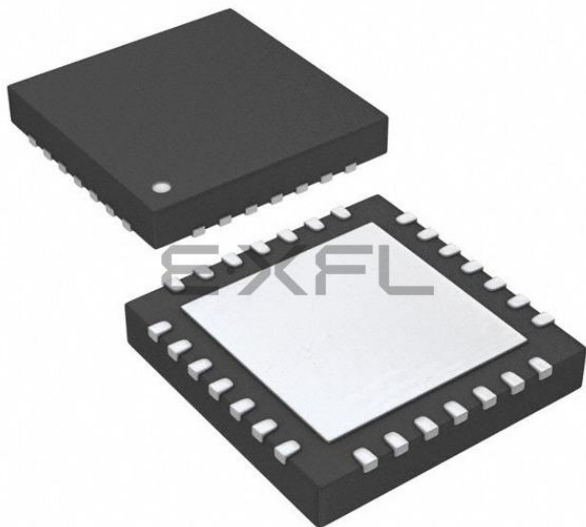




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Details

Product Status	Obsolete
Core Processor	PIC
Core Size	16-Bit
Speed	32MHz
Connectivity	I ² C, IrDA, LINbus, SPI, UART/USART
Peripherals	Brown-out Detect/Reset, LVD, POR, PWM, WDT
Number of I/O	24
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 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/pic24f16km202t-i-ml

PIC24FV16KM204 FAMILY

Pin Diagrams (Continued)

		Pin Features	
		PIC24FXXKM04	PIC24FVXXKM04
48-Pin UQFN ⁽¹⁾	RB9 1	AN21/SDA1/T1CK/U1RTS/U1BCLK/IC2/	/CLC10/CTED4/CN21/RB9
	RC6 2	U1RX/	/CN18/RC6
	RC7 3	U1TX/	/CN17/RC7
	RC8 4	OC2/CN20/RC8	
	RC9 5	IC4/OC2F/CTED7/CN19/RC9	
	RA7 6	IC1/	/CTED3/CN9/RA7
	RA6 7	/OC1A/CTED1/INT2/CN8/RA6	VDDCORE or VCAP
	n/c 8	n/c	n/c
	RB10 9	PGED2/SDI1/OC1C/CTED11/CN16/RB10	
	RB11 10	PGEC2/SCK1/OC2A/CTED9/CN15/RB11	
	RB12 11	/AN12/HLVDIN/	/CTED2/
	RB13 12	CN14/RB12	INT2/CN14/RB12
	RA10 13	/	/AN11/SDO1/OC1D/CTPLS/CN13/RB13
	RA11 14	/	/CN35/RA10
	RB14 15	/	/CTED8/CN36/RA11
	RB15 16	/CVREF/	/
	RB16 17	/AN10/	/
	VSS/AVSS 18	/C1OUT/OCFA/CTED5/INT1/	
	VDD/AVDD 19	CN12/RB14	
	MCLR/RA5 20	/	/AN9/
	n/c 21	/REFO/SS1/TCKIA/CTED6/CN11/RB15	
	RA0 22	VSS/AVSS	
	RA1 23	VDD/AVDD	
	RB0 24	MCLR/VPP/RA5	
	RB1 25	n/c	
		CVREF+/VREF+/	+/AN0/
		CN2/RA0	CTED1/CN2/RA0
		CVREF-/VREF-/	-/AN1/CN3/RA1
		AN2/CTCMP/ULPWU/C1IND/	/
		AN3/C1INC/	/
		AN4/C1INB/	/
		AN5/C1INA/	/
		AN6/CN32/RC0	
		AN7/CN31/RC1	
		AN8/CN10/RC2	
		VDD	
		VSS	
		n/c	
		OSCI/AN13/CLKI/CN30/RA2	
		OSCO/CLKO/AN14/CN29/RA3	
		OCFB/CN33/RA8	
		SOSCI/AN15/	/
		SOSCO/SCLKI/AN16/PWRLCLK/	/
		/CN34/RA9	
		/CN28/RC3	
		/CN25/RC4	
		/CN26/RC5	
		VSS	
		VDD	
		n/c	
		PGED3/AN17/ASDA1/OC1E/CLCINA/CN27/RB5	
		PGEC3/AN18/ASCL1/OC1F/CLCINB/CN24/RB6	
		AN19/INT0/CN23/RB7	AN19/
		AN20/SCL1/U1CTS/C3OUT/OC1B/CTED10/CN22/RB8	/OC1A/INT0/CN23/RB7

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.

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.

TABLE 4-9: MCCP2 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	
CCP2CON1L	164h	CCPON	—	CCPSIDL	r	TMRSYNC	CLKSEL2	CLKSEL1	CLKSEL0	TMRPS1	TMRPS0	T32	CCSEL	MOD3	MOD2	MOD1	MOD0	0000	
CCP2CON1H	166h	OPSSRC	RTRGEN	—	—	IOPS3	IOPS2	IOPS1	IOPS0	TRIGEN	ONESHOT	ALTSYNC	SYNC4	SYNC3	SYNC2	SYNC1	SYNC0	0000	
CCP2CON2L	168h	PWMRSEN	ASDGM	—	SSDG	—	—	—	—	ASDG7	ASDG6	ASDG5	ASDG4	ASDG3	ASDG2	ASDG1	ASDG0	0000	
CCP2CON2H	16Ah	OENSYNC	—	OCFEN ⁽¹⁾	OCEEN ⁽¹⁾	OCDEN ⁽¹⁾	OCCEN ⁽¹⁾	OCBEN ⁽¹⁾	OCAEN	ICGSM1	ICGSM0	—	AUXOUT1	AUXOUT0	ICSEL2	ICSEL1	ICSEL0	0100	
CCP2CON3L	16Ch	—	—	—	—	—	—	—	—	—	—	DT5	DT4	DT3	DT2	DT1	DT0	0000	
CCP2CON3H	16Eh	OETRIG	OSCNT2	OSCNT1	OSCNT0	—	OUTM2 ⁽¹⁾	OUTM1 ⁽¹⁾	OUTM0 ⁽¹⁾	—	—	POLACE	POLBDF ⁽¹⁾	PSSACE1	PSSACE0	PSSBDF1 ⁽¹⁾	PSSBDF0 ⁽¹⁾	0000	
CCP2STATL	170h	—	—	—	—	—	—	—	—	CCPTRIG	TRSET	TRCLR	ASEVT	SCEVT	ICDIS	ICOV	ICBNE	0000	
CCP2TMRL	174h	MCCP2 Time Base Register Low Word																	0000
CCP2TMRH	176h	MCCP2 Time Base Register High Word																	0000
CCP2PRL	178h	MCCP2 Time Base Period Register Low Word																	FFFF
CCP2PRH	17Ah	MCCP2 Time Base Period Register High Word																	FFFF
CCP2RAL	17Ch	Output Compare 2 Data Word A																	0000
CCP2RBL	180h	Output Compare 2 Data Word B																	0000
CCP2BUFL	184h	Input Capture 2 Data Buffer Low Word																	0000
CCP2BUFH	186h	Input Capture 2 Data Buffer High Word																	0000

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

Note 1: These bits are available only on PIC24F(V)16KM2XX devices.

PIC24FV16KM204 FAMILY

REGISTER 8-13: IEC1: INTERRUPT ENABLE CONTROL REGISTER 1

R/W-0	R/W-0	R/W-0	R/W-0	R/W-0	U-0	U-0	U-0
U2TXIE	U2RXIE	INT2IE	CCT4IE	CCT3IE	—	—	—
bit 15						bit 8	

U-0	R/W-0	U-0	R/W-0	R/W-0	R/W-0	R/W-0	R/W-0
—	CCP5IE	—	INT1IE	CNIE	CMIE	BCL1IE	SSP1IE
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 **U2TXIE:** UART2 Transmitter Interrupt Enable bit
 1 = Interrupt request is enabled
 0 = Interrupt request is not enabled
- bit 14 **U2RXIE:** UART2 Receiver Interrupt Enable bit
 1 = Interrupt request is enabled
 0 = Interrupt request is not enabled
- bit 13 **INT2IE:** External Interrupt 2 Enable bit
 1 = Interrupt request is enabled
 0 = Interrupt request is not enabled
- bit 12 **CCT4IE:** Capture/Compare 4 Timer Interrupt Enable bit
 1 = Interrupt request is enabled
 0 = Interrupt request is not enabled
- bit 11 **CCT3IE:** Capture/Compare 3 Timer Interrupt Enable bit
 1 = Interrupt request is enabled
 0 = Interrupt request is not enabled
- bit 10-7 **Unimplemented:** Read as '0'
- bit 6 **CCP5IE:** Capture/Compare 5 Event Interrupt Enable bit
 1 = Interrupt request is enabled
 0 = Interrupt request is not enabled
- bit 5 **Unimplemented:** Read as '0'
- bit 4 **INT1IE:** External Interrupt 1 Enable bit
 1 = Interrupt request is enabled
 0 = Interrupt request is not enabled
- bit 3 **CNIE:** Input Change Notification Interrupt Enable bit
 1 = Interrupt request is enabled
 0 = Interrupt request is not enabled
- bit 2 **CMIE:** Comparator Interrupt Enable bit
 1 = Interrupt request is enabled
 0 = Interrupt request is not enabled
- bit 1 **BCL1IE:** MSSP1 I²C™ Bus Collision Interrupt Enable bit
 1 = Interrupt request is enabled
 0 = Interrupt request is not enabled
- bit 0 **SSP1IE:** MSSP1 SPI/I²C Event Interrupt Enable bit
 1 = Interrupt request is enabled
 0 = Interrupt request is not enabled

PIC24FV16KM204 FAMILY

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.

PIC24FV16KM204 FAMILY

11.2.2 I/O PORT WRITE/READ TIMING

One instruction cycle is required between a port direction change or port write operation, and a read operation of the same port. Typically, this instruction would be a NOP.

11.3 Input Change Notification (ICN)

The Input Change Notification function of the I/O ports allows the PIC24FXXXXX family of devices to generate interrupt requests to the processor in response to a Change-of-State (COS) on selected input pins. This feature is capable of detecting input Change-of-States, even in Sleep mode, when the clocks are disabled. Depending on the device pin count, there are up to 37 external signals (CN0 through CN36) that may be selected (enabled) for generating an interrupt request on a Change-of-State.

There are six control registers associated with the CN module. The CNEN1 and CNEN3 registers contain the interrupt enable control bits for each of the CNx input pins. Setting any of these bits enables a CN interrupt for the corresponding pins.

Each CNx pin also has a weak pull-up/pull-down connected to it. The pull-ups act as a current source that is connected to the pin. The pull-downs act as a current sink to eliminate the need for external resistors when push button or keypad devices are connected.

On any pin, only the pull-up resistor or the pull-down resistor should be enabled, but not both of them. If the push button or the keypad is connected to VDD, enable the pull-down, or if they are connected to VSS, enable the pull-up resistors. The pull-ups are enabled separately using the CNPU1 and CNPU3 registers, which contain the control bits for each of the CNx pins.

Setting any of the control bits enables the weak pull-ups for the corresponding pins. The pull-downs are enabled separately using the CNPD1 and CNPD3 registers, which contain the control bits for each of the CNx pins. Setting any of the control bits enables the weak pull-downs for the corresponding pins.

When the internal pull-up is selected, the pin uses VDD as the pull-up source voltage. When the internal pull-down is selected, the pins are pulled down to VSS by an internal resistor. Make sure that there is no external pull-up source/pull-down sink when the internal pull-ups/pull-downs are enabled.

Note: Pull-ups and pull-downs on Change Notification (CN) pins should always be disabled whenever the port pin is configured as a digital output.

EXAMPLE 11-1: PORT WRITE/READ EXAMPLE

```
MOV    0xFF00, W0;           //Configure PORTB<15:8> as inputs and PORTB<7:0> as outputs
MOV    W0, TRISB;
NOP;                          //Delay 1 cycle
BTSS   PORTB, #13;           //Next Instruction

Equivalent 'C' Code
TRISB = 0xFF00;              //Configure PORTB<15:8> as inputs and PORTB<7:0> as outputs
NOP();                       //Delay 1 cycle
if(PORTBbits.RB13 == 1)     // execute following code if PORTB pin 13 is set.
{
}
```

PIC24FV16KM204 FAMILY

13.4 Input Capture Mode

Input Capture mode is used to capture a timer value from an independent timer base upon an event on an input pin or other internal Trigger source. The input capture features are useful in applications requiring frequency (time period) and pulse measurement. Figure 13-6 depicts a simplified block diagram of Input Capture mode.

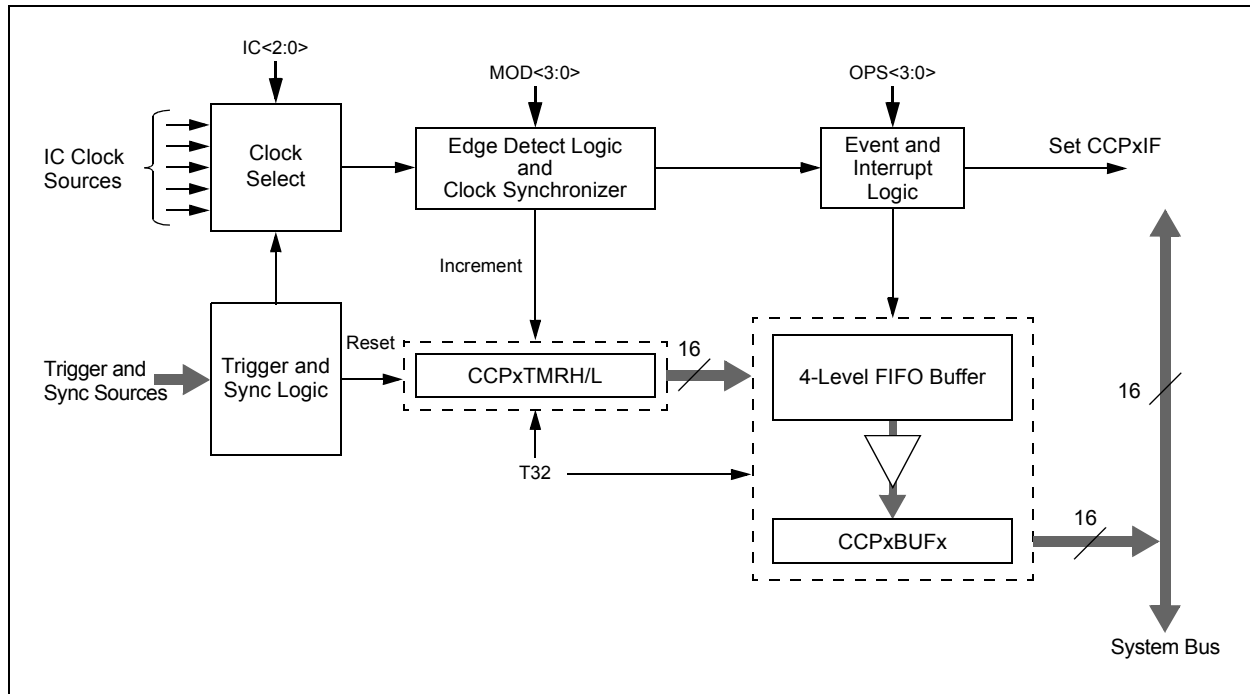
Input Capture mode uses a dedicated 16/32-bit, synchronous, up counting timer for the capture function. The timer value is written to the FIFO when a capture event occurs. The internal value may be read (with a synchronization delay) using the CCPxTMRH/L register.

To use Input Capture mode, the CCSEL bit (CCPxCON1L<4>) must be set. The T32 and the MOD<3:0> bits are used to select the proper Capture mode, as shown in Table 13-4.

TABLE 13-4: INPUT CAPTURE MODES

MOD<3:0> (CCPxCON1L<3:0>)	T32 (CCPxCON1L<5>)	Operating Mode
0000	0	Edge Detect (16-bit capture)
0000	1	Edge Detect (32-bit capture)
0001	0	Every Rising (16-bit capture)
0001	1	Every Rising (32-bit capture)
0010	0	Every Falling (16-bit capture)
0010	1	Every Falling (32-bit capture)
0011	0	Every Rise/Fall (16-bit capture)
0011	1	Every Rise/Fall (32-bit capture)
0100	0	Every 4th Rising (16-bit capture)
0100	1	Every 4th Rising (32-bit capture)
0101	0	Every 16th Rising (16-bit capture)
0101	1	Every 16th Rising (32-bit capture)

FIGURE 13-6: INPUT CAPTURE x BLOCK DIAGRAM



PIC24FV16KM204 FAMILY

REGISTER 14-10: PADCFG1: PAD CONFIGURATION CONTROL REGISTER

U-0	U-0	U-0	U-0	R/W-0	R/W-0	R/W-0	R/W-0
—	—	—	—	SDO2DIS ⁽¹⁾	SCK2DIS ⁽¹⁾	SDO1DIS	SCK1DIS
bit 15				bit 8			

U-0	U-0	U-0	U-0	U-0	U-0	U-0	U-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 15-12 **Unimplemented:** Read as '0'

bit 11 **SDO2DIS:** MSSP2 SDO2 Pin Disable bit⁽¹⁾

1 = The SPI output data (SDO2) of MSSP2 to the pin is disabled

0 = The SPI output data (SDO2) of MSSP2 is output to the pin

bit 10 **SCK2DIS:** MSSP2 SCK2 Pin Disable bit⁽¹⁾

1 = The SPI clock (SCK2) of MSSP2 to the pin is disabled

0 = The SPI clock (SCK2) of MSSP2 is output to the pin

bit 9 **SDO1DIS:** MSSP1 SDO1 Pin Disable bit

1 = The SPI output data (SDO1) of MSSP1 to the pin is disabled

0 = The SPI output data (SDO1) of MSSP1 is output to the pin

bit 8 **SCK1DIS:** MSSP1 SCK1 Pin Disable bit

1 = The SPI clock (SCK1) of MSSP1 to the pin is disabled

0 = The SPI clock (SCK1) of MSSP1 is output to the pin

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

Note 1: These bits are implemented only on PIC24FXXKM20X devices.

15.2 Transmitting in 8-Bit Data Mode

1. Set up the UARTx:
 - a) Write the appropriate values for data, parity and Stop bits.
 - b) Write the appropriate baud rate value to the UxBRG register.
 - c) Set up transmit and receive interrupt enable and priority bits.
2. Enable the UARTx.
3. Set the UTXEN bit (causes a transmit interrupt, two cycles after being set).
4. Write the data byte to the lower byte of the UxTXREG word. The value will be immediately transferred to the Transmit Shift Register (TSR) and the serial bit stream will start shifting out with the next rising edge of the baud clock.
5. Alternately, the data byte may be transferred while UTXEN = 0, and then, the user may set UTXEN. This will cause the serial bit stream to begin immediately, because the baud clock will start from a cleared state.
6. A transmit interrupt will be generated as per interrupt control bit, UTXISELx.

15.3 Transmitting in 9-Bit Data Mode

1. Set up the UARTx (as described in **Section 15.2 “Transmitting in 8-Bit Data Mode”**).
2. Enable the UARTx.
3. Set the UTXEN bit (causes a transmit interrupt, two cycles after being set).
4. Write UxTXREG as a 16-bit value only.
5. A word write to UxTXREG triggers the transfer of the 9-bit data to the TSR. The serial bit stream will start shifting out with the first rising edge of the baud clock.
6. A transmit interrupt will be generated as per the setting of control bit, UTXISELx.

15.4 Break and Sync Transmit Sequence

The following sequence will send a message frame header, made up of a Break, followed by an Auto-Baud Sync byte.

1. Configure the UARTx for the desired mode.
2. Set UTXEN and UTXBRK – this sets up the Break character.
3. Load the UxTXREG with a dummy character to initiate transmission (value is ignored).
4. Write '55h' to UxTXREG – loads the Sync character into the transmit FIFO.
5. After the Break has been sent, the UTXBRK bit is reset by hardware. The Sync character now transmits.

15.5 Receiving in 8-Bit or 9-Bit Data Mode

1. Set up the UARTx (as described in **Section 15.2 “Transmitting in 8-Bit Data Mode”**).
2. Enable the UARTx.
3. A receive interrupt will be generated when one or more data characters have been received, as per interrupt control bit, URXISELx.
4. Read the OERR bit to determine if an overrun error has occurred. The OERR bit must be reset in software.
5. Read UxRXREG.

The act of reading the UxRXREG character will move the next character to the top of the receive FIFO, including a new set of PERR and FERR values.

15.6 Operation of $\overline{\text{UxCTS}}$ and $\overline{\text{UxRTS}}$ Control Pins

UARTx Clear-To-Send ($\overline{\text{UxCTS}}$) and Request-To-Send ($\overline{\text{UxRTS}}$) are the two hardware controlled pins that are associated with the UARTx module. These two pins allow the UARTx to operate in Simplex and Flow Control modes. They are implemented to control the transmission and reception between the Data Terminal Equipment (DTE). The UEN<1:0> bits in the UxMODE register configure these pins.

15.7 Infrared Support

The UARTx module provides two types of infrared UARTx support: one is the IrDA clock output to support an external IrDA encoder and decoder device (legacy module support), and the other is the full implementation of the IrDA encoder and decoder.

As the IrDA modes require a 16x baud clock, they will only work when the BRGH bit (UxMODE<3>) is '0'.

15.7.1 EXTERNAL IrDA SUPPORT – IrDA CLOCK OUTPUT

To support external IrDA encoder and decoder devices, the UxBCLK pin (same as the $\overline{\text{UxRTS}}$ pin) can be configured to generate the 16x baud clock. When UEN<1:0> = 11, the UxBCLK pin will output the 16x baud clock if the UARTx module is enabled; it can be used to support the IrDA codec chip.

15.7.2 BUILT-IN IrDA ENCODER AND DECODER

The UARTx has full implementation of the IrDA encoder and decoder as part of the UARTx module. The built-in IrDA encoder and decoder functionality is enabled using the IREN bit (UxMODE<12>). When enabled (IREN = 1), the receive pin (UxRX) acts as the input from the infrared receiver. The transmit pin (UxTX) acts as the output to the infrared transmitter.

PIC24FV16KM204 FAMILY

REGISTER 20-2: BUFCON0: INTERNAL VOLTAGE REFERENCE CONTROL REGISTER 0

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-1
—	—	—	—	—	—	BUFREF1	BUFREF0
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 **BUFREF<1:0>:** Internal Voltage Reference Select bits

11 = Reference output is set at 4 * BGBUF1⁽¹⁾

10 = Reference output is set at 2 * BGBUF1⁽²⁾

01 = Reference output is set at BGBUF1

00 = Reserved, do not use

Note 1: Available only on PIC24FV16KMXXX devices. The reference may not be within specifications for V_{DD} below specified levels; see Table 27-15 for minimum V_{DD} limits.

2: The reference may not be within specifications for V_{DD} below specified levels; see Table 27-15 for minimum V_{DD} limits.

PIC24FV16KM204 FAMILY

REGISTER 21-1: AMPxCON: OP AMP x CONTROL REGISTER⁽¹⁾

R/W-0	U-0	R/W-0	R/W-0	U-0	U-0	U-0	U-0
AMPEN	—	AMPSIDL	AMPSLP	—	—	—	—
bit 15							bit 8

R/W-0	U-0	R/W-0	R/W-0	R/W-0	R/W-0	R/W-0	R/W-0
SPDSEL	—	NINSEL2	NINSEL1	NINSEL0	PINSEL2	PINSEL1	PINSEL0
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 **AMPEN:** Op Amp x Control Module Enable bit
 1 = Module is enabled
 0 = Module is disabled
- bit 14 **Unimplemented:** Read as '0'
- bit 13 **AMPSIDL:** Op Amp x Peripheral Stop in Idle Mode bit
 1 = Discontinues module operation when device enters Idle mode
 0 = Continues module operation in Idle mode
- bit 12 **AMPSLP:** Op Amp x Peripheral Enabled in Sleep Mode bit
 1 = Continues module operation when device enters Sleep mode
 0 = Discontinues module operation in Sleep mode
- bit 11-8 **Unimplemented:** Read as '0'
- bit 7 **SPDSEL:** Op Amp x Power/Speed Select bit
 1 = Higher power and bandwidth (faster response time)
 0 = Lower power and bandwidth (slower response time)
- bit 6 **Unimplemented:** Read as '0'
- bit 5-3 **NINSEL<2:0>:** Negative Op Amp Input Select bits
 111 = Reserved; do not use
 110 = Reserved; do not use
 101 = Op amp negative input is connected to the op amp output (voltage follower)
 100 = Reserved; do not use
 011 = Reserved; do not use
 010 = Op amp negative input is connected to the OAxIND pin
 001 = Op amp negative input is connected to the OAxINB pin
 000 = Op amp negative input is connected to AVss
- bit 2-0 **PINSEL<2:0>:** Positive Op Amp Input Select bits
 111 = Op amp positive input is connected to the output of the A/D input multiplexer
 110 = Reserved; do not use
 101 = Op amp positive input is connected to the DAC1 output for OA1 (DAC2 output for OA2)
 100 = Reserved; do not use
 011 = Reserved; do not use
 010 = Op amp positive input is connected to the OAxINC pin
 001 = Op amp positive input is connected to the OAxINA pin
 000 = Op amp positive input is connected to AVss

Note 1: This register is available only on PIC24F(V)16KM2XX devices.

PIC24FV16KM204 FAMILY

REGISTER 25-8: DEVID: DEVICE ID REGISTER

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

R	R	R	R	R	R	R	R
FAMID7	FAMID6	FAMID5	FAMID4	FAMID3	FAMID2	FAMID1	FAMID0
bit 15							bit 8

R	R	R	R	R	R	R	R
DEV7	DEV6	DEV5	DEV4	DEV3	DEV2	DEV1	DEV0
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 23-16 **Unimplemented:** Read as '0'

bit 15-8 **FAMID<7:0>:** Device Family Identifier bits
01000101 = PIC24FV16KM204 family

bit 7-0 **DEV<7:0>:** Individual Device Identifier bits

00011111 = PIC24FV16KM204

00011011 = PIC24FV16KM202

00010111 = PIC24FV08KM204

00010011 = PIC24FV08KM202

00001111 = PIC24FV16KM104

00001011 = PIC24FV16KM102

00000011 = PIC24FV08KM102

00000001 = PIC24FV08KM101

00011110 = PIC24F16KM204

00011010 = PIC24F16KM202

00010110 = PIC24F08KM204

00010010 = PIC24F08KM202

00001110 = PIC24F16KM104

00001010 = PIC24F16KM102

00000010 = PIC24F08KM102

00000000 = PIC24F08KM101

26.6 MPLAB X SIM Software Simulator

The MPLAB X SIM Software Simulator allows code development in a PC-hosted environment by simulating the PIC MCUs and dsPIC DSCs on an instruction level. On any given instruction, the data areas can be examined or modified and stimuli can be applied from a comprehensive stimulus controller. Registers can be logged to files for further run-time analysis. The trace buffer and logic analyzer display extend the power of the simulator to record and track program execution, actions on I/O, most peripherals and internal registers.

The MPLAB X SIM Software Simulator fully supports symbolic debugging using the MPLAB XC Compilers, and the MPASM and MPLAB Assemblers. The software simulator offers the flexibility to develop and debug code outside of the hardware laboratory environment, making it an excellent, economical software development tool.

26.7 MPLAB REAL ICE In-Circuit Emulator System

The MPLAB REAL ICE In-Circuit Emulator System is Microchip's next generation high-speed emulator for Microchip Flash DSC and MCU devices. It debugs and programs all 8, 16 and 32-bit MCU, and DSC devices with the easy-to-use, powerful graphical user interface of the MPLAB X IDE.

The emulator is connected to the design engineer's PC using a high-speed USB 2.0 interface and is connected to the target with either a connector compatible with in-circuit debugger systems (RJ-11) or with the new high-speed, noise tolerant, Low-Voltage Differential Signal (LVDS) interconnection (CAT5).

The emulator is field upgradable through future firmware downloads in MPLAB X IDE. MPLAB REAL ICE offers significant advantages over competitive emulators including full-speed emulation, run-time variable watches, trace analysis, complex breakpoints, logic probes, a ruggedized probe interface and long (up to three meters) interconnection cables.

26.8 MPLAB ICD 3 In-Circuit Debugger System

The MPLAB ICD 3 In-Circuit Debugger System is Microchip's most cost-effective, high-speed hardware debugger/programmer for Microchip Flash DSC and MCU devices. It debugs and programs PIC Flash microcontrollers and dsPIC DSCs with the powerful, yet easy-to-use graphical user interface of the MPLAB IDE.

The MPLAB ICD 3 In-Circuit Debugger probe is connected to the design engineer's PC using a high-speed USB 2.0 interface and is connected to the target with a connector compatible with the MPLAB ICD 2 or MPLAB REAL ICE systems (RJ-11). MPLAB ICD 3 supports all MPLAB ICD 2 headers.

26.9 PICkit 3 In-Circuit Debugger/Programmer

The MPLAB PICkit 3 allows debugging and programming of PIC and dsPIC Flash microcontrollers at a most affordable price point using the powerful graphical user interface of the MPLAB IDE. The MPLAB PICkit 3 is connected to the design engineer's PC using a full-speed USB interface and can be connected to the target via a Microchip debug (RJ-11) connector (compatible with MPLAB ICD 3 and MPLAB REAL ICE). The connector uses two device I/O pins and the Reset line to implement in-circuit debugging and In-Circuit Serial Programming™ (ICSP™).

26.10 MPLAB PM3 Device Programmer

The MPLAB PM3 Device Programmer is a universal, CE compliant device programmer with programmable voltage verification at VDDMIN and VDDMAX for maximum reliability. It features a large LCD display (128 x 64) for menus and error messages, and a modular, detachable socket assembly to support various package types. The ICSP cable assembly is included as a standard item. In Stand-Alone mode, the MPLAB PM3 Device Programmer can read, verify and program PIC devices without a PC connection. It can also set code protection in this mode. The MPLAB PM3 connects to the host PC via an RS-232 or USB cable. The MPLAB PM3 has high-speed communications and optimized algorithms for quick programming of large memory devices, and incorporates an MMC card for file storage and data applications.

PIC24FV16KM204 FAMILY

TABLE 27-4: HIGH/LOW-VOLTAGE DETECT CHARACTERISTICS

Standard Operating Conditions: 1.8V to 3.6V (PIC24F16KM204) 2.0V to 5.5V (PIC24FV16KM204)								
Operating temperature			-40°C ≤ TA ≤ +85°C for Industrial -40°C ≤ TA ≤ +125°C for Extended					
Param No.	Symbol	Characteristic		Min	Typ	Max	Units	Conditions
DC18	VHLVD	HLVD Voltage on VDD Transition	HLVDL<3:0> = 0000 ⁽²⁾	—	—	1.90	V	
			HLVDL<3:0> = 0001	1.88	—	2.13	V	
			HLVDL<3:0> = 0010	2.09	—	2.35	V	
			HLVDL<3:0> = 0011	2.25	—	2.53	V	
			HLVDL<3:0> = 0100	2.35	—	2.62	V	
			HLVDL<3:0> = 0101	2.55	—	2.84	V	
			HLVDL<3:0> = 0110	2.80	—	3.10	V	
			HLVDL<3:0> = 0111	2.95	—	3.25	V	
			HLVDL<3:0> = 1000	3.09	—	3.41	V	
			HLVDL<3:0> = 1001	3.27	—	3.59	V	
			HLVDL<3:0> = 1010 ⁽¹⁾	3.46	—	3.79	V	
			HLVDL<3:0> = 1011 ⁽¹⁾	3.62	—	4.01	V	
			HLVDL<3:0> = 1100 ⁽¹⁾	3.91	—	4.26	V	
			HLVDL<3:0> = 1101 ⁽¹⁾	4.18	—	4.55	V	
			HLVDL<3:0> = 1110 ⁽¹⁾	4.49	—	4.87	V	

Note 1: These trip points should not be used on PIC24FXXKMXXX devices.

Note 2: This trip point should not be used on PIC24FVXXKMXXX devices.

TABLE 27-5: BOR TRIP POINTS

Standard Operating Conditions: 1.8V to 3.6V (PIC24F16KM204) 2.0V to 5.5V (PIC24FV16KM204)								
Operating temperature			-40°C ≤ TA ≤ +85°C for Industrial -40°C ≤ TA ≤ +125°C for Extended					
Param No.	Sym	Characteristic		Min	Typ	Max	Units	Conditions
DC15		BOR Hysteresis		—	5	—	mV	
DC19		BOR Voltage on VDD Transition	BORV<1:0> = 00	—	—	—	—	Valid for LPBOR (Note 1)
			BORV<1:0> = 01	2.90	3	3.38	V	
			BORV<1:0> = 10	2.53	2.7	3.07	V	
			BORV<1:0> = 11	1.75	1.85	2.05	V	(Note 2)
			BORV<1:0> = 11	1.95	2.05	2.16	V	(Note 3)

Note 1: LPBOR re-arms the POR circuit but does not cause a BOR.

Note 2: This is valid for PIC24F (3.3V) devices.

Note 3: This is valid for PIC24FV (5V) devices.

PIC24FV16KM204 FAMILY

FIGURE 27-9: BROWN-OUT RESET CHARACTERISTICS

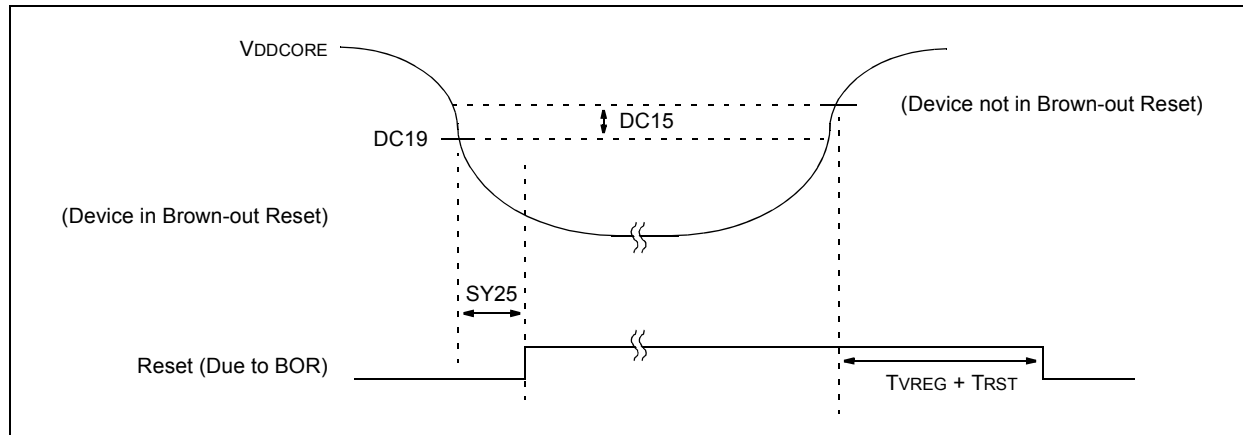


TABLE 27-25: RESET, WATCHDOG TIMER, OSCILLATOR START-UP TIMER, POWER-UP TIMER AND BROWN-OUT RESET TIMING REQUIREMENTS

AC CHARACTERISTICS			Standard Operating Conditions: 1.8V to 3.6V (PIC24F16KM204) 2.0V to 5.5V (PIC24FV16KM204) 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
SY10	TmCL	MCLR Pulse Width (low)	2	—	—	μs	
SY11	TPWRT	Power-up Timer Period	50	64	90	ms	
SY12	TPOR	Power-on Reset Delay	1	5	10	μs	
SY13	TIOZ	I/O High-Impedance from MCLR Low or Watchdog Timer Reset	—	—	100	ns	
SY20	TWDT	Watchdog Timer Time-out Period	0.85	1.0	1.15	ms	1.32 prescaler
			3.4	4.0	4.6	ms	1:128 prescaler
SY25	TBOR	Brown-out Reset Pulse Width	1	—	—	μs	
SY35	TFSCM	Fail-Safe Clock Monitor Delay	—	2.0	2.3	μs	
SY45	TRST	Internal State Reset Time	—	5	—	μs	
SY50	TVREG	On-Chip Voltage Regulator Output Delay	—	10	—	μs	(Note 2)
SY55	TLOCK	PLL Start-up Time	—	100	—	μs	
SY65	TOST	Oscillator Start-up Time	—	1024	—	TOSC	
SY71	TPM	Program Memory Wake-up Time	—	1	—	μs	Sleep wake-up with PMSLP = 0
SY72	TLVR	Low-Voltage Regulator Wake-up Time	—	250	—	μs	

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

2: This applies to PIC24FV16KMXXX devices only.

PIC24FV16KM204 FAMILY

TABLE 27-37: A/D MODULE SPECIFICATIONS

AC CHARACTERISTICS			Standard Operating Conditions: 1.8V to 3.6V (PIC24F16KM204) 2.0V to 5.5V (PIC24FV16KM204) Operating temperature -40°C ≤ T _A ≤ +85°C for Industrial -40°C ≤ T _A ≤ +125°C for Extended				
Param No.	Symbol	Characteristic	Min.	Typ	Max.	Units	Conditions
Device Supply							
AD01	AVDD	Module VDD Supply	Greater of: VDD – 0.3 or 1.8	—	Lesser of: VDD + 0.3 or 3.6	V	PIC24FXXKMXXX devices
			Greater of: VDD – 0.3 or 2.0	—	Lesser of: VDD + 0.3 or 5.5	V	PIC24FVXXKMXXX devices
AD02	AVSS	Module Vss Supply	VSS – 0.3	—	VSS + 0.3	V	
Reference Inputs							
AD05	VREFH	Reference Voltage High	AVSS + 1.7	—	AVDD	V	
AD06	VREFL	Reference Voltage Low	AVSS	—	AVDD – 1.7	V	
AD07	VREF	Absolute Reference Voltage	AVSS – 0.3	—	AVDD + 0.3	V	
AD08	IVREF	Reference Voltage Input Current	—	1.25	—	mA	
AD09	ZVREF	Reference Input Impedance	—	10k	—	Ω	
Analog Input							
AD10	VINH-VINL	Full-Scale Input Span	VREFL	—	VREFH	V	(Note 2)
AD11	VIN	Absolute Input Voltage	AVSS – 0.3	—	AVDD + 0.3	V	
AD12	VINL	Absolute VINL Input Voltage	AVSS – 0.3	—	AVDD/2	V	
AD17	RIN	Recommended Impedance of Analog Voltage Source	—	—	1k	Ω	12-bit
A/D Accuracy							
AD20b	NR	Resolution	—	12	—	bits	
AD21b	INL	Integral Nonlinearity	—	±1	±9	LSb	VINL = AVSS = VREFL = 0V, AVDD = VREFH = 5V
AD22b	DNL	Differential Nonlinearity	—	±1	±5	LSb	VINL = AVSS = VREFL = 0V, AVDD = VREFH = 5V
AD23b	GERR	Gain Error	—	±1	±9	LSb	VINL = AVSS = VREFL = 0V, AVDD = VREFH = 5V
AD24b	E _{OFF}	Offset Error	—	±1	±5	LSb	VINL = AVSS = VREFL = 0V, AVDD = VREFH = 5V
AD25b		Monotonicity ⁽¹⁾	—	—	—	—	Guaranteed

Note 1: The A/D conversion result never decreases with an increase in the input voltage.

2: Measurements are taken with external VREF+ and VREF- used as the A/D voltage reference.

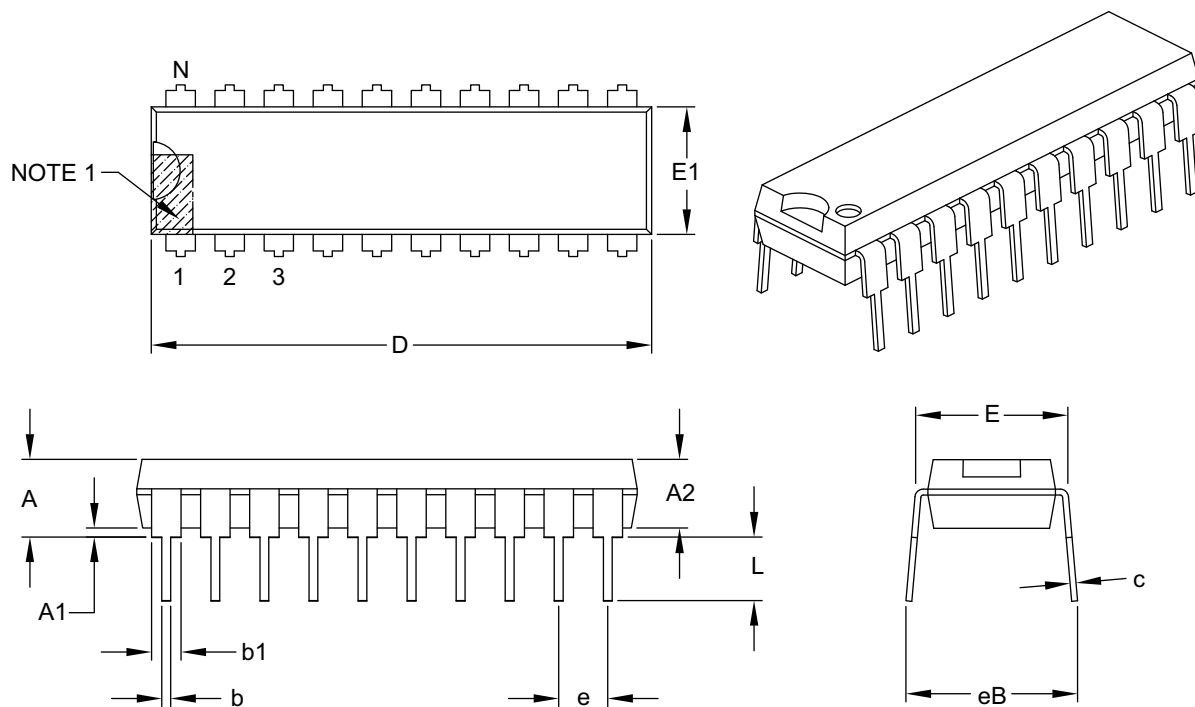
PIC24FV16KM204 FAMILY

28.2 Package Details

The following sections give the technical details of the packages.

20-Lead Plastic Dual In-Line (P) – 300 mil Body [PDIP]

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



Units		INCHES		
Dimension Limits		MIN	NOM	MAX
Number of Pins	N	20		
Pitch	e	.100 BSC		
Top to Seating Plane	A	–	–	.210
Molded Package Thickness	A2	.115	.130	.195
Base to Seating Plane	A1	.015	–	–
Shoulder to Shoulder Width	E	.300	.310	.325
Molded Package Width	E1	.240	.250	.280
Overall Length	D	.980	1.030	1.060
Tip to Seating Plane	L	.115	.130	.150
Lead Thickness	c	.008	.010	.015
Upper Lead Width	b1	.045	.060	.070
Lower Lead Width	b	.014	.018	.022
Overall Row Spacing §	eB	–	–	.430

Notes:

- Pin 1 visual index feature may vary, but must be located within the hatched area.
- § Significant Characteristic.
- Dimensions D and E1 do not include mold flash or protrusions. Mold flash or protrusions shall not exceed .010" per side.
- Dimensioning and tolerancing per ASME Y14.5M.

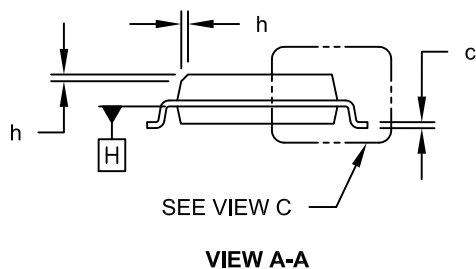
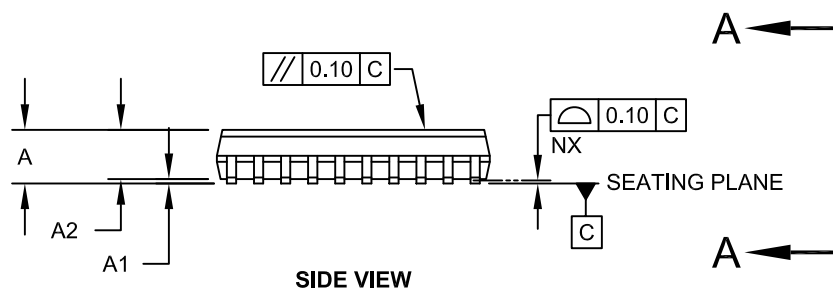
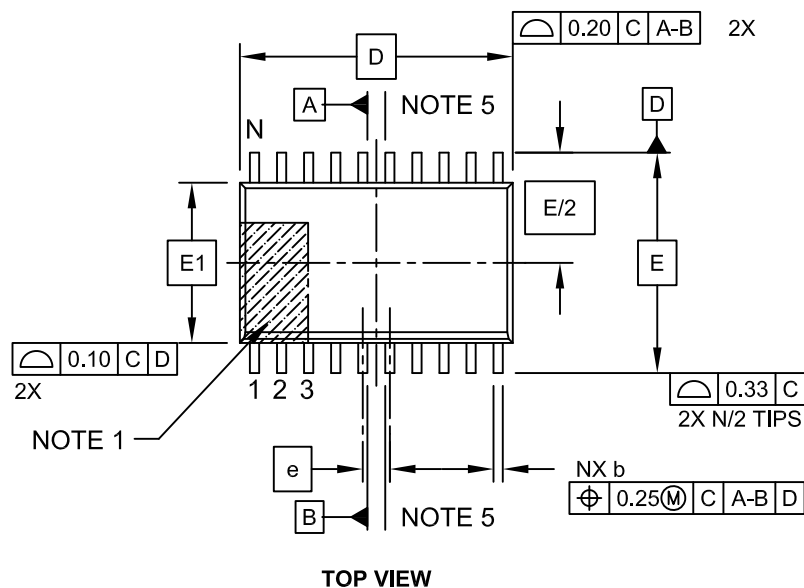
BSC: Basic Dimension. Theoretically exact value shown without tolerances.

Microchip Technology Drawing C04-019B

PIC24FV16KM204 FAMILY

20-Lead Plastic Small Outline (SO) - Wide, 7.50 mm Body [SOIC]

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

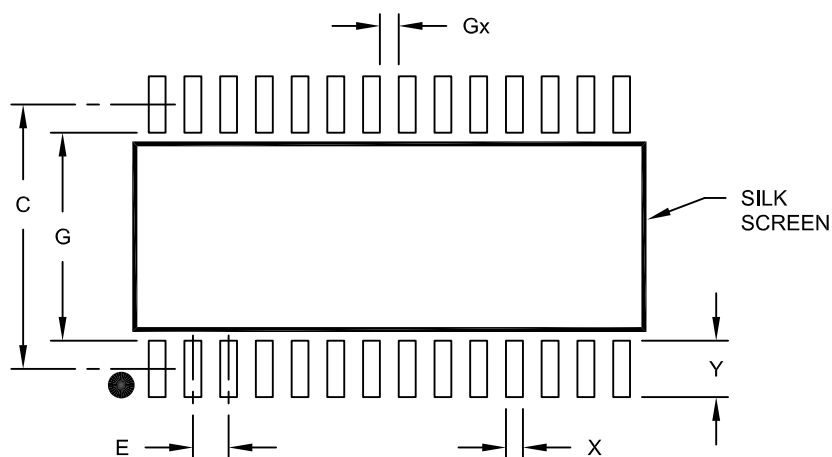


Microchip Technology Drawing C04-094C Sheet 1 of 2

PIC24FV16KM204 FAMILY

28-Lead Plastic Small Outline (SO) - Wide, 7.50 mm Body [SOIC]

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



RECOMMENDED LAND PATTERN

Dimension Limits	Units	MILLIMETERS		
		MIN	NOM	MAX
Contact Pitch	E		1.27 BSC	
Contact Pad Spacing	C		9.40	
Contact Pad Width (X28)	X			0.60
Contact Pad Length (X28)	Y			2.00
Distance Between Pads	Gx	0.67		
Distance Between Pads	G	7.40		

Notes:

1. Dimensioning and tolerancing per ASME Y14.5M

BSC: Basic Dimension. Theoretically exact value shown without tolerances.

Microchip Technology Drawing No. C04-2052A

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