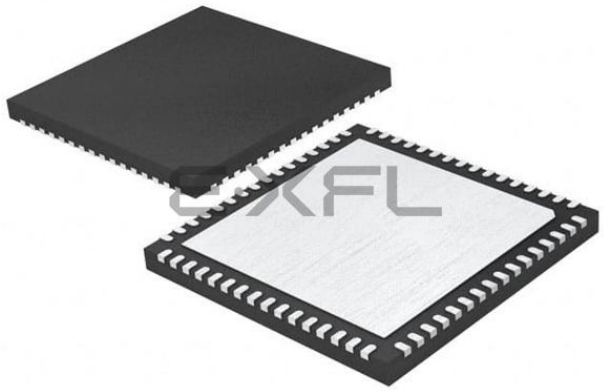
Microchip Technology - PIC24FJ128DA206T-I/MR Datasheet



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Applications of "Embedded - Microcontrollers"

Details	
Product Status	Obsolete
Core Processor	PIC
Core Size	16-Bit
Speed	32MHz
Connectivity	I²C, IrDA, SPI, UART/USART, USB OTG
Peripherals	Brown-out Detect/Reset, GFX, LVD, POR, PWM, WDT
Number of I/O	52
Program Memory Size	128KB (43K x 24)
Program Memory Type	FLASH
EEPROM Size	-
RAM Size	96K x 8
Voltage - Supply (Vcc/Vdd)	2.2V ~ 3.6V
Data Converters	A/D 16x10b
Oscillator Type	Internal
Operating Temperature	-40°C ~ 85°C (TA)
Mounting Type	Surface Mount
Package / Case	64-VFQFN Exposed Pad
Supplier Device Package	64-VQFN (9x9)
Purchase URL	https://www.e-xfl.com/product-detail/microchip-technology/pic24fj128da206t-i-mr

TABLE 2: COMPLETE PIN FUNCTION DESCRIPTIONS FOR 100-PIN DEVICES

Pin	Function	Pin	Function
1	GCLK/CN82/RG15	41	AN12/PMA11/CTEDG2/CN30/RB12
2	VDD	42	AN13/PMA10/CTEDG1/CN31/RB13
3	PMD5/CN63/RE5	43	AN14/CTPLS/**RP14**/PMA1/CN32/RB14
4	SCL3/PMD6/CN64/RE6	44	AN15/REFO/**RP29**/PMA0/CN12/RB15
5	SDA3/PMD7/CN65/RE7	45	VSS
6	**RPI38**/GD0/CN45/RC1	46	VDD
7	**RPI39**/GD8/CN46/RC2	47	**RPI43**/GD14/CN20/RD14
8	**RPI40**/GD1/CN47/RC3	48	**RP5**/GD15/CN21/RD15
9	AN16/**RPI41**/PMCS2/PMA22(2)/CN48/RC4	49	**RP10**/PMA9/CN17/RF4
10	AN17/C1IND/**RP21**/PMA5/PMA18(2)/CN8/RG6	50	**RP17**/PMA8/CN18/RF5
11	AN18/C1INC/**RP26**/PMA4/PMA20(2)/CN9/RG7	51	**RP16**/USBID/CN71/RF3
12	AN19/C2IND/**RP19**/PMA3/PMA21(2)/CN10/RG8	52	**RP30**/GD3/CN70/RF2
13	$\overline{\text{MCLR}}$	53	**RP15**/GD9/CN74/RF8
14	AN20/C2INC/**RP27**/PMA2/CN11/RG9	54	VBUS/CN73/RF7
15	VSS	55	VUSB
16	VDD	56	D-/CN84/RG3
17	TMS/CN33/RA0	57	D+/CN83/RG2
18	**RPI33**/PMCS1/CN66/RE8	58	SCL2/CN35/RA2
19	AN21/**RPI34**/PMA19/CN67/RE9	59	SDA2/PMA20/PMA4(2)/CN36/RA3
20	PGEC3/AN5/C1INA/VBUSON/**RP18**/CN7/RB5	60	TDI/PMA21/PMA3(2)/CN37/RA4
21	PGED3/AN4/C1INB/USBOEN/**RP28**/GD4/CN6/RB4	61	TDO/CN38/RA5
22	AN3/C2INA/GD5/VPIO/CN5/RB3	62	VDD
23	AN2/C2INB/VMIO/**RP13**/GD6/CN4/RB2	63	OSCI/CLKI/CN23/RC12
24	PGEC1/AN1/VREF-(1)/**RP1**/CN3/RB1	64	OSCO/CLKO/CN22/RC15
25	PGED1/AN0/VREF+(1)/**RP0**/CN2/RB0	65	VSS
26	PGEC2/AN6/**RP6**/CN24/RB6	66	SCL1/**RPI36**/PMA22/PMCS2(2)/CN43/RA14
27	PGED2/AN7/**RP7**/RCV/GPWR/CN25/RB7	67	SDA1/**RPI35**/PMBE1/CN44/RA15
28	VREF-/PMA7/CN41/RA9	68	DMLN/RTCC/**RP2**/CN53/RD8
29	VREF+/PMA6/CN42/RA10	69	DPLN/**RP4**/GD10/PMACK2/CN54/RD9
30	AVDD	70	**RP3**/PMA15/PMCS2(3)/CN55/RD10
31	AVSS	71	**RP12**/PMA14/PMCS1(3)/CN56/RD11
32	AN8/**RP8**/GD12/CN26/RB8	72	DMH/**RP11**/INT0/CN49/RD0
33	AN9/**RP9**/GD13/CN27/RB9	73	SOSCI/C3IND/CN1/RC13
34	AN10/CVREF/PMA13/CN28/RB10	74	SOSCO/SCLKI/T1CK/C3INC/**RPI37**/CN0/RC14
35	AN11/PMA12/CN29/RB11	75	VSS
36	VSS	76	VCPCON/**RP24**/GD7/VBUSCHG/CN50/RD1
37	VDD	77	DPH/**RP23**/GD11/PMACK1/CN51/RD2
38	TCK/CN34/RA1	78	**RP22**/PMBE0/CN52/RD3
39	**RP31**/GD2/CN76/RF13	79	**RPI42**/PMD12/CN57/RD12
40	**RPI32**/PMA18/PMA5(2)/CN75/RF12	80	PMD13/CN19/RD13

Legend: **RPn** and **RPIn** represent remappable pins for Peripheral Pin Select (PPS) functions.

Note 1: Alternate pin assignments for VREF+ and VREF- when the $\overline{\text{ALTVREF}}$ Configuration bit is programmed.

2: Alternate pin assignments for EPMP when the $\overline{\text{ALTPMP}}$ Configuration bit is programmed.

3: Pin assignment for PMCSx when CSF<1:0> is not equal to '00'.

4.1.1 PROGRAM MEMORY ORGANIZATION

The program memory space is organized in word-addressable blocks. Although it is treated as 24 bits wide, it is more appropriate to think of each address of the program memory as a lower and upper word, with the upper byte of the upper word being unimplemented. The lower word always has an even address, while the upper word has an odd address (Figure 4-2).

Program memory addresses are always word-aligned on the lower word and addresses are incremented or decremented by two during code execution. This arrangement also provides compatibility with data memory space addressing and makes it possible to access data in the program memory space.

4.1.2 HARD MEMORY VECTORS

All PIC24F devices reserve the addresses between 0x00000 and 0x000200 for hard coded program execution vectors. A hardware Reset vector is provided to redirect code execution from the default value of the PC on device Reset to the actual start of code. A GOTO instruction is programmed by the user at 0x000000 with the actual address for the start of code at 0x000002.

PIC24F devices also have two interrupt vector tables, located from 0x000004 to 0x0000FF and 0x000100 to 0x0001FF. These vector tables allow each of the many device interrupt sources to be handled by separate ISRs. A more detailed discussion of the interrupt vector tables is provided in **Section 7.1 "Interrupt Vector Table"**.

4.1.3 FLASH CONFIGURATION WORDS

In PIC24FJ256DA210 family devices, the top four words of on-chip program memory are reserved for configuration information. On device Reset, the configuration information is copied into the appropriate Configuration register. The addresses of the Flash Configuration Word for devices in the PIC24FJ256DA210 family are shown in Table 4-1. Their location in the memory map is shown with the other memory vectors in Figure 4-1.

The Configuration Words in program memory are a compact format. The actual Configuration bits are mapped in several different registers in the configuration memory space. Their order in the Flash Configuration Words does not reflect a corresponding arrangement in the configuration space. Additional details on the device Configuration Words are provided in **Section 27.1 "Configuration Bits"**.

TABLE 4-1: FLASH CONFIGURATION WORDS FOR PIC24FJ256DA210 FAMILY DEVICES

Device	Program Memory (Words)	Configuration Word Addresses
PIC24FJ128DAXXX	44,032	0x0157F8:0x0157FE
PIC24FJ256DAXXX	87,552	0x02ABF8:0x02ABFE

FIGURE 4-2: PROGRAM MEMORY ORGANIZATION

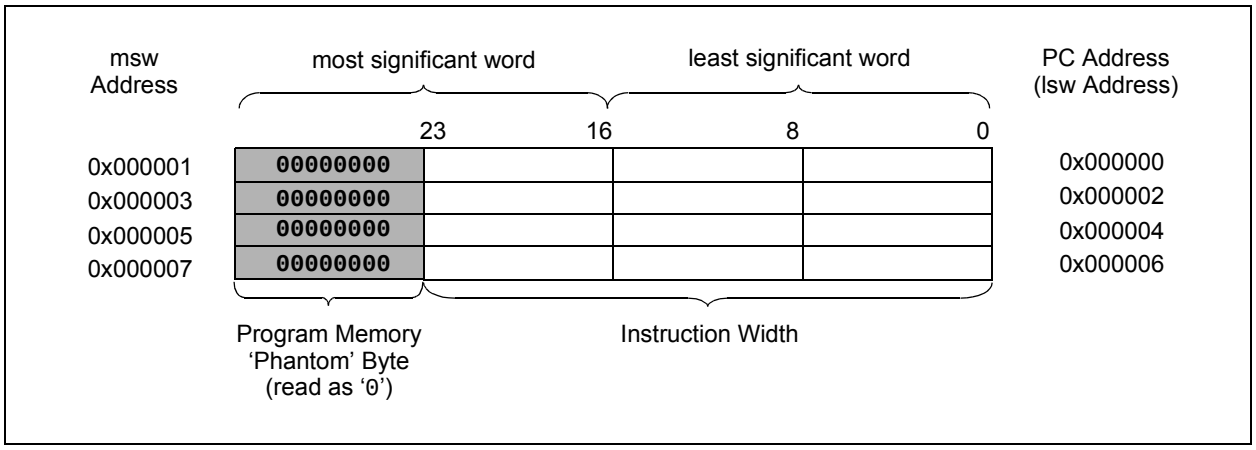

TABLE 4-31: GRAPHICS REGISTER MAP

File Name	Addr	Bit 15	Bit 14	Bit 13	Bit 12	Bit 11	Bit 10	Bit 9	Bit 8	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0	All Resets
G1CMDL	0700	Graphics Command Register<15:0>																0000
G1CMDH	0702	Graphics Command Register<31:16>																0000
G1CON1	0704	G1EN	—	G1SIDL	GCMDWMK4	GCMDWMK3	GCMDWMK2	GCMDWMK1	GCMDWMK0	PUBPP2	PUBPP1	PUBPP0	GCMDCNT4	GCMDCNT3	GCMDCNT2	GCMDCNT1	GCMDCNT0	0000
G1STAT	0706	PUBUSY	—	—	—	—	—	—	—	IPUBUSY	RCCBUSY	CHRBUSY	VMRGN	HMRGN	CMDLV	CMDFUL	CMDMPT	0000
G1IE	0708	PUIE	—	—	—	—	—	—	—	IPUIE	RCCIE	CHRIE	VMRGNIE	HMRGNIE	CMDLVIE	CMDFULIE	CMDMPTIE	0000
G1IR	070A	PUIF	—	—	—	—	—	—	—	IPUIF	RCCIF	CHRIF	VMRGNIF	HMRGNIF	CMDLVIF	CMDFULIF	CMDMPTIF	0000
G1W1ADRL	070C	GPU Work Area 1 Start Address Register<15:0>																0000
G1W1ADRH	070E	—	—	—	—	—	—	—	—	GPU Work Area 1 Start Address Register<23:16>								0000
G1W2ADRL	0710	GPU Work Area 2 Start Address Register<15:0>																0000
G1W2ADRH	0712	—	—	—	—	—	—	—	—	GPU Work Area 2 Start Address Register<23:16>								0000
G1PUW	0714	—	—	—	—	—	GPU Work Area Width Register											0000
G1PUH	0716	—	—	—	—	—	GPU Work Area Height Register											0000
G1DPADRL	0718	Display Buffer Start Address Register<15:0>																0000
G1DPADRH	071A	—	—	—	—	—	—	—	—	Display Buffer Start Address Register<23:16>								0000
G1DPW	071C	—	—	—	—	—	Display Frame Width Register											0000
G1DPH	071E	—	—	—	—	—	Display Frame Height Register											0000
G1DPWT	0720	—	—	—	—	—	Display Total Width Register											0000
G1DPHT	0722	—	—	—	—	—	Display Total Height Register											0000
G1CON2	0724	DPGWDTH1	DPGWDTH0	DPSTGER1	DPSTGER0	—	—	DPTEST1	DPTEST0	DPBPP2	DPBPP1	DPBPP0	—	—	DPMODE2	DPMODE1	DPMODE0	0000
G1CON3	0726	—	—	—	—	—	—	DPPINOE	DPPOWER	DPCLKPOL	DPENPOL	DPVSPOL	DPHSPOL	DPPWROE	DPENOE	DPVSOE	DPHSOE	0000
G1ACTDA	0728	Number of Lines Before the First Active Line Register								Number of Pixels Before the First Active PIxel Register								0000
G1HSYNC	072A	HSYNC Pulse-Width Configuration Register								HSYNC Start Delay Configuration Register								0000
G1VSYNC	072C	VSYNC Pulse-Width Configuration Register								VSYNC Start Delay Configuration Register								0000
G1DBLCON	072E	Vertical Blanking Start to First Displayed Line Configuration Regsiter								Horizontal Blanking Start to First Displayed Line Configuration Regsiter								0000
G1CLUT	0730	CLUTEN	CLUTBUSY	—	—	—	—	CLUTTRD	CLUTRWEN	Color Look-Up Table Memory Address Register								0000
G1CLUTWR	0732	Color Look-up Table Memory Write Data Register																0000
G1CLUTRD	0734	Color Look-up Table Memory Read Data Register																0000
G1MRGN	0736	Vertical Blanking Advance Register								Horizontal Blanking Advance Register								0000
G1CHRX	0738	—	—	—	—	—	Current Character X-Coordinate Position Register											0000
G1CHRY	073A	—	—	—	—	—	Current Character Y-Coordinate Position Register											0000
G1IPU	073C	—	—	—	—	—	—	—	—	—	—	HUFFERR	BLCKERR	LENERR	WRAPERR	IPUDONE	BFINAL	0000
G1DBEN	073E	GDBEN15	GDBEN14	GDBEN13	GDBEN12	GDBEN11	GDBEN10	GDBEN9	GDBEN8	GDBEN7	GDBEN6	GDBEN5	GDBEN4	GDBEN3	GDBEN2	GDBEN1	GDBEN0	0000

Legend: — = unimplemented, read as '0'. Reset values are shown in hexadecimal.

TABLE 4-32: SYSTEM REGISTER MAP

File Name	Addr	Bit 15	Bit 14	Bit 13	Bit 12	Bit 11	Bit 10	Bit 9	Bit 8	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0	All Resets
RCON	0740	TRAPR	IOPUWR	—	—	—	—	CM	VREGS	EXTR	SWR	SWDTEN	WDTO	SLEEP	IDLE	BOR	POR	**Note 1**
OSCCON	0742	—	COSC2	COSC1	COSC0	—	NOSC2	NOSC1	NOSC0	CLKLOCK	IOLOCK	LOCK	—	CF	POSCEN	SOSCEN	OSWEN	**Note 2**
CLKDIV	0744	ROI	DOZE2	DOZE1	DOZE0	DOZEN	RCDIV2	RCDIV1	RCDIV0	CPDIV1	CPDIV0	PLLEN	G1CLKSEL	—	—	—	—	0100
CLKDIV2	0746	GCLKDIV6	GCLKDIV5	GCLKDIV4	GCLKDIV3	GCLKDIV2	GCLKDIV1	GCLKDIV0	—	—	—	—	—	—	—	—	—	0000
OSCTUN	0748	—	—	—	—	—	—	—	—	—	—	TUN5	TUN4	TUN3	TUN2	TUN1	TUN0	0000
REFOCON	074E	ROEN	—	ROSSLP	ROSEL	RODIV3	RODIV2	RODIV1	RODIV0	—	—	—	—	—	—	—	—	0000

Legend: — = unimplemented, read as '0'. Reset values are shown in hexadecimal.
Note 1: The Reset value of the RCON register is dependent on the type of Reset event. See **Section 6.0 "Resets"** for more information.
2: The Reset value of the OSCCON register is dependent on both the type of Reset event and the device configuration. See **Section 8.0 "Oscillator Configuration"** for more information.

TABLE 4-33: NVM REGISTER MAP

File Name	Addr	Bit 15	Bit 14	Bit 13	Bit 12	Bit 11	Bit 10	Bit 9	Bit 8	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0	All Resets
NVMCON	0760	WR	WREN	WRERR	—	—	—	—	—	—	ERASE	—	—	NVMOP3	NVMOP2	NVMOP1	NVMOP0	0000(1)
NVMKEY	0766	—	—	—	—	—	—	—	—	NVMKEY Register<7:0>								0000

Legend: — = unimplemented, read as '0'. Reset values are shown in hexadecimal.
Note 1: Reset value shown is for POR only. Value on other Reset states is dependent on the state of memory write or erase operations at the time of Reset.

TABLE 4-34: PMD REGISTER MAP

File Name	Addr	Bit 15	Bit 14	Bit 13	Bit 12	Bit 11	Bit 10	Bit 9	Bit 8	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0	All Resets
PMD1	0770	T5MD	T4MD	T3MD	T2MD	T1MD	—	—	—	I2C1MD	U2MD	U1MD	SPI2MD	SPI1MD	—	—	ADC1MD	0000
PMD2	0772	IC8MD	IC7MD	IC6MD	IC5MD	IC4MD	IC3MD	IC2MD	IC1MD	OC8MD	OC7MD	OC6MD	OC5MD	OC4MD	OC3MD	OC2MD	OC1MD	0000
PMD3	0774	—	—	—	—	—	CMPMD	RTCCMD	PMPMD(1)	CRCMD	—	—	—	U3MD	I2C3MD	I2C2MD	—	0000
PMD4	0776	—	—	—	—	—	—	—	—	—	UPWMMD	U4MD	—	REFOMD	CTMUMD	LVDMD	USB1MD	0000
PMD5	0778	—	—	—	—	—	—	—	IC9MD	—	—	—	—	—	—	—	OC9MD	0000
PMD6	077A	—	—	—	—	—	—	—	—	—	GFX1MD	—	—	—	—	—	SPI3MD	0000

Legend: — = unimplemented, read as '0'. Reset values are shown in hexadecimal.
Note 1: Unimplemented in 64-pin devices, read as '0'.

4.3.3 READING DATA FROM PROGRAM MEMORY USING EDS

The upper 32 Kbytes of data space may optionally be mapped into any 16K word page of the program space. This provides transparent access of stored constant data from the data space without the need to use special instructions (i.e., TBLRDL/H).

Program space access through the data space occurs when the MSb of EA is '1' and the DSRPAG<9> is also '1'. The lower 8 bits of DSRPAG are concatenated to the Wn<14:0> bits to form a 23-bit EA to access program memory. The DSRPAG<8> decides which word should be addressed; when the bit is '0', the lower word and when '1', the upper word of the program memory is accessed.

The entire program memory is divided into 512 EDS pages, from 0x200 to 0x3FF, each consisting of 16K words of data. Pages, 0x200 to 0x2FF, correspond to the lower words of the program memory, while 0x300 to 0x3FF correspond to the upper words of the program memory.

Using this EDS technique, the entire program memory can be accessed. Previously, the access to the upper word of the program memory was not supported.

Table 4-37 provides the corresponding 23-bit EDS address for program memory with EDS page and source addresses.

For operations that use PSV and are executed outside a REPEAT loop, the MOV and MOV.D instructions will require one instruction cycle in addition to the specified execution time. All other instructions will require two instruction cycles in addition to the specified execution time.

For operations that use PSV, which are executed inside a REPEAT loop, there will be some instances that require two instruction cycles in addition to the specified execution time of the instruction:

- Execution in the first iteration
- Execution in the last iteration
- Execution prior to exiting the loop due to an interrupt
- Execution upon re-entering the loop after an interrupt is serviced

Any other iteration of the REPEAT loop will allow the instruction accessing data, using PSV, to execute in a single cycle.

TABLE 4-37: EDS PROGRAM ADDRESS WITH DIFFERENT PAGES AND ADDRESSES

DSRPAG (Data Space Read Register)	Source Address while Indirect Addressing	23-Bit EA Pointing to EDS	Comment
0x200	0x8000 to 0xFFFF	0x000000 to 0x007FFE	Lower words of 4M program instructions; (8 Mbytes) for read operations only.
• • •		• • •	
0x2FF		0x7F8000 to 0x7FFFFE	
0x300		0x000001 to 0x007FFF	Upper words of 4M program instructions (4 Mbytes remaining, 4 Mbytes are phantom bytes) for read operations only.
• • •		• • •	
0x3FF		0x7F8001 to 0x7FFFFF	
0x000		Invalid Address	Address error trap(1)

Note 1: When the source/destination address is above 0x8000 and DSRPAG/DSWPAG is '0', an address error trap will occur.

REGISTER 7-14: IEC2: INTERRUPT ENABLE CONTROL REGISTER 2

U-0	U-0	R/W-0	R/W-0	R/W-0	R/W-0	R/W-0	R/W-0
—	—	PMPIE(1)	OC8IE	OC7IE	OC6IE	OC5IE	IC6IE
bit 15							bit 8

R/W-0	R/W-0	R/W-0	U-0	U-0	U-0	R/W-0	R/W-0
IC5IE	IC4IE	IC3IE	—	—	—	SPI2IE	SPF2IE
bit 7							bit 0

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

bit 15-14 **Unimplemented:** Read as '0'

bit 13 **PMPIE:** Parallel Master Port Interrupt Enable bit(1)
1 = Interrupt request is enabled
0 = Interrupt request is not enabled

bit 12 **OC8IE:** Output Compare Channel 8 Interrupt Enable bit
1 = Interrupt request is enabled
0 = Interrupt request is not enabled

bit 11 **OC7IE:** Output Compare Channel 7 Interrupt Enable bit
1 = Interrupt request is enabled
0 = Interrupt request is not enabled

bit 10 **OC6IE:** Output Compare Channel 6 Interrupt Enable bit
1 = Interrupt request is enabled
0 = Interrupt request is not enabled

bit 9 **OC5IE:** Output Compare Channel 5 Interrupt Enable bit
1 = Interrupt request is enabled
0 = Interrupt request is not enabled

bit 8 **IC6IE:** Input Capture Channel 6 Interrupt Enable bit
1 = Interrupt request is enabled
0 = Interrupt request is not enabled

bit 7 **IC5IE:** Input Capture Channel 5 Interrupt Enable bit
1 = Interrupt request is enabled
0 = Interrupt request is not enabled

bit 6 **IC4IE:** Input Capture Channel 4 Interrupt Enable bit
1 = Interrupt request is enabled
0 = Interrupt request is not enabled

bit 5 **IC3IE:** Input Capture Channel 3 Interrupt Enable bit
1 = Interrupt request is enabled
0 = Interrupt request is not enabled

bit 4-2 **Unimplemented:** Read as '0'

bit 1 **SPI2IE:** SPI2 Event Interrupt Enable bit
1 = Interrupt request is enabled
0 = Interrupt request is not enabled

bit 0 **SPF2IE:** SPI2 Fault Interrupt Enable bit
1 = Interrupt request is enabled
0 = Interrupt request is not enabled

Note 1: Not available in 64-pin devices (PIC24FJXXXDAX06).

REGISTER 7-30: IPC11: INTERRUPT PRIORITY CONTROL REGISTER 11

U-0	U-0	U-0	U-0	U-0	U-0	U-0	U-0
—	—	—	—	—	—	—	—
bit 15							bit 8

U-0	R/W-1	R/W-0	R/W-0	U-0	R/W-1	R/W-0	R/W-0
—	PMPIP2(1)	PMPIP1(1)	PMPIP0(1)	—	OC8IP2	OC8IP1	OC8IP0
bit 7							bit 0

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

bit 15-7 **Unimplemented:** Read as '0'

bit 6-4 **PMPIP<2:0>:** Parallel Master Port Interrupt Priority bits(1)
- 111 = Interrupt is priority 7 (highest priority interrupt)
- •
- •
- •
- 001 = Interrupt is priority 1
- 000 = Interrupt source is disabled

bit 3 **Unimplemented:** Read as '0'

bit 2-0 **OC8IP<2:0>:** Output Compare Channel 8 Interrupt Priority bits
- 111 = Interrupt is priority 7 (highest priority interrupt)
- •
- •
- •
- 001 = Interrupt is priority 1
- 000 = Interrupt source is disabled

Note 1: Not available in 64-pin devices (PIC24FJXXXDAX06).

8.1 CPU Clocking Scheme

The system clock source can be provided by one of four sources:

- Primary Oscillator (POSC) on the OSCI and OSCO pins
- Secondary Oscillator (SOSC) on the SOSCI and SOSCO pins
- Fast Internal RC (FRC) Oscillator
- Low-Power Internal RC (LPRC) Oscillator

The primary oscillator and FRC sources have the option of using the internal 24x PLL block, which generates the USB module clock, the Graphics module clock and a separate system clock through the 96 MHZ PLL. Refer to **Section 8.5 "96 MHz PLL Block"** for additional information.

The internal FRC provides an 8 MHz clock source. It can optionally be reduced by the programmable clock divider to provide a range of system clock frequencies.

The selected clock source generates the processor and peripheral clock sources. The processor clock source is divided by two to produce the internal instruction cycle clock, FCY. In this document, the instruction cycle clock is also denoted by FOSC/2. The internal instruction cycle clock, FOSC/2, can be provided on the OSCO I/O pin for some operating modes of the primary oscillator.

8.2 Initial Configuration on POR

The oscillator source (and operating mode) that is used at a device Power-on Reset (POR) event is selected using Configuration bit settings. The oscillator Configuration bit settings are located in the Configuration registers in the program memory (refer to **Section 27.1 "Configuration Bits"** for further details). The Primary Oscillator Configuration bits, POSCMD<1:0> (Configuration Word 2<1:0>) and the Initial Oscillator Select Configuration bits, FNOSC<2:0> (Configuration Word 2<10:8>), select the oscillator source that is used at a POR. The FRC primary oscillator with postscaler (FRCDIV) is the default (unprogrammed) selection. The secondary oscillator, or one of the internal oscillators, may be chosen by programming these bit locations.

The Configuration bits allow users to choose between the various clock modes, shown in Table 8-1.

8.2.1 CLOCK SWITCHING MODE CONFIGURATION BITS

The FCKSM Configuration bits (Configuration Word 2<7:6>) are used to jointly configure device clock switching and the Fail-Safe Clock Monitor (FSCM). Clock switching is enabled only when FCKSM1 is programmed ('0'). The FSCM is enabled only when FCKSM<1:0> are both programmed ('00').

TABLE 8-1: CONFIGURATION BIT VALUES FOR CLOCK SELECTION

Oscillator Mode	Oscillator Source	POSCMD<1:0>	FNOSC<2:0>	Notes
Fast RC Oscillator with Postscaler (FRCDIV)	Internal	11	111	**1, 2**
FRC Oscillator/16 (500 KHz)	Internal	11	110	**1**
Low-Power RC Oscillator (LPRC)	Internal	11	101	**1**
Secondary (Timer1) Oscillator (SOSC)	Secondary	11	100	**1**
Primary Oscillator (XT) with PLL Module (XTPLL)	Primary	01	011	**—**
Primary Oscillator (EC) with PLL Module (ECPLL)	Primary	00	011	**1**
Primary Oscillator (HS)	Primary	10	010	**—**
Primary Oscillator (XT)	Primary	01	010	**—**
Primary Oscillator (EC)	Primary	00	010	**1**
Fast RC Oscillator with PLL Module (FRCPLL)	Internal	11	001	**1**
Fast RC Oscillator (FRC)	Internal	11	000	**1**

Note 1: OSCO pin function is determined by the OSCIOFCN Configuration bit.

2: This is the default oscillator mode for an unprogrammed (erased) device.

10.4 Peripheral Pin Select (PPS)

A major challenge in general purpose devices is providing the largest possible set of peripheral features while minimizing the conflict of features on I/O pins. In an application that needs to use more than one peripheral multiplexed on a single pin, inconvenient work arounds in application code or a complete redesign may be the only option.

The Peripheral Pin Select (PPS) feature provides an alternative to these choices by enabling the user's peripheral set selection and its placement on a wide range of I/O pins. By increasing the pinout options available on a particular device, users can better tailor the microcontroller to their entire application, rather than trimming the application to fit the device.

The Peripheral Pin Select feature operates over a fixed subset of digital I/O pins. Users may independently map the input and/or output of any one of many digital peripherals to any one of these I/O pins. PPS is performed in software and generally does not require the device to be reprogrammed. Hardware safeguards are included that prevent accidental or spurious changes to the peripheral mapping once it has been established.

10.4.1 AVAILABLE PINS

The PPS feature is used with a range of up to 44 pins, depending on the particular device and its pin count. Pins that support the Peripheral Pin Select feature include the designation, "RPn" or "RPIn", in their full pin designation, where "n" is the remappable pin number. "RP" is used to designate pins that support both remappable input and output functions, while "RPI" indicates pins that support remappable input functions only.

PIC24FJ256DA210 family devices support a larger number of remappable input only pins than remappable input/output pins. In this device family, there are up to 32 remappable input/output pins, depending on the pin count of the particular device selected; these are numbered, RP0 through RP31. Remappable input only pins are numbered above this range, from RPI32 to RPI43 (or the upper limit for that particular device).

See Table 1-1 for a summary of pinout options in each package offering.

10.4.2 AVAILABLE PERIPHERALS

The peripherals managed by the PPS are all digital only peripherals. These include general serial communications (UART and SPI), general purpose timer clock inputs, timer related peripherals (input capture and output compare) and external interrupt inputs. Also included are the outputs of the comparator module, since these are discrete digital signals.

PPS is not available for I^{2}C™, change notification inputs, RTCC alarm outputs, EPMP signals, graphics controller signals or peripherals with analog inputs.

A key difference between pin select and non-pin select peripherals is that pin select peripherals are not associated with a default I/O pin. The peripheral must always be assigned to a specific I/O pin before it can be used. In contrast, non pin select peripherals are always available on a default pin, assuming that the peripheral is active and not conflicting with another peripheral.

10.4.2.1 Peripheral Pin Select Function Priority

Pin-selectable peripheral outputs (e.g., OC, UART transmit) will take priority over general purpose digital functions on a pin, such as EPMP and port I/O. Specialized digital outputs, such as USB functionality, will take priority over PPS outputs on the same pin. The pin diagrams list peripheral outputs in the order of priority. Refer to them for priority concerns on a particular pin.

Unlike PIC24F devices with fixed peripherals, pin selectable peripheral inputs will never take ownership of a pin. The pin's output buffer will be controlled by the TRISx setting or by a fixed peripheral on the pin. If the pin is configured in digital mode then the PPS input will operate correctly. If an analog function is enabled on the pin the PPS input will be disabled.

10.4.3 CONTROLLING PERIPHERAL PIN SELECT

PPS features are controlled through two sets of Special Function Registers (SFRs): one to map peripheral inputs and one to map outputs. Because they are separately controlled, a particular peripheral's input and output (if the peripheral has both) can be placed on any selectable function pin without constraint.

The association of a peripheral to a peripheral-selectable pin is handled in two different ways, depending on if an input or an output is being mapped.

10.4.3.1 Input Mapping

The inputs of the Peripheral Pin Select options are mapped on the basis of the peripheral; that is, a control register associated with a peripheral dictates the pin it will be mapped to. The RPINRx registers are used to configure peripheral input mapping (see Register 10-8 through Register 10-28). Each register contains two sets of 6-bit fields, with each set associated with one of the pin-selectable peripherals. Programming a given peripheral's bit field with an appropriate 6-bit value maps the RPn/RPIn pin with that value to that peripheral. For any given device, the valid range of values for any of the bit fields corresponds to the maximum number of Peripheral Pin Selections supported by the device.

REGISTER 10-12: RPINR4: PERIPHERAL PIN SELECT INPUT REGISTER 4

U-0	U-0	R/W-1	R/W-1	R/W-1	R/W-1	R/W-1	R/W-1
—	—	T5CKR5	T5CKR4	T5CKR3	T5CKR2	T5CKR1	T5CKR0
bit 15							bit 8

U-0	U-0	R/W-1	R/W-1	R/W-1	R/W-1	R/W-1	R/W-1
—	—	T4CKR5	T4CKR4	T4CKR3	T4CKR2	T4CKR1	T4CKR0
bit 7							bit 0

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

bit 15-14 **Unimplemented:** Read as '0'

bit 13-8 **T5CKR<5:0>:** Assign Timer5 External Clock (T5CK) to Corresponding RPn or RPIn Pin bits

bit 7-6 **Unimplemented:** Read as '0'

bit 5-0 **T4CKR<5:0>:** Assign Timer4 External Clock (T4CK) to Corresponding RPn or RPIn Pin bits

REGISTER 10-13: RPINR7: PERIPHERAL PIN SELECT INPUT REGISTER 7

U-0	U-0	R/W-1	R/W-1	R/W-1	R/W-1	R/W-1	R/W-1
—	—	IC2R5	IC2R4	IC2R3	IC2R2	IC2R1	IC2R0
bit 15							bit 8

U-0	U-0	R/W-1	R/W-1	R/W-1	R/W-1	R/W-1	R/W-1
—	—	IC1R5	IC1R4	IC1R3	IC1R2	IC1R1	IC1R0
bit 7							bit 0

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

bit 15-14 **Unimplemented:** Read as '0'

bit 13-8 **IC2R<5:0>:** Assign Input Capture 2 (IC2) to Corresponding RPn or RPIn Pin bits

bit 7-6 **Unimplemented:** Read as '0'

bit 5-0 **IC1R<5:0>:** Assign Input Capture 1 (IC1) to Corresponding RPn or RPIn Pin bits

REGISTER 10-20: RPINR18: PERIPHERAL PIN SELECT INPUT REGISTER 18

U-0	U-0	R/W-1	R/W-1	R/W-1	R/W-1	R/W-1	R/W-1
—	—	U1CTSR5	U1CTSR4	U1CTSR3	U1CTSR2	U1CTSR1	U1CTSR0
bit 15							bit 8

U-0	U-0	R/W-1	R/W-1	R/W-1	R/W-1	R/W-1	R/W-1
—	—	U1RXR5	U1RXR4	U1RXR3	U1RXR2	U1RXR1	U1RXR0
bit 7							bit 0

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

bit 15-14 **Unimplemented:** Read as '0'

bit 13-8 **U1CTSR<5:0>:** Assign UART1 Clear to Send ($\overline{\text{U1CTS}}$) to Corresponding RPn or RPIn Pin bits

bit 7-6 **Unimplemented:** Read as '0'

bit 5-0 **U1RXR<5:0>:** Assign UART1 Receive (U1RX) to Corresponding RPn or RPIn Pin bits

REGISTER 10-21: RPINR19: PERIPHERAL PIN SELECT INPUT REGISTER 19

U-0	U-0	R/W-1	R/W-1	R/W-1	R/W-1	R/W-1	R/W-1
—	—	U2CTSR5	U2CTSR4	U2CTSR3	U2CTSR2	U2CTSR1	U2CTSR0
bit 15							bit 8

U-0	U-0	R/W-1	R/W-1	R/W-1	R/W-1	R/W-1	R/W-1
—	—	U2RXR5	U2RXR4	U2RXR3	U2RXR2	U2RXR1	U2RXR0
bit 7							bit 0

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

bit 15-14 **Unimplemented:** Read as '0'

bit 13-8 **U2CTSR<5:0>:** Assign UART2 Clear to Send ($\overline{\text{U2CTS}}$) to Corresponding RPn or RPIn Pin bits

bit 7-6 **Unimplemented:** Read as '0'

bit 5-0 **U2RXR<5:0>:** Assign UART2 Receive (U2RX) to Corresponding RPn or RPIn Pin bits

REGISTER 14-2: OCxCON2: OUTPUT COMPARE x CONTROL REGISTER 2 (CONTINUED)

bit 4-0 **SYNCSEL<4:0>:** Trigger/Synchronization Source Selection bits
11111 = This OC module(1)
11110 = Input Capture 9(2)
11101 = Input Capture 6(2)
11100 = CTMU(2)
11011 = A/D(2)
11010 = Comparator 3(2)
11001 = Comparator 2(2)
11000 = Comparator 1(2)
10111 = Input Capture 4(2)
10110 = Input Capture 3(2)
10101 = Input Capture 2(2)
10100 = Input Capture 1(2)
10011 = Input Capture 8(2)
10010 = Input Capture 7(2)
1000x = Reserved
01111 = Timer5
01110 = Timer4
01101 = Timer3
01100 = Timer2
01011 = Timer1
01010 = Input Capture 5(2)
01001 = Output Compare 9(1)
01000 = Output Compare 8(1)
00111 = Output Compare 7(1)
00110 = Output Compare 6(1)
00101 = Output Compare 5(1)
00100 = Output Compare 4(1)
00011 = Output Compare 3(1)
00010 = Output Compare 2(1)
00001 = Output Compare 1(1)
00000 = Not synchronized to any other module

Note 1: Never use an OC module as its own trigger source, either by selecting this mode or another equivalent SYNCSEL setting.
2: Use these inputs as trigger sources only and never as sync sources.
3: The DCB<1:0> bits are double-buffered in the PWM modes only (OCM<2:0> (OCxCON1<2:0>) = 111, 110).

REGISTER 18-4: U1OTGCON: USB ON-THE-GO CONTROL REGISTER

U-0	U-0	U-0	U-0	U-0	U-0	U-0	U-0
—	—	—	—	—	—	—	—
bit 15							bit 8

R/W-0	R/W-0	R/W-0	R/W-0	R/W-0	R/W-0	R/W-0	R/W-0
DPPULUP	DMPULUP	DPPULDWN(1)	DMPULDWN(1)	VBUSON(1)	OTGEN(1)	VBUSCHG(1)	VBUSDIS(1)
bit 7							bit 0

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

bit 15-8 **Unimplemented:** Read as '0'

bit 7 **DPPULUP:** D+ Pull-up Enable bit
1 = D+ data line pull-up resistor is enabled
0 = D+ data line pull-up resistor is disabled

bit 6 **DMPULUP:** D- Pull-up Enable bit
1 = D- data line pull-up resistor is enabled
0 = D- data line pull-up resistor is disabled

bit 5 **DPPULDWN:** D+ Pull-Down Enable bit(1)
1 = D+ data line pull-down resistor is enabled
0 = D+ data line pull-down resistor is disabled

bit 4 **DMPULDWN:** D- Pull-Down Enable bit(1)
1 = D- data line pull-down resistor is enabled
0 = D- data line pull-down resistor is disabled

bit 3 **VBUSON:** VBUS Power-on bit(1)
1 = VBUS line is powered
0 = VBUS line is not powered

bit 2 **OTGEN:** OTG Features Enable bit(1)
1 = USB OTG is enabled; all D+/D- pull-up and pull-down bits are enabled
0 = USB OTG is disabled; D+/D- pull-up and pull-down bits are controlled in hardware by the settings of the HOSTEN and USBEN (U1CON<3,0>) bits

bit 1 **VBUSCHG:** VBUS Charge Select bit(1)
1 = VBUS line is set to charge to 3.3V
0 = VBUS line is set to charge to 5V

bit 0 **VBUSDIS:** VBUS Discharge Enable bit(1)
1 = VBUS line is discharged through a resistor
0 = VBUS line is not discharged

Note 1: These bits are only used in Host mode; do not use in Device mode.

TABLE 19-2: PARALLEL MASTER PORT PIN DESCRIPTION

Pin Name	Type	Description
PMA<22:16>	O	Address bus bits<22-16>
PMA<15>, PMCS2	O	Address bus bit<15>
	O	Chip Select 2 (alternate location)
	I/O	Data bus bit<15> when port size is 16 bits and address is multiplexed
PMA<14>, PMCS1	O	Address bus bit<14>
	O	Chip Select 1 (alternate location)
	I/O	Data bus bit 14 when port size is 16-bit and address is multiplexed
PMA<13:8>	O	Address bus bit< 13-8>
	I/O	Data bus bits<13-8> when port size is 16 bits and address is multiplexed
PMA<7:3>	O	Address bus bit< 7-3>
PMA<2>, PMALU	O	Address bus bit<2>
	O	Address latch upper strobe for multiplexed address
PMA<1>, PMALH	I/O	Address bus bit<1>
	O	Address latch high strobe for multiplexed address
PMA<0>, PMALL	I/O	Address bus bit<0>
	O	Address latch low strobe for multiplexed address
PMD<15:8>	I/O	Data bus bits<15-8> when address is not multiplexed
PMD<7:4>	I/O	Data bus bits<7-4>
	O	Address bus bits<7-4> when port size is 4 bits and address is multiplexed with 1 address phase
PMD<3:0>	I/O	Data bus bits<3-0>
PMCS1	I/O	Chip Select 1
PMCS2	O	Chip Select 2
PMWR, PMENB	I/O	Write strobe or Enable signal depending on Strobe mode
PMRD, PMRD/$\overline{\text{PMWR}}$	I/O	Read strobe or Read/$\overline{\text{Write}}$ signal depending on Strobe mode
PMBE1	O	Byte indicator
PMBE0	O	Nibble or byte indicator
PMACK1	I	Acknowledgment 1
PMACK2	I	Acknowledgment 2

REGISTER 21-7: CRCWDATL: CRC SHIFT LOW REGISTER

R/W-0, HSC	R/W-0, HSC	R/W-0, HSC	R/W-0, HSC	R/W-0, HSC	R/W-0, HSC	R/W-0, HSC	R/W-0, HSC
SDATA15	SDATA14	SDATA13	SDATA12	SDATA11	SDATA10	SDATA9	SDATA8
bit 15							bit 8

R/W-0, HSC	R/W-0, HSC	R/W-0, HSC	R/W-0, HSC	R/W-0, HSC	R/W-0, HSC	R/W-0, HSC	R/W-0, HSC
SDATA7	SDATA6	SDATA5	SDATA4	SDATA3	SDATA2	SDATA1	SDATA0
bit 7							bit 0

Legend:	HSC = Hardware Settable/Clearable bit		
R = Readable bit	W = Writable bit	U = Unimplemented bit, read as ‘0’	
-n = Value at POR	‘1’ = Bit is set	‘0’ = Bit is cleared	x = Bit is unknown

bit 15-0 **SDATA<15:0>:** CRC Shift Register bits
Writing to this register writes to the CRC Shift register through the CRC write bus. Reading from this register reads the CRC read bus.

REGISTER 21-8: CRCWDATH: CRC SHIFT HIGH REGISTER

R/W-0, HSC	R/W-0, HSC	R/W-0, HSC	R/W-0, HSC	R/W-0, HSC	R/W-0, HSC	R/W-0, HSC	R/W-0, HSC
SDATA31	SDATA30	SDATA29	SDATA28	SDATA27	SDATA26	SDATA25	SDATA24
bit 15							bit 8

R/W-0, HSC	R/W-0, HSC	R/W-0, HSC	R/W-0, HSC	R/W-0, HSC	R/W-0, HSC	R/W-0, HSC	R/W-0, HSC
SDATA23	SDATA22	SDATA21	SDATA20	SDATA19	SDATA18	SDATA17	SDATA16
bit 7							bit 0

Legend:	HSC = Hardware Settable/Clearable bit		
R = Readable bit	W = Writable bit	U = Unimplemented bit, read as ‘0’	
-n = Value at POR	‘1’ = Bit is set	‘0’ = Bit is cleared	x = Bit is unknown

bit 15-0 **SDATA<31:16>:** CRC Input Data bits
Writing to this register writes to the CRC Shift register through the CRC write bus. Reading from this register reads the CRC read bus.

REGISTER 24-1: CMxCON: COMPARATOR x CONTROL REGISTERS (COMPARATORS 1 THROUGH 3)

R/W-0	R/W-0	R/W-0	U-0	U-0	U-0	R/W-0, HS	R-0, HSC
CEN	COE	CPOL	—	—	—	CEVT	COUT
bit 15							bit 8

R/W-0	R/W-0	U-0	R/W-0	U-0	U-0	R/W-0	R/W-0
EVPOL1	EVPOL0	—	CREF	—	—	CCH1	CCH0
bit 7							bit 0

Legend:	HS = Hardware Settable bit	HSC = Hardware Settable/Clearable bit	
R = Readable bit	W = Writable bit	U = Unimplemented bit, read as '0'	
-n = Value at POR	'1' = Bit is set	'0' = Bit is cleared	x = Bit is unknown

bit 15 **CEN:** Comparator Enable bit
1 = Comparator is enabled
0 = Comparator is disabled

bit 14 **COE:** Comparator Output Enable bit
1 = Comparator output is present on the CxOUT pin
0 = Comparator output is internal only

bit 13 **CPOL:** Comparator Output Polarity Select bit
1 = Comparator output is inverted
0 = Comparator output is not inverted

bit 12-10 **Unimplemented:** Read as '0'

bit 9 **CEVT:** Comparator Event bit
1 = Comparator event that is defined by EVPOL<1:0> has occurred; subsequent triggers and interrupts are disabled until the bit is cleared
0 = Comparator event has not occurred

bit 8 **COUT:** Comparator Output bit
When CPOL = 0:
1 = $V_{IN+} > V_{IN-}$
0 = $V_{IN+} < V_{IN-}$
When CPOL = 1:
1 = $V_{IN+} < V_{IN-}$
0 = $V_{IN+} > V_{IN-}$

bit 7-6 **EVPOL<1:0>:** Trigger/Event/Interrupt Polarity Select bits
11 = Trigger/event/interrupt is generated on any change of the comparator output (while CEVT = 0)
10 = Trigger/event/interrupt is generated on transition of the comparator output:
If CPOL = 0 (non-inverted polarity):
High-to-low transition only.
If CPOL = 1 (inverted polarity):
Low-to-high transition only.
01 = Trigger/event/interrupt is generated on transition of comparator output:
If CPOL = 0 (non-inverted polarity):
Low-to-high transition only.
If CPOL = 1 (inverted polarity):
High-to-low transition only.
00 = Trigger/event/interrupt generation is disabled

bit 5 **Unimplemented:** Read as '0'

NOTES:

REGISTER 27-2: CW2: FLASH CONFIGURATION WORD 2

U-0	U-0	U-0	U-0	U-0	U-0	U-0	U-0
—	—	—	—	—	—	—	—
bit 23							bit 16

R/PO-1	R/PO-1	R/PO-1	R/PO-1	R/PO-1	R/PO-1	R/PO-1	R/PO-1
IESO	PLLDIV2	PLLDIV1	PLLDIV0	PLL96MHZ	FNOSC2	FNOSC1	FNOSC0
bit 15							bit 8

R/PO-1	R/PO-1	R/PO-1	R/PO-1	r-1	r-1	R/PO-1	R/PO-1
FCKSM1	FCKSM0	OSCIOFCN	IOL1WAY	reserved	reserved	POSCMD1	POSCMD0
bit 7							bit 0

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

bit 23-16 **Unimplemented:** Read as '1'

bit 15 **IESO:** Internal External Switchover bit
1 = IESO mode (Two-Speed Start-up) is enabled
0 = IESO mode (Two-Speed Start-up) is disabled

bit 14-12 **PLLDIV<2:0>:** 96 MHz PLL Prescaler Select bits
111 = Oscillator input is divided by 12 (48 MHz input)
110 = Oscillator input is divided by 8 (32 MHz input)
101 = Oscillator input is divided by 6 (24 MHz input)
100 = Oscillator input is divided by 5 (20 MHz input)
011 = Oscillator input is divided by 4 (16 MHz input)
010 = Oscillator input is divided by 3 (12 MHz input)
001 = Oscillator input is divided by 2 (8 MHz input)
000 = Oscillator input is used directly (4 MHz input)

bit 11 **PLL96MHZ:** 96 MHz PLL Start-Up Enable bit
1 = 96 MHz PLL is enabled automatically on start-up
0 = 96 MHz PLL is software controlled (can be enabled by setting the PLLEN bit in CLKDIV<5>)

bit 10-8 **FNOSC<2:0>:** Initial Oscillator Select bits
111 = Fast RC Oscillator with Postscaler (FRCDIV)
110 = Reserved
101 = Low-Power RC Oscillator (LPRC)
100 = Secondary Oscillator (SOSC)
011 = Primary Oscillator with PLL module (XTPLL, HSPLL, ECPLL)
010 = Primary Oscillator (XT, HS, EC)
001 = Fast RC Oscillator with Postscaler and PLL module (FRCPLL)
000 = Fast RC Oscillator (FRC)

bit 7-6 **FCKSM<1:0>:** Clock Switching and Fail-Safe Clock Monitor Configuration bits
1x = Clock switching and Fail-Safe Clock Monitor are disabled
01 = Clock switching is enabled, Fail-Safe Clock Monitor is disabled
00 = Clock switching is enabled, Fail-Safe Clock Monitor is enabled

bit 5 **OSCIOFCN:** OSCO Pin Configuration bit
If POSCMD<1:0> = 11 or 00:
1 = OSCO/CLKO/RC15 functions as CLKO (FOSC/2)
0 = OSCO/CLKO/RC15 functions as port I/O (RC15)
If POSCMD<1:0> = 10 or 01:
OSCIOFCN has no effect on OSCO/CLKO/RC15.

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