A Project Report On

SMART GRID

Submitted in fulfillment of the requirement for Bachelor Of Engineering In Electrical Engineering

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Certificate

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This is to certify that students have satisfactorily completed her project work titled "***SMART GRID***". Along with his batch mates in partial fulfillment for the Bachelor of Engineering in Electrical Engineering. Under "Mumbai University" Mumbai. During academic year 2019-2020.

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DECLARATION

I hereby declare that I have formed, completed and written the dissertation entitled "**SMART GRID**". It has not previously submitted for the basis of the award of any degree or diploma or either similar title of this for any other diploma/examining body/university.

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It is indeed a matter of great pleasure and privilege to be able to present this project on **"SMART GRID"** The completion of the project work which is partial fulfillment of Degree academic works is a milestone in student's life and its execution is inevitable in the hands of guide. I am highly indebted to the project guide **Prof. IFTEKHAR PATEL** for their invaluable guidance and appreciation for giving form and substances to this report. It is due to their enduring efforts, patience and enthusiasm which has given a sense of direction and purposefulness to this seminar report and ultimately made it success.

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ABSTRACT

The smart grid delivers electricity from producers to consumers using two-way digital technology, and allows control of appliances in the consumer's houses and of machines in factories to save energy, while reducing costs and increasing reliability and transparency. Such a modern electricity network is promoted by many governments as a way of handling energy independence, global warming and security of supply

A smart grid includes an intelligent monitoring system that keeps track of all the electricity that flows in the system. It could incorporate the use of super-conducting transmission lines to reduce losses, as well as the ability to integrate electricity from alternative sources such as solar and wind. When electricity cost is low, the smart grid can offer the customer to run intensive consumption household appliances, such as washing machines, or processes in plants that operate at flexible hours. On the other hand, smart grid at peak hours can, in coordination with the client, turn off selected appliances and machines to reduce demand.

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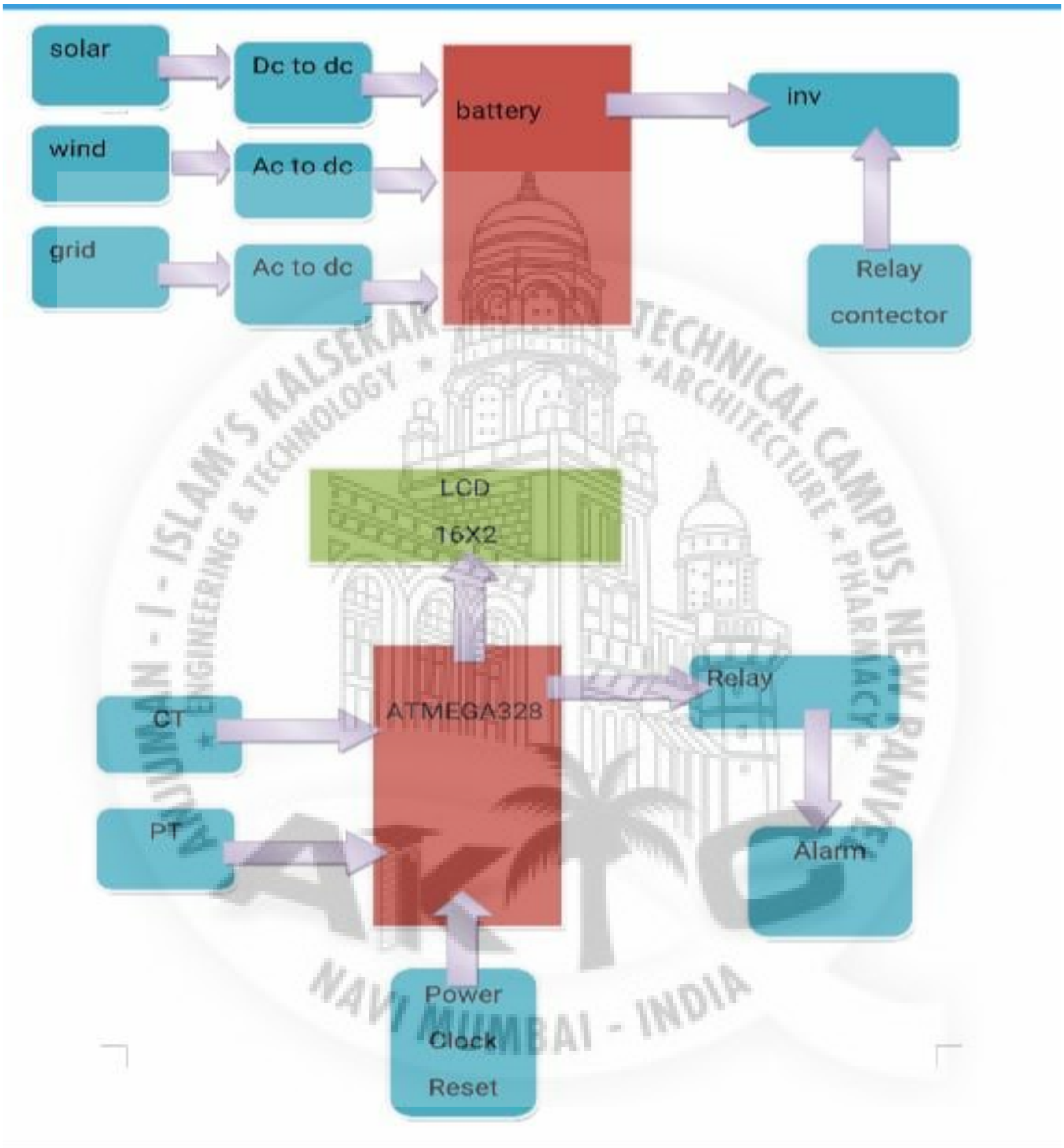
1. INTRODUCTION

The Smart Grid is the modernization of the electricity delivery system. A smart grid differs from the traditional grid in that it allows two-way communication of electricity data, rather than a one way flow. Smart grids enable real time data collection concerning electricity supply and demand during the transmission and distribution process, making monitoring, generation, consumption and maintenance more efficient.

Most electricity grids are based on one-way interaction from the stages of generation to consumption. Smart grids, on the other hand, integrate the action of all users in the power network using computer-based remote control and automation. This two-way interaction is what makes the grid “smart". Like the internet, the Smart Grid consists of controls, computers, automation, telecommunication and equipment that work together, but in this case, these technologies work with the electrical grid to respond digitally to our quickly changing electric demand.

2. BLOCK DIAGRAM



Over the demand and efficiently provide reliable and high-quality service. The smart grid provides the most effective electrical distribution network through the two-way communication system based on the responses of the customer . Power industries worldwide are unpredictably facing huge challenges. Existing grids are also challenged to perform safely and provide reliable supply. In addition, social and political gain is important and depends on the electricity generation and utilization and its environmental impacts. Developing countries are formulating their policy based on the requirement of an enhanced smart grid.

A huge amount of federal funding has been allocated to promote and assist the smart grid policy in different states. Better management for the smart grid in the electricity industry is time-consuming. The smart grid is integrated into the infrastructure that supplies electricity, which is coupled with modern telecommunication, IT, and sensing technology. The great potentiality of the smart grid is defined by its capability to process and to analyze a huge amount of data and to implement critical demand management. The smart grid pro-vides flexible opportunity to the system operator and the end users with its use of artificial intelligence and integration with.

3. COMPONENTS OF SMART GRID

Followings are the components used in smart grid:-

3.1. Distributed Energy Resources.

3.2. Standard Meter.

3.3. Communication Circuit.

3.4. Meeting Load.

3.1. DISTRIBUTED ENERGY RESOURCES:-

3.1.1. Power Supply.

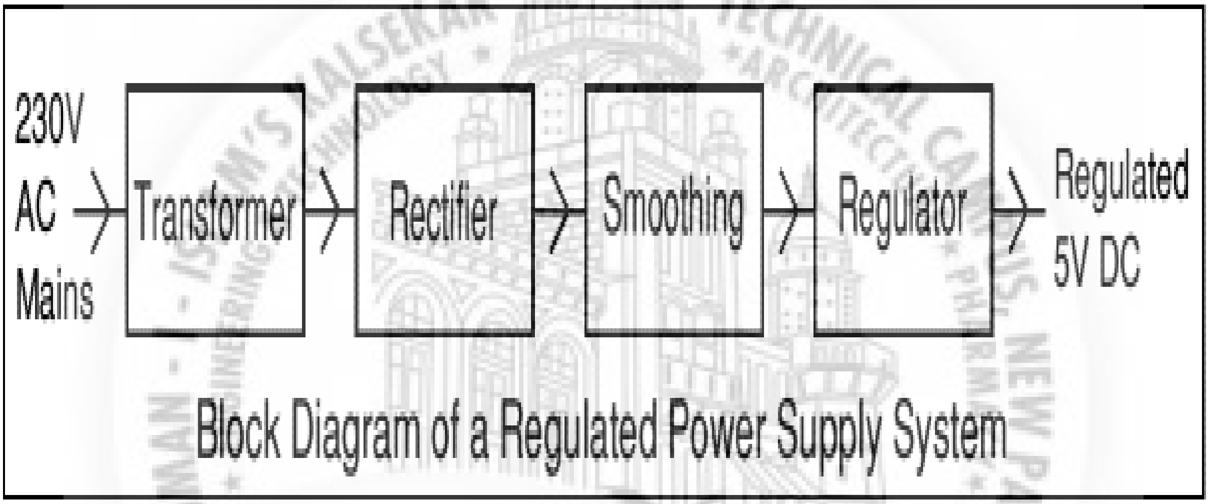
3.1.2. Solar Pannel.

3.1.3. Wind.

3.1.1. POWER SUPPLY

There are many types of power supply. Most are designed to convert high voltage AC mains electricity to a suitable low voltage supply for electronic circuits and other devices. A power supply can by broken down into a series of blocks, each of which performs a particular function.

For example a 5V regulated supply:



Each of the blocks is described in more detail below

- Transformer - steps down high voltage AC mains to low voltage AC.
- Rectifier - converts AC to DC, but the DC output is varying.
- Smoothing - smoothes the DC from varying greatly to a small ripple.
- Regulator - eliminates ripple by setting DC output to a fixed voltage

3.1.2. SOLAR PANEL

A solar cell (also called a photovoltaic cell) is an electrical device that converts the energy of light directly into electricity by the photovoltaic effect. It is a form of photoelectric cell (in that its electrical characteristics—e.g. current, voltage, or resistance—vary when light is incident upon it) which, when exposed to light, can generate and support an electric current without being attached to any external voltage source.

Photovoltaics is the field of technology and research related to the practical application of photovoltaic cells in producing electricity from light, though it is often used specifically to refer to the generation of electricity from sunlight. Cells can be described as *photovoltaic* even when the light source is not necessarily sunlight (lamplight, artificial light, etc.). In such cases the cell is sometimes used as a photodetector (for example infrared detectors), detecting light or other electromagnetic radiation near the visible range, or measuring light intensity.

3.1.3. WIND

Wind energy is harnessed by wind turbines, which convert the energy of the wind into electricity. Wind energy is one of the largest sources of renewable energy. Winds are caused by the uneven heating of the atmosphere by the sun, the irregularities of the earth's surface, and rotation of the earth. This wind flow, or motion energy, when "harvested" by modern wind turbines, can be used to generate electricity. Wind speed generally increases with height, which is why wind turbines tend to be very tall.

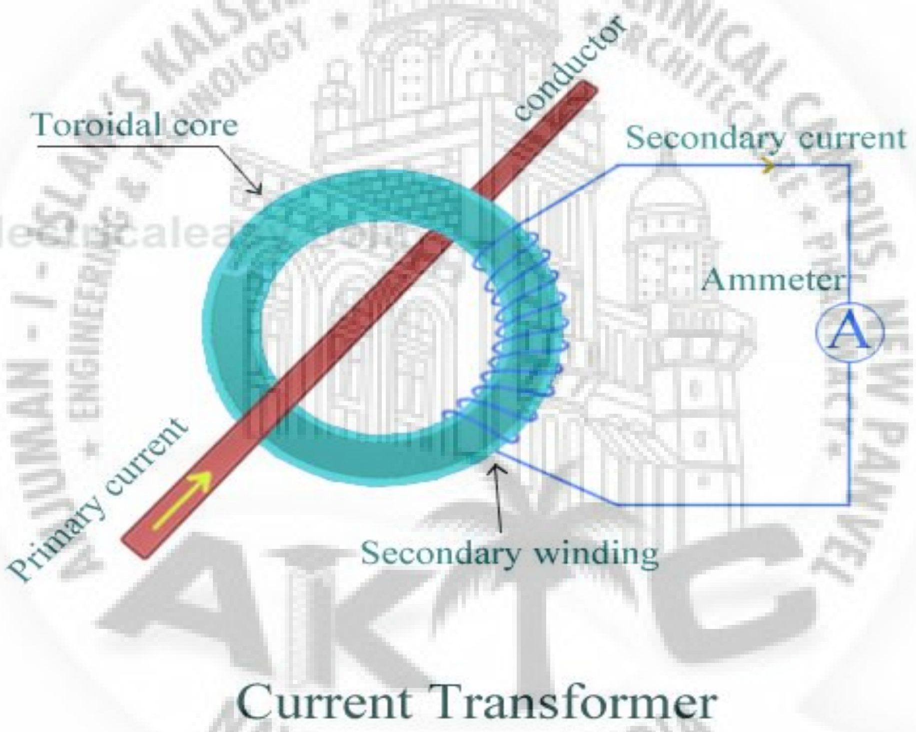
3.2. STANDARD METER

Follings are the standad meters used in smart grid:-

3.2.1. Current Transformer.

3.2.2 Potential Transformer.

3.2.1 CURRENT TRANSFORMER

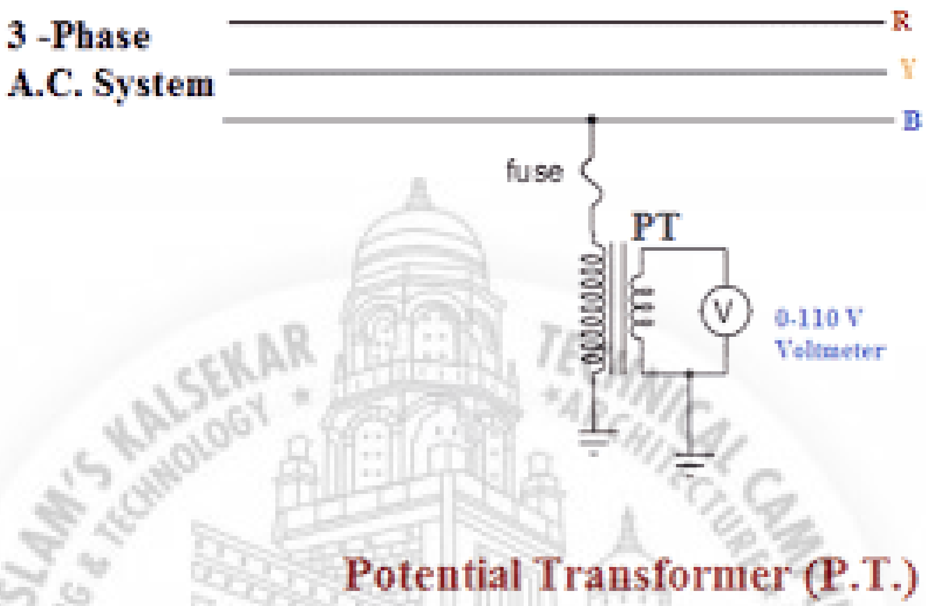


Current transformers are generally used to measure currents of high magnitude. These transformers step down the current to be measured, so that it can be measured with a normal range ammeter. A Current transformer has only one or very few number of primary turns. The primary winding may be just a conductor or a bus bar placed in a hollow core (as shown in the figure). The secondary winding has large number turns accurately

wound for a specific turns ratio. Thus the current transformer steps up (increases) the voltage while stepping down (lowering) the current. Now, the secondary current is measured with the help of an AC ammeter. The turns ratio of a transformer is $N_P / N_S = I_S / I_P$

$$\text{Turns Ratio} = \frac{N_P}{N_S} = \frac{V_P}{V_S} = \frac{I_S}{I_P}$$

3.2.2. POTENTIAL TRANSFORMER



Potential transformer is a voltage step-down transformer which reduces the voltage of a high voltage circuit to a lower level for the purpose of measurement. These are connected across or parallel to the line which is to be monitored

The primary winding consists of a large number of turns which is connected across the high voltage side or the line in which measurements have to be taken or to be protected. The secondary winding has lesser number of turns which is connected to the voltmeters, or potential coils of wattmeter and energy meters, relays and other

control devices. These can be single phase or three phase potential transformers. Irrespective of the primary voltage rating, these are designed to have the secondary output voltage of 110 V

3.3. COMMUNICATION CIRCUIT

Followings are the communication circuit used in smart grid:-

3.3.1. Arduino.

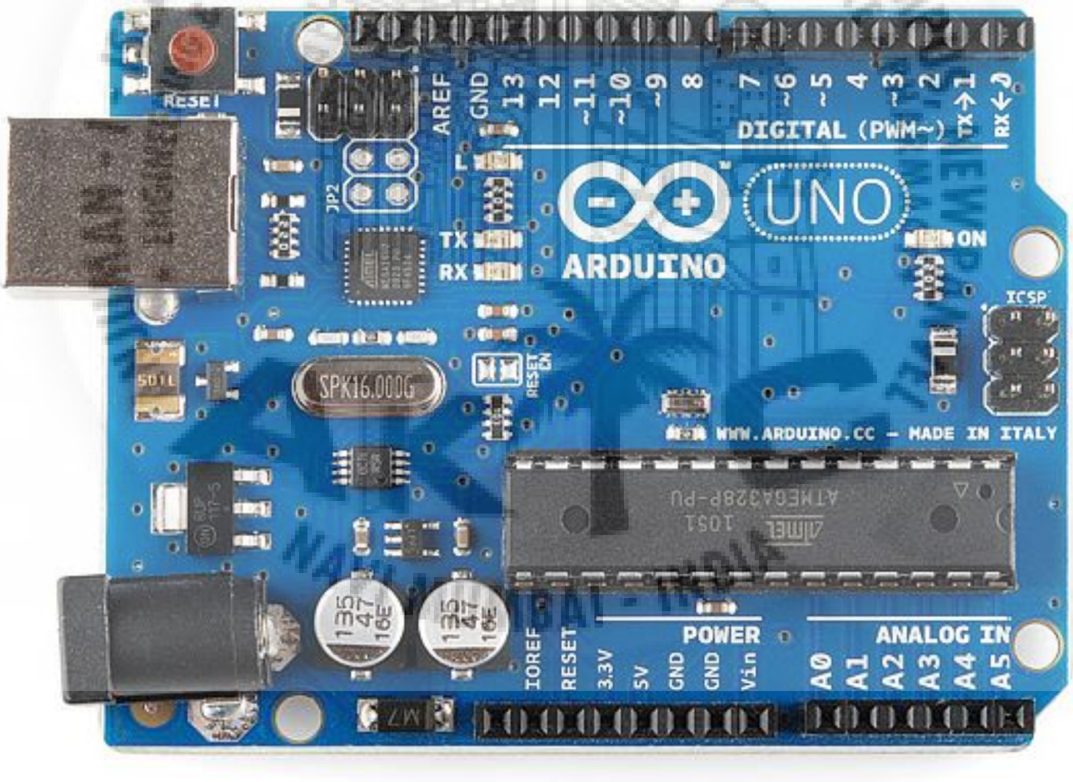
3.3.2. Relay.

3.3.3. Display.

3.3.4. Alarm Buzzer.

3.3.5. Voltage Sensor

3.3.1. ARDUINO

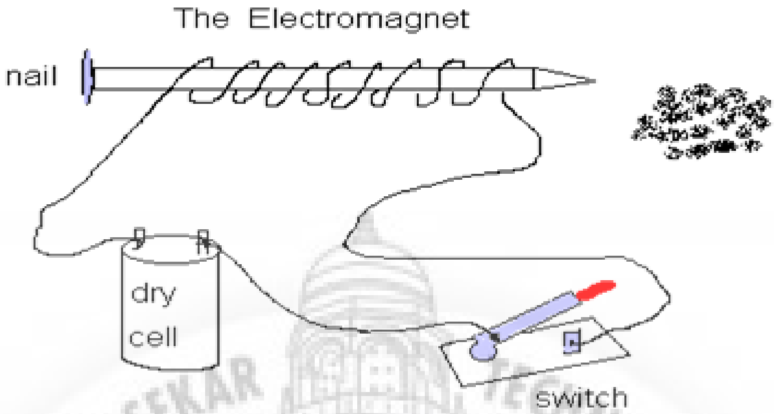


Arduino is an open-source platform used for building electronics projects. Arduino consists of both a physical programmable circuit board (often referred to as a microcontroller) and a piece of software, or IDE (Integrated Development Environment) that runs on your computer, used to write and upload computer code to the physical board.

The Arduino platform has become quite popular with people just starting out with electronics, and for good reason. Unlike most previous programmable circuit boards, the Arduino does not need a separate piece of hardware (called a programmer) in order to load new code onto the board -- you can simply use a USB cable. Additionally, the Arduino IDE uses a simplified version of C++, making it easier to learn to program. Finally, Arduino provides a standard form factor that breaks out the functions of the micro-controller into a more accessible package.

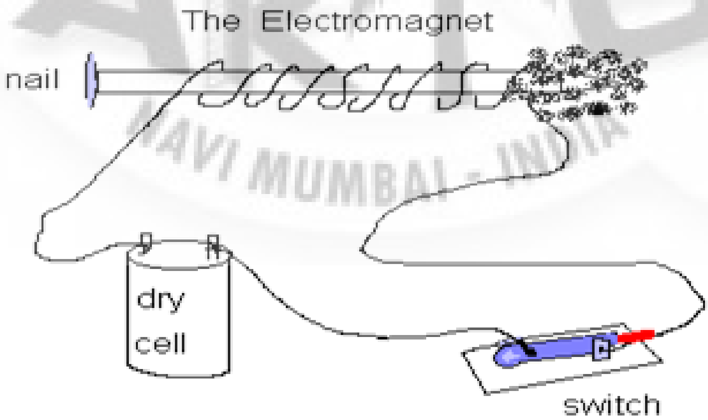
The working of Arduino microcontroller is where the proper connection is made. Checking all the input ports as well as the power supply connection. The output of the pins can be connected with the external devices according to their applications. The program to be executed for the applications can be done by using Arduino software. From this Arduino software, we can edit according to the applications. This software can works on c and c++ programming language. It is fully a high level language. By using the conditions of working, we can create a program to proceed for the applications. Then after, these programs can be uploaded through the Arduino microcontroller by using the power jack cable. The program can be uploaded to the microcontroller and ready for further process. ATMEGA-328 microcontroller can save’s a program and these IC can act’s as a processor to do the process without any error. After by giving an analog or digital input to the system, we can do the process according to the applications. We can control the process of the application by editing the program in the arduino software and again can be uploaded to the Arduino microcontroller via power jack cable. There is an option of reset button. The purpose of reset button is to reset the program which means the previous programs are deleted and we can use the Arduino for the other application purposes. Likewise, these Arduino ATMEGA-328 microcontrollers can be used for n number of applications. These Arduino microcontrollers are widely used in automation industries for controlling the process and to work the system in an automation mode. Here, I have provided a simple Arduino program to do the process of rotating a stepper motor for one revolution. There are many number of example programs that are present in the Arduino software. We can edit these programs for our applications purposes. The example program can be given below.

3.3.2. RELAY



The basis for relays, is the simple electromagnet. A nail, some wire, and a battery is all that is needed to make one, to demonstrate and amaze your small children. add a switch, and presto! You're the talk of the town.

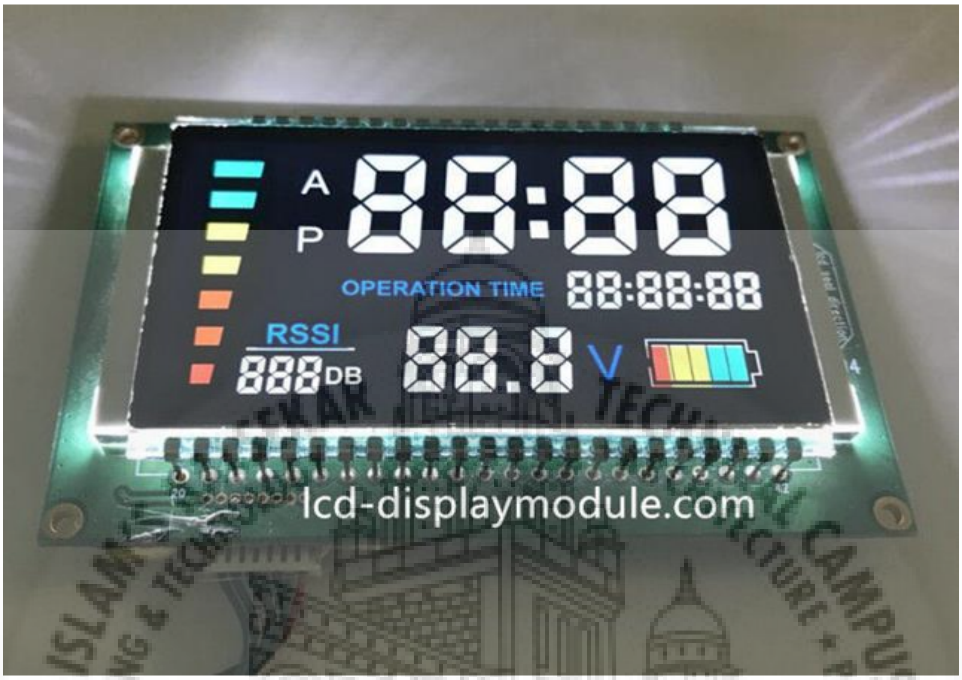
With no power applied to the coil, the nail is NOT magnetized. Connect this to a power source, and it will now grab and hold small pieces of metal.



So, herein lies the concept. If we take an electromagnet, it will interact with metals in its vicinity. now lets take this one step further... If we were to place a piece of metal, near the electromagnet, and connect some contacts, so that when the electromagnet is energized, the contacts close, we have a working relay.

The simplest relay, is the Single Pole, Single Throw (spst) relay. It is nothing more than an electrically controlled on-off switch. It's biggest property, is the ability to use a very small current, to control a much larger current. this is desiresable because we can now use smaller diameter wires, to control the current flow through a much larger wire, and also to limit the wear and tear on the control switch.

3.3.3. DISPLAY



Segment LCDs, also called static displays or glass-only displays, are constructed of two pieces of ITO (Indium tin oxide) glass with a twisted nematic fluid sandwiched in between. A static display is a segment display with one pin for every one segment.

These displays are still one of the most popular technologies in use and the majority of them are custom. Many people think the process of designing a custom segment liquid crystal display is complicated and too complex to be understood except for a few experienced people. But after designing custom LCDs for over 14 years, it can be said that just about anyone can select the best options for their product.

In other words, you don't have to be an engineer, or have a PHD from MIT to design a custom LCD for your application. So instead of offering a list of technical terms and equations, these are the different options available.

Segment displays require less power than other display technology such as TFT, OLED, and UWVD. This makes these LCDs ideal for applications that are battery powered or solar powered. They require the lowest power to drive, an estimated 2uA per centimeter squared. Glass only displays (no backlight and no controller) require an estimated 10% of the power that is required for a LED backlight. In other words, a static display without a backlight will draw around 1mA; the same display with a LED backlight will demand from 10mA up to 25mA. Most displays can be driven at 3.3V or 5V since microprocessors can operate at both voltages. 3.3V is becoming more popular since two double 'AA' batteries can produce between 3.0V and 3.3V.

3.3.4. ALARM BUZZER

A buzzer is a small yet efficient component to add sound features to our project/system. It is very small and compact 2-pin structure hence can be easily used on breadboard, Perf Board and even on PCBs which makes this a widely used component in most electronic applications.

There are two types are buzzers that are commonly available. The one shown here is a simple buzzer which when powered will make a Continuous Beeeeeeppp.... sound, the other type is called a readymade buzzer which will look bulkier than this and will produce a Beep. Beep. Beep. Sound due to the internal oscillating circuit present inside it. But, the one shown here is most widely used because it can be customised with help of other circuits to fit easily in our application.

This buzzer can be used by simply powering it using a DC power supply ranging from 4V to 9V. A simple 9V battery can also be used, but it is recommended to use a regulated +5V or +6V DC supply. The buzzer is normally associated with a switching circuit to turn ON or turn OFF the buzzer at required time and require interval.

3.3.5. VOLTAGE SENSOR

The Voltage Sensor is a simple module that can used with Arduino (or any other microcontroller with input tolerance of 5V) to measure external voltages that are greater than its maximum acceptable value i.e. 5V in case of Arduino.

Following is the image of the Voltage Sensor Module used in this project.

3.3.5.1 PINS OF THE VOLTAGE SENSOR

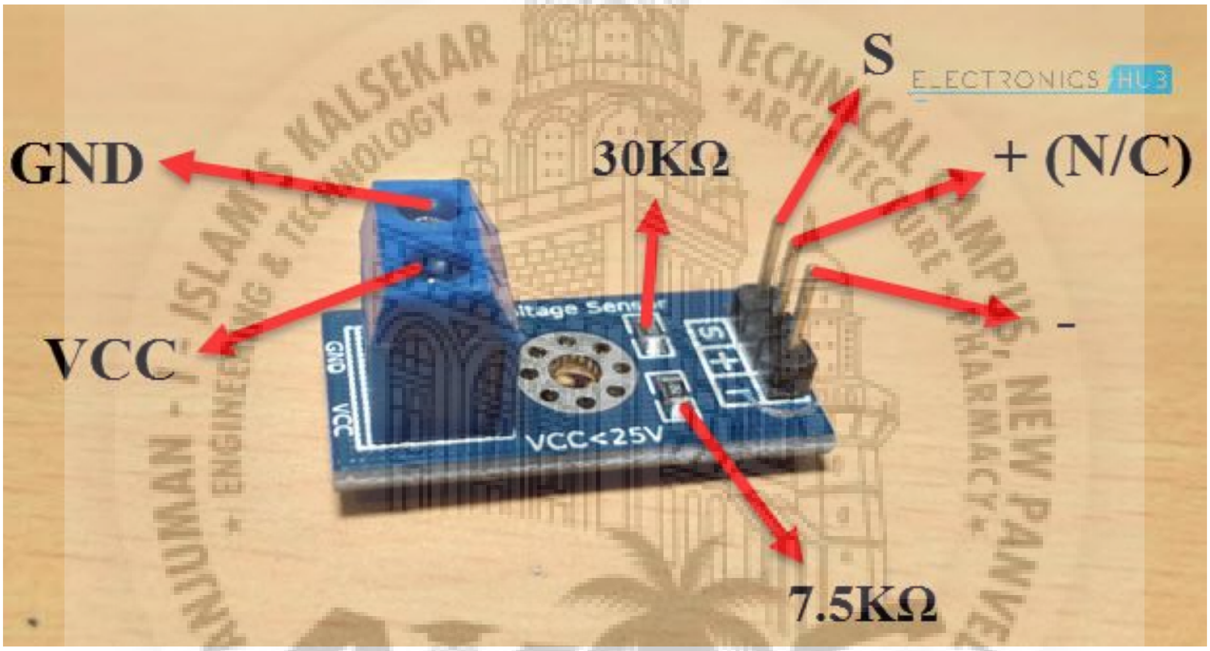
Before going into the details of the Voltage Sensor like its functionality and schematic, let me give you an overview of the available Pins of the Voltage Sensor Module.

Basically, a 25V Voltage Sensor, like the one used here, has 5 pins in total. Two of them are on the two-pin screw terminal and three are male header pins.

The Screw Terminal pins are marked as VCC and GND and they must be connected to the external source of voltage i.e. the voltage that needs to be measured.

Coming to the three male headers, they are marked as S, + and –. The S pin is the “Sense” pin and it must be connected to the Analog Input of the Arduino. The “–” pin must be connected to the GND of the Arduino. The pin marked as “+” is not connected to anything (it is an N/C Pin).

The following image shows the pins of a Voltage Sensor Module.

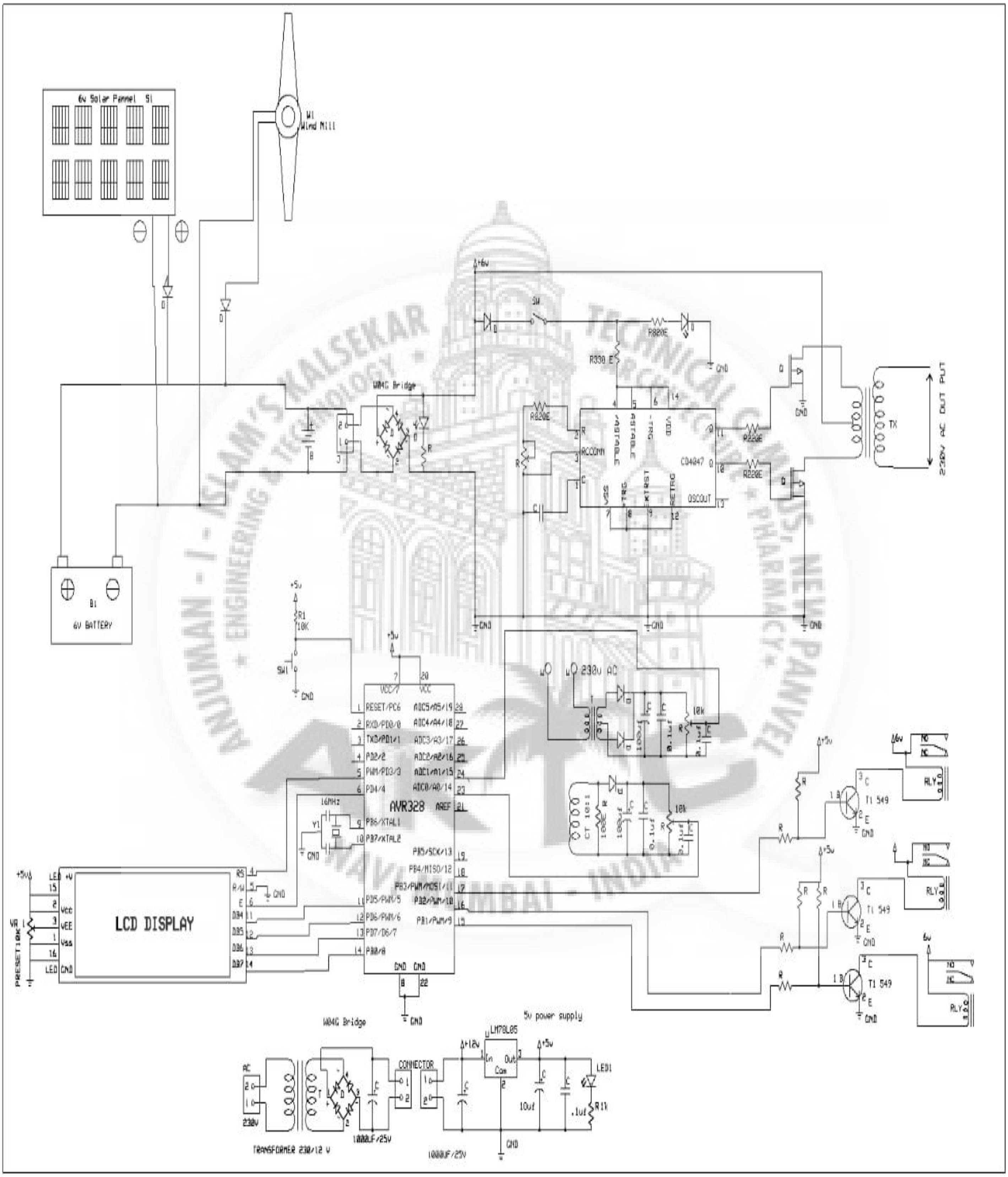


3.4. MEETING LOAD

The identification and appropriate control of flexible load or meeting load can be employed to balance energy and demand. The system to meet the demand not only by changing the generated energy but also by controlling the load when necessary. The load may be AC and DC.

By using load meeting we can control the system with highest reliability with greater efficiency. Which makes system more economical and effective.

4. CIRCUIT DIAGRAM



5. MODE OF OPERATION

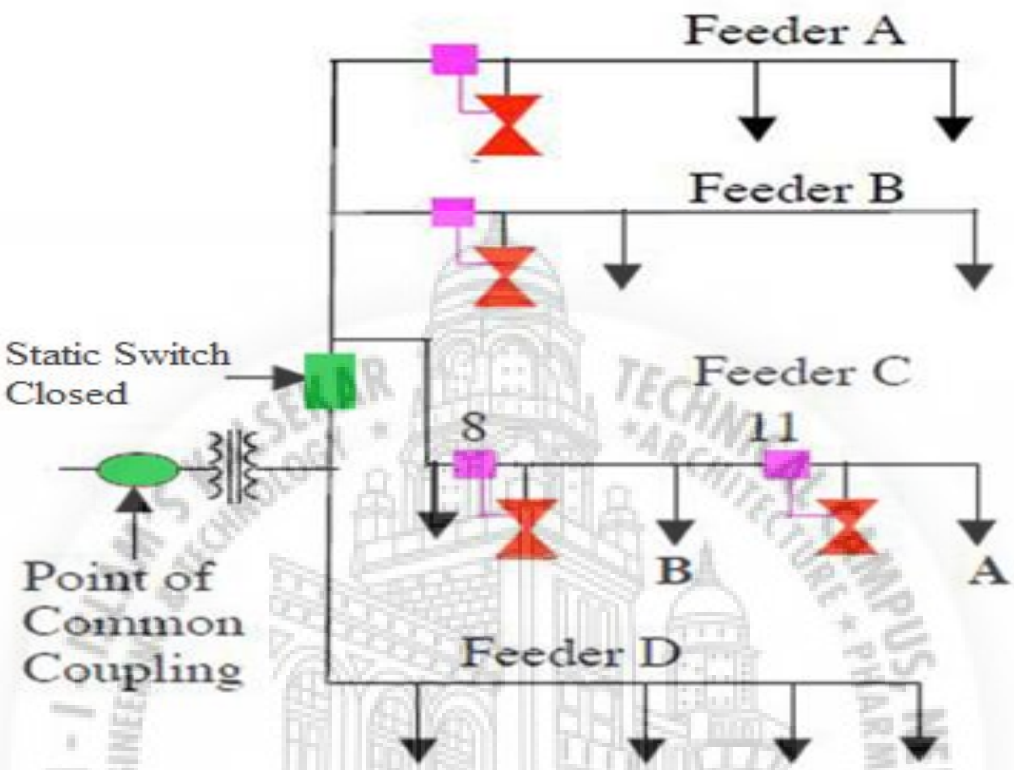
A Micro Grid can operate in grid connected mode or in islanded mode. In grid-connected mode micro grid supplies or draws power to the utility grid depending on the generation and load demand. In case of an emergency and power short age during power interruption the micro grid shifts to island mode of operation. The essential features of micro grid are:

- Provide good independent solution in islanded mode of operation
- Plug and play function, capability to synchronize safely connected MG to the main grid
- Provide V & f protection during islanded operation and capability to resynchronize safely connected MG to main grid
- Ensure stable operation during fault & various network disturbances

There are two modes of operations of smart grid which is:-

5.1. Grid connected mode.
5.2. Islanded mode.

5.1. GRID CONNECTED MODE



The following sequence of operations are simulated in the

Micro grid:

- At t=0s, the real and reactive power set points of each. DG is set to 2.5 kW and 0 kVar(upf).
- At t=1.5s, the real and reactive power set point of DG2 is changed from 2.5 kW and 0 kVar (upf) to 5 kW and 3 kVar (0.85 pf).
- At t=2s, the real power set point of DG1 is changed from 2.5 kW (upf) to 5 kW (upf).
- At t=2.5s, DG2 both real and reactive power set points are made 0.

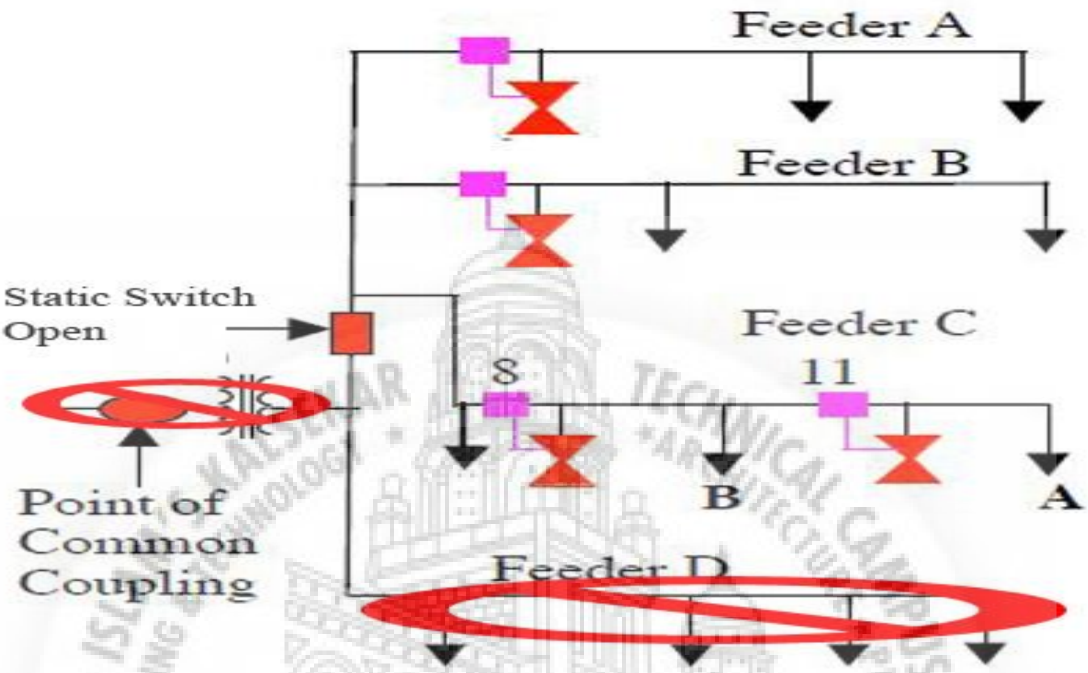
The real and reactive powers of DG1, DG2 and the grid for the events considered above. The

corresponding voltage and frequency at the PCC bus. Prior to the creation of disturbance DG1 and DG2 supply 2.5

kW at unity power factor. The remaining power of 5 kW is supplied by the grid as seen from figure. At t=1.5 s, the active and reactive powers of DG2 increase to 5 kW and 3 kVar respectively. DG1 power remains unchanged and the grid active and reactive power reduce to 2.5 kW and 4.5 kVar respectively. The voltage and frequency settle within limits (±10%V and ± 0.5Hz) with a small transient. At t=2 s, the entire active power is supplied locally and the grid supplies the system losses (0.2 kW) and the rearctive power requirement of

the load (4.5 kVar) as per the set points. Finally, when DG2 set points are made zero at t=2.5 s, the grid active and reactive power increases back to 5 kW and 7.5 kVar respectively. DG1 power remains unchanged. In all these step responses of power set points a settling time of 10 ms is achieved as per the design.

5.2. ISLANDED MODE



A Condition in which a portion of an area Electric Power Systems (EPS) is energized solely by one or more local EPSs through the associated PCCs (Point Of Common Coupling) while that portion of the area EPS is

electrically separated from the rest of the area EPS".

Non-Detection Zone:

- As per IEEE 1547 standard all DERs are to be equipped with under voltage/over voltage relays and under frequency and over frequency relays.
- Set point for voltage relays-OVR-1.1pu; UVR-0.88.
- Set point for frequency relays-OFR-60.5;UFR-59.3

- The presence of real and reactive power mismatch leads to change in voltage and frequency in islanded micro grid.

The relays fail to detect, if the power mismatches are not sufficient to drive the voltage and frequency relays beyond the set points after islanding.

Hence NDZ can be defined as – Zone of real and reactive power mismatches at which if islanding occurs, the corresponding relays fail to identify the islanding condition.

During the transition into island operation it is important that:

- Voltage disturbances are quickly dampened and that protection schemes both inside the LAPES and in the grid are not affected.
- When the transition is completed it is important that the micro-grid has sufficient local power generation and energy storage in order to ensure that loads are powered with the agreed quality level.
- For example, in ac micro-grids it is important that distributed resources are able to provide real and reactive power to the specified load range. This is particularly important in order to avoid loss of stability if there are large motors in the LAPES that require significant amounts of reactive power during startup

Also for ac micro-grids, their control systems must be able to regulate both voltage and frequency within acceptable ranges. In dc micro-grids, neither frequency regulation nor reactive power generation are issues to consider.

- Eventually, it can be anticipated that the micro-grid would be connected to the main grid again. Grid connection of dc micro-grids or ac micro-grids with a power electronics interface with the main grid tends to be simpler than the case of ac micro-grids connected to the main grid through circuit breakers, contactors, or static switches because in the dc micro-grid and the ac micro-grid with a power electronics interface cases reconnection control resides only in this power electronic interface. That is, the controller in this power electronic interface would controlled in order to realize on its grid side some voltage waveform so its amplitude, frequency and phase angle are within specified limits to allow reconnection.

- In the other ac micro-grid cases—those directly connected to the main grid though mechanical switchgear or static switches—reconnection is more complicated because there is no possibility of directly controlling the voltage waveforms at the PCC. In this case, ensuring that the voltage, frequency and phase angle are within acceptable limits depend on how the LAPES distributed resources are controlled.

6. TESTING & TROUBLESHOOTING

Before you apply power, read the instructions carefully to check you haven't missed anything, and whether there are any specific instructions for switching on and testing. Check again that you have all polarity sensitive components the right way around, and that all components are in the correct places. Check off - board components are connected correctly. Check the underside of the board carefully for short circuits between tracks - a common reason for circuits failing to work.

When you are sure everything is correct, apply power and see if the circuit behaves as expected, again following the kit manufacturer's instructions.

If it works, WELL DONE! You have your first working circuit - be proud of it! Skip the rest of this page and click the right arrow at the bottom, or here.

If it doesn't quite work as expected, or doesn't work at all, don't despair. The chances are the fault is quite simple. However, disconnect the power before reading on.

Check the basic's first - is the battery flat? Are you sure the 'On' switch really is on? (Don't laugh, it's easily done) If the project has other switches and controls check these are set correctly.

Next - check again all the components are in the correct place - refer to the diagram in the instructions. Look again at the underside of the board - are there any short circuits? These can be caused by almost invisible 'whiskers' of solder, so check for these with a magnifying glass in good light. Brushing the bottom of the board vigorously with a stiff brush can sometimes remove these.

Pull the components gently to see if they are all fixed into the board properly. Check the soldered joints - poor soldering is the most common cause of circuits failing to work. The joints should by shiny, and those on the circuit board should be volcano shaped with the component wire end sticking out of the top. If any look suspect then redo them. Remove the solder with a solder sucker or braid and try again.

Check for solder splashes shorting across adjacent tracks on the circuit board, especially where connections are very close such as on integrated circuits ('chips'). Solder splashes are most likely on stripboard. You can check for shorts using a multimeter set it to it's continuity range, or low resistance range. Be aware if you do this though, that there will be a resistance between some tracks due to the components. Any resistance below 1 ohm between tracks is likely to be a solder splash. Run the soldering iron between tracks on stripboard to remove any solder bridges.

If the circuit still fails to work you will need to refer to the circuit diagram and take voltage readings from the circuit to find out what's wrong. You will need a multimeter to do this (see tools). Remember that if you find one fault such as a reversed component and correct it, it might have caused damage to other components.

Beginners Guide - More Tools & Test Equipment

To design your own circuits, or build more complex kits, you will probably need more in the way of tools and test equipment. If you did not buy a multimeter before then this is essential now, a basic power supply is also very useful. More expensive items such as an oscilloscope can be useful, but think carefully about whether you really need them - after all, you can build a lot of projects for the price of an oscilloscope. PC-based virtual instruments could perhaps be more suitable. Other tools can be useful too.

Here is a list of other useful items, although this by no means covers all the tools and equipment available. Maplin codes are included, however similar items are available from most suppliers.

6.1. Tools

Helping Hands - Useful for holding PCB's, connectors etc. while you solder them. Also normally have a magnifying glass to help see small components. Can save hours of aggravation! Maplin code YK53H A small vice can also be useful and provides a more rigid mounting than a Helping Hands.

Pearl Catcher - Useful for the retrieving those screws that inevitably fall into the most inaccessible corner of a project! Maplin code BK43W

Heat Shunt - an inexpensive item for soldering heat sensitive devices. Clipped onto the component lead between the joint and the component it will soak up the heat to save you melting your components. As you get faster at soldering you probably won't need it so much. Maplin code FR10L

RCD Circuit Breaker - If you start building mains projects (only do this when you are more experienced and are aware of the safety requirements) then one of these is ESSENTIAL. It could also prevent a shock if you accidentally melt through the soldering iron flex. These are sold very cheaply in most electrical shops. Well worth the price, although check if your building wiring is already protected by an RCD in the consumer unit first.

Breadboard - If you want to test a circuit without soldering it together permanently then these are useful. Just push the wires into holes joined by metal strips to build the circuit. If the circuit doesn't work, you can easily make changes. Different sizes are available, e.g. Maplin code AG10L

Other items - Other sizes of screwdriver, 0.5Kg reel of solder, tool roll or box etc.

6.2. Test Equipment

Multimeter - almost essential for all but the absolute beginner. See the tools section for more information.

Power Supply - Also very useful for powering circuits that you are testing. One with a variable voltage up to at least 12V is best. The current rating doesn't need to be that high, 1A maximum is fine for most jobs. If you can afford it then one with an adjustable current limit is useful - set right it can prevent damage to an incorrect circuit, rather than frying it instantly!

Oscilloscope - Quite expensive and not really worth it for all but the advanced constructor. Nonetheless a very useful piece of test equipment, especially on audio circuits. There are some cheaper PC based alternatives, and some hand - held 'scopes now, although I haven't tried them.

Signal Generator - Useful when testing audio circuits, again not really necessary for beginners. Produces variable frequency waves of several different waveforms (sine, square, triangle)

7. PROGRAMMING AN ATMEGA MICROCONTROLLER (ARDUINO)

7.1. MAKING THE LED BLINK

Now that we know how to switch on a LED, we also want to switch it off again after a certain

Tim-e. We do this by the most simple way: a delay function.

The AVR library provides a very accurate delay function. Make sure your file has the line

#include <util/delay.h> to include the delay functions.

Now the program looks like this:

```
. . .

#include <util/delay.h>

. . .

int main(void) {

//Set the Data Direction Register to output

DDRC |= (1<<5);

while (1) {

//Set the signal to high

PORTC |= (1<<5);

//wait 0.5 sec

_delay_ms(500);
```

```
//Set the signal to low
PORTC &= ~(1<<5);
//wait 0.5 sec
_delay_ms(500);
}
}
. . .
```

After compiling and transferring the program with make prog the led should blink in a fre-

quency of 1 sec.

If it is blinking faster or slower then you maybe have forgotten to fuse the controller. Try make

fuse and see if it changes.

This program does what it is supposed to, but it can be written shorter and with a reduction

of redundant code. First the bit is set and later cleared, this can also be done with the toggle

function which is the equivalent of the XOR operator (see A.1):

```
. . .
#include <util/delay.h>
int main(void) {
//Set the Data Direction Register to output
DDRC |= (1<<5);
```

```
while (1) {
//Toggle the signal
PORTC ^= (1<<5);
//wait 0.5 sec
_delay_ms(500);
}
}
. . .
```

7.2. PROGRAMMING OF VOLTAGE SENSOR OF ARDUION

```
int m;// initialise variable m

float n;//initialise variable n


void setup()

{

  pinMode(A0,INPUT); // set pin a0 as input pin

  Serial.begin(9600);// begin serial communication between arduino and pc

}


void loop()

{

  m=analogRead(A0);// read analog values from pin A0 across capacitor

   n=(m* .304177);// converts analog value(x) into input ac supply value using
this formula ( explained in woeking section)


   Serial.print("   analaog input  " ) ; // specify name to the corresponding value
to be printed

   Serial.print(m) ; // print input analog value on serial monitor

   Serial.print("   ac voltage  ") ; // specify name to the corresponding value to be
printed
```

```
  Serial.print(n) ; // prints the ac value on Serial monitor

  Serial.println();

}
```

8. BENEFITS OR ADVANTAGES OF SMART GRID

Following are the benefits or **advantages of Smart Grid**:

➡It reduces electricity theft.

➡It reduces electricity losses (transmission, distribution etc.)

➡It reduces electricity cost, meter reading cost, T&M operations and maintenance costs etc.

➡It reduces equipment failures due to automatic operation based on varying load conditions. Demand-Response reduces stress on assets of smart grid system during peak conditions which reduces their probability of failure.

➡It reduces sustained outages and reduces consecutively associated restoration cost.

➡It reduces air emissions of CO_2, SO_x, NO_x and PM-2.5. Hence smart grid contributes to keep environment green.

➡It reduces oil usage and wide scale black-outs. Hence smart grid provides security to the people by providing continuous power.

➡Smart grid is capable of meeting increased consumer demand without ading infrastructure.

9. DRAWBACKS OR DISADVANTAGES OF SMART GRID

Following are the drawbacks or **disadvantages of Smart Grid**:

➡Continuous communication network should be available.

➡During emergency situation, network congestion or performance are big challenges in smart grid system.

➡Cellular network providers do not provide guaranteed service in abnormal situations such as wind storm, heavy rain and lightening conditions.

➡Some smart meters can be hacked which can be used to increase or decrease the demand for power.

➡It is expensive to install smart meter compare to traditional old electricity meter.

GLOSSARY

ELECTRIC GRID - A network of synchronized power providers and consumers that are connected by transmission and distribution lines and operated by one or more control centers.

ELECTRIC POWER GRID: A system of synchronized power providers and consumers connected by transmission and distribution lines and operated by one or more control centres.

ELECTRIC SYSTEM RELIABILITY: The degree to which the performance of the elements of the electrical system results in power being delivered to consumers within accepted standards and in the amount desired. Reliability encompasses two concepts, adequacy and security Adequacy implies that there are sufficient generation and transmission resources installed and available to meet projected electrical demand plus reserves for contingencies.

ELECTRIC UTILITY: Any entity that generates, transmits, or distributes electricity and recovers the cost of its generation, transmission or distribution assets and operations, either directly or indirectly, through cost-based rates set by a separate regulatory authority.

ELECTRICITY CONGESTION: A condition that occurs when insufficient transmission capacity is available to implement all of the desired transactions simultaneously.

ELECTRICITY DEMAND: The rate at which energy is delivered to loads and scheduling points by generation, transmission, and distribution facilities.

ENERGY EFFICIENCY, ELECTRICITY: Refers to programs that are aimed at reducing the energy used by specific end-use devices and systems, typically without affecting the services provided.

ENERGY SAVINGS: A reduction in the amount of electricity used by end users as a result of participation in energy efficiency programs and load management programs.

ENERGY SERVICE PROVIDER: An energy entity that provides service to a retail or end-use customer.

BIBLIOGRAPHY

1) https://www.allaboutcircuits.com
2) https://www.electrical4u.com
3) https://www.electronics-tutorials.ws
4) https://www.polytechnichub.com
5) https://www.wikipedia.org
6) https://www.scholar.google.co.in
7) https://www.whatis.techtarget.com
8) https://www.IEEE Conference Publication.com
9) https://www.electronicshub.org

Conclusion

Thus we can conclude that the micro grid is a network of power system having a small network of electricity users with a local source of supply which is usually attached to a centralized national grid but it's able to function independently.

It also provides the following benefits:

- Provide efficient, low-cost, clean energy.
- Improve the operation and stability of the regional electric grid.
- Critical infrastructure that increases reliability and resilience.
- Reduce grid "congestion" and peak loads.
- When properly designed, a regional power grid that combines both large central plants and distributed micro grids can be built with less total capital cost, less installed generation, higher capacity factor on all assets, and higher reliability.