

Flash Microcontroller Programming Specification

1.0 DEVICE OVERVIEW

This document includes the programming specifications for the following devices:

- PIC18F6520
- PIC18F6620
- PIC18F6720
- PIC18F8520
- PIC18F8620
- PIC18F8720

2.0 PROGRAMMING OVERVIEW OF THE PIC18FXX20

PIC18FXX20 devices can be programmed using either the high voltage In-Circuit Serial Programming™ (ICSP™) method, or the low voltage ICSP method. Both of these can be done with the device in the users' system. The low voltage ICSP method is slightly different than the high voltage method, and these differences are noted where applicable. This programming specification applies to PIC18FXX20 devices in all package types.

2.1 Hardware Requirements

In high voltage ICSP mode, the PIC18FXX20 requires two programmable power supplies: one for V_{DD} and one for MCLR/V_{PP}. Both supplies should have a minimum resolution of 0.25V. Refer to Section 6.0 for additional hardware parameters.

2.1.1 LOW VOLTAGE ICSP PROGRAMMING

In low voltage ICSP mode, the PIC18FXX20 can be programmed using a V_{DD} source in the operating range. This only means that MCLR/V_{PP} does not have to be brought to a different voltage, but can instead be left at the normal operating voltage. Refer to Section 6.0 for additional hardware parameters.

2.2 Pin Diagrams

The pin diagrams for the PIC18FXX20 family are shown in Figure 2-1. The pin descriptions of these diagrams do not represent the complete functionality of the device types. Users should refer to the appropriate device data sheet for complete pin descriptions.

TABLE 2-1: PIN DESCRIPTIONS (DURING PROGRAMMING): PIC18FXX20

Pin Name	During Programming		
	Pin Name	Pin Type	Pin Description
MCLR/V _{PP} /RA5	V _{PP}	P	Programming Enable
V _{DD} ⁽²⁾	V _{DD}	P	Power Supply
V _{SS} ⁽²⁾	V _{SS}	P	Ground
AV _{DD}	AV _{DD}	P	Analog Power Supply
AV _{SS}	AV _{SS}	P	Analog Ground
RB5	PGM	I	Low Voltage ICSP™ Input when LVP Configuration bit equals '1' ⁽¹⁾
RB6	SCLK	I	Serial Clock
RB7	SDATA	I/O	Serial Data

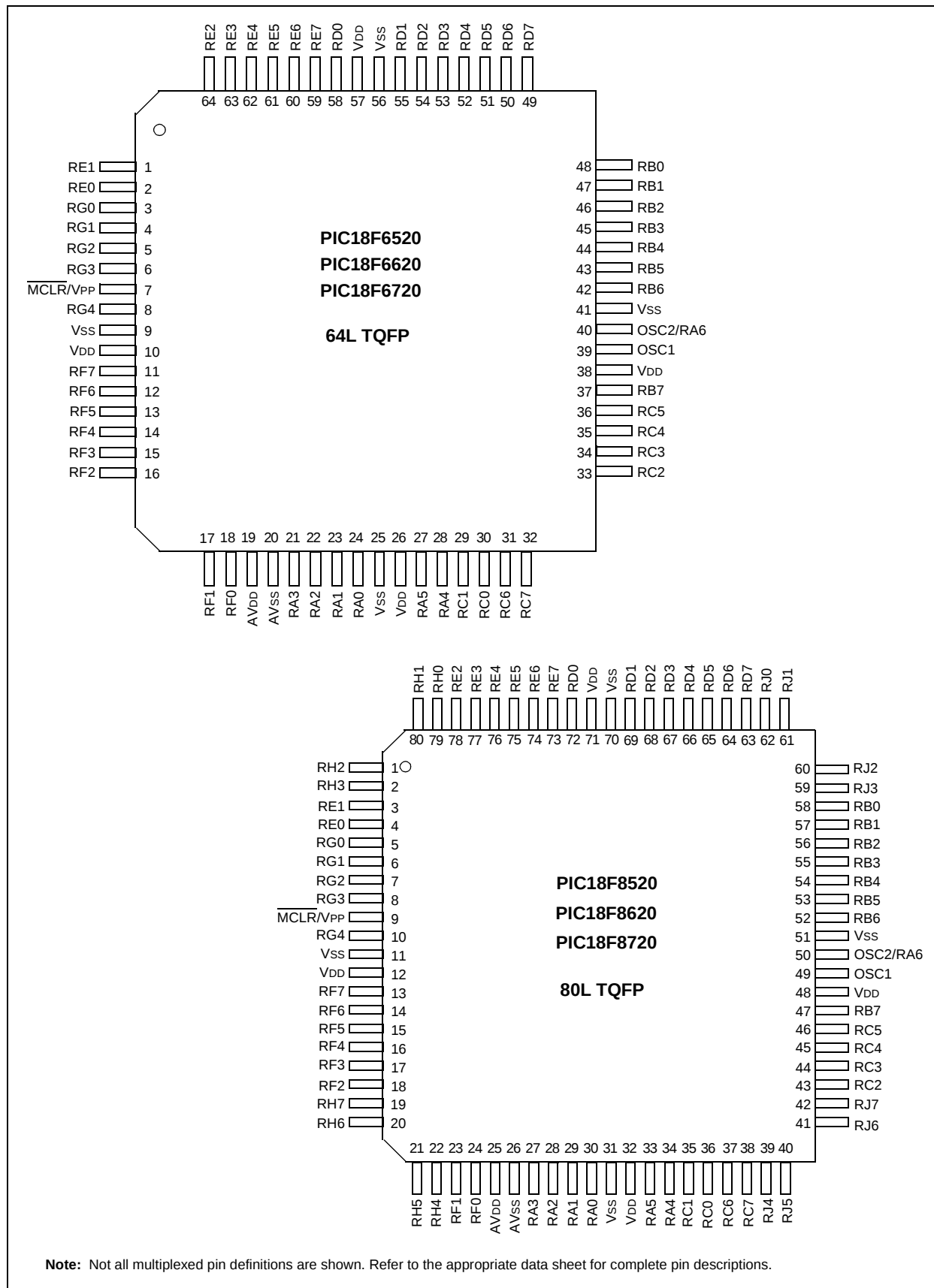
Legend: I = Input, O = Output, P = Power

Note 1: See Section 5.3 for more detail.

2: All power supply and ground must be connected.

PIC18FXX20

FIGURE 2-1: PIC18FXX20 FAMILY PIN DIAGRAMS



2.3 Memory Map

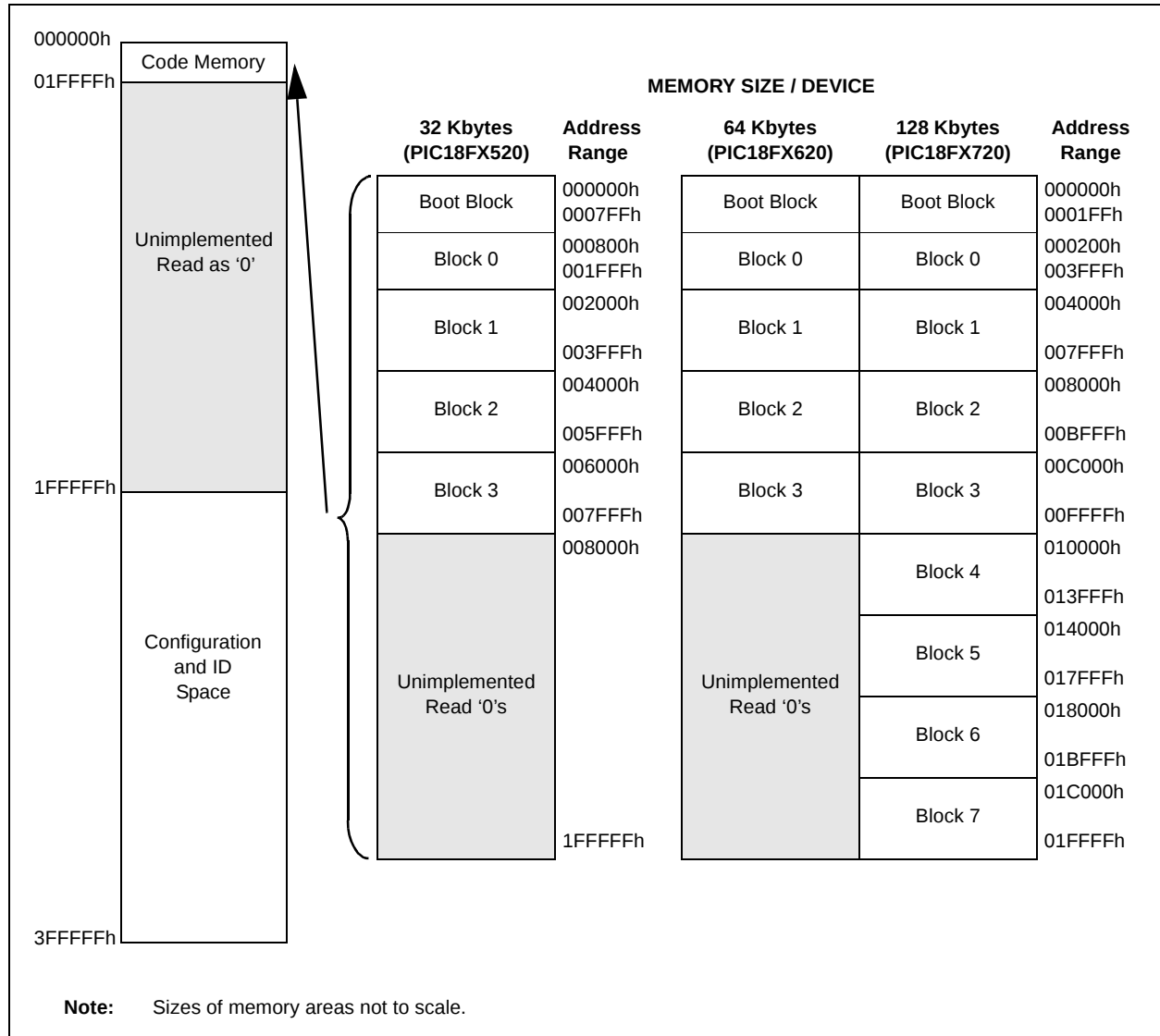
The code memory space extends from 0000h to 1FFFFh (128 Kbytes) in eight 16-Kbyte blocks. Addresses 0000h through 01FFFh, however, define a “Boot Block” region that is treated separately from Block 1. All of these blocks define code protection boundaries within the code memory space.

In contrast, code memory panels are defined in 8-Kbyte boundaries. Panels are discussed in greater detail in Section 3.2.

TABLE 2-2: IMPLEMENTATION OF CODE MEMORY

Device	Code Memory Size (Bytes)
PIC18F6520	000000h - 007FFFh (32K)
PIC18F8520	
PIC18F6620	000000h - 00FFFFh (64K)
PIC18F8620	
PIC18F6720	000000h - 01FFFFh (128K)
PIC18F8720	

FIGURE 2-2: MEMORY MAP AND THE CODE MEMORY SPACE FOR PIC18FXX20 DEVICES



PIC18FXX20

In addition to the code memory space, there are three blocks in the configuration and ID space that are accessible to the user through Table Reads and Table Writes. Their locations in the memory map are shown in Figure 2-3.

Users may store identification information (ID) in eight ID registers. These ID registers are mapped in addresses 200000h through 200007h. The ID locations read out normally, even after code protection is applied.

Locations 300000h through 30000Dh are reserved for the Configuration bits. These bits select various device options, and are described in Section 5.0. These Configuration bits read out normally, even after code protection.

Locations 3FFFEh and 3FFFFh are reserved for the Device ID bits. These bits may be used by the programmer to identify what device type is being programmed, and are described in Section 5.0. These Device ID bits read out normally, even after code protection.

2.3.1 MEMORY ADDRESS POINTER

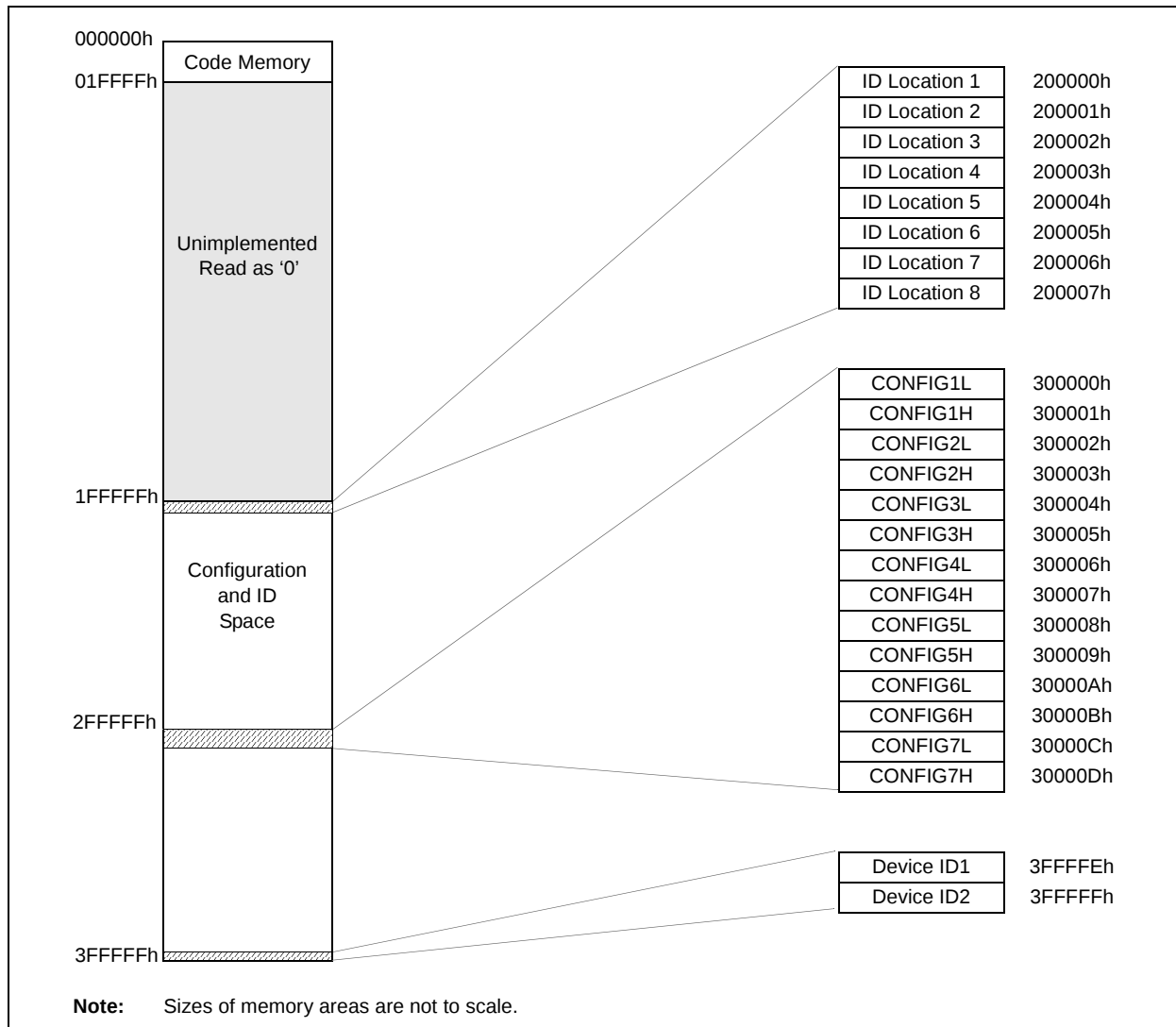
Memory in the address space 000000h to 3FFFFFFh is addressed via the Table Pointer, which is comprised of three pointer registers:

- TBLPTRU, at RAM address 0FF8h
- TBLPTRH, at RAM address 0FF7h
- TBLPTRL, at RAM address 0FF6h

TBLPTRU	TBLPTRH	TBLPTRL
Addr[21:16]	Addr[15:8]	Addr[7:0]

The 4-bit command, '0000' (Core Instruction), is used to load the Table Pointer prior to using many Read or Write operations.

FIGURE 2-3: CONFIGURATION AND ID LOCATIONS FOR PIC18FXX20 DEVICES



2.4 High Level Overview of the Programming Process

Figure 2-4 shows the high level overview of the programming process. First, a bulk erase is performed. Next, the Code Memory, ID Locations, and Data EEPROM are programmed. These memories are then verified to ensure that programming was successful. If no errors are detected, the Configuration bits are then programmed and verified.

2.5 Entering High Voltage ICSP Program/Verify Mode

The high voltage ICSP Program/Verify mode is entered by holding SCLK and SDATA low and then raising MCLR/VPP to V_{IHH} (high voltage). Once in this mode, the Code Memory, Data EEPROM, ID Locations, and Configuration bits can be accessed and programmed in serial fashion.

The sequence that enters the device into the Program/Verify mode places all unused I/Os in the high impedance state.

2.5.1 ENTERING LOW VOLTAGE ICSP PROGRAM/VERIFY MODE

When the LVP configuration bit is '1' (see Section 5.3), the low voltage ICSP mode is enabled. Low voltage ICSP Program/Verify mode is entered by holding SCLK and SDATA low, placing a logic high on PGM, and then raising MCLR/VPP to V_{IH}. In this mode, the RB5/PGM pin is dedicated to the programming function and ceases to be a general purpose I/O pin.

The sequence that enters the device into the Program/Verify mode, places all unused I/Os in the high impedance state.

FIGURE 2-4: HIGH LEVEL PROGRAMMING FLOW

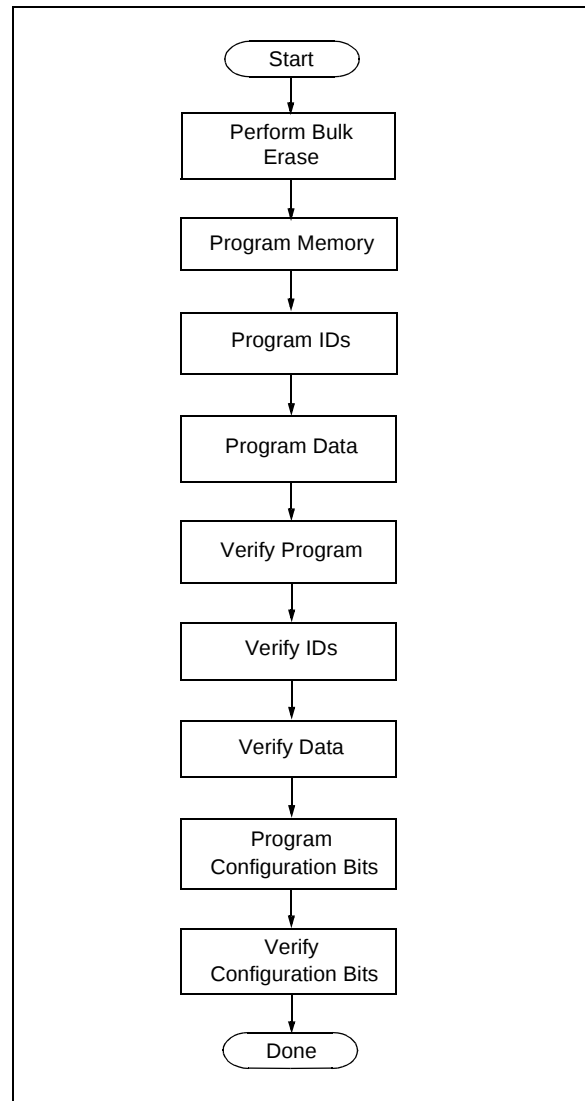


FIGURE 2-5: ENTERING HIGH VOLTAGE PROGRAM/VERIFY MODE

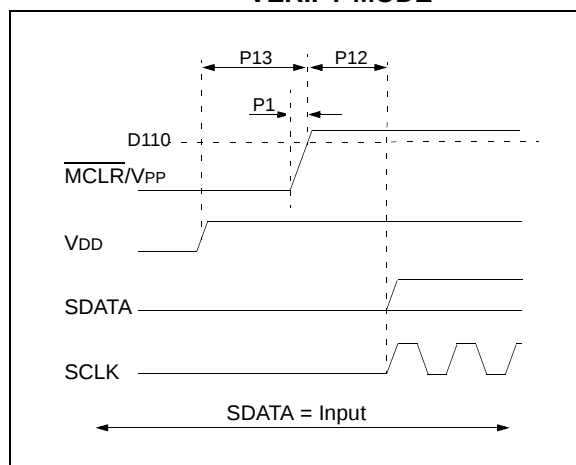
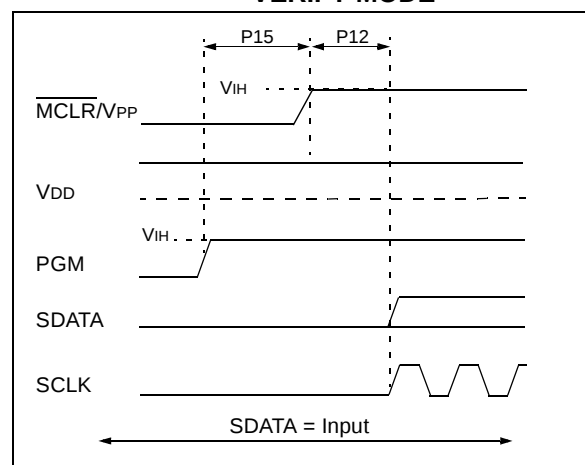


FIGURE 2-6: ENTERING LOW VOLTAGE PROGRAM/VERIFY MODE



PIC18FXX20

2.6 Serial Program/Verify Operation

The SCLK pin is used as a clock input pin and the SDATA pin is used for entering command bits and data input/output during serial operation. Commands and data are transmitted on the rising edge of SCLK, latched on the falling edge of SCLK, and are Least Significant bit (LSb) first.

2.6.1 4-BIT COMMANDS

All instructions are 20-bits, consisting of a leading 4-bit command followed by a 16-bit operand, which depends on the type of command being executed. To input a command, SCLK is cycled four times. The commands needed for programming and verification are shown in Table 2-3.

Depending on the 4-bit command, the 16-bit operand represents 16 bits of input data, or 8 bits of input data and 8 bits of output data.

Throughout this specification, commands and data are presented as illustrated in Figure 2-4. The 4-bit command is shown MSb first. The command operand, or "Data Payload", is shown <MSB><LSB>. Figure 2-7 demonstrates how to serially present a 20-bit command/operand to the device.

2.6.2 CORE INSTRUCTION

The core instruction passes a 16-bit instruction to the CPU core for execution. This is needed to setup registers as appropriate for use with other commands.

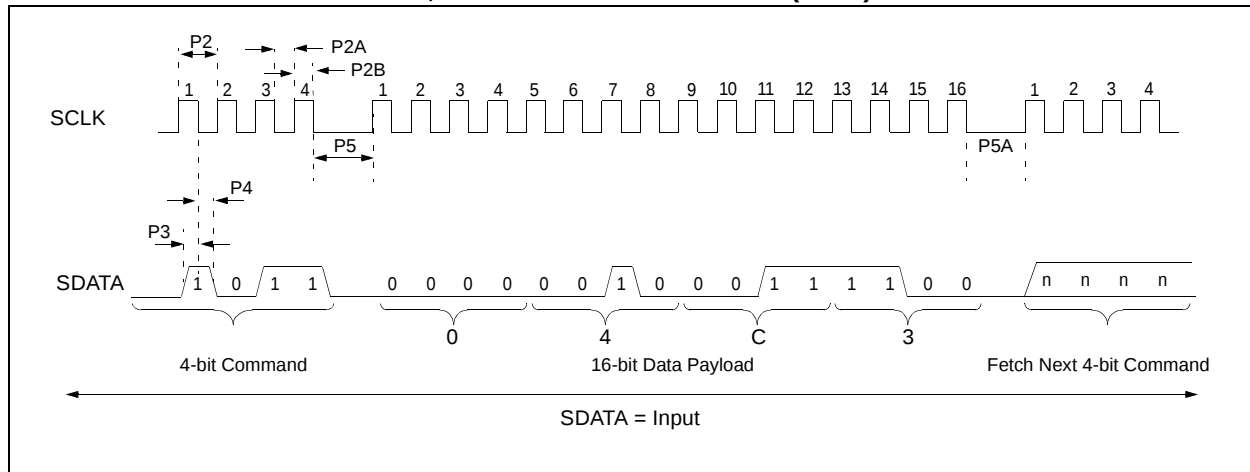
TABLE 2-3: COMMANDS FOR PROGRAMMING

Description	4-Bit Command
Core Instruction (Shift in 16-bit instruction)	0000
Shift out TABLAT register	0010
Table Read	1000
Table Read, post-increment	1001
Table Read, post-decrement	1010
Table Read, pre-increment	1011
Table Write	1100
Table Write, post-increment by 2	1101
Table Write, post-decrement by 2	1110
Table Write, start programming	1111

TABLE 2-4: SAMPLE COMMAND SEQUENCE

4-Bit Command	Data Payload	Core Instruction
1101	3C 40	Table Write, post-increment by 2

FIGURE 2-7: TABLE WRITE, POST-INCREMENT TIMING (1101)



3.0 DEVICE PROGRAMMING

3.1 High Voltage ICSP Bulk Erase

Erasing Code or Data EEPROM is accomplished by writing an “erase option” to address 3C0004h. Code memory may be erased portions at a time, or the user may erase the entire device in one action. “Bulk Erase” operations will also clear any code protect settings associated with the memory block erased. Erase options are detailed in Table 3-1.

TABLE 3-1: BULK ERASE OPTIONS

Description	Data
Chip Erase	80h
Erase Data EEPROM	81h
Erase Boot Block	83h
Erase Block 1	88h
Erase Block 2	89h
Erase Block 3	8Ah
Erase Block 4	8Bh
Erase Block 5	8Ch
Erase Block 6	8Dh
Erase Block 7	8Eh
Erase Block 8	8Fh

The actual Bulk Erase function is a self-timed operation. Once the erase has started (falling edge of the 4th SCLK after the NOP command), serial execution will cease until the erase completes (parameter P11). During this time, SCLK may continue to toggle, but SDATA must be held low.

The code sequence to erase the entire device is shown in Figure 3-1 and the flowchart is shown in Figure 3-2.

Note: A bulk erase is the only way to reprogram code protect bits from an on-state to an off-state. Non-code protect bits are not returned to default settings by a bulk erase. These bits should be programmed to ones, as outlined in Section 3.6, “Configuration Bits Programming”.

FIGURE 3-1: BULK ERASE COMMAND SEQUENCE

4-Bit Command	Data Payload	Core Instruction
0000	0E 3C	MOVLW 3Ch
0000	6E F8	MOVWF TBLPTRU
0000	0E 00	MOVLW 00h
0000	6E F7	MOVWF TBLPTRH
0000	0E 04	MOVLW 04h
0000	6E F6	MOVWF TBLPTRL
1100	00 80	Write 80h TO 3C0004h to erase entire device.
0000	00 00	NOP
0000	00 00	Hold SDATA low until erase completes.

FIGURE 3-2: BULK ERASE FLOW

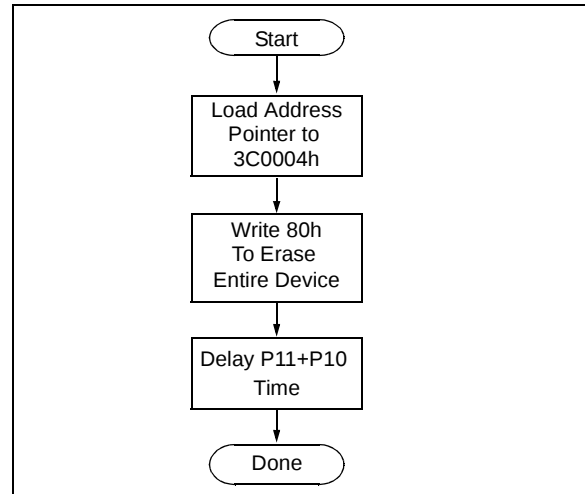
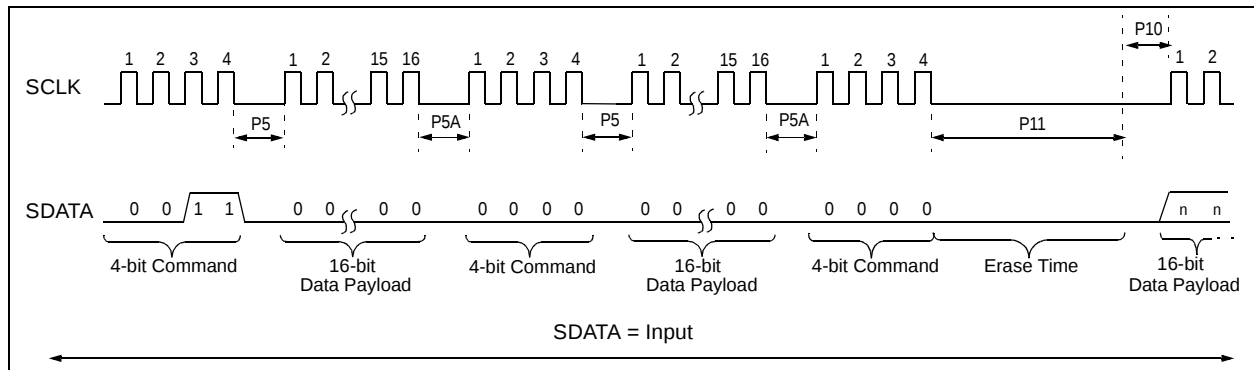


FIGURE 3-3: BULK ERASE TIMING



3.1.1 LOW VOLTAGE ICSP BULK ERASE

When using low voltage ICSP, the part must be supplied by the voltage specified in parameter #D111, if a bulk erase is to be executed. All other bulk erase details as described above apply.

If it is determined that a program memory erase must be performed at a supply voltage below the bulk erase limit, refer to the erase methodology described in Sections 3.1.2 and 3.2.2.

If it is determined that a data EEPROM erase must be performed at a supply voltage below the bulk erase limit, follow the methodology described in Section 3.3 and write ones to the array.

3.1.2 ICSP MULTI-PANEL SINGLE ROW ERASE

Irrespective of whether high or low voltage ICSP is used, it is possible to erase single row (64 bytes of data) in all panels at once. For example, in the case of a 64-Kbyte device (8 panels), 512 bytes through 64 bytes in each panel can be erased simultaneously during each erase sequence. In this case, the offset of the erase within each panel is the same (see Figure 3-6). Multi-panel single row erase is enabled by appropriately configuring the Programming Control register located at 3C0006h.

The multi-panel single row erase duration is externally timed and is controlled by SCLK. After a “Start Programming” command is issued (4-bit, ‘1111’), a NOP is issued, where the 4th SCLK is held high for the duration of the programming time, P9.

After SCLK is brought low, the programming sequence is terminated. SCLK must be held low for the time specified by parameter P10 to allow high voltage discharge of the memory array.

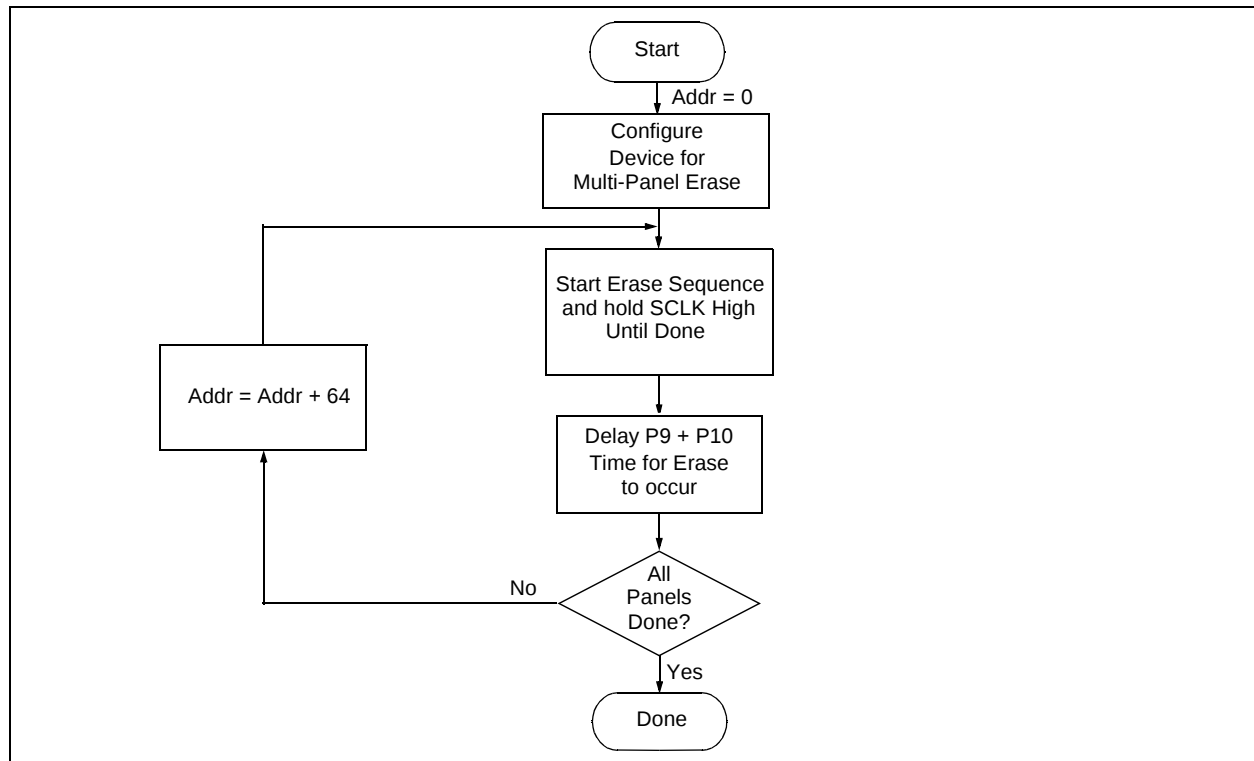
The code sequence to program a PIC18FXX20 device is shown in Table 3-2. The flowchart shown in Figure 3-4 depicts the logic necessary to completely erase a PIC18FXX20 device. The timing diagram that details the “Start Programming” command, and parameters P9 and P10 is shown in Figure 3-7.

Note: The TBLPTR register must contain the same offset value when initiating the programming sequence as it did when the write buffers were loaded.
--

TABLE 3-2: ERASE CODE MEMORY CODE SEQUENCE

4-Bit Command	Data Payload	Core Instruction
Step 1: Direct access to config memory.		
0000	8E A6	BSF EECON1, EEPGD
0000	8C A6	BSF EECON1, CFGS
0000	86 A6	BSF EECON1, WREN
Step 2: Configure device for multi-panel writes.		
0000	0E 3C	MOVLW 3Ch
0000	6E F8	MOVWF TBLPTRU
0000	0E 00	MOVLW 00h
0000	6E F7	MOVWF TBLPTRH
0000	0E 06	MOVLW 06h
0000	6E F6	MOVWF TBLPTRL
1100	00 40	Write 40h to 3C0006h to enable multi-panel erase.
Step 3: Direct access to code memory and enable erase.		
0000	8E A6	BSF EECON1, EEPGD
0000	9C A6	BCF EECON1, CFGS
0000	88 A6	BSF EECON1, FREE
0000	6A F8	CLRF TBLPTRU
0000	6A F7	CLRF TBLPTRH
0000	6A F6	CLRF TBLPTRL
Step 4: Erase single row of all panels at an offset.		
1111	<DummyLSB>	Write 2 dummy bytes and start programming.
0000	<DummyMSB> 00 00	NOP - hold SCLK high for time P9.
Step 5: Repeat step 4, with Address Pointer incremented by 64 until all panels are erased.		

FIGURE 3-4: MULTI-PANEL SINGLE ROW ERASE CODE MEMORY FLOW



3.2 Code Memory Programming

Programming code memory is accomplished by first loading data into the appropriate write buffers and then initiating a programming sequence. Each panel in the code memory space (see Figure 2-2) has an 8-byte deep write buffer that must be loaded prior to initiating a write sequence. The actual memory write sequence takes the contents of these buffers and programs the associated EEPROM code memory.

Typically, all of the program buffers are written in parallel (Multi-Panel Write mode). In other words, in the case of a 128-Kbyte device (16 panels with an 8-byte buffer per panel), 128 bytes will be simultaneously programmed during each programming sequence. In this case, the offset of the write within each panel is the same (see Figure 3-5). Multi-Panel Write mode is enabled by appropriately configuring the Programming Control register located at 3C0006h.

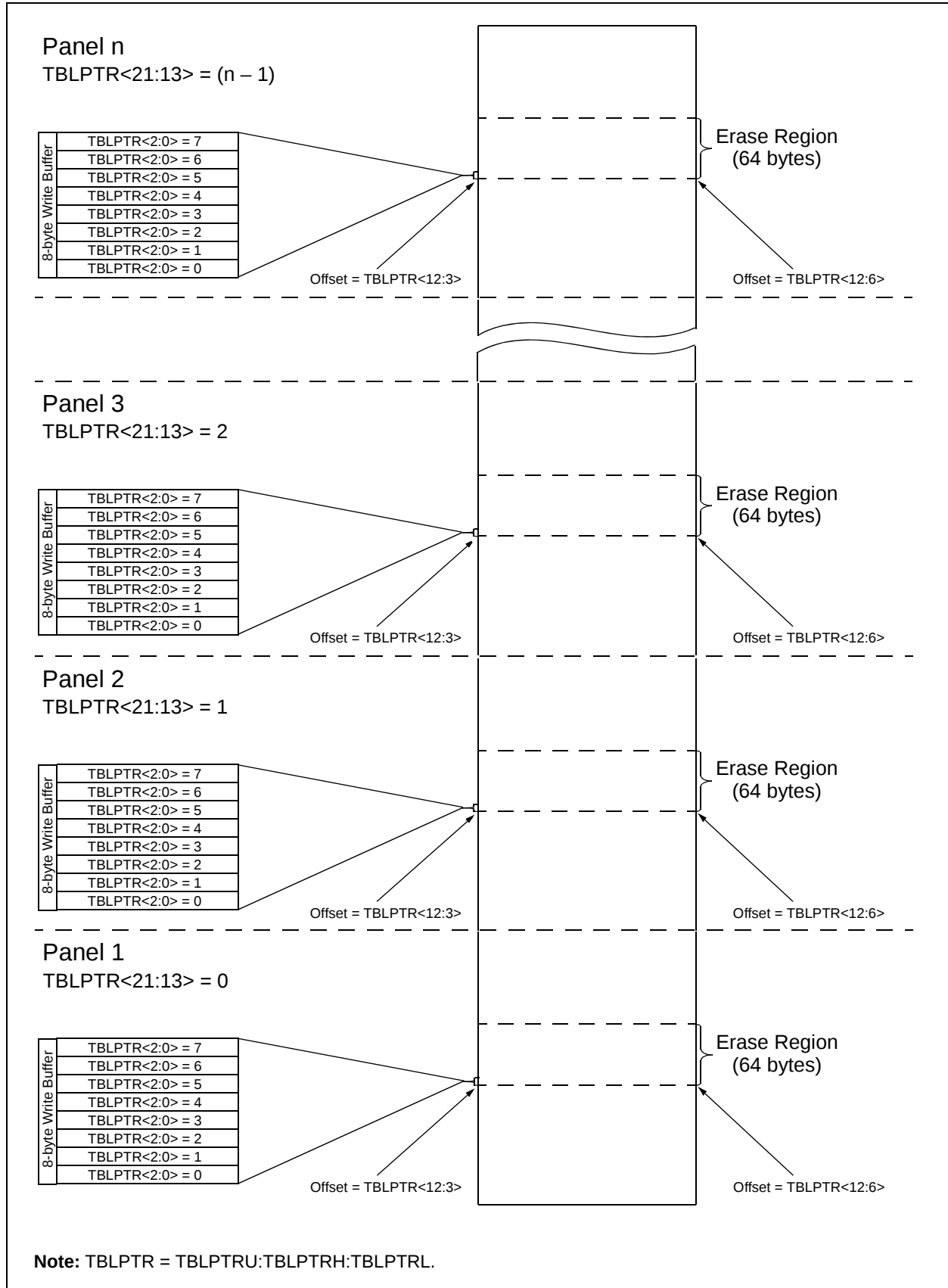
The programming duration is externally timed and is controlled by SCLK. After a “Start Programming” command is issued (4-bit command, ‘1111’), a NOP is issued, where the 4th SCLK is held high for the duration of the programming time, P9.

After SCLK is brought low, the programming sequence is terminated. SCLK must be held low for the time specified by parameter P10 to allow high voltage discharge of the memory array.

The code sequence to program a PIC18FXX20 device is shown in Figure 3-3. The flowchart shown in Figure 3-6 depicts the logic necessary to completely write a PIC18FXX20 device. The timing diagram that details the “Start Programming” command, and parameters P9 and P10, is shown in Figure 3-7.

Note: The TBLPTR register must contain the same offset value when initiating the programming sequence as it did when the write buffers were loaded.
--

FIGURE 3-5: ERASE AND WRITE BOUNDARIES



PIC18FXX20

TABLE 3-3: WRITE CODE MEMORY CODE SEQUENCE

4-Bit Command	Data Payload	Core Instruction
Step 1: Direct access to config memory.		
0000	8E A6	BSF EECON1, EEPGD
0000	8C A6	BSF EECON1, CFGS
0000	86 A6	BSF EECON1, WREN
Step 2: Configure device for multi-panel writes.		
0000	0E 3C	MOVLW 3Ch
0000	6E F8	MOVWF TBLPTRU
0000	0E 00	MOVLW 00h
0000	6E F7	MOVWF TBLPTRH
0000	0E 06	MOVLW 06h
0000	6E F6	MOVWF TBLPTRL
1100	00 40	Write 40h to 3C0006h to enable multi-panel writes.
Step 3: Direct access to code memory.		
0000	8E A6	BSF EECON1, EEPGD
0000	9C A6	BCF EECON1, CFGS
Step 4: Load write buffer for Panel 1.		
0000	0E <Addr[21:16]>	MOVLW <Addr[21:16]>
0000	6E F8	MOVWF TBLPTRU
0000	0E <Addr[15:8]>	MOVLW <Addr[15:8]>
0000	6E F7	MOVWF TBLPTRH
0000	0E <Addr[7:0]>	MOVLW <Addr[7:0]>
0000	6E F6	MOVWF TBLPTRL
1101	<LSB><MSB>	Write 2 bytes and post-increment address by 2
1101	<LSB><MSB>	Write 2 bytes and post-increment address by 2
1101	<LSB><MSB>	Write 2 bytes and post-increment address by 2
1100	<LSB><MSB>	Write 2 bytes
Step 5: Repeat for Panel 2.		
Step 6: Repeat for all but the last panel (N – 1).		
Step 7: Load write buffer for last panel.		
0000	0E <Addr[21:16]>	MOVLW <Addr[21:16]>
0000	6E F8	MOVWF TBLPTRU
0000	0E <Addr[15:8]>	MOVLW <Addr[15:8]>
0000	6E F7	MOVWF TBLPTRH
0000	0E <Addr[7:0]>	MOVLW <Addr[7:0]>
0000	6E F6	MOVWF TBLPTRL
1101	<LSB><MSB>	Write 2 bytes and post-increment address by 2
1101	<LSB><MSB>	Write 2 bytes and post-increment address by 2
1101	<LSB><MSB>	Write 2 bytes and post-increment address by 2
1111	<LSB><MSB>	Write 2 bytes and start programming
0000	00 00	NOP - hold SCLK high for time P9
To continue writing data, repeat steps 2 through 5, where the Address Pointer is incremented by 8 in each panel at each iteration of the loop.		

FIGURE 3-6: PROGRAM CODE MEMORY FLOW

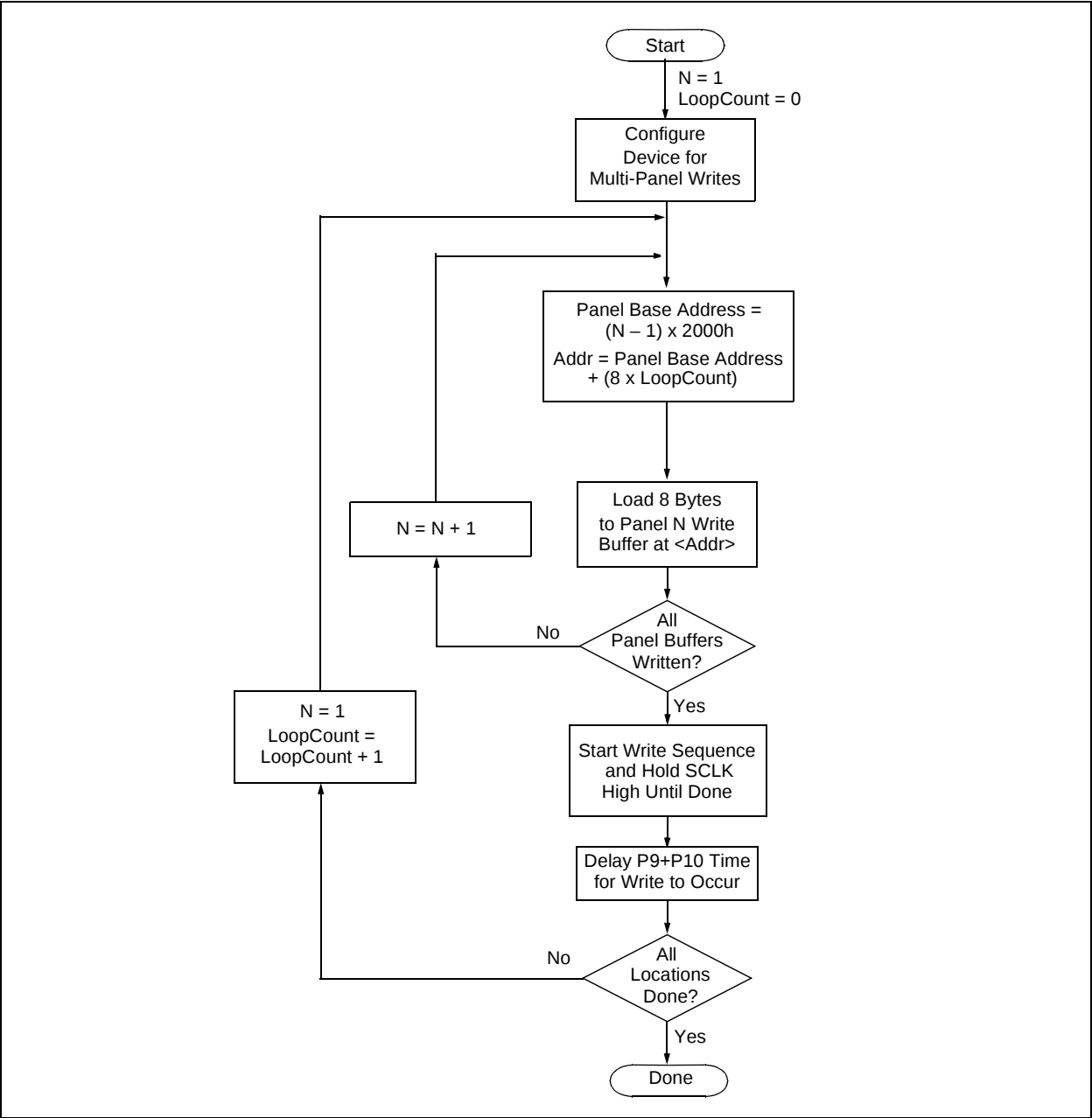
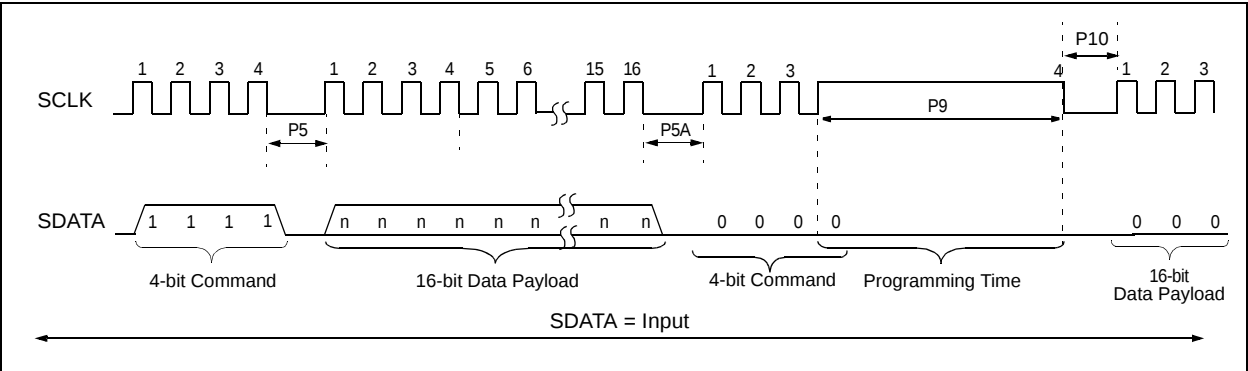


FIGURE 3-7: TABLE WRITE AND START PROGRAMMING INSTRUCTION TIMING (1111)



3.2.1 SINGLE PANEL PROGRAMMING

The programming example presented in Section 3.2 utilizes multi-panel programming. This technique greatly decreases the total amount of time necessary to completely program a device and is the recommended method of completely programming a device.

There may be situations, however, where it is advantageous to limit writes to a single panel. In such cases, the user only needs to disable the multi-panel write feature of the device by appropriately configuring the programming control register located at 3C0006h.

The single panel that will be written will automatically be enabled based on the value of the Table Pointer.

Note: Even though multi-panel writes are disabled, the user must still fill the 8-byte write buffer for the given panel.

3.2.2 MODIFYING CODE MEMORY

All of the programming examples up to this point have assumed that the device has been bulk erased prior to programming (see Section 3.1). It may be the case, however, that the user wishes to modify only a section of an already programmed device.

The minimum amount of data that can be written to the device is 8 bytes. This is accomplished by placing the device in Single Panel Write mode (see Section 3.2.1), loading the 8-byte write buffer for the panel, and then initiating a write sequence. In this case, however, it is assumed that the address space to be written already has data in it (i.e., it is not blank).

The minimum amount of code memory that may be erased at a given time is 64 bytes. Again, the device must be placed in Single Panel Write mode. The EECON1 register must then be used to erase the 64-byte target space prior to writing the data.

When using the EECON1 register to act on code memory, the EEPGD bit must be set (EECON1<7> = 1) and the CFGS bit must be cleared (EECON1<6> = 0). The WREN bit must be set (EECON1<2> = 1) to enable writes of any sort (e.g., erases), and this must be done prior to initiating a write sequence. The FREE bit must be set (EECON1<4> = 1) in order to erase the program space being pointed to by the Table Pointer. The erase sequence is initiated by the setting the WR bit (EECON1<1> = 1). It is strongly recommended that the WREN bit be set only when absolutely necessary.

To help prevent inadvertent writes when using the EECON1 register, EECON2 is used to “enable” the WR bit. This register must be sequentially loaded with 55h and then AAh, immediately prior to asserting the WR bit in order for the write to occur.

The erase will begin on the falling edge of the 4th SCLK, after the WR bit is set. After the erase sequence terminates, SCLK must still be held low for the time specified by parameter #P10 to allow high voltage discharge of the memory array.

TABLE 3-4: MODIFYING CODE MEMORY

4-Bit Command	Data Payload	Core Instruction
Step 1: Direct access to config memory.		
0000	8E A6	BSF EECON1, EEPGD
0000	8C A6	BSF EECON1, CFGS
Step 2: Configure device for single panel writes.		
0000	0E 3C	MOVLW 3Ch
0000	6E F8	MOVWF TBLPTRU
0000	0E 00	MOVLW 00h
0000	6E F7	MOVWF TBLPTRH
0000	0E 06	MOVLW 06h
0000	6E F6	MOVWF TBLPTRL
1100	00 00	Write 00h to 3C0006h to enable single panel writes.
Step 3: Direct access to code memory.		
0000	8E A6	BSF EECON1, EEPGD
0000	9C A6	BCF EECON1, CFGS
Step 4: Set the Table Pointer for the block to be erased.		
0000	0E <Addr[21:16]>	MOVLW <Addr[21:16]>
0000	6E F8	MOVWF TBLPTRU
0000	0E <Addr[8:15]>	MOVLW <Addr[8:15]>
0000	6E F7	MOVWF TBLPTRH
0000	0E <Addr[7:0]>	MOVLW <Addr[7:0]>
0000	6E F6	MOVWF TBLPTRL
Step 5: Enable memory writes and set up an erase.		
0000	84 A6	BSF EECON1, WREN
0000	88 A6	BSF EECON1, FREE
Step 6: Perform required sequence.		
0000	0E 55	MOVLW 55h
0000	6E A7	MOVWF EECON2
0000	0E AA	MOVLW 0AAh
0000	6E A7	MOVWF EECON2
Step 7: Initiate erase.		
0000	82 A6	BSF EECON1, WR
0000	00 00	NOP
Step 8: Wait for P11+P10 and then disable writes.		
0000	94 A6	BCF EECON1, WREN
Step 9: Load write buffer for panel. The correct panel will be selected based on the Table Pointer.		
0000	0E <Addr[8:15]>	MOVLW <Addr[8:15]>
0000	6E F7	MOVWF TBLPTRH
0000	0E <Addr[7:0]>	MOVLW <Addr[7:0]>
0000	6E F6	MOVWF TBLPTRL
1101	<LSB><MSB>	Write 2 bytes and post-increment address by 2
1101	<LSB><MSB>	Write 2 bytes and post-increment address by 2
1101	<LSB><MSB>	Write 2 bytes and post-increment address by 2
1111	<LSB><MSB>	Write 2 bytes and start programming
0000	00 00	NOP - hold SCLK high for time P9
To continue writing data, repeat step 8, where the Address Pointer is incremented by 8 at each iteration of the loop.		

3.3 Data EEPROM Programming

Data EEPROM is accessed one byte at a time via an Address Pointer (register pair EEADR:EEADRH) and a data latch (EEDATA). Data EEPROM is written by loading EEADR:EEADRH with the desired memory location, EEDATA with the data to be written, and initiating a memory write by appropriately configuring the EECON1 and EECON2 registers. A byte write automatically erases the location and writes the new data (erase-before-write).

When using the EECON1 register to perform a data EEPROM write, both the EEPGD and CFGS bits must be cleared ($\text{EECON1}\langle 7:6 \rangle = 00$). The WREN bit must be set ($\text{EECON1}\langle 2 \rangle = 1$) to enable writes of any sort, and this must be done prior to initiating a write sequence. The write sequence is initiated by setting the WR bit ($\text{EECON1}\langle 1 \rangle = 1$). It is strongly recommended that the WREN bit be set only when absolutely necessary.

To help prevent inadvertent writes when using the EECON1 register, EECON2 is used to “enable” the WR bit. This register must be sequentially loaded with 55h and then AAh, immediately prior to asserting the WR bit in order for the write to occur.

The write begins on the falling edge of the 4th SCLK after the WR bit is set. It ends when the WR bit is cleared by hardware.

After the programming sequence terminates, SCLK must still be held low for the time specified by parameter P10 to allow high voltage discharge of the memory array.

FIGURE 3-8: PROGRAM DATA FLOW

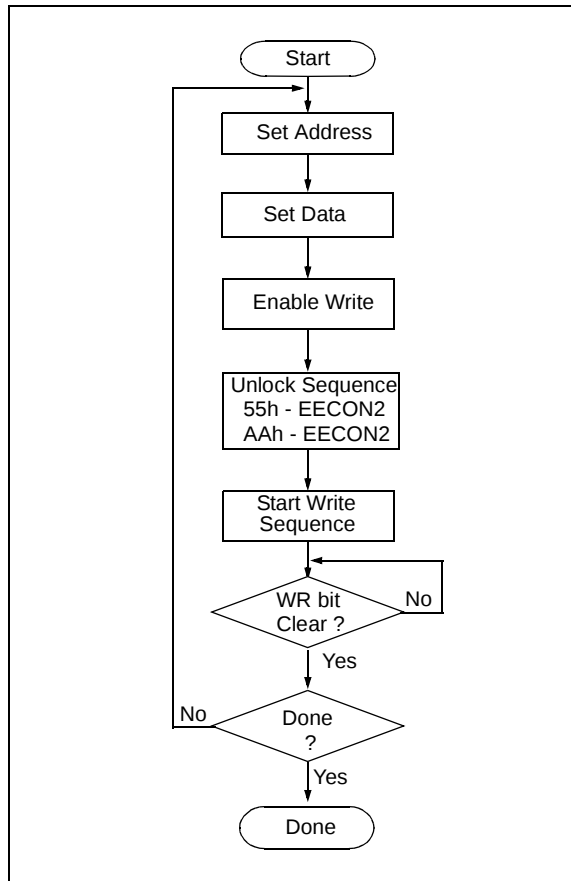


FIGURE 3-9: DATA EEPROM WRITE TIMING

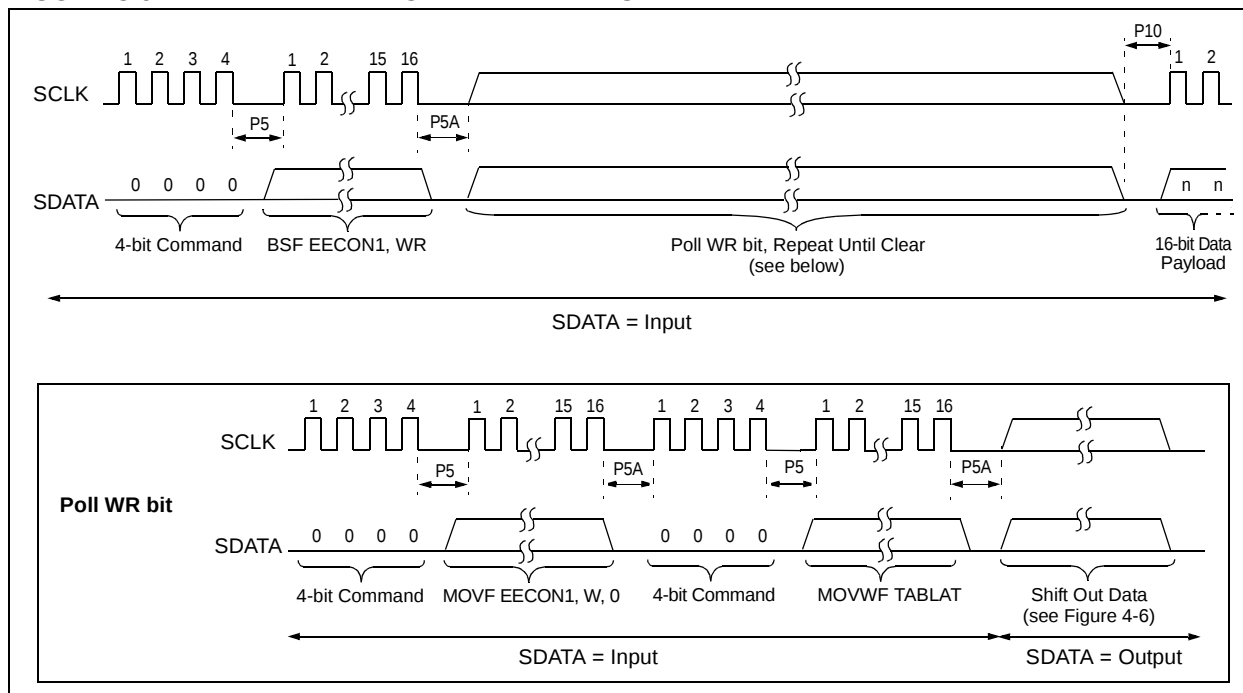


TABLE 3-5: PROGRAMMING DATA MEMORY

4-Bit Command	Data Payload	Core Instruction
Step 1: Direct access to data EEPROM.		
0000 0000	9E A6 9C A6	BCF EECON1, EEPGD BCF EECON1, CFGS
Step 2: Set the data EEPROM Address Pointer.		
0000 0000 0000 0000	0E <Addr> 6E A9 0E <AddrH> 6E AA	MOVLW <Addr> MOVWF EEADR MOVLW <AddrH> MOVWF EEADRH
Step 3: Load the data to be written.		
0000 0000	0E <Data> 6E A8	MOVLW <Data> MOVWF EEDATA
Step 4: Enable memory writes.		
0000	84 A6	BSF EECON1, WREN
Step 5: Perform required sequence.		
0000 0000 0000 0000	0E 55 6E A7 0E AA 6E A7	MOVLW 0X55 MOVWF EECON2 MOVLW 0XAA MOVWF EECON2
Step 6: Initiate write.		
0000	82 A6	BSF EECON1, WR
Step 7: Poll WR bit, repeat until the bit is clear.		
0000 0000 0010	50 A6 6E F5 <LSB><MSB>	MOVF EECON1, W, 0 MOVWF TABLAT Shift out data ⁽¹⁾
Step 8: Disable writes.		
0000	94 A6	BCF EECON1, WREN
Repeat steps 2 through 8 to write more data.		

Note 1: See Figure 4-4 for details on Shift Out Data timing.

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3.4 ID Location Programming

The ID Locations are programmed much like the code memory, except that multi-panel writes must be disabled. The single panel that will be written will automatically be enabled, based on the value of the Table Pointer. The ID registers are mapped in addresses 200000h through 200007h. These locations read out normally, even after code protection.

Note: Even though multi-panel writes are disabled, the user must still fill the 8-byte data buffer for the panel.

Figure 3-6 demonstrates the code sequence required to write the ID locations.

TABLE 3-6: WRITE ID SEQUENCE

4-Bit Command	Data Payload	Core Instruction
Step 1: Direct access to config memory.		
0000	8E A6	BSF EECON1, EEPGD
0000	8C A6	BSF EECON1, CFGS
Step 2: Configure device for single panel writes.		
0000	0E 3C	MOVLW 3Ch
0000	6E F8	MOVWF TBLPTRU
0000	0E 00	MOVLW 00h
0000	6E F7	MOVWF TBLPTRH
0000	0E 06	MOVLW 06h
0000	6E F6	MOVWF TBLPTRL
1100	00 00	Write 00h to 3C0006h to enable single panel writes.
Step 3: Direct access to code memory.		
0000	8E A6	BSF EECON1, EEPGD
0000	9C A6	BCF EECON1, CFGS
Step 4: Load write buffer. Panel will be automatically determined by address.		
0000	0E 20	MOVLW 20h
0000	6E F8	MOVWF TBLPTRU
0000	0E 00	MOVLW 00h
0000	6E F7	MOVWF TBLPTRH
0000	0E 00	MOVLW 00h
0000	6E F6	MOVWF TBLPTRL
1101	<LSB><MSB>	Write 2 bytes and post-increment address by 2
1101	<LSB><MSB>	Write 2 bytes and post-increment address by 2
1101	<LSB><MSB>	Write 2 bytes and post-increment address by 2
1111	<LSB><MSB>	Write 2 bytes and start programming
0000	00 00	NOP - hold SCLK high for time P9

In order to modify the ID locations, refer to the methodology described in Section 3.2.2, "Modifying Code Memory". As with code memory, the ID locations must be erased before modified.

3.5 Boot Block Programming

The Boot Block segment is programmed in exactly the same manner as the ID locations (see Section 3.4). Multi-panel writes must be disabled so that only addresses in the range 0000h to 01FFh will be written.

The code sequence detailed in Figure 3-6 should be used, except that the address data used in "Step 2" will be in the range 000000h to 0001FFh.

3.6 Configuration Bits Programming

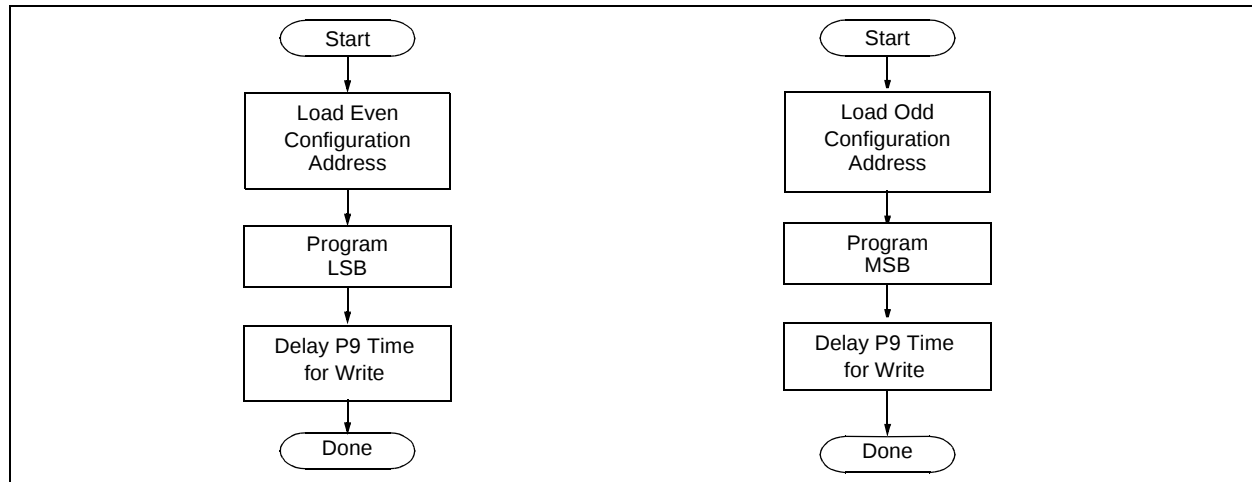
Unlike code memory, the configuration bits are programmed a byte at a time. The "Table Write, Begin Programming" 4-bit command (1111) is used, but only 8 bits of the following 16-bit payload will be written. The LSB of the payload will be written to even addresses, and the MSB will be written to odd addresses. The code sequence to program two consecutive configuration locations is shown in Figure 3-7.

TABLE 3-7: SET ADDRESS POINTER TO CONFIGURATION LOCATION

4-Bit Command	Data Payload	Core Instruction
Step 1: Direct access to config memory.		
0000	8E A6	BSF EECON1, EEPGD
0000	8C A6	BSF EECON1, CFGS
Step 2: Position the program counter ⁽¹⁾ .		
0000	EF 00	GOTO 100000h
0000	F8 00	
Step 3 ⁽²⁾ : Set Table Pointer for config byte to be written. Write even/odd addresses.		
0000	0E 30	MOVLW 30h
0000	6E F8	MOVWF TBLPTRU
0000	0E 00	MOVLW 00h
0000	6E F7	MOVWF TBLPRTH
0000	0E 00	MOVLW 00h
0000	6E F6	MOVWF TBLPTRL
1111	<LSB><MSB ignored>	Load 2 bytes and start programming
0000	00 00	NOP - hold SCLK high for time P9
0000	2A F6	INCF TBLPTRL
1111	<LSB ignored><MSB>	Load 2 bytes and start programming
0000	00 00	NOP - hold SCLK high for time P9

- Note 1:** If the code protection bits are programmed while the program counter resides in the same block, then the interaction of code protection logic may prevent further table write. To avoid this situation, move the program counter outside the code protection area (e.g., GOTO 100000h).
- Note 2:** Enabling the write protection of configuration bits (WRTC = 0 in CONFIG6H) will prevent further writing of configuration bits. Always write all the configuration bits before enabling the write protection for configuration bits.

FIGURE 3-10: CONFIGURATION PROGRAMMING FLOW



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4.0 READING THE DEVICE

4.1 Read Code Memory, ID Locations, and Configuration Bits

Code memory is accessed one byte at a time via the 4-bit command, '1001' (Table Read, post-increment). The contents of memory pointed to by the Table Pointer (TBLPTRU:TBLPTRH:TBLPTRL) are loaded into the Table Latch and then serially output on SDATA.

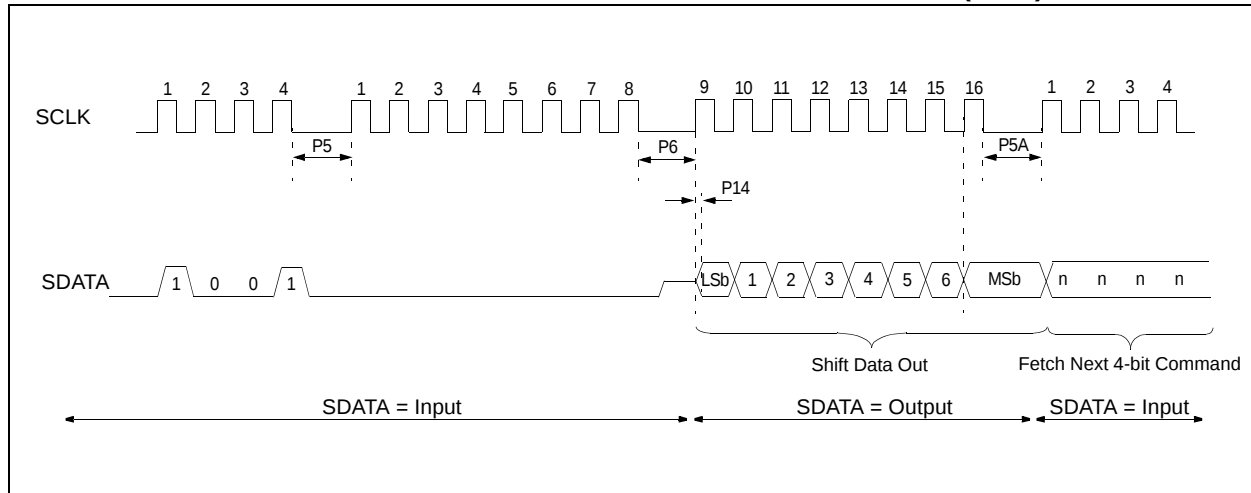
The 4-bit command is shifted in LSb first. The Table Read is executed during the next 8 clocks, then shifted out on SDATA during the last 8 clocks, LSb to MSb. A delay of P6 must be introduced after the falling edge of the 8th SCLK of the operand to allow SDATA to transition from an input to an output. During this time, SCLK must be held low (see Figure 4-1). This operation also increments the Table Pointer by one, pointing to the next byte in code memory for the next read.

This technique will work to read any memory in the 000000h to 3FFFFFFh address space, so it also applies to the reading of the ID and Configuration registers.

TABLE 4-1: READ CODE MEMORY SEQUENCE

4-Bit Command	Data Payload	Core Instruction
Step 1: Set Table Pointer.		
0000	0E <Addr[21:16]>	MOVLW Addr[21:16]
0000	6E F8	MOVWF TBLPTRU
0000	0E <Addr[15:8]>	MOVLW <Addr[15:8]>
0000	6E F7	MOVWF TBLPTRH
0000	0E <Addr[7:0]>	MOVLW <Addr[7:0]>
0000	6E F6	MOVWF TBLPTRL
Step 2: Read memory into Table Latch and then shift out on SDATA, LSb to MSb.		
1001	00 00	TBLRD *+

FIGURE 4-1: TABLE READ POST-INCREMENT INSTRUCTION TIMING (1001)

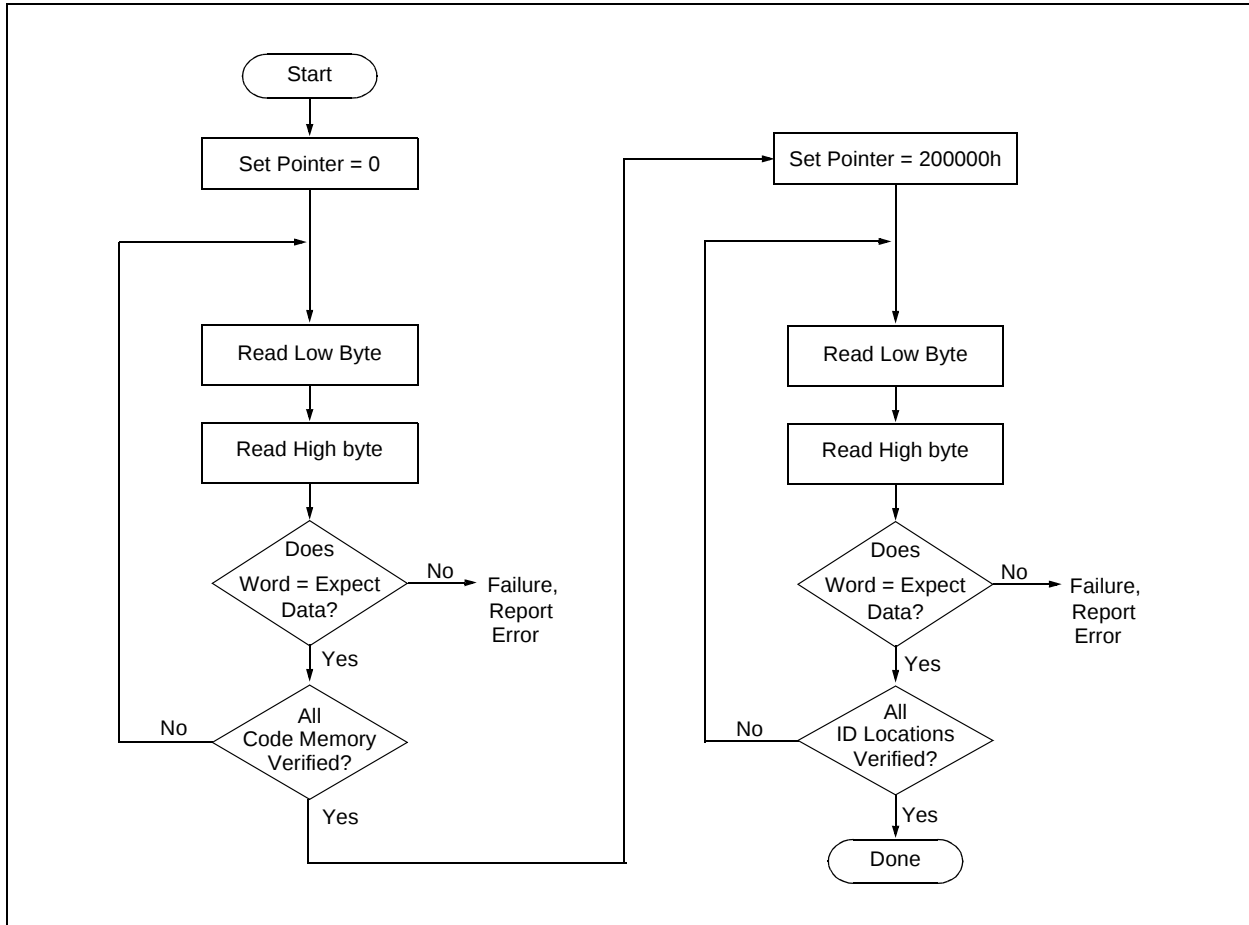


4.2 Verify Code Memory and ID locations

The verify step involves reading back the code memory space and comparing against the copy held in the programmer's buffer. Memory reads occur a single byte at a time, so two bytes must be read to compare against the word in the programmer's buffer. Refer to Section 4.1 for implementation details of reading code memory.

The Table Pointer must be manually set to 200000h (base address of the ID locations), once the code memory has been verified. The post-increment feature of the Table Read 4-bit command may not be used to increment the Table Pointer beyond the code memory space. In a 32-Kbyte device, for example, a post-increment read of address 7FFFh will wrap the Table Pointer back to 0000h, rather than point to unimplemented address 8000h.

FIGURE 4-2: VERIFY CODE MEMORY FLOW



4.3 Verify Configuration Bits

A configuration address may be read and output on SDATA via the 4-bit command, '1001'. Configuration data is read and written in a byte-wise fashion, so it is not necessary to merge two bytes into a word prior to a compare. The result may then be immediately compared to the appropriate configuration data in the programmer's memory for verification. Refer to Section 4.1 for implementation details of reading configuration data.

4.4 Read Data EEPROM Memory

Data EEPROM is accessed one byte at a time via an Address Pointer (register pair EEADR:EEADRH) and a data latch (EEDATA). Data EEPROM is read by loading EEADR:EEADRH with the desired memory location and initiating a memory read by appropriately configuring the EECON1 register. The data will be loaded into EEDATA, where it may be serially output on SDATA via the 4-bit command, '0010' (Shift Out Data Holding register). A delay of P6 must be introduced after the falling edge of the 8th SCLK of the operand to allow SDATA to transition from an input to an output. During this time, SCLK must be held low (see Figure 4-4).

The command sequence to read a single byte of data is shown in Figure 4-2.

FIGURE 4-3: READ DATA EEPROM FLOW

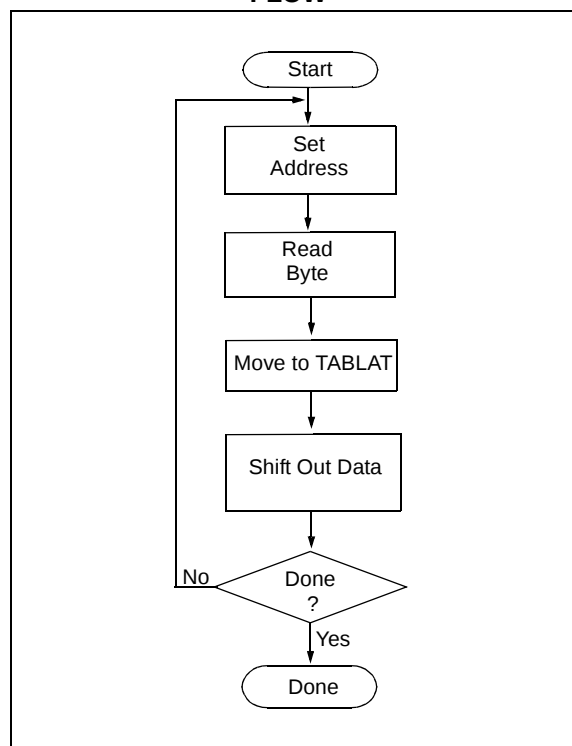
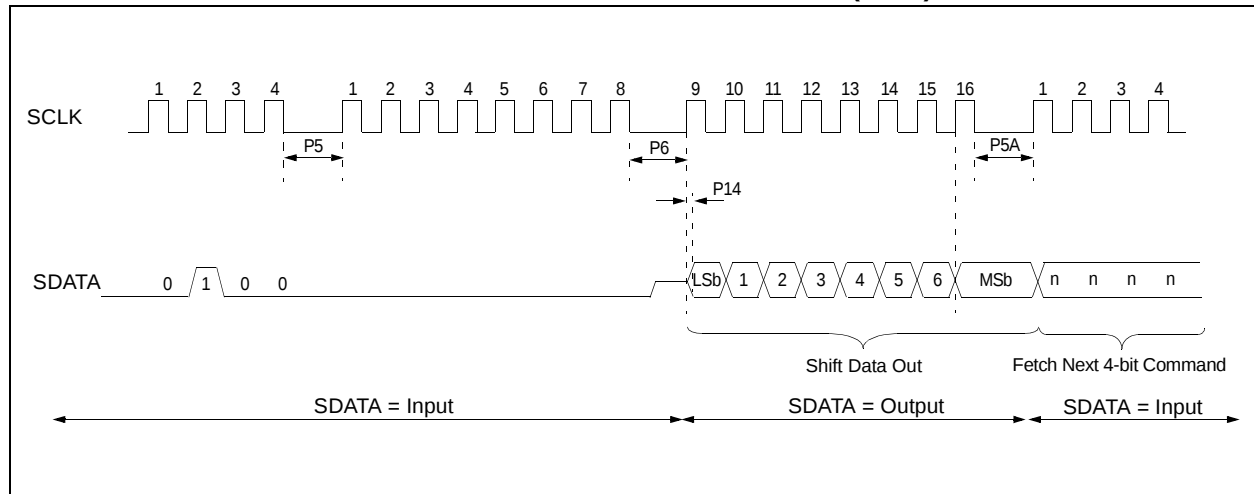


TABLE 4-2: READ DATA EEPROM MEMORY

4-Bit Command	Data Payload	Core Instruction
Step 1: Direct access to data EEPROM.		
0000	9E A6	BCF EECON1, EEPGD
0000	9C A6	BCF EECON1, CFGS
Step 2: Set the data EEPROM Address Pointer.		
0000	0E <Addr>	MOVLW <Addr>
0000	6E A9	MOVWF EEADR
0000	0E <AddrH>	MOVLW <AddrH>
0000	6E AA	MOVWF EEADRH
Step 3: Initiate a memory read.		
0000	80 A6	BSF EECON1, RD
Step 4: Load data into the Serial Data Holding register.		
0000	50 A8	MOVF EEDATA, W, 0
0000	6E F5	MOVWF TABLAT
0010	<LSB><MSB>	Shift Out Data ⁽¹⁾

Note 1: The <LSB> is undefined. The <MSB> is the data.

FIGURE 4-4: SHIFT OUT DATA HOLDING REGISTER TIMING (0010)



4.5 Verify Data EEPROM

A data EEPROM address may be read via a sequence of core instructions (4-bit command, '0000') and then output on SDATA via the 4-bit command, '0010' (Shift Out Data Holding register). The result may then be immediately compared to the appropriate data in the programmer's memory for verification. Refer to Section 4.4 for implementation details of reading data EEPROM.

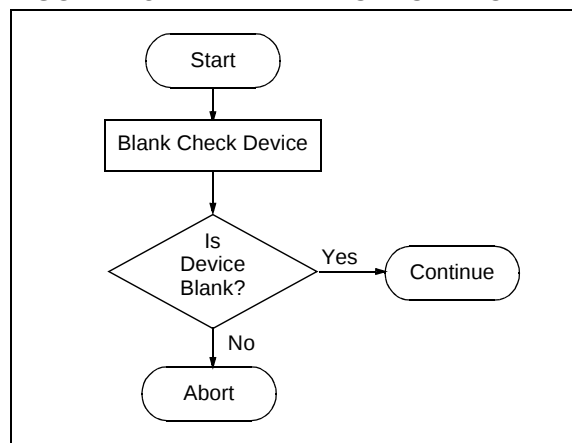
4.6 Blank Check

The term "Blank Check" means to verify that the device has no programmed memory cells. All memories must be verified: Code Memory, Data EEPROM, ID Locations, and Configuration bits. The Device ID registers (3FFFFEh:3FFFFFh) should be ignored.

A "blank" or "erased" memory cell will read as a '1'. So, "Blank Checking" a device merely means to verify that all bytes read as FFh, except the Configuration bits. Unused (reserved) Configuration bits will read '0' (programmed). Refer to Table 5-2 for blank configuration expect data for the various PIC18FXX20 devices.

Given that "Blank Checking" is merely code and data EEPROM verification with FFh expect data, refer to Section 4.4 and Section 4.2 for implementation details.

FIGURE 4-5: BLANK CHECK FLOW



5.0 CONFIGURATION WORD

The PIC18FXX20 devices have several configuration words. These bits can be set or cleared to select various device configurations. All other memory areas should be programmed and verified prior to setting configuration words. These bits may be read out normally, even after read or code protection.

5.1 ID Locations

A user may store identification information (ID) in eight ID locations mapped in 200000h:200007h. It is recommended that the Most Significant nibble of each ID be 0Fh. In doing so, if the user code inadvertently tries to execute from the ID space, the ID data will execute as NOP.

5.2 Device ID Word

The device ID word for the PIC18FXX20 is located at 3FFFFEh:3FFFFFh. These bits may be used by the programmer to identify what device type is being programmed and read out normally, even after code or read protection.

5.3 Low Voltage Programming (LVP) Bit

The LVP bit in Configuration register, CONFIG4L, enables low voltage ICSP programming. The LVP bit defaults to a '1' from the factory.

If Low Voltage Programming mode is not used, the LVP bit can be programmed to a '0' and RB5/PGM becomes a digital I/O pin. However, the LVP bit may only be programmed by entering the high voltage ICSP mode, where $\overline{\text{MCLR}}/\text{VPP}$ is raised to V_{IH} . 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 normal ICSP mode is always available, regardless of the state of the LVP bit, by applying V_{IH} to the $\overline{\text{MCLR}}/\text{VPP}$ pin.

2: While in low voltage ICSP mode, the RB5 pin can no longer be used as a general purpose I/O.

TABLE 5-1: DEVICE ID VALUES

Device	Device ID Value	
	DEVID2	DEVID1
PIC18F6520	0Bh	001x xxxx
PIC18F6620	06h	011x xxxx
PIC18F6720	06h	001x xxxx
PIC18F8520	0Bh	000x xxxx
PIC18F8620	06h	010x xxxx
PIC18F8720	06h	000x xxxx

Note: The 'x's in DEVID1 contain the device revision code.

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TABLE 5-2: PIC18FXX20 CONFIGURATION BITS AND DEVICE IDS

File Name		Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0	Default/ Unprogrammed Value
300001h	CONFIG1H	—	—	OSCS $\overline{\text{EN}}$	—	—	FOSC2	FOSC1	FOSC0	0010 0111
300002h	CONFIG2L	—	—	—	—	BORV1	BORV0	BODEN	PWRTEN	0000 1111
300003h	CONFIG2H	—	—	—	—	WDTPS2	WDTPS1	WDTPS0	WDTEN	0000 1111
300004h ⁽¹⁾	CONFIG3L	WAIT	—	—	—	—	—	PM1	PM0	1000 0011
300005h	CONFIG3H	—	—	—	—	—	—	T1OSCMX ⁽³⁾	CCP2MX	0000 0001
300006h	CONFIG4L	DEBUG	—	—	—	—	LVP	—	STVREN	1000 0101
300008h	CONFIG5L	CP7 ⁽²⁾	CP6 ⁽²⁾	CP5 ⁽²⁾	CP4 ⁽²⁾	CP3	CP2	CP1	CP0	1111 1111
300009h	CONFIG5H	CPD	CPB	—	—	—	—	—	—	1100 0000
30000Ah	CONFIG6L	WRT7 ⁽²⁾	WRT6 ⁽²⁾	WRT5 ⁽²⁾	WRT4 ⁽²⁾	WRT3	WRT2	WRT1	WRT0	1111 1111
30000Bh	CONFIG6H	WRTD	WRTB	WRTC	—	—	—	—	—	1110 0000
30000Ch	CONFIG7L	EBTR7 ⁽²⁾	EBTR6 ⁽²⁾	EBTR5 ⁽²⁾	EBTR4 ⁽²⁾	EBTR3	EBTR2	EBTR1	EBTR0	1111 1111
30000Dh	CONFIG7H	—	EBTRB	—	—	—	—	—	—	0100 0000
3FFFFEh	DEVID1	DEV2	DEV1	DEV0	REV4	REV3	REV2	REV1	REV0	Table 5-1
3FFFFFh	DEVID2	DEV10	DEV9	DEV8	DEV7	DEV6	DEV5	DEV4	DEV3	Table 5-1

Legend: x = unknown, u = unchanged, - = unimplemented, q = value depends on condition.
Shaded cells are unimplemented, read as '0'.

- Note** 1: Unimplemented in PIC18F6X20 devices; maintain this bit set.
2: Unimplemented in PIC18FX620 and PIC18FX520 devices; maintain this bit set.
3: PIC18F8520/8620 devices only.

TABLE 5-3: PIC18FXX20 CONFIGURATION BIT DESCRIPTIONS

Bit Name	Configuration Words	Description
OS $\overline{\text{CEN}}$	CONFIG1H	Low Power System Clock Option (Timer1) Enable bit 1 = Disabled 0 = Timer1 oscillator system clock option enabled
FOSC2:FOSC0	CONFIG1H	Oscillator Selection bits 111 = RC oscillator w/ OSC2 configured as RA6 110 = HS oscillator w/ PLL enabled 101 = EC oscillator w/ OSC2 configured as RA6 100 = RC oscillator w/ OSC2 configured as "divide by 4 clock output" 011 = RC oscillator 010 = HS oscillator 001 = XT oscillator 000 = LP oscillator
BORV1:BORV0	CONFIG2L	Brown-out Reset Voltage bits 11 = VBOR set to 2.0V 10 = VBOR set to 2.7V 01 = VBOR set to 4.2V 00 = VBOR set to 4.5V
BOREN	CONFIG2L	Brown-out Reset Enable bit 1 = Brown-out Reset enabled 0 = Brown-out Reset disabled
PWRTEN	CONFIG2L	Power-up Timer Enable bit 1 = PWRT disabled 0 = PWRT enabled
WDTPS2:WDTPS0	CONFIG2H	Watchdog Timer Postscaler Select bits 111 = 1:128 110 = 1:64 101 = 1:32 100 = 1:16 011 = 1:8 010 = 1:4 001 = 1:2 000 = 1:1
WDTEN	CONFIG2H	Watchdog Timer Enable bit 1 = WDT enabled 0 = WDT disabled (control is placed on SWDTEN bit)
WAIT ⁽¹⁾	CONFIG3L	External Bus Data Wait Enable bit 1 = Wait selections unavailable 0 = Wait selections determined by WAIT1:WAIT0 bits of MEMCOM register
PM1:PM0 ⁽¹⁾	CONFIG3L	Processor Mode Select bits 11 = Microcontroller mode 10 = Microprocessor mode 01 = Microprocessor with Boot Block mode 00 = Extended Microcontroller mode

Note 1: Unimplemented in PIC18F6X20 (64-pin) devices; maintain this bit set.

2: Unimplemented in PIC18FX620 devices; maintain this bit set.

3: PIC18F8520/8620 devices only.

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TABLE 5-3: PIC18FXX20 CONFIGURATION BIT DESCRIPTIONS (CONTINUED)

Bit Name	Configuration Words	Description
T1OSCMX ⁽³⁾	CONFIG3H	Timer1 Oscillator MUX bit 1 = Legacy Timer1 oscillator selected 0 = Low power Timer1 oscillator selected
CCP2MX	CONFIG3H	CCP2 MUX bit 1 = CCP2 input/output is multiplexed with RC1 0 = CCP2 input/output is multiplexed with RB3
DEBUG	CONFIG4L	Background Debugger Enable bit 1 = Background debugger disabled 0 = Background debugger enabled
LVP	CONFIG4L	Low Voltage Programming Enable bit 1 = Low voltage programming enabled 0 = Low voltage programming disabled
STVREN	CONFIG4L	Stack Overflow/Underflow Reset Enable bit 1 = Stack overflow/underflow will cause RESET 0 = Stack overflow/underflow will not cause RESET
CP0	CONFIG5L	Code Protection bits (Block 0) 1 = Code memory not code protected 0 = Code memory code protected
CP1	CONFIG5L	Code Protection bits (Block 1) 1 = Code memory not code protected 0 = Code memory code protected
CP2	CONFIG5L	Code Protection bits (Block 2) 1 = Code memory not code protected 0 = Code memory code protected
CP3	CONFIG5L	Code Protection bits (Block 3) 1 = Code memory not code protected 0 = Code memory code protected
CP4 ⁽²⁾	CONFIG5L	Code Protection bits (Block 4) 1 = Code memory not code protected 0 = Code memory code protected
CP5 ⁽²⁾	CONFIG5L	Code Protection bits (Block 5) 1 = Code memory not code protected 0 = Code memory code protected
CP6 ⁽²⁾	CONFIG5L	Code Protection bits (Block 6) 1 = Code memory not code protected 0 = Code memory code protected
CP7 ⁽²⁾	CONFIG5L	Code Protection bits (Block 7) 1 = Code memory not code protected 0 = Code memory code protected

Note 1: Unimplemented in PIC18F6X20 (64-pin) devices; maintain this bit set.

2: Unimplemented in PIC18FX620 devices; maintain this bit set.

3: PIC18F8520/8620 devices only.

TABLE 5-3: PIC18FXX20 CONFIGURATION BIT DESCRIPTIONS (CONTINUED)

Bit Name	Configuration Words	Description
CPD	CONFIG5H	Code Protection bits (Data EEPROM) 1 = Data EEPROM not code protected 0 = Data EEPROM code protected
CPB	CONFIG5H	Code Protection bits (Boot Block) 1 = Boot block not code protected 0 = Boot block code protected
WRT0	CONFIG6L	Table Write Protection bit (Block 0) 1 = Code memory not write protected 0 = Code memory write protected
WRT1	CONFIG6L	Table Write Protection bit (Block 1) 1 = Code memory not write protected 0 = Code memory write protected
WRT2	CONFIG6L	Table Write Protection bit (Block 2) 1 = Code memory not write protected 0 = Code memory write protected
WRT3	CONFIG6L	Table Write Protection bit (Block 3) 1 = Code memory not write protected 0 = Code memory write protected
WRT4 ⁽²⁾	CONFIG6L	Table Write Protection bit (Block 4) 1 = Code memory not write protected 0 = Code memory write protected
WRT5 ⁽²⁾	CONFIG6L	Table Write Protection bit (Block 5) 1 = Code memory not write protected 0 = Code memory write protected
WRT6 ⁽²⁾	CONFIG6L	Table Write Protection bit (Block 6) 1 = Code memory not write protected 0 = Code memory write protected
WRT7 ⁽²⁾	CONFIG6L	Table Write Protection bit (Block 7) 1 = Code memory not write protected 0 = Code memory write protected
WRTD	CONFIG6H	Table Write Protection bit (Data EEPROM) 1 = Data EEPROM not write protected 0 = Data EEPROM write protected
WRTB	CONFIG6H	Table Write Protection bit (Boot Block) 1 = Boot block not write protected 0 = Boot block write protected
WRTC	CONFIG6H	Table Write Protection bit (Configuration registers) 1 = Configuration registers not write protected 0 = Configuration registers write protected

Note 1: Unimplemented in PIC18F6X20 (64-pin) devices; maintain this bit set.

2: Unimplemented in PIC18FX620 devices; maintain this bit set.

3: PIC18F8520/8620 devices only.

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TABLE 5-3: PIC18FXX20 CONFIGURATION BIT DESCRIPTIONS (CONTINUED)

Bit Name	Configuration Words	Description
EBTR0	CONFIG7L	Table Read Protection bit (Block 0) 1 = Code memory not protected from table reads executed in other blocks 0 = Code memory protected from table reads executed in other blocks
EBTR1	CONFIG7L	Table Read Protection bit (Block 1) 1 = Code memory not protected from Table Reads executed in other blocks 0 = Code memory protected from Table Reads executed in other blocks
EBTR2	CONFIG7L	Table Read Protection bit (Block 2) 1 = Code memory not protected from Table Reads executed in other blocks 0 = Code memory protected from Table Reads executed in other blocks
EBTR3	CONFIG7L	Table Read Protection bit (Block 3) 1 = Code memory not protected from Table Reads executed in other blocks 0 = Code memory protected from Table Reads executed in other blocks
EBTR4 ⁽²⁾	CONFIG7L	Table Read Protection bit (Block 4) 1 = Code memory not protected from Table Reads executed in other blocks 0 = Code memory protected from Table Reads executed in other blocks
EBTR5 ⁽²⁾	CONFIG7L	Table Read Protection bit (Block 5) 1 = Code memory not protected from Table Reads executed in other blocks 0 = Code memory protected from Table Reads executed in other blocks
EBTR6 ⁽²⁾	CONFIG7L	Table Read Protection bit (Block 6) 1 = Code memory not protected from Table Reads executed in other blocks 0 = Code memory protected from Table Reads executed in other blocks
EBTR7 ⁽²⁾	CONFIG7L	Table Read Protection bit (Block 7) 1 = Code memory not protected from Table Reads executed in other blocks 0 = Code memory protected from Table Reads executed in other blocks
EBTRB	CONFIG7H	Table Read Protection bit (Boot Block) 1 = Boot block not protected from Table Reads executed in other blocks 0 = Boot block protected from Table Reads executed in other blocks
DEV10:DEV3	DEVID2	Device ID bits These bits are used with the DEV2:DEV0 bits in the DEVID1 register to identify part number.
DEV2:DEV0	DEVID1	Device ID bits These bits are used with the DEV10:DEV3 bits in the DEVID2 register to identify part number.
REV4:REV0	DEVID1	These bits are used to indicate the revision of the device.

Note 1: Unimplemented in PIC18F6X20 (64-pin) devices; maintain this bit set.

2: Unimplemented in PIC18FX620 devices; maintain this bit set.

3: PIC18F8520/8620 devices only.

5.4 Embedding Configuration Word Information in the HEX File

To allow portability of code, a PIC18FXX20 programmer is required to read the configuration word locations from the HEX file. If configuration word information is not present in the HEX file, then a simple warning message should be issued. Similarly, while saving a HEX file, all configuration word information must be included. An option to not include the configuration word information may be provided. When embedding configuration word information in the HEX file, it should start at address 300000h.

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

5.5 Checksum Computation

The checksum is calculated by summing the following:

- The contents of all code memory locations
- The configuration word, appropriately masked
- ID locations

The Least Significant 16-bits of this sum are the checksum.

Table 5-4 (pages 32 through 37) describes how to calculate the checksum for each device.

Note 1: The checksum calculation differs depending on the code protect setting. Since the code memory locations read out differently, depending on the code protect setting, the table describes how to manipulate the actual code memory values to simulate the values that would be read from a protected device. When calculating a checksum by reading a device, the entire code memory can simply be read and summed. The configuration word and ID locations can always be read.

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TABLE 5-4: CHECKSUM COMPUTATION

Device	Code Protect	Checksum	Blank Value	0xAA at 0 and Max Address
PIC18F6520	None	SUM(0000:07FF)+SUM(0800:1FFF)+SUM(2000:3FFF)+SUM(4000:5FFF)+SUM(6000:7FFF)+(CFGW1L & 0000)+(CFGW1H & 0027)+(CFGW2L & 000F)+(CFGW2H & 000F)+(CFGW3L & 0000)+(CFGW3H & 0002)+(CFGW4L & 0085)+(CFGW4H & 0000)+(CFGW5L & 00FF)+(CFGW5H & 00C0)+(CFGW6L & 00FF)+(CFGW6H & 00E0)+(CFGW7L & 00FF)+(CFGW7H & 0040)	05A8	04FE
	Boot Block	SUM(0800:1FFF)+SUM(2000:3FFF)+SUM(4000:5FFF)+SUM(6000:7FFF)+(CFGW1L & 0000)+(CFGW1H & 0027)+(CFGW2L & 000F)+(CFGW2H & 000F)+(CFGW3L & 0000)+(CFGW3H & 0002)+(CFGW4L & 0085)+(CFGW4H & 0000)+(CFGW5L & 00FF)+(CFGW5H & 00C0)+(CFGW6L & 00FF)+(CFGW6H & 00E0)+(CFGW7L & 00FF)+(CFGW7H & 0040)+SUM(IDs)	077F	734
	Boot/Block1/Block2	SUM(4000:5FFF)+SUM(6000:7FFF)+(CFGW1L & 0000)+(CFGW1H & 0027)+(CFGW2L & 000F)+(CFGW2H & 000F)+(CFGW3L & 0000)+(CFGW3H & 0002)+(CFGW4L & 0085)+(CFGW4H & 0000)+(CFGW5L & 00FF)+(CFGW5H & 00C0)+(CFGW6L & 00FF)+(CFGW6H & 00E0)+(CFGW7L & 00FF)+(CFGW7H & 0040)+SUM(IDs)	857C	8531
	All	(CFGW1L & 0000)+(CFGW1H & 0027)+(CFGW2L & 000F)+(CFGW2H & 000F)+(CFGW3L & 0000)+(CFGW3H & 0002)+(CFGW4L & 0085)+(CFGW4H & 0000)+(CFGW5L & 00FF)+(CFGW5H & 00C0)+(CFGW6L & 00FF)+(CFGW6H & 00E0)+(CFGW7L & 00FF)+(CFGW7H & 0040)+SUM(IDs)	480	048A

Legend: Item Description
 CFGW = Configuration Word
 SUM[a:b] = Sum of locations, a to b inclusive
 SUM_ID = Byte-wise sum of lower four bits of all customer ID locations
 + = Addition
 & = Bit-wise AND

TABLE 5-4: CHECKSUM COMPUTATION (CONTINUED)

Device	Code Protect	Checksum	Blank Value	0xAA at 0 and Max Address
PIC18F6620	None	SUM(0000:01FF)+SUM(0200:3FFF)+SUM(4000:7FFF)+SUM(8000:BFFF)+SUM(C000:FFFF)+(CFGW1L & 0000)+(CFGW1H & 0027)+(CFGW2L & 000F)+(CFGW2H & 000F)+(CFGW3L & 0000)+(CFGW3H & 0001)+(CFGW4L & 0085)+(CFGW4H & 0000)+(CFGW5L & 000F)+(CFGW5H & 00C0)+(CFGW6L & 000F)+(CFGW6H & 00E0)+(CFGW7L & 000F)+(CFGW7H & 0040)	02D8	022E
	Boot Block	SUM(0200:3FFF)+SUM(4000:7FFF)+SUM(8000:BFFF)+SUM(C000:FFFF)+(CFGW1L & 0000)+(CFGW1H & 0027)+(CFGW2L & 000F)+(CFGW2H & 000F)+(CFGW3L & 0000)+(CFGW3H & 0001)+(CFGW4L & 0085)+(CFGW4H & 0000)+(CFGW5L & 000F)+(CFGW5H & 00C0)+(CFGW6L & 000F)+(CFGW6H & 00E0)+(CFGW7L & 000F)+(CFGW7H & 0040)+SUM(IDs)	04AF	455
	Boot/Block1/Block2	SUM(8000:BFFF)+SUM(C000:FFFF)+(CFGW1L & 0000)+(CFGW1H & 0027)+(CFGW2L & 000F)+(CFGW2H & 000F)+(CFGW3L & 0000)+(CFGW3H & 0001)+(CFGW4L & 0085)+(CFGW4H & 0000)+(CFGW5L & 000F)+(CFGW5H & 00C0)+(CFGW6L & 000F)+(CFGW6H & 00E0)+(CFGW7L & 000F)+(CFGW7H & 0040)+SUM(IDs)	82AC	8252
	All	(CFGW1L & 0000)+(CFGW1H & 0027)+(CFGW2L & 000F)+(CFGW2H & 000F)+(CFGW3L & 0000)+(CFGW3H & 0001)+(CFGW4L & 0085)+(CFGW4H & 0000)+(CFGW5L & 000F)+(CFGW5H & 00C0)+(CFGW6L & 000F)+(CFGW6H & 00E0)+(CFGW7L & 000F)+(CFGW7H & 0040)+SUM(IDs)	02A0	029B

Legend: Item Description
 CFGW = Configuration Word
 SUM[a:b] = Sum of locations, a to b inclusive
 SUM_ID = Byte-wise sum of lower four bits of all customer ID locations
 + = Addition
 & = Bit-wise AND

PIC18FXX20

TABLE 5-4: CHECKSUM COMPUTATION (CONTINUED)

Device	Code Protect	Checksum	Blank Value	0xAA at 0 and Max Address
PIC18F6720	None	SUM(0000:01FF)+SUM(0200:3FFF)+SUM(4000:7FFF)+SUM(8000:BFFF)+SUM(C000:FFFF)+SUM(10000:13FFF)+SUM(14000:17FFF)+SUM(18000:1BFFF)+SUM(1C000:1FFFF)+(CFGW1L & 0000)+(CFGW1H & 0027)+(CFGW2L & 000F)+(CFGW2H & 000F)+(CFGW3L & 0000)+(CFGW3H & 0001)+(CFGW4L & 0085)+(CFGW4H & 0000)+(CFGW5L & 00FF)+(CFGW5H & 00C0)+(CFGW6L & 00FF)+(CFGW6H & 00E0)+(CFGW7L & 00FF)+(CFGW7H & 0040)	05A8	04FE
	Boot Block	SUM(0200:3FFF)+SUM(4000:7FFF)+SUM(8000:BFFF)+SUM(C000:FFFF)+SUM(10000:13FFF)+SUM(14000:17FFF)+SUM(18000:1BFFF)+SUM(1C000:1FFFF)+(CFGW1L & 0000)+(CFGW1H & 0027)+(CFGW2L & 000F)+(CFGW2H & 000F)+(CFGW3L & 0000)+(CFGW3H & 0001)+(CFGW4L & 0085)+(CFGW4H & 0000)+(CFGW5L & 00FF)+(CFGW5H & 00C0)+(CFGW6L & 00FF)+(CFGW6H & 00E0)+(CFGW7L & 00FF)+(CFGW7H & 0040)+SUM(IDs)	077F	0734
	Boot/Block1/Block2	SUM(8000:BFFF)+SUM(C000:FFFF)+SUM(10000:13FFF)+SUM(14000:17FFF)+SUM(18000:1BFFF)+SUM(1C000:1FFFF)+(CFGW1L & 0000)+(CFGW1H & 0027)+(CFGW2L & 000F)+(CFGW2H & 000F)+(CFGW3L & 0000)+(CFGW3H & 0001)+(CFGW4L & 0085)+(CFGW4H & 0000)+(CFGW5L & 00FF)+(CFGW5H & 00C0)+(CFGW6L & 00FF)+(CFGW6H & 00E0)+(CFGW7L & 00FF)+(CFGW7H & 0040)+SUM(IDs)	857C	8531
	All	(CFGW1L & 0000)+(CFGW1H & 0027)+(CFGW2L & 000F)+(CFGW2H & 000F)+(CFGW3L & 0000)+(CFGW3H & 0001)+(CFGW4L & 0085)+(CFGW4H & 0000)+(CFGW5L & 00FF)+(CFGW5H & 00C0)+(CFGW6L & 00FF)+(CFGW6H & 00E0)+(CFGW7L & 00FF)+(CFGW7H & 0040)+SUM(IDs)	480	048A

Legend: Item Description
 CFGW = Configuration Word
 SUM[a:b] = Sum of locations, a to b inclusive
 SUM_ID = Byte-wise sum of lower four bits of all customer ID locations
 + = Addition
 & = Bit-wise AND

TABLE 5-4: CHECKSUM COMPUTATION (CONTINUED)

Device	Code Protect	Checksum	Blank Value	0xAA at 0 and Max Address
PIC18F8520	None	SUM(0000:07FF)+SUM(0800:1FFF)+SUM(2000:3FFF)+SUM(4000:5FFF)+SUM(6000:7FFF)+(CFGW1L & 0000)+(CFGW1H & 0027)+(CFGW2L & 000F)+(CFGW2H & 000F)+(CFGW3L & 0000)+(CFGW3H & 0002)+(CFGW4L & 0085)+(CFGW4H & 0000)+(CFGW5L & 00FF)+(CFGW5H & 00C0)+(CFGW6L & 00FF)+(CFGW6H & 00E0)+(CFGW7L & 00FF)+(CFGW7H & 0040)	05AA	500
	Boot Block	SUM(0800:1FFF)+SUM(2000:3FFF)+SUM(4000:5FFF)+SUM(6000:7FFF)+(CFGW1L & 0000)+(CFGW1H & 0027)+(CFGW2L & 000F)+(CFGW2H & 000F)+(CFGW3L & 0000)+(CFGW3H & 0002)+(CFGW4L & 0085)+(CFGW4H & 0000)+(CFGW5L & 00FF)+(CFGW5H & 00C0)+(CFGW6L & 00FF)+(CFGW6H & 00E0)+(CFGW7L & 00FF)+(CFGW7H & 0040)+SUM(IDs)	783	071A
	Boot/Block1/Block2	SUM(4000:5FFF)+SUM(6000:7FFF)+(CFGW1L & 0000)+(CFGW1H & 0027)+(CFGW2L & 000F)+(CFGW2H & 000F)+(CFGW3L & 0000)+(CFGW3H & 0002)+(CFGW4L & 0085)+(CFGW4H & 0000)+(CFGW5L & 00FF)+(CFGW5H & 00C0)+(CFGW6L & 00FF)+(CFGW6H & 00E0)+(CFGW7L & 00FF)+(CFGW7H & 0040)+SUM(IDs)	8580	8517
	All	(CFGW1L & 0000)+(CFGW1H & 0027)+(CFGW2L & 000F)+(CFGW2H & 000F)+(CFGW3L & 0000)+(CFGW3H & 0002)+(CFGW4L & 0085)+(CFGW4H & 0000)+(CFGW5L & 00FF)+(CFGW5H & 00C0)+(CFGW6L & 00FF)+(CFGW6H & 00E0)+(CFGW7L & 00FF)+(CFGW7H & 0040)+SUM(IDs)	484	470

Legend: Item Description
 CFGW = Configuration Word
 SUM[a:b] = Sum of locations, a to b inclusive
 SUM_ID = Byte-wise sum of lower four bits of all customer ID locations
 + = Addition
 & = Bit-wise AND

PIC18FXX20

TABLE 5-4: CHECKSUM COMPUTATION (CONTINUED)

Device	Code Protect	Checksum	Blank Value	0xAA at 0 and Max Address
PIC18F8620	None	SUM(0000:01FF)+SUM(0200:3FFF)+SUM(4000:7FFF)+ SUM(8000:BFFF)+SUM(C000:FFFF)+(CFGW1L & 0000)+ (CFGW1H & 0027)+(CFGW2L & 000F)+(CFGW2H & 000F)+ (CFGW3L & 0083)+(CFGW3H & 0001)+(CFGW4L & 0085)+ (CFGW4H & 0000)+(CFGW5L & 000F)+(CFGW5H & 00C0)+ (CFGW6L & 000F)+(CFGW6H & 00E0)+(CFGW7L & 000F)+ (CFGW7H & 0040)	035B	02B1
	Boot Block	SUM(0200:3FFF)+SUM(4000:7FFF)+SUM(8000:BFFF)+ SUM(C000:FFFF)+(CFGW1L & 0000)+(CFGW1H & 0027)+ (CFGW2L & 000F)+(CFGW2H & 000F)+(CFGW3L & 0083)+ (CFGW3H & 0001)+(CFGW4L & 0085)+(CFGW4H & 0000)+ (CFGW5L & 000F)+(CFGW5H & 00C0)+(CFGW6L & 000F)+ (CFGW6H & 00E0)+(CFGW7L & 000F)+(CFGW7H & 0040)+ SUM(IDs)	052E	04D4
	Boot/ Block1/ Block2	SUM(8000:BFFF)+SUM(C000:FFFF)+(CFGW1L & 0000)+ (CFGW1H & 0027)+(CFGW2L & 000F)+(CFGW2H & 000F)+ (CFGW3L & 0083)+(CFGW3H & 0001)+(CFGW4L & 0085)+ (CFGW4H & 0000)+(CFGW5L & 000F)+(CFGW5H & 00C0)+ (CFGW6L & 000F)+(CFGW6H & 00E0)+(CFGW7L & 000F)+ (CFGW7H & 0040)+SUM(IDs)	832B	82D1
	All	(CFGW1L & 0000)+(CFGW1H & 0027)+(CFGW2L & 000F)+ (CFGW2H & 000F)+(CFGW3L & 0083)+(CFGW3H & 0001)+ (CFGW4L & 0085)+(CFGW4H & 0000)+(CFGW5L & 000F)+ (CFGW5H & 00C0)+(CFGW6L & 000F)+(CFGW6H & 00E0)+ (CFGW7L & 000F)+(CFGW7H & 0040)+SUM(IDs)	031F	031A

Legend: Item Description
CFGW = Configuration Word
SUM[a:b] = Sum of locations, a to b inclusive
SUM_ID = Byte-wise sum of lower four bits of all customer ID locations
+ = Addition
& = Bit-wise AND

TABLE 5-4: CHECKSUM COMPUTATION (CONTINUED)

Device	Code Protect	Checksum	Blank Value	0xAA at 0 and Max Address
PIC18F8720	None	SUM(0000:01FF)+SUM(0200:3FFF)+SUM(4000:7FFF)+SUM(8000:BFFF)+SUM(C000:FFFF)+SUM(10000:13FFF)+SUM(14000:17FFF)+SUM(18000:1BFFF)+SUM(1C000:1FFFF)+(CFGW1L & 0000)+(CFGW1H & 0027)+(CFGW2L & 000F)+(CFGW2H & 000F)+(CFGW3L & 0083)+(CFGW3H & 0001)+(CFGW4L & 0085)+(CFGW4H & 0000)+(CFGW5L & 00FF)+(CFGW5H & 00C0)+(CFGW6L & 00FF)+(CFGW6H & 00E0)+(CFGW7L & 00FF)+(CFGW7H & 0040)	062B	581
	Boot Block	SUM(0200:3FFF)+SUM(4000:7FFF)+SUM(8000:BFFF)+SUM(C000:FFFF)+SUM(10000:13FFF)+SUM(14000:17FFF)+SUM(18000:1BFFF)+SUM(1C000:1FFFF)+(CFGW1L & 0000)+(CFGW1H & 0027)+(CFGW2L & 000F)+(CFGW2H & 000F)+(CFGW3L & 0083)+(CFGW3H & 0001)+(CFGW4L & 0085)+(CFGW4H & 0000)+(CFGW5L & 00FF)+(CFGW5H & 00C0)+(CFGW6L & 00FF)+(CFGW6H & 00E0)+(CFGW7L & 00FF)+(CFGW7H & 0040)+SUM(IDs)	07FE	07A4
	Boot/Block1/Block2	SUM(8000:BFFF)+SUM(C000:FFFF)+SUM(10000:13FFF)+SUM(14000:17FFF)+SUM(18000:1BFFF)+SUM(1C000:1FFFF)+(CFGW1L & 0000)+(CFGW1H & 0027)+(CFGW2L & 000F)+(CFGW2H & 000F)+(CFGW3L & 0083)+(CFGW3H & 0001)+(CFGW4L & 0085)+(CFGW4H & 0000)+(CFGW5L & 00FF)+(CFGW5H & 00C0)+(CFGW6L & 00FF)+(CFGW6H & 00E0)+(CFGW7L & 00FF)+(CFGW7H & 0040)+SUM(IDs)	85FB	85A1
	All	(CFGW1L & 0000)+(CFGW1H & 0027)+(CFGW2L & 000F)+(CFGW2H & 000F)+(CFGW3L & 0083)+(CFGW3H & 0001)+(CFGW4L & 0085)+(CFGW4H & 0000)+(CFGW5L & 00FF)+(CFGW5H & 00C0)+(CFGW6L & 00FF)+(CFGW6H & 00E0)+(CFGW7L & 00FF)+(CFGW7H & 0040)+SUM(IDs)	04FF	04FA

Legend: Item Description
CFGW = Configuration Word
SUM[a:b] = Sum of locations, a to b inclusive
SUM_ID = Byte-wise sum of lower four bits of all customer ID locations
+ = Addition
& = Bit-wise AND

5.6 Embedding Data EEPROM Information In the HEX File

To allow portability of code, a PIC18FXX20 programmer is required to read the data EEPROM information from the HEX file. If data EEPROM information is not present, a simple warning message should be issued. Similarly, when saving a HEX file, all data EEPROM information must be included. An option to not include the data EEPROM information may be provided. When embedding data EEPROM information in the HEX file, it should start at address F00000h.

Microchip Technology Inc. believes that this feature is important for the benefit of the end customer.

PIC18FXX20

6.0 AC/DC CHARACTERISTICS

TIMING REQUIREMENTS FOR PROGRAM/VERIFY TEST MODE

Standard Operating Conditions						
Operating Temperature: 25°C is recommended						
Param No.	Sym	Characteristic	Min	Max	Units	Conditions
D110	VIHH	High Voltage Programming Voltage on $\overline{\text{MCLR}}/\text{VPP}$	9.00	13.25	V	
D110A	VIHL	Low Voltage Programming Voltage on $\overline{\text{MCLR}}/\text{VPP}$	2.00	5.50	V	
D111	VDD	Supply Voltage During Programming	2.00	5.50	V	Normal programming
			4.50	5.50	V	Bulk erase operations
D112	I _{PP}	Programming Current on $\overline{\text{MCLR}}/\text{VPP}$	—	300	μA	
D113	I _{DDP}	Supply Current During Programming	—	10	mA	
D031	V _{IL}	Input Low Voltage	V _{SS}	0.2 V _{DD}	V	
D041	V _{IH}	Input High Voltage	0.8 V _{DD}	V _{DD}	V	
D080	V _{OL}	Output Low Voltage	—	0.6	V	I _{OL} = 8.5 mA @ 4.5V
D090	V _{OH}	Output High Voltage	V _{DD} – 0.7	—	V	I _{OH} = -3.0 mA @ 4.5V
D012	C _{IO}	Capacitive Loading on I/O pin (SDATA)	—	50	pF	To meet AC specifications
P1	T _R	$\overline{\text{MCLR}}/\text{VPP}$ Rise Time to enter Program/Verify mode	—	1.0	μs	(Note 1)
P2	T _{sclk}	Serial Clock (SCLK) Period	100	—	ns	
P2A	T _{sclkL}	Serial Clock (SCLK) Low Time	40	—	ns	
P2B	T _{sclkH}	Serial Clock (SCLK) High Time	40	—	ns	
P3	T _{set1}	Input Data Setup Time to Serial Clock ↓	15	—	ns	
P4	T _{hld1}	Input Data Hold Time from SCLK ↓	15	—	ns	
P5	T _{dly1}	Delay between 4-bit Command and Command Operand	40	—	ns	
P5A	T _{dly1a}	Delay between 4-bit Command Operand and next 4-bit Command	40	—	ns	
P6	T _{dly2}	Delay between Last SCLK ↓ of Command Byte to First SCLK ↑ of Read of Data Word	20	—	ns	
P9	T _{dly5}	SCLK High Time (minimum programming time)	1	—	ms	
P10	T _{dly6}	SCLK Low Time after Programming (high voltage discharge time)	5	—	μs	
P11	T _{dly7}	Delay to allow Self-Timed Data Write or Bulk Erase to occur	10	—	ms	
P11A	T _{drwt}	Data Write Polling Time	4	—	ms	
P12	T _{hld2}	Input Data Hold Time from $\overline{\text{MCLR}}/\text{VPP}$ ↑	2	—	μs	
P13	T _{set2}	V _{DD} ↑ Setup Time to $\overline{\text{MCLR}}/\text{VPP}$ ↑	100	—	ns	
P14	T _{valid}	Data Out Valid from SCLK ↑	10	—	ns	
P15	T _{set3}	PGM ↑ Setup Time to $\overline{\text{MCLR}}/\text{VPP}$ ↑	2	—	μs	

Note 1: Do not allow excess time when transitioning $\overline{\text{MCLR}}$ between V_{IL} and V_{IHH}; this can cause spurious program executions to occur. The maximum transition time is:

1 T_{CY} + T_{PWRT} (if enabled) + 1024 T_{OSC} (for LP, HS, HS/PLL, and XT modes only)
+ 2 ms (for HS/PLL mode only) + 1.5 μs (for EC mode only)

where T_{CY} is the Instruction Cycle Time, T_{PWRT} is the Power-up Timer Period, and T_{OSC} is the Oscillator Period.

For specific values, refer to the Electrical Characteristics section of the Device Data Sheet for the particular 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.
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