Review Article

DSMPI Control Based an Adaptive Active Damper for Improving the Stability of Grid Connected Inverters: A Review

Devendra Singh[1] and Vijay Anand Bharti[2]

[1]PG Scholar, Department of EC, Mittal Institute of Technology, Bhopal, INDIA
[2]Assistant Professor, Department of EC, Mittal Institute of Technology, Bhopal, INDIA

ABSTRACT

introduced into a grid-connected inverter system with instability problems. A flexible working damper can be connected to a standard coupling point (PCC), which can automatically control the visible resistor at a critical value for system stability. In addition, the harmonic-current-reference compensation method is adopted to make the effective water damper more accurate to withstand virtual resistor over a wide range of frequencies. This paper investigates the harmonic-current-reference reference for independent $a-\beta$ dry, synchronous frame $d-q$, and decoupled synchronous $d-q$ independent-controlled three-phase adaptive damper active. In the proposed method, the active damper controls the active and active energy directly and improves the stability of the inverter connected to the grid under the weak grid at the same time. Imitation of the proposed system with PI and DSM-PI controls was performed with the MATLAB Simulink software with comparative analysis between both test systems.

KEYWORDS

Adaptive active damper, grid connected inverters, harmonic current reference compensation technique, PI controller, DSMPI Controller.

1. INTRODUCTION

As the breakdown of the distributed power generation system becomes high, the power grid is seen as a weak grid indicating a large set of grid block values. Or inverters are designed to be stable during a solid grid, but are generally less stable when connected to a weak grid with a common connection area. Typically, impedance-based stability conditions are used to assess system stability. This uses to consider two points there

one is under the condition of a solid grid, the inverter connected to the grid is stable and the second the ratio between the grid impedance and the input output of the inverter satisfies the Nyquist condition.

To improve grid stability, it is possible that control parameters should be developed or the grid-converter control algorithm should be adjusted in such a way that the output impedance becomes positive. These methods make the system robust and stable against a variety of grid impedances but at the same time there is a need for changes in the internal grid configuration of inverters, power circuit and control algorithms, which are usually modularly designed.

Alternatively, an external anti-damping resistor is connected seamlessly to the common junction to reduce resonances between grid and grid connected inverters. This resistor when updated with power transformers to eliminate additional power losses in the system is called an effective water resistor.

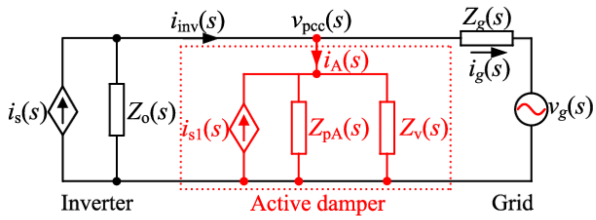

Fig.1.1 Active Damper System Connection

2. LITERATURE REVIEW

M. Liserre, R. Teodorescu, and F. Blaabjerg et al. [1], analyzed the stability problems of grid-connected inverters used in distributed production. Complex controls (e.g., multiple rotating frames or resonant-based) are often required to compensate for the background distortion of the low-frequency grid voltage and the LCL filter is usually found in high frequency. The possible range of grid block values (distributed generation suited to remote areas with radial distribution plants) challenges the stability and effectiveness of the current LCL-filter system. It has been discovered and demonstrated in this paper that the use of active damping helps to stabilize the system in relation to many types of resonances.

J. Sun et al. [2], In a system connected to a multi-inverter grid, the voltage stability of a common coupling point (PCC) is checked taking into account the distribution parameters of the transmission lines. First, the systems on both sides of the PCC are equalized, a circuit equivalent to a small signal such as a "current source grid" is established, and a statistical voltage model of the PCC is obtained. Then, using Euler's formula and Nyquist's stability system, the grid power of the grid-connected PCC system is tested in the form of an impedance analysis on the basis of one-sided happiness. In addition, grid-connected conditions that cause PCC power outages are studied. Phase compensation system based on the restriction phase, compensation management strategy is introduced.

D. Pan, X. Ruan, C. Bao, W. Li, no-X. Wang et al. [3], The effective reduction of Capacitor-current-feedback is an effective means of compressing the resonance of the LCL filter on grid-connected inverters. However, due to grid impedance variations, the LCL-filter resonance frequency will vary in frequency range, which challenges the coefficient of capacitor-current-feedback. Furthermore, if the resonance frequency is equal to one-sixth of the sample (fs / 6), the digital-controlled converter connected to the LCL type grid cannot stabilize regardless of the coefficient of the mcapacitor-current-feedback. In this paper, the correct design coefficient of the current response of the capacitor is presented to address the wide range of grid impedance. First, the genetic requirements for system stability are obtained under different frequency frequencies.

L. Harnefors, L. Zhang, and M. Bongiorno et al. [4], discussed the current control design of three-phase voltage source converters, in which the input approval is obtained. Two design options, the forward and external voltage feed, respectively, are shown to provide the same performance. It is shown how additional components can be added to the controller while keeping the passivity property. This is especially true for noise components. The design approach is ultimately applied to transformers with an LCL input filter, which is displayed in most cases to better match the system in which an internal loop is added to minimize improved LCL resonance.

L. Harnefors, A. G. Yepes, A. Vidal, and J. Doval Gandoy et al. [5], delays in the current control loop of the grid-connected voltage source converter (VSC) may cause damage to the sound of electrical noise in the grid or VSC input filter. Instability is prevented if VSC entry can be made silent. This paper shows how to design an analytics controller for inactivity. The method is applied equally to one- and three-phase systems, that is, in the latter case, in both fixed frame control and synchronization.

J. He, Y. W. Li, D. Bosnjak and B. Harris et al. [6], discusses a control scheme based on impedance simulation to reduce the harmonic resonance of multiple grid-connected-converters (GCCs) with LCL filters. This paper shows that, harmonic sounding occurs when the GCC has an output output that can be compared to the rest of the network in certain bands. It is also revealed that the frequency of resonance is associated with the number of GCCs, grid impedance and capacitive loads. By controlling the grid-side current instead of the converter-side current, the critical LCL filter is limited as an internal component. Therefore, the blockage of the closed loop of the GCC inside the filter can be adjusted. The proposed scheme effectively controls the output of the GCC output to match the external network density, based on the received resonance frequency.

X. Wang, F. Blaabjerg, M. Liserre, Z. Chen, J. He, and Y. W. Li et al. [7], interactions operating on a parallel grid connected to converters corresponding to the impedance of the grid often lead to a number of stability and power quality problems. To deal with them, this paper recommends an effective damper based on a power converter with high control bandwidth. The general idea of this proposal is to dynamically reposition the impedance grid profile seen from the common converter converter, in order to minimize possible oscillations and the distribution of resonance in converters connected to the same grid can be reduced. An effective damper can be a promising way to stabilize power-based AC power systems.

X. Wang, Y. Pang, P. C. Loh, and F. Blaabjerg et al. [8], this book proposes a functional filter consisting of a series of LC-resonance pressure filters in an ac-based energy system. An additional series filter capacitor helps to withstand a lot of system voltage, which is why it allows a low-voltage converter to be used to operate an effective damper. Unlike an effective power filter to minimize harmonics at low frequency, the proposed damper lowers the resonances at the top.

3. PROBLEM FORMULATION

The active damper provides direct control of the active and efficient power and thus enhances system stability so it can access a wide range of applications in the future with relevant research and development. It is possible to attach it to different grid systems easily due to its structure and ability to adjust with various filters and controls. Several active water supply circuits can be used in a single system if the grid contains a large number of inverter connected to the grid. Changes to connected filters and controls themselves provide the scope for a brighter future. The introduction of controls as a control scheme adds additional features to it. Current controls can be updated with flexible controls or neurologic-based controls that can be used to integrate with other sensible and mixed systems in the future, thus gaining scope.

methods of research, development and implementation. Also, it also lowers THD thereby increasing the PCC voltage stabilization and system stability.

4. PROPOSED WORK

This dissertation proposes an inefficient water-repellent drain for an inverter system connected to a grid with instability problems. A flexible active adamper is connected to the common connection area and controls the visual support into a critical value for system stability. The current harmonic reference compensation method is used to control the virtual resistor simulation at wide range. This paper demonstrates the harmonized use of the current reference yo of the α − β vertical frame, the synchronized d − q frame and the decoupled synchronous d-qframe controlled by the third phase of antiretroviral modulation. With the help of this method the active damper directly controls the active and efficient power and also improves the stability of the grid-connected inverters under the weak grid. The MATLAB and Simulation software is used to mimic the proposed system with both PI and FIS controls and feature features well displayed in the analysis of the results.

3.1 Introduction to Grid

The interconnected network used to transmit electricity from producers to consumers is called a grid. The main components of the grid include power generating stations, high power transmission lines that carry search facilities from remote locations, and distribution cables that connect to each customer.

3.2 Grid Instabilities

The advent of electronic power machines in the modern environment has led to the production of various grid instability such as harmonics, energy quality problems etc.

Harmonics voltages of solid sinusoidal or frequency waves are important multipliers of basic frequency. Indirect features of systems and loads on the power grid, promote harmonic distortions. Electronic power tools are a major source of harmonic stimulants. Most devices have a controlled diode rectifier followed by DC-Link, which leads to high harmonic content in the system. This progression leads to harmonic deviation in the power grid voltage through linear impedances. This is a major problem for both the provider and the consumer financially. Various journals indicate that about 30% of high-risk industrial sectors may invite energy expenditure costs of about 4% of their profits and 60% of contribution costs arising from power outages and temporary disruptions. such as voltage imbalances, backslides, arrogance, notch, transients, system malfunctions etc.

3.3 Demands Characterized by The Grid

Standards provided to service companies must be followed by inverter connected to the grid. In particular, future international standards and current standards should be considered. These levels meet issues such as energy quality, grounding, island performance acquisition, etc. The current EN standard is easier to deal with the current consensus compared to the corresponding IEEE and IEC standards. This also echoes the popular inverter topology, which has changed dramatically from inverter connected to a large thyristor grid to small IGBT (insulated-gate-bipolar-transistor) and MOSFET-based.

Inverters should be able to identify the living conditions on the island, and take appropriate steps to protect the system. Islanding is an inverter-driven process where the grid has been terminated intentionally, indirectly, or accidentally. In other words, it can be said that the grid removed from the inverter, later provides only local loads.

The acquisition schemes currently available are usually divided into two groups: active and passive. Performance methods often monitor grid parameters and do not show any impact on energy quality. Functional schemes often introduce disruptions to the grid and thus assess the effect. This system affects the quality of power and there are problems in the system where most inverters are located in line with the grid.

IEEE and IEC standards place limits on the maximum allowable dc current embedded in the grid, to avoid overcrowding of the distribution converter. In particular these limitations are so small that it is difficult for inverter circuitry to measure accurately. This is overcome by using improved rotation or using a line converter between the inverter and the grid. Some inverters use a transformer connected to the HF DC / DC converter to achieve galvanic separation between grid and PV modules. This method helps in the easy support of PV modules.

5. METHODOLOGY

4.1 Model and Component Description

This study focuses mainly on flexible operational mitigation which is the process of adding external support in conjunction with a common contact area to reduce grid between grid and connected inverters. In modern electricity this resistor is replaced by power electronic converters and is called an active damper and the process is called active damping.

on a grid connected inverter under a weak grid. Here the active damper is operated with the help of a filtered LCL grid connected to the inverter. The main components of the proposed model are an active damper that combines the power of an electronics converter and an LCL filter, connected to a common three-phase grid connected to an inverter and grid. in such a way that the outgoing current harmonic components equal the area of the normal harmonic electrical connection.

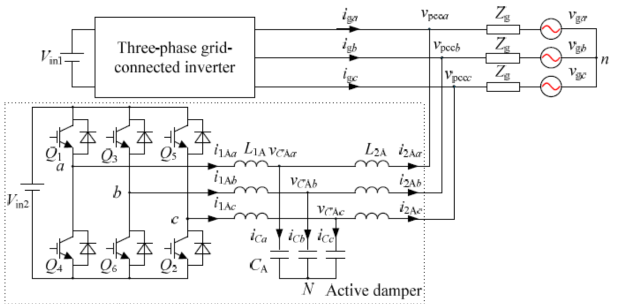

Fig.4.1Circuit Diagram of Three phase grid connected inverter with adaptive active damper

6. SIMULATION RESULTS & ANALYSIS

6.1 Overview of MATLAB & Simulation Software

Simulation software helps us to predict system behavior. We can use simulation software to test new design, detect problems in existing construction, and test systems for conditions that are difficult to reproduce, for example a satellite in outer space. In order to start a simulation, we need to have a mathematical model in the system that can be defined as a block diagram, a circuit diagram scheme or code. Simulation software explores behavior as changing conditions over time or as event events. Simulation software too contains visual tools, for example 3D animation, data display etc. to monitor imitation where applicable.

MATLAB integrates a desktop space designed for repeated analysis and design processes into that programming language that can express matrix and integrate statistics directly. It also contains a Live Editor that assists in creating documents that include code, output and embedded text in a usable notebook.

6.2 Simulation Parameter

Table 6.1 Parameter of Active Damper

PARAMETERS	VALUE
DC Side Voltage	700 V
Grid voltage (RMS) V_g	220V
Port current sensor gain H_{i1}	0.68
current sensor gain H_{icA}	0.42
DC-side capacitor C_{dcA}	150 µF
Funda Mental Frequency	50 Hz
Inverter-side inductor L_f	1.5 mH
Filter capacitor C_f	1.5 µF
Modulation index (PWM)	0.95
Proportional constant	K_p=5
Integral constant	K_i =10
Grid-side inductor L_2	200 mH
Switching Frequency f_{swA}	60 kHz

Table 6.2 Parameters of The Grid-Connected Inverter

PARAMETERS	VALUE
Input voltage V_{in}	700 V
Grid voltage (RMS) V_g	220V
Rated power S	10 KVA
Fundamental Frequency	50 H
Inductor (L_1)	3.2 mH
Filter capacitor C	10 µF
Switching frequency fsw	10 KHz

6.3 SIMULATION MODEL DESCRIPTIONS

Description 1 Fig no. 6.1 shows a three-phase system grid connected to a weak inverter under. If the active damper is controlled under the $\alpha - \beta$ framework and the grid impedance is limited, system stability judgment can be equal to a single-phase system.

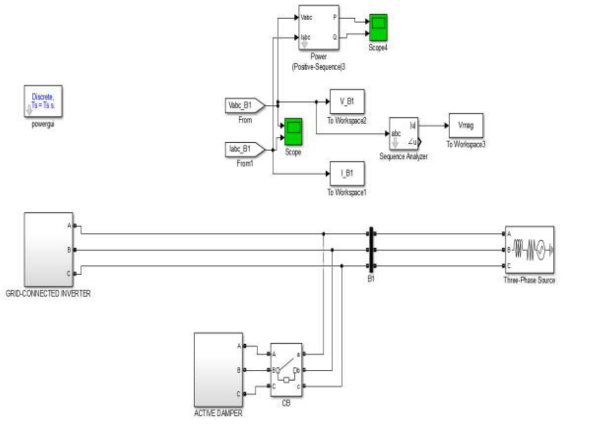

Fig.6.1 Proposed System of the gird-connected inverter with the active damper under weak grid

Therefore, the referenced control method can be applied to a three-stage active damper, which helps the damper work accurately and flexibly to mimic the visible resistance in the PCC. With the benefit of direct control of active and efficient power, the active damper can be controlled under the $d - q$ frame. But the control system becomes more complex due to the existence of integrated goals. the image below shows the proposed test system containing a common source connected to the converter supplied by a DC source. The grid connected inverter and active damper are connected to the PCC using a circuit breaker for a period of 0.2 seconds.

Description 2 (Figure 6.2) the below figure shows a grid connected inverter that is connected via a LCL filter. In order to share the power to the conventional source it makes use of SPWM method of operation.

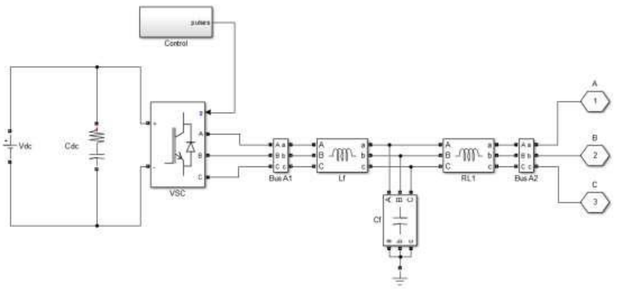

Fig. 6.2 Grid Connected Inverter

Description 3 (Figure 6.3) the below figure shows the internal modeling of the active damper circuit that makes use of d-q – α-β hybrid reference frame controller for its control.

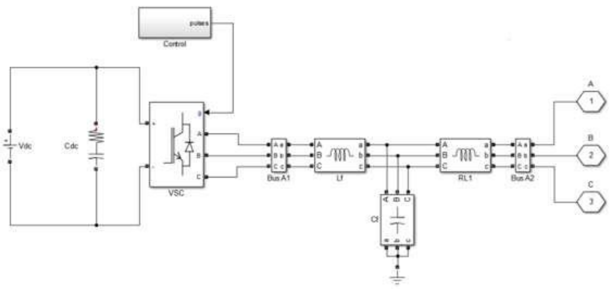

Fig.6.3 Active Damper Circuit

Description 4 (Figure 6.4 and 6.5) the below figure 6.4 shows a PI controlled active damper circuit. It is updated with a DSMPI controlled active damper circuit in figure 6.5so as to obtain a better stability of the PCC voltage.

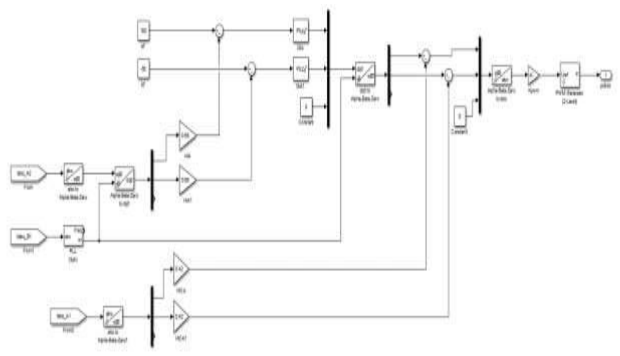

Fig.6.4 Active Damper Control Structure with PI Controller

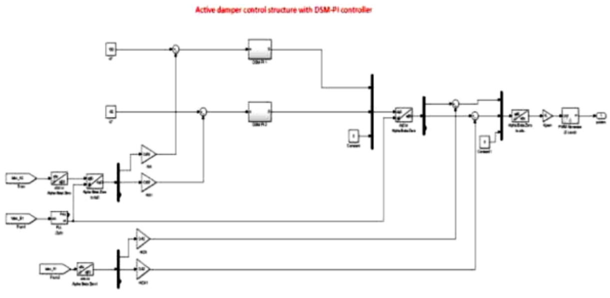

Fig.6.5 Active Damper Control Structure with DSMPI Controller

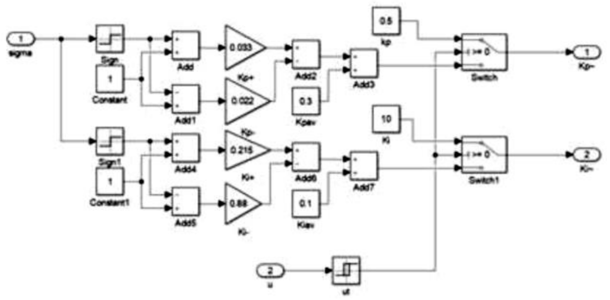

Fig. 6.6 Sliding equation of DSM-PI controller

6.3 SIMULATION RESULT ANALYSIS

In order to obtain the simulation results of the above-described model, the simulation is been run for a tie period of 1 sec. The voltage and current are recorded both with and without active damper circuit. At a time point of 0.2 sec the active damper circuit is introduced to the grid. The below figures depict the traced graphs. Figure 6.7 and 6.8 shows the PCC voltage, current, active power and reactive power when connected with a PI controlled active damper circuit. Figure 6.9 and 6.10 shows the PCC voltage, current, active power and reactive power when connected with a DSMPI controlled active damper circuit.

Figure 6.11 depicts the Vmag at PCC comparative graph between PI and DSMPI Controller.

Figure 6.11 and 6.12 shows the THD of PCC voltage when PI controlled active damper circuit and DSMPI Controlled active damper circuit, respectively, are introduced at 0.2 sec.

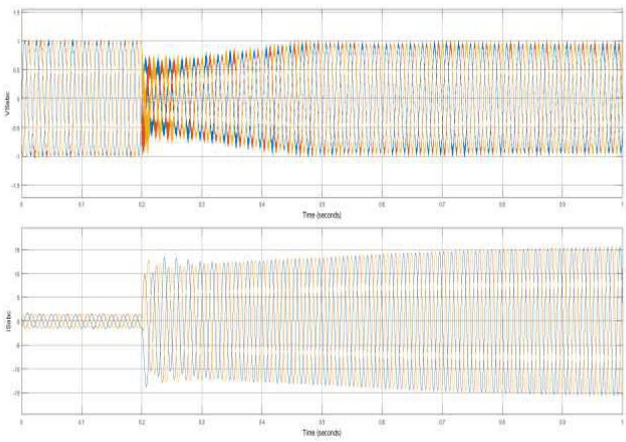

Fig.6.7 PCC Voltages and Currents with PI Controller

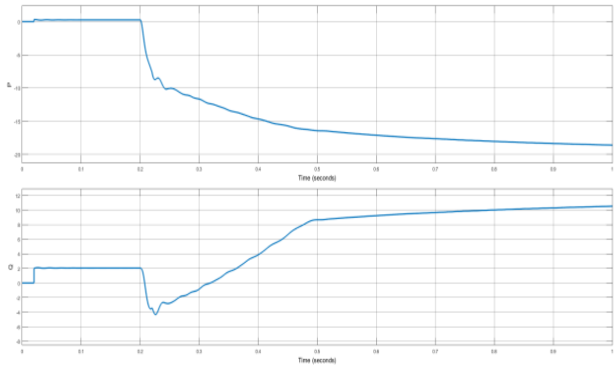

Fig.6.7 PCC Active and Reactive Power with PI Controller

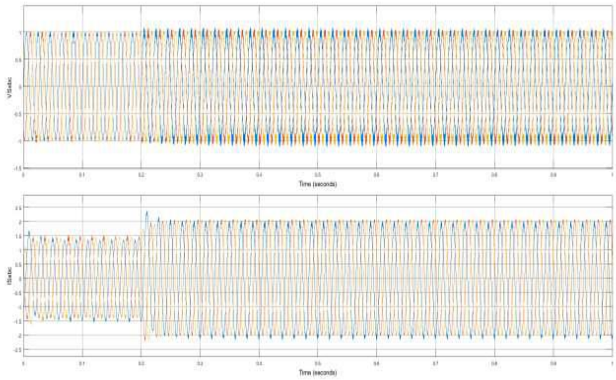

Fig.6.8 PCC Voltages and Currents with DSMPI Controller

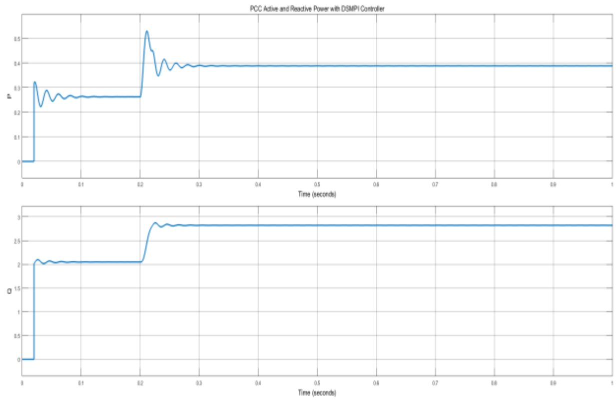

Fig.6.9 PCC Active and Reactive Power with DSMPI Controller

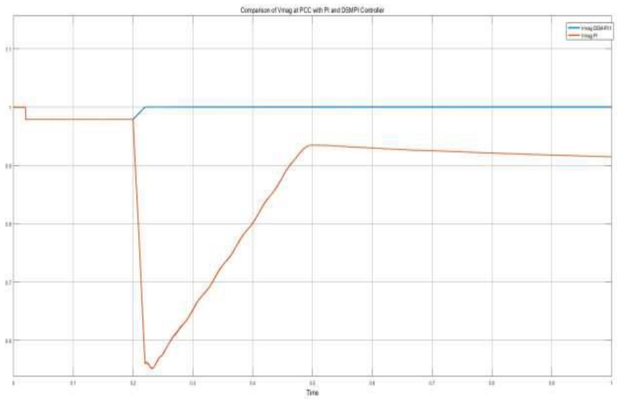

Fig.6.10 Comparison of Vmag at PCC with PI and DSMPI Controller

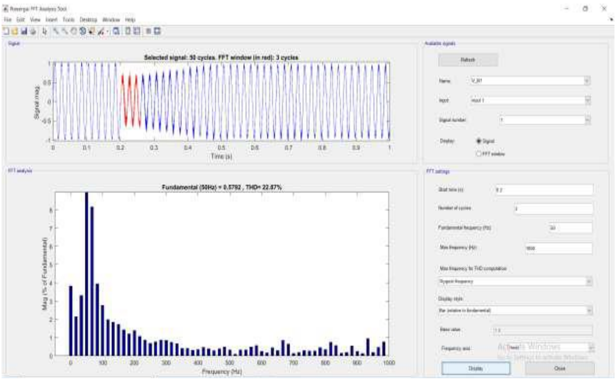

Fig.6.11 THD of PCC Voltage at 0.2sec with PI Controlled Active Damper Circuit

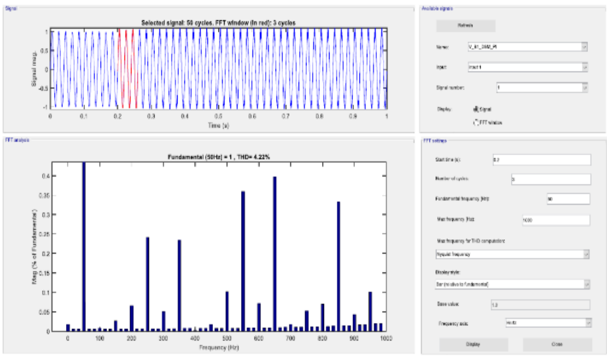

Fig.6.12 THD of PCC Voltage at 0.2sec with DSMPI Controlled Active Damper Circuit

7. CONCLUSIONS & FUTURE SCOPE

7.1 Conclusion

As shown in the graphs above the magnitude of the voltage stays fast in the active damper circuit controlled by DSM-PI and stabilizes accurately at 1pu. However, the stopping time of the active PI of the active damper is slow and the size is unstable and not close to 1pu. PCC voltage THDs are analyzed using the FFT analysis tool when the grid system is connected to different active damper circuits and the harmonics with the DSM-PI controller are much smaller compared to the PI controller. In this thesis, a separate synchronous d − q framework for the third phase of active flexibility is proposed, which controls active and active energy directly and compensates for harmonic-current reference without related conditions. Finally, simulation results are provided to ensure the validity and feasibility of the proposed method. PCC voltage THD for active PI controller was recorded at 22.87% and for DSM-PI control it was recorded at 4.22%.

7.2 Future Scope

As can be assumed from the dissertation that an active damper provides direct control of the active and efficient power and thus increase system robustness can find a wide range of applications in the future with appropriate research and development. It is possible to attach it to different grid systems easily due to its design and ability to adjust with various filters and controls. Several active water supply circuits can be used in a single system if the grid contains a large number of inverters connected to the grid. Changes to connected filters and an independent controller provide the scope for a brighter future. Current controls can be updated with flexible controls or neurologic-based controls that can reduce THD thereby increasing PCC electrical power and system stability.

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