OKI Semiconductor

FEDL9888L-9889L-01
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MSM9888L/9889L

3V, Serial Voice Flash Memory-driving Recording and Playback IC

GENERAL DESCRIPTION

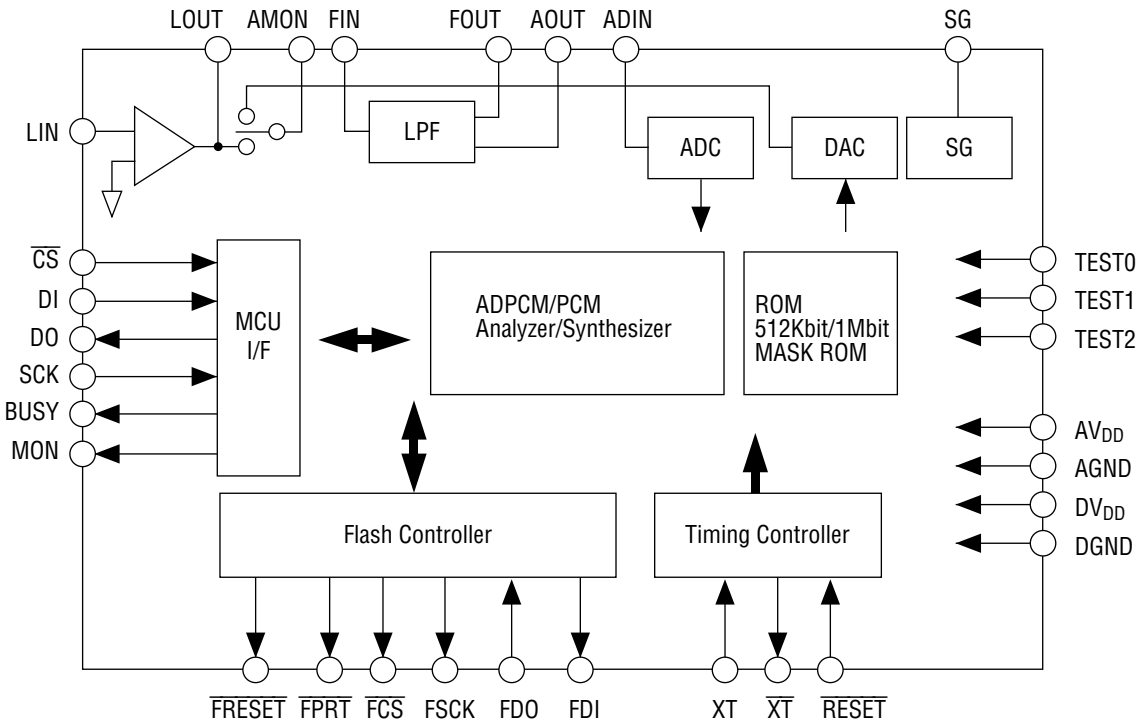
The MSM9888L/9889L are recording and playback ICs that are controlled by a microcontroller in serial mode, compress voice with the OKI ADPCM system with high tone quality, and directly store voice data in the serial voice flash momory. These ICs can operate in the range of 2.7 to 3.6 V and contain a mask ROM. Since the package is small and backup is not needed, these recording and playback ICs are suitable for voice systems such as handy terminals.

FEATURES

- Serial microcontroller interface
- Direct driving of serial voice flash memory
- 2-Mbit (MSM9892L), 4-Mbit (MSM9893L), 8-Mbit (MSM9894AL)
- Built-in mask ROM for fixed message
- Recording time (When the 2-Mbit serial voice flash memory is used)
  : Approximately 65 seconds (Fsam=8.0 kHz)
  : Approximately 81 seconds (Fsam=6.4 kHz)
  : Approximately 130 seconds (Fsam=4.0 kHz)
- Playback time for fixed message
  MSM9888L : Approximately 15 seconds (Fsam=8.0 kHz)
  (Built-in 512-Kbit mask ROM) : Approximately 20 seconds (Fsam=6.4 kHz)
  : Approximately 31 seconds (Fsam=4.0 kHz)
  MSM9889L : Approximately 30 seconds (Fsam=8.0 kHz)
  (Built-in 1-Mbit mask ROM) : Approximately 40 seconds (Fsam=6.4 kHz)
  : Approximately 62 seconds (Fsam=4.0 kHz)
- Any data can be written to and read from the serial voice flash memory.
- Voice analyzing and synthesizing system
  : 4-bit OKI ADPCM system, 8-bit OKI non-linear PCM system (for ROM playback only)
- Sampling frequency (for 4.096 MHz of master oscillation frequency)
  : 2.0 kHz, 2.7 kHz, 3.2kHz, 4.0 kHz, 5.3 kHz, 6.4 kHz, 8.0 kHz
- Built-in 12-bit A/D converter and 12-bit D/A converter
- Built-in LPF : Attenuation rate of –40 dB/oct
- Master oscillation frequency : 4 MHz to 6 MHz
- Supply voltage : 2.7 V to 3.6 V
- Operating temperature : –10°C to +70°C
- Operating current : Up to 15 mA (master oscillation frequency : 6 MHz, supply voltage : 3.6V)
- Number of phrases
  Variable message : 63 phrases
  Fixed message : 255 phrases
- General-purpose message
  Japanese : MSM988L-820
  English : MSM988L-819

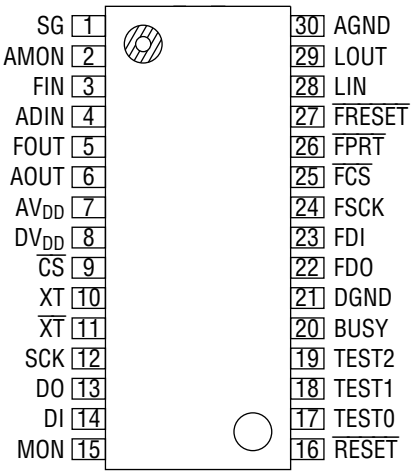
• Package :
MSM9888L : 30-pin plastic SSOP (SSOP30-P-56-0.65-K) (MSM9888L-xxxGS-AK)
MSM9889L : 32-pin plastic TSOP (TSOP(1)32-P-0814-0.50-1K) (MSM9889L-xxxTA)

BLOCK DIAGRAM



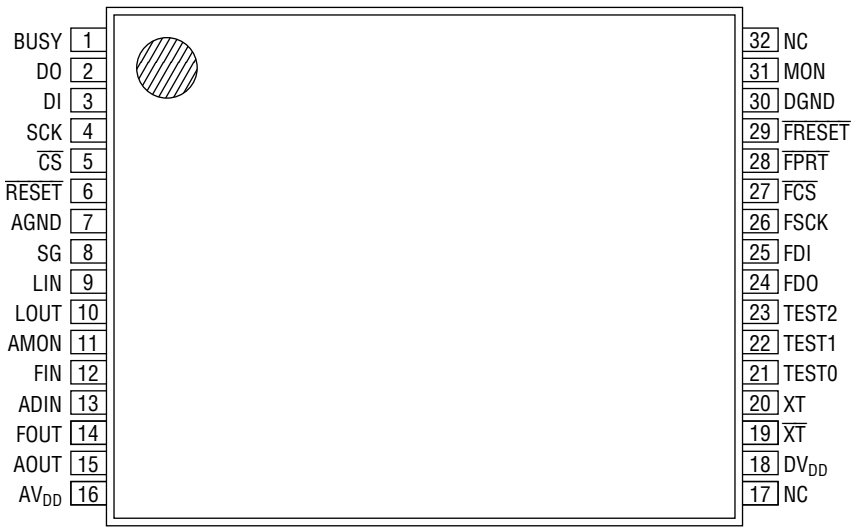
PIN CONFIGURATION (TOP VIEW)

MSM9888L (Built-in 512-Kbit Mask ROM)



30-Pin Plastic SSOP

MSM9889L (Built-in 1-Mbit Mask ROM)



NC : No connection

32-Pin Plastic TSOP

PIN DESCRIPTION

Pin		Symbol	Type	Description
M9888L	M9889L			
14	3	DI	I	Inputs the 8-bit command data.
13	2	DO	O	Outputs the 8-bit status data.
12	4	SCK	I	Inputs the data transfer clock for the DI and DO pins.
9	5	$\overline{CS}$	I	Accepts the SCK pulse, when $\overline{CS}$ is "L" level. Does not accept the SCK pulse when $\overline{CS}$ is "H" level.
20	1	BUSY	O	Outputs "H" level during command execution. When driven high, do not input a command from the external micro-controller.
15	31	MON	O	Outputs "H" level during recording or playback.
23	25	FDI	O	Connected to the DI pin of the serial voice flash memory.
22	24	FDO	I	Connected to the DO pin of the serial voice flash memory.
24	26	FSCK	O	Connected to the SCK pin of the serial voice flash memory.
25	27	$\overline{FCS}$	O	Connected to the $\overline{CS}$ pin of the serial voice flash memory.
26	28	$\overline{FPRT}$	O	Connected to the $\overline{PRT}$ pin of the serial voice flash memory.
27	29	$\overline{FRESET}$	O	Connected to the $\overline{RESET}$ pin of the serial voice flash memory.
10	20	XT	I	Oscillator connecting pins. When using an external clock, input the clock from the XT pin and keep the $\overline{XT}$ pin open. Set the XT pin to the GND level in power-down mode.
11	19	$\overline{XT}$	O	
16	6	$\overline{RESET}$	I	The LSI is reset and starts oscillation when "L" level is input, keep "L" level during oscillation stabilization time. Set to "H" level after oscillation stabilizes. "L" level should be input to this pin until power supply voltage is stabilized at 2.7V or more.
1	8	SG	O	Analog reference voltage (Signal Ground) output pin. Insert an electrolytic capacitor of 1μF between this pin and AGND pin.
28	9	LIN	I	Built-in OP amplifier's invention input pin. The non-invention input pin is internally connected to SG.
29	10	LOUT	O	Built-in OP amplifier's output pin
4	13	ADIN	I	Built-in 12-bit AD converter's input pin
2	11	AMON	O	Connected to the LOUT pin when recording mode, and to the DA converter's output pin when playback mode. Connected to the built-in LPF's input (FIN pin).
3	12	FIN	I	Built-in LPF's input pin
5	14	FOUT	O	Built-in LPF's output pin. Connected to the AD converter's input (ADIN pin).
6	15	AOUT	O	Built-in LPF's output pin. This is the output pin the played back waveform and connected to the speaker driving amplifier.
17-19	21-23	TEST0-2	I	LSI testing pins. Fix to "L".
8	18	DV_{DD}	—	Digital power supply pin. Insert a bypass capacitor of 0.1μF or higher between this pin and DGND pin.
21	30	DGND	—	Digital DGND pin
7	16	AV_{DD}	—	Analog power supply pin. Insert a bypass capacitor of 0.1μF or higher between this pin and AGND pin.
30	7	AGND	—	Analog GND pin

ABSOLUTE MAXIMUM RATINGS

Parameter	Symbol	Condition	Rating	Unit
Power Supply Voltage	V_{DD}	Ta=25°C	–0.3 to +7.0	V
Input Voltage	V_{IN}	Ta=25°C	–0.3 to V_{DD}+0.3	V
Storage Temperature	T_{STG}	—	–55 to +150	°C

RECOMMENDED OPERATING CONDITIONS

Parameter	Symbol	Condition	Range	Unit
Power Supply Voltage	V_{DD}	DGND=AGND=0V	2.7 to 3.6	V
Operating Temperature	T_{op}	—	–40 to +85	°C
Master Clock Frequency	f_{OSC}	—	4.0 to 6.5	MHz

ELECTRICAL CHARACTERISTICS

DC Characteristics

Parameter	Symbol	Condition		Min.	Typ.	Max.	Unit
High-level Input Voltage	V_{IH}	—		V_{DD}×0.85	—	—	V
Low-level Input Voltage	V_{IL}	—		—	—	V_{DD}×0.15	V
High-level Output Voltage	V_{OH}	I_{OH}=-40µA		V_{DD}-0.3	—	—	V
Low-level Output Voltage	V_{OL}	I_{OL}=2mA		—	—	0.45	V
High-level Input Current (*1)	I_{IH1}	V_{IH}=V_{DD}		—	—	10	µA
High-level Input Current (*2)	I_{IH2}	V_{IH}=V_{DD}		—	—	20	µA
Low-level Input Cerrent (*1)	I_{IL1}	V_{IL}=GND		–10	—	—	µA
Low-level Input Current (*2)	I_{IL2}	V_{IL}=GND		–20	—	—	µA
Operating Current	I_{DD}	f_{OSC}=6.5MHz, without load		—	4	15	mA
Standby Current	I_{DDS}	At power down, without load	MSM9888L	—	1	10	µA
			MSM9889L	—	1	Undefined	µA

*1 Applies to input pins excluding XT pin.
*2 Applies to XT pin.

Analog Characteristics

Parameter	Symbol	Condition	Min.	Typ.	Max.	Unit
D/A Output Relative Error	$\lvert V_{DAE} \rvert$	No load	—	—	5	mV
FIN Allowable Input Voltage Range	V_{FIN}	—	$\frac{1}{4} \times V_{DD}$	—	$\frac{3}{4} \times V_{DD}$	V
FIN Input Impedance	R_{FIN}	No load	1	—	—	MΩ
ADIN Allowable Input Voltage Range	V_{ADIN}	—	$\frac{1}{4} \times V_{DD}$	—	$\frac{3}{4} \times V_{DD}$	V
ADIN Input Impedance	R_{ADIN}	—	1	—	—	MΩ
OP Amplifier Open Loop Gain	G_{OP}	f_{IN}=0 to 4kHz	10	—	—	dB
OP Amplifier Input Impedance	R_{INA}	—	1	—	—	MΩ
OP Amplifier Load Resistance	R_{OUTA}	—	100	—	—	kΩ
AOUT Load Resistance	R_{AOUT}	—	50	—	—	kΩ
FOUT Load Resistance	R_{FOUT}	—	50	—	—	kΩ

AC Characteristics

DV_{DD}=AV_{DD}=2.7 to 3.6 V, DGND=AGND=0 V,
Ta=–40 to +85°C, f_{OSC}=4.096 MHz, f_{SAM}=8.0 kHz

Parameter			Symbol	Min.	Typ.	Max.	Unit
Oscillation duty cycle			f_{duty}	40	50	60	%
RESET pulse width			t_{RST}	1µs or longer than when oscillation is stabilized	—	—	—
RESET execution time		Note 1	t_{REX}	—	—	35	ms
Setup and hold time of SCK for $\overline{CS}$			t_{CKC}	200	—	—	ns
Setup and hold time of $\overline{CS}$ for SCK			t_{CCK}	200	—	—	ns
SCK pulse width "H"			t_{CKH}	500	—	—	ns
SCK pulse width "L"			t_{CKL}	500	—	—	ns
Setup time of DI to SCK rise			t_{DS}	200	—	—	ns
Hold time of DI to SCK rise			t_{DH}	200	—	—	ns
Data definition time to $\overline{CS}$ fall			t_{CSE}	—	—	200	ns
Data float time to $\overline{CS}$ fall			t_{CSF}	—	—	200	ns
Data definition time to SCK fall			t_{DD}	—	—	200	ns
Delay time of BUSY rise to 8th SCK bit rise			t_{BSY}	—	—	200	ns
BUSY time at input of command (normal)		Note 1	t_{BR}	—	100	300	µs
BUSY time at input of REC command (2)		Note 1	t_{RECB}	—	—	1	ms
Time from input of REC command (2) to MON rise			t_{RECM}	—	—	1	ms
Time from input of REC command (2) to PRM bit rise			t_{RECR}	—	—	3	ms
BUSY time at input of PLY command (2)		Note 1	t_{PLYB}	—	—	1	ms
Time from input of PLY command (2) to MON rise			t_{PLYM}	—	—	1	ms
Time from input of PLY command (2) to RPM rise			t_{PLYR}	—	—	3	ms
Time from input of STOP command to BUSY fall	During recording		t_{SPCB}	—	40	65	ms
	During Flash playback	Note 2	t_{SPCB}	—	—	500	µs
	During ROM playback	Note 2	t_{SPCB}	—	—	500	µs
Time from input STOP command to MON fall	During recording		t_{SPCM}	—	40	65	ms
	During Flash playback	Note 2	t_{SPCM}	—	—	500	µs
	During ROM playback	Note 2	t_{SPCM}	—	—	500	µs
Time from input STOP command to RPM bit fall	During recording	Note 2	t_{SPCR}	—	—	1	ms
	During Flash playback	Note 2	t_{SPCR}	—	—	500	µs
	During ROM playback	Note 2	t_{SPCR}	—	—	500	µs

Note 1: Proportional to the period of oscillation frequency f_{OSC}.
Note 2: Proportional to the period of sampling frequency f_{SAM}.

DV_{DD}=AV_{DD}=2.7 to 3.6 V, DGND=AGND=0 V,
Ta=–40 to +85°C, f_{OSC}=4.096 MHz, f_{SAM}=8.0 kHz

Parameter			Symbol	Min.	Typ.	Max.	Unit
Time from input of PAUSE command to BUSY fall	During recording	Note 2	t_{PSCB}	—	—	500	µs
	During Flash playback	Note 2	t_{PSCB}			500	µs
	During ROM playback	Note 2	t_{PSCB}			500	µs
Time from input of PAUSE command to VPM bit rise		Note 2	t_{PSCP}	—	—	500	µs
Time from input of STOP command during pause to reset of VPM bit		Note 2	t_{PSCP}	—	—	500	µs
Time from input of STOP command during pause to reset of RPM bit		Note 2	t_{PSCR}			1	ms
Time from input of STOP command during pause to reset of VPM bit		Note 2	t_{PSCP}			1	ms
Time from input of STOP command durig pause to reset of BUSY	During recording		t_{SPCB}	—	40	65	ms
	During Flash playback	Note 2	t_{SPCB}	—	—	500	µs
	During ROM playback	Note 2	t_{SPCB}	—	—	500	µs
Time from input of STOP command during pause to reset of MON	During recording		t_{SPCM}	—	40	65	ms
	During Flash playback	Note 2	t_{SPCM}	—	—	500	µs
	During ROM playback	Note 2	t_{SPCM}	—	—	500	µs
BUSY time at input of INIT command			t_{INIB}	—	40	100	ms
BUSY time at input of BLKRD command (2)			t_{BRD}	—	—	500	µs
BUSY time at input of BLKWR command (3)			t_{BWR}	—	—	500	µs
BUSY time at input of DTRW command (2)			t_{DRW}	—	—	2	ms
BUSY time at input of BYTEW command (3)			t_{WBW}	—	—	300	µs
BUSY time at input of BYTER command (2)			t_{WBR}	—	—	300	µs
BUSY time at input of WEND command			t_{WWN}	—	10	21	ms
BUSY time at input of END command			t_{WEN}	—	—	300	µs
Time from input of PDWN command to BUSY rise	During recording		t_{PDM}	—	40	85	ms
	During Flash playback	Note 2	t_{PDM}	—	—	1	ms
	During ROM playback	Note 2	t_{PDM}	—	—	1	ms
	During standby mode	Note 1	t_{PDM}	—	—	1	ms
Address control time during ROM playback			t_{AD}	—	—	2	ms
Time for delection of phrase by DEL command			t_{DEL}	—	40	50	ms
BUSY time after input of STATUS command			t_{STA}	—	—	10	µs
Time from BUSY being "L" to stop of external crystal clock after input of PDWN command	During Flash playback	Note 2	t_{PXT}	—	—	1	ms
	During Flash playback	Note 2	t_{PXT}	—	—	1	ms
	During ROM playback	Note 2	t_{PXT}	—	—	1	ms
	During standby mode	Note 1	t_{PXT}	—	—	100	µs

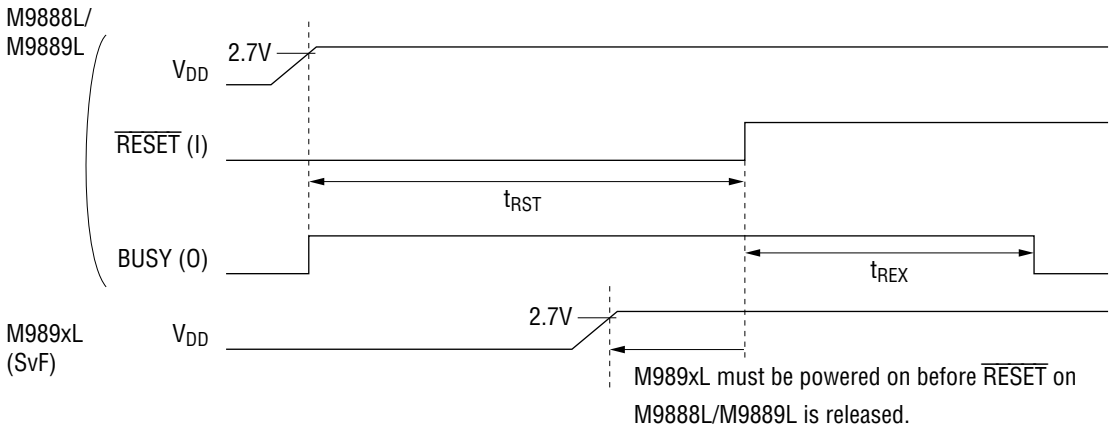
Note 1: Proportional to the period of oscillation frequency f_{OSC}.
Note 2: Proportional to the period of sampling frequency f_{SAM}.

TIMING DIAGRAMS

Reset Function

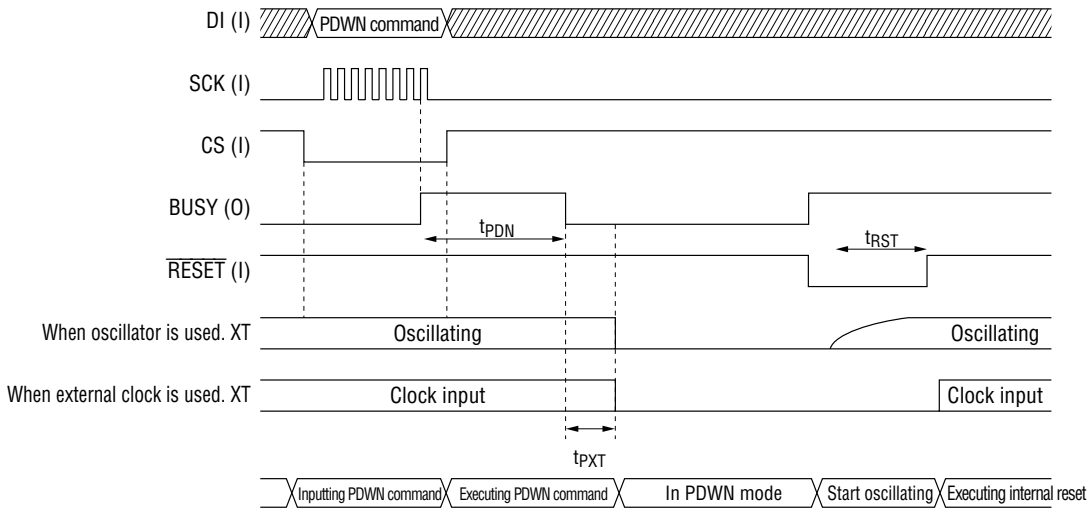
<When the M9888L/M9889L and M989x share the same power supply source>
After powering on the M9888L/M9889L, input "L" level to the M9888L/M9889L's $\overline{\text{RESET}}$ pin. Then, after M9888L/M9889L's V_{DD} level stabilizes at 2.7 V or higher, and after t_{RST} time has passed, input "H" level to the M9888L/M9889L's $\overline{\text{RESET}}$ pin.

<When the M9888L/M9889L and M989xL each use an independent power supply source>
Bring the M9888L/M9889L's $\overline{\text{RESET}}$ pin up to "H" level after satisfying the above timing requirements and after stabilizing the power supply of M989xL at 2.7 V or higher.



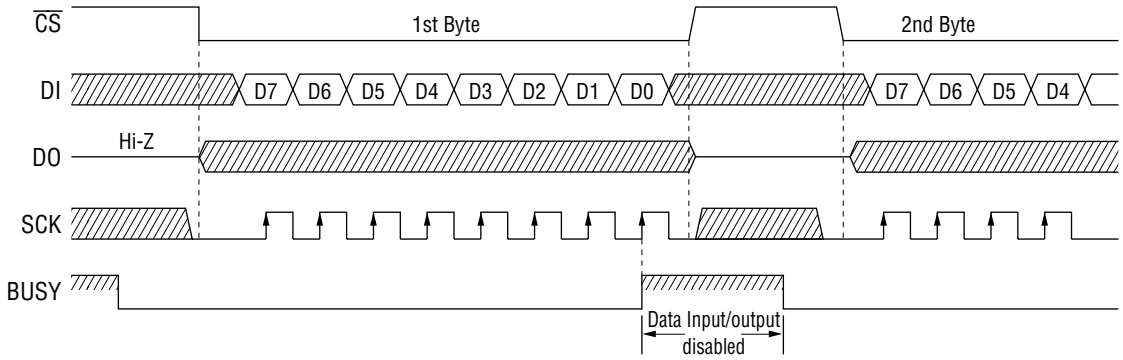
Note: If the above timing requirements are not properly satisfied, M9888L/M9889L's operation may become unstable due to mal-functionality of internal reset function, which may cause incorrect data write to M989xL. This may also cause such symptoms as "unable to record/playback", "message data is missing", etc.

Power-down by the PDWN command (while in "Ready")

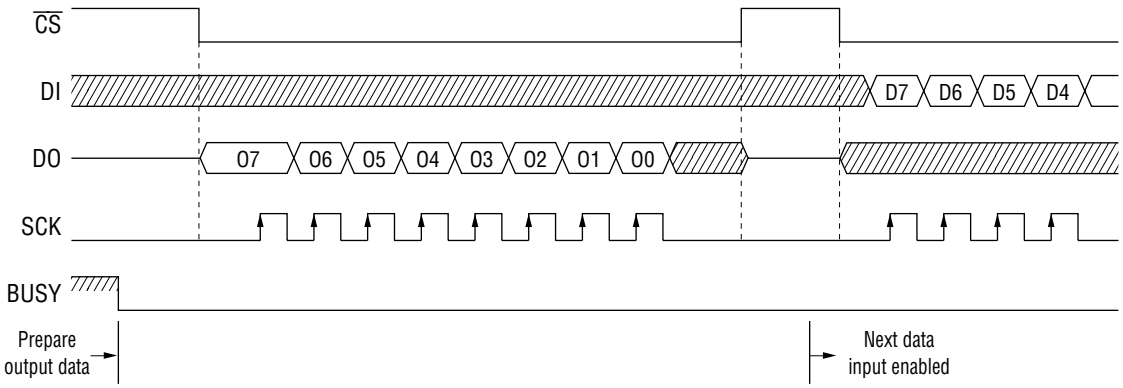


MCU I/f Control Timings

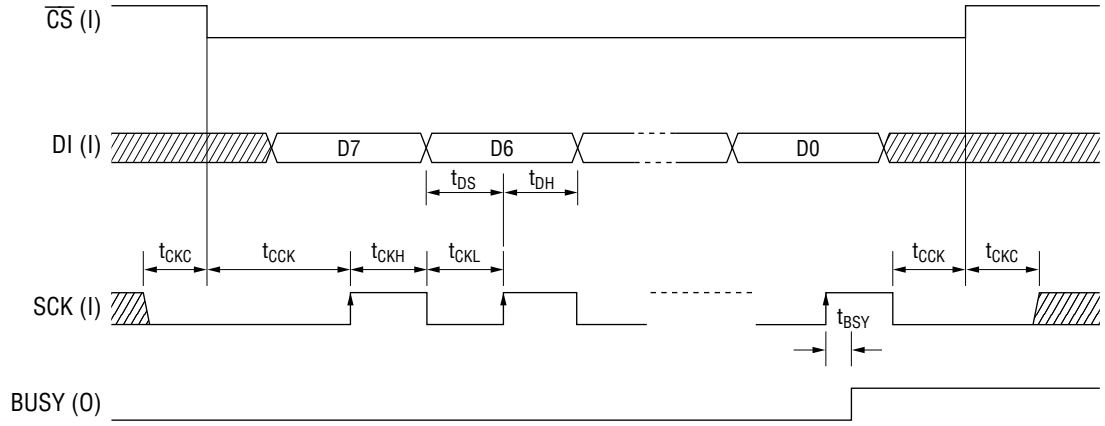
<Timing for Data Write>



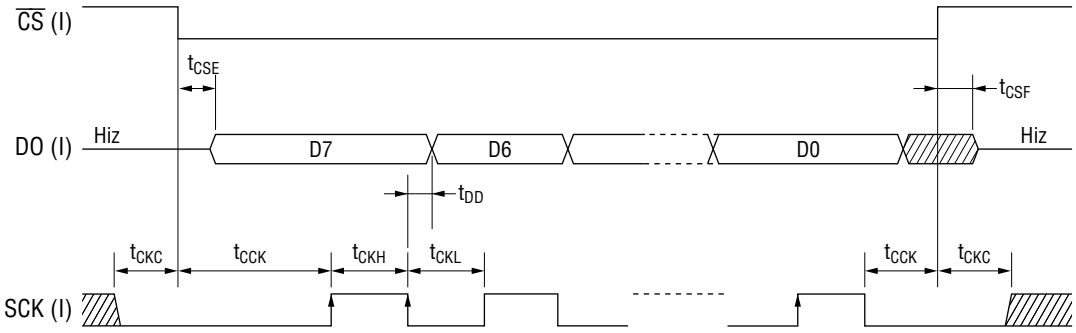
<Timing for Data Read>



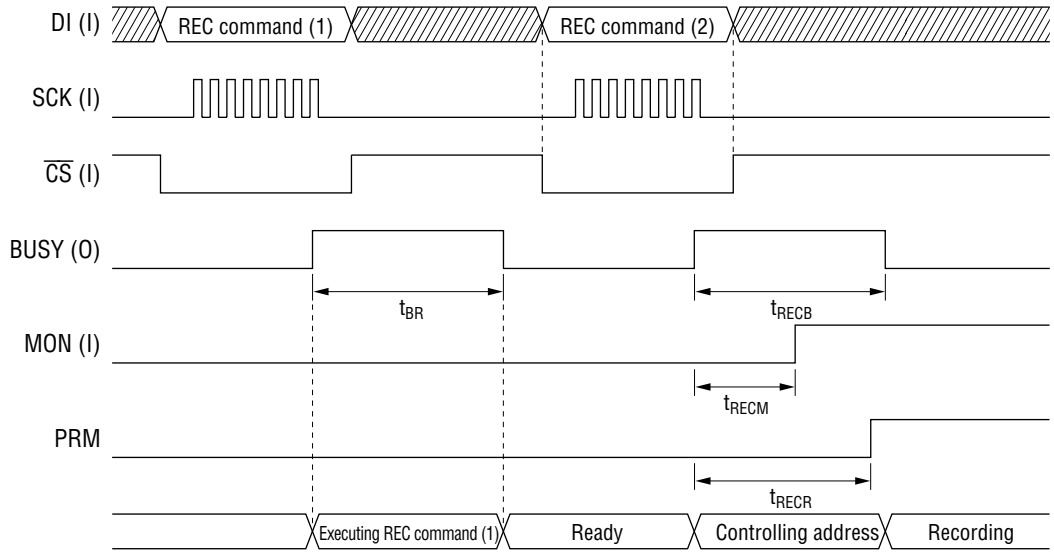
<Timing for Data Write>



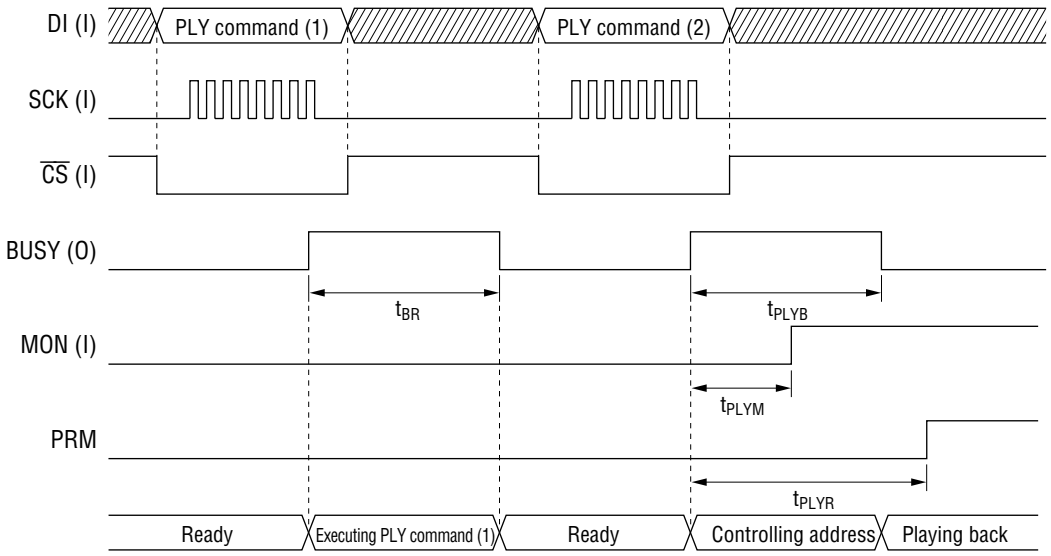
<Timing for Data Read>



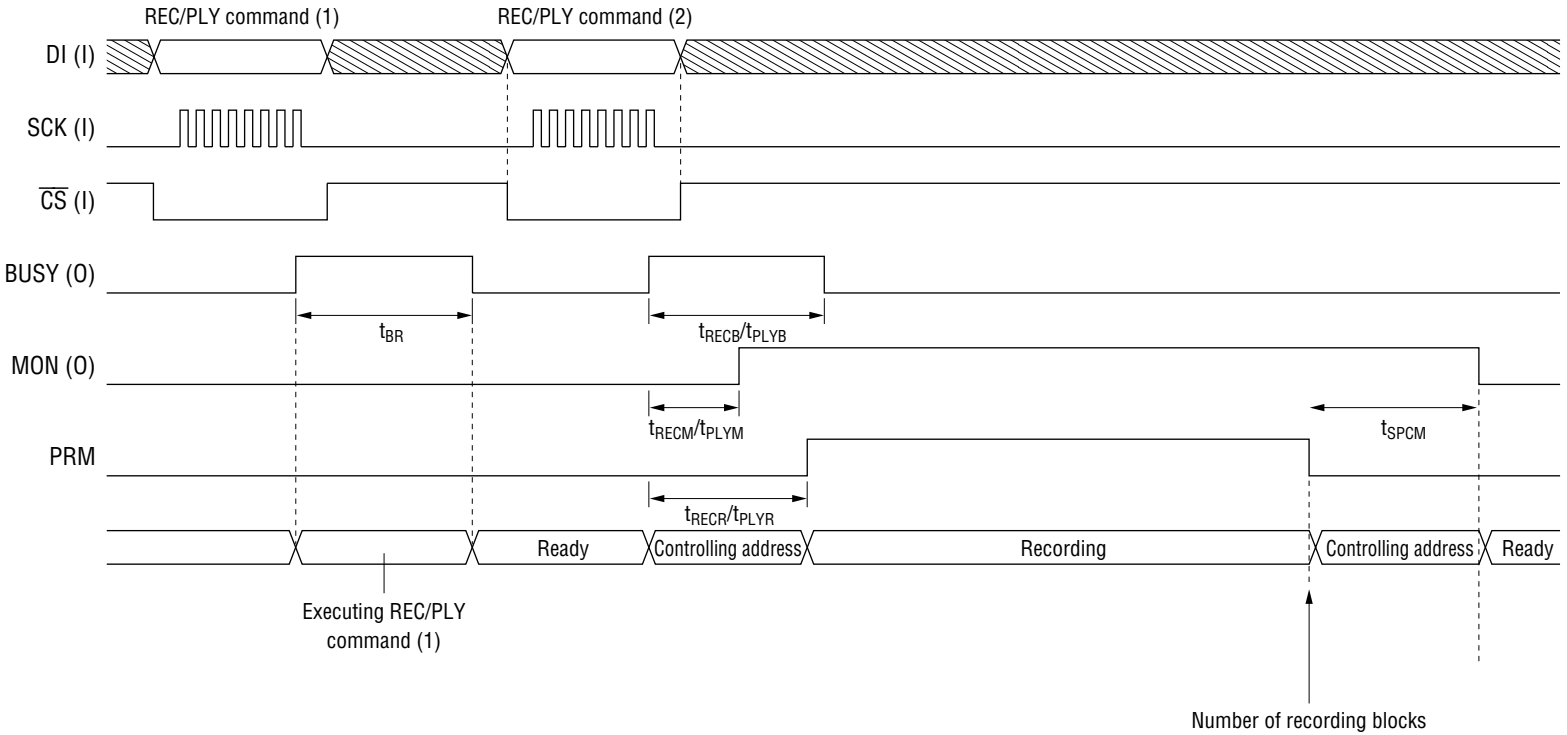
Recording by the REC command



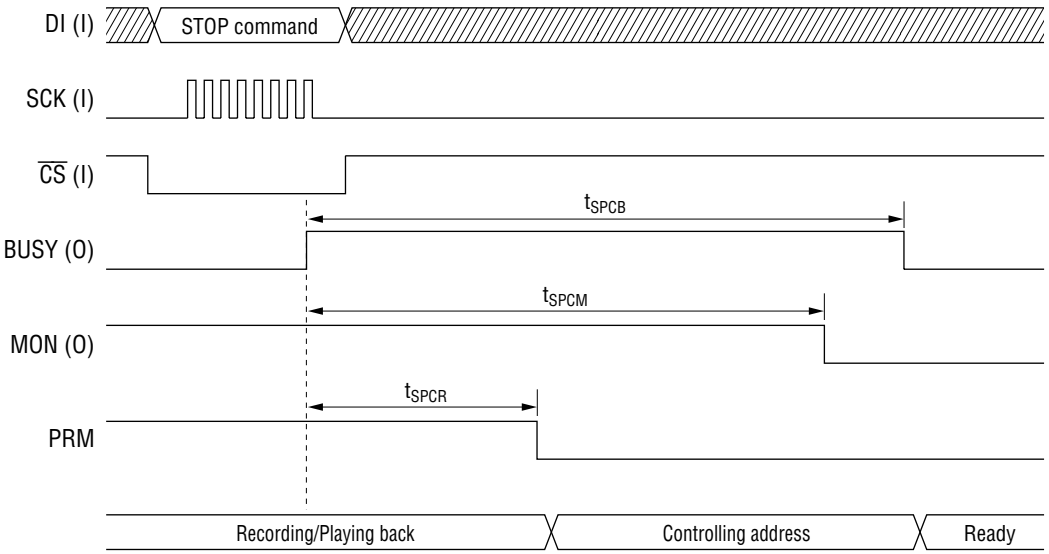
Playback by the PLY command



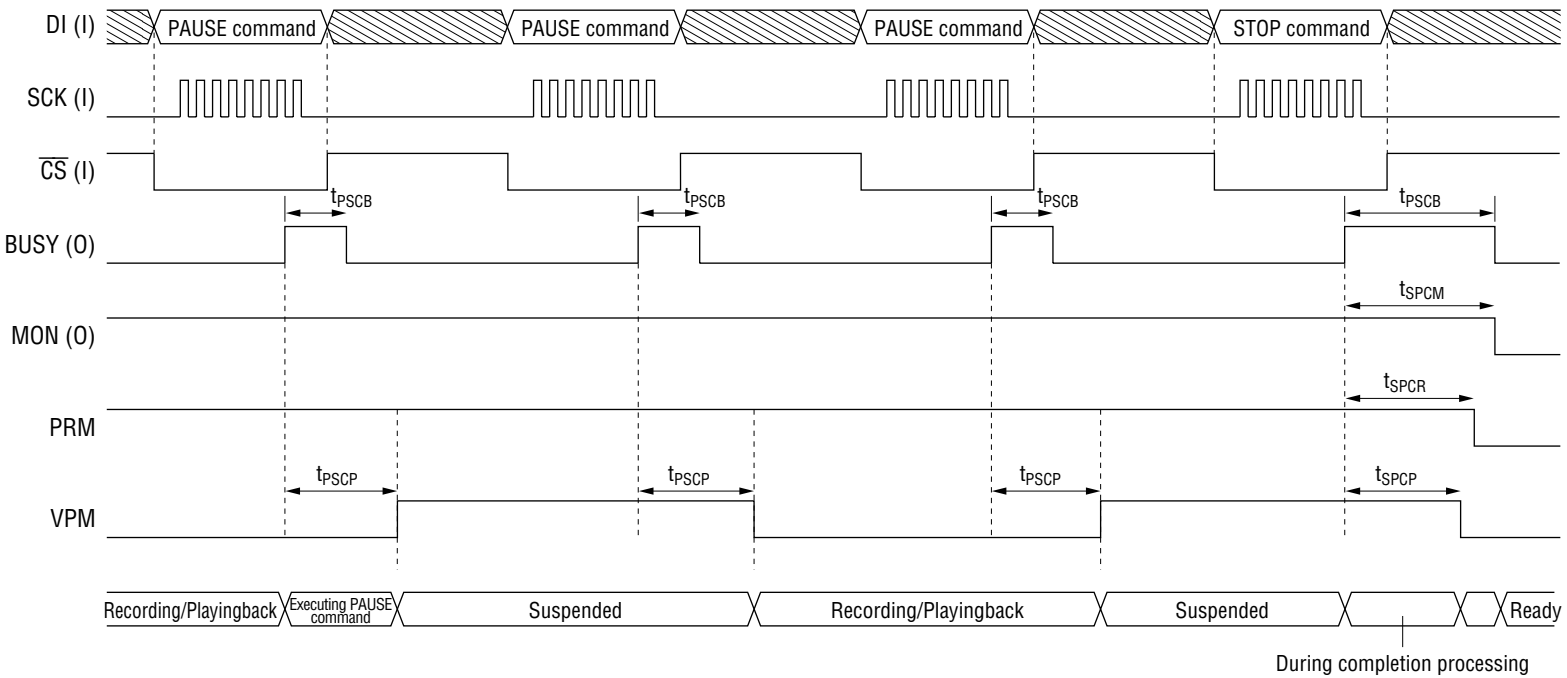
End Recording/Playback without the STOP command



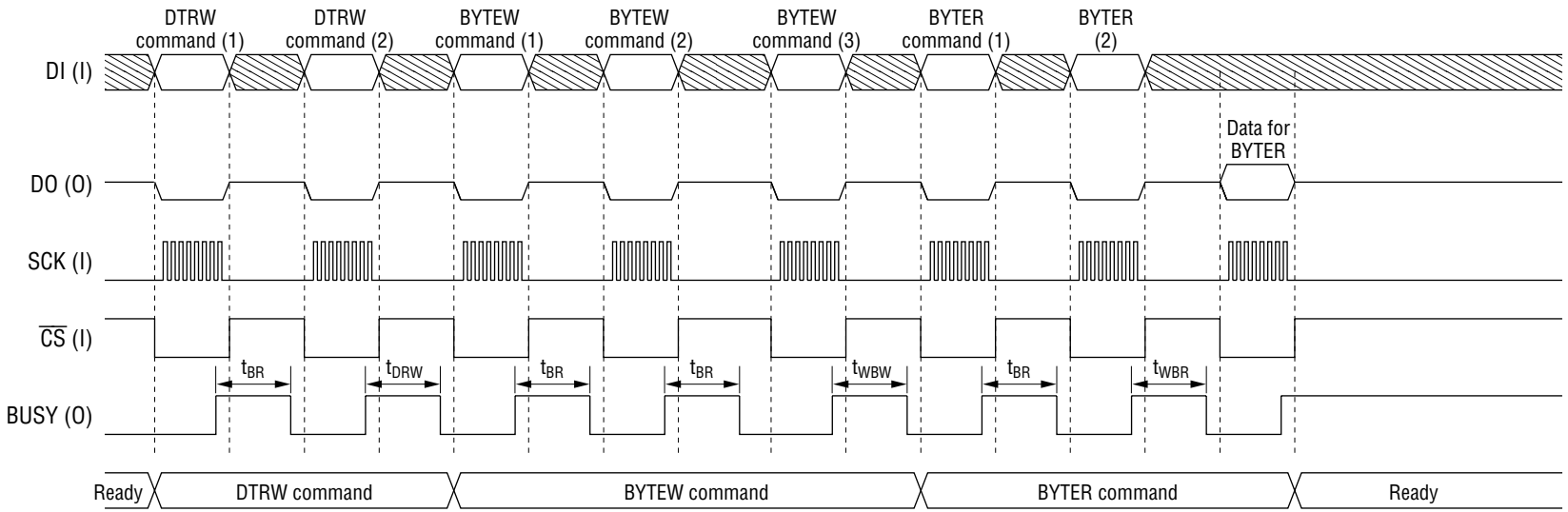
End Recording/Playback by the STOP command



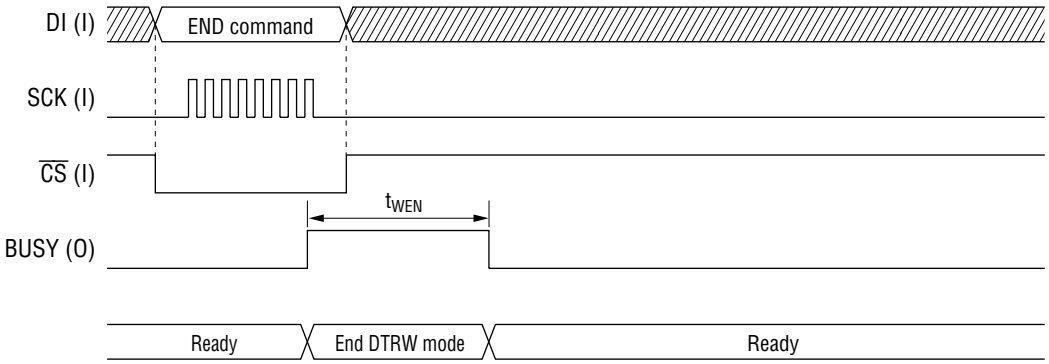
Pause Recording/Playback by the PAUSE command



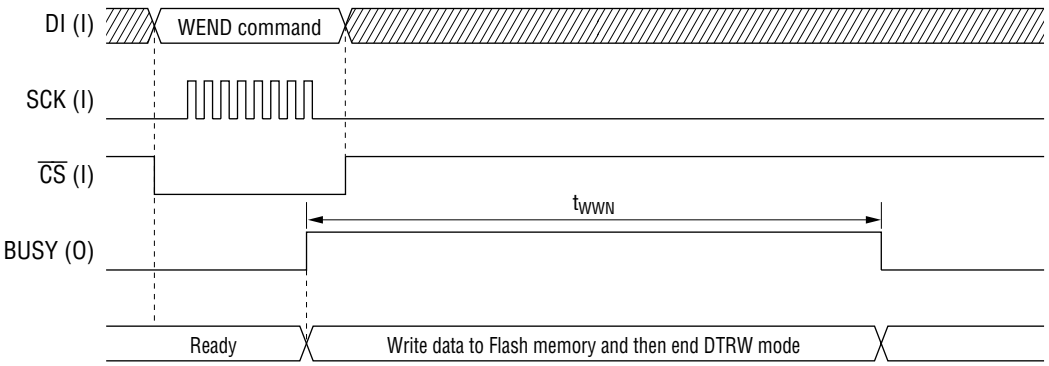
Transfer data by the DTRW command



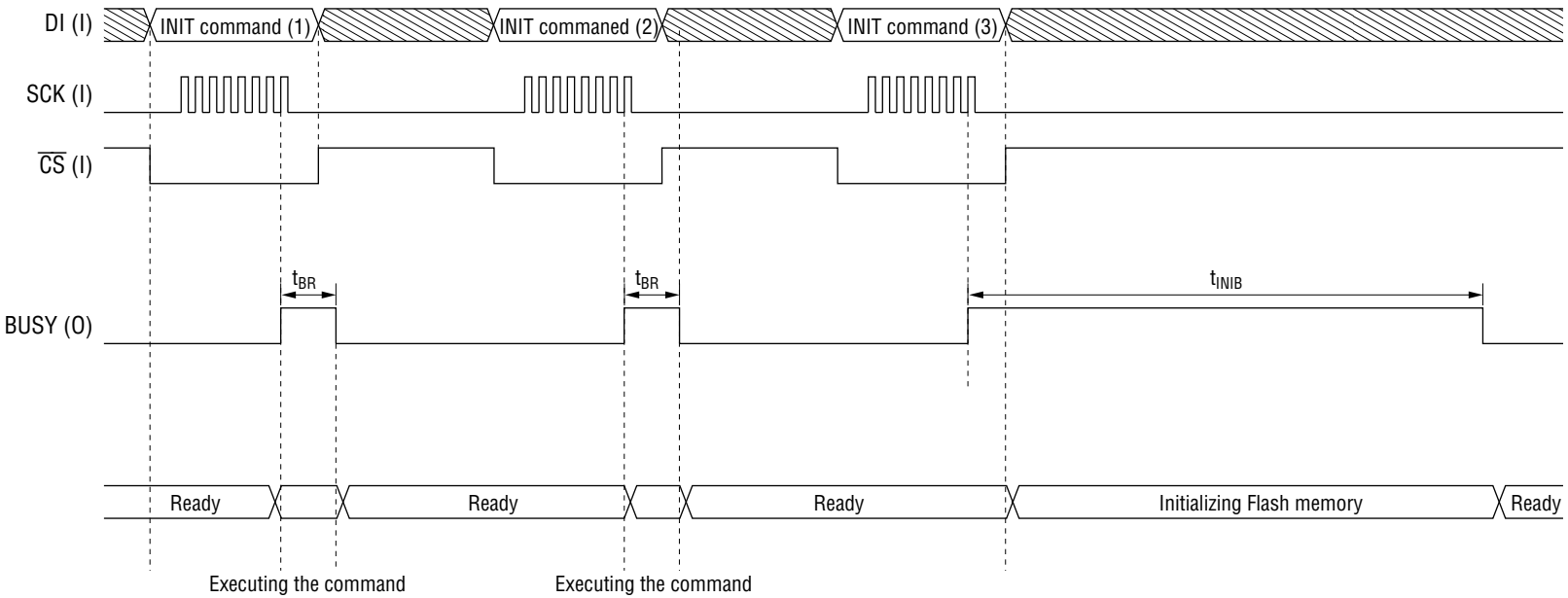
End DTRW mode by the END command



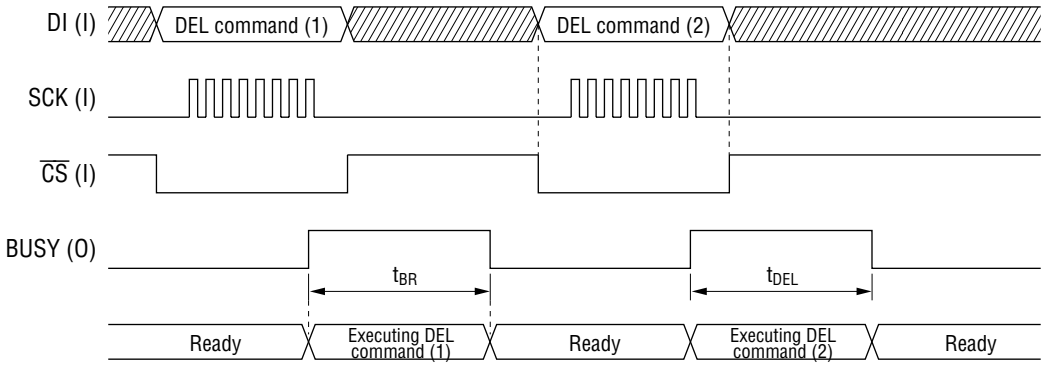
End DTRW mode by the WEND command



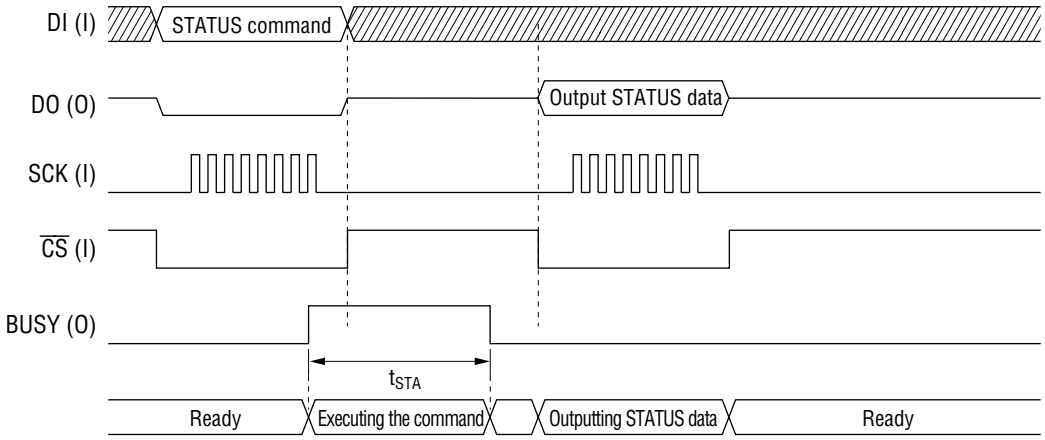
Initialize Flash Memory by the INIT command



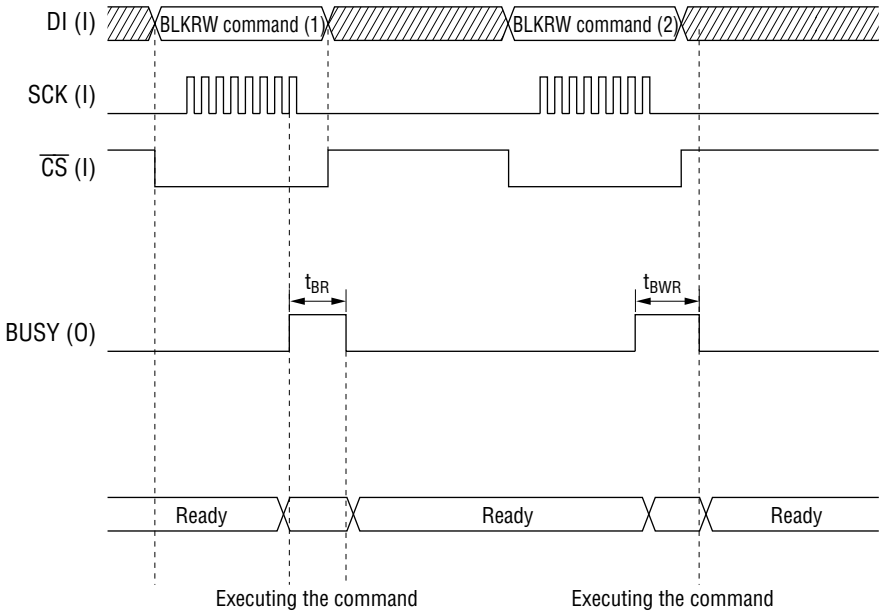
Erase a Phrase by the DEL command



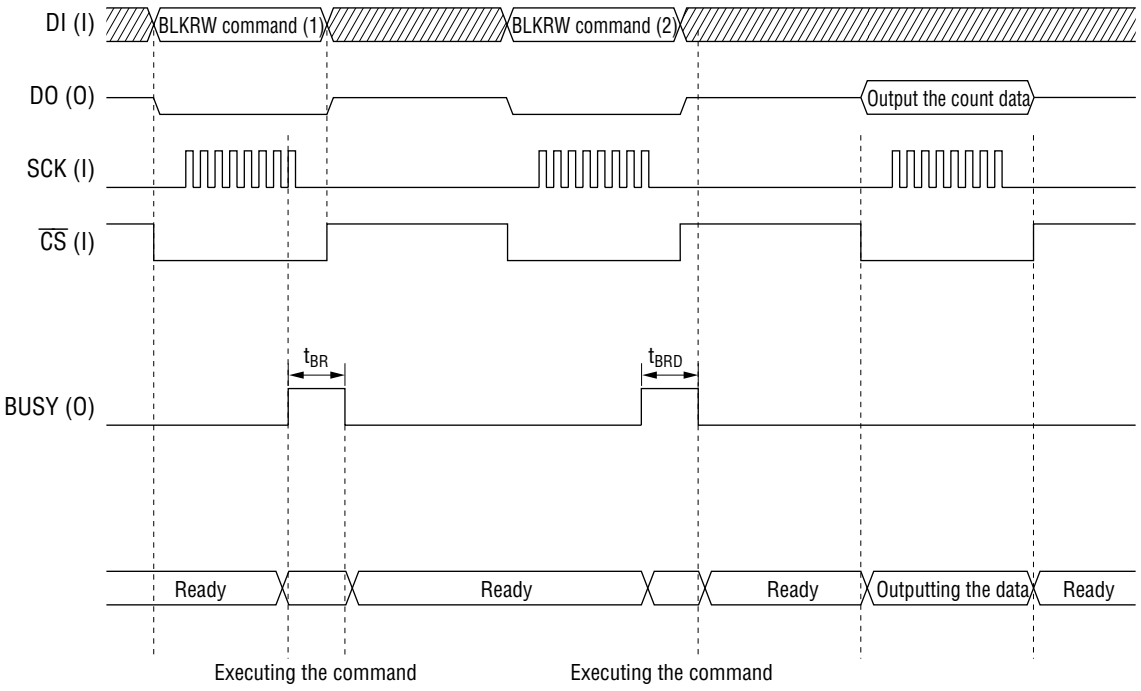
Output Status Data by the STATUS command



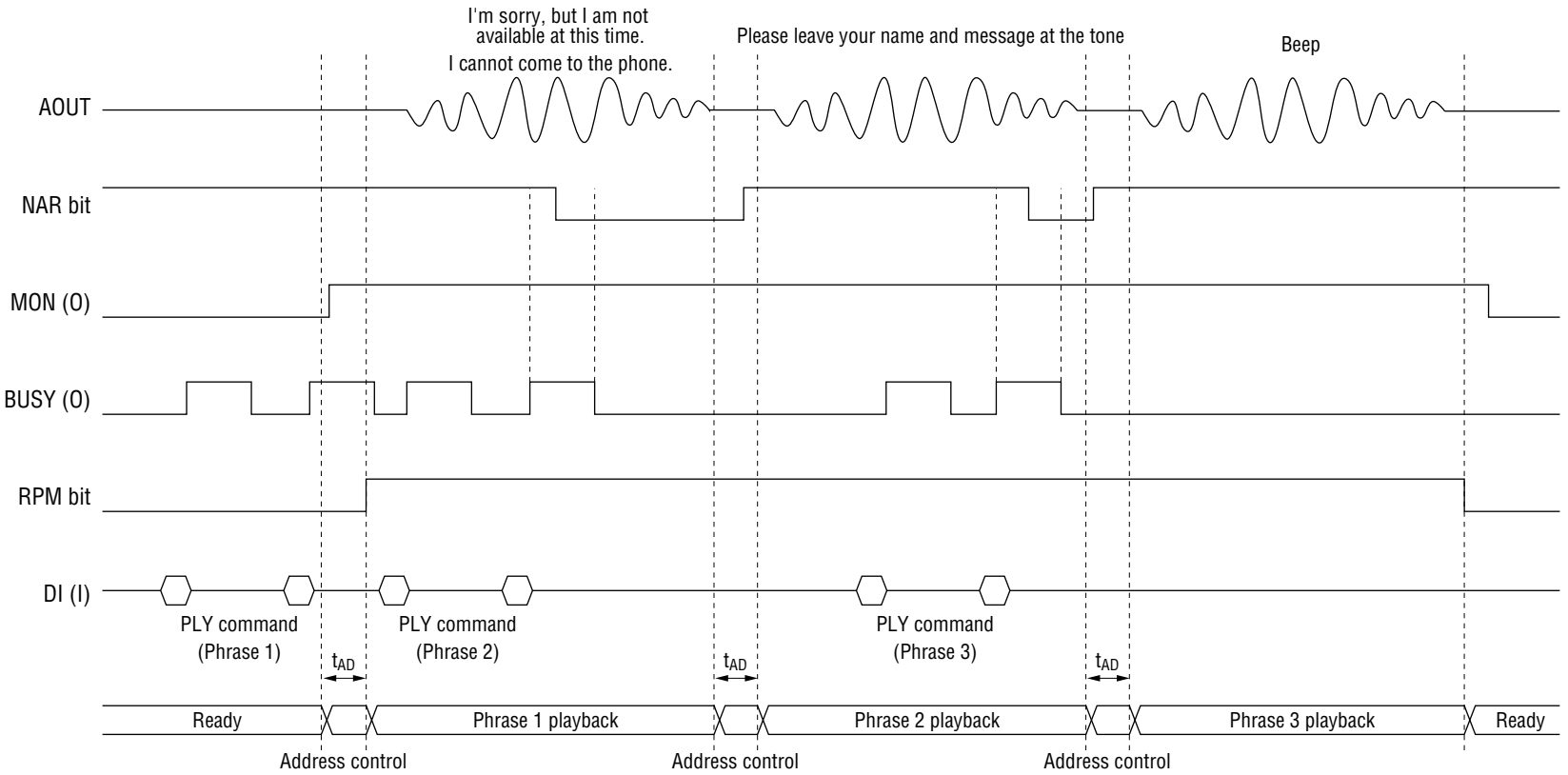
Setup Recording Time by the BLKRW command



Output the Number of Recording Blocks by the BLKRW command



Timing for Continuous ROM Playback by PLY Command



FUNCTIONAL DESCRIPTION

Serial Voice Flash Memory Configuration

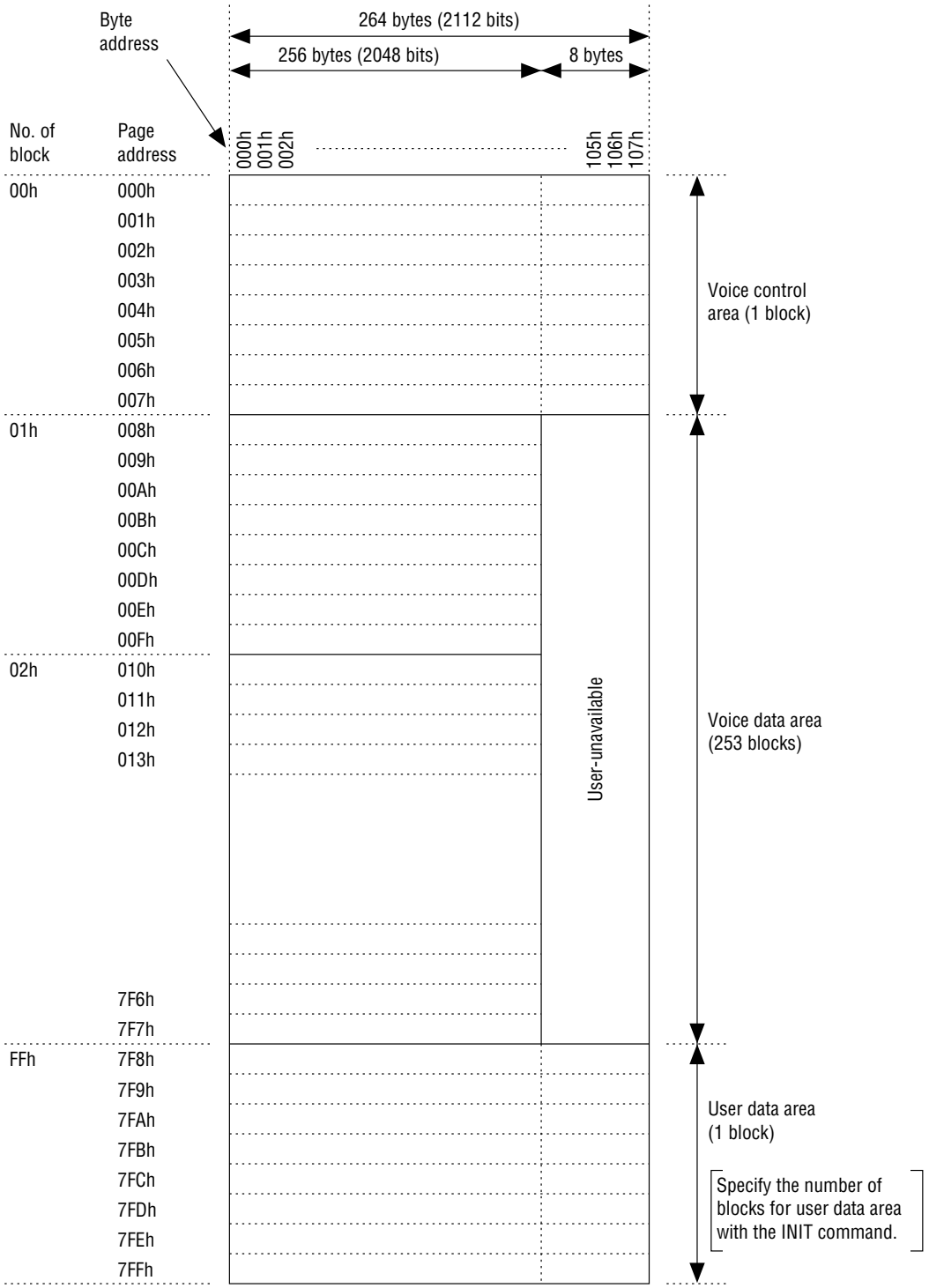
The external serial voice Flash memory consists of the voice control area, voice data area, and user data area. The desired user data area can be secured by specifying the memory capacity before recording.

Voice control area ..... This area stores voice control data such as information on addresses of each phrase. This area uses the first block of Flash memory.
Voice data area ..... This area stores voice (ADPCM) data.
User data area ..... The user can use this area. This area can be accesed with a command. This area can be determined by specifying the number of blocks starting from the last block of Flash memory.

The user data area and recording time are specified for each block. Each block has a size that is 1/256 of the memory capacity of external serial voice Flash memory.
The serial voice Flash memory consists of pages each has 264 bytes.
Before transfering data that is in the user area specified with theINIT command, specify its page address with the DTRW command. Transfer data with the BYTEW and BYTER commands while specifying the byte address.

Serial voice Flash memory model		MSM9892L	MSM9893L MSM9893AL	MSM9894AL
Serial voice Flash memory capacity		2M bits	4M bits	8M bits
Number of pages [Page address]		1024 pages [000h to 3FFh]	2048 pages [000h to 7FFh]	4096 pages [000h to FFFh]
Number of usable blocks		255 blocks	255 blocks	255 blocks
Memory capacity per block				
Voice data area	No. of bits	8192 bits	16384 bits	32768 bits
User data area	No. of bits	8448 bits	16896 bits	33792 bits
	No. of bytes	1056 bytes	2112 bytes	4224 bytes
	No. of pages	4 pages	8 pages	16 pages

Shown below is an example of space allocation when a single block of the 4-Mbit serial voice Flash memory is used for the user data area.



Recording/Playback Time

The recording/playback time is determined by the memory capacity, sampling frequency and coded bit length, and is calculated by the following equation.

$$\text{Recording/playback time} = \frac{\text{Memory capacity [bits]}}{\text{sampling frequency [Hz]} \times \text{bit length [bits]}} \text{ [sec]}$$

For example, if recording is performed at 6.4 kHz sampling frequency after connecting the 4-Mbit serial voice Flash memory, the maximum recording time is calculated as shown below. In this case, the user data area is not specified and all the 255 blocks are used for the voice data area.

$$\text{Recording/playback time} = \frac{255 \text{ blocks} \times 16384 \text{ bits}}{6.4 \text{ kHz} \times 4 \text{ bits}}$$

$$= 163 \text{ seconds}$$

1. Maximum time for recording variable message (recording/playback when serial voice Flash memory is used)

Serial voice Flash memory model		MSM9892L	MSM9893L MSM9893AL	MSM9894AL
Memory capacity		2M bits	4M bits	8M bits
Memory capacity per block		8192 bits	16384 bits	32768 bits
Maximum recording time (255 blocks)	f_{SAM}=4.0 kHz	130 seconds	261 seconds	522 seconds
	f_{SAM}=5.3 kHz	97 seconds	195 seconds	391 seconds
	f_{SAM}=6.4 kHz	81 seconds	163 seconds	326 seconds
	f_{SAM}=8.0 kHz	65 seconds	130 seconds	261 seconds

Note) A sampling frequency can be specified for each phrase.

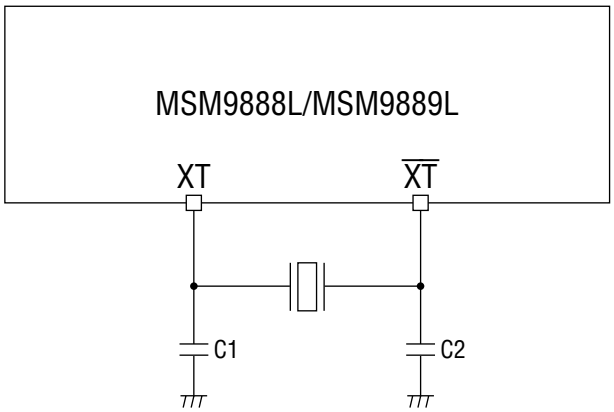
2. Maximum time for recording fixed message (ROM playback with internal ROM)

Model name		MSM9888L		MSM9889L	
Internal ROM memory capacity		512K bits		1M bits	
Voice data area memory capacity		496K bits		1008K bits	
Maximum playback time		4-bit ADPCM	8-bit PCM	4-bit ADPCM	8-bit PCM
	f_{SAM}=4.0 kHz	31.7 seconds	15.8 seconds	65.5 seconds	32.2 seconds
	f_{SAM}=5.3 kHz	23.8 seconds	11.9 seconds	43.8 seconds	24.1 seconds
	f_{SAM}=6.4 kHz	19.8 seconds	9.9 seconds	40.3 seconds	20.1 seconds
	f_{SAM}=8.0 kHz	15.8 seconds	7.9 seconds	32.2 seconds	16.1 seconds

Note 1) The sampling frequency and voice synthesis algorithm can be specified for each phrase.
Note 2) 16 Kbits of the internal ROM is used for the voice control area.
The internal ROM capacity minus 16 Kbits is the voice data area.

Connection of an Oscillator

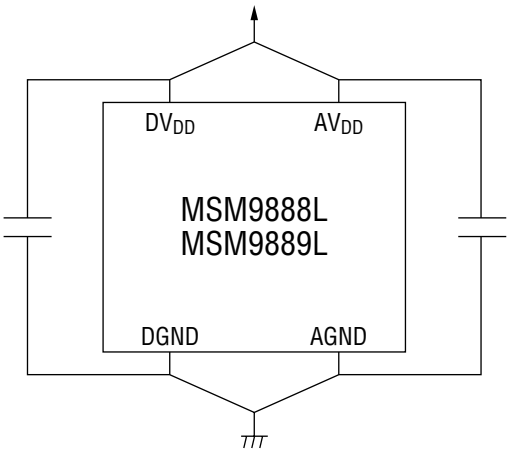
Connect a ceramic oscillator or a crystal oscillator to XT and $\overline{XT}$ pins as shown below. The optimal load capacities when connecting ceramic oscillators from MURATA MFG., KYOCERA CORPORATION, and TDK CORPORATION are shown below for reference.



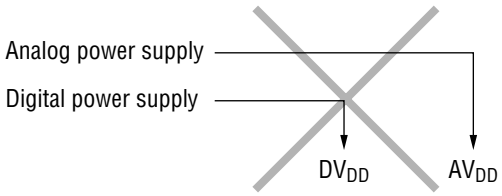
Supplier	Type	Freq. (MHz)	C1 (pF)	C2 (pF)	Applicable IC
MURATA MFG.	CSTLS4M00G56-B0 (with capacitor) CSTCR4M00G55-R0 (with capacitor)	4.0	—	—	M9888L
	CSTLS4M00G53-B0 (with capacitor) CSTCR4M00G53-R0 (with capacitor)				M9889L
	CSTLS6M00G56-B0 (with capacitor) CSTCR6M00G55-R0 (with capacitor)	6.0	—	—	M9888L
	CSTLS6M00G53-B0 (with capacitor) CSTCR6M00G53-R0 (with capacitor)				M9889L
KYOCERA CORPORATION	KBR-4.0MSA/MSB PBRC4.00A	4.0	33	33	M9888L
	KBR-4.0MKC (with capacitor) PBRC4.00B (with capacitor)		—	—	
	KBR-4.0MKD (with capacitor) KBR-4.0MKS (with capacitor))	6.0	—	—	
TDK CORPORATION	FCR4.0MC5 (with capacitor)	4.0	—	—	M9888L M9889L
	FCR6.0MC5 (with capacitor)	6.0			

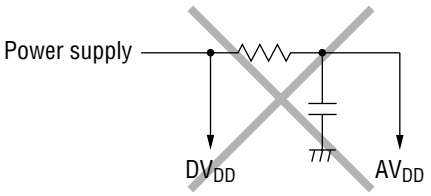
Power Supply Wiring

As shown in the following diagram, supply the power from the same power source, but separate the power supply wiring to the analog portion from that to the logic portion.



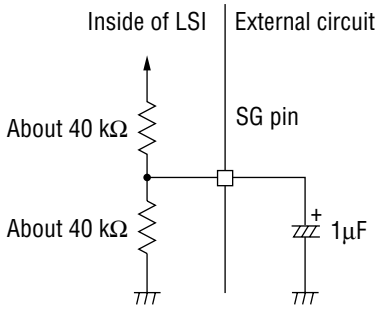
The analog section and logic section must share the same power. Otherwise, a latch-up may occur.





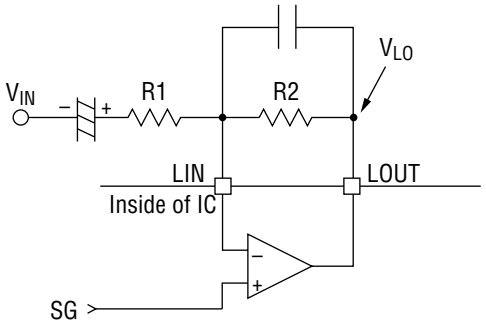
SG Pin

Connect a 1µF electrolytic capacitor to the SG pin as shown below.
After reset or after the PDWN mode is released, do playback after the voltage level on the SG pin is stabilized. The voltage level is stabilized at 1/2 V_{DD}.

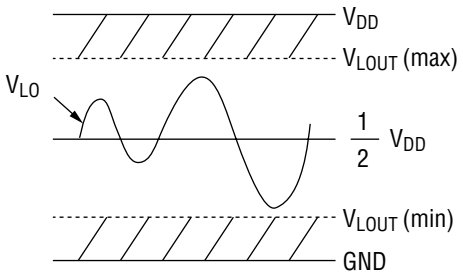


Analog Input Amplifier Circuit

The device has two built-in operational amplifiers for amplifying the microphone output. Each OP amplifier is provided with the inverting input pin and output pin. The analog circuit reference voltage SG (signal ground) is connected internally to the non-inverting input of each OP amplifier.
For amplification, form an inverting amplifier circuit and adjust the amplification ratio by using external resistors as shown below.



$$V_{LO} = \frac{R2}{R1} V_{IN}$$



During recording, the output V_{LO} of OP amp is connected to the input FIN of the LPF. Adjust the amplification ratio by using the external resistors so that the V_{LO} amplitude is within the LOUT admissible input voltage (V_{FIN}) range.
If V_{LO} exceeds the V_{FIN} range, the LPF output waveform will be distorted.
The table below shows an example of the FIN admissible input voltage range for the MSM9888L and MSM9889L.

Parameter	Power Supply Voltage V_{DD}	FIN admissible input Voltage range V_{FIN}		FIN admissible input Voltage
		min.	max.	
MSM9888L	3V	0.75V	2.25V	$1.5V_{P-P}$
MSM9889L	3V	0.75V	2.25V	$1.5V_{P-P}$

The value of the OP amp load resistance R_{OUTA} is 100 kΩ minimum. Therefore the values of the inverting amplifier circuit feedback resistors R2 should be 100 kΩ or more.

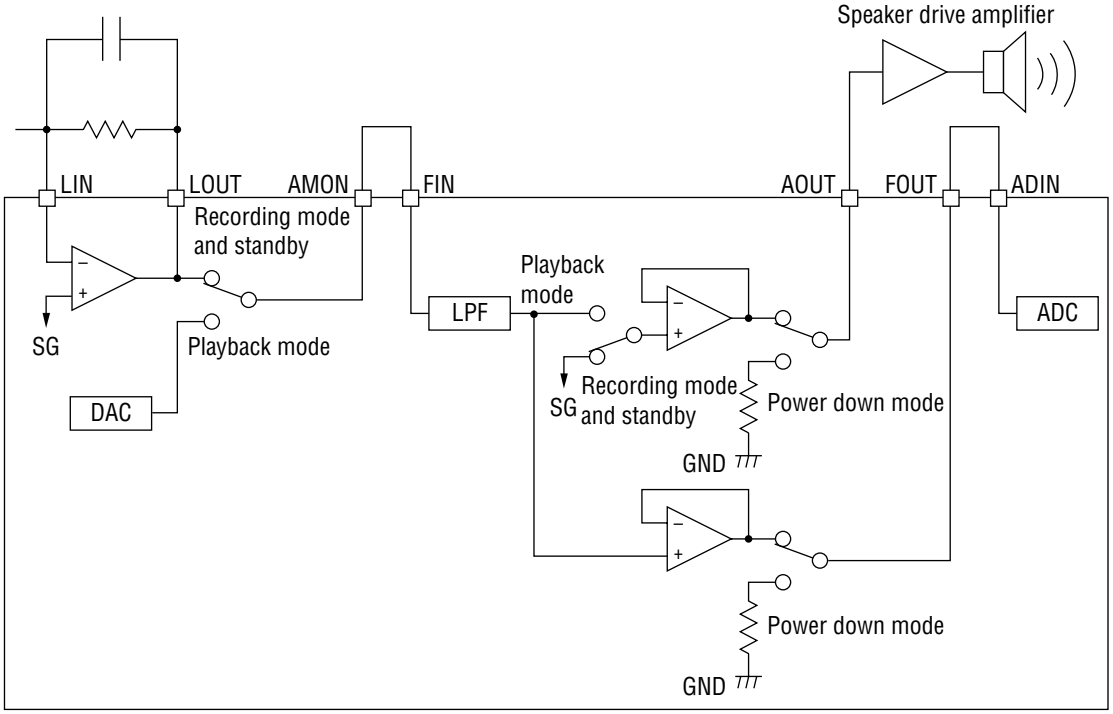
Connection of LPF Circuit Peripherals

The AMON pin is connected internally to the output of the amplifier circuit (LOUT pin) in the recording mode and to the output of the built-in DA converter in the playback mode. Therefore, connect the AMON pin directly to the input (FIN pin) of the built-in LPF.

Both the FOUT and AOUT pins are the output pins of the built-in LPF. Connect the FOUT pin to the input (ADIN pin) of the built-in AD converter and connect the AOUT pin to an external speaker through an external speaker drive amplifier.

In the MSM9888L/9889L, the connection of each of the FOUT and AOUT pins is changed to one of the output of the LPF, GND(ground) level, and SG (signal ground) level, depending on the operation status as shown below.

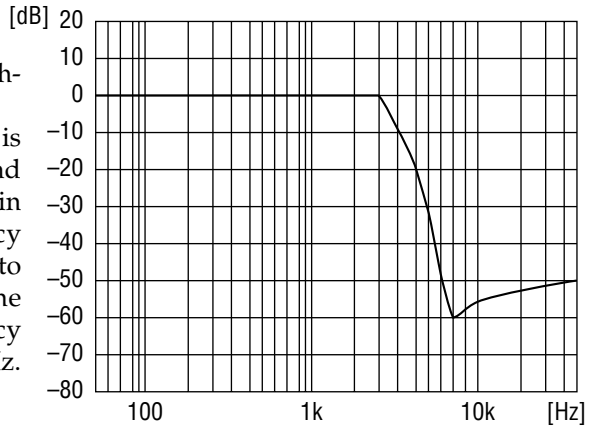
Analog pin	Power down and RESET	During operation ($\overline{\text{RESET}}$ pin = "H")	
		Recording mode/Standby	Playback mode
FOUT pin	GND level	LPF Output (recording waveform)	LPF Output
AOUT pin	GND level	SG level	LPF Output (playback waveform)



Note: This diagram shows the state of each switch during the recording operation.

LPF Characteristics

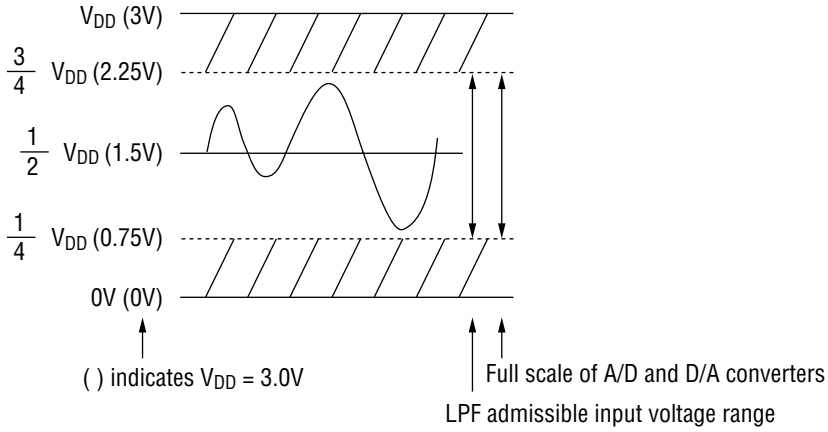
This MSM9888L/9889L contains a fourth-order switched-capacitor LPF.
The attenuation characteristic of this LPF is –40 dB/oct. The cut-off frequency and frequency characteristics of this LPF vary in proportion to the sampling frequency (fsamp). The cut-off frequency is preset to 0.4 times the sampling frequency. The following graph depicts the frequency characteristics of the LPF at fsamp = 8 kHz.



LPF Frequency Characteristics (f_{SAM}=8.0kHz)

Full Scale of A/D and D/A Converters

Parameter	Full scale of A/D and D/A converters		
	min (V)	max (V)	Amplitude (Vp-p)
MSM9888L	$\frac{1}{4} \times V_{DD}$	$\frac{3}{4} \times V_{DD}$	$\frac{1}{2} \times V_{DD}$
MSM9889L	$\frac{1}{4} \times V_{DD}$	$\frac{3}{4} \times V_{DD}$	$\frac{1}{2} \times V_{DD}$



Command Description

This IC is controlled with the following commands via control pins such as $\overline{CS}$, SCK, DI. DO and BUST (if necessary).

1. Command List

Command	D7	D6	D5	D4	D3	D2	D1	D0	Function
NOP	0	0	0	0	0	0	0	0	No function
REC	0	0	0	1	0	S2	S1	S0	Starts recording
	0	0	C5	C4	C3	C2	C1	C0	
PLY	0	0	1	0	0	0	0	M0	Starts playback
	C7	C6	C5	C4	C3	C2	C1	C0	
STOP	0	0	1	1	0	0	0	0	Terminates recording/playback.
PAUSE	0	1	0	0	0	0	0	0	Pauses or resets pause.
BLKRW	0	1	0	1	0	0	0	M1	Sets and reads the recording time.
	D7	D6	D5	D4	D3	D2	D1	D0	
DTRW	0	1	1	0	Pb	Pa	P9	P8	Reads data from or writes data to the flash memory.
	P7	P6	P5	P4	P3	P2	P1	P0	
DEL	0	1	1	1	0	0	0	0	Erases phrases.
	0	0	C5	C4	C3	C2	C1	C0	
PDWN	1	0	0	0	0	0	0	0	Stops the clock to select the power-down mode.
BYTEW	1	0	0	1	0	0	0	B8	Writes the data written with W7 to 0 to the address indicated by B8 to 0 to the flash memory buffer.
	B7	B6	B5	B4	B3	B2	B1	B0	
	W7	W6	W5	W4	W3	W2	W1	W0	
BYTER	1	0	1	0	0	0	0	B8	Reads data inside the buffer at the address indicated by B8 to 0.
	B7	B6	B5	B4	B3	B2	B1	B0	
WEND	1	0	1	1	0	0	0	0	Writes buffer data to the flash memory then quits.
END	1	1	0	0	0	0	0	0	Quits without writing buffer data to hte flash memory.
INIT	1	1	1	0	1	0	1	0	Initializes the voice area part of the flash memory.
	0	0	0	0	0	0	F1	F0	
	U7	U6	U5	U4	U3	U2	U1	U0	
STATUS	1	1	1	1	1	1	1	1	Outputs the status.

C7 to C0 : Phrase No.
S2 to S0 : Sampling frequency
Pb to P0 : Page address on the flash memory
B8 to B0 : Block address on the flash memory
F1 to F0 : Type of flash memory connected
U7 to U0 : Number of user data blocks

Sampling frequency

S2	S1	S0	Sampling frequency (Note 1)	Dividing ratio
0	0	0	2.0kHz	f_{OSC}/2048
0	0	1	2.7kHz	f_{OSC}/1536
0	1	0	3.2kHz	f_{OSC}/1280
0	1	1	4.0kHz	f_{OSC}/1024
1	0	1	5.3kHz	f_{OSC}/768
1	1	0	6.4kHz	f_{OSC}/640
1	1	1	8.0kHz	f_{OSC}/512

(Note 1) f_{OSC}=4.096MHz

MODE0 Setting

M0	Function
0	Flash playback
1	ROM playback

MODE1 Setting

M1	Function
0	Sets the number of blocks to be recorded or played back with D7 to D0.
1	Sets the channel recorded with D7 to D0 and outputs the recording time.

Phrase designation

C7	C6	C5	C4	C3	C2	C1	C0	Phrase No. (HEX)	Flash memory recording	Flash memory playback	ROM playback
0	0	0	0	0	0	0	0	Phrase 0 (00h)	Unavailable	Unavailable	Unavailable
0	0	0	0	0	0	0	1	Phrase 1 (01h)	Available (63 phrases)	Available (63 phrases)	Available (255 phrases)
0	0	0	0	0	0	1	0	Phrase 2 (02h)			
⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮			
0	0	1	1	1	1	1	0	Phrase 62 (3Eh)			
0	0	1	1	1	1	1	1	Phrase 63 (3Fh)			
0	1	0	0	0	0	0	0	Phrase 64 (40h)	Unavailable	Unavailable	
0	1	0	0	0	0	0	1	Phrase 65 (41h)			
⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮			
1	1	1	1	1	1	1	0	Phrase 254 (FEh)			
1	1	1	1	1	1	1	1	Phrase 255 (FFh)			

Page address designation

Pb	Pa	P9	P8	P7	P6	P5	P4	P3	P2	P1	P0	Page address in Flash memory
0	0	0	0	0	0	0	0	0	0	0	0	Page 000h
0	0	0	0	0	0	0	0	0	0	0	1	Page 001h
0	0	0	0	0	0	0	0	0	0	1	0	Page 002h
0	0	0	0	0	0	0	0	0	0	1	1	Page 003h
⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮
1	1	1	1	1	1	1	1	1	1	0	1	Page FFDh
1	1	1	1	1	1	1	1	1	1	1	0	Page FFEh
1	1	1	1	1	1	1	1	1	1	1	1	Page FFFh

2. Relationship between Recording/Playbakc, data transfer, and commands

	Flash memory recording/playback	ROM playback	Flash memory data transfer
NOP	—	—	—
REC	◎	—	—
PLY	◎	◎	—
STOP	○	○	—
PAUSE	○	○	—
BLKRW	○	—	—
DTRW	—	—	◎
DEL	○	—	—
PDWN	○	○	—
BYTEW	—	—	◎
BYTER	—	—	◎
WEND	—	—	◎
END	—	—	○
INIT	◎	—	◎
STATUS	○	○	—

◎ : Necessary

○ : Effective

— : Unnecessary

3. Command Descriptions

1. NOP

• Command

0	0	0	0	0	0	0	0

• Description: Non-operation
No function available.

2. REC

• Command

0	0	0	1	0	S2	S1	S0
0	0	C5	C4	C3	C2	C1	C0

• Description: Records the phrases designated by C7 to C0 with the sampling frequency designated by S2 to S0.

• Others

Sampling frequency

S2	S1	S0	Sampling frequency (Note 1)	Dividing ratio
0	0	0	2.0kHz	$f_{OSC}/2048$
0	0	1	2.7kHz	$f_{OSC}/1536$
0	1	0	3.2kHz	$f_{OSC}/1280$
0	1	1	4.0kHz	$f_{OSC}/1024$
1	0	1	5.3kHz	$f_{OSC}/768$
1	1	0	6.4kHz	$f_{OSC}/640$
1	1	1	8.0kHz	$f_{OSC}/512$

Note 1: Source frequency f_{OSC}=4.096 Hz

Phrase designation (phrases 1 to 63)

C5	C4	C3	C2	C1	C0	Phrase No. (HEX)
0	0	0	0	0	1	Phrase 1 (01h)
0	0	0	0	1	0	Phrase 2 (02h)
0	0	0	0	1	1	Phrase 3 (03h)
⋮			⋮			⋮
1	1	1	1	1	0	Phrase 62 (3Eh)
1	1	1	1	1	1	Phrase 63 (3Fh)

3. PLY

• Command

0	0	1	0	0	0	0	M0
C7	C6	C5	C4	C3	C2	C1	C0

• Description:

M0	Description
0	Plays phrases recorded in Flash memory. Designate the phrases to be played with C5 to C0 (phrases 1 to 63). Set C7 and C6 to "0".
1	Plays a fixed message that is in internal ROM. Designate the phrase to be played with C7 to C0 (phrases 1 to 255).

4. STOP

• Command

0	0	1	1	0	0	0	0

• Description: Quits recording or playback.

5. PAUSE

• Command

0	1	0	0	0	0	0	0

• Description: Pauses recording or plyaback.
Restarts recording or playback if the PAUSE command is input again.

6. BLKRW

• Command

0	1	0	1	0	0	0	M1
D7	D6	D5	D4	D3	D2	D1	D0

Output

O7	O6	O5	O4	O3	O2	O1	O0

• Note: Outputs O7-O0 only when M1 is "1".

• Description: 1. BLKWR command ..... When M1 is "0"
Designates the number of blocks in which phrases are to be recorded.

D7	D6	D5	D4	D3	D2	D1	D0	Number of blocks (HEX)
0	0	0	0	0	0	0	0	Records phrases until memory is full (Remaining block is zero)
0	0	0	0	0	0	0	1	Records 1 (01h) block.
0	0	0	0	0	0	1	0	Records 2 (02h) blocks.
•	•	•	•	•	•	•	•	•
1	1	1	1	1	1	1	0	Records 254 (FEh) blocks.
1	1	1	1	1	1	1	1	Records 255 (FFh) blocks.

2. BLKRD command ..... When M1 is "1"
Outputs the number of blocks in which the phrase (phrases 1 to 63) designated by D7 to D0 was recorded.
If the number of designated phrases is zero, output the number of the remaining recordable blank blocks with O7 to O0.

D7	D6	D5	D4	D3	D2	D1	D0	Data output with O7 to O0
0	0	0	0	0	0	0	0	Outputs the number of the remaining recordable blank blocks.
0	0	0	0	0	0	0	1	Outputs the number of blocks of phrase 1 (01h).
0	0	0	0	0	0	1	0	Outputs the number of blocks of phrase 2 (02h).
•	•	•	•	•	•	•	•	•
0	0	1	1	1	1	1	0	Outputs the number of blocks of phrase 62 (3Eh).
0	0	1	1	1	1	1	1	Outputs the number of blocks of phrase 63 (3Fh).

Flash Memory Devices and Memory Capacity per Block

Shown below is the relationship between Flash memory devices and memory capacity per block. The memory capacity per block is 1/256 of memory capacity irrespective of the model of memory.

Model name	Memory capacity	No. of blocks available for recording/playback	Memory capacity per block (bits)	Memory capacity per block used for recording/playback (bits)
MSM9892L	2Mbit	255	8448	8192
MSM9893L	4Mbit	255	16896	16384
MSM9894L	8Mbit	255	33792	32768

Relationship between Blocks and Recording Time

The recording time is determined by the memory capacity per block used for recording/ playback, number of blocks used for recording, and sampling frequency.
The recording time can be calculated by the following equation.

$$\text{Recording time (seconds)} = \frac{\text{Memory capacity per block used for recording/playback} \times \text{Number of blocks used}}{\text{Sampling frequency (kHz)} \times \text{4-bit ADPCM}}$$

For example, when 4-Mbit serial voice Flash memory is used, the recording time if voice data is recorded in 10 blocks at a 6.4 kHz sampling frequency is calculated as shown below.

Where the memory capacity per block used for recording/playback is 16384 bits,

$$\text{Recording time (seconds)} = \frac{16384 \text{ bits} \times 10 \text{ blocks}}{6.4\text{kHz} \times \text{4-bit ADPCM}}$$

$$= 6.4 \text{ seconds}$$

7. DTRW

• Command

0	1	1	0	Pb	Pa	P9	P8
P7	P6	P5	P4	P3	P2	P1	P0

• Description: Selects the DTRW mode. Inputs data to or outputs data from the flash memory page designated with Pb to P0. To release the DTRW mode, input the WEND command or END command. The flash memory consists of 264 bytes per page.
The number of pages on each flash memory is as follows:

	MSM9892L	MSM9893L	MSM9894L
Memory size	2M bits	4M bits	8M bits
One-block size	8192 bits	16384 bits	32768 bits
Number of pages	1024 Pages	2048 Pages	4096 Pages

8. DEL

• Command

0	1	1	1	0	0	0	0
0	0	C5	C4	C3	C2	C1	C0

• Description: Erases the phrases designated with C5 to C0.
Applied to recording playback using the flash memory and not applied to ROM playback.

9. PDWN

• Command

1	0	0	0	0	0	0	0

• Description: Stops the clock and sets the power-down mode after teh command is input.
To release the power-down mode, input RESET.

10. BYTEW

• Command

1	0	0	1	0	0	0	B8
B7	B6	B5	B4	B3	B2	B1	B0
W7	W6	W5	W4	W3	W2	W1	W0

• Note: This command is valid only in DTRW mode.

• Description: Rewrites the content of the page designated with the DTRW command in units of bytes. Designate the address in the page with B8 to B0 and input data with W7-W0.

11. BYTER

• Command

1	0	1	0	0	0	0	B8
B7	B6	B5	B4	B3	B2	B1	B0

Output

O7	O6	O5	O4	O3	O2	O1	O0

• Note: This command is valid only in DTRW mode.

• Description: Reads the contents of the page designated with the DTRW command in units of byte. When the address in the page is designated with B8-B0, data is output after the command input.

12. WEND

• Command

1	0	1	1	0	0	0	0

• Note: This command is valid only in DTRW mode.

• Description: Writes the content of the page designated with the DTRW command to the flash memory then exits the DTRW mode.

13. END

• Command

1	1	0	0	0	0	0	0

• Note: This command is valid only in DTRW mode.

• Description: Exits the DTRW mode without writing the content of the page designated with the DTRW command to the flash memory.

14. INIT

• Command

1	1	1	0	1	0	1	0
0	0	0	0	0	0	F1	F0
U7	U6	U5	U4	U3	U2	U1	U0

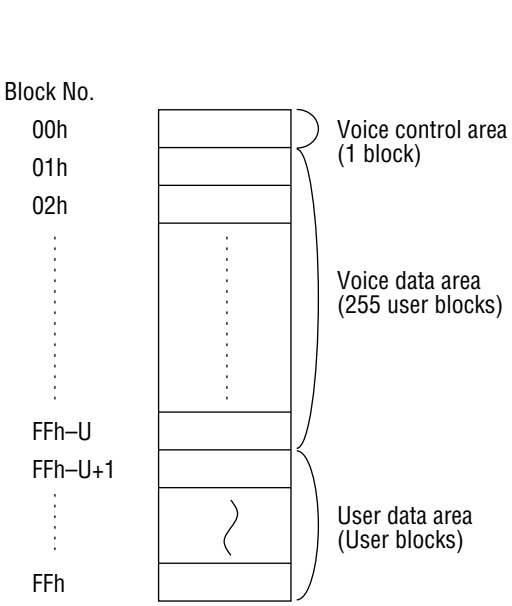
• Description: Initializes the area that excludes the number of blocks designated with U7 to U0 from the end of the flash memory blocks as the recording/playback area. Also, selects the model of the flash memory with F1 and F0.

All voice data recorded in Flash memory can be erased by entering the INIT command.
Also use the INIT command to erase all phrases.

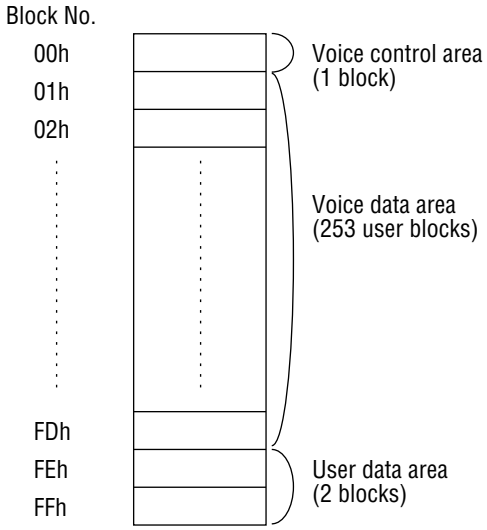
F1	F0	Flash memory size	Model name
0	1	2M bits	MSM9892L
1	0	4M bits	MSM9893L
1	1	8M bits	MSM9894L

U7	U6	U5	U4	U3	U2	U1	U0	Setting of number of user blocks
0	0	0	0	0	0	0	0	The number of blocks designated as a user block is zero.
⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮
1	1	1	1	1	1	1	0	254 blocks are designated as user blocks.
1	1	1	1	1	1	1	1	255 blocks are designated as user blocks.

Flash memory allocation after input of INIT command



Example: The user data area is divided into two blocks.



15. STATUS

• Command

1	1	1	1	1	1	1	1

Output

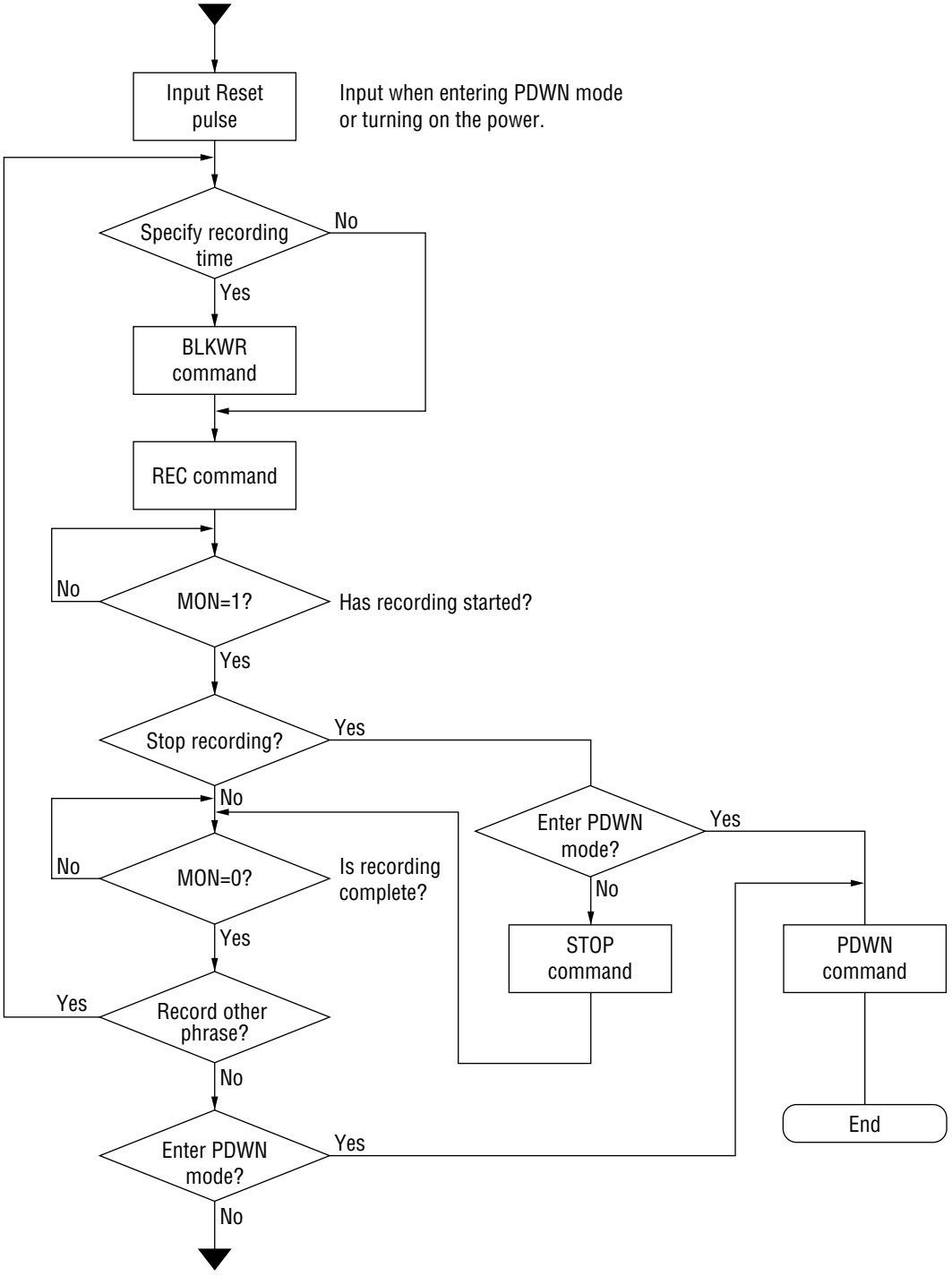
07	06	05	04	03	02	01	00

• Description: Outputs the M9888 status.

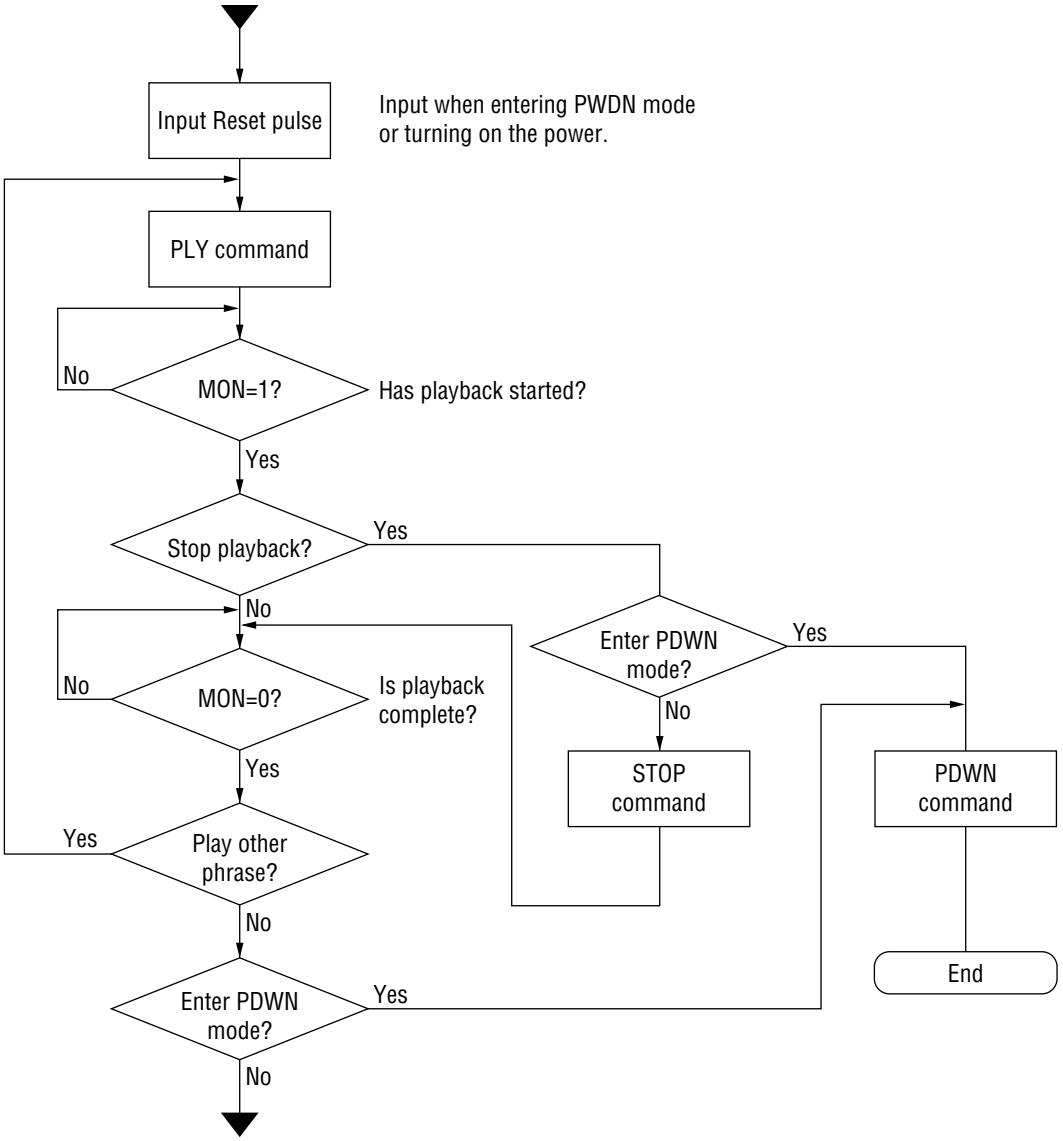
07	MON	Outputs "1" during execution of the REC or PLY command. It includes the memory management time in addition to the recording/playback time. Also, outputs the same value as that of the MON pin.
06	VPM	Outputs "1" during pause.
05	RPM	Outputs "1" during acrual recording by the REC command or during voice output by the PLT command. Otherwise, "0" is output.
04	—	No function
03	MEMFUL	Outputs "1" when there is no space in the voice area on the flash memory.
02	NAR	Outputs "1" when the next phrase can be input during continuous voice playback of the fixed message in the internal ROM.
01	—	No function
00	—	No function

Flowcharts

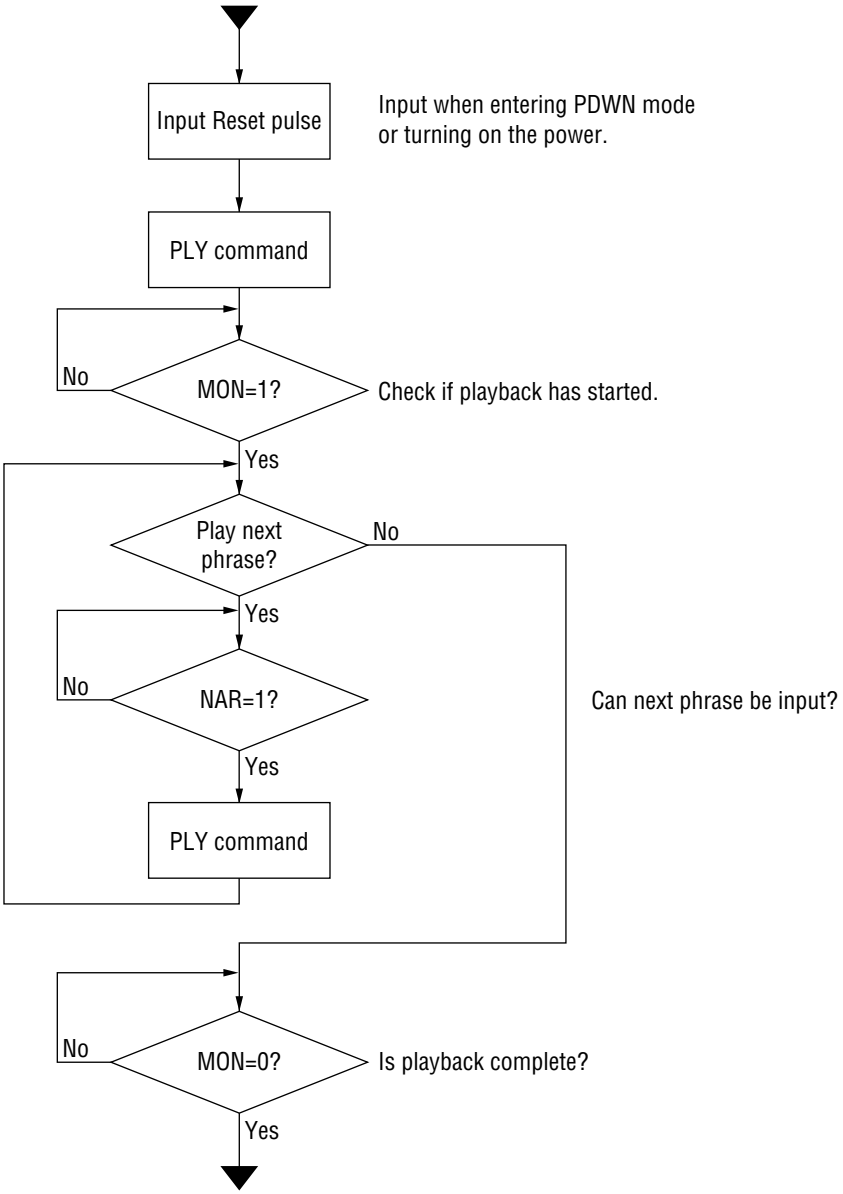
1. Flowchart of recording



2. Flowchart of playback

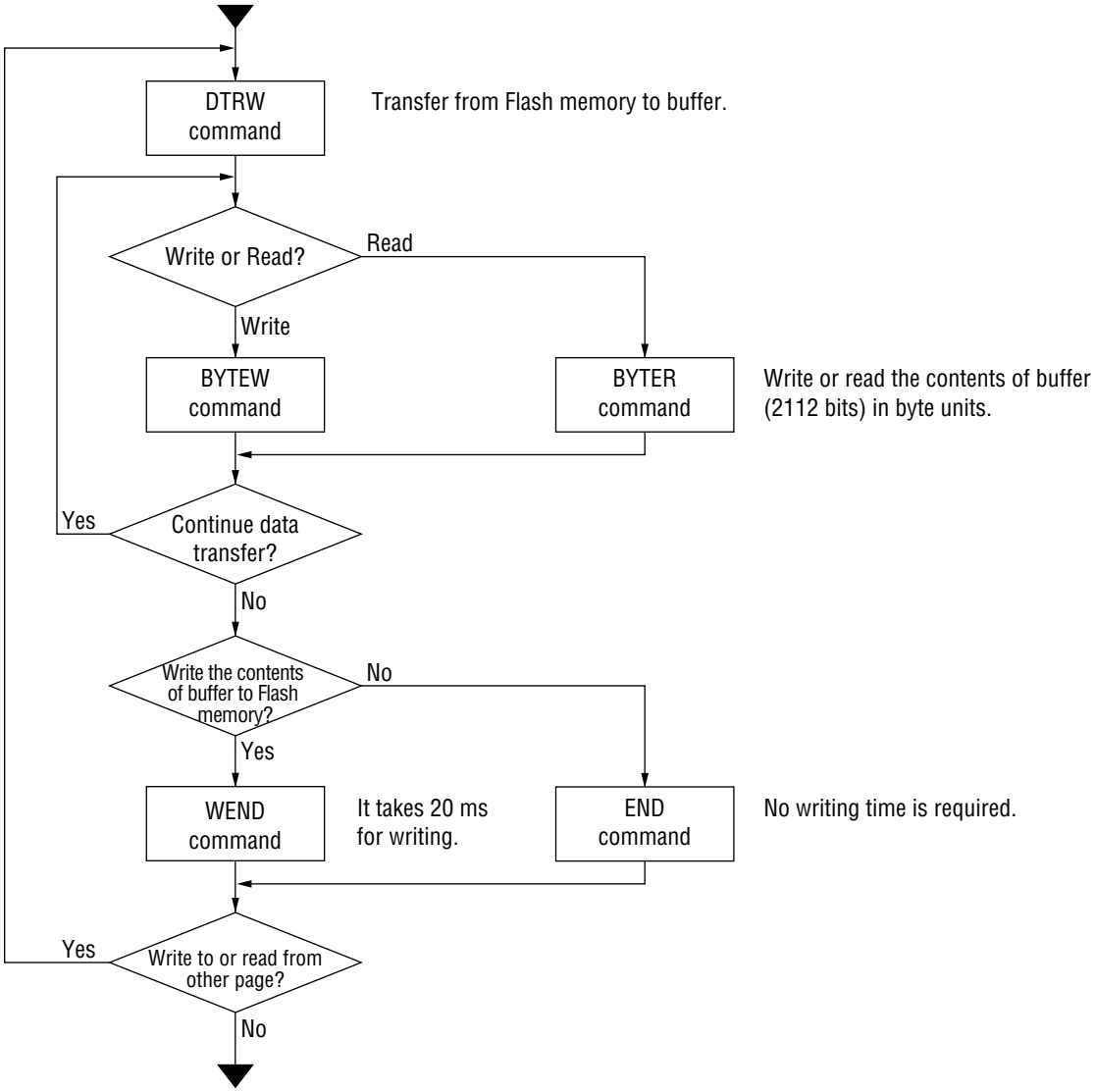


3. Flowchart of continuous ROM playback



Note: This flowchart is used for ROM playback only.
This flowchart cannot be used for Flash memory playback.

4. Flowchart of Data Transfer

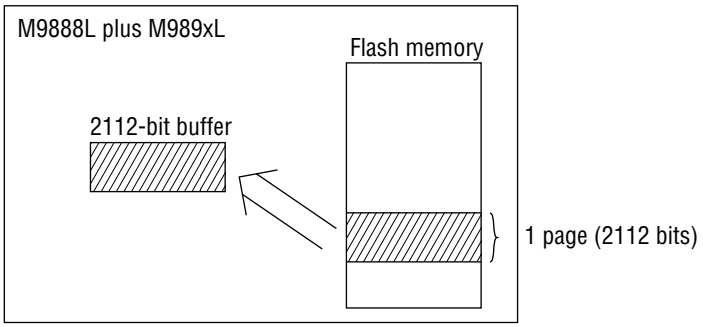


Writing to or Reading from Flash Memory

Data can be written or read in byte units by using both the MSM9888L and MSM989x series (serial voice Flash memory).

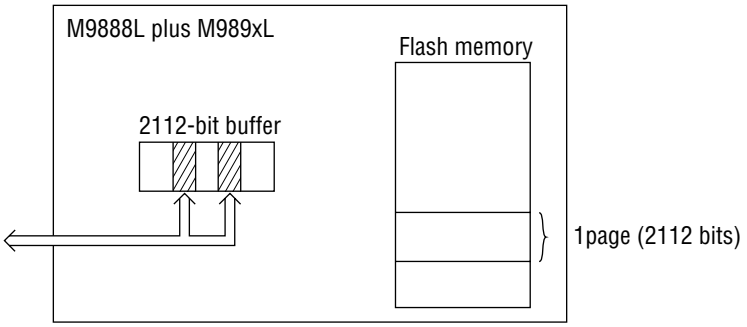
1. DTRW command

This command is used to transfer a page of data from the Flash memory to the 2112-bit buffer. When using this command, it is required to specify the address of a page to be transfered to the buffer.



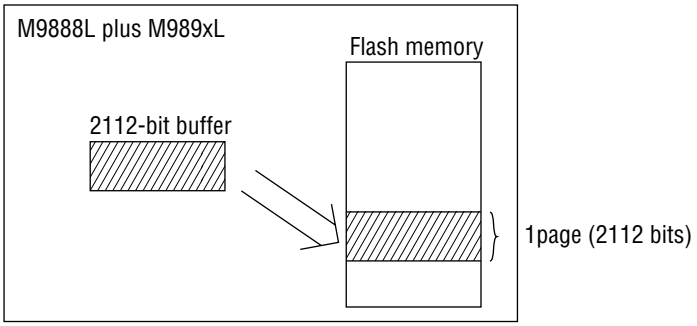
2. BYTEW command and BYTER command

The BYTEW command is used to write in byte units the contents of a 2112-bit buffer transfered with the DTRW command. The BYTER command is used to read them.



3. WEND command

This command is used to write the contents of a 2112-bit buffer to the Flash memory.
It takes about 21 msec for writing.



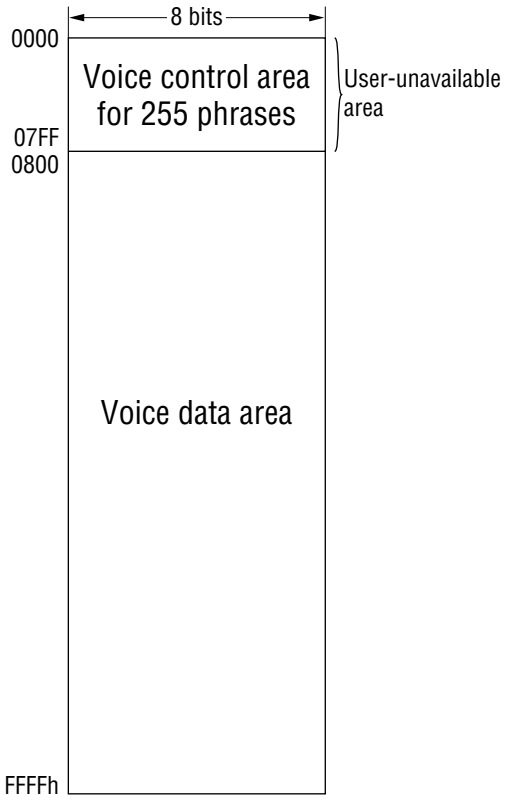
Flash Memory Devices and Memory Capacity per Block

Shown below is the relatiohship between Flash memory devices and memory capacity per block. The memory capacity per blcok is 1/256 of memory capacity irrespective of the model of memory.

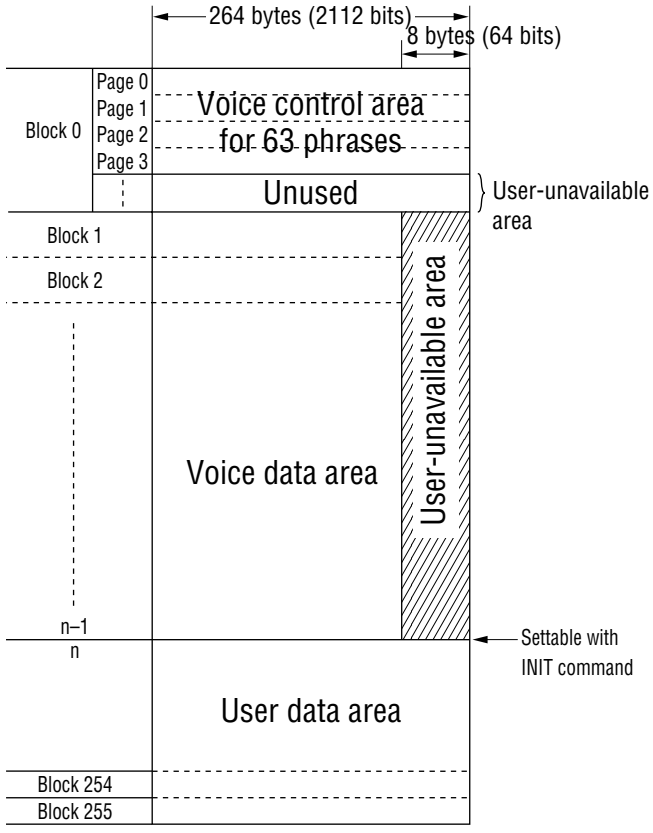
Product name	Memory capacity	No. of blocks available for recording/playback	Memory capacity per block (bits)	Memory capacity per block used for recording/playback (bits)
MSM9892L	2Mbit	255	8448	8192
MSM9893L	4Mbit	255	16896	16384
MSM9894AL	8Mbit	255	33792	32768

Information on Voice Control of M9888L/M9889L

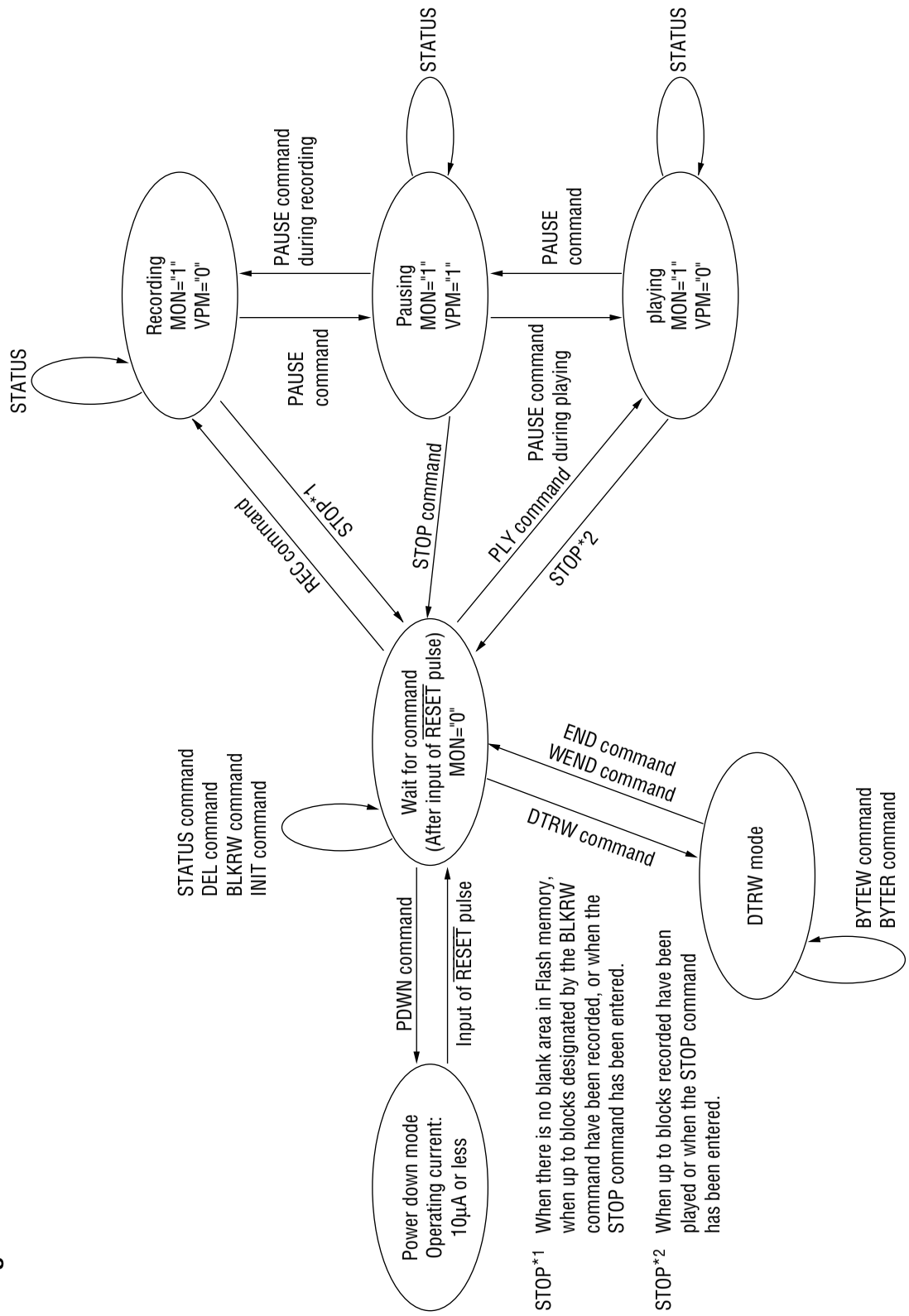
User-unavailable area of internal ROM of M9888L/M9889L



Voice control area and user-unavailable area of M989xL



Change of Status



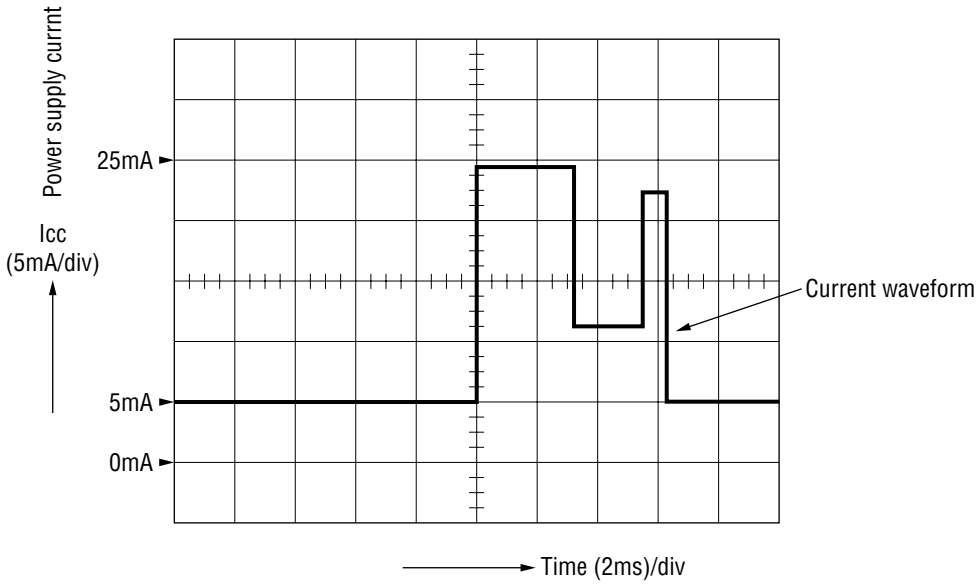
NOTE ON USE

When you design a power supply circuit

The instantaneous current, though it is within the rated value, flows to the MSM989xL series product (serial voice Flash memory) when data is written in the product. See the following figure. When voice data is written to the MSM989xL series product during recording operation, the power supply voltage fluctuated by the instantaneous current may cause noises to be recorded. You should design a power supply circuit considering the above instantaneous current. It is recommended to use a regulator that can regulate the fluctuated voltage due to the instantaneous current.

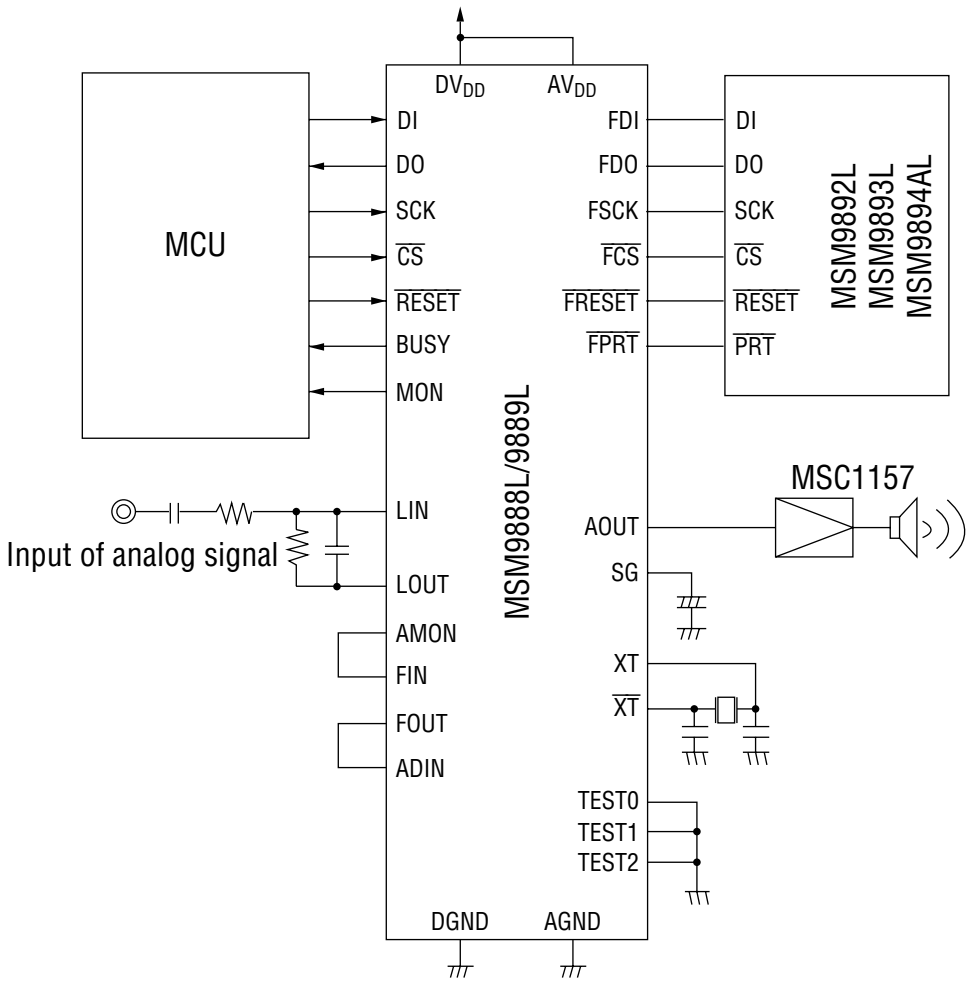
The instantaneous current flows every $512/f_{SAM}$ [sec].

For example, if the sampling frequency f_{SAM} is 8 kHz, the instantaneous current flows every 64 ms.



Power supply current waveform (typical) when the circuit is active at V_{CC}=3.0V

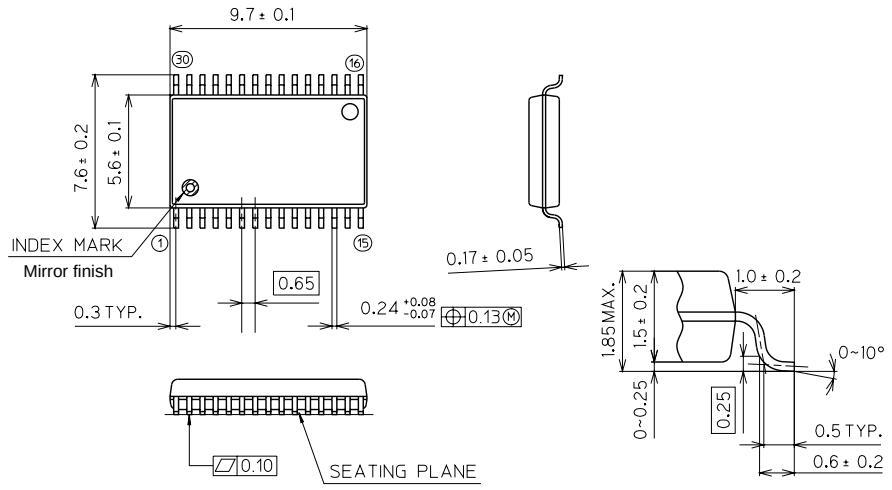
APPLICATION CIRCUIT



PACKAGE DIMENSIONS

(Unit : mm)

SSOP30-P-56-0.65-K



Package material	Epoxy resin
Lead frame material	42 alloy
Pin treatment	Solder plating (≥5 μm)
Package weight (g)	0.19 TYP.
Rev. No./Last Revised	5/Dec. 5, 1996

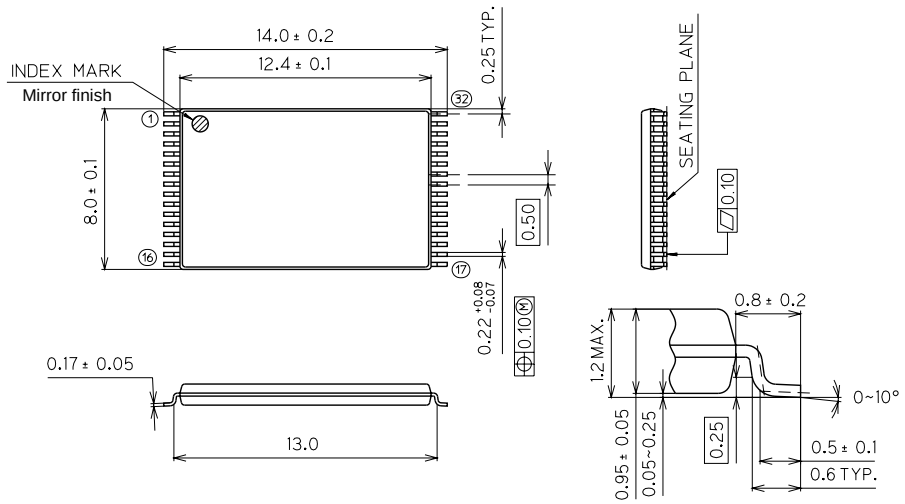
Oki Electric Industry Co., Ltd.

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 Oki's responsible sales person for the product name, package name, pin number, package code and desired mounting conditions (reflow method, temperature and times).

(Unit : mm)

TSOP(1)32-P-0814-0.50-1K



Package material	Epoxy resin
Lead frame material	42 alloy
Pin treatment	Solder plating (≥5 μm)
Package weight (g)	0.27 TYP.
Rev. No./Last Revised	5/Dec. 10, 1996

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REVISION HISTORY

Document No.	Date	Page		Description
		Previous Edition	Current Edition	
E2D0083-29-94	Sep. 1999	—	—	Preliminary edition
FEDL9888L-9889L-01	Feb. 27, 2002	25	25	Changed contents of the table for ceramic oscillators
		—	53	Addition of Revision History

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