

## MSA180

### Piezo Speaker Amplifier

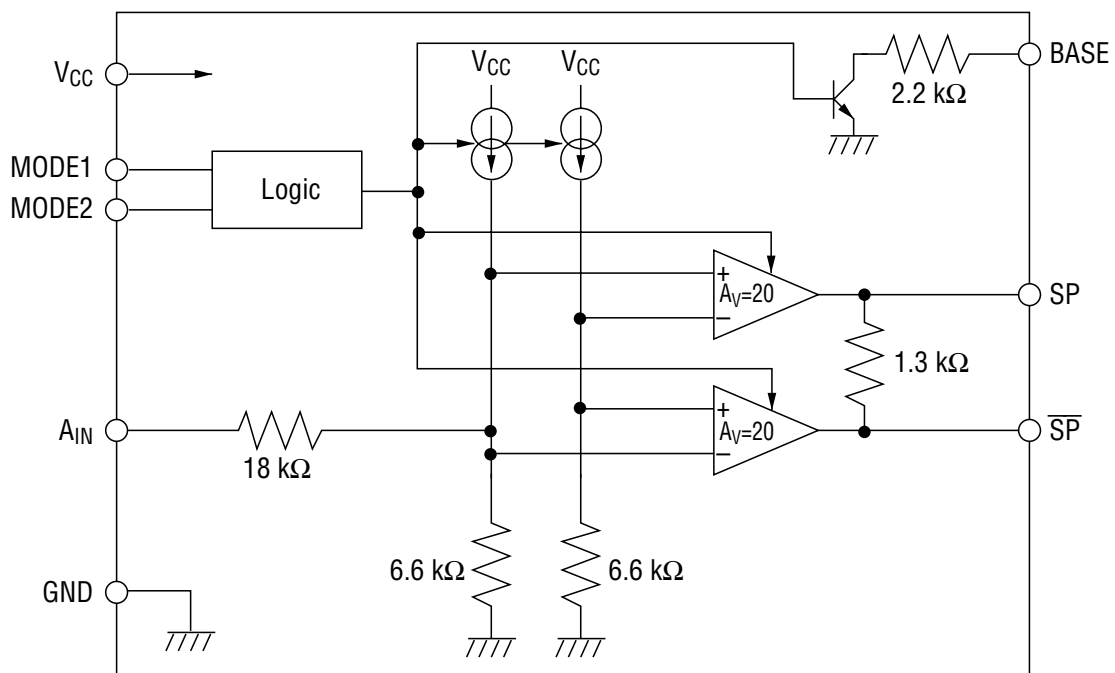
#### GENERAL DESCRIPTION

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.

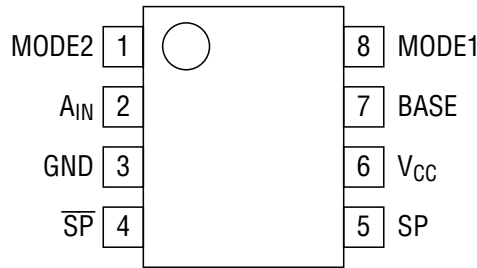
#### FEATURES

- 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 :  $<1$   $\mu$ A
- Differential output : Twice the supply voltage (maximum output amplitude)
- 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 <sub>CC</sub>	—	Power supply pin.
3	GND	—	Ground pin.
2	A <sub>IN</sub>	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 <sub>IH</sub> > 1.0 V on the MODE1 pin and is in standby mode if V <sub>IL</sub> < 0.3 V on the MODE1 pin. When MODE1 is used, MODE2 must be connected to V <sub>CC</sub> .
1	MODE2	I	This pin switches the device between operation and standby modes. The IC is in operation mode if V <sub>IL</sub> < V <sub>CC</sub> - 1.0 V on MODE1 pin and is in standby mode if V <sub>IH</sub> > V <sub>CC</sub> - 0.3 V on MODE1 pin. When MODE2 is used MODE1 must be connected to GND.
7	BASE	0	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	SP̄	0	This is a speaker output pin that provides signals with the same phase as the input.
5	SP	0	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 <sub>CC</sub>	—	-0.3 to +6.5	V	—
Input Voltage	V <sub>IN</sub>	—	-0.3 to V <sub>CC</sub> +0.3	V	A <sub>IN</sub> MODE1 MODE2 BASE
Maximum Output Current	I <sub>OMAX</sub>	V <sub>CC</sub> =3 V	±80	mA	SP, $\overline{SP}$
Power Dissipation	P <sub>D</sub>	Ta=25°C	400	mW	DIP type
			340	mW	SOP type
Junction Temperature	T <sub>JMAX</sub>	—	110	°C	Chip
Storage Temperature	T <sub>STG</sub>	—	-55 to +150	°C	—

**RECOMMENDED OPERATING CONDITIONS**

Parameter	Symbol	Condition	Min.	Max.	Unit
Power Supply Voltage	V <sub>CC</sub>	—	2.0	6.0	V
Load Impedance	Z <sub>L</sub>	—	200	—	Ω
Peak Load Current	I <sub>O-P</sub>	—	—	±30	mA
"H" Input Voltage	V <sub>IH1</sub>	Applied to MODE1 pin	1.0	—	V
	V <sub>IH2</sub>	Applied to MODE2 pin	V <sub>CC</sub> -0.3	—	V
"L" Input Voltage	V <sub>IL1</sub>	Applied to MODE1 pin	—	0.3	V
	V <sub>IL2</sub>	Applied to MODE2 pin	—	V <sub>CC</sub> -1.0	V
Operating Temperature	T <sub>op</sub>	—	-40	+85	°C

## ELECTRICAL CHARACTERISTICS

(Ta=25°C, V<sub>CC</sub>=2 V to 6 V unless otherwise specified)

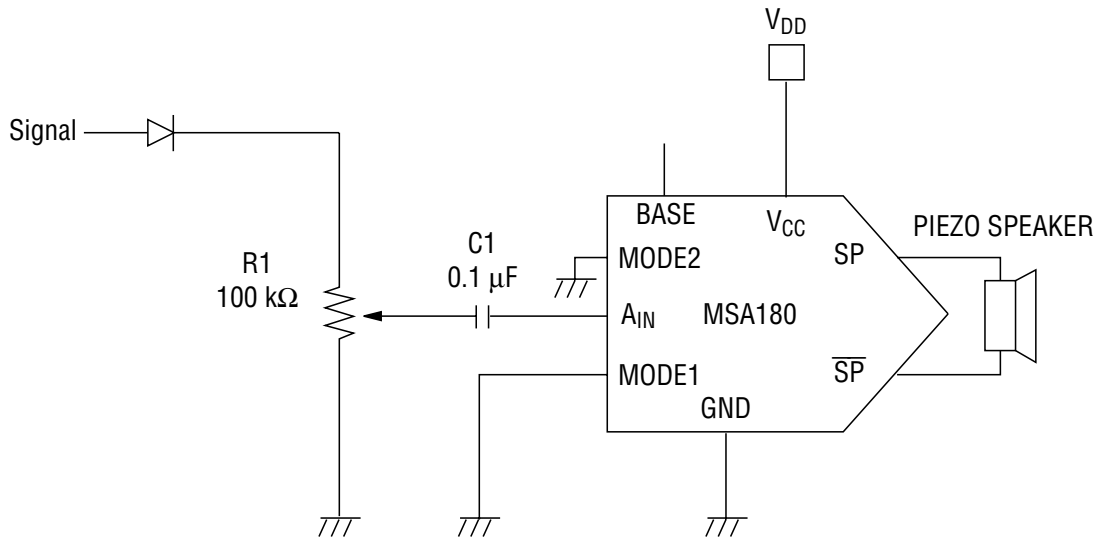
Parameter	Symbol	Condition	Min.	Typ.	Max.	Unit	
Voltage Gain	A <sub>V1</sub>	A <sub>IN</sub> →SP	4.25	5	5.75	V/V	
	A <sub>V2</sub>	A <sub>IN</sub> → $\overline{SP}$	4.25	5	5.75	V/V	
	A <sub>V3</sub>	A <sub>IN</sub> →(SP- $\overline{SP}$ )	8.5	10	11.5	V/V	
A <sub>IN</sub> Input Resistance	R <sub>IN</sub>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

\*1 Typical value is V<sub>O</sub> = V<sub>CC</sub> × 0.625 - 0.25.\*2 Maximum value is ΔV<sub>O</sub> = V<sub>CC</sub> × 0.1.\*3 Typical value is V<sub>AIN</sub> = V<sub>CC</sub> × 0.12 + 0.02.

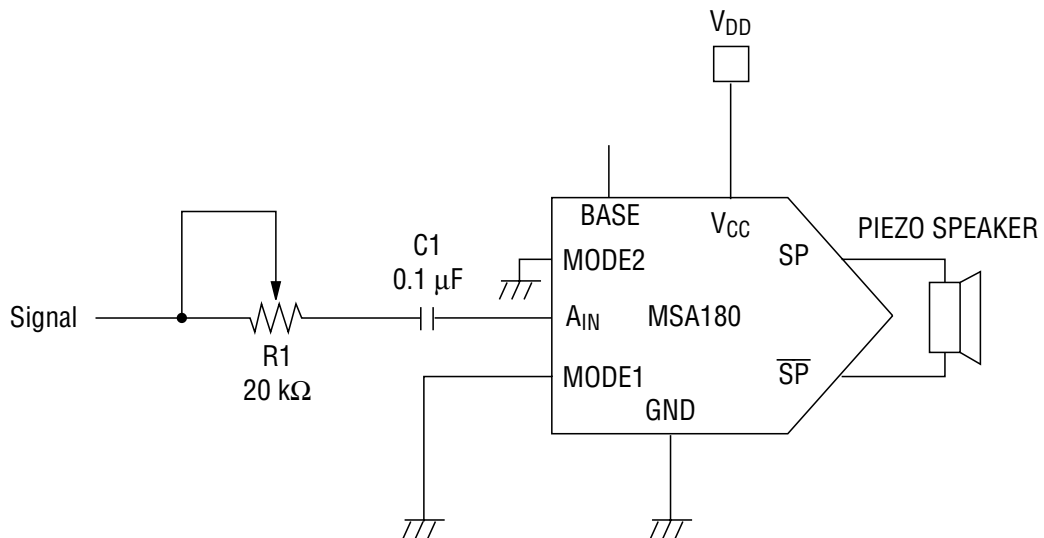
## APPLICATION CIRCUITS

### 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.

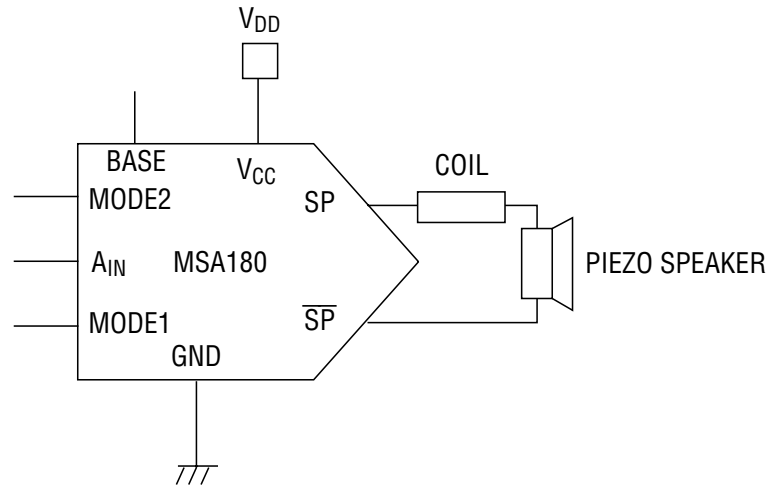


The circuit below also implements gain adjustment for a higher impedance signal source.



### How to Connect the Piezo Speaker

To achieve the full gain level of 10 V, even at a low supply voltage ( $V_{CC}=3\text{ V}$ ), 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 :

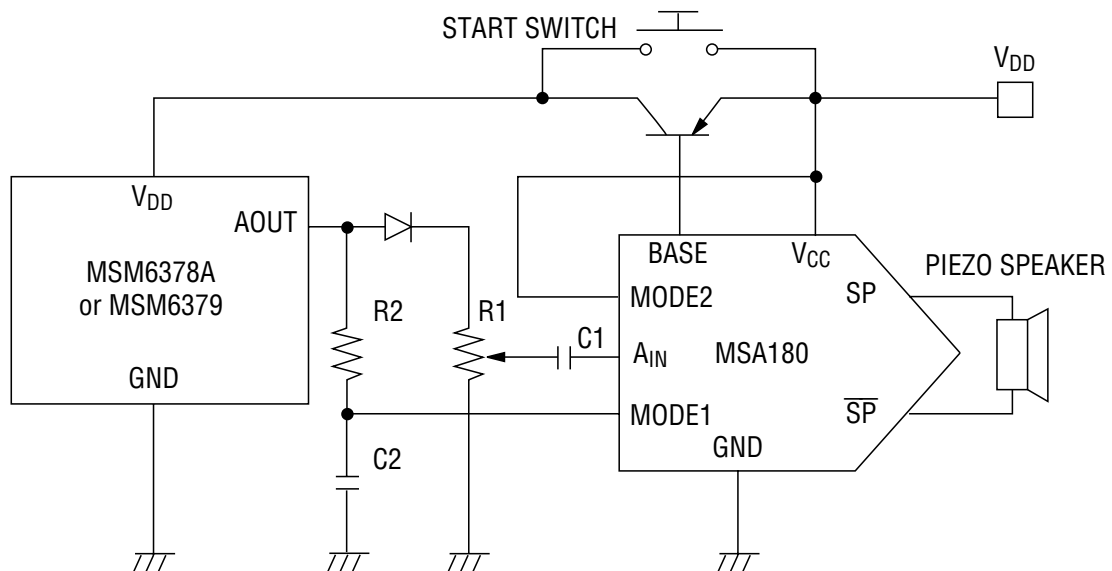
$$f_Q = \frac{1}{2\pi\sqrt{C_L \times L_L}} \text{ [Hz]}$$

Where  $C_L$  is the piezo capacitance and  $L_L$  the coil inductance.

For instance, if the piezo capacitance is 0.1  $\mu\text{F}$  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.

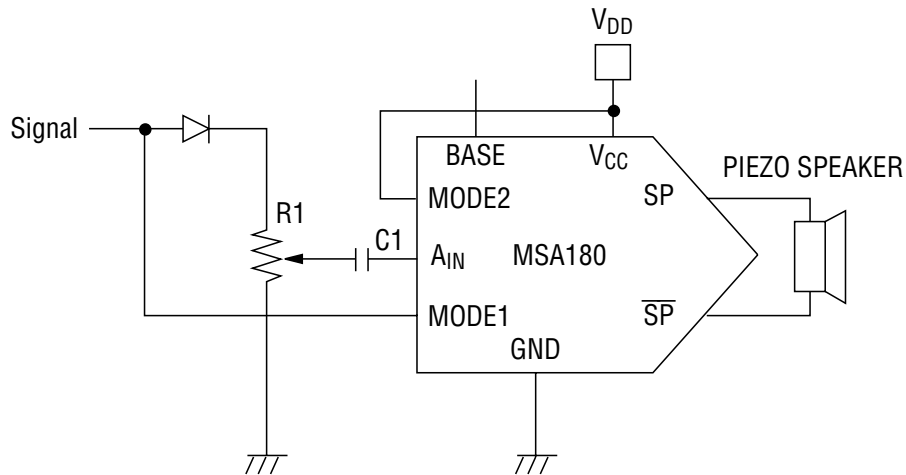


#### Operation Flow

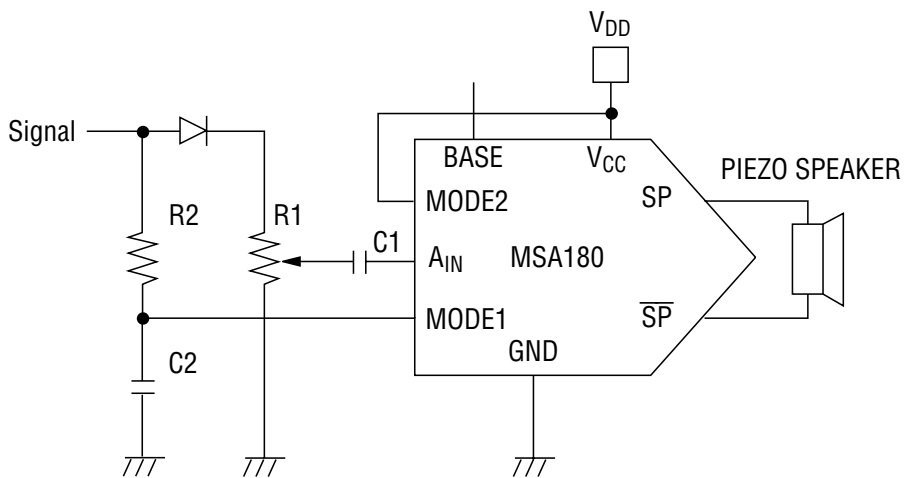
1. When the start switch is pressed, power is supplied to the  $V_{DD}$  pins on the MSM6378A or MSM6379, and operation mode is invoked. Voice output level then rises.
2. When operation mode is involved, the voice signal rises above the GND level, and MODE1 on MSA180 goes high (H).
3. The BASE pin on 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  $V_{IH1}$ , 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:

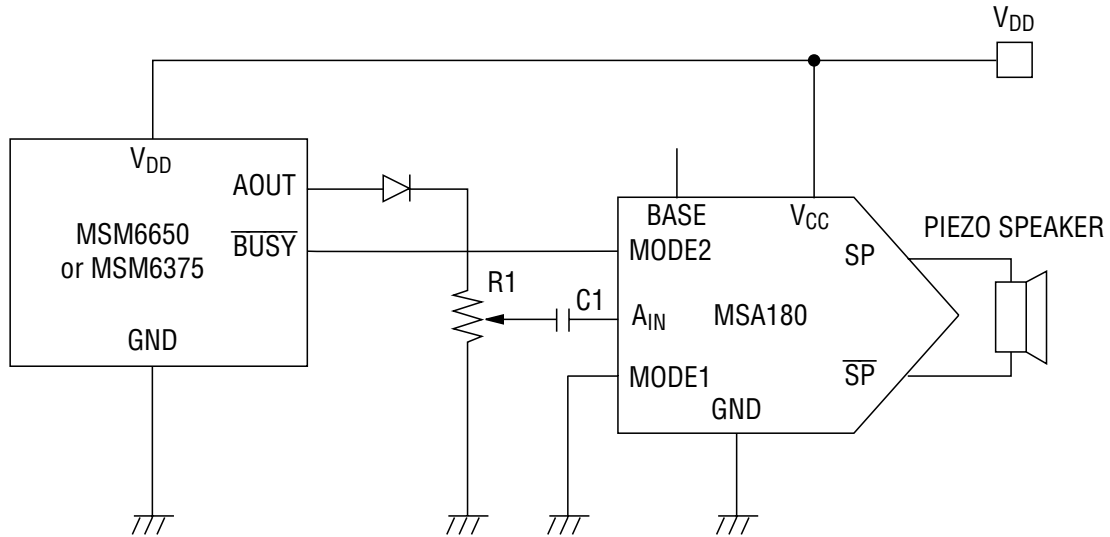
$$f_c = \frac{1}{2\pi \times R2 \times C2} \text{ [Hz]}$$

For instance, if the cutoff frequency is 50 Hz, C2 is 0.1  $\mu$ F and R2 is 30 k $\Omega$ . For a lower cutoff frequency, use a larger value for C2 or R2.



**Application Example for Circuits Containing MSM6375/MSM6650 Family Speech Synthesizers**

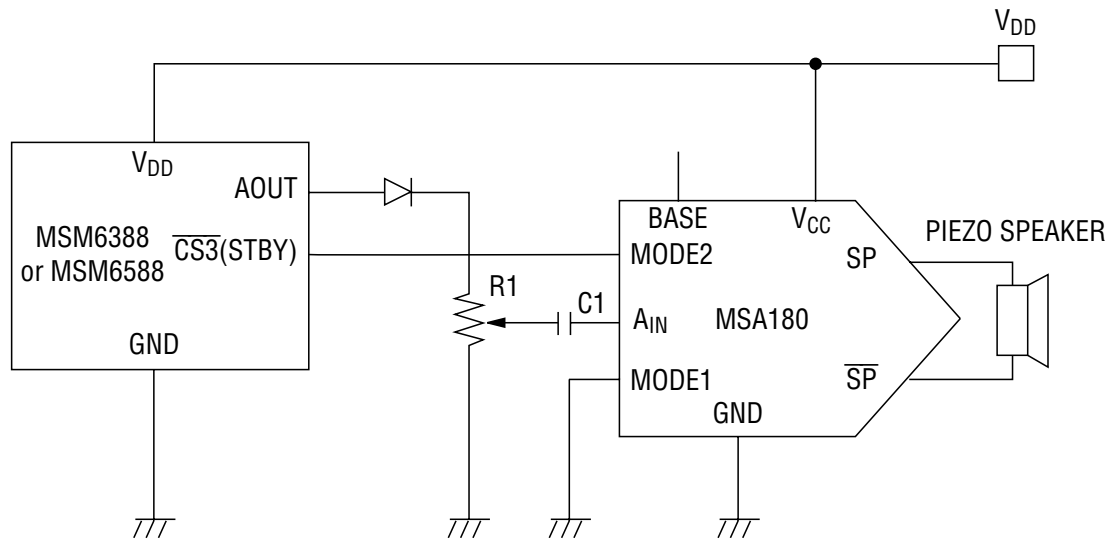
The example below shows how to connect the MSA180 with the MSM6375 or MSM6650 family speech synthesizers using the synthesizer's  $\overline{\text{BUSY}}$  output to control operation and standby mode of the MSA180. As voice output stops,  $\overline{\text{BUSY}}$  rises to the "H" level. For this reason,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



- Notes:
1. The diode on A<sub>OUT</sub> reduces pop noise.
  2. This circuit makes use of the  $\overline{\text{BUSY}}$  output of the speech synthesizer.
  3. As the voice reproduction stops,  $\overline{\text{BUSY}}$  outputs a "H" level to MODE2, setting the stand-by 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**

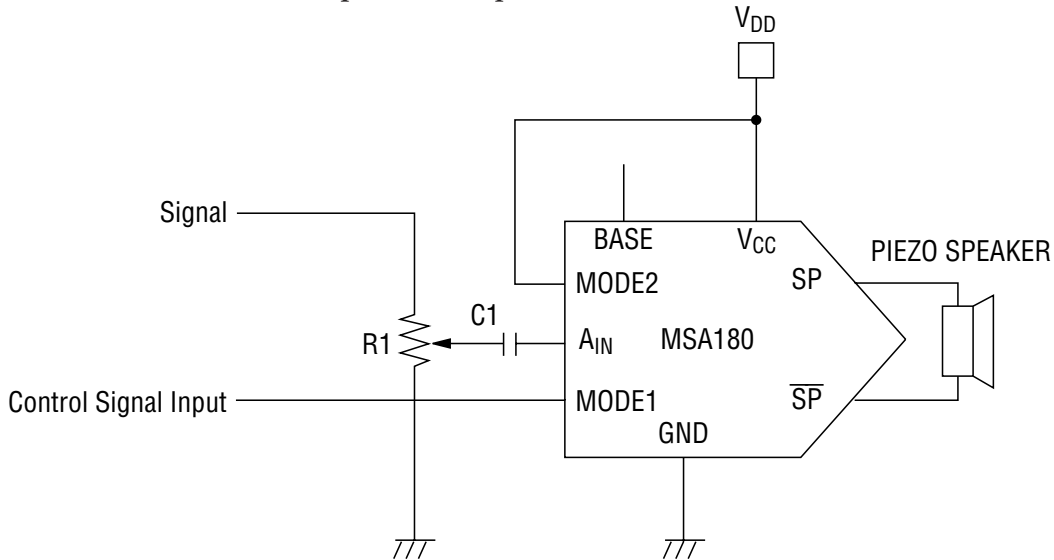
The example below shows how to connect the MSA180 with the MSM6388 or MSM6588 family speech recording ICs using the recorders' STBY output to control operation and standby mode of the MSA180. As voice output stops, STBY rises to the "H" level. For this reason, MODE2 is used to control operation and standby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



- Notes:
1. The diode on A<sub>OUT</sub> 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 stand-by function.
  4. If MODE2 is used, MODE1 must be connected to GND.
  5. Leave the BASE pin open if it is not used.

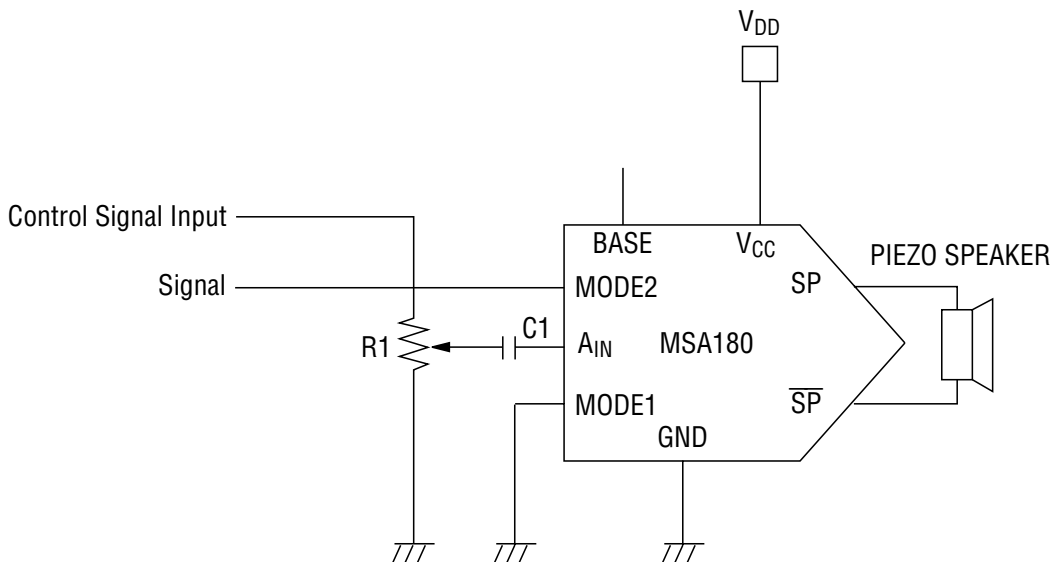
**Application Examples for Circuits Containing a Microcontroller or Other Peripheral Devices**

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<sub>CC</sub> pin.



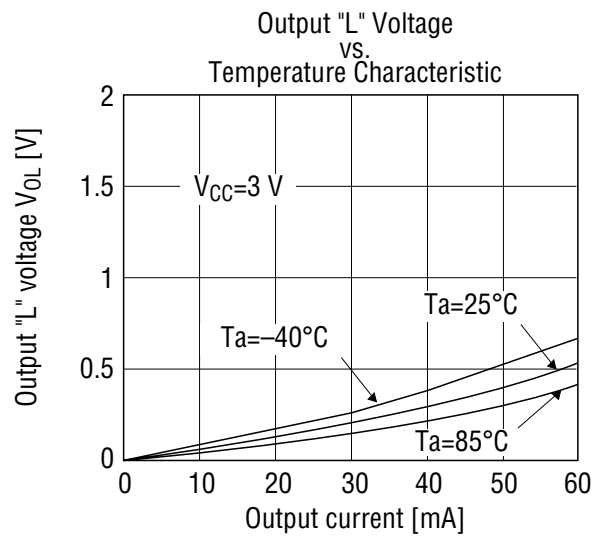
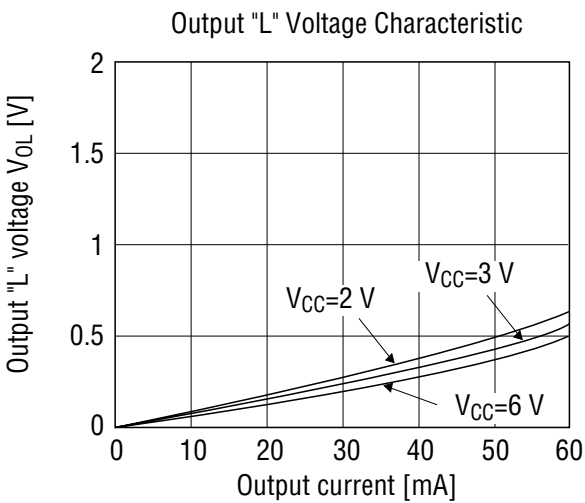
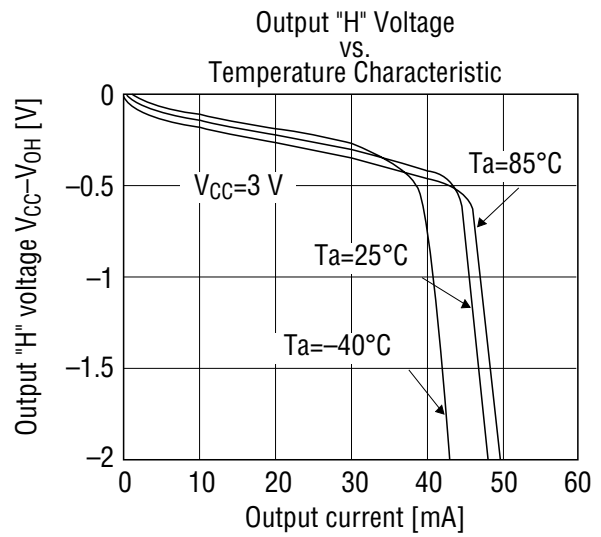
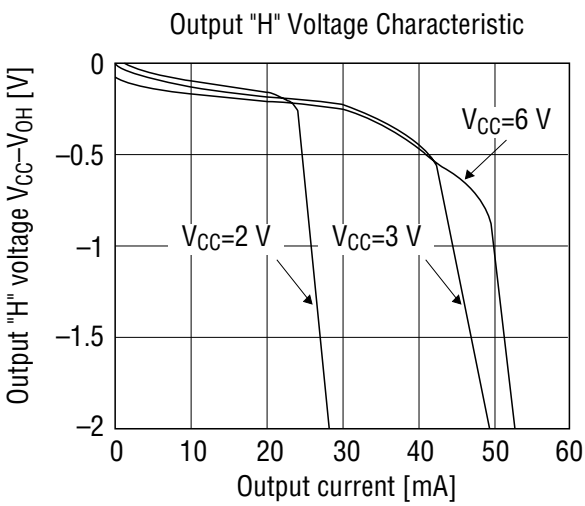
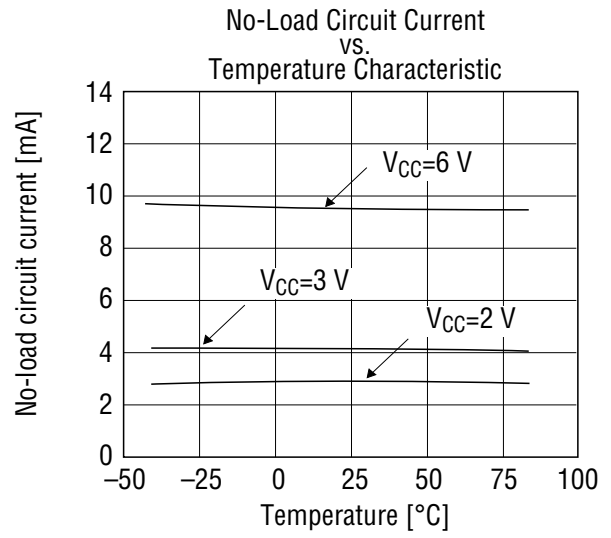
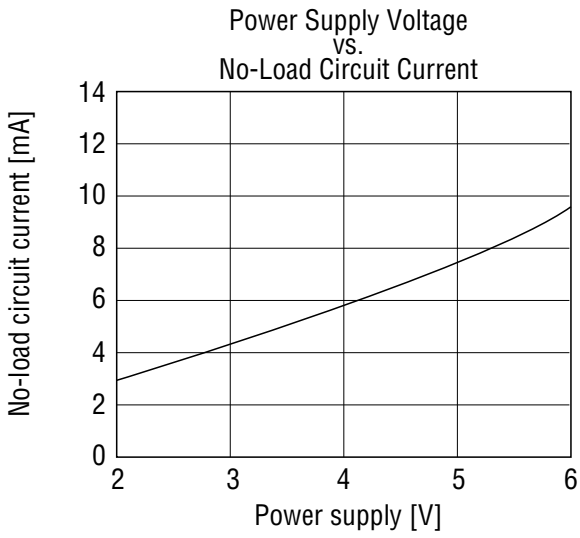
Note: If the BASE pin is not used, leave it open.

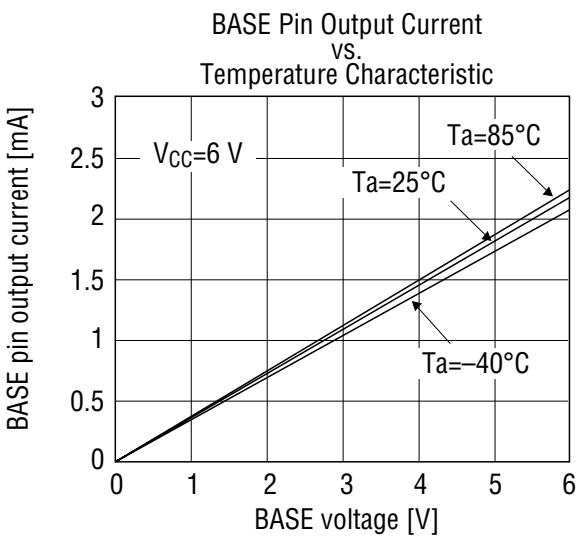
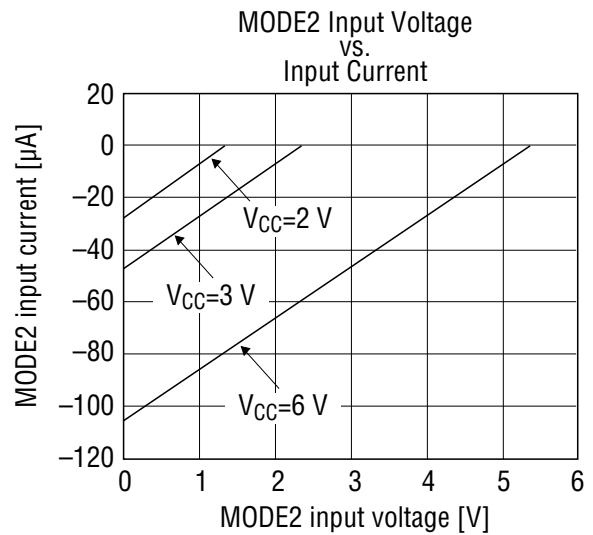
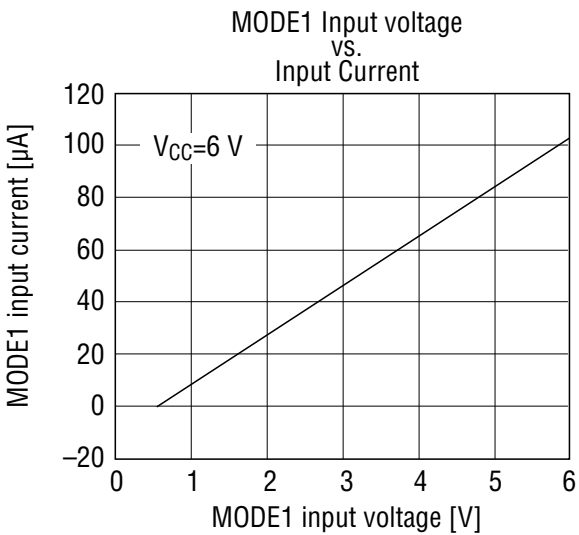
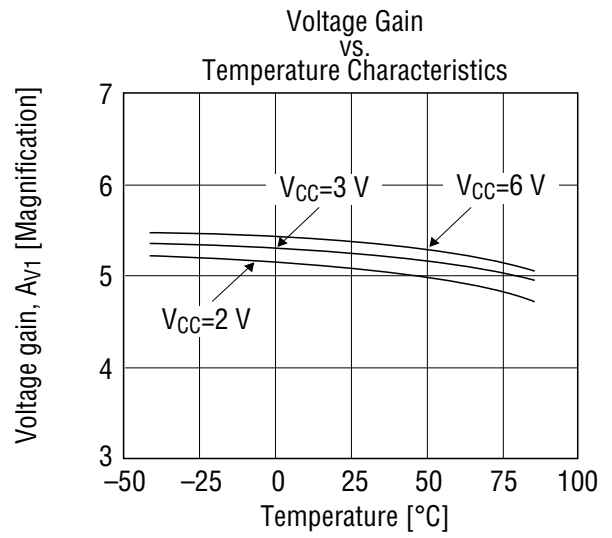
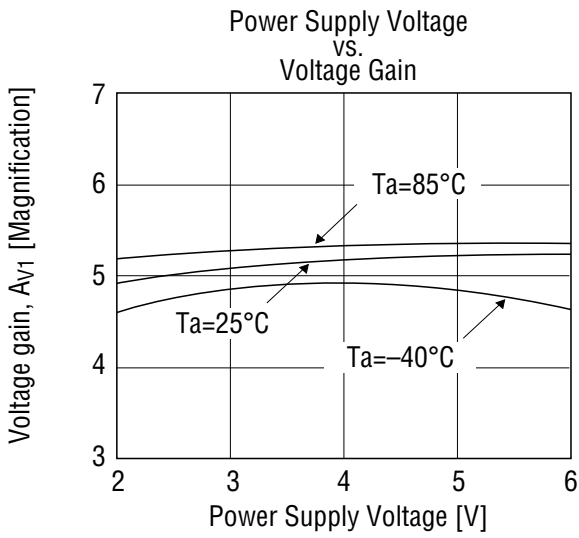
In the circuit below, the signal falls low in operation mode. The MODE2 pin is used. Be sure to connect the MODE1 pin to the GND pin.



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

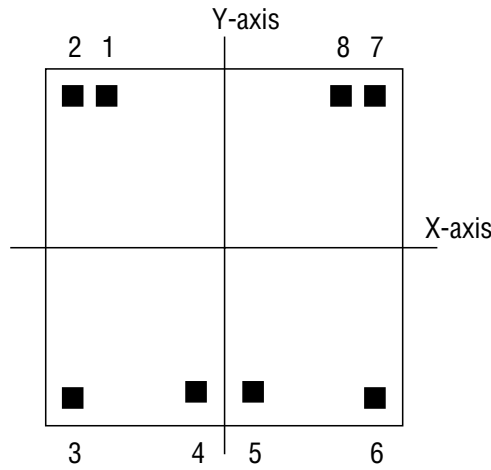
**OPERATING CHARACTERISTICS**





### 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

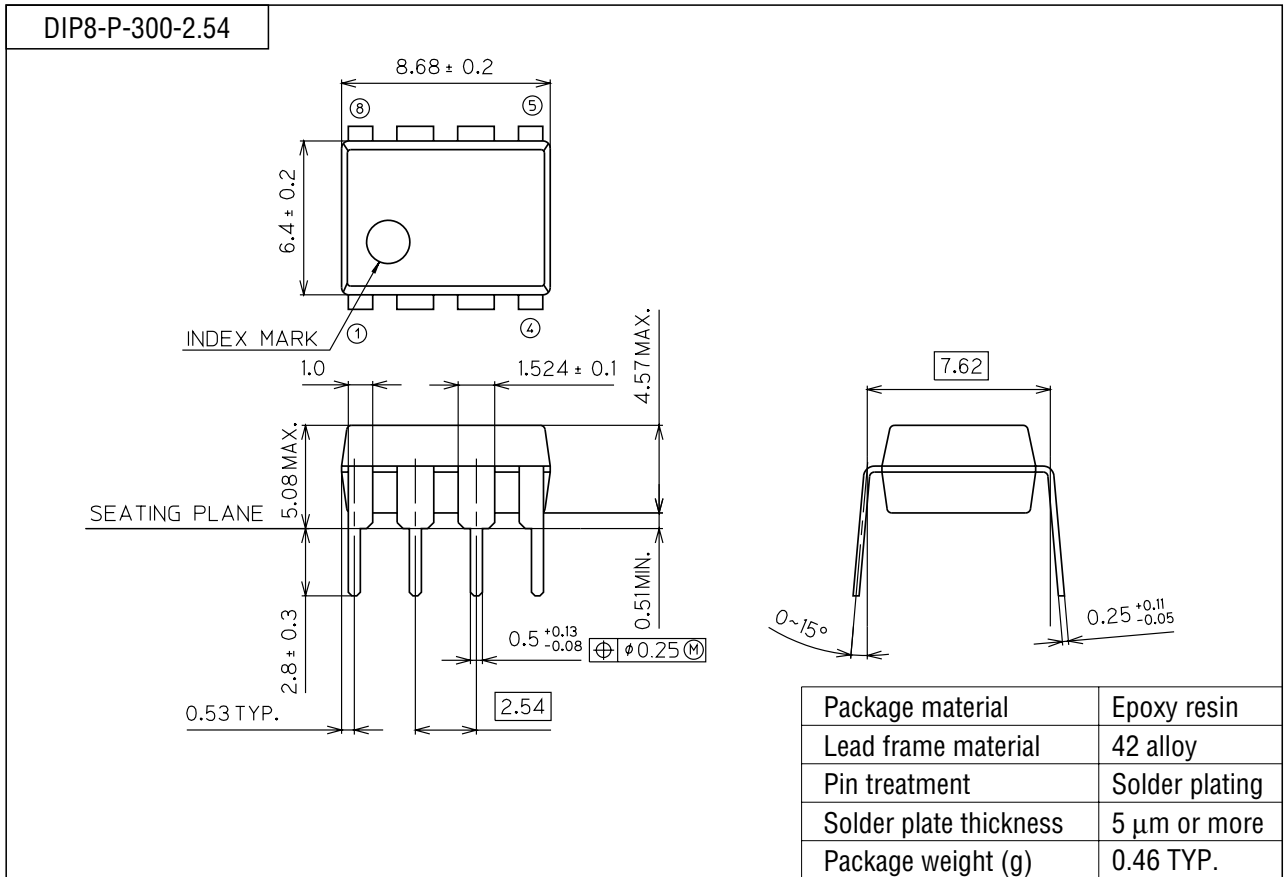


#### Pad Coordinates (Chip center: X=0, Y=0)

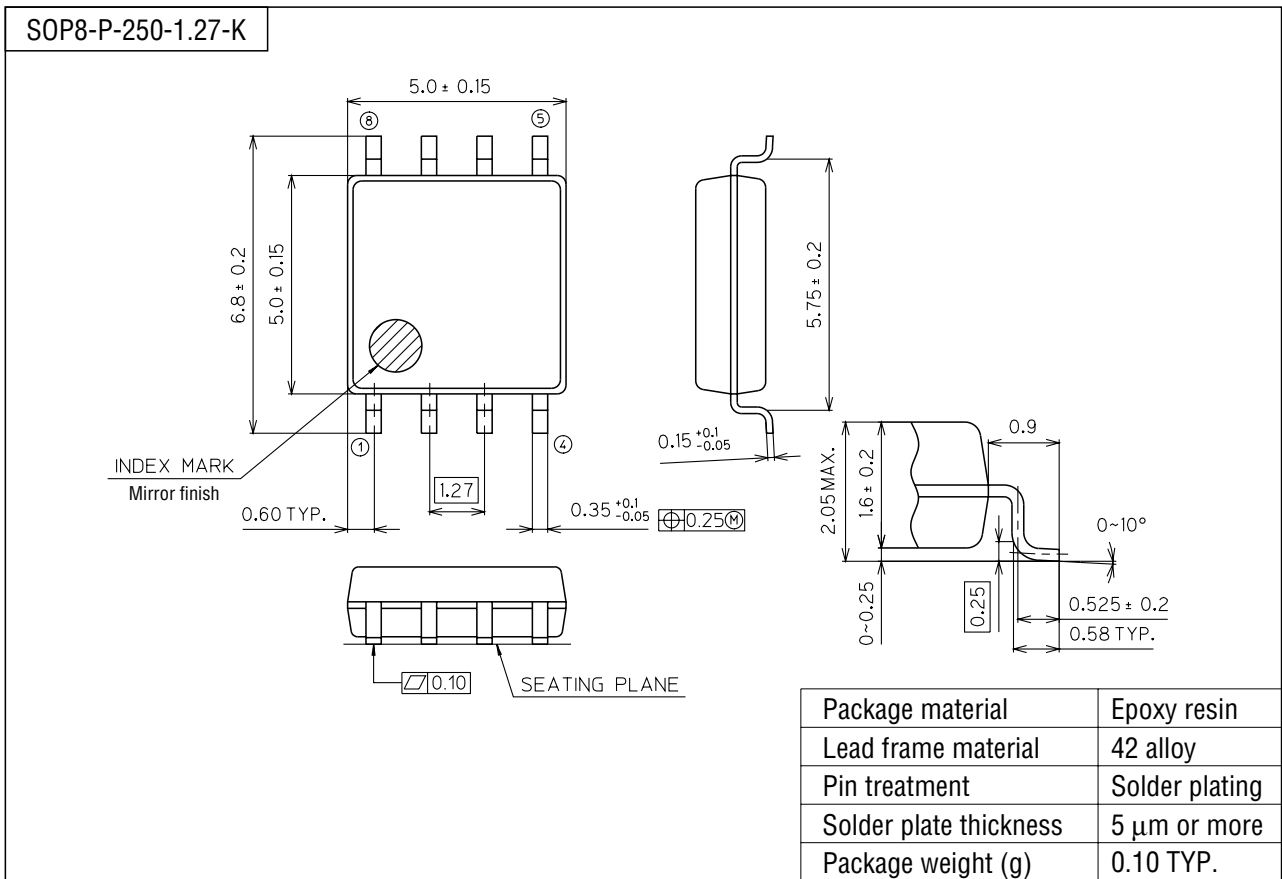
Pad	Pad name	X-coordinate [μm]	Y-coordinate [μm]
1	MODE2	-655	835
2	A <sub>IN</sub>	-835	835
3	GND	-835	-835
4	$\overline{\text{SP}}$	-185	-789
5	SP	121	-789
6	V <sub>CC</sub>	815	-835
7	BASE	793	835
8	MODE1	613	835

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).



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