TM52M8254/58/64/68

DATA SHEET Rev 0.95

(Please read the precautions on the second page before use)

PRECAUTIONS

1. The system frequency can only run below 8MHz. If the system frequency is selected in FRC, CLKPSC (D8h.1~0) can only be set to divide by 2, 4 or 16 and the option to divide 1 is forbidden.

AMENDMENT HISTORY

Version	Date	Description
V0.90	Aug, 2018	New release.
V0.91	Sep, 2018	1. CRC16 address change 2. zero crossing detector circuit for VPP(P37)
V0.92	Nov, 2018	1. Add MSOP10, TSSOP20 and QFN20 package 2. SFR VBGOUT setting
V0.93	Jan, 2019	1. Added LCD chapter 2. Added INTn pin low level wake up function annotation
V0.94	Apr, 2019	1. Change the operating frequency 2. Update the PWM function description
V0.95	May, 2020	1. Added TKSOC/ADSOC/TKEOC usage restrictions 2. ADC conversion frequency restrictions 3. VBG voltage reference 4. Added LVR power consumption note 5. Package and Dice Information

CONTENTS

TM52 F82xx FAMILY

Common Feature

CPU	MTP/Flash Program memory	RAM bytes	Dual Clock	Operation Mode	Timer0 Timer1 Timer2	UART	Real-time Timer3	LVD	LVR
Fast 8051 (2T)	4K~32K with IAP, ISP, ICP	256 ~ 1024	SXT SRC FXT FRC	Fast Slow Idle Stop	8051 Standard		15-bit	2.7V	2.3V 2.7V 3.5V 4.1V

Note: IAP, ISP only for Flash type program memory

Family Members Features

P/N	Program Memory	RAM Bytes	IO Pin	PWM	SAR ADC	Touch Key	LCD	LED	SPI	Status
TM52-M8254	MTP 4K Bytes	512	18	(8+2)-bit x2	12-bit 12-ch	–	4com	–	–	–
TM52-M8258						15-ch				
TM52-M8264	MTP 8K Bytes	512	18	(8+2)-bit x2	12-bit 12-ch	–	4com	–	–	–
TM52-M8268						15-ch				

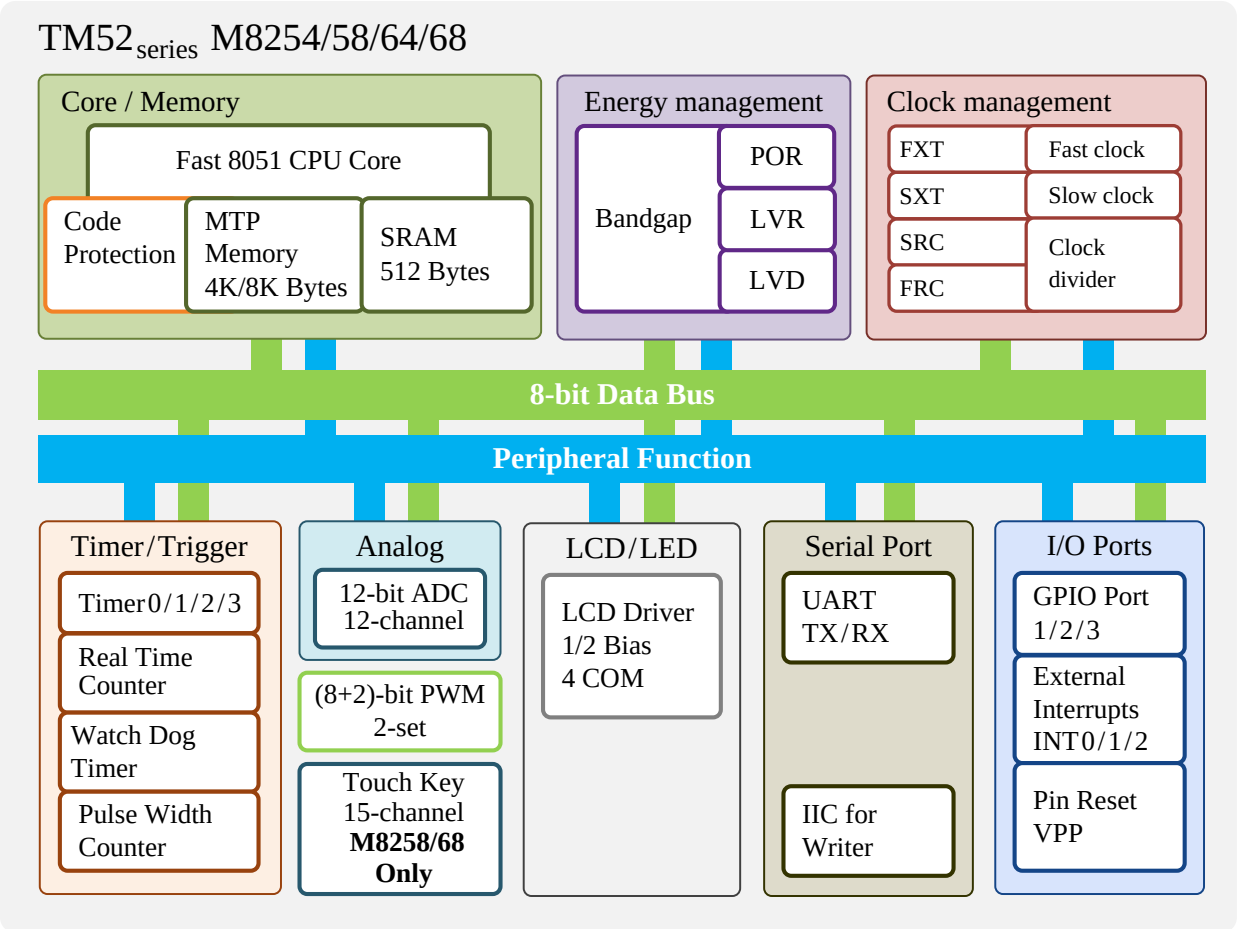
P/N	Operation Voltage	Operation Current				Max. System Clock (Hz)			
		Fast FRC	Slow SRC	Idle SRC	Stop	SXT	SRC	FXT	FRC
TM52-M8254	2.3~5.5V	4.0mA	1.3mA	18μA	0.1μA	32K	68K	6M	12.28M/2
TM52-M8258									
TM52-M8264	2.3~5.5V	4.0mA	1.3mA	18μA	0.1μA	32K	68K	6M	12.28M/2
TM52-M8268									

GENERAL DESCRIPTION

TM52 series M8254/58/64/68 are versions of a new, fast 8051 architecture for an 8-bit microcontroller single chip with an instruction set fully compatible with industry standard 8051, and retains most 8051 peripheral's functional block. Typically, the **TM52** executes instructions six times faster than the standard 8051 architecture.

The **TM52-M8254/58/64/68** provides improved performance, lower cost and fast time-to-market by integrating features on the chip, including 4K/8K Bytes MTP program memory, 512 Bytes SRAM, Low Voltage Reset (LVR), Low Voltage Detector (LVD), dual clock power saving operation mode, 8051 standard UART and Timer0/1/2, real time clock Timer3, 2 set (8+2)-bit PWMs, 10 channels 12-bit A/D Convertor, 15 channels Touch Key (M8258/68 only) and Watch Dog Timer. It's a high reliability and low power consumption feature can be widely applied in consumer and home appliance products.

BLOCK DIAGRAM



Note: 4K Bytes MTP program memory (TM52M8254/58)
8K Bytes MTP program memory (TM52M8264/68)

FEATURES

1. **Standard 8051 Instruction set, fast machine cycle**
   - Executes instructions six times faster than the standard 8051.
2. **MTP Program Memory**
   - 4K Bytes (TM52M8254/58)
   - 8K Bytes (TM52M8264/68)
   - Support "In Circuit Programming" (ICP) for the MTP code
   - Code Protection Capability
3. **Total 512 Bytes SRAM (IRAM + XRAM)**
   - 256 Bytes IRAM in the 8051 internal data memory area
   - 256 Bytes XRAM in the 8051 external data memory area (accessed by MOVX Instruction)
4. **Four System Clock type selections**
   - Fast clock from 1~6MHz Crystal (FXT)
   - Fast clock from Internal RC (FRC/2, 12.288 MHz/2)
   - Slow clock from 32768Hz Crystal (SXT)
   - Slow clock from Internal RC (SRC, 68 KHz)
   - System Clock can be divided by 1/2/4/16 option
5. **8051 Standard Timer – Timer0/1/2**
   - 16-bit Timer0, also supports T0O clock output for Buzzer application
   - 16-bit Timer1
   - 16-bit Timer2, also supports T2O clock output for Buzzer application
6. **15-bit Timer3**
   - Clock source is Slow clock
   - Interrupt period can be clock divided by 32768/16384/8192/128 option
7. **8051 Standard UART**
   - Support One Wire UART mode
8. **Two independent "8+2" bits PWMs with prescaler/ period-adjustment**
9. **15-Channel Touch Key (M8258/68 only)**
10. **12-bit ADC with 10 channels External Pin Input and 2 channels Internal Reference Voltage**
    - Internal Reference Voltage (VBG): 1.25V±1%@5V~3V, 25℃
    - Internal Reference Voltage (VSS): 0V
11. **LCD Driver**
    - 1~1/4 Duty
    - 1/2 Bias
    - Max. 4 COM

12. 10 Sources, 4-level priority Interrupt

- Timer0/Timer1/Timer2/Timer3 Interrupt
- INT0/INT1 pin Falling-Edge/Low-Level Interrupt
- P3.7 (INT2) pin Interrupt
- Port1 Pin Change Interrupt
- UART TX/RX Interrupt
- ADC/Touch Key Interrupt

13. Pin Interrupt can Wake up CPU from Power-Down (Stop) mode

- P3.2/P3.3 (INT0/INT1) Interrupt & Wake-up
- P3.7 (INT2) Interrupt & Wake-up
- Each Port1 pin can be defined as Interrupt & Wake-up pin (by pin change)

14. Max. 18 Programmable I/O pins

- CMOS Output
- Pseudo-Open-Drain, or Open-Drain Output
- Schmitt Trigger Input
- Pin Pull-up can be Enabled or Disabled
- Each Port1 pin can be defined as Interrupt & Wake-up pin (by pin change)

15. Independent RC Oscillating Watch Dog Timer

- 480ms/240ms/120ms/60ms selectable WDT timeout options

16. Five types Reset

- Power on Reset
- Selectable External Pin Reset
- Selectable Watch Dog Reset
- Software Command Reset
- Selectable Low Voltage Reset

17. 4-level Low Voltage Reset

- 2.3V/2.7V/3.5V/4.1V

18. 1-level Low Voltage Detect

- 2.7V (can be disabled)

19. Four Power Operation Modes

- Fast/Slow/Idle/Stop mode

20. On-chip Debug/ICE interface

- This device is not support ICE mode, it needs to be developed by EV Board and development tool

21. Operating Voltage

- V_{CC}=2.7V ~ 5.5V @F_{SYSCLK}=6.144 MHz
- V_{CC}=2.3V ~ 5.5V @F_{SYSCLK}=3.072 MHz

Note: LVR 2.3V cannot cover the operating frequency of 6.144 MHz at high temperatures. It is recommended to use LVR 2.7V@F_{SYSCLK}=6.144 MHz.

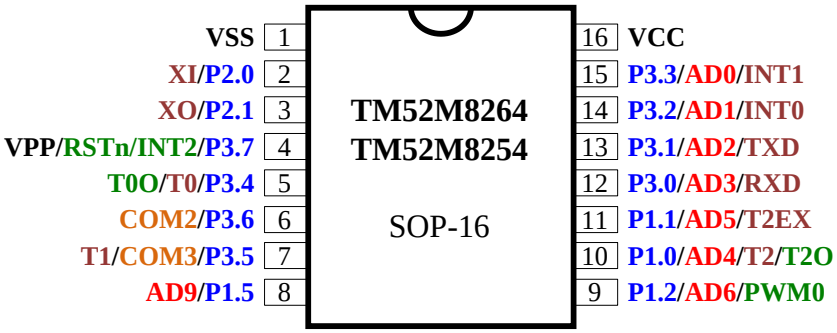
22. Operating Temperature Range

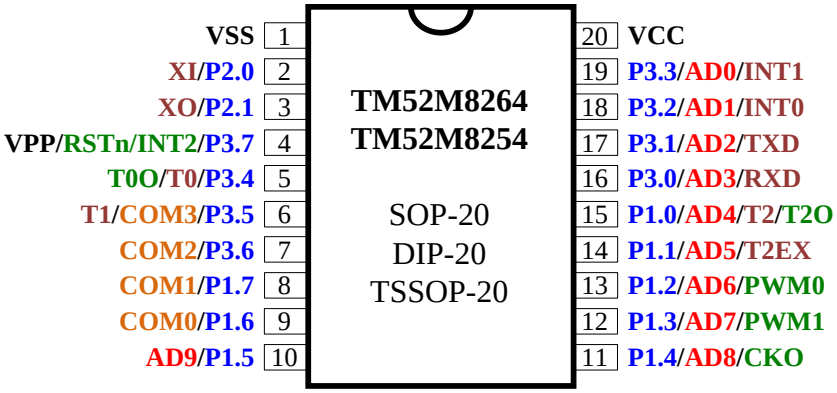
- –40℃ ~ +85℃

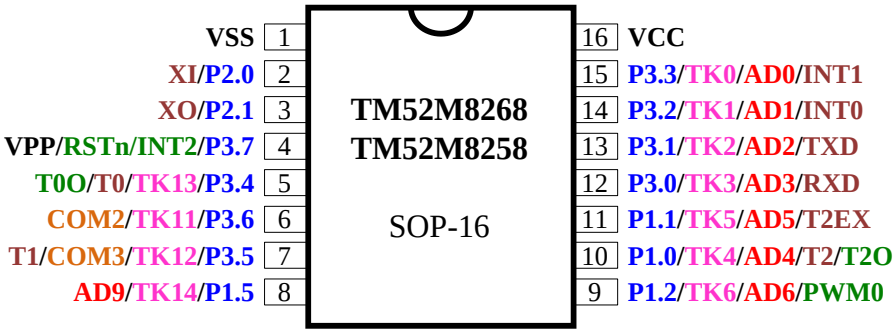
23. Package Types

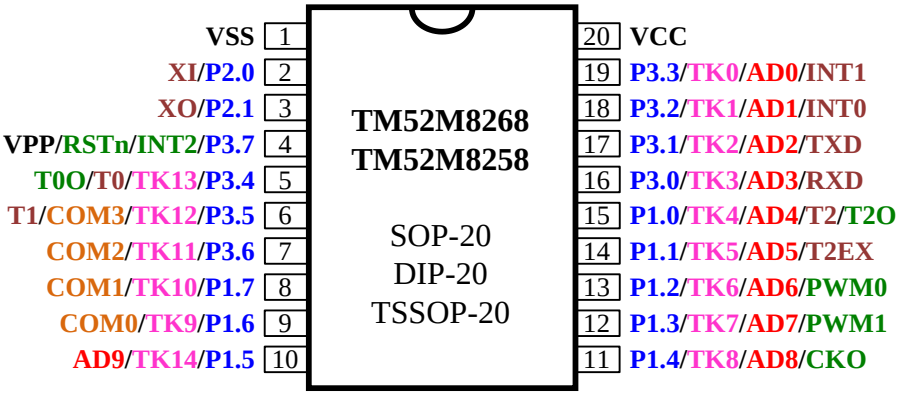
- 16 pin SOP
- 20 pin SOP
- 20 pin DIP
- 10 pin MSOP
- 20 pin TSSOP
- 20 pin QFN

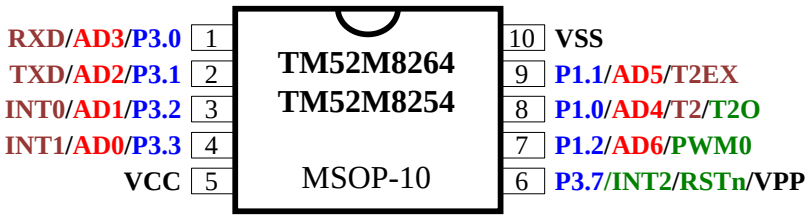
PIN ASSIGNMENT

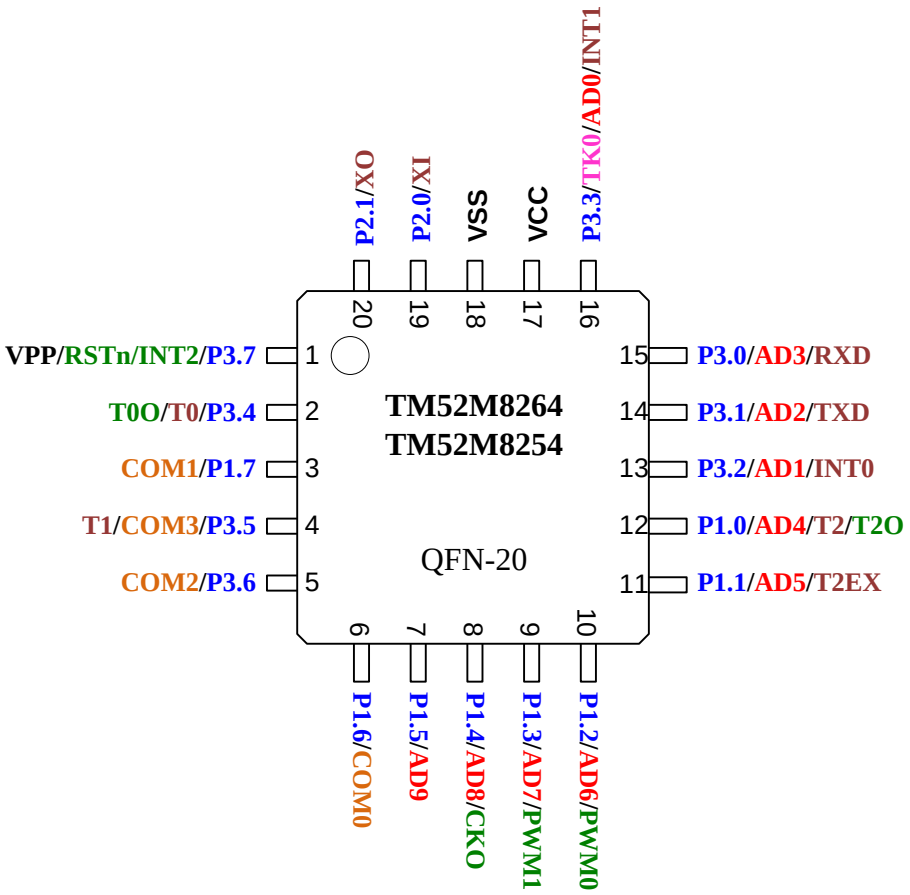




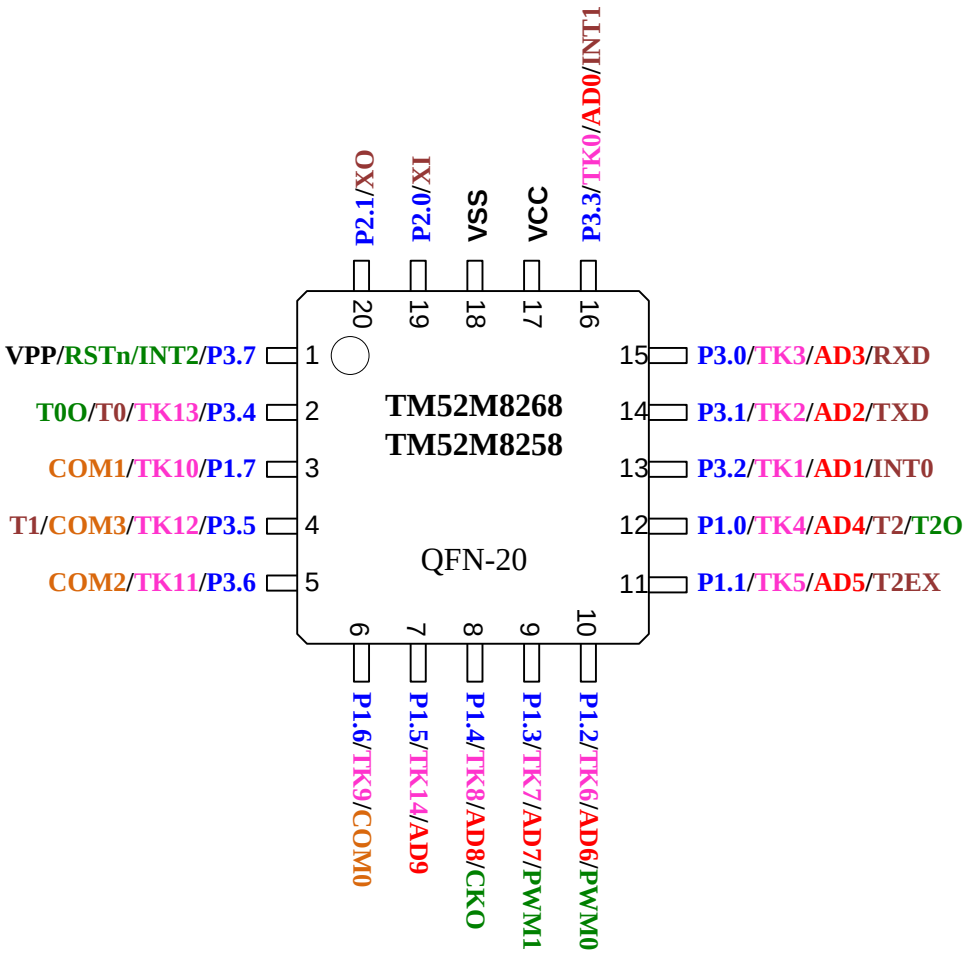





RXD/AD3/P3.0 1
TXD/AD2/P3.1 2
INT0/AD1/P3.2 3
INT1/AD0/P3.3 4
VCC 5
TM52M8264
TM52M8254
MSOP-10
10 VSS
9 P1.1/AD5/T2EX
8 P1.0/AD4/T2/T2O
7 P1.2/AD6/PWM0
6 P3.7/INT2/RSTn/VPP


P2.1/XO 20
P2.0/XI 19
VSS 18
VCC 17
P3.3/TK0/AD0/INT1 16
VPP/RSTn/INT2/P3.7 1
T0O/T0/P3.4 2
COM1/P1.7 3
T1/COM3/P3.5 4
COM2/P3.6 5
TM52M8264
TM52M8254
QFN-20
15 P3.0/AD3/RXD
14 P3.1/AD2/TXD
13 P3.2/AD1/INT0
12 P1.0/AD4/T2/T2O
11 P1.1/AD5/T2EX
6 P1.6/COM0
7 P1.5/AD9
8 P1.4/AD8/CKO
9 P1.3/AD7/PWM1
10 P1.2/AD6/PWM0


RXD/AD3/TK3/P3.0 1
TXD/AD2/TK2/P3.1 2
INT0/AD1/TK1/P3.2 3
INT1/AD0/TK0/P3.3 4
VCC 5
TM52M8268
TM52M8258
MSOP-10
10 VSS
9 P1.1/TK5/AD5/T2EX
8 P1.0/TK4/AD4/T2/T2O
7 P1.2/TK6/AD6/PWM0
6 P3.7/INT2/RSTn/VPP


P2.1/XO
P2.0/XI
VSS
VCC
P3.3/TK0/AD0/INT1
20
19
18
17
16
VPP/RSTn/INT2/P3.7 1
T0O/T0/TK13/P3.4 2
COM1/TK10/P1.7 3
T1/COM3/TK12/P3.5 4
COM2/TK11/P3.6 5
TM52M8268
TM52M8258
QFN-20
15 P3.0/TK3/AD3/RXD
14 P3.1/TK2/AD2/TXD
13 P3.2/TK1/AD1/INT0
12 P1.0/TK4/AD4/T2/T2O
11 P1.1/TK5/AD5/T2EX
6
7
8
9
10
P1.6/TK9/COM0
P1.5/TK14/AD9
P1.4/TK8/AD8/CKO
P1.3/TK7/AD7/PWM1
P1.2/TK6/AD6/PWM0

PIN DESCRIPTION

Name	In/Out	Pin Description
P1.0~P1.7	I/O	Bit-programmable I/O port for Schmitt-trigger input, CMOS push-pull output or "open-drain" output. Pull-up resistors are assignable by software. These pin's level change can interrupt/wake up CPU from Idle/Stop mode.
P3.0~P3.2	I/O	Bit-programmable I/O port for Schmitt-trigger input, CMOS push-pull output or "**pseudo open drain**" output. Pull-up resistors are assignable by software.
P3.3~P3.6 P2.0~P2.1	I/O	Bit-programmable I/O port for Schmitt-trigger input, CMOS push-pull output or "open-drain" output. Pull-up resistors are assignable by software.
P3.7	I/O	Bit-programmable I/O port for Schmitt-trigger input or "open-drain" output.
INT0, INT1	I	External low level or falling edge Interrupt input, Idle/Stop mode wake up input.
INT2	I	External falling edge Interrupt input, Idle/Stop mode wake up input.
RXD	I/O	UART Mode0 transmit & receive data, Mode1/2/3 receive data
TXD	I/O	UART Mode0 transmit clock, Mode1/2/3 transmit data. In One Wire UART mode, this pin transmits and receives serial data.
T0, T1, T2	I	Timer0, Timer1, Timer2 event count pin input.
T2EX	I	Timer2 external trigger input.
T0O	O	Timer0 overflow divided by 64 output
T2O	O	Timer2 overflow divided by 2 output
CKO	O	System Clock divided by 2 output
PWM0, PWM1	O	8+2 bit PWM output
AD0~AD9	I	ADC input
TK0~TK14	I	Touch Key input (M8258/68 only)
COM0~COM3	O	LCD 1/2 bias output
RSTn	I	External active low reset input, Pull-up resistor is fixed enable.
XI, XO	–	Crystal/Resonator oscillator connection for System clock (FXT or SXT)
VPP	I	MTP memory programming high voltage input
VCC, VSS	P	Power input pin and ground

PIN SUMMERY

Pin #		Pin Name	Type	Input			Output			Alternative Function					
SOP-20	SOP-16			Pull-up Control	Wake up	Ext. Interrupt	CMOS P.P.	P.O.D.	O.D.	ADC	Touch Key	UART	PWM	Timer	Others
1	1	**VSS**	P												
2	2	**XI/P2.0**	I/O	⭘			●		●						Crystal
3	3	**XO/P2.1**	I/O	⭘			●		●						Crystal
4	4	**VPP/RSTn/INT2/P3.7**	I/O	⊙	●	●			●						Reset, VPP
5	5	**T0O/T0/TK13/P3.4**	I/O	⭘			●		●		●			●	
6	7	**T1/COM3/TK12/P3.5**	I/O	⭘			●		●		●			●	COM
7	6	**COM2/TK11/P3.6**	I/O	⭘			●		●		●				COM
8	–	**COM1/TK10/P1.7**	I/O	⭘	●		●		●		●				COM
9	–	**COM0/TK9/P1.6**	I/O	⭘	●		●		●		●				COM
10	8	**AD9/ TK14/P1.5**	I/O	⭘	●		●		●	●	●				
11	–	**CKO/AD8/TK8/P1.4**	I/O	⭘	●		●		●	●	●				
12	–	**PWM1/AD7/TK7/P1.3**	I/O	⭘	●		●		●	●	●		●		
13	9	**PWM0/AD6/TK6/P1.2**	I/O	⭘	●		●		●	●	●		●		
14	11	**T2EX/AD5/TK5/P1.1**	I/O	⭘	●		●		●	●	●			●	
15	10	**T2O/T2/AD4/TK4/P1.0**	I/O	⭘	●		●		●	●	●			●	
16	12	**RXD/AD3/TK3/P3.0**	I/O	⭘			●	●		●	●	●			
17	13	**TXD/AD2/TK2/P3.1**	I/O	⭘			●	●		●	●	●			
18	14	**INT0/AD1/TK1/P3.2**	I/O	⭘	●	●	●	●		●	●				
19	15	**INT1/AD0/TK0/P3.3**	I/O	⭘	●	●	●		●	●	●				
20	16	**VCC**	P												

Symbol:

P.P. = Push-Pull
O.D. = Open Drain
P.O.D. = Pseudo Open Drain

PS:

1. ⊙ P3.7 Pull-up resistor can only be pulled up to approximately 0.6VDD
2. ⭘ Port1, P2.0, P2.1, Port3 these pins control Pull up resistor by operation modes

FUNCTIONAL DESCRIPTION

1. CPU Core

In the 8051 architecture, the C programming language is used as a development platform. The TM52 device features a fast 8051 core in a highly integrated microcontroller, allowing designers to be able to achieve improved performance compared to a classic 8051 device. TM52 series microcontrollers provide a complete binary code with standard 8051 instruction set compatibility, ensuring an easy migration path to accelerate the development speed of system products. The CPU core includes an ALU, a program status word (PSW), an accumulator (ACC), a B register, a stack point (SP), DPTRs, a program counter, an instruction decoder, and core special function registers (SFRs).

1.1 Accumulator (ACC)

This register provides one of the operands for most ALU operations. Accumulators are generally referred to as A or Acc and sometimes referred to as Register A. In this document, the accumulator is represented as “A” or “ACC” including the instruction table. The accumulator, as its name suggests, is used as a general register to accumulate the intermediate results of a large number of instructions. The accumulator is the most important and frequently used register to complete arithmetic and logical operations. It holds the intermediate results of most arithmetic and logic operations and assists in data transportation.

SFR **E0h**	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
ACC	ACC.7	ACC.6	ACC.5	ACC.4	ACC.3	ACC.2	ACC.1	ACC.0
R/W	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

E0h.7~0 **ACC:** Accumulator

1.2 B Register (B)

The “B” register is very similar to the ACC and may hold a 1 Byte value. This register provides the second operand for multiply or divide instructions. Otherwise, it may be used as a scratch pad register. The B register is only used by two 8051 instructions, MUL and DIV. When A is to be multiplied or divided by another number, the other number is stored in B. For MUL and DIV instructions, it is necessary that the two operands are in A and B.

SFR **F0h**	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
B	B.7	B.6	B.5	B.4	B.3	B.2	B.1	B.0
R/W	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

F0h.7~0 **B:** B register

1.3 Stack Pointer (SP)

The SP register contains the Stack Pointer. The Stack Pointer is used to load the program counter into memory during LCALL and ACALL instructions and is used to retrieve the program counter from memory in RET and RETI instructions. The stack may also be saved or loaded using PUSH and POP instructions, which also increment and decrement the Stack Pointer.

SFR **81h**	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
SP	SP							
R/W	R/W							
Reset	0	0	0	0	0	1	1	1

81h.7~0 **SP:** Stack Point

1.4 Dual Data Pointer (DPTRs)

TM52 device has two DPTRs, which share the same SFR address. Each DPTR is 16 bits in size and consists of two registers: the DPTR high byte (DPH) and the DPTR low byte (DPL). The DPTR is used for 16-bit-address external memory accesses, for offset code byte fetches, and for offset program jumps. Setting the DPSEL control bit allows the program code to switch between the two physical DPTRs.

SFR **82h**	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
DPL	DPL							
R/W	R/W							
Reset	0	0	0	0	0	0	0	0

82h.7~0 **DPL:** Data Point low byte

SFR **83h**	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
DPH	DPH							
R/W	R/W							
Reset	0	0	0	0	0	0	0	0

83h.7~0 **DPH:** Data Point high byte

SFR **F8h**	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
AUX1	CLRWDT	CLRTM3	TKSOC	ADSOC	CLRPWM0	T2SEL	T1SEL	DPSEL
R/W	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

F8h.0 **DPSEL:** Active DPTR Select

1.5 Program Status Word (PSW)

This register contains status information resulting from CPU and ALU operations. The instructions that affect the PSW are listed below.

Instruction	**Flag**		
	C	**OV**	**AC**
ADD	X	X	X
ADDC	X	X	X
SUBB	X	X	X
MUL	0	X	
DIV	0	X	
DA	X		
RRC	X		
RLC	X		
SETB C	1		

Instruction	**Flag**		
	C	**OV**	**AC**
CLR C	0		
CPL C	X		
ANL C, bit	X		
ANL C, /bit	X		
ORL C, bit	X		
ORL C, /bit	X		
MOV C, bit	X		
CJNE	X		

A “0” means the flag is always cleared, a “1” means the flag is always set and an “X” means that the state of the flag depends on the result of the operation.

SFR **D0h**	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
PSW	CY	AC	F0	RS1	RS0	OV	F1	P
R/W	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

D0h.7 **CY:** ALU carry flag

D0h.6 **AC:** ALU auxiliary carry flag

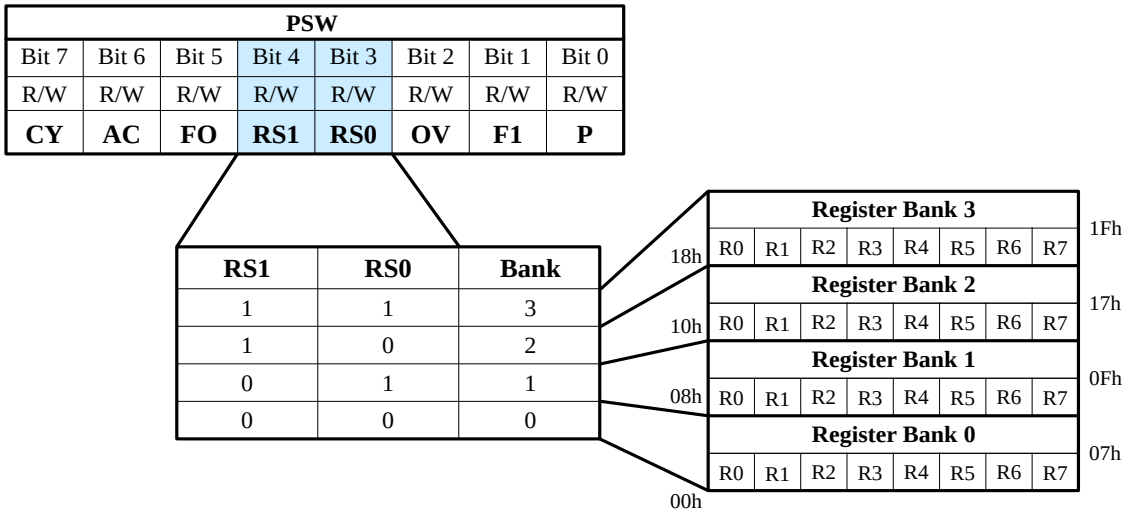
D0h.5 **F0:** General purpose user-definable flag

D0h.4~3 **RS1, RS0:** The contents of (RS1, RS0) enable the working register banks as:
00: Bank 0 (00h~07h)
01: Bank 1 (08h~0Fh)
10: Bank 2 (10h~17h)
11: Bank 3 (18h~1Fh)

D0h.2 **OV:** ALU overflow flag

D0h.1 **F1:** General purpose user-definable flag

D0h.0 **P:** Parity flag. Set/cleared by hardware each instruction cycle to indicate odd/even number of “one” bits in the accumulator.



2. Memory

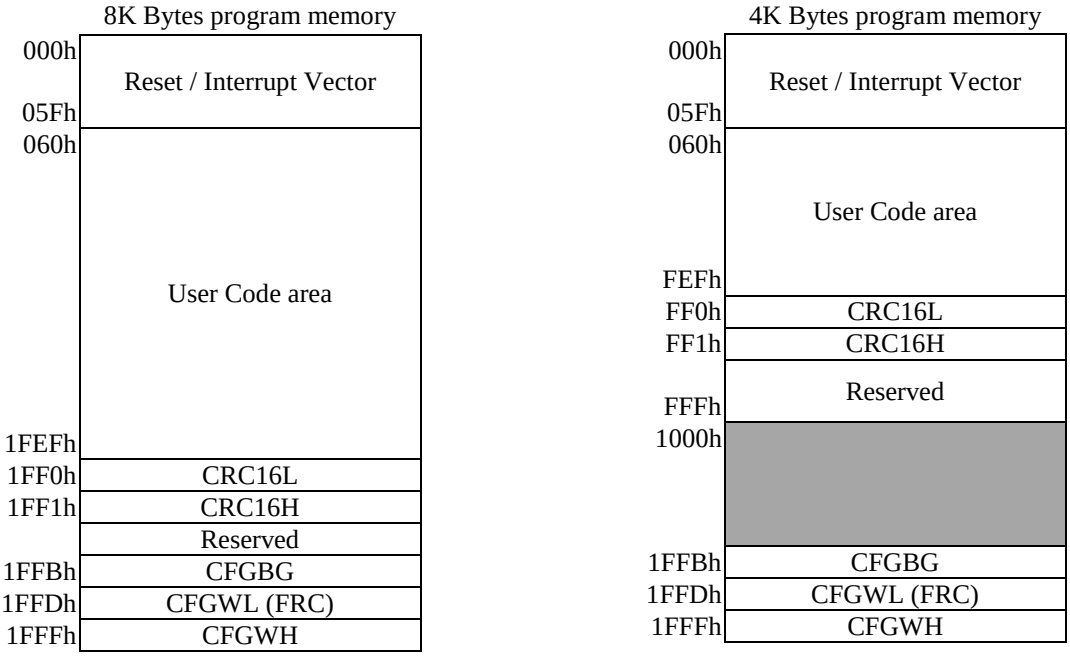
2.1 Program Memory

The Chip has an 8K Bytes MTP program memory for TM52M8264/68, and a 4K Bytes MTP program memory for TM52M8254/58 which can support In Circuit Programming (ICP) mode. The MTP program memory address continuous space (0000h~1FFFh) is partitioned to several sectors for device operation.

2.1.1 Program Memory Functional Partition

The last 6 bytes (1FFAh~1FFFh) of program memory is defined as chip Configuration Word (CFGW), which is loaded into the device control registers upon power on reset (POR). The 0000h~005Fh is occupied by Reset/Interrupt vectors as standard 8051 definition.

CRC16H/L is the reserved area of the checksum. Tenx can provide a CRC verification subroutine. The user can calculate the checksum by the CRC verification subroutine to compare with CRC16H/L and check the validity of the ROM code.



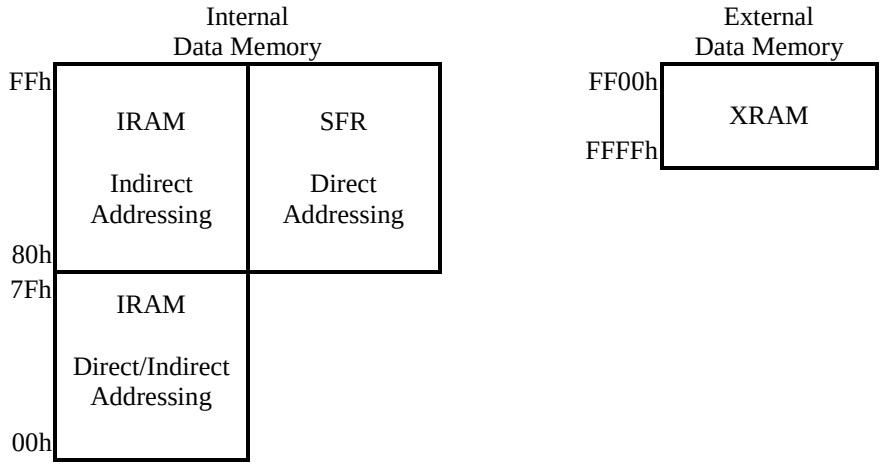
2.1.2 MTP ICP Mode

The MTP memory can be programmed by the tenx proprietary writer **(TWR98/TWR99)**, which needs at least five wires (VCC, VSS, VPP, P3.0 and P3.1) to connect to this chip. If user wants to program the MTP memory on the target circuit board (In Circuit Program, ICP), these pins must be reserved sufficient freedom to be connected to the Writer. Beside 5-Wire mode, the Writer also provide 6-Wire and 7-Wire mode for programming efficiency and speed.

Writer wire number	Pin connection
5-Wire	VCC, VSS, VPP, P3.0, P3.1
6-Wire	VCC, VSS, VPP, P3.0, P3.1, P3.3
7-Wire	VCC, VSS, VPP, P3.0, P3.1, P3.3, P1.2 ***Note:*** P3.2 output FRC/8

2.2 Data Memory

As the standard 8051, the Chip has both Internal and External Data Memory space. The Internal Data Memory space consists of 256 Bytes IRAM and 58 SFRs, which are accessible through a rich instruction set. The External Data Memory space consists of 256 Bytes XRAM, which can be only accessed by MOVX instruction.



2.2.1 IRAM

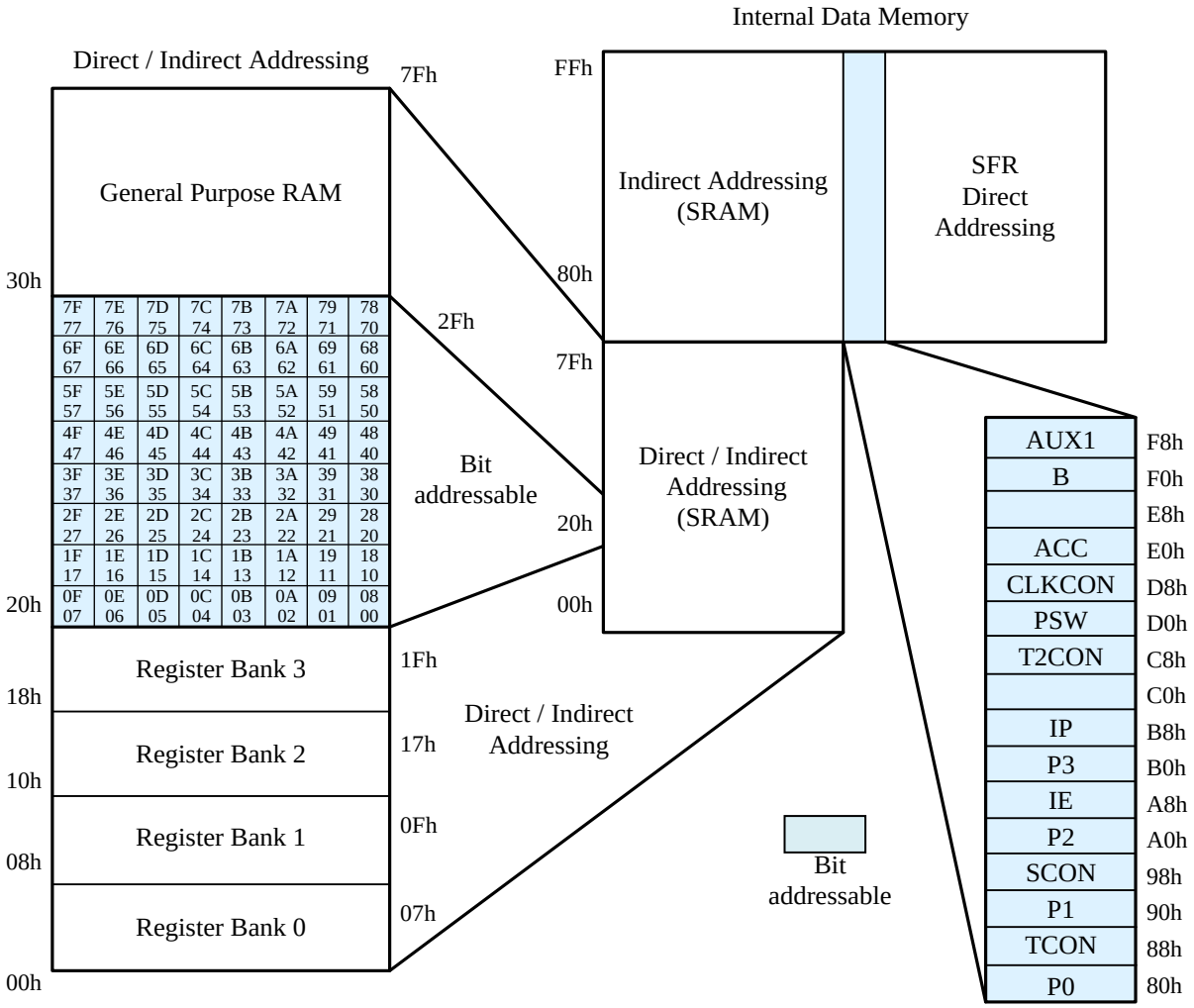
IRAM is located in the 8051 internal data memory space. The whole 256 Bytes IRAM are accessible using indirect addressing but only the lower 128 Bytes are accessible using direct addressing. There are four directly addressable register banks (switching by PSW), which occupy IRAM space from 00h to 1Fh. The address 20h to 2Fh 16 Bytes IRAM space is bit-addressable. IRAM can be used as scratch pad registers or program stack.

2.2.2 XRAM

XRAM is located in the 8051 external data memory space (address from FF00h to FFFFh). The 256 Bytes XRAM can be only accessed by “MOVX” instruction.

2.2.3 SFRs

All peripheral functional modules such as I/O ports, Timers and UART operations for the chip are accessed via Special Function Registers (SFRs). These registers occupy upper 128 Bytes of direct Data Memory space locations in the range 80h to FFh. There are 14 bit-addressable SFRs (which means that eight individual bits inside a single byte are addressable), such as ACC, B register, PSW, TCON, SCON, and others. The remaining SFRs are only byte addressable. SFRs provide control and data exchange with the resources and peripherals of the Chip. The TM52 series of microcontrollers provides complete binary code with standard 8051 instruction set compatibility. Beside the standard 8051 SFRs, the Chip implements additional SFRs used to configure and access subsystems such as the ADC/LCD, which are unique to the Chip.



	8/0	9/1	A/2	B/3	C/4	D/5	E/6	F/7
F8h	AUX1							
F0h	B					CFGBG	CFGWL	AUX2
E8h								
E0h	ACC							
D8h	CLKCON							
D0h	PSW							
C8h	T2CON		RCP2L	RCP2H	TL2	TH2		
C0h								
B8h	IP	IPH	IP1	IP1H				
B0h	P3				TKTMRL	TKTKRH		
A8h	IE	INTE1	ADTKDT	ADCDH	TKDL	TKCON	CHSEL	
A0h	P2	PWMCON	P1MODL	P1MODH	P3MODL	P3MODH	PINMOD	
98h	SCON	SBUF	PWM0PRD	PWM0DH	PWM1PRD	PWM1DH		
90h	P1		COMOE	P2MOD	OPTION	INTFLG	P1WKUP	SWCMD
88h	TCON	TMOD	TL0	TL1	TH0	TH1		
80h	P0	SP	DPL	DPH				PCON

3. LVR and LVD setting

The Chip offers LVR and Low Voltage Detection (LVD) functions. The LVR can be selected by CFGWH as 4.1V, 3.5V, 2.7V, 2.3V. The 2.7V LVD flag is only available when LVR set to 2.3V. The SFR PWRSAV bits also affect LVR/LVD function as tables below.

Operation Mode	SFR PWRSAV	CFGWH LVRE	LVR	LVD 2.7V	Function	Note
Fast Slow	X	00	ON	–	LV Reset 3.5V	
	X	01	ON	–	LV Reset 2.7V	
	X	10	ON	–	LV Reset 4.1V	
	X	11	ON	ON	LV Reset 2.3V	
Idle	0	00	ON	–	LV Reset 3.5V	
	0	01	ON	–	LV Reset 2.7V	
	0	10	ON	–	LV Reset 4.1V	
	0	11	ON	–	LV Reset 2.3V	
	1	00	ON	–	LV Reset 2.3V	
	1	01	ON	–	LV Reset 2.3V	
	1	10	ON	–	LV Reset 2.3V	
	1	11	ON	–	LV Reset 2.3V	
Stop	0	00	ON	–	LV Reset 3.5V	Power consumption about 120uA
	0	01	ON	–	LV Reset 2.7V	
	0	10	ON	–	LV Reset 4.1V	
	0	11	OFF	–	LV Disable	Minimum Power consumption
	1	00	OFF	–	LV Disable	
	1	01	OFF	–	LV Disable	
	1	10	OFF	–	LV Disable	
	1	11	OFF	–	LV Disable	

LVR and LVD function

SFR **F7h**	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
AUX2	WDTE		PWRSAV	VBGOUT	–	–	–	–
R/W	R/W	R/W	R/W	R/W	–	–	–	–
Reset	0	0	0	0	–	–	–	–

F7h.5 Set 1 to reduce the chip's power consumption at Idle and Stop Mode

Flash **1FFFh**	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
CFGWH	PROT	XRSTE	LVRE		–	–	–	–

1FFFh.5~4 **LVRE:** Low Voltage Reset function select
00: Set LVR at 3.5V
01: Set LVR at 2.7V
10: Set LVR at 4.1V
11: Set LVR at 2.3V and LVD at 2.7V

4. Reset

The Chip has five types of reset methods. Resets can be caused by Power on Reset (POR), External Pin Reset (XRST), Software Command Reset (SWRST), Watchdog Timer Reset (WDTR), or Low Voltage Reset (LVR). The CFGWH controls the Reset functionality. The SFRs are returned to their default value after Reset.

4.1 Power on Reset

After Power on Reset, the device stays on Reset state for 40 ms as chip warm up time, then downloads the CFGW register from ROM's last six bytes. The Power on Reset needs VCC pin's voltage first discharge to near VSS level, then rise beyond 2.5V.

4.2 External Pin Reset

External Pin Reset is active low. It needs to keep at least 2 SRC clock cycle long to be seen by the Chip. External Pin Reset can be disabled or enabled by CFGW.

4.3 Software Command Reset

Software Reset is activated by writing the SFR 97h with data 56h.

4.4 Watchdog Timer Reset

WDT overflow Reset is disabled or enabled by SFR F7h. The WDT uses SRC as its counting time base. It runs in Fast/Slow mode and runs or stops in Idle/Stop mode. WDT overflow speed can be defined by WDTPSC SFR. WDT is cleared by device Reset or CLRWDT SFR bit.

4.5 Low Voltage Reset

The Chip offers four options for LVR and Low Voltage Detection (LVD) functions. The user can make a selection by CFGWH, let LVR voltages of 4.1V, 3.5V, 2.7V and 2.3V be selected separately, and let LVD be 2.7V only. If the LVR is selected as 2.3V, the 2.7V LVD flag is available for LVD. If LVR is selected as 2.7V, 3.5V or 4.1V, the LVD flag cannot be used.

System Clock frequency	6.144MHz	3.072MHz	SRC
Minimum LVR level	LVR=2.7V	LVR=2.3V	LVR=2.3V

LVR setting table

Note: LVR must be enable, also refer to AP-TM52XXXXX_02S for LVR setting information

Flash **1FFFh**	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
CFGWH	PROT	XRSTE	LVRE		–	–	–	–

1FFFh.6 **XRSTE:** External Pin Reset control
0: Disable External Pin Reset
1: Enable External Pin Reset

1FFFh.5~4 **LVRE:** Low Voltage Reset function select
00: Set LVR at 3.5V
01: Set LVR at 2.7V
10: Set LVR at 4.1V
11: Set LVR at 2.3V and LVD at 2.7V

SFR **94h**	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
OPTION	UART1W	TKFJMP	WDTPSC		ADCKS		TM3PSC	
R/W	R/W	R/W	R/W		R/W		R/W	
Reset	0	0	0	0	0	0	0	0

94h.5~4 **WDTPSC:** Watchdog Timer pre-scalar time select
00: 480ms WDT overflow rate
01: 240ms WDT overflow rate
10: 120ms WDT overflow rate
11: 60ms WDT overflow rate

SFR **95h**	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
INTFLG	LVD	–	TKIF	ADIF	–	IE2	P1IF	TF3
R/W	R	–	R/W	R/W	–	R/W	R/W	R/W
Reset	–	–	0	0	–	0	0	0

95h.7 **LVD:** Low Voltage Detect flag
Set by H/W when a low voltage occurs. The flag is valid when LVR is 2.3V. This flag is disabled in Stop mode.

SFR **97h**	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
SWCMD	IAPALL/SWRST							
R/W	W						R/W	R/W
Reset	–						–	0

97h.7~0 **SWRST:** Write 56h to generate S/W Reset

SFR **F7h**	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
AUX2	WDTE		PWRSAV	VBGOUT	–	–	–	–
R/W	R/W	R/W	R/W	R/W	–	–	–	–
Reset	0	0	0	0	–	–	–	–

F7h.7~6 **WDTE:** Watchdog Timer Reset control
0x: Watchdog Timer Reset disable
10: Watchdog Timer Reset enable in Fast/Slow mode, disable in Idle/Stop mode
11: Watchdog Timer Reset always enable

SFR **F8h**	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
AUX1	CLRWDT	CLRTM3	TKSOC	ADSOC	CLRPWM0	T2SEL	T1SEL	DPSEL
R/W	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

F8h.7 **CLRWDT:** Set to clear WDT, H/W auto clear it at next clock cycle

5. Clock Circuitry & Operation Mode

5.1 System Clock

The Chip is designed with dual-clock system. During runtime, user can directly switch the System clock from fast to slow or from slow to fast. It also can directly select a clock divider of 1, 2, 4 or 16. The Fast clock can be selected as FXT (Fast Crystal, 1~6 MHz) or FRC/2 (Fast Internal RC, 12.288 MHz/2). The Slow clock can be selected as SXT (Slow Crystal, 32 KHz) or SRC (Slow Internal RC, 68 KHz). Fast mode and Slow mode are defined as the CPU running at Fast and Slow clock speeds.

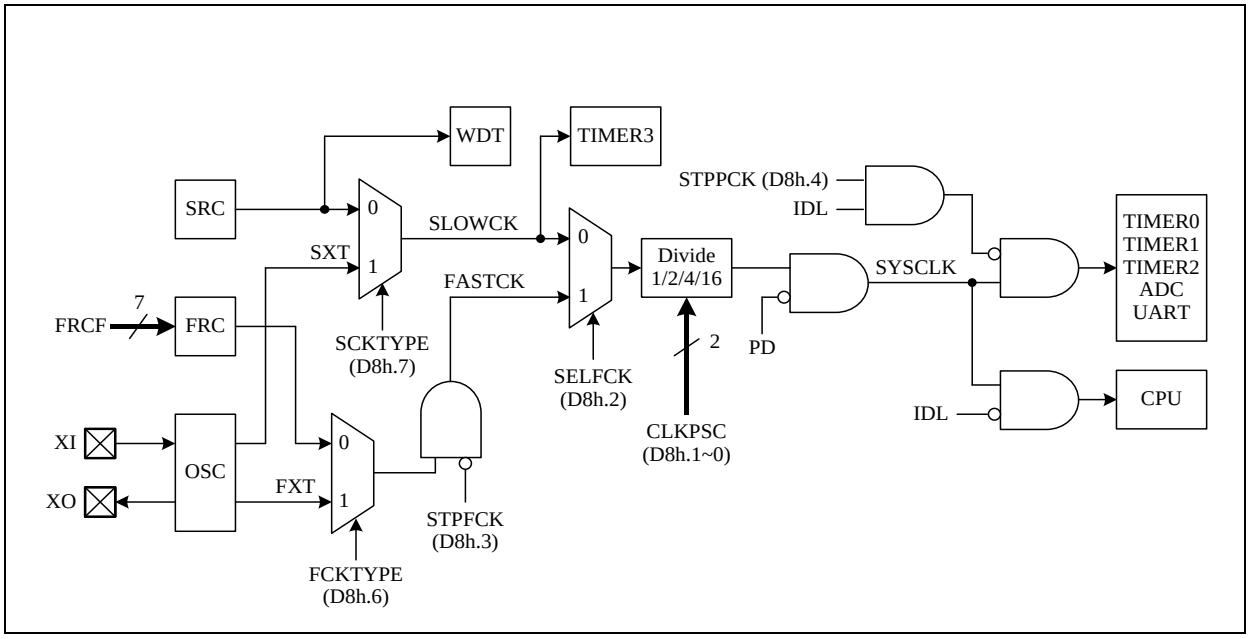
After Reset, the device is running at Slow mode with 68 KHz SRC. S/W should select the proper clock rate for chip operation safety. The higher V_{CC} allows the chip to run at a higher System clock frequency. In a typical condition, a 6 MHz System clock rate requires V_{CC}>2.7V.

The Chip has an external oscillators connected to the XI/XO pins. It relies on external circuitry for the clock signal and frequency stabilization, such as a stand-alone oscillator, quartz crystal, or ceramic resonator. In Fast mode, the fast oscillator can be used in the range from 1~6 MHz. In Slow mode, the slow oscillator can only use a clock frequency of 32.768 KHz.

The **CLKCON** SFR controls the System clock operating. H/W automatically blocks the S/W abnormally setting for this register. S/W can only change the Slow clock type in Fast mode and change the Fast clock type in Slow mode. Never to write both STPFCK=1 & SELFCK=1. It is recommended to write this SFR bit by bit.

If user wants to switch Fsys from Slow clock to FXT, user should be following the step below

1. Set FCKTYPE (D8h.6)
2. Wait 2ms until FXT oscillation stable
3. Set SELFCK (D8h.2)



Clock Structure

MTP **1FFDh**	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
CFGWL	–	FRCF						

1FFDh.6~0 **FRCF:** FRC frequency adjustment.

FRC is trimmed to 12.288 MHz in chip manufacturing. FRCF records the adjustment data.

SFR **F6h**	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
CFGWL	–	FRCF						
R/W	–	R/W						
Reset	–	–	–	–	–	–	–	–

F6h.6~0 **FRCF:** FRC frequency adjustment
00h= lowest frequency, 7Fh=highest frequency.

SFR **D8h**	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
CLKCON	SCKTYPE	FCKTYPE	–	STPPCK	STPFCK	SELFCK	CLKPSC	
R/W	R/W	R/W	–	R/W	R/W	R/W	R/W	
Reset	0	0	–	0	0	0	1	1

D8h.7 **SCKTYPE:** Slow clock type. This bit can be changed only in Fast mode (SELFCK=1).
0: SRC
1: SXT, P2.0 and P2.1 are crystal pins

D8h.6 **FCKTYPE:** Fast clock type. This bit can be changed only in Slow mode (SELFCK=0).
0: FRC
1: FXT, P2.0 and P2.1 are crystal pins, oscillator gain is high for FXT

D8h.4 **STPPCK:** Set 1 to stop UART/Timer0/Timer1/Timer2/ADC clock in Idle mode for current reducing. If set, only Timer3 and pin interrupts are alive in Idle Mode.

D8h.3 **STPFCK:** Set 1 to stop Fast clock for power saving in Slow/Idle mode. This bit can be changed only in Slow mode.

D8h.2 **SELFCK:** System clock source selection. This bit can be changed only when STPFCK=0.
0: Slow clock
1: Fast clock

D8h.1~0 **CLKPSC:** System clock prescaler.
00: System clock is Fast/Slow clock divided by 16
01: System clock is Fast/Slow clock divided by 4
10: System clock is Fast/Slow clock divided by 2
11: System clock is Fast/Slow clock divided by 1

SYSCLK	CLKCON (D8h)			
	bit7 SCKTYPE	bit6 FCKTYPE	bit3 STPFCK	bit2 SELFCK
Fast FXT	0/1	1	0	1
Fast FRC	0/1	0	0	1
Slow SXT	1	0/1	0/1	0
Slow SRC	0	0/1	0/1	0
Fast type change	0/1	0 ← → 1	0/1	0
Slow type change	0 ← → 1	0/1	0	1
Stop FRC/FXT	0/1	0/1	0 → 1	0
Switch to FRC/FXT	0/1	0/1	0	0 → 1
Switch to SRC/SXT	0/1	0/1	0	1 → 0

Note: also refer to AP-TM52XXXXX_01S and AP-TM52XXXXX_02S about System Clock Application Note.

The chip can also output the "System clock divided by 2" signal (CKO) to P1.4 pin. CKO pin's output setting is controlled by TCOE SFR (***see section 7***).

5.2 Operation Modes

There are four operation modes for this device. **Fast Mode** is defined as the CPU running at Fast clock speed. **Slow Mode** is defined as the CPU running at Slow clock speed. When the System clock speed is lower, the power consumption is lower.

Idle Mode is entered by setting the IDL bit in PCON SFR. Both Fast and Slow clock can be set as the System clock source in Idle Mode, but Slow clock is better for power saving. In Idle mode, the CPU puts itself to sleep while the on-chip peripherals stay active. The "STPPCK" bit in CLKCON SFR can be set to furthermore reduce Idle mode current. If STPPCK is set, only Timer3 and pin interrupts are alive in Idle Mode, others peripherals such as Timer0/1/2, UART and ADC are stop. The slower System clock rate also helps current saving. It can be achieved by setup the CLKPSC SFR to divide System clock frequency. Idle mode is terminated by Reset or enabled Interrupts wake up.

Stop Mode is entered by setting the PD bit in PCON SFR. This mode is the so-called "Power Down" mode in standard 8051. In Stop mode, all clocks stop except the WDT could be alive if it is enabled. Stop Mode is terminated by Reset or pin wake up.

Note: Chip cannot enter Stop Mode if INTn pin is low and wakeup is enable. (INTn=0 and EXn=1, n=0,1,2)
Note: FW must turn off Bandgap to obtain Tiny Current (VBGOUT)

SFR **87h**	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
PCON	SMOD	–	–	–	GF1	GF0	PD	IDL
R/W	R/W	–	–	–	R/W	R/W	R/W	R/W
Reset	0	–	–	–	0	0	0	0

87h.1 **PD:** Power down control bit, set 1 to enter STOP mode.

87h.0 **IDL:** Idle mode control bit, set 1 to enter IDLE mode.

SFR **F7h**	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
AUX2	WDTE		PWRSAV	VBGOUT	–	–	–	–
R/W	R/W	R/W	R/W	R/W	–	–	–	–
Reset	0	0	0	0	–	–	–	–

F7h.4 **VBGOUT:** VBG voltage output to P3.2
0: Disable 1: Enable when ADCHS = 1011b

SFR **D8h**	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
CLKCON	SCKTYPE	FCKTYPE	–	STPPCK	STPFCK	SELFCK	CLKPSC	
R/W	R/W	R/W	–	R/W	R/W	R/W	R/W	
Reset	0	0	–	0	0	0	1	1

D8h.7 **SCKTYPE:** Slow clock type. This bit can be changed only in Fast mode (SELFCK=1).
0: SRC 1: SXT

D8h.6 **FCKTYPE:** Fast clock type. This bit can be changed only in Slow mode (SELFCK=0).
0: FRC 1: FXT

D8h.4 **STPPCK:** Set 1 to stop UART/Timer0/Timer1/Timer2/ADC clock in Idle mode for current reducing. If set, only Timer3 and pin interrupts are alive in Idle Mode.

D8h.3 **STPFCK:** Set 1 to stop Fast clock for power saving in Slow/Idle mode. This bit can be changed only in Slow mode.

D8h.2 **SELFCK:** System clock source selection. This bit can be changed only when STPFCK=0.
0: Slow clock 1: Fast clock

D8h.1~0 **CLKPSC:** System clock prescaler.
00: System clock is Fast/Slow clock divided by 16
01: System clock is Fast/Slow clock divided by 4
10: System clock is Fast/Slow clock divided by 2
11: System clock is Fast/Slow clock divided by 1

6. Interrupt & Wake-up

This Chip has a 10-source four-level priority interrupt structure. All enabled Interrupts can wake up CPU from Idle mode, but only the Pin Interrupts can wake up CPU from Stop mode. Each interrupt source has its own enable control bit. An interrupt event will set its individual Interrupt Flag, no matter whether its interrupt enable control bit is 0 or 1. The Interrupt vectors and flags are list below.

Vector	Flag	Description
0003	IE0	INT0 external pin Interrupt (can wake up Stop mode)
000B	TF0	Timer0 Interrupt
0013	IE1	INT1 external pin Interrupt (can wake up Stop mode)
001B	TF1	Timer1 Interrupt
0023	RI+TI	Serial Port (UART) Interrupt
002B	TF2+EXF2	Timer2 Interrupt
0033	–	Reserved for ICE mode use
003B	TF3	Timer3 Interrupt
0043	P1IF	Port1 external pin change Interrupt (can wake up Stop mode)
004B	IE2	INT2 external pin Interrupt (can wake up Stop mode)
0053	ADIF+TKIF	ADC/Touch Key Interrupt

Interrupt Vector & Flag

6.1 Interrupt Enable and Priority Control

The IE and INTE1 SFRs decide whether the pending interrupt is serviced by CPU. The P1WKUP SFR controls the individual Port1 pin's wake-up and interrupt capability. The IP, IPH, IP1 and IP1H SFRs decide the interrupt priority. An interrupt will be serviced as long as an interrupt of equal or higher priority is not already being serviced. If an interrupt of equal or higher level priority is being serviced, the new interrupt will wait until it is finished before being serviced. If a lower priority level interrupt is being serviced, it will be stopped and the new interrupt serviced. When the new interrupt is finished, the lower priority level interrupt that was stopped will be completed.

SFR **96h**	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
P1WKUP	P1WKUP							
R/W	R/W							
Reset	0	0	0	0	0	0	0	0

96h.7~0 **P1WKUP:** P1.7~P1.0 pin individual Wake-up / Interrupt enable control
0: Disable
1: Enable

SFR **A8h**	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
IE	EA	–	ET2	ES	ET1	EX1	ET0	EX0
R/W	R/W	–	R/W	R/W	R/W	R/W	R/W	R/W
Reset	0	–	0	0	0	0	0	0

A8h.7 **EA:** Global interrupt enable control.
0: Disable all Interrupts.
1: Each interrupt is enabled or disabled by its individual interrupt control bit

A8h.5 **ET2:** Timer2 interrupt enable
0: Disable Timer2 interrupt
1: Enable Timer2 interrupt

A8h.4 **ES:** Serial Port (UART) interrupt enable
0: Disable Serial Port (UART) interrupt
1: Enable Serial Port (UART) interrupt

A8h.3 **ET1:** Timer1 interrupt enable
0: Disable Timer1 interrupt
1: Enable Timer1 interrupt

A8h.2 **EX1:** External INT1 pin Interrupt enable and Stop mode wake up enable
0: Disable INT1 pin Interrupt and Stop mode wake up
1: Enable INT1 pin Interrupt and Stop mode wake up, it can wake up CPU from Stop mode no matter EA is 0 or 1.

A8h.1 **ET0:** Timer0 interrupt enable
0: Disable Timer0 interrupt
1: Enable Timer0 interrupt

A8h.0 **EX0:** External INT0 pin Interrupt enable and Stop mode wake up enable
0: Disable INT0 pin Interrupt and Stop mode wake up
1: Enable INT0 pin Interrupt and Stop mode wake up, it can wake up CPU from Stop mode no matter EA is 0 or 1.

SFR **A9h**	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
INTE1	–	–	–	–	ADTKIE	EX2	P1IE	TM3IE
R/W	–	–	–	–	R/W	R/W	R/W	R/W
Reset	–	–	–	–	0	0	0	0

A9h.3 **ADTKIE:** ADC/Touch Key interrupt enable
0: Disable ADC/Touch Key interrupt
1: Enable ADC/Touch Key interrupt

A9h.2 **EX2:** External INT2 pin Interrupt enable and Stop mode wake up enable
0: Disable INT2 pin Interrupt and Stop mode wake up
1: Enable INT2 pin Interrupt and Stop mode wake up, it can wake up CPU from Stop mode no matter EA is 0 or 1.

A9h.1 **P1IE:** Port1 pin change interrupt enable. This bit does not affect the Port1 pin's Stop mode wake up capability.
0: Disable Port1 pin change interrupt
1: Enable Port1 pin change interrupt

A9h.0 **TM3IE:** Timer3 interrupt enable
0: Disable Timer3 interrupt
1: Enable Timer3 interrupt

SFR **B9h**	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
IPH	–	–	PT2H	PSH	PT1H	PX1H	PT0H	PX0H
R/W	–	–	R/W	R/W	R/W	R/W	R/W	R/W
Reset	–	–	0	0	0	0	0	0

SFR **B8h**	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
IP	–	–	PT2	PS	PT1	PX1	PT0	PX0
R/W	–	–	R/W	R/W	R/W	R/W	R/W	R/W
Reset	–	–	0	0	0	0	0	0

B9h.5, B8h.5 **PT2H, PT2 :** Timer2 Interrupt Priority control. (PT2H, PT2) =
11: Level 3 (highest priority)
10: Level 2
01: Level 1
00: Level 0 (lowest priority)

B9h.4, B8h.4 **PSH, PS :** Serial Port (UART) Interrupt Priority control. Definition as above.

B9h.3, B8h.3 **PT1H, PT1 :** Timer1 Interrupt Priority control. Definition as above.

B9h.2, B8h.2 **PX1H, PX1 :** External INT1 pin Interrupt Priority control. Definition as above.

B9h.1, B8h.1 **PT0H, PT0 :** Timer0 Interrupt Priority control. Definition as above.

B9h.0, B8h.0 **PX0H, PX0 :** External INT0 pin Interrupt Priority control. Definition as above.

SFR **BBh**	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
IP1H	–	–	–	–	PADTKIH	PX2H	PP1H	PT3H
R/W	–	–	–	–	R/W	R/W	R/W	R/W
Reset	–	–	–	–	0	0	0	0

SFR **BAh**	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
IP1	–	–	–	–	PADTKI	PX2	PP1	PT3
R/W	–	–	–	–	R/W	R/W	R/W	R/W
Reset	–	–	–	–	0	0	0	0

BBh.3, BAh.3 **PADTKIH, PADTKI :** ADC/Touch Key Interrupt Priority control. Definition as above.

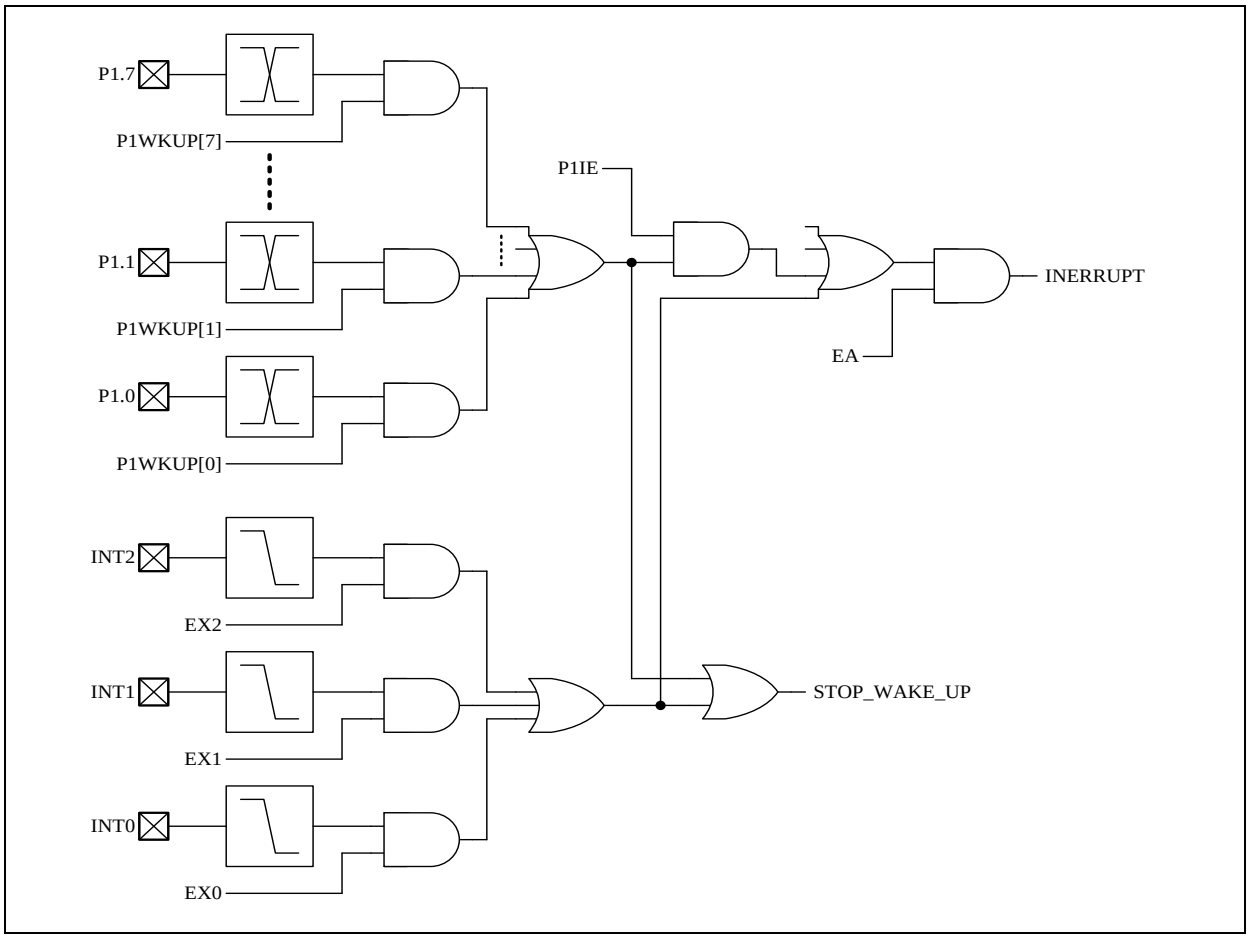
BBh.2, BAh.2 **PX2H, PX2 :** External INT2 pin Interrupt Priority control. Definition as above.

BBh.1, BAh.1 **PP1H, PP1 :** Port1 Pin Change Interrupt Priority control. Definition as above.

BBh.0, BAh.0 **PT3H, PT3 :** Timer3 Interrupt Priority control. Definition as above.

6.2 Pin Interrupt

Pin Interrupts include INT0 (P3.2), INT1 (P3.3), INT2 (P3.7) and Port1 Change Interrupt. These pins also have the Stop mode wake up capability. INT0 and INT1 are falling edge or low level triggered as the 8051 standard. INT2 is falling edge triggered and Port1 Change Interrupt is triggered by any Port1 pin state change.



Pin Interrupt & Wake up

SFR **88h**	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
TCON	TF1	TR1	TF0	TR0	IE1	IT1	IE0	IT0
R/W	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

88h.3 **IE1:** External Interrupt 1 (INT1 pin) edge flag.
Set by H/W when an INT1 pin falling edge is detected, no matter the EX1 is 0 or 1.
It is cleared automatically when the program performs the interrupt service routine.

88h.2 **IT1:** External Interrupt 1 control bit
0: Low level active (level triggered) for INT1 pin
1: Falling edge active (edge triggered) for INT1 pin

88h.1 **IE0:** External Interrupt 0 (INT0 pin) edge flag
Set by H/W when an INT0 pin falling edge is detected, no matter the EX0 is 0 or 1.
It is cleared automatically when the program performs the interrupt service routine.

88h.0 **IT0:** External Interrupt 0 control bit
0: Low level active (level triggered) for INT0 pin
1: Falling edge active (edge triggered) for INT0 pin

Note: Chip cannot enter Stop Mode if INTn pin is low and wakeup is enabled. (INTn=0 and EXn=1, n=0,1,2)

SFR **95h**	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
INTFLG	LVD	–	TKIF	ADIF	–	IE2	P1IF	TF3
R/W	R	–	R/W	R/W	–	R/W	R/W	R/W
Reset	–	–	0	0	–	0	0	0

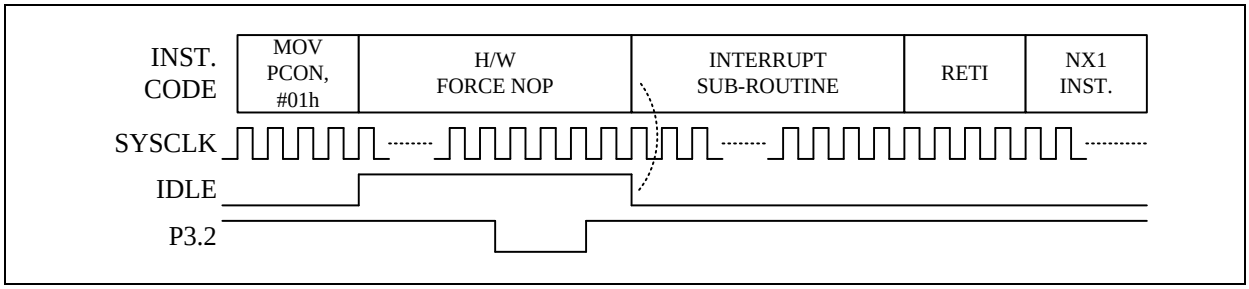
95h.2 **IE2:** External Interrupt 2 (INT2 pin) edge flag
Set by H/W when a falling edge is detected on the INT2 pin, no matter the EX2 is 0 or 1.
It is cleared automatically when the program performs the interrupt service routine.
S/W can write FBh to INTFLG to clear this bit.

95h.1 **P1IF:** Port1 pin change interrupt flag
Set by H/W when a Port1 pin state change is detected and its interrupt enable bit is set (P1WKUP). P1IE does not affect this flag's setting.
It is cleared automatically when the program performs the interrupt service routine.
S/W can write FDh to INTFLG to clear this bit.

Note5: S/W can write 0 to clear a flag in the INTFLG, but writing 1 has no effect.

6.3 Idle mode Wake up and Interrupt

Idle mode is waked up by enabled Interrupts, which means individual interrupt enable bit (ex: EX0) and EA bit must be both set to 1 to establish Idle mode wake up capability. All enabled Interrupts (Pins, Timers, TK and UART) can wake up CPU from Idle mode. Upon Idle wake-up, Interrupt service routine is entered immediately. "The first instruction behind IDL (PCON.0) setting" is executed after interrupt service routine return.



EA=EX0=1, Idle mode wake-up and Interrupt by P3.2 (INT0)

SFR **87h**	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
PCON	SMOD	–	–	–	GF1	GF0	PD	IDL
R/W	R/W	–	–	–	R/W	R/W	R/W	R/W
Reset	0	–	–	–	0	0	0	0

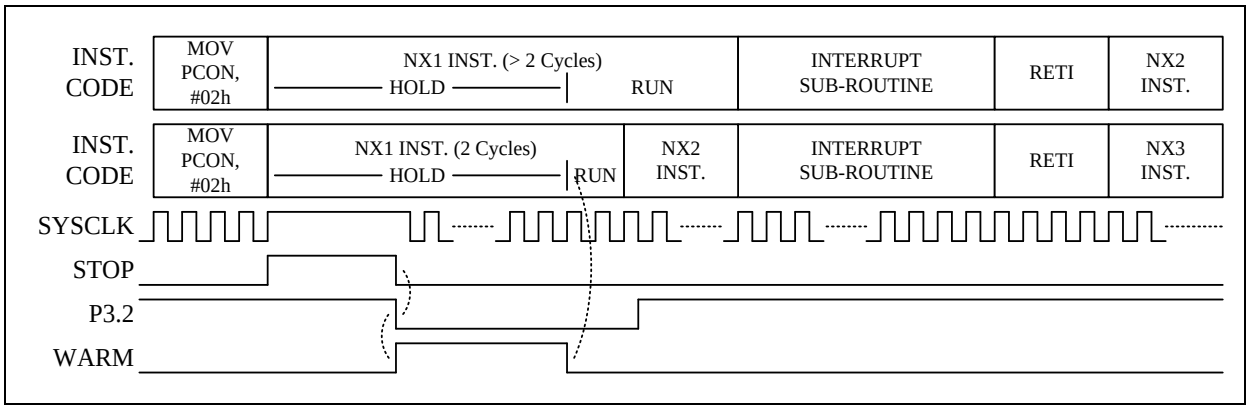
87h.1 **PD:** Power down control bit, set 1 to enter STOP mode.

87h.0 **IDL:** Idle mode control bit, set 1 to enter IDLE mode.

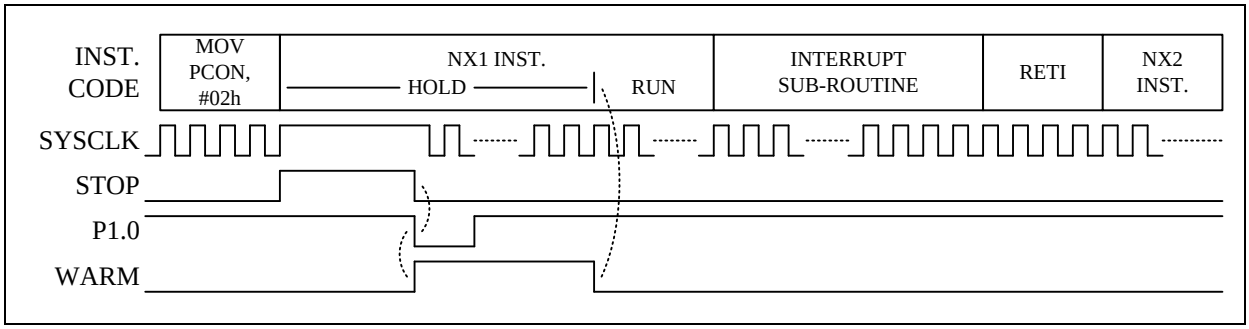
6.4 Stop mode Wake up and Interrupt

Stop mode wake up is simple, as long as the individual pin interrupt enable bit (ex: EX0) is set, the pin wake up capability is asserted. Set EX0/EX1/EX2 can enable INT0/INT1/INT2 pins' Stop mode wake up capability. Set P1WKUP bit 7~0 can enable P1.7~P1.0's Stop mode wake up capability. Upon Stop wake up, "the first instruction behind PD setting (PCON.1)" is executed immediately before Interrupt service. Interrupt entry requires EA=1 (P1WKUP also needs P1IE=1) and trigger state of the pin staying sufficiently long to be observed by the System clock. This feature allows CPU to enter or not enter Interrupt sub-routine after Stop mode wake up.

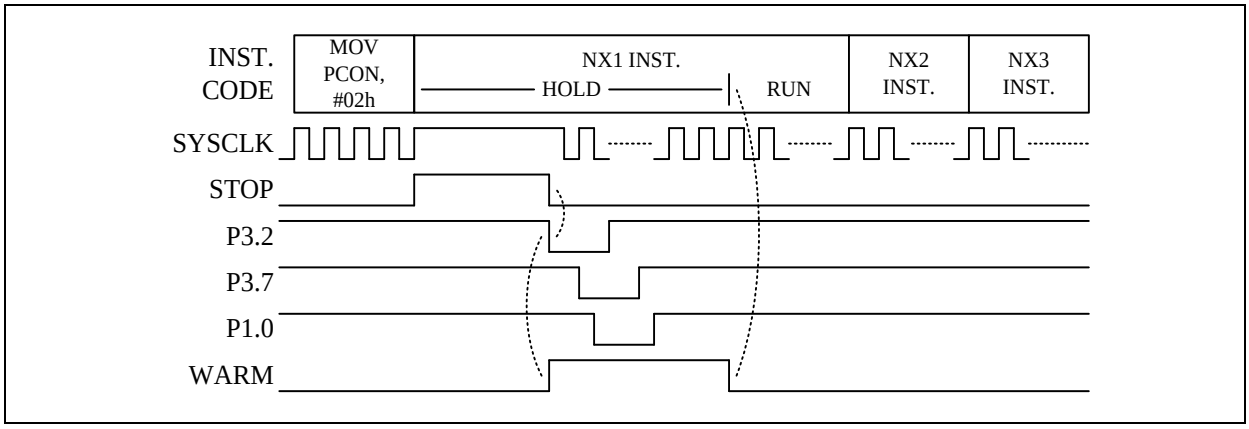
Note: Chip cannot enter Stop Mode if INTn pin is low and wakeup is enabled. (INTn=0 and EXn=1, n=0,1,2)



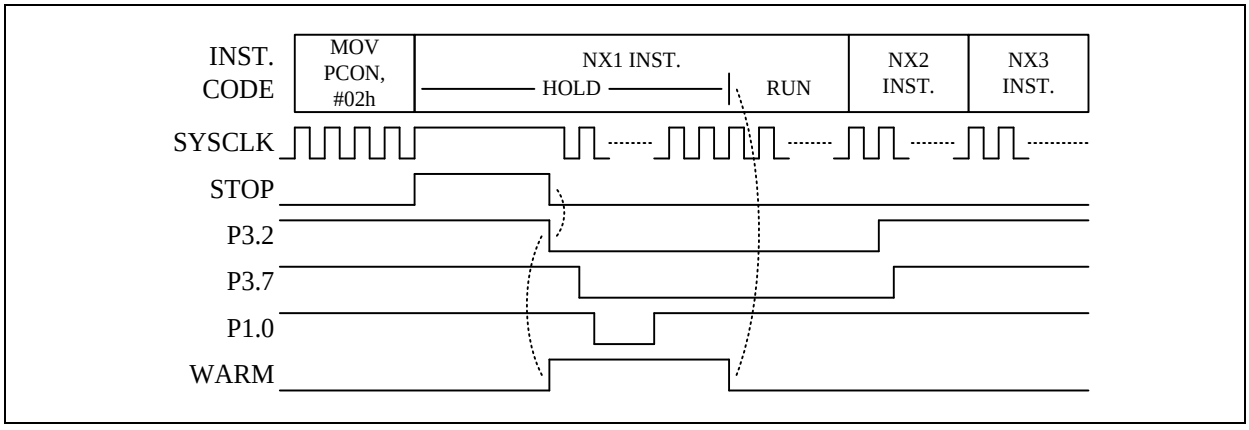
EA=EX0=1, P3.2 (INT0) is sampled after warm-up, Stop mode wake-up and Interrupt



EA=P1IE=P1WKUP=1, P1.0 change (not need clock sample), Stop mode wake-up and Interrupt



EA=EX0=EX2=P1WKUP=1, P1IE=0, Stop mode wake-up but not Interrupt. P3.2/P3.7 pulse too narrow



EX0=EX2=P1WKUP=P1IE=1, EA=0, Stop mode wake-up but not Interrupt

7. I/O Ports

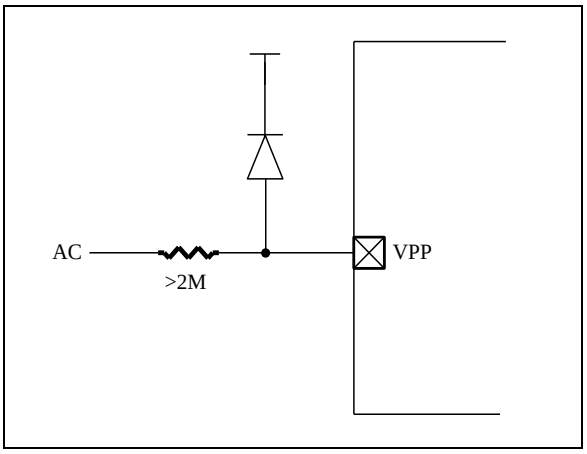
The Chip has total 18 multi-function I/O pins. All I/O pins follow the standard 8051 “Read-Modify-Write” feature. The instructions that read the SFR rather than the Pin State are the ones that read a port or port bit value, possibly change it, and then rewrite it to the SFR (ex: ANL P1, A; INC P2; CPL P3.0). Each I/O pins except P3.7 can operate in four different modes as the table below. P3.7 can be only used as Schmitt-trigger input or open-drain output. P3.7 pin is also shared with RSTn, INT2 and MTP VPP function.

7.1 P3.7

P3.7 can be only used as Schmitt-trigger input or open-drain output, with pull-up resistor. P3.7 pin is shared with RSTn, INT2 and MTP VPP function. When P37 is set high, the IO port can be pulled to approximately $0.6V_{CC}$ and the current consumption is approximately 2uA. When P3.7 is set low, P3.7 will not have additional current consumption.

V_{CC}	P37 pull-up approximately voltage
5V	3.1V
4V	2.3V
3V	1.5V

VPP (P3.7) has no high voltage protection diode, need an external diode and resistor to achiever AC zero crossing detection.



Zero crossing detector circuit for VPP pin

7.2 Port1 & P2.1~P2.0 & P3.6~P3.0

These pins can operate in four different modes as below.

Mode	Pin function (except P3.7)		Px.n SFR data	Pin State	Resistor Pull-up	Digital Input
	P3.0~P3.2	Others				
Mode 0	Pseudo Open Drain	Open Drain	0	Drive Low	N	N
			1	Pull-up	Y	Y
Mode 1	Pseudo Open Drain	Open Drain	0	Drive Low	N	N
			1	Hi-Z	N	Y
Mode 2	CMOS Output		0	Drive Low	N	N
			1	Drive High	N	N
Mode 3	Analog input for ADC, digital input buffer is disabled		X (don't care)	–	N	N

I/O Pin Function Table

If an I/O pin (except P3.7) is used for Schmitt-trigger input, S/W must set the I/O pin to Mode0 or Mode1 and set the corresponding Port Data SFR to 1 to disable the pin's output driving circuitry.

Beside I/O port function, each pin has one or more alternative functions, such as Touch Key, ADC and PWM. Port1/Port3 pins also have standard 8051 auxiliary definition (INT0/1, T0/1/2, T2EX, RXD/TXD) as table below.

Pin Name	8051	Wake-up	CKO	ADC/TK	LCD	others	IO Mode3
P1.0	T2	Y	T2O	AD4/TK4			AD4
P1.1	T2EX	Y		AD5/TK5			AD5
P1.2		Y		AD6/TK6		PWM0	AD6
P1.3		Y		AD7/TK7		PWM1	AD7
P1.4		Y	CKO	AD8/TK8			AD8
P1.5		Y		AD9/TK14			AD9
P1.6		Y		TK9	COM0		
P1.7		Y		TK10	COM1		
P2.0						XI	
P2.1						XO	
P3.0	RXD			AD3/TK3			AD3
P3.1	TXD			AD2/TK2			AD2
P3.2	INT0	Y		AD1/TK1			AD1
P3.3	INT1	Y		AD0/TK0			AD0
P3.4	T0		T0O	TK13			
P3.5	T1			TK12	COM3		
P3.6				TK11	COM2		

Pin multi-function Table

The necessary SFR setting for Port1/P2.1~P2.0/P3.6~P3.0 pin's alternative function is list below.

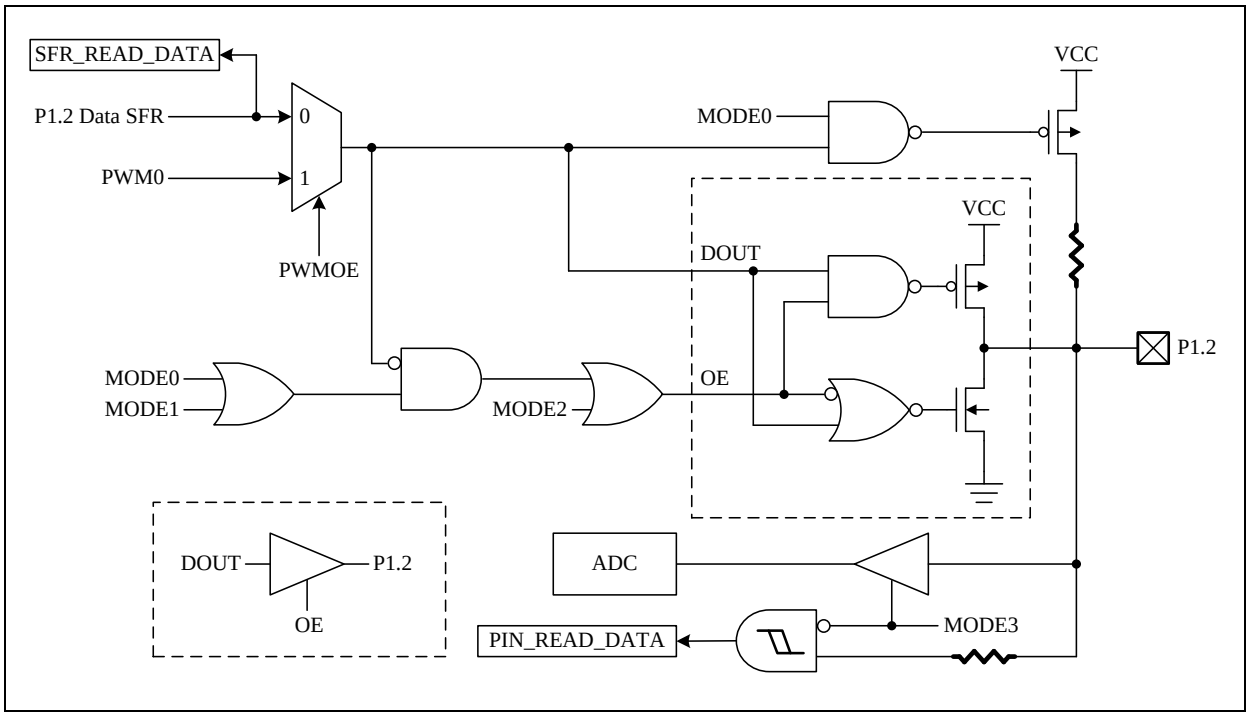
Alternative Function	Mode	Px.n SFR data	Pin State	other necessary SFR setting
T0, T1, T2, T2EX, INT0, INT1	**0**	1	Input with Pull-up	–
	1	1	Input	
RXD, TXD	**0**	1	Input with Pull-up/Pseudo Open Drain Output	–
	1	1	Input/Pseudo Open Drain Output	
CKO, T0O, T2O, PWM0, PWM1	**0**	X	Open Drain Output with Pull-up	PINMOD
	1	X	Open Drain Output	
	2	X	CMOS Push-Pull output	
TK0~TK14	**0**	1	Touch Key Idling, scanning	–
COM0~COM3	**X**	X	1/2 Bias Output	COMOE
ADC0~ADC9	**3**	X	ADC Voltage Input	–
XI, XO	**0**	1	FXT/SXT Crystal Oscillation	CLKCON

Mode Setting for Pin Alternative Function

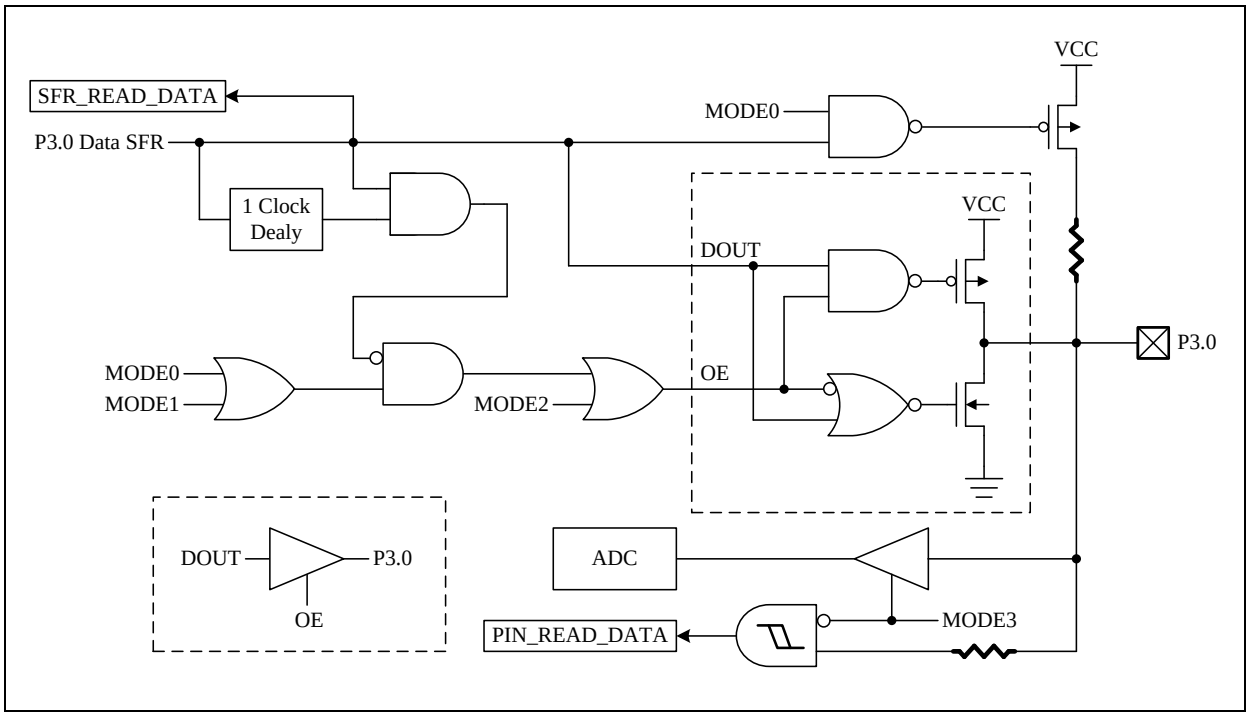
For tables above, a "**CMOS Output**" pin means it can sink and drive at least 4 mA current. It is not recommended to use such pin as input function.

An "**Open Drain**" pin means it can sink at least 4 mA current but only drive a small current (<20 μA). It can be used as input or output function and typically needs an external pull up resistor.

An 8051 standard pin is a "**Pseudo Open Drain**" pin. It can sink at least 4 mA current when output is at low level, and drives at least 4 mA current for 1~2 clock cycle when output transits from low to high, then keeps driving a small current (<20 μA) to maintain the pin at high level. It can be used as input or output function.



P1.2 Pin Structure



P3.0 Pin Structure

SFR **90h**	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
P1	P1.7	P1.6	P1.5	P1.4	P1.3	P1.2	P1.1	P1.0
R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W
Reset	1	1	1	1	1	1	1	1

90h.7~0 **P1:** Port1 data

SFR **A0h**	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
P2	P2.7	P2.6	P2.5	P2.4	P2.3	P2.2	P2.1	P2.0
R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W
Reset	1	1	1	1	1	1	1	1

A0h.1~0 **P2.1~P2.0:** P2.1~P2.0 data

SFR **B0h**	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
P3	P3.7	P3.6	P3.5	P3.4	P3.3	P3.2	P3.1	P3.0
R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W
Reset	1	1	1	1	1	1	1	1

B0h.7 **P3.7:** P3.7 data also controls the pin's I/O mode. If the P3.7 SFR data is "1", the P3.7 is assigned as Schmitt-trigger input mode; otherwise, it is assigned as open-drain output mode.

B0h.6~0 **P3.6~P3.0:** P3.6~P3.0 data

SFR **D8h**	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
CLKCON	SCKTYPE	FCKTYPE	–	STPPCK	STPFCK	SELFCK	CLKPSC	
R/W	R/W	R/W	–	R/W	R/W	R/W	R/W	
Reset	0	0	–	0	0	0	1	1

D8h.7 **SCKTYPE:** Set 1 to enable P2.0 and P2.1 pin's crystal oscillation mode

D8h.6 **FCKTYPE:** Set 1 to enable P2.0 and P2.1 pin's crystal oscillation mode

SFR **A2h**	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
P1MODL	P1MOD3		P1MOD2		P1MOD1		P1MOD0	
R/W	R/W		R/W		R/W		R/W	
Reset	0	0	0	0	0	0	0	0

A2h.7~6 **P1MOD3:** P1.3 pin control.
00: Mode0, P1.3 as Touch Key input.
01: Mode1
10: Mode2
11: Mode3, P1.3 is ADC.

A2h.5~4 **P1MOD2:** P1.2 pin control.
00: Mode0, P1.2 as Touch Key input.
01: Mode1
10: Mode2
11: Mode3, P1.2 is ADC.

A2h.3~2 **P1MOD1:** P1.1 pin control.
00: Mode0, P1.1 as Touch Key input.
01: Mode1
10: Mode2
11: Mode3, P1.1 is ADC.

A2h.1~0 **P1MOD0:** P1.0 pin control.
00: Mode0, P1.0 as Touch Key input.
01: Mode1
10: Mode2
11: Mode3, P1.0 is ADC.

SFR **A3h**	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
P1MODH	P1MOD7		P1MOD6		P1MOD5		P1MOD4	
R/W	R/W		R/W		R/W		R/W	
Reset	0	0	0	0	0	0	0	0

A3h.7~6 **P1MOD7:** P1.7 pin control.
00: Mode0 or P1.7 as Touch Key input.
01: Mode1
10: Mode2
11: Mode3,

A3h.5~4 **P1MOD6:** P1.6 pin control.
00: Mode0 or P1.6 as Touch Key input.
01: Mode1
10: Mode2
11: Mode3,

A3h.3~2 **P1MOD5:** P1.5 pin control.
00: Mode0 or P1.5 as Touch Key input.
01: Mode1
10: Mode2
11: Mode3, P1.5 is ADC input

A3h.1~0 **P1MOD4:** P1.4 pin control.
00: Mode0 or P1.4 as Touch Key input.
01: Mode1
10: Mode2
11: Mode3, P1.4 is ADC.

SFR **A4h**	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
P3MODL	P3MOD3		P3MOD2		P3MOD1		P3MOD0	
R/W	R/W		R/W		R/W		R/W	
Reset	0	1	0	1	0	1	0	1

A4h.7~6 **P3MOD3:** P3.3 pin control.
00: Mode0 or P3.3 as Touch Key input.
01: Mode1
10: Mode2
11: Mode3, P3.3 is ADC.

A4h.5~4 **P3MOD2:** P3.2 pin control.
00: Mode0 or P3.2 as Touch Key input.
01: Mode1
10: Mode2
11: Mode3, P3.2 is ADC.

A4h.3~2 **P3MOD1:** P3.1 pin control.
00: Mode0 or P3.1 as Touch Key input.
01: Mode1
10: Mode2
11: Mode3, P3.1 is ADC.

A4h.1~0 **P3MOD0:** P3.0 pin control.
00: Mode0 or P3.0 as Touch Key input.
01: Mode1
10: Mode2
11: Mode3, P3.0 is ADC.

SFR **A5h**	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
P3MODH	–	–	P3MOD6		P3MOD5		P3MOD4	
R/W	–	–	R/W		R/W		R/W	
Reset	–	–	0	0	0	0	0	0

A5h.5~4 **P3MOD6:** P3.6 pin control.
00: Mode0 or P3.6 as Touch Key input.
01: Mode1
10: Mode2
11: Mode3

A5h.3~2 **P3MOD5:** P3.5 pin control.
00: Mode0 or P35 as Touch Key input.
01: Mode1
10: Mode2
11: Mode3

A5h.1~0 **P3MOD4:** P3.4 pin control.
00: Mode0 or P3.4 as Touch Key input.
01: Mode1
10: Mode2
11: Mode3

SFR **92h**	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
COMOE	–	–	–	–	COM3OE	COM2OE	COM1OE	COM0OE
R/W	–	–	–	–	R/W	R/W	R/W	R/W
Reset	–	–	–	–	0	0	0	0

92h.3 **COM3OE:** P3.5 1/2 bias output
0: Disable 1: Enable

92h.2 **COM2OE:** P3.6 1/2 bias output
0: Disable 1: Enable

92h.1 **COM1OE:** P1.7 1/2 bias output
0: Disable 1: Enable

92h.0 **COM0OE:** P1.6 1/2 bias output
0: Disable 1: Enable

SFR **93h**	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
P2MOD	–	–	–	–	P2MOD1		P2MOD0	
R/W	–	–	–	–	R/W		R/W	
Reset	–	–	–	–	0	1	0	1

93h.3~2 **P2MOD1:** P2.1 pin control.
00: Mode0
01: Mode1
10: Mode2
11: not defined

93h.1~0 **P2MOD0:** P2.0 pin control.
00: Mode0
01: Mode1
10: Mode2
11: not defined

SFR **A6h**	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
PINMOD	PWM1OE	PWM0OE	TCOE	T2OE	–	–	–	T0OE
R/W	R/W	R/W	R/W	R/W	–	–	–	R/W
Reset	0	0	0	0	–	–	–	0

A6h.7 **PWM1OE:** PWM1 control
0: PWM1 disable
1: PWM1 enable and signal output to P1.3 pin

A6h.6 **PWM0OE:** PWM0 control
0: PWM0 disable
1: PWM0 enable and signal output to P1.2 pin

A6h.5 **TCOE:** System clock signal output (CKO) control
0: Disable "System clock divided by 2" output to P1.4 pin
1: Enable "System clock divided by 2" output to P1.4 pin

A6h.4 **T2OE:** Timer2 signal output (T2O) control
0: Disable "Timer2 overflow divided by 2" output to P1.0 pin
1: Enable "Timer2 overflow divided by 2" output to P1.0 pin

A6h.0 **T0OE:** Timer0 signal output (T0O) control
0: Disable "Timer0 overflow divided by 64" output to P3.4 pin
1: Enable "Timer0 overflow divided by 64" output to P3.4 pin

8. Timers

Timer0, Timer1 and Timer2 are provided as standard 8051 compatible timer/counter. Compare to the traditional 12T 8051, the Chip's Timer0/1/2 use 2 System clock cycle as the time base unit. That is, in timer mode, these timers increase at every "2 System clock" rate; in counter mode, T0/T1/T2 pin input pulse must be wider than 2 System clock to be seen by this device. In addition to the standard 8051 timers function. The T0O pin can output the "Timer0 overflow divided by 64" signal, and the T2O pin can output the "Timer2 overflow divided by 2" signal. Timer3 is provided for a real-time clock count, when its time base is SXT.

8.1 Timer0 / Timer1

TCON and TMOD are used to set the mode of operation and to control the running and interrupt generation of the Timer0/1, with the timer/counter values stored in two pairs of 8-bit registers (TL0, TH0, and TL1, TH1).

SFR **88h**	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
TCON	TF1	TR1	TF0	TR0	IE1	IT1	IE0	IT0
R/W	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

88h.7 **TF1:** Timer1 overflow flag
Set by H/W when Timer/Counter 1 overflows
Cleared by H/W when CPU vectors into the interrupt service routine.

88h.6 **TR1:** Timer1 run control
0: Timer1 stops
1: Timer1 runs

88h.5 **TF0:** Timer0 overflow flag
Set by H/W when Timer/Counter 0 overflows
Cleared by H/W when CPU vectors into the interrupt service routine.

88h.4 **TR0:** Timer0 run control
0: Timer0 stops
1: Timer0 runs

SFR **89h**	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
TMOD	GATE1	CT1N	TMOD1		GATE0	CT0N	TMOD0	
R/W	R/W	R/W	R/W		R/W	R/W	R/W	
Reset	0	0	0	0	0	0	0	0

89h.7 **GATE1:** Timer1 gating control bit
0: Timer1 enable when TR1 bit is set
1: Timer1 enable only while the INT1 pin is high and TR1 bit is set

89h.6 **CT1N:** Timer1 Counter/Timer select bit
0: Timer mode, Timer1 data increases at 2 System clock cycle rate
1: Counter mode, Timer1 data increases at T1 pin's negative edge

89h.5~4 **TMOD1:** Timer1 mode select
00: 8-bit timer/counter (TH1) and 5-bit prescaler (TL1)
01: 16-bit timer/counter
10: 8-bit auto-reload timer/counter (TL1). Reloaded from TH1 at overflow.
11: Timer1 stops

89h.3 **GATE0:** Timer0 gating control bit
0: Timer0 enable when TR0 bit is set
1: Timer0 enable only while the INT0 pin is high and TR0 bit is set

89h.2 **CT0N:** Timer0 Counter/Timer select bit
0: Timer mode, Timer0 data increases at 2 System clock cycle rate
1: Counter mode, Timer0 data increases at T0 pin's negative edge

89h.1~0 **TMOD0:** Timer0 mode select
00: 8-bit timer/counter (TH0) and 5-bit prescaler (TL0)
01: 16-bit timer/counter
10: 8-bit auto-reload timer/counter (TL0). Reloaded from TH0 at overflow.
11: TL0 is an 8-bit timer/counter. TH0 is an 8-bit timer/counter using Timer1's TR1 and TF1 bits.

SFR **8Ah**	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
TL0	TL0							
R/W	R/W							
Reset	0	0	0	0	0	0	0	0

8Ah.7~0 **TL0:** Timer0 data low byte

SFR **8Bh**	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
TL1	TL1							
R/W	R/W							
Reset	0	0	0	0	0	0	0	0

8Bh.7~0 **TL1:** Timer1 data low byte

SFR **8Ch**	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
TH0	TH0							
R/W	R/W							
Reset	0	0	0	0	0	0	0	0

8Ch.7~0 **TH0:** Timer0 data high byte

SFR **8Dh**	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
TH1	TH1							
R/W	R/W							
Reset	0	0	0	0	0	0	0	0

8Dh.7~0 **TH1:** Timer1 data high byte

***Note**: See also Chapter 6 for more information on Timer0/1 interrupt enable and priority.*
***Note**: See also Chapter 7 for details on T0O pin output settings.*

8.2 Timer2

Timer2 is controlled through the TCON2 register with the low and high bytes of Timer/Counter2 stored in TL2 and TH2 and the low and high bytes of the Timer2 reload/capture registers stored in RCAP2L and RCAP2H.

SFR **C8h**	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
T2CON	TF2	EXF2	RCLK	TCLK	EXEN2	TR2	CT2N	CPRL2N
R/W	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

C8h.7 **TF2:** Timer2 overflow flag
Set by H/W when Timer/Counter 2 overflows unless RCLK=1 or TCLK=1. This bit must be cleared by S/W.

C8h.6 **EXF2:** T2EX interrupt pin falling edge flag
Set when a capture or a reload is caused by a negative transition on T2EX pin if EXEN2=1. This bit must be cleared by S/W.

C8h.5 **RCLK:** UART receive clock control bit
0: Use Timer1 overflow as receive clock for serial port in mode 1 or 3
1: Use Timer2 overflow as receive clock for serial port in mode 1 or 3

C8h.4 **TCLK:** UART transmit clock control bit
0: Use Timer1 overflow as transmit clock for serial port in mode 1 or 3
1: Use Timer2 overflow as transmit clock for serial port in mode 1 or 3

C8h.3 **EXEN2:** T2EX pin enable
0: T2EX pin disable
1: T2EX pin enable, it cause a capture or reload when a negative transition on T2EX pin is detected if RCLK=TCLK=0

C8h.2 **TR2:** Timer2 run control
0: Timer2 stops
1: Timer2 runs

C8h.1 **CT2N:** Timer2 Counter/Timer select bit
0: Timer mode, Timer2 data increases at 2 System clock cycle rate
1: Counter mode, Timer2 data increases at T2 pin's negative edge

C8h.0 **CPRL2N:** Timer2 Capture/Reload control bit
0: Reload mode, auto-reload on Timer2 overflows or negative transitions on T2EX pin if EXEN2=1.
1: Capture mode, capture on negative transitions on T2EX pin if EXEN2=1.
If RCLK=1 or TCLK=1, CPRL2N is ignored and timer is forced to auto-reload on Timer2 overflow.

SFR **CAh**	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
RCP2L	RCP2L							
R/W	R/W							
Reset	0	0	0	0	0	0	0	0

CAh.7~0 **RCP2L:** Timer2 reload/capture data low byte

SFR **CBh**	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
RCP2H	RCP2H							
R/W	R/W							
Reset	0	0	0	0	0	0	0	0

CBh.7~0 **RCP2H:** Timer2 reload/capture data high byte

SFR **CCh**	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
TL2	TL2							
R/W	R/W							
Reset	0	0	0	0	0	0	0	0

CCh.7~0 **TL2:** Timer2 data low byte

SFR **CDh**	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
TH2	TH2							
R/W	R/W							
Reset	0	0	0	0	0	0	0	0

CDh.7~0 **TH2:** Timer2 data high byte

***Note**: See also Chapter 6 for more information on Timer2 interrupt enable and priority.*
***Note**: See also Chapter 7 for details on T2O pin output settings.*

8.3 Timer3

Timer3 works as a time-base counter, which generates interrupts periodically. It generates an interrupt flag (TF3) with the clock divided by 32768, 16384, 8192, or 128 depending on the TM3PSC SFR. The Timer3 clock source is Slow clock (SRC or SXT). This is ideal for real-time-clock (RTC) functionality when the clock source is SXT.

SFR **94h**	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
OPTION	UART1W	TKFJMP	WDTPSC		ADCKS		TM3PSC	
R/W	R/W	R/W	R/W		R/W		R/W	
Reset	0	0	0	0	0	0	0	0

94h.1~0 **TM3PSC:** Timer3 Interrupt rate
00: Timer3 Interrupt rate is 32768 Slow clock cycle
01: Timer3 Interrupt rate is 16384 Slow clock cycle
10: Timer3 Interrupt rate is 8192 Slow clock cycle
11: Timer3 Interrupt rate is 128 Slow clock cycle

SFR **95h**	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
INTFLG	LVD	–	TKIF	ADIF	–	IE2	P1IF	TF3
R/W	R	–	R/W	R/W	–	R/W	R/W	R/W
Reset	–	–	0	0	–	0	0	0

95h.0 **TF3:** Timer3 Interrupt Flag
Set by H/W when Timer3 reaches TM3PSC setting cycles. Cleared automatically when the program performs the interrupt service routine. S/W can write FEh to INTFLG to clear this bit. (***Note5***)

SFR **F8h**	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
AUX1	CLRWDT	CLRTM3	TKSOC	ADSOC	CLRPWM0	T2SEL	T1SEL	DPSEL
R/W	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

F8h.6 **CLRTM3:** Set 1 to clear Timer3, H/W auto clear it at next clock cycle.

Note6: also refer to Section 6 for more information about Timer3 Interrupt enable and priority.

8.4 T0O and T2O Output Control

This device can generate various frequency waveform pin output (in CMOS or Open-Drain format) for Buzzer. The T0O and T2O waveform is divided by Timer0/Timer2 overflow signal. The T0O waveform is Timer0 overflow divided by 64, and T2O waveform is Timer2 overflow divided by 2. User can control their frequency by Timers auto reload speed. Set T0OE and T2OE SFRs can output these waveforms.

SFR **A6h**	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
PINMOD	PWM1OE	PWM0OE	TCOE	T2OE	–	–	–	T0OE
R/W	R/W	R/W	R/W	R/W	–	–	–	R/W
Reset	0	0	0	0	–	–	–	0

A6h.4 **T2OE:** Timer2 signal output (T2O) control
0: Disable Timer2 overflow divided by 2 output to P1.0
1: Enable Timer2 overflow divided by 2 output to P1.0

A6h.0 **T0OE:** Timer0 signal output (T0O) control
0: Disable Timer0 overflow divided by 64 output to P3.4
1: Enable Timer0 overflow divided by 64 output to P3.4

9. UART

The UART uses SCON and SBUF SFRs. SCON is the control register, SBUF is the data register. Data is written to SBUF for transmission and SBUF is read to obtain received data. The received data and transmitted data registers are completely independent. In addition to standard 8051's full duplex mode, this chip also provides one wire mode. If the UART1W bit is set, both transmit and receive data use P3.1 pin.

SFR **87h**	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
PCON	SMOD	–	–	–	GF1	GF0	PD	IDL
R/W	R/W	–	–	–	R/W	R/W	R/W	R/W
Reset	0	–	–	–	0	0	0	0

87h.7 **SMOD:** UART double baud rate control bit
0: Disable UART double baud rate
1: Enable UART double baud rate

SFR **94h**	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
OPTION	UART1W	TKFJMP	WDTPSC		ADCKS		TM3PSC	
R/W	R/W	R/W	R/W		R/W		R/W	
Reset	0	0	0	0	0	0	0	0

94h.7 **UART1W:** One wire UART mode enable, both TXD/RXD use P3.1 pin
0: Disable one wire UART mode
1: Enable one wire UART mode

SFR **98h**	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
SCON	SM0	SM1	SM2	REN	TB8	RB8	TI	RI
R/W	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

98h.7~6 **SM0,SM1:** Serial port mode select bit 0,1
00: Mode0: 8 bit shift register, Baud Rate=$F_{SYSCLK}/2$
01: Mode1: 8 bit UART, Baud Rate is variable
10: Mode2: 9 bit UART, Baud Rate=$F_{SYSCLK}/32$ or/64
11: Mode3: 9 bit UART, Baud Rate is variable

98h.5 **SM2:** Serial port mode select bit 2
SM2 enables multiprocessor communication over a single serial line and modifies the above as follows. In Modes 2 & 3, if SM2 is set then the received interrupt will not be generated if the received ninth data bit is 0. In Mode 1, the received interrupt will not be generated unless a valid stop bit is received. In Mode 0, SM2 should be 0.

98h.4 **REN:** UART reception enable
0: Disable reception
1: Enable reception

98h.3 **TB8:** Transmit Bit 8, the ninth bit to be transmitted in Mode 2 and 3

98h.2 **RB8:** Receive Bit 8, contains the ninth bit that was received in Mode 2 and 3 or the stop bit is Mode 1 if SM2=0

98h.1 **TI:** Transmit interrupt flag
Set by H/W at the end of the eighth bit in Mode 0, or at the beginning of the stop bit in other modes. Must be cleared by S/W.

98h.0 **RI:** Receive interrupt flag
Set by H/W at the end of the eighth bit in Mode 0, or at the sampling point of the stop bit in other modes. Must be cleared by S/W.

SFR **99h**	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
SBUF	SBUF							
R/W	R/W							
Reset	–	–	–	–	–	–	–	–

99h.7~0 **SBUF:** UART transmit and receive data. Transmit data is written to this location and receive data is read from this location, but the paths are independent.

F_{SYSCLK} denotes System clock frequency, the UART baud rate is calculated as below.

- **Mode 0:**
  Baud Rate=$F_{SYSCLK}/2$
- **Mode 1, 3:** if using Timer1 auto reload mode
  Baud Rate= (SMOD + 1) x F_{SYSCLK}/ (32 x 2 x (256 – TH1))
- **Mode 1, 3:** if using Timer2
  Baud Rate=Timer2 overflow rate/16 = F_{SYSCLK}/ (32 x (65536 – RCP2H, RCP2L))
- **Mode 2:**
  Baud Rate= (SMOD + 1) x $F_{SYSCLK}/64$

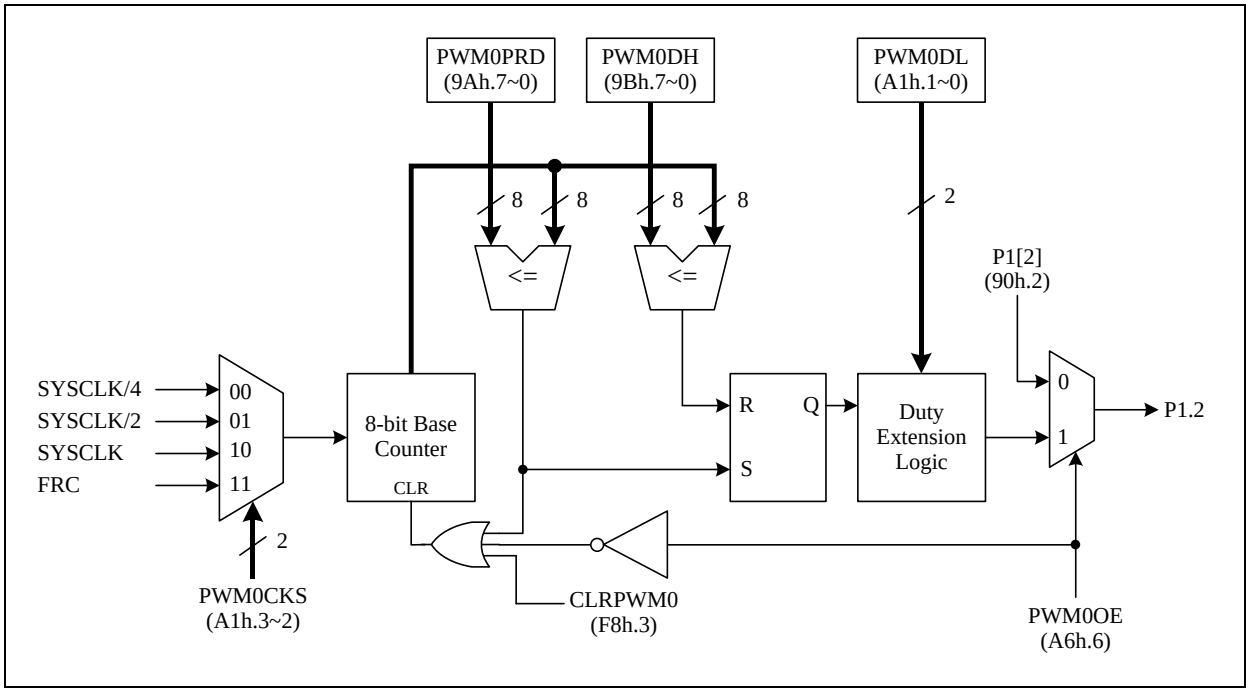
Note6: also refer to Section 6 for more information about UART Interrupt enable and priority.
Note: also refer to Section 8 for more information about how Timer2 controls UART clock.

10. PWMs

The Chip has two independent PWM modules, PWM0 and PWM1. The PWM can generate varies frequency waveform with 1024 duty resolution on the basis of the PWM clock. The PWM clock can select FRC or F_{SYSCLK} divided by 1, 2, or 4 as its clock source. A spread LSB technique allows PWM to run its frequency at the "PWM clock divided by 256" instead of at the "PWM clock divided by 1024", which means the PWM is four times faster than normal. The advantage of a higher PWM frequency is that the post RC filter can transform the PWM signal to a more stable DC voltage level.

The PWM output signal resets to a low level whenever the 8-bit base counter matches the 8-bit MSB of the PWM duty register. When the base counter rolls over, the 2-bit LSB of the PWM duty register decides whether to set the PWM output signal high immediately or set it high after one clock cycle delay. The PWM period can be set by writing the period value to the 8-bit PWM period register.

The pin mode SFR controls the PWM output waveform format. Mode1 makes the PWM open drain output and Mode2 makes the PWM CMOS push-pull output. (***see section 7***)



PWM Structure

SFR **9Ah**	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
PWM0PRD	PWM0PRD							
R/W	R/W							
Reset	1	1	1	1	1	1	1	1

9Ah.7~0 **PWM0PRD:** PWM0 8-bit period register

SFR **9Bh**	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
PWM0DH	PWM0DH							
R/W	R/W							
Reset	1	0	0	0	0	0	0	0

9Bh.7~0 **PWM0DH:** bits 9~2 of the PWM0 10-bit duty register

SFR **9Ch**	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
PWM1PRD	PWM1PRD							
R/W	R/W							
Reset	1	1	1	1	1	1	1	1

9Ch.7~0 **PWM1PRD:** PWM1 8-bit period register

SFR **9Dh**	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
PWM1DH	PWM1DH							
R/W	R/W							
Reset	1	0	0	0	0	0	0	0

9Dh.7~0 **PWM1DH:** bits 9~2 of the PWM1 10-bit duty register

SFR **A1h**	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
PWMCON	PWM1CKS		PWM1DL		PWM0CKS		PWM0DL	
R/W	R/W		R/W		R/W		R/W	
Reset	1	0	0	0	1	0	0	0

A1h.7~6 **PWM1CKS:** PWM1 clock source
00: $F_{SYSCLK}/4$
01: $F_{SYSCLK}/2$
10: F_{SYSCLK}
11: FRC

A1h.5~4 **PWM1DL:** bits 1~0 of the PWM1 10-bit duty register

A1h.3~2 **PWM0CKS:** PWM0 clock source
00: $F_{SYSCLK}/4$
01: $F_{SYSCLK}/2$
10: F_{SYSCLK}
11: FRC

A1h.1~0 **PWM0DL:** bits 1~0 of the PWM0 10-bit duty register

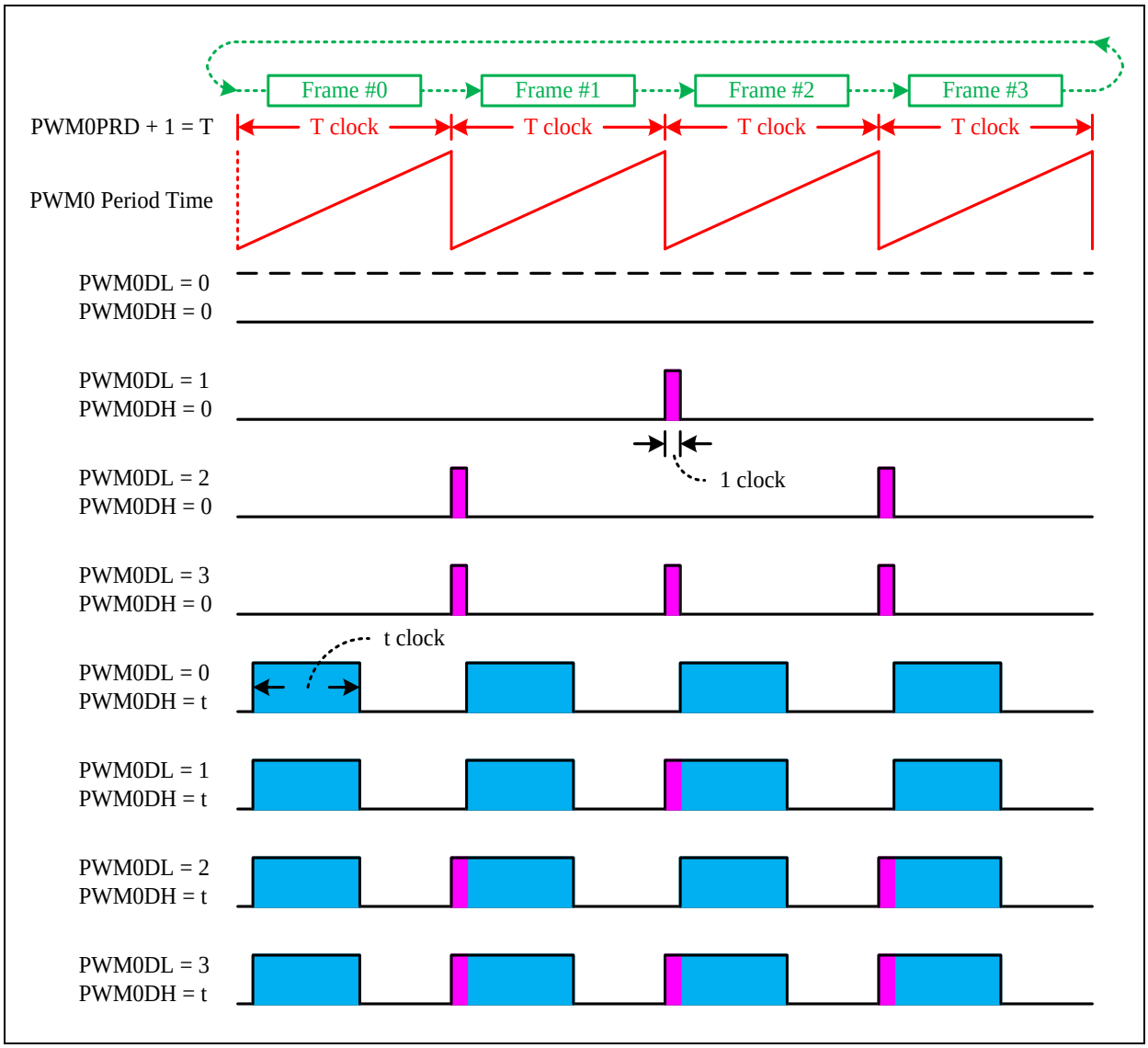
SFR **A6h**	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
PINMOD	PWM1OE	PWM0OE	TCOE	T2OE	–	–	–	T0OE
R/W	R/W	R/W	R/W	R/W	–	–	–	R/W
Reset	0	0	0	0	–	–	–	0

A6h.7 **PWM1OE:** PWM1 control
0: PWM1 disable
1: PWM1 enable and signal output to P1.3 pin

A6h.6 **PWM0OE:** PWM0 control
0: PWM0 disable
1: PWM0 enable and signal output to P1.2 pin

SFR **F8h**	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
AUX1	CLRWDT	CLRTM3	TKSOC	ADSOC	CLRPWM0	T2SEL	T1SEL	DPSEL
R/W	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

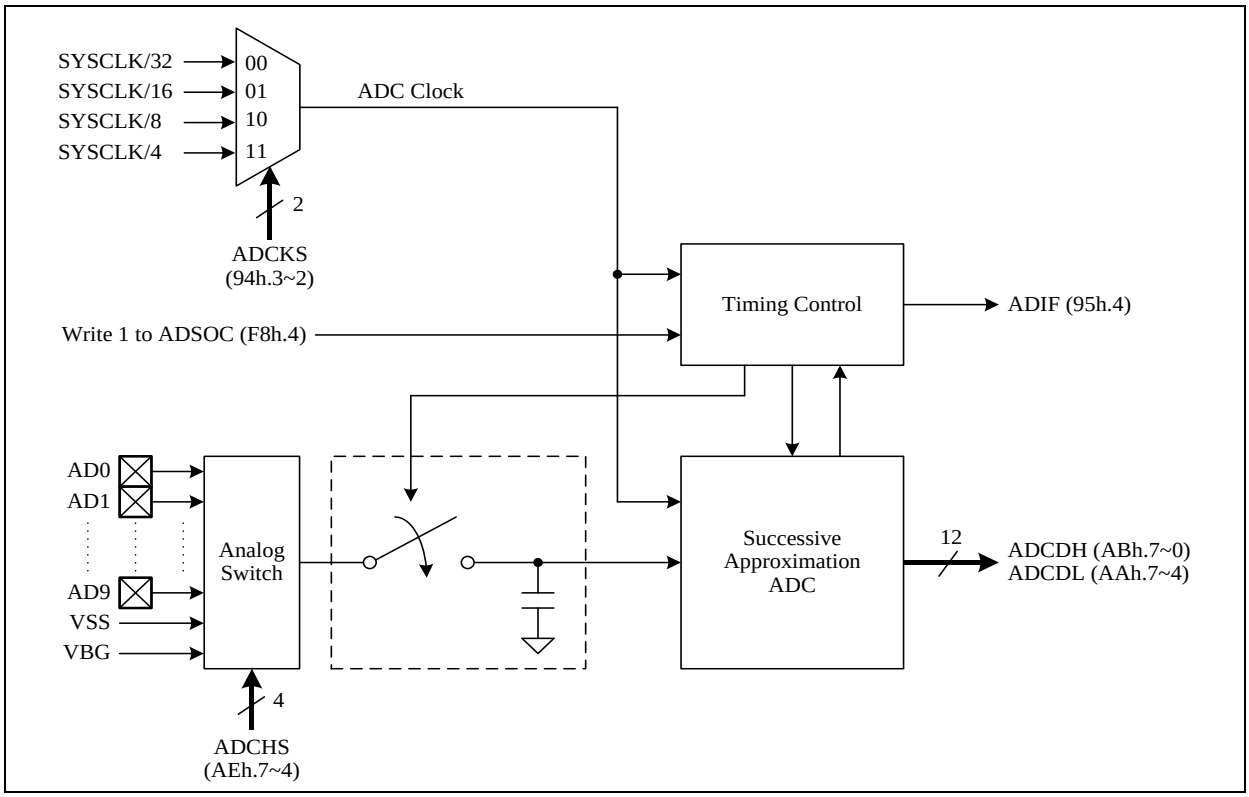
F8h.3 **CLRPWM0:** PWM0 clear enable
0: PWM0 is running
1: PWM0 is cleared and held



PWM Waveform

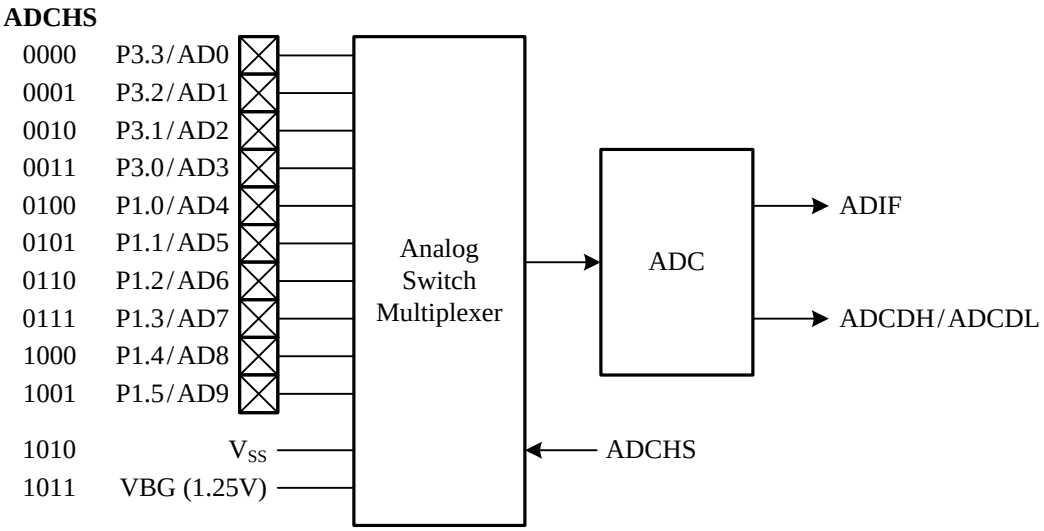
11. ADC

The Chip offers a 12-bit ADC consisting of a 12-channel analog input multiplexer, control register, clock generator, 12-bit successive approximation register, and output data register. To use the ADC, set the ADCKS bit first to choose a proper ADC clock frequency, which must be less than 1 MHz. Then, launch the ADC conversion by setting the ADSOC bit, and H/W will automatic clear it at the end of the conversion. After the end of the conversion, H/W will set the ADIF bit and generate an interrupt if an ADC interrupt is enabled. The ADIF bit can be cleared by writing 0 to this bit or 1 to the ADSOC bit. Because certain channels are shared with the Touch Key, the ADC channel must be configured differently from the Touch Key channel to avoid affecting the channel input sensitivity. The analog input level must remain within the range from V_{SS} to V_{CC}.



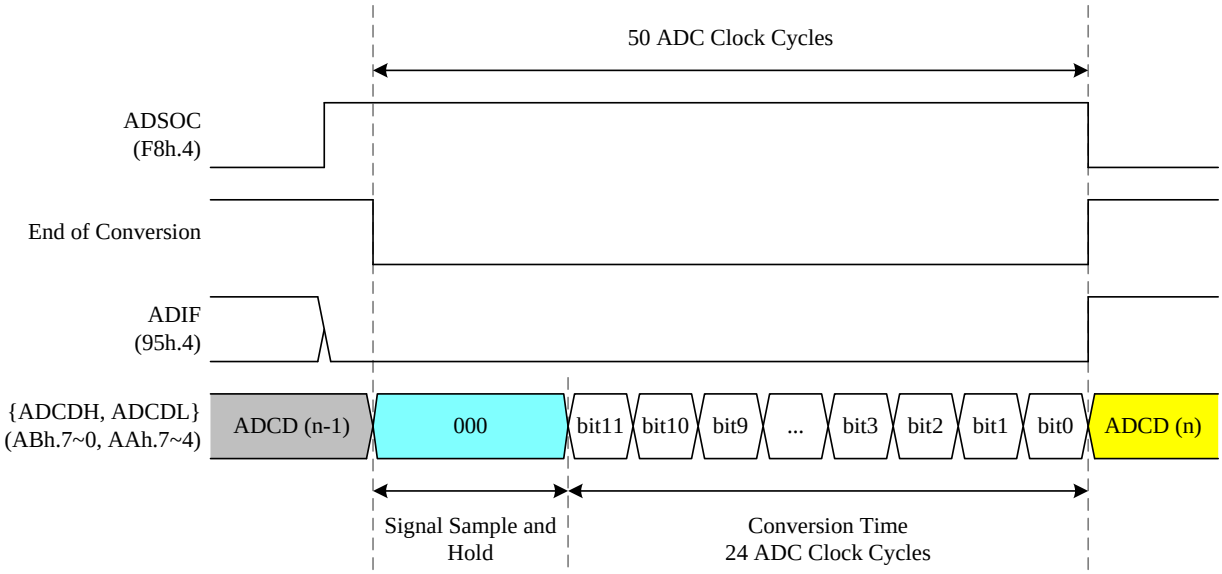
11.1 ADC Channels

The 12-bit ADC has a total of 12 channels, designated AD0~AD9, V_{SS}, and VBG. The ADC channels are connected to the analog input pins via the analog switch multiplexer. The analog switch multiplexer is controlled by the ADCHS register. The Chip offers up to 10 analog input pins, designated AD0~AD9. In addition, there are two analog input pins for voltage reference connections. When ADCHS is set to 1010b, the analog input will connect to V_{SS}, and when ADCHS is set to 1011b, the analog input will connect to VBG. VBG is an internal voltage reference at 1.25V.



11.2 ADC Conversion Time

The conversion time is the time required for the ADC to convert the voltage. The ADC requires two ADC clock cycles to convert each bit and several clock cycles to sample and hold the input voltage. A total of 50 ADC clock cycles are required to perform the complete conversion. When the conversion time is complete, the ADIF interrupt flag is set by H/W, and the result is loaded into the ADCDH and ADCDL registers of the 12-bit A/D result.



SFR **94h**	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
OPTION	UART1W	TKFJMP	WDTPSC		ADCKS		TM3PSC	
R/W	R/W	R/W	R/W		R/W		R/W	
Reset	0	0	0	0	0	0	0	0

94h.3~2 **ADCKS:** ADC clock rate select

00: F_{SYSCLK}/32
01: F_{SYSCLK}/16
10: F_{SYSCLK}/8
11: F_{SYSCLK}/4

SFR **95h**	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
INTFLG	LVD	–	TKIF	ADIF	–	IE2	P1IF	TF3
R/W	R	–	R/W	R/W	–	R/W	R/W	R/W
Reset	–	–	0	0	–	0	0	0

95h.4 **ADIF:** ADC interrupt flag

Set by H/W at the end of ADC conversion. S/W writes EFh to INTFLG or sets the ADSOC bit to clear this flag. (***Note5***)

SFR **AAh**	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
ADTKDT	ADCDL				TKDH			
R/W	R				R			
Reset	–	–	–	–	–	–	–	–

AAh.7~4 **ADCDL:** ADC data bit 3~0

SFR **ABh**	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
ADCDH	ADCDH							
R/W	R							
Reset	–	–	–	–	–	–	–	–

ABh.7~0 **ADCDH:** ADC data bit 11~4

SFR **AEh**	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
CHSEL	ADCHS				TKCHS			
R/W	R/W				R/W			
Reset	1	1	1	1	1	1	1	1

AEh.7~4 **ADCHS:** ADC channel select

0000: AD0 (P3.3)
0001: AD1 (P3.2)
0010: AD2 (P3.1)
0011: AD3 (P3.0)
0100: AD4 (P1.0)
0101: AD5 (P1.1)
0110: AD6 (P1.2)
0111: AD7 (P1.3)
1000: AD8 (P1.4)
1001: AD9 (P1.5)
1010: V_{SS}
1011: V_{BG} (Internal Bandgap Reference Voltage)
11xx: Undefined

Note: FW must turn off Bandgap to obtain Tiny Current (ADCHS≠0b1011)

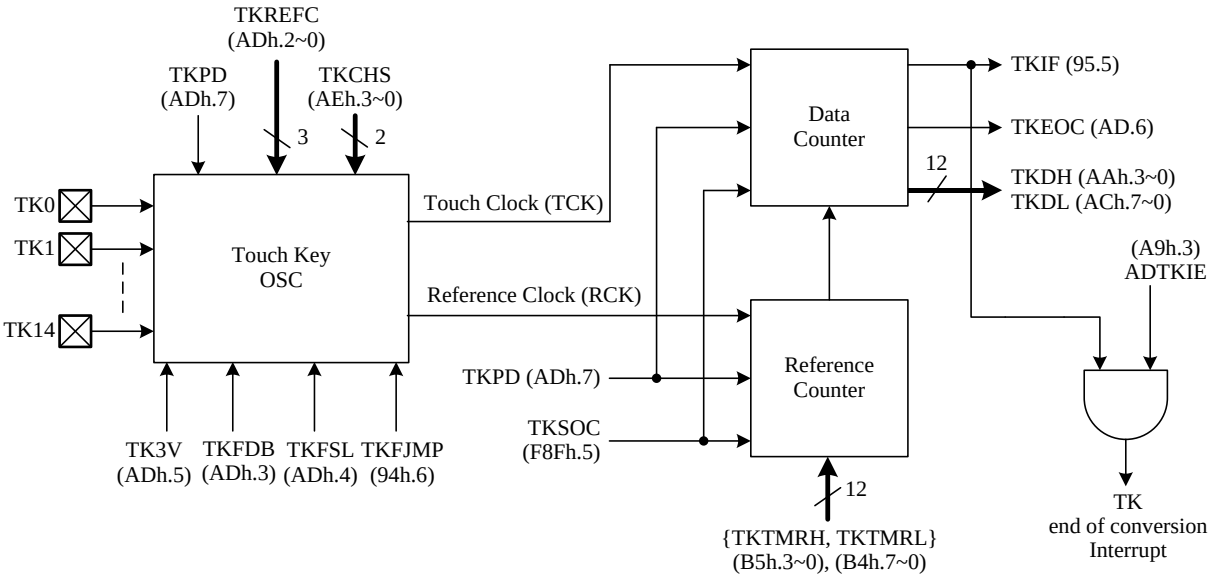
SFR **F8h**	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
AUX1	CLRWDT	CLRTM3	TKSOC	ADSOC	CLRPWM0	T2SEL	T1SEL	DPSEL
R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W
Reset	0	0	0	0	0	0	0	0

F8h.5 **ADSOC:** Start Touch Key conversion

Set the ADSOC bit to start ADC conversion. S/W write 0 to clear this flag. Usually, ADSOC bit can be cleared by H/W at the end of conversion, but HW may fail to clear it may when SW write AUX1 simultaneously. It is recommended to polling ADIF rather than ADSOC.

12. Touch Key (M8258/68 only)

The Touch Key offers an easy, simple and reliable method to implement finger touch detection. In most applications, it doesn't require any external component. The device support 15 channels touch key detection.



Touch Key Structure

To use the Touch Key, user must setup the Pin Mode (***see Section 7***) correctly as below table. Setting Mode0 for an Idling Touch Key pin can pull up the pin and reduce the mutual interference between the adjacent keys.

P1MODx / P3MODx setting for Touch Key	TK0~TK14
Pin is Touch Key, Idling	Mode0
Pin is Touch Key, Scanning	Mode0

In the Touch Key Module, there are two oscillators: Reference Clock (RCK) and Touch Clock (TCK). They are connected to the Reference Counter and Data Counter respectively. The frequency of RCK can be adjusted by setting TKREFC, TKFDB (frequency double) and TKFSL (frequency slow). Reference Counter is used to control conversion time. From starting touch key conversion to end, it will take 0 to 4096 RCK oscillation cycles by setting TKTMR. After end of conversion, user can get TKDATA (TKDH, TKDL) from Data counter. TKDATA is affected by finger touching. As finger touching TCK is getting slower, the value of TKDATA is smaller than the no finger touching. According to the difference of TKDATA, user can check if it is touched of not. A suitable TKTMR and TKREFC setting can adjust TKDATA to adapt the system board circumstances. To get the best TKREFC setting, user can try different TKREFC value (with TKFDB=0), then find the one which makes the TKDATA and TKTMR as close as possible.

To start the Scanning, user assigns TKPD=0, then set the TKSOC bit to start touch key conversion, the TKSOC bit can be automatically cleared while end of conversion. However, if the SYSCLK is too slow, H/W might fail to clear TKSOC due to clock sampling rate. TKEOC=0 means conversion is in process. TKEOC=1 means the conversion is finish, and the touch key counting result is stored into the 12 bits TK Data Counter TKDH and TKDL.

Note: TKEOC may have 3uS delay after TKSOC=1, so F/W must wait enough time before polling this Flag

TKIF will active at the first time enable Touch Key function (TKPD=0), user should clear TKIF after TKPD cleared.

◇ Example:

```
MOV     TKCON,#04h          ; TKPD=0, TKS3V=TKFSL=TKFDB=0
                            ; TKREFC=4h
MOV     TKTMRH,#004h
MOV     TKTMRL,#000h        ; TKTMR=400h
MOV     CHSEL,#0F0h         ; Select TK0
MOV     INTFLG,#11011111b   ; clear TKIF
ORL     INTE1,#008h
ORL     IE,#080h
SETB    TKSOC
```

SFR **94h**	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
OPTION	UART1W	TKFJMP	WDTPSC		ADCKS		TM3PSC	
R/W	R/W	R/W	R/W		R/W		R/W	
Reset	0	0	0	0	0	0	0	0

94h.6 **TKFJMP:** RCK Frequency auto adjust option
0: Disable
1: Enable

SFR **95h**	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
INTFLG	LVD	–	TKIF	ADIF	–	IE2	P1IF	TF3
R/W	R	–	R/W	R/W	–	R/W	R/W	R/W
Reset	–	–	0	0	–	0	0	0

95h.5 **TKIF:** Touch Key Interrupt Flag
Set by H/W at the end of Touch Key conversion if SYSCLK is fast enough. S/W writes DFh to INTFLG or sets the TKSOC bit to clear this flag. (***Note5***)

SFR **AAh**	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
ADTKDT	ADCDL				TKDH			
R/W	R				R			
Reset	–	–	–	–	–	–	–	–

AAh.3~0 **TKDH:** Touch Key counter data bit 10~8

SFR **ACh**	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
TKDL	TKDL							
R/W	R							
Reset	–	–	–	–	–	–	–	–

ACh.7~0 **TKDL:** Touch Key counter data bit 7~0

SFR **ADh**	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
TKCON	TKPD	TKEOC	TKS3V	TKFSL	TKFDB	TKREFC		
R/W	R/W	R	R/W	R/W	R/W	R/W		
Reset	1	0	0	0	0	1	0	0

ADh.7 **TKPD:** Touch Key power down
0: Touch Key enable
1: Touch Key disable

ADh.6 **TKEOC:** Touch Key end of conversion flag, TKEOC may have 3uS delay after TKSOC=1, so F/W must wait enough time before polling this Flag.
0: Indicates conversion is in progress
1: Indicates conversion is finished

ADh.5 **TKS3V:** Touch Key operation voltage select
0: for V_{CC}>3.6V operation
1: for V_{CC}<3.6V operation

ADh.4 **TKFSL:** Touch Key reference clock (RCK) slow frequency enable
0: select normal RCK
1: select slower RCK

ADh.3 **TKFDB:** Touch Key reference clock (RCK) double frequency enable
0: select normal RCK
1: select double RCK

ADh.2~0 **TKREFC:** Touch Key reference clock capacitor select
000: smallest (RCK frequency fastest, conversion time shortest)
…
111: biggest (RCK frequency slowest, conversion time longest)

SFR **B4h**	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
TKTMRL	TKTMRL							
R/W	R/W							
Reset	1	1	1	1	1	1	1	1

B4h.7~0 **TKTMRL:** Touch Key reference counter LSB[7~0]

SFR **B5h**	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
TKTMRH	–	–	–	–	TKTMRH			
R/W	–	–	–	–	R/W			
Reset	–	–	–	–	0	0	0	0

B5h.3~0 **TKTMRH:** Touch Key reference counter MSB[11~8]

SFR **AEh**	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
CHSEL	ADCHS				TKCHS			
R/W	R/W				R/W			
Reset	1	1	1	1	1	1	1	1

AEh.3~0 **TKCHS:** Touch Key channel select

0000: TK0 (P3.3)
0001: TK1 (P3.2)
0010: TK2 (P3.1)
0011: TK3 (P3.0)
0100: TK4 (P1.0)
0101: TK5 (P1.1)
0110: TK6 (P1.2)
0111: TK7 (P1.3)
1000: TK8 (P1.4)
1001: TK9 (P1.6)
1010: TK10 (P1.7)
1011: TK11 (P3.6)
1100: TK12 (P3.5)
1101: TK13 (P3.4)
1110: TK14 (P1.5)
1111: Undefined

SFR **F8h**	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
AUX1	CLRWDT	CLRTM3	TKSOC	ADSOC	CLRPWM0	T2SEL	T1SEL	DPSEL
R/W	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

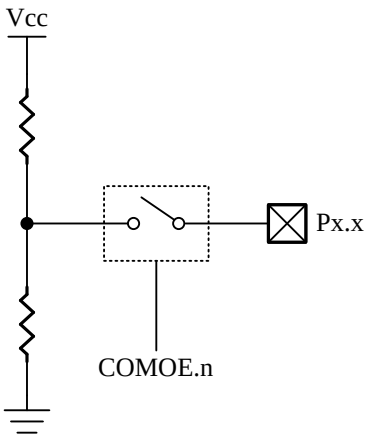
F8h.5 **TKSOC:** Touch Key Start of Conversion

Set the TKSOC bit to start Touch Key conversion. SW write 0 to clear this flag. Usually, TKSOC bit can be cleared by H/W at the end of conversion, but HW may fail to clear it when SW write AUX1 simultaneously or when SYSCLK too slow. It is recommended to polling TKIF/TKEOC rather than polling TKSOC

Note6: also refer to Section 6 for more information about Touch Key Interrupt enable and priority.

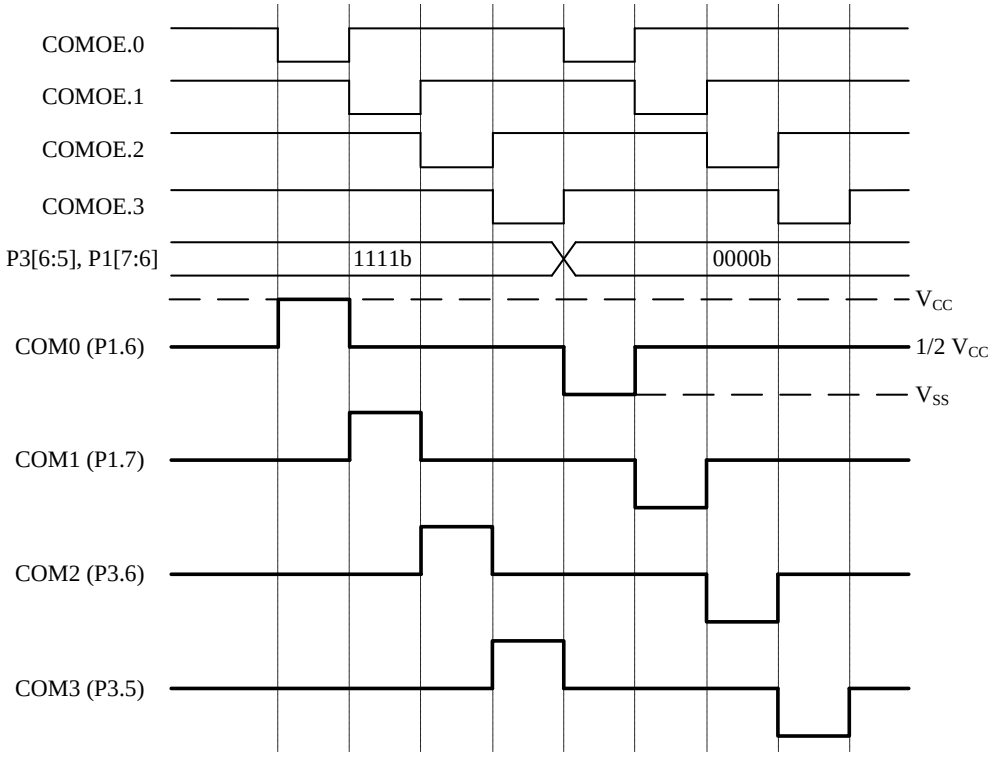
13. S/W Controller LCD Driver

The chip supports an S/W controlled method to driving LCD. It is capable of driving the LCD panel with 52 dots (Max.) by 4 Commons (COM) and 13 Segments (SEG). The P1.6/P1.7/P3.6/P3.5 are used for Common pins COM0~COM3 and other IO pins (except P3.7) can be used for Segment pins. COM0~COM3 are capable to driving 1/2 bias output when setting SFR COMOE respectively. Refer to the following figures.



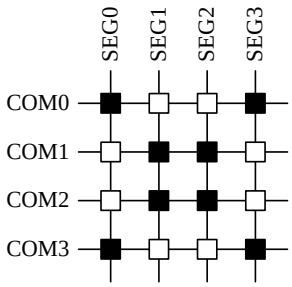
LCD COM0~3 Circuit

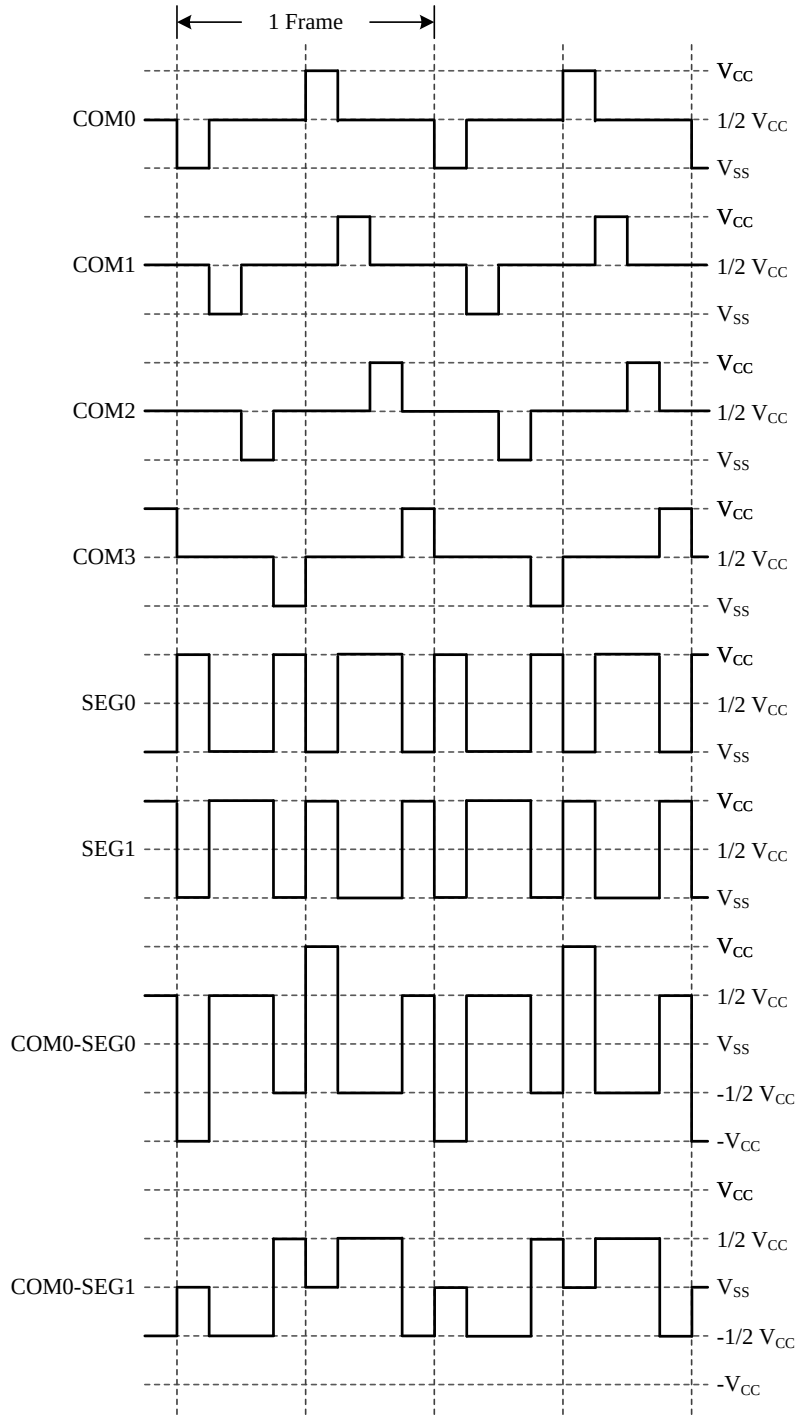
S/W can set P1.6/P1.7/P3.6/P3.5 as CMOS output mode and set SFR COMOE to output 1/2 Vcc. The figure below shows an LCD frame.



S/W Controlled LCD COM0~3 Scanning

1/4 Duty, 1/2 Bias Output Waveform





SFR **92h**	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
COMOE	–	–	–	–	COM3OE	COM2OE	COM1OE	COM0OE
R/W	–	–	–	–	R/W	R/W	R/W	R/W
Reset	–	–	–	–	0	0	0	0

92h.3 **COM3OE:** P3.5 1/2 bias output
0: Disable 1: Enable

92h.2 **COM2OE:** P3.6 1/2 bias output
0: Disable 1: Enable

92h.1 **COM1OE:** P1.7 1/2 bias output
0: Disable 1: Enable

92h.0 **COM0OE:** P1.6 1/2 bias output
0: Disable 1: Enable

SFR **A3h**	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
P1MODH	P1MOD7		P1MOD6		P1MOD5		P1MOD4	
R/W	R/W		R/W		R/W		R/W	
Reset	0	0	0	0	0	0	0	0

A3h.7~6 **P1MOD7:** P1.7 pin control.
00: Mode0 or P1.7 as Touch Key input.
01: Mode1
10: Mode2 as CMOS ouptu
11: Mode3

A3h.5~4 **P1MOD6:** P1.6 pin control.
00: Mode0 or P1.6 as Touch Key input.
01: Mode1
10: Mode2 as CMOS ouptu
11: Mode3

SFR **A5h**	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
P3MODH	–	–	P3MOD6		P3MOD5		P3MOD4	
R/W	–	–	R/W		R/W		R/W	
Reset	–	–	0	0	0	0	0	0

A5h.5~4 **P3MOD6:** P3.6 pin control.
00: Mode0 or P3.6 as Touch Key input.
01: Mode1
10: Mode2 as CMOS ouptu
11: Mode3

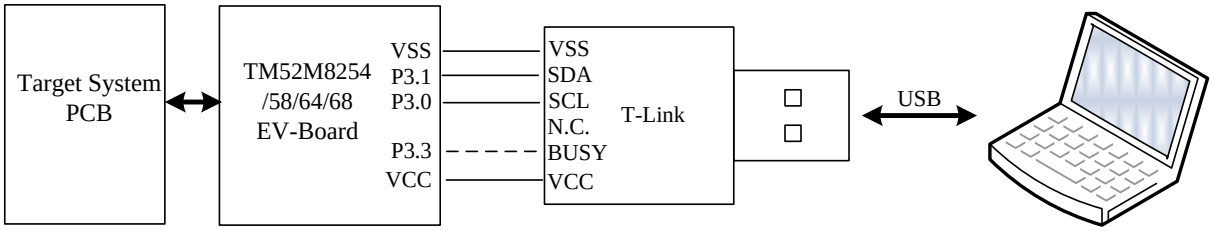
A5h.3~2 **P3MOD5:** P3.5 pin control.
00: Mode0 or P35 as Touch Key input.
01: Mode1
10: Mode2 as CMOS ouptu
11: Mode3

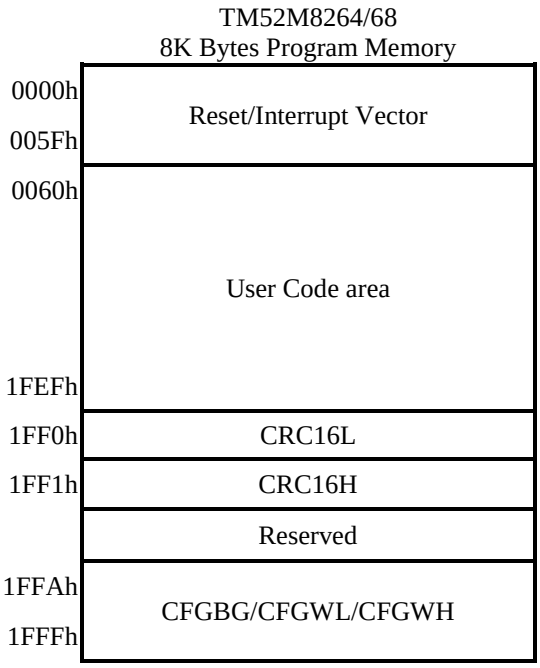
Mode	Pin function (except P3.7)		Px.n SFR data	Pin State	Resistor Pull-up	Digital Input
	P3.0~P3.2	Others				
Mode 0	Pseudo Open Drain	Open Drain	0	Drive Low	N	N
			1	Pull-up	Y	Y
Mode 1	Pseudo Open Drain	Open Drain	0	Drive Low	N	N
			1	Hi-Z	N	Y
Mode 2	CMOS Output		0	Drive Low	N	N
			1	Drive High	N	N
Mode 3	Analog input for ADC, digital input buffer is disabled		X (don't care)	–	N	N

14. In Circuit Emulation (ICE) Mode

This device is not support ICE mode,it needs to be developed by EV Board and development tool (T-Link). User just needs to connect P3.0 and P3.1 pin to the EV Board. But there are some limits for the ICE mode as below.

1. The device must be un-protect.
2. The device's P3.0 and P3.1 pins must work in input Mode (P3MOD0 = 0/1 and P3MOD1=0/1).
3. The T-Link communication pin's function cannot be emulated.





SFR & CFGW MAP

Adr	RST	NAME	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
80h	1111-1111	**P0**	P0.7	P0.6	P0.5	P0.4	P0.3	P0.2	P0.1	P0.0
81h	0000-0111	**SP**	SP							
82h	0000-0000	**DPL**	DPL							
83h	0000-0000	**DPH**	DPH							
87h	0xxx-0000	**PCON**	SMOD	–	–	–	GF1	GF0	PD	IDL
88h	0000-0000	**TCON**	TF1	TR1	TF0	TR0	IE1	IT1	IE0	IT0
89h	0000-0000	**TMOD**	GATE1	CT1N	TMOD1		GATE0	CT0N	TMOD0	
8Ah	0000-0000	**TL0**	TL0							
8Bh	0000-0000	**TL1**	TL1							
8Ch	0000-0000	**TH0**	TH0							
8Dh	0000-0000	**TH1**	TH1							
90h	1111-1111	**P1**	P1.7	P1.6	P1.5	P1.4	P1.3	P1.2	P1.1	P1.0
92h	xxxx-0000	**COMOE**	–	–	–	–	COM3OE	COM2OE	COM1OE	COM0OE
93h	xxxx-0101	**P2MOD**	–	–	–	–	P2MOD1		P2MOD0	
94h	0000-0000	**OPTION**	UART1W	TKFJMP	WDTPSC		ADCKS		TM3PSC	
95h	xx00-x000	**INTFLG**	LVD	–	TKIF	ADIF	–	IE2	P1IF	TF3
96h	0000-0000	**P1WKUP**	P1WKUP							
97h	xxxx-xxx0	**SWCMD**	IAPALL / SWRST							
98h	0000-0000	**SCON**	SM0	SM1	SM2	REN	TB8	RB8	TI	RI
99h	xxxx-xxxx	**SBUF**	SBUF							
9Ah	1111-1111	**PWM0PRD**	PWM0PRD							
9Bh	1000-0000	**PWM0DH**	PWM0DH							
9Ch	1111-1111	**PWM1PRD**	PWM1PRD							
9Dh	1000-0000	**PWM1DH**	PWM1DH							
A0h	1111-1111	**P2**	P2.7	P2.6	P2.5	P2.4	P2.3	P2.2	P2.1	P2.0
A1h	1000-1000	**PWMCON**	PWM1CKS		PWM1DL		PWM0CKS		PWM0DL	
A2h	0000-0000	**P1MODL**	P1MOD3		P1MOD2		P1MOD1		P1MOD0	
A3h	0000-0000	**P1MODH**	P1MOD7		P1MOD6		P1MOD5		P1MOD4	
A4h	0101-0101	**P3MODL**	P3MOD3		P3MOD2		P3MOD1		P3MOD0	
A5h	xx00-0000	**P3MODH**	–	–	P3MOD6		P3MOD5		P3MOD4	
A6h	0000-xxx0	**PINMOD**	PWM1OE	PWM0OE	TCOE	T2OE	–	–	–	T0OE
A8h	0x00-0000	**IE**	EA	–	ET2	ES	ET1	EX1	ET0	EX0
A9h	xxxx-0000	**INTE1**	–	–	–	–	ADTKIE	EX2	P1IE	TM3IE
AAh	xxxx-xxxx	**ADTKDT**	ADCDL				TKDH			
ABh	xxxx-xxxx	**ADCDH**	ADCDH							
ACh	xxxx-xxxx	**TKDL**	TKDL							
ADh	1x00-0100	**TKCON**	TKPD	TKEOC	TKS3V	TKFSL	TKFDB	TKREFC		
AEh	1111-1111	**CHSEL**	ADCHS				TKCHS			
B0h	1111-1111	**P3**	P3.7	P3.6	P3.5	P3.4	P3.3	P3.2	P3.1	P3.0
B4h	1111-1111	**TKTMRL**	TKTMRL							
B5h	xxxx-0000	**TKTMRH**	–	–	–	–	TKTMRH			
B8h	xx00-0000	**IP**	–	–	PT2	PS	PT1	PX1	PT0	PX0
B9h	xx00-0000	**IPH**	–	–	PT2H	PSH	PT1H	PX1H	PT0H	PX0H
BAh	xxxx-0000	**IP1**	–	–	–	–	PADTKI	PX2	PP1	PT3
BBh	xxxx-0000	**IP1H**	–	–	–	–	PADTKIH	PX2H	PP1H	PT3H
C8h	0000-0000	**T2CON**	TF2	EXF2	RCLK	TCLK	EXEN2	TR2	CT2N	CPRL2N
CAh	0000-0000	**RCP2L**	RCP2L							
CBh	0000-0000	**RCP2H**	RCP2H							
CCh	0000-0000	**TL2**	TL2							
CDh	0000-0000	**TH2**	TH2							
D0h	0000-0000	**PSW**	CY	AC	F0	RS1	RS0	OV	F1	P
D8h	00x0-0011	**CLKCON**	SCKTYPE	FCKTYPE	–	STPPCK	STPFCK	SELFCK	CLKPSC	
E0h	0000-0000	**ACC**	ACC.7	ACC.6	ACC.5	ACC.4	ACC.3	ACC.2	ACC.1	ACC.0
F0h	0000-0000	**B**	B.7	B.6	B.5	B.4	B.3	B.2	B.1	B.0
F5h	xxxx-xxxx	**CFGBG**	–	–	–	–	BGTRIM			
F6h	xxxx-xxxx	**CFGWL**	–	FRCF						
F7h	000x-xxxx	**AUX2**	WDTE		PWRSAV	VBGOUT	–	–	–	–
F8h	0000-0000	**AUX1**	CLRWDT	CLRTM3	TKSOC	ADSOC	CLRPWM0	T2SEL	T1SEL	DPSEL

MTP Address	NAME	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
1FFBh	**CFGBG**	–	–	–	–	BGTRIM			
1FFDh	**CFGWL**	–	FRCF						
1FFFh	**CFGWH**	PROT	XRSTE	LVRE		–	–	–	–

SFR & CFGW DESCRIPTION

Adr	SFR	Bit#	Bit Name	R/W	Rst	Description
80h	**P0**	7~0	P0	R/W	FFh	Port0 has no pin out, so P0 is used as general purpose register
81h	**SP**	7~0	SP	R/W	07h	Stack Point
82h	**DPL**	7~0	DPL	R/W	00h	Data Point low byte
83h	**DPH**	7~0	DPH	R/W	00h	Data Point high byte
87h	**PCON**	7	SMOD	R/W	0	Set 1 to enable UART double baud rate
		3	GF1	R/W	0	General purpose flag bit
		2	GF0	R/W	0	General purpose flag bit
		1	PD	R/W	0	Power down control bit, set 1 to enter STOP mode
		0	IDL	R/W	0	Idle control bit, set 1 to enter IDLE mode
88h	**TCON**	7	TF1	R/W	0	Timer1 overflow flag Set by H/W when Timer/Counter 1 overflows. Cleared by H/W when CPU vectors into the interrupt service routine.
		6	TR1	R/W	0	Timer1 run control. 1: timer runs; 0: timer stops
		5	TF0	R/W	0	Timer0 overflow flag Set by H/W when Timer/Counter 0 overflows. Cleared by H/W when CPU vectors into the interrupt service routine.
		4	TR0	R/W	0	Timer0 run control. 1:timer runs; 0:timer stops
		3	IE1	R/W	0	External Interrupt 1 (INT1 pin) edge flag Set by H/W when an INT1 pin falling edge is detected. Cleared by H/W when CPU vectors into the interrupt service routine.
		2	IT1	R/W	0	External Interrupt 1 control bit 0: Low level active (level triggered) for INT1 pin 1: Falling edge active (edge triggered) for INT1 pin
		1	IE0	R/W	0	External Interrupt 0 (INT0 pin) edge flag Set by H/W when an INT0 pin falling edge is detected. Cleared by H/W when CPU vectors into the interrupt service routine.
		0	IT0	R/W	0	External Interrupt 0 control bit 0: Low level active (level triggered) for INT0 pin 1: Falling edge active (edge triggered) for INT0 pin
89h	**TMOD**	7	GATE1	R/W	0	Timer1 gating control bit 0: Timer1 enable when TR1 bit is set 1: Timer1 enable only while the INT1 pin is high and TR1 bit is set
		6	CT1N	R/W	0	Timer1 Counter/Timer select bit 0: Timer mode, Timer1 data increases at 2 System clock cycle rate 1: Counter mode, Timer1 data increases at T1 pin's negative edge
		5~4	TMOD1	R/W	00	Timer1 mode select 00: 8-bit timer/counter (TH1) and 5-bit prescaler (TL1) 01: 16-bit timer/counter 10: 8-bit auto-reload timer/counter (TL1). Reloaded from TH1 at overflow. 11: Timer1 stops
		3	GATE0	R/W	0	Timer0 gating control bit 0: Timer0 enable when TR0 bit is set 1: Timer0 enable only while the INT0 pin is high and TR0 bit is set
		2	CT0N	R/W	0	Timer0 Counter/Timer select bit 0: Timer mode, Timer0 data increases at 2 System clock cycle rate 1: Counter mode, Timer0 data increases at T0 pin's negative edge
		1~0	TMOD0	R/W	00	Timer0 mode select 00: 8-bit timer/counter (TH0) and 5-bit prescaler (TL0) 01: 16-bit timer/counter 10: 8-bit auto-reload timer/counter (TL0). Reloaded from TH0 at overflow. 11: TL0 is an 8-bit timer/counter. TH0 is an 8-bit timer/counter using Timer1's TR1 and TF1 bits.
8Ah	**TL0**	7~0	TL0	R/W	00h	Timer0 data low byte
8Bh	**TL1**	7~0	TL1	R/W	00h	Timer1 data low byte
8Ch	**TH0**	7~0	TH0	R/W	00h	Timer0 data high byte
8Dh	**TH1**	7~0	TH1	R/W	00h	Timer1 data high byte

Adr	SFR	Bit#	Bit Name	R/W	Rst	Description
90h	**P1**	7~0	P1	R/W	FFh	Port1 data
92h	**COMOE**	3	COM3OE	R/W	0	1: P3.5 1/2 bias output, no matter pin mode set
		2	COM2OE	R/W	0	1: P3.6 1/2 bias output, no matter pin mode set
		1	COM1OE	R/W	0	1: P1.7 1/2 bias output, no matter pin mode set
		0	COM0OE	R/W	0	1: P1.6 1/2 bias output, no matter pin mode set
93h	**P2MOD**	3~2	P2MOD1	R/W	01	P2.1 Pin Control 00: Mode0; 01: Mode1; 10: Mode2 11: not defined
		1~0	P2MOD0	R/W	01	P2.0 Pin Control 00: Mode0; 01: Mode1; 10: Mode2 11: not defined
94h	**OPTION**	7	UART1W	R/W	0	Set 1 to enable one wire UART mode, both TXD/RXD use P3.1 pin.
		6	TKFJMP	R/W	0	1: Touch Key RCK auto adjust 0: Touch Key RCK will not change
		5~4	WDTPSC	R/W	00	Watchdog Timer pre-scalar time select 00: 480ms WDT overflow rate 01: 240ms WDT overflow rate 10: 120ms WDT overflow rate 11: 60ms WDT overflow rate
		3~2	ADCKS	R/W	00	ADC clock rate select 00: F_{SYSCLK}/32; 01: F_{SYSCLK}/16; 10: F_{SYSCLK}/8; 11: F_{SYSCLK}/4
		1~0	TM3PSC	R/W	00	Timer3 Interrupt rate 00: Timer3 Interrupt rate is 32768 Slow clock cycle 01: Timer3 Interrupt rate is 16384 Slow clock cycle 10: Timer3 Interrupt rate is 8192 Slow clock cycle 11: Timer3 Interrupt rate is 128 Slow clock cycle
95h	**INTFLG**	7	LVD	R	–	Low Voltage Detect flag (2.7V) Set by H/W when a low voltage occurs. The flag is valid when LVR is 2.3V
		5	TKIF	R/W	0	Touch Key Interrupt Flag Set by H/W at the end of TK conversion if SYSCLK is fast enough. S/W writes DFh to INTFLG or sets the TKSOC bit to clear this flag.
		4	ADIF	R/W	0	ADC interrupt flag Set by H/W at the end of ADC conversion. S/W writes EFh to INTFLG or sets the ADSOC bit to clear this flag.
		2	IE2	R/W	0	External Interrupt 2 (INT2 pin) edge flag Set by H/W when a falling edge is detected on the INT2 pin, no matter the EX2 is 0 or 1. It is cleared automatically when the program performs the interrupt service routine. S/W can write FBh to INTFLG to clear this bit.
		1	P1IF	R/W	0	Port1 pin change Interrupt flag Set by H/W when a Port1 pin state change is detected and its interrupt enable bit is set (P1WKUP). P1IE does not affect this flag's setting. It is cleared automatically when the program performs the interrupt service routine. S/W can write FDh to INTFLG to clear this bit.
		0	TF3	R/W	0	Timer3 Interrupt Flag Set by H/W when Timer3 reaches TM3PSC setting cycles. It is cleared automatically when the program performs the interrupt service routine. S/W can write FEh to INTFLG to clear this bit.
96h	**P1WKUP**	7~0	P1WKUP	R/W	00h	P1.7~P1.0 pin individual Wake-up/Interrupt enable control 0: Disable; 1: Enable.
97h	**SWCMD**	7~0	SWRST	W		Write 56h to generate S/W Reset
		7~0	IAPALL	W		Write 65h to set IAPALL control flag; Write other value to clear IAPALL flag. It is recommended to clear it immediately after IAP access.
		1	WDTO	R	x	WatchDog Time-Out flag
		0	IAPALL	R	0	Flag indicates Flash memory sectors can be accessed by IAP or not. This bit combines with MVCLOCK to define the accessible IAP area.

Adr	SFR	Bit#	Bit Name	R/W	Rst	Description
98h	**SCON**	7	SM0	R/W	0	Serial port mode select bit 0, 1 (SM0, SM1) = 00: Mode0: 8 bit shift register, Baud Rate=F_{SYSCLK}/2 01: Mode1: 8 bit UART, Baud Rate is variable 10: Mode2: 9 bit UART, Baud Rate=F_{SYSCLK}/32 or /64 11: Mode3: 9 bit UART, Baud Rate is variable
		6	SM1	R/W	0	
		5	SM2	R/W	0	Serial port mode select bit 2 SM2 enables multiprocessor communication over a single serial line and modifies the above as follows. In Modes 2 & 3, if SM2 is set then the received interrupt will not be generated if the received ninth data bit is 0. In Mode 1, the received interrupt will not be generated unless a valid stop bit is received. In Mode 0, SM2 should be 0.
		4	REN	R/W	0	Set 1 to enable UART Reception
		3	TB8	R/W	0	Transmitter bit 8, ninth bit to transmit in Modes 2 and 3
		2	RB8	R/W	0	Receive Bit 8, contains the ninth bit that was received in Mode 2 and 3 or the stop bit is Mode 1 if SM2=0
		1	TI	R/W	0	Transmit Interrupt flag Set by H/W at the end of the eighth bit in Mode 0, or at the beginning of the stop bit in other modes. Must be cleared by S/W
		0	RI	R/W	0	Receive Interrupt flag Set by H/W at the end of the eighth bit in Mode 0, or at the sampling point of the stop bit in other modes. Must be cleared by S/W.
99h	**SBUF**	7~0	SBUF	R/W	–	UART transmit and receive data. Transmit data is written to this location and receive data is read from this location, but the paths are independent.
9Ah	**PWM0PRD**	7~0	PWM0PRD	R/W	FFh	PWM0 8-bit period register
9Bh	**PWM0DH**	7~0	PWM0DH	R/W	80h	bits 9~2 of the PWM0 10-bit duty register
9Ch	**PWM1PRD**	7~0	PWM1PRD	R/W	FFh	PWM1 8-bit period register
9Dh	**PWM1DH**	7~0	PWM1DH	R/W	80h	bits 9~2 of the PWM1 10-bit duty register
A0h	**P2**	7~2	P2.7~P2.2	R/W	3Fh	P2.7~P2.2 have no pin out, so these bits are used as general purpose register
		1~0	P2.1~P2.0	R/W	11	P2.1~P2.0 data
A1h	**PWMCON**	7~6	PWM1CKS	R/W	10	PWM1 clock source 00: F_{SYSCLK}/4 01: F_{SYSCLK}/2 10: F_{SYSCLK} 11: FRC
		5~4	PWM1DL	R/W	00	bits 1~0 of the PWM1 10-bit duty register
		3~2	PWM0CKS	R/W	10	PWM0 clock source 00: F_{SYSCLK}/4 01: F_{SYSCLK}/2 10: F_{SYSCLK} 11: FRC
		1~0	PWM0DL	R/W	00	bits 1~0 of the PWM0 10-bit duty register
A2h	**P1MODL**	7~6	P1MOD3	R/W	00	P1.3 Pin Control 00: Mode0; 01: Mode1; 10: Mode2 11: Mode3, P1.3 is ADC input
		5~4	P1MOD2	R/W	00	P1.2 Pin Control 00: Mode0; 01: Mode1; 10: Mode2 11: Mode3, P1.2 is ADC input
		3~2	P1MOD1	R/W	00	P1.1 Pin Control 00: Mode0; 01: Mode1; 10: Mode2 11: Mode3, P1.1 is ADC input
		1~0	P1MOD0	R/W	00	P1.0 Pin Control 00: Mode0; 01: Mode1; 10: Mode2 11: Mode3, P1.0 is ADC input

Adr	SFR	Bit#	Bit Name	R/W	Rst	Description
A3h	**P1MODH**	7~6	P1MOD7	R/W	00	P1.7 Pin Control 00: Mode0; 01: Mode1; 10: Mode2 11: Mode3
		5~4	P1MOD6	R/W	00	P1.6 Pin Control 00: Mode0; 01: Mode1; 10: Mode2 11: Mode3
		3~2	P1MOD5	R/W	00	P1.5 Pin Control 00: Mode0; 01: Mode1; 10: Mode2 11: Mode3, P1.5 is ADC input
		1~0	P1MOD4	R/W	00	P1.4 Pin Control 00: Mode0; 01: Mode1; 10: Mode2 11: Mode3, P1.4 is ADC input
A4h	**P3MODL**	7~6	P3MOD3	R/W	01	P3.3 Pin Control 00: Mode0; 01: Mode1; 10: Mode2 11: Mode3, P3.3 is ADC input
		5~4	P3MOD2	R/W	01	P3.2 Pin Control 00: Mode0; 01: Mode1; 10: Mode2 11: Mode3, P3.2 is ADC input
		3~2	P3MOD1	R/W	01	P3.1 Pin Control 00: Mode0; 01: Mode1; 10: Mode2 11: Mode3, P3.1 is ADC input
		1~0	P3MOD0	R/W	01	P3.0 Pin Control 00: Mode0; 01: Mode1; 10: Mode2 11: Mode3, P3.0 is ADC input
A5h	**P3MODH**	5~4	P3MOD6	R/W	00	P3.6 Pin Control 00: Mode0; 01: Mode1; 10: Mode2 11: Mode3
		3~2	P3MOD5	R/W	00	P3.5 Pin Control 00: Mode0; 01: Mode1; 10: Mode2 11: Mode3
		1~0	P3MOD4	R/W	00	P3.4 Pin Control 00: Mode0; 01: Mode1; 10: Mode2 11: Mode3
A6h	**PINMOD**	7	PWM1OE	R/W	0	PWM1 control 0: PWM1 disable 1: PWM1 enable and signal output to P1.3 pin
		6	PWM0OE	R/W	0	PWM0 control 0: PWM0 disable 1: PWM0 enable and signal output to P1.2 pin
		5	TCOE	R/W	0	Set 1 to enable "System clock divided by 2" (CKO) output to P1.4 pin
		4	T2OE	R/W	0	Set 1 to enable "Timer2 overflow divided by 2" (T2O) output to P1.0 pin
		0	T0OE	R/W	0	Set 1 to enable "Timer0 overflow divided by 64" (T0O) output to P3.4 pin
A8h	**IE**	7	EA	R/W	0	Global interrupt enable control. 0: Disable all Interrupts. 1: Each interrupt is enabled or disabled by its own interrupt control bit.
		5	ET2	R/W	0	Set 1 to enable Timer2 interrupt
		4	ES	R/W	0	Set 1 to enable Serial Port (UART) Interrupt
		3	ET1	R/W	0	Set 1 to enable Timer1 Interrupt
		2	EX1	R/W	0	Set 1 to enable external INT1 pin Interrupt & Stop mode wake up capability
		1	ET0	R/W	0	Set 1 to enable Timer0 Interrupt
		0	EX0	R/W	0	Set 1 to enable external INT0 pin Interrupt & Stop mode wake up capability
A9h	**INTE1**	3	ADTKIE	R/W	0	Set 1 to enable ADC/Touch Key Interrupt
		2	EX2	R/W	0	Set 1 to enable external INT2 pin Interrupt & Stop mode wake up capability
		1	P1IE	R/W	0	Set 1 to enable Port1 Pin Change Interrupt
		0	TM3IE	R/W	0	Set 1 to enable Timer3 Interrupt
AAh	**ADTKDT**	7~4	ADCDL	R	–	ADC data bit 3~0
		3~0	TKDH	R	–	Touch Key counter data bit 11~8
ABh	**ADCDH**	7~0	ADCDH	R	–	ADC data bit 11~4

Adr	SFR	Bit#	Bit Name	R/W	Rst	Description
ACh	**TKDL**	7~0	TKDL	R	–	Touch Key counter data bit 7~0
ADh	**TKCON**	7	TKPD	R/W	1	Touch Key Power Down 0: Touch Key enable; 1: Touch Key disable
		6	TKEOC	R	1	Touch Key end of conversion flag 0: Indicates conversion is in progress 1: Indicates conversion is finished
		5	TKS3V	R/W	0	Touch Key operation voltage select 0: for V_{CC}>3.6V operation 1: for V_{CC}<3.6V operation
		4	TKFSL	R/W	0	Touch Key reference clock (RCK) slow frequency enable 0: select normal RCK 1: select slower RCK
		3	TKFDB	R/W	0	Touch Key reference clock (RCK) double frequency enable 0: select normal RCK 1: select double RCK
		2~0	TKREFC	R/W	100	Touch Key reference clock capacitor select 000: smallest (RCK frequency fastest, conversion time shortest) … 111: biggest (RCK frequency slowest, conversion time longest)
AEh	**CHSEL**	7~4	ADCHS	R/W	1111	ADC channel select 0000: AD0 (P3.3) 0001: AD1 (P3.2) 0010: AD2 (P3.1) 0011: AD3 (P3.0) 0100: AD4 (P1.0) 0101: AD5 (P1.1) 0110: AD6 (P1.2) 0111: AD7 (P1.3) 1000: AD8 (P1.4) 1001: AD9 (P1.5) 1010: V_{SS} 1011: V_{BG} (Internal Bandgap Reference Voltage) 11xx: Undefined
		3~0	TKCHS	R/W	1111	Touch Key channel select 0000: TK0 (P3.3) 0001: TK1 (P3.2) 0010: TK2 (P3.1) 0011: TK3 (P3.0) 0100: TK4 (P1.0) 0101: TK5 (P1.1) 0110: TK6 (P1.2) 0111: TK7 (P1.3) 1000: TK8 (P1.4) 1001: TK9 (P1.6) 1010: TK10 (P1.7) 1011: TK11 (P3.6) 1100: TK12 (P3.5) 1101: TK13 (P3.4) 1110: TK14 (P1.5) 1111: Undefined
B0h	**P3**	7	P3.7	R/W	1	P3.7 data, also controls the pin's I/O mode. If the P3.7 SFR data is "1", the P3.7 is assigned as Schmitt-trigger input mode; otherwise, it is assigned as open-drain output mode.
		6~0	P3.6~P3.0	R/W	7Fh	P3.6~P3.0 data
B4h	**TKTMRL**	7~0	TKTMRL	R/W	FFh	Touch Key reference counter LSB[7~0
B5h	**TKTMRH**	3~0	TKTMRH	R/W	0	Touch Key reference counter MSB[11~8]

Adr	SFR	Bit#	Bit Name	R/W	Rst	Description
B8h	**IP**	5	PT2	R/W	0	Timer2 Interrupt Priority Low bit
		4	PS	R/W	0	Serial Port (UART) Interrupt Priority Low bit
		3	PT1	R/W	0	Timer1 Interrupt Priority Low bit
		2	PX1	R/W	0	External INT1 Pin Interrupt Priority Low bit
		1	PT0	R/W	0	Timer0 Interrupt Priority Low bit
		0	PX0	R/W	0	External INT0 Pin Interrupt Priority Low bit
B9h	**IPH**	5	PT2H	R/W	0	Timer2 Interrupt Priority High bit
		4	PSH	R/W	0	Serial Port (UART) Interrupt Priority High bit
		3	PT1H	R/W	0	Timer1 Interrupt Priority High bit
		2	PX1H	R/W	0	External INT1 Pin Interrupt Priority High bit
		1	PT0H	R/W	0	Timer0 Interrupt Priority High bit
		0	PX0H	R/W	0	External INT0 Pin Interrupt Priority High bit
BAh	**IP1**	3	PADTKI	R/W	0	ADC/Touch Key Interrupt Priority Low bit
		2	PX2	R/W	0	External INT2 Pin Interrupt Priority Low bit
		1	PP1	R/W	0	Port1 pin change Interrupt Priority Low bit
		0	PT3	R/W	0	Timer3 Interrupt Priority Low bit
BBh	**IP1H**	3	PADTKIH	R/W	0	ADC/Touch Key Interrupt Priority High bit
		2	PX2H	R/W	0	External INT2 Pin Interrupt Priority High bit
		1	PP1H	R/W	0	Port1 Interrupt Priority High bit
		0	PT3H	R/W	0	Timer3 Interrupt Priority High bit
C8h	**T2CON**	7	TF2	R/W	0	Timer2 overflow flag Set by H/W when Timer/Counter 2 overflows unless RCLK=1 or TCLK=1. This bit must be cleared by S/W.
		6	EXF2	R/W	0	T2EX interrupt pin falling edge flag Set when a capture or a reload is caused by a negative transition on T2EX pin if EXEN2=1. This bit must be cleared by S/W.
		5	RCLK	R/W	0	UART receive clock control bit 0: Use Timer1 overflow as receive clock for serial port in mode 1 or 3 1: Use Timer2 overflow as receive clock for serial port in mode 1 or 3
		4	TCLK	R/W	0	UART transmit clock control bit 0: Use Timer1 overflow as transmit clock for serial port in mode 1 or 3 1: Use Timer2 overflow as transmit clock for serial port in mode 1 or 3
		3	EXEN2	R/W	0	T2EX pin enable 0: T2EX pin disable 1: T2EX pin enable, it cause a capture or reload when a negative transition on T2EX pin is detected if RCLK=TCLK=0
		2	TR2	R/W	0	Timer2 run control. 1:timer runs; 0:timer stops
		1	CT2N	R/W	0	Timer2 Counter/Timer select bit 0: Timer mode, Timer2 data increases at 2 System clock cycle rate 1: Counter mode, Timer2 data increases at T2 pin's negative edge
		0	CPRL2N	R/W	0	Timer2 Capture/Reload control bit 0: Reload mode, auto-reload on Timer2 overflows or negative transitions on T2EX pin if EXEN2=1. 1: Capture mode, capture on negative transitions on T2EX pin if EXEN2=1. If RCLK=1 or TCLK=1, CPRL2N is ignored and timer is forced to auto-reload on Timer2 overflow.
CAh	**RCP2L**	7~0	RCP2L	R/W	00h	Timer2 reload/capture data low byte
CBh	**RCP2H**	7~0	RCP2H	R/W	00h	Timer2 reload/capture data high byte
CCh	**TL2**	7~0	TL2	R/W	00h	Timer2 data low byte
CDh	**TH2**	7~0	TH2	R/W	00h	Timer2 data high byte

Adr	SFR	Bit#	Bit Name	R/W	Rst	Description
D0h	**PSW**	7	CY	R/W	0	ALU carry flag
		6	AC	R/W	0	ALU auxiliary carry flag
		5	F0	R/W	0	General purpose user-definable flag
		4	RS1	R/W	0	Register Bank Select bit 1
		3	RS0	R/W	0	Register Bank Select bit 0
		2	OV	R/W	0	ALU overflow flag
		1	F1	R/W	0	General purpose user-definable flag
		0	P	R/W	0	Parity flag
D8h	**CLKCON**	7	SCKTYPE	R/W	0	Slow clock Type. This bit can be changed only in Fast mode (SELFCK=1). 0: SRC 1: SXT, P2.0 and P2.1 are crystal pins
		6	FCKTYPE	R/W	0	Fast clock type. This bit can be changed only in Slow mode (SELFCK=0). 0: FRC 1: FXT, P2.0 and P2.1 are crystal pins, oscillator gain is high for FXT
		4	STPPCK	R/W	0	Set 1 to stop UART/Timer0/1/2 clock in Idle mode for current reducing.
		3	STPFCK	R/W	0	Set 1 to stop Fast clock for power saving in Slow/Idle mode. This bit can be changed only in Slow mode.
		2	SELFCK	R/W	0	System clock select. This bit can be changed only when STPFCK=0. 0: Slow clock 1: Fast clock
		1~0	CLKPSC	R/W	11	System clock prescaler. 00: System clock is Fast/Slow clock divided by 16 01: System clock is Fast/Slow clock divided by 4 10: System clock is Fast/Slow clock divided by 2 11: System clock is Fast/Slow clock divided by 1
E0h	**ACC**	7~0	ACC	R/W	00h	Accumulator
F0h	**B**	7~0	B	R/W	00h	B register
F5h	**CFGBG**	3~0	BGTRIM	R/W	–	VBG trimming value
F6h	**CFGWL**	6~0	FRCF	R/W	–	FRC frequency adjustment 00h: lowest frequency 7Fh: highest frequency
F7h	**AUX2**	7~6	WDTE	R/W	–	Watchdog Timer Reset control 0x: WDT disable 10: WDT enable in Fast/Slow mode, disable in Idle/Stop mode 11: WDT always enable
		5	PWRSAV	R/W	–	Set 1 to reduce the chip's power consumption at Idle and Stop Mode.
		4	VBGOUT	R/W	0	1: enable VBG output to P3.2 when ADCHS = 1011b 0: P32 as normal IO
F8h	**AUX1**	7	CLRWDT	R/W	0	Set 1 to clear WDT, H/W auto clear it at next clock cycle
		6	CLRTM3	R/W	0	Set 1 to clear Timer3, HW auto clear it at next clock cycle.
		5	TKSOC	R/W	0	Touch Key Start of Conversion Set the TKSOC bit to start Touch Key conversion. SW write 0 to clear this flag. Usually, TKSOC bit can be cleared by H/W at the end of conversion, but HW may fail to clear it when SW write AUX1 simultaneously or when SYSCLK too slow. It is recommended to polling TKIF/TKEOC rather than polling TKSOC.
		4	ADSOC	R/W	0	ADC Start of Conversion Set the ADSOC bit to start ADC conversion. S/W write 0 to clear this flag. Usually, ADSOC bit can be cleared by H/W at the end of conversion, but HW may fail to clear it may when SW write AUX1 simultaneously. It is recommended to polling ADIF rather than ADSOC.
		0	DPSEL	R/W	0	Active DPTR Select

Adr	MTP	Bit#	Bit Name	Description
1FFBh	**CFGBG**	3~0	BGTRIM	FRC frequency adjustment. VBG is trimmed to 1.25V in chip manufacturing. BGTRIM records the adjustment data.
1FFDh	**CFGWL**	6~0	FRCF	FRC frequency adjustment. FRC is trimmed to 12.288 MHz in chip manufacturing. FRCF records the adjustment data.
1FFFh	**CFGWH**	7	PROT	MTP Code Protect, 1=Protect
		6	XRSTE	External Pin Reset enable, 1=enable.
		5~4	LVRE	Low Voltage Reset function select 00: Set LVR at 3.5V; LVD disable 01: Set LVR at 2.7V; LVD disable 10: Set LVR at 4.1V; LVD disable 11: Set LVR at 2.3V; LVD enable if not in Stop mode

INSTRUCTION SET

Instructions are 1, 2 or 3 bytes long as listed in the 'byte' column below. Each instruction takes 1~8 System clock cycles to execute as listed in the 'cycle' column below.

ARITHMETIC				
Mnemonic	**Description**	**byte**	**cycle**	**opcode**
ADD A,Rn	Add register to A	1	2	28-2F
ADD A,dir	Add direct byte to A	2	2	25
ADD A,@Ri	Add indirect memory to A	1	2	26-27
ADD A,#data	Add immediate to A	2	2	24
ADDC A,Rn	Add register to A with carry	1	2	38-3F
ADDC A,dir	Add direct byte to A with carry	2	2	35
ADDC A,@Ri	Add indirect memory to A with carry	1	2	36-37
ADDC A,#data	Add immediate to A with carry	2	2	34
SUBB A,Rn	Subtract register from A with borrow	1	2	98-9F
SUBB A,dir	Subtract direct byte from A with borrow	2	2	95
SUBB A,@Ri	Subtract indirect memory from A with borrow	1	2	96-97
SUBB A,#data	Subtract immediate from A with borrow	2	2	94
INC A	Increment A	1	2	04
INC Rn	Increment register	1	2	08-0F
INC dir	Increment direct byte	2	2	05
INC @Ri	Increment indirect memory	1	2	06-07
DEC A	Decrement A	1	2	14
DEC Rn	Decrement register	1	2	18-1F
DEC dir	Decrement direct byte	2	2	15
DEC @Ri	Decrement indirect memory	1	2	16-17
INC DPTR	Increment data pointer	1	4	A3
MUL AB	Multiply A by B	1	8	A4
DIV AB	Divide A by B	1	8	84
DA A	Decimal Adjust A	1	2	D4

LOGICAL				
Mnemonic	**Description**	**byte**	**cycle**	**opcode**
ANL A,Rn	AND register to A	1	2	58-5F
ANL A,dir	AND direct byte to A	2	2	55
ANL A,@Ri	AND indirect memory to A	1	2	56-57
ANL A,#data	AND immediate to A	2	2	54
ANL dir,A	AND A to direct byte	2	2	52
ANL dir,#data	AND immediate to direct byte	3	4	53
ORL A,Rn	OR register to A	1	2	48-4F
ORL A,dir	OR direct byte to A	2	2	45
ORL A,@Ri	OR indirect memory to A	1	2	46-47
ORL A,#data	OR immediate to A	2	2	44
ORL dir,A	OR A to direct byte	2	2	42
ORL dir,#data	OR immediate to direct byte	3	4	43
XRL A,Rn	Exclusive-OR register to A	1	2	68-6F
XRL A,dir	Exclusive-OR direct byte to A	2	2	65
XRL A, @Ri	Exclusive-OR indirect memory to A	1	2	66-67
XRL A,#data	Exclusive-OR immediate to A	2	2	64
XRL dir,A	Exclusive-OR A to direct byte	2	2	62
XRL dir,#data	Exclusive-OR immediate to direct byte	3	4	63
CLR A	Clear A	1	2	E4
CPL A	Complement A	1	2	F4
SWAP A	Swap Nibbles of A	1	2	C4

LOGICAL				
Mnemonic	**Description**	**byte**	**cycle**	**opcode**
RL A	Rotate A left	1	2	23
RLC A	Rotate A left through carry	1	2	33
RR A	Rotate A right	1	2	03
RRC A	Rotate A right through carry	1	2	13

DATA TRANSFER				
Mnemonic	**Description**	**byte**	**cycle**	**opcode**
MOV A,Rn	Move register to A	1	2	E8-EF
MOV A,dir	Move direct byte to A	2	2	E5
MOV A,@Ri	Move indirect memory to A	1	2	E6-E7
MOV A,#data	Move immediate to A	2	2	74
MOV Rn,A	Move A to register	1	2	F8-FF
MOV Rn,dir	Move direct byte to register	2	4	A8-AF
MOV Rn,#data	Move immediate to register	2	2	78-7F
MOV dir,A	Move A to direct byte	2	2	F5
MOV dir,Rn	Move register to direct byte	2	4	88-8F
MOV dir,dir	Move direct byte to direct byte	3	4	85
MOV dir,@Ri	Move indirect memory to direct byte	2	4	86-87
MOV dir,#data	Move immediate to direct byte	3	4	75
MOV @Ri,A	Move A to indirect memory	1	2	F6-F7
MOV @Ri,dir	Move direct byte to indirect memory	2	4	A6-A7
MOV @Ri,#data	Move immediate to indirect memory	2	2	76-77
MOV DPTR,#data	Move immediate to data pointer	3	4	90
MOVC A,@A+DPTR	Move code byte relative DPTR to A	1	4	93
MOVC A,@A+PC	Move code byte relative PC to A	1	4	83
MOVX A,@Ri	Move external data(A8) to A	1	4	E2-E3
MOVX A,@DPTR	Move external data(A16) to A	1	4	E0
MOVX @Ri,A	Move A to external data(A8)	1	4	F2-F3
MOVX @DPTR,A	Move A to external data(A16)	1	4	F0
PUSH dir	Push direct byte onto stack	2	4	C0
POP dir	Pop direct byte from stack	2	4	D0
XCH A,Rn	Exchange A and register	1	2	C8-CF
XCH A,dir	Exchange A and direct byte	2	2	C5
XCH A,@Ri	Exchange A and indirect memory	1	2	C6-C7
XCHD A,@Ri	Exchange A and indirect memory nibble	1	2	D6-D7

BOOLEAN				
Mnemonic	**Description**	**byte**	**cycle**	**opcode**
CLR C	Clear carry	1	2	C3
CLR bit	Clear direct bit	2	2	C2
SETB C	Set carry	1	2	D3
SETB bit	Set direct bit	2	2	D2
CPL C	Complement carry	1	2	B3
CPL bit	Complement direct bit	2	2	B2
ANL C,bit	AND direct bit to carry	2	4	82
ANL C,/bit	AND direct bit inverse to carry	2	4	B0
ORL C,bit	OR direct bit to carry	2	4	72
ORL C,/bit	OR direct bit inverse to carry	2	4	A0
MOV C,bit	Move direct bit to carry	2	2	A2
MOV bit,C	Move carry to direct bit	2	4	92

BRANCHING				
Mnemonic	**Description**	**byte**	**cycle**	**opcode**
ACALL addr 11	Absolute jump to subroutine	2	4	11-F1
LCALL addr 16	Long jump to subroutine	3	4	12
RET	Return from subroutine	1	4	22
RETI	Return from interrupt	1	4	32
AJMP addr 11	Absolute jump unconditional	2	4	01-E1
LJMP addr 16	Long jump unconditional	3	4	02
SJMP rel	Short jump (relative address)	2	4	80
JC rel	Jump on carry = 1	2	4	40
JNC rel	Jump on carry = 0	2	4	50
JB bit,rel	Jump on direct bit = 1	3	4	20
JNB bit,rel	Jump on direct bit = 0	3	4	30
JBC bit,rel	Jump on direct bit = 1 and clear	3	4	10
JMP @A+DPTR	Jump indirect relative DPTR	1	4	73
JZ rel	Jump on accumulator = 0	2	4	60
JNZ rel	Jump on accumulator … 0	2	4	70
CJNE A,dir,rel	Compare A,direct, jump not equal relative	3	4	B5
CJNE A,#data,rel	Compare A,immediate, jump not equal relative	3	4	B4
CJNE Rn,#data,rel	Compare register,immediate, jump not equal relative	3	4	B8-BF
CJNE @Ri,#data,rel	Compare indirect,immediate, jump not equal relative	3	4	B6-B7
DJNZ Rn,rel	Decrement register, jump not zero relative	2	4	D8-DF
DJNZ dir,rel	Decrement direct byte, jump not zero relative	3	4	D5

MISCELLANEOUS				
Mnemonic	**Description**	**byte**	**cycle**	**opcode**
NOP	No operation	1	2	00

In the above table, an entry such as E8-EF indicates a continuous block of hex opcodes used for 8 different registers, the register numbers of which are defined by the lowest three bits of the corresponding code. Non-continuous blocks of codes, shown as 11-F1 (for example), are used for absolute jumps and calls with the top 3 bits of the code being used to store the top three bits of the destination address.

ELECTRICAL CHARACTERISTICS

1. Absolute Maximum Ratings (T_A=25℃)

Parameter	Rating	Unit
Supply voltage	V_{SS} –0.3 ~ V_{SS} +5.5	V
Input voltage	V_{SS} –0.3 ~ V_{CC} +0.3	
Output voltage	V_{SS} –0.3 ~ V_{CC} +0.3	
Output current high per 1 PIN	–25	mA
Output current high per all PIN	–80	
Output current low per 1 PIN	+30	
Output current low per all PIN	+150	
Maximum Operating Voltage	5.5	V
Operating temperature	–40 ~ +85	℃
Storage temperature	–65 ~ +150	

2. DC Characteristics (T_A=25 ℃, V_{CC}=2.3V ~ 5.5V)

Parameter	Symbol	Conditions		Min	Typ	Max	Unit
Operating Voltage	V_{CC}	F_{SYSCLK}=6.144 MHz		2.7	–	5.5	V
		F_{SYSCLK}=3.072 MHz		2.3	–	5.5	
Input High Voltage	V_{IH}	All Input, except P3.7, P2.1	V_{CC}=5V	0.6V_{CC}	–	–	V
			V_{CC}=3V	0.6V_{CC}	–	–	V
		P3.7, P2.1	V_{CC}=5V	0.6V_{CC}	–	–	V
			V_{CC}=3V	0.6V_{CC}	–	–	V
Input Low Voltage	V_{IL}	All Input	V_{CC}=5V	–	–	0.2V_{CC}	V
			V_{CC}=3V	–	–	0.2V_{CC}	V
I/O Port Source Current	I_{OH}	All Output except P3.7	V_{CC}=5V, V_{OH}=0.9V_{CC}	5	10	–	mA
			V_{CC}=3V, V_{OH}=0.9V_{CC}	2.5	5	–	
		P3.7	V_{CC}=5V, V_{OH}=2.7V	5	10		uA
I/O Port Sink Current	I_{OL}	All Output,	V_{CC}=5V, V_{OL}=0.1V_{CC}	20	40	–	mA
			V_{CC}=3V, V_{OL}=0.1V_{CC}	10	20	–	
Supply Current	I_{DD}	FAST mode V_{CC}=5V	FXT=6 MHz	–	3.8	–	mA
			FRC=6.144 MHz	–	3.8	–	
		FAST mode V_{CC}=3V	FXT=6 MHz	–	2.5	–	
			FRC=6.144 MHz	–	2.5	–	
		SLOW mode	V_{CC}=3V	–	1	–	
			V_{CC}=5V	–	1.3	–	
		IDLE mode LVR 2.3V or PWRSAV=1	SRC, V_{CC}=5V	–	18	–	µA
			SRC, V_{CC}=3V	–	8	–	
		IDLE mode LVR≠2.3Vand PWRSAV=0	V_{CC}=5V	–	128	–	
			V_{CC}=3V	–	100	–	
		STOP mode, P37=0	V_{CC}=5V	–	0.1	–	
			V_{CC}=3V	–	0.1	–	
		STOP mode, P37=1	V_{CC}=5V		2		
			V_{CC}=3V		0.5		

Parameter	Symbol	Conditions		Min	Typ	Max	Unit
System Clock Frequency	F_{SYSCLK}	V_{CC} >LVR_{TH}	V_{CC}=2.7V	–	–	6.144	MHz
			V_{CC}=2.3V	–	–	3.072	
LVR Reference Voltage	V_{LVR}	T_A=25°C		–	4.1	–	V
				–	3.5	–	V
					2.7		
				–	2.3	–	V
LVR Hysteresis Voltage	V_{HYST}	T_A=25°C		–	±0.1	–	V
LVD Reference Voltage	V_{LVD}	T_A=25°C		–	2.7	–	V
Low Voltage Detection time	t_{LVR}	T_A=25°C		100	–	–	μs
Pull-Up Resistor	R_P	V_{IN}=0V, all except P3.7	V_{CC}=5V	–	41	–	KΩ
			V_{CC}=3V		76		
		V_{IN}=0V, P3.7	V_{CC}=5V	–	204	–	KΩ
			V_{CC}=3V		206		

3. Clock Timing (T_A= –40°C ~ +85°C)

Parameter	Condition	Min	Typ	Max	Unit
FRC Frequency	25℃, V_{CC}=5.0V	–1%	12.288	+1%	MHz
	0℃ ~ 85℃, V_{CC}=5.0V	–1.5%	12.288	+1.5%	
	–40℃ ~ 85℃, V_{CC}=3.0 ~ 5.5V	–6%	12.288	+3%	

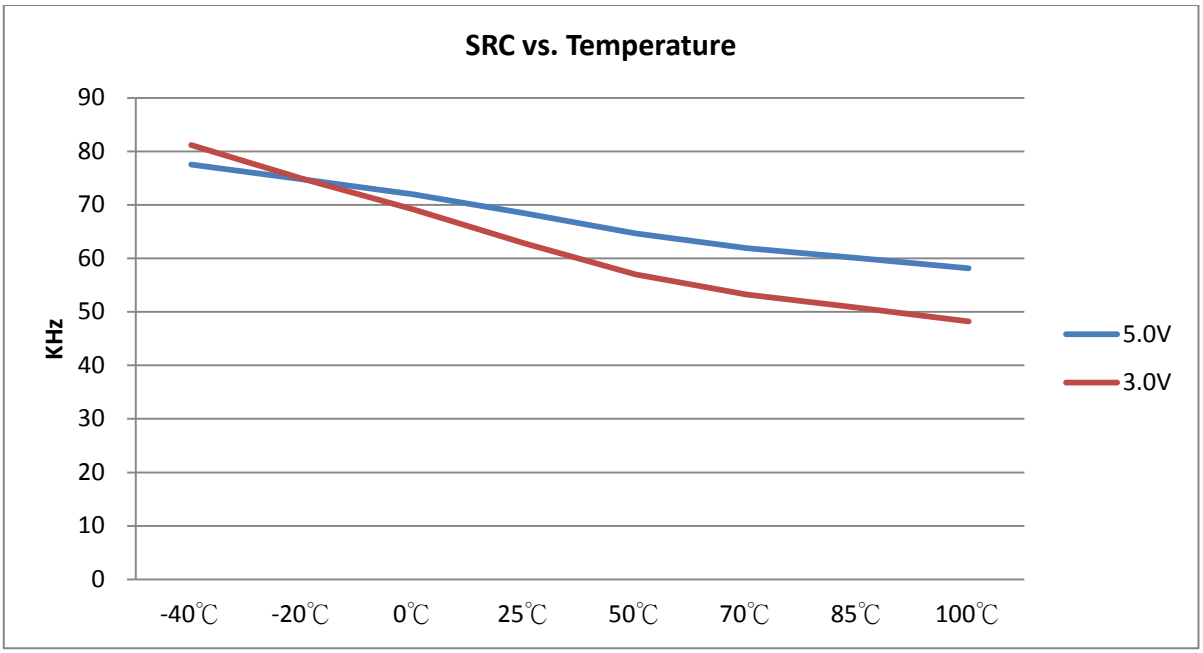
4. Reset Timing Characteristics (T_A= –40°C ~ +85°C)

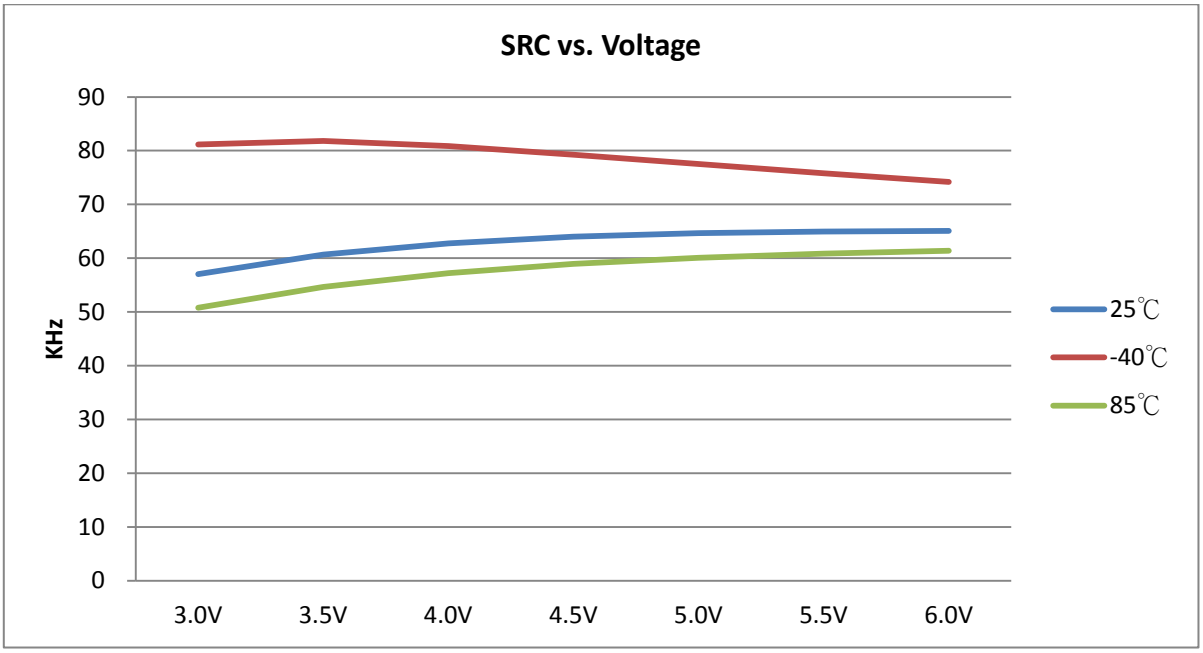
Parameter	Conditions	Min	Typ	Max	Unit
RESET Input Low width	Input V_{CC}=5V ± 10 %	30	–	–	µs
WDT wakeup time	V_{CC}=5V, WDTPSC=11	–	52	–	ms
	V_{CC}=3V, WDTPSC=11	–	52	–	

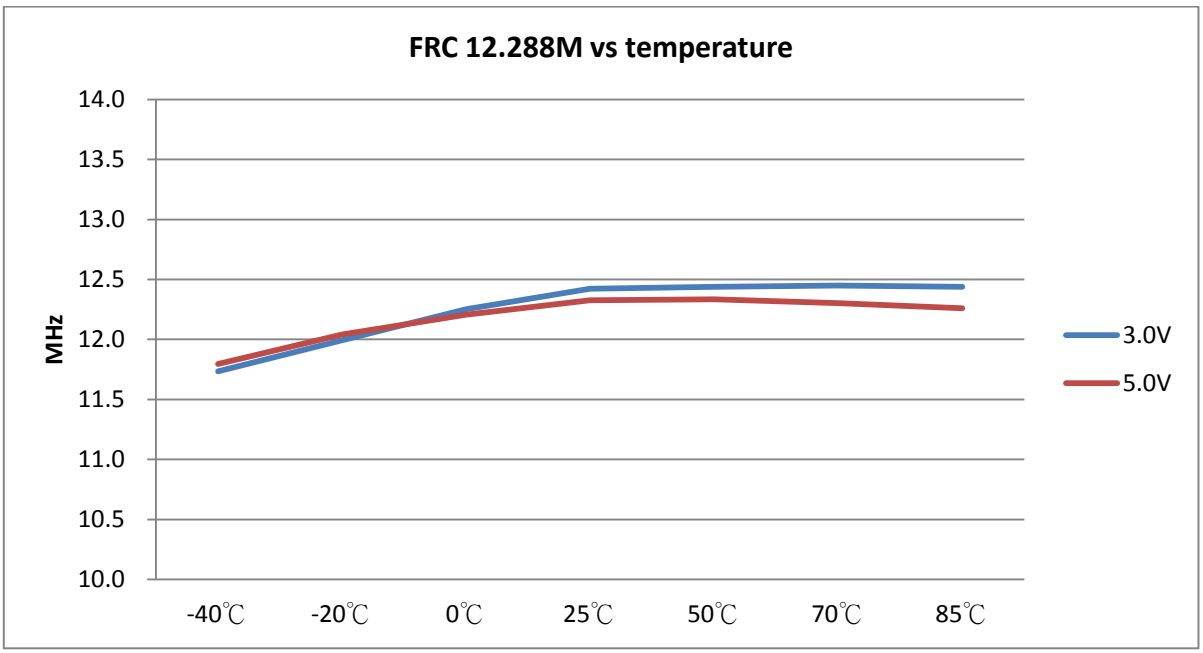
5. ADC Electrical Characteristics (T_A= 25°C, V_{CC}= 3.0V ~ 5.5V, V_{SS}= 0V)

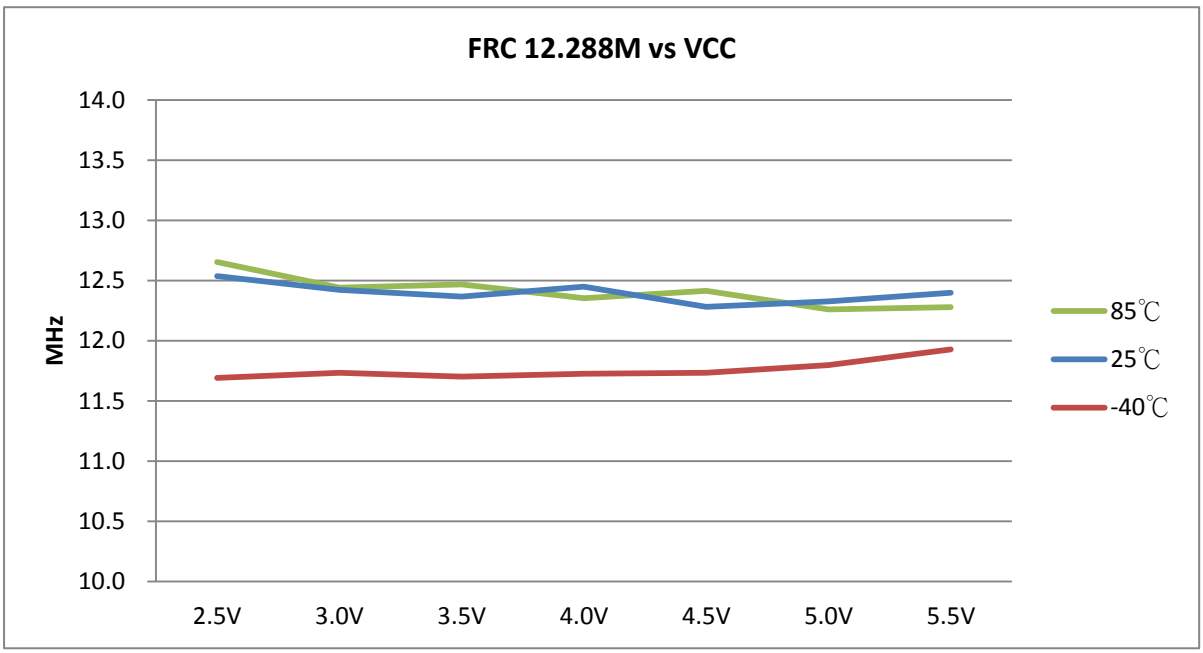
Parameter	Conditions	Min	Typ	Max	Unit
Total Accuracy	V_{CC}=5.12 V, V_{SS}=0V	–	±2.5	±4	LSB
Integral Non-Linearity		–	±3.2	±5	
Max Input Clock (f_{ADC})	Source impedance (Rs < 10K omh)	–	–	2	MHz
	Source impedance (Rs < 20K omh)	–	–	1	
	Source impedance (Rs < 50K omh)	–	–	0.5	
	Source is VBG (ADCHS=1011b)	–	–	0.5	
Conversion Time	F_{ADC} = 1MHz	–	50	–	µs
BandGap Voltage Reference (VBG)	25°C~85°C, Vcc = 5V~3V	-1%	1.25	+1.5%	V
	-20°C~85°C, Vcc = 5V~3V	-2%	1.25	+1.5%	V
Input Voltage	–	V_{SS}	–	V_{CC}	V

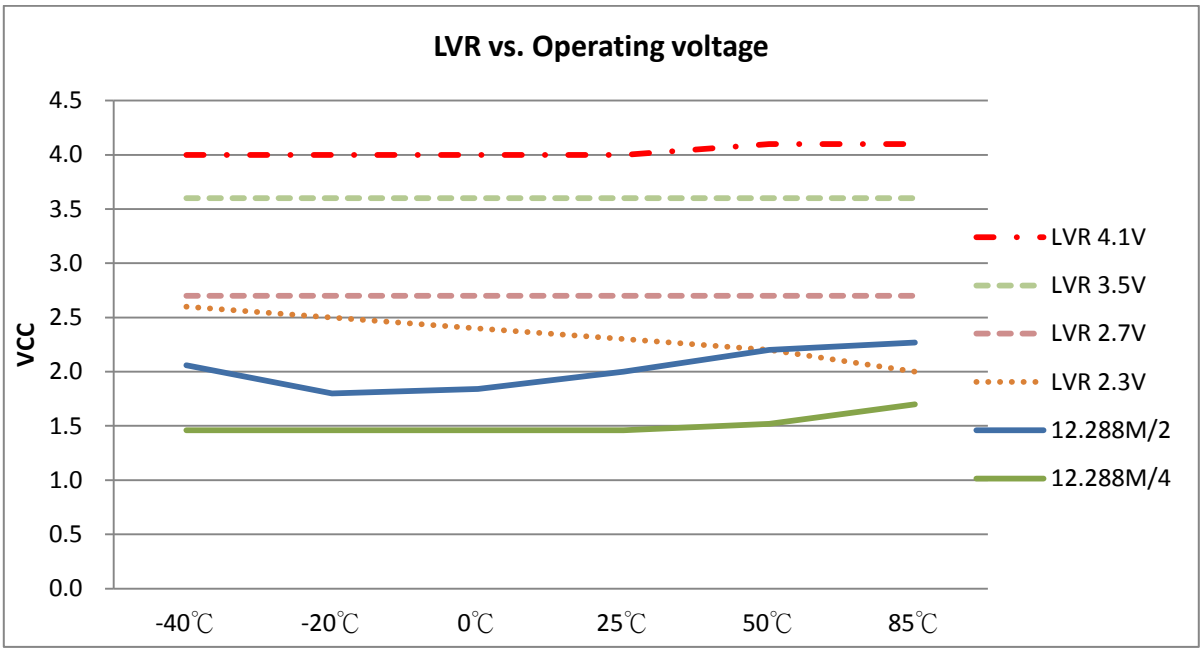
6. Characteristic Graphs



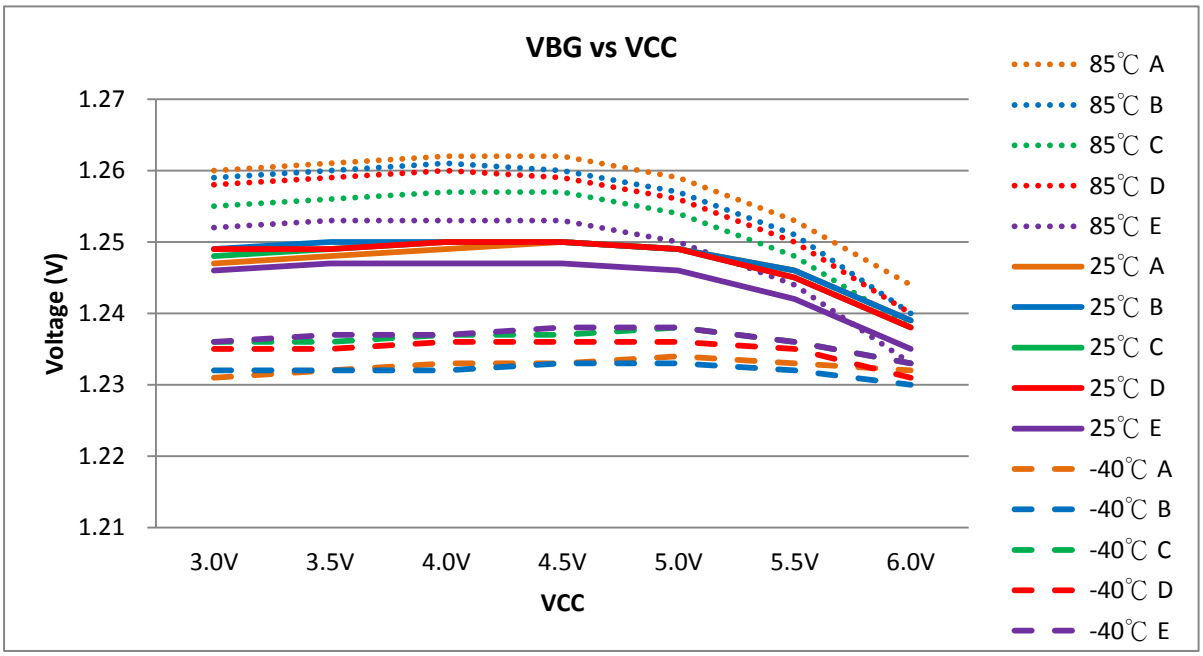



FRC 12.288M vs temperature
14.0
13.5
13.0
12.5
12.0
11.5
11.0
10.5
10.0
MHz
-40℃
-20℃
0℃
25℃
50℃
70℃
85℃
3.0V
5.0V


FRC 12.288M vs VCC
14.0
13.5
13.0
12.5
12.0
11.5
11.0
10.5
10.0
MHz
2.5V
3.0V
3.5V
4.0V
4.5V
5.0V
5.5V
85℃
25℃
-40℃



Note: LVR 2.3V cannot cover the operating frequency of 6.144 MHz at high temperatures. It is recommended to use LVR 2.7V@F_{SYSCLK}=6.144 MHz.



Package and Dice Information

Please note that the package information provided is for reference only. Since this information is frequently updated, users can contact Sales to consult the latest package information and stocks.

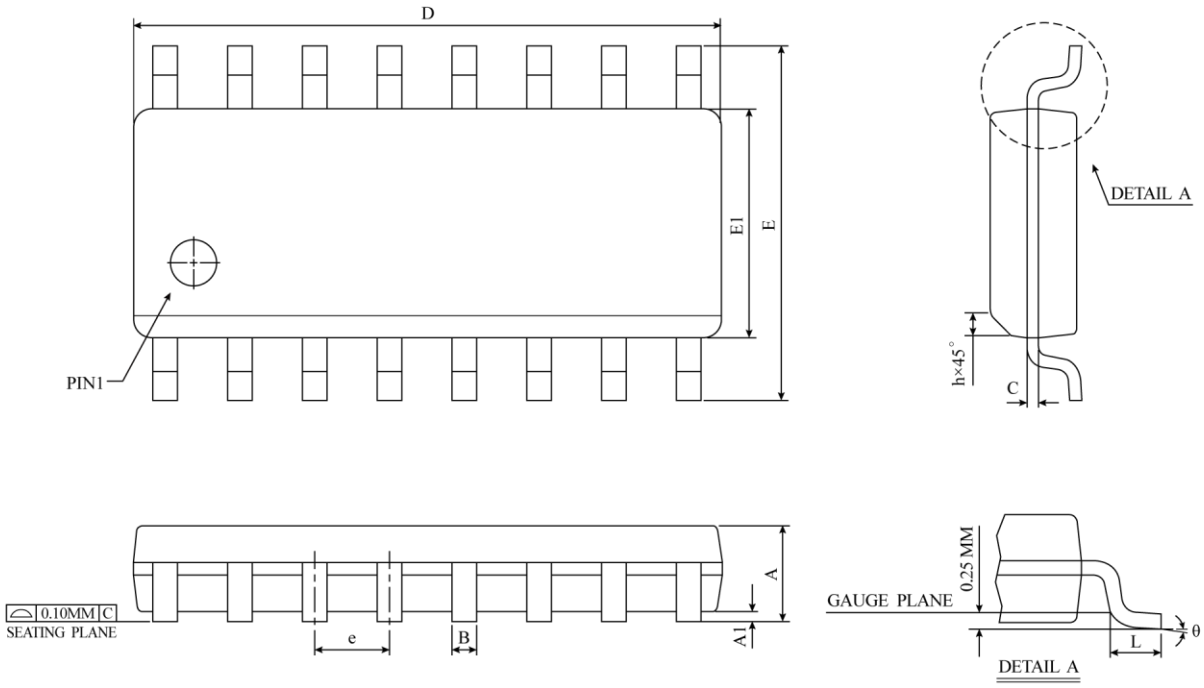
Ordering information

Ordering number	Package
TM52M8268-MTP	Wafer/Dice blank chip
TM52M8268-COD	Wafer/Dice with code
TM52M8268-MTP-16	SOP16-pin (150 mil)
TM52M8268-MTP-21	SOP 20-pin (300 mil)
TM52M8268-MTP-05	DIP 20-pin (300 mil)
TM52M8264-MTP	Wafer/Dice blank chip
TM52M8264-COD	Wafer/Dice with code
TM52M8264-MTP-16	SOP16-pin (150 mil)
TM52M8264-MTP-21	SOP 20-pin (300 mil)
TM52M8264-MTP-05	DIP 20-pin (300 mil)
TM52M8258-MTP	Wafer/Dice blank chip
TM52M8258-COD	Wafer/Dice with code
TM52M8258-MTP-16	SOP16-pin (150 mil)
TM52M8258-MTP-21	SOP 20-pin (300 mil)
TM52M8258-MTP-05	DIP 20-pin (300 mil)
TM52M8254-MTP	Wafer/Dice blank chip
TM52M8254-COD	Wafer/Dice with code
TM52M8254-MTP-16	SOP16-pin (150 mil)
TM52M8254-MTP-21	SOP 20-pin (300 mil)
TM52M8258-MTP-05	DIP 20-pin (300 mil)

Ordering number	Package
TM52M8268-MTP-53	MSOP 10-pin (118 mil)
TM52M8268-MTP-46	TSSOP 20-pin (173 mil)
TM52M8268-MTP-B6	QFN 20-pin (3*3*0.75-0.4mm)
TM52M8264-MTP-53	MSOP 10-pin (118 mil)
TM52M8264-MTP-46	TSSOP 20-pin (173 mil)
TM52M8264-MTP-B6	QFN 20-pin (3*3*0.75-0.4mm)
TM52M8258-MTP-53	MSOP 10-pin (118 mil)
TM52M8258-MTP-46	TSSOP 20-pin (173 mil)
TM52M8258-MTP-B6	QFN 20-pin (3*3*0.75-0.4mm)
TM52M8254-MTP-53	MSOP 10-pin (118 mil)
TM52M8254-MTP-46	TSSOP 20-pin (173 mil)
TM52M8258-MTP-B6	QFN 20-pin (3*3*0.75-0.4mm)

Package Information

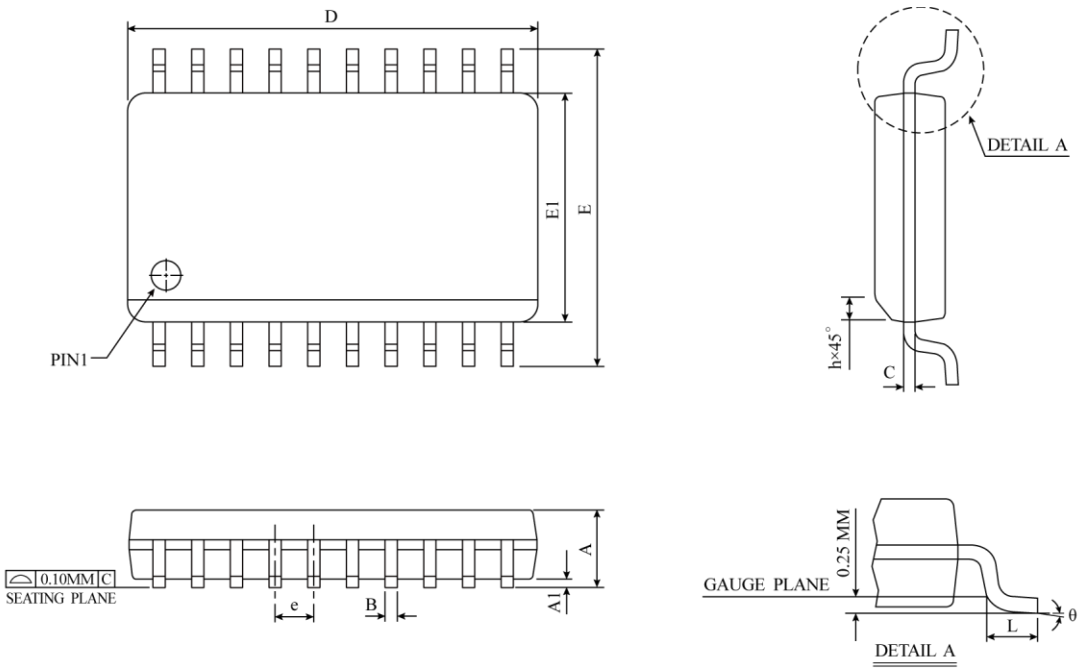
SOP-16 (150mil) Package Dimension



SYMBOL	DIMENSION IN MM			DIMENSION IN INCH		
	MIN	NOM	MAX	MIN	NOM	MAX
A	1.35	1.55	1.75	0.0532	0.0610	0.0688
A1	0.10	0.18	0.25	0.0040	0.0069	0.0098
B	0.33	0.42	0.51	0.0130	0.0165	0.0200
C	0.19	0.22	0.25	0.0075	0.0087	0.0098
D	9.80	9.90	10.00	0.3859	0.3898	0.3937
E	5.80	6.00	6.20	0.2284	0.2362	0.2440
E1	3.80	3.90	4.00	0.1497	0.1536	0.1574
e	1.27 BSC			0.050 BSC		
h	0.25	0.38	0.50	0.0099	0.0148	0.0196
L	0.40	0.84	1.27	0.0160	0.0330	0.0500
θ	0°	4°	8°	0°	4°	8°
JEDEC	MS-012 (AC)					

⚠ * NOTES : DIMENSION " D " DOES NOT INCLUDE MOLD FLASH, PROTRUSIONS OR GATE BURRS. MOLD FLASH, PROTRUSIONS AND GATE BURRS SHALL NOT EXCEED 0.15 MM (0.006 INCH) PER SIDE.

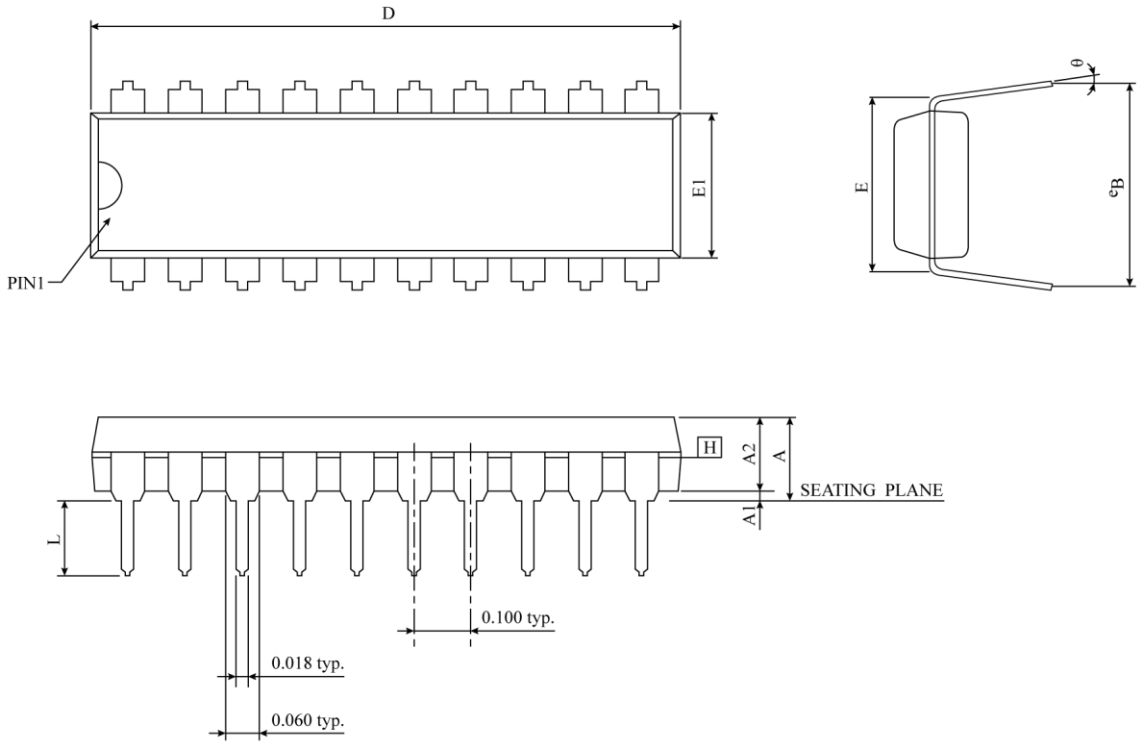
SOP-20 (300mil) Package Dimension



SYMBOL	DIMENSION IN MM			DIMENSION IN INCH		
	MIN	NOM	MAX	MIN	NOM	MAX
A	2.35	2.50	2.65	0.0926	0.0985	0.1043
A1	0.10	0.20	0.30	0.0040	0.0079	0.0118
B	0.33	0.42	0.51	0.0130	0.0165	0.0200
C	0.23	0.28	0.32	0.0091	0.0108	0.0125
D	12.60	12.80	13.00	0.4961	0.5040	0.5118
E	10.00	10.33	10.65	0.3940	0.4425	0.4910
E1	7.40	7.50	7.60	0.2914	0.2953	0.2992
e	1.27 BSC			0.050 BSC		
h	0.25	0.50	0.75	0.0100	0.0195	0.0290
L	0.40	0.84	1.27	0.0160	0.0330	0.0500
θ	0°	4°	8°	0°	4°	8°
JEDEC	MS-013 (AC)					

⚠ * NOTES : DIMENSION " D " DOES NOT INCLUDE MOLD FLASH, PROTRUSIONS OR GATE BURRS. MOLD FLASH, PROTRUSIONS AND GATE BURRS SHALL NOT EXCEED 0.15 MM (0.006 INCH) PER SIDE.

DIP-20 (300mil) Package Dimension

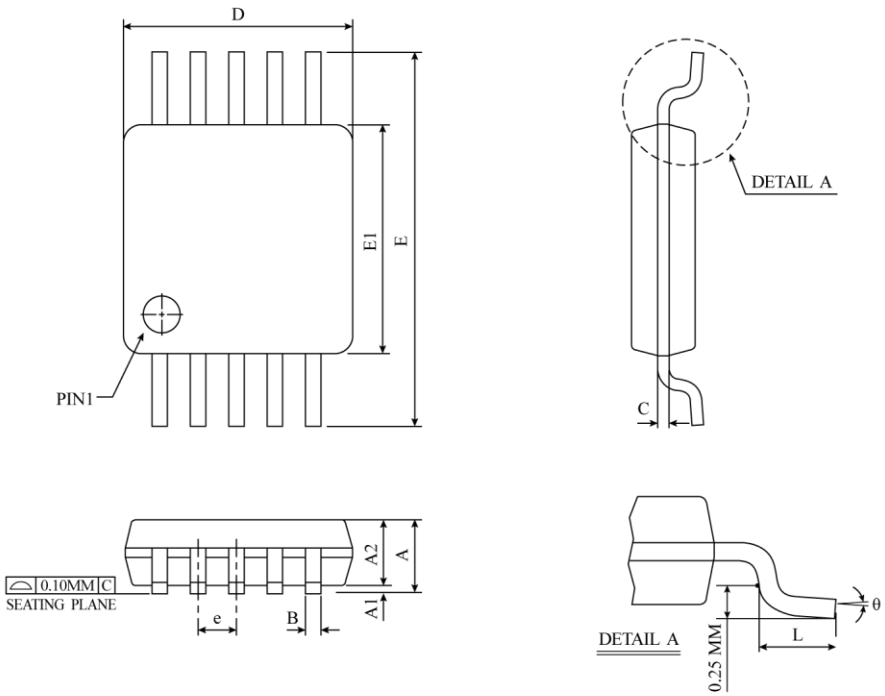


SYMBOL	DIMENSION IN MM			DIMENSION IN INCH		
	MIN	NOM	MAX	MIN	NOM	MAX
A	-	-	4.445	-	-	0.175
A1	0.381	-	-	0.015	-	-
A2	3.175	3.302	3.429	0.125	0.130	0.135
D	25.705	26.061	26.416	1.012	1.026	1.040
E	7.620	7.747	7.874	0.300	0.305	0.310
E1	6.223	6.350	6.477	0.245	0.250	0.255
L	3.048	3.302	3.556	0.120	0.130	0.140
e_B	8.509	9.017	9.525	0.335	0.355	0.375
θ	0°	7.5°	15°	0°	7.5°	15°
JEDEC	MS-001 (AD)					

NOTES：

1. "D" , "E1" DIMENSIONS DO NOT INCLUDE MOLD FLASH OR PROTRUSIONS. MOLD FLASH OR PROTRUSIONS SHALL NOTEXCEED .010 INCH.
2. eB IS MEASURED AT THE LEAD TIPS WITH THE LEADS UNCONSTRAINED.
3. POINTED OR ROUNDED LEAD TIPS ARE PREFERRED TO EASE INSERTION.
4. DISTANCE BETWEEN LEADS INCLUDING DAM BAR PROTRUSIONS TO BE .005 INCH MININUM.
5. DATUM PLANE H COINCIDENT WITH THE BOTTOM OF LEAD, WHERE LEAD EXITS BODY.

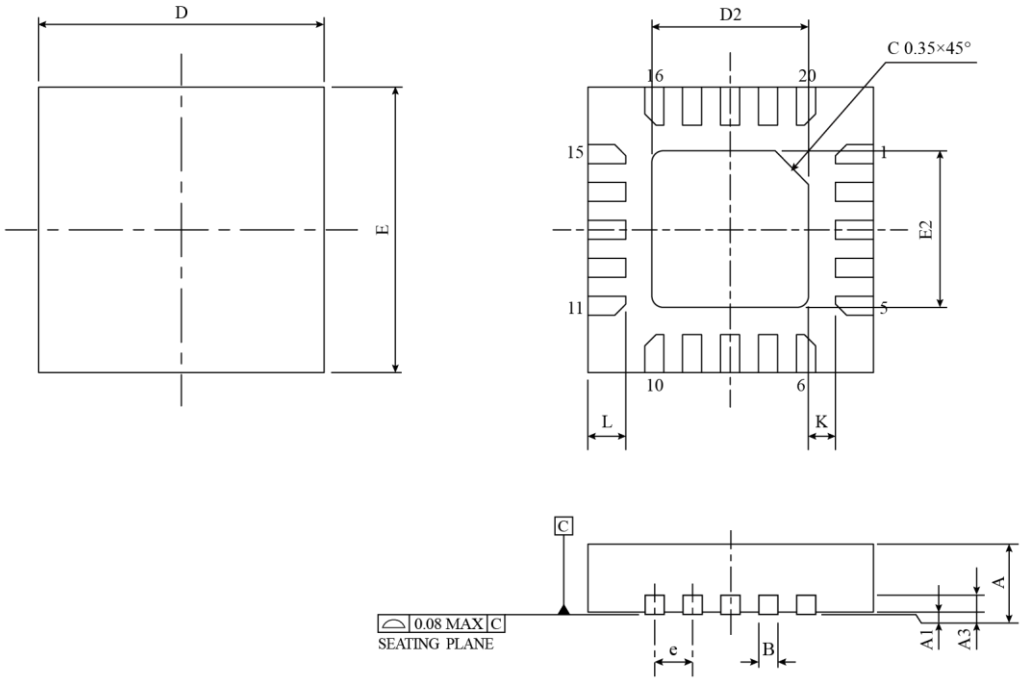
MSOP-10 (118mil) Package Dimension



SYMBOL	DIMENSION IN MM			DIMENSION IN INCH		
	MIN	NOM	MAX	MIN	NOM	MAX
A	0.81	0.96	1.10	0.032	0.038	0.043
A1	0.05	0.10	0.15	0.002	0.004	0.006
A2	0.75	0.85	0.95	0.030	0.034	0.037
B	0.17	0.22	0.27	0.007	0.009	0.011
C	0.13	0.18	0.23	0.005	0.007	0.009
D	2.90	3.00	3.10	0.114	0.118	0.122
E	4.75	4.90	5.05	0.187	0.193	0.199
E1	2.90	3.00	3.10	0.114	0.118	0.122
e	0.50 BSC			0.020 BSC		
L	0.40	0.55	0.70	0.016	0.022	0.028
θ	0°	3°	6°	0°	3°	6°
JEDEC						

⚠ * NOTES : DIMENSION " D " DOES NOT INCLUDE MOLD PROTRUSIONS OR GATE BURRS.
MOLD PROTRUSIONS AND GATE BURRS SHALL NOT EXCEED 0.12 MM (0.005 INCH) PER SIDE.
DIMENSION " E1 " DOES NOT INCLUDE MOLD PROTRUSIONS
MOLD PROTRUSIONS SHALL NOT EXCEED 0.25 MM (0.010 INCH) PER SIDE.

QFN 20 (3*3*0.75-0.4mm) Package Dimension



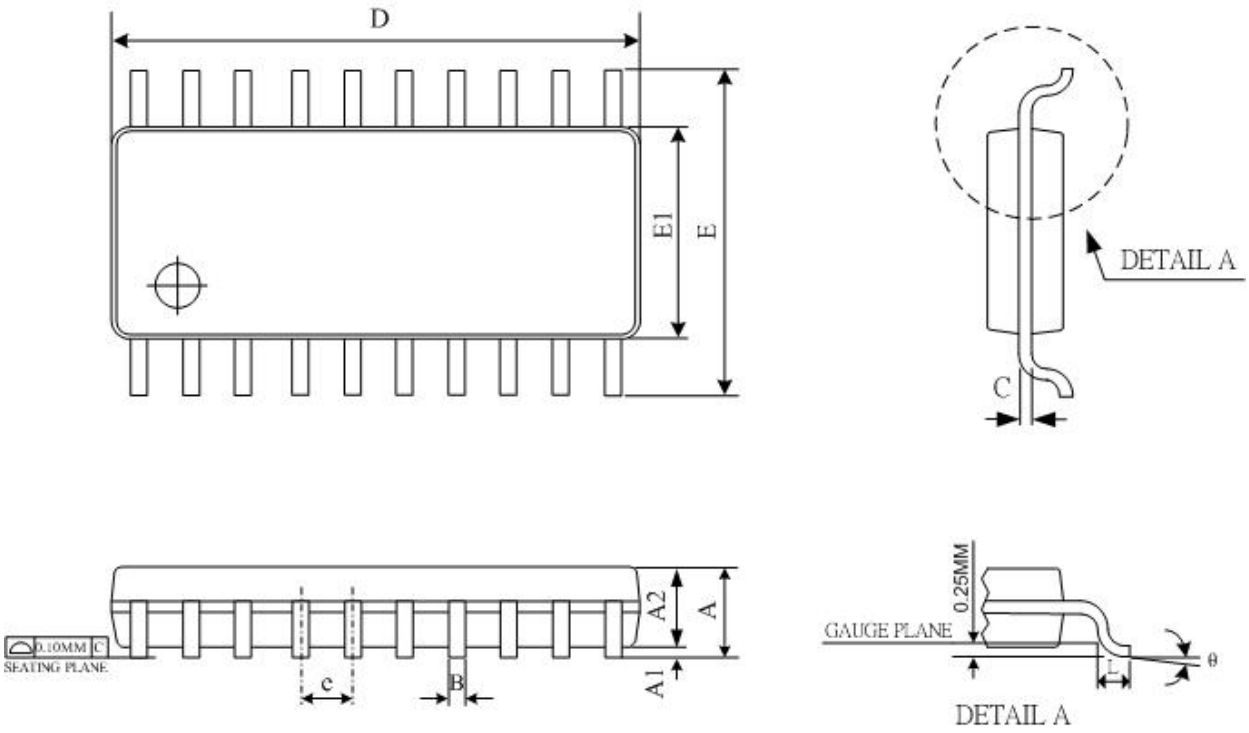
SYMBOL	DIMENSION IN MM			DIMENSION IN INCH		
	MIN	NOM	MAX	MIN	NOM	MAX
A	0.70	0.75	0.80	0.028	0.030	0.031
A1	0.00	0.02	0.05	0.000	0.001	0.002
A3		0.203 REF.			0.008 REF.	
B	0.15	0.20	0.25	0.006	0.008	0.010
D		3.00 BSC			0.118 BSC	
E		3.00 BSC			0.118 BSC	
e		0.40 BSC			0.016 BSC	
K	0.20	-	-	0.008	-	-
E2	1.60	1.65	1.70	0.063	0.065	0.067
D2	1.60	1.65	1.70	0.063	0.065	0.067
L	0.30	0.40	0.50	0.012	0.016	0.020
JEDEC						

⚠ * NOTES : 1. ALL DIMENSION ARE IN MILLIMETRS.

2. DIMENSION B APPLIES TO METALLLIZED TERMINAL AND IS MEASURED BETWEEN 0.15mm AND 0.30mm FROM THE TERMINAL TIP. IF THE TERMINAL HAS THE OPTIONAL RADIUS ON THE OTHER END OF THE TERMINAL, THE DIMENSION B SHOULD NOT BE MEASURED IN THAT RADIUS AREA.

3. BILATERAL COPLANARITY ZONE APPLIES TO THE EXPOSED HEAT SINK SLUG AS WELL AS THE TERMINALS.

TSSOP-20 (173mil) Package Dimension



SYMBOL	DIMENSION IN MM			DIMENSION IN INCH		
	MIN	NOM	MAX	MIN	NOM	MAX
A	-	-	1.2	-	-	0.047
A1	0.05	0.10	0.15	0.002	0.004	0.006
A2	0.8	0.93	1.05	0.031	0.036	0.041
B	0.19	-	0.3	0.007	-	0.012
D	6.4	6.5	6.6	0.252	0.256	0.260
E	6.25	6.4	6.55	0.246	0.252	0.258
E1	4.3	4.4	4.5	0.169	0.173	0.177
e	0.65 BSC			0.026 BSC		
L	0.45	0.60	0.75	0.018	0.024	0.030
θ	0 °		8 °	0 °		8 °
JEDEC	MO-153 AC REV.F					

Notes：
1.DIMENSION "D" DOES NOT INCLUDE MOLD FLASH, PROTRUSIONS OR GATE BURRS. MOLD FLASH, PROTRUSIONS OR GATE BURRS SHALL NOT EXCEED 0.15 PER SIDE.
2.DIMENSION "E1" DOES NOT INCLUDE INTERLEAD FLASH OR PROTRUSION. INTERLEAD FLASH OR PROTRUSION SHALL NOT EXCEED 0.25 PER SIDE.
3.DIMENSION "B" DOES NOT INCLUDE DAMBAR PROTRUSION.ALLOWABLE DAMBAR PROTRUSION SHALL BE 0.08MM TOTAL IN EXCESS OF THE "B" DIMENSION AT MAXIMUM METERIAL CONDITION. DAMBAR CANNOT BE LOCATED ON THE LOWER RADIUS OF THE FOOT. MINIMUM SPACE BETWEEN PROTRUSION AND ADJACENT LEAD IS 0.07MM.