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Transmission and Reception Using Power Line Communication

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ABSTRACT:
This paper presents an overview of the research, operation and importance of the power line communication. PLCC, Power Line Carrier Communication, is an approach to utilize the existing power lines infrastructure for the transmission of information. This type of communication has interested several researchers and utilities during the last decade, trying to achieve higher bit-rates and more reliable communication over the power lines. In today's world every house and building has properly installed electricity lines network. By using the existing AC power lines as a medium to transfer the information, it becomes easy to connect the houses with a network access point without installing new wirings. It includes Broadband over Power Lines (BPL) with data rates sometimes above 1 Mbps and Narrowband over Power Lines with much lower data rates. This is a flexible structure which can be upgraded and adapted to future needs.

KEYWORDS: - dual tone multiple frequency (DTMF), transmitter, receiver

INTRODUCTION:

The communication flow of today is very high. Many applications are operating at high speed and a fixed connection is often preferred. If the power utilities could supply communication over the existing power lines, then it would be a vast breakthrough in communication world. Power line communication (PLC), also called mains communication, power line telecoms (PLT), power band or power line networking (PLN) are terms describing several different systems for using power distribution wires for simultaneous distribution of data. The carrier can communicate voice and data by superimposing an analog signal over the standard 50 or 60 Hz alternating current (AC). However an unfavorable noise conditions, changing impedance and fading are the negative properties present in this type of communication [2]. Systems under trial exist today that claim a bit rate of 1Mb/s, but most commercially available systems use low bit rates, about 10-100 Kb/s. Although the application of OFDM (Orthogonal Frequency Division Multiplexing) is fairly applied to power line communication which helps in designing the MODEM for high data rates [1]. Traditionally electrical utilities used low-speed power-line carrier circuits for control of substations, voice communication, and protection of high-voltage transmission lines. A short-range form of power-line carrier is used for home automation and intercoms. This includes the construction of DTMF (Dual Tone Multiple Frequency) encoder circuit for tone transmission and a matching DTMF decoder circuit for its reception. A pair of amplifier circuit is used that convert sound signal to electrical signal using microphone at output stage and tone input. In order to display the data, a seven segment display driver circuit is constructed which take use of BCD to decimal encoder IC's. A power line communication link is used to establish a connection between transmitter and receiver. An approach to multi hop transmission is introduced which is the preferred choice over the end-to-end transmission [3].
This paper gives the overview of operational principle of transmitter and receiver end, advantages, disadvantages and future scope of power line communication.

OPERATIONAL PRINCIPLE:

This implementation includes construction of transmitter and receiver part. A simple block diagram of power line communication is described in fig.1 which depicts the basic components required in building the infrastructure of transmission and reception of signal. These components include matrix keyboard, DTMF encoder/decoder, op-amp, push pull amplifier, step up and step down transformer, coupling transformers, BCD to decimal decoder, mic, speaker, seven segment display etc.

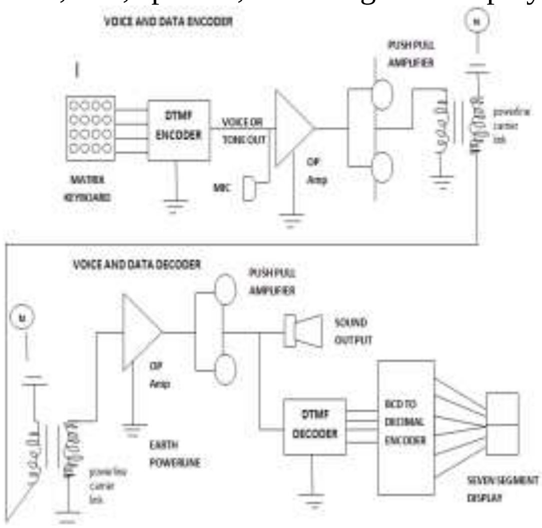

Fig.1 Basic Block Diagram

TRANSMITTER:

Transmitter part mainly consists of DTMF dialer IC UM91214B. This IC is commonly used as a dialer IC in telephones. Its function is to generate the DTMF tones corresponding to the depressed key. This tone is given as input signal to the desired circuit(either Infrared remote or FM transmitter) as shown in the Fig.2. For any depressed key, the corresponding DTMF tone output is available at pin 7 of IC UM91214B. As a 9V battery is used for the remote control unit, however the DTMF dialer IC requires only 3V for its operation, which is derived with the help of zener diode. As in order to maintain the whole circuitry at constant voltage of 12V at output, a voltage regulator IC 7805 is used.

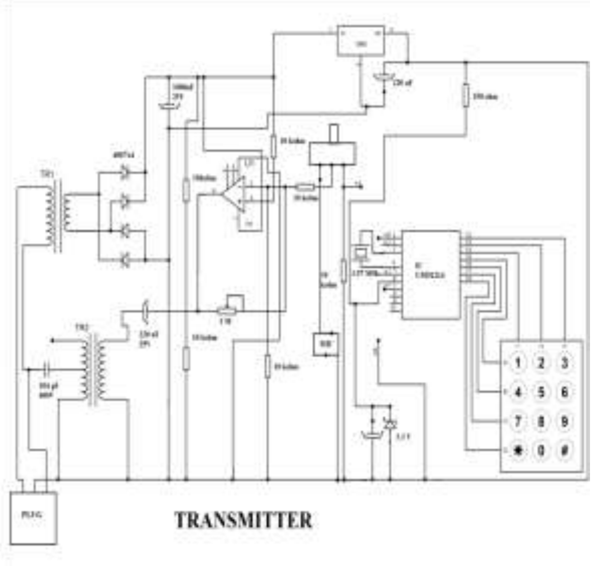

Fig.2 Circuit diagram of Transmitter end

For its time base, the UM91214B requires a quartz crystal of 3.58 MHz, which is connected between pin 3 and 4 of the IC UM91214B to form part of an internal oscillator. The oscillator output is converted into appropriate DTMF signals through frequency division and mixing by control logic. The input is taken from the matrix keyboard. The keyboard interfacing section interfaces the matrix type keyboard with the control logic. Pins 15 through 18 are row pins and pins 12 through 14 are column pins in IC UM91214B. Up to 12 switches are possible with this key array. They represent digits 1 through 9, 0, and symbols * and #. We can easily read the low and high group tones associated with each key pressed from the table

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1.The information is transmitted in the form of these dual band frequencies.

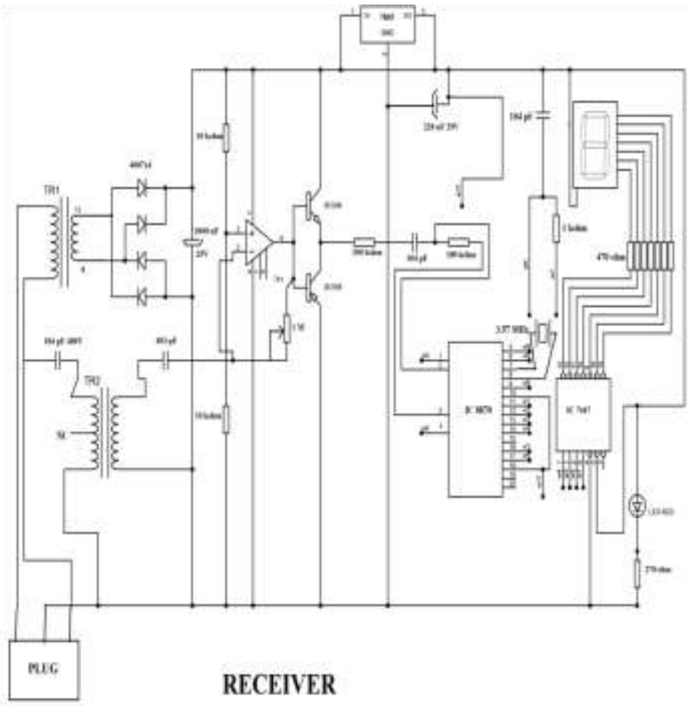
MT8870 OUTPUT TRUTH TABLE

FLOW	FHIGH	KEY	TOE	Q4	Q3	Q2	Q1
697	1209	1	1	0	0	0	1
697	1336	2	1	0	0	1	0
697	1477	3	1	0	0	1	1
770	1209	4	1	0	1	0	0
770	1336	5	1	0	1	0	1
770	1477	6	1	0	1	1	0
852	1209	7	1	0	1	1	1
852	1336	8	1	1	0	0	0
852	1477	9	1	1	0	0	1
941	1209	0	1	1	0	1	0
941	1336	*	1	1	0	1	1
941	1477	#	1	1	1	0	0
697	1633	A	1	1	1	0	1
770	1633	B	1	1	1	1	0
852	1633	C	1	1	1	1	1
941	1633	D	1	0	0	0	0
—	ANY		0	Z	Z	Z	Z

TOE is a three state output-enable input at pin 10 of IC MT8870.
In order to transmit the audio signals, we use the microphone which is connected to the IC 741(op-amp) through a sliding switch. This is highly versatile device which gives a stable amplification with precisely controlled gain characteristics when it is used in negative feedback configuration. In order to make it work in the limited power supply conditions, we take use of class B push pull amplifier which provides an efficient output and have no harmonic oscillations.
This amplified signal is then superimposed over the step up transformer (12V to 220V) by the use of coupling transformer which couples the signal in order to attain a suitable enough frequency (50-60hz). This electrical signal can be transmitted through the AC power lines over a long distance.

RECEIVER:

In order to receive the signal, there should be at least one node present between transmitter and receiver. The implementation of receiver circuit diagram is shown in fig.4. The received electrical signal is then transformed into low voltage by using step down transformer (220v to 12V). This transformed signal is coupled with coupling transformer in order to obtain a constant voltage at the output. Similar to transmitter, class B push pull amplifier is used to provide efficient amplified output having no harmonic oscillations. The output signal will be demodulated by the help of op-amp IC 741 with the reference taken as ground so that the message signal can be extracted.
The desired amplified signal can be either taken as audio output from the speaker or can be passed through the DTMF decoder IC MT8870 to display the data in decimal form. A voltage regulator IC 7805 is present in order to obtain the constant voltage output as the whole circuitry works at 12V.
The MT8870 is a single-chip DTMF receiver IC incorporating switched capacitor filter technology and an advanced digital counting/averaging algorithm for period measurement. The input stage is followed by a low-pass RC active filter, which performs anti-aliasing function. A third-order switched capacitor notch filter then rejects dial tone at 350 and 440 Hz. The signal is still present in its composite form and needs to split into its individual components. This splitting of signal is done by two 6^{th-} order switched capacitor band-pass filters. Each component is smoothed by an output filter and the two resulting rectangular waveforms are then applied to a digital circuit where a counting algorithm measures and averages their periods. An accurate reference clock is provided by quartz crystal of 3.58 Mhz. An Early Steering output is obtained which indicates that two tones of valid frequency have been detected and initiates an RC timing circuit.
If both tones are present for a minimum guard time, then the DTMF signal is decoded and the delayed steering output is raised to indicate that new binary data is available. This binary data available should now be converted into decimal data so as to make it display on the seven segment display. For this, we take use of BCD to decimal converter IC 7447.



RECEIVER

ADVANTAGES:

- Power line communication system has a fine advantage of not having to install wirings for communication as power lines are required regardless, are already distributed throughout buildings.
- Power line communication system is not bothered by huge obstacles between transmitter and receiver unlike wireless technology.
- Data can be transferred from any socket to any socket as long as they share a common earth wire.
- A home network can be created in a matter of seconds with the help of a single transmitter and multiple receivers.
- Power lines are usually the shortest path between transmitting and receiving stations.

DISADVANTAGES:

- Power line communication system is useless if wiring is faulty and fixing a faulty wiring can be expensive.
- Power line communication does not boast a speed in Gigabits like Ethernet but it is on par with speed of wireless technology.
- Both power line communication and wireless have advantages of not needing to install wires but in power line communication, the transmission and receiver modules are still needed whereas in wireless technology there is a single wireless router.
- Noise, impedance changing, fading are the negative parameters which would effect the voice communication.

FUTURE SCOPE:

As power line communication is responsible for providing information in the form of data, voice and video which makes the user free to choose any of the necessary means of communication. The applicability of conventionally used modem makes the transfer of data very reliable. These modems can be installed in the buildings, industries, offices in order to interconnect computers and peripherals. It enables in-vehicle network communication by digital means over direct current (DC) power line. Besides that, a research should be concern and consider avoiding or reducing the attenuation and noise.

CONCLUSION:

Power line communication is a technique that uses the existing power lines for transfer of data. It is an extraordinary alternative for other communication technologies as it bears some advantages over all of them.

This paper depicts the use of power lines for communication by using a set of transmitter and receiver to communicate data and voice. The whole operational principle of both transmitter and receiver is properly explained.

We find that PLC has a very high scope in future and is a brilliant work in progress. It still needs proper guidance but with some improvements it can be the best mode for communication.

We hope that this paper provides a proper understanding of the topic to every reader and gives them a solid impression about the power line communication system.

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