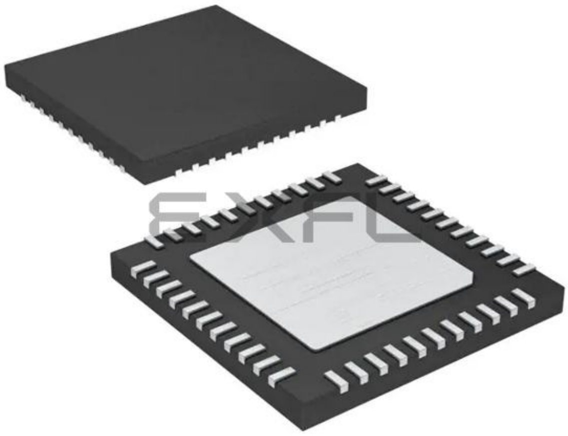


Details	
Product Status	Active
Core Processor	PIC
Core Size	16-Bit
Speed	32MHz
Connectivity	I²C, IrDA, LINbus, SPI, UART/USART
Peripherals	Brown-out Detect/Reset, HLVD, POR, PWM, WDT
Number of I/O	39
Program Memory Size	16KB (5.5K x 24)
Program Memory Type	FLASH
EEPROM Size	512 x 8
RAM Size	2K x 8
Voltage - Supply (Vcc/Vdd)	1.8V ~ 3.6V
Data Converters	A/D 16x12b
Oscillator Type	Internal
Operating Temperature	-40°C ~ 85°C (TA)
Mounting Type	Surface Mount
Package / Case	44-VQFN Exposed Pad
Supplier Device Package	44-QFN (8x8)
Purchase URL	https://www.e-xfl.com/product-detail/microchip-technology/pic24f16ka304-i-ml

TABLE 4-4: ICN 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
CNPD1	0056	CN15PDE(1)	CN14PDE	CN13PDE	CN12PDE	CN11PDE	CN10PDE(1,2)	CN9PDE(1)	CN8PDE(3)	CN7PDE(1)	CN6PDE	CN5PDE	CN4PDE	CN3PDE	CN2PDE	CN1PDE	CN0PDE	0000
CNPD2	0058	CN31PDE(1,2)	CN30PDE	CN29PDE	CN28PDE(1,2)	CN27PDE(1)	CN26PDE(1,2)	CN25PDE(1,2)	CN24PDE(1)	CN23PDE	CN22PDE	CN21PDE	CN20PDE(1,2)	CN19PDE(1,2)	CN18PDE(1,2)	CN17PDE(1,2)	CN16PDE(1)	0000
CNPD3	005A	—	—	—	—	—	—	—	—	—	—	—	CN36PDE(1,2)	CN35PDE(1,2)	CN34PDE(1,2)	CN33PDE(1,2)	CN32PDE(1,2)	0000
CNEN1	0062	CN15IE(1)	CN14IE	CN13IE	CN12IE	CN11IE	CN10IE(1,2)	CN9IE(1)	CN8IE(3)	CN7IE(1)	CN6IE	CN5IE	CN4IE	CN3IE	CN2IE	CN1IE	CN0IE	0000
CNEN2	0064	CN31IE(1,2)	CN30IE	CN29IE	CN28IE(1,2)	CN27IE(1)	CN26IE(1,2)	CN25IE(1,2)	CN24IE(1)	CN23IE	CN22IE	CN21IE	CN20IE(1,2)	CN19IE(1,2)	CN18IE(1,2)	CN17IE(1,2)	CN16IE(1)	0000
CNEN3	0066	—	—	—	—	—	—	—	—	—	—	—	CN36IE(1,2)	CN35IE(1,2)	CN34IE(1,2)	CN33IE(1,2)	CN32IE(1,2)	0000
CNPU1	006E	CN15PUE(1)	CN14PUE	CN13PUE	CN12PUE	CN11PUE	CN10PUE(1,2)	CN9PUE(1)	CN8PUE(3)	CN7PUE(1)	CN6PUE	CN5PUE	CN4PUE	CN3PUE	CN2PUE	CN1PUE	CN0PUE	0000
CNPU2	0070	CN31PUE(1,2)	CN30PUE	CN29PUE	CN28PUE(1,2)	CN27PUE(1)	CN26PUE(1,2)	CN25PUE(1,2)	CN24PUE(1)	CN23PUE	CN22PUE	CN21PUE	CN20PUE(1,2)	CN19PUE(1,2)	CN18PUE(1,2)	CN17PUE(1,2)	CN16PUE(1)	0000
CNPU3	0072	—	—	—	—	—	—	—	—	—	—	—	CN36PUE(1,2)	CN35PUE(1,2)	CN34PUE(1,2)	CN33PUE(1,2)	CN32PUE(1,2)	0000

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

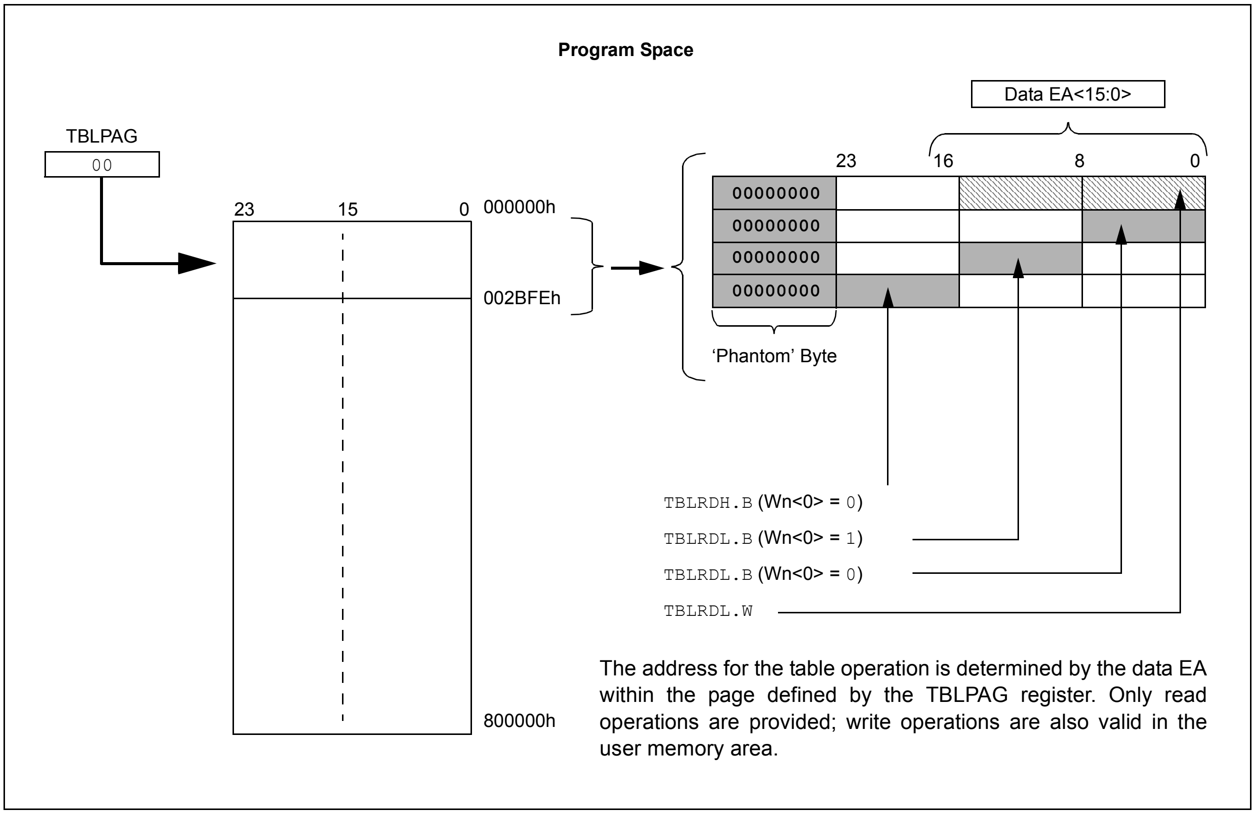
Note 1: These bits are not implemented in 20-pin devices.
2: These bits are not implemented in 28-pin devices.
3: These bits are not implemented in FV devices.

In a similar fashion, two table instructions, TBLWTH and TBLWTL, are used to write individual bytes or words to a program space address. The details of their operation are explained in **Section 5.0 "Flash Program Memory"**.

For all table operations, the area of program memory space to be accessed is determined by the Table Memory Page Address register (TBLPAG). TBLPAG covers the entire program memory space of the device, including user and configuration spaces. When TBLPAG<7> = 0, the table page is located in the user memory space. When TBLPAG<7> = 1, the page is located in configuration space.

Note:	Only Table Read operations will execute in the configuration memory space, and only then, in implemented areas, such as the Device ID. Table write operations are not allowed.

FIGURE 4-6: ACCESSING PROGRAM MEMORY WITH TABLE INSTRUCTIONS



6.4.3 READING THE DATA EEPROM

To read a word from data EEPROM, the table read instruction is used. Since the EEPROM array is only 16 bits wide, only the `TBLRDL` instruction is needed. The read operation is performed by loading TBLPAG and WREG with the address of the EEPROM location, followed by a `TBLRDL` instruction.

A typical read sequence, using the Table Pointer management (`builtin_tblpage` and `builtin_tbloffset`) and table read procedures (`builtin_tblrdl`) from the C30 compiler library, is provided in Example 6-5.

Program Space Visibility (PSV) can also be used to read locations in the data EEPROM.

EXAMPLE 6-5: READING THE DATA EEPROM USING THE TBLRD COMMAND

```
int __attribute__ ((space(eedata))) eeData = 0x1234;
int data;                                           // Data read from EEPROM
/*-----------------------------------------------------------------------------------------------
The variable eeData must be a Global variable declared outside of any method

the code following this comment can be written inside the method that will execute the read
-------------------------------------------------------------------------------------------------
*/
    unsigned int offset;

    // Set up a pointer to the EEPROM location to be erased
    TBLPAG = __builtin_tblpage(&eeData);                // Initialize EE Data page pointer
    offset = __builtin_tbloffset(&eeData);              // Initizlize lower word of address
    data = __builtin_tblrdl(offset);                    // Write EEPROM data to write latch
```


REGISTER 8-4: INTCON2: INTERRUPT CONTROL REGISTER2

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

U-0	U-0	U-0	U-0	U-0	R/W-0	R/W-0	R/W-0
—	—	—	—	—	INT2EP	INT1EP	INT0EP
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 **ALTIVT:** Enable Alternate Interrupt Vector Table bit
1 = Uses Alternate Interrupt Vector Table (AIVT)
0 = Uses standard (default) Interrupt Vector Table (IVT)

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

bit 13-3 **Unimplemented:** Read as ‘0’

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

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

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

REGISTER 8-30: IPC18: INTERRUPT PRIORITY CONTROL REGISTER 18

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
—	—	—	—	—	HLVDIP2	HLVDIP1	HLVDIP0
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 **HLVDIP<2:0>:** High/Low-Voltage Detect Interrupt Priority bits
111 = Interrupt is Priority 7 (highest priority interrupt)
•
•
•
001 = Interrupt is Priority 1
000 = Interrupt source is disabled

REGISTER 8-31: IPC19: INTERRUPT PRIORITY CONTROL REGISTER 19

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	U-0	U-0	U-0
—	CTMUIP2	CTMUIP1	CTMUIP0	—	—	—	—
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 **CTMUIP<2:0>:** CTMU Interrupt Priority bits
111 = Interrupt is Priority 7 (highest priority interrupt)
•
•
•
001 = Interrupt is Priority 1
000 = Interrupt source is disabled

bit 3-0 **Unimplemented:** Read as ‘0’

The following code sequence for a clock switch is recommended:

1. Disable interrupts during the OSCCON register unlock and write sequence.
2. Execute the unlock sequence for the OSCCON high byte by writing 78h and 9Ah to OSCCON<15:8>, in two back-to-back instructions.
3. Write new oscillator source to the NOSCx bits in the instruction immediately following the unlock sequence.
4. Execute the unlock sequence for the OSCCON low byte by writing 46h and 57h to OSCCON<7:0>, in two back-to-back instructions.
5. Set the OSWEN bit in the instruction immediately following the unlock sequence.
6. Continue to execute code that is not clock-sensitive (optional).
7. Invoke an appropriate amount of software delay (cycle counting) to allow the selected oscillator and/or PLL to start and stabilize.
8. Check to see if OSWEN is '0'. If it is, the switch was successful. If OSWEN is still set, then check the LOCK bit to determine the cause of failure.

The core sequence for unlocking the OSCCON register and initiating a clock switch is shown in Example 9-1.

EXAMPLE 9-1: BASIC CODE SEQUENCE FOR CLOCK SWITCHING

```
;Place the new oscillator selection in W0
;OSCCONH (high byte) Unlock Sequence
MOV         #OSCCONH, w1
MOV         #0x78, w2
MOV         #0x9A, w3
MOV.b       w2, [w1]
MOV.b       w3, [w1]
;Set new oscillator selection
MOV.b       WREG, OSCCONH
;OSCCONL (low byte) unlock sequence
MOV         #OSCCONL, w1
MOV         #0x46, w2
MOV         #0x57, w3
MOV.b       w2, [w1]
MOV.b       w3, [w1]
;Start oscillator switch operation
BSET        OSCCON,#0
```

9.5 Reference Clock Output

In addition to the CLKO output (FOSC/2) available in certain oscillator modes, the device clock in the PIC24FV32KA304 family devices can also be configured to provide a reference clock output signal to a port pin. This feature is available in all oscillator configurations and allows the user to select a greater range of clock submultiples to drive external devices in the application.

This reference clock output is controlled by the REFOCON register (Register 9-4). Setting the ROEN bit (REFOCON<15>) makes the clock signal available on the REFO pin. The RODIVx bits (REFOCON<11:8>) enable the selection of 16 different clock divider options.

The ROSSLP and ROSEL bits (REFOCON<13:12>) control the availability of the reference output during Sleep mode. The ROSEL bit determines if the oscillator on OSC1 and OSC2, or the current system clock source, is used for the reference clock output. The ROSSLP bit determines if the reference source is available on REFO when the device is in Sleep mode.

To use the reference clock output in Sleep mode, both the ROSSLP and ROSEL bits must be set. The device clock must also be configured for one of the primary modes (EC, HS or XT); otherwise, if the ROSEL bit is not also set, the oscillator on OSC1 and OSC2 will be powered down when the device enters Sleep mode. Clearing the ROSEL bit allows the reference output frequency to change as the system clock changes during any clock switches.

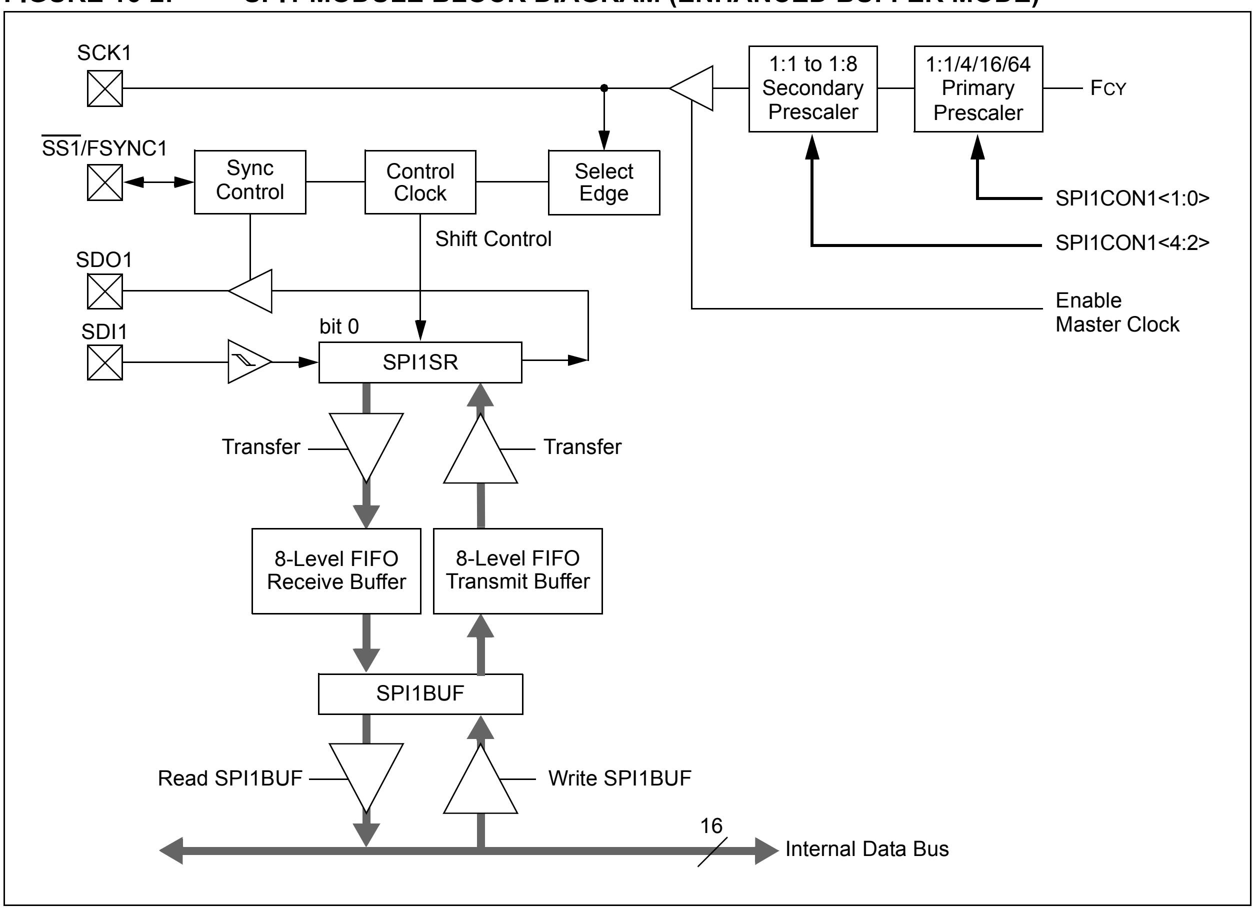
To set up the SPI1 module for the Enhanced Buffer Master (EBM) mode of operation:

1. If using interrupts:
   a) Clear the SPI1IF bit in the IFS0 register.
   b) Set the SPI1IE bit in the IEC0 register.
   c) Write the respective SPI1IPx bits in the IPC2 register.
2. Write the desired settings to the SPI1CON1 and SPI1CON2 registers with the MSTEN bit (SPI1CON1<5>) = `1`.
3. Clear the SPIROV bit (SPI1STAT<6>).
4. Select Enhanced Buffer mode by setting the SPIBEN bit (SPI1CON2<0>).
5. Enable SPI operation by setting the SPIEN bit (SPI1STAT<15>).
6. Write the data to be transmitted to the SPI1BUF register. Transmission (and reception) will start as soon as data is written to the SPI1BUF register.

To set up the SPI1 module for the Enhanced Buffer Slave mode of operation:

1. Clear the SPI1BUF register.
2. If using interrupts:
   a) Clear the SPI1IF bit in the IFS0 register.
   b) Set the SPI1IE bit in the IEC0 register.
   c) Write the respective SPI1IPx bits in the IPC2 register to set the interrupt priority.
3. Write the desired settings to the SPI1CON1 and SPI1CON2 registers with the MSTEN bit (SPI1CON1<5>) = `0`.
4. Clear the SMP bit.
5. If the CKE bit is set, then the SSEN bit must be set, thus enabling the $\overline{SS1}$ pin.
6. Clear the SPIROV bit (SPI1STAT<6>).
7. Select Enhanced Buffer mode by setting the SPIBEN bit (SPI1CON2<0>).
8. Enable SPI operation by setting the SPIEN bit (SPI1STAT<15>).

FIGURE 16-2: SPI1 MODULE BLOCK DIAGRAM (ENHANCED BUFFER MODE)



REGISTER 16-1: SPIxSTAT: SPIx STATUS AND CONTROL REGISTER

R/W-0	U-0	R/W-0	U-0	U-0	R-0, HSC	R-0, HSC	R-0, HSC
SPIEN	—	SPISIDL	—	—	SPIBEC2	SPIBEC1	SPIBEC0
bit 15							bit 8

R-0, HSC	R/C-0, HS	R/W-0, HSC	R/W-0	R/W-0	R/W-0	R-0, HSC	R-0, HSC
SRMPT	SPIROV	SRXMPT	SISEL2	SISEL1	SISEL0	SPITBF	SPIRBF
bit 7							bit 0

Legend:	C = Clearable bit	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 **SPIEN:** SPIx Enable bit
1 = Enables module and configures SCKx, SDOx, SDIx and $\overline{\text{SSx}}$ as serial port pins
0 = Disables module

bit 14 **Unimplemented:** Read as ‘0’

bit 13 **SPISIDL:** SPIx Stop in Idle Mode bit
1 = Discontinues module operation when device enters Idle mode
0 = Continues module operation in Idle mode

bit 12-11 **Unimplemented:** Read as ‘0’

bit 10-8 **SPIBEC<2:0>:** SPIx Buffer Element Count bits (valid in Enhanced Buffer mode)
<u>Master mode:</u>
Number of SPI transfers pending.
<u>Slave mode:</u>
Number of SPI transfers unread.

bit 7 **SRMPT:** SPIx Shift Register (SPIxSR) Empty bit (valid in Enhanced Buffer mode)
1 = SPIx Shift register is empty and ready to send or receive
0 = SPIx Shift register is not empty

bit 6 **SPIROV:** SPIx Receive Overflow Flag bit
1 = A new byte/word is completely received and discarded (the user software has not read the previous data in the SPI1BUF register)
0 = No overflow has occurred

bit 5 **SRXMPT:** SPIx Receive FIFO Empty bit (valid in Enhanced Buffer mode)
1 = Receive FIFO is empty
0 = Receive FIFO is not empty

bit 4-2 **SISEL<2:0>:** SPIx Buffer Interrupt Mode bits (valid in Enhanced Buffer mode)
111 = Interrupt when SPIx transmit buffer is full (SPITBF bit is set)
110 = Interrupt when last bit is shifted into SPIxSR; as a result, the TX FIFO is empty
101 = Interrupt when the last bit is shifted out of SPIxSR; now the transmit is complete
100 = Interrupt when one data byte is shifted into the SPIxSR; as a result, the TX FIFO has one open spot
011 = Interrupt when SPIx receive buffer is full (SPIRBF bit is set)
010 = Interrupt when SPIx receive buffer is 3/4 or more full
001 = Interrupt when data is available in receive buffer (SRMPT bit is set)
000 = Interrupt when the last data in the receive buffer is read; as a result, the buffer is empty (SRXMPT bit is set)

REGISTER 17-1: I2CxCON: I2Cx CONTROL REGISTER

R/W-0	U-0	R/W-0	R/W-1, HC	R/W-0	R/W-0	R/W-0	R/W-0
I2CEN	—	I2CSIDL	SCLREL	IPMIEN	A10M	DISSLW	SMEN
bit 15							bit 8

R/W-0	R/W-0	R/W-0	R/W-0, HC	R/W-0, HC	R/W-0, HC	R/W-0, HC	R/W-0, HC
GCEN	STREN	ACKDT	ACKEN	RCEN	PEN	RSEN	SEN
bit 7							bit 0

Legend:	HC = Hardware 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 **I2CEN:** I2Cx Enable bit
1 = Enables the I2Cx module, and configures the SDAx and SCLx pins as serial port pins
0 = Disables the I2Cx module; all I^{2}C™ pins are controlled by port functions

bit 14 **Unimplemented:** Read as ‘0’

bit 13 **I2CSIDL:** I2Cx Stop in Idle Mode bit
1 = Discontinues module operation when the device enters an Idle mode
0 = Continues module operation in Idle mode

bit 12 **SCLREL:** SCLx Release Control bit (when operating as I^{2}C slave)
1 = Releases SCLx clock
0 = Holds SCLx clock low (clock stretch)
If STREN = 1:
The bit is R/$\overline{W}$ (i.e., software may write ‘0’ to initiate stretch and write ‘1’ to release clock). Hardware is clear at the beginning of the slave transmission. Hardware is clear at the end of slave reception.
If STREN = 0:
The bit is R/S (i.e., software may only write ‘1’ to release clock). Hardware is clear at the beginning of slave transmission.

bit 11 **IPMIEN:** Intelligent Peripheral Management Interface (IPMI) Enable bit
1 = IPMI Support mode is enabled; all addresses are Acknowledged
0 = IPMI Support mode is disabled

bit 10 **A10M:** 10-Bit Slave Addressing bit
1 = I2CxADD is a 10-bit slave address
0 = I2CxADD is a 7-bit slave address

bit 9 **DISSLW:** Disable Slew Rate Control bit
1 = Slew rate control is disabled
0 = Slew rate control is enabled

bit 8 **SMEN:** SMBus Input Levels bit
1 = Enables I/O pin thresholds compliant with the SMBus specification
0 = Disables the SMBus input thresholds

bit 7 **GCEN:** General Call Enable bit (when operating as I^{2}C slave)
1 = Enables interrupt when a general call address is received in the I2CxRSR (module is enabled for reception)
0 = General call address is disabled

bit 6 **STREN:** SCLx Clock Stretch Enable bit (when operating as I^{2}C slave)
Used in conjunction with the SCLREL bit.
1 = Enables software or receives clock stretching
0 = Disables software or receives clock stretching

REGISTER 17-2: I2CxSTAT: I2Cx STATUS REGISTER

R-0, HSC	R-0, HSC	U-0	U-0	U-0	R/C-0, HS	R-0, HSC	R-0, HSC
ACKSTAT	TRSTAT	—	—	—	BCL	GCSTAT	ADD10
bit 15							bit 8

R/C-0, HS	R/C-0, HS	R-0, HSC	R/C-0, HSC	R/C-0, HSC	R-0, HSC	R-0, HSC	R-0, HSC
IWCOL	I2COV	D/$\overline{\text{A}}$	P	S	R/$\overline{\text{W}}$	RBF	TBF
bit 7							bit 0

Legend:	C = Clearable bit	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 **ACKSTAT:** Acknowledge Status bit
1 = NACK was detected last
0 = ACK was detected last
Hardware is set or clear at the end of Acknowledge.

bit 14 **TRSTAT:** Transmit Status bit
(when operating as I^{2}C master; applicable to master transmit operation)
1 = Master transmit is in progress (8 bits + ACK)
0 = Master transmit is not in progress
Hardware is set at the beginning of the master transmission; hardware is clear at the end of slave Acknowledge.

bit 13-11 **Unimplemented:** Read as ‘0’

bit 10 **BCL:** Master Bus Collision Detect bit
1 = A bus collision has been detected during a master operation
0 = No collision
Hardware is set at the detection of a bus collision.

bit 9 **GCSTAT:** General Call Status bit
1 = General call address was received
0 = General call address was not received
Hardware is set when an address matches the general call address; hardware is clear at Stop detection.

bit 8 **ADD10:** 10-Bit Address Status bit
1 = 10-bit address was matched
0 = 10-bit address was not matched
Hardware is set at a match of the 2nd byte of the matched 10-bit address; hardware is clear at Stop detection.

bit 7 **IWCOL:** I2Cx Write Collision Detect bit
1 = An attempt to write to the I2CxTRN register failed because the I^{2}C module is busy
0 = No collision
Hardware is set at an occurrence of a write to I2CxTRN while busy (cleared by software).

bit 6 **I2COV:** I2Cx Receive Overflow Flag bit
1 = A byte was received while the I2CxRCV register is still holding the previous byte
0 = No overflow
Hardware is set at an attempt to transfer I2CxRSR to I2CxRCV (cleared by software).

bit 5 **D/$\overline{\text{A}}$:** Data/$\overline{\text{Address}}$ bit (when operating as I^{2}C slave)
1 = Indicates that the last byte received was data
0 = Indicates that the last byte received was the device address
Hardware is clear at a device address match; hardware is set by a write to I2CxTRN or by reception of a slave byte.

REGISTER 19-10: ALMINSEC: ALARM MINUTES AND SECONDS VALUE REGISTER

U-0	R/W-x	R/W-x	R/W-x	R/W-x	R/W-x	R/W-x	R/W-x
—	MINTEN2	MINTEN1	MINTEN0	MINONE3	MINONE2	MINONE1	MINONE0
bit 15							bit 8

U-0	R/W-x	R/W-x	R/W-x	R/W-x	R/W-x	R/W-x	R/W-x
—	SECTEN2	SECTEN1	SECTEN0	SECONE3	SECONE2	SECONE1	SECONE0
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	**MINTEN<2:0>:** Binary Coded Decimal Value of Minute’s Tens Digit bits Contains a value from 0 to 5.
bit 11-8	**MINONE<3:0>:** Binary Coded Decimal Value of Minute’s Ones Digit bits Contains a value from 0 to 9.
bit 7	**Unimplemented:** Read as ‘0’
bit 6-4	**SECTEN<2:0>:** Binary Coded Decimal Value of Second’s Tens Digit bits Contains a value from 0 to 5.
bit 3-0	**SECONE<3:0>:** Binary Coded Decimal Value of Second’s Ones Digit bits Contains a value from 0 to 9.

REGISTER 22-6: AD1CHITH: A/D SCAN COMPARE HIT REGISTER (HIGH WORD)(1)

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	U-0	R/W-0	R/W-0
—	—	—	—	—	—	CHH17	CHH16
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 15-2 **Unimplemented:** Read as ‘0’.

bit 1-0 **CHH<17:16>:** A/D Compare Hit bits

If CM<1:0> = 11:
1 = A/D Result Buffer x has been written with data or a match has occurred
0 = A/D Result Buffer x has not been written with data

For All Other Values of CM<1:0>:
1 = A match has occurred on A/D Result Channel x
0 = No match has occurred on A/D Result Channel x

Note 1: Unimplemented channels are read as ‘0’.

REGISTER 22-7: AD1CHITL: A/D SCAN COMPARE HIT REGISTER (LOW WORD)(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
CHH15	CHH14	CHH13	CHH12	CHH11	CHH10	CHH9	CHH8
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
CHH7	CHH6	CHH5	CHH4	CHH3	CHH2	CHH1	CHH0
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 **CHH<15:0>:** A/D Compare Hit bits

If CM<1:0> = 11:
1 = A/D Result Buffer x has been written with data or a match has occurred
0 = A/D Result Buffer x has not been written with data

For all other values of CM<1:0>:
1 = A match has occurred on A/D Result Channel x
0 = No match has occurred on A/D Result Channel x

Note 1: Unimplemented channels are read as ‘0’.

TABLE 22-2: 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 22-5: A/D OUTPUT DATA FORMATS (10-BIT)

RAM Contents:							d09	d08	d07	d06	d05	d04	d03	d02	d01	d00
Read to Bus:																
Integer	0	0	0	0	0	0	d09	d08	d07	d06	d05	d04	d03	d02	d01	d00
Signed Integer	s0	s0	s0	s0	s0	s0	d09	d08	d07	d06	d05	d04	d03	d02	d01	d00
Fractional (1.15)	d09	d08	d07	d06	d05	d04	d03	d02	d01	d00	0	0	0	0	0	0
Signed Fractional (1.15)	s0	d09	d08	d07	d06	d05	d04	d03	d02	d01	d00	0	0	0	0	0

TABLE 22-3: 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

TABLE 29-10: DC CHARACTERISTICS: I/O PIN OUTPUT SPECIFICATIONS

DC CHARACTERISTICS			Standard Operating Conditions: 1.8V to 3.6V PIC24F32KA3XX 2.0V to 5.5V PIC24FV32KA3XX Operating temperature -40°C ≤ TA ≤ +85°C for Industrial -40°C ≤ TA ≤ +125°C for Extended					
Param No.	**Sym**	**Characteristic**	**Min**	**Typ(1)**	**Max**	**Units**	**Conditions**	
	VOL	**Output Low Voltage**						
DO10		All I/O Pins	—	—	0.4	V	IOL = 8.0 mA	VDD = 4.5V
			—	—	0.4	V	IOL = 4.0 mA	VDD = 3.6V
			—	—	0.4	V	IOL = 3.5 mA	VDD = 2.0V
DO16		OSC2/CLKO	—	—	0.4	V	IOL = 2.0 mA	VDD = 4.5V
			—	—	0.4	V	IOL = 1.2 mA	VDD = 3.6V
			—	—	0.4	V	IOL = 0.4 mA	VDD = 2.0V
	VOH	**Output High Voltage**						
DO20		All I/O Pins	3.8	—	—	V	IOH = -3.5 mA	VDD = 4.5V
			3	—	—	V	IOH = -3.0 mA	VDD = 3.6V
			1.6	—	—	V	IOH = -1.0 mA	VDD = 2.0V
DO26		OSC2/CLKO	3.8	—	—	V	IOH = -2.0 mA	VDD = 4.5V
			3	—	—	V	IOH = -1.0 mA	VDD = 3.6V
			1.6	—	—	V	IOH = -0.5 mA	VDD = 2.0V

Note 1: Data in “Typ” column is at +25°C unless otherwise stated. Parameters are for design guidance only and are not tested.

TABLE 29-11: DC CHARACTERISTICS: PROGRAM MEMORY

DC CHARACTERISTICS			Standard Operating Conditions: 1.8V to 3.6V PIC24F32KA3XX 2.0V to 5.5V PIC24FV32KA3XX Operating temperature -40°C ≤ TA ≤ +85°C for Industrial -40°C ≤ TA ≤ +125°C for Extended				
Param No.	**Sym**	**Characteristic**	**Min**	**Typ(1)**	**Max**	**Units**	**Conditions**
		Program Flash Memory					
D130	EP	Cell Endurance	10,000(2)	—	—	E/W	
D131	VPR	VDD for Read	VMIN	—	3.6	V	VMIN = Minimum operating voltage
D133A	TIW	Self-Timed Write Cycle Time	—	2	—	ms	
D134	TRETD	Characteristic Retention	40	—	—	Year	Provided no other specifications are violated
D135	IDDP	Supply Current During Programming	—	10	—	mA	

Note 1: Data in “Typ” column is at 3.3V, +25°C unless otherwise stated.
2: Self-write and block erase.

TABLE 29-12: DC CHARACTERISTICS: DATA EEPROM MEMORY

DC CHARACTERISTICS			Standard Operating Conditions: 1.8V to 3.6V PIC24F32KA3XX 2.0V to 5.5V PIC24FV32KA3XX Operating temperature -40°C ≤ TA ≤ +85°C for Industrial -40°C ≤ TA ≤ +125°C for Extended				
Param No.	**Sym**	**Characteristic**	**Min**	**Typ(1)**	**Max**	**Units**	**Conditions**
		Data EEPROM Memory					
D140	EPD	Cell Endurance	100,000	—	—	E/W	
D141	VPRD	VDD for Read	VMIN	—	3.6	V	VMIN = Minimum operating voltage
D143A	TIWD	Self-Timed Write Cycle Time	—	4	—	ms	
D143B	TREF	Number of Total Write/Erase Cycles Before Refresh	—	10M	—	E/W	
D144	TRETDD	Characteristic Retention	40	—	—	Year	Provided no other specifications are violated
D145	IDDPD	Supply Current During Programming	—	7	—	mA	

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

TABLE 29-13: DC CHARACTERISTICS: COMPARATOR SPECIFICATIONS

Operating Conditions: 2.0V < VDD < 3.6V, -40°C < TA < +125°C (unless otherwise stated)							
Param No.	**Symbol**	**Characteristic**	**Min**	**Typ**	**Max**	**Units**	**Comments**
D300	VIOFF	Input Offset Voltage	—	20	40	mV	
D301	VICM	Input Common-Mode Voltage	0	—	VDD	V	
D302	CMRR	Common-Mode Rejection Ratio	55	—	—	dB	

TABLE 29-14: DC CHARACTERISTICS: COMPARATOR VOLTAGE REFERENCE SPECIFICATIONS

Operating Conditions: 2.0V < VDD < 3.6V, -40°C < TA < +125°C (unless otherwise stated)							
Param No.	**Symbol**	**Characteristic**	**Min**	**Typ**	**Max**	**Units**	**Comments**
VRD310	CVRES	Resolution	—	—	VDD/32	LSb	
VRD311	CVRAA	Absolute Accuracy	—	—	AVDD – 1.5	LSb	
VRD312	CVRUR	Unit Resistor Value (R)	—	2k	—	Ω	

TABLE 29-20: PLL CLOCK TIMING SPECIFICATIONS

AC CHARACTERISTICS			Standard Operating Conditions: 1.8V to 3.6V PIC24F32KA3XX 2.0V to 5.5V PIC24FV32KA3XX Operating temperature -40°C ≤ TA ≤ +85°C for Industrial -40°C ≤ TA ≤ +125°C for Extended				
Param No.	Sym	Characteristic(1)	Min	Typ(2)	Max	Units	Conditions
OS50	FPLLI	PLL Input Frequency Range	4	—	8	MHz	ECPLL, HSPLL modes, -40°C ≤ TA ≤ +85°C
OS51	FSYS	PLL Output Frequency Range	16	—	32	MHz	-40°C ≤ TA ≤ +85°C
OS52	TLOCK	PLL Start-up Time (Lock Time)	—	1	2	ms	
OS53	DCLK	CLKO Stability (Jitter)	-2	1	2	%	Measured over a 100 ms period

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

2: Data in “Typ” column is at 3.3V, +25°C unless otherwise stated. Parameters are for design guidance only and are not tested.

TABLE 29-21: AC CHARACTERISTICS: INTERNAL RC ACCURACY

AC CHARACTERISTICS		Standard Operating Conditions: 1.8V to 3.6V PIC24F32KA3XX 2.0V to 5.5V PIC24FV32KA3XX Operating temperature -40°C ≤ TA ≤ +85°C for Industrial -40°C ≤ TA ≤ +125°C for Extended					
Param No.	Characteristic	Min	Typ	Max	Units	Conditions	
F20	**Internal FRC Accuracy @ 8 MHz(1)**						
	FRC	-2	—	+2	%	+25°C	3.0V ≤ VDD ≤ 3.6V, F device 3.2V ≤ VDD ≤ 5.5V, FV device
		-5	—	+5	%	-40°C ≤ TA ≤ +85°C	1.8V ≤ VDD ≤ 3.6V, F device 2.0V ≤ VDD ≤ 5.5V, FV device
	LPRC @ 31 kHz(2)						
F21		-15	—	15	%		

Note 1: Frequency is calibrated at +25°C and 3.3V. The OSCTUN bits can be used to compensate for temperature drift.

2: The change of LPRC frequency as VDD changes.

TABLE 29-22: INTERNAL RC OSCILLATOR SPECIFICATIONS

AC CHARACTERISTICS			Standard Operating Conditions: 1.8V to 3.6V PIC24F32KA3XX 2.0V to 5.5V PIC24FV32KA3XX Operating temperature -40°C ≤ TA ≤ +85°C for Industrial -40°C ≤ TA ≤ +125°C for Extended				
Param No.	Sym	Characteristic(1)	Min	Typ	Max	Units	Conditions
	TFRC	FRC Start-up Time	—	5	—	μs	
	TLPRC	LPRC Start-up Time	—	70	—	μs	

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

FIGURE 30-16: TYPICAL AND MAXIMUM IPD vs. VDD (DEEP SLEEP MODE)

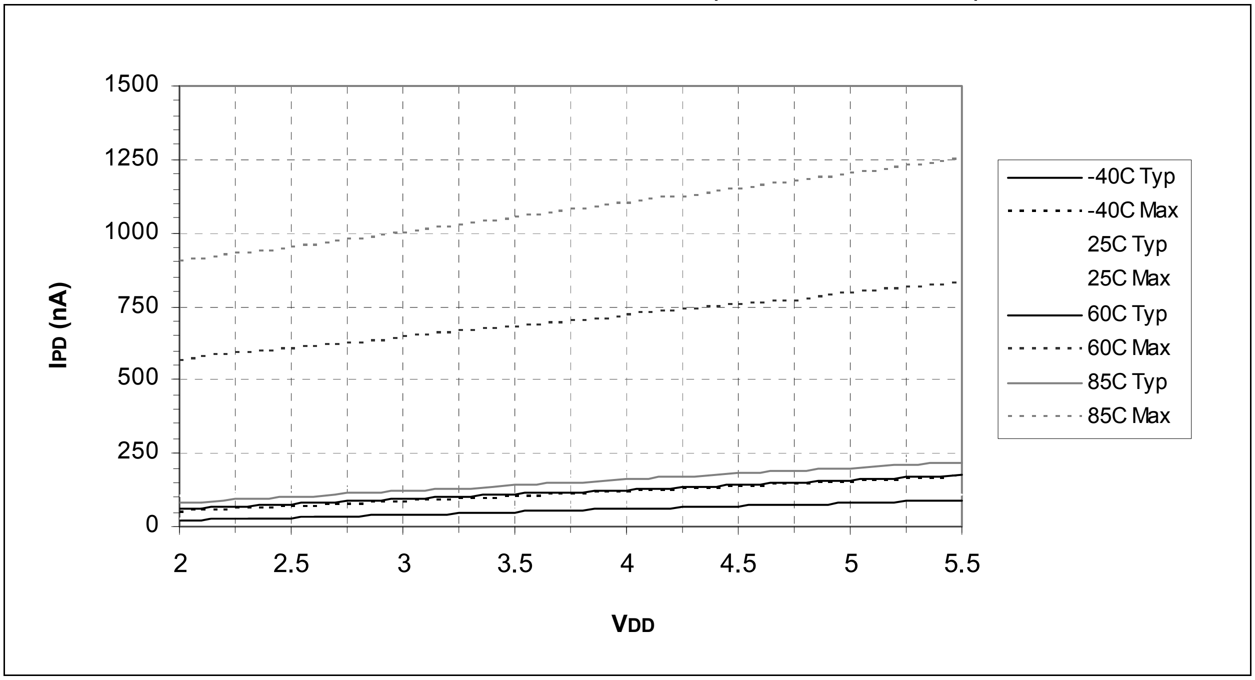


FIGURE 30-17: TYPICAL AND MAXIMUM IPD vs. TEMPERATURE (DEEP SLEEP MODE)

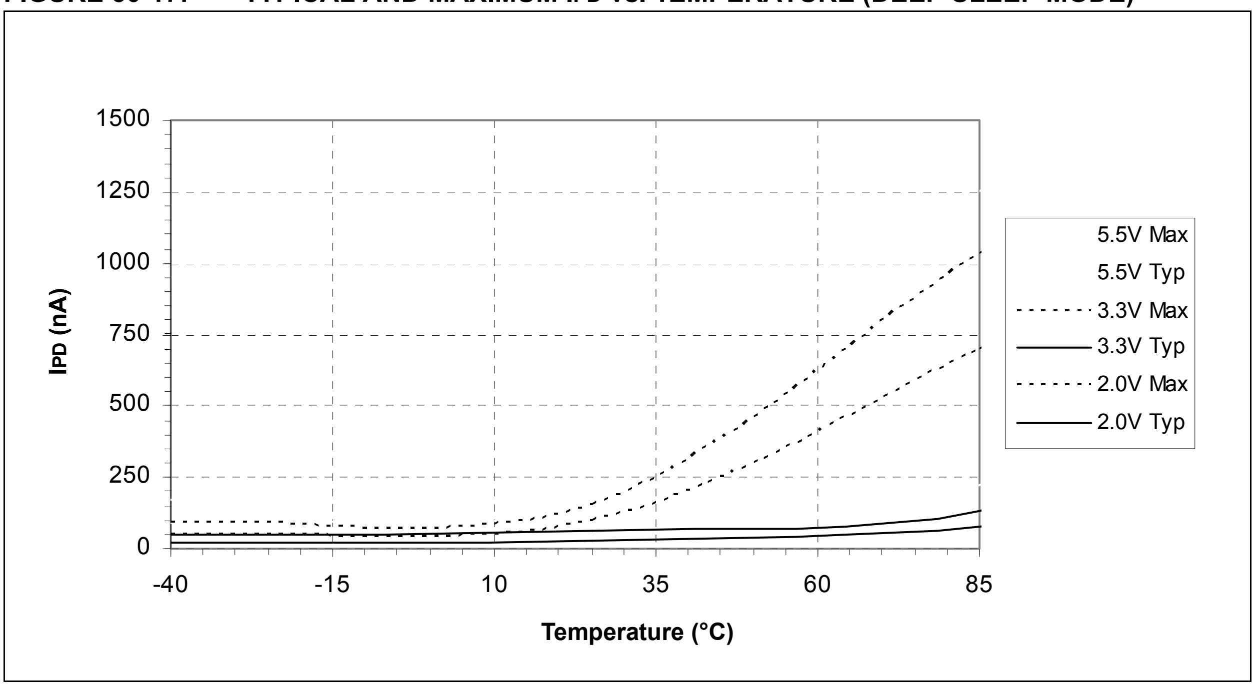


FIGURE 30-22: TYPICAL ΔIDSWDT vs. VDD

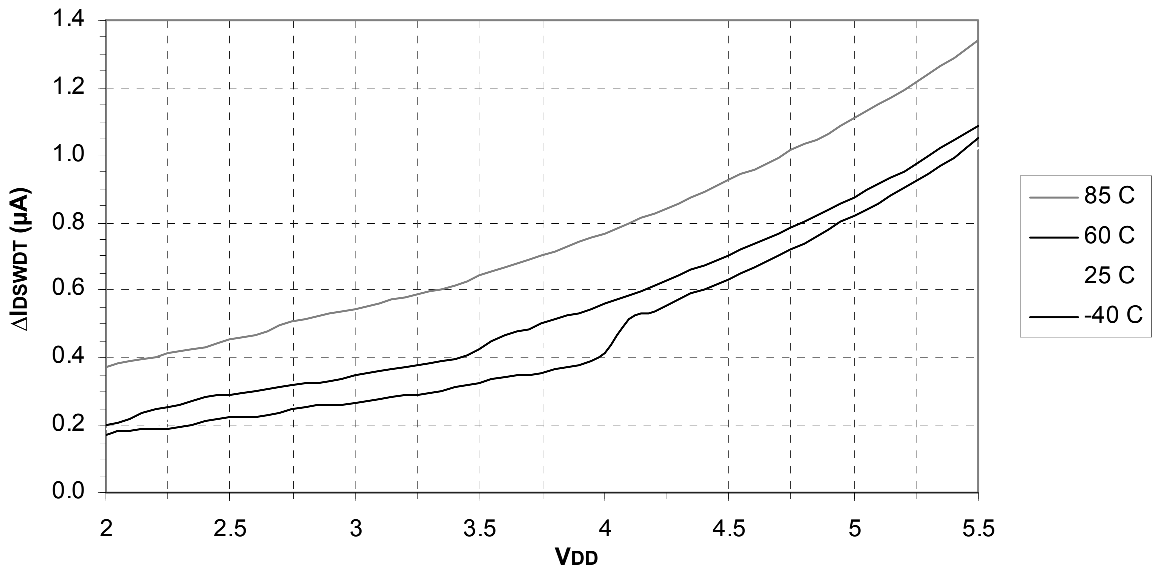


FIGURE 30-23: TYPICAL VBOR vs. TEMPERATURE (BOR TRIP POINT 3)

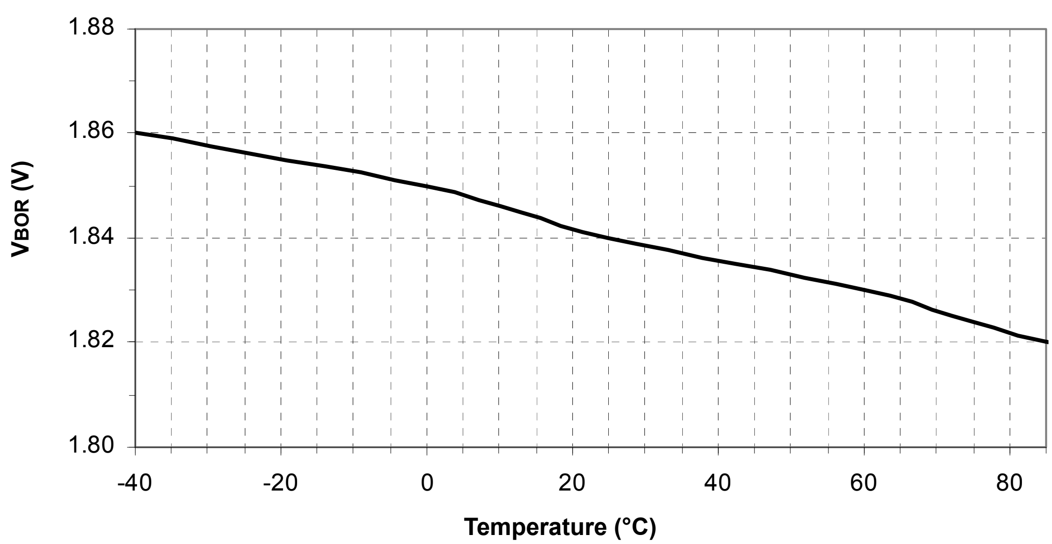


FIGURE 30-38: CTMU OUTPUT CURRENT vs. TEMPERATURE (IRNG<1:0> = 01, 2.0V ≤ VDD ≤ 5.5V)

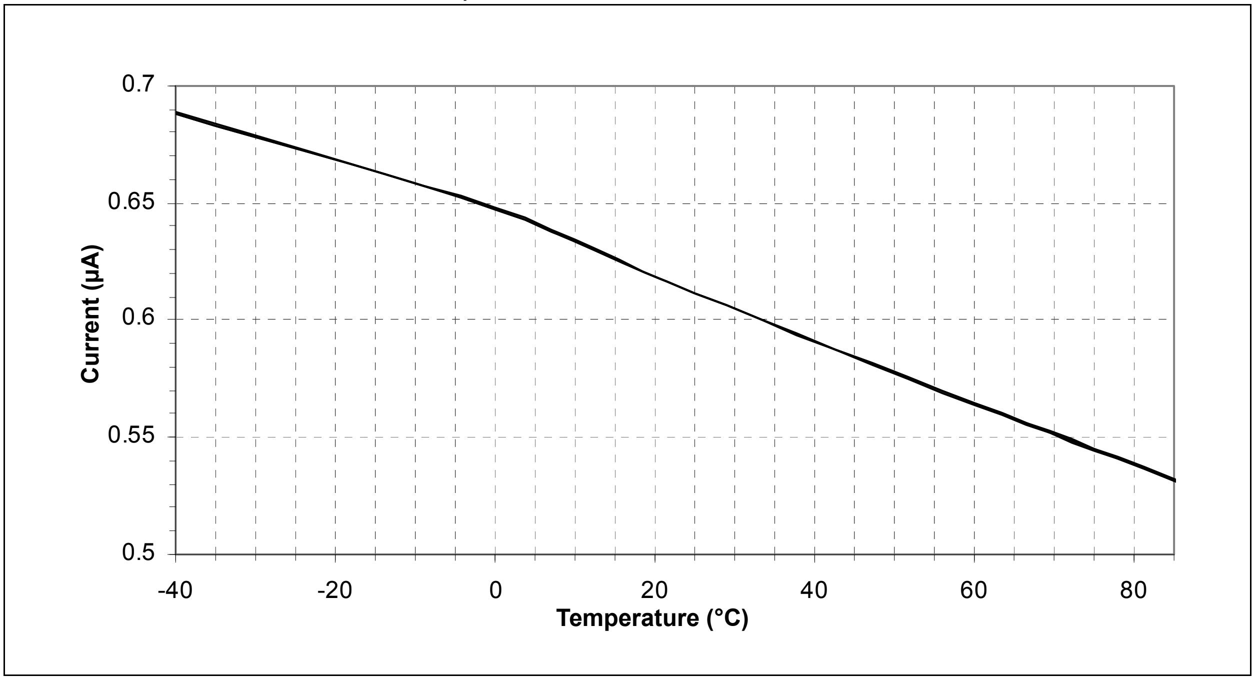
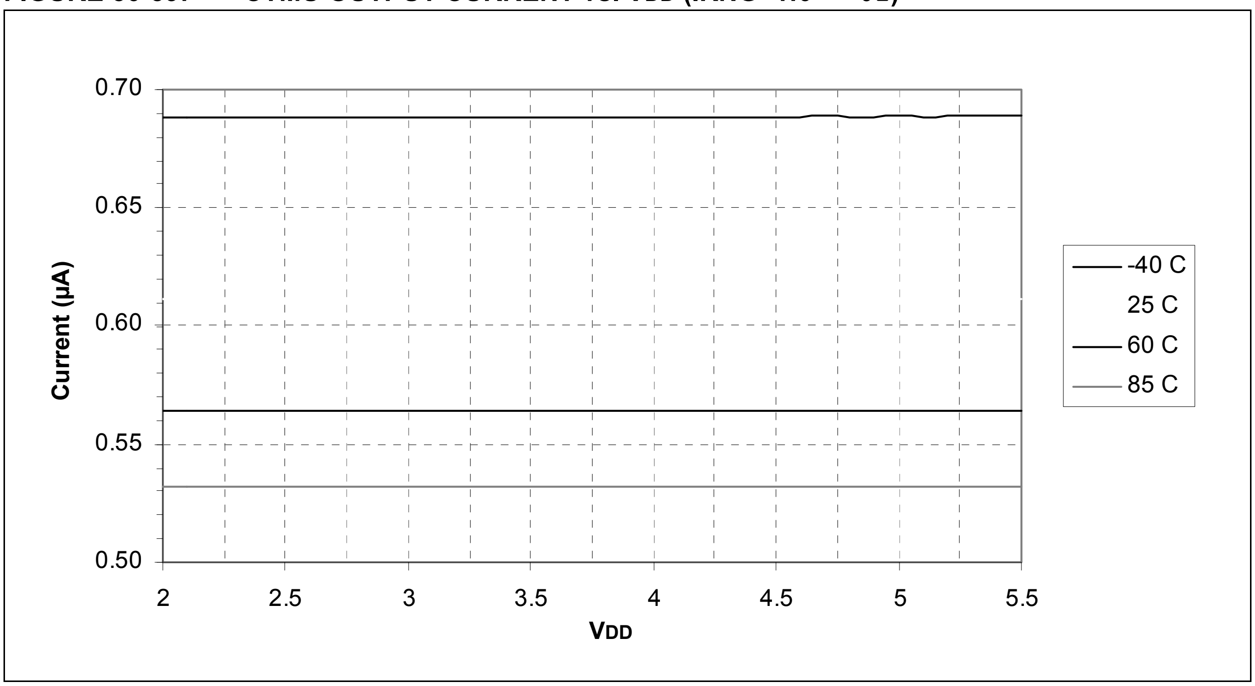


FIGURE 30-39: CTMU OUTPUT CURRENT vs. VDD (IRNG<1:0> = 01)



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