

Palestine Polytechnic University

College of Engineering



**Design and Implementation of a monitoring and control system for
power conversion networks**

Case study: HEPCO

By:

Sujood Abu Dayya

Tarneem Qamran

Aghsan Salman

Supervisor's

Dr.Murad Abusubih

Dr.Fouad Zaro

Submitted to the College of Engineering
in partial fulfillment of the requirements for the
Bachelor degree in Communications & Electronics
and Electrical Energy Engineering

Hebron, October 2020

Table of contents

Chapter one	10
1.1 Overview	11
1.1 Motivation	11
1.1 Objectives	11
1.1 Methodology	11
1.1 Related work	12
1.. Problem	12
1.7 Solution idea	12
1.8 Project Schedule	14
Chapter two	15
1.2 Distribution system	16
1.2.2 Primary Distribution	16
1.2.1 Secondary Distribution	16
1.1 Communication system	17
1.1.2 A typical communication system comprises of following components	18
1.1.1 Arduino	19
1.1.2 Server	20
1.1.3 GPRS/GSM SIM900 module	22
Chapter three	24
2.2 Block Diagram of the system	24
Chapter four	27
3.2 Overview	28
3.1 System components	28
3.1.2 Current transformer	28
3.1.1 Voltage transform	29
3.1.2 relay	29
3.1.3 uno arduino	30
3.1.4 usb-ttl	38

3.1.5 GPRS/GSM SIM900	43
3.2.7 TurnoffthePINlock	48
3.1.4 server.....	50
4.3 cost table for the project.....	51
4.4 table of abbreviation.....	51
4.5 arduino code	53
Chapter five	56
5.1 Result	57
Chapter six.....	58
4.2 problem.....	58
5.2 Recommendations	59
5.3 Conclusion	60
5.4 References.....	61
References	46
List of figure	
Fig2.2: arduino uno...	14
Fig2.2: socket server	14
Fig 2.3: GPRS/GSM SIM900 shield.....	16
Fig 3.1: : block diagram for monitoring/control	21
Fig 3.2: block diagram for substation in detail.....	21
Fig 3.3: block diagram for project	22

Fig4.1:current transformer (ACS).....	38
Fig4.2 voltage transformer (zmp)	38
Fig4.3:relay	40
Fig 4.4:uno arduino pins	41
Fig4.5 the Arduino Board	44
Fig4.6: arduino program.....	45
Fig4.7:usb-ttl.....	45
Fig4.8:at command.....	46
Fig4.9:tll interface GPRS/GSM SIM900	47
Fig4.10:at command(tcp)	48
Fig4.11 : terminal interface socket.....	48
Fig4.12: GPRS/GSM SIM900 shield.....	49
Fig4.13: GPRS/GSM SIM900 shield interface arduino	50
Fig 4.23 execution	52
Fig4.15: Turn off the PIN lock.....	54
Fig 4.16 SIM in gprs	55
Fig4.17:socket program.....	56
Fig 5.1: practical part.....	57
Fig5.2:all component system	58
Fig5.3:control load(open relay).....	59
Fig6.1:port checker	61

List of table

Table 1.1: Project Schedule.

Table 4.1 Cost table for the project44

Table 4.2 Table of abbreviations..... 44

APPINDIX

APPINDIX 1... 64
APPINDIX 2... 65
APPINDIX 3... 66
APPINDIX 4... 67
APPINDIX 5... 68
APPINDIX 6... 69

الاهداء

الي امي الحبيبة منبع الحب والحنان , الي من بذل الغالي والنفيس لايكون كما انا عليه الي والدي العزيز .

الي من ذقت معهم طعم المحبة والاخوة الي اخوتي واسرتي .

الي اساتذتنا والي كل من علمنا حرف.

الي من ضاقت الصدور ذكرهم الي من كانوا قوت قلوبنا الي احبائنا واصدقائنا الاعزاء , الي من كانوا سندا لنا بجهدهم وعلمهم ونصحهم ووقتهم الي مشرفينا الكرام , الدكتور فواد الزرو و الدكتور مراد ابو صبيح.

Abstract

Hebron Electricity Company applies the SCADA system which is a good monitoring system for all the power distribution stations it supervises in the Hebron Governorate. But it shows the status of the stations but needs human intervention in case of any malfunction in any of the stations and this requires time and effort to resolve the defect. Our project will be if it is applied to the stations at a lower cost than SCADA.

This project aims to reduce human effort and time in resolving faults that occur in power distribution stations, this model is intended for remote control and monitoring of stations that use wireless data transmission technology through a segment, GPRS / GSM SIM900, and this system will be less expensive than the applied SCADA system. Currently in power distribution stations.

The control will be automatic in case of failure by separating the circuit breakers, at the same time, all data pertaining to the station will be displayed for monitoring .

المخلص

تطبق شركة كهرباء الخليل نظام السكادا وهونظام مراقبة جيد لجميع محطات توزيع الطاقة التي تشرف عليها في محافظة الخليل , النظام يوضح حالة المحطات ولكنه يحتاج الي تدخل بشري في حالة حدوث اي خلل في أي من المحطات وهذا يتطلب الوقت والجهد لحل العطل. يهدف هذا المشروع للتقليل من الجهد البشري والوقت في حل الاعطال التي تحدث في محطات توزيع الطاقة , هذا النموذج مخصص للتحكم عن بعد ومراقبة المحطات التي تستخدم تقنية نقل البيانات لاسلكيا من خلال قطعة (GPRS/GSM SIM900) .

وهذا النظام سوف يكون اقل تكلفة من نظام السكادا المطبق حاليا في محطات توزيع الطاقة . سيكون التحكم تلقائيا في حالة حدوث عطل عن طريق فصل القواطع الكهربائية وفي الوقت نفسه سيتم عرض جميع البيانات المتعلقة بالمحطة للمراقبة.

Chapter one : Introduction

1.1 Overview.

1.2 Motivation .

1.3 Objectives.

1.4 Methodology.

1.5 Related work.

1.6 Problem .

1.7 Solution idea.

1.8 Project Schedule.

1.1 Overview

This chapter focuses on the main idea in the project which is the data transmission process using 3G technology and the process of self-control (automatic) in power stations , it will state the aims and the previous works related to the project.

1.2 Motivation

Our project helps reduce the human effort and time required to correct faults in power distribution stations, by applying self-control and monitoring in the center that connects all the plants , In our project we will use 3G technology to transmit the data of the stations wirelessly based on the resulting data the correct control will be done .

1.3 Objectives

The aim of this project is to use new and less expensive technologies and systems currently in place in power distribution stations

We aimed to achieve several objectives in our project:

- 1.To improve quality of power remote sensing .
- 2.Real time monitoring.
- 3.To maintain continuity of supply.

1.4 Methodology

The following points outline the project's methodology for the steps:

1. The data will be taken from the station through sensors on it giving data of voltage and current on the station.
2. This data will be input to the control module (Orduino) in which the data will be controlled based on their values.
3. Then the data transfer step will be through 3G technology for circuit breakers .

1.5 Related work

In our studies , various papers have proposed to address issues in automatic electric grids. First of it [Microcontroller Based Electrical Parameter Monitoring System of](#)

[Electronic Load Controller Used in Micro Hydro Power Plant](#) . [1] monitor the electrical parameters such as voltage, current, power and frequency of electronic load controller (ELC) by using microcontroller and liquid crystal display (LCD). The voltage is sensed by using the step down transformer and voltage divider circuit. The current is measured with the help of an ACS 712 current sensor. Frequency signal is obtained by using a frequency signal converter circuit. Microcontroller and liquid crystal display are used as the main devices to monitor the above parameters according to the values obtaining from the sensing circuits.

[An IoT Control System for Wind Power Generators](#) [2] Energy sector as important part of the industry knows nowadays a high transformation towards renewable energy, and one of important solution is the wind energy. The wind control system must guarantee safe and reliable operation, monitor components and variables, and check that these variables are in an admissible range and must perform the detection and prediction of faults. We propose in this paper a new Internet of Things solution to control and monitor a wind energy system.

1.6 Problem

the electric power is highly vulnerable against many forms of natural and malicious physical events , which can adversely affect the overall performance and stability of the grid. Additionally, there is an impending need to equip the distribution lines with a high performance data communication network, that supports future operational requirements like real time monitoring and control (like isolate the fault)is necessary for grid integration.

Difficulty in the process of delivering data correctly across the 3G model. Because it's a wireless transmission. affected by several factors, the most important environment in which the transfer.

1.7 Solution idea

severity of the fault depends on the short-circuit location, the path taken by fault current, the system impedance and its voltage level. In order to maintain the continuation of power supply to all customers which is the core purpose of the power system existence, all faulted parts must be isolated from the system temporary by the protection schemes.

When a fault exists within the relay protection zone at any line, a signal will trip or open the circuit breaker isolating the faulted line . To complete this task successfully, sensors are put in various components in the power network current transformer (CT) and voltage transformer(VT) , The secondary of current transformer is connected to the current coil of relay and secondary of voltage transformer is connected to the voltage coil of the relay. Whenever any fault occurs in the feeder circuit, proportionate secondary current of the CT will flow through the current coil of the relay ,and send this value of current to the microprocessor through 3G ,the microprocessor Take a decision and send signal to relay to open circuit breaker.

fault analysis has to be conducted in every location assuming several fault conditions. The goal is to determine the optimum protection scheme by determining the fault currents & voltages. In reality, power system can consist of thousands of buses which complicate the task of calculating these parameters without the use of computer software .The controlling and monitoring of electrical distribution line is also possible using the internet. It is capable of effective integrate of the infrastructure resources in communications manage for electrical power system, make the information and communication services manage for electrical power system, increase the level of power system information and to get better the utilization efficiency of infrastructure in the existing power system.

1.8 Project Schedule.

This section lists the phases and time schedule for the project for the second semester. and the details distribution of the phased among the working weeks.

Time(week)	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Discussion Idea																
Collecting Data																
Design The System																
Implementatio n																
Documentatio n of the System																

Table 1.1: Project Schedule.

Chapter two : Theoretical background

2.1 Distribution system .

2.1.1 Primary Distribution.

2.1.2 Secondary Distribution.

2.2 Communication system.

2.2.1 A typical communication system comprises of following components.

2.2.2 Arduino.

2.2.3 Server.

2.2.4 GPRS/GSM SIM900 shield.

2.1 Distribution system :

Electrical power distribution is the final stage of an electrical power system, which entails the delivery of electricity to the load. The primary role of this section is to carry the electricity from the transmission lines to the loads in the individual customers to the different strata of society. In the power distribution section of an electrical power system, there are two main subsections: primary distribution and secondary distribution.

2.1.1 Primary Distribution:

Primary distribution lines contain a distribution transformer present in the locality of the clientele. Primary distribution ranges from 4 to 35-kilo Voltage. Only industries can directly feed the transmission line. Most average consumers are connected to a transformer that brings down the voltage to a useable level. The distribution network for the primary distribution comes in three types, although they are mainly of two types—radial or network. A radial network is primarily like a tree, where there is only one line of connection for the customer to the source of supply. A network system, on the other hand, has multiple or parallel connections to the source of supply. A radial connection is primarily used in rural areas, while the network connection is primarily used in load-sensitive areas, such as a dense urban area. However, as bad as radial systems sound, based on there only being a single connection to the source, modern-day radial networks do contain backup options.

2.1.2 Secondary Distribution:

The parameters that encompass the properties of electricity are not strictly limited to voltage and current. When it comes to electricity, there is a third important property of electricity—frequency. There are primarily two frequencies in which electricity is produced, either 50 or 60 Hz. This electricity is then delivered to domestic customers

as single-phase electric power. Seen with an oscilloscope, the domestic power supply in North America would look like a sine wave, oscillating between -170 volts and $+170$ volts, giving an effective voltage of 120 volts RMS.

However, in some countries of Europe and India, three-phase power is more efficient in terms of power delivered per cable used and is more suited to running large electric motors. Some large European appliances may be powered by three-phase power, such as electric stoves and clothes dryers. A ground connection is normally provided for the customer's system, as well as for the equipment owned by the utility. The purpose of connecting the customer's system to the ground is to limit the voltage that may develop if high voltage conductors fall onto lower-voltage conductors, which are usually mounted lower to the ground, or if a failure occurs within a distribution transformer; this process is also famously known as grounding. With this, we can conclude that the distribution of electricity is no small feat and requires a tremendous amount of calculation and engineering with the proper understanding of the geographical area being powered!

2.2 Communication system:

A communications system is an integrated system of communications hardware. This can include transmissions equipment, relay stations, tributary stations and other data terminal equipment. A communications system can even include other communications systems.

Communications systems can include optical communications networks such as fiber-optic cables, radio and even power line communications.

Another distinction in types of communication is duplex communications. Duplex communications allow both parties to communicate to each other at the same time.

Components Of Communication System:

2.2.1 A typical communication system comprises of following components.

1. Source
2. Input Transducer
3. Transmitter
4. Channel
5. Receiver.
6. Output transducer.
7. Destination .

- **Source:** is something which originates the message. It can be human's voice, camera's video, a typed message or data.
- **Input Transducer:** A transducer is a sensor which converts any other form (pressure, light) of a signal into electrical signal. Input transducer converts any other form of energy into electrical signals. This electrical signal is information which needs to be transmitted.
- **Transmitter:** The transmitter is a circuit which modifies the input electrical signal into a suitable form and transmits it through an antenna.
- **Channel:** Channel is the medium by which the modulated signal is transmitted to the receiver. Wire, coaxial cable, radio link, an optical fiber and a waveguide are the examples of a channel.
- **Receiver:** The receiver receives the transmitted signal. The receiver consist of a demodulator . the demodulator demodulates the received signal (modulated signal) using demodulation technique and recover the baseband signal (original signal).

- **Output transducer** : The output transducer converts the electrical signal into its original form. Because we need the original message that the source originated. It converts it into a form which can be understood by the destination unit.
- **Destination**: The destination is the unit to which the message is communicated.

2.2.2 Arduino :

"Arduino board designs use a variety of microprocessors and controllers. The boards are equipped with sets of digital and analog input/output (I/O) pins that may be interfaced to various expansion boards ('shields') or breadboards (For prototyping) and other circuits. The boards feature serial communications interfaces, including Universal Serial Bus (USB) on some models, which are also used for loading programs from personal computers. The microcontrollers can be programmed using C and C++ programming languages. In addition to using traditional compiler toolchains, the Arduino project provides an integrated development environment (IDE) based on the Processing language project." [3]

There are kinds of Arduino pieces:

1. Arduino Uno (R3)
2. LilyPad Arduino
3. Arduino Mega (R3)
4. Arduino Leonardo

And in our project we used Arduino Uno :

Arduino Uno is a microcontroller board based on the ATmega328P (datasheet). It has 14 digital input/output pins (of which 6 can be used as PWM outputs), 6 analog inputs, a 16 MHz ceramic resonator (CSTCE16M0V53-R0), a USB connection, a power jack, an ICSP header and a reset button. It contains everything needed to

support the microcontroller; simply connect it to a computer with a USB cable or power it with a AC-to-DC adapter or battery to get started.. You can tinker with your Uno without worrying too much about doing something wrong, worst case scenario you can replace the chip for a few dollars and start over again.

"Uno" means one in Italian and was chosen to mark the release of Arduino Software (IDE) 1.0. The Uno board and version 1.0 of Arduino Software (IDE) were the reference versions of Arduino, now evolved to newer releases. The Uno board is the first in a series of USB Arduino boards, and the reference model for the Arduino platform; for an extensive list of current, past or outdated boards see the Arduino index of boards.

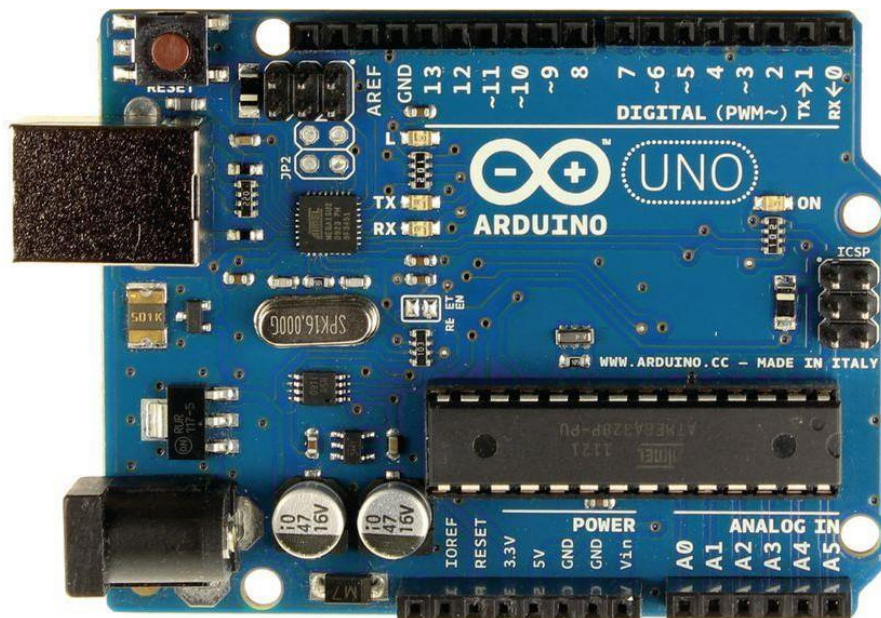


Fig 2.2: Arduino Uno

2.2.3 Server:

a computer system that provides other computers with services related to accessing and retrieving data from a database. Access to the database server may occur via a "front end" running locally a user's machine (e.g., phpMyAdmin), or "back end" running on the database server itself, accessed by remote shell. After the information

in the database is retrieved, it is outputted to the user requesting the data. Many companies utilize a database server for storage. Users can access the data by executing a query using a query language specific to the database.

In our project we will use a program that will be loaded on a personal computer This program represents the work of the server, This program is named(socket_test).

Socket_test:

A java tool for socket testing. It can create both TCP and UDP client or server. It can be used to test any server or client that uses TCP or UDP protocol to communicate.- Create a TCP server socket and send responses to connected clients. - Create a UDP server socket that listens on a particular port.

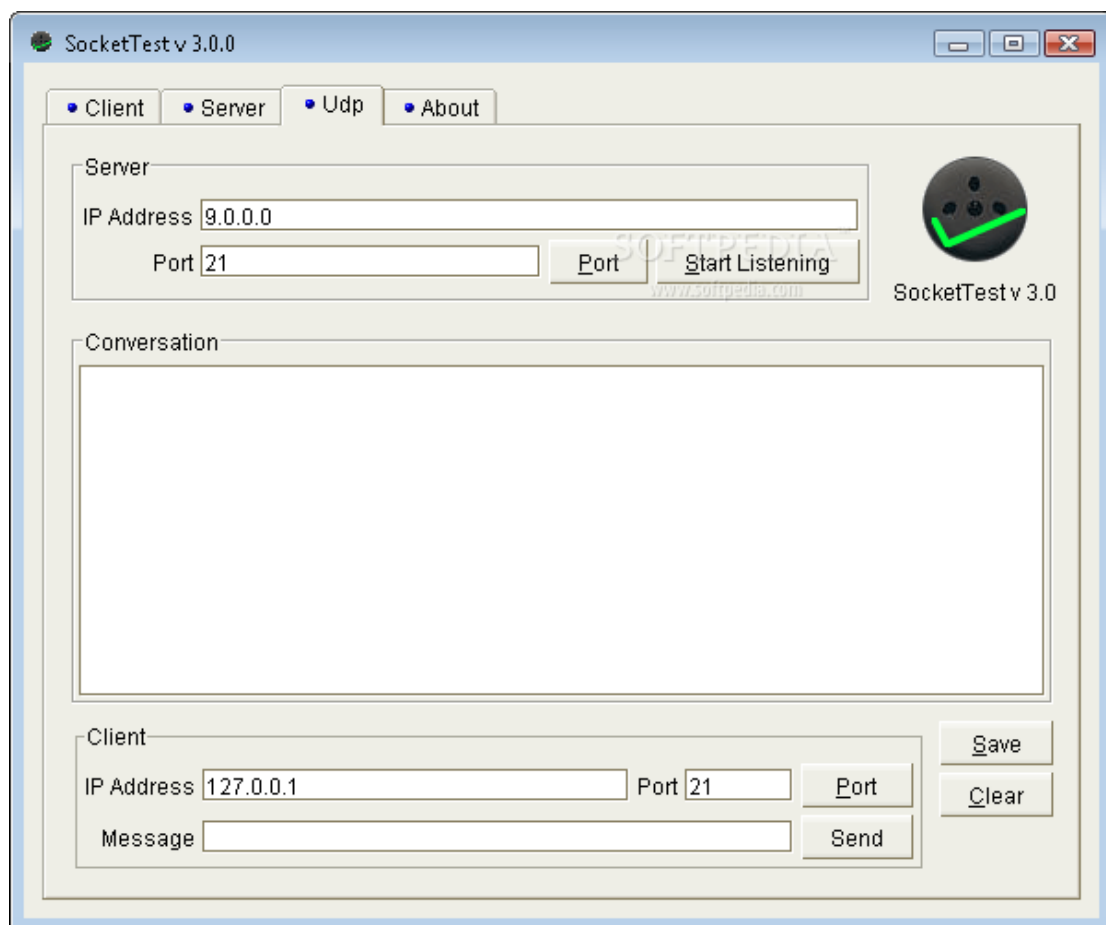


Figure2.2: socket server

2.2.4 GPRS/GSM SIM900 shield.:

The Arduino GSM shield allows an Arduino board to connect to the internet, send and receive SMS, and make voice calls using the GSM library.

The shield will work with the Arduino Uno out of the box. The shield will work with the Mega, Mega ADK, Yun, and Leonardo boards with a minor modification. The Due is not supported at this time.

The GSM library is included with Arduino IDE 1.0.4 and later.

GSM is an international standard for mobile telephones. It is an acronym that stands for Global System for Mobile Communications. It is also sometimes referred to as 2G, as it is a second-generation cellular network.

To use GPRS for internet access, and for the Arduino to request or serve webpages, you need to obtain the Access Point Name (APN) and a username/password from the network operator. See the information in [Connecting to the Internet](#) for more information about using the data capabilities of the shield.

Among other things, GSM supports outgoing and incoming voice calls, Simple Message System (SMS or text messaging), and data communication (via GPRS).

The Arduino GSM shield is a GSM modem. From the mobile operator perspective, the Arduino GSM shield looks just like a mobile phone. From the Arduino perspective, the Arduino GSM shield looks just like a modem.

What is GPRS:

GPRS is a packet switching technology that stands for General Packet Radio Service. It can provide idealized data rates between 56-114 kbit per second.

A number of technologies such as SMS rely on GPRS to function. With the GSM shield, it is also possible to leverage the data communication to access the internet.

Similar to the Ethernet and WiFi libraries, the GSM library allows the Arduino to act as a client or server, using http calls to send and receive web pages.

SIM cards:

In addition to the GSM shield and an Arduino, you need a SIM card. The SIM represents a contract with a communications provider. The communications provider selling you the SIM has to either provide GSM coverage where you are, or have a roaming agreement with a company providing GSM coverage in your location.

It's common for SIM cards to have a four-digit PIN number associated with them for security purposes. Keep note of this number, as it's necessary for connecting to a network. If you lose the PIN associated with your SIM card, you may need to contact your network operator to retrieve it. Some SIM cards become locked if an incorrect PIN is entered too many times. If you're unsure of what the PIN is, look at the documentation that came with your SIM. Using a PUK (PIN Unlock Code), it is possible to reset a lost PIN with the GSM shield and an Arduino. The PUK number will come with your SIM card documentation.

Look at the PIN Management example in the "tools" folder, bundled with the GSM library for an example of how to manage your PIN number with the PUK.



Figure2.3: GPRS/GSM SIM900 shield

Chapter three: Block diagram

3.1 Block Diagram of the system :

This block diagram It generally describes the system, which represents the electrical power distribution stations of Hebron District, which consists of seven stations, and the central block represents the monitoring center in which the server will be located and the reverse direction can be controlled in the circuit breakers for each station and this is what was intended by the control.

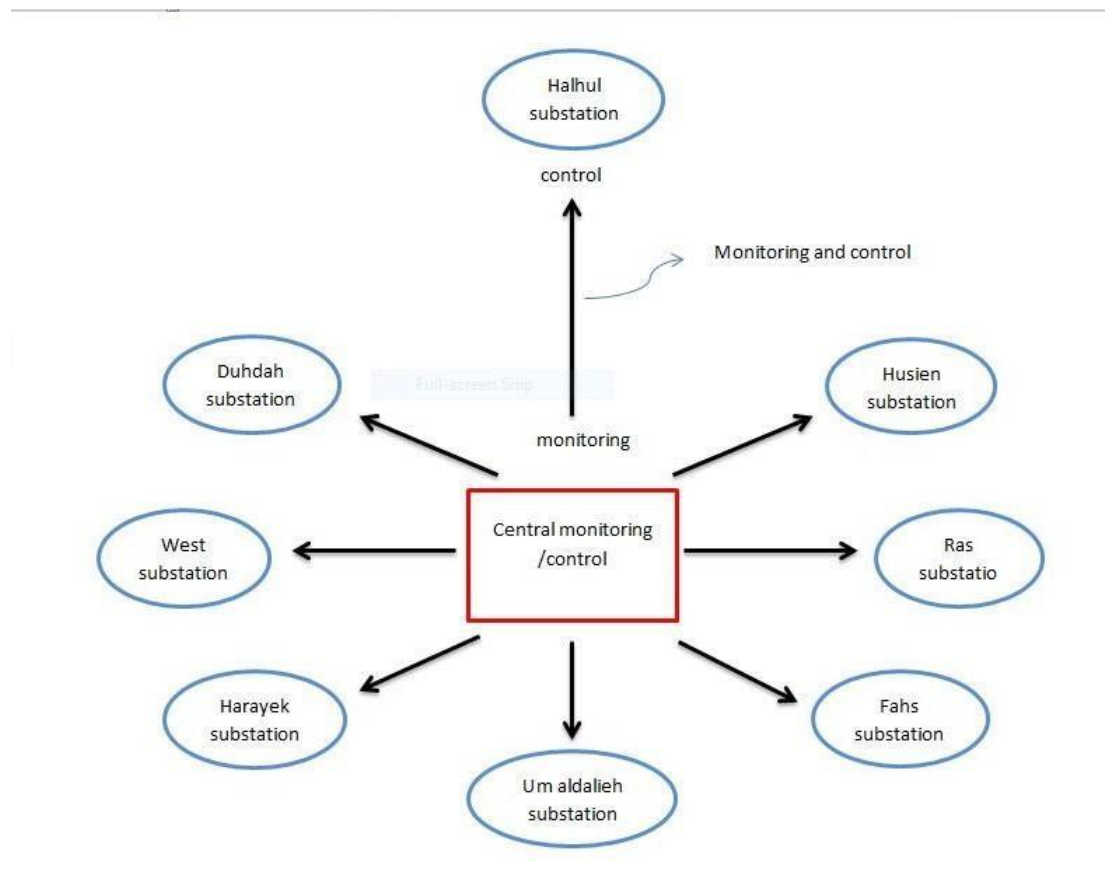


Fig 3.1: block diagram for system in general

This block shows the details of each of the seven stations, which are composed of a transformer and a number of loads that branch out from the main station, and in the context of the project idea, sensors for current and voltage will be placed.

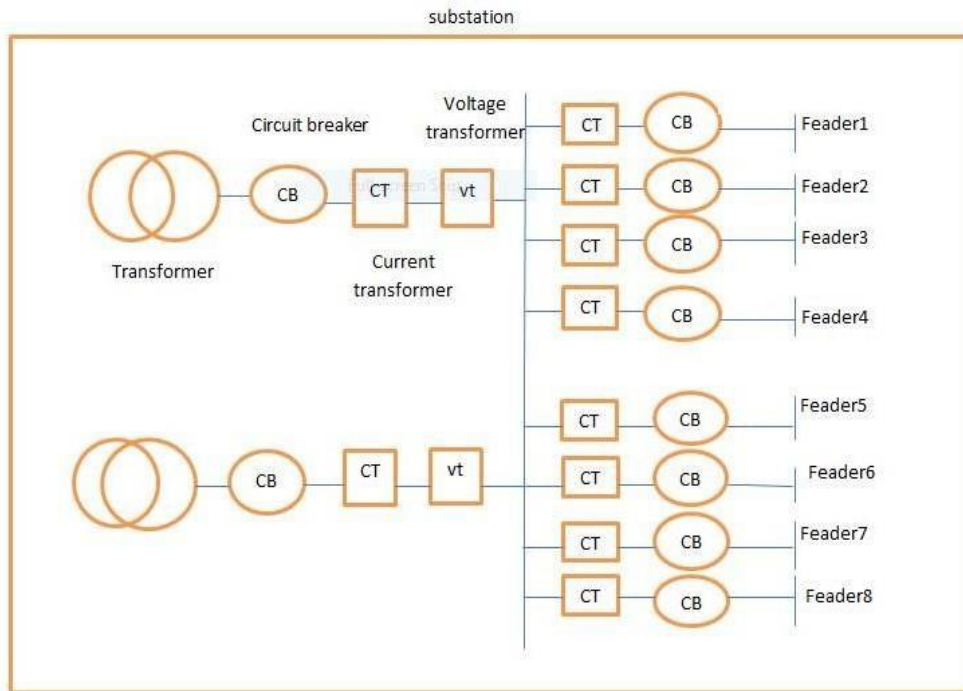


Fig 3.2: block diagram for substation in detail

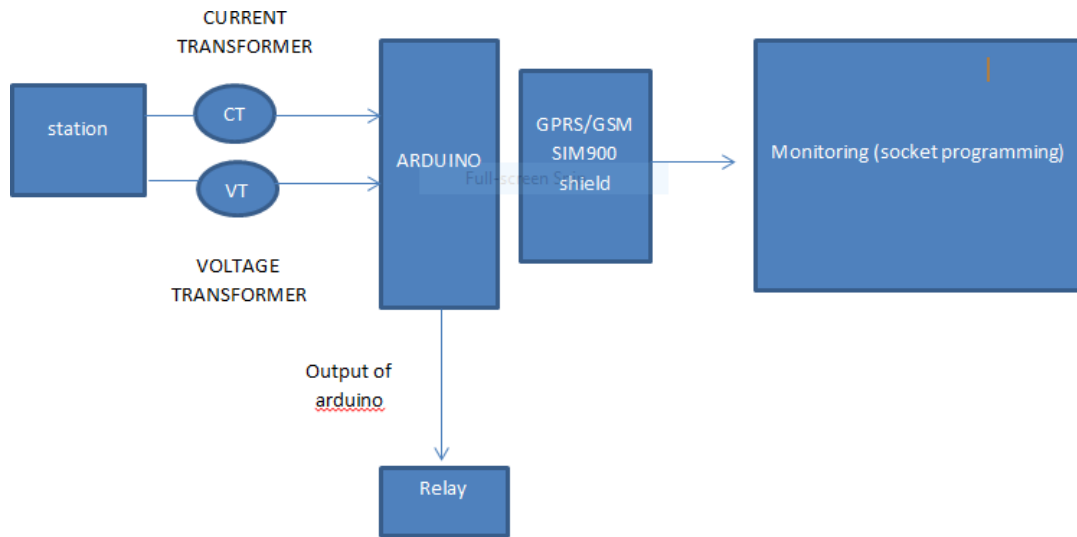


Figure3.3:block diagram for project

Chapter four: System Design

4.1 Overview.

4.2 System components.

4.2.1 Current transformer

4.2.2 Voltage transform

4.2.3 Relay

4.2.4 Microcontroller

4.2.5 Usb_ttl board

4.2.6 GPRS/GSM SIM900 shield

4.2.7 server

4.3 Cost table for the project

4.4 Table of abbreviations

4.5 Arduino code

4.1 Overview:

In this chapter, the detailed and public relations of the entire system will be developed and everything that is going on in the system will be put into action.

A Design Considerations:

- 1.Sensing the value of current and voltage.
- 2.Poles are monitored constantly for current
- 3.Keeping track of threshold values.
- 4.Arduino controls and processes signal.
- 5.Transmitter collects data from controller and transmits to receiver side which exist in monitoring room.

4.2 System components:

4.2.1 Current transformer :Analysis Service current transformer:

Current sensors operate as the sealed secondary of a current transformer while the conductor carrying the current to be measured functions as a one turns primary. Measurement accuracy can be improved by increasing the number of primary turns. Applications include detection of branch circuit overload and load drop or shutdown.

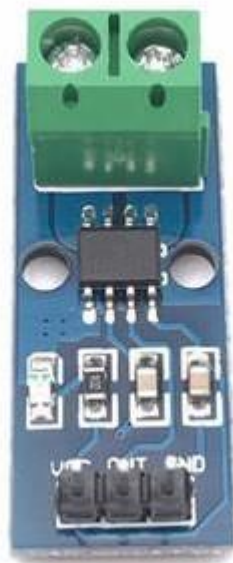


Figure4.1:current transformer (ACS)

4.2.2 voltage transformer :Analysis Service voltage transformer

A volt-ampere (SI symbol: $V \cdot A$ or $V A$; also VA) is the unit used for the apparent power in an electrical circuit. The apparent power equals the product of root-mean-square (RMS) voltage and RMS current.[1] In direct current (DC) circuits, this product is equal to the real power (active power) [2] in watts. Volt-amperes are useful only in the context of alternating current (AC) circuits.

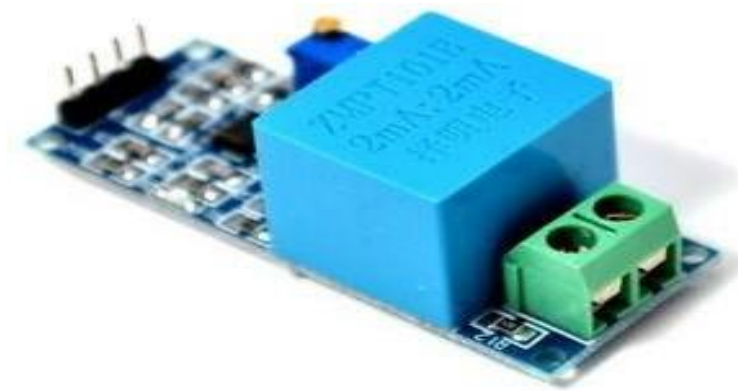


Figure4.2: voltage transformer (zmp)

3.1.2 Relay :

This 5V Relay Module is designed by Single with the aim of providing inexpensive but quality-focused Relays to hobbyists, Makers and general users. Despite the small size, the 1 Channel 5V Relay Module can control a separate isolated circuit of up to 10A and 250V – making it a great choice for most home project applications.

With a relay, you don't have to stress about the dangers of high current and high voltage escaping the circuit you are controlling, as the relay provides isolation to protect both you and your low-voltage circuitry from any possible leakage. Additionally, it only requires a single input/output channel and can be operated from a wide range of different microprocessors or chip-based boards – meaning that you don't need to have special equipment to run the relay, and can simply power and operate it with a simple circuit.



Figure4.3:relay

4.2.4 Microcontroller :

The appropriate controller to perform the operations and functions of this design of the project is the Arduino uno, Because it contains a number of analog pins .

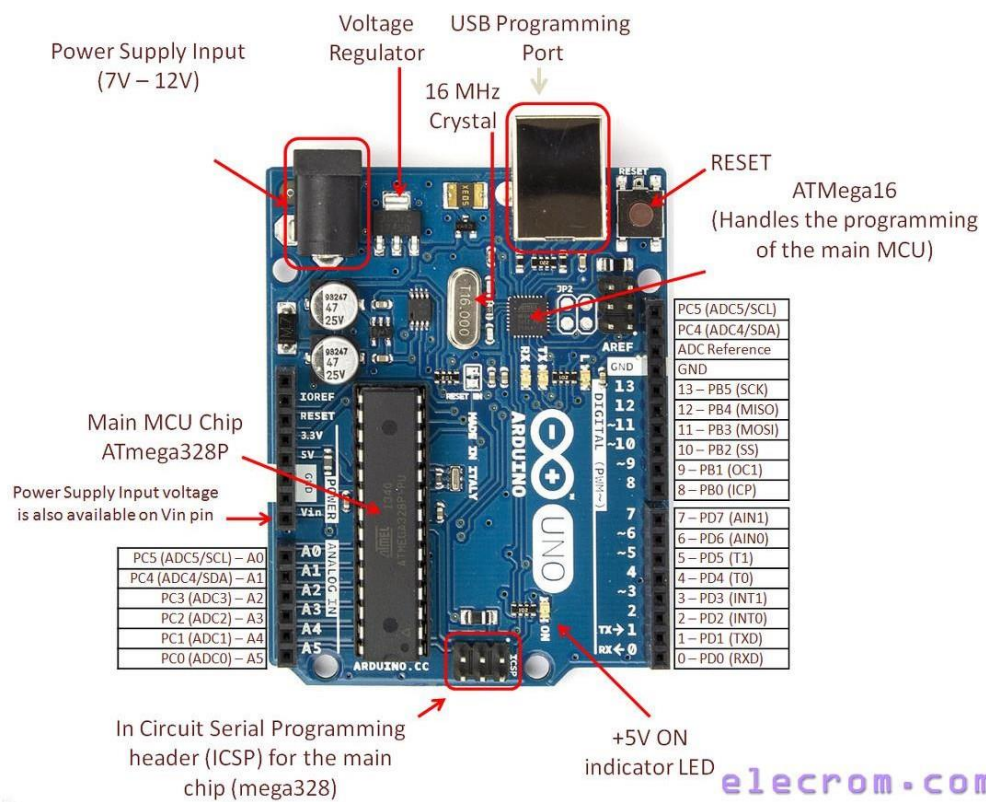


Fig 4.4uno arduino pins

At each station we will need one uno arduino and it meets the demand we need at one stop.

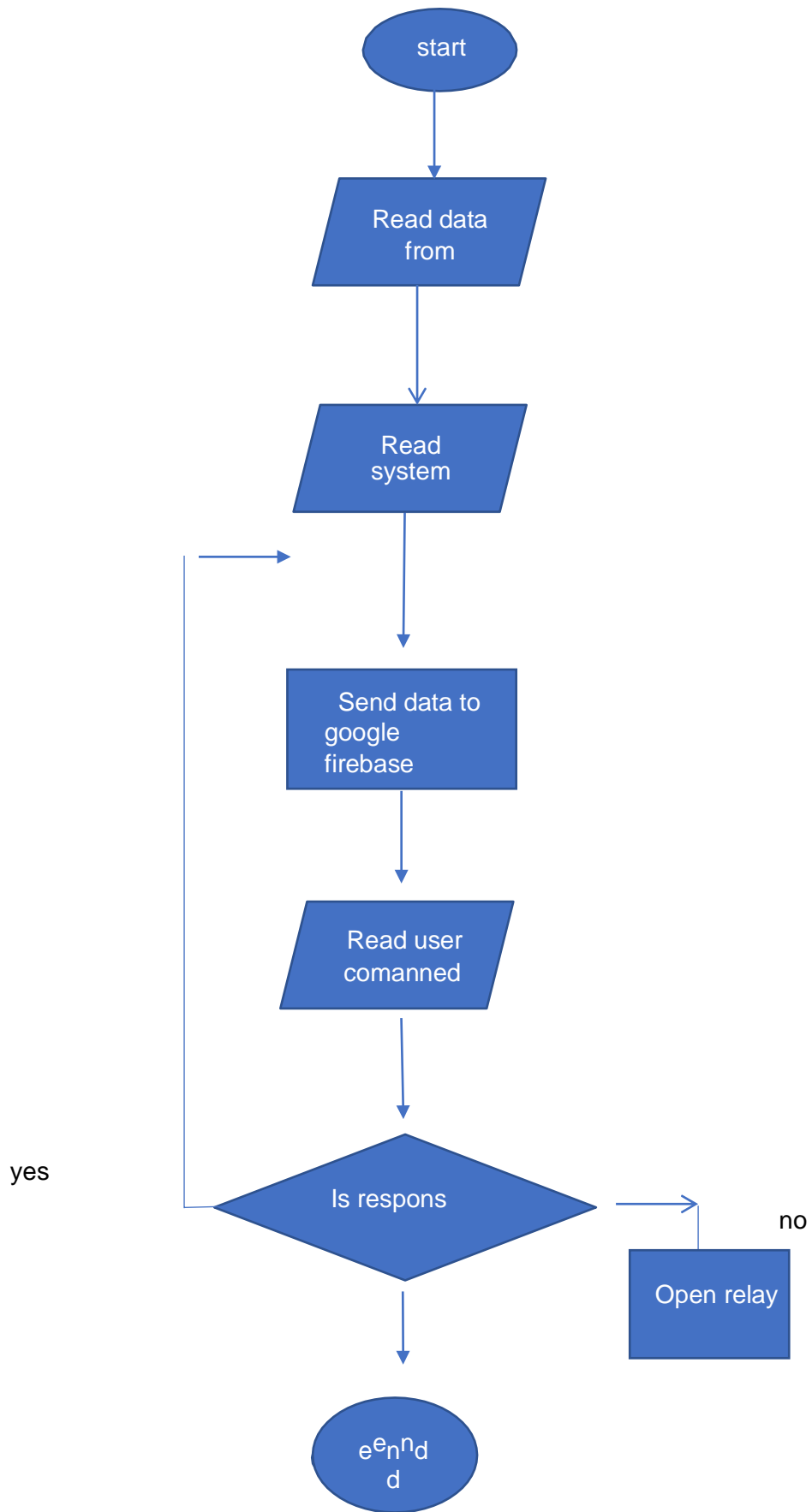
Arduino is an open source physical computing [4] platform based on a simple microcontroller board and development environment that implements the processing language[5]

arduino will control the station and it depends on its programming according to what we need, You will make a comparison between fixed natural values and the values entered as inputs , If these inputs do not apply with normal values, the Arduino will order the circuit breakers to disconnect the station from the voltage and current source, At the same time, it also gives an order to transfer this data wirelessly to the GPRS/GSM SIM900 segment, which contains a receiver and a transmitter and connects with a similar segment so that the data is saved inside the server.

Serial port

The Arduino UNO, when using the SoftwareSerial library, transmits data on its digital IO pins at their voltage levels. When the Uno is supplied at 5V the maximum output voltage is 4.2V, and is 2.3V when supplied by 3V.

At first I put a voltage divider into the transmit signal path, but found it was not necessary, and it works to transmit and receive serial data between the module and the Uno.



flow chart for arduino process

the Arduino Board

Looking at the board from the top down, this is an outline of what you will see (parts of the board you might interact with in the course of normal use are highlighted):

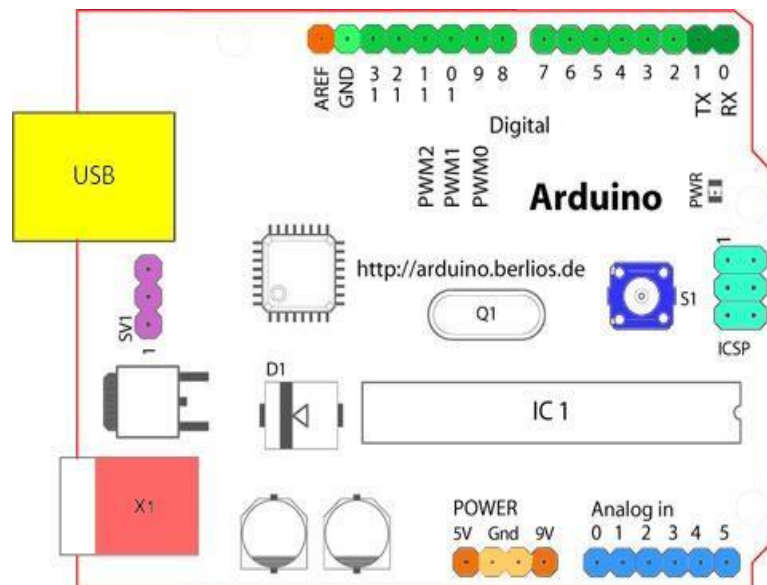


Fig4.5 the Arduino Board

Starting clockwise from the top center:

- Analog Reference pin (orange)
- Digital Ground (light green)
- Digital Pins 2-13 (green)
- Digital Pins 0-1/Serial In/Out - TX/RX (dark green) - These pins cannot be used for digital i/o (digitalRead and digitalWrite) if you are also using serial communication (e.g. Serial.begin)
- Reset Button - S1 (dark blue)
- In-circuit Serial Programmer (blue-green)
- Analog In Pins 0-5 (light blu)
- Power and Ground Pins (power: orange, grounds: light orange)
- External Power Supply In (9-12VDC) - X1 (pink)
- Toggles External Power and USB Power (place jumper on two pins closest to desired supply) - SV1 (purple)
- USB (used for uploading sketches to the board and for serial communication between the board and the computer; can be used to power the board) (yellow)

POWER OF ARDUINO :

Power The Arduino Uno can be powered via the USB connection or with an external power supply.

The power source is selected automatically. External (non-USB) power can come either from an AC-to-DC adapter (wall-wart) or battery.

The adapter can be connected by plugging a 2.1mm center-positive plug into the board's power jack. Leads from a battery can be inserted in the Ground and Vin pin headers of the POWER connector.

The board can operate on an external supply of 6 to 20 volts. If supplied with less than 7V, however, the 5V pin may supply less than five volts and the board may be unstable. If using more than 12V, the voltage regulator may overheat and damage the board.

The recommended range is 7 to 12 volts

The power pins are as follows:

- **VIN.** The input voltage to the Arduino board when it's using an external power source (as opposed to 5 volts from the USB connection or other regulated power source). You can supply voltage through this pin, or, if supplying voltage via the power jack, access it through this pin.
- **5V.** This pin outputs a regulated 5V from the regulator on the board. The board can be supplied with power either from the DC power jack (7 - 12V), the USB connector (5V), or the VIN pin of the board (7-12V). Supplying voltage via the 5V or 3.3V pins bypasses the regulator, and can damage your board. We don't advise it.
- **3V3.** A 3.3 volt supply generated by the on-board regulator. Maximum current draw is 50 mA.
- **GND.** Ground pins.



Fig4.6: arduino program

The Arduino Integrated Development Environment (IDE) is a cross-platform application (for Windows, macOS, Linux) that is written in functions from C and C++[2]. It is used to write and upload programs to Arduino compatible boards, but also, with the help of 3rd party cores, other vendor development boards

calculation:

Power calculations.

In this section we're illustrating our technique in calculating voltage and current RMS values.

For voltage measuring we're using ZMPT101B voltage transformer, that converts voltage from AC range to DC sinusoidal wave form with 2.5v reference value, in order to calculate the RMS value we take 40 samples each cycle (i.e. one sample each 500 micro seconds), then we calculate the RMS value for the measured cycle using the following equation

$$V_{rms/cycle} = \sqrt{\frac{\sum_1^{40} V_{sample}^2}{40}}$$

And for higher accuracy we take the average RMS value for 12 cycle, this process refreshed each 10 seconds, this calculation process used for both current and voltage and for current measuring we're using ACS712 Hall Effect IC. Each 10 seconds we calculate the apparent power

$$P(\text{app}) = V_{rms} \times I_{rms}$$

To calculate the average power we need to calculate PF (power factor), and to do so we measure the time difference b/t voltage zero crossing sample and current zero crossing sample, as we have 20 sample per cycle

$$1 \times \text{Cycle} = 20\text{ms for } 50 \text{ hz frequency}$$

And

$$1 \times \text{Cycle} = 360 \text{ degree}$$

For 20 samples per cycle we have

$$1 \times \text{sample} = 1\text{ms} = 18 \text{ degree.}$$

Now we calculate the number of samples b/t voltage zero crossing sample and current zero

crossing sample

$$V0 \text{ sample \#} - I0 \text{ sample \#} = N.$$

Now for power factor angle

$$\theta = 18 * N$$

$$PF = \text{Cos}(\theta)$$

Average power

$$P_{avg} = S * P$$

4.2.5 usb_ttl board

Transistor-transistor logic (TTL) is a digital logic design in which bipolar transistors act on direct-current pulses. Many TTL logic gates are typically fabricated onto a single integrated circuit (IC). TTL ICs usually have four-digit numbers beginning with 74 or 54.

A TTL device employs transistors with multiple emitters in gates having more than one input. TTL is characterized by high switching speed (in some cases upwards of 125 MHz), and relative immunity to noise. Its principle drawback is the fact that circuits using TTL draw more current than equivalent circuits using metal oxide semiconductor (MOS) logic. Low-current TTL devices are available, but the reduced current demand comes at the expense of some operating speed.



Fig4.7:usb-ttl

We used this piece to do a checkup for orders for AT_Command for GPRS/GSM SIM900 , Through a program terminal .

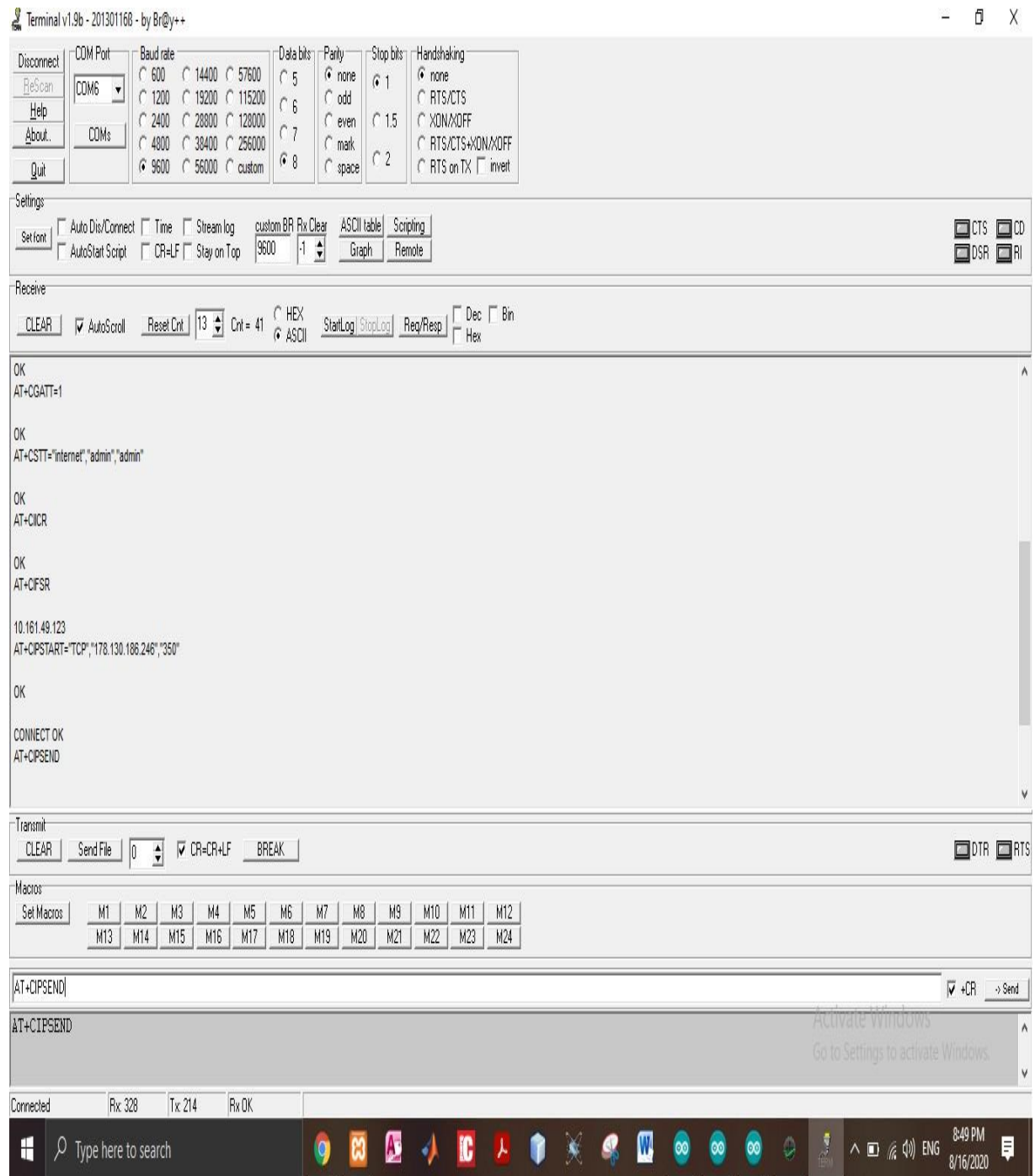


Fig4.8:at command

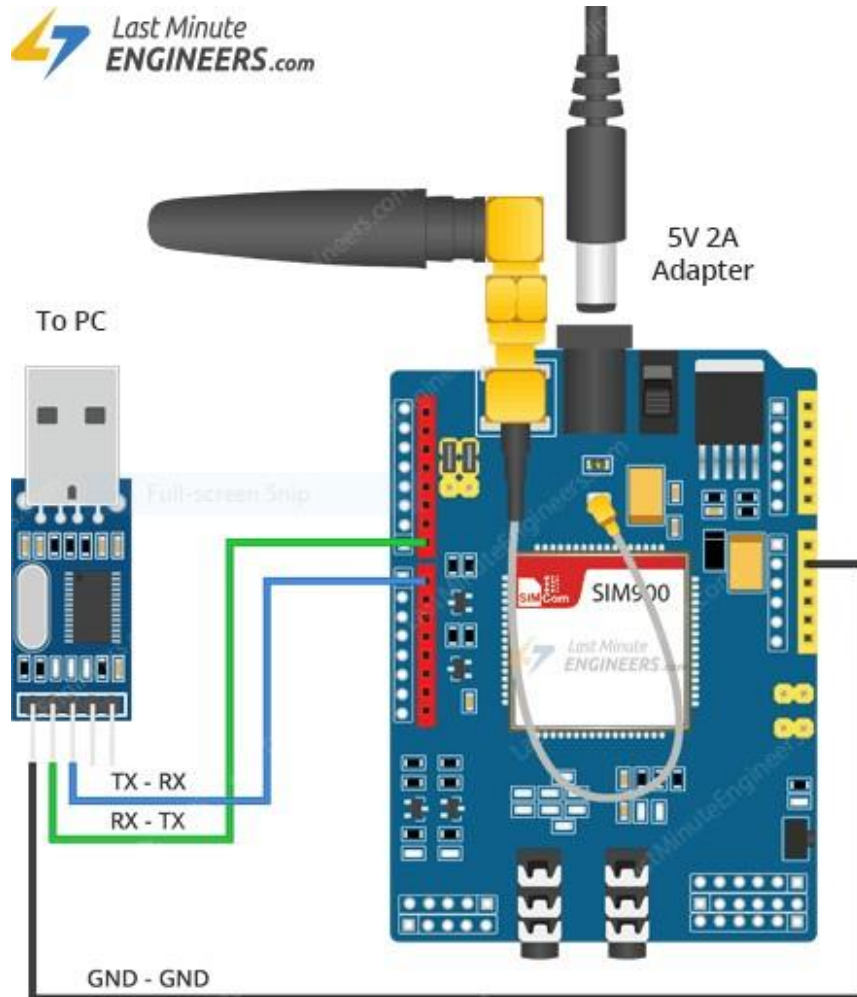


Fig4.9:tll interface GPRS/GSM SIM900

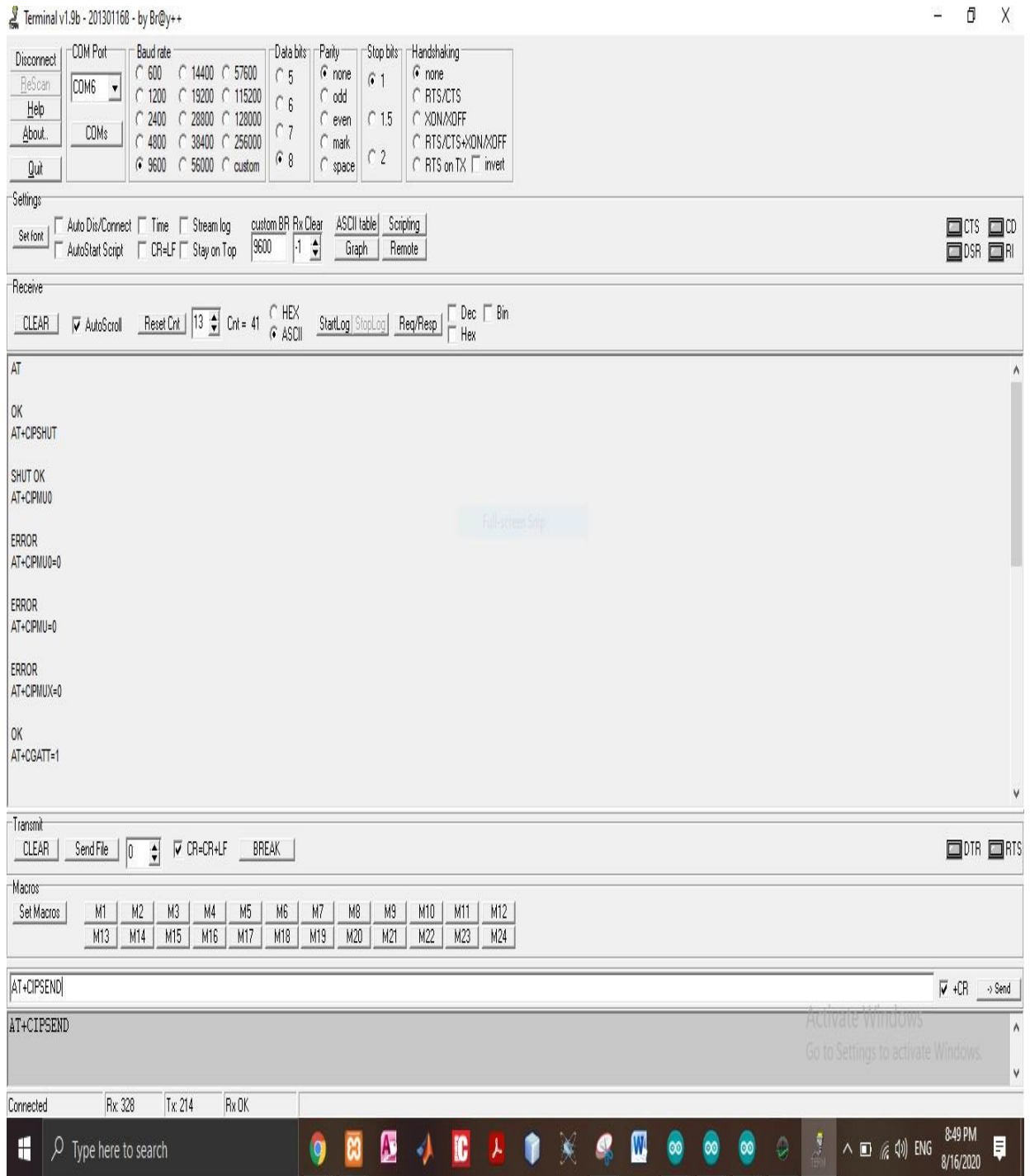


Fig4.10:at command(tcp)

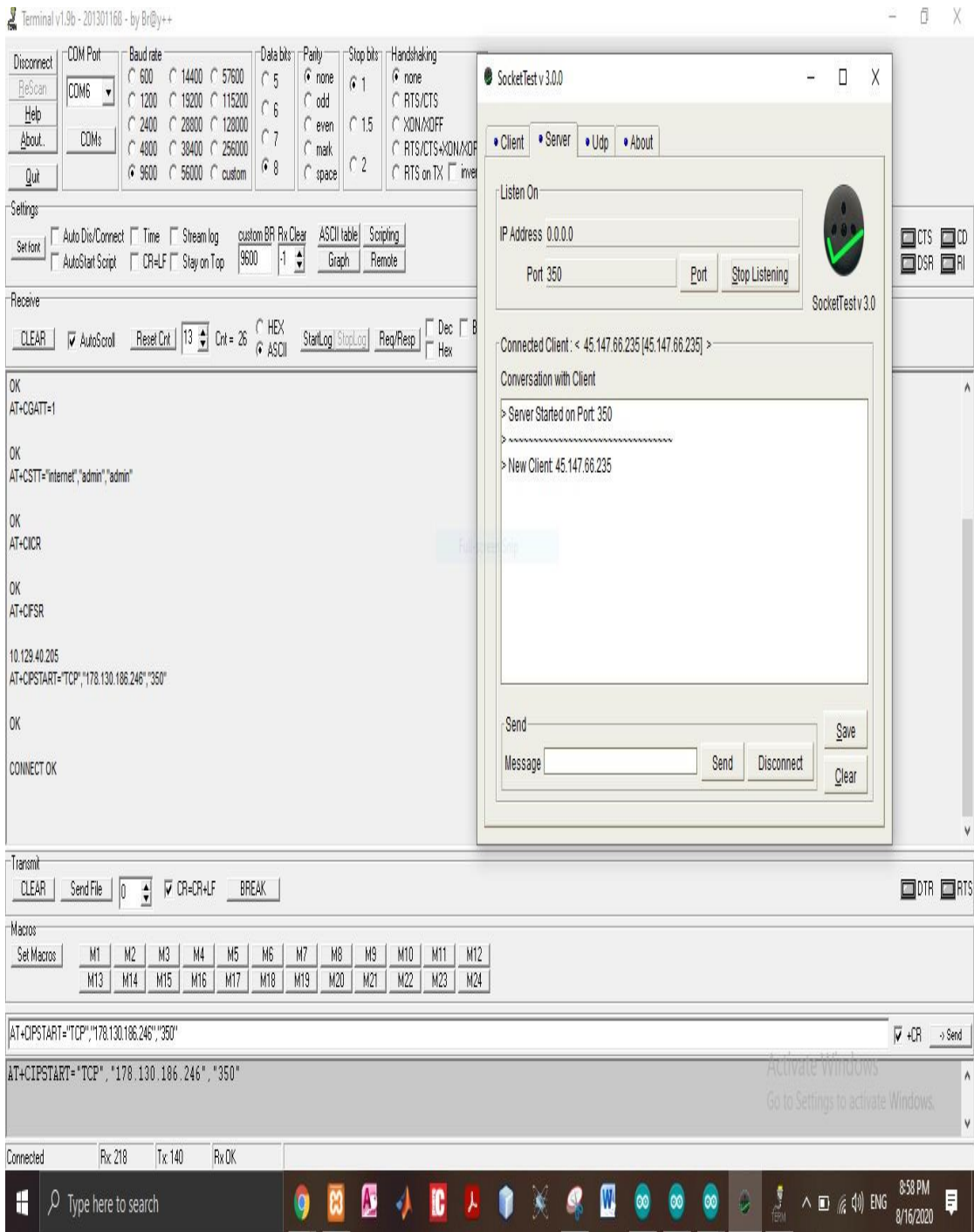


Fig4.11 : terminal interface socket

4.2.6 GPRS/GSM SIM900 shield

This shield has better coverage, GSM backwards-compatibility and even sports a built-in GPS module for geolocation & asset tracking. This all-in-one cellular phone module with that lets you add location-tracking, voice, text, SMS and data to your project in a single shield.

This shield packs a surprising amount of technology into its little frame. At the heart is a powerful GSM cellular module with integrated GPS. On its own, this shield can't do anything. It requires a microcontroller to drive it! We suggest using an Arduino or any 3-5V microcontroller with a UART can send and receive commands over the RX/TX pins.

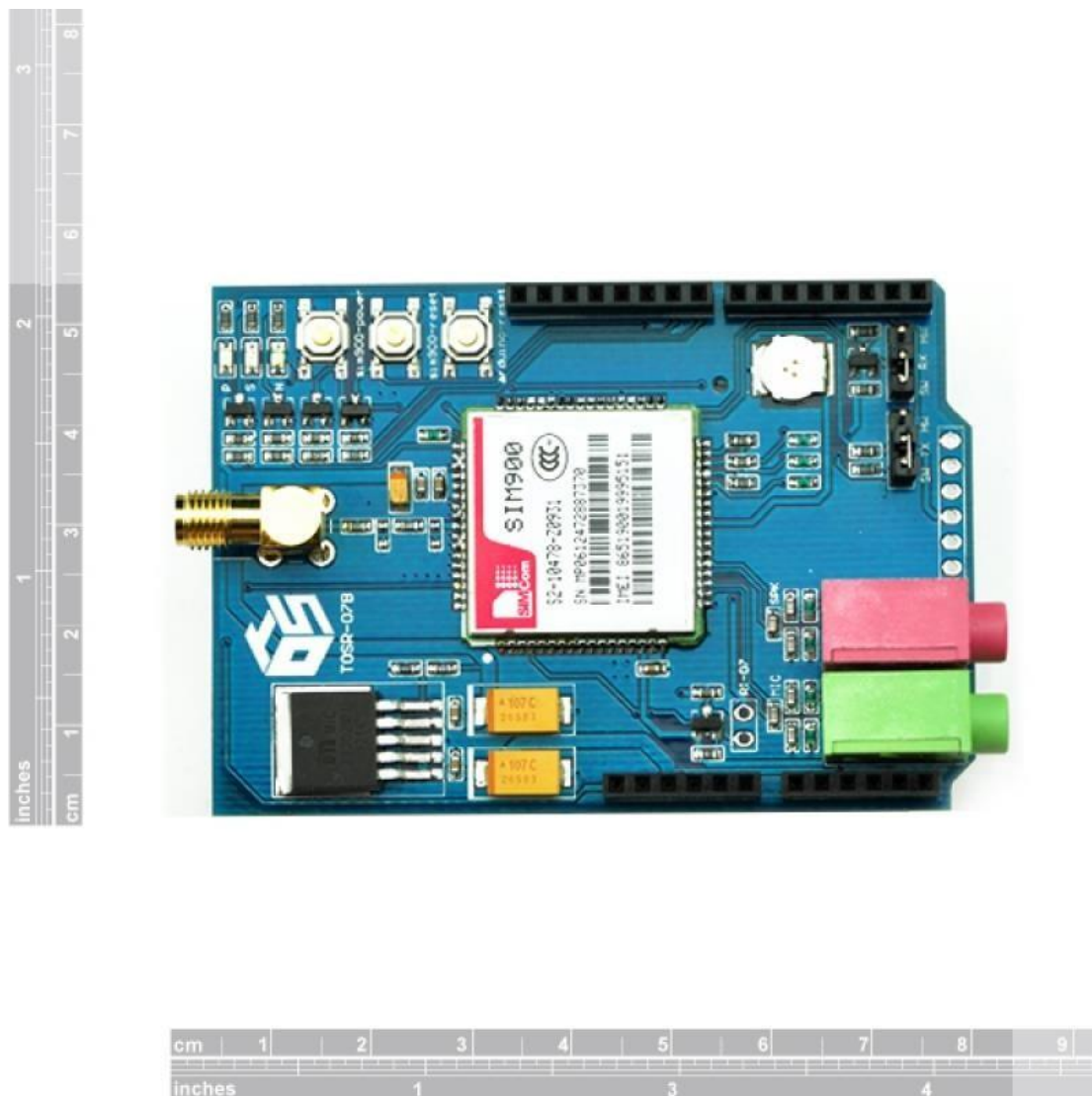


Fig4.12: GPRS/GSM SIM900 shield

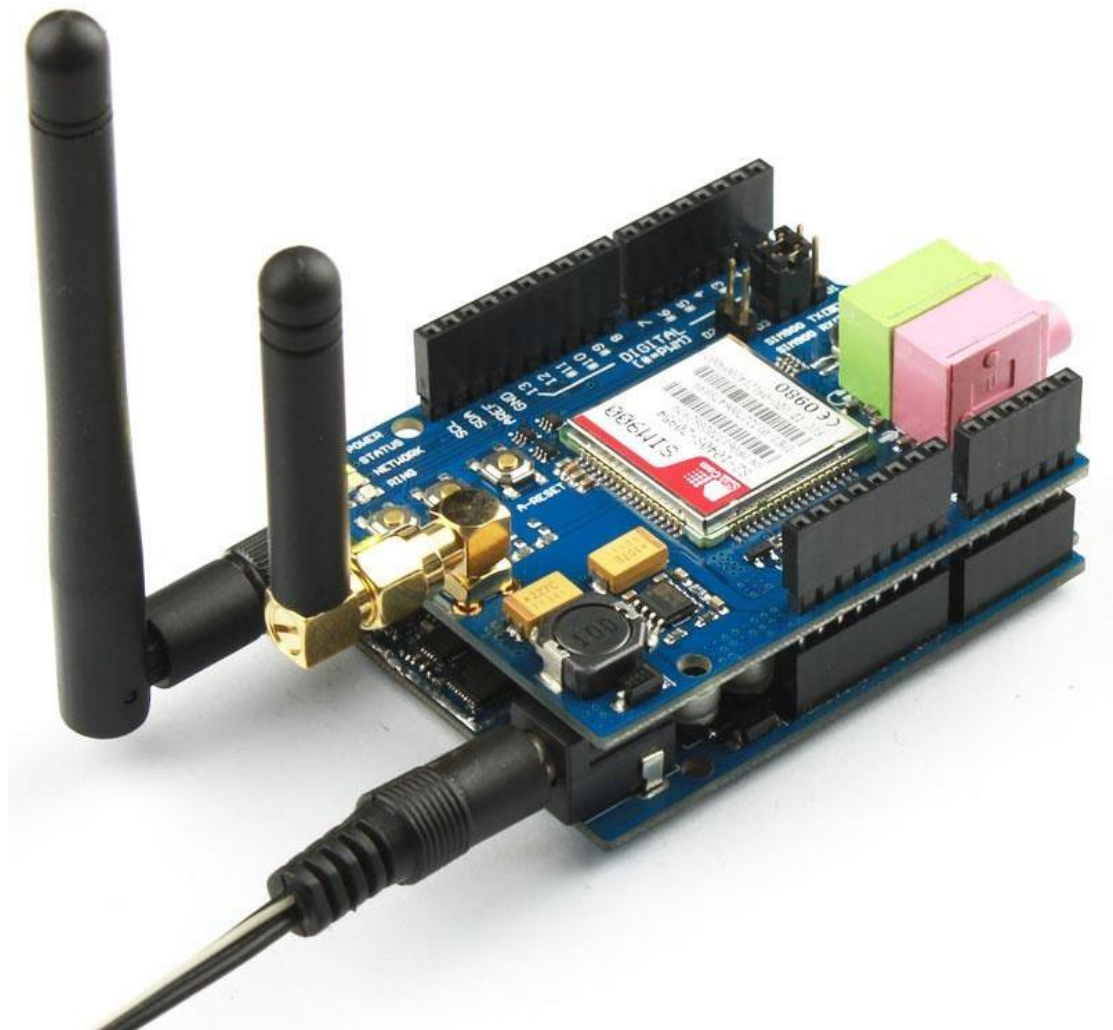


Fig4.13: GPRS/GSM SIM900 shield interface arduino

The buttons

There are 3 buttons on the GSM shield board:

➤ **SIM900 Power Button:**

Stack the GSM shield on your arduino main board. The GSM shield will running automatically when you power up your arduino main board. If you want turn on/off the SIM900 module manually. Just press the the sim900 power button one second.

➤ **SIM900 Reset Button:**

Reset the SIM900 module.

➤ **Arduino Reset Button:**

Reset the Arduino main board. Same function as the Reset Button which on the arduino main board.

The indicator LEDs :

The GSM Shield has three indicator LEDs for the GSM Shield power, SIM900 power and net status.

GSM Shield power(P):

This LED is used to indicate the power status of the GSM Shield. If the external power supply is connected to the arduino board, then the GSM Shield will get power, this LED will light on.

SIM900 power(S):

This LED is used to indicate the power status of the SIM900. After the SIM900 is power on, the status LED will light on.

Net Status(N):

This LED is used to indicate the net status. The LED will blink slowly or quickly according to different states.

AT commands in 3G shield

Command: AT
Response: OK
Notes: This command typically the first command sent to the MODEM. It is used to test the communication between the Two devices.

Command: AT+CREG?
Success Result: +CREG=1,1
OK
Notes: This means the SIM is ready and has connected to the network.

Command: AT+CGATT?
Response: +CGATT: 1
Notes: Check if the SIM has Internet access.

Command: AT+CIPSTATUS
Response : OK
STATE: IP INITIAL
Notes: Query the IP settings.

Command: AT+CIPMUX=0

Fig 4.23 execution

AT commands are commands which are used to control the modems where AT stands for Attention. These commands were derived from Hayes commands which were used by the Hayes smart modems. Every wireless, as well as the dial up modems, require an AT command to interact with a computer machine. These AT commands along with other extended commands also require Hayes command set as a subset.

Types of AT Command:

- 1- **Test:** The test command is utilised to check the compatibility of a command by a modem.
- 2- **Read:** Read command is used for extracting the mobile or modem settings required for operations.
- 3- **Set:** This commands is used to make changes into mobile phone or modem settings required for the operation.
- 4- **Execution:** As the name suggests, this command is used to execute the said operation.

➤ We used project orders AT command (TCP) .

4.2.7 Turn off the PIN lock

To use the SIM card with the shield, you need to turn off the pin lock. The easiest way to do this, is to insert the SIM card in your smartphone and turn off the pin lock in the phone security settings.

In my case, I needed to go through: **Settings** > **Advanced Settings** > **Security** > **SIM lock** and turn off the lock sim card with pin.

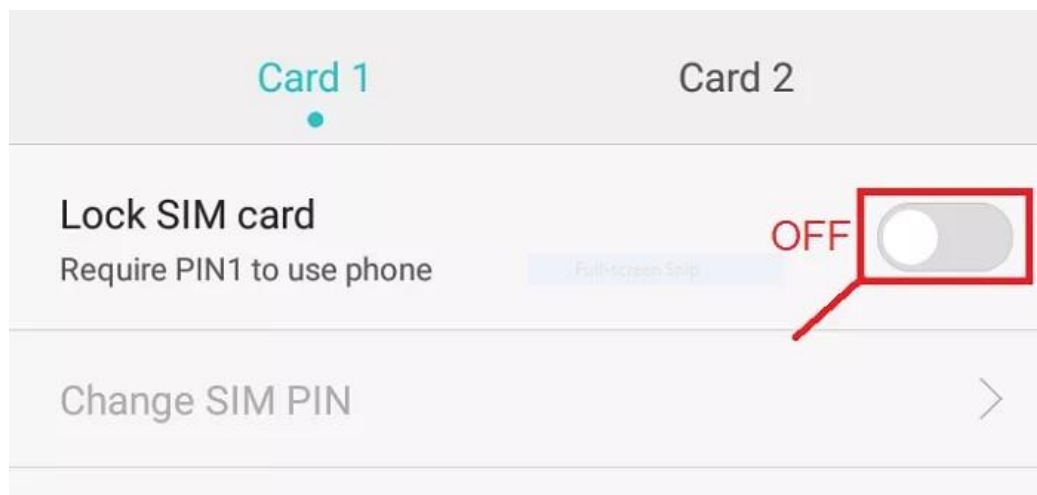


Fig4.15: Turn off the PIN lock



Fig 4.16 SIM in gprs

4.2.8 server:

This server will be used to save data from substation .

It is similar to data warehouse where the website store or maintain their data and information. A Database Server is a computer in a LAN that is dedicated to database storage and retrieval. The database server holds the Database Management System (DBMS) and the databases. Upon requests from the client machines, it searches the database for selected records and passes them back over the network.

A database server can be defined as a server dedicated to providing database services. Such a server runs the database software. A database server can typically be seen in a client-server environment where it provides information sought by the client systems.

A database server is useful for organizations that have a lot of data to deal with on a regular basis. If you have client-server architecture where the clients need process data too frequently, it is better to work with a database server. Some organizations use the file server to store and process data. A database server is much more efficient than a file server.

You will be using a program that simulates the work of the server By connecting to the GPRS/GSM SIM900 model, This program is named (SOCKET) .

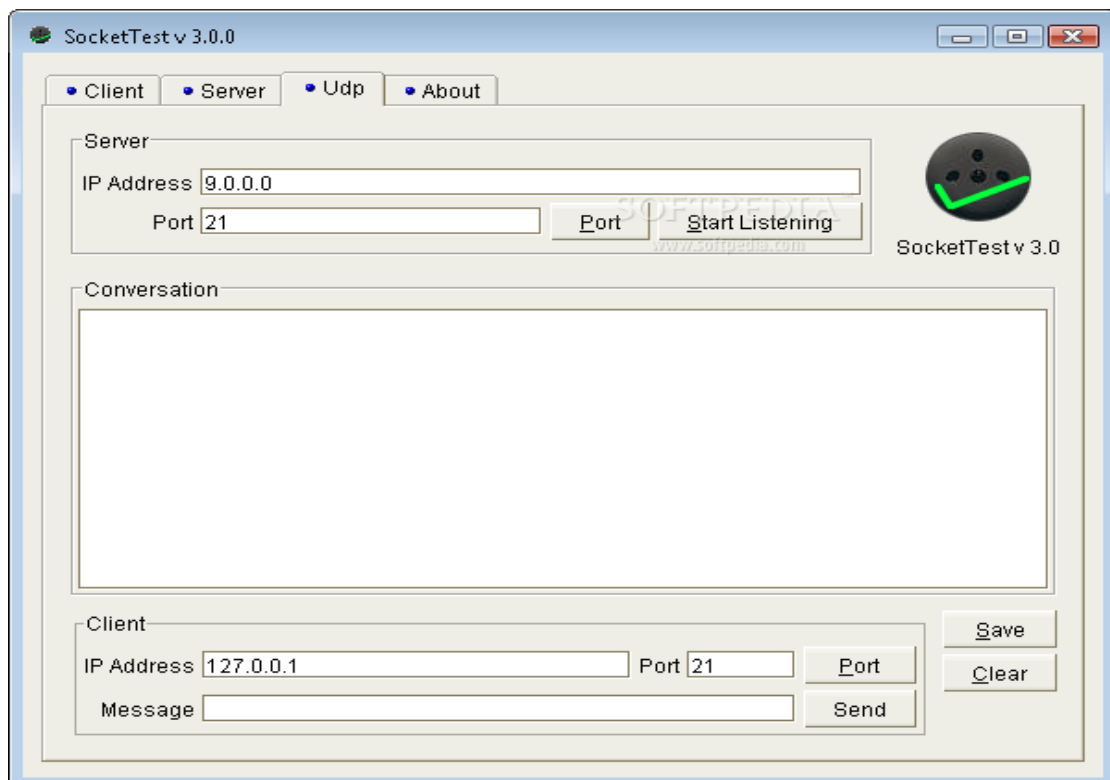


Fig4.17:socket program

4.3 Cost table for the project:

Electronic widget	Numbers	Cost of one
Arduino	1	65
GPRS/GSM modem	1	200
Current transformer	3	105
Voltage transformer	1	35
Usb_ttl	1	20
Relay	3	45
Wires	---	10

Table 4.1 Cost table for the project

3.4 Table of abbreviations

abbreviations	Full meaning
3G	Third generation
SCADA	supervisory control and data acquisition
CT/VT	Current /voltage transformer
USB	Universal serial bus
IDE	Integrated development environment
GSM	Global System for Mobile Communications
GPRS	General Packet Radio Services
SMS	Short Message Service
SQL	Structured Query Language
UART	Universal Asynchronous Receiver Transmitter
USART	Universal Synchronous Asynchronous Receiver Transmitter
DBMS	database management system

TTL	Time To Live
SPI	synchronous serial communication interface
MV	Medium-voltage
TX/RX	Transmitter /receiver
APN	Access point name

Table 4.2 Table of abbreviations

4.5 Arduino code

```
#include <call.h>
#include <gps.h>
#include <GSM.h>
#include <HWSerial.h>
#include <inetGSM.h>
#include <LOG.h>
#include <SIM900.h>
#include <sms.h>
#include <Streaming.h>
#include <WideTextFinder.h>

//EmonLibrary examples openenergymonitor.org, Licence GNU GPL V3
#include "EmonLib.h" // Include Emon LibrarEnergyMonitor
emon1// Create an instance

#include <SoftwareSerial.h>
SoftwareSerial gprsSerial(2,3);
#include <String.h>
EnergyMonitor emon1;
EnergyMonitor emon2;
EnergyMonitor emon3;
const int RELAY1_PIN = 3;
const int RELAY2_PIN = 4;
const int RELAY3_PIN = 5;
void setup(){
  {gprsSerial.begin(9600); // the GPRS baud rate
  Serial.begin(9600); // the GPRS baud rate

  pinMode(RELAY1_PIN, OUTPUT);
  pinMode(RELAY2_PIN, OUTPUT);
  pinMode(RELAY3_PIN, OUTPUT);
  emon1.voltage(A0, 650,1.5); // Voltage: input pin, calibration, phase_shift
  emon1.current(A1,10); // Current: input pin, calibration.
  emon2.voltage(A0, 650,1.7); // Voltage: input pin, calibration, phase_shift
  emon2.current(A2,20); // Current: input pin, calibration.
  emon3.voltage(A0, 650,1.1); // Voltage: input pin, calibration, phase_shift
  emon3.current(A3,7;)
}
void loop(){
{
  digitalWrite(RELAY1_PIN, LOW);
  digitalWrite(RELAY2_PIN, LOW);
  digitalWrite(RELAY3_PIN, LOW);
```

```

emon1.calcVI(20,2000); // Calculate all. No.of half wavelengths
(crossings), time-out
emon2.calcVI(20,2000); // Calculate all. No.of half wavelengths
(crossings), time-out
emon3.calcVI(20,2000); // Calculate all. No.of half wavelengths
(crossings), time-out
Serial.println("first load");// Calculate all. No.of half wavelengths
(crossings), time-out
emon1.serialprint(); // Print out all variables (realpower, apparent
power, Vrms, Irms, power factor)
Serial.println("second load ");// Calculate all. No.of half wavelengths
(crossings), time-out
emon2.serialprint(); // Print out all variables (realpower, apparent
power, Vrms, Irms, power factor)
Serial.println("third load");// Calculate all. No.of half wavelengths
(crossings), time-out
emon3.serialprint(); // Print out all variables (realpower, apparent
power, Vrms, Irms, power factor)
//Serial.println;)(
float realPower = emon1.realPower; //extract Real Power into
variable
float apparentPower = emon1.apparentPower; //extract Apparent Power
into variable
float powerFActor = emon1.powerFactor; //extract Power Factor into
Variable
float supplyVoltage = emon1.Vrms; //extract Vrms into Variable
float Irms = emon1.Irms; //extract Irms into Variable
float realPower1 = emon2.realPower; //extract Real Power into
variable
float apparentPower1 = emon2.apparentPower; //extract Apparent
Power into variable
float powerFActor1 = emon2.powerFactor; //extract Power Factor
into Variable
float supplyVoltage1 = emon2.Vrms; //extract Vrms into Variable
float Irms1 = emon2.Irms; //extract Irms into Variable
float realPower2 = emon3.realPower; //extract Real Power into
variable
float apparentPower2 = emon3.apparentPower; //extract Apparent
Power into variable
float powerFActor2 = emon3.powerFactor; //extract Power Factor
into Variable
float supplyVoltage2 = emon3.Vrms; //extract Vrms into Variable
float Irms2 = emon3.Irms; //extract Irms into Variable
delay(5000);
if(Irms >0.1)
{

```

```

digitalWrite(RELAY1_PIN,LOW);
}
if(Irms1>=0.200)
{
digitalWrite(RELAY2_PIN,LOW);
}
if(Irms2>1 )
{
digitalWrite(RELAY3_PIN,HIGH)
}

if (gprsSerial.available()){
Serial.write(gprsSerial.read;)}

gprsSerial.println("AT;")
delay(100);

gprsSerial.println("AT+CPIN;");
delay(100);

gprsSerial.println("AT+CREG;"); Check the registration status
delay(100);

gprsSerial.println("AT+CGATT;");// Attach to the network
delay(100);

gprsSerial.println("AT+CIPSHUT;");
delay(100);

gprsSerial.println("AT+CIPSTATUS "); Get the status of teh IP
connection
delay(2000);

gprsSerial.println("AT+CIPMUX=0");
delay(100);

ShowSerialData;){

gprsSerial.println("AT+CSTT=\"internet\", \"admin\", \"admin\");//start
task and setting the APN,
delay(100);

ShowSerialData;){

gprsSerial.println("AT+CIICR");//bring up wireless connection
delay(100);

```

```

ShowSerialData;)(

gprsSerial.println("AT+CIFSR");//get local IP address
delay(100);

ShowSerialData;)(

gprsSerial.println("AT+CIPSPRT=0);
delay(100);

ShowSerialData;)(

gprsSerial.println("AT+CIPSTART=\"TCP\",178.130.186.246\",350\"");
);//start up the connection
delay(100);

ShowSerialData;)(

gprsSerial.println("AT+CIPSEND");//begin send data to remote server
delay(100);
ShowSerialData;)(

String str="GET
https://api.thingspeak.com/update?api_key=QI2EG5PVY43QT57D&field
1=0" + String(realPower ) + "&field2="+String(apparentPower; )
Serial.println(str; )
gprsSerial.println(str);//begin send data to remote server

delay(100);
ShowSerialData;)(

gprsSerial.println((char)26);//sending
delay(100);//waitting for reply, important! the time is base on the
condition of internet
gprsSerial.println;)(
ShowSerialData;)(
gprsSerial.println("AT+CIPSHUT");//close the connection
delay(100;)
ShowSerialData;)(
}
void ShowSerialData)(
{
while(gprsSerial.available() !=0)
Serial.write(gprsSerial.read;))(delay(100);
}
}

```


Chapter five : RESULT AND PERFORMANCE

5.1 RESULT AND PERFORMANCE

It connects the project to the practical part

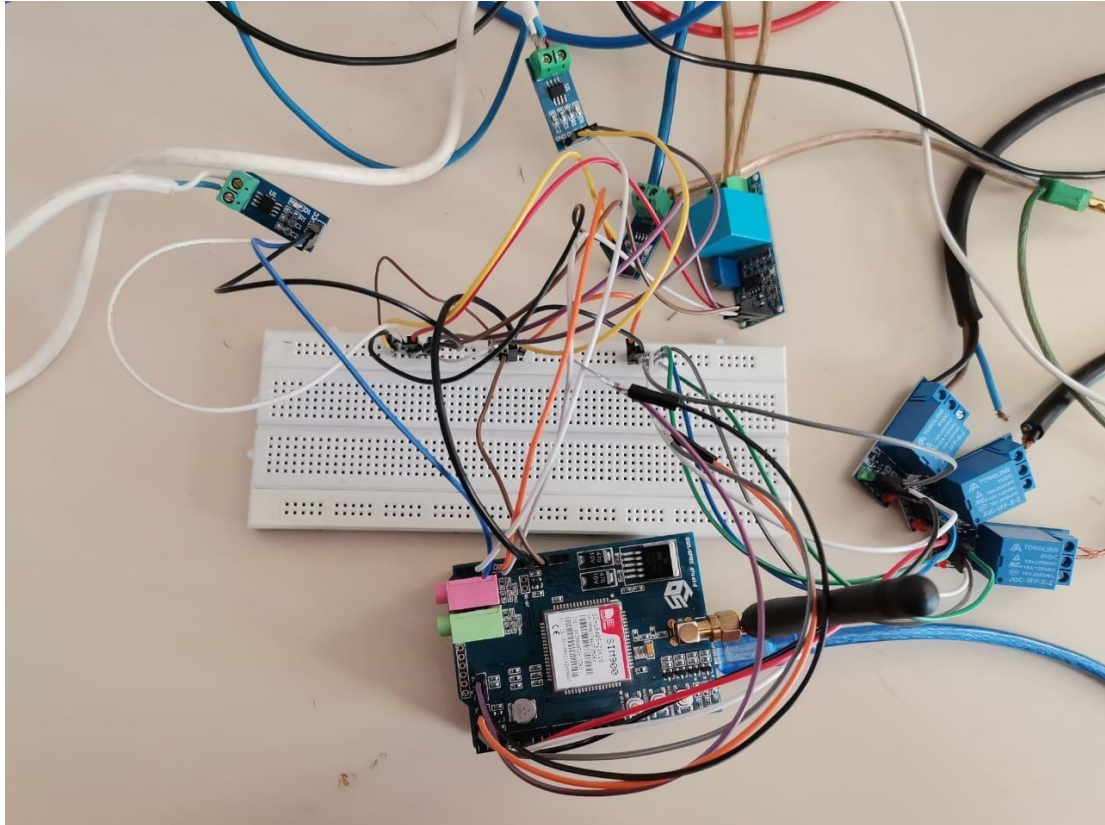


Fig 5.1: practical part

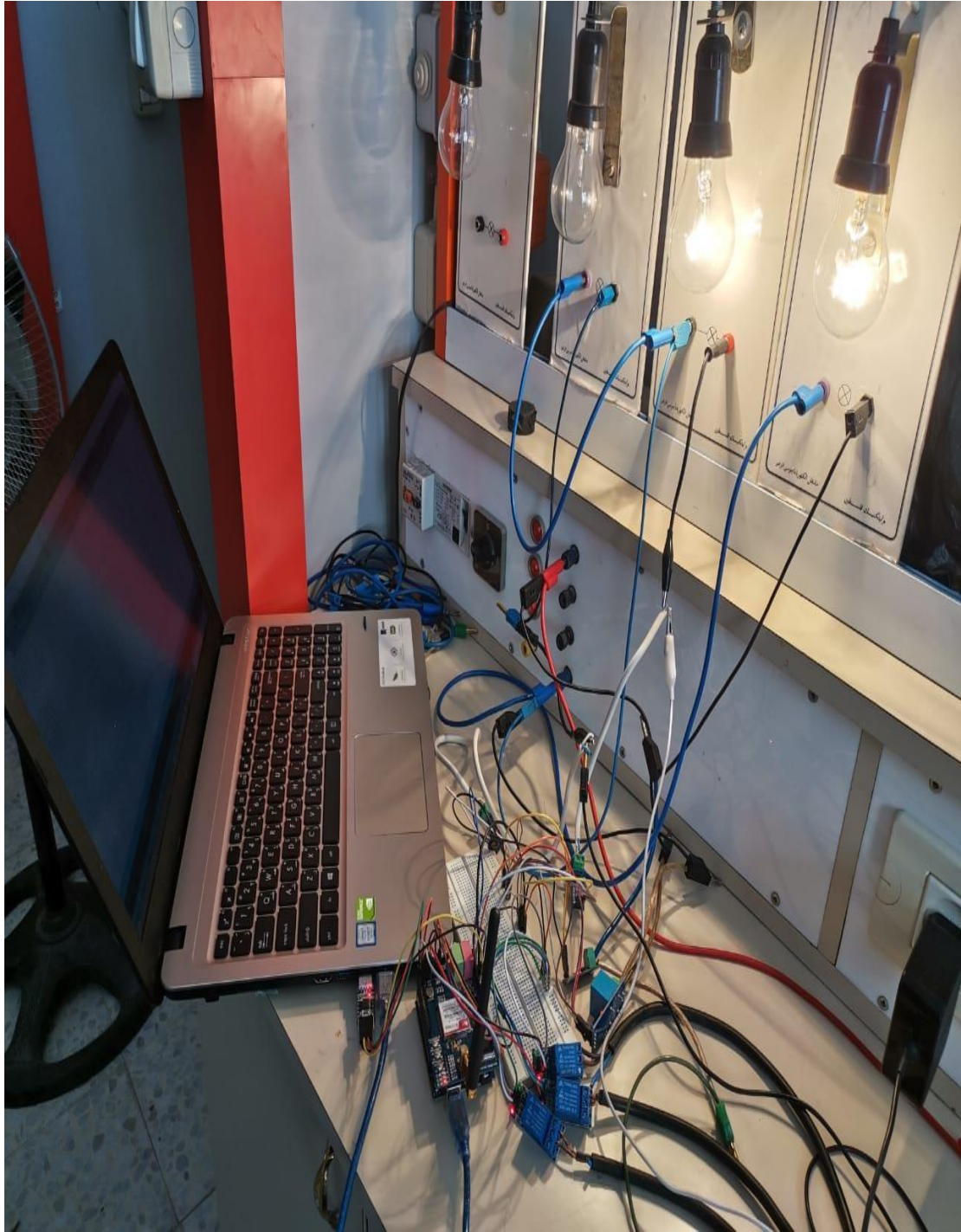


Fig5.2:all component system

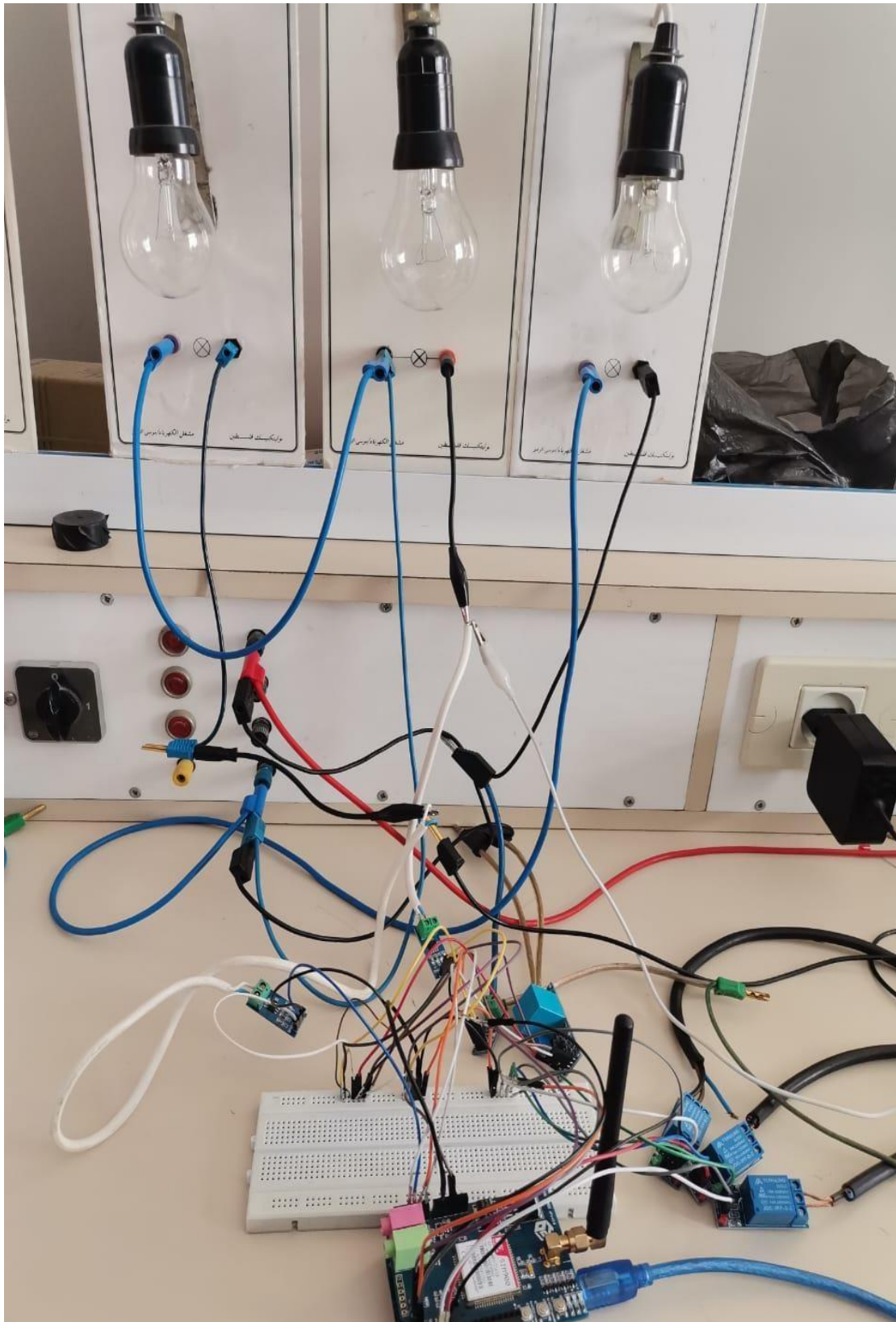


Fig5.3:control load(open relay)

CHAPTER SIX :problem &Conclusion and Recommendations References

6.1 problem

We encountered several problems from them:

1. The port for data transfer [tcp] was closed on the university network, The port for data transfer was closed on the university network, and to solve this problem we opened this port by connecting it to the IP device that we are working on with the help of professors from the Computer Center Department.

Port Checker
Check for open ports and verify port forwarding setup on your router.

Your IP Address
178.130.186.246

Port Number
350 FTP - 21

Port 350 is open.

← Ads by Google

Fig5.1:port checker

2. Need to define some piece-specific libraries GPRS/GSM SIM900

6.2 Recommendations:

- In this section we have some recommendation to be taken in consideration for future development and improvement for this project and/or other similar project.
- Supplying Arduino board with 6.5v power supply is the most suitable and stable case, although Arduino company says "input Voltage recommended = 5-12", 12v power supply cause high power dissipation in Arduino regulator and may cause thermal tripping for the board.
- Supply Hall Effect sensor ACS712T by separate precise 5v power supply or by Arduino 5v terminals, because this specific sensor is highly sensitive to harmonics and noises and need a precise voltage to work probably and precisely.
- Arduino code sketch should be less than 75% of Arduino memory size, because large size sketch files could cause instability in Arduino performance.
- For more precise Current measurement, use current transformer instead of ACS712T.

6.3 Conclusion:

- The idea of the project is based on the use of the wireless Internet to transfer data from one place to another place and also to control the other end. The practical part of the project is a simulation of a control and monitoring system for power distribution stations, by installing sensors to measure the voltage and current on each load branched from the station and then Connect the sensors with the Arduino controller until the control part is completed, and by installing the shield on the Arduino, the values from the sensors for voltage and current will be transferred to the server, which represents the control center, where the current and voltage values for each load that the sensor is connected to appear on it.

- Through practical application, the success of these steps is determined for us, where the value of the currents and voltages of the loads branching from the power distribution station appeared.

References

- [1] N. W. Aung, -Microcontroller Based Electrical Parameter Monitoring System of Electronic Load Controller Used in Micro Hydro Power Plant,|| Journal of Electrical and Electronic Engineering, vol. 3, no. 5, p. 97, 2015 .
- [2] M. Salhaoui, M. Arioua, A. Guerrero-González, and M. S. García-Cascales, – An IoT Control System for Wind Power Generators,|| SpringerLink, 11-Jun-2018. [Online]. Available: https://link.springer.com/chapter/10.1007/978-3-319-91479-4_39. [Accessed: 20-Dec-2019].
- [3] -Arduino,| Wikipedia, 18-Dec-2019. [Online]. Available: <https://en.wikipedia.org/wiki/Arduino>. [Accessed: 20-Dec-2019].
- [4]D. O'Sullivan and T. Igoe, Physical Computing: Sensing and Controlling the Physical World with Computers. Boston, MA, United States: Course Technology Press, 2004.
- [5]M. Banzi, Getting Started with arduino. O'Reilly Media, Inc., 2009.
- [6] The University of New South Wales: GPRS Optimization, Telenor: GPRS FAQ, Networks and Telecommunications Research Group: GPRS, RTX: GSM/GPRS Technology, India Parenting: Why Enable GPRS on Your Mobile Phone

APPENDIX 1

Datasheet for arduino

Microcontroller	ATmega328
Operating Voltage	5V
Input Voltage (recommended)	7-9V
Input Voltage (limits)	6-20V
Digital I/O Pins	14 (of which 6 provide PWM output)
Analog Input Pins	6
DC Current per I/O Pin	40 mA
DC Current for 3.3V Pin	50 mA
Flash Memory	32 KB (ATmega328) (0.5 KB used by bootloader)
SRAM	2 KB (ATmega328)
EEPROM	1 KB (ATmega328)
Clock Speed	16 MHz

APPENDIX 2

Datasheet for 3G shield

SPECIFICATIONS

3G/GPRS specifications:

- Quad-band 850MHz GSM, 900MHz EGSM, 1800MHz DCS, 1900MHz PCS - connect onto any global GSM network with any 2G SIM.
- American Version(SIM5320A): dual-band UMTS/HSDPA 850/1900MHz WCDMA + HSDPA
- European Version(SIM5320E): dual-band UMTS/HSDPA 900/2100MHz WCDMA + HSDPA
- Fully-integrated GPS that can be controlled and query over the same serial port
- Make and receive voice calls using a headset or an external 8 Ω speaker + electret microphone
- Send and receive SMS messages
- Send and receive GPRS data (TCP/IP, HTTP, etc.)
- AT command interface can be used with 300, 600, 1200, 4800, 9600, 19200, 39400, 57600, 115200, 230K, 461K, 961K, 3.2M, 3.7M and 4.0Mbps
- Native USB support - plug it into a computer and you'll get serial ports for AT commands, GPS NMEA as well as a modem (note we've only tried out the AT&NMEA ports on Windows)

GPS specifications

- 16 acquisition channels
- GPS L1 C/A code
- Sensitivity
 - Tracking: -157dBm
 - Cold starts: -144dBm
- Time-To-First-Fix
 - Cold starts: 100s (typ.)
 - Hot starts: 1s (typ.)
- Accuracy: approx 2.5 meters

Full-screen Snip

APPENDIX 3

Datasheet for current transform

ACS712

*Fully Integrated, Hall Effect-Based Linear Current Sensor IC
with 2.1 kVRMS Isolation and a Low-Resistance Current Conductor*

Description (continued)

the device at up to 5× overcurrent conditions. The terminals of the conductive path are electrically isolated from the signal leads (pins 5 through 8). This allows the ACS712 to be used in applications requiring electrical isolation without the use of opto-isolators or other costly isolation techniques.

The ACS712 is provided in a small, surface mount SOIC8 package. The leadframe is plated with 100% matte tin, which is compatible with standard lead (Pb) free printed circuit board assembly processes. Internally, the device is Pb-free, except for flip-chip high-temperature Pb-based solder balls, currently exempt from RoHS. The device is fully calibrated prior to shipment from the factory.

Selection Guide

Part Number	Packing*	T _A (°C)	Optimized Range, I _p (A)	Sensitivity, Sens (Typ) (mV/A)
ACS712ELCTR-05B-T	Tape and reel, 3000 pieces/reel	-40 to 85	±5	185
ACS712ELCTR-20A-T	Tape and reel, 3000 pieces/reel	-40 to 85	±20	100
ACS712ELCTR-30A-T	Tape and reel, 3000 pieces/reel	-40 to 85	±30	66

*Contact Allegro for additional packing options.

Absolute Maximum Ratings

Characteristic	Symbol	Notes	Rating	Units
Supply Voltage	V _{CC}		8	V
Reverse Supply Voltage	V _{RCC}		-0.1	V
Output Voltage	V _{IOUT}		8	V
Reverse Output Voltage	V _{REOUT}		-0.1	V
Output Current Source	I _{OUT(SOURCE)}		3	mA
Output Current Sink	I _{OUT(SINK)}		10	mA
Overcurrent Transient Tolerance	I _p	1 pulse, 100 ms	100	A
Nominal Operating Ambient Temperature	T _A	Range E	-40 to 85	°C
Maximum Junction Temperature	T _{J(max)}		165	°C
Storage Temperature	T _{stg}		-65 to 170	°C

Isolation Characteristics

Characteristic	Symbol	Notes	Rating	Unit
Dielectric Strength Test Voltage*	V _{ISO}	Agency type-tested for 60 seconds per UL standard 60950-1, 1st Edition	2100	VAC
Working Voltage for Basic Isolation	V _{WBSI}	For basic (single) isolation per UL standard 60950-1, 1st Edition	354	VDC or V _{pk}
Working Voltage for Reinforced Isolation	V _{WFR}	For reinforced (double) isolation per UL standard 60950-1, 1st Edition	184	VDC or V _{pk}

* Allegro does not conduct 60-second testing. It is done only during the UL certification process.

Parameter	Specification
Fire and Electric Shock	CAN/CSA-C22.2 No. 60950-1-03 UL 60950-1:2003 EN 60950-1:2001



Allegro MicroSystems, LLC
115 North Street
Worcester, Massachusetts 01615-0039 U.S.A.
1.508.853.3000; www.allegromicro.com

2

APPENDIX 4

Datasheet for voltage transformer

ZMPT101B VOLTAGE TRANSFORMER

Applications

- * Sensing Overload Current
- * Ground fault detection
- * Metering
- * Analog to Digital Circuits



Product Illustration

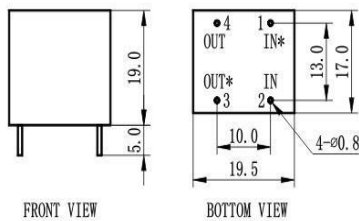
Electrical Specification	
Primary Current	2mA
Secondary Current	2mA
Turns Ratio	1000:1000
Phase Angle Error	$\leq 20'$ (50 Ω)
Current Range	0 ~ 3mA
Linearity	0.1%
Accuracy Class	0.2
Rated Burden	$\leq 200 \Omega$
Frequency Range	50 ~ 60Hz
Dielectric Level	3000VAC/min
DC Resistance at 20 $^{\circ}$ C	110 Ω

Mechanical Specification	
Cup	PBT
Encapsulant	Epoxy
Terminals	Pin $\phi 0.80$ mm
Tolerance	± 0.2 mm
Approx. Weight	13g
Case	Carton

Environment Specification	
Storage Temperature	-40 $^{\circ}$ C ~ +130 $^{\circ}$ C
Insulation Resistance	>100 M Ω

Dimensions (mm)

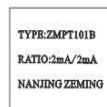
Same Polarity *



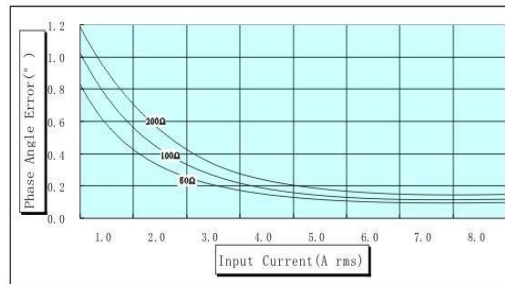
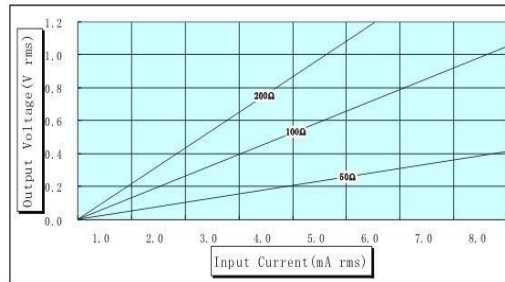
FRONT VIEW

BOTTOM VIEW

Label



Output Characteristic




Description: Micro Precision Voltage Transformers, with low price, small size and easy PCB mounting, are mainly used in electrical energy meters, household electrical equipment, industrial apparatuses, electrical testing equipment and relay protection, widely acclaimed as well.


APPENDIX 5

Datasheet for relay


SRD Series SUBMINATURE HIGH POWER RELAY 7A/10A/15A



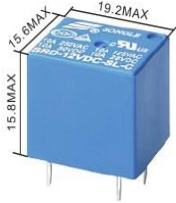
E167996



R50056114
R50137084




CQC08002027667

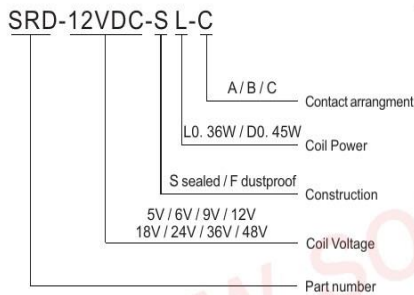


Features

- Miniature volume, PCB usage
- Contact rating: 7A/10A/15A
- Temperature range: +85°C/+105°C



Ordering Information



Contact Rating

Contact arrangement	1A(spstno)/1B(Spstnc)/1C(Spdt)
Contact resistance	100mΩ (1A 6VDC)
Contact material	Silver alloy: AgCdO、AgSnO ₂ 、AgNi
Contact rating	7A/250VAC 10A/250VAC 15A/250VAC
Max switching voltage	250VAC
Max switching current	15A
Max switching power	3750VA
Electrical endurance (frequency: 1800 ops/h)	1x10 ⁵ ops / 1x10 ⁶ ops
Mechanical endurance (frequency: 18000 ops/h)	1x10 ⁷ ops

Characteristics

Insulation system	Class B / Class F	
Insulation resistance	100MΩ (500VDC)	
Dielectric Strength Leakage current 1mA	Between contacts and coil	1500VAC 1 minute
	Between open contacts	1000VAC 1 minute
Operate time (Under nominal voltage)	≤ 10ms	
Release time (Under nominal voltage)	≤ 10ms	
Humidity	85% RH (20°C)	
Ambient Temperature	-40°C~+85°C/-40°C~+105°C	
Shock resistance	Functional	98m/s ²
	Destructive	980m/s ²
Vibration resistance (Double amplitude)	10Hz~55Hz 1.5mm	
Weight	Approx 9g	
Construction	Sealed	

Remark:1)All above data is initial value

Coil Data (at 20°C)

Power dissipation W	Voltage VDC	Current mA	Resistance Ω ± 10%	Pick-up voltage	Drop-out voltage	Max allowable
0.36W (L)	05	71.4	70	75%Max	10%Min	130%
	06	60	100			
	09	40	225			
	12	30	400			
	18	20	900			
	24	15	1600			
	36	10	3600			
0.45W (D)	05	89.3	55	75%Max	10%Min	130%
	06	75	80			
	09	50	180			
	12	37.5	320			
	18	25	720			
	24	18.7	1280			
	36	12.5	2880			
48	10	4500				

This product specification only for your reference, we will not notify you if we do any improvement. We reserve all the right for the final explanation



Web: www.songle.com www.songlerelay.com
 Add.: CW7, Zone A, Far East Industrial Park, Yuyao City, Zhejiang, China Zip Code: 315400

APPENDIX 6

Datasheet for ttl-board



CP2102

SINGLE-CHIP USB TO UART BRIDGE

Single-Chip USB to UART Data Transfer

- Integrated USB transceiver; no external resistors required
- Integrated clock; no external crystal required
- Integrated 1024-Byte EEPROM for vendor ID, product ID, serial number, power descriptor, release number, and product description strings
- On-chip power-on reset circuit
- On-chip voltage regulator: 3.3 V output
- 100% pin and software compatible with CP2101

USB Function Controller

- USB Specification 2.0 compliant; full-speed (12 Mbps)
- USB suspend states supported via SUSPEND pins

Asynchronous Serial Data BUS (UART)

- All handshaking and modem interface signals
- Data formats supported:
 - Data bits: 5, 6, 7, and 8
 - Stop bits: 1, 1.5, and 2
 - Parity: odd, even, mark, space, no parity
- Baud rates: 300 bps to 1 Mbps
- 576 Byte receive buffer; 640 byte transmit buffer
- Hardware or X-On/X-Off handshaking supported
- Event character support
- Line break transmission

Virtual COM Port Device Drivers

- Works with Existing COM Port PC Applications
- Royalty-Free Distribution License
- Windows Vista/XP/Server 2003/2000
- Mac OS-X/iOS-9
- Linux

USBXpress™ Direct Driver Support

- Royalty-Free Distribution License
- Windows Vista/XP/Server 2003/2000
- Windows CE

Example Applications

- Upgrade of RS-232 legacy devices to USB
- Cellular phone USB interface cable
- PDA USB interface cable
- USB to RS-232 serial adapter

Supply Voltage

- Self-powered: 3.0 to 3.6 V
- USB bus powered: 4.0 to 5.25 V

Package

- Pb-free 28-pin QFN (5x5 mm)

Ordering Part Number

- CP2102-GM

Temperature Range: -40 to +85 °C

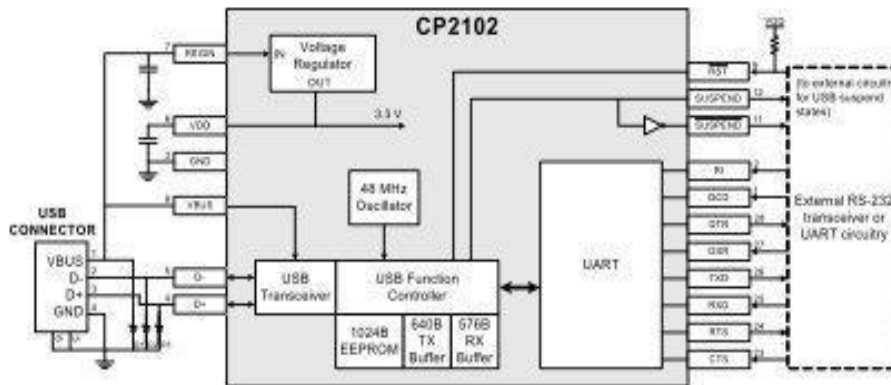


Figure 1. Example System Diagram

