

MSM9802/03/05-xxx**Voice Synthesis IC with Built-in Mask ROM****GENERAL DESCRIPTION**

The MSM9802/03/05 is a PCM voice synthesis IC with built-in mask ROM.

This IC has two user selectable playback algorithms, OKI Non-linear PCM and straight PCM. It also contains a current mode 10-bit D/A converter and a low-pass filter.

External control has been made easy by the built-in edit ROM that can form sentences by linking phrases. By using Oki's Sound Analysis and Editing Tool, ROM data such as Phrase Control Table can be easily set, created, edited, and evaluated.

With the stand-alone mode/microcontroller interface mode switching pin, the MSM9802/03/05 can support various applications.

FEATURES

| Device | ROM size* | Speech period (sec) | | | |
|---------|-----------|---------------------------|---------------------------|---------------------------|----------------------------|
| | | f _{SAM} =4.0 kHz | f _{SAM} =6.4 kHz | f _{SAM} =8.0 kHz | f _{SAM} =16.0 kHz |
| MSM9802 | 512 Kbits | 16.0 | 10.0 | 8.0 | 4.0 |
| MSM9803 | 1 Mbit | 32.4 | 20.2 | 16.2 | 8.1 |
| MSM9805 | 2 Mbits | 65.1 | 40.7 | 32.5 | 16.2 |

* Actual voice ROM area is smaller by 11 Kbits.

- ROM custom
 - 8-bit OKI nonlinear PCM method/8-bit straight PCM method
 - Built-in edit ROM
 - Random playback function
 - Sampling frequency : 4.0 kHz/5.3 kHz/6.4 kHz/8.0 kHz/10.6 kHz/12.8 kHz/16.0 kHz
Note: If RC oscillation is selected, 10.6 kHz, 12.8 kHz, and 16.0 kHz cannot be selected.
 - Maximum number of phrases : 63 (Microcontroller interface mode)
56 (Stand-alone mode)
 - Built-in current mode 10-bit D/A converter
 - Built-in low-pass filter
 - Standby function
 - RC oscillation (256 kHz)/ceramic oscillation (4.096 MHz) selectable
 - Package options:
 - 18-pin plastic DIP (DIP18-P-300-2.54) (Product name: MSM9802-xxxRS/MSM9803-xxxRS/MSM9805-xxxRS)
 - 24-pin plastic SOP (SOP24-P-430-1.27-K) (Product name: MSM9802-xxxGS-K/MSM9803-xxxGS-K/MSM9805-xxxGS-K)
 - 30-pin plastic SSOP (SSOP30-P-56-0.65-K) (Product name: MSM9802-xxxGS-AK/MSM9803-xxxGS-AK/MSM9805-xxxGS-AK)
- xxx indicates code number.

Chip

Note: This data sheet explains a stand-alone mode and a microcontroller interface mode, separately.

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(2) Microcontroller Interface Mode

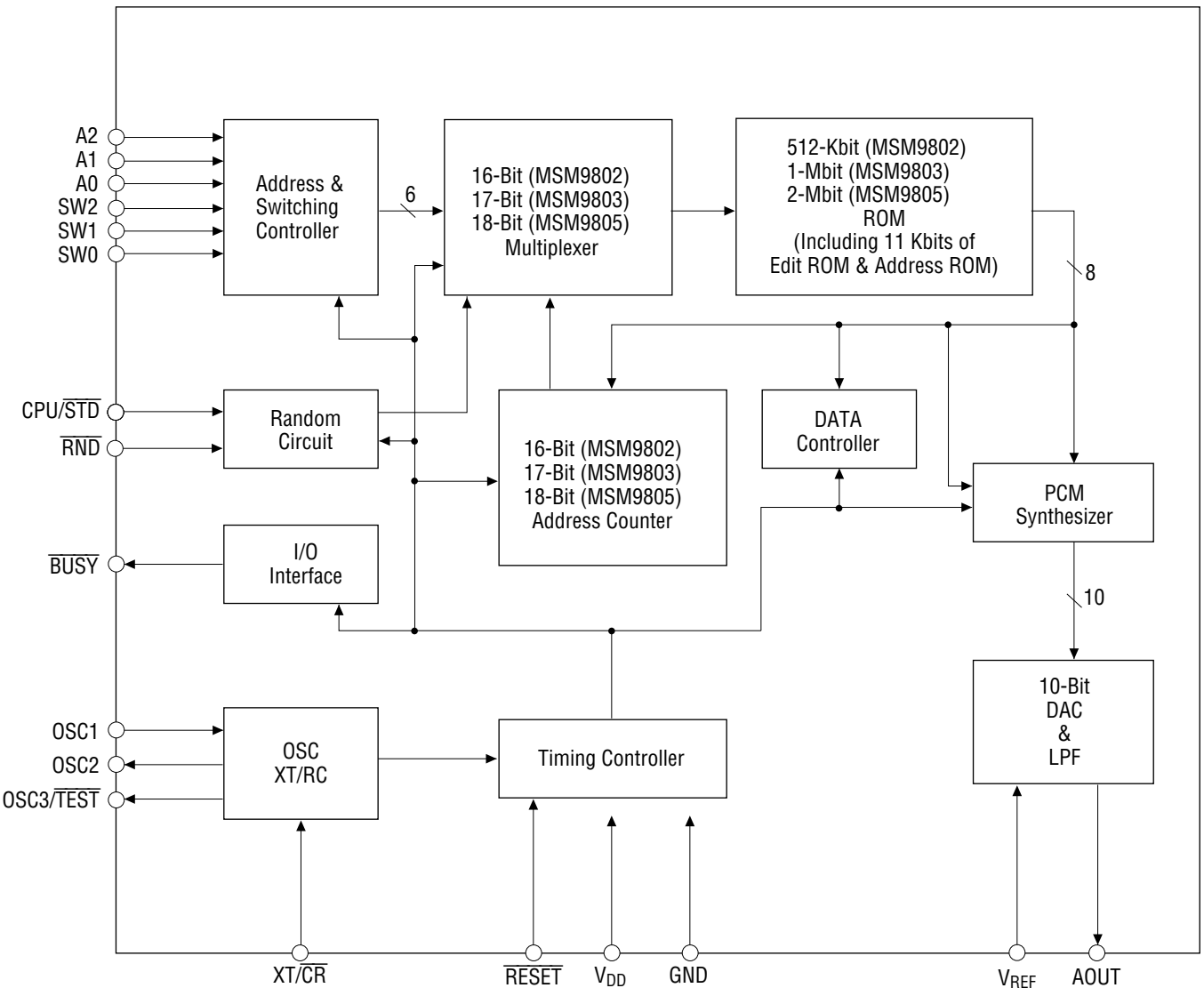
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(3) Common

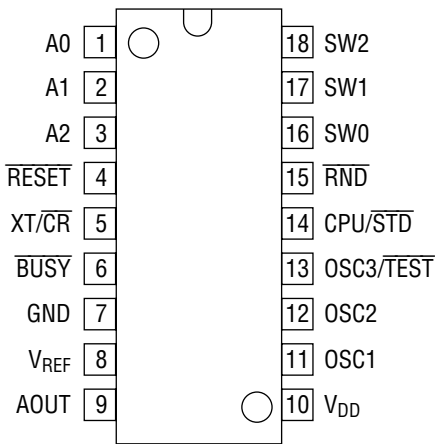
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(1) STAND-ALONE MODE (CPU/STD: "L" level)

BLOCK DIAGRAM

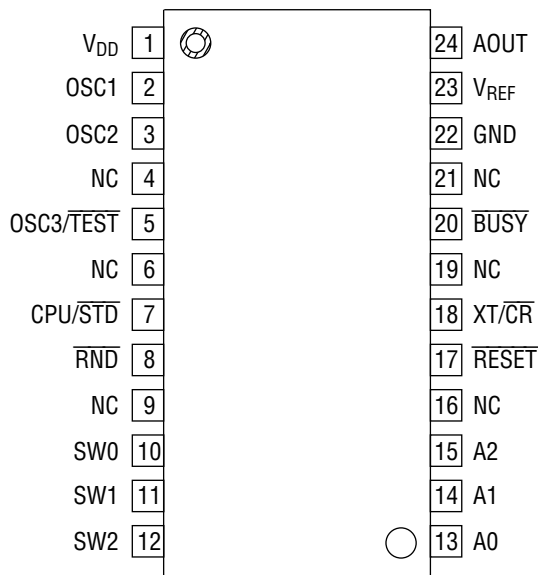


PIN CONFIGURATION (TOP VIEW)



18-Pin Plastic DIP

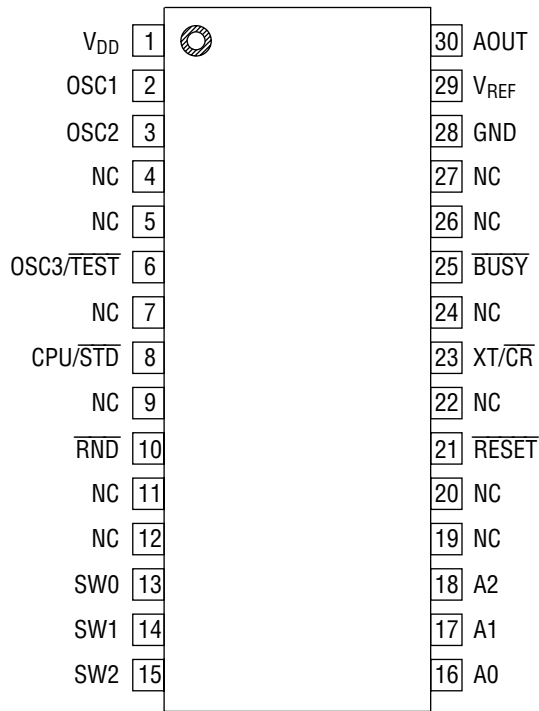
Note: Applicable to MSM9802-xxxRS, MSM9803-xxxRS, and MSM9805-xxxRS.



NC: No connection

24-Pin Plastic SOP

Note: Applicable to MSM9802-xxxGS-K, MSM9803-xxxGS-K, and MSM9805-xxxGS-K.



NC: No connection

30-Pin Plastic SSOP

Note: Applicable to MSM9802-xxxGS-AK, MSM9803-xxxGS-AK, and MSM9805-xxxGS-AK.

PIN DESCRIPTIONS

| Pin | | | Symbol | Type | Description |
|-----|-----|------|--------------------------------------|------|---|
| DIP | SOP | SSOP | | | |
| 4 | 17 | 21 | $\overline{\text{RESET}}$ | I | The IC enters the standby state if this pin is set to "L" level. At this time, oscillation stops and AOUT drives a current of 0mA and becomes GND level, then the IC returns to the initial state. Apply a "L" pulse upon power-on. This pin has an internal pull-up resistor. |
| 6 | 20 | 25 | $\overline{\text{BUSY}}$ | O | Outputs "L" level while voice is being played back. At power-on, this pin is at "H" level. |
| 5 | 18 | 23 | $\text{XT}/\overline{\text{CR}}$ | I | XT/RC switching pin. Set to "H" level if ceramic oscillation is used. Set to "L" level if RC oscillation is used. |
| 14 | 7 | 8 | $\text{CPU}/\overline{\text{STD}}$ | I | Microcontroller interface/stand-alone mode switching pin. Set to "L" level if the MSM9802/03/05 is used in stand-alone mode. |
| 8 | 23 | 29 | V_{REF} | I | Volume setting pin. If this pin is set to GND level, the maximum current is forced in. If this pin is set to V_{DD} level, the minimum current is forced in. A pull-down resistor of approx. 10 Ω is internally connected to this pin during operation. |
| 9 | 24 | 30 | AOUT | O | Voice output pin. The voice signals are output as current changes. In standby state, this pin drives a current of 0 mA and becomes GND level. |
| 7 | 22 | 28 | GND | — | Ground pin. |
| 10 | 1 | 1 | V_{DD} | — | Power supply pin. Insert a bypass capacitor of 0.1 μF or more between V_{DD} and GND pins. |
| 11 | 2 | 2 | OSC1 | I | Ceramic oscillator connection pin when ceramic oscillation is selected. RC connection pin when RC oscillation is selected. Input from this pin if external clock is used. |
| 12 | 3 | 3 | OSC2 | O | Ceramic oscillator connection pin when ceramic oscillation is selected. RC connection pin when RC oscillation is selected. Leave this pin open if external clock is used. Outputs "L" level in standby state. |
| 13 | 5 | 6 | $\text{OSC3}/\overline{\text{TEST}}$ | O | Leave this pin open when ceramic oscillation is used. RC connection pin when RC oscillation is selected. Outputs "H" level in standby state when RC oscillation is selected. |
| 15 | 8 | 10 | $\overline{\text{RND}}$ | I | Random playback starts if $\overline{\text{RND}}$ pin is set to "L" level. Fetches addresses from random address generation circuit in the IC at fall of $\overline{\text{RND}}$. Set to "H" level when the random playback function is not used. This pin has internal pull-up resistor. |

| Pin | | | Symbol | Type | Description |
|-------|-------|-------|-----------|------|---|
| DIP | SOP | SSOP | | | |
| 16-18 | 10-12 | 13-15 | SW0 - SW2 | I | Phrase input pins corresponding to playback sound. If input changes, SW0 to SW2 pins fetch addresses after 16 ms and start voice synthesis. Each of these pins has internal pull-down resistor. |
| 1-3 | 13-15 | 16-18 | A0 - A2 | I | Phrase input pins corresponding to playback sound. Input logic of A0 pin becomes invalid if the random playback function is used. |

ABSOLUTE MAXIMUM RATINGS

(GND=0 V)

| Parameter | Symbol | Condition | Rating | Unit |
|----------------------|-----------|--------------------------|----------------------|--------------------|
| Power Supply Voltage | V_{DD} | $T_a=25^{\circ}\text{C}$ | -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 | $^{\circ}\text{C}$ |

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 | | | $^{\circ}\text{C}$ |
| Master Clock Frequency 1 | f_{OSC1} | When crystal is selected | Min. | Typ. | Max. | MHz |
| | | | 3.5 | 4.096 | 4.5 | |
| Master Clock Frequency 2 | f_{OSC2} | When RC is selected (*1) | 200 | 256 | 300 | kHz |

*1 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

($V_{DD}=5.0\text{ V}$, $GND=0\text{ V}$, $T_a=-40\text{ to }+85^\circ\text{C}$, 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} | $I_{OH}=-1\text{ mA}$ | 4.6 | — | — | V |
| "L" Output Voltage | V_{OL} | $I_{OL}=2\text{ mA}$ | — | — | 0.4 | V |
| "H" Input Current 1 | I_{IH1} | $V_{IH}=V_{DD}$ | — | — | 10 | μA |
| "H" Input Current 2 *1 | I_{IH2} | Internal pull-down resistor | 30 | 90 | 200 | μA |
| "H" Input Current 3 | I_{IH3} | Applies to OSC1 pin only. $V_{IH}=V_{DD}$ | — | — | 15 | μA |
| "L" Input Current 1 | I_{IL1} | $V_{IL}=GND$ | -10 | — | — | μA |
| "L" Input Current 2 *2 | I_{IL2} | Internal pull-up resistor | -200 | -90 | -30 | μA |
| Dynamic Supply Current 1 *3 | I_{DD1} | $V_{REF}=V_{DD}$, AOUT bias voltage=0V | — | 0.4 | 1 | mA |
| Dynamic Supply Current 2 *4 | I_{DD2} | At maximum output current $V_{REF}=GND$, AOUT bias voltage=0V | — | — | 16 | mA |
| Standby Current | I_{DS} | $T_a=-40\text{ to }+70^\circ\text{C}$ | — | — | 10 | μA |
| | | $T_a=70\text{ to }85^\circ\text{C}$ | — | — | 50 | μA |
| AOUT Output Current | I_{AOUT} | At maximum output current, $V_{REF}=GND$, AOUT bias voltage=0V | 6 | 9.5 | 15 | mA |
| V_{REF} Pin Pull-down Resistance | R_{VREF} | — | 7 | 10 | 13 | $\text{k}\Omega$ |

*1 Applicable to SW0-SW2

*2 Applicable to $\overline{\text{RESET}}$, $\overline{\text{RND}}$

*3 Dynamic supply current (excluding DAC output current)

*4 Dynamic supply current at maximum output current

DC Characteristics

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

| 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 *1 | I _{IH2} | Internal pull-down resistor | 10 | 30 | 100 | μA |
| "H" Input Current 3 | I _{IH3} | Applies to OSC1 pin only. V _{IH} =V _{DD} | — | — | 15 | μA |
| "L" Input Current 1 | I _{IL1} | V _{IL} =GND | -10 | — | — | μA |
| "L" Input Current 2 *2 | I _{IL2} | Internal pull-up resistor | -100 | -30 | -10 | μA |
| Dynamic Supply Current 1 *3 | I _{DD1} | V _{REF} =V _{DD} , AOUT bias voltage=0V | — | 0.15 | 0.5 | mA |
| Dynamic Supply Current 2 *4 | I _{DD2} | At maximum output current V _{REF} =GND, AOUT bias voltage=0V | — | — | 5.5 | mA |
| Standby Current | I _{DS} | Ta=-40 to +70°C | — | — | 5 | μA |
| | | Ta=70 to 85°C | — | — | 20 | μA |
| AOUT Output Current | I _{AOUT} | At maximum output current, V _{REF} =GND, AOUT bias voltage=0V | 1.4 | 3.2 | 5 | mA |
| V _{REF} Pin Pull-down Resistance | R _{VREF} | — | 7 | 10 | 13 | kΩ |

*1 Applicable to SW2-SW0

*2 Applicable to $\overline{\text{RESET}}$, $\overline{\text{RND}}$

*3 Dynamic supply current (excluding DAC output current)

*4 Dynamic supply current at maximum output current

AC Characteristics

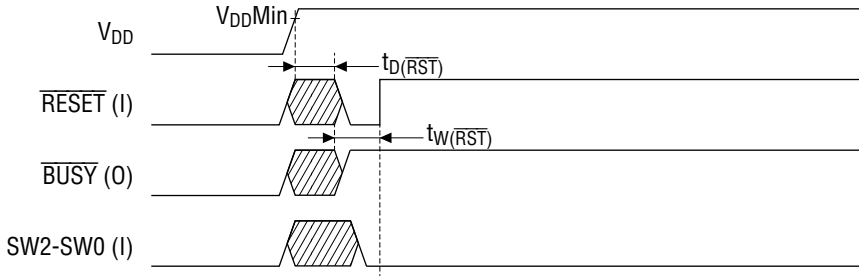
(V_{DD}=5.0 V, GND=0 V, Ta=-40 to +85°C)

| Parameter | Symbol | Condition | Min. | Typ. | Max. | Unit |
|---------------------------------|-------------------------------------|--------------------------------|------|------|------|------|
| Master Clock Duty Cycle | f _{duty} | — | 40 | 50 | 60 | % |
| RESET Input Pulse Width | t _{w(RST)} | — | 10 | — | — | μs |
| RESET Input Time After Power-on | t _{D(RST)} | — | 0 | — | — | μs |
| RND Input Pulse Width | t _{w(RAN)} | — | 100 | — | — | μs |
| SW0-SW2 Input Pulse Width | t _{w(SW)} | — (note) | 16 | — | — | ms |
| BUSY Output Time | t _{SBS} | — | — | — | 10 | μs |
| Chattering Prevention Time 1 | t _{CHA} | — (note) | 14 | 15 | 16 | ms |
| Chattering Prevention Time 2 | t _{CHB} | — (note) | — | — | 16 | ms |
| D/A Converter Change Time | t _{DAR} , t _{DAF} | — (note) | 60 | 64 | 68 | ms |
| Standby Transition Time | t _{STB} | — (note) | 200 | 250 | 300 | ms |
| Silence Time Between Phrases | t _{BLN} | f _{SAM} =8 kHz (note) | 350 | 375 | 500 | μs |
| Random Address Fetch Time | t _{RA} | — (note) | 15 | 16 | 17 | μs |

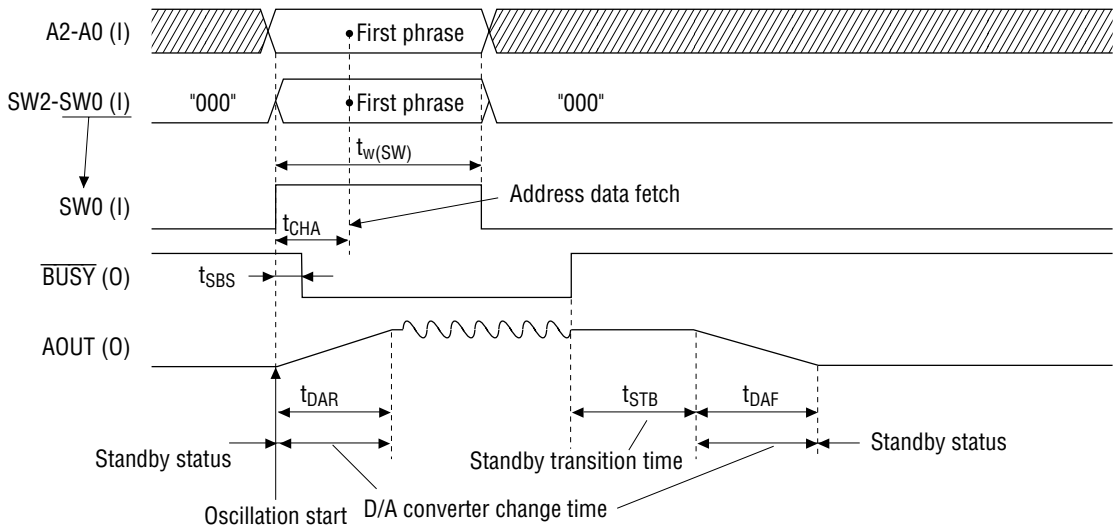
(Note) Proportional to master the periods of oscillation frequencies f_{OSC1} and f_{OSC2}.
The rated values show values when the standard master oscillation frequency is used.

TIMING DIAGRAMS

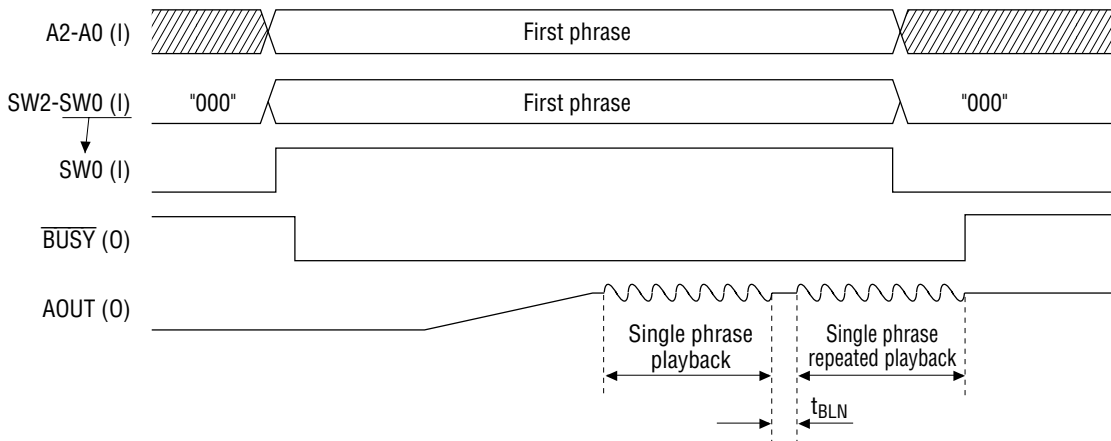
AC Characteristics at Power-On



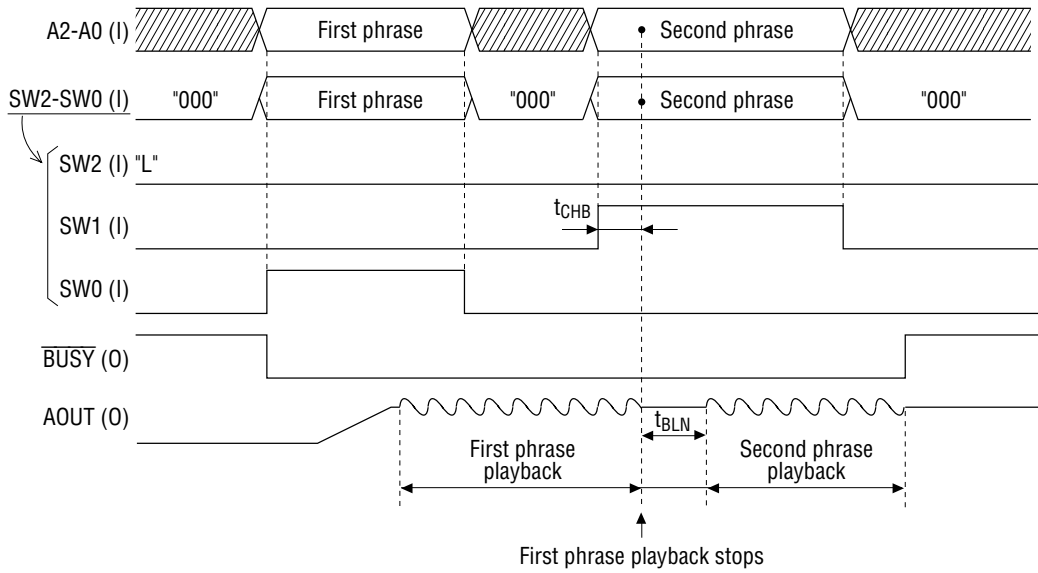
AC Characteristics in Standby Status and when the IC is Activated



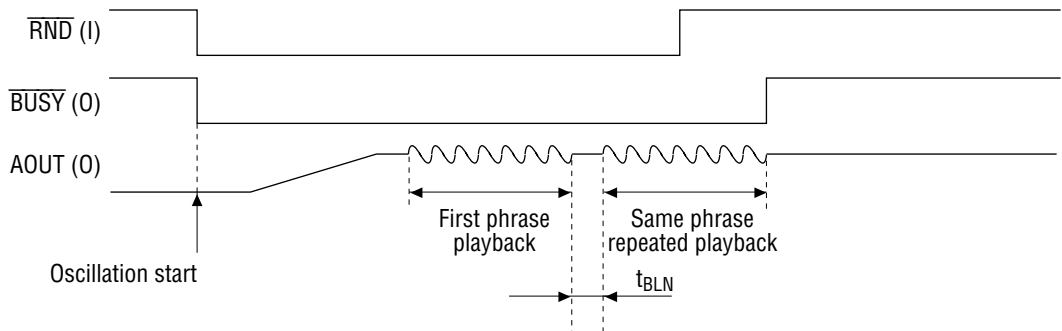
Repeated Playback Timing



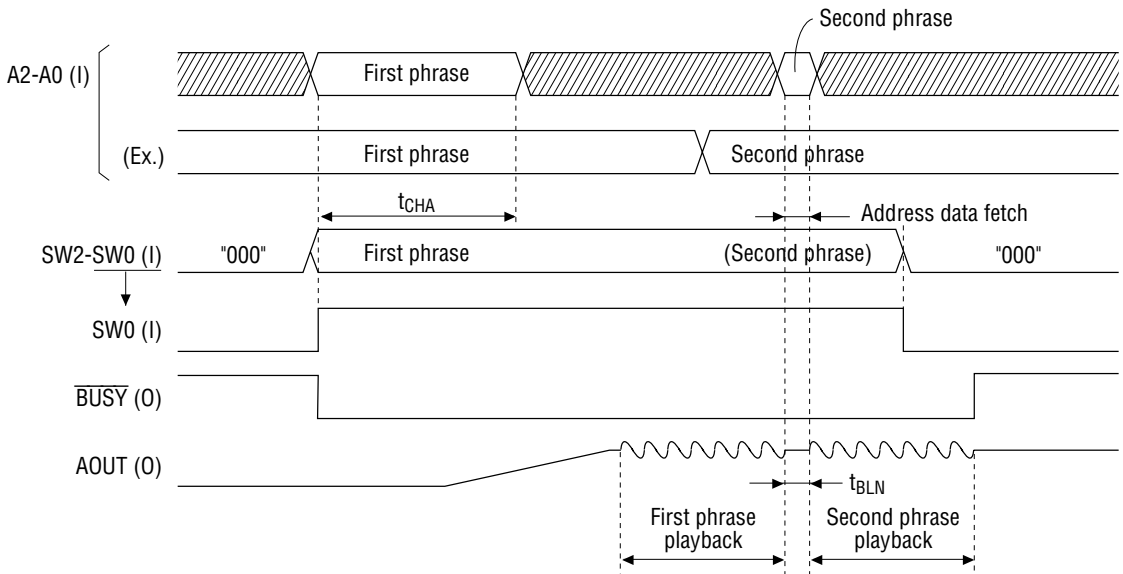
Timing when Changing from SW2 to SW0 During Playback



Repeated Playback Timing for Random Playback



Timing when Changing from A2 to A0 During Playback



FUNCTIONAL DESCRIPTION

1. Playback Code Specification

The user can specify a maximum of 56 phrases. Table 1.1 shows the settings by the A2-A0 and SW2-SW0 pins.

Table 1.1 User-specified Phrases

| A2-A0 | SW2-SW0 | Code Details |
|-------|---------|---------------------------------------|
| 000 | 000 | Inhibit code |
| ⋮ | 001 | User-specified phrase (56 phrases) |
| ⋮ | ⋮ | |
| 111 | 111 | |

2. Pull-up/Pull-down Resistor

The $\overline{\text{RESET}}$ and $\overline{\text{RND}}$ pins have internal pull-up resistors and the SW2-SW0 pins have internal pull-down resistors.

3. Stand-alone Mode

In a stand-alone mode, the SW input interface function and the random playback function can be used.

3.1 SW input interface

With the SW input interface, speech synthesis starts when the state of the SW2-SW0 pins has changed. To prevent chattering, the address data is latched 16 ms (t_{CHA}) after the state of SW2-SW0 has changed. Voice synthesis does not start if the state of the A2-A0 pins has changed. Set the $\overline{\text{RND}}$ pin to "H" level if the random playback function is not used.

Set the A2-A0 pins to "L" level at power-on or at reset.

The SW input interface is effective when the MSM9802/03/05 is operated using a push-button switch. Voice synthesis starts when an address is changed by pressing the push-button switch. If the push-button switch is released during playback, then playback stops after the current phrase is completed.

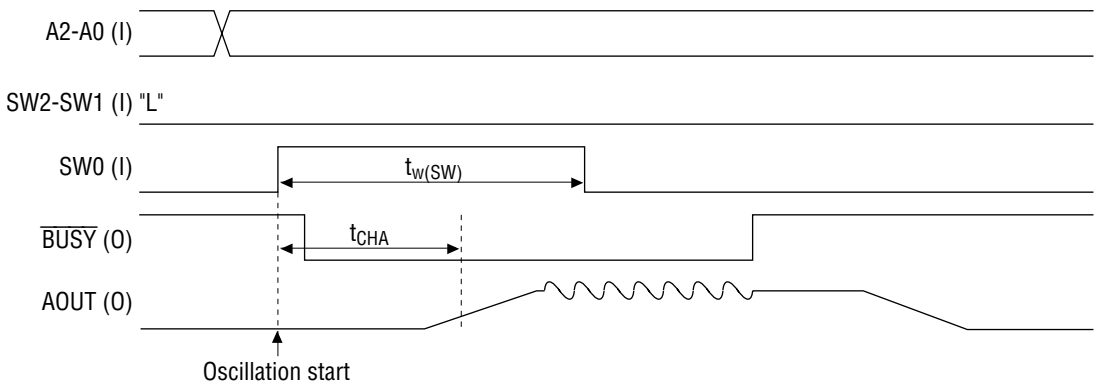


Figure 3.1 SW Input Interface Single-Phrase Playback Timing

If playback is attempted at an unused address in the phrases, AOUT goes to $1/2 I_{AOUT}$ and playback does not occur. Figure 3.2 shows the timing.

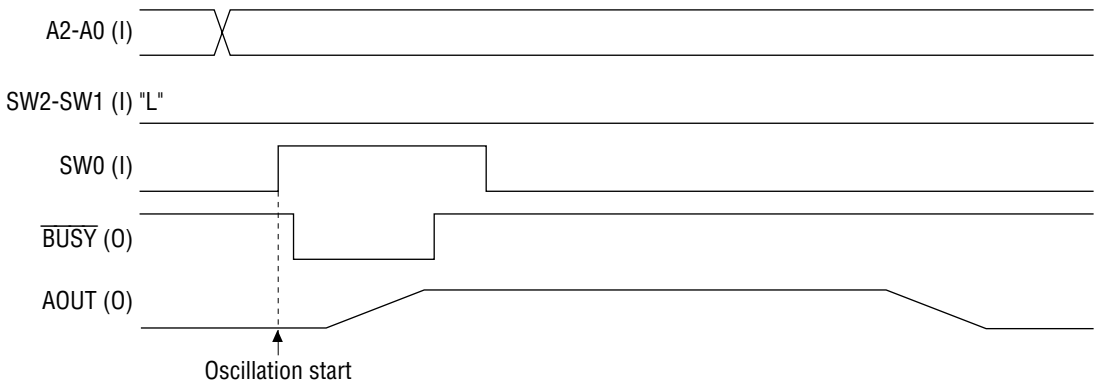


Figure 3.2 Timing when Playback is Attempted at an Unused Phrase Address

In the SW input interface, no phrase is triggered when SW2 to SW0 are all set to "0". Therefore, when the circuit consists of a diode matrices that use push-button switches, the maximum playback phrases are 56 phrases.

$$\begin{array}{c}
 \begin{array}{c}
 \text{A2-A0} \\
 \left[\begin{array}{c}
 000 \\
 001 \\
 002 \\
 \vdots \\
 111
 \end{array} \right] \\
 8 \text{ codes}
 \end{array}
 \times
 \begin{array}{c}
 \text{SW2-SW0} \\
 \left[\begin{array}{c}
 (000) \\
 001 \\
 002 \\
 \vdots \\
 111
 \end{array} \right] \\
 7 \text{ codes}
 \end{array}
 = 56 \text{ Phrases}
 \end{array}$$

\rightarrow Code Prohibited

3.2 Random playback function

The random playback function randomly generates 15 different addresses corresponding to the four bits of the addresses of A0 and SW2-SW0 (except ALL "L") on the IC, after which playback commences.

Therefore, any input to A0 and SW2 to SW0 pins from external control is invalid. Hold these 4 pins either "H" or "L" level. SW2 to SW0 pins may be held open as they have internal pull-down resistor.

Playback may not occur if all the 15 addresses have not been assigned a phrase. Care must be taken when creating ROM data.

For example, when four phrases, "sunny", "rainy", "cloudy", and "snowy", are to be played randomly, set the phrases as shown in Table 3.1 in which a phrase is assigned to all the 15 addresses. The four phrases are then played back at random as shown below.

Table 3.1 Random Address Setup Example

| A2, A1 | A0, SW2-SW0 | Phrase |
|--------|-------------|--------|
| 00 | 0001 | sunny |
| | 0010 | rainy |
| | 0011 | cloudy |
| | 0100 | snowy |
| | 0101 | sunny |
| | ⋮ | ⋮ |
| | 1110 | rainy |
| | 1111 | snowy |

Random playback starts when the timing shown in Figure 3.3 is input to the $\overline{\text{RND}}$ pin. A random address is fixed based on the "H" level time of the $\overline{\text{RND}}$ pin during IC oscillation. Random address is captured at the fall of the $\overline{\text{RND}}$ pin, and voice playback commences. Therefore, when power is turned on, or when $\overline{\text{RESET}}$ is input, the phrase at fixed address "0001" is played while the random counter remains initialized until random playback is initiated.

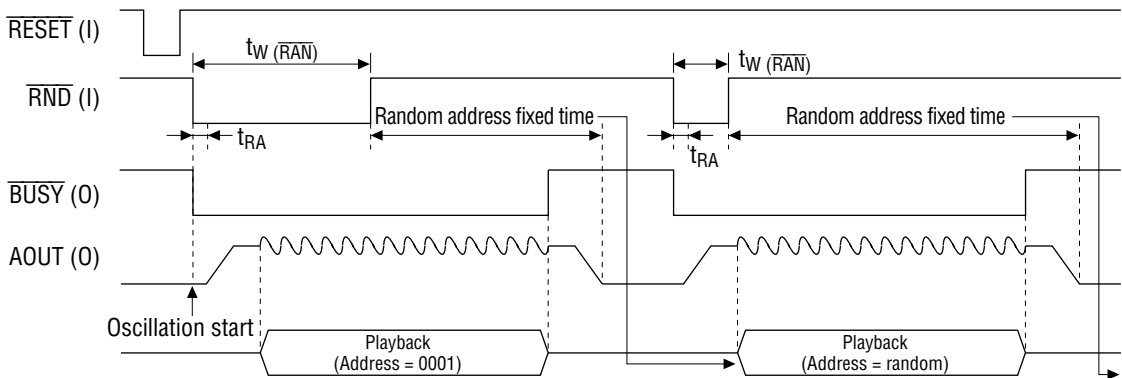


Figure 3.3 Random Address Capture

Table 3.2 Random Playback Address

| A2, A1 | A0, SW2 to SW0 | Phrase (Sample) |
|--------|----------------|-----------------|
| 00 | 0001 | Hit |
| | 0010 | Hit |
| | 0011 | Hit |
| | 0100 | Out |
| | ⋮ | ⋮ |
| | 1111 | Out |
| 01 | 0001 | Hit |
| | 0010 | Out |
| | 0011 | Out |
| | 0100 | Out |
| | ⋮ | ⋮ |
| | 1111 | Out |
| 10 | 0001 | White |
| | 0010 | Black |
| | 0011 | Red |
| | 0100 | Blue |
| | ⋮ | ⋮ |
| | 1111 | Green |
| 11 | 0001 | ⋮ |
| | ⋮ | ⋮ |
| | 1111 | ⋮ |

For a random address, 15 phrases can be set for each logical condition of addresses A2 and A1 (i.e., "00", "01", "10", and "11").

In random playback, the four logic states ("000000", "010000", "100000" and "110000") in user-specified phrases cannot be used. Take it into consideration when creating ROM data.

A random address is set by the "H" level time of the $\overline{\text{RND}}$ pin, so if the same pulse width is input by microcontroller, the random address fixed time becomes constant, and a random phrase may not be played under these conditions. The random address fixed time must be inconsistent in order to produce random playback.

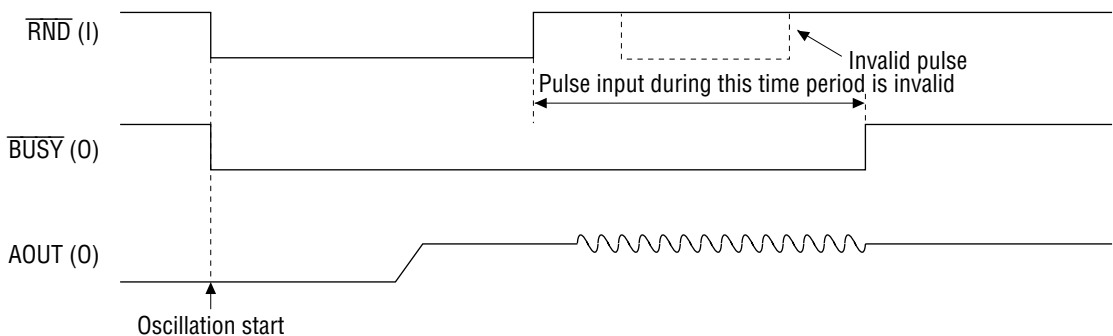


Figure 3.4 Timing when a Pulse is Input to the $\overline{\text{RND}}$ Pin During Random Playback

Table 3.3 Random Playback and Stop Address

| A2, A1 | A0, SW2-SW0* | Code Details |
|--------|-------------------|---|
| 00 | 0001 ⋮ 1111 | Random playback address (15 addresses) |
| 01 | 0001 | Stop address |

* Address(es) corresponding to the A0 and SW2-SW0 pins

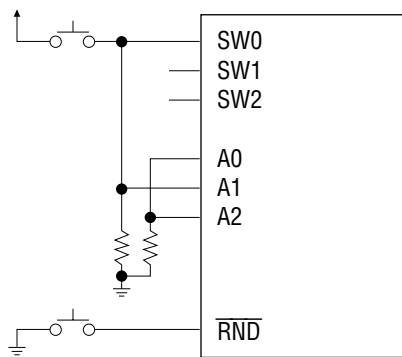
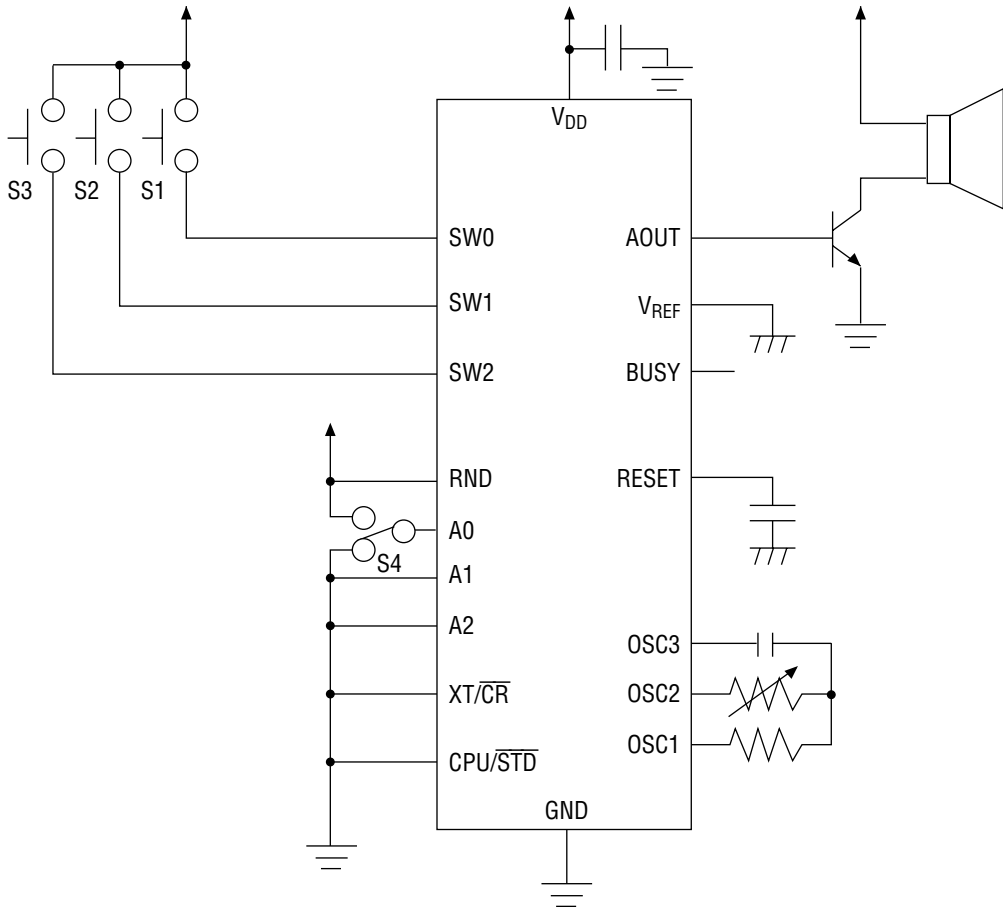


Figure 3.5 Circuit Example for Random Playback Stop

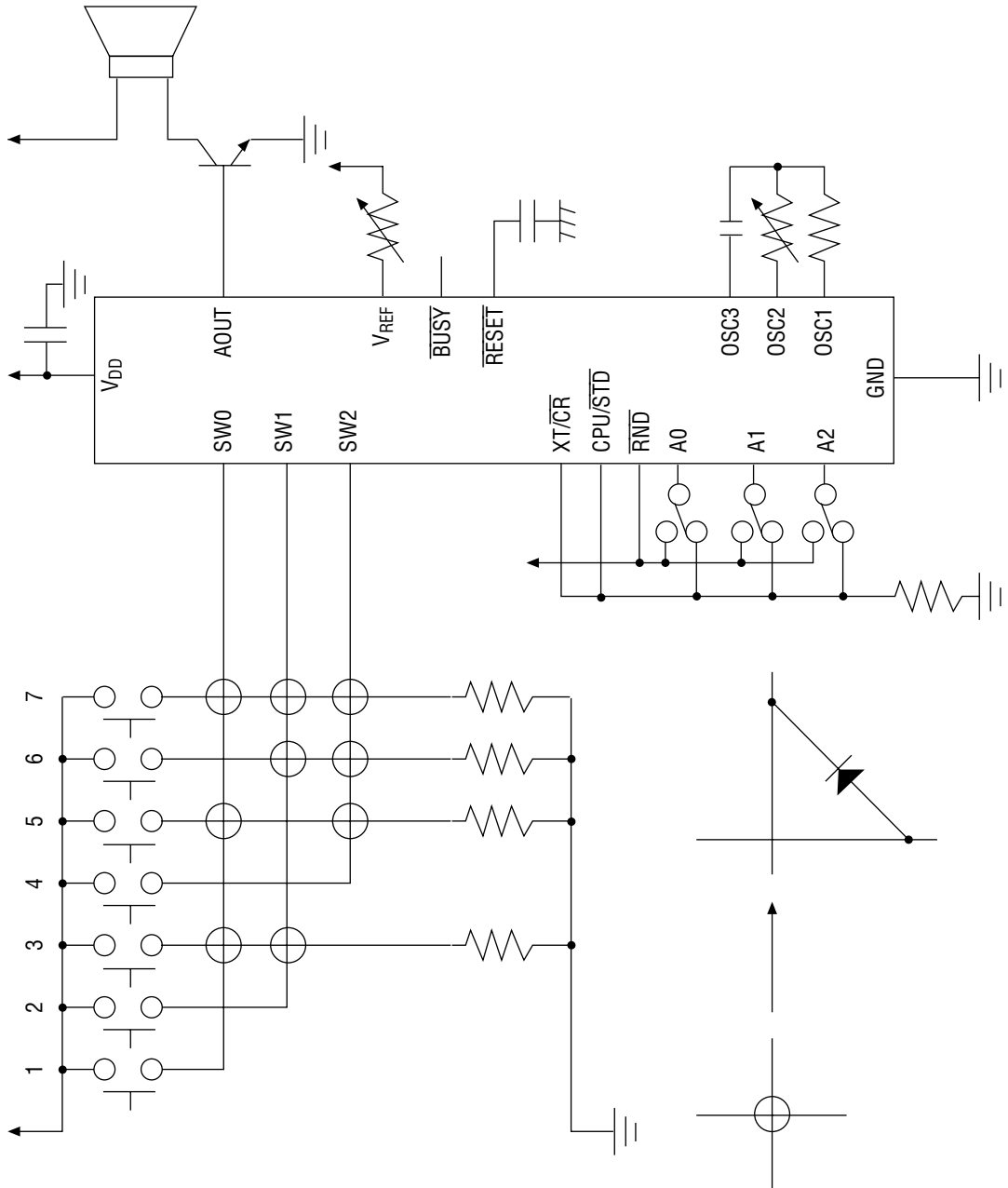
An unused user-specified address is used as a stop address, therefore the IC can enter standby without voice playback, as shown in Figure 3.2.

APPLICATION CIRCUITS



| | | A2 | A1 | A0 | SW2 | SW1 | SW0 | Address [HEX] |
|--------|----|----|----|----|-----|-----|-----|---------------|
| S4="L" | S1 | 0 | 0 | 0 | 0 | 0 | 1 | 01 |
| | S2 | 0 | 0 | 0 | 0 | 1 | 0 | 02 |
| | S3 | 0 | 0 | 0 | 1 | 0 | 0 | 04 |
| S4="H" | S1 | 0 | 0 | 1 | 0 | 0 | 1 | 09 |
| | S2 | 0 | 0 | 1 | 0 | 1 | 0 | 0A |
| | S3 | 0 | 0 | 1 | 1 | 0 | 0 | 0C |

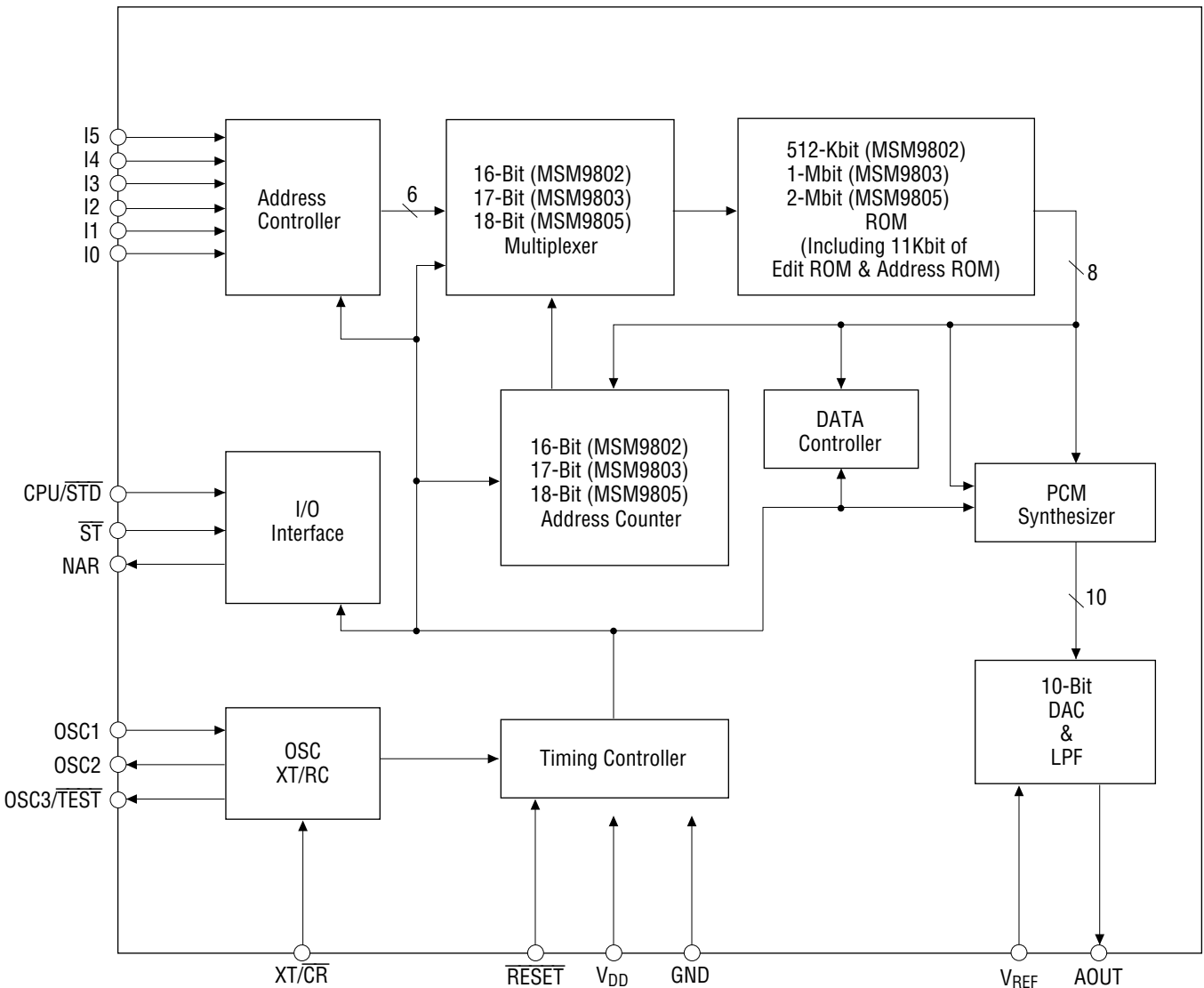
Application Circuit for Playing Six Phrases Using Four Switches



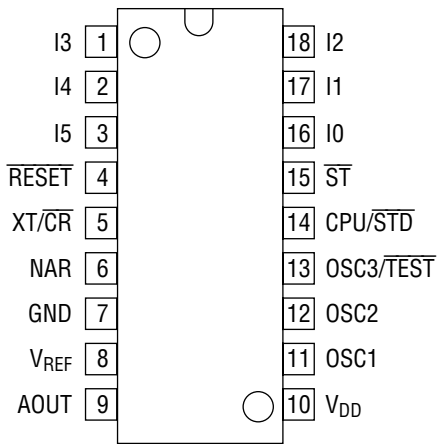
Application Circuit Using Switches

(2) MICROCONTROLLER INTERFACE MODE (CPU/STD: "H" level)

BLOCK DIAGRAM

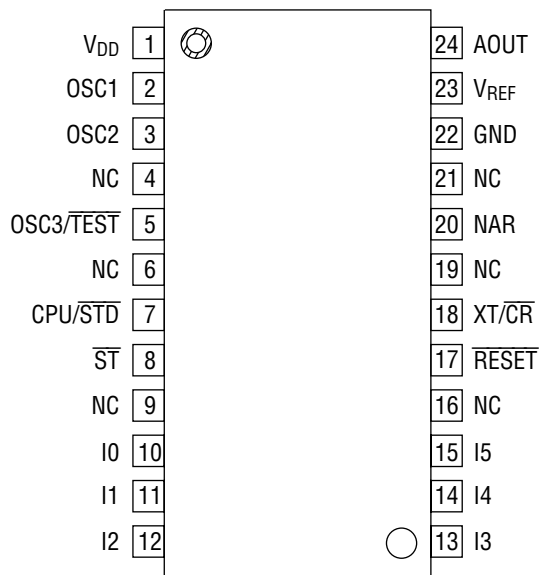


PIN CONFIGURATION (TOP VIEW)



18-Pin Plastic DIP

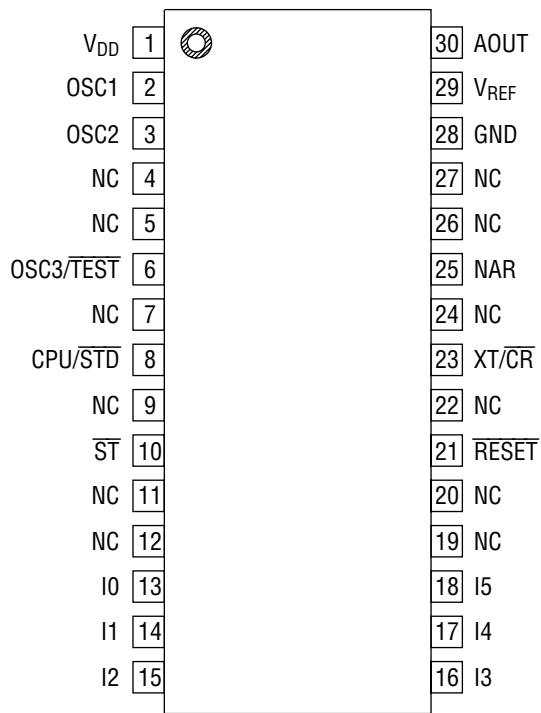
Note: Applicable to MSM9802-xxxRS, MSM9803-xxxRS, and MSM9805-xxxRS.



NC: No connection

24-Pin Plastic SOP

Note: Applicable to MSM9802-xxxGS-K, MSM9803-xxxGS-K, and MSM9805-xxxGS-K.



NC: No connection

30-Pin Plastic SSOP

Note: Applicable to MSM9802-xxxGS-AK, MSM9803-xxxGS-AK, and MSM9805-xxxGS-AK.

PIN DESCRIPTIONS

| Pin | | | Symbol | Type | Description |
|--------------|-------|-------|--------------------------------------|------|---|
| DIP | SOP | SSOP | | | |
| 4 | 17 | 21 | $\overline{\text{RESET}}$ | I | The IC enters the standby state if this pin is set to "L" level. At this time, oscillation stops and AOUT drives a current of 0 mA and becomes GND level, then the IC returns to the initial state. Apply a "L" pulse upon power-on. This pin has an internal pull-up resistor. |
| 6 | 20 | 25 | NAR | O | Signal output pin that indicates whether the 6-bit LATCH (see Block Diagram) is idle. NAR at "H" level indicates that the LATCH is empty and $\overline{\text{ST}}$ input is enabled. |
| 5 | 18 | 23 | $\text{XT}/\overline{\text{CR}}$ | I | XT/RC switching pin. Set to "H" level if ceramic oscillation is used. Set to "L" level if RC oscillation is used. |
| 14 | 7 | 8 | $\text{CPU}/\overline{\text{STD}}$ | I | Microcontroller interface/stand-alone mode switching pin. Set to "H" level if the MSM9802/03/05 is used in microcontroller interface mode. |
| 8 | 23 | 29 | 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. An approx. 10 k Ω pull-down resistor is internally connected to this pin during operation. |
| 9 | 24 | 30 | AOUT | O | Voice output pin. The voice signals are output as current changes. In standby state, this pin drives a current of 0 mA and becomes GND level. |
| 7 | 22 | 28 | GND | — | Ground pin. |
| 10 | 1 | 1 | V_{DD} | — | Power supply pin. Insert a bypass capacitor of 0.1 μF or more between this pin and the GND pin. |
| 11 | 2 | 2 | OSC1 | I | Ceramic oscillator connection pin when ceramic oscillation is selected. RC connection pin when RC oscillation is selected. Input from this pin if external clock is used. |
| 12 | 3 | 3 | OSC2 | O | Ceramic oscillator connection pin when ceramic oscillation is selected. RC connection pin when RC oscillation is selected. Leave this pin open if external clock is used. Outputs "L" level in standby state. |
| 13 | 5 | 6 | $\text{OSC3}/\overline{\text{TEST}}$ | O | Leave this pin open when ceramic oscillation is used. RC connection pin when RC oscillation is selected. Outputs "H" level in standby state when RC oscillation is selected. |
| 15 | 8 | 10 | $\overline{\text{ST}}$ | I | Voice synthesis starts at fall of $\overline{\text{ST}}$, and addresses I0 to I5 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. |
| 16-18 1-3 | 10-15 | 13-18 | I0 - I5 | I | Phrase input pins corresponding to playback sound. |

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 1 | f_{OSC1} | When crystal is selected | Min. | Typ. | Max. | MHz |
| | | | 3.5 | 4.096 | 4.5 | |
| Original Oscillation Frequency 2 | f_{OSC2} | When RC is selected (*1) | 200 | 256 | 300 | kHz |

*1 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

($V_{DD}=5.0\text{ V}$, $GND=0\text{ V}$, $T_a=-40\text{ to }+85^\circ\text{C}$, 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} | $I_{OH}=-1\text{ mA}$ | 4.6 | — | — | V |
| "L" Output Voltage | V_{OL} | $I_{OL}=2\text{ mA}$ | — | — | 0.4 | V |
| "H" Input Current 1 | I_{IH1} | $V_{IH}=V_{DD}$ | — | — | 10 | μA |
| "H" Input Current 2 | I_{IH2} | Applies to OSC1 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 bias voltage=0V | — | 0.4 | 1 | mA |
| Dynamic Supply Current 2 *3 | I_{DD2} | At maximum output current $V_{REF}=GND$, AOUT bias voltage=0V | — | — | 16 | mA |
| Standby Current | I_{DS} | $T_a=-40\text{ to }+70^\circ\text{C}$ | — | — | 10 | μA |
| | | $T_a=70\text{ to }85^\circ\text{C}$ | — | — | 50 | μA |
| AOUT Output Current | I_{AOUT} | At maximum output current, $V_{REF}=GND$, AOUT bias voltage=0V | 6 | 9.5 | 15 | mA |
| V_{REF} Pin Pull-down Resistance | R_{VREF} | — | 7 | 10 | 13 | $\text{k}\Omega$ |

*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

(V_{DD}=3.1 V, GND=0 V, T_a=-40 to +85°C, unless otherwise specified)

| 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 OSC1 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 bias voltage=0V | — | 0.15 | 0.5 | mA |
| Dynamic Supply Current 2 *3 | I _{DD2} | At maximum output current V _{REF} =GND, AOUT bias voltage=0V | — | — | 5.5 | mA |
| Standby Current | I _{DS} | T _a =-40 to +70°C | — | — | 5 | μA |
| | | T _a =70 to 85°C | — | — | 20 | μA |
| AOUT Output Current | I _{AOUT} | At maximum output current, V _{REF} =GND, AOUT bias 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

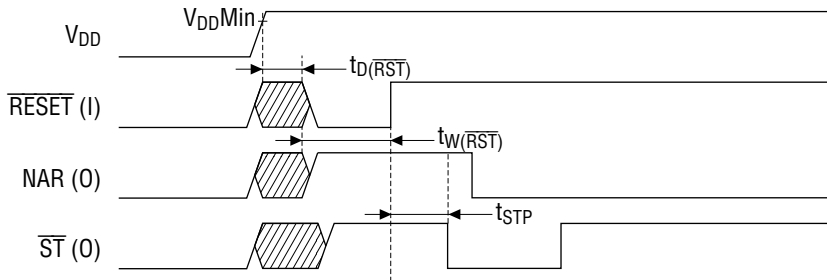
(V_{DD}=5.0 V, GND=0 V, T_a=-40 to +85°C)

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

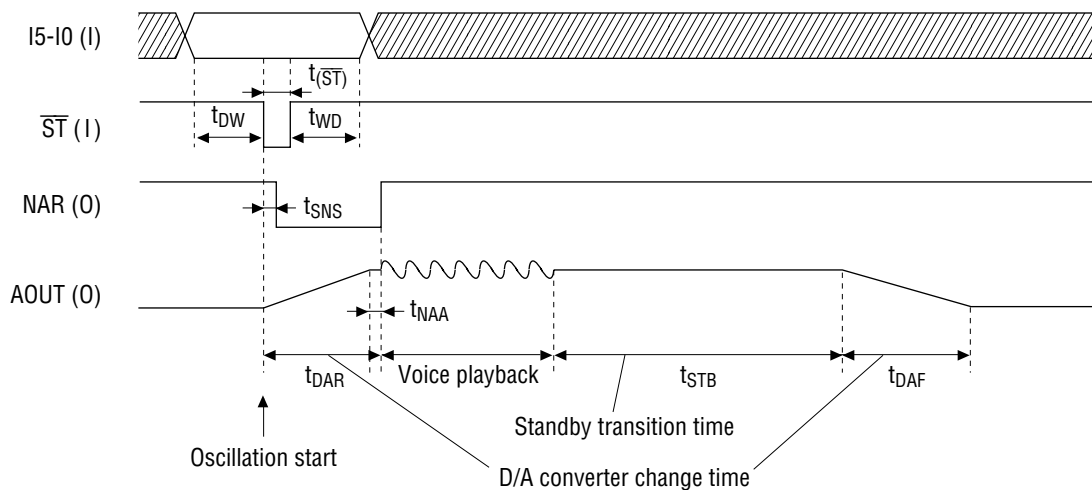
(Note) Proportional to master the periods of oscillation frequencies f_{OSC1} and f_{OSC2}.
The rated values show values when the standard master oscillation frequency is used.

TIMING DIAGRAMS

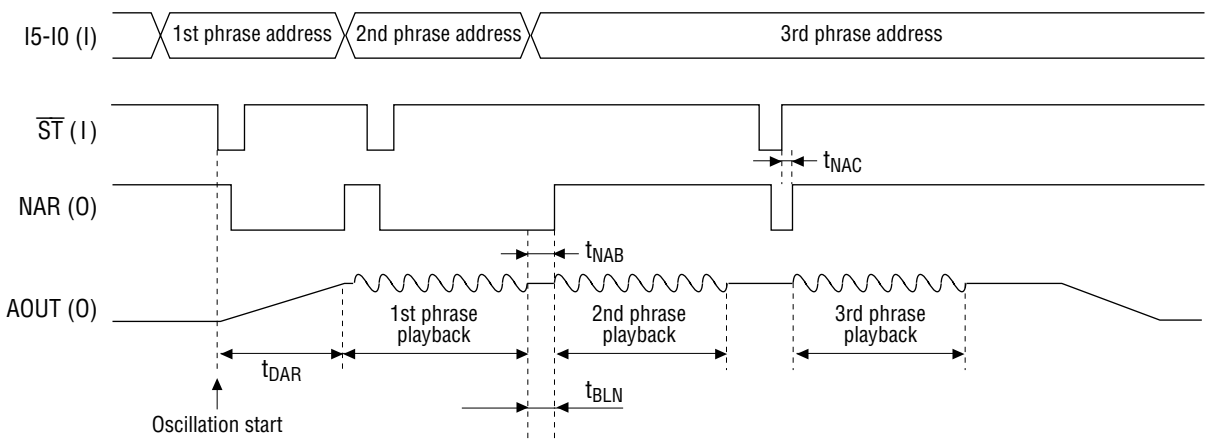
AC Characteristics at Power-On



AC Characteristics in Standby Status and when the IC is Activated



Playback Timing



FUNCTIONAL DESCRIPTION

1. Playback Code Specification

The user can specify a maximum of 63 phrases. Table 1.1 shows the settings by the I5-I0 pins.

Table 1.1 User-specified Phrases

| | |
|--------|---------------------------------------|
| I5-I0 | Code Details |
| 000000 | Stop code |
| 000001 | User-specified phrase (63 Phrases) |
| ⋮ | |
| 111111 | |

2. Address Data

If a phrase is input at I5-I0 pins by address data, and if a \overline{ST} pulse is then applied, voice playback starts. Figure 2.1 shows voice start timing. Figure 2.2 shows timing when an address other than a phrase is input.

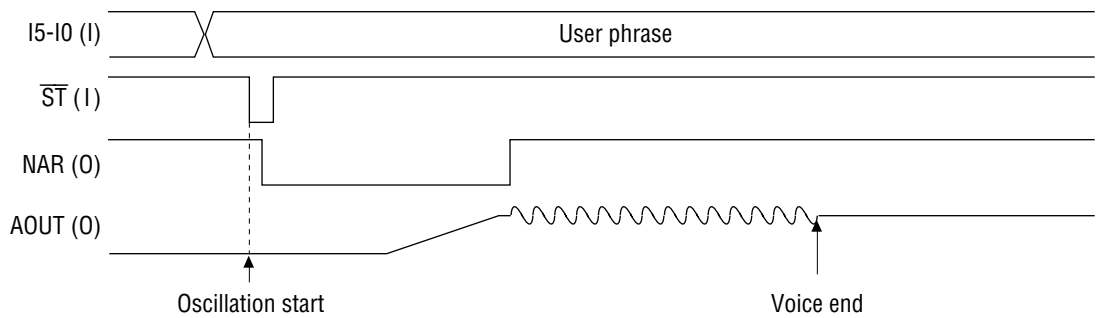


Figure 2.1 Voice Start Timing

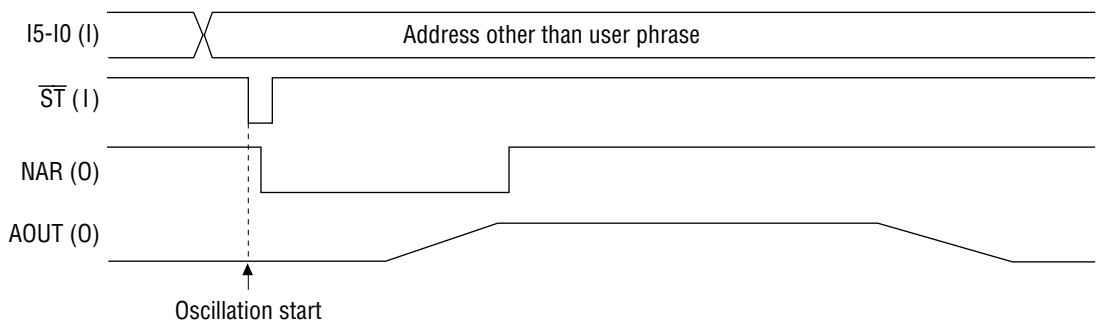


Figure 2.2 Timing when Address Other than a Phrase is Input in Stand-by Mode

3. Stop Code

If I5-I0 are set to "000000" during voice playback, and a \overline{ST} signal is input, playback stops regardless of whether NAR is at "H" or "L" level, then AOUT becomes $1/2 I_{AOUT}$. Stop code becomes valid at the falling edge of \overline{ST} .

Figure 3.1 shows stop code input timing.

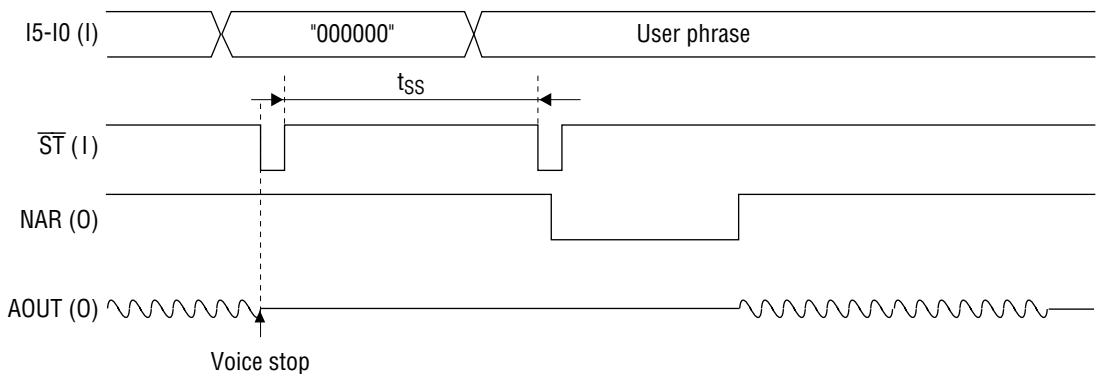


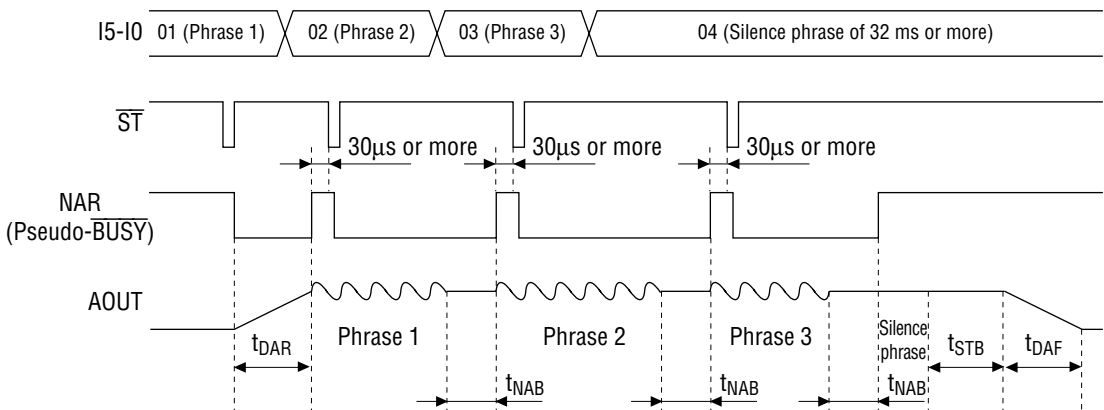
Figure 3.1 Stop Code Input Timing

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

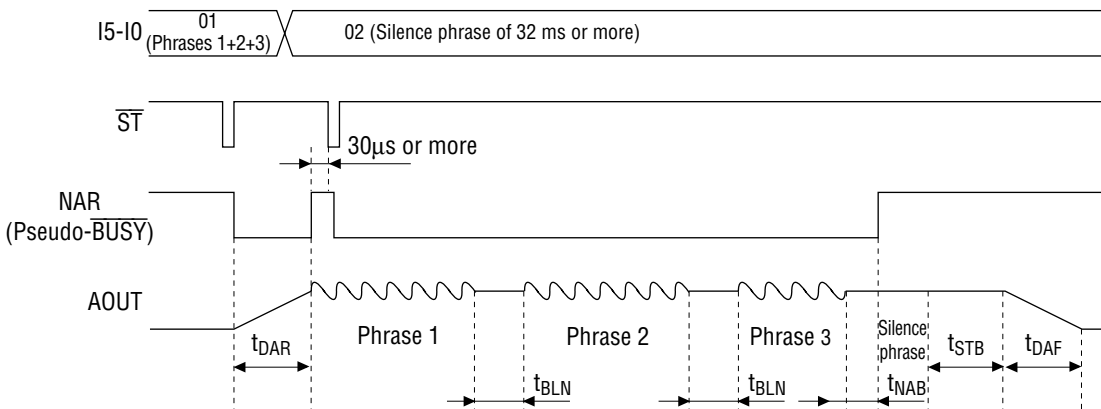
4. Generating Pseudo-BUSY Signal through NAR Pin

If the application in use requires a $\overline{\text{BUSY}}$ signal when this IC is used in microcontroller interface mode, a pseudo- $\overline{\text{BUSY}}$ signal can be generated through the NAR pin by controlling signal timing, as shown below.

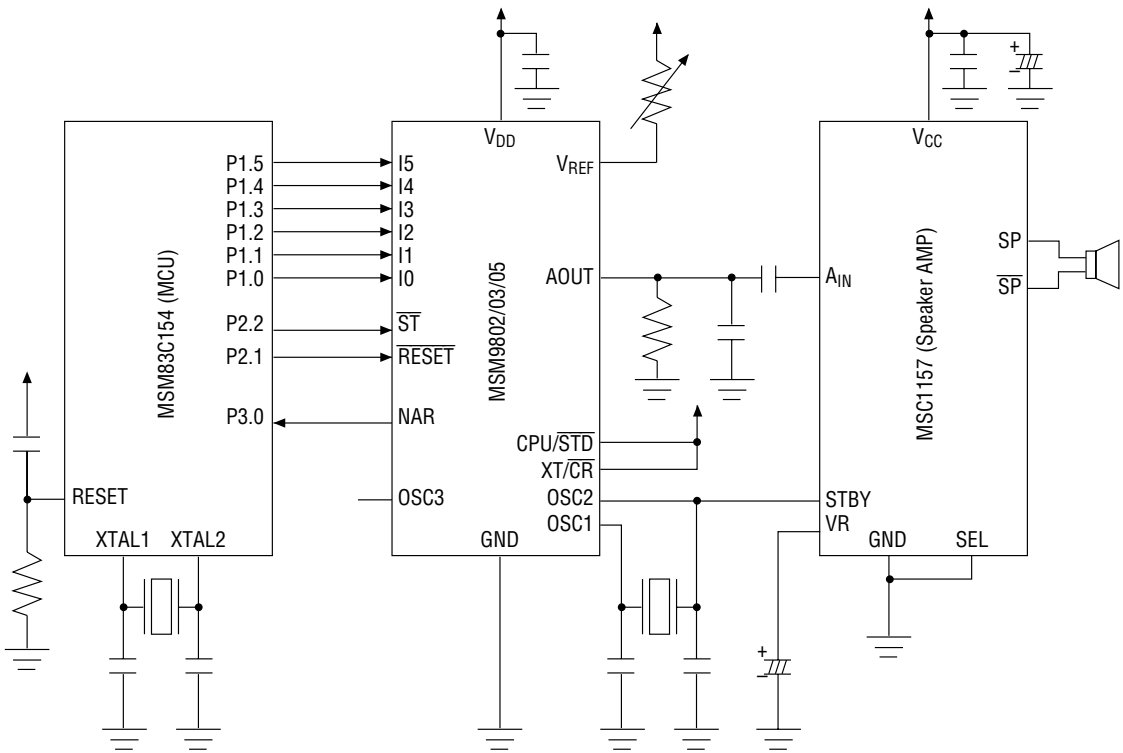
4.1 When edit ROM is not used



4.2 When edit ROM is used



APPLICATION CIRCUIT



Application Circuit in Microcontroller Interface

(3) Common

1. Sampling Frequency

As shown in Table 1.1, 7 sampling frequencies are available. A sampling frequency can be selected and assigned to each phrase in ROM data.

Table 1.1 Sampling Frequency

| Sampling Frequency (At standard oscillation frequency) | Frequency diving ratio | |
|---|----------------------------------|-----------------------------|
| | XT/CR="H" Ceramic Oscillation | XT/CR="L" CR Oscillation |
| 4.0 kHz | f _{osc1} /1024 | f _{osc2} /64 |
| 5.3 kHz | f _{osc1} /768 | f _{osc2} /48 |
| 6.4 kHz | f _{osc1} /640 | f _{osc2} /40 |
| 8.0 kHz | f _{osc1} /512 | f _{osc2} /32 |
| 10.6 kHz | f _{osc1} /384 | Unavailable |
| 12.8 kHz | f _{osc1} /320 | Unavailable |
| 16.0 kHz | f _{osc1} /256 | Unavailable |

Note: When RC oscillation is selected, 10.6 kHz, 12.8 kHz, and 16 kHz cannot be selected.

2. Recording/Playback Time

Figure 2.1 below shows memory allocation of the on-chip Mask ROM. About 11 Kbits of data area is allocated for the Phrase Control Table, Phrase Data Control and Test Data. Therefore, actual data area for storing sound data equals the total Mask ROM capacity minus 11 Kbits.

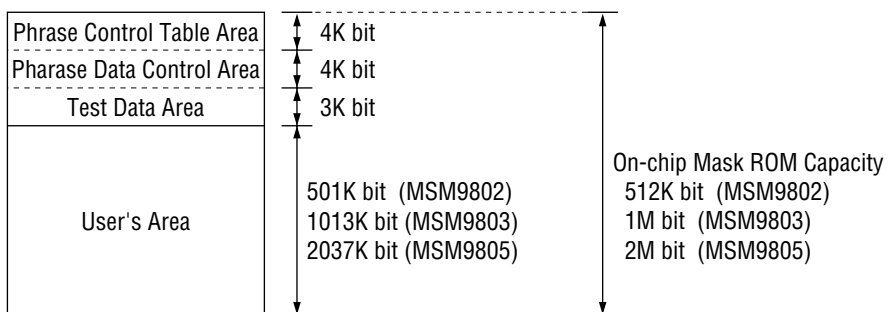


Figure 2.1 Memory Allocation of On-chip Mask ROM

The playback time is obtained by dividing the memory capacity by the bit rate.
 The playback time for 8-bit PCM algorithm is obtained by using the following equation.

$$\text{Playback time [sec]} = \frac{\text{Memory capacity [bit]}}{\text{Bit rate [bps]}} = \frac{\text{Memory capacity [bit]}}{\text{Sampling frequency [Hz]} \times 8 \text{ [bit]}}$$

For example, if all phrases are stored in the MSM9802 at 8 kHz sampling frequency, the maximum playback time is as follows.

$$\text{Playback time} = \frac{(512-11) \times 1024 \text{ [bit]}}{8000 \text{ [Hz]} \times 8 \text{ [bit]}} \approx 8.0 \text{ [sec]}$$

Table 2.1 Maximum playback time

| Model | ROM capacity | User's area | Maximum playback time (sec) | | | |
|---------|--------------|-------------|-----------------------------|--------------------------|--------------------------|---------------------------|
| | | | f _{SAM} =4.0kHz | f _{SAM} =6.4kHz | f _{SAM} =8.0kHz | f _{SAM} =16.0kHz |
| MSM9802 | 512K bit | 501K bit | 16.0 | 10.0 | 8.0 | 4.0 |
| MSM9803 | 1M bit | 1013K bit | 32.4 | 20.2 | 16.2 | 8.1 |
| MSM9805 | 2M bit | 2037K bit | 65.1 | 40.7 | 32.5 | 16.2 |

3. Playback Method

This IC provides two kinds of playback methods, non-linear PCM algorithm and straight PCM algorithm. When the 8-bit non-linear PCM algorithm is selected, sound quality can be improved because a resolution equivalent to 10-bit straight PCM is available around the waveform center. You can select either non-linear PCM algorithm or straight PCM algorithm for each phrase. Table 3.1 shows the relationship between playback methods and applicable sounds. It is recommended to evaluate the sound quality before actual use.

Table 3.1 Relationship between playback methods and applicable sounds

| Playback method | Applicable sound |
|--------------------------------|--------------------------|
| 8-bit non-linear PCM algorithm | Human voice |
| 8-bit straight PCM algorithm | BEEP tone, sound effects |

4. Phrase Control Table

Because the LSI contains the Phrase Control Table, it is possible to play back multiple phrases in succession by a single easy control operation like controlling a single regular phrase playback. Up to 8 combined phrases including a silence can be registered in a single address in the Phrase Control Table.

Further, you can use the maximum memory space for data storage because it is not required to have the same phrase data.

To show an example, let's assume that your application needs to speak two similar sentences, "It is fine today" and "It is rainy today." The two sentences have the common words "it", "is" and "today". What you have to do is to prepare these common sound data, not in sentences but in words, and to store each combined phrase data in Phrase Control Table as shown in Table 4.1 and Figure 4.1

Multiple phrases can be played continuously merely by specifying a desired phrase using an X address. For an example from Table 4.1, when address "01" is specified, "It is fine today" is played, and when address "02" is specified, "It is rainy" is played.

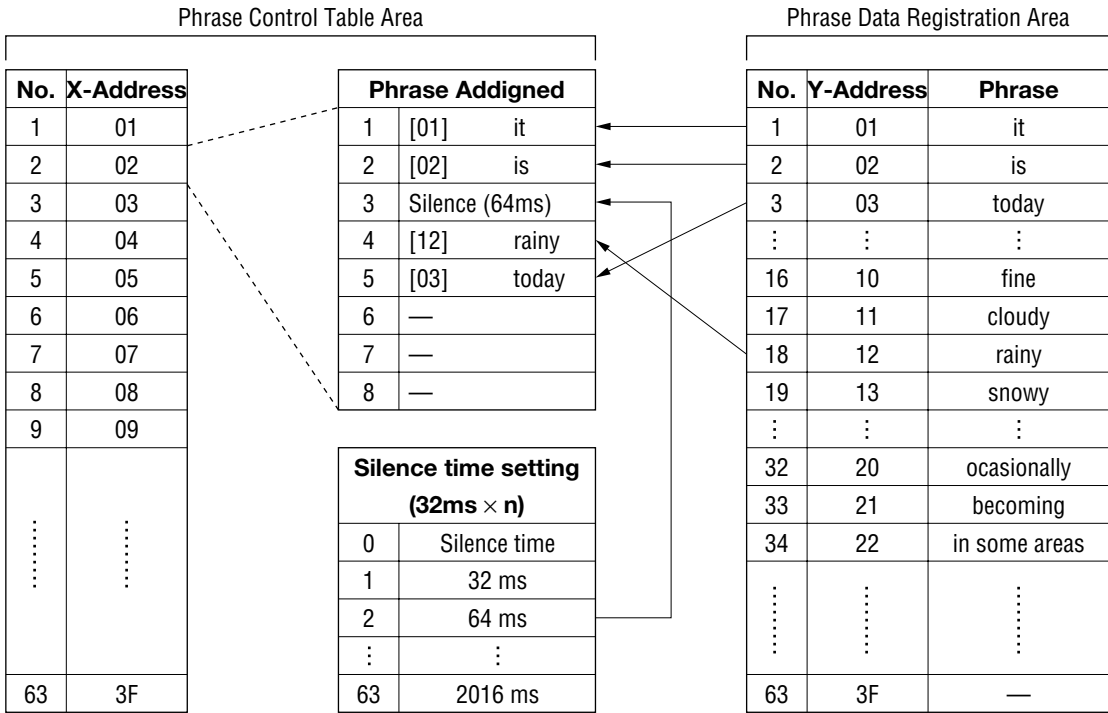
Phrase Control Table, a silence can be inserted without using the User's Area.

| | |
|----------------------------------|---------|
| Minimum time for silence | 32 ms |
| Maximum time for silence | 2016 ms |
| Time unit for setting up silence | 32 ms |

Table 4.1 Matrix of the Phrase Control Table

| No. | X-Address (HEX) | Y-Address (Up to 8 phrases) | | | | | | | | Sound Data |
|-----|-----------------|-----------------------------|------|---------|------|------|------|------|------|--|
| 1 | 01 | [01] | [02] | Silence | [10] | [03] | | | | It is (silence) fine today. |
| 2 | 02 | [01] | [02] | Silence | [12] | [03] | | | | It is (silence) rainy today. |
| 3 | 03 | [01] | [02] | [10] | [21] | [11] | [12] | [22] | [03] | It is fine becoming cloudy, rainy in some areas today. |
| ⋮ | ⋮ | | | | | | | | | ⋮ |
| 62 | 3E | | | | | | | | | |
| 63 | 3F | | | | | | | | | |

Figure 4.1 Phrase Combination Matrix for Phrase Control Table



5. RC Oscillation

Figure 5.1 shows an external circuit using RC oscillation. Figure 5.2 shows the RC oscillation frequency characteristics.

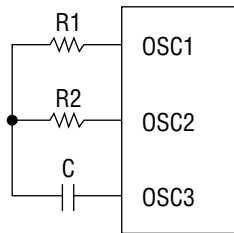


Figure 5.1 RC Oscillation

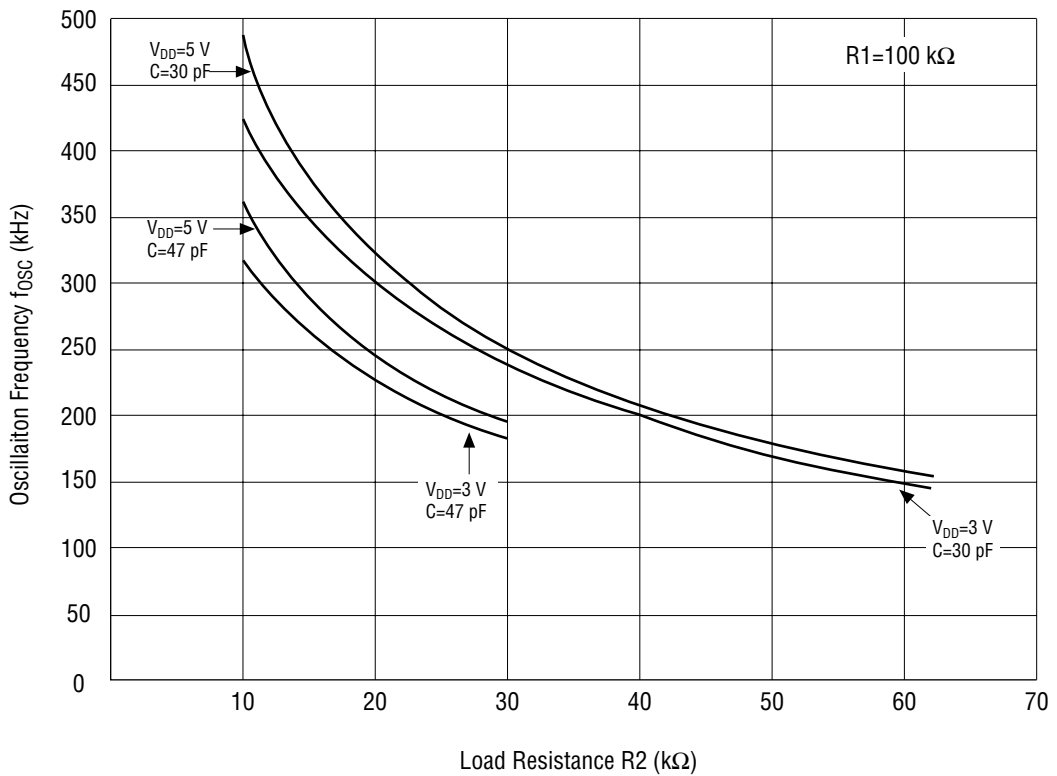


Figure 5.2 RC Oscillation Frequency Characteristics

5.1 Determining RC constants

The RC oscillation frequency characteristics are shown in Figure 5.2. If f_{osc} is set to 256 kHz, use the following values as a guide (see Figure 5.2) to set the C and R2 that fit the printed-circuit board type used.

$$R1=100\text{ k}\Omega, R2=30\text{ k}\Omega, C=30\text{ pF}$$

When choosing RC oscillation, the RC oscillation frequency varies according to the fluctuation of the external C and R2.

5.2 Fluctuation of RC oscillation frequencies

When choosing RC oscillation, the error of RC oscillation frequency due to process variations of the IC is $\pm 4\%$ maximum, and the fluctuation of the RC oscillation frequency when using a capacitor (C) of $\pm 1\%$ accuracy and a resistor (R2) of $\pm 2\%$ accuracy is a maximum of $\pm 7\%$ approximately.

6. Ceramic Oscillation

Figure 6.1 shows an external circuit using a ceramic oscillator.

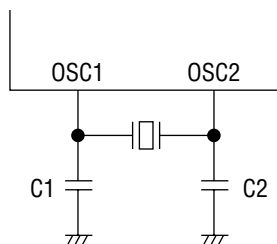


Figure 6.1 Ceramic Oscillation Diagram

For example, the following table shows the optimum load capacitances, power supply voltage ranges, and operating temperature ranges when ceramic oscillators made by Murata MFG Co., Ltd., Kyocera Co., Ltd. and TDK Co., Ltd. are used.

| Maker | Ceramic oscillator | | Optimal load capacity | | supply voltage range (V) | Operating temperature range (°C) |
|-------------|--------------------|--------------------|-----------------------|----------|-----------------------------|--|
| | Type | Frequency (MHz) | C1 (pF) | C2 (pF) | | |
| Murata MFG. | CSA4.09MGU | 4.096 | 30 | 30 | 3.0 to 5.5 | -40 to +85 |
| | CST4.09MGWU | | Built in | Built in | | |
| | CSTCC4.00MG | 4.0 | 15 | 15 | 3.6 to 5.5 | |
| | CSTCC4.00MGU | | | | 2.7 to 5.5 | |
| Kyocera | PBRC4.00A | 4.0 | 33 | 33 | 3.1 to 5.5 | -20 to +80 |
| | KBR-4.0MSB | | | | | |
| | PBRC4.00B | | Built in | Built in | | |
| | KBR-4.0MKC | | | | | |
| TDK | CCR4.00MC3 | 4.0 | Built in | Built in | 2.4 to 5.5 | -40 to +85 |

(Note) When a 4 MHz ceramic oscillator is used, the playback speed of MSM9802/03/05 is slower by 2 percent than that of an analysis tool or a demonstration board.

7. Low-Pass Filter

In this IC, all voice outputs are through the built-in low-pass filter (LPF). Figure 7.1 and Table 7.2 show the LPF frequency characteristics and LPF cutoff frequency respectively. Only the voice output through LPF is enabled in this IC.

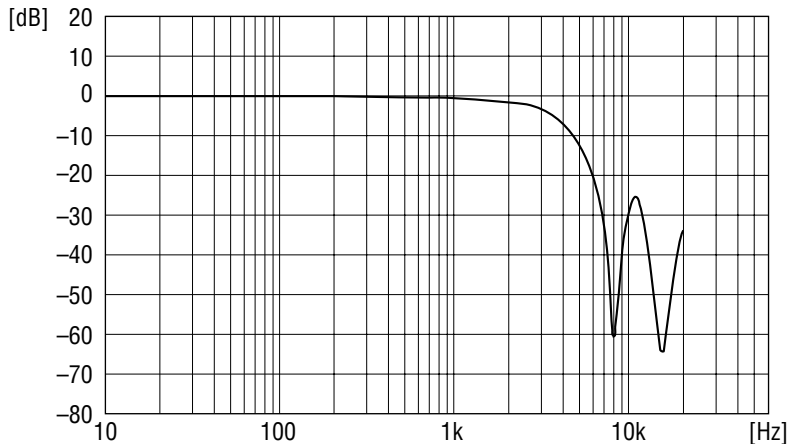


Figure 7.1 LPF Frequency Characteristics ($f_{SAM}=8\text{ kHz}$)

Table 7.2 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 |

8. 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.

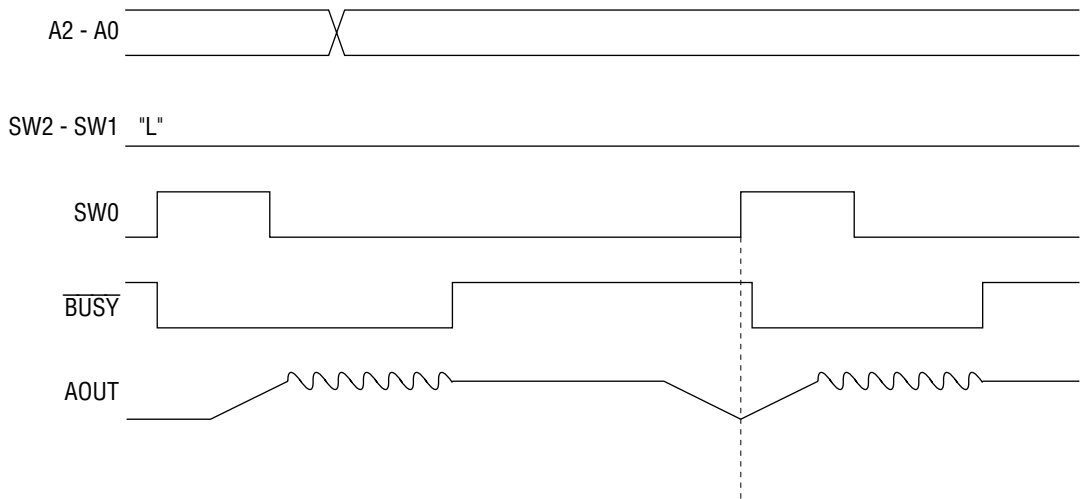


Figure 8.1 Timing for Voice Playback during D/A Converter Change Time (Stand-alone Mode)

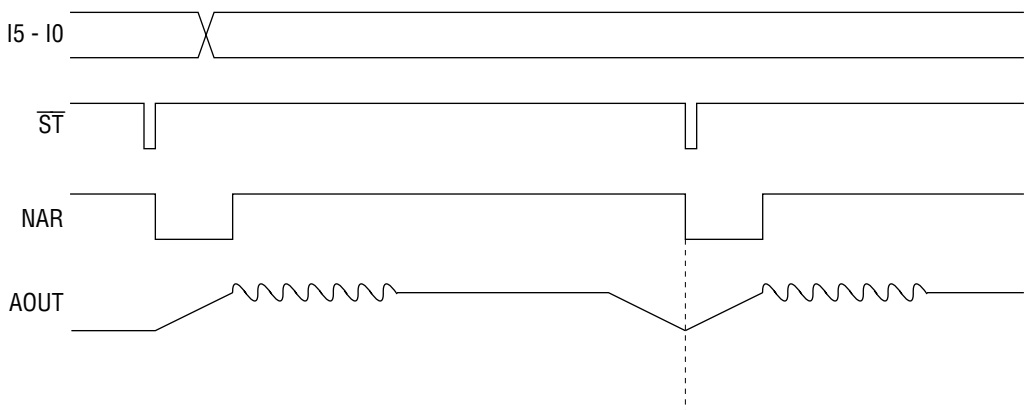


Figure 8.2 Timing for Voice Playback during D/A Converter Change Time (Microcontroller Interface Mode)

If playback is attempted during D/A converter change time as shown in figures 8.1 and 8.2, 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.

9. Voice Output Unit Equivalent Circuit (AOUT, FREF Pins)

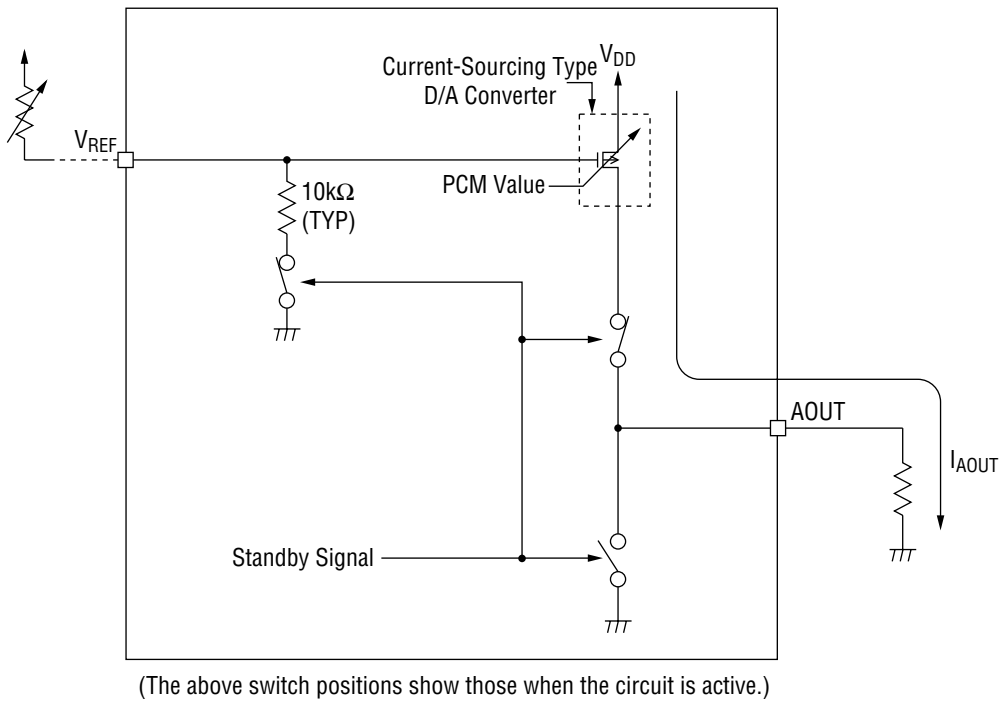
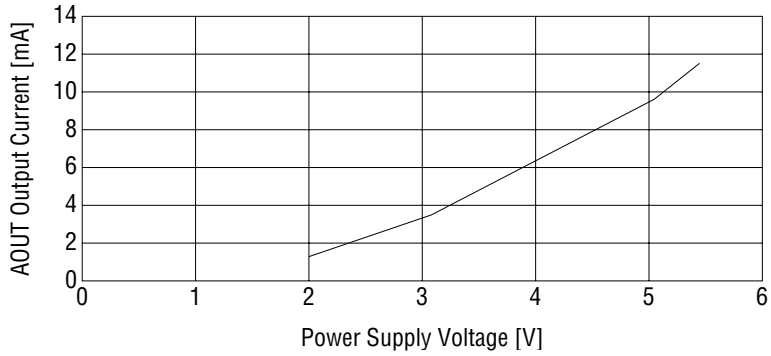


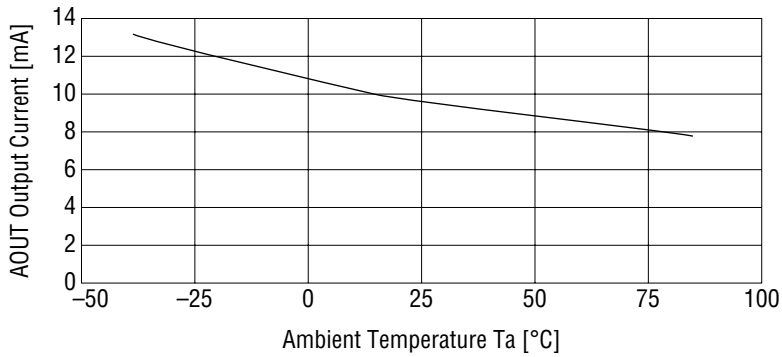
Figure 9.1 Voice Output Unit Equivalent Circuit

D/A CONVERTER OUTPUT CURRENT CHARACTERISTICS

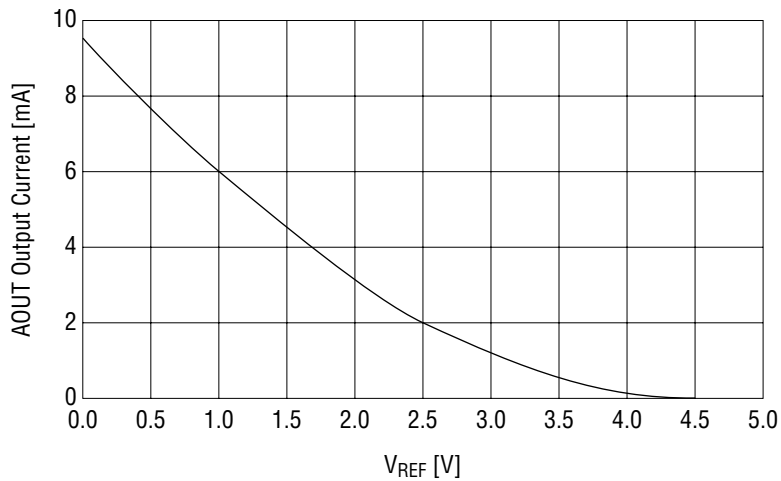
Power Supply Voltage vs. Output Current Characteristics ($T_a=25^\circ\text{C}$, $V_{AOUT}=0\text{V}$)



Temperature vs. Output Current Characteristics ($V_{DD}=5\text{V}$, $V_{AOUT}=0\text{V}$)



V_{REF} Voltage vs. Output Current Characteristics ($T_a=25^\circ\text{C}$, $V_{DD}=5\text{V}$, $V_{AOUT}=0\text{V}$)

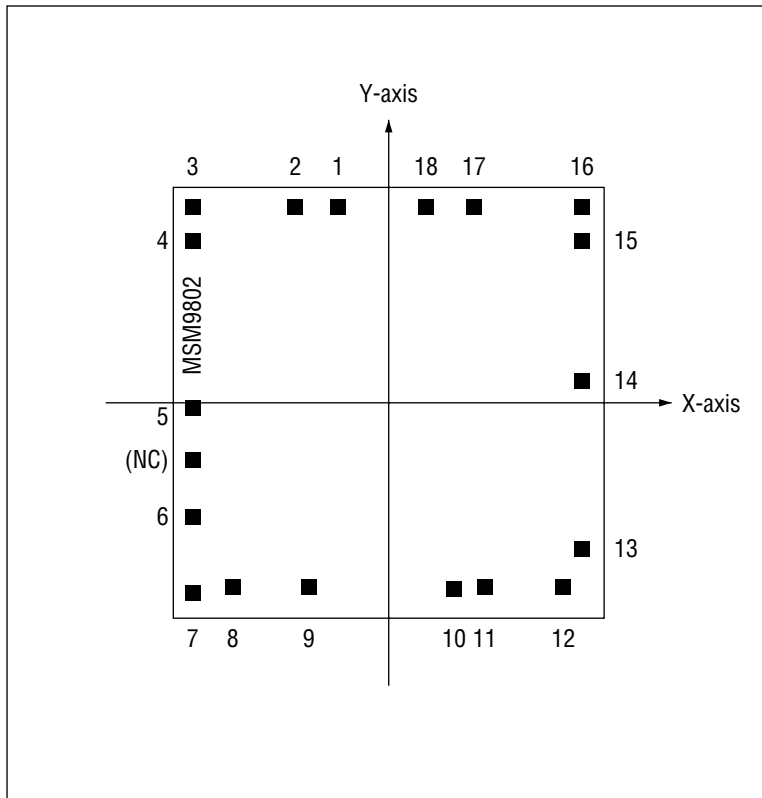


PAD CONFIGURATION

MSM9802

Pad Layout

Chip size : X=3.22mm Y=3.17mm
 Chip thickness : 350µm ± 30µm
 Pad size : 110µm × 110µm
 Substrate potential : GND



Pad Coordinates

(Chip center is located at X=0 and Y=0)

(Unit: µm)

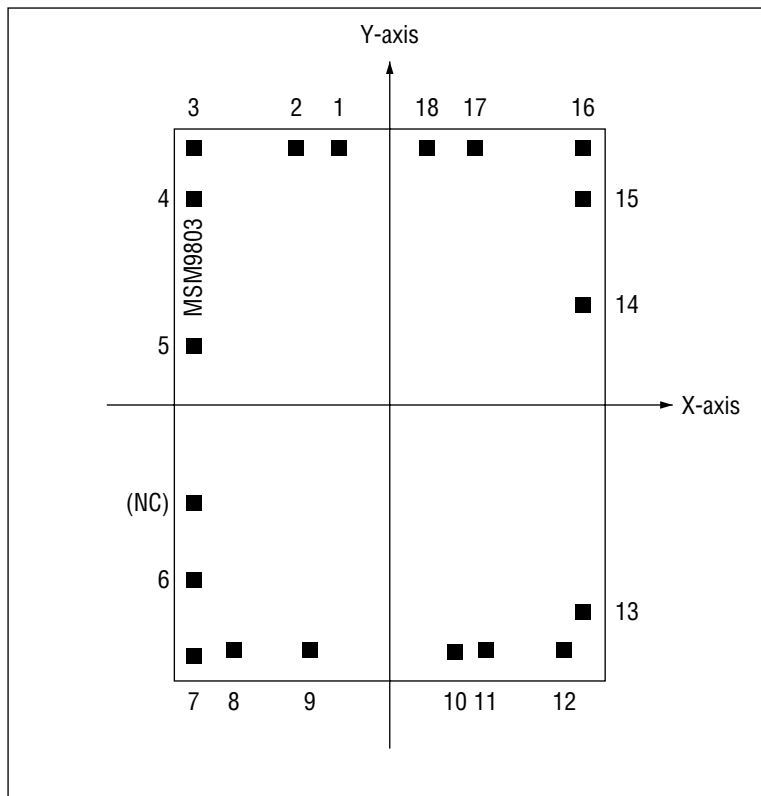
| Pad No. | Pad Name | X-axis | Y-axis | Pad No. | Pad Name | X-axis | Y-axis |
|---------|------------------|--------|--------|---------|-----------------|--------|--------|
| 1 | I3/ (A0) | -415 | 1385 | 10 | V _{DD} | 462 | -1347 |
| 2 | I4/ (A1) | -816 | 1385 | 11 | OSC1 | 742 | -1333 |
| 3 | I5/ (A2) | -1460 | 1385 | 12 | OSC2 | 1349 | -1333 |
| 4 | RESET | -1460 | 1049 | 13 | OSC3 | 1460 | -972 |
| 5 | XT/CR | -1458 | -20 | 14 | CPU/STD | 1389 | 183 |
| 6 | NAR | -1460 | -899 | 15 | ST/(RND) | 1389 | 1058 |
| 7 | GND | -1460 | -1375 | 16 | I0/(SW0) | 1389 | 1385 |
| 8 | V _{REF} | -1135 | -1333 | 17 | I1/(SW1) | 719 | 1385 |
| 9 | AOUT | -585 | -1333 | 18 | I2/(SW2) | 276 | 1385 |

Pad name in parentheses is for stand-alone mode.

MSM9803

Pad Layout

Chip size : X=3.22mm Y=4.06mm
 Chip thickness : 350µm ± 30µm
 Pad size : 110µm × 110µm
 Substrate potential : GND



Pad Coordinates

(Chip center is located at X=0 and Y=0)

(Unit: µm)

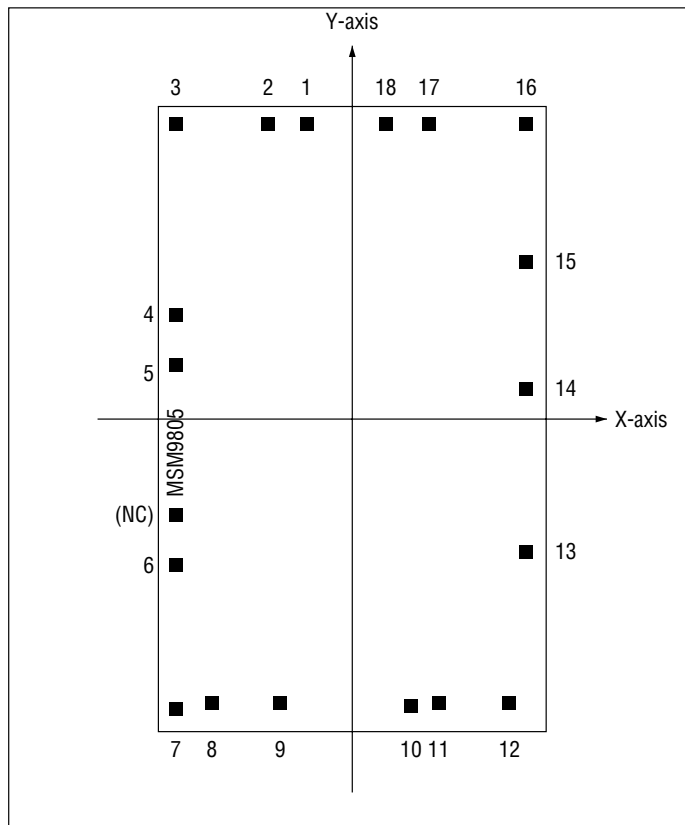
| Pad No. | Pad Name | X-axis | Y-axis | Pad No. | Pad Name | X-axis | Y-axis |
|---------|------------------|--------|--------|---------|-----------------|--------|--------|
| 1 | I3/ (A0) | -415 | 1829 | 10 | V _{DD} | 452 | -1788 |
| 2 | I4/ (A1) | -816 | 1829 | 11 | OSC1 | 742 | -1776 |
| 3 | I5/ (A2) | -1460 | 1829 | 12 | OSC2 | 1349 | -1776 |
| 4 | RESET | -1460 | 1493 | 13 | OSC3 | 1460 | -1415 |
| 5 | XT/CR | -1458 | 424 | 14 | CPU/STD | 1389 | 628 |
| 6 | NAR | -1460 | -1342 | 15 | ST/(RND) | 1389 | 1502 |
| 7 | GND | -1460 | -1818 | 16 | I0/(SW0) | 1389 | 1829 |
| 8 | V _{REF} | -1135 | -1776 | 17 | I1/(SW1) | 720 | 1829 |
| 9 | AOUT | -585 | -1776 | 18 | I2/(SW2) | 276 | 1829 |

Pad name in parentheses is for stand-alone mode.

MSM9805

Pad Layout

Chip size : X=3.22mm Y=5.96mm
 Chip thickness : 350µm ± 30µm
 Pad size : 110µm × 110µm
 Substrate potential : GND



Pad Coordinates

(Chip center is located at X=0 and Y=0)

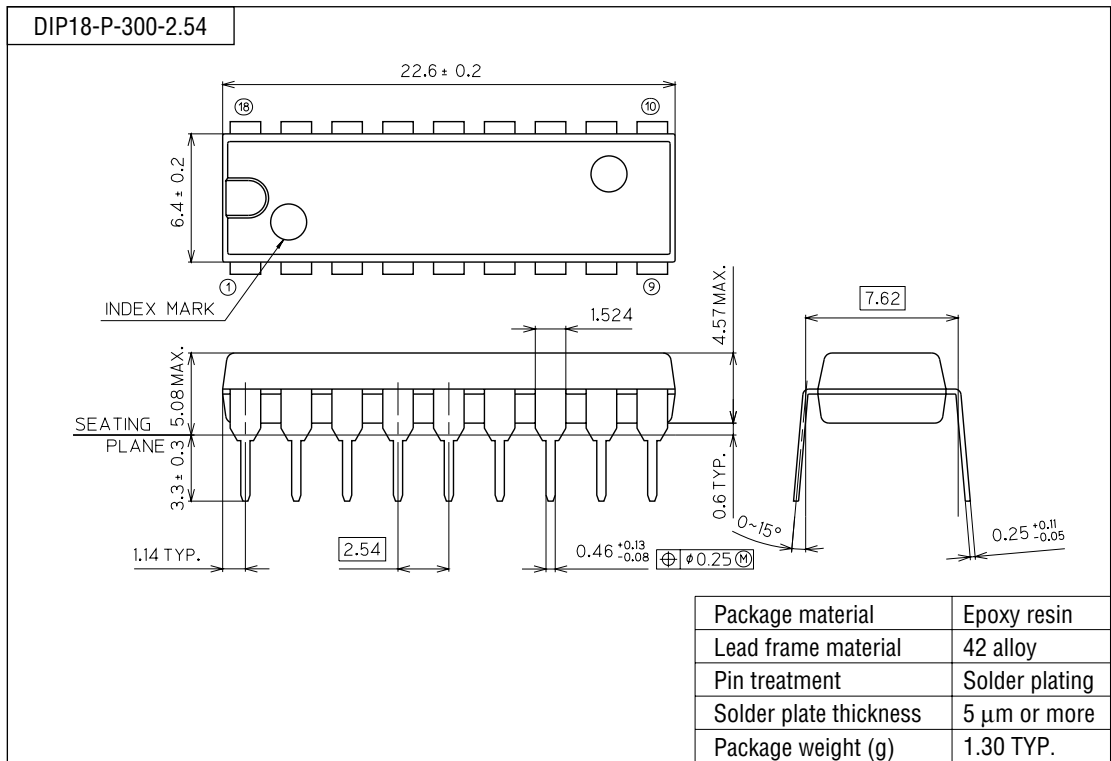
(Unit: µm)

| Pad No. | Pad Name | X-axis | Y-axis | Pad No. | Pad Name | X-axis | Y-axis |
|---------|------------------|--------|--------|---------|-----------------|--------|--------|
| 1 | I3/ (A0) | -415 | 2777 | 10 | V _{DD} | 452 | -2723 |
| 2 | I4/ (A1) | -816 | 2777 | 11 | OSC1 | 742 | -2726 |
| 3 | I5/ (A2) | -1460 | 2777 | 12 | OSC2 | 1349 | -2726 |
| 4 | RESET | -1460 | 882 | 13 | OSC3 | 1460 | -1532 |
| 5 | XT/CR | -1458 | 364 | 14 | CPU/STD | 1453 | 267 |
| 6 | NAR | -1460 | -1546 | 15 | ST/(RND) | 1455 | 1338 |
| 7 | GND | -1460 | -2768 | 16 | I0/(SW0) | 1432 | 2777 |
| 8 | V _{REF} | -1136 | -2726 | 17 | I1/(SW1) | 754 | 2777 |
| 9 | AOUT | -585 | -2726 | 18 | I2/(SW2) | 312 | 2777 |

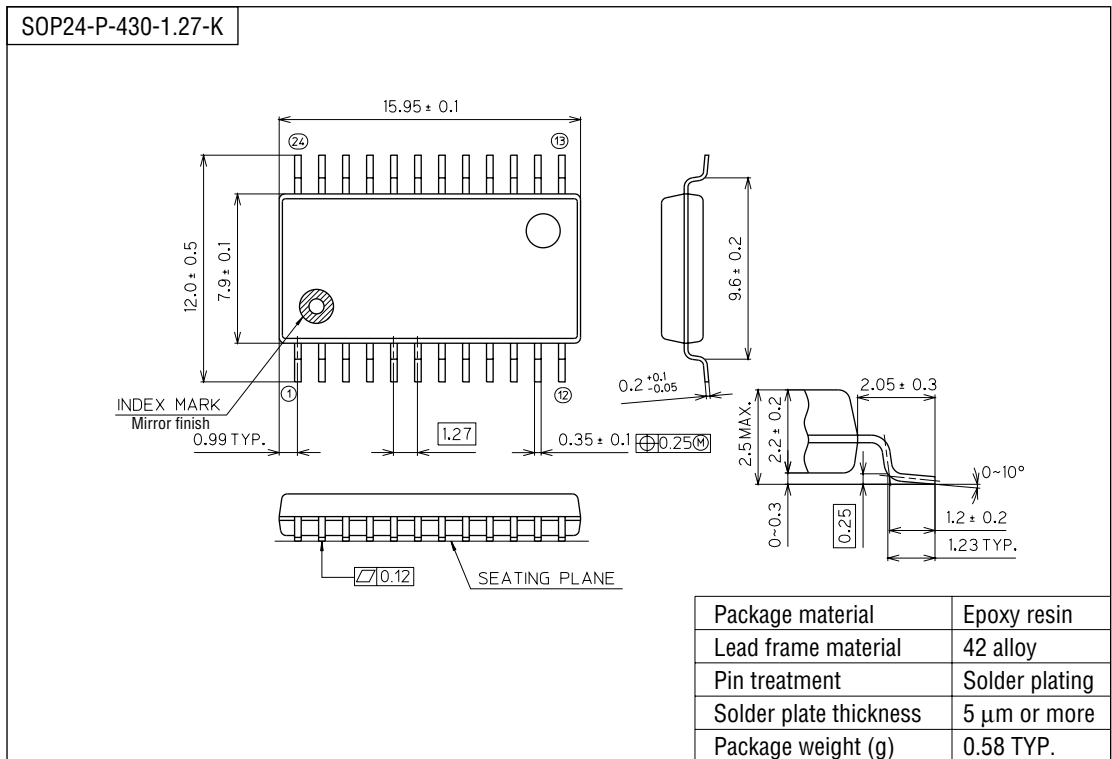
Pad name in parentheses is for stand-alone mode.

PACKAGE DIMENSIONS

(Unit : mm)



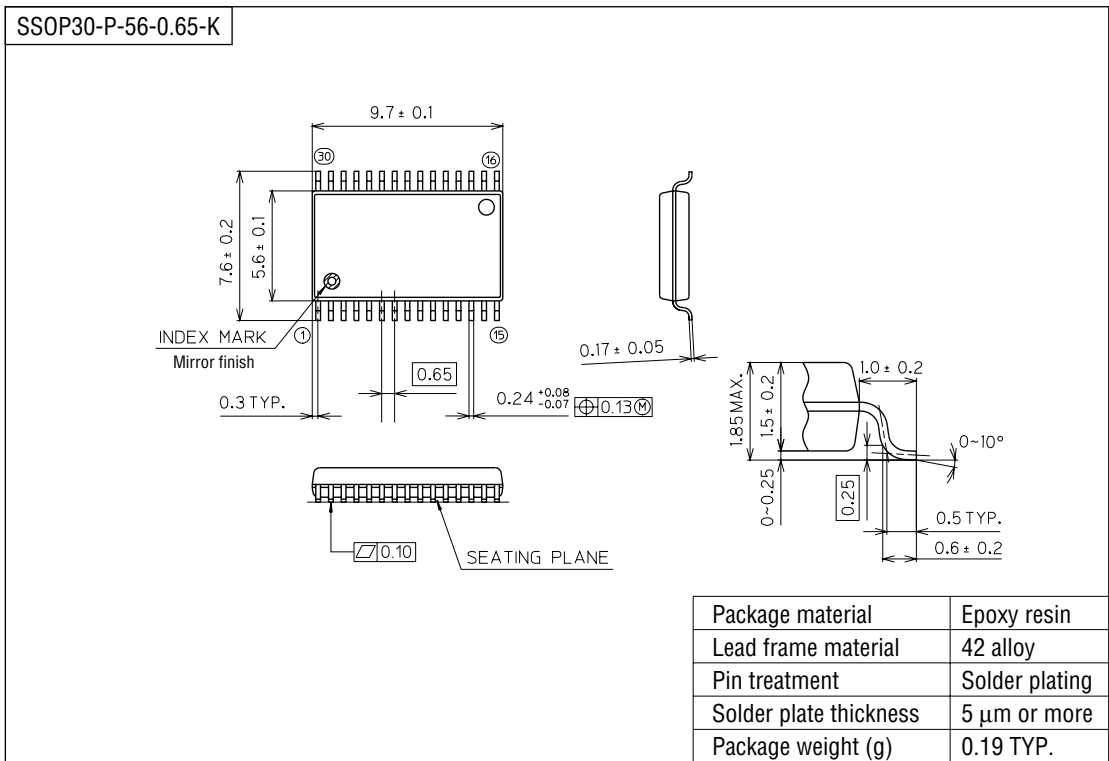
(Unit : mm)



Notes for Mounting the Surface Mount Type Package

The SOP, QFP, TSOP, TQFP, LQFP, 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 on the product name, package name, pin number, package code and desired mounting conditions (reflow method, temperature and times).

(Unit : mm)



Notes for Mounting the Surface Mount Type Package

The SOP, QFP, TSOP, TQFP, LQFP, 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 on the product name, package name, pin number, package code and desired mounting conditions (reflow method, temperature and times).

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