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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	Active
Core Processor	8051
Core Size	8-Bit
Speed	25MHz
Connectivity	SPI, UART/USART
Peripherals	Brown-out Detect/Reset, POR, PWM, Temp Sensor, WDT
Number of I/O	16
Program Memory Size	8KB (8K x 8)
Program Memory Type	FLASH
EEPROM Size	-
RAM Size	256 x 8
Voltage - Supply (Vcc/Vdd)	1.8V ~ 5.25V
Data Converters	A/D 16x12b
Oscillator Type	Internal
Operating Temperature	-40°C ~ 125°C (TA)
Mounting Type	Surface Mount
Package / Case	20-TSSOP (0.173", 4.40mm Width)
Supplier Device Package	20-TSSOP
Purchase URL	https://www.e-xfl.com/product-detail/silicon-labs/c8051f531a-itr

1.9. Port Input/Output

C8051F52x/F52xA/F53x/F53xA devices include up to 16 I/O pins. Port pins are organized as two byte-wide ports. The port pins behave like typical 8051 ports with a few enhancements. Each port pin can be configured as a digital or analog I/O pin. Pins selected as digital I/O can be configured for push-pull or open-drain operation. The “weak pullups” that are fixed on typical 8051 devices may be globally disabled to save power.

The Digital Crossbar allows mapping of internal digital system resources to port I/O pins. On-chip counter/timers, serial buses, hardware interrupts, and other digital signals can be configured to appear on the port pins using the Crossbar control registers. This allows the user to select the exact mix of general-purpose port I/O, digital, and analog resources needed for the application.

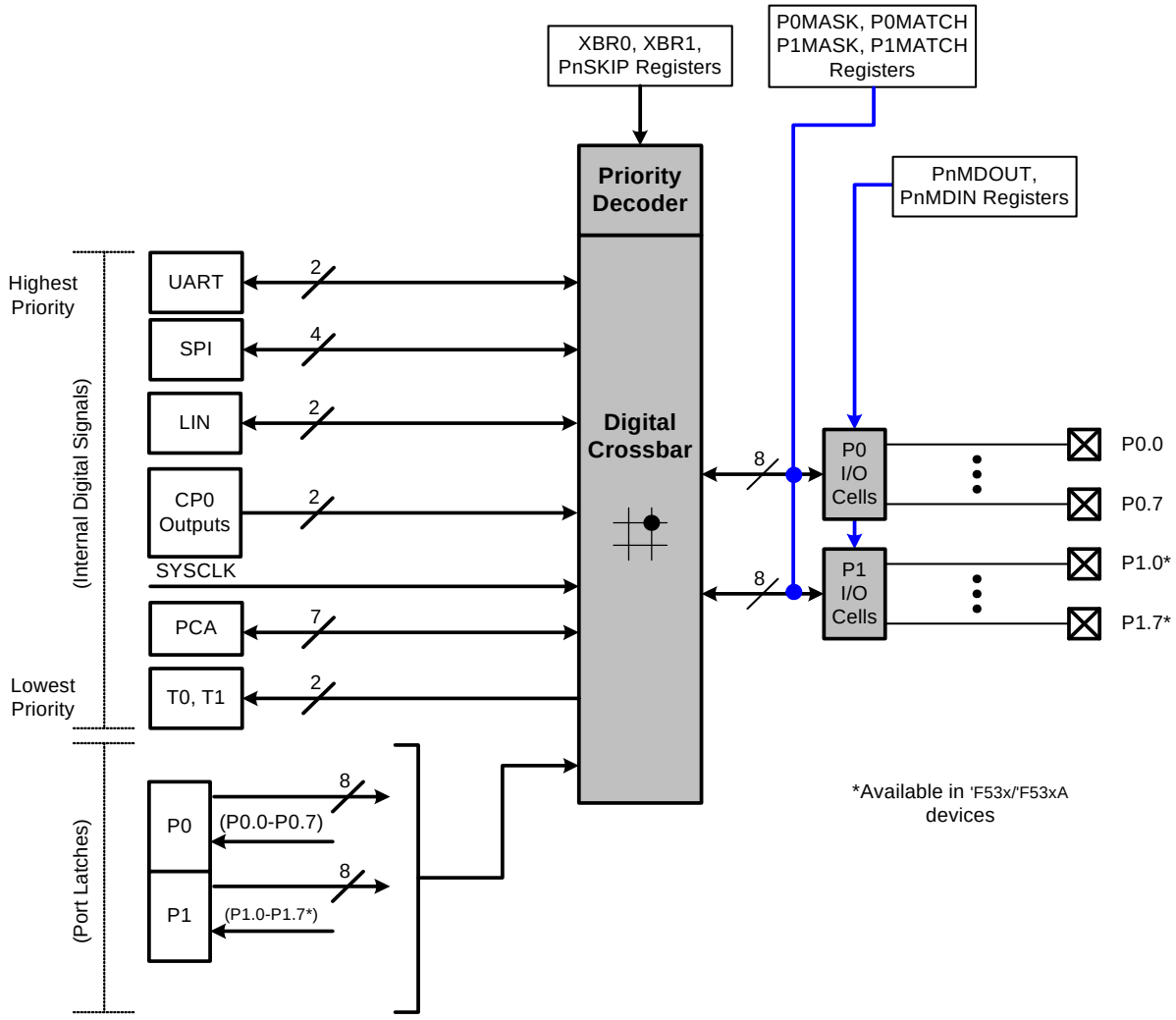


Figure 1.9. Port I/O Functional Block Diagram

Table 2.2. Global DC Electrical Characteristics

–40 to +125 °C, 25 MHz System Clock unless otherwise specified. Typical values are given at 25 °C

Parameter	Conditions	Min	Typ	Max	Units
Digital Supply Current—CPU Inactive (Idle Mode, not fetching instructions from Flash)					
Idle I_{DD}[3,4]	**V_{DD} = 2.1 V:**				
	Clock = 32 kHz	—	8	—	µA
	Clock = 200 kHz	—	22	—	µA
	Clock = 1 MHz	—	0.09	—	mA
	Clock = 25 MHz	—	2.2	5	mA
	V_{DD} = 2.6 V:				
	Clock = 32 kHz	—	9	—	µA
	Clock = 200 kHz	—	30	—	µA
	Clock = 1 MHz	—	0.13	—	mA
	Clock = 25 MHz	—	3	6.5	mA
Idle I_{DD} Frequency Sensitivity[3,6]	T = 25 °C:				
	V_{DD} = 2.1 V, F ≤ 1 MHz	—	90	—	µA/MHz
	V_{DD} = 2.1 V, F > 1 MHz	—	90	—	µA/MHz
	V_{DD} = 2.6 V, F ≤ 1 MHz	—	118	—	µA/MHz
	V_{DD} = 2.6 V, F > 1 MHz	—	118	—	µA/MHz
Digital Supply Current[3] (Stop or Suspend Mode)	Oscillator not running, V_{DD} Monitor Disabled.				
	T = 25 °C	—	2	—	µA
	T = 60 °C	—	3	—	µA
	T = 125 °C	—	50	—	µA

Notes:

1. For more information on V_{REGIN} characteristics, see Table 2.6 on page 30.
2. SYSCLK must be at least 32 kHz to enable debugging.
3. Based on device characterization data; Not production tested.
4. Does not include internal oscillator or internal regulator supply current.
5. I_{DD} can be estimated for frequencies <= 12 MHz by multiplying the frequency of interest by the frequency sensitivity number for that range. When using these numbers to estimate I_{DD} > 12 MHz, the estimate should be the current at 25 MHz minus the difference in current indicated by the frequency sensitivity number. For example: V_{DD} = 2.6 V; F= 20 MHz, I_{DD} = 7.3 mA – (25 MHz – 20 MHz) x 0.184 mA/MHz = 6.38 mA.
6. Idle I_{DD} can be estimated for frequencies <= 1 MHz by multiplying the frequency of interest by the frequency sensitivity number for that range. When using these numbers to estimate I_{DD} > 1 MHz, the estimate should be the current at 25 MHz minus the difference in current indicated by the frequency sensitivity number. For example: V_{DD} = 2.6 V; F= 5 MHz, Idle I_{DD} = 3 mA – (25 MHz– 5 MHz) x 118 µA/MHz = 0.64 mA.

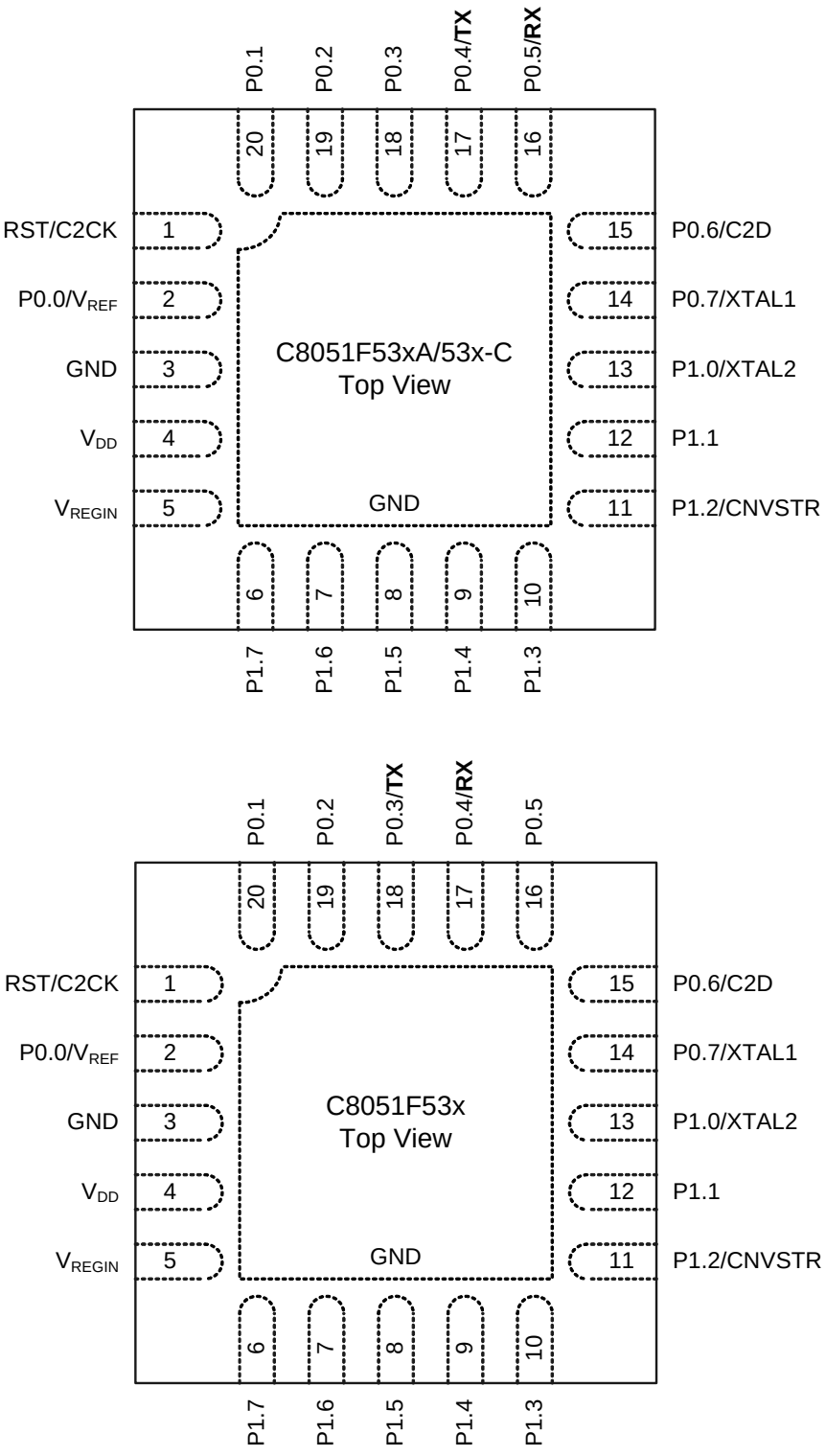


Figure 3.7. QFN-20 Pinout Diagram (Top View)

5. Voltage Reference

The Voltage reference MUX on C8051F52x/F52xA/F53x/F53xA devices is configurable to use an externally connected voltage reference, the internal reference voltage generator, or the V_{DD} power supply voltage (see Figure 5.1). The REFSL bit in the Reference Control register (REF0CN) selects the reference source. For an external source or the internal reference applied to the V_{REF} pin, REFSL should be set to 0. To use V_{DD} as the reference source, REFSL should be set to 1.

The BIASE bit enables the internal voltage bias generator, which is used by the ADC, Temperature Sensor, and internal oscillators. This bit is forced to logic 1 when any of the aforementioned peripherals are enabled. The bias generator may be enabled manually by writing a 1 to the BIASE bit in register REF0CN; see SFR Definition 5.1 for REF0CN register details. The electrical specifications for the voltage reference circuit are given in Table 2.5 on page 29.

The internal voltage reference circuit consists of a temperature stable bandgap voltage reference generator and a gain-of-two output buffer amplifier. The output voltage is selectable between 1.5 V and 2.2 V. The internal voltage reference can be driven out on the V_{REF} pin by setting the REFBE bit in register REF0CN to a 1 (see Figure 5.1). The load seen by the V_{REF} pin must draw less than 200 µA to GND. When using the internal voltage reference, bypass capacitors of 0.1 µF and 4.7 µF are recommended from the V_{REF} pin to GND. If the internal reference is not used, the REFBE bit should be cleared to 0. Electrical specifications for the internal voltage reference are given in Table 2.5 on page 29.

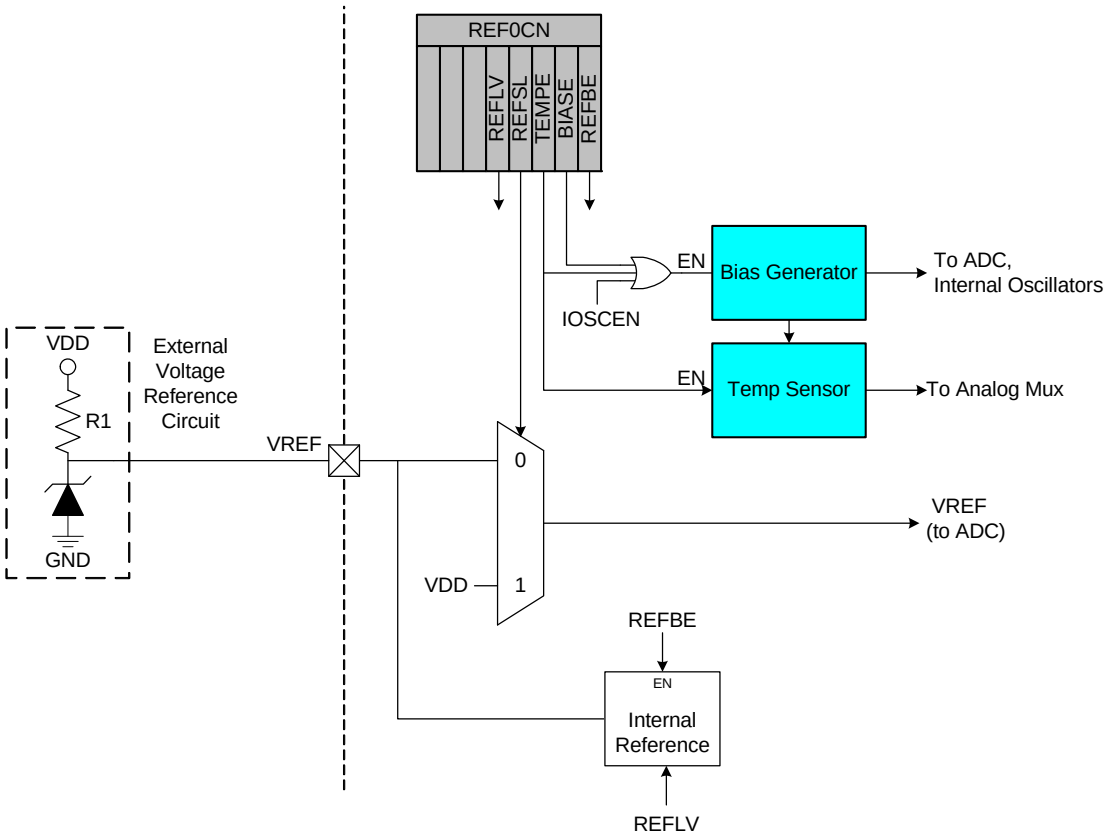


Figure 5.1. Voltage Reference Functional Block Diagram

SFR Definition 8.1. SP: Stack Pointer

R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	Reset Value
								00000111
Bit7	Bit6	Bit5	Bit4	Bit3	Bit2	Bit1	Bit0	

SFR Address: 0x81

Bits7–0: **SP**: Stack Pointer.
The Stack Pointer holds the location of the top of the stack. The stack pointer is incremented before every PUSH operation. The SP register defaults to 0x07 after reset.

SFR Definition 8.2. DPL: Data Pointer Low Byte

R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	Reset Value
								00000000
Bit7	Bit6	Bit5	Bit4	Bit3	Bit2	Bit1	Bit0	

SFR Address: 0x82

Bits7–0: **DPL**: Data Pointer Low.
The DPL register is the low byte of the 16-bit DPTR. DPTR is used to access indirectly addressed XRAM and Flash memory.

SFR Definition 8.3. DPH: Data Pointer High Byte

R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	Reset Value
								00000000
Bit7	Bit6	Bit5	Bit4	Bit3	Bit2	Bit1	Bit0	

SFR Address: 0x83

Bits7–0: **DPH**: Data Pointer High.
The DPH register is the high byte of the 16-bit DPTR. DPTR is used to access indirectly addressed XRAM and Flash memory.

9. Memory Organization and SFRs

The memory organization of the C8051F52x/F52xA/F53x/F53xA is similar to that of a standard 8051. There are two separate memory spaces: program memory and data memory. Program and data memory share the same address space but are accessed via different instruction types. The memory map is shown in Figure 9.1.

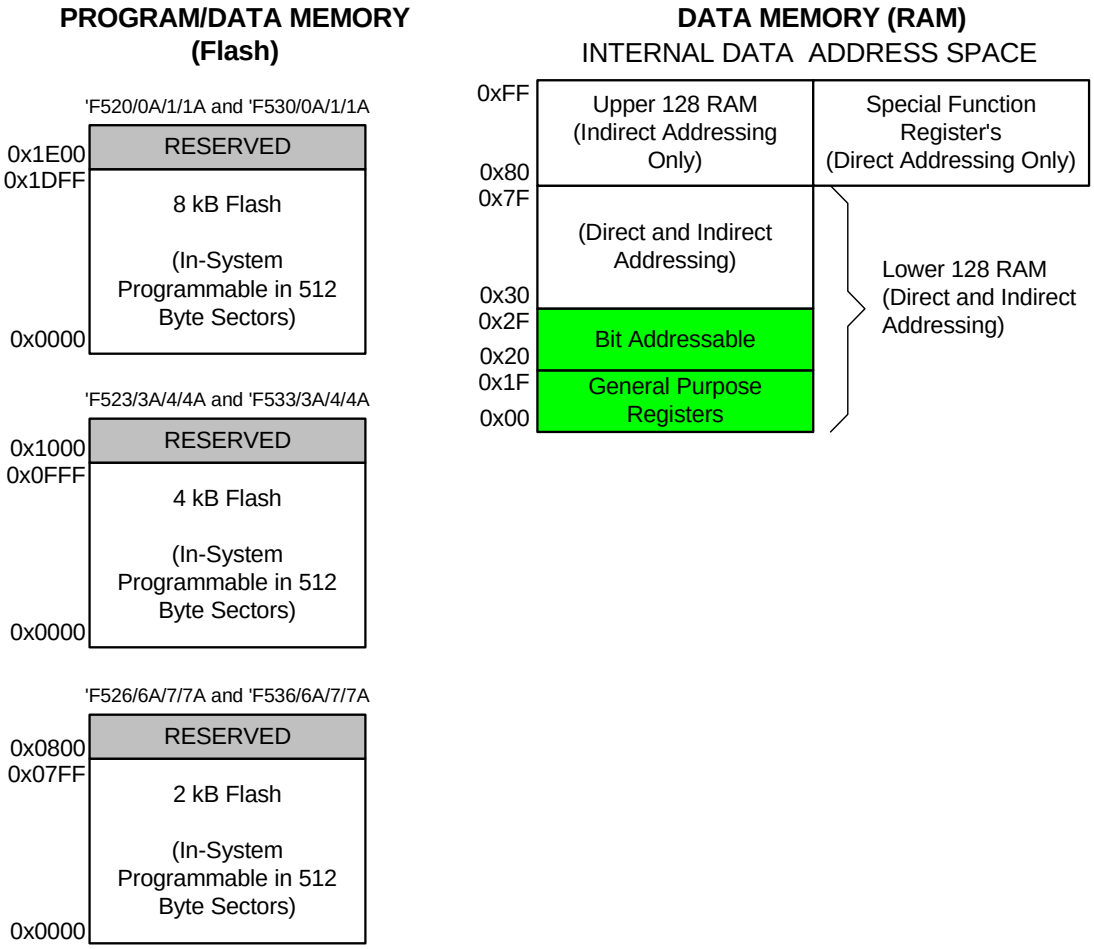


Figure 9.1. Memory Map

9.1. Program Memory

The CIP-51 core has a 64 kB program memory space. The C8051F520/0A/1/1A and C8051F530/0A/1/1A implement 8 kB of this program memory space as in-system, re-programmable Flash memory, organized in a contiguous block from addresses 0x0000 to 0x1FFF. Addresses above 0x1DFF are reserved on the 8 kB devices. The C8051F523/3A/4/4A and C8051F533/3A/4/4A implement 4 kB of Flash from addresses 0x0000 to 0x0FFF. The C8051F526/6A/7/7A and C8051F536/6A/7/7A implement 2 kB of Flash from addresses 0x0000 to 0x07FF.

Program memory is normally assumed to be read-only. However, the C8051F52x/F52xA/F53x/F53xA can write to program memory by setting the Program Store Write Enable bit (PSCTL.0) and using the MOVX write instruction. This feature provides a mechanism for updates to program code and use of the program memory space for non-volatile data storage. Refer to Section “12. Flash Memory” on page 113 for further details.

11.2. Power-Fail Reset / V_{DD} Monitors (VDDMON0 and VDDMON1)

C8051F52x-C/F53x-C devices include two V_{DD} monitors: a standard V_{DD} monitor (VDDMON0) and a level-sensitive V_{DD} monitor (VDDMON1). VDDMON0 is primarily intended for setting a higher threshold to allow safe erase or write of Flash memory from firmware. VDDMON1 is used to hold the device in a reset state during power-up and brownout conditions.

Note: VDDMON1 is not present in older silicon revisions A and B. Please refer to Section “20.4. VDD Monitors and VDD Ramp Time” on page 211 for more details.

When a power-down transition or power irregularity causes V_{DD} to drop below V_{RST}, the power supply monitors (VDDMON0 and VDDMON1) will drive the $\overline{\text{RST}}$ pin low and hold the CIP-51 in a reset state (see Figure 11.2). When V_{DD} returns to a level above V_{RST}, the CIP-51 will be released from the reset state. Note that even though internal data memory contents are not altered by the power-fail reset, it is impossible to determine if V_{DD} dropped below the level required for data retention. If the PORSF flag reads 1, the data may no longer be valid.

VDDMON0 is enabled and is selected as a reset source after power-on resets; however its defined state (enabled/disabled) is not altered by any other reset source. For example, if VDDMON0 is disabled by software, and a software reset is performed, VDDMON0 will still be disabled after that reset.

VDDMON1 is enabled and is selected as a reset source after power-on reset and any other type of reset. There is no register setting that can disable this level-sensitive VDD monitor as a reset source.

To protect the integrity of Flash contents, the V_{DD} monitor (VDDMON0) must be enabled to the higher setting (VDMLVL = '1') and selected as a reset source if software contains routines which erase or write Flash memory. If the V_{DD} monitor is not enabled and set to the higher setting, any erase or write performed on Flash memory will cause a Flash Error device reset.

Note: Please refer to Section “20.5. VDD Monitor (VDDMON0) High Threshold Setting” on page 212 for important notes related to the VDD Monitor high threshold setting in older silicon revisions A and B.

The V_{DD} monitor (VDDMON0) must be enabled before it is selected as a reset source. Selecting the VDDMON0 as a reset source before it is enabled and stabilized may cause a system reset. The procedure for re-enabling the V_{DD} monitor and configuring the V_{DD} monitor as a reset source is shown below:

1. Enable the V_{DD} monitor (VDMEN bit in VDDMON = 1).
2. Wait for the V_{DD} monitor to stabilize (see Table 2.8 on page 32 for the V_{DD} Monitor turn-on time). **Note: This delay should be omitted if software contains routines which write or erase Flash memory.**
3. Select the V_{DD} monitor as a reset source (PORSF bit in RSTSRC = 1).

See Figure 11.2 for V_{DD} monitor timing; note that the reset delay is not incurred after a V_{DD} monitor reset. See Table 2.8 on page 32 for complete electrical characteristics of the V_{DD} monitor.

Note: Software should take care not to inadvertently disable the V_{DD} Monitor (VDDMON0) as a reset source when writing to RSTSRC to enable other reset sources or to trigger a software reset. All writes to RSTSRC should explicitly set PORSF to '1' to keep the V_{DD} Monitor enabled as a reset source.

11.2.1. VDD Monitor Thresholds and Minimum VDD

The minimum operating digital supply voltage (V_{DD}) is specified as 2.0 V in Table 2.2 on page 26. The voltage at which the MCU is released from reset (V_{RST}) can be as low as 1.65 V based on the V_{DD} Monitor thresholds that are specified in Table 2.8 on page 32. This could allow code execution during the power-up

11.3. External Reset

The external RST pin provides a means for external circuitry to force the device into a reset state. Asserting an active-low signal on the RST pin generates a reset; an external pullup and/or decoupling of the RST pin may be necessary to avoid erroneous noise-induced resets. See Table 2.8 on page 32 for complete RST pin specifications. The PINRSF flag (RSTSRC.0) is set on exit from an external reset.

Note: Please refer to Section “20.6. Reset Low Time” on page 212 for restrictions on reset low time in older silicon revisions A and B.

11.4. 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 state of the RST pin is unaffected by this reset.

11.5. Comparator 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 state of the RST pin is unaffected by this reset.

11.6. PCA Watchdog Timer Reset

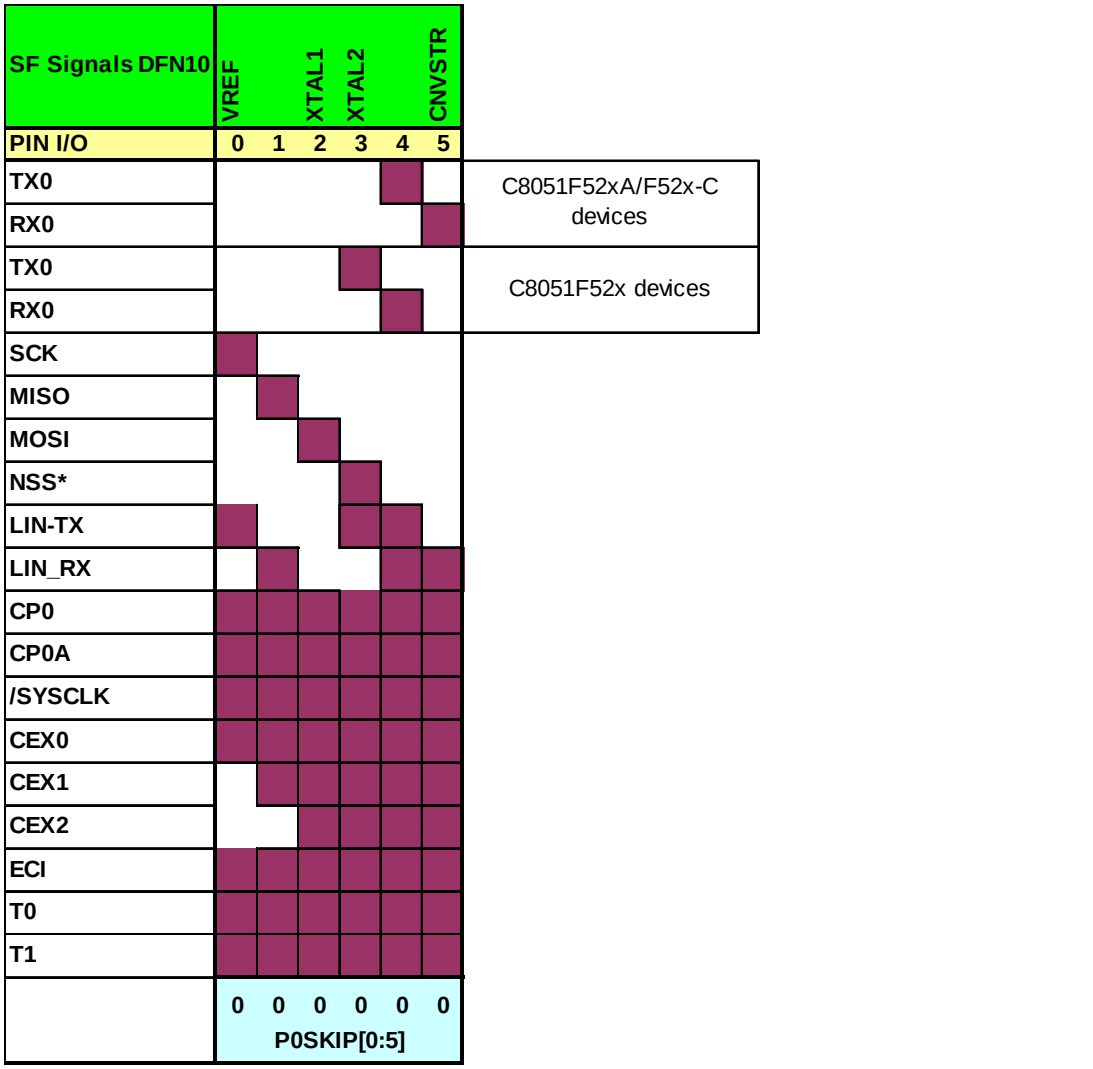
The programmable Watchdog Timer (WDT) function of the Programmable Counter Array (PCA) can be used to prevent software from running out of control during a system malfunction. The PCA WDT function can be enabled or disabled by software as described in Section “19.3. Watchdog Timer Mode” on page 203; 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 state of the RST pin is unaffected by this reset.

11.7. Flash Error Reset

If a Flash read/write/erase or program read targets an illegal address, a system reset is generated. This may occur due to any of the following:

- A Flash write or erase is attempted above user code space. This occurs when PSWE is set to 1 and a MOVX write operation targets an address above the Lock Byte address.
- A Flash read is attempted above user code space. This occurs when a MOVC operation targets an address above the Lock Byte address.
- A program read is attempted above user code space. This occurs when user code attempts to branch to an address above the Lock Byte address.
- A Flash read, write or erase attempt is restricted due to a Flash security setting (see Section “12.4. Security Options” on page 117).
- A Flash write or erase is attempted while the V_{DD} Monitor (VDDMON0) is disabled or not set to its high threshold setting.

The FERROR bit (RSTSRC.6) is set following a Flash error reset. The state of the RST pin is unaffected by this reset.



Note: 4-Wire SPI Only.

Figure 13.5. Crossbar Priority Decoder with No Pins Skipped (DFN 10)

SFR Definition 13.9. P1: Port1

R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	Reset Value
P1.7	P1.6	P1.5	P1.4	P1.3	P1.2	P1.1	P1.0	11111111
Bit7	Bit6	Bit5	Bit4	Bit3	Bit2	Bit1	Bit0	Bit Addressable
							SFR Address:	0x90

Bits7–0: **P1.[7:0]**
Write - Output appears on I/O pins per Crossbar Registers.
0: Logic Low Output.
1: Logic High Output (high impedance if corresponding P1MDOUT.n bit = 0).
Read - Always reads 0 if selected as analog input in register P1MDIN. Directly reads Port pin when configured as digital input.
0: P1.n pin is logic low.
1: P1.n pin is logic high.

SFR Definition 13.10. P1MDIN: Port1 Input Mode

R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	Reset Value
								11111111
Bit7	Bit6	Bit5	Bit4	Bit3	Bit2	Bit1	Bit0	
							SFR Address:	0xF2

Bits7–0: Analog Input Configuration Bits for P1.7–P1.0 (respectively).
Port pins configured as analog inputs have their weak pullup, digital driver, and digital receiver disabled.
0: Corresponding P1.n pin is configured as an analog input.
1: Corresponding P1.n pin is not configured as an analog input.

SFR Definition 14.2. OSCICL: Internal Oscillator Calibration

R	R/W	R/W	R/W	R/W	R/W	R/W	R/W	Reset Value
—	OSCICL							Varies
Bit7	Bit6	Bit5	Bit4	Bit3	Bit2	Bit1	Bit0	
							SFR Address:	0xB3

Bit7: **UNUSED**. Read = 0b. Write = don't care.
Bits6–0: **OSCICL**: Internal Oscillator Calibration Register.
This register determines the internal oscillator period. On C8051F52x/53x devices, the reset value is factory calibrated to generate an internal oscillator frequency of 24.5 MHz.

SFR Definition 14.3. OSCIFIN: Internal Fine Oscillator Calibration

R/W	R/W	R/W	R	R	R/W	R/W	R/W	Reset Value
—	—	OSCIFIN						undetermined
Bit7	Bit6	Bit5	Bit4	Bit3	Bit2	Bit1	Bit0	Bit Addressable
							SFR Address:	0xB0

Bits7–6: **UNUSED**. Read = 00b, Write = don't care.
Bits5–0: **OSCIFIN**. Internal oscillator fine adjustment bits.

The valid range is between 0x00 and 0x27.

This register is a fine adjustment for the internal oscillator period. On C8051F52x/52xA/53x/53xA devices, the reset value is factory calibrated to generate an internal oscillator frequency of 24.5 MHz.

SFR Definition 15.2. SBUF0: Serial (UART0) Port Data Buffer

R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	Reset Value
								00000000
Bit7	Bit6	Bit5	Bit4	Bit3	Bit2	Bit1	Bit0	

SFR Address: 0x99

Bits7–0: **SBUF0[7:0]**: Serial Data Buffer Bits 7–0 (MSB–LSB)
This SFR accesses two registers; a transmit shift register and a receive latch register. When data is written to SBUF0, it goes to the transmit shift register and is held for serial transmission. Writing a byte to SBUF0 initiates the transmission. A read of SBUF0 returns the contents of the receive latch.

Table 15.1. Timer Settings for Standard Baud Rates Using the Internal Oscillator

	Frequency: 24.5 MHz						
	Target Baud Rate (bps)	**Baud Rate % Error**	**Oscillator Divide Factor**	**Timer Clock Source**	**SCA1–SCA0 (pre-scale select)***	**T1M***	**Timer 1 Reload Value (hex)**
SYSCLK from Internal Osc.	230400	–0.32%	106	SYSCLK	XX	1	0xCB
	115200	–0.32%	212	SYSCLK	XX	1	0x96
	57600	0.15%	426	SYSCLK	XX	1	0x2B
	28800	–0.32%	848	SYSCLK / 4	01	0	0x96
	14400	0.15%	1704	SYSCLK / 12	00	0	0xB9
	9600	–0.32%	2544	SYSCLK / 12	00	0	0x96
	2400	–0.32%	10176	SYSCLK / 48	10	0	0x96
	1200	0.15%	20448	SYSCLK / 48	10	0	0x2B

X = Don't care

Note: SCA1–SCA0 and T1M bit definitions can be found in Section 18.1.

SFR Definition 16.1. SPI0CFG: SPI0 Configuration

R	R/W	R/W	R/W	R	R	R	R	Reset Value
SPIBSY	MSTEN	CKPHA	CKPOL	SLVSEL	NSSIN	SRMT	RXBMT	00000111
Bit7	Bit6	Bit5	Bit4	Bit3	Bit2	Bit1	Bit0	

SFR Address: 0xA1

Bit 7: **SPIBSY**: SPI Busy (read only).
This bit is set to logic 1 when a SPI transfer is in progress (Master or Slave Mode).

Bit 6: **MSTEN**: Master Mode Enable.
0: Disable master mode. Operate in slave mode.
1: Enable master mode. Operate as a master.

Bit 5: **CKPHA**: SPI0 Clock Phase.
This bit controls the SPI0 clock phase.
0: Data centered on first edge of SCK period.*
1: Data centered on second edge of SCK period.*

Bit 4: **CKPOL**: SPI0 Clock Polarity.
This bit controls the SPI0 clock polarity.
0: SCK line low in idle state.
1: SCK line high in idle state.

Bit 3: **SLVSEL**: Slave Selected Flag (read only).
This bit is set to logic 1 whenever the NSS pin is low indicating SPI0 is the selected slave. It is cleared to logic 0 when NSS is high (slave not selected). This bit does not indicate the instantaneous value at the NSS pin, but rather a de-glitched version of the pin input.

Bit 2: **NSSIN**: NSS Instantaneous Pin Input (read only).
This bit mimics the instantaneous value that is present on the NSS port pin at the time that the register is read. This input is not de-glitched.

Bit 1: **SRMT**: Shift Register Empty (Valid in Slave Mode, read only).
This bit will be set to logic 1 when all data has been transferred in/out of the shift register, and there is no new information available to read from the transmit buffer or write to the receive buffer. It returns to logic 0 when a data byte is transferred to the shift register from the transmit buffer or by a transition on SCK.
NOTE: SRMT = 1 when in Master Mode.

Bit 0: **RXBMT**: Receive Buffer Empty (Valid in Slave Mode, read only).
This bit will be set to logic 1 when the receive buffer has been read and contains no new information. If there is new information available in the receive buffer that has not been read, this bit will return to logic 0.
NOTE: RXBMT = 1 when in Master Mode.

Note: See Table 16.1 for timing parameters.

17.7. LIN Registers

The following Special Function Registers (SFRs) are available:

17.7.1. LIN Direct Access SFR Registers Definition

SFR Definition 17.1. LINADDR: Indirect Address Register

R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	Reset Value
								00000000
Bit7	Bit6	Bit5	Bit4	Bit3	Bit2	Bit1	Bit0	

SFR Address: 0x92

Bit7–0: **LINADDR7-0**: LIN Indirect Address Register Bits.
This register hold an 8-bit address used to indirectly access the LIN0 core registers. Table 17.4 lists the LIN0 core registers and their indirect addresses. Reads and writes to LINDATA will target the register indicated by the LINADDR bits.

SFR Definition 17.2. LINDATA: LIN Data Register

R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	Reset Value
								00000000
Bit7	Bit6	Bit5	Bit4	Bit3	Bit2	Bit1	Bit0	

SFR Address: 0x93

Bit7–0: **LINDATA7-0**: LIN Indirect Data Register Bits.
When this register is read, it will read the contents of the LIN0 core register pointed to by LINADDR.
When this register is written, it will write the value to the LIN0 core register pointed to by LINADDR.

SFR Definition 17.5. LIN0DT2: LIN0 Data Byte 2

R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	Reset Value
								00000000
Bit7	Bit6	Bit5	Bit4	Bit3	Bit2	Bit1	Bit0	

Address: 0x01 (indirect)

Bit7–0: **LIN0DT2**: LIN Data Byte 2.
Serial Data Byte 2 that is received or transmitted across the LIN interface.

SFR Definition 17.6. LIN0DT3: LIN0 Data Byte 3

R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	Reset Value
								00000000
Bit7	Bit6	Bit5	Bit4	Bit3	Bit2	Bit1	Bit0	

Address: 0x02 (indirect)

Bit7–0: **LIN0DT3**: LIN Data Byte 3.
Serial Data Byte 3 that is received or transmitted across the LIN interface.

SFR Definition 17.7. LIN0DT4: LIN0 Data Byte 4

R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	Reset Value
								00000000
Bit7	Bit6	Bit5	Bit4	Bit3	Bit2	Bit1	Bit0	

Address: 0x03 (indirect)

Bit7–0: **LIN0DT4**: LIN Data Byte 4.
Serial Data Byte 4 that is received or transmitted across the LIN interface.

SFR Definition 18.1. TCON: Timer Control

R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	Reset Value
TF1	TR1	TF0	TR0	IE1	IT1	IE0	IT0	00000000
Bit7	Bit6	Bit5	Bit4	Bit3	Bit2	Bit1	Bit0	Bit Addressable
							SFR Address:	0x88

Bit7: **TF1**: Timer 1 Overflow Flag.
Set by hardware when Timer 1 overflows. This flag can be cleared by software but is automatically cleared when the CPU vectors to the Timer 1 interrupt service routine.
0: No Timer 1 overflow detected.
1: Timer 1 has overflowed.

Bit6: **TR1**: Timer 1 Run Control.
0: Timer 1 disabled.
1: Timer 1 enabled.

Bit5: **TF0**: Timer 0 Overflow Flag.
Set by hardware when Timer 0 overflows. This flag can be cleared by software but is automatically cleared when the CPU vectors to the Timer 0 interrupt service routine.
0: No Timer 0 overflow detected.
1: Timer 0 has overflowed.

Bit4: **TR0**: Timer 0 Run Control.
0: Timer 0 disabled.
1: Timer 0 enabled.

Bit3: **IE1**: External Interrupt 1.
This flag is set by hardware when an edge/level of type defined by IT1 is detected. It can be cleared by software but is automatically cleared when the CPU vectors to the External Interrupt 1 service routine if IT1 = 1. When IT1 = 0, this flag is set to 1 when $\overline{INT0}$ is active as defined by bit IN1PL in register IT01CF (see SFR Definition 10.5. "IT01CF: INT0/INT1 Configuration" on page 105).

Bit2: **IT1**: Interrupt 1 Type Select.
This bit selects whether the configured $\overline{INT0}$ interrupt will be edge or level sensitive. $\overline{INT0}$ is configured active low or high by the IN1PL bit in the IT01CF register (see SFR Definition 10.5. "IT01CF: INT0/INT1 Configuration" on page 105).
0: $\overline{INT0}$ is level triggered.
1: $\overline{INT0}$ is edge triggered.

Bit1: **IE0**: External Interrupt 0.
This flag is set by hardware when an edge/level of type defined by IT0 is detected. It can be cleared by software but is automatically cleared when the CPU vectors to the External Interrupt 0 service routine if IT0 = 1. When IT0 = 0, this flag is set to 1 when $\overline{INT0}$ is active as defined by bit IN0PL in register IT01CF (see SFR Definition 10.5. "IT01CF: INT0/INT1 Configuration" on page 105).

Bit0: **IT0**: Interrupt 0 Type Select.
This bit selects whether the configured $\overline{INT0}$ interrupt will be edge or level sensitive. $\overline{INT0}$ is configured active low or high by the IN0PL bit in register IT01CF (see SFR Definition 10.5. "IT01CF: INT0/INT1 Configuration" on page 105).
0: $\overline{INT0}$ is level triggered.
1: $\overline{INT0}$ is edge triggered.

19. Programmable Counter Array (PCA0)

The Programmable Counter Array (PCA0) provides enhanced timer functionality while requiring less CPU intervention than the standard 8051 counter/timers. The PCA consists of a dedicated 16-bit counter/timer and three 16-bit capture/compare modules. Each capture/compare module has its own associated I/O line (CEXn) which is routed through the Crossbar to Port I/O when enabled (See Section “13.1. Priority Crossbar Decoder” on page 122 for details on configuring the Crossbar). The counter/timer is driven by a programmable timebase that can select between six sources: system clock, system clock divided by four, system clock divided by twelve, the external oscillator clock source divided by 8, Timer 0 overflow, or an external clock signal on the ECI input pin. Each capture/compare module may be configured to operate independently in one of three modes: Edge-Triggered Capture, Software Timer, High-Speed Output, Frequency Output, 8-Bit PWM, or 16-Bit PWM (each mode is described in Section “19.2. Capture/Compare Modules” on page 197). The PCA is configured and controlled through the system controller's Special Function Registers. The PCA block diagram is shown in Figure 19.1.

Important Note: The PCA Module 2 may be used as a watchdog timer (WDT), and is enabled in this mode following a system reset. **Access to certain PCA registers is restricted while WDT mode is enabled**. See Section “19.3. Watchdog Timer Mode” on page 203 for details.

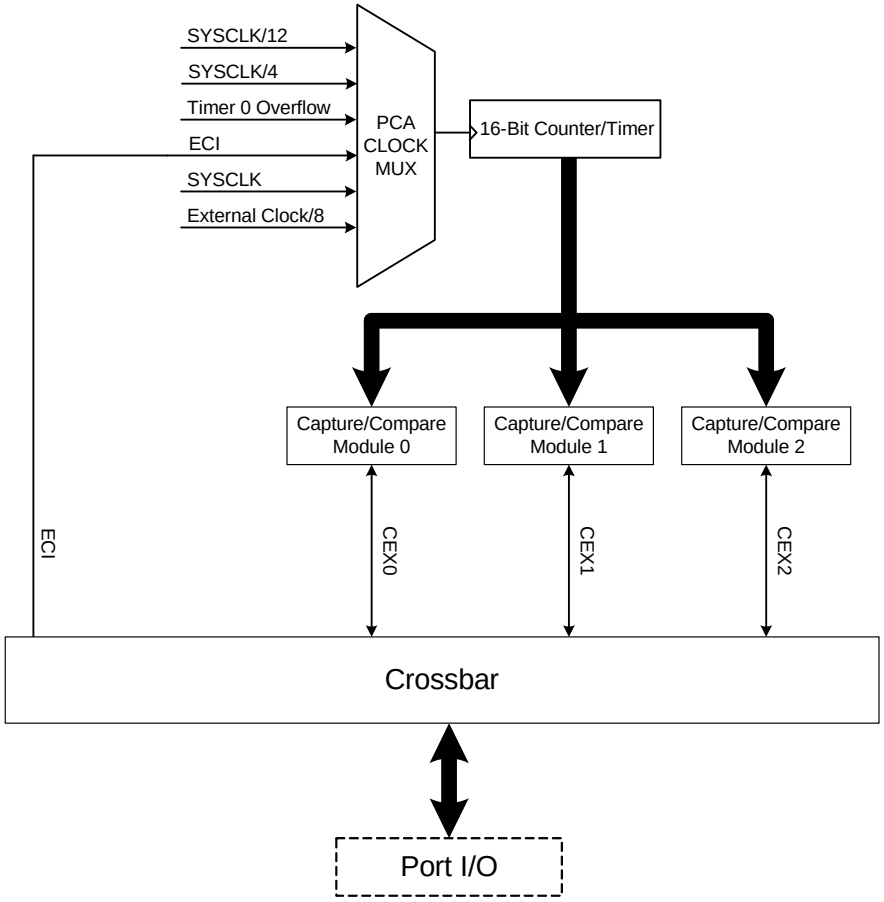


Figure 19.1. PCA Block Diagram

19.2. Capture/Compare Modules

Each module can be configured to operate independently in one of six operation modes: Edge-triggered Capture, Software Timer, High Speed Output, Frequency Output, 8-Bit Pulse Width Modulator, or 16-Bit Pulse Width Modulator. Each module has Special Function Registers (SFRs) associated with it in the CIP-51 system controller. These registers are used to exchange data with a module and configure the module's mode of operation.

Table 19.2 summarizes the bit settings in the PCA0CPMn registers used to select the PCA capture/compare module's operating modes. Setting the ECCFn bit in a PCA0CPMn register enables the module's CCFn interrupt. Note that PCA0 interrupts must be globally enabled before individual CCFn interrupts are recognized. PCA0 interrupts are globally enabled by setting the EA bit and the EPCA0 bit to logic 1. See Figure 19.3 for details on the PCA interrupt configuration.

Table 19.2. PCA0CPM Register Settings for PCA Capture/Compare Modules

PWM16	ECOM	CAPP	CAPN	MAT	TOG	PWM	ECCF	Operation Mode
X	X	1	0	0	0	0	X	Capture triggered by positive edge on CEXn
X	X	0	1	0	0	0	X	Capture triggered by negative edge on CEXn
X	X	1	1	0	0	0	X	Capture triggered by transition on CEXn
X	1	0	0	1	0	0	X	Software Timer
X	1	0	0	1	1	0	X	High Speed Output
X	1	0	0	X	1	1	X	Frequency Output
0	1	0	0	X	0	1	X	8-Bit Pulse Width Modulator
1	1	0	0	X	0	1	X	16-Bit Pulse Width Modulator
X = Don't Care								

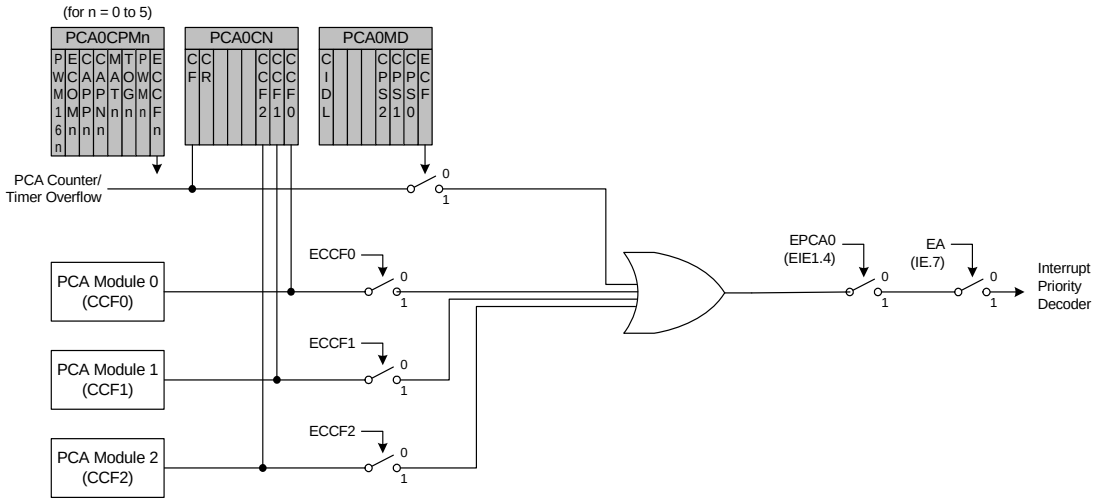


Figure 19.3. PCA Interrupt Block Diagram

19.2.3. High Speed Output Mode

In High Speed Output mode, a module's associated CEXn pin is toggled each time a match occurs between the PCA Counter and the module's 16-bit capture/compare register (PCA0CPHn and PCA0CPLn) Setting the TOGn, MATn, and ECOMn bits in the PCA0CPMn register enables the High-Speed Output mode.

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.

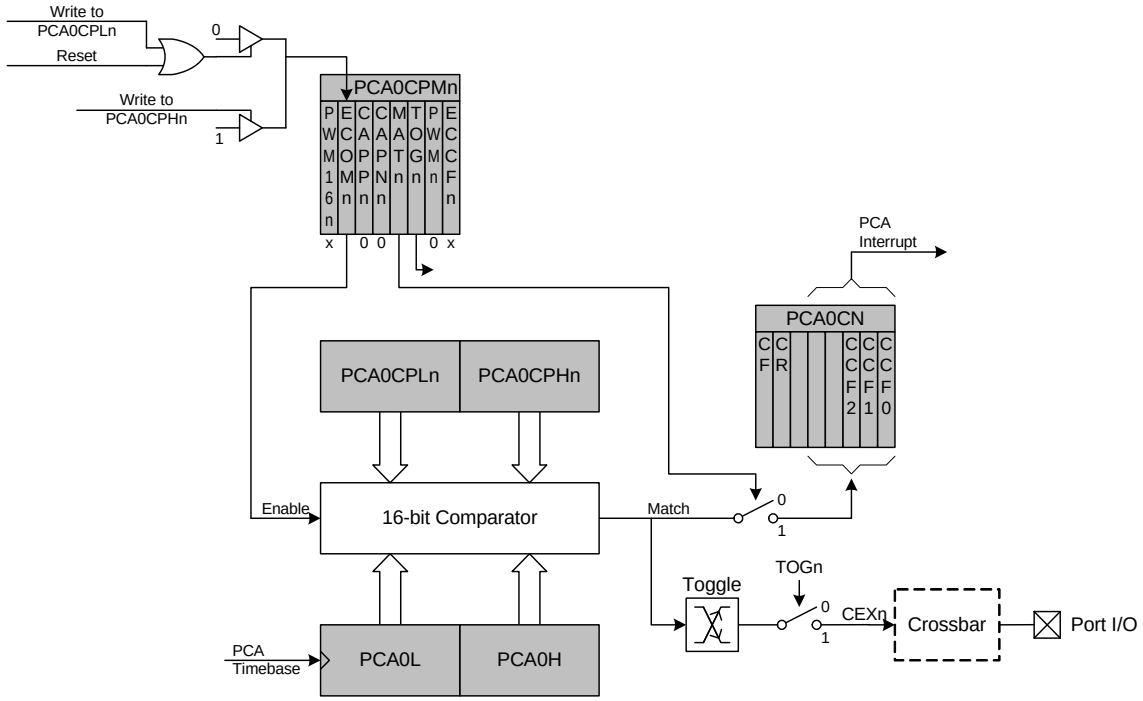


Figure 19.6. PCA High-Speed Output Mode Diagram

Note: The initial state of the Toggle output is logic 1 and is initialized to this state when the module enters High Speed Output Mode.

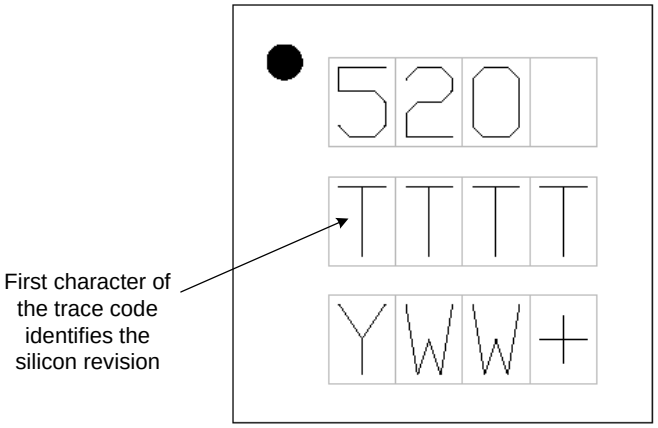


Figure 20.3. Device Package—DFN 10

20.2. Reset Pin Behavior

The reset behavior differs between the silicon revisions of C8051F52x/52xA/F53x/F53xA devices. The differences affect the state of the $\overline{\text{RST}}$ pin during a VDD Monitor reset.

On Revision A devices, a V_{DD} Monitor reset does not affect the state of the $\overline{\text{RST}}$ pin. On Revision B and Revision C devices, a V_{DD} Monitor reset will pull the $\overline{\text{RST}}$ pin low for the duration of the brownout condition.

20.3. Reset Time Delay

The reset time delay differs between the silicon revisions of C8051F52x/52xA/F53x/F53xA devices.

On Revision A devices, the reset time delay will be as long as 80 ms following a power-on reset, meaning it can take up to 80 ms to begin code execution. Subsequent resets will not cause the long delay. On Revision B and Revision C devices, the startup time is around 350 µs, specified as $T_{PORDELAY}$ in Table 2.8, “Reset Electrical Characteristics,” on page 32.

20.4. V_{DD} Monitors and V_{DD} Ramp Time

The number of V_{DD} monitors and definition of “V_{DD} ramp time” differs between the silicon revisions of C8051F52x/52xA/F53x/F53xA devices.

On Revision A and Revision B devices, the only V_{DD} monitor present is the standard V_{DD} monitor (VDDMON0). On these devices, the V_{DD} ramp time is defined as how fast V_{DD} ramps from 0 V to V_{RST}. Here, V_{RST} is the $V_{RST-LOW}$ threshold of VDDMON0 specifed in Table 2.8, “Reset Electrical Characteristics,” on page 32. The maximum V_{DD} ramp time for these devices is 1 ms; slower ramp times may cause the device to be released from reset before V_{DD} reaches the $V_{RST-LOW}$ level.

Revision C devices include two V_{DD} monitors: a standard V_{DD} monitor (VDDMON0) and a level-sensitive V_{DD} monitor (VDDMON1). See Section 11.2 on page 108 for more details. On these devices, the V_{DD} ramp time is defined as how fast V_{DD} ramps from 0 V to V_{RST1}. V_{RST1} is specified in Table 2.8, “Reset Electrical Characteristics,” on page 32 as the threshold of the new level-sensitive V_{DD} monitor (VDDMON1). This new V_{DD} monitor will hold the device in reset until V_{DD} reaches the V_{RST1} level irrespective of the length of the V_{DD} ramp time.

Note: Please refer to Section “11.2.1. VDD Monitor Thresholds and Minimum VDD” on page 108 for recommendations related to minimum V_{DD}.