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AMENDMENT HISTORY

Version	Date	Description
Ver 1.0	September 20, 2012	First issue
Ver 1.1	January 8, 2013	Features add IR describe
Ver 1.2	December 9, 2013	Add OTP program pad describe

1 INTRODUCTION

The SNL16168P is an 8-bit LCD controller **One Time Program** IC embedded 1024 dots with B/W LCD driver. It contains an 8-bit CPU core, LCD Controller, Wave Processing Unit (WPU) and other primary functions for LCD games, Education Learning Aids (ELA).

The WPU is a 4-channel wave table music synthesizer compatible with standard MIDI stream format. Its low power consumption makes it ideal for all battery operated handheld LCD devices.

2 FEATURES

2.1. CPU

- ◆ Single Power Supply 2.2V – 5.5V
- ◆ Programmable system speed for power saving: 2.0MIPS, 1.0MIPS, 0.5MIPS or 0.25MIPS
- ◆ Real Time clock (RTC) is supported.
- ◆ Dedicate 16 I/O pins.
- ◆ Built-in an 8x8 multiplier
- ◆ RAM: 1024 * 8 bits (shared with System register, LCD display RAM and WPU RAM)
- ◆ **ROM: 524286 Bytes (349524 x 12bits)**
- ◆ 3 Operating modes: Normal, Idle and Halt.
- ◆ IR function is provided
- ◆ SONiX SNAD01 ADC Interface is provided.
- ◆ Serial Peripheral Interface (SPI Master Only)
- ◆ H/W 8x8 Matrix key scan Interface (Occupy 8 I/O and share with 8 COM signal)
- ◆ Low Voltage Reset(LVR) is provided
 - Reset at 1.8V
- ◆ Voltage Detect (LVD) is provided
 - 2.2/2.4/2.6/2.8 V

2.2. LCD Driver

- ◆ Up to 16 commons, up to 64 segments, maximum 1024 dots
- ◆ 1/4 , 1/5 or 1/6 bias
- ◆ 1/4, 1/8, 1/12 or 1/16 duty
- ◆ Built-in Voltage booster and voltage regulator
- ◆ 32 levels Brightness Adjustment
- ◆ Support B/W only

2.3. WPU

- ◆ 4 CH Voice/MIDI synthesizer, compatible with General MIDI stream format
- ◆ Mark Event Supported in both Wave and Melody.
- ◆ Individual adaptive playing speed from 4 k - 64 kHz for all 4 voice channels.

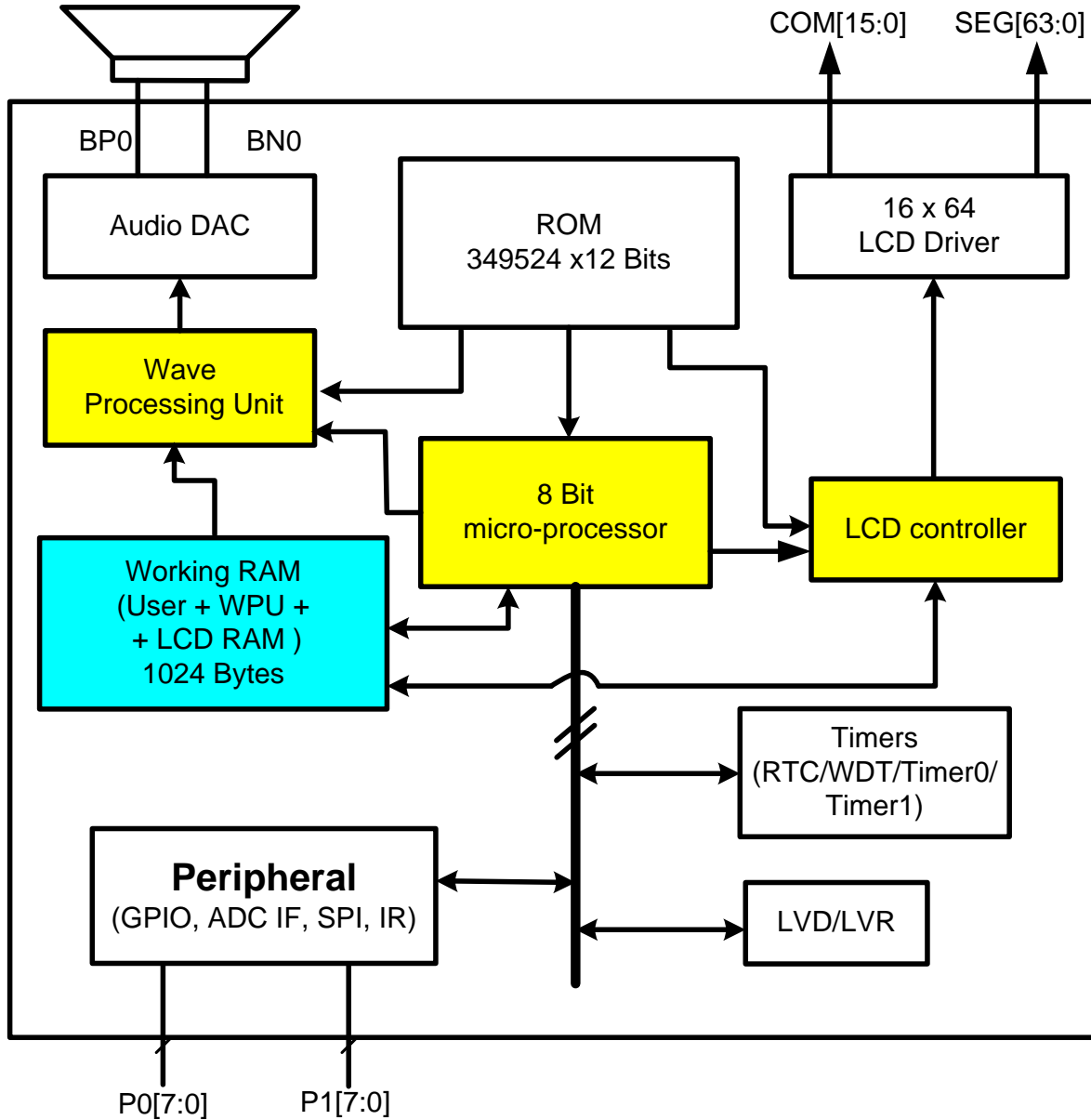


- ◆ Support one flexible WPU channel for SPI application.
- ◆ 12 bits push pull DAC.
- ◆ **Buzzer IO for direct drive Buzzer**

3 PIN ASSIGNMENT

Symbol	I/O	Function Description
P00 ~ P07	I/O	Bit7 ~ Bit0 of I/O port 0
P10 ~ P17	I/O	Bit7 ~ Bit0 of I/O port 1
VDDPP	P	Positive power supply for Audio
GNDPP	P	Negative power supply for Audio
VDDCP	P	Positive power supply for LCD Driver
GNDCP	P	Negative power supply for LCD driver
VDDREG	P	Positive power supply for Regulator
GNDREG	P	Negative power supply for Regulator
CVDD_REGOUT	P	Positive power supply for CPU
VDD	P	Positive power supply for I/O
GND	P	Negative power supply
RST	I	Chip Reset (Active low)
LXIN	I	Low clock Crystal Input
LXOUT	O	Low clock Crystal Out
TESTM	I	Test Pin
BN0	O	Direct Drive negative output
BP0	O	Direct Drive positive output
V1~V4	P	LCD voltage generation
C1N,C1P	P	Charge pump cap
C2N,C2P	P	Charge pump cap
VLCD	P	LCD voltage generation
COM0~COM15	O	LCD COM0~COM15 output
SEG0~SEG63	O	LCD SEG0~SEG63 output
VPP	P	OTP Programming Voltage

4 Block Diagram



5 FUNCTION DESCRIPTION

5.1. ROM

SNL16168P contains a substantial 524286 bytes internal ROM which is shared by program and resource data. Program, voice, melodies, data, images and instrument waveforms are shared within this same ROM area.

5.2. RAM

SNL16168P contains 1024 bytes RAM. The 1024 bytes RAM is divided into 8 pages and each page contains 128 bytes.

Bank Num	Address Range	Description	Total Size (Bytes)
0	0x000 ~ 0x04F	Reserved for System Registers	80
	0x050 ~ 0x05F	User Data	16
	0x060 ~ 0x07F	User Data / Reserved for C	32
1	0x080 ~ 0x0FF	Stack Buffer	128
2	0x100 ~ 0x11F	WPU Channel RAM	32
	0x120 ~ 0x17F	User Data	96
3	0x180 ~ 0x1FF	User Data	128
4	0x200 ~ 0x27F	User Data	128
5	0x280 ~ 0x2FF	User Data	128
6	0x300 ~ 0x37F	LCD Display RAM 0	128
7	0x380 ~ 0x3FF	LCD Display RAM 1	128

5.3. Interrupt

SNL16168P provides 9 interrupt sources; include Timer0, ADIF, SPI, H/W 8x8 Matrix key, WaveMark, edge of P0.7, edge of P0.6, WPU channel buffer and Stack Overflow. When CPU enters an interrupt service routine, the GIE bit (in INTEN) will be cleared to "0". Any other interrupt requests will not be granted at this time. Instead, these requests will be queued in INTRQ.*IRQ, and will be served once GIE is restored to "1" The GIE will be restored to 1 once the CPU exits the ISR.

5.4. Operation Mode

There are three different operation modes in SNL16168P.

Normal Mode : Hi-speed clock ON, selectable system clock rate from 8M to 1M.

Idle Mode : RTC mode, Low-speed clock ON, chip is halt.

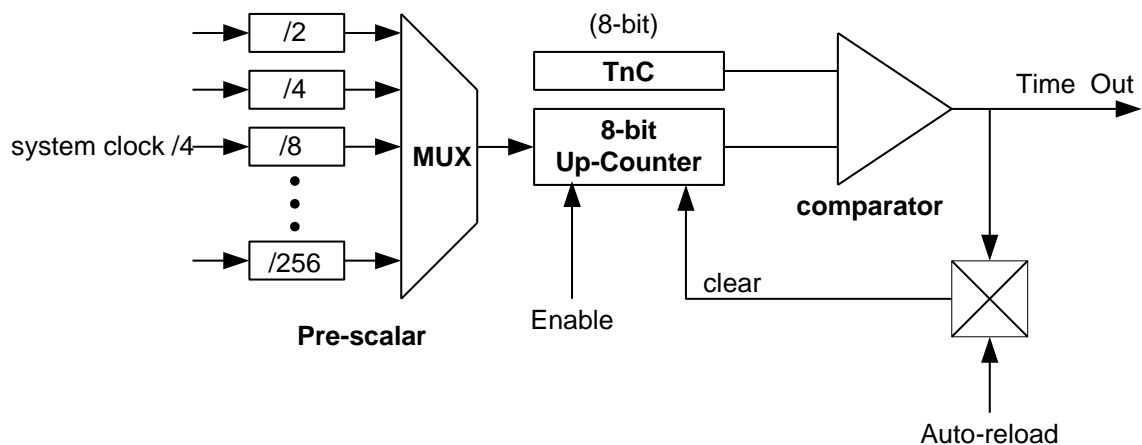
Sleep Mode : Hi and Low speed clock Off, chip is halt.

5.5. Watch Dog Timer

SNL16168P built in an internal WDT (Watch Dog Timer). This Watchdog timer would issue resets signal to this chip if it is not cleared before reaching terminal count (0.25sec). The watchdog timer is enabled at reset and cannot be disabled.

5.6. Timer

The timers consist of a pre-scalar, and an 8-bit Up-counting counter with an auto-reload function. The 4-bit pre-scalar is used as clock division. If a successful event occurs (counting value = setting value), it will issue an interrupt request and continue counting. The clock source of the pre-scalar is system clock /4

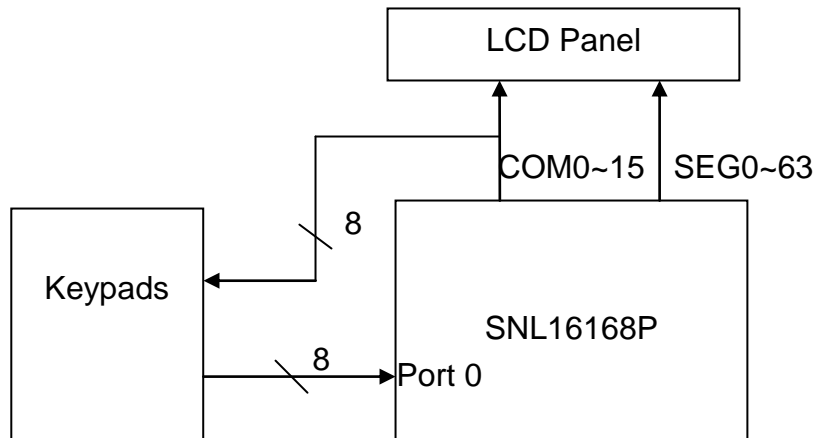


5.7. Voltage detector

The SNL16168P has a Low Voltage Detector (LVD) for power management usage. The status of supplying power can be detected and monitored from 2.2V to 2.8V.

5.8. Auto Scan Key Function

The COM 0~15 can be used for LCD display and at the same time as keyboard scan output. Combine with port 0 serve as keyboard scan input. Maximum 8 * 8 keypads (64 keys) can be used for application.



As shown above, the COM0~15 are used for COM output and at the same time served as keypads output while keyboard scan function is enabled.

5.9. LCD driver

LCD Driver is composed of three parts – LCD Controller, LCD Clock and Charge Pump. LCD Clock is adjustable to produce different frame rate of LCD controller. Charge Pump Unit is in charge of stepping up output voltage to triple of input voltage through charging and discharging capacitance.

5.10. Wave Processing Unit (WPU)

The Wave Processing Unit (WPU) in SNL16168P provides up to 4 voice/music channels. A high-performance multi-channel music synthesizer is built-in to provide high-quality wave-table melody playback. Most of standard MIDI format can be accessed through the MIDI to Melody convert software. The voice playing can support 10-bit PCM, 6-bit ASDPCM and 4-bit ASDPCM compression format.

5.10.1 Voice Synthesizer

The Major function of Voice Synthesizer is to fetch Wave data from ROM and synthesize into voice. It equips with sampling rate counter, auto repetition function, and envelop control for each individual channel. With the help of wave synthesizer, users can play voices easily without any software effort. Besides, it has Wave Mark to record event mark.

5.10.2 Sampling Rate Counters

The unique sampling rate counter is designed in voice channel to be able to play diverse voices at different sampling rates. The playing rate can be adaptively set up among from the wide ranges of 4 KHz to 64 KHz. This feature makes voice close to its original source and yields the better voice quality.

5.10.3 Auto Repetition

Each voice channel is equipped with a hardware auto repeat function. Auto repeat functions are normally used to implement sustain in instrument synthesis but can even be used to repeat any voice data of arbitrary length.

5.11. WPU Channel buffer for SPI application

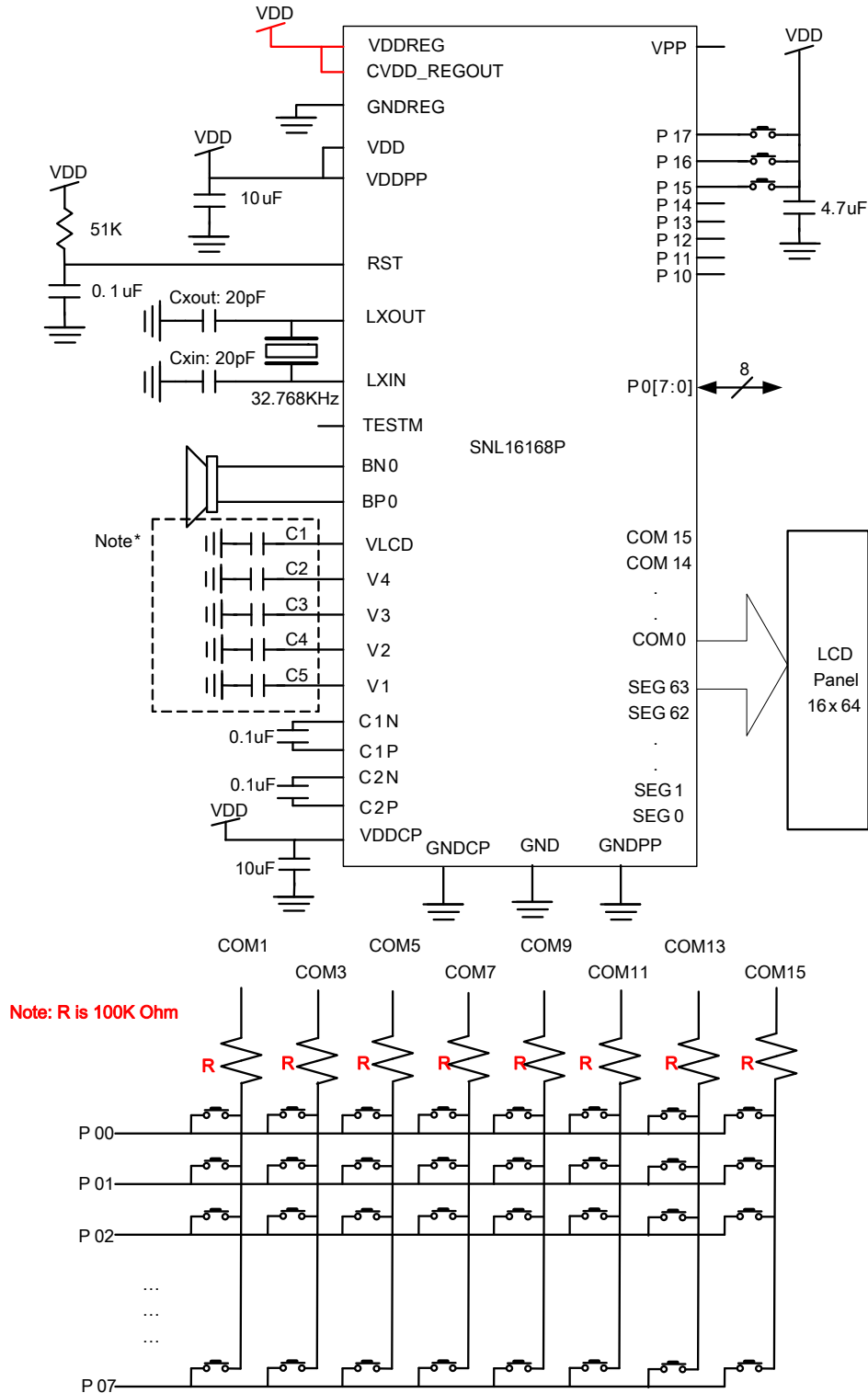
Hardware supports one channel play wave from channel buffer. The voice playing can support 10-bit PCM, 4-bit ASDPCM and 6-bit ASDPCM compression format.

5.12. Buzzer Driver

SNL16168P hardware support can be direct drive the Buzzer. The Buzzer IO pin is share with the Push Pull DAC output pin. User can use register option to select output is Buzzer IO or Push Pull DAC.

6 APPLICATION CIRCUIT

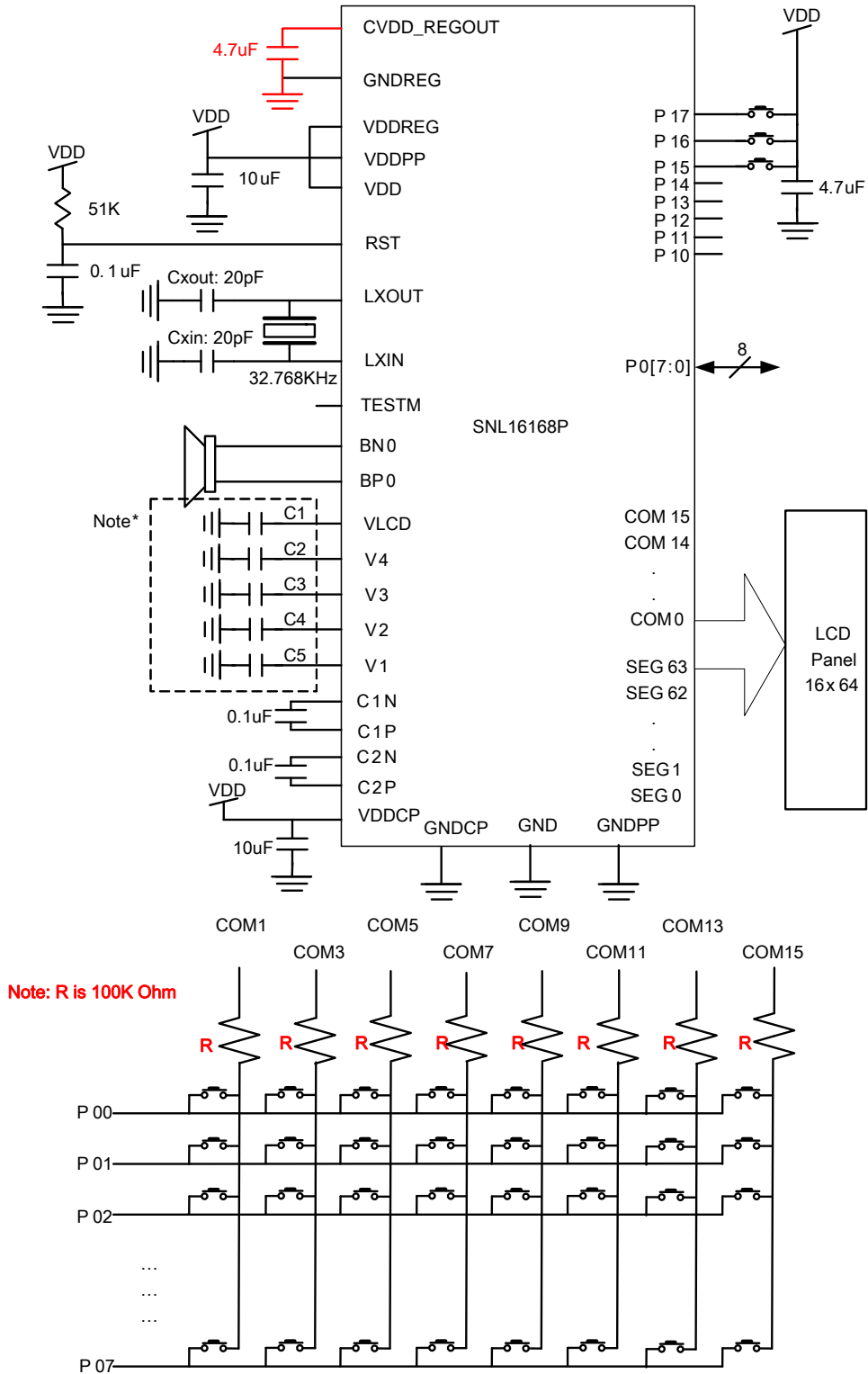
- ◆ Power supply: 3V
- ◆ With 32768 X'TAL



Note* :

The different capacitor values (0.1uF ~ 10uF) of C1 ~ C5 may be required for different LCD panel connected.

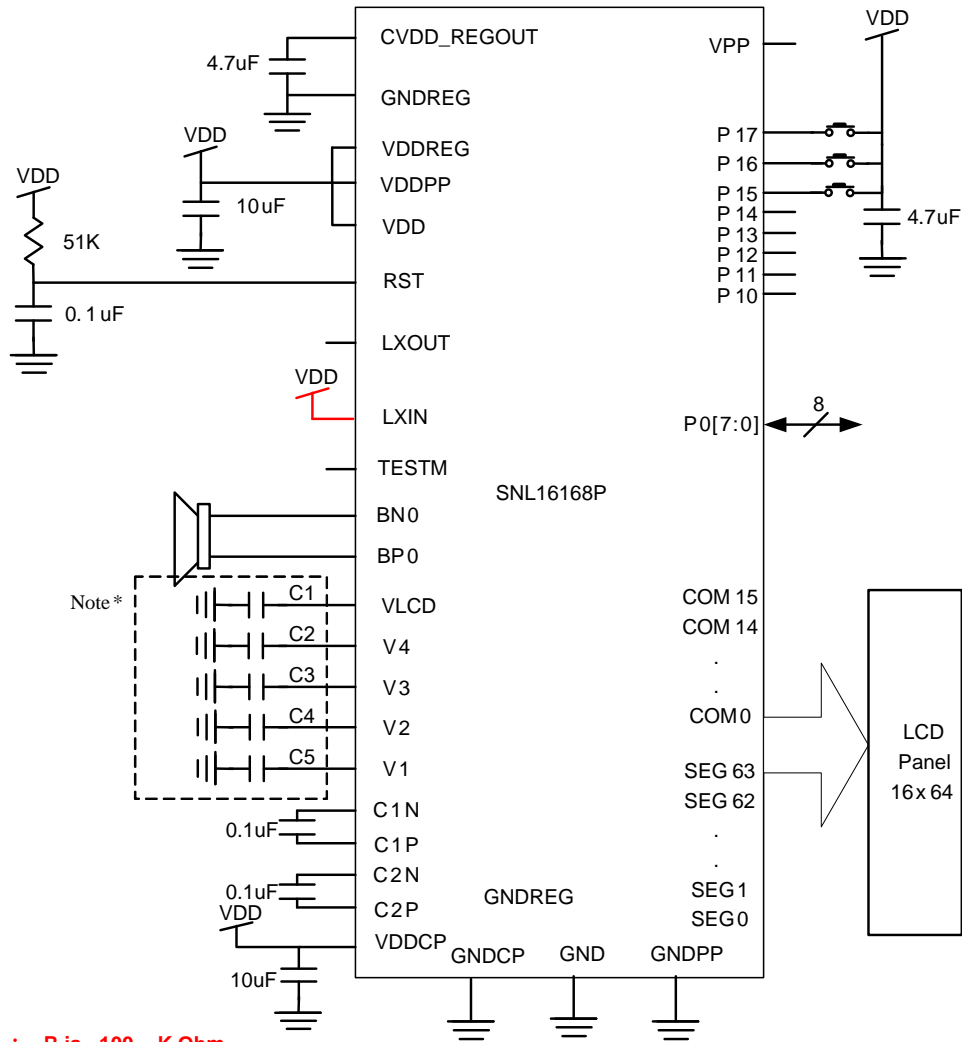
- ◆ Power supply: 4.5V
- ◆ With 32768 X'TAL



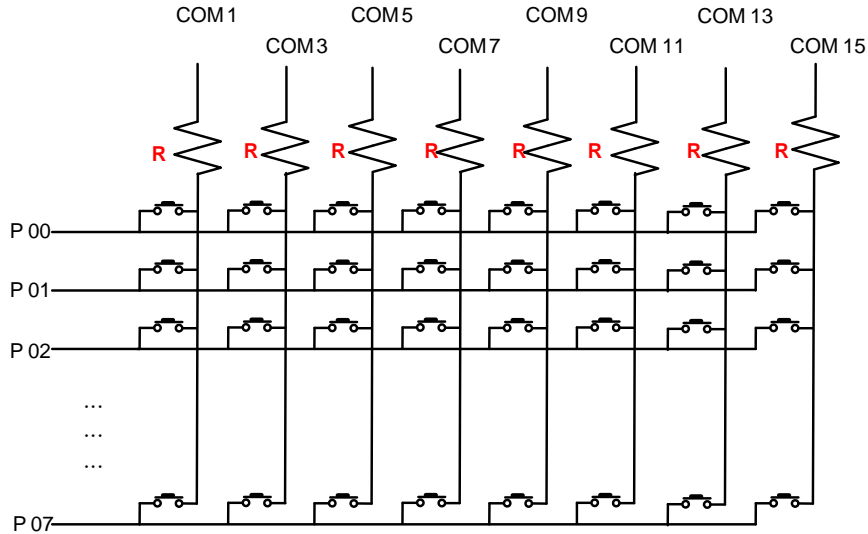
Note* :

The different capacitor values (0.1uF ~ 10uF) of C1 ~ C5 may be required for different LCD panel connected.

- ◆ Power supply: 4.5V
- ◆ Without 32768 X'TAL



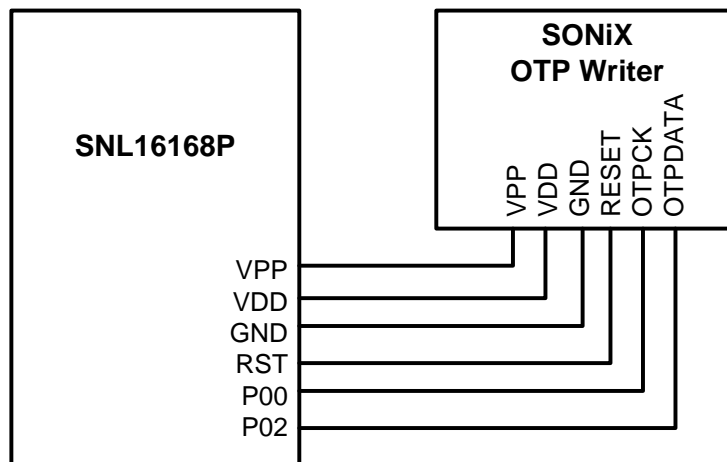
Note : R is 100 KOhm



Note* :

The different capacitor values (0.1uF ~ 10uF) of C1 ~ C5 may be required for different LCD panel connected.

◆ **Serial Program Interface**



If user would like to program BIN file into OTP by SONiX OTP Writer with **serial programming** way. There are total **6** pins programming pins are necessary.

The programming pins are list as below. Some pads are shared with general IO pads.

Symbol	Chip pin name	I/O Status	Description
RST	RST	Input	OTP Reset and Enter OTP mode, Low Active.
VPP	VPP0 and VPP1	Input	VPP for OTP Program. (VPP=7.5V)
VDD	VDD and VDDREG	Input	Positive Power Supply (VDD=3V)
GND	GND and GNDREG	Input	Negative Power Supply
CLK	P00	Input	OTP mode clock input
DATA IN / DATA OUT	P02	Input / Output	DATA IN/OUT of OTP Program and Verify mode.

7 ABSOLUTE MAXIMUM RATING

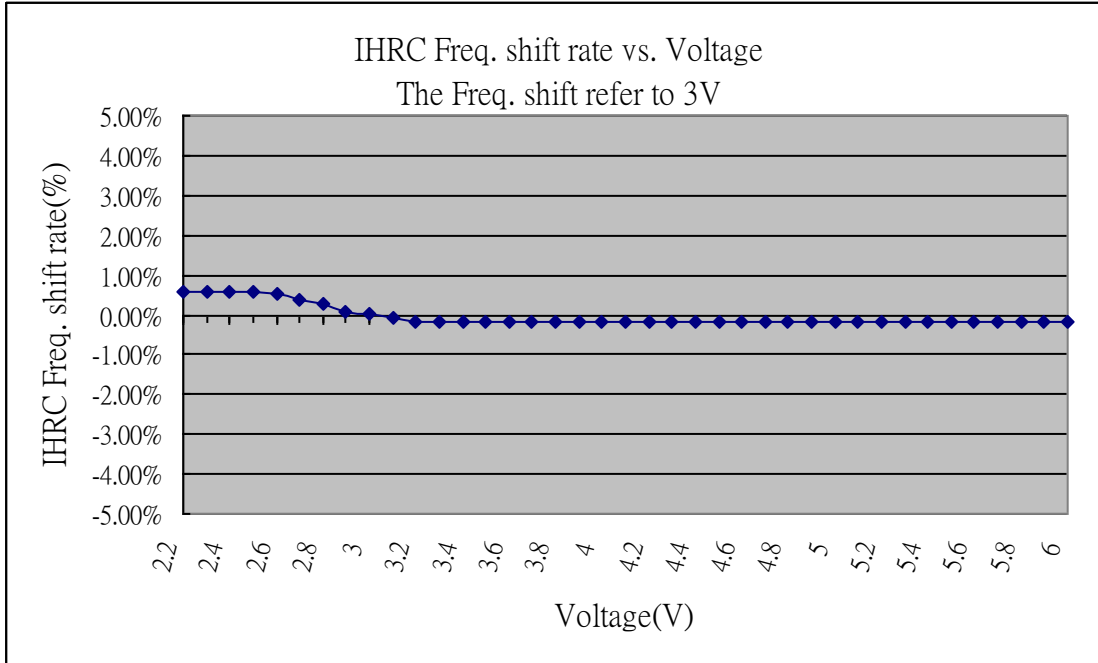
Items	Symbol	Min	Max	Unit.
Supply Voltage	V _{DD}	-0.3	6.0	V
Input Voltage	V _{IN}	V _{SS} -0.3	V _{DD} +0.3	V
Operating Temperature	T _{OP}	0	55.0	°C
Storage Temperature	T _{STG}	-55.0	125.0	°C

8 ELECTRICAL CHARACTERISTICS

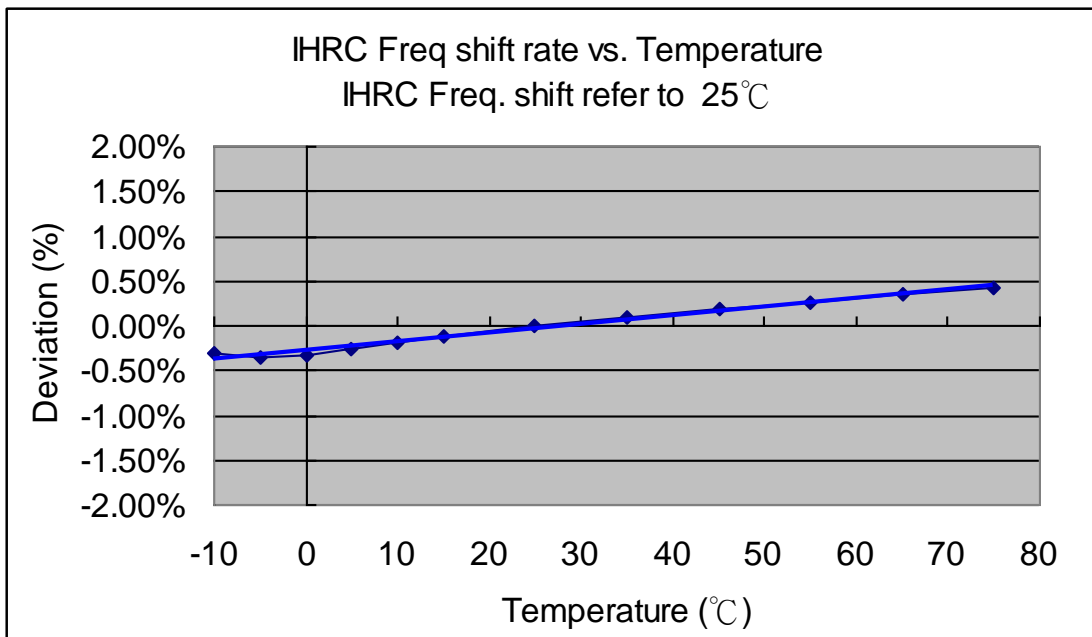
Item	Sym.	Min	Typ.	Max.	Unit	Condition
Operating Voltage	V _{DD}	2.2	-	5.5	V	
Program Mode Voltage (OTP)	V _{PP}	7.25	7.5	7.75	V	OTP Programming Voltage in Normal mode V _{PP} can be floating
Standby Current 1	I _{SBY}	-	3	-	μA	V _{DD} =3V
Standby Current 2	I _{SBY}	-	4	-	μA	V _{DD} =5V
Normal mode operating current (2MIPS)	I _{NOPR}	-	4	-	mA	V _{DD} =3V, no load, push pull turned off. Execute "NOP" instruction
Normal mode operating current (1MIPS)	I _{NOPR}	-	3.8	-	mA	
Normal mode operating current (0.5MIPS)	I _{NOPR}	-	3.7	-	mA	
Normal mode operating current (0.25MIPS)	I _{NOPR}	-	3.6	-	mA	
Idle mode operating current 1	I _{SOPR}	-	25	-	μA	V _{DD} =3V, LCDREGCR = 0xD0, 1/5bias, LCD CLK : 32.768K x'tal, LCD100K disable, CPU halt, Push-Pull off, LCD driver on, without panel.
Idle mode operating current 2	I _{SOPR}	-	5	-	μA	V _{DD} =3V, CPU halt, Push-Pull off, LCD driver off
Input pull high impedance of P0,P1	R _i	-	650K	-	Ω	V _{DD} =3V
Input pull low impedance of P0,P1	R _i	-	1M	-	Ω	V _{DD} =3V
P0,P1 Drive Current	I _{OD}	-	6	-	mA	V _{DD} =3V, V _O =2.4V
P0,P1 Sink Current	I _{OS}	-	6	-	mA	V _{DD} =3V, V _O =0.4V
Low voltage Reset (LVR)			1.8		V	
Push-Pull current	I _{PP}	-	70	-	mA	V _{DD} =3V, Output 1KHz Sin wave.
LCD driver typical voltage	V _{LCD}	3.36		5.16	V	± 5% @ V _{DD} =3V, 1/5 bias, No load
Frequency shift	R _{osc}		16.384		MHz	± 3% @ 3V
Input Low voltage	V _{IL}	V _{SS}	-	0.3* V _{DD}	V	
Input high voltage	V _{IH}	0.7* V _{DD}	-	V _{DD}	V	

9 System High clock(IHRC)

The system high-clock source is from the internal high-speed oscillator built in the SNL16168P chip. The high-speed oscillator uses RC type oscillator circuit. The frequency is affected by the voltage and temperature of the system and the following two diagrams is shown up the relation.



The Figure <9-1> shown up the relationship between the high clock frequency and voltage.



The Figure <9-2> shown up the relationship between the high clock frequency and temperature.

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