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Inverter Control for Grid Connected and Islanding Mode Distribution Generation in a Micro grid

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ABSTRACT: *Distribution Generation (DG) such as Photovoltaic panels are used widely in distribution level which create a necessity to improve the control methods between the grid and the end user level. A micro grid which contains (DG) operates while connected to the grid, but in case of outages it operate independently without the grid. In this paper we are going to simulate and evaluate micro-grid operation during the transition between grid-connected mode and islanding mode under different control strategies. Two DC power supply has been connected to micro-grid via Voltage Source Converter (VSC).A program has been created that simulate the results using given formula for d-q axis. A complete scheme to get the output result has been implemented and number of steps.*

Keywords: *PQ control, voltage source converter, droop control*

I. INTRODUCTION

Two conditions for controlling a micro grid will be analyzed and simulated during, grid connected and islanding mode. The islanding mode is when a part of the system which contains the (DG) disconnected from the rest of the system and continue to operate by itself. In grid connected operation mode, all the controllable distributed generators adopt P/Q control strategy and their desired output values are given by economical operation plan. In islanding operation mode, there will be a master inverter which provides reference voltage and reference frequency for slave inverters. On the other hand, in connected operation mode during the grid-connected operation, the DG will be controlled using current control mode operated to inject preset power to the grid.

II. PQ CONTROL OPERATION

Two control topologies will be used directly connected and inverter interfaced micro-sources .For grid connected mode PQ control operation will be used to interface between the grid and the inverter using park transformation.PQ controller is designed so that the inverter control the active and reactive power of the system from a small signal variations of the voltage magnitude and its phase. Park's transformation is used to convert the three-phase voltages and currents at the grid side into the rotating reference frame components. The control method will follow the below equations:

Ps = Vsd* id …………….... (1)

Qs = - Vsd*iq ………….…. (2)

From (1) and (2) the reference currents for a current controlled inverter with predetermined power settings, Psref and Qsref are given by:

Idref = Psref /Vsd................. (3)

Iqref = -Qsref /Vsd ……….. (4)

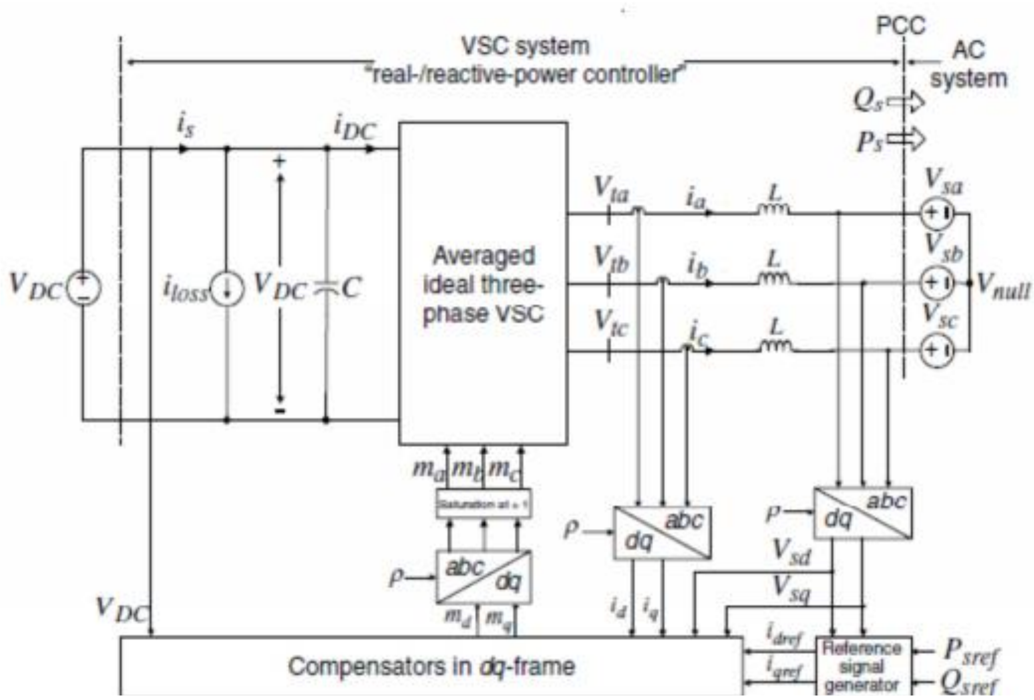

Fig.1. PQ Control Scheme

Pulse Width Modulation (PWM) switching pulses will be used for the inverter and it will be compared to unity triangular wave to give the desired output [Fig1]. The instantaneous values of the rotating reference frame voltages and currentsareVsd, Vsq, id and iq.The grid will be connected to the inverter through the inductance L and PIcontroller coefficients are Kp and Ki.

III. VOLTAGE SOURCE CONVERTER (VSC)

The VSC transmission operation may can be simplified by considering each terminal as a voltage source connected as a reactor to the transmission line. The two terminals are interconnected by a DC link. In this project two DC power supply has been connected to micro-grid via VSC.

IV. SYSTEM PARAMTERTS

In order to design a mathematical model for PQ control loop, the following assumptions and system parameters should be valid:

Table1: design parameters

Parameter	Equation	Value
Dc voltage	---	1445V
Duty Ratio	---	0.65
Transmission Line R	$\frac{X}{R} = 7 \ldots\ldots(4)$	0.8 Ω
Transmission Line L		0.0148H
bus voltage	$V = \frac{Vdc}{2} * Ma \ldots\ldots.(5)$	480V
Proportional compensator	$Kp = \frac{L}{t} \ldots\ldots(6)$	0.6727
Integration compensator	$Ki = \frac{(R+ron)}{L} \ldots\ldots(7)$	36.36
Load	-----	40KW

V. SIMULATION RESULTS

5.1 Three-phase two levels PWM converter:

In this step DC power supply has been connected to micro-grid via VSC, 50KW load has been connectedto the system to determine the reference values of idref&iqref for the next step (Inner-Loop) tuning.

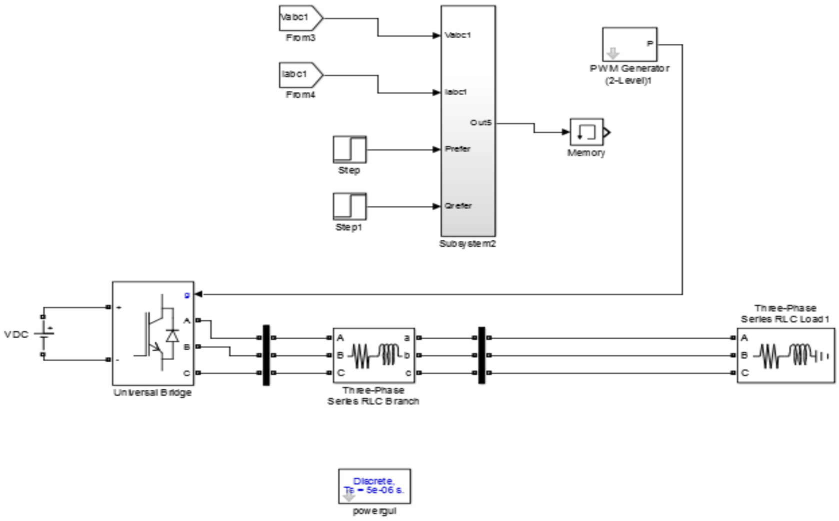

Fig.2 Three-phase two level PWM converter.

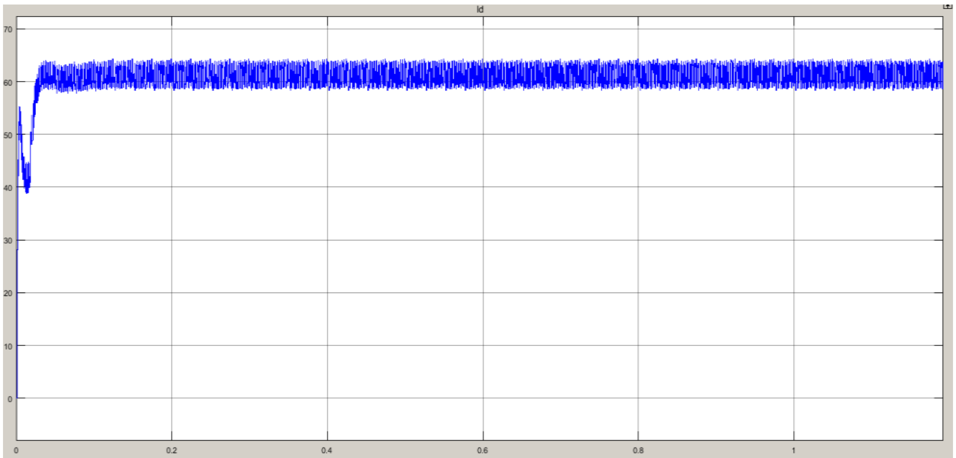

Fig.3.idref

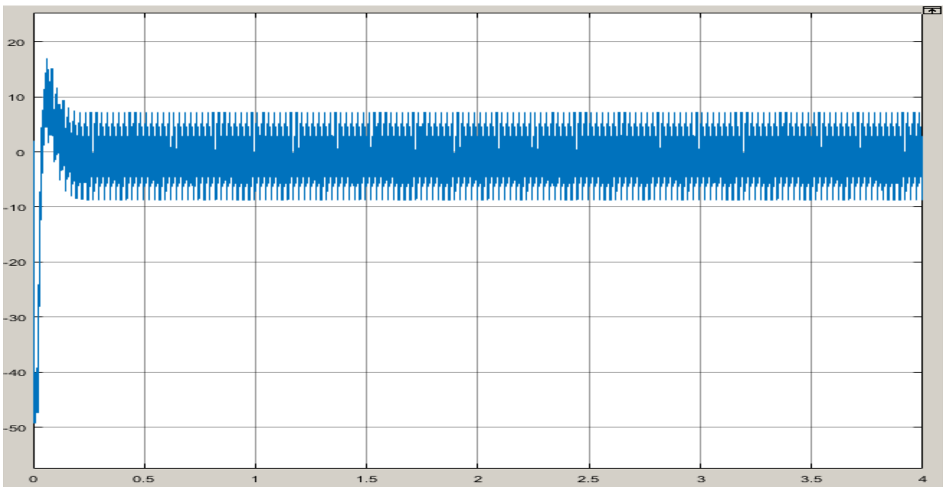

Fig.4.iqref

5.2Inner Loop Tuning:

In this part we replace our load by 480 AC source and use the results from the step above idref&iqref as loop inputs

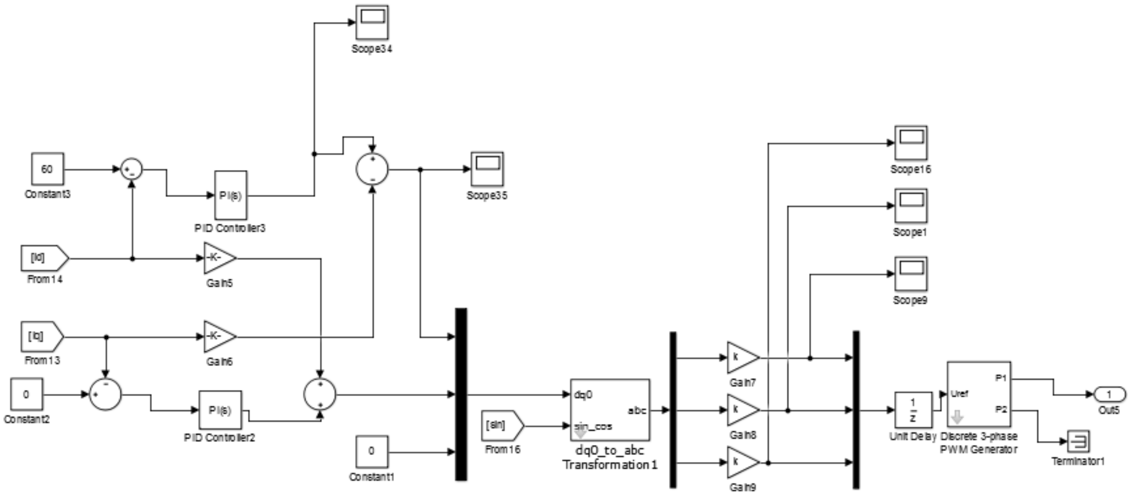

Fig.5. Inner-Loop

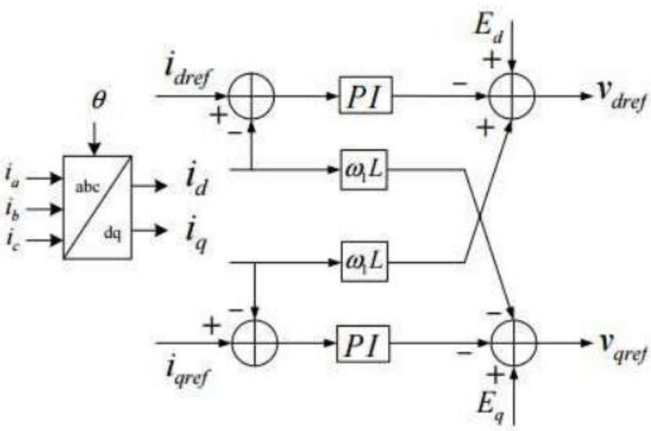

Fig.6. Inner-Loop conventional dq control strategy

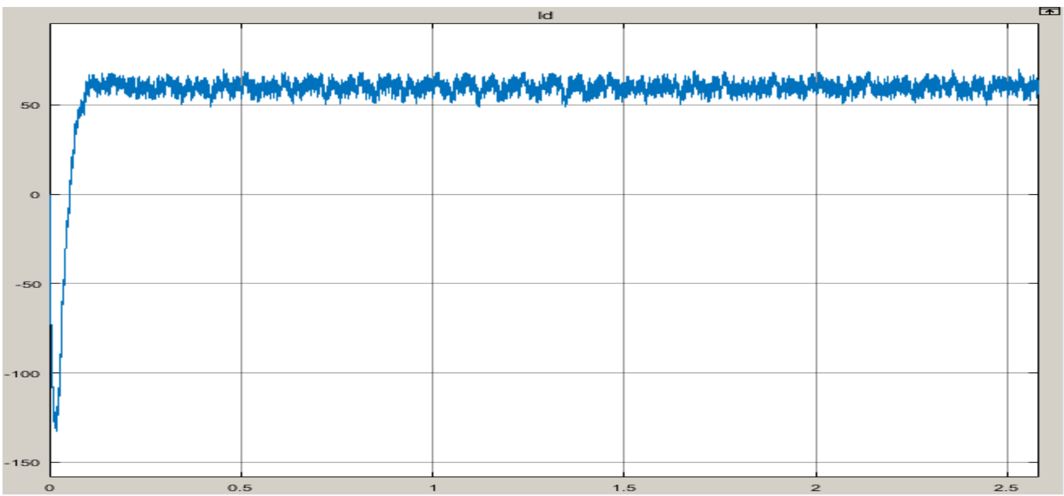

Fig.7. Inner-Loop Id

5.3Outer Loop Tuning:

In power outer loop, the energy management system of the micro-grid provides the active power reference value Pref and reactive power reference value Qref, which depend on the state of the storage system and the load balance of micro-grid

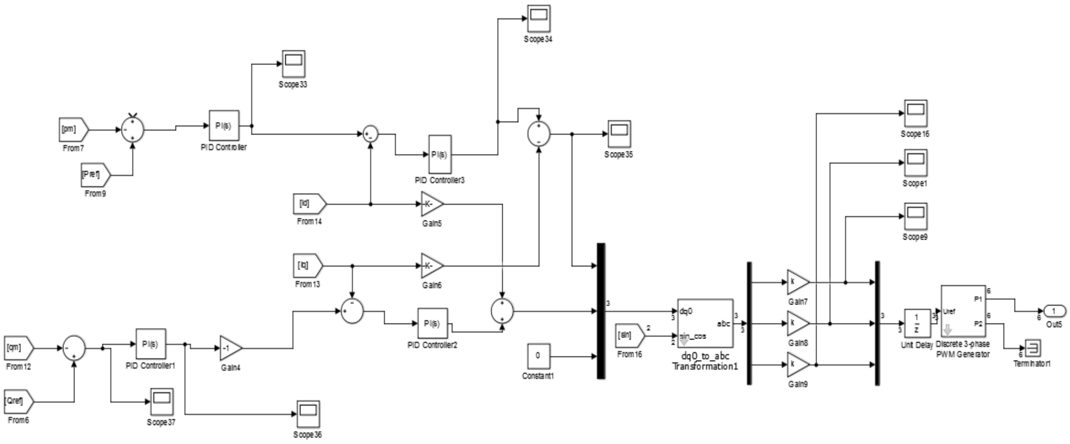

Fig.8. Outer-Loop

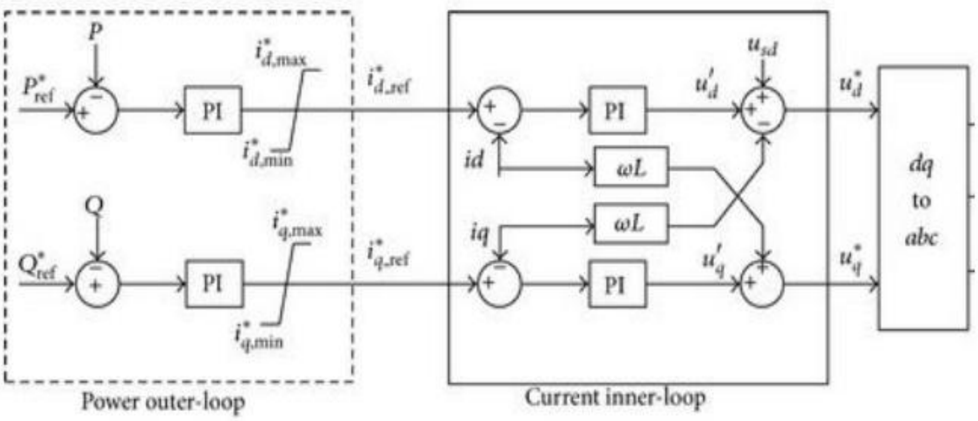

Fig.9. Outer & Inner-Loop conventional dq control strategy.

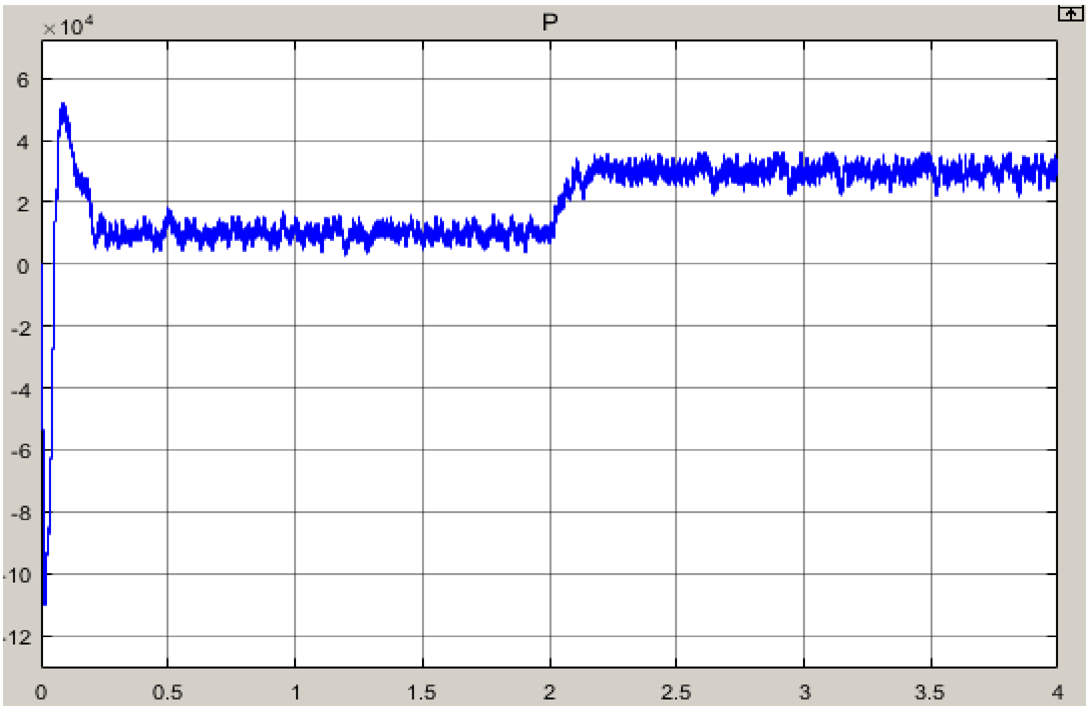

Fig.10.Outer-Loop Pm

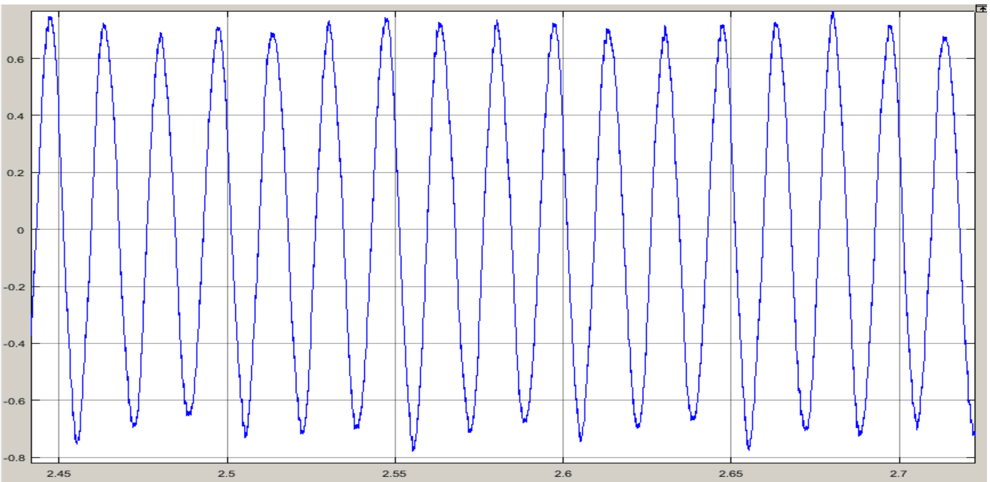

Fig.11. Outer-Loop abc output

The power follow the reference from 10 kW to 30 kW, as found in fig.10

5.4PQ Connected Operation Mode:

Two DC power sources are connected to an electric distribution system via VSCs separately. The Micro-Grid will be tested during Grid connected and island mode.

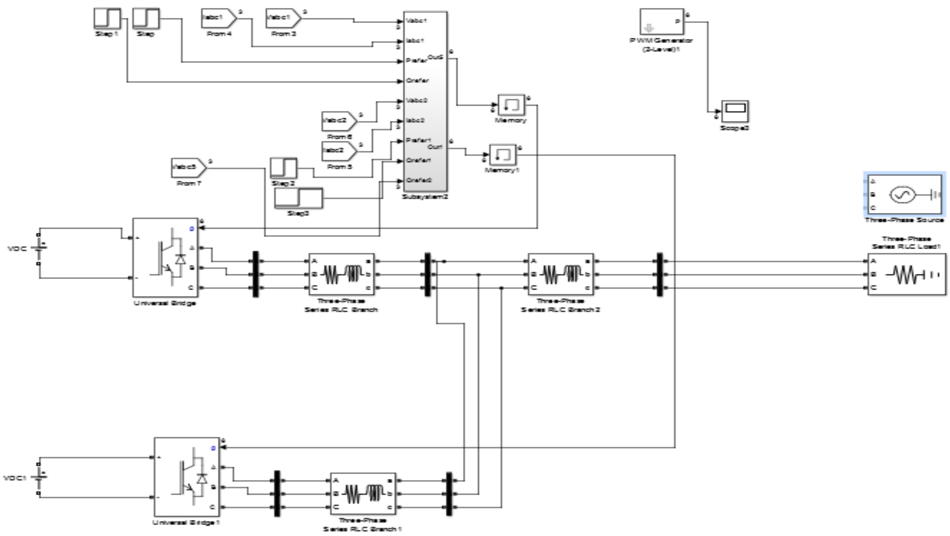

Fig.12.PQ Connected Control Mode

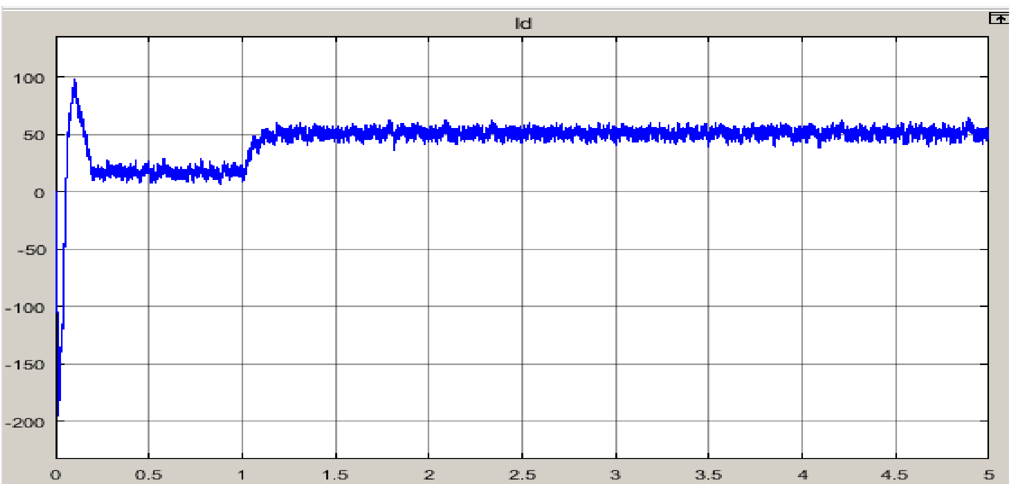

Fig.13.PQ Connected Control Mode Id

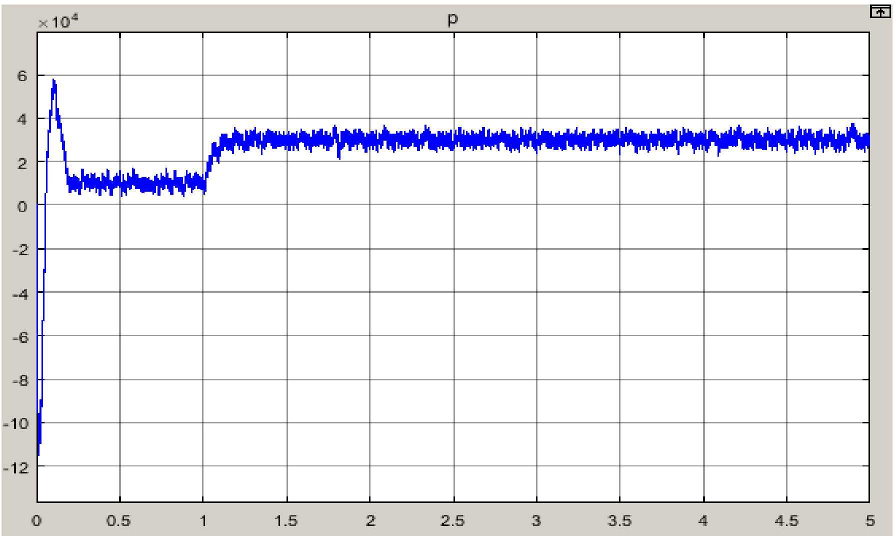

Fig.14.PQ Connected Control Mode Pm

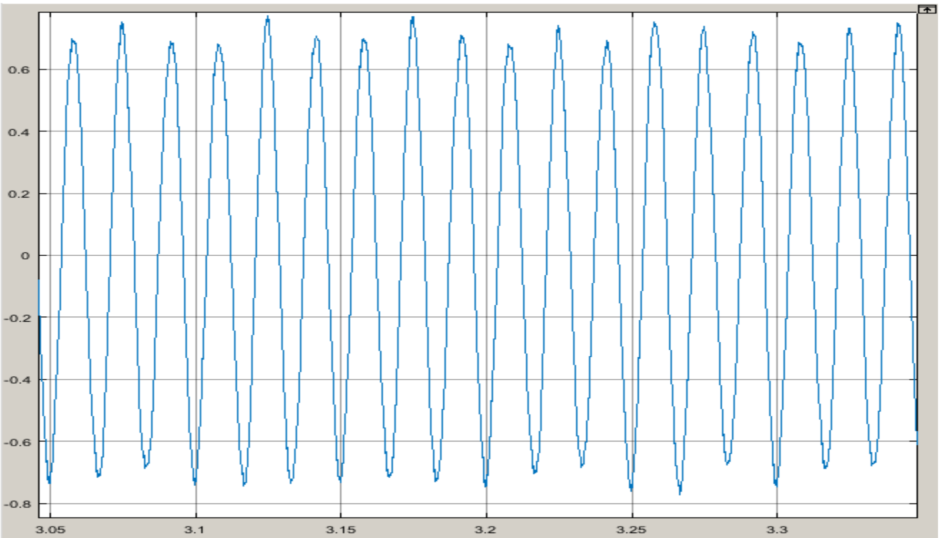

Fig.15.PQ Connected Control Mode abc output

5.5 PQ Islanding Mode with Droop-Loop:

The islanding mode is a condition in which a micro-grid or a portion of the power grid, which contains both load and distributed generation (DG), is isolated from the remainder of the utility system and continues to operate. Droop-loop control has been added to this mode to see the effect of increasing or decreasing the load on the system stability.

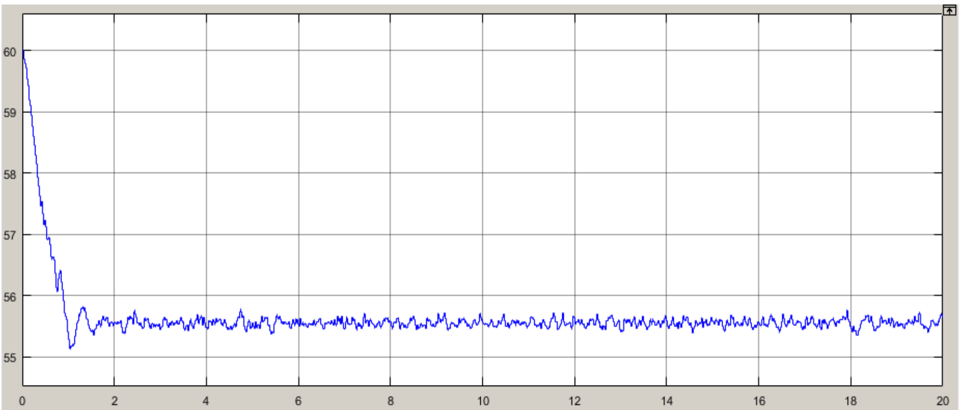

Fig.16. PQ Islanding Mode with Droop Control loop frequency

VI. CONCLUSION

In this paper we study the different power converter operating conditions in grid-connected and islanding modes by using MATLAB/Simulink, we see from our results that during connected operation mode the system keep stable with nominal frequency, and at islanding mode the system has the ability to keep running separately after disconnecting from the main grid. The results also show us how 40KW load can drop the frequency.

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