
ML2502 DATA SHEET
RECORD/PLAYBACK LSI with
128Kbit Analog Cell Storage Flash Memory**Preliminary****Revision 8.0 Apr. 01, 1999**

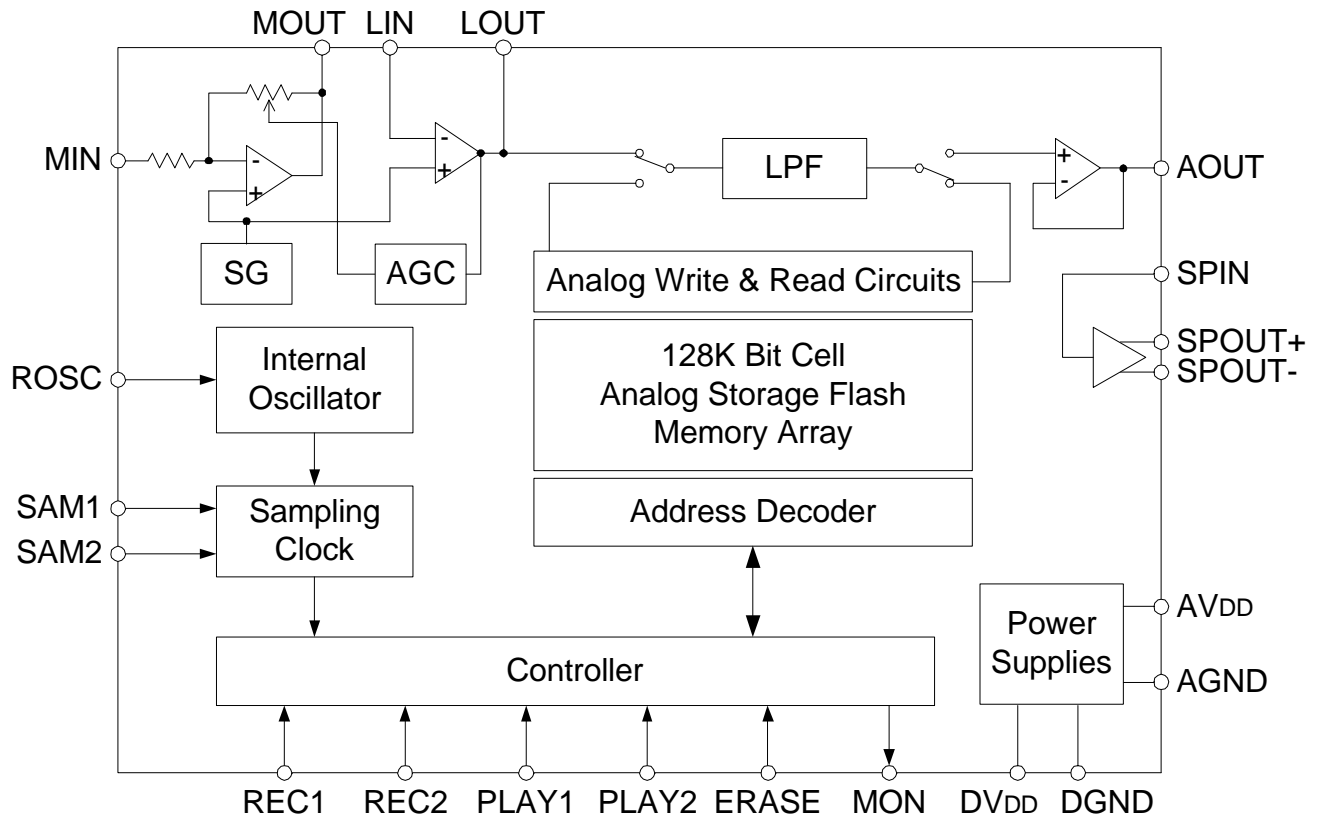
■ GENERAL DESCRIPTION

ML2502 is a record/playback LSI that stores analog signal directly into on-chip Flash memory (128Kbit Cell) without digital conversion utilizing new Analog Storage technology. Such unique features as low voltage operability (2.7 ~ 3.3V), no backup requirement and no external MCU requirement makes the ML2502 an ideal choice for handy Voice Memo, Message Card, toys and other consumer applications.

■ FEATURES

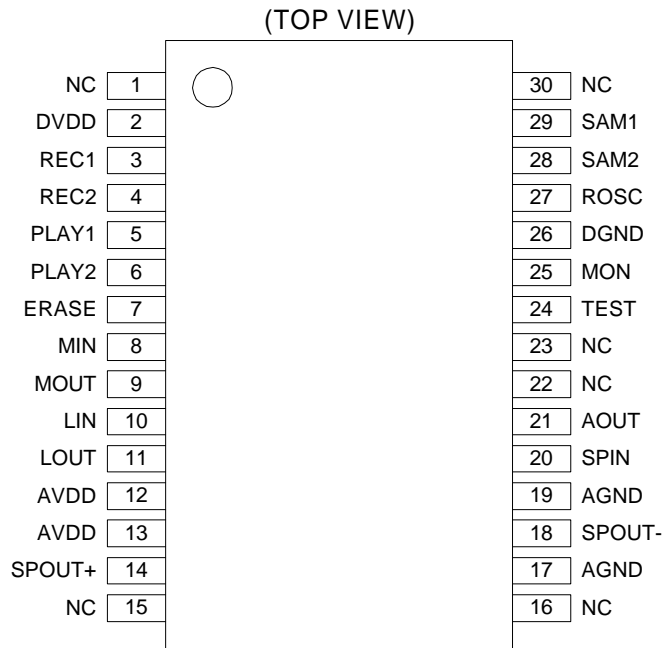
- On-chip 128Kbit Cell Analog Storage Flash Memory
 - Program/Erase Cycles 10K cycles
 - Data Retention Period 10 years
- Record/Playback Control via Switch Input
- Phrasing Mode Single-phrase or Dual-phrase
- Record/Playback Time Length (At 6.4 kHz sampling frequency)
 - In Dual-phrase Mode Max. ap. 10 sec each (Entire memory area divided into 2)
 - In Single-phrase Mode Max. ap. 20sec (Using the whole memory area by wiring REC1 and REC2 pins, PLAY1 and PLAY2 pins together)
- Sampling Frequencies
 - Selectable from 4.0 kHz, 5.3 kHz, 6.4 kHz
- Built-in Mic. Amplifier with AGC (Auto Gain Control)
- Built-in LPF (Low Pass Filter)
- Built-in Speaker Driver
 - Allows to use either Piezo or Dynamic speaker by externally setting up an amplitude ratio.
- On-chip Oscillation Circuit (No requirement for an external oscillator)
- Operating Voltage 2.7V ~ 3.3V
- Operating Temperature -10°C ~ +70°C
- Packaging 30-pin SSOP, Die Form

■ **BLOCK DIAGRAM**



■ **PIN LAYOUT**

PKG Code: SSOP30-P-56-0.65



■ PIN DESCRIPTION

PIN	I/O	Description															
REC1	I	Input start-recording signal for Phrase 1 to this pin. "H" level input to this pin initiates recording to Phrase 1 memory area. Recording goes on while this pin being held "H". In single-phrase mode, the pin is connected to the REC2 pin. The REC1 pin is internally pulled down.															
REC2	I	Input start-recording signal for Phrase 2 to this pin. "H" level input to this pin initiates recording to Phrase 2 memory area. Recording goes on while this pin being held "H". In single phrase mode, the pin is connected to the REC1 pin. The REC2 pin is internally pulled down.															
PLAY1	I	Input start-playback signal for Phrase 1 to this pin. A "H" pulse input to this pin initiates playback of Phrase 1. Re-inputting a "H" pulse during playback causes to stop playback. In single phrase mode, the pin is connected to the PLAY2 pin. The pin is internally pulled down.															
PLAY2	I	Input start-playback signal for Phrase 2 to this pin. A "H" pulse input to this pin initiates playback of Phrase 2. Re-inputting a "H" pulse during playback causes to stop playback. In single phrase mode, the pin is connected to the PLAY1 pin. The pin is internally pulled down.															
ERASE	I	Erase-enable signal input pin, used together with the REC1 and/or REC2. Input "H" level to the REC1/REC2 pin with this pin being held "H" to erase respective phrase. The pin is internally pulled down.															
SAM1 SAM2	I	Pins used to select a sampling frequency. <table border="1" data-bbox="565 1003 1318 1121"> <tbody> <tr> <td>SAM1</td> <td>L</td> <td>L</td> <td>H</td> <td>H</td> </tr> <tr> <td>SAM1</td> <td>L</td> <td>H</td> <td>L</td> <td>H</td> </tr> <tr> <td>Fs</td> <td>4.0kHz</td> <td>5.3kHz</td> <td>6.4kHz</td> <td>Unused</td> </tr> </tbody> </table>	SAM1	L	L	H	H	SAM1	L	H	L	H	Fs	4.0kHz	5.3kHz	6.4kHz	Unused
SAM1	L	L	H	H													
SAM1	L	H	L	H													
Fs	4.0kHz	5.3kHz	6.4kHz	Unused													
MON	O	Output "H" level during record or playback operation.															
ROSC	I	Insert a 30kΩ resistor between this pin and the DGND pin. The resistor determines the oscillation frequency for the internal oscillation circuit.															
MIN	I	Input to the Microphone amplifier.															
MOUT	O	Output from the Microphone amplifier. Voltage amplitude is automatically controlled to an appropriate output level by the internal AGC circuit.															
LIN	I	Input to the Line amplifier. Connected to inverted input for the internal Op. amplifier.															
LOUT	O	Output from the Line amplifier. Connected to the output pin from the internal Op. amplifier. Connecting resistors to the LIN and LOUT pins configures an inverted amplifier.															
AOUT	O	Output analog signal for playback.															
SPIN	I	Input to the speaker driver. The resistor's value inserted between the AOUT and SPIN pin determines voltage amplitude of the speaker driver. Select an appropriate value depending on types of speaker in use.															
SPOUT+ SPOUT-	O	Output from the speaker driver. Connect a speaker in-between these pins. Output two phase-inverted analog signals for playback from the speaker driver.															
DVDD	–	Digital power supply pin. Insert a 0.1μF or larger bypass capacitor between this pin and the DGND pin.															
DGND	–	Digital ground pin.															
AVDD	–	Analog power supply pin. Insert a 0.1μF or larger bypass capacitor between this pin and the AGND pin.															
AGND	–	Analog ground pin.															

■ Record/Playback Operation

ML2502 has two record/playback modes, Dual-phrase record/playback mode and Single-phrase record/playback mode. While in Dual-phrase record/playback mode the total memory space is divided evenly into two areas for 2-phrase record/playback, the entire memory space is used for one phrase record/playback in Single-phrase record/playback mode.

In Dual-phrase record/playback mode the first half of the memory, i.e. from the top address up to the center address, is assigned to Phrase 1, and the second half, i.e. from the center address to the last address, is assigned to Phrase 2. Record/playback of Phrase 1 can be controlled via the REC1 and PLAY1 pins, while Phrase 2 can be controlled via the REC2 and PLAY2 pins respectively.

In Single-phrase mode record/playback must be performed with the REC1 being connected to the REC2 pin and the PLAY1 being connected to the PLAY2 pin respectively.

In both playback modes repetitive playback function for the same phrase is available.

1. Dual-Phrase Record/Playback Mode

1.1 Phrase 1 Recording Operation

- (1) Keep on inputting “H” level to the REC1 pin to power up and start recording from the top address of the memory. Recording goes on while the REC1 pin being held “H” level.
- (2) The LSI automatically ends recording when the center address has been reached.
- (3) The LSI automatically shifts to low-power consumption mode after recording ends.
- (4) To stop recording for phrase 1 before reaching the center address, bring the REC1 pin down to “L” level. The LSI automatically shifts to low-power consumption mode after recording stops.
- (5) During recording operation any signal input to other pins than the REC1 is disregarded.

Note: Re-recording always causes to overwrite the existing recording data for a given phrase.

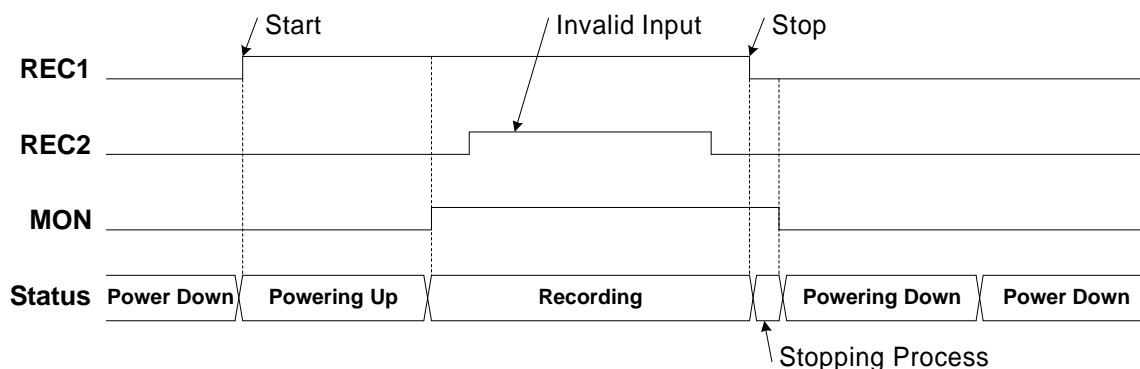


Figure 1.1 Timing Chart for Phrase 1 Recording Operation

1.2 Phrase 1 Playback Operation

- (1) Input a “H” pulse to the PLAY1 pin to power up and start playback from the top address of the memory.
- (2) The LSI automatically ends playback when the last address of the recorded phrase has been reached.
- (3) The LSI automatically shifts to low-power consumption mode after playback ends.
- (4) To stop playback of phrase 1 before reaching the last address, input a “H” pulse again to the PLAY1 or PLAY2 pin. This will cause the LSI to stop playback and then automatically shift to low-power consumption mode.
- (5) During playback operation signal input to the PLAY1 or PLAY2 pin only is valid, any other signal input is disregarded

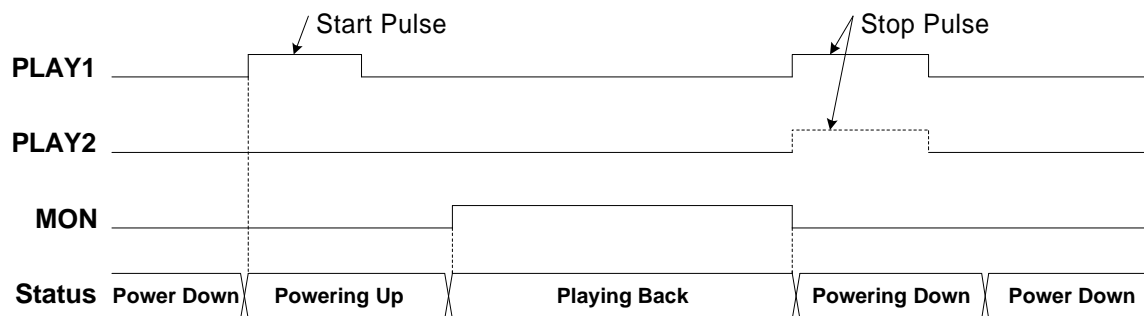


Figure 1.2 Timing Chart for Phrase 1 Playback Operation

1.3 Phrase 1 Erasing Operation

- (1) While inputting “H” level to the ERASE pin, input a “H” pulse to the REC1 pin to start erasing Phrase 1.
- (2) After Phrase 1 having been erased, the LSI automatically shifts to power-down mode for low-power consumption.

Note: Erasing operation cannot be abandoned in the middle once getting started.

Internally, the LSI performs erasing Phrase 1 by recording “Silence” from the top address to address 250. Therefore, if you attempt to playback the erased phrase, the playback starts at the top address of the memory and ends at address 250.

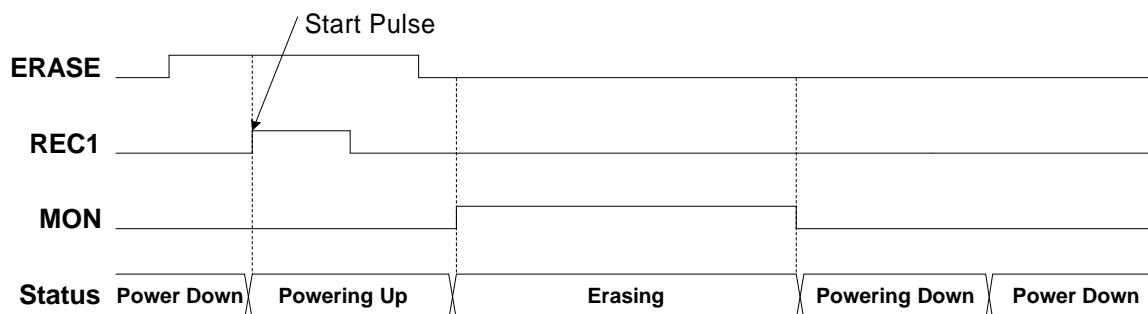


Figure 1.3 Timing Chart for Phrase 1 Erasing Operation

1.4 Phrase 2 Recording Operation

- (1) Keep on inputting "H" level to the REC2 pin to power up and start recording from the top address of the memory. Recording goes on while the REC2 pin being held "H" level.
- (2) The LSI automatically ends recording when the last address of the memory has been reached.
- (3) The LSI automatically shifts to low-power consumption mode after recording ends.
- (4) To stop recording for Phrase 2 before reaching the last address, bring the REC2 pin down to "L" level. The LSI automatically shifts to low-power consumption mode after recording stops.
- (5) During recording operation any signal input to other pins than the REC2 is disregarded.

Note: Re-recording always causes to overwrite the existing recording data for a given phrase.

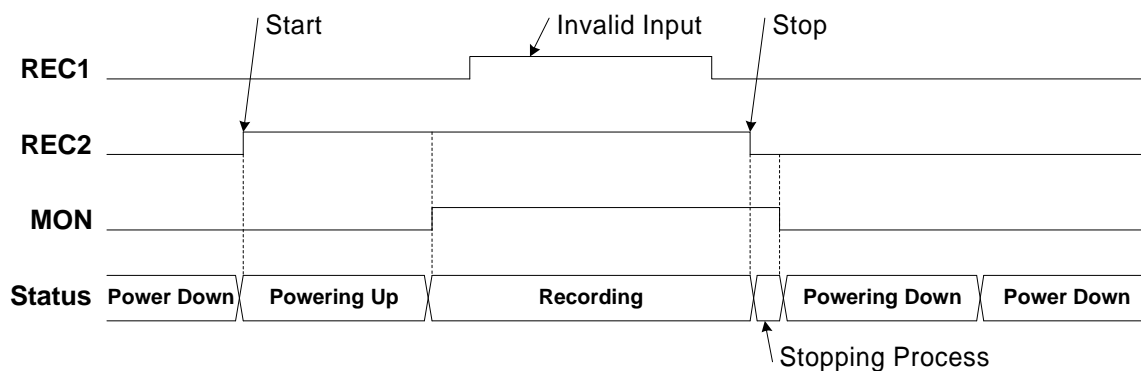


Figure 1.4 Timing Chart for Phrase 2 Recording Operation

1.5 Phrase 2 Playback Operation

- (1) Input a "H" pulse to the PLAY2 pin to power up and start playback from the center address of the memory.
- (2) The LSI automatically ends playback when the last address of the recorded phrase has been reached.
- (3) The LSI automatically shifts to low-power consumption mode after playback ends.
- (4) To stop playback of Phrase 2 before reaching its last address, input a "H" pulse again to the PLAY1 or PLAY2 pin. This will cause the LSI to stop playback and then automatically shift to low-power consumption mode.
- (5) During playback operation signal input to the PLAY1 or PLAY2 pin only is valid, any other signal input is disregarded

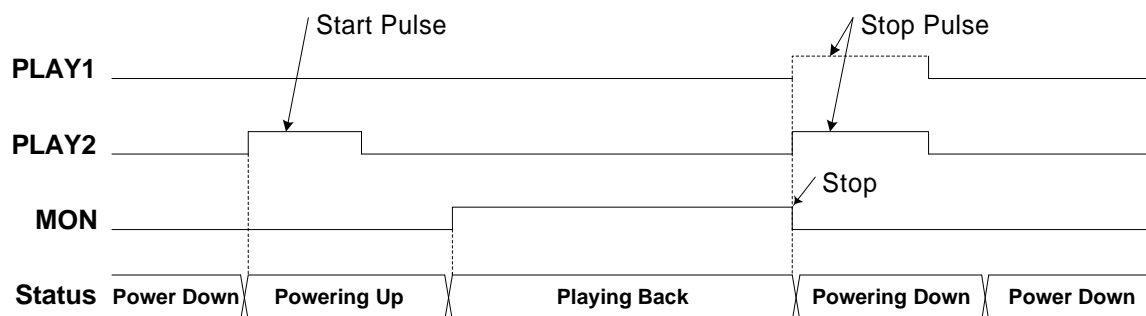


Figure 1.5 Timing Chart for Phrase 2 Playback Operation

1.6 Phrase 2 Erasing Operation

- (1) While inputting "H" level to the ERASE pin, input a "H" pulse to the REC2 pin to start erasing Phrase 2.
- (2) After Phrase 2 having been erased, the LSI automatically shifts to power-down mode for low-power consumption.

Note: Erasing operation cannot be abandoned in the middle once getting started.

Internally, the LSI performs erasing Phrase 2 by recording "Silence" from the center address as far as to address 250. Therefore, if you attempt to playback the erased phrase, the playback starts at the center address of the memory and ends at address 250.

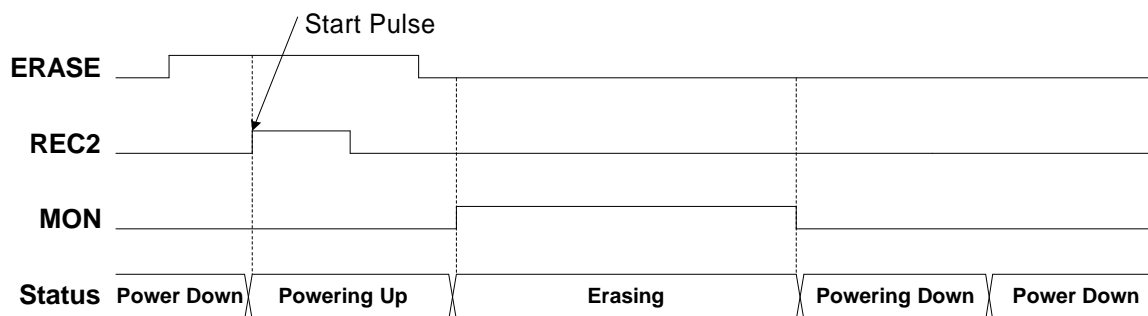


Figure 1.6 Timing Chart for Phrase 2 Erasing Operation

2. Single-phrase Record/Playback Mode

2.1 Recording Operation

- (1) In this mode the REC1 has to be connected with the REC2 pin.
Keep on inputting "H" level to the REC1 and the REC2 pin to power up and start recording from the top address of the memory. Recording goes on while the REC1 and the REC2 pin being held at "H" level.
- (2) The LSI automatically ends recording when the last address of the memory has been reached.
- (3) The LSI automatically shifts to low-power consumption mode after recording ends.
- (4) To stop recording before reaching the last address, bring the REC1 and the REC2 pin down to "L" level. The LSI automatically shifts to low-power consumption mode after recording stops.
- (5) During recording operation any signal input to other pins than the REC1 and the REC2 is disregarded.

Note: Re-recording always causes to overwrite the existing recording data for a given phrase.

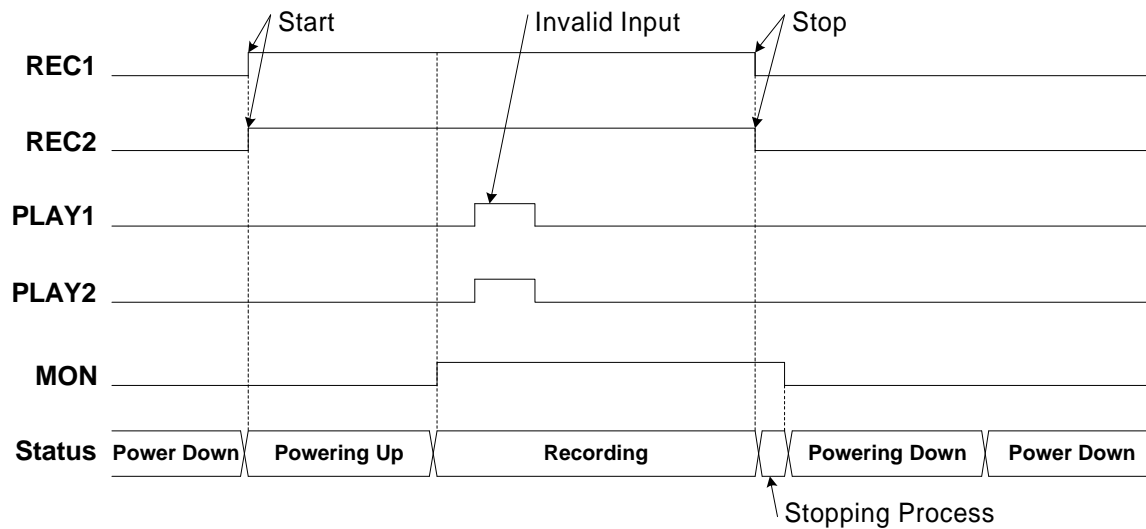


Figure 2.1 Timing Chart for Single-phrase Recording Operation

2.2 Playing Back Operation

- (1) Input "H" pulses to the PLAY1 and the PLAY2 pins simultaneously to power up and start playback from the top address of the memory.
- (2) The LSI automatically ends playback when the last address of the recorded phrase has been reached.
- (3) The LSI automatically shifts to low-power consumption mode after playback ends.
- (4) To stop playback of the phrase before reaching its last address, input "H" pulses again to the PLAY1 and the PLAY2 pins simultaneously. This will cause the LSI to stop playback and then automatically shift to low-power consumption mode.
- (5) During playback operation signal input to the PLAY1 or PLAY2 pin only is valid, any other signal input is disregarded.

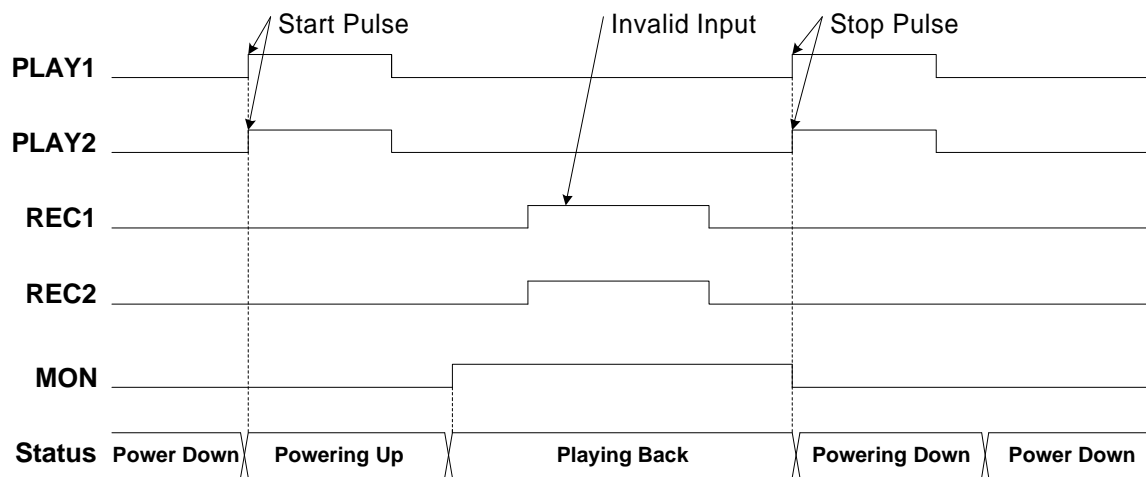


Figure 2.2 Timing Chart for Single-phrase Playback Operation

2.3 Erasing the Phrase 2

- (1) While inputting "H" level to the ERASE pin, input "H" pulses to the REC1 and REC2 pins simultaneously to start erasing the phrase.
- (2) After the phrase having been erased, the LSI automatically shifts to power-down mode for low-power consumption.

Note: Erasing operation cannot be abandoned in the middle once getting started.

Internally, the LSI performs erasing by recording "Silence" from the top address as far as to address 250. Therefore, if you attempt to playback the erased phrase, the playback starts at the top address of the memory and ends at address 250.

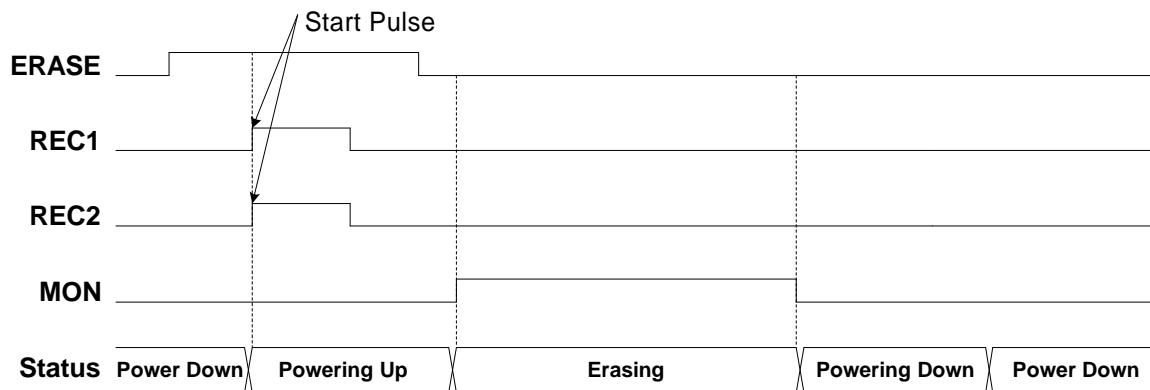


Figure 2.3 Timing Chart for Single-phrase Erasing Operation

3. Repeating Playback Operation

- (1) To repeat playback of the same phrase, keep on inputting “H” level to the PLAY1 or PLAY2 pin. “H” level input to the PLAY1 or PLAY2 causes the LSI to power up and start playback.
- (2) The LSI automatically restarts playback when the last address of the phrase has been reached.
- (3) When the playback reaches to the last address of the phrase, with the PLAY1 or PLAY2 pin being held “L” level, the LSI automatically ends playback.
- (4) The LSI automatically powers down after playback ends.
- (5) To stop playback before repetitive playback session ends, bring the PLAY1 or PLAY2 pin down to “L” level once, and then re-input a “H” pulse to the PLAY1 or PLAY2 pin. The LSI automatically shifts to low-power consumption mode after playback stops.

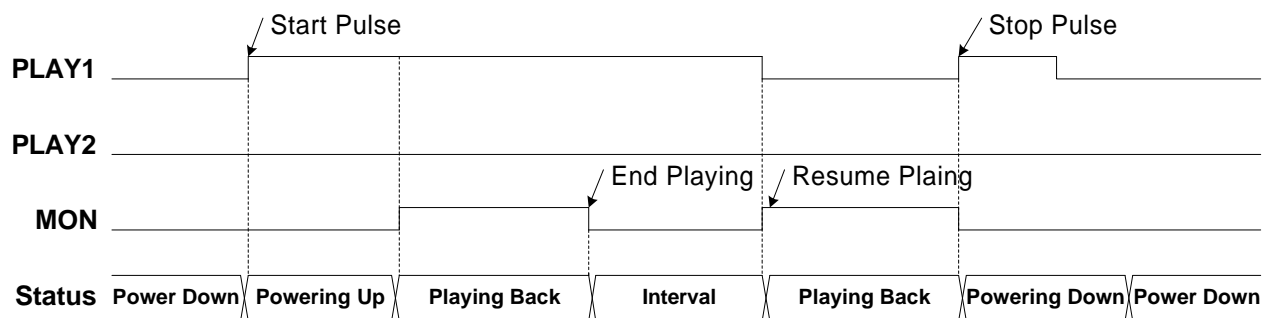


Figure 3.1 Timing Chart for Repetitive Playback Operation

■ ABSOLUTE MAXIMUM RATINGS

Parameter	Symbol	Conditions	Rating	Unit
Power Supply Voltage	VDD	Ta = 25°C	-0.3 ~ +6.0	V
Input Voltage	VIN		-0.3 ~ VDD + 0.3	V
Storage Temperature	TSTG	—	-55 ~ +150	°C

■ RECOMMENDED OPERATING RANGES

Parameter	Symbol	Conditions	Range	Unit
Power Supply Voltage	VDD	DGND=AGND=0V	2.7 ~ 3.3	V
Operating Temperature	TOP	—	-10 ~ +70	°C

■ ELECTRICAL CHARACTERISTICS

● DC Characteristics

DVDD=AVDD=2.7V ~ 3.3V, DGND=AGND=0V, Ta= -10 ~ +70°C

Parameter	Symbol	Conditions	Min.	Typ.	Max.	Unit
"H" Input Voltage	VIH	DGND=AGND=0V	0.8 X VDD	—	—	V
"L" Input Voltage	VIL	—	—	—	0.2 X VDD	V
"H" Output Voltage	VOH	IOH=40μA	VDD - 0.3	—	—	V
"L" Output Voltage	VOL	IOL=2mA	—	—	0.45	V
"H" Input Current *1	I _{IH1}	VIH=VDD	—	—	10	μA
"L" Input Current *1	I _{IL1}	VIL=0V	-10	—	—	μA
"H" Input Current *2	I _{IH2}	VIH=3.0V	10	—	100	μA
"L" Input Current *2	I _{IL2}	VIL=0V	-10	—	—	μA
Operating Current Consumption	IDD	SPOUT Output No Load	—	40	TBD	mA
Powerdown Current Consumption	IDDS1	Ta= -10 ~ +50°C	—	—	10	μA
	IDDS2	Ta= +50 ~ +70°C	—	—	100	μA

Note: 1. Applicable only to those input pins without a pull-down resistor.
 2. Applicable only to those input pins with a pull-down resistor. (REC1, REC2, PLAY1, PLAY2, ERASE pins)

- AC Characteristics

DVDD=AVDD=2.7V ~ 3.3V, DGND=AGND=0V, Ta= -10 ~ +70°C
At fsamp = 6.4 kHz

Parameter	Symbol	Min.	Typ.	Max.	Unit
Power-on Reset Time	tPOR	—	—	10	ms
Min. "H" Pulse Width for Record-Start Input	tWRECST	256	—	—	ms
Min. "L" Pulse Width for Record-Stop Input	tWRECSP	17	—	—	ms
Min. Pulse Width for Playback-Start Input	tWPLYST	17	—	—	ms
Min. Pulse Width for Playback-Stop Input	tWPLYSP	17	—	—	ms
Min. Pulse Width for Erase-Start Input to REC1, REC2	tWERSST	17	—	—	ms
Setup Time for Erase Input - REC1, REC2 Input	tWERS	0	—	—	μs
Hold Time for Erase Input - REC1, REC2 Input	tWERSH	0	—	—	μs
Powering Up Time 1 (at Erasing)	tWS1	15.4	15.6	15.8	ms
Powering Up Time 2	tWS12	252	256	279	ms
Max. Record/Playback Time Length (2-phrase mode) *1	tWRP2	9.5	10	10.5	s
Max. Record/Playback Time Length (1-phrase mode) *1	tWRP1	19	20	21	s
Erase Execution Time *1	tWE	52	54	56	ms
Max. Time for MON to Fall Down at Stop Recording*1	tWS3	14.8	15.6	16.5	ms
Powering Down Time	tWS4	14.8	15.6	16.5	ms

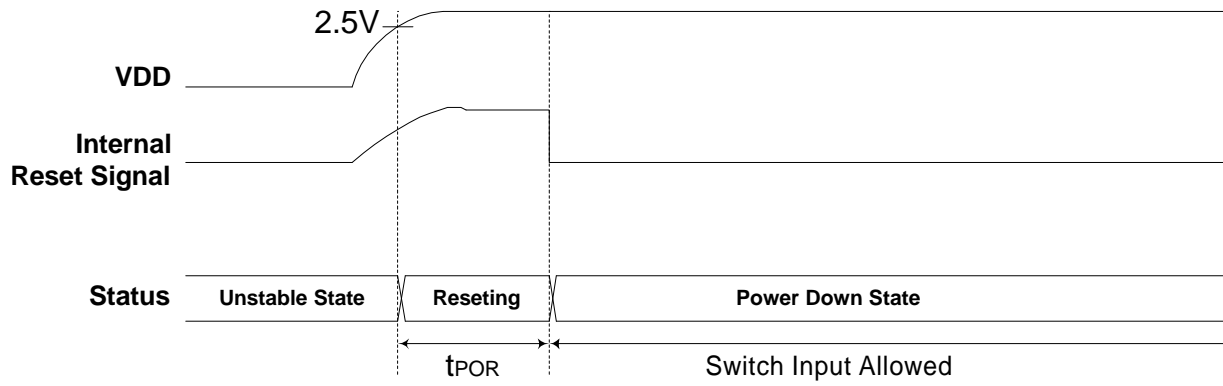
Note: *1. In proportion to sampling frequency.

- **Analog Circuit Characteristics**

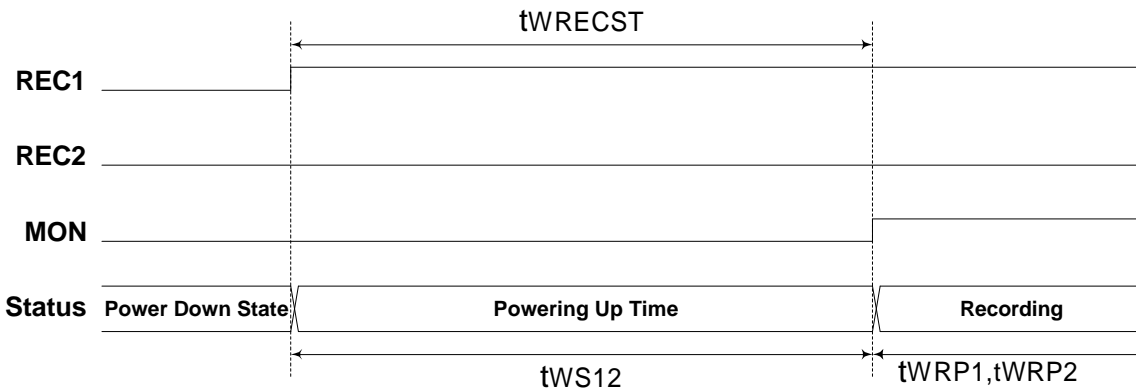
DVDD=AVDD=2.7V ~ 3.3V, DGND=AGND=0V, Ta= -10 ~ +70°C

Parameter	Symbol	Conditions	Min.	Typ.	Max.	Unit
MIN Input Resistance	RMIN	—	4.2	6	7.8	kΩ
Mic. Amp. Voltage Gain Control Range	GMIC	—	8	—	28	V/V
LIN Input Impedance	RIOP	—	1	—	—	MΩ
Line Amp. Open-loop Gain	GOLINE	f _{IN} = 0~4kHz	40	—	—	dB
Output Voltage from MOUT, LOUT, AOUT on Powering Up and Powering Down	VMOTP VLOTP VAOTP	tWS12 and tWS4	1.25	1.35	1.45	V
Output Voltage from SPOUT +/- on Powering Up and Powering Down	VSPOTP VSNOTP	tWS12 and tWS4	1/2 VDD -0.1	1/2 VDD	1/2 VDD +0.1	V
MOUT- LOUT Load Resistance	ROOP	—	200	—	—	kΩ
SPOUT+ / SPOUT- Amplifier Open-loop Gain	GOSP	f _{IN} = 0~4kHz	40	—	—	dB
SPOUT+/SPOUT- Voltage Gain	GSPC	—	0.95	1	1.05	V/V
SPIN Input Impedance	RISP	—	1	—	—	MΩ
SPOUT +/- Output "H" Voltage	VSPH	I _{OH} = 10mA	VDD-0.25	—	—	V
SPOUT +/- Output "L" Voltage	VSPL	I _{OL} = 10mA	—	—	0.25	V
SPOUT Output Offset Voltage	VOFF	No Signal Playback	—	—	±0.3	V
SPOUT Output Load Impedance	RSPC	—	16	—	—	Ω
SPOUT Load Current at Peak Output	ISPO	—	—	—	±125	mA

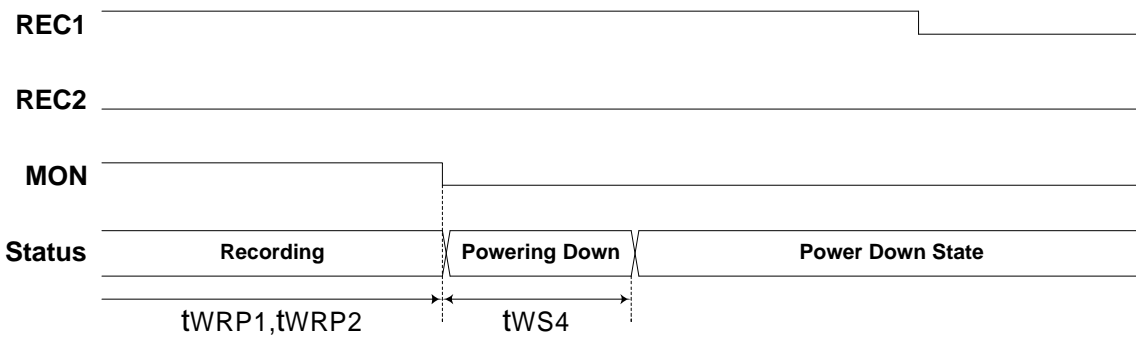
■ TIMING CHARTS
◆ Digital Circuit Section
● Powering Up



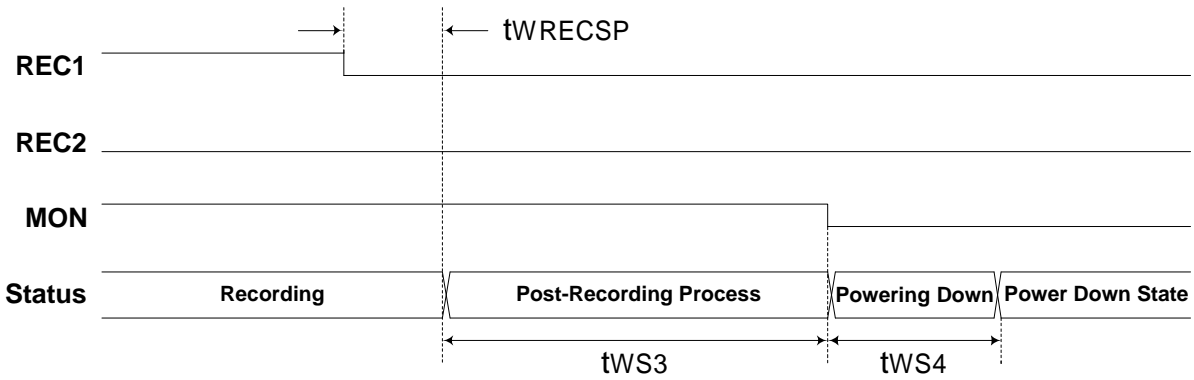
● Start Recording Phase 1



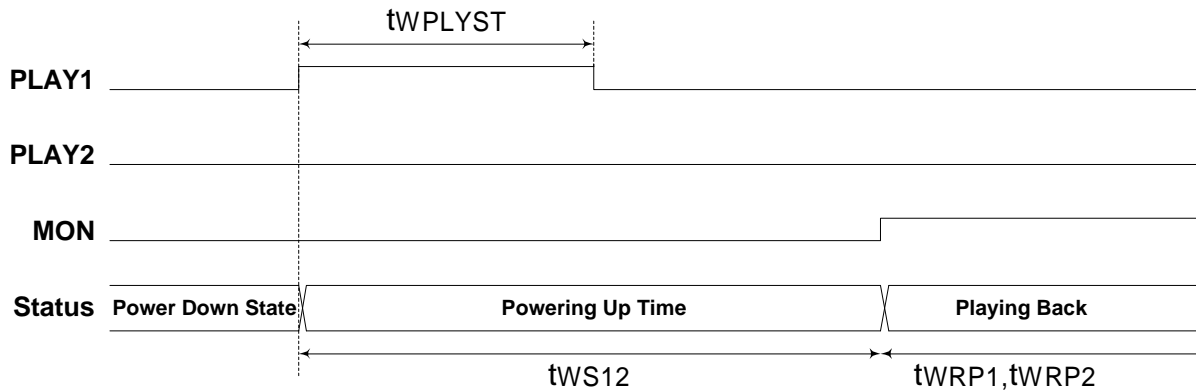
● End Recording Phase 1 (Recording reaches to the last address)



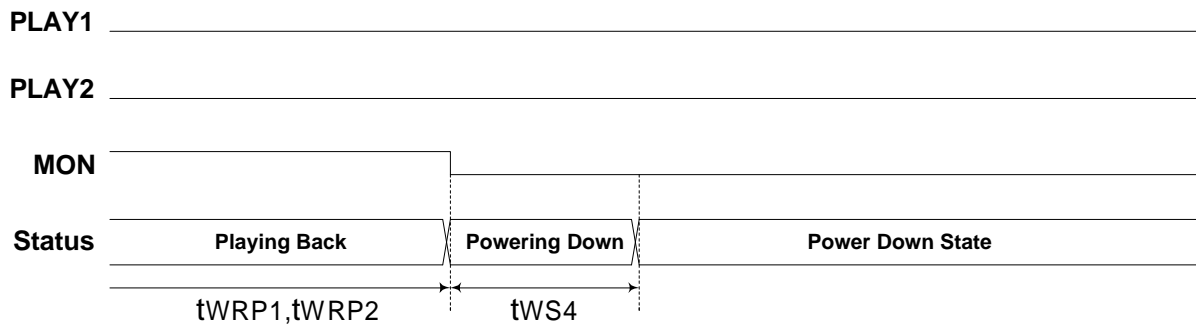
- **Stop Recording Phase 1 (Recording stopped before the last address)**



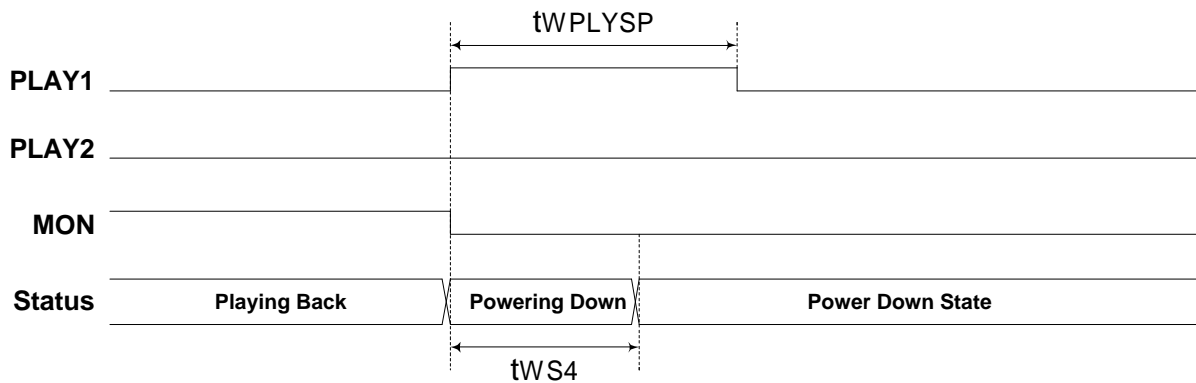
- **Start Playback Phase 1**



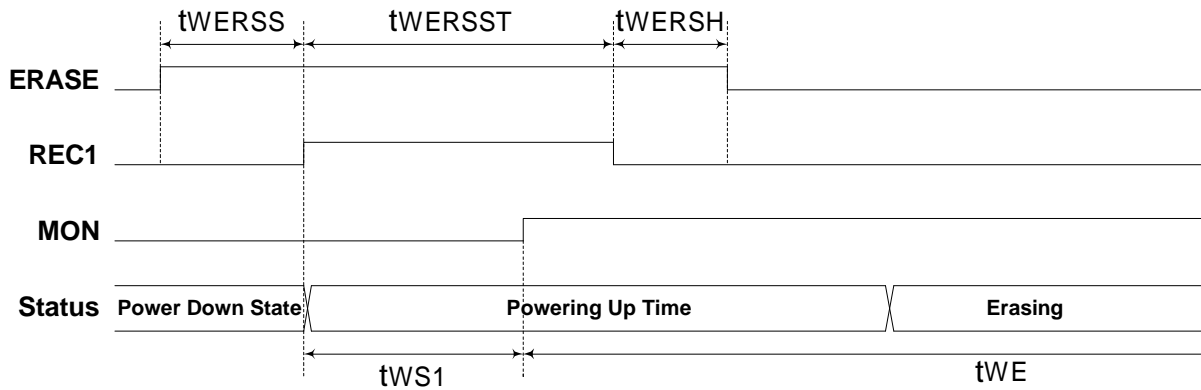
- **End Playback Phase 1 (Playback reaches to the last address)**



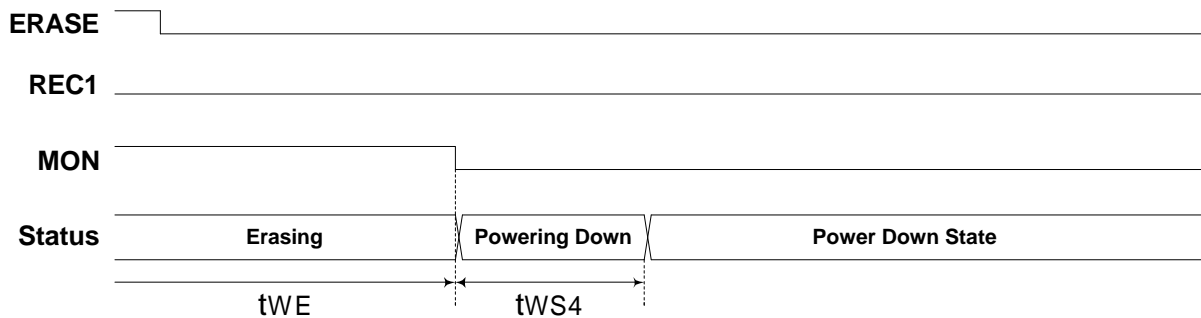
- **Stop Playback Phrase1 (Recording stopped before the last address)**



- **Start Erasing Phase 1**

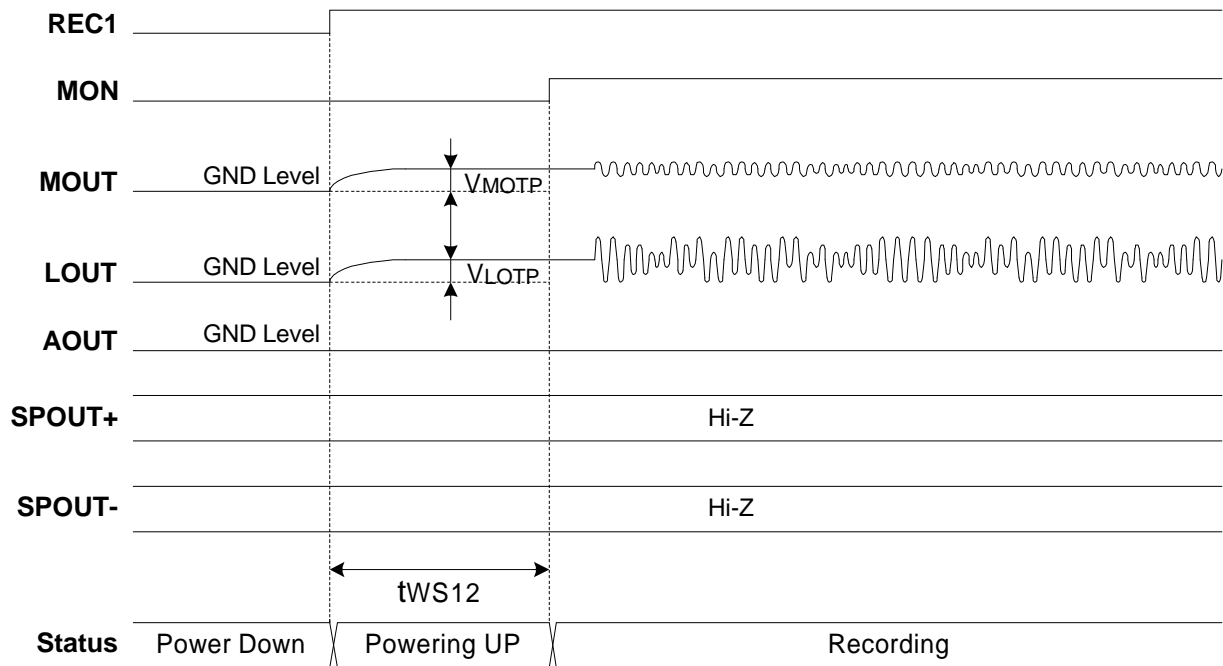


- **End Erasing Phase 1**

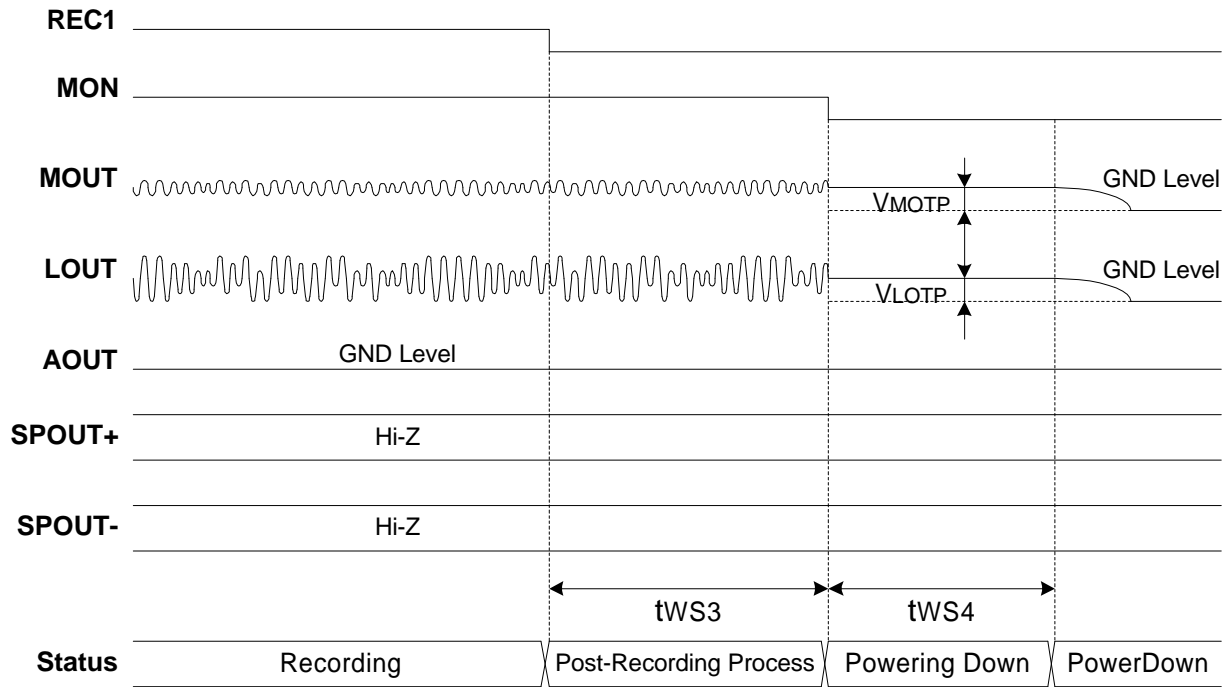


◆ Analog Circuit Section

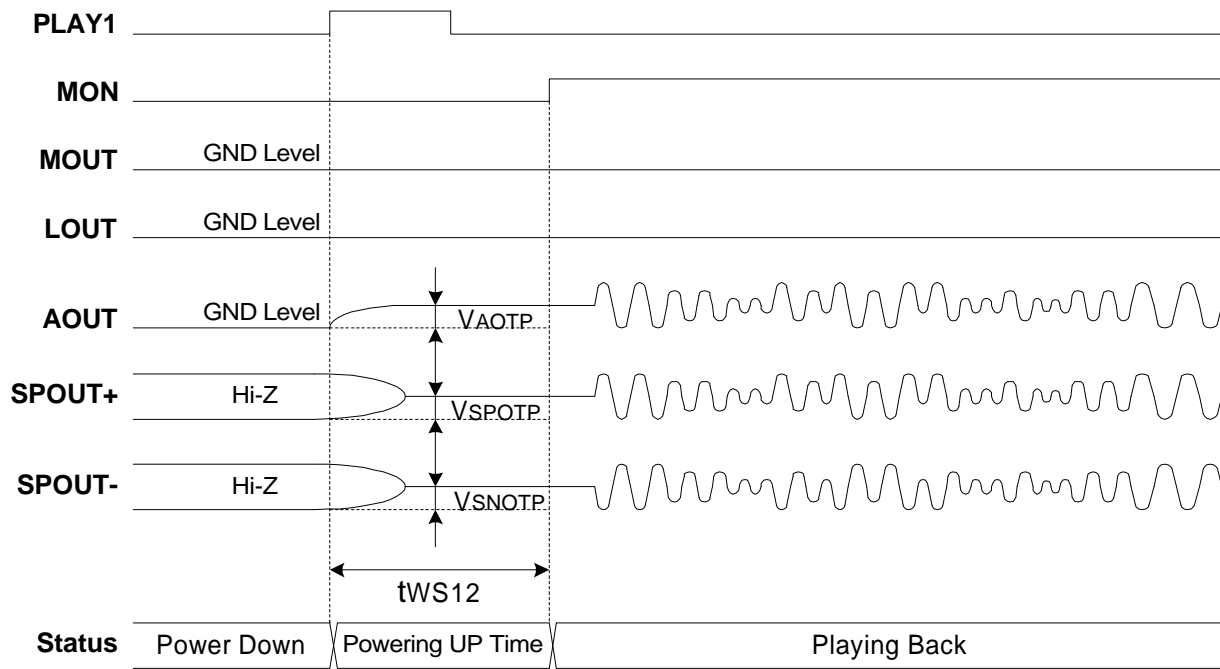
● Start Recording (Phrase 1)



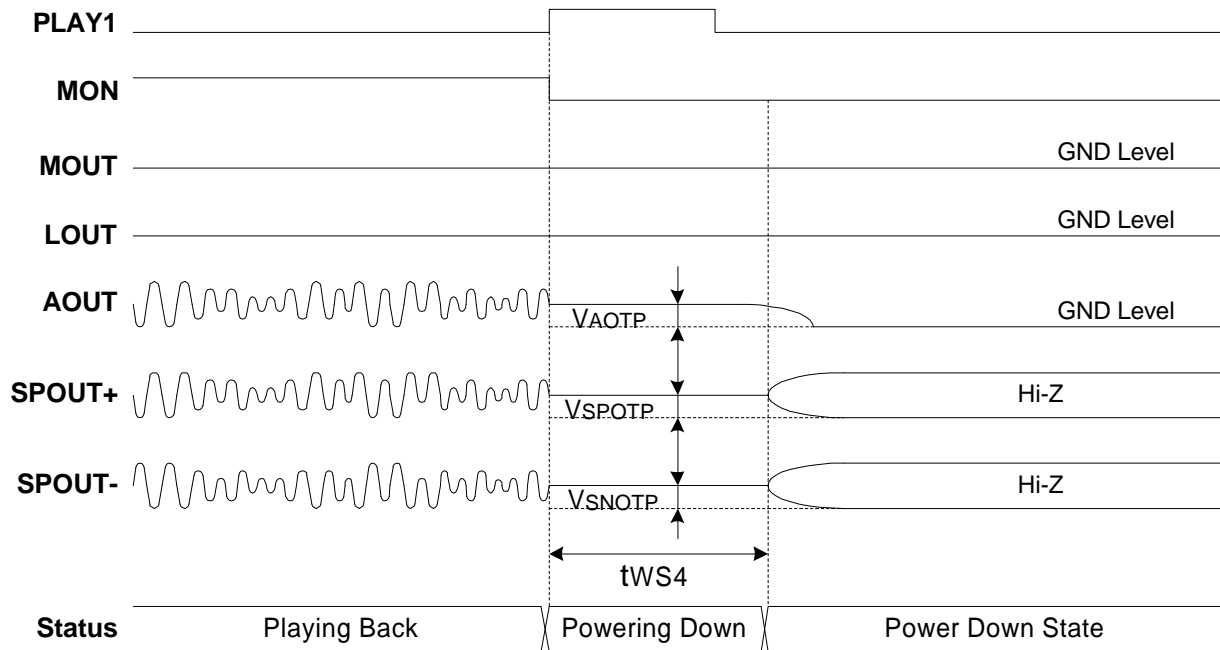
● Stop Recording (Phrase 1)



• **Start Playback (Phrase 1)**



• **Stop Playback (Phrase 1)**



■ Application Circuit Sample

Single-phrase Record/Playback, at 4 kHz sampling frequency and with a Dynamic Speaker.

