



**Elan Microelectronics Corp.**

*ELAN RISC II™ series*

**EPD8000**

**June 20, 2001**

Version 1.2



Specification Revision History		
Version	Content	Date
1.0	Initial version	Feb 7,2001
1.1	a. NEW CPU series rename to <i>ELAN RISC II™ series</i> b. Update TEST pin type c. Exchange the pin number of V4 & VCA pad d. Modify LVD spec to Vdet +/- 0.1V, and add the Vdet hysteresis voltage description e. Modify the DC Specification temperature range to Ta=0~+40 °C f. Add Pad Diagram g. Specify the V0 spec.: VDD=2.3V~3.3V, V0= Typ +/- 4% h. Specify the Vref temperature coefficient: 7mV/°C	May 15,2001
1.2	a. EPG-8000 rename to <b>EPG8000</b> .	June 20,2001

## INDEX

<b>I. General Description.....</b>	<b>1</b>
<b>II. Feature.....</b>	<b>1</b>
<b>III. Block Diagram.....</b>	<b>2</b>
<b>IV. ELAN RISC II™ series Part List .....</b>	<b>3</b>
<b>V. Pin Assignment.....</b>	<b>3</b>
<b>VI. Pin Description.....</b>	<b>5</b>
<b>VII. Function Description</b>	
(1) KERNEL PART.....	7
(2) CPU OPERATION MODE.....	27
(3) Reset and WAKE UP.....	30
(4) Oscillator System.....	34
(5) INTERRUPT.....	37
(6) PERIPHERAL.....	39
<b>A. Timer/Melody Timer/EL Timer/Watchdog Timer.....</b>	<b>39</b>
<b>B. LOW VOLTAGE DETECTION(LVD).....</b>	<b>51</b>
<b>C. SERIAL PERIPHERAL INTERFACE (SPI).....</b>	<b>55</b>
<b>D. Key I/Os.....</b>	<b>64</b>
<b>E. Embedded LCD DRIVER.....</b>	<b>71</b>



*VIII. Electrical Characteristic.....76*

*IX. Pin Type Circuit Diagram.....81*

*X. Application Circuit.....83*

*XI. Instruction Set.....85*

*XII. Pad Diagram.....89*

## **I. General Description**

*ELAN RISC II™ series MCU* is a 8 bit uC based data processor IC for use on palm top devices. Integrated on the chip are large ROM size and large RAM size, 8\*8 hardware multiplier, key input circuit, SPI, melody timer, EL ,low voltage detection and embedded LCD driver(98\*32).

## **II. Feature**

### **(1) Kernel Feature:**

- Operating voltage:2.2~3.6V.
- Maximum operation Speed: 10MHz clock.
- One Instruction cycle time = 2\* System clock time
- 8 bit CPU with 80 instructions.
- 48 K words program ROM.
- 512K words data ROM.
- 128 bytes unbanked RAM, 8K bytes banked RAM .
- RAM stack can achieve maximum 128 levels.
- Enhanced TABLE LOOK UP function(1 or 2 cycles)
- High capacity memory access ability.
- Register to Register instruction.
- Compare and Branch in one instruction (2 cycles).
- Single Repeat function.
- 8\*8 hardware multiplier.
- Decimal ADD and SUB instruction.
- Full range CALL and JUMP ability (2 cycles).

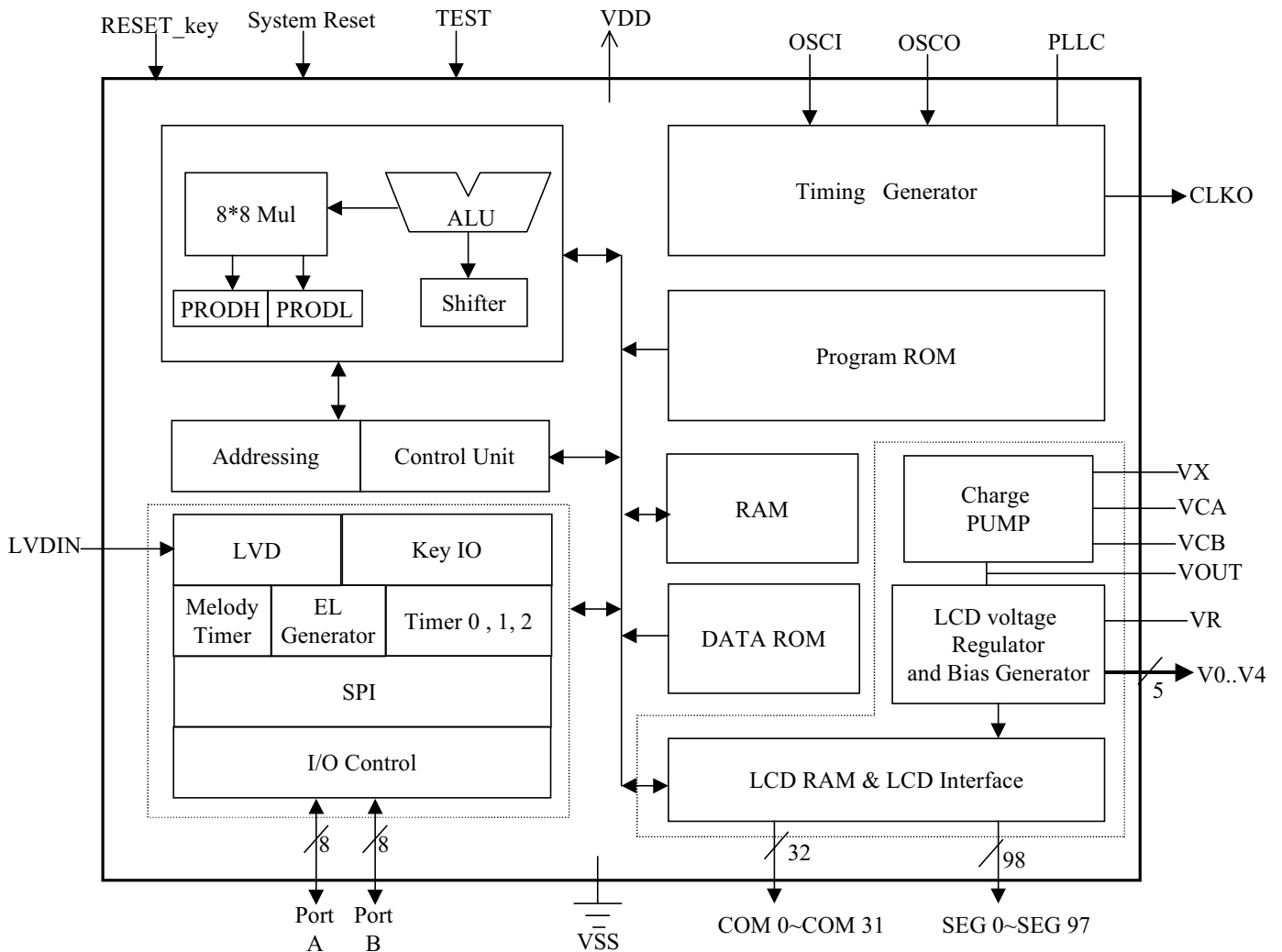
### **(2) Peripheral Feature:**

- 16 I/O pins (Port A ~ Port B )
- One 16 bits general purpose timer, two 8 bits general purpose timer, one melody timer
- EL or IR generator.
- Low voltage detector.
- SPI (Serial Peripheral Interface )
- Clock output for external device.
- Key input and strobe function
- Embedded LCD Driver.(1/11,1/16,1/24 & 1/32 duty selectable)

**(3) Special micro controller Feature:**

- Watchdog Timer with its own on-chip RC oscillator
- CPU mode: SLEEP MODE, IDLE MODE, SLOW MODE, FAST MODE
- PLL frequency adjustable

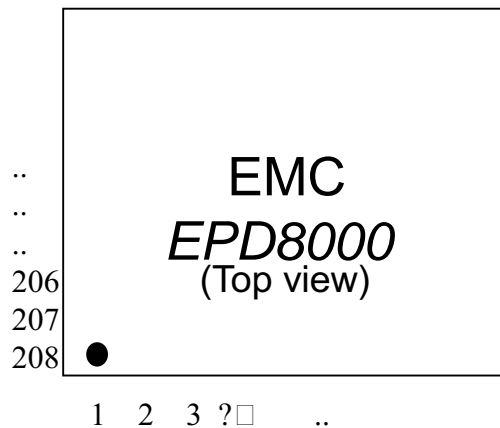
**III. Block Diagram**



#### IV. *ELAN RISC II™ Series Part List*

Part number	PROM	D-ROM	RAM	LCD	Peripheral	I/O pins
EPD8000	48k*16	512K*16	8k*8	Internal 98*32	SPI, Key, Melody, EL,LVD	16 (PortA~B)
EPD1600	48k*16	1M*16	8k*8	Internal 98*32	SPI, Key, Melody, EL,LVD	16 (PortA~B)

#### V. *Pin Assignment*



No.	Pin NAME	No.	Pin NAME	No.	Pin NAME	No.	Pin NAME
1	COM31	53	SEG61	105	SEG29	157	PA.6
2	COM30	54	SEG60	106	SEG28	158	PA.7 (ON_key)
3	COM29	55	SEG59	107	SEG27	159	CLKO
4	COM28	56	SEG58	108	SEG26	160	PB.0(/SPISS)
5	COM27	57	SEG57	109	SEG25	161	PB.1(SPISCK)
6	COM26	58	SEG56	110	SEG24	162	PB.2(SPISDO)
7	COM25	59	SEG55	111	SEG23	163	PB.3(SPISDI)
8	COM24	60	SEG54	112	SEG22	164	PB.4(CK)
9	COM23	61	SEG53	113	SEG21	165	PB.5(CHOP)
10	COM22	62	SEG52	114	SEG20	166	PB.6(MDO2)
11	COM21	63	N.C.	115	SEG19	167	PB.7(MDO1)
12	COM20	64	N.C.	116	SEG18	168	Reset_key
13	COM19	65	N.C.	117	SEG17	169	SYSTEM RESET
14	COM18	66	N.C.	118	SEG16	170	VDD
15	COM17	67	N.C.	119	SEG15(strobe 15)	171	N.C.
16	COM16	68	N.C.	120	SEG14(strobe 14)	172	N.C.



17	SEG97	69	N.C.	121	SEG13(strobe 13)	173	N.C.
18	SEG96	70	SEG51	122	SEG12(strobe 12)	174	N.C.
19	SEG95	71	SEG50	123	SEG11(strobe 11)	175	LVDIN
20	SEG94	72	SEG49	124	SEG10(strobe 10)	176	(Reserved)
21	SEG93	73	SEG48	125	SEG9(strobe 9)	177	(Reserved)
22	SEG92	74	SEG47	126	SEG8(strobe 8)	178	(Reserved)
23	SEG91	75	SEG46	127	SEG7(strobe 7)	179	(Reserved)
24	SEG90	76	SEG45	128	SEG6(strobe 6)	180	(Reserved)
25	SEG89	77	SEG44	129	SEG5(strobe 5)	181	N.C.
26	SEG88	78	SEG43	130	SEG4(strobe 4)	182	N.C.
27	SEG87	79	SEG42	131	SEG3(strobe 3)	183	N.C.
28	SEG86	80	SEG41	132	SEG2(strobe 2)	184	N.C.
29	SEG85	81	SEG40	133	SEG1(strobe 1)	185	N.C.
30	SEG84	82	SEG39	134	SEG0(strobe 0)	186	PLLCC
31	SEG83	83	SEG38	135	COM0	187	GND
32	SEG82	84	SEG37	136	COM1	188	OSCO
33	SEG81	85	SEG36	137	COM2	189	OSCI
34	SEG80	86	SEG35	138	COM3	190	TEST
35	SEG79	87	SEG34	139	COM4	191	N.C.
36	SEG78	88	SEG33	140	COM5	192	N.C.
37	SEG77	89	SEG32	141	COM6	193	N.C.
38	SEG76	90	SEG31	142	COM7	194	N.C.
39	SEG75	91	SEG30	143	COM8	195	N.C.
40	SEG74	92	N.C.	144	COM9	196	N.C.
41	SEG73	93	N.C.	145	COM10	197	N.C.
42	SEG72	94	N.C.	146	COM11	198	N.C.
43	SEG71	95	N.C.	147	COM12	199	VCA
44	SEG70	96	N.C.	148	COM13	200	VX
45	SEG69	97	N.C.	149	COM14	201	V4
46	SEG68	98	N.C.	150	COM15	202	VR
47	SEG67	99	N.C.	151	PA.0	203	V0
48	SEG66	100	N.C.	152	PA.1	204	Vout
49	SEG65	101	N.C.	153	PA.2	205	V1
50	SEG64	102	N.C.	154	PA.3	206	V2
51	SEG63	103	N.C.	155	PA.4	207	V3
52	SEG62	104	N.C.	156	PA.5	208	VCB

**Note: Pad 176 ~ Pad 180 is for factory test only. Please do NOT bonding these pads on application circuit.**



## VI. Pin Description

### (1) System pin

Name	I/O type	Description	Note
<b>VDD</b>	-	Power supply	
<b>VSS</b>	-	Ground	
<b>SYSTEM RESET</b>	I	System reset pin	Int. pull-up
<b>RESET KEY</b>	I	Low voltage related reset pin	Int. pull-up
<b>TEST</b>	I	Test mode select pin(High active)	Int. PULL Down
<b>PLL C</b>	I	PLL capacitor connecting pin	Ext. C to VSS
<b>OSCI</b>	I	X'tal or RC oscillator connecting pin	Ext. R to VDD
<b>OSCO</b>	O	X'tal oscillator connecting pin	
<b>CLKO</b>	O	Clock output pin	
<b>LVDIN</b>	I	Low Voltage detection input pin	

### (2) Embedded LCD pin

Name	I/O type	Description	Note
<b>VCA, VCB</b>	-	Charge Pump capacitor. VCA connect 0.1uF Cap. To VCB	
<b>Vout</b>	-	Charge pump output voltage	
<b>VX</b>	-	Protection circuit output voltage	
<b>VR</b>	-	V0 voltage adjust pin.	
<b>V4...V0</b>	O	LCD bias pin	
<b>COM0~COM31</b>	O	LCD common signal	
<b>SEG0~SEG97</b>	O	LCD segment signal (SEG0~SEG15 is shared with Key strobe)	

### (3) I/O Port

PORT	Bit	Function	I/O type	Description	Notes
<b>Port A</b>	<b>Bit7</b>	General Input	I	On key input	Int. Pull up controllable
		Interrupt and wake up	I	Input port interrupt and wake up pin	
	<b>Bit6~0</b>	General Input	I	Key input	2 Int. Pull up resistor controllable
		Interrupt and wake up	I	Input port interrupt and wake up pin	
<b>Port B</b>	<b>Bit 7</b>	MDO1	O	Melody positive output	-
		General I/O	I/O		Int. Pull up controllable
	<b>Bit 6</b>	MDO2	O	Melody negative output	-
		General I/O	I/O		Int. Pull up controllable
	<b>Bit 5</b>	CHOP	O	EL CHOP output pin	-

	General I/O	I/O		Int. Pull up controllable
<b>Bit 4</b>	CK	O	EL CK output pin	-
	General I/O	I/O		Int. Pull up controllable
<b>Bit 3</b>	SPISDI	I	SPI SDI pin	-
	General I/O	I/O		Int. Pull up controllable
<b>Bit 2</b>	SPISDO	O	SPI SDO pin	-
	General I/O	I/O		Int. Pull up controllable
<b>Bit 1</b>	SPISCK	I/O	SPI SCK pin	-
	General I/O	I/O		Int. Pull up controllable
<b>Bit 0</b>	/SPISS	I	SPI /SS pin	-
	General I/O	I/O		Int. Pull up controllable

## VII. Function Descriptions

### (1) Kernel Part:

#### Feature:

1. Large ROM & RAM capacity, high expand ability.
2. Enhanced TABLE LOOK UP function. (1 or 2 cycles)
3. High capacity external memory access ability.
4. Register to Register instruction:
  - (i) Register to Register within one cycle.
  - (ii) Port to Register or Register to Port within one cycle.
5. Compare and Branch in one instruction(2cycles).
6. Single Repeat function.
7. Decimal ADD and SUB instruction.
8. 8\*8 multiply instruction.
9. Full range CALL and JUMP ability(2 cycles).

#### File Register Map:

RAM size:128 bytes+ 64 bank \*128 bytes=8320 bytes

S P E C I A L R E G I S T E R	Addr.	Unbanked	Addr.	Unbanked
	00h	<b>INDF0</b>	10h	<b>LCDDATA</b>
	01h	<b>FSR0</b>	11h	<b>TRL2</b>
	02h	<b>PCL</b>	12h	<b>PRODL</b>
	03h	<b>PCM</b>	13h	<b>PRODH</b>
	04h	<b>PCH</b>	14h	<b>SPRL</b>
	05h	<b>BSR</b>	15h	<b>SPRM</b>
	06h	<b>STKPTR</b>	16h	<b>SPRH</b>
	07h	<b>BSR1</b>	17h	(reserved)
	08h	<b>INDF1</b>	18h	(reserved)
	09h	<b>FSR1</b>	19h	<b>PORTA</b>
	0Ah	<b>ACC</b>	1Ah	<b>PORTB</b>
	0Bh	<b>TABPTRL</b>	1Bh	(reserved)
	0Ch	<b>TABPTRM</b>	1Ch	(reserved)
	0Dh	<b>TABPTRH</b>	1Dh	(reserved)
0Eh	<b>CPUCON</b>	1Eh	(reserved)	
0Fh	<b>STATUS</b>	1Fh	(reserved)	

CONTROL REGISTER	Addr.	Unbanked	Addr.	Unbanked
	20h	<b>PFS</b>	30h	<b>POST_ID</b>
	21h	<b>PACON</b>	31h	<b>TRL0L</b>
	22h	<b>STBCON</b>	32h	<b>TRL0H</b>
	23h	<b>DCRB</b>	33h	<b>TRL1</b>
	24h	(reserved)	34h	<b>TRCON</b>
	25h	(reserved)	35h	<b>MTRL</b>
	26h	(reserved)	36h	<b>MWTCON</b>
	27h	(reserved)	37h	<b>ELCON</b>
	28h	<b>LCDCON</b>	38h	<b>PAINTSTA</b>
	29h	(reserved)	39h	<b>PAINTEN</b>
	2Ah	(reserved)	3Ah	<b>INTSTA</b>
	2Bh	<b>SPICON</b>	3Bh	<b>INTCON</b>
	2Ch	<b>SPISTA</b>	3Ch	(reserved)
	2Dh	<b>PAWAKE</b>	3Dh	(reserved)
	2Eh	<b>LCDARL</b>	3Eh	(reserved)
2Fh	<b>LCDARH</b>	3Fh	<b>PBCON</b>	

Addr	Unbanked
40h   7fh	General purpose RAM

**Banked Register**(select by BSR)

Addr.	Bank 0	Bank 1	Bank 2	Bank 3	.....	Bank 63
80h   FFh	General Purpose RAM	General Purpose RAM	General Purpose RAM	General Purpose RAM	.....	General Purpose RAM

#Initial Top of STACK position (STKPTR) locates at 00h.

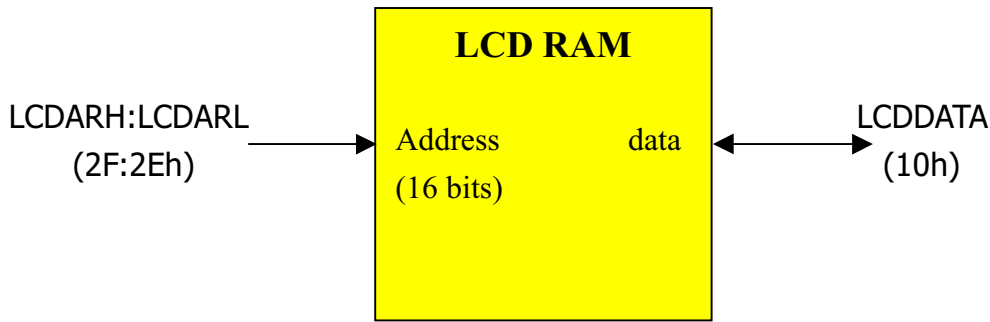
The stack level is bottom up(decrease) start from FFh of BANK 63.

Bit 0~6 of STKPTR use to pointer address from 80h~FFh

Bit 7=1 use to select BANK 63 ,Bit 7=0 use to select BANK 62.

#Each stack level will take 2 bytes, maximum 128 Stack levels.

**LCD RAM MAP:**



**ROM Map:**

**Program ROM:** 8 K words\* 6 Segments=48k words

**Data ROM:** 512K words.

Addr.	Type	Segment
0000h   1FFFh	Program ROM	Segment 0
2000h   3FFFh		Segment 1
4000h   5FFFh		Segment 2
6000h   7FFFh		Segment 3
8000h   9FFFh		Segment 4
A000h   BDFh		Segment 5
BFE0h-BFFBh	TEST Program(28 Words)	
BFFCh-BFFFh	Code Option(4 words)	
C000h-FFFFFh	Reserved (Not Implemented)	
Addr.	Type	Range
100000h   17FFFFh	Data ROM	(0~512K words)

## Register Description

Remark:

**R** = Readable bit    **W** = Writable bit    - = Not implement

Addr.	Register name	bit 7	bit 6	bit 5	bit 4	bit 3	bit 2	bit 1	Bit 0
0	<b>INDF0</b>	R/W Indirect addressing pointer0.							
1	<b>FSR0</b>	R/W File select register 0 for INDF0(R0)							
2	<b>PCL</b>	R/W PC7	R/W PC6	R/W PC5	R/W PC4	R/W PC3	R/W PC2	R/W PC1	R/W PC0
3	<b>PCM</b>	R/W PC15	R/W PC14	R/W PC13	R/W PC12	R/W PC11	R/W PC10	R/W PC9	R/W PC8
4	<b>PCH</b>	-	-	-	-	-	-	-	-
5	<b>BSR</b>	Bit 6,7: R ( Fix at 0 ) , Bit6 ~ Bit 0: R/W Bank select register(for INDF0 & general)							
6	<b>STKPTR</b>	R/W Stack pointer							
7	<b>BSR1</b>	Bit 6,7: R ( Fix at 0 ) , Bit6 ~ Bit 0: R/W Bank select register(for INDF1)							
8	<b>INDF1</b>	R/W Indirect addressing pointer1.							
9	<b>FSR1</b>	Bit 7: R ( Fix at 1 ) , Bit6 ~ Bit 0: R/W File select register 1 for INDF1(R8)							
A	<b>ACC</b>	R/W Accumulator							
B	<b>TABPTRL</b>	R/W Table pointer low							
C	<b>TABPTRM</b>	R/W Table pointer middle							
D	<b>TABPTRH</b>	R/W Table pointer high							
E	<b>CPUCON</b>	R/W CLKOEN	R/W CKS	R/W LVDEN	R /LV	R/W /GLINTD	R PS	R/W MS1	R/W MS0
F	<b>STATUS</b>	R /TO	R /PD	R/W SGE	R/W SLE	R/W OV	R/W Z	R/W DC	R/W C
10	<b>LCDDATA</b>	R/W Indirect register to LCD RAM							
11	<b>TRL2</b>	R/W Timer2 reload register							
12	<b>PRODL</b>	R/W Multiplier product low							
13	<b>PRODH</b>	R/W Multiplier product high							
14	<b>SPRL</b>	R/W Shift register low byte of SPI							
15	<b>SPRM</b>	R/W Shift register middle byte of SPI							
16	<b>SPRH</b>	R/W Shift register high byte of SPI							
17	(Reserved)	-							



18	(Reserved)	-							
19	<b>PORTA</b>	R	R	R	R	R	R	R	R
		A.7	A.6	A.5	A.4	A.3	A.2	A.1	A.0
1A	<b>PORTB</b>	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W
		B.7	B.6	B.5	B.4	B.3	B.2	B.1	B.0
1B	(Reserved)	-							
1C	(Reserved)	-							
1D	(Reserved)	-							
1E	(Reserved)	-							
1F	(Reserved)	-							
20	<b>PFS</b>	R/W PLL frequency select							
21	<b>PACON</b>	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W
		LVD2	LVD1	LVD0	LVDSEL	Bit7PU	/R2EN	/R1EN	KE
22	<b>STBCON</b>	-	R/W	R/W	R/W	R/W	R/W	R/W	R/W
		-	SCAN	BitST	ALL	STB3	STB2	STB1	STB0
23	<b>DCRB</b>	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W
		Bit7DC	Bit6DC	Bit5DC	Bit4DC	Bit3DC	Bit2DC	Bit1DC	Bit0DC
24	(Reserved)	-							
25	(Reserved)	-							
26	(Reserved)	-							
27	(Reserved)	-							
28	<b>LCDCON</b>	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W
		BSEL2	BSEL1	BSEL0	ADJ4	ADJ3	ADJ2	ADJ1	ADJ0
29	(Reserved)	-							
2A	(Reserved)	-							
2B	<b>SPICON</b>	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R
		TLS1	TLS0	BRS2	BRS1	BRS0	EDS	DORD	SE
2C	<b>SPISTA</b>	R/W	R/W	R/W	R/W	R/W	R/W	R	R
		LCDM1	LCDM0	SFR1	SFR0	SPWKEN	SMP	DCOL	RBF
2D	<b>PAWAKE</b>	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W
		WKEN7	WKEN6	WKEN5	WKEN4	WKEN3	WKEN2	WKEN1	WKEN0
2E	<b>LCDARL</b>	R/W Address low to LCD RAM							
2F	<b>LCDARH</b>	-	-	-	-	-	-	R/W	R/W
		-	-	-	-	-	-	LCDARH1	LCDARH0
30	<b>POST_ID</b>	-	R/W	R/W	R/W	-	R/W	R/W	R/W
		-	LCD_ID	FSR1_ID	FSR0_ID	-	LCDPE	FSR1PE	FSR0PE
31	<b>TRL0L</b>	R/W Timer0 reload low byte							
32	<b>TRL0H</b>	R/W Timer0 reload high byte							
33	<b>TRL1</b>	R/W Timer1 reload register							
34	<b>TRCON</b>	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W



		T1WKEN	T1EN	T1PSR1	T1PSR0	T0EN	T0CS	T0PSR1	T0PSR0
35	<b>MTRL</b>	R/W Melody Timer reload register							
36	<b>MWTCON</b>	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W
		T2EN	T2PSR1	T2PSR0	WDTEN	WDTPSR1	WDTPSR0	MTEN	MDO2EN
37	<b>ELCON</b>	R/W	R/W	R/W ELTRL5 ~ ELTRL0					
38	<b>PAINTSTA</b>	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W
		PA7I	PA6I	PA5I	PA4I	PA3I	PA2I	PA1I	PA0I
39	<b>PAINTEN</b>	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W
		PA7IE	PA6IE	PA5IE	PA4IE	PA3IE	PA2IE	PA1IE	PA0IE
3A	<b>INTSTA</b>	-	-	-	R/W	R/W	R/W	R/W	R/W
		-	-	-	SRBFI	LVDI	TMR2I	TMR1I	TMR0I
3B	<b>INTCON</b>	-	-	-	R/W	R/W	R/W	R/W	R/W
		-	-	-	SRBFIE	LVDIE	TMR2IE	TMR1IE	TMR0IE
3C	(Reserved)	-							
3D	(Reserved)	-							
3E	(Reserved)	-							
3F	<b>PBCON</b>	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W
		Bit7PU	Bit6PU	Bit5PU	Bit4PU	Bit3PU	Bit2PU	Bit1PU	Bit0PU

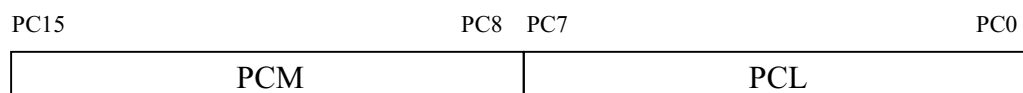
**R0(INDF0)**

\*R0 is not a physically implemented register. It is useful as indirect addressing pointer0.  
Any instruction using R0 as register actually accesses data pointed by the File select register0(R1) and bank select register(R5).

**R1(FSR0)**

\*R1 is an address register for indirect addressing pointer0. User can select up to 256 bytes register on working bank(selected by BSR).  
\*When enable FSR0 auto increase/decrease function by R30(Post\_ID), FSR0 will **NOT** carry into or borrow from BSR register. On the contrary, FSR1 will carry into or borrow from BSR1.

**R2~R4(PCL,PCM,PCH)**



\*Generates up to 48K\*16 on chip ROM addresses to the relative programming instruction codes.

\*\*S0CALL” loads the low 12 bits of the PC(4K\*16 ROM).

\*\*SCALL”, SJUMP” loads the low 13 bits of the PC(8K\*16 ROM).



\*"LCALL", "LJUMP" loads the full 16 bits of the PC(48K\*16 ROM).

\*"ADD R2,A" or "ADC R2,A" allows a relative address be added to the current PC. The carry bit of R2 will automatically carry into PCM .

#### **R5(BSR)**

\*Determine which bank is active(working bank) among the 64 banks.

\*INDF0 is pointed on the working bank determined by R5.

#### **R6(STKPTR)**

\*The stack level is bottom up(decrease) start from FFh of BANK 63.

\*Stack locates on BANK 62 and 63 from address FFh~80h. And initial stack pointer is 00h.

\*Bit 0~6 of STKPTR use to pointer address from 80h~FFh

\*Bit 7=1 used to select BANK 63 ,Bit 7=0 used to select BANK 62.

#### **R7(BSR1)**

\*R7 is a bank register for indirect addressing pointer 1(R8,R9) only. Can't determine the working bank for general register.

#### **R8(INDF1)**

\*R8 is not a physically implemented register. It is useful as indirect addressing pointer 1.

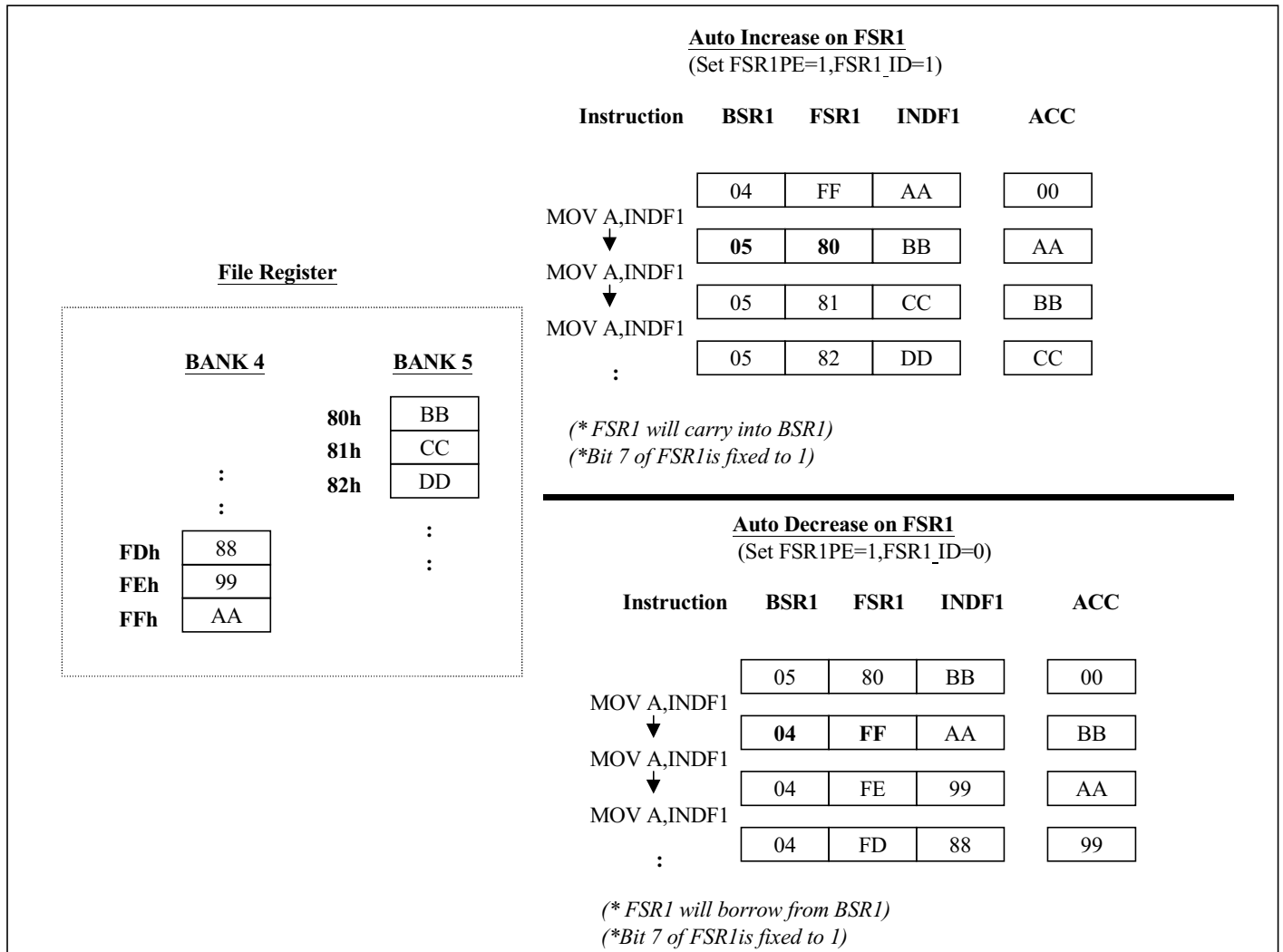
Any instruction using R8 as register actually accesses data pointed by the File select Register1(R9) and bank select register1(R7).

#### **R9(FSR1)**

\*R9 is an address register for INDF1 only. User can select address 0x80 to 0xFF register on the bank pointed by R7.

\*Bit 7 of FSR1 is fixed to 1.

\*Linear addressing ability of INDF1 shown below.



**RA(ACC)**

\*Accumulator. Internal data transfer , or instruction operand holding.

**RB~RD(TABPTRL,TABPTRM,TABPTRH)**



\*Internal program ROM or external memory address register.

\*Bit 23 used to select internal/external memory, **Bit 22~Bit 1** used to point the address of memory, **Bit 0** used to select the low or high byte of pointed word. (See TBRD instruction).

\*External memory table look up function is reserved for the future model.

**RE(CPUCON)**

bit 7							bit0
CLKOEN	CKS	LVDEN	/LV	/GLINTD	PS	MS1	MS0

\*bit7(CLKOEN): clock output enable control bit.

**CLKO** pin is tri-state when clock output disable.(CLKOEN=0)

\*bit6(CKS): clock select bit of clock output pin (CLKO).

0: CLKO pin output frequency at 32.768KHz(Fosc)

1: CLKO pin output frequency at 21.845KHz(Fosc/1.5).

\*bit5(LVDEN): Enable Low Voltage Detector control bit.

\*bit4(/LV): Low voltage detected. This is a read only bits. When the voltage of **LVDIN** pin is lower than Vdet(Vth-)(selected by **LVD0~LVD2** bit of R21), this bit will be clear.

0: Low voltage is detected.

1: Low voltage is not detected or LVD is disable.

\*bit3(/GLINTD): Global interrupt disable bit.

0:Disable all interrupt.

1:Enable all un-mask interrupt.

\*bit2(PS): PLL stable flag. This bit will be cleared when PLL not turned on or PLL is turned on but not stable. And be set after PLL turned on and frequency stable.

0: PLL is not turned on or PLL frequency not yet stable .

1: PLL is turned on and frequency stable.

\*bit1(MS1): Mode select bit 1. Used to enter SLEEP MODE or IDLE MODE after executing “**SLEP**” instruction.

0: SLEEP MODE

1: IDLE MODE

\*bit0(MS0): Mode select bit 0. Used to enter SLOW MODE or FAST MODE.

0: SLOW MODE.

1: FAST MODE.

**RF(STATUS)**

bit 7							bit0
/TO	/PD	SGE	SLE	OV	Z	DC	C

\*bit7(/TO): Reset to 0 when WDT time out reset. Set to 1 by “WDTC” instruction , enter SLEEP MODE , power on reset or Reset pin low condition.

\*bit6(/PD) : Reset to 0 when enter sleep mode. Set to 1 by “WDTC” instruction , power on reset or Reset pin low condition.

\*bit5(SGE): Computation result great than or equal to zero(Positive value) after signed arithmetic. Only affected by HEX arithmetic instruction.

\*bit4(SLE): Computation result less than or equal to zero(Negative value) after signed arithmetic. Only affected by HEX arithmetic instruction.

\*bit3(OV): Overflow flag. Use in signed operation when bit6 carry into or borrow from signed bit(bit7).

Note: 1. When  $OV=1$  after signed arithmetic, user can check **SGE** bit and **SLE** bit to know either overflow (carry into sign bit) or underflow (borrow from sign bit) happened.

**$OV=1$  and  $SGE=1 \rightarrow$  overflow happened**

**$OV=1$  and  $SLE=1 \rightarrow$  underflow happened**

2. When overflow happened, user should **clear** the MSB of Accumulator to get the correct value.

When underflow happened, user should **set** the MSB of accumulator to get the correct value.

**Ex1. ADD positive value with positive value, and ACC signed bit was affected**

```
MOV  ACC,#60h ;signed number +60h
ADD  ACC,#70h ;+60h ADD with +70h
```

**after instruction:**

ACC=d0h

SGE=1, means the result is great than or equal to 0(positive value)

OV=1, means result carry into signed bit(bit 7), overflow happened.

**correct the signed bit:**

ACC=50h (Clear the signed bit)

The actual result=  $+80h * 1(OV=1) + 50h = +d0h$

**Ex2. SUB positive value from negative value, and ACC signed bit was affected**

```
MOV  ACC,#50h ;signed number +50h
SUB  ACC,#90h ;+50h SUB from -70h (signed number of 90h)
```

**after instruction:**

ACC=40h

SLE=1, means the result is less than or equal to 0(negative value)

OV=1, means result borrow from signed bit(bit 7), underflow happened.

**correct the signed bit:**

ACC=c0h (set the signed bit)

The actual result=  $-80h * 1(OV=1) - 40h(\text{signed number of } c0h) = -c0h$

\*bit2(Z) : Zero flag.

\*bit1(DC) : Auxiliary carry flag.

\*bit0(C) : Carry flag.

**R10(LCDDATA)**

\*R10 is an indirect addressing pointer of LCD RAM.

Any instruction using R10 as register actually accesses LCD RAM pointed by

LCDARH:LCDARL(R2F:R2E).

**R11(TRL2)**

\*Timer2 reload register.

**R12,R13(PRODL,PRODH)**

\*An unsigned 8\*8 hardware multiplier is included in the micro controller. The result is stored into the 16 bits product register (PRODH:PRODL).

**R14~R16(SPRL:SPRM:SPRH)**

\*SPI shift buffer for 24/16/8 bits length.

**R17~R18**

\*Reserved.

**R19~R1A(PORTA~PORTB)**

\*Port A ~ Port B are general I/O register.

**R1B~R1F**

\*Reserved.

**R20(PFS)**

\*PLL frequency select.

**R21(PACON)**

bit 7							bit0
LVD2	LVD1	LVD0	LVDSEL	Bit7PU	/R2EN	/R1EN	KE

\*bit7~5(LVD2~0): LVD detection voltage select bits.

LVD2~0	Vdet(Vth-)	Vdet(Vth+)	Deviation	LVD2~0	Vdet(Vth-)	Vdet(Vth+)	Deviation
000	2.2V	2.3V	±0.1V	100	2.6V	2.7V	±0.1V
001	2.3V	2.4V		101	2.7V	2.8V	
010	2.4V	2.5V		110	2.8V	2.9V	
011	2.5V	2.6V		111	2.9V	3.0V	

**The initial value of LVD2~0 after CPU reset is "000".**

\*bit4(LVDSEL): Built in LVD/External LVD select

0: External LVD selected.

1: Built-in LVD selected.

\*bit3(Bit7PU): Enable PortA.7 pull up resistor.

\*bit2(/R2EN): Enable R2(large resistor) pull up resistor.

0: Enable R2 pull up resistor.

1: Disable R2 pull up resistor.

\*bit1(/R1EN): Enable R1 (small resistor) pull up resistor.

0: Enable R1 pull up resistor.

1: Disable R1 pull up resistor.

\*bit0(KE): Key input enable/disable control bit.

0: Disable Key input function (PORTA register is *NOT* correspondence with Key input in software scan mode).

1: Enable Key input function (PORTA register is correspondence with Key input in software scan mode).

**R22(STBCON)**

bit 7							bit 0
-	SCAN	BitST	ALL	STB3	STB2	STB1	STB0

\*bit7: Reserved.

\*bit6(SCAN) : Automatic key scan or specify the scan signal bit by bit (software scan).

0 : Key scan was specified as the bit **STB3~0** defined.

1 : Auto strobe scanning.

\*bit5(BitST) : Enable Bit strobe

0 : Display waveform.

1 : Strobe signal as STB3~0 defined.

\*bit4(ALL): Set All strobe.

0 : Bit strobe.

1 : All strobe.

\*bit3~0(STB3~0): Strobe output selector bit.

**R23(DCRB)**

\*bit7~0(Bit7DC~Bit0DC): Direction control of Port B .

0: output pin

1: input pin

**R24~R27**

\*Reserved.

**R28(LCDBCON)**

bit 7							bit 0
BSEL2	BSEL1	BSEL0	ADJ4	ADJ3	ADJ2	ADJ1	ADJ0

\*bit7~5(BSEL2~0) : LCD Bias select

BSEL2	BSEL1	BSEL0	LCD Bias
0	0	0	1/3
0	0	1	1/3.5

0	1	0	1/4
0	1	1	1/4.5
1	0	0	1/5
1	0	1	1/5.5
1	1	0	1/6
1	1	1	1/6.5

\*bit4~0(ADJ4~0): LCD contrast adjustment .

ADJ4	ADJ3	ADJ2	ADJ1	ADJ0	$\alpha$	Contrast
0	0	0	0	0	0	Weakest
0	0	0	0	1	1	
.	.	.	.	.	.	
.	.	.	.	.	.	
1	1	1	1	0	30	
1	1	1	1	1	31	Strongest

$$V0 = \left(1 + \frac{Rb}{Ra}\right) \times VEV$$

$$VEV = \left(1 - \frac{(31 - \alpha)}{124}\right) \times VREF$$

(Vref=2.12V at 20°C)

## R29~R2A

\*Reserved.

## R2B(SPICON)

bit 7	TLS1	TLS0	BRS2	BRS1	BRS0	EDS	DORD	SE	bit0
-------	------	------	------	------	------	-----	------	----	------

\*Bit7~6(TLS1~TLS0):Shift buffer length select. Shift buffer length is programmable.

00: SPI disable

01: SPI shift buffer length = 24 bits

10: SPI shift buffer length = 16 bits

11: SPI shift buffer length = 8 bits

\*bit5~3(BRS2~BRS0):Bit rate select. Programming the clock frequency/rates and sources.

000:Master,TMR0/2

001:Master,Fsystem/4.

010:Master,Fsystem/16.

011:Master,Fsystem/64.

100:Master,Fsystem/256.

101:Master,Fsystem/1024.

110:Slave,/SS enable

111:Slave,/SS disable

\*bit2(EDS): Select the raising / falling edges latch by programming the EDS bit

0: Falling edge

1: Raising edge

\*bit1(DORD):Data transmission order.

0:Shift left (MSB first)

1:Shift right (LSB first)

\*bit0(SE): Shift Enable.

Set to 1 automatically when write data into SPRL register and begin to shift.

Reset to 0 when transfer buffer empty detected.

**R2C(SPISTA)**

bit 7	bit0						
LCDM1	LCDM0	SFR1	SFR0	SPWKEN	SMP	DCOL	RBF

\*bit7~6(LCDM1~0): LCD operation mode control register.

LCDM1:LCDM0	Operation mode
00	Disable(LCD off)
01	Blanking
10	LCD enable
11	LCD enable

Note: Blanking means All COM & SEG pin are tied to ground.

\*bit5~4(SFR1~0) : Frame frequency adjustment.

SFR1	SFR0	CL frequency	Frame frequency (Hz)		
			Min	Typ	Max
0	0	Fosc / 13	59.1	78.8	98.6
0	1	Fosc / 14	54.9	73.2	91.5
1	0	Fosc / 15	51.3	68.3	85.4
1	1	Fosc / 16	48.0	64.1	80.1

Note: 1.Fosc = 32.8kHz +/- 25% (all conditions)

2.This table is based on 1/32 duty.

\*bit3(SPWKEN):SPI wake up enable control bit.

0:Disable SPI (slave mode) read buffer full wakeup.

1: Enable SPI (slave mode) read buffer full wakeup.

\*bit2(SMP):SPI data input sample phase.

0:Input data sampled at middle of data output time

1:Input data sampled at the end of data output time

**In slave mode, data input sample is fixed at middle of data output time.**

\*bit1(DCOL):SPI data collision.

0:Data collision didn't occurs

1:Data collision occurs. Should be cleared by software.

\*bit0(RBF):Set to 1 by Buffer Full Detector, and clear to 0 automatically when read data from SPRL register.

**R2D(PAWAKE)**

bit 7	bit0						
WKEN7	WKEN6	WKEN5	WKEN4	WKEN3	WKEN2	WKEN1	WKEN0



\*bit7~0(WKEN7~WKEN0): Wake up enable control bit of Port A.

0: Disable Port A wake up function.

1: Enable Port A wake up function.

### R2E~R2F(LCDARL,LCDARH)

\* LCDARH:LCDARL is the address for LCD RAM.

\*LCDARH: Page address for LCD RAM.

\*LCDARL: Column address for LCD RAM.

### R30(POST\_ID)

bit 7							bit 0
-	LCD_ID	FSR1_ID	FSR0_ID	-	LCDPE	FSR1PE	FSR0PE

\*Post increase / decrease control register.

\*For example , enable LCD post decrease function(bit2=1[enable],bit6=0[decrease]), then LCDARL will automatic decrease after access(read or write) LCDDATA(R10).

(Note: LCDARL will NOT carry into /borrow from LCDARH.)

\*bit 0(FSR0PE): Enable FSR0 post increase/decrease function.

\*bit 1(FSR1PE): Enable FSR1 post increase/decrease function.

\*bit 2(LCDPE): Enable LCDARL post increase/decrease function.

\*bit 3: Reserved.

\*bit 4(FSR0\_ID): Set to 1 means auto\_increase, reset to 0 means auto\_decrease of FSR0.

\*bit 5(FSR1\_ID): Set to 1 means auto\_increase, reset to 0 means auto\_decrease of FSR1.

\*bit 6(LCD\_ID): Set to 1 means auto\_increase, reset to 0 means auto\_decrease of LCDARL.

\*bit7: Reserved.

\*The initial value of bit0~bit3 is 0, and bit 4~bit 7 is 1.

### R31~R32(TRL0L~TRL0H)

\*Timer0 reload low byte and high byte.

### R33(TRL1)

\*Timer1 reload register.

### R34(TRCON)

bit 7							bit 0
T1WKEN	T1EN	T1PSR1	T1PSR0	T0EN	T0CS	TOPSR1	TOPSR0

\*Timer0 and timer1 control register.

\*bit7(T1WKEN): Enable bit of Timer1 underflow wake up function in IDLE MODE.

0: Disable Timer1 wake up function .

1: Enable Timer1 wake up function.

\*bit6(T1EN): Timer1 enable control bit  
 0: Disable Timer1(stop counting) .  
 1: Enable Timer1 .

\*bit5~4(T1PSR1~T1PSR0): Timer1 Prescaler select bits.

T1PSR1:T1PSR0	Prescale value
00	1:4
01	1:16
10	1:64
11	1:256

\*bit3(T0EN): Timer0 enable control bit  
 0: Disable Timer0(stop counting) .  
 1: Enable Timer0 .

\*bit2(T0CS): Timer 0 clock source select bit.  
 0: Clock source is from Fosc.  
 1: Clock source is from half of the system clock.

\*bit1~0(T0PSR1:T0PSR0): Timer0 Prescaler select bits.

T0PSR1:T0PSR0	Prescale value
00	1:1
01	1:4
10	1:16
11	1:64

**R35(MTRL)**

\*Melody Timer reload register.

**R36(MWTCON)**

bit 7							bit 0
T2EN	T2PSR1	T2PSR0	WDTEN	WDTPSR1	WDTPSR0	MTEN	MDO2EN

\*Timer2 ,Melody timer and WDT control register.

\*bit7(T2EN): Timer2 enable control bit  
 0: Disable Timer2(stop counting) .  
 1: Enable Timer2 .

\*bit6~5(T2PSR1~T2PSR0): Timer2 Prescaler select bits.

T2PSR1:T2PSR0	Prescale value
00	1:1
01	1:2
10	1:4
11	1:8

\*bit4(WDTEN): Watch Dog Timer enable bit

\*bit3~2(WDTPSR1~WDTPSR0): Watch Dog timer Prescaler select bits.

WDTPSR1:WDTPSR0	Prescale value
00	1:4
01	1:16
10	1:64
11	1:128

\*bit1(MTEN): Melody Timer enable control bit.

\*bit0(MDO2EN): Melody negative output port enable control bit.

**R37(ELCON)**

bit 7		bit0
ELTEN	CKP	ELTRL5 ~ ELTRL0

\*bit7(ELTEN): EL Timer enable control bit.

0: Disable EL Timer(stop counting) and recover CK and CHOP pin to general I/O pin.

1: Enable EL Timer and change Port B.4 and Port B.5 to CK and CHOP output pin.

\*bit6(CKP): EL clock polarity select bit.

0: Idle state for CHOP pin is low level.

1: Idle state for CHOP pin is high level.

\*bit5~0(ELTRL5~0): Used to store the auto reload value of EL timer. When underflow happens, ELTRL will automatic reload into 6 bits counter .

**R38(PAINTSTA)**

bit 7							bit0
PA7I	PA6I	PA5I	PA4I	PA3I	PA2I	PA1I	PA0I

\*bit7~0(PA7I~PA0I): INT status of Port A interrupt. Set when pin **falling edge** detected. Clear by software.

**R39(PAINTEN)**

bit 7							bit0
PA7IE	PA6IE	PA5IE	PA4IE	PA3IE	PA2IE	PA1IE	PA0IE

\*Port A interrupt enable control register

\*bit7~0(PA7IE~PA0IE): Control bit of interrupt.

0: Disable Port A interrupt function.

1: Enable Port A interrupt function.

**R3A(INTSTA)**

bit 7					bit0		
-	-	-	SRBFI	LVDI	TMR2I	TMR1I	TMR0I

\*bit0(TMR0I): Set to 1 when TMR0 underflow happened. Clear to 0 by software or Timer0 disable.

\*bit1(TMR1I): Set to 1 when TMR1 underflow happened. Clear to 0 by software or Timer1 disable.

\*bit2(TMR2I): Set to 1 when TMR2 underflow happened. Clear to 0 by software or Timer2 disable.

\*bit3(LVDI): Set to 1 when LVD low level detected(**Falling edge**). Clear to 0 by software or LVD disable.

\*bit4(SRBF1): Set to 1 when SPI read buffer full happened. Clear to 0 by software or SPI disable.

\*bit5~7: Reserved.

**R3B(INTCON)**

bit 7							bit 0
-	-	-	SRBFIE	LVDIE	TMR2IE	TMR1IE	TMR0IE

\* 0: Disable Port A interrupt function.

1: Enable Port A interrupt function.

\*bit0(TMR0IE): Control bit of TIMER0 interrupt.

\*bit1(TMR1IE): Control bit of TIMER1 interrupt.

\*bit2(TMR2IE): Control bit of TIMER2 interrupt.

\*bit3(LVDIE): Control bit of LVD interrupt.

\*bit4(SRBFIE): Control bit of SPI read buffer full interrupt.

\*bit5~7: Reserved.

**R3C~R3E**

\*Reserved.

**R3F(PBCON)**

\*bit7~0(Bit7PU~Bit0PU):Pull up resistor control of Port B.

0:Disable pull up resistor

1:Enable pull up resistor

**Code Option**

(Locate on the final 4 words of Program ROM)

**WORD0 (0xBFFC):**

bit 7							bit 0
EXTVH	TBRD_3T	DRSEL1	DRSEL0	-	ELSEL	IM	OSCSEL

\*bit0 (OSCSEL): RC oscillator or Crystal select bit

0:RC oscillator

1:Crystal oscillator

\*bit1 (IM): Initial mode after Reset.

0: SLOW Mode

1: FAST Mode

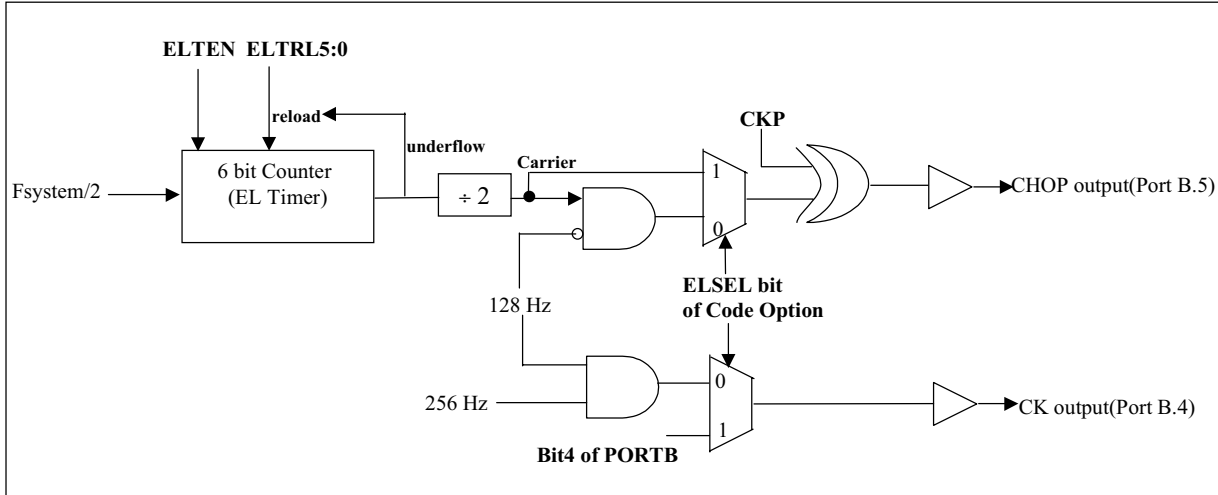
\*bit2(ELSEL): EL output timing select bit

0: CHOP output is from carrier gating with 128Hz and CKP .

CK output is from 128Hz gating with 256Hz.

1: CHOP output is directly from carrier .

CK output is directly from Bit4 of PORTB register.



\*bit3: No use.

\*bit4~bit5(DRSEL1:0): LCD duty ratio select bit.

00: 1/ 11 duty

01: 1/ 16 duty

10: 1/ 24 duty

11: 1/ 32 duty

CL Frequency V.S. Duty ratio table:

		CL frequency			
SFR1	SFR0	1/11 duty	1/16 duty	1/24 duty	1/32 duty
0	0	Fosc /38	Fosc /26	Fosc /17	Fosc /13
0	1	Fosc / 40	Fosc / 28	Fosc / 18	Fosc / 14
1	0	Fosc / 44	Fosc / 30	Fosc / 20	Fosc / 15
1	1	Fosc / 46	Fosc / 32	Fosc / 22	Fosc / 16

\*bit6(TBRD\_3T): TBRD instruction three cycle enable bit.

0: "TBRD" is 2 cycles instruction.

1: "TBRD" is 3 cycles instruction. (for use at large DATA ROM version)

\*bit7(EXTVH): Vout is from external power source or internal charge pump selection.

0: Internal.

1: External

bit 15

bit8

OPV4_1	OPV4_0	OPV3_1	OPV3_0	OPV2_1	OPV2_0	OPV1_1	OPV1_0
--------	--------	--------	--------	--------	--------	--------	--------

\*bit8~bit9(OPV1\_0:1):V1 OP buffer type selection

\*bit10~bit11(OPV2\_0:1):V2 OP buffer type selection

\*bit12~bit13(OPV3\_0:1):V3 OP buffer type selection

\*bit14~bit15(OPV4\_0:1):V4 OP buffer type selection

(OPVx_1,OPVx_0)	00	01	10	11
<b>OP Buffer</b>				
<b>V1</b>	Source	*1	Class A/B	OFF
<b>V2</b>	Sink	*1	Class A/B	OFF
<b>V3</b>	Source	*1	Class A/B	OFF
<b>V4</b>	Sink	*1	Class A/B	OFF

\*1: When Normal display: V1=source, V2=sink, V3=source, V4=sink

When Auto key scan: Every time when 30us strobe start, OP Amp. will change to class A/B for 60us, then return to Normal Display.

Note: OP buffer type configuration for different application

Application	1/3 Bias & Small panel	Other Bias & Small panel	Other Bias & Large panel
<b>OP Buffer</b>			
<b>V1</b>	*1	*1	Class A/B
<b>V2</b>	Off	*1	Class A/B
<b>V3</b>	Off	*1	Class A/B
<b>V4</b>	*1	*1	Class A/B
<b>Circuit</b>			
<b>Current Consumption</b>	Very low	Low	High, but high driving ability

**WORD1 (0xBFFD):**

bit 7	-	-	CSOP	PLLST_OPT	HFSEL	OPT1	OPT0	bit0	-
-------	---	---	------	-----------	-------	------	------	------	---

\*bit0:Reserved.

\*bit1(OPT0):Reserved.

\*bit2(OPT1):Reserved.

\*bit3(HFSEL): High frequency select bit. ***This function is only available in ROMless CPU.***

0: High frequency system clock is from PLL clock.

1: High frequency system clock is from HOSCO pin.

\*bit4(PLLST\_OPT):PLL stable accuracy select bit.

0: PS bit will be set when PLL frequency is within target +/- 10%.

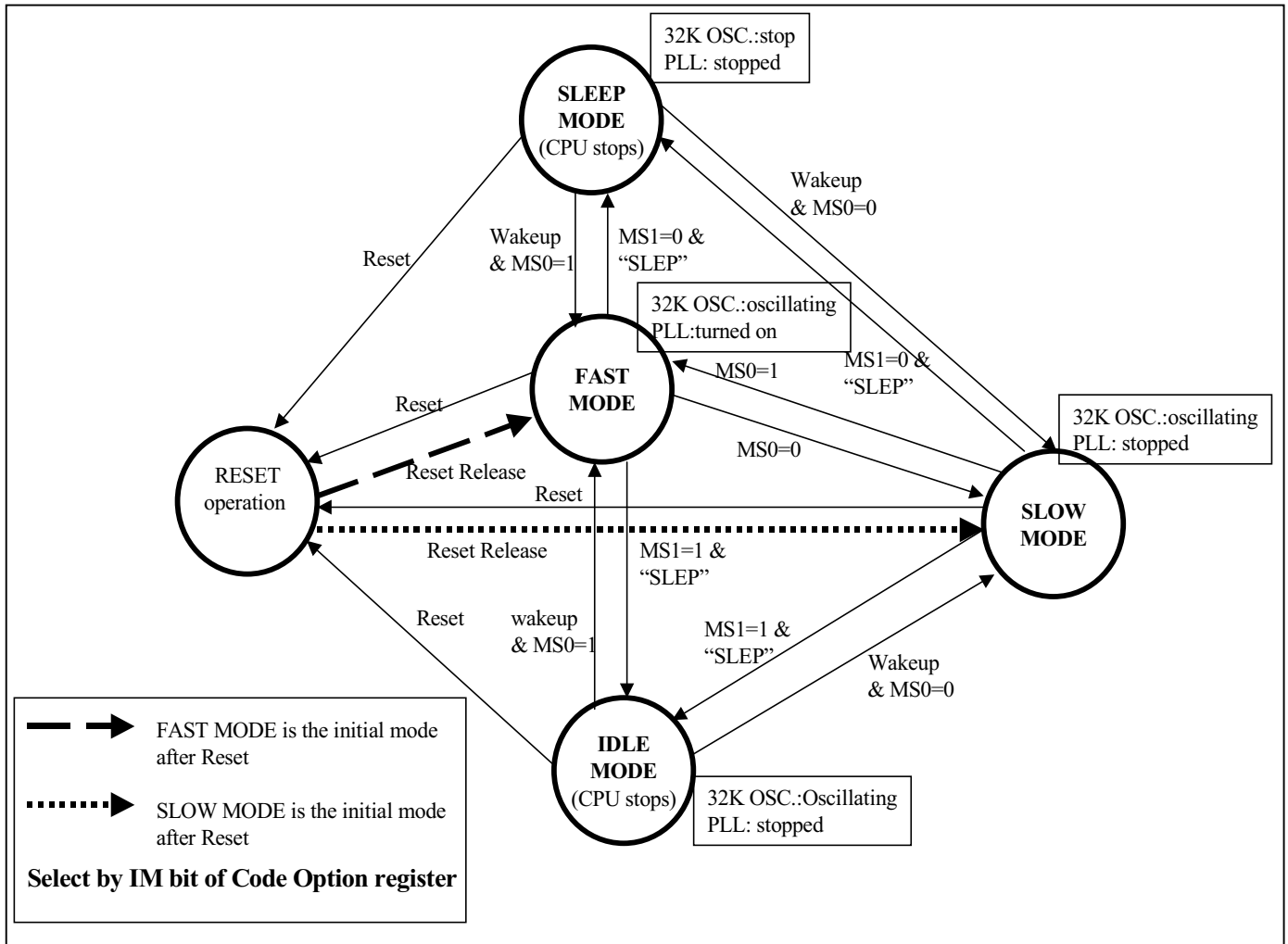
1: PS bit will be set when PLL frequency is within target +/- 3%.

\*bit5(CSOP):Reserved.

\*Bit6~15: Not use.

**WORD2~WORD3 (0xBFFE~0xBFFF):** Not use.

(2) CPU OPERATION MODE:



Mode	SLEEP	IDLE	SLOW	FAST
<b>Device</b>				
<b>Osc.(32768Hz)</b>	X	O	O	O
<b>PLL</b>	X	X	X	O
<b>CPU</b>	X	X	O	O
<b>LVD</b>	O	O	O	O
<b>CLOCK OUTPUT</b>	X	O	O	O
<b>Timer0,1,2, Melody Timer, EL Timer</b>	X	O	O	O
<b>INT</b>	X(*2)	X(*2)	O	O
<b>SPI</b>	O(slave)	O(slave)	O	O
<b>I/O wake up</b>	O	O	X	X
<b>SPI wake up</b>	O	O	X	X
<b>Timer1 wake up</b>	X	O	X	X

(Note): \*1: O: Function available if enable.

X: Function NOT available.

\*2: Interrupt flag will be recorded but not be executed until CPU wake up.

## Function Description:

**1. SLEEP MODE:** When set **MS1** bit of CPUCON register to '0' and execute "SLEP" instruction, the CPU will enter SLEEP MODE.

The SLEEP MODE suspends all system operation and holds the internal status immediately before the suspension with low power consumption. This mode will be released by CPU reset , I/O pins or SPI receive full wake up.

The **/PD** bit of STATUS Register(RFh) is cleared when entering SLEEP MODE.

This bit will be set to 1 by "WDTC" instruction , Power on RESET or Reset pin low condition.

All register and LCD RAM unchanged in SLEEP MODE.

**2.IDLE MODE:** When set **MS1** bit of CPUCON register to '1' and execute "SLEP" instruction, the CPU will enter IDLE MODE.

The IDLE MODE suspends all operations except for the Oscillator , clock output . It retains the internal status with low power consumption without stopping the clock function.

The IDLE MODE will be waken up and return to the either SLOW MODE(**MS0**=0) or FAST MODE(**MS0**=1) by the timer 1 wake up ,SPI receive full or I/O pins wake up (if enable) .

All register and LCD RAM unchanged in IDLE MODE.

**3.SLOW MODE:** When set **MS0** bit of CPUCON register to '0' , the CPU will enter SLOW MODE.

Except PLL and UART, every device can be turned on. System clock is at 32.768KHz.

This feature allows all the internal operations to slow down and thus reduces power consumption.

**4.FAST MODE:** When set **MS0** bit of CPUCON register to '1' , the CPU will enter FAST MODE.

After turning on PLL and wait 32 clocks from Oscillator, then system clock switched to high frequency of PLL(adjustable by PFS register).

This mode allows all the internal operations at fast speed. But it will consumes the most power .



## Register Description:

- **CPUCON Register:**

bit 7							bit0
CLKOEN	CKS	LVDEN	/LV	/GLINTD	PS	MS1	MS0

- ◆ **MS0:** Mode select bit 0. Used to enter SLOW MODE or FAST MODE.
  - 0: SLOW MODE.
  - 1: FAST MODE.
- ◆ **MS1:** Mode select bit 1. Used to enter SLEEP MODE or IDLE MODE after executing “SLEP” instruction.
  - 0: SLEEP MODE
  - 1: IDLE MODE

(3) Reset and WAKE UP:

**RESET:**

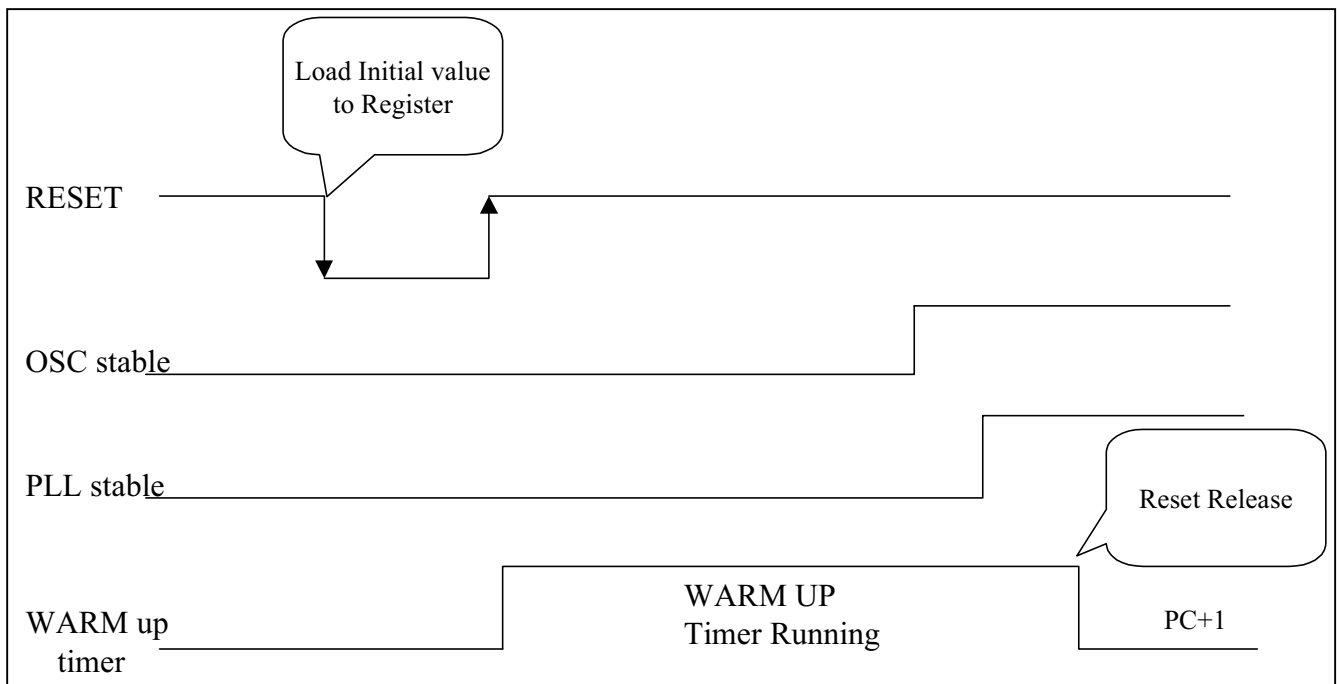
The reset can be caused by :

1. Power on reset.
2. Reset pin(SYSTEM RESET or Reset\_key) is at low condition(level hold)
3. WDT time out(if WDT enable)

If the CPU reset is caused by WDT time out, the **/TO** bit of STATUS register will be cleared. Set to 1 during power up or by “WDTC” instruction or when entering SLEEP MODE.

If the CPU changed to SLEEP MODE, the **/PD** bit of STATUS register will be cleared. Set to 1 during power up or by “WDTC” instruction .

Once the RESET occurs, special function register will be reset to initial value except the **/TO**, **/PD** bit of STATUS register .



EVENT	/TO	/PD	REMARK
WDT time out reset from SLEEP MODE	0	0	
WDT time out reset (not SLEEP MODE)	0	1	
Wake up from SLEEP MODE by SPI or Input port	1	0	
Power up or RESET pin low condition	1	1	

**Initialization after RESET occurs:**

- The oscillator is running, or will be started.
- The Watchdog timer is cleared.

- If power on reset or RESET pin low condition, the /TO bit and /PD bit of RF(STATUS) are set to “1”.  
If WDT time out reset, the /TO bit is cleared.
- The program counter(PCH:PCM:PCL) is clear to all “0”.
- The other register initial value is as following.

**Special Register:**

Addr.	NAME	Initial value	Addr.	NAME	Initial value
00h	INDF0	---- --(*1)	10h	LCDDATA	---- --(*1)
01h	FSR0	0000 0000	11h	TRL2	uuuu uuuu
02h	PCL	0000 0000	12h	PRODL	uuuu uuuu
03h	PCM	0000 0000	13h	PRODH	uuuu uuuu
04h	PCH	---- ----	14h	SPRL	xxxx xxxx
05h	BSR	0000 0000	15h	SPRM	xxxx xxxx
06h	STKPTR	0000 0000	16h	SPRH	xxxx xxxx
07h	BSR1	0000 0000	17h	(reserved)	---- ----
08h	INDF1	---- --(*1)	18h	(reserved)	---- ----
09h	FSR1	1000 0000	19h	PORTA	xxxx xxxx
0Ah	ACC	xxxx xxxx	1Ah	PORTB	xxxx xxxx
0Bh	TABPTRL	0000 0000	1Bh	(reserved)	---- ----
0Ch	TABPTRM	0000 0000	1Ch	(reserved)	---- ----
0Dh	TABPTRH	0000 0000	1Dh	(reserved)	---- ----
0Eh	CPUCON	000x 0x0c(*2)	1Eh	(reserved)	---- ----
0Fh	STATUS	cuxx xxxx (*3)	1Fh	(reserved)	---- ----

**Control Register:**

Addr.	NAME	Initial value	Addr.	NAME	Initial value
20h	PFS	0010 0000	30h	POST_ID	-111 -000
21h	PACON	0000 0110	31h	TRL0L	uuuu uuuu
22h	STBCON	-000 0000	32h	TRL0H	uuuu uuuu
23h	DCRB	1111 1111	33h	TRL1	uuuu uuuu
24h	(reserved)	---- ----	34h	TRCON	0000 0000
25h	(reserved)	---- ----	35h	MTRL	uuuu uuuu
26h	(reserved)	---- ----	36h	MWTCON	0000 0000
27h	(reserved)	---- ----	37h	ELCON	00uu uuuu
28h	LCDCON	0000 0000	38h	PAINTSTA	0000 0000
29h	(reserved)	---- ----	39h	PAINTEN	0000 0000
2Ah	(reserved)	---- ----	3Ah	INTSTA	---0 0000
2Bh	SPICON	0000 0000	3Bh	INTCON	---0 0000
2Ch	SPISTA	0000 0000	3Ch	(reserved)	---- ----
2Dh	PAWAKE	0000 0000	3Dh	(reserved)	---- ----
2Eh	LCDARL	0000 0000	3Eh	(reserved)	---- ----
2Fh	LCDARH	0000 0000	3Fh	PBCON	0000 0000

Legend: x=unknown , -= unimplemented read as “0”, u = unchanged, c = value depends on condition

Note:

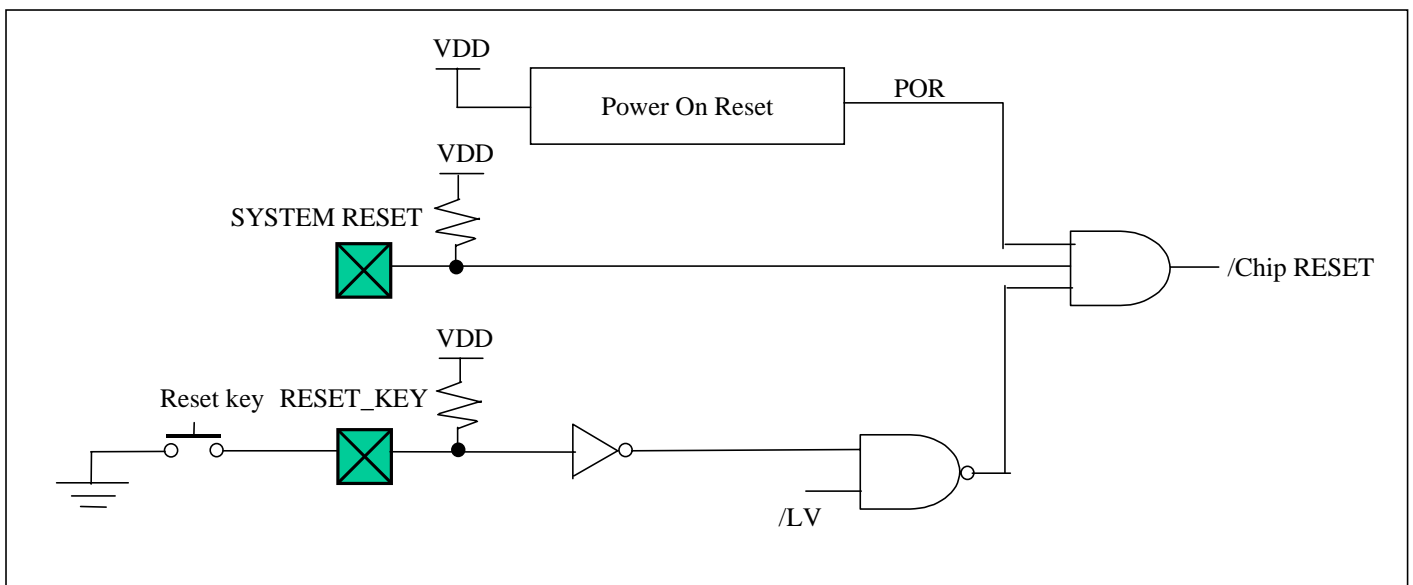
(\*1)Not a physical register

(\*2)Bit0(MS0) of RE(CPUCON) is reload from “**IM**” bit of code option when CPU reset..

(\*3) If power on reset or RESET pin low condition, the **/TO** bit and **/PD** bit of RF(STATUS) are set to “1”.

If WDT time out reset, the **/TO** bit is cleared and **/PD** bit unchanged.

**Block Diagram of On-chip RESET circuit:**



**WAKE UP:**

When SLEEP MODE , oscillator was off . CPU will be awakened by input port or SPI receive full then return to FAST MODE or SLOW MODE (determine by **MS0** bit of CPUCON register).

And when IDLE MODE, oscillator keeps running. CPU will be awakened by Timer1 , input port or SPI receive full then return to FAST MODE or SLOW MODE (determine by **MS0** bit of CPUCON register).

The **T1WKEN** bit of TRCON register can enable/disable Timer1 wake up function. The input port wake up function is enable/disable by PAWAKE register. And SPI wake function is enable/disable by **SPWKEN** bit of SPISTA register.

**Register Description:**

● **TRCON(Timer0 & Timer1 control register)**

bit 7							bit 0
<b>T1WKEN</b>	<b>T1EN</b>	<b>T1PSR1</b>	<b>T1PSR0</b>	<b>TOEN</b>	<b>T0CS</b>	<b>T0PSR1</b>	<b>T0PSR0</b>

- ◆ **T1WKEN:** Enable bit of Timer1 underflow wake up function in IDLE MODE.  
0: Disable Timer1 wake up function .  
1: Enable Timer1 wake up function.

● **PAWAKE (Port A WAKE UP Control Register)**

bit 7							bit 0
<b>WKEN7</b>	<b>WKEN6</b>	<b>WKEN5</b>	<b>WKEN4</b>	<b>WKEN3</b>	<b>WKEN2</b>	<b>WKEN1</b>	<b>WKEN0</b>

- ◆ **WKEN7~WKEN0:** Wake up enable control bit of Port A.  
0: Disable Port A wake up function.  
1: Enable Port A wake up function.

● **SPISTA(SPI status register):**

bit 7							bit 0
<b>LCDM1</b>	<b>LCDM0</b>	<b>SFR1</b>	<b>SFR0</b>	<b>SPWKEN</b>	<b>SMP</b>	<b>DCOL</b>	<b>RBF</b>

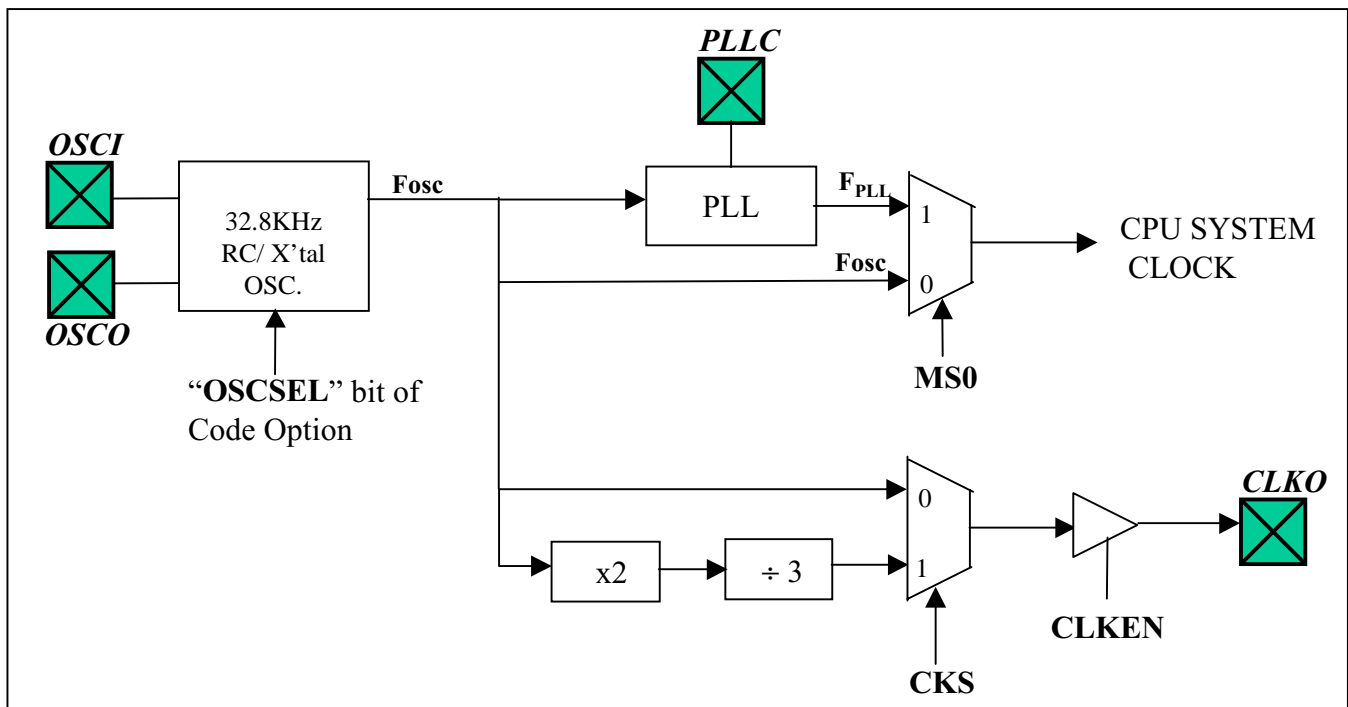
- ◆ **SPWKEN:** SPI wake up enable control bit.  
0:Disable SPI (slave mode) read buffer full wakeup.  
1: Enable SPI (slave mode) read buffer full wakeup.

(4) Oscillator System:

**Feature:**

- 32.8KHz RC OSC(Ext. R and Int. C) or 32768Hz Crystal.
- Built-in PLL, high frequency range can be selected from 262KHz to 10MHz by changing PFS register.
- Clock output with frequency selectable in IDLE MODE, SLOW MODE and FAST MODE.
- Operating voltage from VDD=2.2V~3.6V

**Function Block Diagram:**



**Pin Description:**

- **OSCI:** Input pin for 32.768KHz crystal oscillator or external Resistor- internal Capacitor 32.8KHz oscillator. Selected by Code Option.
- **OSCO:** Output pin for 32.768KHz crystal oscillator. If R-C oscillator is selected, this pin should be floating.

- **CLKO:** Clock output pin for external device(LCD Driver or slave CPU ,etc.). **This pin is tri-state when clock output disable.(CLKOEN=0)**
- **PLL:** Phase lock loop capacitor, connect a capacitor with AVSS.

**Register Description:**

- **PFS:** PLL frequency select register. System clock can be fine tuned from 262KHz to 10MHz. The initial value of PFS register after RESET will be set to “20h” ( $F_{PLL}=2.097$  MHz)

$F_{PLL} = 2 * PFS * F_{osc}$
-------------------------------

PFS reg.	$F_{PLL}$ (MHz)	PFS reg.	$F_{PLL}$ (MHz)
0~3	<i>N.A. (*1)</i>	92	6.029
4	0.262	107	7.012
15	0.983	122	7.995
31	2.032	137	8.978
46	3.015	<i>150</i>	<i>9.83 (*3)</i>
61	3.998	153	10.027
76	4.981	255	16.712

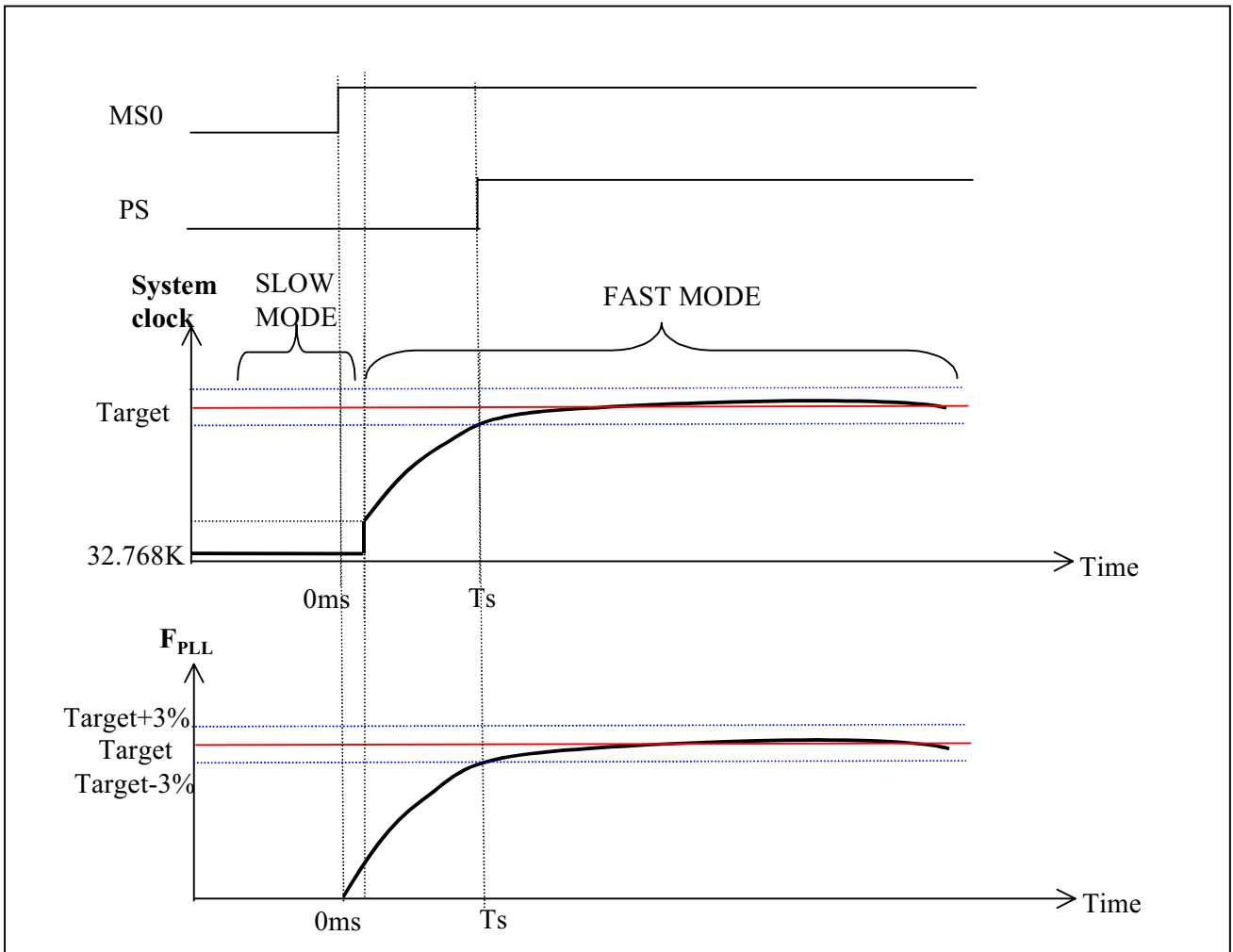
- Note: 1. PFS=0 ~ 3 is not available.  
 2. The Maximum range of PLL is from 262.144 K ~ 16.712 MHz  
 3. When enable UART, system clock should be 9.83MHz  
 4. The table is base on 32.768KHz oscillator frequency.

- **CPUCON Register:**

bit 7				bit0			
CLKOEN	CKS	LVDEN	/LV	/GLINTD	PS	MS1	MS0

- ◆ **CLKOEN:** Clock output enable control bit.  
**CLKO pin is tri-state when clock output disable.(CLKOEN=0)**
- ◆ **CKS:** clock select bit of clock output pin (**CLKO**).  
 0: CLKO pin output frequency at 32.768KHz( $F_{osc}$ )  
 1: CLKO pin output frequency at 21.845KHz( $F_{osc}/1.5$ ).
- ◆ **PS:** PLL stable flag. This bit will be cleared when PLL not turned on or PLL is turned on but not stable. And be set after PLL turned on and frequency stable.  
PLL stable means actual frequency within target frequency +/- 3%.  
 0: PLL is not turned on or PLL frequency not yet stable .  
 1: PLL is turned on and frequency stable.

**Timing Diagram:**



- Note: 1.Slow mode switch to Fast mode at Time=0ms  
 2.System clock will switch to  $F_{PLL}$  immediately,and system clock will be hundreds KHz then.  
 3. When PLLST\_OPT code option =0, PLL frequency will be stable (+/-10%) less than 5ms.  
 And PLLST\_OPT code option =1, PLL frequency will be stable (+/-3%) around 2 to 9ms.



**(5) INTERRUPT:**

There are 3 types of interrupt for the whole operation:

**Level 1:** Input port (Port A) interrupt .

**Level 2:** Timer interrupt. Include of Timer0(TMR0I), Timer1(TMR1I), Timer2 (TMR2I) interrupt.

**Level 3:** Peripheral interrupt. Include of Low voltage detected (LVDI), SPI read buffer full (SRBFI) .

The /GLINTD bit of CPUCON register disable all interrupts, include of LEVEL 1~LEVEL 3. Set this bit to 1 can enable all un-mask interrupt.

**Interrupt vector :**

Interrupt level	Interrupt source	Start address	Remark
	RESET	0x00000	
Level 1	Input Port	0x00002	PAINT
Level 2	Timer	0x00004	Timer0,Timer1,Timer2
Level 3	Peripheral	0x00006	SRBFI, LVDI

**Register Description:**

● CPUCON(CPU control register)

bit 7	CLKOEN	CKS	LV DEN	/LV	/GLINTD	PS	MS1	MS0	bit0
-------	--------	-----	--------	-----	---------	----	-----	-----	------

- ◆ /GLINTD: Global interrupt disable bit.  
0:Disable all interrupt.  
1:Enable all un-mask interrupt.

● PAINTEN (Port A INTERRUPT Enable Control Register)

bit 7	PA7IE	PA6IE	PA5IE	PA4IE	PA3IE	PA2IE	PA1IE	PA0IE	bit0
-------	-------	-------	-------	-------	-------	-------	-------	-------	------

- ◆ PA7IE~PA0IE: Control bit of port A interrupt .  
0: Disable interrupt function.  
1: Enable interrupt function.

● PAINTSTA (Port A INTERRUPT STATUS Register)

bit 7	PA7I	PA6I	PA5I	PA4I	PA3I	PA2I	PA1I	PA0I	bit0
-------	------	------	------	------	------	------	------	------	------

- ◆ PA7I~PA0I: INT status of Port A interrupt. Set to 1 when pin falling edge detected. Clear to 0 by software.

● **INTCON (INT Control Register)**

bit 7	-	-	-	<b>SRBFIE</b>	<b>LVDIE</b>	<b>TMR2IE</b>	<b>TMR1IE</b>	bit0
-------	---	---	---	---------------	--------------	---------------	---------------	------

0: Disable interrupt function.

1: Enable interrupt function.

- ◆ **TMR0IE**: Control bit of TIMER0 interrupt.
- ◆ **TMR1IE**: Control bit of TIMER1 interrupt.
- ◆ **TMR2IE**: Control bit of TIMER2 interrupt.
- ◆ **LVDIE**: Control bit of LVD interrupt.
- ◆ **SRBFIE**: Control bit of SPI read buffer full interrupt

● **INTSTA (INT STATUS Register)**

bit 7	-	-	-	<b>SRBFI</b>	<b>LVDI</b>	<b>TMR2I</b>	<b>TMR1I</b>	bit0
-------	---	---	---	--------------	-------------	--------------	--------------	------

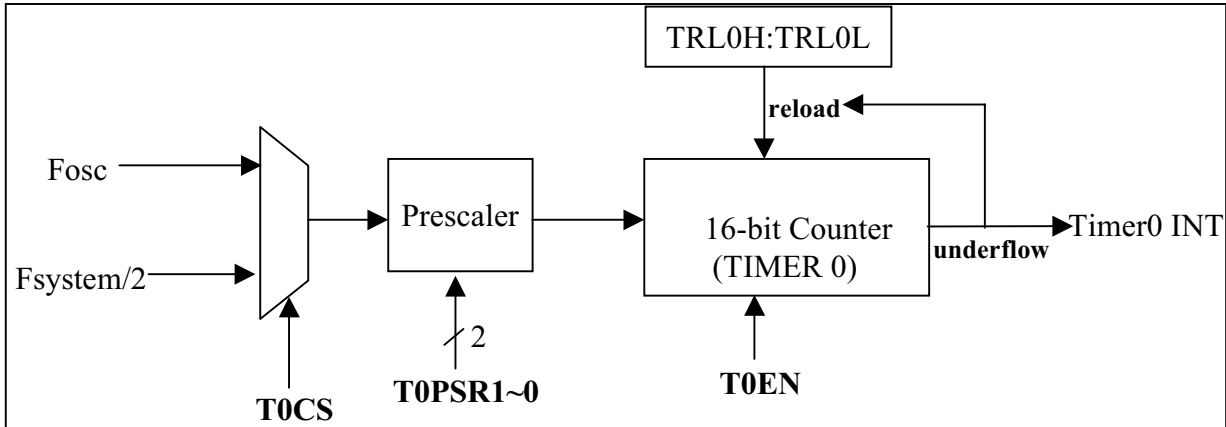
- ◆ **TMR0I**: Set to 1 when TMR0 underflow happened. Clear to 0 by software or Timer0 disable.
- ◆ **TMR1I**: Set to 1 when TMR1 underflow happened. Clear to 0 by software or Timer1 disable.
- ◆ **TMR2I**: Set to 1 when TMR2 underflow happened. Clear to 0 by software or Timer2 disable.
- ◆ **LVDI**: Set to 1 when LVD low level detected(**Falling edge**). Clear to 0 by software or LVD disable.
- ◆ **SRBFI**: Set to 1 when SPI read buffer full interrupt happened. Clear to 0 by software or SPI disable.

(6) PERIPHERAL :

**A. Timer/Melody Timer/EL Timer/Watchdog Timer**

1. Timer0(16 bits):

**Function Block Diagram:**



**Function Description:**

Timer0 is a general purpose 16 bits down counter for some applications required time counting. There is an interrupt available for user’s application. The clock source is selectable from the oscillator clock or half of the system clock.

There is a prescaler for the timer. The **T0PSR1~T0PSR0** bit of TRCON register determine the prescale ratio and generate different clock rate as the clock source for the timer.

Counter value will be decreased by one(count down) according to the timer clock source. When underflow happens, the timer interrupt will be triggered if the global interrupt and timer0 interrupt are both enabled. At the same time, TRL0H:TRL0L will automatic reload into 16 bits counter .

The Timer0 frequency range is from 1/128 Hz(clock source is from Fosc, TRL0H:TRL0L=FFFFh, prescaler=1:64) to 5MHz(clock source is from Fsystem/2, system clock=10MHz, TRL0H:TRL0L=0h, prescaler=1:1).

$$T = \frac{1}{\text{Freq.}} * \text{Prescale} * (\text{TRL0H:TRL0L} + 1)$$

## Register Description:

- **TRL0H:TRL0L(Timer 0 reload register):**

Used to store the auto reload value of TIMER0. When enabling Timer0 or underflow happens, TRL0H:TRL0L register will automatically reload into 16 bits counter .

- **TRCON(Timer0 & Timer1 control register)**

bit 7				bit 0			
T1WKEN	T1EN	T1PSR1	T1PSR0	T0EN	T0CS	T0PSR1	T0PSR0

- ◆ **T0PSR1~T0PSR0:** Timer0 Prescaler select bits.

T0PSR1:T0PSR0	Prescale value
00	1:1
01	1:4
10	1:16
11	1:64

- ◆ **T0CS:** Timer 0 clock source select bit.

0: Clock source is from Fosc.

1: Clock source is from half of the system clock.

- ◆ **T0EN:** Timer0 enable control bit

0: Disable Timer0(stop counting) .

1: Enable Timer0 .

- **INTCON (INT Control Register)**

bit 7				bit 0			
-	-	-	SRBFIE	LVDIE	TMR2IE	TMR1IE	<b>TMR0IE</b>

- ◆ **TMR0IE:** Control bit of TIMER0 interrupt.

0: Disable interrupt function.

1: Enable interrupt function.

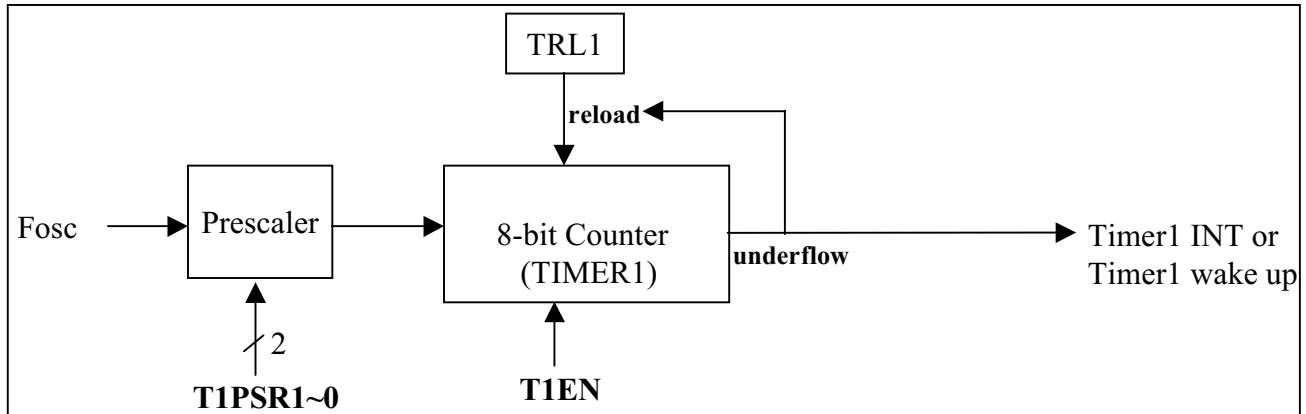
- **INTSTA (INT STATUS Register)**

bit 7				bit 0			
-	-	-	SRBFI	LVDI	TMR2I	TMR1I	<b>TMR0I</b>

- ◆ **TMR0I:** Set to 1 when TMR0 underflow happened. Clear to 0 by software or Timer0 disable.

2.Timer1(8 bits):

**Function Block Diagram:**



**Function Description:**

Timer1 is a general purpose 8 bits down counter for some applications required time counting. There are interrupt and wake up function available for user’s application. The clock source is from the oscillator clock.

There is a prescaler for the timer. The **T1PSR1~T1PSR0** bit of TRCON register determine the prescale ratio and generate different clock rate as the clock source for the timer. Set **T1WKEN** bit of TRCON register to 1 will enable Timer 1 underflow wake up function in IDLE MODE.

Counting value will be decreased by one(count down) according to the timer clock source. When underflow happens, the timer interrupt will be triggered if the global interrupt and timer1 interrupt are both enabled. At the same time,TRL1 will automatic reload into 8 bits counter.

The Timer1 frequency range is from 0.5 Hz(TRL1=FFh, prescaler=1:256) to 8.192KHz(TRL1=0h, prescaler=1:4).

$$T = \frac{1}{F_{osc}} * \text{Prescale} * (TRL1+1)$$

**Register Description:**

- **TRL1(Timer 1 reload register):**

Used to store the auto reload value of TIMER1. When enabling Timer1 or underflow happens, TRL1 register will automatically reload into 8 bits counter .

● **TRCON(Timer0 & Timer1 control register)**

bit 7								bit0	
<b>T1WKEN</b>	<b>T1EN</b>	<b>T1PSR1</b>	<b>T1PSR0</b>	<b>T0EN</b>	<b>T0CS</b>	<b>T0PSR1</b>	<b>T0PSR0</b>		

◆ **T1PSR1~T1PSR0:** Timer1 Prescaler select bits.

T1PSR1:T1PSR0	Prescale value
00	1:4
01	1:16
10	1:64
11	1:256

◆ **T1EN:** Timer1 enable control bit

0: Disable Timer1(stop counting) .

1: Enable Timer1 .

◆ **T1WKEN:** Enable bit of Timer1 underflow wake up function in IDLE MODE.

0: Disable Timer1 wake up function .

1: Enable Timer1 wake up function.

● **INTCON (INT Control Register)**

bit 7								bit0	
-	-	-	<b>SRBFIE</b>	<b>LVDIE</b>	<b>TMR2IE</b>	<b>TMR1IE</b>	<b>TMR0IE</b>		

◆ **TMR1IE:** Control bit of TIMER1 interrupt.

0: Disable interrupt function.

1: Enable interrupt function.

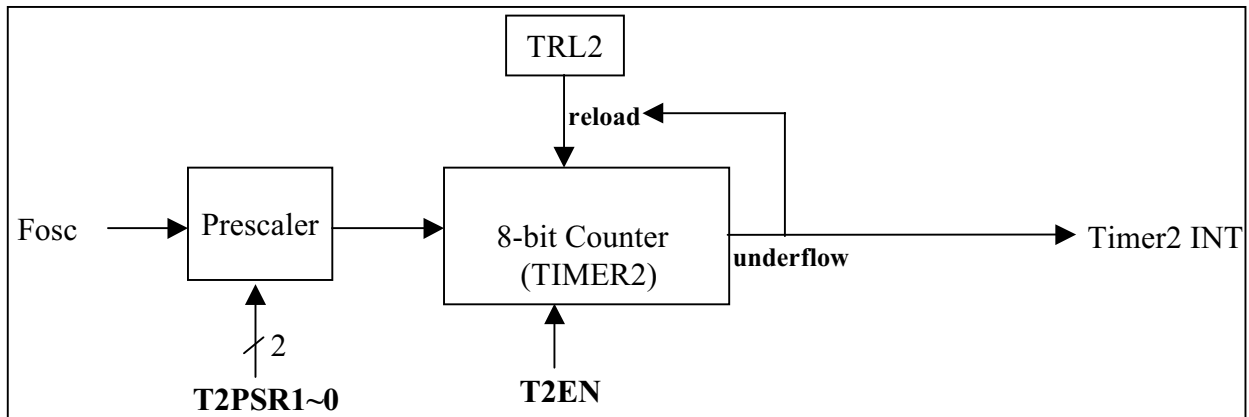
● **INTSTA (INT STATUS Register)**

bit 7								bit0	
-	-	-	<b>SRBFI</b>	<b>LVDI</b>	<b>TMR2I</b>	<b>TMR1I</b>	<b>TMR0I</b>		

◆ **TMR1I:** Set to 1 when TMR1 underflow happened. Clear to 0 by software or Timer1 disable.

3.Timer2(8 bits):

**Function Block Diagram:**



**Function Description:**

Timer2 is a general purpose 8 bits down counter for some applications required time counting. There is an interrupt available for user’s application. The clock source is from the oscillator clock.

There is a prescaler for the timer. The **T2PSR1~T2PSR0** bit of MWTCON register determine the prescale ratio and generate different clock rate as the clock source for the timer.

Counting value will be decreased by one(count down) according to the timer clock source. When underflow happens, the timer interrupt will be triggered if the global interrupt and timer2 interrupt are both enabled. At the same time,TRL2 will automatic reload into 8 bits counter

The Timer2 frequency range is from 16 Hz(TRL2=FFh, prescaler=1:8) to 32.768KHz(TRL2=0h, prescaler =1:1).

$$T = \frac{1}{F_{osc}} * Prescale * (TRL2+1)$$

**Register Description:**

- **TRL2(Timer 2 reload register):**  
Used to store the auto reload value of TIMER2. When enabling Timer2 or underflow happens, TRL2 register will automatically reload into 8 bits counter .
- **MWTCON(Melody Timer , WDT and Timer 2 control register)**

bit 7				bit 0			
T2EN	T2PSR1	T2PSR0	WDTEN	WDTPSR1	WDTPSR0	MTEN	MDO2EN

◆ **T2PSR1~T2PSR0:** Timer2 Prescaler select bits.

T2PSR1:T2PSR0	Prescale value
00	1:1
01	1:2
10	1:4
11	1:8

◆ **T2EN:** Timer2 enable control bit

- 0: Disable Timer2(stop counting) .
- 1: Enable Timer2 .

● **INTCON (INT Control Register)**

bit 7							bit0
-	-	-	SRBFIE	LVDIE	<b>TMR2IE</b>	TMR1IE	TMR0IE

- ◆ **TMR2IE:** Control bit of TIMER2 interrupt.
  - 0: Disable interrupt function.
  - 1: Enable interrupt function.

● **INTSTA (INT STATUS Register)**

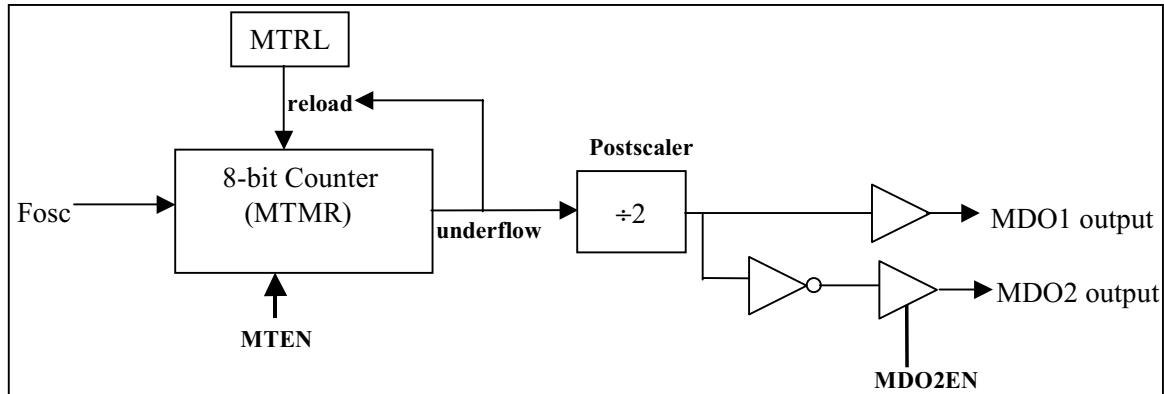
bit 7							bit0
-	-	-	SRBFI	LVDI	<b>TMR2I</b>	TMR1I	TMR0I

- ◆ **TMR2I:** Set to 1 when TMR2 underflow happened. Clear to 0 by software or Timer2 disable.



#### 4.Melody Timer(8 bits):

#### Function Block Diagram:



#### Function Description:

Melody Timer is suitable for counting the tempo and rhythm of music. There are positive/negative output available for user's application. The clock source is from the oscillator clock(32.768KHz).

When set **MTEN to 1** will enable Melody Timer.

Counting value will be decreased by one(count down) according to the timer clock source. When enabling Melody Timer or underflow happens, MTRL will automatic reload into 8 bits counter. And **MDO1** and **MDO2** pin output level will toggle at the same time. **MDO2** pin output is the inverse of **MDO1** pin.

The frequency range of melody timer is from 64 Hz(MTRL=FFh, postscaler=1:2) to 16KHz(MTRL=0h, postscaler=1:2).

$$F = F_{osc} * \frac{1}{(MTRL+1)} * \frac{1}{2}$$

#### Pin Description:

- **MDO1(Melody positive output):** Melody positive output pin.
- **MDO2(Melody negative output):** Melody negative output pin.

#### Register Description:

- **MTRL(Melody Timer reload register):**

Used to store the auto reload value of melody timer. When enabling Melody Timer or underflow happens, MTRL will automatically reload into 8 bits counter .

**● MWTCON(Melody Timer , WDT and Timer 2 control register)**

bit 7

bit0

T2EN	T2PSR1	T2PSR0	WDTEN	WDTPSR1	WDTPSR0	MTEN	MDO2EN
------	--------	--------	-------	---------	---------	------	--------

- ◆ **MTEN**: Melody Timer enable control bit.
- ◆ **MDO2EN**: Melody negative output port enable control bit.

**Melody Table:**

Clock source : 32768 Hz

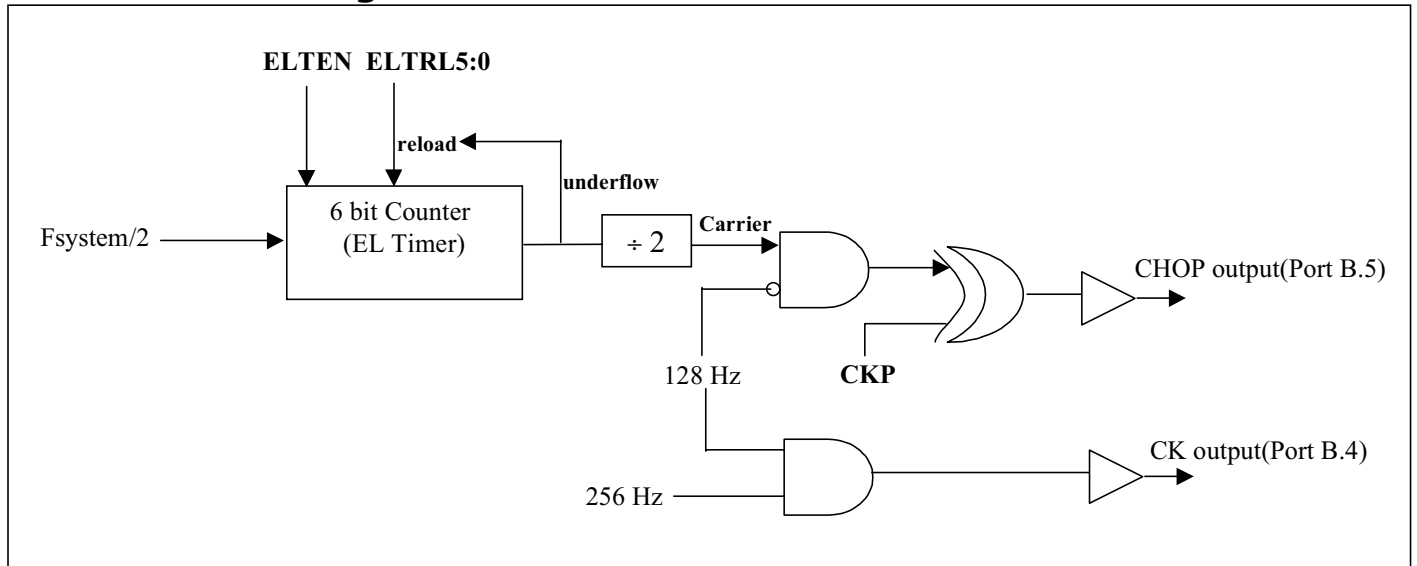
Musical note	Standard Frequency(Hz)	MTRL	Postscaler	F <sub>MELODY</sub> (Hz)	DEV(%)
L1	130.813	124	1:2	131.07	0.20%
L1#	138.591	117	1:2	138.85	0.18%
L2	146.832	111	1:2	146.29	-0.37%
L2#	155.563	104	1:2	156.04	0.31%
L3	164.814	98	1:2	165.49	0.41%
L4	174.614	93	1:2	174.30	-0.18%
L4#	184.997	88	1:2	184.09	-0.49%
L5	195.998	83	1:2	195.05	-0.48%
L5#	207.652	78	1:2	207.39	-0.13%
L6	220.000	73	1:2	221.41	0.64%
L6#	233.082	69	1:2	234.06	0.42%
L7	246.942	65	1:2	248.24	0.53%
M1	261.626	62	1:2	260.06	-0.60%
M1#	277.183	58	1:2	277.69	0.18%
M2	293.665	55	1:2	292.57	-0.37%
M2#	311.127	52	1:2	309.13	-0.64%
M3	329.628	49	1:2	327.68	-0.59%
M4	349.228	46	1:2	348.60	-0.18%
M4#	369.994	43	1:2	372.36	0.64%
M5	391.995	41	1:2	390.10	-0.48%
M5#	415.305	38	1:2	420.10	1.16%
M6	440.000	36	1:2	442.81	0.64%
M6#	466.164	34	1:2	468.11	0.42%
M7	493.883	32	1:2	496.48	0.53%
H1	523.251	30	1:2	528.52	1.01%
H1#	554.365	29	1:2	546.13	-1.48%
H2	587.330	27	1:2	585.14	-0.37%
H2#	622.254	25	1:2	630.15	1.27%
H3	659.255	24	1:2	655.36	-0.59%
H4	698.456	22	1:2	712.35	1.99%
H4#	739.989	21	1:2	744.73	0.64%
H5	783.991	20	1:2	780.19	-0.48%



H5#	830.609	<b>19</b>	1:2	819.20	-1.37%
H6	880.000	<b>18</b>	1:2	862.32	-2.01%
H6#	932.328	<b>17</b>	1:2	910.22	-2.37%
H7	987.767	<b>16</b>	1:2	963.76	-2.43%

5.EL Timer(6 bits):

**Function Block Diagram:**



**Function Description:**

EL Timer is a 6 bit down counter which is suitable for counting the CHOP signal output. The clock source is from 1/2 system clock(1MHz~10MHz).

Counting value will be decreased by one(count down) according to the timer clock source. When underflow happens, the CHOP output level will be toggled. When enabling EL timer or underflow happens , ELTRL will automatic reload into 6 bits counter.

**ELTEN** bit is used to enable EL timer and change Port B.5 and Port B.4 to CHOP and CK output pin. **CKP** bit is used to select clock polarity of CHOP output.(See timing diagram for detail)  
The frequency range of CHOP carrier signal will be 128Hz(System clock at 32768Hz, ELTRL=3Fh) to 2.5MHz(System clock at 10MHz, ELTRL=0h).

$$F_{chop} = (F_{system} / 2) * \frac{1}{(ELTRL+1)} * \frac{1}{2}$$

**Pin Description:**

- **CHOP pin:** Chop output pin of EL driver.
- **CK pin:** CK output pin of EL driver.

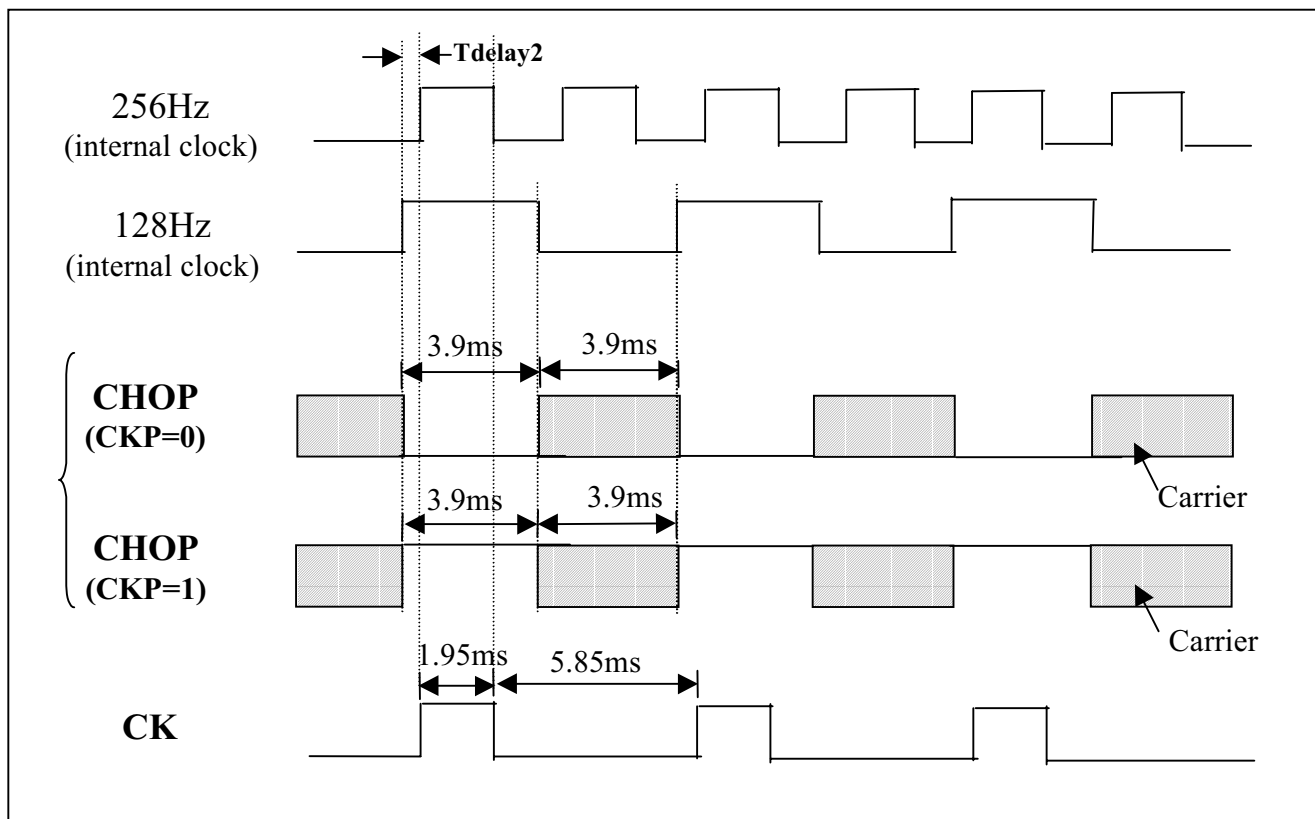
**Register Description:**

● **ELCON(EL control register)**

bit 7	bit 0	
ELTEN	CKP	ELTRL5 ~ ELTRL0

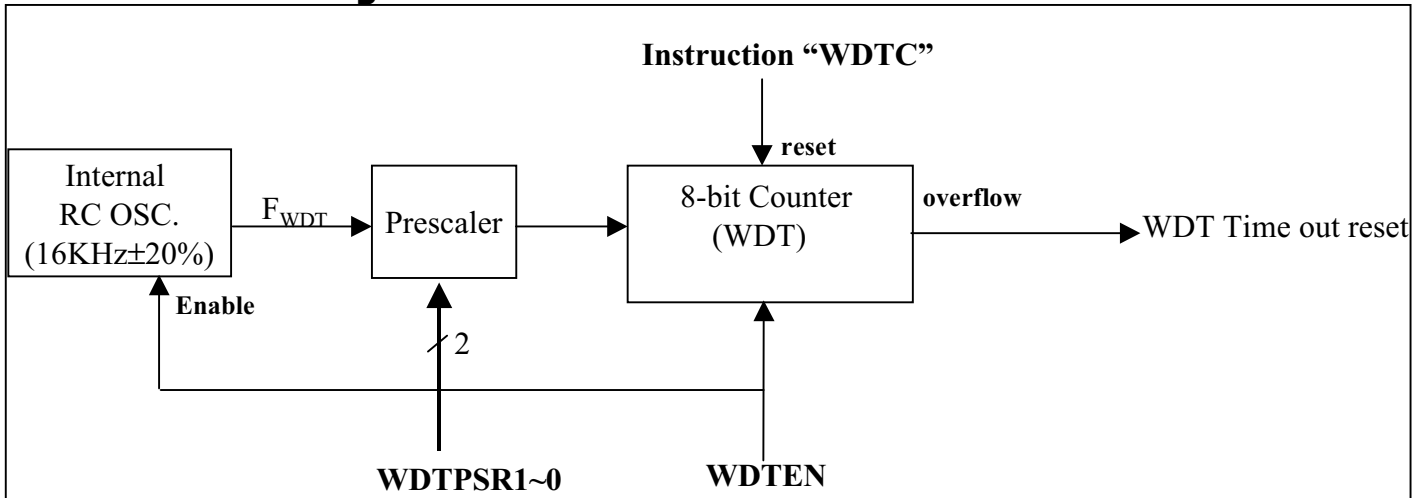
- ◆ **ELTEN:** EL Timer enable control bit.
  - 0: Disable EL Timer(stop counting) and recover CK and CHOP pin to general I/O pin.
  - 1: Enable EL Timer and change Port B.4 and Port B.5 to CK and CHOP output pin.
- ◆ **CKP:** EL clock polarity select bit.
  - 0: Idle state for CHOP pin is low level.
  - 1: Idle state for CHOP pin is high level.
- ◆ **ELTRL5~0:** Used to store the auto reload value of EL timer. When enabling EL timer or underflow happens, **ELTRL5~0** will automatically reload into 6 bits counter .

**Timing Diagram:**



6. Watch Dog Timer(WDT):

**Function Block Diagram:**



**Function Description:**

The clock source of watch dog timer(WDT) is from on-chip RC oscillator(16KHz±20%) . The WDT will keep running even the oscillator has been turned off (i.e. in SLEEP MODE).

WDT time-out will cause the CPU reset(if WDT enabled). To avoid the reset happens, user should clear the WDT value by using “WDTC” instruction before WDT time-out. Set **WDTEN** bit will enable WDT running. The initial state of WDT is disable.

There is also a prescaler to generate different clock rate for the clock source of WDT. The prescaler ratio is defined by **WDTPSR1 & WDTPSR0**.

The WDT time out range will be 64ms(prescaler=1:4) to 2.048 second (prescaler=1:128).

**Register Description:**

● **MWTCON(Melody Timer , WDT and Timer 2 control register)**

bit 7				bit 0			
T2EN	T2PSR1	T2PSR0	WDTEN	WDTPSR1	WDTPSR0	MTEN	MDO2EN

◆ **WDTPSR1~WDTPSR0:** Watch Dog timer Prescaler select bits.

WDTPSR1:WDTPSR0	Prescale value
00	1:4
01	1:16
10	1:64
11	1:128

◆ **WDTEN:** Watch Dog Timer enable bit

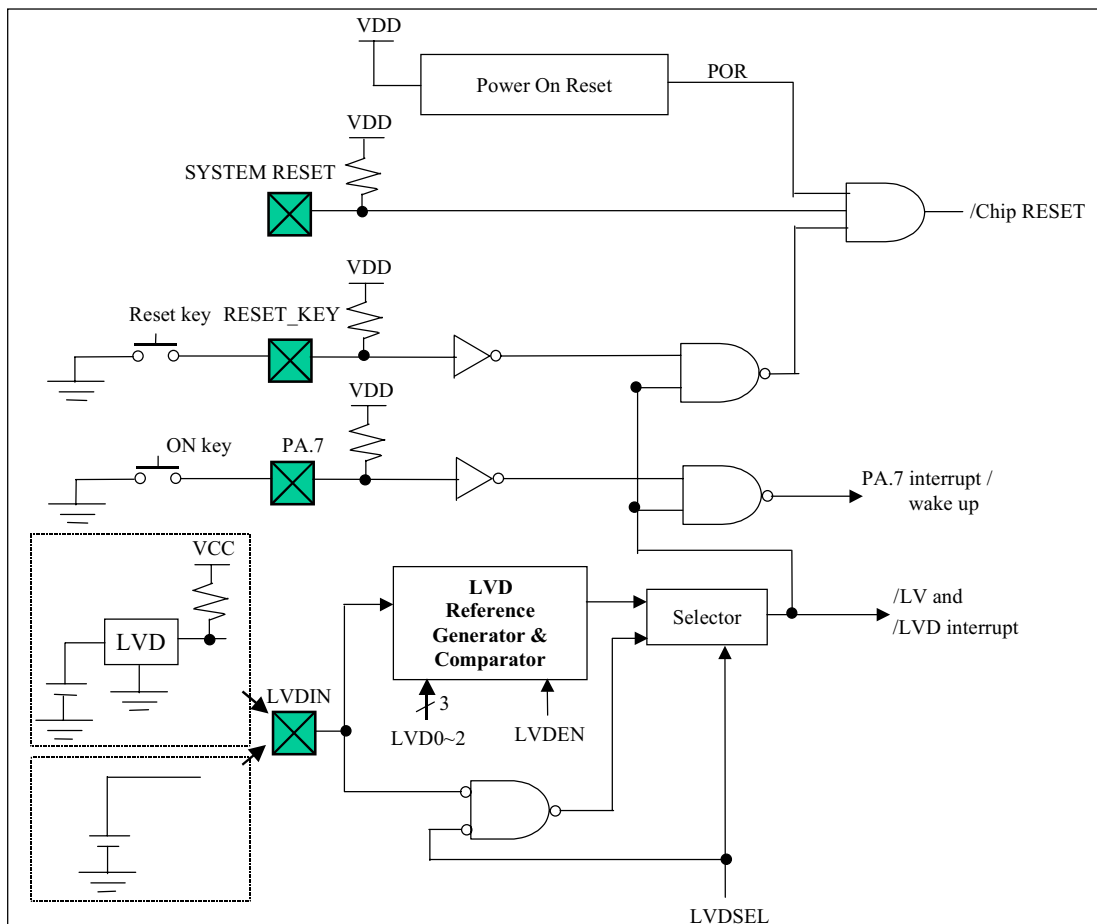
- 0: Disable watch dog timer(stop running) .
- 1: Enable watch dog timer .

## B. LOW VOLTAGE DETECTION(LVD)

### Feature:

- Built-in LVD (Low Voltage Detector),  
 $V_{det}(V_{th-})=2.2V \sim 2.9V \pm 0.1V$ . selectable.
- When the voltage of LVDIN pin is lower than selected detection voltage(/LV=0),  
PA.7 interrupt/Wake up is disabled.  
And the reset function of RESET\_KEY pin is unavailable.
- Built-in LVD/ External LVD selectable.
- LVD interrupt optional.

### Block Diagram:



### Function Description:

Low Voltage Detection function is used to detect Battery Low. When enable **LV DEN** bit of CPUCON Register, **/LV** bit is the voltage detection result of **LVDIN** pin. When the voltage of **LVDIN** pin is lower than  $V_{det}(V_{th-})$ , **/LV** bit will be clear.

Setup **LVDSEL** bit of STBCON register to select either external LVD device or internal built-in LVD.  
Setup **LVD2~LVD0** bit of PACON register to determine the detection voltage.

User can enable Low Voltage Detected Interrupt function. If **/LV** bit becomes low, interrupt will happen at the same time.

When low level detected(**/LV**=0), the PA.7 interrupt/wake up is disable. And the reset caused by **RESET\_KEY** pin is disable.

### Pin Description:

- **LVDIN**: Input pin of Low Voltage Detection to examine the voltage level higher than  $V_{det}(V_{th+})$  or lower than  $V_{det}(V_{th-})$ .

### Register Description:

- **CPUCON Register:**

bit 7	bit 0						
CLKOEN	CKS	<b>LV DEN</b>	<b>/LV</b>	/GLINTD	PS	MS1	MS0

◆ **/LV**: Low voltage detected. This is a read only bits. When the voltage **LVDIN** pin is lower than  $V_{det}(V_{th-})$ , this bit will be clear. Otherwise if higher than  $V_{det}(V_{th+})$ , this bit will be set.

0: Low voltage is detected.

1: Low voltage is not detected or LVD is disable.

**/LV bit will be set to 1 when LVD disable.**

◆ **LV DEN**: Enable Low Voltage Detector.

**LV DEN bit will be clear after CPU reset.**

- **PACON (Port A Control Register)**

bit 7	bit 0						
<b>LVD2</b>	<b>LVD1</b>	<b>LVD0</b>	<b>LVDSEL</b>	Bit7PU	R2EN	R1EN	KE

◆ **LVD2~0**: LVD detection voltage select bits.

**The default value of LVD2~0 after CPU reset is “000”.**



LVD2~0	Vdet(Vth-)	Vdet(Vth+)	Deviation	LVD2~0	Vdet(Vth-)	Vdet(Vth+)	Deviation
000	2.2V	2.3V	±0.1V	100	2.6V	2.7V	±0.1V
001	2.3V	2.4V		101	2.7V	2.8V	
010	2.4V	2.5V		110	2.8V	2.9V	
011	2.5V	2.6V		111	2.9V	3.0V	

- ◆ **LVDSEL:** Built in LVD/External LVD select  
0: External LVD selected.  
1: Built-in LVD selected.

● **INTCON (INT Control Register)**

bit 7								bit 0
-	-	-	SRBFIE	<b>LVDIE</b>	TMR2IE	TMR1IE	TMR0IE	

- ◆ **LVDIE:** Control bit of LVD interrupt.  
0: Disable interrupt function.  
1: Enable interrupt function.

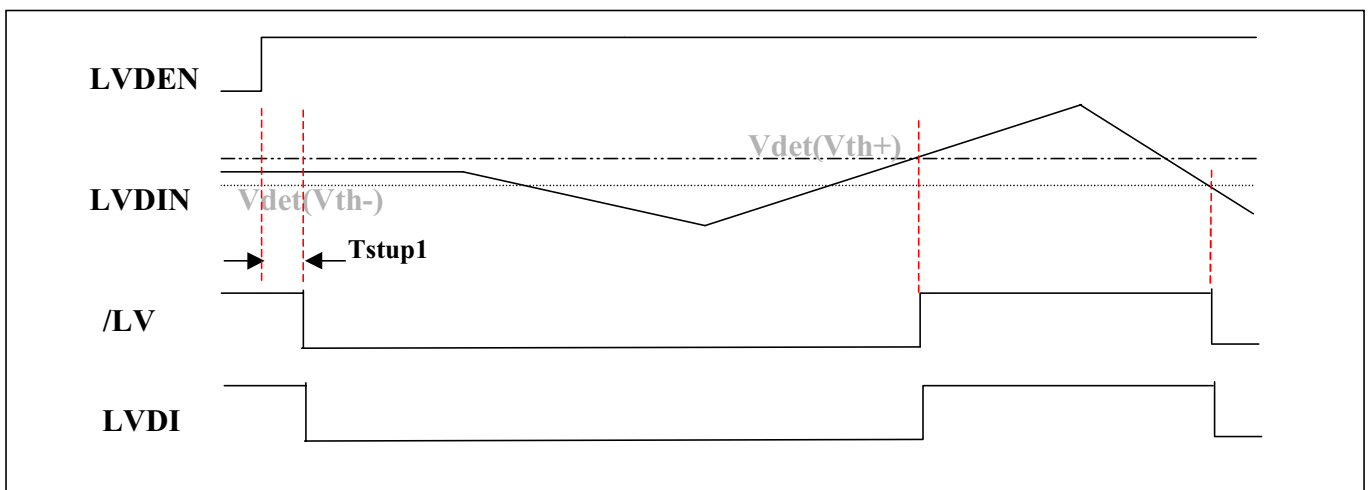
● **INTSTA (INT STATUS Register)**

bit 7								bit 0
-	-	-	SRBFI	<b>LVDI</b>	TMR2I	TMR1I	TMR0I	

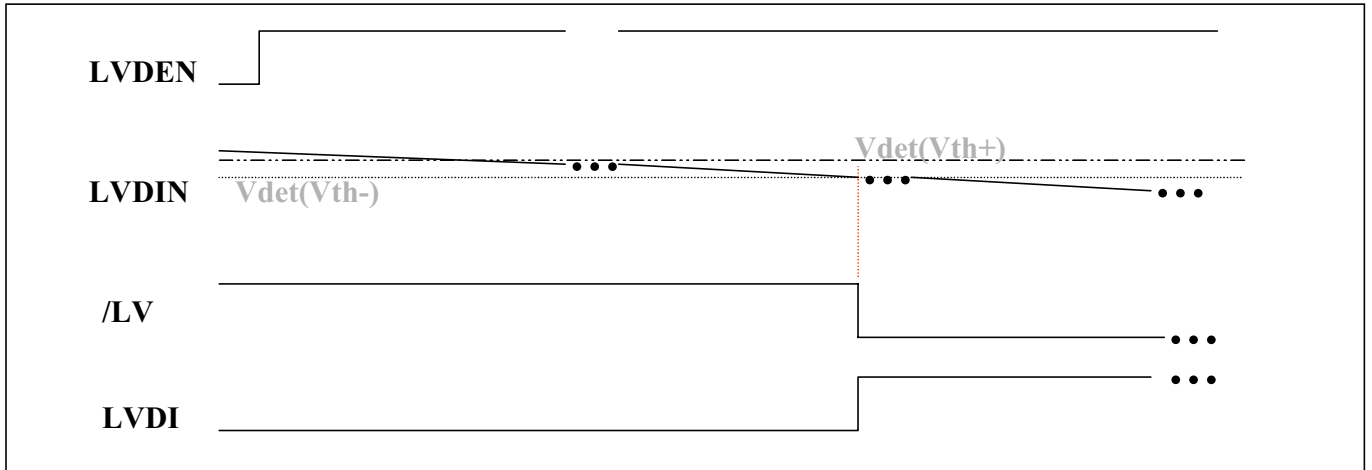
- ◆ **LVDI:** Set to 1 when LVD low level detected(**Falling edge**). Clear by software or LVD disable.

**Timing diagram:**

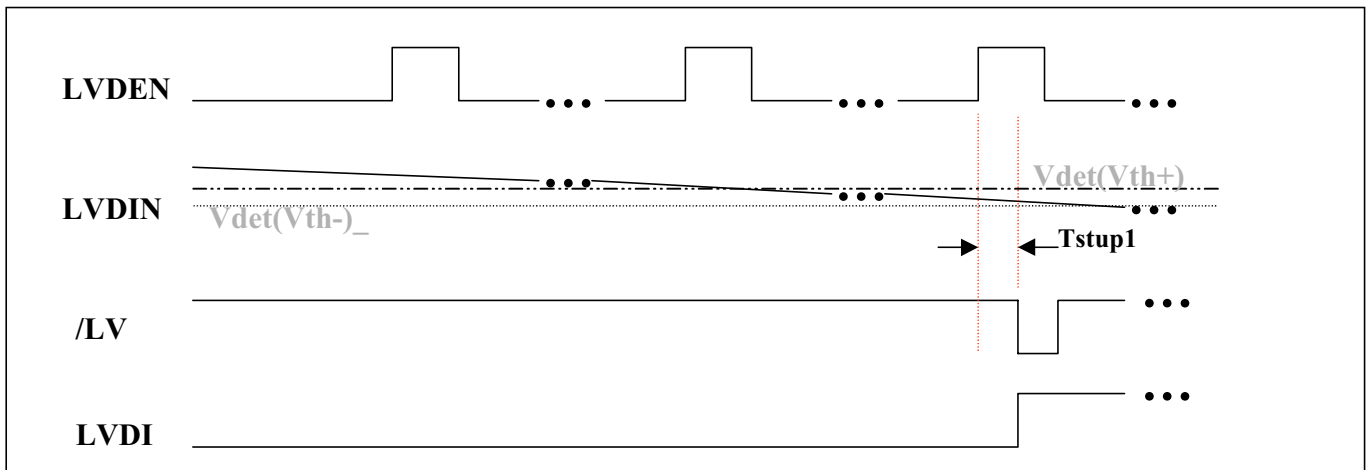
(1) LVDIN voltage is within Vdet threshold region when enabling LVD: *LOW voltage detected*



**(2) Continuous LVD Detection**



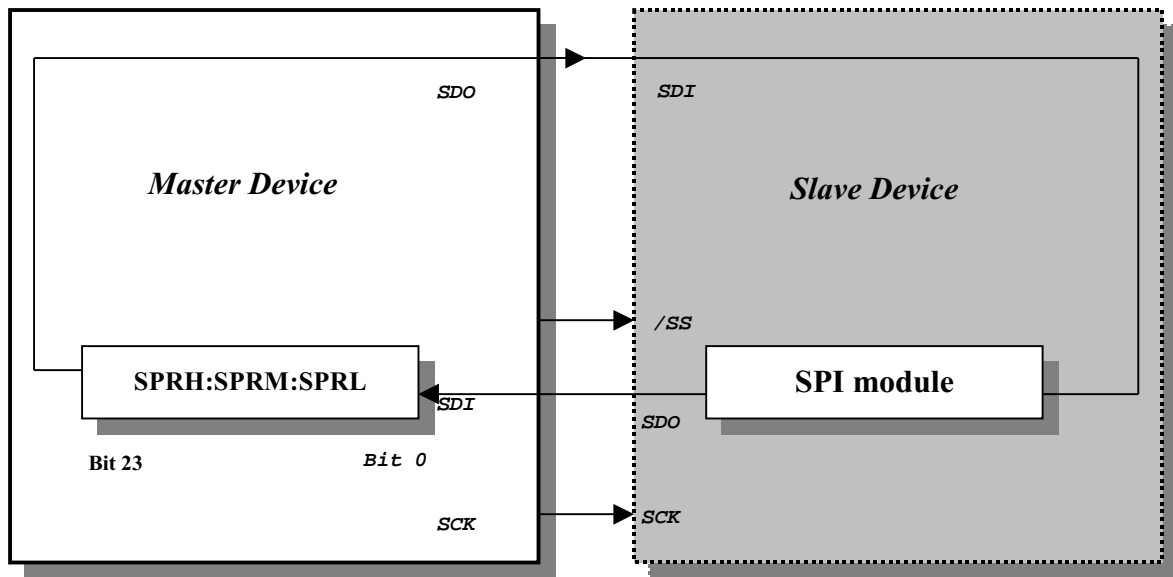
**(3) Power Saving Control of LVD**



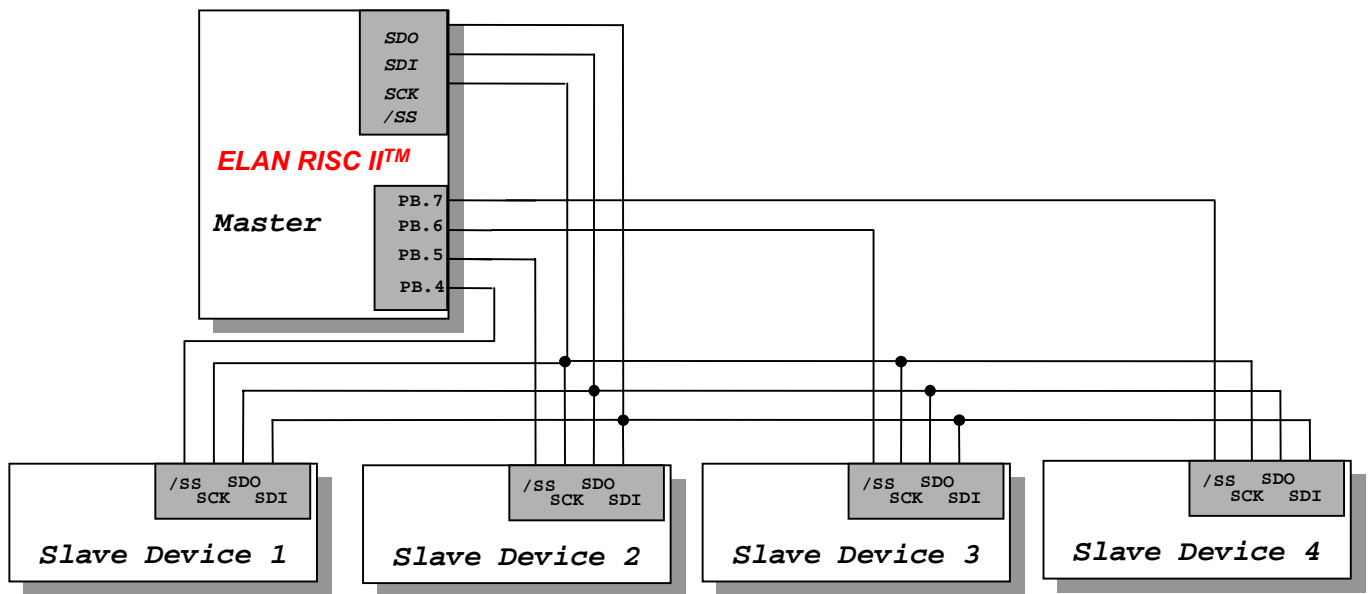
## C. SERIAL PERIPHERAL INTERFACE (SPI)

### Features:

- Operation in either Master mode or Slave mode.
- Three-wire or Four-wire full duplex synchronous communication.
- Programmable Shift Register Length(24/16/8 bits).
- Programmable bit rates of communication.
- Programmable clock polarity.
- Programmable shift direction.
- Programmable sample phase
- Interrupt flag available for the read buffer full.
- Up to 2.5MHz (system clock at 10MHz) bit frequency.

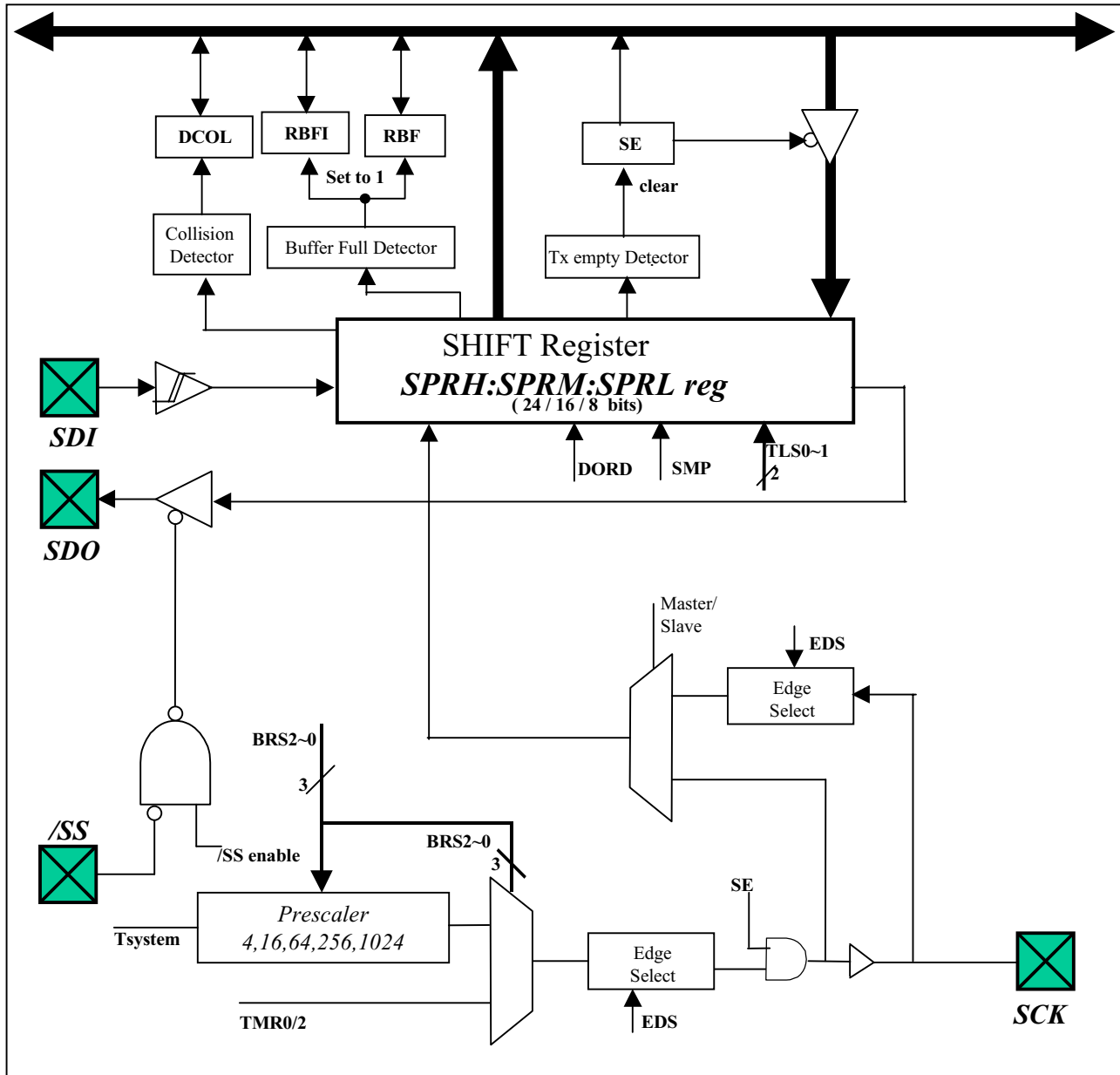


**Fig 1**     *Single SPI Master / Slave Communication*



*Fig 2 The SPI configuration example of Single-Master and Multi-Slaves*

**Function Block:**



*Fig 3 SPI block diagram*

**Function Description**

Fig. 1 shows how MCU communicates with other devices by SPI module. If MCU is a master controller, it sends clock through the SCK pin. An 8-bit data is transmitted and received at the same time. If MCU, however, is defined as a slave, its SCK pin could be programmed as an input pin. Data will continue to be shifted at selected clock rate and the selected edge.

Setup **TLS1~TLS0** bit of SPICON register to select the shift register length of SPI and enable/disable SPI function. Setup **BRS2~BRS0** bit of SPICON register to select the SPI mode(master/slave) and Bit Rate. When master mode, the clock source can be selected from system clock or half of timer 0 interval. When slave mode, the /SS pin can be enable or disable. Set up the **DORD** bit of SPICON register can determine the shift direction. Set up the **EDS** bit of SPICON register can select raising edge or falling edge latch the data. Set up the **SMP** bit of SPISTA register can select the sample phase at middle or the end of data output time.

#### (1) MASTER MODE:

In master mode, SCK pin is as a clock output pin.

If select 24 bits shift register length, SPRH, SPRM and SPRL register is the high, middle and low byte of the shift register. (If select 8 bits shift register length, SPRL register is the content of the shift register.) During write data to SPRH, SPRM and SPRL register, after write data into SPRL register, **SE** bit of SPICON register will be set by hardware automatically and start shifting. After shift buffer empty, **SE** bit will be clear by hardware and stop clock output from **SCK** pin.

Receiver is active while SPI transfer. When receive buffer full, **RBF** flag will be set and interrupt happens(if enable). During read out the shift register content, after SPRL register has been read out, hardware will clear the **RBF** flag automatically. If SPRL register not been read out, **RBF** bit still remains set. Data collision will happens when next clock in.

#### (2) SLAVE MODE:

In slave mode, input clock is from MASTER device. SCK pin is as a clock input pin. The **SE** bit is not useful to control starting shift in this mode. But it is a Transfer buffer empty status bit.

The same as MASTER MODE, user can select shift register length. And write transfer data to SPRH, SPRM, SPRL register. After write data into SPRL register, **SE** bit of SPICON register will be set by hardware. But the start shifting is control by the MASTER device clock input.

While shift buffer empty the **SE** bit will be clear. At the same time, receive buffer was full, **RBF** flag will be set and interrupt happens(if enable). The received data is at SPRH, SPRM and SPRL register, user should read them out before next clock in. Otherwise the data was collision and **DCOL** bit of SPI STATUS register will be set.

**Pin Description:**

- ◆ **SDI(I):** Serial Data Input.  
Receive serially.
- ◆ **SDO(O):** Serial Data Output .  
Transmit serially.  
In slave mode, defined as high-impedance, if not selected.
- ◆ **SCK(I/O):** Serial Clock input/output . When Master mode, sends clock through the SCK pin.  
However, if defined as a slave, its SCK pin is programmed as an input pin .
- ◆ **/SS(I):** /Slave Select . This pin (/SS) will be active when enable /SS function (BRS=110),else /SS pin is a general purpose I/O.  
Master device remains low to /SS pin to signify the slave(s) for transmit/receive data.  
Ignores the data on the SDI and SDO pins while /SS is high, because the SDO is no longer driven.

**Register Description:**

- **SPRH:SPRM:SPRL:** SPI shift buffer for 24/16/8 bits length.  
The buffer will deny any write until the shifting is completed.  
If user select 24 bits shift buffer, SPRH:SPRM:SPRL register is the content of 24 bits shift buffer. Else if select 8 bits shift buffer, SPRL register is the content of the shift register.  
When write data into SPRL register, **SE** bit of SPICON will be set by hardware and start shifting.  
While shift buffer empty ,at the same time, receive buffer was full, the received data is shifted in SPRH, SPRM and SPRL register. After SPRL register has been read out, hardware will clear the **RBF** flag automatically.

- **SPICON(SPI Control register):**

bit 7							bit0
<b>TLS1</b>	<b>TLS0</b>	<b>BRS2</b>	<b>BRS1</b>	<b>BRS0</b>	<b>EDS</b>	<b>DORD</b>	<b>SE</b>

- ◆ **TLS1~TLS0:** Shift buffer length select. Shift buffer length is programmable.
  - 00: SPI disable
  - 01: Enable SPI and shift buffer length = 24 bits
  - 10: Enable SPI and shift buffer length = 16 bits
  - 11: Enable SPI and shift buffer length = 8 bits

- ◆ **BRS2~BRS0:** Bit rate select. Programming the clock frequency/rates and sources.
  - 000:Master,TMR0/2
  - 001:Master,Fsystem/4.
  - 010:Master,Fsystem/16.
  - 011:Master,Fsystem/64.
  - 100:Master,Fsystem/256.
  - 101:Master,Fsystem/1024.
  - 110:Slave,/SS enable
  - 111:Slave,/SS disable

Prescaler		Fsystem		
BRS2:0	Bit rate	10MHz	4MHz	32.768KHz
001	Fsystem/4	2500000	1000000	8196
010	Fsystem/16	625000	250000	2048
011	Fsystem/64	156250	62500	512
100	Fsystem/256	39063	15625	128
101	Fsystem/1024	9766	3906	32

Unit: bits/sec

*Table. SPI bit rate table*

- ◆ **EDS:** Select the raising / falling edges latch by programming the EDS bit
  - 0: Falling edge
  - 1: Raising edge
- ◆ **DORD:** Data transmission order.
  - 0:Shift left (MSB first)
  - 1:Shift right (LSB first)
- ◆ **SE:** Shift enable.
  - Set to 1 automatically when write data into SPRL register and begin to shift.
  - Reset to 0 when transfer buffer empty detected.
  - SE bit will be clear by hardware when enabling SPI.

● **SPISTA(SPI status register):**

bit 7	bit0						
LCDM1	LCDM0	SFR1	SFR0	SPWKEN	SMP	DCOL	RBF

- ◆ **RBF:** Set to 1 by Buffer Full Detector, and clear to 0 automatically when read data from SPRL register.
  - RBF bit will be clear by hardware when enabling SPI. And RBF bit is read-only . Therefore, read SPRL register is necessary to avoid data collision happens(DCOL).



- ◆ **DCOL:** SPI Data collision.
  - 0:Data collision didn't occurs
  - 1:Data collision occurs. Should be cleared by software.

- ◆ **SMP:** SPI data input sample phase.
  - 0:Input data sampled at middle of data output time
  - 1:Input data sampled at the end of data output time

**In slave mode, data input sample is fixed at middle of data output time.**

- ◆ **SPWKEN:** SPI wake up enable control bit.
  - 0:Disable SPI (slave mode) read buffer full wakeup.
  - 1: Enable SPI (slave mode) read buffer full wakeup.

● **INTCON (INT Control Register)**

bit 7							bit0
-	-	-	<b>SRBFIE</b>	LVDIE	TMR2IE	TMR1IE	TMR0IE

- ◆ **SRBFIE:** Control bit of SPI read buffer full interrupt .
  - 0: Disable interrupt function.
  - 1: Enable interrupt function.

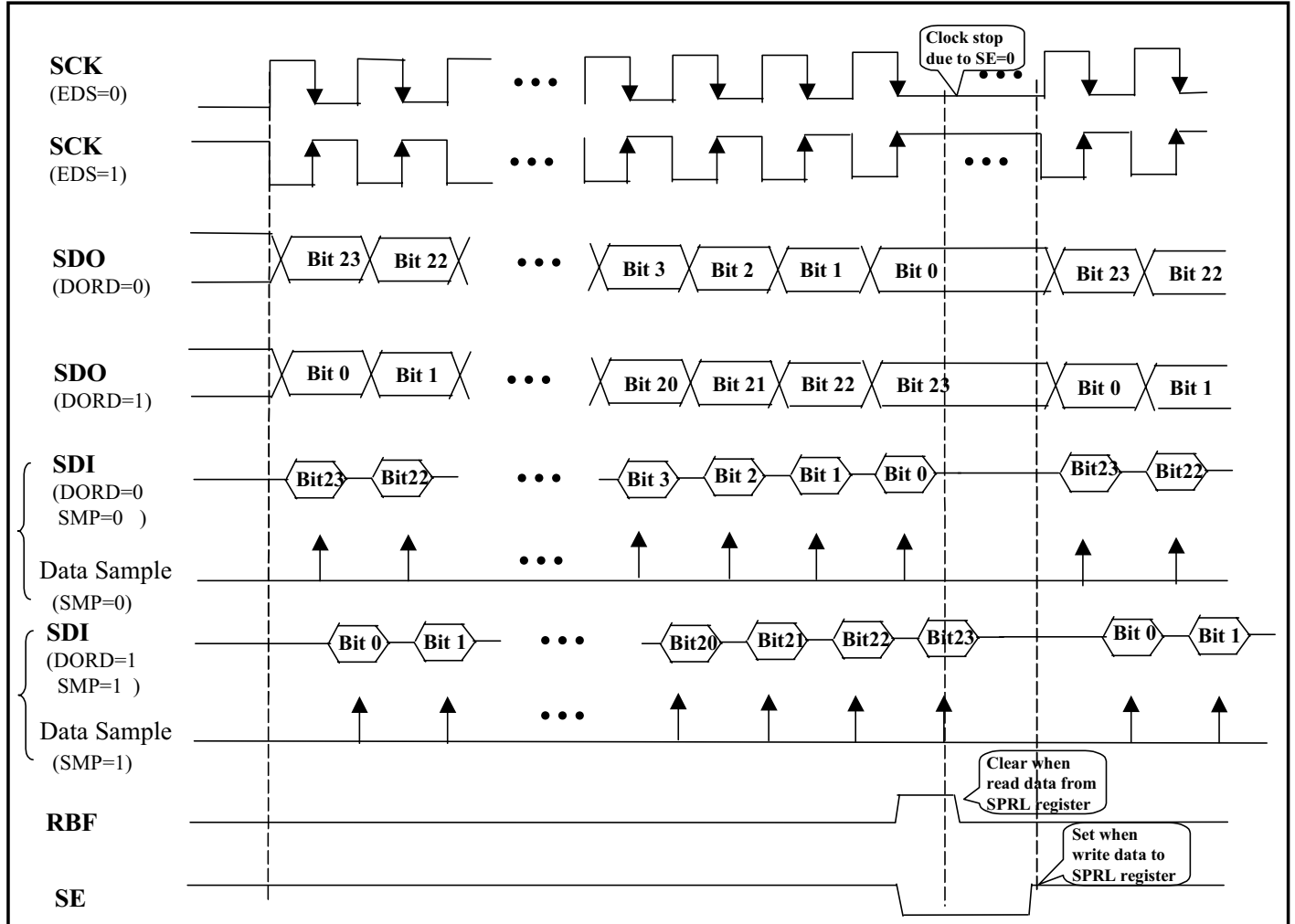
● **INTSTA (INT STATUS Register)**

bit 7							bit0
-	-	-	<b>SRBFI</b>	LVDI	TMR2I	TMR1I	TMR0I

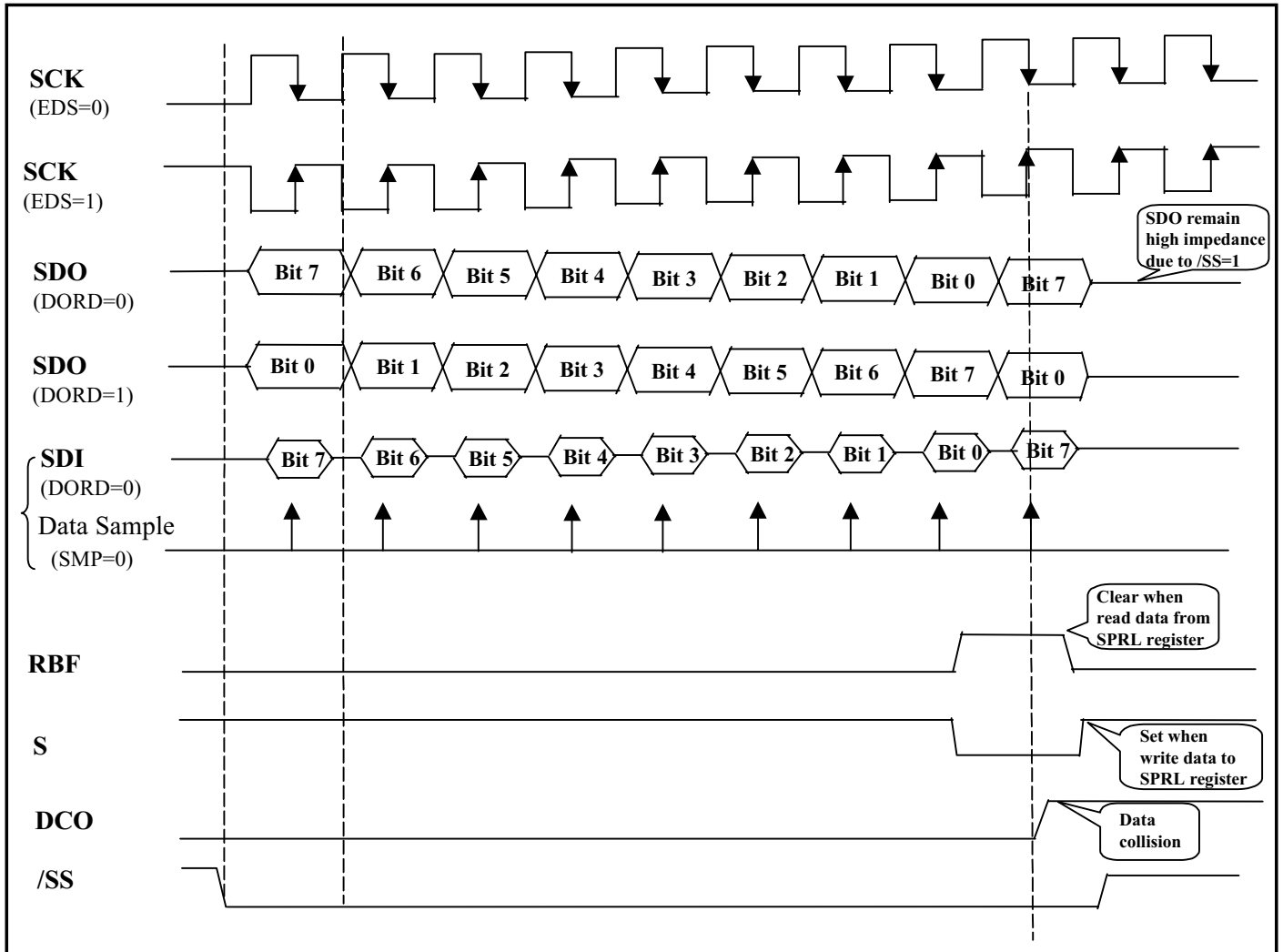
- ◆ **SRBFI:** Set to 1 when SPI read buffer full happened. Clear to 0 by software or SPI disable.

**Timing Diagram:**

(1) MASTER MODE: (Shift buffer Length = 24bits )



(2)SLAVE MODE: (Shift buffer Length = 8 bits , /SS enable)

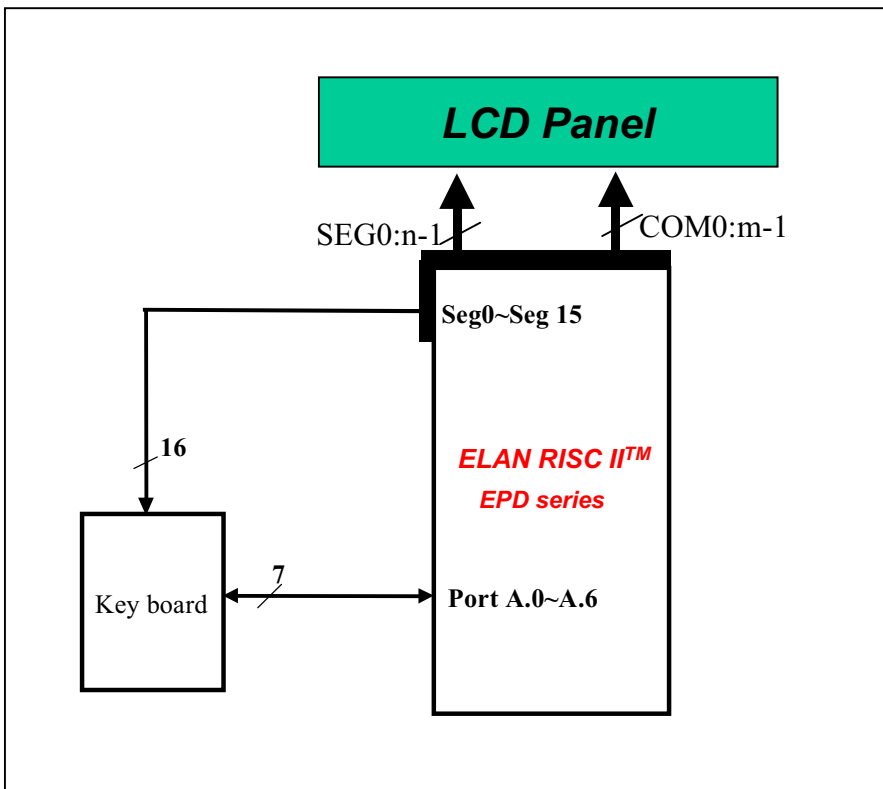


## D. Key I/Os

### Feature

- 7 pins key input(Port A) and 16 pins key strobe (share with LCD segment) can achieve maximum 112 keys matrix.
- Automatic key scan or software key scan.
- Interrupt available when automatic key scan(SCAN=1).
- Wakeup available when key input low level detected at automatic key scan mode(SCAN=1).

### Function Block Diagram



## Function Description

### (1)Key Input:

As shown in the following figure, it is considered that Key strobe output has resistance  $R_{ON}$ , and each key has resistance  $K_{ON}$  and the capacitance  $C$ .

Because longtime strobe output makes LCD display confused, strobe output should be as short as possible.

So  $R_{IN}$  (pull-up resistance) should be low enough for the Capacitance to be charged quickly.

But  $R_{IN}$  should be high enough for  $V_{IN}$  to be judged in "L" level. ( $R_{IN} \gg R_{ON} + K_{ON}$ )

Therefore the value of  $R_{IN}$  should be able to be changeable.

Refer to the following "Key input process".

### Key input process

1. Output the strobe signal
2. Pull up the input port by lowest resistance( $R1$  and  $R2$  enable) : Capacitance is charged quickly.
3. Pull up the input port by highest resistance( $R2$  only enable).
4. Read the key.
5. Disable the pulled-up resistance.
6. Stop the strobe signal

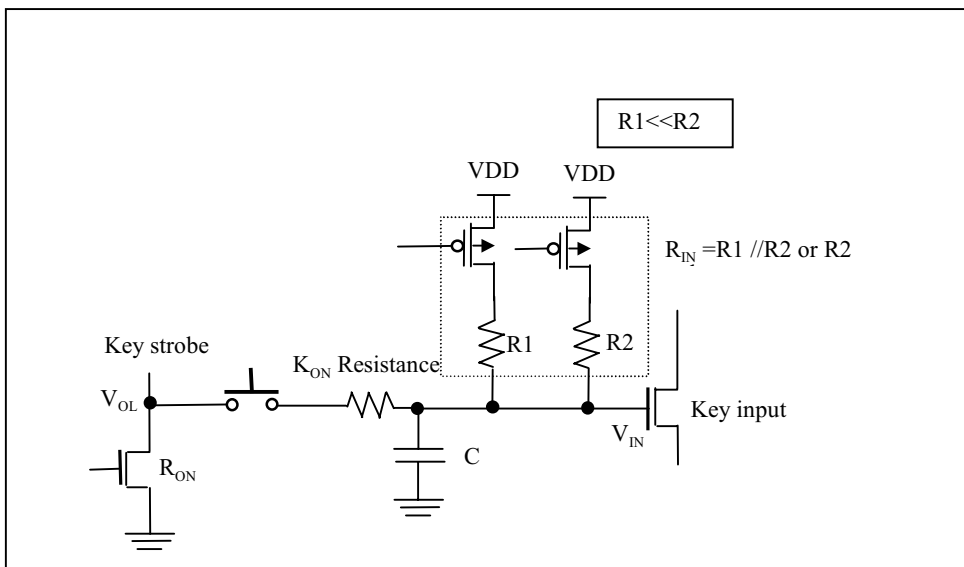


Fig. Key circuit

Functions:

SCAN	BitST	KE	/R1EN	/R2EN	SSCAN *1	SCAN *1	IEN *1	Total pullup resistor	PORTA.0~.A.6	Note
0	0	x	1	1	0	0	0	Floating	0	
			1	1			0	Floating	0	*A
	1	0	1	0			0	R2	0	
			0	1			0	R1	0	
			0	0			0	R1 // R2 *2	0	*B
			1	1			1	Floating	Floating	Prohibited
		1	1	0			1	R2	PA.0~.6	*C
			0	1			1	R1	PA.0~.6	
			0	0			1	R1 // R2 *2	PA.0~.6	
			1	1			1	R2	PA.0~.6	
1	x	x	1	1	0	0	0	Floating	0	*A
			0	0	0	1	0	R1//R2 *2	0	*B
			1	0	1	1	1	R2	PA.0~.6	*C

\*1 : Internal signal - Refer the following "Automatic KeyScan Timing"

\*2  $R1 // R2 = R1R2 / (R1+R2)$

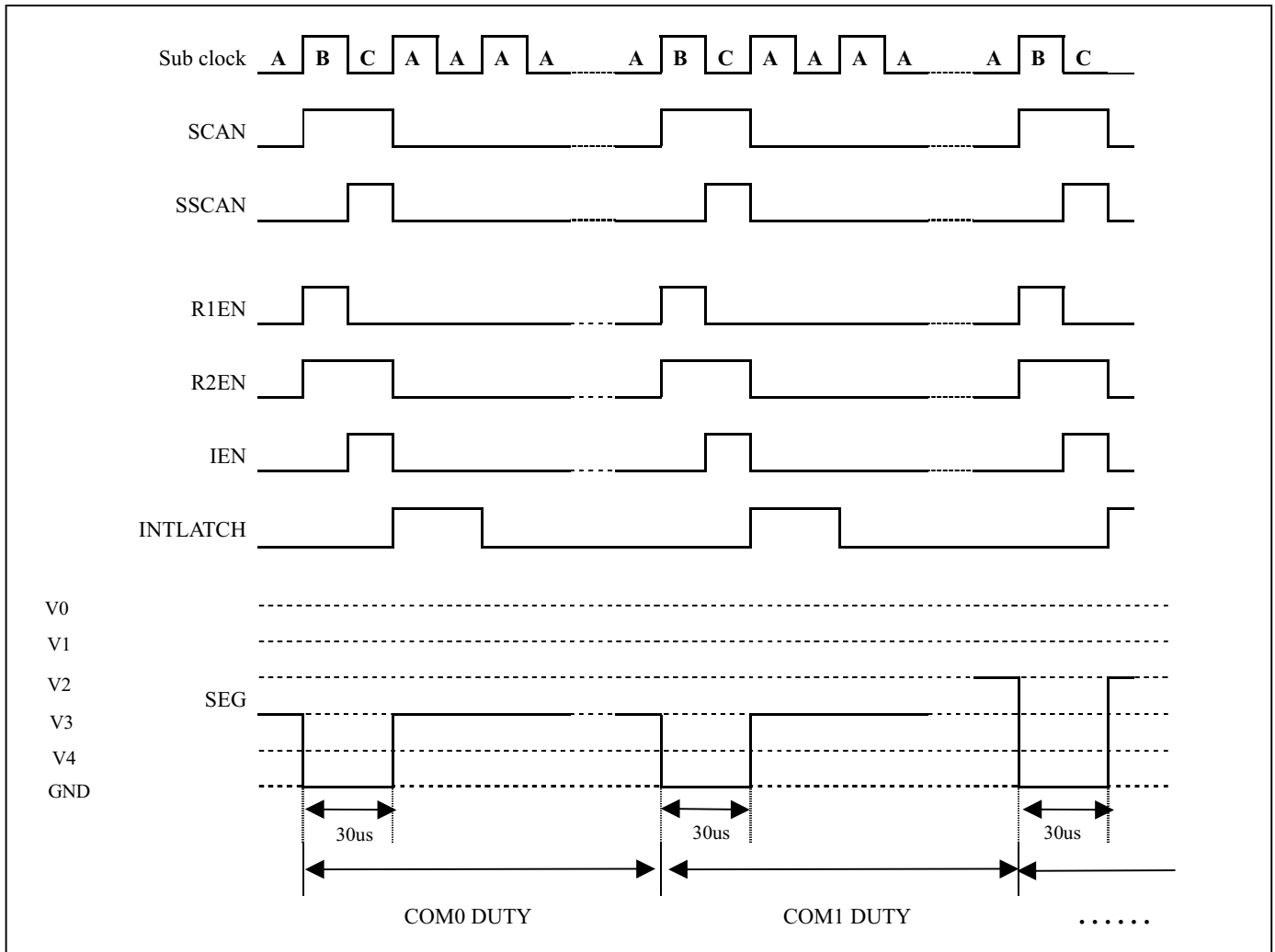


Fig. Automatic KeyScan Timing (SCAN = 1)

## (2) Key Strobe :

Key strobe pin share with LCD segment pin in CPU with embedded LCD driver model .

When shared with LCD segment, to prevent LCD display confused, strobe output should be as short as possible.

The strobe signal can output in the following two ways.

### (1) Automatic key scan:

LCD waveform has a 30us low pulse at the beginning of every common duty signal by setting **SCAN** bit of STBCON register. The strobe timing is as the following figure.

When automatic key scan mode, the PAINT or PORT A wakeup must enable. During Key scan, wakeup and interrupt will happens if key input pin(Port A) low level detected.

### (2) Software key scan :

Segment is switched to strobe signal temporally by setting **BitST** bit of STBCON register to 1 and **SCAN** bit to 0.

Setup **STB3~STB0** bit of STBCON register to select which pin will be strobed.

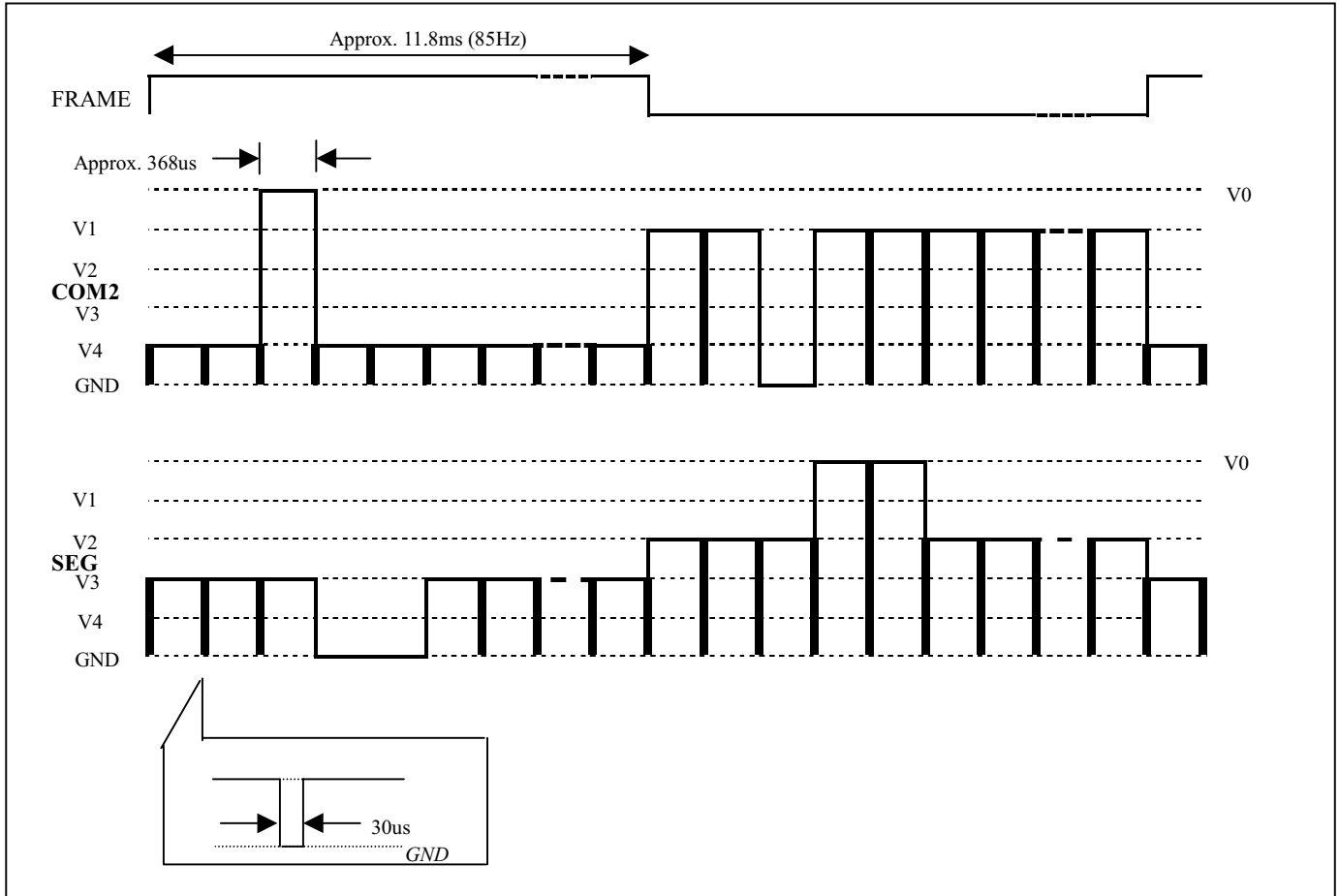
In this mode user can set **ALL** bit of STBCON register to let segment 0~15 to hold at GND level.

**In IDLE MODE**, when automatic key scanning, if PA.0~.6 pin low level detected(when IEN=1), wake up will happen. Then CPU running and interrupt happened (If enable) .

**In SLOW MODE or FAST MODE**, both automatic key scan and software key scan will be used.

Step 1:Automatic key scan will be used to examine “**Is there any key pressed?** ”. If key pressed, PA.0~.6 pin low level detected , then **interrupt will happen** .

Step 2: Software key scan will examine “**which key was pressed**”.



**Fig. Automatic strobe signal (SCAN = 1)**

The function of key strobe pin is as following table.

STBCON				Key Strobe (Share with Segment 0~15)															LCD				
SCAN	BitST	ALL	STB3~0	seg 0	seg 1	seg 2	seg 3	seg 4	seg 5	seg 6	Seg 7	seg 8	seg 9	seg 10	Seg 11	seg 12	seg 13	seg 14	seg 15	seg 16: n-1	com 0:m-1		
0	1	0	xxxx	Display waveform																	Display waveform		
			0000	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1		1	1
			0001	1	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1		1	1
			0010	1	1	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1		1	1
			0011	1	1	1	0	1	1	1	1	1	1	1	1	1	1	1	1	1		1	1
			0100	1	1	1	1	0	1	1	1	1	1	1	1	1	1	1	1	1		1	1
			0101	1	1	1	1	1	0	1	1	1	1	1	1	1	1	1	1	1		1	1
			0110	1	1	1	1	1	1	0	1	1	1	1	1	1	1	1	1	1		1	1
			0111	1	1	1	1	1	1	1	0	1	1	1	1	1	1	1	1	1		1	1
			1000	1	1	1	1	1	1	1	1	0	1	1	1	1	1	1	1	1		1	1
			1001	1	1	1	1	1	1	1	1	1	0	1	1	1	1	1	1	1		1	1
			1010	1	1	1	1	1	1	1	1	1	1	0	1	1	1	1	1	1		1	1
			1011	1	1	1	1	1	1	1	1	1	1	1	0	1	1	1	1	1		1	1
			1100	1	1	1	1	1	1	1	1	1	1	1	1	0	1	1	1	1		1	1
			1101	1	1	1	1	1	1	1	1	1	1	1	1	1	0	1	1	1		1	1
1110	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	1	1	1	1				
1111	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0				
1	x	x	xxxx	Display waveform with automatic key scan																			



## Register Description

- **PortA register (Port A register)**

bit 7

bit0

Bit7	Bit6	Bit5	Bit4	Bit3	Bit2	Bit1	Bit0
------	------	------	------	------	------	------	------

- ◆ **Bit6~Bit0** : Key input , input interrupt or wake up pin. The input structure and 2 stage pull up resistor is controlled together by **/R1EN**,**/R2EN** and **KE** bit of **PACON** register.

- **PACON (Port A Control Register)**

bit 7

bit0

LVD2	LVD1	LVD0	LVDSEL	Bit7PU	<b>/R2EN</b>	<b>/R1EN</b>	<b>KE</b>
------	------	------	--------	--------	--------------	--------------	-----------

- ◆ **KE**: Key input enable/disable control bit.
  - 0: Disable Key input function (PORTA register is **NOT** correspondence with Key input in software scan mode).
  - 1: Enable Key input function (PORTA register is correspondence with Key input in software scan mode).
- ◆ **/R1EN**: R1 pull up resistor(small resistor) control bit.
  - 0: Enable R1 pull up resistor.
  - 1: Disable R1 pull up resistor.
- ◆ **/R2EN**: R2 pull up resistor(large resistor) control bit.
  - 0: Enable R2 pull up resistor.
  - 1: Disable R2 pull up resistor.

- **PAINTEN (Port A INTERRUPT Enable Control Register)**

bit 7

bit0

<b>PA7IE</b>	<b>PA6IE</b>	<b>PA5IE</b>	<b>PA4IE</b>	<b>PA3IE</b>	<b>PA2IE</b>	<b>PA1IE</b>	<b>PA0IE</b>
--------------	--------------	--------------	--------------	--------------	--------------	--------------	--------------

- ◆ **PA7IE~PA0IE**: Control bit of interrupt .
  - 0: Disable interrupt function.
  - 1: Enable interrupt function.

- **PAINTSTA (Port A INTERRUPT STATUS Register)**

bit 7

bit0

<b>PA7I</b>	<b>PA6I</b>	<b>PA5I</b>	<b>PA4I</b>	<b>PA3I</b>	<b>PA2I</b>	<b>PA1I</b>	<b>PA0I</b>
-------------	-------------	-------------	-------------	-------------	-------------	-------------	-------------

- ◆ **PA7I~PA0I**: INT status of Port A interrupt. Set to 1 when pin **falling edge** detected. Clear to 0 by software.

- **STBCON (Strobe output control Register)**

bit 7

bit0

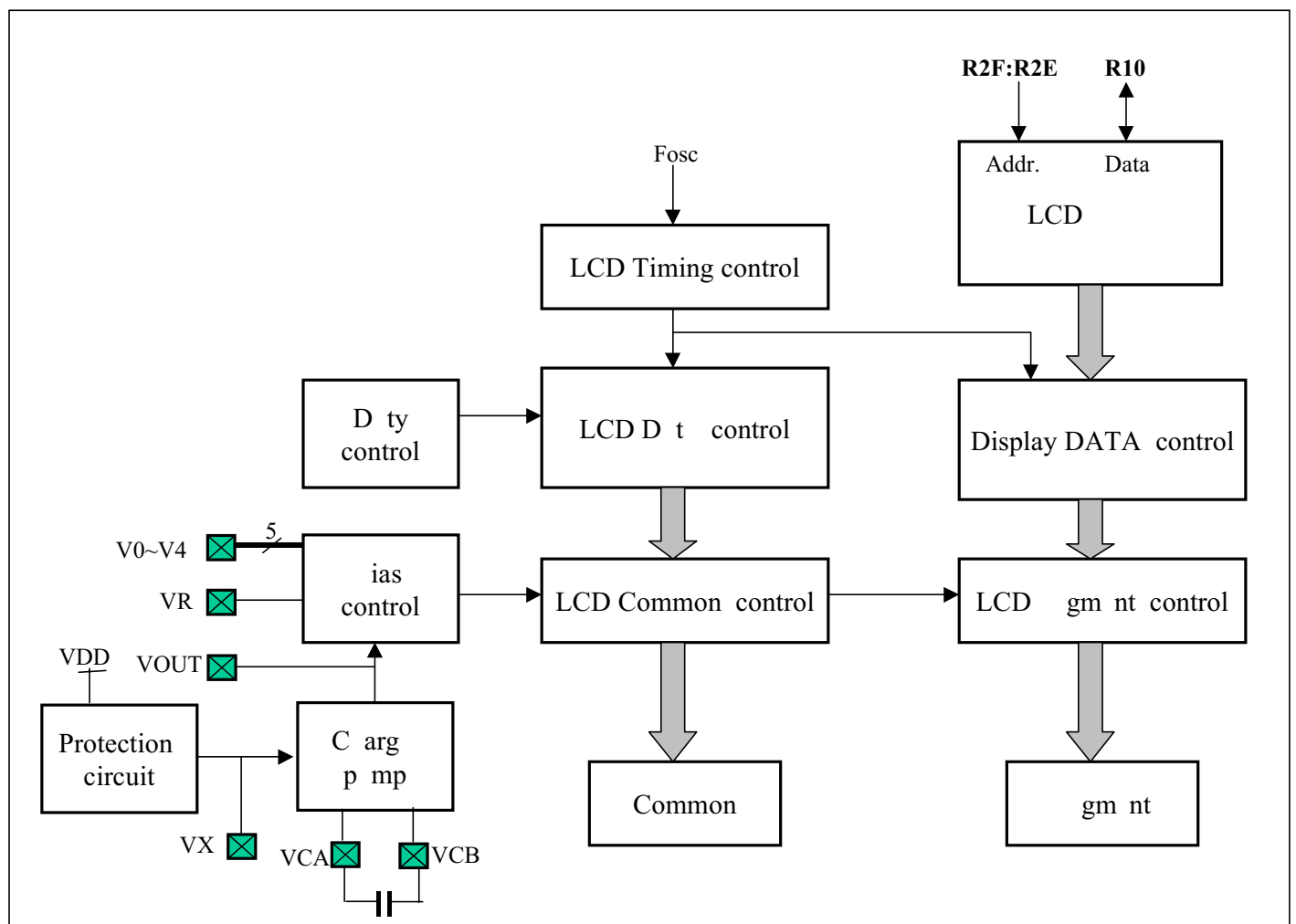
-	<b>SCAN</b>	<b>BitST</b>	<b>ALL</b>	<b>STB3</b>	<b>STB2</b>	<b>STB1</b>	<b>STB0</b>
---	-------------	--------------	------------	-------------	-------------	-------------	-------------

- ◆ **STB0~3**: Strobe output selector bit.
- ◆ **ALL**: Set All strobe.
  - 0 : Bit strobe.
  - 1 : All strobe.
- ◆ **BitST** : Enable Bit strobe
  - 0 : Display waveform.
  - 1 : Strobe signal as **STB3~0** defined.
- ◆ **SCAN** : Automatic key scan or specify the scan signal bit by bit.
  - 0 : Key scan was specified as the bit **STB3~0** defined.
  - 1 : Auto strobe scanning.

### E. Embedded LCD DRIVER

ELAN RISC II™ series provide directly drive LCD . It supports 98 segments 32 commons. There are LCD RAM for direct correspondence with LCD Pixel. Charge pump can pump to 2 times of VDD. The LCD contrast has 32 level adjustable. And the LCD bias are selectable. The maximum LCD operating voltage can be determined by external resistor RA and RB .

### Function Block Diagram



**Register Description:**
**● LCDCON register (LCD control register A)**

bit 7

bit0

<b>BSEL2</b>	<b>BSEL1</b>	<b>BSEL0</b>	<b>ADJ4</b>	<b>ADJ3</b>	<b>ADJ2</b>	<b>ADJ1</b>	<b>ADJ0</b>
--------------	--------------	--------------	-------------	-------------	-------------	-------------	-------------

**◆ ADJ4~0: LCD contrast adjustment .**

ADJ4	ADJ3	ADJ2	ADJ1	ADJ0	$\alpha$	VEV	Contrast
0	0	0	0	0	0	0.75 Vref	Low
0	0	0	0	1	1	0.758 Vref	
.	.	.	.	.	.	.	
.	.	.	.	.	.	.	
1	1	1	1	0	30	0.992Vref	
1	1	1	1	1	31	Vref	High

$$V0 = (1 + \frac{Rb}{Ra}) \times VEV$$

$$VEV = (1 - \frac{(31 - \alpha)}{124}) \times VREF$$

(Vref=2V at 25°C)

**◆ BSEL2~0 : LCD Bias select**

BSEL2	BSEL1	BSEL0	LCD Bias
0	0	0	1/3
0	0	1	1/3.5
0	1	0	1/4
0	1	1	1/4.5
1	0	0	1/5
1	0	1	1/5.5
1	1	0	1/6
1	1	1	1/6.5

**● SPISTA(SPI status register):**

bit 7

bit0

<b>LCDM1</b>	<b>LCDM0</b>	<b>SFR1</b>	<b>SFR0</b>	<b>SPWKEN</b>	<b>SMP</b>	<b>DCOL</b>	<b>RBF</b>
--------------	--------------	-------------	-------------	---------------	------------	-------------	------------

**◆ SFR1~0 : Frame frequency adjustment.**

SFR1	SFR0	CL frequency	Frame frequency (Hz)		
			Min	Typ	Max
0	0	Fosc / 13	59.1	78.8	98.6
0	1	Fosc / 14	54.9	73.2	91.5
1	0	Fosc / 15	51.3	68.3	85.4
1	1	Fosc / 16	48.0	64.1	80.1

Note:1. Fosc = 32.8kHz +/- 25% (all conditions)

2.This table is based on 1/32 duty.

◆ **LCDM1~0:** LCD operation mode control register.

LCDM1:LCDM0	Operation mode
00	Disable(LCD off)
01	Blanking
10	LCD enable
11	

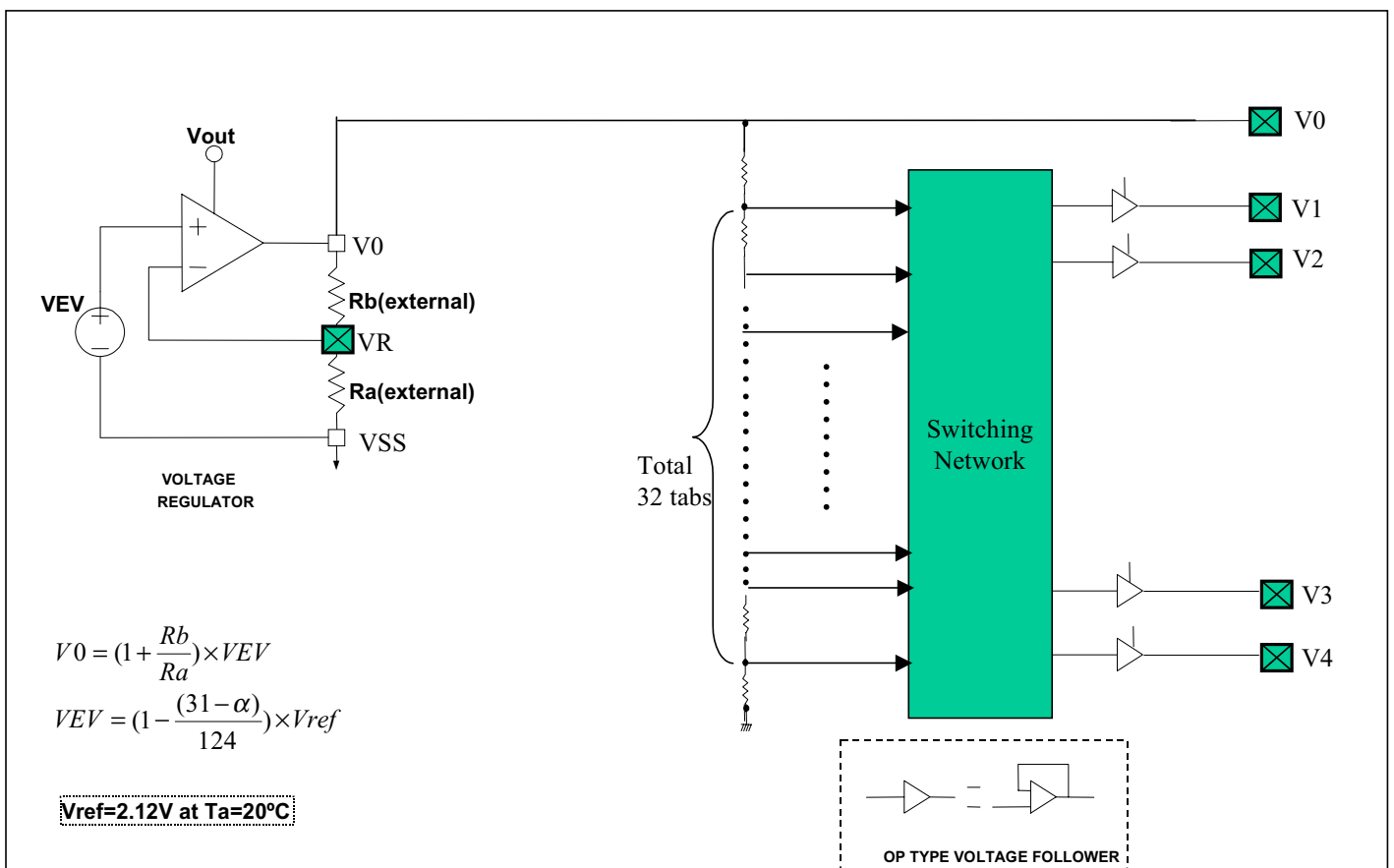
Note: Blanking means All COM & SEG pin are tied to ground.

**LCD Power circuit:**

● **LCDARH:LCDARL(LCD RAM address):**

\*LCDARH: Page address for LCD RAM.

\*LCDARL: Column address for LCD RAM.



**LCD RAM MAP:**

**PAGE 00 (LCDARH=00H)**

RAM address LCDARL	COM0	COM1	COM2	COM3	COM4	COM5	COM6	COM7
	Bit0	Bit1	Bit2	Bit3	Bit4	Bit5	Bit6	Bit7
SEG0	00H							
SEG1	01H							
SEG2	02H							
:	:							
:	:							
SEG96	60H							
SEG97	61H							

**PAGE 01 (LCDARH=01H)**

RAM address LCDARL	COM8	COM9	COM10	COM11	COM12	COM13	COM14	COM15
	Bit0	Bit1	Bit2	Bit3	Bit4	Bit5	Bit6	Bit7
SEG0	00H							
SEG1	01H							
SEG2	02H							
:	:							
:	:							
SEG96	60H							
SEG97	61H							

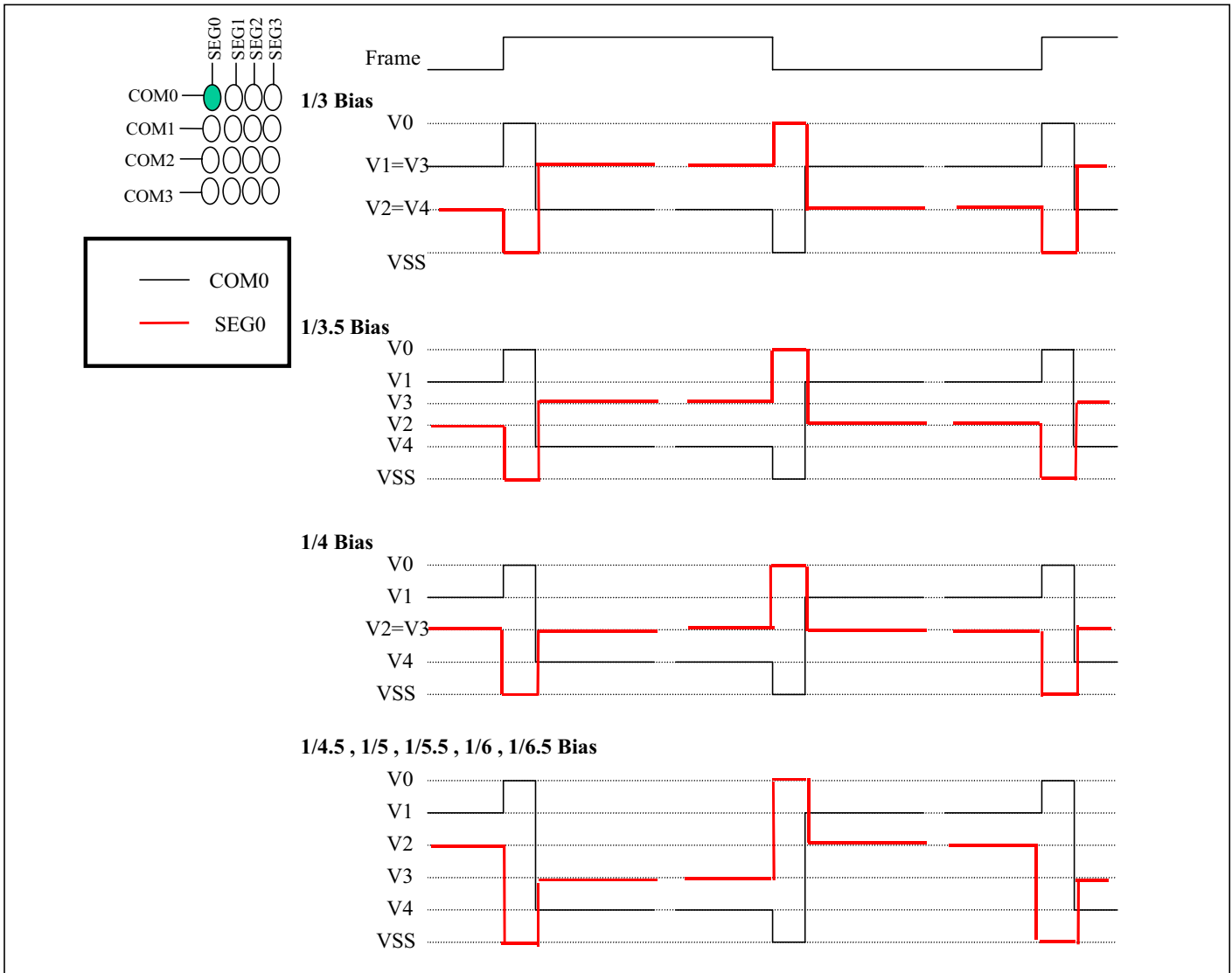
**PAGE 02 (LCDARH=02H)**

RAM address LCDARL	COM16	COM17	COM18	COM19	COM20	COM21	COM22	COM23
	Bit0	Bit1	Bit2	Bit3	Bit4	Bit5	Bit6	Bit7
SEG0	00H							
SEG1	01H							
SEG2	02H							
:	:							
:	:							
SEG96	60H							
SEG97	61H							

**PAGE 03 (LCDARH=03H)**

RAM address LCDARL	COM24	COM25	COM26	COM27	COM28	COM29	COM30	COM31
	Bit0	Bit1	Bit2	Bit3	Bit4	Bit5	Bit6	Bit7
SEG0	00H							
SEG1	01H							
SEG2	02H							
:	:							
:	:							
SEG96	60H							
SEG97	61H							

**LCD WAVEFORM:**



## VIII. Electrical characteristic

### ABSOLUTE MAXIMUM RATINGS

Items	Sym.	Condition	Limits	Unit
Supply voltage	VDD		-0.3 to +3.6	V
Input voltage (general input port)	VIN		-0.5 to VDD +0.5	V
Input voltage(PA[0:6])	VINA		-0.5 to V0+0.5	V
Operating temperature range	TOPR		-10 to +60	°C
Storage temperature range	TSTR		-55 to +125	°C

### RECOMMENDED OPERATING CONDITIONS

Items	Sym.	Condition	Limits	Unit
Supply voltage	VDD		2.6 to 3.2	V
Input voltage	VIH		VDD*0.9 to VDD	V
	VIL		0 to VDD*0.1	V
LVDIN voltage	V <sub>LVD</sub>	LVDSEL=1 (Internal LVD)	2.0V~3.6V	V
Vo voltage	V0	Internal Charge pump	5.3V(Max)	V
Operating temperature	TOPR		0 to +40	°C

### DC ELECTRICAL CHARACTERISTICS (condition : Ta=0~+40 °C, VDD= 2.9 +/- 0.3V)

Parameter	Sym.	Condition	Min	Typ	Max	Unit	
CLOCK	Fmain	Main-clock frequency	1	-	10	MHz	
	Fsub	Sub-clock frequency RC OSC X'tal OSC.	24.6 -	32.8 32.768	41 -	KHz	
Supply current	Idd1	SLEEP mode VDD=3V, no load (Ta=25 °C)	-	-	1	μA	
	Idd2	IDLE mode VDD=3V, LCD disable, RC OSC	-	8	12		
	Idd3		-	5	8		
	Idd4	VDD=3V, LCD enable, Auto Scan on, RC/X'tal OSC (Vo=3.8V, 1/3 Bias, V1 & V4 OP=*1, V2 & V4 OP=Off ,no load)	-	80	100		
			-	20	30		
	Idd5	SLOW mode VDD=3V, LCD disable, RC/X'tal OSC ,no load	-	750	900		
	Idd6	FAST mode VDD=3V, Fmain=4MHz, no load	-	1400	1600		
Idd7	VDD=3V, Fmain=10MHz, ,no load	-	-	-			
Input voltage	VIH1	PA[7],PB[0:7] (as general input port)	VDD*0.7	-	VDD		
	VIL1		0	-	VDD*0.3		
	VIH2	PA[0:6](as general input port, LCD enable)	VDD*0.7	-	V0	V	
	VIL2		0	-	VDD*0.3		
Input threshold voltage (Schmitt)	VT+	Port A interrupt, SYSTEM RESET and RESET_Key	0.5*VDD	-	0.75*VDD	V	
	VT-		0.2*VDD	-	0.4*VDD		
Output current	IOH1	PB[0:3] VDD=3V , VOH=2.4V	-1	-2	-3	mA	
	IOL1	(as general output port) VDD=3V , VOL=0.2V	+1	+2	+3		
	IOH2	PB[6:7] VDD=3V , VOH=2.5V	-1	-2	-3		
	IOL2		VDD=3V , VOL=0.5V	+1	+2	+3	
	IOH3	PB[4:5] VDD=3V, VOH=1V	-3	-6	-9		
	IOL3		VDD=3V, VOL=0.5V	+1.5	+3	+4.5	
Input leakage current	IIL	ALL Input port( without pull up/down resistor) Vin= VDD or GND	-	-	+/-1	μA	
Large Pull up resistance	RPU1	PA[0:6] Key high resistance, pulled up by R2 ,LCD enable	150.	300	450	K Ω	
	RPU3	PA[7], PB[0:7], Vin=GND	500	1000	1500		
	RPU5	SYSTEM RESET And RESET_Key Vin=GND	200	400	800		
Small Pull up resistance	RPU2	PA[0:6] Key low resistance, pulled up by R1//R2 ,LCD enable	40	75	110	K Ω	
	RPU4	PA[7], PB[0:7], Vin=2V	50	100	200		
	RPU6	SYSTEM RESET And RESET_Key Vin=2V	50	100	200		
Large Pull down resistance	RPD1	TEST Vin=VDD	250	500	750	K Ω	
Small Pull down resistance	RPD2	TEST Vin=1V	10	20	30		
Low battery detect voltage	Vdet	Ta=0 to 40 °C	Vdet -0.1v	Vdet(*1)	Vdet +0.1v	V	
LVD supply current	I <sub>lvd</sub>	LVDIN=2V	-	3	5	μA	
Data retention voltage	Vret		1.6	-	-	V	
Power ON reset voltage	Vpor		1.4	1.5	1.6	V	
Charge pump output	Vout	Capacitance of charge pump C1 and C2:0.1μF	2*VX-5%	VX*2	-	V	
Regulated voltage	V0	VDD=2.3V~3.3V, Ta=0 to 40 °C	V0-4%	V0(*2)	V0+4%	V	
Protection circuit voltage	VX		2.6	2.75	2.9	V	
Reference voltage	Vref1	Ta=20 °C (*2)	2.035	2.12	2.205	V	
	Vref2	Ta=0 °C (*2)	2.169	2.26	2.351		
	Vref3	Ta=40 °C (*2)	1.900	1.98	2.060		
LCD display output ON-resistance	ROC	Com[0:31]	VOH=V0 +/- 0.2V	-	2	3	K Ω
			VOM=V1 +/- 0.2V				
			VOM=V4 +/- 0.2V				
			VOL=0.2V				
ROS	Seg[0:97]	VOH=V0 +/- 0.2V	-	2	3	K Ω	
		VOM=V2 +/- 0.2V					
		VOM=V3 +/- 0.2V					
		VOL=0.2V					
Strobe output ON-resistance	ROP	Seg[0:15] V=VDD-0.2V	85	165	250	K Ω	





	RON	V=0.2V	0.7	1.3	2		
Display frame frequency	Frame	Sub-Clock : RC OSC	57.6	-	87.8	Hz	
		Sub-Clock : X'tal OSC	64	-	78.8		
Op. Amp voltage output of LCD power supply	Vout0	V0	No load	-(*)4	V0 (*3)	-(*)4	mV
	Vout1	V1		-(*)4	V1 (*3)	-(*)4	
	Vout2	V2		-(*)4	V2 (*3)	-(*)4	
	Vout3	V3		-(*)4	V3 (*3)	-(*)4	
	Vout4	V4		-(*)4	V4 (*3)	-(*)4	

\*1 : Typical detected voltage is chosen by software from the following.

LVD2~0	Vdet(Vth-)	Vdet(Vth+)	Deviation	LVD2~0	Vdet(Vth-)	Vdet(Vth+)	Deviation
000	2.2V	2.3V	±0.1V	100	2.6V	2.7V	±0.1V
001	2.3V	2.4V		101	2.7V	2.8V	
010	2.4V	2.5V		110	2.8V	2.9V	
011	2.5V	2.6V		111	2.9V	3.0V	

\*2 : Typical regulated voltage for V0 is chosen by software from the following.

$$V_{max} = (1 + \frac{Rb}{Ra}) \times V_{ref}$$

$$V0 = (1 - \frac{(31 - \alpha)}{124}) \times V_{max}$$

$$0.75 V_{max} \leq V0 \leq V_{max} \text{ (32 steps)}$$

**Note:** Vref temperature coefficient = -7mV/ °C (Please refer to Vref1, Vref2, Vref3 DC spec.)

\*3 : V0-V4 Theoretical value

Bias	V0	V1	V2	V3	V4
1/3	V0	2/3 * V0	1/3 * V0	2/3 * V0	1/3 * V0
1/3.5		2.5/3.5 * V0	1.5/3.5 * V0	2/3.5 * V0	1/3.5 * V0
1/4		3/4 * V0	2/4 * V0	2/4 * V0	1/4 * V0
1/4.5		3.5/4.5 * V0	2.5/4.5 * V0	2/4.5 * V0	1/4.5 * V0
1/5		4/5 * V0	3/5 * V0	2/5 * V0	1/5 * V0
1/5.5		4.5/5.5 * V0	3.5/5.5 * V0	2/5.5 * V0	1/5.5 * V0
1/6		5/6 * V0	4/6 * V0	2/6 * V0	1/6 * V0
1/6.5		5.5/6.5 * V0	4.5/6.5 * V0	2/6.5 * V0	1/6.5 * V0

\*3 : The Target value of V0-V4 is Theoretical value +/- 20mV.

AC ELECTRICAL CHARACTERISTICS (condition : Ta= 0~40 °C, VDD= 2.9 +/- 0.3V)

Parameter	Sym.	Condition	Min	Typ	Max	Unit
Strobe output duration	Tst	Automatic key scan mode(SCAN=1), RC OSC.	22.9	30.5	38.2	μs
		Automatic key scan mode(SCAN=1), X'tal OSC.	-	30.52	-	
LVD stable time	Tstup1	LVDEN ↑ to /LV ↓ (LVDIN=2.0V)	-	30	100	μs
SDI data setup time	Tstup2	Setup time of SDI data input to SCK ↑ or SCK ↓	-	25	50	ns
SDI data hold time	Thold2	Hold time of SDI data input to SCK ↓ or SCK ↑	-	25	50	ns
SDO output valid time	Tvalid1	SCK ↑ or SCK ↓ to SDO data output	-	25	50	ns
SCK input high time	Tsckh	Slave mode (Fmain=10MHz)	200	-	-	ns
SCK input low time	Tsckl	Slave mode (Fmain=10MHz)	200	-	-	ns
Slave mode setup time	Tsetup3	/SS ↓ to SCK ↑ or SCK ↓ (Fmain=10MHz)	400	-	-	ns
Slave mode unselect delay time	Tdelay1	/SS ↑ to SDO output hi-impedance delay time	-	25	50	ns
CK delay time	Tdelay2	CHOP carrier stop to CK ↑ delay time	22.9	30.5	38.2	μs
Instruction cycle time	Tcycle	Fmain=1MHz	-	2(*1)	-	μs
		Fmain=4MHz	-	0.5(*1)	-	
		Fmain=10MHz	-	0.2(*1)	-	

\*1: Instruction cycle time= 2 \* System clock time

Figure VIII-1: Low voltage detection timing

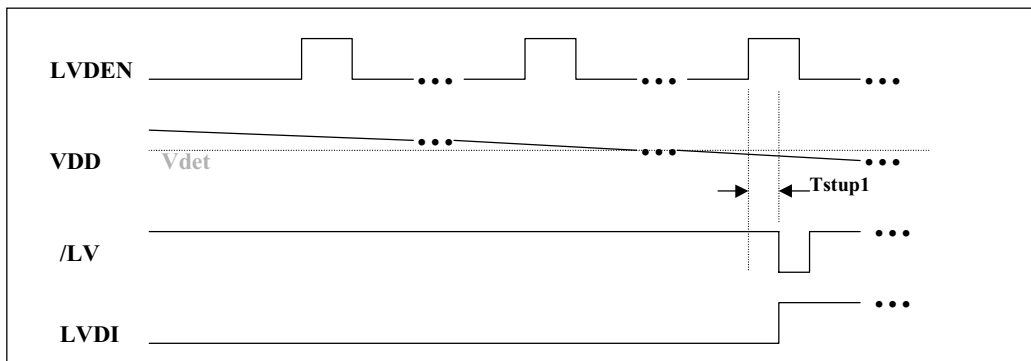


Figure VIII-2: EL timing

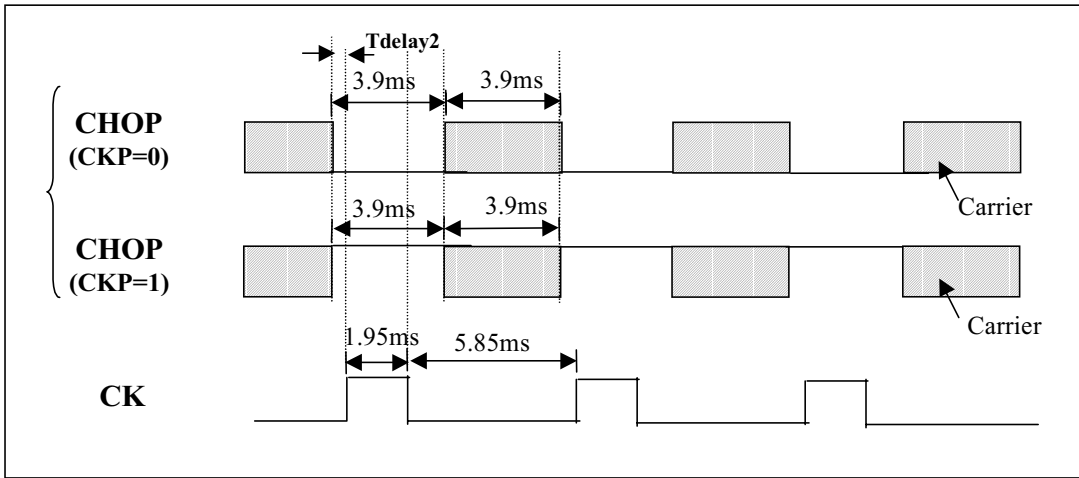


Figure VIII-3: SPI master mode timing

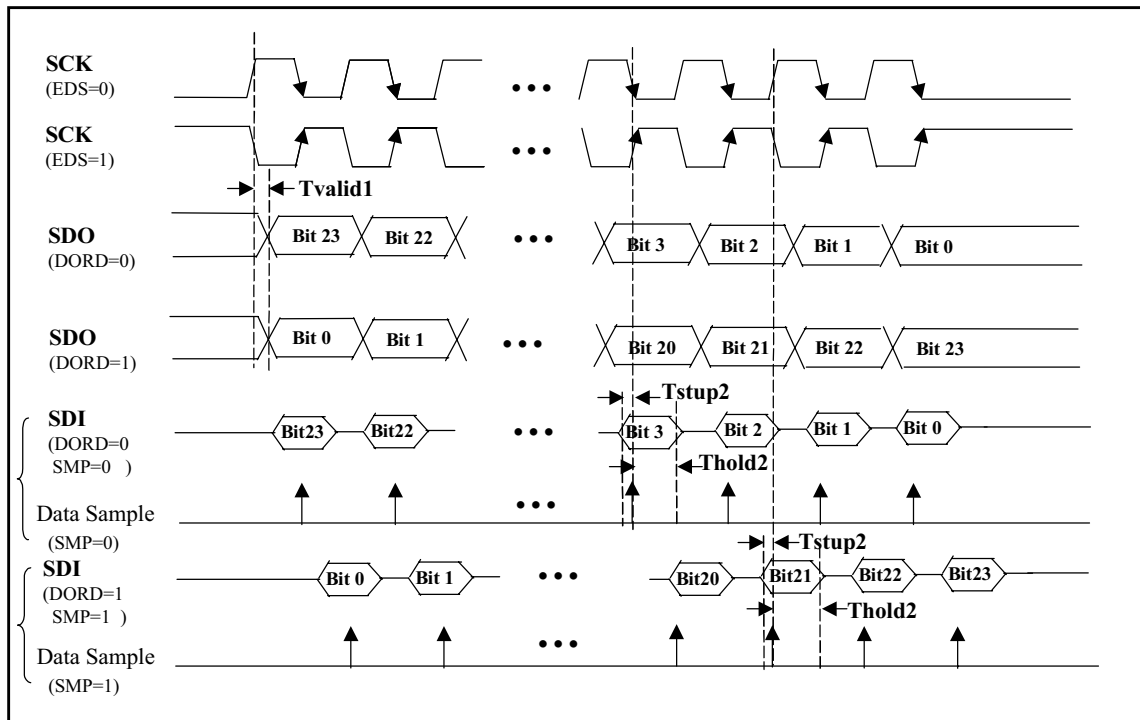
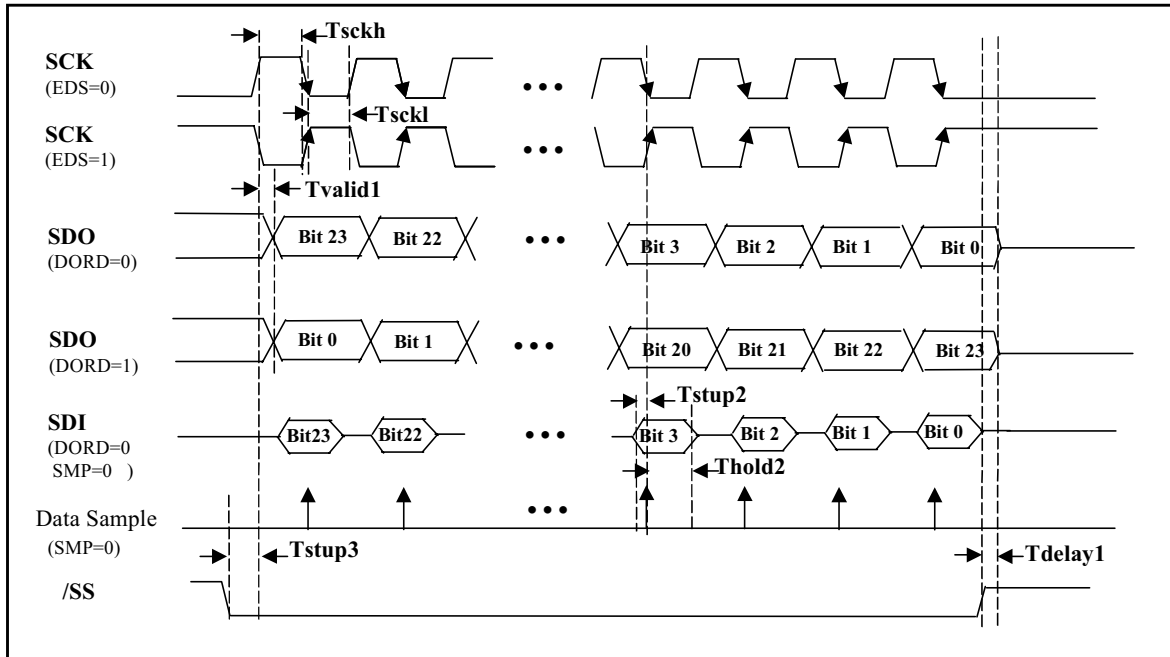
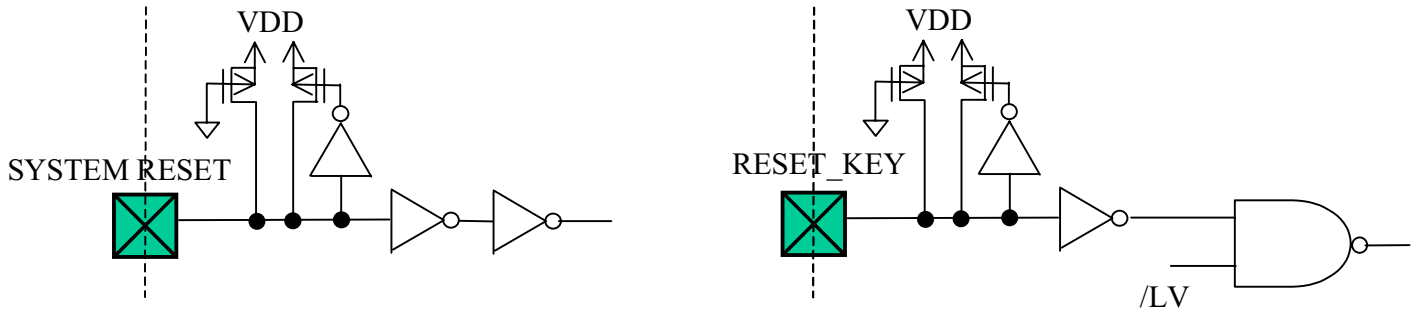


Figure VIII-4: SPI slave mode timing

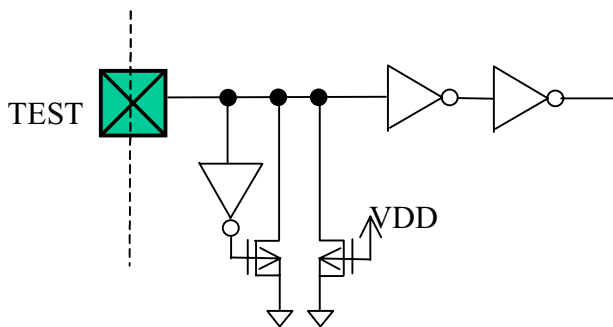


## IX. Pin Type Circuit Diagrams

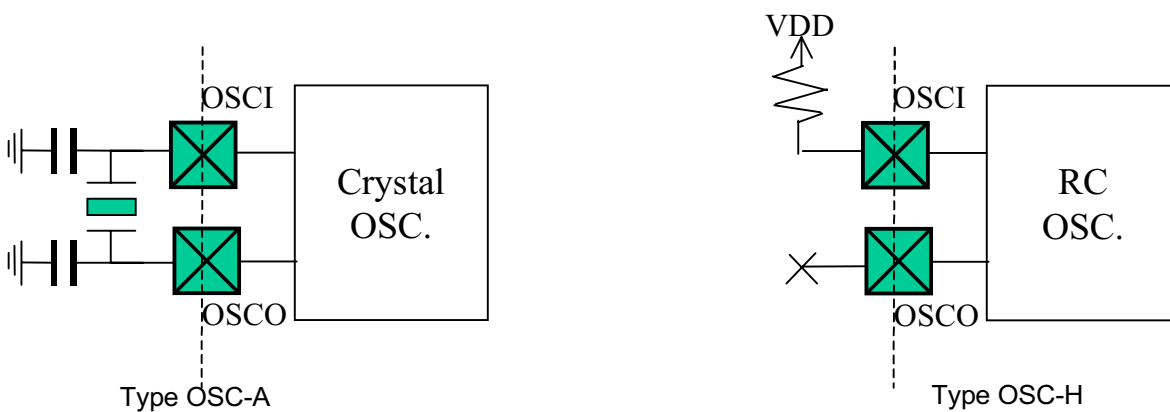
### IX.1 Reset Pin Type



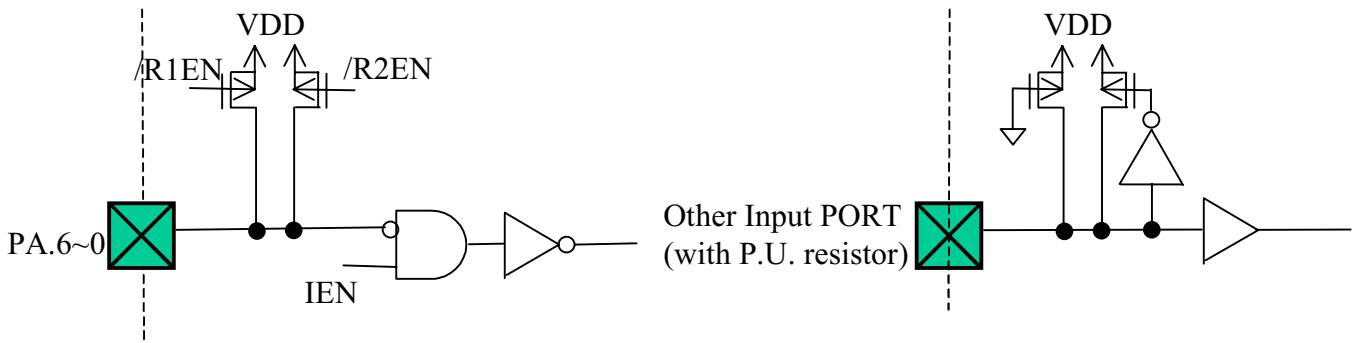
### IX.2 TEST Pin Type



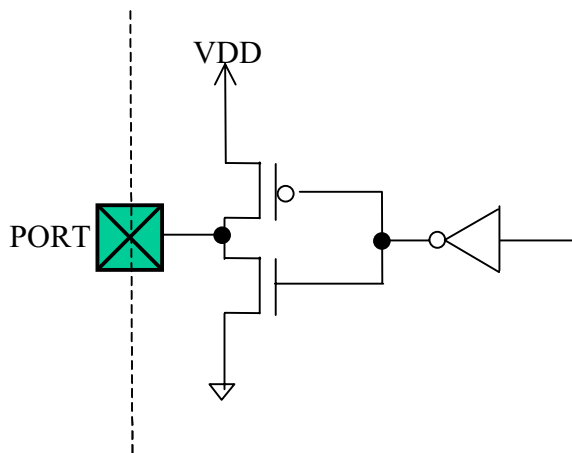
### IX.3 Oscillator Pin Type



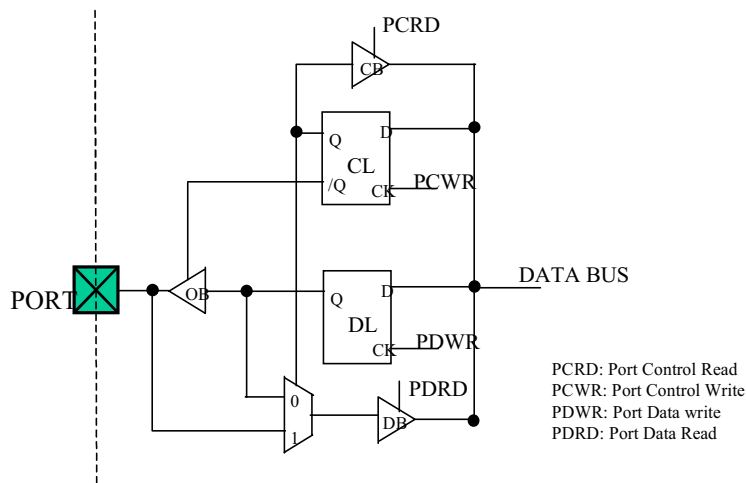
IX.4 Input Pin Type



IX.5 Output Pin Type

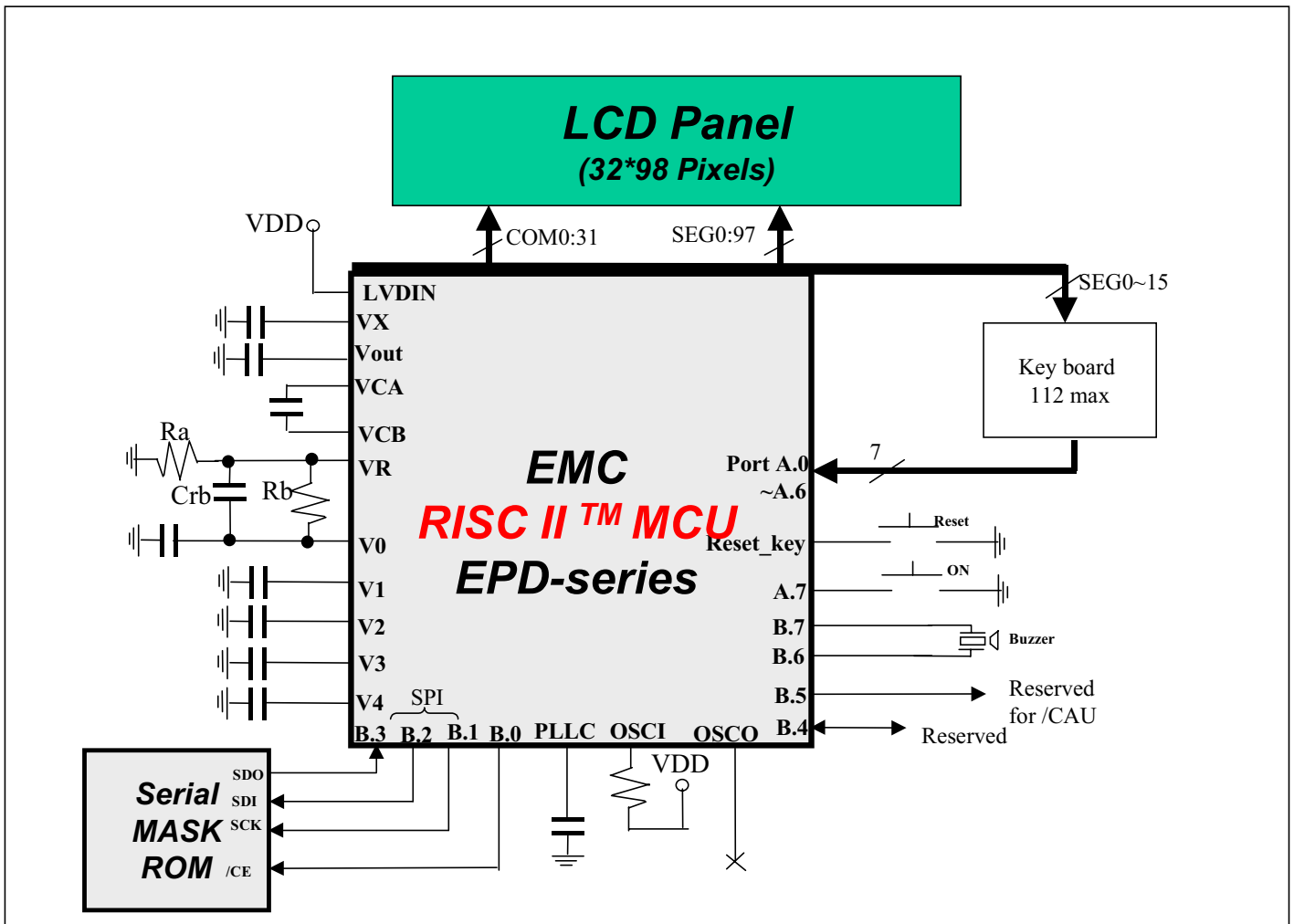


IX.6 General I/O Pin Type

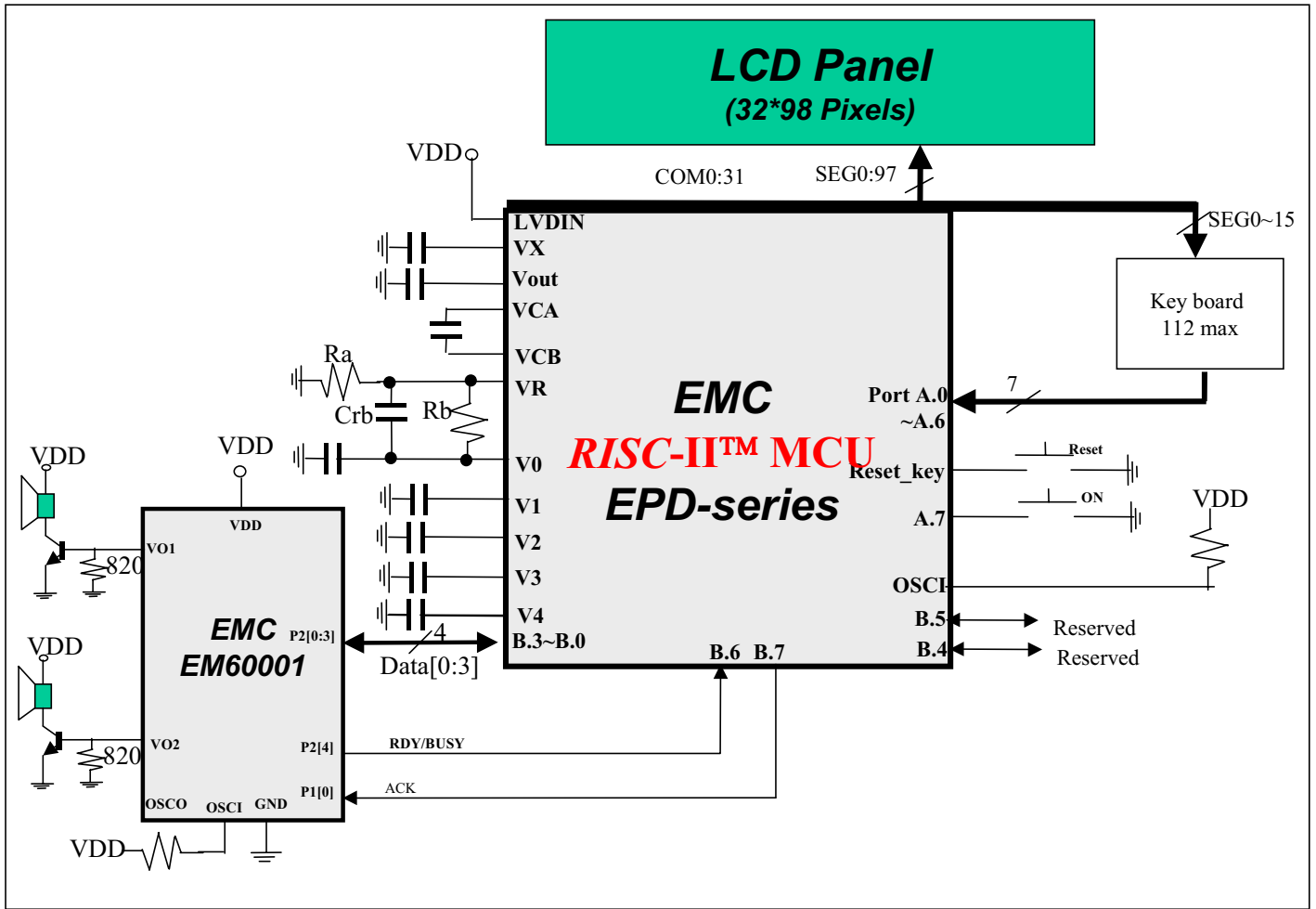


## X. Application Circuit

### (1) Dictionary



(2)ELA Product





## XI. Instruction Set

Remark:

**k:** constant      **r:** File Register      **addr:** address      **b:** bit  
**p:** special file register(0h~1Fh)      **i:** Table pointer control

Type	Instruction Binary	Mnemonic	Operation	Status Affected	Cycles
SYSTEM CONTROL	0000 0000 0000 0000	NOP	No operation	None	1
	0000 0000 0000 0001	WDTC	WDT ← 0 /TO ← 1, /PD ← 1	None	1
	0010 1011 1111 1110	RET	PC ← (Top of Stack)	None	1
	0010 1011 1111 1111	RETI	PC ← (Top of Stack); Enable Interrupt	None	1
	0000 0000 0000 0010	SLEP	Enter IDLE MODE if MS1=1 Enter SLEEP MODE if MS1=0	None	1
	0100 0011 kkkk kkkk	BANK #k	BSR ← k	None	1
TABLE LOOK UP	0100 0000 kkkk kkkk	TBPTL #k	TABPTRL ← k	None	1
	0100 0001 kkkk kkkk	TBPTM #k	TABPTRM ← k	None	1
	0100 0010 kkkk kkkk	TBPTH #k	TABPTRH ← k	None	1
	0010 11ii rrrr rrrr	TBRD i,r	r ← ROM[(TABPTR)]; (*1)(*2)	None	1 or 2 (*3)
	0010 1111 rrrr rrrr	TBRD A,r	r ← ROM[(TABPTR+ACC)]; (*2)	None	1 or 2 (*3)
LOGIC	0000 0010 rrrr rrrr	OR A,r	A ← A .or. r	Z	1
	0000 0011 rrrr rrrr	OR r,A	r ← r .or. A	Z	1
	0100 0100 kkkk kkkk	OR A,#k	A ← A .or. k	Z	1
	0000 0100 rrrr rrrr	AND A,r	A ← A .and. r	Z	1
	0000 0101 rrrr rrrr	AND r,A	r ← r .and. A	Z	1
	0100 0101 kkkk kkkk	AND A,#k	A ← A .and. k	Z	1
	0000 0110 rrrr rrrr	XOR A,r	A ← A .xor. r	Z	1
	0000 0111 rrrr rrrr	XOR r,A	r ← r .xor. A	Z	1
	0100 0110 kkkk kkkk	XOR A,#k	A ← A .xor. k	Z	1
	0000 1000 rrrr rrrr	COMA r	A ← /r	Z	1
	0000 1001 rrrr rrrr	COM r	r ← /r	Z	1
	0000 1010 rrrr rrrr	RRCA r	A(n-1) ← r(n); C ← r(0); A(7) ← C	C	1
	0000 1011 rrrr rrrr	RRC r	r(n-1) ← r(n) C ← r(0), r(7) ← C	C	1
	0000 1100 rrrr rrrr	RLCA r	A(n+1) ← r(n); C ← r(7); A(0) ← C	C	1
LOGIC	0000 1101 rrrr rrrr	RLC r	r(n+1) ← r(n); C ← r(7); r(0) ← C	C	1
	0010 0010 rrrr rrrr	SHRA r	A(n-1) ← r(n) A(7) ← C	None	1
	0010 0011 rrrr rrrr	SHLA r	A(n+1) ← r(n) A(0) ← C	None	1

Compare Branch	0101 1bbb rrrr rrrr aaaa aaaa aaaa aaaa	JBC r,b,addr	If r(b)=0,jump to addr PC[15:0] ← addr (*4)	None	2
	0110 0bbb rrrr rrrr aaaa aaaa aaaa aaaa	JBS r,b,addr	If r(b)=1,jump to addr PC[15:0] ← addr (*4)	None	2
	0101 0000 rrrr rrrr aaaa aaaa aaaa aaaa	JDNZ A,r,addr	A ← r-1, jump to addr if not zero PC[15:0] ← addr (*4)	None	2
	0101 0001 rrrr rrrr aaaa aaaa aaaa aaaa	JDNZ r,addr	r ← r-1, jump to addr if not zero PC[15:0] ← addr (*4)	None	2
	0101 0010 rrrr rrrr aaaa aaaa aaaa aaaa	JINZ A,r,addr	A ← r+1,jump to addr if not zero PC[15:0] ← addr (*4)	None	2
	0101 0011 rrrr rrrr aaaa aaaa aaaa aaaa	JINZ r,addr	r ← r+1,jump to addr if not zero PC[15:0] ← addr (*4)	None	2
	0100 0111 kkkk kkkk aaaa aaaa aaaa aaaa	JGE A,#k,addr	Jump to addr if A ≥ k PC[15:0] ← addr (*4)	None	2
	0100 1000 kkkk kkkk aaaa aaaa aaaa aaaa	JLE A,#k,addr	Jump to addr if A ≤ k PC[15:0] ← addr (*4)	None	2
	0100 1001 kkkk kkkk aaaa aaaa aaaa aaaa	JE A,#k,addr	Jump to addr if A=k PC[15:0] ← addr (*4)	None	2
	0101 0101 rrrr rrrr aaaa aaaa aaaa aaaa	JGE A,r,addr	Jump to addr if A ≥ r PC[15:0] ← addr (*4)	None	2
	0101 0110 rrrr rrrr aaaa aaaa aaaa aaaa	JLE A,r,addr	Jump to addr if A ≤ r PC[15:0] ← addr (*4)	None	2
	0101 0111 rrrr rrrr aaaa aaaa aaaa aaaa	JE A,r,addr	Jump to addr if A=r PC[15:0] ← addr (*4)	None	2
PROCESS	0110 1bbb rrrr rrrr	BC r,b	r(b) ← 0	None	1
	0111 0bbb rrrr rrrr	BS r,b	r(b) ← 1	None	1
	0111 1bbb rrrr rrrr	BTG r,b	r(b) ← /r(b)	None	1
	0000 1111 rrrr rrrr	SWAP r	r(0:3) ↔ r(4:7)	None	1
	0000 1110 rrrr rrrr	SWAPA r	r(0:3) → A(4:7) r(4:7) → A(0:3)	None	1
	0010 0100 rrrr rrrr	CLR r	r ← 0	Z	1
	0010 0101 rrrr rrrr	TEST r	Z ← 0 if r <> 0; Z ← 1 if r = 0	Z	1
PROCESS	0010 0111 rrrr rrrr	RPT r	Single repeat *(r) times on next instruction *(r) is the content of register r	None	1
ARITH-METIC	0001 0000 rrrr rrrr	ADD A,r	A ← A+r	C,DC,Z, OV,SGE, SLE	1
	0001 0001 rrrr rrrr	ADD r,A	r ← r+A (*5)	C,DC,Z, OV,SGE, SLE	1
	0100 1010 kkkk kkkk	ADD A,#k	A ← A+k	C,DC,Z, OV,SGE, SLE	1

	0001 0010 rrrr rrrr	ADC A,r	$A \leftarrow A+r+C$	C,DC,Z, OV,SGE, SLE	1
	0001 0011 rrrr rrrr	ADC r,A	$r \leftarrow r+A+C$	C,DC,Z, OV,SGE, SLE	1
	0100 1011 kkkk kkkk	ADC A,#k	$A \leftarrow A+k+C$	C,DC,Z, OV,SGE, SLE	1
	0001 0110 rrrr rrrr	SUB A,r	$A \leftarrow r-A$	C,DC,Z, OV,SGE, SLE	1
	0001 0111 rrrr rrrr	SUB r,A	$r \leftarrow r-A$	C,DC,Z, OV,SGE, SLE	1
	0100 1100 kkkk kkkk	SUB A,#k	$A \leftarrow k-A$	C,DC,Z, OV,SGE, SLE	1
	0001 1000 rrrr rrrr	SUBB A,r	$A \leftarrow r-A/C$	C,DC,Z, OV,SGE, SLE	1
	0001 1001 rrrr rrrr	SUBB r,A	$r \leftarrow r-A/C$	C,DC,Z, OV,SGE, SLE	1
	0100 1101 kkkk kkkk	SUBB A,#k	$A \leftarrow k-A/C$	C,DC,Z, OV,SGE, SLE	1
	0001 0100 rrrr rrrr	ADDDC A,r	$A \leftarrow (\text{Decimal ADD}) A+r+C$	C,DC,Z	1
	0001 0101 rrrr rrrr	ADDDC r,A	$r \leftarrow (\text{Decimal ADD}) r+A+C$	C,DC,Z	1
	0001 1010 rrrr rrrr	SUBDB A,r	$A \leftarrow (\text{Decimal SUB}) r-A/C$	C,DC,Z	1
	0001 1011 rrrr rrrr	SUBDB r,A	$r \leftarrow (\text{Decimal SUB}) r-A/C$	C,DC,Z	1
	0010 0110 rrrr rrrr	MUL A,r	PRODH:PRODL $\leftarrow A*r$	None	1
ARITH- METIC	0100 1111 kkkk kkkk	MUL A,#k	PRODH:PRODL $\leftarrow A*k$	None	1
	0001 1100 rrrr rrrr	INCA r	$A \leftarrow r+1$	C,Z	1
	0001 1101 rrrr rrrr	INC r	$r \leftarrow r+1$	C,Z	1
	0001 1110 rrrr rrrr	DECA r	$A \leftarrow r-1$	C,Z	1
	0001 1111 rrrr rrrr	DEC r	$r \leftarrow r-1$	C,Z	1
Move	0010 0000 rrrr rrrr	MOV A,r	$A \leftarrow r$	Z	1
	0010 0001 rrrr rrrr	MOV r,A	$r \leftarrow A$	None	1
	100p pppp rrrr rrrr	MOVRP p,r	Register p $\leftarrow$ Register r	None	1
	101p pppp rrrr rrrr	MOVPR r,p	Register r $\leftarrow$ Register p	None	1
	0100 1110 kkkk kkkk	MOV A,#k	$A \leftarrow k$	None	1
Branch	110a aaaa aaaa aaaa	SJMP addr	PC $\leftarrow$ addr PC[13..16] unchange	None	1
	0011 aaaa aaaa aaaa	S0CALL addr	Top of Stack] $\leftarrow$ PC+1 PC[11:0] $\leftarrow$ addr PC[12:16] $\leftarrow$ 00000 (*6)	None	1

111a aaaa aaaa aaaa	SCALL addr	[Top of Stack]←PC+1 PC[12:0] ← addr PC[13:16] unchange	None	1
0000 0000 0010 aaaa aaaa aaaa aaaa aaaa	LJMP addr (2 words)	PC ← addr	None	2
0000 0000 0011 aaaa aaaa aaaa aaaa aaaa	LCALL addr (2 words)	[Top of Stack]←PC+1 PC ← addr	None	2

(\*1) TBRD i,r :

r← ROM[(TABPTR)];

i=00: TABPTR not change

i=01: TABPTR←TABPTR+1

i=10: TABPTR←TABPTR-1

(\*2) TABPTR=(TABPTRH:TABPTRM:TABPTRL).

\*Bit 7 of TABPTRH use to select internal ROM space or external memory space.

Bit7=0: internal ROM space

Bit7=1:external memory space.

\*Bit 0 of TABPTRL use to select low byte or high byte of pointed ROM data.

Bit0=0: Low byte of pointed ROM data

Bit0=1:High byte of pointed ROM data.

\*The maximum table look up space is internal 8Mbytes and external 8Mbytes.

(\*3) **TBRD** instruction will take 2 cycles at first time, and then 1 cycle at following **TBRD** instructions.

Ex1. TBRD 1,reg1 → **Take 2 cycles**

TBRD 1,reg2 → Take 1 cycle

TBRD 1,reg3 → Take 1 cycle

.....

TBRD 1,reg99 → Take 1 cycle

NOP

TBRD 1,reg100 → **Take 2 cycles**

TBRD 1,reg101 → Take 1 cycle

Ex2. MOV A,#10

RPT ACC

TBRD 1,INDF1 → Repeat 10 times, total take 11 cycles

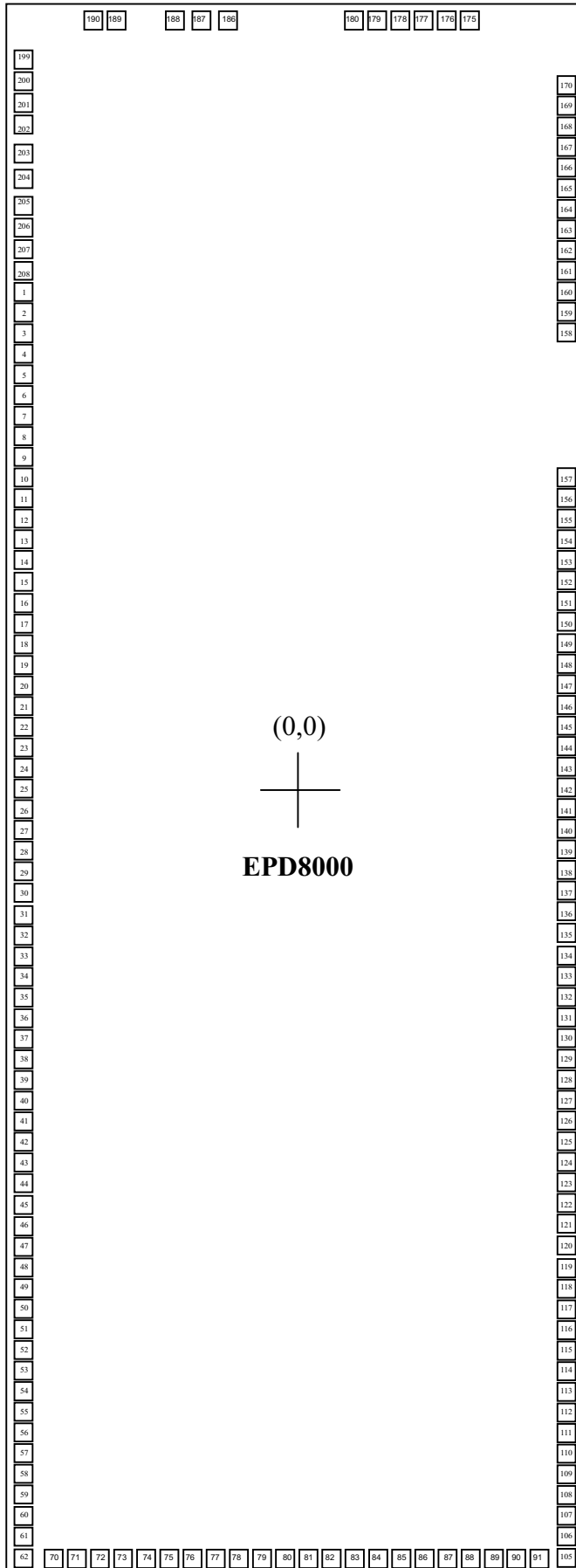
(\*4)The maximum jump range is 64K absolute address, means only can jump within the same 64K range, i.e. 0~64K or 64K~128K.

(\*5)Carry bit of ADD PCL,A or ADD TABPTRL,A will automatic carry into PCH or TABPTR.

The Instruction cycle of write to PC(program counter) takes TWO cycle.

(\*6) S0CALL addressing ability is from 0x000 to 0xFFFF(4K space).

## XII. Pad Diagram



Pin NO.	Symbol	X	Y	Pin NO.	Symbol	X	Y
1	COM31	-1270.0	2505.0	41	SEG73	-1270.0	-1695.0
2	COM30	-1270.0	2400.0	42	SEG72	-1270.0	-1800.0
3	COM29	-1270.0	2295.0	43	SEG71	-1270.0	-1905.0
4	COM28	-1270.0	2190.0	44	SEG70	-1270.0	-2010.0
5	COM27	-1270.0	2085.0	45	SEG69	-1270.0	-2115.0
6	COM26	-1270.0	1980.0	46	SEG68	-1270.0	-2220.0
7	COM25	-1270.0	1875.0	47	SEG67	-1270.0	-2325.0
8	COM24	-1270.0	1770.0	48	SEG66	-1270.0	-2430.0
9	COM23	-1270.0	1665.0	49	SEG65	-1270.0	-2535.0
10	COM22	-1270.0	1560.0	50	SEG64	-1270.0	-2640.0
11	COM21	-1270.0	1455.0	51	SEG63	-1270.0	-2745.0
12	COM20	-1270.0	1350.0	52	SEG62	-1270.0	-2850.0
13	COM19	-1270.0	1245.0	53	SEG61	-1270.0	-2955.0
14	COM18	-1270.0	1140.0	54	SEG60	-1270.0	-3060.0
15	COM17	-1270.0	1035.0	55	SEG59	-1270.0	-3165.0
16	COM16	-1270.0	930.0	56	SEG58	-1270.0	-3270.0
17	SEG97	-1270.0	825.0	57	SEG57	-1270.0	-3375.0
18	SEG96	-1270.0	720.0	58	SEG56	-1270.0	-3480.0
19	SEG95	-1270.0	615.0	59	SEG55	-1270.0	-3590.0
20	SEG94	-1270.0	510.0	60	SEG54	-1270.0	-3700.0
21	SEG93	-1270.0	405.0	61	SEG53	-1270.0	-3810.0
22	SEG92	-1270.0	300.0	62	SEG52	-1270.0	-3920.0
23	SEG91	-1270.0	195.0	63	NC		
24	SEG90	-1270.0	90.0	64	NC		
25	SEG89	-1270.0	-15.0	65	NC		
26	SEG88	-1270.0	-120.0	66	NC		
27	SEG87	-1270.0	-225.0	67	NC		
28	SEG86	-1270.0	-330.0	68	NC		
29	SEG85	-1270.0	-435.0	69	NC		
30	SEG84	-1270.0	-540.0	70	SEG51	-1125.0	-3920.0
31	SEG83	-1270.0	-645.0	71	SEG50	-1015.0	-3920.0
32	SEG82	-1270.0	-750.0	72	SEG49	-905.0	-3920.0
33	SEG81	-1270.0	-855.0	73	SEG48	-795.0	-3920.0
34	SEG80	-1270.0	-960.0	74	SEG47	-685.0	-3920.0
35	SEG79	-1270.0	-1065.0	75	SEG46	-580.0	-3920.0
36	SEG78	-1270.0	-1170.0	76	SEG45	-475.0	-3920.0
37	SEG77	-1270.0	-1275.0	77	SEG44	-370.0	-3920.0
38	SEG76	-1270.0	-1380.0	78	SEG43	-265.0	-3920.0
39	SEG75	-1270.0	-1485.0	79	SEG42	-160.0	-3920.0
40	SEG74	-1270.0	-1590.0	80	SEG41	-55.0	-3920.0



Pin NO.	Symbol	X	Y	Pin NO.	Symbol	X	Y
81	SEG40	50.0	-3920.0	121	SEG13	1270.0	-2220.0
82	SEG39	155.0	-3920.0	122	SEG12	1270.0	-2115.0
83	SEG38	260.0	-3920.0	123	SEG11	1270.0	-2010.0
84	SEG37	365.0	-3920.0	124	SEG10	1270.0	-1905.0
85	SEG36	470.0	-3920.0	125	SEG9	1270.0	-1800.0
86	SEG35	575.0	-3920.0	126	SEG8	1270.0	-1695.0
87	SEG34	685.0	-3920.0	127	SEG7	1270.0	-1590.0
88	SEG33	795.0	-3920.0	128	SEG6	1270.0	-1485.0
89	SEG32	905.0	-3920.0	129	SEG5	1270.0	-1380.0
90	SEG31	1015.0	-3920.0	130	SEG4	1270.0	-1275.0
91	SEG30	1125.0	-3920.0	131	SEG3	1270.0	-1170.0
92	NC			132	SEG2	1270.0	-1065.0
93	NC			133	SEG1	1270.0	-960.0
94	NC			134	SEG0	1270.0	-855.0
95	NC			135	COM0	1270.0	-750.0
96	NC			136	COM1	1270.0	-645.0
97	NC			137	COM2	1270.0	-540.0
98	NC			138	COM3	1270.0	-435.0
99	NC			139	COM4	1270.0	-330.0
100	NC			140	COM5	1270.0	-225.0
101	NC			141	COM6	1270.0	-120.0
102	NC			142	COM7	1270.0	-15.0
103	NC			143	COM8	1270.0	90.0
104	NC			144	COM9	1270.0	195.0
105	SEG29	1270.0	-3920.0	145	COM10	1270.0	300.0
106	SEG28	1270.0	-3810.0	146	COM11	1270.0	405.0
107	SEG27	1270.0	-3700.0	147	COM12	1270.0	510.0
108	SEG26	1270.0	-3590.0	148	COM13	1270.0	615.0
109	SEG25	1270.0	-3480.0	149	COM14	1270.0	720.0
110	SEG24	1270.0	-3375.0	150	COM15	1270.0	825.0
111	SEG23	1270.0	-3270.0	151	PA.0	1270.0	937.5
112	SEG22	1270.0	-3165.0	152	PA.1	1270.0	1057.5
113	SEG21	1270.0	-3060.0	153	PA.2	1270.0	1177.5
114	SEG20	1270.0	-2955.0	154	PA.3	1270.0	1297.5
115	SEG19	1270.0	-2850.0	155	PA.4	1270.0	1417.5
116	SEG18	1270.0	-2745.0	156	PA.5	1270.0	1537.5
117	SEG17	1270.0	-2640.0	157	PA.6	1270.0	1657.5
118	SEG16	1270.0	-2535.0	158	PA.7	1270.0	2183.3
119	SEG15	1270.0	-2430.0	159	CLKO	1270.0	2303.4
120	SEG14	1270.0	-2325.0	160	PB.0	1270.0	2423.4

Pin NO.	Symbol	X	Y	Pin NO.	Symbol	X	Y
161	PB.1	1270.0	2543.3	186	PLL	-223.7	3920.0
162	PB.2	1270.0	2663.4	187	GND	-370.7	3920.0
163	PB.3	1270.0	2783.3	188	OSCO	-510.7	3920.0
164	PB.4	1270.0	2903.4	189	OSCI	-821.7	3920.0
165	PB.5	1270.0	3023.4	190	TEST	-941.6	3920.0
166	PB.6	1270.0	3143.3	191	NC		
167	PB.7	1270.0	3263.4	192	NC		
168	RESET-KEY	1270.0	3383.3	193	NC		
169	SYSTEM RESET	1270.0	3503.4	194	NC		
170	VDD	1270.0	3623.4	195	NC		
171	NC			196	NC		
172	NC			197	NC		
173	NC			198	NC		
174	NC			199	VCA	-1270.0	3702.7
175	LVDIN	1190.7	3920.0	200	VX	-1270.0	3592.7
176	(Reserved)	1058.7	3920.0	201	V4	-1270.0	3482.7
177	(Reserved)	938.7	3920.0	202	VR	-1270.0	3372.7
178	(Reserved)	818.7	3920.0	203	V0	-1270.0	3223.5
179	(Reserved)	698.7	3920.0	204	VOUT	-1270.0	3074.2
180	(Reserved)	578.7	3920.0	205	V1	-1270.0	2925.0
181	NC			206	V2	-1270.0	2820.0
182	NC			207	V3	-1270.0	2715.0
183	NC			208	VCB	-1270.0	2610.0
184	NC						
185	NC						

**Note: Pad 176 ~ Pad 180 is for factory test only. Please do NOT bonding these pads on application circuit.**

Chip size : 2810 \* 8110 um

For PCB layout, IC substrate must be connected to VSS.