Dear customer

ROHM Co., Ltd. ("ROHM"), on the 1st day of April, 2024,
has absorbed into merger with 100%-owned subsidiary of LAPIS Technology Co., Ltd.

Therefore, all references to "LAPIS Technology Co., Ltd.", "LAPIS Technology"
and/or "LAPIS" in this document shall be replaced with "ROHM Co., Ltd."
Furthermore, there are no changes to the documents relating to our products other than
the company name, the company trademark, logo, etc.

Thank you for your understanding.

ROHM Co., Ltd.
April 1, 2024

FEDL22321-03
Issue Date:Jun 29, 2022

ML22Q321/321

ADPCM Speech Synthesis LSI

GENERAL DESCRIPTION

The ML22321/ML22Q321, which include mask ROM and Flash memory for storing speech data, respectively, are speech synthesis LSIs which can control speech playback utilizing a serial interface.
It includes speaker amplifier and 16bit DA Converter, so it is possible to have high quality sound and solution for playback with 1chip.

- Playback Time

Product Name	Capasitance of ROM(bit)	Maximum Playback time(s) （Fsam=8.0kHz）		
		HQ-ADPCM	4bitADPCM2	16bitPCM
ML22Q321/321	920K	36.8	29.4	7.3

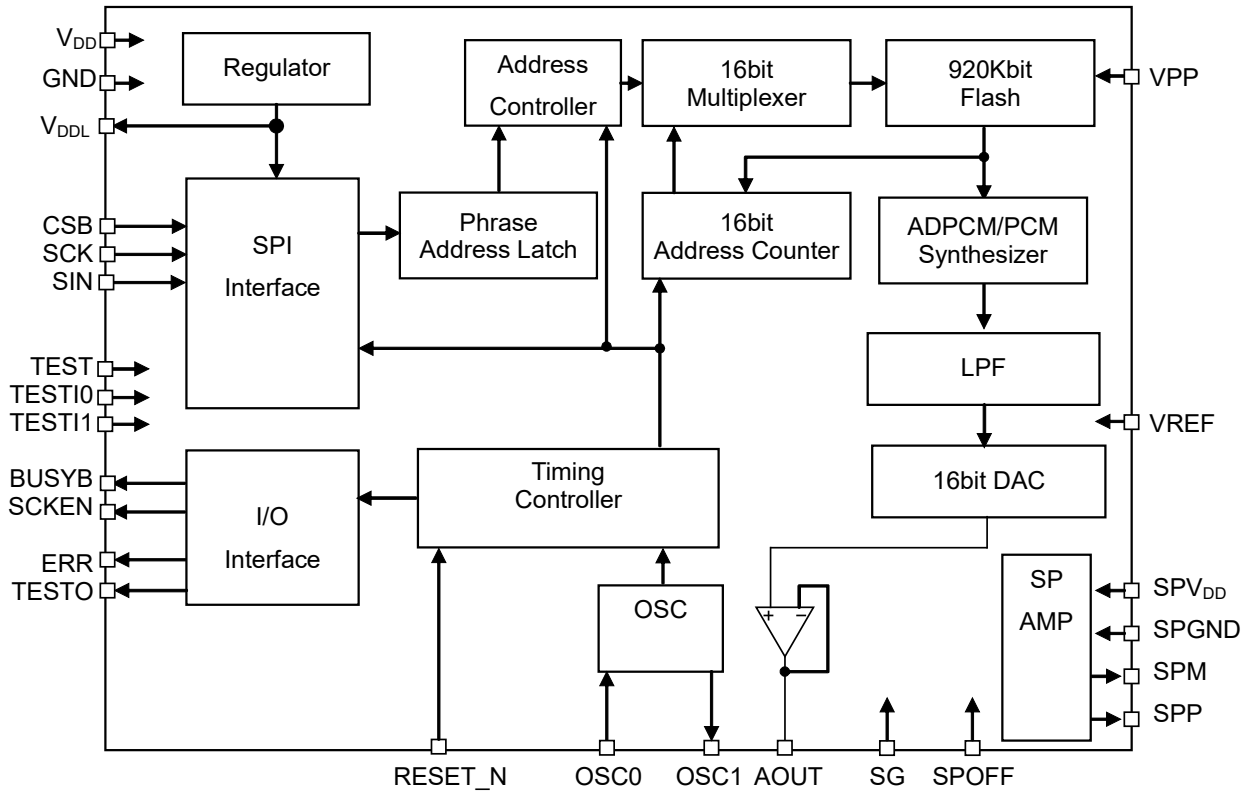
- Speech sysnthesis system: 4-bit ADPCM2
  8-bit/16-bit straight PCM system
  8-bit nonlinear PCM system
  HQ-ADPCM(*1)
  (can be specified for each phrase)
- Speech ROM capacity: ML22321: 920-Kbit Mask ROM
  ML22Q321: 920-Kbit Flash
- Sampling frequency: 8.0/16.0 /32.0kHz, 6.4/12.8/25.6 kHz/, 10.7/21.3 kHz
  (fsam can be specified in units of phrase)
- Volume control function: 32 steps by an analog value input and ADC (OFF is included)
- Analog output: Built-in 16-bit DA converter
- Interface: Synchronous serial interface
  MSB first, LSB first, or default level of synchronous clock is selectable based on ROM data
- Maximum event count: 62 events
- Source oscillation frequency: 4.096 MHz (Typ.)
- Power supply voltage: 2.3V to 5.5V
- Flash memory rewrite cycles: 80 times (ML22Q321)
- Operating temperature range: –40°C to +85°C
- Package: 30-pin plastic SSOP (SSOP30-56-0.65-Z6K8-MC)
- Product name: ML22321-xxxMB (xxx: ROM code number)
  ML22Q321-NNNMB/ML22Q321-xxxMB(xxx: ROM code number)

(*1) Ky's Technology HQ-ADPCM is audio compression technology featuring high-quality sound. It was developed by "Ky's". "Ky's" is a registered trademark of Kyushu Institute of Technology, one of the national universities in Japan.

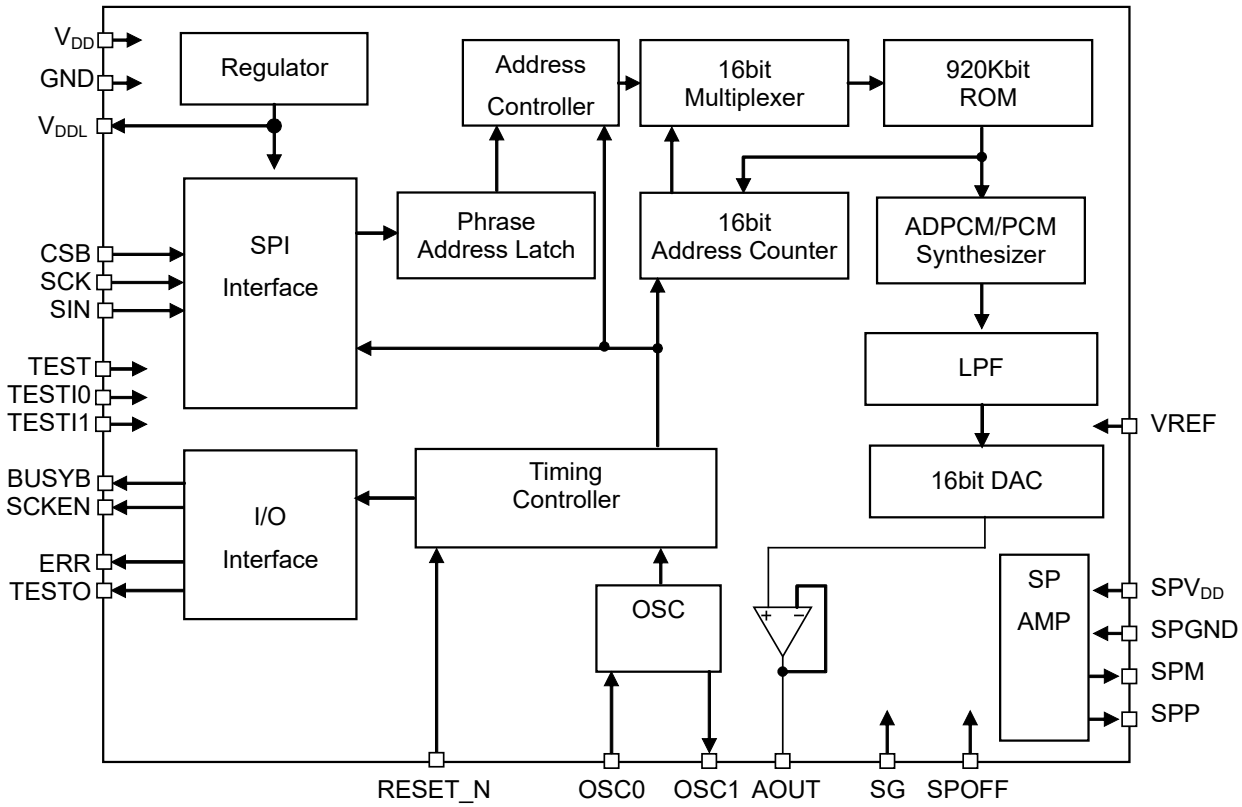
ROHM SEMICONDUCTOR

BLOCK DIAGRAM

ML22Q321-NNN/ML22Q321-xxx

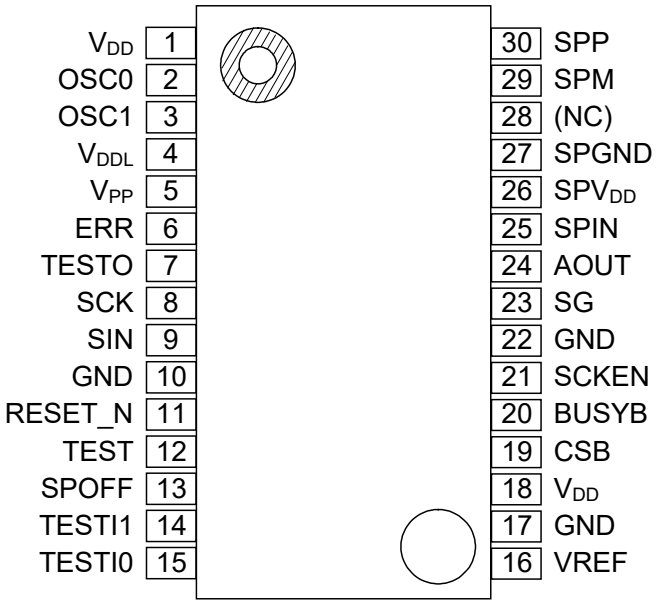


ML22321-xxx


VDD
GND
VDDL
Regulator
Address Controller
16bit Multiplexer
920Kbit ROM
SPI Interface
Phrase Address Latch
16bit Address Counter
ADPCM/PCM Synthesizer
CSB
SCK
SIN
TEST
TESTI0
TESTI1
LPF
VREF
16bit DAC
BUSYB
SCKEN
I/O Interface
Timing Controller
ERR
TESTO
OSC
SP AMP
SPVDD
SPGND
SPM
SPP
RESET_N
OSC0
OSC1
AOUT
SG
SPOFF

PIN CONFIGURATION (TOP VIEW)

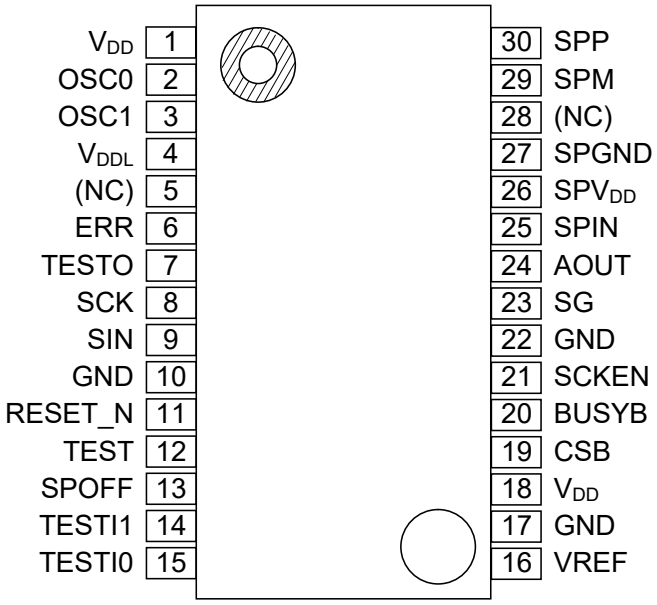
ML22Q321-NNNMB/ML22Q321-xxxMB



NC : unused pin

30-pin Plastic SSOP

ML22321-xxxMB



NC : unused pin

30-pin Plastic SSOP

PIN DESCRIPTIONS

Pin No.	symbol	I/O	Description
11	RESET_N	I	Place this pin at a “L” level when powered on. After the supply voltage is settled, place this pin at a “H” level.
19	CSB	I	Chip select pin. At the “L” level, SCK0 pin and SIN0 pin are available.
8	SCK	I	Synchronous clock input pin for serial interface.
9	SIN	I	Input pin of synchronous serial data.
13	SPOFF	I	Control pin of internal speaker amplifier. In “H” level input, internal speaker amplifier is turned off.
16	VREF	I	Volume control pin. Input the voltage of the range from VDD to GND. Volume is the maximum when input voltage is VDD.
12	TEST	I	Input pin for testing. Fix this pin at a “L” level (GND level).
15	TESTI0	I	Input pin for testing. Fix this pin at a “L” level (GND level).
14	TESTI1	I	Input pin for testing. Fix this pin at a “L” level (GND level).
2	OSC0	I	Pin for connecting a crystal or a ceramic vibrator. A feed back resistor (about 1 MΩ) is included between OSC0 and OSC1 pins. When a vibrator is used, place it as close to the LSI as possible.
3	OSC1	O	Pin for connecting a crystal or a ceramic vibrator. When a vibrator is used, place it as close to the LSI as possible.
20	BUSYB	O	Playback status signal output pin. "L" is outputted when an event is fixed. After playback is completed, “H” is outputted after WS3. Then, when the POP noise measure is completed, it turns standby state.
21	SCKEN	O	Output pin showing the permission state of SCK input of a serial interface The input of SCK and SIN is permitted during H" level output, and it is disregarded during H" level output
6	ERR	O	Error output pin for thermal detection and disconnection detection. If disconnection detection or a higher temperature than the judgment temperature is detected, this pin output “H”. Setting event 1 , operate the disconnection detection. And the 100ms “H” pulse is output right after the event start.
24	AOUT	O	Playback signal output pin. When you use built-in speaker amplifier, connect with the SPIN pin.
7	TESTO	O	Output pin for test.
5	VPP *Note 1	—	Power supply pin for rewriting Flash memory. Fix this pin to GND except when rewriting Flash memory.
1,18	V_{DD}	—	Digital power supply pin. Connect a capacitor of 0.1 μF or more between this pin and GND.
4	V_{DDL}	—	Output pin of the regulator for the internal logic power supply. Connect a electrolytic capacitor of 10 uF or more and a ceramic capacitor of 0.1 μF or more between the V_{DDL} and GND pins.
10,17,22	GND	—	Digital ground pin.
27	SPGND	—	Speaker amplifier ground pin.
26	SPV_{DD}	—	Speaker amplifier power supply pin.
25	SPIN	I	Analog input pin of internal speaker amplifier.
23	SG	O	Built-in speaker amplifier’s reference voltage output pin. Connect a capacitor of 0.1 μF or more between this pin and GND.
30	SPP	O	Positive output pin of the built-in speaker amplifier.
29	SPM	O	Negative output pin of the built-in speaker amplifier.

Notes: 1. Applies to ML22Q321-NNN

ABSOLUTE MAXIMUM RATINGS

(GND = SPGND = 0 V)

Parameter	Symbol	Condition	Rating	Unit
Digital power supply voltage	V_{DD}	Ta = 25 °C	−0.3 to +7.0	V
Internal logic power supply voltage	V_{DDL}		−0.3 to +3.6	V
Speaker power supply voltage	SPV_{DD}		−0.3 to +7.0	V
Flash power supply voltage (Note 1)	VPP		−0.3 to +9.5	V
Input voltage	V_{IN}	Ta = 25 °C When JEDEC 2-layer board is mounted	−0.3 to V_{DD}+0.3	V
Power dissipation	P_D	Ta = 25 °C	861	mW
Output short current	I_{SC1}	except LED drive pin, Ta = 25 °C	−12 to +11	mA
	I_{SC2}	LED drive pin, Ta = 25 °C	−12 to +20	mA
Storage temperature	T_{STG}	—	−55 to +150	°C

Note 1: Applies to the ML22Q321-NNN

RECOMMENDED OPERATING CONDITIONS

(GND = SPGND = 0 V)

Parameter	Symbol	Condition	Range			Unit
Digital power supply voltage	V_{DD}	—	2.3 to 5.5			V
		ML22Q321 read	2.3 to 5.5			
		ML22Q321 write	3.0 to 5.5			
Speaker power supply voltage	SPV_{DD}	—	2.3 to 5.5			V
Flash power supply voltage	VPP	ML22Q321 write	7.7 to 8.3			V
Flash memory rewrite cycles	N	ML22Q321	80			times
Operating temperature	T_{OP1}	ML22321	−40 to +85			°C
	T_{OP2}	ML22Q321 read	-40 to +85			
	T_{OP3}	ML22Q321 write	0 to +40			
Source oscillation frequency	f_{OSC}	—	Min.	Typ.	Max.	MHz
			3.5	4.096	4.5	

ELECTRICAL CHARACTERISTICS

DC Characteristics

V_{DD} = SPV_{DD} = 2.3 to 5.5 V, GND = SPGND = 0 V, Ta = –40 to +85°C

Parameter	Symbol	Condition	Min.	Typ.	Max.	Unit
"H" input voltage	V_{IH}	—	0.7×V_{DD}	—	V_{DD}	V
"L" voltage	V_{IL}	—	0	—	0.3×V_{DD}	V
"H" output voltage 1	V_{OH1}	I_{OH} = –0.5 mA	V_{DD}–0.5	—	—	V
"H" output voltage 2	V_{OH2}	I_{OH} = 100µA OSC1 pin	V_{DD}–0.5	—	—	V
"L" output voltage 1	V_{OL1}	I_{OL} = 0.5 mA	—	—	0.5	V
"L" output voltage 2	V_{OL2}	I_{OL} = 100µA OSC1 pin	—	—	0.5	V
"H" input current 1	I_{IH1}	V_{IH} = V_{DD}	—	—	1	µA
"H" input current 2	I_{IH2}	V_{IH} = V_{DD} TEST, TESTI0, TESTI1 pin	0.02	0.3	1.5	mA
"L" input current 1	I_{IL1}	V_{IL} = GND	–1	—	—	µA
"L" input current 2	I_{IL2}	V_{IL} = GND RESET_N pin	–1.5	–0.3	–0.02	mA
Supply current during operate	I_{DD1}	Non-loaded output V_{DD} = SPV_{DD} = 3.0V	—	2.5	12	mA
	I_{DD2}	Non-loaded output V_{DD} = SPV_{DD} = 5.0V	—	8	12	
Supply current during power down	I_{DDS1}	Ta ≦40°C	—	0.5	2.0	µA
	I_{DDS2}	Ta ≦ 85°C	—	0.5	8.0	

Analog Characteristics

V_{DD} = SPV_{DD} = 2.3 to 5.5 V, GND = SPGND = 0 V, Ta = –40 to +85°C

Parameter	Symbol	Condition	Min.	Typ.	Max.	Unit
AOUT output load resistance	R_{LA}	During 1/2 V_{DD} output	10	—	—	kΩ
AOUT output voltage range	V_{AO}	No output load	1/6×V_{DD}	—	5/6×V_{DD}	V
SG output voltage	V_{SG}	—	0.95xV_{DD}/2	V_{DD}/2	1.05xV_{DD}/2	V
SG output resistance	R_{SG}	—	57	96	135	kΩ
SPM, SPP output load resistance	R_{LSP}	—	8	—	—	Ω
Speaker amplifier output power	P_{SPO}	SPV_{DD}=5.0V, f=1kHz , R_{SPO}=8Ω, THD≧10%	—	1	—	W
Output offset voltage between SPM and SPP with no signal present	V_{OF}	SPIN-SPM gain=0dB 8Ω load	-50	—	50	mV

AC Characteristics

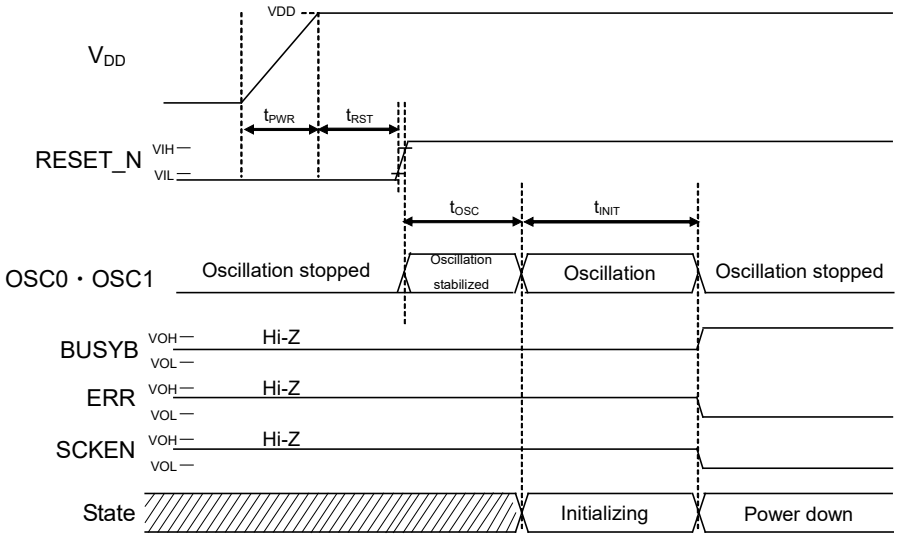
V_{DD} = SPV_{DD} = 2.3 to 5.5 V, GND = SPGND = 0 V, Ta = –40 to +85°C

Parameter	Symbol	Condition	Min.	Typ.	Max.	Unit
Duty cycle of source oscillation	f_{duty}	—	40	50	60	%
RESET_N input pulse width	t_{RST}	—	100	—	—	μs
Voltage startup time	t_{PWR}	—	—	—	10	ms
Initialize time	t_{INIT}	f_{OSC}=4.096MHz	20	—	22	ms
Oscillation stabilizing time	t_{OSC}	—	—	2	20	ms
SCK input cycle	t_{SCYC}	—	500	—	—	ns
SCK input pulse width	t_{SW}	—	200	—	—	ns
Setup time of SIN to the rising of SCK	t_{SS}	—	50	—	—	ns
Hold time of SIN to the rising of SCK	t_{SH}	—	50	—	—	ns
Setup time of CSB to the rising of SCK	t_{CSS}	—	—	2	20	ms
Hold time of CSB to the rising of SCK	t_{CSH}	—	100	—	—	ns
Output delay time1 of SCKEN to falling of CSB	t_{DSEN1}	At the time of release of a standby state	—	—	20	ms
Output delay time2 of SCKEN to falling of CSB	t_{DSEN2}	At the time of the continuous input of an event	—	—	10	μs
Output delay time of BUSYB to falling of SCK	t_{DBSY}	—	—	—	400	μs
“H” level time of CSB	t_{CSBH}	—	1	—	—	ms
SG pin voltage stabilization time(Rising)	t_{SGR}	f_{OSC}=4.096MHz	32	—	34	ms
SG pin voltage stabilization time(Falling)	t_{SGF}	f_{OSC}=4.096MHz	64	—	66	ms
Pop noise elimination time	t_{POPR} t_{POPF}	f_{OSC}=4.096MHz	40	—	42	ms
Disconnection judging time by the DISCONNECT event	t_{DCD}	—	100	—	—	ms

Load capacitance of the output pins = 55 pF (max.)

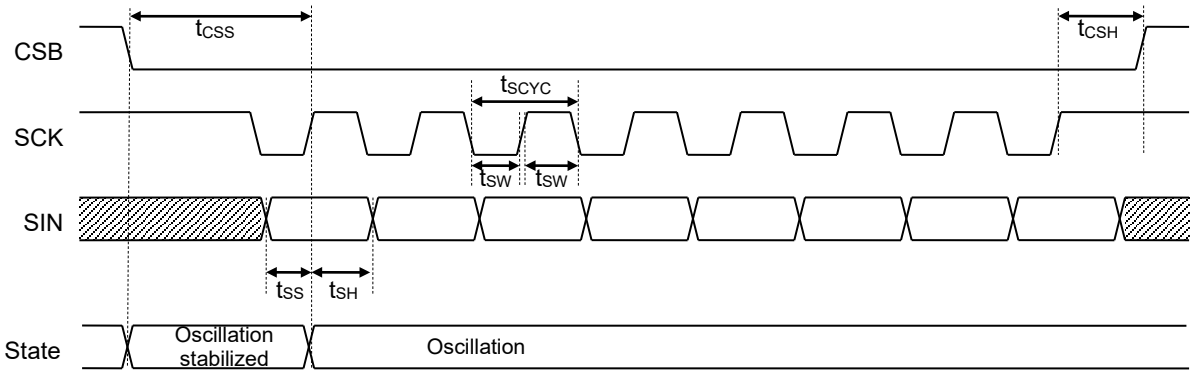
TIMING DIAGRAMS

Power On

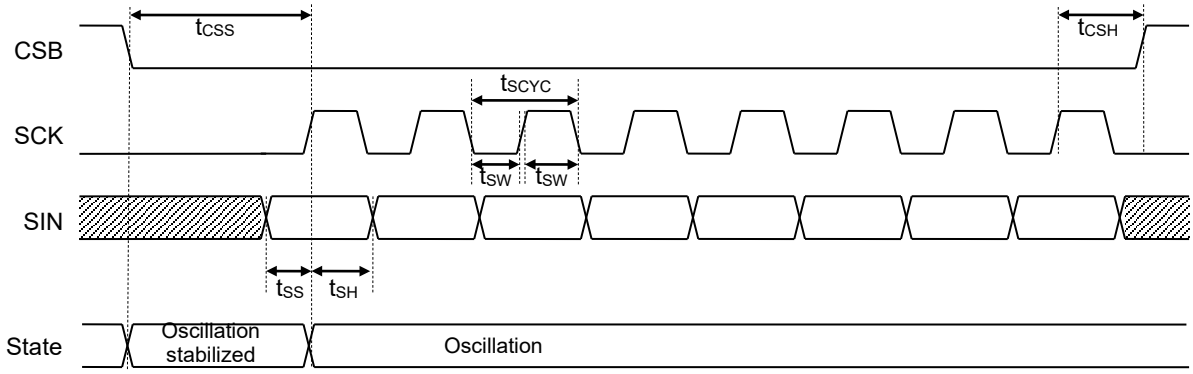


Serial Interface

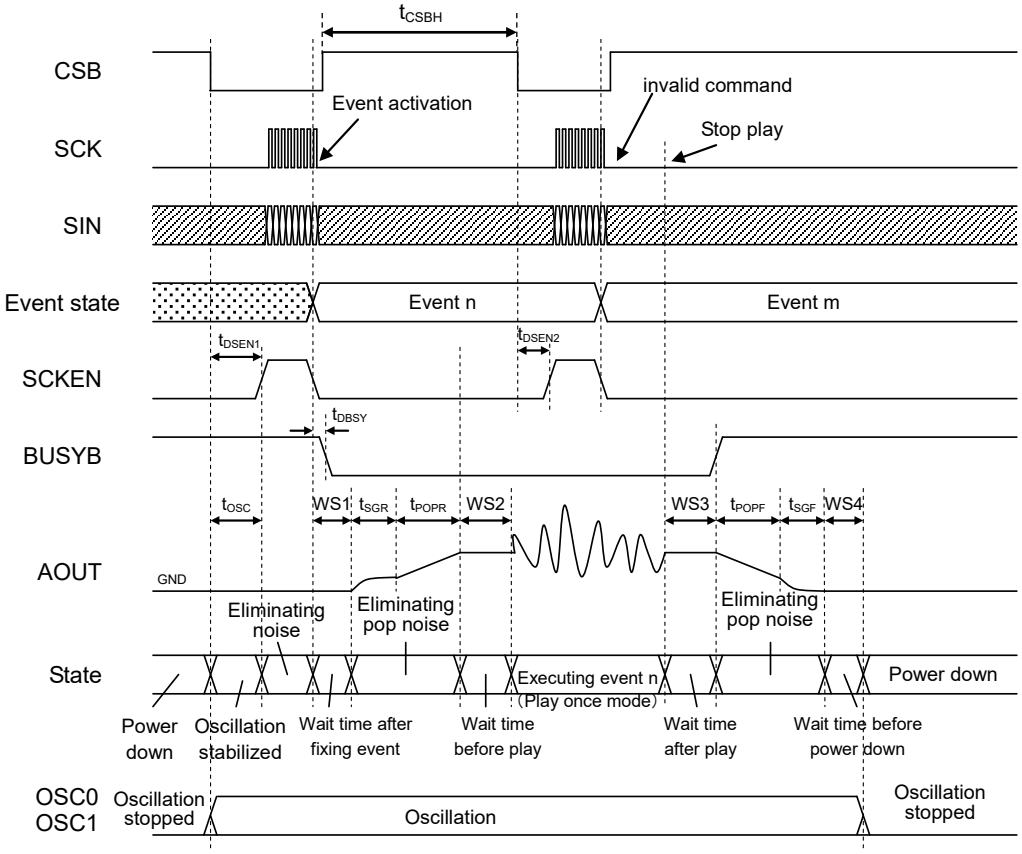
・When the default value of SCK is “H”



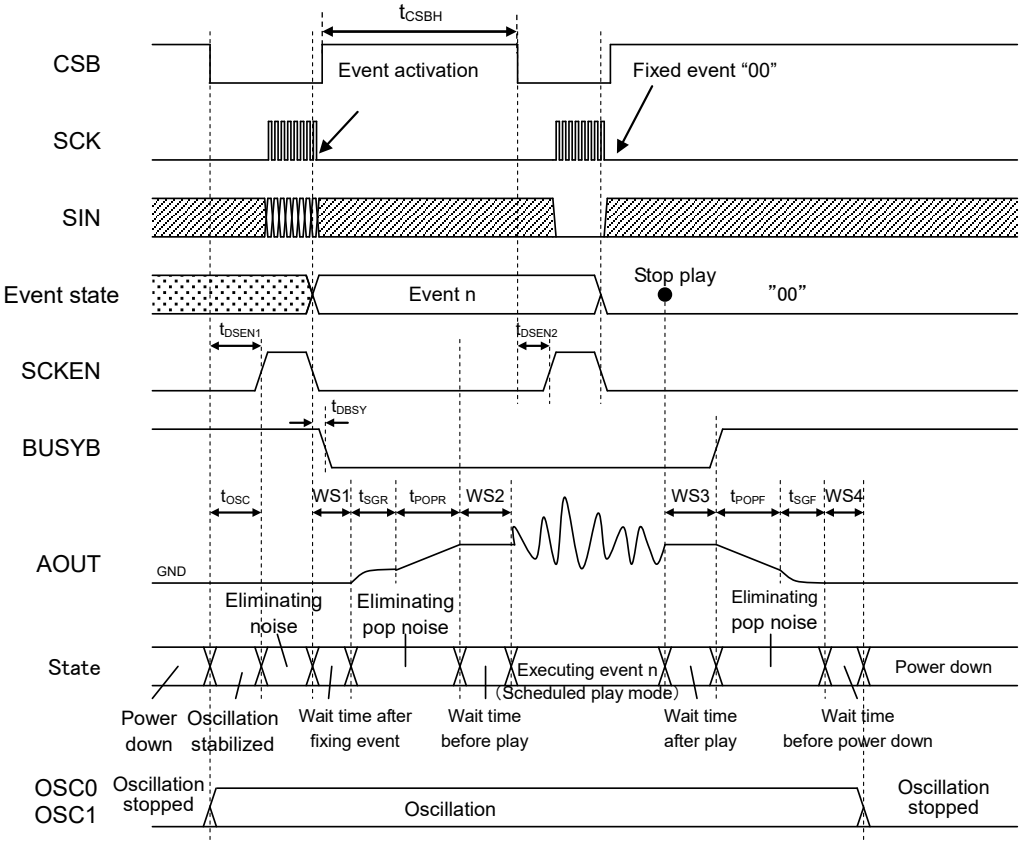
・When the default value of SCK is “L”



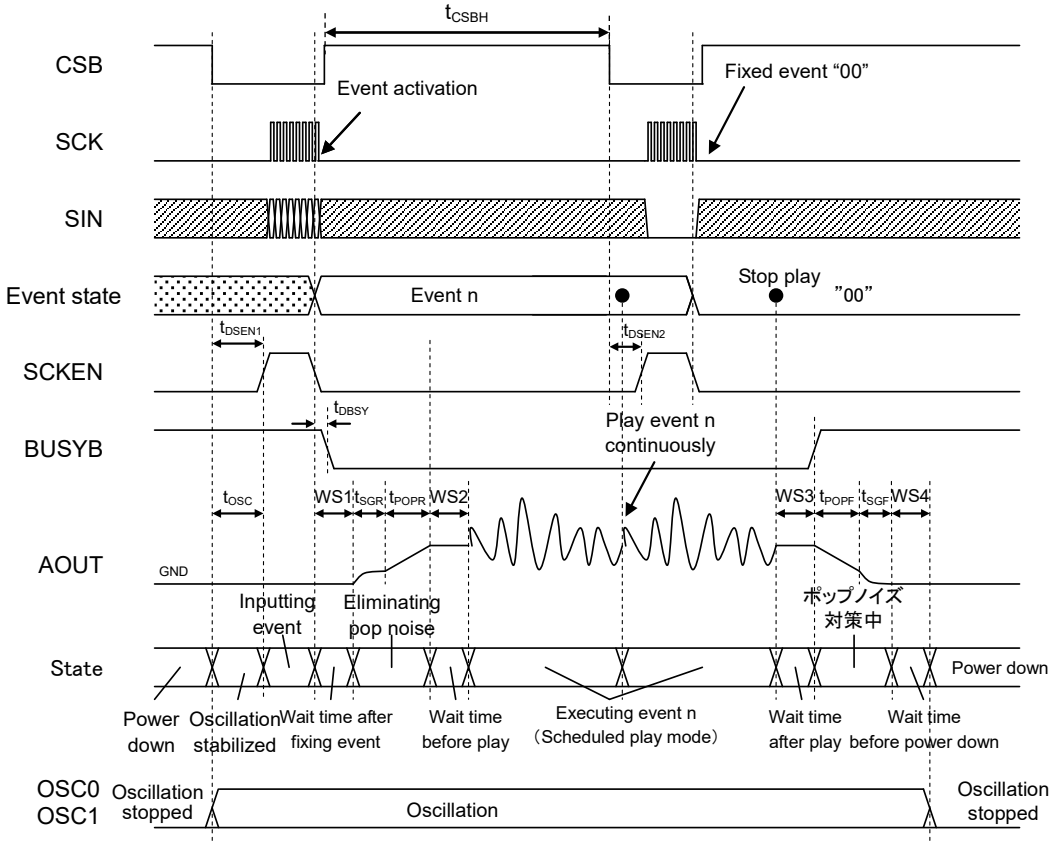
Event Control example 1 (Only one playback in Play once mode)



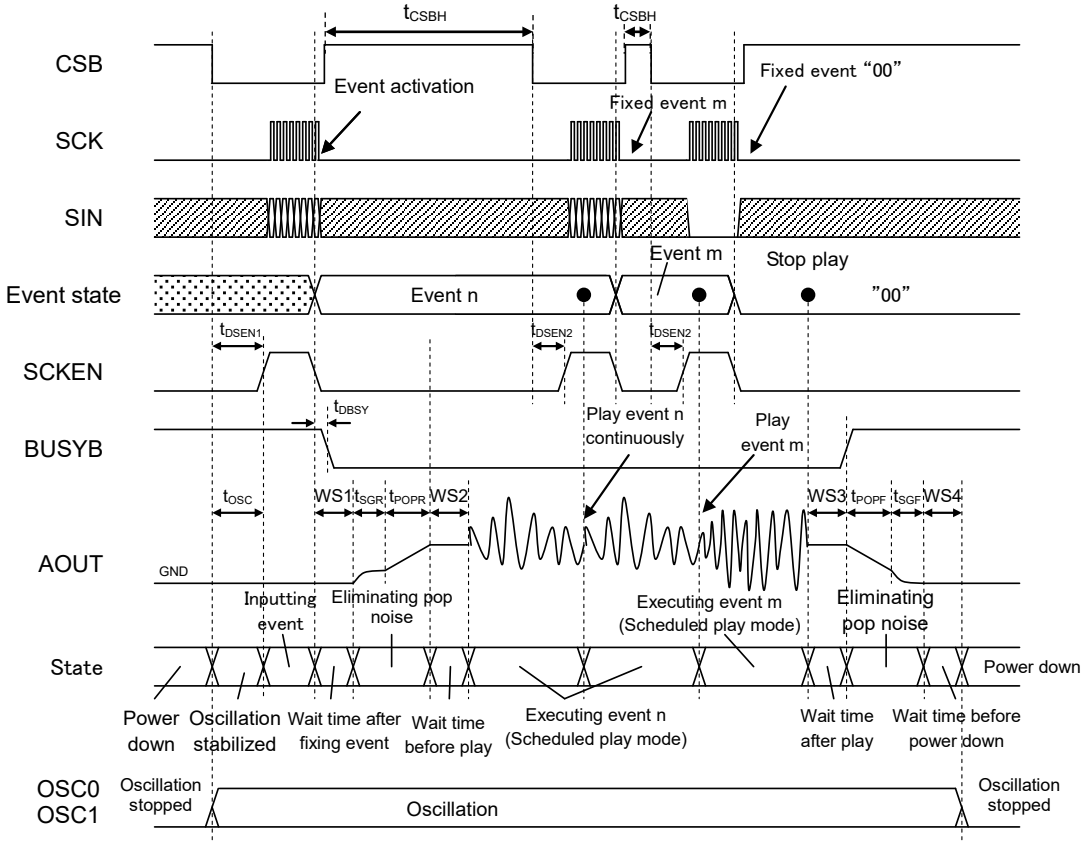
Event Control example 2 (Only one playback in Scheduled play mode)



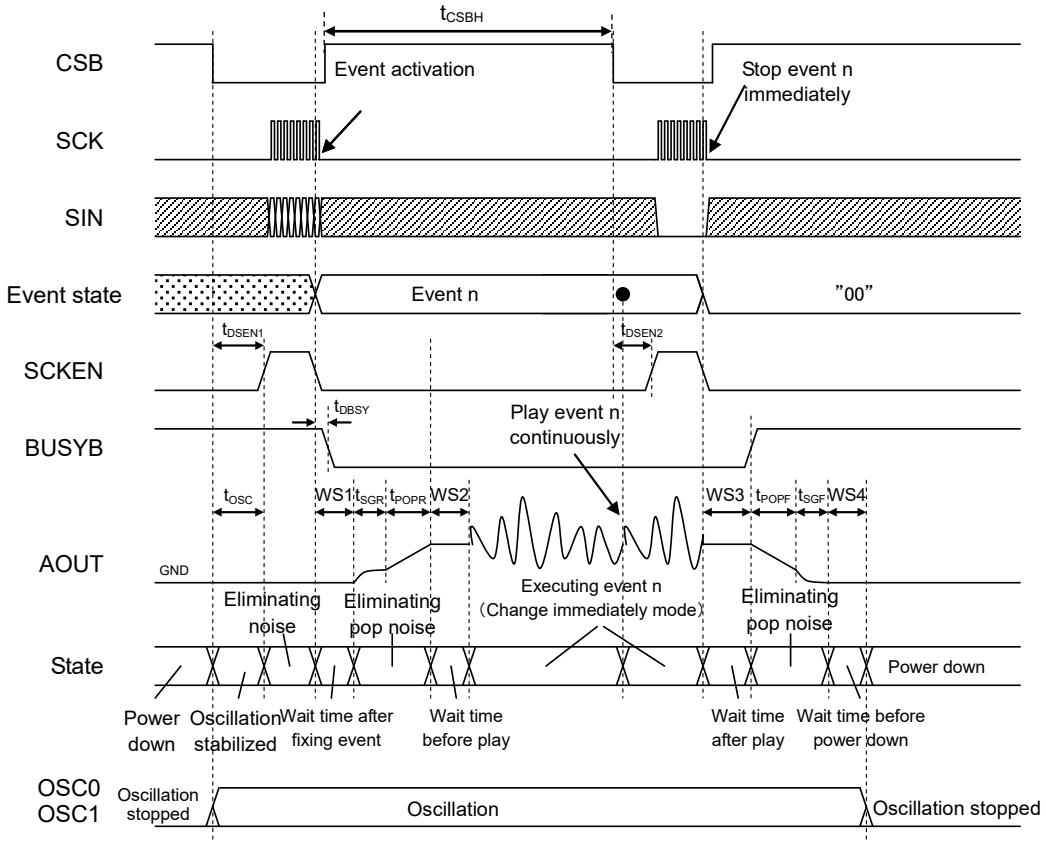
Event Control example 3 (Repetitive playback in Scheduled play mode)



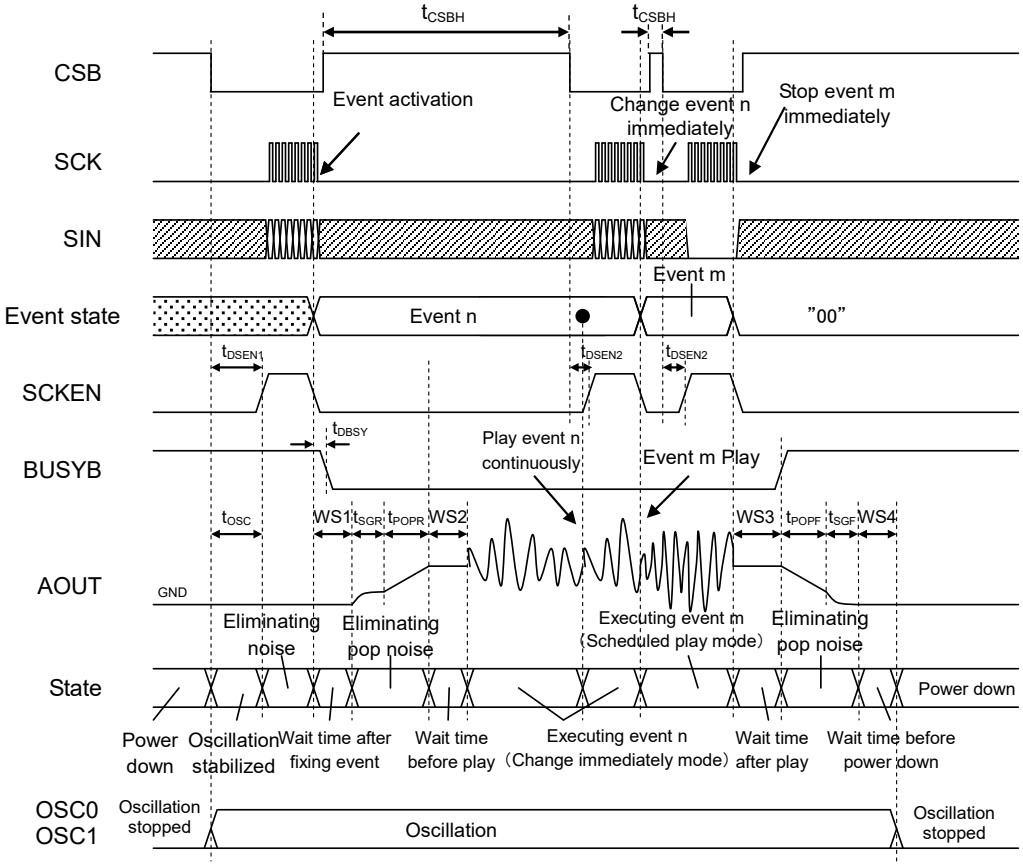
Event Control example 4 (Change in playback phrase in Scheduled play mode)



Event Control example 5 (Repetitive playback in Change immediately mode)



Event Control example 6 (Different consecutive event execution timing diagram in Change immediately mode)

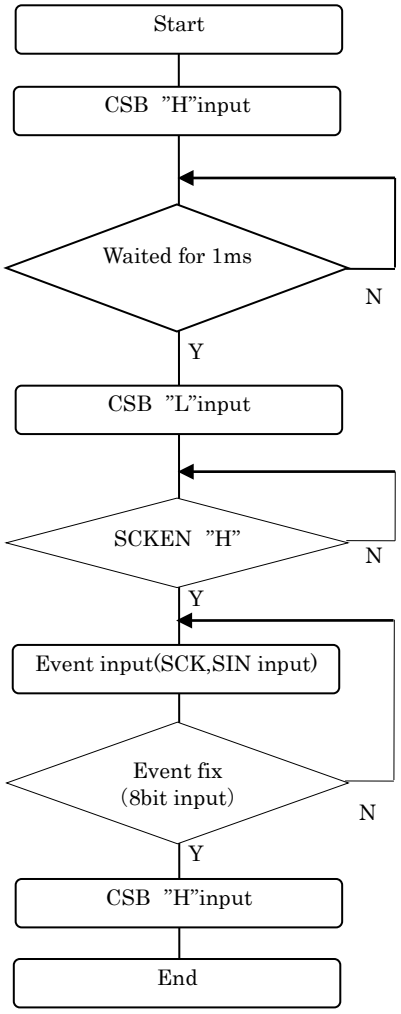


FUNCTIONAL DESCRIPTION

The "Speech LSI Utility" is used for the setting of an each function and the creating of ROM data.
The Speech LSI Utility is dedicated software.

Serial interface input flow chart

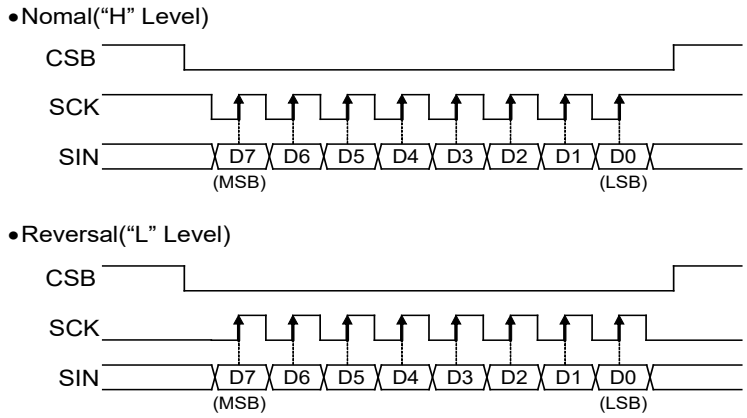
The timing to which the input of serial interface is permitted can be judged by monitoring the output of SCKEN.
The flow chart is shown below.



Synchronous Serial Command Interface

The CSB, SCK, SIN pins are used to input the command data. Driving the CSB pin to “L” level enables the serial CPU interface. After the CSB pin is driven to “L” level, the command data are input through the SIN pin from the MSB or LSB synchronized with the SCK clock. The command data shifts in through the SIN pin at the rising edge of the SCK clock pulse. Then, a command is executed at the rising edge of the eighth pulse of the SCK clock.
The initial value of the SCK pin can be chosen by the mask option of Speech Utility. When setting the initial value of the SCK pin as "H" level, please choose “Nomal ("H" Level)” as a mask option. When setting the initial value of the SCK pin as "L" level, please choose “Reversal("L" Level)” as a mask option.
After a command input should return the CSB pin to "H" level.

Data input timing



Playback mode setup

Playback mode can be set up for every phrase.
Playback mode is set into the ROM data.
The ROM data is created using a Speech LSI Utility.
The Speech LSI Utility is dedicated software.

Playback mode	Operation
Play Once	This mode is playback once. All the commands become invalid during playback.
Scheduled Play	The playback continues until the following command will be inputted, if playback starts. When the following command is inputted into playback, after playback of the present phrase is completed, the following command is executed.
Change Immediately	The playback continues until the following command will be inputted, if playback starts. When the following phrase is inputted into playback, playback of the present phrase is ended on the way, and playback of the following phrase starts.

Event List

Each event is configured by the unit of byte (8-bit).

Event	D7	D6	D5	D4	D3	D2	D1	D0	Description
Stop	0	0	0	0	0	0	0	0	Stop event. The Stop event becomes effective except the phrase in Play Once mode.
Disconnection Detection	0	0	0	0	0	0	0	1	Disconnection Detection event. Please input the Stop event, after you use the Disconnection Detection event.
Play	0	0	0	0	0	0	1	0	PHRASE02
	0	0	0	0	0	0	1	1	PHRASE03
	:								:
	0	0	0	0	1	0	0	1	PHRASE09
	0	0	0	0	1	0	1	0	PHRASE0A
	:								:
	0	0	1	1	1	1	1	1	PHRASE3F

Description of Command Functions

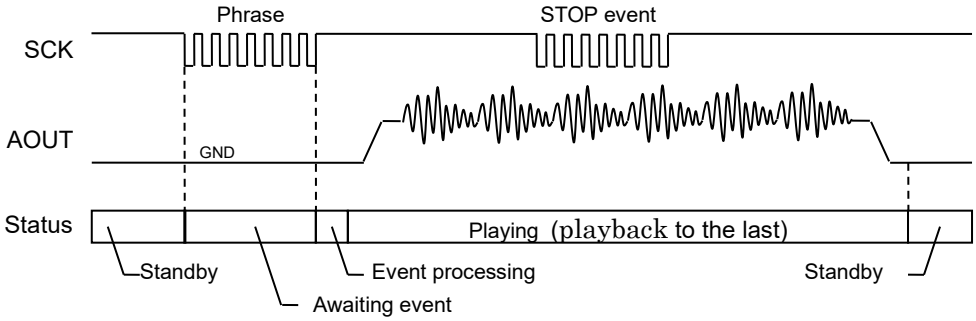
1. Stop event

0	0	0	0	0	0	0	0

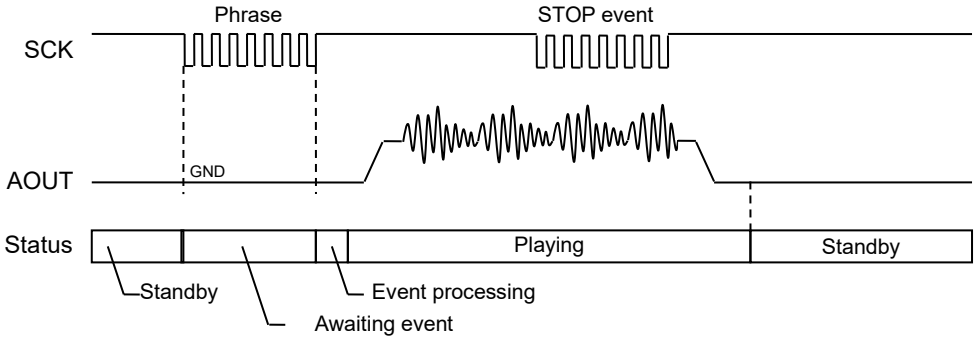
The Stop event is used to stop the repetitive playback. The Stop event becomes effective except the phrase in Play Once mode. When you use Play Once mode, the Stop event is ignored.

When you use Scheduled Play mode, a phrase is played back to the last and the playback is stopped, after the Stop event is inputted. Furthermore, when you use Change Immediately mode, a phrase is not played back to the last and the playback is stopped forcibly, after the Stop event is inputted.

・Stop event operation in the case of Scheduled Play mode



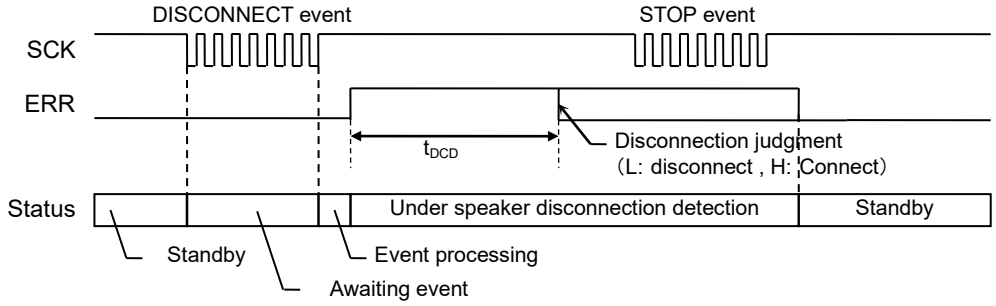
・Stop event operation in the case of Change Immediately mode



2. Disconnection Detection event

0	0	0	0	0	0	0	1

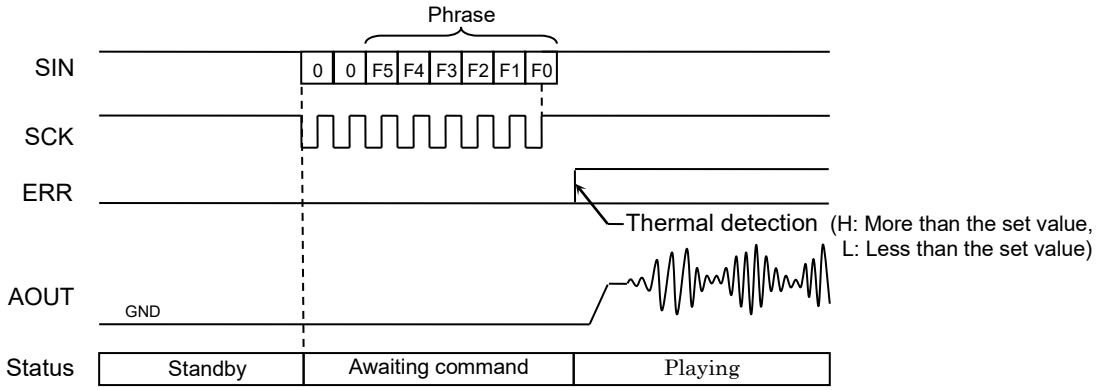
The Disconnection Detection event is used to diagnose whether the speaker is disconnected or not. When the speaker is disconnected, ERR pin outputs "L". Please input the STOP event, after you use the Disconnection Detection event.



3. Play n (n = Phrase 02 to 3F) event

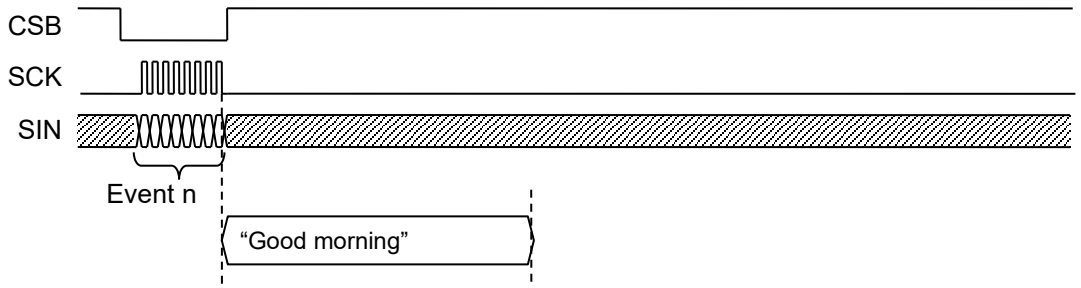
0	0	F5	F4	F3	F2	F1	F0

The Play n (n = Phrase 02 to 3F) event is used to start playback phrase.
After inputting a Play n (n = Phrase 02 to 3F) event, temperature detection is carried out.



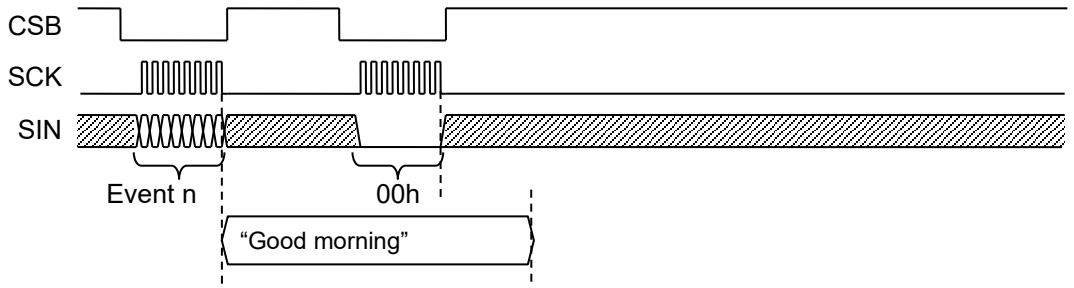
○ Event Control example 1 (Only one playback in Play once mode)

Operation: The specified event is performed once after event starting. Other event inputs are disregarded during event execution.
Control method: Input the event number to be executed to the serial interface pins.



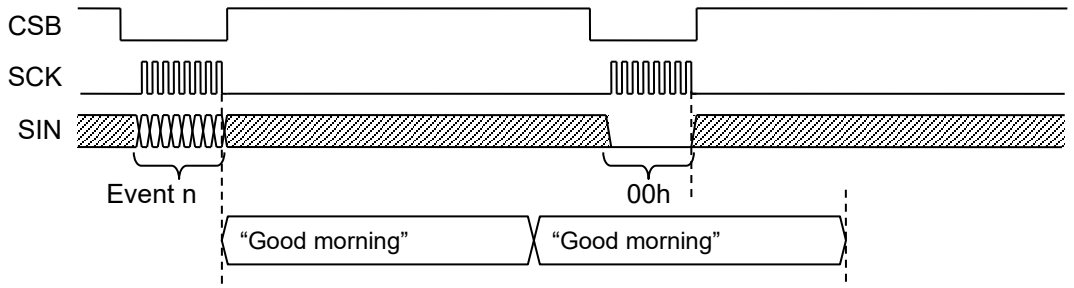
○ Event Control example 2 (Only one playback in Scheduled play mode)

Operation: The specified event is performed once.
Control method: Input the event number to be executed to the serial interface pins. In this mode, the event fixed at the time of the end of phrase playback is performed repeatedly. Therefore, after event activation, input stop event"00" into the serial interface pins before the event is completed.



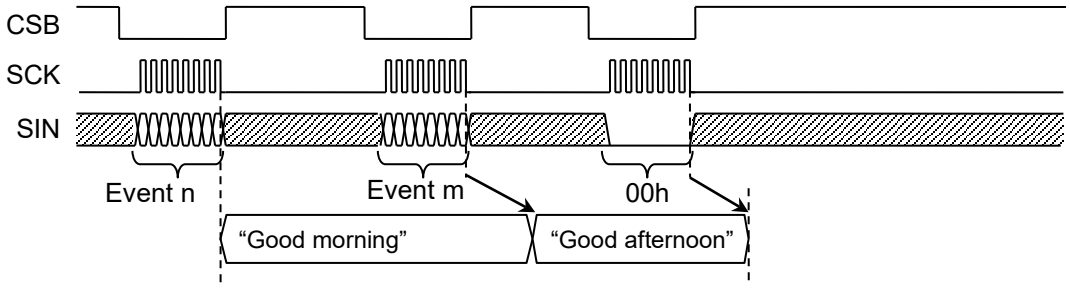
○ Event Control example 3 (Repetitive playback in Scheduled play mode)

Operation: After an event starts, unless a stop command is inputted, the event is performed repetitively.
When a stop event is inputted, the event under execution is performed to the last and stops.
Control method: Input the event number to be executed to the serial interface pins. In this mode, the event fixed at the time of the end of phrase playback is performed repeatedly. After an event starts, unless a stop command is inputted, the event is performed repetitively. When desired to stop event execution, input stop command to the serial interface pins.



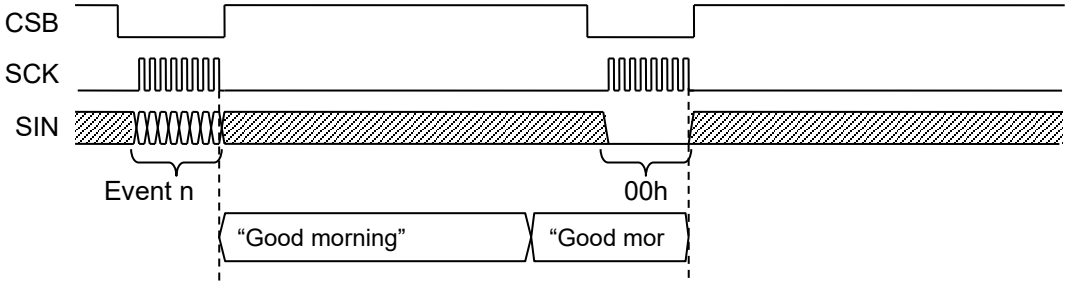
○ Event Control example 4 (Change in playback phrase in Scheduled play mode)

Operation: The event execution specified first is ended and newly specified event execution is started.
Control method: Input the event number to be executed to the serial interface pins. In this mode, the event fixd at the time of the end of phrase playback is performed repeatedly. Therefore, after event activation, input a new event into the serial interface pins before the event is completed.



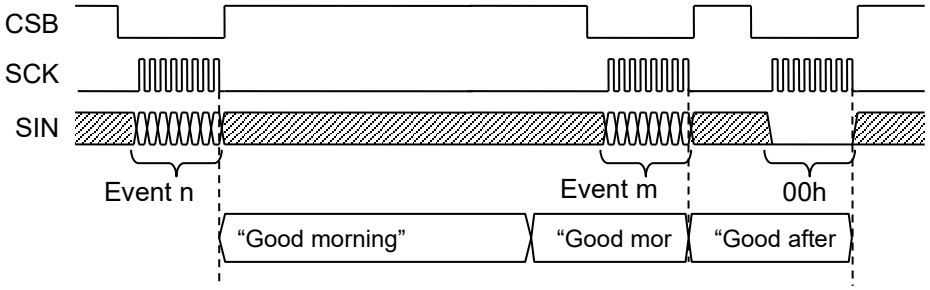
○ Event Control example 5 (Repetitive playback in Change immediately mode)

Operation: After an event starts, unless a stop command is inputted, the event is performed repetitively.
When a stop event is inputted, the event stops immediately.
Control method: Input the event number to be executed to the serial interface pins. When desired to stop event execution, input stop command to the serial interface pins. the event stops immediately.



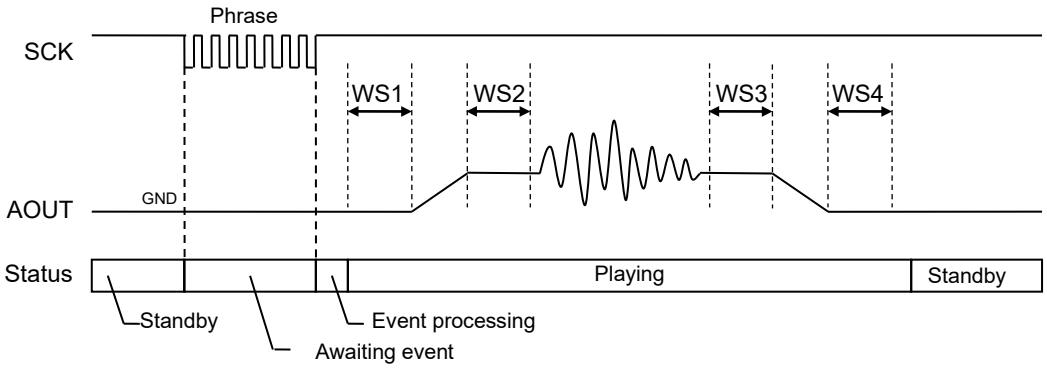
○ Event Control example 6 (Change in playback phrase in Change immediately mode)

Operation: The event under execution is immediately changed into a new event.
Control method: Input the event number to be executed to the serial interface pins. After an event starts, input the next event number to the serial interface pins. The event under execution is immediately changed into a new event.



Wait time setting before and after playback (WS1, WS2, WS3, WS4)

Each phrase can set up the wait time before and after playback.
It is set into the ROM. The ROM data is created using a Speech LSI Utility.
The Speech LSI Utility is dedicated software.



WS1: Time after inputting a phrase address, until SPP/SPM pins are enabled.
WS2: Time after SPP/SPM pins are enabled, until playback is started.
WS3: Time after playback is completed, until SPP/SPM pins are disabled.
WS4: Time after SPP/SPM pins are disabled, until it will be in a standby state.

WS1-WS4 can be arbitrarily set up between 0 to1020ms (4ms unit).

Wait time setting before and after playback (WS1, WS2, WS3, WS4)

Setting value	wait time [ms]	Setting value	wait time [ms]	Setting value	wait time [ms]	Setting value	wait time [ms]	Setting value	wait time [ms]
00h	0	34h	208	67h	412	9Ah	616	CDh	820
01h	4	35h	212	68h	416	9Bh	620	CEh	824
02h	8	36h	216	69h	420	9Ch	624	CFh	828
03h	12	37h	220	6Ah	424	9Dh	628	D0h	832
04h	16	38h	224	6Bh	428	9Eh	632	D1h	836
05h	20	39h	228	6Ch	432	9Fh	636	D2h	840
06h	24	3Ah	232	6Dh	436	A0h	640	D3h	844
07h	28	3Bh	236	6Eh	440	A1h	644	D4h	848
08h	32	3Ch	240	6Fh	444	A2h	648	D5h	852
09h	36	3Dh	244	70h	448	A3h	652	D6h	856
0Ah	40	3Eh	248	71h	452	A4h	656	D7h	860
0Bh	44	3Fh	252	72h	456	A5h	660	D8h	864
0Ch	48	40h	256	73h	460	A6h	664	D9h	868
0Dh	52	41h	260	74h	464	A7h	668	DAh	872
0Eh	56	42h	264	75h	468	A8h	672	DBh	876
0Fh	60	43h	268	76h	472	A9h	676	DCh	880
10h	64	44h	272	77h	476	AAh	680	DDh	884
11h	68	45h	276	78h	480	ABh	684	DEh	888
12h	72	46h	280	79h	484	ACh	688	DFh	892
13h	76	47h	284	7Ah	488	ADh	692	E0h	896
14h	80	48h	288	7Bh	492	AEh	696	E1h	900
15h	84	49h	292	7Ch	496	AFh	700	E2h	904
16h	88	4Ah	296	7Dh	500	B0h	704	E3h	908
17h	92	4Bh	300	7Eh	504	B1h	708	E4h	912
18h	96	4Ch	304	7Fh	508	B2h	712	E5h	916
19h	100	4Dh	308	80h	512	B3h	716	E6h	920
1Ah	104	4Eh	312	81h	516	B4h	720	E7h	924
1Bh	108	4Fh	316	82h	520	B5h	724	E8h	928
1Ch	112	50h	320	83h	524	B6h	728	E9h	932
1Dh	116	51h	324	84h	528	B7h	732	EAh	936
1Eh	120	52h	328	85h	532	B8h	736	EBh	940
1Fh	124	53h	332	86h	536	B9h	740	ECh	944
20h	128	54h	336	87h	540	BAh	744	EDh	948
21h	132	55h	340	88h	544	BBh	748	EEh	952
22h	136	56h	344	89h	548	BCh	752	EFh	956
23h	140	57h	348	8Ah	552	BDh	756	F0h	960
24h	144	58h	352	8Bh	556	BEh	760	F1h	964
25h	148	59h	356	8Ch	560	BFh	764	F2h	968
26h	152	5Ah	360	8Dh	564	C0h	768	F3h	972
27h	156	5Bh	364	8Eh	568	C1h	772	F4h	976
28h	160	5Ch	368	8Fh	572	C2h	776	F5h	980
29h	164	5Dh	372	90h	576	C3h	780	F6h	984
2Ah	168	5Eh	376	91h	580	C4h	784	F7h	988
2Bh	172	5Fh	380	92h	584	C5h	788	F8h	992
2Ch	176	60h	384	93h	588	C6h	792	F9h	996
2Dh	180	61h	388	94h	592	C7h	796	FAh	1000
2Eh	184	62h	392	95h	596	C8h	800	FBh	1004
2Fh	188	63h	396	96h	600	C9h	804	FCh	1008
30h	192	64h	400	97h	604	CAh	808	FDh	1012
31h	196	65h	404	98h	608	CBh	812	FEh	1016
32h	200	66h	408	99h	612	CCh	816	FFh	1020
33h	204								

Volume control (Volume)

Use or unuse of volume control setting by the external VREF input is selectable.
When not using the external VREF input function, the VREF input value becomes null, and it comes to be able to setup volume by ROM data in each phrase.
When using an external VREF input function, the analog value inputted from VREF is changed into 32 steps of volume preset values by ADC. Taking in of a VREF value is carried out every about 10ms.
In this case, the volume setup by ROM data becomes null.

And volume setting is as follows.

Setting value	Volume [dB]	Setting value	Volume [dB]	Setting value	Volume [dB]
00h	+2.98	0Ah	-0.41	15h	-6.87
01h	+2.70	0Bh	-0.83	16h	-7.79
02h	+2.40	0Ch	-1.28	17h	-8.82
03h	+2.10	0Dh	-1.75	18h	-9.99
04h	+1.78	0Eh	-2.25	19h	-11.34
05h	+1.45	0Fh	-2.77	1Ah	-12.94
06h	+1.11	10h	-3.34	1Bh	-14.90
07h	+0.76	11h	-3.94	1Ch	-17.44
08h	+0.39	12h	-4.58	1Dh	-21.04
09h	+0.00	13h	-5.28	1Eh	-27.31
		14h	-6.04	1Fh	OFF

Mask Option Setting

The following table shows the items which can be set by using the Mask option (ROM data):
During initialization processing after power on, mask option data are transferd automatically to each setting.
The ROM data is created using a Speech LSI Utility.
The Speech LSI Utility is dedicated software.

Function	Description	Parameter
Setting of the internal speaker amplifier	Use or unuse of the internal speaker amplifier selectable	Speaker Amp control Use of Speaker Amp
Setting of the internal speaker Gain	+6dB or +12dB selectable	Speaker Amp control Gain +6dB +12dB
SPOFF pin setting	High-impedance input, pull-up input, or pull-down input selectable	Speaker Amp control SPOFF Pin Hi-Z Pull Down Pull Up
Setting of thermal detection	Use or unuse of thermal detection selectable	Speaker AMP control Thermal check ON
Setting of judgement temperature	150°C or 125°C or 100°C selectable	Speaker AMP control Judgement Temperature 150C 125C 100C
SCK pin setting	“H” input or “L” input of default selectable	SPI setting Clock polarity Normal (H Level) Reversal (L Level)
SIN pin setting	LSB first or MSB first selectable	SPI setting Data transfer type LSB first MSB first
Volume control setting	VREF volume function use / unused selectable	Volume Control Sets Volume by VREF-pin

Voice Synthesis Algorithm

Five types of voice synthesis algorithm are supported. They are 4-bit ADPCM2, 8-bit non-linear PCM, 8-bit straight PCM and 16-bit straight PCM. Select the best one according to the characteristics of voice.
The following table shows key features of each algorithm.

Voice synthesis algorithm	Feature
HQ- ADPCM	Algorithm that enables high sound quality and high compression, which have been achieved by the improved 4-bit ADPCM that uses variable bit-length coding.
4-bit ADPCM2	Up version of LAPIS Technology's specific voice synthesis algorithm (: 4-bit ADPCM). Voice quality is improved.
8-bit Nonlinear PCM	Algorithm, which plays back mid-range of waveform as 10-bit equivalent voice quality.
8-bit PCM	Normal 8-bit PCM algorithm
16-bit PCM	Normal 16-bit PCM algorithm

Memory Allocation and Creating Voice Data

The ROM is partitioned into four data areas: voice (i.e., phrase) control area, test area, voice area, and edit ROM area.
The voice control area manages the voice data in the ROM. It contains data for controlling the start/stop addresses of voice data for 62 phrases, use/non-use of the edit ROM function and so on.
The test area contains data for testing.
The voice area contains actual waveform data.
The edit ROM area contains data for effective use of voice data. For the details, refer to the section of "Edit ROM Function."
The edit ROM area is not available if the edit ROM is not used.

The ROM data is created using a dedicated tool.

Configuration of ROM data

0x00000 0x01FFF	Prohibition of use area (Fixed 64 Kbits)
0x02000 max.0x0EFFF	Voice area 2
max.0x0EFFF	Edit ROM area Depends on creation of ROM data.
0x0F000 0x0FFFF	Test area
0x10000 0x103FF	Voice control area (Fixed 8 Kbits)
0x10400 0x1FFFF	Voice area 1

The one phrase must make 50ms or more length.
Since the data which exceeds 64 K bytes in one phrage cannot be played, please devide the voice phrase to be set to each below 64 K bytes, and join those data by the edit phrase function.

Playback Time and Memory Capacity

The playback time depends on the memory capacity, sampling frequency, and the playback method.
The equation to know the playback time is shown below. But this is not applied if the edit ROM function is used.

$$\text{Playback time [sec]} = \frac{1.024 \times (\text{Voice area 1} + \text{Voice area 2}) \text{ [Kbits]}}{\text{Sampling frequency [kHz]} \times \text{Bit length}}$$

(Bit length is 4 at the 4-bit ADPCM2 and 8/16 at the PCM.)

Example) In the case that the sampling frequency is 8 kHz, algorithm is 4-bit ADPCM2, the playback time is approx. 29.4 seconds, as shown below.

$$\text{Playback time} = \frac{1.024 \times 920 \text{ [Kbits]}}{8 \text{ [kHz]} \times 4 \text{ [bits]}} \cong 29.4 \text{ [sec]}$$

Edit ROM Function

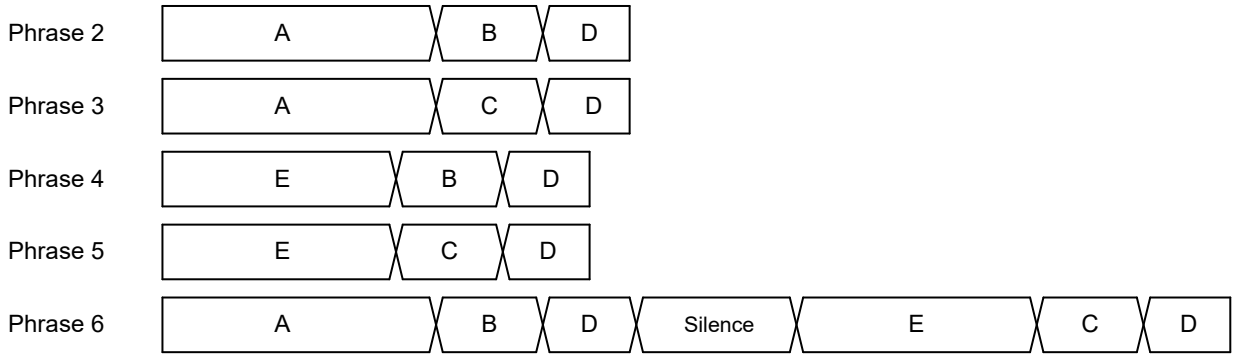
The edit ROM function makes it possible to play back multiple phrases in succession. The following functions are set using the edit ROM function:

- Continuous playback: There is no limit to set the number of times of the continuous playback. It depends on the memory capacity only.
- Silence insertion function: 20ms to 1,024 ms (4ms unit)

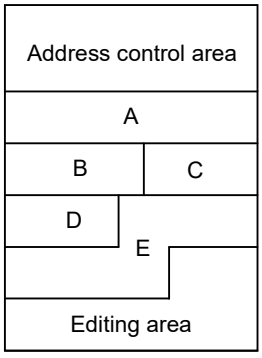
Note: Silent insertion time varies for ±1ms by the sampling frequency

It is possible to use voice ROM effectively to use the edit ROM function.
Below is an example of the ROM structure, case of using the edit ROM function.

Example 1) Phrases using the Edit ROM Function



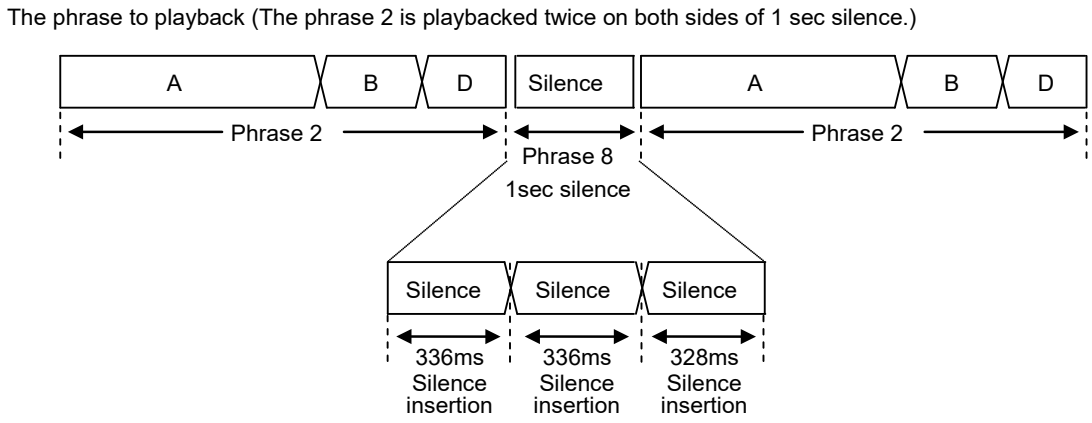
Example 2) Structure of the ROM that contents of Example 1 are stored



Notice of silence insertion function

If it is only silence phrase registered, please put in order three or more silence phrase.
The phrase which is constituted from one or two of silence phrase does not playback.

Example 3) Phrase composition in the case of using silence insertion function



The ROM consumption when using the edit ROM function

When playing more than one phrases continuously, the ROM consumption is used 64 bits per 1 phrase.
The silence insertion function is used 16 bits every once.

TERMINATION OF THE V_{DDL} PIN

The V_{DDL} pin is the regulator output that is power supply pin for the internal logic circuits. Connect a capacitor between this pin and the ground in order to prevent noise generation and power fluctuation.
The recommended capacitance value is shown below. However, it is important to evaluate and decide using the own board. Also, start the next operation after each output voltage is stabilized.

Pin	Recommended capacitance value	Remarks
V_{DDL}	10 μF ±20%	The larger the connection capacitance, the longer the settling time.

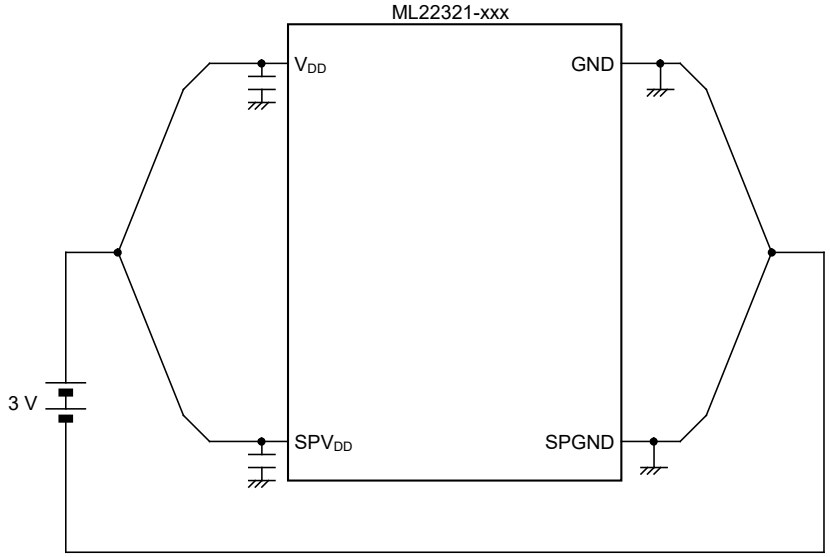
POWER SUPPLY WIRING

The power supply of this LSI is divided into the following sections:

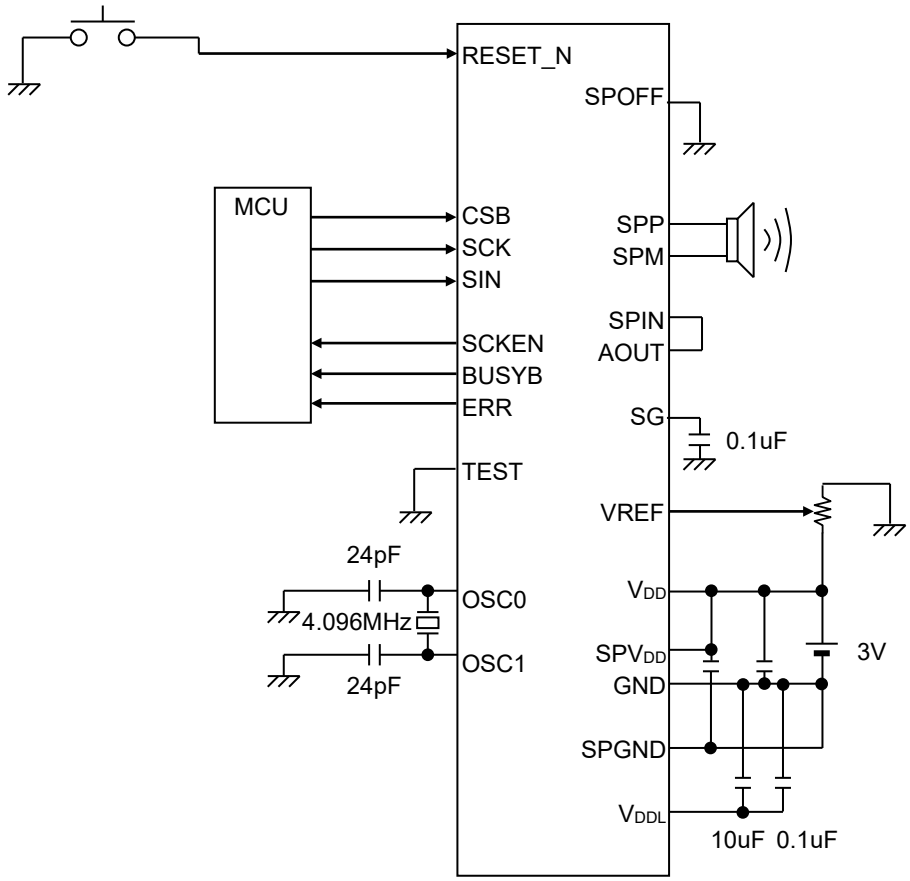
- Digital power supply (V_{DD})
- Analog power supply (SPV_{DD})

As shown below, supply the same power supply to V_{DD} and SPV_{DD} and separate the analog and digital power supplies by wiring.

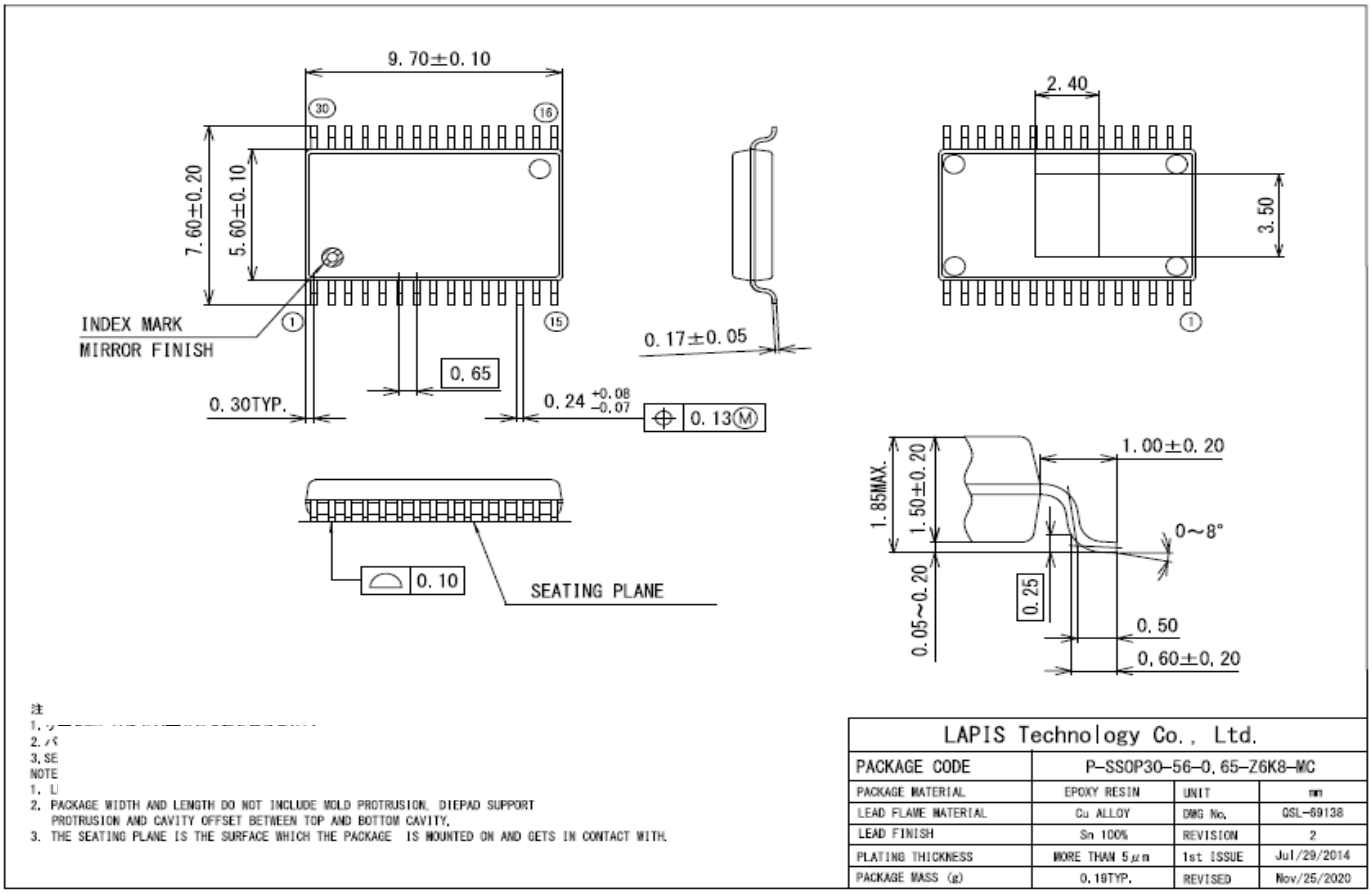
Power supply voltage = 3 V



APPLICATION CIRCUIT



PACKAGE DIMENSIONS



LAPIS Technology Co., Ltd.			
PACKAGE CODE	P-SSOP30-56-0.65-Z6K8-MC		
PACKAGE MATERIAL	EPOXY RESIN	UNIT	mm
LEAD FLAME MATERIAL	Cu ALLOY	DWG No.	QSL-69138
LEAD FINISH	Sn 100%	REVISION	2
PLATING THICKNESS	MORE THAN 5μm	1st ISSUE	Jul/29/2014
PACKAGE MASS (g)	0.19TYP.	REVISED	Nov/25/2020

Notes for Mounting the Surface Mount Type Package

The surface mount type packages are very susceptible to heat in reflow mounting and humidity absorbed in storage. Therefore, before you perform reflow mounting, contact ROHM's responsible sales person for the product name, package name, pin number, package code and desired mounting conditions (reflow method, temperature and times).

The heat resistance (example) of this LSI is shown below. Heat resistance (θ Ja) changes with the size and the number of layers of a substrate.

Die pad on the back of a package partial ground contact area	100%
PCB	JEDEC (W/L/t=76.2/114.5/1.6(mm))
PCB Layer	4L
Air cooling conditions	Calm(0m/sec)
Heat resistance(θJa)	45[℃/W]
Power consumption of Chip PMax at OutputPower 1W (5V)	0.818[W]
Power consumption of Chip PMax at OutputPower 0.5W (3.3V)	0.283[W]

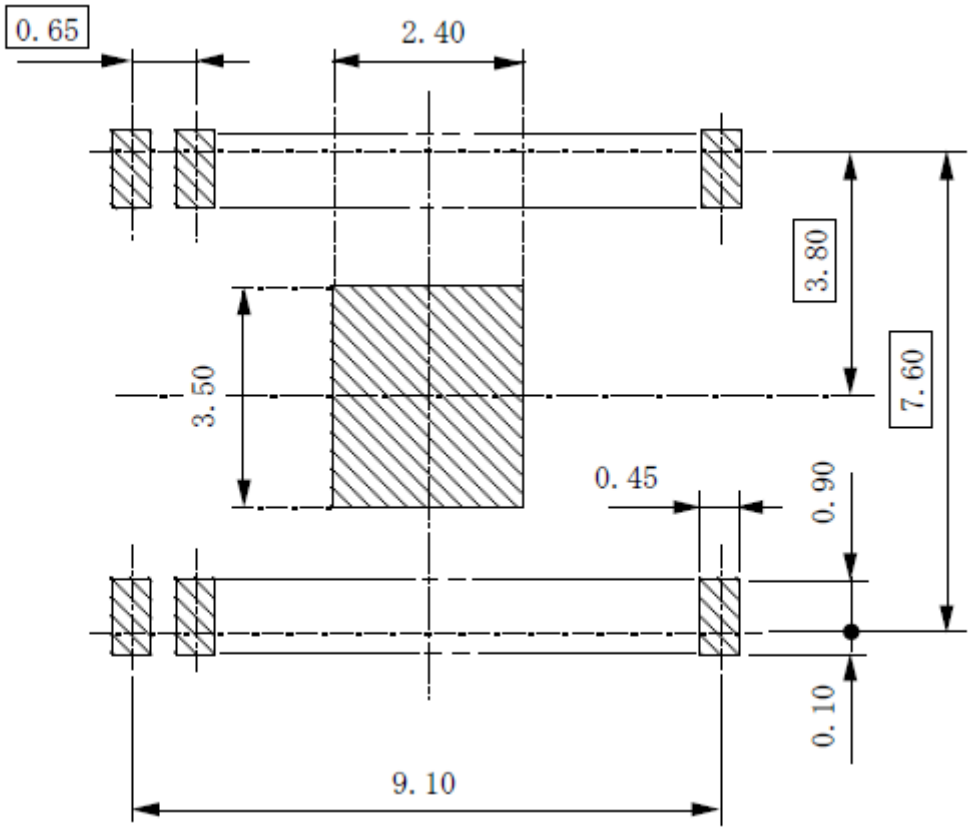
TjMax of this LSI is 125℃. TjMax is expressed with the following formulas.

TjMax = TaMax + θJa × PMax

Mounting area for package lead soldering to PCB (reference data) is shown below.

Die pad on the back of a package should connect with the substrate of opening or a GND for heat dissipation.

Mounting area for package lead soldering to PC boards



[unit:mm]

When laying out PC boards, it is important to design the foot pattern so as to give consideration to ease of mounting, bonding, positioning of parts, reliability, writing, and elimination of solder bridges.

The optimum design for the foot pattern varies with the materials of the substrate, the sort and thickness of used soldering paste,and the way of soldering. Therefore when laying out the foot pattern on the PC boards, refer to this figure which mean themounting area that the package leads are allowable for soldering to PC boards.

REVISION HISTORY

Document No.	Date	Page		Description
		Previous Edition	Current Edition	
FEDL22321-01	Mar. 23,2015	–	–	Final edition 1
FEDL22321-02	May. 27,2020	8	8	Add “H” level time of CSB
		9	9	Add BUSYB, ERR, SCKEN signal to Power On timing diagrams
		10-15	10-15	Add t_{CSBH}
		16	16	Add condition of CSB to Serial interface input flow chart
		32	32	Change of the package.
FEDL22321-03	Jun. 29,2022	–	–	Change of company name.
		32	32	Modified package dimensions from QSL-68294 to QSL-69138.

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