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An Anti-Islanding Protection Method Based on Reactive Power Injection and ROCOF

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ABSTRACT

All Distributed generation (DG) units should be equipped with an anti islanding protection (AIP) scheme to keep away from inadvertent islanding. Unfortunately, generally AIP methods fail to identify islanding if the demand in the islanded circuit matches with the generation in the island. Another concern is that numerous dynamic AIP scheme cause power quality issues. This paper proposes an AIP technique which depends on the combination of a reactive power versus frequency droop and rate of change of frequency (ROCOF). The strategy is designed so that the injection of reactive power is of minor scale during ordinary working conditions. However, the strategy can quickly detect islanding which is confirmed by PSCAD/EMTDC simulations.

I. INTRODUCTION

The quickly expanding amount of Distributed generation (DG) is raising concerns related to the working of distribution network protection. Particularly challenges related to the working of anti islanding protection(AIP) have been contemplated effectively in recent years . Inadvertent islanding is prohibited due to the related safety hazards and it is in this manner compulsory to outfit all DG units with an AIP protection scheme. Islanding should be identified and stopped inside 2 seconds according to many international standards such as the IEEE 1547 [1]. However, faster detection times are required if quick programmed reclosing is used on feeders that contain DG.

AIP protection methods can be divided into passive, active and communications based methods. Passive methods are based on locally measuring certain system quantities, for example, voltage magnitude, frequency or rate of change of frequency (ROCOF). The thought behind these methods is that a few changes in the measured quantities for the most part happen during the transition to islanding. The downside of these methods is that a large portion of these methods fail to detect islanding in case if the production in the islanded circuit nearly matches with the load in the islanded circuit. The problematic active and reactive power imbalance combinations which prompt non-detected islanding are refered to as the non-detective zone (NDZ). Dynamic AIP methods, which depend on floating voltage magnitude or frequency out of the predefined edges by deliberate injection of irritations, are generally characterized by a smaller NDZ in correlation with the passive methods. however, the better islanding detection performance of dynamic methods comes at the cost of debased power quality. Communications based methods are safe to the NDZ issue yet they have a tendency to be expensive.

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Active AIP techniques have recieved significant consideration due to their high performance in the recent years. Particularly frequency float based AIP methods have been featured [2], [3]. Reactive power variation (RPV) based AIP schemes are one of the effective methods for floating frequency during islanding. RPV based AIP methods are positive in the sense that they don't cause current contortion unlike many other active AIP schemes [4]. Controlling the reactive power output of the DG unit is likewise more sensible in contrast with control of the active power output of the DG unit due to financial reasons. That is, DG is wanted to feed all the accessible power provided by the utilized energy source, for example, photovoltaic cells or wind turbine. Reference [5] introduced a Q-f droop based AIP method which pursued to drift the frequency out of the used over-or underfrequency (OUF) thresholds. However, islanding detection can be genuinely slow utilizing this method if the used OUF limits determine a relatively wide normal operation frequency range, such as, many European matrix codes [6]. Reference [7] introduced an discontinuous bilateral RPV method in which there is also a zero period in the RPV pulse notwithstanding the maximum and minimum values ±5% of the active power output. Reference [8] enhanced this bilateral RPV method by [7] by only injecting irregular unilateral RPV pulses. The method appeared to be fit for Chinese OUF thresholds 49.5 Hz and 50.5Hz. However , this method would cause very large disturbances during ordinary working conditions if the method was tuned for a system with more extensive OUF thresholds, for example, Continental Europe where the used OUF thresholds are 47.5 Hz and 51.5 Hz [6]. Reference [9] exhibited an AIP method which is in view of continually injecting a RPV pulse comprising of three parts of equivalent span. The two first parts of the RPV pulse form a symmetric triangular shape, though, the reactive power reference is kept at zero in third part. During islanding, the absolute value of ROCOF will be consistent during the first two parts of the RPV pulse. This can be utilized as a paradigm to detect islanding. However, distinctive approach must be utilized as a part of multi-inverter case unless the RPV pulses happen to be synchronous. In such a case, the occasionally changing frequency is utilized as a paradigm to detect islanding. This approach is innovative as in the sense frequency is not floated outside the used OUF thresholds which encourages the progress to intentional microgrid. However, the method still causes an always injected disturbance which might be hurmful during ordinary grid connected state particularly if large amount of DG units are furnished with this AIP scheme.

This paper shows a active AIP method for inverter associated DG units which depends on compelling the frequency to float at such a rate during islanding, to the point that the used ROCOF threshold is surpassed. This is accomplished by utilizing a devoted reactive power versus frequency droop (Q-f droop). The utilization of the ROCOF work enhances the execution of the AIP method as far as islanding detection time in comparison with the current RPV based AIP methods.

The proposed method is particularly favorable in comparison with existing RPV based AIP methods if the used DG interconnection standard characterizes generally wide OUF thresholds. In addition, the islanding can be distinguished by smaller injection of reactive power in correlation with most existing RPV based AIP schemes. Furthermore, the performance of the proposed method does not degrade when multiple inverter based DG units are furnished with a similar method.

This paper is composed as follows. Part II presents the essential standards behind the proposed method. After this, the simulation model which is utilized for checking the working of the proposed method is exhibited in part

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III, though, the actual simulation results about are exhibited in chapter IV.At long last, conclusions are drawn in chapter V.

II. REACTIVE POWER VARIATION BASED AIP

A. THE Q-F LOAD CURVE –

Most AIP methods depend on detecting the changes in system quantities, for example, voltage and frequency. These changes, which ordinarily happen while islanding happens, are essentially caused by the imbalance between the production and utilization of real and reactive power in the island. The relations amongst dynamic and reactive power with voltage and frequency can be comprehended by looking at a situation where an Inverter is encouraging a parallel load associated with the circuit as appeared in Fig. 1.

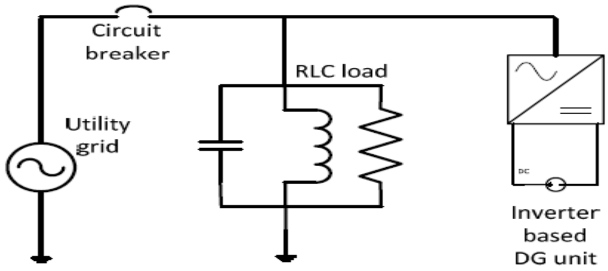

Fig. 1. A simple circuit for islanding detection analysis

B. The proposed AIP method-

The thought behind the Q-f droop based AIP method is to prepare the secured DG unit with a Qref-f droop curve, which is more extreme than the heap bends and that has a negative incline [5]. This guideline is represented in Fig. 2

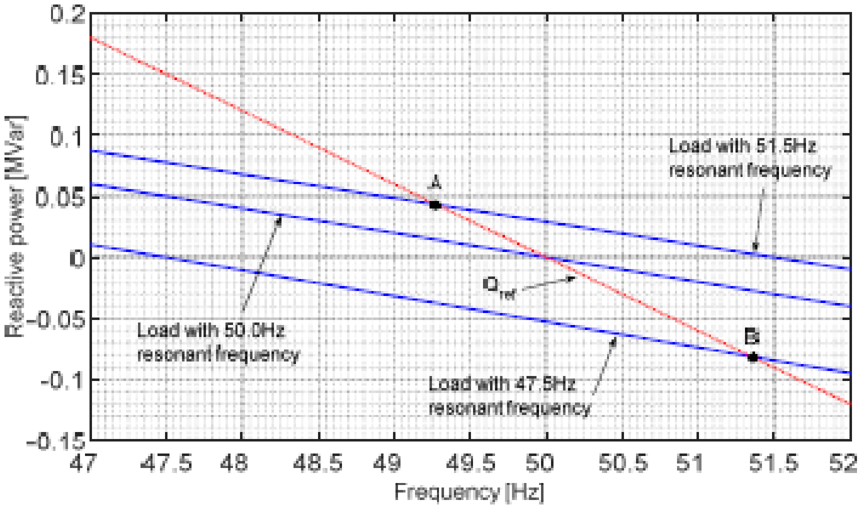

Fig. 2. The principle of Q-f droop based AIP

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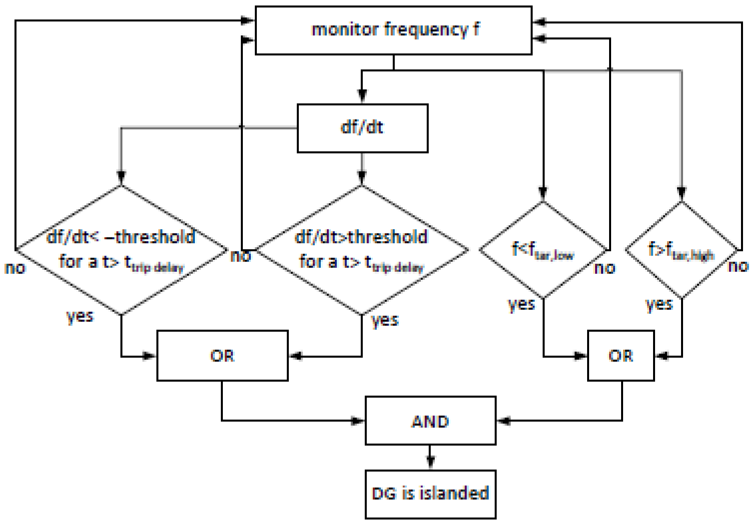

Fig. 3. The islanding detection process in the proposed AIP scheme

III. SIMULATION MODEL

The DG unit utilized as a part of these simulation studies was a 10KVA evaluated full power converter associated wind turbine which depends on the model exhibited in [12]. This DG unit was associated with the 20 kV segment of the circuit by means of a step up transformer whose proportion was 0.69 kV/20 kV as appeared in Fig. 4. The reason for these simulation studies about is to break down the working of the proposed anti-islanding protection. The demonstrating of the mechanical parts of the breeze turbine was consequently not considered in light of the fact that the mechanical time constants are significantly bigger than time constants identified with the proposed against islanding security. The mechanical parts, the generator and generator side converter were in this manner demonstrated as a current source iWT in the DC-connection of the frequency converter whose esteem can be acquired as follows:

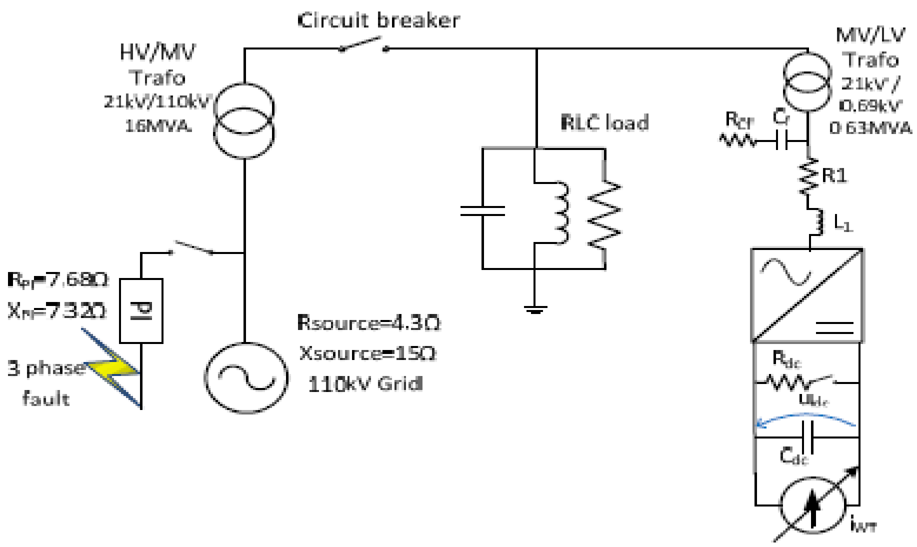

Fig. 4. The simulation model

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IV.CONTROL SYSTEM OF THE CIRCUIT

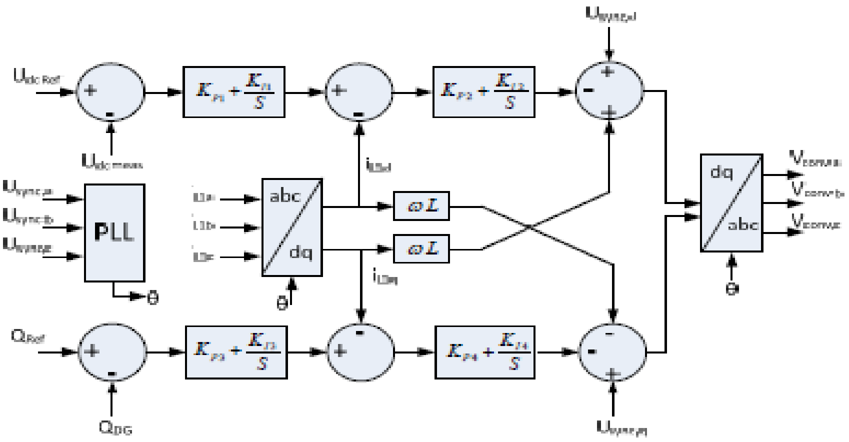

Fig. 5. The control system of the inverter

The control system is appeared in Fig. 5. The vector control the system side converter was built up in a reference frame synchronized to the association point voltage of the DG unit by utilizing a PLL component from the PSCAD master library. The output of the dc-Link voltage controller is the d-component of the inverter converter current. The aim of the dc-Link voltage controller is to keep up constant dc-Link voltage and consequently ensure that the produced active power is fed into the network. The reference value for the reactive power is given according to (8) which, in any case, is rate restricted as communicated in (11). The q-component of the current was constrained to 194.5A which corresponds to 0.95 power factor at appraised control, though, the d-component of the current was restricted to 900 A. The parameters of the used simulation model as given above

V. SIMULATION RESULTS

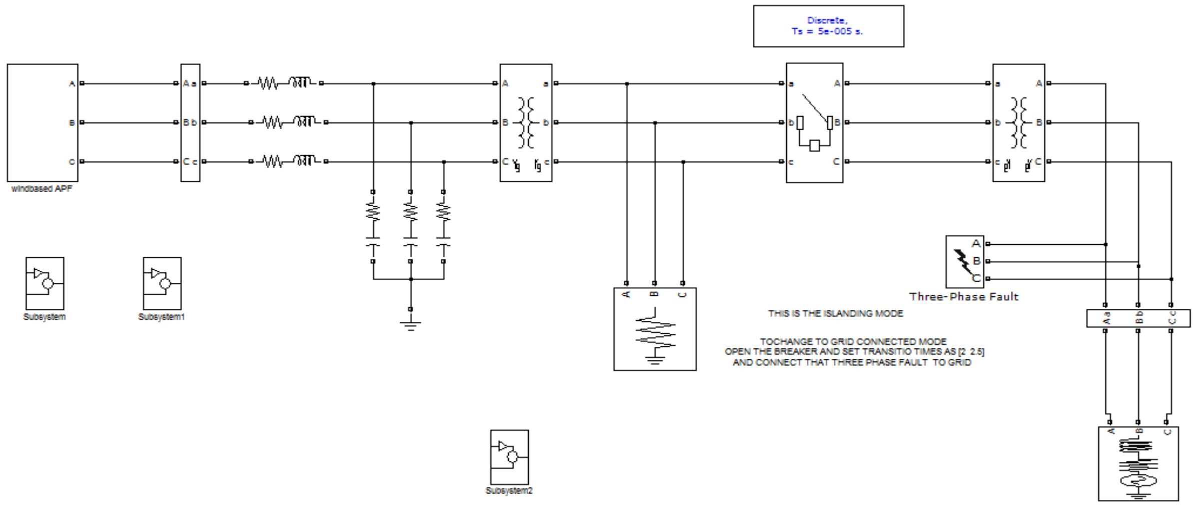

Fig 6.simulation circuit

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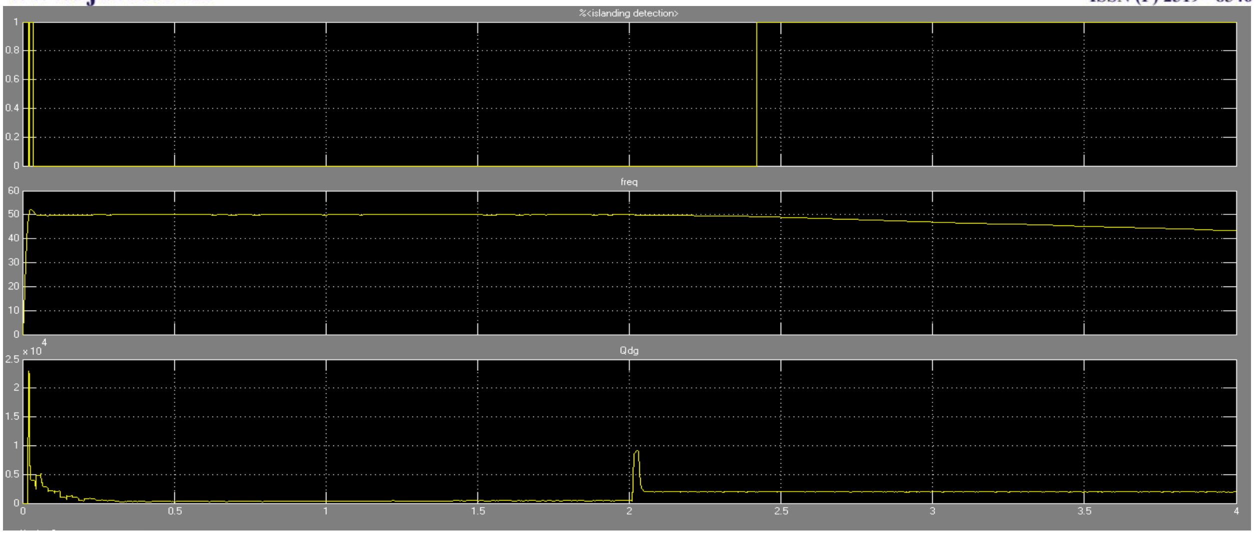

Fig.7 Islanding detection , frequency , reactive power of DG

Grid connected mode with three phase fault in the time interval of 2 to 2.5s

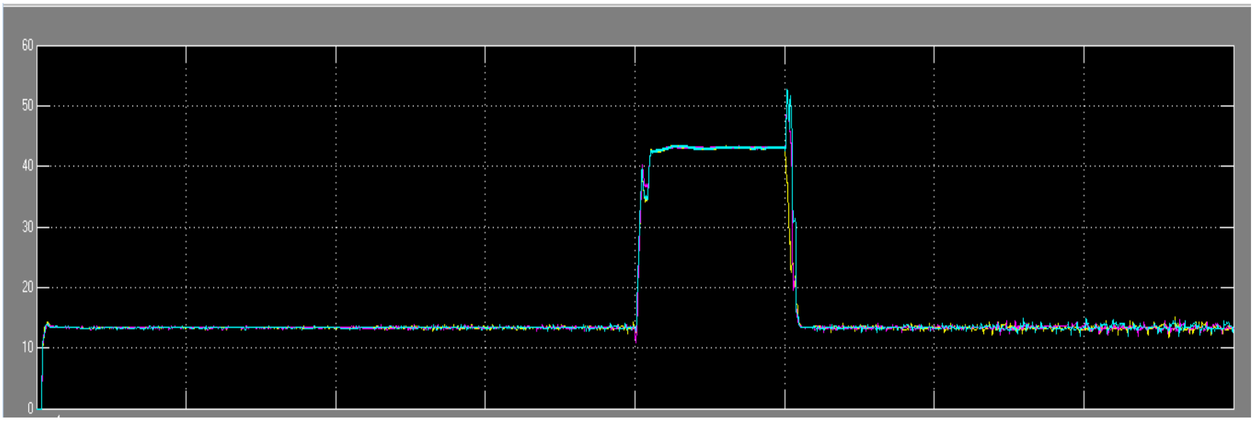

Fig.7 RMS Voltage of Wind

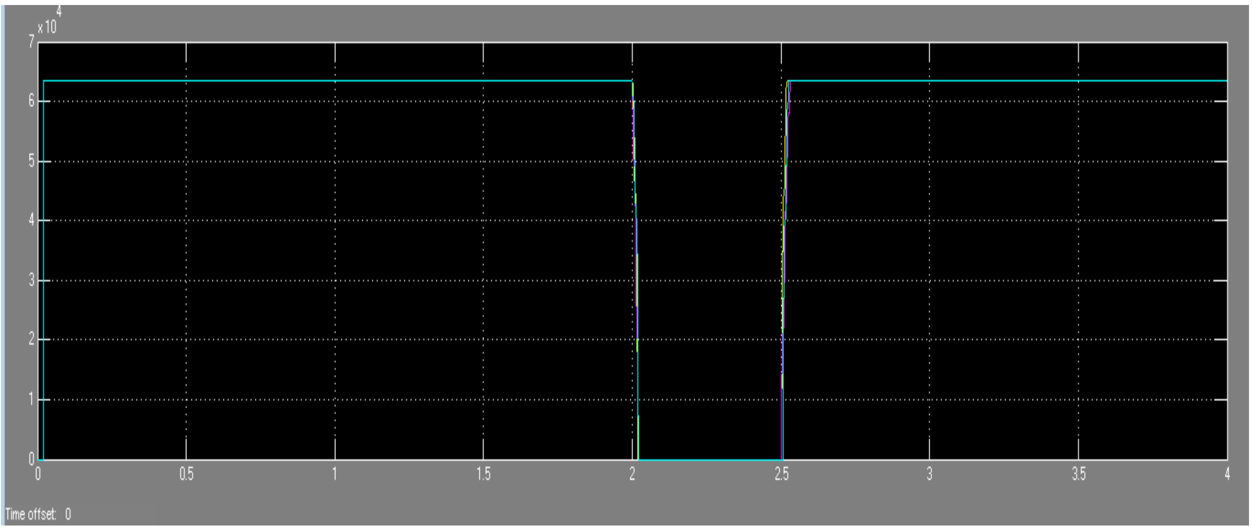

Fig.8 RMS Voltage of Grid

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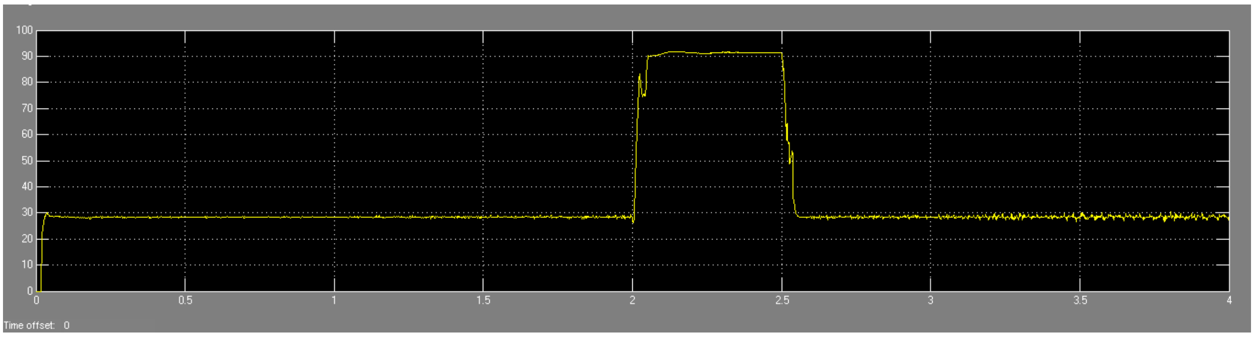

Fig.9 DC Voltage

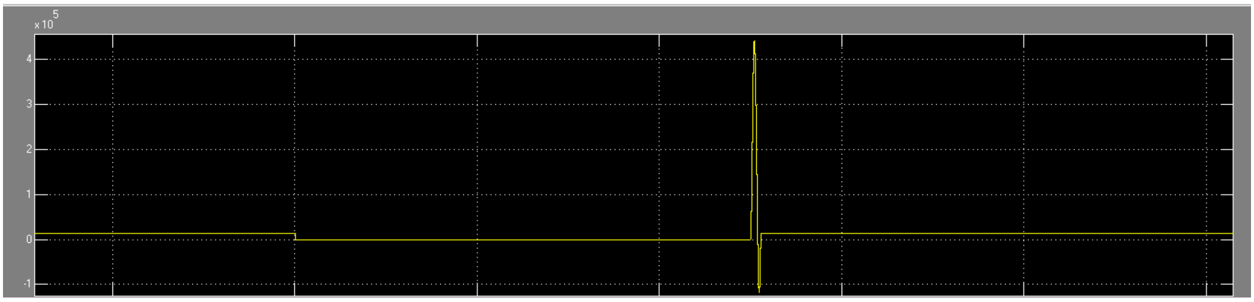

Fig.10 Active power of DG

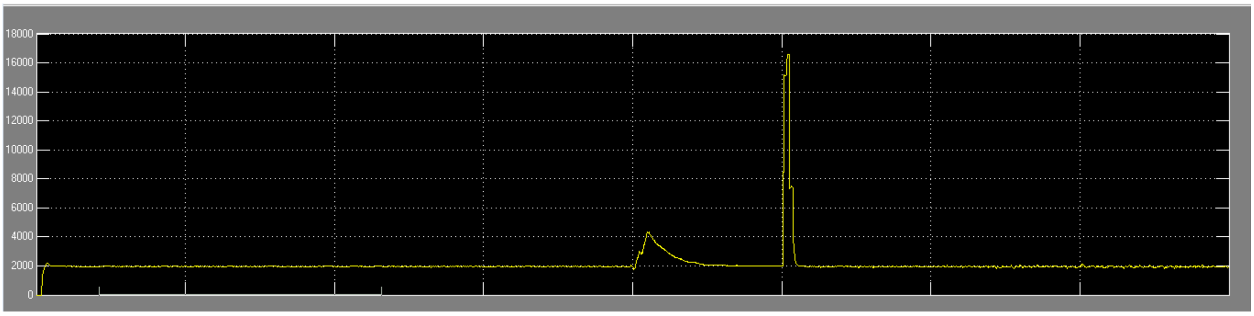

Fig.11 Reactive power of DG

VI. CONCLUSION

This project proposes an AIP strategy in view of the combination of reactive power versus frequency droop,rate of change of frequency(ROCOF) work and frequency checking. The proposed technique gives secure and fast islanding detection while minorly affecting thegrid during normal working conditions. The strategy is particularly advantageous if the used frequency protection thresholds indicate a large normal operating frequencyvariation range for distribution generation units (DG) units. Another advantage of this strategy is that no continuous pulse is being injected when frequency is at its nominal value. The reality that no continuous pulse is being injected makes the strategy naturally reasonable for multi inverter operationlimitation of the reactive power reference that is utilized in the proposed strategy, the reactive power injection reduced in comparison to traditional reactive power versus frequency (Q-f) droop based AIP.

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