International Journal of Engineering & Technology, 7 (4) (2018) 2899-2902

International Journal of Engineering & Technology

Website: www.sciencepubco.com/index.php/IJET
doi: 10.14419/ijet.v7i4.15602
Research paper

Design and implementation of power line communication using microcontroller

Nagaraju Naddi [1] *, Ch.Subrahmanyam [2]

[1,2] Department of Electronics and Communication Engineering, Vardhaman College of Engineering, Hyderabad, India
**Corresponding author E-mail: n.nagaraju@vardhaman.org*

Abstract

Abstract – This paper proposes a novel power line communication system utilizing minimum cables. Conventionally, more number of cables is used to transmit data and power. This leads to increasing the cost, complexity in design and connections, maintenance issues and high man power. In order to avoid these drawbacks, the power line communications system is proposed to transmit the data through the existing power line cables by impressing a modulated carrier signal. The proposed power line communication system is divided into two blocks in design say Transmitter design and Receiver design. At the transmitter side, the data is encoded by using Manchester encoding scheme preceded by Frequency shift keying modulation.Similarly, at the receiver side, the process of demodulation and decoding are used for the retrieval of the original data. In this paper, the STM8 Microcontroller is utilized for the real time validation of the proposed power line communication system design.

Keywords:*Power Lines; Stm8 Microcontroller; Frequency Shift Keying; Manchester Encoding.*

1. Introduction

The communication flow of today is very high. The applications which are operating at high frequency and a fixed connection is always preferred. If we transmit the data through the existing power lines to the customer it could make a tremendous breakthrough in communication. By using a power line as a communication medium will also be a cost effective we compared to other systems because it uses an existing infrastructure, wires exists to ever household will be connected at any time and services being provided at real time.
Power Line Communication (PLC) is a promising emerging technology, which is attracting much attention due to the wide availability of power distribution lines. Power Line Communication basically means any technology that enables data transfer at narrow or broad band speeds through power lines by using advanced modulation technology. Power line communication is also called as power line digital subscriber line, mains communication, power line telecom, power line networking, or broadband over power lines are the systems, which carries the data on a conductor and also used for electronics power transmission.
Home Automation System using power line communication is user friendly and cost efficient. It requires only electricity torun system. So this system is very simple and cheap. Electrical power is transmitted over long distances using high voltage transmission lines, distributed over medium voltages, and used inside buildings at lower voltages.

2. Design methodology

In this, we designed transmitter and receiver. These can be operated around 70-100 KHz. The major parts in the transmitter are Microcontroller, Square to Sine wave converter and Transformer to superimpose the high frequency signal on to the A.C signal. Similarly in the receiver end the main blocks are Transformer, Band Pass Filter, Microcontroller and Triac section.

2.1. Transmitter design

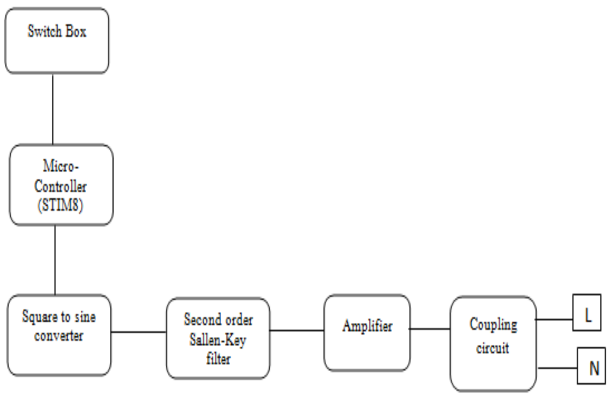

Fig. 2.1: Transmitter Block Diagram.

The Transmitter of the PLC contains the following blocks.

1) Power Supply
2) Microcontroller section
3) Square to Sine wave Converter
4) Coupling section

2.1.1. Microcontroller

In order to work with an components, basic requirement is power supply. In this section there is a requirement of 5V, 12V DC power supply. In this we need to control three switches and generating timing waveforms depending on the switch we pressed. Since we are using only 5 to 6 pins of the microcontroller. We have to select a microcontroller with low pin count, therefore we have chosen STM8 microcontroller.

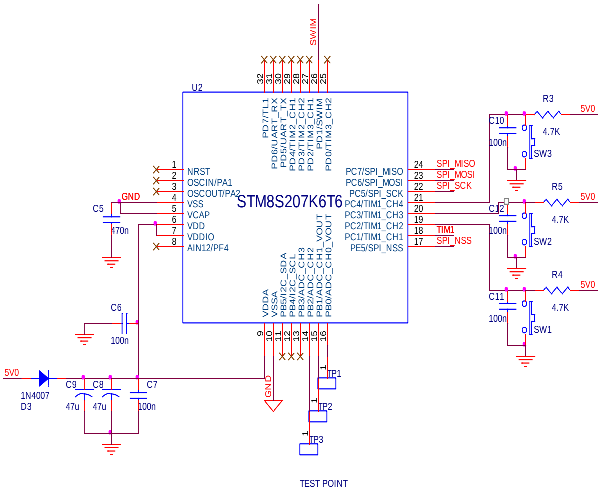

Fig. 2.2: Microcontroller Section- Transmitter End.

In this transmitter part, microcontroller is used for generating timing waveforms using timer channel. These timing waveforms are controlled depends on the switches connected in port C.

2.1.2. Square to sine wave converter

Square wave cannot be superimposed onto the power line. That is why this square wave will be converted into sine wave. Literally we can say that square wave can be converted sine wave by just smoothing it. Hence a Low pass filter can be done this perfectly. Since we are operating with frequencies more than 10KHz, its cutoff frequency designed with 65KHz.

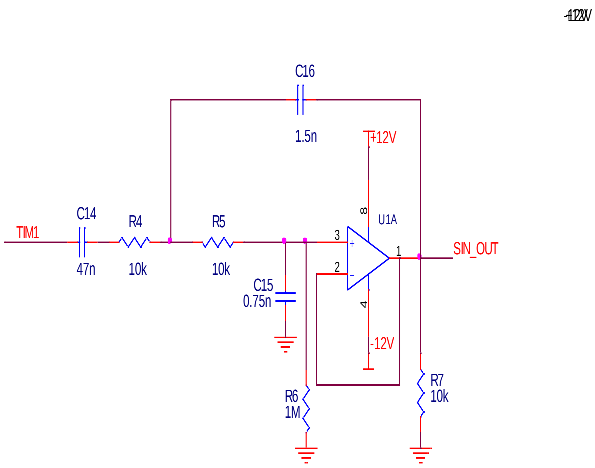

Fig. 2.3: Square Wave to Sine Wave Converter.

2.1.3. Power amplifier

In this amplifier one transistor is used to amplify the positive portion of the signal and other transistor is used to amplify the negative portion of the signal. The circuit is powered by symmetrical DC voltage source +12V and -12V, with a complementary pair of transistors (Q1 is an NPN and Q2 is a PNP). These transistors are connected in such a way both cannot conduct simultaneously. The signal coming from the power amplifier we are giving it to the coupling circuit.

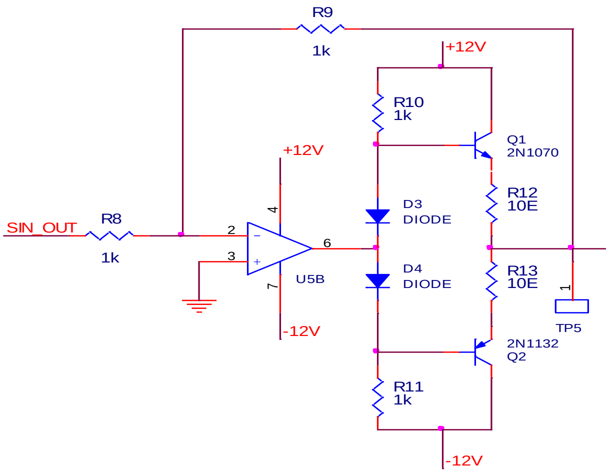

Fig. 2.4: Power Amplifier.

2.1.3. Coupling section

This plays a major role in the transmitter part. This is used for coupling the high frequency signals on to the A.C power line. The sine wave from the square to sine converter will be redirected to this mains coupling interface.

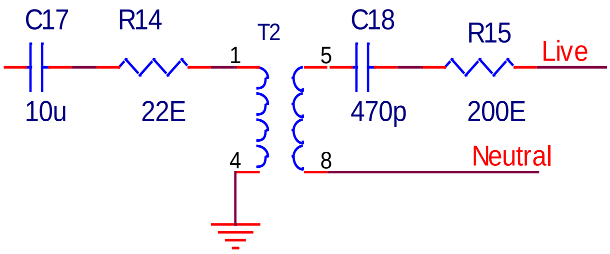

Fig. 2.5: Mains Coupling Interface.

Transformer is used here for isolation from the A.C mains line to the DC side. Coupling to the power line requires some passive components. In the circuit when the high frequency signal (50-70KHz) is given as the input, the capacitor will give the low reactance for these frequencies. And for lower frequencies (let us say 50Hz) it will offer ver high reactance. So at the primary side of the transformer it will allow only high frequency signals. Similarly at the secondary side we use very low capacitance. So that it can allow high frequency signals and those will superimpose onto the 230V AC signal.

2.2. Receiver design

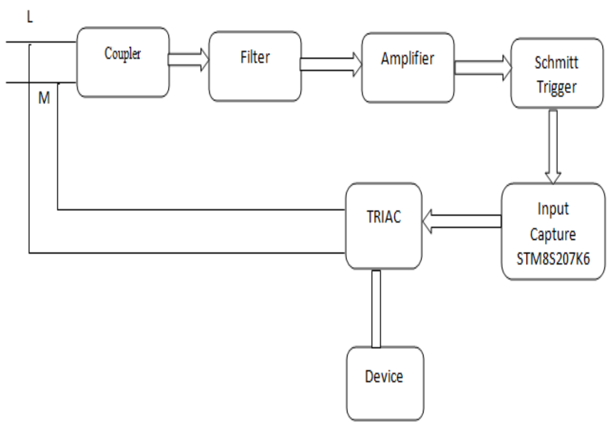

Fig. 2.6: Receiver Block Diagram

In the receiver board the main functional blocks are

1) Coupling Section
2) Band Pass Filter Section
3) Schmitt trigger

4) Microcontroller
5) Trial Section

2.2.1. Coupling Section

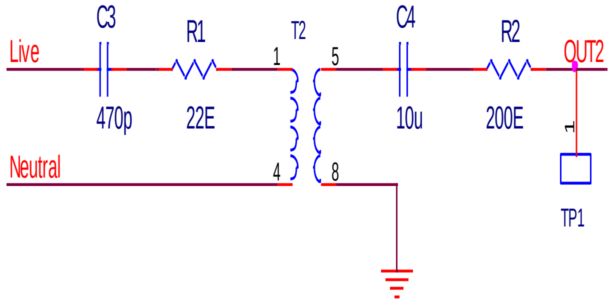

Fig. 2.7: Coupling Section.

This is same as what we used in the transmitter side. Same circuit will be used for receiver also. It will allow only high frequency signals to the DC side. So that the Band Pass Filter can detect the signal from this.

2.2.2. Band pass filter

Band pass Filter function is to allow certain band of frequencies. In the AC mains power lines there are many fluctuations in the voltage. So the noise is very high. After decoupling the signal from the transformer signal consists of noise. And it is unpredictable. To pick out the desired frequency, we need the following section.

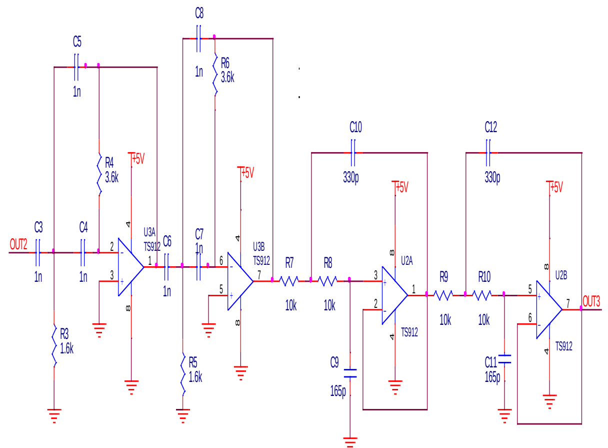

Fig. 2.8: Band Pass Filter.

A four stage band pass filter is designed using four pole high pass filter and a four pole low pass filter. In above figure first two stages are the individual 2-pole high pass filter (Multi feedback filter structure). Last two stages are the two individual 2-pole low pass filter (Sallen-key Filter structure). For designing this BPF we need quad opamp.

2.2.3. Schmitt trigger

For this Schmitt trigger we are giving the input signal from the band pass filter. This Schmitt trigger is converting the sine wave signal to the square wave. The resultant signal from the Schmitt trigger we are giving to the microcontroller. Because, microcontroller will respond to only 1's and 0's.

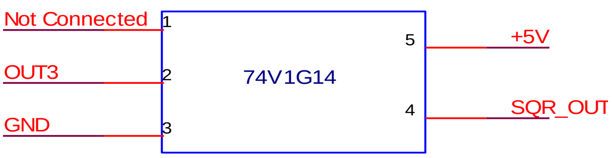

Fig. 2.9: Schmitt Trigger.

2.2.4. Microcontroller

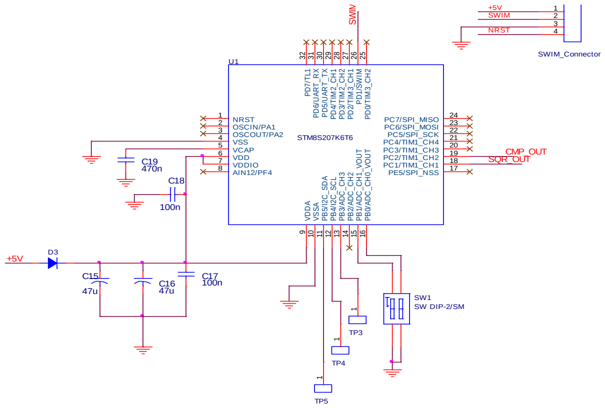

Fig. 2.10: Microcontroller Section – Receiver End.

The function of the microcontroller at the receiver end is to measure the frequency of incoming signal. For this the TIM1 is programmed in Input Capture Mode. With this we can measure the frequency. The TIM1 clock is operating at 16MHz. With reference to this clock frequency the input signal frequency can be measured.

When the measured frequency is equal to the transmitted frequency then, based on that frequency we will get our transmitted data in Manchester code format. From Manchester code we will decode it to our actual data. Then if the transmitted data is belongs to this receiver microcontroller then the GPIO port pin will be enabled/disabled depending upon the previous state of that port. This will be given to the Triac Section.

2.2.5. Triac section

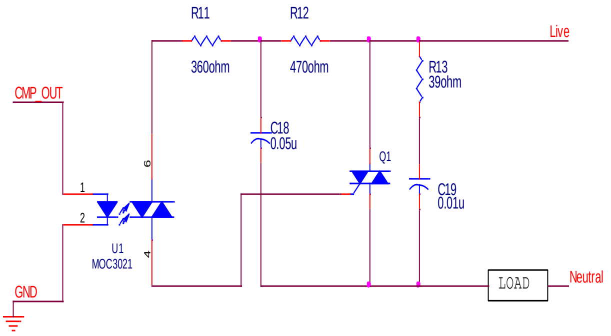

Fig. 2.11: Trialsection.

Triac section will control the loads at the receiver end. The microcontroller output connected to the Opto isolator (MOC3021). For this device at the input side when we apply high voltage, the LED will glow and the TRIAC part at the secondary side of MOC3021 will be on. Then the load will be ON. Similarly when the input to the device is low, the TRIAC will not be active.

3. Simulation results

When the switch is pressed in the transmitter side the microcontroller reads the switch status, and it will take the data which is assigned to that switch. After that we are encoding that data by using Manchester encoding scheme. Now we are modulating this encoded data by using FSK modulation. Finally we will get FSK signal from the microcontroller when switch pressed.

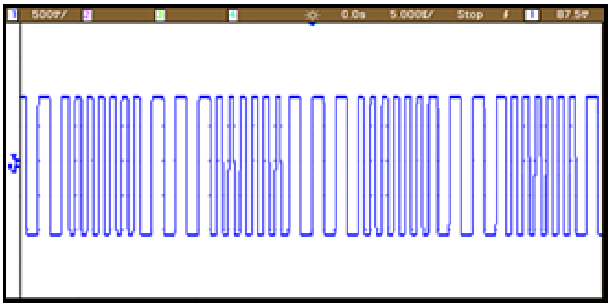

Fig. 3.1:FSK Waveform from Microcontroller.

In AC mains noise will be add more on square waves as compared to sine waves. So we need to convert the above FSK signal into sine wave. For that reason we are using one Low pass Filter to smooth the above wave.

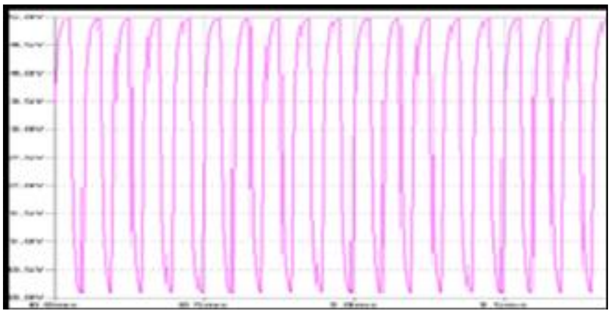

Fig. 3.2: Sine Waveform from Square to Sine Converter.

A Low pass filter is designed in such a way that, to convert square wave to sine wave. For that reason we chose the cut off frequency of the filter lower than the two frequencies of the FSK signal. Using a transformer section we superimposed the sine wave on to the A.C 230V mains power lines. For this transformer we use large capacitance at the primary side compared with the secondary side. Because, this will restrict the 50Hz wave to the secondary side, it will not affect the primary side of the transformer.

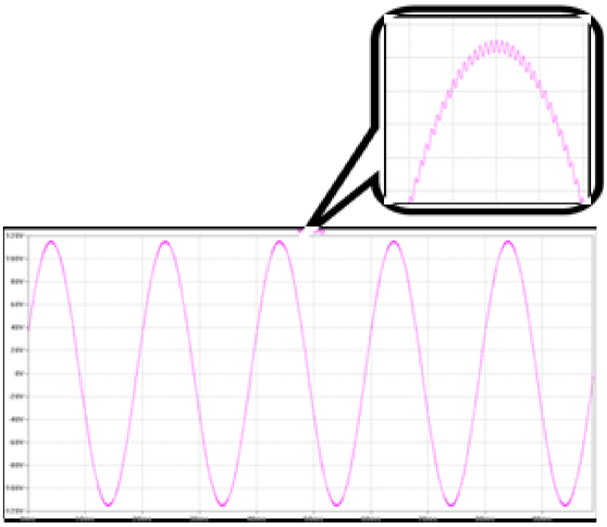

Fig. 3.3:A.C Signal after Superimposing the High Frequency Signal.

4. Conclusion

The actual implementation of the system is to design a power line communication system to transmit the data through the existing power cables. Here we used the FSK modulation, because noise effect is less. When we superimposed the data on to the power lines more noise is added to the actual data because of lot of fluctuations will be in AC mains power supply. By using the band pass filter we picked out the desired signal.

References

[1] Alperen.Mustafa Colak, IIhan Garip, Sevki Demirbas, "Design and Application of a control system for DC motors over power line", Power Electronics and Motion Control Conference and Exposition (PEMC) 2014 16th International, pp, 116-1121, 2014.

[2] Harshad V. Dange, Vamsi K.Gondi "Power Line Communication Based Home Automation and Electricity Distribution Sstem" Published in Process Automation, Control and Computing, 2011 International Conference https://doi.org/10.1109/PACC.2011.5978900.

[3] K.Atukorala D.Wiekoon M.Tharugasini I.Perera C.Silva "Smart eye Integrated Solution to Home Automation security and monitoring through mobile phones" Next Generation Mobile Applications Services and Technologies 2009. Third International Conference, PP.64-69 Sept.2009.

[4] X.iang, .Nguimbis, S.Cheng, H. He,and X.Wu, " A novel scheme for low voltage power line communication signal processing", Int.J.Elect.Power Energy Syst., no.25,pp.269-274,2003.

[5] M.Zimmermann and K.Dostert, "Analsis and modeling of impulse noise in broadband power line communications" IEEE Trans. Electromagn. Compat, vol.44, no, one, pp.249-258, Feb.2002.

[6] C.J.Kim and M.F.Chouikha, "Attenuation Characteristic of high rate home networking PLC signal," IEEE Trans. Power Del., vol. 17, no.4, pp.945-950,oct.2002.https://doi.org/10.1109/TPWRD.2002.803793.

[7] Bal G.,Daedal N.," Design and Implementation of Microcontroller Based Temperature Measurement and Control System Using Power Line Communication", 4th IEEE International Conference on Power Engineering, Energy and Electrical Drivers, Turkey,pp.740-741, 2013.https://doi.org/10.1109/PowerEng.2013.6635848.