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## EM78911

### I. General Description

The EM78911 is an 8-bit CID (Call Identification) RISC type microprocessor with low power , high speed CMOS technology . Integrated onto a single chip are on\_chip watchdog (WDT) , RAM , ROM , programmable real time clock /counter , internal interrupt , power down mode , LCD driver , FSK decoder ,CALL WAITING decoder, DTMF generator and tri-state I/O . The EM78911 provides a single chip solution to design a CID of calling message\_display .

### II. Feature

#### CPU

- Operating voltage range : 2.5V ~ 5.5V
- 16Kx 13 on chip ROM
- 2.8Kx 8 on chip RAM
- **Up to 36 bi-directional tri-state I/O ports**
- 8 level stack for subroutine nesting
- 8-bit real time clock/counter (TCC)
- Two sets of 8 bit counters can be interrupt sources
- Selective signal sources and trigger edges , and with overflow interrupt
- Programmable free running on chip watchdog timer
- 99.9% single instruction cycle commands
- Four modes (internal clock 3.579MHz)
  1. Sleep mode : CPU and 3.579MHz clock turn off, 32.768KHz clock turn off
  2. Idle mode : CPU and 3.579MHz clock turn off, 32.768KHz clock turn on
  3. Green mode : 3.579MHz clock turn off, CPU and 32.768KHz clock turn on
  4. Normal mode : 3.579MHz clock turn on , CPU and 32.768KHz clock turn on
- Ring on voltage detector and low battery detector
- Input port wake up function
- 9 interrupt source , 4 external , 5 internal
- 100 pin QFP or chip
- Port key scan function
- Clock frequency 32.768KHz
- **Eight R-option pins**

#### CID

- Operation Voltage 3.5 ~ 6V for FSK
- Operation Voltage 2.5 ~ 6V for DTMF
- Bell 202 , V.23 FSK demodulator
- DTMF generator
- Ring detector on chip

#### CALL WAITING

- Operation Voltage 3.6 ~ 5.5V
- Compatible with Bellcore special report SR-TSV-002476
- Call-Waiting (2130Hz plus 2750Hz) Alert Signal Detector
- Good talkdown and talkoff performance
- Sensitivity compensated by adjusting input OP gain

#### LCD

- LCD operation voltage chosen by software
- Common driver pins : 16
- Segment driver pins : 60
- 1/4 bias



- 1/8,1/16 duty

### III.Application

1. adjunct units
2. answering machines
3. feature phones

### IV.Pin Configuration

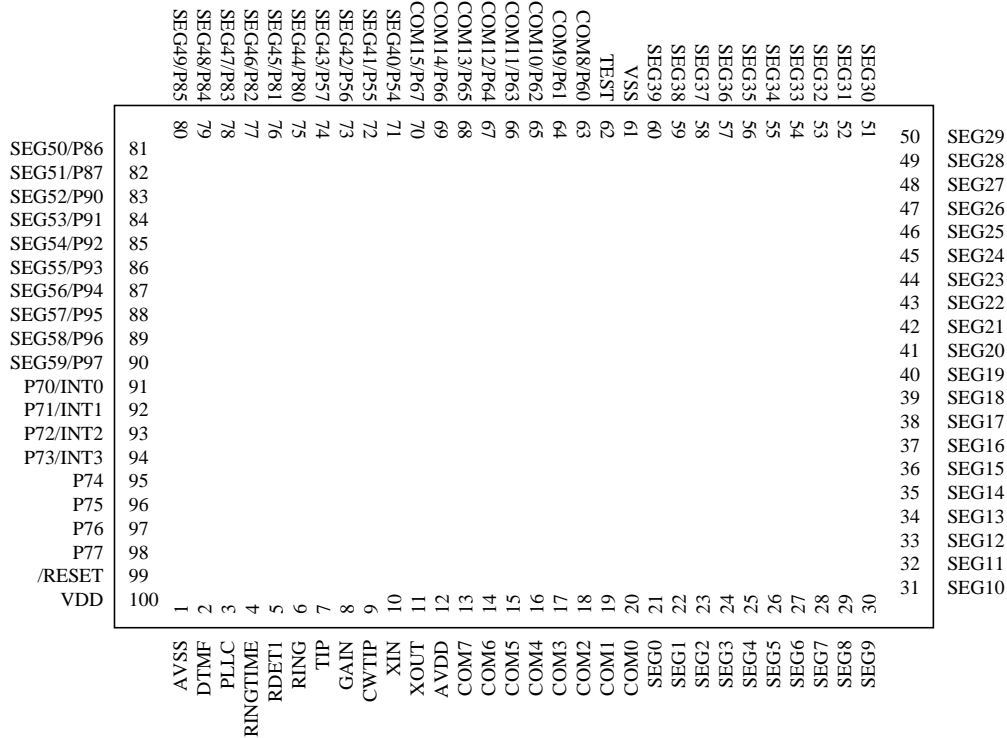


Fig1. Pin Assignment

| OTP writer PIN NAME | MASK ROM PIN NAME | P.S. |
|---------------------|-------------------|------|
| 1.VDD               | VDD,AVDD          |      |
| 2.VPP               | /RESET            |      |
| 3.DINCK             | P77               |      |
| 4.ACLK              | P76               |      |
| 5.PGMB              | P75               |      |
| 6.OEB               | P74               |      |
| 7.DATA              | P73               |      |
| 8.GND               | VSS,AVSS          |      |

## V. Functional Block Diagram

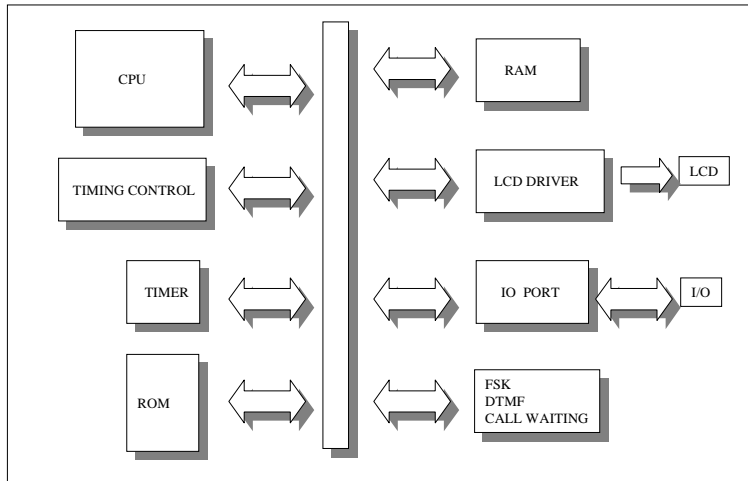


Fig2. Block diagram1

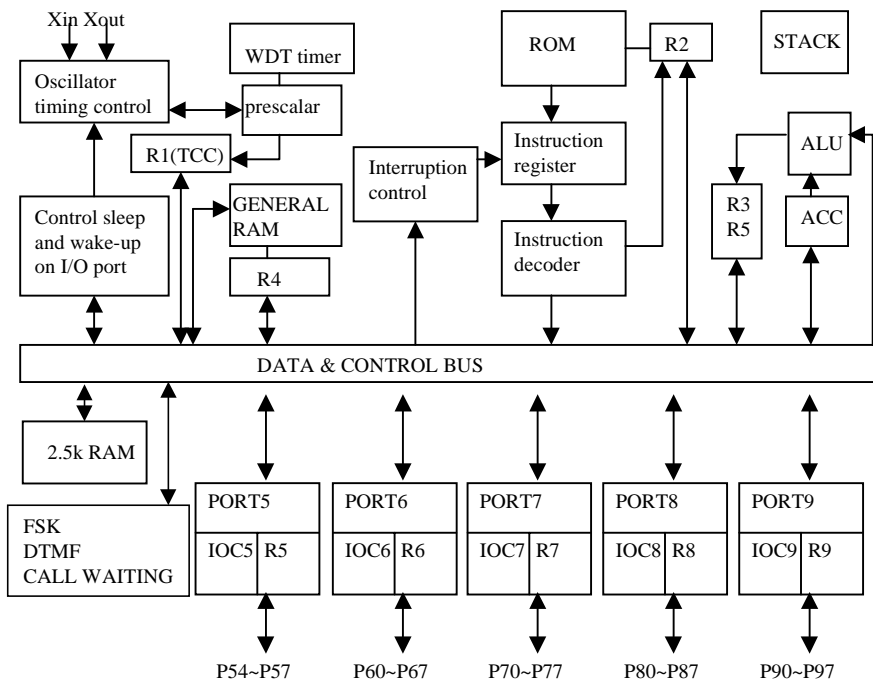


Fig3. Block diagram2



## VI.Pin Descriptions

| PIN  | I/O  | DESCRIPTION  |
|--|--|--|
| VDD<br>AVDD                                  | POWER  | digital power<br>analog power  |
| GND<br>AVSS                                  | POWER  | digital ground<br>analog ground  |
| Xtin   | I  | Input pin for 32.768 kHz oscillator  |
| Xtout  | O  | Output pin for 32.768 kHz oscillator   |
| COM0..COM7<br>COM8..COM15                    | O<br>O (PORT6)   | Common driver pins of LCD drivers  |
| SEG0...SEG43<br>SEG44..SEG51<br>SEG52..SEG59 | O<br>O (PORT8)<br>O (PORT9)                                | Segment driver pins of LCD drivers<br>PORT9 AS FUNCTION KEY CAN WAKE UP WATCHDOG.  |
| PLLCC  | I  | Phase loop lock capacitor, connect a capacitor 0.01u to 0.047u with AVSS   |
| TIP  | I  | Should be connected with TIP side of twisted pair lines for FSK.   |
| RING   | I  | Should be connected with RING side of twisted pair lines for FSK.  |
| CWTIP  | I  | <b>Should be connected with TIP side of twisted pair lines for CW.</b>   |
| GAIN   | I  | <b>OP output pin for gain adjustment.</b>  |
| RDET1  | I  | Detect the energy on the twisted pair lines . These two pins coupled to the twisted pair lines through an attenuating network. |
| /RING TIME                                   | I  | Determine if the incoming ring is valid.An RC network may be connected to the pin.   |
| INT0<br>INT1<br>INT2<br>INT3                 | PORT7(0)<br>PORT7(1)<br>PORT7(2)<br>PORT7(3)<br>PORT7(4:7) | PORT7(0)~PORT7(3) signal can be interrupt signals.<br>Int2 and int3 has the same interrupt flag.<br>IO port                    |
| <b>P5.4 ~P5.7</b>                            | <b>PORT5</b>   | <b>PORT 5 can be INPUT or OUTPUT port each bit.<br/>Shared with LCD segment signals</b>  |
| P6.0 ~P6.7                                   | PORT6  | PORT 6 can be INPUT or OUTPUT port each bit.<br>Shared with LCD common signals   |
| P7.0 ~P7.7                                   | PORT7  | PORT 7 can be INPUT or OUTPUT port each bit.<br>Internal Pull high function.<br>Key scan function.                             |
| P8.0 ~P8.7                                   | PORT8  | PORT 8 can be INPUT or OUTPUT port each bit.<br>And shared with Segment signal.  |
| P9.0 ~P9.7                                   | PORT9  | PORT 9 can be INPUT or OUTPUT port each bit.<br>And can be set to wake up watch dog timer.<br>And shared with Segment signal.  |
| TEST   | I  | Test pin into test mode , normal low   |
| DTMF   | O  | DTMF tone output   |
| RESET  | I  |  |
|  |  |  |

## VII. Functional Descriptions

### VII.1 Operational Registers

#### 1. R0 (Indirect Addressing Register)

\* R0 is not a physically implemented register. It is useful as indirect addressing pointer. Any instruction using R0 as register actually accesses data pointed by the RAM Select Register (R4).

#### 2. R1 (TCC)

\* Increased by an external signal edge applied to TCC, or by the instruction cycle clock.  
Written and read by the program as any other register.

#### 3. R2 (Program Counter)

\* The structure is depicted in Fig. 4.

\* Generates  $16K \times 13$  on-chip ROM addresses to the relative programming instruction codes.

\* "JMP" instruction allows the direct loading of the low 10 program counter bits.

\* "CALL" instruction loads the low 10 bits of the PC, PC+1, and then push into the stack.

\* "RET" ("RETL k", "RETI") instruction loads the program counter with the contents at the top of stack.

\* "MOV R2,A" allows the loading of an address from the A register to the PC, and the ninth and tenth bits are cleared to "0".

\* "ADD R2,A" allows a relative address be added to the current PC, and contents of the ninth and tenth bits are cleared to "0".

\* "TBL" allows a relative address be added to the current PC, and contents of the ninth and tenth bits don't change. The most significant bit (A10~A13) will be loaded with the content of bit PS0~PS3 in the status register (R5) upon the execution of a "JMP", "CALL", "ADD R2,A", or "MOV R2,A" instruction.

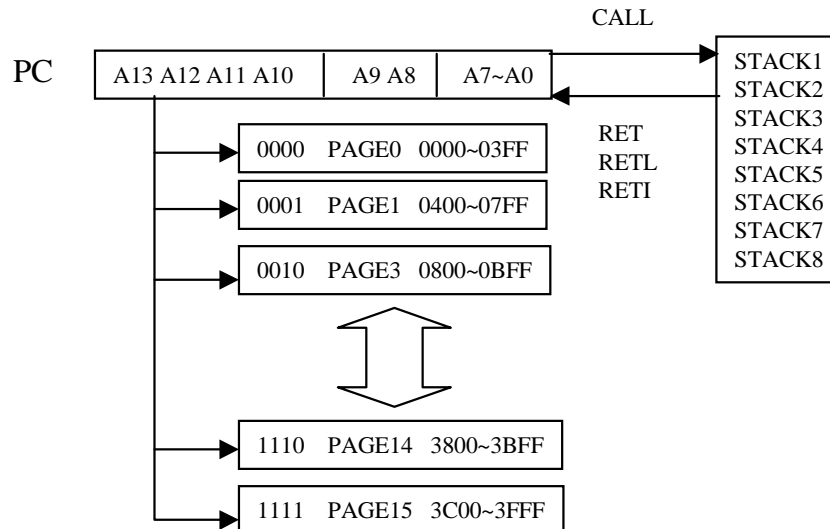


Fig.4 Program counter organization

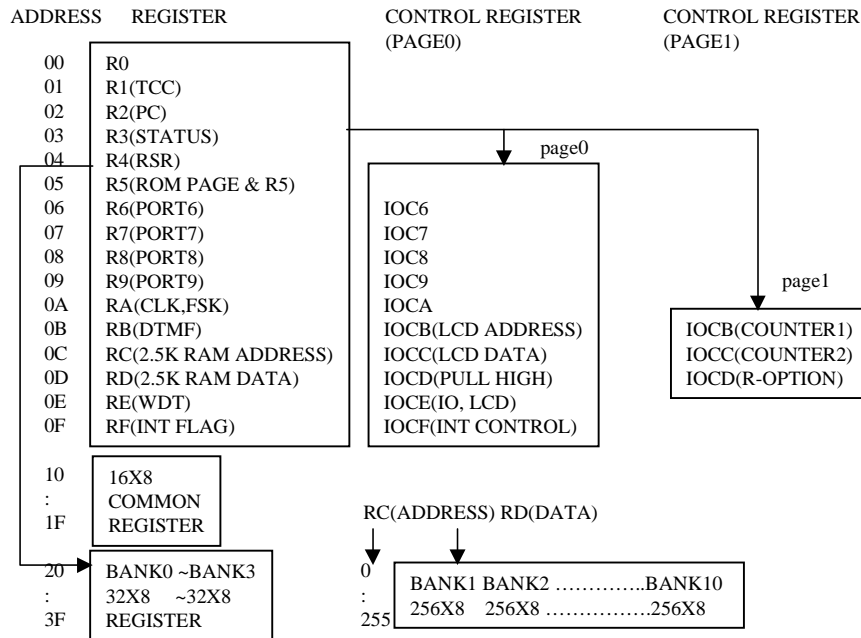


Fig.5 Data memory configuration

4. R3 (Status Register)

|     |      |   |   |   |   |    |   |
|-----|------|---|---|---|---|----|---|
| 7   | 6    | 5 | 4 | 3 | 2 | 1  | 0 |
| CAS | PAGE | - | T | P | Z | DC | C |

- \* Bit 0 (C) Carry flag
- \* Bit 1 (DC) Auxiliary carry flag
- \* Bit 2 (Z) Zero flag
- \* Bit 3 (P) Power down bit. Set to 1 during power on or by a "WDTC" command and reset to 0 by a "SLEP" command.
- \* Bit 4 (T) Time-out bit. Set to 1 by the "SLEP" and "WDTC" command, or during power up and reset to 0 by WDT timeout.

| EVENT                         | T | P | REMARK          |
|-------------------------------|---|---|-----------------|
| WDT wake up from sleep mode   | 0 | 0 |                 |
| WDT time out (not sleep mode) | 0 | 1 |                 |
| /RESET wake up from sleep     | 1 | 0 |                 |
| power up                      | 1 | 1 |                 |
| Low pulse on /RESET           | x | x | x .. don't care |

- \* Bit 5 unused
- \* Bit 6 PAGE : change IOCB ~ IOCE to another page , 0/1 => page0 / page1
- \* Bit7 (CAS : CALL WAITING Output)  
0/1= CW data valid/No data



**5. R4 (RAM Select Register)**

- \* Bits 0 ~ 5 are used to select up to 64 registers in the indirect addressing mode.
- \* Bits 6 ~ 7 determine which bank is activated among the 4 banks.
- \* See the configuration of the data memory in Fig. 5.

**6. R5 (Program Page Select Register)**

|            |            |            |            |     |     |     |     |
|------------|------------|------------|------------|-----|-----|-----|-----|
| 7          | 6          | 5          | 4          | 3   | 2   | 1   | 0   |
| <b>R57</b> | <b>R56</b> | <b>R55</b> | <b>R54</b> | PS3 | PS2 | PS1 | PS0 |

- \* Bit 0 (PS0) ~ 3 (PS3) Page select bits

Page select bits

| PS3 | PS2 | PS1 | PS0 | Program memory page (Address) |
|-----|-----|-----|-----|-------------------------------|
| 0   | 0   | 0   | 0   | Page 0                        |
| 0   | 0   | 0   | 1   | Page 1                        |
| 0   | 0   | 1   | 0   | Page 2                        |
| 0   | 0   | 1   | 1   | Page 3                        |
| 0   | 1   | 0   | 0   | Page 4                        |
| 0   | 1   | 0   | 1   | Page 5                        |
| 0   | 1   | 1   | 0   | Page 6                        |
| 0   | 1   | 1   | 1   | Page 7                        |
| 1   | 0   | 0   | 0   | Page 8                        |
| 1   | 0   | 0   | 1   | Page 9                        |
| 1   | 0   | 1   | 0   | Page 10                       |
| 1   | 0   | 1   | 1   | Page 11                       |
| 1   | 1   | 0   | 0   | Page 12                       |
| 1   | 1   | 0   | 1   | Page 13                       |
| 1   | 1   | 1   | 0   | Page 14                       |
| 1   | 1   | 1   | 1   | Page 15                       |

\*User can use PAGE instruction to change page. To maintain program page by user. Otherwise, user can use far jump (FJMP) or far call (FCALL) instructions to program user's code. And the program page is maintained by EMC's compiler. It will change user's program by inserting instructions within program.

**\*Bit4~7 : PORT5 4-bit I/O register**

**6. R6 ~ R9 (Port 6 ~ Port 9)**

- \* Four 8-bit I/O registers.

**7. RA (FSK Status Register)(bit 0,1,2,4 read only)**

|             |              |             |                 |                |             |            |            |
|-------------|--------------|-------------|-----------------|----------------|-------------|------------|------------|
| 7           | 6            | 5           | 4               | 3              | 2           | 1          | 0          |
| <b>IDLE</b> | <b>/358E</b> | <b>/LPD</b> | <b>/LOW_BAT</b> | <b>/FSKPWR</b> | <b>DATA</b> | <b>/CD</b> | <b>/RD</b> |

- \* Bit0 (Read Only) (Ring detect signal) 0/1 : Ring Valid/Ring Invalid
- \* Bit1 (Read Only) (Carrier detect signal) 0/1 : Carrier Valid/Carrier Invalid
- \* Bit2 (Read Only) (FSK demodulator output signal)  
Fsk data transmitted in a baud rate 1200 Hz.
- \* Bit3 (read/write) (FSK block power up signal)  
1/0 : FSK demodulator block power up/FSK demodulator power down

\* The relation between Bit0 to Bit3 is shown in Fig.6.

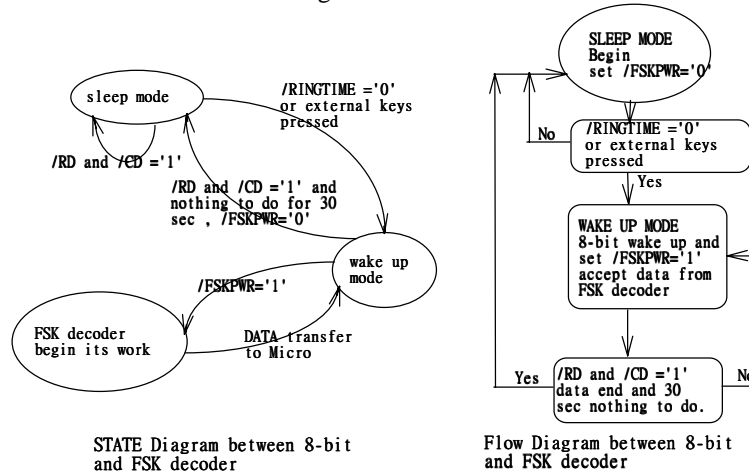


Fig6. The relation between Bit0 to Bit3.

\* Bit4(Read Only)(Low battery signal) 0/1 = Battery voltage is low/Normal .

**If the VDD voltage is under low power range (controlled by IOCA bit0) then sends a '0' signal to /LOW\_BAT bit or a '1' signal to this Bit.**

\* Bit5(read/Write)(Low battery detect enable)  
0/1 = low battery detect DISABLE/ENABLE.

The relation between /LPD,/POVD and /LOW\_BAT can see Fig7.

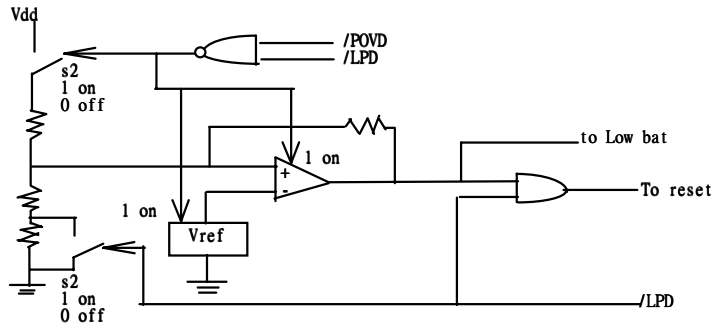


Fig7. The relation between /LPD,/POVD

\* Bit6(read/write)(PLL enable signal)

0/1=DISABLE/ENABLE

The relation between 32.768K and 3.579M can see Fig8.

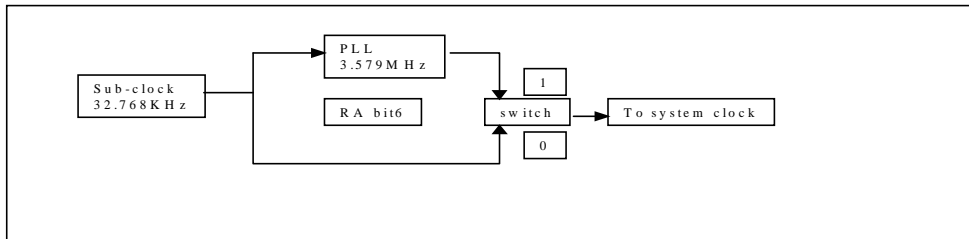


Fig8. The relation between 32.768K and 3.579K .





\* Bit7 IDLE: sleep mode selection bit  
0/1=sleep mode/IDLE mode. This bit will decide SLEP instruction which mode to go.  
These two modes can be waken up by TCC clock or Watch Dog or PORT9 and run from “SLEP” next instruction.

| Wakeup signal          | SLEEP mode              | IDLE mode                                    | GREEN mode               | NORMAL mode              |
|------------------------|-------------------------|--|--------------------------|--------------------------|
|                        | RA(7,6)=(0,0)<br>+ SLEP | RA(7,6)=(1,0)<br>+ SLEP                      | RA(7,6)=(x,0)<br>no SLEP | RA(7,6)=(x,1)<br>no SLEP |
| TCC time out           | X                       | Wake-up<br>+ Interrupt<br>+ Next instruction | Interrupt                | Interrupt                |
| WDT time out           | RESET                   | Wake-up<br>+ Next instruction                | RESET                    | RESET                    |
| Port9<br>/RINGTIME pin | RESET                   | Wake-up<br>+ Next instruction                | X                        | X                        |
| PORT70~73              | X                       | Wake-up<br>+ Interrupt<br>+ Next instruction | Interrupt                | Interrupt                |

\*P70 ~ P73 's wakeup function is controlled by IOCF(1,2,3) and ENI instruction.  
\*P70 's wakeup signal is a rising or falling signal defined by CONT REGISTER bit7.  
\*/RINGTIME pin , Port9 ,Port71,Port72 and Port73 's wakeup signal is a falling edge signal.

8. RB(DTMF tone row and column register) (read/write)

|    |    |    |    |    |    |    |    |
|----|----|----|----|----|----|----|----|
| 7  | 6  | 5  | 4  | 3  | 2  | 1  | 0  |
| c7 | c6 | c5 | c4 | r3 | r2 | r1 | r0 |

\* Bit 0 - Bit 3 are row-frequency tone.  
\* Bit 4 - Bit 7 are column-frequency tone.  
\* Initial RB is equal to high. Bit 7 ~ 0 are all "1", turn off DTMF power .

| bit 3~0     | Row freq |        |          |        |          |
|-------------|----------|--------|----------|--------|----------|
| 1110        | 699.2Hz  | 1      | 2        | 3      | A        |
| 1101        | 771.6Hz  | 4      | 5        | 6      | B        |
| 1011        | 854Hz    | 7      | 8        | 9      | C        |
| 0111        | 940.1Hz  | *      | 0        | #      | D        |
| Column freq |          | 1203Hz | 1331.8Hz | 1472Hz | 1645.2Hz |
| bit 7~4     |          | 1110   | 1101     | 1011   | 0111     |

9. RC(CALLER ID address)(read/write)

|       |       |       |       |       |       |       |       |
|-------|-------|-------|-------|-------|-------|-------|-------|
| 7     | 6     | 5     | 4     | 3     | 2     | 1     | 0     |
| CIDA7 | CIDA6 | CIDA5 | CIDA4 | CIDA3 | CIDA2 | CIDA1 | CIDA0 |

\* Bit 0 ~ Bit 7 select CALLER ID RAM address up to 256.

10. RD(CALLER ID RAM data)(read/write)

\* Bit 0 ~ Bit 8 are CALLER ID RAM data transfer register.  
User can see IOCA register how to select CID RAM banks.

11. RE(LCD Driver,WDT Control)(read/write)

|       |       |        |        |         |        |        |       |
|-------|-------|--------|--------|---------|--------|--------|-------|
| 7     | 6     | 5      | 4      | 3       | 2      | 1      | 0     |
| CWPWR | /WDTE | /WUP9H | /WUP9L | /WURING | LCD_C2 | LCD_C1 | LCD_M |

\* Bit0 (LCD\_M):LCD\_M decides the methods, including duty, bias, and frame frequency.

\* Bit1~Bit2 (LCD\_C#):LCD\_C# decides the LCD display enable or blanking. change the display duty must set the "LCD\_C2,LCD\_C1" to "00".

| LCD_C2,LCD_C1 | LCD Display Control                  | LCD_M  | duty        | bias       |
|---------------|--------------------------------------|--------|-------------|------------|
| 0 0           | change duty<br>Disable(turn off LCD) | 0<br>1 | 1/16<br>1/8 | 1/4<br>1/4 |
| 0 1           | Blanking                             | :      | :           | :          |
| 1 1           | LCD display enable                   | :      | :           | :          |

\* Bit3 (/WURING, RING Wake Up Enable): used to enable the wake-up function of /RINGTIME input pin. (1/0=enable/disable)

\* Bit4 (/WUP9L, PORT9 low nibble Wake Up Enable): used to enable the wake-up function of low nibble in PORT9.(1/0=enable/disable)

\* Bit5 (/WUP9H, PORT9 high nibble Wake Up Enable): used to enable the wake-up function of high nibble in PORT9.(1/0=enable/disable)

\* Bit6 (/WDTE, Watch Dog Timer Enable)

Control bit used to enable Watchdog timer.(1/0=enable/disable)

The relation between Bit3 to Bit6 can see the diagram 9.

\* Bit7(Power control of Call Waiting circuit)

.(1/0=enable circuit /disable circuit) Please enable PLL before enable Call Waiting circuit.

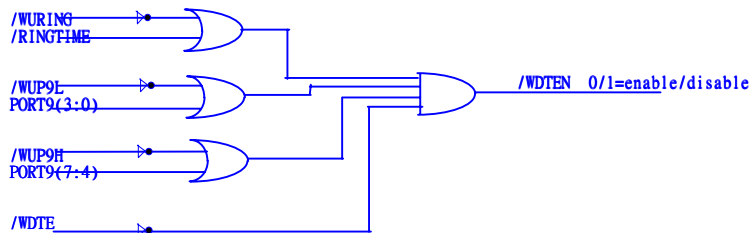


fig.9 Wake up function and control signal

12. RF (Interrupt Status Register)

|      |        |      |      |      |      |      |      |
|------|--------|------|------|------|------|------|------|
| 7    | 6      | 5    | 4    | 3    | 2    | 1    | 0    |
| INT3 | FSK/CW | C8_2 | C8_1 | INT2 | INT1 | INT0 | TCIF |

\* "1" means interrupt request, "0" means non-interrupt

\* Bit 0 (TCIF) TCC timer overflow interrupt flag. Set when TCC timer overflows .

\* Bit 1 (INT0) external INT0 pin interrupt flag .

\* Bit 2 (INT1) external INT1 pin interrupt flag .

\* Bit 3 (INT2) external INT2pin interrupt flag .

\* Bit 4 (C8\_1) internal 8 bit counter interrupt flag .

\* Bit 5 (C8\_2) internal 8 bit counter interrupt flag .

\* Bit 6 ( FSK/CW ) FSK data or Call waiting data interrupt flag

\* Bit 7 (INT3) external INT3 pin interrupt flag.

\* High to low edge trigger , Refer to the Interrupt subsection.

\* IOCF is the interrupt mask register. User can read and clear.



### 13. R10~R3F (General Purpose Register)

- \* R10~R3F (Banks 0~3) all are general purpose registers.

## VII.2 Special Purpose Registers

### 1. A (Accumulator)

- \* Internal data transfer, or instruction operand holding
- \* It's not an addressable register.

### 2. CONT (Control Register)

|                 |     |    |    |     |      |      |      |
|-----------------|-----|----|----|-----|------|------|------|
| 7               | 6   | 5  | 4  | 3   | 2    | 1    | 0    |
| <b>INT_EDGE</b> | INT | TS | TE | PAB | PSR2 | PSR1 | PSR0 |

- \* Bit 0 (PSR0) ~ Bit 2 (PSR2) TCC/WDT prescaler bits.

| PSR2 | PSR1 | PSR0 | TCC Rate | WDT Rate |
|------|------|------|----------|----------|
| 0    | 0    | 0    | 1:2      | 1:1      |
| 0    | 0    | 1    | 1:4      | 1:2      |
| 0    | 1    | 0    | 1:8      | 1:4      |
| 0    | 1    | 1    | 1:16     | 1:8      |
| 1    | 0    | 0    | 1:32     | 1:16     |
| 1    | 0    | 1    | 1:64     | 1:32     |
| 1    | 1    | 0    | 1:128    | 1:64     |
| 1    | 1    | 1    | 1:256    | 1:128    |

- \* Bit 3 (PAB) Prescaler assignment bit.  
0/1 : TCC/WDT
- \* Bit 4 (TE) TCC signal edge  
0: increment from low to high transition on TCC  
1: increment from high to low transition on TCC
- \* Bit 5 (TS) TCC signal source  
0: internal instruction cycle clock  
**1: 16.384KHz**
- \* Bit 6 : (INT)INT enable flag  
0: interrupt masked by DISI or hardware interrupt  
1: interrupt enabled by ENI/RETI instructions
- \* **Bit 7 : INT\_EDGE**  
**0:P70 's interruption source is a rising edge signal.**  
**1:P70 's interruption source is a falling edge signal.**

- \* CONT register is readable and writable.



3. IOC5 (I/O Port Control Register)

|              |              |              |              |          |          |          |            |
|--------------|--------------|--------------|--------------|----------|----------|----------|------------|
| 7            | 6            | 5            | 4            | 3        | 2        | 1        | 0          |
| <b>IOC57</b> | <b>IOC56</b> | <b>IOC55</b> | <b>IOC54</b> | <b>0</b> | <b>0</b> | <b>0</b> | <b>P5S</b> |

\* **Bit0: P5S is switch register for I/O port or LCD signal switching.**

0/1= normal I/O port/SEGMENT output .

\* **Bit1~3: unused**

\* **Bit 4 to Bit7 are PORT5 I/O direction control registers.**

\* "1" put the relative I/O pin into high impedance, while "0" put the relative I/O pin as output.

4. IOC6 ~ IOC9 (I/O Port Control Register)

\* four I/O direction control registers.

\* "1" put the relative I/O pin into high impedance, while "0" put the relative I/O pin as output.

\* User can see IOCB register how to switch to normal I/O port.

5. IOCA (CALLER ID RAM,IO ,PAGE Control Register)(read/write,initial "00000000")

|             |             |          |               |               |               |               |              |
|-------------|-------------|----------|---------------|---------------|---------------|---------------|--------------|
| 7           | 6           | 5        | 4             | 3             | 2             | 1             | 0            |
| <b>P8SH</b> | <b>P8SL</b> | <b>0</b> | <b>CALL_4</b> | <b>CALL_3</b> | <b>CALL_2</b> | <b>CALL_1</b> | <b>RANGE</b> |

\* Bit0 : register to control low power detection range .

0/1=3.2V/3.6V

\* Bit4~Bit1:"000" to "1001" are ten blocks of CALLER ID RAM area. User can use 2.5K RAM with RD ram address.

\* Bit 5 unused

\* Bit6: port8 low nibble switch, 0/1= normal I/O port/SEGMENT output .

\* Bit7: port8 high nibble switch , 0/1= normal I/O port/SEGMENT output

6. IOCB (LCD ADDRESS)

**PAGE0** : Bit6 ~ Bit0 = LCDA6 ~ LCDA0

The LCD display data is stored in the data RAM . The relation of data area and COM/SEG pin is as below:

|                    |                   |       |
|--------------------|-------------------|-------|
| COM15 ~ COM8       | COM7 ~ COM0       |       |
| 40H (Bit15 ~ Bit8) | 00H (Bit7 ~ Bit0) | SEG0  |
| 41H                | 01H               | SEG1  |
| :                  | :                 | :     |
| :                  | :                 | :     |
| :                  | :                 | :     |
| :                  | :                 | :     |
| 7AH                | 4AH               | SEG58 |
| 7BH                | 3BH               | SEG59 |
| 7CH                | 3CH               | Empty |
| :                  | :                 | :     |
| 7FH                | 3FH               | Empty |

**PAGE1** : 8 bit up-counter (COUNTER1) preset and read out register . ( write = preset ) . After a interruption , it will count from "00".



### 7. IOCC (LCD DATA)

**PAGE0** : Bit7 ~ Bit0 = LCD RAM data register

**PAGE1** : 8 bit up-counter (COUNTER2) preset and read out register . ( write = preset) After a interruption , it will count from “00”.

### 8. IOCD (Pull-high Control Register)

**PAGE0:**

|     |     |     |     |     |     |     |     |
|-----|-----|-----|-----|-----|-----|-----|-----|
| 7   | 6   | 5   | 4   | 3   | 2   | 1   | 0   |
| PH7 | PH6 | PH5 | PH4 | PH3 | PH2 | PH1 | PH0 |

\* Bit 0 ~ 7 (/PH#) Control bit used to enable the pull-high of PORT7(#) pin.

- 1: Enable internal pull-high
- 0: Disable internal pull-high

**PAGE1:**

|     |     |     |     |     |     |     |     |
|-----|-----|-----|-----|-----|-----|-----|-----|
| 7   | 6   | 5   | 4   | 3   | 2   | 1   | 0   |
| RO7 | RO6 | RO5 | RO4 | RO3 | RO2 | RO1 | RO0 |

\* **Bit 7 ~ 0 (RO7~0) Control bit used to enable the R-OPTION of PORT97~PORT90 pin.**

- 1: Enable**
- 0: Disable**

**RO is used for R-OPTION . Setting RO to ‘1’ will enable the status of R-option pin (P90 ~ P97) to read by controller. Clearing RO will disable R-option function. If the R-option function is used, user must connect PORT9 pins to GND by 560K external register . If the register is connected/disconnected , the R9 will read as “0/1” when RO is set to ‘1’.**

### 9. IOCE (Bias,PLL Control Register)

**PAGE0 :**

|      |      |     |       |       |       |   |    |
|------|------|-----|-------|-------|-------|---|----|
| 7    | 6    | 5   | 4     | 3     | 2     | 1 | 0  |
| P9SH | P9SL | P6S | Bias3 | Bias2 | Bias1 | 0 | SC |

\* Bit 0 :SC (SCAN KEY signal ) 0/1 = disable/enable. Once you enable this bit , all of the LCD signal will have a low pulse during a common period. This pulse has 30us width. Please use the procedure to implement the key scan function.

- a. set port7 as input port
- b. set IOCD page0 port7 pull high
- c. enable scan key signal
- d. Once push a key . Set RA(6)=1 and switch to normal mode.
- e. Blank LCD. Disable scan key signal.
- f. Set P6S =0. Port6 sent probe signal to port7 and read port7. Get the key.
- g. Note!! A probe signal should be delay a instruction at least to another probe signal.
- h. Set P6S =1. Port6 as LCD signal. Enable LCD.

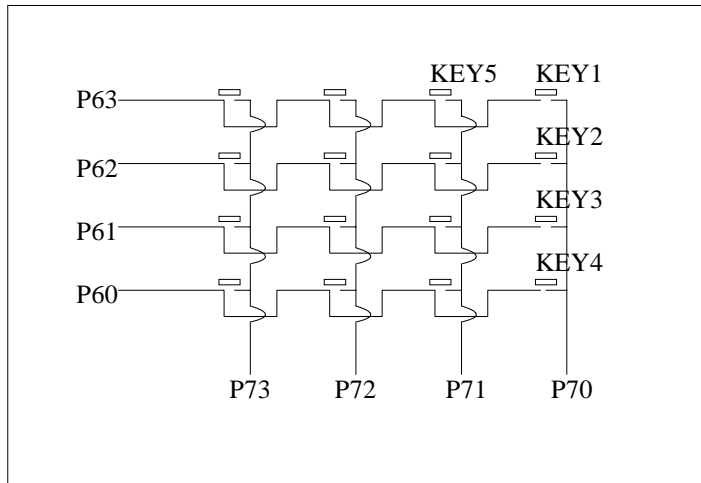


Fig.10. Key scan circuit

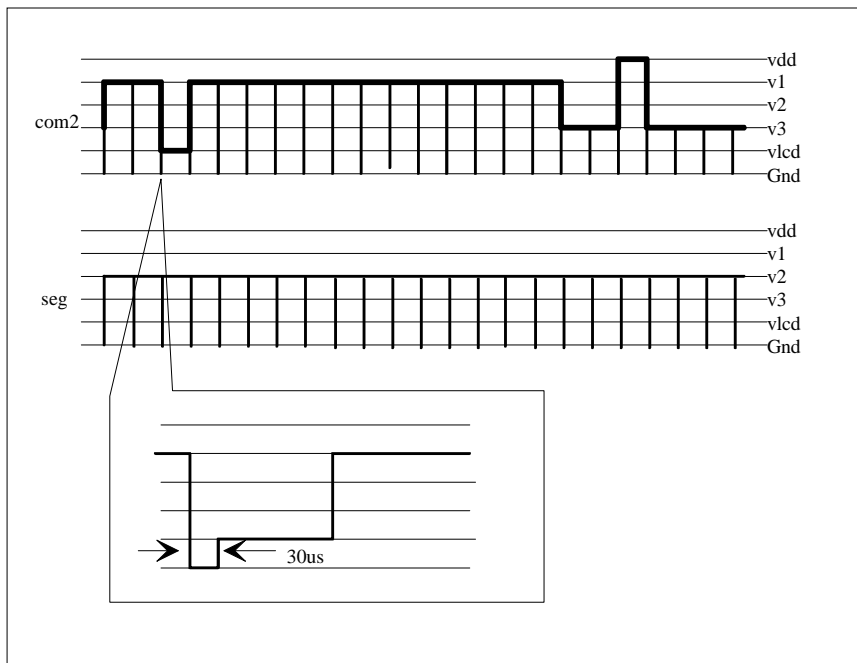


Fig.11.key scan signal

\* Bit 1 :PORT7 PULL HIGH register option. Please use default value.



\* Bit 2~4 (Bias1~Bias3) Control bits used to choose LCD operation voltage .

| LCD operate voltage | Vop (VDD 5V) | VDD=5V |
|---------------------|--------------|--------|
| 000                 | 0.60VDD      | 3.0V   |
| 001                 | 0.66VDD      | 3.3V   |
| 010                 | 0.74VDD      | 3.7V   |
| 011                 | 0.82VDD      | 4.0V   |
| 100                 | 0.87VDD      | 4.4V   |
| 101                 | 0.93VDD      | 4.7V   |
| 110                 | 0.96VDD      | 4.8V   |
| 111                 | 1.00VDD      | 5.0V   |

\* Bit5:port6 switch , 0/1= normal I/O port/COMMON output

\* Bit6:port9 low nibble switch , 0/1= normal I/O port/SEGMENT output . Bit7:port9 high nibble switch

**PAGE1 :**

| 7    | 6    | 5   | 4   | 3    | 2    | 1    | 0 |
|------|------|-----|-----|------|------|------|---|
| OP77 | OP76 | C2S | C1S | PSC1 | PSC0 | CDRD | 0 |

\* Bit0: unused

\* Bit1: cooked data or raw data select bit , 0/1 ==> cooked data/raw data

\* **Bit3~Bit2: counter1 prescaler , reset=(0,0)**

(PSC1,PSC0) = (0,0)=>1:1 , (0,1)=>1:4 , (1,0)=>1:8 , (1,1)=>reserved

\* Bit4:counter1 source , (0/1)=(32768Hz/3.579MHz if enable) scale=1:1

\* Bit5:counter2 source , (0/1)=(32768Hz/3.579MHz if enable) scale=1:1

\* **Bit6:P76 opendrain control (0/1)=(disable/enable)**

\* **Bit7:P77 opendrain control (0/1)=(disable/enable)**

#### 10. IOCF (Interrupt Mask Register)

| 7    | 6      | 5    | 4    | 3    | 2    | 1    | 0    |
|------|--------|------|------|------|------|------|------|
| INT3 | FSK/CW | C8_2 | C8_1 | INT2 | INT1 | INT0 | TCIF |

\* Bit 0 ~ 7 interrupt enable bit.

0: disable interrupt

1: enable interrupt

\* IOCF Register is readable and writable.

### VII.3 TCC/WDT Prescaler

There is an 8-bit counter available as prescaler for the TCC or WDT. The prescaler is available for the TCC only or WDT only at the same time.

- An 8 bit counter is available for TCC or WDT determined by the status of the bit 3 (PAB) of the CONT register.
- See the prescaler ratio in CONT register.
- Fig. 10 depicts the circuit diagram of TCC/WDT.
- Both TCC and prescaler will be cleared by instructions which write to TCC each time.
- The prescaler will be cleared by the WDTC and SLEP instructions, when assigned to WDT mode.

- The prescaler will not be cleared by SLEP instructions, when assigned to TCC mode.

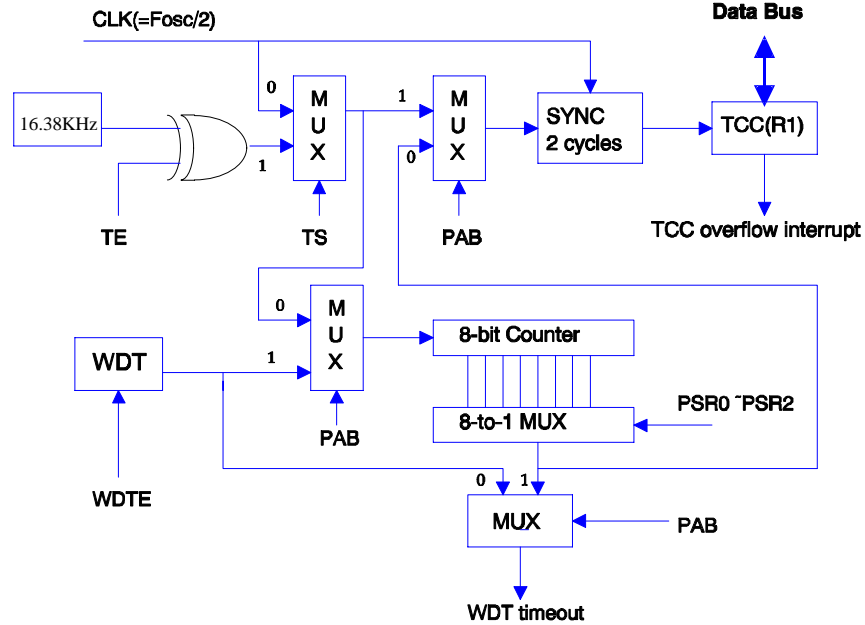


Fig. 10 Block diagram of TCC WDT

#### VII.4 I/O Ports

The I/O registers, Port 6 ~ Port 9, are bi-directional tri-state I/O ports. Port 7 can be pulled-high internally by software control. The I/O ports can be defined as "input" or "output" pins by the I/O control registers (IOC6 ~ IOC9) under program control. The I/O registers and I/O control registers are both readable and writable. The I/O interface circuit is shown in Fig.11.

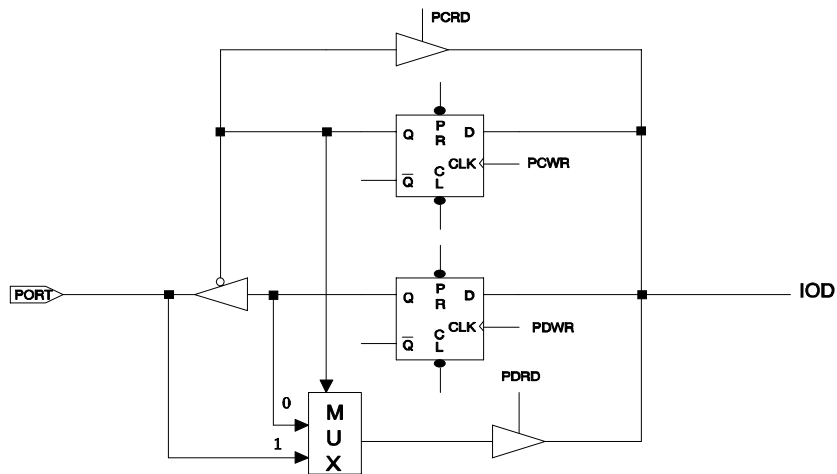


Fig. 11 The circuit of I/O port and I/O control register



## VII.5 RESET and Wake-up

The RESET can be caused by

- (1) Power on reset, or Voltage detector
- (2) WDT timeout. **(if enabled and in GREEN or NORMAL mode)**

Note that only Power on reset, or only Voltage detector in Case(1) is enabled in the system by CODE Option bit. If Voltage detector is disabled, Power on reset is selected in Case (1). Refer to Fig. 12.

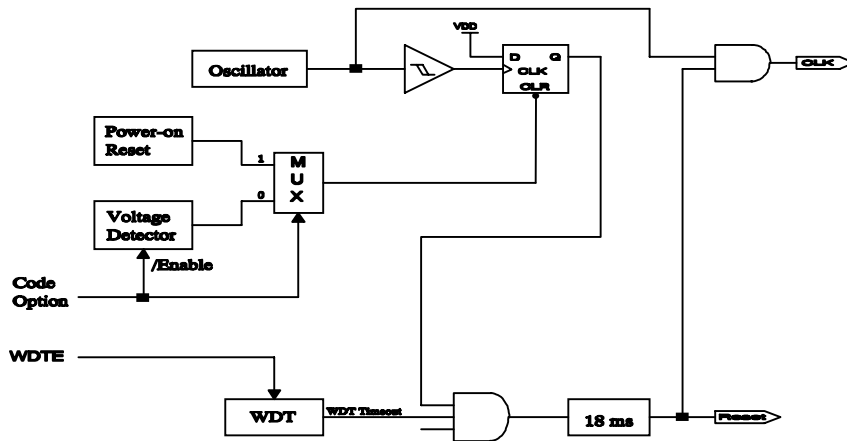


Fig. 12 Block diagram of Reset of controller

**Once the RESET occurs, the following functions are performed.**

- The oscillator is running, or will be started.
- The Program Counter (R2) is set to all "0".
- When power on, the upper 3 bits of R3 and the upper 2 bits of R4 are cleared.
- The Watchdog timer and prescaler are cleared.
- The Watchdog timer is disabled.
- The CONT register is set to all "1"
- The other register (bit7..bit0)

|                 |                         |                                |
|-----------------|-------------------------|--------------------------------|
| R5 = PORT       | IOC5 = "11110000"       |                                |
| R6 = PORT       | IOC6 = "11111111"       |                                |
| R7 = PORT       | IOC7 = "11111111"       |                                |
| R8 = PORT       | IOC8 = "11111111"       |                                |
| R9 = PORT       | IOC9 = "11111111"       |                                |
| RA = "x00x0xxx" | IOCA = "00000000"       |                                |
| RB = "11111111" | Page0 IOCB = "00000000" | Page1 IOCB = "00000000"        |
| RC = "00000000" | Page0 IOCC = "0xxxxxxx" | Page1 IOCC = "00000000"        |
| RD = "xxxxxxxx" | Page0 IOCD = "00000000" | <b>Page1 IOCD = "00000000"</b> |
| RE = "00000000" | Page0 IOCE = "00000000" | Page1 IOCE = "00000000"        |
| RF = "00000000" | IOCF = "00000000"       |                                |

The controller can be awakened from SLEEP mode or IDLE mode (execution of "SLEP" instruction, named as SLEEP MODE or IDLE mode) by (1)TCC time out (2) WDT time-out (if enabled) or, (3) external input at PORT9. The three cases will cause the controller wake up and run from next instruction. After wake-up, user should control WATCH DOG in case of reset in GREEN mode or NORMAL mode. The last two should be open



---

RE register before into sleep mode or IDLE mode . The first one case will set a flag in RF bit0 .But it will not go to address 0x08.



## VII.6 Interrupt

The CALLER ID IC has internal interrupts which are falling edge triggered, as followed : TCC timer overflow interrupt (internal) , two 8-bit counters overflow interrupt .

If these interrupt sources change signal from high to low , then RF register will generate '1' flag to corresponding register if you enable IOCF register.

RF is the interrupt status register which records the interrupt request in flag bit. IOCF is the interrupt mask register. Global interrupt is enabled by ENI instruction and is disabled by DISI instruction. When one of the interrupts (when enabled) generated, will cause the next instruction to be fetched from address 008H. Once in the interrupt service routine the source of the interrupt can be determined by polling the flag bits in the RF register. The interrupt flag bit must be cleared in software before leaving the interrupt service routine and enabling interrupts to avoid recursive interrupts.

There are four external interrupt pins including INT0 , INT1 , INT2 , INT3 . And four internal interrupt available.

Internal signals include TCC,CNT1,CNT2,FSK and CALL WAITING data. The last two will generate a interrupt when the data trasient from high to low.

External interrupt INT0 , INT1 , INT2 , INT3 signals are from PORT7 bit0 to bit3 . If IOCF is enable then these signal will cause interrupt , or these signals will be treated as general input data .

After reset, the next instruction will be fetched from address 000H and the instruction inturrept is 001H and the hardware inturrept is 008H.

TCC will go to address 0x08 in GREEN mode or NORMAL mode after time out. And it will run next instruction from “SLEP” instruction. These two cases will set a RF flag.

It is very important to save ACC,R3 and R5 when processing a interruption.

| Address | Instruction     | Note                    |
|---------|-----------------|-------------------------|
| 0x08    | DISI            | ;Disable interrupt      |
| 0x09    | MOV A_BUFFER,A  | ;Save ACC               |
| 0x0A    | SWAP A_BUFFER   |                         |
| 0x0B    | SWAPA 0x03      | ;Save R3 status         |
| 0x0C    | MOV R3_BUFFER,A |                         |
| 0x0D    | MOV A,0x05      | ;Save ROM page register |
| 0x0E    | MOV R5_BUFFER,A |                         |
| :       | :               |                         |
| :       | :               |                         |
| :       | MOV A,R5_BUFFER | ;Return R5              |
| :       | MOV 0X05,A      |                         |
| :       | SWAPA R3_BUFFER | ;Return R3              |
| :       | MOV 0X03,A      |                         |
| :       | SWAPA A_BUFFER  | ;Return ACC             |
| :       | RETI            |                         |

## VII.7 Instruction Set

Instruction set has the following features:

- (1). Every bit of any register can be set, cleared, or tested directly.
- (2). The I/O register can be regarded as general register. That is, the same instruction can operates on I/O register.



The symbol "R" represents a register designator which specifies which one of the 64 registers (including operational registers and general purpose registers) is to be utilized by the instruction. Bits 6 and 7 in R4 determine the selected register bank. "b" represents a bit field designator which selects the number of the bit, located in the register "R", affected by the operation. "k" represents an 8 or 10-bit constant or literal value.

| INSTRUCTION BINARY | HEX  | MNEMONIC | OPERATION                               | STATUS AFFECTED |
|--------------------|------|----------|---|-----------------|
| 0 0000 0000 0000   | 0000 | NOP      | No Operation                            | None            |
| 0 0000 0000 0001   | 0001 | DAA      | Decimal Adjust A                        | C               |
| 0 0000 0000 0010   | 0002 | CONTW    | A → CONT                                | None            |
| 0 0000 0000 0011   | 0003 | SLEP     | 0 → WDT, Stop oscillator                | T,P             |
| 0 0000 0000 0100   | 0004 | WDTC     | 0 → WDT                                 | T,P             |
| 0 0000 0000 rrrr   | 000r | IOW R    | A → IOCR                                | None            |
| 0 0000 0001 0000   | 0010 | ENI      | Enable Interrupt                        | None            |
| 0 0000 0001 0001   | 0011 | DISI     | Disable Interrupt                       | None            |
| 0 0000 0001 0010   | 0012 | RET      | [Top of Stack] → PC                     | None            |
| 0 0000 0001 0011   | 0013 | RETI     | [Top of Stack] → PC<br>Enable Interrupt | None            |
| 0 0000 0001 0100   | 0014 | CONTR    | CONT → A                                | None            |
| 0 0000 0001 rrrr   | 001r | IOR R    | IOCR → A                                | None            |
| 0 0000 0010 0000   | 0020 | TBL      | R2+A → R2 bits 9,10 do not clear        | Z,C,DC          |
| 0 0000 01rr rrrr   | 00rr | MOV R,A  | A → R                                   | None            |
| 0 0000 1000 0000   | 0080 | CLRA     | 0 → A                                   | Z               |
| 0 0000 11rr rrrr   | 00rr | CLR R    | 0 → R                                   | Z               |
| 0 0001 00rr rrrr   | 01rr | SUB A,R  | R-A → A                                 | Z,C,DC          |
| 0 0001 01rr rrrr   | 01rr | SUB R,A  | R-A → R                                 | Z,C,DC          |
| 0 0001 10rr rrrr   | 01rr | DECA R   | R-1 → A                                 | Z               |
| 0 0001 11rr rrrr   | 01rr | DEC R    | R-1 → R                                 | Z               |
| 0 0010 00rr rrrr   | 02rr | OR A,R   | A ∨ VR → A                              | Z               |
| 0 0010 01rr rrrr   | 02rr | OR R,A   | A ∨ VR → R                              | Z               |
| 0 0010 10rr rrrr   | 02rr | AND A,R  | A & R → A                               | Z               |
| 0 0010 11rr rrrr   | 02rr | AND R,A  | A & R → R                               | Z               |
| 0 0011 00rr rrrr   | 03rr | XOR A,R  | A ⊕ R → A                               | Z               |
| 0 0011 01rr rrrr   | 03rr | XOR R,A  | A ⊕ R → R                               | Z               |
| 0 0011 10rr rrrr   | 03rr | ADD A,R  | A + R → A                               | Z,C,DC          |
| 0 0011 11rr rrrr   | 03rr | ADD R,A  | A + R → R                               | Z,C,DC          |
| 0 0100 00rr rrrr   | 04rr | MOV A,R  | R → A                                   | Z               |
| 0 0100 01rr rrrr   | 04rr | MOV R,R  | R → R                                   | Z               |
| 0 0100 10rr rrrr   | 04rr | COMA R   | /R → A                                  | Z               |
| 0 0100 11rr rrrr   | 04rr | COM R    | /R → R                                  | Z               |
| 0 0101 00rr rrrr   | 05rr | INCA R   | R+1 → A                                 | Z               |
| 0 0101 01rr rrrr   | 05rr | INC R    | R+1 → R                                 | Z               |
| 0 0101 10rr rrrr   | 05rr | DJZA R   | R-1 → A, skip if zero                   | None            |
| 0 0101 11rr rrrr   | 05rr | DJZ R    | R-1 → R, skip if zero                   | None            |
| 0 0110 00rr rrrr   | 06rr | RRCA R   | R(n) → A(n-1)<br>R(0) → C, C → A(7)     | C               |
| 0 0110 01rr rrrr   | 06rr | RRC R    | R(n) → R(n-1)                           | C               |



|          |             |             |             |             |               |                                     |             |
|----------|-------------|-------------|-------------|-------------|---------------|-------------------------------------|-------------|
|          |             |             |             |             |               | R(0) → C, C → R(7)                  |             |
| 0        | 0110        | 10rr        | rrrr        | 06rr        | RLCA R        | R(n) → A(n+1)<br>R(7) → C, C → A(0) | C           |
| 0        | 0110        | 11rr        | rrrr        | 06rr        | RLC R         | R(n) → R(n+1)<br>R(7) → C, C → R(0) | C           |
| 0        | 0111        | 00rr        | rrrr        | 07rr        | SWAPA R       | R(0-3) → A(4-7)<br>R(4-7) → A(0-3)  | None        |
| 0        | 0111        | 01rr        | rrrr        | 07rr        | SWAP R        | R(0-3) ↔ R(4-7)                     | None        |
| 0        | 0111        | 10rr        | rrrr        | 07rr        | JZA R         | R+1 → A, skip if zero               | None        |
| 0        | 0111        | 11rr        | rrrr        | 07rr        | JZ R          | R+1 → R, skip if zero               | None        |
| 0        | 100b        | bbrr        | rrrr        | 0xxx        | BC R,b        | 0 → R(b)                            | None        |
| 0        | 101b        | bbrr        | rrrr        | 0xxx        | BS R,b        | 1 → R(b)                            | None        |
| 0        | 110b        | bbrr        | rrrr        | 0xxx        | JBC R,b       | if R(b)=0, skip                     | None        |
| 0        | 111b        | bbrr        | rrrr        | 0xxx        | JBS R,b       | if R(b)=1, skip                     | None        |
| 1        | 00kk        | kkkk        | kkkk        | 1kkk        | CALL k        | PC+1 → [SP]<br>(Page, k) → PC       | None        |
| 1        | 01kk        | kkkk        | kkkk        | 1kkk        | JMP k         | (Page, k) → PC                      | None        |
| 1        | 1000        | kkkk        | kkkk        | 18kk        | MOV A,k       | k → A                               | None        |
| 1        | 1001        | kkkk        | kkkk        | 19kk        | OR A,k        | A ∨ k → A                           | Z           |
| 1        | 1010        | kkkk        | kkkk        | 1Akk        | AND A,k       | A & k → A                           | Z           |
| 1        | 1011        | kkkk        | kkkk        | 1Bkk        | XOR A,k       | A ⊕ k → A                           | Z           |
| 1        | 1100        | kkkk        | kkkk        | 1Ckk        | RETL k        | k → A, [Top of Stack] → PC          | None        |
| 1        | 1101        | kkkk        | kkkk        | 1Dkk        | SUB A,k       | k-A → A                             | Z,C,DC      |
| 1        | 1110        | 0000        | 0001        | 1E01        | INT           | PC+1 → [SP]<br>001H → PC            | None        |
| <b>1</b> | <b>1110</b> | <b>1000</b> | <b>kkkk</b> | <b>1E8k</b> | <b>PAGE k</b> | <b>K-&gt;R5(3:0)</b>                | <b>None</b> |
| 1        | 1111        | kkkk        | kkkk        | 1Fkk        | ADD A,k       | k+A → A                             | Z,C,DC      |

## VII.8 CODE Option Register

The CALLER ID IC has one CODE option register which is not part of the normal program memory. The option bits cannot be accessed during normal program execution.

|   |   |   |   |   |   |       |             |
|---|---|---|---|---|---|-------|-------------|
| 7 | 6 | 5 | 4 | 3 | 2 | 1     | 0           |
| - | - | - | - | - | - | /POVD | <b>MCLK</b> |

\* **Bit 0** : main clock selection. 0/1 = 3.58MHZ / 1.84MHZ

\* **Bit 1** : (/POVD) : Power on voltage detector.

0: enable

1: disable

|       |            |                |                                |                                      |                    |
|-------|------------|----------------|--------------------------------|--------------------------------------|--------------------|
| /POVD | 2.2V reset | power on reset | Low power detect without reset | Low power detect controlled by RA(5) | sleep mode current |
| 1     | no         | yes            | Yes                            | Yes                                  | 1uA                |
| 0     | yes        | yes            | Yes                            | yes                                  | 15uA               |

\* Bits 2~7 : unused, must be "0"s.

## VII.9 FSK FUNCTION

### VII.9.1 Functional Block Diagram

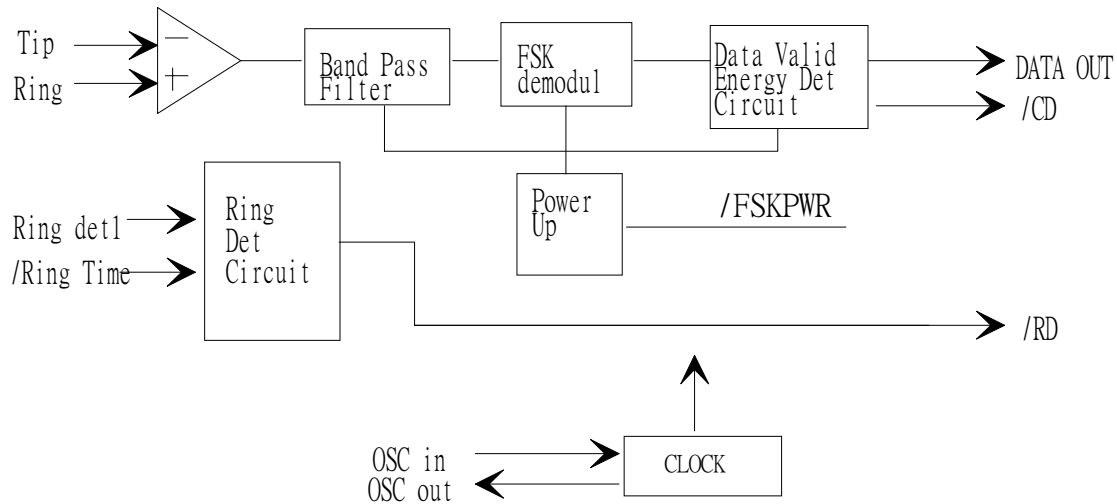


Fig13. FSK Block Diagram

### VII.9.2 Function Descriptions

The CALLER ID IC is a CMOS device designed to support the Caller Number Deliver feature which is offered by the Regional Bell Operating Companies. The FSK block comprises two paths: the signal path and the ring indicator path. The signal path consists of an input differential buffer, a band pass filter, an FSK demodulator and a data valid with carrier detect circuit. The ring detector path includes a clock generator, a ring detect circuit.

**In a typical application, the ring detector maintains the line continuously while all other functions of the chip are inhibited. If a ring signal is sent, the /RINGTIME pin will have a low signal. User can use this signal to wake up whole chip or read /RD signal from RA register.**

**A /FSKPWR input is provided to activate the block regardless of the presence of a power ring signal. If /FSKPWR is sent low, the FSK block will power down whenever it detects a valid ring signal, it will power on when /FSKPWR is high.**

The input buffer accepts a differential AC coupled input signal through the TIP and RING input and feeds this signal to a band pass filter. Once the signal is filtered, the FSK demodulator decodes the information and sends it to a post filter. The output data is then made available at DATA OUT pin. This data, as sent by the central office, includes the header information (alternate "1" and "0") and 150 ms of marking which precedes the date, time and calling number. If no data is present, the DATA OUT pin is held in a high state. This is accomplished by a carrier detect circuit which determines if the in-band energy is high enough. If the incoming signal is valid and thus the demodulated data is transferred to DATA OUT pin. If it is not, then the FSK demodulator is blocked.

### VII.9.3 Ring detect circuit

**When Vdd is applied to the circuit, the RC network will charge cap C1 to Vdd holding /RING TIME off. The resistor network R2 to R3 attenuates the incoming power ring applied to the top of R2. The values given**

have been chosen to provide a sufficient voltage at DET1 pin, to turn on the Schmitt trigger input. When  $V_{t+}$  of the Schmitt is exceeded, cap C1 will discharge.

The value of R1 and C1 must be chosen to hold the /RING TIME pin voltage below the  $V_{t+}$  of the Schmitt between the individual cycle of the power ring. With /RINGTIME enabled, this signal will be a /RD signal in RA through a buffer.

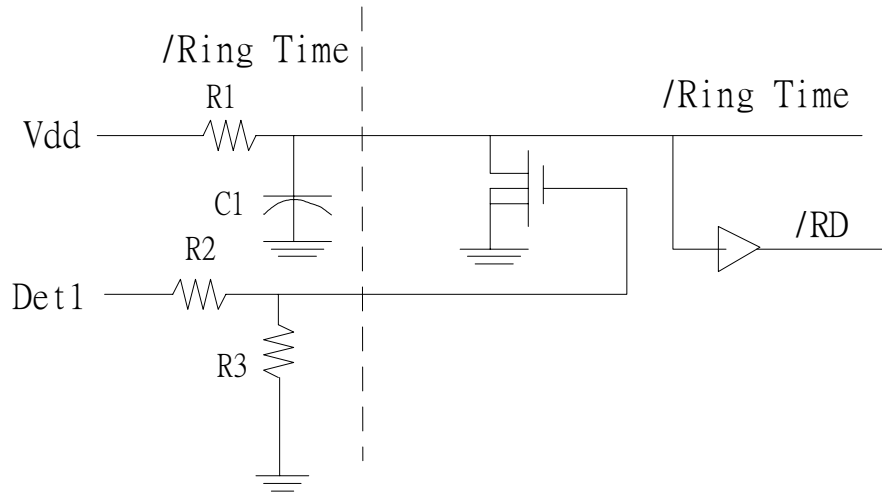


Fig14. ring detect circuit

## VII.10 DTMF ( Dual Tone Multi Frequency ) Tone Generator

Built-in DTMF generator can generate dialing tone signals for telephone of dialing tone type. There are two kinds of DTMF tone . One is the group of row frequency, the other is the group of column frequency, each group has 4 kinds of frequency , user can get 16 kinds of DTMF frequency totally. DTMF generator contains a row frequency sine wave generator for generating the DTMF signal which selected by low order 4 bits of RB and a column frequency sine wave generator for generating the DTMF signal which selected by high order 4 bits of RB. This block can generate single tone by filling one bit zero to this register.

If all the values are high , the power of DTMF will turn off until one or two low values.

Either high or low 4 bits must be set by an effective value, otherwise, if any ineffective value or both 4 bits are load effective value, tone output will be disable. Recommend value refer to table as follow please :

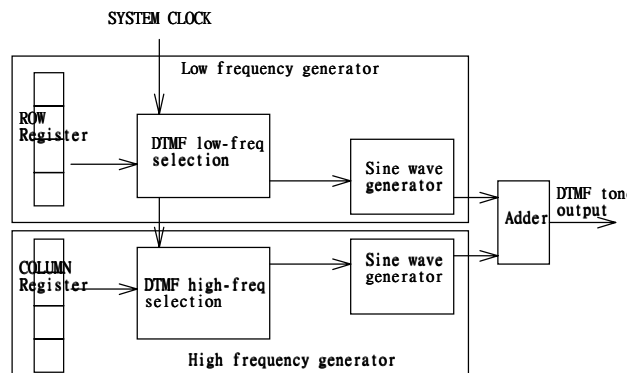


Fig15. DTMF Block Diagram

\* RB ( DTMF Register )

- . Bit 0 - Bit 3 are row-frequency tone.
- . Bit 4 - Bit 7 are column-frequency tone.
- . Initial RB is equal to HIGH.
- . Except below values of RB ,the other values of RB are not effect. If RB is set by ineffective value, the DTMF output will be disable and there is no tone output.
- . Bit 7 ~ 0 are all "1" , turn off DTMF power .

|             |          |        |          |        |          |
|-------------|----------|--------|----------|--------|----------|
| bit 3~0     | Row freq |        |          |        |          |
| 1110        | 699.2Hz  | 1      | 2        | 3      | A        |
| 1101        | 771.6Hz  | 4      | 5        | 6      | B        |
| 1011        | 854Hz    | 7      | 8        | 9      | C        |
| 0111        | 940.1Hz  | *      | 0        | #      | D        |
| Column freq |          | 1203Hz | 1331.8Hz | 1472Hz | 1645.2Hz |
| bit 7~4     |          | 1110   | 1101     | 1011   | 0111     |

## VII.11 LCD Driver

The CALLER ID IC can drive LCD directly and has 60 segments and 16 commons that can drive 60\*16 dots totally. LCD block is made up of LCD driver , display RAM, segment output pins , common output pins and LCD operating power supply pins.

Duty , bias , the number of segment , the number of common and frame frequency are determined by LCD mode register . LCD control register.

The basic structure contains a timing control which uses the basic frequency 32.768KHz to generate the proper timing for different duty and display access. RE register is a command register for LCD driver, the LCD display( disable, enable, blanking) is controlled by LCD\_C and the driving duty and bias is decided by LCD\_M and the display data is stored in data RAM which address and data access controlled by registers IOCB and IOCC.

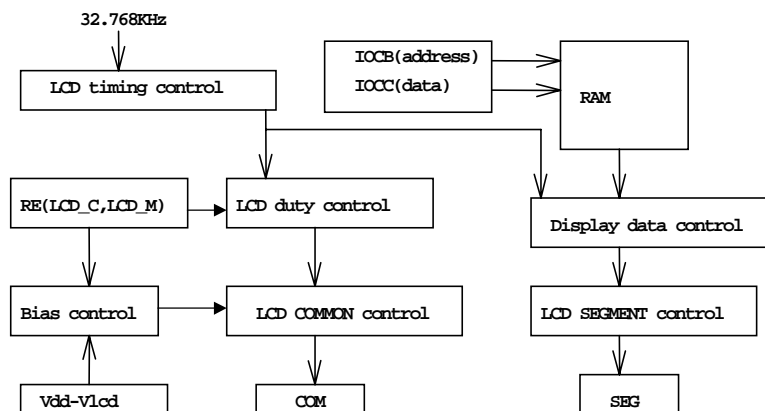


Fig16. LCD DRIVER CONTROL





### VII.11.1 LCD Driver Control

RE(LCD Driver Control)(initial state "00000000")

|   |   |   |   |   |        |        |       |
|---|---|---|---|---|--------|--------|-------|
| 7 | 6 | 5 | 4 | 3 | 2      | 1      | 0     |
| - | - | - | - | - | LCD_C2 | LCD_C1 | LCD_M |

\*Bit0 (LCD\_M):LCD\_M decides the methods, including duty, bias, and frame frequency.

\*Bit1~Bit2 (LCD\_C#):LCD\_C# decides the LCD display enable or blanking. change the display duty must set the LCD\_C to "00".

| LCD_C2,LCD_C1 | LCD Display Control   | LCD_M | duty | bias |
|---------------|-----------------------|-------|------|------|
| 0 0           | change duty           | 0     | 1/16 | 1/4  |
|               | Disable(turn off LCD) | 1     | 1/8  | 1/4  |
| 0 1           | Blanking              | :     | :    | :    |
| 1 1           | LCD display enable    | :     | :    | :    |

### VII.11.2 LCD display area

The LCD display data is stored in the data RAM . The relation of data area and COM/SEG pin is as below:

| COM15 ~ COM8       | COM7 ~ COM0       |       |
|--------------------|-------------------|-------|
| 40H (Bit15 ~ Bit8) | 00H (Bit7 ~ Bit0) | SEG0  |
| 41H                | 01H               | SEG1  |
| :                  | :                 | :     |
| :                  | :                 | :     |
| 7BH                | 3BH               | SEG59 |
| 7CH                | 3CH               | empty |
| 7DH                | 3DH               | empty |
| 7EH                | 3EH               | empty |
| 7FH                | 3FH               | empty |

\*IOCB(LCD Display RAM address)

|   |       |       |       |       |       |       |       |
|---|-------|-------|-------|-------|-------|-------|-------|
| 7 | 6     | 5     | 4     | 3     | 2     | 1     | 0     |
| - | LCDA6 | LCDA5 | LCDA4 | LCDA3 | LCDA2 | LCDA1 | LCDA0 |

Bit 0 ~ Bit 6 select LCD Display RAM address up to 120.

LCD RAM can be write whether in enable or disable mode and read only in disable mode.

\*IOCC(LCD Display data) : Bit 0 ~ Bit 8 are LCD data.

### VII.11.3 LCD COM and SEG signal

\* COM signal : The number of COM pins varies according to the duty cycle used, as following: in 1/8 duty mode COM8 ~ COM15 must be open. in 1/16 duty mode COM0 ~ COM15 pins must be used.

|      | COM0 | COM1 | COM2 | COM3 | COM4 | COM5 | COM6 | COM7 | COM8 | .. | COM15 |
|------|------|------|------|------|------|------|------|------|------|----|-------|
| 1/8  | o    | o    | o    | o    | o    | o    | o    | o    | x    | .. | x     |
| 1/16 | o    | o    | o    | o    | o    | o    | o    | o    | o    | .. | o     |

x:open,o:select

\* SEG signal: The 60 segment signal pins are connected to the corresponding display RAM address 00h to 3Bh. The high byte and the low byte bit7 down to bit0 are correlated to COM15 to COM0 respectively .  
When a bit of display RAM is 1, a select signal is sent to the corresponding segment pin, and when the bit is 0 , a non-select signal is sent to the corresponding segment pin.

\*COM, SEG and Select/Non-select signal is shown as following:

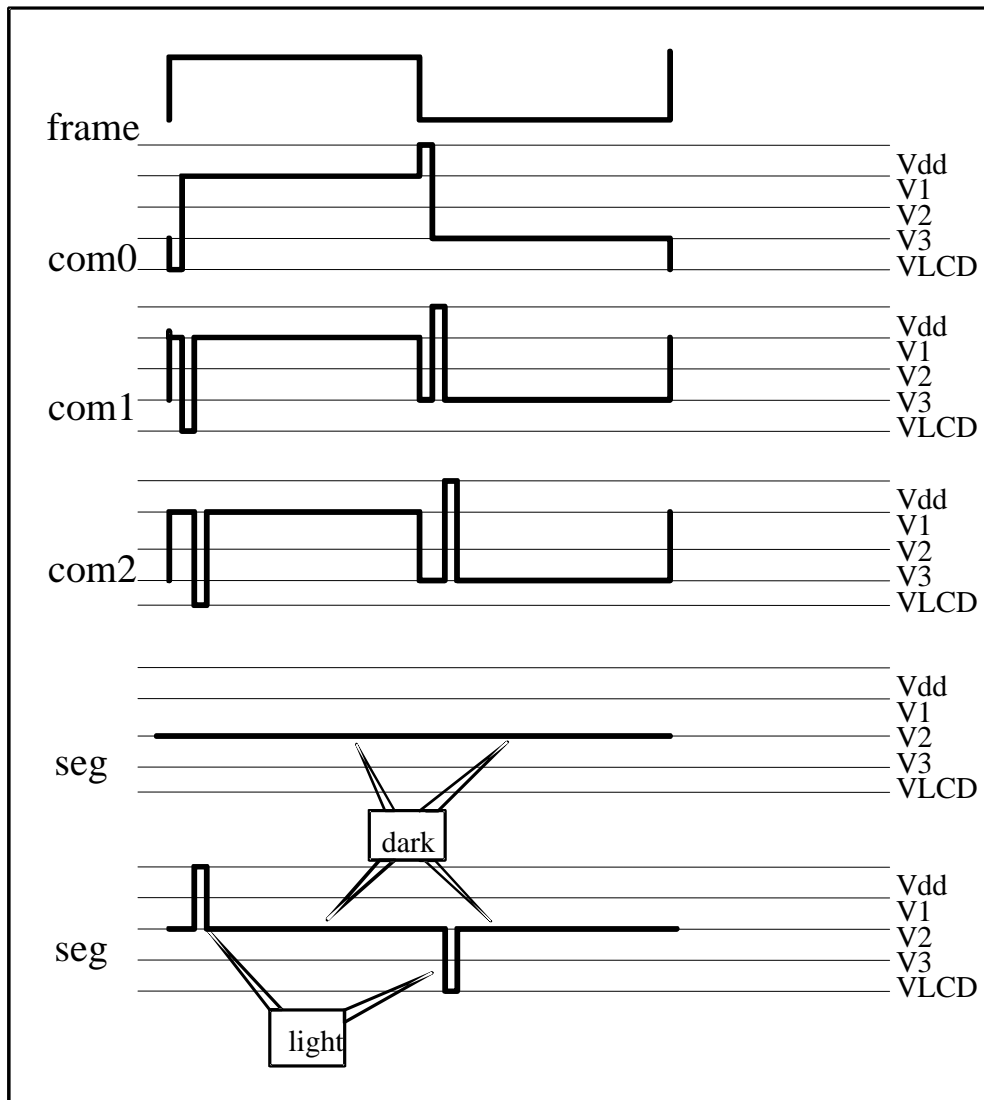


Fig.17 Lcd wave 1/4 bias

### VII.11.4 LCD Bias control

IOCE (Bias Control Register)

|   |   |   |       |       |       |   |   |
|---|---|---|-------|-------|-------|---|---|
| 7 | 6 | 5 | 4     | 3     | 2     | 1 | 0 |
|   |   |   | Bias3 | Bias2 | Bias1 |   |   |

\* Bit 2~4 (Bias1~Bias3) Control bits used to choose LCD operation voltage . The circuit can refer ti figure15.

| LCD operate voltage | Vop (VDD 5V) | VDD=5V |
|---------------------|--------------|--------|
| 000                 | 0.60VDD      | 3.0V   |
| 001                 | 0.66VDD      | 3.3V   |
| 010                 | 0.74VDD      | 3.7V   |
| 011                 | 0.82VDD      | 4.0V   |
| 100                 | 0.87VDD      | 4.4V   |
| 101                 | 0.93VDD      | 4.7V   |
| 110                 | 0.96VDD      | 4.8V   |
| 111                 | 1.00VDD      | 5.0V   |

\* Bit 5~7 unused

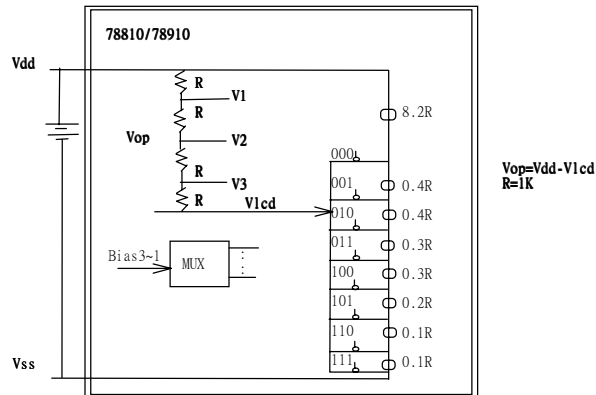


Fig.18 LCD bias circuit

## VII.12 CALL WAITING Function Description

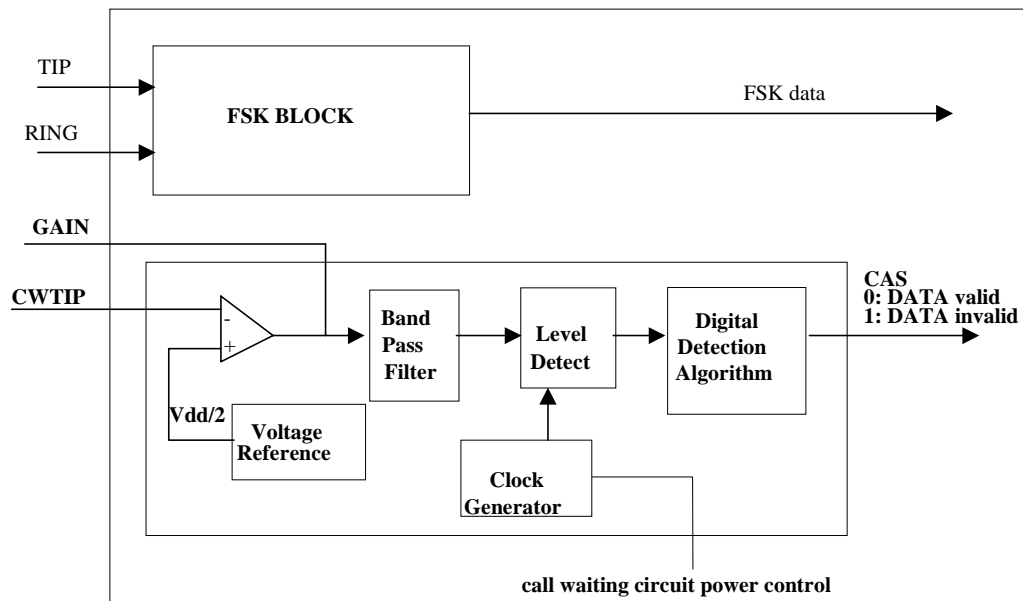


Fig.19 Call Waiting Block Diagram

Call Waiting service works by alerting a customer engaged in a telephone call to a new incoming call. This way the customer can still receive important calls while engaged in a current call. The CALL WAITING DECODER can detect CAS(Call-Waiting Alerting Signal 2130Hz plus 2750Hz) and generate a valid signal on the data pins.

The call waiting decoder is designed to support the Caller Number Deliver feature, which is offered by regional Bell Operating Companies. The call waiting decoder has four blocks, including pre-amplifier, band pass filter, level detect and digital detection algorithm.

In a typical application, after enabling CW circuit (by RE BIT7 CWPWR) this IC receives Tip and Ring signals from twisted pairs. The signals as inputs of pre-amplifier, and the amplifier sends input signal to a band pass filter. Once the signal is filtered, the digital detection block decodes the information and sends it to R3 register bit7 . The output data made available at R3 CAS bit.

The data is CAS signals. The CAS is normal high. When this IC detects 2130Hz and 2750Hz frequency, then CAS pin goes to low.



## VIII. Absolute Operation Maximum Ratings

| RATING                      | SYMBOL          | VALUE                        | UNIT |
|-----------------------------|-----------------|------------------------------|------|
| DC SUPPLY VOLTAGE           | V <sub>dd</sub> | -0.3 To 6                    | V    |
| INPUT VOLTAGE               | V <sub>in</sub> | -0.5 TO V <sub>dd</sub> +0.5 | V    |
| OPERATING TEMPERATURE RANGE | T <sub>a</sub>  | 0 TO 70                      | °C   |

## IX DC Electrical Characteristic

(T<sub>a</sub>=0°C ~ 70°C, V<sub>DD</sub>=5V±5%, V<sub>SS</sub>=0V)

(V<sub>DD</sub>=2.5V to 6V for CPU ; V<sub>DD</sub>=3.5V to 6V for FSK ; V<sub>DD</sub>=2.5V to 6V for DTMF )

| Symbol     | Parameter                                     | Condition   | Min | Typ        | Max        | Unit      |
|------------|---|---|-----|------------|------------|-----------|
| IIL1       | Input Leakage Current for input pins          | V <sub>IN</sub> = V <sub>DD</sub> , V <sub>SS</sub>   |     |            | ±1         | μA        |
| IIL2       | Input Leakage Current for bi-directional pins | V <sub>IN</sub> = V <sub>DD</sub> , V <sub>SS</sub>   |     |            | ±1         | μA        |
| VIH        | Input High Voltage                            |   | 2.5 |            |            | V         |
| VIL        | Input Low Voltage                             |   |     |            | 0.8        | V         |
| VIHT       | Input High Threshold Voltage                  | /RESET, TCC, RDET1  | 2.0 |            |            | V         |
| VILT       | Input Low Threshold Voltage                   | /RESET, TCC, RDET1  |     |            | 0.8        | V         |
| VIHX       | Clock Input High Voltage                      | OSCI  | 3.5 |            |            | V         |
| VILX       | Clock Input Low Voltage                       | OSCI  |     |            | 1.5        | V         |
| VHscan     | Key scan Input High Voltage                   | Port6 for key scan  | 3.5 |            |            | V         |
| VLscan     | Key scan Input Low Voltage                    | Port6 for key scan  |     |            | 1.5        | V         |
| VOH1       | Output High Voltage (port6,7,8)               | IOH = -1.6mA  | 2.4 |            |            | V         |
|            | (port9)                                       | IOH = -6.0mA  | 2.4 |            |            | V         |
| VOL1       | Output Low Voltage (port6,7,8)                | IOL = 1.6mA   |     |            | 0.4        | V         |
|            | (port9)                                       | IOL = 6.0mA   |     |            | 0.4        | V         |
| Vcom       | Com voltage drop                              | I <sub>o</sub> =+/- 50 uA   | -   | -          | 2.9        | V         |
| Vseg       | Segment voltage drop                          | I <sub>o</sub> =+/- 50 uA   | -   | -          | 3.8        | V         |
| Vlcd       | LCD drive reference voltage                   | Contrast adjustment   |     |            |            |           |
| <b>IPH</b> | <b>Pull-high current</b>                      | <b>Pull-high active input pin at VSS</b>  |     | <b>-10</b> | <b>-15</b> | <b>μA</b> |
| ISB1       | Power down current (SLEEP mode)               | All input and I/O pin at V <sub>DD</sub> , output pin floating, WDT disabled  |     | 1          | 4          | μA        |
| ISB2       | Low clock current (GREEN mode)                | CLK=32.768KHz, FSK, DTMF, CW block disable , All input and I/O pin at V <sub>DD</sub> , output pin floating, WDT disabled, LCD enable |     | 65         | 80         | μA        |
| ISB3       | Low clock current (IDLE mode)                 | CLK=32.768KHz, FSK, DTMF, CW block disable , All input and I/O pin at V <sub>DD</sub> , output pin floating, WDT disabled, LCD enable |     | 45         | 60         | μA        |



|     |  |   |     |     |    |
|-----|--|---|-----|-----|----|
| ICC | Operating supply current (NORMAL mode) | CPU disable<br>/RESET=High,<br>CLK=3.579MHz, output pin floating,LCD enable, FSK, DTMF, CW Fblock disable | 1.5 | 1.8 | mA |
|-----|--|---|-----|-----|----|

## IX AC Electrical Characteristic

(Ta=0°C ~ 70°C, VDD=5V, VSS=0V)

| Symbol | Parameter              | Conditions        | Min         | Typ       | Max | Unit     |
|--------|------------------------|-------------------|-------------|-----------|-----|----------|
| Dclk   | Input CLK duty cycle   |                   | 45          | 50        | 55  | %        |
| Tins   | Instruction cycle time | 32.768K<br>3.579M |             | 60<br>550 |     | us<br>ns |
| Tdrh   | Device delay hold time |                   |             | 18        |     | ms       |
| Ttcc   | TCC input period       | Note 1            | (Tins+20)/N |           |     | ns       |
| Twdt   | Watchdog timer period  | Ta = 25°C         |             | 18        |     | ms       |

Note 1: N= selected prescaler ratio.

(FSK Band Pass Filter AC Characteristic)(Vdd=+5V,Ta=+25°C)

| CHARACTERISTIC  | MIN | TYP | MAX | UNIT |
|---|-----|-----|-----|------|
| input sensitivity TIP and RING<br>pin1 and pin2 Vdd=+5V | -40 | -48 | --  | dBm  |

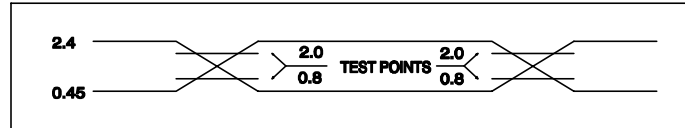
(call waiting Band Pass Filter AC Characteristic) (VDD=+5V,Ta=+25°C)

| CHARACTERISTIC  | MIN | TYP | MAX | UNIT |
|---|-----|-----|-----|------|
| input sensitivity TIP and RING pins ,Vdd=+5V, Input G=1 |     | -38 |     | dBm  |

| Description  | Symbol | Min | Typ | Max       | Unit |
|--|--------|-----|-----|-----------|------|
| OSC start up(32.768KHz)<br>(3.579MHz PLL)            | Tosc   | --  | 300 | 400<br>10 | ms   |
| (FSK AC Characteristic)                              |        |     |     |           |      |
| Carrier detect low                                   | Tcdl   | --  | 10  | 14        | ms   |
| Data out to Carrier det low                          | Tdoc   | --  | 10  | 20        | ns   |
| Power up to FSK(setup time)                          | Tsup   | --  | 15  | 20        | ms   |
| /RD low to Ringtime low                              | Trd    |     |     | 50        | ms   |
| End of FSK to Carrier Detect high                    | Tcdh   | 8   | --  | --        | ms   |
| (Call waiting AC Characteristic)                     |        |     |     |           |      |
| CAS input signal length<br>(2130 ,2750 Hz @ -20dBm ) | Tcasi  |     | 80  |           | ms   |
| Data detect delay time                               | Td     |     | 42  |           | ms   |
| Data release time                                    | Tr     |     | 26  |           | ms   |

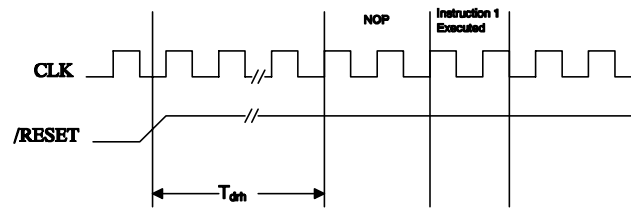
## XI. Timing Diagrams

### AC Test Input/Output Waveform



AC Testing: Input are driven at 2.4V for logic "1", and 0.45V for logic "0". Timing measurements are made at 2.0V for logic "1", and 0.8V for logic "0".

### RESET Timing



### TCC Input Timing

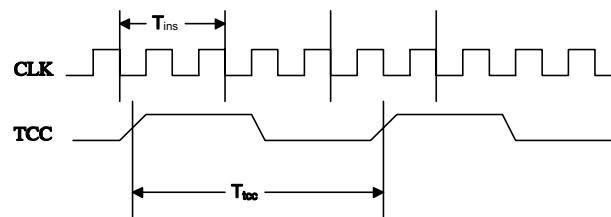


Fig.20 AC timing

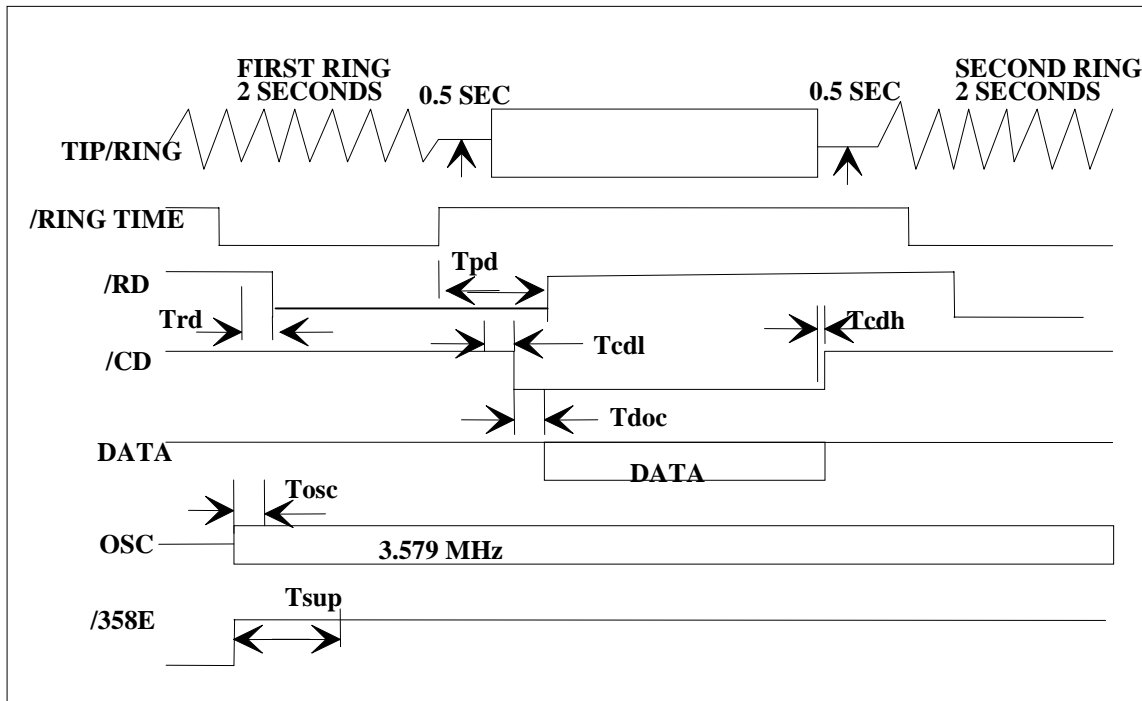


Fig.21 FSK Timing Diagram

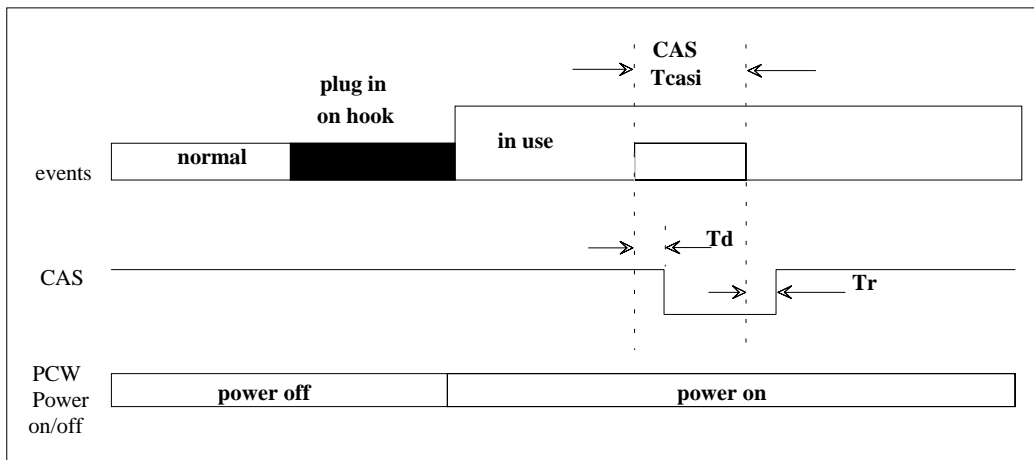


Fig.22 Call Waiting Timing Diagram



## XII. Application Circuit

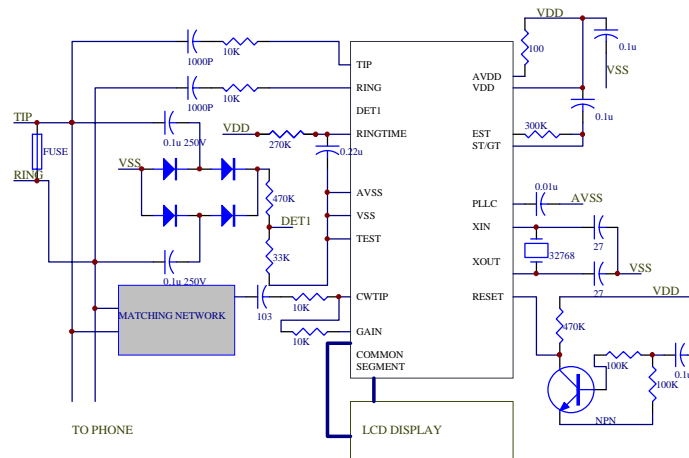


Fig23. APPLICATION CIRCUIT



附錄: EM78R911 SPEC.

IV.Pin Configuration

|        |     |          |    |       |
|--------|-----|----------|----|-------|
| SEG40  | 121 | NC       | 80 | SEG30 |
| SEG41  | 122 | NC       | 79 | SEG29 |
| SEG42  | 123 | SEG39    | 78 | SEG28 |
| SEG43  | 124 | SEG38    | 77 | SEG27 |
| TEST   | 125 | SEG37    | 76 | SEG26 |
| P80    | 126 | SEG36    | 75 | SEG25 |
| P81    | 127 | RESET    | 74 | SEG24 |
| P82    | 128 | P77      | 73 | SEG23 |
| P83    | 129 | P76      | 72 | SEG22 |
| P84    | 130 | P75      | 71 | SEG21 |
| P85    | 131 | P74      | 70 | SEG20 |
| P86    | 132 | P73      | 69 | GND   |
| P87    | 133 | P72      | 68 | NC    |
| P90    | 134 | P71      | 67 | VDD   |
| P91    | 135 | P70      | 66 | CD12  |
| P92    | 136 | P67      | 65 | CD11  |
| P93    | 137 | P66      | 64 | CD10  |
| P94    | 138 | P65      | 63 | CD9   |
| P95    | 139 | P64      | 62 | CD8   |
| P96    | 140 | P63      | 61 | CD7   |
| P97    | 141 | P62      | 60 | CD6   |
| VDD    | 142 | P61      | 59 | CD5   |
| NC     | 143 | P60      | 58 | CD4   |
| GND    | 144 | GND      | 57 | CD3   |
| IOD0   | 145 | VDD      | 56 | CD2   |
| IOD1   | 146 | NC       | 55 | CD1   |
| IOD2   | 147 | IOD6     | 54 | CD0   |
| IOD3   | 148 | IOD5     | 53 | CA13  |
| IOD4   | 149 | IOD4     | 52 | CA12  |
| IOD5   | 150 | IOD3     | 51 | CA11  |
| IOD6   | 151 | IOD2     | 50 | CA10  |
| IOD7   | 152 | IOD1     | 49 | CA9   |
| INSEND | 153 | IOD0     | 48 | CA8   |
| IRSEL  | 154 | NC       | 47 | CA7   |
| PHIOUT | 155 | AVSS     | 46 | CA6   |
| X2OUT  | 156 | DTMF     | 45 | CA5   |
| /HOLD  | 157 | PLLC     | 44 | CA4   |
| /POVD  | 158 | RINGTIME | 43 | CA3   |
| ENTCC  | 159 | RDETI    | 42 | CA2   |
| MCLK   | 160 | RING     | 41 | CA1   |
|        |     | TIP      |    |       |
|        |     | CWRING   |    |       |
|        |     | GAIN     |    |       |
|        |     | XIN      |    |       |
|        |     | XOUT     |    |       |
|        |     | AVDD     |    |       |
|        |     | SEG0     |    |       |
|        |     | SEG1     |    |       |
|        |     | SEG2     |    |       |
|        |     | SEG3     |    |       |
|        |     | SEG4     |    |       |
|        |     | SEG5     |    |       |
|        |     | SEG6     |    |       |
|        |     | SEG7     |    |       |
|        |     | SEG8     |    |       |
|        |     | SEG9     |    |       |
|        |     | VDD      |    |       |
|        |     | NC       |    |       |
|        |     | GND      |    |       |
|        |     | SE10     |    |       |
|        |     | SE11     |    |       |
|        |     | SE12     |    |       |
|        |     | SE13     |    |       |
|        |     | SE14     |    |       |
|        |     | SE15     |    |       |
|        |     | SE16     |    |       |
|        |     | VDD2     |    |       |
|        |     | SE17     |    |       |
|        |     | SE18     |    |       |
|        |     | SE19     |    |       |
|        |     | EPS      |    |       |
|        |     | CA-1     |    |       |
|        |     | CA0      |    |       |

Fig1. Pin Assignment



## VI.Pin Descriptions

| PIN  | I/O  | DESCRIPTION   |
|--|--|---|
| VDD1,VDD2<br>AVDD                            | POWER  | digital power<br>analog power   |
| VSS1,VSS2<br>AVSS                            | POWER  | digital ground<br>analog ground   |
| Xtin   | I  | Input pin for 32.768 kHz oscillator   |
| Xtout  | O  | Output pin for 32.768 kHz oscillator  |
| COM0..COM7<br>COM8..COM15                    | O<br>O (PORT6)   | Common driver pins of LCD drivers   |
| SEG0...SEG43<br>SEG44..SEG51<br>SEG52..SEG59 | O<br>O (PORT8)<br>O (PORT9)                                | Segment driver pins of LCD drivers<br><br>PORT9 AS FUNCTION KEY CAN WAKE UP WATCHDOG.   |
| PLL  | I  | Phase loop lock capacitor   |
| TIP  | I  | Should be connected with TIP side of twisted pair lines   |
| RING   | I  | Should be connected with TIP side of twisted pair lines   |
| <b>CWTIP</b>                                 | <b>I</b>   | <b>Should be connected with TIP side of twisted pair lines for CW.</b>  |
| <b>GAIN</b>                                  | <b>I</b>   | <b>OP output pin for gain adjustment.</b>   |
| RDET1  | I  | Detect the energy on the twisted pair lines . These two pins coupled to the twisted pair lines through an attenuating network.  |
| /RING TIME                                   | I  | Determine if the incoming ring is valid.An RC network may be connected to the pin.  |
| INT0<br>INT1<br>INT2<br>INT3                 | PORT7(0)<br>PORT7(1)<br>PORT7(2)<br>PORT7(3)<br>PORT7(4:7) | PORT7(0)~PORT7(3) signal can be interrupt signals.<br><br>Int2 and int3 has the same interrupt flag.<br><br>IO port   |
| <b>P5.4 ~P7.7</b>                            | <b>PORT5</b>   | <b>PORT 5 can be INPUT or OUTPUT port each bit.<br/>Shared with LCD segment signals</b>   |
| P6.0 ~P6.7                                   | PORT6  | PORT 6 can be INPUT or OUTPUT port each bit.<br>Shared with LCD common signals  |
| P7.0 ~P7.7                                   | PORT7  | PORT 7 can be INPUT or OUTPUT port each bit.<br>Internal Pull high function.<br>Key scan function.  |
| P8.0 ~P8.7                                   | PORT8  | PORT 8 can be INPUT or OUTPUT port each bit.<br>And shared with Segment signal.   |
| P9.0 ~P9.7                                   | PORT9  | PORT 9 can be INPUT or OUTPUT port each bit.<br>And can be set to wake up watch dog timer.<br>And shared with Segment signal.   |
| TEST   | I  | Test pin into test mode , normal low  |
| DTMF   | O  | DTMF tone output  |
| RESET  | I  |   |
|  |  |   |
| X2OUT  | O  | System clock output.  |
| CA-1   | O  | CA-1 is used as address line to select low-order data (8 bits, through CD0~CD7) or high-order data (5 bits, through CD0~CD4)<br>ERS=1 => CA-1 NO USE<br>ERS=0 => CA-1=0 HIGH ORDER DATA |



| CA-1=1 LOW ORDER DATA |   |  |
|-----------------------|---|--|
| ERS                   | I | Input pin used to select the external ROM data bus through bus CD0~D12 or CD0~CD7 only. HIGH/LOW = CD0~CD12 / CD0~CD7.                         |
| ENTCC                 | I | TCC control pin with <b>internal pull-high (560KΩ)</b> . TCC works normally when ENTCC is high, and TCC counting is stopped when ENTCC is low. |
| CA0~CA13              | O | Program code address bus. CA0~CA13 are address output pins for external programming ROM access.  |
| CD0~CD12              | I | Data access in terms of CA0 ~ CA12 addressing.   |
| IRSEL                 | O | IRSEL is an output pin used to select an external EVEN/ODD ROM.  |
| INSEND                | O | Used to indicate the instruction completion and ready for next instruction.  |
| /HOLD                 | I | Microcontroller hold request.  |
| /POVD                 | I | Input pin used to enable Power on voltage detector. Power on voltage detector is enabled if /POVD is low and is disabled if /POVD is high.     |
| MCLK                  | I | <b>Input pin for main clock selection. Internal pull low through a register.</b>   |
| RC4M                  | O | <b>RC clock for program down load</b>  |
| 4MPD                  | I | <b>RC 4M power control pin. This pin pull low internally to enable clock. To pull high externally for disabling clock.</b>                     |
| IOD0~IOD7             | O | I/O data bus.  |
| PH1OUT                | O | Phase 1 output   |

## IX AC Electrical Characteristic

|        |   |          |     |  |    |    |
|--------|---|----------|-----|--|----|----|
| Tdica  | Delay from Phase 3 end to INSEND active   | C1=100pF |     |  | 30 | ns |
| Tdiei  | Delay from Phase 4 end to INSEND inactive | C1=100pF |     |  | 30 | ns |
| Tiew   | INSEND pulse width                        |          | 30  |  |    | ns |
| Tdca   | Delay from Phase 4 end to CA Bus valid    | C1=100pF |     |  | 30 | ns |
| Tacc   | ROM data access time                      |          | 100 |  |    | ns |
| Tcds   | ROM data setup time                       |          | 20  |  |    | ns |
| Tcdh   | ROM data hold time                        |          | 20  |  |    | ns |
| Tdca-1 | Delay time of CA-1                        | C1=100pF |     |  | 30 | ns |

Note 1: N= selected prescaler ratio.

