DAC INTERFACING

Digital-to-analog(DAC) converter

- Used to convert digital pulses to analog signals
- Agenda – Interfacing DAC with 8051 microcontroller
- Resolution – function of no. of binary inputs
  - Common ones – 8, 10 and 12 bits
  - More the bits, more the precision
- MC 1408 – DAC used

MC 1408

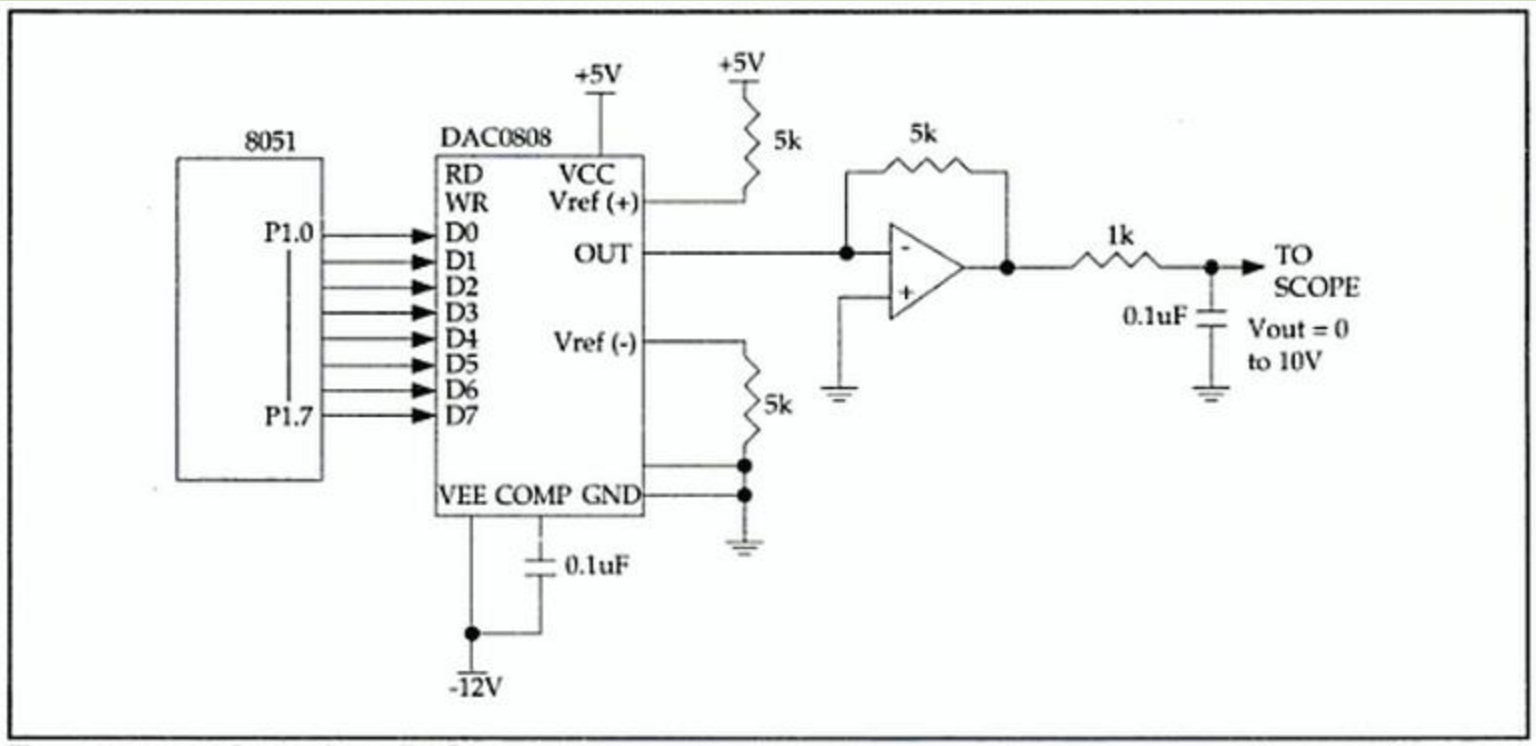


Figure 13-18. 8051 Connection to DAC808

Converting I_{out} to voltage in DAC

- Ideally I_{out} connected directly to resistor
- Real life situations – input resistance of the load affects output voltage
- Avoided by isolating I_{ref} by connecting it to an op-amp such as 741(8-pin dual in-line) with R_f = 5 kΩ for the feedback resistor.

Features

- 8-bit input DAC
- Total current I_{out} is a function of inputs D_7 through D_0
- $I_{out} = I_{ref} \left({}^{D7}/_{2} + {}^{D6}/_{4} + {}^{D5}/_{8} + \ldots + {}^{D0}/_{256} \right)$
- I_{ref} = 2mA → Maximum output current is 1.99mA

INTERFACING..

Saw tooth Wave Form

```
        MOV DPTR, #FFC8
        MOV A,#00
LOOP:   MOVX @DPTR,A
        INC A
        SJMP LOOP
```

Triangular Wave Form

```
        MOV DPTR, #FFC8
START:  MOV A, #00
LOOP1:  MOV @DPTR,A
        INC A
        JNZ LOOP1
        MOV A, #FF
LOOP2:  MOVX @DPTR,A
        DEC A
        JNZ LOOP2
        LJMP START
```

Square Wave

```
START:  MOV DPTR,#FFC8
        MOV A,#00
        MOVX @DPTR,A
        LCALL DELAY
        MOV A,#FF
        MOVX @DPTR,A
        LCALL DELAY
        LJMP START
        DELAY MOV R1, #05
        LOOP MOV R2, #FF
HERE:   DJNZ R2, HERE
        DJNZ R1, LOOP
        RET
```

Staircase Wave Form

```
        MOV DPTR, #FFC8
START:  MOV A, #00
        MOV @DPTR,A
        ACALL DELAY
RPT:    ADD A,#33        ; Hex for 255/5 ~ 51
        MOV @DPTR,A
        ACALL DELAY
        CJNE A,#FE,RPT
        SJMP START
```

Sinusoidal Wave Form

- Perfect sinusoidal wave not possible in DAC
- Can produce a pseudo-sine wave similar to PCM codes
- $V_{out} = 5V + (5 \times \sin\theta)$
- Range – 0 to 10 V (Full scale output of DAC ~ 10V)
- V_{out} for various angles (in intervals of 30) are calculated and noted down in a lookup table.

Lookup Table

Angle θ (in degrees)	sin θ	V_{out}(Voltage Magnitude) 5V + (5 x sinθ)	Values sent to DAC (decimal) (Voltage Mag. x 25.6)
0	0	5	128
30	0.5	7.5	192
60	0.866	9.33	238
90	1.0	10	255
120	0.866	9.33	238
150	0.5	7.5	192
180	0	5	128
210	-0.5	2.5	64
240	-0.866	0.669	17
270	-1.0	0	0
300	-0.866	0.669	17
330	-0.5	2.5	64
360	0	5	128

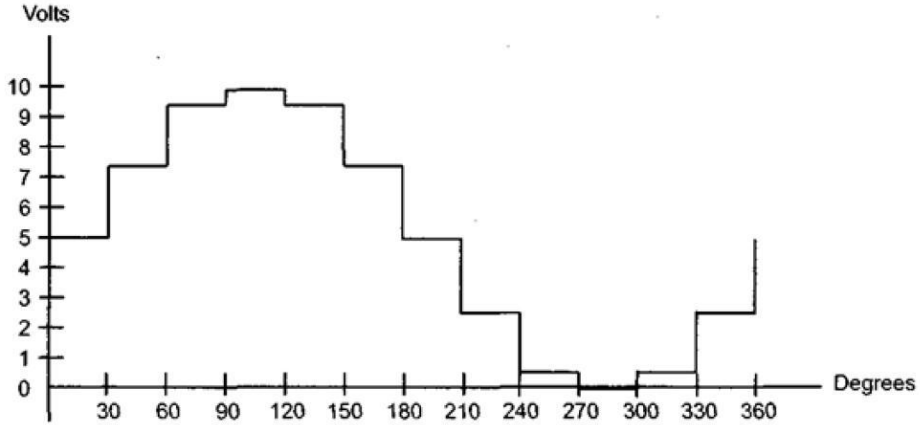
Code for Sine Wave

```
Start:  MOV DPTR,#4500
        MOV R0,#04H
 JO :   MOVX A,@DPTR
        PUSH DPH
        PUSH DPL
        MOV DPTR,#FFC8
        MOV R2,#04
        MOV R1,#0F
DLY1:   MOV R3,#0F
DLY:    DJNZ R3,DLY
        DJNZ R1,DLY1
        DJNZ R2,DLY1
        MOVX @DPTR,A
        POP DPL
        POP DPH
        INC DPTR
        DJNZ R0,JO
        SJMP START
```

Lookup table values:

4500: Hexadecimal values (in order) for the values calculated in the lookup table

Output Waveform



Angle vs. Voltage Magnitude for Sine Wave

SENSOR INTERFACING AND SIGNAL CONDITIONING

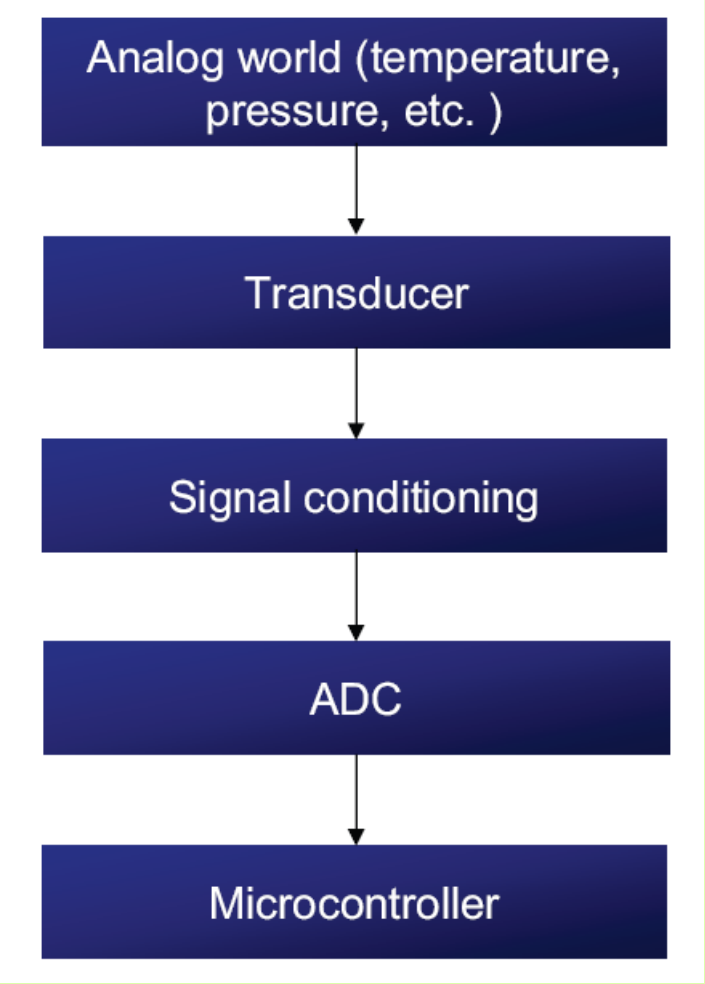
Temperature Sensors

- Transducers convert physical data such as temperature, light intensity, flow and speed to electrical signals.
- Output – voltage, current, resistance or capacitance
- LM 34 series & LM 35 series

Temperature(C)	T_f(K ohms)
0	29.490
25	10.000
50	3.893
75	1.700
100	0.817

Signal Conditioning

- Signal conditioning is a widely used term in the world of data acquisition.
  - It is the conversion of the signals (voltage, current, charge, capacitance, and resistance) produced by transducers to voltage, which is sent to the input of an A to D converter
- Signal conditioning can be a current-to voltage conversion or a signal amplification.
  - The thermistor changes resistance with temperature, while the change of resistance must be translated into voltage in order to be of any use to an ADC



- 8 bit resolution
- 10mV for every degree of temp. change
- V_{out} for full scale output is 2.56V
- V_{ref}=2.56V

8051 Connection to ADC804 and Temperature Sensor

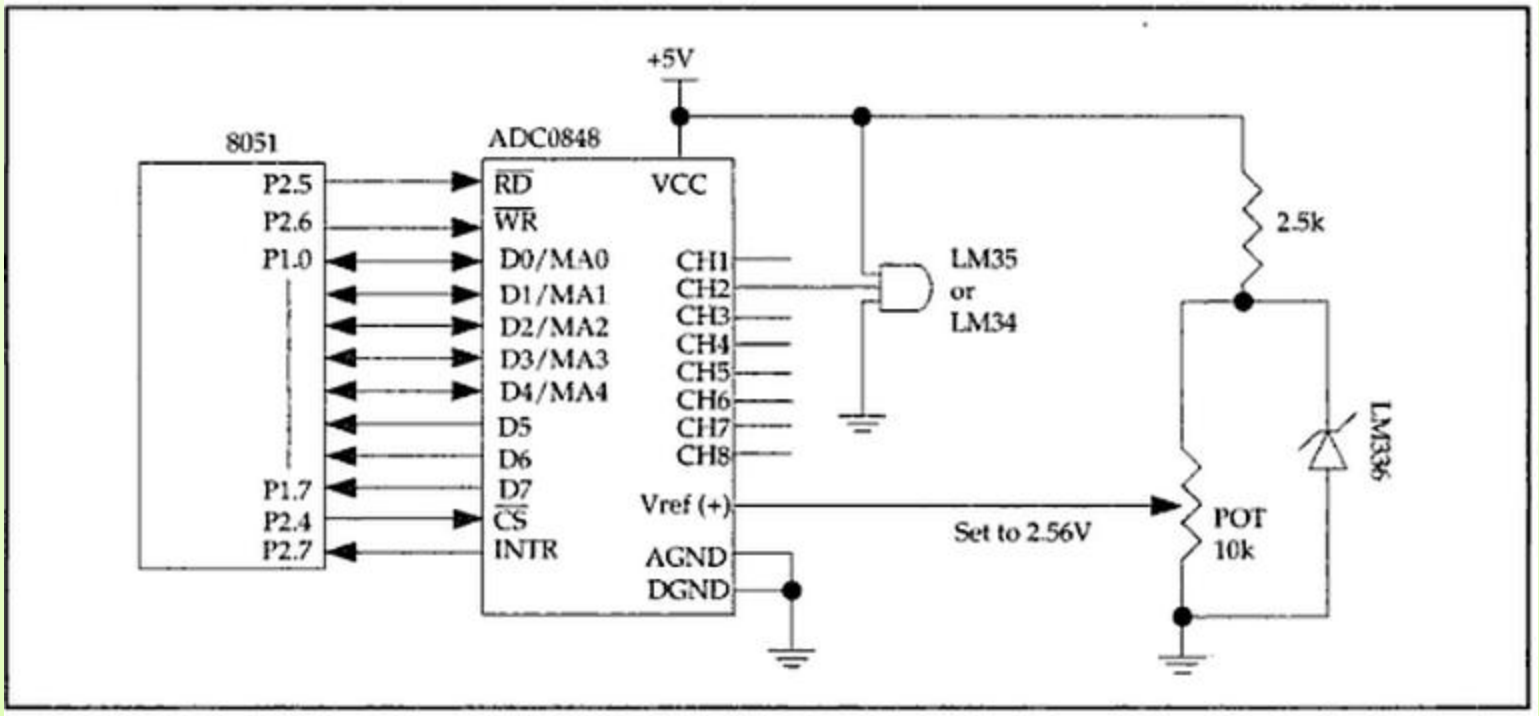


Figure 13-21. 8051 Connection to ADC0848 and Temperature Sensor

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