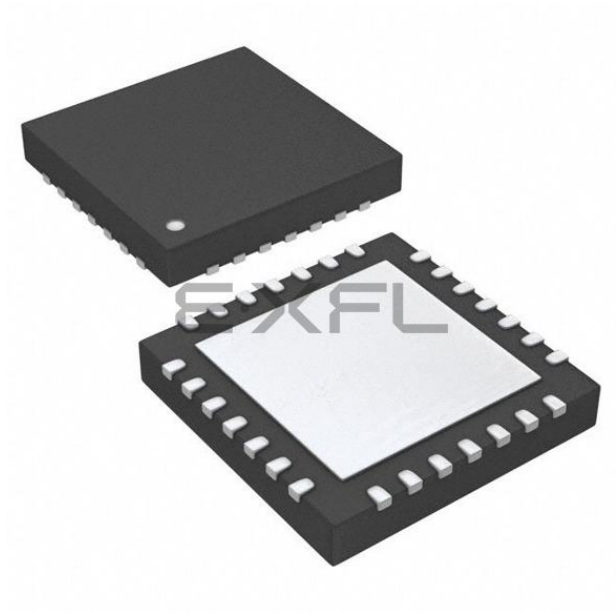

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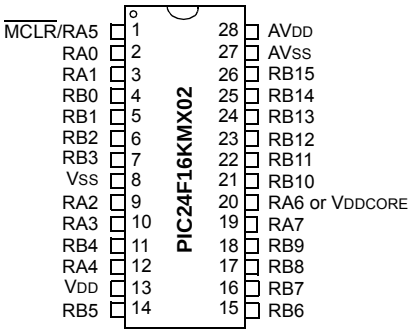
Applications of "Embedded - Microcontrollers"

Details	
Product Status	Active
Core Processor	PIC
Core Size	16-Bit
Speed	32MHz
Connectivity	I²C, IrDA, LINbus, SPI, UART/USART
Peripherals	Brown-out Detect/Reset, LVD, POR, PWM, WDT
Number of I/O	23
Program Memory Size	16KB (5.5K x 24)
Program Memory Type	FLASH
EEPROM Size	512 x 8
RAM Size	2K x 8
Voltage - Supply (Vcc/Vdd)	2V ~ 5V
Data Converters	A/D 19x10b/12b; D/A 2x8b
Oscillator Type	Internal
Operating Temperature	-40°C ~ 85°C (TA)
Mounting Type	Surface Mount
Package / Case	28-VQFN Exposed Pad
Supplier Device Package	28-QFN (6x6)
Purchase URL	https://www.e-xfl.com/product-detail/microchip-technology/pic24fv16km202t-i-ml

Pin Diagrams (Continued)

28-Pin SPDIP/SSOP/SOIC

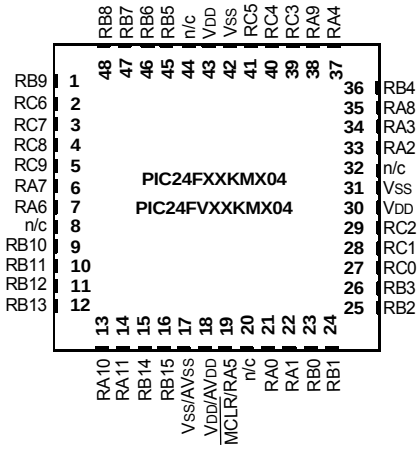


Pin	Pin Features	
	PIC24FXXKMX02	PIC24FVXXKMX02
1	MCLR/VPP/RA5	
2	CVREF+/VREF+/ /AN0/ /CN2/RA0	
3	CVREF-/VREF-/AN1/CN3/RA1	CVREF-/VREF-/AN1/RA1
4	PGED1/AN2/CTCMP/ULPWU/C1IND/ / / /CN4/RB0	
5	PGEC1/ / /AN3/C1INC/ / /CTED12/CN5/RB1	
6	/ /AN4/C1INB/ / /U1RX/TCKIB/CTED13/CN6/RB2	
7	/AN5/C1INA/ / /CN7/RB3	
8	VSS	
9	OSCI/CLKI/AN13/CN30/RA2	
10	OSCO/CLKO/AN14/CN29/RA3	
11	SOSCI/AN15/ / /CN1/RB4	
12	SOSCO/SCLKI/AN16/PWRLCLK/ /CN0/RA4	
13	VDD	
14	PGED3/AN17/ASDA1/ / /OC1E/CLCINA/CN27/RB5	
15	PGEC3/AN18/ASCL1/ / /OC1F/CLCINB/CN24/RB6	
16	AN19/U1TX/INT0/CN23/RB7	AN19/U1TX/ / /INT0/CN23/RB7
17	AN20/SCL1/U1CTS/C3OUT/OC1B/CTED10/CN22/RB8	
18	AN21/SDA1/T1CK/U1RTS/U1BCLK/IC2/ /CLC1O/CTED4/CN21/RB9	
19	/IC1/ / /CTED3/CN9/RA7	
20	/OC1A/CTED1/INT2/CN8/RA6	VCAP OR VDDCORE
21	PGED2/SDI1/ /OC1C/CTED11/CN16/RB10	
22	PGEC2/SCK1/OC2A/CTED9/CN15/RB11	
23	/AN12/HLVDIN/ / / /CTED2/CN14/RB12	/AN12/HLVDIN/ / / /CTED2/INT2/CN14/RB12
24	/ /AN11/SDO1/OCFB/ /OC1D/CTPLS/CN13/RB13	
25	/CVREF/ / /AN10/ / /C1OUT/OCFA/CTED5/INT1/CN12/RB14	
26	/ /AN9/ /REFO/SS1/TCKIA/CTED6/CN11/RB15	
27	VSS/AVSS	
28	VDD/AVDD	

Legend: Values in indicate pin function differences between PIC24F(V)XXKM202 and PIC24F(V)XXKM102 devices.

Pin Diagrams (Continued)

48-Pin UQFN(1)



Legend: Values in indicate pin function differences between PIC24F(V)XXKM202 and PIC24F(V)XXKM102 devices.

Note 1: Exposed pad on underside of device is connected to VSS.

Pin	Pin Features	
	PIC24FXXKMX04	PIC24FVXXKMX04
1	AN21/SDA1/T1CK/U1RTS/U1BCLK/IC2/ /CLC1O/CTED4/CN21/RB9	
2	U1RX/ /CN18/RC6	
3	U1TX/ /CN17/RC7	
4	OC2/CN20/RC8	
5	IC4/OC2F/CTED7/CN19/RC9	
6	IC1/ / /CTED3/CN9/RA7	
7	/OC1A/CTED1/INT2/CN8/RA6	VDDCORE or VCAP
8	n/c	n/c
9	PGED2/SDI1/OC1C/CTED11/CN16/RB10	
10	PGEC2/SCK1/OC2A/CTED9/CN15/RB11	
11	/AN12/HLVDIN/ /CTED2/ CN14/RB12	/AN12/HLVDIN/ /CTED2/ INT2/CN14/RB12
12	/ /AN11/SDO1/OC1D/CTPLS/CN13/RB13	
13	/ /CN35/RA10	
14	/ /CTED8/CN36/RA11	
15	/CVREF/ / /AN10/ / /C1OUT/OCFA/CTED5/INT1/ CN12/RB14	
16	/ /AN9/ /REFO/SS1/TCKIA/CTED6/CN11/RB15	
17	VSS/AVSS	
18	VDD/AVDD	
19	MCLR/VPP/RA5	
20	n/c	
21	CVREF+/VREF+/ +/AN0/ / CN2/RA0	CVREF+/VREF+/ +/AN0/ / CTED1/CN2/RA0
22	CVREF-/VREF-/AN1/CN3/RA1	
23	PGED1/AN2/CTCMP/ULPWU/C1IND/ / / /CN4/RB0	
24	PGEC1/ / /AN3/C1INC/ / /CTED12/CN5/RB1	
25	/ /AN4/C1INB/ / /TCKIB/CTED13/CN6/RB2	
26	/AN5/C1INA/ / /CN7/RB3	
27	AN6/CN32/RC0	
28	AN7/CN31/RC1	
29	AN8/CN10/RC2	
30	VDD	
31	VSS	
32	n/c	
33	OSCI/AN13/CLKI/CN30/RA2	
34	OSCO/CLKO/AN14/CN29/RA3	
35	OCFB/CN33/RA8	
36	SOSCI/AN15/ / /CN1/RB4	
37	SOSCO/SCLKI/AN16/PWRLCLK/ /CN0/RA4	
38	/CN34/RA9	
39	/CN28/RC3	
40	/CN25/RC4	
41	/CN26/RC5	
42	VSS	
43	VDD	
44	n/c	
45	PGED3/AN17/ASDA1/OC1E/CLCINA/CN27/RB5	
46	PGEC3/AN18/ASCL1/OC1F/CLCINB/CN24/RB6	
47	AN19/INT0/CN23/RB7	AN19/ /OC1A/INT0/CN23/RB7
48	AN20/SCL1/U1CTS/C3OUT/OC1B/CTED10/CN22/RB8	

TABLE 1-5: PIC24FV16KM204 FAMILY PINOUT DESCRIPTION (CONTINUED)

Function	F					FV					I/O	Buffer	Description
	Pin Number					Pin Number							
	20-Pin PDIP/ SSOP/ SOIC	28-Pin PDIP/ SSOP/ SOIC	28-Pin QFN	44-Pin QFN/ TQFP	48-Pin UQFN	20-Pin PDIP/ SSOP/ SOIC	28-Pin PDIP/ SSOP/ SOIC	28-Pin QFN	44-Pin QFN/ TQFP	48-Pin UQFN			
RB9	13	18	15	1	1	13	18	15	1	1	I/O	ST	PORTB Pins
RB10	—	21	18	8	9	—	21	18	8	9	I/O	ST	PORTB Pins
RB11	—	22	19	9	10	—	22	19	9	10	I/O	ST	PORTB Pins
RB12	15	23	20	10	11	15	23	20	10	11	I/O	ST	PORTB Pins
RB13	16	24	21	11	12	16	24	21	11	12	I/O	ST	PORTB Pins
RB14	17	25	22	14	15	17	25	22	14	15	I/O	ST	PORTB Pins
RB15	18	26	23	15	16	18	26	23	15	16	I/O	ST	PORTB Pins
RC0	—	—	—	25	27	—	—	—	25	27	I/O	ST	PORTC Pins
RC1	—	—	—	26	28	—	—	—	26	28	I/O	ST	PORTC Pins
RC2	—	—	—	27	29	—	—	—	27	29	I/O	ST	PORTC Pins
RC3	—	—	—	36	39	—	—	—	36	39	I/O	ST	PORTC Pins
RC4	—	—	—	37	40	—	—	—	37	40	I/O	ST	PORTC Pins
RC5	—	—	—	38	41	—	—	—	38	41	I/O	ST	PORTC Pins
RC6	—	—	—	2	2	—	—	—	2	2	I/O	ST	PORTC Pins
RC7	—	—	—	3	3	—	—	—	3	3	I/O	ST	PORTC Pins
RC8	—	—	—	4	4	—	—	—	4	4	I/O	ST	PORTC Pins
RC9	—	—	—	5	5	—	—	—	5	5	I/O	ST	PORTC Pins
REFO	18	26	23	15	16	18	26	23	15	16	O	—	Reference Clock Output
RTCC	—	25	22	14	15	—	25	22	14	15	O	—	Real-Time Clock/Calendar Output
SCK1	15	22	19	9	10	15	22	19	9	10	I/O	ST	MSSP1 SPI Clock
SDI1	17	21	18	8	9	17	21	18	8	9	I	ST	MSSP1 SPI Data Input
SDO1	16	24	21	11	12	16	24	21	11	12	O	—	MSSP1 SPI Data Output
$\overline{SS1}$	18	26	23	15	16	18	26	23	15	16	I	ST	MSSP1 SPI Slave Select Input
SCK2	—	14	11	38	41	—	14	11	38	41	I/O	ST	MSSP2 SPI Clock
SDI2	—	19	16	36	39	—	19	16	36	39	I	ST	MSSP2 SPI Data Input
SDO2	—	15	12	37	40	—	15	12	37	40	O	—	MSSP2 SPI Data Output
$\overline{SS2}$	—	23	20	35	38	—	23	20	35	38	I	ST	MSSP2 SPI Slave Select Input

Legend: ANA = Analog level input/output, ST = Schmitt Trigger input buffer, I^2C™ = I^2C/SMBus input buffer

NOTES:

4.2.2 DATA MEMORY ORGANIZATION AND ALIGNMENT

To maintain backward compatibility with PIC® devices and improve Data Space memory usage efficiency, the PIC24F instruction set supports both word and byte operations. As a consequence of byte accessibility, all EA calculations are internally scaled to step through word-aligned memory. For example, the core recognizes that Post-Modified Register Indirect Addressing mode [Ws++] will result in a value of Ws + 1 for byte operations and Ws + 2 for word operations.

Data byte reads will read the complete word, which contains the byte, using the LSB of any EA to determine which byte to select. The selected byte is placed onto the LSB of the data path. That is, the data memory and the registers are organized as two parallel, byte-wide entities with shared (word) address decode, but separate write lines. Data byte writes only write to the corresponding side of the array or register, which matches the byte address.

All word accesses must be aligned to an even address. Misaligned word data fetches are not supported, so care must be taken when mixing byte and word operations, or translating from 8-bit MCU code. If a misaligned read or write is attempted, an address error trap will be generated. If the error occurred on a read, the instruction underway is completed; if it occurred on a write, the instruction will be executed, but the write will not occur. In either case, a trap is then executed, allowing the system and/or user to examine the machine state prior to execution of the address Fault.

All byte loads into any W register are loaded into the LSB; the MSB is not modified.

A Sign-Extend (SE) instruction is provided to allow the users to translate 8-bit signed data to 16-bit signed values. Alternatively, for 16-bit unsigned data, users can clear the MSB of any W register by executing a Zero-Extend (ZE) instruction on the appropriate address.

Although most instructions are capable of operating on word or byte data sizes, it should be noted that some instructions operate only on words.

4.2.3 NEAR DATA SPACE

The 8-Kbyte area between 0000h and 1FFFh is referred to as the Near Data Space. Locations in this space are directly addressable via a 13-bit absolute address field within all memory direct instructions. The remainder of the Data Space is addressable indirectly. Additionally, the whole Data Space is addressable using MOV instructions, which support Memory Direct Addressing (MDA) with a 16-bit address field. For PIC24FV16KM204 family devices, the entire implemented data memory lies in Near Data Space (NDS).

4.2.4 SFR SPACE

The first 2 Kbytes of the Near Data Space, from 0000h to 07FFh, are primarily occupied with Special Function Registers (SFRs). These are used by the PIC24F core and peripheral modules for controlling the operation of the device.

SFRs are distributed among the modules that they control and are generally grouped together by that module. Much of the SFR space contains unused addresses; these are read as '0'. The SFR space, where the SFRs are actually implemented, is provided in Table 4-2. Each implemented area indicates a 32-byte region where at least one address is implemented as an SFR. A complete listing of implemented SFRs, including their addresses, is provided in Table 4-3 through Table 4-26.

TABLE 4-2: IMPLEMENTED REGIONS OF SFR DATA SPACE

	SFR Space Address							
	xx00	**xx20**	**xx40**	**xx60**	**xx80**	**xxA0**	**xxC0**	**xxE0**
000h	Core			ICN	Interrupts			—
100h	Timers	CLC	MCCP/SCCP					
200h	MSSP	UART	Op Amp	DAC	—	—	I/O	
300h	A/D/CMTU				—	—	—	—
400h	—	—	—	—	—	—	—	ANSEL
500h	—	—	—	—	—	—	—	—
600h	—	RTCC/Comp	—	Band Gap	—			
700h	—	—	System/ HLVD	NVM/PMD	—	—	—	—

Legend: — = No implemented SFRs in this block.

TABLE 4-5: INTERRUPT CONTROLLER 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
INTCON1	80h	NSTDIS	—	—	—	—	—	—	—	—	—	—	MATHERR	ADDRERR	STKERR	OSCFAIL	—	0000
INTCON2	82h	ALTIVT	DISI	—	—	—	—	—	—	—	—	—	—	—	INT2EP	INT1EP	INT0EP	0000
IFS0	84h	NVMIF	—	AD1IF	U1TXIF	U1RXIF	—	—	CCT2IF	CCT1IF	CCP4IF	CCP3IF	—	T1IF	CCP2IF	CCP1IF	INT0IF	0000
IFS1	86h	U2TXIF	U2RXIF	INT2IF	CCT4IF	CCT3IF	—	—	—	—	CCP5IF	—	INT1IF	CNIF	CMIF	BCL1IF	SSP1IF	0000
IFS2	88h	—	—	—	—	—	—	CCT5IF	—	—	—	—	—	—	—	—	—	0000
IFS3	8Ah	—	RTCIF	—	—	—	—	—	—	—	—	—	—	—	BCL2IF	SSP2IF	—	0000
IFS4	8Ch	DAC2IF	DAC1IF	CTMUIF	—	—	—	—	HLVDIF	—	—	—	—	—	U2ERIF	U1ERIF	—	0000
IFS5	8Eh	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	ULPWUIF	0000
IFS6	90h	—	—	—	—	—	—	—	—	—	—	—	—	—	—	CLC2IF	CLC1IF	0000
IEC0	94h	NVMIE	—	AD1IE	U1TXIE	U1RXIE	—	—	CCT2IE	CCT1IE	CCP4IE	CCP3IE	—	T1IE	CCP2IE	CCP1IE	INT0IE	0000
IEC1	96h	U2TXIE	U2RXIE	INT2IE	CCT4IE	CCT3IE	—	—	—	—	CCP5IE	—	INT1IE	CNIE	CMIE	BCL1IE	SSP1IE	0000
IEC2	98h	—	—	—	—	—	—	CCT5IE	—	—	—	—	—	—	—	—	—	0000
IEC3	9Ah	—	RTCIE	—	—	—	—	—	—	—	—	—	—	—	BCL2IE	SSP2IE	—	0000
IEC4	9Ch	DAC2IE	DAC1IE	CTMUIE	—	—	—	—	HLVDIE	—	—	—	—	—	U2ERIE	U1ERIE	—	0000
IEC5	9Eh	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	ULPWUIE	0000
IEC6	A0h	—	—	—	—	—	—	—	—	—	—	—	—	—	—	CLC2IE	CLC1IE	0000
IPC0	A4h	—	T1IP2	T1IP1	T1IP0	—	CCP2IP2	CCP2IP1	CCP2IP0	—	CCP1IP2	CCP1IP1	CCP1IP0	—	INT0IP2	INT0IP1	INT0IP0	4444
IPC1	A6h	—	CCT1IP2	CCT1IP1	CCT1IP0	—	CCP4IP2	CCP4IP1	CCP4IP0	—	CCP3IP2	CCP3IP1	CCP3IP0	—	—	—	—	4440
IPC2	A8h	—	U1RXIP2	U1RXIP1	U1RXIP0	—	—	—	—	—	—	—	—	—	CCT2IP2	CCT2IP1	CCT2IP0	4004
IPC3	AAh	—	NVMIP2	NVMIP1	NVMIP0	—	—	—	—	—	AD1IP2	AD1IP1	AD1IP0	—	U1TXIP2	U1TXIP1	U1TXIP0	4044
IPC4	ACh	—	CNIP2	CNIP1	CNIP0	—	CMIP2	CMIP1	CMIP0	—	BCL1IP2	BCL1IP1	BCL1IP0	—	SSP1IP2	SSP1IP1	SSP1IP0	4444
IPC5	AEh	—	—	—	—	—	CCP5IP2	CCP5IP1	CCP5IP0	—	—	—	—	—	INT1IP2	INT1IP1	INT1IP0	0404
IPC6	B0h	—	CCT3IP2	CCT3IP1	CCT3IP0	—	—	—	—	—	—	—	—	—	—	—	—	4000
IPC7	B2h	—	U2TXIP2	U2TXIP1	U2TXIP0	—	U2RXIP2	U2RXIP1	U2RXIP0	—	INT2IP2	INT2IP1	INT2IP0	—	CCT4IP2	CCT4IP1	CCT4IP0	4444
IPC10	B8h	—	—	—	—	—	—	—	—	—	CCT5IP2	CCT5IP1	CCT5IP0	—	—	—	—	0040
IPC12	BCh	—	—	—	—	—	BCL2IP2	BCL2IP1	BCL2IP0	—	SSP2IP2	SSP2IP1	SSP2IP0	—	—	—	—	0440
IPC15	C2h	—	—	—	—	—	RTCIP2	RTCIP1	RTCIP0	—	—	—	—	—	—	—	—	0400
IPC16	C4h	—	—	—	—	—	U2ERIP2	U2ERIP1	U2ERIP0	—	U1ERIP2	U1ERIP1	U1ERIP0	—	—	—	—	0440
IPC18	C8h	—	—	—	—	—	—	—	—	—	—	—	—	—	HLVDIP2	HLVDIP1	HLVDIP0	0004
IPC19	CAh	—	DAC2IP2	DAC2IP1	DAC2IP0	—	DAC1IP2	DAC1IP1	DAC1IP0	—	CTMUIP2	CTMUIP1	CTMUIP0	—	—	—	—	4440
IPC20	CCh	—	—	—	—	—	—	—	—	—	—	—	—	—	ULPWUIP2	ULPWUIP1	ULPWUIP0	0004
IPC24	D4h	—	—	—	—	—	—	—	—	—	CLC2IP2	CLC2IP1	CLC2IP0	—	CLC1IP2	CLC1IP1	CLC1IP0	0044
INTTREG	E0h	CPUIRQ	—	VHOLD	—	ILR3	ILR2	ILR1	ILR0	—	VECNUM6	VECNUM5	VECNUM4	VECNUM3	VECNUM2	VECNUM1	VECNUM0	0000

Legend: x = unknown, u = unchanged, — = unimplemented, q = value depends on condition, r = reserved.

REGISTER 8-9: IFS4: INTERRUPT FLAG STATUS REGISTER 4

R/W-0, HS	R/W-0, HS	R/W-0, HS	U-0	U-0	U-0	U-0	R/W-0, HS
DAC2IF	DAC1IF	CTMUIF	—	—	—	—	HLVDIF
bit 15							bit 8

U-0	U-0	U-0	U-0	U-0	R/W-0, HS	R/W-0, HS	U-0
—	—	—	—	—	U2ERIF	U1ERIF	—
bit 7							bit 0

Legend:	HS = Hardware Settable 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 **DAC2IF:** Digital-to-Analog Converter 2 Interrupt Flag Status bit
1 = Interrupt request has occurred
0 = Interrupt request has not occurred

bit 14 **DAC1IF:** Digital-to-Analog Converter 1 Interrupt Flag Status bit
1 = Interrupt request has occurred
0 = Interrupt request has not occurred

bit 13 **CTMUIF:** CTMU Interrupt Flag Status bit
1 = Interrupt request has occurred
0 = Interrupt request has not occurred

bit 12-9 **Unimplemented:** Read as '0'

bit 8 **HLVDIF:** High/Low-Voltage Detect Interrupt Flag Status bit
1 = Interrupt request has occurred
0 = Interrupt request has not occurred

bit 7-3 **Unimplemented:** Read as '0'

bit 2 **U2ERIF:** UART2 Error Interrupt Flag Status bit
1 = Interrupt request has occurred
0 = Interrupt request has not occurred

bit 1 **U1ERIF:** UART1 Error Interrupt Flag Status bit
1 = Interrupt request has occurred
0 = Interrupt request has not occurred

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

REGISTER 8-33: IPC20: INTERRUPT PRIORITY CONTROL REGISTER 20

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

U-0	U-0	U-0	U-0	U-0	R/W-1	R/W-0	R/W-0
—	—	—	—	—	ULPWUIP2	ULPWUIP1	ULPWUIP0
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 15-3 **Unimplemented:** Read as ‘0’

bit 2-0 **ULPWUIP<2:0>:** Ultra Low-Power Wake-up Interrupt Priority bits
111 = Interrupt is Priority 7 (highest priority interrupt)
•
•
•
001 = Interrupt is Priority 1
000 = Interrupt source is disabled

REGISTER 8-34: IPC24: INTERRUPT PRIORITY CONTROL REGISTER 24

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
—	CLC2IP2	CLC2IP1	CLC2IP0	—	CLC1IP2	CLC1IP1	CLC1IP0
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 **CLC2IP<2:0>:** CLC2 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 **CLC1IP<2:0>:** CLC1 Interrupt Priority bits
111 = Interrupt is Priority 7 (highest priority interrupt)
•
•
•
001 = Interrupt is Priority 1
000 = Interrupt source is disabled

REGISTER 9-3: OSCTUN: FRC OSCILLATOR TUNE REGISTER

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

U-0	U-0	R/W-0	R/W-0	R/W-0	R/W-0	R/W-0	R/W-0
—	—	TUN5(1)	TUN4(1)	TUN3(1)	TUN2(1)	TUN1(1)	TUN0(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 15-6 **Unimplemented:** Read as '0'

bit 5-0 **TUN<5:0>:** FRC Oscillator Tuning bits(1)

011111 = Maximum frequency deviation
011110
•
•
•
000001
000000 = Center frequency, oscillator is running at factory calibrated frequency
111111
•
•
•
100001
100000 = Minimum frequency deviation

Note 1: Increments or decrements of TUN<5:0> may not change the FRC frequency in equal steps over the FRC tuning range and may not be monotonic.

15.1 UARTx Baud Rate Generator (BRG)

The UARTx module includes a dedicated 16-bit Baud Rate Generator (BRG). The UxBRG register controls the period of a free-running, 16-bit timer. Equation 15-1 provides the formula for computation of the baud rate with BRGH = 0.

EQUATION 15-1: UARTx BAUD RATE WITH BRGH = 0(1)

$$\text{Baud Rate} = \frac{F_{CY}}{16 \cdot (\text{UxBRG} + 1)}$$

$$\text{UxBRG} = \frac{F_{CY}}{16 \cdot \text{Baud Rate}} - 1$$

Note 1: Based on FCY = FOSC/2; Doze mode and PLL are disabled.

Example 15-1 provides the calculation of the baud rate error for the following conditions:

- FCY = 4 MHz
- Desired Baud Rate = 9600

The maximum baud rate (BRGH = 0) possible is FCY/16 (for UxBRG = 0) and the minimum baud rate possible is FCY/(16 * 65536).

Equation 15-2 shows the formula for computation of the baud rate with BRGH = 1.

EQUATION 15-2: UARTx BAUD RATE WITH BRGH = 1(1)

$$\text{Baud Rate} = \frac{F_{CY}}{4 \cdot (\text{UxBRG} + 1)}$$

$$\text{UxBRG} = \frac{F_{CY}}{4 \cdot \text{Baud Rate}} - 1$$

Note 1: Based on FCY = FOSC/2; Doze mode and PLL are disabled.

The maximum baud rate (BRGH = 1) possible is FCY/4 (for UxBRG = 0) and the minimum baud rate possible is FCY/(4 * 65536).

Writing a new value to the UxBRG register causes the BRG timer to be reset (cleared). This ensures the BRG does not wait for a timer overflow before generating the new baud rate.

EXAMPLE 15-1: BAUD RATE ERROR CALCULATION (BRGH = 0)(1)

Desired Baud Rate = FCY/(16 (UxBRG + 1))

Solving for UxBRG value:

UxBRG = ((FCY/Desired Baud Rate)/16) – 1
UxBRG = ((4000000/9600)/16) – 1
UxBRG = 25

Calculated Baud Rate = 4000000/(16 (25 + 1))
= 9615

Error = (Calculated Baud Rate – Desired Baud Rate) / Desired Baud Rate
= (9615 – 9600)/9600
= 0.16%

Note 1: Based on FCY = FOSC/2; Doze mode and PLL are disabled.

16.2 RTCC Module Registers

The RTCC module registers are organized into three categories:

- RTCC Control Registers
- RTCC Value Registers
- Alarm Value Registers

16.2.1 REGISTER MAPPING

To limit the register interface, the RTCC Timer and Alarm Time registers are accessed through corresponding register pointers. The RTCC Value register window (RTCVALH and RTCVALL) uses the RTCPTRx bits (RCFGCAL<9:8>) to select the desired Timer register pair (see Table 16-1).

By writing the RTCVALH byte, the RTCC Pointer value, the RTCPTR<1:0> bits decrement by one until they reach '00'. Once they reach '00', the MINUTES and SECONDS value will be accessible through RTCVALH and RTCVALL until the pointer value is manually changed.

TABLE 16-1: RTCVAL REGISTER MAPPING

RTCPTR<1:0>	RTCC Value Register Window	
	RTCVAL<15:8>	RTCVAL<7:0>
00	MINUTES	SECONDS
01	WEEKDAY	HOURS
10	MONTH	DAY
11	—	YEAR

The Alarm Value register window (ALRMVALH and ALRMVALL) uses the ALRMPTRx bits (ALCFGRPT<9:8>) to select the desired Alarm register pair (see Table 16-2).

By writing the ALRMVALH byte, the ALRMPTR<1:0> bits (Alarm Pointer value) decrement by one until they reach '00'. Once they reach '00', the ALRMMIN and ALRMSEC value will be accessible through ALRMVALH and ALRMVALL, until the pointer value is manually changed.

TABLE 16-2: ALRMVAL REGISTER MAPPING

ALRMPTR <1:0>	Alarm Value Register Window	
	ALRMVALH<15:8>	ALRMVALL<7:0>
00	ALRMMIN	ALRMSEC
01	ALRMWD	ALRMHR
10	ALRMMNTH	ALRMDAY
11	PWCSTAB	PWCSAMP

Considering that the 16-bit core does not distinguish between 8-bit and 16-bit read operations, the user must be aware that when reading either the ALRMVALH or ALRMVALL bytes, the ALRMPTR<1:0> value will be decremented. The same applies to the RTCVALH or RTCVALL bytes with the RTCPTR<1:0> being decremented.

Note: This only applies to read operations and not write operations.

16.2.2 WRITE LOCK

In order to perform a write to any of the RTCC Timer registers, the RTCWREN bit (RCFGCAL<13>) must be set (see Example 16-1 and Example 16-2).

Note: To avoid accidental writes to the timer, it is recommended that the RTCWREN bit (RCFGCAL<13>) is kept clear at any other time. For the RTCWREN bit to be set, there is only one instruction cycle time window allowed between the 55h/AA sequence and the setting of RTCWREN. Therefore, it is recommended that code follow the procedure in Example 16-2.

16.2.3 SELECTING RTCC CLOCK SOURCE

There are four reference source clock options that can be selected for the RTCC using the RTCCLK<1:0> bits (RTCPWC<11:10>): 00 = Secondary Oscillator, 01 = LPRC, 10 = 50 Hz External Clock and 11 = 60 Hz External Clock.

EXAMPLE 16-1: SETTING THE RTCWREN BIT IN ASSEMBLY

```
push    w7              ; Store W7 and W8 values on the stack.
push    w8
disi    #5              ; Disable interrupts until sequence is complete.
mov     #0x55, w7       ; Write 0x55 unlock value to NVMKEY.
mov     w7, NVMKEY
mov     #0xAA, w8       ; Write 0xAA unlock value to NVMKEY.
mov     w8, NVMKEY
bset    RCFGCAL, #13    ; Set the RTCWREN bit.
pop     w8              ; Restore the original W register values from the stack.
pop     w7
```

EXAMPLE 16-2: SETTING THE RTCWREN BIT IN 'C'

```
//This builtin function executes implements the unlock sequence and sets
//the RTCWREN bit.
__builtin_write_RTCWEN();
```

REGISTER 16-3: ALCFGRPT: ALARM CONFIGURATION REGISTER

R/W-0	R/W-0	R/W-0	R/W-0	R/W-0	R/W-0	R/W-0	R/W-0
ALRMEN	CHIME	AMASK3	AMASK2	AMASK1	AMASK0	ALRMPTR1	ALRMPTR0
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
ARPT7	ARPT6	ARPT5	ARPT4	ARPT3	ARPT2	ARPT1	ARPT0
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 **ALRMEN:** Alarm Enable bit

1 = Alarm is enabled (cleared automatically after an alarm event whenever ARPT<7:0> = 00h and CHIME = 0)
0 = Alarm is disabled

bit 14 **CHIME:** Chime Enable bit

1 = Chime is enabled; ARPT<7:0> bits are allowed to roll over from 00h to FFh
0 = Chime is disabled; ARPT<7:0> bits stop once they reach 00h

bit 13-10 **AMASK<3:0>:** Alarm Mask Configuration bits

0000 = Every half second
0001 = Every second
0010 = Every 10 seconds
0011 = Every minute
0100 = Every 10 minutes
0101 = Every hour
0110 = Once a day
0111 = Once a week
1000 = Once a month
1001 = Once a year (except when configured for February 29th, once every 4 years)
101x = Reserved – do not use
11xx = Reserved – do not use

bit 9-8 **ALRMPTR<1:0>:** Alarm Value Register Window Pointer bits

Points to the corresponding Alarm Value registers when reading the ALRMVALH and ALRMVALL registers. The ALRMPTR<1:0> value decrements on every read or write of ALRMVALH until it reaches '00'.

ALRMVAL<15:8>:
00 = ALRMMIN
01 = ALRMWD
10 = ALRMMNTH
11 = Unimplemented

ALRMVAL<7:0>:
00 = ALRMSEC
01 = ALRMHR
10 = ALRMDAY
11 = Unimplemented

bit 7-0 **ARPT<7:0>:** Alarm Repeat Counter Value bits

11111111 = Alarm will repeat 255 more times
.
.
.
00000000 = Alarm will not repeat

The counter decrements on any alarm event; it is prevented from rolling over from 00h to FFh unless CHIME = 1.

16.2.6 ALRMVAL REGISTER MAPPINGS

REGISTER 16-8: ALMTHDY: ALARM MONTH AND DAY VALUE REGISTER(1)

U-0	U-0	U-0	R/W-x	R/W-x	R/W-x	R/W-x	R/W-x
—	—	—	MTHTEN0	MTHONE3	MTHONE2	MTHONE1	MTHONE0
bit 15							bit 8

U-0	U-0	R/W-x	R/W-x	R/W-x	R/W-x	R/W-x	R/W-x
—	—	DAYTEN1	DAYTEN0	DAYONE3	DAYONE2	DAYONE1	DAYONE0
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 15-13 **Unimplemented:** Read as '0'

bit 12 **MTHTEN0:** Binary Coded Decimal Value of Month's Tens Digit bit
Contains a value of '0' or '1'.

bit 11-8 **MTHONE<3:0>:** Binary Coded Decimal Value of Month's Ones Digit bits
Contains a value from 0 to 9.

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

bit 5-4 **DAYTEN<1:0>:** Binary Coded Decimal Value of Day's Tens Digit bits
Contains a value from 0 to 3.

bit 3-0 **DAYONE<3:0>:** Binary Coded Decimal Value of Day's Ones Digit bits
Contains a value from 0 to 9.

Note 1: A write to this register is only allowed when RTCWREN = 1.

REGISTER 16-9: ALWDHR: ALARM WEEKDAY AND HOURS VALUE REGISTER(1)

U-0	U-0	U-0	U-0	U-0	R/W-x	R/W-x	R/W-x
—	—	—	—	—	WDAY2	WDAY1	WDAY0
bit 15							bit 8

U-0	U-0	R/W-x	R/W-x	R/W-x	R/W-x	R/W-x	R/W-x
—	—	HRTEN1	HRTEN0	HRONE3	HRONE2	HRONE1	HRONE0
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 15-11 **Unimplemented:** Read as '0'

bit 10-8 **WDAY<2:0>:** Binary Coded Decimal Value of Weekday Digit bits
Contains a value from 0 to 6.

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

bit 5-4 **HRTEN<1:0>:** Binary Coded Decimal Value of Hour's Tens Digit bits
Contains a value from 0 to 2.

bit 3-0 **HRONE<3:0>:** Binary Coded Decimal Value of Hour's Ones Digit bits
Contains a value from 0 to 9.

Note 1: A write to this register is only allowed when RTCWREN = 1.

REGISTER 17-3: CLCxSEL: CLCx INPUT MUX SELECT REGISTER

U-0	R/W-0	R/W-0	R/W-0	U-0	R/W-0	R/W-0	R/W-0
—	DS42	DS41	DS40	—	DS32	DS31	DS30
bit 15							bit 8

U-0	R/W-0	R/W-0	R/W-0	U-0	R/W-0	R/W-0	R/W-0
—	DS22	DS21	DS20	—	DS12	DS11	DS10
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 **DS4<2:0>:** Data Selection MUX 4 Signal Selection bits
111 = MCCP3 Compare Event Flag (CCP3IF)
110 = MCCP1 Compare Event Flag (CCP1IF)
101 = Digital logic low
100 = CTMU Trigger interrupt
For CLC1:
011 = SPI1 SDIx
010 = Comparator 3 output
001 = CLC2 output
000 = CLCINB I/O pin
For CLC2:
011 = SPI2 SDIx
010 = Comparator 3 output
001 = CLC1 output
000 = CLCINB I/O pin

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

bit 10-8 **DS3<2:0>:** Data Selection MUX 3 Signal Selection bits
111 = MCCP3 Compare Event Flag (CCP3IF)
110 = MCCP2 Compare Event Flag (CCP2IF)
101 = Digital logic low
For CLC1:
100 = UART1 RX
011 = SPI1 SDOx
010 = Comparator 2 output
001 = CLC1 output
000 = CLCINA I/O pin
For CLC2:
100 = UART2 RX
011 = SPI2 SDOx
010 = Comparator 2 output
001 = CLC2 output
000 = CLCINA I/O pin

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

TABLE 19-2: NUMERICAL EQUIVALENTS OF VARIOUS RESULT CODES: 12-BIT FRACTIONAL FORMATS

VIN/VREF	12-Bit Output Code	16-Bit Fractional Format/ Equivalent Decimal Value		16-Bit Signed Fractional Format/ Equivalent Decimal Value	
+4095/4096	0 1111 1111 1111	1111 1111 1111 0000	0.999	0111 1111 1111 1000	0.999
+4094/4096	0 1111 1111 1110	1111 1111 1110 0000	0.998	0111 1111 1110 1000	0.998
		• • •			
+1/4096	0 0000 0000 0001	0000 0000 0001 0000	0.001	0000 0000 0000 1000	0.001
0/4096	0 0000 0000 0000	0000 0000 0000 0000	0.000	0000 0000 0000 0000	0.000
-1/4096	1 0111 1111 1111	0000 0000 0000 0000	0.000	1111 1111 1111 1000	-0.001
		• • •			
-4095/4096	1 0000 0000 0001	0000 0000 0000 0000	0.000	1000 0000 0000 1000	-0.999
-4096/4096	1 0000 0000 0000	0000 0000 0000 0000	0.000	1000 0000 0000 0000	-1.000

FIGURE 19-5: A/D OUTPUT DATA FORMATS (10-BIT)

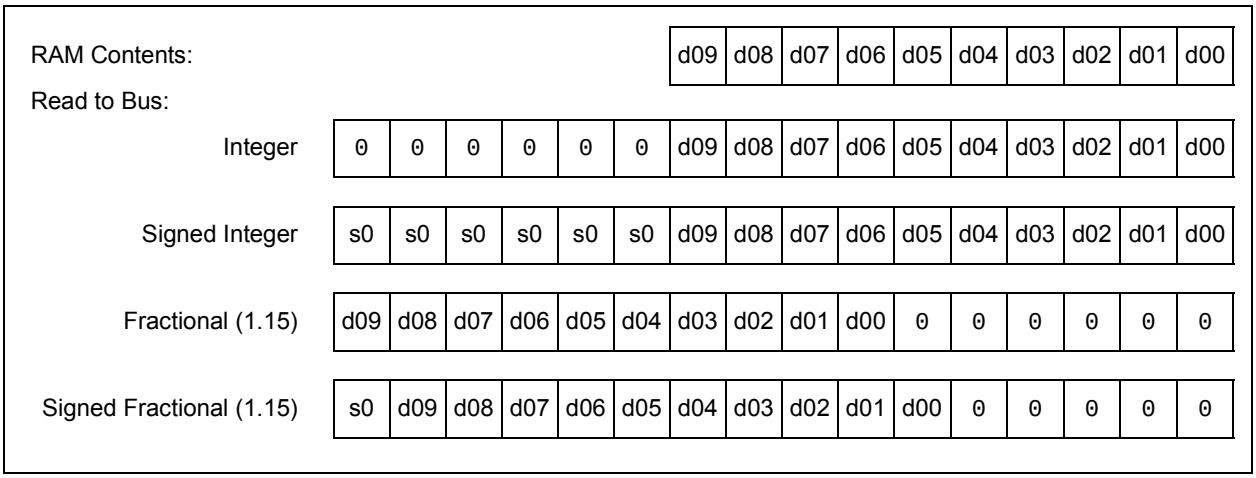
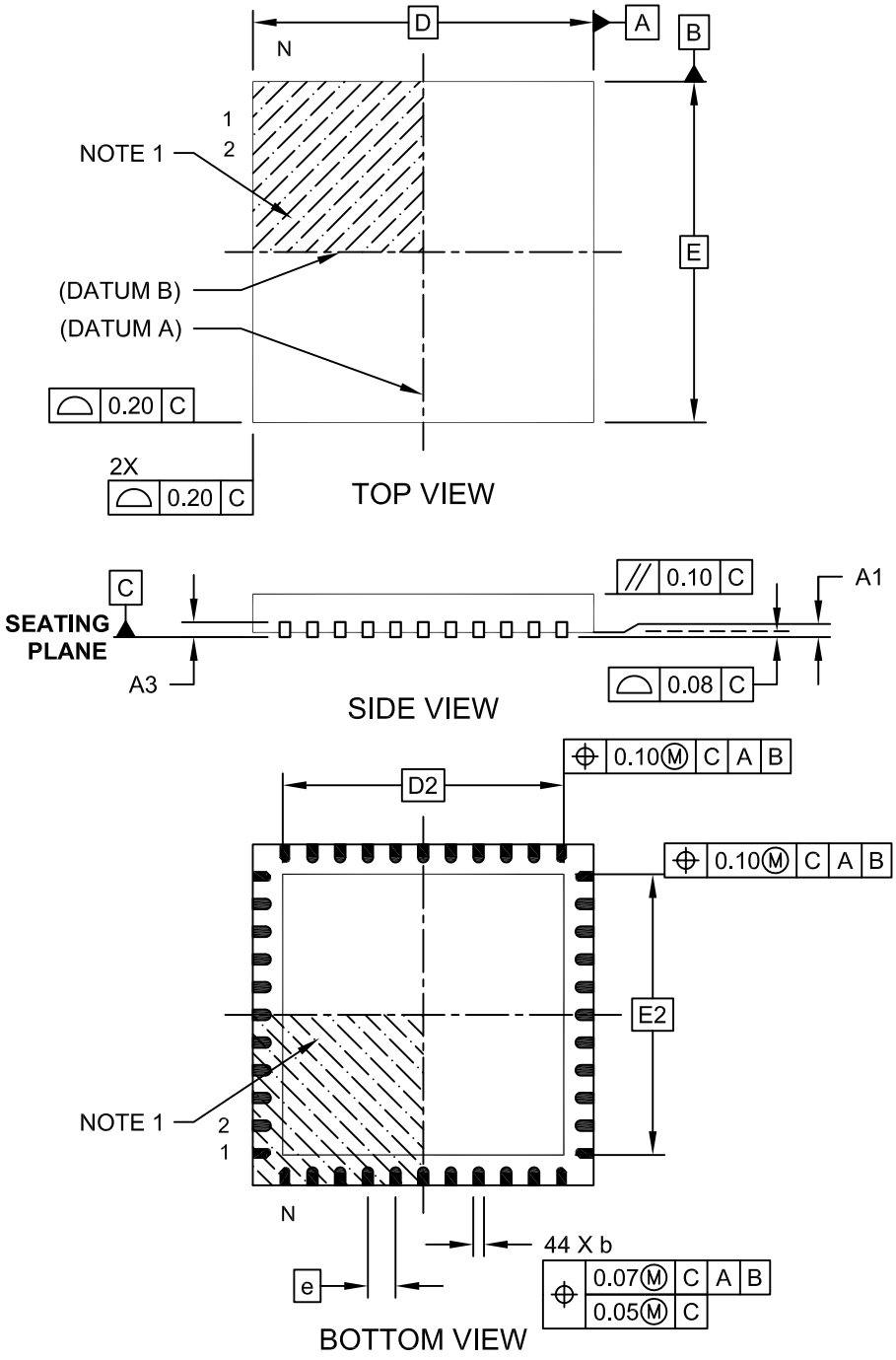


TABLE 19-3: NUMERICAL EQUIVALENTS OF VARIOUS RESULT CODES: 10-BIT INTEGER FORMATS

VIN/VREF	10-Bit Differential Output Code (11-bit result)	16-Bit Integer Format/ Equivalent Decimal Value		16-Bit Signed Integer Format/ Equivalent Decimal Value	
+1023/1024	011 1111 1111	0000 0011 1111 1111	1023	0000 0001 1111 1111	1023
+1022/1024	011 1111 1110	0000 0011 1111 1110	1022	0000 0001 1111 1110	1022
		• • •			
+1/1024	000 0000 0001	0000 0000 0000 0001	1	0000 0000 0000 0001	1
0/1024	000 0000 0000	0000 0000 0000 0000	0	0000 0000 0000 0000	0
-1/1024	101 1111 1111	0000 0000 0000 0000	0	1111 1111 1111 1111	-1
		• • •			
-1023/1024	100 0000 0001	0000 0000 0000 0000	0	1111 1110 0000 0001	-1023
-1024/1024	100 0000 0000	0000 0000 0000 0000	0	1111 1110 0000 0000	-1024

44-Lead Plastic Quad Flat, No Lead Package (ML) - 8x8 mm Body [QFN]

Note: For the most current package drawings, please see the Microchip Packaging Specification located at http://www.microchip.com/packaging



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