

**16-CHANNEL SPEECH+MELODY PROCESSOR  
(BandDirector™ Series)**

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## 1. GENERAL DESCRIPTION

The W567Cxxx is a powerful microcontroller (uC) dedicated to speech and melody synthesis applications. With the help of the embedded 8-bit microprocessor & dedicated H/W, the W567Cxxx can synthesize 16-channel speech+melody simultaneously.

The two channels of synthesized speech can be in different kinds of format, for example ADPCM and MDPCM. The W567Cxxx can provide 16-channel high-quality *WinMelody™*, which can emulate the characteristics of musical instruments, such as piano and violin. The output of speech/melody channels are mixed together through the on-chip digital mixer to produce colorful effects. With these hardware resources, the W567Cxxx is very suitable for high-quality and sophisticated scenario applications.

The W567Cxxx provides at most 24 bi-directional I/Os, maximum 512 bytes RAM, IR carrier, Serial Interface Management, and 32KHz-Divider for more and more sophisticated applications, such as interactive toys, cartridge toys and final count down function. 3 LED output pins with 256-level control means that numerous combination of RGB colors may result in a versatility of colorful effects. In addition, W567Cxxx also provides PWM mode output to save power during playback and Watch Dog Timer to prevent latch-up situation occurring.

The W567Cxxx family contains several items with different playback duration as shown below.

|             |                 |                 |                 |                 |                 |                 |
|-------------|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|
| <b>Item</b> | <b>W567C070</b> | <b>W567C080</b> | <b>W567C100</b> | <b>W567C120</b> | <b>W567C151</b> | <b>W567C171</b> |
| *Duration   | 81 sec.         | 102 sec.        | 115 sec.        | 127 sec.        | 162 sec.        | 196 sec.        |
| <b>Item</b> | <b>W567C210</b> | <b>W567C260</b> | <b>W567C300</b> | <b>W567C340</b> | <b>W567C380</b> |                 |
| Duration    | 230 sec.        | 263 sec.        | 320 sec.        | 358 sec.        | 400 sec.        |                 |
| <b>Item</b> | <b>W567C126</b> | <b>W567C266</b> | <b>W567C306</b> | <b>W567C346</b> | <b>W567C386</b> |                 |
| Duration    | 127 sec.        | 263 sec.        | 320 sec.        | 358 sec.        | 400 sec.        |                 |

Note:

\*: The duration time is based on 5-bit MDPCM at 6 KHz sampling rate. The firmware library and timber library have been excluded from user's ROM space for the duration estimation.

## 2. FEATURES

- Wide range of operating voltage:
  - 8 MHz @ 3.0 volt ~ 5.5 volt
  - 6 MHz @ 2.4 volt ~ 5.5 volt
- Power management:
  - 4 ~ 8 MHz system clocks, with Ring type or crystal type.
  - Stop mode for stopping all IC operations
- Provides up to 24 I/O pins
- F/W speech synthesis:
  - Multiple format parser that supports
    - New 4-bit MDPCM(NM4), 5-bit MDPCM(MDM), 4-bit MDPCM(MD4), 4-bit ADPCM(APM), 8-bit Log PCM(LP8) algorithm can be used
  - Pitch shippable ADPCM for voice changer application
  - Programmable sample rate
- Melody synthesis:
  - 16 melody channels that can emulate characteristics of musical instruments
  - Multi-MIDI simultaneous
  - Multi-MIDI channels dynamic control
  - More MIDI events are supported for colorful melody playback
- Built-in IR carrier generation circuit for simplifying firmware IR application
- Built-in TimerG0 for general purpose applications
- Harmonized synchronization among MIDI, Speech, LED, and Motor
- Build-in 3 LED outputs with 256-level control of brightness.
- Built-in Watch-Dog Timer (WDT) and Low Voltage Reset (LVR)
- Built-in 32KHz crystal oscillator with divider for time-keeping application
- Provide serial interface to access the external memory
  - W55Fxx, W551Cxx
  - SPI flash
- Dynamic control of the Pan assignment to the dual speaker output for stereo effects in the parts of W567Cxx6
- Stereophonic current type digital-to-analog converters (DAC) with 13-bit resolution to drive speaker output
- Stereophonic direct-drive 12-bit PWM output to save power consumption
- Support **PowerScript™** for developing codes in easy way
- Full-fledged development system
  - Source-level ICE debugger (Assembly & **PowerScript™** format)
  - **Ultra I/O™** tool for event synchronization mechanism
  - ICE system with USB port
  - User-friendly GUI environment
- Available package form:
  - COB is essential

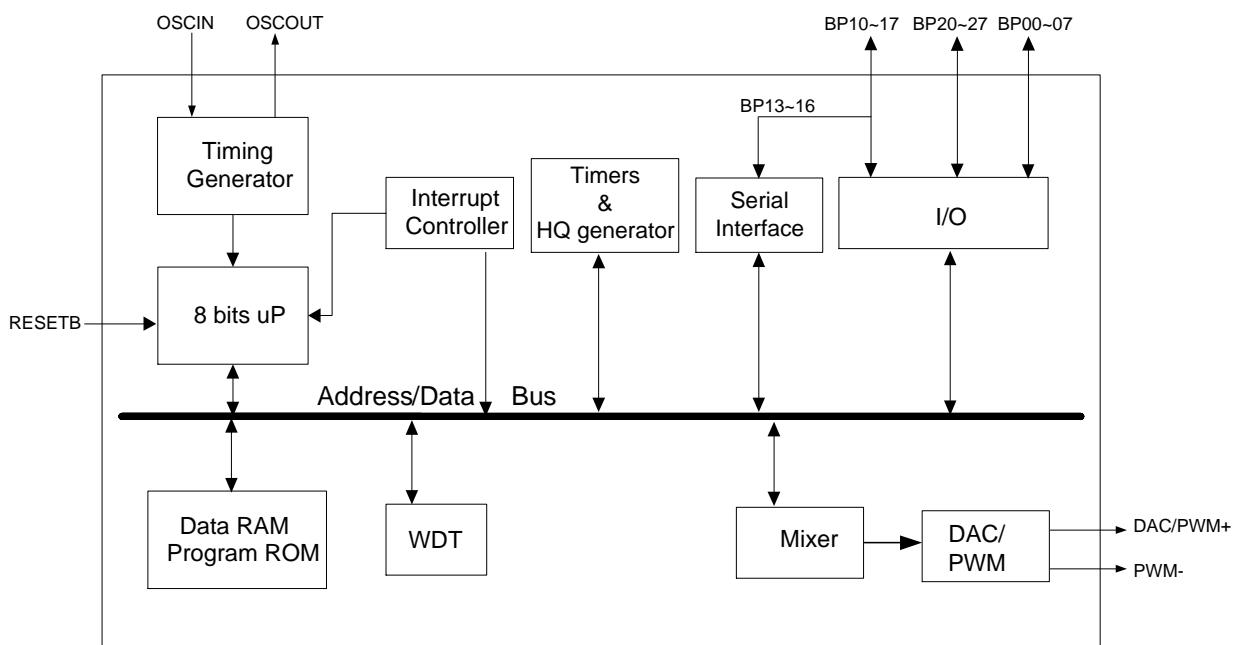
### 3. PIN DESCRIPTION

| PIN NAME                | I/O   | FUNCTION   |
|-------------------------|-------|--|
| /RESET                  | I     | IC reset input, low active.  |
| OSCIN                   | I     | Main-clock oscillation input. When Ring type is used, connects Rosc between OSCIN and VSS to generate the system clock frequency.<br>Reserved one 100pF~200pF capacity to Vdd from OSCin pin to make Ring frequency stability<br>When use X'tal, it is X'tal IN.   |
| OSCOU                   | O     | Main-clock oscillation output only for X'tal.  |
| X32I                    | I     | 32 KHz crystal oscillator with divider for time-keeping application  |
| X32O                    | Out   | 32 KHz crystal oscillator with divider for time-keeping application  |
| BP00~BP07               | I/O   | General input/output pins. When used as output pin, it can be open-drain or CMOS type and it can sink 25mA for high-current applications. When used as input pin, there may have a pull-high option and generate interrupt request to release IC from STOP mode.<br>When BP07 is used as output pin, it can be the IR transmission carrier for IR applications. BP04~BP06 are used as 3 LED outputs with 256-level control.                  |
| BP10~BP17               | I/O   | General input/output pins. When used as output pin, it can be open-drain or CMOS type. When used as input pin, there may have a pull-high option and generate interrupt request to release IC from STOP mode.<br>When serial interface is enabled, and set memory type as W55F/W551C, BP14~BP16 are used to be an interface with the external memory, W55Fxx or W551Cxxx. If set memory to SPI flash, BP13~BP16 are used to be an interface. |
| BP20~BP27               | I/O   | General input/output pins. When used as output pin, it can be open-drain or CMOS type. When used as input pin, there may have a pull-high option and generate interrupt request to release IC from STOP mode.  |
| PWM+/DAC                | O     | PWM driver positive output or Current type DAC output  |
| PWM-                    | O     | PWM driver negative output   |
| PWM1+/DAC1 <sup>1</sup> | O     | PWM driver positive output or Current type DAC output  |
| PWM1-                   | O     | PWM driver negative output   |
| TEST                    | I     | Test input, internally pulled low. Do not connect during normal operation.   |
| VDD                     | Power | Positive power supply for uP and peripherals.<br>All VDD pins must be bonded out and connect to VDD  |
| VDD1                    | Power | Only W567C151/171 for Positive power supply for uP and peripherals.<br>It needs be bonded out and connect to VDD.  |
| VSS                     | Power | Negative power supply for uP and peripherals.  |
| VDDOSC                  | Power | Positive power supply for oscillation.   |

<sup>1</sup> Only W567Cxx6 series provides these pins for dual speaker output.

| PIN NAME | I/O   | FUNCTION   |
|----------|-------|--|
| VDDSPK   | Power | Positive power supply for speaker driver.  |
| VSSSPK   | Power | Negative power supply for speaker driver.  |
| VDD_BP1  | Power | Positive power supply for BP1 including serial interface Management (SIM).   |
| CVDD     | O     | For 3 battery(3.3V~5.5V) application ,add the capacitor 0.1uF to shunts between CVDD and GND as power stability for regulator output.<br>For 2 battery(2.2V~3.6V) application, CVDD will connect to VDD directly.<br>Note: W567C151/171 without CVDD pin, the application circuit don't need consider 3/2 battery application. |

#### 4. BLOCK DIAGRAM



5. ITEM VS PIN TABLE

| PIN name  | C070/ 080/<br>100/ 120 | C151/ 171 | C210/<br>260/ 300/<br>340/ 380 | C126/<br>266/ 306/<br>346/ 386 | Comment   |
|-----------|------------------------|-----------|--------------------------------|--------------------------------|---|
| BP00~BP07 | V                      | V         | V                              | V                              |   |
| BP10~BP17 | V                      | V         | V                              | V                              |   |
| BP20~BP27 | V                      | V         | V                              | V                              |   |
| /RESET    | V                      | V         | V                              | V                              |   |
| TEST      | V                      | V         | V                              | V                              |   |
| PWM+/DAC  | V                      | V         | V                              | V                              |   |
| PWM-      | V                      | V         | V                              | V                              |   |
| PWM1+/DAC | -                      | -         | -                              | V                              |   |
| PWM1-     | -                      | -         | -                              | V                              |   |
| OSCIN     | V                      | V         | V                              | V                              |   |
| OSCOUT    | V                      | V         | V                              | V                              | Crystal mode  |
| X32I      | V                      | V         | V                              | V                              |   |
| X32O      | V                      | V         | V                              | V                              |   |
| VDD       | V                      | V         | V                              | V                              |   |
| VSS       | V                      | V         | V                              | V                              |   |
| VDDSPK    | V                      | V         | V                              | V                              | Support speaker power                                 |
| VSSSPK    | V                      | V         | V                              | V                              |   |
| VDD_BP1   | V                      | V         | V                              | V                              | Support BP10~BP17<br>including SIM interface<br>power |
| VDDOSC    | V                      | V         | V                              | V                              | Support OSCIN/OUT<br>power                            |
| VSSOSC    | V                      | V         | V                              | V                              |   |
| CVDD      | V                      | -         | V                              | V                              | Regulator out   |
| VDD1      |                        | V         |                                |                                | Connect to VDD  |

## 6. ELECTRICAL CHARACTERISTICS

### 6.1 Absolute Maximum Ratings

| PARAMETER                                   | RATING                 | UNIT |
|---|------------------------|------|
| Supply Voltage to Ground Potential          | -0.3 to +7.0           | V    |
| D.C. Voltage on Any Pin to Ground Potential | -0.3 to $V_{DD} + 0.3$ | V    |
| Operating Temperature                       | 0 to +70               | °C   |
| Storage Temperature                         | -55 to +150            | °C   |

Note: Exposure to conditions beyond those listed under Absolute Maximum Ratings may adversely affect the life and reliability of the device.

### 6.2 DC Characteristics

( $V_{DD} - V_{SS} = 4.5$  V,  $F_M = 8$  MHz,  $T_a = 25^\circ\text{C}$ , No Load unless otherwise specified)

| PARAMETER                              | SYM.      | TEST CONDITIONS                                    | SPEC.        |      |              | UNIT          |
|--|-----------|--|--------------|------|--------------|---------------|
|  |           |  | Min.         | Typ. | Max.         |               |
| Operating Voltage                      | $V_{DD}$  | $F_{SYS} = 6$ MHz                                  | 2.4          | -    | 5.5          | V             |
|  |           | $F_{SYS} = 8$ MHz                                  | 3.0          | -    | 5.5          | V             |
| Operating Current                      | $I_{OP1}$ | No load, $F_{SYS} = 6$ MHz                         | -            | 6    | 10           | mA            |
| Standby Current                        | $I_{SB}$  | STOP mode  | -            | 1    | 2            | $\mu\text{A}$ |
| 32KHz Crystal current                  | $I_{32K}$ | $F_{OSC}$ disable, No load, Wake up frequency: 2Hz | -            | 6    | 15           | $\mu\text{A}$ |
| Input Low Voltage                      | $V_{IL}$  | All input pins                                     | $V_{SS}$     | -    | $0.3 V_{DD}$ | V             |
| Input High Voltage                     | $V_{IH}$  | All input pins                                     | $0.7 V_{DD}$ | -    | $V_{DD}$     | V             |
| Input Current<br>BP0, BP1, BP2, /RESET | $I_{IN1}$ | $V_{IN} = 0$ V, pulled-high resistor = 500k ohm    | -5           | -9   | -14          | $\mu\text{A}$ |
| Input Current<br>BP0, BP1, BP2, /RESET | $I_{IN2}$ | $V_{IN} = 0$ V, pulled-high resistor = 150k ohm    | -15          | -30  | -45          | $\mu\text{A}$ |
| Output Current (BP0)                   | $I_{OL}$  | $V_{DD} = 3$ V, $V_{OUT} = 0.4$ V                  | 8            | 12   | -            | mA            |
|  | $I_{OH}$  | $V_{DD} = 3$ V, $V_{OUT} = 2.6$ V                  | -4           | -6   | -            | mA            |
|  | $I_{OL}$  | $V_{DD} = 4.5$ V, $V_{OUT} = 1.0$ V                | -            | 25   | -            | mA            |
|  | $I_{OH}$  | $V_{DD} = 4.5$ V, $V_{OUT} = 3.5$ V                | -            | -12  | -            | mA            |

|                               |           |  |              |              |              |            |
|-------------------------------|-----------|--|--------------|--------------|--------------|------------|
| Output Current<br>(BP1, BP2)  | $I_{OL}$  | $V_{DD} = 3V, V_{OUT} = 0.4V$                                      | 4            | 8            | -            | mA         |
|                               | $I_{OH}$  | $V_{DD} = 3V, V_{OUT} = 2.6V$                                      | -4           | -6           | -            | mA         |
|                               | $I_{OL}$  | $V_{DD} = 4.5V, V_{OUT} = 1.0V$                                    | -            | 12           | -            | mA         |
|                               | $I_{OH}$  | $V_{DD} = 4.5V, V_{OUT} = 3.5V$                                    | -            | -12          | -            | mA         |
| DAC Full Scale Current        | $I_{DAC}$ | $V_{DD} = 4.5V, R_L = 100\Omega$                                   | -2.4<br>-4.0 | -3.0<br>-5.0 | -3.6<br>-6.0 | mA         |
| Output Current<br>PWM+ / PWM- | $I_{OL1}$ | $R_L = 8\text{ Ohm},$<br>$[PWM+] \text{---}[R_L] \text{---}[PWM-]$ | +200         | -            | -            | mA         |
|                               | $I_{OH1}$ |  | -200         | -            | -            | mA         |
| Pull-high Resistor Test       | $R_{PL}$  |  | 75           | 150          | 225          | K $\Omega$ |

### 6.3 AC Characteristics

( $V_{DD}-V_{SS} = 4.5\text{ V}$ ,  $F_M = 8\text{ MHz}$ ,  $T_a = 25^\circ\text{C}$ ; No Load unless otherwise specified)

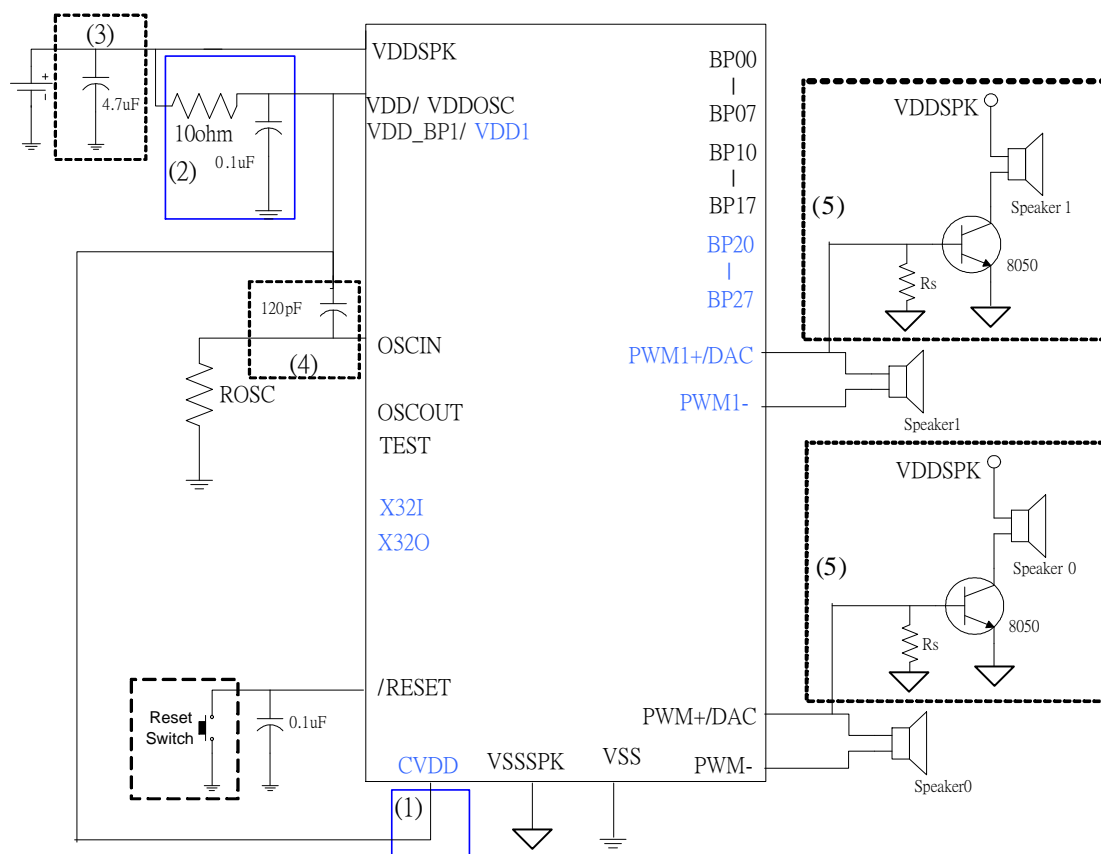
| PARAMETER                                 | SYM.                 | TEST CONDITIONS                   | SPEC. |      |      | UNIT      |
|---|----------------------|-----------------------------------|-------|------|------|-----------|
|   |                      |                                   | Min.  | Typ. | Max. |           |
| Main-Clock                                | $F_M$                | Ring type, *Rosc = TBD $\Omega$   | 5.4   | 6    | 6.6  | MHz       |
|   |                      | Ring type, *Rosc = TBD $\Omega$   | 7.2   | 8    | 8.8  |           |
| Main-Clock Wake-up Stable Time            | $T_{WSM}$            | Ring type, R = TBD K $\Omega$     | -     | 3    | 5    | mS        |
| Main-Clock Frequency Deviation, Ring type | $\frac{\Delta F}{F}$ | $\frac{F_{MAX} - F_{MN}}{F_{MN}}$ | -     | 3    | 7.5  | %         |
| Cycle Time                                | $T_{CYC}$            | CPU clock = 6 MHz                 | 166   | -    | DC   | nS        |
| RESETB Active Width                       | $T_{RES}$            | After $F_{SYS}$ stable            | 4     | -    | -    | $T_{CYC}$ |

\*: Typical ROSC value for each part number should refer to design guide.



## 7. TYPICAL APPLICATION CIRCUIT

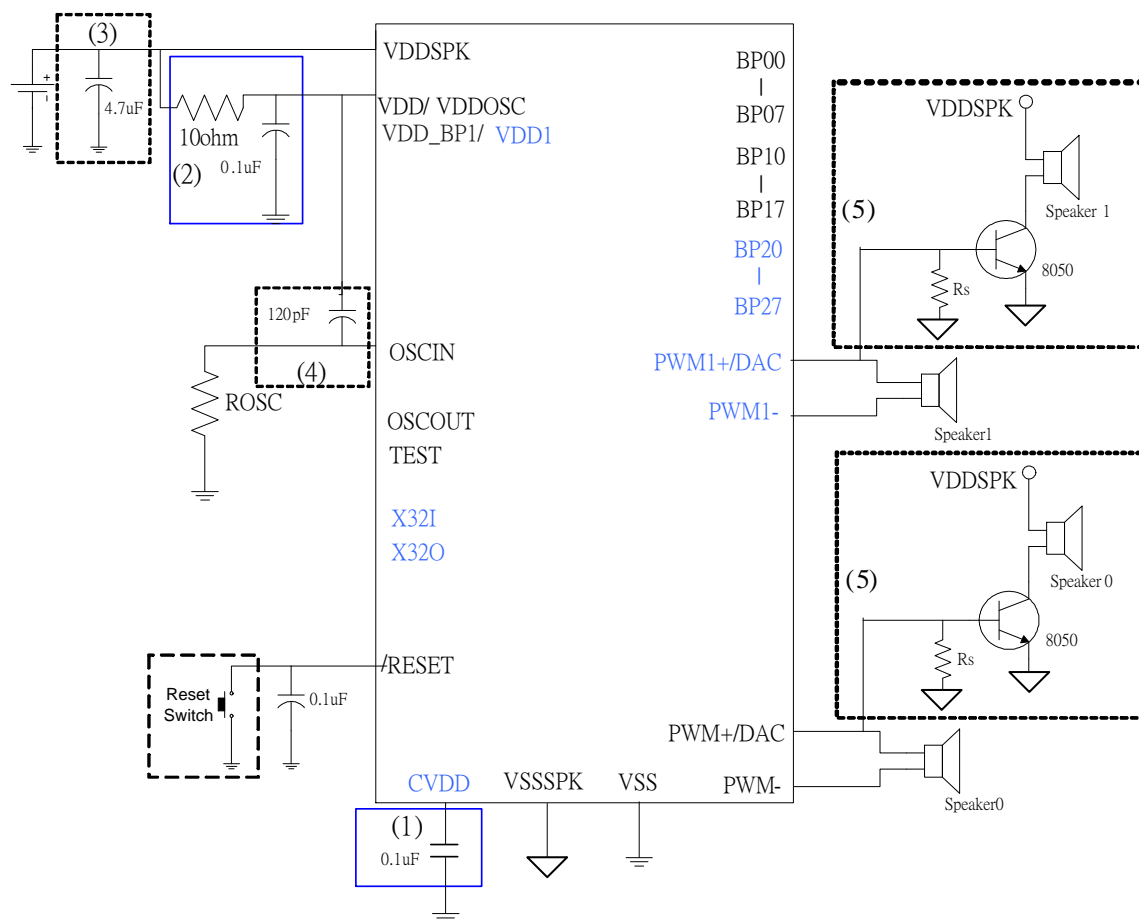
### (a) Rosc with 2 Battery



#### Notes:

1. The block (1): If the project is two-battery application (Voltage 3.6V~2.2V), it is necessary to connect CVDD to VDD.
2. The block (2): The low-pass filter circuit is necessary for VDD stability, in order to avoid VDDSPK noise.
3. The block (3): The capacitor, 4.7uF, shunted between VDD and GND is necessary for power stability. However, the value of capacitor depends on the power loading of the application.
4. The typical value of Rosc is 300 K $\Omega$  for 8MHz and 390 K $\Omega$  for 6MHz, and the Rosc should be connected to GND (VSS). Please refer to design guide to get typical Rosc value for each part number.
5. The block (4):The capacitor, 120pF, shunted between OSCIN and VDD is optional for Fosc stability, which can prevent noise from happening, because it can block the affection of larger current while playing. However, the value of capacitor depends on the application (100pF~200pF is recommended)
6. The block (5): The Rs value is suggested of 270 $\Omega$  ~ 1K $\Omega$  to limit large DAC output current flowing into transistor.
7. The above application circuit is for reference only. No warranty for mass production.

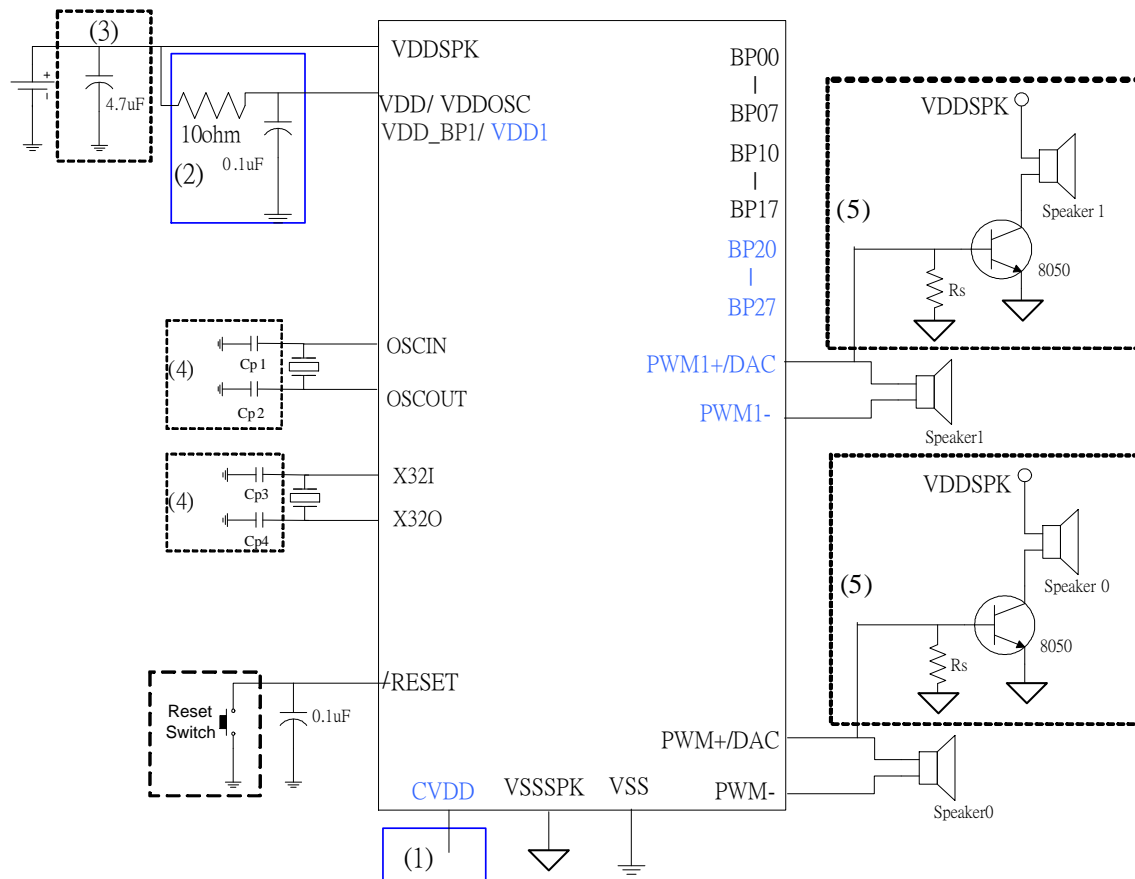
(b) Rosc with 3 Battery



Notes:

1. The block (1): If the project is three-battery application (Voltage 5.5V~3.0V), it is necessary to connect a 0.1uF between CVDD and GND (VSS).
2. The block (2): The low-pass filter circuit is necessary for VDD stability, in order to avoid VDDSPK noise
3. The block (3): The capacitor, 4.7uF, shunted between VDD and GND is necessary for power stability. However, the value of capacitor depends on the power loading of the application.
4. The typical value of Rosc is 300 KΩ for 8MHz and 390 KΩ for 6MHz, and the Rosc should be connected to GND (VSS). Please refer to design guide to get typical Rosc value for each part number.
5. The block (4)The capacitor, 120pF, shunted between OSCIN and VDD is optional for Fosc, which can prevent noise from happening, because it can block the affection of larger current while playing. However, the value of capacitor depends on the application (100pF~200pF is recommended)
6. The block (5): The Rs value is suggested of 270Ω ~ 1KΩ to limit large DAC output current flowing into transistor.
7. The above application circuit is for reference only. No warranty for mass production.

(c) Crystal



Notes:

1. The block (1): Please refer to (a) and (b) circuits for two-battery or three-battery application.
2. The block (2): The low-pass filter circuit is necessary for VDD stability, in order to avoid VDDSPK noise.
3. The block (3): The capacitor, 4.7uF, shunted between VDD and GND is necessary for power stability. However the value of capacitor depends on the power loading of the application
4. The block (4): Cp1 and Cp2 (15~30pF) are optional for main Crystal, which can be skipped normally.
5. The block (5): The Rs value is suggested of 270Ω ~ 1KΩ to limit large DAC output current flowing into transistor.
6. Cp3 and Cp4 (15~30pF) are optional for 32KHz Crystal, which can be skipped normally.
7. Please connect all VDD pins include VDDOSC/VDD\_BP1 to VDD. If with SIM application, the VDD\_BP1 pin can connect to different voltage for SPI flash or W551Cxx and the BP10~BP17 also use the same power VDD\_BP1.
8. The above application circuit is for reference only. No warranty for mass production.
9. Other application circuits please refer to Design Guide.

**(d) PCB layout guide**

1. The IC substrate should be connected to VSS in PCB layout, but VSSSPK can't connect with IC substrate directly. Both VSS and VSSSPK tie together in battery negative power.
2. Each VDD, VDDOSC, VDD\_BP1, VDD1 and VDDSPK pad must connect to positive power to support stable voltage for individual function work successfully. (Don't let them be floating.)

**8. REVISION HISTORY**

| VERSION | DATE      | REASONS FOR CHANGE   | PAGE  |
|---------|-----------|--|-------|
| A0.0    | Dec 2006  | Preliminary release.   |       |
| A1.0    | May 2007  | <ul style="list-style-type: none"> <li>● Add IO description for different body</li> <li>● Modify application circuit</li> </ul>  |       |
| A2.0    | Nov 2007  | <ul style="list-style-type: none"> <li>● Modify application circuit (naming)</li> <li>● Modify Logo</li> </ul>   |       |
| A3.0    | Sep. 2008 | <ul style="list-style-type: none"> <li>● Change logo</li> </ul>  |       |
| A4.0    | Jun. 2009 | <ul style="list-style-type: none"> <li>● Modify application circuit</li> </ul>   |       |
| A5.0    | Jun. 2010 | <ul style="list-style-type: none"> <li>● Add application circuit for 2 battery</li> </ul>  |       |
|         |           |  | 7     |
| A6.0    | Dec. 2010 | <ul style="list-style-type: none"> <li>● Update output current for BP1/2 @4.5V/3.0V and update BP0 @4.5V</li> <li>● Add application circuit for Ring OSCin pin to 120pF to VDD for option</li> <li>● Modify the description for application circuit</li> <li>● Support MD4 format for F/W library</li> </ul> | 9~15  |
|         |           |  | 9~15  |
|         |           |  | 3     |
| A7.0    | July 2011 | <ul style="list-style-type: none"> <li>● Add new chip W567C151/171 application circuit</li> </ul>  | 2, 5  |
|         |           |  | 9~18  |
|         |           | <ul style="list-style-type: none"> <li>● Remove W567C150/170</li> </ul>  | 2     |
| A8.0    | Aug. 2011 | <ul style="list-style-type: none"> <li>● Add new chip W567C151/171 pad description</li> <li>● Add new chip W567C151/171 application circuit</li> <li>● Add SIM application circuits</li> </ul>   | 5     |
|         |           |  | 9~20  |
|         |           |  | 20    |
| A9.0    | Jan. 2012 | <ul style="list-style-type: none"> <li>● Add W567CP80 OTP chip</li> <li>● Add items vs pad table</li> <li>● Modify application circuits</li> </ul>   | 2     |
|         |           |  | 7     |
| A10.0   | Mar. 2012 | <ul style="list-style-type: none"> <li>● BP00~BP03 share pins as OTP writer in W567CP80.</li> <li>● Update operating current DC spec.</li> </ul>   | 4     |
|         |           |  | 9     |
| A11.0   | Jun. 2012 | <ul style="list-style-type: none"> <li>● Revised VDD_SIM to VDD_BP1</li> </ul>   | 5, 7  |
|         |           |  | 11~13 |

### Important Notice

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**Insecure usage includes, but is not limited to: equipment for surgical implementation, atomic energy control instruments, airplane or spaceship instruments, the control or operation of dynamic, brake or safety systems designed for vehicular use, traffic signal instruments, all types of safety devices, and other applications intended to support or sustain life.**

**All Insecure Usage shall be made at customer’s risk, and in the event that third parties lay claims to Nuvoton as a result of customer’s Insecure Usage, customer shall indemnify the damages and liabilities thus incurred by Nuvoton.**

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