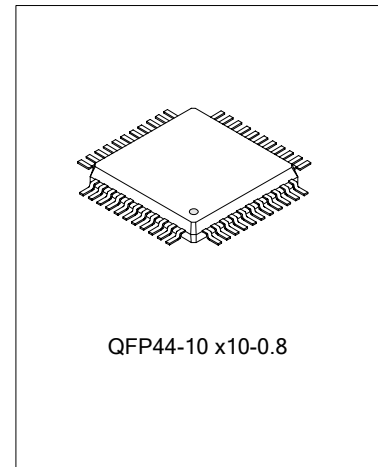


AUDIO SYSTEM CONTROL MCU WITH ANALOG RADIO FUNCTION

DESCRIPTION

SC9308 is a SOC based on Silan's 8-bit MCU SC65X for analog radio DFR control with low voltage low power consumption. Built-in LCD driver which can drive max. 4X14 segments display, 31 configurable I/O ports and three 8-bit counters, two of which can be combined to achieve 16 timing length; Built-in real time clock ensures the system uninterrupted counting when it is in sleep state; 11 interrupt sources, including four external interrupts, enabling the system to respond quickly to internal or external events. Multi-mode optional serial communication circuits greatly increase the system's scalability. Built-in 3.2MHz RC oscillator with external 75KHz oscillator can achieve the perfect balance between power and speed. In high speed application, it can extend external high frequency crystal through PC.4/5 pin, maximum up to 6MHz.



APPLICATIONS

* Widely applied in portable audio control system with LCD.

ORDERING INFORMATION

Part No.	Package	Marking
SC9308	COB44	No
SC9308P	QFP-44-10×10-0.8	SC9308P

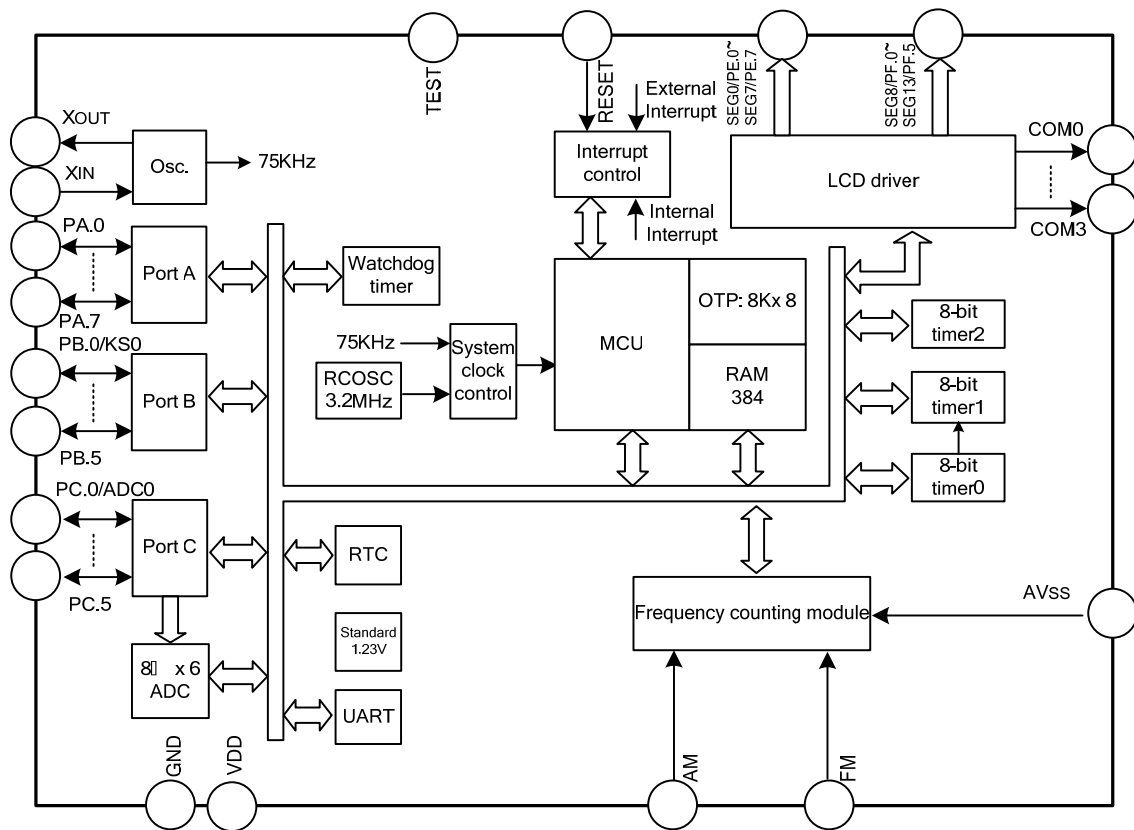
FEATURES

- * Memory
 - 384-byte data memory
 - 8K-byte program memory (OTP)
- * I/O configuration
 - General-purpose I/O: 17 pins with pull up resistor;
 - SEG: also can be used as I/O.
- * LCD controller/driver
 - Drive 7 words display max.
 - 14 SEG x 4 COM
 - Display mode: duty, bias can be programmable
- * 8-bit timer/counter T0/T1/T2
 - Timing time can be set by program
 - External events counting
 - Arbitrary clock frequency output
 - T0/T1 can be 16-bit counter
- * Operating voltage range: 3.0~3.6V
- * Clock source
 - External clock source: 75KHz Crystal
 - Built-in RC oscillator: 3.2MHz;
 - Extension Crystal: 2~6MHz(VDD>2.4V@4MHz)
- * RTC
 - Year/month/day display
 - Provide BCD code data directly
 - Leap year auto adjust
 - Timing alarm
- * Local oscillator frequency counting circuit
 - Local oscillator:
 - FM frequency range: 30MHz~150MHz
 - AM frequency range: 0.5MHz~30MHz
 - Counter: 16-bit, gate time 1/4/8ms
- * Built-in voltage reference
 - VREF=1.23V±5%

FEATURES (Continued)

- * A/D converter
 - 4-channels with 8-bit conversion precision
 - External reference voltage selectable
 - Battery voltage monitor
- * UART serial communication interface
 - 2-line Asynchronous communication
 - Communication speed can be selected flexibly
 - Quick interrupt response
- * Interrupt source
 - 5 external interrupts, maskable
 - 6 internal interrupts, maskable

BLOCK DIAGRAM



Note: VPP pin can be diplexed as RESET, when program the OTP memory, this pin is connected to 12V voltage.

ABSOLUTE MAXIMUM RATINGS

Characteristics	Symbol	Ratings	Unit
Supply Voltage	V _{DD}	-0.3~5.5	V
Input Voltage (All The I/O Pins)	V _{I1}	-0.3~V _{DD} +0.3	V
Input Voltage (RESET)	V _{I1}	-0.3~V _{DD} +0.3	V
Output Voltage	V _O	-0.3~V _{DD} +0.3	V
Output High Level Current	I _{OH}	-15	mA
Output Low Level Current	I _{OL}	30	mA
Operating Ambient Temperature	T _{amb}	-20~+75	°C
Storage Temperature	T _{STG}	-40~+125	°C

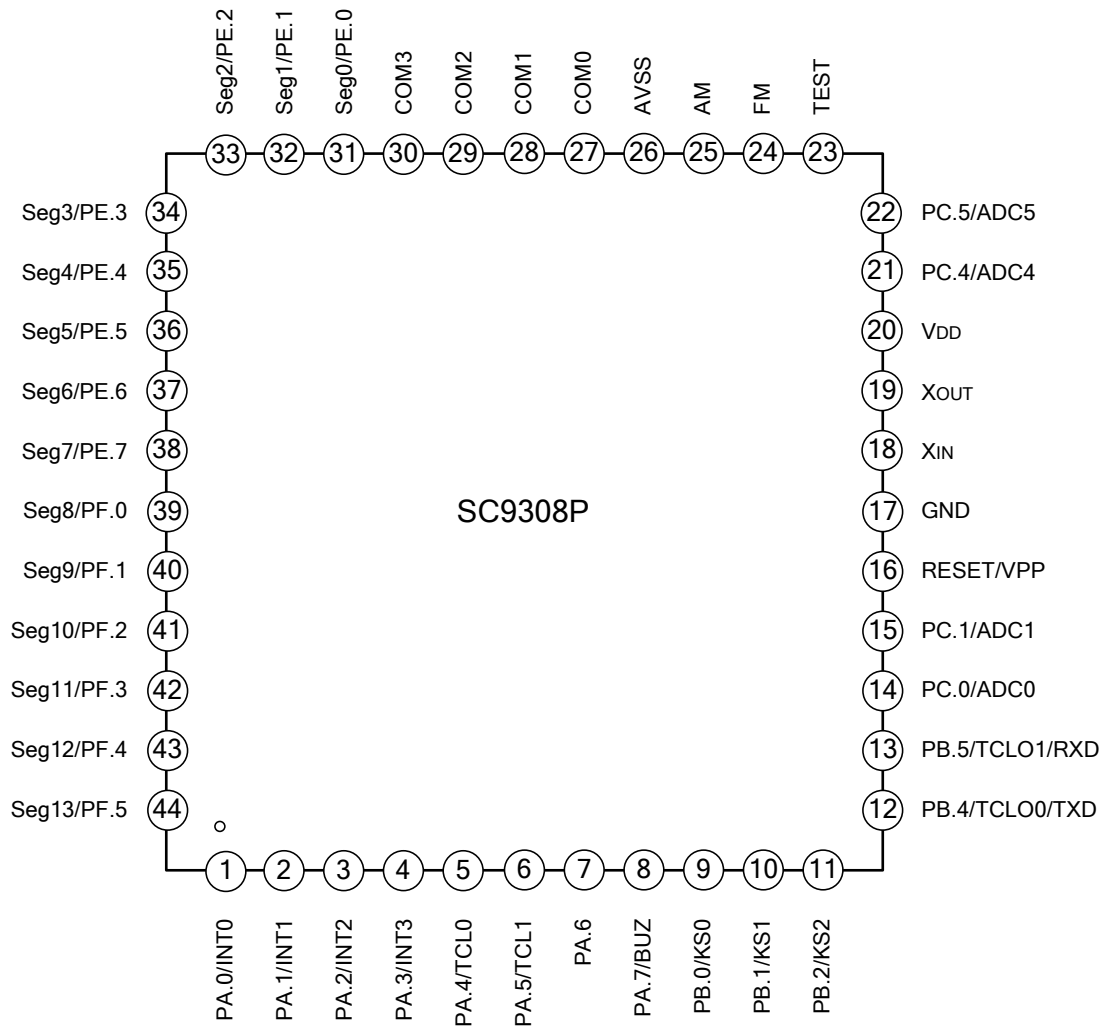
ELECTRICAL CHARACTERISTICS (Unless otherwise specified, T_{amb}=25 °C, V_{DD}=3.3V)

Characteristics	Symbol	Test conditions	Min.	Typ.	Max.	Unit
Operating Voltage	V _{DD}		3.0	3.3	3.6	V
Quiescent Current	I _{Q1}	OSC 75KHz stop, CPU Clk stop			1	μA
	I _{Q2}	OSC=75KHz,CPU Clk=75KHz Sleep (Note 1)		5.5		μA
Operating Current	I _{DD}	OSC=75KHz,CPU Clk=3.2MHz, all the modules start		1.7	3.0	mA
Input High Voltage	V _{IH1}	PA/B/C	2.4	-		V
	V _{IH2}	PE/F	2.0	-		
Input Low Voltage	V _{IL1}	PA/B/C		-	1.0	V
	V _{IL2}	PE/F (Note2)		-	1.0	
Output High Voltage	V _{OH1}	V _{DD} =3V,PA/B/C,I _{OH} =-1mA	2.8			V
	V _{OH2}	V _{DD} =3V,PE/F,I _{OH} =-1mA	2.5			
Output Low Voltage	V _{OL1}	V _{DD} =3V,PA/B/C,I _{OH} =1mA			0.2	V
	V _{OL2}	V _{DD} =3V,PE/F,I _{OH} =1mA			0.2	
Input High Leakage Current	I _{LIH}	V _{IN} =V _{DD} , all the input pins			1	μA
Input Low Leakage Current	I _{LIL}	V _{IN} =0V,all the input pins			1	
75KHz Crystal Oscillator Feedback Resistor	R _{osc}	V _{DD} =3.0V,X _{IN} =V _{DD} , X _{OUT} =0V	3000	6000	9000	KΩ
Pull-Down Resistor	RL1	V _{DD} =3.0V,V _{IN} (FM/AM)=V _{DD}	9	10.5	12	KΩ
	RL2	V _{DD} =3.0V,Test = V _{DD}		83		
Pull-Up Resistor	RH1	V _{DD} =3.0V,V _{IN} (=0,PA/B/C		25		KΩ
	RH2	V _{DD} =3.0V,V _{reset} = 0		67		

Note

1. Only 75KHz crystal oscillator and RTC are working.
2. CMOS input, when input voltage is 1.6V, the state of read port is uncertain.

PIN CONFIGURATION



PIN DESCRIPTION

Pin No.	Pin Name	Diplex pin	I/O	Pin Descriptions
1	PA.0	INT0	I/O	Universal input / output; 8bit read/write; Configurable bit operation.
2	PA.1	INT1		
3	PA.2	INT2		
4	PA.3	INT3		
5	PA.4	TCL0		
6	PA.5	TCL1		
7	PA.6	—		
8	PA.7	BUZ		
9	PB.0	KS0		
10	PB.1	KS1		
11	PB.2	KS2		
12	PB.4	TCLO0		
13	PB.5	TCLO1		
14	PC.0	ADC0	I/O	Universal input / output; Configurable bit operation.
15	PC.1	ADC1	AD input	
16	RESET	VPP	—	System reset pin
17	GND	—	—	Digital ground
18	XOUT	—	O	Low frequency oscillator output
19	XIN	—	I	Low frequency oscillator input
20	VDD	—	—	Digital power supply
21	PC.4	ADC4	I/O AD input	Universal input / output; Configurable bit operation. PC4/5 can also be used as high speed crystal interface;
22	PC.5	ADC5		
23	TEST	—	—	Test enable pin, internal pull-down resistor
24	FM	—	I	FM signal input
25	AM	—	I	AM signal output
26	AVSS	—	—	Analog ground
27~30	COM0~COM3	—	O	LCD display scan common signal
31~38	SEG0~7	PE.0~7	I/O	Segments scan signal output, maximum output 4-bit data each pin. Drive LCD screen together with COM signal. Can be as general-purpose input/output port.
39~44	SEG8~SEG13	PF.0~5	I/O	Segments scan signal output, maximum output 4-bit data each pin. Drive LCD screen together with COM signal. Can be as common input/output port. (Refer to LCD module description)

SHARED PIN DESCRIPTION

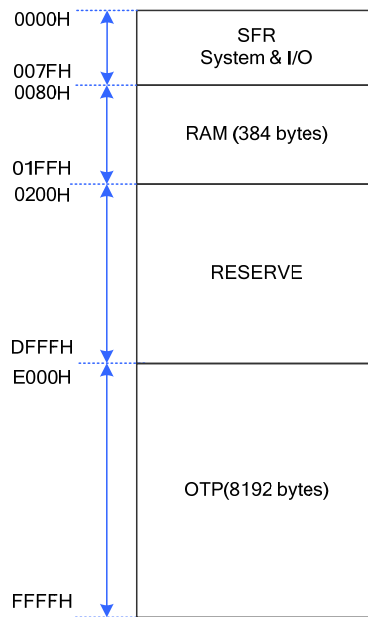
Pin no.	Shared pin	I/O	Descriptions
12	TXD	O	Serial communication data output
13	RXD	I	Serial communication data input
1-4	INT0-INT3	I	External interrupt input
5	TCL0	I	External counting pulse/clock input of timer 0
6	TCL1	I	External counting pulse/clock input of timer 1
8	BUZ	O	Buzzer signal output
9~11	KS0-KS2	I	Key scan input, can generate interrupt
12	TCLO0	O	Frequency division output of timer 0
13	TCLO1	O	Frequency division output of timer 1
16	VPP	—	High voltage pin, when download OTP, connects to 12V voltage
31~38	PE0~PE7	I/O	General purpose I/O port PORTE
39~44	PF0~PF5	I/O	General purpose I/O port PORTF
21	XIN4M	I	High frequency crystal input<ADC channel forbids>
22	XOUT4M	O	High frequency crystal output <ADC channel forbids>

FUNCTION DESCRIPTION

SC9308 has embedded SC65X core and 8K-byte OTP program memory, the data memory is 384-byte. Built-in RC oscillator generates 3.2MHz clock frequency, and after 1/2, 1/4 divided frequency, It can also be used as system main clock together with external 75KHz crystal or extended high speed clock by PC4/5 to implement applications in different modes, thus to maximize reduce the power consumption. The built-in counting circuit can count the local oscillator signal frequency. In addition, it has three 8-bit counters T0/T1/T2. T0/T1 can be used separately and also be used as 16-bit counter. The built-in RTC module can provides powerful calendar/alarm functions, and provides 4 kinds of frequency BUZ signals. PA/B/C/E/F can provide max. 31 I/O ports, where PA/B has pull-up configuration and selectable open-drain output function, PC can be shared as ADC analog pin of ADC, PE/F can be used as LCD display data scan output. LCD driver can drive seven 8-segment display in maximum, and bias voltage 1/3 and 1/2 are selectable, duty is 1/2, 1/3, 1/4 programmable control to meet the various display requirements.

MCU Address Space

MCU uses 16-bit address bus, the maximum addressing space is 64-kByte (0000H~FFFFH). The address assignment of memory space is as follows:



SFR: Special function registers. This block includes system control, state register and the mapping of ports and display data block.

Register Mapping Table

0000H~007FH is assigned to I/O and some function registers. Where 0000H~000FH is assigned to the core. Function registers and I/O ports configuration of used address space is as follows:

Module	Register	I/O	Address	Function descriptions
Used Address Space				
Interrupt Control	IRQIP	W/R	00H	Maskable interrupt enable register
	IRQDP	W/R	01H	Maskable interrupt source register
	NMIIP	W/R	02H	Non-maskable interrupt enable register
	NMIDP	W/R	03H	Non-maskable interrupt source register
	INTCON	W/R	47H	Interrupt control register
	NMI is not used in the circuit, reserved. Forbid it by SEN instruction of program.			
Watchdog Timer	WDTCON	W/R	04H	Watchdog timer setting and enable register
	WDT CLR0	W	09H	Watchdog clear register (write 53H, ACH to 09H, 0AH, can clear WDT)
	WDT CLR1	W	0AH	
MCU control	MCU_SLP	W	06H	MCU sleep control register
	MCU_STATUS	R	07H	MCU state register
Bit Operation Control	BITCTRL	W/R	08H	Bit operation address space selection register(refer to 《SC65X instructions》 for details)
System Control	SYSCON	W/R	45H	System function control register
Clock Control	CLKCON	W/R	46H	System clock control register
Block Signal Selection Control	CLKSEL	W/R	4BH	Block signal selection control register

Module	Register	I/O	Address	Function descriptions
RTC Data and Control	RTC_CS	W/R	30H	RTC control register
	YEARH	W/R	31H	MSB of year data(BCD: 00~99)
	SECOND	W/R	32H	Second data(BCD: 00~59)
	MIN	W/R	33H	Minute data(BCD: 00~59)
	HOUR	W/R	34H	Hour data(BCD: 00~23)
	DAY	W/R	35H	Day data(BCD: 01~31)
	WEEK	W/R	36H	Week data(BCD: 0~6)
	MON	W/R	37H	Month data(BCD: 01~12)
	YEARL	W/R	38H	LSB of year data(BCD: 00~99)
	MIN_ALARM	W/R	39H	Minute alarm setting
	HOUR_ALARM	W/R	3AH	Hour alarm setting
	DAY_ALARM	W/R	3BH	Day alarm setting
	WEEK_ALARM	W/R	3CH	Week alarm time setting
	CKO_CS	W	3DH	BUZ signal control
TIMER2	T2CON	W/R	48H	Control register
	T2REF	W/R	49H	Preassign register/capture register
TIMER0	T0CON	W/R	4CH	Control register
	T0REF	W/R	4DH	Preassign register
TIMER1	T1CON	W/R	4EH	Control register
	T1REF	W/R	4FH	Preassign register
UART	UART_BUF_ADDR	W/R	62H	Transmitting/receiving data buffer
	SCON_ADDR	W/R	63H	UART control register
	BRCON_ADDR	W/R	64H	Baud rate control register
	BRTIMER_ADDR	W/R	65H	Baud rate counting initial value setting register
Analog/Digital Converter	ADDATA	R	50H	Conversion result of 8-bit storage
	ADCON	W/R	51H	Analog/digital control and state
Local oscillator amply	PLLCON	W/R	52H	Local oscillator input control register
Frequency counter	IFMOD	W/R	55H	Frequency counting mode control register
	IFCNT0	W/R	56H	Low 8-bit of frequency counting data
	IFCNT1	W/R	57H	High 8-bit of frequency counting data
Port and Direction Control	TRISA	W/R	59H	Direction control register of port A
	PORTA	W/R	5DH	Data temporary storage register of port A
	TRISB	W/R	5AH	Direction control register of port B
	PORTB	W/R	5EH	Data temporary storage register of port B
	TRISC	W/R	5BH	Direction control register of port C
	PORTC	W/R	5FH	Data temporary storage register of port C
	APCON	W/R	5CH	Port and A/D input duplex selection control

Module	Register	I/O	Address	Function descriptions
Pull-up Configuration	PUA	W/R	60H	I/O port pull-up mode selection register
	PUB	W/R	61H	I/O port pull-up mode selection register
SEG Diplex Port	PORTE	W/R	68H	Data temporary storage register of port E
	PORTF	W/R	69H	Data temporary storage register of port F
	Refer to LCD module description for details.			
SEG Diplex Control	SEG_CTRL0	W	6BH	SEG0~3 pin configuration register
	SEG_CTRL1	W	6CH	SEG4~7 pin configuration register
	SEG_CTRL2	W	6DH	SEG8~11 pin configuration register
	SEG_CTRL3	W	6EH	SEG12~13 pin configuration register
68—69H Unused				
LCD Interface Control	LCDCON	W	67H	LCD control register
	LCDPWR	W/R	66H	LCD control register
	Display RAM			
	LCDREG0	W/R	72H	LCD display register 0
	LCDREG1	W/R	73H	LCD display register 1
	LCDREG2	W/R	74H	LCD display register 2
	LCDREG3	W/R	75H	LCD display register 3
	LCDREG4	W/R	76H	LCD display register 4
	LCDREG5	W/R	77H	LCD display register 5
	LCDREG6	W/R	78H	LCD display register 6
	LCDREG7	W/R	79H	LCD display register 7

Interrupt control

SC65X supports two kinds of interrupts: Non-maskable interrupt NMI; maskable interrupt IRQ. Where PRI of non-maskable interrupt NMI is higher than maskable interrupt IRQ. However, this circuit does not implement NMI interrupt.

1. Maskable interrupts

SC9308 has 11 maskable interrupts in total without PRI; Setting IRQIP register to determine if the interrupt is enable. All the maskable interrupts use the same entry address FFF8H.

2. Non-maskable interrupts(reserved)

Non-maskable interrupt NMI, active high. Entry address is FFFCH/FFFDH. This circuit does not implement NMI function. There is no need to set NMIP and NMIDP registers.

3. External interrupts

SC9308 has 4 IO input interrupts ExtInt0~3, input by PA0~3 pins; one is used for scan interrupt KSINT, shares one interrupt source with ExtInt2, corresponding to IRQDP.6. ExtInt3 and IF interrupt IRQIFC share one interrupt source, corresponding to IRQDP.7. In addition, RTC and Timer2 share one interrupt source.

Watchdog Timer

Watchdog timer adopts independent counter. Watchdog (WDT) is mainly used for program monitor, after counting overflows, generates reset signal to avoid endless loop or other error execution state. When 75K crystal oscillator is operating, the longest overflow time is 873.6ms.

Operating mode control

SC9308 work in three modes: normal mode, sleep mode, and data maintained mode. Normal mode can be divided into high-speed mode and low-speed mode. Their difference is the system clock from different sources. The high speed mode system clock comes from internal RC oscillator or high speed oscillator extended by PC4/5, while the low speed mode system clock comes from external low speed oscillator.

After power on, CPU clock is provided by internal RC oscillator. When this oscillator is working, the internal reference module is needed to open. Select clock frequency or switch to the external low speed clock (75KHz) by setting system control register and clock control register.

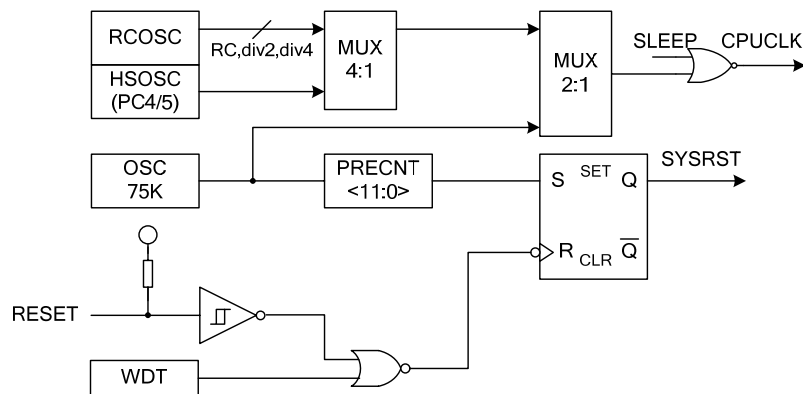
The MCU enters sleep mode by setting SLEEP flag of MCU sleep control register MCU_SLP as 1. After the MCU enters sleep mode, external 75KHz oscillator still works, and CPU clock will be turned off. But it can still response to internal timer interrupt or external IO interrupt. The circuit enters sleep mode which can reduce the system standby power dissipation (75KHz crystal oscillator operating, when RTC enables at 3V operating voltage, typical power dissipation current <math><5\mu\text{A}</math>). Reset, internal or external interrupt can wake up CPU and make it enter work in full speed.

When system clock comes from external low speed oscillator, if this oscillator is closed by program, the circuit will enter data save mode. In this mode, RAM data is saved. The dissipation current is reduced to less than 1uA. External IO interrupt or reset can make the oscillator work again.

Note: The clock should be switch to 75KHz before entering the sleep mode. Turn off the power reference circuit and other relative circuits to reduce the power dissipation.

Clock and Reset

SC9308 supports many selectable operating clocks. The clock source can be external 75KHz crystal oscillator, and can also be the clock generated by internal RC oscillator. When need high precision and high speed application, it can extend high frequency external oscillator through PC4/5. The structure is as follows:



The system reset occurs when: internal watchdog counting overflows; external Reset pin input low level. The circuit jumps to the start address of the program from reset address FFFAH and begins working normally. SC9308 has built in RC oscillator, and frequency of RC oscillator is about 3.2MHz when supply voltage is 3V. If you need to fast response to internal and external events without high precision, adopt RC oscillator as CPU clock to make the system process the events quickly. Due to RC oscillator will vary following the voltage and temperature, PC4/PC5 must be used to extend high-speed oscillator to satisfy the system requirements under the conditions that need high-precision timing or asynchronous communication, etc.. RC oscillator begins to work after reset, and CPU clock selects the RC oscillator.

Real time Clock (RTC)

RTC module can provide powerful timing function. When it starts, it will work separately from CPU. It can provide minute, hour and year/month/day, etc. in BCD formats. Minute, hour, week, day alarm can be set, and the alarm function can be triggered by interrupt or inquiring the alarm flag by software. At the same time, it will generate 0.5s real time clock signal, which can trigger interrupt. This interrupt shares one channel with alarm interrupt. It is used together with INTCON register. At the same time, it provides 4 BUZ signals to driver the buzzer.

Timer T0/T1/T2

SC9308 includes three 8-bit timers Timer0, Timer1 and Timer2. Where, T0 and T1 timers can be together used as 16-bit timer. When T0 or T1 are used separately, their functions are as follows:

- 8-bit programmable timing, generate interrupt after setting the time interval
- Arbitrary frequency output
- External clock frequency division

T0/T1/T2 has one control register and one pre-assignment register.

T2 timer has input capture except for the similar functions as T0/T1. capture signal input are all diplex with PA6 pin.

UART

SC9308 has built-in full duplex async communication interface. Communication port with three modes: 8bit variable baud rate, 9bit fixed baud rate or variable baud rate communication.

- Tx pin diplex with PB4, RX pin diplex with PB5
- Baud rate presetting register can adjust baud rate freely
- Transmitting and receiving interrupt cooperation dual buffer can make sure the high speed communication stable and reduce the CPU load.

8-bit ADC

8-bit AD converter is mainly used for keyboard scan or electronic volume display. It has 4 input channels (PC0/1/4/5). Select a channel and input switch level by program and the result is stored in an 8-bit register. Conversion clock has 4 selectable clock sources. Input internal reference voltage through channel 6 of ADC to detect the battery voltage(together with internal standard voltage). PC4/5 can also be used to extend high frequency oscillator pin, if it is not connected to oscillator, do not effect ADC input channel. Adopt 75KHz clock, one AD conversion needs 12 clock cycles, and the typical conversion time of ADC is 160 μ s.

Frequency counting module

This module mainly includes local oscillator signal amplifier and gate control counting two sections. FM or AM local oscillator signal is counted by a 16-bit counter after amplified. This counter gate control time can select 1/4/8ms, so the local oscillator frequency can be got easily according to the counter value and gate time, then display on LCD according to application requirements.

I/O Port

SC9308 has 5 groups of I/O ports: PA, PB, PC, PE, PF. PA has 8 pins, where 4 pins are used for external interrupt input. PB has 5 pins, where 3 pins are used for key input interrupt. PC has 4 pins which are shared with ADC input channel. PE/PF are shared with SEG segments, and can also be used as common IO, 14 pins in total. So there are max. 31 pins can be used as IO pins.

Ports PA/B configured three registers. Data register PORTx latches the output data, direction register TRISx controls the dataflow direction (set 1 to be output). PUA register and TRISA register can implement input pull-up or output open-drain of port A. PB has only 5 pins, port PC of PUB register is controlled by 3 registers, TRISC realizes direction selection, PORTC stores output data, APCON realizes the switch of analog channel and digital channel.

Register PORTx is readable/writable. When PORTx is set as output, read the last writing data of this register; when it is set as input, read the pin state.

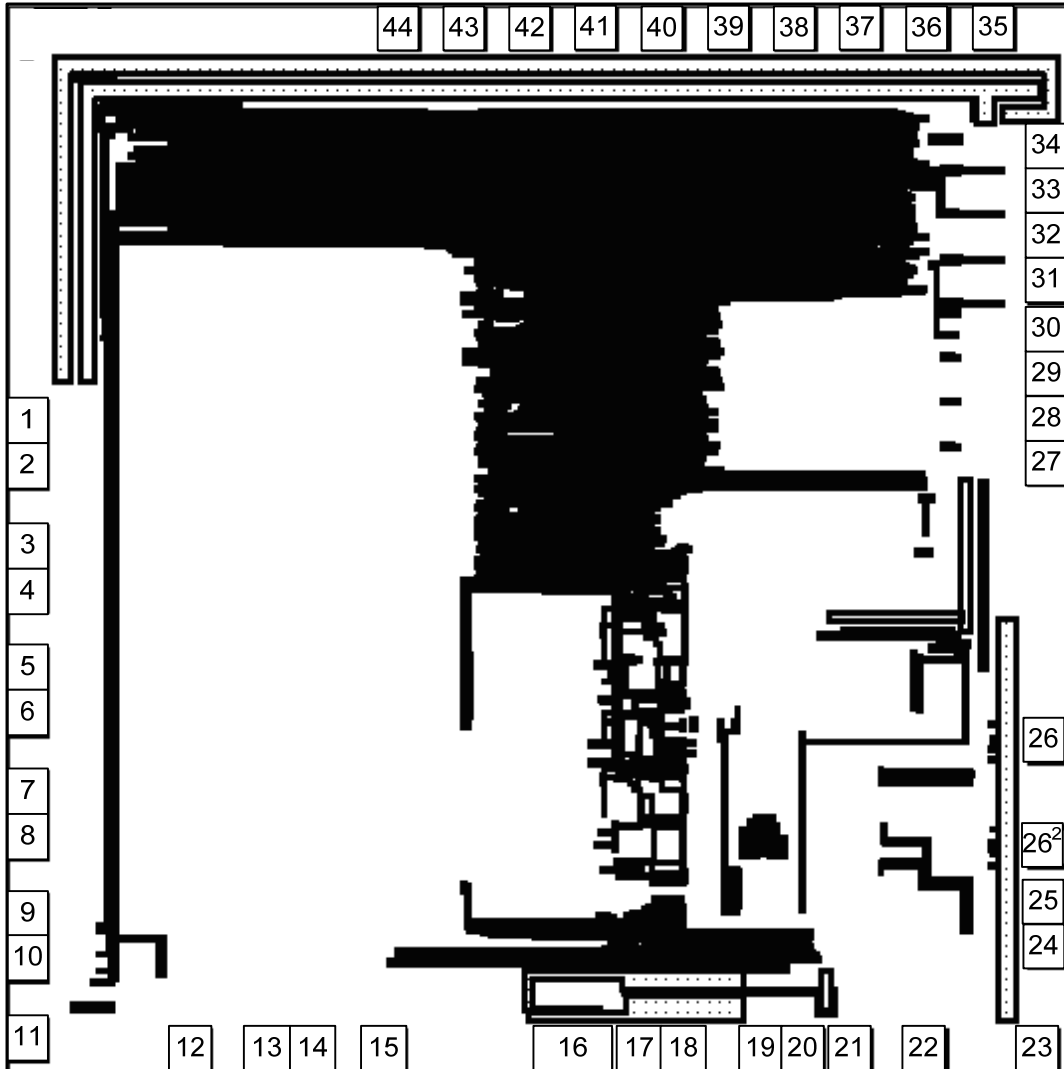
Display Driver

LCD module can drive maximum 14 SEG x 4 COM LCD board. It is mainly composed of the following parts:

- Control circuit
- 8 display data memory registers are all readable/writable
- 14 SEG outputs
- 4 COM outputs

Each SEG can be used as common I/O port.

CHIP TOPOLOGY



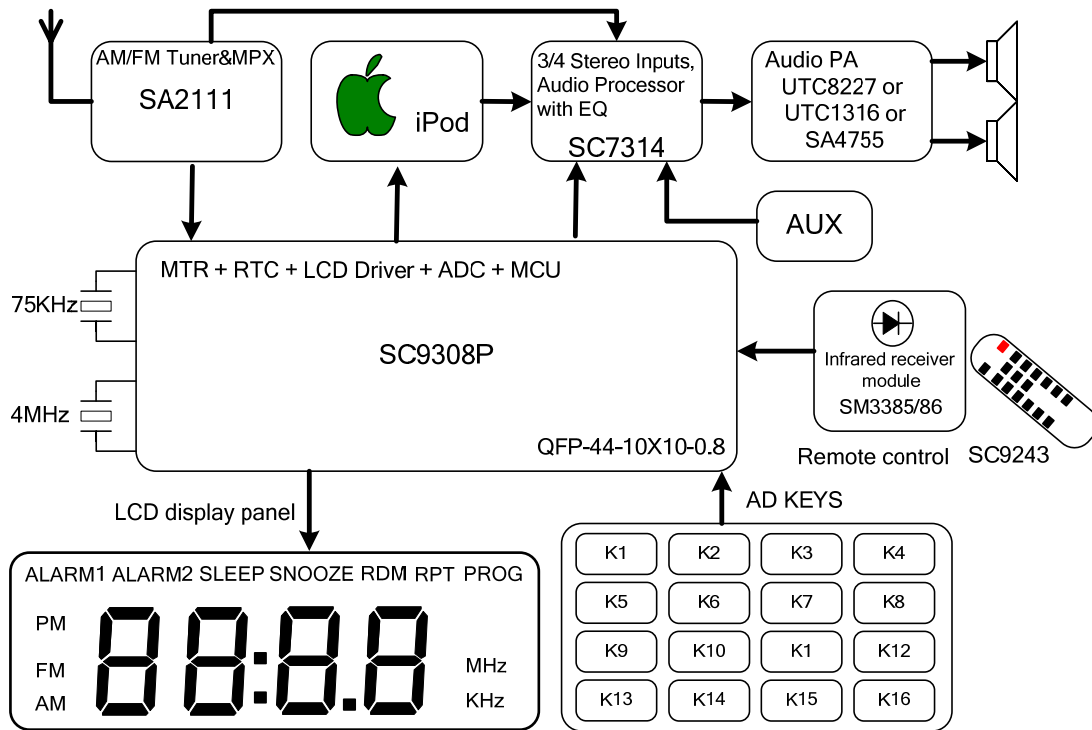
KEY PAD COORDINATE1 (Die size: 2390* 2490 unit: μm)

NO.	Symbol	X axis	Y axis	NO.	Symbol	X axis	Y axis
1	PA0	-1198	261.76	24	FM	1198	-914.25
2	PA1	-1198	161.76	25	AM	1198	-814.25
3	PA2	-1198	-15.2	26 ²	AVSS	1198	-690.65
4	PA3	-1198	-115.2	26	AVSS	1198	-453.45
5	PA4	-1198	-292.16	27	COM0	1198	169.88
6	PA5	-1198	-392.16	28	COM1	1198	269.88
7	PA6	-1198	-596.12	29	COM2	1198	369.88
8	PA7	-1198	-669.12	30	COM3	1198	469.88
9	PB0	-1198	-846.08	31	SEG0	1198	576.32
10	PB1	-1198	-946.08	32	SEG1	1198	676.8
11	PB2	-1198	-1123.04	33	SEG2	1198	777.28
12	PB4	-814.03	-1148	34	SEG3	1198	877.76
13	PB5	-637.07	-1148	35	SEG4	1071.97	1148
14	PC0	-537.07	-1148	36	SEG5	916.58	1148
15	PC1	-360.11	-1148	37	SEG6	761.19	11489
16	RESET	82.82	-1148	38	SEG7	605.8	1148
17	GND	237.82	-1148	39	SEG8	450.41	1148
18	XOUT	337.82	-1148	40	SEG9	295.02	1148
19	XIN	525.04	-1148	41	SEG10	139.63	1148
20	VDD	625.04	-1148	42	SEG11	-15.76	1148
21	PC4	735.04	-1148	43	SEG12	-171.15	1148
22	PC5	912	-1148	44	SEG13	-326.54	1148
23	TEST	1174.36	-1148				

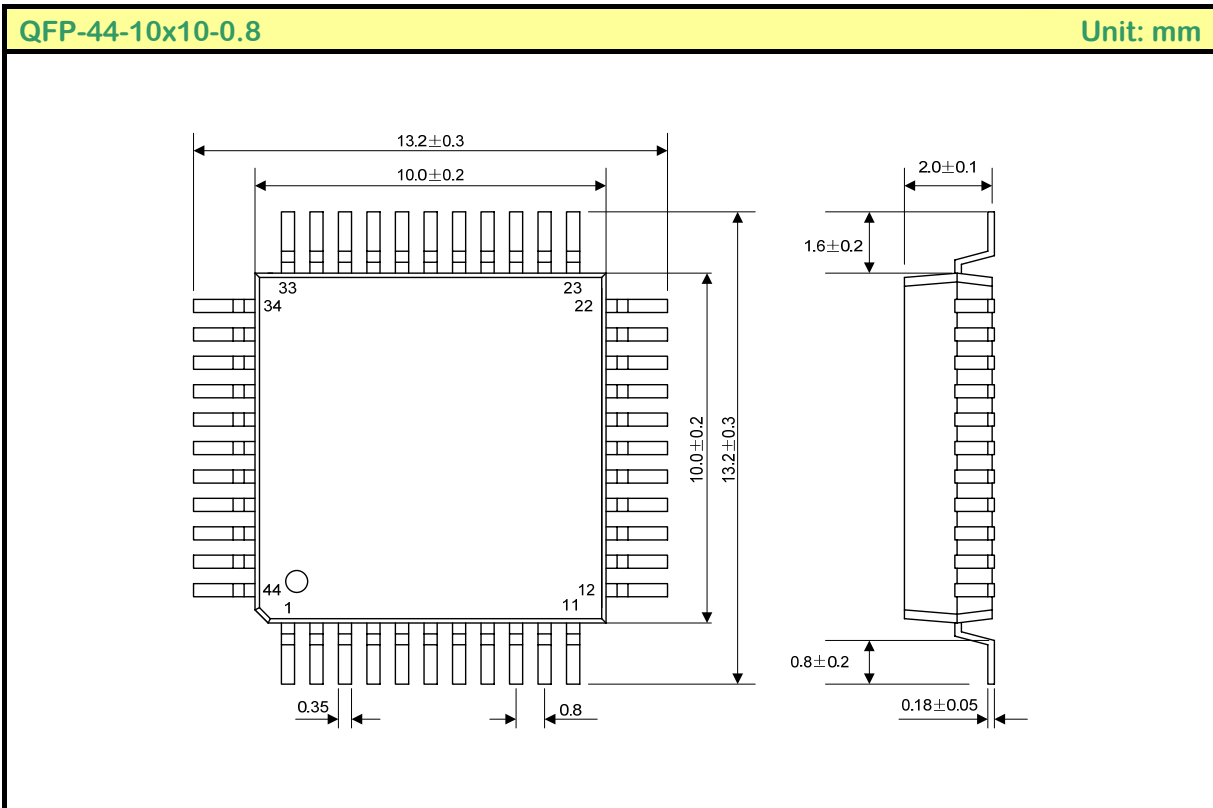
Note 1: The coordinate origin is in the middle of the die.

Note 2: The two pads marked with 26 in above table should be bounding to one pin.

TYPICAL APPLICATION DIAGRAM



PACKAGE OUTLINE



MOS DEVICES OPERATE NOTES:

Electrostatic charges may exist in many things. Please take following preventive measures to prevent effectively the MOS electric circuit as a result of the damage which is caused by discharge:

- The operator must put on wrist strap which should be earthed to against electrostatic.
- Equipment cases should be earthed.
- All tools used during assembly, including soldering tools and solder baths, must be earthed.
- MOS devices should be packed in antistatic/conductive containers for transportation.

Note: Silan reserves the right to make changes without notice in this specification for the improvement of the design and performance.

Silan will supply the best possible product for customers.