International Journal of Technical Innovation in Modern Engineering & Science (IJTIMES)
Impact Factor: 3.45 (SJIF-2015), e-ISSN: 2455-2585
Volume 3, Issue 12, December-2017

PV Compensation in Improving the Voltage Quality in LV Electrical Networks

Lakshmi Devi Porupureddi, Dr. A.Aruna Kumari

PG student, department of mechanical engineering, JNTUH college of engineering, Hyderabad

Professor, department of mechanical engineering, JNTUH college of engineering, Hyderabad

devi.porupureddi@gmail.com

arunajntu@yahoo.co.in

***Abstract*:** Of all known power quality problems, voltage sags provide the greatest cause for concern. Sags occur more frequently than outages and therefore, tend to be more costly for the high –technology industry as modern technical equipments need a good quality voltage. Voltage sag can affect both the magnitude and phase of the voltage. Although the voltage sag is only for a short duration, sensitive equipments may malfunction.The project aims to compensate the voltage sag with solar power batteries with invertes.At day time solar power PV panel charge the batteries and when ever sag occurs,the voltage is compensated with synchronized inverter in series with the existing transformer.The Series voltage regulator regulates the output voltage by injecting voltage in synchronism with the supply when an upstream sag is detected, thus protecting the loads from voltage sags.It is cost effective customer based solution to regulate the voltage sag which improves voltage quality at load side and can be directly connected to AC power line

Keywords: voltage drop, transformers, aurdino mega 2560, PV system, tap changing process

I.INTRODUCTION

photovoltaic systems connected to a network are increasingly used in developed countries. these systems are installed at the prospect of developing this type of clean energy without the emission of pollutant gases.the availability of energy is an important factor for the development and improvement of living conditions of the population. the availability at all times and the quality of this energy are highly demanded. thus, the quality of the voltage measured by the voltage drop becomes unacceptable when it exceeds 10%. the distributor makes various techniques such as: strengthening of sections of the conductors, installation of new stations mv / lv transformers, etc.. knowing that the voltage quality is affected by the distance between the power source and load. the installation of pv systems connected to the grid, in underserved areas, is a solution increasingly used to solve the problem of voltage drop and for the same opportunity to provide clean electricity.support tools to determine the profitability and performance of pv systems connected to the lv network have been used.the connection instead of the voltage drop to a mini-solar power plant, improves the electrical quality of the line by injecting into the network of clean electrical energy photovoltaic own to benefit the rural population. A voltage sag or voltage dip is a short duration reduction in rms voltage which can be caused by a short circuit, overload or starting of electric motors. A voltage sag happens when the rms voltage decreases between 10 and 90 percent of nominal voltage for one-half cycle to one minute.

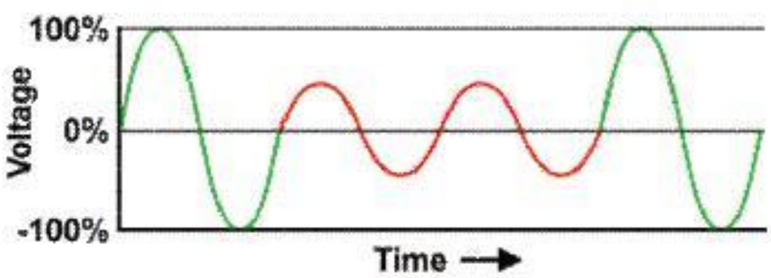


Fig1: Voltage Sag

A) Causes of voltage sag: There are several factors which cause voltage sag to happen:Since the electric motors draw more current when they are starting than when they are running at their rated speed, starting an electric motor can be a reason of a voltage sag.When a line-to-ground fault occurs, there will be a voltage sag until the protective switch gear operates.Some accidents in power lines such as lightning or a falling object can be a cause of line-to-ground fault and a voltage sag as a result.Sudden load changes or excessive loads can cause a voltage sag.Depending on the transformer connections, transformers energizing could be another reason for voltage sags happening.Voltage sags can arrive from the utility but most are caused by in-building equipment. In residential homes, voltage sags are sometimes seen when refrigerators, air-conditioners, or furnace fans start up. Voltage sags can also be caused by the switching of heavy loads or the starting of large motors. To illustrate, an induction motor can draw six to ten times of its full load current during starting. If the current magnitude is relatively larger than the available fault current at that point in the system, the voltage sag can become significant.

B)Voltage compensation: When the voltage is below the required level, reactive power produced by inductance needs to be offset by capacitance. Synchronous condensers—can be used to generate reactive power, when they are operated as a motor. Shunt Capacitance—Capacitor banks can be connected in parallel to the transmission lines.

C)Alternate voltage compensation for low voltage: In a power system, voltage at various buses tends to increase or decrease during its daily operation. To ensure constant voltage to consumers, various techniques are utilized.When the voltage is below the required level, reactive power produced by inductance needs to be offset by capacitance.

- Synchronous condensers—can be used to generate reactive power, when they are operated as a motor.
- Shunt Capacitance—Capacitor banks can be connected in parallel to the transmission lines.
- Series Capacitance—Capacitors connected in series, especially for long lines can be used to raise the voltage.
- Tap Changing Transformers—Transformer tappings can be automatically changed, to alter the voltage accordingly\]

II. Methodology

A) Model representation:

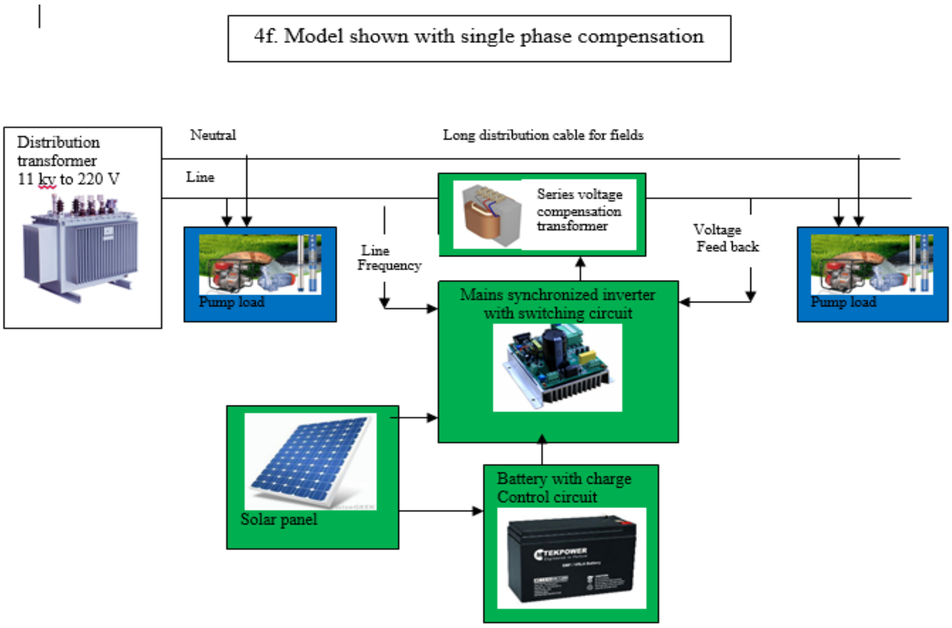


Fig 2: model representation

B) Solar power system: A Solar Photo Voltaic panel designed to absorb the sun's rays as a source of energy for generating electricity The Sun – that massive nuclear power plant in the sky – bathes Earth in enough energy to fulfill all the world's power needs many times over. All life on earth gets its energy from the Sun; even the coal and oil burned today produces power by releasing the stored solar energy from hundreds of millions of years ago, thus the name "fossil fuels."

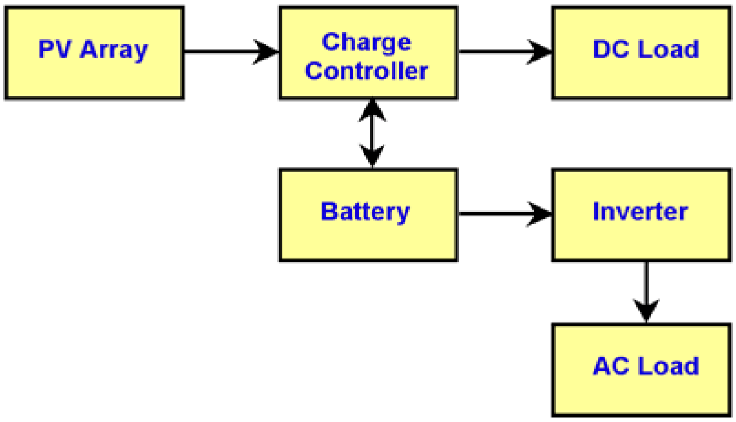


Fig 3: flow chart representing solar power system

All light, including sunlight, contains energy. Usually when light hits an object, the energy turns into heat, but when light hits certain materials, like a solar panel, the energy instead turns into an electrical current, which we can then harness for power.Solar photovoltaic (PV) panels use silicon crystals, which produce an electrical current when struck by light. While silicon is very efficient at turning light energy into electricty

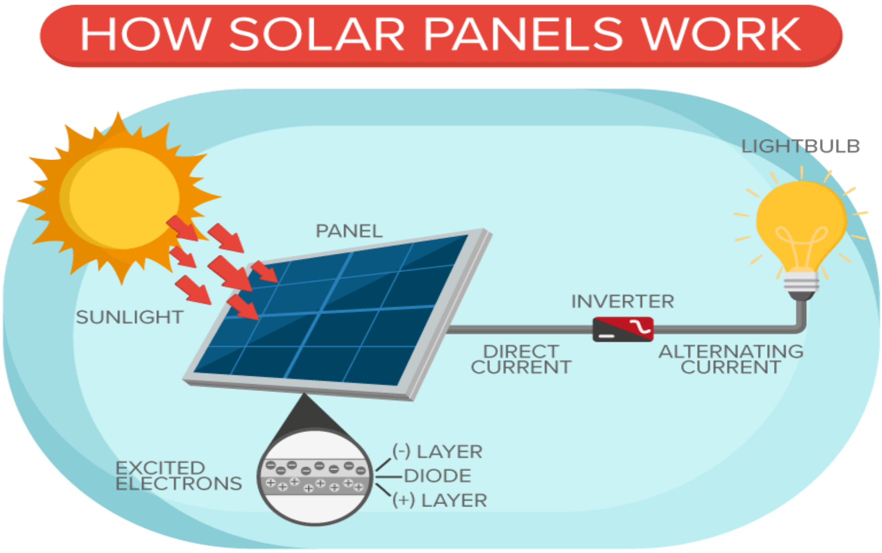


Fig 4: working of solar panel

*C) Bright future for solar power:*It is very important that we continue to harness and increase our use of solar power (and other clean, renewable energies) especially as fossil fuels become depleted, more expensive, and fall out of favor with their consumers. Solar power is one of the safest, cleanest, and most reliable forms of producing electricity in the world today. As the global demand for energy grows and conventional energy resources become increasingly costly to extract, people are looking to the power of the Sun. In contrast to fossil fuels, the price of solar has fallen dramatically as its use has become ubiquitous. According to Swanson's Law, when solar manufacturing capacity doubles, prices fall by 20%. Solar is no longer cost prohibitive; the price of producing electricity from solar panels has dropped from Rs 300 per watt in 1976 to Rs 30 per watt in 2016 with prices only continuing to drop due to better technology, a more mature industry, and more innovative financing plans.

D) Why solar panels? Why is solar energy important to us? Every beam of light that we can convert into electricity is another step in reducing our dependence on polluting fossil fuels, and that's one way we can help preserve our planet for ourselves and future generations. The solar power is used to charge the batteries as well directly power the power (Ac power 50 Hz) Amplifier when the sun is available

E) Batteries: In electricity, a battery is a device consisting of one or more electrochemical cells that convert stored chemical energy into electrical energy There are two types of batteries: primary batteries (disposable batteries), which are designed to be used once and discarded, and secondary batteries (rechargeable batteries), which are designed to be recharged and used multiple times. Batteries come in many sizes; from miniature cells used to power hearing aids and wristwatches to battery banks the size of rooms that provide standby power for telephone exchanges and computer data centers.

F)Sealed Lead-acid batteries: A VRLA battery stands for (valve-regulated lead-acid battery)[1] more commonly known as a sealed lead-acid (SLA), gel cell, or maintenance free battery, is a type of lead-acid rechargeable battery. Due to their construction, the Gel and Absorbed Glass Mat (AGM) types of VRLA can be mounted in any orientation, and do not require constant maintenance. They are widely used in large portable electrical devices, off-grid power systems and similar roles, where large amounts of storage are needed at a lower cost than other low-maintenance technologies.

G) Solar Battery Charge Controllers: The Solar Controller will continuously monitor the charge and cut it off when charging is complete, Preventing overcharge, Prevent battery discharge and also the solar panels are made with blocking diodes to prevent battery discharge during low light conditions.

H) Inverters: The role of an inverter is to convert the direct current produced by the battery into alternating current required by all your house hold devices, while taking power mainly from solar panel when the High light is present and also charges the Battery. When in low light or night the Inverter takes power from the batteries. The Ac produced is given to primarily of compensations transformer via tapping based on the requirement of compensation.

III. COMPENSATION TRANSFORMER

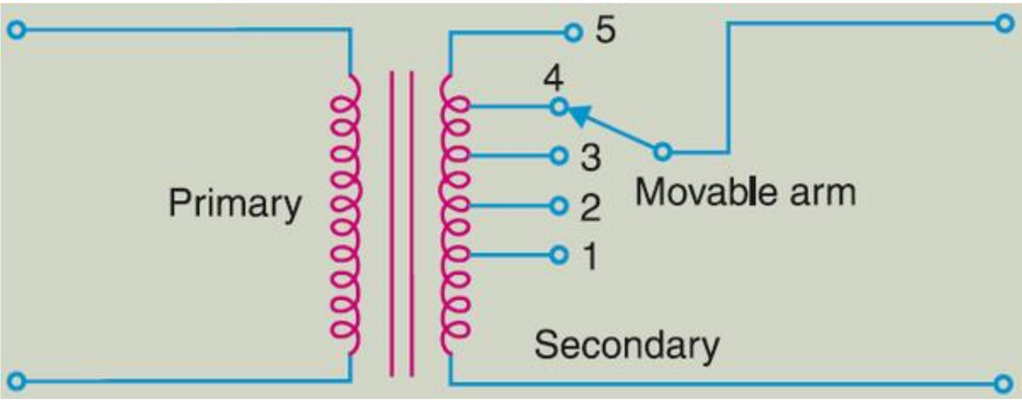


Fig 5: multi tap transformer

Taking in to consideration voltage levels are as low as 140 voltages the compensation required is almost 60 Vac. The secondary of the transformer is fixed to 60 volts but the primary has 4 tapping which is switched by the relays. The compensation rated as follows to maintain at least 200 to 220 volts AC. For 140 volts compensation is 60 Vac, For 150 volts compensation is 50 Vac, For 170 volts compensation is 40 Vac and For 190 volts compensation is 30 Vac. The compensation transformer is placed in series with in between line out going for loads at far away distance from the distribution transformerFor demonstration we will be using a 24 volts AC voltage transformer and voltage variation we will create from 14to 24volts (140 to 240) with tapping changing at the secondary of the transformer and the Compensation transformer will compensate up to 6 Vac and 1 amp load.

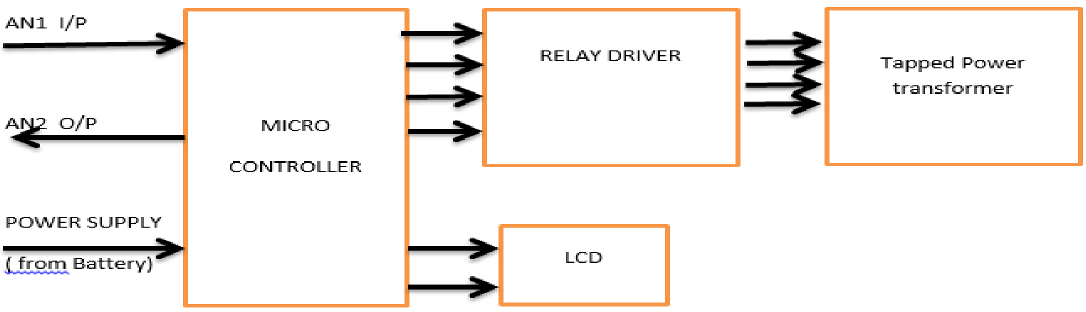
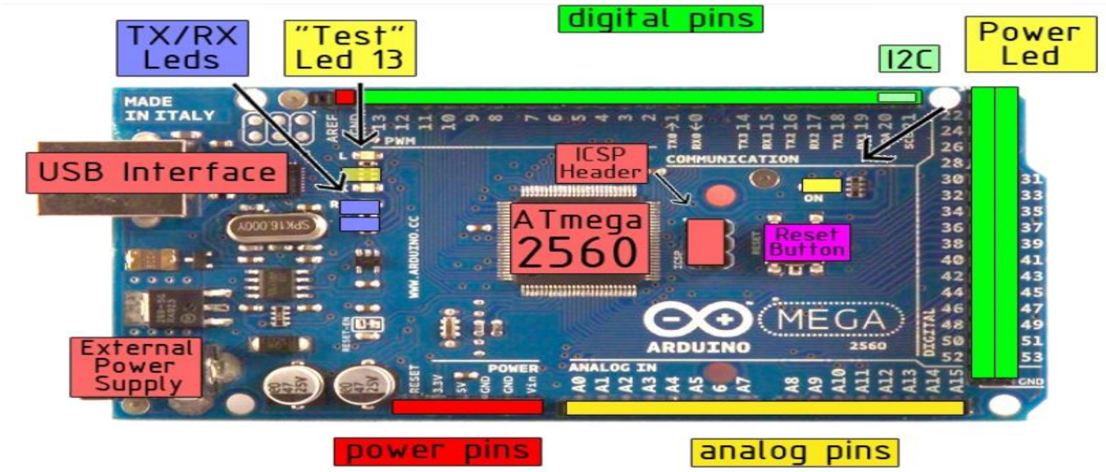


Fig 6: control unit

A)MICRO CONTROLLER(AURDINO MEGA 2560):

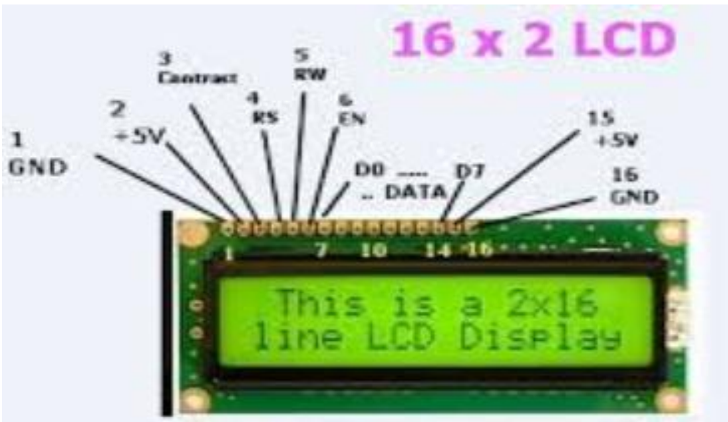
The Arduino Mega 2560 is a microcontroller board based on the ATmega2560. It has 54 digital input/output pins (of which 14 can be used as PWM outputs),16 analog inputs, 4 UARTs(hardware serial ports), a 16 MHz crystal oscillator, a USB connection, a power jack, an ICSP header, and a reset button.



B) RELAY DRIVER(UL 2003):

A Relay driver IC is an electro-magnetic switch that will be used whenever we want to use a low voltage circuit to switch a light bulb ON and OFF which is connected to 220V mains supply.

LCD:A liquid-crystal display (LCD) is a flat-panel display or other electronically modulated optical device that uses the light-modulating properties of liquid crystals.



IV. RESULTS & DISCUSSION:

System architecture in a nut shell:

Taking in to consideration voltage levels are as low as 140 voltages the compensation required is almost 60 Vac. The secondary of the transformer is fixed to 60 volts but the primary has 4 tapping which is switched by the relays. The compensation rated as follows to maintain at least 200 to 220 volts AC.

Taking in to consideration voltage levels are as low as 140 voltages the compensation required is almost 60 Vac. The secondary of the transformer is fixed to 60 volts but the primary has 4 tapping which is switched by the relays. The compensation rated as follows to maintain at least 200 to 220 volts AC.

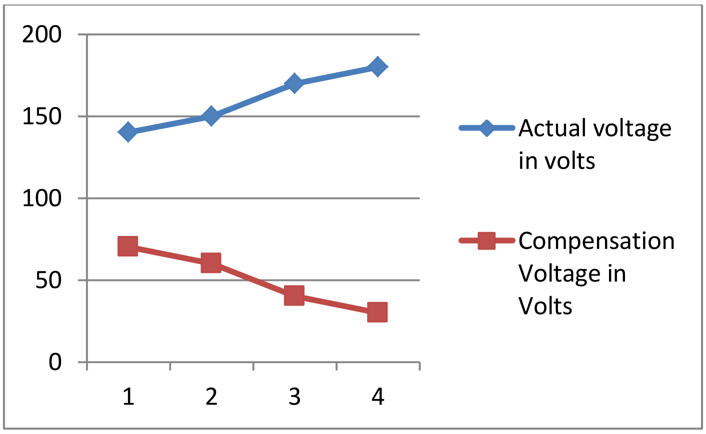
For 140 volts compensation is 60 Vac, For 150 volts compensation is 50 Vac, For 170 volts compensation is 40 Vac and For 190 volts compensation is 30 Vac. The compensation transformer is placed in series with in between line out going for loads at far away distance from the distribution transformer

Actual voltage in volts	Compensation Voltage in Volts
140	70
150	60
170	40
180	30

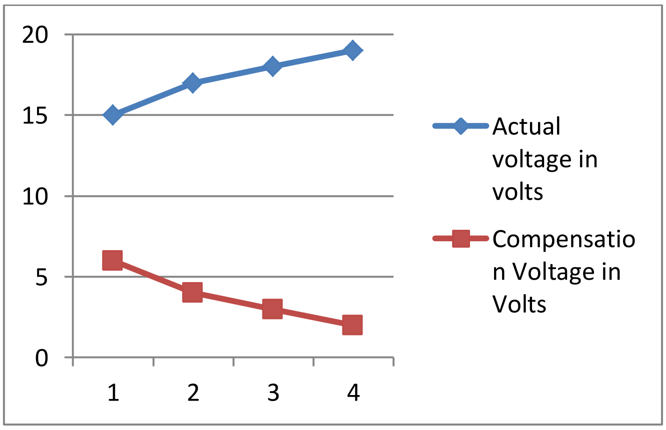
For demonstration we will be using a 24 VOLTS AC TRANSFORMER and voltage variation we will create from 14to 24volts (140 to 240) with tapping changing at the secondary of the transformer and the Compensation transformer will compensate up to 6 Vac and 1 amp load.

Actual voltage in volts	Compensation Voltage in Volts
15	6
17	4
18	3
19	2

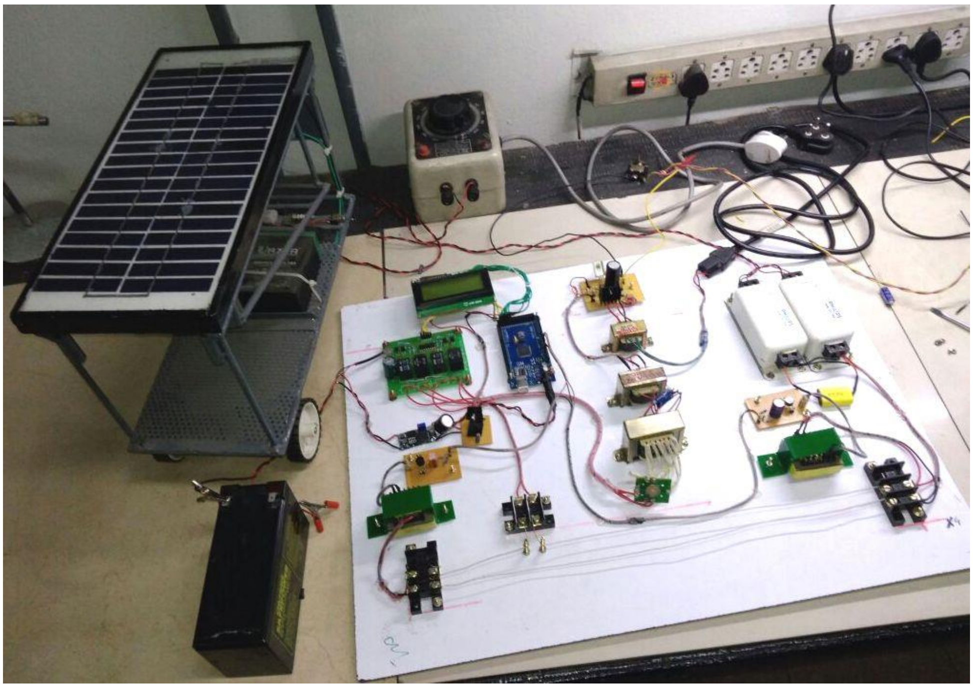
For 230vac the graphical view (Actual voltage in volts vs Compensation Voltage in Volts)



FOR 24VDC THE GRAPHICAL VIEW (ACTUAL VOLTAGE IN VOLTS VS COMPENSATION VOLTAGE IN VOLTS)



Model represtation:



V. CONCLUSION

By implementing this solution we overcome the voltage sag in rural distribution lines with solar power batteries with inverters.

At day time solar power PV panel charge the batteries and whenever sag occurs, the voltage is compensated with synchronized inverter in series with the existing transformer.

The Series voltage regulator regulates the output voltage by injecting voltage in synchronism with the supply when an upstream sag is detected, thus protecting the loads from voltage sags.

It is cost effective customer based solution to regulate the voltage sag which improves voltage quality at load side and can be directly connected to AC power line.

VI. REFERENCES

[1]ALI NACI CELIK, NASIR ACIGOZ. MODELING AND EXPERIMENTAL VERIFICATION OF THE OPERATING CURRENT OF MONO – CRYSTALLINE PV MODULES USING FOUR AND FIVE PARAMETER MODELS. SCIENCE DIRECT.

[2]HTTP://IEEEXPLORE.IEEE.ORG/DOCUMENT/7449281

[3]HTTP://WWW.CIRED.NET/PUBLICATIONS/CIRED2001/2_41.PDF

[4]HTTP://WWW.INGENTACONNECT.COM/CONTENT/TCSAE/TCSAE/2016/00000032/A00100S1/ART00028

[5]HTTP://WWW.BAHDELA.COM/INDEX.PHP?ID_PRODUCT=30&CONTROLLER=PRODUCT

[6]HTTPS://WWW.IJAREEIE.COM/UPLOAD/2014/FEB14-SPECIAL/21_PAPER%2037.PDF

[7]HTTP://IEEEXPLORE.IEEE.ORG/DOCUMENT/7846199/?RELOAD=TRUE

[8]HTTP://IEEEXPLORE.IEEE.ORG/DOCUMENT/6533412/

[9]HTTPS://CLEANTECHNICA.COM/2013/10/05/A-POTENTIAL-SOLUTION-FOR-LONG-DISTANCE-POWER-TRANSMISSION-LEAKAG