International Journal for Research in Engineering Application & Management (IJREAM)
ISSN : 2454-9150 Vol-04, Issue-02, May 2018

Hardware Implementation Of Multi-Level Inverter Based DVR

Mr. Vishal V. Ghatge, PG Student, **Department of Electrical, Electronics & Power, MGM's JNEC,Aurangabad,vishalghatge60@gmail.com**

Prof. Anjali V. Naik, Assistant Professor, **Department of Electrical, Electronics & Power, MGM's JNEC, Aurangabad,avnaik08@gmail.com**

Abstract **This project proposes the Hardware implementation of the multilevel inverter based DVR system which can mitigate the problem related with the voltage sag in the distribution system for single phase supply. Voltage sag can causes many problems to entire system. The Multi-level inverter based DVR which is used to protect the sensitive equipment such as computer, printer from line fault such as voltage sag. This proposed work consist of the implementation of the DVR in the distribution system is based on the multilevel inverter topology against voltage sag by using microcontroller.**

Keywords* — *Dynamic voltage restorer (DVR), Multi-level inverter (MLI), Power quality, Voltage sag.

I. INTRODUCTION

Now-a-days the use of power electronics devices, computer, printer etc. can create power quality issue. Among those power quality issue the most of them is related to the voltage such as voltage sag, voltage swell etc. As per IEEE the voltage sag is defined as the RMS line voltage decreases to 10 % to 90 % of nominal line voltage. The time interval for voltage sag is about 0.5 Cycle to 1 min. As there are many custom power devices has been used to compensate such problems. Dynamic voltage restorer is one of the device that can be capable of generating and absorbing active and reactive power in distribution system against the voltage Sag [1]. In this paper the multilevel inverter based DVR is used. The multilevel inverter provide much attention in recent year because they can operate with PWM techniques also with amplitude modulation. It can also provide the improve output voltage waveform. Multilevel inverter based DVR provide the compensation of the voltage sag with less voltage stress [2]. Voltage in the distribution system is commonly affected by the disturbances such as voltage sag. Also the voltage levels of system gets increases so multilevel inverter emerged as one of the best solution for high voltage level operation [3]. There are different topologies are used in the case of multilevel inverter that have been discussed [4]. The MATLAB modal have been invented for the system. The Simulation modal is developed for the POD control technique of 5 level diode clamp MLI presented [5]. Interline dynamic voltage restorer can be used to mitigate voltage Sag, its performance is based on the load power factor, simulation modal presented [6]. Simulation modal has been done for closed loop and open loop system, where the PQ theory has been used to generate reference voltage [7]. Z source converter has been implemented for the various power conversions for that impedance circuit is presented [8]. Analysis and implementation of the Five level cascaded H Bridge inverter is presented, the configuration is useful in the constant frequency applications and reactive power compensation [9].

II. DYNAMIC VOLTAGE RESTORER:

The power quality issues like voltage sag voltage swell are more intense disturbances. To avoid such disturbances the various custom power devices are used. DVR is one of the devices used to compensate the voltage sag. It is device that is connected between the source and load at point of common coupling, to regulate load side voltage.

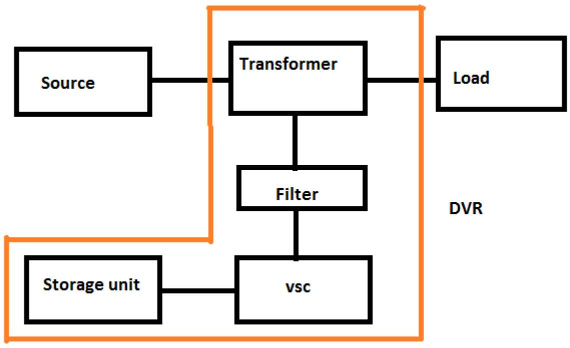

Fig.1 Basic block diagram of DVR

Under normal operating conditions, when there was no voltage sag, DVR provides very less magnitude of voltage to compensate for the voltage drop of transformer and device losses. But when there is a voltage sag in distribution system, DVR will generate a required controlled voltage of high magnitude and desired phase angle which ensures that load voltage is uninterrupted and is maintained.

III. HARDWARE MODEL

In multilevel inverter based DVR, MOSFET bridge circuit, MOSFET driver, Voltage regulator, Microcontroller, Step up transformer is used.

 DOI : 10.18231/2454-9150.2018.0262

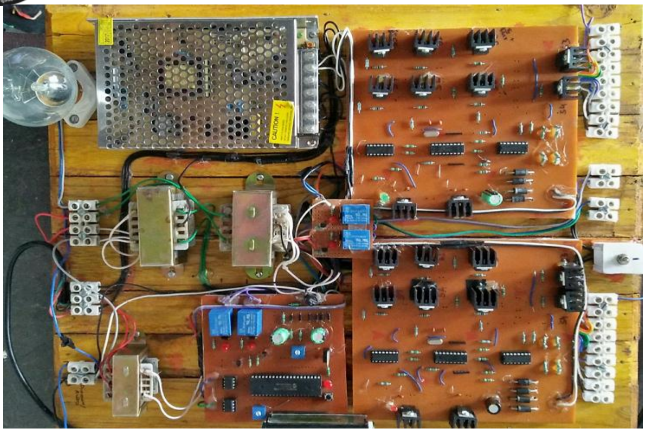

Fig.2 Hardware model of MLI based DVR

In this project we are designing multi stage, Multi-level inverter based dynamic voltage restorer system (DVR) to protect sensitive devices such as computer etc. from line faults such as voltage sag. In this we constantly monitor the input line voltage using voltage reading circuit. This input is given to microcontroller unit. The ADC of microcontroller reads real time voltage. If the voltage is less than 10% of nominal voltage (Voltage Sag) then accordingly microcontroller triggers the MOSFET driver and hence the MOSFET Bridge to produce constant voltage of 230V to protect the load device from voltage sag condition. When voltage is normal then microcontroller turns off triggering to the bridge. Step up transformers are connected in series with the line source and load.

Some of Important part of the MLI Based DVR is:

(1) Voltage reading circuit:

The purpose of designing this circuit is to sense direct line voltage by the microcontroller for getting accurate voltage reading. PIC microcontrollers are capable of sensing direct line voltages. For this we have to design a circuit with a Diode, few Resistors & Capacitors. This analog input is given to PIC microcontrollers ADC pin for reading. The operating frequency of PIC is very high (20 MHz), so any small change in line voltage is sensed quickly and action is taken in fraction of second.

(2) Microcontroller unit (PIC16F877A):

The PIC16F877A Microcontroller is 40 pin IC having 33 I/O Pins, All are Tri-State, It has operating voltage from 3.3 to 5V also it has 8-channel Analog-to-Digital Converter (A/D). PIC Microcontroller is easily available in the market also ideal for high power applications.

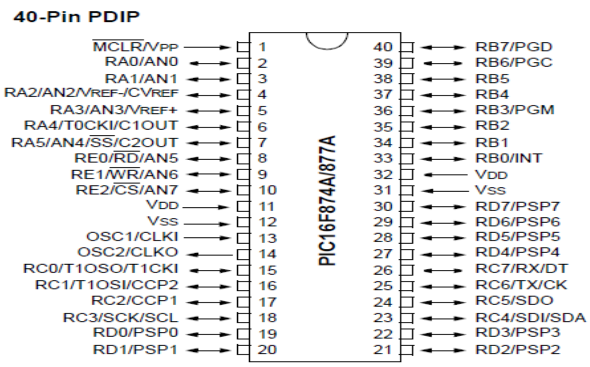

Fig.3 PIC16F877A (40 pin IC)

(3) MOSFET Bridge Circuit:

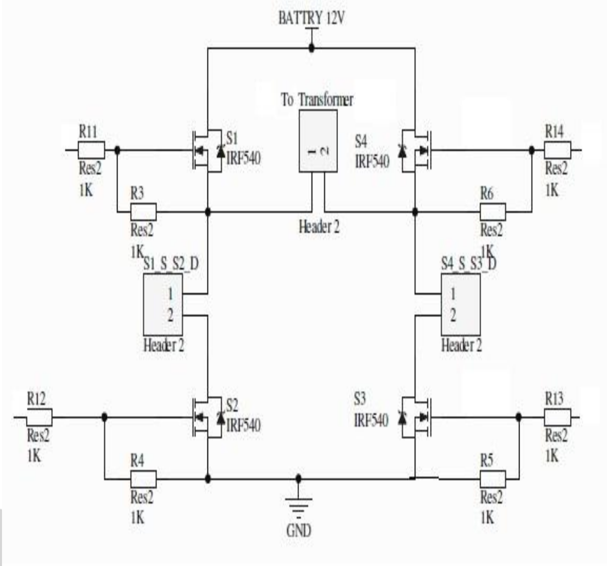

Fig.4 MOSFET Bridge circuit

The MOSFET Bridge circuit in which four MOSFET are connected. S1 & S2 are connected in such a way that source terminal of 'S1' is connected to Drain of 'S2'. Similarly Source of 'S4' is connected to Drain of 'S3'. Drains of 'S1' & 'S4' and Source terminals of 'S2' & 'S3' are connected to each other to form a bridge network & are connected to 12V battery '+ve' & '-ve' respectively. All MOSFETS are triggered by microcontroller through resistance of (S1 by R11; S2 by R12; S3 by R13; S4 by R14). Also Resistances R3, R4, R5 & R6 of each are connected between Gate & Source terminal of each MOSFET S1-S4 respectively to avoid triggering of Gate terminal due to floating voltage. Output of Bridge 'Header 2' with name 'To Transformer' is connected to Step up transformer to boost voltage from 12V to 230V. Battery Voltage of 12V and Ground terminal are connected to Bridge as shown. All four MOSFETs are triggered in Chris-Cross way i.e. 'S1' & 'S3' are triggered ON simultaneously keeping 'S2' & 'S4' OFF while 'S2' & 'S4' are triggered ON simultaneously keeping 'S1' &'S3' OFF.

(4) MOSFET IRF540 :

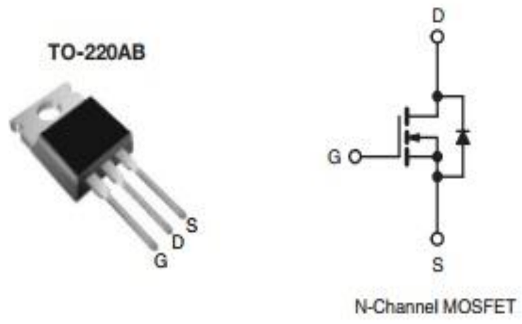

Fig.5 MOSFET IRF540

MOSFET are used for the switching purpose. It required simple drive requirement. It is having gate voltage rating of +/- 20V.

DOI : 10.18231/2454-9150.2018.0262

ISSN : 2454-9150 Vol-04, Issue-02, May 2018

TABLE 1 COMPONENT & RATINGS

COMPONENT	RATING
Step down transformer	230V/12V
Step up transformer	12V/30V
microcontroller	PIC16F877A
MOSFET IRF540	+/- 20V
Lamp load	25W,230V,50Hz
SMPS	12V,5A

IV. RESULT AND DISCUSSION

The complete hardware implementation of MLI based DVR is shown in fig.6, where multilevel & multistage inverter is used. In this project we have design two multilevel inverter (each can generate seven- level waveform). Under normal operation the voltage is around 230v. When the voltage is less then 190V means there is occurrence of voltage sag then it will trigger 2 relays & one stage gets activated. when there sag detected which is less than 170V then all 4 relays gets triggered & it will activate the stage 1&2 both so that voltage gets boost to compensate the voltage sag.

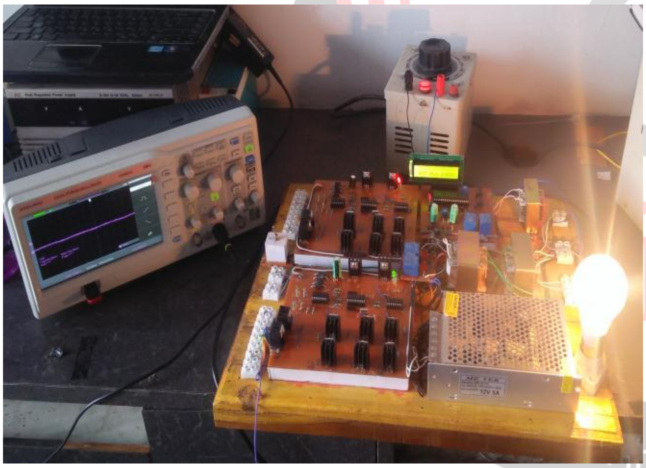

Fig.6 Setup of MLI based DVR

There are Eight MOSFET switches are used in one MOSFET Bridge circuit i.e. S1,S2,S3,S4,S5,S6,S7,S8 etc. The switching pulse waveform is shown below:

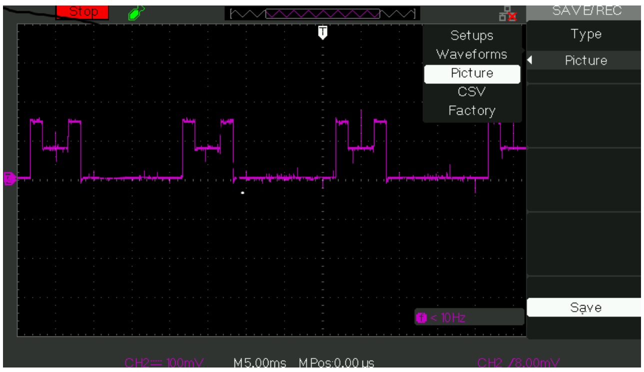

Fig.7 Switching pulse of switch S1

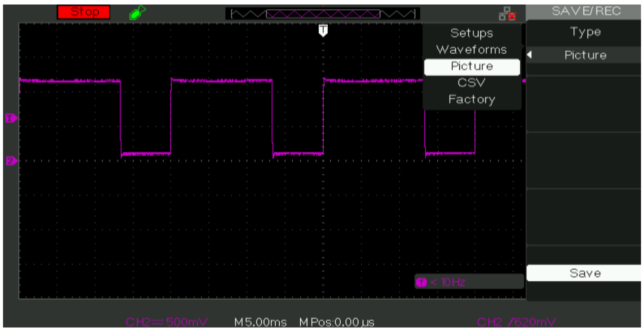

Fig.7 Switching pulse of switch S2

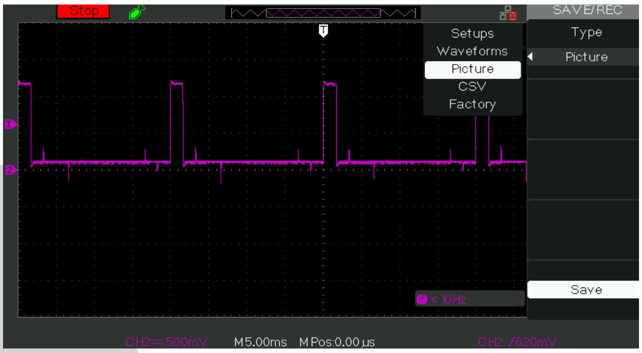

Fig.8 Switching pulse of switch S3

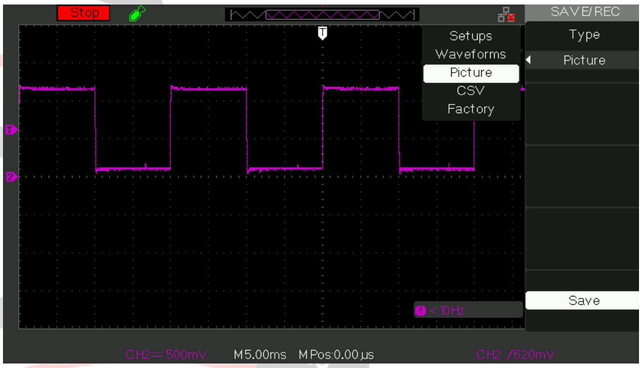

Fig.9 Switching pulse of switch S4

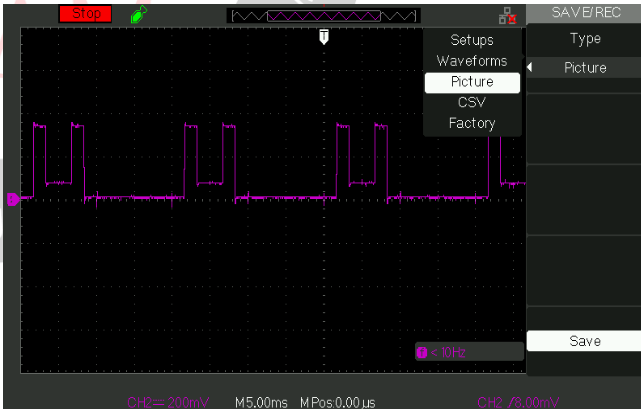

Fig.10 Switching pulse of switch S5

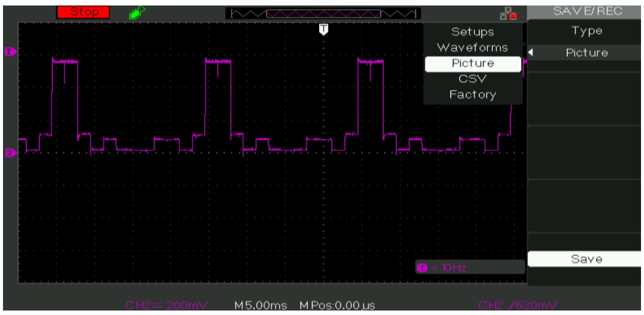

Fig.11 Switching pulse of switch S6

 DOI : 10.18231/2454-9150.2018.0262

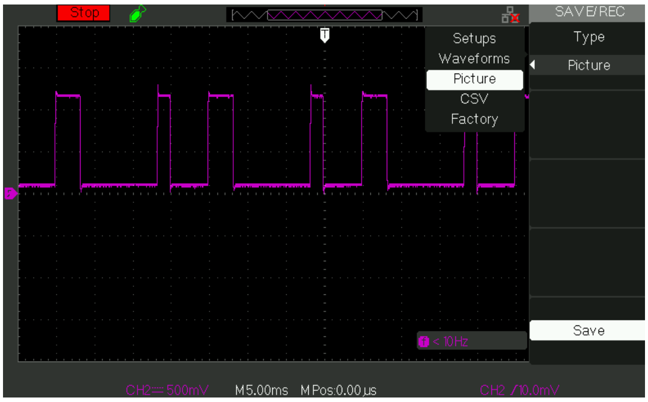

Fig.12 Switching pulse of switch S7

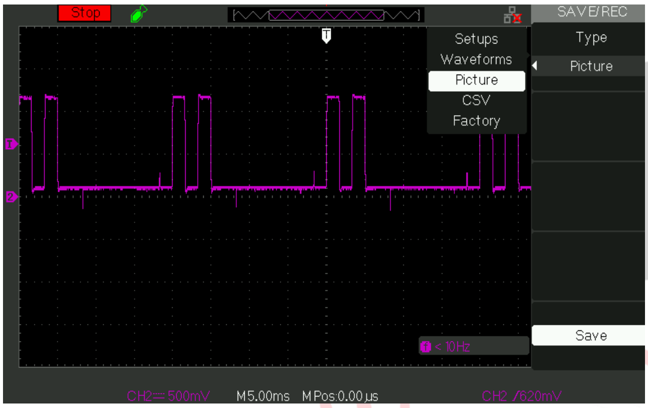

Fig.12 Switching pulse of switch S8

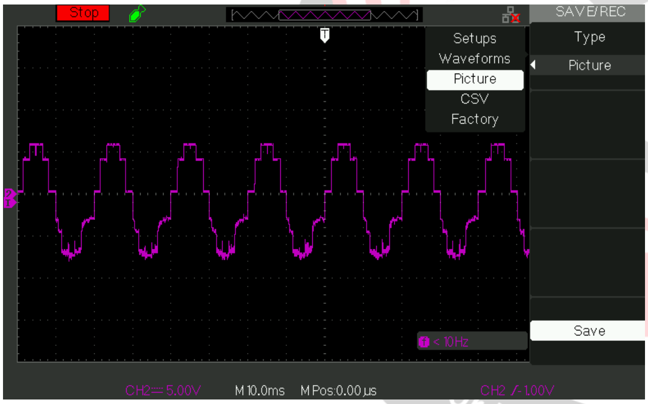

Fig.13 MLI output waveform with load

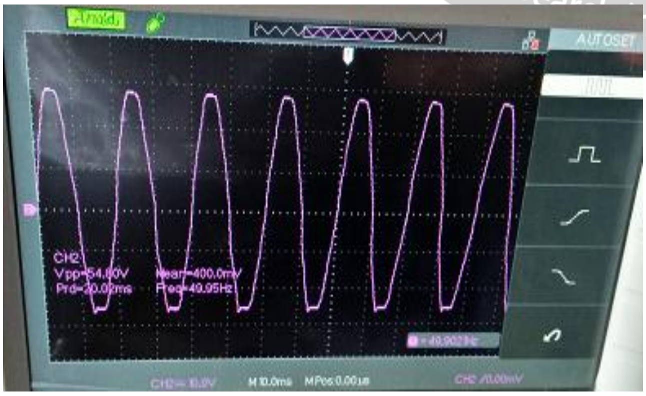

Fig.14 Waveform after sag compensation

The output waveform is shown in Fig.14 is the waveform obtain after sag compensation. When the voltage is less than 190V then one stage of MLI inject the voltage to compensate the voltage sag.

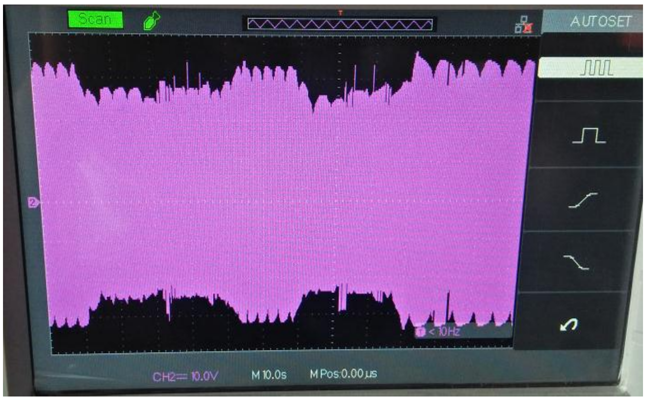

Fig.15 sag compensation

In above Fig.15 shows whenever the Voltage is less than 190V than the one stage inject the voltage in the system. When the voltage is less than 170V, both stage of multilevel inverter to be trigger to compensate voltage sag.

V. Conclusion

The hardware implementation of multilevel inverter based DVR is represented. DVR is the one of the custom power device, which can compensate the voltage sag in the system. It can be one of the effective solution, small size & fast response device. The result shows that MLI based DVR technique implemented can compensate the voltage sag effectively. Multilevel inverter can inject the waveform when voltage sag is detected to boost the voltage with low harmonic distortion.

References

[1] Smitha Sethumadhavan, "Hardware Implementation of MLI Based Dynamic Voltage Restorer''International Journal of Science and Research (IJSR) ISSN (Online): 2319-7064

[2] Dr.A.Jaya Laxmi, Dr. K. Uma Rao, "Hardware Implementation Of Single Phase Dynamic Voltage Restorer",16th National Power System Conferances15th-17th December, 2010.

[3] D.MohanReddy,T.Gowrimanoher,"Mitigation of interruption and voltage sag, swell using cascade multilevel inverter based dvr'', International Journal of Electrical and Electronics Engineering Research (IJEEER)

[4] Anand Mishra,Manoj Solanki, "Multilevel Inverter: A Review on Methodology, Topologies & Techniques", IJCSNT 2017/ijcsnt.2017.6.1.01

[5] Girish Singh Kushwaha, Tarun Tailor, Lokesh Chadokar, "Dynamic Voltage Restorer Based on Multilevel Inverter", International Research Journal of Engineering and Technology (IRJET) e-ISSN: 2395 -0056 Volume: 04 Issue: 04 | Apr 2017

[6] Masoud Shahabadini and Hossein Iman-Eini, "Improving the Performance of Cascaded H-bridge based Interline Dynamic Voltage Restorer'', 0885-8977 (c) 2015 IEEE.

 DOI : 10.18231/2454-9150.2018.0262

[7] Alexander Kara,"Power Supply Quality improvement using dynamic voltage restorer" IEEE 1998.

[8] Shazly A. Mohammed, Aurelio G. Cerrada, Abdel-Moamen M. A, and B. Hasanin, "DVR System for compensation of voltage sag", International Journal Of Computational Engineering Research (ijceronline.com) Vol. 3 Issue. 1

[9] Fang Zheng Peng, "Z-Source Inverter", IEEE Transactions of Industry applications, Vol. 39, No. 2, march/april 2003.

[10] Ebrahim Babaei " A new scheme for MLI based DVR", International conference on Electrical machines and systems ICEMS,PPI-69(2011).

[11] Dugan, R.,Santoso, S.,Mcgranaghan(2003) Electrical Power quality: New york:Mcgraw-Hill

 DOI : 10.18231/2454-9150.2018.0262