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Mean Time between Failure (MTBF) Calculation of Solar Battery Charger System

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ABSTRACT:

The photovoltaic system is one of the most widely used forms of renewable energy. PV technology's costs must be significantly reduced while, its flexibility and reliability is must be improved, in order for it to be widely adopted. This system is clean, quiet and non-pullulating. The system is fully configurable in that their ability can be expanded incrementally to accommodate the growth of the load. The PV system must durable with lower failure rate and operating life expectancy of much more than 20years. To have good reliability the PV system requires regular maintenance. The sustainability of a PV system with regular maintenance at regular intervals is described using mean time between failure (MTBF) is simply a statistical analysis of failure rates across a product's whole useful life.

Key words: PV System, MTBF, Regular Maintenance.

Introduction:-

The mean time between system failures is a measure of how long it takes for a system to fail on average (MTBF).The Mean Time Between Failure is a crucial maintenance metric for measuring performance, protection and equipment design, particularly in critical or complicated assist systems. The availability formula requires mean time repair ,and MTBF is one half of that formula (MTTR).The MTBF formula considers unscheduled maintenance but ignores planned maintenance. Such as checks, recalls and preventive parts replacement. Failure is a challenge and the only way to solve a problem is to know what there is to know about it. One technique to learn more about a failure and reduce its impact is to measure the Mean Time Between Failure (MTBF) .By doing an MTBF evaluation, the maintenance crew may reduce downtime while saving money and working faster. The MTBF of photovoltaic modules and PV system components os measured in years.

Literature views:

Fault analysis is required in a solar PV array because it enhances the PV systems dependability, efficiency, and safety. If a fault in a PV system is not detected in a timely manner, not only is the power generation capability reduced, but the fault is often cascaded across the entire system. The PV system's health should be monitored on a regular basis because it's critical to identify the cause of any problems that could affect the system's performance. [1]
It is obvious that present IEC tests are insufficient to address lifetime stress, as failures on certified PV modules have been reported in the field. However in order to improve product quality consistency, production quality assurance needs to be strengthened. Regardless, laboratories do research and provide certification services. A large number of failure modes are now being noticed. The environment chamber tests (damp fire, humidity, freeze, temperature period 200), hot spot test, and mechanical load test are the most extreme testing in the current standard. [2]

Photovoltaic systems are one of the most widely used renewable systems. Solar cells are devices that convert sunlight light into electricity. It is safe, quiet, and non- polluting; it is renewable; it is extremely modular, with incremental capacity increases to match gradual load growth; and it is dependable, with a low failure rate and service life times of more than 20 years. A method for designing and developing a standalone photovoltaic system has been suggested by a number of authors. This Solar Photovoltaic System Design includes array and cell sizing. The array is intended to replace the load on a daily basis, but the fuel cell is intended to keep the load operating for a long length of time, on average isolating days. On a below- average day, the array will not be able to deliver all of the amp-hours of command negative replace the battery drain. The array cannot provide all the amp-hours of command required to replace the load's draw from the battery on a below-average day. As a result the battery is discharged at the end of the day. If the weather forecast for the next day is poor, the battery will discharge some of its charge to keep the loads functioning. The battery can only be depleted for so long before it is ruined. As a result, the battery life should be sufficient to run the loads "efficiently", that is, without the usage of any additional power sources. [3]

The possibility that a device will performs its needed function for a specific amount of the time under specified conditions is defined as reliability. The accuracy of a prediction is highly dependent on the definition of a number of parameters. For repairable products, is assessed in terms of mean time between failure (MTBF), while for non-repairable products, reliable is measured in terms of mean time between failures (MTTR). It is critical to have a correct understanding of MTBF. Reliability figures can differ significantly between supplier, and meaningful comparisons can only be made if the assumptions and methods used are understood. [4]

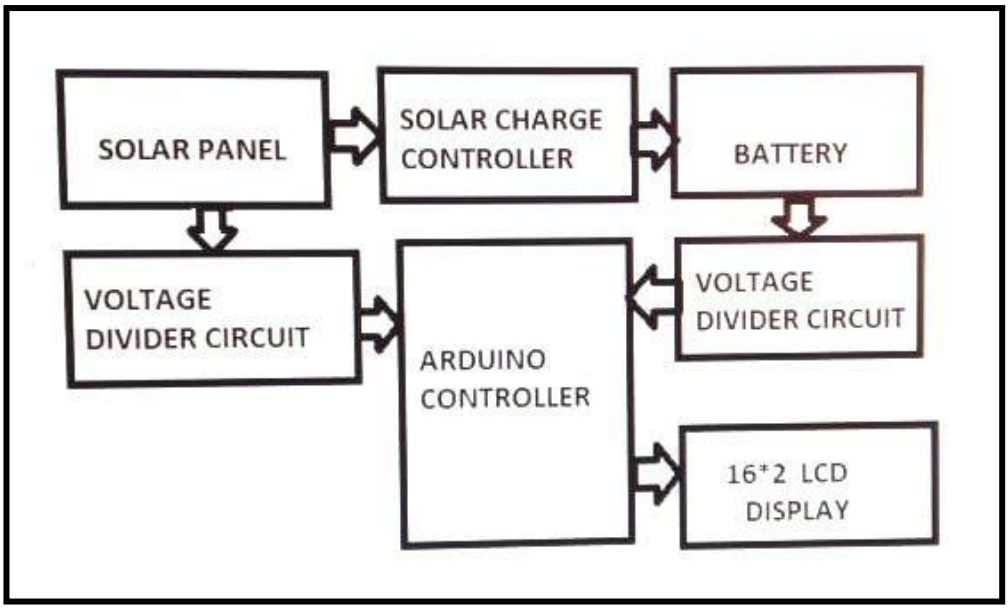
Genetic programming (GP) is a technique derived from the genetic algorithm (GA) that is based on biological evaluation. The GP algorithm system can generate a dynamic reliability model without making any assumptions about software failure mechanisms. [5]

MTBF and MTTR are used in logistics for spare part planning for repairable goods, as well as a measure of hardware and software dependability. For example, replacement or nonrepairable item planning, warranty planning, and part-part obsolescence planning. Even more dubious is the use of MTBF as a metric of system viability. It fluctuates not only as a result of stress, but also as a result of other factors.[6]

To characterize the system nominal reliability, a reliability model is typically built during the system design phase. It's used to forecast reliability performance so that design goals and system needs can be compared. The MTBF is a typical statistic for measuring a system's repair ability. When a system has redundant components, the impact of maintenance on the MTBF must be taken into account. For example, a system with a maintenance policy of repairing failed redundant subsystem components before a critical failure has a longer MTBF than one with a maintenance policy of fixing all failed components after a severe failure. A popular maintenance concept is to restore any broken redundant components before they cause a severe failure. [7]

As chip efficiency improves with numerous clock domains on chip and the synchronizer chain's utilization grows, the mean time between failures criteria become more difficult to achieve. The chip level mean time between failure must account for total chips sent to total product effect to ensure that the product performs reliably in the field. [8]

3 Block Diagram :-



4 Methodology :-

I) Failure :

Failure isn't always black and white situation. It takes place in stages. A car can still drive with a flat tyre, and a computer can still function even if a few keys are missing from the keyboard. They do not, however, work as they should. This is how failure is defined.

II) MTBF :

The Mean Time Between Failures (MTBF) is a formula that calculate the average amount of time between two failures.

To calculate the MTBF, multiply the total number of operation hours in a year by the number of mistakes that occurred during that period. In most cases, the Mean Time Between failure (MTBF) is expressed in hours.

MTBF= # of operational hours/ # of failures

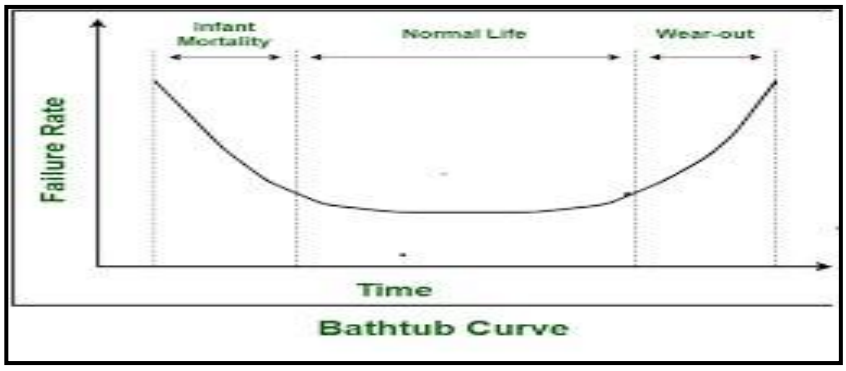
Asset, for e.g., may have been operational for one thousand per year that asset failed 8 times during the course of that year. As a result, that piece of machinery has MTBF of 125 hours. You must gather data from the devices' over all performance to get accurate estimate of MTBF. Human activities such as layout, construction and maintenance among others influence how each asset operates under different conditions. As a result, you should avoid planning your activities around a manuals MTBF estimate. MTBF is the time elapsed between two successive failures and is a substantially different concept to MTTF (Mean Time To Failure). MTTF is a statistical parameter referring to the time elapsed from the start of operation and the first failure. It assumes that mathematical model of reliability is the exponential function which would seem sensible following real world examples.

III) How to use MTBF :

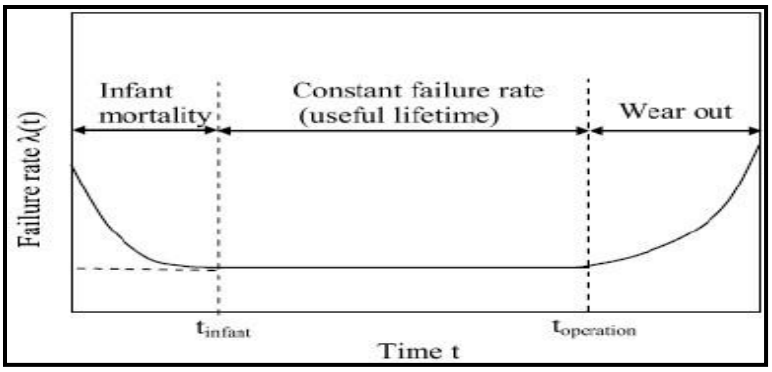
The MTBF is a measurement of how likely an asset is to fail in a certain time frame or how probable a specific form of failure is to occur. When used in conjunction with other maintenance approaches such as failure codes and root cause analysis, as well as extra maintenance metrics such as MTTR, it can help you avoid costly failure. Knowing this information makes it easier to create PMs, which can improve dependability by resolving issues before a problem. If a failure occurs, having all of the necessary information allows you to improve maintainability.

IV) How to calculate solar reliability :

The failure rate is the frequency with which a designed problem occurs as specified by reliability engineering. Over time, the rate of failure follows a bathtub- shaped curve.



The rate at which photovoltaic system fair early in their life cycle is determined by the production process, shipping, and various environmental conditions present at the start of a solar project. Solar arrays should be monitored for a brief period of time (known as the "burn-in period") to ensure normal procedures. This indicates that the array has stabilized and is about to reach the end of its useful life. A string for central solar inverters life span is normally between 10 and 15 years.



MTBF is the reverse of the failure rate only during the useful life time, not the average life span of a drug. It doesn't account for infant mortality or the time it takes for a solar inverter to hang out. You can calculate the MTBF to be 100 years if you see at the bathtub curve again and describe the failure rate as .01 happening per year. The average failure rate is calculated by taking the reverse of the MTBF. Even though the MTBF is 100 years in this case, it is only acceptable for the useful life span, which is usually closer to your time limit.

$$MTBF = = \frac{1}{\lambda} \quad \frac{1}{.01} \quad {}_{c} = 100\ years$$

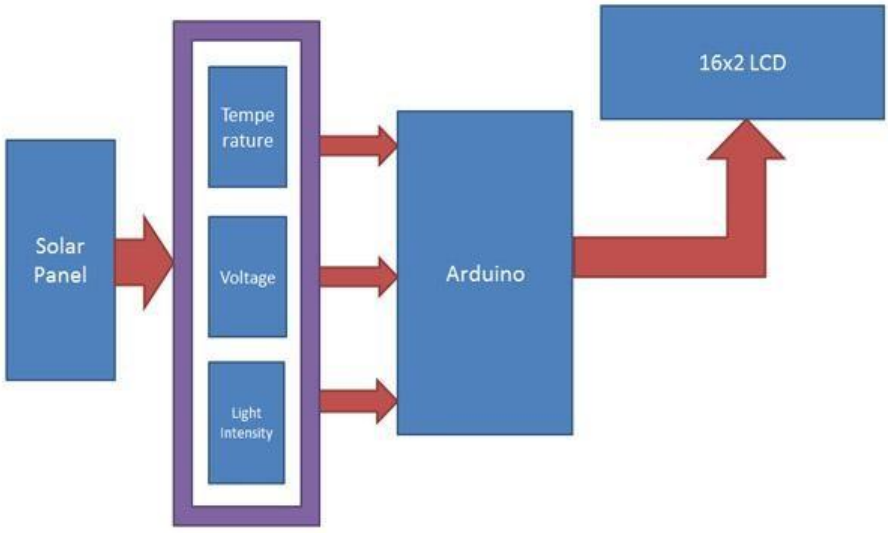
yrIt's also able to match the costs of two solar inverters with varying efficiency levels. To do so, you must factor in extra balance of system (BOS) costs in order to achieve the same power output, To calculate the cost of solar inverter, multiply the price of the BOS by additional percentage of material required (1- the efficiency ratio). This enables you to compare to inverters side by side.

$$C_w = C_i + C_{BOS} \times (1 - \frac{\quad}{\quad}^{\eta 4}) \eta B$$

If you want to get much more precise, use the PV system software to measure the effective output for the same array with only the pv panel modified. Replace the efficiencies ratio with the special production ratio and compare the results.

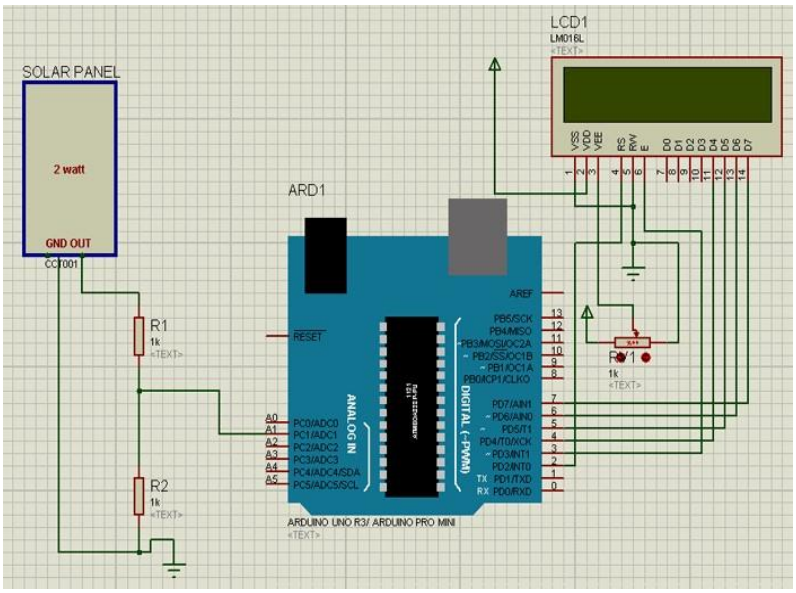
$$Cw = Ci + CBOS \times (1 - \frac{kWhA}{kWhB})$$

All of the parameters in this circuit are in analogue. We just need to convert them to digital form and display them on LCD. Measurement often necessitates the addition of a few extra circuits.



V) Voltage Measurement :

The measurement of the voltage of a solar panel is easy and can be done up to 5 volts . If wish to measure voltage higher than 5 Volts, we will need to add some circuitry, such as a voltage divider. This circuitry responds to voltage, which refers to the amount of voltage we are measure.
For example, we don't need to any additional circuitry to measure 5 Volts. Connect the solar panel output voltage to the analog pin on the arduino, convert to digital, and display the result on an LCD or PC. Let imagine if you need to measure up to 10 Volts and you have to relay on the circuitry that comes with the kit.



To measure voltage, we must use the following formula :-
(Analog value/Resistor factor)*reference = voltage amount of voltage.
When and where :-

Analog value = voltage divider's Analog output
1023.0/(R2/R1+R2) = Resistor factor citation 5Volts.

Let's say

R1=1000Ω

R2=2700 Ω
1023.0*(1000/2700+1000) = Resistor factor.
For up-to 10 Volts, the Resistor factor is 365.35; for more information see the table.

Sr. No.	Maximum Voltage	R1	R2	Resistor Factor
01	5 volt			1023
02	10 volt	1k	1k	511.5
03	15 volt	2k	1k	341
04	20 volt	3k	1k	255

The following are the components that are used :

1) Arduino
2) Solar panel
3) LM35
4) LDR
5) LCD
6) Resisters
7) Wire connections

VII) What can be done to increase MTBF? :

Failure has to consequences: decreased production and increased maintenance costs. As a result all of these variables prices are higher and revenue is less likely to reach the bottom line. As a result it's critical for manufactures to prevent failures, and increasing MTBF should be one of your main focuses. Fortunately, there are a number of approaches that may be used to address the fundamental causes of failure while also increasing the MTBF.

Enhance the preventive maintenance procedures:

Preventive maintenance has the ability to significantly improve MTBF if performed correctly. Preventing equipment problems before they start is possible when you take constructive measures. PM's, on the other hand, might back fire if the process isn't up to snuff.

Preventive maintenance will potentially cause a faster breakdown if manuals are available incomplete, checklists are unclear of non-existent, or technicians aren't properly qualified. Focus on providing the right tools to your maintenance team and making them as available as possible to enhance your PM operation.

VIII) Analyze the source of the problem:

Understanding why an asset failed will help you avoid it from happening again, or at least make it happen less frequently. A root cause analyses using the five whys is the most effective way to get to the bottom of failure. This help you to move beyond just addressing a short-term issue and into a long-term solnstead of simply replacing a faulty component, you can determine whether a higher-quality replacement is available and why one was not ordered in the first place. These not only improves MTBF on one asset, but it also has the ability to increase the MTBF across the board by improving processes.

Conclusion:

This paper illustrates the MTBF calculation of PV System in terms of Hrs. Along with MTBF the input power and output power of PV system is also shown. Based on the calculated value of MTBF it clearly understandable that the reliable operating life of PV syste

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