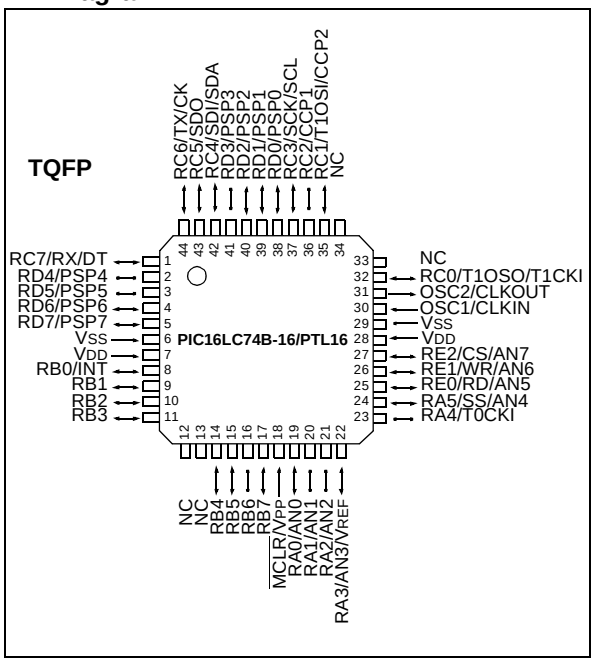
PIC16LC74B-16/PTL16

8-Bit CMOS Microcontrollers with A/D Converter

PIC16LC74B-16/PTL16 Microcontroller Core Features:

- High-performance RISC CPU
- Specially tested
  - 16MHz @ 3V
- Only 35 single word instructions to learn
- All single cycle instructions except for program branches which are two cycle
- Operating speed: DC - 16 MHz clock input
  DC - 250 ns instruction cycle
- 4K x 14 words of Program Memory, 192 x 8 bytes of Data Memory (RAM)
- Interrupt capability
- Eight level deep hardware stack
- Direct, indirect and relative addressing modes
- Power-on Reset (POR)
- Power-up Timer (PWRT) and Oscillator Start-up Timer (OST)
- Watchdog Timer (WDT) with its own on-chip RC oscillator for reliable operation
- Programmable code-protection
- Power saving SLEEP mode
- Selectable oscillator options
- Low-power, high-speed CMOS EPROM technology
- Wide operating voltage range: 2.5V to 5.5V
- High Sink/Source Current 25/25 mA
- Commercial, Industrial and Automotive temperature ranges
- Low-power consumption:
  - < 5 mA @ 5V, 4 MHz
  - 23 μA typical @ 3V, 32 kHz
  - < 3 μA typical standby current

Pin Diagram:



Peripheral Features:

- Timer0: 8-bit timer/counter with 8-bit prescaler
- Timer1: 16-bit timer/counter with prescaler can be incremented during sleep via external crystal/clock
- Timer2: 8-bit timer/counter with 8-bit period register, prescaler and postscaler
- Capture, Compare, PWM module(s)
  - Capture is 16 bit, max. resolution is 15.6 ns
  - Compare is 16 bit, max. resolution is 250 ns
  - PWM max. resolution is 10 bit
- 8-bit multichannel analog-to-digital converter
- Synchronous Serial Port (SSP) with SPI™ and I^2C™
- Universal Synchronous Asynchronous Receiver Transmitter (USART/SCI)
- Parallel Slave Port (PSP), 8-bits wide, with external $\overline{RD}$, $\overline{WR}$ and $\overline{CS}$ controls
- Brown-out detection circuitry for Brown-out Reset (BOR) Pin Diagrams

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Table of Contents

1.0 General Description 3
2.0 Electrical Characteristics 5
3.0 DC and AC Characteristics Graphs and Tables 27
4.0 Packaging Information 29
Index 33
On-Line Support 35
Reader Response 36
Product Identification System 37

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Corrections to this Data Sheet

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- E-mail us at webmaster@microchip.com.

We appreciate your assistance in making this a better document.

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1.0 GENERAL DESCRIPTION

This data sheet covers the PIC16LC74B-16/PTL16 device. The functional characteristics of this device are identical to the PIC16LC74B. For electrical specifications, see the electrical specifications contained within this document. For all other information about this device, see the PIC16C63A/65B/73B/74B data sheet (DS30605).

NOTES:

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2.0 ELECTRICAL CHARACTERISTICS

Absolute Maximum Ratings (†)

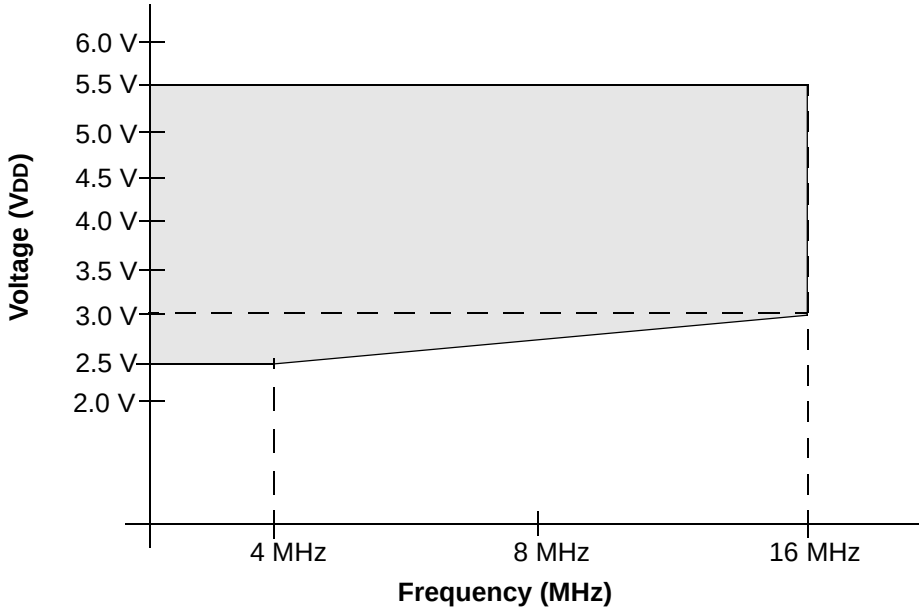
Ambient temperature under bias ..... -55°C to +125°C
Storage temperature ..... -65°C to +150°C
Voltage on any pin with respect to V_{SS} (except V_{DD}, $\overline{MCLR}$, and RA4) ..... -0.3V to (V_{DD} + 0.3V)
Voltage on V_{DD} with respect to V_{SS} ..... -0.3V to +7.5V
Voltage on $\overline{MCLR}$ with respect to V_{SS} (Note 2) ..... 0V to +13.25V
Voltage on RA4 with respect to Vss ..... 0V to +8.5V
Total power dissipation (Note 1) 1.0W
Maximum current out of V_{SS} pin ..... 300 mA
Maximum current into V_{DD} pin ..... 250 mA
Input clamp current, I_{IK} (V_I < 0 or V_I > V_{DD}) ..... ±20 mA
Output clamp current, I_{OK} (V_O < 0 or V_O > V_{DD}) ..... ±20 mA
Maximum output current sunk by any I/O pin ..... 25 mA
Maximum output current sourced by any I/O pin ..... 25 mA
Maximum current sunk by PORTA, PORTB, and PORTE (combined) ..... 200 mA
Maximum current sourced by PORTA, PORTB, and PORTE (combined) ..... 200 mA
Maximum current sunk by PORTC and PORTD (combined) ..... 200 mA
Maximum current sourced by PORTC and PORTD (combined) ..... 200 mA

Note 1: Power dissipation is calculated as follows: $Pdis = V_{DD} \times \{I_{DD} - \sum I_{OH}\} + \sum \{(V_{DD}-V_{OH}) \times I_{OH}\} + \sum(Vol \times I_{OL})$

Note 2: Voltage spikes below V_{SS} at the $\overline{MCLR}/V_{PP}$ pin, inducing currents greater than 80 mA, may cause latch-up. Thus, a series resistor of 50-100Ω should be used when applying a "low" level to the $\overline{MCLR}/V_{PP}$ pin rather than pulling this pin directly to V_{SS}.

† NOTICE: Stresses above those listed under "Absolute Maximum Ratings" may cause permanent damage to the device. This is a stress rating only and functional operation of the device, at those or any other conditions above those indicated in the operation listings of this specification, is not implied. Exposure to maximum rating conditions for extended periods may affect device reliability.

FIGURE 2-1: PIC16LC74B-16/PTL16 VOLTAGE-FREQUENCY GRAPH



Fmax = (24 MHz/V)(VDD.APP.MIN - 2.5V) + 4 MHz

Note: VDD.APP.MIN is the minimum VDD of the PICmicro® device in the application. Fmax is no greater than 16 MHz.

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2.1 DC Characteristics: PIC16LC74B-16/PTL-04 (Commercial)

DC CHARACTERISTICS			Standard Operating Conditions (unless otherwise stated) Operating temperature 0°C ≤ TA ≤ +70°C for commercial				
Param No.	**Sym**	**Characteristic**	**Min**	**Typ†**	**Max**	**Units**	**Conditions**
D001	VDD	**Supply Voltage**	2.5 VBOR*	- -	5.5 5.5	V V	RC, LP, XT, HS osc modes (DC - 4 MHz) BOR enabled (Note 7)
D002*	VDR	**RAM Data Retention Voltage** (Note 1)	-	TBD	-	V	
D003	VPOR	**VDD Start Voltage** to ensure internal Power-on Reset signal	-	VSS	-	V	
D004* D004A*	SVDD	**VDD Rise Rate** to ensure internal Power-on Reset signal	0.05 TBD	- -	- -	V/mS V/mS	PWRT enabled ($\overline{\text{PWRTE}}$ bit clear) PWRT disabled ($\overline{\text{PWRTE}}$ bit set)
D005	VBOR	**Brown-out Reset** voltage trip point	3.65	-	4.35	V	BODEN bit set
D010	IDD	**Supply Current** (Note 2, 5)	- - -	2.0 3.0 22.5	3.8 6.0 48	mA mA µA	XT, RC osc modes FOSC = 4 MHz, VDD = 3.0V (Note 4) HS oscillator mode Fosc = 16MHz, VDD = 3.0V LP osc mode FOSC = 32 kHz, VDD = 3.0V, WDT disabled
D021	IPD	**Power-down Current** (Note 3, 5)	-	0.9	5	µA	VDD = 3.0V, WDT disabled, 0°C to +70°C
D022* D022A*	ΔIWDT ΔIBOR	**Module Differential Current** (Note 6) Watchdog Timer Brown-out Reset	- -	6.0 350	20 425	µA µA	WDTE bit set, VDD = 4.0V BODEN bit set, VDD = 5.0V

* These parameters are characterized but not tested.

† Data in "Typ" column is at 3V, 25°C unless otherwise stated. These parameters are for design guidance only and are not tested.

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

2: The supply current is mainly a function of the operating voltage and frequency. Other factors such as I/O pin loading and switching rate, oscillator type, internal code execution pattern, and temperature also have an impact on the current consumption.
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 VDD.
$\overline{\text{MCLR}}$ = VDD; WDT enabled/disabled as specified.

3: The power-down current in SLEEP mode does not depend on the oscillator type. Power-down current is measured with the part in SLEEP mode, with all I/O pins in hi-impedance state and tied to VDD and VSS.

4: For RC osc mode, current through Rext is not included. The current through the resistor can be estimated by the formula Ir = VDD/2Rext (mA) with Rext in kOhm.

5: Timer1 oscillator (when enabled) adds approximately 20 µA to the specification. This value is from characterization and is for design guidance only. This is not tested.

6: The Δ current is the additional current consumed when this peripheral is enabled. This current should be added to the base IDD or IPD measurement.

7: When BOR is enabled, the device will operate correctly until the VBOR voltage trip point is reached.

2.2 DC Characteristics: PIC16LC74B-16/PTL-04 (Commercial)

DC CHARACTERISTICS			Standard Operating Conditions (unless otherwise stated) Operating temperature 0°C ≤ TA ≤ +70°C for commercial Operating voltage VDD range as described in DC spec Section 2.1				
Param No.	**Sym**	**Characteristic**	**Min**	**Typ†**	**Max**	**Units**	**Conditions**
		Input Low Voltage					
	VIL	I/O ports					
D030		with TTL buffer	VSS	-	0.15VDD	V	For entire VDD range
D030A			VSS	-	0.8V	V	4.5V ≤ VDD ≤ 5.5V
D031		with Schmitt Trigger buffer	VSS	-	0.2VDD	V	
D032		$\overline{MCLR}$, OSC1 (in RC mode)	Vss	-	0.2VDD	V	
D033		OSC1 (in XT, HS and LP modes)	Vss	-	0.3VDD	V	Note1
		Input High Voltage					
	VIH	I/O ports		-			
D040		with TTL buffer	2.0	-	VDD	V	4.5V ≤ VDD ≤ 5.5V
D040A			0.25VDD + 0.8V	-	VDD	V	For entire VDD range
D041		with Schmitt Trigger buffer	0.8VDD	-	VDD	V	For entire VDD range
D042		$\overline{MCLR}$	0.8VDD	-	VDD	V	
D042A		OSC1 (XT, HS and LP modes)	0.7VDD	-	VDD	V	Note1
D043		OSC1 (in RC mode)	0.9VDD	-	VDD	V	
		Input Leakage Current (Notes 2, 3)					
D060	IIL	I/O ports	-	-	±1	µA	Vss ≤ VPIN ≤ VDD, Pin at hi-impedance
D061		$\overline{MCLR}$, RA4/T0CKI	-	-	±5	µA	Vss ≤ VPIN ≤ VDD
D063		OSC1	-	-	±5	µA	Vss ≤ VPIN ≤ VDD, XT, HS and LP osc modes
D070	IPURB	**PORTB weak pull-up current**	50	250	400	µA	VDD = 5V, VPIN = VSS
		Output Low Voltage					
D080	VOL	I/O ports	-	-	0.6	V	IOL = 8.5 mA, VDD = 4.5V, -40°C to +85°C
			-	-	0.6	V	IOL = 7.0 mA, VDD = 4.5V, -40°C to +125°C
D083		OSC2/CLKOUT (RC osc mode)	-	-	0.6	V	IOL = 1.6 mA, VDD = 4.5V, -40°C to +85°C
			-	-	0.6	V	IOL = 1.2 mA, VDD = 4.5V, -40°C to +125°C
		Output High Voltage					
D090	VOH	I/O ports (Note 3)	VDD-0.7	-	-	V	IOH = -3.0 mA, VDD = 4.5V, -40°C to +85°C

* These parameters are characterized but not tested.

† Data in "Typ" column is at 3V, 25°C unless otherwise stated. These parameters are for design guidance only and are not tested.

Note 1: In RC oscillator mode, the OSC1/CLKIN pin is a Schmitt Trigger input. It is not recommended that the device be driven with external clock in RC mode.

2: The leakage current on the $\overline{MCLR}$/VPP pin is strongly dependent on the applied voltage level. The specified levels represent normal operating conditions. Higher leakage current may be measured at different input voltages.

3: Negative current is defined as current sourced by the pin.

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2.2 DC Characteristics: PIC16LC74B-16/PTL-04 (Commercial) (Cont.'d)

DC CHARACTERISTICS			Standard Operating Conditions (unless otherwise stated) Operating temperature 0°C ≤ TA ≤ +70°C for commercial Operating voltage VDD range as described in DC spec Section 2.1				
Param No.	**Sym**	**Characteristic**	**Min**	**Typ†**	**Max**	**Units**	**Conditions**
			VDD-0.7	-	-	V	IOH = -2.5 mA, VDD = 4.5V, -40°C to +125°C
D092		OSC2/CLKOUT (RC osc mode)	VDD-0.7	-	-	V	IOH = -1.3 mA, VDD = 4.5V, -40°C to +85°C
			VDD-0.7	-	-	V	IOH = -1.0 mA, VDD = 4.5V, -40°C to +125°C
D150*	VOD	**Open-Drain High Voltage**	-	-	8.5	V	RA4 pin
		Capacitive Loading Specs on Output Pins					
D100	COSC2	OSC2 pin	-	-	15	pF	In XT, HS and LP modes when external clock is used to drive OSC1.
D101	CIO	All I/O pins and OSC2 (in RC mode)	-	-	50	pF	
D102	Cb	SCL, SDA in I^2C mode	-	-	400	pF	

* These parameters are characterized but not tested.

† Data in "Typ" column is at 3V, 25°C unless otherwise stated. These parameters are for design guidance only and are not tested.

Note 1: In RC oscillator mode, the OSC1/CLKIN pin is a Schmitt Trigger input. It is not recommended that the device be driven with external clock in RC mode.

2: The leakage current on the $\overline{MCLR}$/VPP pin is strongly dependent on the applied voltage level. The specified levels represent normal operating conditions. Higher leakage current may be measured at different input voltages.

3: Negative current is defined as current sourced by the pin.

2.3 AC (Timing) Characteristics

2.3.1 TIMING PARAMETER SYMBOLOGY

The timing parameter symbols have been created using one of the following formats:

1. TppS2ppS
2. TppS
3. TCC:ST (I^2C specifications only)
4. Ts (I^2C specifications only)

T			
F	Frequency	T	Time

Lowercase letters (pp) and their meanings:

pp			
cc	CCP1	osc	OSC1
ck	CLKOUT	rd	$\overline{RD}$
cs	$\overline{CS}$	rw	$\overline{RD}$ or $\overline{WR}$
di	SDI	sc	SCK
do	SDO	ss	$\overline{SS}$
dt	Data in	t0	T0CKI
io	I/O port	t1	T1CKI
mc	$\overline{MCLR}$	wr	$\overline{WR}$

Uppercase letters and their meanings:

S			
F	Fall	P	Period
H	High	R	Rise
I	Invalid (Hi-impedance)	V	Valid
L	Low	Z	Hi-impedance
I^2C only			
AA	output access	High	High
BUF	Bus free	Low	Low

TCC:ST (I^2C specifications only)

CC			
HD	Hold	SU	Setup
ST			
DAT	DATA input hold	STO	STOP condition
STA	START condition		

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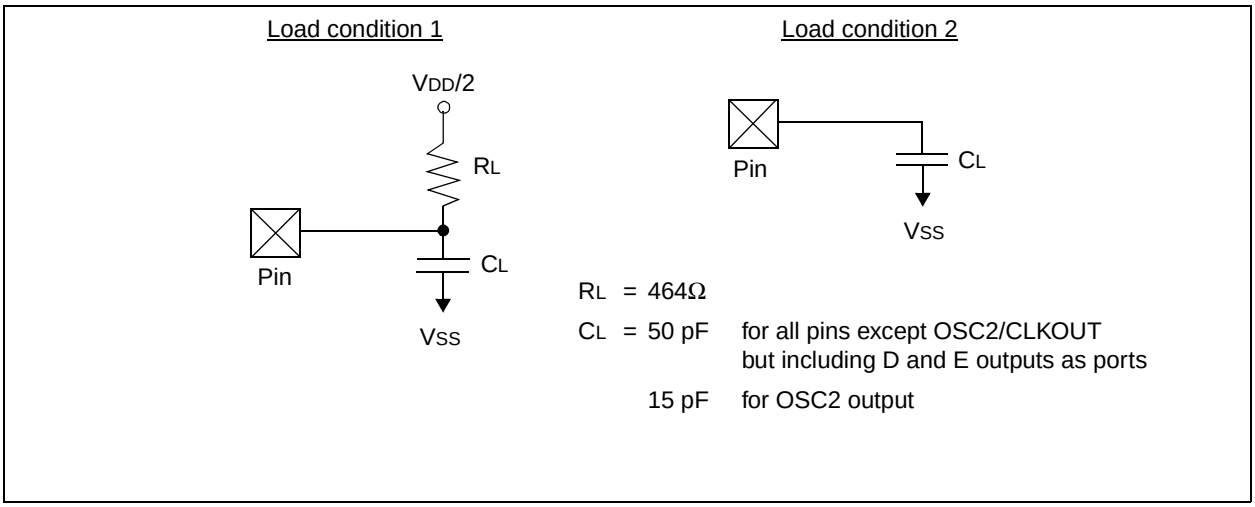
2.3.2 TIMING CONDITIONS

The temperature and voltages specified in Table 2-1 apply to all timing specifications unless otherwise noted. Figure 2-2 specifies the load conditions for the timing specifications.

TABLE 2-1: TEMPERATURE AND VOLTAGE SPECIFICATIONS - AC

AC CHARACTERISTICS	**Standard Operating Conditions (unless otherwise stated)** Operating temperature 0°C ≤ TA ≤ +70°C for commercial Operating voltage VDD range as described in DC spec Section 2.1. LC parts operate for commercial/industrial temp's only.

FIGURE 2-2: LOAD CONDITIONS FOR DEVICE TIMING SPECIFICATIONS



2.3.3 TIMING DIAGRAMS AND SPECIFICATIONS

FIGURE 2-3: EXTERNAL CLOCK TIMING

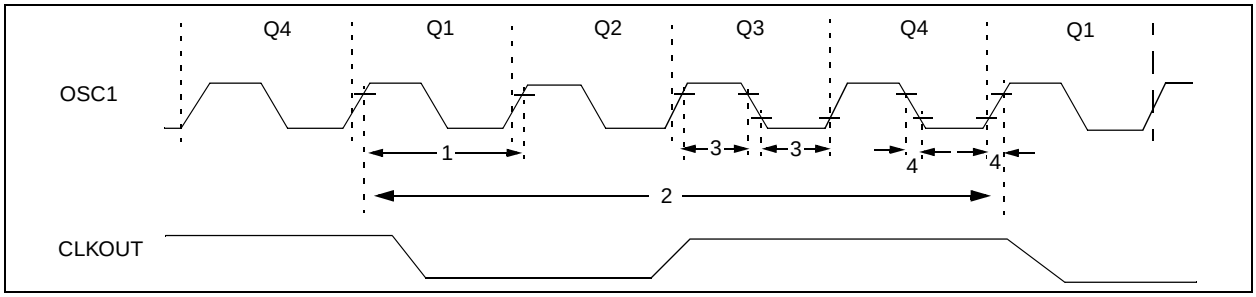


TABLE 2-2: EXTERNAL CLOCK TIMING REQUIREMENTS

Param No.	Sym	Characteristic	Min (Note 2)	Typ†	Max (Note 3)	Units	Conditions
1A	Fosc	**External CLKIN Frequency** (Note 1)	DC	—	4	MHz	RC and XT osc modes
			DC	—	4	MHz	HS osc mode (-04)
			DC	—	20	MHz	HS osc mode (-20)
			DC	—	200	kHz	LP osc mode
		Oscillator Frequency (Note 1)	DC	—	4	MHz	RC osc mode
			0.1	—	4	MHz	XT osc mode
			4	—	20	MHz	HS osc mode
			5	—	200	kHz	LP osc mode
1	Tosc	**External CLKIN Period** (Note 3)	250	—	—	ns	RC and XT osc modes
			250	—	—	ns	HS osc mode (-04)
			50	—	—	ns	HS osc mode (-20)
			5	—	—	µs	LP osc mode
		Oscillator Period (Note 3)	250	—	—	ns	RC osc mode
			250	—	10,000	ns	XT osc mode
			250	—	250	ns	HS osc mode (-04)
			50	—	250	ns	HS osc mode (-20)
			5	—	—	µs	LP osc mode
2	TCY	**Instruction Cycle Time** (Note 1)	200	—	DC	ns	TCY = 4/FOSC
3*	TosL, TosH	**External Clock in (OSC1) High or Low Time**	100	—	—	ns	XT oscillator
			2.5	—	—	µs	LP oscillator
			15	—	—	ns	HS oscillator
4*	TosR, TosF	**External Clock in (OSC1) Rise or Fall Time**	—	—	25	ns	XT oscillator
			—	—	50	ns	LP oscillator
			—	—	15	ns	HS oscillator

* These parameters are characterized but not tested.

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

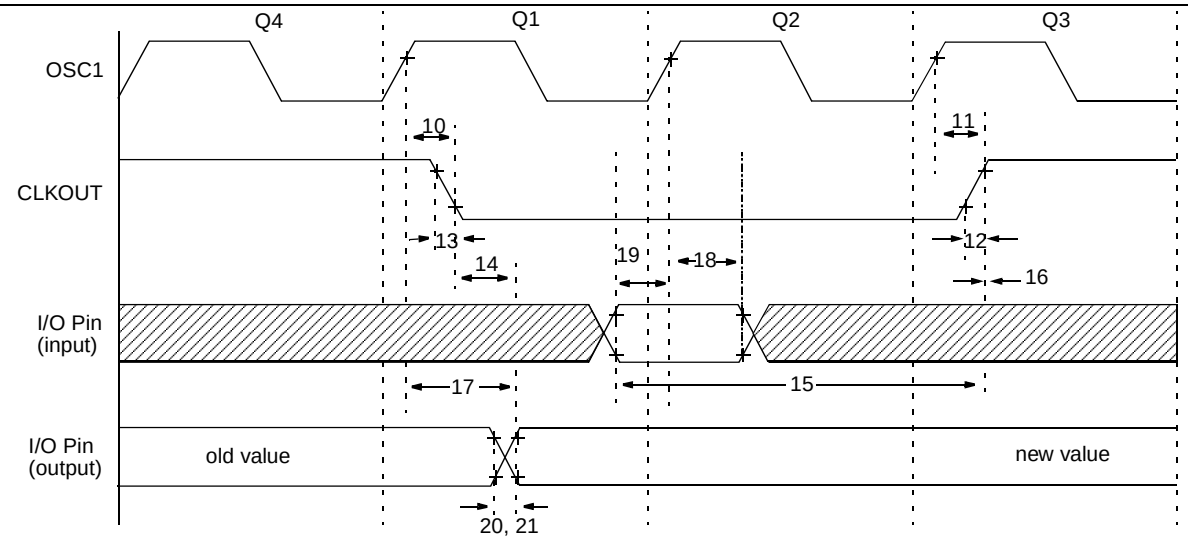
Note 1: Instruction cycle period (TCY) equals four times the input oscillator time-base period. All specified values are based on characterization data for that particular oscillator type under standard operating conditions with the device executing code. Exceeding these specified limits may result in an unstable oscillator operation and/or higher than expected current consumption.

2: All devices are tested to operate at "min." values with an external clock applied to the OSC1/CLKIN pin.

3: When an external clock input is used, the "Max." cycle time limit is "DC" (no clock) for all devices.

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FIGURE 2-4: CLKOUT AND I/O TIMING



Note: Refer to Figure 2.1 for load conditions.

TABLE 2-3: CLKOUT AND I/O TIMING REQUIREMENTS

Param No.	Sym	Characteristic	Min	Typ†	Max	Units	Conditions
10*	TosH2ckL	OSC1↑ to CLKOUT↓	—	75	200	ns	Note 1
11*	TosH2ckH	OSC1↑ to CLKOUT↑	—	75	200	ns	Note 1
12*	TckR	CLKOUT rise time	—	35	100	ns	Note 1
13*	TckF	CLKOUT fall time	—	35	100	ns	Note 1
14*	TckL2ioV	CLKOUT ↓ to Port out valid	—	—	0.5TCY + 20	ns	Note 1
15*	TioV2ckH	Port in valid before CLKOUT ↑	Tosc + 200	—	—	ns	Note 1
16*	TckH2ioI	Port in hold after CLKOUT ↑	0	—	—	ns	Note 1
17*	TosH2ioV	OSC1↑ (Q1 cycle) to Port out valid	—	50	150	ns	
18A*	TosH2ioI	OSC1↑ (Q2 cycle) to Port input invalid (I/O in hold time)	200	—	—	ns	
19*	TioV2osH	Port input valid to OSC1↑ (I/O in setup time)	0	—	—	ns	
20A*	TioR	Port output rise time	—	—	80	ns	
21A*	TioF	Port output fall time	—	—	80	ns	
22††*	Tinp	INT pin high or low time	TCY	—	—	ns	
23††*	Trbp	RB7:RB4 change INT high or low time	TCY	—	—	ns	

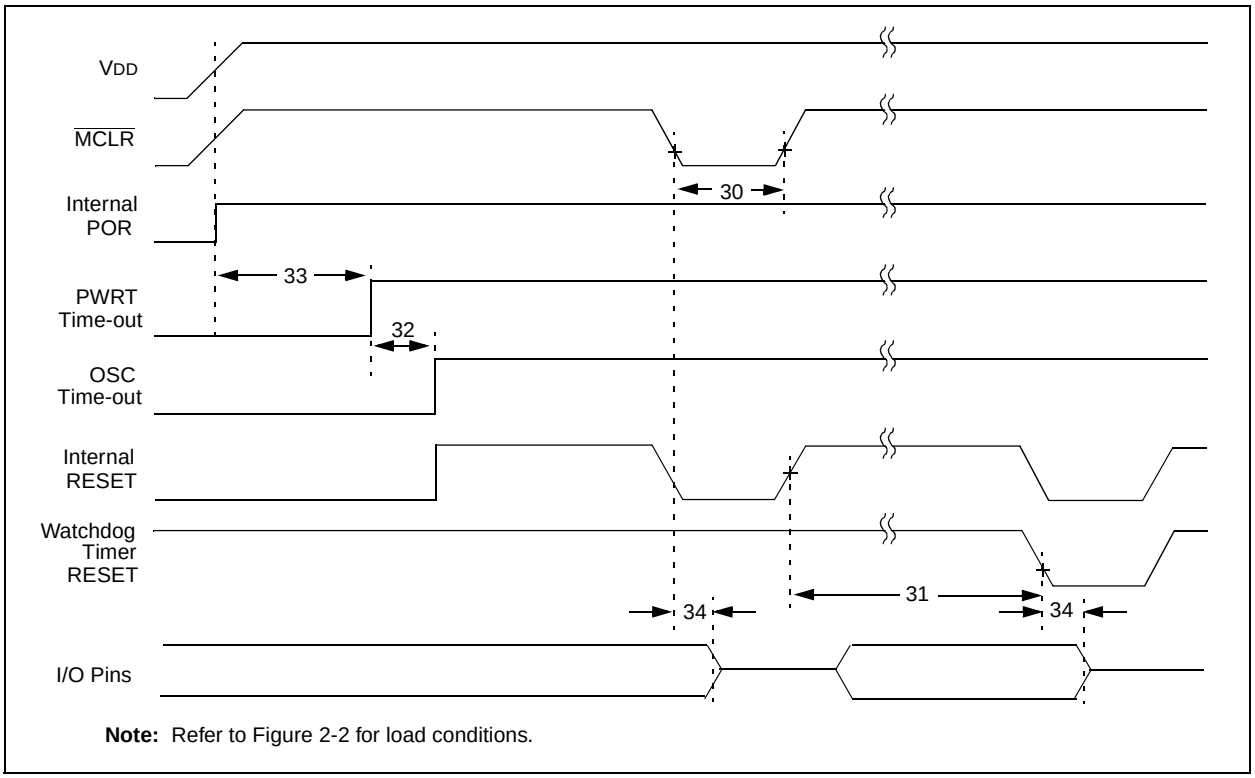
* These parameters are characterized but not tested.

† Data in "Typ" column is at 3V, 25°C unless otherwise stated. These parameters are for design guidance only and are not tested.

†† These parameters are asynchronous events not related to any internal clock edge.

Note 1: Measurements are taken in RC mode where CLKOUT output is 4 x TOSC.

FIGURE 2-5: RESET, WATCHDOG TIMER, OSCILLATOR START-UP TIMER AND POWER-UP TIMER TIMING



Note: Refer to Figure 2-2 for load conditions.

FIGURE 2-6: BROWN-OUT RESET TIMING

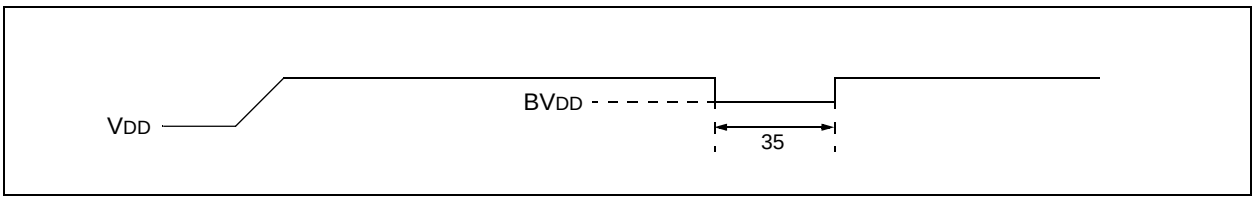


TABLE 2-4: RESET, WATCHDOG TIMER, OSCILLATOR START-UP TIMER, POWER-UP TIMER AND BROWN-OUT RESET REQUIREMENTS

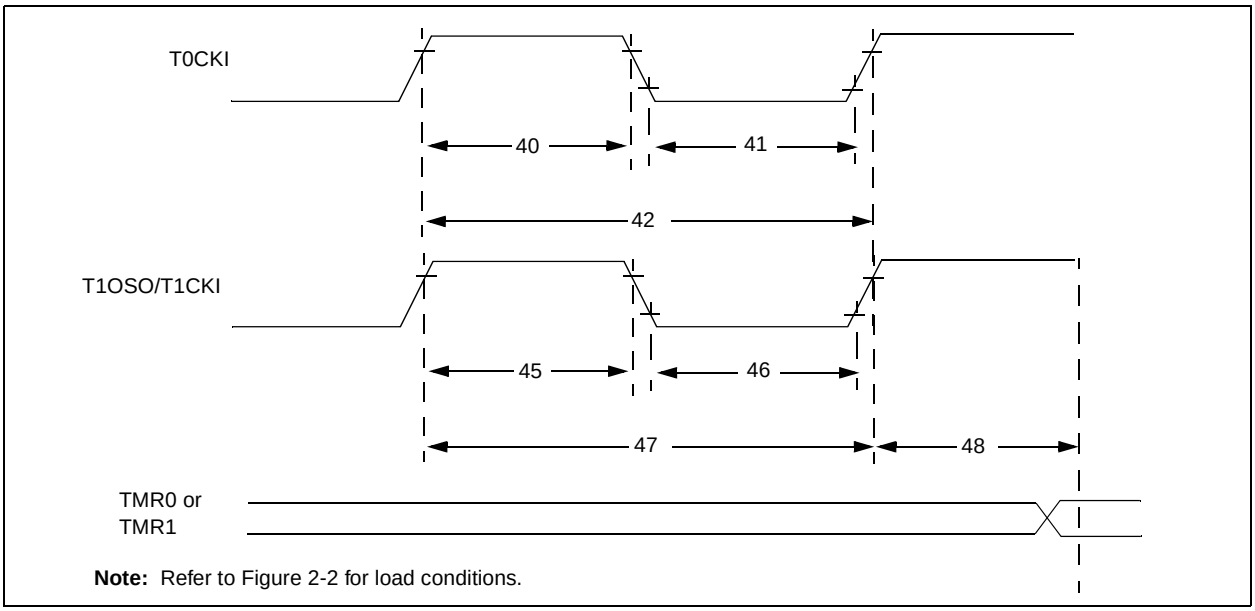
Parameter No.	Sym	Characteristic	Min	Typ†	Max	Units	Conditions
30	TmcL	$\overline{MCLR}$ Pulse Width (low)	2	—	—	µs	VDD = 5V, -40°C to +125°C
31*	Twdt	Watchdog Timer Time-out Period (No Prescaler)	7	18	33	ms	VDD = 5V, -40°C to +125°C
32	Tost	Oscillation Start-up Timer Period	—	1024 TOSC	—	—	TOSC = OSC1 period
33*	Tpwrt	Power-up Timer Period	28	72	132	ms	VDD = 5V, -40°C to +125°C
34	TIOZ	I/O Hi-impedance from $\overline{MCLR}$ Low or WDT reset	—	—	2.1	µs	
35	TBOR	Brown-out Reset Pulse Width	100	—	—	µs	VDD ≤ BVDD (D005)

* These parameters are characterized but not tested.

† Data in "Typ" column is at 3V, 25°C unless otherwise stated. These parameters are for design guidance only and are not tested.

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FIGURE 2-7: TIMER0 AND TIMER1 EXTERNAL CLOCK TIMINGS



Note: Refer to Figure 2-2 for load conditions.

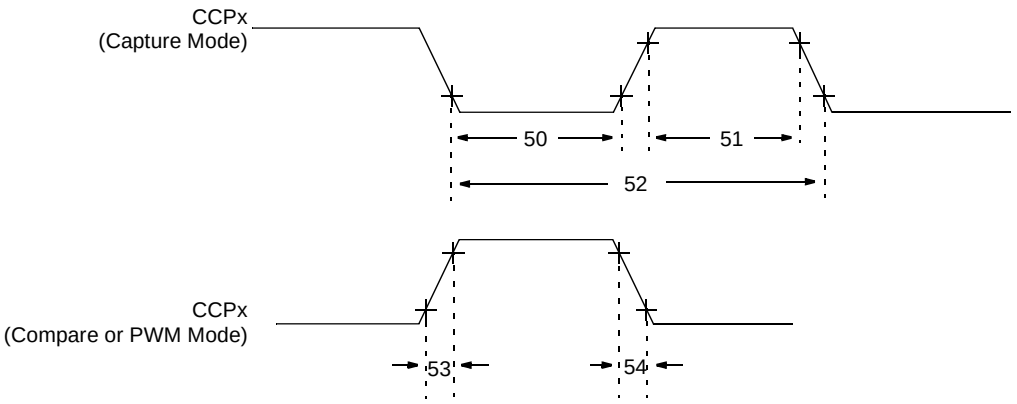
TABLE 2-5: TIMER0 AND TIMER1 EXTERNAL CLOCK REQUIREMENTS

Param No.	Sym	Characteristic			Min	Typ†	Max	Units	Conditions
40*	Tt0H	T0CKI High Pulse Width		No Prescaler	0.5TCY + 20	—	—	ns	Must also meet parameter 42
				With Prescaler	10	—	—	ns	
41*	Tt0L	T0CKI Low Pulse Width		No Prescaler	0.5TCY + 20	—	—	ns	Must also meet parameter 42
				With Prescaler	10	—	—	ns	
42*	Tt0P	T0CKI Period		No Prescaler	TCY + 40	—	—	ns	
				With Prescaler	Greater of: 20 or TCY + 40 / N	—	—	ns	N = prescale value (2, 4,..., 256)
45*	Tt1H	T1CKI High Time	Synchronous, Prescaler = 1		0.5TCY + 20	—	—	ns	Must also meet parameter 47
			Synchronous, Prescaler = 2,4,8		25	—	—	ns	
			Asynchronous		50	—	—	ns	
46*	Tt1L	T1CKI Low Time	Synchronous, Prescaler = 1		0.5TCY + 20	—	—	ns	Must also meet parameter 47
			Synchronous, Prescaler = 2,4,8		25	—	—	ns	
			Asynchronous		50	—	—	ns	
47*	Tt1P	T1CKI input period	Synchronous		Greater of: 50 OR TCY + 40 / N				N = prescale value (1, 2, 4, 8)
			Asynchronous		100	—	—	ns	
	Ft1	Timer1 oscillator input frequency range (oscillator enabled by setting bit T1OSCEN)			DC	—	200	kHz	
48	TCKEZtmr1	Delay from external clock edge to timer increment			2Tosc	—	7Tosc	—	

* These parameters are characterized but not tested.

† Data in "Typ" column is at 3V, 25°C unless otherwise stated. These parameters are for design guidance only and are not tested.

FIGURE 2-8: CAPTURE/COMPARE/PWM TIMINGS (CCP1 AND CCP2)



Note: Refer to Figure 2-2 for load conditions.

TABLE 2-6: CAPTURE/COMPARE/PWM REQUIREMENTS (CCP1 AND CCP2)

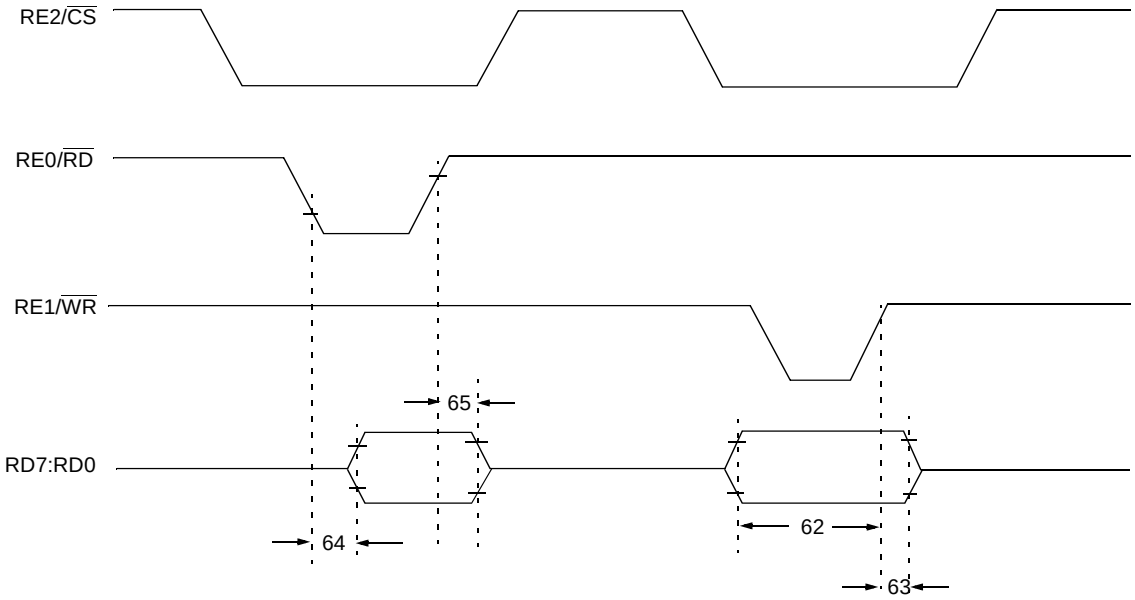
Param No.	Sym	Characteristic		Min	Typ†	Max	Units	Conditions
50*	TccL	CCP1 and CCP2 input low time	No Prescaler	0.5TCY + 20	—	—	ns	
			With Prescaler	20	—	—	ns	
51*	TccH	CCP1 and CCP2 input high time	No Prescaler	0.5TCY + 20	—	—	ns	
			With Prescaler	20	—	—	ns	
52*	TccP	CCP1 and CCP2 input period		$\frac{3T_{CY} + 40}{N}$	—	—	ns	N = prescale value (1,4 or 16)
53*	TccR	CCP1 and CCP2 output rise time		—	25	45	ns	
54*	TccF	CCP1 and CCP2 output fall time		—	25	45	ns	

* These parameters are characterized but not tested.

† Data in "Typ" column is at 3V, 25°C unless otherwise stated. These parameters are for design guidance only and are not tested.

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FIGURE 2-9: PARALLEL SLAVE PORT TIMING (PIC16LC74B-16/PTL16)



Note: Refer to Figure 2-2 for load conditions.

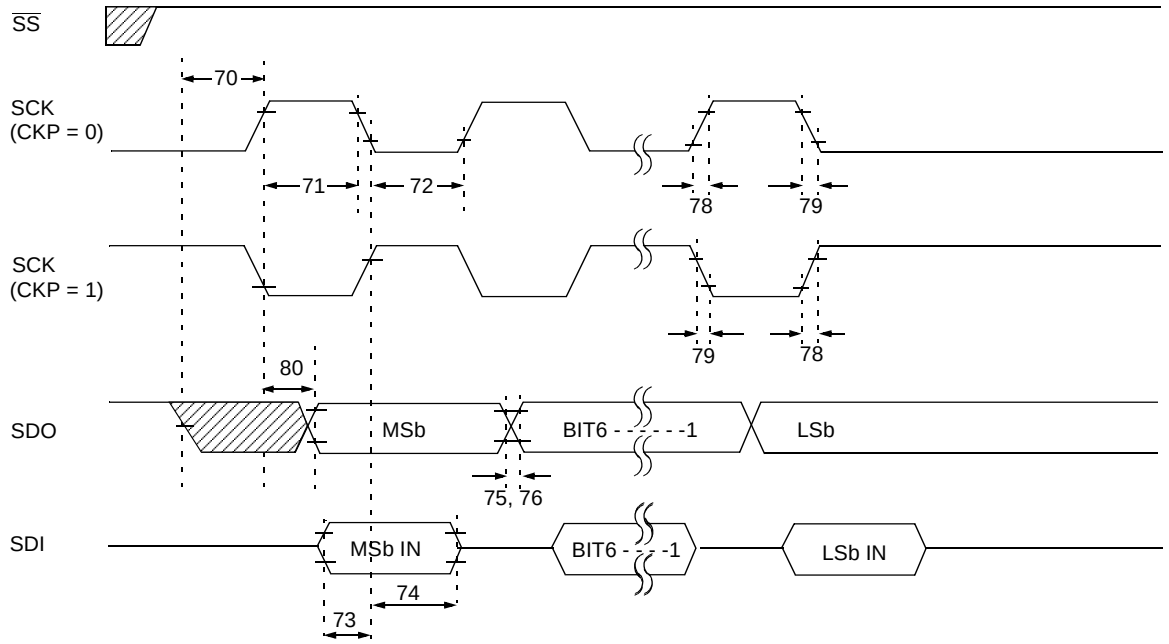
TABLE 2-7: PARALLEL SLAVE PORT REQUIREMENTS (PIC16LC74B-16/PTL16)

Parameter No.	Sym	Characteristic	Min	Typ†	Max	Units	Conditions
62*	TdtV2wrH	Data in valid before $\overline{WR}\uparrow$ or $\overline{CS}\uparrow$ (setup time)	20	—	—	ns	
63*	TwrH2dtI	$\overline{WR}\uparrow$ or $\overline{CS}\uparrow$ to data–in invalid (hold time)	35	—	—	ns	
64	TrdL2dtV	$\overline{RD}\downarrow$ and $\overline{CS}\downarrow$ to data–out valid	—	—	80	ns	
65*	TrdH2dtI	$\overline{RD}\uparrow$ or $\overline{CS}\uparrow$ to data–out invalid	10	—	30	ns	

* These parameters are characterized but not tested.

† Data in "Typ" column is at 3V, 25°C unless otherwise stated. These parameters are for design guidance only and are not tested.

FIGURE 2-10: EXAMPLE SPI MASTER MODE TIMING (CKE = 0)



Note: Refer to Figure 2-2 for load conditions.

TABLE 2-8: EXAMPLE SPI MODE REQUIREMENTS (MASTER MODE, CKE = 0)

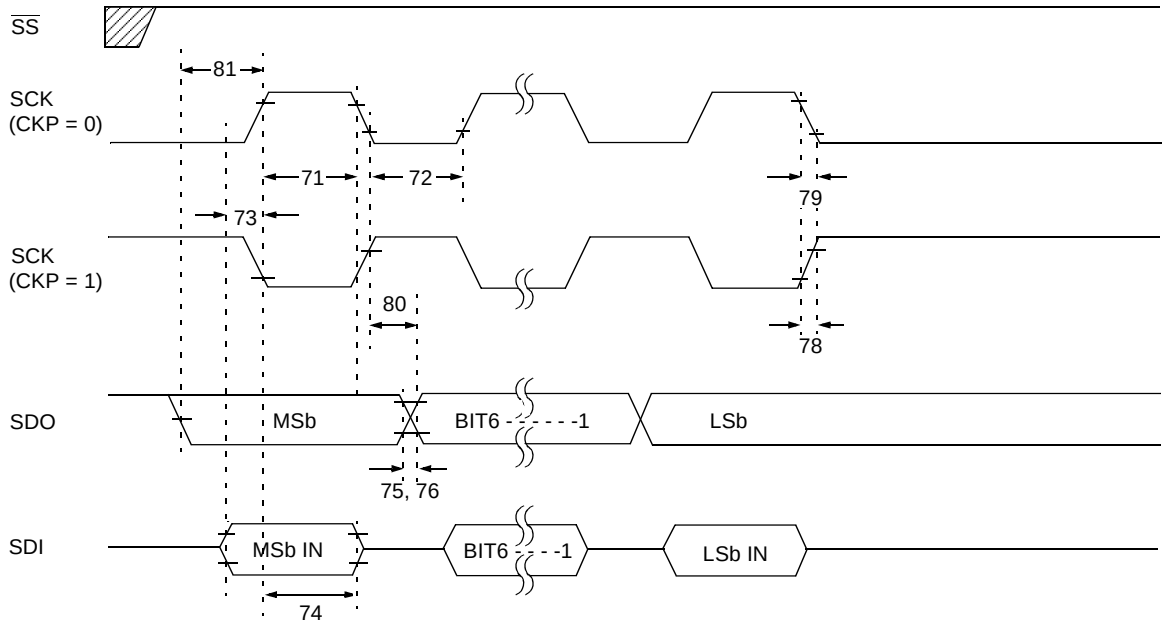
Param. No.	Symbol	Characteristic		Min	Typ†	Max	Units	Conditions
70	TssL2scH, TssL2scL	$\overline{SS}\downarrow$ to SCK$\downarrow$ or SCK$\uparrow$ input		TCY	—	—	ns	
71	TscH	SCK input high time (slave mode)	Continuous	1.25TCY + 30	—	—	ns	
71A			Single Byte	40	—	—	ns	Note 1
72	TscL	SCK input low time (slave mode)	Continuous	1.25TCY + 30	—	—	ns	
72A			Single Byte	40	—	—	ns	Note 1
73	TdiV2scH, TdiV2scL	Setup time of SDI data input to SCK edge		100	—	—	ns	
73A	TB2B	Last clock edge of Byte1 to the 1st clock edge of Byte2		1.5TCY + 40	—	—	ns	Note 1
74	TscH2diL, TscL2diL	Hold time of SDI data input to SCK edge		100	—	—	ns	
75	TdoR	SDO data output rise time		—	20	45	ns	
76	TdoF	SDO data output fall time		—	10	25	ns	
78	TscR	SCK output rise time (master mode)		—	20	45	ns	
79	TscF	SCK output fall time (master mode)		—	10	25	ns	
80	TscH2doV, TscL2doV	SDO data output valid after SCK edge		—	—	100	ns	

† Data in "Typ" column is at 3V, 25°C unless otherwise stated. These parameters are for design guidance only and are not tested.

Note 1: Specification 73A is only required if specifications 71A and 72A are used.

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FIGURE 2-11: EXAMPLE SPI MASTER MODE TIMING (CKE = 1)



Note: Refer to Figure 2.1 for load conditions.

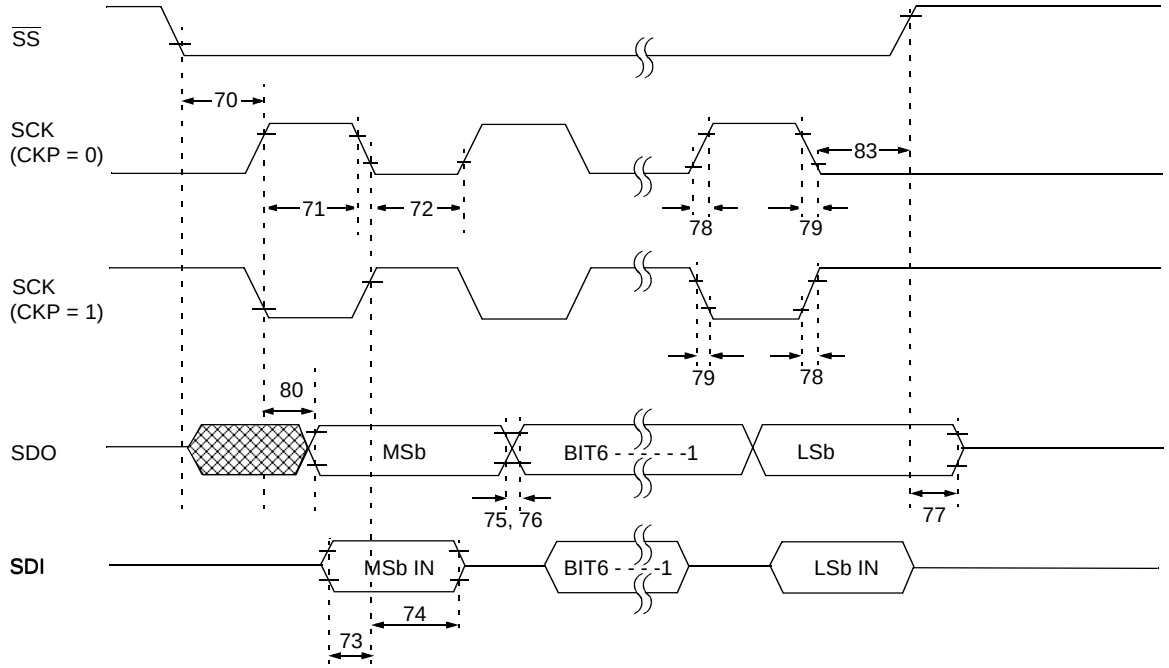
TABLE 2-9: EXAMPLE SPI MODE REQUIREMENTS (MASTER MODE, CKE = 1)

Param. No.	Symbol	Characteristic		Min	Typ†	Max	Units	Conditions
71	TscH	SCK input high time (slave mode)	Continuous	1.25TCY + 30	—	—	ns	
71A			Single Byte	40	—	—	ns	Note 1
72	TscL	SCK input low time (slave mode)	Continuous	1.25TCY + 30	—	—	ns	
72A			Single Byte	40	—	—	ns	Note 1
73	TdiV2scH, TdiV2scL	Setup time of SDI data input to SCK edge		100	—	—	ns	
73A	TB2B	Last clock edge of Byte1 to the 1st clock edge of Byte2		1.5TCY + 40	—	—	ns	Note 1
74	TscH2diL, TscL2diL	Hold time of SDI data input to SCK edge		100	—	—	ns	
75	TdoR	SDO data output rise time			20	45	ns	
76	TdoF	SDO data output fall time		—	10	25	ns	
78	TscR	SCK output rise time (master mode)			20	45	ns	
79	TscF	SCK output fall time (master mode)		—	10	25	ns	
80	TscH2doV, TscL2doV	SDO data output valid after SCK edge			—	100	ns	
81	TdoV2scH, TdoV2scL	SDO data output setup to SCK edge		TCY	—	—	ns	

† Data in "Typ" column is at 3V, 25°C unless otherwise stated. These parameters are for design guidance only and are not tested.

Note 1: Specification 73A is only required if specifications 71A and 72A are used.

FIGURE 2-12: EXAMPLE SPI SLAVE MODE TIMING (CKE = 0)



Note: Refer to Figure 2-2 for load conditions.

TABLE 2-10: EXAMPLE SPI MODE REQUIREMENTS (SLAVE MODE TIMING (CKE = 0)

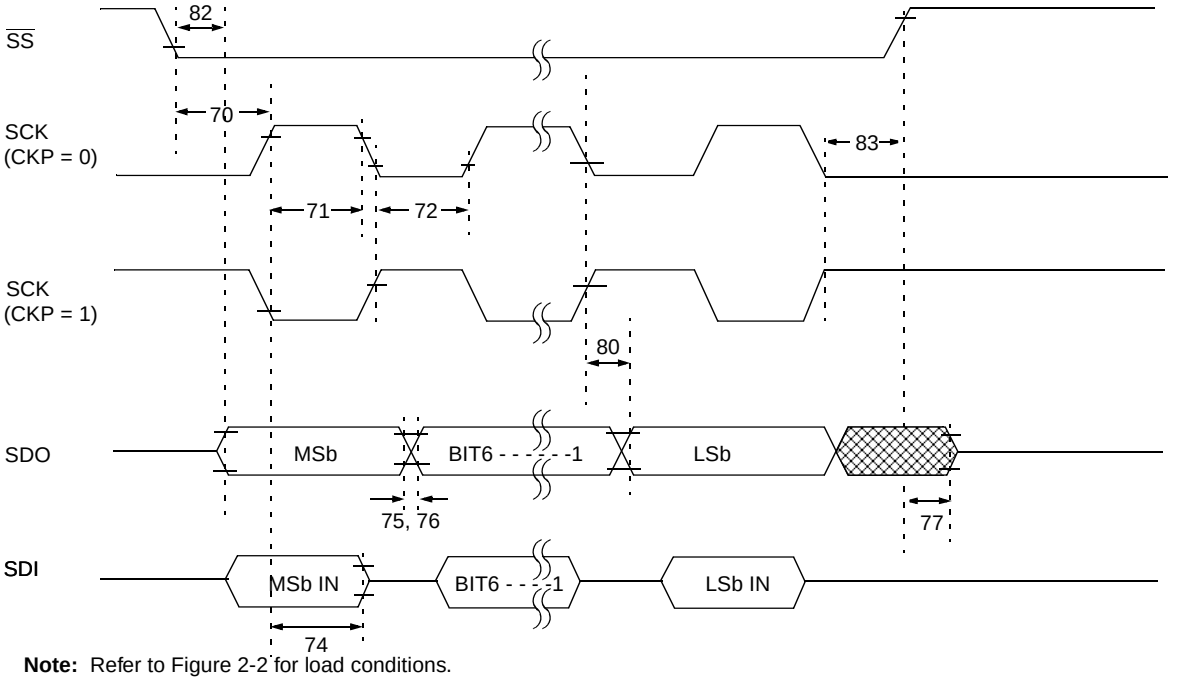
Param. No.	Symbol	Characteristic		Min	Typ†	Max	Units	Conditions
70	TssL2scH, TssL2scL	$\overline{SS}\downarrow$ to SCK$\downarrow$ or SCK$\uparrow$ input		TCY	—	—	ns	
71	TscH	SCK input high time (slave mode)	Continuous	1.25TCY + 30	—	—	ns	
71A			Single Byte	40	—	—	ns	Note 1
72	TscL	SCK input low time (slave mode)	Continuous	1.25TCY + 30	—	—	ns	
72A			Single Byte	40	—	—	ns	Note 1
73	TdiV2scH, TdiV2scL	Setup time of SDI data input to SCK edge		100	—	—	ns	
73A	TB2B	Last clock edge of Byte1 to the 1st clock edge of Byte2		1.5TCY + 40	—	—	ns	Note 1
74	TscH2diL, TscL2diL	Hold time of SDI data input to SCK edge		100	—	—	ns	
75	TdoR	SDO data output rise time			20	45	ns	
76	TdoF	SDO data output fall time		—	10	25	ns	
77	TssH2doZ	$\overline{SS}\uparrow$ to SDO output hi-impedance		10	—	50	ns	
78	TscR	SCK output rise time (master mode)			20	45	ns	
79	TscF	SCK output fall time (master mode)		—	10	25	ns	
80	TscH2doV, TscL2doV	SDO data output valid after SCK edge			—	100	ns	
83	TscH2ssH, TscL2ssH	$\overline{SS}\uparrow$ after SCK edge		1.5TCY + 40	—	—	ns	

† Data in "Typ" column is at 3V, 25°C unless otherwise stated. These parameters are for design guidance only and are not tested.

Note 1: Specification 73A is only required if specifications 71A and 72A are used.

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FIGURE 2-13: EXAMPLE SPI SLAVE MODE TIMING (CKE = 1)



Note: Refer to Figure 2-2 for load conditions.

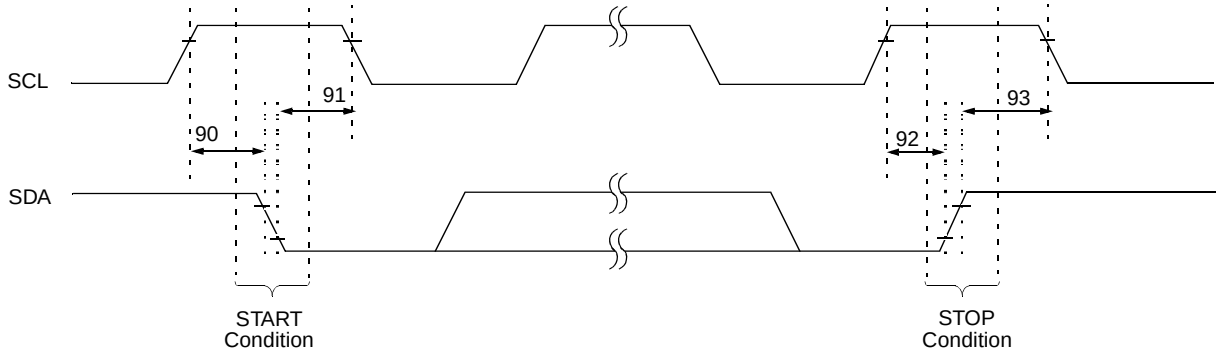
TABLE 2-11: EXAMPLE SPI SLAVE MODE REQUIREMENTS (CKE = 1)

Param. No.	Symbol	Characteristic		Min	Typ†	Max	Units	Conditions
70	TssL2scH, TssL2scL	$\overline{SS}\downarrow$ to SCK$\downarrow$ or SCK$\uparrow$ input		TCY	—	—	ns	
71	TscH	SCK input high time (slave mode)	Continuous	1.25TCY + 30	—	—	ns	
71A			Single Byte	40	—	—	ns	Note 1
72	TscL	SCK input low time (slave mode)	Continuous	1.25TCY + 30	—	—	ns	
72A			Single Byte	40	—	—	ns	Note 1
73A	TB2B	Last clock edge of Byte1 to the 1st clock edge of Byte2		1.5TCY + 40	—	—	ns	Note 1
74	TscH2diL, TscL2diL	Hold time of SDI data input to SCK edge		100	—	—	ns	
75	TdoR	SDO data output rise time			20	45	ns	
76	TdoF	SDO data output fall time		—	10	25	ns	
77	TssH2doZ	$\overline{SS}\uparrow$ to SDO output hi-impedance		10	—	50	ns	
78	TscR	SCK output rise time (master mode)		—	20	45	ns	
79	TscF	SCK output fall time (master mode)		—	10	25	ns	
80	TscH2doV, TscL2doV	SDO data output valid after SCK edge		—	—	100	ns	
82	TssL2doV	SDO data output valid after $\overline{SS}\downarrow$ edge		—	—	100	ns	
83	TscH2ssH, TscL2ssH	$\overline{SS}\uparrow$ after SCK edge		1.5TCY + 40	—	—	ns	

† Data in "Typ" column is at 3V, 25°C unless otherwise stated. These parameters are for design guidance only and are not tested.

Note 1: Specification 73A is only required if specifications 71A and 72A are used.

FIGURE 2-14: I²C BUS START/STOP BITS TIMING



Note: Refer to Figure 2-2 for load conditions.

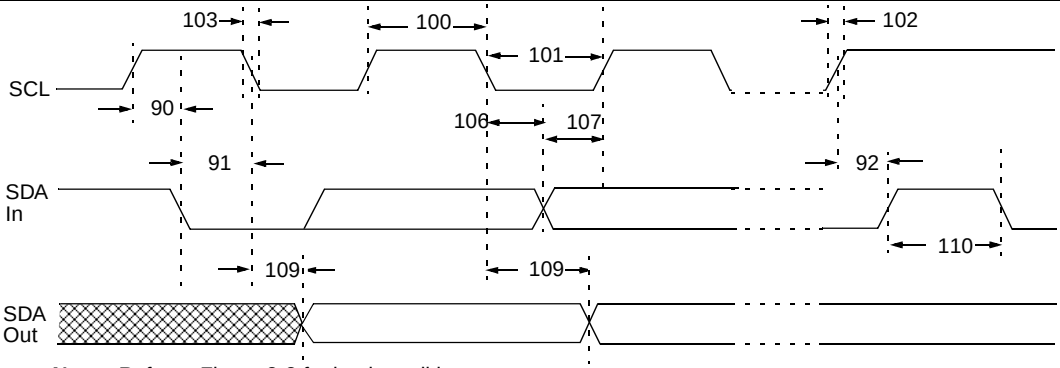
TABLE 2-12: I²C BUS START/STOP BITS REQUIREMENTS

Parameter No.	Sym	Characteristic		Min	Typ	Max	Units	Conditions
90*	TSU:STA	START condition Setup time	100 kHz mode	4700	—	—	ns	Only relevant for repeated START condition
			400 kHz mode	600	—	—		
91*	THD:STA	START condition Hold time	100 kHz mode	4000	—	—	ns	After this period the first clock pulse is generated
			400 kHz mode	600	—	—		
92*	TSU:STO	STOP condition Setup time	100 kHz mode	4700	—	—	ns	
			400 kHz mode	600	—	—		
93	THD:STO	STOP condition Hold time	100 kHz mode	4000	—	—	ns	
			400 kHz mode	600	—	—		

* These parameters are characterized but not tested.

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FIGURE 2-15: I²C BUS DATA TIMING



Note: Refer to Figure 2-2 for load conditions.

TABLE 2-13: I²C BUS DATA REQUIREMENTS

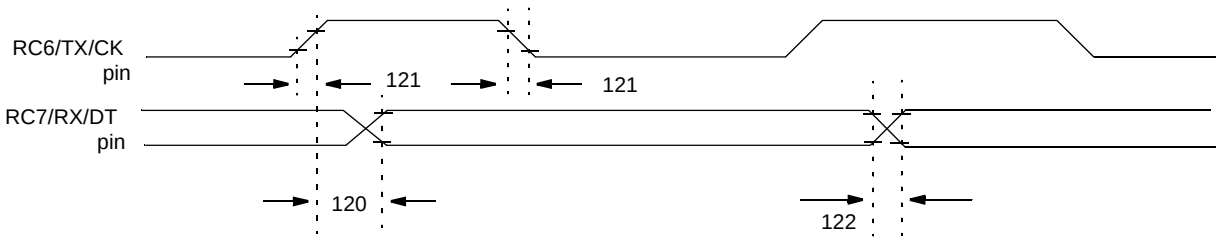
Parameter No.	Sym	Characteristic		Min	Max	Units	Conditions
100*	THIGH	Clock high time	100 kHz mode	4.0	—	µs	Device must operate at a minimum of 1.5 MHz
			400 kHz mode	0.6	—	µs	Device must operate at a minimum of 10 MHz
			SSP Module	1.5TCY	—		
101*	TLOW	Clock low time	100 kHz mode	4.7	—	µs	Device must operate at a minimum of 1.5 MHz
			400 kHz mode	1.3	—	µs	Device must operate at a minimum of 10 MHz
			SSP Module	1.5TCY	—		
102*	TR	SDA and SCL rise time	100 kHz mode	—	1000	ns	
			400 kHz mode	20 + 0.1Cb	300	ns	Cb is specified to be from 10-400 pF
103*	TF	SDA and SCL fall time	100 kHz mode	—	300	ns	
			400 kHz mode	20 + 0.1Cb	300	ns	Cb is specified to be from 10-400 pF
90*	TSU:STA	START condition setup time	100 kHz mode	4.7	—	µs	Only relevant for repeated START condition
			400 kHz mode	0.6	—	µs	
91*	THD:STA	START condition hold time	100 kHz mode	4.0	—	µs	After this period the first clock pulse is generated
			400 kHz mode	0.6	—	µs	
106*	THD:DAT	Data input hold time	100 kHz mode	0	—	ns	
			400 kHz mode	0	0.9	µs	
107*	TSU:DAT	Data input setup time	100 kHz mode	250	—	ns	Note 2
			400 kHz mode	100	—	ns	
92*	TSU:STO	STOP condition setup time	100 kHz mode	4.7	—	µs	
			400 kHz mode	0.6	—	µs	
109*	TAA	Output valid from clock	100 kHz mode	—	3500	ns	Note 1
			400 kHz mode	—	—	ns	
110*	TBUF	Bus free time	100 kHz mode	4.7	—	µs	Time the bus must be free before a new transmission can start
			400 kHz mode	1.3	—	µs	
	Cb	Bus capacitive loading		—	400	pF	

* These parameters are characterized but not tested.

Note 1: As a transmitter, the device must provide this internal minimum delay time to bridge the undefined region (min. 300 ns) of the falling edge of SCL to avoid unintended generation of START or STOP conditions.

2: A fast-mode (400 kHz) I²C-bus device can be used in a standard-mode (100 kHz) I²C-bus system, but the requirement Tsu:DAT ≥ 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 TR max.+tsu; DAT = 1000 + 250 = 1250 ns (according to the standard-mode I²C bus specification) before the SCL line is released.

FIGURE 2-16: USART SYNCHRONOUS TRANSMISSION (MASTER/SLAVE) TIMING



Note: Refer to Figure 2-2 for load conditions.

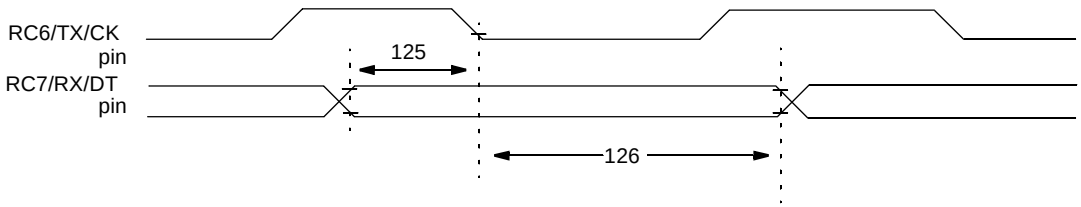
TABLE 2-14: USART SYNCHRONOUS TRANSMISSION REQUIREMENTS

Param No.	Sym	Characteristic	Min	Typ†	Max	Units	Conditions
120*	TckH2dtV	SYNC XMIT (MASTER & SLAVE) Clock high to data out valid	—	—	100	ns	
121*	Tckrf	Clock out rise time and fall time (Master Mode)	—	—	50	ns	
122*	Tdtrf	Data out rise time and fall time	—	—	50	ns	

* These parameters are characterized but not tested.

† Data in "Typ" column is at 3V, 25°C unless otherwise stated. These parameters are for design guidance only and are not tested.

FIGURE 2-17: USART SYNCHRONOUS RECEIVE (MASTER/SLAVE) TIMING



Note: Refer to Figure 2-2 for load conditions.

TABLE 2-15: USART SYNCHRONOUS RECEIVE REQUIREMENTS

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

* These parameters are characterized but not tested.

† Data in "Typ" column is at 3V, 25°C unless otherwise stated. These parameters are for design guidance only and are not tested.

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TABLE 2-16: A/D CONVERTER CHARACTERISTICS: PIC16LC74B-16/PTL16-04 (COMMERCIAL)

Param No.	Sym	Characteristic	Min	Typ†	Max	Units	Conditions
A01	NR	Resolution	—	—	8 bits	bit	VREF = VDD
A02	EABS	Total Absolute error	—	—	< ± 1	LSb	VREF = VDD VSS ≤ VAIN ≤ VREF
A03	EIL	Integral linearity error	—	—	< ± 1	LSb	VREF = VDD VSS ≤ VAIN ≤ VREF
A04	EDL	Differential linearity error	—	—	< ± 1	LSb	VREF = VDD VSS ≤ VAIN ≤ VREF
A05	EFS	Full scale error	—	—	< ± 1	LSb	VREF = VDD VSS ≤ VAIN ≤ VREF
A06	EOFF	Offset error	—	—	< ± 1	LSb	VREF = VDD VSS ≤ VAIN ≤ VREF
A10	—	Monotonicity (Note 3)	—	guaranteed	—	—	VSS ≤ VAIN ≤ VREF
A20	VREF	Reference voltage	2.5V	—	VDD + 0.3	V	
A25	VAIN	Analog input voltage	VSS - 0.3	—	VREF + 0.3	V	
A30	ZAIN	Recommended impedance of analog voltage source	—	—	10.0	kΩ	
A40	IAD	A/D conversion current (VDD)	—	90	—	µA	Average current consumption when A/D is on. (Note 1)
A50	IREF	VREF input current (Note 2)	10	—	1000	µA	During VAIN acquisition. Based on differential of VHOLD to VAIN to charge CHOLD
			—	—	10	µA	During A/D Conversion cycle

* These parameters are characterized but not tested.

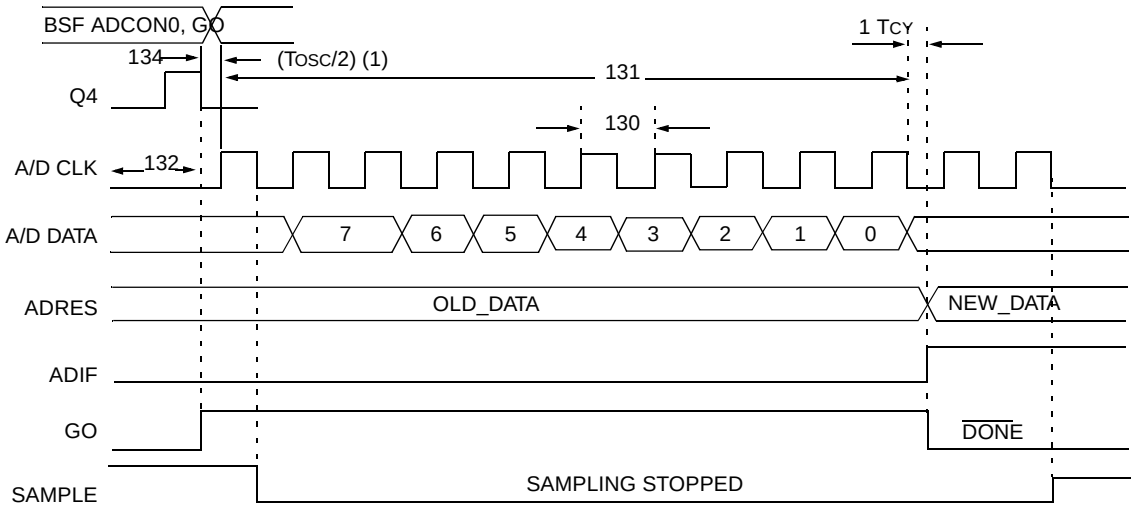
†Data in "Typ" column is at 3V, 25°C unless otherwise stated. These parameters are for design guidance only and are not tested.

Note 1: When A/D is off, it will not consume any current other than minor leakage current. The power-down current spec includes any such leakage from the A/D module.

2: VREF current is from RA3 pin or VDD pin, whichever is selected as reference input.

3: The A/D conversion result never decreases with an increase in the input voltage and has no missing codes.

FIGURE 2-18: A/D CONVERSION TIMING



Note 1: If the A/D clock source is selected as RC, a time of TCY is added before the A/D clock starts. This allows the SLEEP instruction to be executed.

TABLE 2-17: A/D CONVERSION REQUIREMENTS

Param No.	Sym	Characteristic	Min	Typ†	Max	Units	Conditions
130	TAD	A/D clock period	2.0	—	—	µs	TOSC based, VREF full range
			3.0	6.0	9.0	µs	A/D RC Mode
131	TCNV	Conversion time (not including S/H time) (Note 1)	11 Note 2	— 16	11 —	TAD µs	VDD = 3.0V, Temp. = 100°C, Rs = 10KΩ
132	TACQ	Acquisition time	5*	—	—	µs	The minimum time is the amplifier settling time. This may be used if the "new" input voltage has not changed by more than 1 LSb (i.e., 20.0 mV @ 5.12V) from the last sampled voltage (as stated on CHOLD).
134	TGO	Q4 to A/D clock start	—	TOSC/2	—	—	If the A/D clock source is selected as RC, a time of TCY is added before the A/D clock starts. This allows the SLEEP instruction to be executed.
135	TSWC	Switching from convert → sample time	1.5 §	—	—	TAD	

* These parameters are characterized but not tested.

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

Note 1: ADRES register may be read on the following TCY cycle.

2: See A/D section for minimum requirements.

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3.0 DC AND AC CHARACTERISTICS GRAPHS AND TABLES

Graphs and Tables not available at this time.

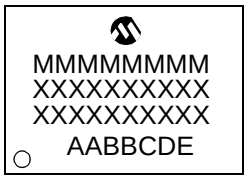
NOTES:

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4.0 PACKAGING INFORMATION

4.1 Package Marking Information

44-Lead TQFP



Example

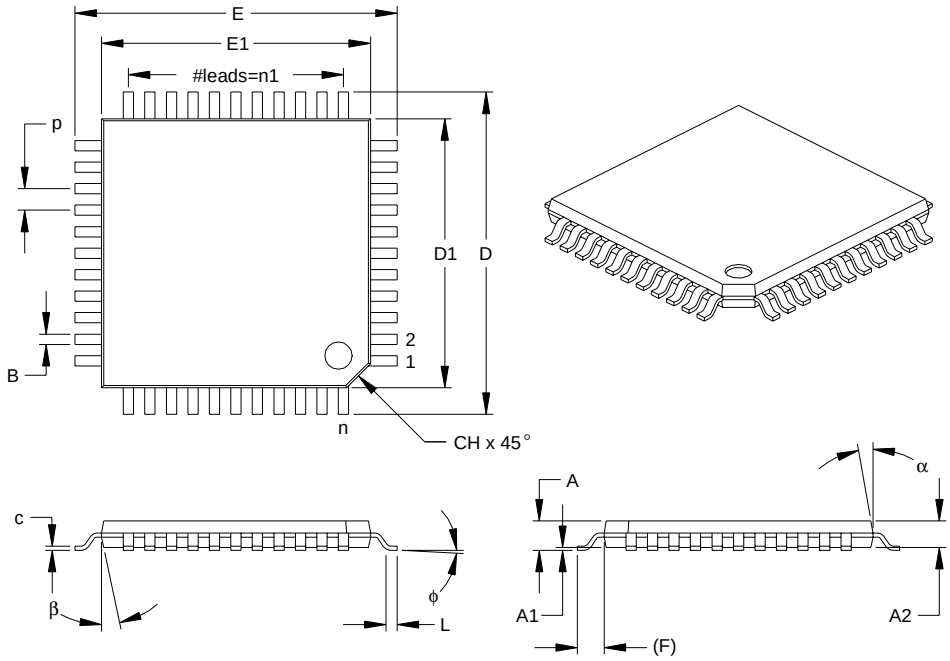


Legend:	MM...M	Microchip part number information
	XX...X	Customer specific information*
	AA	Year code (last 2 digits of calendar year)
	BB	Week code (week of January 1 is week '01')
	C	Facility code of the plant at which wafer is manufactured O = Outside Vendor C = 5" Line S = 6" Line H = 8" Line
	D	Mask revision number
	E	Assembly code of the plant or country of origin in which part was assembled

Note: In the event the full Microchip part number cannot be marked on one line, it will be carried over to the next line thus limiting the number of available characters for customer specific information.

***** Standard OTP marking consists of Microchip part number, year code, week code, facility code, mask rev#, and assembly code. For OTP marking beyond this, certain price adders apply. Please check with your Microchip Sales Office. For QTP devices, any special marking adders are included in QTP price.

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



Units		INCHES			MILLIMETERS*		
Dimension Limits		MIN	NOM	MAX	MIN	NOM	MAX
Number of Pins	n		44			44	
Pitch	p		.031			0.80	
Pins per Side	n1		11			11	
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	.004	.006	0.05	0.10	0.15
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	.004	.006	.008	0.09	0.15	0.20
Lead Width	B	.012	.015	.017	0.30	0.38	0.44
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

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. C04-076

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APPENDIX A: REVISION HISTORY

Version	Date	Revision Description
A	6/99	This is a new data sheet providing the electrical specifications for the 3V, 16 MHz device. For all other information, see the PIC16C63A/65B/73B/74B data sheet (DS30605).

NOTES:

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INDEX

A

A/D
- Converter Characteristics 25
- Timing Diagram 26

Absolute Maximum Ratings 5

B

Brown-out Reset (BOR)
- Timing Diagram 14

C

Capture/Compare/PWM (CCP)
- Timing Diagram 16

D

DC Characteristics 8

E

Electrical Characteristics 5
Errata 2

G

General Description 3

I

I^2C (SSP Module)
- Timing Diagram, Data 23
- Timing Diagram, Start/Stop Bits 22

P

Packaging 29
Parallel Slave Port (PSP)
- Timing Diagram 17

Power-on Reset (POR)
- Timing Diagram 14

Product Identification System 37

R

Reset
- Timing Diagram 14

Revision History 31

T

Timer0
- Timing Diagram 15

Timer1
- Timing Diagram 15

Timing Diagrams and Specifications 12
- A/D Conversion 26
- Brown-out Reset (BOR) 14
- Capture/Compare/PWM (CCP) 16
- CLKOUT and I/O 13
- External Clock 12
- I^2C Bus Data 23
- I^2C Bus Start/Stop Bits 22
- Oscillator Start-up Timer (OST) 14
- Parallel Slave Port (PSP) 17
- Power-up Timer (PWRT) 14
- Reset 14
- Timer0 and Timer1 15
- USART Synchronous Receive (Master/Slave) 24
- USART SynchronousTransmission (Master/Slave) .. 24
- Watchdog Timer (WDT) 14

U

USART
- Synchronous Master Mode
  - Timing Diagram, Synchronous Receive 24
  - Timing Diagram, Synchronous Transmission 24

W

Watchdog Timer (WDT)
- Timing Diagram 14

WWW, On-Line Support 2

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PART NO.	-XX	X	/XX	L16
Device	Frequency Range	Temperature Range	Package	Pattern

Device	PIC16LC7X(1), PIC16LC7XT(2);VDD range 2.5V to 5.5V	
Frequency Range	04	= 4 MHz
	16	= 16 MHz
	20	= 20 MHz
Temperature Range	blank	= 0°C to 70°C (Commercial)
Package	PT	= TQFP (Thin Quad Flatpack)
Pattern	QTP, SQTP, Code or Special Requirements L16 = 3V, 16 MHz	

Examples:

a) PIC16LC74B-16/PTL16 = Commercial temp., TQFP package, 16 MHz, low voltage VDD limits, QTP pattern #301.

Note 1: LC = Low Voltage CMOS
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* JW Devices are UV erasable and can be programmed to any device configuration. JW Devices meet the electrical requirement of each oscillator type (including LC devices).

NOTES:

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