

MSM9836-xxx**Built-in Mask ROM Voice Synthesis IC****GENERAL DESCRIPTION**

The MSM9836 is a PCM voice synthesis IC with built-in 3-Mbit mask ROM, D/A converter, and low-pass filter (LPF).

The MSM9836 is specifically designed for applications that use a microcontroller.

For this reason, functional support for standalone mode and RC oscillation has been omitted from the MSM9805, and the ROM capacity and the number of phrases have been increased.

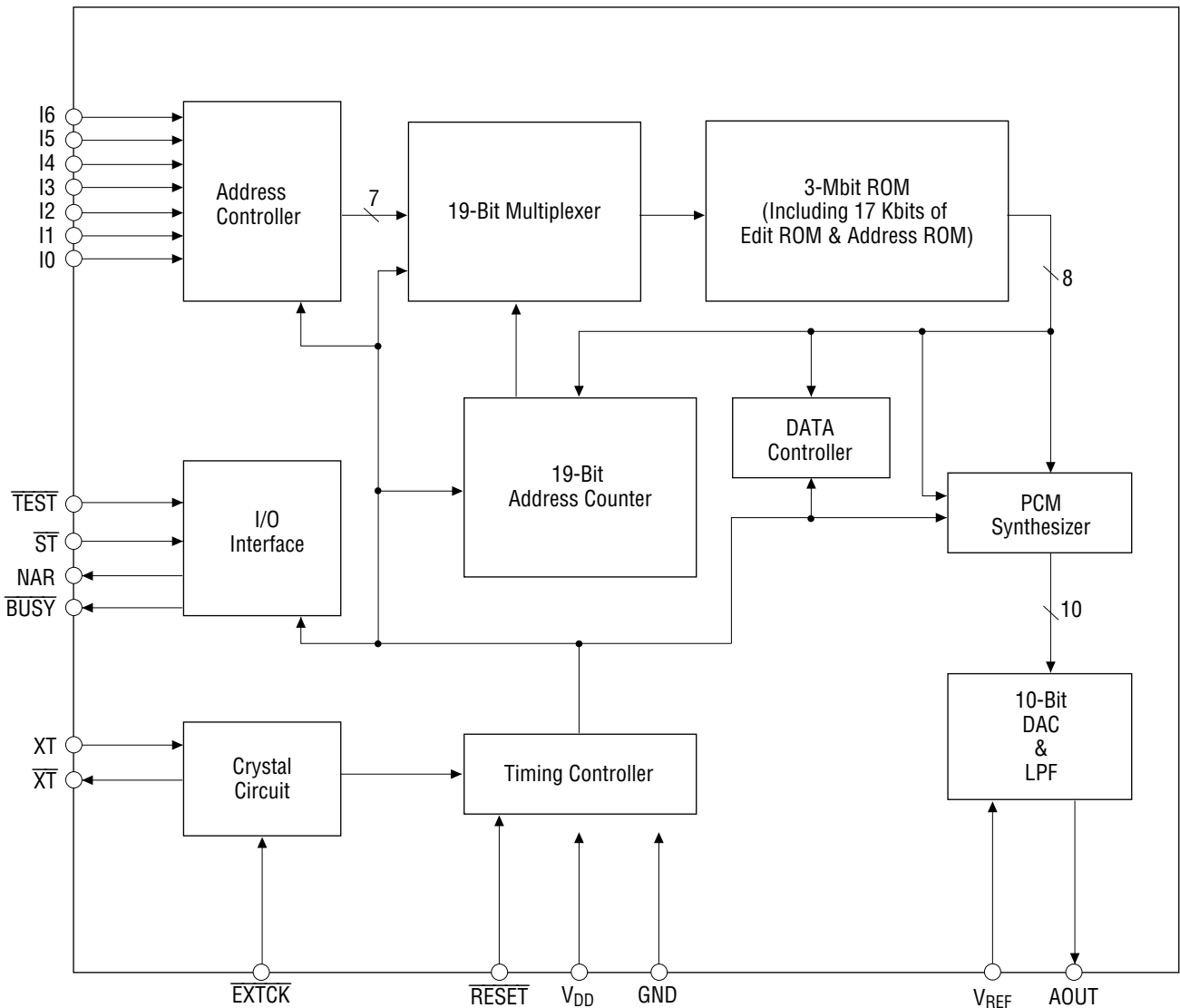
The following table lists the functional differences between the MSM9836 and the MSM9805.

	MSM9836	MSM9805
ROM Capacity	3 Mbits	2 Mbits
Interface	Microcontroller	Microcontroller/Standalone
Oscillation	Ceramic	Ceramic/RC
Maximum Number of Phrases	127	63
Status Signal	NAR/ <u>BUSY</u> simultaneous output	Only NAR output when operating in microcontroller interface mode

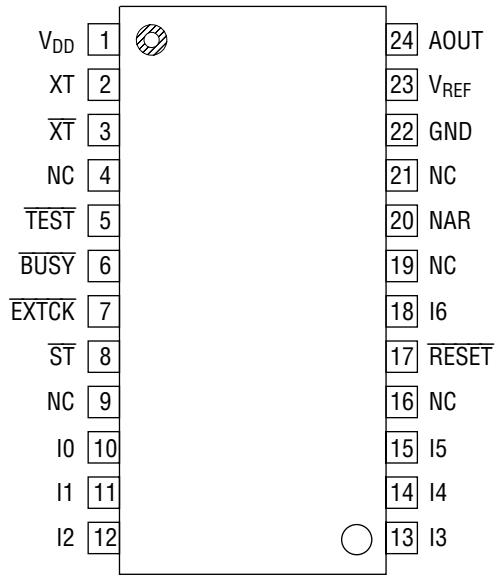
FEATURES

- 8-bit OKI nonlinear PCM method
- Sampling frequency : 4.0 kHz/5.3 kHz/6.4 kHz/8.0 kHz/10.6 kHz/12.8 kHz/
(Can be set for each phrase) 16.0 kHz
- ROM capacity : 3 Mbits
- Maximum playback time : 97.7 sec ($f_{SAM} = 4.0$ kHz)
73.7 sec ($f_{SAM} = 5.3$ kHz)
61.0 sec ($f_{SAM} = 6.4$ kHz)
- Master clock frequency : 4.096 MHz
(Ceramic oscillation/external clock input)
- Edit ROM function
- Maximum number of phrases : 127
- Built-in current mode 10-bit D/A converter
- Built-in low-pass filter
- Power supply voltage : +2.0 to +5.5 V
- Package :
24-pin plastic SOP (SOP24-P-430-1.27-K) (Product name: MSM9836-xxxGS-K)
xxx indicates code number.

BLOCK DIAGRAM



PIN CONFIGURATION (TOP VIEW)



NC : No connection

24-Pin Plastic SOP

PIN DESCRIPTIONS

Pin	Symbol	Type	Description
17	$\overline{\text{RESET}}$	I	The IC enters the standby state if this pin is set to "L" level. At this time, oscillation stops and AOUT output becomes GND level, then the IC returns to the initial state. This IC has a built-in power-on reset circuit. To operate power-on reset correctly, apply the power within 1 ms up to V_{DD} . If the power cannot be applied within 1ms, apply a $\overline{\text{RESET}}$ pulse during power-on. This pin has an internal pull-up resistor.
20	NAR	O	Signal output pin that indicates whether the 7-bit LATCH (see Block Diagram) is idle. NAR at "H" level indicates that the LATCH is empty and $\overline{\text{ST}}$ input is enabled.
7	$\overline{\text{EXTCK}}$	I	Ceramic oscillator input/external clock input switching pin. Set to "H" level if ceramic oscillation is used. Set to "L" level if external clock is used.
23	V_{REF}	I	Volume setting pin. If this pin is set to GND level, the maximum current is forced in, and if set to V_{DD} level, the minimum current is forced in. This pin has a built-in pull-down resistor of approx. 10 k Ω .
24	AOUT	O	Voice output pin. The voice signals are output as current changes. A "L" level signal is output through this pin in standby state.
22	GND	—	Ground pin.
1	V_{DD}	—	Power supply pin. Insert a bypass capacitor of 0.1 μF or more between this pin and the GND pin.
2	XT	I	Ceramic oscillator connection pin when ceramic oscillation is selected. Input from this pin if external clock is used.
3	$\overline{\text{XT}}$	O	Ceramic oscillator connection pin when ceramic oscillation is selected. Leave this pin open if external clock is used. A "L" level signal is output through this pin in standby state.
5	$\overline{\text{TEST}}$	I	Normally leave this pin open. This pin is used only for testing the internal circuit.
8	$\overline{\text{ST}}$	I	Voice synthesis starts at fall of $\overline{\text{ST}}$, and addresses I0 to I6 are fetched at rise of $\overline{\text{ST}}$. Input $\overline{\text{ST}}$ when NAR, the status signal, is at "H" level. This pin has internal pull-up resistor.
10-15, 18	I0 - I6	I	Phrase input pins corresponding to playback sound.
6	$\overline{\text{BUSY}}$	O	This pin is at "H" level upon power-on. A "L" level signal is output through this pin for the time during which voice is being played.

ABSOLUTE MAXIMUM RATINGS

(GND=0V)

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

RECOMMENDED OPERATING CONDITIONS

(GND=0 V)

Parameter	Symbol	Condition	Range			Unit
Power Supply Voltage	V _{DD}	—	2.0 to 5.5			V
Operating Temperature	T _{op}	—	-40 to +85			°C
Original Oscillation Frequency	f _{OSC}	When crystal is selected	Min.	Typ.	Max.	MHz
			3.5	4.096	4.5	

Note: The accuracy of the oscillation frequency when RC oscillation is selected depends largely on the accuracy of the external R and C.

ELECTRICAL CHARACTERISTICS

DC Characteristics (1)

(V_{DD}=5.0 V, GND=0 V, Ta=-40 to +85°C, unless otherwise specified)

Parameter	Symbol	Condition	Min.	Typ.	Max.	Unit
"H" Input Voltage	V _{IH}	—	4.2	—	—	V
"L" Input Voltage	V _{IL}	—	—	—	0.8	V
"H" Output Voltage	V _{OH}	I _{OH} =-1 mA	4.6	—	—	V
"L" Output Voltage	V _{OL}	I _{OL} =2 mA	—	—	0.4	V
"H" Input Current 1	I _{IH1}	V _{IH} =V _{DD}	—	—	10	μA
"H" Input Current 2	I _{IH2}	Applies to XT pin only. V _{IH} =V _{DD}	—	—	15	μA
"L" Input Current 1	I _{IL1}	V _{IL} =GND	-10	—	—	μA
"L" Input Current 2 (*1)	I _{IL2}	Internal pull-up resistor	-200	-90	-30	μA
Dynamic Supply Current 1 (*2)	I _{DD1}	V _{REF} =V _{DD} , AOUT voltage=0V	—	0.4	1	mA
Dynamic Supply Current 2 (*3)	I _{DD2}	At maximum output current V _{REF} =GND, AOUT voltage=0V	—	—	16	mA
Standby Supply Current	I _{DS}	Ta=-40 to +70°C	—	—	10	μA
		Ta=-40 to +85°C	—	—	50	μA
AOUT Output Current	I _{AOUT}	At maximum output current V _{REF} =V _{DD} , AOUT voltage=0V	6	9.5	15	mA
V _{REF} Pin Pull-Down Resistance	R _{VREF}	—	7	10	13	kΩ

*1 Applicable to $\overline{\text{RESET}}$, $\overline{\text{ST}}$

*2 Dynamic supply current excluding DAC output current

*3 Dynamic supply current at maximum output current

DC Characteristics (2)

(V_{DD}=3.1 V, GND=0 V, Ta=-40 to +85°C)

Parameter	Symbol	Condition	Min.	Typ.	Max.	Unit
"H" Input Voltage	V _{IH}	—	2.7	—	—	V
"L" Input Voltage	V _{IL}	—	—	—	0.5	V
"H" Output Voltage	V _{OH}	I _{OH} =-1 mA	2.6	—	—	V
"L" Output Voltage	V _{OL}	I _{OL} =2 mA	—	—	0.4	V
"H" Input Current 1	I _{IH1}	V _{IH} =V _{DD}	—	—	10	μA
"H" Input Current 2	I _{IH2}	Applies to XT pin only. V _{IH} =V _{DD}	—	—	15	μA
"L" Input Current 1	I _{IL1}	V _{IL} =GND	-10	—	—	μA
"L" Input Current 2 (*1)	I _{IL2}	Internal pull-up resistor	-100	-30	-10	μA
Dynamic Supply Current 1 (*2)	I _{DD1}	V _{REF} =V _{DD} , AOUT voltage=0V	—	0.15	0.5	mA
Dynamic Supply Current 2 (*3)	I _{DD2}	At maximum output current V _{REF} =GND, AOUT voltage=0V	—	—	5.5	mA
Standby Supply Current	I _{DS}	Ta=-40 to +70°C	—	—	5	μA
		Ta=-40 to +85°C	—	—	20	μA
AOUT Output Current	I _{AOUT}	At maximum output current V _{REF} =V _{DD} , AOUT voltage=0V	1.4	3.2	5	mA
V _{REF} Pin Pull-Down Resistance	R _{VREF}	—	7	10	13	kΩ

*1 Applicable to $\overline{\text{RESET}}$, $\overline{\text{ST}}$

*2 Dynamic supply current excluding DAC output current

*3 Dynamic supply current at maximum output current

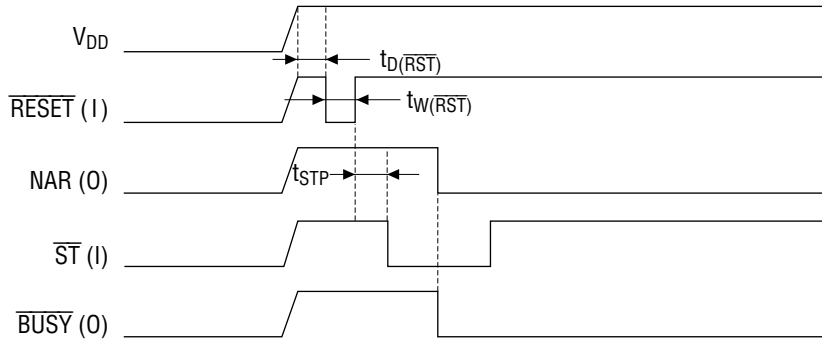
AC Characteristics

(V_{DD}=5.0 V, GND=0 V, Ta=-40 to +85°C)

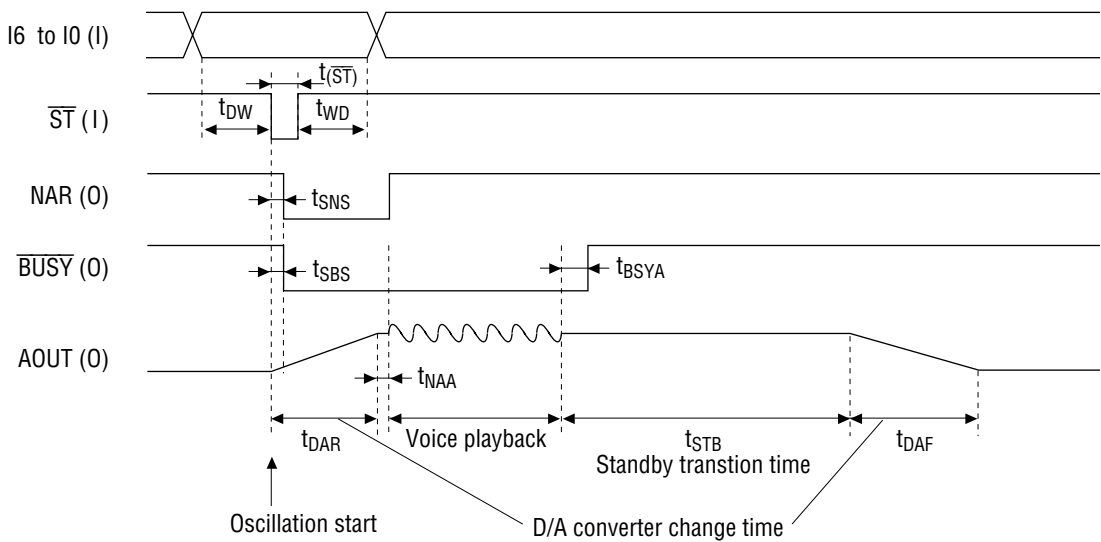
Parameter	Symbol	Condition	Min.	Typ.	Max.	Unit
Master Clock Duty Cycle	f _{duty}	—	40	50	60	%
$\overline{\text{RESET}}$ Input Pulse Width	t _{w(RST)}	—	10	—	—	μs
$\overline{\text{RESET}}$ Input Time After Power-on	t _{D(RST)}	—	0	—	—	μs
$\overline{\text{ST}}$ Signal Setup Time	t _{STP}	At power-on	1	—	—	μs
$\overline{\text{ST}}$ Input Pulse Width	t _($\overline{\text{ST}}$)	—	0.35	—	2000	μs
The $\overline{\text{ST}}$ - $\overline{\text{ST}}$ Pulse Interval	t _{SS}	Upon entering the stop code	40	—	—	μs
Data Setup Time	t _{DW}	—	1	—	—	μs
Data Hold Time	t _{WD}	—	1	—	—	μs
NAR Output Time 1	t _{SNS}	f _{SAM} =8 kHz	—	—	10	μs
NAR Output Time 2	t _{NAA}	f _{SAM} =8 kHz	350	375	400	μs
NAR Output Time 3	t _{NAB}	f _{SAM} =8 kHz	315	440	500	μs
NAR Output Time 4	t _{NAC}	f _{SAM} =8 kHz	350	375	500	μs
BUSY Output Time 1	t _{SBS}	f _{SAM} =8 kHz	—	—	10	μs
BUSY Output Time 2	t _{BSYA}	f _{SAM} =8 kHz	350	375	400	μs
D/A Converter Change Time	t _{DAR} , t _{DAF}	—	60	64	68	ms
Standby Transition Time (at end of voice output)	t _{STB}	—	200	250	300	ms
Silence Time Between Phrases	t _{BLN}	f _{SAM} =8 kHz	350	375	500	μs

TIMING DIAGRAMS

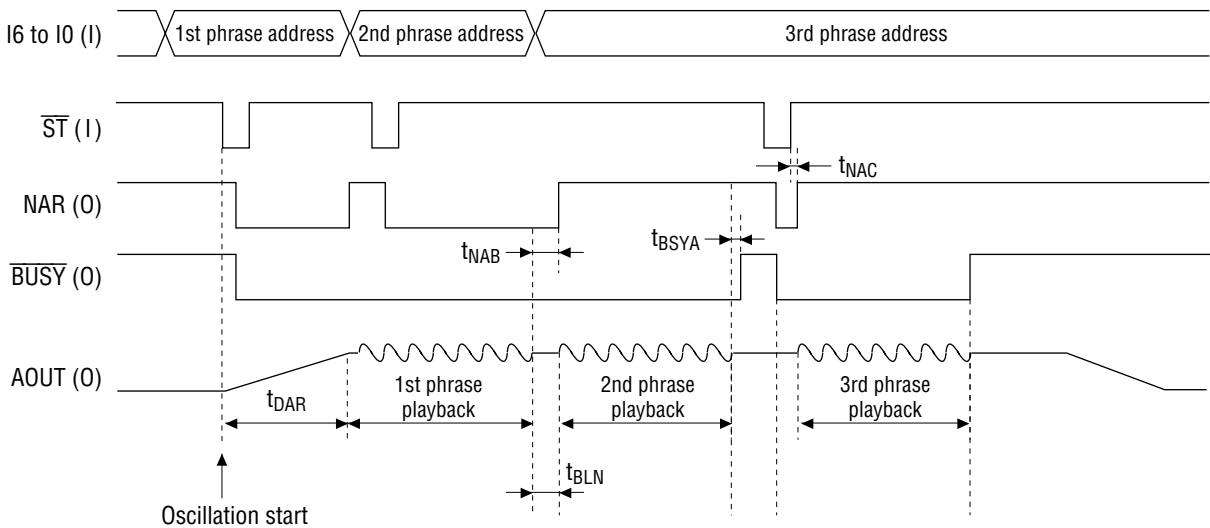
1. AC Characteristics at Power-On



2. AC Characteristics in Standby Status and when the IC is Activated

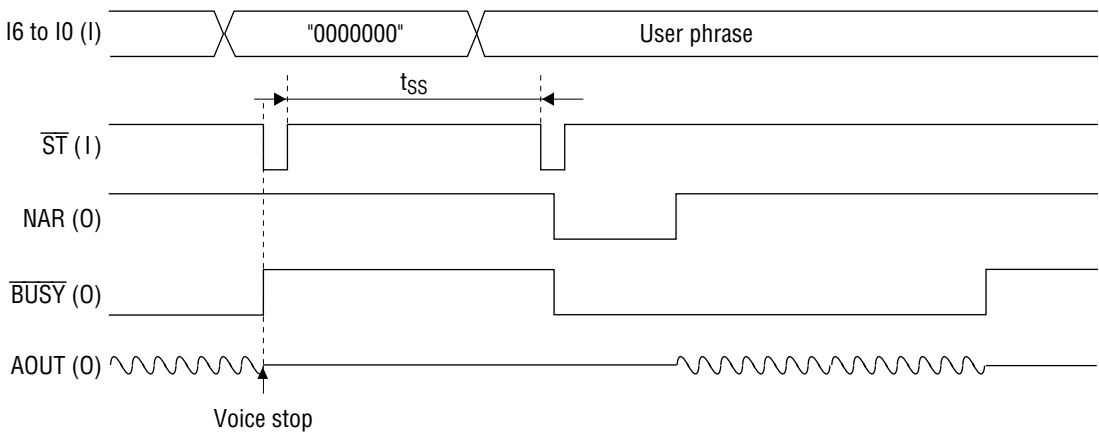


3. Playback Timing



The pins I6 to I0 are used to enter the address of a phrase subject to voice synthesis. Voice synthesis starts by entering the \overline{ST} signal during addressing.

4. Stop Code Input Timing



When I6-I0 are set to "0000000" during voice playback (during the output of "L" level at the $\overline{\text{BUSY}}$ pin), and a $\overline{\text{ST}}$ signal is input, playback stops regardless of whether NAR is at "H" or "L" level and AOUT becomes $1/2 I_{\text{AOUT}}$. Stop code becomes valid at the falling edge of $\overline{\text{ST}}$.

The stop code does not initialize internal units but only stops playback. To initialize an internal register, use the $\overline{\text{RESET}}$ pin.

FUNCTIONAL DESCRIPTION

1. Sampling Frequency

Sampling frequencies can be set for each address of the internal ROM. The following seven frequencies can be selected when creating voice data:

4.0 kHz, 5.3 kHz, 6.4 kHz, 8.0 kHz, 10.6 kHz, 12.8 kHz, 16.0 kHz

2. Voice Playback Time

As shown in Figure 1, the internal ROM consists of edit ROM area, voice data management area, test data area, and voice data area. The actual capacity for voice data is different from the indicated ROM capacity.

Edit ROM Area	8 Kbits
Voice Data Management Area	8 Kbits
Test Data Area	1 Kbits
Voice Data Area	

Figure 1 Internal ROM (3-Mbit) Configuration

Use the following expression for a rough estimate of voice playback time :

$$\text{Playback time} = (3072 - 8 - 8 - 1) \text{ [Kbits]} \times 1024 \div 8 \div (\text{sampling frequency}) \text{ [Hz]}$$

For example, if data for MSM9836 is created at an 8.0 kHz sampling rate, the playback time is

$$(3072 - 8 - 8 - 1) \text{ [Kbits]} \times 1024 \div 8 \div 8000 \text{ [Hz]} \approx 48.8 \text{ [sec]}$$

3. Playback Method

The OKI nonlinear PCM method has been employed.

This method is suited to the waveforms that require high accuracy around the center of an amplitude, like the amplitude of human voices.

The center area has accuracy of the amplitude equivalent to a 10-bit straight PCM.

4. Edit ROM

With the internal edit ROM, the MSM9836 can perform continuous playback of multiple phrases with the same control as single phrase playback.

For example: The phrase "Today's weather is ..." can be used to illustrate the differences between the use of the edit ROM and non-use of the edit ROM. In the case of non-use of the edit ROM, individual data must be stored in the voice data control area (see Table 1), then for playback of "Today's weather is sunny" and "Today's weather is rainy", each phrase must be addressed individually.

On the other hand, the MSM9836 has edit ROM functions, which eliminate the need for an external microcontroller to provide the continuous timing necessary for voice concatenation. This means that individual phrases or words which are stored in voice data control area (see Table 2) can be concatenated in the edit ROM and assigned a single address according to their content. This feature allows for efficient use of memory for phrase storage in ROM. Table 2 shows phrases/words stored in ROM and their addresses, Table 3 shows how you can combine the phrase/word addresses (up to a maximum of 8) in the edit ROM to achieve fully concatenated phrases.

The edit ROM can also perform silence playback, with no silence data required to be stored in the voice data control area.

- Minimum silence time 32 ms
- Maximum silence time 4064 ms
- Setting of silence time in 32-ms steps

Table 1 Phrases stored in data control area (when edit ROM is not used)

Address [HEX]	Phrase
01	Today's weather is sunny.
02	Today's weather is rainy.
03	Today's weather is sunny becoming cloudy, rainy in some areas.
⋮	⋮
7F	

Table 2 Phrases stored in data control area (when edit ROM is used)

Address [HEX]	Phrase
01	Today's
02	weather
03	sunny
04	rainy
05	is
⋮	⋮
7F	

Table 3 Edit ROM Configuration

Address [HEX]	Address Assinymt in Phrase ROM
01	[01][02][05][03] ← "Today's weather is sunny."
02	[01][02][05][04] ← "Today's weather is rainy."
03	
⋮	⋮
7F	

Up to 8 phrases including silence can be registered into one address in the edit ROM.

5. Oscillation and Clock Input

5.1 Ceramic oscillation

Figure 2 shows an external circuit using a ceramic oscillator.

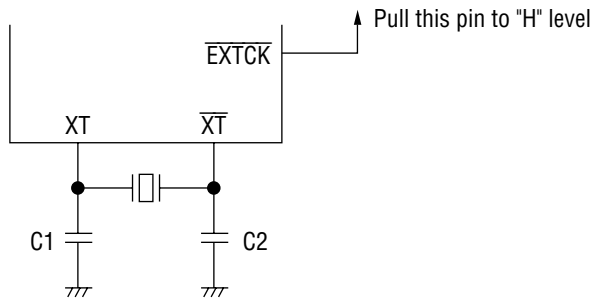


Figure 2 External Circuit Using a Ceramic Oscillator

5.2 External clock input

Figure 3 shows a circuit for external clock input.

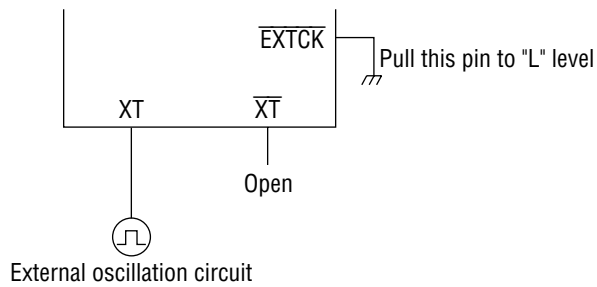


Figure 3 Circuit for External Clock Input

6. Low-Pass Filter

In this IC, all voice outputs are through the built-in low-pass filter (LPF). Figure 4 and Table 4 show the LPF frequency characteristics and LPF cutoff frequency respectively. Only the voice output through LPF is enabled in this IC.

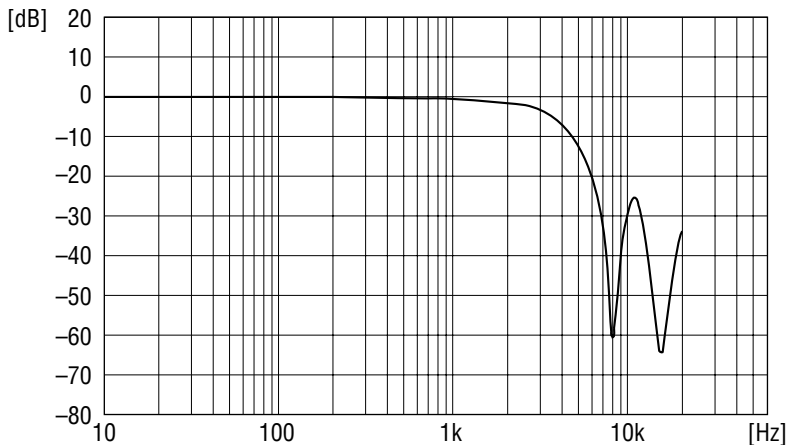


Figure 4 LPF Frequency Characteristics ($f_{SAM}=8\text{ kHz}$)

Table 4 LPF Cutoff Frequency

Sampling Frequency (kHz) (f_{SAM})	Cutoff Frequency (kHz) (f_{CUT})
4.0	1.2
5.3	1.6
6.4	2.0
8.0	2.5
10.6	3.2
12.8	4.0
16.0	5.0

7. Standby Transition

When playback of a phrase is finished, if playback of the next phrase does not start up within t_{STB} (0.25 sec. typ.), the IC enters standby status and the entire operation stops.

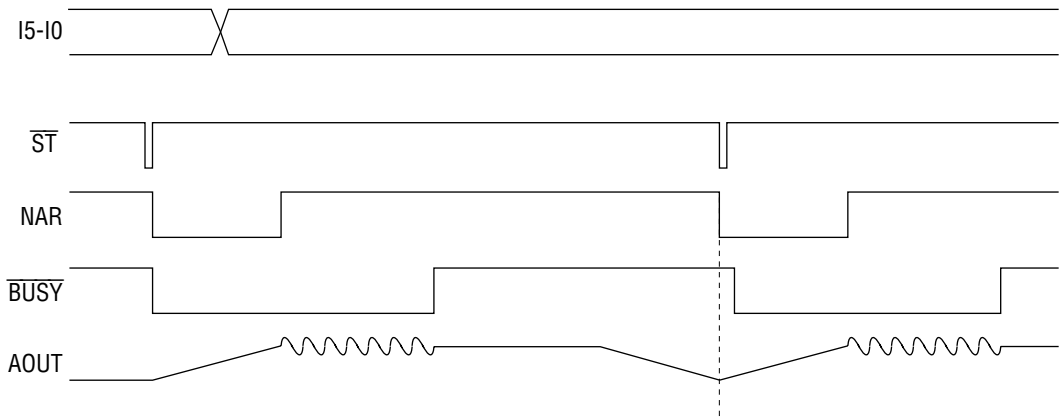
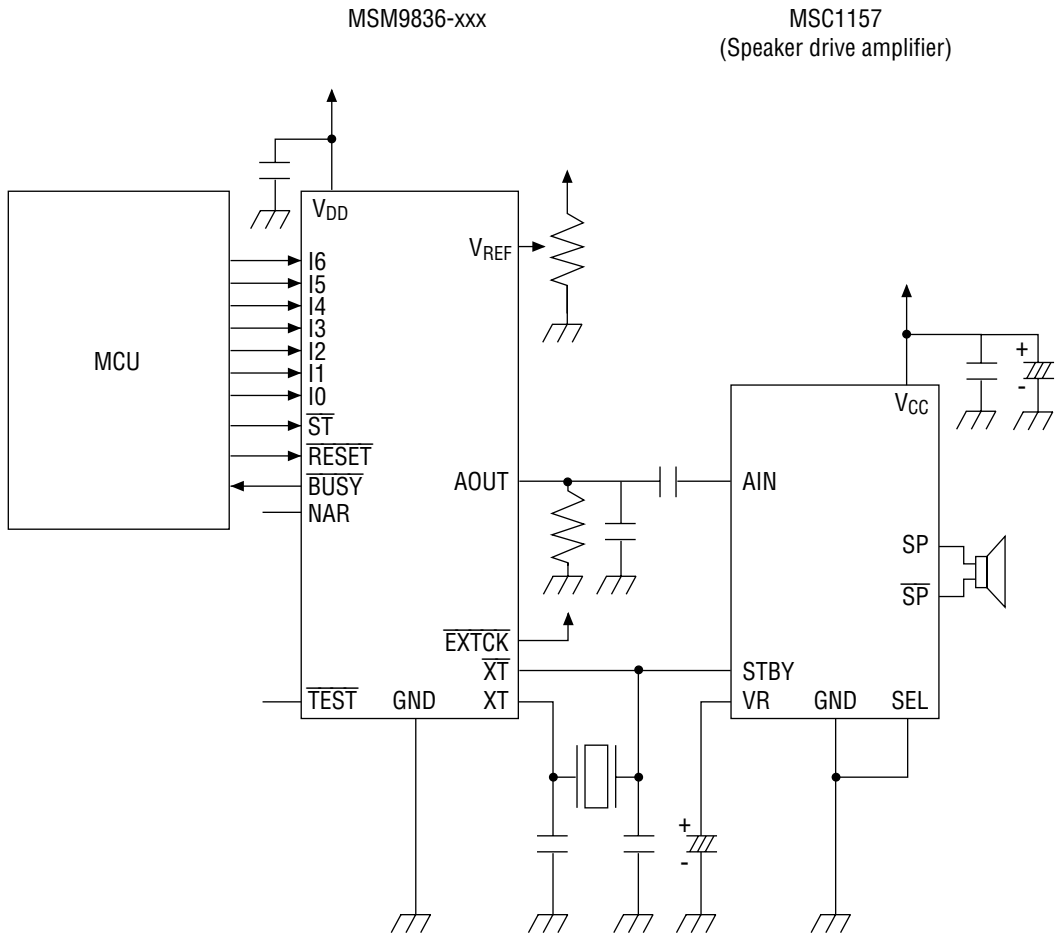


Figure 5 Voice Playback Timing during D/A Converter Change Time

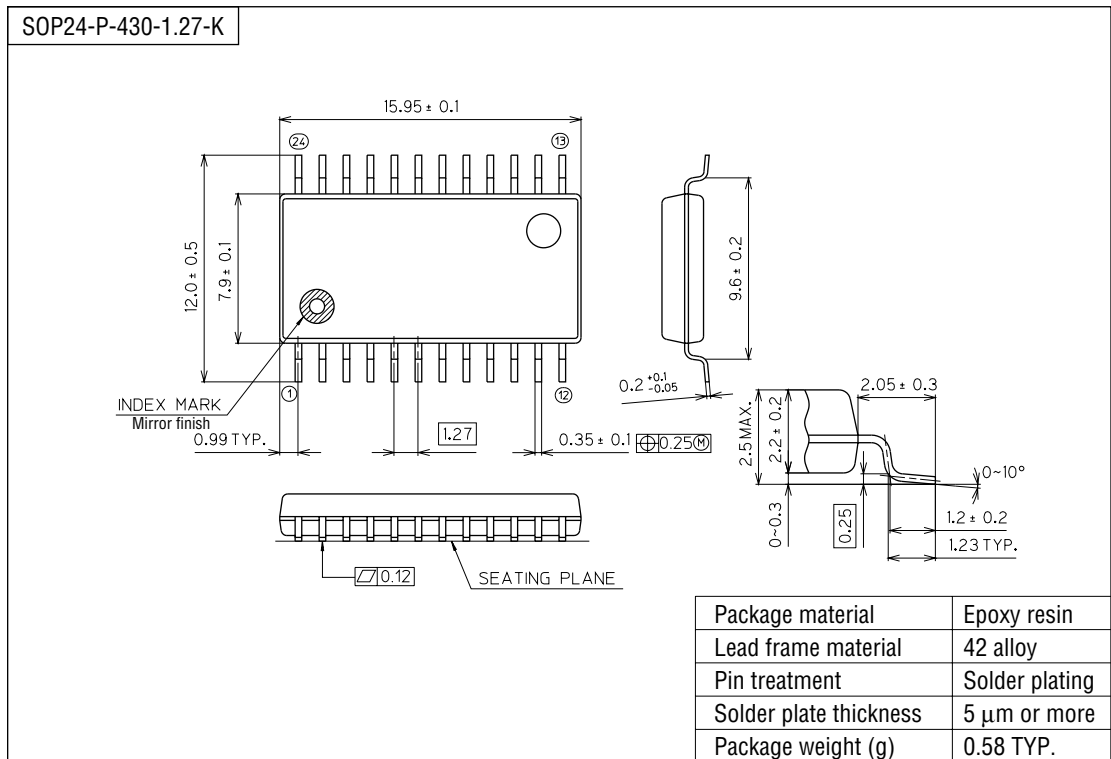
If playback is attempted during D/A converter change time as shown in Figure 5, the IC exits from standby status and the output from the D/A converter begins going to the $1/2 I_{AOUT}$ level. When the output reaches $1/2 I_{AOUT}$, voice playback starts.

APPLICATION CIRCUIT



PACKAGE DIMENSIONS

(Unit : mm)



Notes for Mounting the Surface Mount Type Package

The SOP, QFP, TSOP, SOJ, QFJ (PLCC), SHP and BGA are surface mount type packages, which 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).