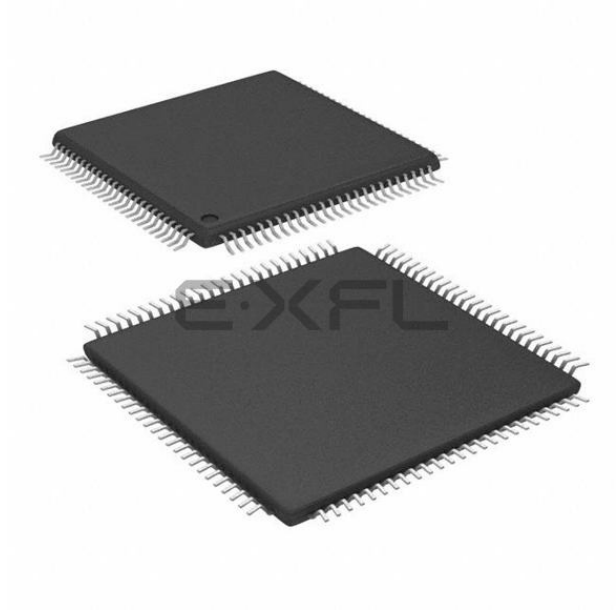
Microchip Technology - PIC24HJ256GP210AT-I/PT Datasheet



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"Embedded - Microcontrollers" refer to small, integrated circuits designed to perform specific tasks within larger systems. These microcontrollers are essentially compact computers on a single chip, containing a processor core, memory, and programmable input/output peripherals. They are called "embedded" because they are embedded within electronic devices to control various functions, rather than serving as standalone computers. Microcontrollers are crucial in modern electronics, providing the intelligence and control needed for a wide range of applications.

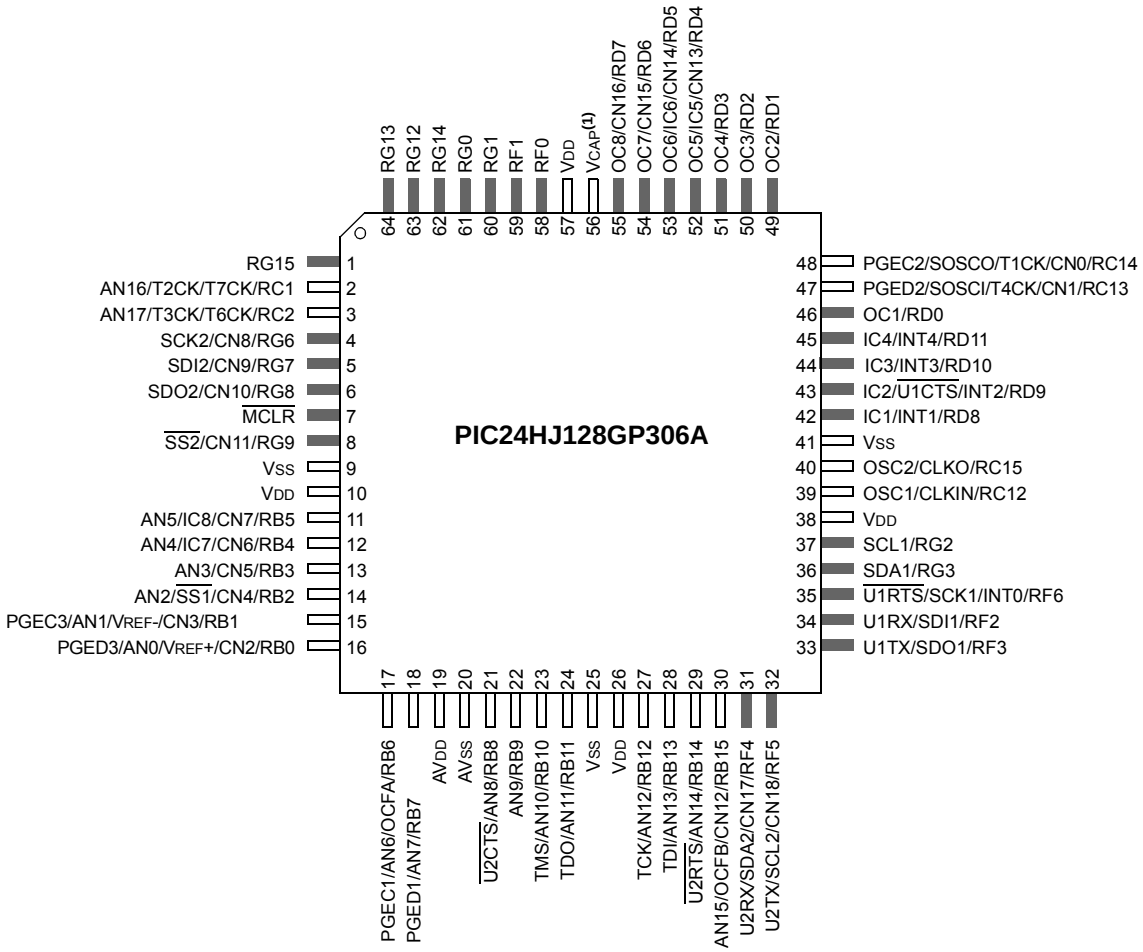
Applications of "Embedded - Microcontrollers"

Details	
Product Status	Active
Core Processor	PIC
Core Size	16-Bit
Speed	40 MIPs
Connectivity	I²C, IrDA, LINbus, SPI, UART/USART
Peripherals	Brown-out Detect/Reset, DMA, POR, PWM, WDT
Number of I/O	85
Program Memory Size	256KB (85.5K x 24)
Program Memory Type	FLASH
EEPROM Size	-
RAM Size	16K x 8
Voltage - Supply (Vcc/Vdd)	3V ~ 3.6V
Data Converters	A/D 32x10b/12b
Oscillator Type	Internal
Operating Temperature	-40°C ~ 85°C (TA)
Mounting Type	Surface Mount
Package / Case	100-TQFP
Supplier Device Package	100-TQFP (12x12)
Purchase URL	https://www.e-xfl.com/product-detail/microchip-technology/pic24hj256gp210at-i-pt

Pin Diagrams (Continued)

64-Pin TQFP

■ = Pins are up to 5V tolerant



Note 1: Refer to **Section 2.3 "CPU Logic Filter Capacitor Connection (VCAP)"** for proper connection to this pin.

4.0 MEMORY ORGANIZATION

Note: This data sheet summarizes the features of the PIC24HJXXXGPX06A/X08A/X10A family of devices. However, it is not intended to be a comprehensive reference source. To complement the information in this data sheet, refer to **Section 3. "Data Memory"** (DS70202) of the *"dsPIC33F/PIC24H Family Reference Manual"*, which is available from the Microchip web site (www.microchip.com).

The PIC24HJXXXGPX06A/X08A/X10A architecture features separate program and data memory spaces and buses. This architecture also allows the direct access of program memory from the data space during code execution.

4.1 Program Address Space

The program address memory space of the PIC24HJXXXGPX06A/X08A/X10A devices is 4M instructions. The space is addressable by a 24-bit value derived from either the 23-bit Program Counter (PC) during program execution, or from table operation or data space remapping as described in **Section 4.4 "Interfacing Program and Data Memory Spaces"**.

User access to the program memory space is restricted to the lower half of the address range (0x000000 to 0x7FFFFF). The exception is the use of TBLRD/TBLWT operations, which use TBLPAG<7> to permit access to the Configuration bits and Device ID sections of the configuration memory space.

Memory maps for the PIC24HJXXXGPX06A/X08A/X10A family of devices are shown in Figure 4-1.

FIGURE 4-1: PROGRAM MEMORY MAP FOR PIC24HJXXXGPX06A/X08A/X10A FAMILY DEVICES

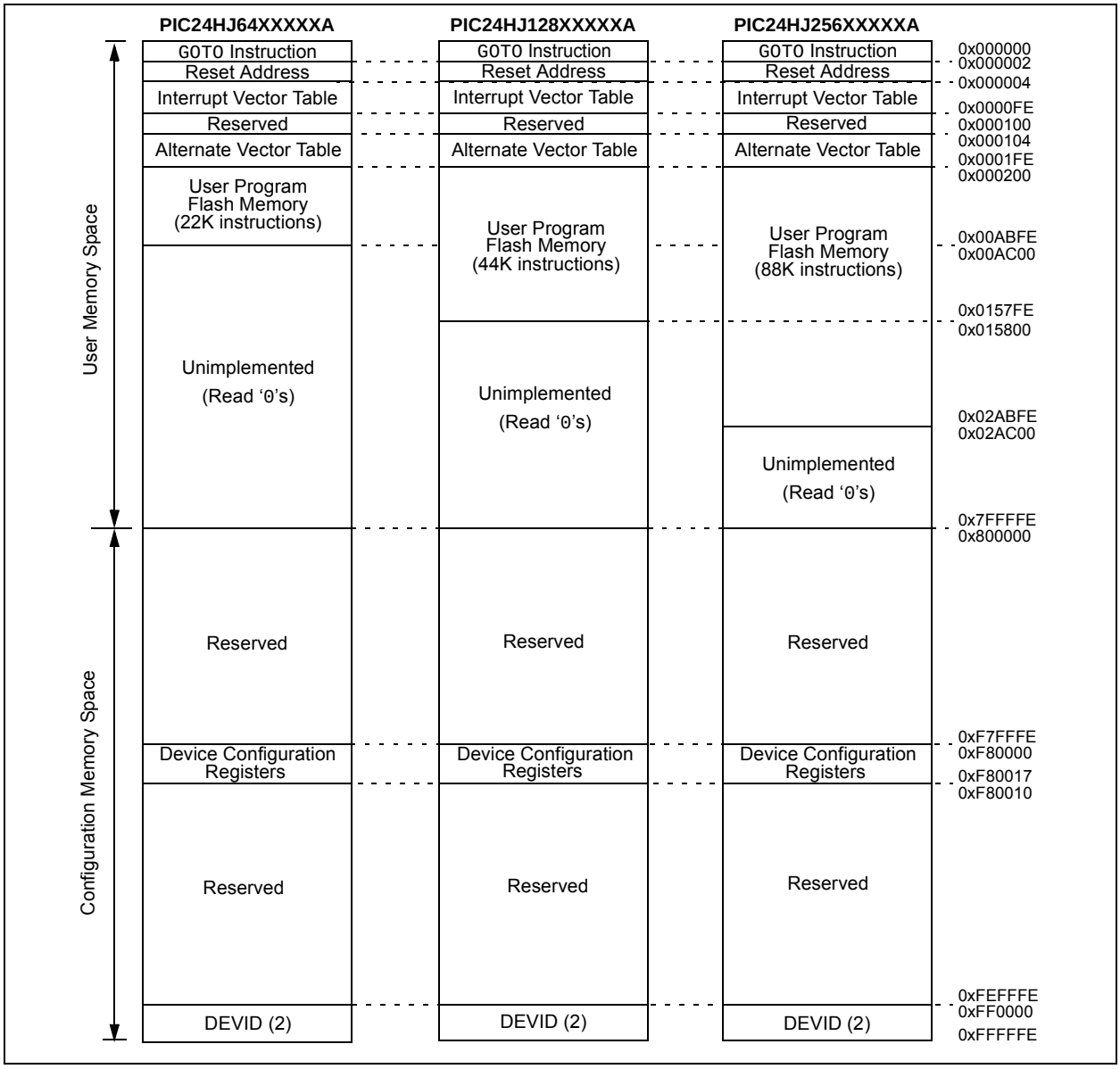


TABLE 4-6: TIMER REGISTER MAP

SFR Name	SFR 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
TMR1	0100	Timer1 Register																0000
PR1	0102	Period Register 1																FFFF
T1CON	0104	TON	—	TSIDL	—	—	—	—	—	—	TGATE	TCKPS<1:0>		—	TSYNC	TCS	—	0000
TMR2	0106	Timer2 Register																0000
TMR3HLD	0108	Timer3 Holding Register (for 32-bit timer operations only)																xxxx
TMR3	010A	Timer3 Register																0000
PR2	010C	Period Register 2																FFFF
PR3	010E	Period Register 3																FFFF
T2CON	0110	TON	—	TSIDL	—	—	—	—	—	—	TGATE	TCKPS<1:0>		T32	—	TCS	—	0000
T3CON	0112	TON	—	TSIDL	—	—	—	—	—	—	TGATE	TCKPS<1:0>		—	—	TCS	—	0000
TMR4	0114	Timer4 Register																0000
TMR5HLD	0116	Timer5 Holding Register (for 32-bit operations only)																xxxx
TMR5	0118	Timer5 Register																0000
PR4	011A	Period Register 4																FFFF
PR5	011C	Period Register 5																FFFF
T4CON	011E	TON	—	TSIDL	—	—	—	—	—	—	TGATE	TCKPS<1:0>		T32	—	TCS	—	0000
T5CON	0120	TON	—	TSIDL	—	—	—	—	—	—	TGATE	TCKPS<1:0>		—	—	TCS	—	0000
TMR6	0122	Timer6 Register																0000
TMR7HLD	0124	Timer7 Holding Register (for 32-bit operations only)																xxxx
TMR7	0126	Timer7 Register																0000
PR6	0128	Period Register 6																FFFF
PR7	012A	Period Register 7																FFFF
T6CON	012C	TON	—	TSIDL	—	—	—	—	—	—	TGATE	TCKPS<1:0>		T32	—	TCS	—	0000
T7CON	012E	TON	—	TSIDL	—	—	—	—	—	—	TGATE	TCKPS<1:0>		—	—	TCS	—	0000
TMR8	0130	Timer8 Register																0000
TMR9HLD	0132	Timer9 Holding Register (for 32-bit operations only)																xxxx
TMR9	0134	Timer9 Register																0000
PR8	0136	Period Register 8																FFFF
PR9	0138	Period Register 9																FFFF
T8CON	013A	TON	—	TSIDL	—	—	—	—	—	—	TGATE	TCKPS<1:0>		T32	—	TCS	—	0000
T9CON	013C	TON	—	TSIDL	—	—	—	—	—	—	TGATE	TCKPS<1:0>		—	—	TCS	—	0000

Legend: x = unknown value on Reset, — = unimplemented, read as '0'. Reset values are shown in hexadecimal for PinHigh devices.

TABLE 6-3: RESET DELAY TIMES FOR VARIOUS DEVICE RESETS

Reset Type	Clock Source	$\overline{\text{SYSRST}}$ Delay	System Clock Delay	FSCM Delay	See Notes
POR	EC, FRC, LPRC	TPOR + TSTARTUP + TRST	—	—	**1, 2, 3**
	ECPLL, FRCPLL	TPOR + TSTARTUP + TRST	TLOCK	TFSCM	**1, 2, 3, 5, 6**
	XT, HS, SOSC	TPOR + TSTARTUP + TRST	TOST	TFSCM	**1, 2, 3, 4, 6**
	XTPLL, HSPLL	TPOR + TSTARTUP + TRST	TOST + TLOCK	TFSCM	**1, 2, 3, 4, 5, 6**
$\overline{\text{MCLR}}$	Any Clock	TRST	—	—	**3**
WDT	Any Clock	TRST	—	—	**3**
Software	Any clock	TRST	—	—	**3**
Illegal Opcode	Any Clock	TRST	—	—	**3**
Uninitialized W	Any Clock	TRST	—	—	**3**
Trap Conflict	Any Clock	TRST	—	—	**3**

Note 1: TPOR = Power-on Reset delay (10 μs nominal).

2: TSTARTUP = Conditional POR delay of 20 μs nominal (if on-chip regulator is enabled) or 64 ms nominal Power-up Timer delay (if regulator is disabled). TSTARTUP is also applied to all returns from powered-down states, including waking from Sleep mode, only if the regulator is enabled.

3: TRST = Internal state Reset time (20 μs nominal).

4: TOST = Oscillator Start-up Timer. A 10-bit counter counts 1024 oscillator periods before releasing the oscillator clock to the system.

5: TLOCK = PLL lock time (20 μs nominal).

6: TFSCM = Fail-Safe Clock Monitor delay (100 μs nominal).

6.2.1 POR AND LONG OSCILLATOR START-UP TIMES

The oscillator start-up circuitry and its associated delay timers are not linked to the device Reset delays that occur at power-up. Some crystal circuits (especially low-frequency crystals) have a relatively long start-up time. Therefore, one or more of the following conditions is possible after the Reset signal is released:

- The oscillator circuit has not begun to oscillate
- The Oscillator Start-up Timer has not expired (if a crystal oscillator is used)
- The PLL has not achieved a lock (if PLL is used)

The device will not begin to execute code until a valid clock source has been released to the system. Therefore, the oscillator and PLL start-up delays must be considered when the Reset delay time must be known.

6.2.2 FAIL-SAFE CLOCK MONITOR (FSCM) AND DEVICE RESETS

If the FSCM is enabled, it begins to monitor the system clock source when the Reset signal is released. If a valid clock source is not available at this time, the device automatically switches to the FRC oscillator and the user can switch to the desired crystal oscillator in the Trap Service Routine.

6.2.2.1 FSCM Delay for Crystal and PLL Clock Sources

When the system clock source is provided by a crystal oscillator and/or the PLL, a small delay, TFSCM, is automatically inserted after the POR and PWRT delay times. The FSCM does not begin to monitor the system clock source until this delay expires. The FSCM delay time is nominally 500 μs and provides additional time for the oscillator and/or PLL to stabilize. In most cases, the FSCM delay prevents an oscillator failure trap at a device Reset when the PWRT is disabled.

6.3 Special Function Register Reset States

Most of the Special Function Registers (SFRs) associated with the CPU and peripherals are reset to a particular value at a device Reset. The SFRs are grouped by their peripheral or CPU function and their Reset values are specified in each section of this manual.

The Reset value for each SFR does not depend on the type of Reset, with the exception of two registers. The Reset value for the Reset Control register, RCON, depends on the type of device Reset. The Reset value for the Oscillator Control register, OSCCON, depends on the type of Reset and the programmed values of the oscillator Configuration bits in the FOSC Configuration register.

REGISTER 7-4: INTCON2: INTERRUPT CONTROL REGISTER 2

R/W-0	R-0	U-0	U-0	U-0	U-0	U-0	U-0
ALTIVT	DISI	—	—	—	—	—	—
bit 15							bit 8

U-0	U-0	U-0	R/W-0	R/W-0	R/W-0	R/W-0	R/W-0
—	—	—	INT4EP	INT3EP	INT2EP	INT1EP	INT0EP
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 **ALTIVT:** Enable Alternate Interrupt Vector Table bit
1 = Use alternate vector table
0 = Use standard (default) vector table

bit 14 **DISI:** DISI Instruction Status bit
1 = DISI instruction is active
0 = DISI instruction is not active

bit 13-5 **Unimplemented:** Read as '0'

bit 4 **INT4EP:** External Interrupt 4 Edge Detect Polarity Select bit
1 = Interrupt on negative edge
0 = Interrupt on positive edge

bit 3 **INT3EP:** External Interrupt 3 Edge Detect Polarity Select bit
1 = Interrupt on negative edge
0 = Interrupt on positive edge

bit 2 **INT2EP:** External Interrupt 2 Edge Detect Polarity Select bit
1 = Interrupt on negative edge
0 = Interrupt on positive edge

bit 1 **INT1EP:** External Interrupt 1 Edge Detect Polarity Select bit
1 = Interrupt on negative edge
0 = Interrupt on positive edge

bit 0 **INT0EP:** External Interrupt 0 Edge Detect Polarity Select bit
1 = Interrupt on negative edge
0 = Interrupt on positive edge

REGISTER 7-14: IEC4: INTERRUPT ENABLE CONTROL REGISTER 4

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	U-0	R/W-0	R/W-0	U-0
C2TXIE	C1TXIE	DMA7IE	DMA6IE	—	U2EIE	U1EIE	—
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 **C2TXIE:** ECAN2 Transmit Data Request Interrupt Enable bit
1 = Interrupt request enabled
0 = Interrupt request not enabled

bit 6 **C1TXIE:** ECAN1 Transmit Data Request Interrupt Enable bit
1 = Interrupt request enabled
0 = Interrupt request not enabled

bit 5 **DMA7IE:** DMA Channel 7 Data Transfer Complete Enable Status bit
1 = Interrupt request enabled
0 = Interrupt request not enabled

bit 4 **DMA6IE:** DMA Channel 6 Data Transfer Complete Enable Status bit
1 = Interrupt request enabled
0 = Interrupt request not enabled

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

bit 2 **U2EIE:** UART2 Error Interrupt Enable bit
1 = Interrupt request enabled
0 = Interrupt request not enabled

bit 1 **U1EIE:** UART1 Error Interrupt Enable bit
1 = Interrupt request enabled
0 = Interrupt request not enabled

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

REGISTER 7-27: IPC12: INTERRUPT PRIORITY CONTROL REGISTER 12

U-0	R/W-1	R/W-0	R/W-0	U-0	R/W-1	R/W-0	R/W-0
—	T8IP<2:0>			—	MI2C2IP<2:0>		
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
—	SI2C2IP<2:0>			—	T7IP<2:0>		
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 **Unimplemented:** Read as '0'

bit 14-12 **T8IP<2:0>:** Timer8 Interrupt Priority bits
111 = Interrupt is priority 7 (highest priority interrupt)
•
•
•
001 = Interrupt is priority 1
000 = Interrupt source is disabled

bit 11 **Unimplemented:** Read as '0'

bit 10-8 **MI2C2IP<2:0>:** I2C2 Master Events Interrupt Priority bits
111 = Interrupt is priority 7 (highest priority interrupt)
•
•
•
001 = Interrupt is priority 1
000 = Interrupt source is disabled

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

bit 6-4 **SI2C2IP<2:0>:** I2C2 Slave Events Interrupt Priority bits
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 **T7IP<2:0>:** Timer7 Interrupt Priority bits
111 = Interrupt is priority 7 (highest priority interrupt)
•
•
•
001 = Interrupt is priority 1
000 = Interrupt source is disabled

REGISTER 8-5: DMAxPAD: DMA CHANNEL x PERIPHERAL ADDRESS REGISTER(1)

R/W-0	R/W-0	R/W-0	R/W-0	R/W-0	R/W-0	R/W-0	R/W-0
PAD<15:8>							
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
PAD<7:0>							
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 15-0 **PAD<15:0>:** Peripheral Address Register bits

Note 1: If the channel is enabled (i.e., active), writes to this register may result in unpredictable behavior of the DMA channel and should be avoided.

REGISTER 8-6: DMAxCNT: DMA CHANNEL x TRANSFER COUNT REGISTER(1)

U-0	U-0	U-0	U-0	U-0	U-0	R/W-0	R/W-0
—	—	—	—	—	—	CNT<9:8>(2)	
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
CNT<7:0>(2)							
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

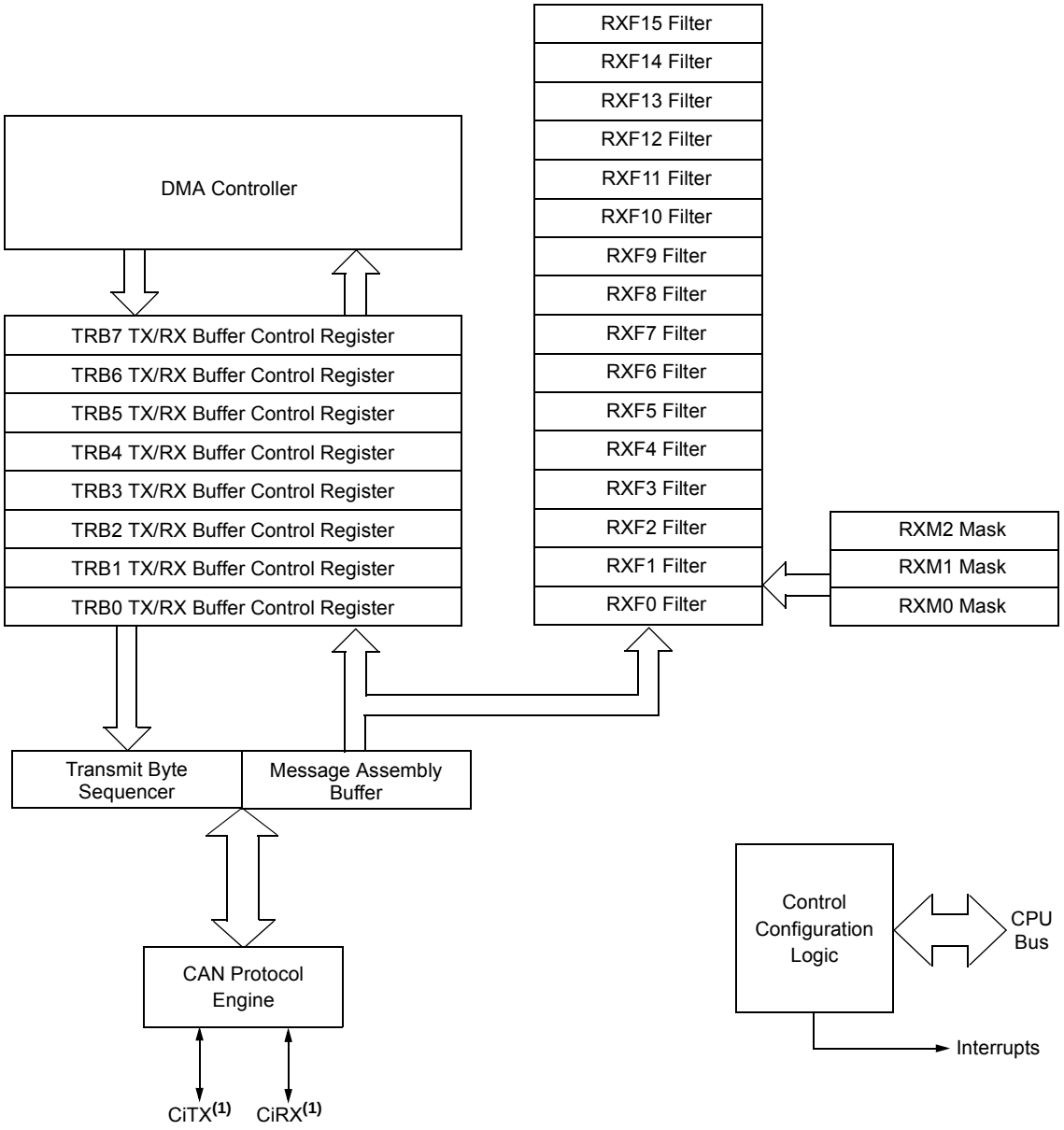
bit 15-10 **Unimplemented:** Read as '0'

bit 9-0 **CNT<9:0>:** DMA Transfer Count Register bits(2)

Note 1: If the channel is enabled (i.e., active), writes to this register may result in unpredictable behavior of the DMA channel and should be avoided.

2: Number of DMA transfers = CNT<9:0> + 1.

FIGURE 19-1: ECAN™ MODULE BLOCK DIAGRAM



Note 1: i = 1 or 2 refers to a particular ECAN™ module (ECAN1 or ECAN2).

REGISTER 19-1: CiCTRL1: ECAN™ MODULE CONTROL REGISTER 1

U-0	U-0	R/W-0	R/W-0	r-0	R/W-1	R/W-0	R/W-0
—	—	CSIDL	ABAT	—	REQOP<2:0>		
bit 15							bit 8

R-1	R-0	R-0	U-0	R/W-0	U-0	U-0	R/W-0
OPMODE<2:0>			—	CANCAP	—	—	WIN
bit 7							bit 0

Legend:	r = Bit is Reserved		
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 **CSIDL:** Stop in Idle Mode bit
1 = Discontinue module operation when device enters Idle mode
0 = Continue module operation in Idle mode

bit 12 **ABAT:** Abort All Pending Transmissions bit
1 = Signal all transmit buffers to abort transmission
0 = Module will clear this bit when all transmissions are aborted

bit 11 **Reserved:** Do not use

bit 10-8 **REQOP<2:0>:** Request Operation Mode bits
111 = Set Listen All Messages mode
110 = Reserved – do not use
101 = Reserved – do not use
100 = Set Configuration mode
011 = Set Listen Only Mode
010 = Set Loopback mode
001 = Set Disable mode
000 = Set Normal Operation mode

bit 7-5 **OPMODE<2:0>:** Operation Mode bits
111 = Module is in Listen All Messages mode
110 = Reserved
101 = Reserved
100 = Module is in Configuration mode
011 = Module is in Listen Only mode
010 = Module is in Loopback mode
001 = Module is in Disable mode
000 = Module is in Normal Operation mode

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

bit 3 **CANCAP:** CAN Message Receive Timer Capture Event Enable bit
1 = Enable input capture based on CAN message receive
0 = Disable CAN capture

bit 2-1 **Unimplemented:** Read as '0'

bit 0 **WIN:** SFR Map Window Select bit
1 = Use filter window
0 = Use buffer window

REGISTER 19-20: CiRXMnSID: ECAN™ MODULE ACCEPTANCE FILTER MASK n STANDARD IDENTIFIER

R/W-x	R/W-x	R/W-x	R/W-x	R/W-x	R/W-x	R/W-x	R/W-x
SID<10:3>							
bit 15							bit 8

R/W-x	R/W-x	R/W-x	U-0	R/W-x	U-0	R/W-x	R/W-x
SID<2:0>			—	MIDE	—	EID<17:16>	
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 15-5 **SID<10:0>:** Standard Identifier bits
1 = Include bit SIDx in filter comparison
0 = Bit SIDx is don't care in filter comparison

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

bit 3 **MIDE:** Identifier Receive Mode bit
1 = Match only message types (standard or extended address) that correspond to EXIDE bit in filter
0 = Match either standard or extended address message if filters match
(i.e., if (Filter SID) = (Message SID) or if (Filter SID/EID) = (Message SID/EID))

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

bit 1-0 **EID<17:16>:** Extended Identifier bits
1 = Include bit EIDx in filter comparison
0 = Bit EIDx is don't care in filter comparison

REGISTER 19-21: CiRXMnEID: ECAN™ TECHNOLOGY ACCEPTANCE FILTER MASK n EXTENDED IDENTIFIER

R/W-x	R/W-x	R/W-x	R/W-x	R/W-x	R/W-x	R/W-x	R/W-x
EID<15:8>							
bit 15							bit 8

R/W-x	R/W-x	R/W-x	R/W-x	R/W-x	R/W-x	R/W-x	R/W-x
EID<7:0>							
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 15-0 **EID<15:0>:** Extended Identifier bits
1 = Include bit EIDx in filter comparison
0 = Bit EIDx is don't care in filter comparison

TABLE 21-2: CONFIGURATION BITS DESCRIPTION (CONTINUED)

Bit Field	Register	RTSP Effect	Description
SSS<2:0>	FSS	Immediate	Secure Segment Program Flash Code Protection Size (**FOR 128K and 256K DEVICES**) X11 = No Secure program Flash segment Secure space is 8K IW less BS 110 = Standard security; secure program Flash segment starts at End of BS, ends at 0x003FFE 010 = High security; secure program Flash segment starts at End of BS, ends at 0x003FFE Secure space is 16K IW less BS 101 = Standard security; secure program Flash segment starts at End of BS, ends at 0x007FFE 001 = High security; secure program Flash segment starts at End of BS, ends at 0x007FFE Secure space is 32K IW less BS 100 = Standard security; secure program Flash segment starts at End of BS, ends at 0x00FFFE 000 = High security; secure program Flash segment starts at End of BS, ends at 0x00FFFE (**FOR 64K DEVICES**) X11 = No Secure program Flash segment Secure space is 4K IW less BS 110 = Standard security; secure program Flash segment starts at End of BS, ends at 0x001FFE 010 = High security; secure program Flash segment starts at End of BS, ends at 0x001FFE Secure space is 8K IW less BS 101 = Standard security; secure program Flash segment starts at End of BS, ends at 0x003FFE 001 = High security; secure program Flash segment starts at End of BS, ends at 0x003FFE Secure space is 16K IW less BS 100 = Standard security; secure program Flash segment starts at End of BS, ends at 0x007FFE 000 = High security; secure program Flash segment starts at End of BS, ends at 0x007FFE
RSS<1:0>	FSS	Immediate	Secure Segment RAM Code Protection 11 = No Secure RAM defined 10 = Secure RAM is 256 Bytes less BS RAM 01 = Secure RAM is 2048 Bytes less BS RAM 00 = Secure RAM is 4096 Bytes less BS RAM
GSS<1:0>	FGS	Immediate	General Segment Code-Protect bit 11 = User program memory is not code-protected 10 = Standard Security; general program Flash segment starts at End of SS, ends at EOM 0x = High Security; general program Flash segment starts at End of ESS, ends at EOM
GWRP	FGS	Immediate	General Segment Write-Protect bit 1 = User program memory is not write-protected 0 = User program memory is write-protected

TABLE 22-2: INSTRUCTION SET OVERVIEW (CONTINUED)

Base Instr #	Assembly Mnemonic	Assembly Syntax		Description	# of Words	# of Cycles	Status Flags Affected
47	RCALL	RCALL	Expr	Relative Call	1	2	None
		RCALL	Wn	Computed Call	1	2	None
48	REPEAT	REPEAT	#lit14	Repeat Next Instruction lit14 + 1 times	1	1	None
		REPEAT	Wn	Repeat Next Instruction (Wn) + 1 times	1	1	None
49	RESET	RESET		Software device Reset	1	1	None
50	RETFIE	RETFIE		Return from interrupt	1	3 (2)	None
51	RETLW	RETLW	#lit10,Wn	Return with literal in Wn	1	3 (2)	None
52	RETURN	RETURN		Return from Subroutine	1	3 (2)	None
53	RLC	RLC	f	f = Rotate Left through Carry f	1	1	C,N,Z
		RLC	f,WREG	WREG = Rotate Left through Carry f	1	1	C,N,Z
		RLC	Ws,Wd	Wd = Rotate Left through Carry Ws	1	1	C,N,Z
54	RLNC	RLNC	f	f = Rotate Left (No Carry) f	1	1	N,Z
		RLNC	f,WREG	WREG = Rotate Left (No Carry) f	1	1	N,Z
		RLNC	Ws,Wd	Wd = Rotate Left (No Carry) Ws	1	1	N,Z
55	RRC	RRC	f	f = Rotate Right through Carry f	1	1	C,N,Z
		RRC	f,WREG	WREG = Rotate Right through Carry f	1	1	C,N,Z
		RRC	Ws,Wd	Wd = Rotate Right through Carry Ws	1	1	C,N,Z
56	RRNC	RRNC	f	f = Rotate Right (No Carry) f	1	1	N,Z
		RRNC	f,WREG	WREG = Rotate Right (No Carry) f	1	1	N,Z
		RRNC	Ws,Wd	Wd = Rotate Right (No Carry) Ws	1	1	N,Z
57	SE	SE	Ws,Wnd	Wnd = sign-extended Ws	1	1	C,N,Z
58	SETM	SETM	f	f = 0xFFFF	1	1	None
		SETM	WREG	WREG = 0xFFFF	1	1	None
		SETM	Ws	Ws = 0xFFFF	1	1	None
59	SL	SL	f	f = Left Shift f	1	1	C,N,OV,Z
		SL	f,WREG	WREG = Left Shift f	1	1	C,N,OV,Z
		SL	Ws,Wd	Wd = Left Shift Ws	1	1	C,N,OV,Z
		SL	Wb,Wns,Wnd	Wnd = Left Shift Wb by Wns	1	1	N,Z
		SL	Wb,#lit5,Wnd	Wnd = Left Shift Wb by lit5	1	1	N,Z
60	SUB	SUB	f	f = f – WREG	1	1	C,DC,N,OV,Z
		SUB	f,WREG	WREG = f – WREG	1	1	C,DC,N,OV,Z
		SUB	#lit10,Wn	Wn = Wn – lit10	1	1	C,DC,N,OV,Z
		SUB	Wb,Ws,Wd	Wd = Wb – Ws	1	1	C,DC,N,OV,Z
		SUB	Wb,#lit5,Wd	Wd = Wb – lit5	1	1	C,DC,N,OV,Z
61	SUBB	SUBB	f	f = f – WREG – ($\overline{C}$)	1	1	C,DC,N,OV,Z
		SUBB	f,WREG	WREG = f – WREG – ($\overline{C}$)	1	1	C,DC,N,OV,Z
		SUBB	#lit10,Wn	Wn = Wn – lit10 – ($\overline{C}$)	1	1	C,DC,N,OV,Z
		SUBB	Wb,Ws,Wd	Wd = Wb – Ws – ($\overline{C}$)	1	1	C,DC,N,OV,Z
		SUBB	Wb,#lit5,Wd	Wd = Wb – lit5 – ($\overline{C}$)	1	1	C,DC,N,OV,Z
62	SUBR	SUBR	f	f = WREG – f	1	1	C,DC,N,OV,Z
		SUBR	f,WREG	WREG = WREG – f	1	1	C,DC,N,OV,Z
		SUBR	Wb,Ws,Wd	Wd = Ws – Wb	1	1	C,DC,N,OV,Z
		SUBR	Wb,#lit5,Wd	Wd = lit5 – Wb	1	1	C,DC,N,OV,Z
63	SUBBR	SUBBR	f	f = WREG – f – ($\overline{C}$)	1	1	C,DC,N,OV,Z
		SUBBR	f,WREG	WREG = WREG – f – ($\overline{C}$)	1	1	C,DC,N,OV,Z
		SUBBR	Wb,Ws,Wd	Wd = Ws – Wb – ($\overline{C}$)	1	1	C,DC,N,OV,Z
		SUBBR	Wb,#lit5,Wd	Wd = lit5 – Wb – ($\overline{C}$)	1	1	C,DC,N,OV,Z
64	SWAP	SWAP.b	Wn	Wn = nibble swap Wn	1	1	None
		SWAP	Wn	Wn = byte swap Wn	1	1	None
65	TBLRDH	TBLRDH	Ws,Wd	Read Prog<23:16> to Wd<7:0>	1	2	None

TABLE 24-5: DC CHARACTERISTICS: OPERATING CURRENT (IDD)

DC CHARACTERISTICS			Standard Operating Conditions: 3.0V to 3.6V (unless otherwise stated) Operating temperature -40°C ≤ TA ≤ +85°C for Industrial -40°C ≤ TA ≤ +125°C for Extended			
Parameter No.(3)	**Typical(2)**	**Max**	**Units**	**Conditions**		
Operating Current (IDD)(1)						
DC20d	27	30	mA	-40°C	3.3V	10 MIPS
DC20a	27	30	mA	+25°C		
DC20b	27	30	mA	+85°C		
DC20c	27	35	mA	+125°C		
DC21d	36	40	mA	-40°C	3.3V	16 MIPS
DC21a	37	40	mA	+25°C		
DC21b	38	45	mA	+85°C		
DC21c	39	45	mA	+125°C		
DC22d	43	50	mA	-40°C	3.3V	20 MIPS
DC22a	46	50	mA	+25°C		
DC22b	46	55	mA	+85°C		
DC22c	47	55	mA	+125°C		
DC23d	65	70	mA	-40°C	3.3V	30 MIPS
DC23a	65	70	mA	+25°C		
DC23b	65	70	mA	+85°C		
DC23c	65	70	mA	+125°C		
DC24d	84	90	mA	-40°C	3.3V	40 MIPS
DC24a	84	90	mA	+25°C		
DC24b	84	90	mA	+85°C		
DC24c	84	90	mA	+125°C		

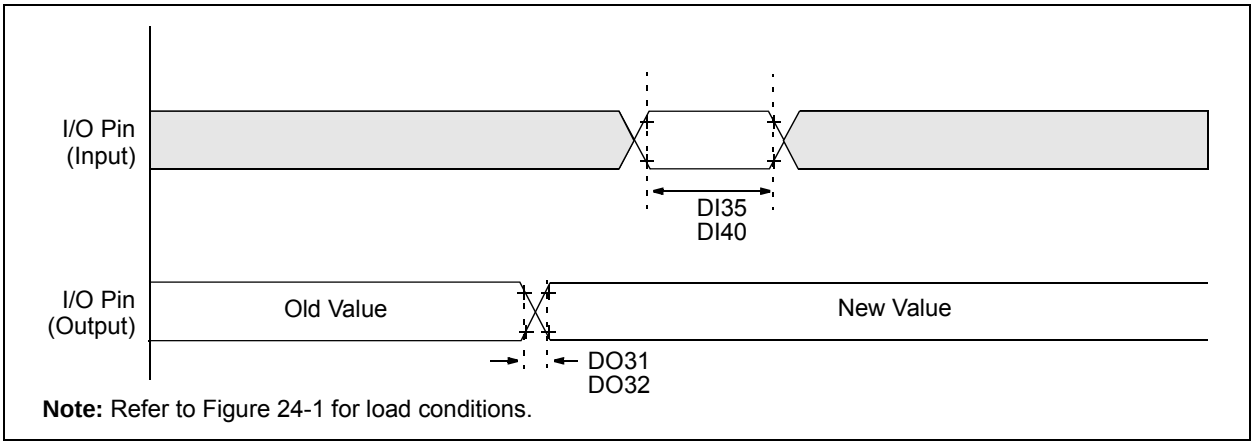
Note 1: IDD is primarily a function of the operating voltage and frequency. Other factors, such as I/O pin loading and switching rate, oscillator type, internal code execution pattern and temperature, also have an impact on the current consumption. The test conditions for all IDD measurements are as follows:

- Oscillator is configured in EC mode with PLL, OSC1 is driven with external square wave from rail-to-rail (EC clock overshoot/undershoot < 250 mV required)
- CLKO is configured as an I/O input pin in the Configuration word
- All I/O pins are configured as inputs and pulled to VSS
- $\overline{\text{MCLR}}$ = VDD, WDT and FSCM are disabled
- CPU, SRAM, program memory and data memory are operational
- No peripheral modules are operating; however, every peripheral is being clocked (defined PMDx bits are set to zero and unimplemented PMDx bits are set to one)
- CPU executing `while(1)` statement
- JTAG is disabled

2: These parameters are characterized but not tested in manufacturing.

3: Data in “Typ” column is at 3.3V, +25ºC unless otherwise stated.

FIGURE 24-3: CLKO AND I/O TIMING CHARACTERISTICS



Note: Refer to Figure 24-1 for load conditions.

TABLE 24-20: I/O TIMING REQUIREMENTS

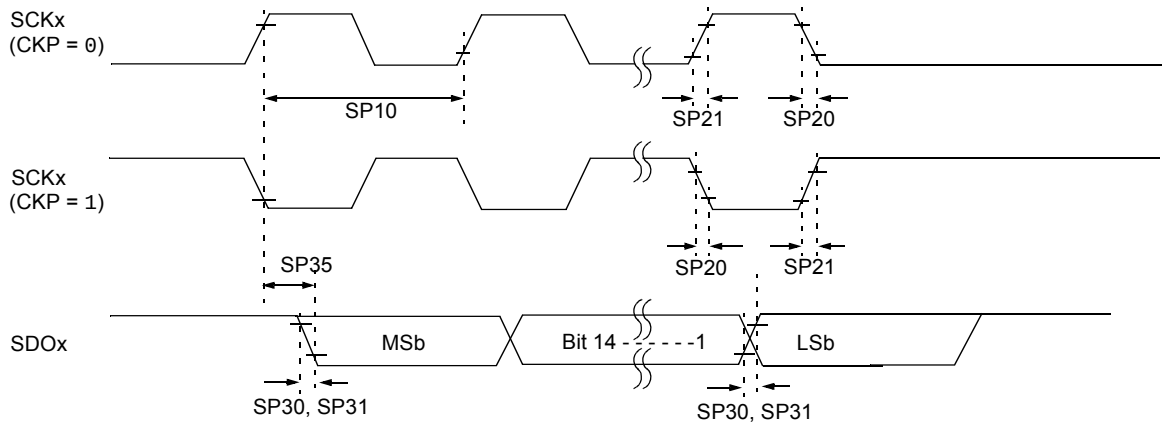
AC CHARACTERISTICS		**Standard Operating Conditions: 3.0V to 3.6V (unless otherwise stated)** Operating temperature -40°C ≤ TA ≤ +85°C for Industrial -40°C ≤ TA ≤ +125°C for Extended					
Param No.	**Symbol**	**Characteristic**	**Min**	**Typ(1)**	**Max**	**Units**	**Conditions**
DO31	TIOR	Port Output Rise Time	—	10	25	ns	—
DO32	TIOF	Port Output Fall Time	—	10	25	ns	—
DI35	TINP	INTx Pin High or Low Time (input)	20	—	—	ns	—
DI40	TRBP	CNx High or Low Time (input)	2	—	—	TCY	—

Note 1: Data in "Typ" column is at 3.3V, 25°C unless otherwise stated.

TABLE 24-28: SPIx MAXIMUM DATA/CLOCK RATE SUMMARY

AC CHARACTERISTICS			Standard Operating Conditions: 3.0V to 3.6V (unless otherwise stated) Operating temperature -40°C ≤ TA ≤ +85°C for Industrial -40°C ≤ TA ≤ +125°C for Extended			
Maximum Data Rate	**Master Transmit Only (Half-Duplex)**	**Master Transmit/Receive (Full-Duplex)**	**Slave Transmit/Receive (Full-Duplex)**	**CKE**	**CKP**	**SMP**
15 MHz	Table 24-29	—	—	0,1	0,1	0,1
10 MHz	—	Table 24-30	—	1	0,1	1
10 MHz	—	Table 24-31	—	0	0,1	1
15 MHz	—	—	Table 24-32	1	0	0
11 MHz	—	—	Table 24-33	1	1	0
15 MHz	—	—	Table 24-34	0	1	0
11 MHz	—	—	Table 24-35	0	0	0

FIGURE 24-9: SPIx MASTER MODE (HALF-DUPLEX, TRANSMIT ONLY CKE = 0) TIMING CHARACTERISTICS



Note: Refer to Figure 24-1 for load conditions.

TABLE 24-43: ADC CONVERSION (10-BIT MODE) TIMING REQUIREMENTS

AC CHARACTERISTICS			Standard Operating Conditions: 3.0V to 3.6V (unless otherwise stated) Operating temperature -40°C ≤ TA ≤ +85°C for Industrial -40°C ≤ TA ≤ +125°C for Extended				
Param No.	**Symbol**	**Characteristic**	**Min.**	**Typ(1)**	**Max.**	**Units**	**Conditions**
Clock Parameters							
AD50	TAD	ADC Clock Period	76	—	—	ns	—
AD51	tRC	ADC Internal RC Oscillator Period	—	250	—	ns	—
Conversion Rate							
AD55	tCONV	Conversion Time	—	12 TAD	—	—	—
AD56	FCNV	Throughput Rate	—	—	1.1	Msps	—
AD57	TSAMP	Sample Time	2 TAD	—	—	—	—
Timing Parameters							
AD60	tPCS	Conversion Start from Sample Trigger(2)	2.0 TAD	—	3.0 TAD	—	Auto-Convert Trigger not selected
AD61	tPSS	Sample Start from Setting Sample (SAMP) bit(2)	2.0 TAD	—	3.0 TAD	—	—
AD62	tCSS	Conversion Completion to Sample Start (ASAM = 1)(2)	—	0.5 TAD	—	—	—
AD63	tDPU	Time to Stabilize Analog Stage from ADC Off to ADC On(2,3)	—	—	20	μs	—

Note 1: These parameters are characterized but not tested in manufacturing.

2: Because the sample caps eventually loses charge, clock rates below 10 kHz may affect linearity performance, especially at elevated temperatures.

3: tDPU is the time required for the ADC module to stabilize when it is turned on (AD1CON1<ADON> = 1). During this time, the ADC result is indeterminate.

TABLE 24-44: DMA READ/WRITE TIMING REQUIREMENTS

AC CHARACTERISTICS		Standard Operating Conditions: 3.0V to 3.6V (unless otherwise stated) Operating temperature -40°C ≤ TA ≤ +85°C for Industrial -40°C ≤ TA ≤ +125°C for Extended				
Param No.	**Characteristic**	**Min.**	**Typ**	**Max.**	**Units**	**Conditions**
DM1a	DMA Read/Write Cycle Time	—	—	2 TCY	ns	This characteristic applies to PIC24HJ256GPX06A/X08A/X10A devices only.
DM1b	DMA Read/Write Cycle Time	—	—	1 TCY	ns	This characteristic applies to all devices with the exception of the PIC24HJ256GPX06A/X08A/X10A.

NOTES:

APPENDIX A: MIGRATING FROM PIC24HJXXXGPX06/X08/X10 DEVICES TO PIC24HJXXXGPX06A/X08A/X10A DEVICES

The PIC24HJXXXGPX06A/X08A/X10A devices were designed to enhance the PIC24HJXXXGPX06/X08/X10 families of devices.

In general, the PIC24HJXXXGPX06A/X08A/X10A devices are backward-compatible with PIC24HJXXXGPX06/X08/X10 devices; however, manufacturing differences may cause PIC24HJXXXGPX06A/X08A/X10A devices to behave differently from PIC24HJXXXGPX06/X08/X10 devices. Therefore, complete system test and characterization is recommended if PIC24HJXXXGPX06A/X08A/X10A devices are used to replace PIC24HJXXXGPX06/X08/X10 devices.

The following enhancements were introduced:

- Extended temperature support of up to +125ºC
- Enhanced Flash module with higher endurance and retention
- New PLL Lock Enable configuration bit
- Added Timer5 trigger for ADC1 and Timer3 trigger for ADC2

TABLE B-2: MAJOR SECTION UPDATES (CONTINUED)

Section Name	Update Description
Section 24.0 "Electrical Characteristics"	Removed Note 4 from the DC Temperature and Voltage Specifications (see Table 24-4). Updated the maximum value for parameter DI19 and added parameters DI28, DI29, DI60a, DI60b, and DI60c to the I/O Pin Input Specifications (see Table 24-9). Removed Note 2 from the AC Characteristics: Internal RC Accuracy (see Table 24-18). Updated the characteristic description for parameter DI35 in the I/O Timing Requirements (see Table 24-20). Updated the ADC Module Specification minimum values for parameters AD05 and AD07, and updated the maximum value for parameter AD06 (see Table 24-39). Added Note 1 to the ADC Module Specifications (12-bit Mode) (see Table 24-40). Added Note 1 to the ADC Module Specifications (10-bit Mode) (see Table 24-41). Added DMA Read/Write Timing Requirements (see Table 24-44).
Section 25.0 "High Temperature Electrical Characteristics"	Updated all ambient temperature end range values to +150ºC throughout the chapter. Updated the storage temperature end range to +160ºC. Updated the maximum junction temperature from +145ºC to +155ºC. Updated the maximum values for High Temperature Devices in the Thermal Operating Conditions (see Table 25-2). Added Note 3 and updated the ADC Module Specifications (12-bit Mode), removing all parameters with the exception of HAD33a (see Table 25-15). Added Note 3 and updated the ADC Module Specifications (10-bit Mode), removing all parameters with the exception of HAD33b (see Table 25-16).