A Fuzzy Based Grid Contactless System for Matrix Converter

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Abstract

Inductively coupled, bidirectional grid interfaces are gaining popularity as an attractive solution for vehicle-to-grid (v2g) and grid-to-vehicle (g2v) systems. However, such systems conventionally use a large, electrolytic dc-link capacitor as well as a large input inductor, leading to expensive, bulky, and less reliable systems. Fuzzy based grid contact less system for matrix converter are gaining popularity as an efficient and reliable technique. Moreover MCs are invariably rich in harmonics and thus affect both power quality and power factor on the grid side. although fuzzy based grid contact less system for matrix converter are proposed as an alternative, the matrix converter is an ac–ac power converter topology, mainly based on semiconductor switches with minimal requirements for passive components. Performance of such converter has been analyzed when driving linear load current fuzzy logic controllers. The matrix converter system that allows bidirectional power flow and it converts a voltage with a variable amplitude and frequency from a constant voltage of magnitude and frequency. Thus the proposed system employs a simpler switching strategy with a lower switching frequency and reduces the total harmonics. Effective simulation results shown by using MATLAB.

Index terms- *grid integration, inductive power transfer, matrix converter, fuzzy logic, wireless power transfer, Total harmonics distortion.*

I. INTRODUCTION

In recent years, the demand for electric vehicles (EVs) has raised significantly because of many reasons, like improvement in EV technologies, high fuel costs associated with conventional vehicles, and increased awareness on reducing greenhouse gas emissions. Moreover, with the emergence of vehicle-to-grid (V2G) and grid-to-vehicle (G2V) technologies, EVs are proposed as energy storage devices for storage and retrieval of energy for dynamic demand management currently, hard-wired bidirectional grid interfaces are used for grid integration of EVs. Although hard-wired interfaces between EVs and also the utility grid are simple, they must be suitably isolated to avoid the risk of shock hazards [4]. However, they still increase the risk of electrocution, significantly under wet environments and harsh weather conditions, like snow and ice, making safe use of hard-wired interfaces practically difficult. Since these particular grid interfaces are equipped with long cables, they'll also be inconvenient and inflexible in recent years, inductive power transfer (IPT) has emerged as a favored technique for supplying contactless power for a wide range of applications. In contrast to hardwired interfaces, contactless grid interfaces based on bidirectional inductive power transfer (BD-IPT) technology have shown substantial promise as an attractive solution for V2G and G2V applications because of their higher galvanic isolation, flexibility, and efficiencies comparable to hard-wired systems.

However, the operating frequencies of BD-IPT systems are usually much higher than the utility grid frequency. Therefore, contactless grid integration of EVs for V2G or G2V applications involves a single or multistage frequency conversion, using one or more bidirectional power electronic converters. Furthermore, as a typical BD-IPT system includes a sixth or eighth order, high-frequency resonant network control of such systems is more demanding in contrast to traditional applications. However, 2 differing kinds of bidirectional device topologies that are used for grid integration of BD-IPT systems are presented in the literature. Due to variations in the nature of supply voltage and frequency (source) and the varying requirements of modern applications (loads), power conversion is essential in order to ensure a proper and energy efficient operation of equipment. This thesis gives a brief overview on the power electronic technology, static AC/AC power frequency conversion structures and introduces the matrix converter (MC), which is the main topic of this work. There are many electrical loads like linear loads, non-linear loads, lightning loads etc. But in this thesis linear, passive resistance and inductance (RL) loads are considered to evaluate the performance of matrix converter. In order to get the desired response the output currents are compared with the reference current, which gives an error value from the difference of two currents. The closed loop control is used to suppress the error and finally the matrix converter gives the response with the reduction in harmonic content of output current waveforms. For the proper regulation of matrix converter various controllers are discussed in this paper. Firstly the performance of the conventional PI controller fed matrix converter was observed and then followed by Fuzzy Logic Controller was connected to the matrix converter. The Simulink Model was developed by using MATLAB Simulink software and to evaluate the effectiveness of the matrix converter during balanced and distorted supply voltage conditions. The output waveforms of the matrix converter fed in to linear RL load, during these conditions are observed.

II. MATRIX CONVERTER (MC) BASED BIDIRECTIONAL CONTACTLESS GRID INTERFACE SYSTEM

Matrix converter based grid integrated BD-IPT interface that a rates the fore mentioned issues of previously reported bidirectional contactless grid interfaces**.** Shown in figure: 1BD-IPT systems are usually much higher than the utility grid frequency. Therefore, contactless grid integration of EVs for V2G or G2V applications involves a Single or multistage frequency conversion, using one or more bidirectional power electronic converters.

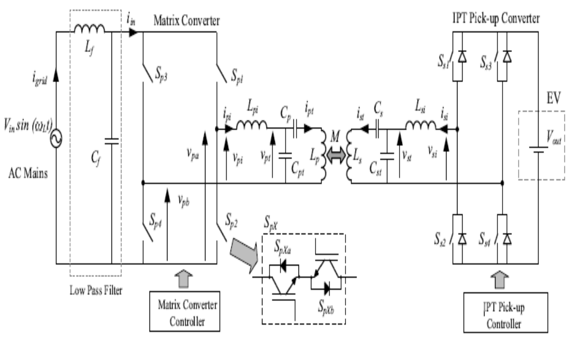

Fig: 1Matrix Converter (MC) based bidirectional contactless grid interface system

However, differing kinds of bidirectional device topologies that are used for grid integration of BD-IPT systems matrix converter (MC)-based bidirectional inductively coupled grid interfaces.MC topology that is operated using a current communication algorithm based on the output current direction is yet to be reported for application similar to BD-IPT systems, where high frequency resonant

A. *IPT Pick Up Convertor*

IPT pickup convertor is a transducer that captures or senses mechanical vibrations Inductive power transfer is a technology, which is now recognized as an efficient an acceptable technique for contactless power transfer across an air gap through weak magnetic coupling. As many industrial and domestic applications require power with no physical contacts, IPT is gaining global popularity and wide acceptance for numerous applications, as it offers the advantages of high efficiency, typically about 85–90%, robustness and high reliability in hostile environments being unaffected by duster chemicals. IPT systems are used in variety of industrial and consumer applications.

Material handling systems, clean rooms, mobile device and battery charging, home appliances, biomedical implants circuitry, and charging of electric vehicles (EVs) can be considered as prime. Majority of these IPT powered applications require power flow in one direction and, consequently, most of the analysis, modeling, and design have been carried out in relation unidirectional power flow of IPT systems. Numerous IPT systems, with different circuit topologies and compensation techniques, have been proposed and successfully implemented in the past to cater for a variety of applications that range from low-power biomedical implants to high-power battery-charging systems in electric vehicles (EVs). A system as shown in Figure: 2consist of two physically detached subsystems with power transfer through induction.

Typically, the system supplying the power is stationary and is named the primary, transmitter, or source. The system receiving the power is attached to a movable frame and is named the secondary, pickup, or receiver. The power is transferred via induction between two magnetically coupled coils, much like in a transformer.

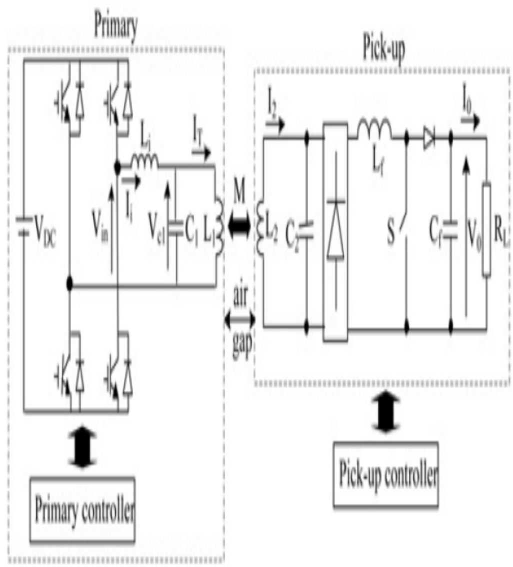

Fig: 2 A Typical IPT Systems

The coupling medium between the coils is air, which has a much higher magnetic reluctance than do the Ferromagnetic materials used in transformers. As a result, the coupling coefficient is in the range of 0.1-0.2 for stationary charging applications and less than 0.1 for midrange resonant applications. Therefore, these systems are usually referred to as loosely coupled systems to distinguish them from the tightly coupled transformer coils.

Design and control of typical IPT systems have been well known and reported in literature IPT control technique with only a single controller have been proposed and implemented in the past. The proposed technique is based on monitoring the variations in induced primary winding (L1) voltage and controls the primary current to regulate the amount of power transfer from the primary side to the load (pick-up).

B. *Wireless Power Transfer (WPT)*

Wireless energy transmission is the transmission of electrical energy from a power source to an electrical load, such as an electrical power grid or a consuming device, without the use of discrete human-made conductors. Wireless power is a generic term that refers to a number of different power transmission technologies that use time magnetic, or electromagnetic fields. In wireless power transfer, a wireless transmitter connected to a power source conveys the field energy across an intervening space to one or more receivers, where it is converted back to an electrical current and then used. Wireless transmission is useful to power electrical devices in cases where inter connecting wires are inconvenient, hazardous, or are not possible.

Application of this type include electric tooth brush chargers, RFID tags, smartcards, and chargers for implantable medical devices like artificial cardiac pacemakers, and inductive powering or charging of electric vehicles like trains or buses. In radioactive far-field techniques, also called power beaming, power is transferred by beams of electromagnetic radiation, like microwaves or laser beams. These techniques can transport energy longer distances but must be aimed at the receiver. Proposed applications for this type are solar power satellites, and wireless powered drone aircraft. These system has some disadvantages such as reduced maximum voltage transfer ratio, many bi-directional switches needed, increased complexity of control Sensitivity to input voltage disturbances, Complex commutation method.

III. FUZZY BASED GRID CONTACTLESS SYSTEM FOR MATRIX ONVERTER

Inductively coupled, bidirectional grid interfaces are gaining popularity as an attractive solution for vehicle-to-grid (V2G) and grid-to-vehicle (G2V) systems. However, such systems conventionally employ a large, electrolytic dc-link capacitor as well as a large input inductor, leading to expensive, bulky, and less reliable systems. Although, matrix converter (MC) based bidirectional inductive power transfer (BD-IPT) grid interfaces have been proposed as an alternative, implementation of safe and reliable MCs in BD-IPT applications is still a challenge, owing to the absence of natural freewheeling paths and higher complexity. In existing system it provides more harmonics .As a solution, proposes a new, fuzzy logic and carrier control technique with inductively coupled, bidirectional grid interface, without a dc-link capacitor and an input inductor, consisting of two back-to-back connected converters

Fuzzy based grid contactless system for matrix converter consists of ac input, matrix converter, resonant network, carrier control technique, Clark transform and fuzzy logic is showing figure.3 In ac input 440 volts applied to matrix converter. Matrix converter operates with IGBT switches. Resonant network contains LCCL primary side and secondary side using this network power is transfer from primary side to secondary side. Carrier control technique is used to control the voltage and current.

A. *Block Diagram of Fuzzy Based Grid Contactless System For Matrix Converter*

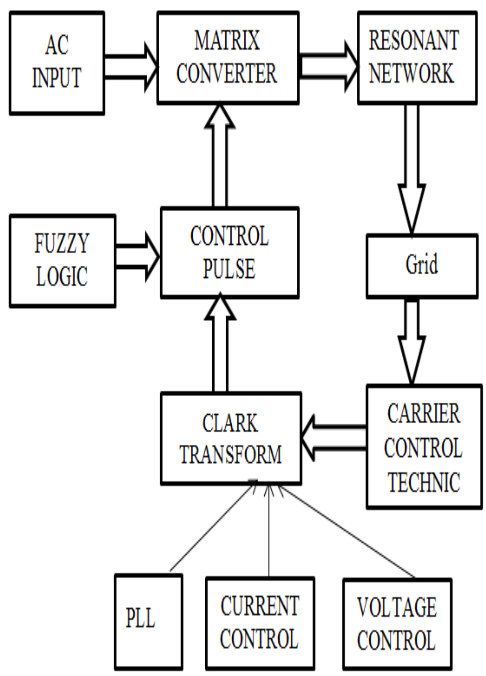

Fig: 3.Block diagram of fuzzy based grid contactless system for matrix converter

B.Low Pass Filter

A resistor–inductor circuit (RL circuit), or RL filter or RL network, is an electric circuit composed of resistors and inductors driven by a voltage or current source. First-order RL circuit is composed of one resistor and one inductor and is the simplest type of RL circuit. A first order RL circuit is one of the simplest analogue infinite impulse response electronic filters. It consists of a resistor and an inductor, either in series driven by a voltage source or in parallel driven by a current source. Complex control law implementation, commutation and other reasons. With these developments, matrix converters could replace cycloconverter in many areas.

C. AC Converter

Converting AC power to AC power allows control of the voltage, frequency, and phase of the waveform applied to a load from a supplied AC system. The two main categories that can be used to separate the types of converters are whether the frequency of the waveform is changed. AC/AC converters that don't allow the user to modify the frequencies are known as AC Voltage Controllers, or AC Regulators. AC converters that allow the user to change the frequency are simply referred to as frequency converters for AC to AC conversion. Under frequency converters there are three different types of converters that are typically used: cycloconverter, matrix converter, DC link converter (AC/DC/AC converter currently the application.

D. Fuzzy Controller

The fuzzy controller, explained about structure of fuzzy controller and this fuzzy controller using matrix converter in simulation circuit. Compare to PI controller, the fuzzy logic is very good for nonlinear systems and with very wide ranges of operation. This pi controller gives a good response when the process to be controlled has a pair of dominant poles, but for more complex systems it is not recommended. Fuzzy logic is widely used in machine control. This makes it easier to mechanize tasks that are already successfully performed by humans. A fuzzy control system is a control system based on fuzzy logic a mathematical system that analyzes analog input values in terms of logical variables that take on continuous values between 0 and 1 the use of this technique eliminates the need to consider too many inputs in the de

They can converter the multiple inputs into single output in the form of current. The function of controller is reduce the ripple content in current, they produce the pure current. The term "fuzzy" refers to the fact that the logic involved can deal with concepts that cannot be expressed as "true" or "false" but rather as "partially true", fuzzy logic has the advantage that the solution to the problem can be cast in terms that human operators can understand, so that their experience can be used in the design of the controller. This makes it easier to mechanize tasks that are already successfully performed by humans In fuzzy method, the torque is important parameter to control the torque and reduce the ripple content in current wave form. The speed dynamic of the proposed Fuzzy scheme is shown in figure the speed control of matrix converter in induction machine using fuzzy controller.

Likewise to the output voltages, the input currents are generated directly by the output Currents, by sequential piecewise the sampling of output current waveforms. The speed dynamic of the proposed Fuzzy scheme is shown in fig.10. In PI controller method, the torque is important parameter to control the torque and reduce the ripple content in current wave form. Likewise to the output voltages, the input currents are directly generated by the output Currents, synthesized by sequential piecewise sampling of the output current waveform

E. Wireless Power Transfer (WPT)

Wireless power transfer (WPT)as shown in figure 4.5, wireless energy transmission, or electromagnetic power transfer is the transmission of electrical energy from a power source to an electrical load, such as an electrical power grid or a consuming device, without the use of discrete human-made conductors. Wireless power is a generic term that refers to a number of difference power transmission technologies that use time-varying electric, magnetic, or electromagnetic fields. In wireless power transfer, a wireless transmitter connected to a power source conveys the field energy across an intervening space to one or more receivers, where it is converted back to an electrical current and then used. Wireless transmission is useful to power electrical devices in cases where interconnecting wires are inconvenient, hazardous, or are not possible. Wireless power techniques mainly fall into two categories, on-radioactive and radioactive. In near field or non-radioactive techniques, power is transferred by fields using inductive coupling between coils of wire, or by electric fields using capacitive coupling between metal electrodes. Inductive coupling is the most widely used wireless technology; its applications include electric tooth brush chargers, RFID tags, smartcards, and chargers for implantable medical devices like artificial cardiac pacemakers, and inductive powering or charging of electric vehicles like trainer buses.

F. Inductive Power Transmission

The distance at which the energy can be transferred is increased if the transmitter and receiver coils are resonating at the same frequency. This resonant frequency refers to the frequency at which an object naturally vibrates or rings – much like the way a tuning fork rings at a particular frequency and can achieve their maximum amplitude.

IV. CARRIER CONTROL TECHNIQUE

A. Voltage Controller

A voltage controller, also called an AC voltage controller or AC regulator is an electronic module based on either thyristors, TRIACs, SCRs or IGBTs, which converts a fixed voltage, fixed frequency alternating current (AC) electrical input supply to obtain variable voltage in output delivered to a resistive load. This varied voltage output is used for dimming street lights, varying heating temperatures in homes or industry, speed control of fans and winding machines and many other applications, in a similar fashion to an auto transformer. Voltage controller modules come under the purview of power electronics.. Voltage controllers have largely replaced such modules as magnetic amplifiers and saturable reactors in industrial use. Voltage controller's work in two different ways, either through "on-and-off control" or through "phase control

B. Phase-Locked Loop (PLL)

A phase-locked loop or phase lock loop (PLL) is a control system that generates an output signal whose phase is related to the phase of an input signal. While there are several differing types, it is easy to initially visualize as a circuit consisting of a variable frequency oscillator and a phase detector. The oscillator generates a periodic signal, and the phase detector compares the phase of that signal with the phase of the input periodic signal, adjusting the oscillator to keep the phases matched. Keeping the input and output phase in lock step also implies keeping the input and output frequencies the same. Consequently, in addition to synchronizing signals, a phase-locked loop can track an input frequency, or it can generate a frequency that is a multiple of the input frequency. These properties are used for computer clock synchronization, demodulation, and frequency synthesis.

V. RESULT

A. Simulation Block Diagram Of Proposed System

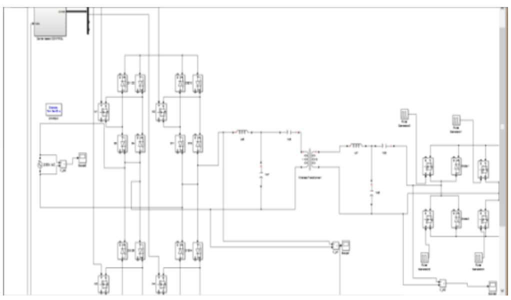

Fig: 4. Simulation diagram of proposed system

B. Carrier Control

Carrier control technique is used to control the voltage and current they given the input of fuzzy

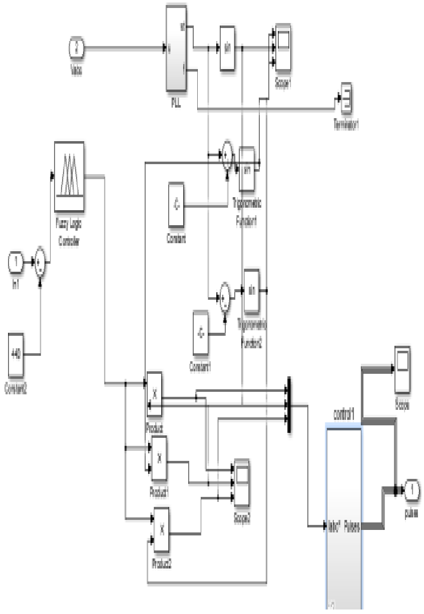

Fig: 5.carrier control

C. Control Pulse

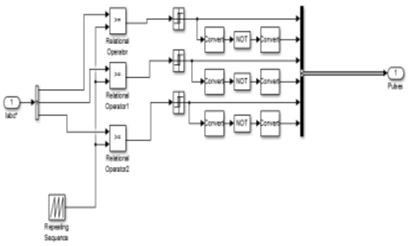

Fig: 6.control pulse

D. Fuzzy Logic Control

Fuzzy logic control has worked in member ship function they input is sine wave output is triangular wave

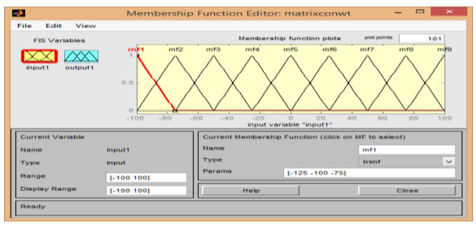

Fig: 7. Plot is drawn by input variables and membership function

E. Membership Function

Membership functions allow us to graphically represent a fuzzy set. The x axis represents the universe of discourse, whereas the y axis represents the degrees of membership in the [0, 1] interval.

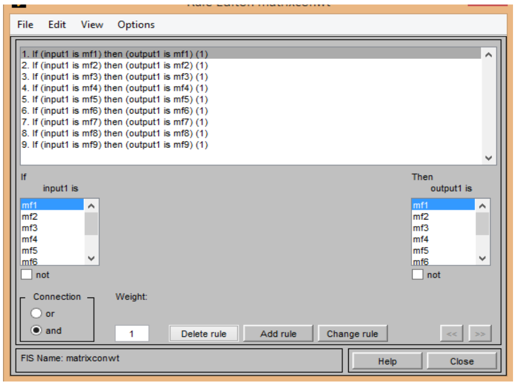

Fig: 8. membership function

F. Simulation Parameter

This is the block diagram for control parameters showing different modes of operation in which we can select the voltage regulation mode and Vary regulation mode. Also we can set the external reactive current Iq ref for grid side to zero which gives flexibility to simulate various fault 47 conditions. Here we input the required values of voltage regulator gains (both proportional and integral), power regulator gains, current regulator gains and their respective rate of change.

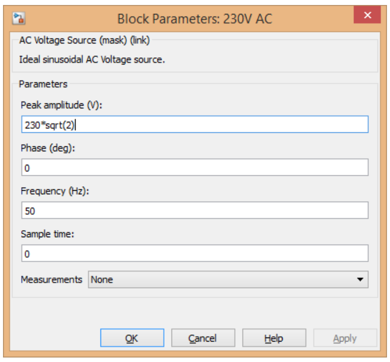

Fig: 9.simulation parameters

G. Input Voltage Of Proposed System

They input voltage is given to the circuit is 230v

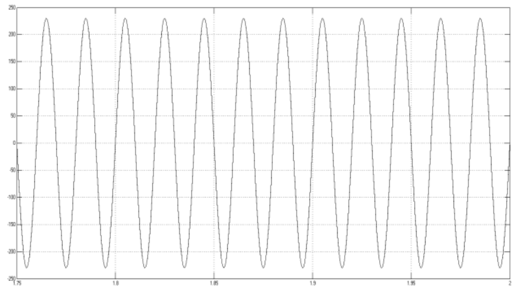

Fig: 10.Input voltage of proposed system is input voltage is given to the circuit is 230v

H. Output Voltage of Proposed System

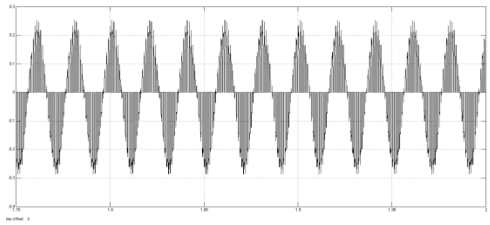

Fig: 11. Output voltage of proposed system is voltage is 220v

VI. CONCLUSION

Fuzzy based grid contactless system for matrix converter system has been presented in order to investigate the variation of the grid current total harmonic distortion (THD) as well as the power factor with phase modulations of the MC and the secondary converter. The validity of the proposed model has been verified by simulation results. The Fuzzy based grid contactless system for matrix converter system exhibit significantly lower grid current THD along with a higher power factor over the normal MC based system. Fuzzy logic shows the better performance in suppressing the harmonics of linear load currents in terms of THD. Simulation results displayed the effectiveness of Matrix Converter with reduced THD values.

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