CONTROL TECHNIQUE FOR INVERTER BASED MICRO GRID

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ABSTRACT: *Micro Grid (MG) may be treated as a low voltage network of local distributed energy sources and local loads. Micro Grids (MG) are usually a small scale power supply networks with total installed capacities around a few hundred kilowatts to few megawatts. The main aim of micro grids are supplying power to remote place or village by utilizing the available local resources, where there is no grid connection and also micro grids can be designed for uninterruptable power supply with high quality power to sensitive loads in a certain area.*

Micro Grid (MG) can be operated in two modes one is grid connected and another one is islanded mode. Each mode has its own control strategies. In this project islanded mode is mainly focused.

In previous method virtual output impedance method is used. By using this method the derivative of output current may amplify the magnitude of harmonic currents. Due to this power supply is interrupted and the power sharing among the inverters is not satisfactory.

To overcome above problem a new control technique is proposed. This method contains Second Order General Integrator (SOGI) and virtual output impedance. This method increases the impedance certainly and limits the circulating currents (harmonic currents) in the inverter. The main objective of this project is to limit the circulating currents (harmonic currents) in the inverter and proper power sharing among the inverters in islanded mode by using proposed control techniques.

The proposed method is simulated in MATLAB/SIMULINK environment.

INTRODUCTION

This part gives brief presentation of Distributed Generation (DG), various techniques used to produce electrical power and how to use DGs, how securing the islanding of conveyed age and various kinds of circulated age, advantages of appropriated age and confronting specialized difficulties in disseminated age has clarified.

INTRODUCTION TO DISTRIBUTED GENERATION

Presently a day's interconnection of Distributed Generations (DG) which works in corresponding with electrical power organization, and is right now changing the standard used to live with. Disseminated age is acquiring overall interest as a result of biological issues, filling in energy costs and power plant development cost. Circulated ages are generally little and a large number of them utilize environmentally friendly power sources like energy components, gas turbines, miniature hydro, wind turbines and electrical peculiarity. Numerous DGs use power electronic inverters, rather than pivoting generators. The inverters regularly have quick current restricting capacities for self insurance, and may not be harmed by out-of-stage reclosing. The activity of disseminated age will improve the quality power in power framework and this interconnection particularly with invert power stream might prompt a few issues like voltage and recurrence deviation, music, dependability of the power framework and islanding peculiarity.

Islanding is quite possibly the most specialized concern related with the development of conveyed age associated with utility organizations. Islanding can be characterized as a situation wherein a piece of the utility framework contains both burden and disseminated age remains empowered, even as being confined from the remainder of the utility framework. Islanding recognition is mandatory component for network associated inverters are indicated in worldwide necessities and ideas. Inverters generally perform current control and solidarity power element and utilize aloof screen for islanding location techniques dependent on privately estimated boundaries. Under islanding conditions, the greatness and recurrence of the voltage on the element at the reason behind normal coupling will in general float from the evaluated matrix esteems as a component of the power lopsidedness. It is notable that dissemination framework does at this point don't have any dynamic power producing source and does presently don't obtain energy if there should be an occurrence of an issue in transmission line.

Notwithstanding, with designated conveyed age this supposition that is presently not legitimate. In most recent exercise DG is needed to disengage the utilities from the network if there should be an occurrence of islanding. The inconveniences about islanding are:

1. Protection issues on the grounds that a piece of the framework stays keyed up while it isn't unsurprising.
2. Islanded framework might be deficiently grounded by the DG interconnection.
3. Immediate reclosing should cause out of stage in the gadget.
4. Loss of the executives over voltage and recurrence inside the framework.
5. Excessive transient burdens upon reconnection to the framework.
6. Uncoordinated assurance.

The methodologies of islanding discovery are to check the DG yield boundary for the framework and relying upon the estimations choose whether an islanding condition has happened from observing of

these boundaries. Islanding location procedures can be isolated into remote and nearby methods.

ISLANDING MODE

This describes the introduction of islanding mode, troubles with islanding, protection of islanding method, utility point of view of distributed generator islanding, benefits of islanding detection techniques, drawbacks of islanding techniques and the back ground of islanding.

INTRODUCTION OF ISLANDING MODE

Islanding is a condition in which distribution system turns into electrically separated from main grid of the power system, but it remains to be energized by distributed generation connected to it. As shown in Fig 3.1. Conventionally, a distribution system does now not have any energetic strength generating source in it. It doesn't obtain power in case of fault in transmission line upstream but with distributed generation, this assumption is no longer valid. Modern practice is nearly all utilities require distributed generation to be disconnected from the grid instantly possible in case of islanding. During continuous supply on the utility grid, if power failure occurs at utility grid may cause islanding of generators. The loss of grid is intentionally known as islanding. The non-intentional islanding is caused by chance of shut down of the grid is more importance. As there are various issues with involuntary islanding. Normal stipulates maximum delay of two seconds for finding of an unintentional island and all distributed generations ceasing to strengthen the distribution system.

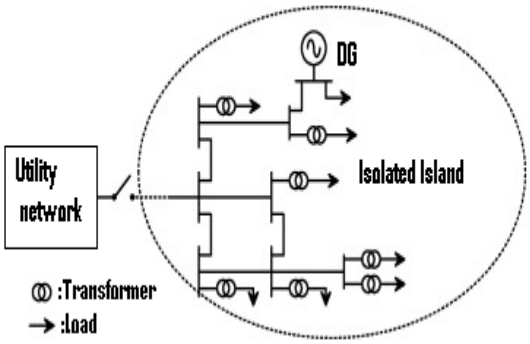


Fig 1 Scenario of islanding operation

ISSUES WITH ISLANDING

- Despite the fact that there are not many advantages of islanding activity just as couple of disadvantages are there in is landing. Not many of them are as per the following:
- Line worker security can be compromised with the guide of allocated innovation sources taking care of a framework after fundamental sources have been opened and named out.
- The voltage and recurrence probably won't be kept up with inside legitimate stage. Islanded outline work might be deficiently grounded by the appropriated age interconnection.
- Immediate reclosing could get out of stage reclosing of appropriated age. As a result of which enormous mechanical forces and flows are made that can hurt the generators or central players additionally, homeless people are made, which are conceivably unsafe to utility and other shopper hardware. Out of stage reclosing, if occurs at a voltage top, will create totally unreasonable capacitive exchanging transitory and in a softly damped framework, the tallness over-voltage can push toward multiple times of appraised voltage.
- Various hazards jumping out from this incorporate the debasement of the electric parts as an outcome of voltage and recurrence floats. Due to these reasons, distinguish the islanding rapidly and impeccably.

Application Perspective of Distributed Generator Network Islanding

Utilities have a more noteworthy useful perspective of conveyed age islanding. Their goal is to further develop the dissemination level purchaser administration unwavering quality especially in areas, wherein the trustworthiness is underneath customer's necessities. It's previously mentioned that shopper unfaltering quality could improve with the expansion of disseminated age sources and that the DG might bring the ability to the table for power back to the utility. Regardless, without complex examinations and progressive exorbitant edge work redesigns DG islanding isn't allowed. Some of instances of those examinations are: genuine power and responsive power profile and control, making arrangements for islanding, least/most feeder stacking, profile of islanding load, least/most voltage profile, affectability security and DG dormancy. Another specific model is the method of auto re-terminations of circuit breakers, incapacitated the principle line re-terminations and should be taken out other security gadgets to permit great coordination of utility administrations and DG sources.

Insurance may likewise increment as utility laborers won't just have to remain out the utility lines yet they will require setting aside extra effort to prohibit all the introduced DG lines. A measure of the necessary establishment investigations of an Independent power producer should complete to have the limit island are: 1. coincidental islanding and expected islanding study, 2. constancy, 3. quality power study, 4. gear utility further develop evaluation, 5. wellbeing audits, and 6. beneficial benefit study. Obviously the cost of planning of a conveyed age to be fit for islanding or to be simply brought into the significant utility guaranteed

framework requires wide spread, expensive designing and creation overviews which might be outside the monetary extent of minimal appropriated age (DG) providers.

Benefits of Islanding Detection Techniques

1. Remote methodologies - Highly reliant
2. Local exhibitions
3. a. Latent methods -
   1) Short ID time.
   2) Do not upset the edge work.
   3) Accurate when there is an immense difference in age and request in islanding framework.

   b. Dynamic procedures – There is acceptable coordinating among age and request in the islanding framework can be recognized.

   c. Mixture procedures -
   1) Have a little non distinguishing zone.
   2) Perturbation is introduced just when islanding is suspected.

Drawbacks of Islanding Detection Techniques

1. Remote technique is expensive to execute exceptionally for little frameworks.
2. Local methods
   a. Uninvolved techniques -
   1) Difficult to distinguish islanding when the heap and age in the islanded framework intently same.
   2) Special thought must be taken while drawing the lines.
   3) If the setting is exorbitantly strong then it could get result annoyance stumbling.
   b. Dynamic strategies -
   1) Introduce inconvenience in the framework work.
   2) Detection time is moderate as an outcome of extra time needed to see the framework reaction for inconvenience.
   3) Perturbation much of the time ruins the power amount and if adequately significant, it might ruin the framework soundness in any event, when joined to the matrix.
   c. Crossover systems - Islanding ID time is reached out as both inactive and dynamic method is executed.

THE BACKGROUND OF ISLANDING

The need for electrical energy is never finish. Alongside the advancement popular for electric power, economical advancement, natural issues, and power quality and constancy have transform into worries. Electrical utilities are alluring increasingly stressed. Since open transmission and dissemination frameworks are confronting their working requirements with expanding load. Ozone depleting substance outflow has achieved call for cleaner and inexhaustible power sources. Improvement in information has been making the whole society extra power destitute and making extra basic burdens. Under such circumstance, Distributed Generation (DG) with different sources has gotten individuals thought as a promising goal to the above issues.

As shown by L. Philipson, Distributed Generation (DG) involves utilizing a few little generators of 2 to 50MW yield power, set at a few purposeful focuses all over urban areas and towns, subsequently each gives capacity to few clients in closeness and far off age alludes to utilize considerably lesser producing units, of under 500kW yield power and regularly measured to serve individual homes or organizations. Later creations will more often than not join two classes into one, i.e., Distributed Generation (DG), allude to drive age at shopper destinations to give or all of purchaser burden or reinforcement supply or at substations to diminish top burden interest and reschedule substation office fortifications. In this proposition, the aggregate hypothesis is utilized.

Disseminated Generation (DG) is old idea. Since regular diesel generator as reinforcement power supply for risky burdens has been utilized for quite a long time. Notwithstanding, because of its less productivity, significant expense, and commotion and vapor, diesel generator would be upsetting in any applications yet pressing circumstance, hands on work and it has never transform into precise appropriated age source on the present establishment.

Natural agreeable Renewable Energy Sources (RES, for example, photovoltaic technique and wind electric generators, perfect and productive petroleum derivative advances, like miniature gas generators, and hydrogen electric gadgets power devices, has give incredible freedoms to the improvement in dispersed age.

Gas terminated little turbines are the 25kw to 100kW yield power reach can be mass shaped simple expense, which use air bearing and recuperation to accomplish pragmatic effectiveness great with power yield.

Energy component has the righteousness of zero discharge, higher effectiveness, and trustworthiness, thusly has the conceivable to precisely change power age. The hydrogen can be uncommonly provided either straightforwardly or improved from petroleum gas or fluid energy units, for instance alcohols or gas.

The fastest creating sustainable power source is wind producing power. By and large around the world, realistic breeze energy surpasses the as of now introduced limit of normal energy sources by a component of four. Photovoltaic frameworks are can be used as a piece of various sizes and show upgraded

possibilities in those spaces with high strength and unwavering quality of sunshine.

To worry above age and capacity advances in a circulated age environment includes most recent specialized issues. Circulated Generation (DG) units are requiring power electronic interfacing, various techniques of oversee and dispatch. A Distributed Generation (DG) unit would have the option to work any of the island cycle or matrix associated process. In island activity, it'd be give consistent, considerably less guideline mistake, significantly less broad symphonious twisting, and speedy reaction power under various burden conditions. In network associated activity, it would give consistent state decoupled dynamic power (P), receptive power (Q) control and suitable activities under interfacing, detaching, and reclosing tasks. If various units are associated equal on a similar transport, right burden sharing would be worked among the units.

A dc or ac Voltage Source Inverter (VSI) is generally utilized interface for Distributed Generation (DG) units, which includes diverse geography and control viewpoints under various working circumstance. Only with appropriate control execution of every individual unit can be resembling of at least two inverters or interfacing. This incorporates P and Q control under various nearby burden attributes and working conditions. As expressed over, the extraordinary trouble in the power electronic interfaces for Distributed Generation (DG) units makes a great deal of examination issues notwithstanding various potential outcomes to propel advances. A large number of the issues are tackled or somewhat settled, while numerous issues are as yet not settled or even not found. For the most part, reasonable working Distributed Generation (DG) frameworks need to precisely tackle conceivable specialized issues in the resulting three classifications - arranging of a solitary inverter unit with quality yield voltage in island activity, control of line genuine and responsive power staying between Distributed Generating (DG) units, the utility matrix in lattice connected activity, or change for elite execution and minimal overhead. Because of gigantic capability of Distributed Generation (DG) advancements, these examine issues merit specific considerations and merit cautious further examinations.

In Distributed Generation (DG) area, including both island activity and matrix connected activity, has been explored and arranged into different subtopics as recorded beneath.

1. Voltage and current overseeing of individual inverters in island activity.
2. Framework geography.
3. Overwhelming solidness issues.
4. Heartbeat Width Modulation (PWM) procedure.
5. Line intelligent activity of inverters and P, Q control.
6. Forepart rectifier overseeing in controlled ac-dc-ac frameworks.

V and I control of individual inverters in island mode

Prior to being worked in network mode activity, Distributed Generation (DG) unit needs to work in island activity at the underlying spot as a voltage source providing nearby burden with quality power. Numerous analysts has been led around here, which can be founded on sorted the control techniques utilized PID control, model based straight control, overwhelming control, plunging mode control, inner model standard based control, and speedy control.

The framework geography

All the three stage inverters are remembered for the above distributions are all in 3-Ø, 3-wire framework, any place the electrical converter itself doesn't offer a nonpartisan point. For the most part Δ/Y transformer is utilized through auxiliary community grounded before the electrical converter controlling the heap or being joined to utility framework as displayed in Fig.3.2.

In this geography, the 3wire frameworks on the Δ side just have two free sizes and 0-pivot current can't stream, that makes the framework nearly simple to control. The drawback is the presence of the expensive, profound, and enormous transformer.

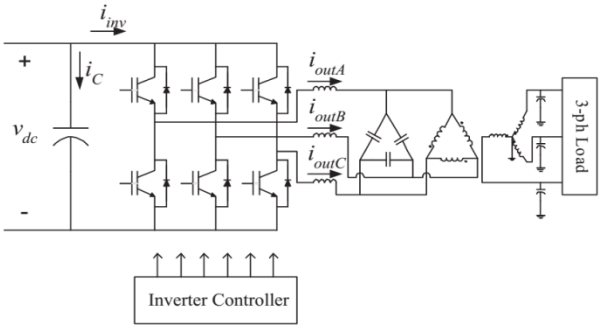


Fig 3.2 The three-phase three-wire inverter topology

PROPOSED CONCEPT

This depicts the presentation of proposed idea; MG associated in various modes like grid associated mode and islanded activity, their control techniques like p-q control techniques and steady current control techniques. And likewise audit of different hang control techniques and proposed control technique, summary.

Introduction to Proposed Concept

A MG might be treated as a low voltage organization of neighborhood Distributed Energy Resources (DERs) and nearby loads. The power output of the DERs is controlled by a focal controller or a singular controller. Besides, MGs are generally a limited scale power supply

networks with complete introduced limits around a couple hundred kilowatts to few megawatts. The primary point of MG is to power a remote spot or a town by using the nearby resources accessible, where there is no grid association and likewise MG can be intended to give uninterruptible high quality power to delicate loads in a specific region. The element that makes MG a one of a kind power systems is that, although it tends to be worked in corresponding with the grid and it very well may be naturally moved to islanded mode whenever its control systems identifies a fault or aggravation in power quality from the grid. When the fault is cleared or the unsettling influence vanishes, the MG can be resynchronized with the principle organization. The expansion of MGs additionally decreases the load on conventional power age plants and help in diminishing carbon foot in the climate.

Inverter based MG assumes a basic part in making the system more dependable and more coordinated with different sorts of DERs. A MG with a legitimate control strategy can give attachment and play admittance to the Micro Sources (MS). The square chart of inverter based MG is shown in Fig 4.1. The basic boundaries that are needed to be controlled in a MG are active power dispatch of different miniature sources, power sharing among the inverters, voltages and the frequency of the system.

MG has to working modes, grid associated mode and the other, islanded mode. When it is associated with grid, control strategy should have the option to make inverters to siphon the set worth of active and reactive powers and here consistent current control or PQ control can be executed. During islanded mode, control strategy should control the voltage and frequency of the MG notwithstanding the active and reactive powers and here p-f and Q-V hang methods track down their application. This hang method is more appropriate for high and medium voltage grids due to their inductive nature.

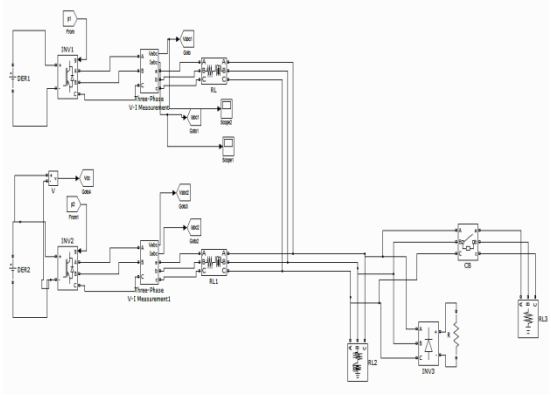
For low voltage grids, particularly MGs, where the sources are resistively coupled, control method inverse to conventional hang methods work all the more precisely yet there are issues identified with solidness, and just, voltage control is achieved yet no power dispatch and legitimate control over power sharing among the inverters is mind boggling. To resolve these issue, indirect tasks of conventional hang or virtual impedance loop methods might be utilized.

In this project an original control strategy which utilizes virtual impedance loop method and Second Order General Integrator (SOGI) related to indirect activity of conventional hang method is proposed.

RESULTS & ANALYSIS

This describes the MATLAB/SIMULINK results and analysis of micro grid and summary.

MATLAB/SIMULINK RESULTS



Block diagram of tested micro grid structure in SIMULINK

Fig 5.1 shows that it has two DER units interfaced by two inverters, inverter-1 and inverter-2 respectively and are connected through distribution system. In this system there are two critical loads, in which one is nonlinear load and another one is RL load and there it is a noncritical load, which is on/off with help of through a circuit breaker, which operates based on the situation of micro grid.

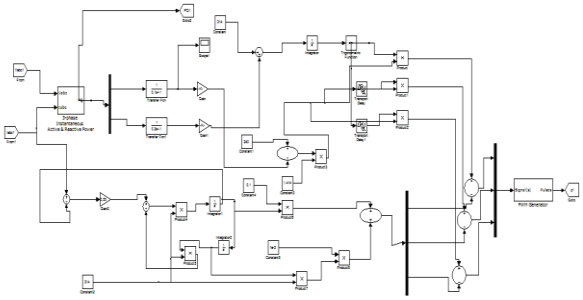


Fig 5.2 SIMULINK circuit of the proposed control strategy

Fig 5.2 shows the simulink circuit of the proposed control strategy, in this circuit the voltages are given to three phase instantaneous active and reactive power block. This gives the real and reactive power, these real and reactive powers are converting to voltage and frequency through transformation circuit, the voltage is connected to PI controller circuit. This PI controller corrects the error signals and will give voltage signals. The voltage signals will be phase shift to 0^0, 120^0, 240^0 and these are connected summing circuit and another circuit, voltage is given to second order general integrator. This output is connected to virtual impedance. This will give the output result as three

phase voltage signals. These voltage signals are used for pulse generation to trigger the inverter.

Output results:

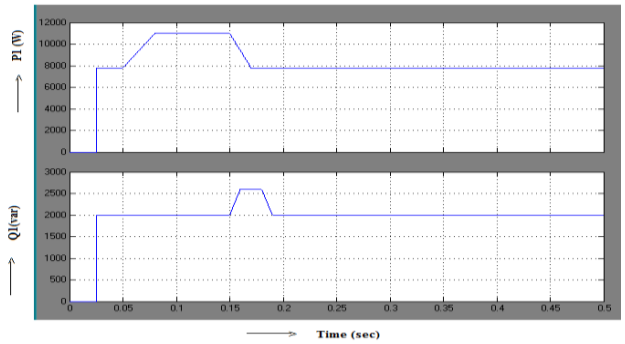


Fig 5.3 Real & reactive power of the inverter-1

Fig 5.3 shows the real and reactive power of inverters. When the load is connected between the time 0.5sec to 0.15sec, real power demand is increasing and reactive power is decreasing. When the load is removed the real power is decreasing and reactive power is increasing in the inverter 1.

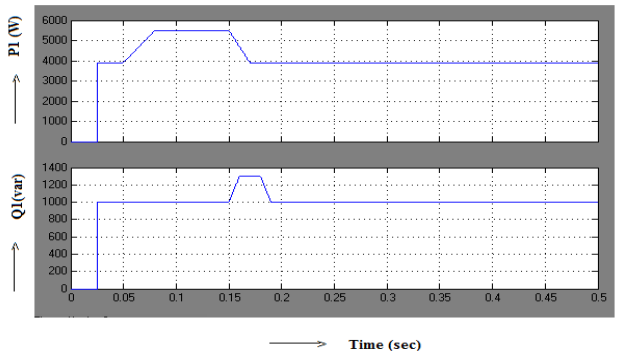


Fig 5.4 Real & reactive powers of inverter-2

Fig 5.3 shows the real and reactive power of inverters. When the load is connected between the time 0.5sec to 0.15sec, real power demand is increasing and reactive power is decreasing. When the load is removed, the real power is decreasing and reactive power is increasing in the inverter 2. This means proper power sharing between inverter 1 and inverter 2 has done.

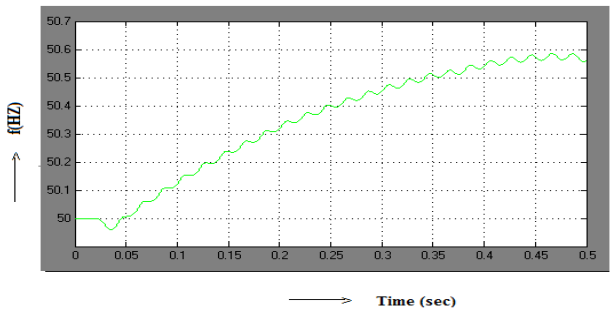


Fig 5.5 Frequency of the inverters

Fig 5.5 shows the frequency of the inverters; here the inverter frequency is stable in 50.55 Hz.

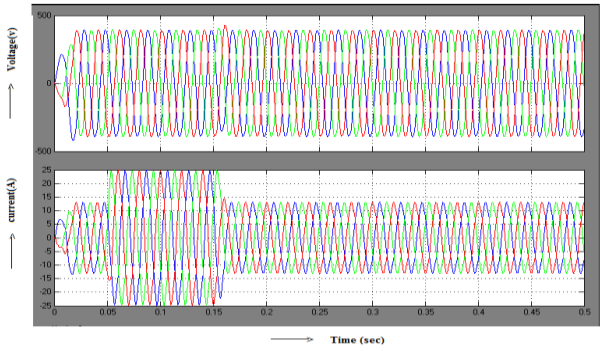


Fig 5.6 Output voltage & current of inverter-1

Fig 5.6 shows the output result of voltage and current of inverter, where the circuit breaker is closed at the duration of 0.05 sec to 0.15 sec when the load is connected. The inverter current raises to 25 A in inverter 1 and voltage is constant.

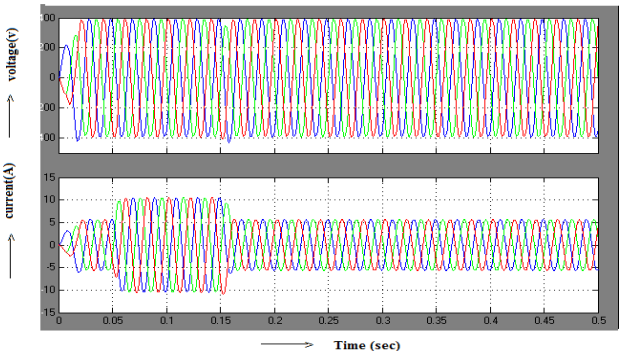


Fig 5.7 Output voltage & current of inverter-2

Fig 5.7 shows the output result of voltage and current of inverter, where the circuit breaker is closed at the duration of 0.05 sec to 0.15 sec when the load is connected. The inverter current raises to 10 A in inverter 1 and voltage is constant.

By seeing these results when critical or non critical loads are connected, the inverters share the current properly so that there is no effect on the inverters operation by using the second order general integrator with virtual impedance method. The circulating currents in the inverter 1 and inverter 2 share accordingly. So that the inverters are not affected by the circulating currents and inverters work effectively.

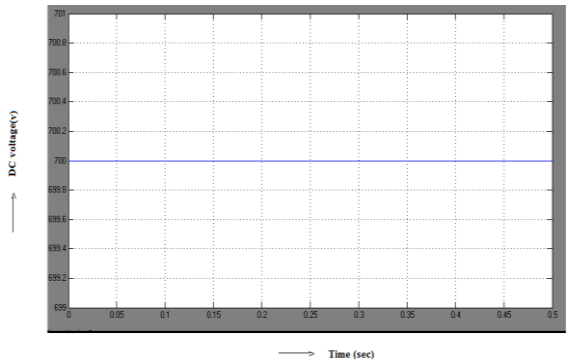


Fig 5.8 DC bus voltage of the inverters

Fig 5.8 shows dc supply voltage of inverter 1 and inverter 2. The dc input voltage is given to inverters in simulink circuit.

Fig 5.9 shows the total harmonic distortion results of the circulating current. Using the controlling techniques we can limit the circulating currents within the acceptable value.

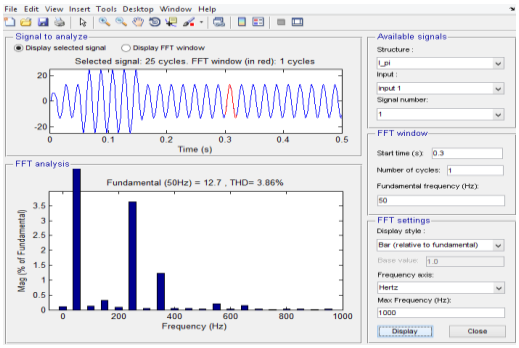


Fig 5.9 THD analysis results of circulating current

CONCLUSION

The virtual impedance loop with SOGI control method can effectively enhance the power sharing ability of inverters and this technique limits the circulating currents in the inverters effectively. This type of control method can be used for the MGs which are located at rural or remote place.

SCOPE FOR FUTURE PROJECT WORK

In future using the fuzzy logic controller the inverters are control the effectively, power sharing and limit the circulating currents effectively, and achieve better total harmonic distortion.

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