Power Line Based Intercom

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Abstract

Every building has power line and the main function of this power line is distributing electric energy to your daily electric equipments. So can we use this existing power line as communication network to make an intercom system? Yes we can make it without expense of running new wiring. Further this system can be used as musical distribution system and to monitor the rooms in the buildings.

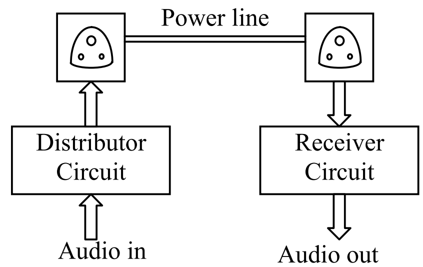
Introduction

To make intercom communication through the existing power line, we need to send our audio signal with the 50 Hz power signal. But can we send our audio signal through the power line without any modification and can we receive that as it is? No because our audio signals frequency is in the range of 20 Hz to 20 kHz, so we can not extract our audio signal from the power signal. Therefore we modify our audio signal to distinguish it from the power signal.

In this power line based intercom project we used Frequency Modulation to separate our audio signal from the power signal. Here the audio signal is modulated with a high frequency carrier and then the modulated signal is injected into the power line through a high pass coupler circuit.

The reason for choosing the Frequency Modulation is, it gives excellent quality signal output and free from noise, whereas intercom uses amplitude modulated carrier gives poor signal to noise ratio. Further PLL detection system used in the FM based intercom gives additional noise rejection.

Power Line Based Intercom circuits and their basic function



The power line based intercom system consist two basic circuits and they are Distributor and Receiver circuits. Distributor circuit is used to modulate our signal into frequency modulated form and to change our modulated carrier signal into desired form. Receiver circuit is used to demodulate our modulated carrier signal which is received from the power line and to filter our audio signal noisy signal.

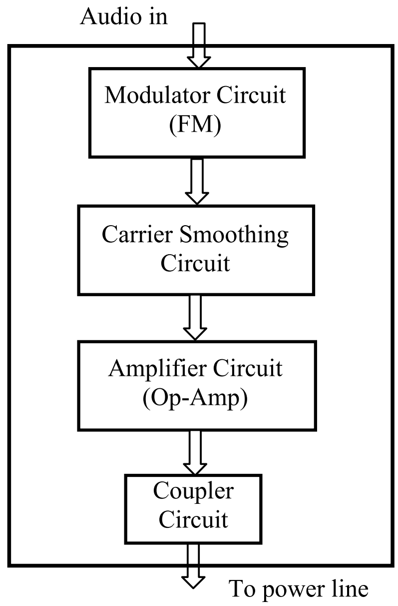
Distributor circuit

Distributor circuit consist four functional units as shown in the receiver functional block diagram.

Frequency Modulator

In this functional unit we use LM566 Voltage Control Oscillator to the frequency modulation. Here VCO generates high frequency square wave carrier and this free running frequency is determined by external resistor and capacitor. The VCO output frequency is linearly proportional to the control voltage i.e. VCO converts voltage to frequency.

External capacitor used in this circuit is fixed (470pF) but external resistor is used with a 10kΩ tune potentiometer control which is used to control the free running carrier frequency. In this circuit we got frequency range minimum of 50 kHz and maximum of 125 kHz by changing this tune potentiometer control.



Distributor functional block diagram

Carrier smoothing

In this circuit modulated carrier signal is changed to desired form i.e. it is smoothed closer to sinusoidal form. This function is dune by IF Transformer with an external parallel capacitor. IFT is a tunable inductance and this IFT and parallel combination is act as a tune filter, so IFT can be tuned to get desired smooth output.

Modulated carrier output from the VCO is switched by a switching transistor across the IFT and this signal is filtered by the IFT combination to get a smooth carrier output.

Regulated Amplifier Circuit

This is amplify modulate carrier signal injected into the power line. In this circuit a 50kΩ tune potentiometer control is used to set the amount of carrier level injected at the power line.

Coupler circuit

This is a high pass filter between the power line and the Distributor and this prevent the power frequency signal (50Hz) to the Distributor Circuit. In this circuit we use pulse transformer (1:1) with a capacitor to prevent 50 Hz low frequency.

Receiver Circuit

This circuit consist six functional units as shown in the Receiver circuit functional block diagram

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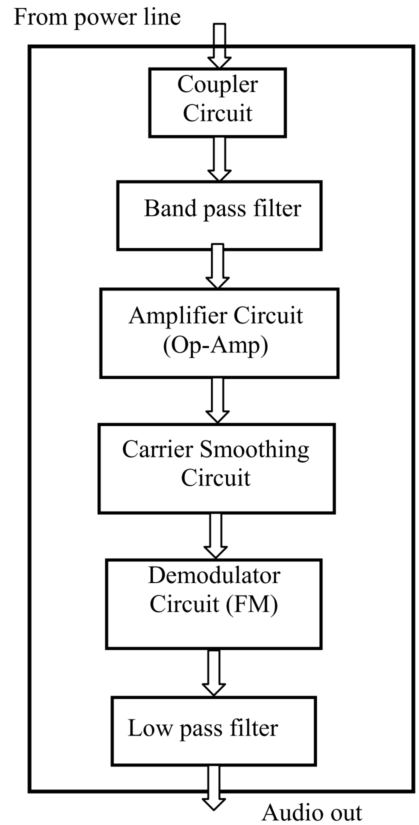

Receiver circuit functional block diagram

Coupler Circuit

This Coupler circuit also same as that used in the Distributor circuit and this also prevent the power signal to Receiver Circuit.

Band Pass filter circuit

This circuit only allows the desired frequency signals i.e. modulated carrier signals and prevent other frequencies such as noises and low frequency that not filtered by the coupler circuit.

Amplifier Circuit & smoothing Circuit

These circuits are same as those used in the Distributor circuits but only the difference is amplifier in this circuit designed without tune potentiometer, so here the amplification is always fixed.

Demodulator circuit

LM565 Phase Locked Loops is used in this circuit to demodulate the modulated signal from the power line. PLL containing a stable, highly linear control Voltage Controlled Oscillator for low distortion FM demodulation, and a double balanced Phase detector with good carrier suppression. In this circuit phase detector and VCO are connected to make a close loop system. Frequency of VCO in PLL is determined by external timing resistor and capacitor i.e. the characteristics of the closed loop system bandwidth, response speed, capture and pull in range can be adjusted with an external resistor and capacitor. Here to the external capacitor is fixed but 10kΩ tune potentiometer control is used with a timing resistor to alter the VCO frequency. So the demodulated output frequencies can be altered by this tune potentiometer.

Low pass filter

This circuit only allows the signal which frequency is less than the maximum of hearable frequency 20 kHz and prevents the other signals. Purpose of this circuit is to prevent the high frequency in the demodulator output.

Tuning the circuits

To receive a better audio signal both Distributor circuit and Receiver circuit should be tuned. To match the sending end and receiving end signal frequency the tune potentiometer controls in the modulator circuit and the demodulator circuit should be tuned. This can be done by sending a particular audio frequency signal into the distributor circuit and tune the potentiometer controls until get the same frequency at the receiving with an oscilloscope. The IF Transformers can be tuned to get better smooth carrier. This can be done by tracing the IFT output in the oscilloscope but here we can do this without any audio signal input.

Conclusion

Power line based intercom system has sophisticated implementation because of every building has electrical network. However this system can be reliable for a 100 m building itself, we can not make sure the audio transmission beyond that building since there would be power transformers along the transmission line which do not permit the high frequency in between.

The electrical appliances which are generating undesirable harmonics such as CFL bulbs, motor drives and also switching ON and OFF process of electrical equipments may disturb our audio transmission.

This system will provide cost effective since our implementation cost is much lower than the expense for running a new wiring network .There for we do not need to reinstall the communication network wires and this prevent unnecessary expenses. Cost of our circuit is less than Rs 2000, in addition power consumption of our circuit is less than 5 Watts

Acknowledgement

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