

Electronics Communications Laboratory

Practical Work Session 5

FSK transceiver

5.1 Introduction

The goal of this practice is to implement an FSK transceiver using the DSP TMS320C6713 development boards. The binary source will be the function generator.

5.2 Transmitter interconnection diagram

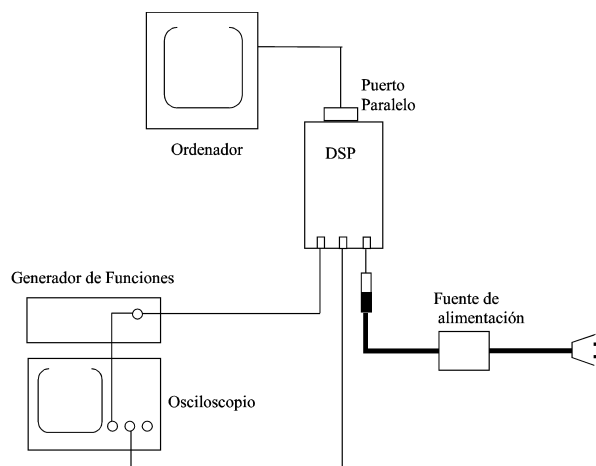


Figure 1 Interconnection of the transmitter's elements

For the first part of this practice, each group will connect the various elements as indicated in Figure 1.

The DSP board is connected to the computer through the parallel port. The DSP output is connected to one of the oscilloscope channels through one of the two BNC/jack connectors. The output of function generator is connected to both the oscilloscope and the DSP input through the BNC T-connector.

CAUTION: DO NOT CONNECT THE OUTPUT OF THE DSP TO THE OUTPUT OF THE FUNCTION GENERATOR

Note: The jack-jack connector is only used in the second part of the practice.

5.3 Combined transmitter and receiver interconnection diagram

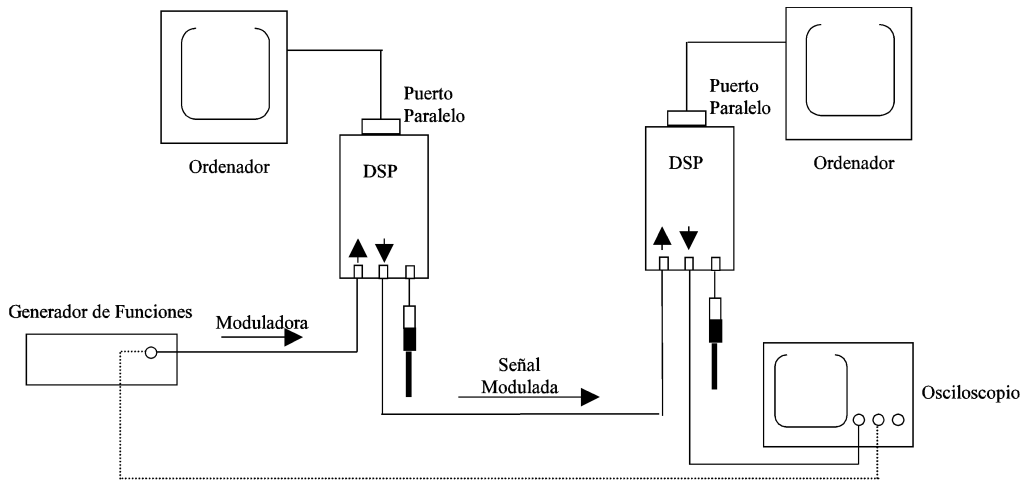


Figure 2 Interconnection of the transmitter and the receiver

The second part of the practical session requires two DSP boards interconnected (one for transmission, one for reception), as shown in Figure 2. The bit source (function generator) is connected to the transmitter board and the FSK-modulated output is displayed in the oscilloscope. The jack/jack cable is used for transmitting the FSK symbols to the receiver board. The receiver board output is connected to the oscilloscope.

CAUTION: DO NOT CONNECT THE OUTPUTS OF THE TWO DSPs, AS THIS WOULD SERIOUSLY DAMAGE THEM

5.4 Practical work

5.4.1 FSK transmitter

The first part of this practice proposes to program an FSK transmitter, whose block diagram is shown in Figure 3.

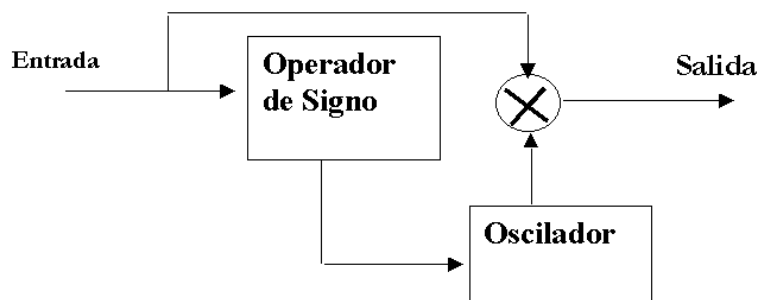


Figure 3 Block diagram of the FSK transmitter

The FSK transmitter output is given by $y(t) = \cos(2 * \pi(f_0 + \Delta f * s[n]))$, where f_0 is the frequency for symbol 0, $s[n]$ is the symbol to be transmitted at discrete-time instant $t=nT$, T is the sampling period.

The carrier frequencies must be set to $f_0 = 10Khz$ for 0 and $f_1 = f_0 + \Delta f = 14Khz$ for 1.

5.4.1.1 Carrier generation

An unstable IIR filter is used to generate the sine wave (Figure 4).

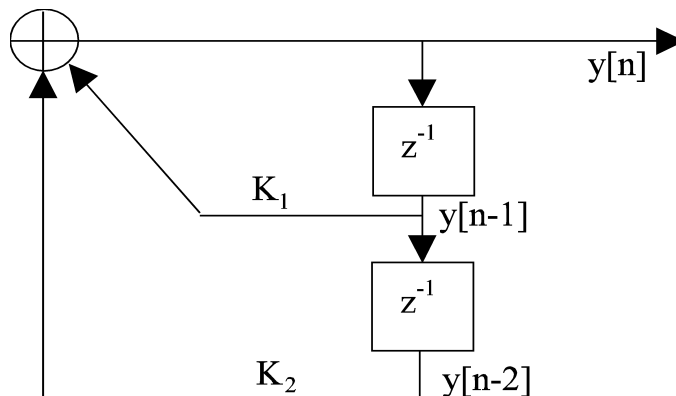


Figure 4 Carrier generation through an unstable IIR filter

If the system shown in Figure 4 is excited with $y[n-1] \neq 0$ or $y[n-2] \neq 0$, the output $y[n]$ is a sine wave. In your code, $y[n]$ should be stored as `sinX` and $y[n-1]$ is stored as `Yminus1`. $K_1 = \text{Coeff}$ and $K_2 = -1$. For FSK transmission, a second carrier should be generated (one carrier frequency per bit value). This second carrier can be easily generated, by simply changing the coefficients.

5.4.1.2 FSK modulation subsystem

- The 16-bit variable A receives the data read from the codec (ADC)
- Extract the sign of variable A using a mask implemented with a logical AND operator. Just like we did in the ASK practice, you need to identify the position in A that stores the sign, and you need to put the remaining bits to zero using the AND operation. The bit that carries the sign information should be preserved.
- Assign one of the two carriers according to the observed/detected bit value (or equivalently the extracted sign).
- Store the result in the output.

Note: Play around with different carrier frequencies.

5.4.2 FSK receiver implementation

Figure 5 shows the block diagram of the considered FSK receiver.

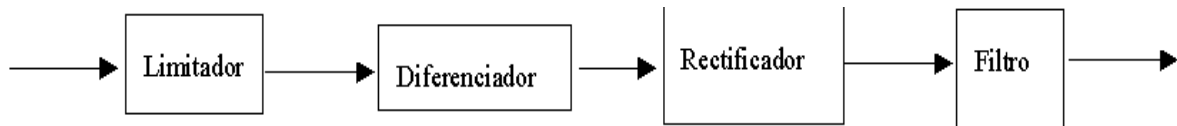


Figure 5 Block diagram of the FSK receiver

The FSK received signal is processed by the following elements:

5.4.2.1 Limiter

The limiter transforms the input into a sequence of 1s and -1s (or zeros).

5.4.2.2 Differentiator

The differentiator extracts the frequency information by subtracting neighbouring samples.

5.4.2.3 Rectifier

The rectifier prepares the previously obtained samples before their subsequent filtering, by taking their absolute value. After the rectifier, the difference between the carrier frequencies will be given by more or less spacing between positive samples.

5.4.2.4 Filtering

The filter calculates the average of the last K (K= number of filter coefficients) samples of the rectified signal.

- a.) Implement a rectangular filter (constant-coefficient filter), which simply takes the average.
- b.) Use a low-pass FIR filter whose cut-off frequency lies between the two carrier frequencies. This way, you will generate an output close to zero if the upper frequency was transmitted. The fir filter coefficients may be generated with the MATLAB function `fir1`.

A program with the following structure should be implemented:

```

* FSK RECEIVER

// Read data from codec register and store in memory
**** Implement ****

// Limiter
**** Implement ****

// Differentiate
**** Implement ****

// Rectifier
**** Implement ****

// Filter
//   stores result in first element of FIR buffer
//   weight and add all elements of FIR buffer
//   shifts elements of FIR buffer

**** Implement ****

// Store result in output
**** Implement ****
  
```