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C8051F340/1/2/3/4/5/6/7/8/9/A/B/C/D

Full Speed USB Flash MCU Family

Analog Peripherals
- **10-Bit ADC (C8051F340/1/2/3/4/5/6/7/A/B only)**
  - Up to 200 ksps
  - Built-in analog multiplexer with single-ended and differential mode
  - VREF from external pin, internal reference, or V_{DD}
  - Built-in temperature sensor
  - External conversion start input option
- **Two comparators**
- **Internal voltage reference (C8051F340/1/2/3/4/5/6/7/A/B only)**
- **Brown-out detector and POR Circuitry**

USB Function Controller
- USB specification 2.0 compliant
- Full speed (12 Mbps) or low speed (1.5 Mbps) operation
- Integrated clock recovery; no external crystal required for full speed or low speed
- Supports eight flexible endpoints
- 1 kB USB buffer memory
- Integrated transceiver; no external resistors required

On-Chip Debug
- On-chip debug circuitry facilitates full speed, non-intrusive in-system debug (No emulator required)
- Provides breakpoints, single stepping, inspect/modify memory and registers
- Superior performance to emulation systems using ICE-chips, target pods, and sockets

Voltage Supply Input: 2.7 to 5.25 V
- Voltages from 3.6 to 5.25 V supported using On-Chip Voltage Regulator

HIgh Speed 8051 µC Core
- Pipelined instruction architecture; executes 70% of Instructions in 1 or 2 system clocks
- 48 MIPS and 25 MIPS versions available.
- Expanded interrupt handler

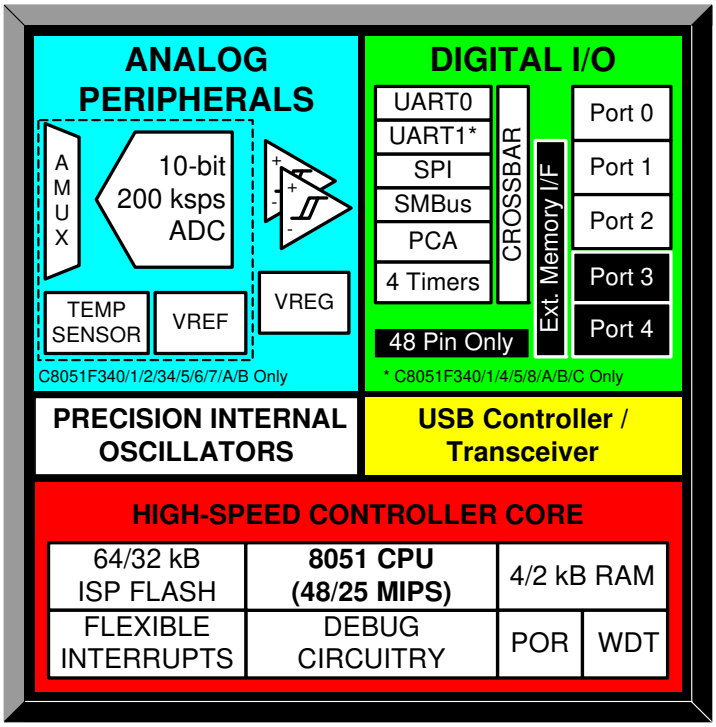
Memory
- 4352 or 2304 Bytes RAM
- 64 or 32 kB Flash; In-system programmable in 512-byte sectors

Digital Peripherals
- 40/25 Port I/O; All 5 V tolerant with high sink current
- Hardware enhanced SPI™, SMBus™, and one or two enhanced UART serial ports
- Four general purpose 16-bit counter/timers
- 16-bit programmable counter array (PCA) with five capture/compare modules
- External Memory Interface (EMIF)

Clock Sources
- Internal Oscillator: ±0.25% accuracy with clock recovery enabled. Supports all USB and UART modes
- External Oscillator: Crystal, RC, C, or clock (1 or 2 Pin modes)
- Low Frequency (80 kHz) Internal Oscillator
- Can switch between clock sources on-the-fly

Packages
- 48-pin TQFP (C8051F340/1/4/5/8/C)
- 32-pin LQFP (C8051F342/3/6/7/9/A/B/D)
- 5x5 mm 32-pin QFN (C8051F342/3/6/7/9/A/B)

Temperature Range: –40 to +85 °C



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1. System Overview

C8051F340/1/2/3/4/5/6/7/8/9/A/B/C/D devices are fully integrated mixed-signal System-on-a-Chip MCUs. Highlighted features are listed below. Refer to Table 1.1 for specific product feature selection.

- High-speed pipelined 8051-compatible microcontroller core (up to 48 MIPS)
- In-system, full-speed, non-intrusive debug interface (on-chip)
- Universal Serial Bus (USB) Function Controller with eight flexible endpoint pipes, integrated transceiver, and 1 kB FIFO RAM
- Supply Voltage Regulator
- True 10-bit 200 ksps differential / single-ended ADC with analog multiplexer
- On-chip Voltage Reference and Temperature Sensor
- On-chip Voltage Comparators (2)
- Precision internal calibrated 12 MHz internal oscillator and 4x clock multiplier
- Internal low-frequency oscillator for additional power savings
- Up to 64 kB of on-chip Flash memory
- Up to 4352 Bytes of on-chip RAM (256 + 4 kB)
- External Memory Interface (EMIF) available on 48-pin versions.
- SMBus/I2C, up to 2 UARTs, and Enhanced SPI serial interfaces implemented in hardware
- Four general-purpose 16-bit timers
- Programmable Counter/Timer Array (PCA) with five capture/compare modules and Watchdog Timer function
- On-chip Power-On Reset, V_{DD} Monitor, and Missing Clock Detector
- Up to 40 Port I/O (5 V tolerant)

With on-chip Power-On Reset, V_{DD} monitor, Voltage Regulator, Watchdog Timer, and clock oscillator, C8051F340/1/2/3/4/5/6/7/8/9/A/B/C/D devices are truly stand-alone System-on-a-Chip solutions. The Flash memory can be reprogrammed in-circuit, providing non-volatile data storage, and also allowing field upgrades of the 8051 firmware. User software has complete control of all peripherals, and may individually shut down any or all peripherals for power savings.

The on-chip Silicon Labs 2-Wire (C2) Development Interface allows non-intrusive (uses no on-chip resources), full speed, in-circuit debugging using the production MCU installed in the final application. This debug logic supports inspection and modification of memory and registers, setting breakpoints, single stepping, run and halt commands. All analog and digital peripherals are fully functional while debugging using C2. The two C2 interface pins can be shared with user functions, allowing in-system debugging without occupying package pins.

Each device is specified for 2.7–5.25 V operation over the industrial temperature range (–40 to +85 °C). For voltages above 3.6 V, the on-chip Voltage Regulator must be used. A minimum of 3.0 V is required for USB communication. The Port I/O and $\overline{\text{RST}}$ pins are tolerant of input signals up to 5 V. C8051F340/1/2/3/4/5/6/7/8/9/A/B/C/D devices are available in 48-pin TQFP, 32-pin LQFP, or 32-pin QFN packages. See Table 1.1, “Product Selection Guide,” on page 18 for feature and package choices.

Table 1.1. Product Selection Guide

Ordering Part Number	MIPS (Peak)	Flash Memory (Bytes)	RAM	Calibrated Internal Oscillator	Low Frequency Oscillator	USB with 1k Endpoint RAM	Supply Voltage Regulator	SMBus/I2C	Enhanced SPI	UARTs	Timers (16-bit)	Programmable Counter Array	Digital Port I/Os	External Memory Interface (EMIF)	10-bit 200 ksps ADC	Temperature Sensor	Voltage Reference	Analog Comparators	Package
C8051F340-GQ	48	64k	4352	✓	✓	✓	✓	✓	✓	2	4	✓	40	✓	✓	✓	✓	2	TQFP48
C8051F341-GQ	48	32k	2304	✓	✓	✓	✓	✓	✓	2	4	✓	40	✓	✓	✓	✓	2	TQFP48
C8051F342-GQ	48	64k	4352	✓	✓	✓	✓	✓	✓	1	4	✓	25	—	✓	✓	✓	2	LQFP32
C8051F342-GM	48	64k	4352	✓	✓	✓	✓	✓	✓	1	4	✓	25	—	✓	✓	✓	2	QFN32
C8051F343-GQ	48	32k	2304	✓	✓	✓	✓	✓	✓	1	4	✓	25	—	✓	✓	✓	2	LQFP32
C8051F343-GM	48	32k	2304	✓	✓	✓	✓	✓	✓	1	4	✓	25	—	✓	✓	✓	2	QFN32
C8051F344-GQ	25	64k	4352	✓	✓	✓	✓	✓	✓	2	4	✓	40	✓	✓	✓	✓	2	TQFP48
C8051F345-GQ	25	32k	2304	✓	✓	✓	✓	✓	✓	2	4	✓	40	✓	✓	✓	✓	2	TQFP48
C8051F346-GQ	25	64k	4352	✓	—	✓	✓	✓	✓	1	4	✓	25	—	✓	✓	✓	2	LQFP32
C8051F346-GM	25	64k	4352	✓	—	✓	✓	✓	✓	1	4	✓	25	—	✓	✓	✓	2	QFN32
C8051F347-GQ	25	32k	2304	✓	—	✓	✓	✓	✓	1	4	✓	25	—	✓	✓	✓	2	LQFP32
C8051F347-GM	25	32k	2304	✓	—	✓	✓	✓	✓	1	4	✓	25	—	✓	✓	✓	2	QFN32
C8051F348-GQ	25	32k	2304	✓	✓	✓	✓	✓	✓	2	4	✓	40	✓	—	—	—	2	TQFP48
C8051F349-GQ	25	32k	2304	✓	✓	✓	✓	✓	✓	1	4	✓	25	—	—	—	—	2	LQFP32
C8051F349-GM	25	32k	2304	✓	✓	✓	✓	✓	✓	1	4	✓	25	—	—	—	—	2	QFN32
C8051F34A-GQ	48	64k	4352	✓	✓	✓	✓	✓	✓	2	4	✓	25	—	✓	✓	✓	2	LQFP32
C8051F34A-GM	48	64k	4352	✓	✓	✓	✓	✓	✓	2	4	✓	25	—	✓	✓	✓	2	QFN32
C8051F34B-GQ	48	32k	2304	✓	✓	✓	✓	✓	✓	2	4	✓	25	—	✓	✓	✓	2	LQFP32
C8051F34B-GM	48	32k	2304	✓	✓	✓	✓	✓	✓	2	4	✓	25	—	✓	✓	✓	2	QFN32
C8051F34C-GQ	48	64k	4352	✓	✓	✓	✓	✓	✓	2	4	✓	40	✓	—	—	—	2	TQFP48
C8051F34D-GQ	48	64k	4352	✓	✓	✓	✓	✓	✓	1	4	✓	25	—	—	—	—	2	LQFP32

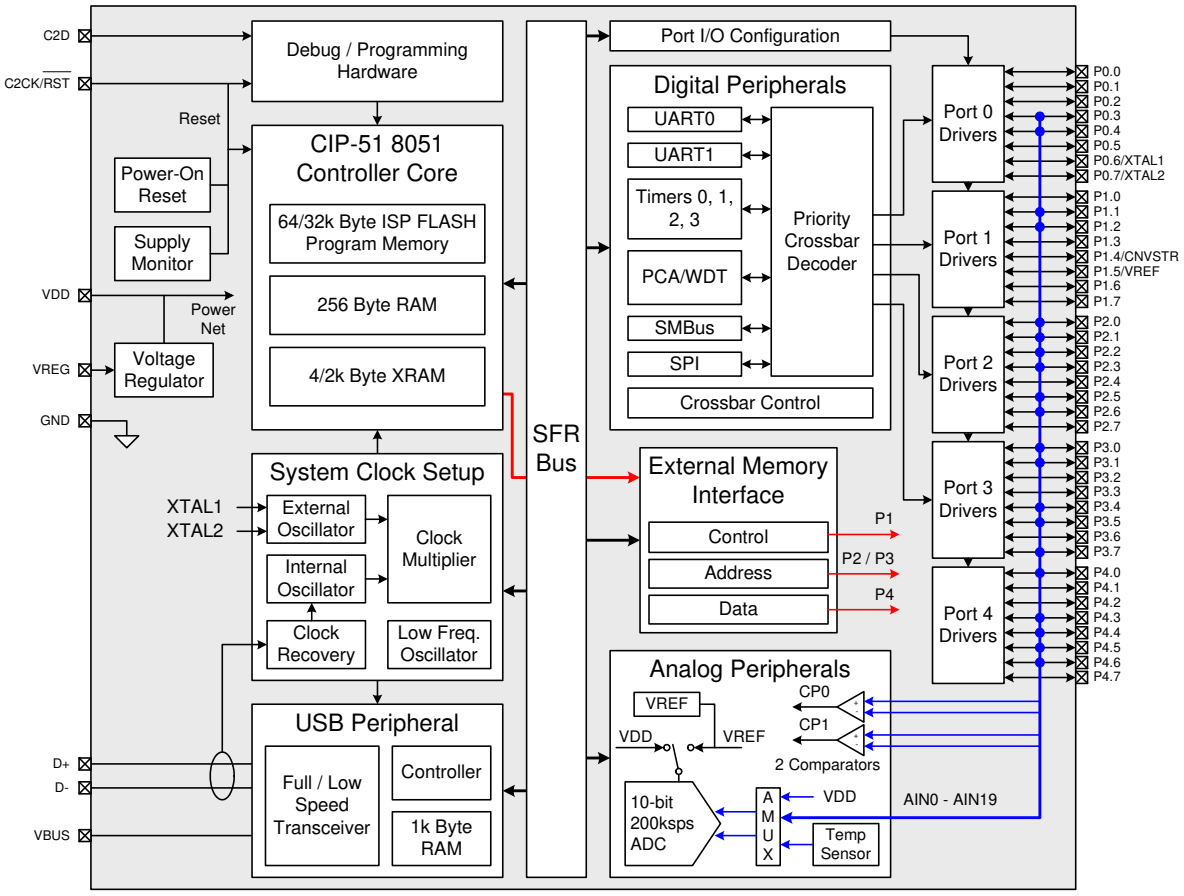
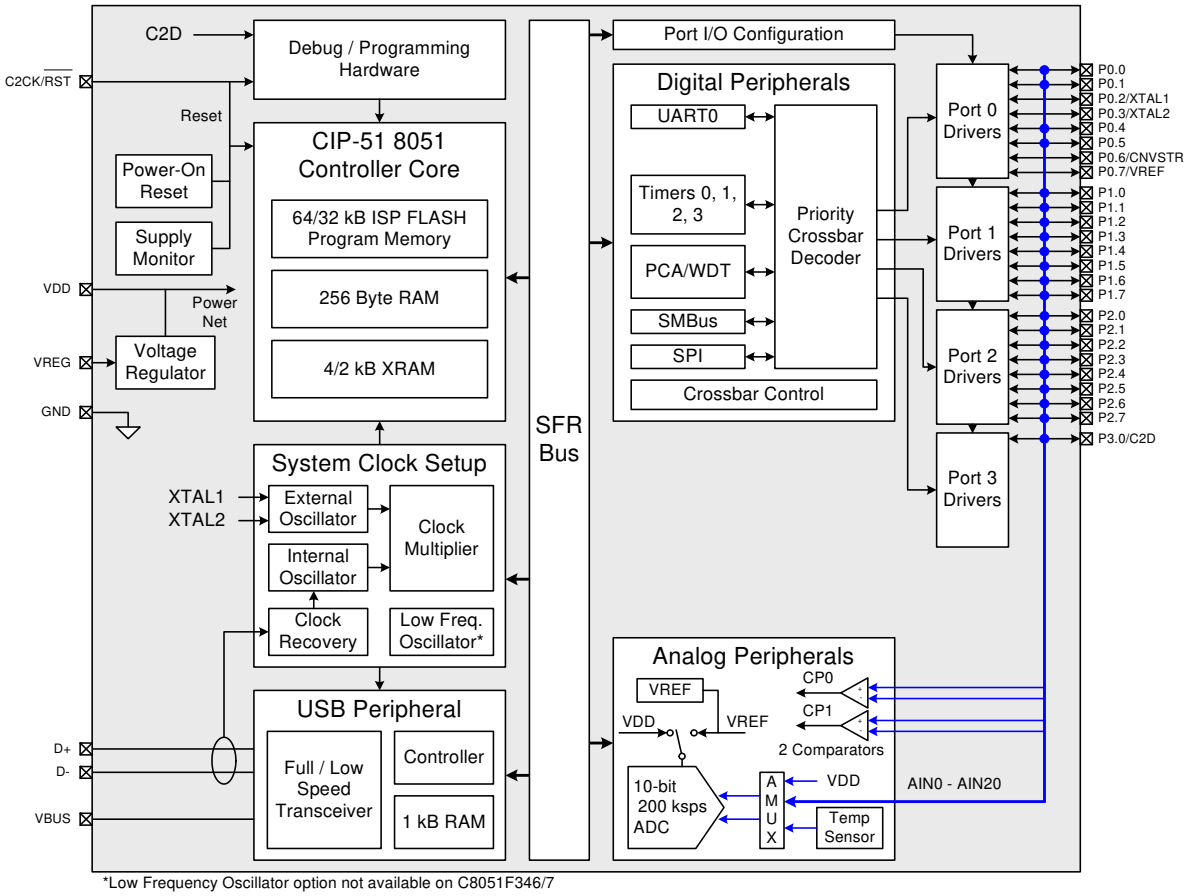


Figure 1.1. C8051F340/1/4/5 Block Diagram



*Low Frequency Oscillator option not available on C8051F346/7

Figure 1.2. C8051F342/3/6/7 Block Diagram

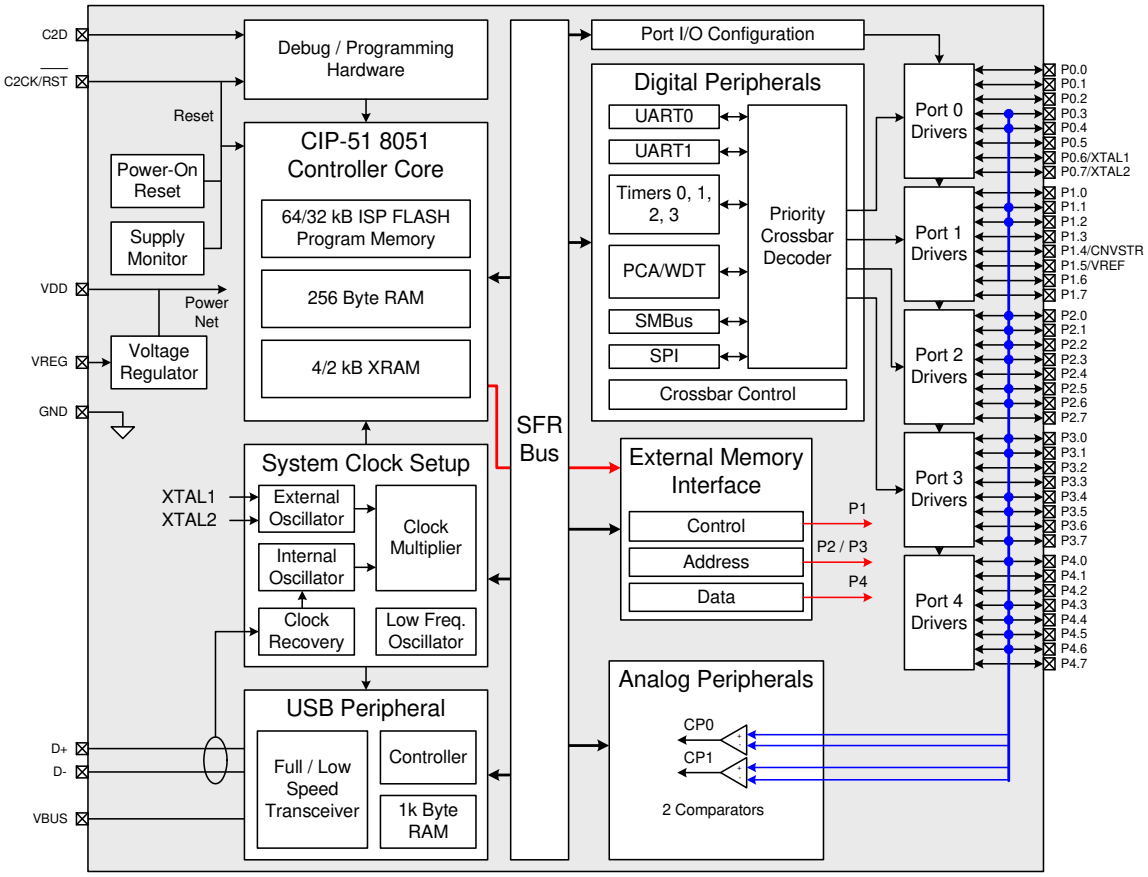


Figure 1.3. C8051F348/C Block Diagram

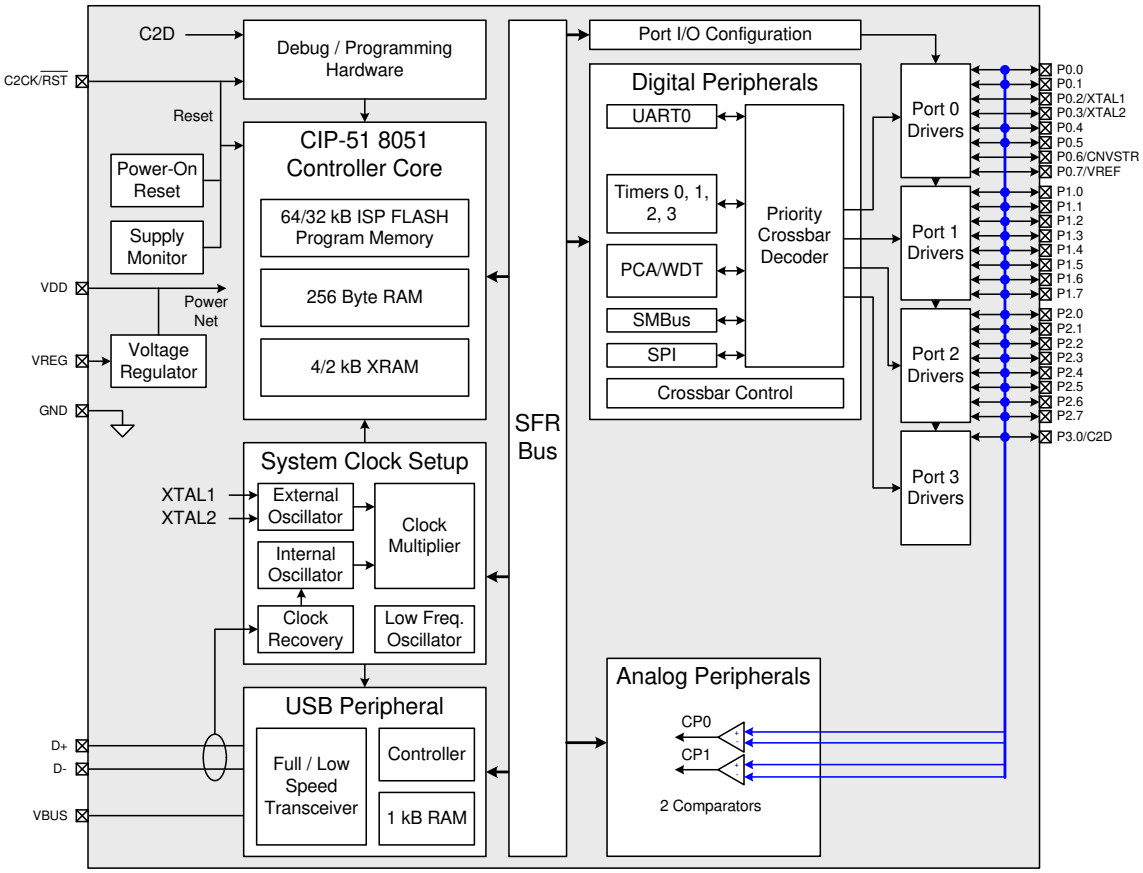


Figure 1.4. C8051F349/D Block Diagram

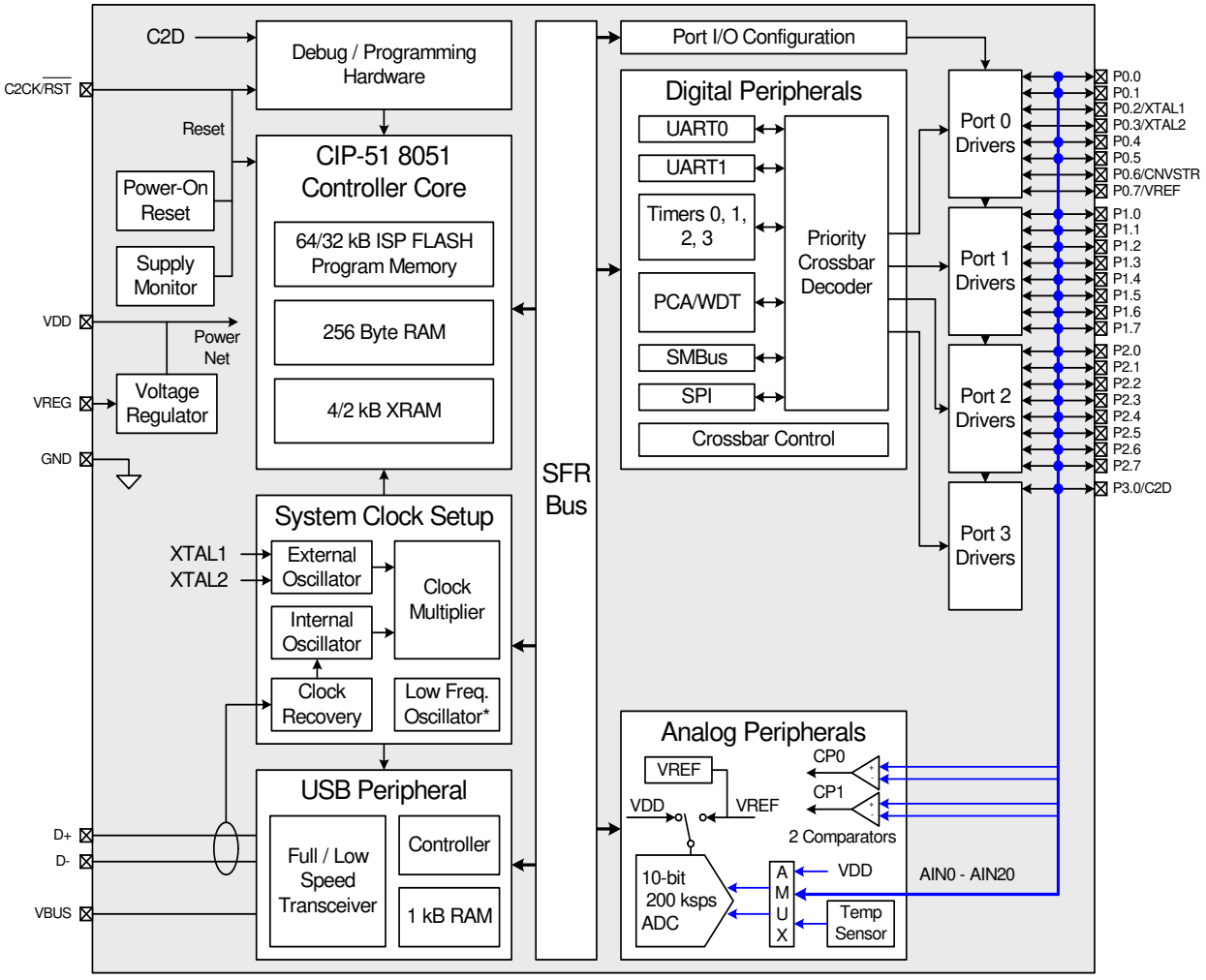


Figure 1.5. C8051F34A/B Block Diagram

2. Absolute Maximum Ratings

Table 2.1. Absolute Maximum Ratings*

Parameter	Conditions	Min	Typ	Max	Units
Ambient temperature under bias		–55		125	°C
Storage Temperature		–65		150	°C
Voltage on any Port I/O Pin or $\overline{\text{RST}}$ with respect to GND		–0.3		5.8	V
Voltage on V_{DD} with respect to GND		–0.3		4.2	V
Maximum Total current through V_{DD} and GND				500	mA
Maximum output current sunk by $\overline{\text{RST}}$ or any Port pin				100	mA

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

3. Global DC Electrical Characteristics

Table 3.1. Global DC Electrical Characteristics

–40 to +85 °C, 25 MHz System Clock unless otherwise specified.

Parameter	Conditions	Min	Typ	Max	Units
Digital Supply Voltage[1]		VRST	3.3	3.6	V
Digital Supply RAM Data Retention Voltage			1.5		V
SYSCLK (System Clock)[2]	C8051F340/1/2/3/A/B/C/D C8051F344/5/6/7/8/9	0 0		48 25	MHz
Specified Operating Temperature Range		–40		+85	°C
Digital Supply Current - CPU Active (Normal Mode, accessing Flash)					
I_{DD}[3]	V_{DD} = 3.3 V, SYSCLK = 48 MHz V_{DD} = 3.3 V, SYSCLK = 24 MHz V_{DD} = 3.3 V, SYSCLK = 1 MHz V_{DD} = 3.3 V, SYSCLK = 80 kHz V_{DD} = 3.6 V, SYSCLK = 48 MHz V_{DD} = 3.6 V, SYSCLK = 24 MHz		25.9 13.9 0.69 55 29.7 15.9	28.5 15.7 32.3 18	mA mA mA µA mA mA
I_{DD} Supply Sensitivity[3,4]	SYSCLK = 1 MHz, relative to V_{DD} = 3.3 V SYSCLK = 24 MHz, relative to V_{DD} = 3.3 V		47 46		%/V %/V
I_{DD} Frequency Sensitivity[3,5]	V_{DD} = 3.3 V, SYSCLK ≤ 30 MHz, T = 25 ºC V_{DD} = 3.3 V, SYSCLK > 30 MHz, T = 25 ºC V_{DD} = 3.6 V, SYSCLK ≤ 30 MHz, T = 25 ºC V_{DD} = 3.6 V, SYSCLK > 30 MHz, T = 25 ºC		0.69 0.44 0.80 0.50		mA/MHz mA/MHz mA/MHz mA/MHz
Digital Supply Current - CPU Inactive (Idle Mode, not accessing Flash)					
I_{DD}[3]	V_{DD} = 3.3 V, SYSCLK = 48 MHz V_{DD} = 3.3 V, SYSCLK = 24 MHz V_{DD} = 3.3 V, SYSCLK = 1 MHz V_{DD} = 3.3 V, SYSCLK = 80 kHz V_{DD} = 3.6 V, SYSCLK = 48 MHz V_{DD} = 3.6 V, SYSCLK = 24 MHz		16.6 8.25 0.44 35 18.6 9.26	18.75 9.34 20.9 10.5	mA mA mA µA mA mA
I_{DD} Supply Sensitivity[3,4]	SYSCLK = 1 MHz, relative to V_{DD} = 3.3 V SYSCLK = 24 MHz, relative to V_{DD} = 3.3 V		41 39		%/V %/V