THE DESINGN OF A SYSTEM BY WHICH SOME OF THE AIR PARAMETERS ARE TRANSMITTED BETWEEN AIR AND THE GROUND STATION USING A MODEL AIRCRAFT

KARA Sadik[*], GUVEN Aysegul[**]
[*]Electronic Engineering Departmant, Engineering Faculty, Erciyes University, 38039, Kayseri, Turkey.
[**]Civil Aviation School, Erciyes University, 38039, Kayseri, Turkey

Keywords: *Radio Telemetri, Temparature Sensing*

Abstract

In the system realized in this study, several air parameters are transmitted between model aircraft and ground station.

System eqipment consists of a model aircraft, a transmitter and a receiver that has got min 4, max 8 channells capable of FM (Frequency Modulation) or PCM (Pulse Code Modulation); a personal computer (PC); an interfacing board capable of converting digital signal into analog signal and vice versa; an FM receiver; temperature sensing circuit; and an FM transmitter capable of sending the information on model aircraft on 74.1MHz frequency band with 0.2 seconds of interval.

Flight and all sorts of movements of model aircraft is controlled from the ground station by radio waves. Temperature information of the air is transmitted to the receiver at ground station by FM transmitter placed on aircraft at 74.1 MHz frequency.

Information sent from the aircraft to the ground station is processed by Delphi software.

1 Introduction

Due to the fact that unmanned vehicles bring some advantages in terms of both acquisition and management costs, compared to manned aircraft, their use in missions which might be risky for men is increasing day by day. Nowadays these aircrafts are used in military/civil exploration-observation, military targets, electronical communication branches, and some different fields[1, 2, 3, 4]. In this study, a model aircraft is used to ensure temperature information in the air to be sent to the ground by radio waves and these parameters are visualized on computer screen at real time.

2 General Circuit Description

2.1 Temperature Sensing and Signal Processing Unit

The system, described in this paper, consist of a temperature sensor, an amplifier unit, an analog to digital convertor (ADC) and a shift register which are placed on the model aircraft. As the model aircraft starts sending temperature signals received by a temperature sensor, these signals are amplified and then digitalized using a 8-bit analog to digital convertor. 8-bit parallel digital data are converted into serial form using a parallel in serial out shift register (74LS165). Shift register converts the input signal into binary coded information of 8 bits, sampling it at 488Hz. Figure-1 shows a block diagram of this system.

In this system, 2 different clock signals are used. The first one is used in

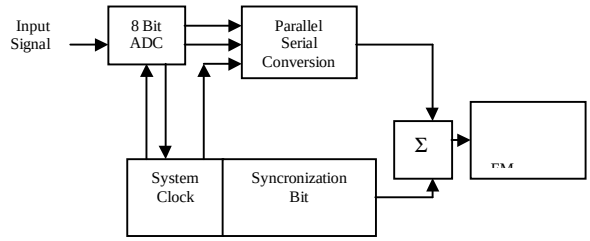


Figure 1. Block Diagram of the System

ADC process (f_{clk1}=3.9KHz), the second one is used in parallel-serial conversion and control logic.

Serial data pulses pass over a resistance and on another resistance syncron pulses arrive at inverting input of the op-amp summation unit. Noninverting input of the op-amp is connected to the GND. Output amplitude is adjusted by the trimpot connected between the output and the inverting pins of the op-amp. Output signal is obtained from the 6th pin of the op-amp and a capacitor is serially connected so that dc level of the output signal shouldn't influence the next signal [5,6,7].

8 bit parallel input signal, converted into digital signals by analog-digital convertor, is kept at the outputs form of until the second 'end the conversion' signal is produced. After the 5th pulse of the second of Johnson Counter (CD4017 National Semiconducter, CA) of the two connected in cascade, the level of the input signal falls from 1 to 0 (Figure-2).

This signal is used as 'system reset' As this signal resets the counter at every 0.2 seconds, all outputs fall to the GND level. Oscilator, being resetted after each conversion prevents phase shifts.

74LS165(recorder shifting from 8 bits' parallel to serial) transmitts 8 bits' information at the input to the output after 8 clock pulses. Composite signal at the output consists of this 8 bits' information and syncronazition bit of 5Hz of second frequency divider (4017). Each bit is represented by a clock pulse. Composite signal is obtained from at output of LM741 summation circuit. This composite signal is transmitted to the receiver by an FM transmitter. Therefore continously

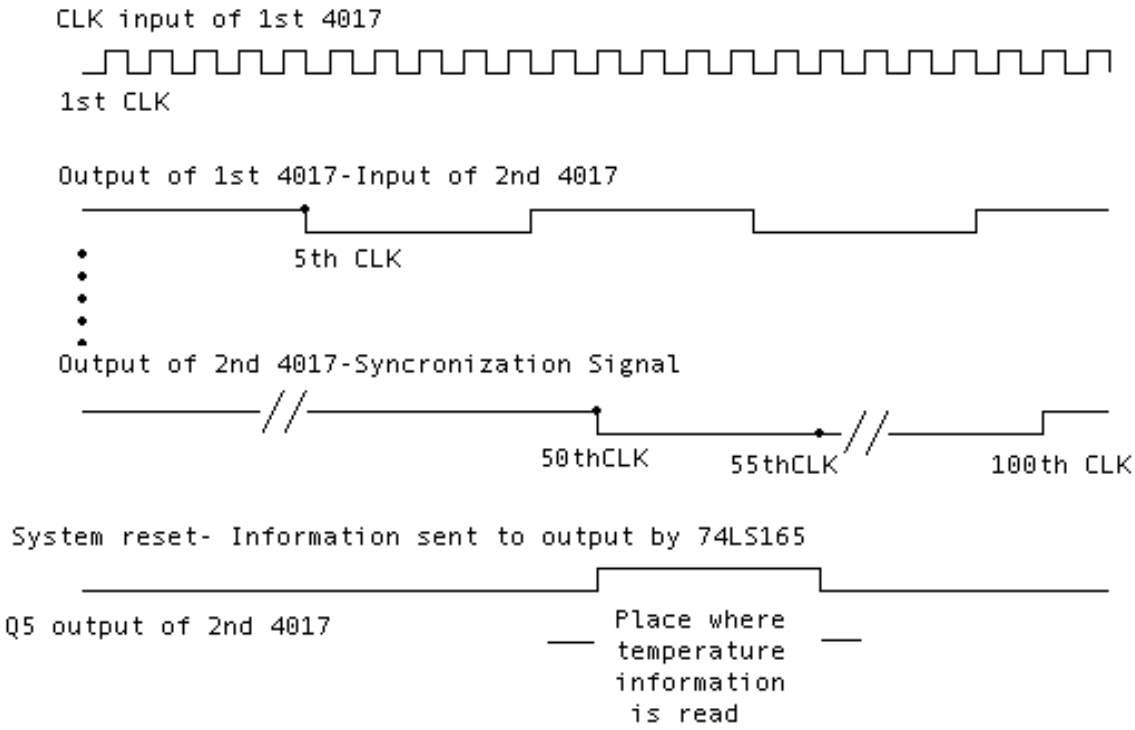


Figure 2.Timing Functions of Signal Processing Unit

changing temperature parameter is received and evaluated on computer at real time.

2.2 FM Transmitter and Receiver Unit

The system consists of a transmitter and a receiver communicating over an FM band (74.1 MHz). Pulse code modulation (PCM) is used in transmitting the signals. Receiver side, consists of an FM radio and a PC. Firstly amplitude of the composite signal, received from the radio, is amplified. Later serially obtained information is applied to the A/D inputs of interfacing board (PCL-711) which is in PC and data and syncronization pulses are seperated from each other by software written. As a result of the transformation of 8 bits' information signal into temperature information it represents, this information is visualized on PC screen at real time[9,10].

The biggest problem encountered in transmitting the signals on FM band is, so many various types of noises mix with the information signal. Suppressing the noise analoguosly by high degree filters causes unwanted changes in the basic structure of the real information.

Signals are received by the receiver unit with the help of the receiver antenna, amplified and then demodulated. Demodulated signal is reamplified and output signal is obtained.

2.2.1 Transmitter Unit

While the receiver and transmitter are designed as crystal controlled in the modulator part of prototype, circuit syncronization is performed by crystal controlled oscilator. So, timing variations of temperature information are obtained in the same way on the receiver side.

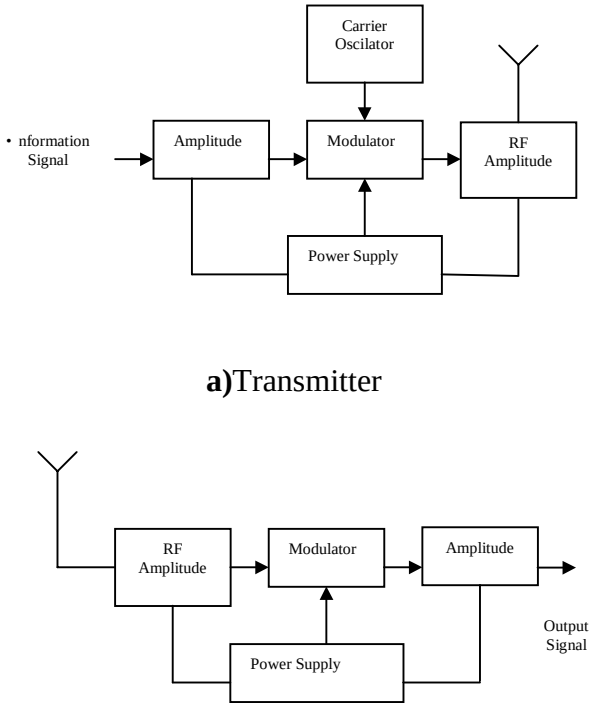
In this study we aimed to transmit signals that have low amplitude and low frequency.

Environment is air, carrier signal is radio waves, modulation types are pulse cod modulation and frquency modulation, broadcasting band is local FM band (74.1MHz), channel number is 1 and transmitter broadcasting distance is around 1000metres in the open field.

Both transmitter and receiver systems have been designed with crystal oscilators and thus phase shifts have been kept at min, which occur between each other in transmitted information.

Phase Locked Loop (PLL) frequency synthesis was used in the used system so modulated signal was transmitted to the receiver side[10,11].

PLL is a negatif feedback system and consists of 3 main components. These are; a loop filter, a multiplier and a voltage controlled oscilator. Converting the temperature information we'll send into digital signal will ensure it to be less affected by the noises in the transfer environment.



a)Transmitter

b)Receiver

Figure 3. Single Channel Radio Telemetri System

2.2.2 Receiver Unit

The noises on the composite signal received from FM radio receiver must be filtered. Noise has both low frequency and high frequency components. Filteration of

the composite signal will make signal processing simpler. Composite signal is clearly obtained by seramic filters consisting of FL1(455KHz) and FL2(10.7MHz). Signal whose amplitude level is amplified to 24Vpp level at amplifier is transmitted to interfacing board [10,11].

Syncronization pulse and thermal heat available in the composite signal obtained are seperated from each other by computer software realized by the use of PCL-711 Intrfacing Board.

3 Software

Temperature information received from FM receiver using PCL-711 interfacing board is processed and managed to be visualized on computer screen at real time.

3.1 Receiving Temperature Information

Data acquisition unit, which is used to transfer temperature information from the receiver to the computer, is provided by PCL-711 interfacing board to be connected to computer equipment.

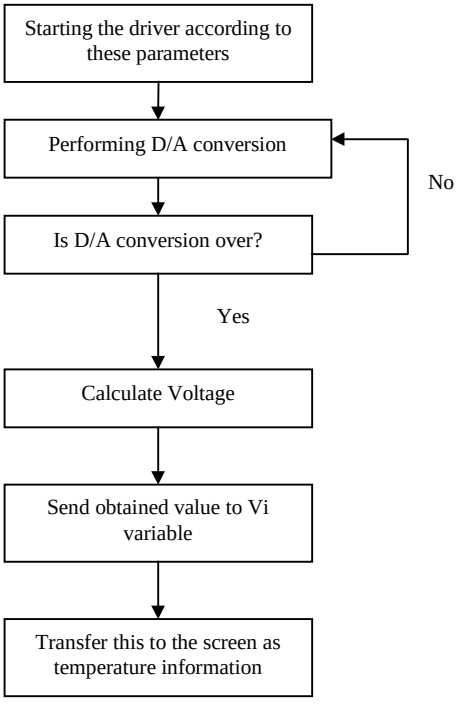


Figure 4. Flow Chart of Program

Here the information from the receiver is applied to the input connector of PCL-711 and new information from the input is ensured to be received with the production of data ready bit (DRDY-Data Rady)

We are able to adjust the conversion time used by Intel-8253 counter/timer on board so that input information can be received. In this study, conversion frequency is adjusted to 2MHz.

At the and of each conversion, ‘end of conversion’ signal (interrupt) is produced and output voltage is calculated according to the input values and this value is sent to Vi variable. By the help of the software used, temperature information matching this variable is visualized on computer screen at real time[12].

4 Results

Today the use of unmanned vehicles is increasing day by day. These aircrafts are used in many fields that are likely to be dangeraus for manned vehicles, also in military exploration and observation.

It is so important to receive various parameters about the aircraft (like temperature, pressure, velocity of the wind) and evaluate them at real time and unmanned vehicless can manage them safely.

In this study the temperature parametres in the air are ensured to be transmitted to the ground by a digital telemetry system.

Model aircraft is controlled by remote control using radio frequencies. In order to prevent the balance problems that are likely to occur in case of being overloaded temperature sensing and FM transmitter unit placed on the aircraft are tried to be kept as light as possible. In addition, in order to prevent the signals representing temperature information from being distorted by the electrical noises spreading from the engine of model aircraft and remote control, analog signal is converted into digital pulses in serial after

temperature receiving process and is sent to transmitter unit. In order to prevent digital signals in serialy representing the temperature information on the receiver's side, from being mixed with each other; temperature information of 8 bits is sent by being placed on a syncronization pulse at a much lower frequency than the frequency itself.

Thermal information on model aircraft which is received from FM receiver and constituted by applying to PCL-711 interfacing board can be visualized on computer screen as real timed by the help of a software.

References

[1] R. C. Michelson, Enabling Technogogy for UAVs, P. 307-311, *ISSC-Seminar Airborn Imaging Systems for UAV's* , Belgium, February 12-13, 1998

[2] H. Eric, K. Isaac and P. Antonio, Development of a Flight Test System for Unmanned Air Vehicles, *IEEE Control Systems*, 19, 55-60, (1999).

[3] D. Edberg, *Dijital Proportional R/C System*, p. 14-30, Dynamic Modelling Co.,USA, 1996.

[4] J. D. Anderson, *Introduction to Flight*, p. 15-67, Mc Graw-Hill International Editions, Singapore, 1989.

[5] National Semiconductor, *National Data Acquisition Databook*, Vol.5, p. 38-46, National Semiconductor Corporation, USA, 1995.

[6] National Semiconductor, *High-Performance Analog and Mixed Signal Product*, Vol.3, p.18,20, National Semiconductor Cop., U.S.A, 1995.

[7] M. M. Mano, *Digital Logic and Computer Design*, p. 276-323, Prentice-Hall Inc., 1984.

[8] D. Alvis, *Microprocessor and Peripheral Handbook*, Vol.2, p. 37-39, Prence Cop.,1989.

[9] National Semiconductor, *Linear Aplications Handbook*, p.125-136 National Semiconductor Cop.,California,1986.

[10] C. F. Coombs, Jr, *Electronic Instrument Handbook*, p.250-267, USA 1995.

[11] Motorola, *Semiconductor Technical Data*, Vol. 8, p. 95-103, Motorolla Inc., Hong Kong, 1995.

[12] Adventech, *PCL-711 PC-LabCard User's Manuel*, Adventech Co., p. 10-87, Taiwan, 1993.