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The 16F62X microcontroller

The 16F62X family of microcontrollers includes the two devices 16F627 and 16F628.

The 16F62X microcontrollers are flash devices and have 18 pins and data EEPROM just like the 16F84, but they have more functions. Notably there is an on board oscillator so an external crystal is not required. This frees up two pins for extra I/O. The 16F62X in fact can use 16 of its 18 pins as I/O.

Table 17.1 shows the specification of the 16F62X devices and the 16F84 for comparison.

Table 17.1 The 16F62X specification

Device	Flash Program Memory (bytes)	RAM Data Memory (bytes)	EEPROM Data Memory (bytes)	Timer Modules	I/O Pins
16F627	1024	224	128	3	16
16F628	2048	224	128	3	16
16F84	1024	68	64	1	13

16F62X oscillator modes

The 16F62X can be operated in 8 different oscillator modes. They are selected when programming the device just like the 16F84, or by inserting the configuration bits in the header.

The options are:

- LP Low Power Crystal, 32.768kHz
- XT 4MHz Crystal
- HS High Speed Crystal, 20MHz
- ER External Resistor (2 modes)
- INTRC Internal Resistor/Capacitor (2 modes)
- EC External Clock in

The two modes for the internal resistor/capacitor configuration are 4MHz and 37kHz. The default setting is 4MHz. The 16F627 header, HEAD62RC.ASM, selects the 37kHz oscillator by clearing the OSCF (oscillator frequency) bit, bit3 in the Peripheral Control Register, PCON with BCF PCON,3.

There was obviously a good reason for Microchip choosing 37kHz for the oscillator instead of 32.768kHz, I only wish I knew what it was! 32.768kHz as we have seen before (HEADER84.ASM) can give us TMR0 pulses of 32 a second when setting the option register to divide the program timing pulses by 256.

The most attractive proposition I can see using 37kHz is:

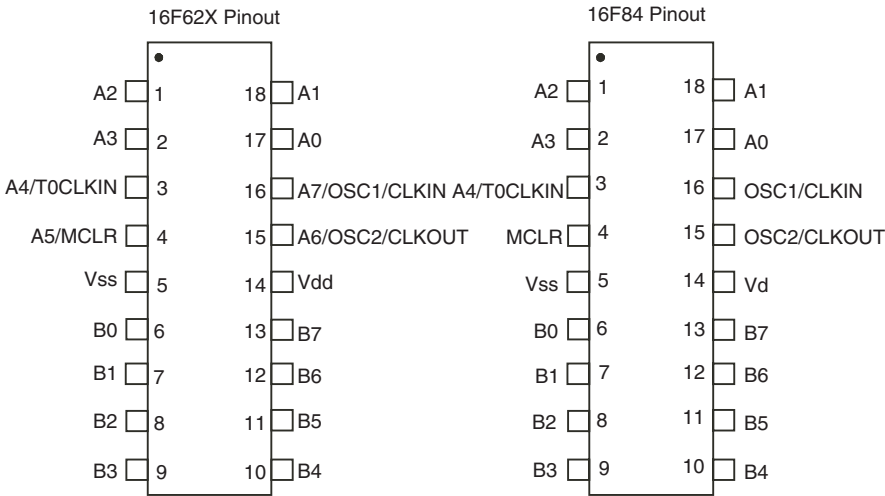
- Clock frequency = 37kHz,
- Program execution frequency is $37\text{kHz}/4 = 9250\text{Hz}$.
- Setting the prescaler to /32 gives TMR0 pulses of $9250 / 32 = 289.0625\text{Hz} = 0.03459459\text{s}$ for each pulse.
- Counting 29 TMR0 pulses gives a time of 0.100324324s i.e. $0.1\text{s} + 0.3\%$ error. If this error, about 4.5 minutes a day, is unacceptable then a 32.768kHz crystal can be used as we did with the 16F84.

Since the programs used previously on the 16F84 did not require any accurate timing our 16F62X header will set the prescaler to divide by 32 and use a subroutine to count 29 TMR0 pulses to give a time of 0.1s.

All of the 16F84 programs can then be transferred to the 16F62X header.

The choice of a 32.768kHz crystal or the 37kHz internal RC will obviously make a difference to the timing routines in the header. I have therefore included two headers for the 16F62X devices. HEAD62LP.ASM for use with the 32kHz crystal and HEAD62RC.ASM for use with the 37kHz internal RC oscillator.

16F62X and 16F84 Pinouts



16F62X Port configuration

The header (HEAD62RC.ASM) will configure the 16F62X I/O as shown in Figure 17.1.

The header (HEAD62LP.ASM) will configure the 16F62X I/O as shown in Figure 17.2.

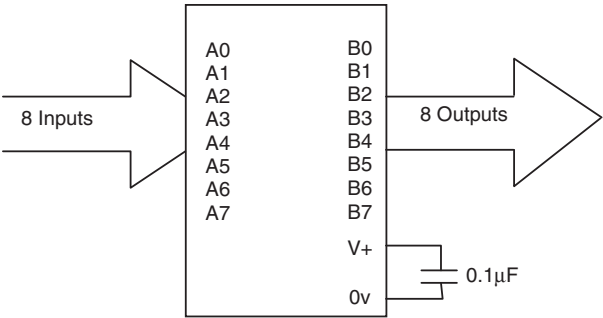


Figure 17.1 The 16F62X port configuration in HEAD62RC.ASM

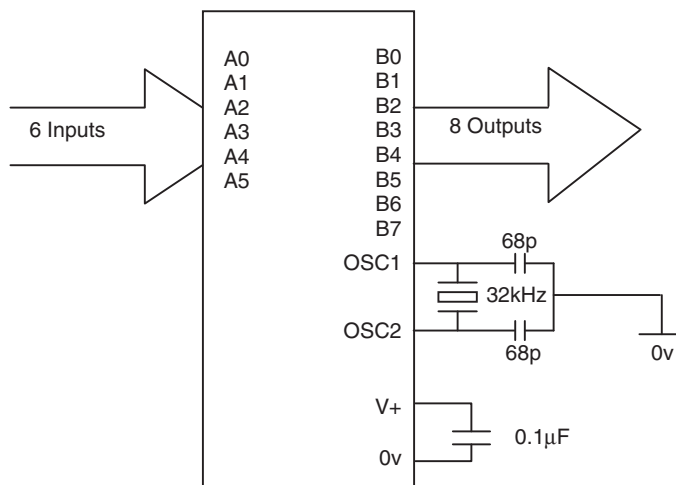


Figure 17.2 The 16F62X port configuration in HEAD62LP.ASM

16F62X Memory map

The 16F62X Memory Map at the end of the chapter (page 256).

The 16F62X headers

HEAD62LP.ASM

;HEAD62LP.ASM using the 32kHz crystal

;PortA bits 0 to 5 are inputs

;PortB bits 0 to 7 are outputs

;Prescaler / 256

;EQUATES SECTION

TMR0	EQU	1
OPTION_R	EQU	1
PORTA	EQU	5
PORTB	EQU	6
TRISA	EQU	5
TRISB	EQU	6
STATUS	EQU	3
ZEROBIT	EQU	2
CARRY	EQU	0
EEADR	EQU	1BH
EEDATA	EQU	1AH

EECON1	EQU	1CH
EECON2	EQU	1DH
RD	EQU	0
WR	EQU	1
WREN	EQU	2
COUNT	EQU	20H

```
*****
;
```

```
LIST      P=16F627    ;using the 627
ORG       0
GOTO     START
```

```
*****
;
```

```
Configuration Bits
```

```
__CONFIG H'3F00'    ;selects LP oscillator, WDT off,
                    ;Code Protection disabled.
```

```
*****
;
```

```
;SUBROUTINE SECTION.
```

```
;1 SECOND DELAY
```

```
DELAY1  CLRF      TMR0           ;Start TMR0
LOOPA   MOVF      TMR0,W         ;Read TMR0 into W
        SUBLW     .32            ;TIME-W
        BTFSS     STATUS,ZEROBIT ;Check TIME-W=0
        GOTO      LOOPA
        RETLW     0              ;Return after TMR0 = 32
```

```
;0.5 SECOND DELAY
```

```
DELAYP5 CLRF      TMR0           ;Start TMR0
LOOPB   MOVF      TMR0,W         ;Read TMR0 into W
        SUBLW     .16            ;TIME-W
        BTFSS     STATUS,ZEROBIT ;Check TIME-W=0
        GOTO      LOOPB
        RETLW     0              ;Return after TMR0 = 16
```

```
*****
;
```

```
;CONFIGURATION SECTION.
```

```
START   BSF       STATUS,5      ;Bank1
        MOVLW     B'11111111'
        MOVWF     TRISA         ;PortA is input
```

```
        MOVLW    B'00000000'
        MOVWF    TRISB      ;PortB is output

        MOVLW    B'00000111'
        MOVWF    OPTION_R   ;Option Register, TMR0/256

        BCF      STATUS,5   ;Bank0
        CLRF     PORTA
        CLRF     PORTB

        MOVLW    .7
        MOVWF    1FH        ;CMCON turns off comparators.

;*****
;
;Program starts now.

END
```

HEAD62RC.ASM

```
;HEAD62RC.ASM using the 37kHz internal RC
                                ;PortA bits 0 to 7 are inputs
                                ;PortB bits 0 to 7 are outputs
                                ;Prescaler/32
```

```
;*****
;
;EQUATES SECTION
```

TMR0	EQU	1
OPTION_R	EQU	1
PORTA	EQU	5
PORTB	EQU	6
TRISA	EQU	5
TRISB	EQU	6
STATUS	EQU	3
ZEROBIT	EQU	2
CARRY	EQU	0
EEADR	EQU	1BH
EEDATA	EQU	1AH
EECON1	EQU	1CH
EECON2	EQU	1DH
RD	EQU	0
WR	EQU	1
WREN	EQU	2
PCON	EQU	0EH
COUNT	EQU	20H

```
*****
;
```

```
LIST      P=16F627    ;using the 627
ORG       0
GOTO      START
```

```
*****
;
```

```
Configuration Bits
```

```
__CONFIG H'3F10'    ;selects Internal RC oscillator, WDT off,
                    ;Code Protection disabled.
```

```
*****
;
```

```
;SUBROUTINE SECTION.
```

```
;0.1 SECOND DELAY
```

```
DELAYP1  CLRF      TMR0          ;Start TMR0
LOOPA    MOVF      TMR0,W        ;Read TMR0 into W
          SUBLW     .29           ;TIME-W
          BTFSS     STATUS,ZEROBIT ;Check TIME-W=0
          GOTO      LOOPA
          RETLW     0             ;Return after TMR0 = 29
```

```
;0.5 SECOND DELAY
```

```
DELAYP5  MOVLW     5
          MOVWF     COUNT
LOOPB    CALL      DELAYP1      ;0.1s delay
          DECFSZ    COUNT
          GOTO      LOOPB
          RETLW     0           ;Return after 5 DELAYP1
```

```
;1 SECOND DELAY
```

```
DELAY1   MOVLW     10
          MOVWF     COUNT
LOOPC    CALL      DELAYP1      ;0.1s delay
          DECFSZ    COUNT
          GOTO      LOOPC
          RETLW     0           ;Return after 10 DELAYP1
```

```
*****
;
```

```
;CONFIGURATION SECTION.
```

```
START    BSF       STATUS,5     ;Bank1
          MOVLW     B'11111111'
          MOVWF     TRISA        ;PortA is input
```

```

MOVLW    B'00000000'
MOVWF    TRISB      ;PortB is output

MOVLW    B'00000100'
MOVWF    OPTION_R    ;Option Register, TMR0 / 32
CLRF     PCON        ;Select 37kHz oscillator.
BCF      STATUS,5    ;Bank0
CLRF     PORTA
CLRF     PORTB

MOVLW    .7
MOVWF    1FH         ;CMCON turns off comparators.

```

```

;*****
;
;Program starts now.

```

A 16F627 application – flashing an LED on and off

In order to introduce the operation of the 16F672 device we will consider the simple example of the single LED flashing on and off, which was introduced in Chapter 2.

The 16F627 will be operated in the INTRC mode using the internal 37kHz oscillator.

The circuit diagram for this is shown in Figure 17.3.

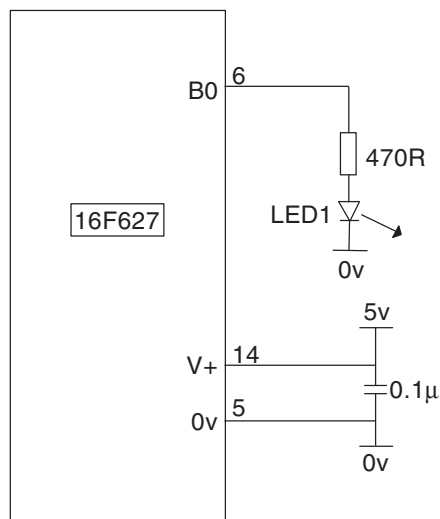


Figure 17.3 The 16F627 LED flashing circuit

The 16F627 LED flasher code

```

;FLASH_RC.ASM using the 37kHz internal RC
                                ;PortA bits 0 to 7 are inputs
                                ;PortB bits 0 to 7 are outputs
                                ;Prescaler/32

;*****
;
;EQUATES SECTION

TMR0      EQU      1
OPTION_R   EQU      1
PORTA     EQU      5
PORTB     EQU      6
TRISA     EQU      5
TRISB     EQU      6
STATUS    EQU      3
ZEROBIT    EQU      2
CARRY     EQU      0
EEADR     EQU      1BH
EEDATA    EQU      1AH
EECON1    EQU      1CH
EECON2    EQU      1DH
RD        EQU      0
WR        EQU      1
WREN      EQU      2
PCON      EQU      0EH
COUNT    EQU      20H

;*****
;
LIST      P=16F627   ;using the 627
ORG       0
GOTO      START

;*****
;
;Configuration Bits

__CONFIG H'3F10'      ;selects Internal RC oscillator, WDT off,
                        ;Code Protection disabled.

;*****
;
;SUBROUTINE SECTION.

;0.1 SECOND DELAY
DELAYP1    CLRF      TMR0      ;Start TMR0

```

```
LOOPA    MOVF      TMR0,W           ;Read TMR0 into W
          SUBLW    .29              ;TIME-W
          BTFSS    STATUS,ZEROBIT   ;Check TIME-W=0
          GOTO     LOOPA
          RETLW    0                ;Return after TMR0 = 29
```

;0.5 SECOND DELAY

```
DELAYP5  MOVLW    5
          MOVWF    COUNT
LOOPB    CALL     DELAYP1           ;0.1s delay
          DECFSZ   COUNT
          GOTO     LOOPB
          RETLW    0                ;Return after 5 DELAYP1
```

;CONFIGURATION SECTION.

```
START    BSF      STATUS,5         ;Bank1
          MOVLW    B'11111111'
          MOVWF    TRISA            ;PortA is input

          MOVLW    B'00000000'
          MOVWF    TRISB            ;PortB is output

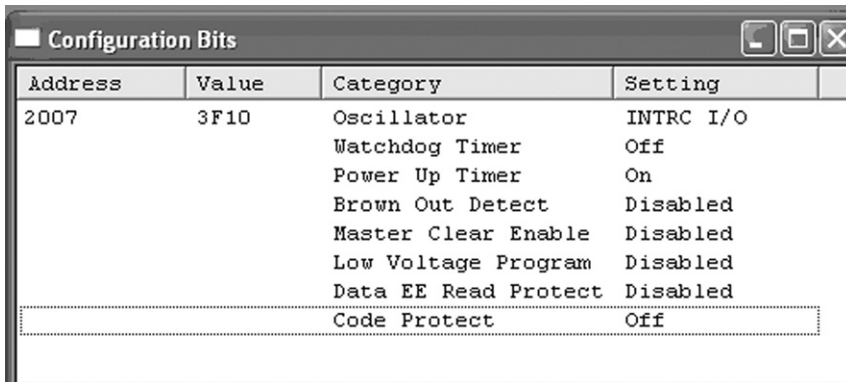
          MOVLW    B'00000100'
          MOVWF    OPTION_R         ;Option Register, TMR0 / 32
          CLRF     PCON              ;Selects 37kHz oscillator.
          BCF      STATUS,5         ;Bank0
          CLRF     PORTA
          CLRF     PORTB

          MOVLW    .7
          MOVWF    1FH              ;CMCON turns off comparators.
```

;Program starts now.

```
BEGIN    BSF      PORTB,0          ;Turn on LED
          CALL     DELAYP5          ;Wait 0.5s
          BCF      PORTB,0          ;Turn off LED
          CALL     DELAYP5          ;Wait 0.5s
          GOTO     BEGIN            ;Repeat

END
```



Address	Value	Category	Setting
2007	3F10	Oscillator	INTRC I/O
		Watchdog Timer	Off
		Power Up Timer	On
		Brown Out Detect	Disabled
		Master Clear Enable	Disabled
		Low Voltage Program	Disabled
		Data EE Read Protect	Disabled
		Code Protect	Off

Figure 17.4 Configuration settings for FLASH_RC.HEX

The operation of the program after ‘Program starts now’, is exactly the same as in FLASHER.ASM in Chapter 2, using the 16F84.

All of the programs using the 16F84 can be transferred by copying the code starting at ‘Program starts now’ and pasting into HEAD62RC.ASM or HEAD62LP.ASM as required.

Configuration settings for the 16F627

When programming the Code FLASH_RC.HEX into the 16F627 use the configuration settings shown in Figure 17.4. This setting equates to H’3F10’ which can be written into the Configuration Bits setting in your code.

Other features of the 16F62X

The 16F62X also includes,

- An analogue comparator module with 2 analogue comparators and an on-chip voltage reference module.
- Timer1 a 16 bit timer/counter module with external crystal/clock capability and Timer2 an 8 bit timer/counter with prescaler and postscaler.
- A Capture, Compare and Pulse Width Modulation modes.

Please refer to the 16F62X data sheet for operation of these other features.

Address	File Name	File Name	File Name	File Name
00h	Ind.Add	Ind.Add	Ind.Add	Ind.Add
01h	TMR0	Option	TMR0	Option
02h	PCL	PCL	PCL	PCL
03h	Status	Status	Status	Status
04h	FSR	FSR	FSR	FSR
05h	PORTA	TRISA		
06h	PORTB	TRISB	PORTB	TRISB
07h				
08h				
09h				
0Ah	PCLATH	PCLATH	PCLATH	PCLATH
0Bh	INTCON	INTCON	INTCON	INTCON
0Ch	PIR1	PIE1		
0Dh				
0Eh	TMR1L	PCON		
0Fh	TMR1H			
10h	T1CON			
11h	TMR2			
12h	T2CON	PR2		
13h				
14h				
15h	CCPR1L			
16h	CCPR1H			
17h	CCP1CON			
18h	RCSTA	TXSTA		
19h	TXREG	SPBRG		
1Ah	RCREG	EEDATA		
1Bh		EEADR		
1Ch		EECON1		
1Dh		EECON2		
1Eh				
1Fh	CMCON	VRCON		
	General Purpose Register 96 bytes	General Purpose Register 80 bytes	General Purpose Register 48 bytes	
6Fh				
7F h				
Bank0		Bank1	Bank2	Bank3

The 16F62X memory map