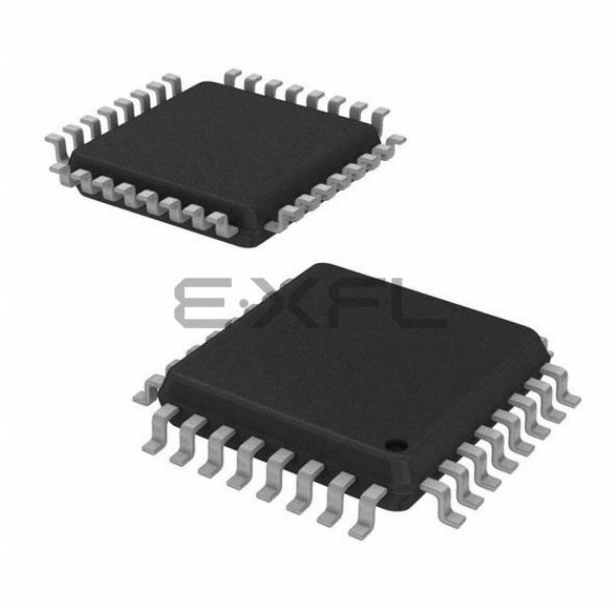

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What is "Embedded - Microcontrollers"?

"Embedded - Microcontrollers" refer to small, integrated circuits designed to perform specific tasks within larger systems. These microcontrollers are essentially compact computers on a single chip, containing a processor core, memory, and programmable input/output peripherals. They are called "embedded" because they are embedded within electronic devices to control various functions, rather than serving as standalone computers. Microcontrollers are crucial in modern electronics, providing the intelligence and control needed for a wide range of applications.

Applications of "Embedded - Microcontrollers"

Details	
Product Status	Obsolete
Core Processor	8051
Core Size	8-Bit
Speed	25MHz
Connectivity	SMBus (2-Wire/I²C), SPI, UART/USART
Peripherals	Brown-out Detect/Reset, POR, PWM, Temp Sensor, WDT
Number of I/O	24
Program Memory Size	64KB (64K x 8)
Program Memory Type	FLASH
EEPROM Size	-
RAM Size	4.25K x 8
Voltage - Supply (Vcc/Vdd)	0.9V ~ 3.6V
Data Converters	A/D 23x10b
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/c8051f930-f-gq

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1.4. Programmable Counter Array

An on-chip Programmable Counter/Timer Array (PCA) is included in addition to the four 16-bit general purpose counter/timers. The PCA consists of a dedicated 16-bit counter/timer time base with six programmable capture/compare modules. The PCA clock is derived from one of six sources: the system clock divided by 12, the system clock divided by 4, Timer 0 overflows, an External Clock Input (ECI), the system clock, or the external oscillator clock source divided by 8.

Each capture/compare module can be configured to operate in a variety of modes: edge-triggered capture, software timer, high-speed output, pulse width modulator (8, 9, 10, 11, or 16-bit), or frequency output. Additionally, Capture/Compare Module 5 offers watchdog timer (WDT) capabilities. Following a system reset, Module 5 is configured and enabled in WDT mode. The PCA Capture/Compare Module I/O and External Clock Input may be routed to Port I/O via the Digital Crossbar.

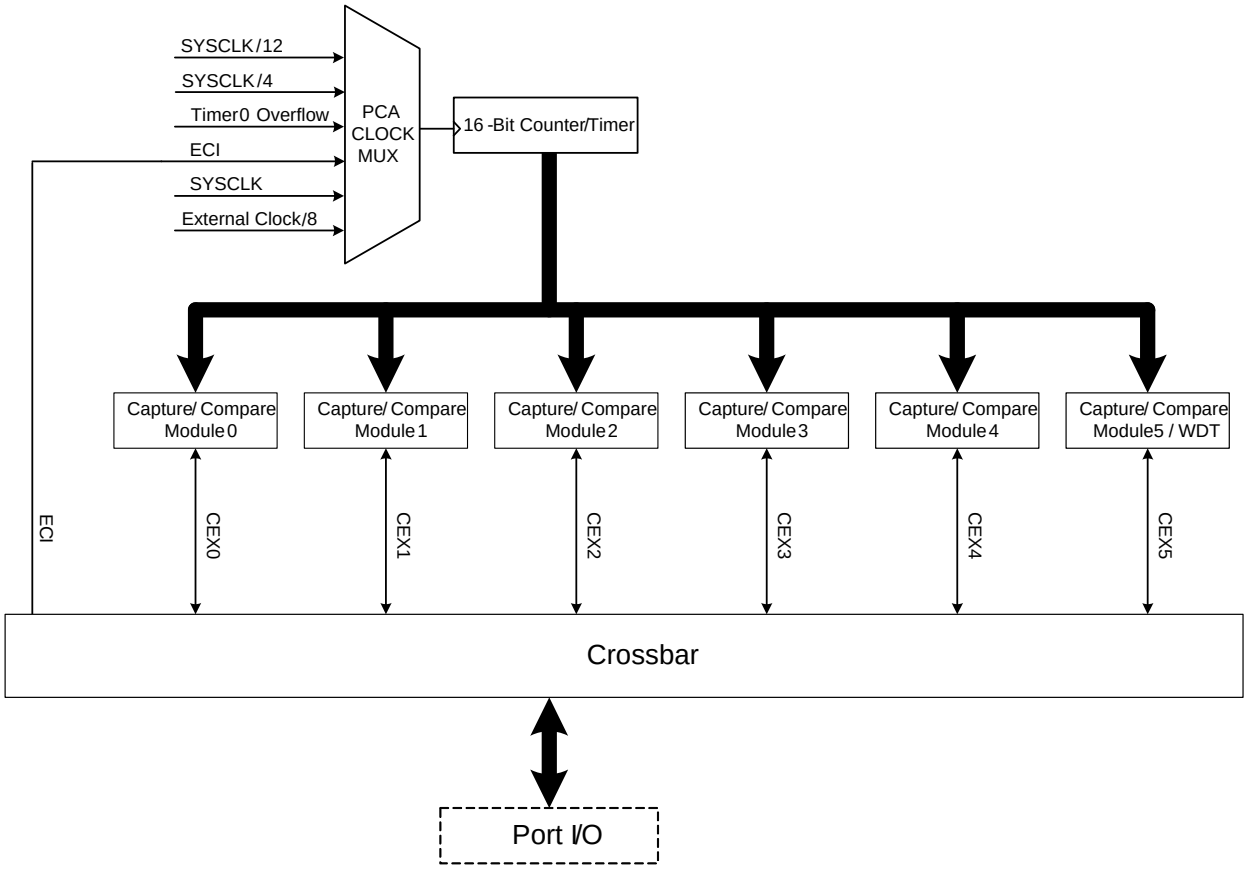


Figure 1.6. PCA Block Diagram

1.5. 10-Bit SAR ADC with 16-bit Auto-Averaging Accumulator and Autonomous Low Power Burst Mode

C8051F93x-C8051F92x devices have a 300 ksps, 10-bit successive-approximation-register (SAR) ADC with integrated track-and-hold and programmable window detector. ADC0 also has an autonomous low power Burst Mode which can automatically enable ADC0, capture and accumulate samples, then place ADC0 in a low power shutdown mode without CPU intervention. It also has a 16-bit accumulator that can automatically average the ADC results, providing an effective 11, 12, or 13 bit ADC result without any additional CPU intervention.

Table 4.5. Power Management Electrical Specifications

V_{DD} = 1.8 to 3.6 V, –40 to +85 °C unless otherwise specified.

Parameter	Conditions	Min	Typ	Max	Units
Idle Mode Wake-up Time		2	—	3	SYSCLKs
Suspend Mode Wake-up Time	Low power oscillator	—	400	—	ns
	Precision oscillator	—	1.3	—	µs
Sleep Mode Wake-up Time	Two-cell mode	—	2	—	µs
	One-cell mode	—	10	—	µs

Table 4.6. Flash Electrical Characteristics

V_{DD} = 1.8 to 3.6 V, –40 to +85 °C unless otherwise specified.

Parameter	Conditions	Min	Typ	Max	Units
Flash Size	C8051F930/1	65536*	—	—	bytes
	C8051F920/1	32768	—	—	bytes
Scratchpad Size		1024	—	1024	bytes
Endurance		1k	30k	—	Erase/Write Cycles
Erase Cycle Time		28	32	36	ms
Write Cycle Time		57	64	71	µs
***Note:** 1024 bytes at addresses 0xFC00 to 0xFFFF are reserved.					

Table 4.7. Internal Precision Oscillator Electrical Characteristics

V_{DD} = 1.8 to 3.6 V; T_A = –40 to +85 °C unless otherwise specified; Using factory-calibrated settings.

Parameter	Conditions	Min	Typ	Max	Units
Oscillator Frequency	–40 to +85 °C, V_{DD} = 1.8–3.6 V	24	24.5	25	MHz
Oscillator Supply Current (from V_{DD})	25 °C; includes bias current of 90–100 µA	—	300*	—	µA
***Note:** Does not include clock divider or clock tree supply current.					

Table 4.8. Internal Low-Power Oscillator Electrical Characteristics

V_{DD} = 1.8 to 3.6 V; T_A = –40 to +85 °C unless otherwise specified; Using factory-calibrated settings.

Parameter	Conditions	Min	Typ	Max	Units
Oscillator Frequency	–40 to +85 °C, V_{DD} = 1.8–3.6 V	18	20	22	MHz
Oscillator Supply Current (from V_{DD})	25 °C No separate bias current required.	—	100*	—	µA
***Note:** Does not include clock divider or clock tree supply current.					

5.4.1. Window Detector In Single-Ended Mode

Figure 5.5 shows two example window comparisons for right-justified data, with ADC0LTH:ADC0LTL = 0x0080 (128d) and ADC0GTH:ADC0GTL = 0x0040 (64d). The input voltage can range from 0 to VREF x (1023/1024) with respect to GND, and is represented by a 10-bit unsigned integer value. In the left example, an AD0WINT interrupt will be generated if the ADC0 conversion word (ADC0H:ADC0L) is within the range defined by ADC0GTH:ADC0GTL and ADC0LTH:ADC0LTL (if 0x0040 < ADC0H:ADC0L < 0x0080). In the right example, and AD0WINT interrupt will be generated if the ADC0 conversion word is outside of the range defined by the ADC0GT and ADC0LT registers (if ADC0H:ADC0L < 0x0040 or ADC0H:ADC0L > 0x0080). Figure 5.6 shows an example using left-justified data with the same comparison values.

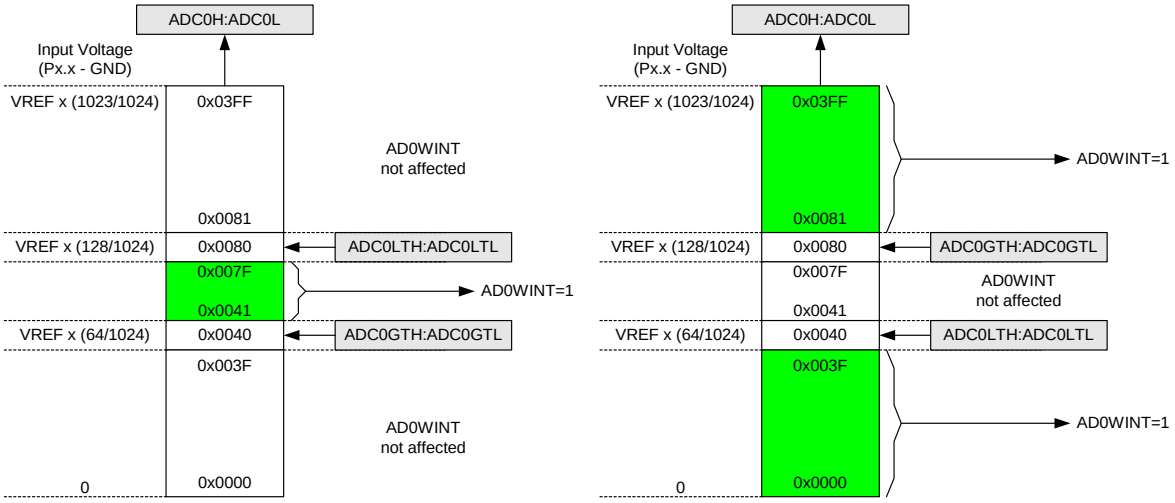


Figure 5.5. ADC Window Compare Example: Right-Justified Single-Ended Data

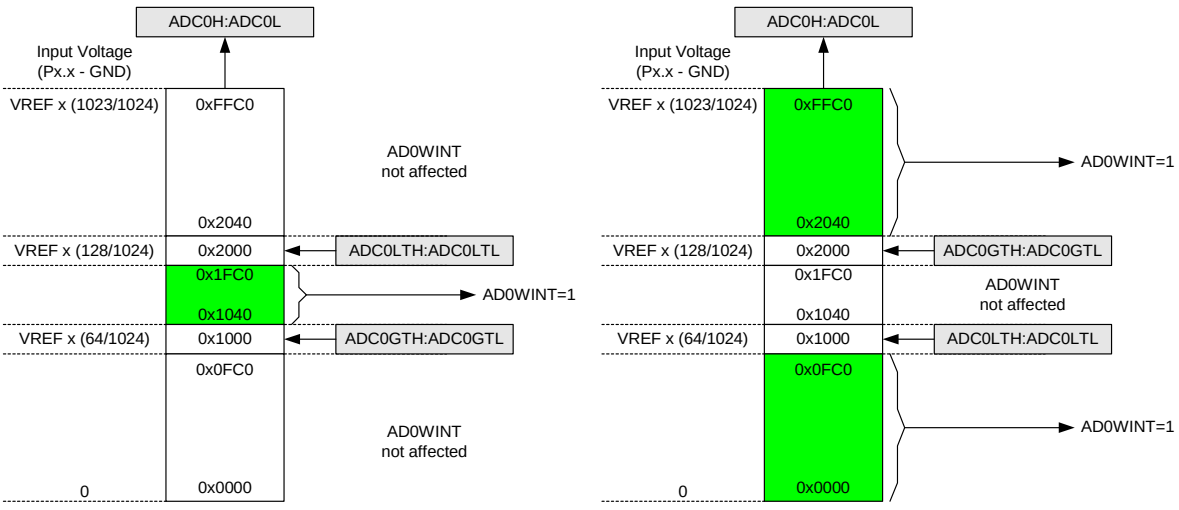


Figure 5.6. ADC Window Compare Example: Left-Justified Single-Ended Data

5.4.2. ADC0 Specifications

See “4. Electrical Characteristics” on page 43 for a detailed listing of ADC0 specifications.

7.3. Comparator Response Time

Comparator response time may be configured in software via the CPTnMD registers described on "CPT0MD: Comparator 0 Mode Selection" on page 94 and "CPT1MD: Comparator 1 Mode Selection" on page 96. Four response time settings are available: Mode 0 (Fastest Response Time), Mode 1, Mode 2, and Mode 3 (Lowest Power). Selecting a longer response time reduces the Comparator active supply current. The Comparators also have low power shutdown state, which is entered any time the comparator is disabled. Comparator rising edge and falling edge response times are typically not equal. See Table 4.13 on page 62 for complete comparator timing and supply current specifications.

7.4. Comparator Hysterisis

The Comparators feature software-programmable hysterisis that can be used to stabilize the comparator output while a transition is occurring on the input. Using the CPTnCN registers, 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 (i.e., the comparator negative input).

Figure 7.3 shows that when positive hysterisis is enabled, the comparator output does not transition from logic 0 to logic 1 until the comparator positive input voltage has exceeded the threshold voltage by an amount equal to the programmed hysterisis. It also shows that when negative hysterisis is enabled, the comparator output does not transition from logic 1 to logic 0 until the comparator positive input voltage has fallen below the threshold voltage by an amount equal to the programmed hysterisis.

The amount of positive hysterisis is determined by the settings of the CPnHYP bits in the CPTnCN register and the amount of negative hysteresis voltage is determined by the settings of the CPnHYN bits in the same register. Settings of 20 mV, 10 mV, 5 mV, or 0 mV can be programmed for both positive and negative hysterisis. See Section "Table 4.13. Comparator Electrical Characteristics" on page 62 for complete comparator hysterisis specifications.

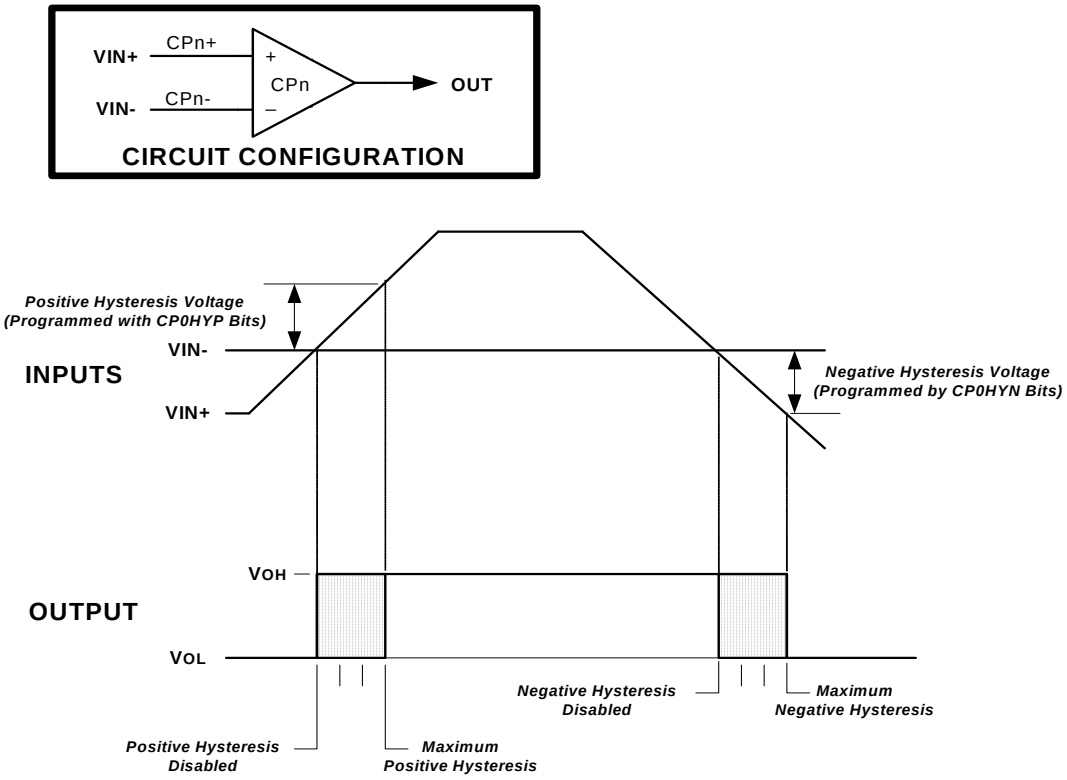


Figure 7.3. Comparator Hysteresis Plot

8. 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. The CIP-51 also includes on-chip debug hardware (see description in Section 27), 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 8.1 for a block diagram). The CIP-51 includes the following features:

- Fully Compatible with MCS-51 Instruction Set
- 25 MIPS Peak Throughput with 25 MHz Clock
- 0 to 25 MHz Clock Frequency
- Extended Interrupt Handler
- Reset Input
- Power Management Modes
- On-chip Debug Logic
- Program and Data Memory Security

Performance

The CIP-51 employs a pipelined architecture that greatly increases its instruction throughput over the standard 8051 architecture. In a standard 8051, all instructions except for MUL and DIV take 12 or 24 system clock cycles to execute, and usually have a maximum system clock of 12 MHz. By contrast, the CIP-51 core executes 70% of its instructions in one or two system clock cycles, with no instructions taking more than eight system clock cycles.

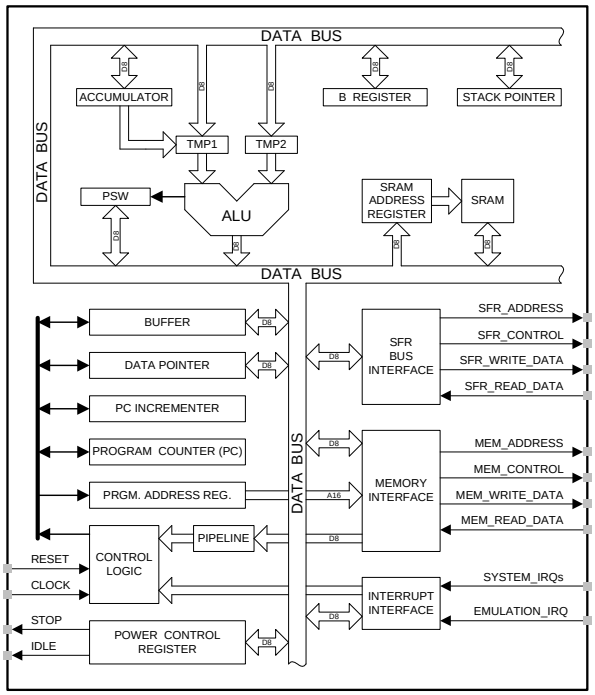
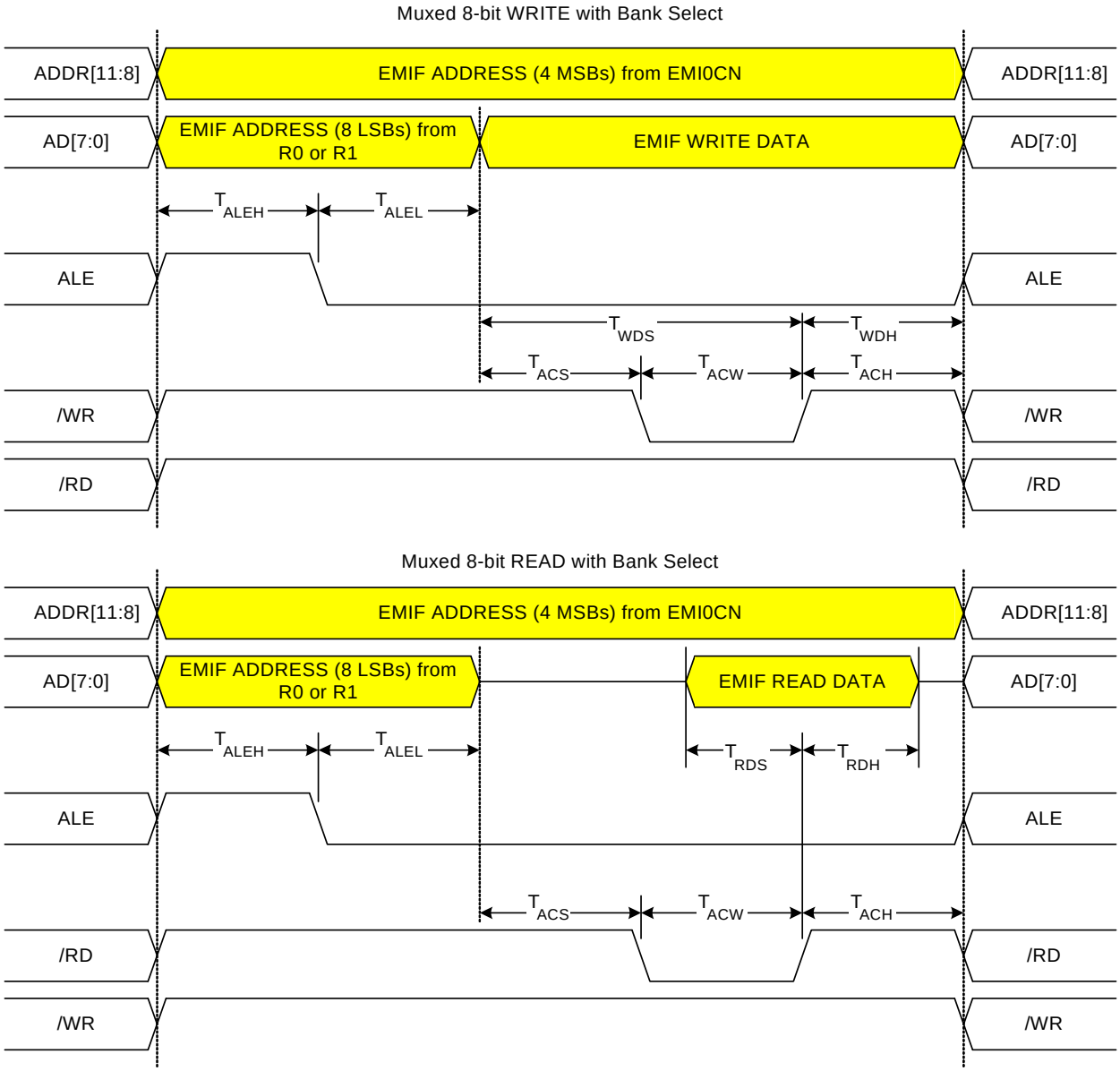


Figure 8.1. CIP-51 Block Diagram

Table 8.1. CIP-51 Instruction Set Summary

Mnemonic	Description	Bytes	Clock Cycles
Arithmetic Operations			
ADD A, Rn	Add register to A	1	1
ADD A, direct	Add direct byte to A	2	2
ADD A, @Ri	Add indirect RAM to A	1	2
ADD A, #data	Add immediate to A	2	2
ADDC A, Rn	Add register to A with carry	1	1
ADDC A, direct	Add direct byte to A with carry	2	2
ADDC A, @Ri	Add indirect RAM to A with carry	1	2
ADDC A, #data	Add immediate to A with carry	2	2
SUBB A, Rn	Subtract register from A with borrow	1	1
SUBB A, direct	Subtract direct byte from A with borrow	2	2
SUBB A, @Ri	Subtract indirect RAM from A with borrow	1	2
SUBB A, #data	Subtract immediate from A with borrow	2	2
INC A	Increment A	1	1
INC Rn	Increment register	1	1
INC direct	Increment direct byte	2	2
INC @Ri	Increment indirect RAM	1	2
DEC A	Decrement A	1	1
DEC Rn	Decrement register	1	1
DEC direct	Decrement direct byte	2	2
DEC @Ri	Decrement indirect RAM	1	2
INC DPTR	Increment Data Pointer	1	1
MUL AB	Multiply A and B	1	4
DIV AB	Divide A by B	1	8
DA A	Decimal adjust A	1	1
Logical Operations			
ANL A, Rn	AND Register to A	1	1
ANL A, direct	AND direct byte to A	2	2
ANL A, @Ri	AND indirect RAM to A	1	2
ANL A, #data	AND immediate to A	2	2
ANL direct, A	AND A to direct byte	2	2
ANL direct, #data	AND immediate to direct byte	3	3
ORL A, Rn	OR Register to A	1	1
ORL A, direct	OR direct byte to A	2	2
ORL A, @Ri	OR indirect RAM to A	1	2
ORL A, #data	OR immediate to A	2	2
ORL direct, A	OR A to direct byte	2	2
ORL direct, #data	OR immediate to direct byte	3	3
XRL A, Rn	Exclusive-OR Register to A	1	1
XRL A, direct	Exclusive-OR direct byte to A	2	2
XRL A, @Ri	Exclusive-OR indirect RAM to A	1	2
XRL A, #data	Exclusive-OR immediate to A	2	2
XRL direct, A	Exclusive-OR A to direct byte	2	2
XRL direct, #data	Exclusive-OR immediate to direct byte	3	3

10.8.2.1.Multiplexed 8-bit MOVX with Bank Select: EMI0CF[3:2] = 10.



Note: See the Port Input/Output chapter to determine which port pins are mapped to the ADDR[11:8], AD[7:0], ALE, /RD, and /WR signals.

Figure 10.6. Multiplexed 8-bit MOVX with Bank Select Timing

11. Special Function Registers

The direct-access data memory locations from 0x80 to 0xFF constitute the special function registers (SFRs). The SFRs provide control and data exchange with the C8051F93x-C8051F92x's resources and peripherals. The CIP-51 controller core duplicates the SFRs found in a typical 8051 implementation as well as implementing additional SFRs used to configure and access the sub-systems unique to the C8051F93x-C8051F92x. This allows the addition of new functionality while retaining compatibility with the MCS-51™ instruction set. Table 11.1 and Table 11.2 list the SFRs implemented in the C8051F93x-C8051F92x device family.

The SFR registers are accessed anytime the direct addressing mode is used to access memory locations from 0x80 to 0xFF. SFRs with addresses ending in 0x0 or 0x8 (e.g. P0, TCON, SCON0, IE, etc.) are bit-addressable as well as byte-addressable. All other SFRs are byte-addressable only. Unoccupied addresses in the SFR space are reserved for future use. Accessing these areas will have an indeterminate effect and should be avoided. Refer to the corresponding pages of the data sheet, as indicated in Table 11.3, for a detailed description of each register.

Table 11.1. Special Function Register (SFR) Memory Map (Page 0x0)

F8	SPI0CN	PCA0L	PCA0H	PCA0CPL0	PCA0CPH0	PCA0CPL4	PCA0CPH4	VDM0CN
F0	B	P0MDIN	P1MDIN	P2MDIN	SMB0ADR	SMB0ADM	EIP1	EIP2
E8	ADC0CN	PCA0CPL1	PCA0CPH1	PCA0CPL2	PCA0CPH2	PCA0CPL3	PCA0CPH3	RSTSRC
E0	ACC	XBR0	XBR1	XBR2	IT01CF		EIE1	EIE2
D8	PCA0CN	PCA0MD	PCA0CPM0	PCA0CPM1	PCA0CPM2	PCA0CPM3	PCA0CPM4	PCA0PWM
D0	PSW	REF0CN	PCA0CPL5	PCA0CPH5	P0SKIP	P1SKIP	P2SKIP	P0MAT
C8	TMR2CN	REG0CN	TMR2RLL	TMR2RLH	TMR2L	TMR2H	PCA0CPM5	P1MAT
C0	SMB0CN	SMB0CF	SMB0DAT	ADC0GTL	ADC0GTH	ADC0LTL	ADC0LTH	P0MASK
B8	IP	IREF0CN	ADC0AC	ADC0MX	ADC0CF	ADC0L	ADC0H	P1MASK
B0	SPI1CN	OSCXCN	OSCICN	OSCICL		PMU0CF	FLSCL	FLKEY
A8	IE	CLKSEL	EMI0CN	EMI0CF	RTC0ADR	RTC0DAT	RTC0KEY	EMI0TC
A0	P2	SPI0CFG	SPI0CKR	SPI0DAT	P0MDOUT	P1MDOUT	P2MDOUT	SFRPAGE
98	SCON0	SBUF0	CPT1CN	CPT0CN	CPT1MD	CPT0MD	CPT1MX	CPT0MX
90	P1	TMR3CN	TMR3RLL	TMR3RLH	TMR3L	TMR3H	DC0CF	DC0CN
88	TCON	TMOD	TL0	TL1	TH0	TH1	CKCON	PSCTL
80	P0	SP	DPL	DPH	SPI1CFG	SPI1CKR	SPI1DAT	PCON
	0(8)	1(9)	2(A)	3(B)	4(C)	5(D)	6(E)	7(F)

(bit addressable)

12.5. Interrupt Register Descriptions

The SFRs used to enable the interrupt sources and set their priority level are described in the following register descriptions. 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).

SFR Definition 12.2. IP: Interrupt Priority

Bit	7	6	5	4	3	2	1	0
Name		PSPI0	PT2	PS0	PT1	PX1	PT0	PX0
Type	R	R/W	R/W	R/W	R/W	R/W	R/W	R/W
Reset	1	0	0	0	0	0	0	0

SFR Page = 0x0; SFR Address = 0xB8; Bit-Addressable

Bit	Name	Function
7	Unused	**Unused.** Read = 1b, Write = don't care.
6	PSPI0	**Serial Peripheral Interface (SPI0) Interrupt Priority Control.** This bit sets the priority of the SPI0 interrupt. 0: SPI0 interrupt set to low priority level. 1: SPI0 interrupt set to high priority level.
5	PT2	**Timer 2 Interrupt Priority Control.** This bit sets the priority of the Timer 2 interrupt. 0: Timer 2 interrupt set to low priority level. 1: Timer 2 interrupt set to high priority level.
4	PS0	**UART0 Interrupt Priority Control.** This bit sets the priority of the UART0 interrupt. 0: UART0 interrupt set to low priority level. 1: UART0 interrupt set to high priority level.
3	PT1	**Timer 1 Interrupt Priority Control.** This bit sets the priority of the Timer 1 interrupt. 0: Timer 1 interrupt set to low priority level. 1: Timer 1 interrupt set to high priority level.
2	PX1	**External Interrupt 1 Priority Control.** This bit sets the priority of the External Interrupt 1 interrupt. 0: External Interrupt 1 set to low priority level. 1: External Interrupt 1 set to high priority level.
1	PT0	**Timer 0 Interrupt Priority Control.** This bit sets the priority of the Timer 0 interrupt. 0: Timer 0 interrupt set to low priority level. 1: Timer 0 interrupt set to high priority level.
0	PX0	**External Interrupt 0 Priority Control.** This bit sets the priority of the External Interrupt 0 interrupt. 0: External Interrupt 0 set to low priority level. 1: External Interrupt 0 set to high priority level.

SFR Definition 13.1. PSCTL: Program Store R/W Control

Bit	7	6	5	4	3	2	1	0
Name						SFLE	PSEE	PSWE
Type	R	R	R	R	R	R/W	R/W	R/W
Reset	0	0	0	0	0	0	0	0

SFR Page =0x0; SFR Address = 0x8F

Bit	Name	Function
7:3	Unused	**Unused.** Read = 00000b, Write = don't care.
2	SFLE	**Scratchpad Flash Memory Access Enable.** When this bit is set, Flash MOVC reads and MOVX writes from user software are directed to the Scratchpad Flash sector. Flash accesses outside the address range 0x0000-0x03FF should not be attempted and may yield undefined results when SFLE is set to 1. 0: Flash access from user software directed to the Program/Data Flash sector. 1: Flash access from user software directed to the Scratchpad Sector.
1	PSEE	**Program Store Erase Enable.** Setting this bit (in combination with PSWE) allows an entire page of Flash program memory to be erased. If this bit is logic 1 and Flash writes are enabled (PSWE is logic 1), a write to Flash memory using the MOVX instruction will erase the entire page that contains the location addressed by the MOVX instruction. The value of the data byte written does not matter. 0: Flash program memory erasure disabled. 1: Flash program memory erasure enabled.
0	PSWE	**Program Store Write Enable.** Setting this bit allows writing a byte of data to the Flash program memory using the MOVX write instruction. The Flash location should be erased before writing data. 0: Writes to Flash program memory disabled. 1: Writes to Flash program memory enabled; the MOVX write instruction targets Flash memory.

SFR Definition 16.2. DC0CF: DC-DC Converter Configuration

Bit	7	6	5	4	3	2	1	0
Name	Reserved	CLKDIV[1:0]		AD0CKINV	CLKINV	ILIMIT	VDDSLP	CLKSEL
Type	R	R/W	R/W	R/W	R/W	R/W	R/W	R/W
Reset	0	0	0	0	0	0	0	0

SFR Page = 0x0; SFR Address = 0x96

Bit	Name	Function
7	Reserved	**Reserved.** Read = 0b; Must write 0b.
6:5	CLKDIV[1:0]	**DC-DC Clock Divider.** Divides the dc-dc converter clock when the system clock is selected as the clock source for dc-dc converter. These bits are ignored when the dc-dc converter is clocked from its local oscillator. 00: The dc-dc converter clock is system clock divided by 1. 01: The dc-dc converter clock is system clock divided by 2. 10: The dc-dc converter clock is system clock divided by 4. 11: The dc-dc converter clock is system clock divided by 8.
4	AD0CKINV	**ADC0 Clock Inversion (Clock Invert During Sync).** Inverts the ADC0 SAR clock derived from the dc-dc converter clock when the SYNC bit (DC0CN.3) is enabled. This bit is ignored when the SYNC bit is set to zero. 0: ADC0 SAR clock is inverted. 1: ADC0 SAR clock is not inverted.
3	CLKINV	**DC-DC Converter Clock Invert.** Inverts the system clock used as the input to the dc-dc clock divider. 0: The dc-dc converter clock is not inverted. 1: The dc-dc converter clock is inverted.
2	ILIMIT	**Peak Current Limit Threshold.** Sets the threshold for the maximum allowed peak inductor current. See Table 16.1 for peak inductor current levels. 0: Peak inductor current is set at a lower level. 1: Peak inductor current is set at a higher level.
1	VDDSLP	**VDD-DC+ Sleep Mode Connection.** Specifies the power source for VDD/DC+ in Sleep Mode when the dc-dc converter is enabled. 0: VDD-DC+ connected to VBAT in Sleep Mode. 1: VDD-DC+ is floating in Sleep Mode.
0	CLKSEL	**DC-DC Converter Clock Source Select.** Specifies the dc-dc converter clock source. 0: The dc-dc converter is clocked from its local oscillator. 1: The dc-dc converter is clocked from the system clock.

16.10. DC-DC Converter Specifications

See Table 4.14 on page 64 for a detailed listing of dc-dc converter specifications.

18.3. External Reset

The external $\overline{\text{RST}}$ pin provides a means for external circuitry to force the device into a reset state. Asserting an active-low signal on the $\overline{\text{RST}}$ pin generates a reset; an external pullup and/or decoupling of the $\overline{\text{RST}}$ pin may be necessary to avoid erroneous noise-induced resets. See Table 4.4 for complete $\overline{\text{RST}}$ pin specifications. The external reset remains functional even when the device is in the low power suspend and sleep modes. The PINRSF flag (RSTSRC.0) is set on exit from an external reset.

18.4. Missing Clock Detector Reset

The Missing Clock Detector (MCD) is a one-shot circuit that is triggered by the system clock. If the system clock remains high or low for more than 100 µs, the one-shot will time out and generate a reset. After a MCD reset, the MCDRSF flag (RSTSRC.2) will read 1, signifying the MCD as the reset source; otherwise, this bit reads 0. Writing a 1 to the MCDRSF bit enables the Missing Clock Detector; writing a 0 disables it. The missing clock detector reset is automatically disabled when the device is in the low power Suspend or Sleep mode. Upon exit from either low power state, the enabled/disabled state of this reset source is restored to its previous value. The state of the $\overline{\text{RST}}$ pin is unaffected by this reset.

18.5. Comparator0 Reset

Comparator0 can be configured as a reset source by writing a 1 to the C0RSEF flag (RSTSRC.5). Comparator0 should be enabled and allowed to settle prior to writing to C0RSEF to prevent any turn-on chatter on the output from generating an unwanted reset. The Comparator0 reset is active-low: if the non-inverting input voltage (on CP0+) is less than the inverting input voltage (on CP0-), the device is put into the reset state. After a Comparator0 reset, the C0RSEF flag (RSTSRC.5) will read 1 signifying Comparator0 as the reset source; otherwise, this bit reads 0. The Comparator0 reset source remains functional even when the device is in the low power suspend and sleep states as long as Comparator0 is also enabled as a wake-up source. The state of the $\overline{\text{RST}}$ pin is unaffected by this reset.

18.6. PCA Watchdog Timer Reset

The programmable Watchdog Timer (WDT) function of the Programmable Counter Array (PCA) can be used to prevent software from running out of control during a system malfunction. The PCA WDT function can be enabled or disabled by software as described in Section “26.4. Watchdog Timer Mode” on page 311; the WDT is enabled and clocked by SYSCLK / 12 following any reset. If a system malfunction prevents user software from updating the WDT, a reset is generated and the WDTRSF bit (RSTSRC.5) is set to 1. The PCA Watchdog Timer reset source is automatically disabled when the device is in the low power Suspend or Sleep mode. Upon exit from either low power state, the enabled/disabled state of this reset source is restored to its previous value.The state of the $\overline{\text{RST}}$ pin is unaffected by this reset.

SFR Definition 19.2. OSCICN: Internal Oscillator Control

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

SFR Page = 0x0; SFR Address = 0xB2

Bit	Name	Function
7	IOSCEN	**Internal Oscillator Enable.** 0: Internal oscillator disabled. 1: Internal oscillator enabled.
6	IFRDY	**Internal Oscillator Frequency Ready Flag.** 0: Internal oscillator is not running at its programmed frequency. 1: Internal oscillator is running at its programmed frequency.
5:0	Reserved	**Reserved.** Read = 001111b. Must Write 001111b.

Note: It is recommended to use read-modify-write operations such as ORL and ANL to set or clear the enable bit of this register.

SFR Definition 19.3. OSCICL: Internal Oscillator Calibration

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

SFR Page = 0x0; SFR Address = 0xB3

Bit	Name	Function
7	SSE	**Spread Spectrum Enable.** 0: Spread Spectrum clock dithering disabled. 1: Spread Spectrum clock dithering enabled.
6:0	OSCICL	**Internal Oscillator Calibration.** Factory calibrated to obtain a frequency of 24.5 MHz. Incrementing this register decreases the oscillator frequency and decrementing this register increases the oscillator frequency. The step size is approximately 1% of the calibrated frequency. The recommended calibration frequency range is between 16 and 24.5 MHz.

20.2.4. Automatic Gain Control (Crystal Mode Only) and SmaRTClock Bias Doubling

Automatic Gain Control allows the SmaRTClock oscillator to trim the oscillation amplitude of a crystal in order to achieve the lowest possible power consumption. Automatic Gain Control automatically detects when the oscillation amplitude has reached a point where it safe to reduce the drive current, therefore, it may be enabled during crystal startup. It is recommended to enable Automatic Gain Control in most systems which use the SmaRTClock oscillator in Crystal Mode. The following are recommended crystal specifications and operating conditions when Automatic Gain Control is enabled:

- ESR < 50 kΩ
- Load Capacitance < 10 pF
- Supply Voltage < 3.0 V
- Temperature > –20 °C

When using Automatic Gain Control, it is recommended to perform an oscillation robustness test to ensure that the chosen crystal will oscillate under the worst case condition to which the system will be exposed. The worst case condition that should result in the least robust oscillation is at the following system conditions: lowest temperature, highest supply voltage, highest ESR, highest load capacitance, and lowest bias current (AGC enabled, Bias Double Disabled).

To perform the oscillation robustness test, the SmaRTClock oscillator should be enabled and selected as the system clock source. Next, the SYSCLK signal should be routed to a port pin configured as a push-pull digital output. The positive duty cycle of the output clock can be used as an indicator of oscillation robustness. As shown in Figure 20.2, duty cycles less than 55% indicate a robust oscillation. As the duty cycle approaches 60%, oscillation becomes less reliable and the risk of clock failure increases. Increasing the bias current (by disabling AGC) will always improve oscillation robustness and will reduce the output clock's duty cycle. This test should be performed at the worst case system conditions, as results at very low temperatures or high supply voltage will vary from results taken at room temperature or low supply voltage.

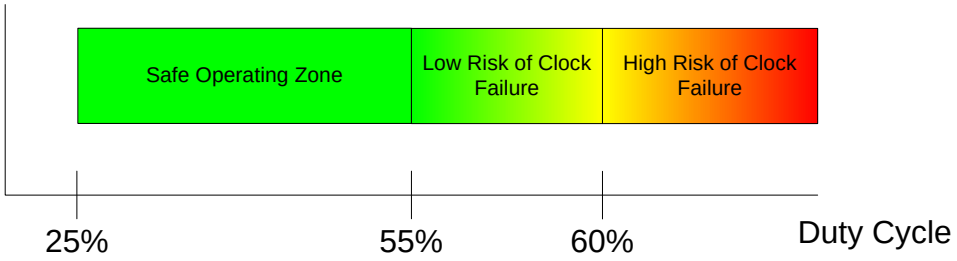


Figure 20.2. Interpreting Oscillation Robustness (Duty Cycle) Test Results

As an alternative to performing the oscillation robustness test, Automatic Gain Control may be disabled at the cost of increased power consumption (approximately 200 nA). Disabling Automatic Gain Control will provide the crystal oscillator with higher immunity against external factors which may lead to clock failure. Automatic Gain Control must be disabled if using the SmaRTClock oscillator in self-oscillate mode.

SFR Definition 21.6. P1MASK: Port1 Mask Register

Bit	7	6	5	4	3	2	1	0
Name	P1MASK[7:0]							
Type	R/W							
Reset	0	0	0	0	0	0	0	0

SFR Page= 0x0; SFR Address = 0xBF

Bit	Name	Function
7:0	P1MASK[7:0]	**Port 1 Mask Value.** Selects P1 pins to be compared to the corresponding bits in P1MAT. 0: P1.n pin logic value is ignored and cannot cause a Port Mismatch event. 1: P1.n pin logic value is compared to P1MAT.n.
Note: On C8051F931/21 devices, port match is not available on P1.6 or P1.7. The corresponding P1MASK bits must be set to 0b.		

SFR Definition 21.7. P1MAT: Port1 Match Register

Bit	7	6	5	4	3	2	1	0
Name	P1MAT[7:0]							
Type	R/W							
Reset	1	1	1	1	1	1	1	1

SFR Page = 0x0; SFR Address = 0xCF

Bit	Name	Function
7:0	P1MAT[7:0]	**Port 1 Match Value.** Match comparison value used on Port 1 for bits in P1MASK which are set to 1. 0: P1.n pin logic value is compared with logic LOW. 1: P1.n pin logic value is compared with logic HIGH.
Note: On C8051F931/21 devices, port match is not available on P1.6 or P1.7.		

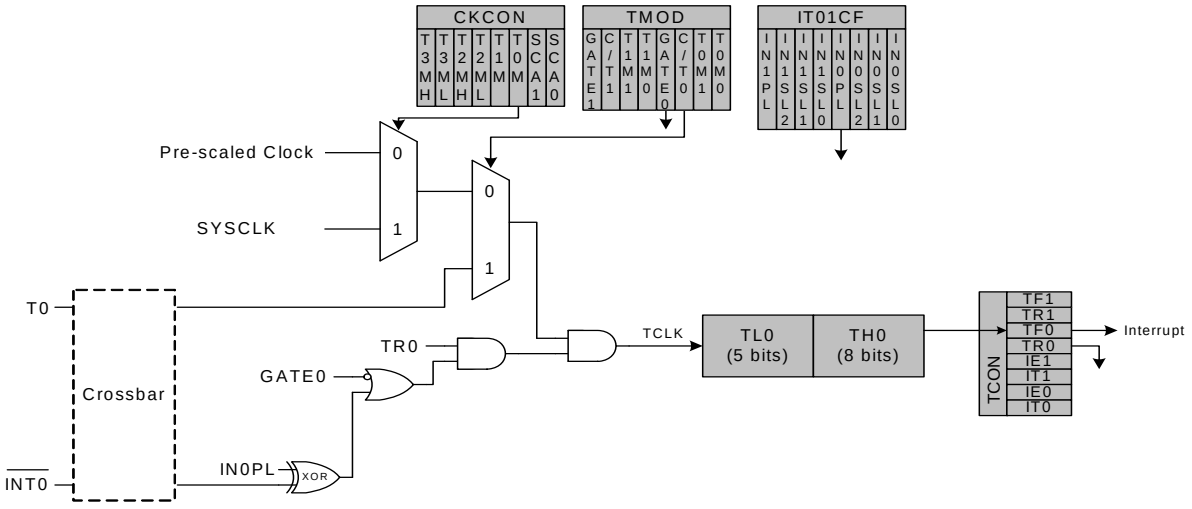


Figure 25.1. T0 Mode 0 Block Diagram

25.1.2. Mode 1: 16-bit Counter/Timer

Mode 1 operation is the same as Mode 0, except that the counter/timer registers use all 16 bits. The counter/timers are enabled and configured in Mode 1 in the same manner as for Mode 0.

SFR Definition 25.14. TMR3RLL: Timer 3 Reload Register Low Byte

Bit	7	6	5	4	3	2	1	0
Name	TMR3RLL[7:0]							
Type	R/W							
Reset	0	0	0	0	0	0	0	0

SFR Page = 0x0; SFR Address = 0x92

Bit	Name	Function
7:0	TMR3RLL[7:0]	**Timer 3 Reload Register Low Byte.** TMR3RLL holds the low byte of the reload value for Timer 3.

SFR Definition 25.15. TMR3RLH: Timer 3 Reload Register High Byte

Bit	7	6	5	4	3	2	1	0
Name	TMR3RLH[7:0]							
Type	R/W							
Reset	0	0	0	0	0	0	0	0

SFR Page = 0x0; SFR Address = 0x93

Bit	Name	Function
7:0	TMR3RLH[7:0]	**Timer 3 Reload Register High Byte.** TMR3RLH holds the high byte of the reload value for Timer 3.