# SIGNAL GENERATING TECHNIQUES USING PIC16F84 MICROCONTROLLERS

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**Abstract:** Testing various electronic devices requires usually a well defined input signal, of a specified variation pattern in time. Since sine wave, triangular or rectangular patterns are easily obtained with common signal generators, the focus was passed towards non regular signals and a simple digital microcontroller driven signal generator was designed.

**Keywords:** PIC16F84 microcontroller, signal generator, code sequence

## I. INTRODUCTION

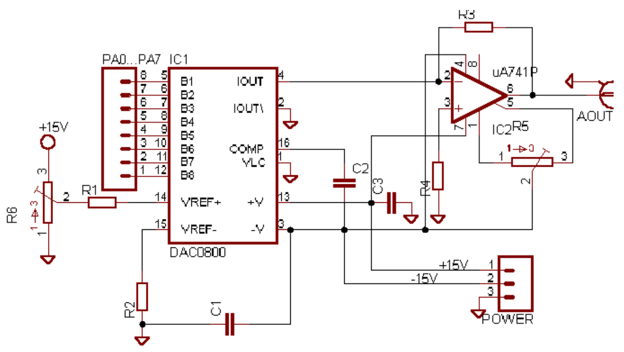
The PIC16FXX family has special features to reduce external components, thus reducing cost, enhancing system reliability and reducing power consumption. The devices with Flash program memory allow the same device package to be used for prototyping and production. In-circuit reprogrammability allows the code to be updated without the device being removed from the end application. This is useful in the development of many applications where the device may not be easily accessible, but the prototypes may require code updates [1].

To develop application software and to program the PIC16F84 microcontroller, an *original user interface was designed*, including a source code editor, a compiler (Parallax Compiler) and an unique featured program mode interface which can send to the device program code, data memory code and configuration information.

The DAC0800 series are monolithic 8-bit high-speed current-output digital-to-analog converters (DAC). The circuit has two current outputs, $I_0$ and $\overline{I_0}$. Their sum is equal to $(255/256)\cdot I_{REF}$ where $I_{REF}$ is an externally reference current. $B_1$ to $B_8$ represent eight control bits thus forming a one byte control word to whom the $I_0$ current is proportional.

## II. SIGNAL GENERATING TECHNIQUES

In combination with a 741 operational amplifier and driven by a PIC16F84 microcontroller, the DAC08 is used to generate various periodic signal patterns (fig.1.).



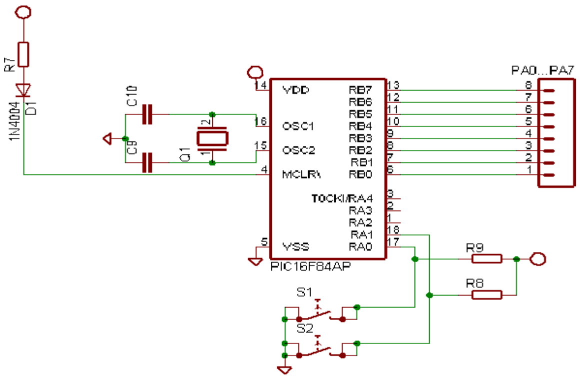




Fig. 1. Electronic circuit for signal generating device.    Fig. 2. The Digital control unit for the signal generator.

The reference voltage is obtained by adjusting $R_6$ and is set to 12,8V. $A_{out}$ issues the positive voltage $V_{out}$. Considering $R_3 = R_1$, the fraction $R_3/R_1$ will give 1. A variable resistor ($R_5$) assures 0V output value for control word "00000000".

The PIC16F84 microcontroller is connected to DAC08 (fig.2.). On RA0 and RA1 are connected two push – buttons to achieve various functions implemented into the signal generating device.

## III. SOFTWARE DEVELOPMENT

At 4 MHz clock rate, 1 instruction cycle takes 1µs thus regarding a 2 instruction set for modifying value on PORTB output, the minimum output signal period will be 2µs so the maximum frequency 500 KHz. To increase this value, a higher clock rate must be used.

To obtain a triangular periodic waveform, the control byte must be incremented from zero to half maximum value, i.e. 127 ('1111111') then decremented until reaches zero again. This is achieved by using DEC PORTB instruction and a comparison like CJNE PORTB, #127, loop.

The most useful characteristic of this method is generating non specific pattern based signals, upon a predefined table, stored in PIC16F84's data memory. Considering 100 values stored in the general purpose register space, starting with address 10h, using indirect addressing we can read out those values and generate the desired periodic output signal.

Values stored in data memory must be 8 bits wide, so a scaling must be proceeded if necessary. The above given code sequence generates periodic signal at the maximum output frequency. If needed, delays can be introduced into the main loop, so the signal’s period can be increased.

## IV. THE EXPERIMENTAL DEVICE

In order to design a fully independent device, testing was accomplished using an experimental circuit (fig.3.) which included the PIC16F84 microcontroller, DAC08, 741 operational amplifier, a programmable peripheral interface i8255A made by Intel (for port extending), control LEDs and a 4 switches block.

For program the experimental device, a PIC16F84 programmer was used, driven by the PC’s parallel port and a HAMEG series oscilloscope to monitor the output signal (fig.4).

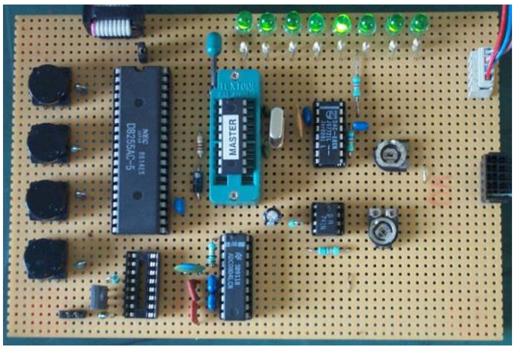


Fig. 3. Experimental device circuit.

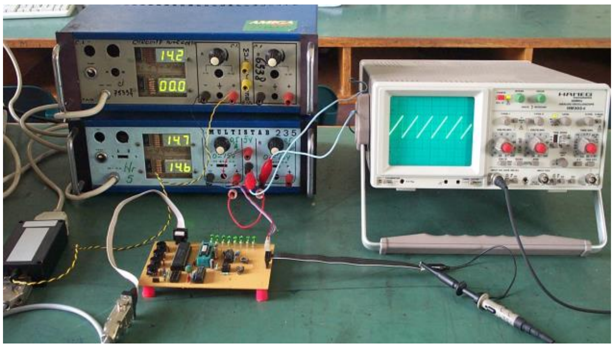


Fig. 4. Experimental testing bench.

First it was implemented a triangular wave signal, of 6,4V peak to peak amplitude and of maximum frequency, like shown in figure 5. With a simple routine, the device can be turned into a low cost time base generator with output signal (fig.6).

Finally, programming the PIC16F84 microcontroller with the code sequence given in List 1 it was obtained a non-specific periodical pattern illustrated in figure 7.

**LIST1**

```
        device pic16c84,xt_osc,wdt_off,pwrt_off,protect_off
        ID 'test'
        org 0
        jmp START
        org 0Ch
temp    ds 1
temp2   ds 1
```

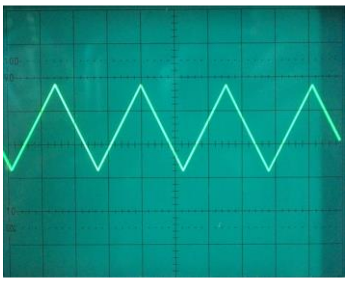


Fig. 5. Triangular wave signal.

```
START  CLRF RA
       CLRF RB
       MOV !RA,#00h
       MOV !RB,#00h
       MOV RB,#83h
       MOV RA,#0Ch
       MOV RA,#0Fh
       mov rb,#0
loop   MOV RA,#08h
       MOV RA,#0Ch
       mov rb,#10
       MOV RA,#08h
       MOV RA,#0Ch
       mov rb,#30
       MOV RA,#08h
       MOV RA,#0Ch
       mov rb,#255
       MOV RA,#08h
       MOV RA,#0Ch
       call delay
       mov rb,#255
       MOV RA,#08h
       MOV RA,#0Ch
       mov rb,#40
       MOV RA,#08h
       MOV RA,#0Ch
       call delay
       mov rb,#0
       MOV RA,#08h
       MOV RA,#0Ch
       JMP loop
DELAY  MOV temp, #1
              MOV temp2, #1
x      DJNZ temp2, x
       MOV temp2, #255
       DJNZ temp, x
       RET
       END
```

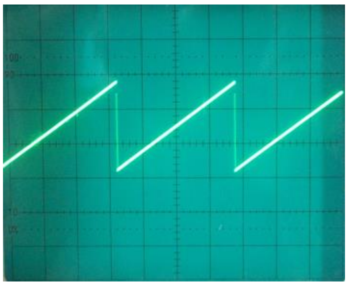


Fig. 6. Time base signal.

Fig. 7. Non-specific periodical signal.

## V. CONCLUSIONS

Modern signal generating techniques require development of specialized software routines implemented into a microcontroller driven system. Using a proper digital to analog converter various non-specific pattern signals can be easyly obtained. It was designed and implemented a low cost device which can be used as a base platform for further developments.

## VI. REFERENCES

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[2] Microchip Inc. – Programming PIC16F84 microcontrollers;
[3] *** - DAC08 Data Sheet