

OVERVIEW

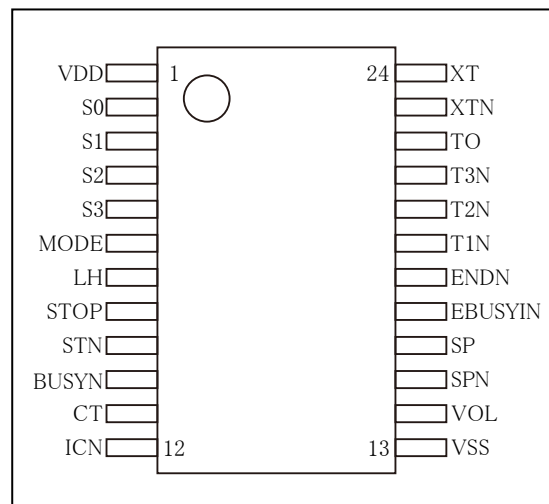
The SM1350ADJM is single-chip high tone quality melody IC, fabricated using NPC's Molybdenum-gate CMOS process. Melodies are selected in serial or binary (parallel) mode, 16 programmable melodies are stored, and the high tone quality melody is output by how to specify the user. It is making this IC ideal for mechanical clocks and similar applications where high tone quality output is demanded.

FEATURES

- Basic Functions
 - 4.0MHz oscillator frequency
 - Power-save function
 - Oscillator stopped when no output
 - S0 to S3, MODE, LH pull-up resistors open
 - A-class output
 - Chattering prevention circuit (STN, STOP, S0 to S3)
 - 10-bit D/A converter current-summing
- Sound Generator Functions
 - DWS (dual wave synthesis) sound generators
 - 4 simultaneous sounds for 4 tones
- Melody Functions
 - 16 programmable melodies
 - Level hold/one-shot melody modes
 - Serial/binary (parallel) select modes
- Control Signal Outputs
 - BUSYN signal : LOW during melody output
 - CT signal : pulse output synchronizing with selected notes or rests (This function cannot be used with this product.)
- 2.4 to 5.5V supply voltage
- Molybdenum-gate CMOS
- Package : 24-pin SSOP

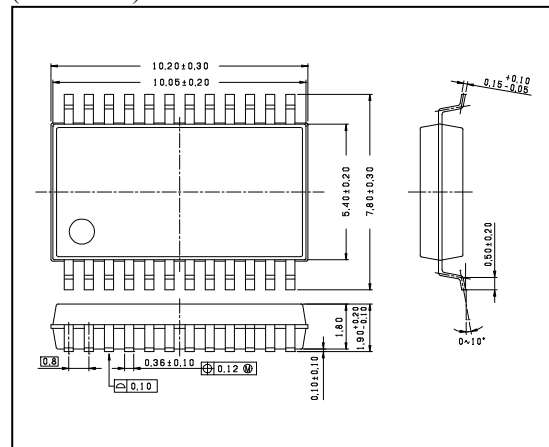
PINOUT

(Top view)



PACKAGE DIMENSIONS

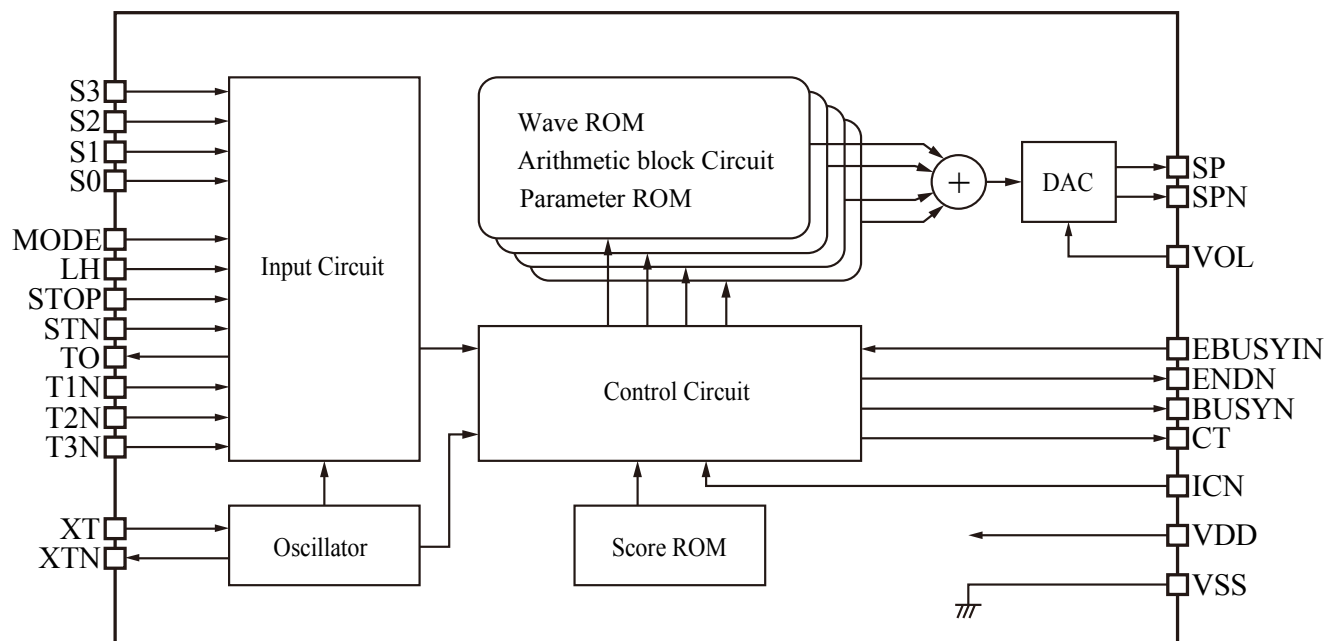
(Unit : mm)



ORDERING INFORMATION

Device	Package
SM1350ADJM	24 pin SSOP

BLOCK DIAGRAM



PIN DESCRIPTION

No.	Pin Name	I/O	State ^{*1}	Description
1	VDD	-	-	Supply pin
2	S0	I	SU	Binary select mode : Phrase select pins. Serial select mode : S0 and S1 control melody output.
3	S1			
4	S2			
5	S3			
6	MODE	I	SU	Melody select mode control. Binary mode when LOW, and serial mode when HIGH.
7	LH	I	SU	Melody output mode control. One-shot when LOW, and level hold when HIGH.
8	STOP	I	U	One-shot melody mode : Melody output stop control. Level hold melody mode : invalid input.
9	STN	I	U	Melody start control
10	BUSYN	O	C	Busy output signal. LOW when a melody is output.
11	CT	O	C	OPEN (LOW output)
12	ICN	I	U	Initialization clear input
13	VSS	-	-	Ground pin
14	VOL	I	-	Volume adjusts control. Volume adjusted using an external resistor.
15	SPN	O	P	VOL current output
16	SP	O	P	10-bit D/A converter output
17	EBUSYIN	I	U	It is not necessary to use it usually. It should connect VDD or OPEN. When this terminal is made LOW, BUSYN compulsorily becomes LOW. A pop sound might be emitted.
18	ENDN	O	C	Pulse signal when melody output ends
19	T1N	I	U	Test signal inputs This terminal cannot be used. It should connect VDD or OPEN.
20	T2N	I	U	
21	T3N	I	U	
22	TO	O	C	Test signal output. 62.5kHz output when not in test mode.
23	XTN	O	-	Oscillator output
24	XT	I	-	Oscillator input

*1. U : pull-up resistor connection

SU : pull-up resistor connection only when melody output starts

(Function for current consumption decrease when driving with battery. Only when the terminal is read, the pull-up resistor is connected.)

P : p-channel open drain

C : complementary output

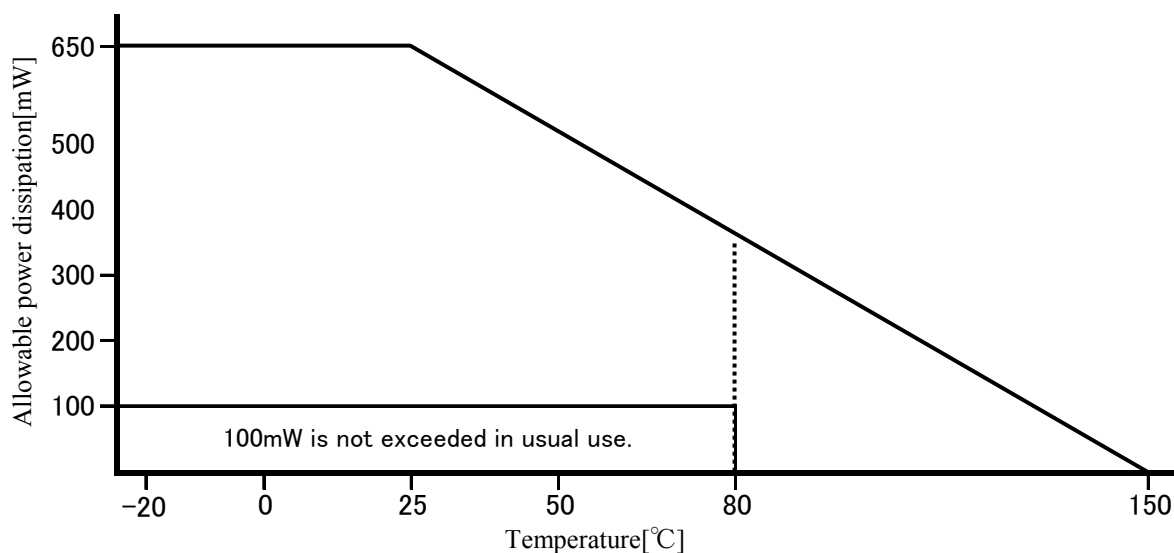
SPECIFICATIONS

Absolute Maximum Ratings

$V_{SS}=0V$

Parameter	Symbol	Rating	Unit
Supply voltage	V_{DD}	-0.3 to 7.0	V
Input voltage ^{*1}	V_{IN}	-0.3 to $V_{DD}+0.3$	V
Output voltage ^{*1}	V_{OUT}	-0.3 to $V_{DD}+0.3$	V
Operating temperature	T_{OPR}	-20 to 80	°C
Storage temperature	T_{STG}	-40 to 125	°C
Allowable power dissipation	P_W	650	mW

*1. They are range of the voltage where IC destroys and the characteristics degradation and the reliability decrease are not caused.



Recommended Operating Conditions

$V_{SS}=0V$

Parameter	Symbol	Rating			Unit
		MIN	TYP	MAX	
Supply voltage	V_{DD}	2.4		5.5	V
Operating temperature	T_a	-20		80	°C

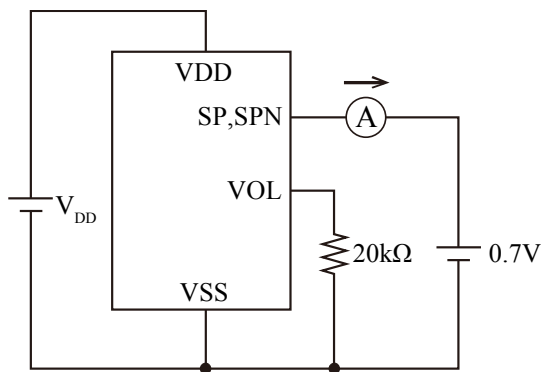
DC Characteristics

$T_a=25^{\circ}\text{C}$, $V_{DD}=3.0\text{V}$ or 5.0V , $V_{SS}=0\text{V}$, $f_0=4.0\text{MHz}$ unless otherwise noted.

Parameter	Pin Name	Symbol	Condition	Rating			Unit
				MIN	TYP	MAX	
Minimum operating supply voltage ^{*1}	VDD,VSS	V_{MIN}				2.4	V
Maximum operating supply voltage ^{*1}	VDD,VSS	V_{MAX}		5.5			V
Standby current consumption	VDD	I_{STBY}	No melody output			1.0	μA
Operating current consumption	VDD	I_{DD}	BUSYN,CT,TO, SP,SPN,ENDN, open	$V_{\text{DD}}=3.0\text{V}$		3.5	mA
				$V_{\text{DD}}=5.0\text{V}$		9.5	
HIGH-level input voltage	S0~S3,MODE, LH,STOP,STN,	V_{IH}		$V_{\text{DD}}-0.3$		V_{DD}	V
LOW-level input voltage	ICN,EBUSYIN	V_{IL}		V_{SS}		$V_{\text{SS}}+0.3$	V
HIGH-level input current	S0~S3,MODE, LH,STOP,STN,	I_{IH}	$V_{\text{IH}}=V_{\text{DD}}$	$V_{\text{DD}}=3.0\text{V}$		1	μA
				$V_{\text{DD}}=5.0\text{V}$		1	
LOW-level input current	ICN,EBUSYIN	I_{IL}	$V_{\text{IL}}=V_{\text{SS}}$	$V_{\text{DD}}=3.0\text{V}$	10	20	μA
				$V_{\text{DD}}=5.0\text{V}$	30	50	
HIGH-level output current1	BUSYN,CT,TO	I_{OH1}	$V_{\text{OH1}}=V_{\text{DD}}-0.7$	2.0			mA
LOW-level output current1		I_{OL1}	$V_{\text{OL1}}=V_{\text{SS}}+0.7$	2.0			mA
HIGH-level output current2	ENDN	I_{OH2}	$V_{\text{OH2}}=V_{\text{DD}}-0.7$	3.0			mA
LOW-level output current2		I_{OL2}	$V_{\text{OL2}}=V_{\text{SS}}+0.7$	3.0			mA
Output current3 ^{*2}	SP,SPN	I_{OH3}	$V_{\text{OH3}}=V_{\text{SS}}+0.7$	$V_{\text{DD}}=3.0\text{V}$		4.0	mA
				$V_{\text{DD}}=5.0\text{V}$		7.7	

*1. Supply voltage ratings shown are with oscillator running and all functions operating normally.

*2. Output current when 20k Ω volume control resistor is connected to VOL, and all D/A converter bits ON, measured using the following circuit.



AC Characteristics

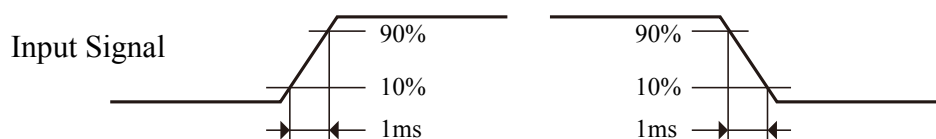
 $T_a=25^{\circ}\text{C}$, $V_{DD}=3.0\text{V}$ or 5.0V , $V_{SS}=0\text{V}$ unless otherwise noted.

Parameter	Symbol	Condition	Rating			Unit
			MIN	TYP	MAX	
Initialization clear time	t_{ICW}		1.0			μsec
ICN-STN time to spare	t_{SS}				10	μsec
STN pulse width	t_{STW}		81921			μsec
Clock frequency ^{*1}	f_{XII}		3.8	4.0	4.2	MHz
Clock duty cycle ^{*1}	R_{XTI}		40	50	60	%
Oscillator stop time	t_{XEN}		180224		196608	μsec
D/A converter rise delay time	t_{DAST}		40000	81921	163842	μsec
D/A converter fall delay time	t_{DAEN}		180224		196608	μsec
Standby chattering prevention time	t_{CH1}	STN, STOP Time after oscillator start	40000	81921	163842	μsec
Oscillator chattering prevention time	t_{CH2}	STN, STOP	65537		81921	μsec
Melody select chattering prevention time	t_{CH3}	S0~S3 Applied level hold melody mode	65536		131072	μsec
MODE, LH read timing	t_{MR}		10000	15875	31750	μsec
S0 to S3 read timing	t_{SR}		10000	31875	63750	μsec
BUSYN fall delay time	t_{BYST}		4096	8192	16384	μsec
BUSYN rise delay time ^{*2}	t_{BYEN}				8192	μsec
Melody start delay time	t_{PYST}		8192	16384	32768	μsec
STOP pulse width	t_{STPW}		81921			μsec
ENDN delay time	t_{EDST}				8192	μsec
ENDN pulse width	t_{EDW}		8	16	32	μsec

*1. These are ratings when clock signals are input from the outside to XT pin.

*2. The time taken for fast damping to reduce the envelope to 0 level.

Note. Input signal should be risen or fallen to the following time or less.



FUNCTIONAL DESCRIPTION

Chattering Prevention

STN, STOP chattering prevention function

(a) Oscillator stopping (Standby Mode)

The oscillator starts when STN goes from HIGH to LOW in standby mode. Input data is received and melody data output starts 81.9ms after the oscillator start if STN is LOW. SM1350 does not operate even if the signal is input to STOP in standby mode.

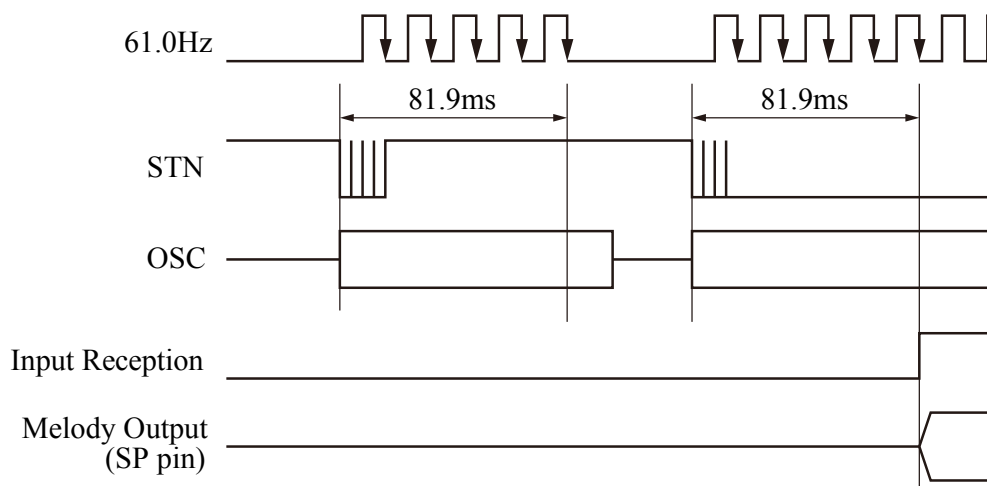


Figure 1. STN,STOP chattering prevention timing (oscillator stopping)

(b) Oscillator running

Input data is considered valid 81.9ms after STN and STOP have last changed state. Input data is considered invalid for intervals less than 65.5ms.

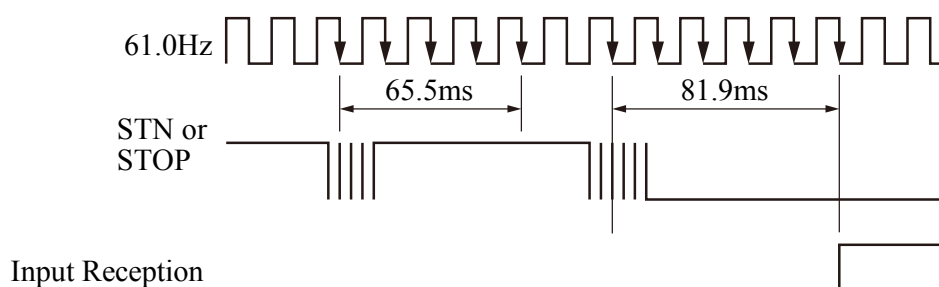


Figure 2. STN,STOP chattering prevention timing (oscillator running)

S0 to S3 chattering prevention function

In binary select mode, S0 to S3 are sampled in sync with the 15.26Hz clock during level-hold melody output. The chatter prevention function compares the data sampled 65.5ms after a data transition on S0 to S3 with the data sampled 65.5ms before the data transition. If the 2 data samples are the same, then the data transition is considered invalid. However, if they are not the same indicating a true transition has occurred, melody output stops and only restarts again after 2 consecutive identical melody select data samples occur. Note that except for binary select mode with level hold output, the S0 to S3 chattering prevention circuit is disabled.

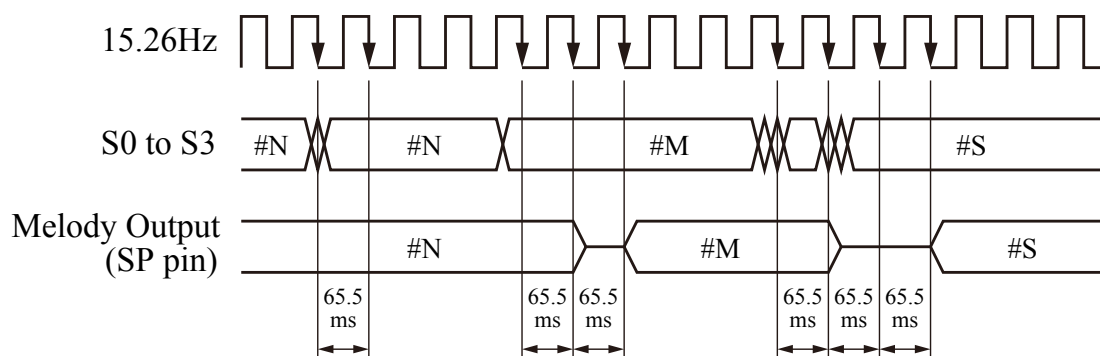


Figure 3. S0~S3 chattering prevention timing

Initialization

When power on and ICN goes LOW, all pins and internal states are initialized to the states shown below. It is recommended to initialize before melody output for steady operation.

■ Output pins

- SP, SPN : Open
- ENDN : V_{DD}
- CT : V_{SS}
- BUSYN : V_{DD}

■ Serial melody counter

Reset to first melody (S0 to S3 all 0)

■ Oscillator circuit

Stopped

Melody Output Circuit

The volume control circuit comprises a P-channel current-summing D/A converter, a built-in constant-current source and an external variable resistor.

Output circuit (A-class)

The A-class output circuit comprises a single 10-bit D/A converter with current output on SP. The D/A converter is set ON immediately after the oscillator starts, and the current output that results is the center point above and below which the converter current output varies in response to the waveform amplitude. The SP output is current-to-voltage converted for connection to audio equipment or amplifiers. The 4 sound generator waveforms are time multiplexed, so an integrating circuit must be connected between SP and the amplifier to recover the signal.

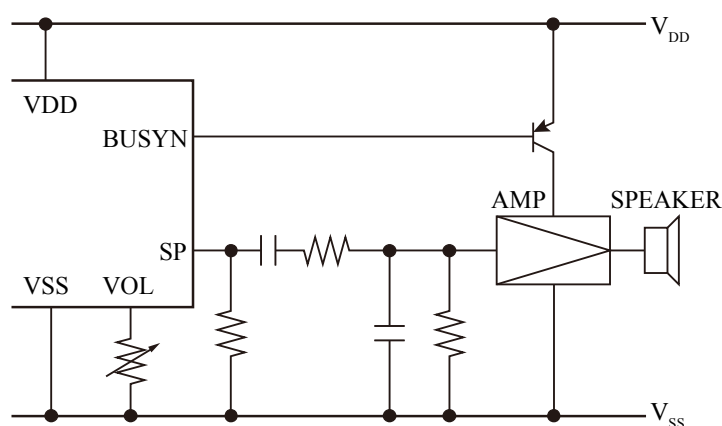


Figure 4. Output circuit (A-class)

Pin Functions

STN pin

Melody start signal. Melody starts when LOW is detected.

One-shot melody output (LH=LOW)

One-shot melody is a melody control that stops melody after it play to the last of the melody when there is a start trigger. When STN goes LOW during melody output, the melody specified with S0 to S3 is played

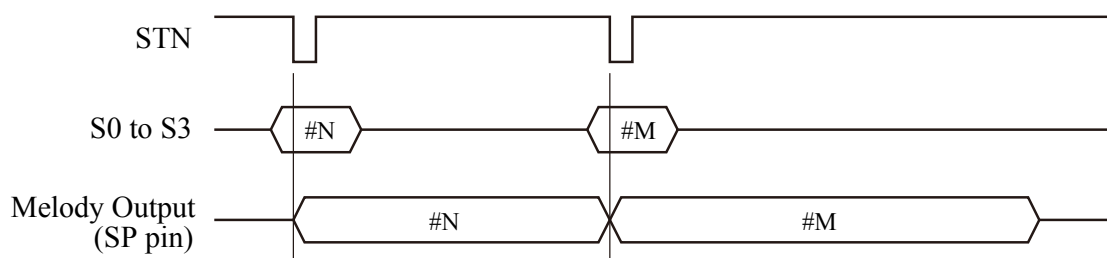


Figure 5. One-shot mode

One-shot mode repeat function

In one-shot melody mode, the output repeats the same melody while STN is LOW. When STN goes HIGH, the output continues until the end of the currently playing melody and then stops.

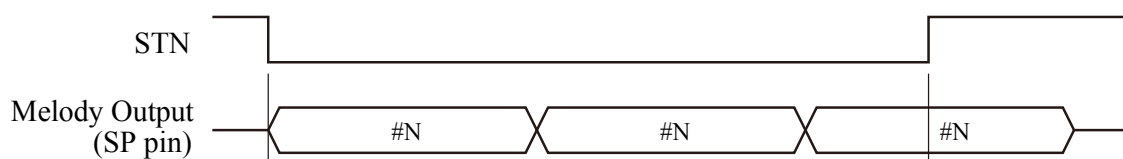


Figure 6. One-shot melody repeat timing

Level hold melody output (LH=HIGH)

Level hold melody output is played when STN is LOW, and it goes HIGH, it is melody control which stops in the middle of melody. When either of S0 to S3 changes during melody output, it restarts from the head of the melody newly selected.

* This function is effective only while the level hold melody output in the binary select mode.

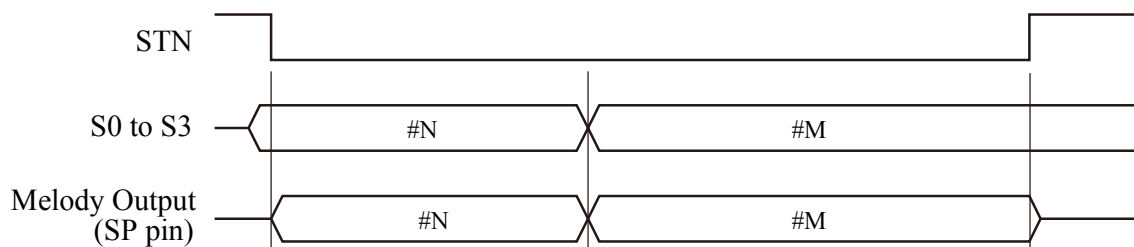


Figure 7. Level hold mode

Binary select mode (MODE=LOW)

A melody of 1 to 16 is selected according to the condition (0000 to 1111) of S0 to S3.

Serial select mode (MODE=HIGH)

In serial select mode, the next melody is selected by cycling through the melodies in the order #N→#N+1...#N-1→#N when the STN input goes LOW. Note that when melody output is stopped using the STOP input, the melody-select counter increments.

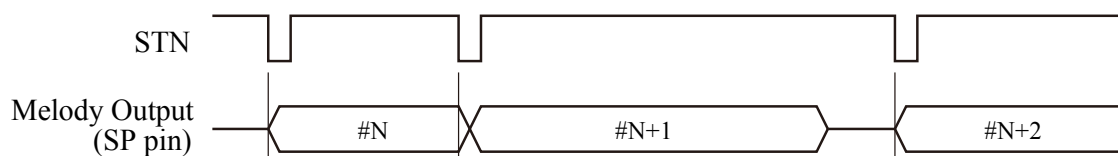
One-shot melody output (LH=LOW)

Figure 8. One-shot mode (serial select)

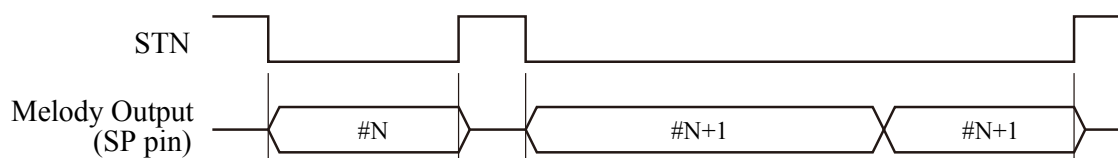
Level hold melody output (LH=HIGH)

Figure 9. Level hold mode (serial select)

The melody selection in serial mode is controlled by S0 and S1 as shown in the following table. The states of S0 and S1 are read in immediately after startup and the change of S0 and S1 during melody output is invalid.

S1	S0	Melody counter
LOW	–	Increments when melody output stops
HIGH	LOW	No increment
HIGH	HIGH	Increments when melody output starts

Stable 1. S0, S1 resistor and melody counter

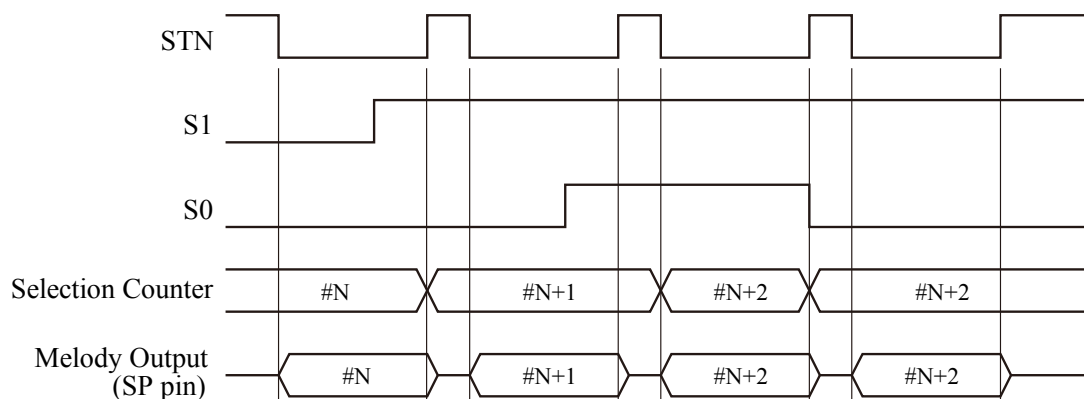


Figure 10. S0, S1 melody output control timing

STOP pin

One-shot output mode stops when STOP goes from HIGH to LOW. The STOP input is ignored in level hold output mode and is also ignored in one-shot mode when STN is LOW. Note that even when STOP is LOW, STN has higher priority.

CT pin

A pulse in sync with selected notes or rests is output on CT. But this function cannot be used with this product.

Fast Damping

When melody output stops, the D/A converter output amplitude dose not fall to zero instantaneously, instead the output converges to zero within a maximum of 8.2ms to prevent noise being generated. Also, when one-shot melody output mode is stopped melody output by STOP pin, melody output becomes standby state after the fast damping interval. When melody out is stopped by ICN input, it instantaneously becomes 0 level.

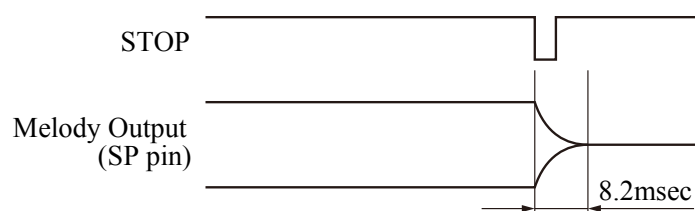


Figure 11. Fast damping timing

TIMING DIAGRAMS

One-shot Melody Mode

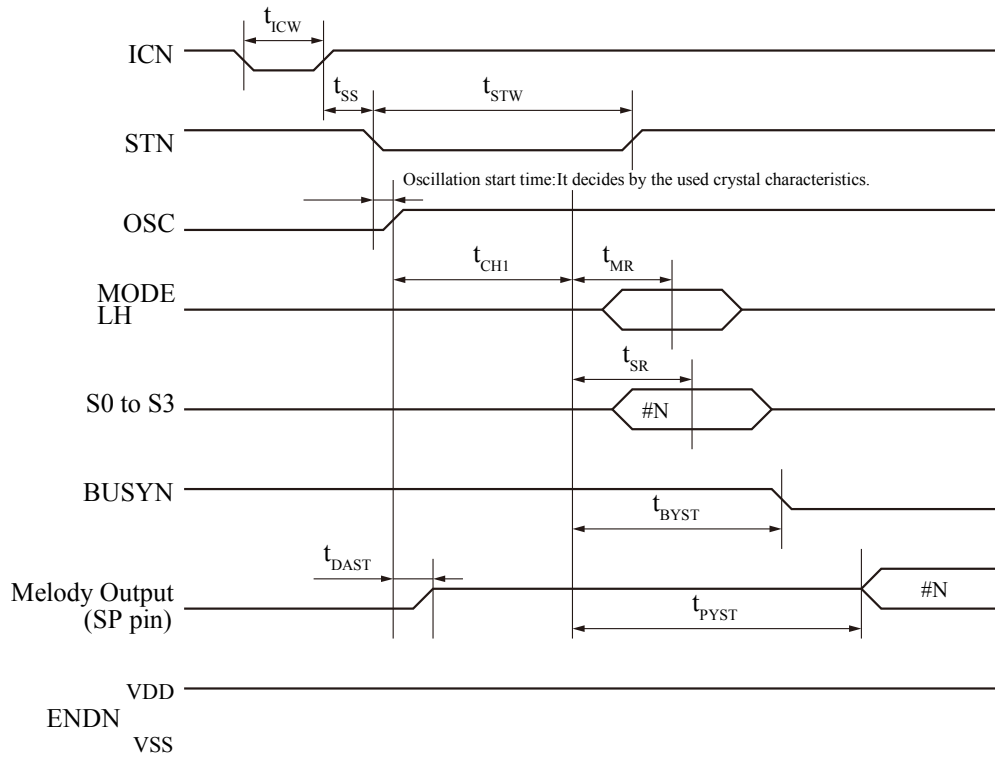


Figure 12. One-shot mode (standby to melody start)

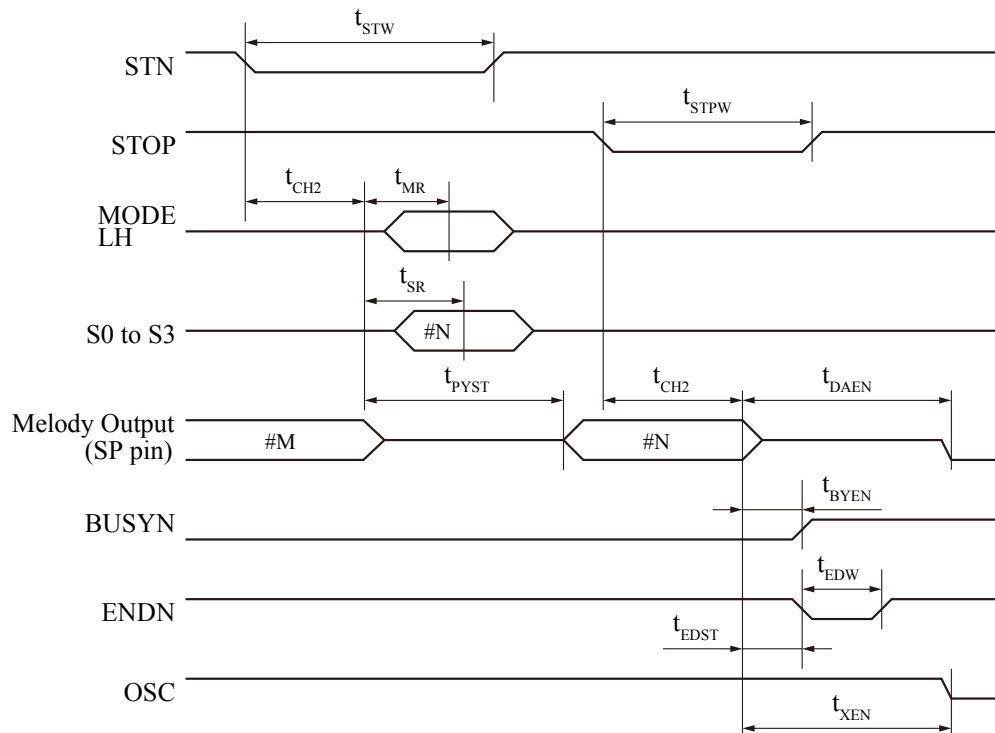


Figure 13. One-shot mode (melody stop by STOP pin)

Level Hold Melody Mode

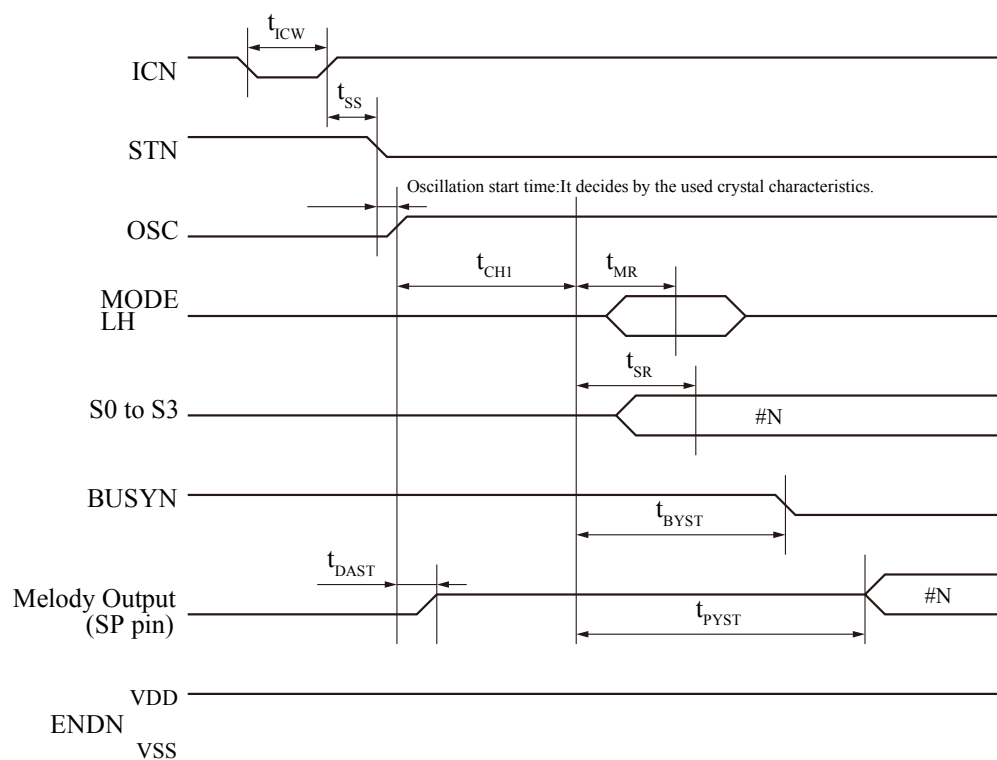


Figure 14. Level hold mode (standby to melody start)

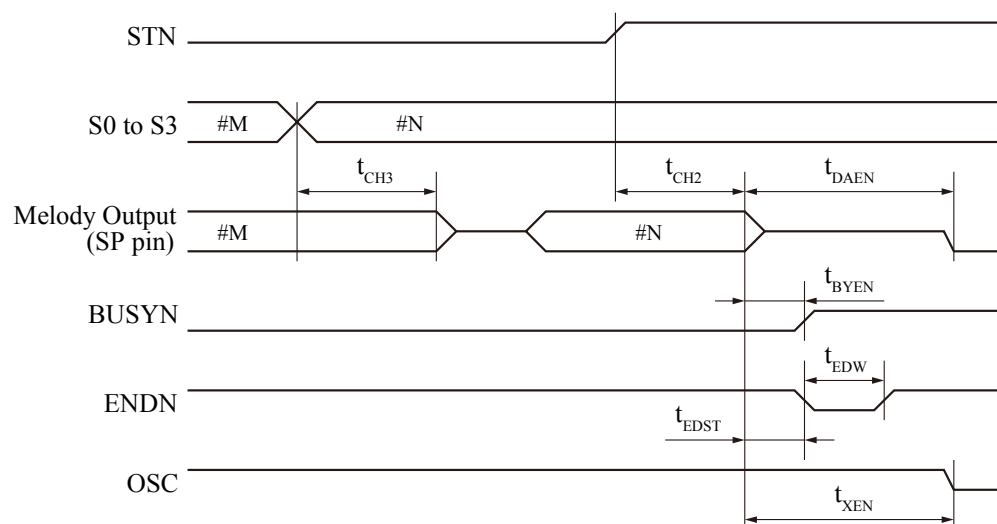
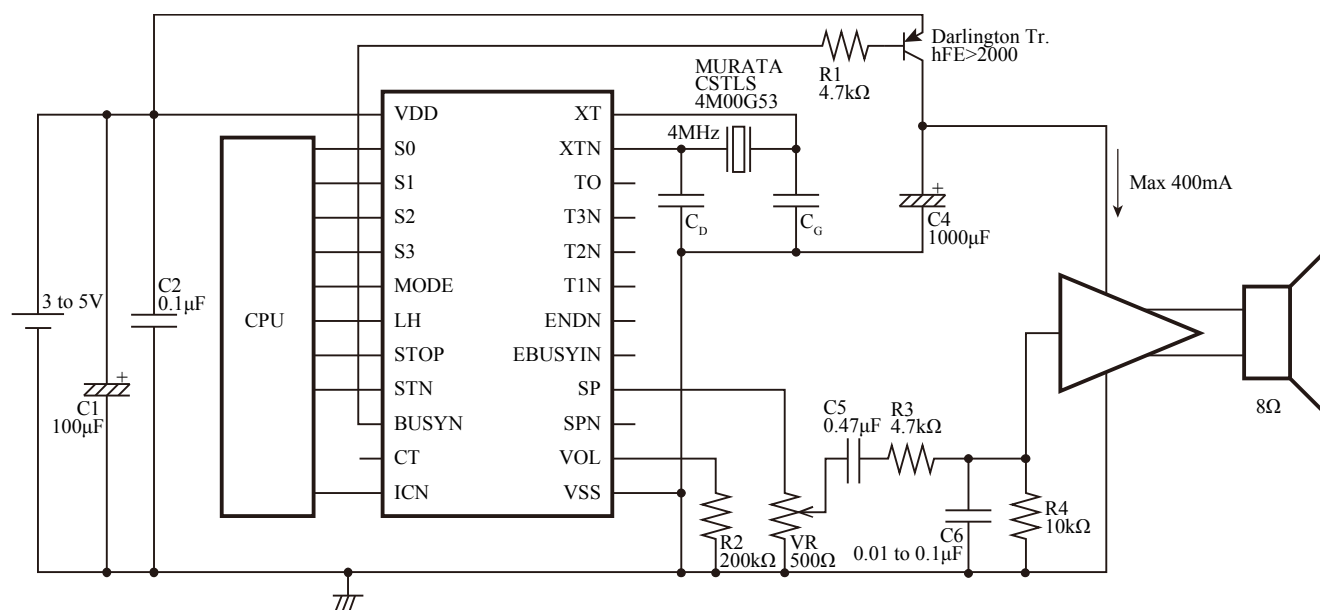


Figure 15. Level hold mode (melody stop by STN Low → High)

TYPICAL APPLICATIONS



ROM SPECIFICATIONS

Melody name, Tempo, Sound assign, Time interval mode, CT mode (TROM, AROM)

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Music No.	Melody name	Tempo	Sound assign				Time interval mode				CT mode
			CH1	CH2	CH3	CH4	CH1	CH2	CH3	CH4	
1	Pinpon16	48	0	1	F	F	0	0	0	0	pulse
2	chime1	124	3	3	3	3	0	0	0	0	pulse
3	sys1	200	4	4	4	4	0	0	0	0	pulse
4	sys2	91	4	4	4	4	0	0	0	0	pulse
5	pro1	124	5	5	5	5	0	0	0	0	pulse
6	pro2	219	5	5	5	5	0	0	0	0	pulse
7	yobi1	62	6	6	6	6	0	0	0	0	pulse
8	yobi2	119	6	6	6	6	0	0	0	0	pulse
9	purururu	553	7	8	8	8	0	0	0	0	pulse
10	pirarara	267	9	9	9	9	0	0	0	0	pulse
11	kankan	105	A	A	A	A	0	0	0	0	pulse
12	booboo	124	B	B	B	B	0	0	0	0	pulse
13	pipo	114	8	7	8	8	0	0	0	0	pulse
14	pipipi	167	D	D	E	E	0	0	0	0	pulse
15	flicker	86	C	C	C	C	0	0	0	0	pulse
16	Westminster	52	2	2	2	2	0	0	0	0	pulse

Sound Supply (VROM1, VROM2)

No.	Sound Name	MAIN								SUB								EFFECT	
		AR	DR	DL	SR	RR	TL	Wave No.	Wave Pattern Name	AR	DR	DL	SR	RR	TL	Wave No.	Wave Pattern Name	TYPE	DEPTH
0	PinponF#	15	02	03	12	12	31	0	pinponF#	15	02	03	12	12	31	0	pinponF#	norm	0
1	PinponD	15	03	03	14	12	29	1	pinponD	15	03	03	14	12	29	1	pinponD	norm	0
2	CHIME	00	15	31	00	11	31	7	chime22	00	15	31	00	11	31	4	Flute	chr1	0
3	A.Pmelo!	00	08	31	14	08	31	4	Flute	00	08	31	14	08	27	4	Flute	norm	0
4	EIA.Pian	00	09	15	12	10	31	4	Flute	00	11	31	12	10	31	2	sin	norm	0
5	A.P bns3	00	09	29	06	08	28	4	Flute	00	09	31	06	08	28	2	sin	norm	0
6	jngleVo2	00	00	00	00	00	29	2	sin	00	00	00	00	00	29	7	chime22	norm	0
7	squire 5	00	08	08	09	04	27	5	squire	00	00	00	00	00	27	5	squire	chr1	0
8	squire 6	00	08	08	09	04	27	5	squire	01	00	00	00	02	27	5	squire	norm	0
9	Organ 3	00	00	00	00	02	29	6	strings1	02	00	00	00	02	30	2	sin	norm	2
A	Strings4	00	09	09	10	07	29	6	strings1	00	09	09	05	05	29	5	squire	chr2	2
B	squer 3	00	00	00	00	00	31	5	squire	00	00	00	00	00	31	3	harpsic1	chr2	2
C	Harpsi2	00	00	00	00	00	29	3	harpsic1	00	00	00	00	00	29	3	harpsic1	chr2	2
D	Bell 2c	00	06	24	05	03	28	5	squire	00	08	21	06	04	25	5	squire	norm	0
E	Harpsi3	00	00	00	00	00	30	3	harpsic1	00	00	00	00	00	30	3	harpsic1	chr2	2
F		00	00	00	00	00	31	4	Flute	00	00	00	00	00	31	2	sin	norm	0

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1-9-9, Hatchobori, Chuo-ku,
Tokyo 104-0032, Japan
Telephone: +81-3-5541-6501
Facsimile: +81-3-5541-6510
<http://www.npc.co.jp/>
Email: sales@npc.co.jp

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