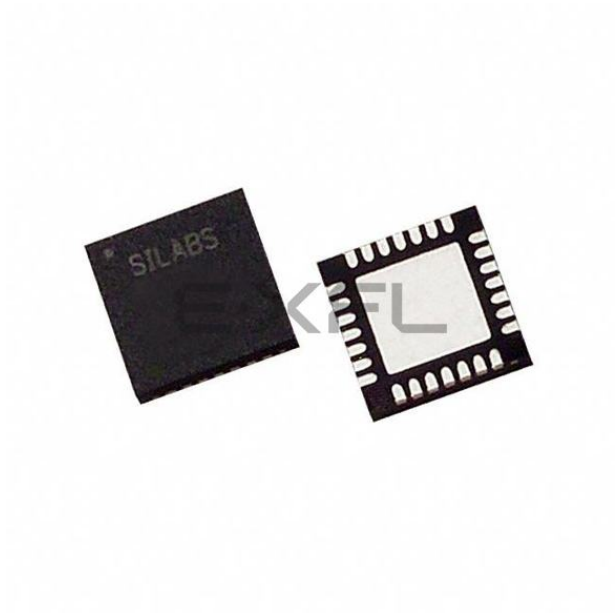

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Applications of "Embedded - Microcontrollers"

Details	
Product Status	Obsolete
Core Processor	8051
Core Size	8-Bit
Speed	48 MIPS
Connectivity	I²C, SPI, UART/USART, USB
Peripherals	POR, PWM, WDT
Number of I/O	21
Program Memory Size	16KB (16K x 8)
Program Memory Type	OTP
EEPROM Size	-
RAM Size	1.25K x 8
Voltage - Supply (Vcc/Vdd)	1.8V ~ 5.25V
Data Converters	-
Oscillator Type	Internal
Operating Temperature	-40°C ~ 85°C (TA)
Mounting Type	Surface Mount
Package / Case	28-VFQFN Exposed Pad
Supplier Device Package	28-QFN (5x5)
Purchase URL	https://www.e-xfl.com/product-detail/silicon-labs/c8051t323-gmr

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4. LQFP-32 Package Specifications

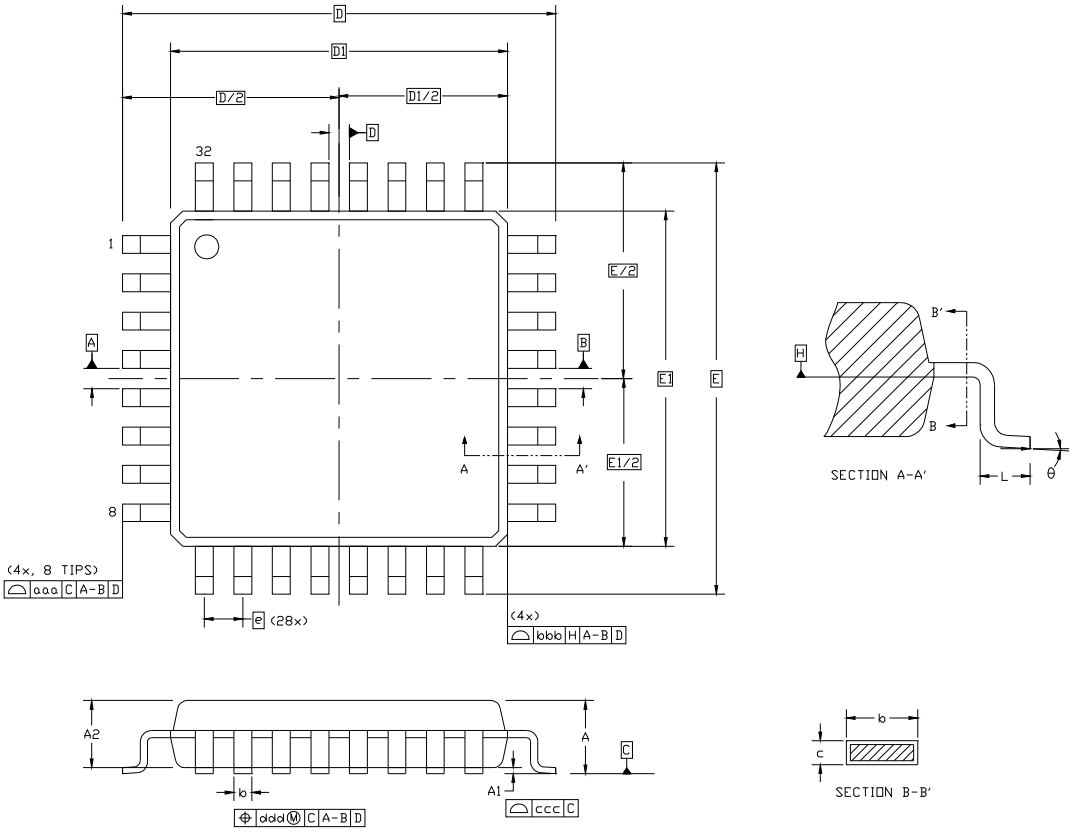


Figure 4.1. LQFP-32 Package Drawing

Table 4.1. LQFP-32 Package Dimensions

Dimension	Min	Typ	Max	Dimension	Min	Typ	Max
A	—	—	1.60	E	9.00 BSC.		
A1	0.05	—	0.15	E1	7.00 BSC.		
A2	1.35	1.40	1.45	L	0.45	0.60	0.75
b	0.30	0.37	0.45	aaa	0.20		
c	0.09	—	0.20	bbb	0.20		
D	9.00 BSC.			ccc	0.10		
D1	7.00 BSC.			ddd	0.20		
e	0.80 BSC.			θ	0°	3.5°	7°

Notes:

1. All dimensions shown are in millimeters (mm) unless otherwise noted.
2. Dimensioning and Tolerancing per ANSI Y14.5M-1994.
3. This drawing conforms to JEDEC outline MS-026, variation BBA.
4. Recommended card reflow profile is per the JEDEC/IPC J-STD-020C specification for Small Body Components.

8.1. Output Code Formatting

The ADC measures the input voltage with reference to GND. The registers ADC0H and ADC0L contain the high and low bytes of the output conversion code from the ADC at the completion of each conversion. Data can be right-justified or left-justified, depending on the setting of the AD0LJST bit. Conversion codes are represented as 10-bit unsigned integers. Inputs are measured from 0 to VREF x 1023/1024. Example codes are shown below for both right-justified and left-justified data. Unused bits in the ADC0H and ADC0L registers are set to 0.

Input Voltage	Right-Justified ADC0H:ADC0L (AD0LJST = 0)	Left-Justified ADC0H:ADC0L (AD0LJST = 1)
VREF x 1023/1024	0x03FF	0xFFC0
VREF x 512/1024	0x0200	0x8000
VREF x 256/1024	0x0100	0x4000
0	0x0000	0x0000

8.2. 8-Bit Mode

Setting the ADC08BE bit in register ADC0CF to 1 will put the ADC in 8-bit mode. In 8-bit mode, only the 8 MSBs of data are converted, and the ADC0H register holds the results. The AD0LJST bit is ignored for 8-bit mode. 8-bit conversions take two fewer SAR clock cycles than 10-bit conversions, so the conversion is completed faster, and a 500 ksps sampling rate can be achieved with a slower SAR clock.

8.3. Modes of Operation

ADC0 has a maximum conversion speed of 500 ksps. The ADC0 conversion clock is a divided version of the system clock, determined by the AD0SC bits in the ADC0CF register.

8.3.1. Starting a Conversion

A conversion can be initiated in one of six ways, depending on the programmed states of the ADC0 Start of Conversion Mode bits (AD0CM2–0) in register ADC0CN. Conversions may be initiated by one of the following:

1. Writing a 1 to the AD0BUSY bit of register ADC0CN
2. A Timer 0 overflow (i.e., timed continuous conversions)
3. A Timer 2 overflow
4. A Timer 1 overflow
5. A rising edge on the CNVSTR input signal
6. A Timer 3 overflow

Writing a 1 to AD0BUSY provides software control of ADC0 whereby conversions are performed "on-demand". During conversion, the AD0BUSY bit is set to logic 1 and reset to logic 0 when the conversion is complete. The falling edge of AD0BUSY triggers an interrupt (when enabled) and sets the ADC0 interrupt flag (AD0INT). Note: When polling for ADC conversion completions, the ADC0 interrupt flag (AD0INT) should be used. Converted data is available in the ADC0 data registers, ADC0H:ADC0L, when bit AD0INT is logic 1. Note that when Timer 2 or Timer 3 overflows are used as the conversion source, Low Byte overflows are used if Timer 2/3 is in 8-bit mode; High byte overflows are used if Timer 2/3 is in 16-bit mode. See Section “28. Timers” on page 246 for timer configuration.

Important Note About Using CNVSTR: The CNVSTR input pin also functions as a Port I/O pin. When the CNVSTR input is used as the ADC0 conversion source, the associated pin should be skipped by the Digital Crossbar. See Section “22. Port Input/Output” on page 138 for details on Port I/O configuration.

9.1. Calibration

The uncalibrated temperature sensor output is extremely linear and suitable for relative temperature measurements (see Table 7.11 on page 41 for specifications). For absolute temperature measurements, offset and/or gain calibration is recommended.

A single-point offset measurement of the temperature sensor is performed on each device during production test. The TOFFH and TOFFL calibration values represent the output of the ADC when reading the temperature sensor at 0 degrees Celsius, and using the internal regulator as a voltage reference. The TOFFH and TOFFL values can be read from EPROM memory and are located at 0x3FFB (TOFFH) and 0x3FFA (TOFFL). The temperature sensor offset information is left-justified, so TOFFH contains the 8 most-significant bits of the calibration value and TOFFL.7-6 contain the 2 least-significant bits of the calibration value, as shown in Figure 9.2. One LSB of this measurement is equivalent to one LSB of the ADC output under the measurement conditions.

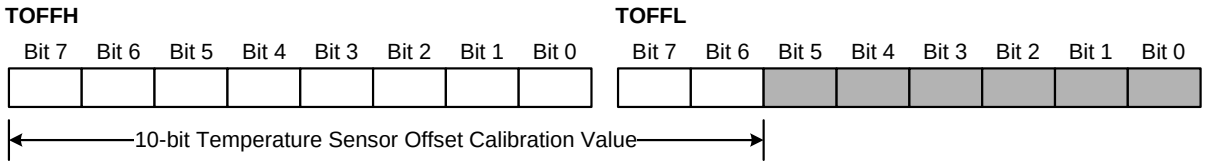


Figure 9.2. TOFFH and TOFFL Calibration Value Orientation

Figure 9.3 shows the typical temperature sensor error assuming a 1-point calibration at 0 °C. **Parameters that affect ADC measurement, in particular the voltage reference value, will also affect temperature measurement.**

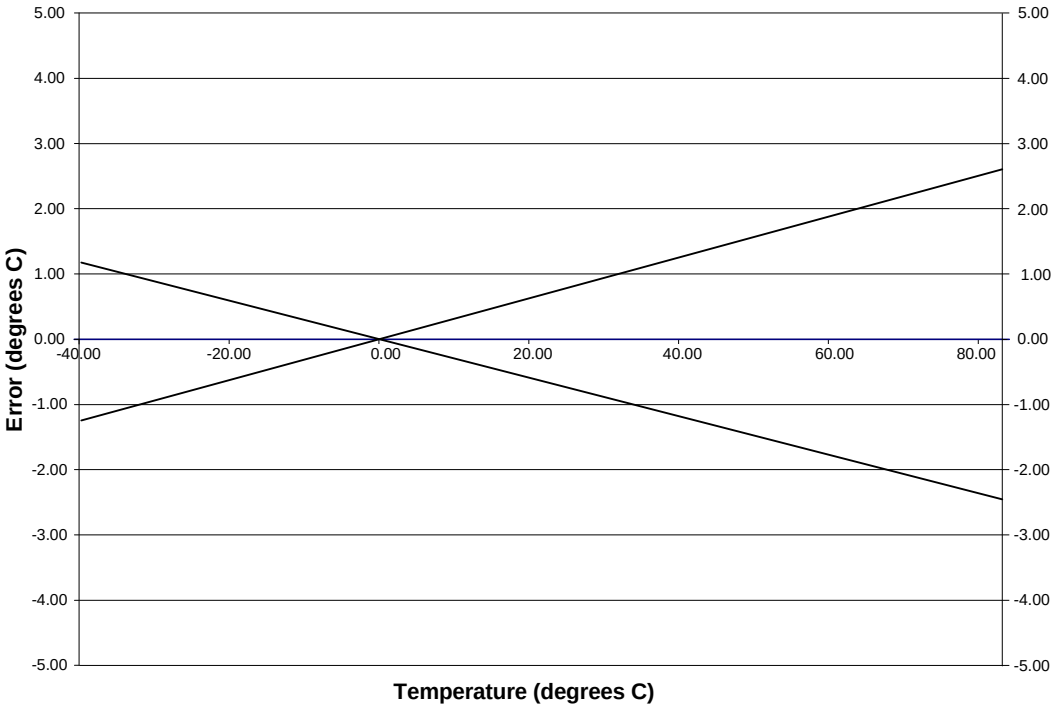


Figure 9.3. Temperature Sensor Error with 1-Point Calibration at 0 Celsius

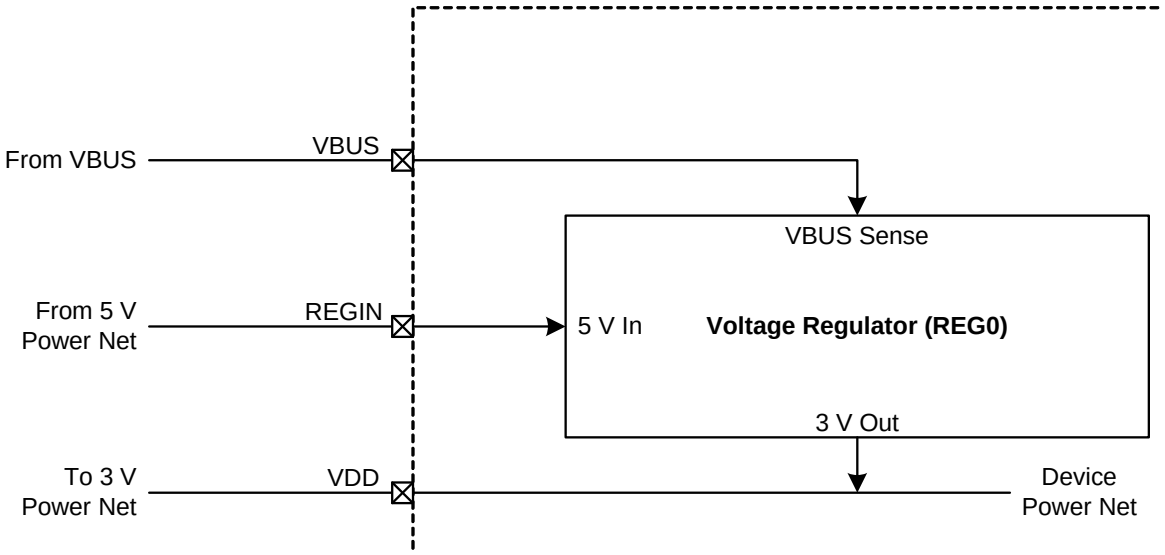


Figure 11.2. REG0 Configuration: USB Self-Powered

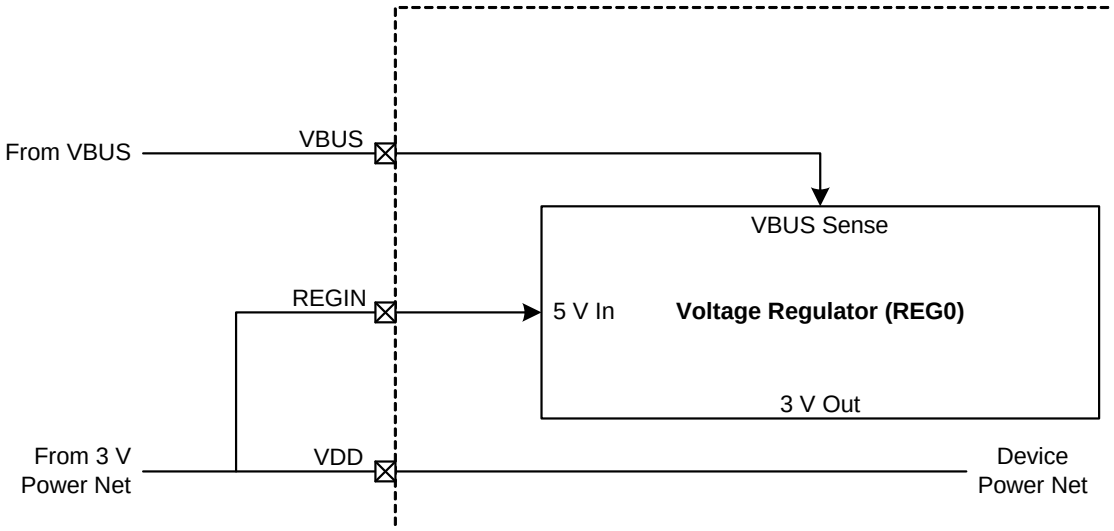


Figure 11.3. REG0 Configuration: USB Self-Powered, Regulator Disabled

SFR Definition 11.1. REG01CN: Voltage Regulator Control

Bit	7	6	5	4	3	2	1	0
Name	REG0DIS	VBSTAT	Reserved	REG0MD	STOPCF	Reserved	REG1MD	MPCE
Type	R/W	R	R/W	R/W	R/W	R/W	R/W	R/W
Reset	0	0	0	0	0	0	0	0

SFR Address = 0xC9

Bit	Name	Function
7	REG0DIS	**Voltage Regulator (REG0) Disable.** This bit enables or disables the REG0 Voltage Regulator. 0: Voltage Regulator Enabled. 1: Voltage Regulator Disabled.
6	VBSTAT	**VBUS Signal Status.** This bit indicates whether the device is connected to a USB network. 0: VBUS signal currently absent (device not attached to USB network). 1: VBUS signal currently present (device attached to USB network).
5	Reserved	Must Write 0b.
4	REG0MD	**Voltage Regulator (REG0) Mode Select.** This bit selects the Voltage Regulator mode for REG0. When REG0MD is set to 1, the REG0 voltage regulator operates in lower power (suspend) mode. 0: REG0 Voltage Regulator in normal mode. 1: REG0 Voltage Regulator in low power mode.
3	STOPCF	**Stop Mode Configuration (REG1).** This bit configures the REG1 regulator's behavior when the device enters STOP mode. 0: REG1 Regulator is still active in STOP mode. Any enabled reset source will reset the device. 1: REG1 Regulator is shut down in STOP mode. Only the $\overline{\text{RST}}$ pin or power cycle can reset the device.
2	Reserved	Must Write 0b.
1	REG1MD	**Voltage Regulator (REG1) Mode.** This bit selects the Voltage Regulator mode for REG1. When REG1MD is set to 1, the REG1 voltage regulator operates in lower power mode. 0: REG1 Voltage Regulator in normal mode. 1: REG1 Voltage Regulator in low power mode. **Note:** This bit should not be set to '1' if the REG0 Voltage Regulator is disabled.
0	MPCE	**Memory Power Controller Enable.** This bit can help the system save power at slower system clock frequencies (about 2.0 MHz or less) by automatically shutting down the EPROM memory between clocks when information is not being fetched from the EPROM memory. This bit has no effect when the prefetch engine is enabled. 0: Normal Mode - Memory power controller disabled (EPROM memory is always on). 1: Low Power Mode - Memory power controller enabled (EPROM turns on/off as needed). **Note:** If an external clock source is used with the Memory Power Controller enabled, and the clock frequency changes from slow (< 2.0 MHz) to fast (> 2.0 MHz), up to 20 clocks may be "skipped" to ensure that the EPROM power is stable before reading memory.

12.2. CIP-51 Register Descriptions

Following are descriptions of SFRs related to the operation of the CIP-51 System Controller. Reserved bits should always be written to the value indicated in the SFR description. Future product versions may use these bits to implement new features in which case the reset value of the bit will be the indicated value, selecting the feature's default state. Detailed descriptions of the remaining SFRs are included in the sections of the datasheet associated with their corresponding system function.

SFR Definition 12.1. DPL: Data Pointer Low Byte

Bit	7	6	5	4	3	2	1	0
Name	DPL[7:0]							
Type	R/W							
Reset	0	0	0	0	0	0	0	0

SFR Address = 0x82

Bit	Name	Function
7:0	DPL[7:0]	**Data Pointer Low.** The DPL register is the low byte of the 16-bit DPTR.

SFR Definition 12.2. DPH: Data Pointer High Byte

Bit	7	6	5	4	3	2	1	0
Name	DPH[7:0]							
Type	R/W							
Reset	0	0	0	0	0	0	0	0

SFR Address = 0x83

Bit	Name	Function
7:0	DPH[7:0]	**Data Pointer High.** The DPH register is the high byte of the 16-bit DPTR.

Table 16.2. Special Function Registers

SFRs are listed in alphabetical order. All undefined SFR locations are reserved

Register	Address	Description	Page
ACC	0xE0	Accumulator	74
ADC0CF	0xBC	ADC0 Configuration	49
ADC0CN	0xE8	ADC0 Control	51
ADC0GTH	0xC4	ADC0 Greater-Than Compare High	52
ADC0GTL	0xC3	ADC0 Greater-Than Compare Low	52
ADC0H	0xBE	ADC0 High	50
ADC0L	0xBD	ADC0 Low	50
ADC0LTH	0xC6	ADC0 Less-Than Compare Word High	53
ADC0LTL	0xC5	ADC0 Less-Than Compare Word Low	53
AMX0P	0xBB	AMUX0 Positive Channel Select	56
B	0xF0	B Register	74
CKCON	0x8E	Clock Control	247
CLKMUL	0xB9	Clock Multiplier Control	132
CLKSEL	0xA9	Clock Select	129
CPT0CN	0x9B	Comparator0 Control	80
CPT0MD	0x9D	Comparator0 Mode Selection	81
CPT0MX	0x9F	Comparator0 MUX Selection	85
CPT1CN	0x9B	Comparator1 Control	82
CPT1MD	0x9D	Comparator1 Mode Selection	83
CPT1MX	0x9F	Comparator1 MUX Selection	86
DPH	0x83	Data Pointer High	73
DPL	0x82	Data Pointer Low	73
EIE1	0xE6	Extended Interrupt Enable 1	106
EIE2	0xE7	Extended Interrupt Enable 2	108
EIP1	0xF6	Extended Interrupt Priority 1	107
EIP2	0xF7	Extended Interrupt Priority 2	109
EMI0CF	0x85	External Memory Configuration	94
EMI0CN	0xAA	External Memory Interface Control	91

17.1. MCU Interrupt Sources and Vectors

The C8051T620/1/6/7 & C8051T320/1/2/3 MCUs support 18 interrupt sources. Software can simulate an interrupt by setting any interrupt-pending flag to logic 1. If interrupts are enabled for the flag, an interrupt request will be generated and the CPU will vector to the ISR address associated with the interrupt-pending flag. MCU interrupt sources, associated vector addresses, priority order and control bits are summarized in Table 17.1. Refer to the datasheet section associated with a particular on-chip peripheral for information regarding valid interrupt conditions for the peripheral and the behavior of its interrupt-pending flag(s).

17.1.1. Interrupt Priorities

Each interrupt source can be individually programmed to one of two priority levels: low or high. A low priority interrupt service routine can be preempted by a high priority interrupt. A high priority interrupt cannot be preempted. Each interrupt has an associated interrupt priority bit in an SFR (IP, EIP1, or EIP2) used to configure its priority level. Low priority is the default. If two interrupts are recognized simultaneously, the interrupt with the higher priority is serviced first. If both interrupts have the same priority level, a fixed priority order is used to arbitrate, given in Table 17.1.

17.1.2. Interrupt Latency

Interrupt response time depends on the state of the CPU when the interrupt occurs. Pending interrupts are sampled and priority decoded each system clock cycle. Therefore, the fastest possible response time is 6 system clock cycles: 1 clock cycle to detect the interrupt and 5 clock cycles to complete the LCALL to the ISR. If an interrupt is pending when a RETI is executed, a single instruction is executed before an LCALL is made to service the pending interrupt. Therefore, the maximum response time for an interrupt (when no other interrupt is currently being serviced or the new interrupt is of greater priority) occurs when the CPU is performing an RETI instruction followed by a DIV as the next instruction. In this case, the response time is 20 system clock cycles: 1 clock cycle to detect the interrupt, 6 clock cycles to execute the RETI, 8 clock cycles to complete the DIV instruction and 5 clock cycles to execute the LCALL to the ISR. If the CPU is executing an ISR for an interrupt with equal or higher priority, the new interrupt will not be serviced until the current ISR completes, including the RETI and following instruction.

Note that the CPU is stalled during EPROM write operations and USB FIFO MOVX accesses (see Section “15.2.3. Accessing USB FIFO Space” on page 91). Interrupt service latency will be increased for interrupts occurring while the CPU is stalled. The latency for these situations will be determined by the standard interrupt service procedure (as described above) and the amount of time the CPU is stalled.

17.2. Interrupt Register Descriptions

The SFRs used to enable the interrupt sources and set their priority level are described in this section. Refer to the data sheet section associated with a particular on-chip peripheral for information regarding valid interrupt conditions for the peripheral and the behavior of its interrupt-pending flag(s).

18.1.2. EPROM In-Application Programming

The EPROM of the C8051T620/1/6/7 & C8051T320/1/2/3 devices has an In-Application Programming option. In-Application Programming will be much slower than normal programming where the V_{PP} programming voltage is applied to the V_{PP} pin, but it allows a small number of bytes to be programmed anywhere in the non-reserved areas of the EPROM. In order to use this option, V_{IO} must be within a specific range and a capacitor must be connected externally to the V_{PP} pin. Refer to Section "7. Electrical Characteristics" on page 34 for the acceptable range of values for V_{IO} and the capacitor on the V_{PP} pin.

Bytes in the EPROM memory must be written one byte at a time. An EPROM write will be performed after each MOVX write instruction. The recommended procedure for writing to the EPROM is as follows:

1. **Disable interrupts**.
2. **Change the core clock to 25 MHz or less.**
3. Enable the VDD Monitor. **Write 0x80 to VDM0CN.**
4. Enable the VDD Monitor as a reset source. **Write 0x02 to RSTSRC.**
5. Disable the Prefetch engine. **Write 0x00 to the PFE0CN register.**
6. **Set the VPP Pin to an open-drain configuration, with a '1' in the port latch.**
7. **Set the PSWE bit (register PSCTL).**
8. **Write the first key code to MEMKEY: 0xA5**.
9. **Write the second key code to MEMKEY: 0xF1**.
10. Enable in-application programming. **Write 0x80 to the IAPCN register.**
11. Using a MOVX write instruction, **write a single data byte to the desired location.**
12. Disable in-application EPROM programming. **Write 0x00 to the IAPCN register.**
13. **Clear the PSWE bit**.
14. Re-enable the Prefetch engine. **Write 0x20 to the PFE0CN register.**
15. **Delay for at least 1 us.**
16. Disable the programming hardware. **Write 0x40 to the IAPCN register.**
17. **Restore the core clock** (if changed in Step 2)
18. **Re-enable interrupts**.

Steps 8–11 must be repeated for each byte to be written.

When an application uses the In-Application Programming feature, the V_{PP} pin must be set to open-drain mode, with a '1' in the port latch. The pin can still be used a as a general-purpose I/O pin if the programming circuitry of the pin is disabled after all writes are completed by using the IAPHWD bit in the IAPCN register (IAPCN.6). It is not necessary to disable the programming hardware if the In-Application Programming feature has not been used.

Important Note: Software should delay for at least 1 µs after the last EPROM write before setting the IAPHWD bit.

SFR Definition 22.2. XBR1: Port I/O Crossbar Register 1

Bit	7	6	5	4	3	2	1	0
Name	WEAKPUD	XBARE	T1E	T0E	ECIE	PCA0ME[2:0]		
Type	R/W	R/W	R/W	R/W	R/W	R/W		
Reset	0	0	0	0	0	0	0	0

SFR Address = 0xE2

Bit	Name	Function
7	WEAKPUD	**Port I/O Weak Pullup Disable.** 0: Weak Pullups enabled (except for Ports whose I/O are configured for analog mode). 1: Weak Pullups disabled.
6	XBARE	**Crossbar Enable.** 0: Crossbar disabled. 1: Crossbar enabled.
5	T1E	**T1 Enable.** 0: T1 unavailable at Port pin. 1: T1 routed to Port pin.
4	T0E	**T0 Enable.** 0: T0 unavailable at Port pin. 1: T0 routed to Port pin.
3	ECIE	**PCA0 External Counter Input Enable.** 0: ECI unavailable at Port pin. 1: ECI routed to Port pin.
2:0	PCA0ME[2:0]	**PCA Module I/O Enable Bits.** 000: All PCA I/O unavailable at Port pins. 001: CEX0 routed to Port pin. 010: CEX0, CEX1 routed to Port pins. 011: CEX0, CEX1, CEX2 routed to Port pins. 100: CEX0, CEX1, CEX2, CEX3 routed to Port pins. 101: CEX0, CEX1, CEX2, CEX3, CEX4 routed to Port pins. 110-111: Reserved.

23.5. FIFO Management

1024 bytes of on-chip XRAM are used as FIFO space for USB0. This FIFO space is split between Endpoints0-3 as shown in Figure 23.3. FIFO space allocated for Endpoints1-3 is configurable as IN, OUT, or both (Split Mode: half IN, half OUT).

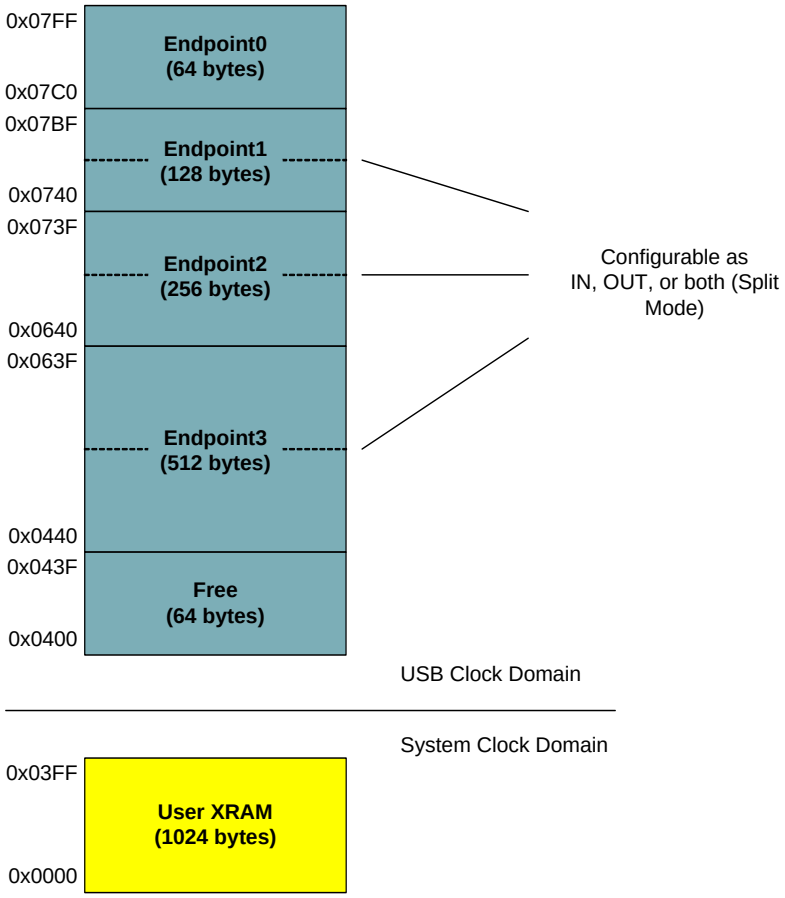


Figure 23.3. C8051T620/1 and C8051T320/1/2/3 USB FIFO Allocation

USB Register Definition 23.12. OUT1INT: USB0 OUT Endpoint Interrupt

Bit	7	6	5	4	3	2	1	0
Name					OUT3	OUT2	OUT1	
Type	R	R	R	R	R	R	R	R
Reset	0	0	0	0	0	0	0	0

USB Register Address = 0x04

Bit	Name	Function
7:4	Unused	Read = 0000b. Write = don't care.
3	OUT3	**OUT Endpoint 3 Interrupt-pending Flag.** This bit is cleared when software reads the OUT1INT register. 0: OUT Endpoint 3 interrupt inactive. 1: OUT Endpoint 3 interrupt active.
2	OUT2	**OUT Endpoint 2 Interrupt-pending Flag.** This bit is cleared when software reads the OUT1INT register. 0: OUT Endpoint 2 interrupt inactive. 1: OUT Endpoint 2 interrupt active.
1	OUT1	**OUT Endpoint 1 Interrupt-pending Flag.** This bit is cleared when software reads the OUT1INT register. 0: OUT Endpoint 1 interrupt inactive. 1: OUT Endpoint 1 interrupt active.
0	Unused	Read = 0b. Write = don't care.

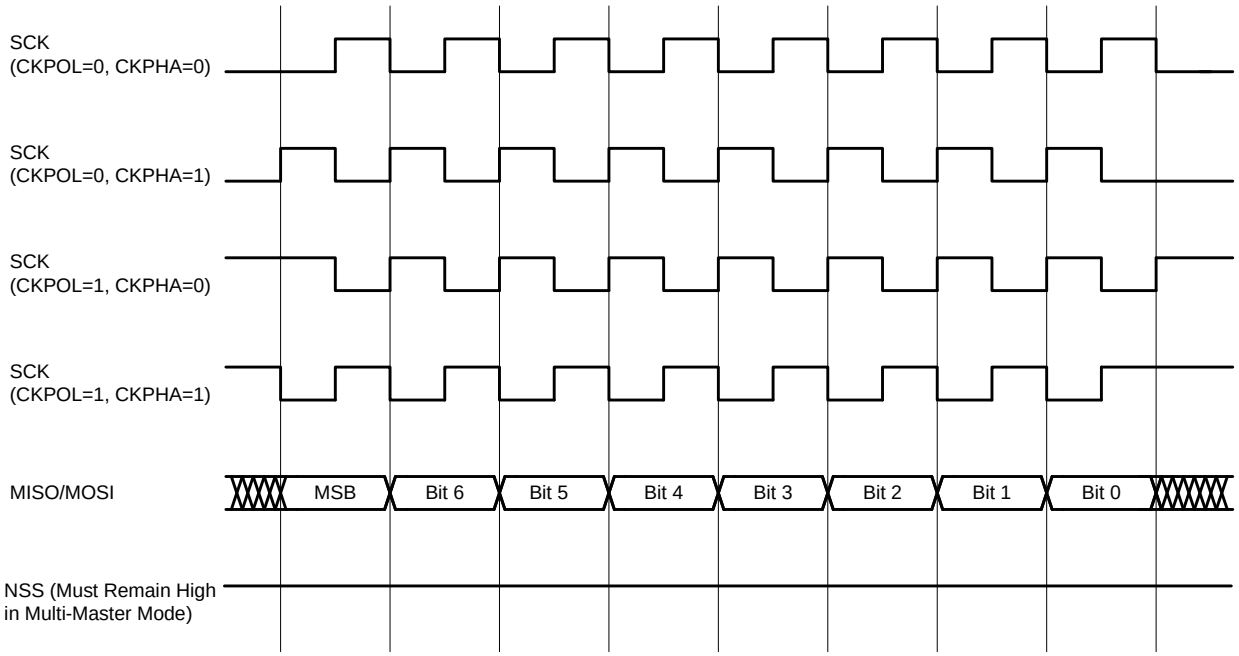


Figure 27.5. Master Mode Data/Clock Timing

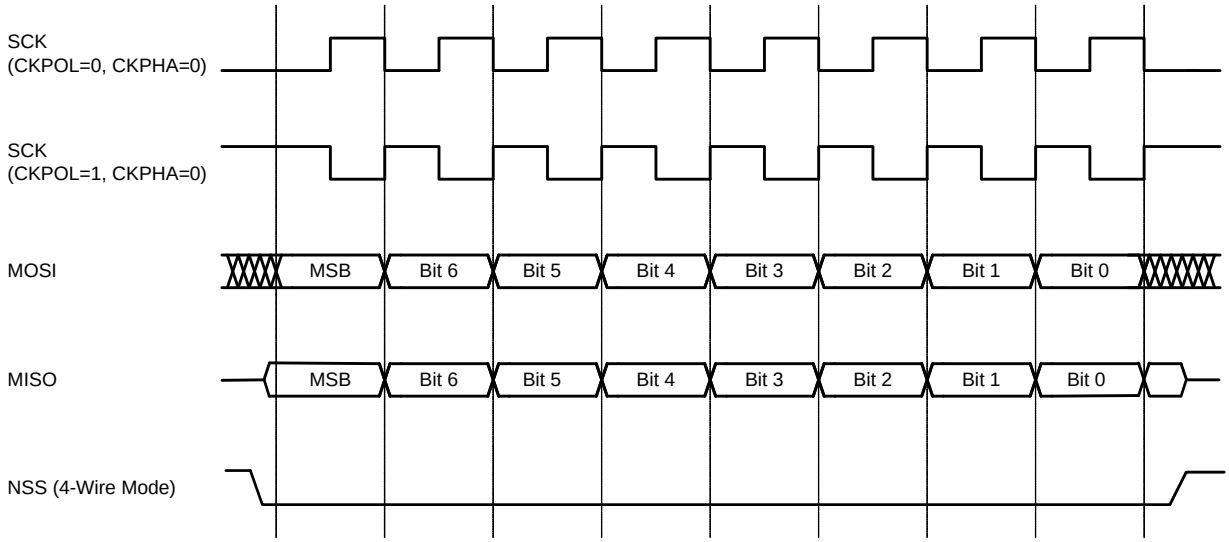


Figure 27.6. Slave Mode Data/Clock Timing (CKPHA = 0)

SFR Definition 27.2. SPI0CN: SPI0 Control

Bit	7	6	5	4	3	2	1	0
Name	SPIF	WCOL	MODF	RXOVRN	NSSMD[1:0]		TXBMT	SPIEN
Type	R/W	R/W	R/W	R/W	R/W		R	R/W
Reset	0	0	0	0	0	1	1	0

SFR Address = 0xF8; Bit-Addressable

Bit	Name	Function
7	SPIF	**SPI0 Interrupt Flag.** This bit is set to logic 1 by hardware at the end of a data transfer. If SPI interrupts are enabled, an interrupt will be generated. This bit is not automatically cleared by hardware, and must be cleared by software.
6	WCOL	**Write Collision Flag.** This bit is set to logic 1 if a write to SPI0DAT is attempted when TXBMT is 0. When this occurs, the write to SPI0DAT will be ignored, and the transmit buffer will not be written. If SPI interrupts are enabled, an interrupt will be generated. This bit is not automatically cleared by hardware, and must be cleared by software.
5	MODF	**Mode Fault Flag.** This bit is set to logic 1 by hardware when a master mode collision is detected (NSS is low, MSTEN = 1, and NSSMD[1:0] = 01). If SPI interrupts are enabled, an interrupt will be generated. This bit is not automatically cleared by hardware, and must be cleared by software.
4	RXOVRN	**Receive Overrun Flag (valid in slave mode only).** This bit is set to logic 1 by hardware when the receive buffer still holds unread data from a previous transfer and the last bit of the current transfer is shifted into the SPI0 shift register. If SPI interrupts are enabled, an interrupt will be generated. This bit is not automatically cleared by hardware, and must be cleared by software.
3:2	NSSMD[1:0]	**Slave Select Mode.** Selects between the following NSS operation modes: (See Section 27.2 and Section 27.3). 00: 3-Wire Slave or 3-Wire Master Mode. NSS signal is not routed to a port pin. 01: 4-Wire Slave or Multi-Master Mode (Default). NSS is an input to the device. 1x: 4-Wire Single-Master Mode. NSS signal is mapped as an output from the device and will assume the value of NSSMD0.
1	TXBMT	**Transmit Buffer Empty.** This bit will be set to logic 0 when new data has been written to the transmit buffer. When data in the transmit buffer is transferred to the SPI shift register, this bit will be set to logic 1, indicating that it is safe to write a new byte to the transmit buffer.
0	SPIEN	**SPI0 Enable.** 0: SPI disabled. 1: SPI enabled.

28.2.3. Low-Frequency Oscillator (LFO) Capture Mode

The Low-Frequency Oscillator Capture Mode allows the LFO clock to be measured against the system clock or an external oscillator source. Timer 2 can be clocked from the system clock, the system clock divided by 12, or the external oscillator divided by 8, depending on the T2ML (CKCON.4), and T2XCLK settings.

Setting TF2CEN to 1 enables the LFO Capture Mode for Timer 2. In this mode, T2SPLIT should be set to 0, as the full 16-bit timer is used. Upon a falling edge of the low-frequency oscillator, the contents of Timer 2 (TMR2H:TMR2L) are loaded into the Timer 2 reload registers (TMR2RLH:TMR2RLL) and the TF2H flag is set. By recording the difference between two successive timer capture values, the LFO clock frequency can be determined with respect to the Timer 2 clock. The Timer 2 clock should be much faster than the LFO to achieve an accurate reading.

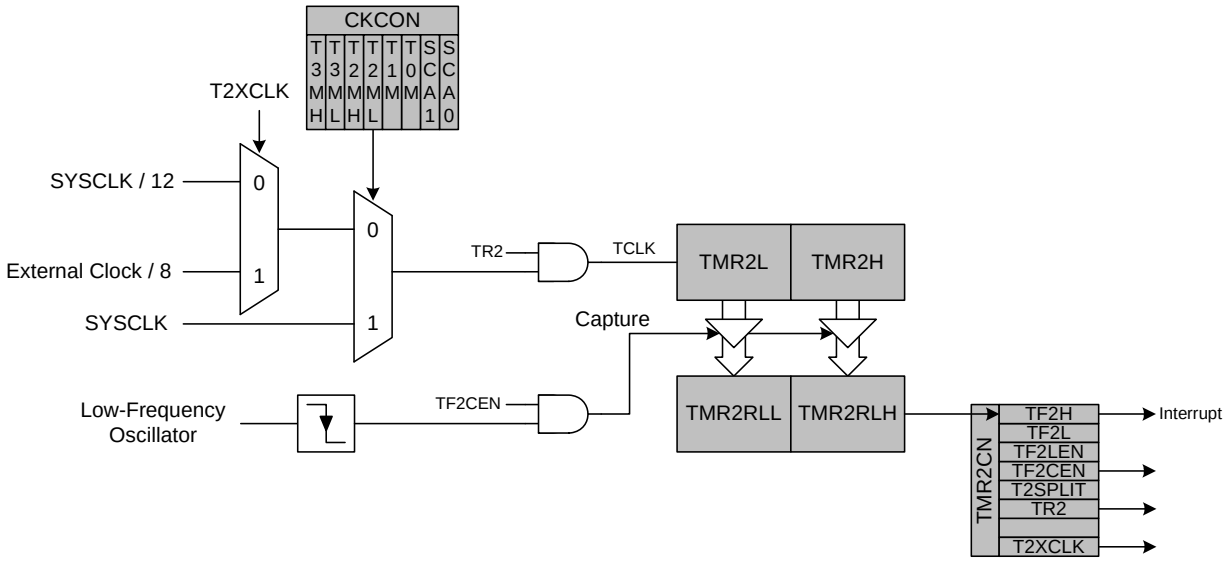


Figure 28.6. Timer 2 Low-Frequency Oscillation Capture Mode Block Diagram

Table 29.2. PCA0CPM and PCA0PWM Bit Settings for PCA Capture/Compare Modules

Operational Mode	PCA0CPMn								PCA0PWM				
Bit Number	7	6	5	4	3	2	1	0	7	6	5	4-2	1-0
Capture triggered by positive edge on CEXn	X	X	1	0	0	0	0	A	0	X	B	XXX	XX
Capture triggered by negative edge on CEXn	X	X	0	1	0	0	0	A	0	X	B	XXX	XX
Capture triggered by any transition on CEXn	X	X	1	1	0	0	0	A	0	X	B	XXX	XX
Software Timer	X	C	0	0	1	0	0	A	0	X	B	XXX	XX
High Speed Output	X	C	0	0	1	1	0	A	0	X	B	XXX	XX
Frequency Output	X	C	0	0	0	1	1	A	0	X	B	XXX	XX
8-Bit Pulse Width Modulator (Note 7)	0	C	0	0	E	0	1	A	0	X	B	XXX	00
9-Bit Pulse Width Modulator (Note 7)	0	C	0	0	E	0	1	A	D	X	B	XXX	01
10-Bit Pulse Width Modulator (Note 7)	0	C	0	0	E	0	1	A	D	X	B	XXX	10
11-Bit Pulse Width Modulator (Note 7)	0	C	0	0	E	0	1	A	D	X	B	XXX	11
16-Bit Pulse Width Modulator	1	C	0	0	E	0	1	A	0	X	B	XXX	XX

1. X = Don't Care (no functional difference for individual module if 1 or 0).
2. A = Enable interrupts for this module (PCA interrupt triggered on CCFn set to 1).
3. B = Enable 8th, 9th, 10th or 11th bit overflow interrupt (Depends on setting of CLSEL[1:0]).
4. C = When set to 0, the digital comparator is off. For high speed and frequency output modes, the associated pin will not toggle. In any of the PWM modes, this generates a 0% duty cycle (output = 0).
5. D = Selects whether the Capture/Compare register (0) or the Auto-Reload register (1) for the associated channel is accessed via addresses PCA0CPHn and PCA0CPLn.
6. E = When set, a match event will cause the CCFn flag for the associated channel to be set.
7. All modules set to 8, 9, 10 or 11-bit PWM mode use the same cycle length setting.

29.3.1. Edge-triggered Capture Mode

In this mode, a valid transition on the CEXn pin causes the PCA to capture the value of the PCA counter/timer and load it into the corresponding module's 16-bit capture/compare register (PCA0CPLn and PCA0CPHn). The CAPPn and CAPNn bits in the PCA0CPMn register are used to select the type of transition that triggers the capture: low-to-high transition (positive edge), high-to-low transition (negative edge), or either transition (positive or negative edge). When a capture occurs, the Capture/Compare Flag (CCFn) in PCA0CN is set to logic 1. An interrupt request is generated if the CCFn interrupt for that module is enabled. The CCFn bit is not automatically cleared by hardware when the CPU vectors to the interrupt service routine, and must be cleared by software. If both CAPPn and CAPNn bits are set to logic 1, then the state of the Port pin associated with CEXn can be read directly to determine whether a rising-edge or falling-edge caused the capture.

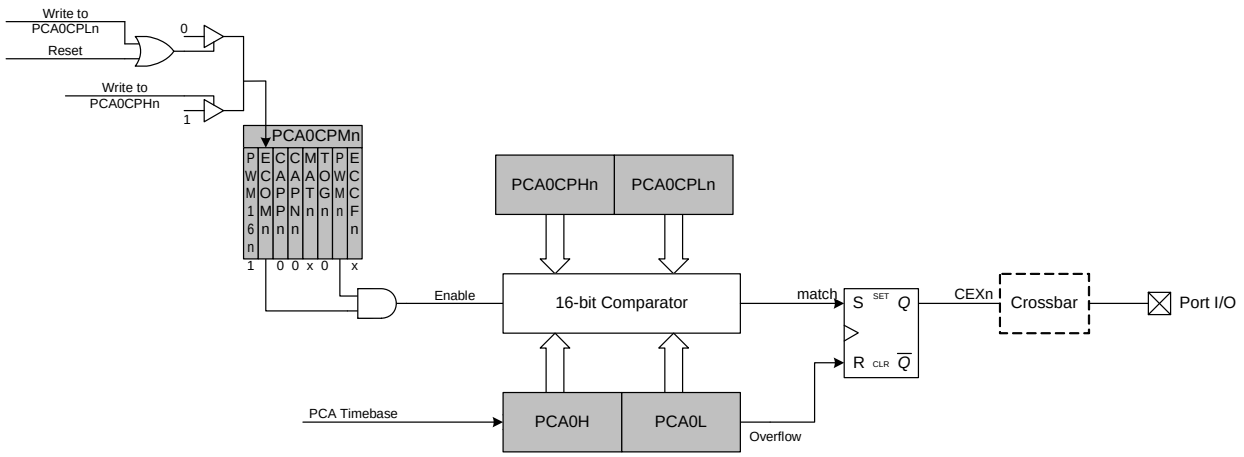


Figure 29.10. PCA 16-Bit PWM Mode

29.4. Watchdog Timer Mode

A programmable watchdog timer (WDT) function is available through the PCA Module 4. The WDT is used to generate a reset if the time between writes to the WDT update register (PCA0CPH4) exceed a specified limit. The WDT can be configured and enabled/disabled as needed by software.

With the WDTE bit set in the PCA0MD register, Module 4 operates as a watchdog timer (WDT). The Module 4 high byte is compared to the PCA counter high byte; the Module 4 low byte holds the offset to be used when WDT updates are performed. **The Watchdog Timer is enabled on reset. Writes to some PCA registers are restricted while the Watchdog Timer is enabled.** The WDT will generate a reset shortly after code begins execution. To avoid this reset, the WDT should be explicitly disabled (and optionally re-configured and re-enabled if it is used in the system).

29.4.1. Watchdog Timer Operation

While the WDT is enabled:

- PCA counter is forced on.
- Writes to PCA0L and PCA0H are not allowed.
- PCA clock source bits (CPS2–CPS0) are frozen.
- PCA Idle control bit (CIDL) is frozen.
- Module 4 is forced into software timer mode.
- Writes to the Module 4 mode register (PCA0CPM4) are disabled.

While the WDT is enabled, writes to the CR bit will not change the PCA counter state; the counter will run until the WDT is disabled. The PCA counter run control bit (CR) will read zero if the WDT is enabled but user software has not enabled the PCA counter. If a match occurs between PCA0CPH4 and PCA0H while the WDT is enabled, a reset will be generated. To prevent a WDT reset, the WDT may be updated with a write of any value to PCA0CPH4. Upon a PCA0CPH4 write, PCA0H plus the offset held in PCA0CPL4 is loaded into PCA0CPH4 (See Figure 29.11).

30.2. C2 Pin Sharing

The C2 protocol allows the C2 pins to be shared with user functions so that in-system debugging and EPROM programming functions may be performed. This is possible because C2 communication is typically performed when the device is in the halt state, where all on-chip peripherals and user software are stalled. In this halted state, the C2 interface can safely ‘borrow’ the C2CK (normally RST) and C2D pins. In most applications, external resistors are required to isolate C2 interface traffic from the user application when performing debug functions. These external resistors are not necessary for production boards. A typical isolation configuration is shown in Figure 30.1.

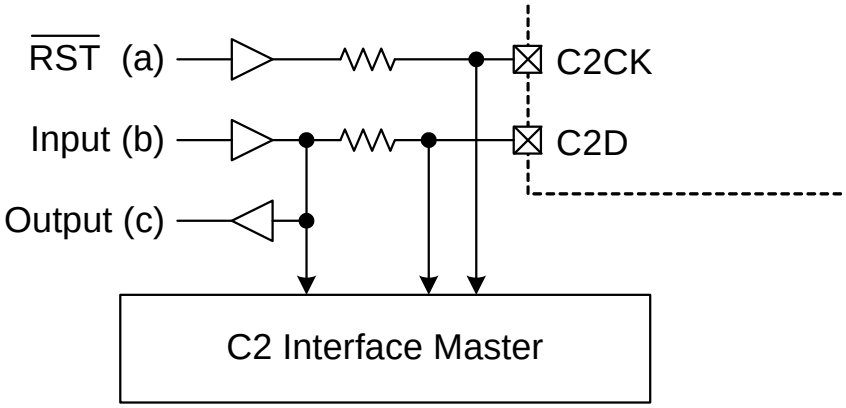
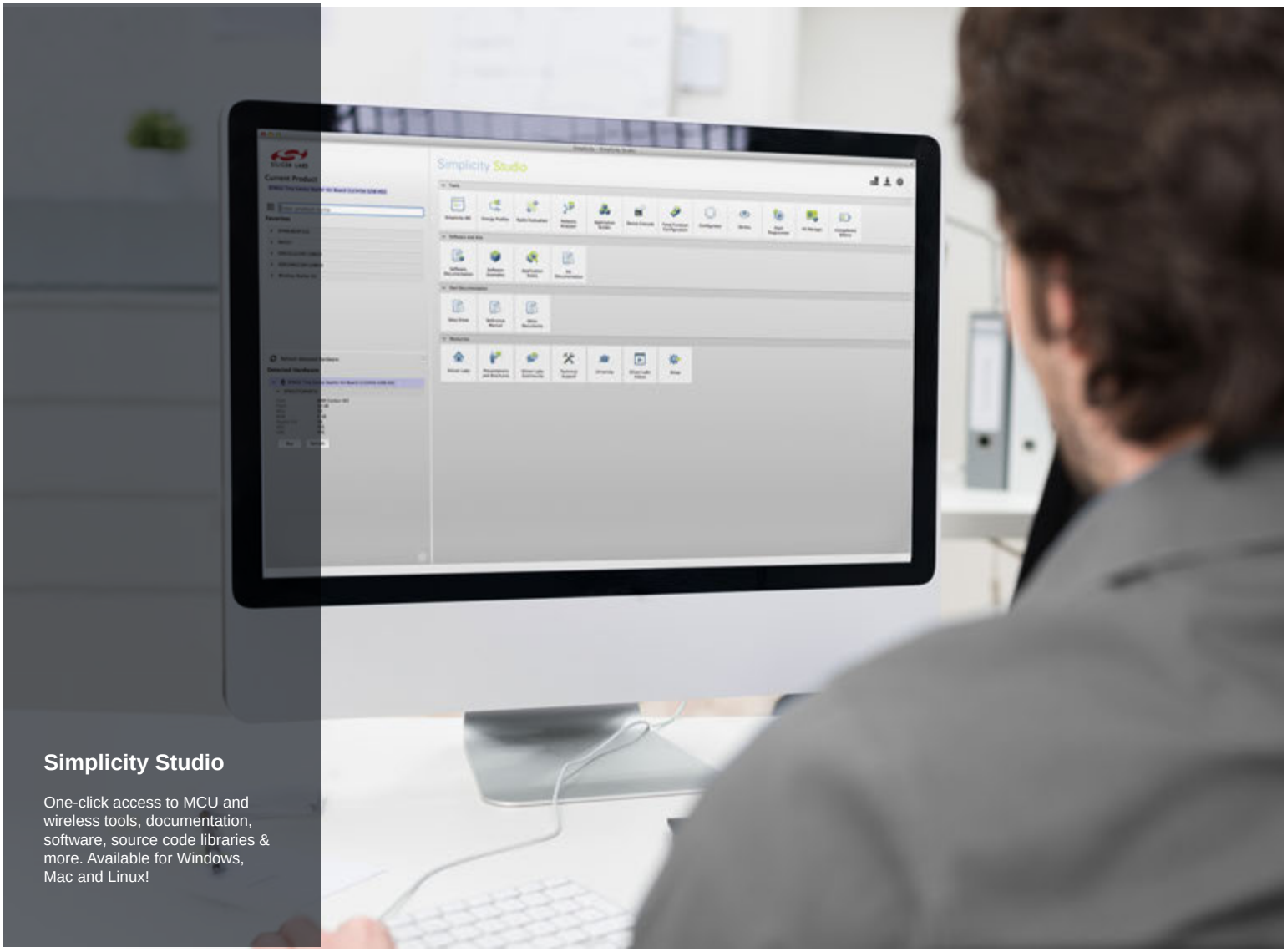


Figure 30.1. Typical C2 Pin Sharing

The configuration in Figure 30.1 assumes the following:

1. The user input (b) cannot change state while the target device is halted.
2. The RST pin on the target device is used as an input only.

Additional resistors may be necessary depending on the specific application.



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