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### Analog Peripherals ('F390/2/4/6/8 and 'F370/4)

- **10-Bit ADC**
  - Programmable throughput up to 500 ksps
  - Up to 16 external inputs, programmable as single-ended or differential
  - Reference from on-chip voltage reference,  $V_{DD}$  or external VREF pin
  - Internal or external start of conversion sources
- **Two 10-Bit Current Output DACs**
  - Supports output through resets for continuous operation
- **Comparator**
  - Programmable hysteresis and response time
  - Configurable as interrupt or reset source
- **Precision Temperature Sensor**
  - Accurate to  $\pm 2$  °C across temperature range with no user calibration

### 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

### Low Power

- 160  $\mu$ A/MHz Active mode with 49 MHz internal precision oscillator
- 200 nA Stop mode current

### Temperature Range

- -40 to +85 °C ('F37x)
- -40 to +105 °C ('F39x)

### Package

- 24-Pin QFN ('F390/1/4/5 and 'F37x)
- 20-Pin QFN ('F392/3/6/7/8/9)

### High-Speed 8051 $\mu$ C Core

- Pipelined instruction architecture; executes 70% of instructions in 1 or 2 system clocks
- Up to 50 MIPS throughput with 50 MHz clock
- Expanded interrupt handler

### Memory

- Up to 1 kB internal data RAM (256 + 768)
- Up to 16 kB Flash; In-system programmable in 512-byte Sectors
- 512 bytes of byte-programmable EEPROM; 1 million write/erase cycles ('F37x)

### Digital Peripherals

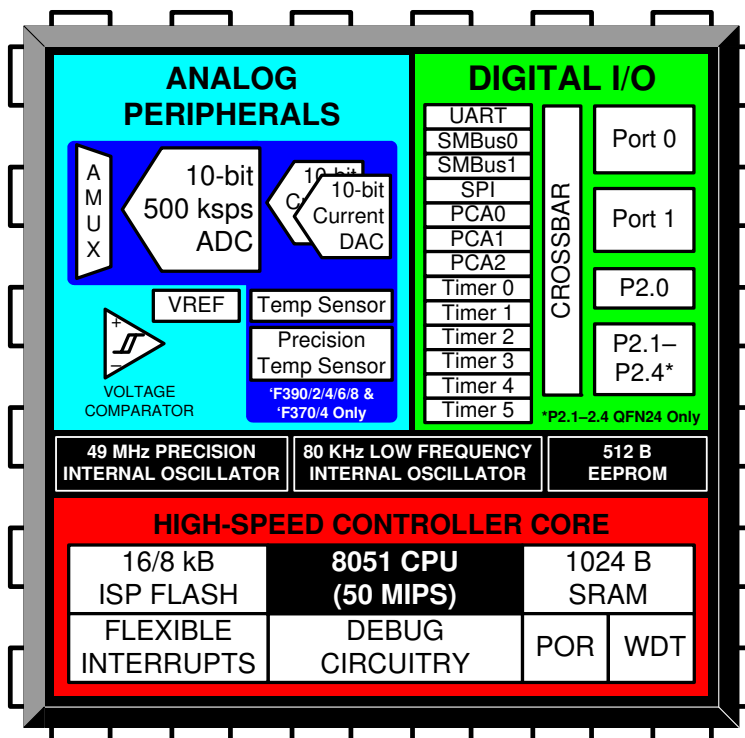
- 21 or 17 Port I/O
- UART, 2 SMBus (I<sup>2</sup>C compatible), and SPI serial ports
- Six general purpose 16-bit counter/timers
- 16-Bit programmable counter array (PCA) with three capture/compare modules and PWM functionality

### Clock Sources

- 49 MHz  $\pm 2\%$  precision internal oscillator
  - Supports crystal-less UART operation
  - Low-power suspend mode with fast wake time
- 80 kHz low-frequency, low-power oscillator
- External oscillator: Crystal, RC, C, or CMOS clock
- Can switch between clock sources on-the-fly; useful in power saving modes

### Supply Voltage 1.8 to 3.6 V

- Built-in voltage supply monitor



# C8051F39x/37x

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## Table of Contents

<b>1. System Overview</b> .....	<b>17</b>
<b>2. Ordering Information</b> .....	<b>20</b>
<b>3. C8051F33x Compatibility</b> .....	<b>21</b>
3.1. Hardware Incompatibilities .....	21
<b>4. Pin Definitions</b> .....	<b>22</b>
<b>5. QFN-20 Package Specifications</b> .....	<b>28</b>
<b>6. QFN-24 Package Specifications</b> .....	<b>30</b>
<b>7. Electrical Characteristics</b> .....	<b>32</b>
7.1. Absolute Maximum Specifications.....	32
7.2. Electrical Characteristics .....	33
7.3. Typical Performance Curves .....	45
<b>8. Precision Temperature Sensor (C8051F390/2/4/6/8 and C8051F370/4 Only)</b> .....	<b>47</b>
8.1. Temperature in Two's Complement .....	47
<b>9. 10-Bit ADC (ADC0, C8051F390/2/4/6/8 and C8051F370/4 Only)</b> .....	<b>50</b>
9.1. Output Code Formatting .....	51
9.2. Modes of Operation.....	52
9.2.1. Starting a Conversion.....	52
9.2.2. Tracking Modes.....	53
9.2.3. Settling Time Requirements.....	54
9.3. Programmable Window Detector.....	58
9.3.1. Window Detector Example.....	60
9.4. ADC0 Analog Multiplexer (C8051F390/2/4/6/8 and C8051F370/4 Only) .....	61
<b>10. Temperature Sensor (C8051F390/2/4/6/8 and C8051F370/4 Only)</b> .....	<b>64</b>
10.1. Calibration .....	65
<b>11. 10-Bit Current Mode DACs (IDA0, IDA1, C8051F390/2/4/6/8 and C8051F370/4 Only)</b> .....	<b>66</b>
11.1. IDAC Output Scheduling .....	66
11.1.1. Update Output On-Demand .....	66
11.1.2. Update Output Based on Timer Overflow .....	68
11.1.3. Update Output Based on CNVSTR Edge .....	68
11.2. IDAC Reset Behavior .....	68
11.3. IDAC Output Mapping .....	68
<b>12. Voltage Reference Options</b> .....	<b>73</b>
<b>13. Voltage Regulator</b> .....	<b>75</b>
13.1. Power Modes.....	75
<b>14. Comparator0</b> .....	<b>76</b>
14.1. Comparator Multiplexer .....	80
<b>15. CIP-51 Microcontroller</b> .....	<b>82</b>
15.1. Instruction Set.....	83
15.1.1. Instruction and CPU Timing .....	83
15.2. CIP-51 Register Descriptions .....	87
<b>16. Prefetch Engine</b> .....	<b>92</b>

# C8051F39x/37x

---

<b>17. Memory Organization</b> .....	<b>93</b>
17.1. Program Memory .....	94
17.1.1. MOVX Instruction and Program Memory .....	94
17.2. Data Memory .....	94
17.2.1. Internal RAM .....	94
17.2.1.1. General Purpose Registers .....	95
17.2.1.2. Bit Addressable Locations .....	95
17.2.1.3. Stack .....	95
17.2.2. External RAM .....	95
<b>18. Device ID Registers</b> .....	<b>97</b>
<b>19. Special Function Registers</b> .....	<b>101</b>
19.1. SFR Paging .....	101
19.2. Interrupts and Automatic SFR Paging .....	101
19.3. SFR Page Stack Example .....	103
<b>20. Interrupts</b> .....	<b>117</b>
20.1. MCU Interrupt Sources and Vectors .....	118
20.1.1. Interrupt Priorities .....	118
20.1.2. Interrupt Latency .....	118
20.2. Interrupt Register Descriptions .....	120
20.3. External Interrupts INT0 and INT1 .....	128
<b>21. Flash Memory</b> .....	<b>131</b>
21.1. Programming The Flash Memory .....	131
21.1.1. Flash Lock and Key Functions .....	131
21.1.2. Flash Erase Procedure .....	131
21.1.3. Flash Write Procedure .....	132
21.2. Non-volatile Data Storage .....	132
21.3. Security Options .....	133
21.4. Flash Write and Erase Guidelines .....	135
21.4.1. $V_{DD}$ Maintenance and the $V_{DD}$ Monitor .....	135
21.4.2. PSWE Maintenance .....	135
21.4.3. System Clock .....	136
<b>22. EEPROM (C8051F37x)</b> .....	<b>140</b>
22.1. EEPROM Communication Protocol .....	140
22.1.1. Slave Address Byte .....	141
22.1.2. Acknowledgement (ACK) .....	141
22.1.3. Not-Acknowledgement (NACK) .....	141
22.1.4. Reset .....	141
22.2. Write Operation .....	142
22.3. Read Operation .....	143
22.3.1. Current Address Read .....	143
22.3.2. Selective Address Read .....	145
<b>23. Cyclic Redundancy Check Unit (CRC0)</b> .....	<b>147</b>
23.1. CRC Algorithm .....	147
23.2. Preparing for a CRC Calculation .....	149
23.3. Performing a CRC Calculation .....	149

---

---

23.4. Accessing the CRC0 Result .....	149
23.5. CRC0 Bit Reverse Feature .....	149
<b>24. Reset Sources .....</b>	<b>155</b>
24.1. Power-On Reset .....	156
24.2. Power-Fail Reset / VDD Monitor .....	157
24.3. External Reset .....	159
24.4. Missing Clock Detector Reset .....	159
24.5. Comparator0 Reset .....	159
24.6. PCA Watchdog Timer Reset .....	159
24.7. Flash Error Reset .....	159
24.8. Software Reset .....	159
<b>25. Power Management Modes .....</b>	<b>161</b>
25.1. Idle Mode .....	161
25.2. Stop Mode .....	162
25.3. Suspend Mode .....	162
<b>26. Oscillators and Clock Selection .....</b>	<b>164</b>
26.1. System Clock Selection .....	165
26.2. Programmable Internal High-Frequency (H-F) Oscillator .....	166
26.2.1. Internal Oscillator Suspend Mode .....	166
26.3. Programmable Internal Low-Frequency (L-F) Oscillator .....	168
26.3.1. Calibrating the Internal L-F Oscillator .....	168
26.4. Internal Low-Power Oscillator .....	169
26.5. External Oscillator Drive Circuit .....	169
26.5.1. External Crystal Mode .....	169
26.5.2. External RC Example .....	171
26.5.3. External Capacitor Example .....	171
<b>27. Port Input/Output .....</b>	<b>173</b>
27.1. Port I/O Modes of Operation .....	174
27.1.1. Port Pins Configured for Analog I/O .....	174
27.1.2. Port Pins Configured For Digital I/O .....	174
27.2. Assigning Port I/O Pins to Analog and Digital Functions .....	175
27.2.1. Assigning Port I/O Pins to Analog Functions .....	175
27.2.2. Assigning Port I/O Pins to Digital Functions .....	176
27.2.3. Assigning Port I/O Pins to External Event Trigger Functions .....	177
27.3. Priority Crossbar Decoder .....	178
27.4. Port I/O Initialization .....	180
27.5. Port Match .....	183
27.6. Special Function Registers for Accessing and Configuring Port I/O .....	185
<b>28. SMBus0 and SMBus1 (I2C Compatible) .....</b>	<b>192</b>
28.1. Supporting Documents .....	193
28.2. SMBus Configuration .....	193
28.3. SMBus Operation .....	193
28.3.1. Transmitter vs. Receiver .....	194
28.3.2. Arbitration .....	194
28.3.3. Clock Low Extension .....	194

---

# C8051F39x/37x

---

28.3.4. SCL Low Timeout.....	194
28.3.5. SCL High (SMBus Free) Timeout .....	195
28.4. Using the SMBus.....	195
28.4.1. SMBus Configuration Register.....	195
28.4.2. SMBus Pin Swap .....	197
28.4.3. SMBus Timing Control .....	197
28.4.4. SMBnCN Control Register .....	201
28.4.4.1. Software ACK Generation .....	201
28.4.4.2. Hardware ACK Generation .....	201
28.4.5. Hardware Slave Address Recognition .....	204
28.4.6. Data Register .....	209
28.5. SMBus Transfer Modes.....	211
28.5.1. Write Sequence (Master) .....	211
28.5.2. Read Sequence (Master) .....	212
28.5.3. Write Sequence (Slave) .....	213
28.5.4. Read Sequence (Slave).....	214
28.6. SMBus Status Decoding.....	214
<b>29. UART0 .....</b>	<b>220</b>
29.1. Enhanced Baud Rate Generation.....	221
29.2. Operational Modes .....	222
29.2.1. 8-Bit UART .....	222
29.2.2. 9-Bit UART .....	223
29.3. Multiprocessor Communications .....	224
<b>30. Enhanced Serial Peripheral Interface (SPI0) .....</b>	<b>228</b>
30.1. Signal Descriptions.....	229
30.1.1. Master Out, Slave In (MOSI).....	229
30.1.2. Master In, Slave Out (MISO).....	229
30.1.3. Serial Clock (SCK) .....	229
30.1.4. Slave Select (NSS) .....	229
30.2. SPI0 Master Mode Operation.....	230
30.3. SPI0 Slave Mode Operation.....	231
30.4. SPI0 Interrupt Sources .....	232
30.5. Serial Clock Phase and Polarity .....	232
30.6. SPI Special Function Registers .....	234
<b>31. Timers .....</b>	<b>242</b>
31.1. Timer 0 and Timer 1 .....	245
31.1.1. Mode 0: 13-bit Counter/Timer .....	245
31.1.2. Mode 1: 16-bit Counter/Timer .....	246
31.1.3. Mode 2: 8-bit Counter/Timer with Auto-Reload.....	247
31.1.4. Mode 3: Two 8-bit Counter/Timers (Timer 0 Only).....	248
31.2. Timer 2 .....	253
31.2.1. 16-bit Timer with Auto-Reload.....	253
31.2.2. 8-bit Timers with Auto-Reload.....	254
31.2.3. Low-Frequency Oscillator (LFO) Capture Mode .....	255
31.3. Timer 3 .....	259

---

---

31.3.1. 16-bit Timer with Auto-Reload.....	259
31.3.2. 8-bit Timers with Auto-Reload.....	260
31.3.3. Low-Frequency Oscillator (LFO) Capture Mode .....	261
31.4. Timer 4 .....	265
31.4.1. 16-bit Timer with Auto-Reload.....	265
31.4.2. 8-bit Timers with Auto-Reload.....	266
31.5. Timer 5 .....	270
31.5.1. 16-bit Timer with Auto-Reload.....	270
31.5.2. 8-bit Timers with Auto-Reload.....	271
<b>32. Programmable Counter Array.....</b>	<b>275</b>
32.1. PCA Counter/Timer .....	276
32.2. PCA0 Interrupt Sources.....	277
32.3. Capture/Compare Modules .....	278
32.3.1. Edge-triggered Capture Mode.....	279
32.3.2. Software Timer (Compare) Mode.....	280
32.3.3. High-Speed Output Mode .....	281
32.3.4. Frequency Output Mode .....	282
32.3.5. 8-bit, 9-bit, 10-bit and 11-bit Pulse Width Modulator Modes .....	282
32.3.5.1. 8-bit Pulse Width Modulator Mode.....	283
32.3.5.2. 9/10/11-bit Pulse Width Modulator Mode.....	284
32.3.6. 16-Bit Pulse Width Modulator Mode.....	285
32.4. Watchdog Timer Mode .....	286
32.4.1. Watchdog Timer Operation .....	286
32.4.2. Watchdog Timer Usage .....	287
32.5. Comparator Clear Function .....	288
32.6. Register Descriptions for PCA0.....	290
<b>33. C2 Interface .....</b>	<b>297</b>
33.1. C2 Interface Registers.....	297
33.2. C2 Pin Sharing .....	300
<b>Document Change List.....</b>	<b>301</b>
<b>Contact Information.....</b>	<b>302</b>



## List of Figures

Figure 1.1. C8051F392/3/6/7/8/9 Block Diagram .....	18
Figure 1.2. C8051F390/1/4/5 Block Diagram .....	18
Figure 1.3. C8051F370/1/4/5 Block Diagram .....	19
Figure 4.1. C8051F392/3/6/7/8/9 QFN-20 Pinout Diagram (Top View) .....	25
Figure 4.2. C8051F390/1/4/5 Pinout Diagram (Top View) .....	26
Figure 4.3. C8051F370/1/4/5 Pinout Diagram (Top View) .....	27
Figure 5.1. QFN-20 Package Drawing .....	28
Figure 5.2. QFN-20 Recommended PCB Land Pattern .....	29
Figure 6.1. QFN-24 Package Drawing .....	30
Figure 6.2. QFN-24 Recommended PCB Land Pattern .....	31
Figure 7.1. Normal Mode Digital Supply Current vs. Frequency .....	45
Figure 7.2. Idle Mode Digital Supply Current vs. Frequency .....	45
Figure 7.3. Precision Temperature Sensor Error vs. Temperature .....	46
Figure 9.1. ADC0 Functional Block Diagram .....	50
Figure 9.2. 10-Bit ADC Track and Conversion Example Timing .....	53
Figure 9.3. ADC0 Equivalent Input Circuits .....	54
Figure 9.4. ADC Window Compare Example: Right-Justified, Single-Ended Data ..	60
Figure 9.5. ADC Window Compare Example: Left-Justified, Single-Ended Data ....	60
Figure 9.6. ADC0 Multiplexer Block Diagram .....	61
Figure 10.1. Temperature Sensor Transfer Function .....	64
Figure 10.2. Temperature Sensor Error with 1-Point Calibration at 0 °C .....	65
Figure 11.1. IDA0 Functional Block Diagram .....	66
Figure 11.2. IDA1 Functional Block Diagram .....	67
Figure 11.3. IDA0 Data Word Mapping .....	68
Figure 12.1. Voltage Reference Functional Block Diagram .....	73
Figure 14.1. Comparator0 Functional Block Diagram .....	76
Figure 14.2. Comparator Hysteresis Plot .....	77
Figure 14.3. Comparator Input Multiplexer Block Diagram .....	80
Figure 15.1. CIP-51 Block Diagram .....	82
Figure 17.1. C8051F39x/37x Memory Map .....	93
Figure 17.2. Flash Program Memory Map .....	94
Figure 19.1. SFR Page Stack .....	102
Figure 19.2. SFR Page Stack While Using SFR Page 0x0F To Access TS0CN ..	103
Figure 19.3. SFR Page Stack After SPI0 Interrupt Occurs .....	104
Figure 19.4. SFR Page Stack Upon PCA Interrupt Occurring During a SPI0 ISR	105
Figure 19.5. SFR Page Stack Upon Return from PCA0 Interrupt .....	106
Figure 19.6. SFR Page Stack Upon Return From SPI0 Interrupt .....	107
Figure 21.1. Security Byte Decoding .....	133
Figure 22.1. Slave Address Byte Definition .....	141
Figure 22.2. Write Operation (Single Byte) .....	142
Figure 22.3. Write Operation (Multiple Bytes) .....	142
Figure 22.4. Current Address Read Operation (Single Byte) .....	143
Figure 22.5. Current Address Read Operation (Multiple Bytes) .....	144

# C8051F39x/37x

---

Figure 22.6. Selective Address Read (Single Byte) .....	145
Figure 22.7. Selective Address Read (Multiple Bytes) .....	146
Figure 23.1. CRC0 Block Diagram .....	147
Figure 23.2. Bit Reverse Register .....	149
Figure 24.1. Reset Sources .....	155
Figure 24.2. Power-On and VDD Monitor Reset Timing .....	156
Figure 26.1. Oscillator Options .....	164
Figure 26.2. External Crystal Example .....	170
Figure 27.1. Port I/O Functional Block Diagram .....	173
Figure 27.2. Port I/O Cell Block Diagram .....	174
Figure 27.3. Crossbar Priority Decoder - Possible Pin Assignments .....	178
Figure 27.4. Crossbar Priority Decoder Example .....	179
Figure 28.1. SMBus0 Block Diagram .....	192
Figure 28.2. Typical SMBus Configuration .....	193
Figure 28.3. SMBus Transaction .....	194
Figure 28.4. Typical SMBus SCL Generation .....	196
Figure 28.5. Typical Master Write Sequence .....	211
Figure 28.6. Typical Master Read Sequence .....	212
Figure 28.7. Typical Slave Write Sequence .....	213
Figure 28.8. Typical Slave Read Sequence .....	214
Figure 29.1. UART0 Block Diagram .....	220
Figure 29.2. UART0 Baud Rate Logic .....	221
Figure 29.3. UART Interconnect Diagram .....	222
Figure 29.4. 8-Bit UART Timing Diagram .....	222
Figure 29.5. 9-Bit UART Timing Diagram .....	223
Figure 29.6. UART Multi-Processor Mode Interconnect Diagram .....	224
Figure 30.1. SPI Block Diagram .....	228
Figure 30.2. Multiple-Master Mode Connection Diagram .....	230
Figure 30.3. 3-Wire Single Master and 3-Wire Single Slave Mode Connection Diagram 231	
Figure 30.4. 4-Wire Single Master Mode and 4-Wire Slave Mode Connection Diagram 231	
Figure 30.5. Master Mode Data/Clock Timing .....	233
Figure 30.6. Slave Mode Data/Clock Timing (CKPHA = 0) .....	233
Figure 30.7. Slave Mode Data/Clock Timing (CKPHA = 1) .....	234
Figure 30.8. SPI Master Timing (CKPHA = 0) .....	238
Figure 30.9. SPI Master Timing (CKPHA = 1) .....	239
Figure 30.10. SPI Slave Timing (CKPHA = 0) .....	239
Figure 30.11. SPI Slave Timing (CKPHA = 1) .....	240
Figure 31.1. T0 Mode 0 Block Diagram .....	246
Figure 31.2. T0 Mode 2 Block Diagram .....	247
Figure 31.3. T0 Mode 3 Block Diagram .....	248
Figure 31.4. Timer 2 16-Bit Mode Block Diagram .....	253
Figure 31.5. Timer 2 8-Bit Mode Block Diagram .....	254
Figure 31.6. Timer 2 Low-Frequency Oscillation Capture Mode Block Diagram ...	255

---

---

Figure 31.7. Timer 3 16-Bit Mode Block Diagram .....	259
Figure 31.8. Timer 3 8-Bit Mode Block Diagram .....	260
Figure 31.9. Timer 3 Low-Frequency Oscillation Capture Mode Block Diagram ...	261
Figure 31.10. Timer 4 16-Bit Mode Block Diagram .....	265
Figure 31.11. Timer 4 8-Bit Mode Block Diagram .....	266
Figure 31.12. Timer 5 16-Bit Mode Block Diagram .....	270
Figure 31.13. Timer 5 8-Bit Mode Block Diagram .....	271
Figure 32.1. PCA Block Diagram .....	275
Figure 32.2. PCA Counter/Timer Block Diagram .....	276
Figure 32.3. PCA Interrupt Block Diagram .....	277
Figure 32.4. PCA Capture Mode Diagram .....	279
Figure 32.5. PCA Software Timer Mode Diagram .....	280
Figure 32.6. PCA High-Speed Output Mode Diagram .....	281
Figure 32.7. PCA Frequency Output Mode .....	282
Figure 32.8. PCA 8-Bit PWM Mode Diagram .....	283
Figure 32.9. PCA 9, 10 and 11-Bit PWM Mode Diagram .....	284
Figure 32.10. PCA 16-Bit PWM Mode .....	285
Figure 32.11. PCA Module 2 with Watchdog Timer Enabled .....	286
Figure 32.12. Comparator Clear Function Diagram .....	288
Figure 32.13. CEXn with CPCEn = 1, CPCPOL = 0 .....	288
Figure 32.14. CEXn with CPCEn = 1, CPCPOL = 1 .....	289
Figure 32.15. CEXn with CPCEn = 1, CPCPOL = 0 .....	289
Figure 32.16. CEXn with CPCEn = 1, CPCPOL = 1 .....	289
Figure 33.1. Typical C2 Pin Sharing .....	300

## List of Tables

Table 2.1. Product Selection Guide .....	20
Table 3.1. C8051F33x Replacement Part Numbers .....	21
Table 4.1. Pin Definitions for the C8051F39x/37x .....	22
Table 5.1. QFN-20 Package Dimensions .....	28
Table 5.2. QFN-20 PCB Land Pattern Dimensions .....	29
Table 6.1. QFN-24 Package Dimensions .....	30
Table 6.2. QFN-24 PCB Land Pattern Dimensions .....	31
Table 7.1. Absolute Maximum Ratings .....	32
Table 7.2. Global Electrical Characteristics .....	33
Table 7.3. Port I/O DC Electrical Characteristics .....	35
Table 7.4. Reset Electrical Characteristics .....	36
Table 7.5. Flash Electrical Characteristics .....	37
Table 7.6. EEPROM Electrical Characteristics .....	37
Table 7.7. Internal High-Frequency Oscillator Electrical Characteristics .....	38
Table 7.8. Internal Low-Frequency Oscillator Electrical Characteristics .....	38
Table 7.9. Internal Low-Power Oscillator Electrical Characteristics .....	38
Table 7.10. ADC0 Electrical Characteristics .....	39
Table 7.11. ADC Temperature Sensor Electrical Characteristics .....	40
Table 7.12. Precision Temperature Sensor Electrical Characteristics .....	40
Table 7.13. Voltage Reference Electrical Characteristics .....	41
Table 7.14. Voltage Regulator Electrical Characteristics .....	41
Table 7.15. IDAC Electrical Characteristics .....	42
Table 7.16. Comparator Electrical Characteristics .....	43
Table 8.1. Example Temperature Values in TS0DATH:TS0DATL .....	47
Table 15.1. CIP-51 Instruction Set Summary .....	84
Table 19.1. SFR Page Stack .....	101
Table 19.2. Special Function Register (SFR) Memory Map .....	111
Table 19.3. Special Function Registers .....	112
Table 20.1. Configurable Interrupt Priority Decoding .....	118
Table 20.2. Interrupt Summary .....	119
Table 21.1. Flash Security Summary .....	133
Table 23.1. Example 16-bit CRC Outputs .....	148
Table 27.1. Port I/O Assignment for Analog Functions .....	175
Table 27.2. Port I/O Assignment for Digital Functions .....	176
Table 27.3. Port I/O Assignment for External Event Trigger Functions .....	177
Table 28.1. SMBus Clock Source Selection .....	196
Table 28.2. Minimum SDA Setup and Hold Times .....	197
Table 28.3. Sources for Hardware Changes to SMBnCN .....	204
Table 28.4. Hardware Address Recognition Examples (EHACK = 1) .....	205
Table 28.5. SMBus Status Decoding: Hardware ACK Disabled (EHACK = 0) .....	215
Table 28.6. SMBus Status Decoding: Hardware ACK Enabled (EHACK = 1) .....	217
Table 29.1. Timer Settings for Standard Baud Rates Using The Internal 49 MHz Oscillator .....	227

# C8051F39x/37x

---

Table 29.2. Timer Settings for Standard Baud Rates Using an External 22.1184 MHz Oscillator .....	227
Table 30.1. SPI Slave Timing Parameters .....	241
Table 32.1. PCA Timebase Input Options .....	276
Table 32.2. PCA0CPM and PCA0PWM Bit Settings for PCA Capture/Compare Modules .....	278
Table 32.3. Watchdog Timer Timeout Intervals1 .....	287

## List of Registers

SFR Definition 8.1. TS0CN: Temperature Sensor Control .....	48
SFR Definition 8.2. TS0DATH: Temperature Sensor Output High Byte .....	49
SFR Definition 8.3. TS0DATL: Temperature Sensor Output Low Byte .....	49
SFR Definition 9.1. ADC0CF: ADC0 Configuration .....	55
SFR Definition 9.2. ADC0H: ADC0 Data Word MSB .....	56
SFR Definition 9.3. ADC0L: ADC0 Data Word LSB .....	56
SFR Definition 9.4. ADC0CN: ADC0 Control .....	57
SFR Definition 9.5. ADC0GTH: ADC0 Greater Than Data High Byte .....	58
SFR Definition 9.6. ADC0GTL: ADC0 Greater-Than Data Low Byte .....	58
SFR Definition 9.7. ADC0LTH: ADC0 Less-Than Data High Byte .....	59
SFR Definition 9.8. ADC0LTL: ADC0 Less-Than Data Low Byte .....	59
SFR Definition 9.9. AMX0P: AMUX0 Positive Channel Select .....	62
SFR Definition 9.10. AMX0N: AMUX0 Negative Channel Select .....	63
SFR Definition 11.1. IDA0CN: IDA0 Control .....	69
SFR Definition 11.2. IDA0H: IDA0 Data Word MSB .....	70
SFR Definition 11.3. IDA0L: IDA0 Data Word LSB .....	70
SFR Definition 11.4. IDA1CN: IDA1 Control .....	71
SFR Definition 11.5. IDA1H: IDA1 Data Word MSB .....	72
SFR Definition 11.6. IDA1L: IDA1 Data Word LSB .....	72
SFR Definition 12.1. REF0CN: Reference Control .....	74
SFR Definition 13.1. REG0CN: Voltage Regulator Control .....	75
SFR Definition 14.1. CPT0CN: Comparator0 Control .....	78
SFR Definition 14.2. CPT0MD: Comparator0 Mode Selection .....	79
SFR Definition 14.3. CPT0MX: Comparator0 MUX Selection .....	81
SFR Definition 15.1. DPL: Data Pointer Low Byte .....	88
SFR Definition 15.2. DPH: Data Pointer High Byte .....	88
SFR Definition 15.3. SP: Stack Pointer .....	89
SFR Definition 15.4. ACC: Accumulator .....	89
SFR Definition 15.5. B: B Register .....	90
SFR Definition 15.6. PSW: Program Status Word .....	91
SFR Definition 16.1. PFE0CN: Prefetch Engine Control .....	92
SFR Definition 17.1. EMI0CN: External Memory Interface Control .....	96
SFR Definition 18.1. DERIVID: Device Derivative ID .....	97
SFR Definition 18.2. REVISION: Device Revision ID .....	98
SFR Definition 18.3. SN3: Serial Number Byte 3 .....	98
SFR Definition 18.4. SN2: Serial Number Byte 2 .....	99
SFR Definition 18.5. SN1: Serial Number Byte 1 .....	99
SFR Definition 18.6. SN0: Serial Number Byte 0 .....	100
SFR Definition 19.1. SFRPAGE: SFR Page .....	108
SFR Definition 19.2. SFRPGCN: SFR Page Control .....	109
SFR Definition 19.3. SFRSTACK: SFR Page Stack .....	110
SFR Definition 20.1. IE: Interrupt Enable .....	120
SFR Definition 20.2. IP: Interrupt Priority .....	121

# C8051F39x/37x

---

SFR Definition 20.3. IPH: Interrupt Priority High .....	122
SFR Definition 20.4. EIE1: Extended Interrupt Enable 1 .....	123
SFR Definition 20.5. EIP1: Extended Interrupt Priority 1 .....	124
SFR Definition 20.6. EIP1H: Extended Interrupt Priority 1 High .....	125
SFR Definition 20.7. EIE2: Extended Interrupt Enable 2 .....	126
SFR Definition 20.8. EIP2: Extended Interrupt Priority 2 .....	127
SFR Definition 20.9. EIP2H: Extended Interrupt Priority 2 High .....	127
SFR Definition 20.10. IT01CF: INT0/INT1 Configuration .....	129
SFR Definition 21.1. PSCCTL: Program Store R/W Control .....	137
SFR Definition 21.2. FLKEY: Flash Lock and Key .....	138
SFR Definition 21.3. FLSCCL: Flash Scale .....	139
SFR Definition 23.1. CRC0CN: CRC0 Control .....	150
SFR Definition 23.2. CRC0IN: CRC0 Data Input .....	151
SFR Definition 23.3. CRC0DAT: CRC0 Data Output .....	151
SFR Definition 23.4. CRC0AUTO: CRC0 Automatic Control .....	152
SFR Definition 23.5. CRC0CNT: CRC0 Automatic Flash Sector Count .....	153
SFR Definition 23.6. CRC0FLIP: CRC0 Bit Flip .....	154
SFR Definition 24.1. VDM0CN: VDD Monitor Control .....	158
SFR Definition 24.2. RSTSRC: Reset Source .....	160
SFR Definition 25.1. PCON: Power Control .....	163
SFR Definition 26.1. CLKSEL: Clock Select .....	165
SFR Definition 26.2. OSCICL: Internal H-F Oscillator Calibration .....	166
SFR Definition 26.3. OSCICN: Internal H-F Oscillator Control .....	167
SFR Definition 26.4. OSCLCN: Internal L-F Oscillator Control .....	168
SFR Definition 26.5. OSCXCN: External Oscillator Control .....	172
SFR Definition 27.1. XBR0: Port I/O Crossbar Register 0 .....	181
SFR Definition 27.2. XBR1: Port I/O Crossbar Register 1 .....	182
SFR Definition 27.3. P0MASK: Port 0 Mask Register .....	183
SFR Definition 27.4. P0MAT: Port 0 Match Register .....	184
SFR Definition 27.5. P1MASK: Port 1 Mask Register .....	184
SFR Definition 27.6. P1MAT: Port 1 Match Register .....	185
SFR Definition 27.7. P0: Port 0 .....	186
SFR Definition 27.8. P0MDIN: Port 0 Input Mode .....	186
SFR Definition 27.9. P0MDOUT: Port 0 Output Mode .....	187
SFR Definition 27.10. P0SKIP: Port 0 Skip .....	187
SFR Definition 27.11. P1: Port 1 .....	188
SFR Definition 27.12. P1MDIN: Port 1 Input Mode .....	188
SFR Definition 27.13. P1MDOUT: Port 1 Output Mode .....	189
SFR Definition 27.14. P1SKIP: Port 1 Skip .....	189
SFR Definition 27.15. P2: Port 2 .....	190
SFR Definition 27.16. P2MDIN: Port 2 Input Mode .....	190
SFR Definition 27.17. P2MDOUT: Port 2 Output Mode .....	191
SFR Definition 27.18. P2SKIP: Port 2 Skip .....	191
SFR Definition 28.1. SMB0CF: SMBus Clock/Configuration .....	198
SFR Definition 28.2. SMB1CF: SMBus Clock/Configuration .....	199

---

---

SFR Definition 28.3. SMBTC: SMBus Timing and Pin Control .....	200
SFR Definition 28.4. SMB0CN: SMBus Control .....	202
SFR Definition 28.5. SMB1CN: SMBus Control .....	203
SFR Definition 28.6. SMB0ADR: SMBus0 Slave Address .....	205
SFR Definition 28.7. SMB0ADM: SMBus0 Slave Address Mask .....	206
SFR Definition 28.8. SMB1ADR: SMBus1 Slave Address .....	207
SFR Definition 28.9. SMB1ADM: SMBus1 Slave Address Mask .....	208
SFR Definition 28.10. SMB0DAT: SMBus Data .....	209
SFR Definition 28.11. SMB1DAT: SMBus Data .....	210
SFR Definition 29.1. SCON0: Serial Port 0 Control .....	225
SFR Definition 29.2. SBUF0: Serial (UART0) Port Data Buffer .....	226
SFR Definition 30.1. SPI0CFG: SPI0 Configuration .....	235
SFR Definition 30.2. SPI0CN: SPI0 Control .....	236
SFR Definition 30.3. SPI0CKR: SPI0 Clock Rate .....	237
SFR Definition 30.4. SPI0DAT: SPI0 Data .....	238
SFR Definition 31.1. CKCON: Clock Control .....	243
SFR Definition 31.2. CKCON1: Clock Control 1 .....	244
SFR Definition 31.3. TCON: Timer Control .....	249
SFR Definition 31.4. TMOD: Timer Mode .....	250
SFR Definition 31.5. TL0: Timer 0 Low Byte .....	251
SFR Definition 31.6. TL1: Timer 1 Low Byte .....	251
SFR Definition 31.7. TH0: Timer 0 High Byte .....	252
SFR Definition 31.8. TH1: Timer 1 High Byte .....	252
SFR Definition 31.9. TMR2CN: Timer 2 Control .....	256
SFR Definition 31.10. TMR2RLL: Timer 2 Reload Register Low Byte .....	257
SFR Definition 31.11. TMR2RLH: Timer 2 Reload Register High Byte .....	257
SFR Definition 31.12. TMR2L: Timer 2 Low Byte .....	257
SFR Definition 31.13. TMR2H: Timer 2 High Byte .....	258
SFR Definition 31.14. TMR3CN: Timer 3 Control .....	262
SFR Definition 31.15. TMR3RLL: Timer 3 Reload Register Low Byte .....	263
SFR Definition 31.16. TMR3RLH: Timer 3 Reload Register High Byte .....	263
SFR Definition 31.17. TMR3L: Timer 3 Low Byte .....	263
SFR Definition 31.18. TMR3H: Timer 3 High Byte .....	264
SFR Definition 31.19. TMR4CN: Timer 4 Control .....	267
SFR Definition 31.20. TMR4RLL: Timer 4 Reload Register Low Byte .....	268
SFR Definition 31.21. TMR4RLH: Timer 4 Reload Register High Byte .....	268
SFR Definition 31.22. TMR4L: Timer 4 Low Byte .....	268
SFR Definition 31.23. TMR4H: Timer 4 High Byte .....	269
SFR Definition 31.24. TMR5CN: Timer 5 Control .....	272
SFR Definition 31.25. TMR5RLL: Timer 5 Reload Register Low Byte .....	273
SFR Definition 31.26. TMR5RLH: Timer 5 Reload Register High Byte .....	273
SFR Definition 31.27. TMR5L: Timer 5 Low Byte .....	273
SFR Definition 31.28. TMR5H: Timer 5 High Byte .....	274
SFR Definition 32.1. PCA0CN: PCA Control .....	290
SFR Definition 32.2. PCA0MD: PCA Mode .....	291

---



# C8051F39x/37x

---

SFR Definition 32.3. PCA0PWM: PCA PWM Configuration .....	292
SFR Definition 32.4. PCA0CLR: PCA Comparator Clear Control .....	293
SFR Definition 32.5. PCA0CPMn: PCA Capture/Compare Mode .....	294
SFR Definition 32.6. PCA0L: PCA Counter/Timer Low Byte .....	295
SFR Definition 32.7. PCA0H: PCA Counter/Timer High Byte .....	295
SFR Definition 32.8. PCA0CPLn: PCA Capture Module Low Byte .....	296
SFR Definition 32.9. PCA0CPHn: PCA Capture Module High Byte .....	296
C2 Register Definition 33.1. C2ADD: C2 Address .....	297
C2 Register Definition 33.2. DEVICEID: C2 Device ID .....	298
C2 Register Definition 33.3. REVID: C2 Revision ID .....	298
C2 Register Definition 33.4. FPCTL: C2 Flash Programming Control .....	299
C2 Register Definition 33.5. FPDAT: C2 Flash Programming Data .....	299

## 1. System Overview

C8051F39x/37x devices are fully integrated mixed-signal System-on-a-Chip MCUs. Highlighted features are listed below. Refer to Section “2. Ordering Information” on page 20 for specific product feature selection and part ordering numbers.

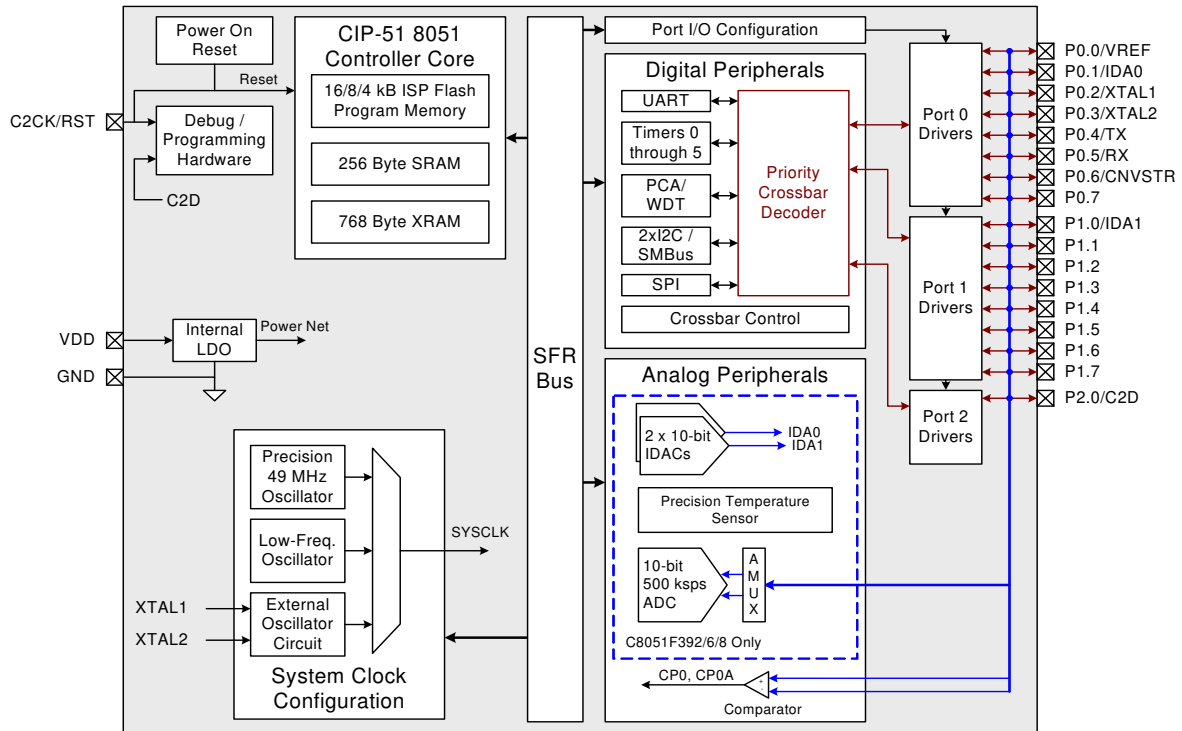
- High-speed pipelined 8051-compatible microcontroller core (up to 50 MIPS)
- In-system, full-speed, non-intrusive debug interface (on-chip)
- True 10-bit 500 ksps 20 or 16-channel single-ended/differential ADC with analog multiplexer
- Two 10-bit Current Output DACs
- Precision temperature sensor with  $\pm 2$  °C absolute accuracy
- Precision programmable 49 MHz internal oscillator
- Low-power, low-frequency oscillator
- 16 kB of on-chip Flash memory
- 1024 bytes of on-chip RAM
- Co-packaged with 512 bytes of EEPROM memory, accessible via I<sup>2</sup>C (C8051F37x)
- Two SMBus/I<sup>2</sup>C, UART, and SPI serial interfaces implemented in hardware
- Six general-purpose 16-bit timers
- Programmable Counter/Timer Array (PCA) with three capture/compare modules and Watchdog Timer function
- On-chip Power-On Reset, V<sub>DD</sub> Monitor, and Temperature Sensor
- On-chip Voltage Comparator
- 21 or 17 Port I/O
- Low-power suspend mode with fast wake-up time

With on-chip Power-On Reset, V<sub>DD</sub> monitor, Watchdog Timer, and clock oscillator, the C8051F39x/37x devices are truly stand-alone System-on-a-Chip solutions. The Flash memory can be reprogrammed even 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.

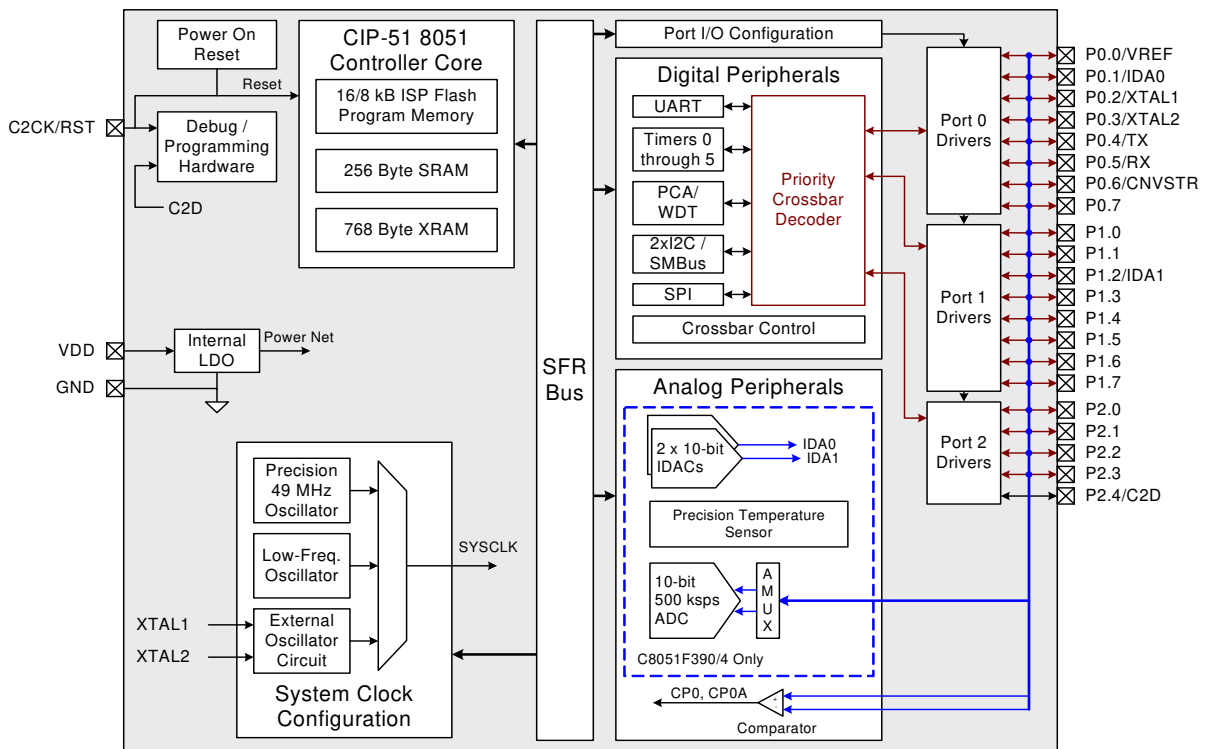
The on-chip Silicon Labs 2-Wire (C2) Development Interface allows non-intrusive (uses no on-chip resources), full speed, in-circuit debugging using the production MCU installed in the final application. This debug logic supports inspection and modification of memory and registers, setting breakpoints, 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.

The C8051F37x devices are specified for 1.8 to 3.6 V operation over the industrial temperature range (–40 to +85 °C), while the C8051F39x devices operate over an extended temperature range (–40 to +105 °C). The C8051F392/3/6/7/8/9 are available in a 20-pin QFN package and the C8051F390/1/4/5 and C8051F37x are available in a 24-pin QFN package. Both package options are lead-free and RoHS compliant. See Section “2. Ordering Information” on page 20 for ordering information. Block diagrams are included in Figure 1.1, Figure 1.2 and Figure 1.3.

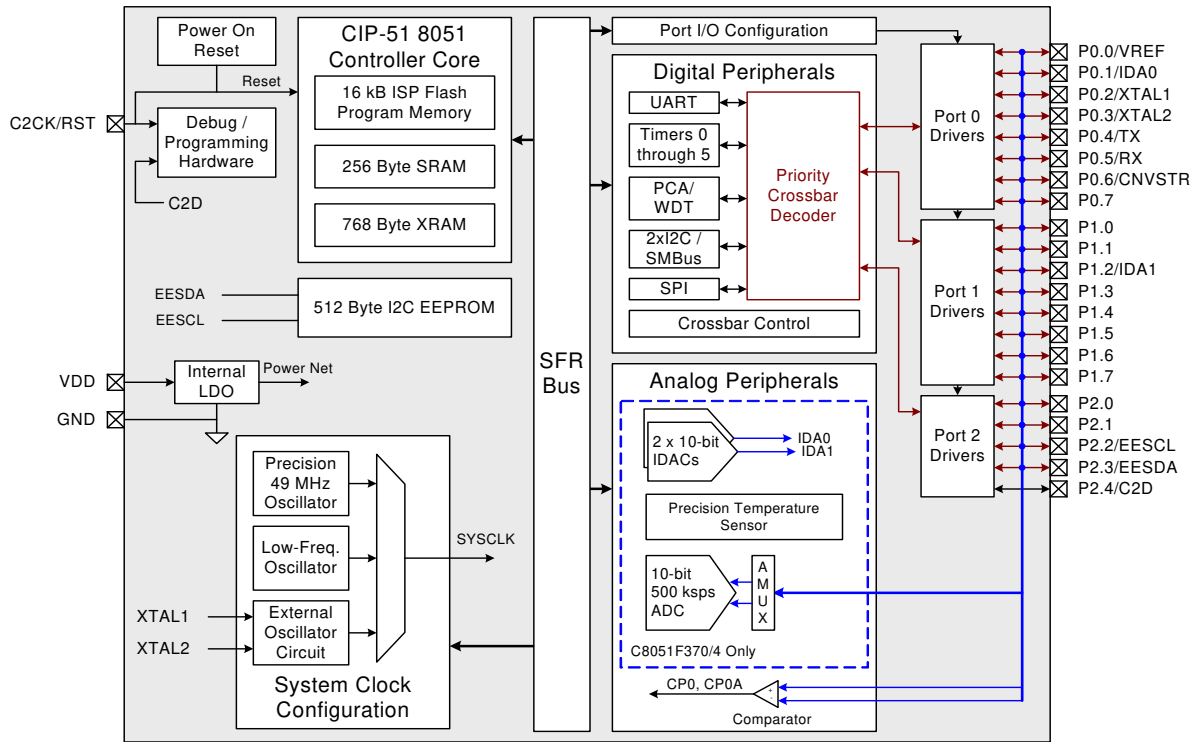
# C8051F39x/37x



**Figure 1.1. C8051F392/3/6/7/8/9 Block Diagram**



**Figure 1.2. C8051F390/1/4/5 Block Diagram**



**Figure 1.3. C8051F370/1/4/5 Block Diagram**

## 2. Ordering Information

The following features are common to all device in this family:

- 50 MIPS throughput (peak)
- 1 kB of RAM (256 internal bytes and 768 XRAM bytes)
- Calibrated internal 49 MHz oscillator
- Internal 80 kHz oscillator
- Two SMBus/I<sup>2</sup>C
- Enhanced SPI, Enhanced UART
- Six Timers
- Three Programmable Counter Array channels
- Analog Comparator
- Lead-free / RoHS Compliant

Table 2.1 shows the features that differentiate the devices in this family.

**Table 2.1. Product Selection Guide**

Ordering Part Number	Flash Memory (Bytes)	EEPROM (Bytes)	Digital Port I/Os	10-bit ADC Channels	10-bit DAC Channels	On-Chip Voltage Reference	Precision Temperature Sensor	Package 4x4 mm
C8051F370-A-GM	16k	512	21	20	2	Y	Y	QFN-24
C8051F371-A-GM	16k	512	21	—	—	—	—	QFN-24
C8051F374-A-GM	8k	512	21	20	2	Y	Y	QFN-24
C8051F375-A-GM	8k	512	21	—	—	—	—	QFN-24
C8051F390-A-GM	16k	—	21	20	2	Y	Y	QFN-24
C8051F391-A-GM	16k	—	21	—	—	—	—	QFN-24
C8051F392-A-GM	16k	—	17	16	2	Y	Y	QFN-20
C8051F393-A-GM	16k	—	17	—	—	—	—	QFN-20
C8051F394-A-GM	8k	—	21	20	2	Y	Y	QFN-24
C8051F395-A-GM	8k	—	21	—	—	—	—	QFN-24
C8051F396-A-GM	8k	—	17	16	2	Y	Y	QFN-20
C8051F397-A-GM	8k	—	17	—	—	—	—	QFN-20
C8051F398-A-GM	4k	—	17	16	2	Y	Y	QFN-20
C8051F399-A-GM	4k	—	17	—	—	—	—	QFN-20

## 3. C8051F33x Compatibility

The C8051F39x/37x family is designed to be a pin and code compatible replacement for the C8051F33x device family, with an enhanced feature set. The C8051F39x/37x device should function as a drop-in replacement for the C8051F33x devices in most applications. Table 3.1 lists recommended replacement part numbers for C8051F33x devices. See “3.1. Hardware Incompatibilities” to determine if any changes are necessary when upgrading an existing C8051F33x design to the C8051F39x/37x.

**Table 3.1. C8051F33x Replacement Part Numbers**

C8051F33x Part Number	C8051F39x/37x Part Number
C8051F330-GM	C8051F396-A-GM
C8051F331-GM	C8051F397-A-GM
C8051F332-GM	C8051F398-A-GM
C8051F333-GM	C8051F399-A-GM
C8051F334-GM	C8051F398-A-GM
C8051F335-GM	C8051F399-A-GM
C8051F336-GM	C8051F392-A-GM
C8051F337-GM	C8051F393-A-GM
C8051F338-GM	C8051F390-A-GM
C8051F339-GM	C8051F391-A-GM

### 3.1. Hardware Incompatibilities

While the C8051F39x/37x family includes a number of new features not found on the C8051F33x family, there are some differences that should be considered for any design port.

- **Internal High-Frequency Oscillator:** The undivided high-frequency oscillator on the C8051F39x/37x is 49 MHz, whereas the undivided high-frequency oscillator on the C8051F33x is 24.5 MHz. Correspondingly, the internal high frequency divide ratios (IFCN) have doubled. Thus, firmware written for the C8051F33x where the CLKSL[1:0] = 00b will result in the same SYSCLK frequency on the C8051F39x/37x.
- **Fabrication Technology:** The C8051F39x/37x is manufactured using a different technology process than the C8051F33x. As a result, many of the electrical performance parameters will have subtle differences. These differences should not affect most systems but it is nonetheless important to review the electrical parameters for any blocks that are used in the design, and ensure they are compatible with the existing hardware.
- **5 V Tolerance:** The port I/O pins on the C8501F39x/37x are not 5 V tolerant, whereas the port I/O pins on the C8051F33x are 5 V tolerant.
- **Lock Byte Address:** The lock byte for C8051F39x/7x devices with 16 kB of Flash resides at address 0x3FFF, whereas the lock byte for C8051F33x devices with 16 kB of Flash resides at address 0x3DFF. The lock byte for C8051F39x/7x devices with 8 kB of Flash resides at address 0x1FFF, whereas the lock byte for C8051F33x devices with 8 kB of Flash resides at address 0x1DFF.

## 4. Pin Definitions

Table 4.1. Pin Definitions for the C8051F39x/37x

Name	Pin 'F392/3/6/ 7/8/9	Pin 'F390/1/ 4/5	Pin 'F370/1/ 4/5	Type	Description
V <sub>DD</sub>	3	4	4		Power Supply Voltage.
GND	2	3	3		Ground. This ground connection is required. The center pad may optionally be connected to ground also.
$\overline{\text{RST}}$	4	5	5	D I/O	Device Reset. Open-drain output of internal POR or V <sub>DD</sub> monitor. An external source can initiate a system reset by driving this pin low for at least 10 $\mu\text{s}$ .
C2CK				D I/O	Clock signal for the C2 Debug Interface.
C2D	5	6	6	D I/O	Bi-directional data signal for the C2 Debug Interface. Shared with P2.0 on 20-pin packaging and P2.4 on 24-pin packaging.
P0.0/ VREF	1	2	2	D I/O or A In  A In	Port 0.0.  External VREF input.
P0.1 IDA0	20	1	1	D I/O or A In  A Out	Port 0.1.  IDA0 Output.
P0.2/ XTAL1	19	24	24	D I/O or A In  A In	Port 0.2.  External Clock Input. This pin is the external oscillator return for a crystal or resonator.
P0.3/ XTAL2	18	23	23	D I/O or A In  A I/O or D In	Port 0.3.  External Clock Output. For an external crystal or resonator, this pin is the excitation driver. This pin is the external clock input for CMOS, capacitor, or RC oscillator configurations.
P0.4	17	22	22	D I/O or A In	Port 0.4.
P0.5	16	21	21	D I/O or A In	Port 0.5.

# C8051F39x/37x

**Table 4.1. Pin Definitions for the C8051F39x/37x (Continued)**

Name	Pin 'F392/3/6/ 7/8/9	Pin 'F390/1/ 4/5	Pin 'F370/1/ 4/5	Type	Description
P0.6/  CNVSTR	15	20	20	D I/O or A In  D In	Port 0.6.  ADC0 External Convert Start or IDA0 Update Source Input.
P0.7	14	19	19	D I/O or A In	Port 0.7.
P1.0  IDA1	13	—	—	D I/O or A In  A Out	Port 1.0.  IDA1 Output.
P1.0		18	18	D I/O or A In	Port 1.0.
P1.1	12	17	17	D I/O or A In	Port 1.1.
P1.2  IDA1	-	16	16	D I/O or A In  A Out	Port 1.2.  IDA1 Output.
P1.2	11	—	—	D I/O or A In	Port 1.2.
P1.3	10	15	15	D I/O or A In	Port 1.3.
P1.4	9	14	14	D I/O or A In	Port 1.4.
P1.5	8	13	13	D I/O or A In	Port 1.5.
P1.6	7	12	12	D I/O or A In	Port 1.6.
P1.7	6	11	11	D I/O or A In	Port 1.7.
P2.0	5	10	10	D I/O or A In	Port 2.0. (Also C2D on 20-pin Packaging)
P2.1	—	9	9	D I/O or A In	Port 2.1.



**Table 4.1. Pin Definitions for the C8051F39x/37x (Continued)**

Name	Pin 'F392/3/6/ 7/8/9	Pin 'F390/1/ 4/5	Pin 'F370/1/ 4/5	Type	Description
P2.2	—	8	—	D I/O or A In	Port 2.2.
P2.2  EESCL	-	—	8	D I/O or A In  D I/O	Port 2.2.  EEPROM SCL Connection.
P2.3	—	7	—	D I/O or A In	Port 2.3.
P2.3  EESDA	-	—	7	D I/O or A In  D I/O	Port 2.3.  EEPROM SDA Connection.
P2.4	—	6	6	D I/O	Port 2.4. (Also C2D on 24-pin Packaging)

# C8051F39x/37x

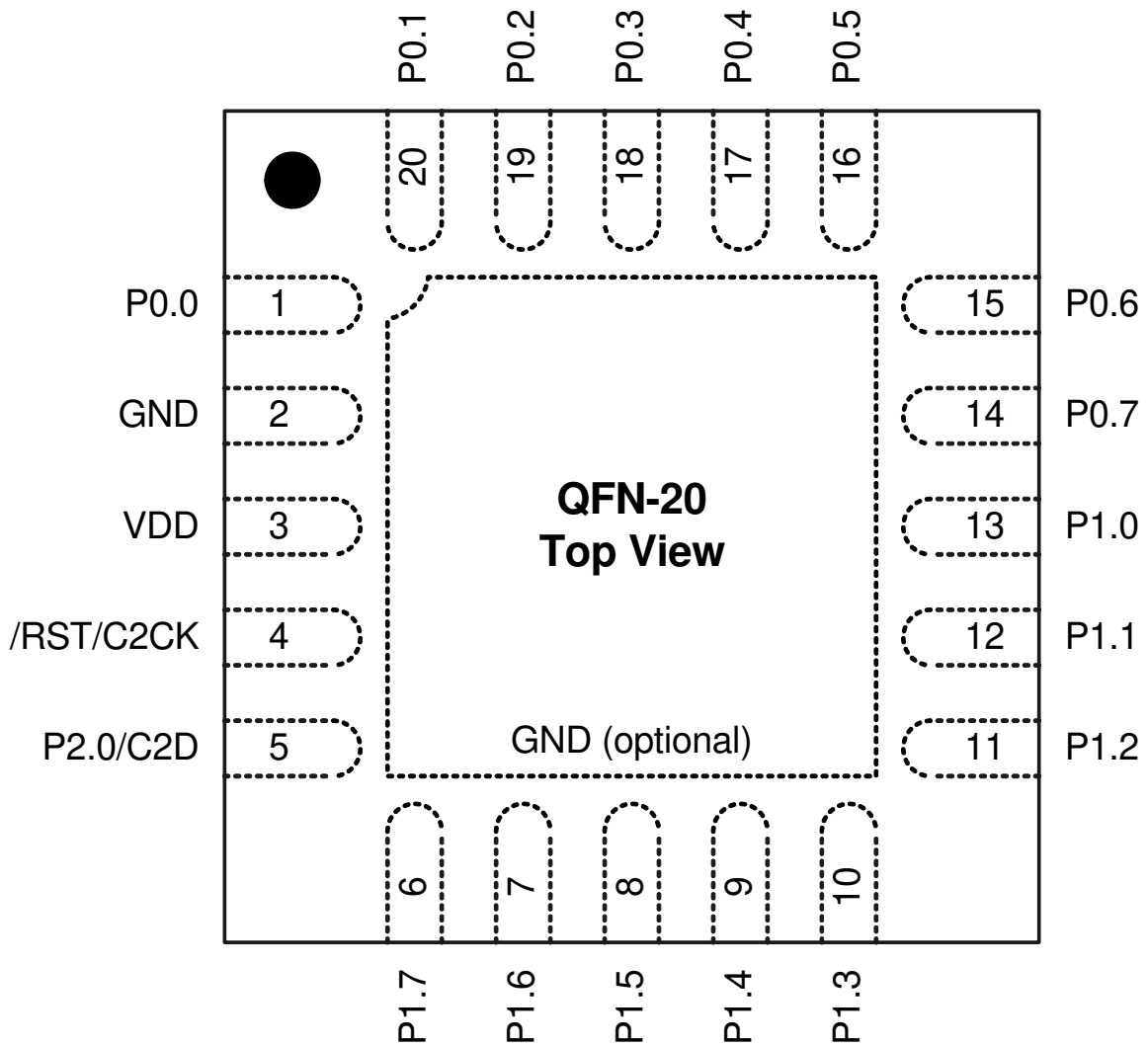


Figure 4.1. C8051F392/3/6/7/8/9 QFN-20 Pinout Diagram (Top View)