ANALOG-TO-DIGITAL (ADC) & DIGITAL-TO-ANALOG (DAC) CONVERTERS
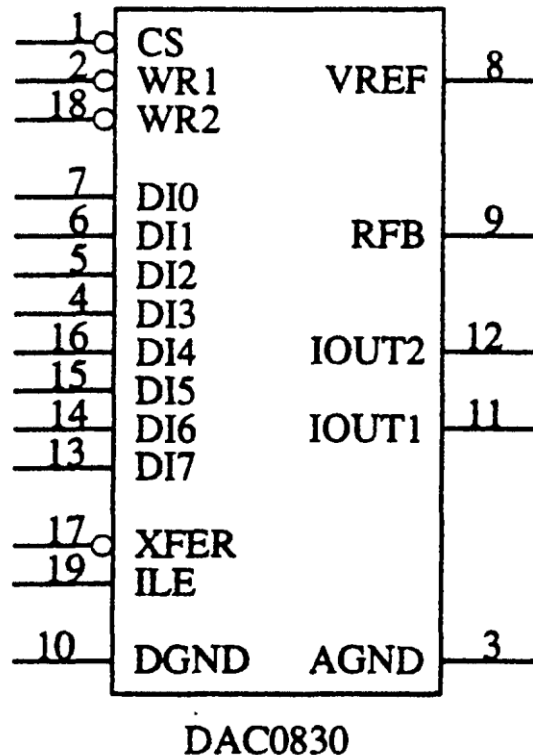
ADC & DAC CONVERTERS

➤ *Many events monitored and controlled by the microprocessor are analog events.*

- o 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**

- o A fairly common and low-cost digital-to-analog converter is the DAC0830. (National Semiconductor Corp.)

- o An 8-bit converter that transforms an 8-bit binary number into an analog voltage.

- o Other converters are available that convert from 10-, 12-, or 16-bit binary numbers into analog voltages.

ADC & DAC CONVERTERS

➤ **The DAC0830 Digital-to-Analog Converter**

o The number of voltage steps generated by the converter is equal to the number of binary input combinations.

  o an 8-bit converter generates 256 voltage levels

  o a 10-bit converter generates 1024 levels

DAC0830

ADC & DAC CONVERTERS

➤ **The DAC0830 Digital-to-Analog Converter**

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

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

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

o Because this is an 8-bit converter, its output step voltage is defined as –VREF (reference voltage), divided by 255.

    o the step voltage is often called the resolution of the converter. For VREF=-5.1v, find the output for 10010010

ADC & DAC CONVERTERS

➢ **The DAC0830 Digital-to-Analog Converter**
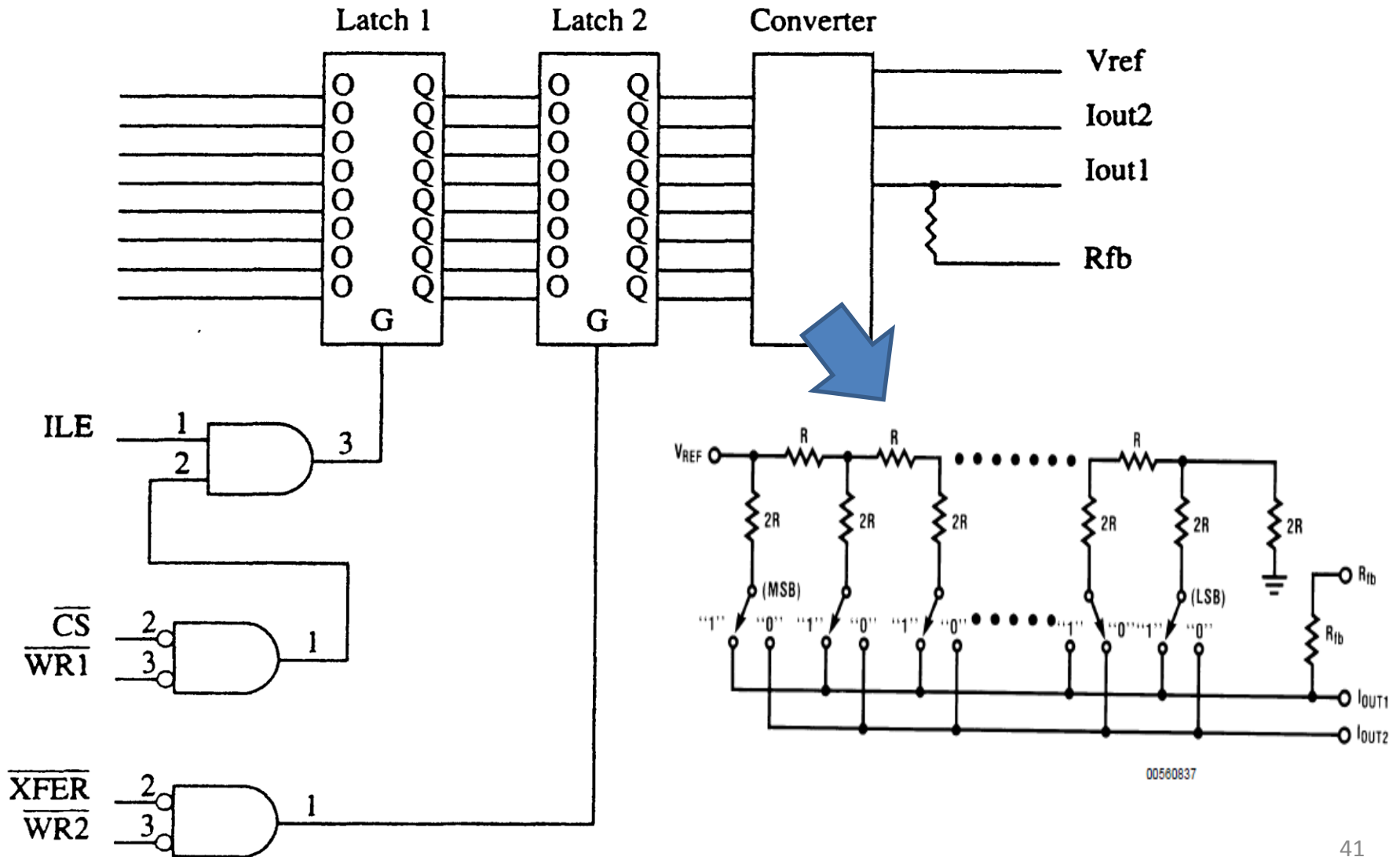
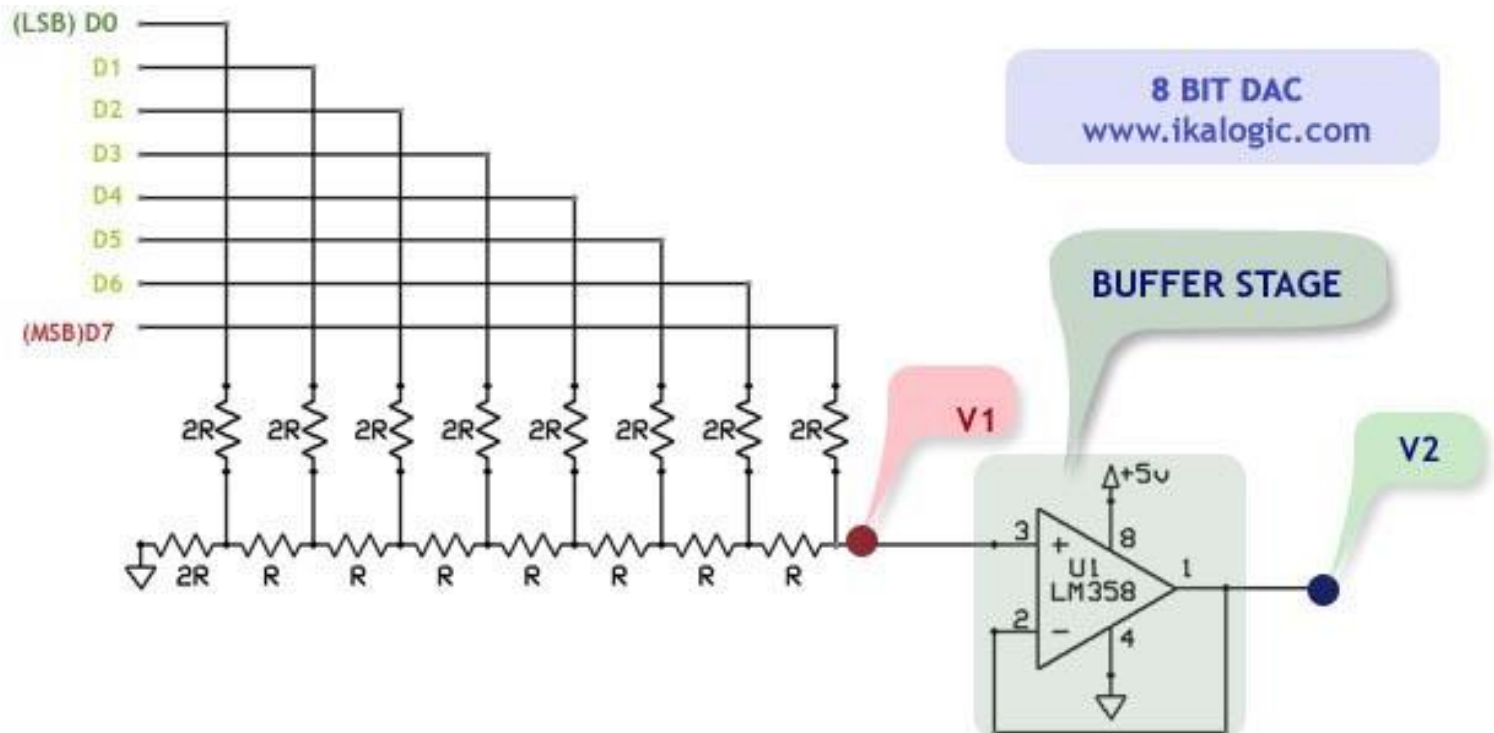# ADC & DAC CONVERTERS

➢ **The DAC0830 Digital-to-Analog Converter**

- o This device contains two internal registers.
    - o the first is a holding register
    - o the second connects to the R–2R internal ladder converter

- o The two latches allow one byte to be held while another is converted.

- o The first latch is often disabled and the second for entering data into the converter.

- o Both latches within the DAC0830 are transparent latches.
    - o when G input is logic 1, data pass through
    - o when G input becomes logic 0, data are latched

ADC & DAC CONVERTERS

➤ **The DAC0830 Digital-to-Analog Converter**

o The output of the R–2R ladder within the converter appears at IOUT1 and IOUT2.

o These outputs are designed to be applied to an operational amplifier such as a 741 or similar device.

ADC & DAC CONVERTERS

➢ *Example: Connecting the DAC0830 to the Microprocessor.*

o The DAC0830 is decoded at I/O port address 20H.

   o when an OUT 20H,AL instruction is executed, contents of data bus connections AD0–AD7 are passed to the converter in the DAC0830
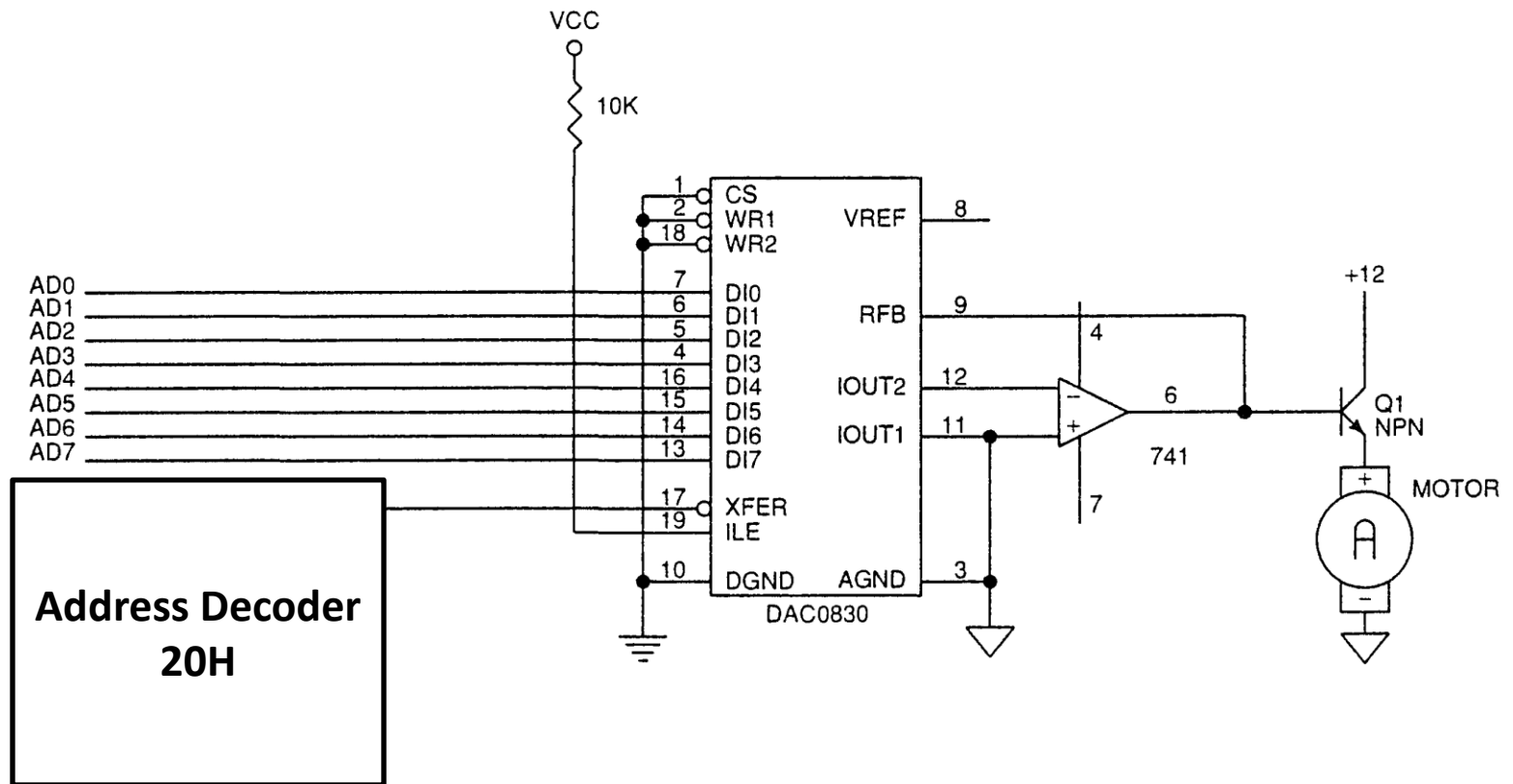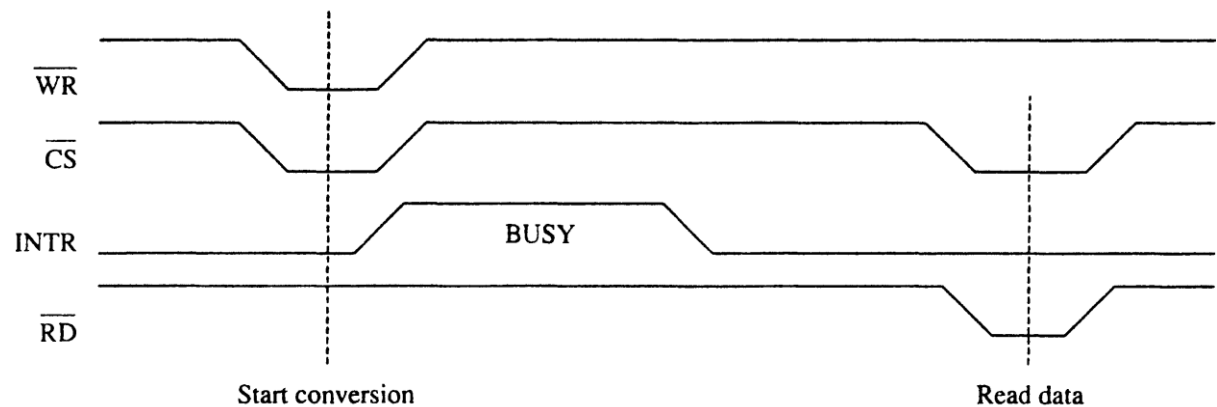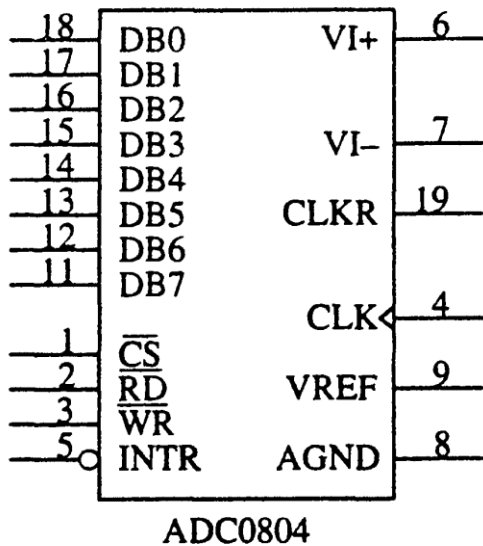
ADC & DAC CONVERTERS

➤ **The ADC080X Analog-to-Digital Converter**

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

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

- o To operate the converter, the WR pin is pulsed with CS grounded to start the conversion process.

ADC & DAC CONVERTERS

➤ **The ADC080X Analog-to-Digital Converter**

o timing diagram shows the interaction of the control signals.

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

o Another option is to connect the INTR pin to an interrupt input, so when the conversion is complete, an interrupt occurs.

ADC & DAC CONVERTERS
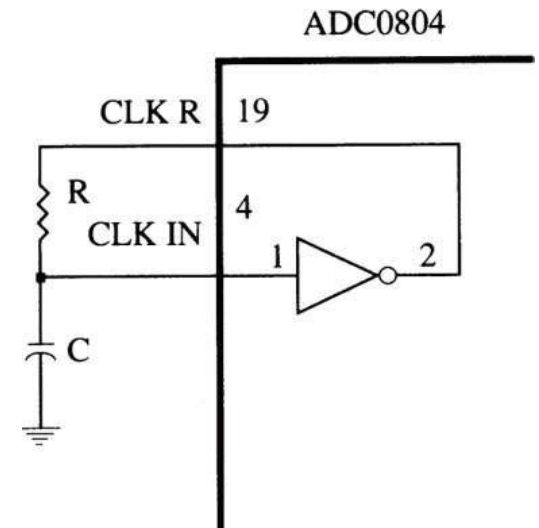
➢ **The ADC080X Analog-to-Digital Converter**

- 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
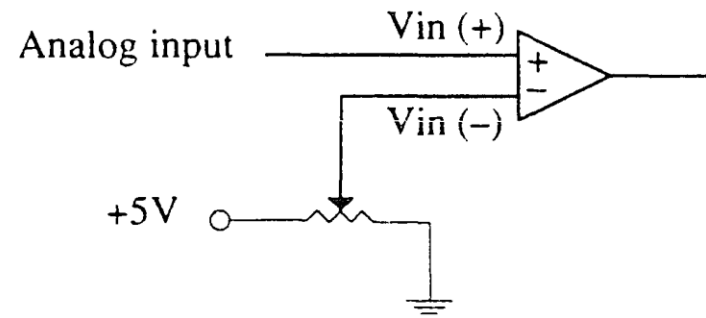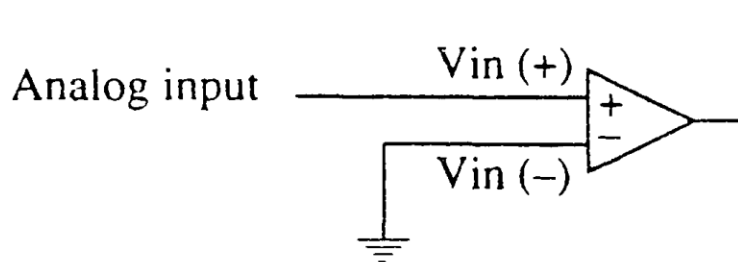
ADC & DAC CONVERTERS
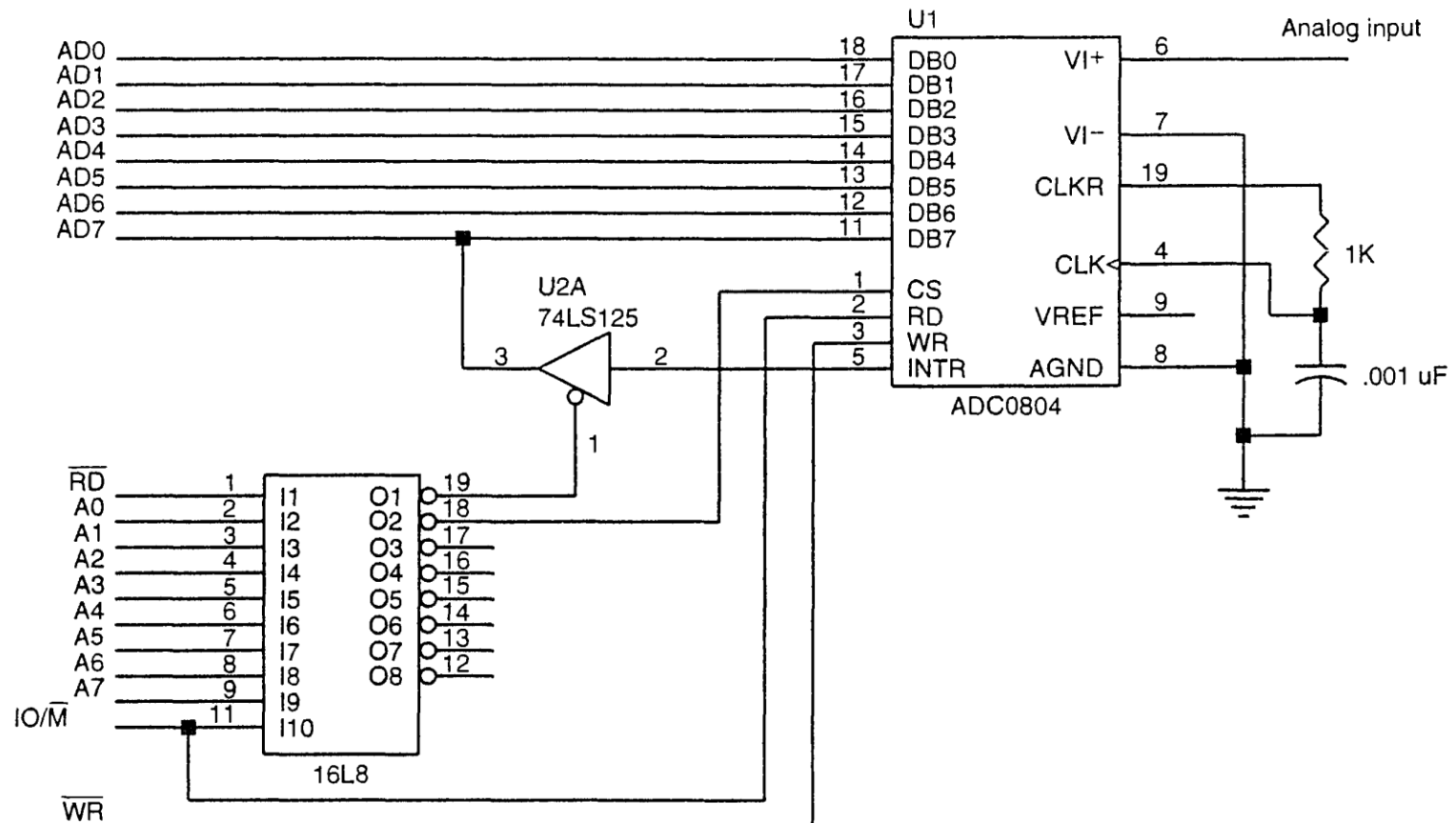
➢ **The ADC080X Analog-to-Digital Converter**

- o ***Generating the Clock Signal:*** ADC0804 requires a clock source to operate.

- o It can be an external clock applied to CLK IN pin or can be generated with an RC circuit.

  - o permissible range of clock frequencies is 100KHz–1460 KHz.

  - o desirable to use a frequency as close as possible to 1460 KHz so conversion time is minimized

- o If generated with an RC circuit,

  CLK IN and CLK R pins are connected

  to an RC circuit

ADC & DAC CONVERTERS

➢ **The ADC080X Analog-to-Digital Converter**

    o ADC0804 interfaced to an 8086

        o VREF is not attached to anything, which is normal

ADC & DAC CONVERTERS

➢ **The ADC080X Analog-to-Digital Converter**

o 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
```
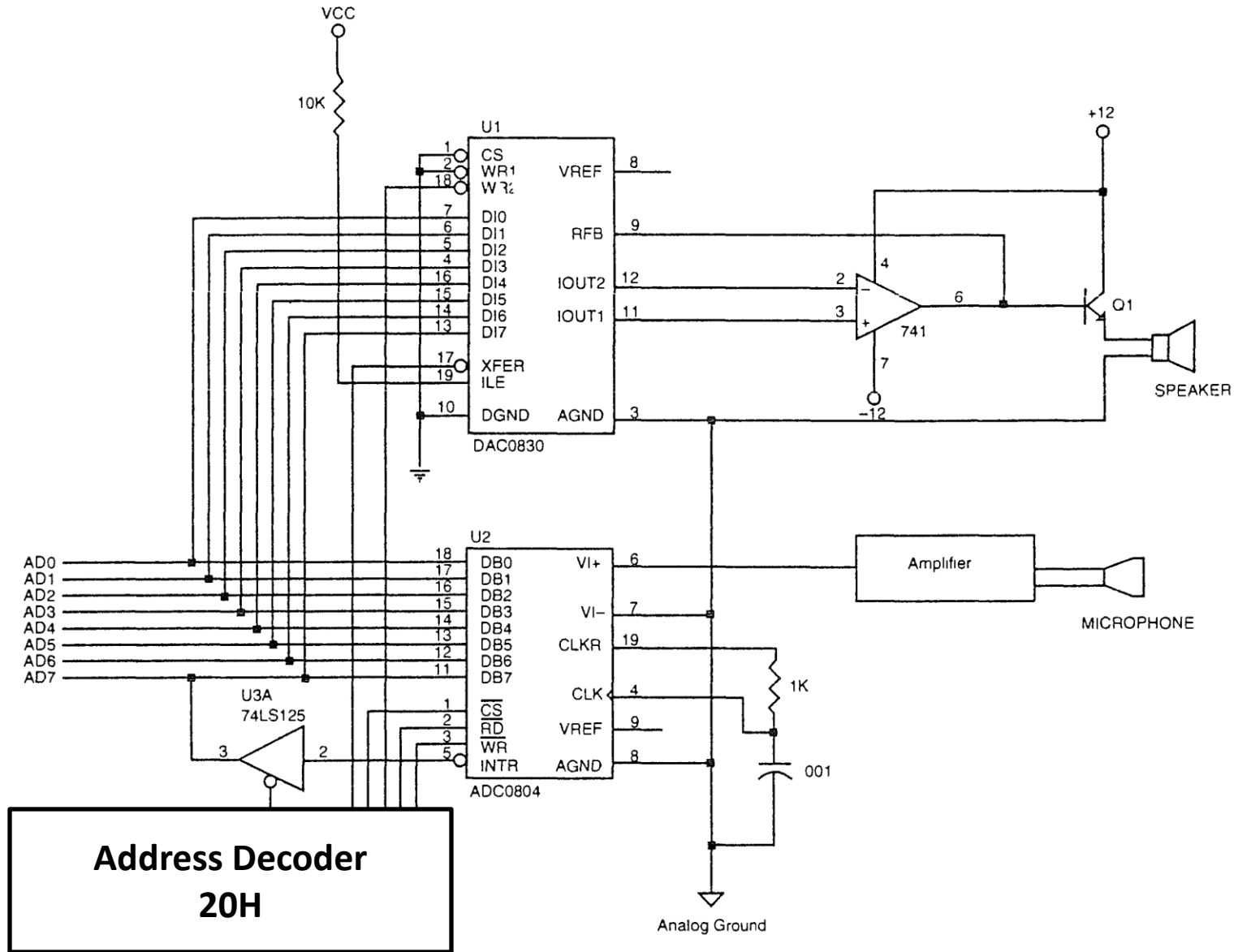
ADC & DAC CONVERTERS

➢ **Using the ADC0804 and the DAC0830**

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

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

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

ADC & DAC CONVERTERS

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