PIC16F716

PIC16F716
Silicon Errata and Data Sheet Clarification

The PIC16F716 device that you have received conforms functionally to the current Device Data Sheet (DS41206**B**), except for the anomalies described in this document.

The silicon issues discussed in the following pages are for silicon revisions with the Device and Revision IDs listed in Table 1. The silicon issues are summarized in Table 2.

The errata described in this document will be addressed in future revisions of the PIC16F716 silicon.

Note:	This document summarizes all silicon errata issues from all revisions of silicon, previous as well as current. Only the issues indicated in the last column of Table 2 apply to the current silicon revision **(A6)**.

Data Sheet clarifications and corrections start on page 4, following the discussion of silicon issues.

The silicon revision level can be identified using the current version of MPLAB® IDE and Microchip's programmers, debuggers, and emulation tools, which are available at the Microchip corporate web site (www.microchip.com).

For example, to identify the silicon revision level using MPLAB IDE in conjunction with MPLAB ICD 2, MPLAB ICD 3, PICkit™ 2 or PICkit™ 3:

1. Using the appropriate interface, connect the device to the MPLAB ICD 2 programmer/ debugger, PICkit™ 2 or PICkit™ 3.
2. From the main menu in MPLAB IDE, select *Configure>Select Device*, and then select the target part number in the dialog box.
3. Select the MPLAB hardware tool (*Programmer>Select Tool*).
4. Perform a "Connect" operation to the device (*Programmer>Connect*). Depending on the development tool used, the part number *and* Device Revision ID value appear in the **Output** window.

Note:	If you are unable to extract the silicon revision level, please contact your local Microchip sales office for assistance.

The Device ID values for the various devices and silicon revisions are shown in Table 1.

TABLE 1: SILICON DEVREV VALUES

Part Number	Device ID(1)	Revision ID for Silicon Revision(2)		
		A4	A5	A6
PIC16F716	01 0001 010x xxxx	4	5	5

Note 1: The device and revision data is stored in the Device ID located at 2006h in program memory.

2: Refer to the *"PIC16F716 Flash Programming Specification"* (DS40245) for detailed information.

TABLE 2: SILICON ISSUE SUMMARY

Module	Feature	Item Number	Issue Summary	Affected Revisions(1)		
				A4	A5	A6
Programming	In-Circuit Serial Programming™ (ICSP™)	1.	Oscillator affects programming.	X		
ECCP	Software Interrupt mode/ Special Event Trigger	2.	RB3 cannot drive high in these ECCP modes.	X	X	X
ECCP	PWM	3.	Duty cycle may be extended by one oscillator period.	X	X	X

Note 1: Only those issues indicated in the last column apply to the current silicon revision.

Silicon Errata Issues

Note:	This document summarizes all silicon errata issues from all revisions of silicon, previous as well as current. Only the issues indicated by the shaded column in the following tables apply to the current silicon revision **(A6)**.

1. Module: Silicon – Programming

The oscillator circuitry may prevent proper initialization of the Programming mode when the part is programmed in-circuit.

Work around

Tie the OSC1/EXTCLK pin (pin 16 of 18-pin package or pin 18 of 20-pin package) to ground to disable the oscillator during In-Circuit Serial Programming™.

Affected Silicon Revisions

A4	A5	A6					
X							

2. Module: ECCP

The ECCP module will override pin data of the RB3/CCP1 pin when operating in Software Interrupt mode (CCP1M = 0xA) or Special Event Trigger mode (CCP1M = 0xB). The RB3/CCP1 pin can be used as a general purpose input by setting the TRISB3 bit. However, if the pin is configured as an output, the ECCP module will always drive the pin low.

This affects all released versions of silicon.

Work around

None.

Affected Silicon Revisions

A4	A5	A6					
X	X	X					

3. Module: ECCP

The falling edge of the PWM waveform may be extended by one system oscillator period if the falling edge coincides with a write to the PORTB register.

This affects all released versions of silicon.

Work around

Test the PWM pin status in software and postpone writing to PORTB until the pin is low.

Affected Silicon Revisions

A4	A5	A6					
X	X	X					

Data Sheet Clarifications

The following typographical corrections and clarifications are to be noted for the latest version of the device data sheet (DS41206**B**):

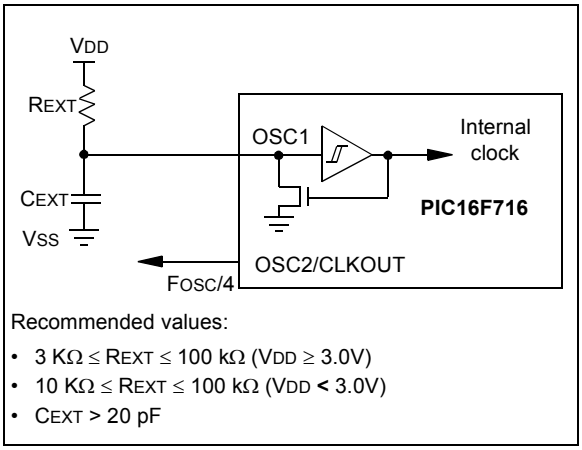
Note:	Corrections are shown in **bold**. Where possible, the original bold text formatting has been removed for clarity.

1. Module: Oscillator Configuration

In Figure 9-3, revise the second line of recommended values as follows:

10 kΩ ≤ REXT ≤ 100 kΩ (VDD < 3.0V)

FIGURE 9-3: RC OSCILLATOR MODE



Recommended values:

- 3 KΩ ≤ REXT ≤ 100 kΩ (VDD ≥ 3.0V)
- 10 KΩ ≤ REXT ≤ 100 kΩ (VDD < 3.0V)
- CEXT > 20 pF

2. Module: Electrical Characteristics

In Section 12.4, “DC Characteristics: PIC16F716 (Industrial, Extended)”, changes to parameter numbers D033A and D042B are shown in bold and italics below.

12.4 DC Characteristics: PIC16FXXXX (Industrial, Extended)

DC CHARACTERISTICS			Standard Operating Conditions (unless otherwise stated) Operating temperature -40°C ≤ TA ≤ +85°C for industrial -40°C ≤ TA ≤ +125°C for extended Operating voltage VDD range as described in DC specification **Section 12.1 “DC Characteristics: PIC16F716 (Industrial, Extended)”** and **Section 12.4 “DC Characteristics: PIC16F716 (Industrial, Extended)”**				
Param No.	**Sym**	**Characteristic**	**Min**	**Typ†**	**Max**	**Units**	**Conditions**
	VIL	**Input Low Voltage**					
		I/O ports					
D030		with TTL buffer	VSS	—	0.8V	V	4.5V ≤ VDD ≤ 5.5V
D030A			VSS	—	0.15VDD	V	otherwise
D031		with Schmitt Trigger buffer	VSS	—	0.2VDD	V	
D032		MCLR, OSC1 (in RC mode)	VSS	—	0.2VDD	V	
D033		OSC1 (in HS mode)	VSS	—	0.3VDD	V	**(Note 1)**
D033A		OSC1 (in XT and LP modes)	VSS	—	***0.3***	V	
	VIH	**Input High Voltage**					
		I/O ports		—			
D040		with TTL buffer	2.0	—	VDD	V	4.5V ≤ VDD ≤ 5.5V
D040A			0.25 VDD + 0.8V	—	VDD	V	otherwise
D041		with Schmitt Trigger buffer	0.8 VDD	—	VDD	V	For entire VDD range
D042		MCLR	0.8 VDD	—	VDD	V	
D042A		OSC1 (HS)	0.7 VDD	—	VDD	V	**(Note 1)**
D042B		***OSC1 (XT and LP modes)***	***1.6***	**—**	***VDD***	***V***	
D043		OSC1 (in RC mode)	0.9 VDD	—	VDD	V	
	IIL	**Input Leakage Current(2), (3)**					
D060		I/O ports	—	—	±1	µA	Vss ≤ VPIN ≤ VDD, Pin at high-impedance
D061		MCLR, RA4/T0CKI	—	—	±5	µA	Vss ≤ VPIN ≤ VDD
D063		OSC1/CLKIN	—	—	±5	µA	Vss ≤ VPIN ≤ VDD, XT, HS and LP Oscillator modes
D070	IPURB	**PORTB weak pull-up current**	50	250	400	µA	VDD = 5V, VPIN = VSS
	VOL	**Output Low Voltage**					
D080		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 Oscillator 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
	VOH	**Output High Voltage**					
D090		I/O ports(3)	VDD – 0.7	—	—	V	IOH = -3.0 mA, VDD = 4.5V, -40°C to +85°C
			VDD – 0.7	—	—	V	IOH = -2.5 mA, VDD = 4.5V, -40°C to +125°C
D092		OSC2/CLKOUT (RC Oscillator 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/CLKOUT 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	

* 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: In RC Oscillator mode, the OSC1/CLKIN pin is a Schmitt Trigger input. It is not recommended that the PIC® microcontroller be driven with external clock in RC mode.

2: The leakage current on the 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.

3. Module: Interrupts

The IOCB register is not used on this device. The interrupt-on-change feature will automatically be enabled for any RB<7:4> configured as an input. See **Section 3.2 "PORTB and the TRISB Register"** in the data sheet (DS41206B) for more information.

REGISTER 2-3: INTCON: INTERRUPT CONTROL REGISTER

R/W-0	R/W-0	R/W-0	R/W-0	R/W-0	R/W-0	R/W-0	R/W-x
GIE	PEIE	T0IE	INTE	RBIE	T0IF(1)	INTF	RBIF
bit 7							bit 0

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

bit 7 **GIE:** Global Interrupt Enable bit
1 = Enables all unmasked interrupts
0 = Disables all interrupts

bit 6 **PEIE:** Peripheral Interrupt Enable bit
1 = Enables all unmasked peripheral interrupts
0 = Disables all peripheral interrupts

bit 5 **T0IE:** Timer0 Overflow Interrupt Enable bit
1 = Enables the Timer0 interrupt
0 = Disables the Timer0 interrupt

bit 4 **INTE:** RB0/INT External Interrupt Enable bit
1 = Enables the RB0/INT external interrupt
0 = Disables the RB0/INT external interrupt

bit 3 **RBIE:** PORTB Change Interrupt Enable bit
1 = Enables the PORTB change interrupt
0 = Disables the PORTB change interrupt

bit 2 **T0IF:** Timer0 Overflow Interrupt Flag bit(1)
1 = TMR0 register has overflowed (must be cleared in software)
0 = TMR0 register did not overflow

bit 1 **INTF:** RB0/INT External Interrupt Flag bit
1 = The RB0/INT external interrupt occurred (must be cleared in software)
0 = The RB0/INT external interrupt did not occur

bit 0 **RBIF:** PORTB Change Interrupt Flag bit
1 = When at least one of the PORTB general purpose I/O pins changed state (must be cleared in software)
0 = None of the PORTB general purpose I/O pins have changed state

Note 1: T0IF bit is set when Timer0 rolls over. Timer0 is unchanged on Reset and should be initialized before clearing T0IF bit.

4. Module: ADC

Corrected values for the acquisition time example for the 8-bit ADC used by this device are shown below.

EQUATION 7-1: ACQUISITION TIME EXAMPLE

Assumptions: $Temperature = 50°C$ *and external impedance of* $10k\Omega$ *5.0V* V_{DD}

$$T_{ACQ} = \text{Amplifier Settling Time} + \text{Hold Capacitor Charging Time} + \text{Temperature Coefficient}$$
$$= T_{AMP} + T_C + T_{COFF}$$
$$= 5\,\mu s + T_C + [(\text{Temperature} - 25°C)(0.05\mu s/°C)]$$

The value for T_C *can be approximated with the following equations:*

$$V_{APPLIED}\left(1 - \frac{1}{511}\right) = V_{CHOLD} \quad ;[1]\ V_{CHOLD}\ \text{charged to within 1/2 lsb}$$

$$V_{APPLIED}\left(1 - e^{\frac{-T_C}{RC}}\right) = V_{CHOLD} \quad ;[2]\ V_{CHOLD}\ \text{charge response to}\ V_{APPLIED}$$

$$V_{APPLIED}\left(1 - e^{\frac{-T_C}{RC}}\right) = V_{APPLIED}\left(1 - \frac{1}{511}\right) \quad ;\text{combining [1] and [2]}$$

Solving for T_C*:*

$$T_C = -C_{HOLD}(R_{IC} + R_{SS} + R_S)\ ln(1/511)$$
$$= -10pF(1k\Omega + 7k\Omega + 10k\Omega)\ ln(0.0019569)$$
$$= 1.12\mu s$$

Therefore:

$$T_{ACQ} = 5MS + 1.12MS + [(50°C - 25°C)(0.05MS/°C)]$$
$$= 7.37\mu s$$

5. Module: Electrical Characteristics

In Section 12.0, “Electrical Characteristics”, change (in bold):

From: Voltage on RA4 with respect to Vss 0V to +8.5V

To: Voltage on RA4 with respect to Vss **-0.3V** to +8.5V

APPENDIX A: REVISION HISTORY

Rev. A Document (2/19/04)

First revision of this document.

Rev. B Document (7/12/04)

Changes made to parameter numbers D033A and D042B in Section 12.4, “DC Characteristics: PIC16F716 (Industrial, Extended)”.

Rev. C Document (3/28/07)

Changes made to the data sheet revision referenced (DS41206B), emphasis added in Figure 9-3, “RC Oscillator Mode”, to the second recommended value, removed note 1 in register 2-3, “INTCON: Interrupt Control Register”, and adjusted values in Equation 7-1 “Acquisition Time Example”.

Rev. D Document (8/22/07)

Added Module 5: Electrical Characteristics (add -0.3V to “Voltage on RA4”).

Rev. E Document (4/02/08)

Added Module 2: ECCP on first page.

Rev. F Document (5/10)

Updated Errata to new format.

Added Module 3:ECCP. Added Tables 1 and 2.

NOTES:

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