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Applications of "Embedded - Microcontrollers"

Details	
Product Status	Not For New Designs
Core Processor	8051
Core Size	8-Bit
Speed	48MHz
Connectivity	EBI/EMI, SMBus (2-Wire/I²C), SPI, UART/USART, USB
Peripherals	Brown-out Detect/Reset, POR, PWM, Temp Sensor, WDT
Number of I/O	40
Program Memory Size	32KB (32K x 8)
Program Memory Type	FLASH
EEPROM Size	-
RAM Size	2.25K x 8
Voltage - Supply (Vcc/Vdd)	2.7V ~ 3.6V
Data Converters	A/D 20x10b
Oscillator Type	Internal
Operating Temperature	-40°C ~ 85°C (TA)
Mounting Type	Surface Mount
Package / Case	48-TQFP
Supplier Device Package	48-TQFP (7x7)
Purchase URL	https://www.e-xfl.com/product-detail/silicon-labs/c8051f341-gq

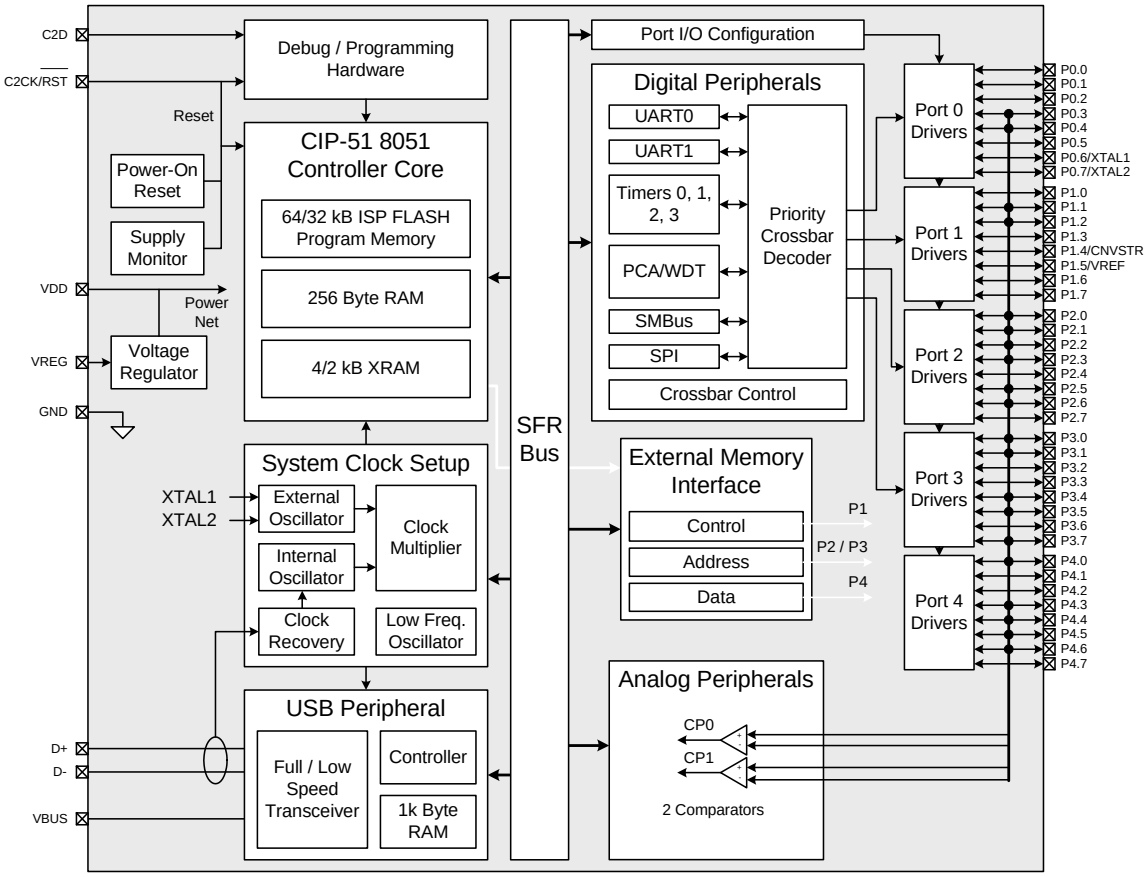


Figure 1.3. C8051F348/C Block Diagram

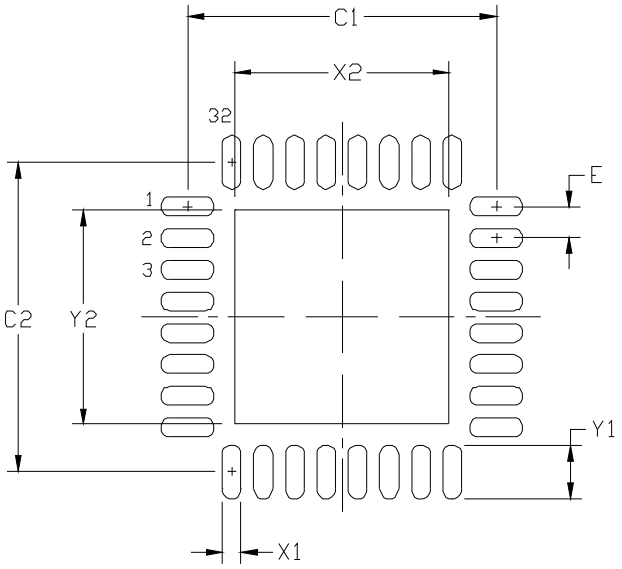


Figure 4.9. QFN-32 Recommended PCB Land Pattern

Table 4.7. QFN-32 PCB Land Pattern Dimesions

Dimension	Min	Max
C1	4.80	4.90
C2	4.80	4.90
E	0.50 BSC	
X1	0.20	0.30

Dimension	Min	Max
X2	3.20	3.40
Y1	0.75	0.85
Y2	3.20	3.40

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 60µm 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 perimeter pins.
7. A 3x3 array of 1.0 mm openings on a 1.2mm pitch should be used for the center pad to assure the proper paste volume.

Card Assembly:

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

9. CIP-51 Microcontroller

The MCU system controller core is the CIP-51 microcontroller. The CIP-51 is fully compatible with the MCS-51™ instruction set; standard 803x/805x assemblers and compilers can be used to develop software. The MCU family has a superset of all the peripherals included with a standard 8051. Included are four 16-bit counter/timers (see description in **Section 21**), an enhanced full-duplex UART (see description in **Section 18**), an Enhanced SPI (see description in **Section 20**), 256 bytes of internal RAM, 128 byte Special Function Register (SFR) address space (**Section 9.2.6**), and 25 Port I/O (see description in **Section 15**). The CIP-51 also includes on-chip debug hardware (see description in **Section 23**), and interfaces directly with the analog and digital subsystems providing a complete data acquisition or control-system solution in a single integrated circuit.

The CIP-51 Microcontroller core implements the standard 8051 organization and peripherals as well as additional custom peripherals and functions to extend its capability (see Figure 9.1 for a block diagram). The CIP-51 includes the following features:

- Fully Compatible with MCS-51 Instruction Set
- 0 to 48 MHz Clock Frequency
- 256 Bytes of Internal RAM
- 25 Port I/O
- Extended Interrupt Handler
- Reset Input
- Power Management Modes
- On-chip Debug Logic
- Program and Data Memory Security

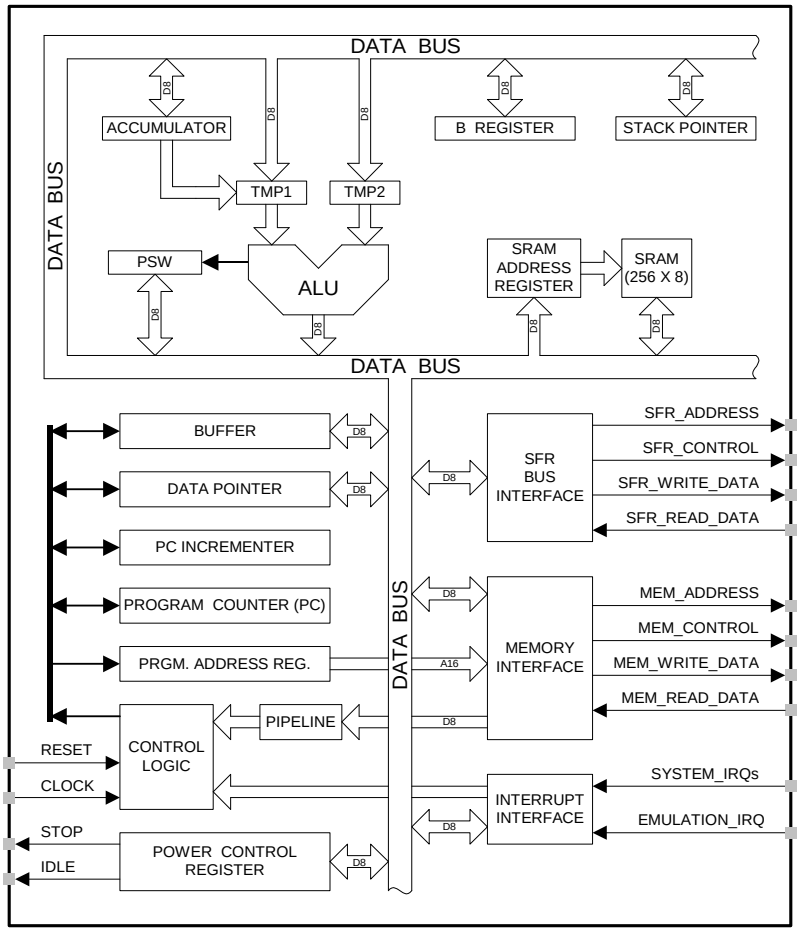


Figure 9.1. CIP-51 Block Diagram

Table 9.3. Special Function Registers (Continued)

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

Register	Address	Description	Page
P1MDIN	0xF2	Port 1 Input Mode Configuration	152
P1MDOUT	0xA5	Port 1 Output Mode Configuration	152
P1SKIP	0xD5	Port 1 Skip	153
P2	0xA0	Port 2 Latch	153
P2MDIN	0xF3	Port 2 Input Mode Configuration	153
P2MDOUT	0xA6	Port 2 Output Mode Configuration	154
P2SKIP	0xD6	Port 2 Skip	154
P3	0xB0	Port 3 Latch	155
P3MDIN	0xF4	Port 3 Input Mode Configuration	155
P3MDOUT	0xA7	Port 3 Output Mode Configuration	155
P3SKIP	0xDF	Port 3Skip	156
P4	0xC7	Port 4 Latch	156
P4MDIN	0xF5	Port 4 Input Mode Configuration	157
P4MDOUT	0xAE	Port 4 Output Mode Configuration	157
PCA0CN	0xD8	PCA Control	266
PCA0CPH0	0xFC	PCA Capture 0 High	270
PCA0CPH1	0xEA	PCA Capture 1 High	270
PCA0CPH2	0xEC	PCA Capture 2 High	270
PCA0CPH3	0xEE	PCA Capture 3High	270
PCA0CPH4	0xFE	PCA Capture 4 High	270
PCA0CPL0	0xFB	PCA Capture 0 Low	269
PCA0CPL1	0xE9	PCA Capture 1 Low	269
PCA0CPL2	0xEB	PCA Capture 2 Low	269
PCA0CPL3	0xED	PCA Capture 3 Low	269
PCA0CPL4	0xFD	PCA Capture 4 Low	269
PCA0CPM0	0xDA	PCA Module 0 Mode Register	268
PCA0CPM1	0xDB	PCA Module 1 Mode Register	268
PCA0CPM2	0xDC	PCA Module 2 Mode Register	268
PCA0CPM3	0xDD	PCA Module 3 Mode Register	268
PCA0CPM4	0xDE	PCA Module 4 Mode Register	268
PCA0H	0xFA	PCA Counter High	269
PCA0L	0xF9	PCA Counter Low	269
PCA0MD	0xD9	PCA Mode	267
PCON	0x87	Power Control	98
PFE0CN	0xAF	Prefetch Engine Control	99
PSCTL	0x8F	Program Store R/W Control	112
PSW	0xD0	Program Status Word	87
REF0CN	0xD1	Voltage Reference Control	58
REG0CN	0xC9	Voltage Regulator Control	72
RSTSRC	0xEF	Reset Source Configuration/Status	105
SBCON1	0xAC	UART1 Baud Rate Generator Control	220
SBRLH1	0xB5	UART1 Baud Rate Generator High	221
SBRLL1	0xB4	UART1 Baud Rate Generator Low	221
SBUF1	0xD3	UART1 Data Buffer	220
SCON1	0xD2	UART1 Control	218

SFR Definition 9.11. EIE2: Extended Interrupt Enable 2

R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	Reset Value
-	-	-	-	-	-	ES1	EVBUS	00000000
Bit7	Bit6	Bit5	Bit4	Bit3	Bit2	Bit1	Bit0	SFR Address:
								0xE7

Bits7–2: UNUSED. Read = 000000b. Write = don't care.
Bit1: ES1: Enable UART1 Interrupt.
This bit sets the masking of the UART1 interrupt.
0: Disable UART1 interrupt.
1: Enable UART1 interrupt.
Bit0: EVBUS: Enable VBUS Level Interrupt.
This bit sets the masking of the VBUS interrupt.
0: Disable all VBUS interrupts.
1: Enable interrupt requests generated by VBUS level sense.

SFR Definition 9.12. EIP2: Extended Interrupt Priority 2

R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	Reset Value
-	-	-	-	-	-	PS1	PVBUS	00000000
Bit7	Bit6	Bit5	Bit4	Bit3	Bit2	Bit1	Bit0	SFR Address:
								0xF7

Bits7–2: UNUSED. Read = 000000b. Write = don't care.
Bit1: PS1: UART1 Interrupt Priority Control.
This bit sets the priority of the UART1 interrupt.
0: UART1 interrupt set to low priority level.
1: UART1 interrupts set to high priority level.
Bit0: PVBUS: VBUS Level Interrupt Priority Control.
This bit sets the priority of the VBUS interrupt.
0: VBUS interrupt set to low priority level.
1: VBUS interrupt set to high priority level.

11.8. Software Reset

Software may force a reset by writing a ‘1’ to the SWRSF bit (RSTSRC.4). The SWRSF bit will read ‘1’ following a software forced reset. The state of the $\overline{\text{RST}}$ pin is unaffected by this reset.

11.9. USB Reset

Writing ‘1’ to the USBRSF bit in register RSTSRC selects USB0 as a reset source. With USB0 selected as a reset source, a system reset will be generated when either of the following occur:

1. RESET signaling is detected on the USB network. The USB Function Controller (USB0) must be enabled for RESET signaling to be detected. See **Section “16. Universal Serial Bus Controller (USB0)” on page 159** for information on the USB Function Controller.
2. The voltage on the VBUS pin matches the polarity selected by the VBPOL bit in register REG0CN. See **Section “8. Voltage Regulator (REG0)” on page 69** for details on the VBUS detection circuit.

The USBRSF bit will read ‘1’ following a USB reset. The state of the $\overline{\text{RST}}$ pin is unaffected by this reset.

13.7.1.3.8-bit MOVX with Bank Select: EMI0CF[4:2] = ‘110’.

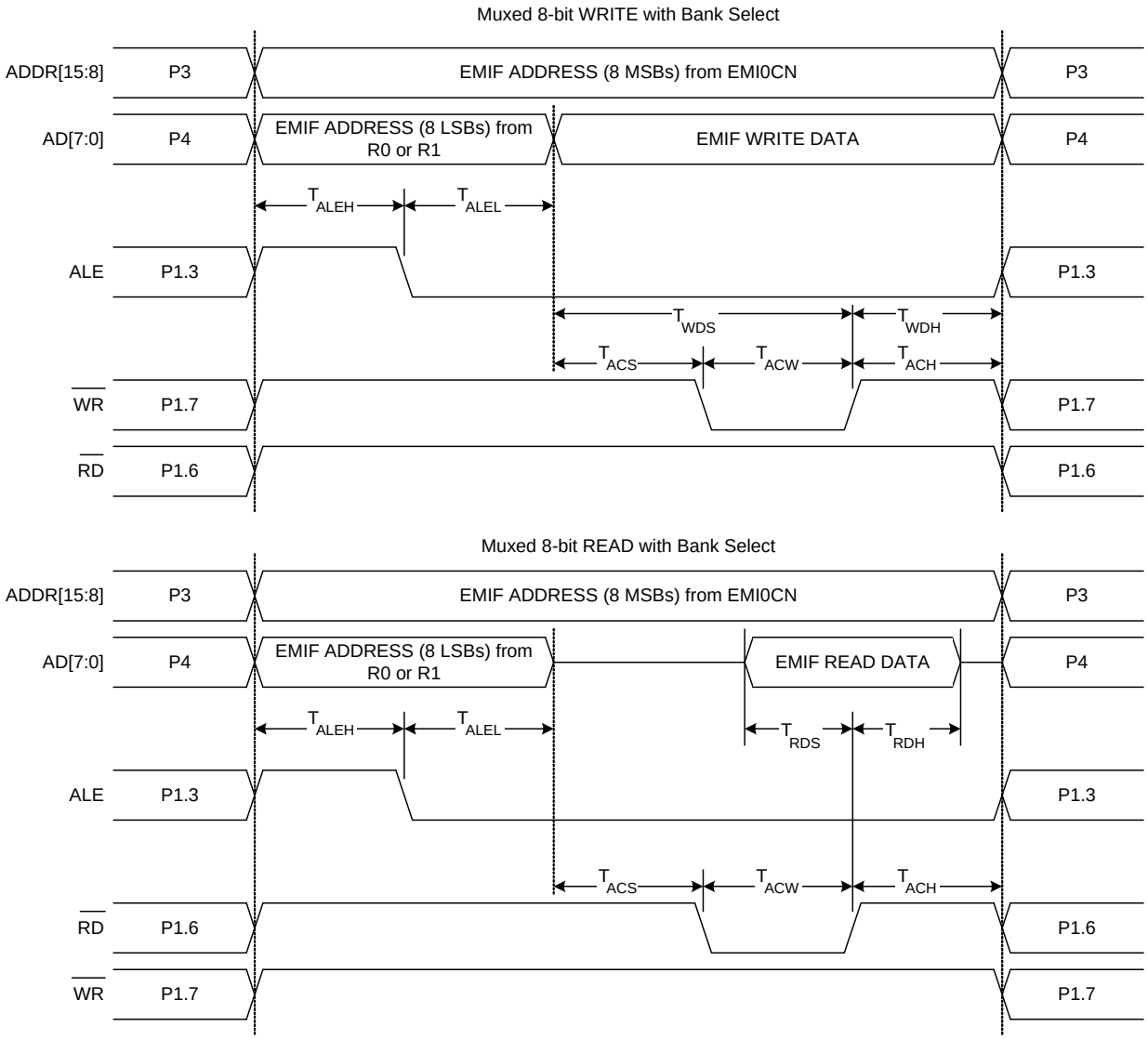


Figure 13.7. Non-multiplexed 8-bit MOVX with Bank Select Timing

SFR Definition 16.2. USB0ADR: USB0 Indirect Address

R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	Reset Value
BUSY	AUTORD	USBADDR						00000000
Bit7	Bit6	Bit5	Bit4	Bit3	Bit2	Bit1	Bit0	SFR Address: 0x96

Bits7: BUSY: USB0 Register Read Busy Flag
This bit is used during indirect USB0 register accesses. Software should write '1' to this bit to initiate a read of the USB0 register targeted by the USBADDR bits (USB0ADR.[5-0]). The target address and BUSY bit may be written in the same write to USB0ADR. After BUSY is set to '1', hardware will clear BUSY when the targeted register data is ready in the USB0DAT register. Software should check BUSY for '0' before writing to USB0DAT.
Write:
0: No effect.
1: A USB0 indirect register read is initiated at the address specified by the USBADDR bits.
Read:
0: USB0DAT register data is valid.
1: USB0 is busy accessing an indirect register; USB0DAT register data is invalid.

Bit6: AUTORD: USB0 Register Auto-read Flag
This bit is used for block FIFO reads.
0: BUSY must be written manually for each USB0 indirect register read.
1: The next indirect register read will automatically be initiated when software reads USB0DAT (USBADDR bits will not be changed).

Bits5–0: USBADDR: USB0 Indirect Register Address
These bits hold a 6-bit address used to indirectly access the USB0 core registers. Table 16.2 lists the USB0 core registers and their indirect addresses. Reads and writes to USB0DAT will target the register indicated by the USBADDR bits.

mode feature of the internal oscillator.

USB0 exits Suspend mode when any of the following occur: (1) Resume signaling is detected or generated, (2) Reset signaling is detected, or (3) a device or USB reset occurs. If suspended, the internal oscillator will exit Suspend mode upon any of the above listed events.

Resume Signaling: USB0 will exit Suspend mode if Resume signaling is detected on the bus. A Resume interrupt will be generated upon detection if enabled (RESINTE = ‘1’). Software may force a Remote Wakeup by writing ‘1’ to the RESUME bit (POWER.2). When forcing a Remote Wakeup, software should write RESUME = ‘0’ to end Resume signaling 10-15 ms after the Remote Wakeup is initiated (RESUME = ‘1’).

ISO Update: When software writes ‘1’ to the ISOUP bit (POWER.7), the ISO Update function is enabled. With ISO Update enabled, new packets written to an ISO IN endpoint will not be transmitted until a new Start-Of-Frame (SOF) is received. If the ISO IN endpoint receives an IN token before a SOF, USB0 will transmit a zero-length packet. When ISOUP = ‘1’, ISO Update is enabled for all ISO endpoints.

USB Enable: USB0 is disabled following a Power-On-Reset (POR). USB0 is enabled by clearing the USBINH bit (POWER.4). Once written to ‘0’, the USBINH can only be set to ‘1’ by one of the following: (1) a Power-On-Reset (POR), or (2) an asynchronous USB0 reset generated by writing ‘1’ to the USBRST bit (POWER.3).

Software should perform all USB0 configuration before enabling USB0. The configuration sequence should be performed as follows:

Step 1. Select and enable the USB clock source.
Step 2. Reset USB0 by writing USBRST= ‘1’.
Step 3. Configure and enable the USB Transceiver.
Step 4. Perform any USB0 function configuration (interrupts, Suspend detect).
Step 5. Enable USB0 by writing USBINH = ‘0’.

USB Register Definition 16.8. POWER: USB0 Power

R/W	R/W	R/W	R/W	R/W	R/W	R	R/W	Reset Value
ISOUD	-	-	USBINH	USBRST	RESUME	SUSMD	SUSEN	00010000
Bit7	Bit6	Bit5	Bit4	Bit3	Bit2	Bit1	Bit0	USB Address: 0x01

Bit7: ISOUD: ISO Update
This bit affects all IN Isochronous endpoints.
0: When software writes INPRDY = ‘1’, USB0 will send the packet when the next IN token is received.
1: When software writes INPRDY = ‘1’, USB0 will wait for a SOF token before sending the packet. If an IN token is received before a SOF token, USB0 will send a zero-length data packet.

Bits6–5: Unused. Read = 00b. Write = don’t care.

Bit4: USBINH: USB0 Inhibit
This bit is set to ‘1’ following a power-on reset (POR) or an asynchronous USB0 reset (see Bit3: RESET). Software should clear this bit after all USB0 and transceiver initialization is complete. Software cannot set this bit to ‘1’.
0: USB0 enabled.
1: USB0 inhibited. All USB traffic is ignored.

Bit3: USBRST: Reset Detect
Writing ‘1’ to this bit forces an asynchronous USB0 reset. Reading this bit provides bus reset status information.
Read:
0: Reset signaling is not present on the bus.
1: Reset signaling detected on the bus.

Bit2: RESUME: Force Resume
Software can force resume signaling on the bus to wake USB0 from suspend mode. Writing a ‘1’ to this bit while in Suspend mode (SUSMD = ‘1’) forces USB0 to generate Resume signaling on the bus (a remote Wakeup event). Software should write RESUME = ‘0’ after 10 ms to15 ms to end the Resume signaling. An interrupt is generated, and hardware clears SUSMD, when software writes RESUME = ‘0’.

Bit1: SUSMD: Suspend Mode
Set to ‘1’ by hardware when USB0 enters suspend mode. Cleared by hardware when software writes RESUME = ‘0’ (following a remote wakeup) or reads the CMINT register after detection of Resume signaling on the bus.
0: USB0 not in suspend mode.
1: USB0 in suspend mode.

Bit0: SUSEN: Suspend Detection Enable
0: Suspend detection disabled. USB0 will ignore suspend signaling on the bus.
1: Suspend detection enabled. USB0 will enter suspend mode if it detects suspend signaling on the bus.

USB Register Definition 16.18. E0CNT: USB0 Endpoint 0 Data Count

R	R	R	R	R	R	R	R	Reset Value
-	E0CNT							00000000
Bit7	Bit6	Bit5	Bit4	Bit3	Bit2	Bit1	Bit0	USB Address: 0x16

Bit7: Unused. Read = 0; Write = don't care.
Bits6–0: E0CNT: Endpoint 0 Data Count
This 7-bit number indicates the number of received data bytes in the Endpoint 0 FIFO. This number is only valid while bit OPRDY is a '1'.

16.11. Configuring Endpoints1-3

Endpoints1-3 are configured and controlled through their own sets of the following control/status registers: IN registers EINCSRL and EINCSRH, and OUT registers EOUTCSRL and EOUTCSRH. Only one set of endpoint control/status registers is mapped into the USB register address space at a time, defined by the contents of the INDEX register (USB Register Definition 16.4).

Endpoints1-3 can be configured as IN, OUT, or both IN/OUT (Split Mode) as described in **Section 16.5.1**. The endpoint mode (Split/Normal) is selected via the SPLIT bit in register EINCSRH.

When SPLIT = '1', the corresponding endpoint FIFO is split, and both IN and OUT pipes are available.

When SPLIT = '0', the corresponding endpoint functions as either IN or OUT; the endpoint direction is selected by the DIRSEL bit in register EINCSRH.

16.12. Controlling Endpoints1-3 IN

Endpoints1-3 IN are managed via USB registers EINCSRL and EINCSRH. All IN endpoints can be used for Interrupt, Bulk, or Isochronous transfers. Isochronous (ISO) mode is enabled by writing '1' to the ISO bit in register EINCSRH. Bulk and Interrupt transfers are handled identically by hardware.

An Endpoint1-3 IN interrupt is generated by any of the following conditions:

1. An IN packet is successfully transferred to the host.
2. Software writes '1' to the FLUSH bit (EINCSRL.3) when the target FIFO is not empty.
3. Hardware generates a STALL condition.

16.12.1.Endpoints1-3 IN Interrupt or Bulk Mode

When the ISO bit (EINCSRH.6) = '0' the target endpoint operates in Bulk or Interrupt Mode. Once an endpoint has been configured to operate in Bulk/Interrupt IN mode (typically following an Endpoint0 SET_INTERFACE command), firmware should load an IN packet into the endpoint IN FIFO and set the INPRDY bit (EINCSRL.0). Upon reception of an IN token, hardware will transmit the data, clear the INPRDY bit, and generate an interrupt.

17. SMBus

The SMBus I/O interface is a two-wire, bi-directional serial bus. The SMBus is compliant with the System Management Bus Specification, version 1.1, and compatible with the I2C serial bus. Reads and writes to the interface by the system controller are byte oriented with the SMBus interface autonomously controlling the serial transfer of the data. Data can be transferred at up to 1/20th of the system clock as a master or slave (this can be faster than allowed by the SMBus specification, depending on the system clock used). A method of extending the clock-low duration is available to accommodate devices with different speed capabilities on the same bus.

The SMBus interface may operate as a master and/or slave, and may function on a bus with multiple masters. The SMBus provides control of SDA (serial data), SCL (serial clock) generation and synchronization, arbitration logic, and START/STOP control and generation. Three SFRs are associated with the SMBus: SMB0CF configures the SMBus; SMB0CN controls the status of the SMBus; and SMB0DAT is the data register, used for both transmitting and receiving SMBus data and slave addresses.

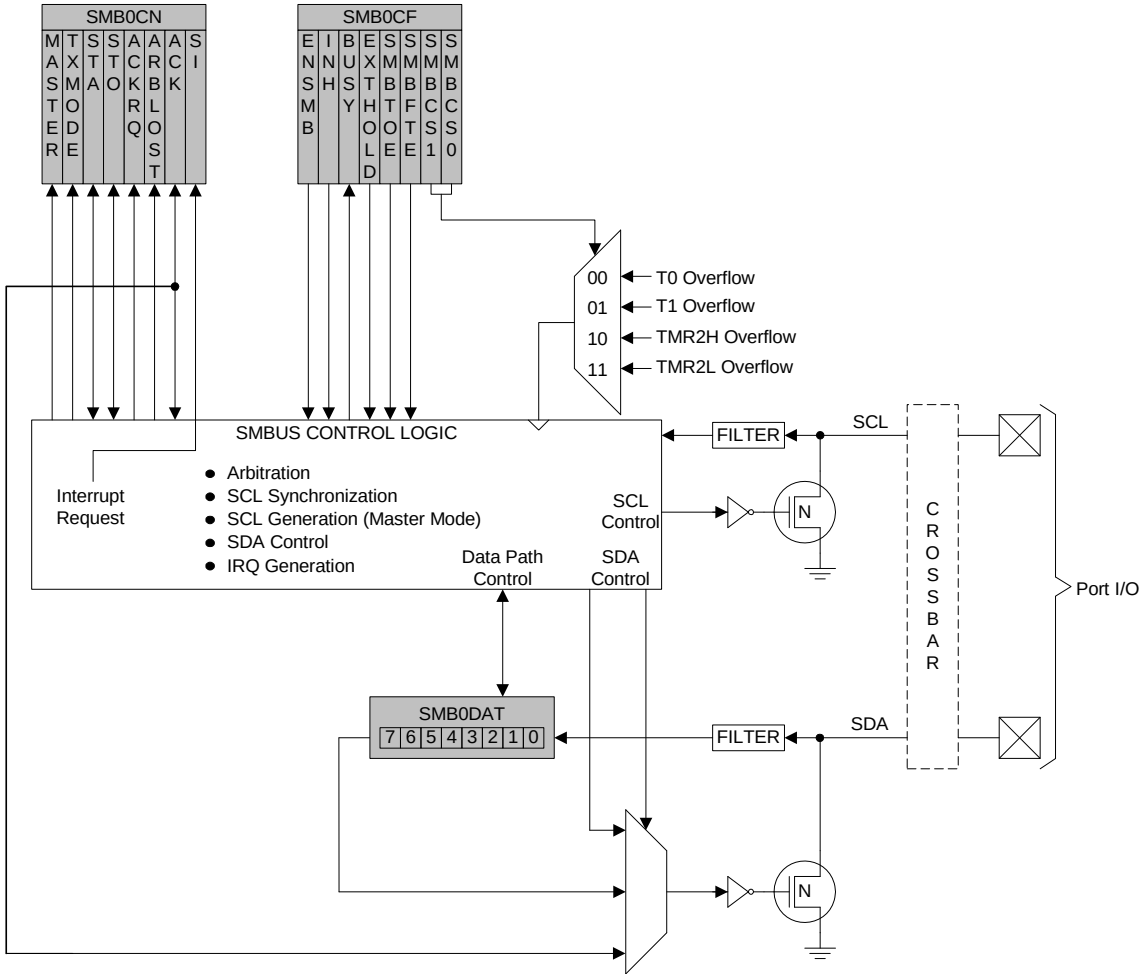


Figure 17.1. SMBus Block Diagram

SMBus configuration options include:

- Timeout detection (SCL Low Timeout and/or Bus Free Timeout)
- SDA setup and hold time extensions
- Slave event enable/disable
- Clock source selection

These options are selected in the SMB0CF register, as described in **Section "17.4.1. SMBus Configuration Register" on page 192**.

17.4.1. SMBus Configuration Register

The SMBus Configuration register (SMB0CF) is used to enable the SMBus Master and/or Slave modes, select the SMBus clock source, and select the SMBus timing and timeout options. When the ENSMB bit is set, the SMBus is enabled for all master and slave events. Slave events may be disabled by setting the INH bit. With slave events inhibited, the SMBus interface will still monitor the SCL and SDA pins; however, the interface will NACK all received addresses and will not generate any slave interrupts. When the INH bit is set, all slave events will be inhibited following the next START (interrupts will continue for the duration of the current transfer).

Table 17.1. SMBus Clock Source Selection

SMBCS1	SMBCS0	SMBus Clock Source
0	0	Timer 0 Overflow
0	1	Timer 1 Overflow
1	0	Timer 2 High Byte Overflow
1	1	Timer 2 Low Byte Overflow

The SMBCS1-0 bits select the SMBus clock source, which is used only when operating as a master or when the Free Timeout detection is enabled. When operating as a master, overflows from the selected source determine the absolute minimum SCL low and high times as defined in Equation 17.1. Note that the selected clock source may be shared by other peripherals so long as the timer is left running at all times. For example, Timer 1 overflows may generate the SMBus and UART baud rates simultaneously. Timer configuration is covered in **Section "21. Timers" on page 235**.

$$T_{HighMin} = T_{LowMin} = \frac{1}{f_{ClockSourceOverflow}}$$

Equation 17.1. Minimum SCL High and Low Times

The selected clock source should be configured to establish the minimum SCL High and Low times as per Equation 17.1. When the interface is operating as a master (and SCL is not driven or extended by any other devices on the bus), the typical SMBus bit rate is approximated by Equation 17.2.

$$BitRate = \frac{f_{ClockSourceOverflow}}{3}$$

Equation 17.2. Typical SMBus Bit Rate

19. UART1 (C8051F340/1/4/5/8/A/B/C Only)

UART1 is an asynchronous, full duplex serial port offering a variety of data formatting options. A dedicated baud rate generator with a 16-bit timer and selectable prescaler is included, which can generate a wide range of baud rates (details in **Section "19.1. Baud Rate Generator" on page 214**). A received data FIFO allows UART1 to receive up to three data bytes before data is lost and an overflow occurs.

UART1 has six associated SFRs. Three are used for the Baud Rate Generator (SBCON1, SBRLH1, and SBRLL1), two are used for data formatting, control, and status functions (SCON1, SMOD1), and one is used to send and receive data (SBUF1). The single SBUF1 location provides access to both the transmit holding register and the receive FIFO. **Writes to SBUF1 always access the Transmit Holding Register. Reads of SBUF1 always access the first byte of the Receive FIFO; it is not possible to read data from the Transmit Holding Register.**

With UART1 interrupts enabled, an interrupt is generated each time a transmit is completed (TI1 is set in SCON1), or a data byte has been received (RI1 is set in SCON1). The UART1 interrupt flags are not cleared by hardware when the CPU vectors to the interrupt service routine. They must be cleared manually by software, allowing software to determine the cause of the UART1 interrupt (transmit complete or receive complete). Note that if additional bytes are available in the Receive FIFO, the RI1 bit cannot be cleared by software.

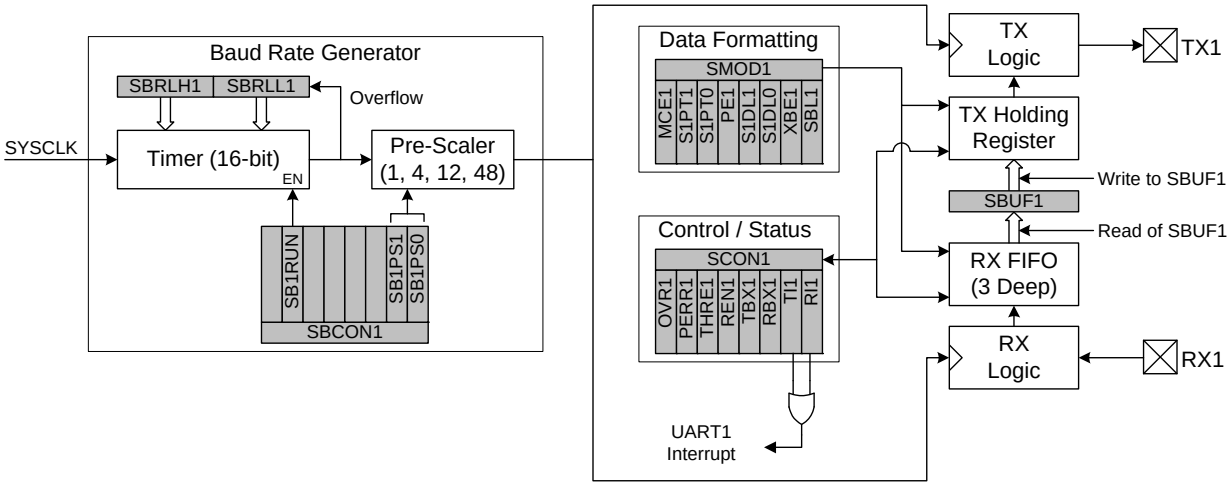


Figure 19.1. UART1 Block Diagram

19.1. Baud Rate Generator

The UART1 baud rate is generated by a dedicated 16-bit timer which runs from the controller's core clock (SYSCLK), and has prescaler options of 1, 4, 12, or 48. The timer and prescaler options combined allow for a wide selection of baud rates over many SYSCLK frequencies.

The baud rate generator is configured using three registers: SBCON1, SBRLH1, and SBRLL1. The UART1 Baud Rate Generator Control Register (SBCON1, SFR Definition 19.4) enables or disables the baud rate generator, and selects the prescaler value for the timer. The baud rate generator must be enabled for UART1 to function. Registers SBRLH1 and SBRLL1 contain a 16-bit reload value for the dedicated 16-bit timer. The internal timer counts up from the reload value on every clock tick. On timer overflows (0xFFFF to 0x0000), the timer is reloaded. For reliable UART operation, it is recommended that the UART baud rate is not configured for baud rates faster than SYSCLK/16. The baud rate for UART1 is defined in Equation 19.1.

$$\text{Baud Rate} = \frac{\text{SYSCLK}}{(65536 - (\text{SBRLH1:SBRLL1}))} \times \frac{1}{2} \times \frac{1}{\text{Prescaler}}$$

Equation 19.1. UART1 Baud Rate

A quick reference for typical baud rates and system clock frequencies is given in Table 19.1.

Table 19.1. Baud Rate Generator Settings for Standard Baud Rates

	Target Baud Rate (bps)	Actual Baud Rate (bps)	Baud Rate Error	Oscillator Divide Factor	SB1PS[1:0] (Prescaler Bits)	Reload Value in SBRLH1:SBRLL1
SYSCLK = 12 MHz	230400	230769	0.16%	52	11	0xFFE6
	115200	115385	0.16%	104	11	0xFFCC
	57600	57692	0.16%	208	11	0xFF98
	28800	28846	0.16%	416	11	0xFF30
	14400	14388	0.08%	834	11	0xFE5F
	9600	9600	0.0%	1250	11	0xFD8F
	2400	2400	0.0%	5000	11	0xF63C
	1200	1200	0.0%	10000	11	0xEC78
SYSCLK = 24 MHz	230400	230769	0.16%	104	11	0xFFCC
	115200	115385	0.16%	208	11	0xFF98
	57600	57692	0.16%	416	11	0xFF30
	28800	28777	0.08%	834	11	0xFE5F
	14400	14406	0.04%	1666	11	0xFCBF
	9600	9600	0.0%	2500	11	0xFB1E
	2400	2400	0.0%	10000	11	0xEC78
	1200	1200	0.0%	20000	11	0xD8F0
SYSCLK = 48 MHz	230400	230769	0.16%	208	11	0xFF98
	115200	115385	0.16%	416	11	0xFF30
	57600	57554	0.08%	834	11	0xFE5F
	28800	28812	0.04%	1666	11	0xFCBF
	14400	14397	0.02%	3334	11	0xF97D
	9600	9600	0.0%	5000	11	0xF63C
	2400	2400	0.0%	20000	11	0xD8F0
	1200	1200	0.0%	40000	11	0xB1E0

SFR Definition 19.2. SMOD1: UART1 Mode

R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	Reset Value
MCE1	S1PT1	S1PT0	PE1	S1DL1	S1DL0	XBE1	SBL1	00001100
Bit7	Bit6	Bit5	Bit4	Bit3	Bit2	Bit1	Bit0	

SFR Address: 0xE5

Bit7: MCE1: Multiprocessor Communication Enable.
0: RI will be activated if stop bit(s) are ‘1’.
1: RI will be activated if stop bit(s) and extra bit are ‘1’ (extra bit must be enabled using XBE1).
Note: This function is not available when hardware parity is enabled.

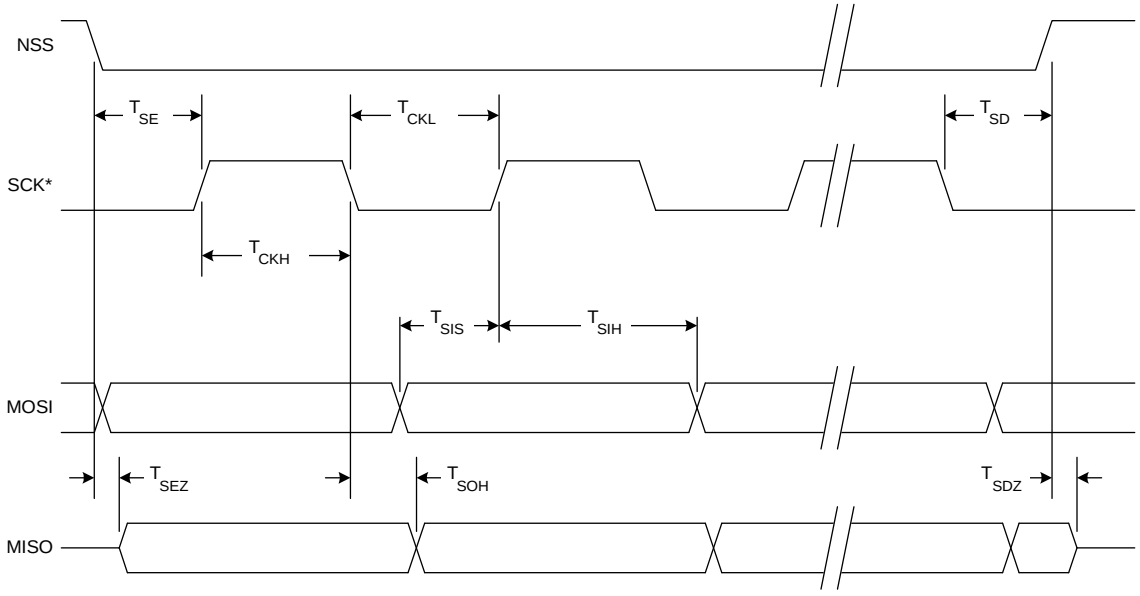
Bits6–5: S1PT[1:0]: Parity Type.
00: Odd
01: Even
10: Mark
11: Space

Bit4: PE1: Parity Enable.
This bit activates hardware parity generation and checking. The parity type is selected by bits S1PT1-0 when parity is enabled.
0: Hardware parity is disabled.
1: Hardware parity is enabled.

Bits3–2: S1DL[1:0]: Data Length.
00: 5-bit data
01: 6-bit data
10: 7-bit data
11: 8-bit data

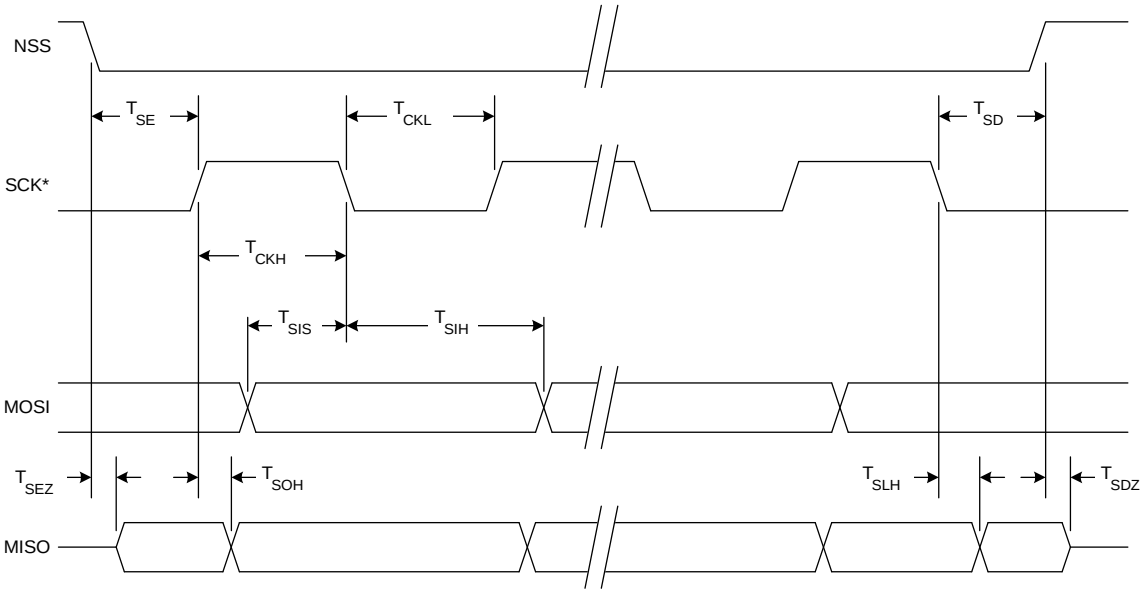
Bit1: XBE1: Extra Bit Enable
When enabled, the value of TBX1 will be appended to the data field.
0: Extra Bit Disabled.
1: Extra Bit Enabled.

Bit0: SBL1: Stop Bit Length
0: Short - Stop bit is active for one bit time.
1: Long - Stop bit is active for two bit times (data length = 6, 7, or 8 bits), or 1.5 bit times (data length = 5 bits).



* SCK is shown for CKPOL = 0. SCK is the opposite polarity for CKPOL = 1.

Figure 20.10. SPI Slave Timing (CKPHA = 0)



* SCK is shown for CKPOL = 0. SCK is the opposite polarity for CKPOL = 1.

Figure 20.11. SPI Slave Timing (CKPHA = 1)

21.2. Timer 2

Timer 2 is a 16-bit timer formed by two 8-bit SFRs: TMR2L (low byte) and TMR2H (high byte). Timer 2 may operate in 16-bit auto-reload mode, (split) 8-bit auto-reload mode, USB Start-of-Frame (SOF) capture mode, or Low-Frequency Oscillator (LFO) Falling Edge capture mode. The Timer 2 operation mode is defined by the T2SPLIT (TMR2CN.3), T2CE (TMR2CN.4) bits, and T2CSS (TMR2CN.1) bits.

Timer 2 may be clocked by the system clock, the system clock divided by 12, or the external oscillator source divided by 8. The external clock mode is ideal for real-time clock (RTC) functionality, where the internal oscillator drives the system clock while Timer 2 (and/or the PCA) is clocked by an external precision oscillator. Note that the external oscillator source divided by 8 is synchronized with the system clock.

21.2.1. 16-bit Timer with Auto-Reload

When T2SPLIT = ‘0’ and T2CE = ‘0’, Timer 2 operates as a 16-bit timer with auto-reload. Timer 2 can be clocked by SYSCLK, SYSCLK divided by 12, or the external oscillator clock source divided by 8. As the 16-bit timer register increments and overflows from 0xFFFF to 0x0000, the 16-bit value in the Timer 2 reload registers (TMR2RLH and TMR2RLL) is loaded into the Timer 2 register as shown in Figure 21.4, and the Timer 2 High Byte Overflow Flag (TMR2CN.7) is set. If Timer 2 interrupts are enabled, an interrupt will be generated on each Timer 2 overflow. Additionally, if Timer 2 interrupts are enabled and the TF2LEN bit is set (TMR2CN.5), an interrupt will be generated each time the lower 8 bits (TMR2L) overflow from 0xFF to 0x00.

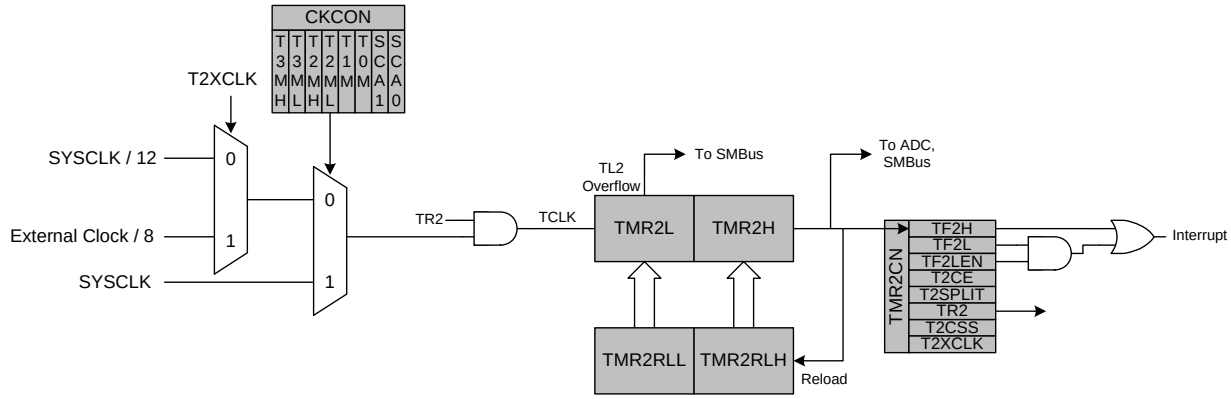


Figure 21.4. Timer 2 16-Bit Mode Block Diagram

22.2.6. 16-Bit Pulse Width Modulator Mode

A PCA module may also be operated in 16-Bit PWM mode. In this mode, the 16-bit capture/compare module defines the number of PCA clocks for the low time of the PWM signal. When the PCA counter matches the module contents, the output on CEXn is asserted high; when the counter overflows, CEXn is asserted low. To output a varying duty cycle, new value writes should be synchronized with PCA CCFn match interrupts. 16-Bit PWM Mode is enabled by setting the ECOMn, PWMn, and PWM16n bits in the PCA0CPMn register. For a varying duty cycle, match interrupts should be enabled (ECCFn = 1 AND MATn = 1) to help synchronize the capture/compare register writes. The duty cycle for 16-Bit PWM Mode is given by Equation 22.3.

Important Note About Capture/Compare Registers: When writing a 16-bit value to the PCA0 Capture/Compare registers, the low byte should always be written first. Writing to PCA0CPLn clears the ECOMn bit to '0'; writing to PCA0CPHn sets ECOMn to '1'.

$$DutyCycle = \frac{(65536 - PCA0CPn)}{65536}$$

Equation 22.3. 16-Bit PWM Duty Cycle

Using Equation 22.3, the largest duty cycle is 100% (PCA0CPn = 0), and the smallest duty cycle is 0.0015% (PCA0CPn = 0xFFFF). A 0% duty cycle may be generated by clearing the ECOMn bit to '0'.

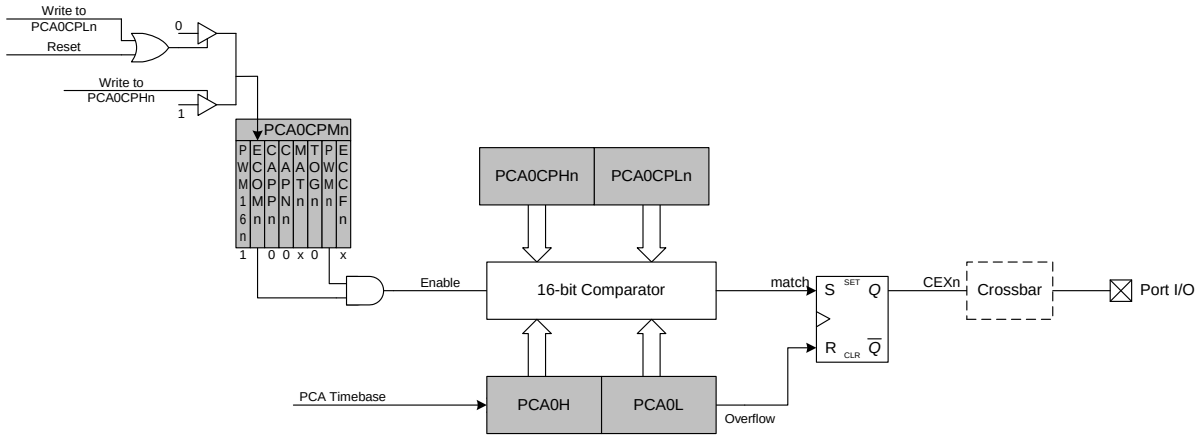


Figure 22.9. PCA 16-Bit PWM Mode

22.4. Register Descriptions for PCA

Following are detailed descriptions of the special function registers related to the operation of the PCA.

SFR Definition 22.1. PCA0CN: PCA Control

R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	Reset Value
CF	CR	-	CCF4	CCF3	CCF2	CCF1	CCF0	00000000
Bit7	Bit6	Bit5	Bit4	Bit3	Bit2	Bit1	Bit0	SFR Address:
							(bit addressable)	0xD8

Bit7: CF: PCA Counter/Timer Overflow Flag.
Set by hardware when the PCA Counter/Timer overflows from 0xFFFF to 0x0000. When the Counter/Timer Overflow (CF) interrupt is enabled, setting this bit causes the CPU to vector to the PCA interrupt service routine. This bit is not automatically cleared by hardware and must be cleared by software.

Bit6: CR: PCA Counter/Timer Run Control.
This bit enables/disables the PCA Counter/Timer.
0: PCA Counter/Timer disabled.
1: PCA Counter/Timer enabled.

Bit5: UNUSED. Read = 0b, Write = don't care.

Bit4: CCF4: PCA Module 4 Capture/Compare Flag.
This bit is set by hardware when a match or capture occurs. When the CCF4 interrupt is enabled, setting this bit causes the CPU to vector to the PCA interrupt service routine. This bit is not automatically cleared by hardware and must be cleared by software.

Bit3: CCF3: PCA Module 3 Capture/Compare Flag.
This bit is set by hardware when a match or capture occurs. When the CCF3 interrupt is enabled, setting this bit causes the CPU to vector to the PCA interrupt service routine. This bit is not automatically cleared by hardware and must be cleared by software.

Bit2: CCF2: PCA Module 2 Capture/Compare Flag.
This bit is set by hardware when a match or capture occurs. When the CCF2 interrupt is enabled, setting this bit causes the CPU to vector to the PCA interrupt service routine. This bit is not automatically cleared by hardware and must be cleared by software.

Bit1: CCF1: PCA Module 1 Capture/Compare Flag.
This bit is set by hardware when a match or capture occurs. When the CCF1 interrupt is enabled, setting this bit causes the CPU to vector to the PCA interrupt service routine. This bit is not automatically cleared by hardware and must be cleared by software.

Bit0: CCF0: PCA Module 0 Capture/Compare Flag.
This bit is set by hardware when a match or capture occurs. When the CCF0 interrupt is enabled, setting this bit causes the CPU to vector to the PCA interrupt service routine. This bit is not automatically cleared by hardware and must be cleared by software.