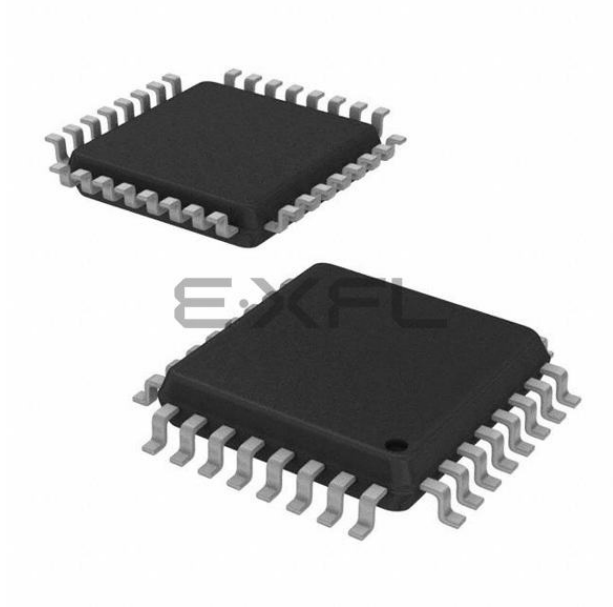

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Applications of "Embedded - Microcontrollers"

Details	
Product Status	Active
Core Processor	8051
Core Size	8-Bit
Speed	48 MIPS
Connectivity	I²C, SPI, UART/USART, USB
Peripherals	Brown-out Detect/Reset, POR, PWM, Temp Sensor, WDT
Number of I/O	25
Program Memory Size	16KB (16K x 8)
Program Memory Type	FLASH
EEPROM Size	-
RAM Size	2.25K x 8
Voltage - Supply (Vcc/Vdd)	2.7V ~ 5.25V
Data Converters	A/D 21x10b
Oscillator Type	Internal
Operating Temperature	-40°C ~ 85°C (TA)
Mounting Type	Surface Mount
Package / Case	32-LQFP
Supplier Device Package	32-LQFP (7x7)
Purchase URL	https://www.e-xfl.com/product-detail/silicon-labs/c8051f38c-gqr

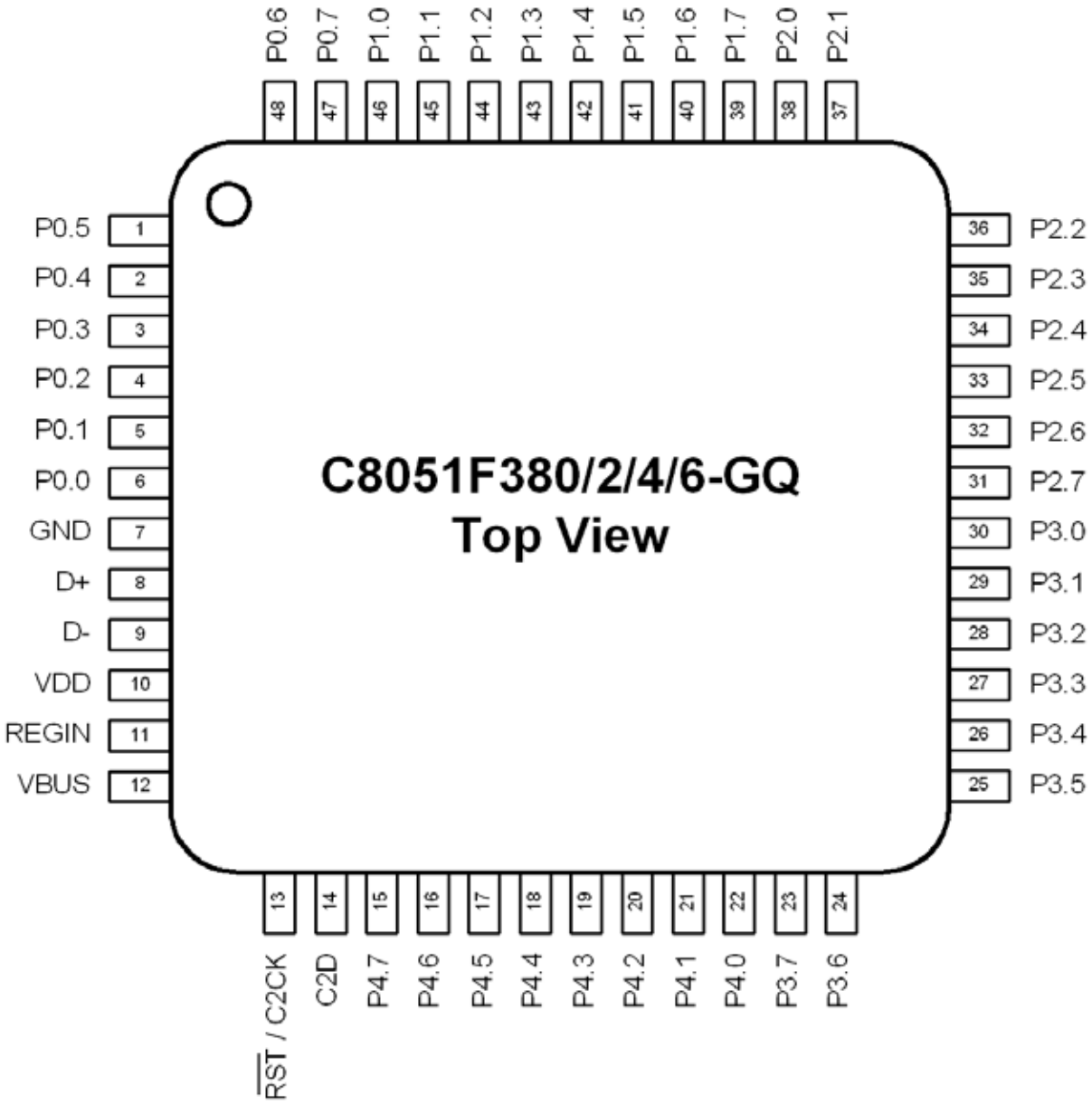

Figure 3.1. TQFP-48 Pinout Diagram (Top View)

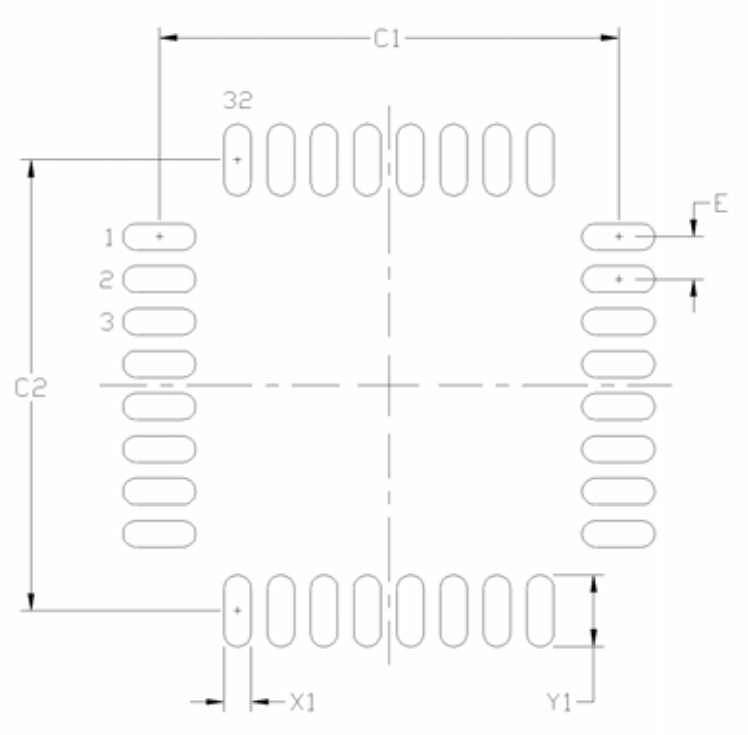

Figure 3.6. LQFP-32 Recommended PCB Land Pattern

Table 3.5. LQFP-32 PCB Land Pattern Dimensions

Dimension	Min	Max
C1	8.40	8.50
C2	8.40	8.50
E	0.80 BSC	
X1	0.40	0.50
Y1	1.25	1.35

Notes:
General:
1. All dimensions shown are in millimeters (mm) unless otherwise noted.
2. This Land Pattern Design is based on the IPC-7351 guidelines.

Solder Mask Design:
3. All metal pads are to be non-solder mask defined (NSMD). Clearance between the solder mask and the metal pad is to be 60 µm minimum, all the way around the pad.

Stencil Design:
4. A stainless steel, laser-cut and electro-polished stencil with trapezoidal walls should be used to assure good solder paste release.
5. The stencil thickness should be 0.125 mm (5 mils).
6. The ratio of stencil aperture to land pad size should be 1:1 for all pads.

Card Assembly:
7. A No-Clean, Type-3 solder paste is recommended.
8. The recommended card reflow profile is per the JEDEC/IPC J-STD-020 specification for Small Body Components.

5. Electrical Characteristics

5.1. Absolute Maximum Specifications

Table 5.1. Absolute Maximum Ratings

Parameter	Conditions	Min	Typ	Max	Units
Junction Temperature Under Bias		–55	—	125	°C
Storage Temperature		–65	—	150	°C
Voltage on $\overline{RST}$, VBUS, or any Port I/O Pin with Respect to GND	$V_{DD} \geq 2.2$ V $V_{DD} < 2.2$ V	–0.3 –0.3	— —	5.8 V_{DD} + 3.6	V V
Voltage on V_{DD} with Respect to GND	Regulator1 in Normal Mode Regulator1 in Bypass Mode	–0.3 –0.3	— —	4.2 1.98	V V
Maximum Total Current through V_{DD} or GND		—	—	500	mA
Maximum Output Current sunk by $\overline{RST}$ or any Port Pin		—	—	100	mA

Note: Stresses above those listed under “Absolute Maximum Ratings” may cause permanent damage to the device. This is a stress rating only and functional operation of the devices at those or any other conditions above those indicated in the operation listings of this specification is not implied. Exposure to maximum rating conditions for extended periods may affect device reliability.

SFR Definition 6.4. ADC0CN: ADC0 Control

Bit	7	6	5	4	3	2	1	0
Name	AD0EN	AD0TM	AD0INT	AD0BUSY	AD0WINT	AD0CM[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 = 0xE8; SFR Page = All Pages; Bit-Addressable

Bit	Name	Function
7	AD0EN	**ADC0 Enable Bit.** 0: ADC0 Disabled. ADC0 is in low-power shutdown. 1: ADC0 Enabled. ADC0 is active and ready for data conversions.
6	AD0TM	**ADC0 Track Mode Bit.** 0: Normal Track Mode: When ADC0 is enabled, tracking is continuous unless a conversion is in progress. Conversion begins immediately on start-of-conversion event, as defined by AD0CM[2:0]. 1: Delayed Track Mode: When ADC0 is enabled, input is tracked when a conversion is not in progress. A start-of-conversion signal initiates three SAR clocks of additional tracking, and then begins the conversion. Note that there is not a tracking delay when CNVSTR is used (AD0CM[2:0] = 100).
5	AD0INT	**ADC0 Conversion Complete Interrupt Flag.** 0: ADC0 has not completed a data conversion since AD0INT was last cleared. 1: ADC0 has completed a data conversion.
4	AD0BUSY	**ADC0 Busy Bit.** **Read:** 0: ADC0 conversion is not in progress. 1: ADC0 conversion is in progress. **Write:** 0: No Effect. 1: Initiates ADC0 Conversion if AD0CM[2:0] = 000b
3	AD0WINT	**ADC0 Window Compare Interrupt Flag.** 0: ADC0 Window Comparison Data match has not occurred since this flag was last cleared. 1: ADC0 Window Comparison Data match has occurred.
2:0	AD0CM[2:0]	**ADC0 Start of Conversion Mode Select.** 000: ADC0 start-of-conversion source is write of 1 to AD0BUSY. 001: ADC0 start-of-conversion source is overflow of Timer 0. 010: ADC0 start-of-conversion source is overflow of Timer 2. 011: ADC0 start-of-conversion source is overflow of Timer 1. 100: ADC0 start-of-conversion source is rising edge of external CNVSTR. 101: ADC0 start-of-conversion source is overflow of Timer 3. 110: ADC0 start-of-conversion source is overflow of Timer 4. 111: ADC0 start-of-conversion source is overflow of Timer 5.

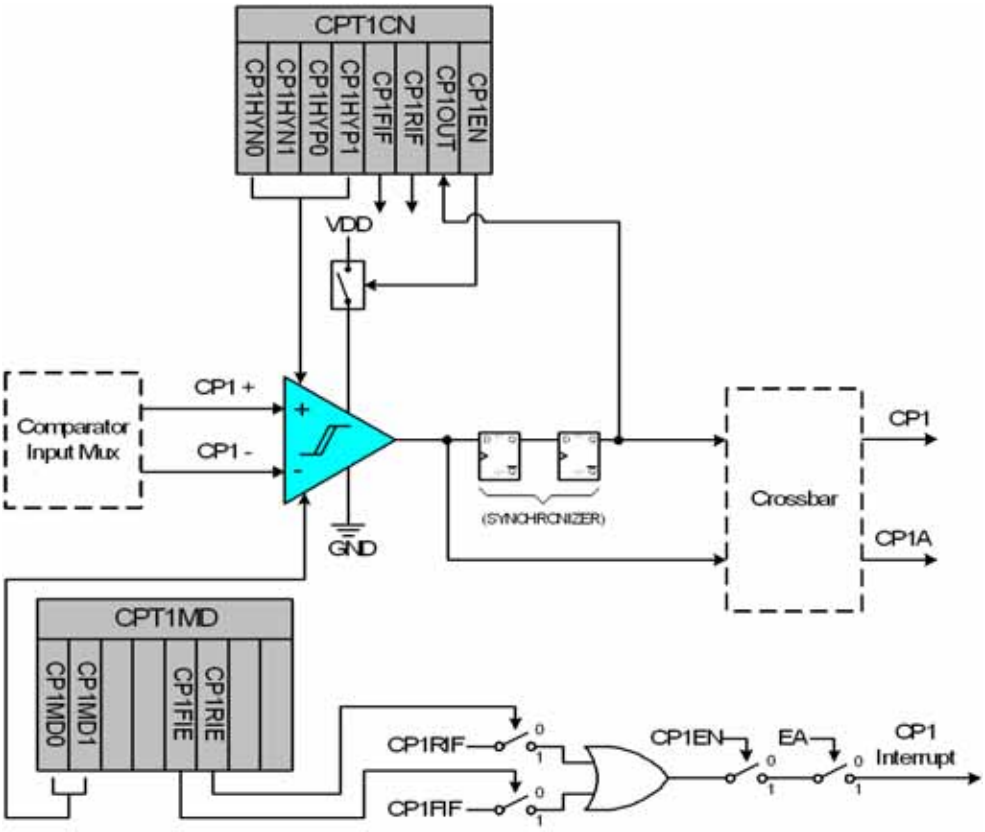

Figure 8.2. Comparator1 Functional Block Diagram

The Comparator output can be polled in software, used as an interrupt source, and/or routed to a Port pin. When routed to a Port pin, the Comparator output is available asynchronous or synchronous to the system clock; the asynchronous output is available even in STOP mode (with no system clock active). When disabled, the Comparator output (if assigned to a Port I/O pin via the Crossbar) defaults to the logic low state, and the power supply to the comparator is turned off. See Section “20.1. Priority Crossbar Decoder” on page 154 for details on configuring Comparator outputs via the digital Crossbar. Comparator inputs can be externally driven from –0.25 V to (V_{DD}) + 0.25 V without damage or upset. The complete Comparator electrical specifications are given in Section “5. Electrical Characteristics” on page 37.

The Comparator response time may be configured in software via the CPTnMD registers (see SFR Definition 8.2 and SFR Definition 8.4). Selecting a longer response time reduces the Comparator supply current.

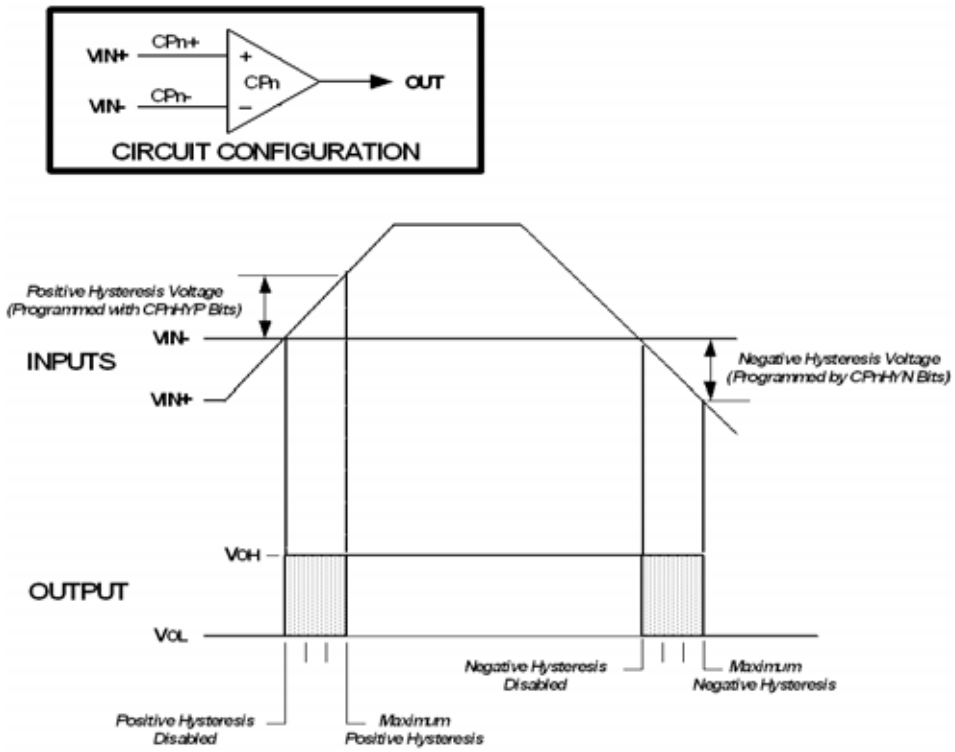

Figure 8.3. Comparator Hysteresis Plot

The Comparator hysteresis is software-programmable via its Comparator Control register CPTnCN (for n = 0 or 1). The user can program both the amount of hysteresis voltage (referred to the input voltage) and the positive and negative-going symmetry of this hysteresis around the threshold voltage.

The Comparator hysteresis is programmed using Bits 3–0 in the Comparator Control Register CPTnCN (shown in SFR Definition 8.1). The amount of negative hysteresis voltage is determined by the settings of the CPnHYN bits. Settings of 20, 10 or 5 mV of nominal negative hysteresis can be programmed, or negative hysteresis can be disabled. In a similar way, the amount of positive hysteresis is determined by the setting the CPnHYP bits.

Comparator interrupts can be generated on both rising-edge and falling-edge output transitions. (For Interrupt enable and priority control, see Section “16.1. MCU Interrupt Sources and Vectors” on page 119). The CPnFIF flag is set to logic 1 upon a Comparator falling-edge occurrence, and the CPnRIF flag is set to logic 1 upon the Comparator rising-edge occurrence. Once set, these bits remain set until cleared by software. The Comparator rising-edge interrupt mask is enabled by setting CPnRIE to a logic 1. The Comparator falling-edge interrupt mask is enabled by setting CPnFIE to a logic 1.

The output state of the Comparator can be obtained at any time by reading the CPnOUT bit. The Comparator is enabled by setting the CPnEN bit to logic 1, and is disabled by clearing this bit to logic 0.

Note that false rising edges and falling edges can be detected when the comparator is first powered on or if changes are made to the hysteresis or response time control bits. Therefore, it is recommended that the rising-edge and falling-edge flags be explicitly cleared to logic 0 a short time after the comparator is enabled or its mode bits have been changed.

SFR Definition 8.1. CPT0CN: Comparator0 Control

Bit	7	6	5	4	3	2	1	0
Name	CP0EN	CP0OUT	CP0RIF	CP0FIF	CP0HYP[1:0]		CP0HYN[1:0]	
Type	R/W	R	R/W	R/W	R/W		R/W	
Reset	0	0	0	0	0	0	0	0

SFR Address = 0x9B; SFR Page = All Pages

Bit	Name	Function
7	CP0EN	**Comparator0 Enable Bit.** 0: Comparator0 Disabled. 1: Comparator0 Enabled.
6	CP0OUT	**Comparator0 Output State Flag.** 0: Voltage on CP0+ < CP0–. 1: Voltage on CP0+ > CP0–.
5	CP0RIF	**Comparator0 Rising-Edge Flag. Must be cleared by software.** 0: No Comparator0 Rising Edge has occurred since this flag was last cleared. 1: Comparator0 Rising Edge has occurred.
4	CP0FIF	**Comparator0 Falling-Edge Flag. Must be cleared by software.** 0: No Comparator0 Falling-Edge has occurred since this flag was last cleared. 1: Comparator0 Falling-Edge has occurred.
3:2	CP0HYP[1:0]	**Comparator0 Positive Hysteresis Control Bits.** 00: Positive Hysteresis Disabled. 01: Positive Hysteresis = 5 mV. 10: Positive Hysteresis = 10 mV. 11: Positive Hysteresis = 20 mV.
1:0	CP0HYN[1:0]	**Comparator0 Negative Hysteresis Control Bits.** 00: Negative Hysteresis Disabled. 01: Negative Hysteresis = 5 mV. 10: Negative Hysteresis = 10 mV. 11: Negative Hysteresis = 20 mV.

The upper 128 bytes of data memory are accessible only by indirect addressing. This region occupies the same address space as the Special Function Registers (SFR) but is physically separate from the SFR space. The addressing mode used by an instruction when accessing locations above 0x7F determines whether the CPU accesses the upper 128 bytes of data memory space or the SFRs. Instructions that use direct addressing will access the SFR space. Instructions using indirect addressing above 0x7F access the upper 128 bytes of data memory. Figure 13.1 illustrates the data memory organization of the CIP-51.

13.3. General Purpose Registers

The lower 32 bytes of data memory, locations 0x00 through 0x1F, may be addressed as four banks of general-purpose registers. Each bank consists of eight byte-wide registers designated R0 through R7. Only one of these banks may be enabled at a time. Two bits in the program status word, RS0 (PSW.3) and RS1 (PSW.4), select the active register bank (see description of the PSW in SFR Definition 11.6). This allows fast context switching when entering subroutines and interrupt service routines. Indirect addressing modes use registers R0 and R1 as index registers.

13.4. Bit Addressable Locations

In addition to direct access to data memory organized as bytes, the sixteen data memory locations at 0x20 through 0x2F are also accessible as 128 individually addressable bits. Each bit has a bit address from 0x00 to 0x7F. Bit 0 of the byte at 0x20 has bit address 0x00 while bit7 of the byte at 0x20 has bit address 0x07. Bit 7 of the byte at 0x2F has bit address 0x7F. A bit access is distinguished from a full byte access by the type of instruction used (bit source or destination operands as opposed to a byte source or destination).

The MCS-51™ assembly language allows an alternate notation for bit addressing of the form XX.B where XX is the byte address and B is the bit position within the byte. For example, the instruction:

```
MOV    C, 22h.3
```

moves the Boolean value at 0x13 (bit 3 of the byte at location 0x22) into the Carry flag.

13.5. Stack

A programmer's stack can be located anywhere in the 256-byte data memory. The stack area is designated using the Stack Pointer (SP, 0x81) SFR. The SP will point to the last location used. The next value pushed on the stack is placed at SP+1 and then SP is incremented. A reset initializes the stack pointer to location 0x07. Therefore, the first value pushed on the stack is placed at location 0x08, which is also the first register (R0) of register bank 1. Thus, if more than one register bank is to be used, the SP should be initialized to a location in the data memory not being used for data storage. The stack depth can extend up to 256 bytes.

14.2. Accessing USB FIFO Space

The C8051F380/1/2/3/4/5/6/7/C include 1k of RAM which functions as USB FIFO space. Figure 14.1 shows an expanded view of the FIFO space and user XRAM. FIFO space is normally accessed via USB FIFO registers; see Section “21.5. FIFO Management” on page 181 for more information on accessing these FIFOs. The MOVX instruction should not be used to load or modify USB data in the FIFO space.

Unused areas of the USB FIFO space may be used as general purpose XRAM if necessary. The FIFO block operates on the USB clock domain; thus the USB clock must be active when accessing FIFO space. Note that the number of SYSCLK cycles required by the MOVX instruction is increased when accessing USB FIFO space.

To access the FIFO RAM directly using MOVX instructions, the following conditions must be met: (1) the USBFAE bit in register EMI0CF must be set to 1, and (2) the USB clock must be greater than or equal to twice the SYSCLK (USBCLK ≥ 2 x SYSCLK). When this bit is set, the USB FIFO space is mapped into XRAM space at addresses 0x0400 to 0x07FF. The normal XRAM (on-chip or external) at the same addresses cannot be accessed when the USBFAE bit is set to 1.

Important Note: The USB clock must be active when accessing FIFO space.

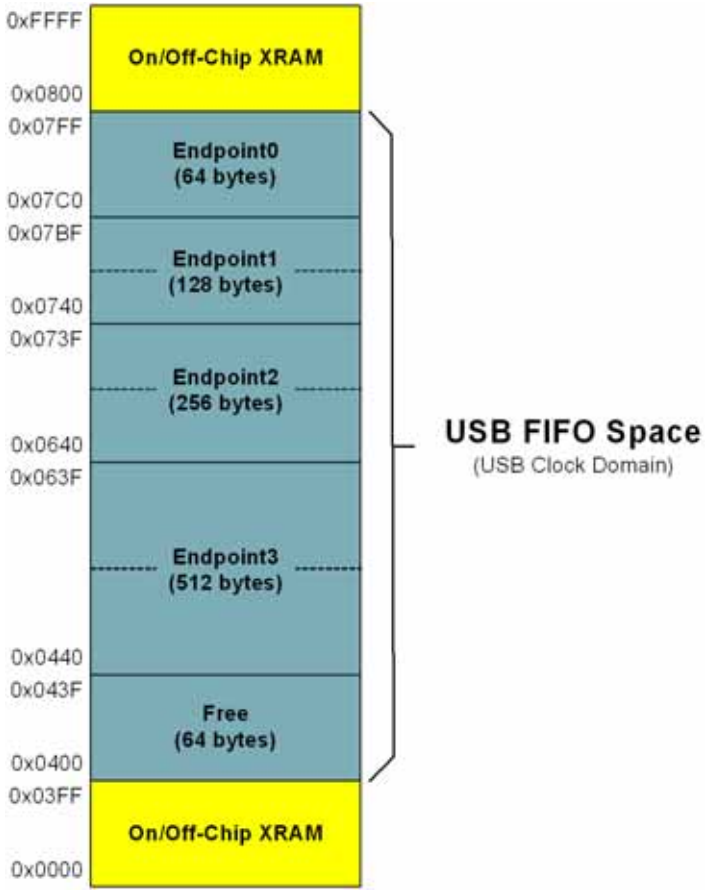

Figure 14.1. USB FIFO Space and XRAM Memory Map with USBFAE set to ‘1’

14.7.2.2. 8-bit MOVX without Bank Select: EMI0CF[4:2] = 001 or 011

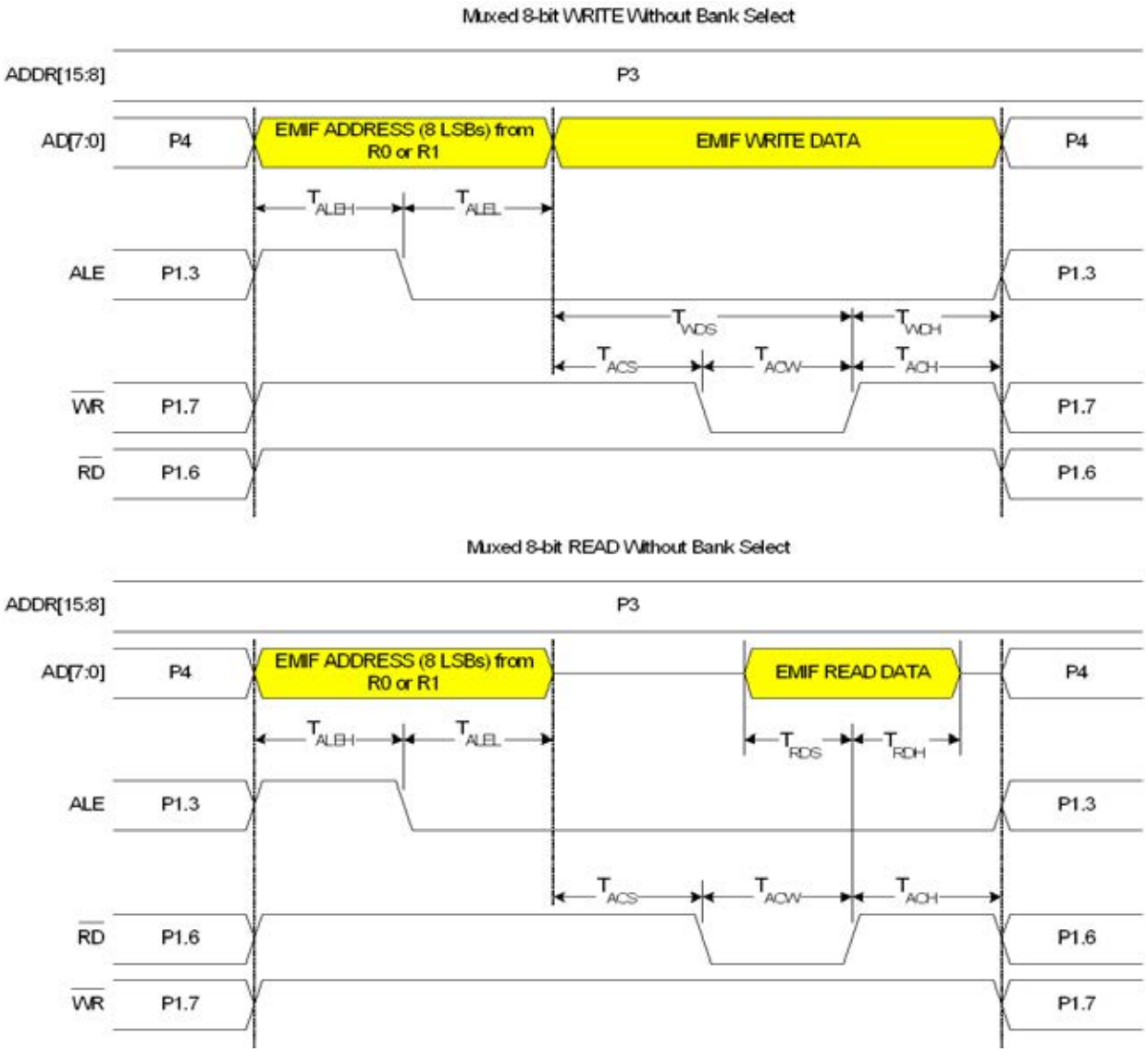

Figure 14.9. Multiplexed 8-bit MOVX without Bank Select Timing

SFR Definition 16.3. EIE1: Extended Interrupt Enable 1

Bit	7	6	5	4	3	2	1	0
Name	ET3	ECP1	ECP0	EPCA0	EADC0	EWADC0	EUSB0	ESMB0
Type	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W
Reset	0	0	0	0	0	0	0	0

SFR Address = 0xE6; SFR Page = All Pages

Bit	Name	Function
7	ET3	**Enable Timer 3 Interrupt.** This bit sets the masking of the Timer 3 interrupt. 0: Disable Timer 3 interrupts. 1: Enable interrupt requests generated by the TF3L or TF3H flags.
6	ECP1	**Enable Comparator1 (CP1) Interrupt.** This bit sets the masking of the CP1 interrupt. 0: Disable CP1 interrupts. 1: Enable interrupt requests generated by the CP1RIF or CP1FIF flags.
5	ECP0	**Enable Comparator0 (CP0) Interrupt.** This bit sets the masking of the CP0 interrupt. 0: Disable CP0 interrupts. 1: Enable interrupt requests generated by the CP0RIF or CP0FIF flags.
4	EPCA0	**Enable Programmable Counter Array (PCA0) Interrupt.** This bit sets the masking of the PCA0 interrupts. 0: Disable all PCA0 interrupts. 1: Enable interrupt requests generated by PCA0.
3	EADC0	**Enable ADC0 Conversion Complete Interrupt.** This bit sets the masking of the ADC0 Conversion Complete interrupt. 0: Disable ADC0 Conversion Complete interrupt. 1: Enable interrupt requests generated by the AD0INT flag.
2	EWADC0	**Enable Window Comparison ADC0 Interrupt.** This bit sets the masking of ADC0 Window Comparison interrupt. 0: Disable ADC0 Window Comparison interrupt. 1: Enable interrupt requests generated by ADC0 Window Compare flag (AD0WINT).
1	EUSB0	**Enable USB (USB0) Interrupt.** This bit sets the masking of the USB0 interrupt. 0: Disable all USB0 interrupts. 1: Enable interrupt requests generated by USB0.
0	ESMB0	**Enable SMBus0 Interrupt.** This bit sets the masking of the SMB0 interrupt. 0: Disable all SMB0 interrupts. 1: Enable interrupt requests generated by SMB0.

17.1. Power-On Reset

During power-up, the device is held in a reset state and the $\overline{RST}$ pin is driven low until V_{DD} settles above V_{RST}. A delay occurs before the device is released from reset; the delay decreases as the V_{DD} ramp time increases (V_{DD} ramp time is defined as how fast V_{DD} ramps from 0 V to V_{RST}). Figure 17.2. plots the power-on and V_{DD} monitor event timing. The maximum V_{DD} ramp time is 1 ms; slower ramp times may cause the device to be released from reset before V_{DD} reaches the V_{RST} level. For ramp times less than 1 ms, the power-on reset delay ($T_{PORDelay}$) is typically less than 0.3 ms.

On exit from a power-on or V_{DD} monitor reset, the PORSF flag (RSTSRC.1) is set by hardware to logic 1. When PORSF is set, all of the other reset flags in the RSTSRC Register are indeterminate (PORSF is cleared by all other resets). Since all resets cause program execution to begin at the same location (0x0000) software can read the PORSF flag to determine if a power-up was the cause of reset. The content of internal data memory should be assumed to be undefined after a power-on reset. The V_{DD} monitor is enabled following a power-on reset.

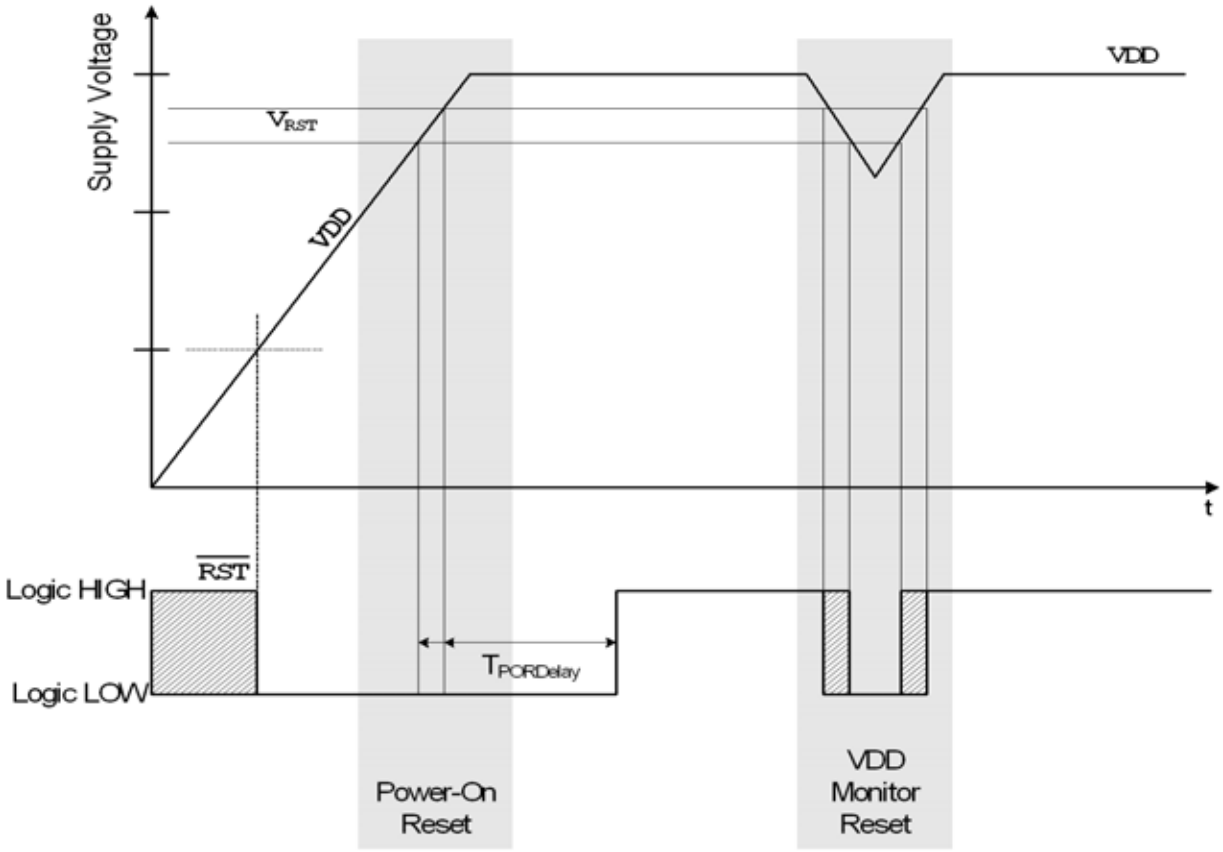

Figure 17.2. Power-On and V_{DD} Monitor Reset Timing

19.3. Programmable Internal High-Frequency (H-F) Oscillator

All C8051F380/1/2/3/4/5/6/7/C devices include a programmable internal high-frequency oscillator that defaults as the system clock after a system reset. The internal oscillator period can be adjusted via the OSCICL register as defined by SFR Definition 19.2.

On C8051F380/1/2/3/4/5/6/7/C devices, OSCICL is factory calibrated to obtain a 48 MHz base frequency. Note that the system clock may be derived from the programmed internal oscillator divided by 1, 2, 4, or 8 after a divide by 4 stage, as defined by the IFCN bits in register OSCICN. The divide value defaults to 8 following a reset, which results in a 1.5 MHz system clock.

19.3.1. Internal Oscillator Suspend Mode

When software writes a logic 1 to SUSPEND (OSCICN.5), the internal oscillator is suspended. If the system clock is derived from the internal oscillator, the input clock to the peripheral or CIP-51 will be stopped until a non-idle USB event is detected or a rising or falling edge occurs on the VBUS signal. Note that the USB transceiver can still detect USB events when it is disabled.

When one of the oscillator awakening events occur, the internal oscillator, CIP-51, and affected peripherals resume normal operation. The CPU resumes execution at the instruction following the write to the SUSPEND bit.

Note: The prefetch engine can be turned off in suspend mode to save power. Additionally, both Voltage Regulators (REG0 and REG1) have low-power modes for additional power savings in suspend mode.

SFR Definition 19.2. OSCICL: Internal H-F Oscillator Calibration

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

SFR Address = 0xB3; SFR Page = All Pages

Bit	Name	Function
7	Unused	Read = 0; Write = don't care
6:0	OSCICL[6:0]	**Internal Oscillator Calibration Bits.** These bits determine the internal oscillator period. When set to 0000000b, the H-F oscillator operates at its fastest setting. When set to 1111111b, the H-F oscillator operates at its slowest setting. The reset value is factory calibrated to generate an internal oscillator frequency of 48 MHz. OSCICL should only be changed by firmware when the H-F oscillator is disabled (IOSCEN = 0).

19.4. Clock Multiplier

The C8051F380/1/2/3/4/5/6/7/C device includes a 48 MHz high-frequency oscillator instead of a 12 MHz oscillator and a 4x Clock Multiplier, so the USB0 module can be run directly from the internal high-frequency oscillator. For compatibility with C8051F34x and C8051F32x devices however, the CLKMUL register (SFR Definition 19.4) behaves as if the Clock Multiplier is present and working.

SFR Definition 19.4. CLKMUL: Clock Multiplier Control

Bit	7	6	5	4	3	2	1	0
Name	MULEN	MULINIT	MULRDY				MULSEL[1:0]	
Type	R	R	R	R	R	R	R	
Reset	1	1	1	0	0	0	0	0

SFR Address = 0xB9; SFR Page = 0

Bit	Name	Description
7	MULEN	**Clock Multiplier Enable Bit.** This bit always reads 1.
6	MULINIT	**Clock Multiplier Initialize Bit.** This bit always reads 1.
5	MULRDY	**Clock Multiplier Ready Bit.** This bit always reads 1.
4:2	Unused	Read = 000b; Write = don't care
1:0	MULSEL[1:0]	**Clock Multiplier Input Select Bits.** These bits always read 00.

19.5. Programmable Internal Low-Frequency (L-F) Oscillator

All C8051F380/1/2/3/4/5/6/7/C devices include a programmable low-frequency internal oscillator, which is calibrated to a nominal frequency of 80 kHz. The low-frequency oscillator circuit includes a divider that can be changed to divide the clock by 1, 2, 4, or 8, using the OSCLD bits in the OSCLCN register (see SFR Definition 19.5). Additionally, the OSCLF[3:0] bits can be used to adjust the oscillator's output frequency.

19.5.1. Calibrating the Internal L-F Oscillator

Timers 2 and 3 include capture functions that can be used to capture the oscillator frequency, when running from a known time base. When either Timer 2 or Timer 3 is configured for L-F Oscillator Capture Mode, a falling edge (Timer 2) or rising edge (Timer 3) of the low-frequency oscillator's output will cause a capture event on the corresponding timer. As a capture event occurs, the current timer value (TMRnH:TMRnL) is copied into the timer reload registers (TMRnRLH:TMRnRLL). By recording the difference between two successive timer capture values, the low-frequency oscillator's period can be calculated. The OSCLF bits can then be adjusted to produce the desired oscillator frequency.

SFR Definition 19.5. OSCLCN: Internal L-F Oscillator Control

Bit	7	6	5	4	3	2	1	0
Name	OSCLEN	OSCLRDY	OSCLF[3:0]				OSCLD[1:0]	
Type	R/W	R	R.W				R/W	
Reset	0	0	Varies	Varies	Varies	Varies	0	0

SFR Address = 0x86; SFR Page = All Pages

Bit	Name	Function
7	OSCLEN	**Internal L-F Oscillator Enable.** 0: Internal L-F Oscillator Disabled. 1: Internal L-F Oscillator Enabled.
6	OSCLRDY	**Internal L-F Oscillator Ready.** 0: Internal L-F Oscillator frequency not stabilized. 1: Internal L-F Oscillator frequency stabilized. **Note:** OSCLRDY is only set back to 0 in the event of a device reset or a change to the OSCLD[1:0] bits.
5:2	OSCLF[3:0]	**Internal L-F Oscillator Frequency Control Bits.** Fine-tune control bits for the Internal L-F oscillator frequency. When set to 0000b, the L-F oscillator operates at its fastest setting. When set to 1111b, the L-F oscillator operates at its slowest setting. The OSCLF bits should only be changed by firmware when the L-F oscillator is disabled (OSCLEN = 0).
1:0	OSCLD[1:0]	**Internal L-F Oscillator Divider Select.** 00: Divide by 8 selected. 01: Divide by 4 selected. 10: Divide by 2 selected. 11: Divide by 1 selected.

Table 22.3. Sources for Hardware Changes to SMBnCN

Bit	Set by Hardware When:	Cleared by Hardware When:
MASTERn	■ A START is generated.	■ A STOP is generated. ■ Arbitration is lost.
TXMODEn	■ START is generated. ■ SMBnDAT is written before the start of an SMBus frame.	■ A START is detected. ■ Arbitration is lost. ■ SMBnDAT is not written before the start of an SMBus frame.
STAn	■ A START followed by an address byte is received.	■ Must be cleared by software.
STOn	■ A STOP is detected while addressed as a slave. ■ Arbitration is lost due to a detected STOP.	■ A pending STOP is generated.
ACKRQn	■ A byte has been received and an ACK response value is needed (only when hardware ACK is not enabled).	■ After each ACK cycle.
ARBLOSTn	■ A repeated START is detected as a MASTER when STAn is low (unwanted repeated START). ■ SCLn is sensed low while attempting to generate a STOP or repeated START condition. ■ SDAn is sensed low while transmitting a 1 (excluding ACK bits).	■ Each time SIn is cleared.
ACKn	■ The incoming ACK value is low (ACKNOWLEDGE).	■ The incoming ACK value is high (NOT ACKNOWLEDGE).
SIn	■ A START has been generated. ■ Lost arbitration. ■ A byte has been transmitted and an ACK/NACK received. ■ A byte has been received. ■ A START or repeated START followed by a slave address + R/W has been received. ■ A STOP has been received.	■ Must be cleared by software.

22.4.4. Hardware Slave Address Recognition

The SMBus hardware has the capability to automatically recognize incoming slave addresses and send an ACK without software intervention. Automatic slave address recognition is enabled by setting the EHACK bit in register SMB0ADM to 1. This will enable both automatic slave address recognition and automatic hardware ACK generation for received bytes (as a master or slave). More detail on automatic hardware ACK generation can be found in Section 22.4.3.2.

The registers used to define which address(es) are recognized by the hardware are the SMBus Slave Address register and the SMBus Slave Address Mask register. A single address or range of addresses (including the General Call Address 0x00) can be specified using these two registers. The most-significant seven bits of the two registers are used to define which addresses will be ACKed. A 1 in bit positions of the slave address mask SLVM[6:0] enable a comparison between the received slave address and the hardware's slave address SLV[6:0] for those bits. A 0 in a bit of the slave address mask means that bit will be treated as a "don't care" for comparison purposes. In this case, either a 1 or a 0 value are acceptable on

24.3. Configuration and Operation

UART1 provides standard asynchronous, full duplex communication. It can operate in a point-to-point serial communications application, or as a node on a multi-processor serial interface. To operate in a point-to-point application, where there are only two devices on the serial bus, the MCE1 bit in SMOD1 should be cleared to 0. For operation as part of a multi-processor communications bus, the MCE1 and XBE1 bits should both be set to 1. In both types of applications, data is transmitted from the microcontroller on the TX1 pin, and received on the RX1 pin. The TX1 and RX1 pins are configured using the crossbar and the Port I/O registers, as detailed in Section “20. Port Input/Output” on page 153.

In typical UART communications, The transmit (TX) output of one device is connected to the receive (RX) input of the other device, either directly or through a bus transceiver, as shown in Figure 24.5.

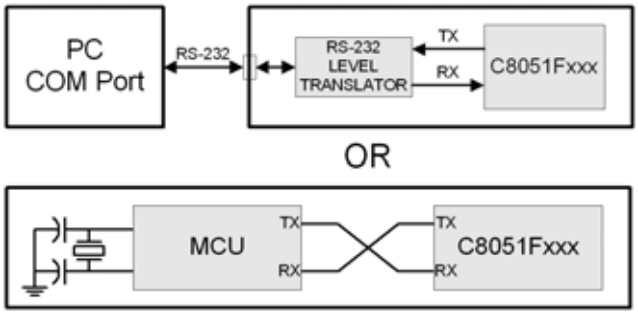

Figure 24.5. Typical UART Interconnect Diagram

24.3.1. Data Transmission

Data transmission is double-buffered, and begins when software writes a data byte to the SBUF1 register. Writing to SBUF1 places data in the Transmit Holding Register, and the Transmit Holding Register Empty flag (THRE1) will be cleared to 0. If the UARTs shift register is empty (i.e. no transmission is in progress) the data will be placed in the shift register, and the THRE1 bit will be set to 1. If a transmission is in progress, the data will remain in the Transmit Holding Register until the current transmission is complete. The TI1 Transmit Interrupt Flag (SCON1.1) will be set at the end of any transmission (the beginning of the stop-bit time). If enabled, an interrupt will occur when TI1 is set.

If the extra bit function is enabled (XBE1 = 1) and the parity function is disabled (PE1 = 0), the value of the TBX1 (SCON1.3) bit will be sent in the extra bit position. When the parity function is enabled (PE1 = 1), hardware will generate the parity bit according to the selected parity type (selected with S1PT[1:0]), and append it to the data field. Note: when parity is enabled, the extra bit function is not available.

24.3.2. Data Reception

Data reception can begin any time after the REN1 Receive Enable bit (SCON1.4) is set to logic 1. After the stop bit is received, the data byte will be stored in the receive FIFO if the following conditions are met: the receive FIFO (3 bytes deep) must not be full, and the stop bit(s) must be logic 1. In the event that the receive FIFO is full, the incoming byte will be lost, and a Receive FIFO Overrun Error will be generated (OVR1 in register SCON1 will be set to logic 1). If the stop bit(s) were logic 0, the incoming data will not be stored in the receive FIFO. If the reception conditions are met, the data is stored in the receive FIFO, and the RI1 flag will be set. Note: when MCE1 = 1, RI1 will only be set if the extra bit was equal to 1. Data can be read from the receive FIFO by reading the SBUF1 register. The SBUF1 register represents the oldest byte in the FIFO. After SBUF1 is read, the next byte in the FIFO is immediately loaded into SBUF1, and space is made available in the FIFO for another incoming byte. If enabled, an interrupt will occur when RI1 is set. RI1 can only be cleared to '0' by software when there is no more information in the FIFO. The recommended procedure to empty the FIFO contents is:

28.2. C2 Pin Sharing

The C2 protocol allows the C2 pins to be shared with user functions so that in-system debugging and Flash programming 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 ($\overline{\text{RST}}$) and C2D pins. In most applications, external resistors are required to isolate C2 interface traffic from the user application. A typical isolation configuration is shown in Figure 28.1.

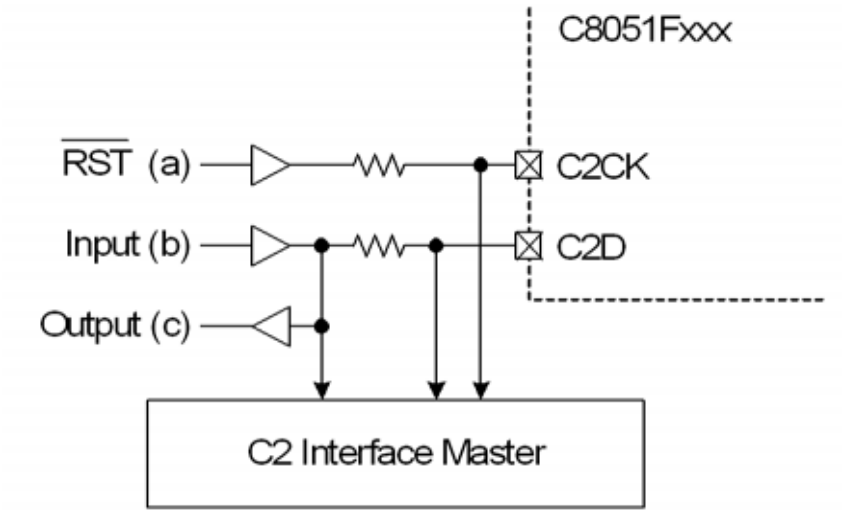

Figure 28.1. Typical C2 Pin Sharing

The configuration in Figure 28.1 assumes the following:

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

Additional resistors may be necessary depending on the specific application.

Document Change List

Revision 0.2 to Revision 1.0

- Updated Electrical Characteristics tables with latest data: Table 4.2, Table 4.4, Table 4.5, Table 4.7, Table 4.8, Table 4.10, Table 4.11 and Table 4.12.
- Changed bit REG01CN.5 to Reserved in SFR Definition 8.1 and updated corresponding descriptions in sections 16.9 and 18.3.1.
- Updated Figure 18.1. Oscillator Options.
- Changed SFR Page in SFR Definition 21.2.
- Updated descriptions of XOSCMD for Capacitor and RC modes in SFR Definition 18.6.

Revision 1.0 to Revision 1.1

- Updated front-page diagram to reflect the correct number of Timers, 6 instead of 4.
- Updated Table 3.2, “TQFP-48 Package Dimensions,” on page 26 with the following:
  - Fixed right-most column name from Min to Max
  - Added max values for dimensions A, A1, A2, b, c, L, and q
- Updated Figure 3.8 and Table 3.6 with correct QFN-32 package drawing and dimensions.
- Updated Table 5.10, “ADC0 Electrical Characteristics,” on page 42 with new maximum value for ADC0 Power Supply Current. This addresses an item from the May 18th, 2012 Errata.
- Added Section 6.2 regarding the Temperature Sensor.
- Removed references to programmable gain in “6. 10-Bit ADC (ADC0, C8051F380/1/2/3/C only)” .
- Updated Table 15.1, “Special Function Register (SFR) Memory Map,” on page 112 to fill in the missing row information for the 0xC8 row.
- Updated Table 16.1, “Interrupt Summary,” on page 120. The TMR4CN register is not bit-addressable.
- Updated definition for the 000b value of the CLKSL bits in SFR Definition 19.1 (CLKSEL) to include the /4 factor.

Revision 1.1 to Revision 1.2

- Updated Comparator Input Offset Voltage specification in Table 5.13 on page 44.

Revision 1.2 to Revision 1.3

- Added VBUS to Table 5.1, “Absolute Maximum Ratings,” on page 37.
- Added the “4. Typical Connection Diagrams” chapter.
- Removed Figure 8.1, Figure 8.2, Figure 8.3, and Figure 8.4. These figures were replaced with a reference to the “4. Typical Connection Diagrams” chapter.

Revision 1.3 to Revision 1.4

- Added new device C8051F38C.
- Updated Flash Endurance minimum specification, Flash Erase Cycle Time maximum specification, and added a note to Table 5.6 on page 40.
- Updated Figure 22.1 to show proper clock sources for SMBus0 and SMBus1.