Single stage String Inverter for a GCPV system with Integrated P&O-Fuzzy Logic Control MPPT Technique

1.0 ABSTRACT

This project presents a development of artificial intelligence based Integrated Perturb and Observe (P&O) - Fuzzy Logic Control (FLC) Maximum Power Point Tracking (MPPT) technique for Single-phase Single stage Photovoltaic (PV) Inverter. The proposed system is applied in Grid Connected Photovoltaic (PV) system. Previous works on Single stage PV inverter comes with various types of circuit configuration and switching techniques incorporating with MPPT, however each topology has their advantages and disadvantages and also has their own circuit limitation. Therefore the proposed single stage PV converter is a bridge inverter that reduced number of power switching, harmonics, yielding higher reliability and overall power conversion efficiency. The inverter is tested on 340W system using two series of STP170s-24/Ac PV modules. The MPPT unit keeps tracking the maximum power from the PV array by changing the modulation index and the phase angle of inverter's output voltage. The inverter switching frequency is 25 kHz and IGBT is used as a power switch. The MPPT and Pulse Width Modulation (PWM) control algorithm are implemented simultaneously on one power circuit. The simulation model is developed using MATLAB/SIMULINK. The simulation and experimental results were evaluated under steady state and dynamic operation.

2.0 INTRODUCTION

The conventional multi-stage PV inverter have achieved higher efficiency but the usage of many count of electronics components, increased complexities, affect the reliability and difficult for miniaturized future technology. The circuitry of present string inverter is very complicated and required sophisticated controller. Typically, the first stage operates as boost or buck-boost type DC to DC converter and second stage inverts DC power into AC power (Figure 1). It is beneficial to studies on single stage string inverter (Figure 2) for grid connected photovoltaic system with Fuzzy Logic Control (FLC) based MPPT as solution to the conventional two stage configuration and MPPT. This method work well on imprecise input, does not require complex and accurate mathematical model and capable to handling non-linearity. The system is simple and practical than conventional non-linear controller.

3.0 OBJECTIVE

1. To develop simple circuit topology of single stage string inverter for GCPV system that reduced number of power switching, yielding higher reliability and overall power conversion efficiency.
2. To design the new control scheme of MPPT and Pulse Width Modulation (PWM) control technique simultaneously on one power circuit (Single-stage) using Digital Signal Processor (DSP).
3. To implement new artificial intelligent controlling based Maximum Power Point Tracker (MPPT) combining advantages of Perturb and Observe (P&O) and Fuzzy Logic Control (FLC).
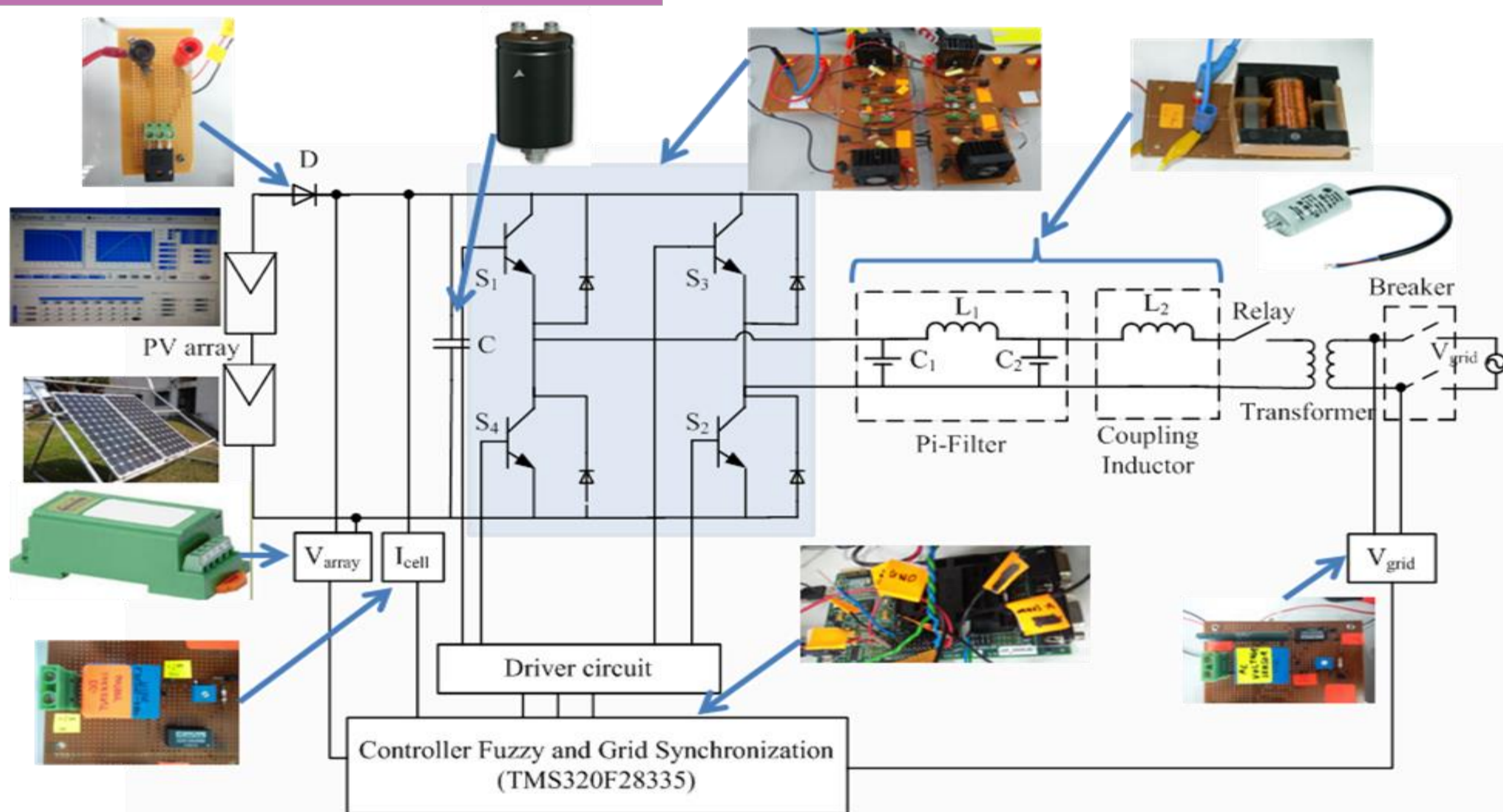
4.0 METHODOLOGY

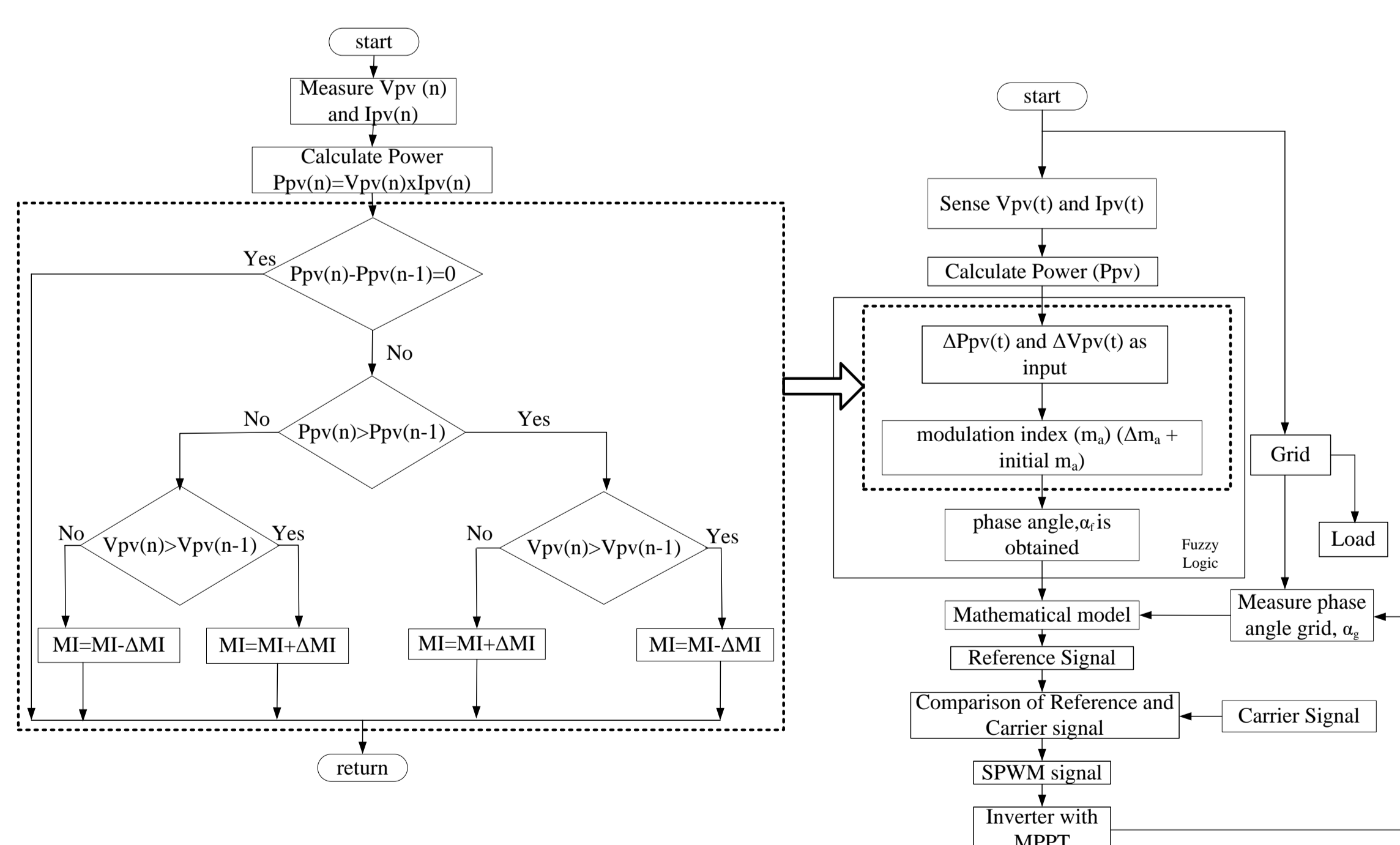Figure 3 : Overall PV system configuration

Figure 4 : Comparison flowchart of conventional P&O and modified P&O FLC based MPPT technique
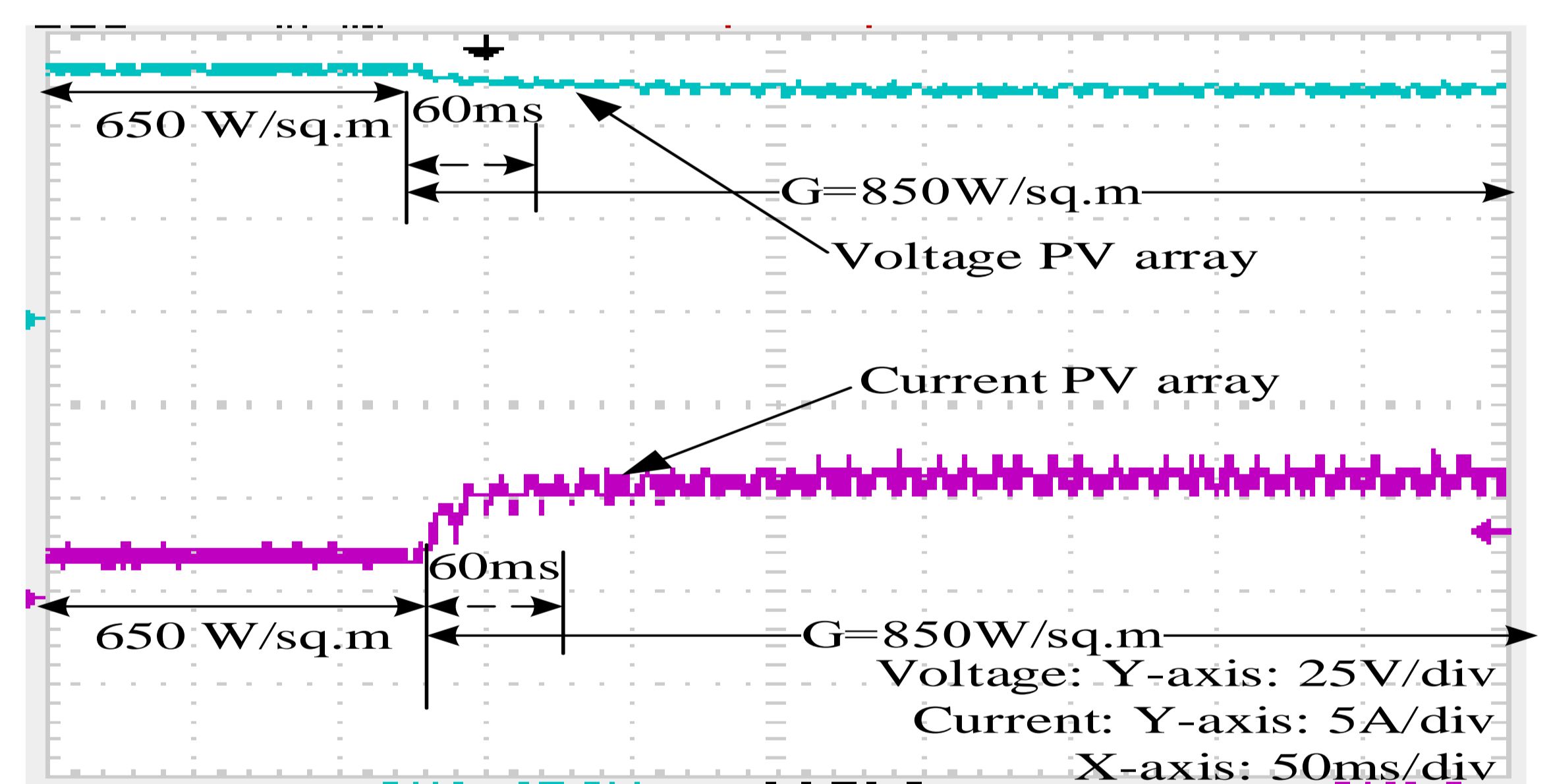
5.0 RESULTS

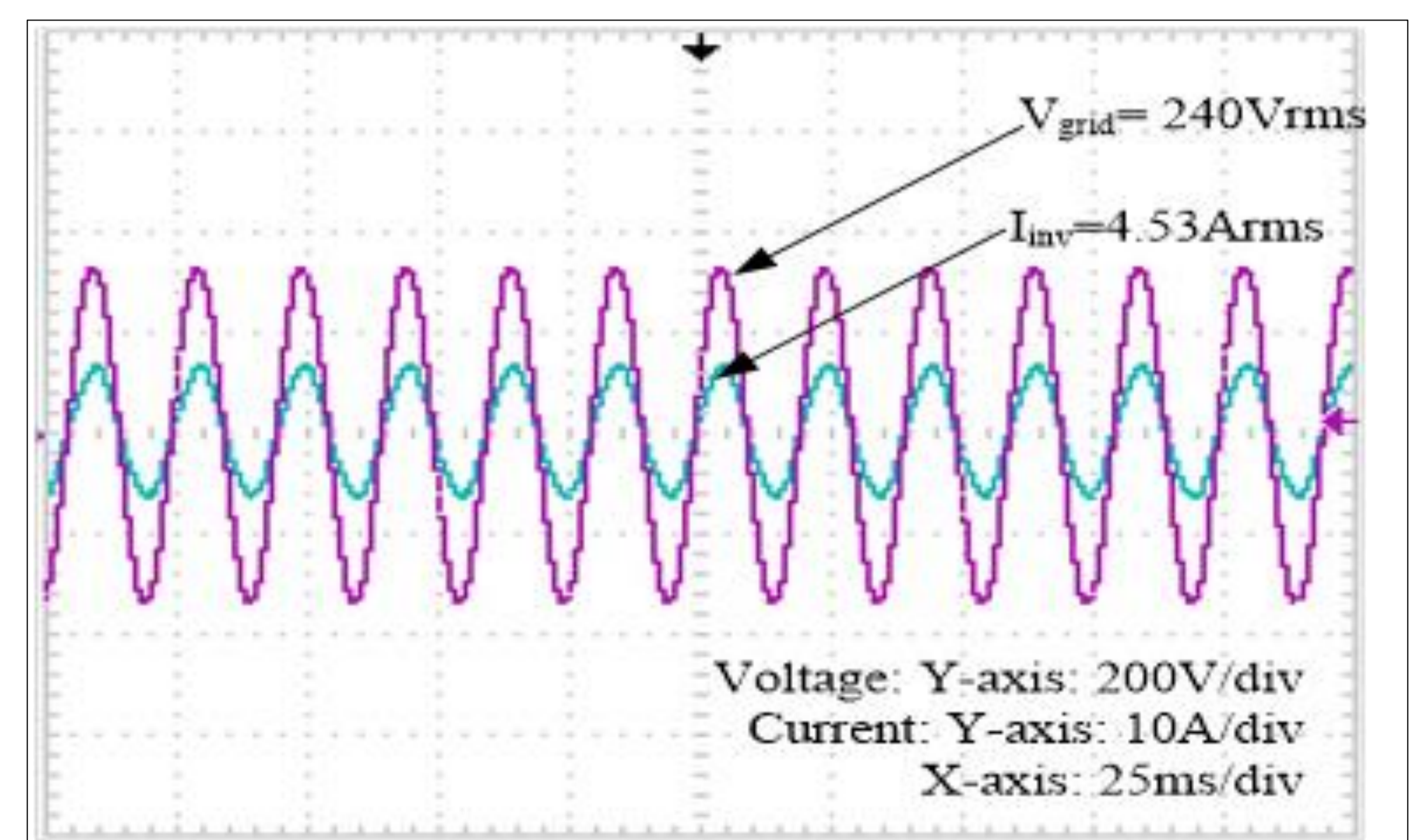Figure 5: Experimental results of MPPT response when solar irradiance varies from 650 W/m^2 to 850 W/m^2

Figure 6: Experimental Results of Grid Voltage, V_{grid} and Inverter's Output Current, I_{inv} at Solar Irradiance of 1200W/m^2

6.0 CONCLUSION

The principles of single stage string inverter have been demonstrated and the switching function has been implemented in artificial intelligent based Integrated P&O FLC. Experience in designing the FLC in string inverter for implementation on grid connected PV system is outlined. It has been shown that Integrated P&O- FLC could work effectively to be used in single stage string inverter.