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Solar Panels Fault Detection

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Introduction:

A photovoltaic power station, also known as a solar park, is a large-scale photovoltaic system (PV system) designed for the supply of merchant power into the electricity grid. They are differentiated from most building-mounted and other decentralized solar power applications because they supply power at the utility level, rather than to a local user or users. They are sometimes also referred to as solar farms or solar ranches, especially when sited in agricultural areas. The generic expression utility-scale solar is sometimes used to describe this type of project.

Monitoring and detecting faults on a set of solar panels, using a wireless sensor network (WNS) is our contribution in this paper, this work is part of project we are working on at Al- Zaytoonah University. The research problem has been exposed by engineers and technicians or operators dealing with PV panel's maintenance, in order to monitor and detect faults within solar panels which affect considerably the energy produced by the solar panels. The proposed solution is based on installing WSN nodes with appropriate sensors for more often occurred faults on the 45 solar panels installed on the roof of IT faculty.

A simulation has been done on nodes distribution and a study for the design of a node with appropriate sensors taking into account the priorities of the processing faults. Finally a graphic user interface is designed and adapted to tele-monitoring panels using WSN. The primary tests of hardware implementation gave interesting results, the sensors calibration and interference transmission problem have been solved. Monitoring and detecting faults on a set of solar panels, using a wireless sensor network (WNS) is our contribution in this paper, this work is part of project we are working on at Al- Zaytoonah University.

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The primary tests of hardware implementation gave interesting results, the sensors calibration and interference transmission problem have been solved. Here we are checking with LPC2148 controller of ARM family about the functionality of each panel. If the fault detected then a message will be sent to the stored mobile number with that particular solar panel details.

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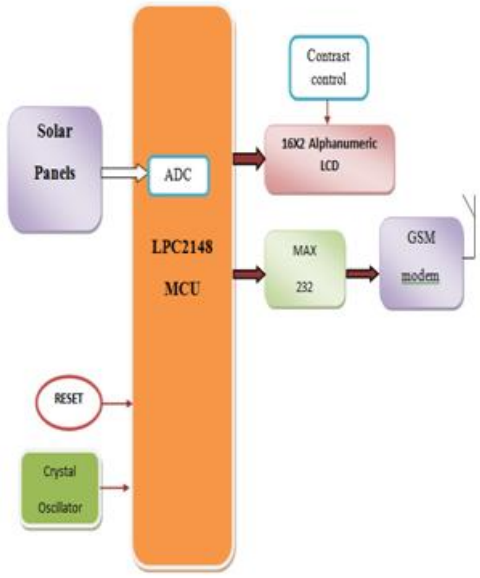
If the panel becomes faulty then the voltage will not be the usual as compared to others. In that way the faulty panel is detected.



Issues in photovoltaic systems:

There are a lot of studies analyzing different issues present in PV systems, demonstrating an interest in detecting faults to the greatest extent as early as possible. A study conducted in Spain discusses the following failures in solar modules:

- Yellowing and browning
- Delamination
- Bubbles in the solar module
- Cracks in cells
- Defects in anti-reflective coating
- Hot spots caused by the panel acting as a load

Another study identified the following conditions:
- Edge-seal delamination
- Newly cracked cells
- Delamination over cells and interconnections
- Split encapsulation over cells and interconnections
- Protruding interconnections

It has also been found that connections and the welds can degrade over time. In conclusion it can be said that there is a wide range of failure conditions.

This breadth motivates the use of classes of failures, based on the electrical properties induced during a fault and the categorization into ground faults, line-line faults, and open-circuit faults. Ground faults are defined as a conductor accidentally having contact with the system ground. Line-line faults occur when two different potentials conduct by accident. Open-circuit faults occur when a conductor is accidentally removed from a closed circuit. The same study concludes that ground and line-line faults typically exhibit a significant drop in output voltage, but also states that open-circuit faults and degradation causes significant decrease in current.

Modules used in this project:

The LPC2148 are based on a 16/32 bit ARM7TDMI-S™ CPU with real-time emulation and embedded trace support, together with 128/512 kilobytes of embedded high speed flash memory. A 128-bit wide memory interface and unique accelerator architecture enable 32-bit code execution at maximum clock rate. For critical code size applications, the alternative 16-bit Thumb Mode reduces code by more than 30% with minimal performance penalty. With their compact 64 pin package, low power consumption, various 32-bit timers, 4- channel 10-bit ADC, USB PORT,PWM channels and 46 GPIO lines with up to 9 external interrupt pins these microcontrollers are particularly suitable for industrial control, medical systems, access control and point-of-sale. With a wide range of serial communications interfaces, they are also very well suited for communication gateways, protocol converters and embedded soft modems as well as many other general-purpose applications.

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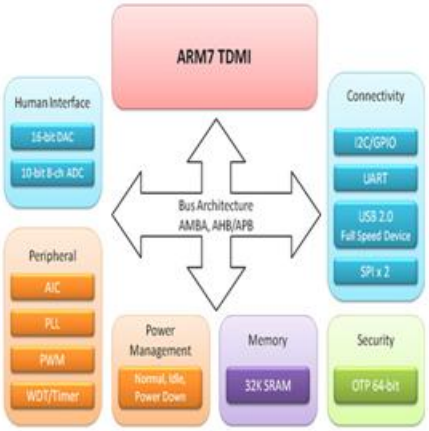


This project uses regulated 3.3V, 500mA power supply. Unregulated 12V DC is used for relay. 7805 three terminal voltage regulator is used for voltage regulation. Bridge type full wave rectifier is used to rectify the ac output of secondary of 230/12V step down transformer.

ARM7TDMI Processor Core:

- Current low-end ARM core for applications like digital mobile phones
- TDMI
  - T: Thumb, 16-bit compressed instruction set
  - D: on-chip Debug support, enabling the processor to halt in response to a debug request
  - M: enhanced Multiplier, yield a full 64-bit result, high performance
  - I: Embedded ICE hardware
- Von Neumann architecture

Global System for Mobile Communication (GSM) Definition:

GSM, which stands for Global System for Mobile communications, reigns (important) as the world's most widely used cell phone technology. Cell phones use a cell phone service carrier's GSM network by searching for cell phone towers in the nearby area. Global system for mobile communication (GSM) is a globally accepted standard for digital cellular communication. GSM is the name of a standardization group established in 1982 to create a common European mobile telephone standard that would formulate specifications for a pan-European mobile cellular radio system operating at 900 MHz. It is estimated that many countries outside of Europe will join the GSM partnership.

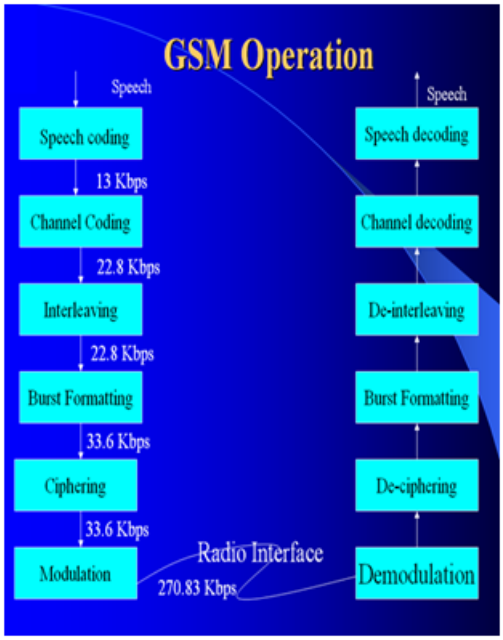
General Features:

- Tri-band GSM/GPRS900/1800/1900Mhz
- GPRS multi-slot class 10
- GPRS mobile station class –B
- Complaint to GSM phase 2/2+

i. -class 4(2W @900MHz)

ii. -class 1(1W @/18001900MHz)

- Dimensions: 40x33x2.85 mm
- Weight: 8gm
- 7. Control via AT commands
- (GSM 07.07, 07.05 and SIMCOM enhanced AT commands)
- SIM application tool kit
- supply voltage range 3.5…….4.5 v
- Low power consumption
- Normal operation temperature: -20 'C to +55 'C
- Restricted operation temperature : -20 'C to -25 'C and +55 'C to +70 'C
- storage temperature: -40 'C to +80 'C



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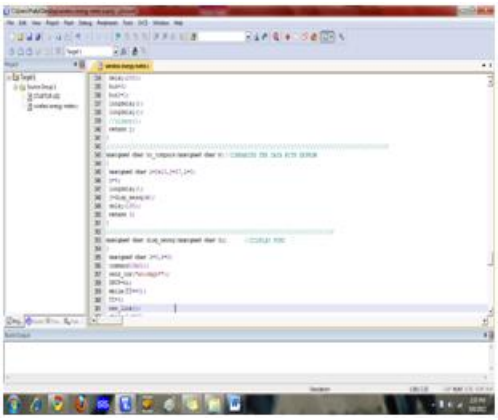
Software Tools:

Keil compiler is a software used where the machine language code is written and compiled. After compilation, the machine source code is converted into hex code which is to be dumped into the microcontroller for further processing. Keil compiler also supports C language code.



Flash Magic:

Flash Magic is a tool which is used to program hex code in EEPROM of micro-controller. It is a freeware tool. It only supports the micro-controller of Philips and NXP. It can burn a hex code into that controller which supports ISP (in system programming) feature. Flash magic supports several chips like **ARM Cortex M0, M3, M4, ARM7 and 8051.**

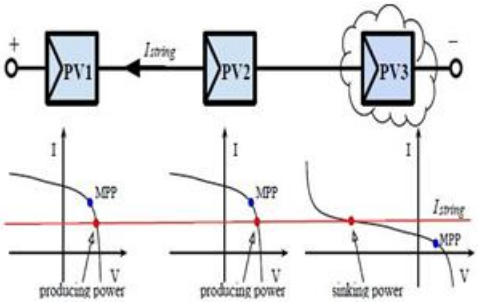
Advantages:

1. Solar energy is free of pollution.
2. The plant requires little maintenance or help after setup.
3. It is economical. When it is connected to the grid, solar energy can overtake the highest cost electricity at peak demand and can also reduce grid loading, apart from getting rid of the need for local battery power in darkness.

Applications:

Average insulation showing land area (small black dots) required to replace the world primary energy supply with solar electricity. 18 TW is 568 Exajoule (EJ) per year. Insulation for most people is from 150 to 300 W/m² or 3.5 to 7.0 kWh/m²/day. Solar energy refers primarily to the use of solar radiation for practical ends. However, all renewable energies, other than geothermal and tidal, derive their energy from the sun. Solar technologies are broadly characterized as either passive or active depending on the way they capture, convert and distribute sunlight. Active solar techniques use photovoltaic panels, pumps, and fans to convert sunlight into useful outputs. Passive solar techniques include selecting materials with favorable thermal properties, designing spaces that naturally circulate air, and referencing the position of a building to the Sun.

Active solar technologies increase the supply of energy and are considered supply side technologies, while passive solar technologies reduce the need for alternate resources and are generally considered demand side technologies Solar cells can also be applied to other electronics devices to make it self-power sustainable in the sun. There are solar cell phone chargers, solar bike light and solar camping lanterns that people can adopt for daily use. Solar power plants can face high installation costs, although this has been decreasing due to the learning curve. Developing countries have started to build solar power plants, replacing other sources of energy generation.



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CONCLUSION:

This study has focused on three main areas associated with locating faults in solar panels. Fault detection is important since solar panel installations have been shown to be susceptible to a wide range of fault conditions. It is also motivated by the fact that 24/7 automated surveillance can reduce the time from a fault occurring to replacement of the faulty solar panel. There is also a real-world need for fault detection since studies have concluded that faults may have a significant effect on power production. The main constraints have been to only study measurements of voltage and current, with additional access to indirect low-resolution temperatures. This follows since other studies typically have access to both solar irradiation data and temperature measurements taken on the solar panel.

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