (single-stage conversion indicates direct linkage of PV source to the dc side). But in the case of a two-stage conversion, the proposed comprehensive technique to protect the inverter during voltage sags while providing reactive power assistance for the grid has been presented as a viable option. All inverter designs and changes, whether for single-stage or two-stage conversions, must accept various sorts of failures and address FRT capability based on GCs. They must also.. Under grid faults, PV inverter disconnection happens because of excessive dc-link voltage, excessive ac currents, and a possible loss of grid voltage synchronization.

4. CASE STUDY FOR A TWO-STAGE **CONVERSION**

A two-stage GCPPP incorporates a dc– dc converterbetweenthePVclustersandtheinverter.Inhigh-powerGCPPPs,morethanonedc–dcconvertercanbeincorporated,oneforevery eachPVexhibit.Inspiteofhavingafewdc–dcconverters,theseframeworks will be alluded at any rate as two-stageGCPPPs.Intwo-stageGCPPPs,theMPPfollowing The dc–dc converter handles (MPPT). Aside from that, an inverter controls the voltage at which the dc connection is made.

The dc-interface voltage continues to rise as long as there is no movement in the dc–dc converter's control during a voltage sag; thus, the PV modules' output power is not reduced. Because of this, the framework is not self-enforcing when the framework fails. In order to reduce the power generated by the PV modules and provide the GCPPP with FRT capability, a specific control activity must be conducted. When the dc voltage exceeds a certain limit, the dc–dc converter can be shut off to provide overvoltage safety for the dc-link. Hysteresis controllers are used to activate and deactivate the converter when the link voltage drops below an acceptable level. Control of dc-link voltage during the voltage list process is proposed in this research, and there is no large increase in this transient.

Figure 1 depicts the case study for a GCPPP with two stages. One 1-MVA inverter and two 100-kW parallel dc–dc boost converters make up this system. Table II summarizes the features of each dc–dc converter, as well as the PV arrays connected to them. Table I contains the remainder of the system's information.

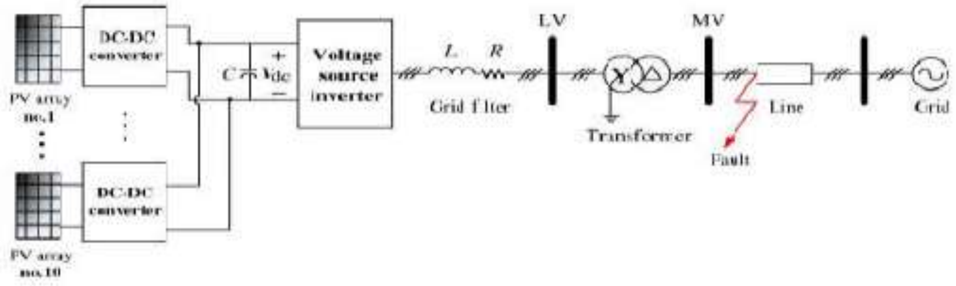


Fig.1.Diagramofthetwo-stageconversion-basedGCPPP.

TABLEICASESTUDYSYSTEMSPECIFICATIONS

PV module specifications		PV inverter specifications	
Maximum operating voltage (V_{mpp})	35.6 V	Maximum dc power	1133 kW
Maximum operating current (I_{mpp})	8.29 A	Maximum dc input voltage	1000 V
Open circuit voltage (V_{oc})	44.3 V	Rated dc voltage	800 V
Short circuit current (I_{sc})	8.74 A	Apparent power rating (at STC)	1100 kVA
Number of parallel modules, n_p	155	**Filter**	$R = 1\ m\Omega$ $L = 150\ \mu H$
Number of series modules, n_s	22	**Transformer**	1.2 MVA 20/0.415 kV Dyn11 50 Hz

TABLEIIPVARRAYSANDDC–DCCONVERTER SPECIFICATIONS IN TWO-STAGEGCPPP

DC–DC converter and PV array specifications			
Input voltage of the dc–dc converter at MPP, V_{PV}	356 V	Output voltage of the dc–dc converter, V_{dc}	800 V
Number of parallel PV modules in each array, n_p	34	DC–DC converter inductance, L_i	1 mH
Number of series PV modules in each array, n_s	10	DC-link capacitance, C	31 mF

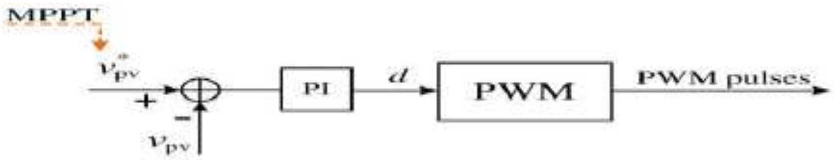
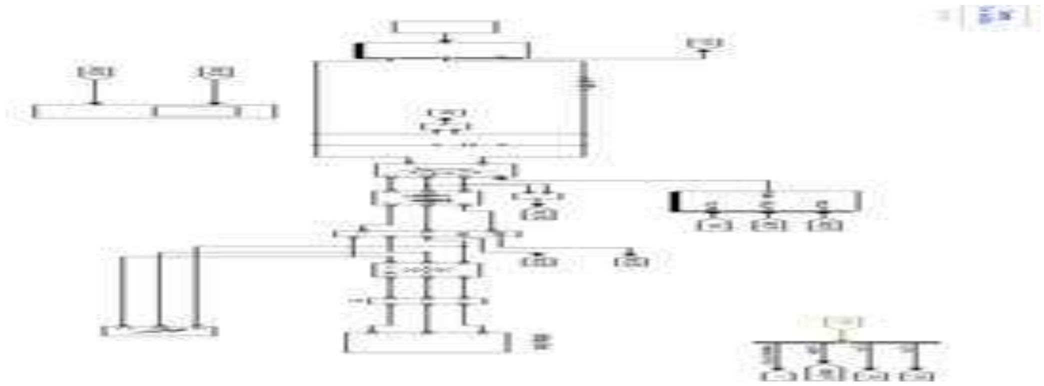


Fig.2.Controldiagramofthedc–dcconverter.

5.SIMULATIONRESULTS

5.1CASESTUDYFORASINGLE-STAGECONVERSION



1 control diagram of single stage conversionAll inverter designs and changes, whether for single-stage or two-stage conversions, must accept various sorts of failures and address FRT capability based on GCs. They must also.. Grid faults cause PV inverter disconnection due to three main factors: Excessive DC voltage; excessive ac current; and the loss of grid voltage synchronization, which may conflict with the FRT capabilities a single-stage conversion is utilized, though the voltage

sag detection and reactive power regulation are updated based on individual measurements of the grid voltages.

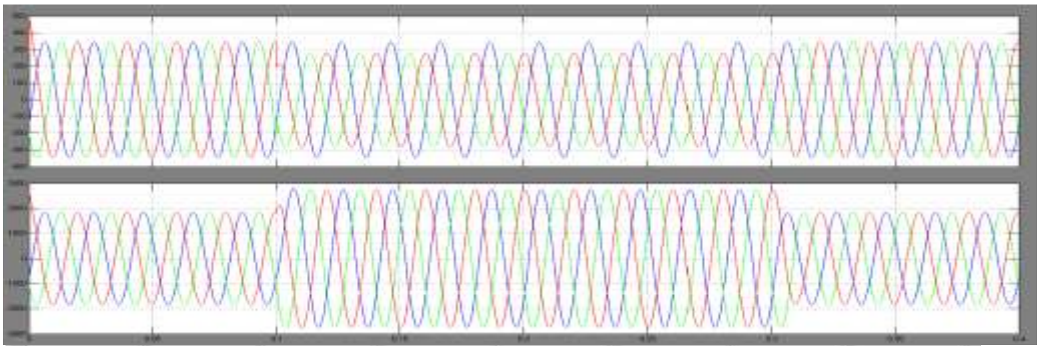
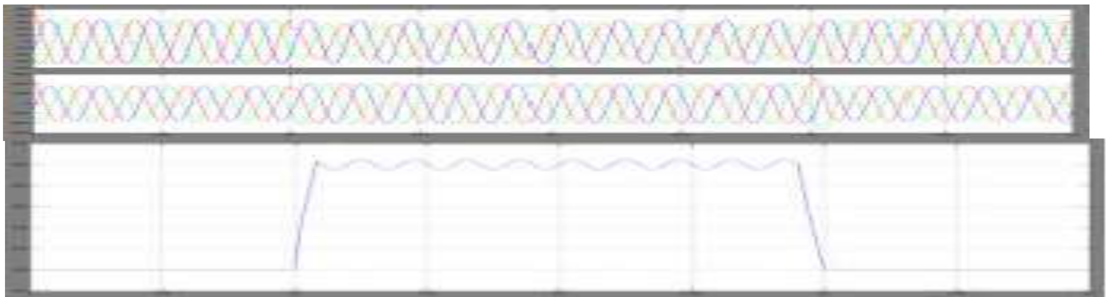


Fig.3.2(a)Gridvoltagesand(b)gridcurrentsatLVsideunder60%SLGvoltagesagatMVsideoftransformer

The output currents exceed the limits. Thiswill lead to inverter disconnection, although it is notappliedinthissimulation.Unbalancedanddistorted

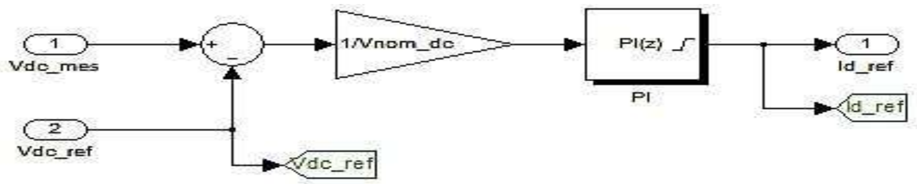
Fig.3.5dc-linkvoltageunderanSLGvoltagesagatMVsideofthetransformer



currentsare produced because the instantaneous outputpowerandthedc-linkvoltagehavelow-frequencyripples,andtherefore,theactivecurrentreferencecontainslow-frequencyripplesaswell.The finalreferenceforthedcurrentcomponent(idref)

shouldbelimitedconsideringtheneedofreactivecurrentinjection.

Fig.3.7dc-linkvoltageunder60%SLGvoltagesagatMVsideofthetransformer



5.2

FOR A TWO-STAGE

Fig.3.3currentlimiter

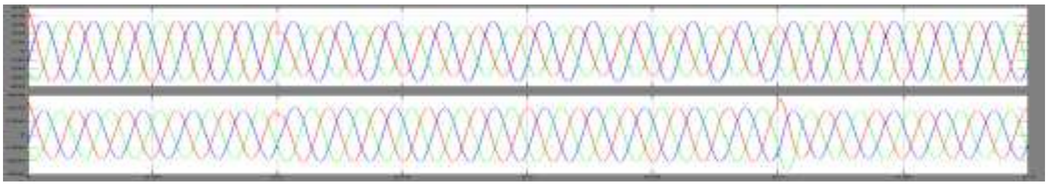


Fig.3.4AddingthecurrentlimitertotheVSIcontrol
(a) grid voltages and (b) grid currents.Under an SLGvoltagesagatMVsideofthetransformer
Thegeneratedcurrentsafterapplyingthecurrentlimiter in this example. Onecan observe inFig. 6.4 that the grid currents are balanced. This isbecause the active current reference (idref) is limited toanalmostconstantvalueduring thevoltagesag.Itshouldbementionedthatwhenoperatingwithlowsolarradiationand/or smallvoltagesags.

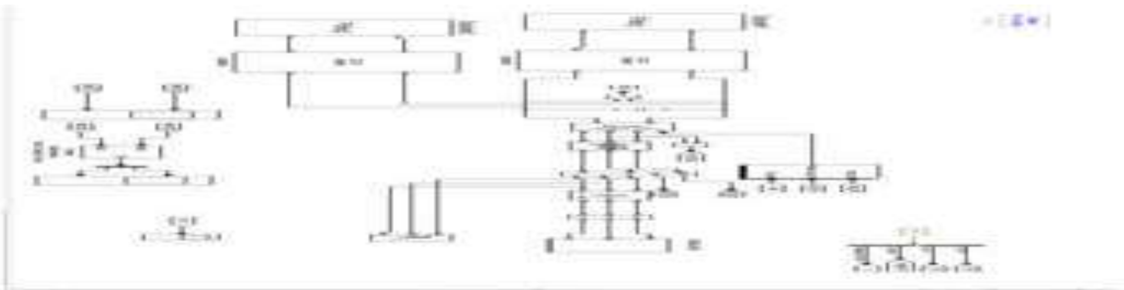


Fig.3.8controldiagramoftwostageconversion

a dc–dc converter between the PV arrays and the inverter is included in a GCPPP with two stages. One dc–dc converter can be used for each PV array in high-power GCPPPs. The two-stage GCPPP designation will be applied to these systems despite the fact that they contain a number of dc–dc converters. In two-stage GCPPPs, the dc–dc converter performs MPP tracking (MPPT) while the inverter regulates the dc-link voltage. the power generated by the PV modules will be lost in the event of a voltage drop in the DC–DC converter if no action is taken. isnotreducedandtherefore,thedc-linkvoltagekeepsrisingandmayexceedthemaximumlimit.Hence, thesystemisnotself-protectedduringgridfault conditions.A specificcontrol actionhas tobe takentoreducethepowergeneratedbythePVmodulesandprovidethetwo-stageGCPPPwithFRTcapability.

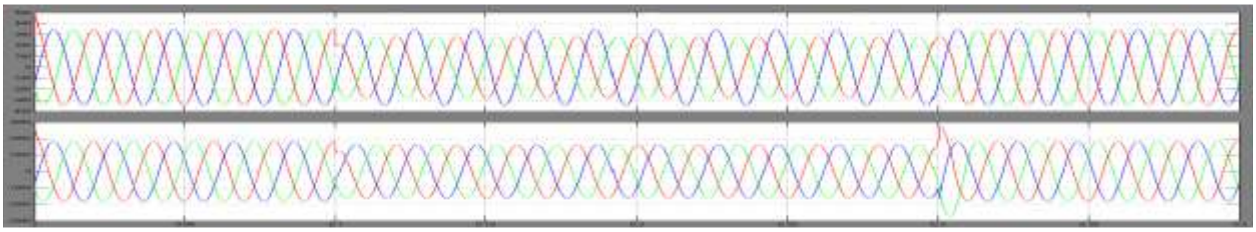


Fig.3.9controldiagramofdc-dcconverter

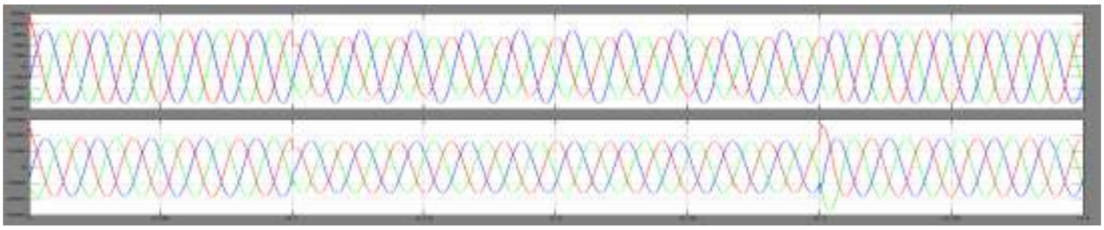
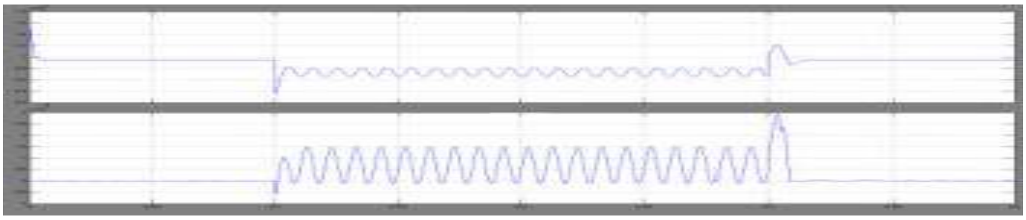


Fig.3.10shortcircuitingofPVpanels(a)gridvoltages(b)gridcurrents

Fig.3.11Short-circuitingPVpanelsdc-linkvoltagewhenapplyinga60%SLGvoltagesagatMVsideofthetransformer
Fig.3.12Short-circuitingthePVpanels:(a)injectedactivepowerand(b)reactivepowertothegrid



Prerequisites for actionof the GCPPPs at fault

In this research, the conditions for single- and two-stage network-associated inverters are discussed..Some controller tweaks have been proposed to alter the GCPPP in a way that rides past flaws according to GCs. These modifications include the addition of current limiters and a variety of methods for regulating the dc-interface voltage. Since it is assumed that the dc-interface voltage is generally restricted in the single-stage design, the GCPPP is self-secured. However, this is not true in the two-stage design. The two-stage architecture of the GCPPP has been proposed with three different ways to ensure that the GCPPP can endure any kind of GC deficits without being split. When there are voltage hangs, first and second techniques both require that the PV clusters do not produce any electricity, but a third strategy adjusts their power purpose in order for the network to get a less amount of power. Various contextual investigations carried out by reproductions have demonstrated the legitimacy of all the approaches provided for riding via voltage hangs..

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