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"[Embedded - Microcontrollers](#)" refer to small, integrated circuits designed to perform specific tasks within larger systems. These microcontrollers are essentially compact computers on a single chip, containing a processor core, memory, and programmable input/output peripherals. They are called "embedded" because they are embedded within electronic devices to control various functions, rather than serving as standalone computers. Microcontrollers are crucial in modern electronics, providing the intelligence and control needed for a wide range of applications.

Applications of "[Embedded - Microcontrollers](#)"

Details

Product Status	Active
Core Processor	PIC
Core Size	8-Bit
Speed	33MHz
Connectivity	I ² C, SPI, UART/USART
Peripherals	Brown-out Detect/Reset, POR, PWM, WDT
Number of I/O	50
Program Memory Size	32KB (16K x 16)
Program Memory Type	OTP
EEPROM Size	-
RAM Size	902 x 8
Voltage - Supply (Vcc/Vdd)	4.5V ~ 5.5V
Data Converters	A/D 12x10b
Oscillator Type	External
Operating Temperature	0°C ~ 70°C (TA)
Mounting Type	Surface Mount
Package / Case	64-TQFP
Supplier Device Package	64-TQFP (10x10)
Purchase URL	https://www.e-xfl.com/product-detail/microchip-technology/pic17c756at-33-pt

TABLE 5-4: INITIALIZATION CONDITIONS FOR SPECIAL FUNCTION REGISTERS

Register	Address	Power-on Reset Brown-out Reset	MCLR Reset WDT Reset	Wake-up from SLEEP through Interrupt
Unbanked				
INDF0	00h	N/A	N/A	N/A
FSR0	01h	xxxx xxxx	uuuu uuuu	uuuu uuuu
PCL	02h	0000h	0000h	PC + 1 ⁽²⁾
PCLATH	03h	0000 0000	uuuu uuuu	uuuu uuuu
ALUSTA	04h	1111 xxxx	1111 uuuu	1111 uuuu
T0STA	05h	0000 000-	0000 000-	0000 000-
CPUSTA ⁽³⁾	06h	--11 11qq	--11 qquu	--uu qquu
INTSTA	07h	0000 0000	0000 0000	uuuu uuuu ⁽¹⁾
INDF1	08h	N/A	N/A	N/A
FSR1	09h	xxxx xxxx	uuuu uuuu	uuuu uuuu
WREG	0Ah	xxxx xxxx	uuuu uuuu	uuuu uuuu
TMR0L	0Bh	xxxx xxxx	uuuu uuuu	uuuu uuuu
TMR0H	0Ch	xxxx xxxx	uuuu uuuu	uuuu uuuu
TBLPTRL	0Dh	0000 0000	0000 0000	uuuu uuuu
TBLPTRH	0Eh	0000 0000	0000 0000	uuuu uuuu
BSR	0Fh	0000 0000	0000 0000	uuuu uuuu
Bank 0				
PORTA ^(4,6)	10h	0-xx 11xx	0-uu 11uu	u-uu uuuu
DDRB	11h	1111 1111	1111 1111	uuuu uuuu
PORTB ⁽⁴⁾	12h	xxxx xxxx	uuuu uuuu	uuuu uuuu
RCSTA1	13h	0000 -00x	0000 -00u	uuuu -uuu
RCREG1	14h	xxxx xxxx	uuuu uuuu	uuuu uuuu
TXSTA1	15h	0000 --1x	0000 --1u	uuuu --uu
TXREG1	16h	xxxx xxxx	uuuu uuuu	uuuu uuuu
SPBRG1	17h	0000 0000	0000 0000	uuuu uuuu

Legend: u = unchanged, x = unknown, - = unimplemented, read as '0', q = value depends on condition

Note 1: One or more bits in INTSTA, PIR1, PIR2 will be affected (to cause wake-up).

2: When the wake-up is due to an interrupt and the GLINTD bit is cleared, the PC is loaded with the interrupt vector.

3: See Table 5-3 for RESET value of specific condition.

4: This is the value that will be in the port output latch.

5: When the device is configured for Microprocessor or Extended Microcontroller mode, the operation of this port does not rely on these registers.

6: On any device RESET, these pins are configured as inputs.

PIC17C7XX

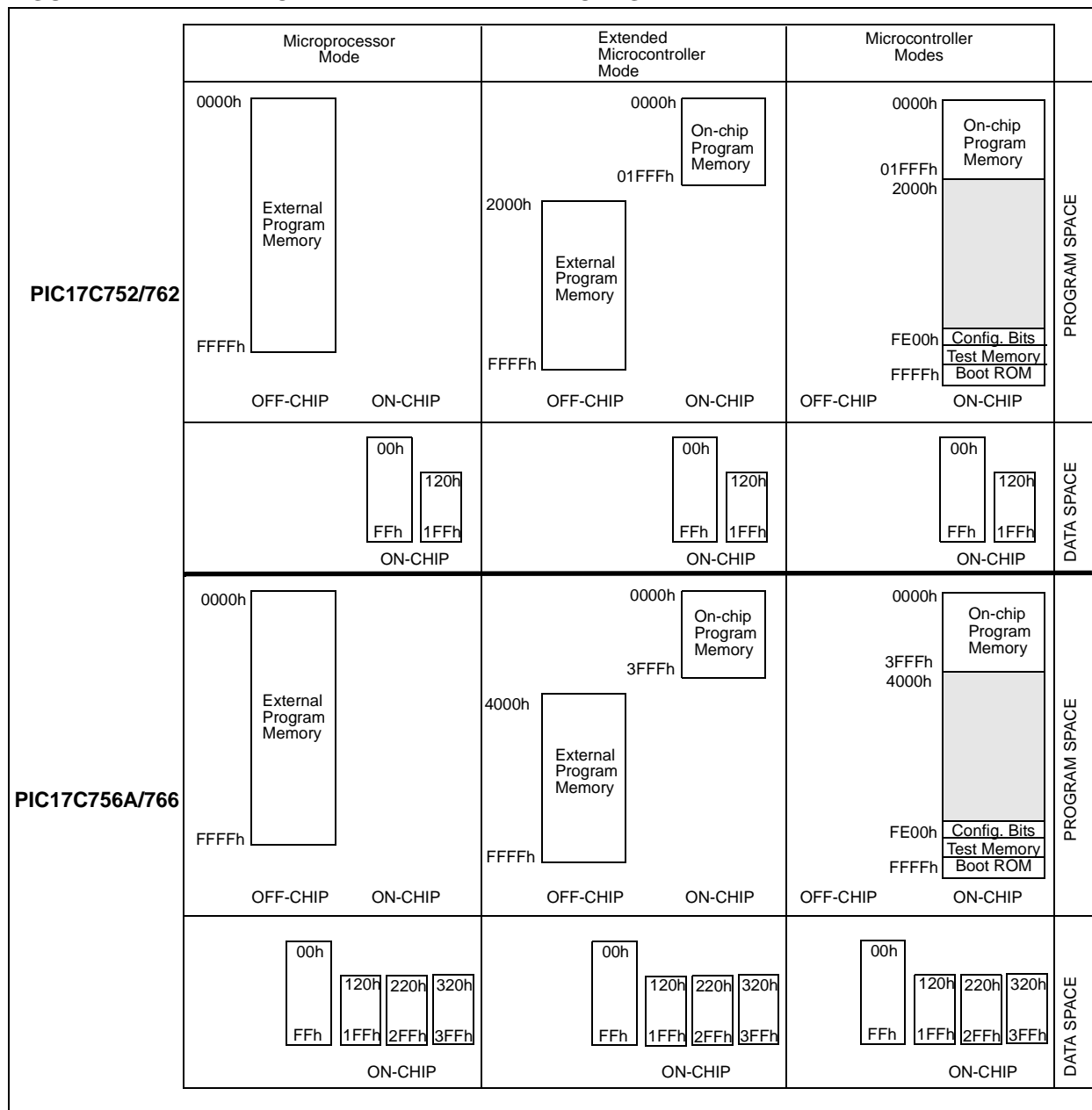
TABLE 7-1: MODE MEMORY ACCESS

Operating Mode	Internal Program Memory	Configuration Bits, Test Memory, Boot ROM
Microprocessor	No Access	No Access
Microcontroller	Access	Access
Extended Microcontroller	Access	No Access
Protected Microcontroller	Access	Access

The PIC17C7XX can operate in modes where the program memory is off-chip. They are the Microprocessor and Extended Microcontroller modes. The Microprocessor mode is the default for an unprogrammed device.

Regardless of the processor mode, data memory is always on-chip.

FIGURE 7-2: MEMORY MAP IN DIFFERENT MODES



10.0 I/O PORTS

PIC17C75X devices have seven I/O ports, PORTA through PORTG. PIC17C76X devices have nine I/O ports, PORTA through PORTJ. PORTB through PORTJ have a corresponding Data Direction Register (DDR), which is used to configure the port pins as inputs or outputs. Some of these ports pins are multiplexed with alternate functions.

PORTC, PORTD, and PORTE are multiplexed with the system bus. These pins are configured as the system bus when the device's configuration bits are selected to Microprocessor or Extended Microcontroller modes. In the two other microcontroller modes, these pins are general purpose I/O.

PORTA, PORTB, PORTE<3>, PORTF, PORTG and the upper four bits of PORTH are multiplexed with the peripheral features of the device. These peripheral features are:

- Timer Modules
- Capture Modules
- PWM Modules
- USART/SCI Modules
- SSP Module
- A/D Module
- External Interrupt pin

When some of these peripheral modules are turned on, the port pin will automatically configure to the alternate function. The modules that do this are:

- PWM Module
- SSP Module
- USART/SCI Module

When a pin is automatically configured as an output by a peripheral module, the pins data direction (DDR) bit is unknown. After disabling the peripheral module, the user should re-initialize the DDR bit to the desired configuration.

The other peripheral modules (which require an input) must have their data direction bits configured appropriately.

<p>Note: A pin that is a peripheral input, can be configured as an output (DDRx<y> is cleared). The peripheral events will be determined by the action output on the port pin.</p>

When the device enters the "RESET state", the Data Direction registers (DDR) are forced set, which will make the I/O hi-impedance inputs. The RESET state of some peripheral modules may force the I/O to other operations, such as analog inputs or the system bus.

13.1.3.3 External Clock Source

The PWMs will operate, regardless of the clock source of the timer. The use of an external clock has ramifications that must be understood. Because the external TCLK12 input is synchronized internally (sampled once per instruction cycle), the time TCLK12 changes to the time the timer increments, will vary by as much as 1Tcy (one instruction cycle). This will cause jitter in the duty cycle as well as the period of the PWM output.

This jitter will be $\pm 1Tcy$, unless the external clock is synchronized with the processor clock. Use of one of the PWM outputs as the clock source to the TCLK12 input, will supply a synchronized clock.

In general, when using an external clock source for PWM, its frequency should be much less than the device frequency (Fosc).

13.1.3.4 Maximum Resolution/Frequency for External Clock Input

The use of an external clock for the PWM time base (Timer1 or Timer2) limits the PWM output to a maximum resolution of 8-bits. The PWxDCL<7:6> bits must be kept cleared. Use of any other value will distort the PWM output. All resolutions are supported when internal clock mode is selected. The maximum attainable frequency is also lower. This is a result of the timing requirements of an external clock input for a timer (see the Electrical Specification section). The maximum PWM frequency, when the timers clock source is the RB4/TCLK12 pin, is shown in Table 13-4 (Standard Resolution mode).

TABLE 13-5: REGISTERS/BITS ASSOCIATED WITH PWM

Address	Name	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0	Value on POR, BOR	MCLR, WDT
16h, Bank 3	TCON1	CA2ED1	CA2ED0	CA1ED1	CA1ED0	T16	TMR3CS	TMR2CS	TMR1CS	0000 0000	0000 0000
17h, Bank 3	TCON2	CA2OVF	CA1OVF	PWM2ON	PWM1ON	CA1/PR3	TMR3ON	TMR2ON	TMR1ON	0000 0000	0000 0000
16h, Bank 7	TCON3	—	CA4OVF	CA3OVF	CA4ED1	CA4ED0	CA3ED1	CA3ED0	PWM3ON	-000 0000	-000 0000
10h, Bank 2	TMR1	Timer1's Register								xxxx xxxx	uuuu uuuu
11h, Bank 2	TMR2	Timer2's Register								xxxx xxxx	uuuu uuuu
16h, Bank 1	PIR1	RBIF	TMR3IF	TMR2IF	TMR1IF	CA2IF	CA1IF	TX1IF	RC1IF	x000 0010	u000 0010
17h, Bank 1	PIE1	RBIE	TMR3IE	TMR2IE	TMR1IE	CA2IE	CA1IE	TX1IE	RC1IE	0000 0000	0000 0000
07h, Unbanked	INTSTA	PEIF	T0CKIF	T0IF	INTF	PEIE	T0CKIE	T0IE	INTE	0000 0000	0000 0000
06h, Unbanked	CPUSTA	—	—	STKAV	GLINTD	T0	PD	POR	BOR	--11 11qq	--11 qquu
14h, Bank 2	PR1	Timer1 Period Register								xxxx xxxx	uuuu uuuu
15h, Bank 2	PR2	Timer2 Period Register								xxxx xxxx	uuuu uuuu
10h, Bank 3	PW1DCL	DC1	DC0	—	—	—	—	—	—	xx-- ----	uu-- ----
11h, Bank 3	PW2DCL	DC1	DC0	TM2PW2	—	—	—	—	—	xx0- ----	uu0- ----
10h, Bank 7	PW3DCL	DC1	DC0	TM2PW3	—	—	—	—	—	xx0- ----	uu0- ----
12h, Bank 3	PW1DCH	DC9	DC8	DC7	DC6	DC5	DC4	DC3	DC2	xxxx xxxx	uuuu uuuu
13h, Bank 3	PW2DCH	DC9	DC8	DC7	DC6	DC5	DC4	DC3	DC2	xxxx xxxx	uuuu uuuu
11h, Bank 7	PW3DCH	DC9	DC8	DC7	DC6	DC5	DC4	DC3	DC2	xxxx xxxx	uuuu uuuu

Legend: x = unknown, u = unchanged, - = unimplemented, read as '0', q = value depends on conditions.
Shaded cells are not used by PWM Module.

PIC17C7XX

13.2.4 EXTERNAL CLOCK INPUT FOR TIMER3

When TMR3CS is set, the 16-bit TMR3 increments on the falling edge of clock input TCLK3. The input on the RB5/TCLK3 pin is sampled and synchronized by the internal phase clocks, twice every instruction cycle. This causes a delay from the time a falling edge appears on TCLK3 to the time TMR3 is actually incremented. For the external clock input timing requirements, see the Electrical Specification section. Figure 13-7 shows the timing diagram when operating from an external clock.

13.2.5 READING/WRITING TIMER3

Since Timer3 is a 16-bit timer and only 8-bits at a time can be read or written, care should be taken when reading or writing while the timer is running. The best method is to stop the timer, perform any read or write operation and then restart Timer3 (using the TMR3ON bit). However, if it is necessary to keep Timer3 free-running, care must be taken. For writing to the 16-bit TMR3, Example 13-2 may be used. For reading the 16-bit TMR3, Example 13-3 may be used. Interrupts must be disabled during this routine.

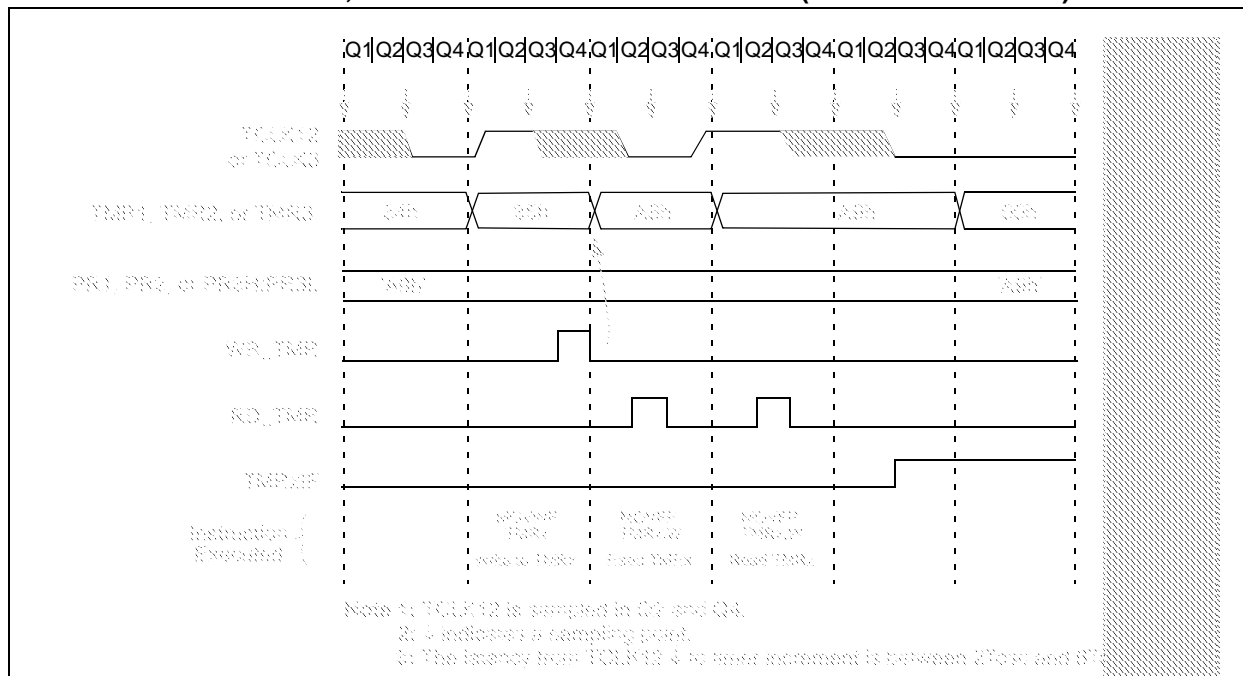
EXAMPLE 13-2: WRITING TO TMR3

```
BSF    CPUSTA, GLINTD    ; Disable interrupts
MOVFP  RAM_L,  TMR3L     ;
MOVFP  RAM_H,  TMR3H     ;
BCF    CPUSTA, GLINTD    ; Done, enable interrupts
```

EXAMPLE 13-3: READING FROM TMR3

```
MOVFP  TMR3L, TMPLO      ; read low TMR3
MOVFP  TMR3H, TMPHI      ; read high TMR3
MOVFP  TMPLO, WREG        ; tmplo -> wreg
CPFSLT TMR3L              ; TMR3L < wreg?
RETURN                                ; no then return
MOVFP  TMR3L, TMPLO      ; read low TMR3
MOVFP  TMR3H, TMPHI      ; read high TMR3
RETURN                                ; return
```

FIGURE 13-7: TIMER1, TIMER2 AND TIMER3 OPERATION (IN COUNTER MODE)



PIC17C7XX

The USART can be configured as a full duplex asynchronous system that can communicate with peripheral devices such as CRT terminals and personal computers, or it can be configured as a half duplex synchronous system that can communicate with peripheral devices such as A/D or D/A integrated circuits, Serial EEPROMs etc. The USART can be configured in the following modes:

- Asynchronous (full duplex)
- Synchronous - Master (half duplex)
- Synchronous - Slave (half duplex)

The SPEN (RCSTA<7>) bit has to be set in order to configure the I/O pins as the Serial Communication Interface (USART).

The USART module will control the direction of the RX/DT and TX/CK pins, depending on the states of the USART configuration bits in the RCSTA and TXSTA registers. The bits that control I/O direction are:

- SPEN
- TXEN
- SREN
- CREN
- CSRC

REGISTER 14-2: RCSTA1 REGISTER (ADDRESS: 13h, BANK 0) RCSTA2 REGISTER (ADDRESS: 13h, BANK 4)

R/W-0	R/W-0	R/W-0	R/W-0	U-0	R-0	R-0	R-x
SPEN	RX9	SREN	CREN	—	FERR	OERR	RX9D
bit 7							bit 0

- bit 7 **SPEN:** Serial Port Enable bit
1 = Configures TX/CK and RX/DT pins as serial port pins
0 = Serial port disabled
- bit 6 **RX9:** 9-bit Receive Select bit
1 = Selects 9-bit reception
0 = Selects 8-bit reception
- bit 5 **SREN:** Single Receive Enable bit
This bit enables the reception of a single byte. After receiving the byte, this bit is automatically cleared.
Synchronous mode:
1 = Enable reception
0 = Disable reception
Note: This bit is ignored in synchronous slave reception.
Asynchronous mode:
Don't care
- bit 4 **CREN:** Continuous Receive Enable bit
This bit enables the continuous reception of serial data.
Asynchronous mode:
1 = Enable continuous reception
0 = Disables continuous reception
Synchronous mode:
1 = Enables continuous reception until CREN is cleared (CREN overrides SREN)
0 = Disables continuous reception
- bit 3 **Unimplemented:** Read as '0'
- bit 2 **FERR:** Framing Error bit
1 = Framing error (updated by reading RCREG)
0 = No framing error
- bit 1 **OERR:** Overrun Error bit
1 = Overrun (cleared by clearing CREN)
0 = No overrun error
- bit 0 **RX9D:** 9th bit of Receive Data (can be the software calculated parity bit)

Legend:

R = Readable bit	W = Writable bit	U = Unimplemented bit, read as '0'
- n = Value at POR Reset	'1' = Bit is set	'0' = Bit is cleared x = Bit is unknown

14.3.2 USART SYNCHRONOUS MASTER RECEPTION

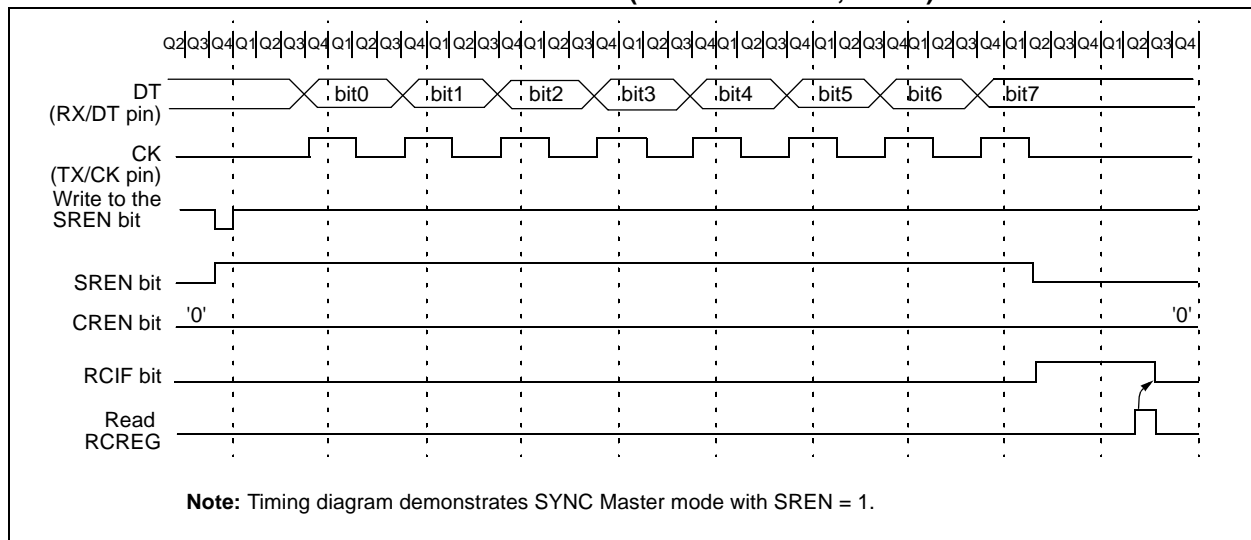
Once Synchronous mode is selected, reception is enabled by setting either the SREN (RCSTA<5>) bit or the CREN (RCSTA<4>) bit. Data is sampled on the RX/DT pin on the falling edge of the clock. If SREN is set, then only a single word is received. If CREN is set, the reception is continuous until CREN is reset. If both bits are set, then CREN takes precedence. After clocking the last bit, the received data in the Receive Shift Register (RSR) is transferred to RCREG (if it is empty). If the transfer is complete, the interrupt bit RCIF is set. The actual interrupt can be enabled/disabled by setting/clearing the RCIE bit. RCIF is a read only bit which is reset by the hardware. In this case, it is reset when RCREG has been read and is empty. RCREG is a double buffered register; i.e., it is a two deep FIFO. It is possible for two bytes of data to be received and transferred to the RCREG FIFO and a third byte to begin shifting into the RSR. On the clocking of the last bit of the third byte, if RCREG is still full, then the overrun error bit OERR (RCSTA<1>) is set. The word in the RSR will be lost. RCREG can be read twice to retrieve the two bytes in the FIFO. The OERR bit has to be cleared in software. This is done by clearing the CREN bit. If OERR is set, transfers from RSR to RCREG are inhibited, so it is essential to clear the OERR bit if it is set. The 9th receive bit is buffered the same way as the receive data. Reading the RCREG register will allow the RX9D and FERR bits to be loaded with values for the next received data; therefore, it is essential for the user to read the RCSTA register before reading RCREG in order not to lose the old FERR and RX9D information.

Steps to follow when setting up a Synchronous Master Reception:

1. Initialize the SPBRG register for the appropriate baud rate. See Section 14.1 for details.
2. Enable the synchronous master serial port by setting bits SYNC, SPEN, and CSRC.
3. If interrupts are desired, then set the RCIE bit.
4. If 9-bit reception is desired, then set the RX9 bit.
5. If a single reception is required, set bit SREN. For continuous reception set bit CREN.
6. The RCIF bit will be set when reception is complete and an interrupt will be generated if the RCIE bit was set.
7. Read RCSTA to get the ninth bit (if enabled) and determine if any error occurred during reception.
8. Read the 8-bit received data by reading RCREG.
9. If any error occurred, clear the error by clearing CREN.

Note: To terminate a reception, either clear the SREN and CREN bits, or the SPEN bit. This will reset the receive logic so that it will be in the proper state when receive is re-enabled.

FIGURE 14-10: SYNCHRONOUS RECEPTION (MASTER MODE, SREN)



PIC17C7XX

16.4.1 A/D RESULT REGISTERS

The ADRESH:ADRESL register pair is the location where the 10-bit A/D result is loaded at the completion of the A/D conversion. This register pair is 16-bits wide. The A/D module gives the flexibility to left or right justify the 10-bit result in the 16-bit result register. The A/D Format Select bit (ADFM) controls this justification. Figure 16-6 shows the operation of the A/D result justification. The extra bits are loaded with '0's'. When an A/D result will not overwrite these locations (A/D disable), these registers may be used as two general purpose 8-bit registers.

16.5 A/D Operation During SLEEP

The A/D module can operate during SLEEP mode. This requires that the A/D clock source be set to RC (ADCS1:ADCS0 = 11). When the RC clock source is selected, the A/D module waits one instruction cycle before starting the conversion. This allows the SLEEP instruction to be executed, which eliminates all digital switching noise from the conversion. When the conversion is completed, the GO/DONE bit will be cleared, and the result loaded into the ADRES register. If the A/D interrupt is enabled, the device will wake-up from

SLEEP. If the A/D interrupt is not enabled, the A/D module will then be turned off, although the ADON bit will remain set.

When the A/D clock source is another clock option (not RC), a SLEEP instruction will cause the present conversion to be aborted and the A/D module to be turned off, though the ADON bit will remain set.

Turning off the A/D places the A/D module in its lowest current consumption state.

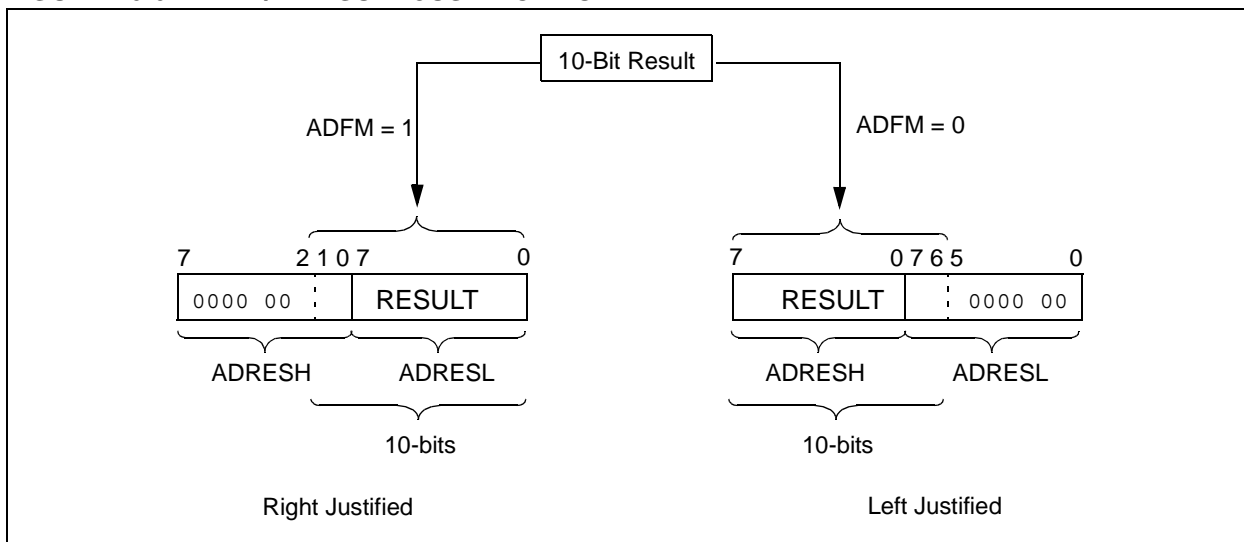
Note: For the A/D module to operate in SLEEP, the A/D clock source must be set to RC (ADCS1:ADCS0 = 11). To allow the conversion to occur during SLEEP, ensure the SLEEP instruction immediately follows the instruction that sets the GO/DONE bit.

16.6 Effects of a RESET

A device RESET forces all registers to their RESET state. This forces the A/D module to be turned off, and any conversion is aborted.

The value that is in the ADRESH:ADRESL registers is not modified for a Power-on Reset. The ADRESH:ADRESL registers will contain unknown data after a Power-on Reset.

FIGURE 16-6: A/D RESULT JUSTIFICATION



ADDWFC		ADD WREG and Carry bit to f						
Syntax:	[<i>label</i>] ADDWFC f,d							
Operands:	0 ≤ f ≤ 255 d ∈ [0,1]							
Operation:	(WREG) + (f) + C → (dest)							
Status Affected:	OV, C, DC, Z							
Encoding:	<table border="1"><tr><td>0001</td><td>000d</td><td>ffff</td><td>ffff</td></tr></table>				0001	000d	ffff	ffff
0001	000d	ffff	ffff					
Description:	Add WREG, the Carry Flag and data memory location 'f'. If 'd' is 0, the result is placed in WREG. If 'd' is 1, the result is placed in data memory location 'f'.							
Words:	1							
Cycles:	1							
Q Cycle Activity:								
	Q1	Q2	Q3	Q4				
	Decode	Read register 'f'	Process Data	Write to destination				

Example: ADDWFC REG 0

Before Instruction

Carry bit = 1
REG = 0x02
WREG = 0x4D

After Instruction

Carry bit = 0
REG = 0x02
WREG = 0x50

ANDLW		And Literal with WREG						
Syntax:	[<i>label</i>] ANDLW k							
Operands:	$0 \leq k \leq 255$							
Operation:	(WREG) .AND. (k) \rightarrow (WREG)							
Status Affected:	Z							
Encoding:	<table border="1"><tr><td>1011</td><td>0101</td><td>kkkk</td><td>kkkk</td></tr></table>				1011	0101	kkkk	kkkk
1011	0101	kkkk	kkkk					
Description:	The contents of WREG are AND'ed with the 8-bit literal 'k'. The result is placed in WREG.							
Words:	1							
Cycles:	1							
Q Cycle Activity:								
	Q1	Q2	Q3	Q4				
	Decode	Read literal 'k'	Process Data	Write to WREG				

Example: ANDLW 0x5F

Before Instruction

WREG = 0xA3

After Instruction

WREG = 0x03

Compare f with WREG, skip if f = WREG				
CPFSEQ				
Syntax:	[<i>label</i>] CPFSEQ f			
Operands:	0 ≤ f ≤ 255			
Operation:	(f) – (WREG), skip if (f) = (WREG) (unsigned comparison)			
Status Affected:	None			
Encoding:	0011	0001	ffff	ffff
Description:	Compares the contents of data memory location 'f' to the contents of WREG by performing an unsigned subtraction. If 'f' = WREG, then the fetched instruction is discarded and a NOP is executed instead, making this a two-cycle instruction.			
Words:	1			
Cycles:	1 (2)			
Q Cycle Activity:				
	Q1	Q2	Q3	Q4
	Decode	Read register 'f'	Process Data	No operation
If skip:				
	Q1	Q2	Q3	Q4
	No operation	No operation	No operation	No operation

Example:

```

HERE    CPFSEQ REG
NEQUAL  :
EQUAL   :

```

Before Instruction

```

PC Address = HERE
WREG       = ?
REG        = ?

```

After Instruction

```

If REG     = WREG;
PC         = Address (EQUAL)
If REG     ≠ WREG;
PC         = Address (NEQUAL)

```

Compare f with WREG, skip if f > WREG								
CPFSGT								
Syntax:	[<i>label</i>] CPFSGT f							
Operands:	$0 \leq f \leq 255$							
Operation:	(f) – (WREG), skip if (f) > (WREG) (unsigned comparison)							
Status Affected:	None							
Encoding:	<table><tr><td>0011</td><td>0010</td><td>ffff</td><td>ffff</td></tr></table>				0011	0010	ffff	ffff
0011	0010	ffff	ffff					
Description:	Compares the contents of data memory location 'f' to the contents of the WREG by performing an unsigned subtraction. If the contents of 'f' are greater than the contents of WREG, then the fetched instruction is discarded and a NOP is executed instead, making this a two-cycle instruction.							
Words:	1							
Cycles:	1 (2)							
Q Cycle Activity:								
	Q1	Q2	Q3	Q4				
	Decode	Read register 'f'	Process Data	No operation				
If skip:								
	Q1	Q2	Q3	Q4				
	No operation	No operation	No operation	No operation				

Example:

```

HERE    CPFSGT REG
NGREATER :
GREATER  :

```

Before Instruction

```

PC       = Address (HERE)
WREG     = ?

```

After Instruction

```

If REG   > WREG;
PC       = Address (GREATER)
If REG   ≤ WREG;
PC       = Address (NGREATER)

```

PIC17C7XX

RETURN Return from Subroutine

Syntax: [*label*] RETURN

Operands: None

Operation: TOS → PC;

Status Affected: None

Encoding:

0000	0000	0000	0010
------	------	------	------

Description: Return from subroutine. The stack is popped and the top of the stack (TOS) is loaded into the program counter.

Words: 1

Cycles: 2

Q Cycle Activity:

Q1	Q2	Q3	Q4
Decode	No operation	Process Data	POP PC from stack
No operation	No operation	No operation	No operation

Example: RETURN

After Interrupt
PC = TOS

RLCF Rotate Left f through Carry

Syntax: [*label*] RLCF f,d

Operands: $0 \leq f \leq 255$
 $d \in [0,1]$

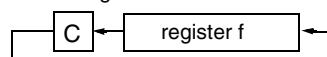
Operation: $f \langle n \rangle \rightarrow d \langle n+1 \rangle$;
 $f \langle 7 \rangle \rightarrow C$;
 $C \rightarrow d \langle 0 \rangle$

Status Affected: C

Encoding:

0001	101d	ffff	ffff
------	------	------	------

Description: The contents of register 'f' are rotated one bit to the left through the Carry Flag. If 'd' is 0, the result is placed in WREG. If 'd' is 1, the result is stored back in register 'f'.



Words: 1

Cycles: 1

Q Cycle Activity:

Q1	Q2	Q3	Q4
Decode	Read register 'f'	Process Data	Write to destination

Example: RLCF REG, 0

Before Instruction

REG = 1110 0110
C = 0

After Instruction

REG = 1110 0110
WREG = 1100 1100
C = 1

PIC17C7XX

Param No.	Sym	Characteristic		Min	Max	Units	Conditions
110	Tbuf	Bus free time	100 kHz mode	4.7	—	ms	Time the bus must be free before a new transmission can start
			400 kHz mode	1.3	—	ms	
			1 MHz mode ⁽¹⁾	0.5	—	ms	
D102	Cb	Bus capacitive loading		—	400	pF	

- Note**
- 1: Maximum pin capacitance = 10 pF for all I²C pins.
 - 2: A fast mode (400 KHz) I²C bus device can be used in a standard mode I²C bus system, but the parameter # 107 \geq 250 ns must then be met. This will automatically be the case if the device does not stretch the LOW period of the SCL signal. If such a device does stretch the LOW period of the SCL signal, it must output the next data bit to the SDA line. Parameter #102 + #107 = 1000 + 250 = 1250 ns (for 100 kHz mode) before the SCL line is released.
 - 3: C_b is specified to be from 10-400pF. The minimum specifications are characterized with C_b=10pF. The rise time spec (t_r) is characterized with R_p=R_p min. The minimum fall time specification (t_f) is characterized with C_b=10pF, and R_p=R_p max. These are only valid for fast mode operation (V_{DD}=4.5-5.5V) and where the SPM bit (SSPSTAT<7>) =1.)
 - 4: Max specifications for these parameters are valid for falling edge only. Specs are characterized with R_p=R_p min and C_b=400pF for standard mode, 200pF for fast mode, and 10pF for 1MHz mode.

FIGURE 20-19: USART SYNCHRONOUS TRANSMISSION (MASTER/SLAVE) TIMING

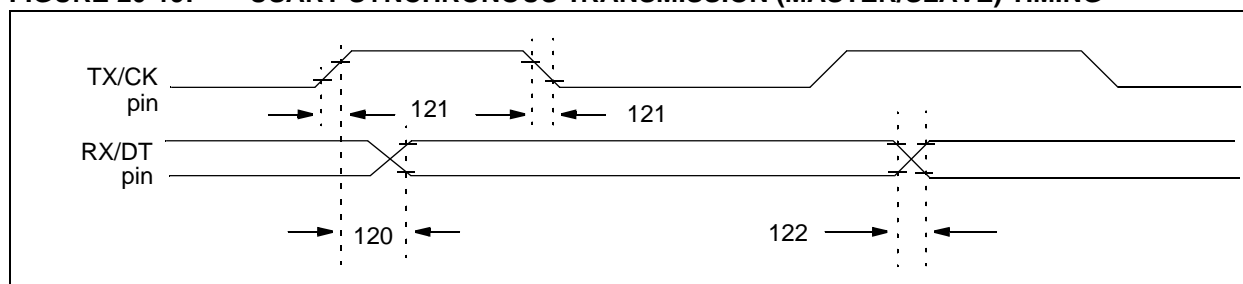


TABLE 20-14: USART SYNCHRONOUS TRANSMISSION REQUIREMENTS

Param No.	Sym	Characteristic		Min	Typ†	Max	Units	Conditions
120	TckH2dtV	<u>SYNC XMIT (MASTER & SLAVE)</u>						
		Clock high to data out valid						
				—	—	50	ns	
				—	—	75	ns	
121	TckRF	Clock out rise time and fall time (Master mode)		—	—	25	ns	
				—	—	40	ns	
122	TdtRF	Data out rise time and fall time		—	—	25	ns	
				—	—	40	ns	

† Data in "Typ" column is at 5V, 25°C unless otherwise stated.

FIGURE 20-20: USART SYNCHRONOUS RECEIVE (MASTER/SLAVE) TIMING

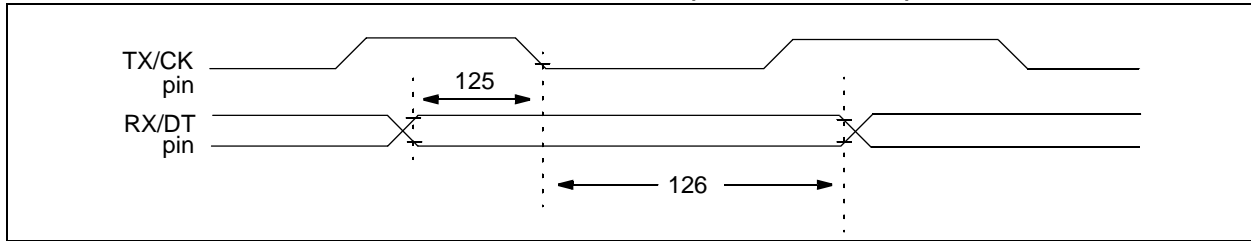


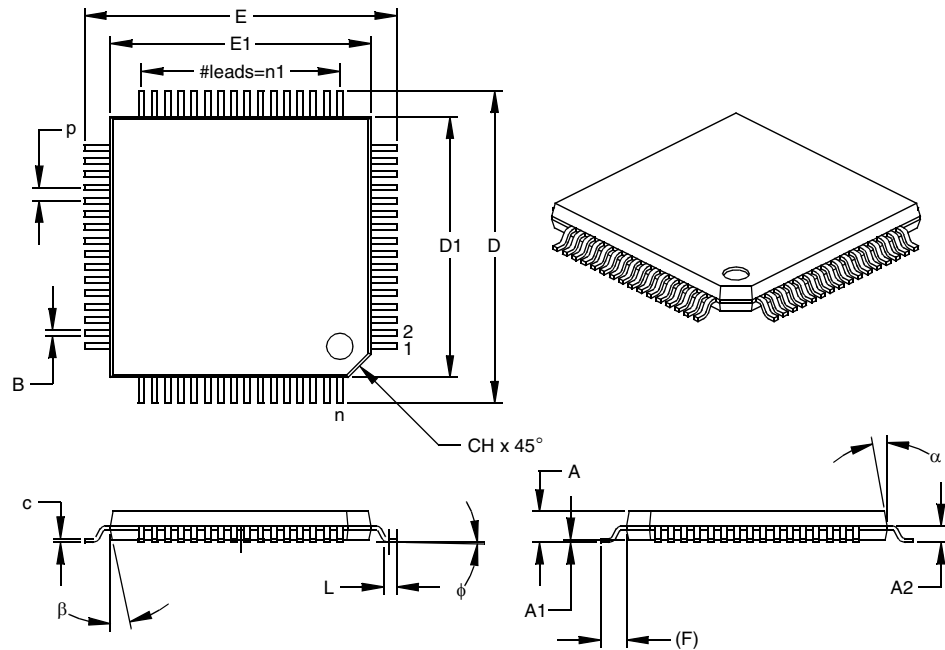
TABLE 20-15: USART SYNCHRONOUS RECEIVE REQUIREMENTS

Param No.	Sym	Characteristic	Min	Typ†	Max	Units	Conditions
125	TdtV2ckL	<u>SYNC RCV (MASTER & SLAVE)</u> Data setup before CK↓ (DT setup time)	15	—	—	ns	
126	TckL2dtl	Data hold after CK↓ (DT hold time)	15	—	—	ns	

† Data in "Typ" column is at 5V, 25°C unless otherwise stated.

64-Lead Plastic Thin Quad Flatpack (PT) 10x10x1 mm Body, 1.0/0.10 mm Lead Form (TQFP)

Note: For the most current package drawings, please see the Microchip Packaging Specification located at <http://www.microchip.com/packaging>



Units		INCHES			MILLIMETERS*		
Dimension Limits		MIN	NOM	MAX	MIN	NOM	MAX
Number of Pins	n		64			64	
Pitch	p		.020			0.50	
Pins per Side	n1		16			16	
Overall Height	A	.039	.043	.047	1.00	1.10	1.20
Molded Package Thickness	A2	.037	.039	.041	0.95	1.00	1.05
Standoff §	A1	.002	.006	.010	0.05	0.15	0.25
Foot Length	L	.018	.024	.030	0.45	0.60	0.75
Footprint (Reference)	(F)		.039			1.00	
Foot Angle	φ	0	3.5	7	0	3.5	7
Overall Width	E	.463	.472	.482	11.75	12.00	12.25
Overall Length	D	.463	.472	.482	11.75	12.00	12.25
Molded Package Width	E1	.390	.394	.398	9.90	10.00	10.10
Molded Package Length	D1	.390	.394	.398	9.90	10.00	10.10
Lead Thickness	c	.005	.007	.009	0.13	0.18	0.23
Lead Width	B	.007	.009	.011	0.17	0.22	0.27
Pin 1 Corner Chamfer	CH	.025	.035	.045	0.64	0.89	1.14
Mold Draft Angle Top	α	5	10	15	5	10	15
Mold Draft Angle Bottom	β	5	10	15	5	10	15

* Controlling Parameter
§ Significant Characteristic

Notes:

Dimensions D1 and E1 do not include mold flash or protrusions. Mold flash or protrusions shall not exceed .010" (0.254mm) per side.

JEDEC Equivalent: MS-026

Drawing No. C04-085

INDEX

A

A/D

Accuracy/Error	189
ADCON0 Register.....	179
ADCON1 Register.....	180
ADIF bit.....	181
Analog Input Model Block Diagram.....	184
Analog-to-Digital Converter.....	179
Block Diagram.....	181
Configuring Analog Port Pins.....	186
Configuring the Interrupt.....	181
Configuring the Module.....	181
Connection Considerations.....	189
Conversion Clock.....	185
Conversions.....	186
Converter Characteristics	263
Delays.....	183
Effects of a RESET	188
Equations.....	183
Flow Chart of A/D Operation.....	187
GO/DONE bit	181
Internal Sampling Switch (Rss) Impedence.....	183
Operation During SLEEP	188
Sampling Requirements.....	183
Sampling Time.....	183
Source Impedence.....	183
Time Delays.....	183
Transfer Function.....	189
A/D Interrupt.....	38
A/D Interrupt Flag bit, ADIF.....	38
A/D Module Interrupt Enable, ADIE	36
ACK.....	144
Acknowledge Data bit, AKD	136
Acknowledge Pulse.....	144
Acknowledge Sequence Enable bit, AKE	136
Acknowledge Status bit, AKS	136
ADCON0	49
ADCON1	49
ADDLW	202
ADDWF	202
ADDWFC	203
ADIE.....	36
ADIF.....	38
ADRES Register	179
ADRESH	49
ADRESL.....	49
AKD.....	136
AKE.....	136
AKS.....	136, 159
ALU	11
ALUSTA	198
ALUSTA Register.....	51
ANDLW	203
ANDWF.....	204
Application Note AN552, 'Implementing Wake-up on Keystroke.'	74
Application Note AN578, 'Use of the SSP Module in the I ² C Multi-Master Environment.'	143
Assembler	
MPASM Assembler.....	233
Asynchronous Master Transmission.....	123
Asynchronous Transmitter	123

B

Bank Select Register (BSR)	57
Banking.....	46, 57
Baud Rate Formula.....	120
Baud Rate Generator	153
Baud Rate Generator (BRG)	120
Baud Rates	
Asynchronous Mode.....	122
Synchronous Mode.....	121
BCF	204
BCLIE	36
BCLIF	38
BF	134, 144, 159, 162
Bit Manipulation	198
Block Diagrams	
A/D.....	181
Analog Input Model.....	184
Baud Rate Generator	153
BSR Operation	57
External Brown-out Protection Circuit (Case1).....	31
External Power-on Reset Circuit	24
External Program Memory Connection	45
I ² C Master Mode	151
I ² C Module.....	143
Indirect Addressing.....	54
On-chip Reset Circuit	23
PORTD	80
PORTE	82, 90, 91
Program Counter Operation	56
PWM.....	107
RA0 and RA1.....	72
RA2.....	72
RA3.....	73
RA4 and RA5.....	73
RB3:RB2 Port Pins	75
RB7:RB4 and RB1:RB0 Port Pins	74
RC7:RC0 Port Pins.....	78
SSP (I ² C Mode).....	143
SSP (SPI Mode)	137
SSP Module (I ² C Master Mode)	133
SSP Module (I ² C Slave Mode).....	133
SSP Module (SPI Mode)	133
Timer3 with One Capture and One Period Register	110
TMR1 and TMR2 in 16-bit Timer/Counter Mode	105
TMR1 and TMR2 in Two 8-bit Timer/Counter Mode	104
TMR3 with Two Capture Registers.....	112
Using CALL, GOTO.....	56
WDT	193
BODEN	31
Borrow	11
BRG	120, 153
Brown-out Protection	31
Brown-out Reset (BOR).....	31
BSF	205
BSR	57
BSR Operation	57
BTFSC	205
BTFSS	206
BTG	206
Buffer Full bit, BF	144
Buffer Full Status bit, BF	134
Bus Arbitration	170
Bus Collision	
Section.....	170

F

Family of Devices	
PIC17C75X	8
FERR	125
Flowcharts	
Acknowledge	166
Master Receiver	163
Master Transmit	160
RESTART Condition	157
Start Condition	155
STOP Condition	168
FOSC0	191
FOSC1	191
FS0	51
FS1	51
FS2	51
FS3	51
FSR0	54
FSR1	54

G

GCE	136
General Call Address Sequence	149
General Call Address Support	149
General Call Enable bit, GCE	136
General Format for Instructions	198
General Purpose RAM	43
General Purpose RAM Bank	57
General Purpose Register (GPR)	46
GLINTD	39, 52, 111, 194
Global Interrupt Disable bit, GLINTD	39
GOTO	212
GPR (General Purpose Register)	46
GPR Banks	57
Graphs	
RC Oscillator Frequency vs. VDD (CEXT = 100 pF) ...	268
RC Oscillator Frequency vs. VDD (CEXT = 22 pF)	268
RC Oscillator Frequency vs. VDD (CEXT = 300 pF) ...	269
Transconductance of LF Oscillator vs. VDD	270
Transconductance of XT Oscillator vs. VDD	270
Typical RC Oscillator vs. Temperature	267

H

Hardware Multiplier	67
---------------------------	----

I

I/O Ports	
Bi-directional	93
I/O Ports	71
Programming Considerations	93
Read-Modify-Write Instructions	93
Successive Operations	94
I ² C	143
I ² C Input	279
I ² C Master Mode Receiver Flow Chart	163
I ² C Master Mode Reception	162
I ² C Master Mode RESTART Condition	156
I ² C Mode Selection	143
I ² C Module	
Acknowledge Flow Chart	166
Acknowledge Sequence Timing	165
Addressing	145
Baud Rate Generator	153
Block Diagram	151
BRG Block Diagram	153
BRG Reset due to SDA Collision	172
BRG Timing	153
Bus Arbitration	170

Bus Collision	170
Acknowledge	170
RESTART Condition	173
RESTART Condition Timing (Case1)	173
RESTART Condition Timing (Case2)	173
START Condition	171
START Condition Timing	171, 172
STOP Condition	174
STOP Condition Timing (Case1)	174
STOP Condition Timing (Case2)	174
Transmit Timing	170
Bus Collision Timing	170
Clock Arbitration	169
Clock Arbitration Timing (Master Transmit)	169
Conditions to not give ACK Pulse	144
General Call Address Support	149
Master Mode	151
Master Mode 7-bit Reception timing	164
Master Mode Operation	152
Master Mode Start Condition	154
Master Mode Transmission	159
Master Mode Transmit Sequence	152
Master Transmit Flowchart	160
Multi-Master Communication	170
Multi-master Mode	152
Operation	143
Repeat Start Condition timing	156
RESTART Condition Flowchart	157
Slave Mode	144
Slave Reception	145
Slave Transmission	146
SSPBUF	144
Start Condition Flowchart	155
Stop Condition Flowchart	168
Stop Condition Receive or Transmit timing	167
Stop Condition timing	167
Waveforms for 7-bit Reception	146
Waveforms for 7-bit Transmission	146
I ² C Module Address Register, SSPADD	144
I ² C Slave Mode	144
INCF	213
INCFSNZ	214
INCFSZ	213
In-Circuit Serial Programming	196
INDFO	54
INDF1	54
Indirect Addressing	
Indirect Addressing	54
Operation	55
Registers	54
Initializing PORTB	75
Initializing PORTC	78
Initializing PORTD	80
Initializing PORTE	82, 84, 86
INSTA	48
Instruction Flow/Pipelining	21
Instruction Set	
ADDLW	202
ADDWF	202
ADDWFC	203
ANDLW	203
ANDWF	204
BCF	204
BSF	205
BTFSC	205
BTFSS	206

PIC17C7XX

BTG.....	206	Capture4 Interrupt	38
CALL.....	207	Context Saving	39
CLRF.....	207	Flag bits	
CLRWDT.....	208	TMR1IE	33
COMF.....	208	TMR1IF.....	33
CPFSEQ.....	209	TMR2IE	33
CPFSGT.....	209	TMR2IF.....	33
CPFSLT.....	210	TMR3IE	33
DAW.....	210	TMR3IF.....	33
DECF.....	211	Global Interrupt Disable.....	39
DECFSNZ.....	212	Interrupts	33
DECFSZ.....	211	Logic	33
GOTO.....	212	Operation	39
INCF.....	213	Peripheral Interrupt Enable.....	35
INCFSNZ.....	214	Peripheral Interrupt Request.....	37
INCFSZ.....	213	PIE2 Register	36
IORLW.....	214	PIR1 Register	37
IORWF.....	215	PIR2 Register	38
LCALL.....	215	PORTB Interrupt on Change	37
MOVFP.....	216	PWM.....	108
MOVLB.....	216	RA0/INT	39
MOVLR.....	217	Status Register	34
MOVLW.....	217	Synchronous Serial Port Interrupt.....	38
MOVFP.....	218	T0CKI Interrupt	39
MOVWF.....	218	Timing.....	40
MULLW.....	219	TMR1 Overflow Interrupt	37
MULWF.....	219	TMR2 Overflow Interrupt	37
NEGW.....	220	TMR3 Overflow Interrupt	37
NOP.....	220	USART1 Receive Interrupt	37
RETFIE.....	221	USART1 Transmit Interrupt	37
RETLW.....	221	USART2 Receive Interrupt	38
RETURN.....	222	Vectors	
RLCF.....	222	Peripheral Interrupt.....	39
RLNCF.....	223	Program Memory Locations	43
RRCF.....	223	RA0/INT Interrupt	39
RRNCF.....	224	T0CKI Interrupt.....	39
SETF.....	224	Vectors/Priorities.....	39
SLEEP.....	225	Wake-up from SLEEP.....	194
SUBLW.....	225	INTF.....	34
SUBWF.....	226	INTSTA Register.....	34
SUBWFB.....	226	IORLW.....	214
SWAPF.....	227	IORWF.....	215
TABLRD.....	227, 228	IRBPU VS. VDD	274
TABLWT.....	228, 229	K	
TLRD.....	229	KeeLoq Evaluation and Programming Tools	236
TLWT.....	230	L	
TSTFSZ.....	230	LCALL.....	54, 215
XORLW.....	231	M	
XORWF.....	231	Maps	
Instruction Set Summary.....	197	Register File Map.....	47
Instructions		Memory	
TABLRD.....	64	External Interface	45
TLRD.....	64	External Memory Waveforms	45
INT Pin	40	Memory Map (Different Modes)	44
INTE.....	34	Mode Memory Access	44
INTEDG.....	53, 97	Organization	43
Inter-Integrated Circuit (I ² C).....	133	Program Memory	43
Internal Sampling Switch (R _{ss}) Impedance	183	Program Memory Map	43
Interrupt on Change Feature.....	74	Microcontroller	43
Interrupt Status Register (INTSTA)	34	Microprocessor	43
Interrupts		Minimizing Current Consumption.....	195
A/D Interrupt.....	38	MOVFP.....	46, 216
Bus Collision Interrupt.....	38	Moving Data Between Data and Program Memories	46
Capture1 Interrupt.....	37	MOVLB.....	46, 216
Capture2 Interrupt.....	37	MOVLR.....	217
Capture3 Interrupt.....	38	MOVLW.....	217

PIC17C7XX

R

R/W	134	PR1	49
R/W bit	145	PR2	49
R/W bit	145	PR3H/CA1H	49
RA1/T0CKI pin	97	PR3L/CA1L	49
RBIE	35	PRODH	50
RBIF	37	PRODL	50
RBPUR	74	PW1DCH	49
RC Oscillator	20	PW1DCL	49
RC Oscillator Frequencies	269	PW2/DCL	49
RC1IE	35	PW2DCH	49
RC1IF	37	PW3DCH	50
RC2IE	36	PW3DCL	50
RC2IF	38	RCREG1	48
RCE, Receive Enable bit, RCE	136	RCREG2	49
RCREG	125, 126, 130, 131	RCSTA1	48
RCREG1	27, 48	RCSTA2	49
RCREG2	27, 49	SPBRG1	48
RCSTA	126, 130, 132	SPBRG2	49
RCSTA1	27, 48	SSPADD	50
RCSTA2	27, 49	SSPBUF	50
Read/Write bit, R/W	134	SSPCON1	50
Reading 16-bit Value	99	SSPCON2	50
Receive Overflow Indicator bit, SSPOV	135	SSPSTAT	50, 134
Receive Status and Control Register	117	T0STA	48, 53, 97
Register File Map	47	TBLPTRH	48
Registers		TBLPTRL	48
ADCON0	49	TCON1	49, 101
ADCON1	49	TCON2	49, 102
ADRESH	49	TCON3	50, 103
ADRESL	49	TMR0H	48
ALUSTA	39, 48, 51	TMR1	49
BRG	120	TMR2	49
BSR	39, 48	TMR3H	49
CA2H	49	TMR3L	49
CA2L	49	TXREG1	48
CA3H	50	TXREG2	49
CA3L	50	TXSTA1	48
CA4H	50	TXSTA2	49
CA4L	50	WREG	39, 48
CPUSTA	48, 52	Registers	
DDRB	48	TMR0L	48
DDRC	48	Reset	
DDRD	48	Section	23
DDRE	48	Status Bits and Their Significance	25
DDRF	49	Time-Out in Various Situations	25
DDRG	49	Time-Out Sequence	25
FSR0	48, 54	Restart Condition Enabled bit, RSE	136
FSR1	48, 54	RETFIE	221
INDF0	48, 54	RETLW	221
INDF1	48, 54	RETURN	222
INSTA	48	RLCF	222
INTSTA	34	RLNCF	223
PCL	48	RRCF	223
PCLATH	48	RRNCF	224
PIE1	35, 48	RSE	136
PIE2	36, 49	RX Pin Sampling Scheme	125
PIR1	37, 48	S	
PIR2	38, 49	S	134
PORTA	48	SAE	136
PORTB	48	Sampling	125
PORTC	48	Saving STATUS and WREG in RAM	42
PORTD	48	SCK	137
PORTE	48	SCL	144
PORTF	49	SDA	144
PORTG	49	SDI	137
		SDO	137

SEEVAL Evaluation and Programming System.....	236
Serial Clock, SCK	137
Serial Clock, SCL	144
Serial Data Address, SDA	144
Serial Data In, SDI	137
Serial Data Out, SDO	137
SETF	224
SFR	198
SFR (Special Function Registers).....	43
SFR As Source/Destination	198
Signed Math	11
Slave Select Synchronization	140
Slave Select, \overline{SS}	137
SLEEP	194, 225
SLEEP Mode, All Peripherals Disabled	273
SLEEP Mode, BOR Enabled	273
SMP	134
Software Simulator (MPLAB SIM).....	234
SPBRG	126, 130, 132
SPBRG1	27, 48
SPBRG2	27, 49
SPE	136
Special Features of the CPU	191
Special Function Registers	43, 198
Summary.....	48
Special Function Registers, File Map	47
SPI	
Master Mode	139
Serial Clock	137
Serial Data In	137
Serial Data Out	137
Serial Peripheral Interface (SPI)	133
Slave Select	137
SPI clock	139
SPI Mode	137
SPI Clock Edge Select, CKE	134
SPI Data Input Sample Phase Select, SMP	134
SPI Master/Slave Connection	138
SPI Module	
Master/Slave Connection	138
Slave Mode	140
Slave Select Synchronization	140
Slave Synch Timing	140
\overline{SS}	137
SSP	133
Block Diagram (SPI Mode)	137
SPI Mode	137
SSPADD	144, 145
SSPBUF	139, 144
SSPCON1	135
SSPCON2	136
SSPSR	139, 144
SSPSTAT	134, 144
SSP I ² C	
SSP I ² C Operation	143
SSP Module	
SPI Master Mode	139
SPI Master/Slave Connection	138
SPI Slave Mode	140
SSPCON1 Register	143
SSP Overflow Detect bit, SSPOV	144
SSPADD	50
SSPBUF	50, 144
SSPCON1	50, 135, 143
SSPCON2	50, 136
SSPEN	135

SSPIE	36
SSPIF	38, 145
SSPM3:SSPM0	135
SSPOV	135, 144, 162
SSPSTAT	50, 134, 144
ST Input	278
Stack	
Operation	54
Pointer	54
Stack	43
START bit (S)	134
START Condition Enabled bit, SAE	136
STKAV	52, 54
STOP bit (P)	134
STOP Condition Enable bit	136
SUBLW	225
SUBWF	226
SUBWFB	226
SWAPF	227
Synchronous Master Mode	127
Synchronous Master Reception	129
Synchronous Master Transmission	127
Synchronous Serial Port	133
Synchronous Serial Port Enable bit, SSPEN	135
Synchronous Serial Port Interrupt	38
Synchronous Serial Port Interrupt Enable, SSPIE	36
Synchronous Serial Port Mode Select bits,	
SSPM3:SSPM0	135
Synchronous Slave Mode	131
T	
T0CKI	39
T0CKI Pin	40
T0CKIE	34
T0CKIF	34
T0CS	53, 97
T0IE	34
T0IF	34
T0SE	53, 97
T0STA	53
T16	101
Table Latch	55
Table Pointer	55
Table Read	
Example	64
Table Reads Section	64
TLRD	64
Table Write	
Code	62
Timing	62
To External Memory	62
TABLRD	227, 228
TABLWT	228, 229
TAD	185
TBLATH	55
TBLATL	55
TBLPTRH	55
TBLPTL	55
TCLK12	101
TCLK3	101
TCON1	28, 49
TCON2	49
TCON2,TCON3	28
TCON3	50, 103
Time-Out Sequence	25
Timer Resources	95

PIC17C7XX

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