Real Time System

Third Level

Lecture Nine

Questions

RealTime Systems.
Dr. Osama Abbas Hussein

Goals
Up-on completing this lecture, the student should be able to:

1- account for all the topics covered in lectures 1 through 8
2- solid understanding of design questions.

Lec. 1

- What are the ADC, why it's needed and what its application?
- What are the classifications of ADC according to the techniques, explain it in details?
- Draw and explain it in details the process steps of ADC?
- Sine wave signal with voltage range from 0 to 10V, what is the discrete voltage range and output binary equivalent by using 2, 3 and 4 ADC converter?
- Explain in details what is the resolution of ADC and depends on what? What is the effect of high and low resolution on the output signal? How can we get a higher resolution? Assume that an 8 bits ADC is used to digitize a 5V full-scale signal, what is the resolution?
- Explain in details what is the accuracy of ADC and depends on what? What is the effect of high and low accuracy on the output signal? How can we improve the accuracy? Support your answer with drawing.
- What is the aliasing and how can be avoided?

Lec. 2

- What are the types of ADC? Explain in details the (faster or the most accurate … etc.) type (How it work, what it consist of and what does is the Advantages and Disadvantages with draw)?
- Draw and explain in details (How it work, what it consist of and what does is the Advantages and Disadvantages with draw) the (Flash, Delta-Sigma, Dual Slope, Successive Approximation) ADC?
- What are the difference between (Compare between) flash and delta (or any other types)?
- What are the ADC Specifications? Explain it in brief? Also what are the parameters that effect on the ADC errors? How can we avoid it?
- A transducer is to be used to find the temperature over a range of 0 to 100 C. we are required to read and display the temperature to a resolution of +- 1 C. the transducer produces a voltage from 0 to 3v over this temperature range with +-3mv noise. Specify the number of bits in ADC: a) Based on dynamic range. b) Based on required resolutions?

- Assume a 10 bits ADC is used to convert analog signal with V_{in} = 0.6V V_{ref} = 1V, what is the digital value of V_{in}?

Lec. 3

- What is the conversion time and quantization error? Assume an ADC has a conversion time of 100 µs. what is the maximum frequency that can be converted? A 1 Khz sinusoidal signal to be digitized using 8-bit ADC. Find the conversion time that can be used? An analog signal of amplitude 12v is sampled with an 8bit ADC; calculate the maximum and average quantization error?
- What are the DAC, why it's needed and what its application?
- What are the types of DAC? Explain in details the (faster or the most accurate … etc.) type? Support your answer with drawing.
- Draw and explain in details (How it work, what it consist of and what does is the Advantages and Disadvantages with draw) the (Binary Weighted Resistor, R-2R Ladder) DAC?
- What are the difference between (Compare between) Binary Weighted Resistor and R-2R Ladder DAC?
- What are the equations and derivatives of the (Binary Weighted Resistor, R-2R Ladder) DAC? Write it in full details?
- What are the DAC Specifications? Explain it in brief? Support your answer with drawing.
- What are the ADC errors? Explain it in brief? Support your answer with drawing.

Lec. 4

- What are a system, real-time system, response-time of a system, and failure system? What are the Characteristics of RTS?
- What are the terms associated with RTS?
- What are the Types of RTS and compare between them?
- What are the issues in the design of a real time system? Draw the disciplines that impact on real time system?

Lec. 5

- What are the data, signal and transmission?

- Draw and explain in details how can the signal be represented? What is the difference between them? And what it's the purpose of each representation?
- Draw and explain in details the types of the signal? What is the difference between them? And what it's the purpose of each type?
- What is the classification of analog signal and what are the parameters of it? And how the frequency effects on the analog signal? And what are the bit rate and bit internal in digital signal?

Lec. 6

- What is the sensor, and what are the quantities that can be sensed, explain in details?
- What is the transducer? Draw and explain the block diagram of the transducer?
- What are the Characteristics of Transducers? What is the Classification of Transducers? And what are the parameters of the transducer?
- Explain in details the active & passive transducer?
- Draw and explain in details with the advantage and disadvantage the piezoelectric transducer?
- What is the difference between sensor and transducer?

Lec. 7

- What is buffer? And why it's used?
- What is Tri-state buffer? What are its types? Why it's used? Draw an example on it?
- Explain in full details, what is flip-flop? And what is the D – flip-flop?
- What is the difference between buffer and latch? And What is the difference latch and flip flop?

Lec. 8

- Explain in details, what is the 74LS244? What its features? Draw its logic diagram and write its true table? And what are the Absolute Maximum Ratings and Recommended Operating Conditions of it?

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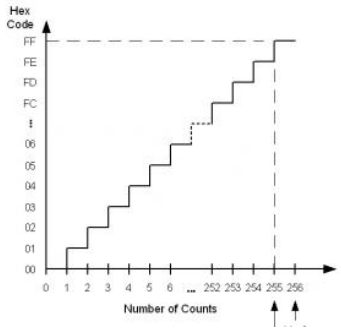
- Explain in details, what is the 74LS374? Draw its logic diagram and write its true table? And what are the Absolute Maximum Ratings and Recommended Operating Conditions of it?
- What is the difference between buffer and driver?
- What are the purposes of Programmable Devices? Or why the Programmable Devices are invented? And what are requirements for a programmable interfacing device?
- Is the 74LS245 programmable or not? If not, can we make it programmable? How?
- How can the processer write into to CR, explain in details with draw?
- Write a program to initialize the 74LS245 as an output buffer and send a byte?
- In the µ-p application, we need registers that can be used as I/O ports, how can we achieve that? Draw and explain in details?
- What is the handshake signal? What is the used of it?
- Draw and explain the steps of input and output data between the peripheral device and µ-p?

General notes

In the design of ADC if said draw the design it means the relation between the analog input and the digital output (linearity)



An ADC and DAC Least Significant Bit (LSB):-

What is an LSB? The LSB is the smallest level that an ADC can convert, or is the smallest increment a DAC outputs. Both converters are used at the boundaries between the analog and digital realms, making it possible for the analog circuits to talk to the digital ones and backwards.

The ADC needs a voltage reference to convert an analog signal into a digital word. Depending on the number of bits it has, the ADC divides the voltage reference in small levels called counts. For example, if this is an 8-bit ADC, the counts will look like those in Figure 1. In an 8-bit ADC there are $2^8 = 256$ counts.

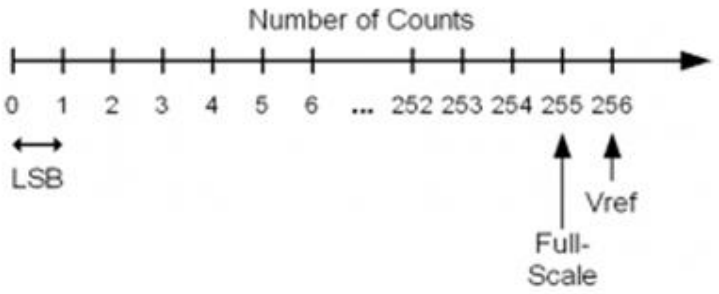


Figure 1

One count is 1 LSB, and is defined as follows:

$$\mathrm{LSB} = \frac{\mathrm{Vref}}{2^N} \tag{1}$$

where N is the ADC's or DAC's number of bits.

For ADCs that have a differential voltage reference, the LSB is

$$\mathrm{LSB} = \frac{\mathrm{Vref}(+) - \mathrm{Vref}(-)}{2^N} \tag{2}$$

where Vref(+) and Vref(-) are the non-inverting and the inverting inputs of the differential voltage reference respectively.

The ADC outputs a digital word that shows how many counts are in its input voltage level. As the ADC counts the input level, it never reaches the voltage reference. Its full scale (FS) is calculated with the following formula:

$$\mathrm{FS} = \mathrm{Vref} - 1 \cdot \mathrm{LSB} \tag{3}$$

After replacing the LSB in equation (3), the ADC full-scale results as in equation (4).

$$\mathrm{FS} = \mathrm{Vref} \cdot \frac{2^N - 1}{2^N} \tag{4}$$

In our 8-bit ADC example, if the voltage reference is Vref = 5V, then the LSB and FS are:

$$\text{LSB} = \frac{\text{Vref}}{2^N} = \frac{5\text{V}}{2^8} = 19.531\ \text{mV and}$$
$$\text{FS} = \text{Vref} - 1\,\text{LSB} = 4.98047\text{V} \quad (5)$$

As you can see, and ADC can never reach its Vref but, as the number of bits is higher, it gets very close to its reference voltage. The same can be said about a DAC.

Moreover, from equation (1), we can write the mathematical relation between Vref and LSB as follows:

$$\text{Vref} = 2^N \cdot \text{LSB} \quad (6)$$

If we replace Vref in equation (3), and after calculations, we can write the definition of the LSB as a function of the ADC's full-scale, as in equation (7).

$$\text{LSB} = \frac{\text{FS}}{2^N - 1} \quad (7)$$

This is the trouble, as the LSB has two definitions, equations (1) and (7). Both of them are valid, and some authors are ambiguous or confused about them. I have seen articles in which Vref is considered the component full-scale, which is the premise that generates subsequent wrong definitions.

Therefore, all one needs to remember about the LSB is its definition, as follows:

$$\text{LSB} = \frac{\text{Vref}}{2^N}, \text{ or}$$
$$\text{LSB} = \frac{\text{FS}}{2^N - 1} \quad (8)$$
$$\text{where FS} = \text{Vref} - 1\,\text{LSB}$$

Resolution = Vref.

Number of resisters in flash type is 2^N

Number of comparators in flash type is 2^N-1

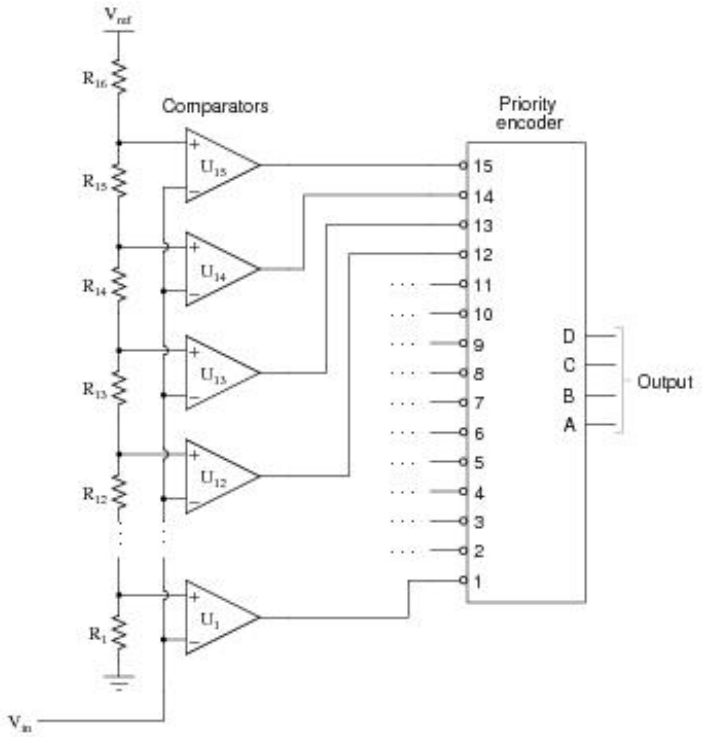
- Assume an AD7823 has 8 bit, if the V_{ref} is 2.5V what is the LSB and FS?

- Design a Binary Weighted Resistor with 4 bits and R 5kΩ and R_F 8kΩ to produces an analog output voltage range from 0v to -15v? or what are the analog outputs?
- Consider the same DAC above. What value of R_F will give the output range -10 V ≤ Vo ≤ 0 V?
- A data acquisition uses a DAC with a range of ±10 V. and a resolution of 0.04 V. How many bits must be present in the DAC?
- How many comparators are needed in a 4-bit flash ADC?
- Predict how the operation of this "flash" analog-to-digital converter (ADC) circuit will be affected as a result of the following faults. Consider each fault independently (one at a time, no multiple faults)?

  Resistor R16 connected to ground.

  Resistor R1 connected to Vref.

  Solder bridge (short) across resistor R14.



- The above "flash" ADC circuit has a problem. The output code jumps from 0000 to 1111 with just the slightest amount of input voltage (Vin). In fact, the only time it outputs 0000 is when the input terminal is slightly negative with reference to ground. Identify at least one possible component faults that could cause this problem?

Real Time System

Third Level

Lecture Ten

8155/8156 Multipurpose Programmable Devices

RealTime Systems.
Dr. Osama Abbas Hussein

Goals
Up-on completing this lecture, the student should be able to:

1- Identify the concepts behind programmable devices
2- Utilize the programmable devices into the RT designs.