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Grid Synchronization Failure Based On Voltage and Frequency Variations beyond Limit

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Abstract -In this project we are getting to implement the utilization of up-to-date technology in sensing the very low variations in frequency or voltage magnitude of a generator during a power system during which there could also be many generators working in synchronism with the grid in terms of phase sequence, voltage magnitude and frequency. In today's practical power system as we all know many generators or power source are working together and to take care of stability between all, the detection and isolation of the sources rupture of synchronism, is of crucial significance as otherwise it might have caused the whole system to fail. Hence various techniques are developed in industries and power plants (especially solar energy plants) to stay all the generators and sources in synchronism with the facility Grid and just in case of and failure detect and isolate the failed generator out of the grid and hence maintain a stable operation of the facility System.

1. INTRODUCTION

The project is meant to develop a system to detect the synchronization failure of any external supply source to the facility grid on sensing the abnormalities in frequency and voltage.

There are several power generation units connected to the grid like hydel, thermal, solar etc. to provide power to the load. These generating units got to supply power consistent with the principles of the grid. These rules involve maintaining a voltage and therefore the frequency variations within limits.

If there's any deviation from the suitable limit of the grid it's mandatory that an equivalent feeder should automatically get disconnected from the grid which by effect is termed as islanding. This prevents in large scale brown out or black out of the grid power. So it's preferable to possess a system which may warn the grid beforehand in order that alternate arrangements are kept on standby to avoid complete grid failure.

This system is predicated on a microcontroller of 8051family and/or Arduino. The microcontroller monitors the under/over voltage being derived from a group of comparators. because the frequency of the mains supply can't be changed, the project uses a variable frequency generator (555-timer) for changing the frequency, while a typical variac is employed to vary the input voltage to check the functioning of the project.

A lamp load (indicating a predictable blackout, brownout) is being driven from the microcontroller just in case of voltage/frequency going out of acceptable range. Further the project are often enhanced by using power electronic devices to isolate the grid from the erring supply source by sensing cycle by cycle deviation for more sophisticated means of detection.

2. MAIN OBJECTIVE

The main objective of this project is aimed at development of such a system so as to avoid any over/under voltage and /or over/under frequency in Power System.

It also uses phase sequence indicator to show any phase sequence of the system (RYB or RBY).

This project further enhances the system reliability and security by avoiding failure of the entire system due to abnormalities in one or two of system units.

In case of any abnormal conditions pertaining to voltage or frequency the fault has to be detected and the system to be is landed or disconnected from main grid. The faulty unit shall be replaced by a standby unit to meet the load requirement; this can be achieved by further implementation of electronics devices.

The project aims to detect voltage variations beyond (200-250) volts and frequency variation beyond (49-50) Hz. A phase sequence indicator is used to indicate the phase sequence of the 3-phase system. The entire projects works on three phase basis to achieve practical power system protection goals.

3. PROPOSED SYSTEM

The system uses Arduino UNO/ Microcontrollers of 8051 families or could potentiallyuse any microcontroller as the brain of the project sensing the input parameters i.e. voltage and frequency, comparing it to pre-set values and accordingly making tripping decisions.

The system uses a 555 timer to generate a variable frequency of the desired value for project observations. The voltage is stepped down and fed to the controller through a regulator. The voltage adjustments can be done using screw driven potentiometers.

System Design:

Fig 1. Block Diagram

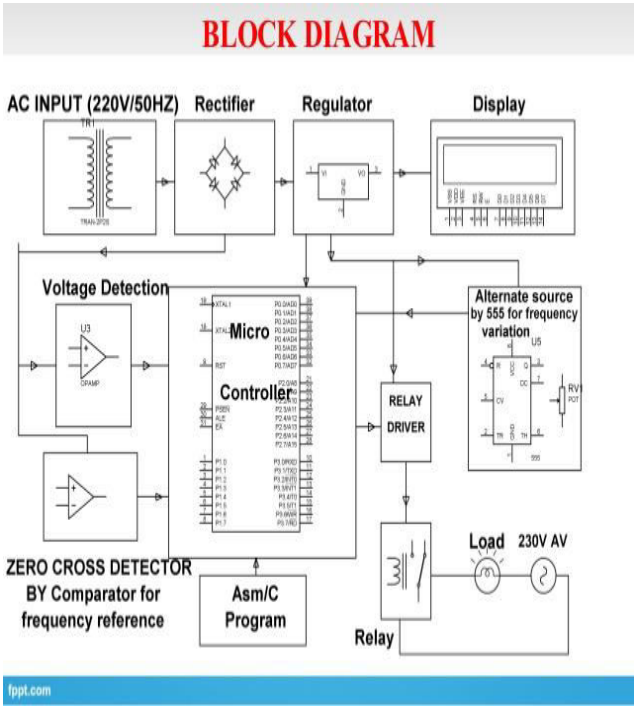


Fig 3.1- Block Diagram of Project

Project Circuit Diagram:

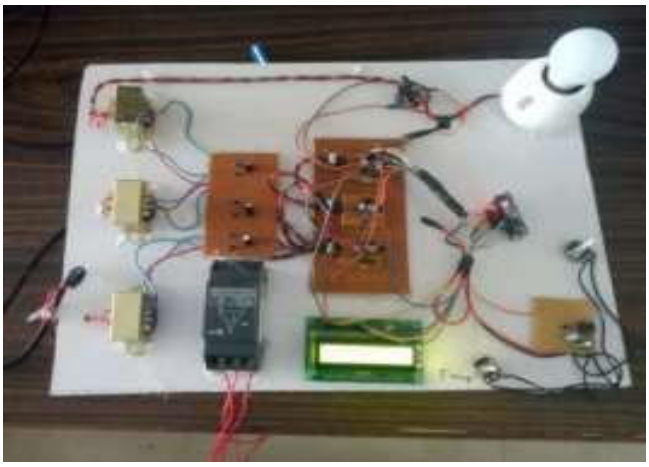


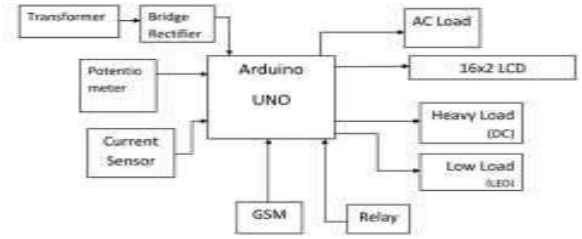
Fig 2. 3 phase implementation of project

Working Principle:

230v power supply is given to the step down transformer. Rating of the transformer is 12v. It are often given to bride rectifier which consists of rectifier, filter and a transformer. Rectifier converts the ac into dc and filter gives the pure dc signal by blocking ripples.

The dc voltage is further regulated and Microcontroller receives this DC power from rectifiers. The output of the microcontroller is connected to16×2 LCD Display. The voltage are often varied by varying the voltage potentiometer. The variable frequency is obtained from a 555 timer to check the functionality of the project.

In case one for correct synchronization load testing is completed by connecting Heavy load lamp of 20W and for



light load LED are connected. A Pot is connected at the input of the microcontroller. By varying pot the voltage changes after reaching the suitable voltage the LCD displays trip voltage. The relay circuit are going to be opened and therefore the lamp are going to be protected. The frequency variation is shown before tripping. the sunshine will flicker before it turned OFF.

An addition phase sequence detector is employed to point the phase sequence of the facility supply. RYB is that the normal phase sequence. If the phase sequence of the availability changes thanks to any reason i.e. reversal of generator rotation then the phase sequence indicator detects the phase sequence and accordingly a tripping signal should be generated to avoid mal operation of the whole grid.

Hardware Description:

- Arduino UNO MC
- LCD 16x2
- Transformers (230/12v)
- Diode Rectifier+ Capacitor Filter
- Relay
- Lamp Load
- Potentiometer
- Data Monitoring System (PC/Laptop)

ARDUINO SOFTWARE IDE: Language used: Embedded C. The Arduino integrated development environment (IDE) may be a cross-platform application that's written within the programing language Java. It originated from the IDE for the languages Processing and Wiring.

The Arduino IDE supports the languages C and C++ using special rules of code structuring. The Arduino IDE supplies a software library from the Wiring project, which provides many common input and output procedures. User-written code only requires two basic functions, for starting the sketch and therefore the main program loop, that are compiled and linked with a program stubmain() into an executable cyclic supervisory program with the GNU toolchain, also included with the IDE distribution. The Arduino IDE employs the program Arduino to convert the executable code into a document in hexadecimal encoding that's loaded into the Arduino board by a loader program within the board's firmware.

Python is an interpreted high-level programing language for general-purpose programming. Created by Guido van Rossum and first released in 1991, Python features a design philosophy that emphasizes code readability, notably using significant whitespace. It provides constructs that enable clear programming on both small and enormous scales.
Python features a dynamic type system and automatic memory management. It supports multiple programming paradigms, including object-oriented, imperative, functional and

procedural, and features a large and comprehensive standard library. Python interpreters are available for several operating systems. CPython, the reference implementation of Python, is open source software and features a community-based development model, as do nearly all of its variant implementations. CPython is managed by the non- profit Python Software Foundation.

4. ARDUINO UNO

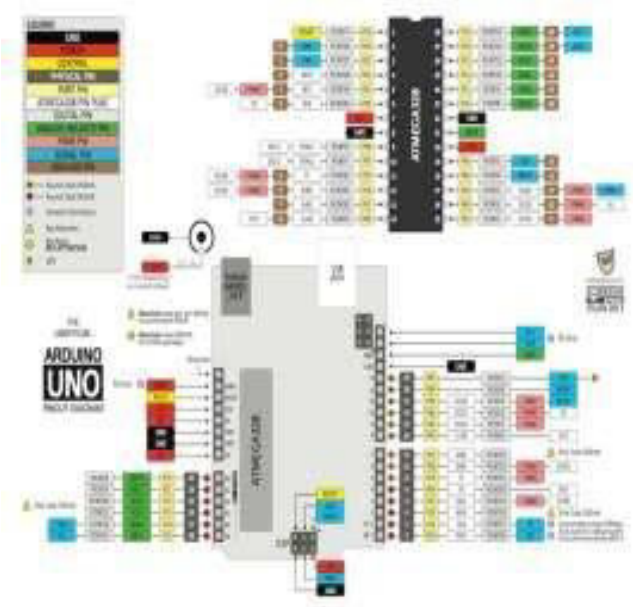
Arduino Uno may be a microcontroller board supported the mega 328. it's a ceramic resonator that's 16MHz, fourteen digital input/output pins (six of which may be used as PWM outputs), a push button , a USB connection, an influence jack and 6 analog inputs. it's an 8-bit microcontroller supported RISC architecture.

The Arduino doesn't use a RC oscillator, but rather a quartz oscillator due to the standard factor (Q). the standard factor for a quartz oscillator is of the order 100,000 whereas the standard factor for an RC oscillator is of the order 100. a top quality factor is defined as: Q = f/BW

Where f is that the resonant frequency and BW is that the bandwidth.

Fig: 2 Arduino block diagram

The Arduino Uno are often powered via the USB connection or with an external power supply. the facility source is chosen automatically. External (non-USB) power can come either from an AC-to-DC adapter or battery. The adapter are often connected by plugging a 2.1mm center-positive plug into the board's power jack. Leads from A battery are often inserted within the GND and Vin pin headers of the facility



connector. The board are often operate an external supply of 6-20volts. If furnished with less than7V, however, the 5V pin could provide but 5V and therefore the board could also be unstable. If using quite 12V, the transformer may overheat and damage the board. The recommended voltage is between 7-12V because if the voltage dips below 7V, the 5V pin on the Arduino board will become unstable and if the voltage rises above 12V, the board may overheat and become damaged.

The power pins are as follows:

VIN The input voltage to the Arduino board when it's using an external power source (as against 5volts from USB connection or other regulated power source).You can supply voltage through this pin or,if supplying voltage via the facility jack, access it through this pin.5V.The regulated power supply wont to power the microcontroller and other components on the board. this will come either from VIN via an on-board regulator, or be supplied by USB or another regulated 5V.3V3.A3.3 volt-supply generated by the on-board FTDI (Future Technology Devices International) chip. Maximum current draw is 50mA.

MEMORY: The Atmega328 has 32 KB of non-volatile storage for storing code (of which 0.5 KB is employed for the bootloader). it's also 2 KB of SRAM and 1 KB of EEPROM (which are often read and written with the EEPROM library).

Each of the 14 digital pins on the Uno are often used as an input or output, using pin Mode (), digital Write(), and digital Read() functions. They operate at 5 volts. Each pin can provide or receive a maximum of 40 mA and has an indoor pull-up resistor (disconnected by default) of 20-50KOhms. Additionally, some pins have specialized functions:

• Serial: 0 (RX) and 1 (TX). used to receive (RX) and transmit (TX) TTL serial data. These pins are connected to the corresponding pins of the ATmega8U2 USB-to-TTL Serial chip.

• External Interrupts: 2 and three . These pins are often configured to trigger an interrupt on a coffee value, a rising or falling edge, or a change in value. See the attach Interrupt () function for details.

• PWM: 3, 5, 6, 9, 10, and 11. Provide 8-bit PWM output with the analog Write () function.

• SPI: 10 (SS), 11 (MOSI), 12 (MISO), 13 (SCK).

These pins support SPI communication, which, although provided by the underlying hardware, isn't currently included within the Arduino language.

• LED: 13. there's a built-in LED connected to digital pin 13. When the pin is HIGH value, the LED is on, when the pin is LOW, it's off.

The Uno has 6 analog inputs, each of which give 10 bits of resolution (i.e. 1024 different values). By default they measure from ground to five volts, though is it possible to vary the upper end of their range using the AREF pin and therefore the analog Reference ()function. Additionally, some pins have specialized functionality:

• I 2C: 4 (SDA) and 5 (SCL). Support I2C (TWI) communication using the Wire library. There are a few of other pins on the board:

• AREF. Reference voltage for the analog inputs. Used with analog Reference ().

• Reset. Bring this line LOW to reset the microcontroller. Typically wont to add a push button to shields which block the one on the board.

WORKING MODULE: The Arduino Uno are often programmed with the Arduino software (download). The ATmega328 on the Arduino Uno comes Pre Burned with a bootloader that permits you to upload new code thereto without the utilization of an external hardware programmer. It communicates using the first STK500 protocol. you'll also

bypass the bootloader and program the microcontroller through the ICSP (In-Circuit Serial Programming) header.

Rather than requiring a physical press of the push button before an upload, the Arduino Uno is meant during a way that permits it to be reset by software running on a connected computer. one among the hardware flow control lines (DTR) of the ATmega8U2 is connected to the reset line of the ATmega328 via a 100nanofarad capacitor. When this line is asserted (taken low), the reset line drops long enough to reset the chip. The Arduino software uses this capability to permit you to upload code by simply pressing the upload button within the Arduino environment. this suggests that the bootloader can have a shorter timeout, because the lowering of DTR are often well-coordinated with the beginning of the upload. This setup has other implications. When the Uno is connected to either a computer running Mac OS X or Linux, it resets whenever a connection is formed thereto from software (via USB). For the subsequent half- second approximately, the bootloader is running on the Uno. While it's programmed to ignore malformed data (i.e. anything besides an upload of latest code), it'll intercept the primary few bytes of knowledge sent to the board after a connection is opened. If a sketch running on the board receives one-time configuration or other data when it first starts, confirm that the software with which it communicates waits a second after opening the connection and before sending this data. The Uno contains a trace which will be move disable the auto-reset. The pads on either side of the trace are often soldered together to re-enable it. It's labelled "RESET-EN". you'll even be ready to disable the auto-reset by connecting a 110 ohm resistor from 5V to the reset line.

TRANSFORMER: In detecting power system synchronization failure system on sensing frequency or voltage beyond the suitable range, the transformer is employed for step down the ac voltages. It steps down the 220V ac into 12V. RELAY-In this technique, the load relay is employed for turn on or off the output load and it consists of normally open and shut contacts.

LOAD: during this system, the lamp is employed as an output load.

SINGLE PHASING PREVENTOR:

Protection of induction motors against single phasing or reverse phasing or unbalance supply is one among the main problems in electrical systems. For safe running of 3-phase motors, special protections that keep endless watch on supply conditions are very essentials. The main explanation for motors burn-out is overloading which occurs thanks to unbalance supply or single phasing. Phase failure occurs just in case of fuse blown-off, loose connections or loss of phase from supply itself.

ARDUINO TO 16×2 LCD MODULE: RS

Pin of the LCD module is connected to digital pin 12 of the Arduino. R/W pin of the LCD is grounded. Enable pin of the LCD module is connected to digital pin 11 of the Arduino. During this project, the LCD module and Arduino are interfaced within the 4-bit mode. This suggests only four of the digital input lines (DB4 to DB7) of the LCD are used. This method is extremely simple, requires less connections and you'll almost utilize the complete potential of the LCD module. Digital lines DB4, DB5, DB6 and DB7 are interfaced to digital pins 5, 4, 3 and a couple of of the Arduino. The 10K potentiometer is employed for adjusting the contrast of the display. 560 ohm resistor R1 limits the present through the rear light LED. The Arduino are often powered through the external power jack provided on the board. +5V required in another parts of the circuit are often tapped from the 5V source on the Arduino board. The Arduino are often also powered from the PC through the USB port.

5. RESULTS

It is observed that the tolerance of voltage is ± 10 volt and tolerance of frequency is ±2.0 as per standard. Normally the range of the voltage and frequency is 230 volt and 50Hz respectively consistent with Indian standard. during this paper consistent with the results we observed the subsequent conditions. Condition 1: When supply is constant that's 230 volts, 50Hz then we get constant sinusoidal waveform as output. (230volt), Frequency: (50Hz) These Parameters Limits Voltage (Volts) Frequency (H z) Over Limits 240 52.5 Constant Limit 230 50 under

Limits 220 47.5 38 Stable sinusoidal waveform Condition 2: When given supply voltage is below tolerance limit that's below 220 volts then we get the sine waveform with reducing magnitude .Sinusoidal waveform with decrease in amplitude Condition 3: When given supply voltage is above tolerance limit that's above 240 volts then we get the sine waveform with increasing magnitude. Sinusoidal waveform with increase in amplitude Condition 4: Similarly, when frequency is above tolerance limit we get sizable amount of oscillation in sinusoidal waveform. : Sinusoidal waveform with increase in frequency Condition 5: When frequency is below tolerance limit we get less number of oscillation in sinusoidal waveform. : Sinusoidal waveform with decrease in frequency. These outputs are obtained within the PC or within the lab oscilloscope and may verify the result.

6. CONCLUSION AND FUTURE SCOPE

This paper gives brief idea about developing a system to detect the synchronization failure of any external supply source to the facility grid on sensing the bad voltage and frequency.

Number of distributed generators connected in parallel to the grid, to provide power to the load. Each generator having follow the principles of grid. These rules involve maintaining a voltage and frequency variation within limits. When any fault occurs on grid and thanks to this grid broken a rules and deviation occur in voltage and frequency. When deviation occur in grid feeder is mandatory to open from grid and this process is term as islanding. This prevent grid failure or blackout

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