MSM 9831-XXX

Preliminary

VOICE SYNTHESIS LSI with on-chip 384Kbit MASK ROM

■ General Description

MSM9831 is a PCM-based Voice Synthesis LSI (Playback only) with on-chip 384Kbit Mask ROM, D/A Converter and Low-Pass Filter.
Serial input interface for an external MCU makes **MSM9831** a better choice for size-critical applications with less wiring pin-count in small foot-print packaging.

■ Features

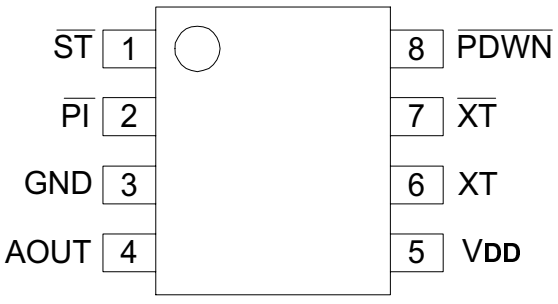
- 8-bit OKI Non-Linear PCM Algorithm
- Sampling Frequency (Selectable on each phrase)
  4.0 / 5.3 / 6.4 / 8.0 / 10.6 / 12.8 / 16.0 KHz
- On-chip Mask ROM Capacity 384Kbit
- Maximum Playback Time Length (At fosc. = 4.096MHz with a Ceramic Oscillator)
  12.1 sec. at fsam = 4.0 KHz
  6.0 sec. at fsam = 8.0 KHz
  3.0 sec. at fsam = 16.0 KHz
- Clock Oscillation
  4.096 MHz (With a Ceramic Oscillator or External Clock Input)
- User definable Phrase Control Table function
- Maximum number of Phrase 31 phrases
- 10-bit current-output-type D/A Converter
- A built-in LPF
- Packaging for commercial supply 8-pin SOP (SOP8-P-250-1.27-K)
  (Product Code MSM9831-xxx MA)
- Power Supply Voltage +2.0 ~ +5.5 V

■ Comparison Table with MSM9802

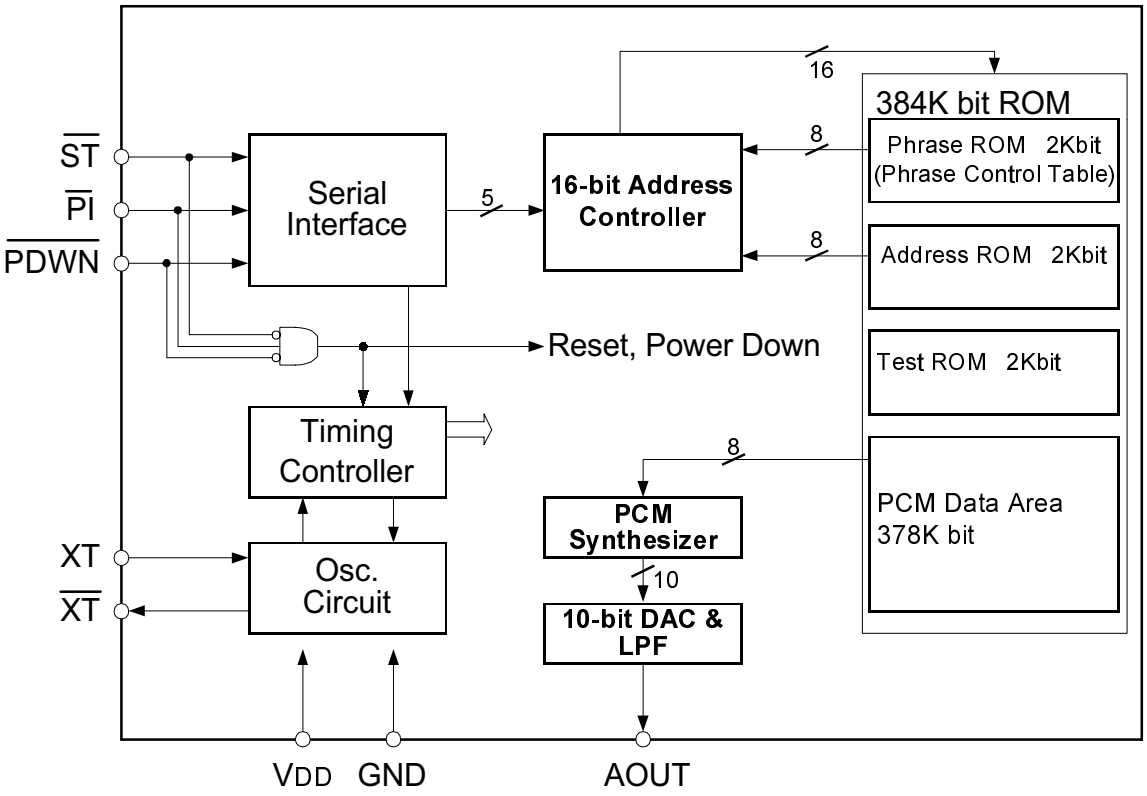
	MSM9831	MSM9802
Mask ROM Capacity	384K Bit	512K Bit
Interface	MCU(Serial)	MCU(Parallel)/Stand-alone
Oscillation	Ceramic/External Clock	Ceramic/CR
Max. Phrase Number	31	63
Status Signal Output	None	NAR/$\overline{\text{BUSY}}$

■ Pin Layout (Top View)

8-pin Plastic SOP



■ Block Diagram



■ Pin Description

Pin Name	Pin No.	I/O	Description
$\overline{ST}$	1	I	Playback starter pin. Phrase Address (number) is determined by the number or times of pulse input to $\overline{PI}$ pin while $\overline{ST}$ being held "L". Playback starts on $\overline{ST}$'s rising edge with phrase address data loaded into the LSI. When no pulse input to $\overline{PI}$ made while $\overline{ST}$ being held "L", the LSI recognizes it as "Stop Code" to stop playback.
$\overline{PI}$	2	I	Address input pin. The phrase number to playback is determined by the times of pulse pulse input to $\overline{PI}$ pin while $\overline{ST}$ being held "L". 32-time pulse input has the internal counter initialized.
GND	3	-	Ground pin
AOUT	4	O	Analog output pin. Built with N-MOS open-drain type, wave-form output is made in the form of changing output current. While $\overline{PDWN}$ being held "H", AOUT maintains 1/2 level output, thus the current keeps on flowing. The Pop-Noise Canceller is put into works when standby is reset to return to be active, and when entering into standby mode.
V_{DD}	5	-	Power Supply pin. Insert a 0.1μF or larger by-pass capacitor in-between GND pin and this pin.
XT	6	I	Wired to the ceramic oscillator when a ceramic oscillator is in used. Input the clock signal to this pin when the external clock is selected as the timing source. Using a ceramic oscillator or an external clock can be selected with **OKI**'s Analizing and Editing Tool.
$\overline{XT}$	7	O	Wired to the ceramic oscillator when a ceramic oscillator is in use. When the external clock is in use, keep this pin open.
$\overline{PDWN}$	8	I	The LSI remains in standby mode while this pin being held "L".

■ Absolute Maximum Ratings

(GND=0V)

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

■ Recommended Operating Ranges

(GND=0V)

Parameter	Symbol	Conditions	Range			Unit
Power Supply Voltage	V_{DD}	—	+2.0 ~ +5.5			V
Operating Temperature	T_{OP}	—	-40 ~ +85			°C
Oscillation Frequency (1)	f_{OSC1}	With a Ceramic Osc.	Min.	Typ.	Max.	MHz
			3.5	4.096	4.5	
Oscillation Frequency (2)	f_{OSC2}	With the external clock V_{DD}=+2.7 ~ +5.5V	3.5	4.096	16	MHz
		With the external clock V_{DD}=+2.0 ~ +2.7V	3.5	4.096	4.5	MHz

■ DC Characteristics

(Unless otherwise specified; V_{DD} = 5.0V, GND = 0V, Ta = -40 ~ +85ºC)

Parameter	Symbol	Conditions	Min.	Typ.	Max.	Unit
"H" Input Voltage	V_{IH}	—	V_{DD} x 0.8	—	—	V
"L" Input Votage	T_{IL}	—	—	—	V_{DD} x 0.2	V
"H" Input Current	I_{IH}	V_{IH} = V_{DD}	—	—	10	μA
"L" Input Current	I_{IL}	V_{IL} = GND	-10	—	—	μA
Operating Current	I_{DD}	Excluding DAC output Current	—	1	2	mA
Standby Current	I_{DS}	Ta = -40°C ~ +70°C	—	—	10	μA
		Ta = -40°C ~ +85°C	—	—	50	μA
AOUT Output Current	I_{AOUT}	At max. current output		-5.0		mA

(Unless otherwise specified; V_{DD} = 3.0V, GND = 0V, Ta =- 40 ~ +85ºC)

Parameter	Symbol	Conditions	Min.	Typ.	Max.	Unit
"H" Input Voltage	V_{IH}	—	V_{DD}x 0.8	—	—	V
"L" Input Votage	T_{IL}	—	—	—	V_{DD}x 0.2	V
"H" Input Current	I_{IH}	$V_{IH} = V_{DD}$	—	—	10	μA
"L" Input Current	I_{IL}	V_{IL} = GND	-10	—	—	μA
Operating Current	I_{DD}	Excluding DAC output Current	—	0.15	0.5	mA
Standby Current	I_{DS}	Ta = -40°C ~ +70°C	—	—	5	μA
		Ta = -40°C ~ +85°C	—	—	20	μA
AOUT Output Current	I_{AOUT}	At max. current output		-2.5		mA

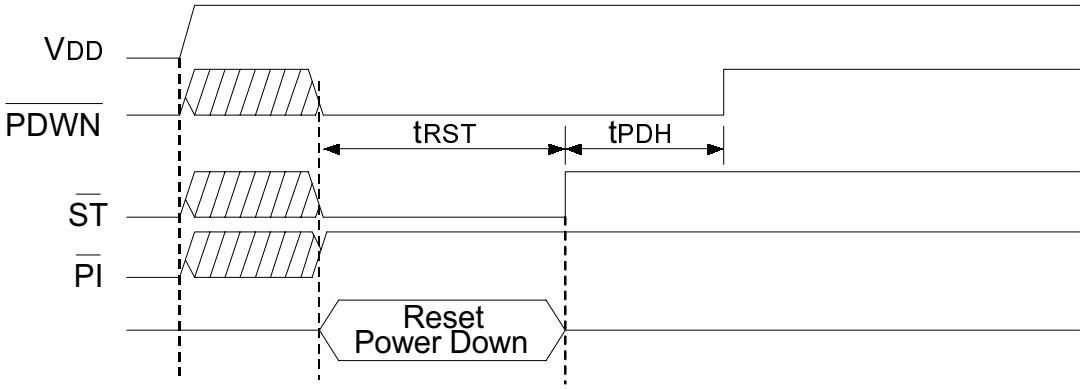
■ AC Characteristics

(Oscillation Frequency at f_{OSC}=4.096MHz., V_{DD}=2.0~5.0V, GND=0V, Ta=-40~+85°C)

Parameter	Symbol	Conditions	Min.	Typ.	Max.	Unit
Oscillation duty cycle	f_{duty}	—	40	50	60	%
Time before RESET input after Power On	t_{RST}	—	10	—	—	μs
$\overline{PDWN}$ hold time after RESET input	t_{PDH}	—	10	—	—	μs
DA Converter shifting time (Pop-Noise Canceller working time)	t_{DAR},t_{DAF}	—	60	64	68	μs
$\overline{PDWN}$ - $\overline{ST}$ setup time	t_{PDSS}	—	1	—	—	μs
$\overline{ST}$ - $\overline{PI}$ setup time	t_{SPS}	—	1	—	—	μs
$\overline{PI}$ pulse width	t_{PW}	—	0.35	—	2000	μs
$\overline{PI}$ cycle time	t_{PC}	—	0.7	—	4000	μs
$\overline{ST}$ - $\overline{PI}$ hold time	t_{SPH}	—	1	—	—	μs
$\overline{ST}$ - AOUT setup time	t_{SAS}	At f_{SAM} = 8.0KHz	—	—	1050	μs
Phrase stop time	t_{DPS}	At f_{SAM} = 8.0KHz	—	—	350	μs
Silence in-between phrases	t_{BLN}	At f_{SAM} = 8.0KHz	—	—	700	μs
Stop $\overline{ST}$ pulse width	t_{SSW}	—	0.35	—	2000	μs
Phrase $\overline{ST}$ - Phrase $\overline{ST}$ pulse interval	t_{PP}	At f_{SAM} = 8.0KHz	1050	—	—	μs
Phrase $\overline{ST}$ - Stop $\overline{ST}$ pulse interval	t_{PS}	At f_{SAM} = 8.0KHz	1050	—	—	μs
Stop $\overline{ST}$ - Phrase $\overline{ST}$ pulse interval	t_{SP}	At f_{SAM} = 8.0KHz	500	—	—	μs

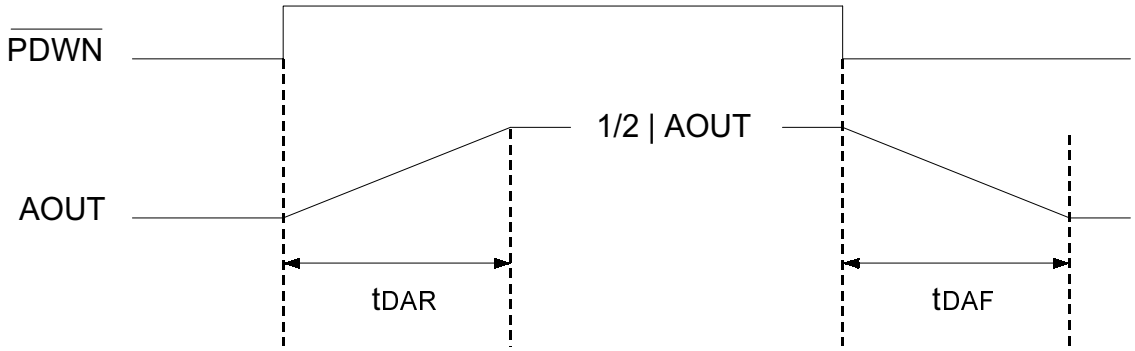
■ Timing Chart

1. Timing chart (1) : Power-On

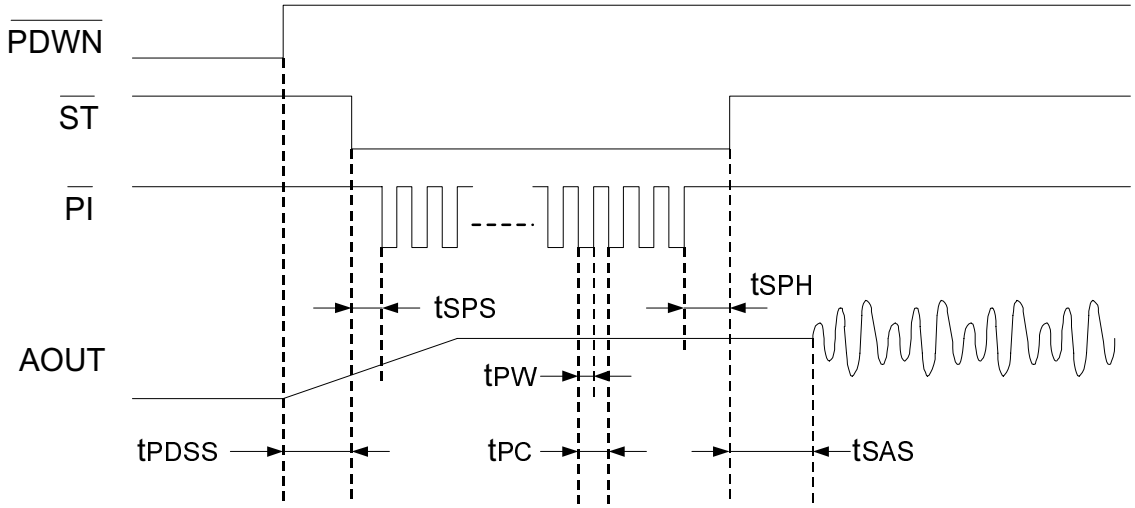


Note : A level input in combination of PDWN="L", ST="L" and PI="H" resets the LSI. After Power-On, you need to do an initial reset as shown in the above chart.

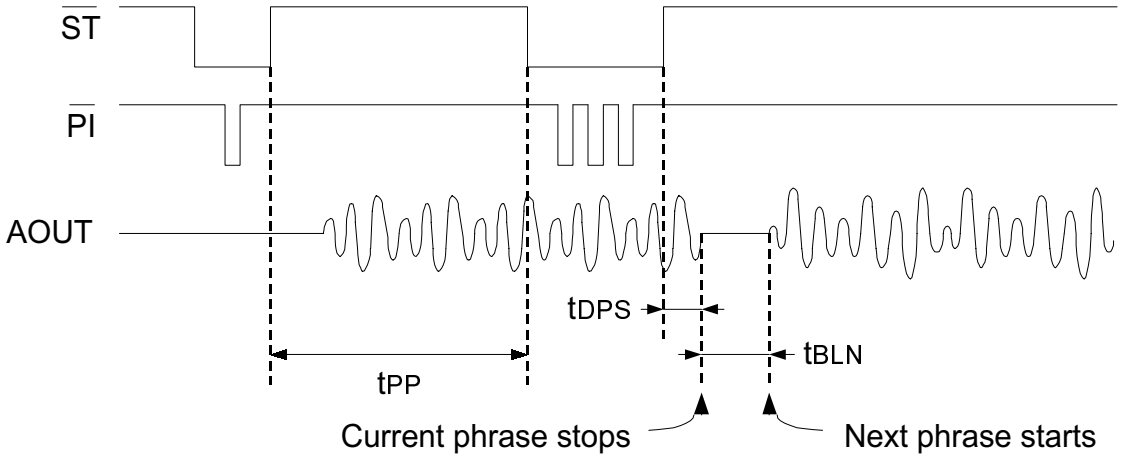
2. Timing Chart (2) : Activating the LSI and Standby Mode



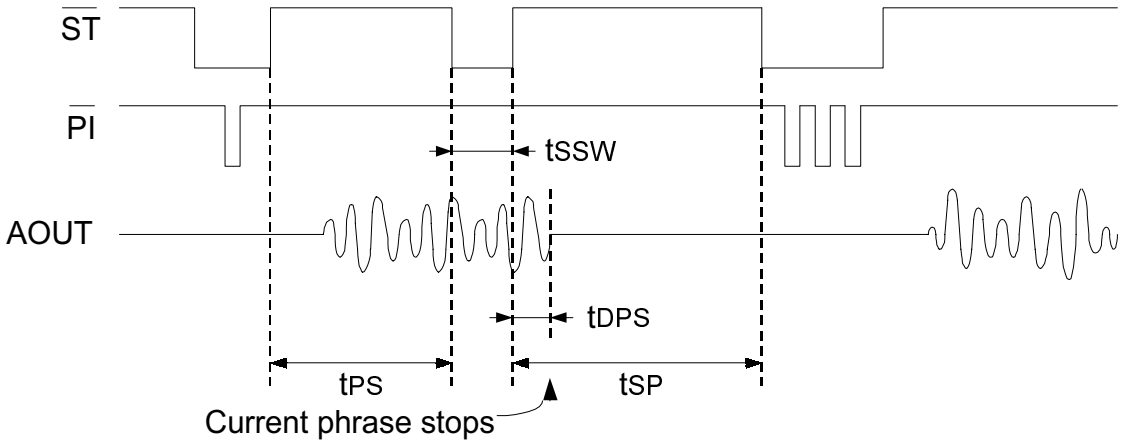
3. Timing Chart (3) : Playback



4. Timing Chart (4) : Re-inputting the address while playback is going on



5. Timing Chart (5) : Stop Code Input



■ Functional Description

1. Sampling Frequency

Sampling Frequency can be selected and set up on each phrase address, in preparing Voice Data File (known as ROM File) at the pre-production stage. 7 sampling frequencies are available for user's choice as follows;

4.0 KHz / 5.3 KHz / 6.4 KHz / 8.0 KHz / 10.6 KHz / 12.8 KHz / 16.0 KHz

2. Playback Time Length

Figure 1 below shows memory space allocation of on-chip 384K bit Mask ROM.
Mask ROM is partitioned into 4 data areas; user's Voice Data Area, Phrase Control Data Area, Address Control Data Area and Test Data Area. Actual memory space usable for PCM data storage (User's Area) is less than the total Mask ROM capacity (384K bit) indicated in this document.

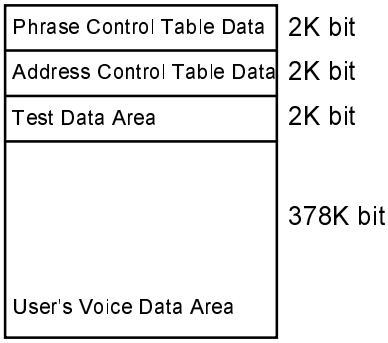


Figure 1 Memory Allocation of on-chip Mask ROM (384K bit)

The following formula is to calculate playback time length;

Playback Time (sec.) = (384 - 2 - 2 - 2) K bit × 1024 ÷ 8 ÷ (Sampling Frequency) Hz

For example, when you create your voice data for MSM9831 at 8.0 KHz Sampling Frequency;

Playback Time (sec.) = (384 - 2 - 2 - 2) K bit × 1024 ÷ 8 ÷ 8000 (Hz) ≒ 6.0 sec.

3. Playback Algorithm

MSM9831 uses OKI Non-Linear PCM algorithm, an advanced variation of PCM.
In the mid-range of wave-form, **OKI** 8-bit Non-Linear PCM has precision and quality equivalent to those of 10-bit Straight PCM.

4. Inserting Silence

In addition to normal recorded sound phrases, MSM9831 allows a user to play back or insert silence (silent phrase). User can set up time length of silence by 32ms. step. The minimum and maximum time length of silent phrase is 32ms. and 996ms.

5. Phrase Control Table

A unique feature of MSM9831 is user-definable Phrase Control Table function, that enables a user to play back multiple phrases in a single continuous session with same simple control as in a regular single phrase playback session.
As an example, let's assume you want to have several similar phrases like "It will be xxxxx today". "xxx" can be "sunny", "rainy" or "cloudy". Without the Phrase Control Table, "It will be sunny today" and "It will be rainy today" in full sentence must be separately stored in the Address Control Table (**Table 1**), if you want to play back one of those phrases with a single control operation. While, with the Phrase Control Table, multiple phrases can be played back in a single continuous session
When the Mask ROM has the voice data shown in **Table 2** and phrase control data shown in **Table 3**, you simply specify the address **"01H"** to get "It will be sunny today" played back. Also, a single control action to select **"02H"** address has "It will be rainy today" played back. By utilizing the Phrase Control Table function, you can avoid data redundancy as in **Table 1**, and thus the limited memory resource can be more efficiently used.

You can also insert a silent phrase instead of an ordinary recorded phrase. The minimum time length of a silent phrase is 32 ms. and the maximum is 996ms. You can set up the length of silence by 32ms. step.
The playback timing chart is shown on the following page.

Table 1 Without Phrase Control Table /The content of the phrase data controlledby the Address Control Table

Address HEX	Content of Phrase
01	It will be sunny today.
02	It will be rainy today.
03	It will be sunny but occasionally cloudy today.
⋮	
1F	Silence 320ms.

Table 2 With Phrase Control Table / The content of the phrase data controlledby the Address Control Table

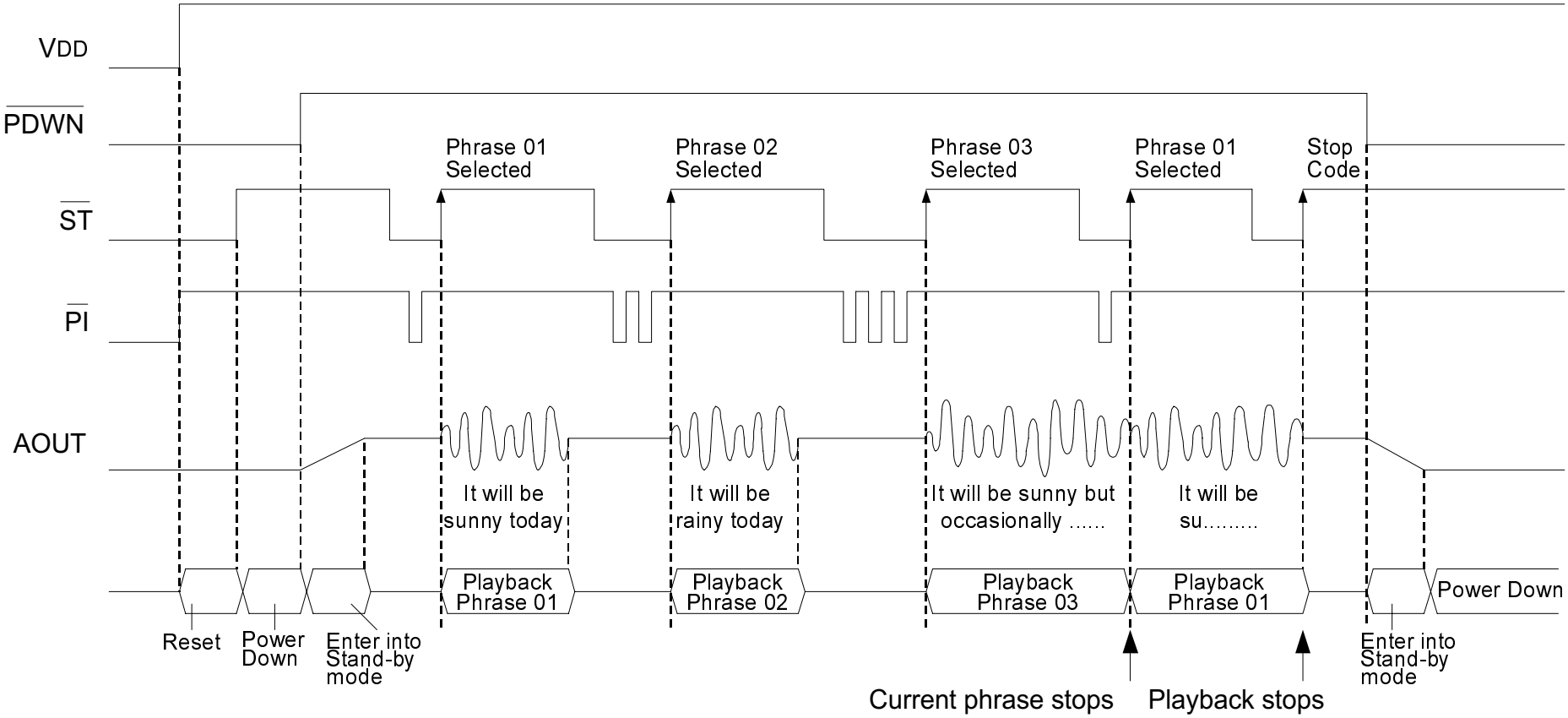
Address HEX	Content of Phrase
01	It
02	will be
03	sunny
04	rainy
05	today
⋮	
1F	Silence 320ms.

Table 3 User-defined Data in the Phrase Control Table

Address HEX	Phrase Assigned to ROM Address	
01	01 02 03 05	← "It will be sunny today."
02	01 02 04 05	← "It will be rainy today."
03		
⋮		
1F	1F 01 02 04 1F 05 1F 1F	

Up to 8 phrases including silent phrase(s) can be assigned to a single ROM address of the Phrase Control Table.

● Timing Chart (6) : Playback Using the Phrase Control Table



6. Oscillation, Clock Signal Input

6-1 Using a Ceramic Oscillator

Figure 2 shows an oscillation circuit diagram using a Ceramic Oscillator.
(Select “Use a Ceramic Oscillator” option on selecting options)

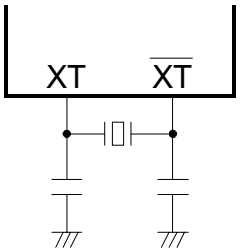
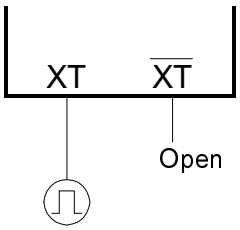


Figure 2 Oscillation Circuit with an external Ceramic oscillator

6-2 Using External Clock Input

Figure 3 shows an oscillation circuit diagram using an external clock input.
(Select “Use an external clock input” option on selecting options)



External Clock, etc. as the timing source

Figure 3 Oscillation Circuit using an external clock input

5. Low-Pass Filter

Analog output of **MSM9831** is made through and after built-in low-pass filter. Output before low-pass filter is unavailable.

Figure 4 shows LPF Output Frequency Characteristics and **Table 4** indicates LPF Cut-Off Frequency. Output Frequency Characteristics and Cut-Off Frequency are in proportion to the sampling frequency selected.

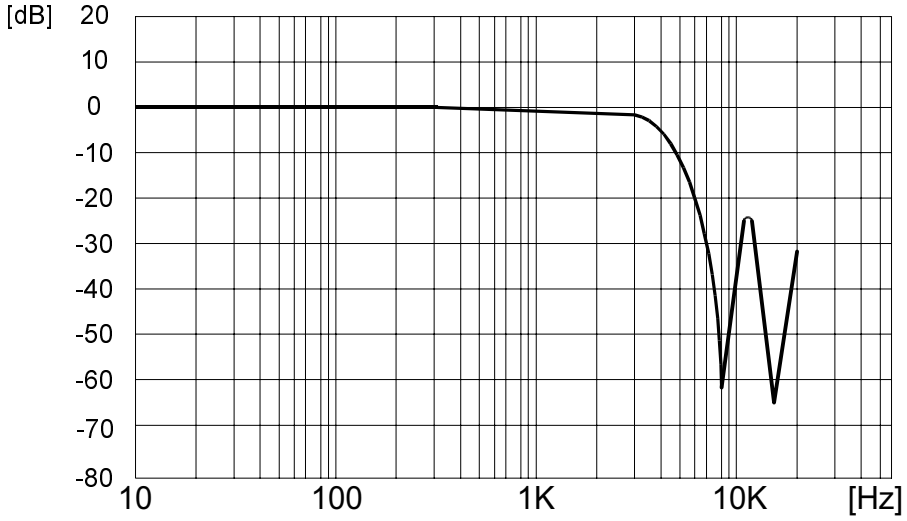
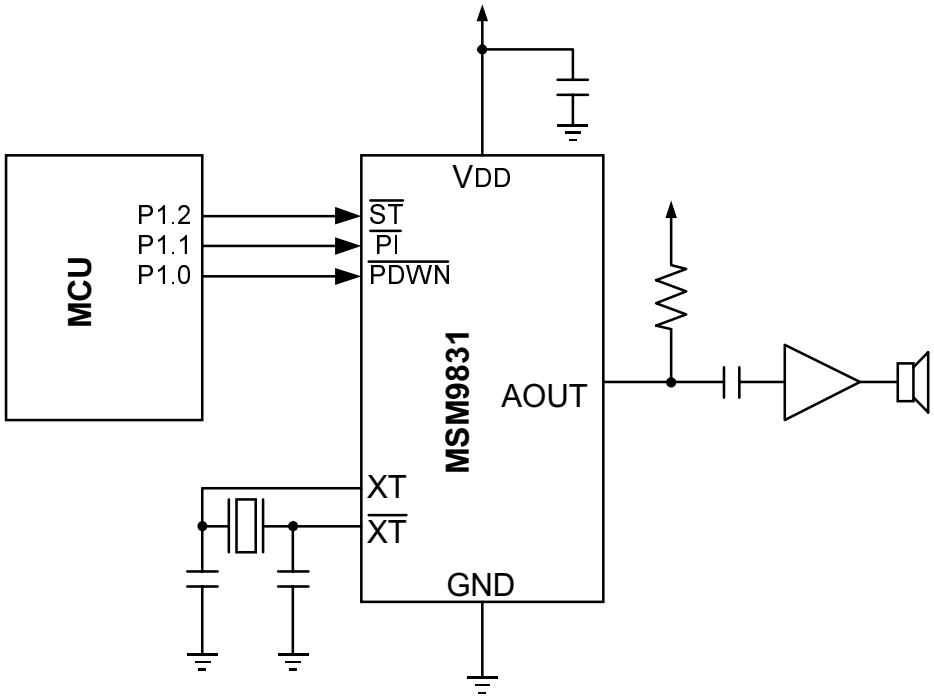


Figure 4 LPF Output Frequency Characteristics (fsam = 8.0 KHz)

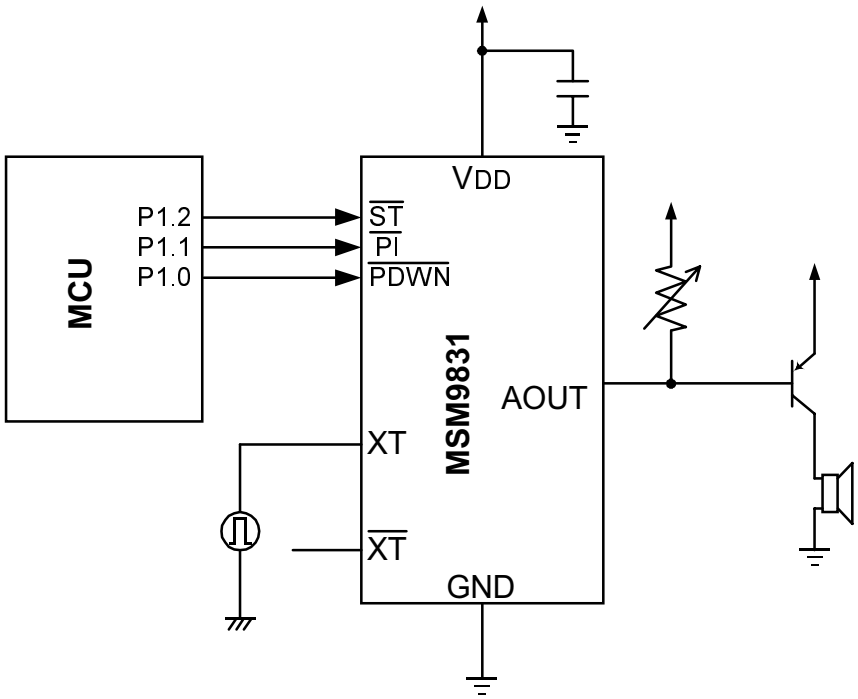
Table 4 LPF Cut-Off Frequency

Sampling Frequency fsam (KHz)	Cut-Off Frequency fcut (KHz)
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

■ Sample Circuit Diagram



A sample circuit with a Ceramic Oscillator and an Amplifier to drive a loud-speaker in use.



A sample circuit with the external clock input and a Transistor to drive a loud-speaker in use.