OKI Semiconductor

This version: Feb. 1999
Previous version: May. 1997

MSA180

Piezo Speaker Amplifier

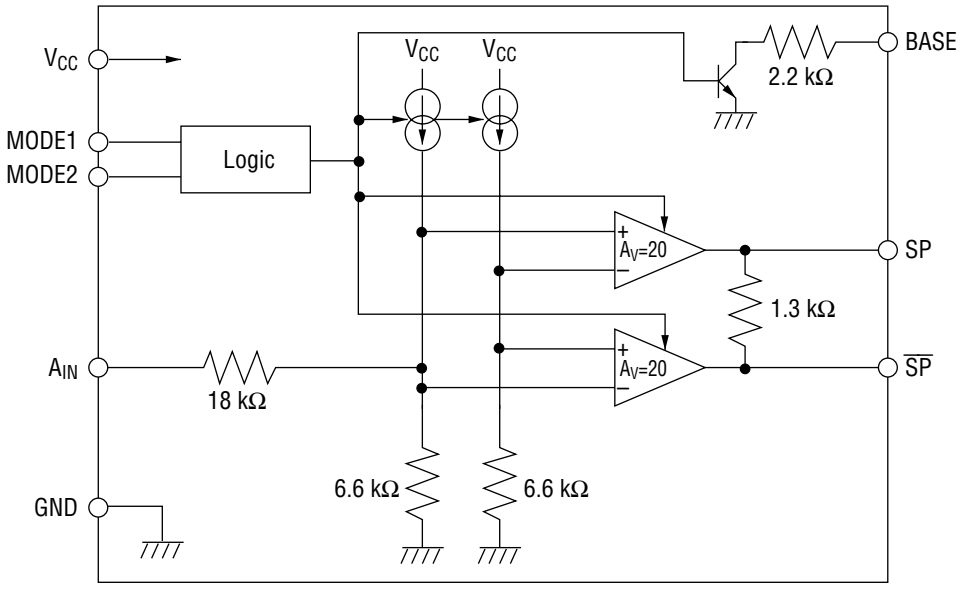
GENERAL DESCRIPTION

The MSA180 is a piezo speaker driver for OKI's speech synthesizers. Its voltage gain can be adjusted by a factor of up to 10. The differential output provides an amplitude of twice the voltage supply. A separate output connects to the base of an external transistor for controlling system voltage. A standby function eliminates power loss when no input signal is present.

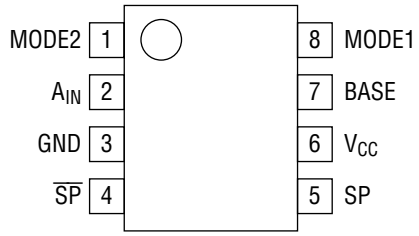
FEATURES

- Power supply voltage : 2.0 V to 6.0 V (single supply voltage)
- Low current consumption : 4.2 mA typ (V_{CC}=3 V, no load)
- Standby current : <1 µA
- Differential output amplitube) : Twice the supply voltage (maximum output
- Package options :
  8-pin plastic DIP (DIP8-P-300-2.54) (Product name: MSA180RS)
  8-pin plastic SOP (SOP8-P-250-1.27-K) (Product name: MSA180MS-K)
  Chip

BLOCK DIAGRAM



PIN CONFIGURATION (TOP VIEW)



8-Pin Plastic DIP or 8-Pin Plastic SOP

PIN DESCRIPTIONS

Pin	Symbol	Type	Description
6	V_{CC}	—	Power supply pin.
3	GND	—	Ground pin.
2	A_{IN}	I	Voice signal input pin.
8	MODE1	I	This pin switches the device between operation and standby modes. The IC is in operation mode if V_{IH} > 1.0 V on the MODE1 pin and is in standby mode if V_{IL} < 0.3 V on the MODE1 pin. When MODE1 is used, MODE2 must be connected to V_{CC}.
1	MODE2	I	This pin switches the device between operation and standby modes. The IC is in operation mode if $V_{IL} < V_{CC}$–1.0 V on MODE1 pin and is in standby mode if $V_{IH} > V_{CC}$–0.3 V on MODE1 pin. When MODE2 is used MODE1 must be connected to GND.
7	BASE	O	This pin is connected to the base of an external transistor. If an external transistor is not used to control system voltage, this pin must be left open.
4	$\overline{SP}$	O	This is a speaker output pin that provides signals with the same phase as the input.
5	SP	O	This is a speaker output pin that provides signals with an inverted phase to the input.

ABSOLUTE MAXIMUM RATINGS

(Ta=25°C unless otherwise specified)

Parameter	Symbol	Condition	Rating	Unit	Remarks
Power Supply Voltage	V_{CC}	—	–0.3 to +6.5	V	—
Input Voltage	V_{IN}	—	–0.3 to V_{CC}+0.3	V	A_{IN} MODE1 MODE2 BASE
Maximum Output Current	I_{OMAX}	V_{CC}=3 V	±80	mA	SP, $\overline{SP}$
Power Dissipation	P_D	Ta=25°C	400	mW	DIP type
			340	mW	SOP type
Junction Temperature	T_{jMAX}	—	110	°C	Chip
Storage Temperature	T_{STG}	—	–55 to +150	°C	—

RECOMMENDED OPERATING CONDITIONS

Parameter	Symbol	Condition	Min.	Max.	Unit
Power Supply Voltage	V_{CC}	—	2.0	6.0	V
Load Impedance	Z_L	—	200	—	Ω
Peak Load Current	I_{O-P}	—	—	±30	mA
"H" Input Voltage	V_{IH1}	Applied to MODE1 pin	1.0	—	V
	V_{IH2}	Applied to MODE2 pin	V_{CC}–0.3	—	V
"L" Input Voltage	V_{IL1}	Applied to MODE1 pin	—	0.3	V
	V_{IL2}	Applied to MODE2 pin	—	V_{CC}–1.0	V
Operating Temperature	T_{op}	—	–40	+85	°C

ELECTRICAL CHARACTERISTICS

(Ta=25°C, V_{CC}=2 V to 6 V unless otherwise specified)

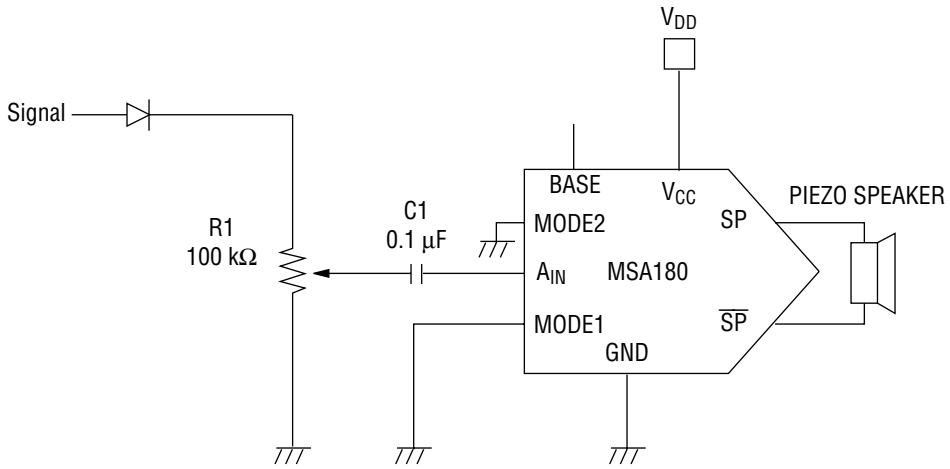
Parameter	Symbol	Condition		Min.	Typ.	Max.	Unit
Voltage Gain	A_{V1}	$A_{IN}\rightarrow SP$		4.25	5	5.75	V/V
	A_{V2}	$A_{IN}\rightarrow \overline{SP}$		4.25	5	5.75	V/V
	A_{V3}	$A_{IN}\rightarrow (SP\text{-}\overline{SP})$		8.5	10	11.5	V/V
A_{IN} Input Resistance	R_{IN}	—		17.2	24.6	32.0	kΩ
Output DC Voltage *1	V_O	No signal	V_{CC}=2 V	0.7	1.0	1.3	V
			V_{CC}=6 V	2.5	3.5	4.6	V
Output DC Offset Voltage *2	ΔV_O	$SP\text{-}\overline{SP}$	V_{CC}=2 V	—	—	0.2	V
			V_{CC}=6 V	—	—	0.6	V
SP, $\overline{SP}$ Output "H" Voltage	V_{OH}	I_{OUT}=–10 mA		V_{CC}–0.25	—	—	V
SP, $\overline{SP}$ Output "L" Voltage	V_{OL}	I_{OUT}=10 mA		—	—	0.25	V
Operating Current	I_{CC}	V_{CC}=3 V Z_L=∞ BASE=Open MODE1=MODE2=GND or MODE1=MODE2=V_{CC}		—	4.2	6.2	mA
Circuit Current in Standby Mode	I_{CCS}	A_{IN}=Open MODE1=GND MODE2=V_{CC}		—	—	1	µA
A_{IN} Input DC Bias Voltage *3	V_{AIN}	V_{CC}=2 V		0.18	0.26	0.34	V
		V_{CC}=6 V		0.52	0.74	0.96	V
MODE1 "H" Input Current	I_{IH1}	MODE1=V_{CC}		—	—	160	µA
MODE2 "H" Input Current	I_{IH2}	MODE2=V_{CC}		—	—	1	µA
MODE1 "L" Input Current	I_{IL1}	MODE1=GND		–1	—	—	µA
MODE2 "L" Input Current	I_{IL2}	MODE2=GND		–160	—	—	µA
Base Output Current	I_{BO1}	V_{CC}=2 V BASE=V_{CC}		0.4	—	—	mA
	I_{BO2}	V_{CC}=6 V BASE=V_{CC}		1.6	—	—	mA

*1 Typical value is $V_O = V_{CC} \times 0.625 - 0.25$.
*2 Maximum value is $\Delta V_O = V_{CC} \times 0.1$.
*3 Typical value is $V_{AIN} = V_{CC} \times 0.12 + 0.02$.

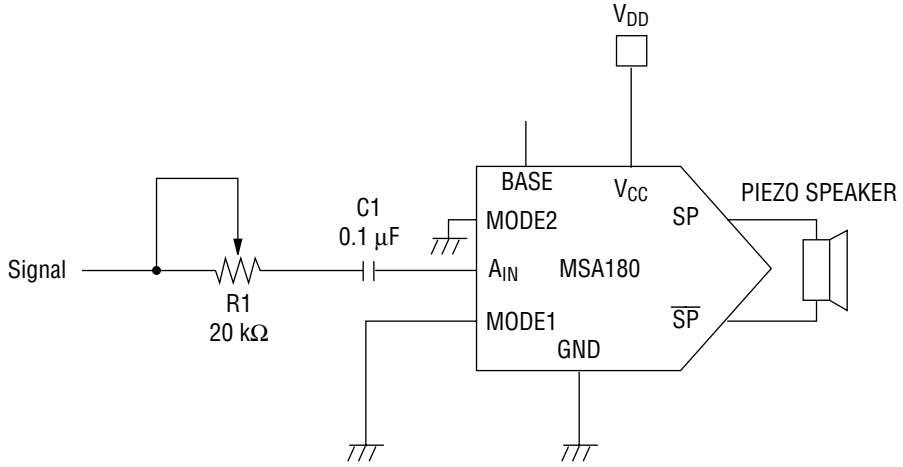
APPLICATION CIRCUITS

How to Adjust Gain

Gain control adjustment of the input signal level is shown below. When using OKI's speech synthesizer devices, insert a diode in series with the variable resistor to reduce pop noise.

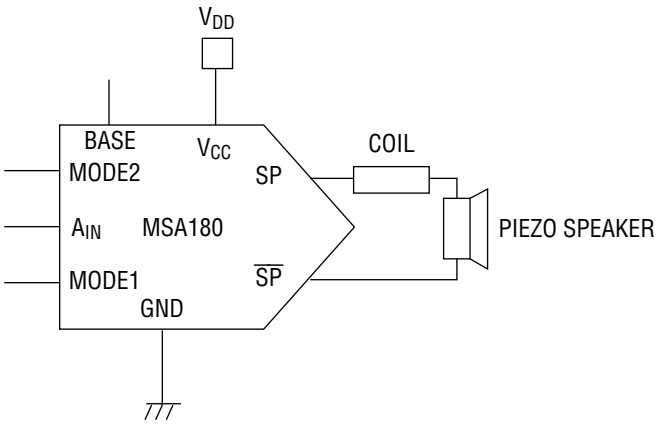


The circuit below also implements gain adjustment for a higher impedance signal source.



How to Connect the Piezo Speaker

To achieve the full gain level of 10 V, even at a low supply voltage (V_{CC}=3 V), connect a coil in series with the piezo speaker.



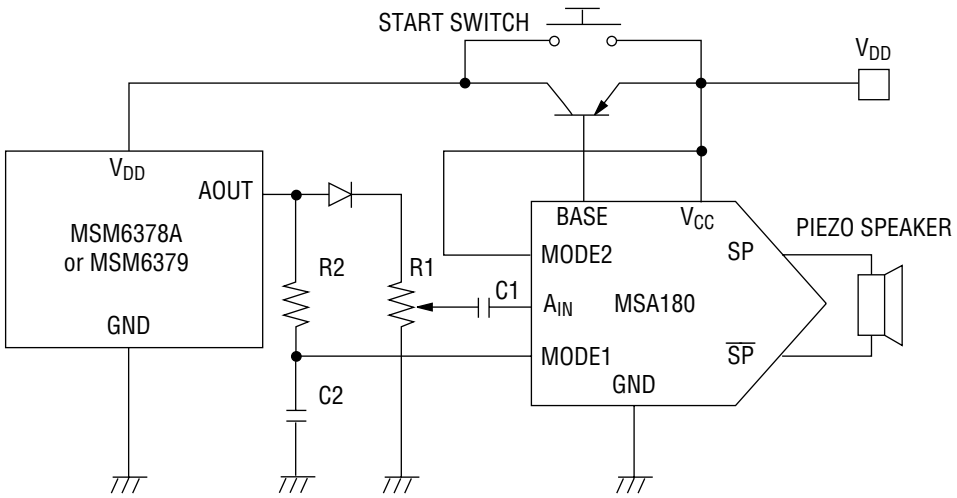
The resonance frequency that occurs in the circuit containing the coil and the piezo speaker is :

$$f_Q = \frac{1}{2\pi\sqrt{C_L \times L_L}} \text{ [Hz]}$$

Where C_L is the piezo capacitance and L_L the coil inductance.
For instance, if the piezo capacitance is 0.1 µF and f_Q is in a range of 2 to 3 kHz, then the coil inductance should be 30 mH.

Application Example for Circuits Containing the MSM6378A/MSM6379 Speech Synthesizers

This example shows how to connect the MSA180 with an MSM6378A or MSM6379 speech synthesizer using an external transistor and the MODE1 pin. The analog output of both synthesizers lowers to 0 V in their standby mode. For this reason, the voice signal can be used to control operation and standby modes of the MSA180. The circuit also controls the voltage via an external transistor. If this function is not used, leave the BASE pin open.

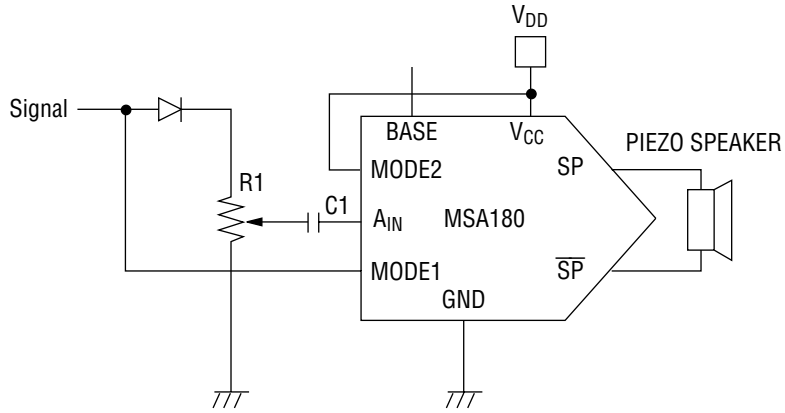


Operation Flow

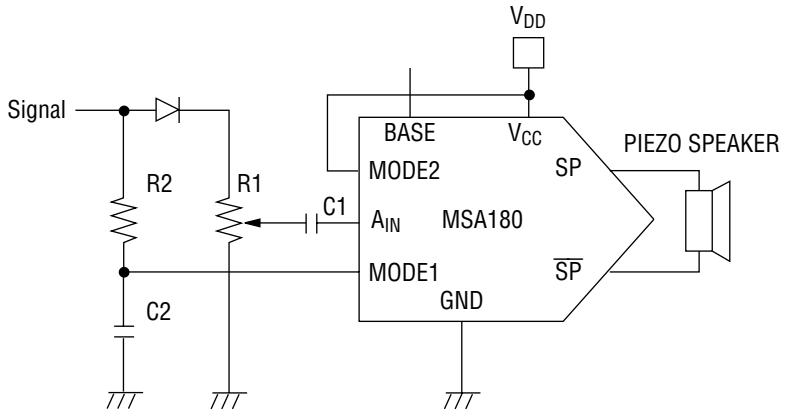
1. When the start switch is pressed, power is supplied to the V_{DD} pins on the MSM6378A or MSM6379, and operation mode is invoked. Voice output level then rises.
2. When operation mode is involved, the voice signal rises above the GND level, and MODE1 on MSA180 goes high (H).
3. The BASE pin on MSA180 goes low (L) to drive the external transistor for power-supply control.
4. The audio IC continues to operate using the external transistor as a power supply. The device continues to operate and voice sounds, even if the start switch is released at this time.
5. When the sound ends, MODE1 on MSA180 falls low (L), the voice signal falls to GND level, and standby mode ensues.
6. The external transistor for power-supply control is switched off, switching the voice synthesizer off because the power supply is switched off.

Supplemental Information When Using a Voice Signal on the MODE1 Pin

When using the voice signal on MODE1, as in the circuit below, care must be taken regarding the voice input level. Application of the voice signal below V_{IH1} level to the MODE1 pin causes the MSA180 to switch into standby mode, interrupting the voice reproduction flow, and causing undesired noises.



When using a voice signal lower than V_{IH}, refer to the circuit below. With a low-pass filter consisting of R2 and C2, voice levels lower than V_{IH1} are passed through. However, select values for R2 and C2 such that the input voltage on MODE1 is greater than V_{IH2}.



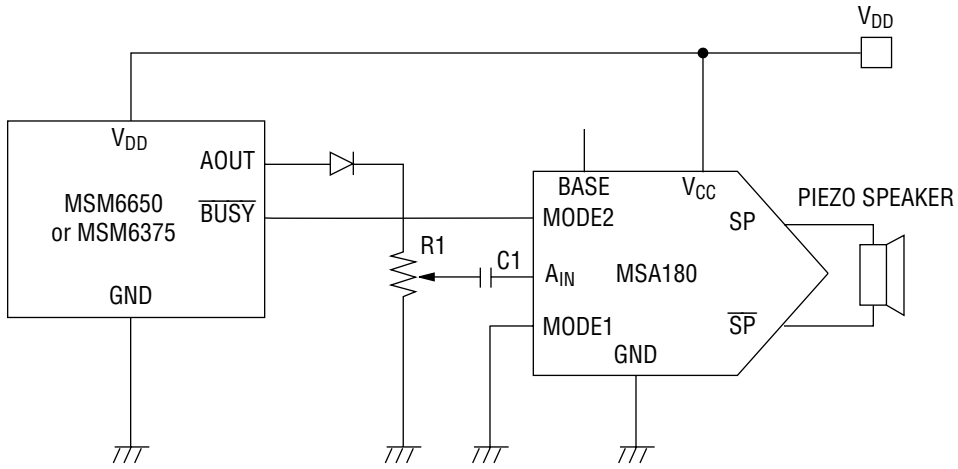
The cutoff frequency of the low-pass filter is calculated as follows:

$$f_C = \frac{1}{2\pi \times R2 \times C2} \text{ [Hz]}$$

For instance, if the cutoff frequency is 50 Hz, C2 is 0.1 µF and R2 is 30 kΩ. For a lower cutoff frequency, use a larger value for C2 or R2.

Application Example for Circuits Containing MSM6375/MSM6650 Family Speech Synthesizers

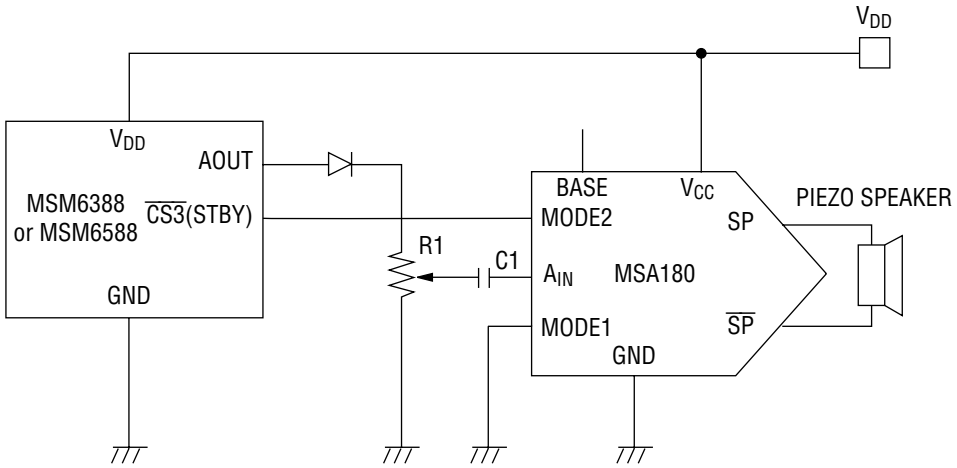
The example below shows how to connect the MSA180 with the MSM6375 or MSM6650 family speech synthesizers using the synthesizer's $\overline{BUSY}$ output to control operation and standby mode of the MSA180. As voice output stops, $\overline{BUSY}$ rises to the "H" level. For this reason, MODE2 is used to control operation and standby modes of the MSA180.



Notes:
1. The diode on A_{OUT} reduces pop noise.
2. This circuit makes use of the $\overline{BUSY}$ output of the speech synthesizer.
3. As the voice reproduction stops, $\overline{BUSY}$ outputs a "H" level to MODE2, setting the standby function.
4. If MODE2 is used, MODE1 must be connected to GND.
5. Leave the BASE pin open if it is not used.

Application Example for Circuits Containing the MSM6388/MSM6588 Speech Recorders

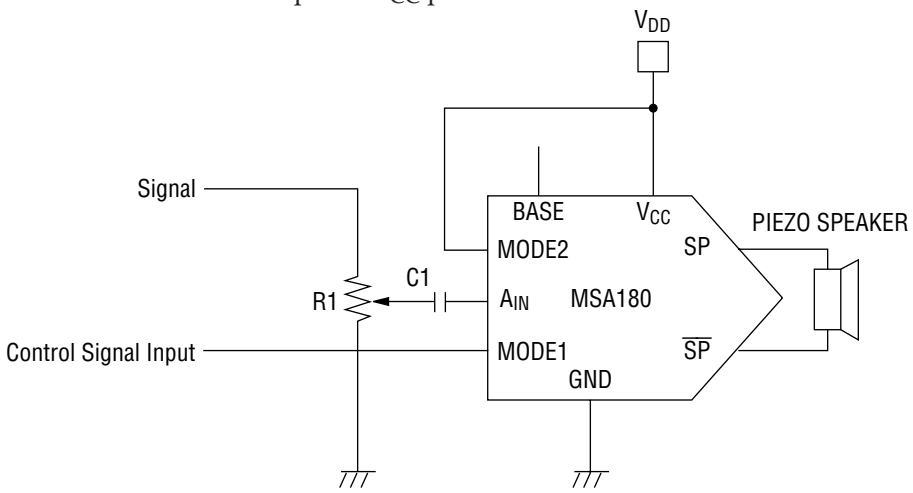
The example below shows how to connect the MSA180 with the MSM6388 or MSM6588 family speech recording ICs using the recorders' STBY output to control operation and standby mode of the MSA180. As voice output stops, STBY rises to the "H" level. For this reason, MODE2 is used to control operation and standby modes of the MSA180.



Notes: 1. The diode on A_{OUT} reduces pop noise.
2. This circuit makes use of the STBY output of the speech synthesizer.
3. As the voice reproduction stops, STBY outputs a "H" level to MODE2, setting the standby function.
4. If MODE2 is used, MODE1 must be connected to GND.
5. Leave the BASE pin open if it is not used.

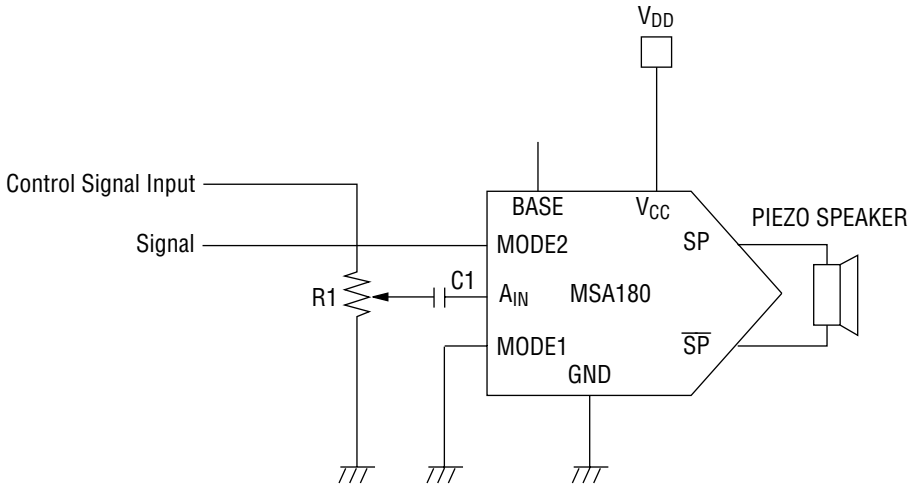
Application Examples for Circuits Containing a Microcontroller or Other Peripheral Devices

The circuit below uses a voice signal which rises high in operation mode. The MODE1 pin is used. Be sure to connect the MODE2 pin to V_{CC} pin.



Note: If the BASE pin is not used, leave it open.

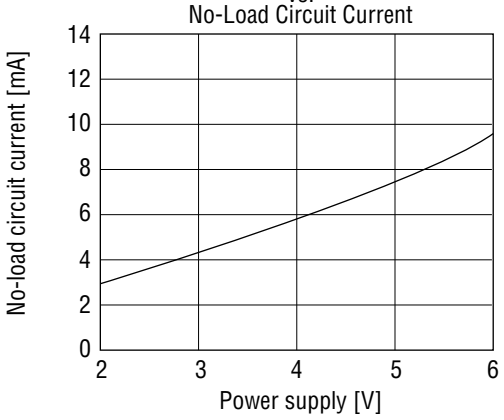
In the circuit below, the signal falls low in operation mode. The MODE2 pin is used. Be sure to connect the MODE1 pin to the GND pin.



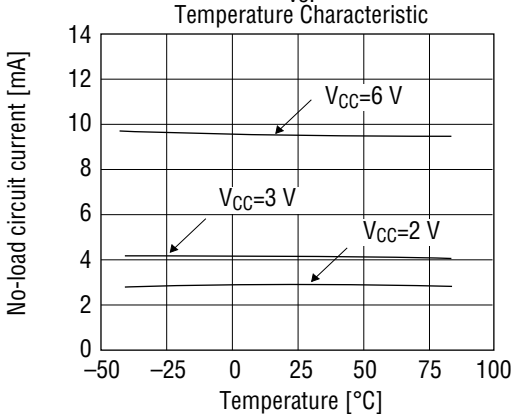
Note: If the BASE pin is not used, leave it open.

OPERATING CHARACTERISTICS

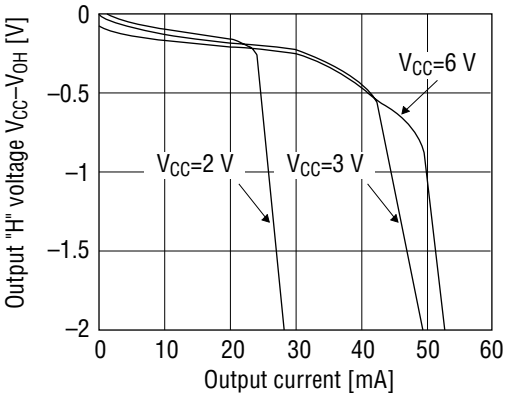
Power Supply Voltage vs. No-Load Circuit Current



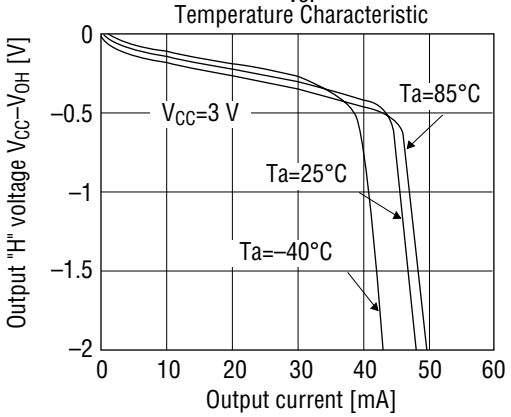
No-Load Circuit Current vs. Temperature Characteristic



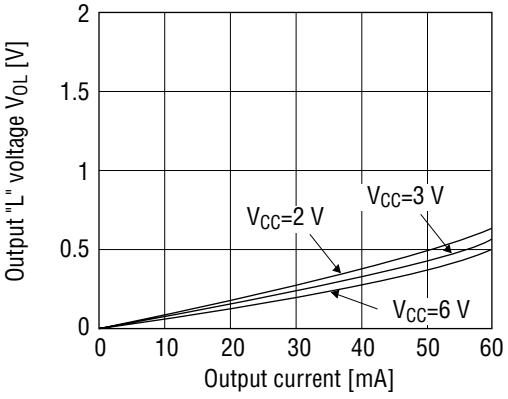
Output "H" Voltage Characteristic



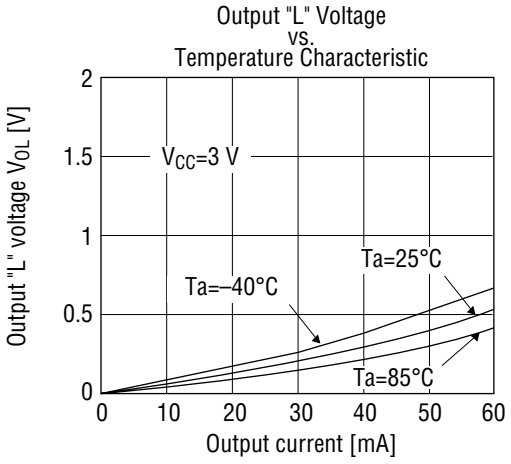
Output "H" Voltage vs. Temperature Characteristic



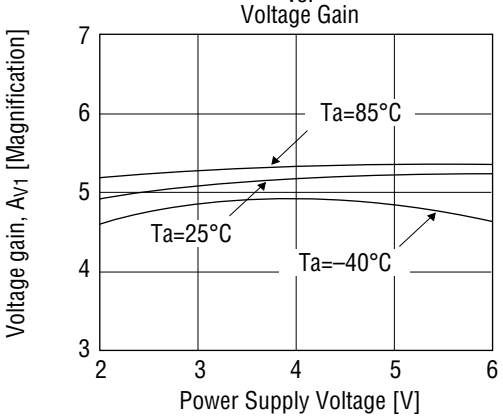
Output "L" Voltage Characteristic



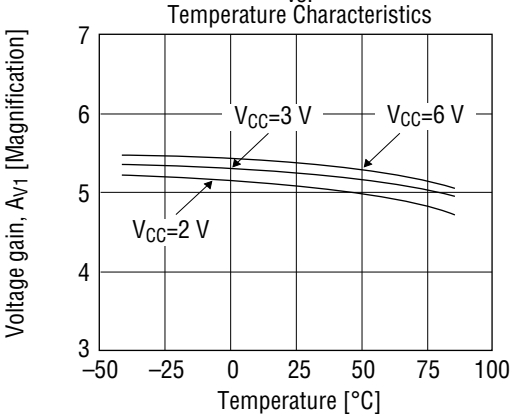
Output "L" Voltage vs. Temperature Characteristic



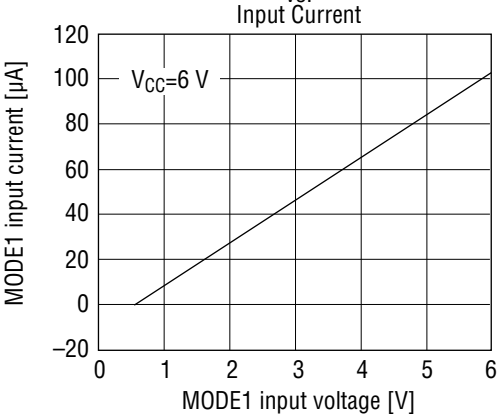
Power Supply Voltage
vs.
Voltage Gain



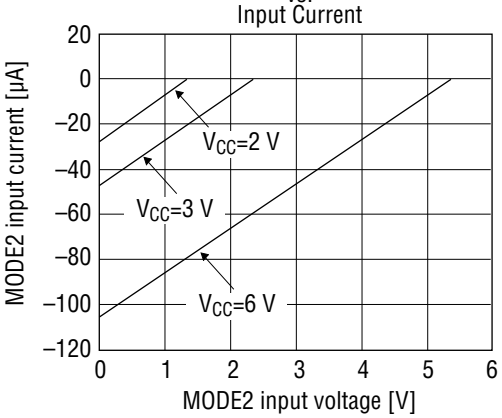
Voltage Gain
vs.
Temperature Characteristics



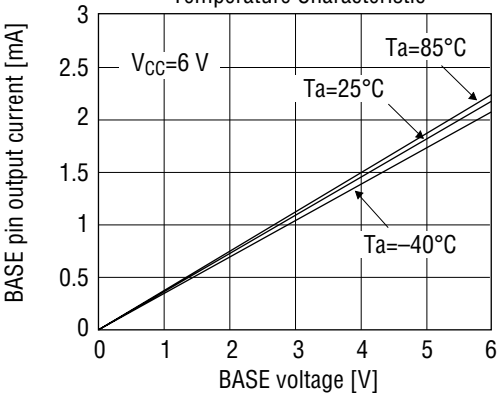
MODE1 Input voltage
vs.
Input Current



MODE2 Input Voltage
vs.
Input Current

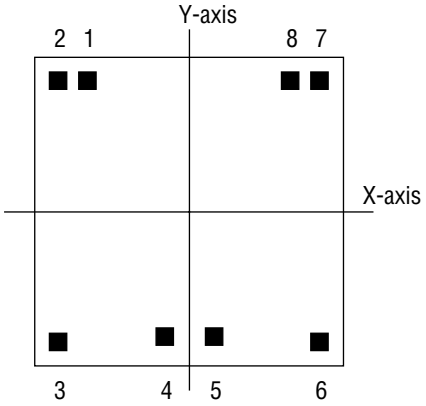


BASE Pin Output Current
vs.
Temperature Characteristic



PAD CONFIGURATION

- Chip Layout
  - Chip size : 2.00 mm × 2.00 mm
  - Chip thickness : 350 µm ± 30 µm
  - Pad size : 110 µm × 110 µm
  - Board potential : GND potential



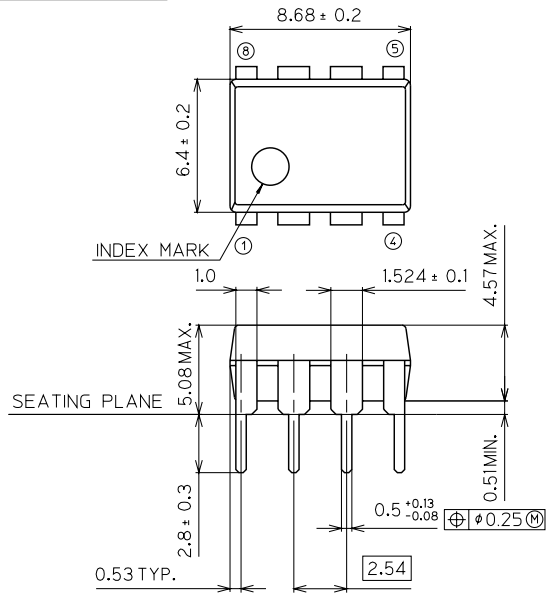
Pad Coordinates (Chip center: X=0, Y=0)

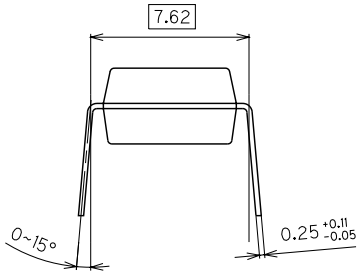
Pad	Pad name	X-coordinate [µm]	Y-coordinate [µm]
1	MODE2	–655	835
2	A_{IN}	–835	835
3	GND	–835	–835
4	$\overline{SP}$	–185	–789
5	SP	121	–789
6	V_{CC}	815	–835
7	BASE	793	835
8	MODE1	613	835

PACKAGE DIMENSIONS

(Unit : mm)

DIP8-P-300-2.54

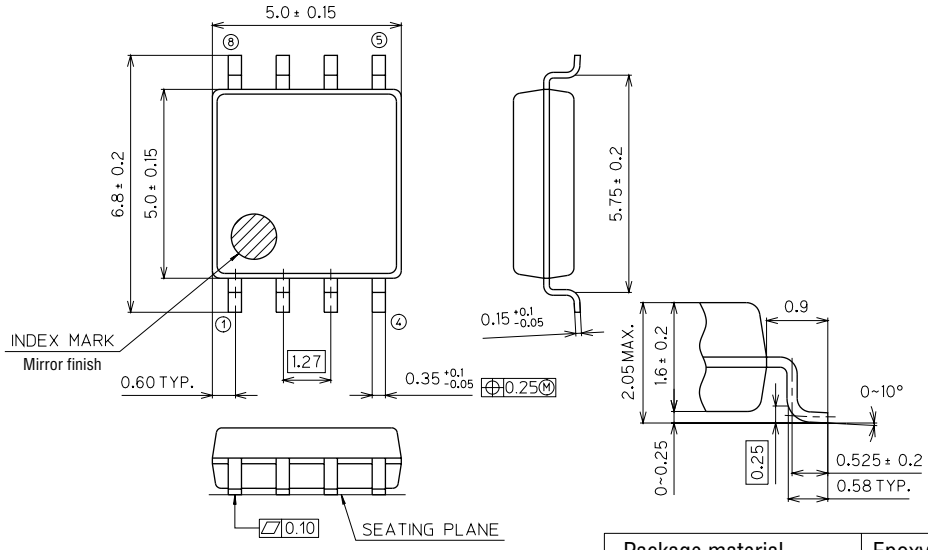




Package material	Epoxy resin
Lead frame material	42 alloy
Pin treatment	Solder plating
Solder plate thickness	5 μm or more
Package weight (g)	0.46 TYP.

(Unit : mm)

SOP8-P-250-1.27-K



Package material	Epoxy resin
Lead frame material	42 alloy
Pin treatment	Solder plating
Solder plate thickness	5 μm or more
Package weight (g)	0.10 TYP.

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).

NOTICE

1. The information contained herein can change without notice owing to product and/or technical improvements. Before using the product, please make sure that the information being referred to is up-to-date.

2. The outline of action and examples for application circuits described herein have been chosen as an explanation for the standard action and performance of the product. When planning to use the product, please ensure that the external conditions are reflected in the actual circuit, assembly, and program designs.

3. When designing your product, please use our product below the specified maximum ratings and within the specified operating ranges including, but not limited to, operating voltage, power dissipation, and operating temperature.

4. Oki assumes no responsibility or liability whatsoever for any failure or unusual or unexpected operation resulting from misuse, neglect, improper installation, repair, alteration or accident, improper handling, or unusual physical or electrical stress including, but not limited to, exposure to parameters beyond the specified maximum ratings or operation outside the specified operating range.

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