TRANSMITTER FOR PROFESSIONAL MICROPHONE

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Abstract: This project deals with the design of a transmitter in a wireless microphone system, which connects to microphone through the XLR connector. The paper contains description of individual blocks which are necessary for processing and transmitting the signal generated by the microphone, describes methods of frequency modulation using a phase locked loop and compares their advantages and disadvantages. As the last, it deals with the choosing of an antenna and its adjustment to appropriate dimensions.

Keywords: microphone, wireless microphone, transmitter, phase-locked loop, frequency synthesizer, frequency modulation, meander antenna

1. INTRODUCTION

This project deals with the design of a transmitter working in a wireless microphone system. The audio signal from the microphone is transferred by a frequency modulated carrier signal with a frequency of 175 MHz, where a Stage Line TXS 130 wireless system works as a receiver.

The frequency stability of the carrier signal is ensured by the ADF4360-8 integrated circuit, which works as a frequency synthesizer. With the internal voltage controlled oscillator, it represents a phase locked loop and a frequency modulator at the same time. The frequency synthesizer is controlled by an ATtiny26L micro-processor through serial peripheral interface.

Part of the work is also the design of the antenna and developing the source code for the frequency synthesizer control and battery level monitoring.

2. BLOCK DIAGRAM

The block diagram of the designed module is showing in Figure 1, where the individual blocks are connected to a cascade.

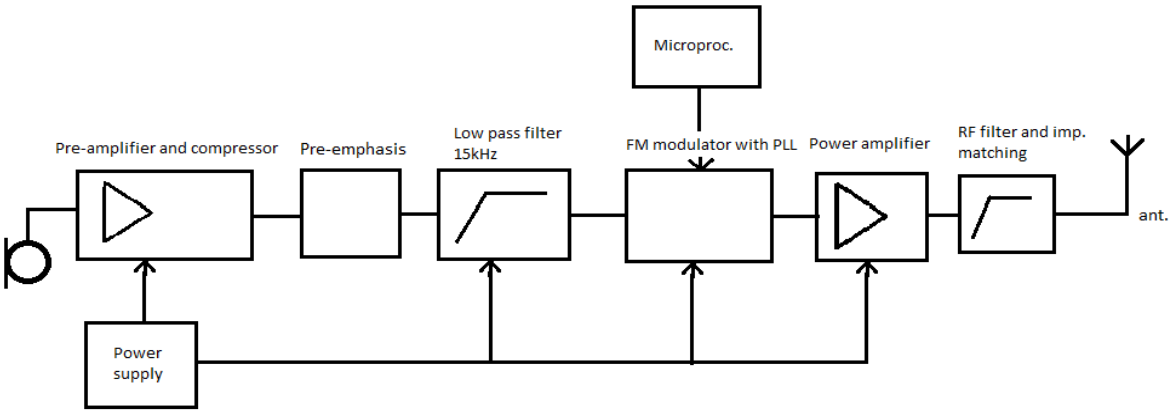

Figure 1: Block diagram

3. TRANSMITTER

3.1. PREAMPLIFIER

The module is connected to the desired electro-dynamic microphone by an XLR connector. The first block in the chain of signal processing is a SSM2166 pre-amplifier produced by Analog Devices. It contains a built-in compressor with adjustable compression ratio, a noise gate and a limiter. The parameters of these parts are easily adjustable by connecting passive components between appropriate pins. This pre-amplifier allows the application of automatic gain control mode by setting the compression ratio to 2:1. This mode can be turned off by a switch, the module then works in normal mode.

The multifunction of the integrated circuit and the easy adjustment of the parameters include one disadvantage, which is the low dynamic range caused by the fix level of the noise gate. The dynamic range does not exceed 50 dB.

3.2. PRE-EMPHASIS

The next block is called pre-emphases. This block attenuates the low frequencies of the transmitted signal. In fact this is a CR circuit with cut-off frequency of 2 kHz. Pre-emphasis is an important part of the transmitter, which prevents the additional distortion caused by overloading the limiter with low frequency components.

3.3. FILTERS

In the next step, a low pass active filter suppresses the frequency components higher than 15 kHz, and an another high-pass passive filter cuts off the frequencies lower than 100 Hz. These parts of the signal are undesirable for further processing.

3.4. PHASE LOCKED LOOP AND MODULATOR

The frequency stability is ensured by a phase locked loop, which works as well as a frequency modulator.

The phase locked loop is made up of an ADF4360-8 frequency synthesizer from the Analog Devices, an internal voltage controlled oscillator (VCO), and further contains a loop filter working as a low-pass filter with a cut off frequency of 100 Hz, which is the lowest frequency component of the audio signal. Phase locked loop tries to set the output frequency to the desired one as fast as possible, and with the low level of the loop filter cut-off frequency, the synthesizer reacts for the slow changes of the audio signal. The disadvantage of this method is the slow reaction time for the changes in the output frequency. However, the module is using only one channel, so it is not causing any problems.

There is a voltage summer connected between the VCO and the loop filter. Its task is to add the voltage level of the control signal obtained from the synthesizer and the modified signal from the microphone. The level of the modified audio signal is set to a defined value, so its peak level causes a 40 kHz step in the output signal of the VCO. The result is a frequency modulated signal with a stable carrier and adjustable output power, which level can be set by programming.

MAR-6+ meets the requirements of a wideband monolithic power amplifier, which works up to 2 GHz. Its only task is amplifying the frequency modulated signal to the desirable level.

3.5. ADJUSTMENTS

The last block before the antenna is an impedance adjusting circuit called Pi match. The circuit matches the impedance and the power between the power amplifier and the antenna, also cuts off the higher harmonic components caused by the non-linear function of the power amplifier.

3.6. MICRO-CONTROLLER

The micro-controller ATtiny26L serves for setting the frequency dividers inside the synthesizer. After turning on the device, the controller sends out 3 data streams to the synthesizer. The data stream contains information for the desired operation of the synthesizer.

Its next task is the battery level monitoring, which is performed with built-in AD converter. After a certain voltage level drop, the micro-controller sends a signalisation to a diode.

The module contains other functions, like a switchable automatic gain control mode, where it controls the compression ratio of the pre-amplifier, and a Mute function, where the gain is set to zero.

3.7. POWER SUPPLY

The whole module is powered by a single 9 V battery. A symmetrical power supply is necessary for the correct function of the operational amplifiers. It is provided by a TLE2426 integrated circuit, which works as a rail-splitter. This component is transforming the 9 V non-symmetrical power supply to 4.5 V symmetrical.

With one piece of AL battery, the module should operate for 10 hours.

4. ANTENNA

The wavelength of the carrier frequency is 1.7 m. In terms of the mobility, using a simple quarter wave antenna is too large, so it is necessary to shrink the dimensions of the antenna. Appropriate choices are like using an electrical prolongation method, or application of a Meander antenna. The second one is a quarter wave antenna spread to a rectangular shape, which is connected to the bottom side of the module. With this application, we get a vertically omnidirectional antenna, and against the normal quarter wave antenna we can save 92% of length.

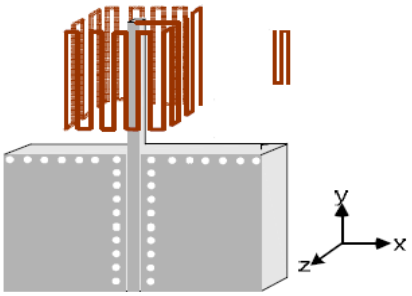

Figure 2: Antenna Meander

5. CONCLUSION

In this project, a transmitter was designed, with whom I am demonstrating the more modern methods of the classic narrowband frequency modulation. My work contains the selection of suitable components, the impedance and power matching of single blocks, finding an appropriate antenna miniaturizing method, the developing of source codes and programming the micro-controller.

The result is a compact module, which enables a simplex communication on the VHF bandwidth. The module works properly only with the correct electro-dynamic microphone and receiver.

The implementation of the module will be completed up to the time of the thesis defense. At this time it is in experimental phase.

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