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Accomplishment of power quality enhancement by analyzing the optical filter technique inside the MATLAB atmosphere

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Abstract

The main objective is coordinating the DG to the utility grid. The fundamental goal is to synchronize the DG to the utility grid. This research work actualizes diverse control procedures for grid inverter systems. An examination of hysteresis controller is considered for providing control of a grid connected inverter. The objectives of the present work are to implement an intelligent controller for grid connected voltage source inverter. It is observed that there are number of control techniques implemented by different authors for improvement in power quality but above control techniques have limitations in reducing the magnitude of harmonics to acceptable level. However, these techniques provide good results in terms of Total Harmonic Distortion. Therefore, the transfer function of the multiple optical ring resonators is determined in z-domain and its routine is evaluated in MATLAB environment. To ensure grid stability, active and reactive power control, Power quality improvements are the main objectives. The performances of the proposed multiple optical ring resonators were evaluated in MATLAB environment. Glass silica with moderate refractive index contrast was proposed as waveguide material for ring as well as bus at the initial stages of it because of its wide transparency window (from visible to infrared), low intrinsic loss, and its compatibility with mature fiber-optic technology.

Keywords: PWM, DPGS, Fuzzy, PID, MZI

1. Introduction

A grid linked PWM voltage source inverter utilizing the PID controller, Fuzzy controller and aggregate of these along with hysteresis controller in the control loop is highlighted through this work and for the same simulation in MATLAB is carried out. From this study we depict that, combination of these controllers Hybrid fuzzy PID with hysteresis current controller is able to strength the power quality of the grid system as it has the capability to reduce the switching frequency supposing the bandwidth is expanded without any massive growth in the current error. For a periodic index modulation with the small index contrast, the reflection and the transmission are correctly modeled using coupled mode. The performance of the Hybrid fuzzy PID controller is advanced to that of other (PID or Fuzzy) controller because it has been experimented that (PID Fuzzy) controller is able to get steady state current in slighter time with condensed error. As a result, the THD level of grid current is considerably condensed as compared to other controller. Furthermore, switching frequency of the inverter system has been deduced, in that in turn, switching losses are also decreased to a sure volume.

2. Objectives and Scope of the Work

The objectives of the present work are to implement an intelligent controller for a single phase grid connected voltage source inverter. The improvement in power quality is to be achieved by reducing the harmonic content in the current and compared by implementing three control schemes.

1. PID controller
2. Fuzzy Logic Controller
3. Hybrid Fuzzy PID Controller

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The above three control scheme has been tested for performance. The work is implemented in MATLAB Simulink.

The main objective is coordinating the DG to the utility grid.

- Active and reactive power control.
- Power quality improvement.
- To ensure grid stability.
- The transfer function of the multiple optical ring resonators is determined in z-domain and its performance as optical filter was evaluated in MATLAB environment.

Neural network along with Hysteresis controller may be used in future for better performance in terms of THD and magnitude of harmonics at fundamental frequency. Some other controllers may also be implemented to reduce the hysteresis current leading to better synchronizing of supply side and demand side. Moreover the use of intelligent controller along with hysteresis controller instead of hysteresis controller alone is a more suitable option as the pulses acquired from such techniques will reduce the harmonic content in the current due to hysteresis. Neural network based intelligent controller may provide better results as compared to fuzzy and conventional controllers.

3. Review of Literature

Yaosuo Xue *et al.* described that the inverters in metric weight unit applications perpetually expertise a large vary of dc input voltage variations, wherever the output voltage has to be improved up to tier compatible with ac grid. Boost inverters realize their niches playing power conversion beneath variable dc sources as obtained from wind and solar power. Distinctive necessities for little distributed power generation systems embrace low value, high potency and tolerance for a particularly wide selection of input voltage variations [1].

Adel M. Sharaf *et al.* elaborated a novel facts based scheme with a smart dynamic control strategy and modulated filter compensator is designed to stabilize the common DC collection bus output voltage for the photovoltaic, fuel cell, wind turbine and diesel sources in the village/Island micro grid utilization system [2].

Yuija Shang and Aiguo Wu discussed the problem of harmonic detection delay by the instantaneous reactive power method, a TS fuzzy logic along with synthetic sinusoid generation technique based shunt active power filter is proposed. The VSI gate switching signals are derived from adaptive- hysteresis controller so that the modulation frequency remains nearly constant, which will improve the PWM performances and APF substantially. The experimental data shows that the dynamic and steady behavior of the active filter is perfect [3].

Marian P. Kazmierkowski *et al.* used current management techniques for three-phase voltage supply pulse breadth modulated converters. Use of linear prophetic and on-line optimized current controller is growing quick in medium and high performance systems, particularly for traction and high power units. physical phenomenon current controller, in their improved versions, are like minded to quick, correct conversion systems [4].

Krismadinata, Nasrudin and Abd Rahim described a control method for single phase grid connected inverter system for distributed generation application. Single band hysteresis current controller is applied as the control method. The

current produced by this inverter is in phase with grid voltage and also achieve unity power factor. This method also reduces the number of components such as phase lock loop circuits and cost significantly [5].

From the literature survey, it is observed that there are number of control techniques implemented by different authors for improvement in power quality but above control techniques have limitations in reducing the magnitude of harmonics to acceptable level. However, these techniques provide good results in terms of Total Harmonic Distortion. Therefore, intelligent controllers which take care of both the parameters (magnitude of harmonics and THD) simultaneously must be used for improvement in power quality.

4. Significance of Power System

When the total load on the system approaches purely resistive, the total current requirements and losses are minimum. When the system efficiency is maximized (i.e., minimum power required to serve all loads), two significant benefits are realized:

1. Power losses are minimized.
2. Extra capacity is made available in the transmission lines, distribution lines, and substation equipment because this equipment is rated on the amount of current carrying capability. If the current flow is less, the equipment has more capacity available to serve additional load.

5. Matlab Implementation

We have described the various optical filtering techniques with its working principle and its importance in the field of signal processing. This paper includes the detail mathematical derivation of the optical filtering techniques by the proper application of the Mach-Zehnder interferometer, optical ring resonator and optical fiber Bragg grating. By the suitable combination of the MZI, optical ring resonator and fiber Bragg grating filtering techniques, we can obtain the desired filter response for different application such as notch filtering, band rejection or band pass characteristics. In this paper we have also shown the combination of MZI and ring resonator device known as the ARMA filter design techniques that can able to provide the maximally flat response. The paper includes the detailed derivation and implementation of each section including Fiber Bragg grating filtering techniques through MATLAB.

All the ring dimensions were in millimeter ranges. The advantages of using SOI as waveguide material helped ring resonator architecture further miniaturizing. Therefore, a fourth ring has been introduced in the existing triple ring resonator (TRR) architecture with ring lengths at micrometer range.

In the novel quadruple optical ring resonator (QORR) architecture the fourth ring eventually modulates the effective unit delay to half in comparison to TRR and thus the FSR gets enhanced further. The FSRs obtained from different models are: 342.4THz (using SOI waveguides) and 264.6 THz (using SiN waveguides) with cross talks around -30dB and zero resonance loss in each case. Four such prototypes have been simulated with consistent results.

One model with superior parameter using SOI waveguide material is capable of providing yet another better result with FSR of 705THz with cross talk level of -35 dB have been achieved. A QORR structure with glass-silica waveguides and ring lengths in millimeter range have also been investigated to compare and contrast the performance (refer Table 6.1). Yet

another QORR model in SOI material exhibits consistencies in its characteristics with an FSR of 1175 THz with crosstalk level around -50 dB. In all the cases group delay and dispersion characteristics have been investigated.

6. Results & Findings

There are many types of optical filters exists. The Fourier series can be rewritten in terms of the exponential function with complex arguments as follows. Where the frequency response of the filter is, is the order of the filter, and the terms are the complex weighting co-efficient. A weighted sum is common to any basic function decomposition. An incoming signal is split into number of parts that are individually weighted and then recombined. The optical analog is found in interferometers. The frequency is referenced to the central frequency and normalized to one period, called the free spectral range (FSR). Changing the splitting or combining ratios adjust the coefficients in the Fourier series. A -term series result when the light splits into paths, with each path having a relative delay that is longer than the previous path. The distinguishing features of this general class are that there are a finite numbers of delay and no recirculating delay paths. The interfering paths are always feeding forward even though the interferometer may be folded such as with a Michelson interferometer. The signal processing term is used to designate this type of filter is moving average (MA) or finite impulse response filter. There are two outputs: Out1 corresponds to the transmission response of the FPI, and Out2 corresponds to its reflection response. Filters with feedback paths are classified as autoregressive (AR) or infinite impulse response (IIR) filters in digital signal processing. When several stages are cascaded, the resulting transmission response of the FPI and Out2 corresponds to its reflection response. When several stages are cascaded, the resulting transmission response is described by one over a Fourier series as follows:

- The reflection response is given by the sum of an AR and MA response and is classified as an autoregressive moving average (ARMA) filter. Both digital filters and optical filters consist of splitter, delays, and combiners. These parts are identified for the MZI and FPI, respectively. Many stages are formed by concatenating single stages or combining stages in the various architectures. The optical path lengths are typically integer multiples of the smallest path length difference. The unit delay is defined as τ where τ is the smallest path length and is called the unit delay length. Digital signal processing techniques are relevant to optical filters because they are linear, time-invariant systems that have discrete delays. The delay are discrete value of the unit delay, the frequency response is periodic. One period is defined as the FSR, which is related to the unit delay.
- Vernier principle based modeling and analysis of an optical ring resonator structure that includes four asymmetric rings are introduced in this Chapter to obtain very wide free spectral range (FSR). Delay line signal processing approach in Z-domain modeling is used for analysis of waveguide based novel quadruple optical ring resonator (QORR). Two QORR architectures made of SOI and SiN waveguides have been compared, which produce FSR of 343.4 THz 264.6 THz respectively. Apart from obtaining wider FSR and adequate suppression of spurious interstitial modes close to - 30 dB, this chapter presents group delay and dispersion

characteristics for QORR made of materials with different effective refractive indices. It is established fact that by decreasing ring perimeter this FSR can further be enhanced. Apart from those measures, high index contrast waveguide consisting of glass core may be used to make up bending loss arisen out of extremely small ring radii.

7. Electrical Grid

An electrical grid is an interconnected network for delivering electricity from suppliers to consumers. It consists of generating stations that produce electrical power, high-voltage transmission lines that carry power from distant sources to demand centers, and distribution lines that connect individual customers. Power stations may be located near a fuel source, at a dam site, or to take advantage of renewable energy sources, and are often located away from heavily populated areas. They are usually quite large to take advantage of the economies of scale. The electric power which is generated is stepped up to a higher voltage-at which it connects to the transmission network. The transmission network will move the power long distances, sometimes across international boundaries, until it reaches its wholesale customer (usually the company that owns the local distribution network). On arrival at a substation, the power will be stepped down from a transmission level voltage to a distribution level voltage. As it exits the substation, it enters the distribution wiring. Finally, upon arrival at the service location, the power is stepped down again from the distribution voltage to the required service voltage(s).

8. Power System Efficiency

Therefore, when the total load on the system approaches purely resistive, the total current requirements and losses are minimum. When the system efficiency is maximized (i.e., minimum power required to serve all loads), two significant benefits are realized:

1. Power losses are minimized.
2. Extra capacity is made available in the transmission lines, distribution lines, and substation equipment because this equipment is rated on the amount of current carrying capability. If the current flow is less, the equipment has more capacity available to serve additional load

9. Conclusions

The main objective is coordinating the DG to the utility grid. The fundamental goal is to synchronize the DG to the utility grid. This research work actualizes diverse control procedures for grid inverter systems. An examination of hysteresis controller is considered for providing control of a grid connected inverter. The objectives of the present work are to implement an intelligent controller for grid connected voltage source Inverter. The power quality improvement is presented through this work and for the same simulation in MATLAB/Simulink is carried out. The transfer function of the multiple optical ring resonators is evaluated in z-domain and its performance as optical filter is founded in MATLAB environment. Free Spectral Range (FSR), crosstalk, dispersion etc. has been addressed in detail in terms of expansion of FSR, reduction of cross talk. Several structures of multiple optical ring resonators have been proposed and their mathematical modeling in z-domain has been developed. The performances of the proposed different optical ring resonators were evaluated. From this study we observed that,

combination of these controllers Hybrid Fuzzy PID with hysteresis current controller is able to enhance the power quality of the grid system as it has the capability to reduce the switching frequency even if the bandwidth is increased without any significant increase in the current error. The transfer function of the multiple optical ring resonators is determined in z-domain and its performance as optical filter is evaluated in MATLAB environment. The key parameters of multiple optical ring Free Spectral Range (FSR), crosstalk, dispersion etc. has been addressed in detail in terms of expansion of FSR, reduction of cross talk. Several structures of multiple optical ring resonators have been proposed and their mathematical modeling in z-domain has been developed. The performances of the proposed different optical ring resonators were evaluated.

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