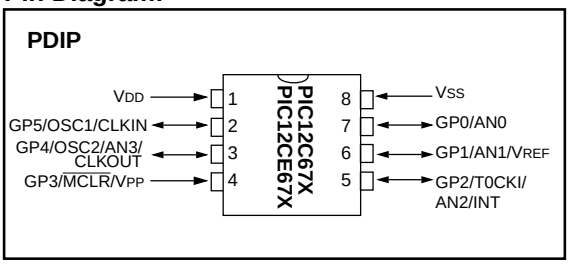
PIC12C67X AND PIC12CE67X

EPROM Memory Programming Specification

This document includes the programming specifications for the following devices:

- PIC12C671
- PIC12C672
- PIC12CE673
- PIC12CE674

Pin Diagram:



1.0 PROGRAMMING THE PIC12C67X AND PIC12CE67X

The PIC12C67X and PIC12CE67X can be programmed using a serial method. In serial mode the PIC12C67X and PIC12CE67X can be programmed while in the users system. This allows for increased design flexibility.

1.1 Hardware Requirements

The PIC12C67X and PIC12CE67X requires two programmable power supplies, one for VDD (2.0V to 6.0V recommended) and one for VPP (12V to 14V). Both supplies should have a minimum resolution of 0.25V.

1.2 Programming Mode

The programming mode for the PIC12C67X and PIC12CE67X allows programming of user program memory, special locations used for ID, and the configuration word for the PIC12C67X and PIC12CE67X.

PIN DESCRIPTIONS (DURING PROGRAMMING): PIC12C671/672 and PIC12CE673/674

Pin Name	During Programming		
	Pin Name	Pin Type	Pin Description
GP1	CLOCK	I	Clock input
GP0	DATA	I/O	Data input/output
GP3/MCLR/VPP	VPP	P	Programming Power
VDD	VDD	P	Power Supply
VSS	VSS	P	Ground

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

2.0 PROGRAM MODE ENTRY

2.1 User Program Memory Map

The user memory space extends from 0x0000 to 0x1FFF (8K). Table 2-1 shows actual implementation of program memory in the PIC12C67X family.

TABLE 2-1: IMPLEMENTATION OF PROGRAM MEMORY IN THE PIC12C67X

Device	Program Memory Size
PIC12C671/ PIC12CE673	0x000 - 0x3FF (1K)
PIC12C672/ PIC12CE674	0x000 - 0x7FF (2K)

When the PC reaches the last location of the implemented program memory, it will wrap around and address a location within the physically implemented memory (see Figure 2-1).

In programming mode the program memory space extends from 0x0000 to 0x3FFF, with the first half (0x0000-0x1FFF) being user program memory and the second half (0x2000-0x3FFF) being configuration memory. The PC will increment from 0x0000 to 0x1FFF and wrap to 0x000 or 0x2000 to 0x3FFF and wrap around to 0x2000 (not to 0x0000). Once in configuration memory, the highest bit of the PC stays a '1', thus always pointing to the configuration memory. The only way to point to user program memory is to reset the part and reenter program/verify mode, as described in Section 2.2.

The last location of the program memory space holds the factory programmed oscillator calibration value. This location should not be programmed except when blank (a non-blank value should not cause the device to fail a blank check). If blank, the programmer should program it to a RETLW XX statement where "XX" is the calibration value.

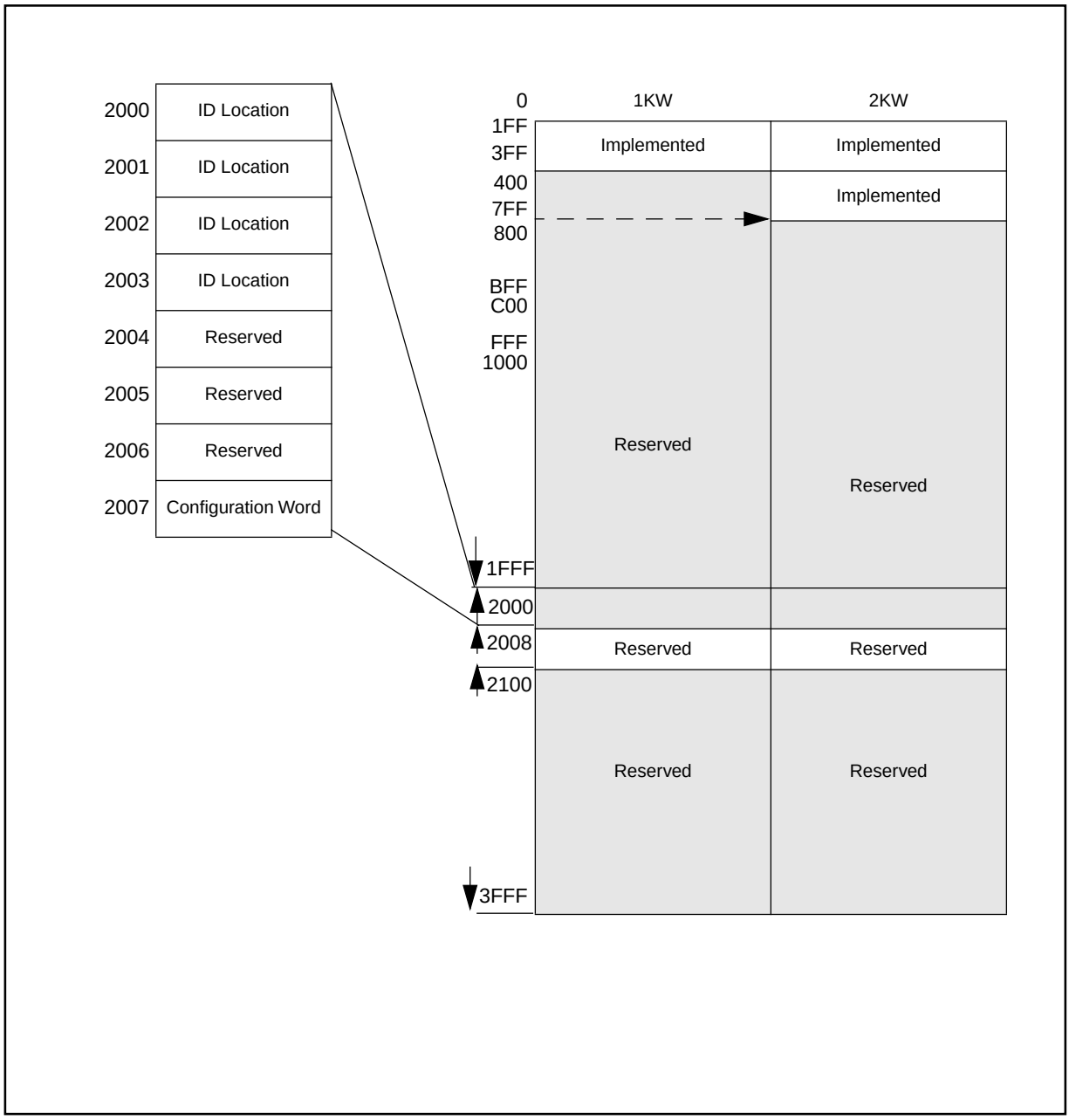
In the configuration memory space, 0x2000-0x20FF are utilized. When in configuration memory, as in the user memory, the 0x2000-0x2XFF segment is repeatedly accessed as the PC exceeds 0x2XFF (see Figure 2-1).

A user may store identification information (ID) in four ID locations. The ID locations are mapped in [0x2000 : 0x2003].

Note 1: All other locations in PIC configuration memory are reserved and should not be programmed.

Note 2: Due to the secure nature of the on-board EEPROM memory in the PIC12CE673/674, it can be accessed only by the user program.

FIGURE 2-1: PROGRAM MEMORY MAPPING



2.2 Program/Verify Mode

The program/verify mode is entered by holding pins GP1 and GP0 low while raising $\overline{MCLR}$ pin from V_{IL} to V_{IHH} (high voltage). VDD is then raised from VIL to VIH.Once in this mode the user program memory and the configuration memory can be accessed and programmed in serial fashion. The mode of operation is serial, and the memory that is accessed is the user program memory. GP1 is a Schmitt Trigger input in this mode.

The sequence that enters the device into the programming/verify mode places all other logic into the reset state (the $\overline{MCLR}$ pin was initially at V_{IL}). This means that all I/O are in the reset state (High impedance inputs).

Note 1: The $\overline{MCLR}$ pin must be raised from V_{IL} to V_{IHH} before V_{DD} is applied. This is to ensure that the device does not have the PC incremented while in valid operation range.

Note 2: Do not power GP2, GP4 or GP5 before V_{DD} is applied.

1.0.1 PROGRAM/VERIFY OPERATION

The GP1 pin is used as a clock input pin, and the GP0 pin is used for entering command bits and data input/output during serial operation. To input a command, the clock pin (GP1) is cycled six times. Each command bit is latched on the falling edge of the clock with the least significant bit (LSB) of the command being input first. The data on pin GP0 is required to have a minimum setup and hold time (see AC/DC specs) with respect to the falling edge of the clock. Commands that have data associated with them (read and load) are specified to have a minimum delay of 1µs between the command and the data. After this delay the clock pin is cycled 16 times with the first cycle being a start bit and the last cycle being a stop bit. Data is also input and output LSB first. Therefore, during a read operation the LSB will be transmitted onto pin GP0 on the rising edge of the second cycle, and during a load operation the LSB will be latched on the falling edge of the second cycle. A minimum 1µs delay is also specified between consecutive commands.

All commands are transmitted LSB first. Data words are also transmitted LSB first. The data is transmitted on the rising edge and latched on the falling edge of the clock. To allow for decoding of commands and reversal of data pin configuration, a time separation of at least 1µs is required between a command and a data word (or another command).

The commands that are available are listed in Table 1-1.

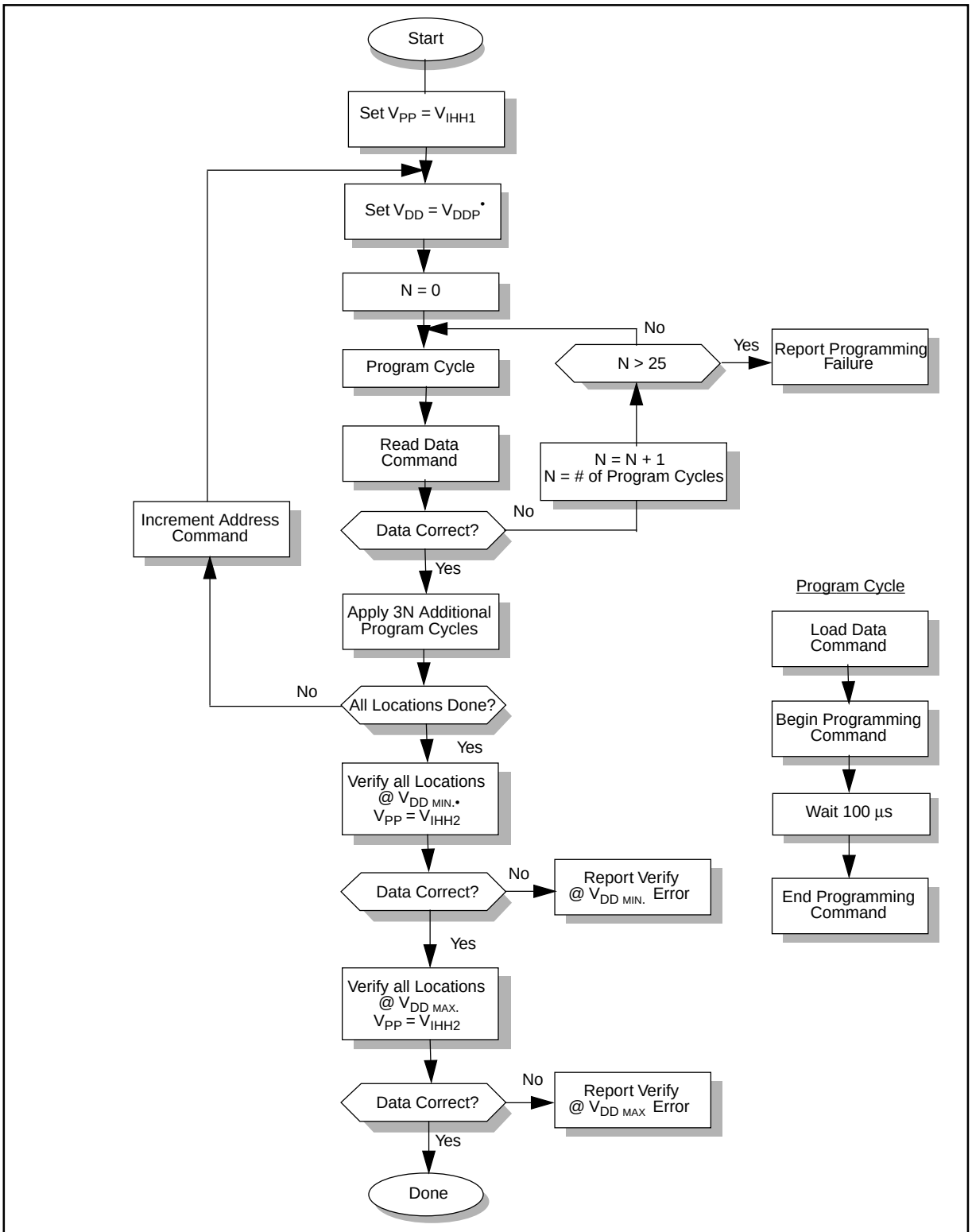
1.0.1.1 LOAD CONFIGURATION

After receiving this command, the program counter (PC) will be set to 0x2000. By then applying 16 cycles to the clock pin, the chip will load 14-bits a “data word” as described above, to be programmed into the configuration memory. A description of the memory mapping schemes for normal operation and configuration mode operation is shown in Figure 2-1. After the configuration memory is entered, the only way to get back to the user program memory is to exit the program/verify test mode by taking $\overline{MCLR}$ low (V_{IL}).

TABLE 1-1: COMMAND MAPPING

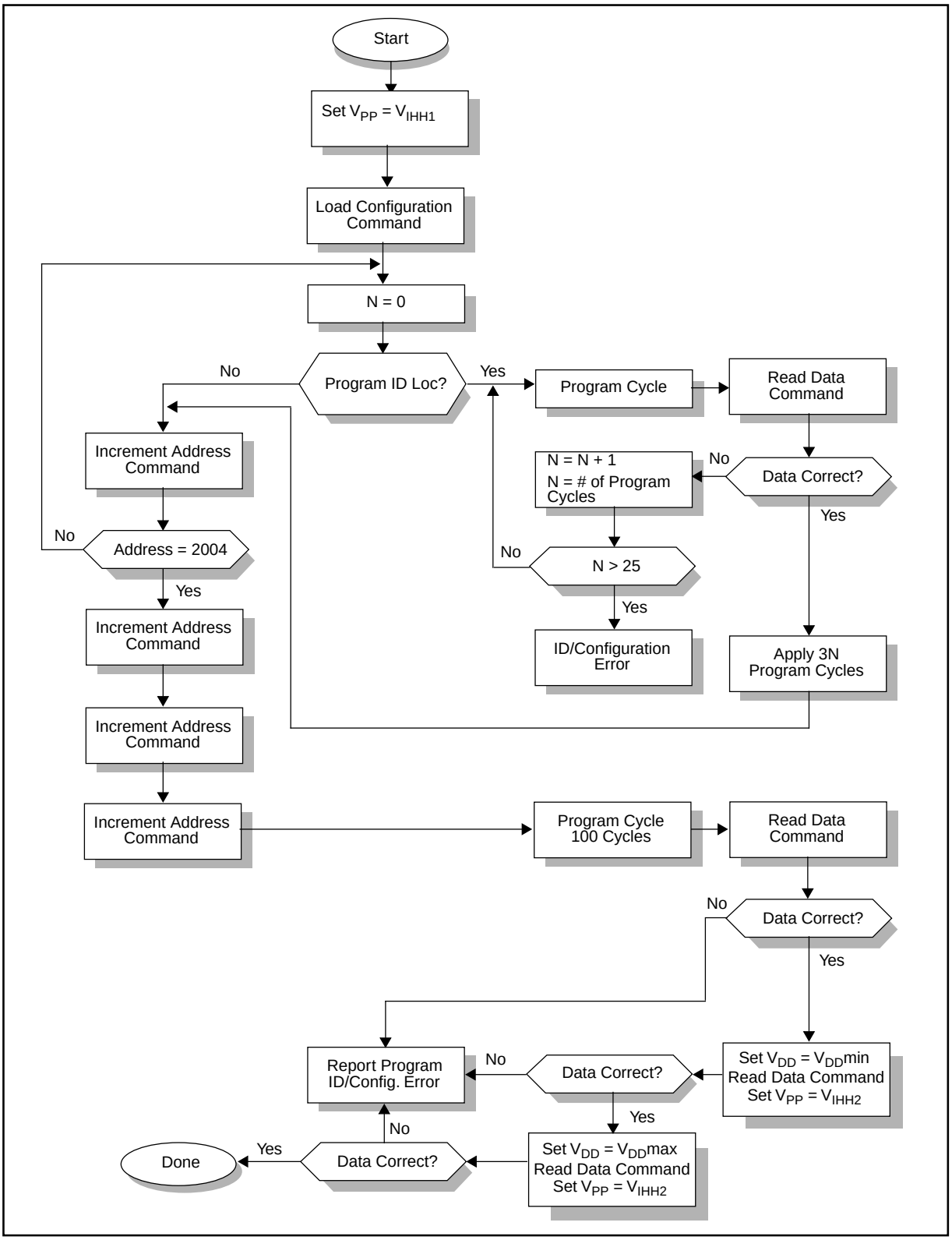
Command	Mapping (MSB ... LSB)						Data
Load Configuration	0	0	0	0	0	0	0, data(14), 0
Load Data	0	0	0	0	1	0	0, data(14), 0
Read Data	0	0	0	1	0	0	0, data(14), 0
Increment Address	0	0	0	1	1	0	
Begin programming	0	0	1	0	0	0	
End Programming	0	0	1	1	1	0	

FIGURE 1-1: PROGRAM FLOW CHART - PIC12C67X AND PIC12CE67X PROGRAM MEMORY



• $V_{DDP} = V_{DD}$ range for programming (typically 4.75V - 5.25V).
$V_{DD\ MIN.}$ = Minimum V_{DD} for device operation.
$V_{DD\ MAX.}$ = Maximum V_{DD} for device operation.

FIGURE 1-2: PROGRAM FLOW CHART - PIC12C67X AND PIC12CE67X CONFIGURATION WORD & ID LOCATIONS



1.0.1.2 LOAD DATA

After receiving this command, the chip will load in a 14-bit “data word” when 16 cycles are applied, as described previously. A timing diagram for the load data command is shown in Figure 4-1.

1.0.1.3 READ DATA

After receiving this command, the chip will transmit data bits out of the memory currently accessed starting with the second rising edge of the clock input. The GP0 pin will go into output mode on the second rising clock edge, and it will revert back to input mode (hi-impedance) after the 16th rising edge. A timing diagram of this command is shown in Figure 4-2.

1.0.1.4 INCREMENT ADDRESS

The PC is incremented when this command is received. A timing diagram of this command is shown in Figure 4-3.

1.0.1.5 BEGIN PROGRAMMING

A load command (load configuration or load data) must be given before every begin programming command. Programming of the appropriate memory (test program memory or user program memory) will begin after this command is received and decoded. Programming should be performed with a series of 100µs programming pulses. A programming pulse is defined as the time between the begin programming command and the end programming command.

1.0.1.6 END PROGRAMMING

After receiving this command, the chip stops programming the memory (configuration program memory or user program memory) that it was programming at the time.

1.1 Programming Algorithm Requires Variable VDD

The PIC12C67X and PIC12CE67X uses an intelligent algorithm. The algorithm calls for program verification at VDDmin as well as VDDmax. Verification at VDDmin guarantees good “erase margin”. Verification at VDDmax guarantees good “program margin”.

The actual programming must be done with VDD in the VDDP range (4.75 - 5.25V).

VDDP = VCC range required during programming.

VDD min. = minimum operating VDD spec for the part.

VDD max. = maximum operating VDD spec for the part.

Programmers must verify the PIC12C67X and PIC12CE67X at its specified VDDmax and VDDmin levels. Since Microchip may introduce future versions of the PIC12C67X and PIC12CE67X with a broader VDD range, it is best that these levels are user selectable (defaults are ok).

Note:	Any programmer not meeting these requirements may only be classified as “prototype” or “development” programmer but not a “production” quality programmer.

2.0 CONFIGURATION WORD

The PIC12C67X and PIC12CE67X family members have several configuration bits. These bits can be programmed (reads '0') or left unprogrammed (reads '1') to select various device configurations. Figure 2-1 provides an overview of configuration bits.

FIGURE 2-1: CONFIGURATION WORD

Bit Number:

13	12	11	10	9	8	7	6	5	4	3	2	1	0
CP1	CP0	CP1	CP0	CP1	CP0	MCLRE	CP1	CP0	PWRTE	WDTE	FOSC2	FOSC1	FOSC0

Register: CONFIG
Address 2007h

bit 13-8, 6-5: CP1:CP0: Code Protection bits (1) (2)

11 = Code protection off
10 = 0400h-07FFh code protected;
01 = 0200h-07FFh code protected;
00 = 0000h-07FFh code protected;

bit 7: MCLRE: GP3/MCLR pin function select

1 = GP3/MCLR pin function is MCLR
0 = GP3/MCLR pin function is digital I/O, MCLR internally tied to Vdd

bit 4: PWRTE: Power-up Timer Enable bit (1)

1 = PWRT disabled
0 = PWRT enabled

bit 3: WDTE: Watchdog Timer Enable bit

1 = WDT enabled
0 = WDT disabled

bit 2-0: FOSC2:FOSC0: Oscillator Selection bits

111 = EXTRC oscillator / CLKOUT function on GP4/OSC2/CLKOUT pin
110 = EXTRC oscillator / GP4 function on GP4/OSC2/CLKOUT pin
101 = INTRC oscillator / CLKOUT function on GP4/OSC2/CLKOUT pin
100 = INTRC oscillator / GP4 function on GP4/OSC2/CLKOUT pin
011 = invalid selection
010 = HS oscillator
001 = XT oscillator
000 = LP oscillator

Note 3: All of the CP1:CP0 pairs have to be given the same value to enable the code protection scheme listed.

4: 07FFh is always uncodeprotected on the 12C672 and 03FFh is always uncodeprotected on the 12C671. This location contains the RETLW xx calibration instruction for the INTRC.

3.0 CODE PROTECTION

The program code written into the EPROM can be protected by writing to the CP0 & CP1 bits of the configuration word.

For PIC12C67X and PIC12CE67X devices, once code protection is enabled, all protected segments read '0's (or “garbage values”) and are prevented from further programming. All unprotected segments, including ID and configuration word locations , and calibration word location read normally and can be programmed.

3.1 Embedding Configuration Word and ID Information in the Hex File

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

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

TABLE 3-1: CONFIGURATION WORD

PIC12C671, PIC12CE673

To code protect:

- Protect all memory `00 0000 X00X XXXX`
- Protect 0200h-07FFh `01 0101 X01X XXXX`
- No code protection `11 1111 X11X XXXX`

Program Memory Segment	R/W in Protected Mode	R/W in Unprotected Mode
Configuration Word (0x2007)	Read Unscrambled, Write Enabled	Read Unscrambled, Write Enabled
Unprotected memory segment	Read Unscrambled, Write Enabled	Read Unscrambled, Write Enabled
Protected memory segment	Read All 0’s, Write Disabled	Read Unscrambled, Write Enabled
ID Locations (0x2000 : 0x2003)	Read Unscrambled, Write Enabled	Read Unscrambled, Write Enabled
INTRC Calibration Word (0X3FF)	Read Unscrambled, Write Enabled	Read Unscrambled, Write Enabled

PIC12C672, PIC12CE674

To code protect:

- Protect all memory `00 0000 X00X XXXX`
- Protect 0200h-07FFh `01 0101 X01X XXXX`
- Protect 0400h-07FFh `10 1010 X10X XXXX`
- No code protection `11 1111 X11X XXXX`

Program Memory Segment	R/W in Protected Mode	R/W in Unprotected Mode
Configuration Word (0x2007)	Read Unscrambled, Write Enabled	Read Unscrambled, Write Enabled
Unprotected memory segment	Read Unscrambled, Write Enabled	Read Unscrambled, Write Enabled
Protected memory segment	Read All 0’s, Write Disabled	Read Unscrambled, Write Enabled
ID Locations (0x2000 : 0x2003)	Read Unscrambled, Write Enabled	Read Unscrambled, Write Enabled
INTRC Calibration Word (0X7FF)	Read Unscrambled, Write Enabled	Read Unscrambled, Write Enabled

3.2 Checksum

3.2.1 CHECKSUM CALCULATIONS

Checksum is calculated by reading the contents of the PIC12C67X and PIC12CE67X memory locations and adding the opcodes up to the maximum user addressable location, excluding the oscillator calibration location in the last address, e.g., 0x3FE for the PIC12C671/CE673. Any carry bits exceeding 16-bits are neglected. Finally, the configuration word (appropriately masked) is added to the checksum. Checksum computation for each member of the PIC12C67X and PIC12CE67X devices is shown in Table 3-2.

The checksum is calculated by summing the following:

- The contents of all program memory locations
- The configuration word, appropriately masked
- Masked ID locations (when applicable)

The least significant 16 bits of this sum is the checksum.

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

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

TABLE 3-2: CHECKSUM COMPUTATION

Device	Code Protect	Checksum*	Blank Value	Ox25E6 at 0 and max address
PIC12C671 PIC12CE673	OFF 1/2 ALL	SUM[0x000:0x3FE] + CFGW & 0x3FFF SUM[0x000:0x1FF] + CFGW & 0x3FFF + SUM_ID CFGW & 0x3FFF + SUM_ID	3B3F 4E5E 3B4E	070D 0013 071C
PIC12C672 PIC12CE674	OFF 1/2 3/4 ALL	SUM[0x000:0x7FE] + CFGW & 0x3FFF SUM[0x000:0x3FF] + CFGW & 0x3FFF + SUM_ID SUM[0x000:0x1FF] + CFGW & 0x3FFF + SUM_ID CFGW & 0x3FFF + SUM_ID	373F 5D6E 4A5E 374E	030D 0F23 FC13 031C

Legend: CFGW = Configuration Word
SUM[a:b] = [Sum of locations a through b inclusive]
SUM_ID = ID locations masked by 0xF then made into a 16-bit value with ID0 as the most significant nibble.
For example,
ID0 = 0x12, ID1 = 0x37, ID2 = 0x4, ID3 = 0x26, then SUM_ID = 0x2746.
*Checksum = [Sum of all the individual expressions] **MODULO** [0xFFFF]
+ = Addition
& = Bitwise AND

4.0 PROGRAM/VERIFY MODE ELECTRICAL CHARACTERISTICS

TABLE 4-1: AC/DC CHARACTERISTICS
TIMING REQUIREMENTS FOR PROGRAM/VERIFY TEST MODE

Standard Operating Conditions Operating Temperature: +10°C ≤ TA ≤ +40°C, unless otherwise stated, (25°C is recommended) Operating Voltage: 4.5V ≤ VDD ≤ 5.5V, unless otherwise stated.							
Parameter No.	**Sym.**	**Characteristic**	**Min.**	**Typ.**	**Max.**	**Units**	**Conditions**
General							
PD1	VDDP	Supply voltage during programming	4.75	5.0	5.25	V	
PD2	IDDP	Supply current (from VDD) during programming			20	mA	
PD3	VDDV	Supply voltage during verify	VDDmin		VDDmax	V	Note 1
PD4	VIHH1	Voltage on $\overline{MCLR}$/VPP during programming	12.75		13.25	V	Note 2
PD5	VIHH2	Voltage on $\overline{MCLR}$/VPP during verify	VDD + 4.0		13.5		
PD6	IPP	Programming supply current (from VPP)			50	mA	
PD9	VIH1	(GP0, GP1) input high level	0.8 VDD			V	Schmitt Trigger input
PD8	VIL1	(GP0, GP1) input low level	0.2 VDD			V	Schmitt Trigger input
Serial Program Verify							
P1	TR	$\overline{MCLR}$/VPP rise time (VSS to VIHH) for test mode entry			8.0	µs	
P2	Tf	$\overline{MCLR}$ Fall time			8.0	µs	
P3	Tset1	Data in setup time before clock ↓	100			ns	
P4	Thld1	Data in hold time after clock ↓	100			ns	
P5	Tdly1	Data input not driven to next clock input (delay required between command/data or command/command)	1.0			µs	
P6	Tdly2	Delay between clock ↓ to clock ↑ of next command or data	1.0			µs	
P7	Tdly3	Clock ↑ to data out valid (during read data)	200			ns	
P8	Thld0	Hold time after VDD↑	2			µs	
P9	TPPDP	Hold time after VPP↑	5			µs	

Note 1: Program must be verified at the minimum and maximum VDD limits for the part.
Note 2: VIHH must be greater than VDD + 4.5V to stay in programming/verify mode.

FIGURE 4-1: LOAD DATA COMMAND (PROGRAM/VERIFY)

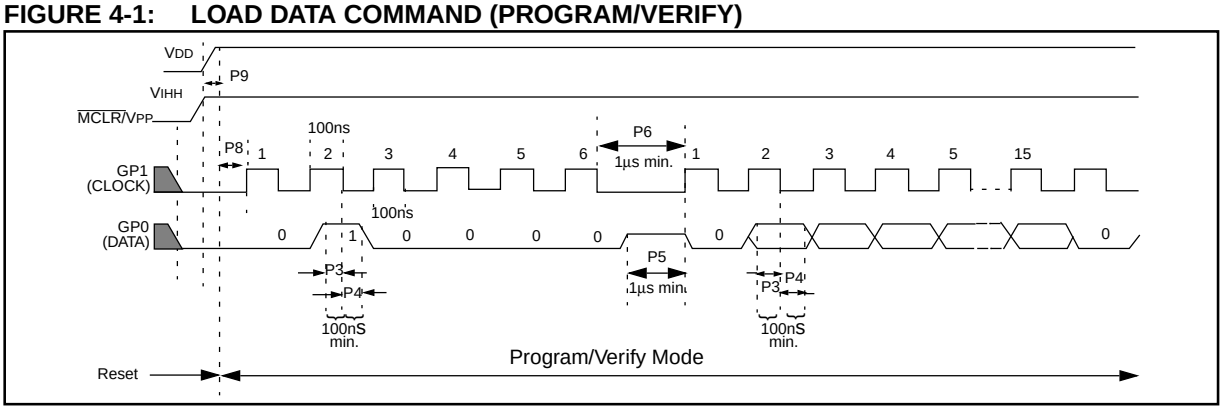


FIGURE 4-2: READ DATA COMMAND (PROGRAM/VERIFY)

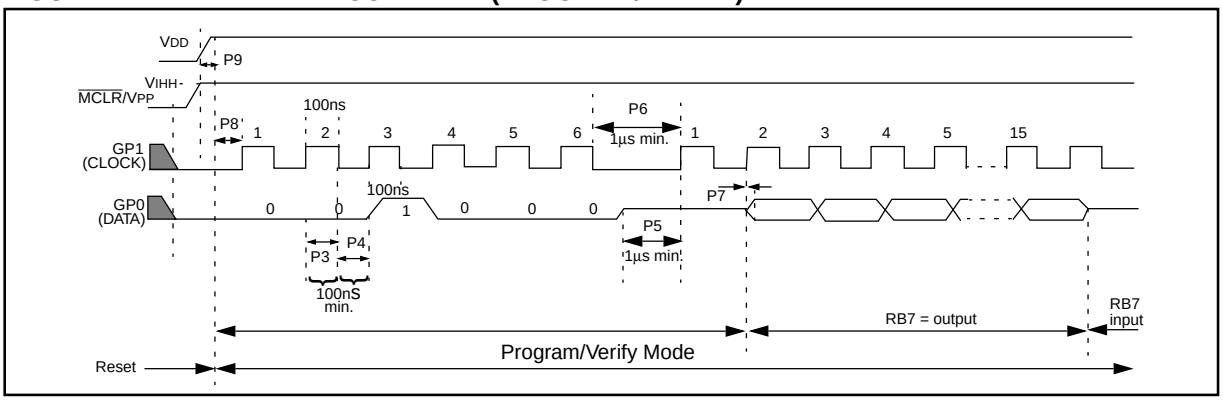
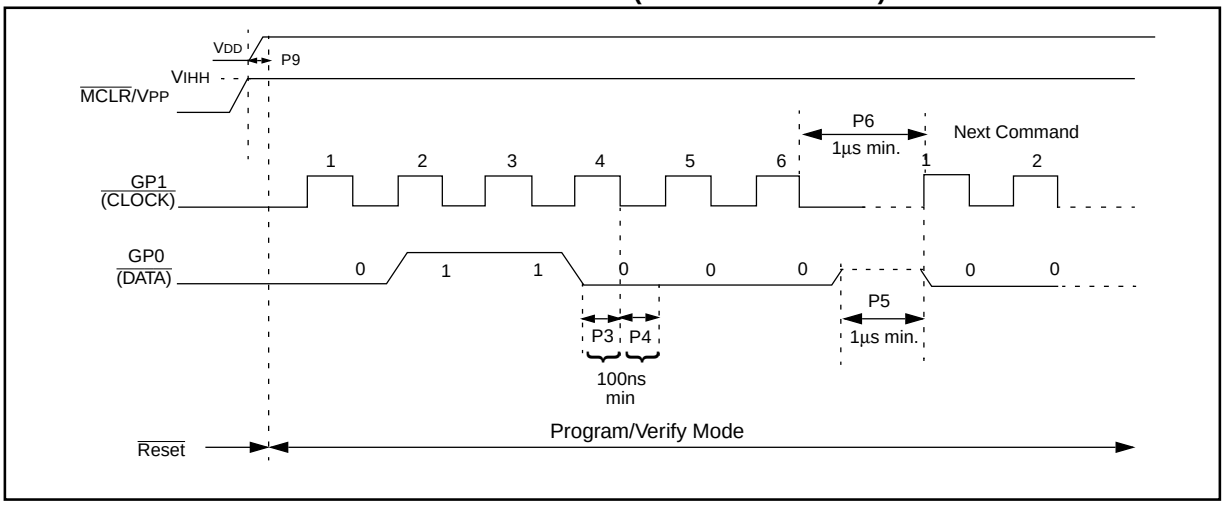


FIGURE 4-3: INCREMENT ADDRESS COMMAND (PROGRAM/VERIFY)



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