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Laboratory FM Transmitter Design And Implementation

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Abstract: The main aim of this paper is to present the case study of developing a low power FM Transmitter in the laboratory.

I. INTRODUCTION

Communication system may be the fastest growing technologies in our culture today. Communication simply means the process of sending messages or information from one place to another. In the past, communication was done using signs, fire, drum beats, runners and even carrier pigeons.[2] In modern times, these crude ways of communication have been replaced by electrical communication in which electrical signals are used for communication. Now communication has evolved into telegraphy, telephony, radio, microwave, satellite, mobile, optical and computer communications.FM broadcasting is invented in 1933 by American engineer Edwin Armstrong.

Because of low cost of the equipments for an FM transmitter, leads to rapid growth in the year of world war II. After the 3 years from the war, 600 licensed FM station were broadcasting in the US and, by the end of 1980 there were more than 4,000 stations.[1]

The FM modulation is the technique in which transmission of information over a carrier wave by varying the frequency. This technique is different than AM modulation, in which transmission of information over a carrier wave by varying the amplitude. AM modulation has limited applications due to its poor noise handling capacity. That means due to crowding in AM broadcast band and inability of standard AM receiver to eliminate noise. The tonal fidelity of standard station is purposely limited. Sound quality of FM signal is better than AM signal. But FM signal do not travel as far as AM because they use higher frequencies.

Many radio stations send out both kind of signal. AM may be used for talk show and FM for music. The FM band used is 88MHz to108 MHz. In Japan, the band 76MHz-95MHz is used.

Many commercial Broadcasting high power FM transmitter are available and are being used. This paper presents the process, challenges and limitations observed while developing low power, low cost or low range FM transmitter prototype for the laboratory or as a lab kit.

II. BLOCK DIAGRAM OF PROPOSED SYSTEM

Audio Mixer is used to take in all audio streams (mono and stereo) and combine selected streams for feeding to RF modulator. Streams could be microphones, audio outputs of various devices, audio output of phones etc. RF Oscillator and modulator will generate the radio frequency required for transmission, and will modulate it with audio streams from Audio Mixer. The output power of the oscillator/modulator is generally less than 10 milliwatt. RF Power Amplifier will amplify the output power of the RF Oscillator and modulator to a level above 4W.

The RF Power Amplifier will have a low pass filter at its input to reduce the level of harmonics before amplification. The output of RF Power Amplifier will be the input to low pass filter, which will reduce any harmonics produced by the

RF Power Amplifier. VSWR Meter will be fed by the output of the Low Pass Filter. It will measure the transmitted power and reflected power. The reflected power is a measure of antenna mismatch. the antenna will be fed from output of the VSWR meter, through a co-axial transmission line. Antenna will be matched with the transmission line using a Balun. Antenna will radiate the RF Power in the space.

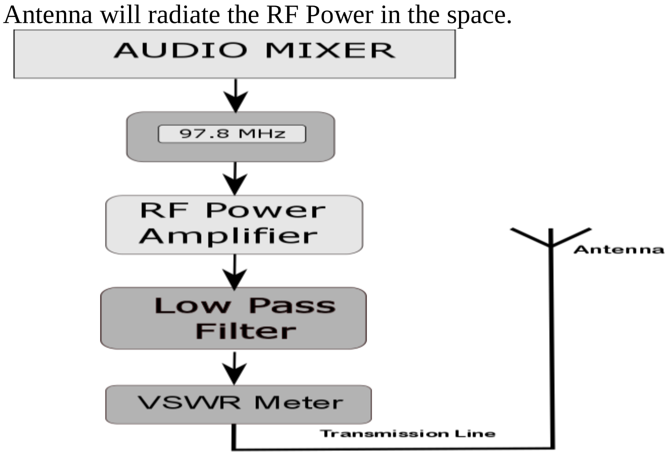

Figure 1: Flow Diagram of FM Transmitter

USES OF FREQUENCY MODULATION

FM is a system by which modulating audio is made to change the instantaneous frequency of the carrier. In AM system the total wave power varies with modulation and the carrier power remains constant, and in an FM system the total power transmitted remains constant and the carrier varies. Various electronics machines and noises cause amplitude disturbance in the transmission of amplitude modulated wave. This makes the reception noisy. So, there is need to reduce noise and frequency modulation is resilient to noise as it has improved signal to noise ratio. One of the needs of frequency modulation is that it does not suffer audio amplitude variations as the signal level varies, and makes FM ideal for use in mobile applications where signal levels constantly vary. As only frequency changes are required to be carried, any amplifiers in the transmitter do not need to be linear. FM system has a greater efficiency than many other modes. The use of non linear amplifiers means that transmitter efficiency levels will be higher.

III. CHALLENGES FACED

The most difficult challenge faced while designing this circuit is availability of components. At the start of designing, we had problem with deciding what type of circuit must be designed – analog or digital? While there are numerous types of circuit and components are available for design, we decided to go for transmitter using discrete components to get in depth knowledge of the working of the FM transmitter. The various components are not available in local market and because of that we continuously had to change our circuit or make changes in circuit we finalized. For simulations, the components are not available in proteus so we cannot simulate the circuit to know its working and try to detect the errors. After that, while actual mounting of circuit on breadboard, the circuit wasn't working properly because of loose connections and also the external disturbances. We tried the circuit on PCB and we got the output. But still there was problem of tuning the amplifier circuit and disturbance in speaker hence we had to put the amplifier circuit in case. For the modulator and oscillator sections, the inductor is most important aspect of circuit and we require the special value inductors which are not available in market and we had to design them ourselves.

IV. WORKING

A. WORKING OF AUDIO AMPLIFIER

The TDA2030 is a monolithic integrated circuit in Pentawatt package, intended for use as a low frequency class AB amplifier. Typically it provides 14W output power (d = 0.5%) at 14V/4W; at ± 14V or 28V, the guaranteed output power is 12W on a 4W load and 8W on a 8W (DIN45500). TheTDA2030 provides high output current and has very low harmonic and cross-over distortion. Further the device incorporates an original (and patented) short circuit protection system comprising an arrangement for automatically limiting the dissipated power so as to keep the working point of the output transistors within their safe operating area. A conventional thermal shut-down system is also included.

The diodes are connected in bridge form the rectifier. Capacitors used after the bridge of diodes are used for filtering purpose. After capacitors we get filtered DC. This DC is given to pin no. 5 and 3 of audio amplifier IC. Resistor is connected to IC TDA2030 are used for closed loop gain settings. The POT connected at pin no. 1 is used for impedance matching between microphone and IC. The POT connected at pin no. 2 is used for volume adjustment. The remaining resistors and capacitors are used for frequency stability and determining upper and lower cutoff frequency. All the value of the resistors and capacitors are between the preferred range given in the datasheet of the audio amplifier IC and ensure the proper operation of the amplifier. The value of all components is determined after lots of trial and error methods to get proper working.

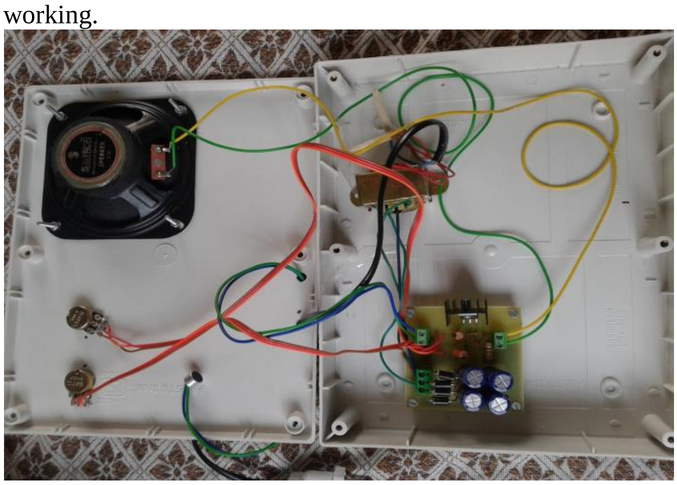

Figure 2: Module of audio Amplifier

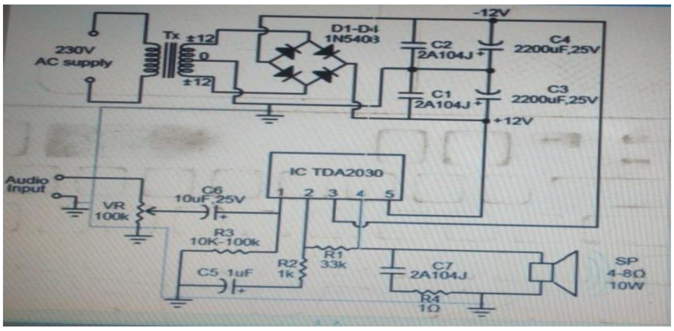

Figure 3: Circuit diagram Audio Amplifier

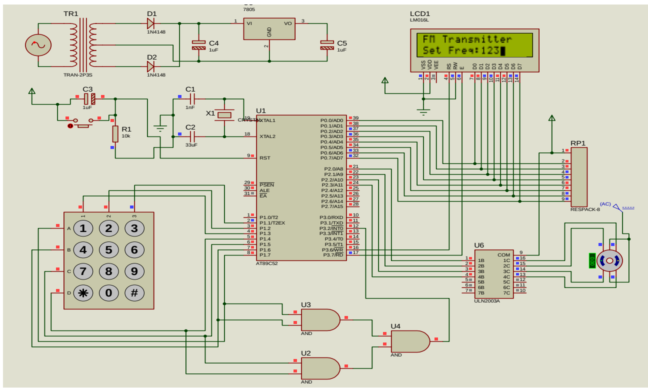

Figure 5: Circuit diagram of Variable Frequency Meter

B. WORKING OF STEPPER MOTOR INTERFACE

Microcontroller AT 89S52 is a central controlling which is programmed to scan decimal number entered from keypad and to save as reference speed and to send number to display. 24MHz crystal is connected to provide the required clock for the microcontroller. 10µF capacitor and 10KΩ is used to provide Power On Reset (POR) for the 89S52 microcontroller. The 3 x 4 keypad module is used with character *, 0 to 9 and # connected to Port 1. The way to enter decimal number is starting from pressing decimal number and then closing by pressing character #. The entered character is scanned with row and column to determined decimal value. The decimal value is saved in RAM and sent to display as reference rotation speed in rpm. The stepper motor four phases, bipolar is connected with microcontroller through IC buffer 2003 to modify TTL voltage from microcontroller into 12 V which is suitable into stepper motor.

Microcontroller send 8 bit of data from accumulator into Port 3 and then only four bit of that data used to turn stepper motor. It will turn stepper motor right if the byte of data in accumulator is rotated left and turn stepper motor left if the byte of data in accumulator is rotated right. The display unit consists of two lines and sixteen columns (2*16) of liquid crystal display (LCD) and is used to display reference and actual speed in rpm. The LCD control pins RS and En is connected to P3.6 and P3.7 of microcontroller while the data D0 to D7 is connected to P0.0 to P0.7.

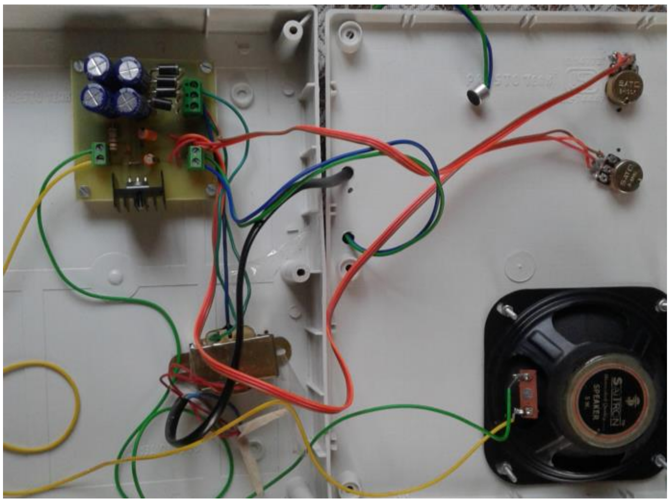

Figure 4: Module of Variable Frequency Meter

C. WORKING OF MODULATOR

This FM transmitter has 3 RF stages. A (VFO) Variable Frequency Oscillator (30mw), a class C drive stage (150 mw) as buffer and a class C final power amplifier.

Basically every FM transmitter has to have a voltage controlled oscillator (VCO). This is a high frequency oscillator whose output frequency changes based on the voltage applied at a particular control point. This is a variable frequency oscillator (VFO). Q1 with is associated components from the VFO. The VFO output is fed to Q2. Q2 being a buffer does not load the VFO but amplifies the power only. This output is fed to the final RF power amplifier Q3, the output of which feeds the tuned circuit. If one feeds the VFO transistor Q1 directly with a microphone at its base, it becomes a FM transmitter circuit.

At V1 at 12 volts DC it will deliver 1 watt RF power. With Yagi antenna, looking like early days of TV antenna with aluminum pipes at both at transmitter and receiver end looking each other at line of sight distance, the range can be up to 5km.

We can also use 70 to 75 cm single wire standing straight as antenna for getting a rage of about 100-200 meters indoor. Similar length telescopic antenna is also can be used. The frequency of transmitter can be set to 88-108 MHz FM band by adjusting the TR (trimmer1) of the VFO or by changing the spacing between coil L1. Higher frequency setting will not work as the BC 547/548 has a low cut off frequency.

Figure 6: Module of FM Modulator

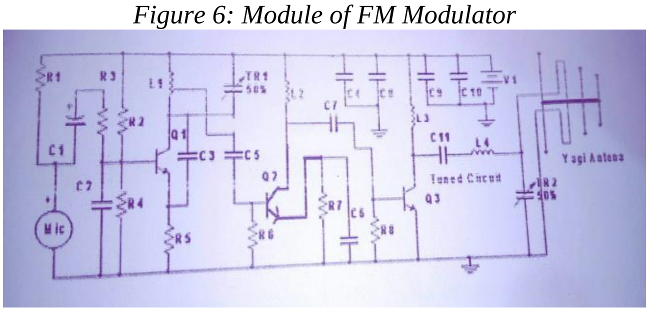

Figure 7: Circuit diagram of FM Modulator

V. CONCLUSION

Study of low power, low range, FM transmitter undertaken and its presented here. It is a workable solution provided specific components are available. If not the discrete components approach needs lot of modification and redesigning. Also there are lot of deviations in the output parameters like frequency and power in this approach and digital /VLSI technology may be tried or recommended.

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