
ePS6610

**RISC II Series
Microcontroller**

Product Specification

DOC. VERSION 1.3

ELAN MICROELECTRONICS CORP.

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Contents

1	General Description	1
1.1	Application.....	1
2	Features	1
2.1	MCU	1
2.2	Peripheral Configuration	2
2.3	Internal Specification	2
3	Block Diagram	3
4	Pin Assignment	4
5	Pin Description	5
5.1	MCU System Pins (7 Pins).....	5
5.2	Embedded LCD Pins (53 Pins)	5
5.3	I/O Port (8 Pins)	5
6	Code Option.....	6
7	Function Description	7
7.1	Reset Function	7
7.1.1	Power-on Reset.....	8
7.1.2	RSTB Pin.....	8
7.1.3	WDT Time-out	8
7.1.4	32768Hz Crystal Stable Time	8
7.1.5	Status (R0Fh)	9
7.1.6	Initialization after Reset	11
7.1.6.1	Special Register	11
7.1.6.2	Control Register	12
7.2	Oscillator System	12
7.2.1	32.8kHz RC or 32.768kHz Crystal Oscillator	13
7.2.2	200kHz/300kHz/500kHz RC External Oscillator	13
7.3	MCU Operation Mode	14
7.3.1	Slow, Fast, Sleep, and Idle Mode Operation.....	15
7.3.2	Wake-up Operation	17
7.4	Interrupts	17
7.4.1	Global Interrupt.....	17
7.4.2	Input Port (Port A.7 ~ Port A.0) Interrupt	18
7.4.3	Timer 0, Timer 1, and Timer 2 Interrupts	19
7.4.3.1	Timer 0 Interrupt.....	19
7.4.3.2	Timer 1 Interrupt.....	20
7.4.3.3	Timer 2 Interrupt.....	20
7.4.3.4	Code Example:.....	21
7.5	Program ROM Map	21



7.6	RAM Map for Special and Control Registers.....	22
7.6.1	Special and Control Registers.....	22
7.6.2	Other Unbanked General RAM.....	23
7.6.3	Banked General RAM.....	24
7.7	LCD RAM Map.....	24
7.8	Special Function Registers.....	24
7.8.1	ACC (R0Ah): Accumulator.....	24
7.8.2	POST_ID (R33h): Post Increase / Decrease Control Register.....	25
7.8.3	BSR, FSR0, INDF0 (R02h, R01h, R00h): Indirect Address Pointer 0 Registers.....	25
7.8.4	BSR1, FSR1, INDF1 (R05h, R04h, R03h): Indirect Address Pointer 1 Registers.....	25
7.8.5	STKPTR (R06h): Stack Pointer Register.....	27
7.8.6	PCL, PCM (R07h, R08h): Program Counter Registers.....	27
7.8.7	TABPTRL, TABPTRM (R0Bh, R0Ch): Table Pointer Registers.....	28
7.8.8	Port A, Port B (R10h, R11h): General I/O Pin Registers.....	29
7.8.9	STBCON (R20): Strobe Output Control Register.....	29
7.8.10	PACON (R29h): Port A Control Register.....	29
7.8.11	PAWAKE (R2Ah): Port A Wake-up Control Register.....	30
7.8.12	PAINTEN (R2Bh): Port A Interrupt Enable Control Register.....	30
7.8.13	PAINTSTA (R2Ch): Port A Interrupt Status Register.....	30
7.8.14	DCRA (R2Dh): Port A Direction Control Register.....	30
7.8.15	PBCON (R2Eh): Port B Pull up Resistor Control Register.....	31
7.8.16	DCRB (R2Fh): Port B Direction Control Register.....	31
8	Peripheral	32
8.1	Timer 0 (16 Bits Timer with Event Counter Function).....	32
8.1.1	Timer 0 Registers.....	33
8.2	Timer 1 (8 Bits).....	36
8.2.1	Timer 1 Registers.....	36
8.3	Timer 2 (8 Bits).....	38
8.3.1	Timer 2 Registers.....	39
8.4	Watchdog Timer (WDT).....	41
8.4.1	Watchdog Timer (WDT) Registers.....	41
8.5	Input/Output Key.....	42
8.5.1	Key Functions.....	43
8.5.2	Key Strobe.....	44
8.5.2.1	Automatic Key Scan.....	44
8.5.2.2	Software Key Scan.....	45
8.5.2.3	Key Strobe Pin Function.....	46
8.5.3	Input/Output Key Registers.....	46

8.6	LCD Driver	50
8.6.1	LCD Driver Registers	51
8.6.2	LCD RAM Map	53
8.6.3	LCD Driving Method Circuit.....	54
8.6.4	LCD COM Waveforms.....	55
8.6.5	LCD COM and SEG Waveforms	56
9	Electrical Characteristics	58
9.1	VDD=1.5V Electrical Characteristics.....	58
10	Pin Type Circuit Diagrams.....	60
11	Application Circuits	62
12	Instruction Set	63
13	Pad Diagram and Locations.....	65
13.1	Pad Coordinates	66



Specification Revision History

Doc. Version	Revision Description	Date
0.1	Initial version	2008/8/12
0.2	Added the code options: the Port A set and operating voltage set (Section 6) Modified the Electrical characteristics for VDD=1.5V: The pull-up R and current of the I/O ports, and ROP & RON (Section 9.1) Added a Power-on reset voltage on Section 9.1 Added a 3V Operating Voltage Added an Electrical characteristics for VDD=3V (Section 9.2) Added the application circuit for VDD=3.0V (Section 10)	2009/11/2
0.3	1. Added an Electrical Characteristics section. 2. Added attention (the Point 6th). 3. Modified the block diagram.	2009/12/29
1.0	Upgraded to version 1.0	2010/03/31
1.1	1. Deleted the VDD=3.0V Electrical Characteristics entries. 2. Modified Operating voltage only has 1.5V	2010/11/09
1.2	1. Modified the supply voltage on the absolute maximum ratings 2. Added the Vret and Vpor into DC electrical characteristics	2013/09/03
1.3	1. Added the notes for the special register "LCDARL" in Section 1, Section 7.1.6 and Section 8.6.1 2. Modified the Electrical Characteristics	2014/05/22

1 General Description

The **ePS6610** is an 8-bit RISC MCU embedded with a 5×40 LCD driver along with two 8-bit timers, one 16-bit general timer, and a watchdog timer. It has also on-chip 1.2K bytes RAM and 8K words program ROM. It is highly ideal for advance scientific calculator application, particularly those requiring high performance and low cost solution.

The MCU core is one of ELAN's second generation RISC based IC's, known as RISC II (RII) series. The core was specifically designed for low power and portable device applications. The ePS6610 also supports Fast mode, Slow mode, Idle mode, as well as Sleep mode to enhance its low power consumption features.

IMPORTANT NOTES

- Do not use Register BSR (02h) Bit 7 ~ Bit 4.
- Do not use Register BSR1 (05h) Bit 7 ~ Bit 4.
- Check the range of BSR and BSR1, which should be from 0x00~0x09.
- Do not use LCD RAM 28h ~ FFh.
- Do not use JDNZ at FSR1 (04h) special register.
- Do not use JDNZ at LCDARL (09h) special register.
- Do not use PUSH, POP by "MOV A,r" to avoid affecting S_Z.

1.1 Application

- Calculating machine

2 Features

2.1 MCU

- 8 bit RISC MCU
- Operating voltage: 1.2V~1.8V
- Clock Source: Dual system clock
 - Low-frequency: 32kHz Internal RC oscillator / Crystal oscillator
 - High-frequency: 200kHz / 300kHz / 500kHz External RC oscillator
- One Instruction cycle time = 2 × System clock time
- Program ROM addressing: Max. of 8K words
- 128 bytes un-banked RAM including special registers and common registers

- 10×128 bytes banked RAM
- Max. of 32 levels of RAM stack
- Table Look-up function is fast and highly efficient when combined with Repeat instruction
- Register-to-Register move instruction
- Compare and Branch in one instruction (2 cycles)
- Single Repeat function (256 repeat times max.)
- Decimal ADD and SUB instruction
- Full range Call and Jump ability (2 cycles)

2.2 Peripheral Configuration

- 16 general I/O pins (Port A and Port B)
- 5 / 4 / 3 COM × 40 SEG LCD driver (embedded)
- One 16-bit timer (Timer 0) with event counter function
- One 8-bit timer (Timer 1) with wake-up function
- One 8-bit timer (Timer 2)
- One 8-bit Watchdog Timer
- Key I/O function with 64 keys maximum

2.3 Internal Specification

- Watchdog Timer with its own on-chip RC oscillator
- MCU operating modes: Sleep Mode, Idle Mode, Slow Mode, and Fast Mode
- Supports RC and Crystal oscillation for system clock
- MCU wake-up function consists of input wake up and Timer 1 wake up
- MCU interrupt function consist of Input port interrupt and Timer interrupt (Timers 0 ~ 2)

3 Block Diagram

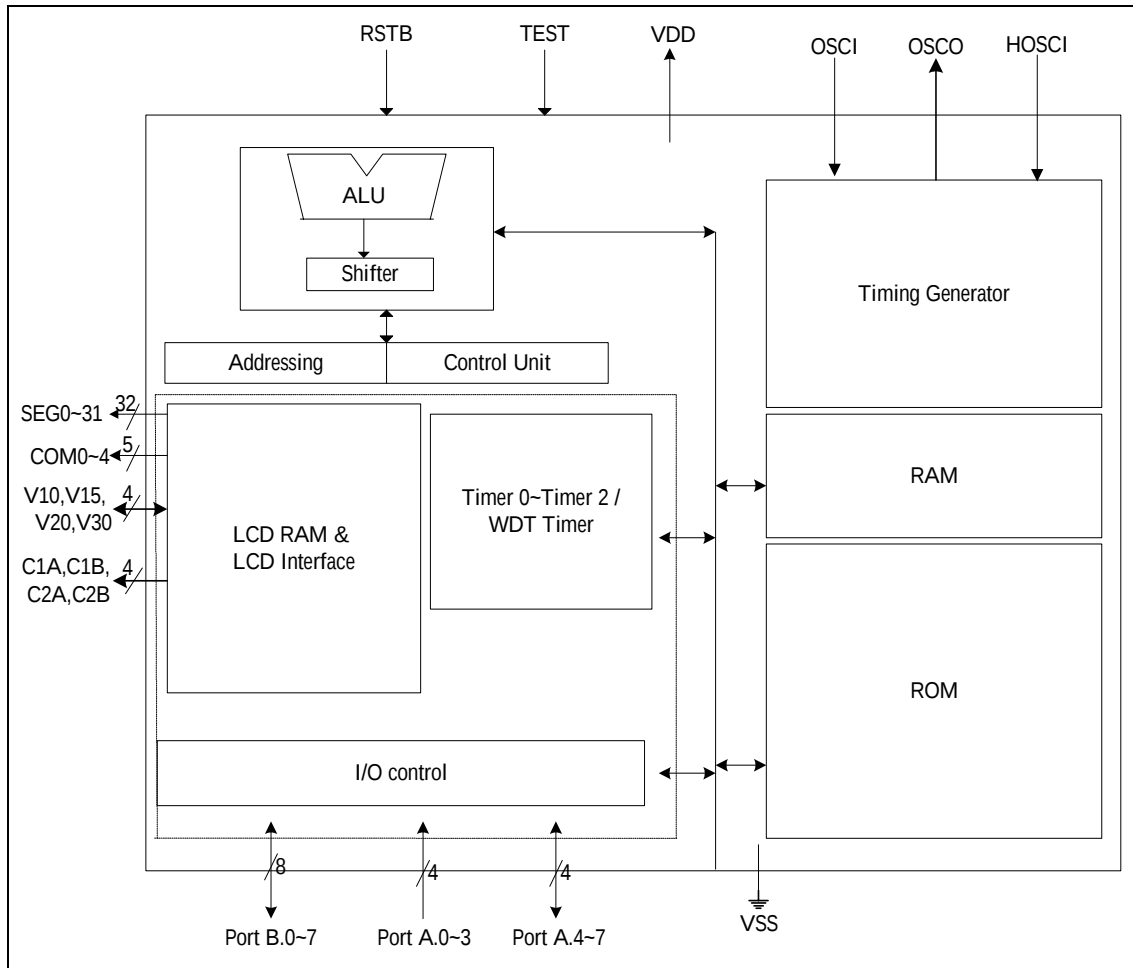


Figure 3-1 ePS6610 Block Diagram

4 Pin Assignment

■ 68-pin Chip Type

No.	Pin Name	No.	Pin Name	No.	Pin Name	No.	Pin Name
1	NC	26	NC	51	NC	76	NC
2	NC	27	NC	52	NC	77	NC
3	NC	28	NC	53	NC	78	NC
4	NC	29	NC	54	NC	79	NC
5	NC	30	NC	55	NC	80	NC
6	NC	31	NC	56	NC	81	NC
7	COM4	32	NC	57	SEG29	82	C1A
8	COM3	33	SEG12/Strobe12	58	SEG30	83	C1B
9	COM2	34	SEG13/Strobe13	59	SEG31	84	C2A
10	COM1	35	SEG14/Strobe14	60	PortA.7	85	C2B
11	COM0	36	SEG15/Strobe15	61	PortA.6	86	V20
12	SEG0/Strobe0	37	SEG16	62	PortA.5	87	V15
13	SEG1/Strobe1	38	SEG17	63	PortA.4	88	V10
14	SEG2/Strobe2	39	SEG18	64	VSS	89	Port A.0
15	SEG3/Strobe3	40	SEG19	65	SEG32/Port B.0	90	Port A.1
16	SEG4/Strobe4	41	SEG20	66	SEG33/Port B.1	91	Port A.2
17	SEG5/Strobe5	42	SEG21	67	SEG34/Port B.2	92	Port A.3
18	SEG6/Strobe6	43	SEG22	68	SEG35/Port B.3	93	TEST
19	SEG7/Strobe7	44	SEG23	69	SEG36/Port B.4	94	RESETB
20	SEG8/Strobe8	45	SEG24	70	SEG37/Port B.5	95	OSCO
21	SEG9/Strobe9	46	SEG25	71	SEG38/Port B.6	96	OSCI
22	SEG10/Strobe10	47	SEG26	72	SEG39/Port B.7 (EVIN)	97	HOSCI
23	SEG11/Strobe11	48	SEG27	73	V30	98	VDD
24	NC	49	SEG28	74	NC	99	NC
25	NC	50	NC	75	NC	100	NC

5 Pin Description

5.1 MCU System Pins (7 Pins)

Name	I/O/P Type	Description	Note
VDD	P	Digital and Analog positive power supply, the range is from 1.2V~1.8V	-
VSS	P	Digital and Analog negative power supply.	-
RSTB	I	System reset pin. Low active, Connect 0.1 uF to VSS.	Int. Pull-up
TEST	I	Test mode select pin (High active). For chip internal test only, Normally connect to VSS.	Int. Pull Down
OSCI	I	Crystal oscillator connecting pin	-
OSCO	O	Crystal oscillator connecting pin	-
HOSCI	I	Hi-Speed RC oscillator connecting pin.	Ext. R to VDD

5.2 Embedded LCD Pins (53 Pins)

Name	I/O/P Type	Description	Note
COM0~COM4	O	LCD common signal output pin	-
SEG0~SEG15	O	LCD segment signal output pin shared with Key Strobe 0~15	-
SEG16~ SEG31	O	LCD segment signal output pin	-
SEG32~SEG39 / Port B.0~7	I/O	LCD segment signal output pin or I/O pin; define by code option	-
C1A, C1B		LCD voltage charge-pump pin. Connect 0.1 μ F between C1A and C1B.	-
C2A, C2B		LCD voltage charge-pump pin. Connect 0.1 μ F between C2A and C2B.	-
V30, V20, V15, V10	O	LCD bias Pin. Connect 0.1 μ F to Vss	-

5.3 I/O Port (8 Pins)

Port	Bit	Function	I/O Type	Power Source	Description	Note
Port A	Bits 3~0 (for key scan)	General Input	I	VDD	Key input	Int. Pull-up (R1: small resistor, R2: Large resistor) controllable
		Interrupt and wake up	I	VDD	Input port interrupt and wake-up pin	
	Bits 7~4	General Input	I	VDD		Int. Pull-up (R2: Large resistor) controllable
		Interrupt and wake up	I	VDD	Input port interrupt and wake-up pin	
		General Output	O	VDD		

6 Code Option

Located at Address 0x000C~0x000F of Program ROM

- Initial mode after reset:
 - Select “Slow” mode or “Fast” mode

NOTE

For Initial mode after reset, it is recommended that you set the setting to “Slow mode.”

- Low Frequency Oscillator:
 - Select “Crystal” oscillator or “Internal RC” oscillator
- Reset pin’s condition:
 - Select “Level hold” or “One short” for the reset pin
- The Operating voltage option:
 - Only has “1.5V”
- Maximum duty ratio and LCD bias option:
 - Select “1/5 duty and 1/3 bias” or “1/4 duty and 1/3 bias” or “1/3 duty and 1/2 bias”
- The LCD’s charge pump option (only for VDD=1.5V and 1/3 bias):
 - Select “2 x VDD” or “3 x VDD”
- Port B low nibble control bit (SEG32~SEG35):
 - Select “LCD segment signal output” or “general I/O functions”
- Port B high nibble control bit (SEG36~SEG39):
 - Select “LCD segment signal output” or “general I/O functions”
- Key matrix combination (SEG0-15 driver):
 - Select “Port A and SEG” or “Port A and Port B”
- The PA.3 control function option:
 - Select “PA.3 cannot control by KEL and SCAN (PA.3 cannot be keyed with SEG0~15)” or “PA.3 can control by KEL and SCAN (PA.3 can be keyed with SEG0~15)”
- The PA.7 control function option:
 - Select “PA.7 can control by KEH” or “PA.7 cannot control by KEH”
- The PA.0’s Key matrix combination:
 - Select “PA.0 and SEG” or “PA.0 and Port B or none”

- The PA.1's Key matrix combination:
 - Select "PA.1 and SEG" or "PA.1 and Port B or none"
- The PA.2's Key matrix combination:
 - Select "PA.2 and SEG" or "PA.2 and Port B or none"
- The PA.3's Key matrix combination:
 - Select "PA.3 and SEG" or "PA.3 and Port B or none"
- The PA.4's Key matrix combination:
 - Select "PA.4 and SEG" or "PA.4 and Port B or none"
- The PA.5's Key matrix combination:
 - Select "PA.5 and SEG" or "PA.5 and Port B or none"
- The PA.6's Key matrix combination:
 - Select "PA.6 and SEG" or "PA.6 and Port B or none"
- The PA.7's Key matrix combination:
 - Select "PA.7 and SEG" or "PA.7 and Port B or none"

7 Function Description

7.1 Reset Function

Reset can be generated by one of the following:

- Power-on voltage detector reset and power-on reset
- WDT time out
- RSTB pin pull low

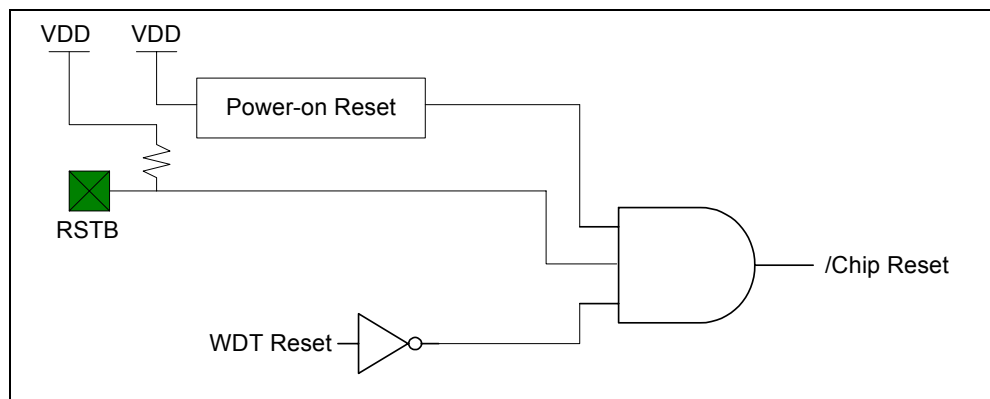


Figure 7-1 On-chip Reset Schematic Diagram

7.1.1 Power-on Reset

The power-on reset circuit holds the device under reset condition until VDD is above V_{POR} (power-on reset voltage). Whenever the voltage supply is below V_{POR} , a Reset will occur.

7.1.2 RSTB Pin

In normal condition, the RSTB pin is pulled up to VDD. Whenever the RSTB is at a low condition (level hold or one short), a Reset will occur.

7.1.3 WDT Time-out

When the Watchdog Timer is enabled, the WDT time-out will cause the chip to reset. To prevent reset from occurring, the WDT value should be cleared with the “WDTC” instruction before WDT time-out. WDT time-out can also be used to flag software malfunction.

7.1.4 32768Hz Crystal Stable Time

■ Power-on Reset Timing

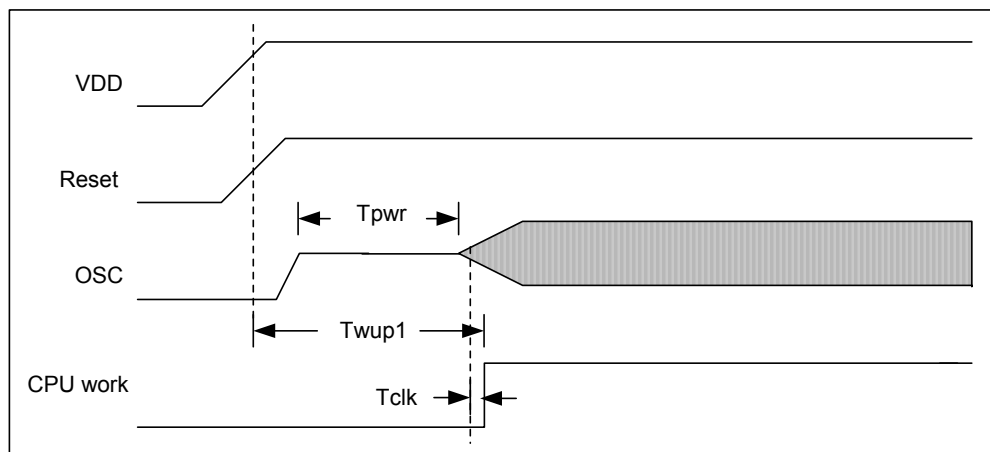


Figure 7-2a Power-on Reset Timing Diagram

■ Sleep Mode Wake-up Timing

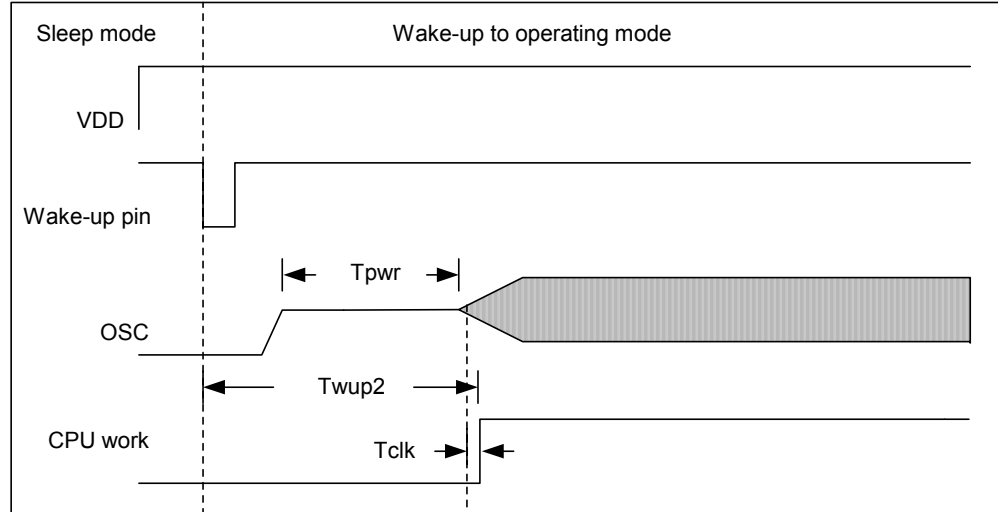


Figure 7-2b Sleep Mode Wake-up Timing Diagram

Condition: Vdd = 1.5V, Cosc = 20pF and Ta = 25°C

Symbol	Characteristics	Min.	Typ.	Max.	Unit
Tpwr	Oscillator start up time	-	480	780	ms
Twup1	CPU warm up time (Power-on reset)	-	500	800	ms
Twup2	CPU warm up time (Sleep mode wakeup)	-	485	785	ms
Tclk	Detect slow clock time	-	1.0	1.1	ms

7.1.5 Status (R0Fh)

Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
/TO	/PD	SGE	SLE	OV	Z	DC	C

Bit 0 (C): Carry flag or inverse of Borrow flag (B). Under SUB operation, Borrow flag is indicated by the inverse of the Carry bit (B = /C).

Bit 1 (DC): Auxiliary carry flag

Bit 2 (Z): Zero flag

Bit 3 (OV): Overflow flag. Used in signed operation when Bit 6 is carried into or borrows from a signed bit (Bit 7).

Bit 4 (SLE): Computation result is less than or equal to zero (negative value) after a signed arithmetic. This is affected by HEX arithmetic instruction only.

Bit 5 (SGE): Computation result is greater than or equal to zero (positive value) after a signed arithmetic. This is affected by HEX arithmetic instruction only.

NOTE

1. When $OV=1$ after a signed arithmetic, check the SGE bit and SLE bit to verify whether overflow (carry into sign bit) or underflow (borrow from sign bit) occurred.
 If $OV=1$ and $SGE=1 \rightarrow$ overflow occurred.
 If $OV=1$ and $SLE=1 \rightarrow$ underflow occurred.
2. When overflow occurred, the MSB of the Accumulator should be cleared to obtain the correct value.
 When underflow occurred, the MSB of the Accumulator should be set to obtain the correct value.

Example 1: ADD positive value with a positive value, and the ACC signed bit will be affected.

```
MOV      ACC, #60h          ; Signed number +60h
ADD      ACC, #70h          ; +60h ADD WITH +70h
```

Unsigned bit results after execution of the instruction:

ACC = 0D0h SGE=1, means that the result is greater than or equal to 0 (positive value)
 OV=1, means that overflow occurred and the result is carried into signed bit (Bit 7)

Signed bit results after execution of the instruction:

ACC = 50h (signed bit is cleared)

The actual result = +80h ($OV=1$) + 50h = +0D0h

Example 2: SUB positive value from negative value, and the ACC signed bit will be affected.

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

Unsigned bit results after execution of the instruction:

ACC = 40h SLE=1, means that the result is less than or equal to 0 (negative value)
 OV=1, Underflow occurred and the result borrowed from a signed bit (Bit 7)

Signed bit results after execution of the instruction:

ACC = 0C0h (the signed bit is set)

The actual result = -80h ($OV=1$) + 0C0h (signed number of 0C0h) = 40h

Bit 6 (/PD): Reset to “0” when /PD enters Sleep mode. Set to “1” by “WDTC” instruction, power-on reset, or by Reset pin low condition.

Bit 7 (/TO): Reset to “0” at WDT time out reset. Set to “1” by “WDTC” instruction, power-on reset, Reset pin low condition, or when the MCU enters into Sleep Mode.

When a reset occurs, the special function registers are reset to their initial value except for the /TO and /PD bits of the Status register.

Bit 7 (/TO)	Bit 6 (/PD)	Event
0	0	WDT time out reset from Sleep mode
0	1	WDT time out reset (not from Sleep mode)
1	0	Reserved
1	1	Power up or RSTB pin low condition

7.1.6 Initialization after Reset

- The oscillator is running, or will be started.
- The Watchdog timer is cleared.
- During power-on reset or RSTB pin low condition, the /TO bit and /PD bit of RF (Status) are set to “1.” At WDT time out reset, the /TO bit is cleared.
- The program counter (PCM: PCL) is clear to all “0.”
- The following table shows the other registers' initial values.

7.1.6.1 Special Register

Addr.	Name	Initial Value	Addr.	Name	Initial Value
00h	INDF0	---- ¹	10h	Port A	xxxx xxxx
01h	FSR0	0000 0000	11h	Port B	xxxx xxxx
02h	BSR	0000 0000	12h	—	—
03h	INDF1	---- ¹	13h	General RAM	uuuu uuuu
04h	FSR1	1000 0000	14h	General RAM	uuuu uuuu
05h	BSR1	0000 0000	15h	General RAM	uuuu uuuu
06h	STKPTR	0000 0000	16h	General RAM	uuuu uuuu
07h	PCL	0000 0000	17h	General RAM	uuuu uuuu
08h	PCM	0000 0000	18h	General RAM	uuuu uuuu
09h	LCDARL	xx00 0000 ⁴	19h	General RAM	uuuu uuuu
0Ah	ACC	xxxx xxxx	1Ah	General RAM	uuuu uuuu
0Bh	TABPTRL	0000 0000	1Bh	General RAM	uuuu uuuu
0Ch	TABPTRM	0000 0000	1Ch	General RAM	uuuu uuuu
0Dh	TABPTRH	uuuu uuuu	1Dh	General RAM	uuuu uuuu
0Eh	LCDDATA	---- ¹	1Eh	General RAM	uuuu uuuu
0Fh	STATUS	cuxx xxxx ²	1Fh	General RAM	uuuu uuuu

7.1.6.2 Control Register

Addr.	Name	Initial Value	Addr.	Name	Initial Value
20h	STBCON	0000 0000	2Ch	PAINTSTA	0000 0000
21h	INTCON	---- -000	2Dh	DCRA	1111 ----
22h	INTSTA	---- -000	2Eh	PBCON	0000 0000
23h	TR01CON	0000 0000	2Fh	DCRB	1111 1111
24h	TRL0L	uuuu uuuu	30h	—	—
25h	TRL0H	uuuu uuuu	31h	—	—
26h	TRL1	uuuu uuuu	32h	LCDCON	000- 00-0
27h	TR2WCON	0000 0000	33h	POST_ID	-111 -000 ³
28h	TRL2	uuuu uuuu	34h	CPUCON	---- -00c ³
29h	PACON	0000 0000	35h	T0CL	0000 0000
2Ah	PAWAKE	0000 0000	36h	T0CH	0000 0000
2Bh	PAINTEN	0000 0000			

Legend: x: unknown -: unimplemented, read as "0"
u: unchanged, c: value depends on actual condition

¹ Not a physical register.

² If it is a power-on reset or the RSTB pin is at low condition, the /TO bit and /PD bit of RF (Status) are set to "1." If it is a WDT time out reset, the /TO bit is cleared and /PD bit remains unchanged.

³ Bit 0 (MS0) of RE (CPUCON) is reloaded from "INIM" bit of code option when the MCU resets.

⁴ Bits 6~7 of R9 (LCDARL) are **unknown value** on ePS6610, and user do not use the instruction "JDNZ" at R9. However the Bits 6~7 of R9 (LCDARL) are different from the PMePS266 board.

7.2 Oscillator System

The oscillator system is used to generate the device clock. The oscillator system is composed of an Internal RC, or crystal oscillator for Slow mode and an external RC oscillator for Fast mode as shown in the diagram below.

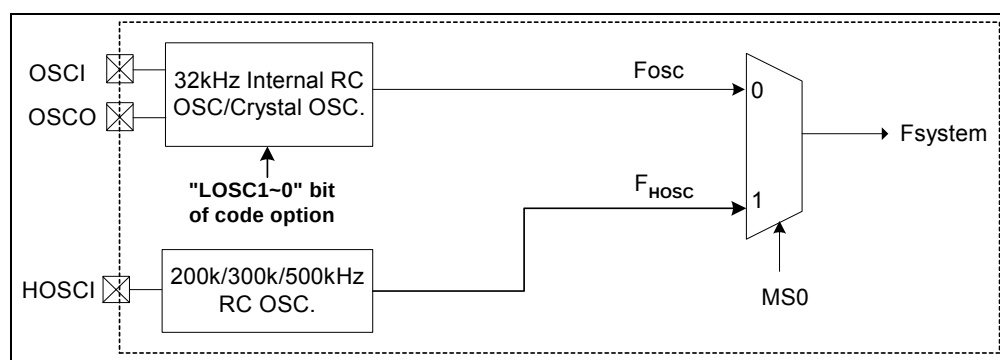


Figure 7-3 Oscillator System Function Block Diagram

The **MS0** bit (mode select bit) of **CPUCON** register (R34h) is used to set the Slow or Fast mode (see Section 7.3.1).

0: Slow mode (MCU system Clock is from Fosc)

1: Fast mode (MCU system Clock is from F_HOSC)

7.2.1 32.8kHz RC or 32.768kHz Crystal Oscillator

- 32.8kHz RC Internal oscillator:
Select “RC oscillator for FOSC” in the code option and allow OSCI and OSCO pins to remain floating.
- 32.768kHz Crystal oscillator:
Select “Crystal oscillator for FOSC” in the code option and connect a crystal and a resistor (10 M Ω) between OSCI and OSCO pins. The OSCI and OSCO pins are also connected to ground through a 20 pF capacitor respectively.

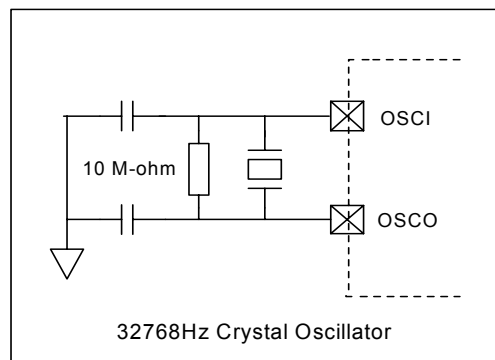


Figure 7-4 Slow Mode Crystal Circuit Diagram

7.2.2 200kHz/300kHz/500kHz RC External Oscillator

A resistor should be connected between HOSCI and Vdd pin.

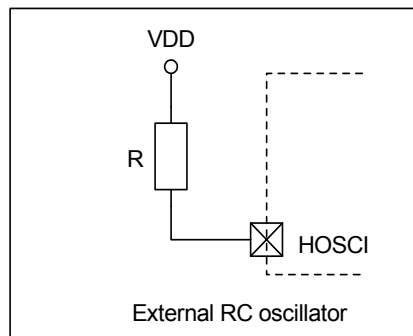


Figure 7-5 Fast Mode RC Oscillators Circuit Diagram

7.3 MCU Operation Mode

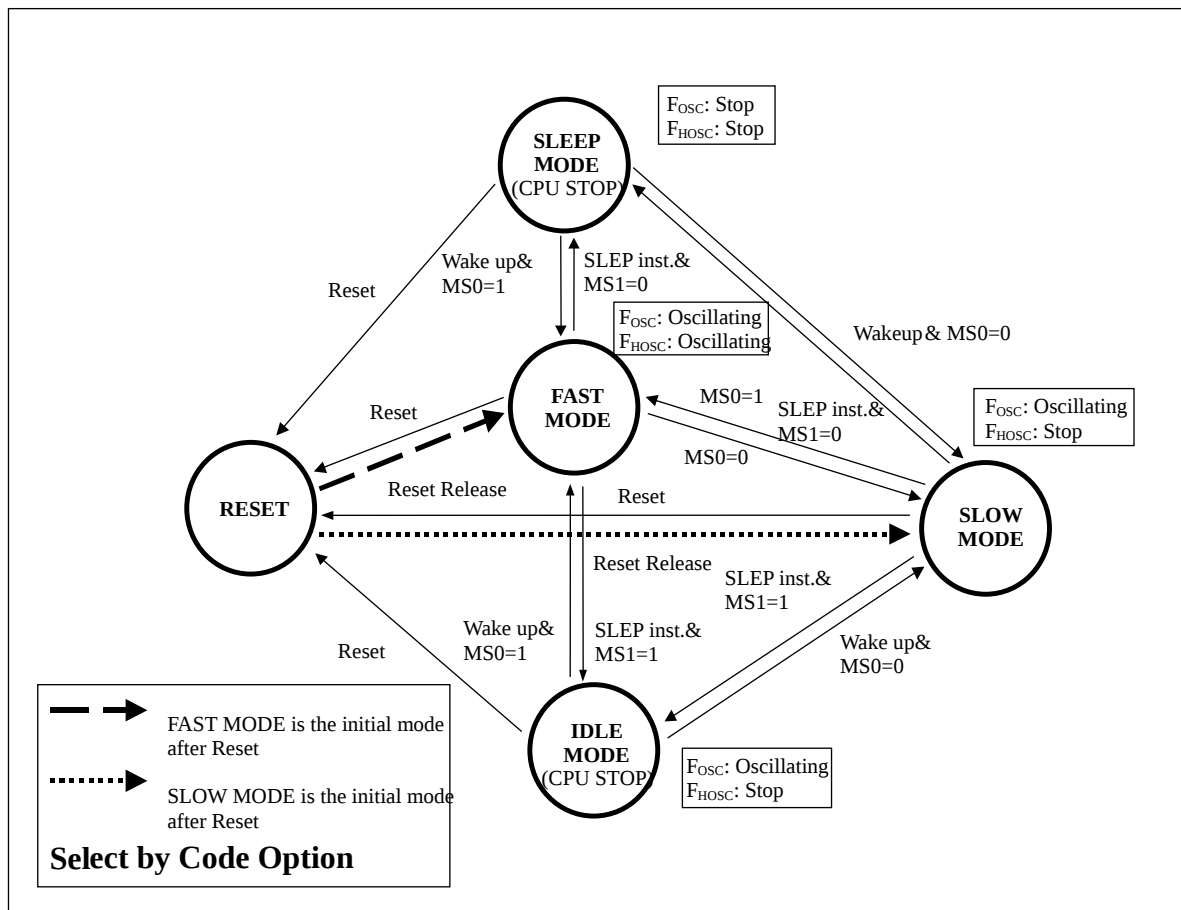


Figure 7-6 MCU Operation Block Diagram

The following table shows the supported device functions for each MCU Mode.

Device \ Mode	Sleep	Idle	Slow	Fast
Osc.(32768Hz)	×	✓	✓	✓
Fsystem	×	×	From Osc.	From Hosc.
Timers 0~2	×	×	✓	✓
INT	×*	×*	✓	✓
I/O wake up	✓	✓	×	×
Timer 1 wake up	×	✓	×	×

Legend: ✓ = Function is available if enabled × : Function is NOT supported

* The Interrupt flag will be recorded but not executed until MCU wakes up.

7.3.1 Slow, Fast, Sleep, and Idle Mode Operation

■ CPUCON (R34h): MCU Control Register

Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
–	–	–	–	–	GLINT	MS1	MS0

Bit 0 (MS0): Select Slow Mode or Fast Mode

0: Slow Mode

1: Fast Mode

Bit 1 (MS1): Select Sleep Mode or Idle Mode after executing “SLEP” instruction.

0: Sleep Mode

1: Idle Mode

■ Slow Mode:

When the MS0 bit of the CPUCON register is set to “0,” the MCU will enter into Slow Mode and the corresponding system clock is at 32kHz. The Slow mode feature allows performance of all system operations at reduced power consumption.

NOTE

The instruction “NOP” should be added after the “BC CPUCON, MS0” instruction when the MCU is made to enter into Slow Mode from Fast Mode. See the code example at the end of this Section.

■ Fast Mode:

When the MS0 bit of the CPUCON register is set to “1,” the MCU will enter into Fast Mode. After setting the MS0 bit, it needs to count 32 clocks from HOSC, then the system clock switches from slow to high frequency. This mode allows performance of all the system operations at fast speed, but under maximum power consumption.

■ Idle Mode:

When the MS1 bit of the CPUCON register is set to “1.” and the “SLEP” instruction is executed, the MCU will enter into Idle Mode. The Idle Mode suspends all system operations except for the 32kHz oscillator. It retains the internal status under low power consumption without stopping the clock function.

The Idle Mode is awoken by Timer 1 wake up or by I/O pin wake up (if enabled) and returns to the either Slow Mode (MS0=0) or Fast Mode (MS0=1)

NOTE

All registers remain unchanged during Sleep Mode.

■ Sleep Mode:

When the MS1 bit of the CPUCON register is set to “0,” and the “SLEP” instruction is executed, the MCU will enter into Sleep Mode. Sleep Mode suspends all system operation and put on hold the internal status immediately before the suspension of the operation. Sleep Mode operates under very low power consumption and is awakened by I/O pin wake up.

NOTE

- The /PD bit of the Status Register (R0Fh) is cleared when the MCU enters Sleep Mode.
- This /PD bit is set to “1” by “WDTC” instruction, power-on reset, or by RSTB pin low condition.
- All registers remain unchanged during Sleep Mode.

■ Slow Mode to Fast Mode Timing:

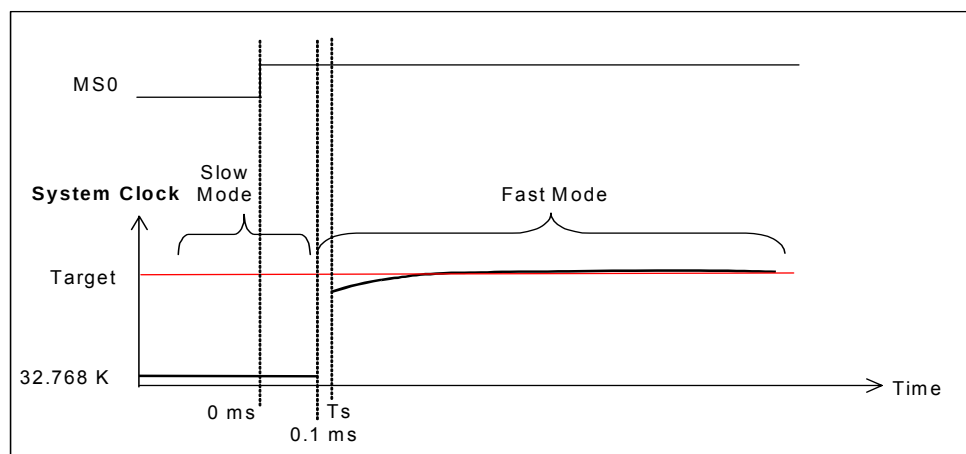


Figure 7-7 Slow Mode to Fast Mode Timing Diagram

- NOTE:**
1. Slow Mode switches to Fast Mode at Time=0ms.
 2. System clock will switch to Fast Mode after a delay of 0.1ms by oscillator and enters into Fast Mode (i.e., system clock will be at 200, 300, or 500 kHz).
 3. High frequency RC will stabilized at Time=Ts (around 15µs~30µs).

■ Code Example:

<pre> ;Entry FAST mode BS CPUCON,MS0 ;Entry SLOW mode BC CPUCON,MS0 ;FAST mode Entry SLOW mode BS CPUCON,MS0 : : BC CPUCON,MS0 NOP </pre>	<pre> ;Entry IDLE mode BS CPUCON,MS1 SLEP NOP ;Entry SLEEP mode BC CPUCON,MS1 SLEP NOP </pre>
---	--

7.3.2 Wake-up Operation

Oscillator is off during Sleep Mode. The MCU is awoken by input port (Port A), then returns to Fast Mode or Slow Mode (as determined by MS0 bit of CPUCON register described in previous section).

When in Idle Mode, the 32kHz oscillator keeps on running. The MCU is awoken by input port (Port A) or Timer1, then returns to Fast Mode or Slow Mode (as determined by MS0 bit of CPUCON register described in previous section).

■ PAWAKE (R2Ah): Port A Wake-up Function Control Register

Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
WKEN7	WKEN6	WKEN5	WKEN4	WKEN3	WKEN2	WKEN1	WKEN0

Bit 7 (WKEN7) ~ Bit 0 (WKEN0): Wake-up function control bit of Port A.7 ~ Port A.0

0: Disable Port A.7 ~ Port A.0 wake-up function

1: Enable Port A.7 ~ Port A.0 wake-up function

■ T1WKEN Bit of (R23h): Timer 0 and Timer 1 Control Register

Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
T1WKEN	T1EN	T1PSR1	T1PSR0	T0EN	T0CS	T0PSR1	T0PSR0

Bit 7 (T1WKEN): Timer 1 underflow wake-up function control bit in Idle Mode

0: Disable Timer 1 wake-up function

1: Enable Timer 1 wake-up function.

7.4 Interrupts

When interrupt occurs, the GLINT bit of the CPUCON register is reset to “0”. It disables all interrupts, including Levels 1 ~ 5. Setting this bit to “1” will enable all un-masked interrupts.

7.4.1 Global Interrupt

■ GLINT Bit of CPUCON (R34h) MCU Control Register

Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
–	–	–	–	–	GLINT	MS1	MS0

Bit 2 (GLINT): Global interrupt control bit

0: Disables all interrupts, including Level 1 ~ Level 5

1: Enables all un-masked interrupts

■ Interrupt Vector

Interrupt Level	Interrupt Source	Start Address	Remarks
–	RESET	0x00000	–
Level 1	Port A.7 ~ 0	0x00002	PAINT
Level 2	Reserved	0x00004	Reserved
Level 3	Reserved	0x00006	Reserved
Level 4	Timers 0~2	0x00008	TMR0I, TMR1I, TMR2I
Level 5	Reserved	0x0000A	Reserved

■ Code Example:

```

; ***** Reset program
ResetSEG CSEG 0X00
    LJMP  RESET           ;(0x00) Initialize
    LJMP  PAINT           ;(0x02) Port A Interrupt
    LJMP  RESERVED       ;(0x04) Reserved
    LJMP  RESERVED       ;(0x06) Reserved
    LJMP  TIMERINT        ;(0x08) Timer-0,1,2 Interrupt
    LJMP  RESERVED       ;(0x0A) Reserved
INT CSEG 0x20
; --- Push interrupt register
PUSH:
    MOVPR StatusBuf,Status
    MOV AccBuf,A
    RET
; --- Pop interrupt register
POP:
    MOV A,AccBuf
    MOVPR Status,StatusBuf
    RETI

```

7.4.2 Input Port (Port A.7 ~ Port A.0) Interrupt

Port A.0 ~ Port A.7 are used as external interrupt/wake up input. If PA7IE ~ PA0IE bits of PAINTEN register are set to “1,” Port A.0 ~ Port A.7 are the external interrupt input port format.

■ PAINTSTA (R2Ch): Port A.7 ~ Port A.0 Interrupt Status Register

Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
PA7I	PA6I	PA5I	PA4I	PA3I	PA2I	PA1I	PA0I

Bit 7 (PA7I) ~ Bit 0 (PA0I): Port A.7 ~ Port A.0 Interrupt status

Set to “1” when a pin falling edge is detected.

Clear to “0” by software.

■ **PAINTEN (R2Bh): Port A.7 ~ Port A.0 Interrupt Control Register**

Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
PA7IE	PA6IE	PA5IE	PA4IE	PA3IE	PA2IE	PA1IE	PA0IE

Bit 7 (PA7IE) ~ Bit 0 (PA0IE): PortA.7 ~ PortA.0 Interrupt control bits

0: Disable Interrupt function

1: Enable Interrupt function

■ **Code Example:**

```

; === Input Port A Interrupt
PAINT:
    S0CALL PUSH
    CLR     PAINTSTA
    :
    SJMP    POP
    RETI
  
```

7.4.3 Timer 0, Timer 1, and Timer 2 Interrupts

7.4.3.1 Timer 0 Interrupt

Timer 0 is a 16-bit timer used for general time counting. When the counting value underflows, Timer 0 interrupt takes place and the TRL0H: TRL0L value is reloaded into the timer automatically.

■ **TMR0IE Bit of INTCON (R21h) Timer Interrupt Control Register**

Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
—	—	—	—	—	TMR2IE	TMR1IE	TMR0IE

Bit 0 (TMR0IE): Control bit of Timer 0 interrupt

0: Disable Timer 0 interrupt function

1: Enable Timer 0 interrupt function

■ **TMR0I Bit of INTSTA (R22h) Timer Interrupt Status Register**

Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
—	—	—	—	—	TMR2I	TMR1I	TMR0I

Bit 0 (TMR0I): Status bit of Timer 0 interrupt

Set to “1” when Timer 0 counters underflows.

Clear to “0” by software.

7.4.3.2 Timer 1 Interrupt

Timer 1 is an 8-bit timer used for time counting and wake-up functions. When the counting value of Timer 1 underflows, interrupt occurs and the TRL1 value is reloaded to the timer.

■ TMR1IE Bit of INTCON (R21h) Timer Interrupt Control Register

Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
–	–	–	–	–	TMR2IE	TMR1IE	TMR0IE

Bit 1 (TMR1IE): Control bit of Timer 1 Interrupt

0: Disable Timer 1 interrupt function

1: Enable Timer 1 interrupt function

■ TMR1I Bit of INTSTA (R22h) Timer Interrupt Status Register

Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
–	–	–	–	–	TMR2I	TMR1I	TMR0I

Bit 1 (TMR1I): Status bit of Timer 1 Interrupt

Set to “1” when Timer 1 counters underflows.

Clear to “0” by software.

7.4.3.3 Timer 2 Interrupt

Timer 2 is an 8-bit timer for time counting. When the counting value of Timer 2 underflows, an interrupt occurs and the TRL2 value will be reloaded to the timer.

■ TMR2IE Bit of INTCON (R21h) Timer Interrupt Control Register

Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
–	–	–	–	–	TMR2IE	TMR1IE	TMR0IE

Bit 2 (TMR2IE): Control bit of Timer 2 Interrupt

0: Disable Timer 2 interrupt function

1: Enable Timer 2 interrupt function

■ TMR2I Bit of INTSTA (R22h) Timer Interrupt Status Register

Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
–	–	–	–	–	TMR2I	TMR1I	TMR0I

Bit 2 (TMR2I): Status bit of Timer 2 Interrupt

Set to “1” when Timer 2 Counter underflows

Clear to “0” by software.

7.4.3.4 Code Example:

```

; === Timer-0,1,2 Interrupt
TIMERINT:
    S0CALL PUSH
    JBS    INTSTA, TMR0I, toTM0INT
    JBS    INTSTA, TMR1I, toTM1INT
    JBS    INTSTA, TMR2I, toTM2INT
    SJMP   POP

; --- Timer 0 Interrupt
toTM0INT:
    BC     INTSTA, TMR0I
    :
    SJMP   POP
    RETI

; --- Timer 1 Interrupt
toTM1INT:
    BC     INTSTA, TMR1I
    :
    SJMP   POP
    RETI

; --- Timer 2 Interrupt
toTM2INT:
    BC     INTSTA, TMR2I
    :
    SJMP   POP
    RETI

```

7.5 Program ROM Map

ROM Size = 8K Words	
Address	Description
0000h 000Bh	Interrupt Vector (12 words)
000Ch 000Fh	Code Option (4 words)
0010h 001Fh	Test Program (16 words)
0020h 1FFFh	Program or Fixed data region

7.6 RAM Map for Special and Control Registers

RAM Size: 86 Bytes + 10 Banks × 128 Bytes = 1366 Bytes

7.6.1 Special and Control Registers

Legend: R = Readable bit W = Writable bit - = Not implemented

Addr.	Register Name	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
0	INDF0	R/W Indirect Addressing Pointer 0							
1	FSR0	R/W File Select Register 0 for INDF0 (R0)							
2	BSR	R Fixed 0	R Fixed 0	R Fixed 0	R Fixed 0	R/W Bank select register (for INDF0 & general)	R/W	R/W	R/W
3	INDF1	R/W Indirect Addressing Pointer 1							
4	FSR1	R Fixed 1	R/W	R/W	R/W	R/W	R/W	R/W	R/W
5	BSR1	R Fixed 0	R Fixed 0	R Fixed 0	R Fixed 0	R/W Bank select Register 1 (for INDF1)	R/W	R/W	R/W
6	STKPTR	R/W Stack Pointer							
7	PCL	R/W PC7	R/W PC6	R/W PC5	R/W PC4	R/W PC3	R/W PC2	R/W PC1	R/W PC0
8	PCM	R Fixed 0	R Fixed 0	R Fixed 0	R/W PC12	R/W PC11	R/W PC10	R/W PC9	R/W PC8
9	LCDARL	R/W LCD RAM Column Address							
A	ACC	R/W Accumulator							
B	TABPTRL	R/W Low Byte of Table Pointer							
C	TABPTRM	R Fixed 0	R Fixed 0	R/W Middle Byte of Table Pointer					
D	TABPTRH	R/W							
E	LCDDATA	R/W Indirect Register to LCD RAM							
F	STATUS	R /TO	R /PD	R/W SGE	R/W SLE	R/W OV	R/W Z	R/W DC	R/W C
10	Port A	R/W Port A.7	R/W Port A.6	R/W Port A.5	R/W Port A.4	R Port A.3	R Port A.2	R Port A.1	R Port A.0
11	Port B	R/W Port B.7	R/W Port B.6	R/W Port B.5	R/W Port B.4	R/W Port B.3	R/W Port B.2	R/W Port B.1	R/W Port B.0
20	STBCON	R/W SCAN	R/W KEL	R/W R1EN	R/W BitST	R/W STB3	R/W STB2	R/W STB1	R/W STB0
21	INTCON	- -	- -	- -	- -	- -	R/W TMR2IE	R/W TMR1IE	R/W TMR0IE

Addr.	Register Name	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
22	INTSTA	-	-	-	-	-	R/W	R/W	R/W
		-	-	-	-	-	TMR2I	TMR1I	TMR0I
23	TR01CON	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W
		T1WKEN	T1EN	T1PSR1	T1PSR0	T0EN	T0CS	T0PSR1	T0PSR0
24	TRL0L	R/W							
		Timer 0 Auto-reload Register Low Byte							
25	TRL0H	R/W							
		Timer 0 Auto-reload Register High Byte							
26	TRL1	R/W							
		Timer 1 Auto-reload Register							
27	TR2WCON	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W
		WDTEN	T0ENMD	WDTPSR1	WDTPSR0	T2EN	T2CS	T2PSR1	T2PSR0
28	TRL2	R/W							
		Timer 2 Auto-reload Register							
29	PACON	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W
		PA7PU	PA6PU	PA5PU	PA4PU	PA3PU	PA2PU	PA1PU	PA0PU
2A	PAWAKE	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W
		WKEN7	WKEN6	WKEN5	WKEN4	WKEN3	WKEN2	WKEN1	WKEN0
2B	PAINTEN	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W
		PA7IE	PA6IE	PA5IE	PA4IE	PA3IE	PA2IE	PA1IE	PA0IE
2C	PAINTSTA	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W
		PA7I	PA6I	PA5I	PA4I	PA3I	PA2I	PA1I	PA0I
2D	DCRA	R/W	R/W	R/W	R/W	-	-	-	-
		PA7DC	PA6DC	PA5DC	PA4DC	-	-	-	-
2E	PBCON	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W
		PB7PU	PB6PU	PB5PU	PB4PU	PB3PU	PB2PU	PB1PU	PB0PU
2F	DCRB	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W
		PB7DC	PB6DC	PB5DC	PB4DC	PB3DC	PB2DC	PB1DC	PB0DC
32	LCDCON	R/W	R/W	R/W	-	R/W	R/W	-	R/W
		KEH	BLANK	LCDON	-	LCR1	LCR0	-	LBVON
33	POST_ID	-	R/W	R/W	R/W	-	R/W	R/W	R/W
		-	LCD_ID	FSR1_ID	FSR0_ID	-	LCD_PE	FSR1_PE	FSR0_PE
34	CPUCON	-	-	-	-	-	R/W	R/W	R/W
		-	-	-	-	-	GLINT	MS1	MS0
35	T0CL	R							
		Timer 0 Counting Value Low Byte Register							
36	T0CH	R							
		Timer 0 Counting Value High Byte Register							

7.6.2 Other Unbanked General RAM

Address	Unbanked
13h 1Fh	General purpose RAM
37h 7Fh	General purpose RAM

7.6.3 Banked General RAM

Address	Bank 0	Bank 1	Bank 2	Bank 3		Bank 9
80h FFh	General Purpose RAM	General Purpose RAM	General Purpose RAM	General Purpose RAM		General Purpose RAM

7.7 LCD RAM Map

■ 1/5 Duty

RAM Address		COM0	COM1	COM2	COM3	COM4	-	-	-
LCDARL		Bit 0	Bit 1	Bit 2	Bit 3	Bit 4	Bit 5	Bit 6	Bit 7
SEG0	00H								
:	:								
SEG39	27H								

■ 1/4 Duty

RAM Address		COM0	COM1	COM2	COM3	-	-	-	-
LCDARL		Bit 0	Bit 1	Bit 2	Bit 3	Bit 4	Bit 5	Bit 6	Bit 7
SEG0	00H								
:	:								
SEG39	27H								

■ 1/3 Duty

RAM Address		COM0	COM1	COM2	-	-	-	-	-
LCDARL		Bit 0	Bit 1	Bit 2	Bit 3	Bit 4	Bit 5	Bit 6	Bit 7
SEG0	00H								
:	:								
SEG39	27H								

7.8 Special Function Registers

7.8.1 ACC (R0Ah): Accumulator

Internal data transfer operation, or instruction operand holding usually involves the temporary storage function of the Accumulator, which is not an addressable register.

7.8.2 *POST_ID (R33h): Post Increase / Decrease Control Register*

Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
–	LCD_ID	FSR1_ID	FSR0_ID	–	LCDPE	FSR1PE	FSR0PE

Bit 0 (FSR0PE): Enable FSR0 post increase/decrease function. FSR0 will NOT carry into or borrow from BSR.

Bit 1 (FSR1PE): Enable FSR1 post increase/decrease function. FSR1 will carry into or borrow from BSR1.

Bit 4 (FSR0_ID): 0: Auto decrease FSR0
1: Auto increase FSR0

Bit 5 (FSR1_ID): 0: Auto decrease FSR1
1: Auto increase FSR1

7.8.3 *BSR, FSR0, INDF0 (R02h, R01h, R00h): Indirect Address Pointer 0 Registers*

BSR (R02h) determines which bank is active (working bank) among the 10 banks (Bank 0 ~ Bank 9).

FSR0 (R01h) is an address register for INDF0. Up to 256 bytes (Address: 00 ~ 0FFh) can be selected.

INDF0 (R00h) is not a physically implemented register.

7.8.4 *BSR1, FSR1, INDF1 (R05h, R04h, R03h): Indirect Address Pointer 1 Registers*

BSR1 (R05h) is a bank register for INDF1. It cannot determine the working bank for the general register.

FSR1 (R04h) is an address register for INDF1. Up to 128 bytes (Address: 80 ~ 0FFh) can be selected. Bit 7 of FSR1 is fixed to “1.”

INDF1 (R03h) is not a physically implemented register.

■ Code Example 1:

Data transform Bank 0 to Bank 1:

```

MOV    A, #00110011B      ; Enable FSR0 & FSR1 post increase
MOV    POST_ID, A
BANK   #0                  ; BSR = 0 working Bank
MOV    A, #1
MOV    BSR1, A             ; BSR1 = 1 is Bank 1
MOV    A, #80H
MOV    FSR0, A             ; FSR0 = 80H
CLR    FSR1                ; FSR1 = 80H
MOV    A, #80H
RPT    ACC
MOVVRP  INDF1, INDF0       ; Move 80H ~ 0FFH data to Bank 1
:

```

■ INDF1 Linear Address Capabilities

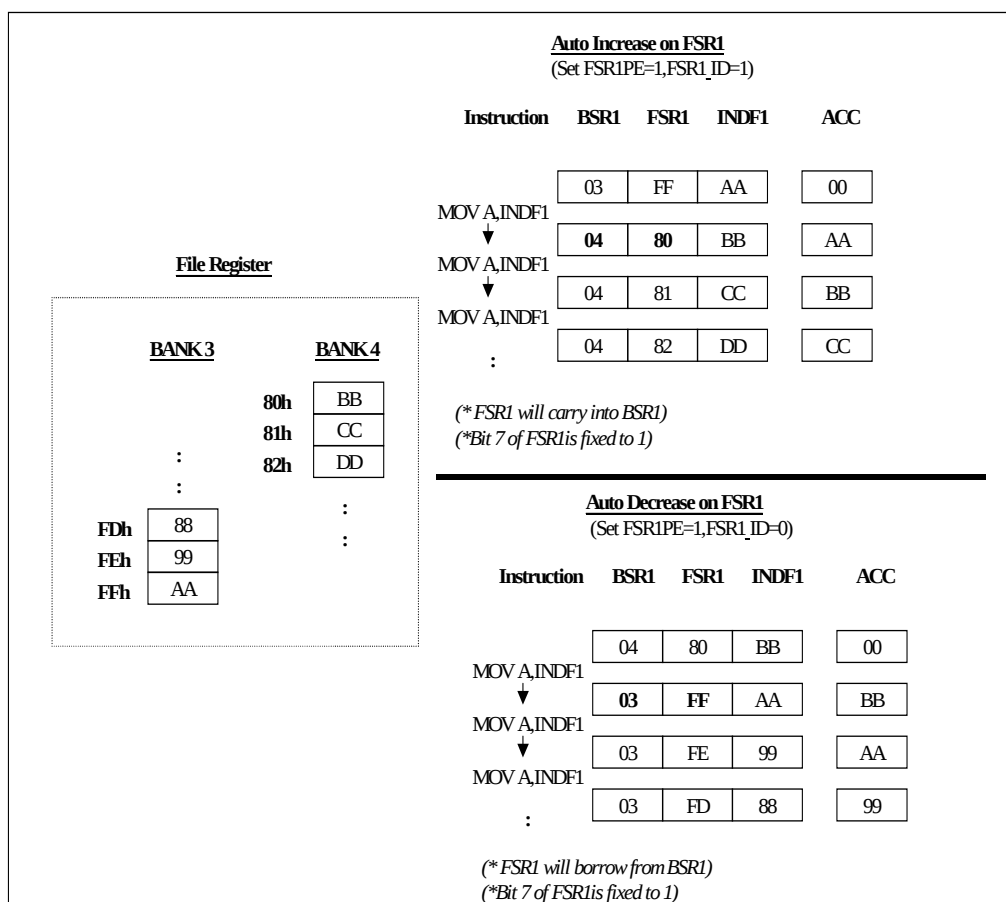


Figure 7-8 INDF1 Linear Address Capabilities Diagram

■ Code Example 2:

```

;*****
;*      Const => Working bank setting
;*      REG => Save or Recall register
;*****
;      ***** RAM stack macro
;      *****
;      *** Initial RAM stack
;      *****
;      InIRAMsk MACRO  #Const
;      MOV      A,#Const
;      MOV      BSR1,A
;      CLR      FSR1
;      BS       POST_ID,FSR1PE
;      ENDM
;      *** Push RAM stack
;      *****
;      PushRAM MACRO  REG
;      BS       POST_ID,FSR1_ID
;      MOV      MOVPR REG,INDF1
;      ENDM
;      *** Pop RAM stack
;      *****
;      PopRAM MACRO  REG
;      BC       POST_ID,FSR1_ID
;      MOVPR    REG,INDF1
;      ENDM
;      *****
;      *** Main start program
;      *****
;      Mstart:
;      *****
;      InIRAMsk #29
;      *****
;      MnLoop:
;      *****
;      LJMP     MnLoop
;      *****
;      *** Interrupt routine
;      *****
;      IntSR:
;      *****
;      PushRAM  ACC
;      PushRAM  Status
;      *****
;      *****
;      PopRAM   Status
;      PopRAM   ACC
;      RETI
;      *****

```

7.8.5 STKPTR (R06h): Stack Pointer Register

The initial stack pointer is 00h. Each INT/CALL will stack two bytes of address with a total capacity of 32 levels. When stack overflows, it will replace the first stack level.

NOTE

This Bank RAM does not include the stack RAM. The stack RAM is independent and cannot be seen.

7.8.6 PCL, PCM (R07h, R08h): Program Counter Registers

Bit15	Bit14	Bit13	Bit12	Bit11	Bit10	Bit9	Bit8	Bit7	Bit6	Bit5	Bit4	Bit3	Bit2	Bit1	Bit0
–	–	–	PCM					PCL							

The configuration structure can generate up to 8K×16 on-chip ROM addresses for the relative programming instruction codes.

“S0CALL” loads the low 12 bits of the PC (4K×16 ROM)

"SCALL" or "SJMP" loads the low 13 bits of the PC (8K×16 ROM)

"LCALL" or "LJMP" loads the full 14 bits of the PC (16K×16 ROM)

“**ADD R7, A**” or “**ADC R7, A**” allows a relative address to be added into the current PC. The carry bit of R7 will automatically carry into PCM.

■ **Code Example:**

```

START:
    MOV    A,entry
    MOV    number,A                ;number ← entry
    LCALL  Indirect_JUMP
AAA:
    :
    :
Indirect_JUMP:
    MOV    A,number
    ADD    A,ACC                   ;A← 2*A
    ADD    PCL,A                   ;PCL← PCL+A
Function_table:
    LJMP   Function_Address_1      ; Number=0
    LJMP   Function_Address_2      ; Number=1
    LJMP   Function_Address_3      ; Number=2
    LJMP   Function_Address_4      ; Number=3
    LJMP   Function_Address_5      ; Number=4
    LJMP   Function_Address_6      ; Number=5
    LJMP   Function_Address_7      ; Number=6
    :
Function_Address_1:
    :                               ; Function 1 operation
    :
    RET                               ; PC will return to AAA label
    
```

7.8.7 TABPTRL, TABPTRM (R0Bh, R0Ch): Table Pointer Registers

Bit15	Bit14	Bit13	Bit12	Bit11	Bit10	Bit9	Bit8	Bit7	Bit6	Bit5	Bit4	Bit3	Bit2	Bit1	Bit0
0	0	TABPTRM						TABPTRL							

Program ROM or Internal ROM address register.

Bit 13 ~ Bit 1 are used to point the memory address.

Bit 0 is used to select low byte or high byte (see TBRD instruction in the Instruction Set under Section 12)

■ **Code Example:**

```

; *** Program ROM
:
:
TBPTM  #(PROMTAB*2)/100H
TBPTL  #PROMTAB*2
:
:
TBRD   0,ACC                ; no change
TBRD   1,ACC                ; auto-increase
TBRD   2,ACC                ; auto-decrease
:
:
; *** Program ROM data
PROMTAB:
    DB    0x00,0x01,0x02,0x03,0x04,0x05
    DB    0x10,0x11,0x12,0x13,0x14,0x15
    DB    0x20,0x21,0x22,0x23,0x24,0x25
    
```

7.8.8 Port A, Port B (R10h, R11h): General I/O Pin Registers

Port A (R10h) Port A.0 ~ 7 are general I/O pin registers

Port B (R11h) Port B.0 ~ 7 are general I/O pin registers

7.8.9 STBCON (R20): Strobe Output Control Register

Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
SCAN	KEL	R1EN	BitST	STB3	STB2	STB1	STB0

Bit 7 (SCAN): Automatic key scan or specify the scan signal bit by bit

0: Key scan is specified as "Bits STB3 ~ 0 defined"

1: Auto strobe scanning

Bit 6 (KEL): Low nibble key input enable/disable control bit

0: Disable Low nibble key input function (Port A.0~3 do not correspond with Key input in software scan mode)

1: Enable Low nibble key input function (Port A.0~3 correspond with Key input in software scan mode)

Bit 5 (R1EN): R1 pull up resistor (small resistor) control bit for Port A.3 ~ Port A.0.

0: Disable R1 pull up resistor

1: Enable R1 pull up resistor

Bit 4 (BitST): Enable SEG0 ~ SEG15 as key strobe pins

0: SEG0 ~ SEG15 are used as LCD segment signal pins only

1: SEG0 ~ SEG15 are used as key strobe pins and LCD segment pins.
Strobe signal is STB3 ~ 0 defined

Bits 3 ~ 0 (STB3 ~ 0): 16 to 1 multiplexing selector of key strobe pin

7.8.10 PACON (R29h): Port A Control Register

Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
PA7PU	PA6PU	PA5PU	PA4PU	PA3PU	PA2PU	PA1PU	PA0PU

Bits 7 ~ 0 (PA7PU ~ PA0PU): Enable PortA.0 ~ Port A.7 pull-up resistor bits

0: Disable Port A.0 ~ Port A.7 pull-up resistor

1: Enable Port A.0 ~ Port A.7 pull-up resistor

7.8.11 PAWAKE (R2Ah): Port A Wake-up Control Register

Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
WKEN7	WKEN6	WKEN5	WKEN4	WKEN3	WKEN2	WKEN1	WKEN0

Bits 7 ~ 0 (WKEN7 ~ WKEN0): Wake-up enable control bits of Port A.7~Port A.0.

0: Disable Port A.7 ~ Port A.0 wake-up function

1: Enable Port A.7 ~ Port A.0 wake-up function

NOTE

This function is only available with Port A selected as input pin.

7.8.12 PAINTEN (R2Bh): Port A Interrupt Enable Control Register

Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
PA7IE	PA6IE	PA5IE	PA4IE	PA3IE	PA2IE	PA1IE	PA0IE

Bit 7 ~ Bit 0 (PA7IE ~ PA0IE): Interrupt Control bits

0: Disable Port A interrupt function

1: Enable Port A interrupt function

NOTE

This function is only available with Port A selected as input pin.

7.8.13 PAINTSTA (R2Ch): Port A Interrupt Status Register

Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
PA7I	PA6I	PA5I	PA4I	PA3I	PA2I	PA1I	PA0I

Bit 7 ~ Bit 0 (PA7I ~ PA0I): INT status of Port A.7 ~ Port A.0 interrupts bits

Set to "1" when pin falling edge is detected

Cleared ("0") by software

7.8.14 DCRA (R2Dh): Port A Direction Control Register

Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
PA7DC	PA6DC	PA5DC	PA4DC	-	-	-	-

Bit 7 ~ Bit 4 (PA7DC ~ PA4DC): PortA.4~PortA.7 direction control bits

0: Set to output pin

1: Set to input pin

7.8.15 PBCON (R2Eh): Port B Pull up Resistor Control Register

Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
PB7PU	PB6PU	PB5PU	PB4PU	PB3PU	PB2PU	PB1PU	PB0PU

Bit 7 ~ Bit 0 (PB7PU ~ PB0PU): Port B.0 ~ Port B.7 pull-up resistor control bits

0: Disable pull-up resistor

1: Enable pull-up resistor

NOTE

This function is only available with Port B selected as input pin.

7.8.16 DCRB (R2Fh): Port B Direction Control Register

Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
PB7DC	PB6DC	PB5DC	PB4DC	PB3DC	PB2DC	PB1DC	PB0DC

Bit 7 ~ Bit 0 (PB7DC ~ PB0DC): Port B.0 ~PortB.7 direction control bits

0: Set to output pin

1: Set to input pin

NOTE

When Port B bit is set as input pin, a 5 μ sec delay in reading Port B data must be provided. Otherwise, the read data will be inaccurate. See the Example below.

■ **Code Example:**

```

; *** Set Port B to input pins
MOV    A, #0XFF
MOV    DCRB, A
MOV    PBCON, A
Read_PB:
JBS    PORTB, 0, Read_PB
    Delay 5usec
JBS    PORTB, 0, Read_PB
SJMP   Read_PB

```

8 Peripheral

8.1 Timer 0 (16 Bits Timer with Event Counter Function)

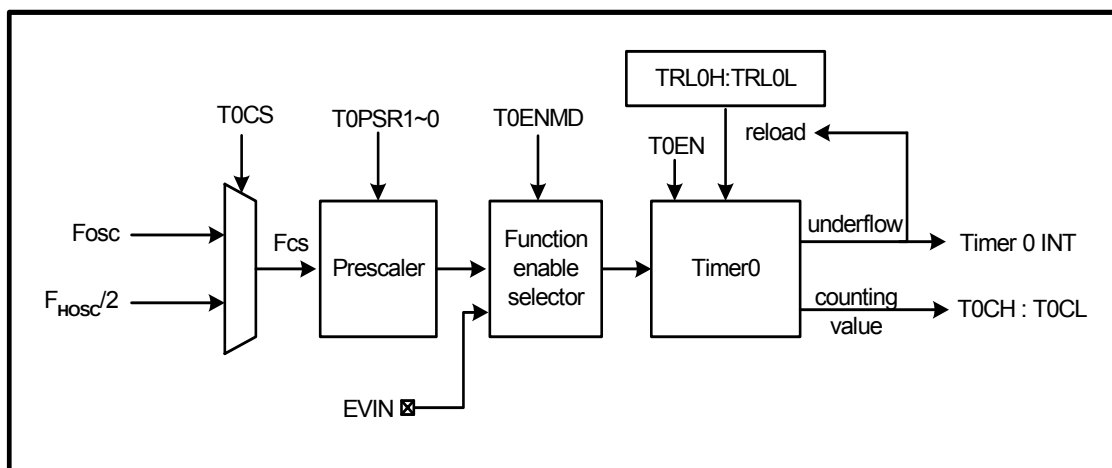


Figure 8-1a Timer 0 Function Block Diagram

■ Timer 0 Mode

Timer 0 is a general-purpose 16 bits down counter used on applications that require time counting with interrupt. The clock source (F_{cs}) is selectable from the oscillator clock (F_{osc}) or half of the system clock (F_{hosc}).

A prescaler for the timer is also provided. The $T0PSR1 \sim T0PSR0$ bits of $TR01CON$ register determine the prescaler ratio and generate different clock rates as clock source for the timer.

The Counter value is decremented by one (count down) according to the timer clock source frequency. When underflow occurs, the timer interrupt is triggered if the global interrupt and Timer 0 interrupt are both enabled. At the same time, $TRL0H:TRL0L$ will automatically be reloaded into the 16-bit counter.

$$T = \frac{1}{F_{cs}} \times \text{Prescaler} \times (TRL0H:TRL0L + 1)$$

■ Event Counter Mode, EVIN (Port B.7) Pin

The Event counter is a function that allows the 16-bit counter value to be decremented by one when an event occurs on the EVIN pin at every rising edge. In other words, the clock source of Timer 0 is from an external event (EVIN pin).

The EVIN pin can be configured into event counter input function by setting the $T0ENMD$ bit of the $TR2WCON$ register (see next page) to “1.” The counter value of Timer 0 will be stored in $T0CH:T0CL$ registers.

NOTE

If the program uses the event counter mode, Port B.7 will be fixed as input pin and Port B.7 cannot be controlled by the "Port B high nibble control bit" code option.

■ **Event Counter Mode Example:**

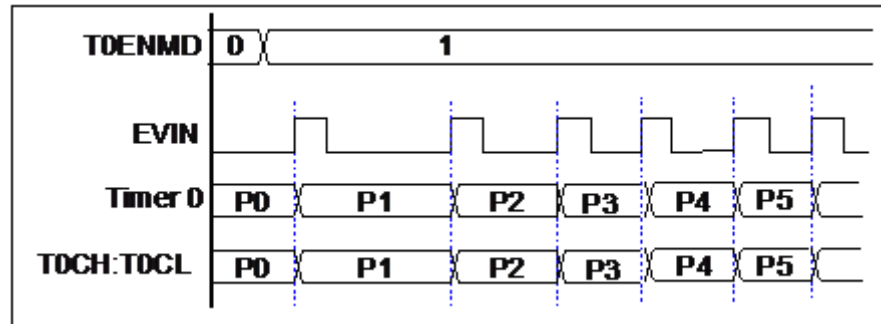


Figure 8-1b Event Counter Mode Example Timing Diagram

8.1.1 Timer 0 Registers

■ **TRL0H:TRL0L (R25h, R24h): Timer 0 Reload Registers**

Reloaded registers are used to store the auto-reload value of Timer 0. When Timer 0 is enabled or underflow occurs, TRL0H:TRL0L register values will automatically be reloaded into the 16 bits counter.

■ **T0CH: T0CL (R36H, R35H): Timer 0 Counter Value Register**

Used to store the value compared with Timer 0 register.

■ **TR01CON (R23h): Timer 0 and Timer 1 Control Register**

Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
T1WKEN	T1EN	T1PSR1	T1PSR0	T0EN	T0CS	T0PSR1	T0PSR0

Bit 3 (T0EN): Timer 0 enable control bit

- 0: Disable
- 1: Enable

Bit 2 (T0CS): Timer 0 clock source select bit

- 0: Clock source is from Fosc
- 1: Clock source is from FHOSC/2

Bit 1 ~ Bit 0 (T0PSR1 ~ T0PSR0): Timer 0 prescaler select bits

T0PSR1: T0PSR0	Prescaler Value
00	1:1
01	1:4
10	1:16
11	1:64

■ **TR2WCON (R27h): Timer 2/Watchdog Timer Control Register**

Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
WDTEN	T0ENMD	WDTPSR1	WDTPSR0	T2EN	T2CS	T2PSR1	T2PSR0

Bit 6 (T0ENMD): Timer 0/Event counter select bit

0: Timer 0 mode

1: Event counter mode

■ **CPUCON (R34h): MCU Control Register**

Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
—	—	—	—	—	GLINT	MS1	MS0

Bit 2 (GLINT): Global interrupt enable/disable bit

0: Disable all interrupts

1: Enable all un-mask interrupts

■ **INTCON (R21h): Timer Interrupt Control Register**

Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
—	—	—	—	—	TMR2IE	TMR1IE	TMR0IE

Bit 0 (TMR0IE): Timer 0 interrupt control bit

0: Disable Interrupt function

1: Enable Interrupt function

■ **INTSTA (R22h): Timer Interrupt Status Register**

Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
—	—	—	—	—	TMR2I	TMR1I	TMR0I

Bit 0 (TMR0I): When Timer 0 Interrupt occurs, this bit will be set, and cleared to “0” by software.

■ **Code Example:**

```

; === Timer 0 interrupt
TIMERINT:
    PUSH
    JBC    INTSTA,TMR0I,Q_Time
    BC     INTSTA,TMR0I
    BTG    PORT A,7
Q_Time:
    POP
    RETI
; === Timer0 = [1/(300K/2)] * [1 x(1FFFh + 1)]
Timer0SR:
    :
    System setting 300KHz
    PA.7 setting output pin
    :
    MOV     A,#0B00000100
    AND     TR01CON,A                ; Fhosc & Pre-scale 1:1
    MOV     A,#0X1F
    MOV     TRL0H,A
    MOV     A,#0XFF
    MOV     TRL0L,A                ; 13.65ms=[1x(8191 + 1)/(300K/2)
    BC     TR2TWCON,T0ENMD          ; 0=>Timer 0 mode
    BS     TR01CON,T0EN             ; Timer 0 enable
    BS     INTCON,TMR0IE            ; Timer 0 interrupt enable
    BC     INTSTA,TMR0I             ; Clear Timer 0 interrupt status
    BS     CPUCON,GLINT             ; Enable global interrupt
TimeLoop:
    SJMP    TimeLoop
; === Event mode interrupt
TIMERINT:
    PUSH
    JBC    INTSTA,TMR0I,Q_Time
    BC     INTSTA,TMR0I
    BTG    PORT A,7
Q_Time:
    POP
    RETI
; === Event counter set
TR0_Event:
    :
    PA.7 setting output pin
    :
    MOV     A,#0XFF                ; Switch 256 times reload
    MOV     TRL0L,A
    CLR     TRL0H                  ; Count start 00FFh
    BS     TR2TWCON,T0ENMD          ; 1=>Event counter mode
    BS     INTCON,TMR0IE            ; Enable Timer 0 interrupt
    BS     CPUCON,GLINT             ; Enable global interrupt
EventWait:
    SJMP    EventWait

```

8.2 Timer 1 (8 Bits)

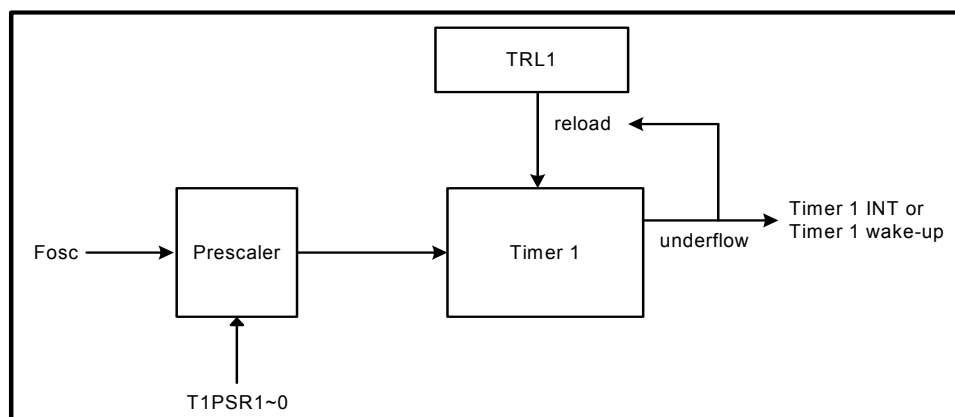


Figure 8-2 Timer 1 Function Block Diagram

Timer 1 is a general-purpose 8-bit down counter used on applications that require time counting with interrupt and wake-up functions. The clock source is from the oscillator clock (Fosc).

A prescaler for the timer is also available. The T1PSR1 ~ T1PSR0 bits of TR01CON register determine the pre-scale ratio and generate different clock rates as clock source for the timer. Setting T1WKEN bit of TR01CON register to “1” will enable the Timer 1 underflow wake-up function in Idle Mode.

The Counter value will be decremented by one (count down) according to timer clock source frequency. When the counter underflows, the timer interrupt is triggered if the global interrupt and Timer 1 interrupt are both enabled. At the same time, TRL1 value will be automatically reloaded into the 8-bit counter.

$$T = \frac{1}{F_{OSC}} \times \text{Prescaler} \times (TRL1 + 1)$$

8.2.1 Timer 1 Registers

■ TRL1 (R26h): Timer 1 Reload Register

This register is used to store the auto-reload value of Timer 1. When Timer 1 is enabled or underflow occurs, TRL1 register value will be automatically reloaded into the 8-bit counter.

■ **CPUCON (R34h): MCU Control Register**

Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
-	-	-	-	-	GLINT	MS1	MS0

Bit 2 (GLINT): Global interrupt enable/disable bit

0: Disable all interrupt

1: Enable all un-mask interrupt

■ **TR01CON (R23h): Timer 0 and Timer 1 Control Register**

Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
T1WKEN	T1EN	T1PSR1	T1PSR0	T0EN	T0CS	T0PSR1	T0PSR0

Bit 7 (T1WKEN): Enable bit of Timer 1 underflow wake-up function in Idle Mode

0: Disable Timer 1 wake-up function

1: Enable Timer 1 wake-up function

Bit 6 (T1EN): Timer 1 enable control bit

0: Disable Timer 1 (stop counting)

1: Enable Timer 1

Bit 5 ~ Bit 4 (T1PSR1 ~ T1PSR0): Timer 1 prescaler select bits

T1PSR1: T1PSR0	Prescaler Value
00	1:4
01	1:16
10	1:64
11	1:256

■ **INTCON (R21h): Timer Interrupt Control Register**

Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
-	-	-	-	-	TMR2IE	TMR1IE	TMR0IE

Bit 1 (TMR1IE): Control bit of Timer 1 interrupt.

0: Disable Interrupt function

1: Enable Interrupt function

■ **INTSTA (R22h): Timer Interrupt Status Register**

Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
-	-	-	-	-	TMR2I	TMR1I	TMR0I

Bit 1 (TMR1I): When Timer 1 interrupt occurs, this bit will be set, and Cleared to "0" by software.

■ Code Example:

```

; === Timer 1 interrupt
TIMERINT:
    PUSH
    JBC     INTSTA,TMR1I,Q_Time
    BC      INTSTA,TMR1I
    BTG     Port A,7
Q_Time:
    POP
    RETI
; === Timer1 = 32.768K / [256 x (3Fh + 1)]
Timer1SR:
    :
    PA.7 setting output pin
    :
    MOV     A,#10110000B
    MOV     TR01CON,A                ; Fosc & Pre-scale 1:256 & wakeup
    MOV     A,#03FH
    MOV     TRL1,A                  ; 0.5sec=[256x(63+1)]/32.768K
    BS      TR01CON,T1EN            ; Timer 1 enable
    BS      INTCON,TMR1IE          ; Timer 1 interrupt enable
    BC      INTSTA,TMR1I           ; Clear Timer 1 interrupt status
    BS      CPUCON,GLINT           ; Enable global interrupt
    BS      CPUCON,MS1             ; Idle mode
T1Wloop:
    SLEEP
    NOP
    :
    SJMP    T1Wloop
    
```

8.3 Timer 2 (8 Bits)

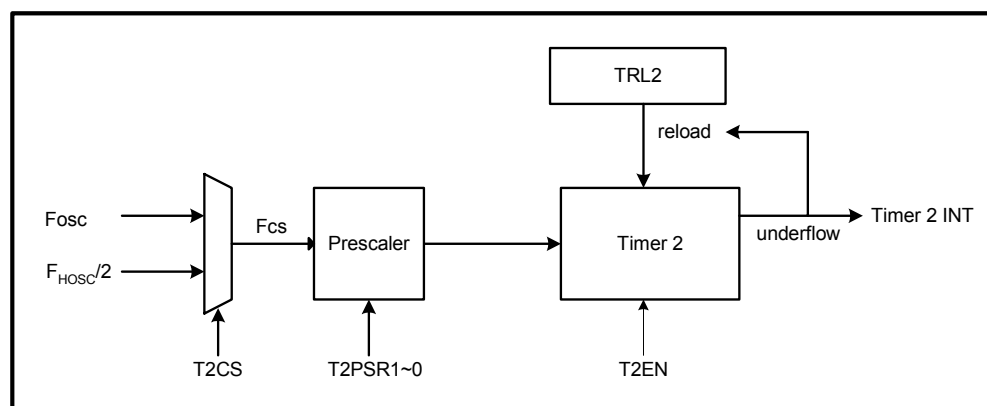


Figure 8-3 Timer 2 Function Block Diagram

Timer 2 is a general-purpose 8-bit down counter used on applications that require a time counter with interrupt. The clock source (Fcs) may be selected from the oscillator clock (F_{osc}) or half of the system clock ($F_{HOSC}/2$).

A prescaler for the timer is also available. The T2PSR1 ~ T2PSR0 bits of TR2WCON register determine the prescaler ratio and generate different clock rates as clock source for the timer.

Counter value is decreased by one (counting down) according to the timer clock source frequency. When counter value underflows, the timer interrupt is triggered (if Timer 2 interrupt is enabled).

$$T = \frac{1}{F_{CS}} \times \text{Prescaler} \times (TRL2 + 1)$$

8.3.1 Timer 2 Registers

■ TRL2 (R28h): Timer 2 Reload Register

This register is used to store the auto-reload value of Timer 2. When Timer 2 is enabled or underflow occurs, TRL2 register value will be automatically reloaded into the 8-bit counter.

■ TR2WCON (R27h): Timer 2/Watchdog Timer Control Register

Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
WDTEN	T0ENMD	WDTPSR1	WDTPSR0	T2EN	T2CS	T2PSR1	T2PSR0

Bit 3 (T2EN): Timer 2 Enable Control Bits

- 0: Disable Timer 2 (stop counting)
- 1: Enable Timer 2

Bit 2 (T2CS): Timer 2 Clock Source Select Bit

- 0: Clock source is from FOSC
- 1: Clock source is from FHOSC/2

Bit 1 ~ Bit 0 (T2PSR1 ~ T2PSR0): Timer 2 Prescaler Select Bits

T2PSR1: T2PSR0	Prescaler Value
00	1:1
01	1:2
10	1:4
11	1:8

■ CPUCON (R34h): MCU Control Register

Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
–	–	–	–	–	GLINT	MS1	MS0

Bit 2 (GLINT): Global Interrupt Enable/Disable Bit

0: Disable all interrupts

1: Enable all un-masked interrupts

■ INTCON (R21h): Timer Interrupt Control Register

Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
–	–	–	–	–	TMR2IE	TMR1IE	TMR0IE

Bit 2 (TMR2IE): Control bit of Timer 2 interrupt

0: Disable Interrupt function

1: Enable Interrupt function

■ INTSTA (R22h): Timer Interrupt Status Register

Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
–	–	–	–	–	TMR2I	TMR1I	TMR0I

Bit 2 (TMR2I): When Timer 2 interrupt occurs, this bit will be set, and Cleared to “0” by software.

■ Code Example:

```

; === Timer 2 interrupt
TIMERINT:
    PUSH
    JBC    INTSTA,TMR2I,Q_Time
    BC     INTSTA,TMR2I
    BTG    Port A,7
Q_Time:
    POP
    RETI
; === Timer2 = (1/32.768K) X [4 x (FFh + 1)]
Timer2SR:
    :
    PA.7 setting output pin
    :
    MOV    A,#00000010B
    MOV    TR2CON,A                ;Fosc & Pre-scale=1:4
    MOV    A,#0XFF
    MOV    TRL2,A                  ;31.25ms=[4x(255+1)]/32768
    BS     TR2CON,T2EN              ;Timer 2 Enable
    BS     INTCON,TMR2IE            ;Timer 2 Interrupt Enable
    BC     INTSTA,TMR2I            ;Clear Timer 2 Interrupt Status
TMR2Loop:
    SJMP   TMR2Loop
    
```

8.4 Watchdog Timer (WDT)

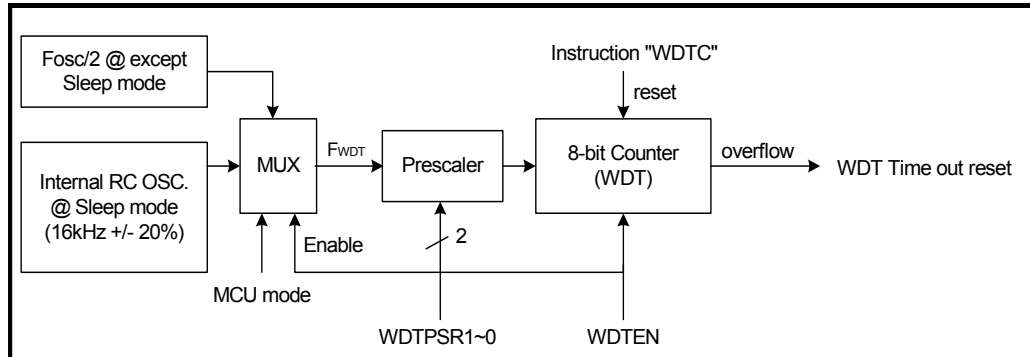


Figure 8-4 Watchdog Timer Functional Block Diagram

The watchdog timer (WDT) clock source comes from an on-chip RC oscillator (16kHz $\pm$ 20%, MCU in Sleep mode) or FOSC/2 (MCU in Fast, Slow, or Idle mode). Therefore the WDT will keep on running even after the oscillator has been turned off.

The WDTEN bit controls the WDT's enable/disable functions. The initial state of the WDT is disabled. When WDT is enabled, its time-out will cause the MCU to reset. The "WDTC" instruction should be used to clear the WDT value before WDT time-out. A prescaler is provided to generate different clock rates for the WDT clock source. The prescaler ratio is defined by WDTPSR1 and WDTPSR0.

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

$$T = \frac{1}{F_{WDT}} \times \text{Prescaler} \times (WDT + 1)$$

8.4.1 Watchdog Timer (WDT) Registers

■ TR2WCON (R27h): Timer 2/Watchdog Timer Control Register

Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
WDTEN	T0ENMD	WDTPSR1	WDTPSR0	T2EN	T2CS	T2PSR1	T2PSR0

Bit 7 (WDTEN): Watchdog Timer enable bit

0: Disable watchdog timer (stop running)

1: Enable watchdog timer

Bit 5 ~ Bit 4 (WDTPSR1 ~ WDTPSR0): Watchdog timer prescaler select bits

WDTPSR1: WDTPSR0	Prescaler Value
00	1:4
01	1:16
10	1:64
11	1:128

■ Code Example:

```

; === WDT setting 2.048sec
:
Timer1 (0.5sec wakeup)
:
BS      TR2WCON, WDTCSR1
BS      TR2WCON, WDTCSR0      ; Pre-scale 1:128
BC      CPUCON, MS1           ; Change to sleep mode
WDTC
SLEP
WDT_Loop:
SJMP    WDT_Loop
; === Timer 1 interrupt 0.5 sec
TIMERINT:
PUSH
JBC     INTSTA, TMR1I, Q_Time
BC      INTSTA, TMR1I
WDTC
:
:
Q_Time:
POP
RETI

```

8.5 Input/Output Key

- Four pins key input (Port A.3 ~ 0) and 16 pins key strobe (shared with LCD segment) can have a maximum of 64 keys matrix.

NOTE

The PA.3's code option must set to "PA.3 can control by KEL and SCAN" when the Key matrix combination is PA[3:0] and SEG[15:0].

- Automatic key scan or software key scan
- Interrupt is available under automatic key scan mode (SCAN=1)
- Wake-up is available when key input falling edge is detected under automatic key scan mode (SCAN=1).
- Wake-up is available when key input falling edge is detected under automatic key scan mode (SCAN=1).

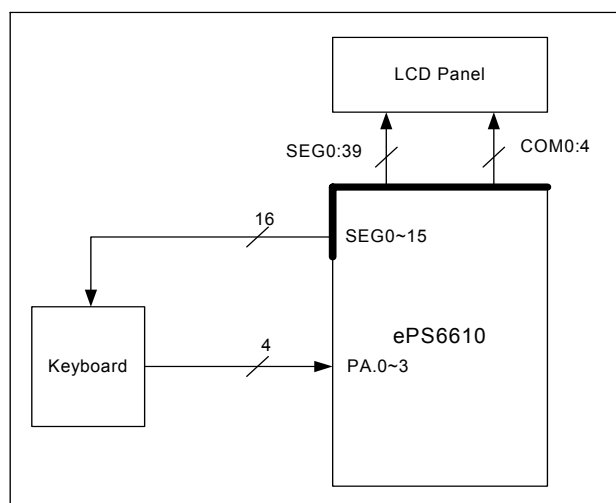


Figure 8-5 Key Function Block Diagram

As shown in the circuit diagram below, it is assumed that the key strobe output has resistance R_{ON} , while each key has resistance K_{ON} and capacitance C . Long strobe output duration will cause the LCD display to malfunction. Hence, strobe output time should be made as short as possible. Therefore, R_{IN} (pull-up resistance) should be low enough to allow quick charge to capacitor. On the contrary, R_{IN} should be high enough for V_{IN} to be considered as “L” level ($R_{IN} \gg R_{ON} + K_{ON}$). Therefore, the value of R_{IN} should remain changeable.

The following is the normal key input process:

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

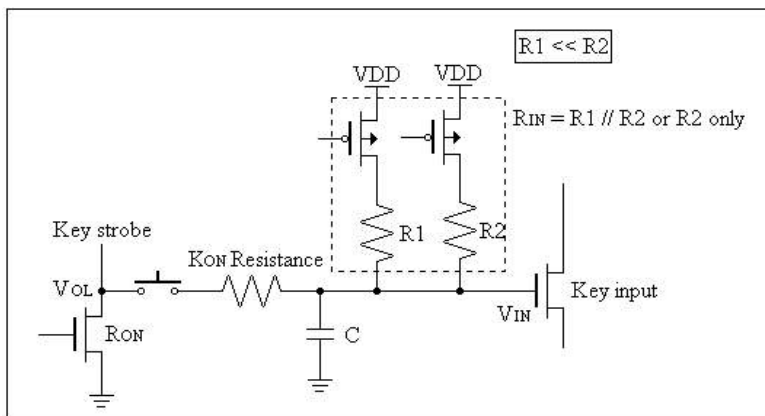


Figure 8-6 Key Circuit Diagram

8.5.1 Key Functions

SCAN	KEL	R1EN	PA3PU ~ PA0PU	IEN ¹	Total Pull-up Resistor	Port A.0 ~ 3	Note
0	0	×	×	0	Floating	High-Z	-
	1	0	0	1	Floating	Floating	Prohibited
		0	1	1	R2	PA.0~.3	-
		1	0	1	R1	PA.0~.3	-
		1	1	1	$R1 // R2$ ²	PA.0~.3	-
1	×	0	0	0	Floating	High-Z	A ³
		1	1	0	$R1 // R2$ ²	High-Z	B ³
		0	1	1	R2	PA.0~ 3	C ³

× : Don't care

¹ Internal signal. Refer to the Automatic Key Scan Timing Diagram (Figure 8-7) below.

² $R1 // R2 = R1R2 / (R1+R2)$.

³ Sub clock signal. Refer to the Automatic Key Scan Timing Diagram (Figure 8-7) below.

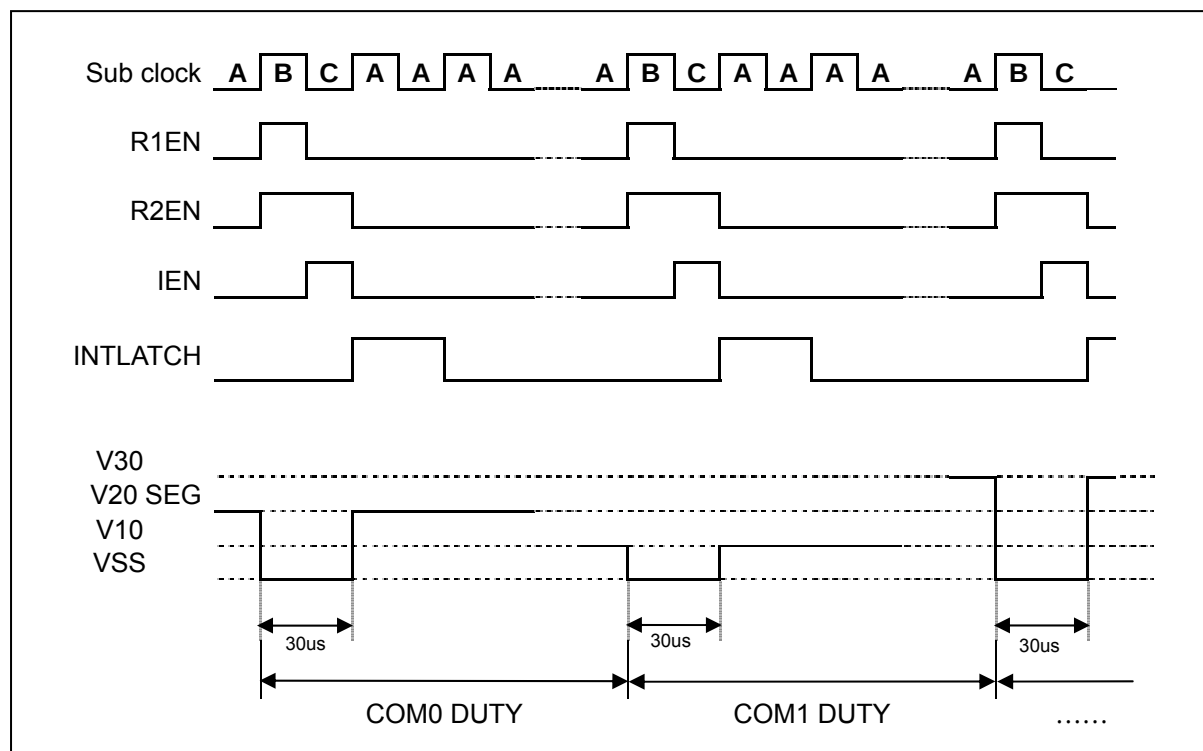


Figure 8-7 Automatic Key Scan Timing (SCAN = 1) Timing Diagram

8.5.2 Key Strobe

The key strobe pin shares with LCD segment pin in the CPU embedded with LCD driver model. When sharing with LCD segment, strobe output should be as short as possible to prevent LCD display error.

There are two ways to output a strobe signal, by Automatic Key scan and by software Key scan.

8.5.2.1 Automatic Key Scan

The LCD waveform has a 30μs low pulse at the beginning of every common duty signal by setting the SCAN bit of STBCON register. The strobe timing is as shown in the following figure (Figure 8-8) on Automatic Key Scan Strobe Signal.

When in automatic key scan mode, Bits 3 ~ 0 of PAINT or PAWAKE must be enabled. During key scan, wake up and interrupt will occur if any of the falling edge of the key input pins (Port A.3 ~ Port A.0) is detected.

NOTE

The "SCAN" bit turn on/off in the key loop should be avoided.

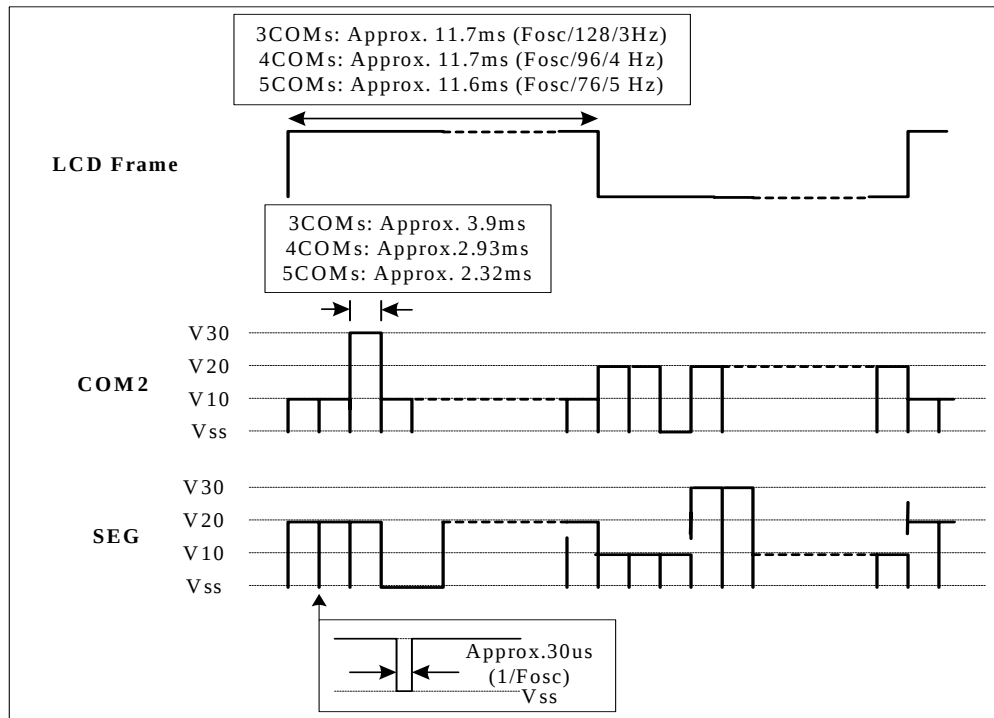


Figure 8-8 Automatic Key Scan Strobe Signal (SCAN = 1) Timing Diagram

8.5.2.2 Software Key Scan

Segment is switched to strobe signal temporally by setting the BitST bit of the STBCON register to "1" and the SCAN bit to "0." Set the STB3 ~ STB0 bits of the STBCON register to select which pin will be strobed.

■ In Idle Mode

During automatic key scanning, if any of the falling edge of the PA.0 ~ 3 pins is detected (when PAINTEN=1), wake-up will occur. Then the CPU runs and interrupt is triggered (if enabled).

■ In Slow Mode or Fast Mode

Both automatic and software key scans are applicable.

- Automatic key scan is used to determine "whether any key is pressed." If a key is pressed, PA.0 ~ 3 pin falling edge is detected, and then interrupt is triggered.
- Software key scan is used to determine "which key was pressed."

8.5.2.3 Key Strobe Pin Function

STBCON			Key Strobe (Shared with Segments 0 ~ 15)															LCD		
SCAN	BitST	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	0	xxxx	Display waveform																	
	1	0000	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	Display waveform	
		0001	1	0	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		
		0011	1	1	1	0	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		
		0101	1	1	1	1	1	0	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		
		0111	1	1	1	1	1	1	1	0	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		
		1001	1	1	1	1	1	1	1	1	1	0	1	1	1	1	1	1		
		1010	1	1	1	1	1	1	1	1	1	1	0	1	1	1	1	1		
		1011	1	1	1	1	1	1	1	1	1	1	1	0	1	1	1	1		
		1100	1	1	1	1	1	1	1	1	1	1	1	1	0	1	1	1		
		1101	1	1	1	1	1	1	1	1	1	1	1	1	1	0	1	1		
		1110	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	1		
		1111	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0		
1	×	xxxx	Display waveform with automatic key scan																	

8.5.3 Input/Output Key Registers

■ Port A (R10h): Port A Register

Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
PA7	PA6	PA5	PA4	PA3	PA2	PA1	PA0

Bit 2 ~ Bit 0: The input structure and two-stage pull-up resistor are controlled together by PA2PU ~ PA0PU bits of the PACON register and R1EN, KEL bits of the STBCON register (see below).

Bit 3: The input structure and two-stage pull-up resistor are controlled together by PA3PU bit of the PACON register and R1EN bit of the STBCON register (see below). The input function is controlled by KEL bit of the STBCON register when the Port A.3's code option set to "PA.3 can control by KEL and SCAN".

Bit 6 ~ Bit 4: The input structure and pull-up resistor are controlled together by PA6PU ~ PA4PU bits of the PACON register, KEH bit of the LCDCON register (see below).

Bit 7: The input structure and pull up resistor are controlled together by PA7PU bit of the PACON register (see below). The input function is controlled by KEH bit of the LCDCON register when the Port A.7's code option set to "PA.7 can control by KEH".

■ **PACON (R29h): Port A Control Register**

Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
PA7PU	PA6PU	PA5PU	PA4PU	PA3PU	PA2PU	PA1PU	PA0PU

Bit 3 ~ Bit 0 (PA3PU ~ PA0PU): Pull-up resistor (R2 large resistor) control bits

0: Disable Port A.0 ~ Port A.3 pull-up resistor

1: Enable Port A.0 ~ Port A.3 pull-up resistor

Bit 7 ~ Bit 4 (PA7PU ~ PA4PU): Pull-up resistor control bits

0: Disable Port A.4 ~ Port A.7 pull-up resistor

1: Enable Port A.4 ~ Port A.7 pull-up resistor

■ **LCDCON (R32h): LCD Control Register**

Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
KEH	BLANK	LCDCON	–	LCR1	LCR0	–	LBVON

Bit 7 (KEH): High nibble key (Port A.7 ~ Port A.4) input enable/disable control bit

0: Disable High nibble key input function

1: Enable High nibble key input function

■ **PAINTEN (R2Bh): Port A Interrupt Enable Control Register**

Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
PA7IE	PA6IE	PA5IE	PA4IE	PA3IE	PA2IE	PA1IE	PA0IE

Bit 7 ~ Bit 0 (PA7IE ~ PA0IE): Interrupt control bit

0: Disable Interrupt function

1: Enable Interrupt function

NOTE

This function is only available with Port A selected as input pin.

■ **PAINTSTA (R2Ch): Port A Interrupt Status Register**

Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
PA7I	PA6I	PA5I	PA4I	PA3I	PA2I	PA1I	PA0I

Bit 7 ~ Bit 0 (PA7I ~ PA0I): INT status of Port A interrupt

Set to “1” when pin falling edge is detected, and

Clear to “0” by software.

■ **STBCON (R20h): Strobe Output Control Register**

Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
SCAN	KEL	R1EN	BitST	STB3	STB2	STB1	STB0

Bit 7 (SCAN): Automatic key scan or specify the scan signal bit by bit

0: Key scan specified as Bit STB3 ~ 0 defined

1: Auto strobe scanning

Bit 6 (KEL): Low nibble key input enable/disable control bit

0: Disable Low nibble key input function (Port A.0~3 do NOT correspond with Key input in software scan mode)

1: Enable Low nibble key input function (Port A.0~3 corresponds with Key input in software scan mode)

Bit 5 (R1EN): R1 pull-up resistor (small resistor) control bit for Port A.3 ~ Port A.0

0: Disable R1 pull-up resistor

1: Enable R1 pull-up resistor

Bit 4 (BitST): Enable bit strobe

0: Display waveform

1: Strobe signal specified as STB3 ~ 0 defined.

Bit 3 ~ Bit 0 (STB0 ~ STB3): Strobe output selector bits

■ **Code Example:**

```

; Key Matrix 1 (Port A and Ground):
; === Sleep mode
PAIN_SR:
;
; --- Port A 0~7 input pins
MOV    A, #0XF0
MOV    DCRA, A
; --- Port A wakeup
MOV    A, #11111111B
MOV    PAWAKE, A
; --- R1EN & R2EN Pull-up & KE enable
MOV    A, #0XFF
MOV    PACON, A
BS     STBCON, R1EN
BS     STBCON, KEL
BS     LCDCON, KEH
; --- Port A interrupt enable
MOV    A, #11111111B
MOV    PAINTEN, A
CLR    PAINTSTA
BS     CPUCON, GLINT
; --- Sleep MODE
BC     CPUCON, MS1
PAINloop:
SLEP
NOP
;
SJMP   PAINloop

```

(Continuation)

```
; *** Interrupt PortA data
INPTINT:
    PUSH
    MOV RP A, PAINTSTA
    MOV    Key_No, A
    CLR    PAINTSTA
    POP
    RETI
```

NOTE

The PA.0~7's code option must be set to "PA.0~7 and Port B or none" by setting the bit when the Key matrix combination is PA[7:0] and Port B or Ground.

```
; Key Matrix 2 (Port A.0~3 and SEG0 ~ SEG15):
; *** Key scan function
:
    LCD display setting
:
    MOV    A, #0X0F
    OR     PACON, A      ; R2EN enable
    MOV    PAWAKE, A     ; Port A setting wakeup function
:
; === Idle mode auto key scan routine
    BS     STBCON, SCAN ; Auto-key scan enable
    BS     CPUCON, MS1  ; Idle mode
KeyIdle:
    SLEP
    NOP
:
; === Key scan routine
KeyScan:
    CLR     STBCON      ; Auto-key scan disable
KeyLoop:
    BS     STBCON, R1EN ; R1EN enable
    BS     STBCON, KEL  ; Key enable
    BS     STBCON, BitST; Strobe ON
    LCALL  DLY50US
    BC     PACON, R1EN  ; R1EN disable
    MOVL   A, Port A    ; Port A input data
    BC     STBCON, BitST; Strobe OFF
    BC     PACON, KEL   ; Key disable
    JLE    A, #0X0E, KeyScan ; If A <= PORT A Goto KeyScan
    INC    STBCON
:
    SJMP   KeyLoop
:
```

(Continuation)

```

KeyScan:
; --- Clear key number
    CLR    Key_No
; --- Key Scan is finish
KeyScanOk:
    MOV    Key_No, A
    MOV    A, STBCON
    MOVH   Key_No, A      ; Key_No: XXXX XXXX
    
```

NOTE

The PA.0~7's code option must be set to "PA.0~7 and SEG" by setting the bit when the Key matrix combination is PA[7:0] and SEG.

8.6 LCD Driver

The ePS6610 provides directly driven LCD. It supports multiplexed drive for 40SEGs × 5COMs which allows the use of pads as an LCD driver pin or as key input port. The available LCD RAM corresponds directly with LCD Pixel. The LCD frame rate is as follows.

Duty	LCD Frame Rate
1/3	Approx. 11.7ms (Fosc/128/3Hz)
1/4	Approx. 11.7ms (Fosc/96/4Hz)
1/5	Approx. 11.6ms (Fosc/76/5Hz)

This embedded LCD driver generates waveforms to drive the display.

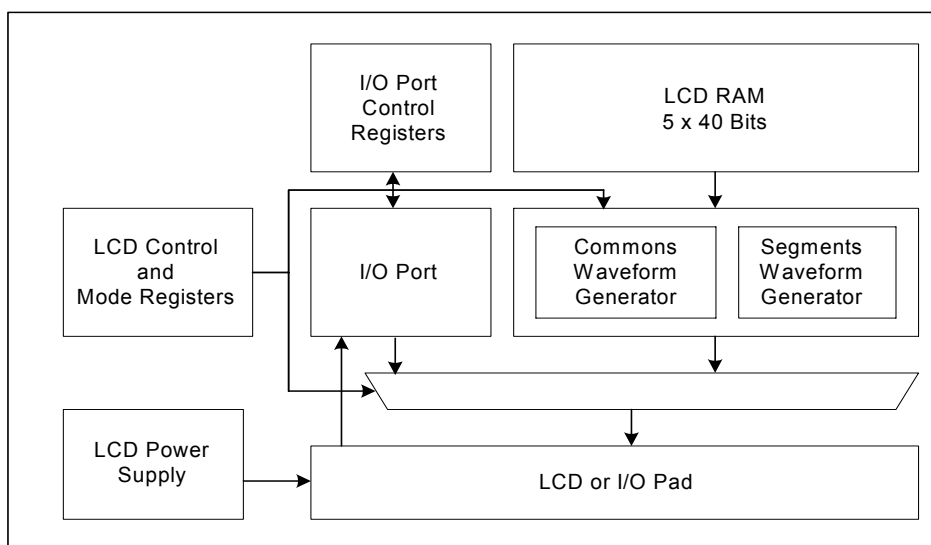


Figure 8-9a LCD Driver Function Block Diagram

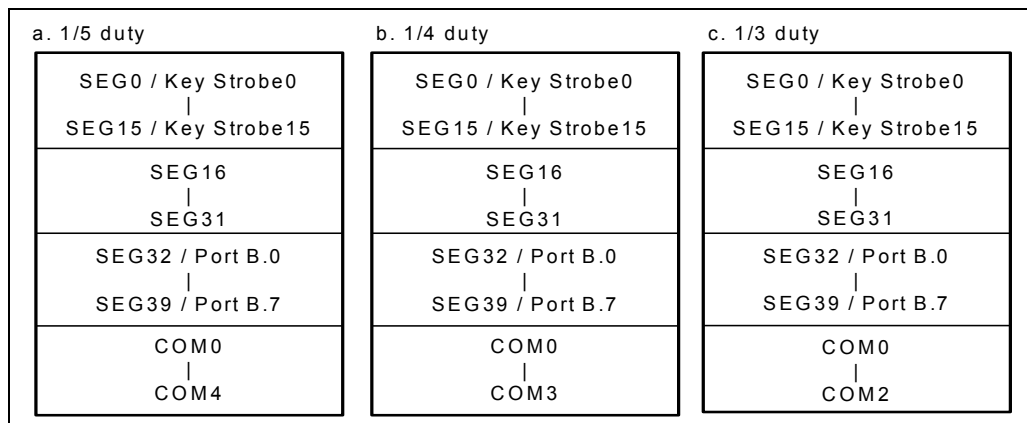


Figure 8-9b LCD Pin Configuration

8.6.1 LCD Driver Registers

■ LCDCON (R32h): LCD Control Register

Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
KEH	BLANK	LCDON	—	LCR1	LCR0	—	LBVON

Bit 6 (BLANK): LCD Blanking control bit

- 0: Disable
- 1: Enable (All SEG pins output “0” signal)

Bit 5 (LCDON): LCD display control bit

- 0: LCD display off
- 1: LCD display on

NOTE

All COM and SEG pins are tied to ground when LCD display is off.

Bit 3, Bit 2 (LCR1, LCR0): LCD Bias Voltage Charge-pump Rate select bits

LCR1:LCR0	Charge-Pump Rate (Hz)
00	8K
01	4K
10	2K
11	16K

Bit 0 (LBVON): Bias Voltage Charge-pump control bit

- 0: Disable
- 1: Enable

■ LCDARL (R09h): LCD RAM Column Address Register

Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
LCDARL7	LCDARL6	LCDARL5	LCDARL4	LCDARL3	LCDARL2	LCDARL1	LCDARL0

Bits 7~6 (LCDARL7~6): unknown value. (Note: Do not use JDNZ at LCDARL (09h) special register)

■ LCDDATA (R0Eh): LCDDATA register

This register is an indirect address pointer of LCD RAM. Any instruction that uses LCDDATA as register, actually accesses LCD RAM via the address pointed by LCDARL (see the figure below).

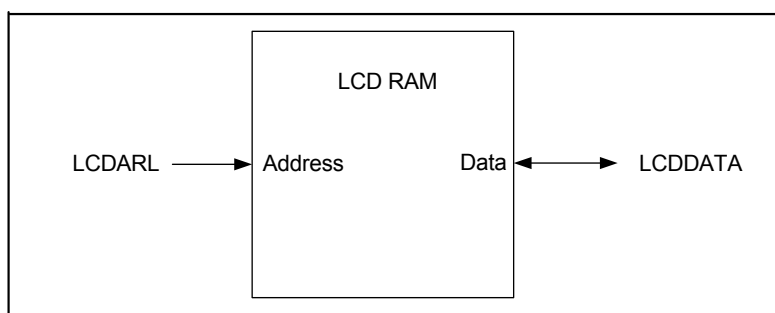


Figure 8-10 LCDDATA Register Access through LCD RAM

■ POST_ID (R33h): Post Increase / Decrease Control Register

Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
–	LCD_ID	FSR1_ID	FSR0_ID	–	LCDPE	FSR1PE	FSR0PE

After accessing (read or write) the LCD RAM, the LCDARL register can be automatically increased or decreased by setting the POST_ID register.

Bit 6 (LCD_ID): Set to “1” to auto-increase the LCDARL register.

Reset to “0” to auto-decrease the LCDARL register

Bit 2 (LCDPE): Enable LCDARL post increase/decrease function

■ **Code Example:**

```

; === LCD Setting
L_Initial:
; --- LCD Off, Normal Display Mode, Charge-Pump rate=8K
    MOV    A, #00000001B
    MOV    LCDCON, A
    SCALL  DspRAMdot
; --- LCD turn-on
    BS     LCDCON, LCDON
    LCALL  Delay1sec
    :
DspLoop:
; --- LCD Blanking
    BS     LCDCON, BLANK
    LCALL  Delay1sec
; --- Normal display
    BC     LCDCOM, BLANK
    LCALL  Delay1sec
    :
    SJMP   DspLoop

; *** Display LCD RAM is data 55 & AA
DspRAMdot:
; --- LCD increase enable.
    BS     POST_ID, LCDPE
    BS     POST_ID, LCD_ID
DspRAMd1:
    CLR    LCDARL
    TBPTH  #0x14
; === Write LCD RAM is dot matrix
WrLRAMd:
    MOV    A, #0XAA
    MOV    LCDDATA, A
    MOV    A, #0X55
    MOV    LCDDATA, A
    JDNZ   TABPTRH, WrLRAMd
    CLR    LCDARL
    RET

```

8.6.2 LCD RAM Map

■ **1/5 Duty**

RAM Address	LCDARL	COM 0	COM 1	COM 2	COM 3	COM 4	-	-	-
		Bit 0	Bit 1	Bit 2	Bit 3	Bit 4	Bit 5	Bit 6	Bit 7
SEG0	00H								
:	:								
SEG39	27H								

■ 1/4 Duty

RAM Address		COM 0	COM 1	COM 2	COM 3	-	-	-	-
LCDARL		Bit 0	Bit 1	Bit 2	Bit 3	Bit 4	Bit 5	Bit 6	Bit 7
SEG0	00H								
:	:								
SEG39	27H								

■ 1/3 Duty

RAM Address		COM 0	COM 1	COM 2	-	-	-	-	-
LCDARL		Bit 0	Bit 1	Bit 2	Bit 3	Bit 4	Bit 5	Bit 6	Bit 7
SEG0	00H								
:	:								
SEG39	27H								

8.6.3 LCD Driving Method Circuit

■ 1/3 Bias

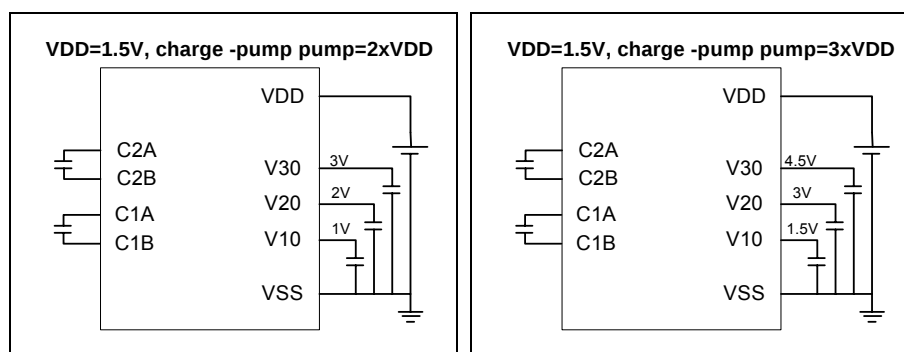


Figure 8-11a LCD Driving Method Circuit for 1/3 Bias

■ 1/2 Bias

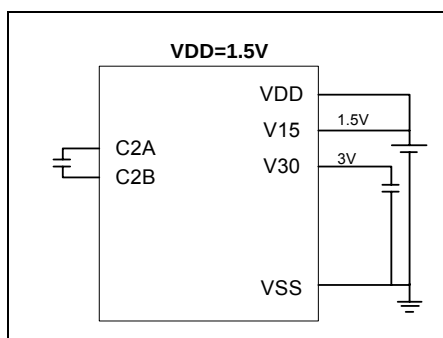


Figure 8-11b LCD Driving Method Circuit for 1/2 Bias

NOTE

V20=V10=Hi-z, let these be floating. Let C1A and C1B be floating.

8.6.4 LCD COM Waveforms

■ 1/5 Duty and 1/3 Bias

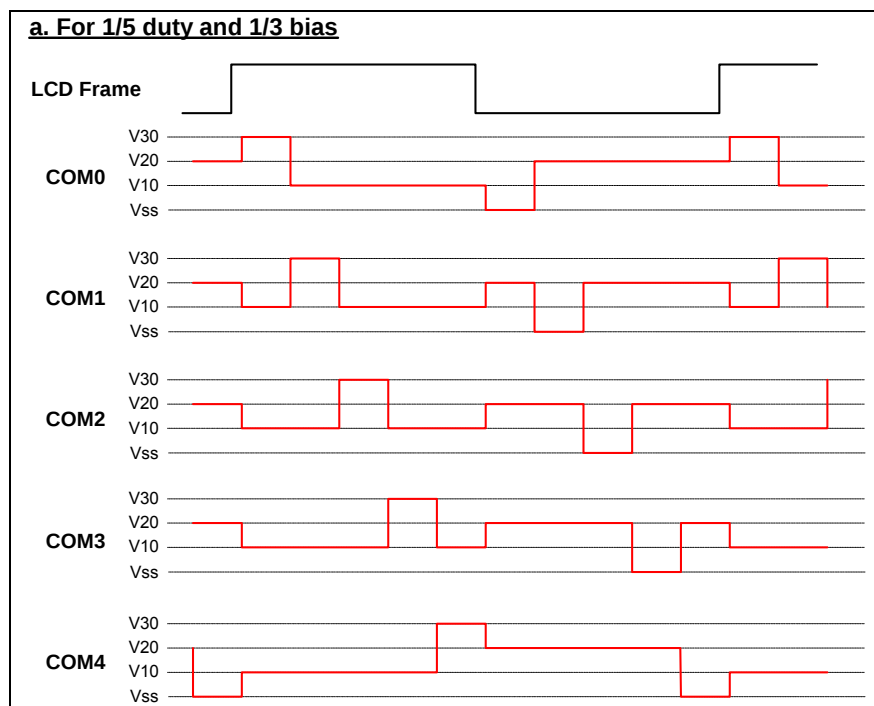


Figure 8-12a LCD COM Waveform for 1/5 Duty and 1/3 Bias

■ 1/4 Duty and 1/3 Bias

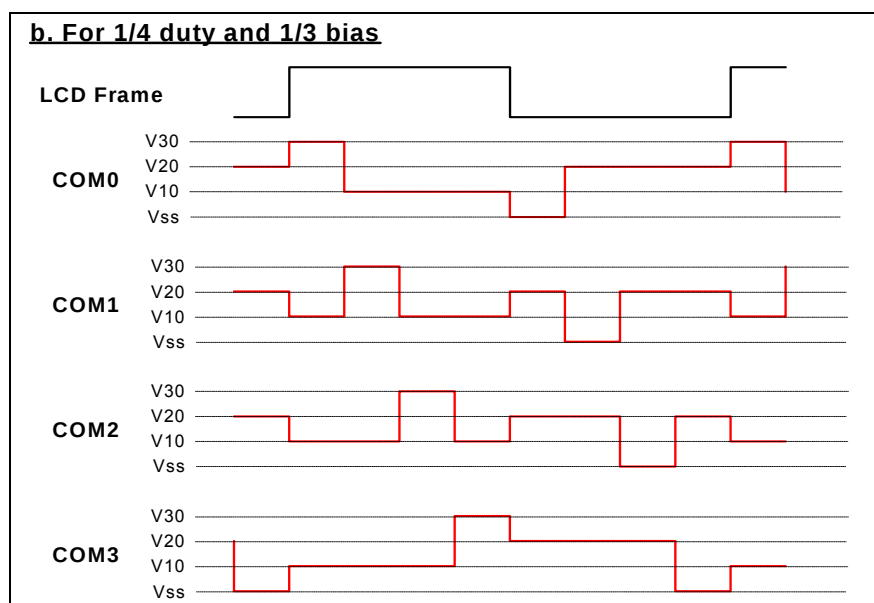


Figure 8-12b LCD COM Waveform for 1/4 Duty and 1/3 Bias

■ 1/3 Duty and 1/2 Bias

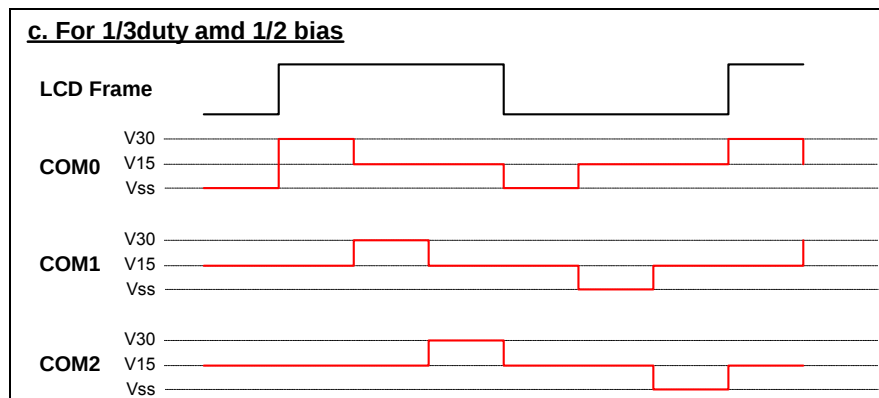


Figure 8-12c LCD COM Waveform for 1/3 Duty and 1/2 Bias

8.6.5 LCD COM and SEG Waveforms

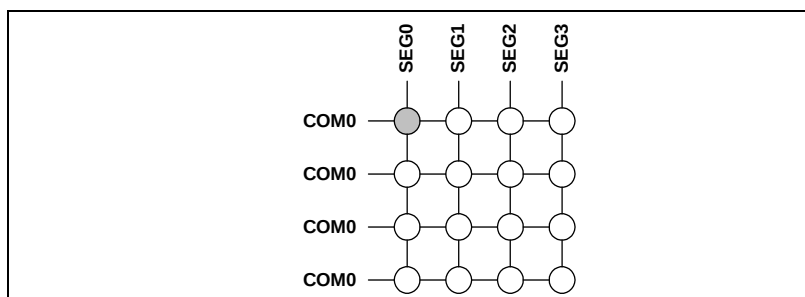


Figure 8-13a LCD COM and SEG Waveform Matrix

■ 1/5 Duty and 1/3 Bias

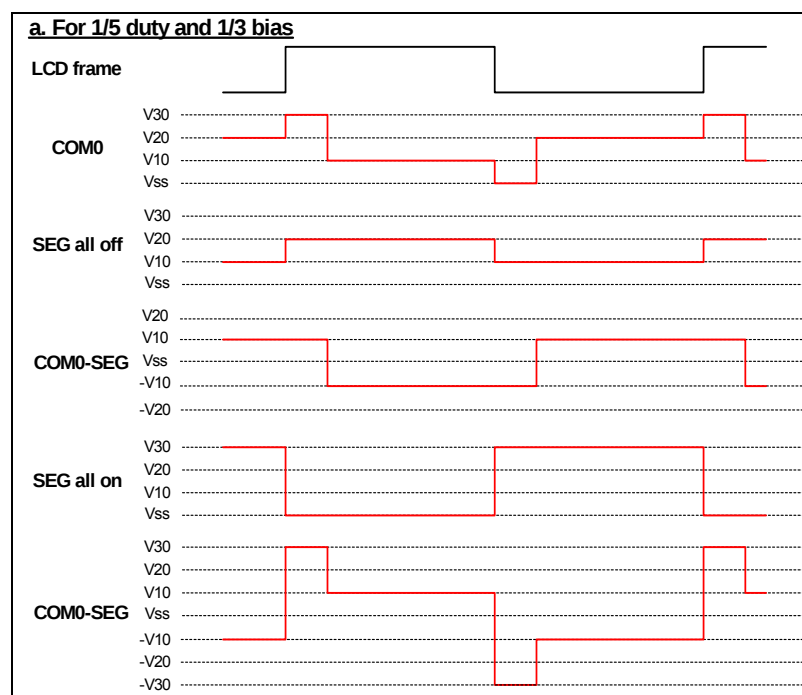


Figure 8-13b LCD COM and SEG Waveform for 1/5 Duty and 1/3 Bias

■ **1/4 Duty and 1/3 Bias**

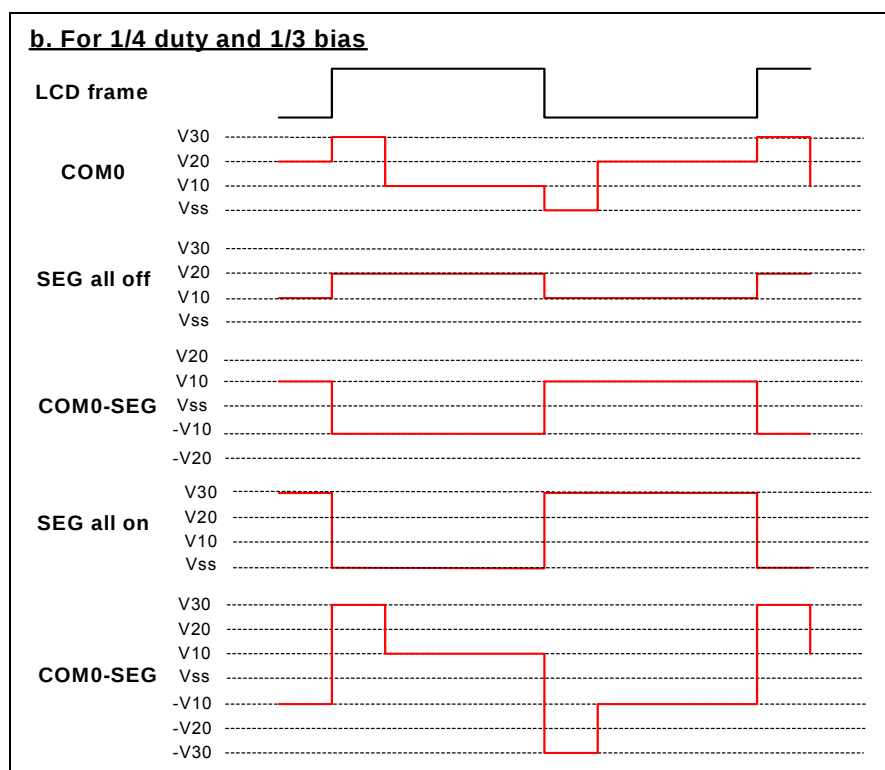


Figure 8-13c LCD COM and SEG Waveform for 1/4 Duty and 1/3 Bias

■ **1/3 Duty and 1/2 Bias**

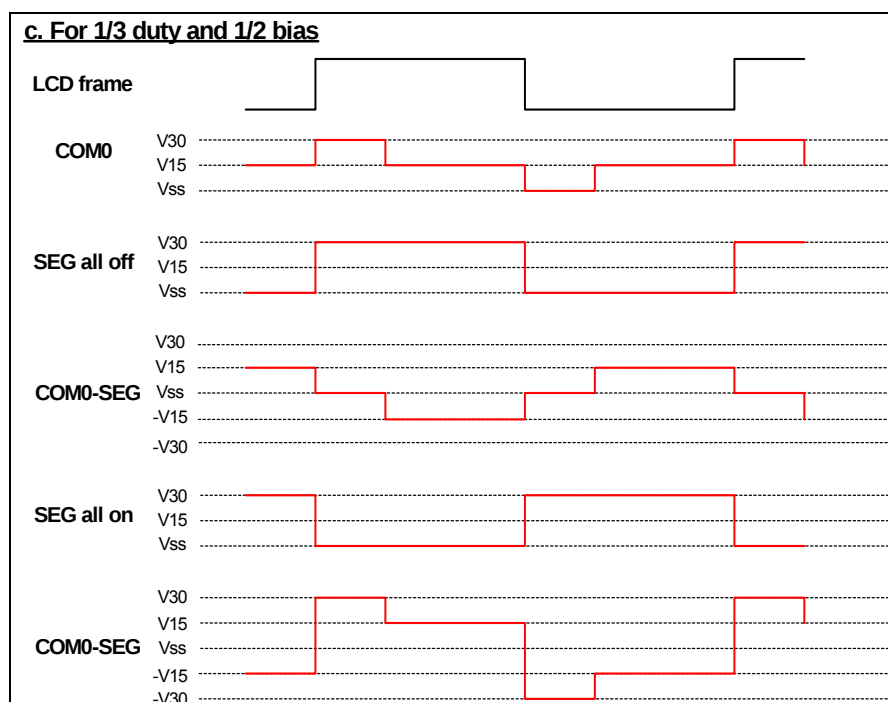


Figure 8-13d LCD COM and SEG Waveform for 1/3 Duty and 1/2 Bias

9 Electrical Characteristics

9.1 VDD=1.5V Electrical Characteristics

■ Absolute Maximum Ratings

Items	Sym.	Condition	Limits	Unit
Supply voltage	VDD	-	-0.3 to +2.0	V
Input voltage (general input port)	VIN	-	-0.5 to VDD +0.5	V
Operating temperature range	TOPR	-	-10 to +70	°C
Storage temperature range	TSTR	-	-55 to +125	°C

■ Recommended Operating Conditions

Items	Sym.	Condition	Limits	Unit
Supply voltage	VDD	-	1.2 to 1.8	V
Input voltage	VIH	-	VDD x 0.9 to VDD	V
	VIL	-	0 to VDD x 0.1	V
Operating temperature	TOPR	-	-10 to +70	°C

■ DC Electrical Characteristics (Condition: Ta=25°C, VDD= 1.5V)

Parameter	Sym.	Condition		Min.	Typ.	Max.	Unit
Clock	F _{HOSC}	Main-clock frequency	RC OSC. R=1.5MΩ	140	200	260	kHz
			RC OSC. R=1MΩ	210	300	390	
			RC OSC. R=560KΩ	350	500	650	
	F _{osc}	Sub-clock frequency	Internal RC OSC	24.6	32.8	41	kHz
			Crystal OSC.	-	32.768	-	
Supply Current	I _{dd1}	Sleep mode	VDD=1.5V, no load	-	-	1	μA
	I _{dd2}	Idle mode	VDD=1.5V RC OSC, LCD enable, no load	-	2	4	
	I _{dd3}		VDD=1.5V, X'tal OSC, LCD enable, no load	-	2	4	
	I _{dd4}	Slow mode	VDD=1.5V, RC OSC, LCD enable, no load	-	4	6	
	I _{dd5}		VDD=1.5V, X'tal OSC, LCD enable, no load	-	3	6	
	I _{dd6}	Fast mode	VDD=1.5V, FHOSC =200kHz, LCD enable, no load	-	16	22	
	I _{dd7}		VDD=1.5V, FHOSC =300kHz, LCD enable, no load	-	22	32	
	I _{dd8}		VDD=1.5V, FHOSC =500kHz, LCD enable, no load	-	32	52	
Input Voltage	VIH1	PA [0:7], PB [0:7] (as general input port)		VDD×0.7	-	VDD	V
	VIL1			0	-	VDD×0.3	

(Continuation)

Parameter	Sym.	Condition		Min.	Typ.	Max.	Unit
Input Threshold Voltage (Schmitt)	VT+	RSTB		0.5×VDD	-	0.75×VDD	V
	VT−			0.2×VDD	-	0.4×VDD	
Input Leakage Current	IIL	ALL Input port (without pull up/down resistor) Vin= VDD or GND		-	-	+/-1	μA
Large Pull-up Resistance	RPU5	RSTB	Vin=GND	300	450	800	KΩ
Small Pull-up Resistance	RPU6	RSTB	Vin=1V	10	30	60	KΩ
Large Pull-down Resistance	RPD1	TEST	Vin=VDD	250	500	800	KΩ
Small Pull-down Resistance	RPD2	TEST	Vin=0.5V	3	6	12	KΩ
Output Current	IOH1	PA[4:7], PB[0:7] (as general output port)	VDD=1.5V, VOH=1.2V, LCD enabled	-0.7	-0.9	-1.3	mA
	IOL1		VDD=1.5V, VOL=0.2V, LCD enabled	0.7	0.9	1.3	
Large Pull-up Resistance	RPU1	PA[0:7]	Key high resistance, pulled up by R2, LCD enabled, Vin2=0.5V	180	280	430	KΩ
	RPU3	PB[0:7]	Vin=0.5V, LCD enabled	200	320	500	
Small Pull-up Resistance	RPU2	PA[0:3]	Key high resistance, pulled up by R2//R1, LCD enabled, Vin2=0 V	12	18	26	KΩ
	RPU4	PA[4:7]	Vin=1V, LCD enabled	40	60	95	
Data retention voltage	Vret			1.2	-	-	V
Power on reset voltage	Vpor			1.0	1.05	1.1	V
LCD Driver							
LCD Display Output ON-resistance	ROC	Com[0:4]	VOH=V30 +/- 0.2V	0.35	0.4	0.5	KΩ
			VOM=V20 +/- 0.2V	0.55	0.65	0.75	
			VOM=V10 +/- 0.2V	0.35	0.40	0.45	
			VOL=0.2V	0.25	0.3	0.35	
	ROS	Seg[0:39]	VOH=V30 +/- 0.2V	0.35	0.4	0.5	KΩ
			VOM=V15 +/- 0.2V	0.45	0.6	0.85	
			VOL=0.2V	0.25	0.3	0.35	
Strobe Output ON-resistance	ROP	Seg[0:15] (as key strobe)	V=VDD-0.2V	145	200	280	KΩ
	RON		V=0.2V	1	1.2	1.5	

10 Pin Type Circuit Diagrams

■ Reset Pin Type

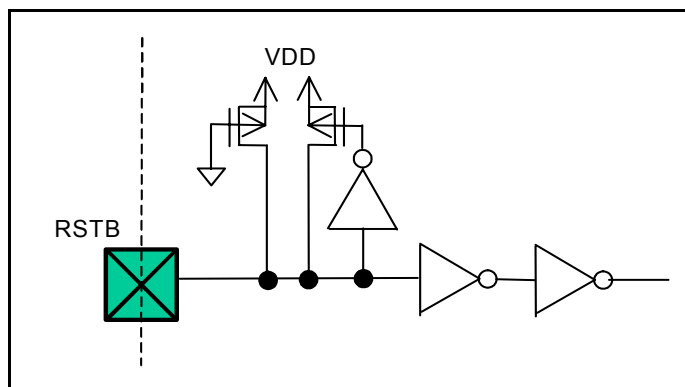


Figure 10-1a Reset Pin Type Circuit Diagram

■ Test Pin Type

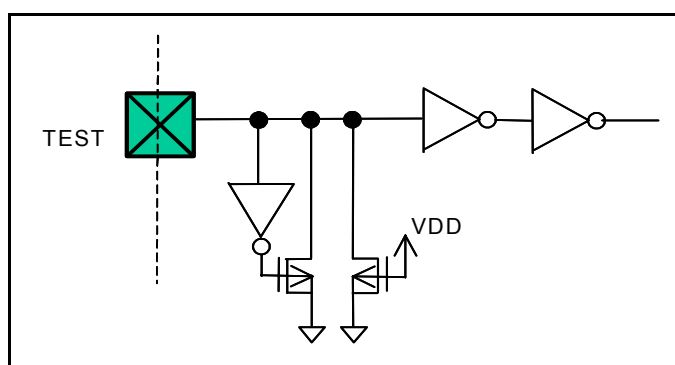


Figure 10-1b Test Pin Type Circuit Diagram

■ Oscillator Pin Type

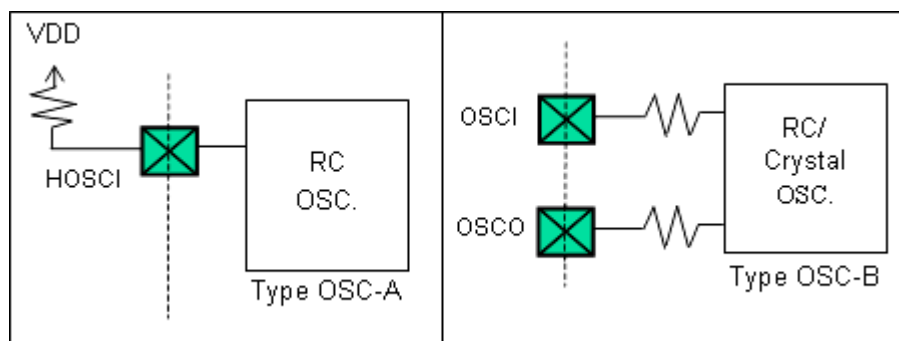


Fig. 10-1c Oscillator Pin Type Circuit Diagram

■ **Input Pin Type(PA.0~3)**

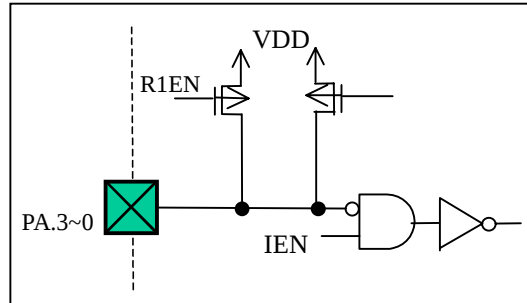


Figure 10-4 Input Pin Type Circuit Diagram

■ **I/O Pin Type(PA.4~7)**

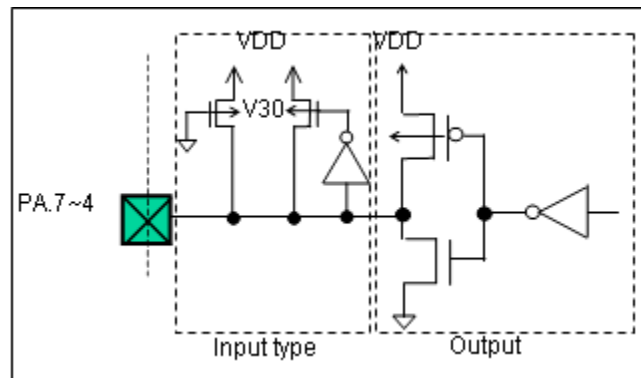


Figure 10-1d I/O Pin Type Circuit Diagram

■ **SEG and I/O Share Pin Type**

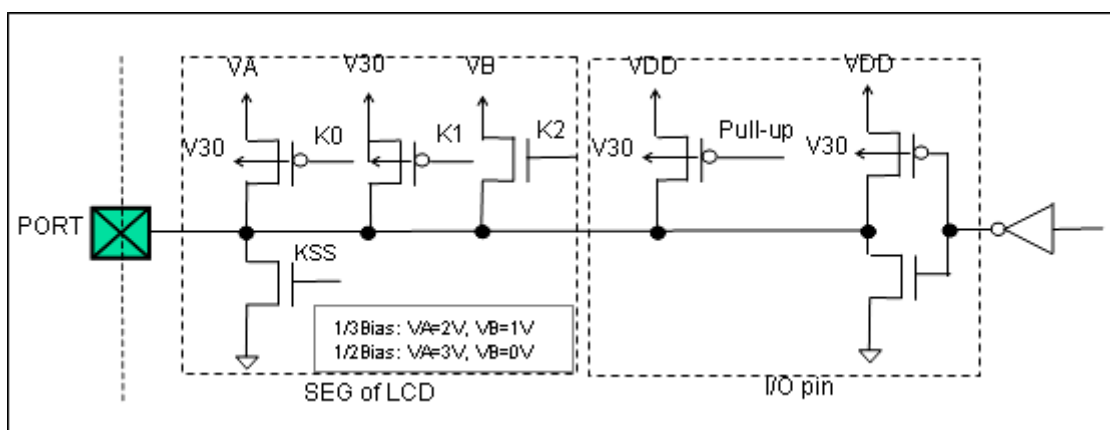
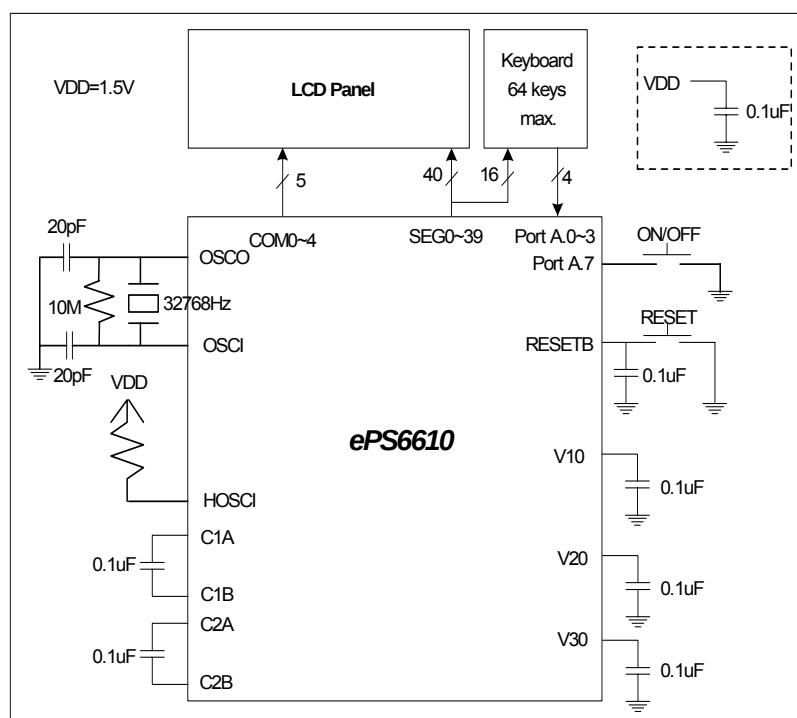
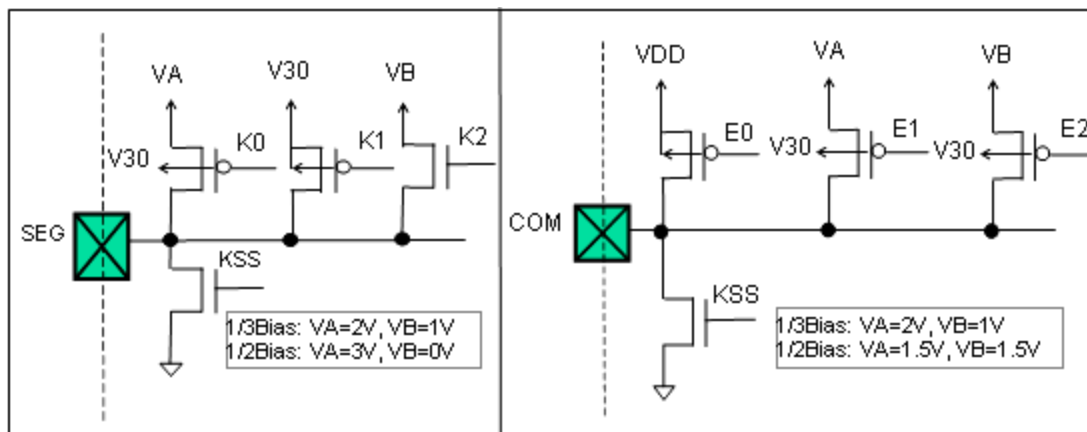


Fig 10-1e SEG and I/O Share Pin Type Circuit Diagram



12 Instruction Set

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

Type	Binary Instruction	Mnemonic	Operation	Status Affected	Cycle
System Control	0000 0000 0000 0000	NOP	No operation	None	1
	0000 0000 0000 0001	WDTC	WDT ← 0; /TO ← 1; /PD ← 1	None	1
	0000 0000 0000 0010	SLEP	Enter IDLE MODE if MS1=1 Enter SLEEP MODE if MS1=0	None	1
	0010 0111 rrrr rrrr	RPT r ("r" is the content of register r)	Single repeat (r) times on next instruction	None	1
	0100 0011 kkkk kkkk	BANK #k	BSR ← k	None	1
Subroutine	0011 aaaa aaaa aaaa	S0CALL addr	Top of Stack] ← PC+1 PC[11:0] ← addr PC[12:16] ← 00000 (*5)	None	1
	111a aaaa aaaa aaaa	SCALL addr	[Top of Stack] ← PC+1; PC[12:0] ← addr; PC[13:16] unchanged	None	1
	0000 0000 0011 0000 00aa aaaa aaaa aaaa	LCALL addr (two words)	[Top of Stack] ← PC+1; PC ← addr	None	2
	0010 1011 1111 1110	RET	PC ← (Top of Stack)	None	1
	0010 1011 1111 1111	RETI	PC ← (Top of Stack); Enable Interrupt	None	1
Compare	0010 0101 rrrr rrrr	TEST r	Z ← 0 if r > 0; Z ← 1 if r = 0	Z	1
Jump	110a aaaa aaaa aaaa	SJMP addr	PC ← addr PC[13..15] unchange	None	1
	0000 0000 0010 0000 00aa aaaa aaaa aaaa	LJMP addr (two words)	PC ← addr	None	2
Compare & Jump	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 (*3)	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 (*3)	None	2
	0100 0111 kkkk kkkk aaaa aaaa aaaa aaaa	JGE A,#k,addr	Jump to addr if A k PC[15:0] ← addr (*3)	None	2
	0100 1000 kkkk kkkk aaaa aaaa aaaa aaaa	JLE A,#k,addr	Jump to addr if A k PC[15:0] ← addr (*3)	None	2
	0100 1001 kkkk kkkk aaaa aaaa aaaa aaaa	JE A,#k,addr	Jump to addr if A=k PC[15:0] ← addr (*3)	None	2
	0101 0101 rrrr rrrr aaaa aaaa aaaa aaaa	JGE A,r,addr	Jump to addr if A r PC[15:0] ← addr (*3)	None	2
	0101 0110 rrrr rrrr aaaa aaaa aaaa aaaa	JLE A,r,addr	Jump to addr if A r PC[15:0] ← addr (*3)	None	2
	0101 0111 rrrr rrrr aaaa aaaa aaaa aaaa	JE A,r,addr	Jump to addr if A=r PC[15:0] ← addr (*3)	None	2
Bit Compare and Jump	0101 1bbb rrrr rrrr aaaa aaaa aaaa aaaa	JBC r,b,addr	If r(b)=0, jump to addr PC[15:0] ← addr (*3)	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 (*3)	None	2
Data Transfer	0010 0000 rrrr rrrr	MOV A,r	A ← r	Z	1
	0010 0001 rrrr rrrr	MOV r,A	r ← A	None	1
	100p pppp rrrr rrrr	MOVVR p,r	Register p ← Register r	None	1
	101p pppp rrrr rrrr	MOVVR r,p	Register r ← Register p	None	1
	0100 1110 kkkk kkkk	MOV A,#k	A ← k	None	1
	0010 0100 rrrr rrrr	CLR r	r ← 0	Z	1
Rom 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	2
	0010 1111 rrrr rrrr	TBRD A,r	r ← ROM[(TABPTR+ACC)] (*2)	None	2

Type	Binary Instruction	Mnemonic	Operation	Status Affected	Cycle
Logic Operation	0000 0010 rrrr rrrr	OR A,r	$A \leftarrow A \text{.or. } r$	Z	1
	0000 0011 rrrr rrrr	OR r,A	$r \leftarrow r \text{.or. } A$	Z	1
	0100 0100 kkkk kkkk	OR A,#k	$A \leftarrow A \text{.or. } k$	Z	1
	0000 0100 rrrr rrrr	AND A,r	$A \leftarrow A \text{.and. } r$	Z	1
	0000 0101 rrrr rrrr	AND r,A	$r \leftarrow r \text{.and. } A$	Z	1
	0100 0101 kkkk kkkk	AND A,#k	$A \leftarrow A \text{.and. } k$	Z	1
	0000 0110 rrrr rrrr	XOR A,r	$A \leftarrow A \text{.xor. } r$	Z	1
	0000 0111 rrrr rrrr	XOR r,A	$r \leftarrow r \text{.xor. } A$	Z	1
	0100 0110 kkkk kkkk	XOR A,#k	$A \leftarrow A \text{.xor. } k$	Z	1
	0000 1000 rrrr rrrr	COMA r	$A \leftarrow /r$	Z	1
Arithmetic Operation	0000 1001 rrrr rrrr	COM r	$r \leftarrow /r$	Z	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 0000 rrrr rrrr	ADD A,r	$A \leftarrow A+r$	C,DC,Z,OV,SGE,SLE	1
	0001 0001 rrrr rrrr	ADD r,A	$r \leftarrow r+A$ (*4)	C,DC,Z,OV,SGE,SLE	1
	0100 1010 kkkk kkkk	ADD A,#k	$A \leftarrow A+k$	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 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
	0001 0110 rrrr rrrr	SUB A,r	$A \leftarrow r-A$ (*6)	C,DC,Z,OV,SGE,SLE	1
	0001 0111 rrrr rrrr	SUB r,A	$r \leftarrow r-A$ (*6)	C,DC,Z,OV,SGE,SLE	1
	0100 1100 kkkk kkkk	SUB A,#k	$A \leftarrow k-A$ (*6)	C,DC,Z,OV,SGE,SLE	1
	0001 1000 rrrr rrrr	SUBB A,r	$A \leftarrow r-A/C$ (*6)	C,DC,Z,OV,SGE,SLE	1
	0001 1001 rrrr rrrr	SUBB r,A	$r \leftarrow r-A/C$ (*6)	C,DC,Z,OV,SGE,SLE	1
	0100 1101 kkkk kkkk	SUBB A,#k	$A \leftarrow k-A/C$ (*6)	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
Rotate	0000 1010 rrrr rrrr	RRCA r	$A(n-1) \leftarrow r(n); C \leftarrow r(0); A(7) \leftarrow C$	C	1
	0000 1011 rrrr rrrr	RRC r	$r(n-1) \leftarrow r(n); C \leftarrow r(0); r(7) \leftarrow C$	C	1
	0000 1100 rrrr rrrr	RLCA r	$A(n+1) \leftarrow r(n); C \leftarrow r(7); A(0) \leftarrow C$	C	1
	0000 1101 rrrr rrrr	RLC r	$r(n+1) \leftarrow r(n); C \leftarrow r(7); r(0) \leftarrow C$	C	1
Shift	0010 0010 rrrr rrrr	SHRA r	$A(n-1) \leftarrow r(n); A(7) \leftarrow C$	None	1
	0010 0011 rrrr rrrr	SHLA r	$A(n+1) \leftarrow r(n); A(0) \leftarrow C$	None	1
Exchange	0101 0100 rrrr rrrr	EX r	$r(7-0) \leftrightarrow A(7-0)$	None	1
Bit Manipulation	0110 1bbb rrrr rrrr	BC r,b	$r(b) \leftarrow 0$	None	1
	0111 0bbb rrrr rrrr	BS r,b	$r(b) \leftarrow 1$	None	1
	0111 1bbb rrrr rrrr	BTG r,b	$r(b) \leftarrow /r(b)$	None	1
	0101 0010 rrrr rrrr	EXL r	$r(3-0) \leftrightarrow A(3-0)$	None	1
Nibble Operation	0101 0011 rrrr rrrr	EXH r	$r(7-4) \leftrightarrow A(3-0)$	None	1
	0010 0110 rrrr rrrr	MOVL r,A	$r(3-0) \leftarrow A(3-0)$	None	1
	0010 1000 rrrr rrrr	MOVH r,A	$r(7-4) \leftarrow A(3-0)$	None	1
	0010 1001 rrrr rrrr	MOVL A,r	$A(3-0) \leftarrow r(3-0); A(7-4) \leftarrow 0$	None	1
	0010 1010 rrrr rrrr	MOVH A,r	$A(3-0) \leftarrow r(7-4); A(7-4) \leftarrow 0$	None	1
	0000 0001 rrrr rrrr	SFR4 r	$r(7-4) \leftarrow A(3-0); r(3-0) \leftarrow r(7-4); A(3-0) \leftarrow r(3-0)$	None	1
	0100 1111 rrrr rrrr	SFL4 r	$r(3-0) \leftarrow A(3-0); r(7-4) \leftarrow r(3-0); A(3-0) \leftarrow r(7-4)$	None	1
	0000 1111 rrrr rrrr	SWAP r	$r(0:3) \leftrightarrow r(4:7)$	None	1
	0000 1110 rrrr rrrr	SWAPA r	$r(0:3) \rightarrow A(4:7); r(4:7) \rightarrow A(0:3)$	None	1

(*1) TBRD i, r:

$r \leftarrow \text{ROM}[(\text{TABPTR})]$

i=00: TABPTR no change

wi=01: TABPTR $\leftarrow$ TABPTR+1

i=10: TABPTR $\leftarrow$ TABPTR-1

(*2) $TABPTR = (TABPTRM: TABPTRL)$

Bit 0 = 0: Low byte of the pointed ROM data

Bit 0 = 1: High byte of the pointed ROM data

NOTE

- Bit 0 of TABPTRL is used to select either low byte or high byte of the pointed ROM data.
- The maximum table look-up space is internal 16K bytes (8K words).

(*3) The maximum jump range is 8K words absolute address

(*4) Carry bit of "ADD PCL, A" or "ADD TABPTRL, A" will automatically carry into PCM or TABPTRM. The Instruction cycle of write to PC (program counter) takes two cycles.

(*5) S0CALL addressing ability is from 0x000 to 0xFFFF (4K words space)

(*6) When in SUB operation, borrow flag is indicated by the inverse of the carry bit, that is $B=/C$

13 Pad Diagram and Locations

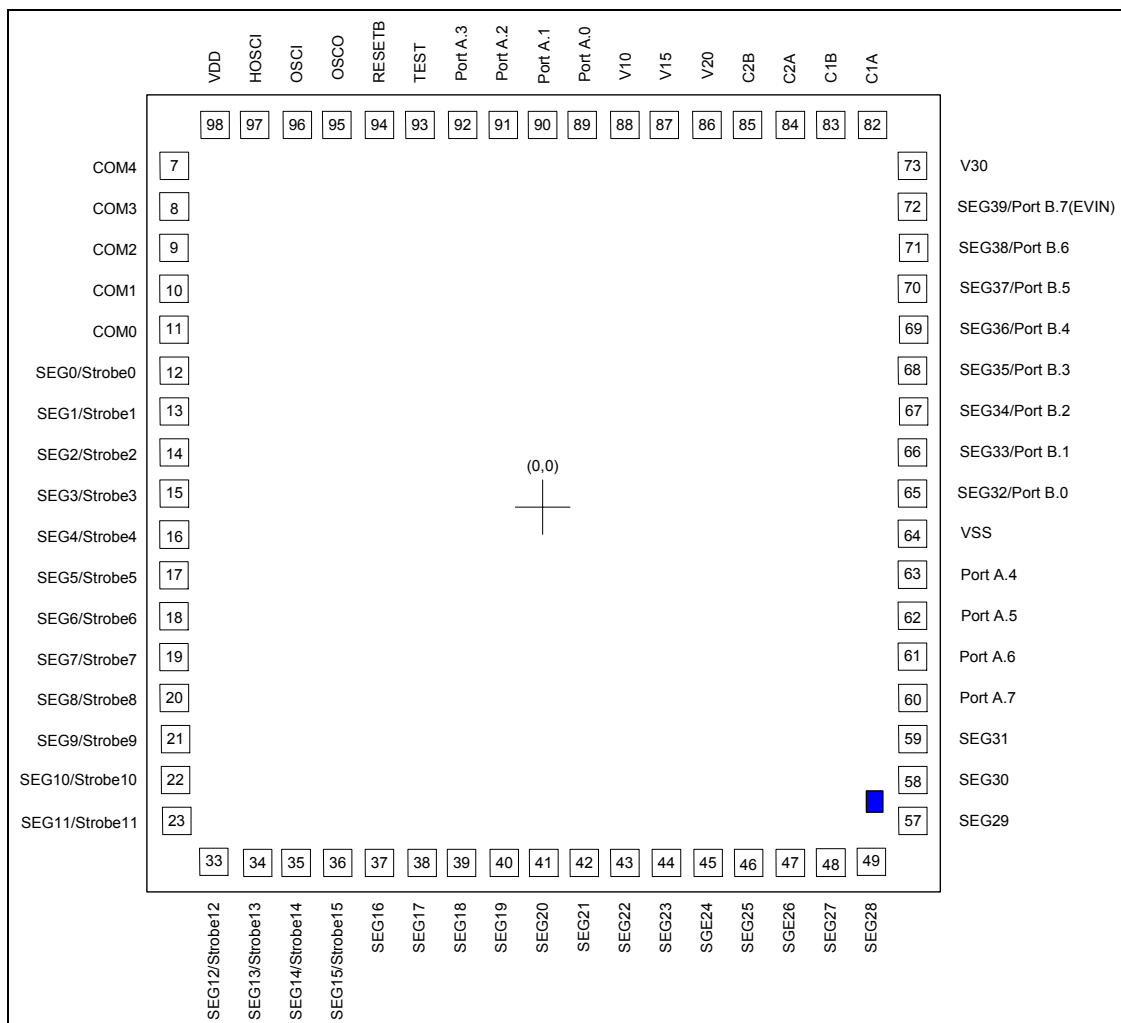


Figure 13-1 ePS6610 98 Pin-Out

13.1 Pad Coordinates

■ Chip Size: 1800 × 1920 μm^2

Pin No.	Symbol	X	Y
1	NC	-	-
2	NC	-	-
3	NC	-	-
4	NC	-	-
5	NC	-	-
6	NC	-	-
7	COM4	-796.65	719.55
8	COM3	-796.65	629.55
9	COM2	-796.65	539.55
10	COM1	-796.65	449.55
11	COM0	-796.65	359.55
12	SEG0/Strobe0	-796.65	269.55
13	SEG1/Strobe1	-796.65	179.55
14	SEG2/Strobe2	-796.65	89.55
15	SEG3/Strobe3	-796.65	-0.45
16	SEG4/Strobe4	-796.65	-90.45
17	SEG5/Strobe5	-796.65	-180.45
18	SEG6/Strobe6	-796.65	-270.45
19	SEG7/Strobe7	-796.65	-360.45
20	SEG8/Strobe8	-796.65	-450.45
21	SEG9/Strobe9	-796.65	-540.45
22	SEG10/Strobe10	-796.65	-630.45
23	SEG11/Strobe11	-796.65	-720.45
24	NC	-	-
25	NC	-	-
26	NC	-	-
27	NC	-	-
28	NC	-	-
29	NC	-	-
30	NC	-	-
31	NC	-	-
32	NC	-	-
33	SEG12/Strobe12	-782.05	-856.65
34	SEG13/Strobe13	-692.05	-856.65
35	SEG14/Strobe14	-602.05	-856.65
36	SEG15/Strobe15	-512.05	-856.65
37	SEG16	-422.05	-856.65
38	SEG17	-332.05	-856.65
39	SEG18	-242.05	-856.65
40	SEG19	-152.05	-856.65

Pin No.	Symbol	X	Y
41	SEG20	-62.05	-856.65
42	SEG21	27.95	-856.65
43	SEG22	117.95	-856.65
44	SEG23	207.95	-856.65
45	SEG24	297.95	-856.65
46	SEG25	387.95	-856.65
47	SEG26	477.95	-856.65
48	SEG27	567.95	-856.65
49	SEG28	657.95	-856.65
50	NC	-	-
51	NC	-	-
52	NC	-	-
53	NC	-	-
54	NC	-	-
55	NC	-	-
56	NC	-	-
57	SEG29	796.65	-842.55
58	SEG30	796.65	-752.55
59	SEG31	796.65	-662.55
60	PortA.7	787.5	-550.15
61	PortA.6	787.5	-460.15
62	PortA.5	787.5	-370.15
63	PortA.4	787.5	-280.15
64	VSS	787.5	-180.15
65	SEG32/PortB.0	787.5	-75
66	SEG33/PortB.1	787.5	23.1
67	SEG34/PortB.2	787.5	121.4
68	SEG35/PortB.3	787.5	219.5
69	SEG36/PortB.4	787.5	317.8
70	SEG37/PortB.5	787.5	415.9
71	SEG38/PortB.6	787.5	514.2
72	SEG39/PortB.7	787.5	612.3
73	V30	787.5	718
74	NC	-	-
75	NC	-	-
76	NC	-	-
77	NC	-	-
78	NC	-	-
79	NC	-	-
80	NC	-	-

(Continuation)

Pin No.	Symbol	X	Y	Pin No.	Symbol	X	Y
81	NC	-	-	91	PortA.1	-32.65	856.65
82	C1A	778.4	856.65	92	PortA.0	-122.65	856.65
83	C1B	688.4	856.65	93	TEST	-213.7	856.65
84	C2A	598.4	856.65	94	RESETB	-303.7	856.65
85	C2B	508.4	856.65	95	OSCO	-393.7	856.65
86	V20	418.4	856.65	96	OSCI	-483.7	856.65
87	V15	328.4	856.65	97	HOSCI	-573.7	856.65
88	V10	238.4	856.65	98	VDD	-675.4	843.6
89	PortA.3	148.4	856.65	99	NC	-	-
90	PortA.2	57.35	856.65	100	NC	-	-

NOTE

For PCB layout, the die pad must be connected to VSS (the IC substrate must be connected to VSS or kept floating).

