New Control Strategy for Inverter Based Micro Grid

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Abstract: **Micro grids frameworks are little scale power supply arranges that have neighbourhood power era. Micro grids network got to be one of the key spot in examination on dispersed vitality frameworks. Micro grids are fit for both creating their own electric force with little scale conveyed era (miniaturized scale sources) and receiving/sending out energy to the fundamental utility lattice. In this undertaking a control system for inverter based MG which can guarantee soundness and appropriate force sharing among the inverters, in islanded mode, is proposed. A MG can be worked in two modes, matrix associated and islanded mode. Every mode has its own control methodology. Small scale lattices (MG), for the most part inverter based, are increasing more significance as they can oblige different sorts of DGs viably and for their unrivaled force quality. The general control logic inside of a miniaturized scale matrix is that sources must depend just on nearby data, yet must participate with different sources. To perform that objective, the proposed controller uses hang attributes for dynamic force/recurrence and responsive force/voltage. The proposed control procedure depends on the utilization of a stage bolted circle to quantify the miniaturized scale framework recurrence at the inverter terminals, and to encourage regulation of the inverter stage in respect to the Micro grids network. This control system permits miniaturized scale lattices to flawlessly transition between matrix associated and self-sufficient operation, and the other way around. The controller has been actualized in a real Micro grids network that joined different sources.**

Keywords— Micro grid, islanded operation

I. Introduction

At the present time, Micro grids framework can be viewed as a controlled cell of a power framework. Illustration gratia, the cell may well be controlled as a solitary dispatch capable burden, which can respond in little time to give the requests of the transmission framework. On the client side miniaturized scale frameworks can be developed to address interesting issues. They help the neighbourhood dependability, decrease feeder misfortune, bolster nearby voltages, convey prevalent adequacy through castoff waste warmth, voltage list rectification and giving uninterruptible influence supply works. Nowadays conveyed era is bringing more acknowledgment in a de-controlled environment. Joining of circulated era and absorption of controllers has led to customary force system to work as a dynamic force system. Under this interruption the force system parts into part generators and burdens. The heap interest can be tallied with the supply force of an island. If there should be an occurrence of business and mechanical touchy burdens the need of prevalent force quality and unwavering quality is awesome. A Micro grids network can be a DC framework, an AC framework or even a high recurrence AC lattice framework. A Micro network framework is sorted out as an island. The issue of disposing of harmonics in disposing inverters has been the center of examination for a long time. The present pattern of tweak control for multilevel inverters is to yield top notch power with high productivity. Therefore, well known conventional PWM balance routines are not the best answer for multilevel inverter control because of their high exchanging recurrence. The particular consonant disposal strategy has developed as a promising tweak control technique for multilevel inverters. The real trouble for the particular consonant end technique is to unravel the mathematical statements describing music; then again, the arrangements are not accessible for the entire balance file extent, and it doesn't dispense with any number of indicated sounds to fulfill the application prerequisites. The proposed symphonies disposal technique is utilized to dispense with any number of sounds and can be connected to DCMLI application necessities

II. Power Network In Islanded Mode

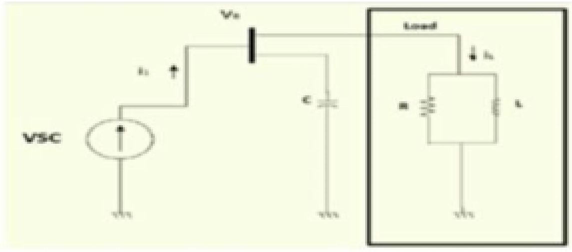

Fig. 1: Converter based Power Network in islanded mode

The Figure 1 construes the plan of a fundamental miniaturized scale matrix. The framework involves a gatherer transport, a converter, a transport capacitor C and a heap. The heap is signified as a parallel mix of resistance R and inductance L and the heap is ventured to be in an imbalanced condition. With every one of these suspicions, a key recurrence model of the converter is legitimized, where the converter is demonstrated as a normal current source

Mg In Grid Connected Mode

There are different entrenched control system to control strategies to control the inverters in a MG when it is working in Grid associated mode [2,3]. Much of the time, both of consistent current control or PQ control is utilized. These two strategies are quickly clarified underneath.

Constant Current Control

In this control method [2], inverters are forced to inject constant current output. The block diagram of this control shown in the fig.2. And its controller is shown in fig.3.

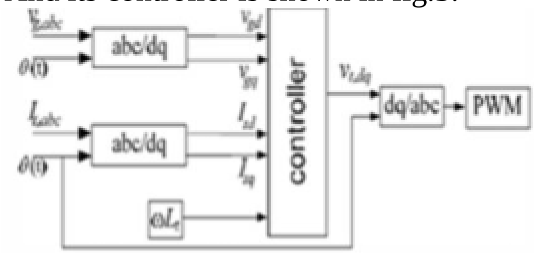

Fig. 2: Block diagram of Constant Current Control

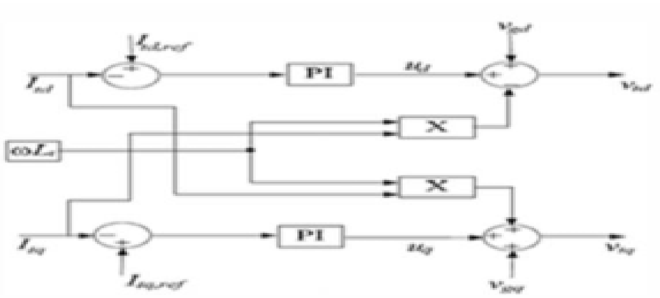

Fig. 3: Block diagram of Controller

The consistent current control measures the heap voltage Vgabc and the inverter current Igabc and exchanges them to dq outline. The converter amounts Id and Iq are then contrasted and reference DC amounts Itd,ref(active force set point) and Itq,ref(reactive force set point) to acquire mistake signals. The blunder signs are then connected to corresponding Integral (PI) controllers to adjust the mistakes and characterized the reference voltage signals Vtd and Vtq. These reference voltages are againe changed to three stage amounts and are given to the beat generator to produce beats for the inverter. By and large, this procedure compels the inverter to infuse the characterized streams and in the meantime it controls the voltage at the association point as measured from the network side

III.PQ CONTROL METHOD

The piece outline of PQ [3] control is appeared in fig.4. The control structure of this sort is calm like the consistent current control. The main distinction b tween the two controls is the directed parameters and they achieve the same conclusion, which is yield force control, in this control sort, the managed parameters control, in this control type, the regulated parameters are the active and reactive powers instead of the current. Active and reactive powers are measured at the output terminal of the inverter and then compared with the reference values to obtain the errors. These error signals are then applied to two PI controllers in

order to obtain Id,ref and Iq,ref. the rest of the process is similar to the constant current control technique shown earlier in fig.2 and .3

IV.REVIEW OF VARIOUS DROOP CONTROL TECHNIQUES

Conventional Droop Method

The basic equations that governs transfer of power in conventional power system are given by From the equations, it is clear that real power is dependent on the phase angle delta or frequency and the reactive power is based on the voltage profile of the system. These relations holds good in inductance dominated networks. Now, many wireless control strategies [4-7] for inverters in islanded operation use the various droop methods which are derived from Eq.(1) and Eq.(2) Where, f and V are the instantaneous frequency and voltage of the system and f0 and V0 are nominal frequency and voltages respectively, and mp, mQ are the droop coefficients of the droop equations(3) and (4) respectively. The block diagram for the droop control is shown in fig.5.

$$P = \frac{Vs \times Vr}{X} Sin\delta \qquad (1)$$

$$Q = \frac{Vs^2}{X} - \frac{Vs \times Vr}{X} Cos\delta \qquad (2)$$

$$f = f^* - m_P P \qquad (3)$$

$$V = V^* - m_Q Q \qquad (4)$$

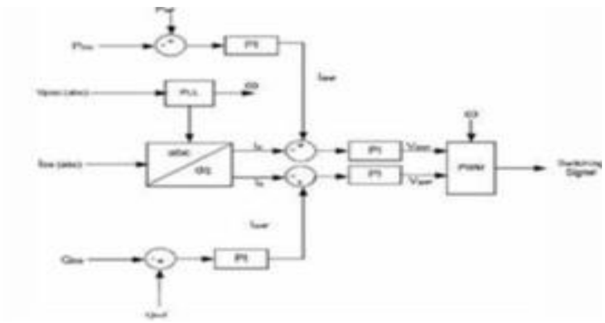

Fig. 4: Block diagram of PQ Control

As shown in the fig. 5, frequency reference is generated by real power Vs frequency droop and the reactive power Vs voltage droop generates the voltage magnitude reference. Now the voltage reference to the pulse generator is derived by using the following equations. The required phase angle wt, can obtained by integrating the frequency w

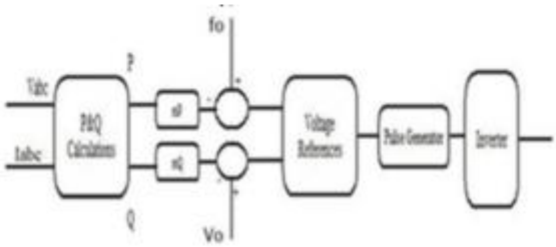

Fig. 5: Block diagram of conventional droop method

$$Va = V_m Sin(\omega t) \quad (5)$$

$$Vb = V_m Sin(\omega t - 120^0) \quad (6)$$

$$Vc = V_m Sin(\omega t + 120^0) \quad (7)$$

$$\omega t = \int \omega dt \quad (8)$$

Opposite droop method

Incase of MGs where the network is resistive in natured, the basic equations that govern the power flows are given by the following equations

$$P = \frac{Vs^2}{R} - \frac{Vs \times Vr}{R} Cos\delta \quad (9)$$

$$Q = \frac{Vs \times Vr}{R} Sin\delta \quad (10)$$

$$V = V^0 - m_P P \quad (11)$$

$$f = f^0 - m_Q Q \quad (12)$$

The block diagram for the opposite droop control method is shown in the fig.6. As shown in the fig.6, real power Vs frequency droop is used to get the reference of voltage magnitude. The comparison between the above two mentioned droop methods is shown in the following table.1.

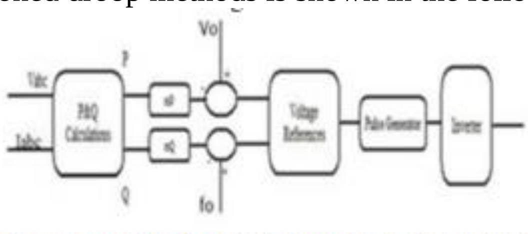

Fig. 6: B ock diagram of opposite droop method

Hence, from the table I, it is clear that conventional droop method has multiple advantages over opposite droop method. Also the above two mentioned methods cannot make the DERs share load properly if non linear loads are present in the MG.

Table 1 Comparison between the two droop methods

Parameter	Conventional droop	Opposite droop
Compatible with high voltage networks	Yes	No
Compatible with low voltage networks	No	Yes
Power dispatch	Yes	No
Direct voltage control	No	Yes
Compatible with generators	Yes	No

Virtual output impedance method

The block diagram of this method is shown in the following fig. 7. Here the method is implemented by drooping the reference voltage proportional to the time derivative of inverter output current and thus increasing the total inverter output impedance

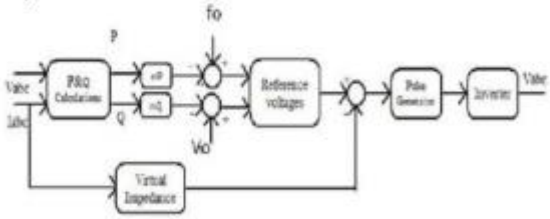

Fig. 7: Block diagram of virtual impedance loop method

$$V_{ref} = V_{droop} - z(s)I_0 \quad (13)$$

V.PROPOSED CONTROL TECHNIQUE

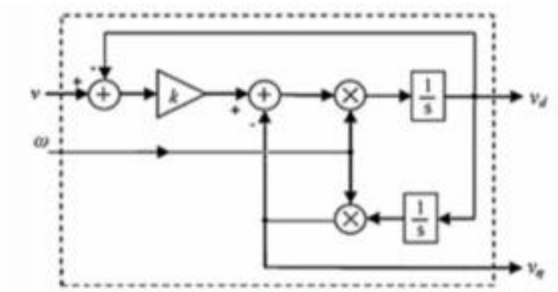

Fig. 8: Block diagram of SOGI

$$V_d = I_0 \, Sin(\omega t) \quad (14)$$

$$V_q = -I_0 \, Cos(\omega t) \quad (15)$$

Now the virtual impedance loop can be implemented by using these two outputs. The time derivative of output current is given by,

$$\frac{dI_0}{dt} = \frac{d(ISin(\omega t))}{dt} - I\omega Cos(\omega t) = \omega V_q \quad (16)$$

So the virtual impedance can be implemented simply by multiplying impedance values Z(s) with -Vq

$$z_v(s) = -\omega L_v V_q \quad (17)$$

$$z_v(s)=R_v V_d \quad (18)$$

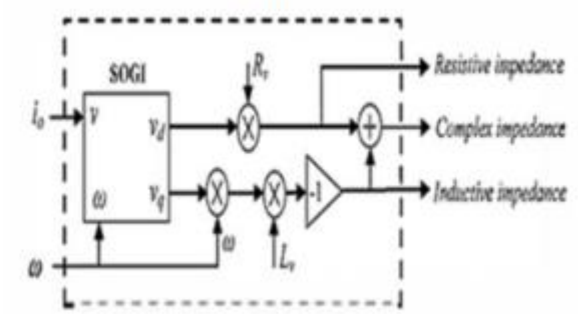

Fig. 9: Implementation of virtual impedance using SOGI

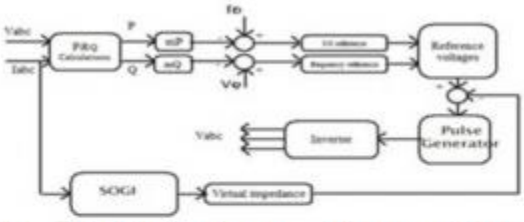

Fig. 10: Block diagram of proposed control method using SOGI

VI.RENEWABLE ENERGY SOURCES

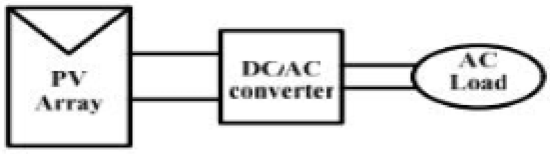

Fig. 11: Block diagram representation of Photovoltaic system

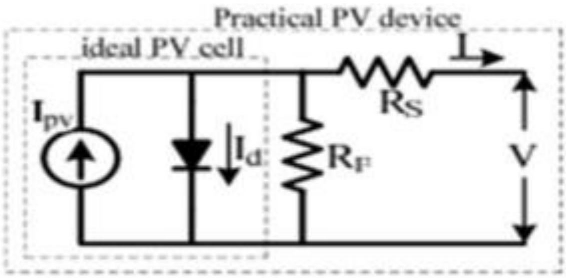

Fig. 12: Practical PV device

Diode-Clamped Multilevel Inverter

Table 2: DCMLI voltage levels and switching states

Voltage V_a	Switch State							
	S_{a1}	S_{a2}	S_{a3}	S_{a4}	S'_{a1}	S'_{a2}	S'_{a3}	S'_{a4}
$V_4 = 4Vdc$	1	1	1	1	0	0	0	0
$V_3 = 3Vdc$	0	1	1	1	1	0	0	0
$V_2 = 2Vdc$	0	0	1	1	1	1	0	0
$V_1 = Vdc$	0	0	0	1	1	1	1	0
$V_0 = 0$	0	0	0	0	1	1	1	1

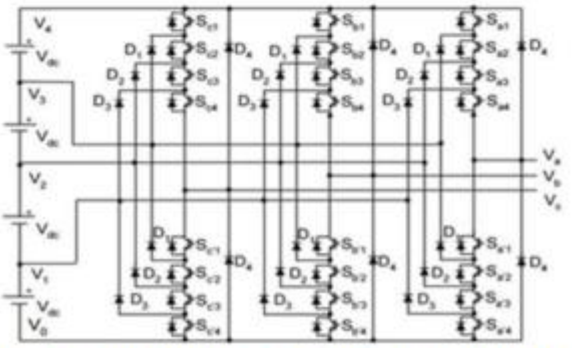

Fig. 13: A three-phase five-level diode-clamped multilevel inverter schematic.

VII. MATLAB/SIMULINK RESULTS

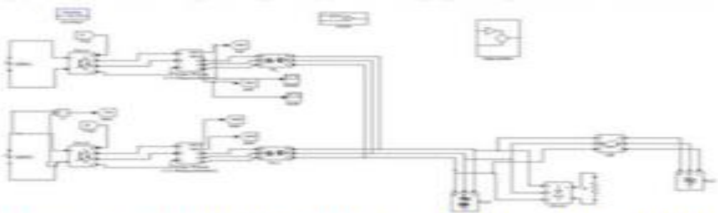

Fig. 14: Simulated model of proposed control strategy based

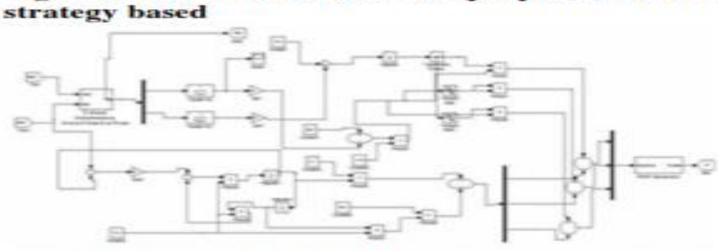

Fig. 15: Proposed control strategy

Fig. 16: Simulation output of P1 and Q1

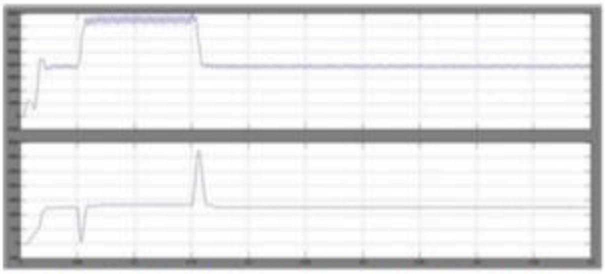

Fig. 17: Simulated output wave form of P2 and Q2

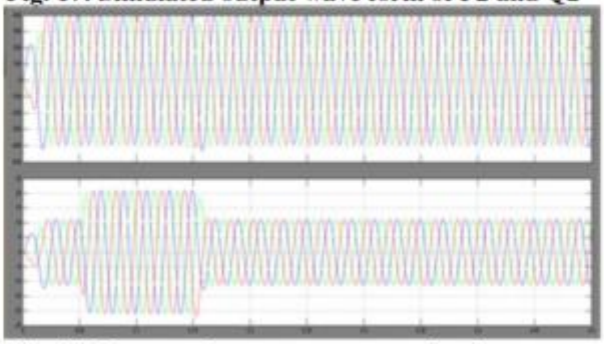

Fig. 18: Inverter 1 output current and voltage

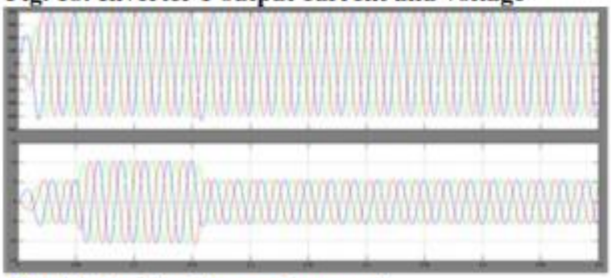

Fig. 19: Inv 2 voltage and current

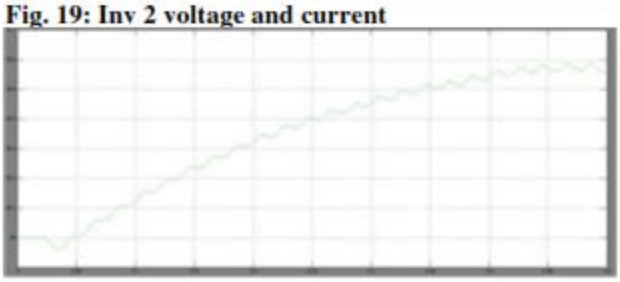

Fig. 20: Frequency

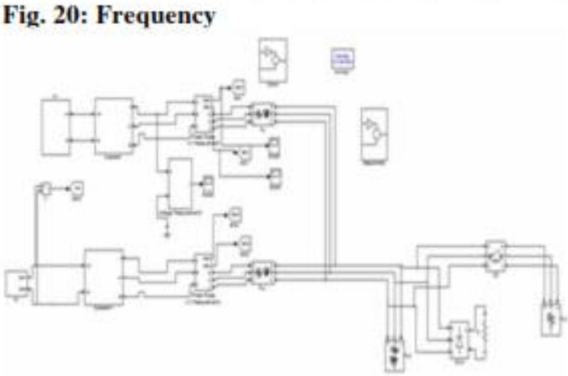

Fig. 21: Simulink model of the proposed concept with Renewable energy sources with three phase five level diode clamped multilevel inverter

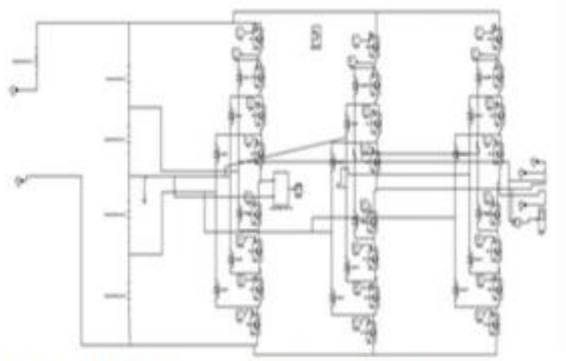

Fig. 26: Matlab/Simulink model of a three-phase five-level diode-clamped multilevel inverter

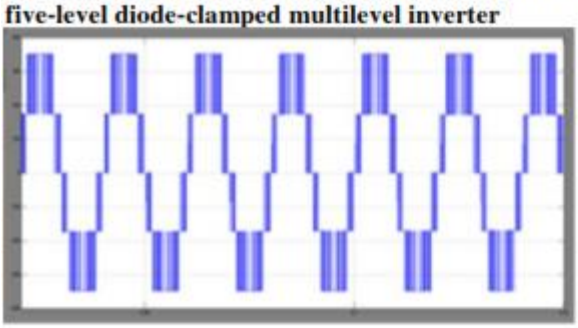

Fig. 27: Output voltage of five level inverter with phase A

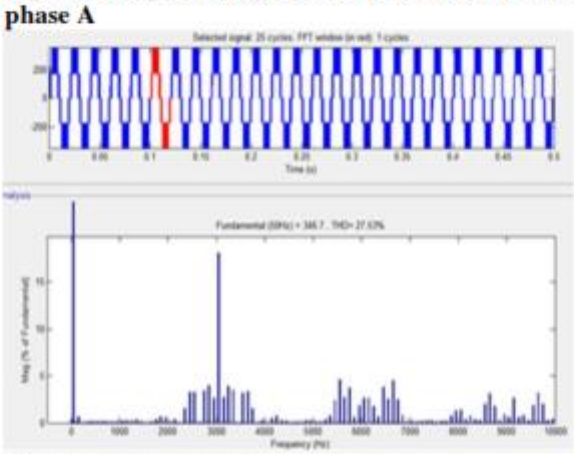

Fig. 28: THD of the five level inverter

VIII. Conclusion

A novel control system for inverter based MG working in islanded mode has been proposed. The virtual impedance circle with SOGI in conjunction with backhanded operation of hang control technique can successfully upgrade the force sharing capacity of inverters and the dependability of the MG to a decent degree. For perfect inverter joined voltage sources hang control can help in sharing genuine and receptive force. The control outline is generally straightforward inferable from the confined sensor and controller element association. The test is to incorporate era and burden motion, with their controls, and ensure soundness of islanded smaller scale matrices.

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