



MICROCHIP PIC16F/LF182X/PIC12F/LF1822

PIC16F/LF182X/PIC12F/LF1822 Memory Programming Specification

This document includes the programming specifications for the following devices:

- PIC12F1822 • PIC12LF1822
- PIC16F1823 • PIC16LF1823
- PIC16F1824 • PIC16LF1824
- PIC16F1825 • PIC16LF1825
- PIC16F1826 • PIC16LF1826
- PIC16F1827 • PIC16LF1827
- PIC16F1828 • PIC16LF1828
- PIC16F1829 • PIC16LF1829

1.0 OVERVIEW

The PIC16F/LF182X and PIC12F/LF1822 devices can be programmed using either the high-voltage In-Circuit Serial Programming™ (ICSP™) method or the low-voltage ICSP™ method.

1.1 Hardware Requirements

1.1.1 HIGH-VOLTAGE ICSP PROGRAMMING

In High-Voltage ICSP™ mode, these devices require two programmable power supplies: one for VDD and one for the MCLR/VPP pin.

1.1.2 LOW-VOLTAGE ICSP PROGRAMMING

In Low-Voltage ICSP™ mode, these devices can be programmed using a single VDD source in the operating range. The MCLR/VPP pin does not have to be brought to a different voltage, but can instead be left at the normal operating voltage.

1.1.2.1 Single-Supply ICSP Programming

The LVP bit in Configuration Word 2 enables single-supply (low-voltage) ICSP programming. The LVP bit defaults to a '1' (enabled) from the factory. The LVP bit may only be programmed to '0' by entering the High-Voltage ICSP mode, where the MCLR/VPP pin is raised to VIH. Once the LVP bit is programmed to a '0', only the High-Voltage ICSP mode is available and only the High-Voltage ICSP mode can be used to program the device.

Note 1: The High-Voltage ICSP mode is always available, regardless of the state of the LVP bit, by applying VIH to the MCLR/VPP pin.

2: While in Low-Voltage ICSP mode, MCLR is always enabled, regardless of the MCLRE bit, and the port pin can no longer be used as a general purpose input.

PIC16F/LF182X/PIC12F/LF1822

1.2 Pin Utilization

Five pins are needed for ICSP™ programming. The pins are listed in Table 1-1 and Table 1-2.

TABLE 1-1: PIN DESCRIPTIONS DURING PROGRAMMING – PIC16F1826/PIC16LF1826, PIC16F1827/PIC16LF1827

Pin Name	During Programming		
	Function	Pin Type	Pin Description
RB6	ICSPCLK	I	Clock Input – Schmitt Trigger Input
RB7	ICSPDAT	I/O	Data Input/Output – Schmitt Trigger Input
RA5/MCLR/VPP	Program/Verify mode	P ⁽¹⁾	Program Mode Select/Programming Power Supply
VDD	VDD	P	Power Supply
VSS	VSS	P	Ground

Legend: I = Input, O = Output, P = Power

Note 1: In the PIC12F/LF1822 and PIC16F/LF182X, the programming high voltage is internally generated. To activate the Program/Verify mode, high voltage needs to be applied to MCLR input. Since the MCLR is used for a level source, MCLR does not draw any significant current.

TABLE 1-2: PIN DESCRIPTIONS DURING PROGRAMMING – PIC12F/LF1822, PIC16F/LF1823, PIC16F/LF1824, PIC16F/LF1825, PIC16F/LF1828 and PIC16F/LF1829

Pin Name	During Programming		
	Function	Pin Type	Pin Description
RA1	ICSPCLK	I	Clock Input – Schmitt Trigger Input
RA0	ICSPDAT	I/O	Data Input/Output – Schmitt Trigger Input
RA3/MCLR/VPP	Program/Verify mode	P ⁽¹⁾	Program Mode Select/Programming Power Supply
VDD	VDD	P	Power Supply
VSS	VSS	P	Ground

Legend: I = Input, O = Output, P = Power

Note 1: In the PIC12F/LF1822 and PIC16F/LF182X, the programming high voltage is internally generated. To activate the Program/Verify mode, high voltage needs to be applied to MCLR input. Since the MCLR is used for a level source, MCLR does not draw any significant current.

PIC16F/LF182X/PIC12F/LF1822

2.0 DEVICE PINOUTS

The pin diagrams for the PIC16F/LF182X and PIC12F/LF1822 family are shown in Figure 2-1 through Figure 2-9. The pins that are required for programming are listed in Table 1-1 and shown in bold lettering in the pin diagrams.

FIGURE 2-1: 18-PIN DIAGRAM FOR PIC16F1826/1827 AND PIC16LF1826/1827

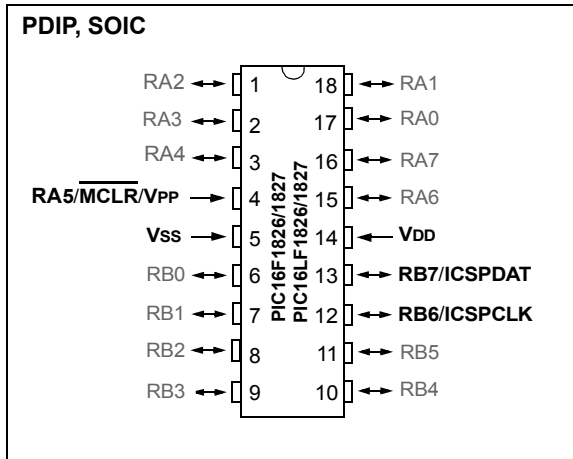


FIGURE 2-2: 20-PIN DIAGRAM FOR PIC16F1826/1827 AND PIC16LF1826/1827

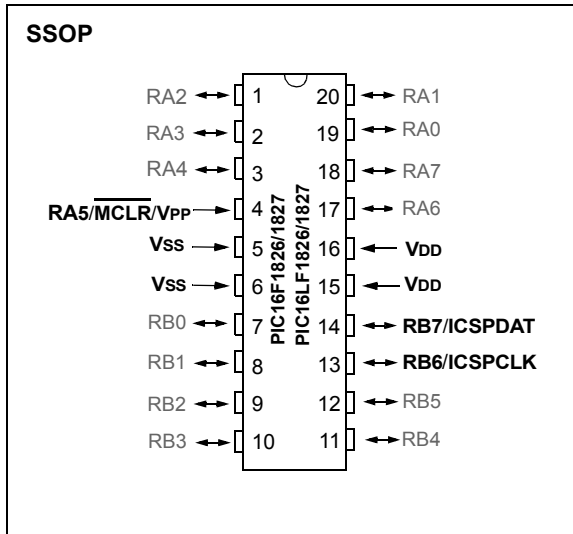


FIGURE 2-3: 28-PIN DIAGRAM FOR PIC16F1826/1827 AND PIC16LF1826/1827

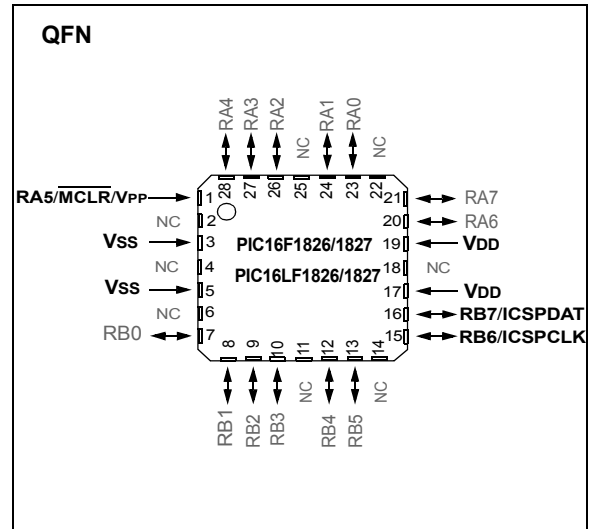


FIGURE 2-4: 8-PIN DIAGRAM FOR PIC12F1822/PIC12LF1822

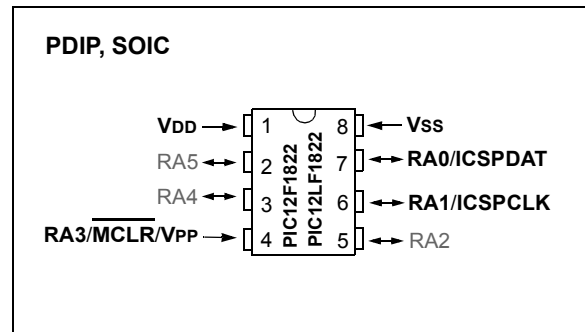
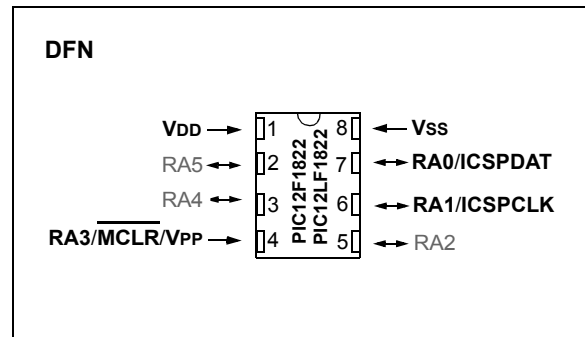


FIGURE 2-5: 8-PIN DIAGRAM FOR PIC12F1822/PIC12LF1822



PIC16F/LF182X/PIC12F/LF1822

FIGURE 2-6: 14-PIN DIAGRAM FOR PIC16F/LF1823, PIC16F/LF1824 AND PIC16F/LF1825

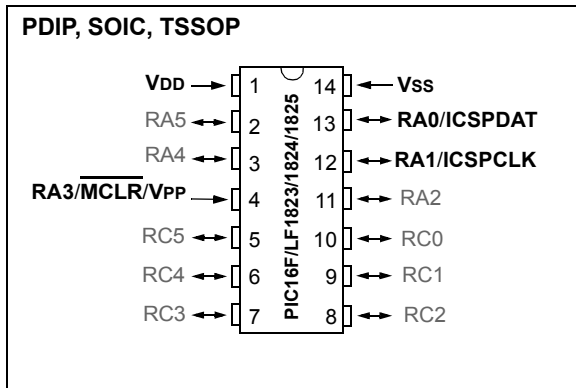


FIGURE 2-7: 16-PIN DIAGRAM FOR PIC16F/LF1823, PIC16F/LF1824 AND PIC16F/LF1825

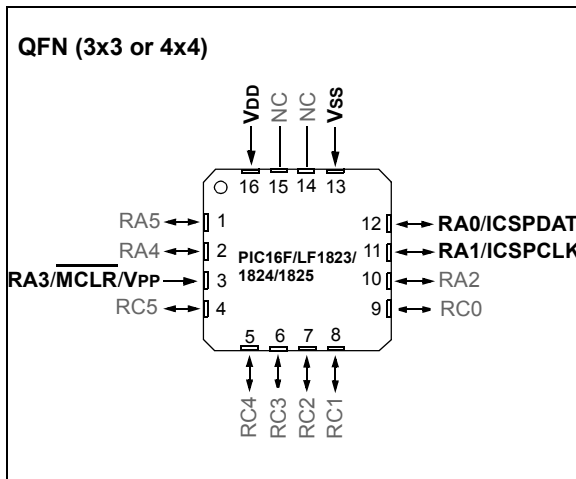


FIGURE 2-9: 20-PIN DIAGRAM FOR PIC16F/LF1828 AND PIC16F/LF1829

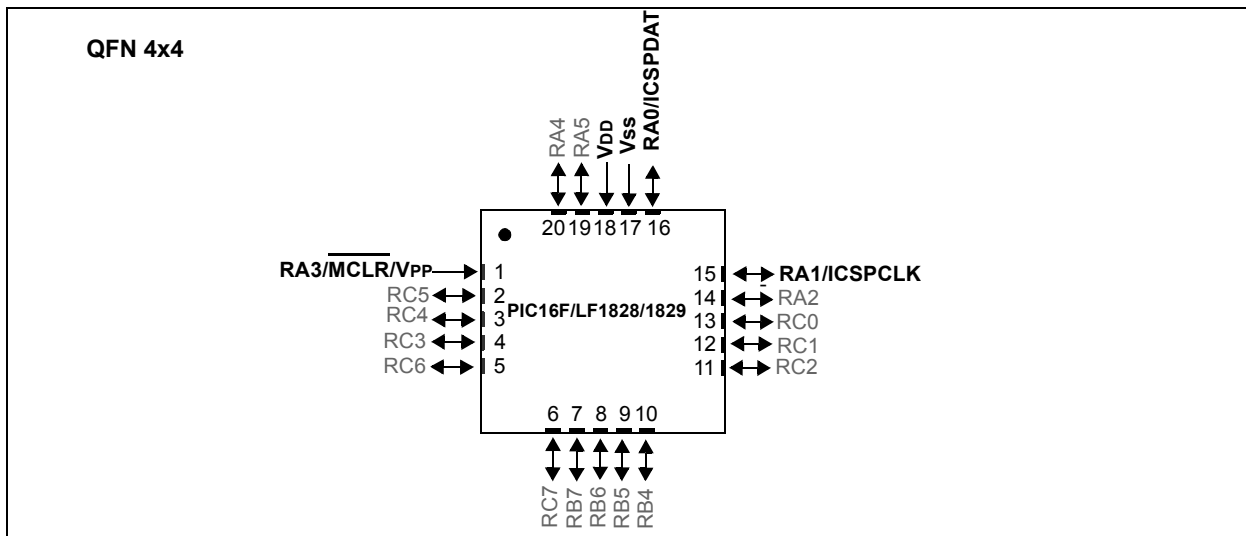
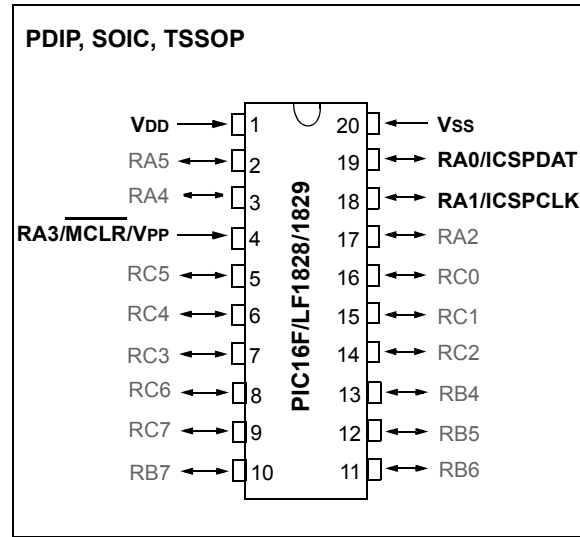


FIGURE 2-8: 20-PIN DIAGRAM FOR PIC16F/LF1828 AND PIC16F/LF1829

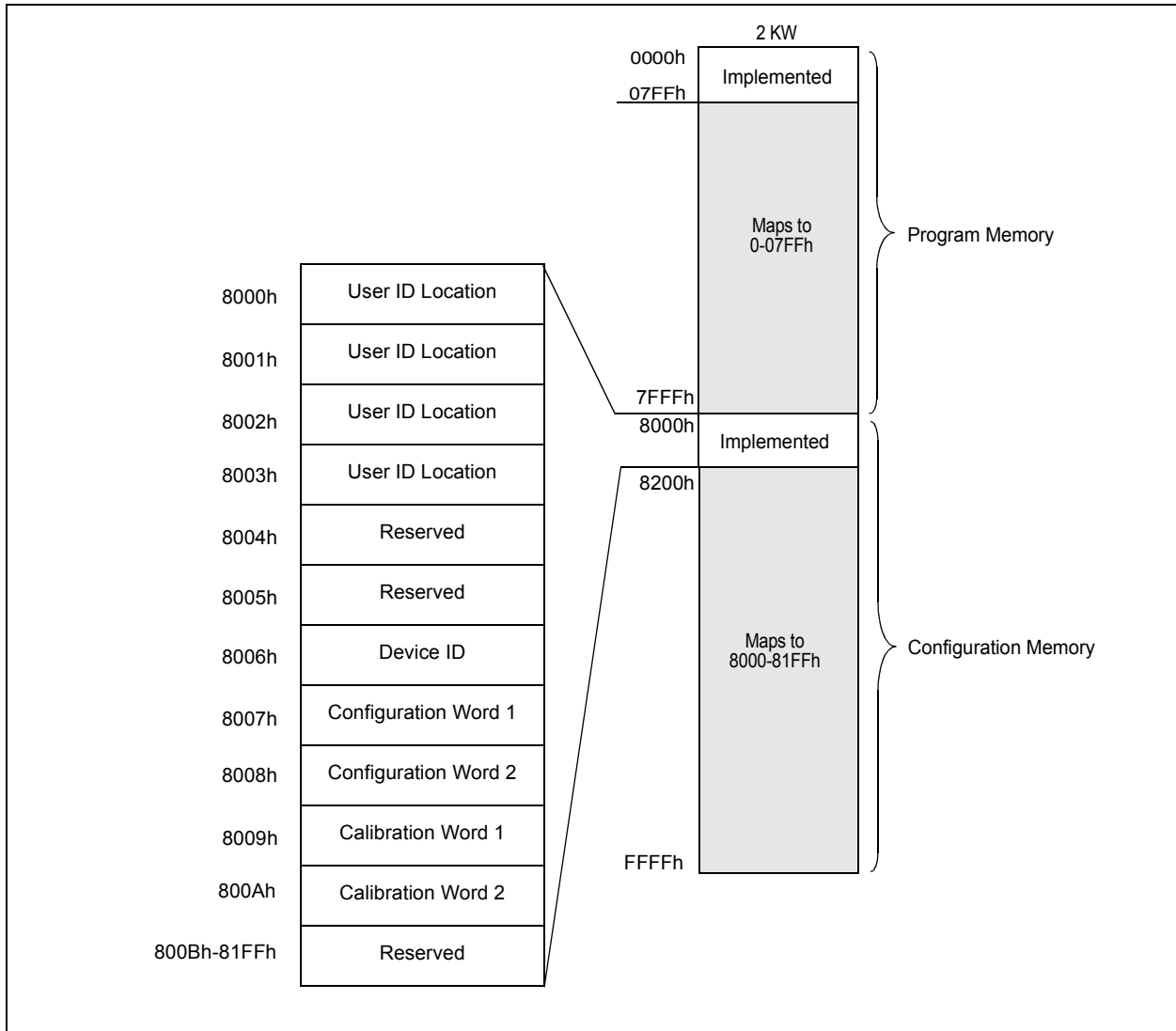


PIC16F/LF182X/PIC12F/LF1822

3.0 MEMORY MAP

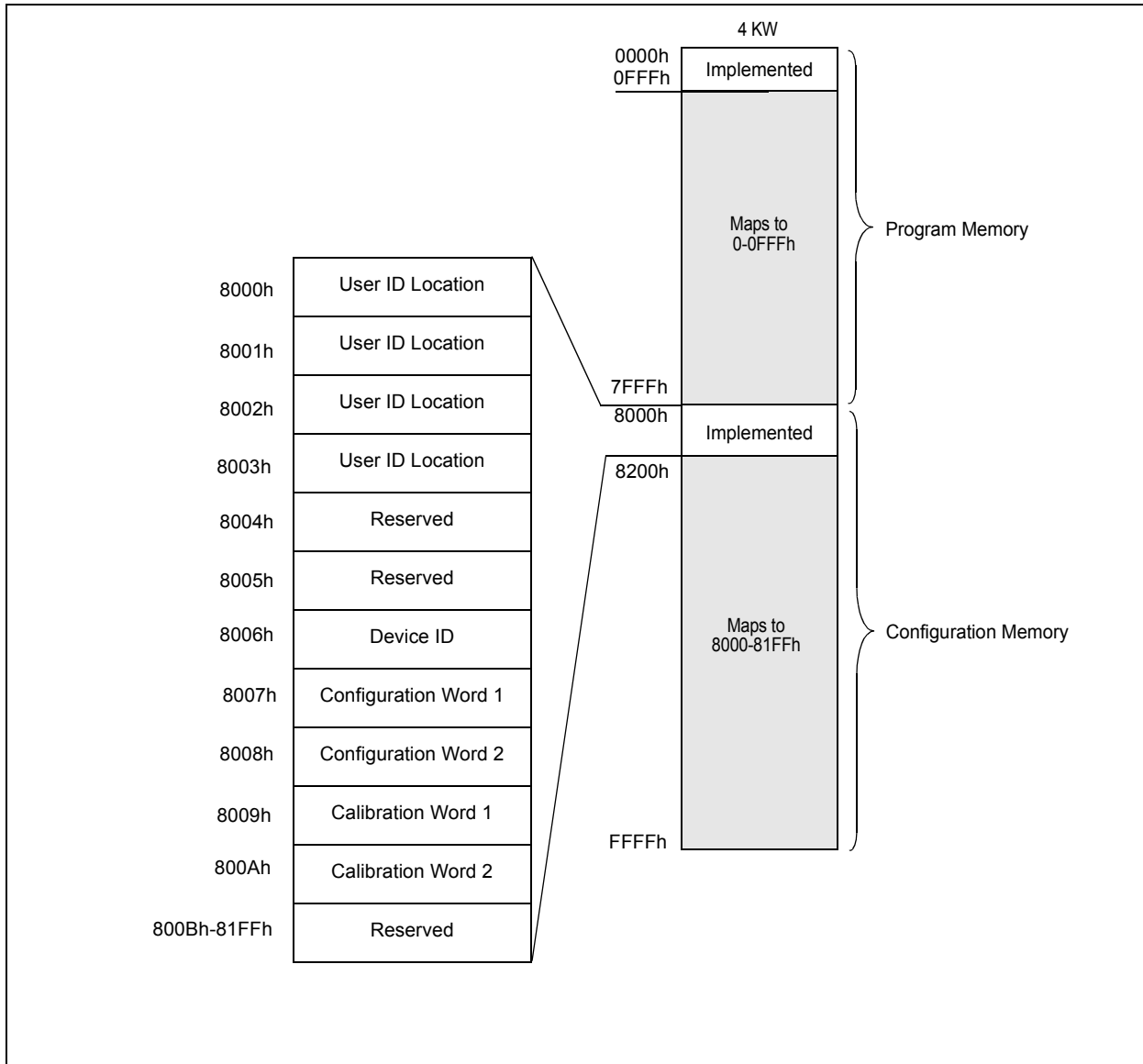
The memory for the PIC16F/LF182X and PIC12F/LF1822 devices is broken into two sections: program memory and configuration memory. Only the size of the program memory changes between devices, the configuration memory remains the same.

FIGURE 3-1: PIC12F1822/PIC12LF1822, PIC16F1823/PIC16LF1823, PIC16F1826/PIC16LF1826 PROGRAM MEMORY MAPPING



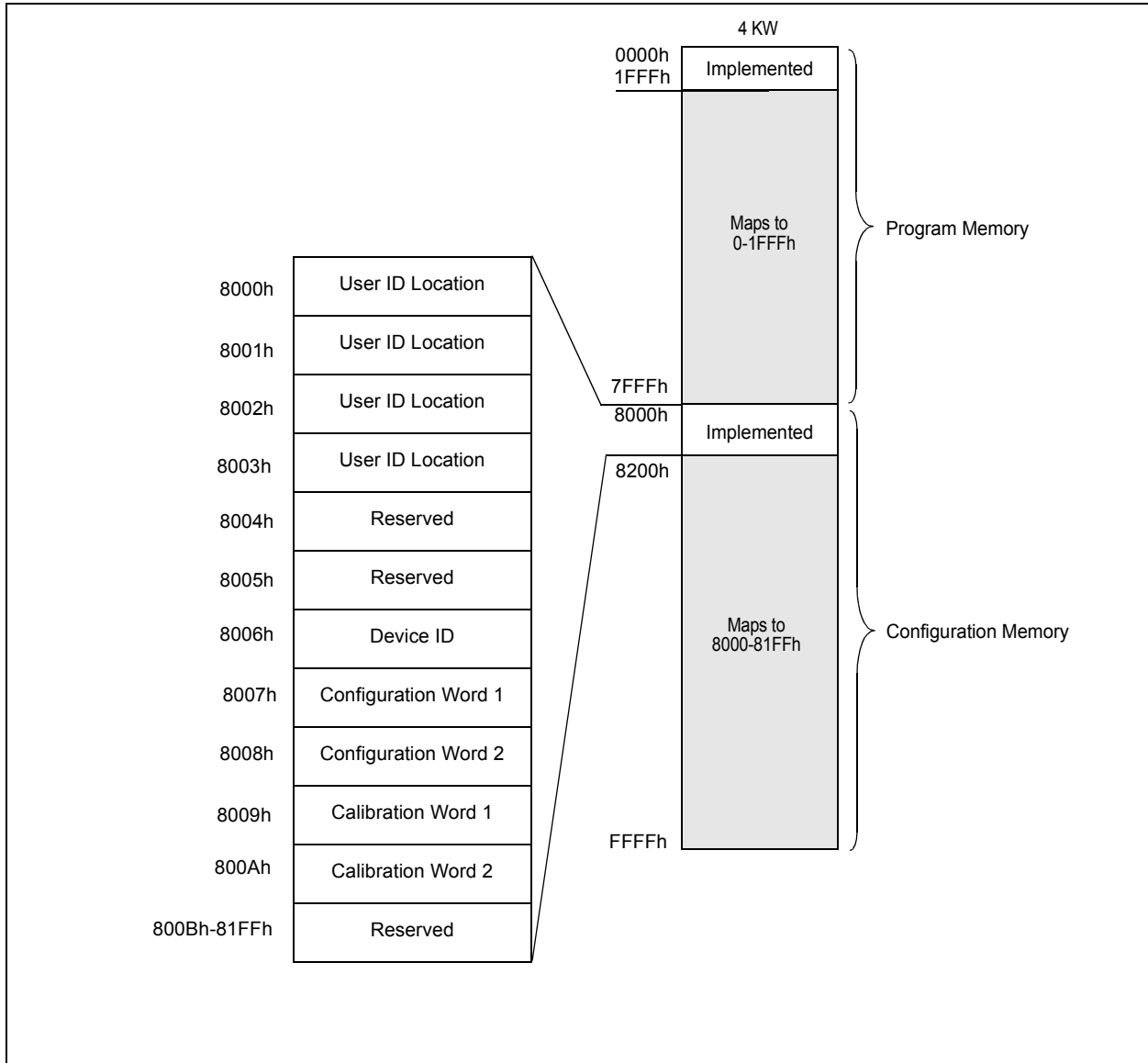
PIC16F/LF182X/PIC12F/LF1822

FIGURE 3-2: PIC16F/LF1827, PIC16F/LF1824 AND PIC16F/LF1828 PROGRAM MEMORY MAPPING



PIC16F/LF182X/PIC12F/LF1822

FIGURE 3-3: PIC16F/LF1825 AND PIC16F/LF1829 PROGRAM MEMORY MAPPING



PIC16F/LF182X/PIC12F/LF1822

3.1 User ID Location

A user may store identification information (user ID) in four designated locations. The user ID locations are mapped to 8000h-8003h. Each location is 14 bits in length. Code protection has no effect on these memory locations. Each location may be read with code protection enabled or disabled.

Note: MPLAB® IDE only displays the 7 Least Significant bits (LSb) of each user ID location, the upper bits are not read. It is recommended that only the 7 LSb's be used if MPLAB IDE is the primary tool used to read these addresses.

3.2 Device ID

The device ID word is located at 8006h. This location is read-only and cannot be erased or modified.

REGISTER 3-1: DEVICE ID: DEVICE ID REGISTER⁽¹⁾

R	R	R	R	R	R	R
DEV8	DEV7	DEV6	DEV5	DEV4	DEV3	DEV2
bit 13						bit 7

R	R	R	R	R	R	R
DEV1	DEV0	REV4	REV3	REV2	REV1	REV0
bit 6						bit 0

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

bit 13-5 **DEV<8:0>**: Device ID bits
 These bits are used to identify the part number.

bit 4-0 **REV<4:0>**: Revision ID bits
 These bits are used to identify the revision.

Note 1: This location cannot be written.

PIC16F/LF182X/PIC12F/LF1822

TABLE 3-1: DEVICE ID VALUES

DEVICE	DEVICE ID VALUES	
	DEV	REV
PIC16F1826	10 0111 100	x xxxx
PIC16F1827	10 0111 101	x xxxx
PIC16LF1826	10 1000 100	x xxxx
PIC16LF1827	10 1000 101	x xxxx
PIC16F1823	10 0111 001	x xxxx
PIC16LF1823	10 1000 001	x xxxx
PIC12F1822	10 0111 000	x xxxx
PIC12LF1822	10 1000 000	x xxxx
PIC16F1824	10 0111 010	x xxxx
PIC16LF1824	10 1000 010	x xxxx
PIC16F1825	10 0111 011	x xxxx
PIC16LF1825	10 1000 011	x xxxx
PIC16F1828	10 0111 110	x xxxx
PIC16LF1828	10 1000 110	x xxxx
PIC16F1829	10 0111 111	x xxxx
PIC16LF1829	10 1000 111	x xxxx

3.3 Configuration Words

There are two Configuration Words, Configuration Word 1 (8007h) and Configuration Word 2 (8008h). The individual bits within these Configuration Words are used to enable or disable device functions such as the Brown-out Reset, code protection and Power-up Timer.

3.4 Calibration Words

The internal calibration values are factory calibrated and stored in Calibration Words 1 and 2 (8009h, 800Ah).

The Calibration Words do not participate in erase operations. The device can be erased without affecting the Calibration Words.

PIC16F/LF182X/PIC12F/LF1822

REGISTER 3-2: CONFIGURATION WORD 1

R/P-1	R/P-1	R/P-1	R/P-1	R/P-1	R/P-1	R/P-1
FCMEN	IESO	CLKOUTEN	BOREN1	BOREN0	CPD	CP
bit 13						bit 7

R/P-1	R/P-1	R/P-1	R/P-1	R/P-1	R/P-1	R/P-1
MCLRRE	PWRTE	WDTE1	WDTE0	FOSC2	FOSC1	FOSC0
bit 6						bit 0

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

- bit 13 **FCMEN:** Fail-Safe Clock Monitor Enable bit
 1 = Fail-Safe Clock Monitor is enabled
 0 = Fail-Safe Clock Monitor is disabled
- bit 12 **IESO:** Internal External Switchover bit
 1 = Internal/External Switchover mode is enabled
 0 = Internal/External Switchover mode is disabled
- bit 11 **CLKOUTEN:** Clock Out Enable bit
 1 = CLKOUT function is disabled. I/O or oscillator function on CLKOUT pin.
 0 = CLKOUT function is enabled on CLKOUT pin
- bit 10-9 **BOREN<1:0>:** Brown-out Reset Enable bits⁽¹⁾
 11 = BOR enabled
 10 = BOR enabled during operation and disabled in Sleep
 01 = BOR controlled by SBOREN bit of the PCON register
 00 = BOR disabled
- bit 8 **CPD:** Data Code Protection bit⁽²⁾
 1 = Data memory code protection is disabled
 0 = Data memory code protection is enabled
- bit 7 **CP:** Code Protection bit⁽³⁾
 1 = Program memory code protection is disabled
 0 = Program memory code protection is enabled
- bit 6 **MCLRRE:** MCLR/VPP Pin Function Select bit
 If LVP bit = 1:
 This bit is ignored.
 If LVP bit = 0:
 1 = MCLR/VPP pin function is MCLR; Weak pull-up enabled.
 0 = MCLR/VPP pin function is digital input; MCLR internally disabled; Weak pull-up under control of WPUA register.
- bit 5 **PWRTE:** Power-up Timer Enable bit⁽¹⁾
 1 = PWRT disabled
 0 = PWRT enabled
- bit 4-3 **WDTE<1:0>:** Watchdog Timer Enable bit
 11 = WDT enabled
 10 = WDT enabled while running and disabled in Sleep
 01 = WDT controlled by the SWDTEN bit in the WDTCON register
 00 = WDT disabled
- bit 2-0 **FOSC<2:0>:** Oscillator Selection bits
 111 = ECH: External Clock, High-Power mode: on CLKIN pin
 110 = ECM: External Clock, Medium-Power mode: on CLKIN pin
 101 = ECL: External Clock, Low-Power mode: on CLKIN pin
 100 = INTOSC oscillator: I/O function on OSC1 pin
 011 = EXTRC oscillator: RC function on OSC1 pin
 010 = HS oscillator: High-speed crystal/resonator on OSC2 pin and OSC1 pin
 001 = XT oscillator: Crystal/resonator on OSC2 pin and OSC1 pin
 000 = LP oscillator: Low-power crystal on OSC2 pin and OSC1 pin

- Note 1:** Enabling Brown-out Reset does not automatically enable Power-up Timer.
Note 2: The entire data EEPROM will be erased when the code protection is turned off during an erase.
Note 3: The entire program memory will be erased when the code protection is turned off.

PIC16F/LF182X/PIC12F/LF1822

REGISTER 3-3: CONFIGURATION WORD 2

R/P-1	R/P-1	U-1	R/P-1	R/P-1	R/P-1	U-1
LVP	DEBUG	—	BORV	STVREN	PLLEN	—
bit 13						bit 7

U-1	U-1	R-1	U-1	U-1	R/P-1	R/P-1
—	—	RESERVED ⁽²⁾	—	—	WRT1	WRT0
bit 6						bit 0

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

- bit 13 **LVP:** Low-Voltage Programming Enable bit⁽¹⁾
 1 = Low-voltage programming enabled
 0 = HV on MCLR/VPP must be used for programming
- bit 12 **DEBUG:** In-Circuit Debugger Mode bit
 1 = In-Circuit Debugger disabled, ICSPCLK and ICSPDAT are general purpose I/O pins
 0 = In-Circuit Debugger enabled, ICSPCLK and ICSPDAT are dedicated to the debugger
- bit 11 **Unimplemented:** Read as '1'
- bit 10 **BORV:** Brown-out Reset Voltage Selection bit
 1 = Brown-out Reset voltage set to 1.9V
 0 = Brown-out Reset voltage set to 2.7V
- bit 9 **STVREN:** Stack Overflow/Underflow Reset Enable bit
 1 = Stack overflow or underflow will cause a Reset
 0 = Stack overflow or underflow will not cause a Reset
- bit 8 **PLLEN:** PLL Enable bit
 1 = 4xPLL enabled
 0 = 4xPLL disabled
- bit 7-5 **Unimplemented:** Read as '1'
- bit 4 **Reserved:** Read as '1'⁽²⁾
- bit 3-2 **Unimplemented:** Read as '1'
- bit 1-0 **WRT<1:0>:** Flash Memory Self-Write Protection bits
2 kW Flash memory (PIC16F1826/PIC16LF1826):
 11 = Write protection off
 10 = 000h to 1FFh write-protected, 200h to 7FFh may be modified by EECON control
 01 = 000h to 3FFh write-protected, 400h to 7FFh may be modified by EECON control
 00 = 000h to 7FFh write-protected, no addresses may be modified by EECON control
4 kW Flash memory (PIC16F1827/PIC16LF1827):
 11 = Write protection off
 10 = 000h to 1FFh write-protected, 200h to FFFh may be modified by EECON control
 01 = 000h to 7FFh write-protected, 800h to FFFh may be modified by EECON control
 00 = 000h to FFFh write-protected, no addresses may be modified by EECON control

Note 1: The LVP bit cannot be programmed to '0' when Programming mode is entered via LVP.
Note 2: This bit must be programmed as a '1'.

PIC16F/LF182X/PIC12F/LF1822

4.0 PROGRAM/VERIFY MODE

In Program/Verify mode, the program memory and the configuration memory can be accessed and programmed in serial fashion. ICSPDAT and ICSPCLK are used for the data and the clock, respectively. All commands and data words are transmitted LSb first. Data changes on the rising edge of the ICSPCLK and latched on the falling edge. In Program/Verify mode both the ICSPDAT and ICSPCLK are Schmitt Trigger inputs. The sequence that enters the device into Program/Verify mode places all other logic into the Reset state. Upon entering Program/Verify mode, all I/Os are automatically configured as high-impedance inputs and the address is cleared.

4.1 High-Voltage Program/Verify Mode Entry and Exit

There are two different methods of entering Program/Verify mode via high-voltage:

- VPP – First entry mode
- VDD – First entry mode

4.1.1 VPP – FIRST ENTRY MODE

To enter Program/Verify mode via the VPP-first method the following sequence must be followed:

1. Hold ICSPCLK and ICSPDAT low. All other pins should be unpowered.
2. Raise the voltage on $\overline{\text{MCLR}}$ from 0V to V_{IH} .
3. Raise the voltage on VDD FROM 0V to the desired operating voltage.

The VPP-first entry prevents the device from executing code prior to entering Program/Verify mode. For example, when Configuration Word 1 has $\overline{\text{MCLR}}$ disabled ($\text{MCLRE} = 0$), the power-up time is disabled ($\text{PWRTÉ} = 0$), the internal oscillator is selected ($\text{FOSC} = 100$), and ICSPCLK and ICSPDAT pins are driven by the user application, the device will execute code. Since this may prevent entry, VPP-first entry mode is strongly recommended. See the timing diagram in Figure 8-2.

4.1.2 VDD – FIRST ENTRY MODE

To enter Program/Verify mode via the VDD-first method the following sequence must be followed:

1. Hold ICSPCLK and ICSPDAT low.
2. Raise the voltage on VDD from 0V to the desired operating voltage.
3. Raise the voltage on $\overline{\text{MCLR}}$ from VDD or below to V_{IH} .

The VDD-first method is useful when programming the device when VDD is already applied, for it is not necessary to disconnect VDD to enter Program/Verify mode. See the timing diagram in Figure 8-1.

4.1.3 PROGRAM/VERIFY MODE EXIT

To exit Program/Verify mode take $\overline{\text{MCLR}}$ to VDD or lower (V_{IL}). See Figures 8-3 and 8-4.

4.2 Low-Voltage Programming (LVP) Mode

The Low-Voltage Programming mode allows the PIC16F/LF182X and PIC12F/LF1822 devices to be programmed using VDD only, without high voltage. When the LVP bit of Configuration Word 2 register is set to '1', the low-voltage ICSP programming entry is enabled. To disable the Low-Voltage ICSP mode, the LVP bit must be programmed to '0'. This can only be done while in the High-Voltage Entry mode.

Entry into the Low-Voltage ICSP Program/Verify modes requires the following steps:

1. $\overline{\text{MCLR}}$ is brought to V_{IL} .
2. A 32-bit key sequence is presented on ICSPDAT, while clocking ICSPCLK.

The key sequence is a specific 32-bit pattern, '0100 1101 0100 0011 0100 1000 0101 0000' (more easily remembered as MCHP in ASCII). The device will enter Program/Verify mode only if the sequence is valid. The Least Significant bit of the Least Significant nibble must be shifted in first.

Once the key sequence is complete, $\overline{\text{MCLR}}$ must be held at V_{IL} for as long as Program/Verify mode is to be maintained.

For low-voltage programming timing, see Figure 8-8 and Figure 8-9.

Exiting Program/Verify mode is done by no longer driving $\overline{\text{MCLR}}$ to V_{IL} . See Figure 8-8 and Figure 8-9.

Note: To enter LVP mode, the LSB of the Least Significant nibble must be shifted in first. This differs from entering the key sequence on other parts.

PIC16F/LF182X/PIC12F/LF1822

4.3 Program/Verify Commands

The PIC16F/LF182X and PIC12F/LF1822 implement 13 programming commands; each six bits in length. The commands are summarized in Table 4-1.

Commands that have data associated with them are specified to have a minimum delay of TDLY between the command and the data. After this delay 16 clocks are required to either clock in or clock out the 14-bit data word. The first clock is for the Start bit and the last clock is for the Stop bit.

TABLE 4-1: COMMAND MAPPING

Command	Mapping		Data/Note
	Binary (MSb ... LSb)	Hex	
Load Configuration	x 0 0 0 0 0	00h	0, data (14), 0
Load Data For Program Memory	x 0 0 0 1 0	02h	0, data (14), 0
Load Data For Data Memory	x 0 0 0 1 1	03h	0, data (8), zero (6), 0
Read Data From Program Memory	x 0 0 1 0 0	04h	0, data (14), 0
Read Data From Data Memory	x 0 0 1 0 1	05h	0, data (8), zero (6), 0
Increment Address	x 0 0 1 1 0	06h	—
Reset Address	x 1 0 1 1 0	16h	—
Begin Internally Timed Programming	x 0 1 0 0 0	08h	—
Begin Externally Timed Programming	x 1 1 0 0 0	18h	—
End Externally Timed Programming	x 0 1 0 1 0	0Ah	—
Bulk Erase Program Memory	x 0 1 0 0 1	09h	Internally Timed
Bulk Erase Data Memory	x 0 1 0 1 1	0Bh	Internally Timed
Row Erase Program Memory	x 1 0 0 0 1	11h	Internally Timed

PIC16F/LF182X/PIC12F/LF1822

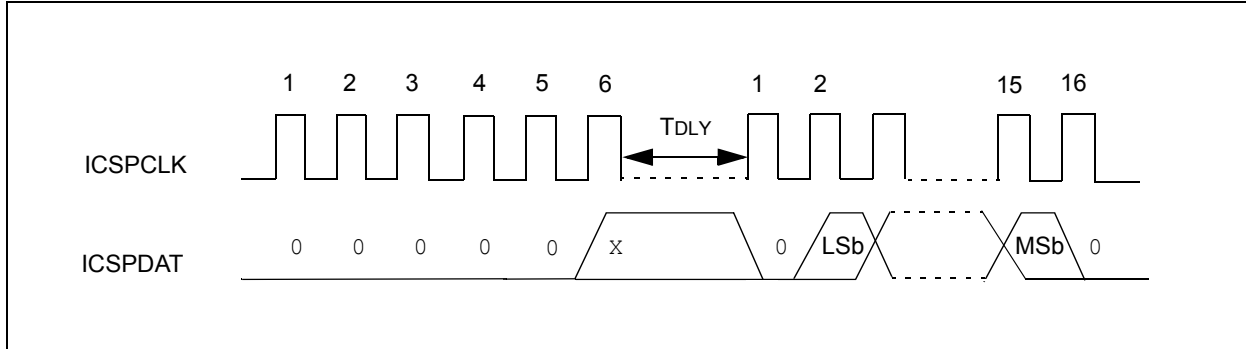
4.3.1 LOAD CONFIGURATION

The Load Configuration command is used to access the configuration memory (User ID Locations, Configuration Words, Calibration Words). The Load Configuration command sets the address to 8000h and loads the data latches with one word of data (see Figure 4-1).

After issuing the Load Configuration command, use the Increment Address command until the proper address to be programmed is reached. The address is then programmed by issuing either the Begin Internally Timed Programming or Begin Externally Timed Programming command.

The only way to get back to the program memory (address 0) is to exit Program/Verify mode or issue the Reset Address command after the configuration memory has been accessed by the Load Configuration command.

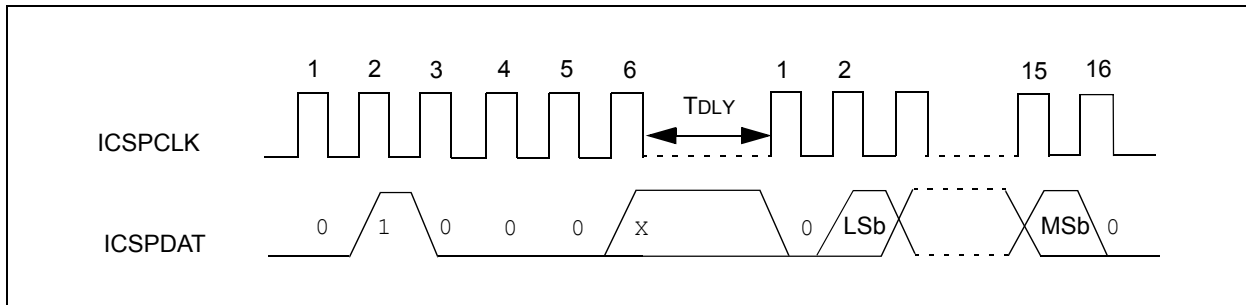
FIGURE 4-1: LOAD CONFIGURATION



4.3.2 LOAD DATA FOR PROGRAM MEMORY

The Load Data for Program Memory command is used to load one 14-bit word into the data latches. The word programs into program memory after the Begin Internally Timed Programming or Begin Externally Timed Programming command is issued (see Figure 4-2).

FIGURE 4-2: LOAD DATA FOR PROGRAM MEMORY

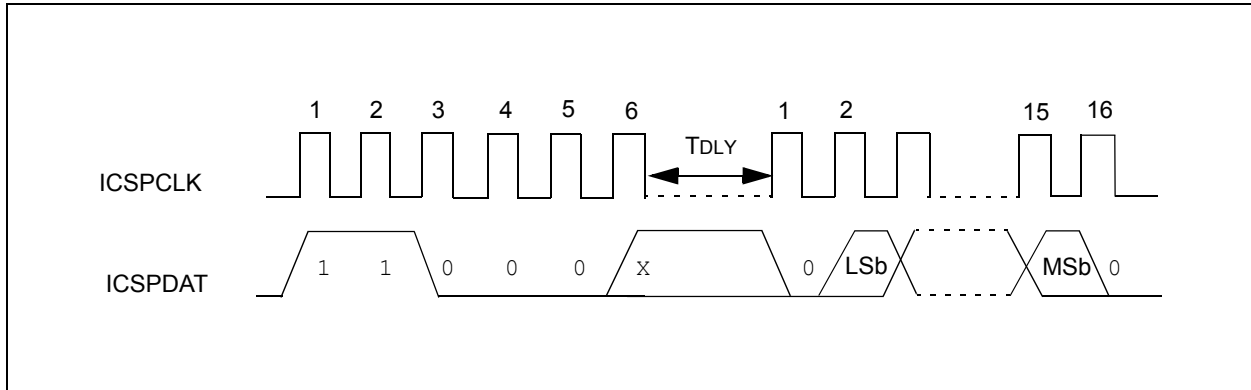


PIC16F/LF182X/PIC12F/LF1822

4.3.3 LOAD DATA FOR DATA MEMORY

The Load Data for Data Memory command will load a 14-bit “data word” when 16 cycles are applied. However, the data memory is only 8 bits wide and thus, only the first 8 bits of data after the Start bit will be programmed into the data memory. It is still necessary to cycle the clock the full 16 cycles in order to allow the internal circuitry to reset properly (see Figure 4-3).

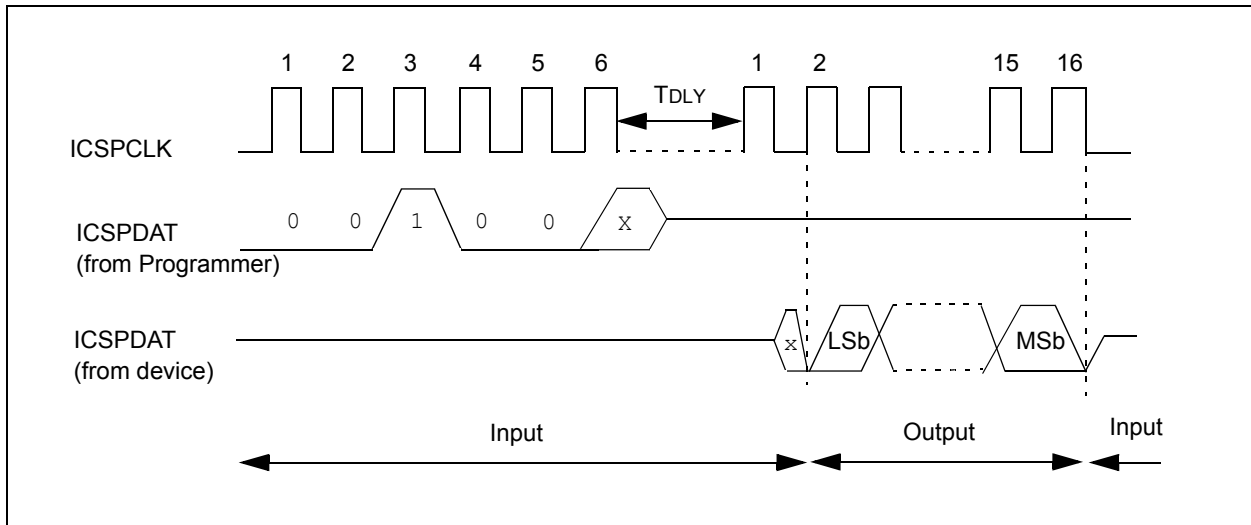
FIGURE 4-3: LOAD DATA FOR DATA MEMORY COMMAND



4.3.4 READ DATA FROM PROGRAM MEMORY

The Read Data from Program Memory command will transmit data bits out of the program memory map currently accessed, starting with the second rising edge of the clock input. The ICSPDAT pin will go into Output mode on the first falling clock edge, and it will revert to Input mode (high-impedance) after the 16th falling edge of the clock. If the program memory is code-protected (\overline{CP}), the data will be read as zeros (see Figure 4-4).

FIGURE 4-4: READ DATA FROM PROGRAM MEMORY

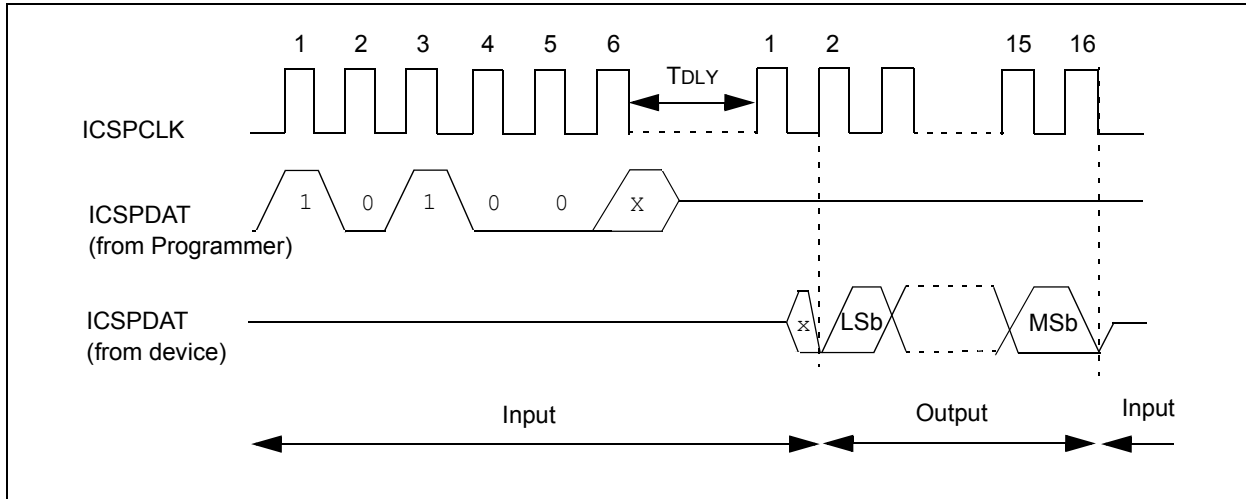


PIC16F/LF182X/PIC12F/LF1822

4.3.5 READ DATA FROM DATA MEMORY

The Read Data from Data Memory command will transmit data bits out of the data memory starting with the second rising edge of the clock input. The ICSPDAT pin will go into Output mode on the second rising edge, and it will revert to Input mode (high-impedance) after the 16th rising edge. The data memory is 8 bits wide, and therefore, only the first 8 bits that are output are actual data. If the data memory is code-protected, the data is read as all zeros. A timing diagram of this command is shown in Figure 4-5.

FIGURE 4-5: READ DATA FROM DATA MEMORY COMMAND

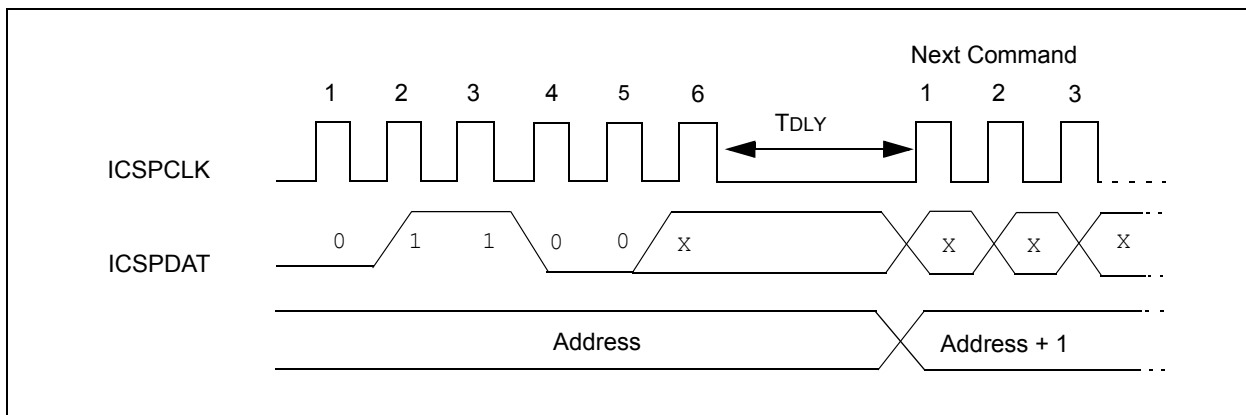


4.3.6 INCREMENT ADDRESS

The address is incremented when this command is received. It is not possible to decrement the address. To reset this counter, the user must use the Reset Address command or exit Program/Verify mode and re-enter it.

If the address is incremented from address 7FFFh, it will wrap-around to location 0000h. If the address is incremented from FFFFh, it will wrap-around to location 8000h.

FIGURE 4-6: INCREMENT ADDRESS

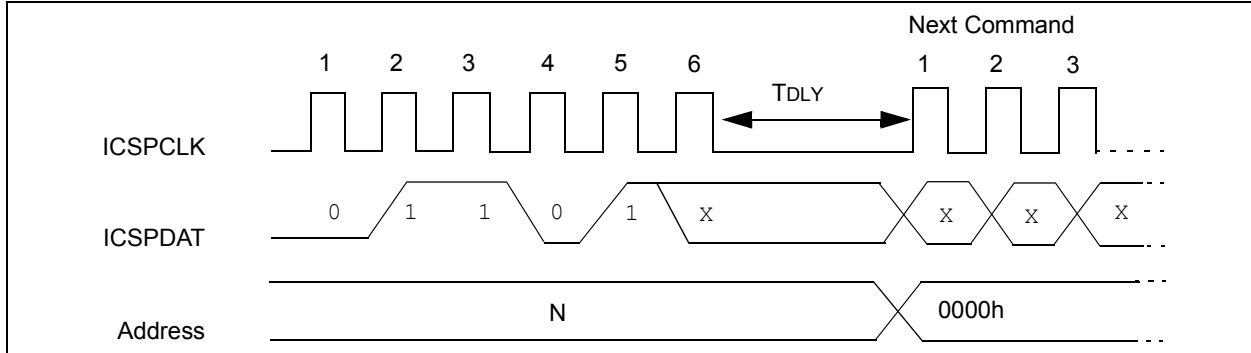


PIC16F/LF182X/PIC12F/LF1822

4.3.7 RESET ADDRESS

The Reset Address command will reset the address to 0000h, regardless of the current value. The address is used in program memory or the configuration memory.

FIGURE 4-7: RESET ADDRESS



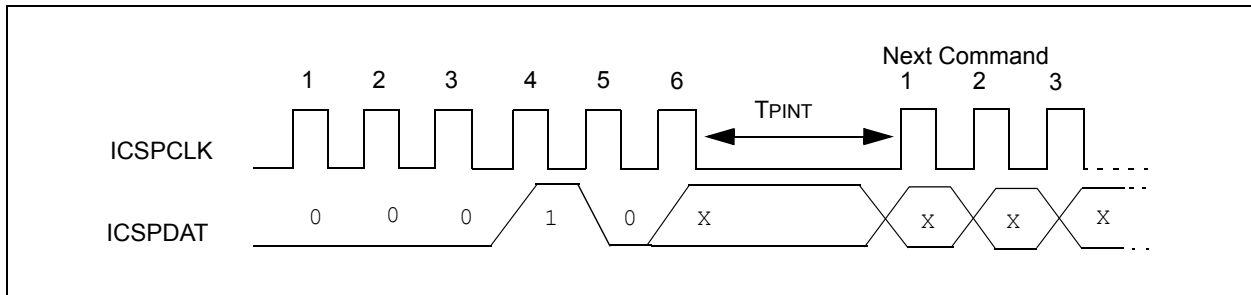
4.3.8 BEGIN INTERNALLY TIMED PROGRAMMING

A Load Configuration or Load Data for Program Memory command must be given before every Begin Programming command. Programming of the addressed memory will begin after this command is received. An internal timing mechanism executes the write. The user must allow for the program cycle time, T_{PINT} , for the programming to complete.

The End Externally Timed Programming command is not needed when the Begin Internally Timed Programming is used to start the programming.

The program memory address that is being programmed is not erased prior to being programmed. However, the EEPROM memory address that is being programmed is erased prior to being programmed with internally timed programming.

FIGURE 4-8: BEGIN INTERNALLY TIMED PROGRAMMING



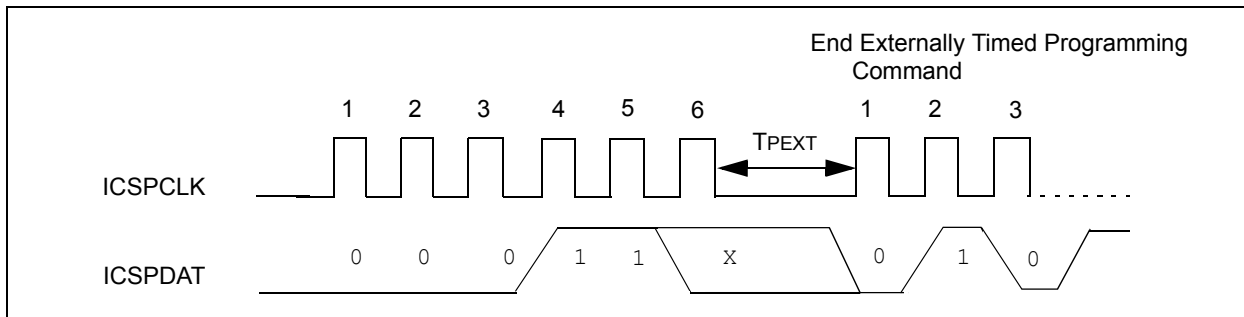
PIC16F/LF182X/PIC12F/LF1822

4.3.9 BEGIN EXTERNALLY TIMED PROGRAMMING

A Load Configuration, Load Data for Program Memory or Load Data for Data Memory command must be given before every Begin Programming command. Programming of the addressed memory will begin after this command is received. To complete the programming the End Externally Timed Programming command must be sent in the specified time window defined by T_{PEXT} . No internal erase is performed for the data EEPROM, therefore, the device should be erased prior to executing this command.

The Begin Externally Timed Programming command cannot be used for programming the Configuration Words (see Figure 4-9).

FIGURE 4-9: BEGIN EXTERNALLY TIMED PROGRAMMING

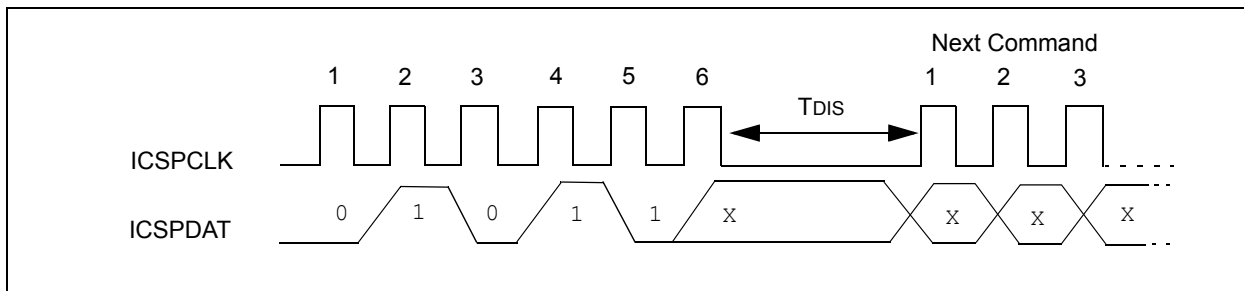


4.3.10 END EXTERNALLY TIMED PROGRAMMING

This command is required after a Begin Externally Timed Programming command is given. This command must be sent within the time window specified by T_{PEXT} after the Begin Externally Timed Programming command is sent.

After sending the End Externally Timed Programming command, an additional delay (T_{DIS}) is required before sending the next command. This delay is longer than the delay ordinarily required between other commands (see Figure 4-10).

FIGURE 4-10: END EXTERNALLY TIMED PROGRAMMING



PIC16F/LF182X/PIC12F/LF1822

4.3.11 BULK ERASE PROGRAM MEMORY

The Bulk Erase Program Memory command performs two different functions dependent on the current state of the address.

Address 0000h-7FFFh:

- Program Memory is erased
- Configuration Words are erased
- If $\overline{CPD} = 0$, Data Memory is erased

Address 8000h-8008h:

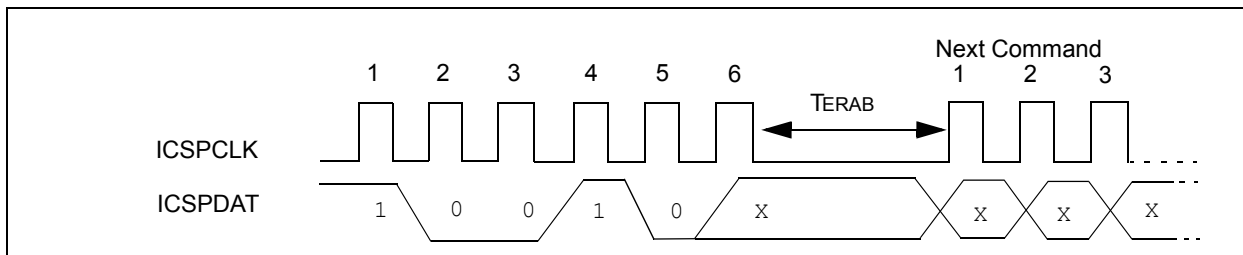
- Program Memory is erased
- Configuration Words are erased
- User ID Locations are erased
- If $\overline{CPD} = 0$, Data Memory is erased

A Bulk Erase Program Memory command should not be issued when the address is greater than 8008h.

After receiving the Bulk Erase Program Memory command the erase will not complete until the time interval, T_{ERAB} , has expired.

Note: The code protection Configuration bit (\overline{CP}) has no effect on the Bulk Erase Program Memory command.

FIGURE 4-11: BULK ERASE PROGRAM MEMORY



4.3.12 BULK ERASE DATA MEMORY

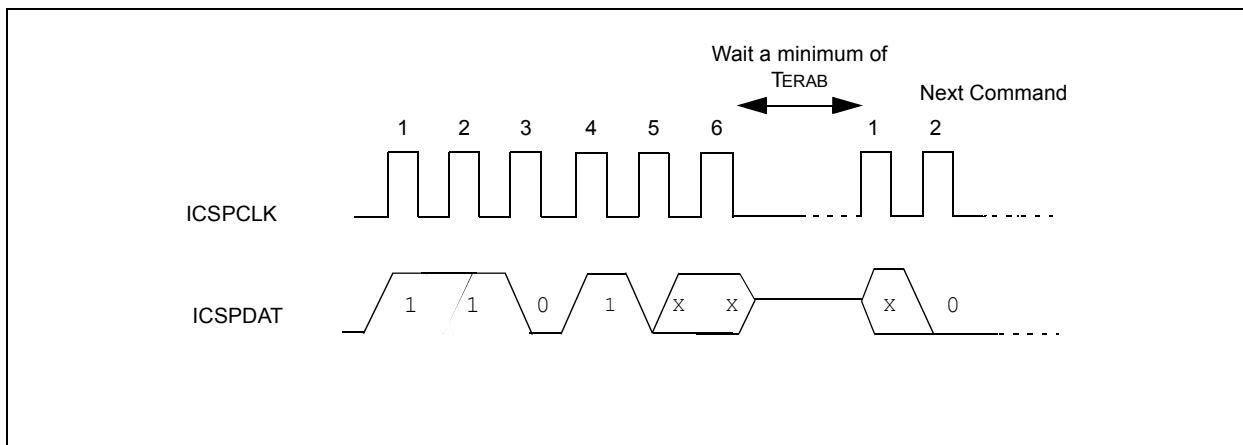
To perform an erase of the data memory, after a Bulk Erase Data Memory command, wait a minimum of T_{ERAB} to complete Bulk Erase.

To erase data memory when data code-protect is active ($\overline{CPD} = 0$), the Bulk Erase Program Memory command should be used.

After receiving the Bulk Erase Data Memory command, the erase will not complete until the time interval, T_{ERAB} , has expired.

Note: Data memory will not erase if code-protected ($\overline{CPD} = 0$).

FIGURE 4-12: BULK ERASE DATA MEMORY COMMAND



PIC16F/LF182X/PIC12F/LF1822

4.3.13 ROW ERASE PROGRAM MEMORY

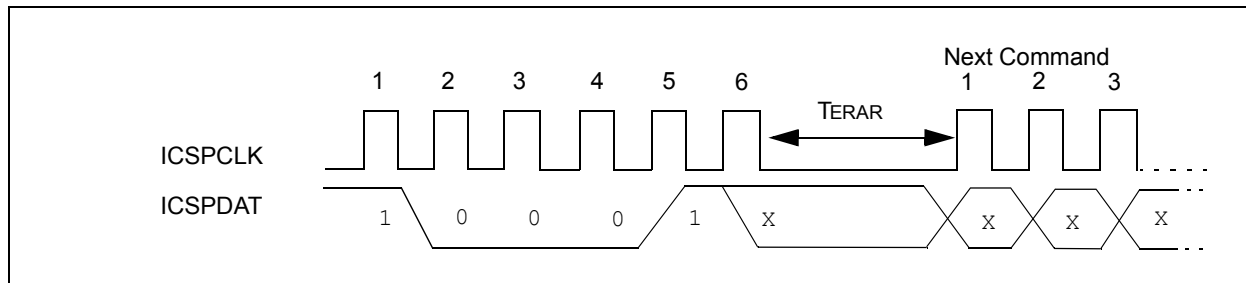
The Row Erase Program Memory command will erase an individual row. Refer to Table 4-2 for row sizes of specific devices and the PC bits used to address them. If the program memory is code-protected the Row Erase Program Memory command will be ignored. When the address is 8000h-8008h the Row Erase Program Memory command will only erase the user ID locations regardless of the setting of the \overline{CP} Configuration bit.

After receiving the Row Erase Program Memory command the erase will not complete until the time interval, T_{ERAR} , has expired.

TABLE 4-2: PROGRAMMING ROW SIZE AND LATCHES

Devices	PC	Row Size	Number of Latches
PIC16F1826/1827	<15:5>	32	8
PIC12F1822/16F1823	<15:4>	16	16
PIC16F1824/1825	<15:5>	32	32
PIC16F1828/1829	<15:5>	32	32

FIGURE 4-13: ROW ERASE PROGRAM MEMORY



5.0 PROGRAMMING ALGORITHMS

The PIC12F1822/16F182X devices use internal latches to temporarily store the 14-bit words used for programming. Refer to Table 4-2 for specific latch information. The data latches allow the user to write the program words with a single Begin Externally Timed Programming or Begin Internally Timed Programming command. The Load Program Data or the Load Configuration command is used to load a single data latch. The data latch will hold the data until the Begin Externally Timed Programming or Begin Internally Timed Programming command is given.

The data latches are aligned with the LSbs of the address. The PC's address at the time the Begin Externally Timed Programming or Begin Internally Timed Programming command is given will determine which location(s) in memory are written. Writes cannot cross the physical boundary. For example, with the PIC16F1827, attempting to write from address 0002h-0009h will result in data being written to 0008h-000Fh.

If more than the maximum number of data latches are written without a Begin Externally Timed Programming or Begin Internally Timed Programming command, the data in the data latches will be overwritten. The following figures show the recommended flowcharts for programming.

PIC16F/LF182X/PIC12F/LF1822

FIGURE 5-1: DEVICE PROGRAM/VERIFY FLOWCHART

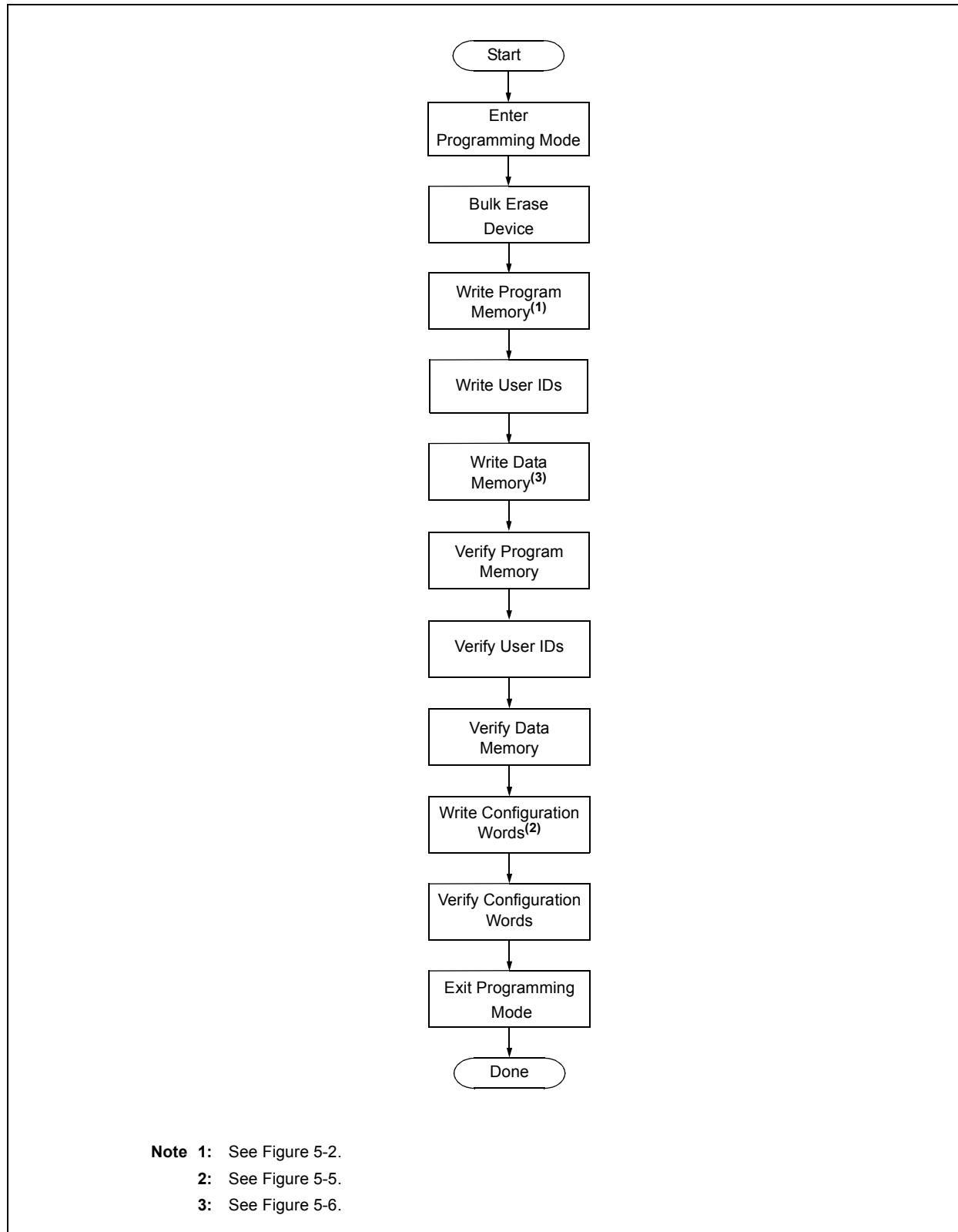
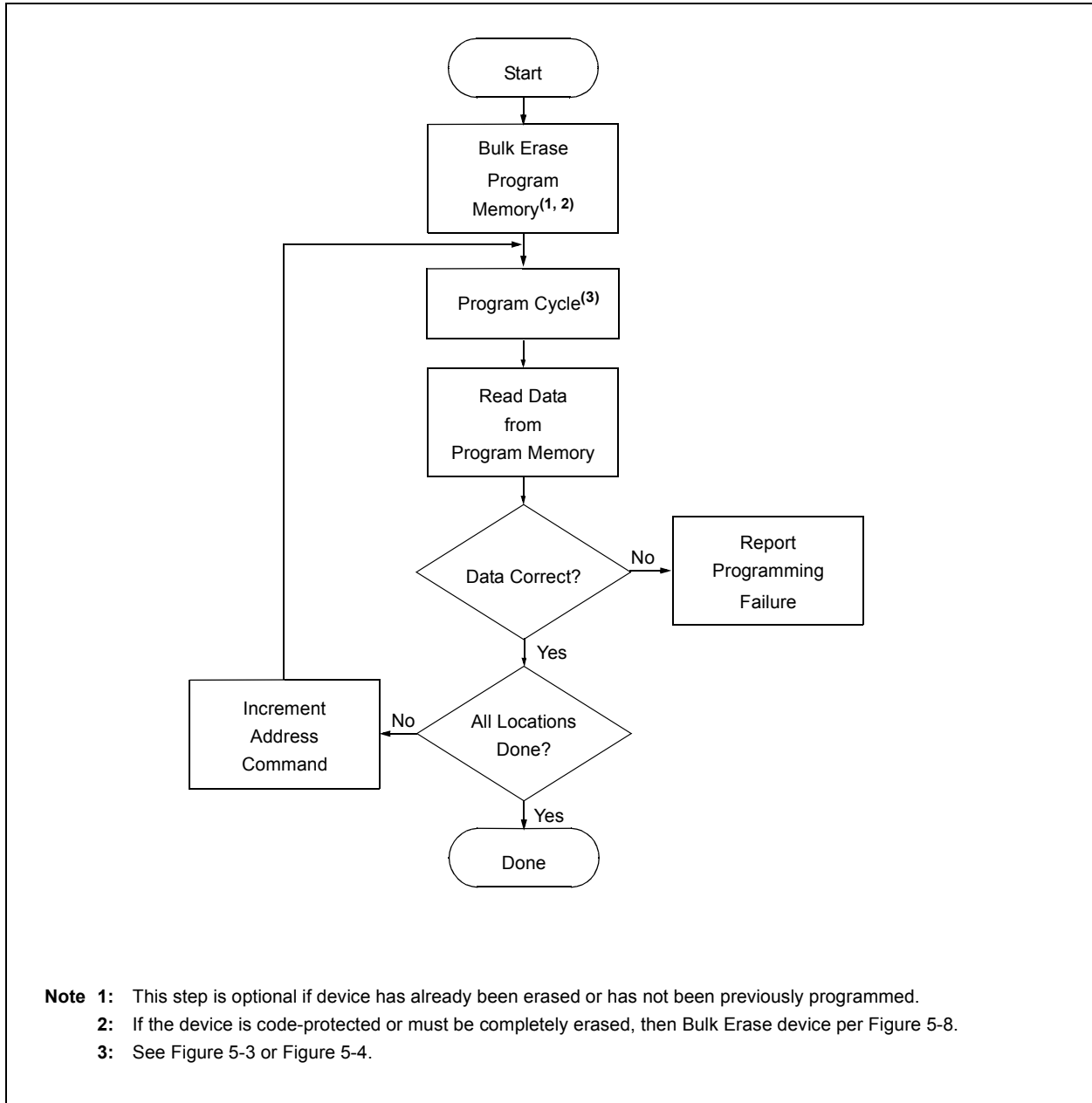


FIGURE 5-2: PROGRAM MEMORY FLOWCHART



PIC16F/LF182X/PIC12F/LF1822

FIGURE 5-3: ONE-WORD PROGRAM CYCLE

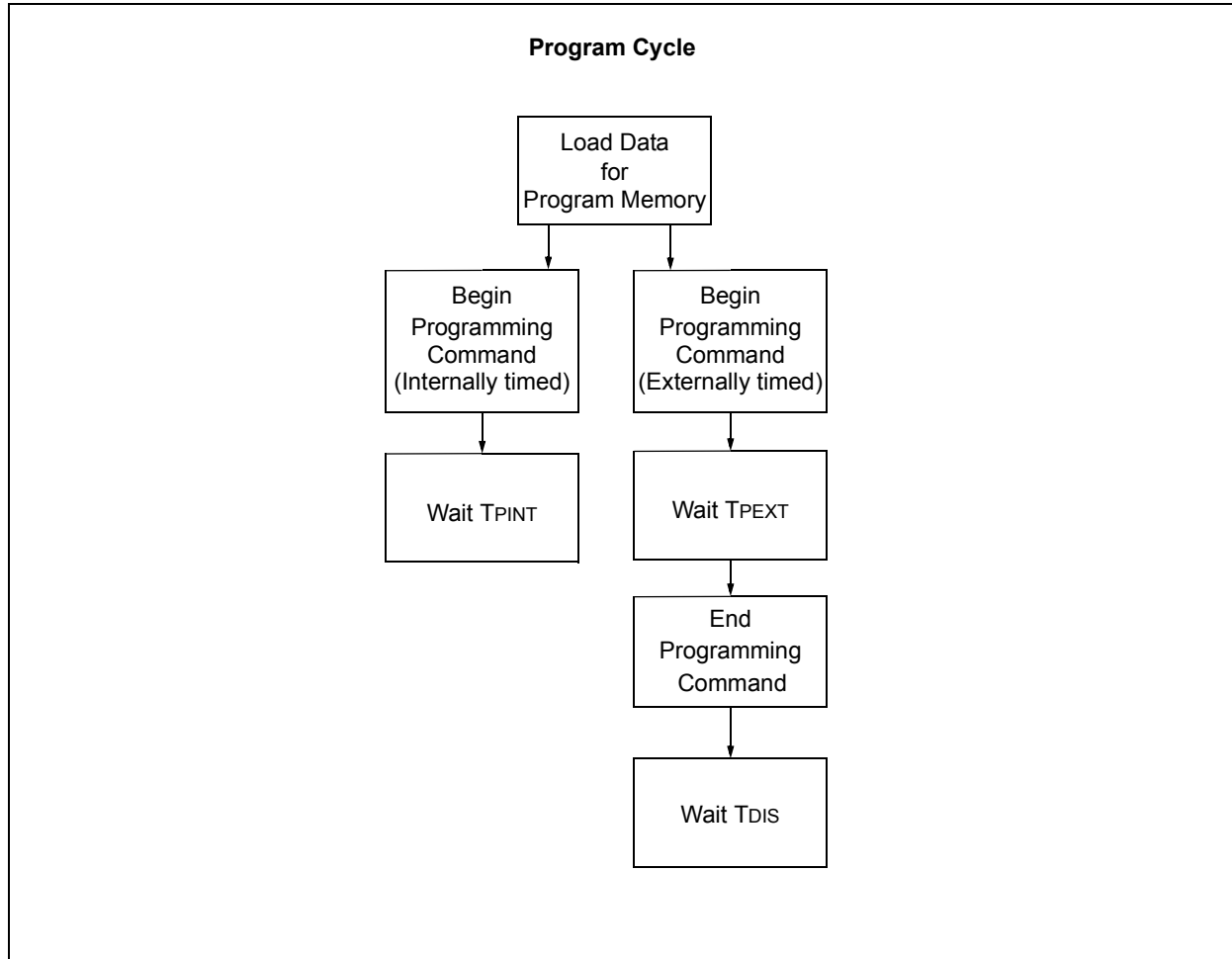
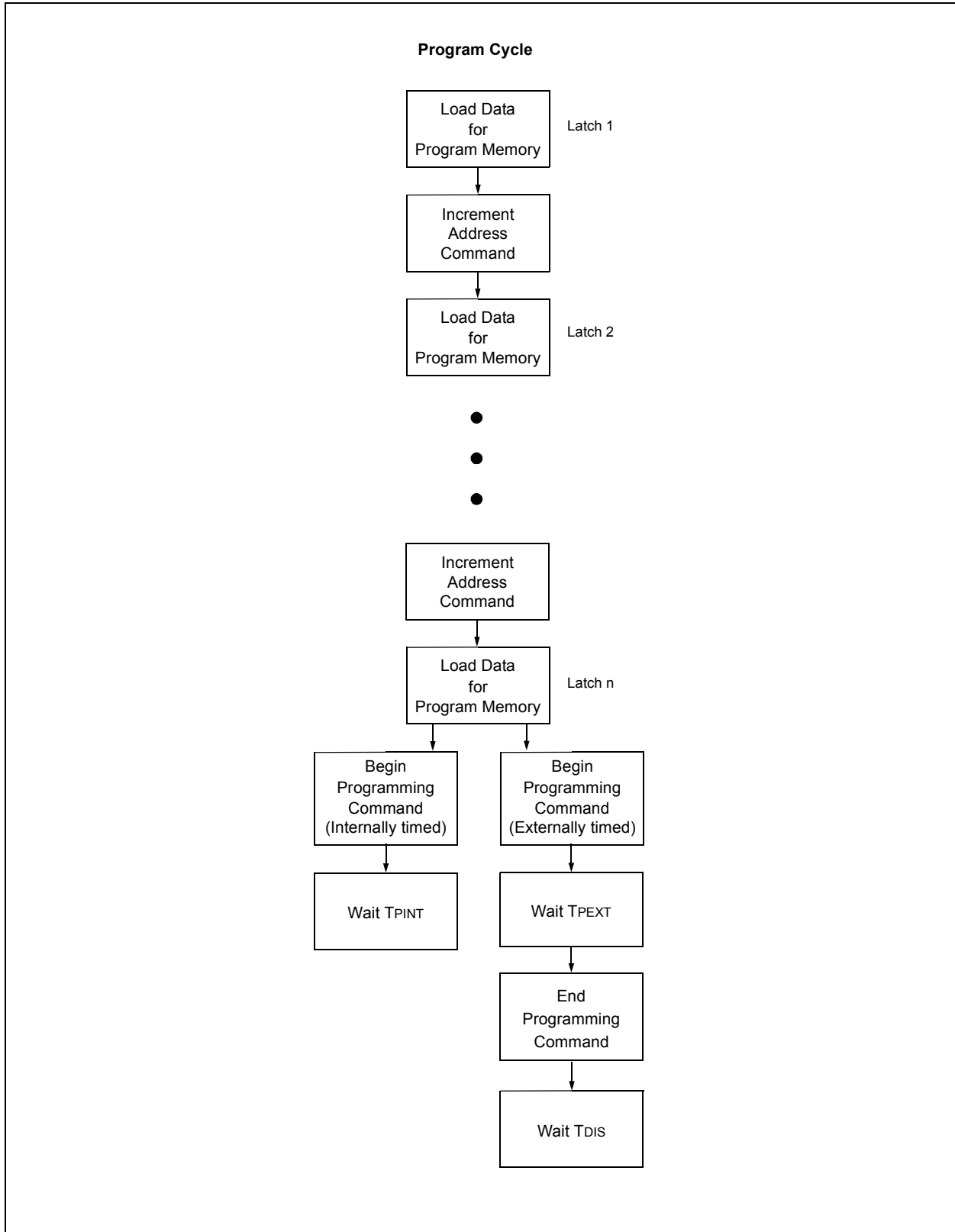


FIGURE 5-4: MULTIPLE-WORD PROGRAM CYCLE



PIC16F/LF182X/PIC12F/LF1822

FIGURE 5-5: CONFIGURATION MEMORY PROGRAM FLOWCHART

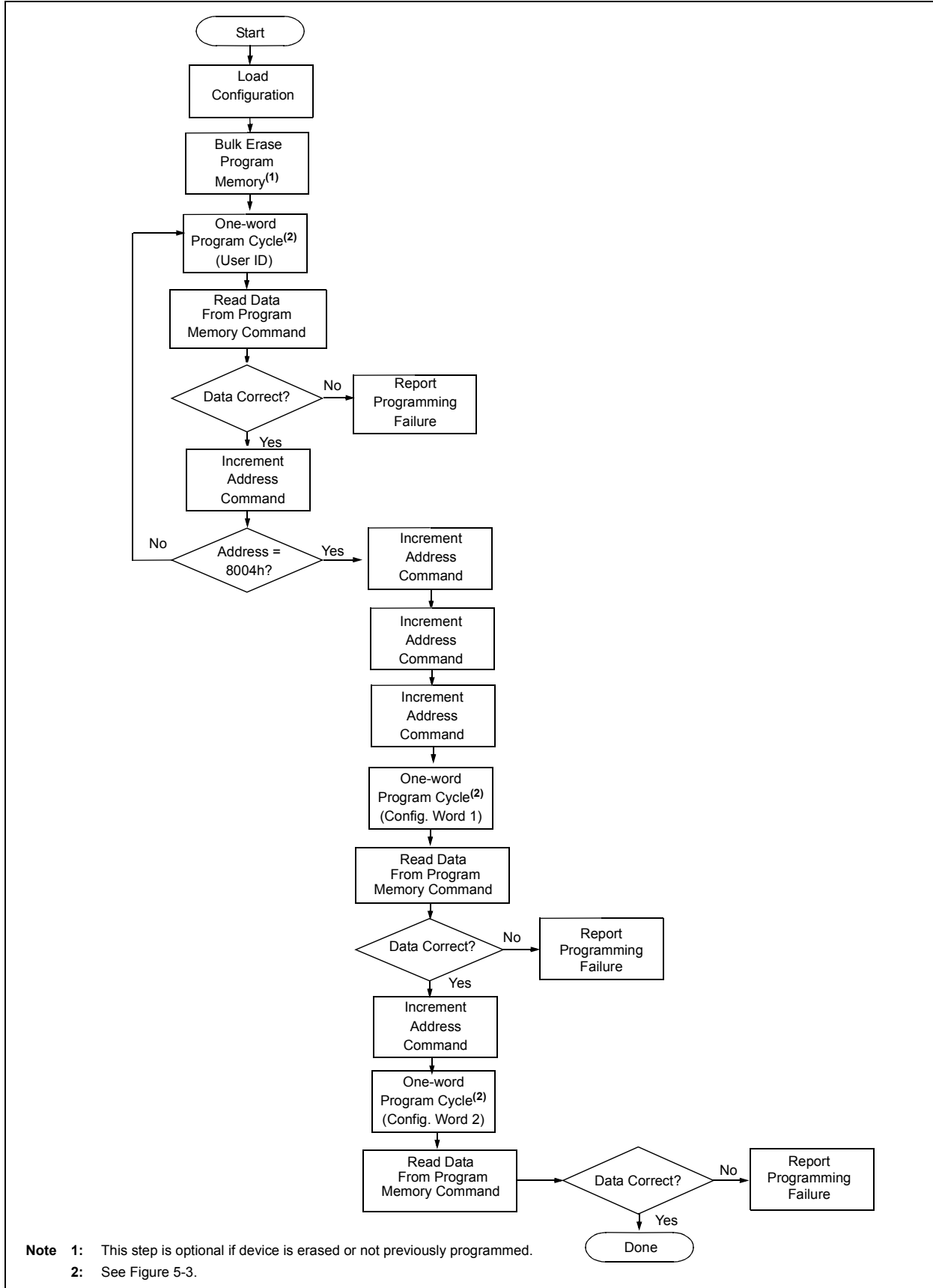
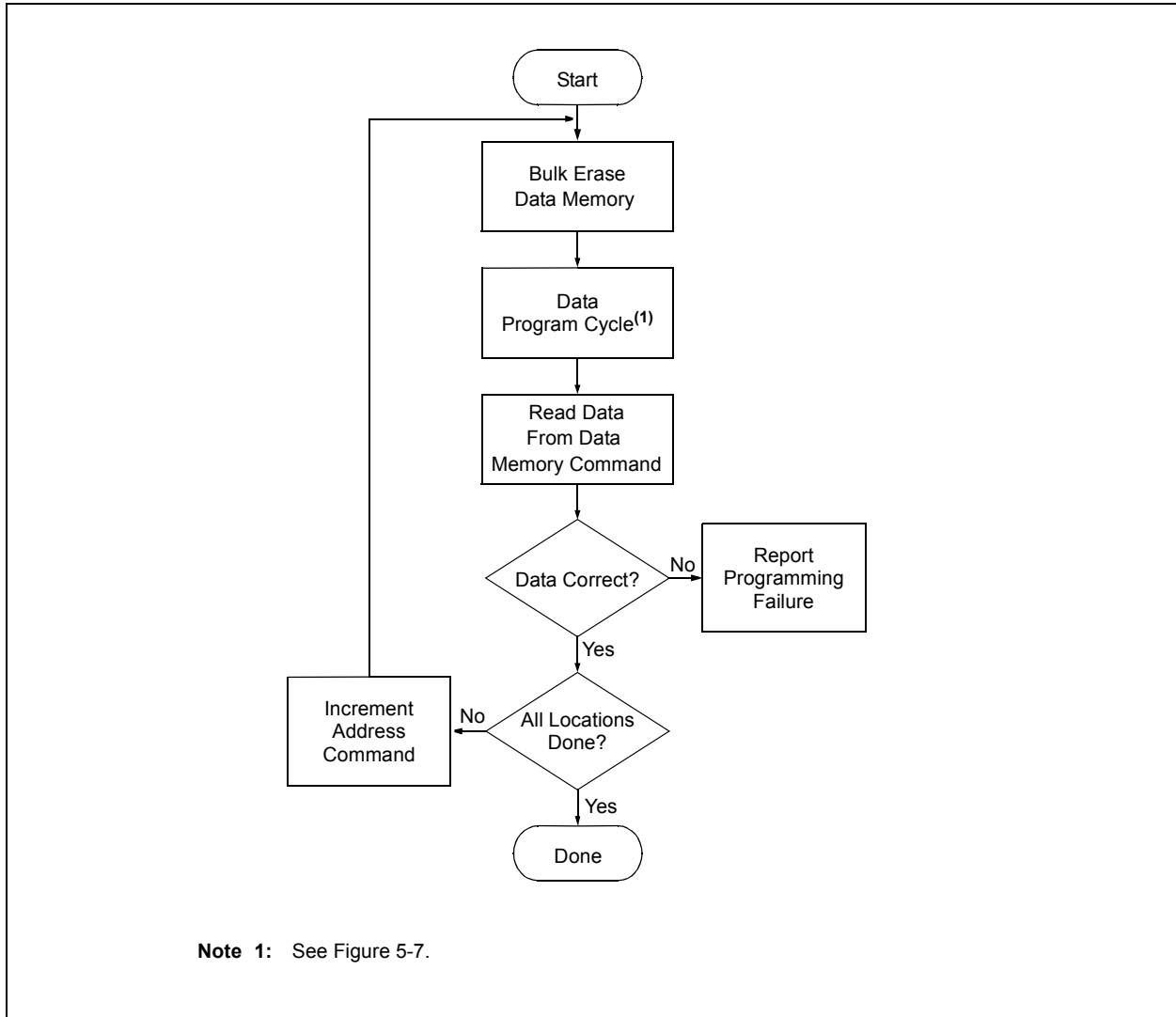


FIGURE 5-6: DATA MEMORY PROGRAM FLOWCHART



PIC16F/LF182X/PIC12F/LF1822

FIGURE 5-7: DATA MEMORY PROGRAM CYCLE

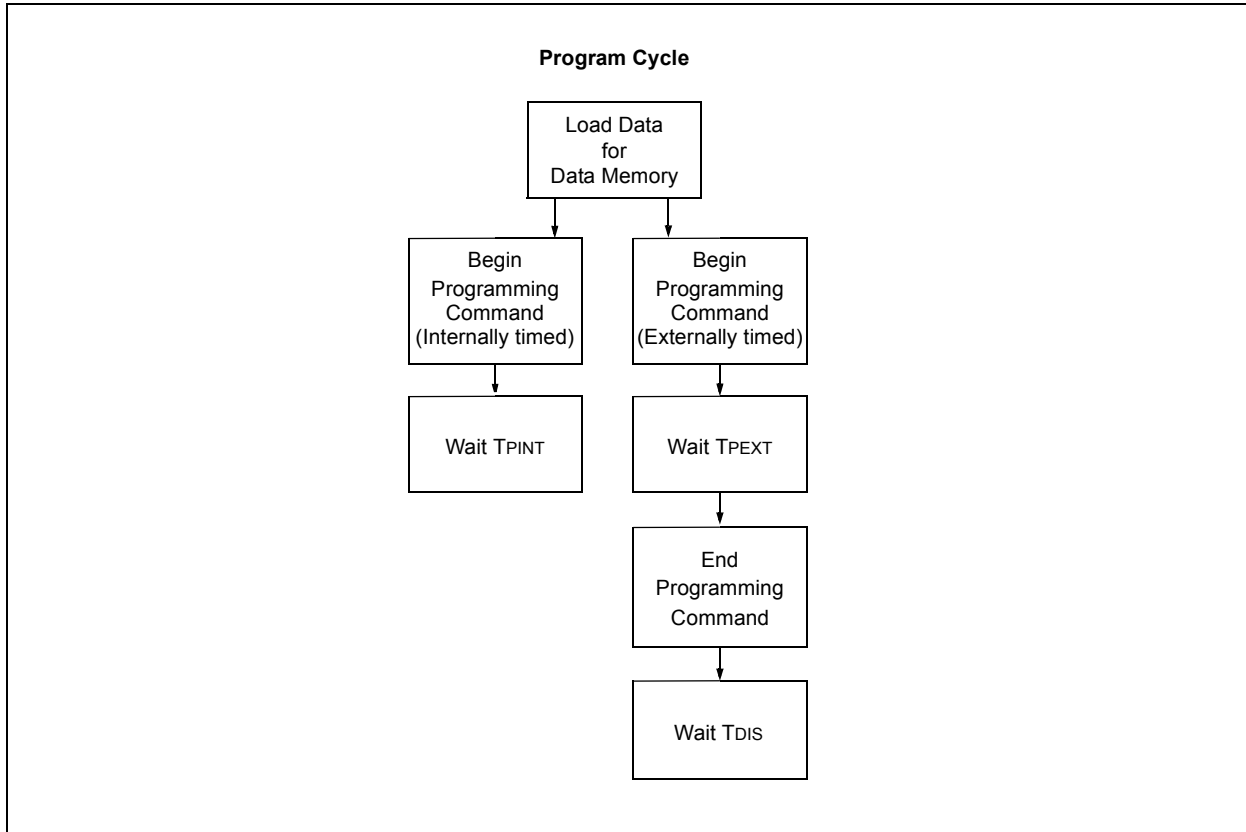
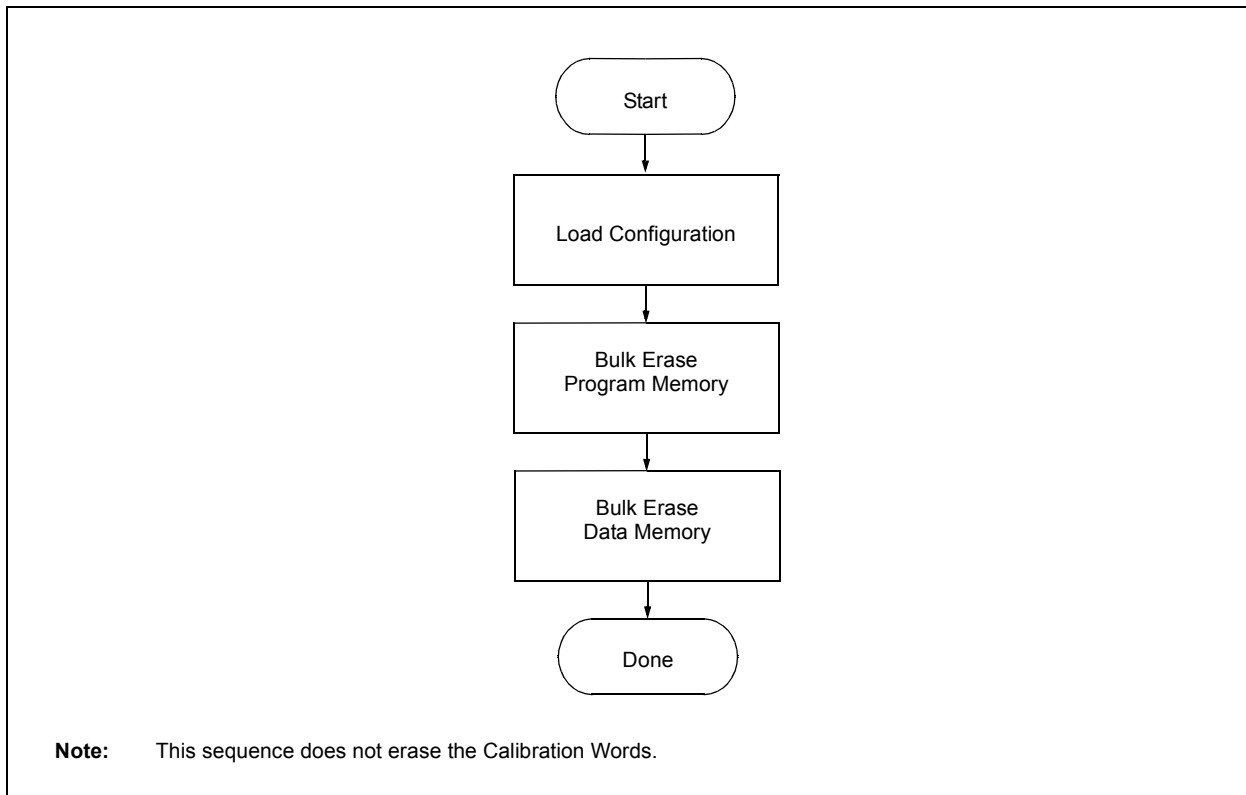


FIGURE 5-8: ERASE FLOWCHART



6.0 CODE PROTECTION

Code protection is controlled using the \overline{CP} bit in Configuration Word 1. When code protection is enabled, all program memory locations (0000h-7FFFh) read as all '0'. Further programming is disabled for the program memory (0000h-7FFFh).

Data memory is protected with its own code-protect bit (\overline{CPD}). When data code-protection is enabled ($\overline{CPD} = 0$), all data memory locations read as '0'. Further programming is disabled for the data memory. Data memory can still be programmed and read during program execution.

The user ID locations and Configuration Words can be programmed and read out regardless of the code protection settings.

6.1 Program Memory

Code protection is enabled by programming the \overline{CP} bit in Configuration Word 1 register to '0'.

The only way to disable code protection is to use the Bulk Erase Program Memory command.

6.2 Data Memory

Data memory protection is enabled by programming the \overline{CPD} bit in Configuration Word 1 register to '0'.

The only way to disable code protection is to use the Bulk Erase Program Memory command.

Note: To ensure system security, if \overline{CPD} bit = 0, the Bulk Erase Program Memory command will also erase data memory.

7.0 HEX FILE USAGE

In the hex file there are two bytes per program word stored in the Intel[®] INHX32 hex format. Data is stored LSB first, MSB second. Because there are two bytes per word, the addresses in the hex file are 2x the address in program memory. (Example: Configuration Word 1 is stored at 8007h on the PIC16F/LF182X and PIC12F/LF1822. In the hex file this will be referenced as 1000Eh-1000Fh).

7.1 Configuration Word

To allow portability of code, it is strongly recommended that the programmer is able to read the Configuration Words and user ID locations from the hex file. If the Configuration Words information was not present in the hex file, a simple warning message may be issued. Similarly, while saving a hex file, Configuration Words and user ID information should be included.

7.2 Device ID and Revision

If a device ID is present in the hex file at 1000Ch-1000Dh (8006h on the part), the programmer should verify the device ID (excluding the revision) against the value read from the part. On a mismatch condition the programmer should generate a warning message.

7.3 Data EEPROM

The programmer should be able to read data memory information from a hex file and write data memory contents to a hex file.

The physical address range of the 256 byte data memory is 0000h-00FFh. However, these addresses are logically mapped to address 1E000h-1E1FFh in the hex file. This provides a way of differentiating between the data and program memory locations in this range. The format for data memory storage is one data byte per address location, LSb aligned.

PIC16F/LF182X/PIC12F/LF1822

7.4 Checksum Computation

The checksum is calculated by two different methods dependent on the setting of the \overline{CP} Configuration bit.

TABLE 7-1: CONFIGURATION WORD MASK VALUES

Device	Config. Word 1 Mask	Config. Word 2 Mask
PIC16F1826	3FFFh	3713h
PIC16F1827	3FFFh	3713h
PIC16LF1826	3FFFh	3703h
PIC16LF1827	3FFFh	3703h
PIC12F1822	3FFFh	3713h
PIC12LF1822	3FFFh	3713h
PIC16F1823	3FFFh	3713h
PIC16LF1823	3FFFh	3713h
PIC16F1824	3FFFh	3713h
PIC16LF1824	3FFFh	3713h
PIC16F1825	3FFFh	3713h
PIC16LF1825	3FFFh	3713h
PIC16F1828	3FFFh	3713h
PIC16LF1828	3FFFh	3713h
PIC16F1829	3FFFh	3713h
PIC16LF1829	3FFFh	3713h

7.4.1 PROGRAM CODE PROTECTION DISABLED

With the program code protection disabled, the checksum is computed by reading the contents of the PIC16F/LF182X and PIC12F/LF1822 program memory locations and adding up the program memory data starting at address 0000h, up to the maximum user addressable location. Any Carry bit exceeding 16 bits are ignored. Additionally, the relevant bits of the Configuration Words are added to the checksum. All unimplemented Configuration bits are masked to '0'.

Note: Data memory does not effect the checksum.

EXAMPLE 7-1: CHECKSUM COMPUTED WITH PROGRAM CODE PROTECTION DISABLED PIC16F1827, BLANK DEVICE

PIC16F1827	Sum of Memory addresses 0000h-0FFFh	F000h
	Configuration Word 1	3FFFh
	Configuration Word 1 mask	3FFFh
	Configuration Word 2	3FFFh
	Configuration Word 2 mask	3713h
	Checksum = F000h + (3FFFh and 3FFFh) + (3FFFh and 3713h)	
	= F000h + 3FFFh + 3713h	
	= 6712h	

EXAMPLE 7-2: CHECKSUM COMPUTED WITH PROGRAM CODE PROTECTION DISABLED PIC16LF1827, 00AAh AT FIRST AND LAST ADDRESS

PIC16LF1827	Sum of Memory addresses 0000h-0FFFh	7156h
	Configuration Word 1	3FFFh
	Configuration Word 1 mask	3FFFh
	Configuration Word 2	3FFFh
	Configuration Word 2 mask	3703h
	Checksum = 7156h + (3FFFh and 3FFFh) + (3FFFh and 3703h)	
	= 7156h + 3FFFh + 3703h	
	= E858h	

PIC16F/LF182X/PIC12F/LF1822

7.4.2 PROGRAM CODE PROTECTION ENABLED

With the program code protection enabled, the checksum is computed in the following manner: The Least Significant nibble of each User ID is used to create a 16-bit value. The masked value of User ID

location 8000h is the Most Significant nibble. This Sum of User IDs is summed with the Configuration Words (all unimplemented Configuration bits are masked to '0').

Note: Data memory does not effect the checksum.

EXAMPLE 7-3: CHECKSUM COMPUTED WITH PROGRAM CODE PROTECTION ENABLED PIC16F1827, BLANK DEVICE

PIC16F1827	Configuration Word 1	3F7Fh
	Configuration Word 1 mask	3FFFh
	Configuration Word 2	3FFFh
	Configuration Word 2 mask	3713h
	User ID (8000h)	0006h
	User ID (8001h)	0007h
	User ID (8002h)	0001h
	User ID (8003h)	0002h
	Sum of User IDs = (0006h and 000Fh) << 12 + (0007h and 000Fh) << 8 + (0001h and 000Fh) << 4 + (0002h and 000Fh)	
	= 6000h + 0700h + 0010h + 0002h	
	= 6712h	
	Checksum = (3F7Fh and 3FFFh) + (3FFFh and 3713h) + Sum of User IDs	
	= 3F7Fh + 3713h + 6712h	
	= DDA4h	

EXAMPLE 7-4: CHECKSUM COMPUTED WITH PROGRAM CODE PROTECTION ENABLED PIC16LF1827, 00AAh AT FIRST AND LAST ADDRESS

PIC16LF1827	Configuration Word 1	3F7Fh
	Configuration Word 1 mask	3FFFh
	Configuration Word 2	3FFFh
	Configuration Word 2 mask	3703h
	User ID (8000h)	000Eh
	User ID (8001h)	0008h
	User ID (8002h)	0005h
	User ID (8003h)	0008h
	Sum of User IDs = (000Eh and 000Fh) << 12 + (0008h and 000Fh) << 8 + (0005h and 000Fh) << 4 + (0008h and 000Fh)	
	= E000h + 0800h + 0050h + 0008h	
	= E858h	
	Checksum = (3F7Fh and 3FFFh) + (3FFFh and 3703h) + Sum of User IDs	
	= 3F7Fh + 3703h + E858h	
	= 5EDAh	

PIC16F/LF182X/PIC12F/LF1822

8.0 ELECTRICAL SPECIFICATIONS

Refer to device specific data sheet for absolute maximum ratings.

TABLE 8-1: AC/DC CHARACTERISTICS TIMING REQUIREMENTS FOR PROGRAM/VERIFY MODE

AC/DC CHARACTERISTICS		Standard Operating Conditions (unless otherwise stated) Operating Temperature $-40^{\circ}\text{C} \leq T_A \leq +85^{\circ}\text{C}$					
Sym.	Characteristics	Min.	Typ.	Max.	Units	Conditions/Comments	
Supply Voltages and Currents							
VDD	VDD						
	Read/Write and Row Erase operations	PIC12F1822 PIC16F182X	2.1	—	5.5	V	
		PIC12LF1822 PIC16LF182X	2.1	—	3.6	V	
	Bulk Erase operations	PIC12F1822 PIC16F182X	2.7	—	5.5	V	
PIC12LF1822 PIC16LF182X		2.7	—	3.6	V		
IDDI	Current on VDD, Idle	—	—	1.0	mA		
IDDP	Current on VDD, Programming	—	—	3.0	mA		
IPP	VPP						
	Current on $\overline{\text{MCLR}}/\text{VPP}$		—	—	600	μA	
VIHH	High voltage on $\overline{\text{MCLR}}/\text{VPP}$ for Program/Verify mode entry	8.0	—	9.0	V		
TVHHR	$\overline{\text{MCLR}}$ rise time (V_{IL} to V_{IHH}) for Program/Verify mode entry	—	—	1.0	μs		
I/O pins							
VIH	(ICSPCLK, ICSPDAT, $\overline{\text{MCLR}}/\text{VPP}$) input high level	0.8 VDD	—	—	V		
VIL	(ICSPCLK, ICSPDAT, $\overline{\text{MCLR}}/\text{VPP}$) input low level	—	—	0.2 VDD	V		
VOH	ICSPDAT output high level	VDD-0.7 VDD-0.7 VDD-0.7	—	—	V	IOH = 3.5 mA, VDD = 5V IOH = 3 mA, VDD = 3.3V IOH = 2 mA, VDD = 1.8V	
VOL	ICSPDAT output low level	—	—	VSS+0.6 VSS+0.6 VSS+0.6	V	IOH = 8 mA, VDD = 5V IOH = 6 mA, VDD = 3.3V IOH = 3 mA, VDD = 1.8V	
Programming Mode Entry and Exit							
TENTS	Programming mode entry setup time: ICSPCLK, ICSPDAT setup time before VDD or $\overline{\text{MCLR}}\uparrow$	100	—	—	ns		
TENTH	Programming mode entry hold time: ICSPCLK, ICSPDAT hold time after VDD or $\overline{\text{MCLR}}\uparrow$	250	—	—	μs		
Serial Program/Verify							
TCKL	Clock Low Pulse Width	100	—	—	ns		
TCKH	Clock High Pulse Width	100	—	—	ns		
Tds	Data in setup time before clock \downarrow	100	—	—	ns		
TdH	Data in hold time after clock \downarrow	100	—	—	ns		
Tco	Clock \uparrow to data out valid (during a Read Data command)	0	—	80	ns		
TLZD	Clock \downarrow to data low-impedance (during a Read Data command)	0	—	80	ns		
THZD	Clock \downarrow to data high-impedance (during a Read Data command)	0	—	80	ns		
TdLY	Data input not driven to next clock input (delay required between command/data or command/command)	1.0	—	—	μs		
TERAB	Bulk Erase cycle time	—	—	5	ms		
TERAR	Row Erase cycle time	—	—	2.5	ms		

PIC16F/LF182X/PIC12F/LF1822

TABLE 8-1: AC/DC CHARACTERISTICS TIMING REQUIREMENTS FOR PROGRAM/VERIFY

AC/DC CHARACTERISTICS		Standard Operating Conditions (unless otherwise stated) Operating Temperature $-40^{\circ}\text{C} \leq T_A \leq +85^{\circ}\text{C}$				
Sym.	Characteristics	Min.	Typ.	Max.	Units	Conditions/Comments
TPINT	Internally timed programming operation time	—	—	2.5	ms	Program memory Configuration words EEPROM
		—	—	5	ms	
		—	—	5	ms	
TPEXT	Externally timed programming pulse	1.0	—	2.1	ms	
TDIS	Time delay from program to compare (HV discharge time)	100	—	—	μs	
TEXIT	Time delay when exiting Program/Verify mode	1	—	—	μs	

8.1 AC Timing Diagrams

FIGURE 8-1: PROGRAMMING MODE ENTRY – V_{DD} FIRST

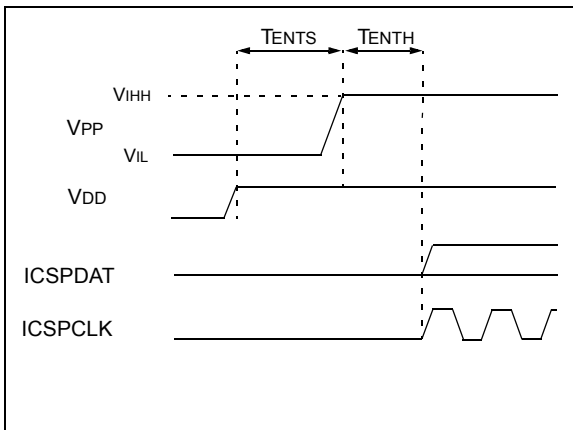


FIGURE 8-2: PROGRAMMING MODE ENTRY – V_{PP} FIRST

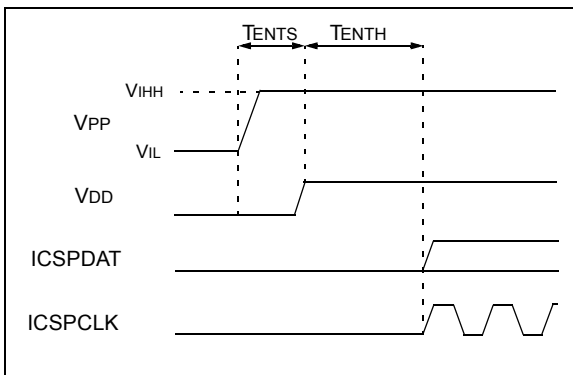


FIGURE 8-3: PROGRAMMING MODE EXIT – V_{PP} LAST

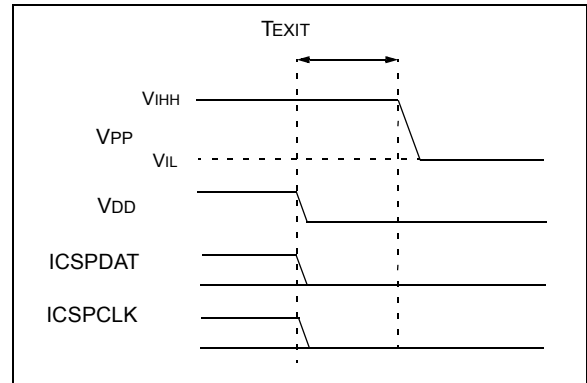
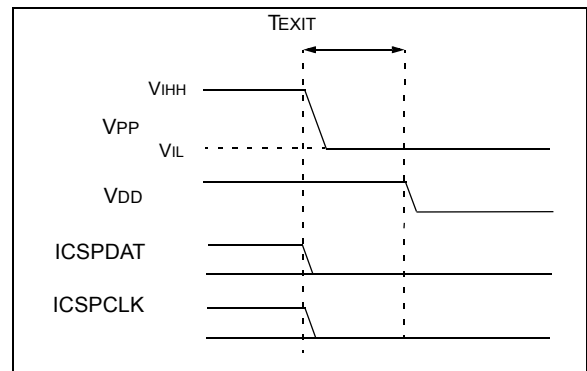


FIGURE 8-4: PROGRAMMING MODE EXIT – V_{DD} LAST



PIC16F/LF182X/PIC12F/LF1822

FIGURE 8-5: CLOCK AND DATA TIMING

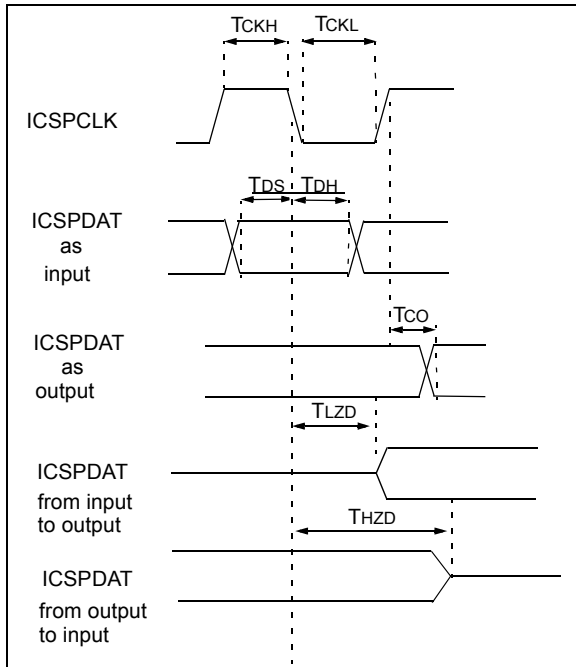
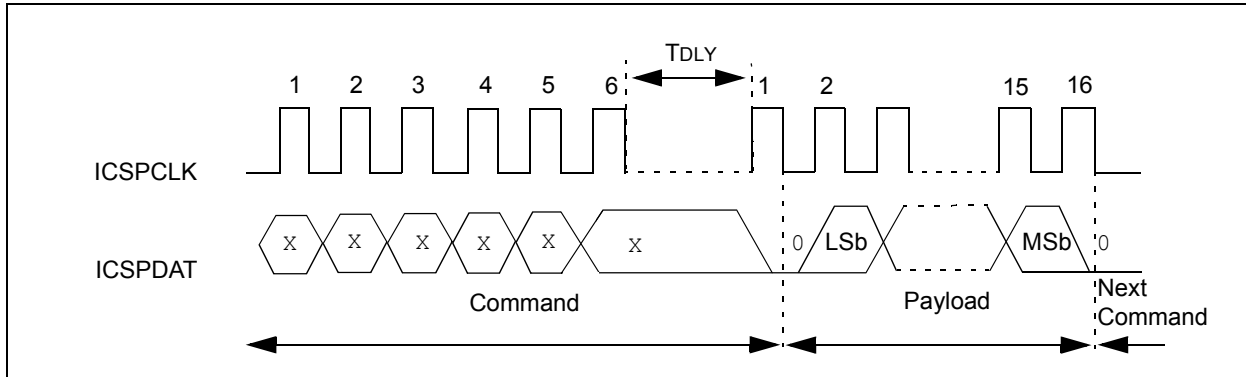


FIGURE 8-6: WRITE COMMAND-PAYLOAD TIMING



PIC16F/LF182X/PIC12F/LF1822

FIGURE 8-7: READ COMMAND-PAYLOAD TIMING

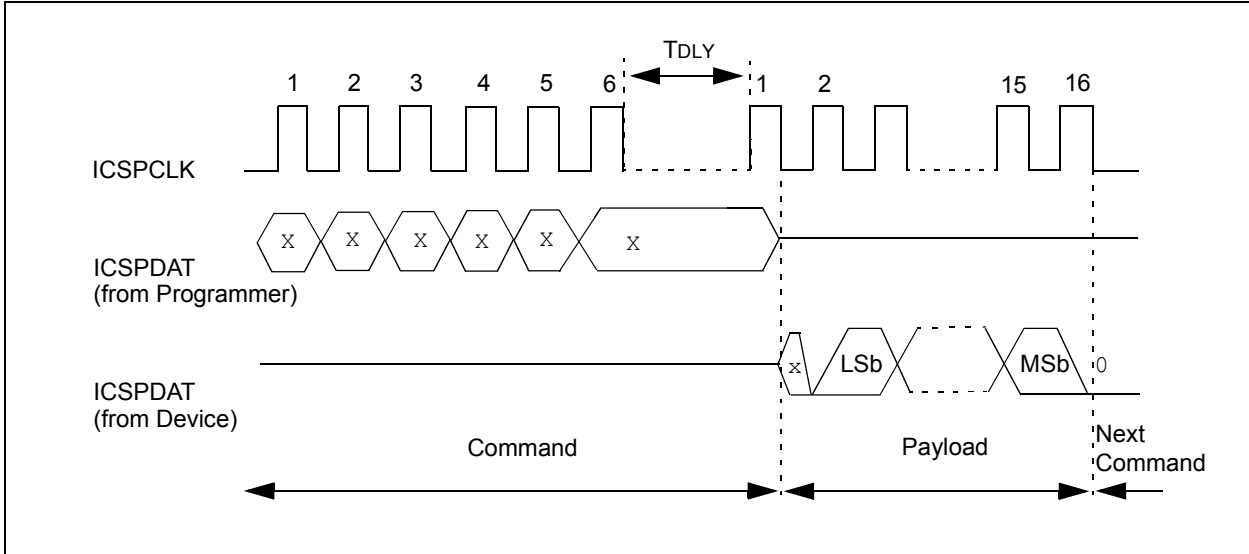
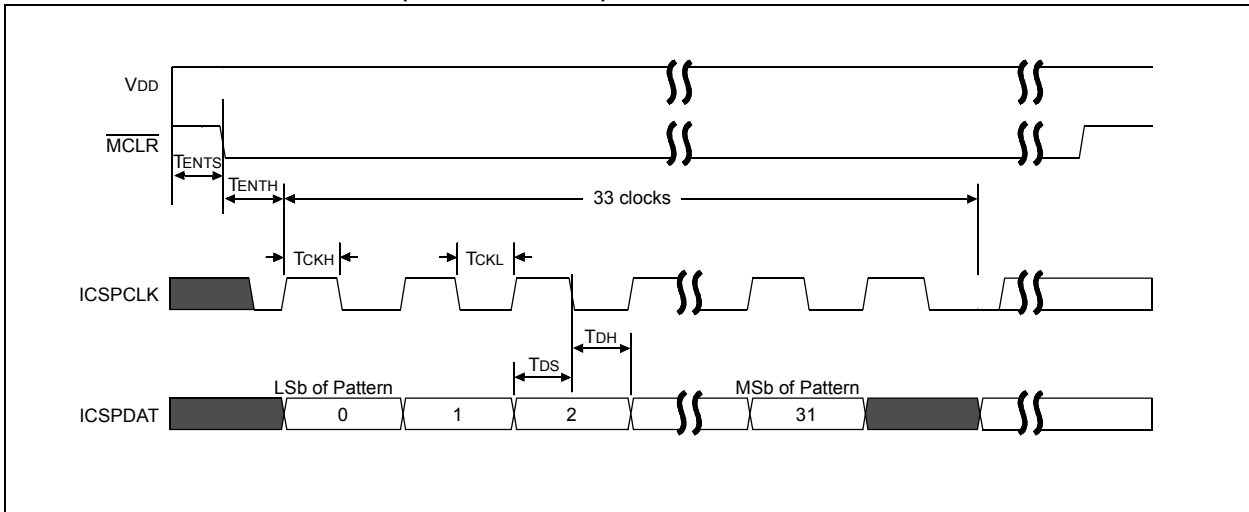
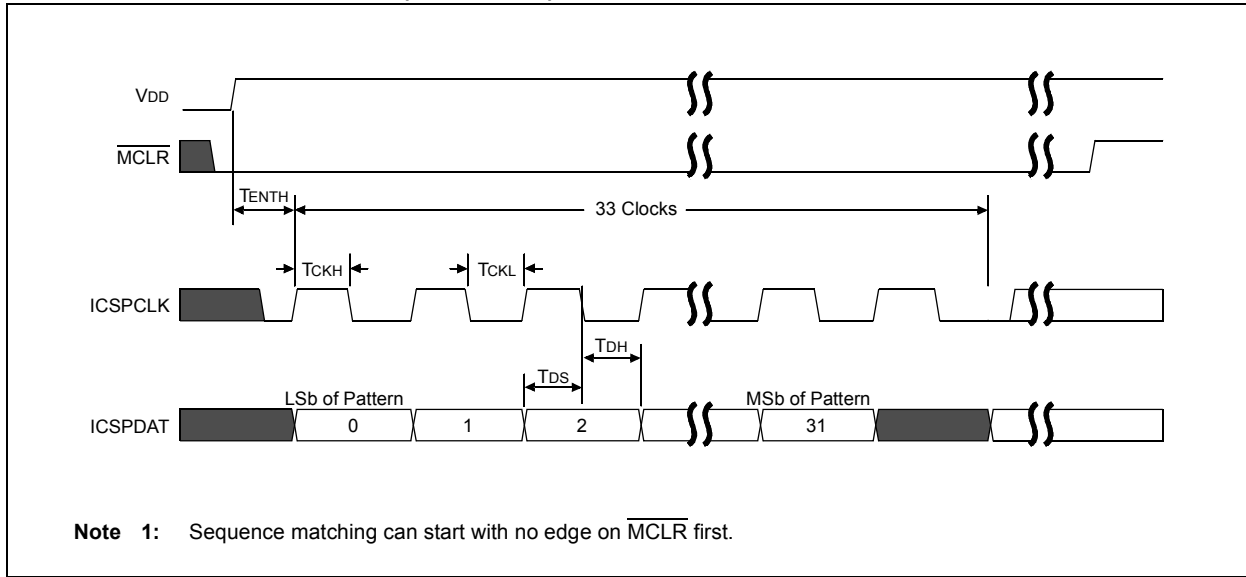


FIGURE 8-8: LVP ENTRY (POWERING UP)



PIC16F/LF182X/PIC12F/LF1822

FIGURE 8-9: LVP ENTRY (POWERED)



APPENDIX A: REVISION HISTORY

Revision A (06/2009)

Original release of this document.

Revision B (10/2009)

Added PIC12F/LF1822 and PIC16F/LF1823 devices.

Revision C (03/2010)

Added PIC12F/LF1824, PIC16F/LF1825, PIC16F/LF1828 and PIC16F/LF1829 devices; Added Figure 2-8, Figure 2-9 and Figure 3-3.

PIC16F/LF182X/PIC12F/LF1822

NOTES:

Note the following details of the code protection feature on Microchip devices:

- Microchip products meet the specification contained in their particular Microchip Data Sheet.
- Microchip believes that its family of products is one of the most secure families of its kind on the market today, when used in the intended manner and under normal conditions.
- There are dishonest and possibly illegal methods used to breach the code protection feature. All of these methods, to our knowledge, require using the Microchip products in a manner outside the operating specifications contained in Microchip's Data Sheets. Most likely, the person doing so is engaged in theft of intellectual property.
- Microchip is willing to work with the customer who is concerned about the integrity of their code.
- Neither Microchip nor any other semiconductor manufacturer can guarantee the security of their code. Code protection does not mean that we are guaranteeing the product as "unbreakable."

Code protection is constantly evolving. We at Microchip are committed to continuously improving the code protection features of our products. Attempts to break Microchip's code protection feature may be a violation of the Digital Millennium Copyright Act. If such acts allow unauthorized access to your software or other copyrighted work, you may have a right to sue for relief under that Act.

Information contained in this publication regarding device applications and the like is provided only for your convenience and may be superseded by updates. It is your responsibility to ensure that your application meets with your specifications. MICROCHIP MAKES NO REPRESENTATIONS OR WARRANTIES OF ANY KIND WHETHER EXPRESS OR IMPLIED, WRITTEN OR ORAL, STATUTORY OR OTHERWISE, RELATED TO THE INFORMATION, INCLUDING BUT NOT LIMITED TO ITS CONDITION, QUALITY, PERFORMANCE, MERCHANTABILITY OR FITNESS FOR PURPOSE. Microchip disclaims all liability arising from this information and its use. Use of Microchip devices in life support and/or safety applications is entirely at the buyer's risk, and the buyer agrees to defend, indemnify and hold harmless Microchip from any and all damages, claims, suits, or expenses resulting from such use. No licenses are conveyed, implicitly or otherwise, under any Microchip intellectual property rights.

Trademarks

The Microchip name and logo, the Microchip logo, dsPIC, KEELOQ, KEELOQ logo, MPLAB, PIC, PICmicro, PICSTART, PIC³² logo, rPIC and UNI/O are registered trademarks of Microchip Technology Incorporated in the U.S.A. and other countries.

FilterLab, Hampshire, HI-TECH C, Linear Active Thermistor, MXDEV, MXLAB, SEEVAL and The Embedded Control Solutions Company are registered trademarks of Microchip Technology Incorporated in the U.S.A.

Analog-for-the-Digital Age, Application Maestro, CodeGuard, dsPICDEM, dsPICDEM.net, dsPICworks, dsSPEAK, ECAN, ECONOMONITOR, FanSense, HI-TIDE, In-Circuit Serial Programming, ICSP, Mindi, MiWi, MPASM, MPLAB Certified logo, MPLIB, MPLINK, mTouch, Octopus, Omniscient Code Generation, PICC, PICC-18, PICDEM, PICDEM.net, PICkit, PICTail, REAL ICE, rLAB, Select Mode, Total Endurance, TSHARC, UniWinDriver, WiperLock and ZENA are trademarks of Microchip Technology Incorporated in the U.S.A. and other countries.

SQTP is a service mark of Microchip Technology Incorporated in the U.S.A.

All other trademarks mentioned herein are property of their respective companies.

© 2010, Microchip Technology Incorporated, Printed in the U.S.A., All Rights Reserved.

 Printed on recycled paper.

ISBN: 978-1-60932-058-4

Microchip received ISO/TS-16949:2002 certification for its worldwide headquarters, design and wafer fabrication facilities in Chandler and Tempe, Arizona; Gresham, Oregon and design centers in California and India. The Company's quality system processes and procedures are for its PIC® MCUs and dsPIC® DSCs, KEELOQ® code hopping devices, Serial EEPROMs, microperipherals, nonvolatile memory and analog products. In addition, Microchip's quality system for the design and manufacture of development systems is ISO 9001:2000 certified.

**QUALITY MANAGEMENT SYSTEM
CERTIFIED BY DNV
== ISO/TS 16949:2002 ==**



WORLDWIDE SALES AND SERVICE

AMERICAS

Corporate Office
2355 West Chandler Blvd.
Chandler, AZ 85224-6199
Tel: 480-792-7200
Fax: 480-792-7277
Technical Support:
<http://support.microchip.com>
Web Address:
www.microchip.com

Atlanta
Duluth, GA
Tel: 678-957-9614
Fax: 678-957-1455

Boston
Westborough, MA
Tel: 774-760-0087
Fax: 774-760-0088

Chicago
Itasca, IL
Tel: 630-285-0071
Fax: 630-285-0075

Cleveland
Independence, OH
Tel: 216-447-0464
Fax: 216-447-0643

Dallas
Addison, TX
Tel: 972-818-7423
Fax: 972-818-2924

Detroit
Farmington Hills, MI
Tel: 248-538-2250
Fax: 248-538-2260

Kokomo
Kokomo, IN
Tel: 765-864-8360
Fax: 765-864-8387

Los Angeles
Mission Viejo, CA
Tel: 949-462-9523
Fax: 949-462-9608

Santa Clara
Santa Clara, CA
Tel: 408-961-6444
Fax: 408-961-6445

Toronto
Mississauga, Ontario,
Canada
Tel: 905-673-0699
Fax: 905-673-6509

ASIA/PACIFIC

Asia Pacific Office
Suites 3707-14, 37th Floor
Tower 6, The Gateway
Harbour City, Kowloon
Hong Kong
Tel: 852-2401-1200
Fax: 852-2401-3431

Australia - Sydney
Tel: 61-2-9868-6733
Fax: 61-2-9868-6755

China - Beijing
Tel: 86-10-8528-2100
Fax: 86-10-8528-2104

China - Chengdu
Tel: 86-28-8665-5511
Fax: 86-28-8665-7889

China - Chongqing
Tel: 86-23-8980-9588
Fax: 86-23-8980-9500

China - Hong Kong SAR
Tel: 852-2401-1200
Fax: 852-2401-3431

China - Nanjing
Tel: 86-25-8473-2460
Fax: 86-25-8473-2470

China - Qingdao
Tel: 86-532-8502-7355
Fax: 86-532-8502-7205

China - Shanghai
Tel: 86-21-5407-5533
Fax: 86-21-5407-5066

China - Shenyang
Tel: 86-24-2334-2829
Fax: 86-24-2334-2393

China - Shenzhen
Tel: 86-755-8203-2660
Fax: 86-755-8203-1760

China - Wuhan
Tel: 86-27-5980-5300
Fax: 86-27-5980-5118

China - Xian
Tel: 86-29-8833-7252
Fax: 86-29-8833-7256

China - Xiamen
Tel: 86-592-2388138
Fax: 86-592-2388130

China - Zhuhai
Tel: 86-756-3210040
Fax: 86-756-3210049

ASIA/PACIFIC

India - Bangalore
Tel: 91-80-3090-4444
Fax: 91-80-3090-4123

India - New Delhi
Tel: 91-11-4160-8631
Fax: 91-11-4160-8632

India - Pune
Tel: 91-20-2566-1512
Fax: 91-20-2566-1513

Japan - Yokohama
Tel: 81-45-471- 6166
Fax: 81-45-471-6122

Korea - Daegu
Tel: 82-53-744-4301
Fax: 82-53-744-4302

Korea - Seoul
Tel: 82-2-554-7200
Fax: 82-2-558-5932 or
82-2-558-5934

Malaysia - Kuala Lumpur
Tel: 60-3-6201-9857
Fax: 60-3-6201-9859

Malaysia - Penang
Tel: 60-4-227-8870
Fax: 60-4-227-4068

Philippines - Manila
Tel: 63-2-634-9065
Fax: 63-2-634-9069

Singapore
Tel: 65-6334-8870
Fax: 65-6334-8850

Taiwan - Hsin Chu
Tel: 886-3-6578-300
Fax: 886-3-6578-370

Taiwan - Kaohsiung
Tel: 886-7-536-4818
Fax: 886-7-536-4803

Taiwan - Taipei
Tel: 886-2-2500-6610
Fax: 886-2-2508-0102

Thailand - Bangkok
Tel: 66-2-694-1351
Fax: 66-2-694-1350

EUROPE

Austria - Wels
Tel: 43-7242-2244-39
Fax: 43-7242-2244-393

Denmark - Copenhagen
Tel: 45-4450-2828
Fax: 45-4485-2829

France - Paris
Tel: 33-1-69-53-63-20
Fax: 33-1-69-30-90-79

Germany - Munich
Tel: 49-89-627-144-0
Fax: 49-89-627-144-44

Italy - Milan
Tel: 39-0331-742611
Fax: 39-0331-466781

Netherlands - Drunen
Tel: 31-416-690399
Fax: 31-416-690340

Spain - Madrid
Tel: 34-91-708-08-90
Fax: 34-91-708-08-91

UK - Wokingham
Tel: 44-118-921-5869
Fax: 44-118-921-5820

01/05/10