

PIC16F785/HV785

FIGURE 1-1: 20-PIN DIAGRAM FOR PIC16F785/HV785

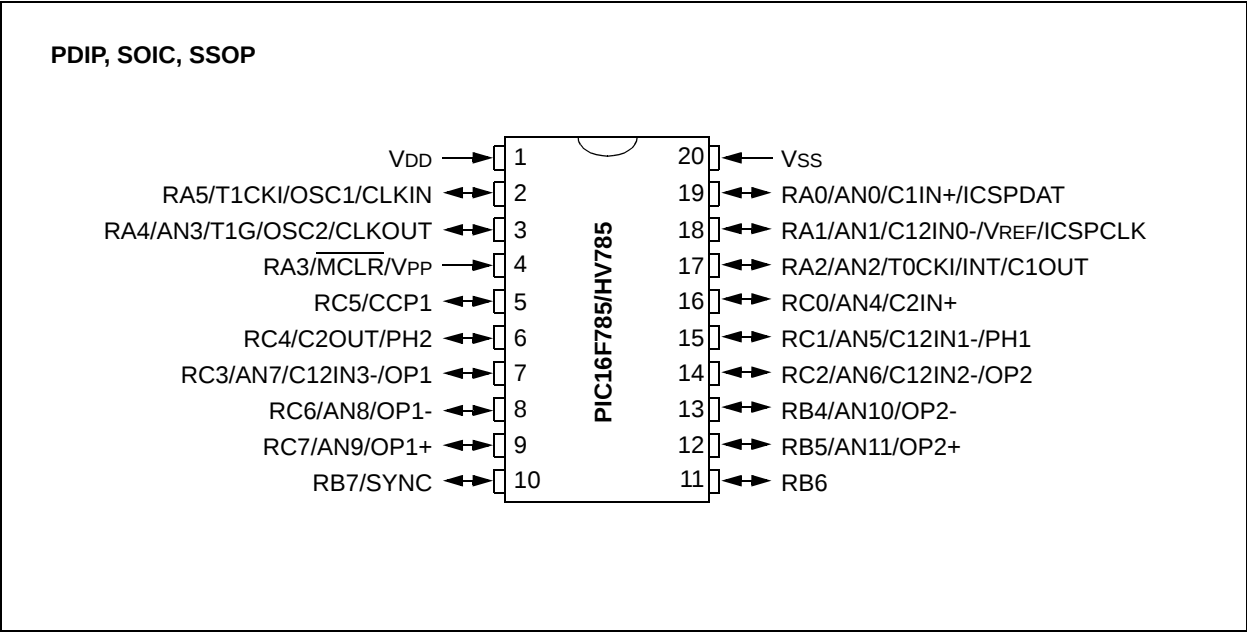


FIGURE 1-2: 20-PIN DIAGRAM FOR PIC16F785/HV785

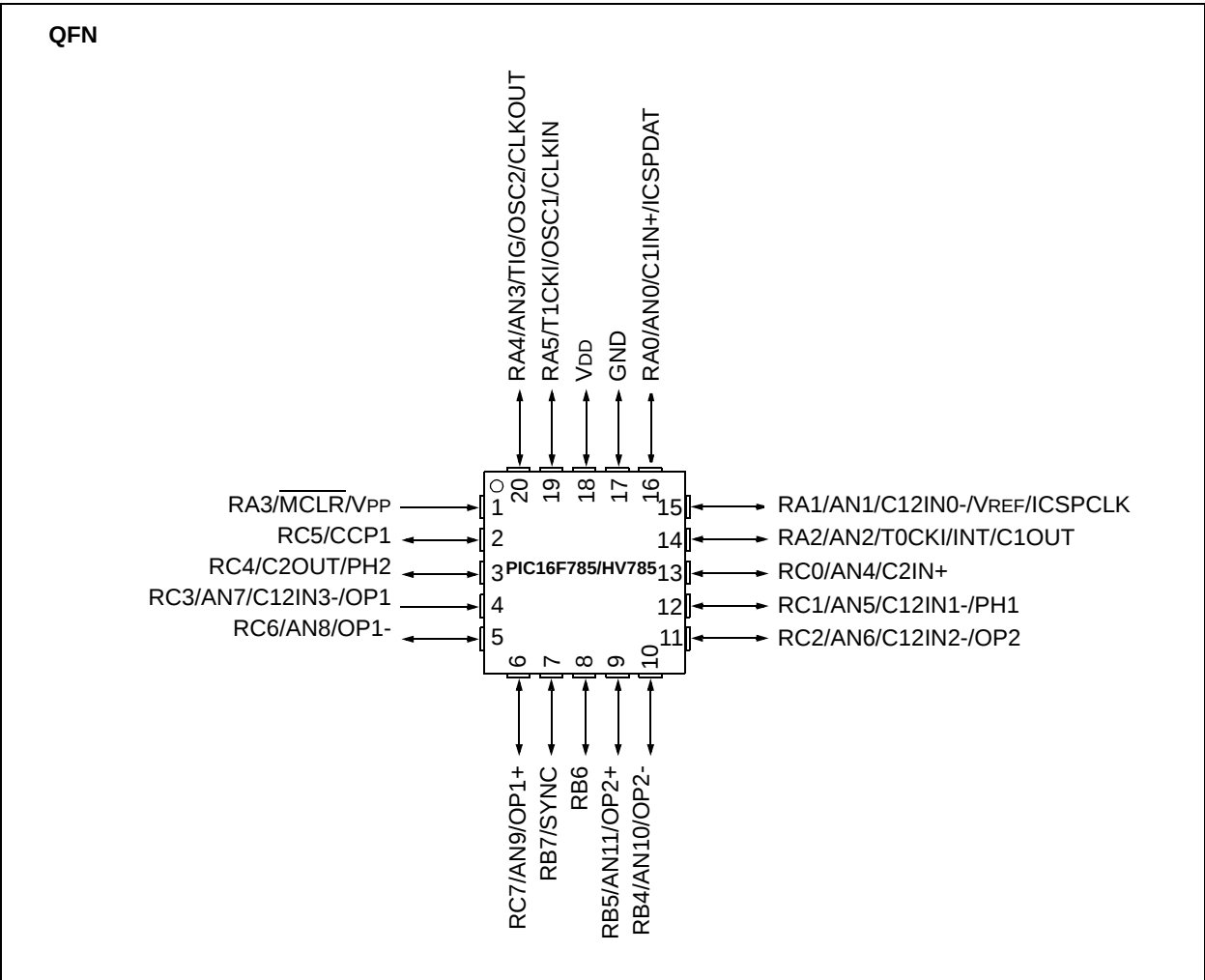
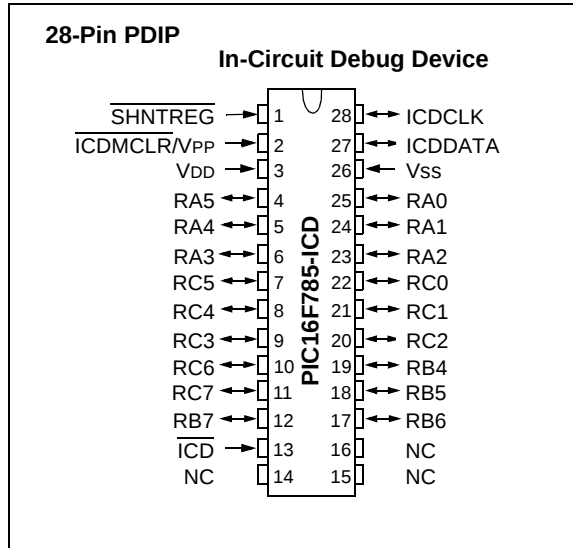


FIGURE 1-3: ICD PINOUT



2.0 MEMORY DESCRIPTION

2.1 Program Memory Map

The user memory space extends from 0x0000 to 0x1FFF, with addresses 0x0000-0x07FF implemented. In Program/Verify mode, the program memory space extends from 0x0000 to 0x3FFF, with the first half (0x0000-0x1FFF) being user program memory and the second half (0x2000-0x3FFF) being configuration memory. The PC will increment from 0x0000-0x1FFF and wrap to 0x0000. If the PC starts at 0x2000 it will increment to 0x3FFF and wrap around to 0x2000 (not to 0x0000). Once in configuration memory, the highest bit of the PC stays a '1', thus always pointing to the configuration memory. The only way to point to user program memory is to reset the part and re-enter Program/Verify mode as described in **Section 3.0 "Program/Verify Mode"**.

In the configuration memory space, 0x2000-0x203F are physically implemented. However, only locations 0x2000-0x2003 and 0x2007-0x2009 are available. The other locations are reserved.

2.2 User ID Locations

A user may store identification information (user ID) in four designated locations. The user ID locations are mapped in [0x2000-0x2003]. It is recommended that the user use only the seven Least Significant bits (LSb) of each user ID location. The user ID locations read out normally, even after code protection is enabled. It is recommended that user ID locations are written as '11 1111 1bbb bbbb' where 'bbb bbbb' is user ID information.

The 14 bits may be programmed, but only the 7 LSbs are displayed by MPLAB® IDE. The 1111's are "don't care" bits and are not read by MPLAB® IDE.

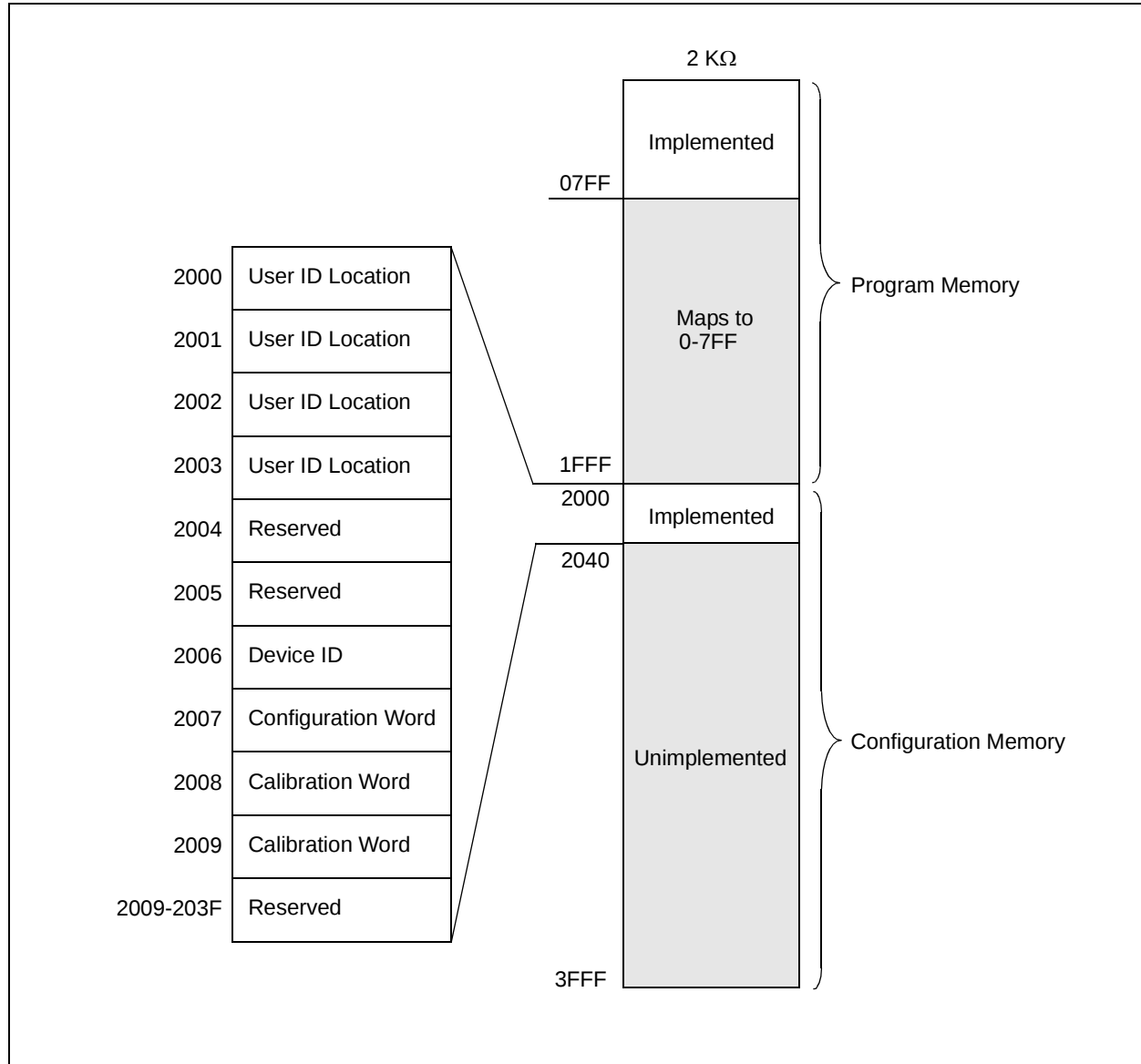
2.3 Calibration Words

The 8 MHz Internal Oscillator (INTOSC), the Power-on Reset (POR), the Brown-out Reset (BOR) modules and band gap voltage reference are factory calibrated. These values are stored in Calibration Words at addresses 0x2008 and 0x2009.

The Calibration Word locations are written at the time of manufacturing and are not erased when a Bulk Erase is performed. See **Section 3.1.5.10 "Bulk Erase Program Memory"** for more information on the various erase sequences. However, it is possible to inadvertently write to these locations. The device may not function properly or may operate outside of specifications if the Calibration Word locations do not contain the correct value. Therefore, it is recommended that the Calibration Words be read prior to any programming procedure and verified after programming is complete. See Figure 3-21 for a flowchart of the recommended verification procedure.

The device should not be used if the verification of the Calibration Word values fail after the device is programmed. The 0x3FFF value is a special case, it is a valid calibration value but, it is also the erased state of the register.

FIGURE 2-1: PROGRAM MEMORY MAPPING



PIC16F785/HV785

3.0 PROGRAM/VERIFY MODE

Two methods are available to enter Program/Verify mode. The 'VPP-first' method is entered by holding ICSPDAT and ICSPCLK low while raising MCLR pin from V_{IL} to V_{IH} (high voltage), then applying V_{DD} and data. This method can be used for any Configuration Word selection and **must** be used if the INTOSC and internal MCLR options are selected ($FOSC<2:0> = 100$ or 101 and $MCLRE = 0$). The VPP-first entry prevents the device from executing code prior to entering Program/Verify mode. See the timing diagram in Figure 3-1. To prevent the device from executing code while exiting Program/Verify mode, the 'VPP-last' must also be used if the INTOSC and internal MCLR options are selected. See the timing diagram in Figure 3-3.

The second entry method, 'VDD-first', is entered by applying V_{DD} , holding ICSPDAT and ICSPCLK low, then raising MCLR pin from V_{IL} to V_{IH} (high voltage), followed by data. This method can be used for any Configuration Word selection **except** when INTOSC and internal MCLR options are selected ($FOSC<2:0> = 100$ or 101 and $MCLRE = 0$). This technique is useful when programming the device when V_{DD} is already applied, for it is not necessary to disconnect V_{DD} to enter or exit Program/Verify mode. See the timing diagram in Figure 3-2.

Once in this mode, the program memory, data memory, and configuration memory can be accessed and programmed in serial fashion. ICSPDAT and ICSPCLK are Schmitt Trigger inputs in this mode.

The sequence that enters the device into the Programming/Verify mode momentarily places all other logic into the Reset state (the MCLR pin was initially at V_{IL}). Therefore, all I/O's are in the Reset state (high-impedance inputs) and the Program Counter (PC) is cleared.

To prevent a device configured with INTOSC and internal MCLR from executing after exiting Program/Verify mode, V_{DD} needs to power-down before V_{PP} . See Figure 3-3 for the timing.

FIGURE 3-1: VPP-FIRST PROGRAM/VERIFY MODE ENTRY

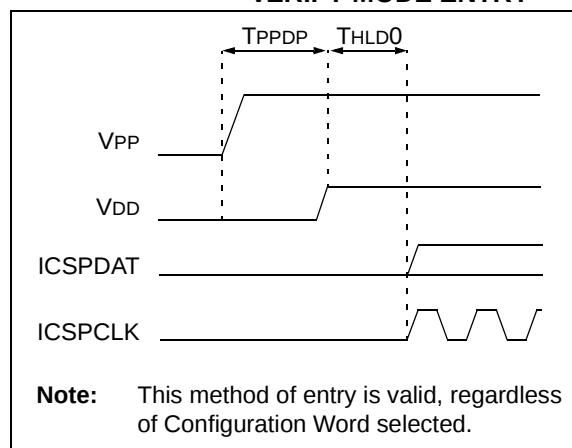


FIGURE 3-2: VDD-FIRST PROGRAM/VERIFY MODE ENTRY

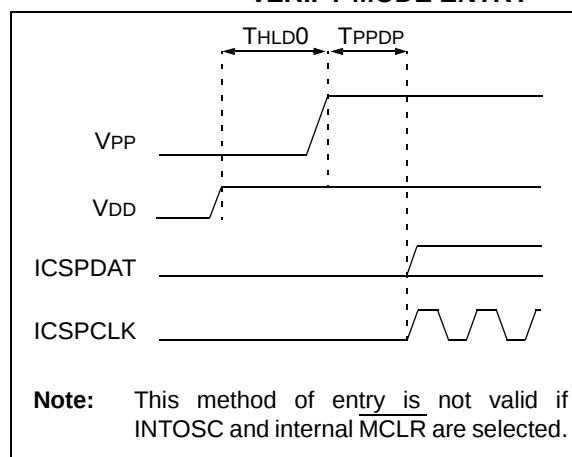
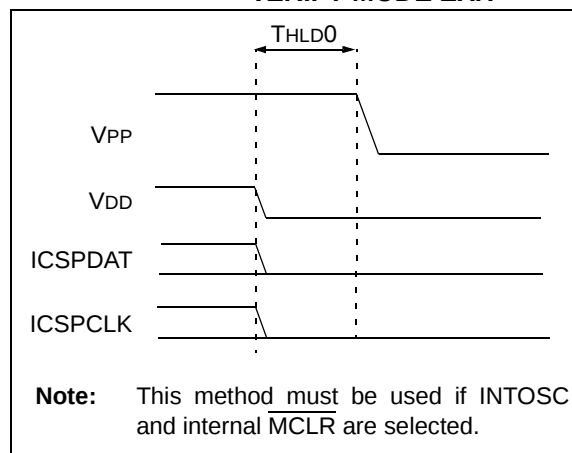


FIGURE 3-3: VPP-LAST PROGRAM/VERIFY MODE EXIT



3.1 Program/Erase Algorithms

The PIC16F785/HV785 program memory may be written in two ways. The fastest method writes four words at a time. However, one-word writes are also supported for backward compatibility with previous 8-pin and 14-pin Flash devices. The four-word algorithm is used to program the program memory and the user ID locations only. The one-word algorithm can write any available memory location (i.e., program memory, configuration memory and data memory).

After writing the array, the PC may be reset and the entire array read back to verify the write. It is not possible to verify immediately following the write because the PC can only increment, not decrement.

A device Reset will clear the PC and set the address to '0'. The Increment Address command will increment the PC. The Load Configuration command will set the PC to 0x2000. The available commands are shown in Table 3-1.

3.1.1 FOUR-WORD PROGRAMMING

Only the program memory can be written using this algorithm. Data and configuration memory (>0x2003) must use the one-word programming algorithm (Section 3.1.2 "One-Word Programming").

This algorithm writes four sequential addresses in program memory. The four addresses must point to a four-word block with addresses modulo 4 of 0, 1, 2 and 3. For example, programming address 4 through 7 can be programmed together. Programming addresses 2 through 5 will create an unexpected result.

The sequence for programming four words of program memory at a time is as follows:

1. Load a word at the current program memory address using Load Data for Program Memory command.
2. Issue an Increment Address command.
3. Load a word at the current program memory address using Load Data for Program Memory command.
4. Repeat Steps 2 and 3, two more times.
5. Issue a Begin Programming command, either internally or externally timed.
6. Wait T_{PROG1} (internally timed) or T_{PROG2} (externally timed).
7. Issue an End Programming command if externally timed.
8. Issue an Increment Address command.
9. Repeat steps 1 through 8 as required to write program memory.

See Figure 3-17 for more information.

3.1.2 ONE-WORD PROGRAMMING

The program memory may also be written one-word at a time to allow compatibility with other 8-pin and 14-pin Flash PIC[®] devices. Configuration memory (>0x2003) and data memory must be written one-word (or byte) at a time with the exception of the user ID locations.

Note: The four write latches must be reset after programming the user ID (0x2000-0x2003) or Configuration Word (0x2007). See Section 3.1.3 "Resetting Write Latches".

The sequence for programming one-word of program memory at a time is as follows:

1. Load a word at the current program memory address using Load Data for Program Memory command.
2. Issue a Begin Programming command either internally or externally timed.
3. Wait T_{PROG1} (internally timed) or T_{PROG2} (externally timed).
4. Issue an End Programming command if externally timed.
5. Issue an Increment Address command.
6. Repeat this sequence as required to write program, data or configuration memory.

See Figure 3-16 for more information.

3.1.3 RESETTING WRITE LATCHES

The user ID (0x2000-0x2003) and Configuration Word (0x2007) are mapped into the configuration memory but do not physically reside in it. As a result, the write latches are not reset when programming these locations and must be reset by the programmer. This can be done in two ways, either loading all four latches with '1's or by exiting Program/Verify mode.

The sequence for manually resetting the write latches is as follows:

1. Load a word using Load Data for Program Memory command with a data word of all '1's.
2. Issue an Increment Address command.
3. Repeat this sequence three times to all four write latches to 1's (Reset state).

PIC16F785/HV785

3.1.4 ERASE ALGORITHMS

The PIC16F785/HV785 will erase different memory locations depending on the Program Counter (PC), $\overline{CP}$ and $\overline{CPD}$ values, and which erase command is executed. The following sequences can be used to erase noted memory locations. In each sequence, the data memory will be erased if the $\overline{CPD}$ bit in the Configuration Word is programmed (clear).

To erase the program memory and Configuration Word (0x2007), the following sequence must be performed.

Note: The Calibration Words (0x2008-0x2009) and user ID (0x2000-0x2003) **will not** be erased.

1. Do a Bulk Erase Program Memory command.
2. Wait TERA to complete erase.

To erase the user ID (0x2000-0x2003), Configuration Word (0x2007) and program memory use the following sequence. Note that the Calibration Words (0x2008-0x2009) **will not** be erased.

1. Perform a Load Configuration command with dummy data to point the Program Counter (PC) to 0x2000.
2. Perform a Bulk Erase Program Memory command.
3. Wait TERA to complete erase.

Note: See Table 3-2.

3.1.5 SERIAL PROGRAM/VERIFY OPERATION

The ICSPCLK pin is used as a clock input and the ICSPDAT pin is used for entering command bits and data input/output during serial operation. To input a command, ICSPCLK is cycled six times. Each command bit is latched on the falling edge of the clock with the LSb of the command being input first. The data input onto the ICSPDAT pin is required to have a minimum setup and hold time (see Table 6-1), with respect to the falling edge of the clock. Commands that have data associated with them (read and load) are specified to have a minimum delay of 1 μ s between the command and the data. After this delay, the clock pin is cycled 16 times with the first cycle being a Start bit and the last cycle being a Stop bit.

During a read operation, the LSb will be transmitted onto ICSPDAT pin on the rising edge of the second cycle. For a load operation, the LSb will be latched on the falling edge of the second cycle. A minimum 1 μ s delay is also specified between consecutive commands, except for the End Programming command, which requires a 100 μ s TDIS.

All commands and data words are transmitted LSb first. Data is transmitted on the rising edge and latched on the falling edge of the ICSPCLK. To allow for decoding of commands and reversal of data pin configuration, a time separation of at least 1 μ s is required between a command and a data word.

The commands that are available are described in Table 3-1.

TABLE 3-1: COMMAND MAPPING FOR PIC16F785/HV785

Command	Mapping (MSb ... LSb)						Data
Load Configuration	x	x	0	0	0	0	0, ones data (14), 0
Load Data for Program Memory	x	x	0	0	1	0	0, data (14), 0
Load Data for Data Memory	x	x	0	0	1	1	0, data (8), zero (6), 0
Read Data from Program Memory	x	x	0	1	0	0	0, data (14), 0
Read Data from Data Memory	x	x	0	1	0	1	0, data (8), zero (6), 0
Increment Address	x	x	0	1	1	0	
Begin Programming (internally timed)	x	0	1	0	0	0	
Begin Programming (externally timed) ⁽¹⁾	x	1	1	0	0	0	
End Programming	x	0	1	0	1	0	
Bulk Erase Program Memory (internally timed) ⁽²⁾	x	x	1	0	0	1	
Bulk Erase Data Memory (internally timed) ⁽²⁾	x	x	1	0	1	1	
Row Erase Program Memory (internally timed) ⁽²⁾	x	1	0	0	0	1	

Note 1: Externally timed Data EE programming is a program-only command. No erase cycle is performed.

2: VDD must be at least 4.0V for this command.

3.1.5.1 Load Configuration

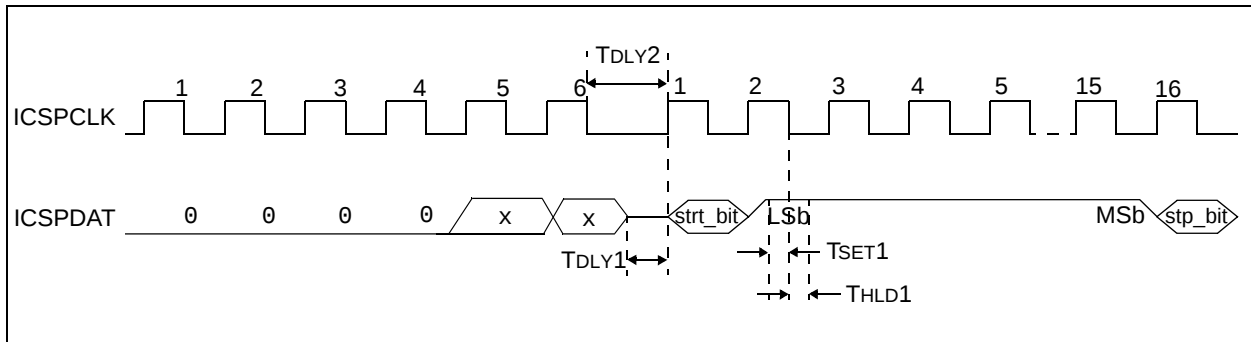
The Load Configuration command is used to access the Configuration Word (0x2007) and the user ID (0x2000-0x2003). This command sets the Program Counter (PC) to address 0x2000. The data field must be loaded with all ones.

After receiving this command, the Configuration Word is accessed by performing an Increment Address command 7 times to point the PC to the Configuration Word. Data can be loaded using the Load Data for Program Memory command then be programmed using a Begin Programming command, either internally or externally timed.

After the 6-bit command is input, ICSPCLK pin is cycled an additional 16 times for the Start bit, 14 bits of data and a Stop bit (see Figure 3-4).

After the configuration memory is entered, the only way to get back to the program memory is to exit the Program/Verify mode by taking $\overline{\text{MCLR}}$ low (V_{IL}).

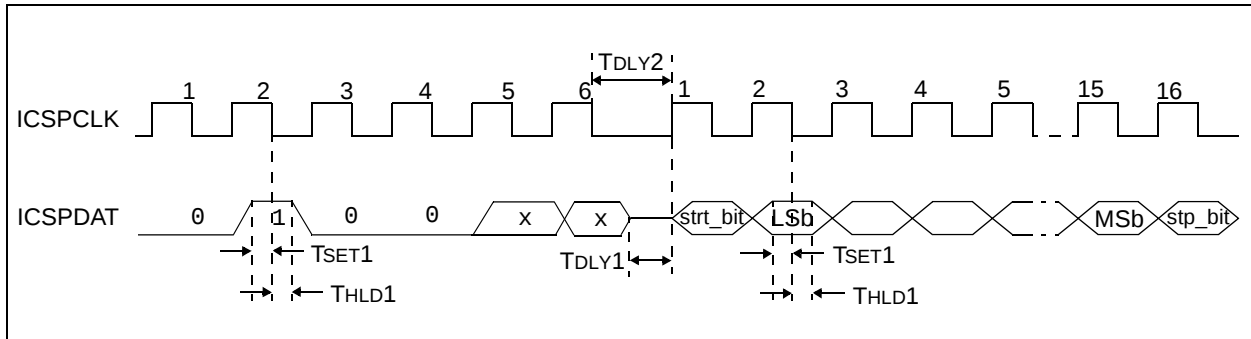
FIGURE 3-4: LOAD CONFIGURATION COMMAND



3.1.5.2 Load Data for Program Memory

After receiving this command, the device will load in a 14-bit 'data word' when 16 cycles are applied, as described previously. A timing diagram for the Load Data for Program Memory command is shown in Figure 3-5.

FIGURE 3-5: LOAD DATA FOR PROGRAM MEMORY COMMAND

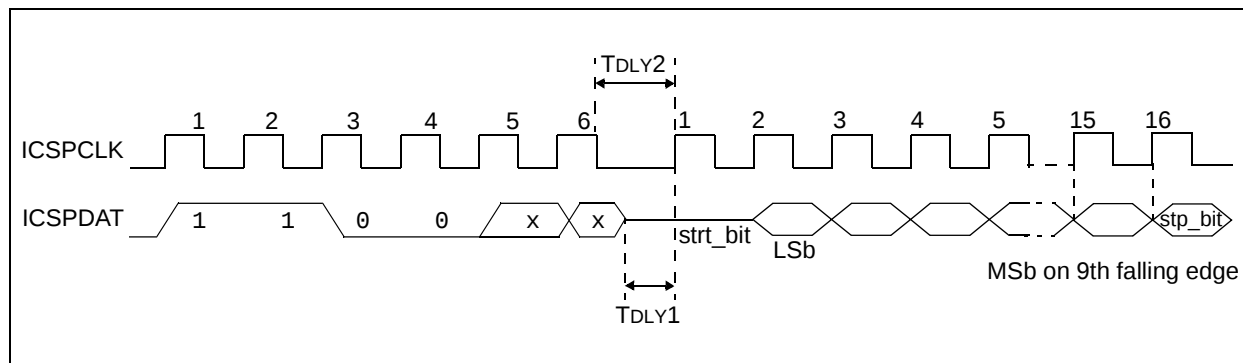


PIC16F785/HV785

3.1.5.3 Load Data for Data Memory

After receiving this command, the device will load in 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. The data memory contains 256 bytes.

FIGURE 3-6: LOAD DATA FOR DATA MEMORY COMMAND

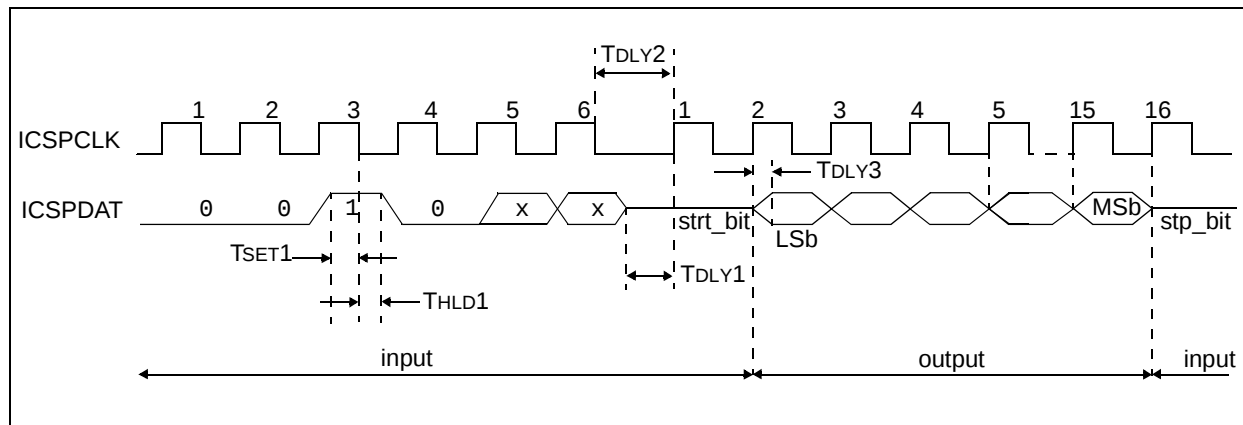


3.1.5.4 Read Data from Program Memory

After receiving this command, the device will transmit data bits out of the program memory (user or configuration) currently accessed, starting with the second rising edge of the clock input. The data pin will go into Output mode on the second rising clock edge, and it will revert to Input mode (high-impedance) after the 16th rising edge.

If the program memory is code-protected ($\overline{CP} = 0$), the data is read as '0's.

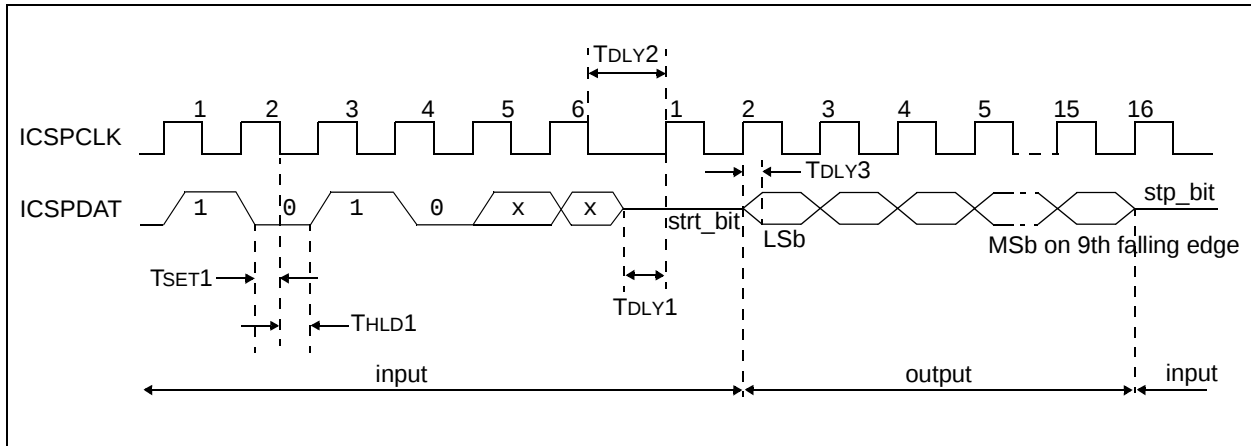
FIGURE 3-7: READ DATA FROM PROGRAM MEMORY COMMAND



3.1.5.5 Read Data from Data Memory

After receiving this command, the device 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. As previously stated, 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 '0's. A timing diagram of this command is shown in Figure 3-8.

FIGURE 3-8: READ DATA FROM DATA MEMORY COMMAND

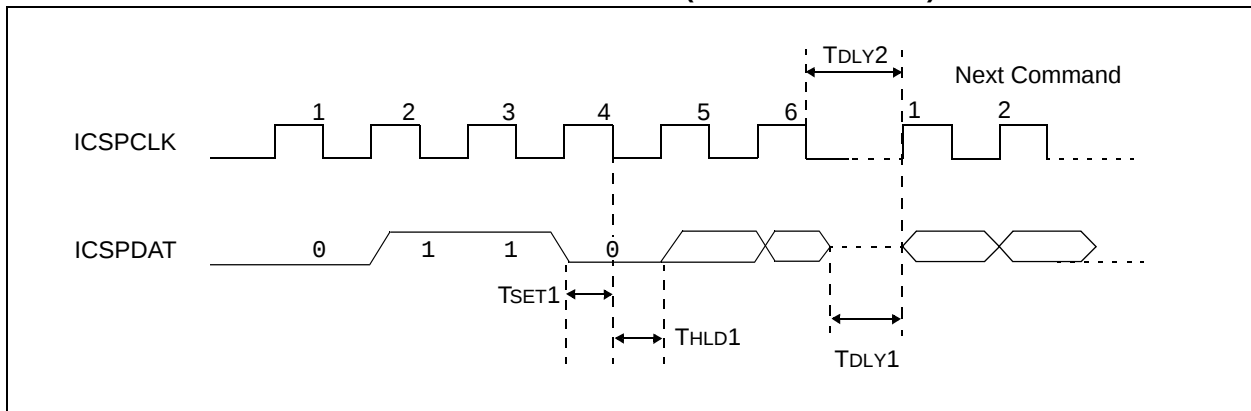


3.1.5.6 Increment Address

The PC is incremented when this command is received. A timing diagram of this command is shown in Figure 3-9.

It is not possible to decrement the address counter. To reset this counter, the user should exit and re-enter Program/Verify mode.

FIGURE 3-9: INCREMENT ADDRESS COMMAND (PROGRAM/VERIFY)



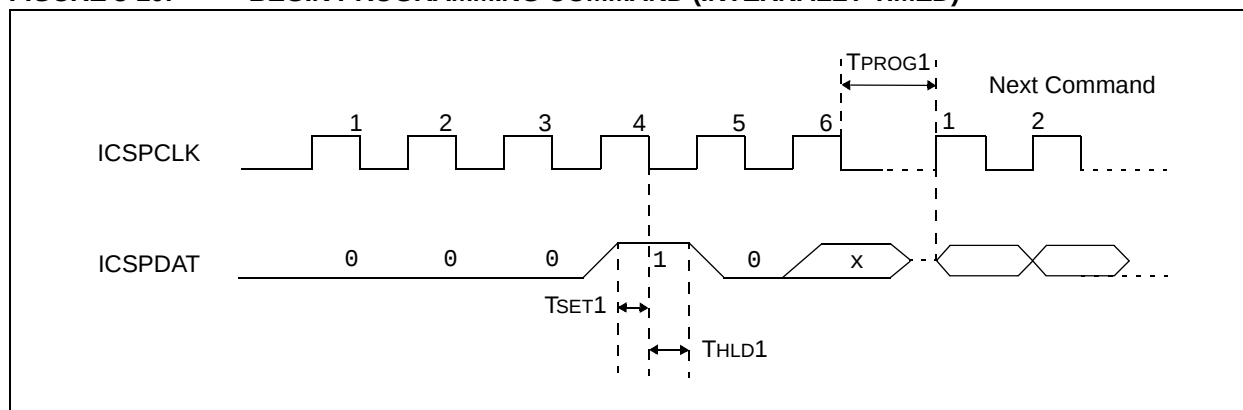
PIC16F785/HV785

3.1.5.7 Begin Programming (Internally Timed)

A Load command must be given before every Begin Programming command. Programming of the appropriate memory (user program memory, configuration memory or data memory) will begin after this command is received and decoded. An internal timing mechanism executes a write. The user must allow for program cycle time for programming to complete. No End Programming command is required.

The addressed location is not erased before programming.

FIGURE 3-10: BEGIN PROGRAMMING COMMAND (INTERNALLY TIMED)

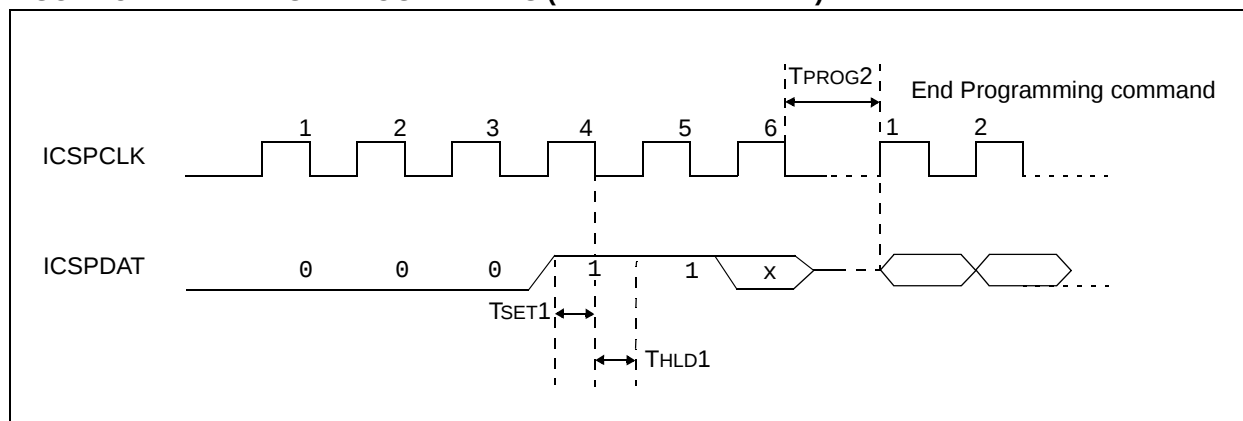


3.1.5.8 Begin Programming (Externally Timed)

A Load command must be given before every Begin Programming command. Programming of the appropriate memory (program memory, configuration or data memory) will begin after this command is received and decoded. Programming requires (TPROG2) time and is terminated using an End Programming command.

The addressed location is not erased before programming.

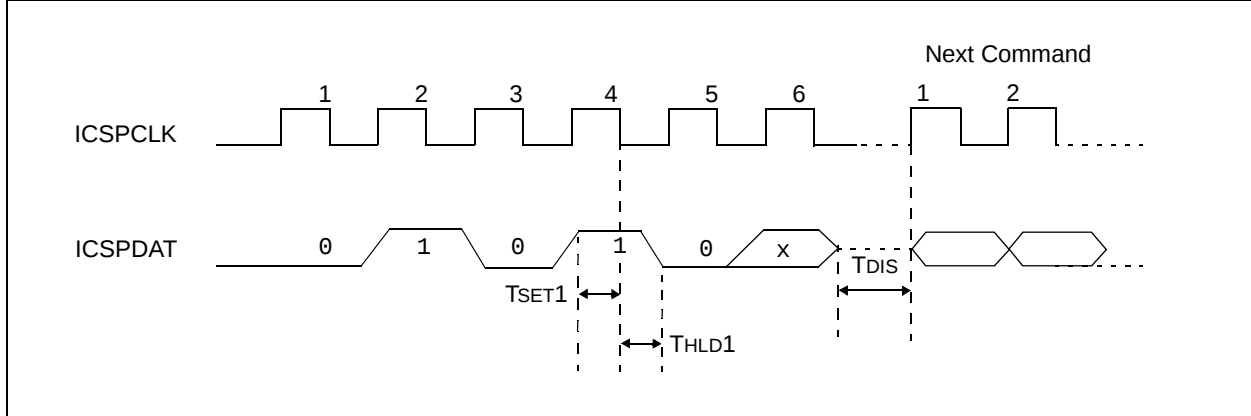
FIGURE 3-11: BEGIN PROGRAMMING (EXTERNALLY TIMED)



3.1.5.9 End Programming

The End Programming command is executed when terminating external timing or programming. The End Programming command requires a 100 μ s TDIS.

FIGURE 3-12: END PROGRAMMING (SERIAL PROGRAM/VERIFY)

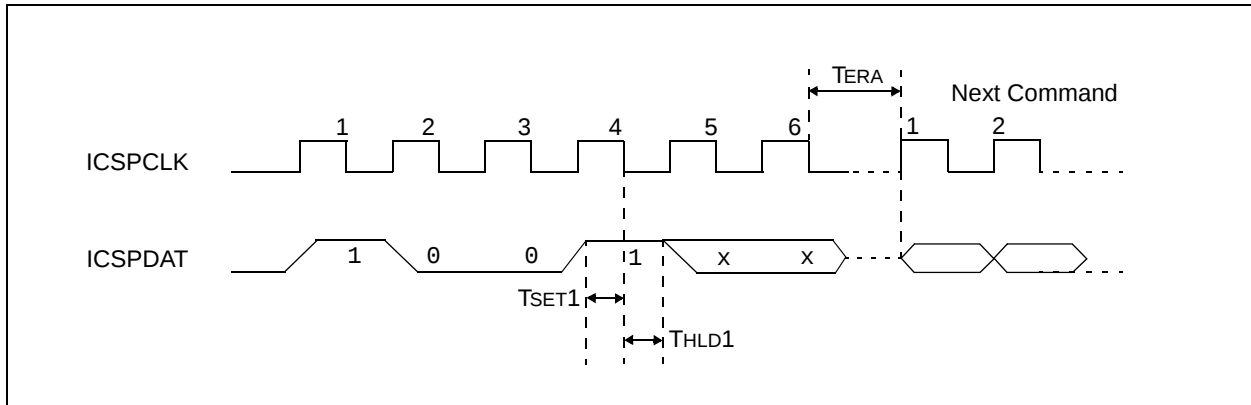


3.1.5.10 Bulk Erase Program Memory

After this command is performed, the entire program memory and Configuration Word (0x2007) are erased. Data memory will also be erased if the CPD bit in the Configuration Word is programmed (clear). See **Section 3.1.4 “Erase Algorithms”** for erase sequences.

Note: All Bulk Erase operations must take place between 4.5V and 5.5V VDD for PIC16F785, 2.0V to 5.5V VDD for PIC16F785-ICD and 4.5V to 4.9V for PIC16HV785.

FIGURE 3-13: BULK ERASE PROGRAM MEMORY COMMAND



PIC16F785/HV785

TABLE 3-2: BULK ERASE RESULTS

PC =	Programming Memory Space (Program Memory)	Configuration Memory Space		
		Configuration Word	User ID	Calibration Word
Configuration Word or Program Memory Space	E	E	U	U
First User ID Location	E	E	E	U
Either Calibration Word	E	E	E	E

Legend: E = Erased, U = Unchanged.

3.1.5.11 Bulk Erase Data Memory

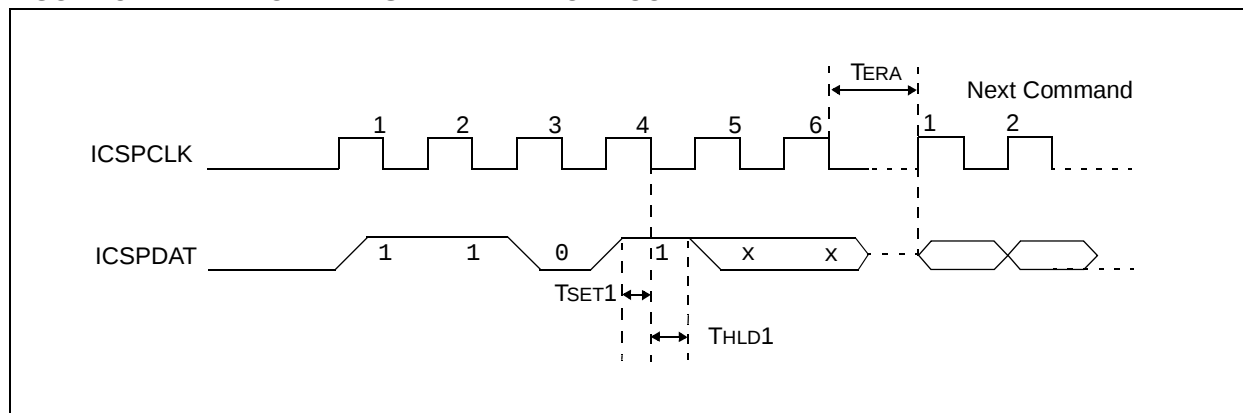
To perform an erase of the data memory, the following sequence must be performed.

1. Perform a Bulk Erase Data Memory command.
2. Wait TERA to complete Bulk Erase.

Data memory won't erase if code-protected ($\overline{\text{CPD}} = 0$). If $\text{CPD} = 0$, a Bulk Erase program memory must be used.

Note: All Bulk Erase operations must take place between 4.5V and 5.5V V_{DD} for PIC16F785, 2.0V to 5.5V V_{DD} for PIC16F785-ICD and 4.5V to 4.9V for PIC16HV785.

FIGURE 3-14: BULK ERASE DATA MEMORY COMMAND



3.1.5.12 Row Erase Program Memory

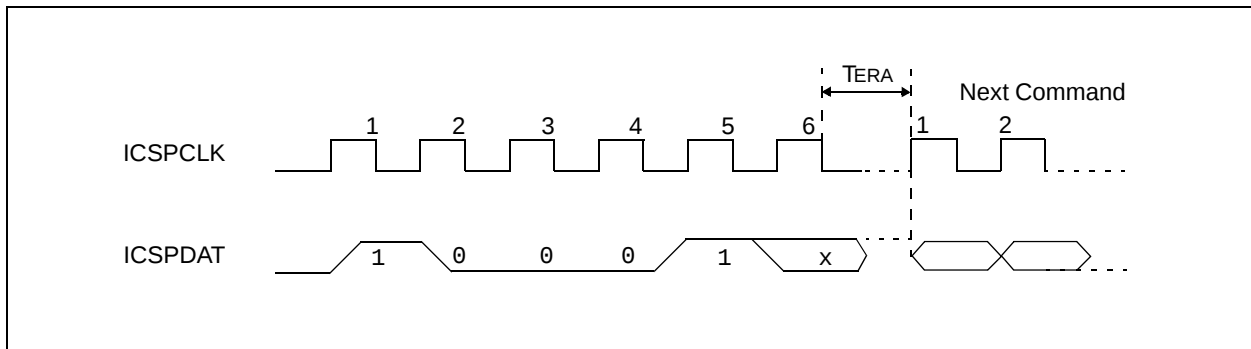
This command erases the 16-word row of program memory pointed to by $\overline{PC}<11:4>$. If the program memory array is protected ($\overline{CP} = 0$) or the $\overline{PC}$ points to configuration memory ($>0x2000$), the command is ignored.

To perform a Row Erase Program Memory, the following sequence must be performed.

1. Execute a Row Erase Program Memory command.
2. Wait TERA to complete a row erase.

Note: All row erase operations must take place between 4.5V and 5.5V V_{DD} for PIC16F785, 2.0V to 5.5V V_{DD} for PIC16F785-ICD and 4.5V to 4.9V for PIC16HV785.

FIGURE 3-15: ROW ERASE PROGRAM MEMORY COMMAND



PIC16F785/HV785

FIGURE 3-16: ONE-WORD PROGRAMMING FLOWCHART

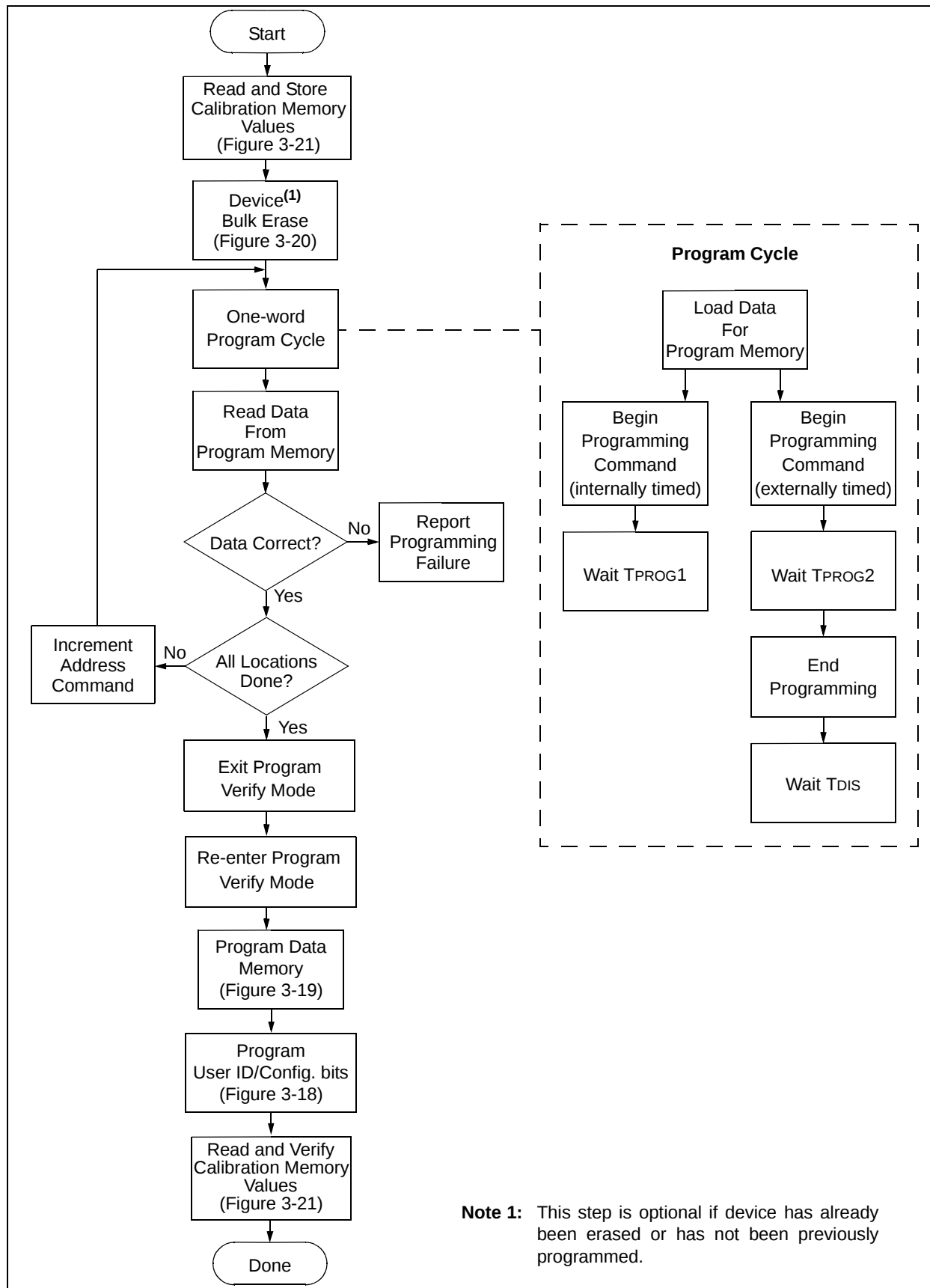
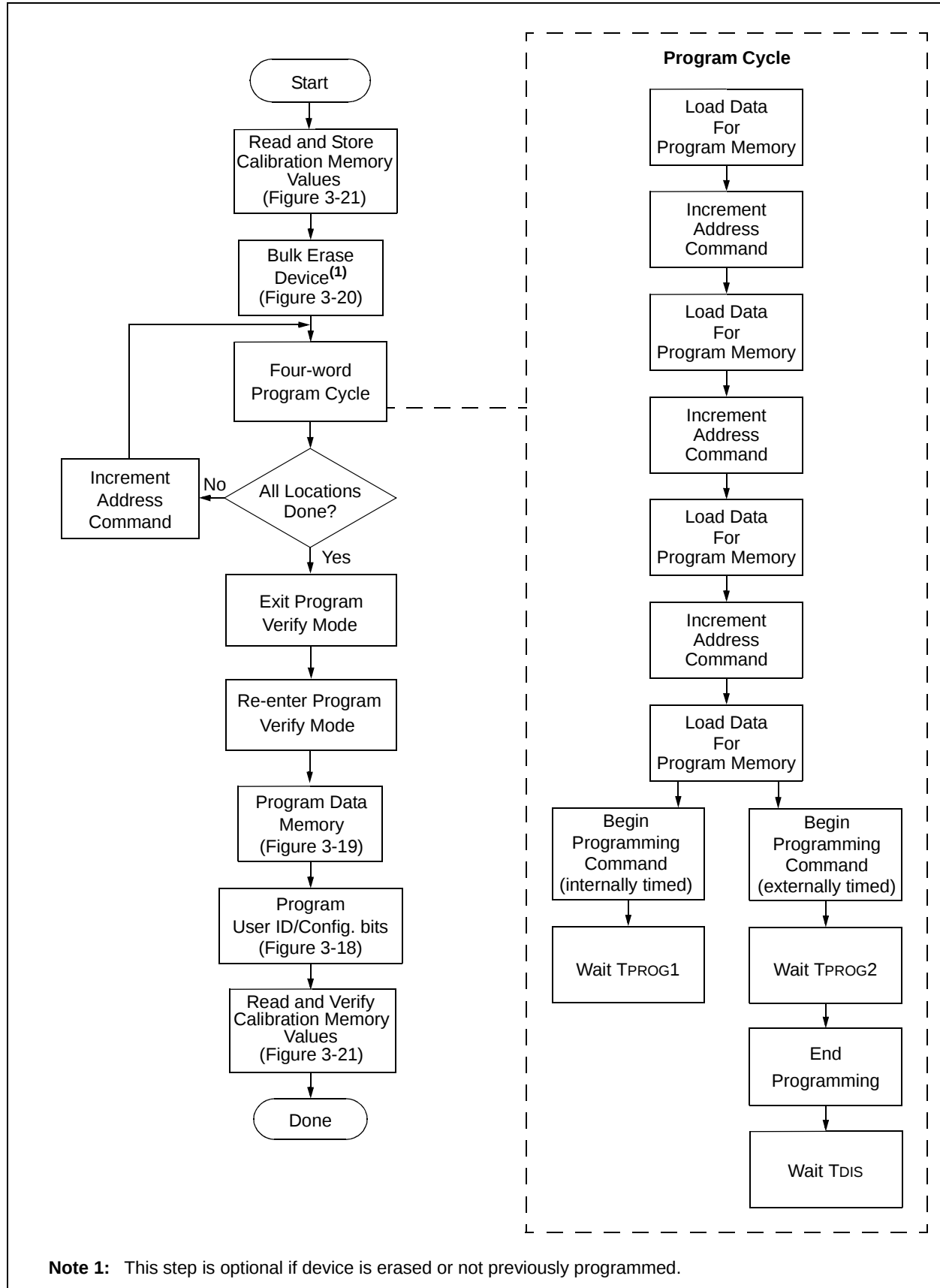


FIGURE 3-17: FOUR-WORD PROGRAMMING FLOWCHART



PIC16F785/HV785

FIGURE 3-18: PROGRAM FLOWCHART – PIC16F785/HV785 CONFIGURATION MEMORY

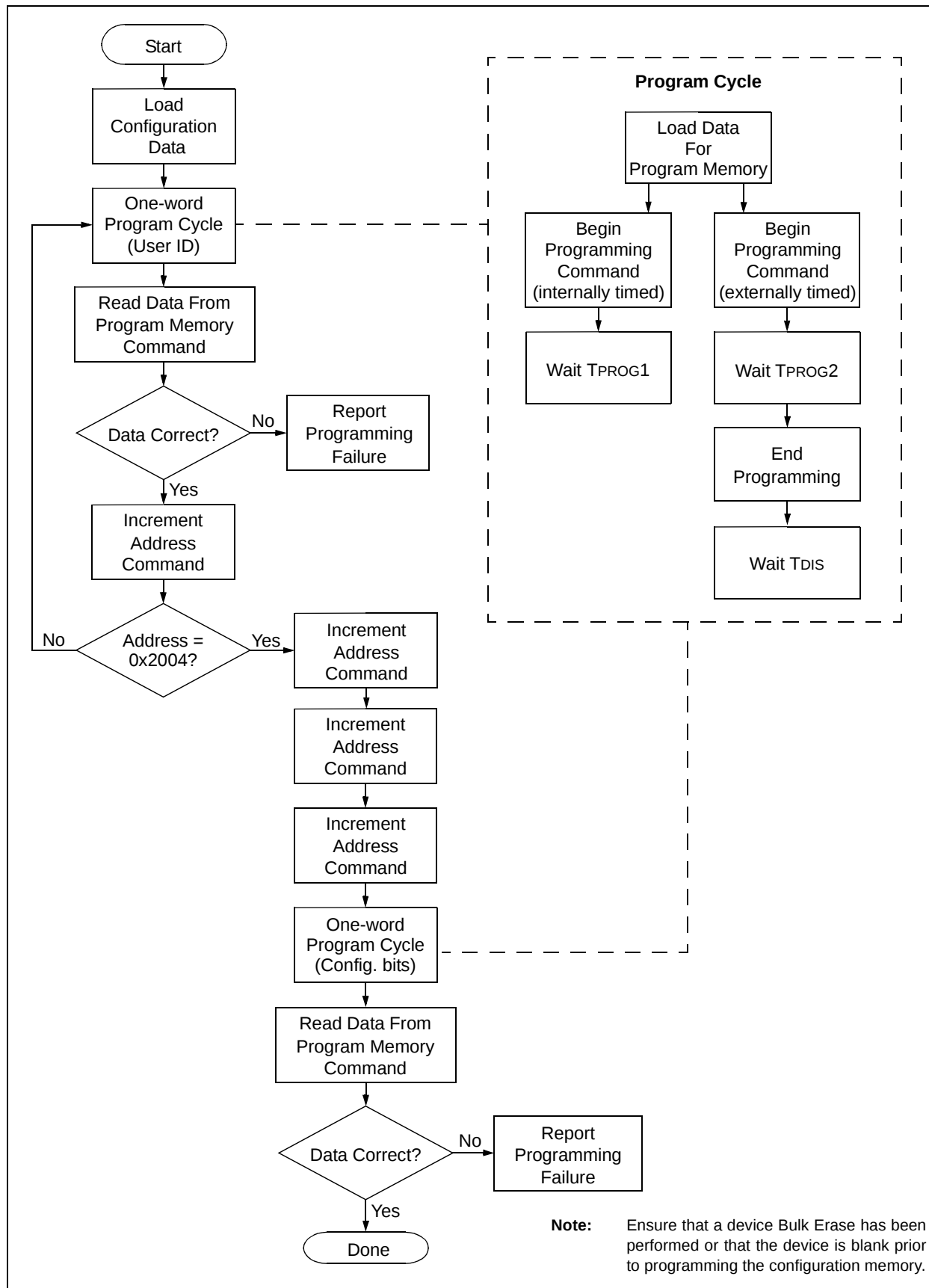
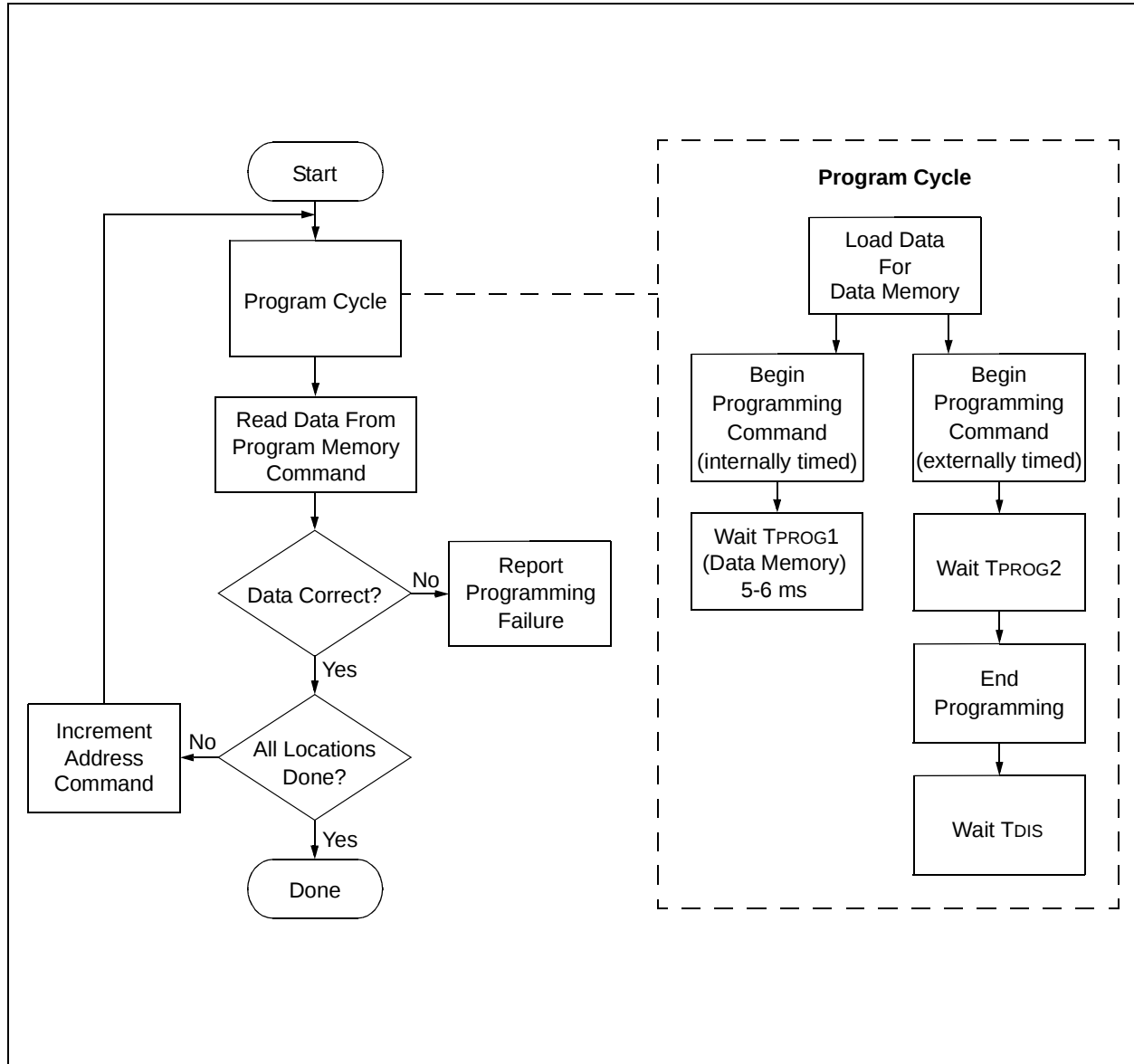


FIGURE 3-19: PROGRAM FLOWCHART – PIC16F785/HV785 DATA MEMORY



PIC16F785/HV785

FIGURE 3-20: PROGRAM FLOWCHART – ERASE FLASH DEVICE

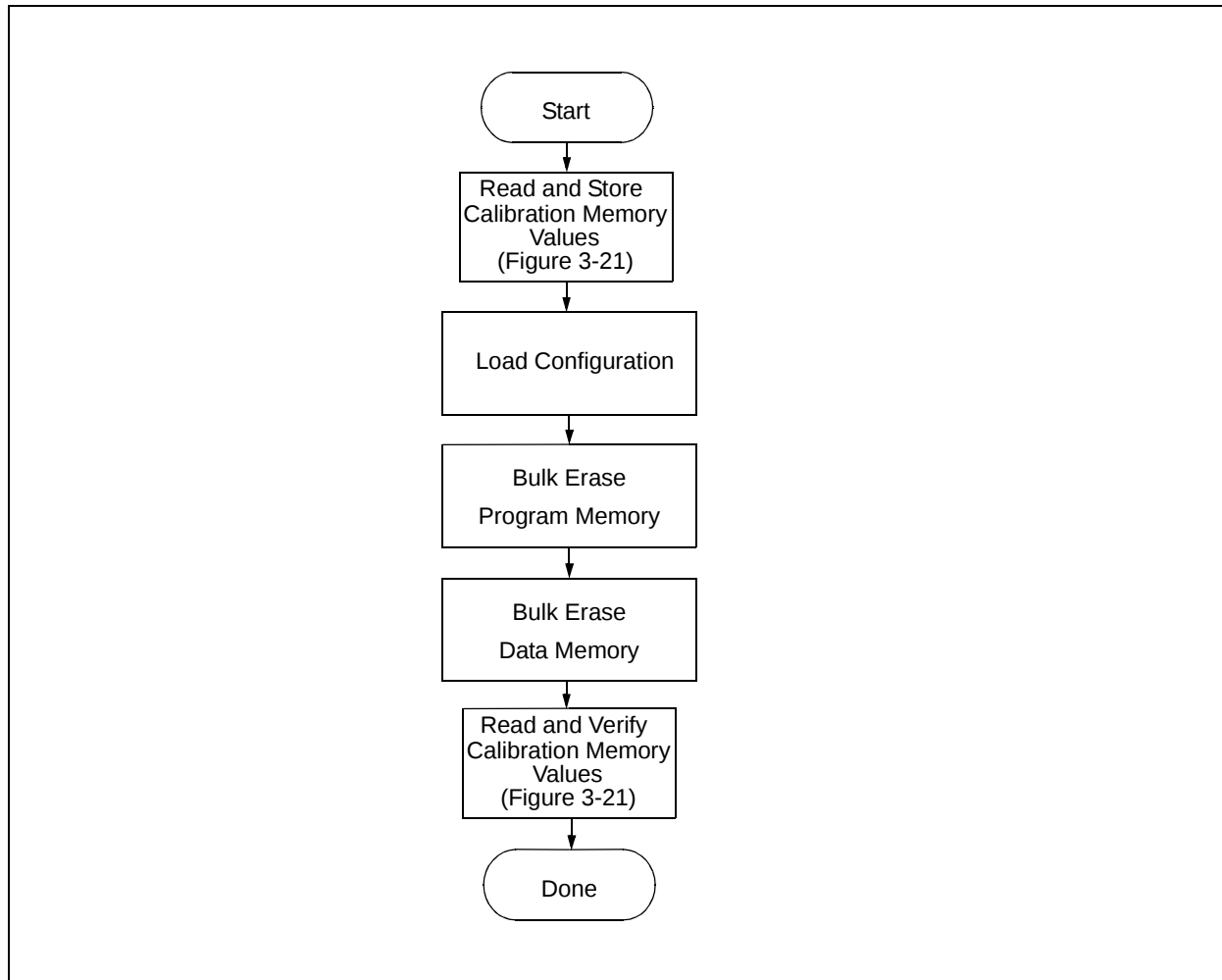
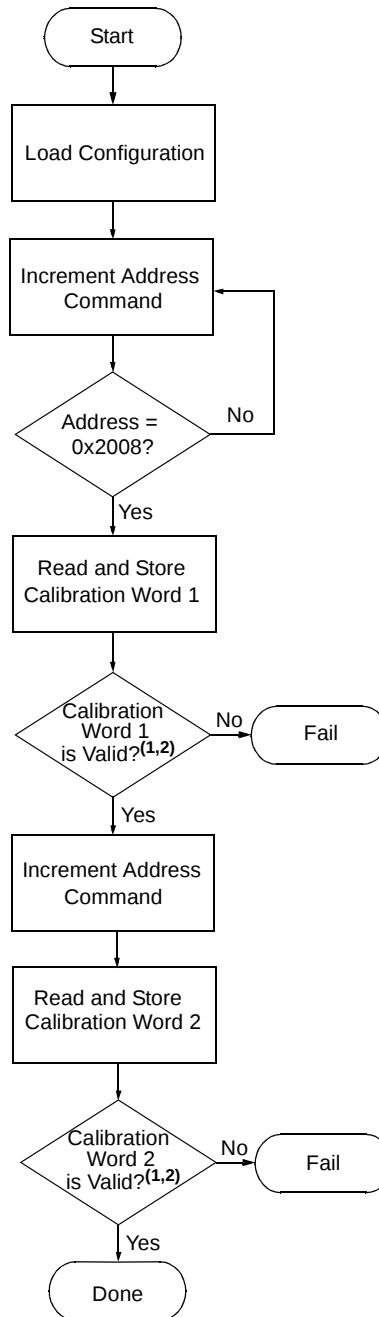


FIGURE 3-21: CALIBRATION WORD VERIFICATION FLOWCHART



Note 1: This step is not required for the Read and Store Calibration Memory Values procedure.

Note 2: The device should not be used if verification of the Calibration Word locations fails. This information should be reported to the user through the user interface of the device programmer.

PIC16F785/HV785

4.0 CONFIGURATION WORD

The PIC16F785/HV785 has several Configuration bits. These bits can be programmed (reads '0') or left unchanged (reads '1') to select various device configurations.

REGISTER 4-1: CONFIG: CONFIGURATION WORD (ADDRESS: 2007h)

U-1	U-1	R/P-1	R/P-1	R/P-1	R/P-1	R/P-1
–	–	FCMEN ⁽⁵⁾	IESO	BOREN1 ⁽¹⁾	BOREN0 ⁽¹⁾	CPD ^(2,3)
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
CP ⁽²⁾	MCLRE ⁽⁴⁾	PWRT ^E	WDTE ⁽⁵⁾	FOSC2	FOSC1	FOSC0
bit 6						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 13-12 **Unimplemented:** Read as '1'

bit 11 **FCMEN:** Fail-Safe Clock Monitor Enabled bit⁽⁵⁾

1 = Fail-Safe Clock Monitor is enabled

0 = Fail-Safe Clock Monitor is disabled

bit 10 **IESO:** Internal External Switchover bit

1 = Internal External Switchover mode is enabled

0 = Internal External Switchover mode is disabled

bit 9-8 **BOREN<1:0>:** Brown-out Reset Selection bits⁽¹⁾

11 = BOR enabled

10 = BOR enabled during operation and disabled in Sleep

01 = BOR controlled by SBOREN bit (PCON<4>)

00 = BOR disabled

bit 7 **CPD:** Data Code Protection bit^(2,3)

1 = Data memory code protection is disabled

0 = Data memory code protection is enabled

bit 6 **CP:** Code Protection bit⁽²⁾

1 = Program memory code protection is disabled

0 = Program memory code protection is enabled

bit 5 **MCLRE:** RA3/MCLR pin function select bit⁽⁴⁾

1 = RA3/MCLR pin function is MCLR

0 = RA3/MCLR pin function is digital input, MCLR internally tied to VDD

bit 4 **PWRT:** Power-up Timer Enable bit

1 = PWRT disabled

0 = PWRT enabled

bit 3 **WDTE:** Watchdog Timer Enable bit⁽⁵⁾

1 = WDT enabled

0 = WDT disabled and can be enabled by SWDTEN bit (WDTCON<0>)

REGISTER 4-1: CONFIG: CONFIGURATION WORD (ADDRESS: 2007h) (CONTINUED)

bit 2-0 **FOSC<2:0>**: Oscillator Selection bits

111 = RC oscillator: CLKOUT function on RA4/AN3/T1G/OSC2/CLKOUT pin, RC on RA5/T1CKI/OSC1/CLKIN

110 = RCIO oscillator: I/O function on RA4/AN3/T1G/OSC2/CLKOUT pin, RC on RA5/T1CKI/OSC1/CLKIN

101 = INTOSC oscillator: CLKOUT function on RA4/AN3/T1G/OSC2/CLKOUT pin, I/O function on RA5/T1CKI/OSC1/CLKIN

100 = INTOSCIO oscillator: I/O function on RA4/AN3/T1G/OSC2/CLKOUT pin, I/O function on RA5/T1CKI/OSC1/CLKIN

011 = EC: I/O function on RA4/AN3/T1G/OSC2/CLKOUT pin, CLKIN on RA5/T1CKI/OSC1/CLKIN

010 = HS oscillator: High-speed crystal/resonator on RA4/AN3/T1G/OSC2/CLKOUT and RA5/T1CKI/OSC1/CLKIN⁽⁵⁾

001 = XT oscillator: Crystal/resonator on RA4/AN3/T1G/OSC2/CLKOUT and RA5/T1CKI/OSC1/CLKIN⁽⁵⁾

000 = LP oscillator: Low-power crystal on RA4/AN3/T1G/OSC2/CLKOUT and RA5/T1CKI/OSC1/CLKIN⁽⁵⁾

- Note**
- 1: Enabling Brown-out Reset does not automatically enable Power-up Timer.
 - 2: Program memory Bulk Erase must be performed to turn off code protection.
 - 3: The entire data EEPROM will be erased when the code protection is turned off.
 - 4: When MCLR is asserted in INTOSC or RC mode, the internal clock oscillator is disabled.
 - 5: If the HS, XT, or LP oscillator fails In Fail-Safe mode the Watchdog time-out can occur only once after which it will be disabled until the oscillator is restored..

4.1 Device ID Word

The device ID word for the PIC16F785/HV785 is located at 2006h. This location cannot be erased.

TABLE 4-1: DEVICE ID VALUES

Device	Device ID Values	
	Dev	Rev
PIC16HV785	01 0010 001	x xxxx
PIC16F785	01 0010 000	x xxxx

PIC16F785/HV785

5.0 CODE PROTECTION

For the PIC16F785/HV785, once the $\overline{\text{CP}}$ bit is programmed to '0', all program memory locations read all '0's. The user ID locations and the Configuration Word read out in an unprotected fashion. Further programming is disabled for the entire program memory.

Data memory is protected with its own code-protect bit ($\overline{\text{CPD}}$). When enabled, the data memory can still be programmed and read using the EECON1 register.

The user ID locations and the Configuration Word can be programmed regardless of the state of the $\overline{\text{CP}}$ and $\overline{\text{CPD}}$ bits.

5.1 Disabling Code Protection

It is recommended to use the procedure in Figure 3-20 to disable code protection of the device. This sequence will erase the program memory, data memory, Configuration Word (0x2007) and user ID locations (0x2000-0x2003). The Calibration Words (0x2008-0x2009) **will not** be erased.

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

5.2 Embedding Configuration Word and User ID Information in the Hex File

To allow portability of code, the programmer is required to read the Configuration Word and user ID locations from the hex file when loading the hex file. If Configuration Word information was not present in the hex file, a simple warning message may be issued. Similarly, while saving a hex file, Configuration Word and user ID information must be included. An option to not include this information may be provided.

Specifically for the PIC16F785/HV785, the data memory should also be embedded in the hex file (see **Section 5.3.2 "Embedding Data Memory Contents in Hex File"**).

Microchip Technology Incorporated feels strongly that this feature is important for the benefit of the end customer.

5.3 Checksum Computation

5.3.1 CHECKSUM

Checksum is calculated by reading the contents of the PIC16F785/HV785 memory locations and adding up the opcodes up to the maximum user addressable location (e.g., 0x7FF for the PIC16F785/HV785). Any Carry bits exceeding 16 bits are neglected. Finally, the Configuration Word (appropriately masked) is added to the checksum. Checksum computation for the PIC16F785/HV785 devices is shown in Table 5-1.

The checksum is calculated by summing the following:

- The contents of all program memory locations
- The Configuration Word, appropriately masked
- Masked user ID locations (when applicable)

The 16 LSbs of this sum is the checksum.

The following table describes how to calculate the checksum for each device. Note that the checksum calculation differs depending on the code-protect setting. Since the program memory locations read out '0's when code-protected, the table describes how to manipulate the actual program memory values to simulate values that would be read from a protected device. When calculating a checksum by reading a device, the entire program memory can simply be read and summed. The Configuration Word and user ID locations can always be read regardless of code-protect setting.

Note:	Some older devices have an additional value added in the checksum. This is to maintain compatibility with older device programmer checksums.
--------------	--

TABLE 5-1: CHECKSUM COMPUTATIONS

Device	Code-Protect	Checksum*	Blank Value	0x25E6 at 0 and Max. Address
PIC16F785/HV785	OFF	SUM[0x0000:0x7FFF] + CFGW & 0FFF	07FF	D3CD
	ALL	CFGW & 0x0FFF + SUM_ID	173E ⁽¹⁾	E30C ⁽¹⁾

Legend: CFGW = Configuration Word. Example calculations assume Configuration Word is erased (all 1's).

SUM[a:b] = [Sum of locations a to b inclusive]

SUM_ID = User ID locations masked by 0xF then made into a 16-bit value with ID0 as the Most Significant nibble.

For example, ID0 = 0x1, ID1 = 0x2, ID3 = 0x3, ID4 = 0x4, then SUM_ID = 0x1234.

The 4 LSbs of the unprotected checksum is used for the example calculations.

* = Checksum – [Sum of all the individual expressions] MODULO [0xFFFF]

+ = Addition

& = Bitwise AND

Note 1: Checksum shown assumes that both the data and program memory are code-protected and that SUM_ID contains the unprotected checksum.

5.3.2 EMBEDDING DATA MEMORY CONTENTS IN HEX FILE

The programmer should be able to read data memory information from a hex file and conversely (as an option), write data memory contents to a hex file along with program memory information and Configuration Word (0x2007) and user ID (0x2000-0x2003) information.

The 256 data memory locations are logically mapped starting at address 0x2100. The format for data memory storage is one data byte per address location, LSb aligned.

PIC16F785/HV785

6.0 PROGRAM/VERIFY MODE ELECTRICAL CHARACTERISTICS

TABLE 6-1: AC/DC CHARACTERISTICS TIMING REQUIREMENTS FOR PROGRAM/VERIFY MODE

AC/DC CHARACTERISTICS		Standard Operating Conditions (unless otherwise stated)				
		Operating Temperature		$-40^{\circ}\text{C} \leq T_A \leq +85^{\circ}\text{C}$		
		Operating Voltage		$4.5\text{V} \leq V_{DD} \leq 5.5\text{V}$		
Sym.	Characteristics	Min.	Typ.	Max.	Units	Conditions/Comments
General						
V _{DD}	V _{DD} level for read/write operations, program and data memory	2.0	—	5.5	V	PIC16F785/PIC16F785-ICD PS200
		2.0	—	4.9	V	
	V _{DD} level for Bulk Erase operations, program and data memory	2.0	—	5.5	V	PIC16F785-ICD
		4.5	—	5.5	V	PIC16F785
		4.5	—	4.9 ⁽¹⁾	V	PIC16HV785
V _{IHH}	High voltage on $\overline{\text{MCLR}}$ for Program/Verify mode entry	10	—	12	V	
T _{VHHR}	$\overline{\text{MCLR}}$ rise time (V _{SS} to V _{HH}) for Program/Verify mode entry	—	—	1.0	μs	
T _{PPDP}	Hold time after V _{PP} changes	5	—	—	μs	
V _{IH1}	(ICSPCLK, ICSPDAT) input high level	0.8 V _{DD}	—	—	V	
V _{IL1}	(ICSPCLK, ICSPDAT) input low level	0.2 V _{DD}	—	—	V	
T _{SET0}	ICSPCLK, ICSPDAT setup time before $\overline{\text{MCLR}} \uparrow$ (Program/Verify mode selection pattern setup time)	100	—	—	ns	
T _{HLDO}	Hold time after V _{DD} changes	5	—	—	μs	
Serial Program/Verify						
T _{SET1}	Data in setup time before clock ↓	100	—	—	ns	
T _{HLDO1}	Data in hold time after clock ↓	100	—	—	ns	
T _{DLY1}	Data input not driven to next clock input (delay required between command/data or command/command)	1.0	—	—	μs	
T _{DLY2}	Delay between clock ↓ to clock ↑ of next command or data	1.0	—	—	μs	
T _{DLY3}	Clock ↑ to data out valid (during a Read Data command)	—	—	80	ns	
T _{ERA}	Erase cycle time	—	5	6	ms	
T _{PROG1}	Programming cycle time (internally timed)	2	—	2.5	ms	Program memory
		5	—	6	ms	Data memory
T _{PROG2}	Programming cycle time (externally timed)	2	—	2.5	ms	10°C ≤ T _A ≤ +40°C Program memory
T _{DIS}	Time delay from program to compare (HV discharge time)	100	—	—	μs	

Note 1: Exceeding the maximum voltage may cause the shunt regulator to draw excessive current and damage the device.

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, rfPIC 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, PIC³² logo, 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.

© 2009, Microchip Technology Incorporated, Printed in the U.S.A., All Rights Reserved.

 Printed on recycled paper.

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

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.



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 - 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 - Xiamen

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

China - Xian

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

China - Zhuhai

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

ASIA/PACIFIC

India - Bangalore

Tel: 91-80-3090-4444
Fax: 91-80-3090-4080

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

03/26/09