PIC18F1230/1330

Flash Microcontroller Programming Specification

1.0 DEVICE OVERVIEW

This document includes the programming specifications for the following devices:

- PIC18F1230
- PIC18F1330
- PIC18F1330-ICD

2.0 PROGRAMMING OVERVIEW

PIC18F1230/1330 devices can be programmed using the high-voltage In-Circuit Serial Programming™ (ICSP™) method. This method can be done with the device in the user's system. This programming specification applies to PIC18F1230/1330 devices in all package types.

2.1 Hardware Requirements

In High-Voltage ICSP mode, PIC18F1230/1330 devices require two programmable power supplies: one for VDD and one for MCLR/VPP/RA5/FLTA. Both supplies should have a minimum resolution of 0.25V. Refer to **Section 6.0 "AC/DC Characteristics Timing Requirements for Program/Verify Test Mode"** for additional hardware parameters.

2.2 Pin Diagrams

The pin diagrams for the PIC18F1230/1330 family are shown in Figure 2-1, Figure 2-2 and Figure 2-3.

TABLE 2-1: PIN DESCRIPTIONS (DURING PROGRAMMING): PIC18F1230/1330

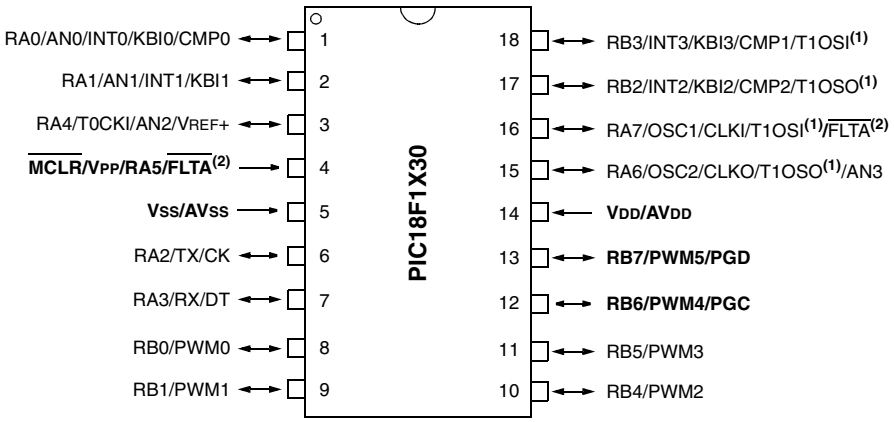
Pin Name	During Programming		
	Pin Name	Pin Type	Pin Description
MCLR/VPP/RA5/FLTA	VPP	P	Programming Enable
VDD(1)	VDD	P	Power Supply
VSS(1)	VSS	P	Ground
RB6	PGC	I	Serial Clock
RB7	PGD	I/O	Serial Data

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

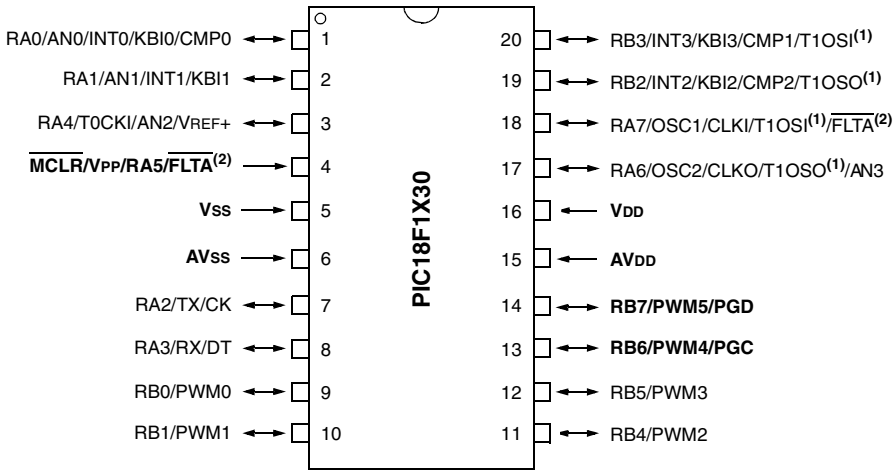
Note 1: All power supply (VDD) and ground (VSS) pins must be connected.

FIGURE 2-1: PIC18F1230/1330 FAMILY PIN DIAGRAMS

18-Pin PDIP, SOIC



20-Pin SSOP

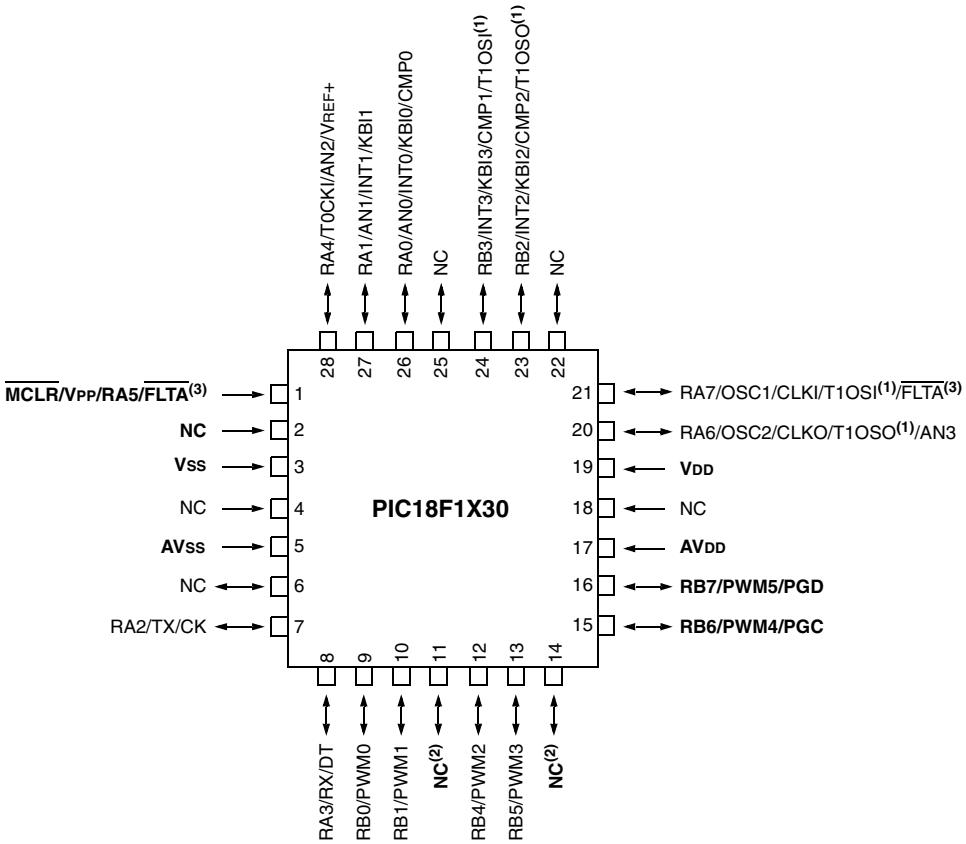


Note 1: Placement of T1OSI and T1OSO depends on the value of the Configuration bit, T1OSCMX of CONFIG3H.

2: Placement of $\overline{\text{FLTA}}$ depends on the value of the Configuration bit, FLTAMX of CONFIG3H.

FIGURE 2-2: PIC18F1230/1330 FAMILY PIN DIAGRAMS

28-Pin QFN



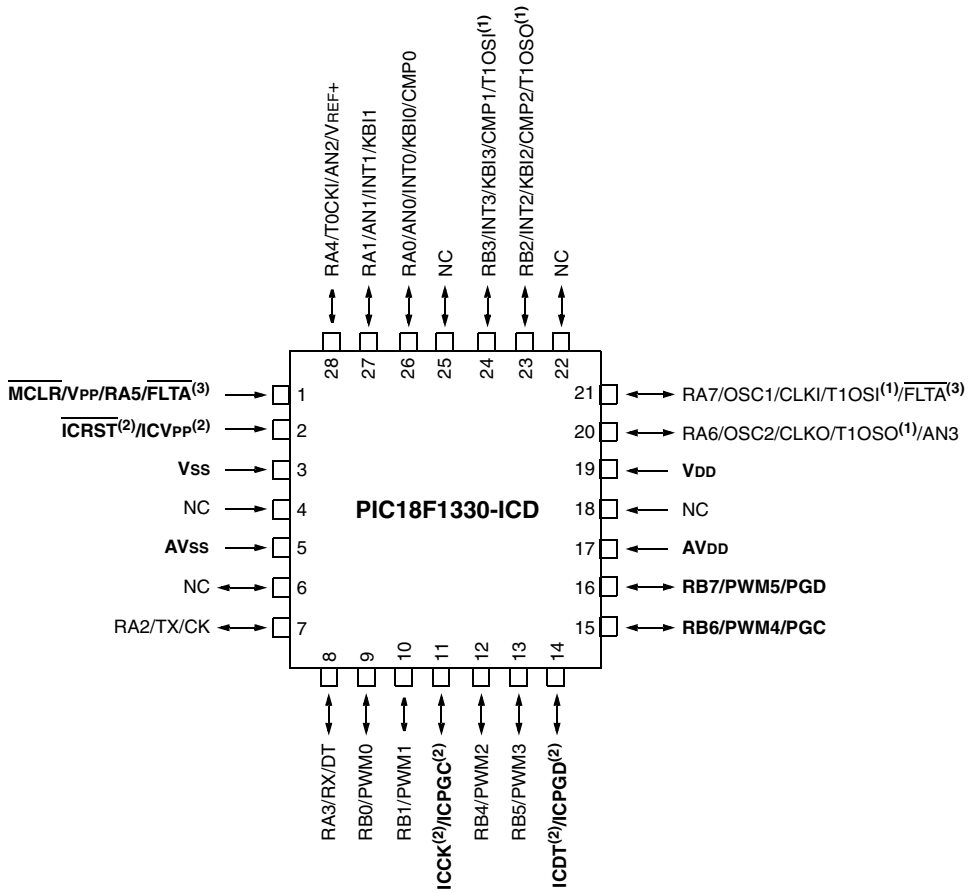
Note 1: Placement of T1OSI and T1OSO depends on the value of the Configuration bit, T1OSCMX of CONFIG3H.

2: Pin feature is dependent on device configuration.

3: Placement of $\overline{\text{FLTA}}$ depends on the value of the Configuration bit, FLTAMX of CONFIG3H.

FIGURE 2-3: PIC18F1330-ICD DEVICE PIN DIAGRAM

28-Pin QFN



Note 1: Placement of T1OSI and T1OSO depends on the value of the Configuration bit, T1OSCMX of CONFIG3H.

2: Pin feature is dependent on device configuration.

3: Placement of $\overline{\text{FLTA}}$ depends on the value of the Configuration bit, FLTAMX of CONFIG3H.

2.3 Memory Maps

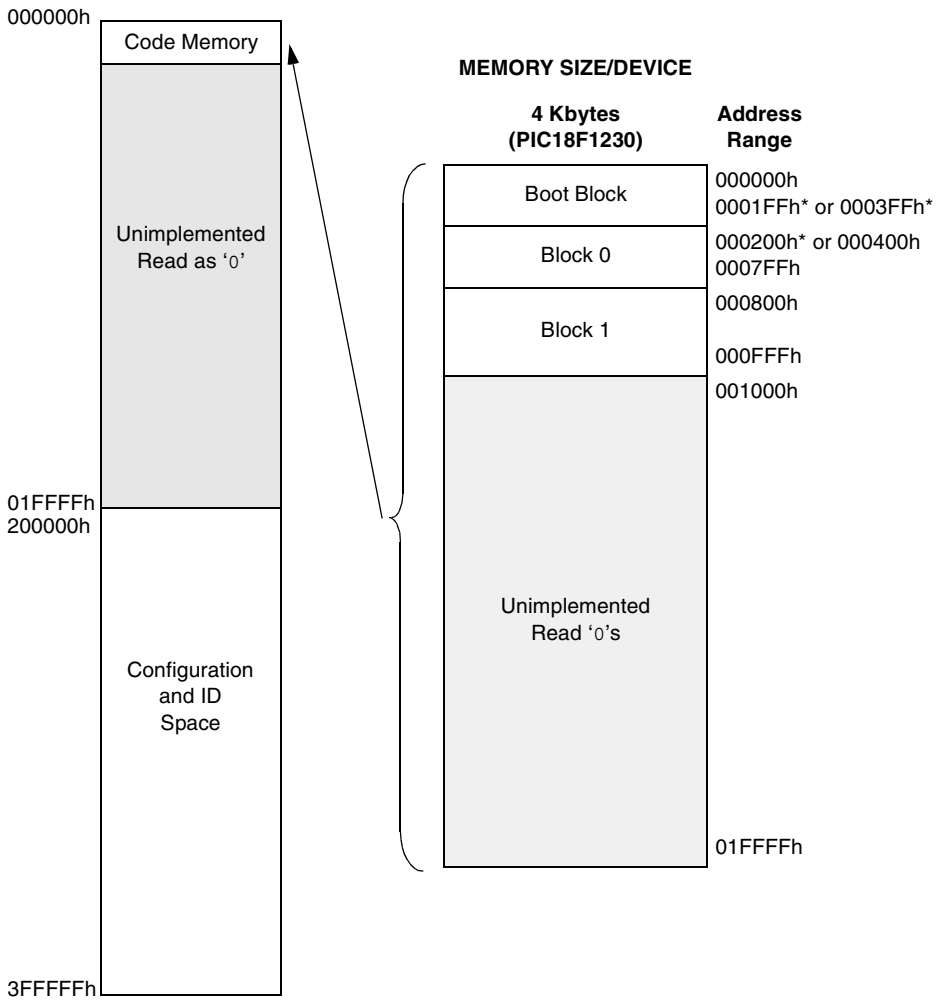
For the PIC18F1330 device, the code memory space extends from 00000h to 01FFFh (8 Kbytes) in two 4-Kbyte blocks. For the PIC18F1230 device, the code memory space extends from 00000h to 00FFFh (4 Kbytes) in two 2-Kbyte blocks. Addresses 00000h through 07FFh, however, define a “Boot Block” region that is treated separately from Block 0. All of these blocks define code protection boundaries within the code memory space.

The size of the Boot Block in PIC18F1230/1330 devices can be configured as 256, 512 or 1K words. This is done through the BBSIZ<1:0> bits in the Configuration register, CONFIG4L (see Table 5-1). It is important to note that increasing the size of the Boot Block decreases the size of Block 0.

TABLE 2-2: IMPLEMENTATION OF CODE MEMORY

Device	Code Memory Size (Bytes)
PIC18F1230	00000h-00FFFh (4K)
PIC18F1330	00000h-01FFFh (8K)

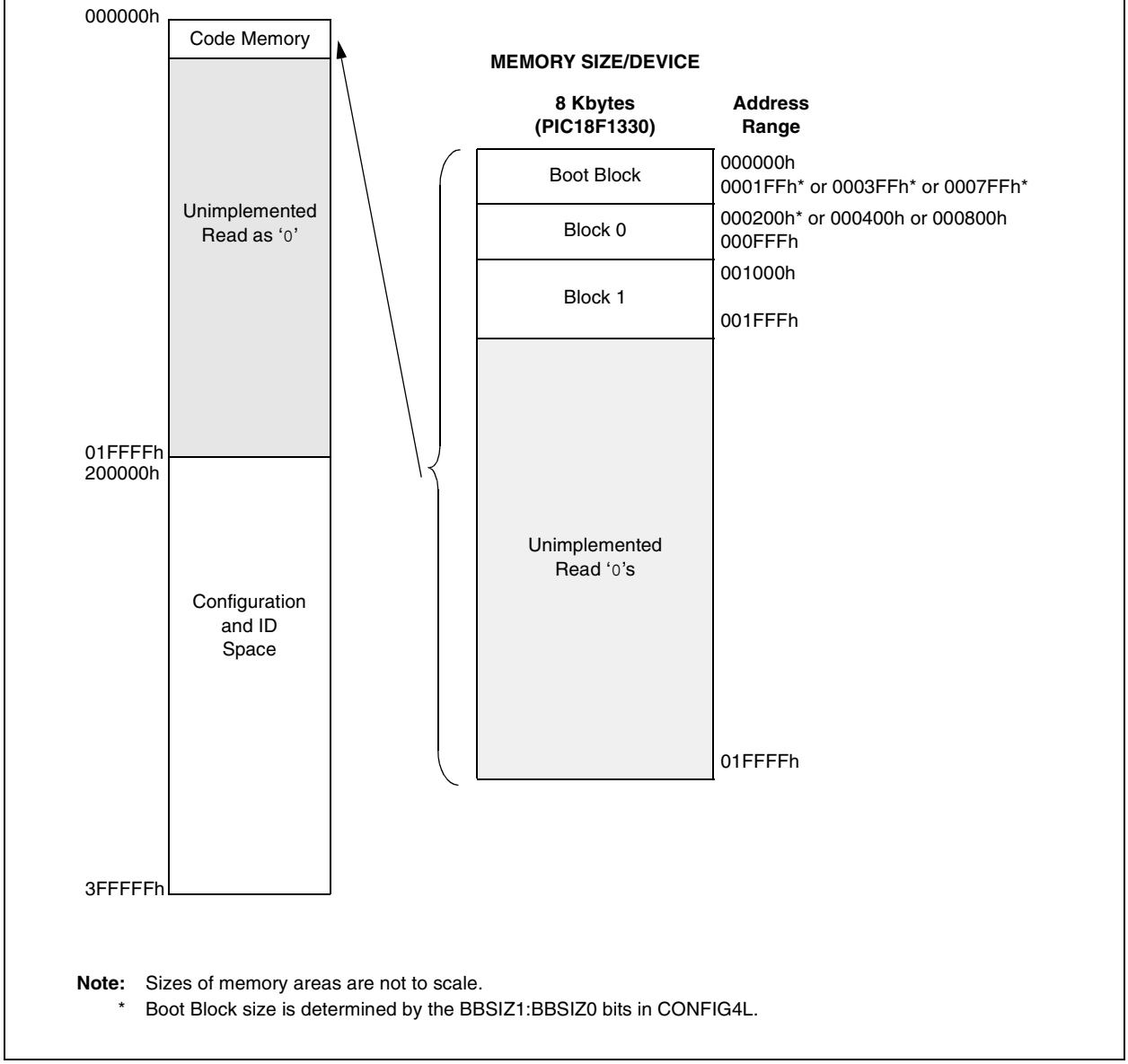
FIGURE 2-4: MEMORY MAP AND CODE MEMORY SPACE FOR THE PIC18F1230 DEVICE



Note: Sizes of memory areas are not to scale.

* Boot Block size is determined by the BBSIZ1:BBSIZ0 bits in CONFIG4L.

FIGURE 2-5: MEMORY MAP AND CODE MEMORY SPACE FOR THE PIC18F1330 DEVICE



Note: Sizes of memory areas are not to scale.

* Boot Block size is determined by the BBSIZ1:BBSIZ0 bits in CONFIG4L.

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 2-6.

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 "Configuration Word"**. These Configuration bits read out normally, even after code protection.

Locations 3FFFFEh and 3FFFFFh 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 "Configuration Word"**. These Device ID bits read out normally, even after code protection.

2.3.1 MEMORY ADDRESS POINTER

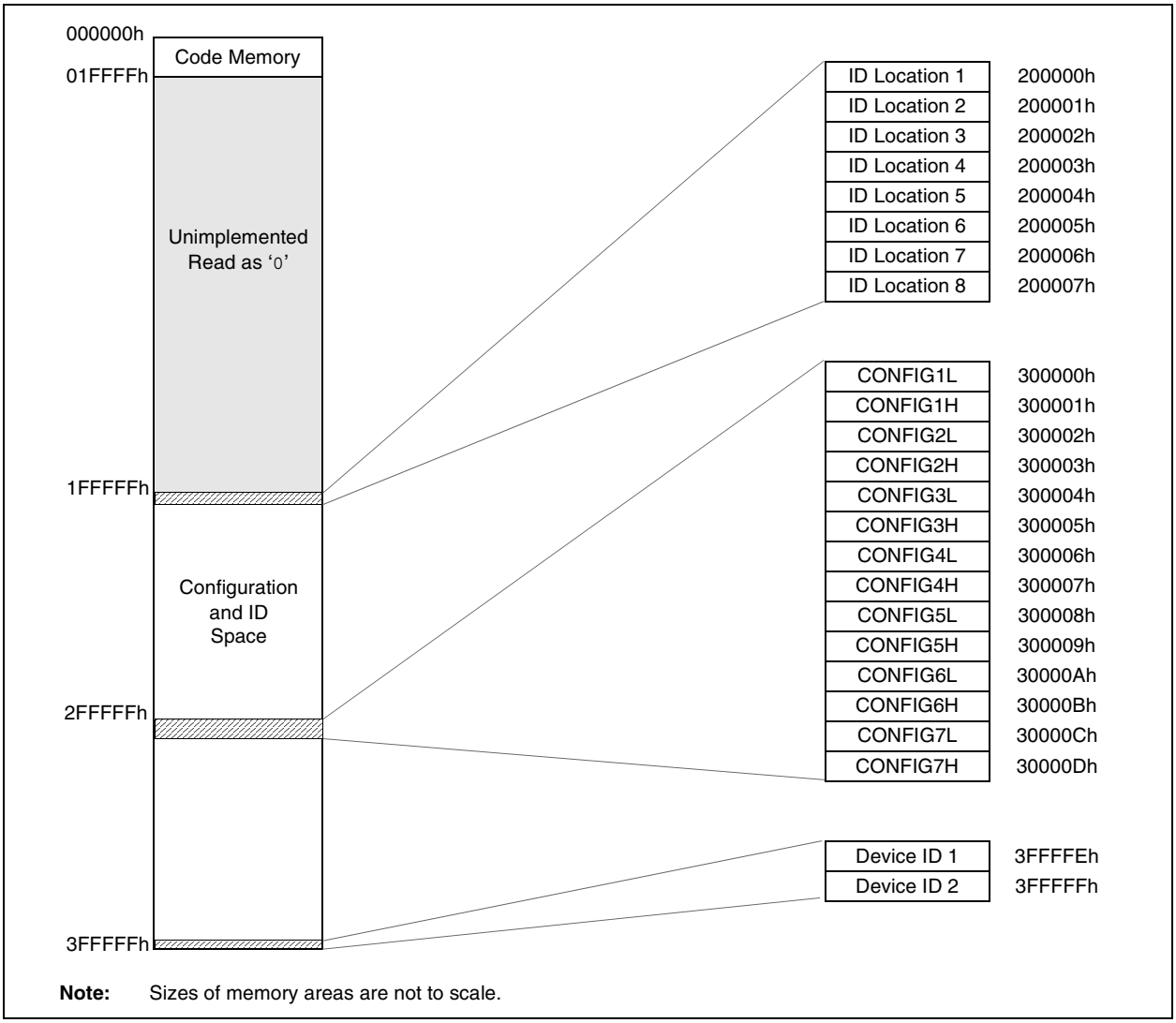
Memory in the address space, 0000000h to 3FFFFFh, is addressed via the Table Pointer register, which is comprised of three pointer registers:

- 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 2-6: CONFIGURATION AND ID LOCATIONS FOR THE PIC18F1230/1330 DEVICES

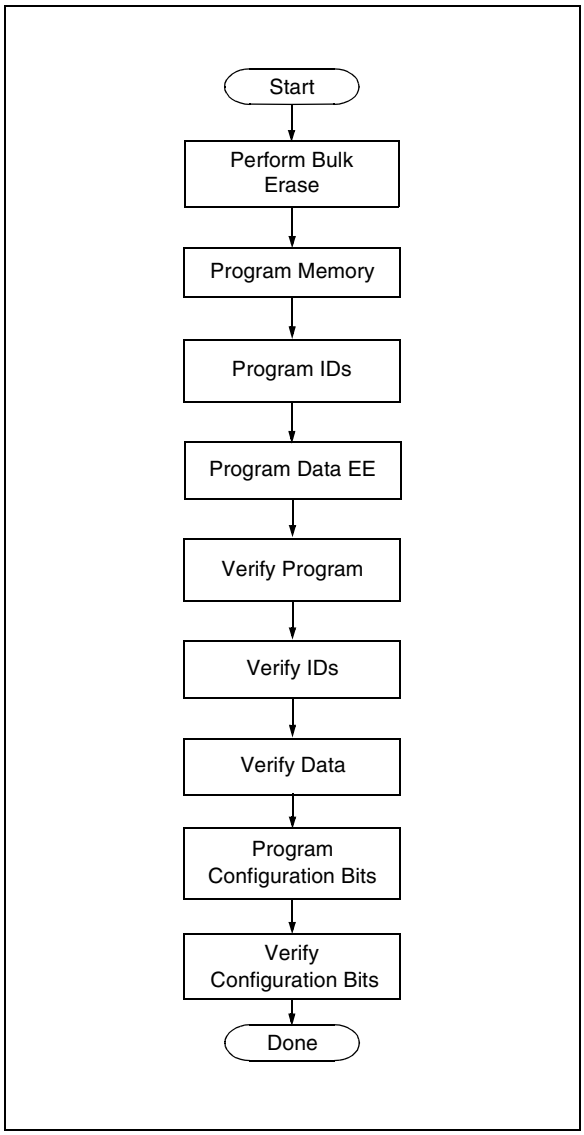


Note: Sizes of memory areas are not to scale.

2.4 High-Level Overview of the Programming Process

Figure 2-7 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 (see **Section 3.3 "Data EEPROM Programming"**). These memories are then verified to ensure that programming was successful. If no errors are detected, the Configuration bits are then programmed and verified.

FIGURE 2-7: HIGH-LEVEL PROGRAMMING FLOW



2.5 Entering and Exiting High-Voltage ICSP Program/Verify Mode

As shown in Figure 2-8, the High-Voltage ICSP Program/Verify mode is entered by holding PGC and PGD low and then raising MCLR/VPP/RA5/FLTA to VIHH (high voltage). Once in this mode, the code memory, data EEPROM (see **Section 3.3 "Data EEPROM Programming"**), ID locations and Configuration bits can be accessed and programmed in serial fashion. Figure 2-9 shows the exit sequence.

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

FIGURE 2-8: ENTERING HIGH-VOLTAGE PROGRAM/VERIFY MODE

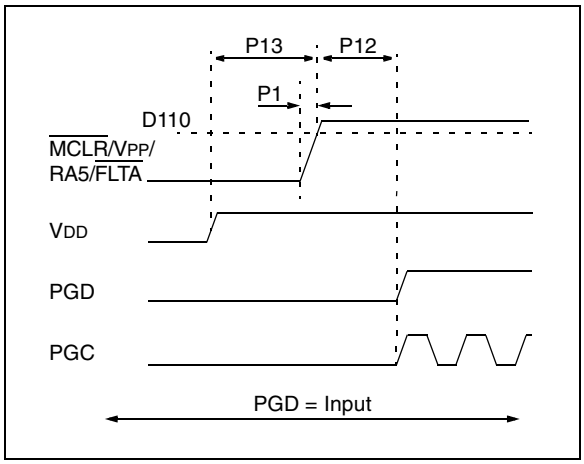
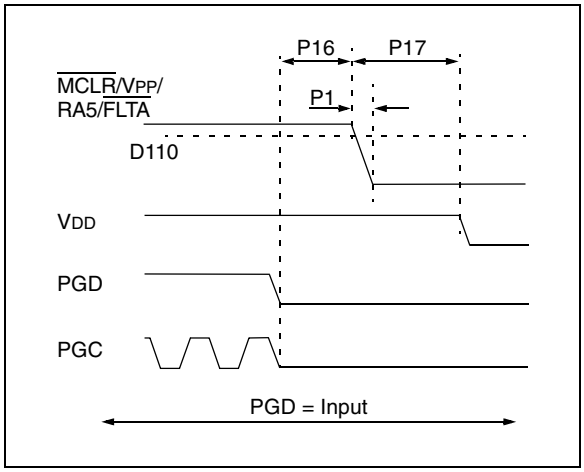


FIGURE 2-9: EXITING HIGH-VOLTAGE PROGRAM/VERIFY MODE



2.6 Serial Program/Verify Operation

The PGC pin is used as a clock input pin and the PGD pin is used for entering command bits and data input/output during serial operation. Commands and data are transmitted on the rising edge of PGC, latched on the falling edge of PGC 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, PGC 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 Table 2-4. The 4-bit command is shown Most Significant bit (MSb) first. The command operand, or "Data Payload", is shown <MSB><LSB>. Figure 2-10 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 set up registers as appropriate for use with other commands.

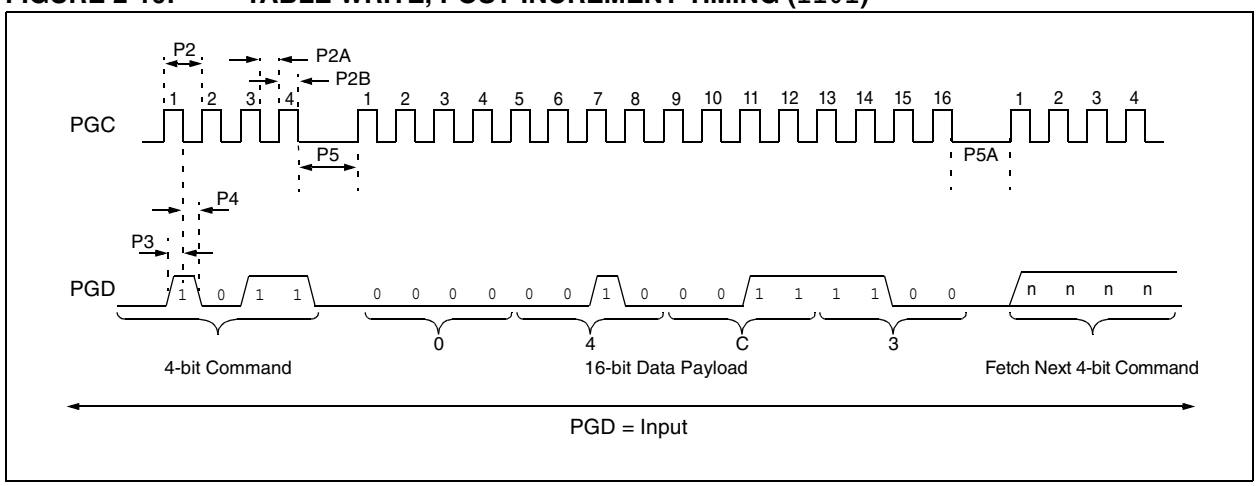
TABLE 2-3: COMMANDS FOR PROGRAMMING

Description	4-bit Command
Core Instruction (Shift in16-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, start programming, post-increment 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 2-10: TABLE WRITE, POST-INCREMENT TIMING (1101)



2.7 28-Pin PIC18F1330-ICD Device (Dedicated ICD Port)

The PIC18F1330-ICD 28-pin QFN device has a dedicated ICSP/ICD port. The primary purpose of this port is to provide an alternate In-Circuit Debugging (ICD) option and free the pins (RB6, RB7 and MCLR) that would normally be used for debugging the application. In conjunction with ICD capability, however, the dedicated ICSP/ICD port also provides an alternate port for ICSP.

The dedicated ICSP/ICD port functions the same as the default ICSP/ICD port; however, alternate pins are used instead of the default pins. Table 2-5 identifies the functionally equivalent pins for ICSP purposes.

The dedicated ICSP/ICD port is an alternate port. Thus, ICSP is still available through the default port. When the VIH is seen on the MCLR/VPP/RA5/FLTA pin prior to applying VIH to the ICRST/ICVPP pin, then the state of the ICRST/ICVPP pin is ignored. Likewise, when the VIH is seen on ICRST/ICVPP prior to applying VIH to MCLR/VPP/RA5/FLTA, then the state of the MCLR/VPP/RA5/FLTA pin is ignored.

TABLE 2-5: ICSP™ EQUIVALENT PINS

Pin Name	During Programming			
	Pin Name	Pin Type	Dedicated Pin	Pin Description
MCLR/VPP/RA5/FLTA	VPP	P	ICRST/ICVPP	Programming Enable
RB6	PGC	I	ICCK/ICPGC	Serial Clock
RB7	PGD	I/O	ICDT/ICPGD	Serial Data

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

3.0 DEVICE PROGRAMMING

Programming includes the ability to erase or write the various memory regions within the device.

In all cases except high-voltage ICSP Bulk Erase, the EECON1 register must be configured in order to operate on a particular memory region.

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 or write sequence is initiated by setting the WR bit (EECON1<1> = 1). It is strongly recommended that the WREN bit only be set immediately prior to a program erase.

3.1 ICSP Erase

3.1.1 HIGH-VOLTAGE ICSP BULK ERASE

Erasing code or data EEPROM is accomplished by configuring two Bulk Erase Control registers located at 3C0004h and 3C0005h. 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. If data EEPROM is code-protected (CPD = 0), the user must request an erase of data EEPROM (e.g., 0084h as shown in Table 3-1).

TABLE 3-1: BULK ERASE OPTIONS

Description	Data (3C0005h:3C0004h)
Chip Erase	0F87h
Erase Data EEPROM(1)	0084h
Erase Boot Block	0081h
Erase Configuration Bits	0082h
Erase Code EEPROM Block 0	0180h
Erase Code EEPROM Block 1	0280h
Erase Code EEPROM Block 2	0480h
Erase Code EEPROM Block 3	0880h

Note 1: Selected devices only, see **Section 3.3 "Data EEPROM Programming"**.

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

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

Note: A Bulk Erase is the only way to reprogram code-protect bits from an ON state to an OFF state.

TABLE 3-2: 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 05	MOVLW 05h
0000	6E F6	MOVWF TBLPTRL
1100	0F 0F	Write 0Fh to 3C0005h
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	87 87	Write 8787h to 3C0004h to erase entire device.
0000	00 00	NOP
0000	00 00	Hold PGD low until erase completes.

FIGURE 3-1: BULK ERASE FLOW

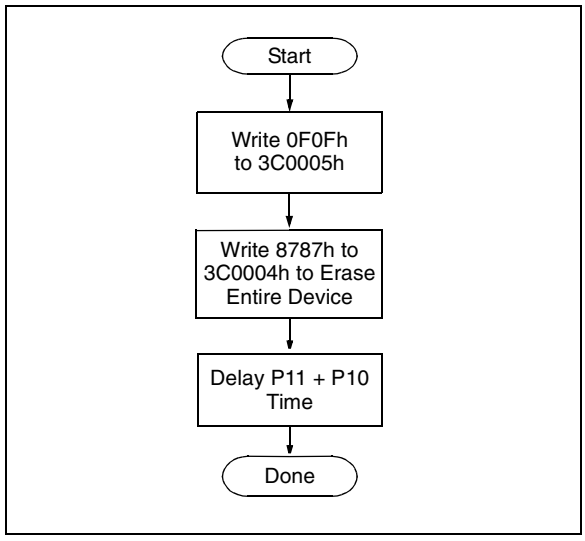
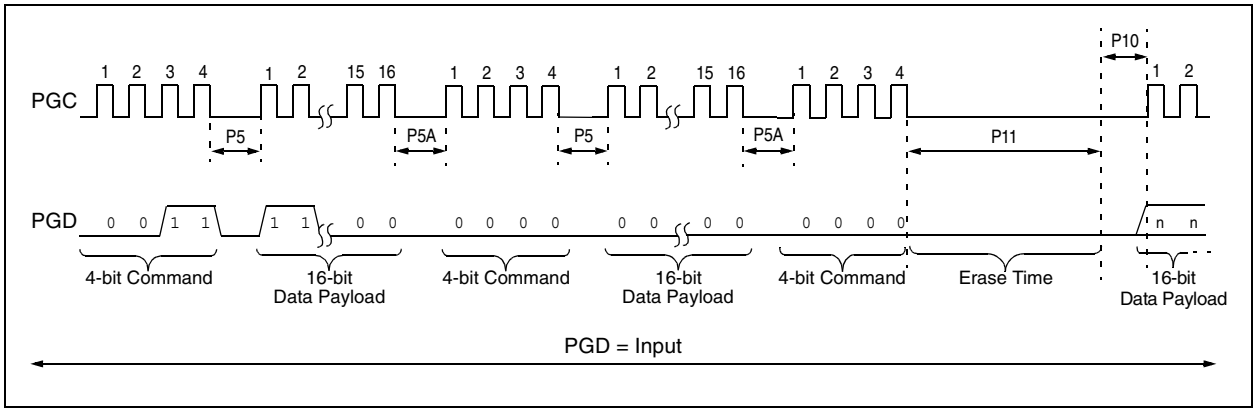


FIGURE 3-2: BULK ERASE TIMING



3.1.2 ICSP ROW ERASE

For a PIC18F1230/1330 device, it is possible to erase one row (64 bytes of data), provided the block is not code or write-protected. Rows are located at static boundaries, beginning at program memory address 000000h, extending to the internal program memory limit (see **Section 2.3 "Memory Maps"**).

The Row Erase duration is externally timed and is controlled by PGC. After the WR bit in EECON1 is set, a NOP is issued, where the 4th PGC is held high for the duration of the programming time, P9.

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

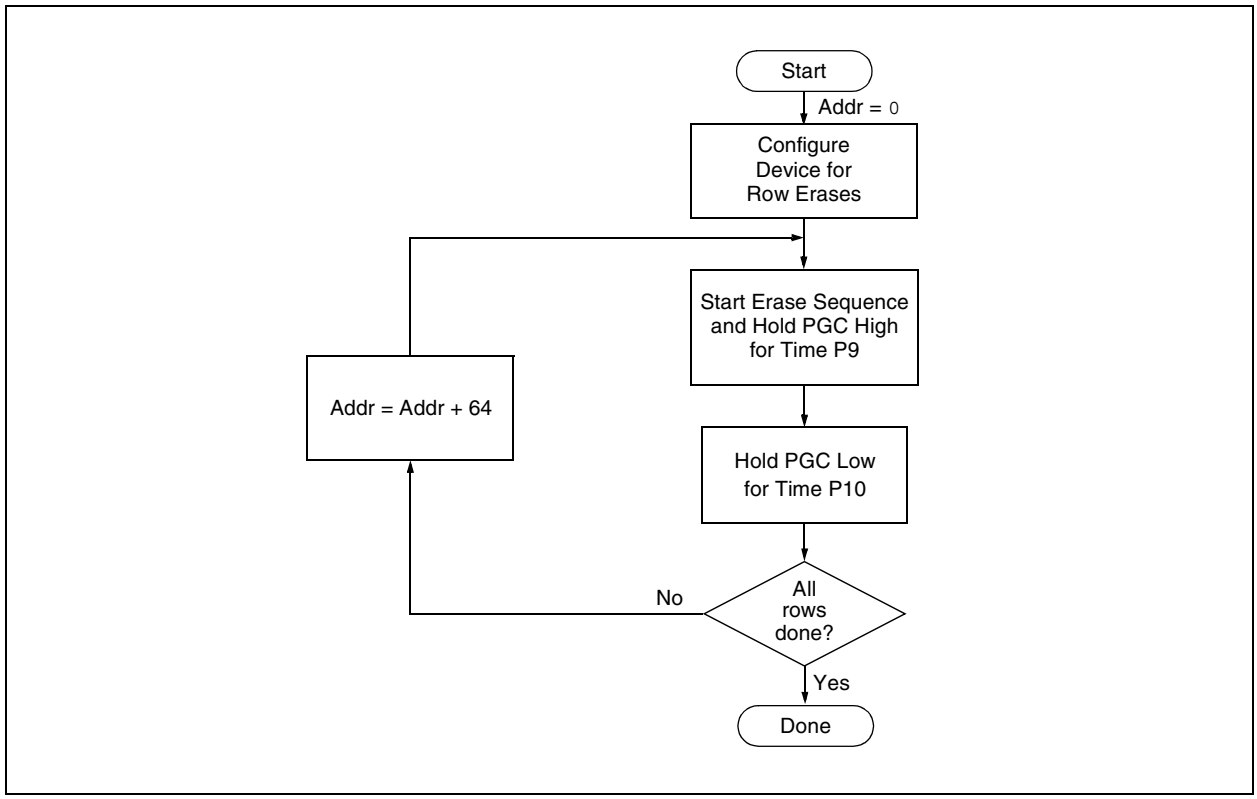
The code sequence to Row Erase a PIC18F1230/1330 device is shown in Table 3-3. The flowchart shown in Figure 3-3 depicts the logic necessary to completely erase a PIC18F1230/1330 device. The timing diagram that details the Start Programming command and parameters P9 and P10 is shown in Figure 3-5.

Note:	The TBLPTR register can point at any byte within the row intended for erase.

TABLE 3-3: ERASE CODE MEMORY CODE SEQUENCE

4-bit Command	Data Payload	Core Instruction
Step 1: Direct access to code memory and enable writes.		
0000	8E A6	BSF EECON1, EEPGD
0000	9C A6	BCF EECON1, CFGS
0000	84 A6	BSF EECON1, WREN
Step 2: Point to first row in code memory.		
0000	6A F8	CLRF TBLPTRU
0000	6A F7	CLRF TBLPTRH
0000	6A F6	CLRF TBLPTRL
Step 3: Enable erase and erase single row.		
0000	88 A6	BSF EECON1, FREE
0000	82 A6	BSF EECON1, WR
0000	00 00	NOP - hold PGC high for time P9 and low for time P10.
Step 4: Repeat step 3, with Address Pointer incremented by 64 until all rows are erased.		

FIGURE 3-3: SINGLE ROW ERASE CODE MEMORY FLOW



3.2 Code Memory Programming

Programming code memory is accomplished by first loading data into the write buffer and then initiating a programming sequence. The write and erase buffer sizes shown in Table 3-4 can be mapped to any location of the same size, beginning at 000000h. The actual memory write sequence takes the contents of this buffer and programs the proper amount of code memory that contains the Table Pointer.

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

After PGC is brought low, the programming sequence is terminated. PGC 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 PIC18F1230/1330 device is shown in Table 3-5. The flowchart shown in Figure 3-4 depicts the logic necessary to completely write a PIC18F1230/1330 device. The timing diagram that details the Start Programming command and parameters P9 and P10 is shown in Figure 3-5.

Note:	The TBLPTR register must point to the same region when initiating the programming sequence as it did when the write buffers were loaded.

TABLE 3-4: WRITE AND ERASE BUFFER SIZES

Device	Write Buffer Size (bytes)	Erase Buffer Size (bytes)
PIC18F1230	8	64
PIC18F1330		

TABLE 3-5: WRITE CODE MEMORY CODE SEQUENCE

4-bit Command	Data Payload	Core Instruction
Step 1: Direct access to code memory and enable writes.		
0000	8E A6	BSF EECON1, EEPGD
0000	9C A6	BCF EECON1, CFGS
Step 2: Load write buffer.		
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 3: Repeat for all but the last two bytes.		
1101	<MSB><LSB>	Write 2 bytes and post-increment address by 2.
Step 4: Load write buffer for last two bytes.		
1111	<MSB><LSB>	Write 2 bytes and start programming.
0000	00 00	NOP - hold PGC high for time P9 and low for time P10.
To continue writing data, repeat steps 2 through 4, where the Address Pointer is incremented by 2 at each iteration of the loop.		

FIGURE 3-4: PROGRAM CODE MEMORY FLOW ‘

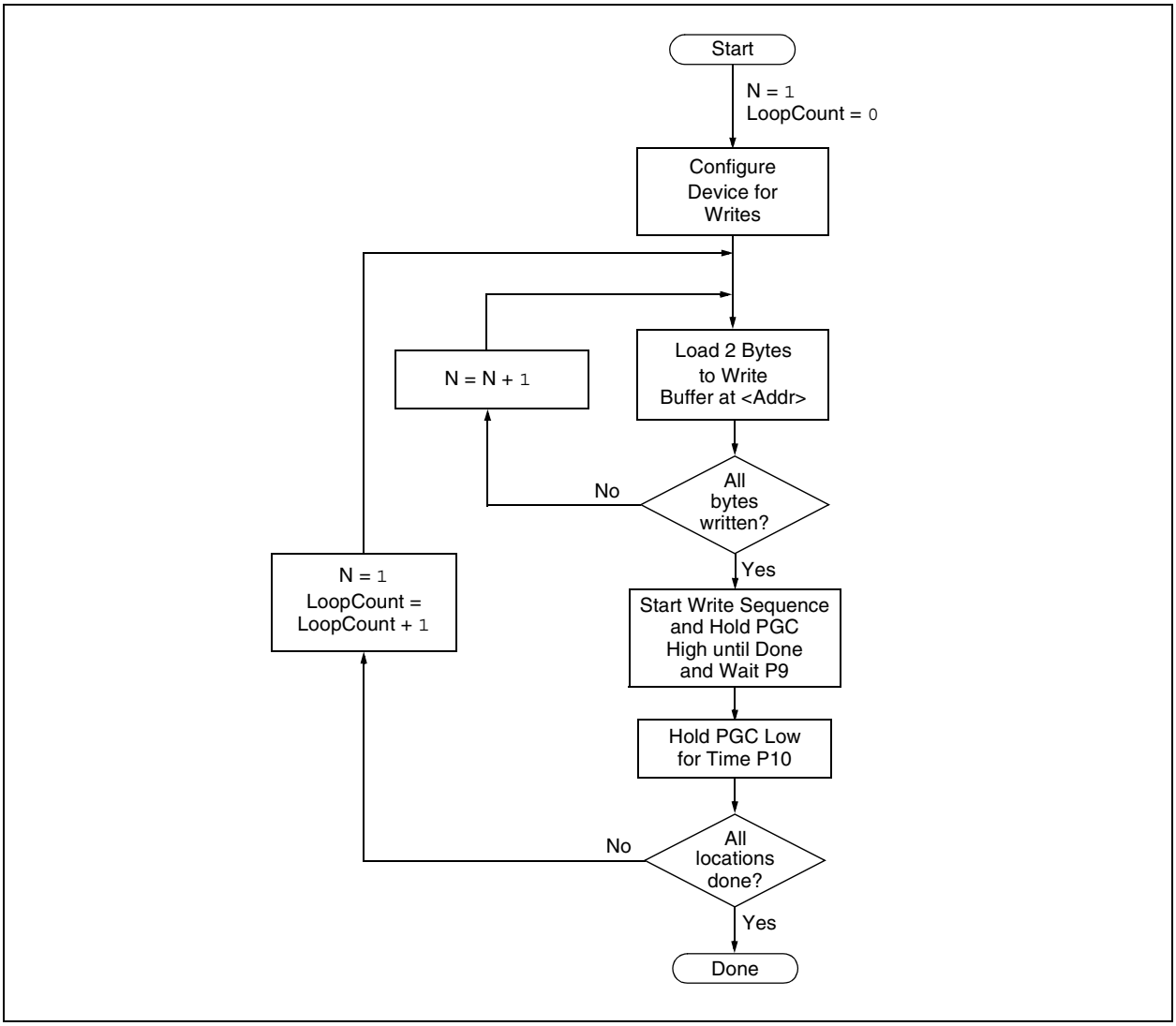
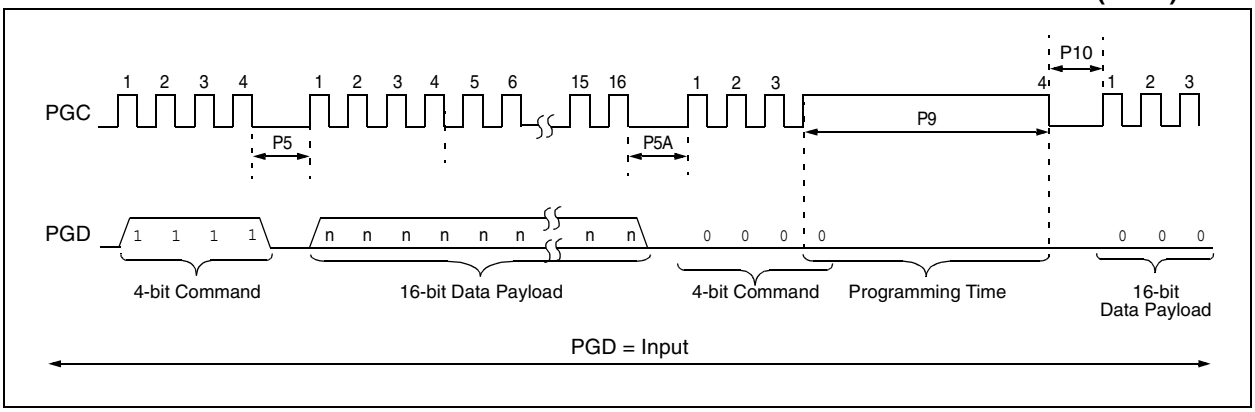


FIGURE 3-5: TABLE WRITE AND START PROGRAMMING INSTRUCTION TIMING (1111)



3.2.1 MODIFYING CODE MEMORY

The previous programming example assumed that the device had been Bulk Erased prior to programming (see **Section 3.1.1 "High-Voltage ICSP Bulk Erase"**). It may be the case, however, that the user wishes to modify only a section of an already programmed device.

The appropriate number of bytes required for the erase buffer must be read out of code memory (as described in **Section 4.2 "Verify Code Memory and ID Locations"**) and buffered. Modifications can be made on this buffer. Then, the block of code memory that was read out must be erased and rewritten with the modified data.

The WREN bit must be set if the WR bit in EECON1 is used to initiate a write sequence.

TABLE 3-6: MODIFYING CODE MEMORY

4-bit Command	Data Payload	Core Instruction
Step 1: Direct access to code memory.		
Step 2: Read and modify code memory (see **Section 4.1 "Read Code Memory, ID Locations and Configuration Bits"**).		
0000	8E A6	BSF EECON1, EEPGD
0000	9C A6	BCF EECON1, CFGS
Step 3: 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 4: Enable memory writes and set up an erase.		
0000	84 A6	BSF EECON1, WREN
0000	88 A6	BSF EECON1, FREE
Step 5: Initiate erase.		
0000	82 A6	BSF EECON1, WR
0000	00 00	NOP - hold PGC high for time P9 and low for time P10.
Step 6: Load write buffer. The correct bytes will be selected based on the Table Pointer.		
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
1101	<MSB><LSB>	Write 2 bytes and post-increment address by 2.
.	.	
.	.	Repeat as many times as necessary to fill the write buffer
.	.	
1111	<MSB><LSB>	Write 2 bytes and start programming.
0000	00 00	NOP - hold PGC high for time P9 and low for time P10.
To continue modifying data, repeat Steps 2 through 6, where the Address Pointer is incremented by the appropriate number of bytes (see Table 3-4) at each iteration of the loop. The write cycle must be repeated enough times to completely rewrite the contents of the erase buffer.		
Step 7: Disable writes.		
0000	94 A6	BCF EECON1, WREN

3.3 Data EEPROM Programming

Data EEPROM is accessed one byte at a time via an Address Pointer (register pair, EEADRH:EEADR) and a Data Latch (EEDATA). Data EEPROM is written by loading EEADRH:EEADR with the desired memory location, EEDATA with the data to be written and initiating a memory write by appropriately configuring the EECON1 register. 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 (EECON1<7:6> = 00). The WREN bit must be set (EECON1<2> = 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 (EECON1<1> = 1).

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

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

FIGURE 3-6: PROGRAM DATA FLOW

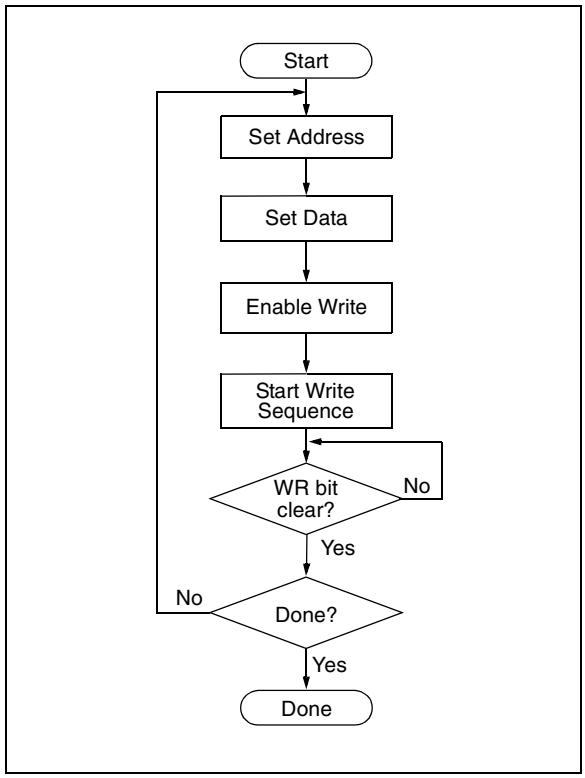


FIGURE 3-7: DATA EEPROM WRITE TIMING

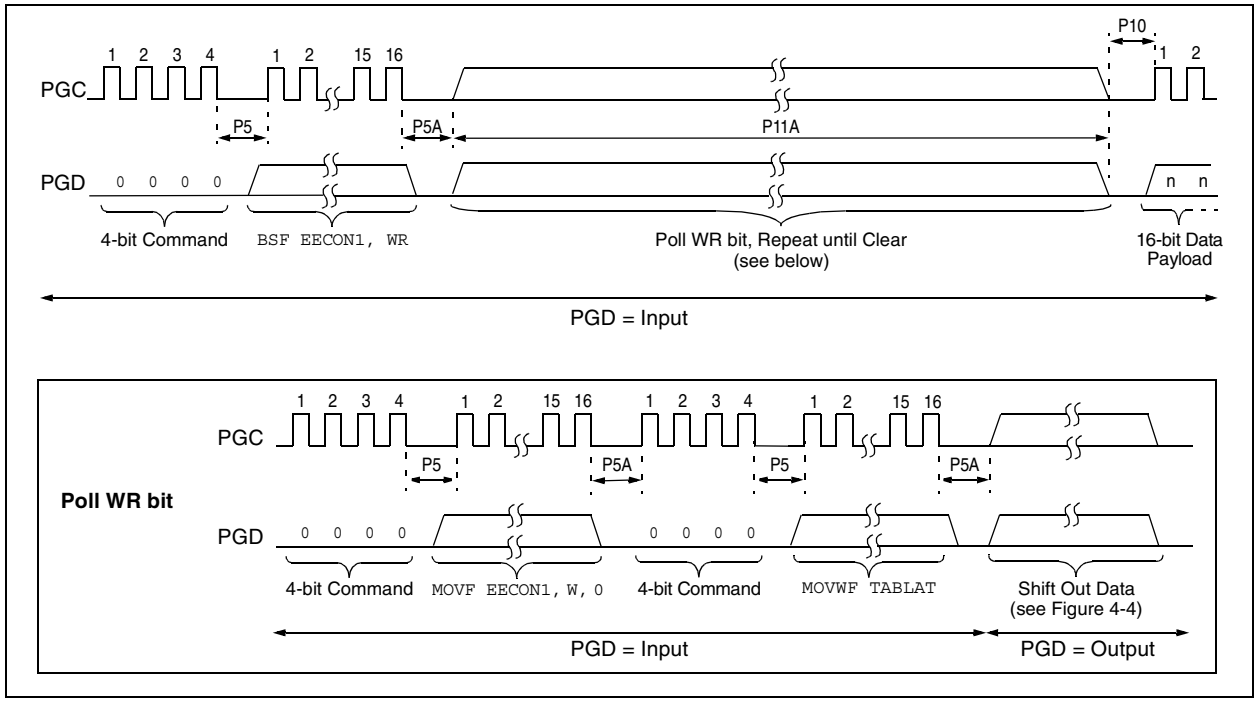


TABLE 3-7: PROGRAMMING DATA MEMORY

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	OE <AddrH>	MOVLW <AddrH>
0000	6E AA	MOVWF EEADRH
Step 3: Load the data to be written.		
0000	0E <Data>	MOVLW <Data>
0000	6E A8	MOVWF EEDATA
Step 4: Enable memory writes.		
0000	84 A6	BSF EECON1, WREN
Step 5: Initiate write.		
0000	82 A6	BSF EECON1, WR
Step 6: Poll WR bit, repeat until the bit is clear.		
0000	50 A6	MOVF EECON1, W, 0
0000	6E F5	MOVWF TABLAT
0000	00 00	NOP
0010	<MSB><LSB>	Shift out data(1)
Step 7: Hold PGC low for time P10.		
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.

3.4 ID Location Programming

The ID locations are programmed much like the code memory. The ID registers are mapped in addresses 200000h through 200007h. These locations read out normally even after code protection.

Note:	The user only needs to fill the first 8 bytes of the write buffer in order to write the ID locations.

Table 3-8 demonstrates the code sequence required to write the ID locations.

In order to modify the ID locations, refer to the methodology described in **Section 3.2.1 "Modifying Code Memory"**. As with code memory, the ID locations must be erased before being modified.

TABLE 3-8: WRITE ID SEQUENCE

4-bit Command	Data Payload	Core Instruction
Step 1: Direct access to code memory and enable writes.		
0000	8E A6	BSF EECON1, EEPGD
0000	9C A6	BCF EECON1, CFGS
Step 2: Load write buffer with 8 bytes and write.		
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	<MSB><LSB>	Write 2 bytes and post-increment address by 2.
1101	<MSB><LSB>	Write 2 bytes and post-increment address by 2.
1101	<MSB><LSB>	Write 2 bytes and post-increment address by 2.
1111	<MSB><LSB>	Write 2 bytes and start programming.
0000	00 00	NOP - hold PGC high for time P9 and low for time P10.

3.5 Boot Block Programming

The code sequence detailed in Table 3-5 should be used, except that the address used in “Step 2” will be in the range of 00000h to 007FFh.

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 Table 3-9.

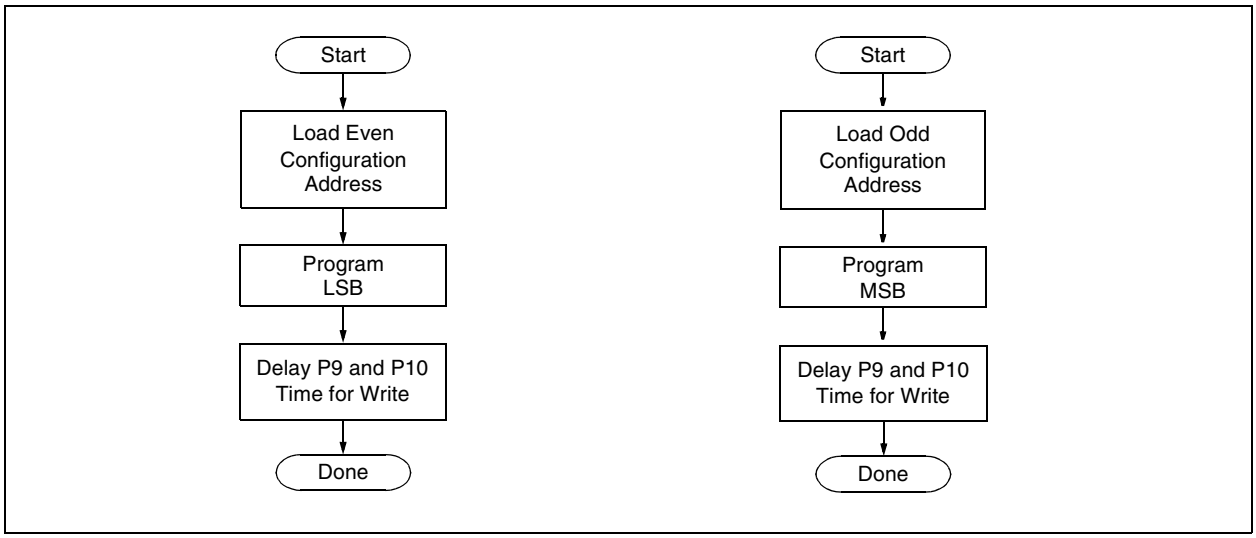
Note:	The address must be explicitly written for each byte programmed. The addresses can not be incremented in this mode.

TABLE 3-9: SET ADDRESS POINTER TO CONFIGURATION LOCATION

4-bit Command	Data Payload	Core Instruction
Step 1: Enable writes and direct access to Configuration memory.		
0000	8E A6	BSF EECON1, EEPGD
0000	8C A6	BSF EECON1, CFGS
Step 2: Set Table Pointer for Configuration byte to be written. Write even/odd addresses.(1)		
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	<MSB ignored><LSB>	Load 2 bytes and start programming.
0000	00 00	NOP - hold PGC high for time P9 and low for time P10.
0000	0E 01	MOVLW 01h
0000	6E F6	MOVWF TBLPTRL
1111	<MSB><LSB ignored>	Load 2 bytes and start programming.
0000	00 00	NOP - hold PGC high for time P9 and low for time P10.

Note 1: 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 3-8: CONFIGURATION PROGRAMMING FLOW



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 serially output on PGD.

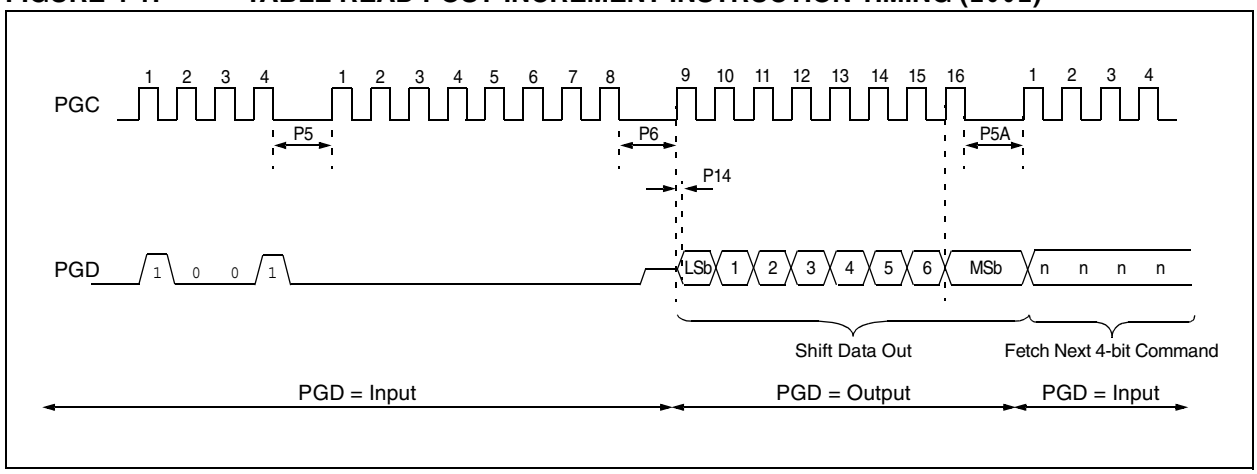
The 4-bit command is shifted in LSb first. The read is executed during the next 8 clocks, then shifted out on PGD during the last 8 clocks, LSb to MSb. A delay of P6 must be introduced after the falling edge of the 8th PGC of the operand to allow PGD to transition from an input to an output. During this time, PGC 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 3FFFFFh 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 and then shift out on PGD, LSb to MSb.		
1001	00 00	TBLRD *+

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

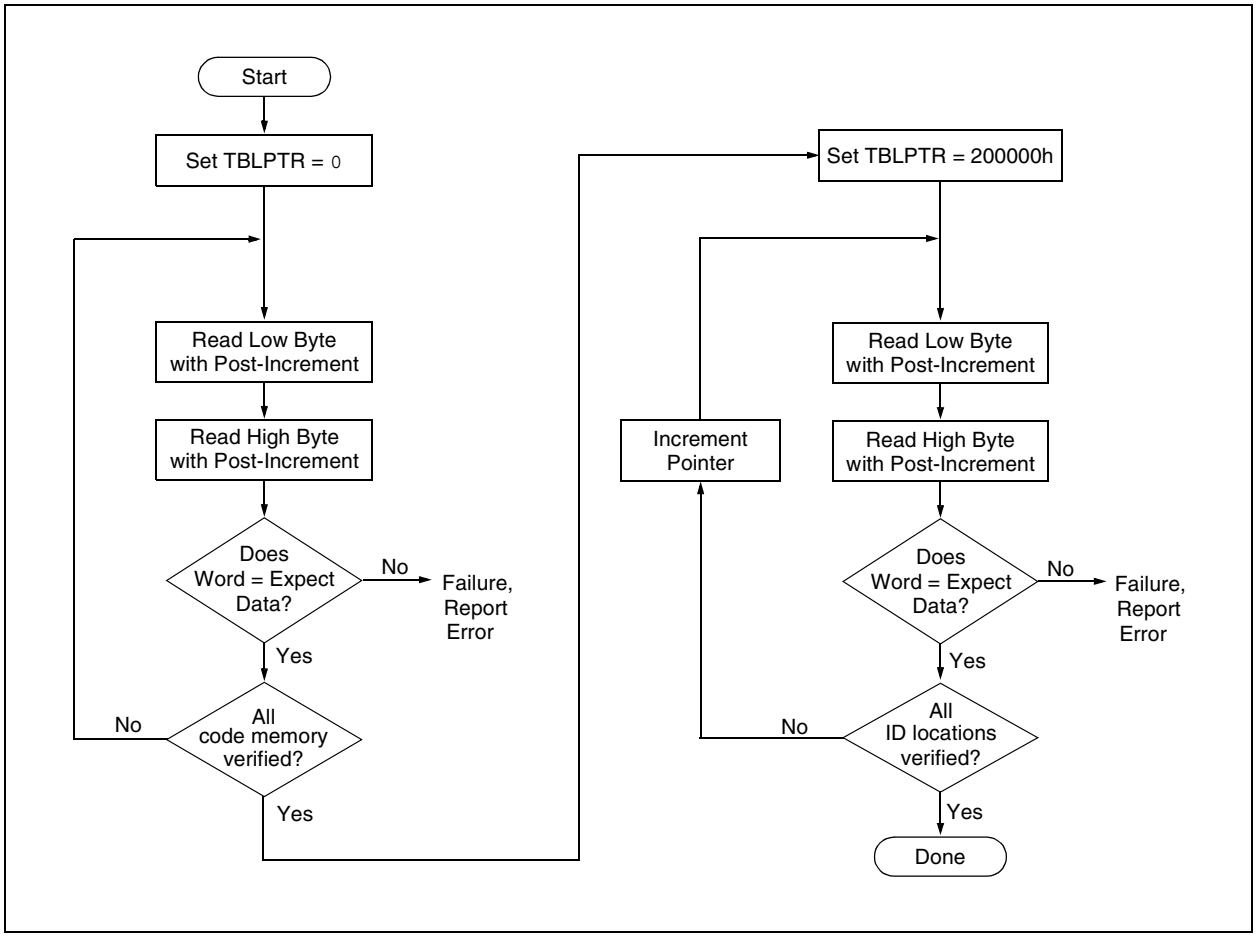


4.2 Verify Code Memory and ID Locations

The verify step involves reading back the code memory space and comparing it 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 "Read Code Memory, ID Locations and Configuration Bits"** 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 an 8-Kbyte device, for example, a post-increment read of address 01FFFh will wrap the Table Pointer back to 00000h, rather than point to unimplemented address, 02000h.

FIGURE 4-2: VERIFY CODE MEMORY FLOW



4.3 Verify Configuration Bits

A Configuration address may be read and output on PGD 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 "Read Code Memory, ID Locations and Configuration Bits"** 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, EEADRH:EEADR) and a Data Latch (EEDATA). Data EEPROM is read by loading EEADRH:EEADR 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 PGD 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 PGC of the operand to allow PGD to transition from an input to an output. During this time, PGC must be held low (see Figure 4-4).

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

FIGURE 4-3: READ DATA EEPROM FLOW

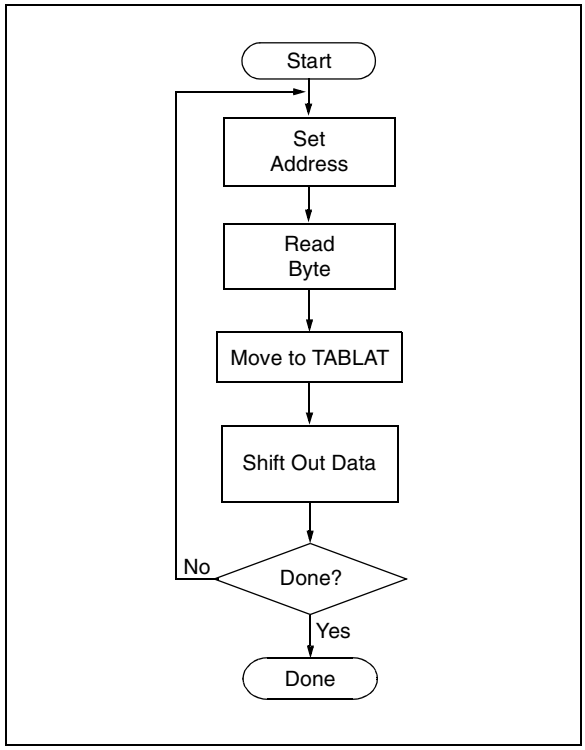
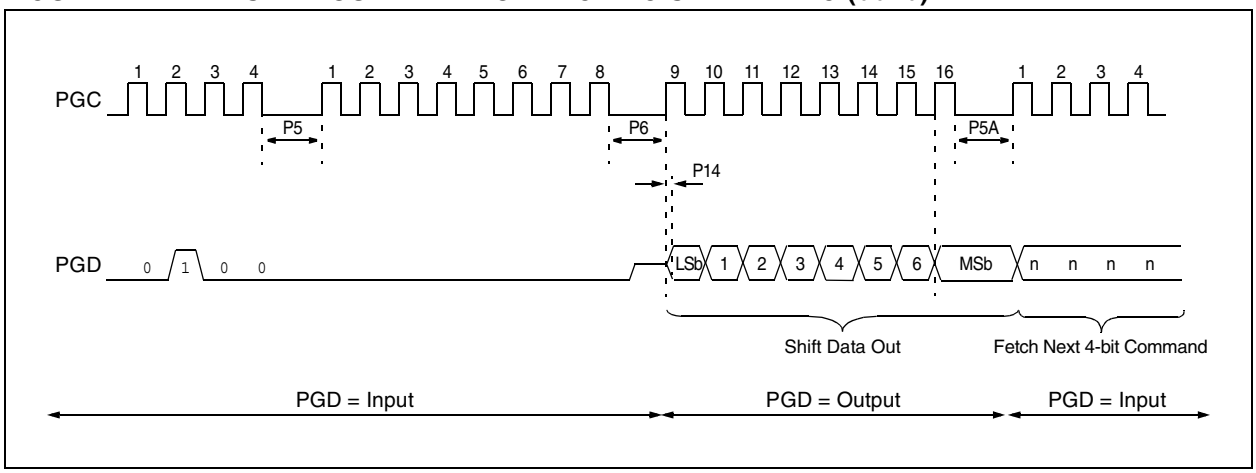


TABLE 4-2: READ DATA EEPROM MEMORY

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	OE <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
0000	00 00	NOP
0010	<MSB><LSB>	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 PGD via the 4-bit command, '0010' (TABLAT register). The result may then be immediately compared to the appropriate data in the programmer's memory for verification. Refer to **Section 4.4 "Read Data EEPROM Memory"** for implementation details of reading data EEPROM.

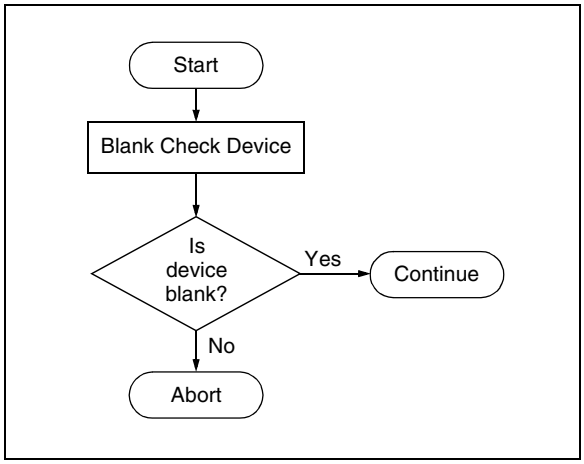
4.6 Blank Check

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'. Therefore, 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 5-1 for blank Configuration expect data for the various PIC18F1230/1330 devices.

Given that Blank Checking is merely code and data EEPROM verification with FFh expect data, refer to **Section 4.4 "Read Data EEPROM Memory"** and **Section 4.2 "Verify Code Memory and ID Locations"** for implementation details.

FIGURE 4-5: BLANK CHECK FLOW



5.0 CONFIGURATION WORD

The PIC18F1230/1330 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. See Table 5-1 for a list of Configuration bits and Device IDs and Table 5-3 for the Configuration bit descriptions.

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 Fh. In doing so, if the user code inadvertently tries to execute from the ID space, the ID data will execute as a NOP.

5.2 Device ID Word

The Device ID Word for the PIC18F1230/1330 devices 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. See Table 5-2 for a complete list of Device ID values.

FIGURE 5-1: READ DEVICE ID WORD FLOW

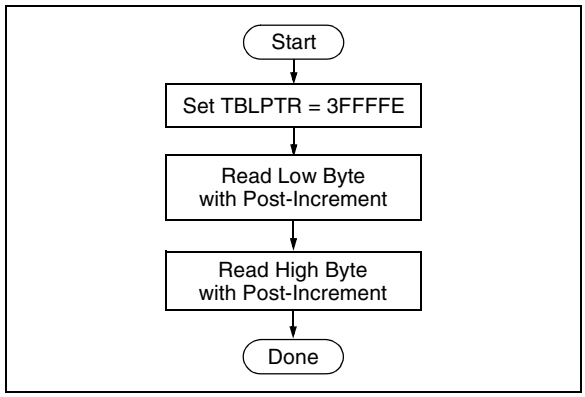


TABLE 5-1: CONFIGURATION BITS AND DEVICE IDs

File Name		Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0	Default/ Unprogrammed Value
300001h	CONFIG1H	IESO	FCMEN	—	—	FOSC3	FOSC2	FOSC1	FOSC0	00-- 0111
300002h	CONFIG2L	—	—	—	BORV1	BORV0	BOREN1	BOREN0	$\overline{\text{PWRTEN}}$	---1 1111
300003h	CONFIG2H	—	—	—	WDTPS3	WDTPS2	WDTPS1	WDTPS0	WDTEN	---1 1111
300004h	CONFIG3L	—	—	—	—	HPOL	LPOL	PWMPIN	—	---- 111-
300005h	CONFIG3H	MCLRE	—	—	—	T1OSCMX	—	—	FLTAMX	1--- 0--1
300006h	CONFIG4L	$\overline{\text{BKBUG}}$	XINST	BBSIZ1	BBSIZ0	—	—	—	STVREN	1000 ---1
300008h	CONFIG5L	—	—	—	—	—	—	CP1	CP0	---- --11
300009h	CONFIG5H	CPD	CPB	—	—	—	—	—	—	11-- ----
30000Ah	CONFIG6L	—	—	—	—	—	—	WRT1	WRT0	---- --11
30000Bh	CONFIG6H	WRTD	WRTB	WRTC	—	—	—	—	—	111- ----
30000Ch	CONFIG7L	—	—	—	—	—	—	EBTR1	EBTR0	---- --11
30000Dh	CONFIG7H	—	EBTRB	—	—	—	—	—	—	-1-- ----
3FFFFEh	DEVID1(1)	DEV2	DEV1	DEV0	REV4	REV3	REV2	REV1	REV0	See Table 5-2
3FFFFFh	DEVID2(1)	DEV10	DEV9	DEV8	DEV7	DEEV6	DEV5	DEV4	DEV3	See Table 5-2

Legend: x = unknown, u = unchanged, - = unimplemented.Shaded cells are unimplemented, read as '0'.

Note 1: DEVID registers are read-only and cannot be programmed by the user.

TABLE 5-2: DEVICE ID VALUE

Device	Device ID Value	
	DEVID2	DEVID1
PIC18F1230	1Eh	000x xxxx
PIC18F1330	1Eh	001x xxxx
PIC18F1330-ICD	1Fh	111x xxxx

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

TABLE 5-3: PIC18F1230/1330 BIT DESCRIPTIONS

Bit Name	Configuration Words	Description
IESO	CONFIG1H	Internal External Switchover bit 1 = Internal External Switchover mode enabled 0 = Internal External Switchover mode disabled
FCMEN	CONFIG1H	Fail-Safe Clock Monitor Enable bit 1 = Fail-Safe Clock Monitor enabled 0 = Fail-Safe Clock Monitor disabled
FOSC3:FOSC0	CONFIG1H	Oscillator Selection bits 11xx = External RC oscillator, CLKO function on RA6 101x = External RC oscillator, CLKO function on RA6 1001 = Internal RC oscillator, CLKO function on RA6, port function on RA7 1000 = Internal RC oscillator, port function on RA6, port function on RA7 0111 = External RC oscillator, port function on RA6 0110 = HS oscillator, PLL enabled (Clock Frequency = 4 x FOSC1) 0101 = EC oscillator, port function on RA6 0100 = EC oscillator, CLKO function on RA6 0011 = External RC oscillator, CLKO function on RA6 0010 = HS oscillator 0001 = XT oscillator 0000 = LP oscillator
BORV1:BORV0	CONFIG2L	Brown-out Reset Voltage bits 11 = V_{BOR} set to 2.0V 10 = V_{BOR} set to 2.7V 01 = V_{BOR} set to 4.2V 00 = V_{BOR} set to 4.5V
BOREN1:BOREN0	CONFIG2L	Brown-out Reset Enable bits 11 = Brown-out Reset enabled in hardware only (SBOREN is disabled) 10 = Brown-out Reset enabled in hardware only and disabled in Sleep mode (SBOREN is disabled) 01 = Brown-out Reset enabled and controlled by software (SBOREN is enabled) 00 = Brown-out Reset disabled in hardware and software
$\overline{\text{PWRTEN}}$	CONFIG2L	Power-up Timer Enable bit 1 = PWRT disabled 0 = PWRT enabled
WDTPS3:WDTPS0	CONFIG2H	Watchdog Timer Postscaler Select bits 1111 = 1:32,768 1110 = 1:16,384 1101 = 1:8,192 1100 = 1:4,096 1011 = 1:2,048 1010 = 1:1,024 1001 = 1:512 1000 = 1:256 0111 = 1:128 0110 = 1:64 0101 = 1:32 0100 = 1:16 0011 = 1:8 0010 = 1:4 0001 = 1:2 0000 = 1:1

Note 1: The BBSIZ1:BBSIZ0 bits can not be changed once any of the following code-protect bits are enabled: CPB or CP0, WRTB or WRT0, EBTRB or EBTR0.

TABLE 5-3: PIC18F1230/1330 BIT DESCRIPTIONS (CONTINUED)

Bit Name	Configuration Words	Description
WDTEN	CONFIG2H	Watchdog Timer Enable bit 1 = WDT enabled 0 = WDT disabled (control is placed on SWDTEN bit)
HPOL	CONFIG3L	High Side Transistors Polarity bit (Odd PWM Output Polarity Control bit) 1 = PWM 1, 3 and 5 are active-high (default) 0 = PWM 1, 3 and 5 are active-low
LPOL	CONFIG3L	Low Side Transistors Polarity bit (Even PWM Output Polarity Control bit) 1 = PWM 0, 2 and 4 are active-high (default) 0 = PWM 0, 2 and 4 are active-low
PWMPIN	CONFIG3L	PWM Output Pins Reset State Control bit 1 = PWM outputs disabled upon Reset 0 = PWM outputs drive active states upon Reset
MCLRE	CONFIG3H	$\overline{\text{MCLR}}$ Pin Enable bit 1 = $\overline{\text{MCLR}}$ pin enabled, RA5 input pin disabled 0 = RA5 input pin enabled, $\overline{\text{MCLR}}$ pin disabled
T1OSCMX	CONFIG3H	T1OSC MUX bit 1 = T1OSC pins reside on RA6 and RA7 0 = T1OSC pins reside on RB2 and RB3
FLTAMX	CONFIG3H	$\overline{\text{FLTA}}$ MUX bit 1 = $\overline{\text{FLTA}}$ is multiplexed with RA5 0 = $\overline{\text{FLTA}}$ is multiplexed with RA7
$\overline{\text{BKBUG}}$	CONFIG4L	Background Debugger Enable bit 1 = Background debugger disabled, RB6 and RB7 configured as general purpose I/O pins 0 = Background debugger enabled, RB6 and RB7 are dedicated to In-Circuit Debug
XINST	CONFIG4L	Extended Instruction Set Enable bit 1 = Instruction set extension and Indexed Addressing mode enabled 0 = Instruction set extension and Indexed Addressing mode disabled (Legacy mode)
BBSIZ1:BBSIZ0(1)	CONFIG4L	Boot Block Size Select bits For PIC18F1330 device: 11 = 1 kW Boot Block size 10 = 1 kW Boot Block size 01 = 512W Boot Block size 00 = 256W Boot Block size For PIC18F1230 device: 11 = 512W Boot Block size 10 = 512W Boot Block size 01 = 512W Boot Block size 00 = 256W Boot Block size
STVREN	CONFIG4L	Stack Overflow/Underflow Reset Enable bit 1 = Reset on stack overflow/underflow enabled 0 = Reset on stack overflow/underflow disabled
CP1	CONFIG5L	Code Protection bits (Block 1 code memory area) 1 = Block 1 is not code-protected 0 = Block 1 is code-protected

Note 1: The BBSIZ1:BBSIZ0 bits can not be changed once any of the following code-protect bits are enabled: CPB or CP0, WRTB or WRT0, EBTRB or EBTR0.

TABLE 5-3: PIC18F1230/1330 BIT DESCRIPTIONS (CONTINUED)

Bit Name	Configuration Words	Description
CP0	CONFIG5L	Code Protection bits (Block 0 code memory area) 1 = Block 0 is not code-protected 0 = Block 0 is code-protected
CPD	CONFIG5H	Code Protection bits (Data EEPROM) 1 = Data EEPROM is not code-protected 0 = Data EEPROM is code-protected
CPB	CONFIG5H	Code Protection bits (Boot Block memory area) 1 = Boot Block is not code-protected 0 = Boot Block is code-protected
WRT1	CONFIG6L	Write Protection bits (Block 1 code memory area) 1 = Block 1 is not write-protected 0 = Block 1 is write-protected
WRT0	CONFIG6L	Write Protection bits (Block 0 code memory area) 1 = Block 0 is not write-protected 0 = Block 0 is write-protected
WRTD	CONFIG6H	Write Protection bit (Data EEPROM) 1 = Data EEPROM is not write-protected 0 = Data EEPROM is write-protected
WRTB	CONFIG6H	Write Protection bit (Boot Block memory area) 1 = Boot Block is not write-protected 0 = Boot Block is write-protected
WRTC	CONFIG6H	Write Protection bit (Configuration registers) 1 = Configuration registers are not write-protected 0 = Configuration registers are write-protected
EBTR1	CONFIG7L	Table Read Protection bit (Block 1 code memory area) 1 = Block 1 is not protected from table reads executed in other blocks 0 = Block 1 is protected from table reads executed in other blocks
EBTR0	CONFIG7L	Table Read Protection bit (Block 0 code memory area) 1 = Block 0 is not protected from table reads executed in other blocks 0 = Block 0 is protected from table reads executed in other blocks
EBTRB	CONFIG7H	Table Read Protection bit (Boot Block memory area) 1 = Boot Block is not protected from table reads executed in other blocks 0 = Boot Block is 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.

Note 1: The BBSIZ1:BBSIZ0 bits can not be changed once any of the following code-protect bits are enabled: CPB or CP0, WRTB or WRT0, EBTRB or EBTR0.

5.3 Embedding Configuration Word Information in the HEX File

To allow portability of code, a PIC18F1230/1330 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.

5.4 Embedding Data EEPROM Information in the HEX File

To allow portability of code, a PIC18F1230/1330 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.

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 30 through 31) describes how to calculate the checksum for each device.

Note:	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.

TABLE 5-4: CHECKSUM COMPUTATION

Device	Code-Protect	Checksum	Blank Value	0xAA at 0 and Max Address
PIC18F1230	None	SUM(0000:01FF)+SUM(0200:FFF)+SUM(1000:1FFF)+(CONFIG0 & 0000)+ (CONFIG1 & 0007)+(CONFIG2 & 001F)+(CONFIG3 & 001F)+ (CONFIG4 & 000E)+(CONFIG5 & 0081)+(CONFIG6 & 0081)+ (CONFIG7 & 0000)+(CONFIG8 & 0003)+(CONFIG9 & 00C0)+ (CONFIG10 & 0003)+(CONFIG11 & 00E0)+(CONFIG12 & 0003)+ (CONFIG13 & 0040)	F33E	F294
	Boot 256W	SUM(0200:FFF)+SUM(1000:1FFF)+(CONFIG0 & 0000)+(CONFIG1 & 0007)+ (CONFIG2 & 001F)+(CONFIG3 & 001F)+(CONFIG4 & 000E)+ (CONFIG5 & 0081)+(CONFIG6 & 0081)+(CONFIG7 & 0000)+ (CONFIG8 & 0003)+(CONFIG9 & 00C0)+(CONFIG10 & 0003)+ (CONFIG11 & 00E0)+(CONFIG12 & 0003)+(CONFIG13 & 0040)+SUM(IDs)	F2FE	F254
	Boot 512W	SUM(0400:FFF)+SUM(1000:1FFF)+(CONFIG0 & 0000)+(CONFIG1 & 0007)+ (CONFIG2 & 001F)+(CONFIG3 & 001F)+(CONFIG4 & 000E)+ (CONFIG5 & 0081)+(CONFIG6 & 0081)+(CONFIG7 & 0000)+ (CONFIG8 & 0003)+(CONFIG9 & 00C0)+(CONFIG10 & 0003)+ (CONFIG11 & 00E0)+(CONFIG12 & 0003)+(CONFIG13 & 0040)+SUM(IDs)	F30E	F264
	Boot/ Block 0	SUM(1000:1FFF)+(CONFIG0 & 0000)+(CONFIG1 & 0007)+ (CONFIG2 & 001F)+(CONFIG3 & 001F)+(CONFIG4 & 000E)+ (CONFIG5 & 0081)+(CONFIG6 & 0081)+(CONFIG7 & 0000)+ (CONFIG8 & 0003)+(CONFIG9 & 00C0)+(CONFIG10 & 0003)+ (CONFIG11 & 00E0)+(CONFIG12 & 0003)+(CONFIG13 & 0040)+SUM(IDs)	F30D	F263
	All	(CONFIG0 & 0000)+(CONFIG1 & 0007)+(CONFIG2 & 001F)+ (CONFIG3 & 001F)+(CONFIG4 & 000E)+(CONFIG5 & 0081)+ (CONFIG6 & 0081)+(CONFIG7 & 0000)+(CONFIG8 & 0003)+ (CONFIG9 & 00C0)+(CONFIG10 & 0003)+(CONFIG11 & 00E0)+ (CONFIG12 & 0003)+(CONFIG13 & 0040)+SUM(IDs)	F31B	F271

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
PIC18F1330	None	SUM(0000:01FF)+SUM(0200:FFF)+SUM(1000:1FFF)+(CONFIG0 & 0000)+ (CONFIG1 & 0007)+(CONFIG2 & 001F)+(CONFIG3 & 001F)+ (CONFIG4 & 000E)+(CONFIG5 & 0081)+(CONFIG6 & 0081)+ (CONFIG7 & 0000)+(CONFIG8 & 0003)+(CONFIG9 & 00C0)+ (CONFIG10 & 0003)+(CONFIG11 & 00E0)+(CONFIG12 & 0003)+ (CONFIG13 & 0040)	E33E	E294
	Boot 256W	SUM(0200:FFF)+SUM(1000:1FFF)+(CONFIG0 & 0000)+(CONFIG1 & 0007)+ (CONFIG2 & 001F)+(CONFIG3 & 001F)+(CONFIG4 & 000E)+ (CONFIG5 & 0081)+(CONFIG6 & 0081)+(CONFIG7 & 0000)+ (CONFIG8 & 0003)+(CONFIG9 & 00C0)+(CONFIG10 & 0003)+ (CONFIG11 & 00E0)+(CONFIG12 & 0003)+(CONFIG13 & 0040)+SUM(IDs)	E2FE	E254
	Boot 512W	SUM(0400:FFF)+SUM(1000:1FFF)+(CONFIG0 & 0000)+(CONFIG1 & 0007)+ (CONFIG2 & 001F)+(CONFIG3 & 001F)+(CONFIG4 & 000E)+ (CONFIG5 & 0081)+(CONFIG6 & 0081)+(CONFIG7 & 0000)+ (CONFIG8 & 0003)+(CONFIG9 & 00C0)+(CONFIG10 & 0003)+ (CONFIG11 & 00E0)+(CONFIG12 & 0003)+(CONFIG13 & 0040)+SUM(IDs)	E30E	E264
	Boot 1 kW	SUM(0800:FFF)+SUM(1000:1FFF)+(CONFIG0 & 0000)+(CONFIG1 & 0007)+ (CONFIG2 & 001F)+(CONFIG3 & 001F)+(CONFIG4 & 000E)+ (CONFIG5 & 0081)+(CONFIG6 & 0081)+(CONFIG7 & 0000)+ (CONFIG8 & 0003)+(CONFIG9 & 00C0)+(CONFIG10 & 0003)+ (CONFIG11 & 00E0)+(CONFIG12 & 0003)+(CONFIG13 & 0040)+SUM(IDs)	E31E	E274
	Boot/ Block 0	SUM(1000:1FFF)+(CONFIG0 & 0000)+(CONFIG1 & 0007)+ (CONFIG2 & 001F)+(CONFIG3 & 001F)+(CONFIG4 & 000E)+ (CONFIG5 & 0081)+(CONFIG6 & 0081)+(CONFIG7 & 0000)+ (CONFIG8 & 0003)+(CONFIG9 & 00C0)+(CONFIG10 & 0003)+ (CONFIG11 & 00E0)+(CONFIG12 & 0003)+(CONFIG13 & 0040)+SUM(IDs)	E31D	E273
	All	(CONFIG0 & 0000)+(CONFIG1 & 0007)+(CONFIG2 & 001F)+ (CONFIG3 & 001F)+(CONFIG4 & 000E)+(CONFIG5 & 0081)+ (CONFIG6 & 0081)+(CONFIG7 & 0000)+(CONFIG8 & 0003)+ (CONFIG9 & 00C0)+(CONFIG10 & 0003)+(CONFIG11 & 00E0)+ (CONFIG12 & 0003)+(CONFIG13 & 0040)+SUM(IDs)	E31B	E271

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

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 MCLR/VPP/RA5/FLTA	VDD + 4.0	12.5	V	**(Note 2)**
D110A	VIHL	Low-Voltage Programming Voltage on MCLR/VPP/RA5/FLTA	2.00	5.50	V	**(Note 2)**
D111	VDD	Supply Voltage During Programming	2.00	5.50	V	Externally timed, row erases and all writes
			3.00	5.50	V	Self-timed, bulk erases only **(Note 3)**
D112	IPP	Programming Current on MCLR/VPP/RA5/FLTA	—	300	µA	**(Note 2)**
D113	IDDP	Supply Current During Programming	—	10	mA	
D031	VIL	Input Low Voltage	VSS	0.2 VDD	V	
D041	VIH	Input High Voltage	0.8 VDD	VDD	V	
D080	VOL	Output Low Voltage	—	0.6	V	IOL = 8.5 mA @ 4.5V
D090	VOH	Output High Voltage	VDD – 0.7	—	V	IOH = -3.0 mA @ 4.5V
D012	CIO	Capacitive Loading on I/O pin (PGD)	—	50	pF	To meet AC specifications
P1	TR	MCLR/VPP/RA5/FLTA Rise Time to Enter Program/Verify mode	—	1.0	µs	**(Notes 1, 2)**
P2	TPGC	Serial Clock (PGC) Period	100	—	ns	VDD = 5.0V
			1	—	µs	VDD = 2.0V
P2A	TPGCL	Serial Clock (PGC) Low Time	40	—	ns	VDD = 5.0V
			400	—	ns	VDD = 2.0V
P2B	TPGCH	Serial Clock (PGC) High Time	40	—	ns	VDD = 5.0V
			400	—	ns	VDD = 2.0V
P3	TSET1	Input Data Setup Time to Serial Clock ↓	15	—	ns	
P4	THLD1	Input Data Hold Time from PGC ↓	15	—	ns	
P5	TDLY1	Delay between 4-bit Command and Command Operand	40	—	ns	
P5A	TDLY1A	Delay between 4-bit Command Operand and Next 4-bit Command	40	—	ns	
P6	TDLY2	Delay between Last PGC ↓ of Command Byte to First PGC ↑ of Read of Data Word	20	—	ns	
P9	TDLY5	PGC High Time (minimum programming time)	1	—	ms	Externally Timed
P10	TDLY6	PGC Low Time after Programming (high-voltage discharge time)	100	—	µs	
P11	TDLY7	Delay to allow Self-Timed Data Write or Bulk Erase to Occur	5	—	ms	

Note 1: Do not allow excess time when transitioning MCLR between VIL and VIHH; this can cause spurious program executions to occur. The maximum transition time is:

1 TCY + TPWRT (if enabled) + 1024 TOSC (for LP, HS, HS/PLL and XT modes only) +
2 ms (for HS/PLL mode only) + 1.5 µs (for EC mode only)

where TCY is the instruction cycle time, TPWRT is the Power-up Timer period and TOSC is the oscillator period. For specific values, refer to the Electrical Characteristics section of the device data sheet for the particular device.

2: This specification also applies to ICVPP for PIC18F1330-ICD device.

3: At 0°C-50°C.

6.0 AC/DC CHARACTERISTICS TIMING REQUIREMENTS FOR PROGRAM/VERIFY TEST MODE (CONTINUED)

Standard Operating Conditions
Operating Temperature: 25°C is recommended

Param No.	Sym	Characteristic	Min	Max	Units	Conditions
P11A	TDRWT	Data Write Polling Time	4	—	ms	
P12	THLD2	Input Data Hold Time from $\overline{MCLR}$/VPP/RA5/$\overline{FLTA}$ ↑	2	—	µs	
P13	TSET2	VDD ↑ Setup Time to $\overline{MCLR}$/VPP/RA5/$\overline{FLTA}$ ↑	100	—	ns	**(Note 2)**
P14	TVALID	Data Out Valid from PGC ↑	10	—	ns	
P15	TSET3	PGM ↑ Setup Time to $\overline{MCLR}$/VPP/RA5/$\overline{FLTA}$ ↑	2	—	µs	**(Note 2)**
P16	TDLY8	Delay between Last PGC ↓ and $\overline{MCLR}$/VPP/RA5/$\overline{FLTA}$ ↓	0	—	s	
P17	THLD3	$\overline{MCLR}$/VPP/RA5/$\overline{FLTA}$ ↓ to VDD ↓	—	100	ns	
P18	THLD4	$\overline{MCLR}$/VPP/RA5/$\overline{FLTA}$ ↓ to PGM ↓	0	—	s	

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

1 TCY + TPWRT (if enabled) + 1024 TOSC (for LP, HS, HS/PLL and XT modes only) +
2 ms (for HS/PLL mode only) + 1.5 µs (for EC mode only)

where TCY is the instruction cycle time, TPWRT is the Power-up Timer period and TOSC is the oscillator period. For specific values, refer to the Electrical Characteristics section of the device data sheet for the particular device.

2: This specification also applies to ICVPP for PIC18F1330-ICD device.

3: At 0°C-50°C.

NOTES:

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

- Microchip products meet the specification contained in their particular Microchip Data Sheet.
- Microchip believes that its family of products is one of the most secure families of its kind on the market today, when used in the intended manner and under normal conditions.
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