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"power line communication"

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1. ABSTRACT: -

The power line modem is a dedicated device, "which is used for transferring data over low voltage power line, where electrical power is transmitted over high voltage transmission line distributed over medium voltage & used inside the building at lower voltages." Most PLC's technologies limits themselves to one set of wires (for ex. premises wiring),but some can cross between two levels (for ex. both distribution network & premises wiring). Proper distribution network i.e. transformer prevents propagating the signal which is generated or produced due to multiple PLC technologies to be bridged to form very large network.

Power line communication or power line carrier also known as power line digital subscriber line (PDSL), mains communication, power line telecom (PTL)or broadband over power lines(BPL)are systems which carrying data on a conductor i.e. "power line communication".

This technology can be extensively used in centralized electric meter reading, remote monitoring of electrical equipment, building automation and security control, stage lighting and street lighting control applications, information displays and it can also play a role in the final leg of Internet connection in special circumstances.

2. INTRODUCTION: -

This project is based on data transmission over the power line. The power line modem uses the power line cable as communication medium. It is convenient as it eliminates the need to lay additional cables. The modem at the transmission end modulates the signal from data terminal through RS-232 interface onto the carrier signal in the power line. At the receiving end, the modem recovers the data from the power line carrier signal by demodulation and sends the data to data terminals through RS-232 interface.

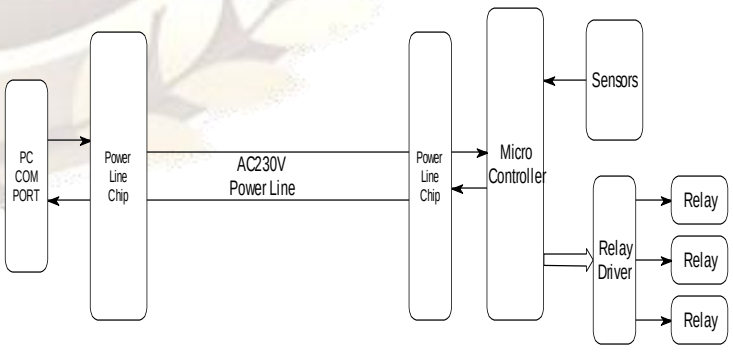
Power line communication modems transmit digital data on the live and neutral cables of the building power distribution network. Data is typically transmitted at carrier frequencies in the range from 50 kHz to 500 kHz using a variety of modulation techniques, including amplitude shift keying, frequency-shift keying (FSK), binary phase shift keying (BPSK), and direct-sequence spread spectrum (DSSS).

All power line communications systems operate by impressing a modulated carrier signal on the wiring system. Different types of power line communications use different frequency bands,

Depending on the signal transmission characteristics of the power wiring used.

Data rates over a power line communication system vary widely. Low-frequency (about 100-200 kHz) carriers impressed on high-voltage transmission lines may carry one or two analog voice circuits, or telemetry and control circuits with an equivalent data rate of a few hundred bits per second; however, these circuits may be many miles long. Higher data rates generally imply shorter ranges; a local area network operating at millions of bits per second may only cover one floor of an office building, but eliminates installation of dedicated network cabling.

3. BLOCK DIAGRAM:-



3.1 Functional Description:- In this Project the data is being transferred over AC line from PC communication port, which is encoded and decoded by PLC chips. The received information signal is then send to the microcontroller and according to the

status of information signal, several devices are operated.

Both transmission and reception stages are controlled either by the master clock of the microcontroller, or by the on-chip reference oscillator connected to a crystal. This holds for the accuracy of the transmission carrier and the exact trimming of the digital filter, thus making the performance totally independent of application disturbances such as component spread, temperature, and supply drift and so on. The interface with the power network is made by means of a LC network. The device includes a power output stage able to feed a 120 dBmV (RMS) signal on a typical 30 W load. To reduce power consumption, the IC is disabled by a power-down input (pin PD): in this mode, the on-chip oscillator remains active and the clock continues to be supplied at pin CLKOUT. For low-power operation in reception mode, this pin can be dynamically controlled by the microcontroller. When the circuit is connected to an external clock generator, the clock signal must be applied at pin OSC1 (pin 7); OSC2 (pin 8) must be left open. Use of the on-chip clock circuitry is shown. All logic inputs and outputs are compatible with TTL/CMOS levels, providing an easy connection to a standard microcontroller I/O port. The digital part of the IC is fully scan-testable. Two digital inputs, SCANTEST and TEST1, are used for production test: these pins must be left open in functional mode (correct levels are internally defined by pull-up/down resistors).

3.2 Transmission Mode:-

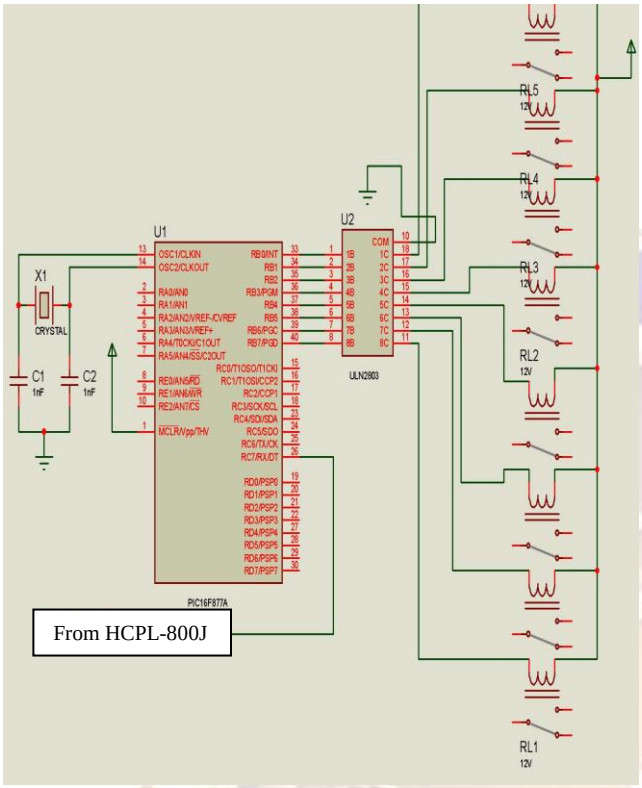
The carrier frequency is generated by the scanning of a ROM memory under the control of the microcontroller clock or the reference frequency provided by the on-chip oscillator, thus providing strict stability with respect to environmental conditions. High frequency clocking rejects the aliasing components to such an extent that they are filtered by the coupling LC network and do not cause any significant disturbance. The data modulation is applied through pin DATAIN and smoothly applied by specific digital circuitry to the carrier (shaping). Harmonic components are limited in this process, thus avoiding unacceptable disturbance of the transmission channel (according to CISPR16 and EN50065-1 recommendations). A -55 dB total harmonic distortion is reached when using the typical LC coupling network (or an equivalent filter). The D/A converter and the power stage are set in order to provide a maximum signal level of 122 dBmV (RMS) at the output. The output of the power stage (TXOUT) always has to be connected to a decoupling capacitor, because of a DC level of 0.5VDD at this pin, present even when the device is not transmitting. This pin also has to be protected against over voltage and negative transient signals. The DC level of TXOUT can be used to bias an unipolar transient suppressor, as shown in the application diagram. Direct connection to the mains is done through a LC network for low-cost applications. However, a HF signal transformer could be used when power-line insulation has to be performed.

3.3 Receiving Mode:-

The input signal received by the modem is applied to a wide range input amplifier with Automatic Gain Control (-6 to +30 dB). This is basically for noise performance improvement and signal level adjustment that ensures a maximum sensitivity of the A/D converter. Then an 8-bit A/D conversion is performed, followed by digital band pass filtering, in order to meet the CISPR normalization and to accomplish additional limitations encountered in current applications.

After digital demodulation, the base band data signal is made available after pulse shaping. The signal pin (RXIN) is a high-impedance input, which has to be protected and DC decoupled for the same reasons as with pin TXOUT. The high sensitivity (82 dBmV) of this input requires an efficient 50 Hz rejection filter (realized by the LC coupling network) also used as an anti-aliasing filter for the internal digital processing The output of the power stage (TXOUT) always has to be connected to a decoupling capacitor, because of a DC level of 0.5VDD at this pin, present even when the device is not transmitting. This pin also has to be protected against over voltage and negative transient signals. The DC level of TXOUT can be used to bias a unipolar transient suppressor, as shown in the application diagram. Direct connection to the mains is done through a LC network for low-cost applications. However, a HF signal transformer could be used when power-line insulation has to be performed.

4. CIRCUIT DIAGRAM: -



4.1 Working:-

This circuit contains PC on one side and microcontroller based relay switching drives on another side. We send the data using program prepared in Visual Basic (VB) through serial port. This serial port is connected to PLM. This PLM is assigned supply of 230v mains.

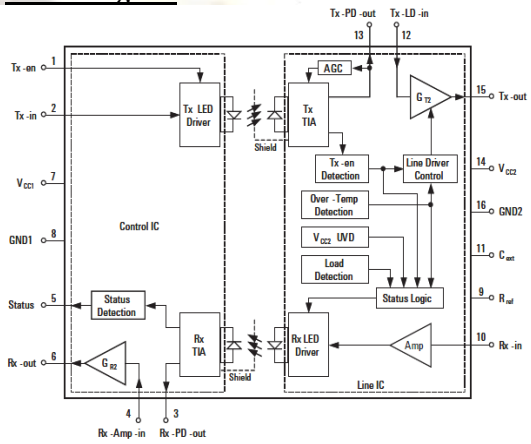
On the receiver side, same circuit is connected to power line on the same phase. This circuit receives data from the PC attached with the circuit which is connected to PIC microcontroller. Whenever it gets data (for ex) A, microcontroller reads the data and ON the first relay. When it gets B, 1st relay becomes OFF. When it gets data C, microcontroller reads the data and ON the second relay. When it gets D, the second relay becomes OFF. Thus this process is carried out.

Visual Basic contains the program of scheduling and manual switching operation. As this program starts, some atomization functions starts performing for the atomization industry. The PC side circuit is connected to MAX 232 for the voltage shifting. On the other side of microcontroller, relay driver is connected to relay circuit.

First, we prepare the program for microcontroller serial baud rate i.e. 600 bits/sec. This program is also applicable for PC side. Then serial values come to microcontroller. This microcontroller reads the value and compare it whether these are A, B, C or D. When it finds equal, particular task i.e. relay ON/OFF is carried out. Relay doesn't drive microcontroller circuit so we use driver circuit i.e. transistor base Darlington array in a single chip (ULN 2803). This chip contains 8 Darlington arrays.

5. HCPL-800J: -

5.1 Block Diagram: -



General Description: -

The HCPL-800J is a modem IC, specifically dedicated to ASK transmission by means of the home power supply Network, at 600 or 1200 baud data rate. It operates from a Single 5 V supply. The HCPL-800J is a galvanic- ally isolated Power line Data Access Arrangement IC. It provides the key features of isolation, Tx line driver and Rx amplifier as required in a power line modem application. Used together with a simple Coupling circuit, the HCPL-800Joffers a highly integrated, cost-effective Analogue Front End(AFE) solution. Optical coupling technology provides very high isolation mode rejection, facilitating excellent EMI and EMC performance. Application robustness is enhanced by the inherent properties of opt isolation devices, to effectively block the transfer of damaging surge transients. Excellent transmitter performance is achieved with the use of a high efficiency, low distortion line driver stage. Transmitter robustness is further enhanced with integrated load detection and over- temperature protection functions. The HCPL-800J is designed to work with various transceiver ICs

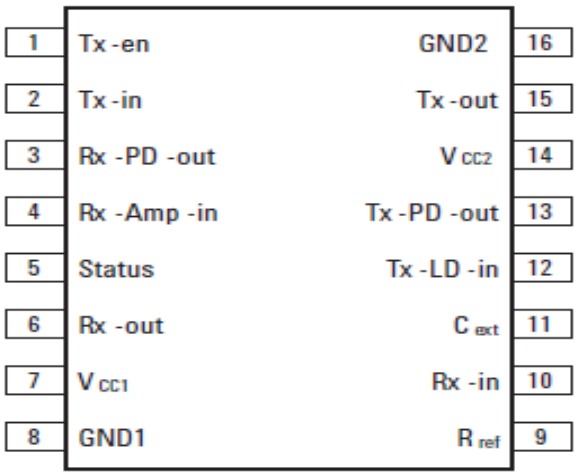
and significantly simplify the implementation of a power line modem.

The HCPL-800J incorporates two integrated circuits—a control IC and a line IC, optically isolated from each other. The modulated signal from the PLM transceiver is input to the control IC. This transmit signal is optically coupled to the line IC, then amplified, and sent to the power line. In the other direction, a potentially weak and noisy signal from the power line is received by the line IC and optically coupled to the control IC, where it is amplified and output to the PLM transceiver. The HCPL-800J incorporates protection mechanisms including over-temperature, over-current and low supply voltage detection, and line condition monitoring. It operates from two +5 V power supplies and is supplied in a 16-pin SOIC (Small Outline IC) package.

5.2 Features: -

- Full digital carrier generation and shaping
- Modulation/demodulation frequency set by clock adjustment, from microcontroller or on-chip oscillator
- Automatic gain control at receiver input
- -60 dB Overall Tx Distortion
- 25 nV/ Typical Input Referred Noise
- Load Detection Function
- Under-Voltage Detection
- Over-Temperature Shutdown
- Highly Efficient Tx Line Driver
- Built-in Rx Amplifier
- Temperature Range: -40°C to +85°C

5.3 Pin Diagram of HCPL 800J: -



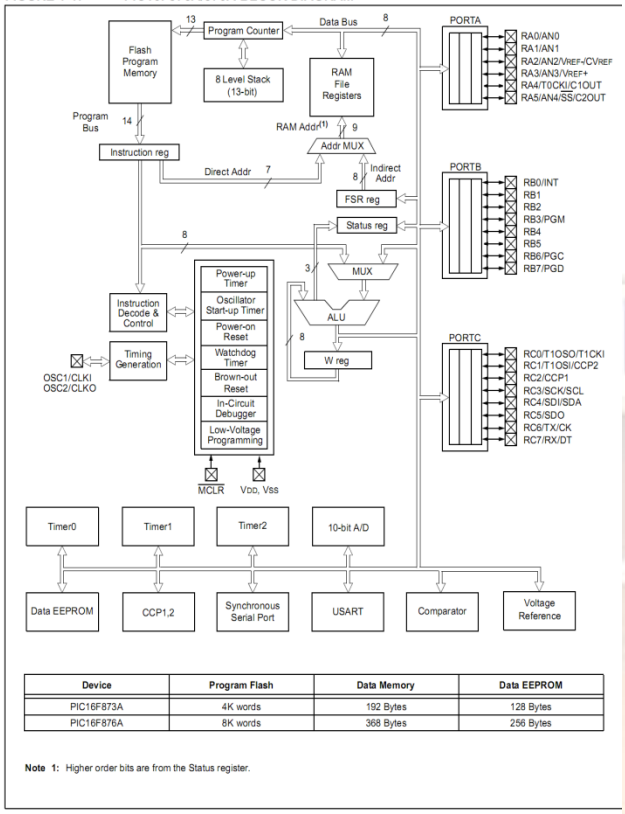
5.4 Pin Description:-

Pin Descriptions

Pin No.	Symbol	Description
1	Tx-en	Transmit Enable Input
2	Tx-in	Transmit Input Signal
3	Rx-PD-out	Rx Photodetector Output
4	Rx-Amp-in	Receiver Output Amplifier Input
5	Status	Signal indicating Line Condition
6	Rx-out	Receiving Signal Output
7	V_{CC1}	5 V Power Supply
8	GND1	V_{CC1} Power Supply Ground
9	R_{ref}	Sets Line Driver biasing current, typically 24 kΩ
10	Rx-in	Receiving Signal Input from Powerline
11	C_{ext}	External Capacitor
12	Tx-LD-in	Tx Line Driver Input
13	Tx-PD-out	Tx Photodetector Output
14	V_{CC2}	5 V Power Supply
15	Tx-out	Transmit Signal Output to Powerline
16	GND2	V_{CC2} Power Supply Ground

6. MICROCONTROLLER PIC16F873A:-

FIGURE 1-1: PIC16F873A/876A BLOCK DIAGRAM



Device	Program Flash	Data Memory	Data EEPROM
PIC16F873A	4K words	192 Bytes	128 Bytes
PIC16F876A	8K words	368 Bytes	256 Bytes

Note 1: Higher order bits are from the Status register.

The main role of microcontroller is to check received information with the prepared program available inside the microcontroller; depending upon which several relays (i.e. devices) are operated.

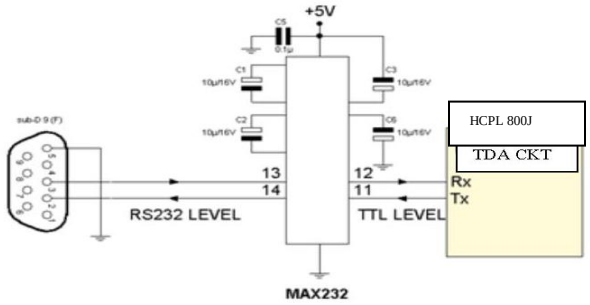
The microcontroller PIC 16F873A is a High-Performance RISC CPU .It will provide only 35 single-word instructions. Its operating speed is DC-20MHz clock input which contains 8K x 14 words of Flash Program Memory, 368 x 8 bytes of Data Memory (RAM) & 256 x 8 bytes of EEPROM Data Memory. It contains three timers, three ports, USART with 9-bit address detection & Brown-out detection circuitry for Brown-out Reset. It uses CMOS tech. with Low-power, high-speed Flash/EEPROM technology & Low power consumption

6.1 Microcontroller Features : -

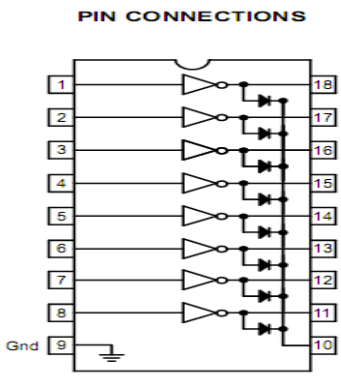
•100,000 erase/write cycle Enhanced Flash program memory typical
•1,000,000 erase/write cycle Data EEPROM memory typical
•Data EEPROM Retention > 40 years
•Self-reprogrammable under software control
•Single-supply 5V In-Circuit Serial Programming

7. MAX 232: -

We send the data using program prepared in visual basic through this serial port. This serial port is connected to Power line modem & is assigned supply of 230V mains. The PC side is connected to MAX 232 for the voltage shifting.



8. ULN 2803(Relay Driver IC) : -



The eight NPN Darlington connected transistors in this family of arrays are ideally suited for interfacing between low logic level digital circuitry (such as TTL, CMOS or PMOS/NMOS) and the higher current/voltage requirements of lamps, relays, printer hammers or other similar loads for a broad range of computer, industrial, and consumer applications. All devices feature open–collector outputs and freewheeling clamp diodes for transient suppression.

The ULN2803 is designed to be compatible with standard TTL families while the ULN2804 is optimized for 6 to 15 volt high level CMOS or PMOS. It is used for impedance matching between microcontroller & relays which are going to operate for particular application because microcontroller cannot be directly interface with the relays.

MAXIMUM RATINGS (T_A = 25°C and rating apply to any one devi package, unless otherwise noted.)

Rating	Symbol	Value
Output Voltage	V_O	50
Input Voltage (Except ULN2801)	V_I	30
Collector Current – Continuous	I_C	500
Base Current – Continuous	I_B	25
Operating Ambient Temperature Range	T_A	0 to +70
Storage Temperature Range	T_{stg}	−55 to +15
Junction Temperature	T_J	125

$R_{\theta JA}$ = 55°C/W
Do not exceed maximum current limit per driver.

ORDERING INFORMATION

Device	Characteristics		
	Input Compatibility	V_{CE}(Max)/I_C(Max)	Te
ULN2803A	TTL, 5.0 V CMOS	50 V/500 mA	T_A =

9. NEED FOR VISUAL BASIC: -

There are several programming tools that allow us to build such visually appealing and intuitive interfaces. These tools allow us to design interfaces that user-friendly feature such as menus, buttons, windows etc. Interfaces that use graphics came to be known as graphical user interfaces (GUI). These become very popular because the user could identify with the graphics displayed on screen. And we associate more with images than words. Mention the word print to the person and it invokes the image of printer. However, the disadvantages of such tools are that the interface using code. The programmer has to code the user interface features specifying the size, position etc. This makes designing the user interfaces a major task in itself. The next step is to code the functionality to be provided by the system. Each time the user clicks on buttons, the application must determine which button has been clicked and performs the necessary action. When a number button is clicked the number is to be displayed otherwise the selected operation is to be performed. This has to be implemented by writing code. Therefore, a programmer spends a lot of time writing code for the user interface. Moreover, a large percentage of the time is wasted in action such as aligning the buttons properly, determining which button has clicked and then executing the appropriate code. This means that if the process of building the user interface is simplified then the time and effort required in developing an application can be reduced. The need of the hour was environment that would allow easy design of the user interface. Thus was born the art of Visual programming.

10. APPLICATIONS:-

- Home & Industrial Automation.
- Automatic Meter Reading.
- Lighting Control.
- Status Monitoring and Control.
- Low Speed Data Communication Networks.
- Intelligent Buildings.
- Power Distribution Management.
- Power line Modem.

11. ADVANTAGES: -

- It provides Mobility, Flexibility & Stability.
- Ease of installation for indoor setup.
- It eliminates the need of additional cables.
- PLC solution is a complementary or alternative solution to traditional fixed line networks, wireless networks and VDSL networks.

12. CONCLUSION: -

Though we believe that India is being a super power on the basis of connecting roads, electricity, water & definitely we all. But why we can't able to connect television set, high speed broadband & many tele- facilities to each & every part of our country.
But now, yes it can! It all achieves by just a single line called as PLC.
As per indicated in application, the power line provides wide areas of communication through all the channels, with this power line provides mobility, flexibility & stability because of it's small size & portable size, internet accessibility & easy of installation. Power line communication is not so powered because of less inventions due to that cost required to design transceiver at each station is very high. So, today's point of view the first challenge is to reduce the cost. So, in future we definitely proved that power line communication is the most efficient, powerful & cheapest media of communication.

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- [2]http://www.datasheetsite.com/datasheet/MAX 232
- [3]http://www.agilent.com/semiconductors
- [4]http://www.avagotech.com
- [5]http://www.xtentechnology.com
- [6]http://www.ebook.com

SOURCE CODE FOR MICROCONTROLLER

```
unsigned char i;
char txt[4];
void main() {
   TRISB       = 0x00;                    // designate
PORTB as OUTput
   PORTB = 0;     // Initialize USART module (8 bit,
600 baud rate, no parity bit..)
  Usart_Init(200);
  do {
     if (Usart_Data_Ready())
       {   // If data is received
        i = Usart_Read();       // Read the received data
        switch (i) {
                case 'A': PORTB.F0 = 1 ; break;
                case 'B': PORTB.F0 = 0 ; break;
                case 'C': PORTB.F1 = 1 ; break;
                case 'D': PORTB.F1 = 0 ; break;
                case 'E': PORTB.F2 = 1 ; break;
                case 'F': PORTB.F2 = 0 ; break;
                case 'G': PORTB.F3 = 1 ; break;
                case 'H': PORTB.F3 = 0 ; break;
                case 'I': PORTB.F4 = 1 ; break;
                case 'J': PORTB.F4 = 0 ; break;
                case 'K': PORTB.F5 = 1 ; break;
                case 'L': PORTB.F5 = 0 ; break;
                case 'M': PORTB.F6 = 1 ; break;
                case 'N': PORTB.F6 = 0 ; break;
                case 'O': PORTB.F7 = 1 ; break;
                case 'P': PORTB.F7 = 0 ; break;
                }
  }
  } while (1);
}
```