

# Electronic measurement of different parameters using a user-friendly test apparatus

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## ABSTRACT

In this paper, we present the design and fabrication of a automated test-kit for measurement of various electrical parameters like voltage, current, etc.,

**Index Terms** — Voltage, Current, Microcontroller.

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## I. INTRODUCTION

The paper deals with the design and implementation of an automated test-kit for measurement of various electrical quantities. Electricity is defined by 3 major attributes : Voltage, Current and Resistance. Voltage is the ‘pressure’ that makes electric charge move. Current is the charge’s ‘flow’ – the rate, at which the current moves through the conductor, measured at any particular point. The conductor offers a certain amount of resistance to this flow, which varies depending on the conductor’s composition and size.

Voltage, Current and Resistance are all interrelated – you can’t change one without changing another. Current is equal to Voltage, divided by Resistance (commonly written as  $I = v / r$ ). This makes intuitive sense. If you increase the pressure working on electric charge or decrease the resistance, more charge will flow. If you decrease pressure or increase resistance, less charge will flow. How does all of this come together in your home? The power distribution grid delivers electricity from a power plant to your house. Inside your house, the electric charge moves in a large circuit, which is composed of many smaller circuits.

One end of the circuit, the hot wire, leads to the power plant. The other end, called the neutral wire, leads to ground. Because the hot wire connects to a high energy source and the neutral wire connects to an electrically neutral source (the earth), there is a voltage across the circuit – charge

moves whenever the circuit is closed. The current is said to be alternative current, because it rapidly changes direction. The power distribution grid delivers electricity at a consistent voltage (240 volts in India), but resistance (and therefore current) varies in a house.

## II. INFORMATION COLLECTION

Our project is a miniaturized version of the Test Kit that is being used as of now. The drawback with the presently used Test Kit is that it needs 240V AC supply for its operation and it is bulky in nature. Thus it is not that convenient for use. Since the Test Kit is not very popular, collecting information was rather difficult. The information that was collected can be grouped into three categories :

### A. Information About The Micro-controller Release :

The Test Kit is used to test the micro-controller Release. Thus a detailed study of the micro-controller Release had to be carried out. The study revealed all the internal details of the structure and the architecture of the micro-controller Release. Also the various signal and how they affected the operation of the card was found out on a step by step basis. Each and every part of the internal organization was 2 studied minutely. The current and the voltage levels that the card needs for its internal operation were also found out.

### *B. Information About The Presently Used Test Kit :*

A detailed study of the presently used Test Kit had to be carried out. The study revealed all the internal details of the structure and the architecture of the Test Kit. Also the various signals that were coming in and going out of the Test Kit were studied and each of their significance was also taken into consideration. The various hardware aspects were all looked into carefully so that no problem arises in the design of the new and improved Handheld Test Kit.

### *C. Information About The Limitations Of The Presently Used Test Kits :*

After an established backhand was generated, we shifted our focus to the user interface. We studied the limitations of the presently used Test Kits and worked around them to create an effective solution. Some most encountered problems were that the Test Kit required a 240V AC supply which is not possible to obtain everywhere especially in conditions where there is total cut-off of electricity. So we created an internal power supply, so that no external supply was needed. Providing batteries did this, so that the Test Kit would work on batteries rather than on 240V AC supply. We also added a battery low indicator circuit so that the batteries could be changed as and when required. Another problem was that the presently used Test Kit was bulky and not convenient to carry from one place to another. So we reduced the size so that it becomes very light and can be carried on the palm of the user's hand.

### *D. Definitions*

Some general definitions referred to when System Analysis and Design is concerned are given below.

*E. System:* A regular or orderly arrangement of components or parts in a connected and interrelated series or whole; a series or group of components necessary to some operations.

*Analysis:* Breaking a problem into successively manageable parts for individual study is known as analysis.

### *F. System Analyst:*

It is a person who starts with a complex problem, breaks it down for analysis, and designs a better system based on specifications set in advance. Here the System Analysts are the designers of the product. System Analysis: Reduction of an entire system by studying the various operations and their relationships with the system; and examination of a business activity with a view of identifying problem areas and recovering alternate solutions. Above the term "System" refers to our project. To develop the whole system there were many steps involved such as : Studying The System, Planning The System, Designing The System, Quality Of The System, Testing The System, Removing The Errors, Final Fabrication .

### *G. Studying The System :*

Studying the system means studying the necessity of the system, the background of the system and the requirements of the system. The necessity, the background and the requirements are three very important points while studying the system. The necessity of the system helps in the facilities to be included so that the system developed should stand different and better from the existing similar systems. The knowledge of the background of the system to be developed helps the developer in better designing of the system. Before getting started with the development of the system it is important to jot down the requirements of the system for it helps in developing the system; the programmer does not need to worry about what will be required next. If all the required information are present then it prevents time wastage that might be useful in crisis.

### *H. Quality :*

It is a relative term and is generally used to explain the end use of product for e.g., a gear used in a sugar cane extracting machine though not of the same material and possessing good finish, tolerance and accuracy of the gear used in the head stock of the sophisticated that may be considered of good quality it works satisfactorily in the machine. Thus a system is said of good quality if it works well in the user environment for which it is meant. Quality is thus defined as fitness for purpose.

### **Characteristics Of A System**

Each of the systems has some characteristics that are common among them. Those are organization, interaction, interdependence, integration and the central objective.

#### *A. Organization :*

Organization is an arrangement of components to achieve some goal. The components work together in some pre-defined order. Each of the components is assigned with some work to be done which will be taking from its previous stage and giving its output as an input to the next stage. The data to be stored in the memory of the system has to be properly organized and then it has to be stored in the memory of the system

The system components work with each other in some pre defined steps. Thus organization in a system persists for without proper organization the system won't be upto expectation. And by making the system systematic and in proper organized fashion, saves a lot of time which can be effectively used in some other aspect of development or in some other fruitful way.

#### *B. Interaction :*

Interaction refers to the manner in which each component function with other component of the system. Each component will be interacting with the other component of the system in order to produce required results. In a computer system the CPU works with input to produce the required output, the memory stores data fed by the input.

Thus in a system each component functions by interacting with other component of the system. In a system the user has to interact with the memory to store the data. Without proper interaction the desired result or output may not be obtained. For proper interaction there is a need of proper interface and that each unit functions with proper co-ordination with each other. The time required to develop a system is affected to a large scale by the degree of quality of interface and in turn interaction. Thus for fast and better development of the system proper interaction between the system units is quite essential.

#### *C. Interdependence :*

Interdependence refers to the fact that parts of components of the system depend on each other to produce required output that is output of one component form input of the next component in the system. Thus the components of the system are interdependent upon the input received from other components for giving proper output. In a system the functioning of each unit is largely 3 dependent upon the input that each unit receives and that in turn depends upon the kind of output the unit before gives. Thus it forms a chain wherein the output and input of, each unit are interdependent upon each other. Therefore the designer has always to keep the quality of input that he gives into the system in mind to get the desired output not only from the whole system but also from each and every unit of the system as a whole.

#### *D. Integration :*

Integration is concerned with how a system is tied together. Part of system works together in order to achieve common goal, thus forming integration.

#### *E. Central Objective :*

The stated objective and real objective of the system could differ based on the type of project. The system designer should develop a central objective by taking into consideration real objective and stated objective. For the designer it is always important to keep in mind the goals that he has set for his system to achieve. The goals over here means the kind of output, the time consumed by the output, the function of each unit in the system and the facilities he wants his system to provide as a whole.

In keeping stated objectives in mind the system designer can fore plan about the requirements of his system so that every desired object is available at the hour of need so that no further time would be wasted in accumulating those objects when required. It makes the designer foresight about what hurdles he might face in future and plan accordingly so that he can carry out his work without any hurdles. It also helps him to plan and plot out everything in advance so that he should be able to develop the system in estimated time. Thus in brief central objectives play the following part in system development :

- Fix an amount of time within which to complete the system development.
- Make all the necessary things available in advance which might be required later so that one doesn't have to rush for them at the appointed hour.
- Plan and plot out everything in advance for the smooth development of the system.
- Find solutions to difficulties which might be faced in future.

### **III. ELEMENTS OF A SYSTEM**

The various elements of a system are: Inputs And Outputs, Integrated Circuits (IC's), Control, Feedback, Environment, Boundaries And Interface.

#### *A. Inputs And Outputs :*

The final aim of any system is to produce the output as per the users requirement. The output should be accurate, timely and user-friendly. Inputs are elements that make the system to work in order to produce required output. Input could be resources or information. For proper output it is important to govern the quality of input being given to the system. For if the input is not proper it directly affects the working of the system on the whole as all the units in the system are interdependent on the input they receive which in turn is dependent on the input that the system receives. The system designer also has to keep the design of the output that the user would get. The output should always be accurate and user-friendly in the sense that it should be easy even for the beginner to work on the system. In this system the user would have to input data that can be stored, modified and deleted as the user wishes to.

#### *B. Integrated Circuits (IC's) :*

The IC's transform input to output. The IC's should be designed of such type that they can accept the input in the given form and give output in desired format. For any system the IC's play an important role because they control and time the internal operations of the system. An efficient IC is the most underrated important point that governs the system works. Efficient IC's automatically increase the speed of operation of within the system through proper governing and of the operations being carried out in the system. And since to give the output required, it plays such an important role in the upgrading class of the system.

The IC's automatically become an important point to be paid attention to. Poor IC's would not be able to manage the activities like governing the inputs, managing the signals within the system, governing the output etc. Since the above functions if not paid attention to would lead to slowing down the execution speed to a large extent the IC's become such an important issue to be looked for while designing and developing of the system so that the expected speed

should be gained while processing which should not be hampered later by wrong choice of IC's.

### C. Control :

The control element controls the working of the system at all the stages. It is necessary to control input, process and output, continuously, in order to get desired result. Control is a system for measuring and checking a phenomenon. It suggests when to inspect, how often to inspect and how much to inspect. In addition it incorporates a feed back mechanism which explores the causes of poor quality and takes corrective actions. Control differs from inspection, as it ascertains quality characteristics of a item, compares the same with prescribed quality standards and separates defective items from non defective ones. Inspection, however does not involve any mechanism to take corrective action.

Control is making sure that the programmed production is constantly maintained. The designer has to be in constant touch with the system which helps him in controlling the system. The designer has always to keep input in mind, what inputs are required for developing the system as thought of. If there is even a slight misconception about the output required this might track the designer off the development of the system.

The control on the system is very important for the designer because without control, the system working may go haywire. A properly controlled system is bound to give better output than a system whose working is haywire. The control on the system helps in reducing the time within which an output is expected. A control is always necessary to regulate the working of the system. Control leads to better management which is necessary for the proper functioning of the system.

### D. Feedback :

Feedback helps to compare output produced with output expected and changes in the process or input in order to reduce the difference between the output produced and output expected. With this way the system developer can gauge the output he is getting and make required changes accordingly. This step plays a major role in improvising the system output. The system output is 4 important in the way that it speaks a lot about userfriendliness of the system. User-friendliness is a very important feature of a system because of the following reasons:

- It saves a lot of time of the user.
- It reduces the complications in the system handling, i.e., It should be easy to operate upon.
- It builds a friendly environment for the user to work in.

Also the system output that the developer gets would show him the way where he went wrong, if the system output is not up to the expectation. If the output is upto the expectation, then the developer can think of ways to improvise it. Hence the feedback that the developer gets helps him in a lot of ways.

### E. Environment :

All the things that are outside the system are called environment of system. The environments do affect working of the system. The system should be sensitive to the changes in its environment. A healthy working environment always helps the designer in developing and working with the system.

A helpful environment leads to efficient and faster development of the system, which is important in the final analysis. The environment leads a very important role in the way the system is interfaced and communicates with the user. The environment should be such that it should affect system input in a positive way, which would affect the output that the system gives.

### F. Boundaries And Interface :

The boundary tells the extent of the system. The boundaries divide the things into the system and its environment. The things that are inside boundary are part of the system otherwise which are outside the boundaries are its environment. It is very much essential to limit the system by its boundaries so that system's working can be controlled. Interface means interaction of the system with the system outside its boundaries.

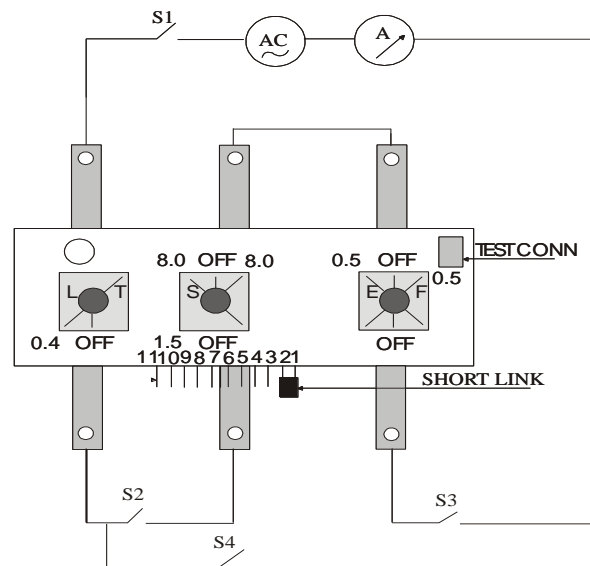


Fig. 1 : Front-view of the micro-controller release

### Quality Control And Inspection

**Definition And Concept :** An item or component or product which is manufactured is required to perform certain functions. The act of checking whether a component actually does so or not is called inspection. In other words, inspection means checking the acceptability of the manufactured product. Inspection measures the quality of a product of service in terms of pre-decided standards. Product quality may be specified by its hardness, shape surface finish, chemical composition, dimensions, etc [3].

**Purpose Or Objectives Of Inspection :** Inspection separates defective component from non defective ones adequate quality products. Inspection locates defects in raw material

and flaws in the process causes problems at the final stage. For e.g., detecting the parts having improper tolerances, during processing itself, it will minimize the troubles arising at the time of assembly. Inspection prevents further work being done on semi-finished products already detected as spoiled. Inspection detects that the product works and it works properly without hurting anybody. Inspection detects sources of weakness and trouble in the finished products and thus checks the work of designers.

#### *Difference Between Inspection And Testing*

**Inspection :** Inspection has to do with the observation of process and procedures to manufacture to influence the prescience of desired qualities and properties. By inspection we can improve the quality of the job during preparation itself. Inspection is visual and pertains to various parts of a job based on their requirement and specification.

**Testing :** Testing is normally carried out before production commences on different plates parts of different material consisting the jobs. Testing can be destructive or non destructive depending on the application whether prefabrication or post fabrication.

#### • *Quality Assurance :*

This term most often used to describe a formal system within a company for managing quality control activities in effect, it is quality control of the quality function. A quality assurance system formally defines and controls all company activities that affect customers satisfaction with the quality of goods or services. Inspection alone does not assure quality performances to requirements of the customer. This applies not only to complete products such as satellites or nuclear submarines but also to simple products such as nails or pipe fittings.

#### **MCB's and the microcontroller release About MCCB's**

MCCB is an abbreviation for Molded Case Circuit Breaker. MCCB is one which is assembled as an integral supporting unit with enclosed housing of insulating material for making, carrying and breaking currents between separate contacts under normal circuit condition and also making, carrying for a specified time and breaking current under specified abnormal condition such as those of overload condition and short circuit condition. MCCB's are designed to provide protection to low voltage distribution system [4].

Using the interruption capacity of an arc in air inside the molded case, the MCCB has been designed to interrupt current with range from few amperes to several kiloamperes. These developments have greatly increased the system flexibility of MCCB and it is now possible to tailor an MCCB to satisfy a wide range of applications. Present day MCCB can be founded in all low voltage (less than 1000 V) applications, in residential electrical distribution panel, in the industrial power distribution center, and in main power feed panels used in large buildings such as offices, hospitals, and shopping centers.

The MCCB are generally used as a back-up device in a system. MCCB is connected to the incoming supply from the transformer secondary. Sometimes MCCB is connected to the load directly and sometimes it is also equipped with

overload relay and contactor depending upon the number of switching operations required to be carried out on the load as the life of MCCB is around 10000 operations whereas the life of contactors is in millions. In distribution system, the switching operations are less. So, only MCCB can serve both the functions : overload as well as short circuit. But for overload, frequent switches operation are required for example motor circuit, the application of MCCB needs overload relay and contractor to be equipped with.

The MCCB primary function is to protect down stream circuit element in the event of an over current. MCCB automatically isolates the electrical circuit under sustained overloads or short circuit.

#### *About Micro-controller Release :*

The micro-controller Release is the heart of the MCCB. When a fault occurs, the micro-controller Release trips the MCCB within a certain period of time. This depends on how the Release is calibrated. The Release is provided with three external rotary switches. They are, Long Time or Overload, Short Time or Short Circuit, and Earth Fault. The release is a protection and control module in the d sine range of MCCB's. This is basically an electronic release and can be used in MCCB's on the switchboard panels for controlling and protection of various current loads [2].

The protection can be done for different values of the rated currents in the same release. The above is done using micro-controller which is programmed in C language. The current in the circuit is stepped down, simulated into an equivalent dc voltage and given to the micro-controller after amplifying. The phase currents through the different phases are passed through the primary of the current transformer, which is, a bar/link having rectangular cross section. According to different ratings of MCCB's, current transformers (CT's) are selected.

These CT's steps down the phase currents to a level compatible to the release. In the d sine range of MCCB's there are different rated current ratings of the circuit breaker to suit the applications of the customers. The following are the rated current ratings: 160A, 250A 400A & 630A. Since the CT's have multiple ratings we can use same card for different current ratings. However, the CT's used for earth fault protection is a core balanced current transformer (CBCT) which provides the vector sum of all the primary currents. Any fault sensed due to unbalance in the system provides an output by the earth fault CT that will trip the breaker [1].

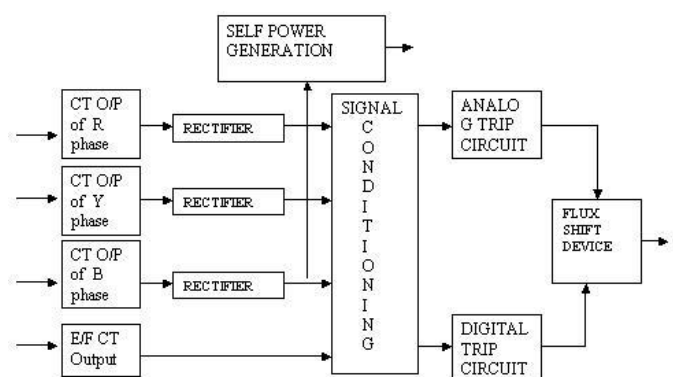


Fig. 2 Block diagram of release

There is no need of external power supply needed by the release as it is internally generated using the current in the load. In addition to this a comparator is used to check and control the variation in the power supply to get a constant output. It has also a thermal memory protection, which trips the breaker again and again, after it is tripped once due to a fault condition. This is done to cool down the breaker after tripping and it is accomplished by a charging capacitor, which is used to give trip signal until the capacitor is fully discharged. We have used the circuit in [5] to determine & find some of the electrical parameters.

## REFERENCES

- [1] Milman & Halkias, *Integrated Electronics*, Mc Graw Hill.
- [2] Awad, Elias M, *System Analysis and Design*.
- [3] Philips Datasheets.
- [4] Motorola Datasheets.
- [5] <https://www.engineersgarage.com/contributions/solar-panel-parameters-monitoring-using-arduino/>

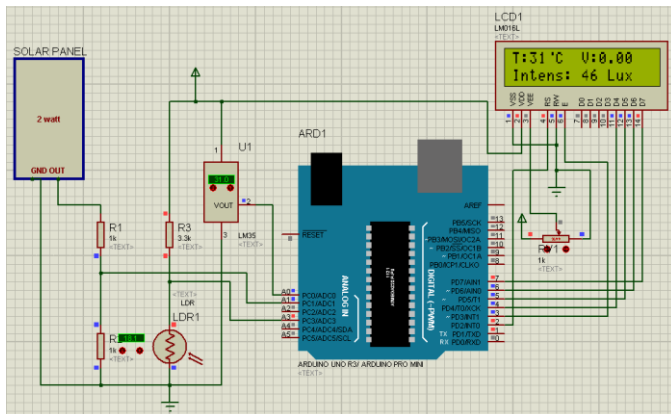


Fig. 5 : Measurement of parameters [5]

### Faults:

There are mainly two types of faults which occur : viz., Phase Fault and Earth Fault

**Phase Fault** :- This type of fault occurs when one out of the three phases fails. Thus the remaining two draw more current which is hazardous to the equipments.

**Earth Fault** :- This type of fault occurs when the ground wire fails. Thus, the live wire draws very large current and causes damage to the equipments connected.

## IV. CONCLUSION

This project making process has exposed us to the various advancements in the diversified field of hardware study. It has helped us not only to develop endurance and concentration in our subject but also unraveled a determination to take up a challenge and complete it. This project forming has enlightened us about the different aspects taken in the formation of hardware and has taught us how to be tactful in the time of crisis of any sort.

This project has also made us familiar with the procedures involved in the process and formation of turn key projects. It has also made us conversant with other various details involved, such as, the estimation for finding out the time taken to develop product and its different analysis and design areas. We would like to state that this project making has been a boon to us as it has shown us so many hidden points and important aspects in the execution of a project, which would have otherwise been impossible to learn just from books. It has also given us practical view point of the subject and has prepared us to take up further challenges, thereby brightening our future prospects in the industry.