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Applications of "<u>Embedded -</u> <u>Microcontrollers</u>"

Details

Product Status	Active
Core Processor	PIC
Core Size	8-Bit
Speed	20MHz
Connectivity	-
Peripherals	POR, WDT
Number of I/O	20
Program Memory Size	768B (512 x 12)
Program Memory Type	OTP
EEPROM Size	-
RAM Size	24 x 8
Voltage - Supply (Vcc/Vdd)	4.5V ~ 5.5V
Data Converters	-
Oscillator Type	External
Operating Temperature	0°C ~ 70°C (TA)
Mounting Type	Surface Mount
Package / Case	28-SSOP (0.209", 5.30mm Width)
Supplier Device Package	28-SSOP
Purchase URL	https://www.e-xfl.com/product-detail/microchip-technology/pic16c55-hs-ss

Email: info@E-XFL.COM

Address: Room A, 16/F, Full Win Commercial Centre, 573 Nathan Road, Mongkok, Hong Kong

NOTES:

4.4 RC Oscillator

For timing insensitive applications, the RC device option offers additional cost savings. The RC oscillator frequency is a function of the supply voltage, the resistor (REXT) and capacitor (CEXT) values, and the operating temperature. In addition to this, the oscillator frequency will vary from unit to unit due to normal process parameter variation. Furthermore, the difference in lead frame capacitance between package types will also affect the oscillation frequency, especially for low CEXT values. The user also needs to take into account variation due to tolerance of external R and C components used.

Figure 4-5 shows how the R/C combination is connected to the PIC16C5X. For REXT values below 2.2 k Ω , the oscillator operation may become unstable, or stop completely. For very high REXT values (e.g., 1 M Ω) the oscillator becomes sensitive to noise, humidity and leakage. Thus, we recommend keeping REXT between 3 k Ω and 100 k Ω .

Although the oscillator will operate with no external capacitor (CEXT = 0 pF), we recommend using values above 20 pF for noise and stability reasons. With no or small external capacitance, the oscillation frequency can vary dramatically due to changes in external capacitances, such as PCB trace capacitance or package lead frame capacitance.

The Electrical Specifications sections show RC frequency variation from part to part due to normal process variation. The variation is larger for larger R (since leakage current variation will affect RC frequency more for large R) and for smaller C (since variation of input capacitance will affect RC frequency more).

Also, see the Electrical Specifications sections for variation of oscillator frequency due to VDD for given REXT/ CEXT values as well as frequency variation due to operating temperature for given R, C, and VDD values.

The oscillator frequency, divided by 4, is available on the OSC2/CLKOUT pin, and can be used for test purposes or to synchronize other logic.



Note: If you change from this device to another device, please verify oscillator characteristics in your application.

6.2.2 SPECIAL FUNCTION REGISTERS

The Special Function Registers are registers used by the CPU and peripheral functions to control the operation of the device (Table 6-1).

The Special Registers can be classified into two sets. The Special Function Registers associated with the "core" functions are described in this section. Those related to the operation of the peripheral features are described in the section for each peripheral feature.

Address	Name	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0	Value on Power-on Reset	Details on Page
N/A	TRIS	I/O Cont	I/O Control Registers (TRISA, TRISB, TRISC)								35
N/A	OPTION	Contains	s control b	oits to cor	figure Ti	mer0 and	Timer0/V	VDT pres	caler	11 1111	30
00h	INDF	Uses co	Uses contents of FSR to address data memory (not a physical register)							XXXX XXXX	32
01h	TMR0	Timer0 I	Timer0 Module Register							XXXX XXXX	38
02h ⁽¹⁾	PCL	Low ord	Low order 8 bits of PC							1111 1111	31
03h	STATUS	PA2	PA1	PA0	TO	PD	Z	DC	С	0001 1xxx	29
04h	FSR	Indirect	Indirect data memory address pointer						1xxx xxxx (3)	32	
05h	PORTA	—	—	—	—	RA3	RA2	RA1	RA0	xxxx	35
06h	PORTB	RB7	RB6	RB5	RB4	RB3	RB2	RB1	RB0	XXXX XXXX	35
07h ⁽²⁾	PORTC	RC7	RC6	RC5	RC4	RC3	RC2	RC1	RC0	XXXX XXXX	35

|--|

Legend: x = unknown, u = unchanged, - = unimplemented, read as '0' (if applicable). Shaded cells = unimplemented or unused

Note 1: The upper byte of the Program Counter is not directly accessible. See Section 6.5 for an explanation of how to access these bits.

2: File address 07h is a General Purpose Register on the PIC16C54, PIC16CR54, PIC16C56, PIC16CR56, PIC16CR58 and PIC16CR58.

3: These values are valid for PIC16C57/CR57/C58/CR58. For the PIC16C54/CR54/C55/C56/CR56, the value on RESET is 111x xxxx and for MCLR and WDT Reset, the value is 111u uuuu.

6.4 **OPTION Register**

The OPTION Register is a 6-bit wide, write-only register which contains various control bits to configure the Timer0/WDT prescaler and Timer0.

By executing the OPTION instruction, the contents of the W Register will be transferred to the OPTION Register. A RESET sets the OPTION<5:0> bits.

REGISTER 6-2: OPTION REGISTER

U-0	U-0	W-1	W-1	W-1	W-1	W-1	W-1
_	—	T0CS	TOSE	PSA	PS2	PS1	PS0
bit 7							bit 0

- bit 7-6: Unimplemented: Read as '0'
- bit 5: **TOCS**: Timer0 clock source select bit
 - 1 = Transition on T0CKI pin
 - 0 = Internal instruction cycle clock (CLKOUT)
- bit 4: **TOSE**: Timer0 source edge select bit
 - 1 = Increment on high-to-low transition on T0CKI pin
 - 0 = Increment on low-to-high transition on T0CKI pin
- bit 3: **PSA**: Prescaler assignment bit
 - 1 = Prescaler assigned to the WDT
 - 0 = Prescaler assigned to Timer0

bit 2-0: **PS<2:0>:** Prescaler rate select bits

Bit Value	Timer0 Rate	WDT Rate
000	1:2	1:1
001	1:4	1:2
010	1:8	1:4
011	1:16	1:8
100	1:32	1:16
101	1:64	1:32
110	1 : 128	1:64
111	1 : 256	1 : 128

Legend:			
R = Readable bit	W = Writable bit	U = Unimplemented bit, re	ead as '0'
-n = Value at POR	1 = bit is set	0 = bit is cleared	x = bit is unknown

8.2 Prescaler

An 8-bit counter is available as a prescaler for the Timer0 module, or as a postscaler for the Watchdog Timer (WDT), respectively (Section 9.2.1). For simplicity, this counter is being referred to as "prescaler" throughout this data sheet. Note that the prescaler may be used by either the Timer0 module or the WDT, but not both. Thus, a prescaler assignment for the Timer0 module means that there is no prescaler for the WDT, and vice-versa.

The PSA and PS<2:0> bits (OPTION<3:0>) determine prescaler assignment and prescale ratio.

When assigned to the Timer0 module, all instructions writing to the TMR0 register (e.g., CLRF 1, MOVWF 1, BSF 1, x, etc.) will clear the prescaler. When assigned to WDT, a CLRWDT instruction will clear the prescaler along with the WDT. The prescaler is neither readable nor writable. On a RESET, the prescaler contains all '0's.

8.2.1 SWITCHING PRESCALER ASSIGNMENT

The prescaler assignment is fully under software control (i.e., it can be changed "on the fly" during program execution). To avoid an unintended device RESET, the following instruction sequence (Example 8-1) must be executed when changing the prescaler assignment from Timer0 to the WDT.

EXAMPLE 8-1: CHANGING PRESCALER (TIMER0→WDT)

CLRWDT	;Clear WDT
CLRF TMR0	;Clear TMR0 & Prescaler
MOVLW B'00xx1111'	;Last 3 instructions in
	this example
OPTION	;are required only if
	;desired
CLRWDT	;PS<2:0> are 000 or
	;001
MOVLW B'00xx1xxx'	;Set Prescaler to
OPTION	;desired WDT rate

To change prescaler from the WDT to the Timer0 module, use the sequence shown in Example 8-2. This sequence must be used even if the WDT is disabled. A CLRWDT instruction should be executed before switching the prescaler.

EXAMPLE 8-2: CHANGING PRESCALER (WDT \rightarrow TIMER0)

CLRWDT		;Clear WDT and
		;prescaler
MOVLW	B'xxxx0xxx'	;Select TMR0, new
		;prescale value and
		;clock source

OPTION





NOTES:

GOTO	Unconditional Branch							
Syntax:	[label]	GOTO	k					
Operands:	$0 \le k \le 511$							
Operation:	$k \rightarrow PC<8:0>;$ STATUS<6:5> $\rightarrow PC<10:9>$							
Status Affected:	None							
Encoding:	101k	kkkk	kkkk					
Description:	GOTO is an unconditional branch. The 9-bit immediate value is loaded into PC bits <8:0>. The upper bits of PC are loaded from STATUS<6:5>. GOTO is a two- cycle instruction.							
Words:	1							
Cycles:	2							
Example:	GOTO TH	IERE						
After Instructi PC =	on address	G (THER	E)					

INCF	Increment f			
Syntax:	[label] INCF f,d			
Operands:	$\begin{array}{l} 0 \leq f \leq 31 \\ d \in [0,1] \end{array}$			
Operation:	(f) + 1 \rightarrow (dest)			
Status Affected:	Z			
Encoding:	0010 10df ffff			
Description: The contents of register 'f' an incremented. If 'd' is 0 the res placed in the W register. If 'd the result is placed back in register 'f'.				
Words:	1			
Cycles:	1			
Example:	INCF CNT, 1			
Before Instru CNT Z After Instructi CNT Z	ction = 0xFF = 0 ion = 0x00 = 1			

INCFSZ	Increment f, Skip if 0						
Syntax:	[label] INCFSZ f,d						
Operands:	$\begin{array}{l} 0\leq f\leq 31\\ d\in [0,1] \end{array}$						
Operation:	(f) + 1 \rightarrow (dest), skip if result = 0						
Status Affected:	None						
Encoding:	0011 11df ffff						
Description:	The contents of register 'f' are incremented. If 'd' is 0 the result is placed in the W register. If 'd' is 1 the result is placed back in register 'f'. If the result is 0, then the next instruction, which is already fetched, is discarded and a NOP is executed instead making it a two- cycle instruction						
Words:	1						
Cycles:	1(2)						
Example:	HERE INCFSZ CNT, 1 GOTO LOOP						
CONTINUE •							
Before Instru	iction						
PC	= address (HERE)						
After Instruct	ion						
CNT	= CNT + 1;						
if CNT	= 0,						
PC	= address (CONTINUE);						
if CNT	≠ 0, 						
PC	= address (HERE +1)						

12.2 DC Characteristics: PIC16C54/55/56/57-RCI, XTI, 10I, HSI, LPI (Industrial)

PIC16C54/55/56/57-RCI, XTI, 10I, HSI, LPI (Industrial)		Standard Operating Conditions (unless otherwise specified) Operating Temperature $-40^{\circ}C \le TA \le +85^{\circ}C$ for industrial					
Param No.	Symbol	Characteristic/Device	Min	Тур†	Max	Units	Conditions
D001	Vdd	Supply Voltage PIC16C5X-RCI PIC16C5X-XTI PIC16C5X-10I PIC16C5X-HSI PIC16C5X-HSI	3.0 3.0 4.5 4.5		6.25 6.25 5.5 5.5 6.25	V V V V	
D002	Vdr	RAM Data Retention Voltage ⁽¹⁾	2.5	1.5*		V	Device in SLEEP mode
D003	VPOR	VDD Start Voltage to ensure Power-on Reset	—	Vss	—	V	See Section 5.1 for details on Power-on Reset
D004	SVDD	VDD Rise Rate to ensure Power-on Reset	0.05*	—	—	V/ms	See Section 5.1 for details on Power-on Reset
D010	IDD	Supply Current ⁽²⁾ PIC16C5X-RCI ⁽³⁾ PIC16C5X-XTI PIC16C5X-10I PIC16C5X-HSI PIC16C5X-HSI PIC16C5X-LPI		1.8 1.8 4.8 9.0 15	3.3 3.3 10 10 20 40	mA mA mA mA μA	Fosc = 4 MHz, VDD = $5.5V$ Fosc = 4 MHz, VDD = $5.5V$ Fosc = 10 MHz, VDD = $5.5V$ Fosc = 10 MHz, VDD = $5.5V$ Fosc = 20 MHz, VDD = $5.5V$ Fosc = 32 kHz, VDD = $3.0V$, WDT disabled
D020	IPD	Power-down Current ⁽²⁾	_	4.0 0.6	14 12	μΑ μΑ	VDD = 3.0V, WDT enabled VDD = 3.0V, WDT disabled

* These parameters are characterized but not tested.

- † Data in "Typ" column is based on characterization results at 25°C. This data is for design guidance only and is not tested.
- Note 1: This is the limit to which VDD can be lowered in SLEEP mode without losing RAM data.
 - 2: The supply current is mainly a function of the operating voltage and frequency. Other factors such as bus loading, oscillator type, bus rate, internal code execution pattern and temperature also have an impact on the current consumption.
 - a) The test conditions for all IDD measurements in active Operation mode are: OSC1 = external square wave, from rail-to-rail; all I/O pins tristated, pulled to Vss, T0CKI = VDD, MCLR = VDD; WDT enabled/disabled as specified.
 - b) For standby current measurements, the conditions are the same, except that the device is in SLEEP mode. The power-down current in SLEEP mode does not depend on the oscillator type.
 - **3:** Does not include current through REXT. The current through the resistor can be estimated by the formula: IR = VDD/2REXT (mA) with REXT in kΩ.

12.3 DC Characteristics: PIC16C54/55/56/57-RCE, XTE, 10E, HSE, LPE (Extended)

PIC16C54/55/56/57-RCE, XTE, 10E, HSE, LPE (Extended)			Standard Operating Conditions (unless otherwise specified) Operating Temperature $-40^{\circ}C \le TA \le +125^{\circ}C$ for extended					
Param No.	Symbol	Characteristic/Device	Min	Тур†	Max	Units	Conditions	
D001	Vdd	Supply Voltage PIC16C5X-RCE PIC16C5X-XTE PIC16C5X-10E PIC16C5X-HSE PIC16C5X-LPE	3.25 3.25 4.5 4.5 2.5		6.0 6.0 5.5 5.5 6.0	V V V V V		
D002	Vdr	RAM Data Retention Voltage ⁽¹⁾	—	1.5*	_	V	Device in SLEEP mode	
D003	VPOR	VDD Start Voltage to ensure Power-on Reset	—	Vss	—	V	See Section 5.1 for details on Power-on Reset	
D004	SVDD	VDD Rise Rate to ensure Power-on Reset	0.05*	_	—	V/ms	See Section 5.1 for details on Power-on Reset	
D010	IDD	Supply Current ⁽²⁾ PIC16C5X-RCE ⁽³⁾ PIC16C5X-XTE PIC16C5X-10E PIC16C5X-HSE PIC16C5X-HSE PIC16C5X-LPE		1.8 1.8 4.8 9.0 19	3.3 3.3 10 10 20 55	mA mA mA mA μA	Fosc = 4 MHz, VDD = $5.5V$ Fosc = 4 MHz, VDD = $5.5V$ Fosc = 10 MHz, VDD = $5.5V$ Fosc = 10 MHz, VDD = $5.5V$ Fosc = 16 MHz, VDD = $5.5V$ Fosc = 32 kHz, VDD = $3.25V$, WDT disabled	
D020	IPD	Power-down Current ⁽²⁾	_	5.0 0.8	22 18	μΑ μΑ	VDD = 3.25V, WDT enabled VDD = 3.25V, WDT disabled	

* These parameters are characterized but not tested.

† Data in "Typ" column is based on characterization results at 25°C. This data is for design guidance only and is not tested.

Note 1: This is the limit to which VDD can be lowered in SLEEP mode without losing RAM data.

2: The supply current is mainly a function of the operating voltage and frequency. Other factors such as bus loading, oscillator type, bus rate, internal code execution pattern and temperature also have an impact on the current consumption.

- a) The test conditions for all IDD measurements in active Operation mode are: OSC1 = external square wave, from rail-to-rail; all I/O pins tristated, pulled to Vss, T0CKI = VDD, MCLR = VDD; WDT enabled/disabled as specified.
- b) For standby current measurements, the conditions are the same, except that the device is in SLEEP mode. The power-down current in SLEEP mode does not depend on the oscillator type.
- **3:** Does not include current through REXT. The current through the resistor can be estimated by the formula: IR = VDD/2REXT (mA) with REXT in k Ω .



FIGURE 14-5: TYPICAL IPD vs. VDD, WATCHDOG DISABLED





TABLE 15-2: CLKOUT AND I/O TIMING REQUIREMENTS - PIC16C54A

AC Characteristics		$\begin{array}{llllllllllllllllllllllllllllllllllll$							
Param No.	Symbol	Characteristic	Min	Тур†	Max	Units			
10	TosH2ckL	OSC1↑ to CLKOUT↓ ⁽¹⁾		15	30**	ns			
11	TosH2ckH	OSC1↑ to CLKOUT↑ ⁽¹⁾		15	30**	ns			
12	TckR	CLKOUT rise time ⁽¹⁾	—	5.0	15**	ns			
13	TckF	CLKOUT fall time ⁽¹⁾		5.0	15**	ns			
14	TckL2ioV	CLKOUT↓ to Port out valid ⁽¹⁾		—	40**	ns			
15	TioV2ckH	Port in valid before CLKOUT↑ ⁽¹⁾	0.25 TCY+30*	_	_	ns			
16	TckH2iol	Port in hold after CLKOUT ⁽¹⁾	0*	—	_	ns			
17	TosH2ioV	OSC1 [↑] (Q1 cycle) to Port out valid ⁽²⁾	—	_	100*	ns			
18	TosH2iol	OSC1 [↑] (Q2 cycle) to Port input invalid (I/O in hold time)	TBD		_	ns			
19	TioV2osH	Port input valid to OSC1↑ (I/O in setup time)	TBD	—	_	ns			
20	TioR	Port output rise time ⁽²⁾	—	10	25**	ns			
21	TioF	Port output fall time ⁽²⁾		10	25**	ns			

* These parameters are characterized but not tested.

** These parameters are design targets and are not tested. No characterization data available at this time.

† Data in the Typical ("Typ") column is based on characterization results at 25°C. This data is for design guidance only and is not tested.

Note 1: Measurements are taken in RC Mode where CLKOUT output is 4 x Tosc.

2: Please refer to Figure 15-1 for load conditions.



TABLE 15-4: TIMER0 CLOCK REQUIREMENTS - PIC16C54A

	Standard Operating Conditions (unless otherwise specified)								
	Operating Temperature $0^{\circ}C \le TA \le +70^{\circ}C$ for commercial								
AC Characteristics			$-40^{\circ}C \le TA \le +85^{\circ}C$ for industrial						
$-20^{\circ}C \le TA \le$						or indus	trial - PIC16LV54A-02I		
	$-40^{\circ}C \le TA \le +125^{\circ}C$ for extended								
Param No.	Symbol	Characteristic	Min	Тур†	Max	Units	Conditions		
40	Tt0H	T0CKI High Pulse Width							
		- No Prescaler	0.5 TCY + 20*	—	—	ns			
		- With Prescaler	10*			ns			
41	Tt0L	T0CKI Low Pulse Width							
		- No Prescaler	0.5 TCY + 20*	—	—	ns			
		- With Prescaler	10*			ns			
42	Tt0P	T0CKI Period	20 or <u>Tcy + 40</u> *	_	_	ns	Whichever is greater.		
			N				N = Prescale Value		
							(1, 2, 4,, 256)		

* These parameters are characterized but not tested.

† Data in the Typical ("Typ") column is at 5V, 25°C unless otherwise stated. These parameters are for design guidance only and are not tested.

PIC16C5X

FIGURE 16-5: TYPICAL IPD vs. VDD, WATCHDOG DISABLED (25°C)









FIGURE 16-17: TRANSCONDUCTANCE (gm) OF HS OSCILLATOR vs. VDD





FIGURE 16-21: PORTA, B AND C IOH vs. VOH, VDD = 5V















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