# SPLB20D

## 480 DOTS DATA BANK

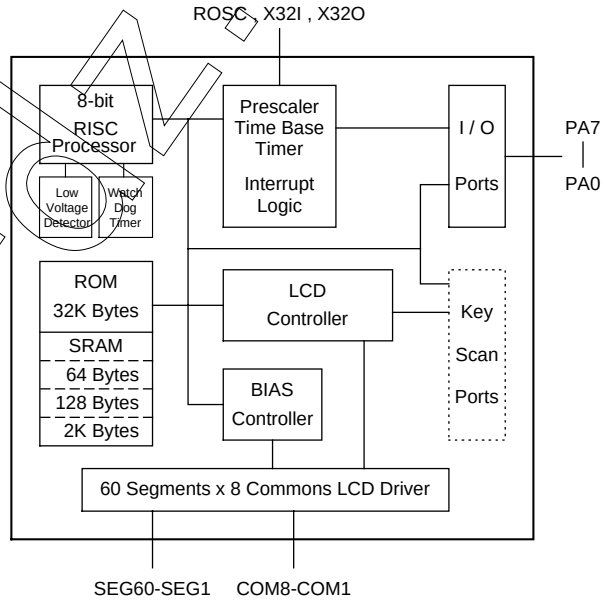
### GENERAL DESCRIPTION

SPLB20D, an 8-bit CMOS microcontroller with advanced processing technology and mechanism by Sunplus, contains tons of functionalities in a compact package such as SRAM, ROM, I/Os, an interrupt controller, a timer and a LCD controller/driver. The amount of 30K bytes of ROM is able to provide proper space for LCD graphical data. The 128 bytes of CPU working SRAM are totally free to users. In addition, 8 I/Os, timer, LCD driver, NMI controller, Watch-Dog Timer, Low Voltage Power Down and other features increase the capability of driving sophisticated functions and displaying remarkable LCD graphics. SPLB20D is a high-end micro-controller that filled with modern technology and strong backup from Sunplus. Obviously, it is the most suitable product for your solution.

### FEATURES

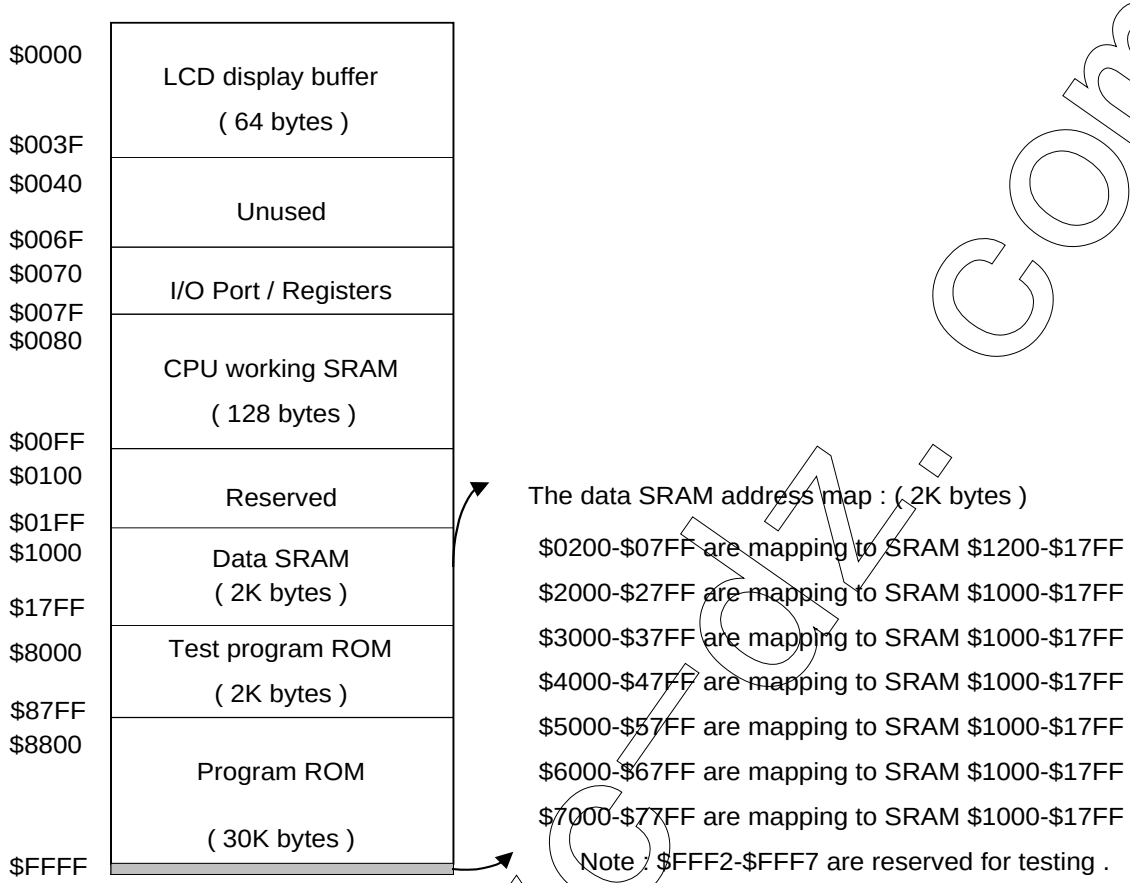
- 8-bit CPU (CPU14B)
- 30K bytes ROM
- 60 * 8 dual port SRAM for LCD display buffer
- 128 bytes SRAM for CPU working space
- 2K bytes SRAM for data
- 8 I/O ports
- LCD controller/driver (1/4 bias, Vop = VDD, Type-B)
  - . 60 * 8 (480 dots)
  - . 60 * 6 (360 dots)
  - . 48 * 8 (384 dots)
  - . 48 * 6 (288 dots)
- Built-in R-oscillator and 32.768KHz crystal oscillator
- 8-bit Reloadable timer/counter with pre-scaler
- NMI controller with following sources
  - . 2Hz for RTC
  - . 128Hz
  - . Key(PA7-PA0)
  - . Counter overflow
- Halt and Standby mode
- Watch Dog Timer (WDT)
- Low Voltage Power Down (LVPD)
- Wide operating range: 2.4V – 5.5V @ 1.0MHz

### BLOCK DIAGRAM



## FUNCTION DESCRIPTION

### ■ ROM AREA



## ■ LCD MAPPING AND SPECIFICATION

$00H - $3F SRAM space is allocated for LCD display buffer. To display a pattern on LCD, user just write the corresponding bits of display buffer. The following table shows the mapping between LCD and display buffer.

| | SEG8 - SEG1 (b7 – b0) | SEG16 – SEG9 (b7 – b0) | SEG24 - SEG17 (b7 – b0) | SEG32 - SEG25 (b7 – b0) | SEG40 - SEG33 (b7 – b0) | SEG48 - SEG41 (b7 – b0) | SEG56 - SEG49 (b7 – b0) | SEG60 - SEG57 (b7 – b0) |
|---|---|---|---|---|---|---|---|---|
| COM1 | 07H | 06H | 05H | 04H | 03H | 02H | 01H | 00H |
| COM2 | 0FH | 0EH | 0DH | 0CH | 0BH | 0AH | 09H | 08H |
| COM3 | 17H | 16H | 15H | 14H | 13H | 12H | 11H | 10H |
| COM4 | 1FH | 1EH | 1DH | 1CH | 1BH | 1AH | 19H | 18H |
| COM5 | 27H | 26H | 25H | 24H | 23H | 22H | 21H | 20H |
| COM6 | 2FH | 2EH | 2DH | 2CH | 2BH | 2AH | 29H | 28H |
| COM7 | 37H | 36H | 35H | 34H | 33H | 32H | 31H | 30H |
| COM8 | 3FH | 3EH | 3DH | 3CH | 3BH | 3AH | 39H | 38H |

The SPLB20D supports LCD's with following characteristics:

Duty: 1/6 or 1/8

Bias: 1/4; $V_{LCD}$ = VDD

V1 = VDD * 3/4

V2 = VDD * 2/4

V3 = VDD * 1/4

$V_{EE}$ = GND

## ■ MASK OPTIONS:

1. 32K from Crystal / R-osc with prescaler

The system time base, LCD timing and auto-strobe signals are generated from 32.768KHz crystal oscillator. To support those systems without 32.768KHz crystal, this option is provided. When non-crystal mode is selected, the signals and timing listed above will be generated from prescaler. By programming register $007C, users can get a suitable clock to replace 32.768KHz clock. Register $007A:B5 can be used to turn off this clock.

2.DOGEN (WDT Enable) / DOGDIS (WDT Disable)

There is an on-chip WDT available on SPLB20D. The WDT is designed for recovering from system crash. If the system is hanged, WDT will generate a system reset to restart system after 1 second. If WDT is enabled, the WDT should be cleared every 0.5 seconds to avoid accidental reset. The WDT can be cleared by writing to $007F. Note that the WDT only works when 32768 crystal is available.

3. Low Voltage Power Down (LVPD) Enable/Disable

Low Voltage Power Down circuit will be enabled only when 32768 signal is available. If LVPD circuit sensed VDD <= 2.2V, the system will enter Low Voltage (standby) mode after R-osc stops. In Low Voltage mode current consumption will be minimized. This feature can be used to avoid possible data loss during battery replacement.

**PIN DESCRIPTION**

| Mnemonic | PIN No. | Type | Description |
|---|---|---|---|
| VDD | 25 | I | Power supply input |
| VSS | 52 | I | Ground input |
| RESET | 27 | I | System reset input (internal pull-high), low active |
| TEST | 21 | I | Test input (internal pull-low), high active |
| X32I | 29 | I | 32.768 KHz crystal input |
| X32O | 28 | O | 32.768 KHz crystal output |
| ROSC | 26 | I | R-oscillator input, connect a resistor to VDD through a resistor |
| PA7 – PA0 | 37-30 | I/O | Input / output port |
| COM8 – COM6<br>COM5 – COM3<br>COM2 – COM1 | 38-40<br>24-22<br>20-19 | O | LCD common output |
| SEG60 – SEG50<br>SEG49 – SEG19<br>SEG18 – SEG1 | 41-51<br>53-83<br>1-9 | O | LCD segment output. |

Note 1: All of the SEG16 – SEG1 can be used as key strobe output pins by software programming register ($007E). There are two kinds of combinations for key scan option.

| No. of selected key scan port | The option for key scan port | ( $ 007E ) bit 2, bit 1, bit 0 |
|---|---|---|
| No. ≦ 8 | SEG8 – SEG1 or<br>SEG16 – SEG9 | 1 , 0 , 1<br>1 , 1 , 0 |
| 9 ≦ No. ≦ 16 | SEG16 - SEG1 | 1 , 1 , 1 |

Note 2: When the ROSC is selected, it is in the R-oscillator mode. Then the pin X32I should be connected to VSS and the pin X32O should be floating.

**ABSOLUTE MAXIMUM RATINGS**

| Characteristics | Symbol | Ratings |
|---|---|---|
| DC Supply Voltage | $V_{DD}$ | < 6V |
| Input Voltage Range | $V_{IN}$ | -0.5V to VDD + 0.5V |
| Operating Temperature | $T_A$ | 0℃ to +60℃ |
| Storage Temperature | $T_{STO}$ | -50℃ to +150℃ |

Note: Stresses beyond those given in the Absolute Maximum Rating table may cause operational errors or damage to the device. For normal operational conditions see AC/DC Electrical Characteristics.

**DC CHARACTERISTICS ( TA = 25 ℃ , VDD = 3V )**

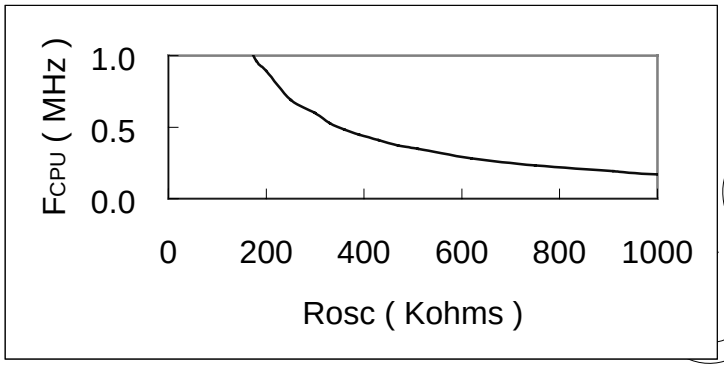
| Characteristics | Symbol | Limit | | | Unit | Test Condition |
|---|---|---|---|---|---|---|
| | | Min. | Typ. | Max. | | |
| Operating Voltage | $V_{DD}$ | 2.4 | - | 3.4 | V | For 2-battery |
| Operating Current | $I_{OP}$ | - | 160 | - | μA | $F_{CPU}$ = 500KHz @ 3V, no load |
| Standby Current | $I_{STBY}$ | - | - | 1.0 | μA | VDD = 3V, 32768Hz OFF |
| Input High Level | $V_{IH}$ | 2.0 | - | - | V | VDD = 3V |
| Input Low Level | $V_{IL}$ | - | - | 0.8 | V | VDD = 3V |
| Output High I ( PA5 – PA0 ) | $I_{OH}$ | - | -1.0 | - | mA | VDD = 3V $V_{OH}$ = 2V |
| Output Sink I ( PA5 – PA0 ) | $I_{OL}$ | - | 1.0 | - | mA | VDD = 3V $V_{OL}$ = 1V |
| Output High I ( PA7 – PA6 ) | $I_{OH}$ | - | -2.5 | - | mA | VDD = 3V $V_{OH}$ = 2V |
| Output Sink I ( PA7 – PA6 ) | $I_{OL}$ | - | 2.5 | - | mA | VDD = 3V $V_{OL}$ = 1V |
| OSC Resistor | $R_{osc}$ | - | 350 | - | Kohm | $F_{CPU}$ = 500KHz @ 3V |
| CPU Clock | $F_{CPU}$ | - | - | 1.0 | MHz | VDD = 3V |

**DC CHARACTERISTICS ( TA = 25 ℃, VDD = 4.5V )**

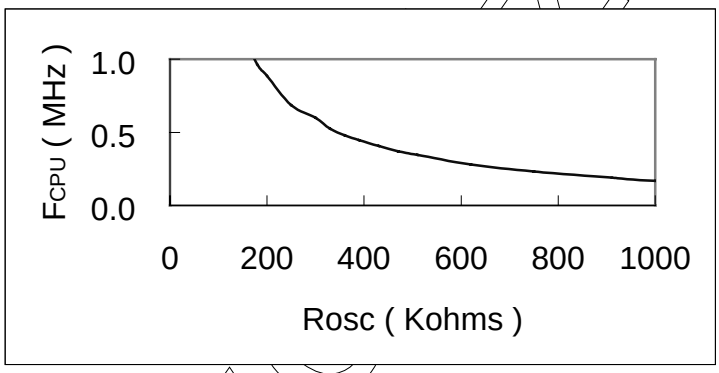
| Characteristics | Symbol | Limit | | | Unit | Test Condition |
|---|---|---|---|---|---|---|
| | | Min. | Typ. | Max. | | |
| Operating Voltage | $V_{DD}$ | 3.6 | - | 5.5 | V | For 3-battery |
| Operating Current | $I_{OP}$ | - | 400 | - | μA | $F_{CPU}$ = 500KHz @ 4.5V, no load |
| Standby Current | $I_{STBY}$ | - | - | 1.0 | μA | VDD = 4.5V, 32768Hz OFF |
| Input High Level | $V_{IH}$ | 3.0 | - | - | V | VDD = 4.5V |
| Input Low Level | $V_{IL}$ | - | - | 0.8 | V | VDD = 4.5V |
| Output High I ( PA5 – PA0 ) | $I_{OH}$ | - | -1.0 | - | mA | VDD = 4.5V<br>$V_{OH}$ = 3.5V |
| Output Sink I ( PA5 – PA0 ) | $I_{OL}$ | - | 1.0 | - | mA | VDD = 4.5V<br>$V_{OL}$ = 0.8V |
| Output High I ( PA7 – PA6 ) | $I_{OH}$ | - | -3.0 | - | mA | VDD = 4.5V<br>$V_{OH}$ = 3.5V |
| Output Sink I ( PA7 – PA6 ) | $I_{OL}$ | - | 3.0 | - | mA | VDD = 4.5V<br>$V_{OL}$ = 0.8V |
| OSC Resistor | $R_{osc}$ | - | 350 | - | Kohm | $F_{CPU}$ = 500KHz @ 4.5V |
| CPU Clock | $F_{CPU}$ | - | - | 1.0 | MHz | VDD = 4.5V |

**The relationships between the Rosc and the Fosc**

VDD = 3V, Ta = 25℃

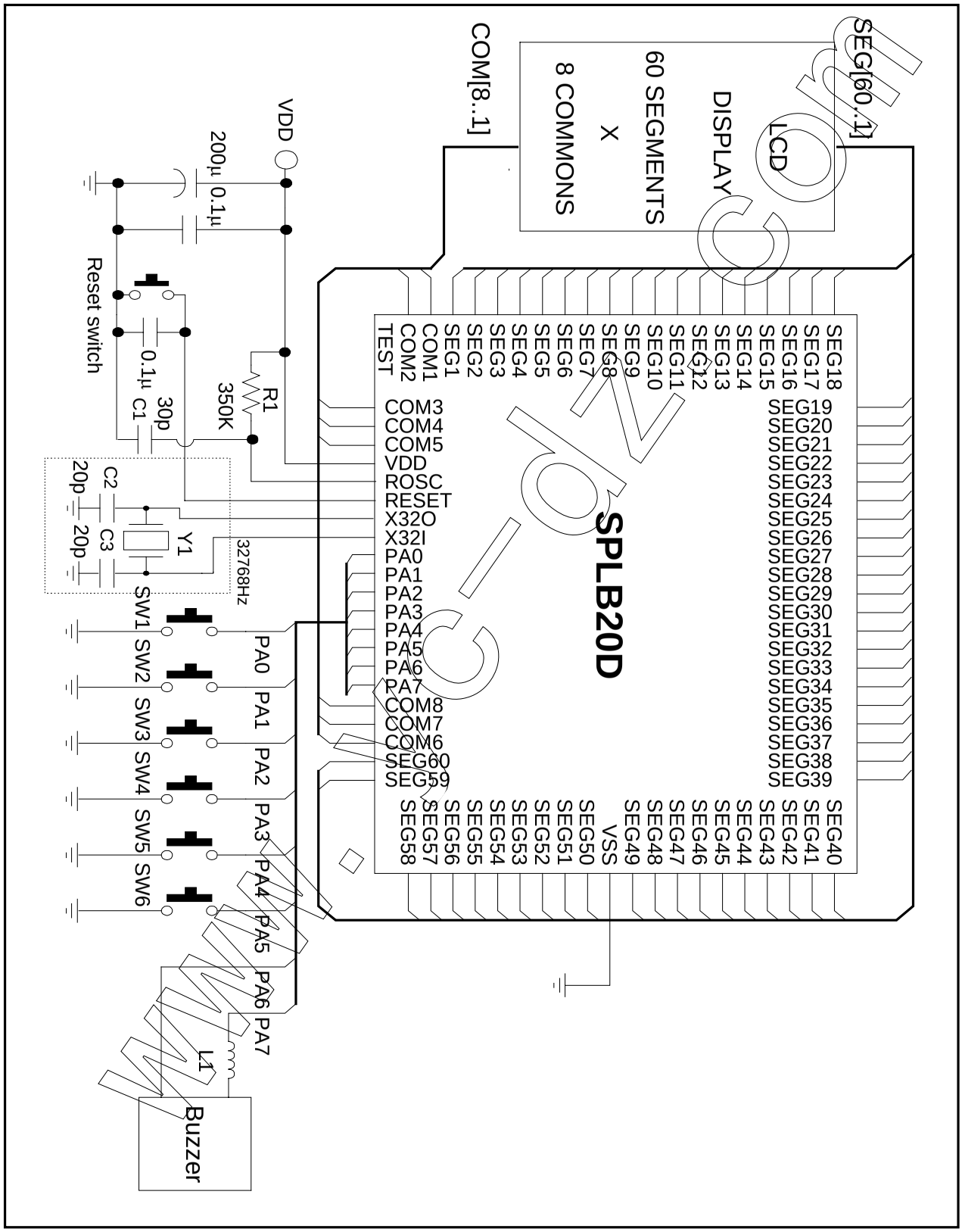


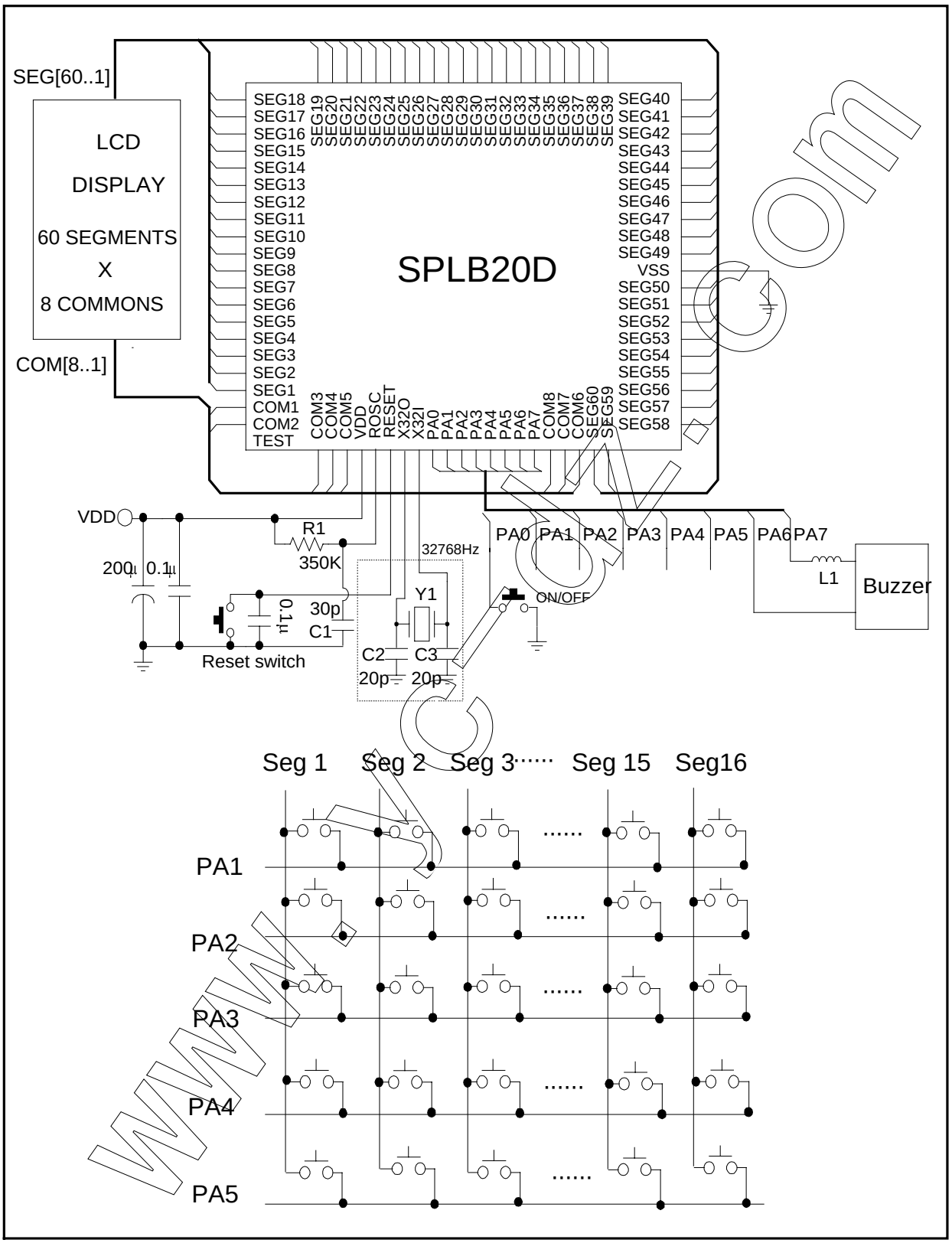

VDD = 4.5V, Ta = 25℃



## APPLICATION NOTES

### ■ SPLB20D Application Circuit




SEG[60..1]
LCD
DISPLAY
60 SEGMENTS
X
8 COMMONS
COM[8..1]
SPLB20D
SEG18 SEG17 SEG16 SEG15 SEG14 SEG13 SEG12 SEG11 SEG10 SEG9 SEG8 SEG7 SEG6 SEG5 SEG4 SEG3 SEG2 SEG1 COM1 COM2 TEST
SEG19 SEG20 SEG21 SEG22 SEG23 SEG24 SEG25 SEG26 SEG27 SEG28 SEG29 SEG30 SEG31 SEG32 SEG33 SEG34 SEG35 SEG36 SEG37 SEG38 SEG39
SEG40 SEG41 SEG42 SEG43 SEG44 SEG45 SEG46 SEG47 SEG48 SEG49 VSS SEG50 SEG51 SEG52 SEG53 SEG54 SEG55 SEG56 SEG57 SEG58
COM3 COM4 COM5 VDD ROSC RESET X32O X32I PA0 PA1 PA2 PA3 PA4 PA5 PA6 PA7 COM8 COM7 COM6 SEG60 SEG59
VDD
R1
350K
200µ
0.1µ
0.1µ
Reset switch
32768Hz
Y1
30p
C1
C2
20p
C3
20p
ON/OFF
PA0 PA1 PA2 PA3 PA4 PA5 PA6 PA7
L1
Buzzer
Seg 1 Seg 2 Seg 3····· Seg 15 Seg16
PA1
PA2
PA3
PA4
PA5

Note: 1.In the CRYSTAL mode, the accurate time base is generated from the 32768Hz crystal oscillator, the 32768Hz crystal oscillator should be installed.

2.In the ROSC mode, a suitable time base is generated from the R-Oscillator. The 32768Hz crystal oscillator is unnecessary to be installed.

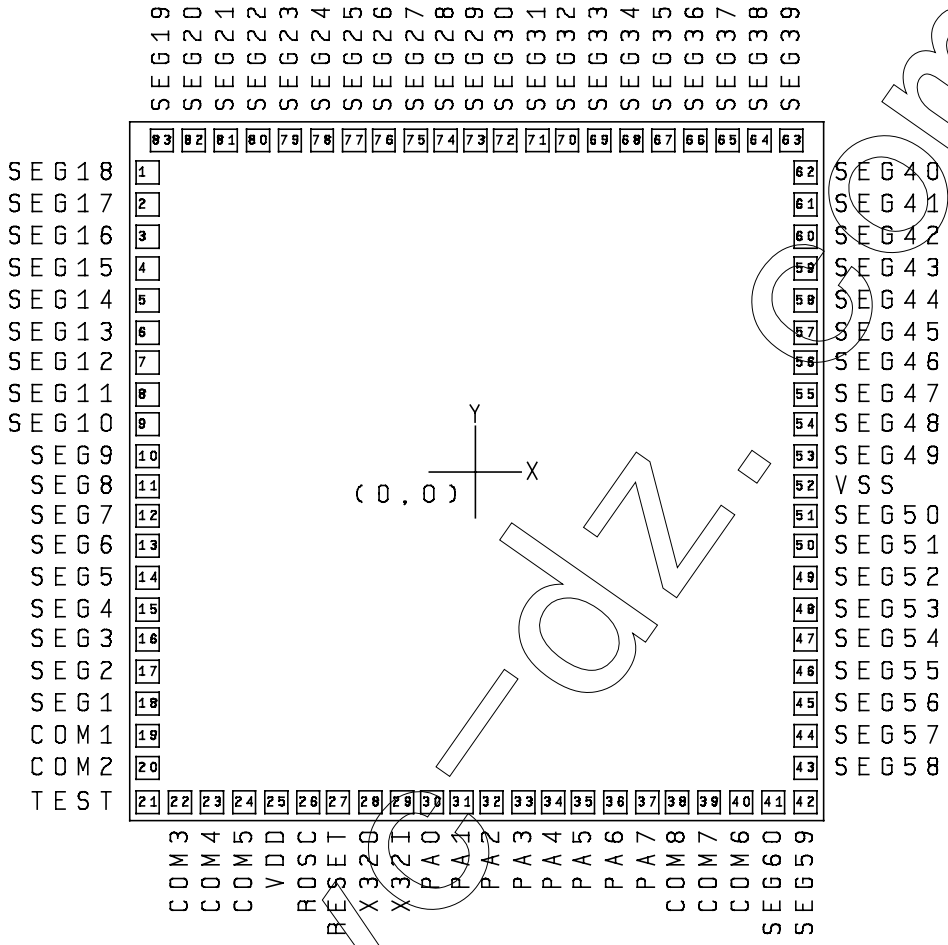
3.To avoid the noise interference on PCB around R-Oscillator and crystal circuit, following rules are suggested:

(1) R1 and C1 should be placed near to ROSC pin as possible.

(2) C2, C3 and crystal should be placed near to X32I and X32O as possible. A shielding by ground is suggested.

## PAD ASSIGNMENT AND LOCATIONS

### ■ PAD Assignment




Chip Size: 3190μm x 3210μm

This IC substrate should be connected to VSS

Note: To ensure that the IC functions properly, please bond all of VDD, VSS, AVDD and AVSS pins.

### Ordering Information

| Product Number | Package Type |
|---|---|
| SPLB20D-nnnnV-C | Chip form |

Note1: Code number (nnnnV) is assigned for customer.

Note2: Code number (nnnn = 0000 - 9999); version (V = A - Z).

NOTE: SUNPLUS TECHNOLOGY CO., LTD reserves the right to make changes at any time without notice in order to improve the design and performance to supply the best possible product.

■ **PAD Locations**

| Pad No | Pad Name | X | Y | Pad No | Pad Name | X | Y |
|---|---|---|---|---|---|---|---|
| 1 | SEG18 | -1438 | 1306 | 33 | PA3 | 202 | -1448 |
| 2 | SEG17 | -1438 | 1166 | 34 | PA4 | 334 | -1448 |
| 3 | SEG16 | -1438 | 1026 | 35 | PA5 | 469 | -1448 |
| 4 | SEG15 | -1438 | 886 | 36 | PA6 | 604 | -1448 |
| 5 | SEG14 | -1438 | 746 | 37 | PA7 | 741 | -1448 |
| 6 | SEG13 | -1438 | 609 | 38 | COM8 | 878 | -1448 |
| 7 | SEG12 | -1438 | 472 | 39 | COM7 | 1018 | -1448 |
| 8 | SEG11 | -1438 | 337 | 40 | COM6 | 1158 | -1448 |
| 9 | SEG10 | -1438 | 202 | 41 | SEG60 | 1300 | -1448 |
| 10 | SEG9 | -1438 | 70 | 42 | SEG59 | 1438 | -1448 |
| 11 | SEG8 | -1438 | -62 | 43 | SEG58 | 1438 | -1298 |
| 12 | SEG7 | -1438 | -194 | 44 | SEG57 | 1438 | -1158 |
| 13 | SEG6 | -1438 | -329 | 45 | SEG56 | 1438 | -1018 |
| 14 | SEG5 | -1438 | -464 | 46 | SEG55 | 1438 | -878 |
| 15 | SEG4 | -1438 | -601 | 47 | SEG54 | 1438 | -738 |
| 16 | SEG3 | -1438 | -738 | 48 | SEG53 | 1438 | -601 |
| 17 | SEG2 | -1438 | -878 | 49 | SEG52 | 1438 | -464 |
| 18 | SEG1 | -1438 | -1018 | 50 | SEG51 | 1438 | -329 |
| 19 | COM1 | -1438 | -1158 | 51 | SEG50 | 1438 | -194 |
| 20 | COM2 | -1438 | -1298 | 52 | VSS | 1438 | -62 |
| 21 | TEST | -1438 | -1448 | 53 | SEG49 | 1438 | 70 |
| 22 | COM3 | -1298 | -1448 | 54 | SEG48 | 1438 | 202 |
| 23 | COM4 | -1158 | -1448 | 55 | SEG47 | 1438 | 337 |
| 24 | COM5 | -1018 | -1448 | 56 | SEG46 | 1438 | 472 |
| 25 | VDD | -878 | -1448 | 57 | SEG45 | 1438 | 609 |
| 26 | ROSC | -738 | -1448 | 58 | SEG44 | 1438 | 746 |
| 27 | RESET | -601 | -1448 | 59 | SEG43 | 1438 | 886 |
| 28 | X32O | -464 | -1448 | 60 | SEG42 | 1438 | 1026 |
| 29 | X32I | -329 | -1448 | 61 | SEG41 | 1438 | 1166 |
| 30 | PA0 | -194 | -1448 | 62 | SEG40 | 1438 | 1306 |
| 31 | PA1 | -62 | -1448 | 63 | SEG39 | 1374 | 1448 |
| 32 | PA2 | 70 | -1448 | 64 | SEG38 | 1234 | 1448 |

| Pad No | Pad Name | X | Y | Pad No | Pad Name | X | Y |
|---|---|---|---|---|---|---|---|
| 65 | SEG37 | 1094 | 1448 | 75 | SEG27 | -266 | 1448 |
| 66 | SEG36 | 954 | 1448 | 76 | SEG26 | -401 | 1448 |
| 67 | SEG35 | 814 | 1448 | 77 | SEG25 | -536 | 1448 |
| 68 | SEG34 | 674 | 1448 | 78 | SEG24 | -673 | 1448 |
| 69 | SEG33 | 537 | 1448 | 79 | SEG23 | -810 | 1448 |
| 70 | SEG32 | 400 | 1448 | 80 | SEG22 | -950 | 1448 |
| 71 | SEG31 | 265 | 1448 | 81 | SEG21 | -1090 | 1448 |
| 72 | SEG30 | 130 | 1448 | 82 | SEG20 | -1230 | 1448 |
| 73 | SEG29 | -2 | 1448 | 83 | SEG19 | -1370 | 1448 |
| 74 | SEG28 | -134 | 1448 | | | | |

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