PORTING CONSIDERATIONS FROM C8051F330-5 AND C8051F336-9 TO C8051F39X/37X

1. Introduction

This application note highlights the differences among the C8051F330-5, C8051F336-9, and C8051F39x/37x MCUs. These devices are designed to be code-compatible and pin-compatible, and thus require very minor changes when porting firmware and hardware between MCUs in these three families. The 'F39x/37x is the newest among the three families and includes an enhanced feature set in addition to all of the peripherals of the 'F330-5 and 'F336-9.

2. Common Features

Some digital and analog peripherals are common to the three families. If SFR paging is accounted for, firmware written for these peripherals will work on any of the three families. The list of common digital and analog peripherals is:

- ADC and ADC Temperature Sensor
- Comparator
- IDAC 0
- PCA
- SMBus 0
- SPI
- Timers 0, 1, 2, 3
- UART

Note that while these peripherals are common to all three families, they might not be available in each part number of a product family. Refer to the Ordering Information sections of the applicable data sheets to determine the specific part number that includes the peripherals necessary for the system.

As an example, the C8051F330-GM is pin- and code-compatible with the C8051F393-A-GM. However, the C8051F393-A-GM does not include an ADC peripheral. If this peripheral is necessary for the system, the appropriate upgrade choice is the C8051F392-A-GM.

2.1. Pin-Compatibility

Corresponding package options in each product family are 100% pin-compatible; therefore, no PCB redesign is necessary when switching between these product families. Additional porting considerations are discussed in Section 3. Table 1 accounts for pin-compatibility but not memory size and available peripherals. A specific 'F39x/37x part number is recommended for each 'F330-5 and 'F336-9 part number in Section 4.

Table 1. Pin-Compatible MCUs

Package	C8051F330/1/2/3/4/5	C8051F336/7/8/9	C8051F39x/37x	
QFN-20 (all are pin compatible)	C8051F330-GM C8051F331-GM C8051F332-GM C8051F333-GM C8051F334-GM C8051F335-GM	C8051F336-GM C8051F337-GM	C8051F392-GM C8051F393-GM C8051F396-GM C8051F397-GM C8051F398-GM C8051F399-GM	
QFN-24 (all are pin compatible)	—	C8051F338-GM C8051F339-GM	C8051F390-GM C8051F391-GM C8051F394-GM C8051F395-GM	C8051F370-GM C8051F371-GM C8051F374-GM C8051F375-GM

3. Distinguishing Factors

Table 2 lists the primary differences between the three MCU families. Some peripherals and capabilities are unique to certain product families. When moving a design from one MCU family to another, ensure that the new MCU family includes the necessary features. Also, note that the features listed in the table might not be available in all products in the product family. See the applicable data sheet to determine the part number that includes features necessary for the design.

The addition of features to the 'F39x/37x family created minor differences between some common components of the three families. When porting code between these families, it will be necessary to make minor firmware changes if these components are used. These differences and the required changes are detailed in Sections 3.1 through 3.7. If these changes are accounted for, any firmware written for one of the three product families can run directly on an MCU from the other two product families.

Table 2. Features Differences between MCU Families

Feature	C8051F330/1/2/3/4/5	C8051F336/7/8/9	C8051F39x/37x
Core			
System Clock Maximum	25	25	50
Internal Oscillator Calibration Frequency	24.5 MHz	24.5 MHz	49 MHz
Program Memory Maximum	8 kB	16 kB	16 kB
XRAM	512 B	512 B	768 B
SFR Paging	—	—	✓
Analog			
ADC Channels	16	20	20
ADC Temp Sensor	✓	✓	✓
Precision Temp Sensor	—	—	✓
IDACs	1	1	2
Digital			
Port Pins	17	21	21
All Port Pins 5 V Tolerant	✓	✓	—
Timers	4	4	6
SMBus/I^{2}C	1	1	2
CRC	—	—	✓
Pinout and Packages			
QFN-20	✓	✓	✓
QFN-24	—	✓	✓

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3.1. Internal High-Frequency Oscillator

The 'F330-5 and 'F336-9 devices include an internal high-frequency oscillator calibrated to 24.5 MHz. The 'F39x/37x devices include an internal high-frequency oscillator calibrated to 49 MHz. Upon reset, the system clock (SYSCLK) frequency is 3.0625 MHz on all three families.

Internal high-frequency oscillator firmware written for the 'F330-5 or 'F336-9 will result in the same SYSCLK frequency on the 'F39x/37x. Internal high-frequency oscillator firmware written for the 'F39x/37x will result in the same SYSCLK frequency on a 'F330-5 or 'F336-9 as long as the 49 MHz frequency is not selected.

Table 3. SYSCLK Frequency

CLKSEL[1:0]	OSCICN[1:0]	SYSCLK Frequency		
		C8051F330/1/2/3/4/5	C8051F336/7/8/9	C8051F39x/37x
11b	XXb*	—	—	49 MHz
00b	11b	24.5 MHz	24.5 MHz	24.5 MHz
00b	10b	12.25 MHz	12.25 MHz	12.25 MHz
00b	01b	6.125 MHz	6.125 MHz	6.125 MHz
00b	00b	3.0625 MHz	3.0625 MHz	3.0625 MHz
* **Note:** XX denotes don't care				

3.2. Special Function Register Paging

The 'F39x/37x devices implement a paged special function register (SFR) scheme which greatly expands the number of available SFR addresses. This SFR address expansion provides support for more peripherals such as:

- Second current DAC (IDA1)
- Second SMBus peripheral (SMBus1)
- CRC unit (CRC0)
- Precision temperature sensor (TS0)
- Timer 4 and Timer 5

To correctly read or write to SFRs in a 'F39x/37x device, the SFRPAGE register must be set to the correct SFR page. The SFRPAGE register itself is accessible from all SFR pages. For example, to access the IDA1 control register IDA1CN, SFRPAGE must be set to 0x0F.

```
SFRPAGE = CONFIG_PAGE;                          // Switch SFR page to 0x0F
IDA1CN |= 0x80;                                 // Enable IDA1
```

CONFIG_PAGE is defined as 0x0F in the C8051F390_defs.h header file. It is recommended to use the defined constants for SFRPAGE to enhance code readability and to reduce the porting effort for future platforms.

When porting code from a 'F330-5 or 'F336-9 device to a 'F39x/37x device, modify the firmware to set the SFRPAGE before any SFR accesses. When porting code from a 'F39x/37x device to a 'F33x device, remove all writes to SFRPAGE.

3.3. Special Function Registers

The SFR memory maps of the 'F330-5, 'F336-9, and 'F39x/37x are very similar. However, there are a few differences related to functionality or features found on only one of the two device families. Fortunately, SFRs that exist on one family but not on the other can be safely written and read on the other device family without causing a problem. Likewise, certain registers have additional bits defined that are not present on both devices. In these cases, the default bit settings are safe to write, and the read values of those bits are defined in the data sheet. Figure 1 shows the combined SFR map of the three device families. The locations of SFRs that differ between the three families and those with only bitwise differences are highlighted.

Address	Page	0(8) Bit-Addressable	1(9)	2(A)	3(B)	4(C)	5(D)	6(E)	7(F)
F8		SPI0CN	PCA0L	PCA0H	PCA0CPL0	PCA0CPH0	P0MAT	P0MASK	VDM0CN
F0		B	P0MDIN	P1MDIN	P2MDIN	CKCON1		EIP1	PCA0PWM
E8		ADC0CN	PCA0CPL1	PCA0CPH1	PCA0CPL2	PCA0CPH2	P1MAT	P1MASK	RSTSRC
E0	0	ACC	XBR0	XBR1	OSCLCN	IT01CF		EIE1	SMB0ADM
	F								SMB1ADM
D8		PCA0CN	PCA0MD	PCA0CPM0	PCA0CPM1	PCA0CPM2	CRC0AUTO	CRC0CNT	CRC0CN
D0	0	PSW	REF0CN	TS0DATL	TS0DATH	P0SKIP	P1SKIP	P2SKIP	SMB0ADR
	F			TS0CN	SFRSTACK				SMB1ADR
C8	0	TMR2CN	REG0CN	TMR2RLL	TMR2RLH	TMR2L	TMR2H	PCA0CLR	SFRPGCN
	F	TMR5CN		TMR5RLL	TMR5RLH	TMR5L	TMR5H		
C0	0	SMB0CN	SMB0CF	SMB0DAT	ADC0GTL	ADC0GTH	ADC0LTL	ADC0LTH	SMBTC
	F	SMB1CN	SMB1CF	SMB1DAT					
B8	0	IP	IDA0CN	AMX0N	AMX0P	ADC0CF	ADC0L	ADC0H	EIP2
	F		IDA1CN						
B0			OSCXCN	OSCICN	OSCICL		PFE0CN	FLSCL	FLKEY
A8	0	IE	CLKSEL	EMI0CN	DERIVID	REVISION			EIE2
	F				SN0	SN1	SN2	SN3	
A0		P2	SPI0CFG	SPI0CKR	SPI0DAT	P0MDOUT	P1MDOUT	P2MDOUT	SFRPAGE
98		SCON0	SBUF0	CRC0FLIP	CPT0CN	CRC0IN	CPT0MD	CRC0DAT	CPT0MX
90	0	P1	TMR3CN	TMR3RLL	TMR3RLH	TMR3L	TMR3H	IDA0L	IDA0H
	F		TMR4CN	TMR4RLL	TMR4RLH	TMR4L	TMR4H	IDA1L	IDA1H
88		TCON	TMOD	TL0	TL1	TH0	TH1	CKCON	PSCTL
80		P0	SP	DPL	DPH	IPH	EIP1H	EIP2H	PCON

(yellow)	denotes SFRs on 'F336-9 and 'F39x/37x only
(green)	denotes SFRs on 'F39x/37x only
(blue)	denotes bitwise differences across all three families

Figure 1. 'F330-5, 'F336-9, and 'F39x/37x SFR Memory Map

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3.4. Precision Temperature Sensor

An ADC temperature sensor is included in the 'F330-5, 'F336-9, and 'F39x/37x families. The 'F39x/37x family also includes a self-contained precision temperature sensor that is accurate to ±2 °C.

The 'F39x/37x precision temperature sensor directly reports the die temperature in degrees Celsius as a 16-bit, two's complement number. The ±2 °C accuracy is achieved with no calibration. Though the 'F39x/37x retains an ADC temperature sensor for 'F330-5 and 'F336-9 compatibility, 'F39x/37x designs are encouraged to utilize the ±2 °C accurate precision temperature sensor.

3.5. Lock Byte

On every Silicon Labs MCU, the lock byte is located in the last byte of user-accessible flash. The 'F330-5 family has 8K, 4K, and 2K of flash. The 'F336-9 family has 16K of flash. The 'F39x/37x family has 16K, 8K, and 4K of flash. When porting firmware from one family to another, the location of the lock byte must be moved if it is used.

Table 4. Location of Lock Byte

Flash Size	Lock Byte Address		
	C8051F330/1/2/3/4/5	C8051F336/7/8/9	C8051F39x/37x
16K Flash	—	0x3DFF	0x3FFF
8K Flash	0x1DFF	—	0x1FFF
4K Flash	0x0FFF	—	0x0FFF
2K Flash	0x07FF	—	—

3.6. Differences in Electrical Characteristics

Table 5 lists select electrical characteristics that have a wider specification on the 'F39x/37x compared to the 'F330-5 and 'F336-9. Electrical characteristics in this list were selected based on significance, and the list is not comprehensive.

Note: Refer to the respective data sheets for the comprehensive electrical characteristics.

All port pins on the 'F330-5 and 'F336-9 devices are 5 V tolerant. On 'F39x/37x devices, all port pins are not 5 V tolerant, and power should not be applied to any port pin until the voltage on the VDD pin is within the data sheet specification.

Table 5. Selected Differences in Electrical Characteristics

Parameter	Conditions	'F330-5	'F336-9	'F39x/37x	Units
Voltage on any Port I/O Pin or $\overline{\text{RST}}$ with respect to GND, Absolute Maximum		5.8	5.8	V_{DD}* + 0.3	V
Specified Operating Temperature Range, Maximum		85	85	105 ('F39x) 85 ('F37x)	°C
Digital Supply Current—CPU Active (Normal Mode, Fetching Instructions from flash), Typical	V_{DD} = 3.0 V, F = 80 kHz	31	35	250	µA
Digital Supply Current—CPU Inactive (Idle Mode, Not Fetching Instructions from flash), Typical	V_{DD} = 3.0 V, F = 80 kHz	16	13	100	µA
Port I/O Input High Voltage, Minimum		2	2	$V_{DD} - 0.4$ ($1.8 \leq V_{DD} < 2.7$) $V_{DD} - 0.5$ ($2.7 \leq V_{DD} \leq 3.6$)	V
Port I/O Input Low Voltage, Maximum		0.8	0.8	0.5 ($1.8 \leq V_{DD} < 2.7$) 0.6 ($2.7 \leq V_{DD} \leq 3.6$)	V
Flash Erase Cycle Time, Maximum		20	20	27	ms
ADC INL, Maximum		±1	±1	±2	LSB
IDAC INL, Typical		±0.5	±0.5	<±1	LSB
IDAC INL, Maximum		—	±2	±3	LSB
IDAC DNL, Maximum		±1	±1	±1 (0 to +105 °C) ±1.3 (–40 to 0°C)	LSB

* Note: Maximum V_{DD} is 3.6 V on 'F39x/37x

Electrical characteristics obtained from:
- C8051F330-5 data sheet v1.7
- C8051F336-9 data sheet v1.0
- C8051F39x/37x data sheet v0.71

3.7. Other Peripherals

All other peripherals and features not discussed in the previous sections are functionally the same between the two device families. If SFR paging is accounted for, firmware written for these peripherals will operate the same way on any of the three device families.

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4. Recommended Part Numbers

The 'F39x/37x devices was designed to be pin- and code-compatible with the 'F330-5 and 'F336-9 devices. Table 6 identifies a specific 'F39x/37x part number for each 'F330-5 and 'F336-9 part number. Recommended 'F39x/37x part numbers were selected based on pin-compatibility, flash size, and available peripherals.

Table 6. 'F330-5 and 'F336-9 Replacement Part Numbers

C8051F330/1/2/3/4/5	C8051F336/7/8/9	C8051F39x/37x	
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	C8051F370-A-GM
—	C8051F339-GM	C8051F391-A-GM	C8051F371-A-GM
* Note: 2 kB flash is unavailable on 'F39x/37x. Smallest flash size on 'F39x/37x is 4 kB.			

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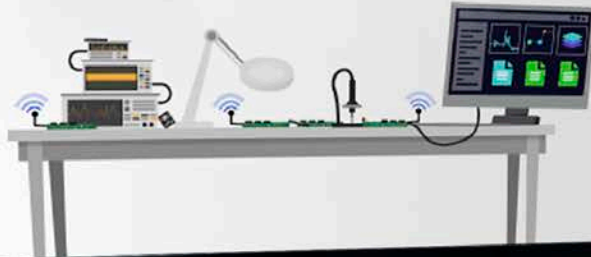
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