Section A -Research paper
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Power Amplification of Inverter by Vector Modulation Control in Super Capacitor Grid Integrated PV Simulink Module

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Abstract- **In this paper introduced the grid integrated PV Simulink module using converter instead of transformer to transform the DC voltage into a high-quality AC voltage. This sort of system module referred as transformer less PV Simulink system module. The proposed Simulink system module based on filtration mechanism to mitigate the harmonics presented in the system module during the transmission of power towards grid. In this paper, proposed two mechanism of filtration, first one is module using LCL resonant filter and second one is digital filter. The presented Simulink module has been consisted several module blocks like MPPT, CSI, VDC, current and voltage regulator, controller for inverter. In this module system, MPPT getting the voltage from PV panel module for boosting it and transferred to CSI and then output of this further driven by SPWM which further filtered by the digital filter and LCL filter and then computed the total harmonics distortion which is 0.19% for digital filter-based PV inverter Simulink module system and much better than the LCL filter.**

Keywords: Digital Filter, LCL, MPPT, PV, CSI, SPWM, SVPWM, H-Bridge.

NOMENCLATURE

PV	Photo Voltaic
PWM	Pulse Width Modulation
SPWM	Sinusoidal Pulse Width Modulation
SVPWM	Space Vector Pulse Width Modulation
MPPT	Maximum Power Point Tracking
CSI	Current Source Inverter
VSI	Voltage Source Inverter
AC	Alternating Current
DC	Direct Current
V_{DC}	Voltage at DC Capacitor
LCL	Inductor-Capacitor-Inductor

1. INTRODUCTION

Rapid development will increase the demand of electrical power, resultant a huge stress has constructed on natural assets which causes pollution and not environment pleasant. So, for the conservation of natural assets we have suggest to applied an environment pleasant and truthful techniques which includes Renewable Energy Systems (RESS) [1] [2]. In today's scenario, the maximum efficient method for generation of electrical power is power plants primarily based on coal operation which generates approx. 33% of emission of CO2 [3]. The current improvement in the area of semiconductor material offers us a desire to lessen the pollutant emission way of means of the usage of those semiconductor substances with superior PV technology. These structures of PV technology are much less pricey than the traditional power plants primarily based on coal operations [4] [5] [6] [7].

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The rapid enhancement in the semiconductor material manufacturing technology such as monocrystalline silicon materials reduces the manufacturing cost of the PV system module. However, the optimization of concerning issues in grid connected solar power system are the major technical challenge [8] [9] [10].

The proposed Simulink module block has been constructed by the many module block. The below depicted figure 1 shown these sorts of module block for proposed mechanism that is based on LCL and digital filter control methodology. As above depicted figure 1 shows that the different function blocks for proposed Simulink module using LCL, digital filter and inverter control mechanism to deduce the unwanted ripple i.e. harmonics and provide high quality AC voltage towards several appliances such as low voltage distribution grid, medium voltage distribution grid and high voltage distribution grid appliances, which have commonly used in domestic and commercial sectors.

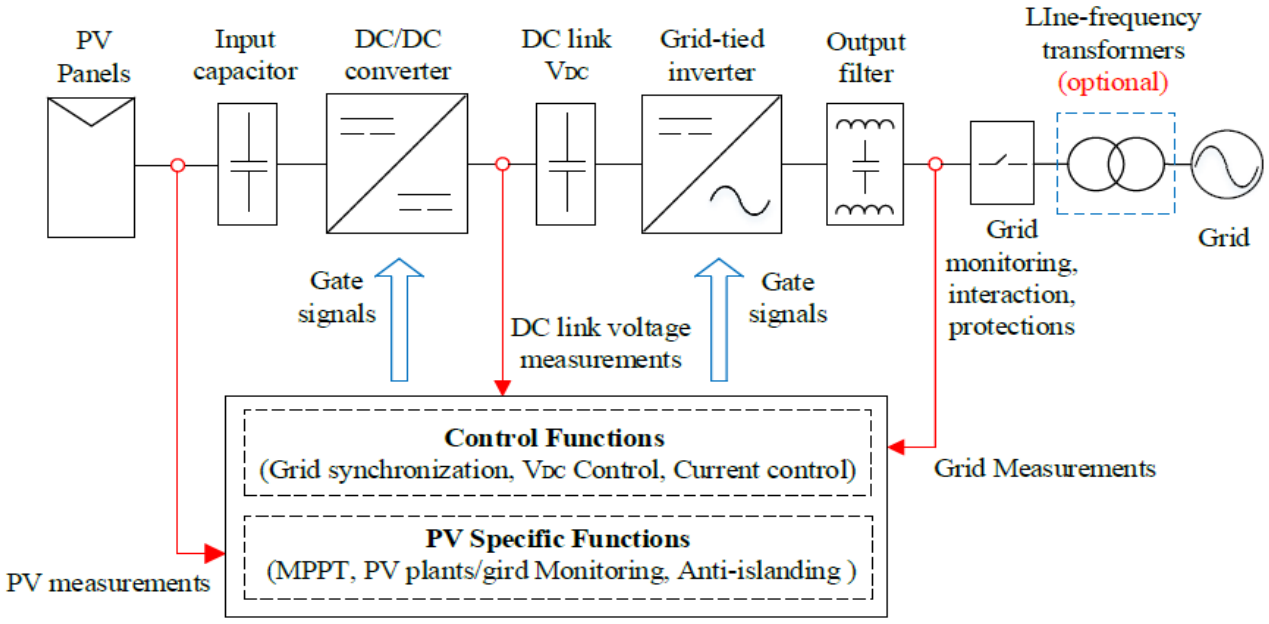

Figure 1: Overview of Grid Connected PV System Module

The organization of this paper as following: An overview of SPWM and SVPWM present in the section II, the modelling of Simulink using LCL and digital filter discusses in the section III, in the section IV discusses the simulation results for the proposed Simulink module based on LCL resonant filter, the simulation results for the proposed Simulink module based on digital filter discusses in the section V. Finally, the conclusion and some perspectives discuss in the section VI.

2. OVERVIEW OF SPWM AND SVPWM PRINCIPLE

There is majorly focused terminology about the grid integrated solar power system such as PV Simulink block module for domestic and industrial use are optimization of PV Simulink block module and their inverter control mechanism. This grid integrated PV module system can be categorized as voltage and current type module circuit [11]. The control based on current and control based on voltage are the mechanism which controlled the current type inverter circuitry. The mechanism commonly used for pulse width modulation is pulse width modulation [PWM] mechanism which incorporated SPWM and SVPWM and also help in mitigating the harmonics present in the grid [12] [13].

SPWM Principle: SPWM is a mechanism of modulation which modulated the width of the pulse and primarily based on the principle of pulse width modulation. SPWM primarily based on principle of PWM that change or modify the pattern of the pulse width as per modulated width of the pulse [14]. In this modulation technique namely sinusoidal pulse width modulation mechanism, the law of sine would arrange the duty ratio of time for width of the pulse and also the output wave of module has a sine wave which had got after filtration [15]. SPWM commonly used in PV Simulink block module as a modulation mechanism because of rapid development in the field of controlled power electronics devices and advanced high-speed microprocessors [16].

SVPWM Principle: The mechanism of pulse width modulation such as SVPWM very much inspired by the analysis of flux linkage. The main aim of flux linkage analysis is to control the trajectory of chain magnet space vector of the motor to the

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approximately circle of the base and also mitigate the torque ripple present in the motor and finally get a better performance [14]. Similarly, when SVPWM applied to the PV inverter module its controlled effectively and mitigates the content of harmonics present in the output current and protect the system module [15].

3. GRID INTEGRATED PV SIMULINK MODULE BASED ON DIFFERENT FILTRATION MECHANISM

The grid integrated transformer-less PV Simulink module has been proposed in this section. For solving the problem of harmonics at the load grid side of the proposed module system, the filtration mechanism has been proposed. In this Simulink module two sorts of filter mechanism have used, first one based on passive element i.e. LCL filter referred as dual tuned resonant filter depicted below in the figure 2 and second one based on digital filter using diode behave as clipper circuit depicted below in the figure 3.

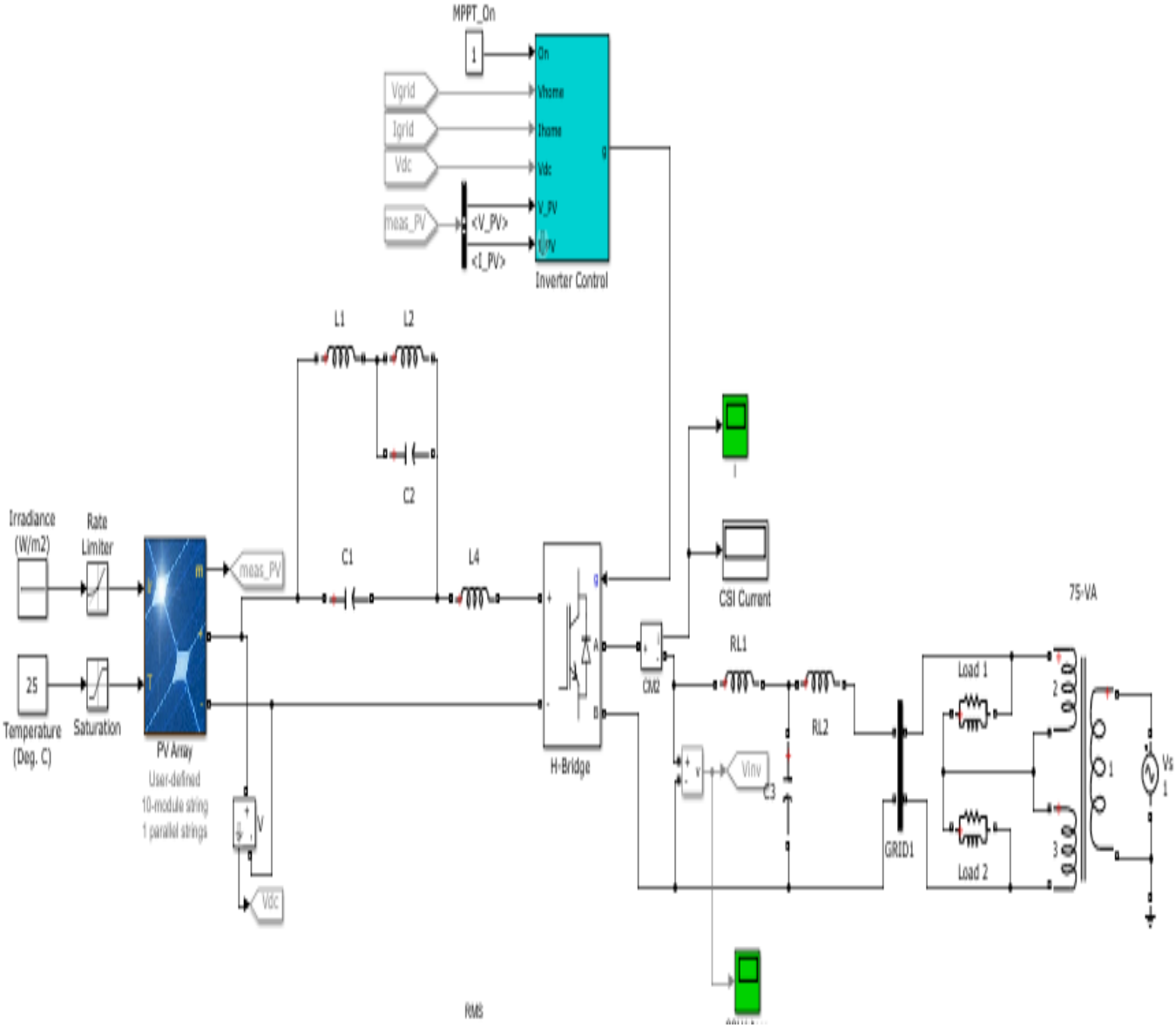

Figure 2: Grid Integrated PV Simulink Module Based on LCL Dual Tuned Resonant Filter

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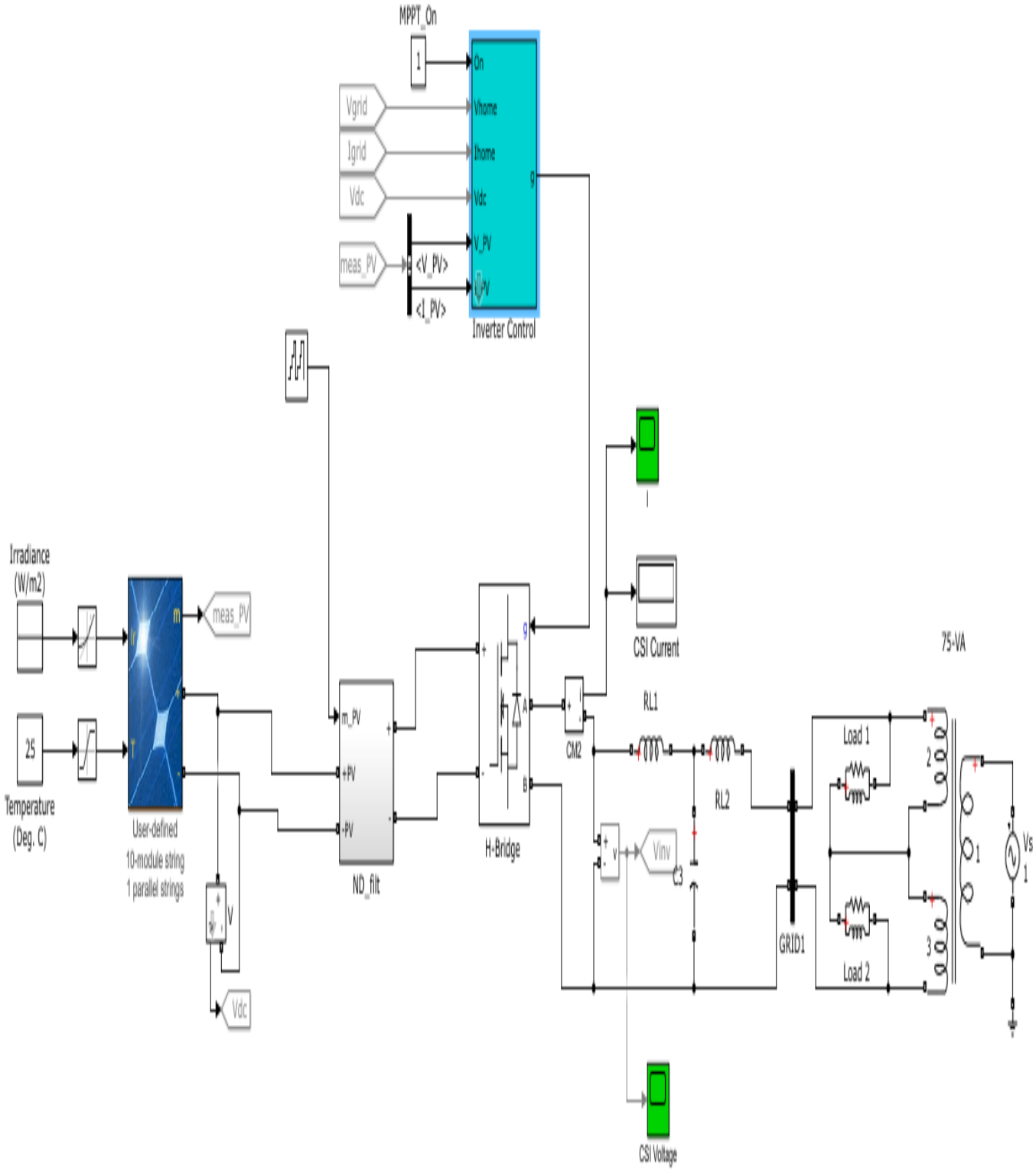

Figure 3: Grid Integrated PV Simulink Module Based on Digital Filter

As above depicted figure 2 shows that the grid integrated PV Simulink module based on LCL dual tuned resonant filter that contains several module parts such as PV module, inverter control, dual tuned resonant LCL filter with H-Bridge. Similarly,

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the control of inverter module system block consists of several part module blocks such as MPPT based on perturb and observe mechanism, regulator for V_{DC}, regulator for current, PLL and most important space vector pulse width modulation generator.

As above depicted figure 3 shows that the grid integrated PV Simulink module based on digital filter that contains several module parts such as PV module, inverter control, digital filter with H-Bridge. Similarly, the control of inverter module system block consists of several part module blocks such as MPPT based on perturb and observe mechanism, regulator for V_{DC}, regulator for current, PLL and most important space vector pulse width modulation generator.

4. SIMULATION RESULTS FOR GRID INTEGRATED PV SIMULINK MODULE BASED ON DIFFERENT FILTRATION MECHANISM

For the calculation of results required the input parameters. In the table 1 shows the input parameters for proposed system-based model.

Table 1: input parameters for proposed system-based model.

S. No.	Name of Input Parameter	Rating Value
01	Voltage of PV at Open Circuit	80 Volt
02	Current of PV at Short Circuit	8 Ampere
03	Rated Power of PV Array Module	500 Watt
04	Value of L_{DC} (Filter Applied)	5 milli-Henry
05	Value of L_{DC} (No Filter Applied)	300 milli-Henry
06	Frequency for Carrier Signal	3500 Hz
07	Value of L_1 (Inductor at DC Side)	5 milli-Henry
08	Value of L_2 (Inductor at DC Side)	10 milli-Henry
09	Value of C_1 (Capacitor at DC Side)	125 µ-Farad
10	Value of C_2 (Capacitor at DC Side)	250 µ-Farad
11	Value of L_1 (Inductor at AC Side)	50 milli-Henry
12	Value of L_2 (Inductor at AC Side)	50 milli-Henry
13	Value of C_3 (Capacitor at AC Side)	250 µ-Farad

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A. SIMULATION RESULTS FOR GRID INTEGRATED PV SIMULINK MODULE BASED ON DUAL TUNED RESONANT LCL FILTER WITH H-BRIDGE

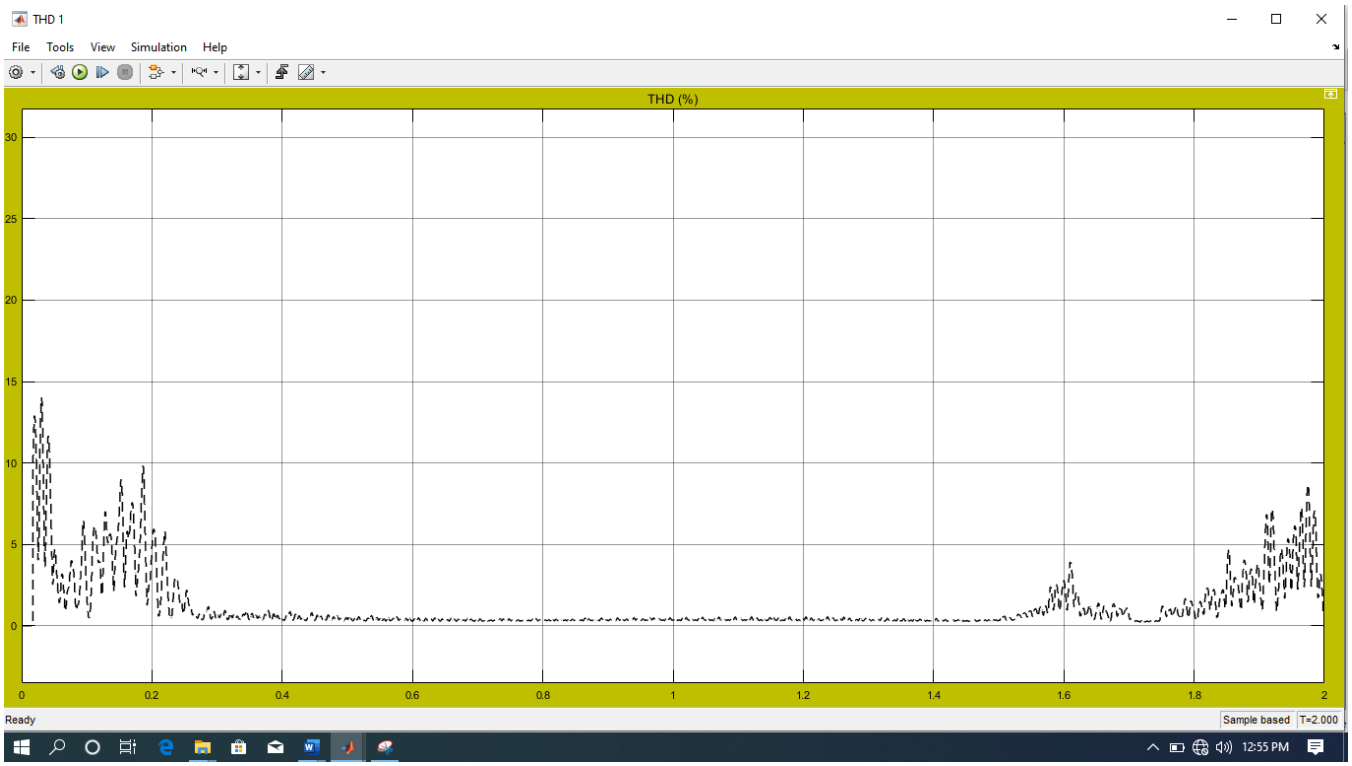

Figure 4: Graphical THD Outcome for Proposed Dual Tuned Resonant LCL Filter based Simulink Module System

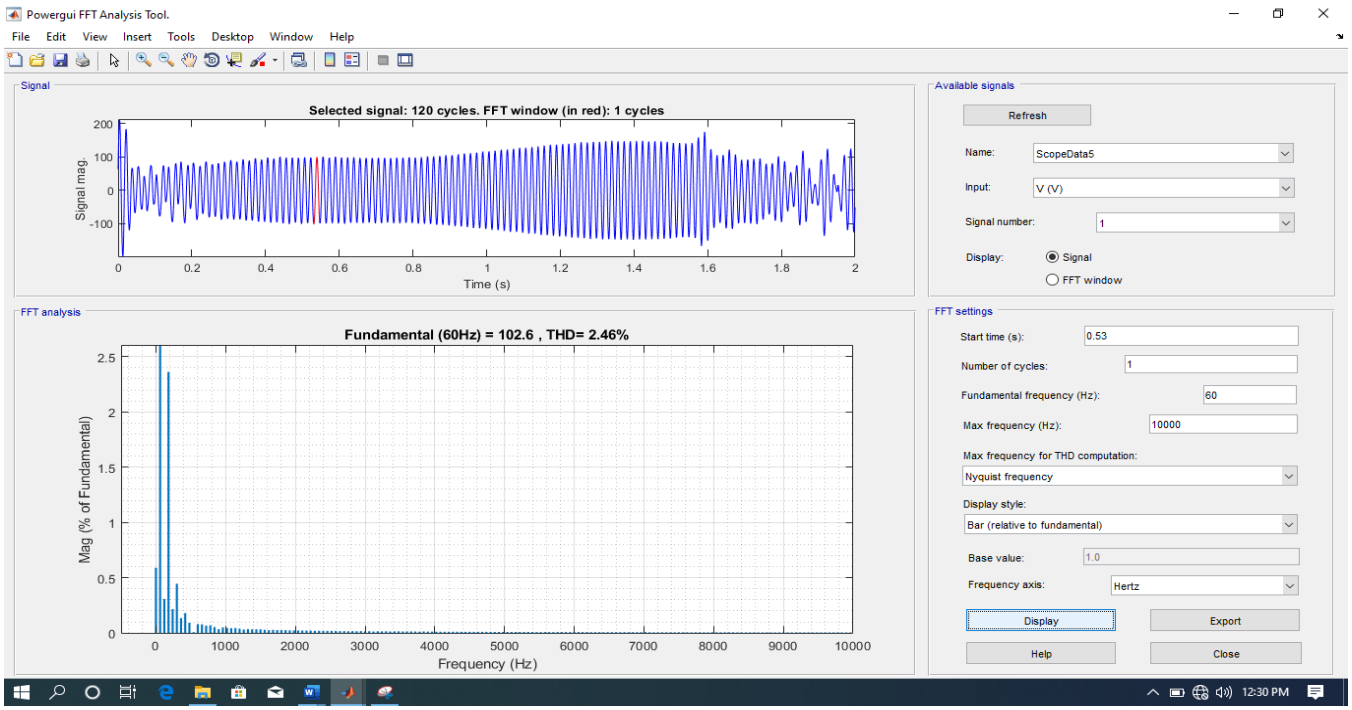

Figure 5: THD FFT Analysis of Selected Signal for Proposed Dual Tuned Resonant LCL Filter based Simulink Module System

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B. SIMULATION RESULTS FOR GRID INTEGRATED PV SIMULINK MODULE BASED ON DIGITAL FILTER WITH H-BRIDGE

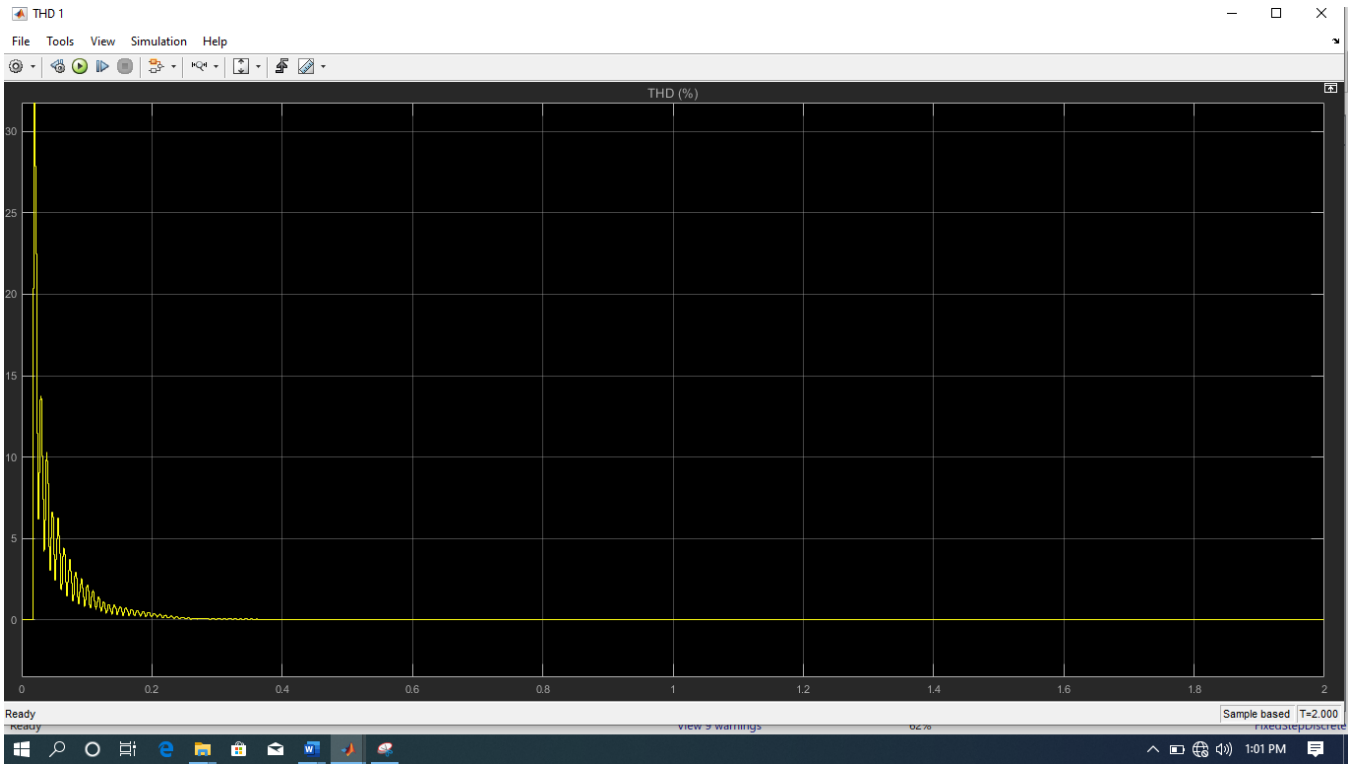

Figure 6: Graphical THD Outcome for Proposed Digital Filter based Simulink Module System

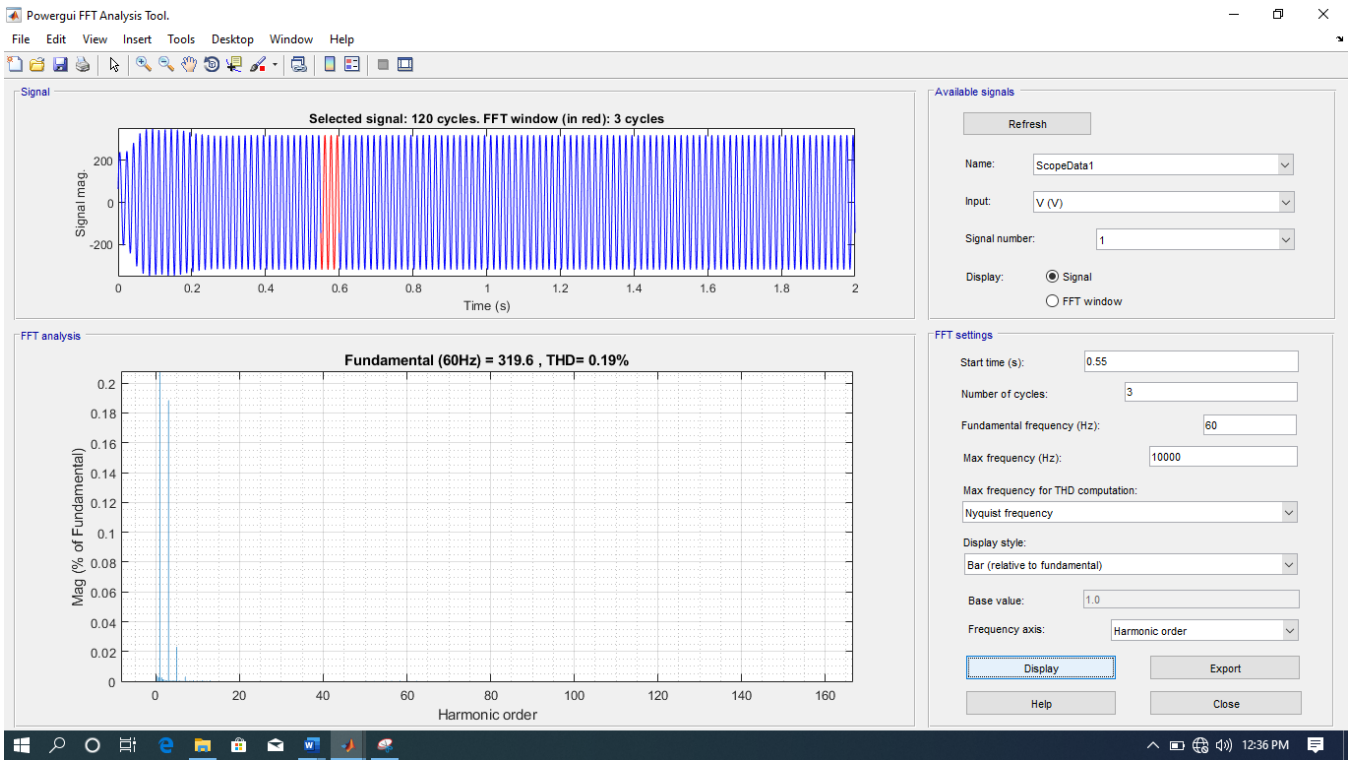

Figure 7: THD FFT Analysis of Selected Signal for Proposed Digital Filter based Simulink Module System

As above depicted figure 4 and figure 5 shows that the graphical THD outcome for proposed dual tuned resonant LCL filter based Simulink module system and THD FFT analysis of selected signal for proposed dual tuned resonant LCL filter based Simulink module system respectively. As above depicted figure 6 and figure 7 shows that the graphical THD outcome for proposed digital filter-based Simulink module system and THD FFT analysis of selected signal for proposed digital filter-based Simulink module system respectively.

5. CONCLUSION

The proposed Simulink system module based on filtration mechanism to mitigate the harmonics presented in the system module during the transmission of power towards grid. In this paper, proposed two mechanism of filtration, first one is module using LCL dual tuned resonant filter with H-Bridge and second one is digital filter with H-Bridge. The presented Simulink module has been consisted several module blocks like MPPT, CSI, VDC, current and voltage regulator, controller for inverter. In this module system, MPPT getting the voltage from PV panel module for boosting it and transferred to CSI and then output of this further driven by SPWM which further filtered by the digital filter with H-Bridge and LCL dual tuned resonant filter with H-Bridge and then computed the total harmonics distortion which was 0.19% for digital filter with H-Bridge based PV inverter Simulink module system and much better than the LCL dual tuned resonant filter.

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