



## A. HE83123 Introduction

HE83123 is a member of 8-bit Micro-controller series that is developed by King Billion. This IC has built-in 320-dot LCD driver. PWM device provide the complete speech output mechanism. The 64K ROM Size can storage around 20 second's speech.(3K bps) This IC is applicable to the small/medium systems such as LCD Games and Perpetual Calendar etc. This IC is very easy to learn and use. Most of instructions take only 3 oscillator clocks (machine cycles). As a result this IC is suitable for the applications that require higher performance system.

## B. HE83123 Features

- Operation Voltage : 2.2V – 5.5V
- System Clock : DC ~ 8MHz @ 5.0V  
DC ~ 4MHz @ 2.2V
- Internal ROM : 64K Bytes(64K Program ROM)
- Internal RAM : 256 Bytes
- Dual Clock System : Normal (Fast) clock : 32.768K ~ 8MHz  
Slow clock : 32.768KHz
- Operation Mode : DUAL 、 FAST 、 SLOW 、 IDLE 、 SLEEP Mode.
- With WDT (WATCH DOG TIMER) to prevent deadlock condition.
- 8-bit Bi-directional I/O port. Mask Option can select PUSH-PULL or OPEN DRAIN output mode for each I/O pin.
- 320 dots LCD driver (A 、 B TYPE selectable).
- PWM device.
- Two external interrupts and two internal timers interrupts.
- Two 16-bit timers.
- Instruction set : 32 instructions, 4 addressing mode. 8-bit DATA POINTER for RAM and 16-bit TABLE POINTER for ROM.



## C.HE83123 Application

- LCD Game 、Perpetual Calendar System etc..

## D. Pin Assignment

| Pin #    | Pin Name    | I/O     | Function                                                                                                                               | Description                                                                                                                                                                                                                                                                                                                                                                                        |
|----------|-------------|---------|----------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 68<br>67 | FXI,<br>FXO | B,<br>O | External fast clock pin.<br>Connecting to crystal or RC to generate 32.768 kHz ~ 8MHz system clock.                                    | Mask Option settings :<br><br>MO_FCK/SCKN=00 : Slow Clock only<br>01 : Illegal<br>10 : Dual Clock<br>11 : Fast Clock only<br><br>MO_FOSCE=0 : Internal fast oscillation<br>1 : External fast oscillation<br>MO_FXTAL=0 : R,C oscillation for Fast Clock<br>1 : Crystal oscillation for Fast Clock<br>MO_SXTAL=0 : R,C oscillation for 32.768K Clock<br>1 : Crystal oscillation for 32.768K Clock • |
| 71<br>70 | SXI,<br>SXO | I,<br>O | External slow clock pin.<br>Connecting with 32.768 Hz OSC to generate the stable frequency for Slow Clock Mode and Timer clock source. | Program the value of OP1and OP2 to change the operating modes (Normal, Slow, Idle and Sleep).<br><br>In Dual Clock mode , the system runs in Fast Clock, only the LCD and timer I use the 32.768K clock source                                                                                                                                                                                     |
| 66       | RSTP_N      | I       | System Reset Signal.                                                                                                                   | Pull this pin to low level to reset the system. Besides, select the Mask Option (MQ_PORE=1) to enable the HE83123 internal Power-on Reset function.<br><br>In addition, the MO_WDTE is used for Watch<br><br>Timer setting :<br><br>MO_WDTE=0 : Disable Watch Dog Timer<br>=1 : Enable Watch Dog Timer                                                                                             |
| 69       | TSTP_P      | I       | Test Pin                                                                                                                               | Pull the pin to high level to enter into testing mode.                                                                                                                                                                                                                                                                                                                                             |



|            |           |   |                                                                                                                        |                                                                                                                                                                                                                         |
|------------|-----------|---|------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 73..<br>80 | PRTD[7:0] | B | Port D bi-directional I/O pin (8 pins). PRTD[7:2] is also a Wake-up pin and PRTD[7:6] is used for interrupt input pin. | Mask Option MO_DPP[7:0] to preset the output type :<br><br>MO_DPP=1 : Push-pull output;<br><br>=0 : Open-drain output<br><br>When assigned the port to input pin, send a '1' and read the result to get the input value |
| 44..<br>51 | COM[7:0]  | O | LCD COMmon Output                                                                                                      | Data filled from D8H, please refer the LCD RAM map                                                                                                                                                                      |
| 4..43      | SEG[39:0] | O | LCD SEGment Output                                                                                                     |                                                                                                                                                                                                                         |
| 53         | LC2       | B | Charge Pump Switch 1                                                                                                   | Please refer the application circuit.                                                                                                                                                                                   |
| 52         | LC1       | B | Charge Pump Switch 2                                                                                                   |                                                                                                                                                                                                                         |
| 55         | LV3       | B | Charge Pump V3                                                                                                         | Please refer the application circuit.                                                                                                                                                                                   |
| 54         | LV1       | B | Charge Pump V1                                                                                                         |                                                                                                                                                                                                                         |
| 56..<br>59 | LR[4..1]  | B | LCD Resister level 4 ~ 0                                                                                               | Please refer the application circuit.                                                                                                                                                                                   |
| 60         | LVG       | I | LCD Virtual Ground                                                                                                     | Please refer the application circuit.                                                                                                                                                                                   |
| 2          | PWMP      | O | PWM +ve output pin can directly drive Speaker or Buzzer for sound output.                                              | Set the Bit2 for VOC register (PWM =1) to turn on the PWM                                                                                                                                                               |
| 3          | PWMN      | O | PWM -ve output pin can directly drive Speaker or Buzzer for sound output.                                              | Set the Bit2 for VOC register (PWM =1) to turn on the PWM                                                                                                                                                               |
| 72         | VDD       | P | Positive Power Input                                                                                                   |                                                                                                                                                                                                                         |
| 61         | GND       | P | Power Ground Input                                                                                                     |                                                                                                                                                                                                                         |

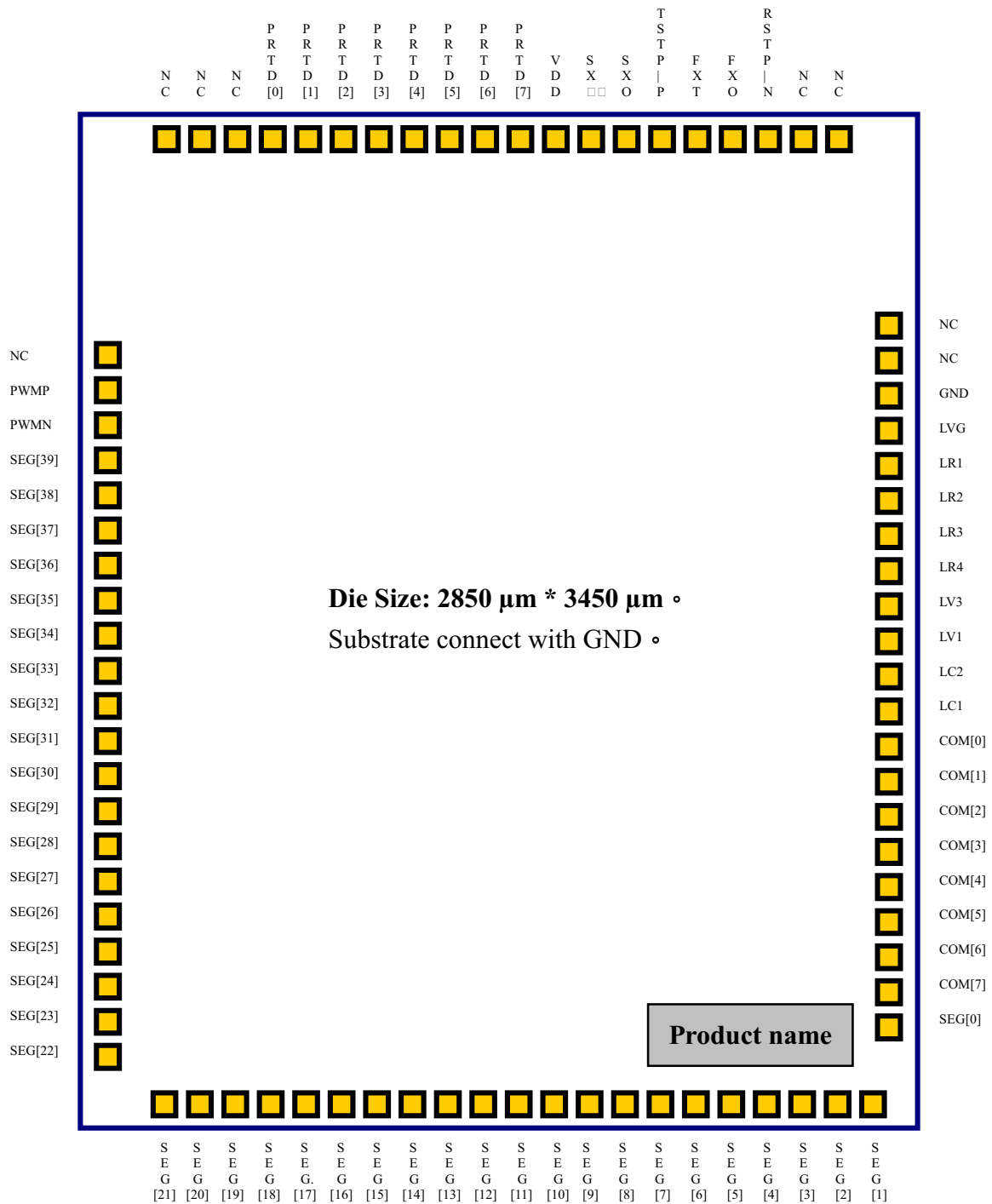


## E.LCD RAM Map

|      | SEG<br>[7:0] | SEG<br>[15:8] | SEG<br>[23:16] | SEG<br>[31:24] | SEG<br>[39:32] |
|------|--------------|---------------|----------------|----------------|----------------|
| COM0 | D8H          | E0H           | E8H            | F0H            | F8H            |
| COM1 | D9H          | E1H           | E9H            | F1H            | F9H            |
| COM2 | DAH          | E2H           | EAH            | F2H            | FAH            |
| COM3 | DBH          | E3H           | EBH            | F3H            | FBH            |
| COM4 | DCH          | E4H           | ECH            | F4H            | FCH            |
| COM5 | DDH          | E5H           | EDH            | F5H            | FDH            |
| COM6 | DEH          | E6H           | EEH            | F6H            | FEH            |
| COM7 | DFH          | E7H           | EFH            | F7H            | FFH            |



## F. Pin Diagram





## G. Bonding Pad Location

| PIN<br>Number | PIN<br>Name | X<br>Coordinate | Y<br>Coordinate | PIN<br>Number | PIN<br>Name | X<br>Coordinate | Y<br>Coordinate |
|---------------|-------------|-----------------|-----------------|---------------|-------------|-----------------|-----------------|
| 1             | NC          | X= -1339.50     | Y= 905.20       | 43            | SEG[0]      | X= 1339.90      | Y= -1302.80     |
| 2             | PWMP        | X= -1339.50     | Y= 789.80       | 44            | COM[7]      | X= 1339.90      | Y= -1187.20     |
| 3             | PWMN        | X= -1339.50     | Y= 674.20       | 45            | COM[6]      | X= 1339.90      | Y= -1071.80     |
| 4             | SEG[39]     | X= -1339.50     | Y= 558.80       | 46            | COM[5]      | X= 1339.90      | Y= -956.20      |
| 5             | SEG[38]     | X= -1339.50     | Y= 443.20       | 47            | COM[4]      | X= 1339.90      | Y= -840.80      |
| 6             | SEG[37]     | X= -1339.50     | Y= 327.80       | 48            | COM[3]      | X= 1339.90      | Y= -725.20      |
| 7             | SEG[36]     | X= -1339.50     | Y= 212.20       | 49            | COM[2]      | X= 1339.90      | Y= -609.80      |
| 8             | SEG[35]     | X= -1339.50     | Y= 96.80        | 50            | COM[1]      | X= 1339.90      | Y= -494.20      |
| 9             | SEG[34]     | X= -1339.50     | Y= -18.80       | 51            | COM[0]      | X= 1339.90      | Y= -378.80      |
| 10            | SEG[33]     | X= -1339.50     | Y= -134.20      | 52            | LC1         | X= 1339.90      | Y= -263.20      |
| 11            | SEG[32]     | X= -1339.50     | Y= -249.80      | 53            | LC2         | X= 1339.90      | Y= -147.80      |
| 12            | SEG[31]     | X= -1339.50     | Y= -365.20      | 54            | LV1         | X= 1339.90      | Y= -32.20       |
| 13            | SEG[30]     | X= -1339.50     | Y= -480.80      | 55            | LV3         | X= 1339.90      | Y= 83.20        |
| 14            | SEG[29]     | X= -1339.50     | Y= -596.20      | 56            | LR4         | X= 1339.90      | Y= 198.80       |
| 15            | SEG[28]     | X= -1339.50     | Y= -711.80      | 57            | LR3         | X= 1339.90      | Y= 314.20       |
| 16            | SEG[27]     | X= -1339.50     | Y= -827.20      | 58            | LR2         | X= 1339.90      | Y= 429.80       |
| 17            | SEG[26]     | X= -1339.50     | Y= -942.80      | 59            | LR1         | X= 1339.90      | Y= 545.20       |
| 18            | SEG[25]     | X= -1339.50     | Y= -1058.20     | 60            | LVG         | X= 1339.90      | Y= 660.80       |
| 19            | SEG[24]     | X= -1339.50     | Y= -1173.80     | 61            | GND         | X= 1339.90      | Y= 776.20       |
| 20            | SEG[23]     | X= -1339.50     | Y= -1289.20     | 62            | NC          | X= 1339.90      | Y= 891.80       |
| 21            | SEG[22]     | X= -1339.50     | Y= -1404.80     | 63            | NC          | X= 1339.90      | Y= 1007.20      |
| 22            | SEG[21]     | X= -1075.00     | Y= -1641.00     | 64            | NC          | X= 1121.00      | Y= 1639.60      |



|    |         |            |             |    |         |             |            |
|----|---------|------------|-------------|----|---------|-------------|------------|
| 23 | SEG[20] | X= -959.50 | Y= -1641.00 | 65 | NC      | X= 1005.50  | Y= 1639.60 |
| 24 | SEG[19] | X= -844.00 | Y= -1641.00 | 66 | RSTP_N  | X= 890.00   | Y= 1639.60 |
| 25 | SEG[18] | X= -728.50 | Y= -1641.00 | 67 | FXO     | X= 774.50   | Y= 1639.60 |
| 26 | SEG[17] | X= -613.00 | Y= -1641.00 | 68 | FXI     | X= 659.00   | Y= 1639.60 |
| 27 | SEG[16] | X= -497.60 | Y= -1641.00 | 69 | TSTP_P  | X= 543.50   | Y= 1639.60 |
| 28 | SEG[15] | X= -382.10 | Y= -1641.00 | 70 | SXO     | X= 428.10   | Y= 1639.60 |
| 29 | SEG[14] | X= -266.60 | Y= -1641.00 | 71 | SXI     | X= 312.60   | Y= 1639.60 |
| 30 | SEG[13] | X= -151.10 | Y= -1641.00 | 72 | VDD     | X= 197.10   | Y= 1639.60 |
| 31 | SEG[12] | X= -35.50  | Y= -1641.00 | 73 | PRTD[7] | X= 81.50    | Y= 1639.60 |
| 32 | SEG[11] | X= 80.00   | Y= -1641.00 | 74 | PRTD[6] | X= -34.00   | Y= 1639.60 |
| 33 | SEG[10] | X= 195.40  | Y= -1641.00 | 75 | PRTD[5] | X= -149.40  | Y= 1639.60 |
| 34 | SEG[9]  | X= 310.90  | Y= -1641.00 | 76 | PRTD[4] | X= -264.90  | Y= 1639.60 |
| 35 | SEG[8]  | X= 426.40  | Y= -1641.00 | 77 | PRTD[3] | X= -380.40  | Y= 1639.60 |
| 36 | SEG[7]  | X= 542.00  | Y= -1641.00 | 78 | PRTD[2] | X= -495.90  | Y= 1639.60 |
| 37 | SEG[6]  | X= 657.50  | Y= -1641.00 | 79 | PRTD[1] | X= -611.50  | Y= 1639.60 |
| 38 | SEG[5]  | X= 773.00  | Y= -1641.00 | 80 | PRTD[0] | X= -727.00  | Y= 1639.60 |
| 39 | SEG[4]  | X= 888.50  | Y= -1641.00 | 81 | NC      | X= -842.50  | Y= 1639.60 |
| 40 | SEG[3]  | X= 1004.00 | Y= -1641.00 | 82 | NC      | X= -958.00  | Y= 1639.60 |
| 41 | SEG[2]  | X= 1119.50 | Y= -1641.00 | 83 | NC      | X= -1073.50 | Y= 1639.60 |
| 42 | SEG[1]  | X= 1235.00 | Y= -1641.00 |    |         |             |            |



## H. DA/DC Characteristics

### Absolute Maximum Rating

| Item                  | Sym.     | Rating                           | Condition |
|-----------------------|----------|----------------------------------|-----------|
| Supply Voltage        | $V_{dd}$ | $-0.5V \sim 8V$                  |           |
| Input Voltage         | $V_{in}$ | $-0.5V \sim V_{dd}+0.5V$         |           |
| Output Voltage        | $V_o$    | $-0.5V \sim V_{dd}+0.5V$         |           |
| Operating Temperature | $T_{op}$ | $0^{\circ}C \sim 70^{\circ}C$    |           |
| Storage Temperature   | $T_{st}$ | $-50^{\circ}C \sim 100^{\circ}C$ |           |

### Recommended Operating Conditions

| Item                  | Sym.      | Rating                           | Condition     |
|-----------------------|-----------|----------------------------------|---------------|
| Supply Voltage        | $V_{dd}$  | $2.2V \sim 5.5V$                 |               |
| Input Voltage         | $V_{ih}$  | $0.9 V_{dd} \sim V_{dd}$         |               |
|                       | $V_{il}$  | $0.0V \sim 0.1V_{dd}$            |               |
| Operating Frequency   | $F_{max}$ | 8MHz                             | $V_{dd}=5.0V$ |
|                       |           | 4MHz                             | $V_{dd}=2.2V$ |
| Operating Temperature | $T_{op}$  | $0^{\circ}C \sim 70^{\circ}C$    |               |
| Storage Temperature   | $T_{st}$  | $-50^{\circ}C \sim 100^{\circ}C$ |               |



Testing Condition : TEMP=25°C, VDD=3V+/-10%, GND=0V

|                          | PARAMETER               |                             | CONDITION                                                                                                            | MIN                    | TYP                    | MAX                    | UNIT |
|--------------------------|-------------------------|-----------------------------|----------------------------------------------------------------------------------------------------------------------|------------------------|------------------------|------------------------|------|
| <b>I<sub>Fast</sub></b>  | NORMAL Mode Current     | System                      | 2M ext. R/C                                                                                                          |                        | 0.75                   | 1                      | mA   |
| <b>I<sub>Slow</sub></b>  | SLOW Mode Current       | System                      | 32.768K X'tal<br>LCD Disable                                                                                         |                        | 10                     | 20                     | μA   |
| <b>I<sub>Idle</sub></b>  | IDLE Mode Current       | System                      | 32.769K X'tal<br>LCD Disable                                                                                         |                        | 6                      | 10                     | μA   |
| <b>I<sub>LCD</sub></b>   | Extra Current if LCD ON | System                      | LCD Enable,<br>LCD option=300Kohm<br>Voltage-doubler OFF                                                             |                        | 12                     | 20                     | μA   |
|                          |                         |                             | LCD Enable,<br>LCD option=30Kohm,<br>Voltage-doubler ON                                                              |                        | 100                    | 120                    |      |
|                          |                         |                             |                                                                                                                      |                        |                        |                        |      |
| <b>I<sub>Sleep</sub></b> | Sleep Mode Current      | System                      |                                                                                                                      |                        |                        | 1                      | μA   |
| <b>I<sub>PWM</sub></b>   | PWM Output Current      | PWMP, PWMN <sup>*2</sup>    | With 32Ω Loading                                                                                                     | 10                     | 14                     |                        | mA   |
|                          |                         |                             | With 64Ω Loading                                                                                                     | 6                      | 8                      |                        | mA   |
|                          |                         |                             | With 100Ω Loading                                                                                                    | 4                      | 5                      |                        | mA   |
| <b>V<sub>iH</sub></b>    | Input High Voltage      | I/O pins                    |                                                                                                                      | 0.8<br>V <sub>DD</sub> |                        |                        | V    |
| <b>V<sub>iL</sub></b>    | Input Low Voltage       | I/O pins                    |                                                                                                                      |                        |                        | 0.2<br>V <sub>DD</sub> | V    |
| <b>V<sub>hys</sub></b>   | Input Hysteresis Width  | I/O, RSTP_N                 | Threshold=2/3V <sub>DD</sub> (input from<br>low to high)<br>Threshold=1/3V <sub>DD</sub> (input from<br>high to low) |                        | 1/3<br>V <sub>DD</sub> |                        | V    |
| <b>I<sub>oH</sub></b>    | Output Drive Current    | I/O pull-high <sup>*1</sup> | V <sub>oL</sub> =2.0V                                                                                                | 50                     |                        |                        | μA   |
| <b>I<sub>oL_1</sub></b>  | Output Sink Current     | I/O pull-low <sup>*1</sup>  | V <sub>oL</sub> =0.4V                                                                                                | 1.0                    |                        |                        | mA   |
| <b>I<sub>iL_1</sub></b>  | Input Low Current       | RSTP_N                      | V <sub>iL</sub> =GND, pull high Internally                                                                           |                        | 20                     |                        | μA   |
| <b>I<sub>iL_2</sub></b>  | Input Low Current       | I/O                         | V <sub>iL</sub> =GND, if pull high<br>Internally by user                                                             |                        | 100                    |                        | μA   |

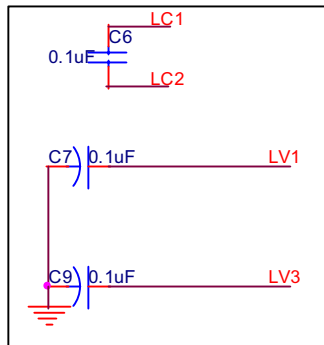


Note:     \*1: Drive Current Spec. for Push-Pull I/O port only  
              Sink Current Spec. for both Push-Pull and Open-Drain I/O port.

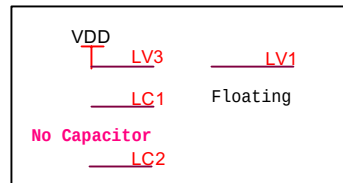
\*2: This Spec. base on one driver only. There are five build-in driver,               so user just  
multiply the number of driver he used to one driver current  
to get the total amount of current.(  $I_{PWM} * N$ ;  $N=0,1,2,3,4,5$ )

# I. Application Circuit

Twice Charge Pump is selected  
LCD Max. Voltage=LV3=3/2\*VDD

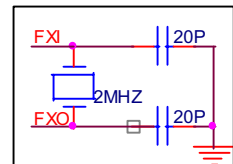


Twice Charge Pump is selected  
LCD Max. Voltage=LV3=VDD

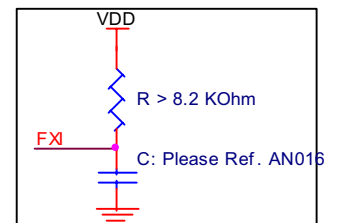


No External Parts is necessary if user adopt Internal Fast RC Clock

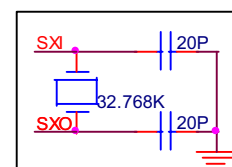
External Fast Clock:  
Crystal osc.



External Fast Clock:  
RC osc.



External Slow Clock:  
Crystal osc.



External Slow Clock:  
RC osc.

