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1. GENERAL DESCRIPTION

The N567Lxxx is an 8-bit uC based speech/melody synthesizer for 1 or 2 battery application.

The N567Lxxx can implement high sound quality voice and up to 8-ch wavetable melody. It provides at most 16 I/O pins, high sink capability, H/W PWM I/O and IR carrier. In addition, N567Lxxx build in booster for VP 3.3V or 4.2V to drive LEDs, PWM mode audio output to drive speaker directly and LVR, Watch Dog Timer to prevent latch-up situation occurring, and LVD to avoid battery over drain. For oscillation, the N567Lxxx provides either internal oscillation to reduce external component or X'tal interface for high accuracy oscillation frequency.

The N567Lxxx family contains several items with different playback durations as shown below:

Item	N567L080	N567L120	N567L160	N567L200
ROM (KB)	254	416	528	638
Duration	84 sec	124 sec.	158 sec.	192 sec.

Note: *: The duration time is based on 4-bit NM4 at 6 KHz sampling rate. The firmware library have been excluded from user's ROM space for the duration estimation.

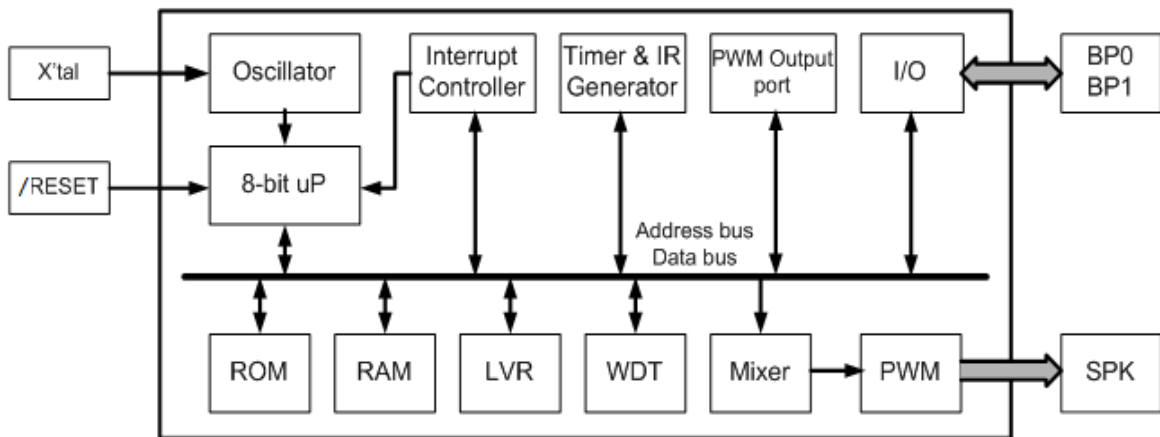
2. FEATURES

- ✓ Build in 8-bit 65C02
- ✓ Operating voltage: 1.0 ~ 3.6V
- ✓ Build in internal booster to pump VP as 3.3V or 4.2V (by mask option)
- ✓ Build in ROOSC (TRIM), system clock set as 4,096 KHz, 6,144 KHz or 8,192 KHz by Mask Option
- ✓ System Frequency deviation: +/-3% at Vbat 1.5V
- ✓ Provides X'tal mode in N567Lxxx. (i.e., X'tal value = 2 x System Clock)
 - X'tal 8MHz for the system clock of 4MHz
 - X'tal 12MHz for the system clock of 6MHz
 - X'tal 16MHz for the system clock of 8MHz
- ✓ 8-ch wavetable melody, or 2-ch Speech + 6-ch wavetable melody
- ✓ Build in 16 bidirectional GPIO
- ✓ RAM: 384B
- ✓ 3-pair H/W PWM I/O with 6-bit resolution for LED fading effect
- ✓ AUD output: 12-bit PWM output to drive speaker directly
- ✓ F/W speech synthesis: 5-bit MDPCM, 4-bit MDPCM, 8-bit Log PCM
- ✓ No need external Schottky Barrier Diode
- ✓ Typical VP driving current: 30mA
- ✓ Built-in IR carrier generation circuit for simplifying firmware IR application
- ✓ Built-in TimerG1 for general purpose applications
- ✓ Harmonized synchronization among MIDI, Speech, and LED
- ✓ Built-in Watch-Dog Timer (WDT) and Low Voltage Reset (LVR) by mask option
- ✓ Low Voltage detection: 1.0/1.1V (as mask option 1-battery) or 2.0/2.2V (as mask option 2-battery), for user's program control to avoid battery over drain

3. PAD DESCRIPTION

Name	I/O	Description
BP00 – BP07	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. BP07 is used as output pin, it can be the IR transmission carrier for IR application. BP00~BP05 are shared as 3-pair H/W PWM outputs with 64-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.
Vbat	P	Positive power supply of battery for booster.
VSSbat*3	P	Negative power supply of battery for booster.
VDD*3	P	Positive power supply for uP and I/O port
VSS*2	P	Negative power supply for uP and I/O port
VDDSPK	P	Positive power supply for speaker.
VSSSPK	P	Negative power supply for speaker.
PWM+	O	PWM driver positive output
PWM-	O	PWM driver negative output
VP*3	O	The voltage booster voltage output
VQ*4	I	The voltage booster internal switch input
OSCIN	I	X'tal in for the master frequency.
OSCOUT	O	X'tal out for the master frequency.
/RESET	I	Reset with an internal pull-up resistor.

4. BLOCK DIAGRAM



5. ELECTRICAL CHARACTERISTICS

5.1 Absolute Maximum Ratings

PARAMETER	RATING	UNIT
Supply Voltage to Ground Potential	-0.3 to +4.0	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.

5.2 D.C. Characteristics

($V_{bat} - V_{SSbat} = 1.5V \pm 10\%$, $T_A = 25^\circ C$; unless otherwise specified)

PARAMETER	SYM.	CONDITIONS	MIN.	TYP.	MAX.	UNIT
Operating voltage	V_{bat}	$F_{sys} = 4,6,8MHz$, $V_P = 3.3V$	1.0	-	1.8	V
	V_{bat}	$F_{sys} = 4,6,8MHz$, $V_P = 4.2V$	1.0	-	3.6	
Operating current (without external load)	I_{op}	$F_{sys} = 8MHz$, $V_P = 3.3V$	-	10	-	mA
	I_{op}	$F_{sys} = 8MHz$, $V_P = 4.2V$	-	18	-	
Standby current	I_{sb}	$V_P = 3.3V$, $V_P = 4.2V$	-	-	1	μA
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 Low Voltage	V_{IL}	Reset pin	V_{SS}	-	0.3 V_{bat}	V
Input High Voltage	V_{IH}	Reset pin	$0.7 V_{bat}$	-	V_{bat}	V
*Low Battery Protection current	I_{BP}	$V_P = 3.3V$, $V_P = 4.2V$ at $V_{bat} = 0.8V$ POR or STOP mode release	-	10	-	μA
Input Current I/O pins	I_{IN1}	$V_{IN} = 0V$, $V_{DD} = 4.2V$, pulled-high resistor = 110k ohm	-23	-38	-57	μA
Input Current I/O pins	I_{IN1}	$V_{IN} = 0V$, $V_{DD} = 4.2V$, pulled-high resistor = 330k ohm	-7	-13	-20	μA
IO output capability	I_{OL1}	$V_P = 3.3V$, $V_{out} = 0.4V$ (BP0)	8	12	-	mA
	I_{OH1}	$V_P = 3.3V$, $V_{out} = 2.9V$ (BP0)	-4	-6	-	
	I_{OL1}	$V_P = 3.3V$, $V_{out} = 0.4V$ (BP1)	4	6	-	
	I_{OH1}	$V_P = 3.3V$, $V_{out} = 2.9V$ (BP1)	-4	-6	-	
**PWM driver current	I_{pw}	$V_P = 3.3V$, $R_I = 8\Omega$, connect to PWM+ and PWM-	125	-	-	mA
Low Voltage Detect	V_{SD}	1.0V option of one battery	0.95	1.0	1.05	V

		1.1V option of one battery	1.05	1.1	1.16	V
		2.0V option of two batteries	1.90	2.0	2.10	V
		2.2V option of two batteries	2.09	2.2	2.31	V
LVR for booster	V _{TH}	F _{sys} = 8MHz F _{sys} = 6MHz F _{sys} = 4MHz	-	2.2	-	V
Booster output voltage	VP	VP=3.3V	3.0	3.3	3.6	V
		VP=4.2V	3.8	4.2	4.6	
Booster output driving	I _b	VP=3.3V		35		mA
		VP=4.2V		30		
Booster efficiency	-	V _{bat} = 1.5V, VP = 3.3V, L = 100uH, Resistance of L = 0.7 ohm	-	80	-	%
		V _{bat} = 1.5V, VP = 4.2V, L = 100uH, Resistance of L = 0.7 ohm	-	75	-	

*:Low voltage start-up/wake-up protection to avoid booster enable to consume large current.

**: The value represents the audio PWM buffer size, and it means the buffer allows PWM transient current to pass through it instantaneously. The value listed here is measured from VP=3.3V, where VP is powered by power supply instead of N567L booster, because N567L booster can't generate the DC current as large as 125mA continuously

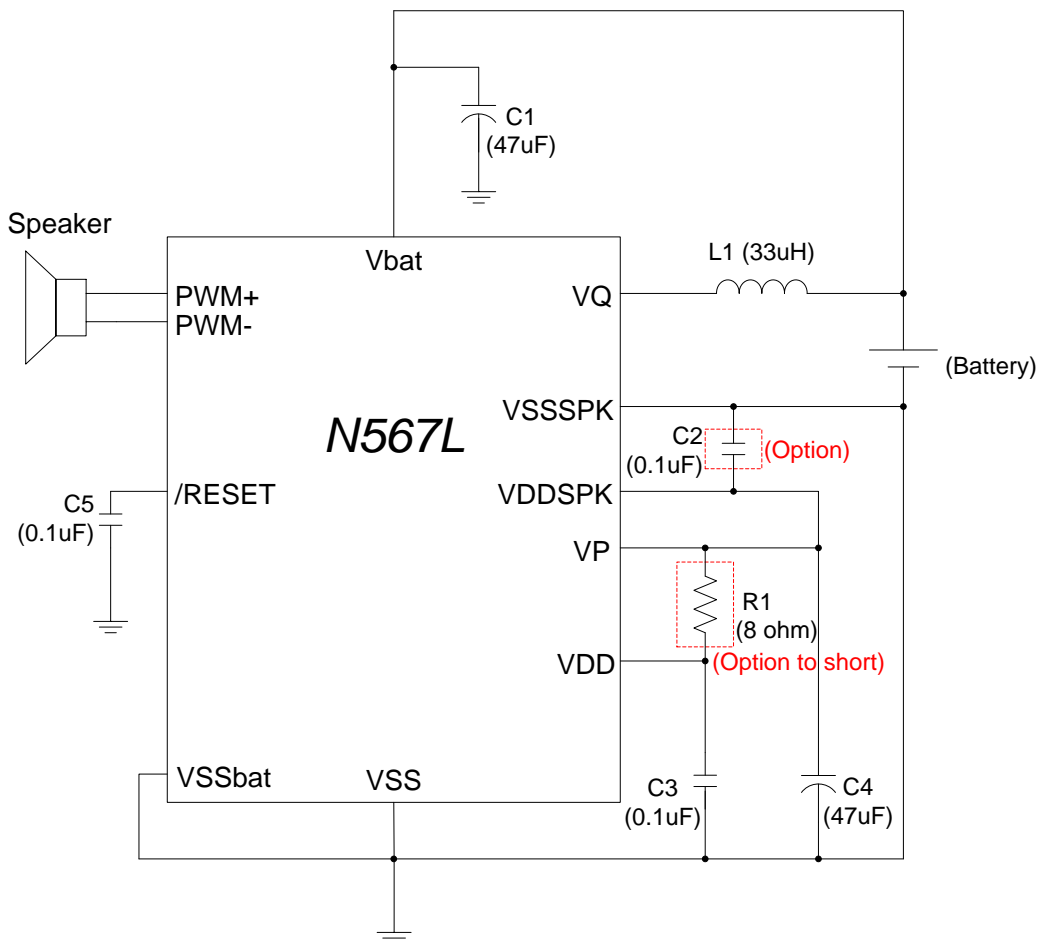
Note: Based on the limitation of booster capability, user has to take care of the power consumption of audio PWM, in order to keep VP=3.3V, both for constant LED brightness and playback volume.

5.3 A.C. Characteristics

(V_{bat}-V_{SSbat} = 1.5 V, F_M = 8 MHz, T_a = 25°C; No Load unless otherwise specified)

PARAMETER	SYM.	TEST CONDITIONS	SPEC.			UNIT
			Min.	Typ.	Max.	
Main-Clock	F _M	Internal OSC (TRIM)	3973	4096	4218	KHz
		Internal OSC (TRIM)	5959	6144	6328	
		Internal OSC (TRIM)	7946	8192	8437	
Main-clock wake-up stable time	T _{WSM}	2 ¹⁶ clock cycle	8		16	mS
Cycle Time	T _{cyc}	CPU clock = 8 MHz	125		DC	nS
/RESET active width	T _{RST}	After F _{sys} stable	4			T _{CYC}

6. TYPICAL APPLICATION CIRCUIT



Note:

1. C1, C4 are must to stable power.
2. C3 is must to filter power noise
3. C5 is must to be POR
4. L1 is must for booster
5. C2 is optional to filter harmonic of PWM output
6. R1 is optional to be a low-pass filter in heavy loading application. As ignoring it, it should be shorted in VP and VDD

7. REVISION HISTORY

Version	Date	Description	Page
A1.0	Nov-4-2014	First establishment	
A1.1	Dec-16-2014	Update LVD voltage and Application circuit	
A1.2	Jul-9-2015	Update operation current typical value	6

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