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Power Line Communication

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Abstract: **The main core of this project is the design of a simple, low-cost but high voice quality communication system which uses already installed power line as a communication channel without interrupting power transmission. This will save the cost of channel.**

***Key Word*: Coupling transformer, Power line**

I. INTRODUCTION

Power Line Communications (PLC) is a promising emerging technology, which has attracted much attention due to the wide availability of power distribution lines. PLC is a critical energy control networking technology for Smart Grid, Smart Cities, and Smart Buildings applications. PLC has many advantages over other wired and wireless communication methods. However, PLC technology must overcome some significant technical challenges to be practical.

This project is based on Power Line Communications. Its main objective issending some type of signal over a power line, using modulation or another similar method to transmit the signal over the line, where it can be picked up and demodulated or make usable again by some other method.

We select this project becauseit solves a common problem many people have today, which is sending signals throughout a building without causing mess of wires and which will provide fast and effective fault detection and rectification in case of device failure. Our idea involves replacing the conventional wired up switchboards causing mess of wires and their frequent failure (especially in places like auditorium) with singlettransmitter control panel with full control of all thereby connected devices using single power line cable and thus minimizing wiring costs. This is anexciting project because it is something which is very marketable. Compatibility with existing homes and wiring. This type of system would require no new wiring, and very little technical knowledge to install, since it would simply involve switching ON the transmitter and plugging in to incoming power supply. The complete system is suitable for high-quality transmission of speech or music, and will operate from any AC outlet anywhere on a 5m home site. Frequency response is 20±20,000 Hz and THD are under 2% for speech and music program material. Transmission distance along a power line is at least adequate to include all outlets in and around a suburban home and yard. Whereas many carrier systems operate satisfactorily only when transmitter and receiver are plugged into the same side of the 120±240/V power service line, this system operates equally well with the receiver on either side of the line. The transmitter is plugged into the AC line at a radio or stereo system source. The signal for the transmitter is ideally taken from the MONITOR or TAPE OUT connectors provided on component system Hi-Fi receivers. If these outputs are not available, the signal could be taken from the main or extra speaker terminals, although the remote volume would then be under control of the local gain control. The carrier system receiver need only be plugged into the AC line at the remote listening location. The design includes a 2.5W power amplifier to drive a speaker directly In order to achieve the objective of the project, there are several scopes that have been outlined. The scope of this project includes using, Frequency modulation, frequency demodulation, removing noise from audio signal, amplifying received signal, build hardware for the system, and interface the hardware with different electronics components.

<u>Block diagram:</u>

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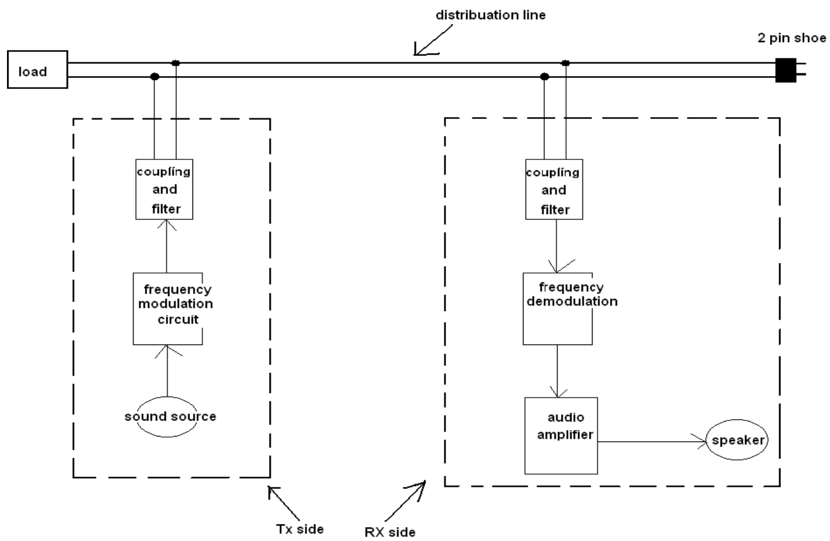
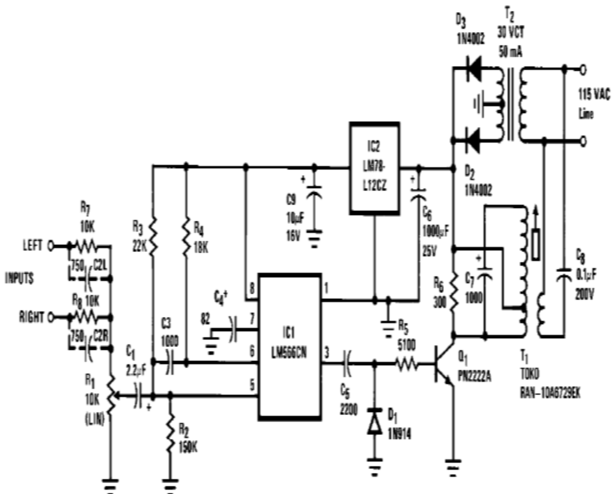


Figure 1: Circuit Diagram and Hardware Implementation



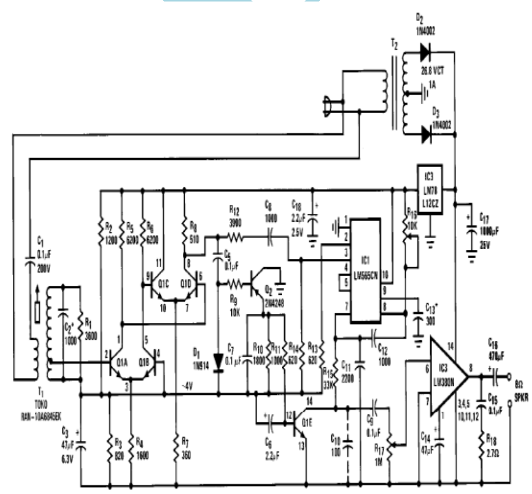


Figure 2: Circuit Diagram for Transmitter Side   Figure 3: Circuit Diagram of Receiver Side

II. WORKING

Two input terminals are provided so that both LEFT and RIGHT signals of a stereo set may be combined for mono transmission to a single remote speaker if desired. The input signal level is adjustable by R1 to prevent over modulation of the carrier. Adding C2 improves the frequency response to 20 kHz as shown in Figure. Although casual listening does not demand such performance, it could be desired in some circumstances. The VCO free-running frequency or carrier frequency fc, determined by R4 and C4 is set at 200 kHz which is high enough to be effectively coupled to the AC line. VCO sensitivity under the selected bias conditions with VS e 12V is about g0.66 fc/V. For minimum distortion, the deviation should be limited to g10%; thus maximum input at pin Ý5 of the VCO is 0.15V peak. A reduction due to the summing network brings the required input to about 0.2V rms for g10% modulation of fc, based on nominal output levels from stereo receivers. Input potentiometer R1 is provided to set the required level. The output at pin Ý3 of the LM566, being a frequency modulated square wave of approximately 6V pk-pk amplitude, is amplified by a single transistor Q1 and coupled to the AC line via the tuned transformer T1. Because T1 is tuned to fc, it appears as a high impedance collector load, so Q1 need not have additional current limiting. The collector signal may be as much as 40±50V pk-pk. Coupling capacitor C8 isolates the transformer from the line at 60 Hz. A Voltage regulator provides necessary supply rejection for the VCO. The power transformer is sized for peak secondary voltage somewhat below the regulator breakdown voltage (30V) with a 120V line.The receiver amplifies, limits, and demodulates the received FM signal in the presence of line transient interference sometimes as high as several hundred volts peak. In addition, it provides audio mute in the absence of carrier and 2W output to a speaker. The carrier signal is capacitive coupled from the line to the tuned transformer T1. Loaded Q of the secondary tank T1C2 is decreased by shunt resistor R1 to enable acceptance of the g10% modulated carrier, and to prevent excessive tank circuit ringing on noise spikes. The secondary of T1 is tapped to match the base input impedance of Q1A. Recovered carrier at the secondary of T1 may be anywhere from 0.2 to 45V p-p; the base of Q1A may see pk-to-pk signal levels from 12 mV to 2.6V. Q1A±Q1D operates as a two-stage limiter amplifier whose output is a symmetrical square wave of about 7V pk-pk with rise and fall times of 100 ns. The output of the limiting amplifier is applied directly to the mute peak detector, but is reduced to 1V pk±pk for driving the PLL detector. The PLL detector operates as a narrow band tracking filter which tracks the input signal and provides a low-distortion demodulated audio output with high S/N. The oscillator within the PLL is set to free-run at or near the carrier frequency of 200 kHz. The free-run frequency is of 1/ (3.7 R16C13). Since the PLL will lock to a carrier near its free-run frequency, an adjustment of R16 is not strictly necessary; R16 could be fixed at 4700 or 5100X. Actually, the PLL with the indicated value of C11 can lock on a carrier within about g40 kHz of its center frequency. However, rejection of impulse noise in difficult circumstances can be maximized by carefully adjusting fo to the carrier frequency fc. Adding C10 e 100 pF will reduce the carrier level fed to the power amplifier. Even though the listener cannot hear the carrier, the audio amplifier could overload due to carrier signal power. A mute circuit is included to quiet the receiver in the absence of a carrier. Otherwise, when the transmitter is turned OFF, an excessive noise level would result as the PLL attempts to lock on noise. The mute detector consists of a voltage doubling peak detector D1Q2C7. The peak detector shunts the 1±2 mA bias away from Q1E without loading thelimiter amplifier. When no carrier is present, the a4V line biases Q1E ON via R10 and R11; and the audio signal is shorted to ground. When a carrier is present, the 7V square wave from the limiter amplifier is peak detected, and the resultant negative output is integrated by R9C7, averaged by R10 across C7, and further integrated by R11C6. The resultant output of about b4V subtracts from the a4V bias supply, thus depriving Q1E of base current. Peak detector integration and averaging prevents noise spikes from deactivating the mute in the absence of a carrier when the limiter amplifier output is a series of narrow 7V spikes. The LM380 supplies 2.5W of audio power to an 8X load. Although this is adequate for casual listening in the kitchen or garage, for hi-fi listening, a larger amplifier may be direct.

III. CONCLUSION

Overall S/N is about 65 dB. Distortion is below about 4% at low frequencies and in actual program material it should not exceed 2% as very little signal power occurs in music above about 1 kHz. The 2.5W audio amplifier provides an adequate sound level for casual listening. The LM380 has a fixed gain of 50. Therefore for a 2.5W max output, the input must be 89 mV. This is slightly less than the g10% deviation level so we are within design requirements. Average program level would run a good 10 dB below this level at 28 mV input. Noise rejection is more than adequate to suppress line noise due to fluorescent lamps and normal line transients. Appliance motors on the same side of the 220V line may produce some noise. Even SCR dimmers produce only a background of impulse noise depending upon the relative location of receiver and SCR. Otherwise, performance is noise-free anywhere in the home. Satisfactory operation was observed in a factory building so long as transmitter and receiver were connected to the same phase of the three-phase service line.

IV. ADVANTAGES OF PLC TECHNOLOGY

PLC is appealing because there is no need to run additional wires to powered devices. PLC can also work where radio frequency (RF) cannot. For example smart meters in the basement of a building basement are unlikely to be able to use RF to communicate with the neighborhood data concentrator. PLC communication on the other hand can traverse the power wires to reach the data concentrator.

For these reasons most utilities around the world have chosen PLC for their smart grid projects, and most cities have chosen PLC for their smart street light projects.

V. APPLICATION

Additional applications other than home music systems are possible. Intercoms are one possibility, with a separate transmitter and receiver located at each station. A microphone can serve as the source material and the system can act as a monitor for a nursery room. Background music may be added to existing buildings without the expense running new wiring.

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VI. FUTURE WORK RECOMMENDATION:

This system has some limitation which can be overcome in future, and can be advanced to fulfill the future requirements. The recommended work for future is:

- Using power line communication for automation (DTMF base)
- Using same power line for data transmission by using different frequencies.
- Using power line communication for automation

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