ANALOG-TO-DIGITAL (ADC) & DIGITAL-TO-ANALOG (DAC) CONVERTERS
Many events monitored and controlled by the microprocessor are analog events.

- These range from monitoring all forms of events, even speech, to controlling motors and like devices.

These devices are used to interface the microprocessor to the analog world.

The DAC0830 Digital-to-Analog Converter

- A fairly common and low-cost digital-to-analog converter is the DAC0830. (National Semiconductor Corp.)
- An 8-bit converter that transforms an 8-bit binary number into an analog voltage.
- Other converters are available that convert from 10-, 12-, or 16-bit binary numbers into analog voltages.
The DAC0830 Digital-to-Analog Converter

- The number of voltage steps generated by the converter is equal to the number of binary input combinations.
  - an 8-bit converter generates 256 voltage levels
  - a 10-bit converter generates 1024 levels
The DAC0830 Digital-to-Analog Converter

- The DAC0830 is a medium-speed converter that transforms a digital input to an analog output in approximately 1.0 µs.

- The device has eight data bus connections for the application of the digital input code.

- Analog outputs labeled IOUT1 & IOUT2 are inputs to an external operational amplifier.

- Because this is an 8-bit converter, its output step voltage is defined as \(-V_{\text{REF}}\) (reference voltage), divided by 255.
  - the step voltage is often called the resolution of the converter. For $V_{\text{REF}}=-5.1\text{v}$, find the output for 10010010
The DAC0830 Digital-to-Analog Converter
The DAC0830 Digital-to-Analog Converter

- This device contains two internal registers.
  - the first is a holding register
  - the second connects to the R–2R internal ladder converter
- The two latches allow one byte to be held while another is converted.
- The first latch is often disabled and the second for entering data into the converter.
- Both latches within the DAC0830 are transparent latches.
  - when G input is logic 1, data pass through
  - when G input becomes logic 0, data are latched
The DAC0830 Digital-to-Analog Converter

- The output of the R–2R ladder within the converter appears at IOUT1 and IOUT2.
- These outputs are designed to be applied to an operational amplifier such as a 741 or similar device.
Example: Connecting the DAC0830 to the Microprocessor.

- The DAC0830 is decoded at I/O port address 20H.
  - when an OUT 20H,AL instruction is executed, contents of data bus connections AD0–AD7 are passed to the converter in the DAC0830
The ADC080X Analog-to-Digital Converter

- A common, low-cost ADC, compatible with a wide range of microprocessors.
  - while there are faster ADCs available with more resolution, this device is ideal for applications that do not require a high degree of accuracy

- ADC080X requires up to 100 µs to convert an analog input voltage into a digital output code.

- To operate the converter, the WR pin is pulsed with CS grounded to start the conversion process.
The ADC080X Analog-to-Digital Converter

- timing diagram shows the interaction of the control signals.

- If a time delay is used that allows at least 100 µs of time, there is no need to test INTR pin.

- Another option is to connect the INTR pin to an interrupt input, so when the conversion is complete, an interrupt occurs.
The ADC080X Analog-to-Digital Converter

- Before ADC0804 can be connected, the two analog inputs must be understood:
  - VIN(+) and VIN(−)

- These differential inputs are summed by the operational amplifier to produce a signal for the internal analog-to-digital converter.

- These inputs are connected to an internal operational amplifier.
The ADC080X Analog-to-Digital Converter

- **Generating the Clock Signal**: ADC0804 requires a clock source to operate.
  - It can be an external clock applied to CLK IN pin or can be generated with an RC circuit.
  - Permissible range of clock frequencies is 100KHz-1460 KHz.
  - Desirable to use a frequency as close as possible to 1460 KHz so conversion time is minimized.

- If generated with an RC circuit, CLK IN and CLK R pins are connected to an RC circuit.
The ADC080X Analog-to-Digital Converter

- ADC0804 interfaced to an 8086
  - VREF is not attached to anything, which is normal
The ADC080X Analog-to-Digital Converter

- ADC0804 interfaced to an 8086

; A procedure that reads data from the ADC and returns it in AL.

; ADCX PROC NEAR

    OUT 40H, AL ; start conversion

ADCX1:

    IN AL, 42H ; read INTR
    TEST AL, 80H ; test INTR
    JNZ ADCX1 ; repeat until INTR = 0
    IN AL, 40H ; get ADC data
    RET

ADCX ENDP
Using the ADC0804 and the DAC0830

- This illustrates an example using an ADC0804 and a DAC0830 to capture and replay audio signals or speech.

- A speech synthesizer has been used in the past to generate speech, but quality was poor.

- For human quality speech, we can use an ADC0804 to capture an audio signal and store it for later playback through a DAC0830.
Using the ADC0804 and the DAC0830

Address Decoder
20H
Using the ADC0804 and the DAC0830

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