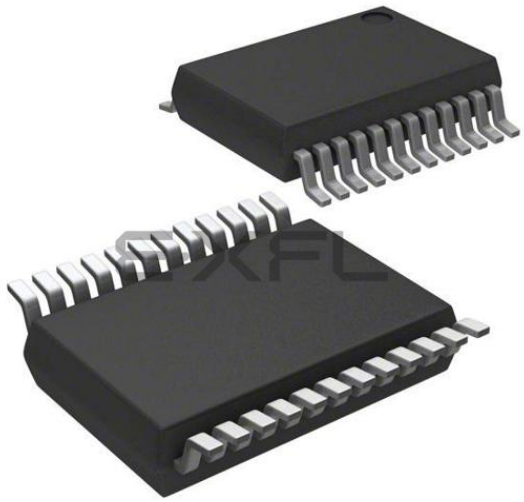

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Applications of "Embedded - Microcontrollers"

Details	
Product Status	Obsolete
Core Processor	CIP-51 8051
Core Size	8-Bit
Speed	25MHz
Connectivity	SMBus (2-Wire/I²C), SPI, UART/USART
Peripherals	Brown-out Detect/Reset, POR, PWM, WDT
Number of I/O	17
Program Memory Size	8KB (8K x 8)
Program Memory Type	FLASH
EEPROM Size	-
RAM Size	512 x 8
Voltage - Supply (Vcc/Vdd)	1.8V ~ 3.6V
Data Converters	-
Oscillator Type	Internal
Operating Temperature	-40°C ~ 85°C (TA)
Mounting Type	Surface Mount
Package / Case	24-SSOP (0.154", 3.90mm Width)
Supplier Device Package	24-QSOP
Purchase URL	https://www.e-xfl.com/product-detail/silicon-labs/c8051f987-gur

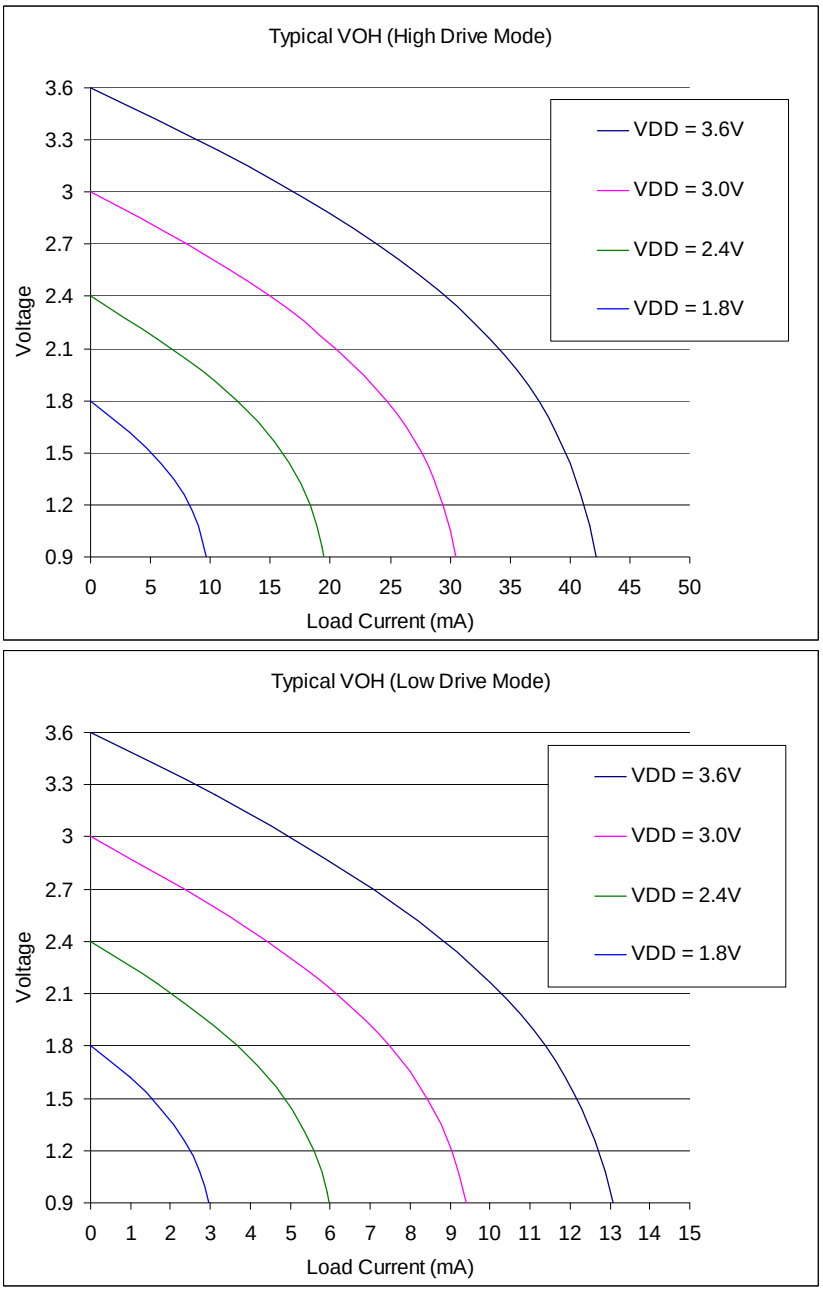

Figure 4.3. Typical VOH Curves, 1.8–3.6 V

SFR Definition 5.12. ADC0MX: ADC0 Input Channel Select

Bit	7	6	5	4	3	2	1	0
Name				AD0MX				
Type	R	R	R	R/W	R/W	R/W	R/W	R/W
Reset	0	0	0	1	1	1	1	1

SFR Page = 0x0; SFR Address = 0x96

Bit	Name	Function
7:5	Unused	Read = 000b; Write = Don't Care.
4:0	AD0MX	**AMUX0 Positive Input Selection.** Selects the positive input channel for ADC0.

00000:	Reserved.	10000:	Reserved.
00001:	P0.1	10001:	Reserved.
00010:	P0.2	10010:	Reserved.
00011:	P0.3	10011:	Reserved.
00100:	P0.4	10100:	Reserved.
00101:	P0.5	10101:	Reserved.
00110:	P0.6	10110:	Reserved.
00111:	P0.7	10111:	Reserved.
01000:	Reserved.	11000:	Reserved.
01001:	Reserved.	11001:	Reserved.
01010:	P1.2	11010:	Reserved.
01011:	P1.3	11011:	Temperature Sensor
01100:	P1.4 (only available on 24-pin devices)	11100:	V_{DD} Supply Voltage
01101:	Reserved.	11101:	Digital Supply Voltage (VREG0 Output, 1.7 V Typical)
01110:	Reserved.		
01111:	Reserved.	11110:	V_{DD} Supply Voltage
		11111:	Ground

SFR Definition 8.7. CS0SS: Capacitive Sense Auto-Scan Start Channel

Bit	7	6	5	4	3	2	1	0
Name				CS0SS[4:0]				
Type	R	R	R	R/W	R/W	R/W	R/W	R/W
Reset	0	0	0	0	0	0	0	0

SFR Page = 0x0; SFR Address = 0xDD

Bit	Name	Description
7:5	Unused	Read = 000b; Write = Don't care
4:0	CS0SS[4:0]	**Starting Channel for Auto-Scan.** Sets the first CS0 channel to be selected by the mux for Capacitive Sense conversion when auto-scan is enabled and active. All channels detailed in CS0MX SFR Definition 8.15 are possible choices for this register. When auto-scan is enabled, a write to CS0SS will also update CS0MX.

SFR Definition 8.8. CS0SE: Capacitive Sense Auto-Scan End Channel

Bit	7	6	5	4	3	2	1	0
Name				CS0SE[4:0]				
Type	R	R	R	R/W	R/W	R/W	R/W	R/W
Reset	0	0	0	0	0	0	0	0

SFR Page = 0x0; SFR Address = 0xDE

Bit	Name	Description
7:5	Unused	Read = 000b; Write = Don't care
4:0	CS0SE[4:0]	**Ending Channel for Auto-Scan.** Sets the last CS0 channel to be selected by the mux for Capacitive Sense conversion when auto-scan is enabled and active. All channels detailed in CS0MX SFR Definition 8.15 are possible choices for this register.

With the CIP-51's maximum system clock at 25 MHz, it has a peak throughput of 25 MIPS. The CIP-51 has a total of 109 instructions. The table below shows the total number of instructions that require each execution time.

Clocks to Execute	1	2	2/3	3	3/4	4	4/5	5	8
Number of Instructions	26	50	5	14	7	3	1	2	1

9.2. Programming and Debugging Support

In-system programming of the Flash program memory and communication with on-chip debug support logic is accomplished via the Silicon Labs 2-Wire Development Interface (C2).

The on-chip debug support logic facilitates full speed in-circuit debugging, allowing the setting of hardware breakpoints, starting, stopping and single stepping through program execution (including interrupt service routines), examination of the program's call stack, and reading/writing the contents of registers and memory. This method of on-chip debugging is completely non-intrusive, requiring no RAM, Stack, timers, or other on-chip resources. C2 details can be found in Section “27. C2 Interface” on page 319.

The CIP-51 is supported by development tools from Silicon Labs and third party vendors. Silicon Labs provides an integrated development environment (IDE) including editor, debugger and programmer. The IDE's debugger and programmer interface to the CIP-51 via the C2 interface to provide fast and efficient in-system device programming and debugging. Third party macro assemblers and C compilers are also available.

9.3. Instruction Set

The instruction set of the CIP-51 System Controller is fully compatible with the standard MCS-51™ instruction set. Standard 8051 development tools can be used to develop software for the CIP-51. All CIP-51 instructions are the binary and functional equivalent of their MCS-51™ counterparts, including opcodes, addressing modes and effect on PSW flags. However, instruction timing is different than that of the standard 8051.

9.3.1. Instruction and CPU Timing

In many 8051 implementations, a distinction is made between machine cycles and clock cycles, with machine cycles varying from 2 to 12 clock cycles in length. However, the CIP-51 implementation is based solely on clock cycle timing. All instruction timings are specified in terms of clock cycles.

Due to the pipelined architecture of the CIP-51, most instructions execute in the same number of clock cycles as there are program bytes in the instruction. Conditional branch instructions take one less clock cycle to complete when the branch is not taken as opposed to when the branch is taken. Table 9.1 is the CIP-51 Instruction Set Summary, which includes the mnemonic, number of bytes, and number of clock cycles for each instruction.

SFR Definition 9.3. SP: Stack Pointer

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

SFR Page = All; SFR Address = 0x81

Bit	Name	Function
7:0	SP[7:0]	**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 9.4. ACC: Accumulator

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

SFR Page = All; SFR Address = 0xE0; Bit-Addressable

Bit	Name	Function
7:0	ACC[7:0]	**Accumulator.** This register is the accumulator for arithmetic operations.

SFR Definition 9.5. B: B Register

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

SFR Page = All; SFR Address = 0xF0; Bit-Addressable

Bit	Name	Function
7:0	B[7:0]	**B Register.** This register serves as a second accumulator for certain arithmetic operations.

Table 12.3. Special Function Registers (Continued)

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

Register	Address	SFR Page	Description	Page
TCON	0x88	0x0	Timer/Counter Control	284
TH0	0x8C	0x0	Timer/Counter 0 High	287
TH1	0x8D	0x0	Timer/Counter 1 High	287
TL0	0x8A	0x0	Timer/Counter 0 Low	286
TL1	0x8B	0x0	Timer/Counter 1 Low	286
TMOD	0x89	0x0	Timer/Counter Mode	285
TMR2CN	0xC8	0x0	Timer/Counter 2 Control	291
TMR2H	0xCD	0x0	Timer/Counter 2 High	293
TMR2L	0xCC	0x0	Timer/Counter 2 Low	293
TMR2RLH	0xCB	0x0	Timer/Counter 2 Reload High	292
TMR2RLL	0xCA	0x0	Timer/Counter 2 Reload Low	292
TMR3CN	0x91	0x0	Timer/Counter 3 Control	297
TMR3H	0x95	0x0	Timer/Counter 3 High	299
TMR3L	0x94	0x0	Timer/Counter 3 Low	299
TMR3RLH	0x93	0x0	Timer/Counter 3 Reload High	298
TMR3RLL	0x92	0x0	Timer/Counter 3 Reload Low	298
TOFFH	0x8E	0xF	Temperature Offset High	87
TOFFL	0x8D	0xF	Temperature Offset Low	87
VDM0CN	0xFF	0x0	VDD Monitor Control	184
XBR0	0xE1	0x0	Port I/O Crossbar Control 0	222
XBR1	0xE2	0x0	Port I/O Crossbar Control 1	223
XBR2	0xE3	0x0	Port I/O Crossbar Control 2	224

SFR Definition 13.2. 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 = All; SFR Address = 0xB8; Bit-Addressable

Bit	Name	Function
7	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.

14.3. Security Options

The CIP-51 provides security options to protect the Flash memory from inadvertent modification by software as well as to prevent the viewing of proprietary program code and constants. The Program Store Write Enable (bit PSWE in register PSCTL) and the Program Store Erase Enable (bit PSEE in register PSCTL) bits protect the Flash memory from accidental modification by software. PSWE must be explicitly set to 1 before software can modify the Flash memory; both PSWE and PSEE must be set to 1 before software can erase Flash memory. Additional security features prevent proprietary program code and data constants from being read or altered across the C2 interface.

A Security Lock Byte located at the last byte of Flash user space offers protection of the Flash program memory from access (reads, writes, or erases) by unprotected code or the C2 interface. See **Section "10. Memory Organization" on page 128** for the location of the security byte. The Flash security mechanism allows the user to lock *n* 512-byte Flash pages, starting at page 0 (addresses 0x0000 to 0x01FF), where *n* is the 1s complement number represented by the Security Lock Byte. **The page containing the Flash Security Lock Byte is unlocked when no other Flash pages are locked (all bits of the Lock Byte are 1) and locked when any other Flash pages are locked (any bit of the Lock Byte is 0).**

Security Lock Byte:	1111 1011b
ones Complement:	0000 0100b
Flash pages locked:	5 (First four Flash pages + Lock Byte Page)

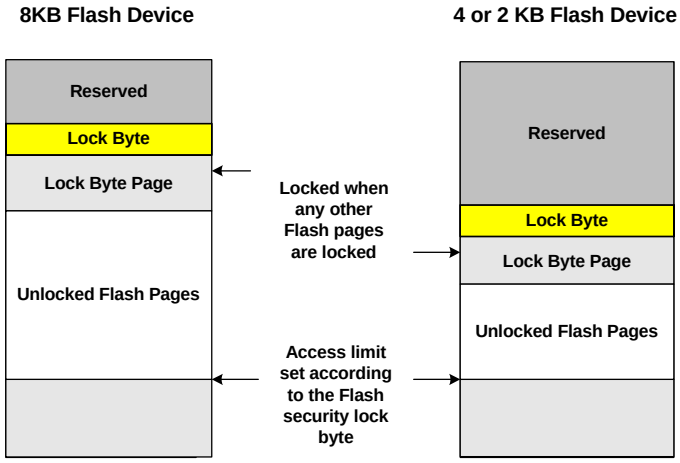

Figure 14.1. Flash Program Memory Map (8 kB and smaller devices)

The level of Flash security depends on the Flash access method. The three Flash access methods that can be restricted are reads, writes, and erases from the C2 debug interface, user firmware executing on unlocked pages, and user firmware executing on locked pages. Table 14.1 summarizes the Flash security features of the C8051F99x-C8051F98x devices.

14.4. Determining the Device Part Number at Run Time

In many applications, user software may need to determine the MCU part number at run time in order to determine the hardware capabilities. The part number can be determined by reading the value of the DEVICEID Special Function Register.

The value of the DEVICEID register can be decoded as follows:

0xD0—C8051F990
0xD1—C8051F991
0xD6—C8051F996
0xD2—C8051F997

0xD3—C8051F980
0xD4—C8051F981
0xD5—C8051F982
0xD7—C8051F983
0xD8—C8051F985
0xD9—C8051F986
0xDA—C8051F987
0xDB—C8051F988
0xDC—C8051F989

SFR Definition 14.1. DEVICEID: Device Identification

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

SFR Page = 0xF; SFR Address = 0xE3

Bit	Name	Function
7:0	DEVICEID[7:0]	**Device Identification.** These bits contain a value that can be decoded to determine the device part number.

15.1. Normal Mode

The MCU is fully functional in normal mode. Figure 15.1 shows the on-chip power distribution to various peripherals. There are two supply voltages powering various sections of the chip: V_{DD} and the 1.8 V internal core supply. All analog peripherals are directly powered from the V_{DD} pin. All digital peripherals and the CIP-51 core are powered from the 1.8 V internal core supply. RAM, PMU0 and the SmaRTClock are always powered directly from the V_{DD} pin in sleep mode and powered from the core supply in all other power modes.

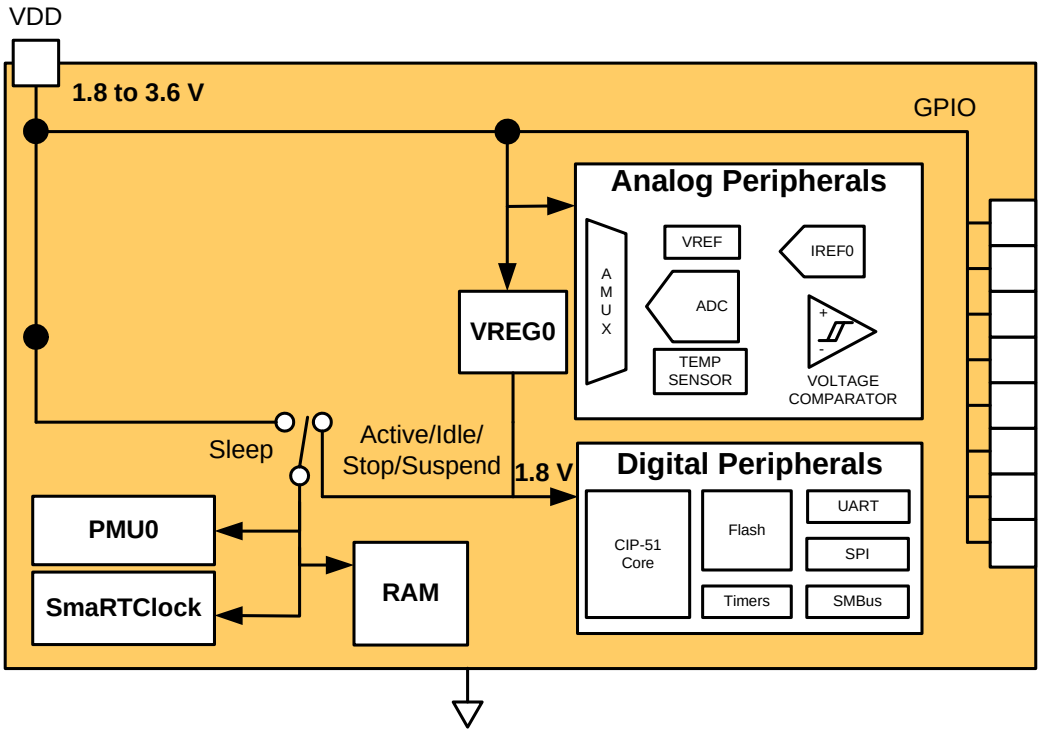

Figure 15.1. C8051F99x-C8051F98x Power Distribution

SFR Definition 15.3. PMU0MD: Power Management Unit Mode

Bit	7	6	5	4	3	2	1	0
Name	RTCOE	WAKEOE	MONDIS					
Type	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W
Reset	0	0	0	0	0	0	0	0

SFR Page = 0xF; SFR Address = 0xB5

Bit	Name	Function
7	RTCOE	**Buffered SmaRTClock Output Enable.** Enables the buffered SmaRTClock oscillator output on P0.2. 0: Buffered SmaRTClock output not enabled. 1: Buffered SmaRTClock output is enabled.
6	WAKEOE	**Wakeup Request Output Enable.** Enables the Sleep Mode wake-up request signal on P0.3. 0: Wake-up request signal is not enabled. 1: Wake-up request signal is enabled.
5	MONDIS*	**POR Supply Monitor Disable.** Writing a 1 to this bit disables the POR supply monitor.
4:0	Unused	Read = 00000b. Write = Don't Care.
Notes: The POR Supply Monitor should not be disabled if the supply voltage is greater than 2.4 V. The lowest power sleep mode current, 10 nA typical, can only be achieved when the supply voltage is less than 2.4 V. The lowest power sleep mode for voltages above 2.4 V is 50 nA typical with the POR Supply Monitor enabled.		

18.1. Power-On Reset

During power-up, the device is held in a reset state and the $\overline{RST}$ pin voltage tracks V_{DD} (through a weak pull-up) until the device is released from reset. After VDD settles above VPOR, a delay occurs before the device is released from reset; the delay decreases as the V_{DD} ramp time increases (V_{DD} ramp time is defined as how fast V_{DD} ramps from 0 V to V_{POR}). Figure 18.2 plots the power-on and V_{DD} monitor reset timing. For valid ramp times (less than 3 ms), the power-on reset delay ($T_{PORDelay}$) is typically 7 ms (V_{DD} = 1.8 V) or 15 ms (V_{DD} = 3.6 V).

Note: The maximum V_{DD} ramp time is 3 ms; slower ramp times may cause the device to be released from reset before V_{DD} reaches the V_{POR} level.

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

The POR supply monitor can be disabled to save power by writing 1 to the MONDIS (PMU0MD.5) bit. When the POR supply monitor is disabled, all reset sources will trigger a full POR and will re-enable the POR supply monitor.

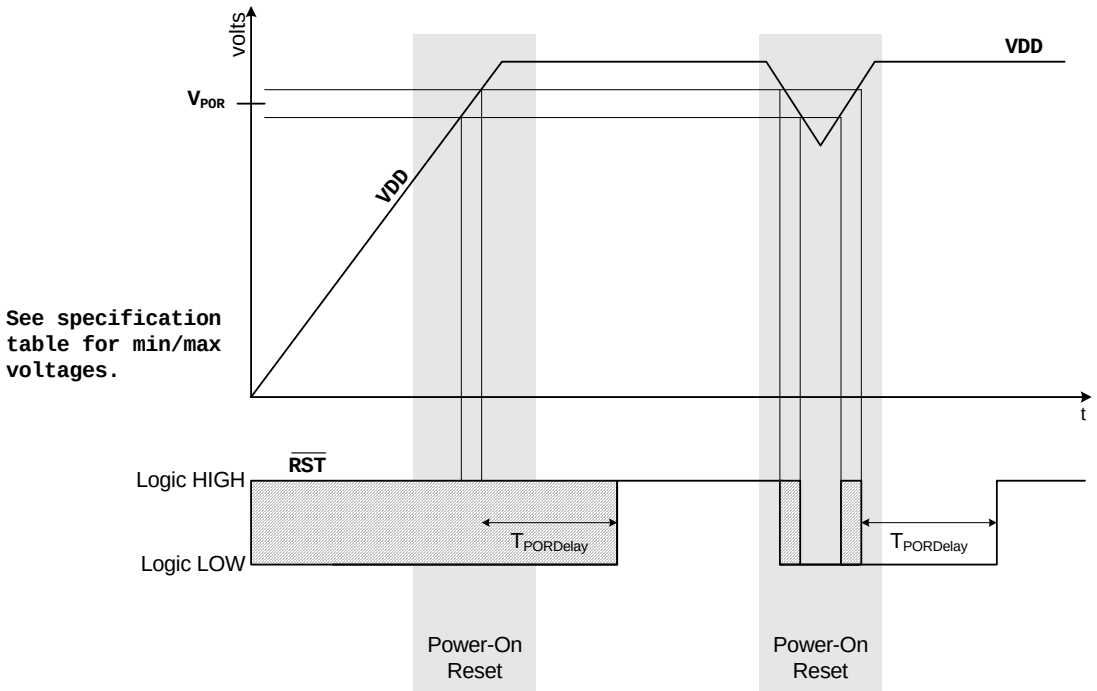

Figure 18.2. Power-Fail Reset Timing Diagram

22.4.2. SMB0CN Control Register

SMB0CN is used to control the interface and to provide status information (see SFR Definition 22.2). The higher four bits of SMB0CN (MASTER, TXMODE, STA, and STO) form a status vector that can be used to jump to service routines. MASTER indicates whether a device is the master or slave during the current transfer. TXMODE indicates whether the device is transmitting or receiving data for the current byte.

STA and STO indicate that a START and/or STOP has been detected or generated since the last SMBus interrupt. STA and STO are also used to generate START and STOP conditions when operating as a master. Writing a 1 to STA will cause the SMBus interface to enter Master Mode and generate a START when the bus becomes free (STA is not cleared by hardware after the START is generated). Writing a 1 to STO while in Master Mode will cause the interface to generate a STOP and end the current transfer after the next ACK cycle. If STO and STA are both set (while in Master Mode), a STOP followed by a START will be generated.

The ARBLOST bit indicates that the interface has lost an arbitration. This may occur anytime the interface is transmitting (master or slave). A lost arbitration while operating as a slave indicates a bus error condition. ARBLOST is cleared by hardware each time SI is cleared.

The SI bit (SMBus Interrupt Flag) is set at the beginning and end of each transfer, after each byte frame, or when an arbitration is lost; see Table 22.3 for more details.

Important Note About the SI Bit: The SMBus interface is stalled while SI is set; thus SCL is held low, and the bus is stalled until software clears SI.

22.4.2.1.Software ACK Generation

When the EHACK bit in register SMB0ADM is cleared to 0, the firmware on the device must detect incoming slave addresses and ACK or NACK the slave address and incoming data bytes. As a receiver, writing the ACK bit defines the outgoing ACK value; as a transmitter, reading the ACK bit indicates the value received during the last ACK cycle. ACKRQ is set each time a byte is received, indicating that an outgoing ACK value is needed. When ACKRQ is set, software should write the desired outgoing value to the ACK bit before clearing SI. A NACK will be generated if software does not write the ACK bit before clearing SI. SDA will reflect the defined ACK value immediately following a write to the ACK bit; however SCL will remain low until SI is cleared. If a received slave address is not acknowledged, further slave events will be ignored until the next START is detected.

22.4.2.2.Hardware ACK Generation

When the EHACK bit in register SMB0ADM is set to 1, automatic slave address recognition and ACK generation is enabled. More detail about automatic slave address recognition can be found in Section 22.4.3. As a receiver, the value currently specified by the ACK bit will be automatically sent on the bus during the ACK cycle of an incoming data byte. As a transmitter, reading the ACK bit indicates the value received on the last ACK cycle. The ACKRQ bit is not used when hardware ACK generation is enabled. If a received slave address is NACKed by hardware, further slave events will be ignored until the next START is detected, and no interrupt will be generated.

Table 22.3 lists all sources for hardware changes to the SMB0CN bits. Refer to Table 22.5 for SMBus status decoding using the SMB0CN register.

Table 22.3. Sources for Hardware Changes to SMB0CN

Bit	Set by Hardware When:	Cleared by Hardware When:
MASTER	■ A START is generated.	■ A STOP is generated. ■ Arbitration is lost.
TXMODE	■ START is generated. ■ SMB0DAT is written before the start of an SMBus frame.	■ A START is detected. ■ Arbitration is lost. ■ SMB0DAT is not written before the start of an SMBus frame.
STA	■ A START followed by an address byte is received.	■ Must be cleared by software.
STO	■ A STOP is detected while addressed as a slave. ■ Arbitration is lost due to a detected STOP.	■ A pending STOP is generated.
ACKRQ	■ A byte has been received and an ACK response value is needed (only when hardware ACK is not enabled).	■ After each ACK cycle.
ARBLOST	■ A repeated START is detected as a MASTER when STA is low (unwanted repeated START). ■ SCL is sensed low while attempting to generate a STOP or repeated START condition. ■ SDA is sensed low while transmitting a 1 (excluding ACK bits).	■ Each time SI is cleared.
ACK	■ The incoming ACK value is low (ACKNOWLEDGE).	■ The incoming ACK value is high (NOT ACKNOWLEDGE).
SI	■ A START has been generated. ■ Lost arbitration. ■ A byte has been transmitted and an ACK/NACK received. ■ A byte has been received. ■ A START or repeated START followed by a slave address + R/W has been received. ■ A STOP has been received.	■ Must be cleared by software.

SFR Definition 22.3. SMB0ADR: SMBus Slave Address

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

SFR Page = 0x0; SFR Address = 0xF4

Bit	Name	Function
7:1	SLV[6:0]	**SMBus Hardware Slave Address.** Defines the SMBus Slave Address(es) for automatic hardware acknowledgement. Only address bits which have a 1 in the corresponding bit position in SLVM[6:0] are checked against the incoming address. This allows multiple addresses to be recognized.
0	GC	**General Call Address Enable.** When hardware address recognition is enabled (EHACK = 1), this bit will determine whether the General Call Address (0x00) is also recognized by hardware. 0: General Call Address is ignored. 1: General Call Address is recognized.

SFR Definition 22.4. SMB0ADM: SMBus Slave Address Mask

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

SFR Page = 0x0; SFR Address = 0xF5

Bit	Name	Function
7:1	SLVM[6:0]	**SMBus Slave Address Mask.** Defines which bits of register SMB0ADR are compared with an incoming address byte, and which bits are ignored. Any bit set to 1 in SLVM[6:0] enables comparisons with the corresponding bit in SLV[6:0]. Bits set to 0 are ignored (can be either 0 or 1 in the incoming address).
0	EHACK	**Hardware Acknowledge Enable.** Enables hardware acknowledgement of slave address and received data bytes. 0: Firmware must manually acknowledge all incoming address and data bytes. 1: Automatic Slave Address Recognition and Hardware Acknowledge is Enabled.

Table 22.6. SMBus Status Decoding With Hardware ACK Generation Enabled (EHACK = 1)

Mode	Values Read				Current SMbus State	Typical Response Options	Values to Write			Next Status Vector Expected
	Status Vector	ACKRQ	ARBLOST	ACK			STA	STO	ACK	
Master Transmitter	1110	0	0	X	A master START was generated.	Load slave address + R/W into SMB0DAT.	0	0	X	1100
	1100	0	0	0	A master data or address byte was transmitted; NACK received.	Set STA to restart transfer.	1	0	X	1110
						Abort transfer.	0	1	X	—
		0	0	1	A master data or address byte was transmitted; ACK received.	Load next data byte into SMB0DAT.	0	0	X	1100
						End transfer with STOP.	0	1	X	—
						End transfer with STOP and start another transfer.	1	1	X	—
						Send repeated START.	1	0	X	1110
						Switch to Master Receiver Mode (clear SI without writing new data to SMB0DAT). Set ACK for initial data byte.	0	0	1	1000
Master Receiver	1000	0	0	1	A master data byte was received; ACK sent.	Set ACK for next data byte; Read SMB0DAT.	0	0	1	1000
						Set NACK to indicate next data byte as the last data byte; Read SMB0DAT.	0	0	0	1000
						Initiate repeated START.	1	0	0	1110
						Switch to Master Transmitter Mode (write to SMB0DAT before clearing SI).	0	0	X	1100
		0	0	0	A master data byte was received; NACK sent (last byte).	Read SMB0DAT; send STOP.	0	1	0	—
						Read SMB0DAT; Send STOP followed by START.	1	1	0	1110
						Initiate repeated START.	1	0	0	1110
						Switch to Master Transmitter Mode (write to SMB0DAT before clearing SI).	0	0	X	1100

Table 23.1. Timer Settings for Standard Baud Rates Using The Internal 24.5 MHz Oscillator

	Frequency: 24.5 MHz						
	Target Baud Rate (bps)	Baud Rate % Error	Oscillator Divide Factor	Timer Clock Source	SCA1–SCA0 (pre-scale select)[1]	T1M[1]	Timer 1 Reload Value (hex)
SYSCLK from Internal Osc.	230400	–0.32%	106	SYSCLK	XX[2]	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

Notes:
1. SCA1–SCA0 and T1M bit definitions can be found in Section 25.1.
2. X = Don't care.

Table 23.2. Timer Settings for Standard Baud Rates Using an External 22.1184 MHz Oscillator

	Frequency: 22.1184 MHz						
	Target Baud Rate (bps)	Baud Rate % Error	Oscillator Divide Factor	Timer Clock Source	SCA1–SCA0 (pre-scale select)[1]	T1M[1]	Timer 1 Reload Value (hex)
SYSCLK from External Osc.	230400	0.00%	96	SYSCLK	XX[2]	1	0xD0
	115200	0.00%	192	SYSCLK	XX	1	0xA0
	57600	0.00%	384	SYSCLK	XX	1	0x40
	28800	0.00%	768	SYSCLK / 12	00	0	0xE0
	14400	0.00%	1536	SYSCLK / 12	00	0	0xC0
	9600	0.00%	2304	SYSCLK / 12	00	0	0xA0
	2400	0.00%	9216	SYSCLK / 48	10	0	0xA0
	1200	0.00%	18432	SYSCLK / 48	10	0	0x40
SYSCLK from Internal Osc.	230400	0.00%	96	EXTCLK / 8	11	0	0xFA
	115200	0.00%	192	EXTCLK / 8	11	0	0xF4
	57600	0.00%	384	EXTCLK / 8	11	0	0xE8
	28800	0.00%	768	EXTCLK / 8	11	0	0xD0
	14400	0.00%	1536	EXTCLK / 8	11	0	0xA0
	9600	0.00%	2304	EXTCLK / 8	11	0	0x70

Notes:
1. SCA1–SCA0 and T1M bit definitions can be found in Section 25.1.
2. X = Don't care.

26.3.6. 16-Bit Pulse Width Modulator Mode

A PCA module may also be operated in 16-Bit PWM mode. 16-bit PWM mode is independent of the other (8/9/10/11-bit) PWM modes. 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 16-bit 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. If the MATn bit is set to 1, the CCFn flag for the module will be set each time a 16-bit comparator match (rising edge) occurs. The CF flag in PCA0CN can be used to detect the overflow (falling edge). The duty cycle for 16-Bit PWM Mode is given by Equation 26.4.

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.

$$\text{Duty Cycle} = \frac{(65536 - PCA0CPn)}{65536}$$

Equation 26.4. 16-Bit PWM Duty Cycle

Using Equation 26.4, 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.

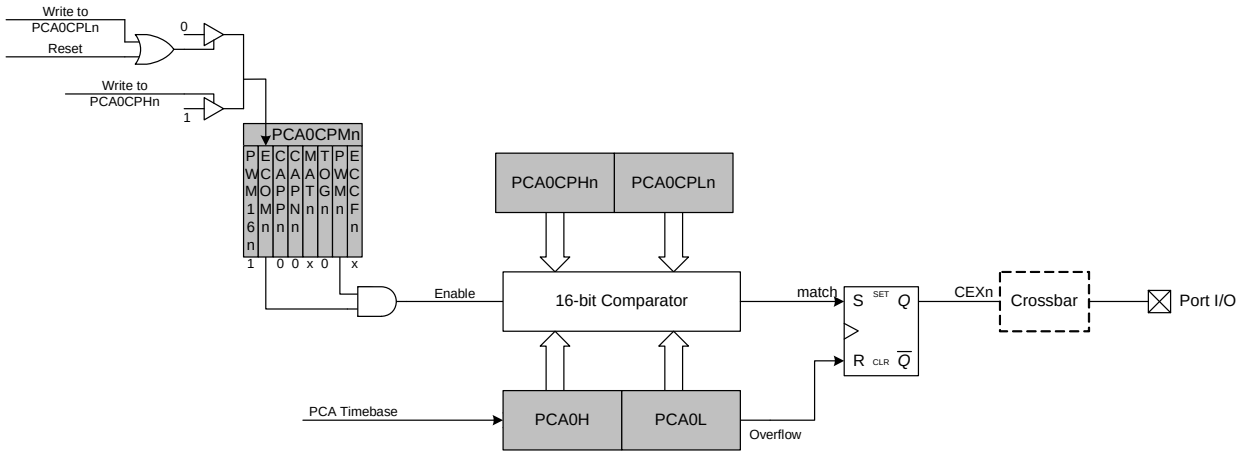

Figure 26.10. PCA 16-Bit PWM Mode

C2 Register Definition 27.4. FPCTL: C2 Flash Programming Control

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

C2 Address: 0x02

Bit	Name	Function
7:0	FPCTL[7:0]	**Flash Programming Control Register.** This register is used to enable Flash programming via the C2 interface. To enable C2 Flash programming, the following codes must be written in order: 0x02, 0x01. Note that once C2 Flash programming is enabled, a system reset must be issued to resume normal operation.

C2 Register Definition 27.5. FPDAT: C2 Flash Programming Data

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

C2 Address: 0xB4

Bit	Name	Function	
7:0	FPDAT[7:0]	**C2 Flash Programming Data Register.** This register is used to pass Flash commands, addresses, and data during C2 Flash accesses. Valid commands are listed below.	
		Code	**Command**
		0x06	Flash Block Read
		0x07	Flash Block Write
		0x08	Flash Page Erase
		0x03	Device Erase

27.2. C2 Pin Sharing

The C2 protocol allows the C2 pins to be shared with user functions so that in-system debugging and Flash programming may be performed. This is possible because C2 communication is typically performed when the device is in the halt state, where all on-chip peripherals and user software are stalled. In this halted state, the C2 interface can safely “borrow” the C2CK (RST) and C2D pins. In most applications, external resistors are required to isolate C2 interface traffic from the user application. A typical isolation configuration is shown in Figure 27.1.

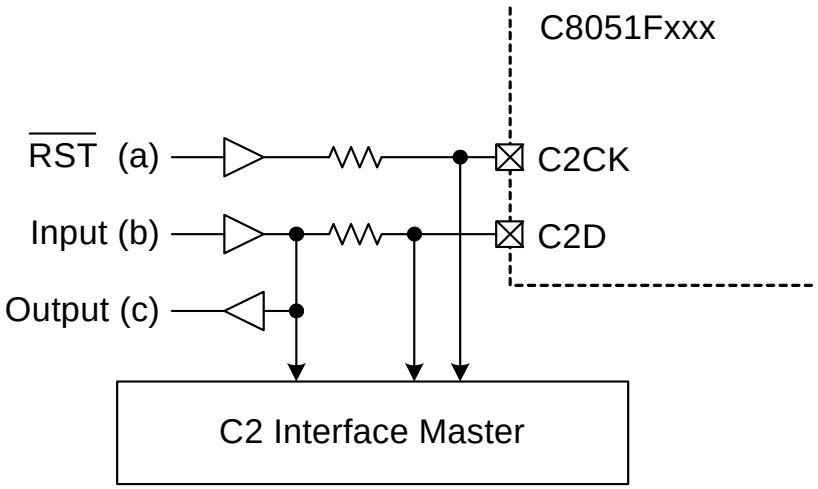

Figure 27.1. Typical C2 Pin Sharing

The configuration in Figure 27.1 assumes the following:

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

Additional resistors may be necessary depending on the specific application.