Pb Free ROHM Electronic Components   RoHS Directive Compliance

Operational Amplifiers Series

Input/Output Full Swing Low Power Operational Amplifiers

LM7101G

●General Description

The LM7101G operational amplifier provides on both the input and output full swing operation.
The LM7101G is high voltage gain, low distortion, low consumption current. It's suitable for battery operation mobile equipment.

●Key Specifications

- Low Operating Supply Voltage (single supply): +1.8V to +5.0V
- Wide Temperature Range: 40°C to +85°C
- Low Input Bias Current: 1pA (Typ.)
- Input Offset Voltage: 3.5mV (Max.)
- High Voltage gain(RL=10 kΩ): 100dB(Typ.)

●Package

	W(Typ.) xD(Typ.) xH(Max.)
SSOP5	2.90mm x 2.80mm x 1.25mm

●Features

- High voltage gain
- low distortion
- Low operating supply voltage
- Low input bias current
- Low supply current
- Input/Output Full Swing

●Applications

- Customer electronics
- Buffer
- Active filter
- Mobile equipment
- Battery equipment

●Simplified schematic

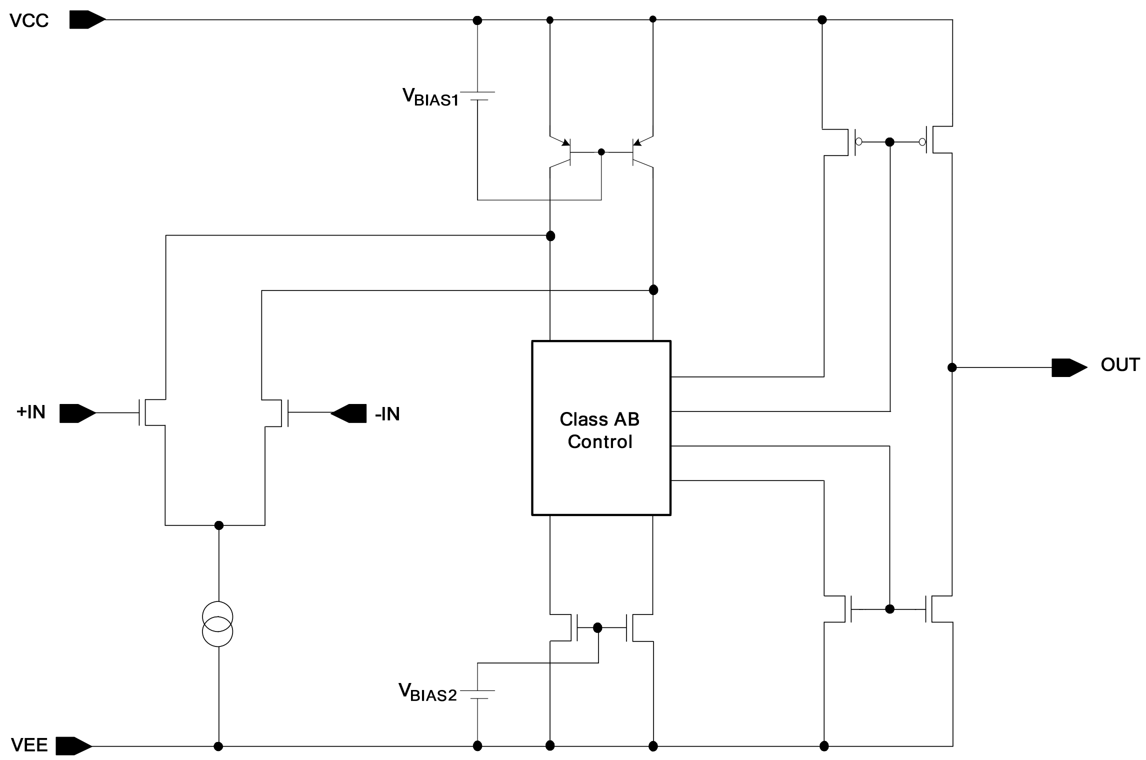
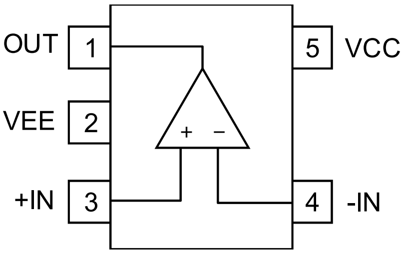


Figure1. Simplified schematic

○Product structure：Silicon monolithic integrated circuit　○This product is not designed protection against radioactive rays.

●Pin Configuration

LM7101G : SSOP5



Pin No.	Pin Name
1	OUT
2	VEE
3	+IN
4	-IN
5	VCC

Package
SSOP5
LM7101G

●Ordering Information

L M 7 1 0 1 G - T R

Part Number	Package	Packaging and forming specification
LM7101	G:SSOP5	TR: Embossed tape and reel

●Line-up

Topr	Package		Operable Part Number
-40°C to +85°C	SSOP5	Reel of 3000	LM7101G-TR

●Absolute Maximum Ratings(Ta=25°C)

Parameter	Symbol		Ratings	Unit
Supply Voltage	VCC-VEE		+7	V
Power dissipation	Pd	SSOP5	675[*1*2]	mW
Differential Input Voltage[*3]	Vid		VCC to VEE	V
Input Common-mode Voltage Range	Vicm		(VEE - 0.3) to (VCC + 0.3)	V
Input Current [*4]	Ii		-10	mA
Operable with low voltage	Vopr		+1.8 to +5.0	V
Operating Temperature	Topr		- 40 to +85	°C
Storage Temperature	Tstg		- 55 to +150	°C
Maximum Junction Temperature	Tjmax		+150	°C

Note: Absolute maximum rating item indicates the condition which must not be exceeded.
Application of voltage in excess of absolute maximum rating or use out absolute maximum rated temperature environment may cause deterioration of characteristics.

*1 To use at temperature above Ta＝25°C reduce 5.4mW/°C.

*2 Mounted on a FR4 glass epoxy PCB(70mm×70mm×1.6mm).

*3 The voltage difference between inverting input and non-inverting input is the differential input voltage. Then input terminal voltage is set to more than VEE.

*4 When input terminal voltage is about VEE-0.6V, the input terminal current will be a very large value. Adding a limit resistor, the input current will be smaller than the maximum limit.

●**Electrical Characteristics**:

○LM7101G (Unless otherwise specified VCC=+1.8V, VEE=0V)

Parameter	Symbol	Temperature Range	Limits			Unit	Condition
			Min.	Typ.	Max.		
Input Offset Voltage *5*6	Vio	25°C	-	0.1	3	mV	VIN= VCC/2
		Full Range	-	-	3.5		
Input Offset Voltage Drift	ΔVio/ΔT	25°C	-	2	-	μV/°C	-
Input Bias Current *5	Ib	25°C	-	1	200	pA	-
Supply Current*6	ICC	25°C	-	760	1100	μA	Av=0dB, VIN= VCC/2
		Full range	-	-	1200		
Maximum Output Voltage(High)	VOH	25°C	100	30	-	mV	RL=2kΩ to VCC/2
			50	10	-		RL=10kΩ to VCC/2
Maximum Output Voltage(Low)	VOL	25°C	-	30	100	mV	RL=2kΩ to VCC/2
			-	10	50		RL=10kΩ to VCC/2
Large Signal Voltage Gain	Av	25°C	84	100	-	dB	RL=10kΩ to VCC/2
			84	95	-		RL=2kΩ to VCC/2
Input Common-mode Voltage Range	Vicm	25°C	VEE	-	VCC-0.1	V	VEE to VCC-0.1V
Common-mode Rejection Ratio	CMRR	25°C	60	90	-	dB	VCM=0.5V
Power supply reject-ratio	PSRR	25°C	65	100	-	dB	VCC=1.8V to 5.0V VCM=0.5V
Output Source Current *7	Isource	25°C	-	6	-	mA	OUT=0V, short current
Output Sink Current *7	Isink	25°C	-	6	-	mA	OUT=1.8V, short current
Slew Rate	SR	25°C	-	1.2	-	V/μs	RL=2kΩ to VCC/2 OUT=1.4V_{P-P}
Gain Bandwidth	GBW	25°C	-	1.5	-	MHz	CL=25pF, RL=10kΩ Av=40dB, f=100kHz
Phase Margin	θ	25°C	-	45	-	Deg	CL=25pF, RL=10kΩ Av=40dB
Gain Margin	GM	25°C	-	9	-	dB	CL=25pF, RL=10kΩ Av=40dB
Input Referred Noise Voltage	Vn	25°C	-	35	-	$nV/\sqrt{Hz}$	f=1kHz
Total Harmonic Distortion+ Noise	THD+N	25°C	-	0.004	-	%	OUT=1.4V_{P-P}, f=1kHz RL=2kΩ to VCC/2 Av=0dB, DIN-AUDIO

*5 Absolute value.
*6 Full range: Ta=-40°C to +85°C
*7 Under the high temperature environment, consider the power dissipation of IC when selecting the output current.
When the terminal short circuits are continuously output, the output current is reduced to climb to the temperature inside IC.

○LM7101G (Unless otherwise specified VCC=+5.0V, VEE=0V)

Parameter	Symbol	Temperature Range	Limits			Unit	Condition
			Min.	Typ.	Max.		
Input Offset Voltage [*8*9]	Vio	25°C	-	0.1	3	mV	VIN= VCC/2
		Full Range	-	-	3.5		
Input Offset Voltage Drift	ΔVio/ΔT	25°C	-	2	-	μV/°C	-
Input Bias Current [*8]	Ib	25°C	-	1	200	pA	-
Supply Current[*9]	ICC	25°C	-	800	1300	μA	Av=0dB, VIN=VCC/2
		Full range	-	-	1400		
Maximum Output Voltage(High)	VOH	25°C	150	50	-	mV	RL=2kΩ to VCC/2
			400	150	-		RL=600Ω to VCC/2
Maximum Output Voltage(Low)	VOL	25°C	-	50	150	mV	RL=2kΩ to VCC/2
			-	100	400		RL=600Ω to VCC/2
Large Signal Voltage Gain	Av	25°C	84	100	-	dB	RL=10kΩ to VCC/2
			84	95	-		RL=2kΩ to VCC/2
Input Common-mode Voltage Range	Vicm	25°C	VEE	-	VCC	V	VEE to VCC
Common-mode Rejection Ratio	CMRR	25°C	60	90	-	dB	VCM=0.5V
Power supply reject-ratio	PSRR	25°C	65	100	-	dB	VCC=1.8V to 5.0V VCM=0.5V
Output Source Current [*10]	Isource	25°C		80	-	mA	OUT=0V, short current
Output Sink Current [*10]	Isink	25°C		80	-	mA	OUT=5V, short current
Slew Rate	SR	25°C	-	1.2	-	V/μs	RL=2kΩ to VCC/2 OUT=4V_{P-P}
Gain Bandwidth	GBW	25°C	-	1.5	-	MHz	CL=25pF, RL=10kΩ Av=40dB, f=100kHz
Phase Margin	θ	25°C	-	45	-	Deg	CL=25pF, RL=10kΩ Av=40dB
Gain Margin	GM	25°C	-	9	-	dB	CL=25pF, RL=10kΩ Av=40dB
Input Referred Noise Voltage	Vn	25°C	-	35	-	$nV/\sqrt{Hz}$	f=1kHz
Total Harmonic Distortion+ Noise	THD+N	25°C	-	0.004	-	%	OUT=4V_{P-P}, f=1kHz RL=2kΩ to VCC/2 Av=0dB, DIN-AUDIO

*8 Absolute value
*9 Full range: Ta=-40°C to +85°C
*10 Under the high temperature environment, consider the power dissipation of IC when selecting the output current.
When the terminal short circuits are continuously output, the output current is reduced to climb to the temperature inside IC.

Description of electrical characteristics

Described here are the terms of electric characteristics used in this datasheet. Items and symbols used are also shown. Note that item name and symbol and their meaning may differ from those on another manufacture's document or general document.

1. Absolute maximum ratings
   Absolute maximum rating item indicates the condition which must not be exceeded. Application of voltage in excess of absolute maximum rating or use out of absolute maximum rated temperature environment may cause deterioration of characteristics.
   1.1 Power supply voltage (VCC/VEE)
      Indicates the maximum voltage that can be applied between the positive power supply terminal and negative power supply terminal without deterioration or destruction of characteristics of internal circuit.
   1.2 Differential input voltage (Vid)
      Indicates the maximum voltage that can be applied between non-inverting terminal and inverting terminal without deterioration and destruction of characteristics of IC.
   1.3 Input common-mode voltage range (Vicm)
      Indicates the maximum voltage that can be applied to non-inverting terminal and inverting terminal without deterioration or destruction of characteristics. Input common-mode voltage range of the maximum ratings not assures normal operation of IC. When normal Operation of IC is desired, the input common-mode voltage of characteristics item must be followed.
   1.4 Power dissipation (Pd)
      Indicates the power that can be consumed by specified mounted board at the ambient temperature 25℃(normal temperature). As for package product, Pd is determined by the temperature that can be permitted by IC chip in the package (maximum junction temperature) and thermal resistance of the package.
2. Electrical characteristics item
   2.1 Input offset voltage (Vio)
      Indicates the voltage difference between non-inverting terminal and inverting terminal. It can be translated into the input voltage difference required for setting the output voltage at 0 V.
   2.2 Input offset voltage drift (△Vio/△T)
      Denotes the ratio of the input offset voltage fluctuation to the ambient temperature fluctuation.
   2.3 Input bias current (Ib)
      Indicates the current that flows into or out of the input terminal. It is defined by the average of input bias current at non-inverting terminal and input bias current at inverting terminal.
   2.4 Circuit current (ICC)
      Indicates the IC current that flows under specified conditions and no-load steady status.
   2.5 Maximum output voltage(High) / Maximum output voltage(Low) (VOH/VOL)
      Indicates the voltage range of the output under specified load condition. It is typically divided into maximum output voltage High and low. Maximum output voltage high indicates the upper limit of output voltage. Maximum output voltage low indicates the lower limit.
   2.6 Output source current/ output sink current (Isource/Isink)
      The maximum current that can be output under specific output conditions, it is divided into output source current and output sink current. The output source current indicates the current flowing out of the IC, and the output sink current the current flowing into the IC.
   2.7 Large signal voltage gain (Av)
      Indicates the amplifying rate (gain) of output voltage against the voltage difference between non-inverting terminal and inverting terminal. It is normally the amplifying rate (gain) with reference to DC voltage.
      Av = (Output voltage) / (Differential Input voltage)
   2.8 Input common-mode voltage range (Vicm)
      Indicates the input voltage range where IC operates normally.
   2.9 Common-mode rejection ratio (CMRR)
      Indicates the ratio of fluctuation of input offset voltage when in-phase input voltage is changed. It is normally the fluctuation of DC.
      CMRR = (Change of Input common-mode voltage)/(Input offset fluctuation)
   2.10 Power supply rejection ratio (PSRR)
      Indicates the ratio of fluctuation of input offset voltage when supply voltage is changed. It is normally the fluctuation of DC. PSRR= (Change of power supply voltage)/(Input offset fluctuation)
   2.11 Slew rate (SR)
      Indicates the time fluctuation ratio of voltage output when step input signal is applied.
   2.12 Gain Band Width (GBW)
      Indicates to multiply by the frequency and the gain where the voltage gain decreases 6dB/octave.
   2.13 Phase Margin (θ)
      Indicates the margin of phase from 180 degree phase lag at unity gain frequency.
   2.14 Gain Margin (GM)
      Indicates the difference between 0dB and the gain where operational amplifier has 180 degree phase delay.
   2.15 Total harmonic distortion + Noise (THD+N)
      Indicates the fluctuation of input offset voltage or that of output voltage with reference to the change of output voltage of driven channel.
   2.16 Input referred noise voltage (Vn)
      Indicates a noise voltage generated inside the operational amplifier equivalent by ideal voltage source connected in series with input terminal.

●**Typical Performance Curves**

○**LM7101G**

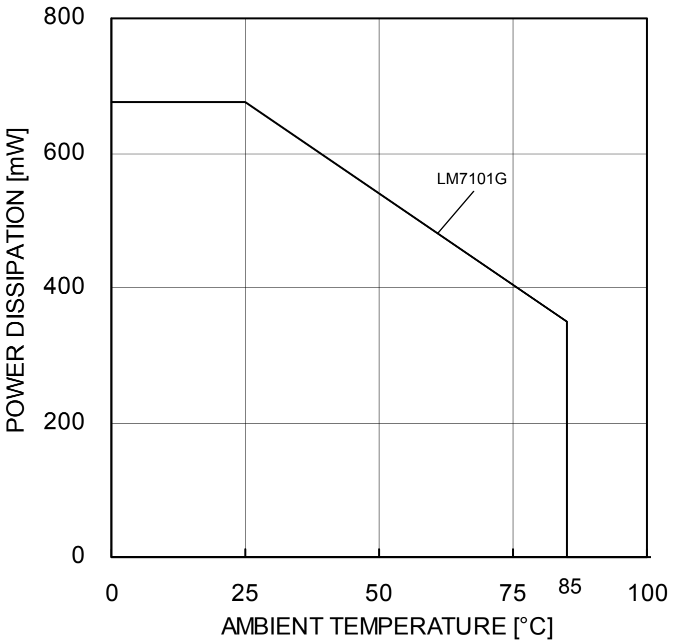


Figure 2.
Derating curve

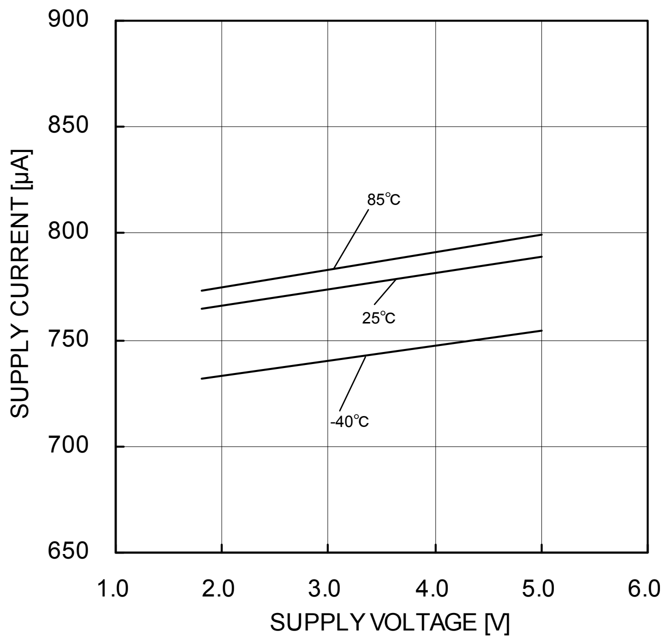


Figure 3.
Supply Current – Supply Voltage

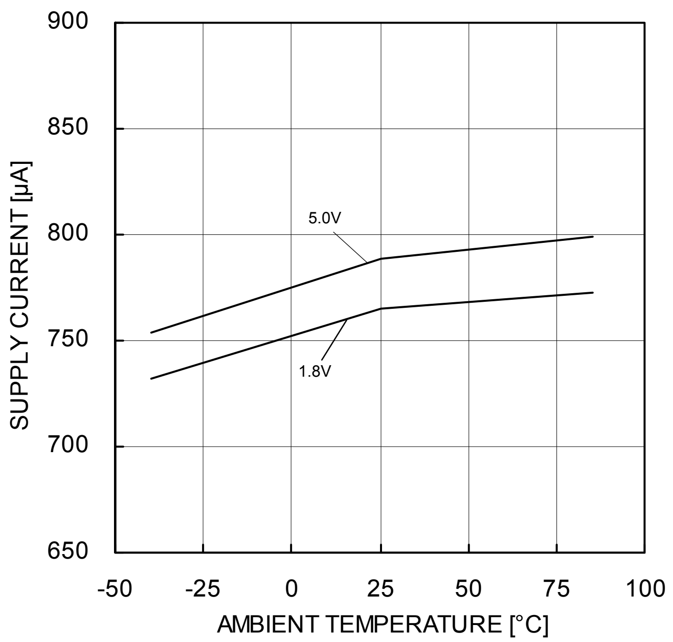


Figure 4.
Supply Current – Ambient Temperature

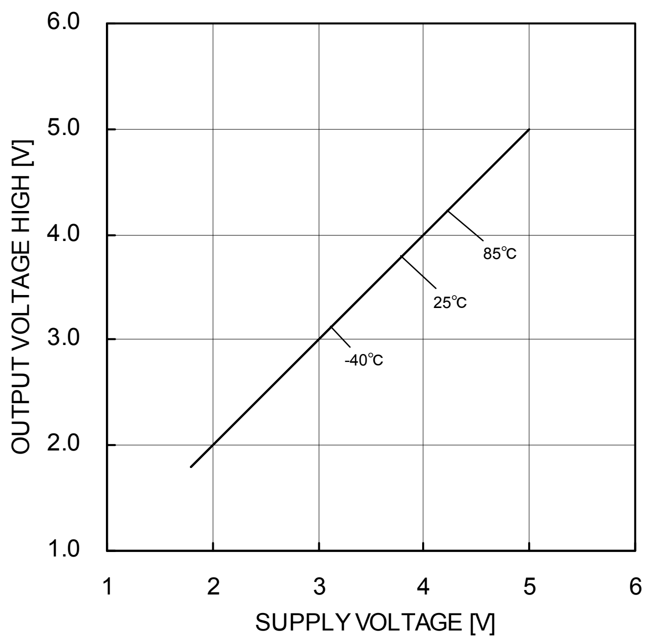


Figure 5.
Output Voltage High – Supply Voltage
(RL=2kΩ)

(*)The data above is measurement value of typical sample, it is not guaranteed.

●Typical Performance Curves (Reference data) – Continued

○**LM7101G**

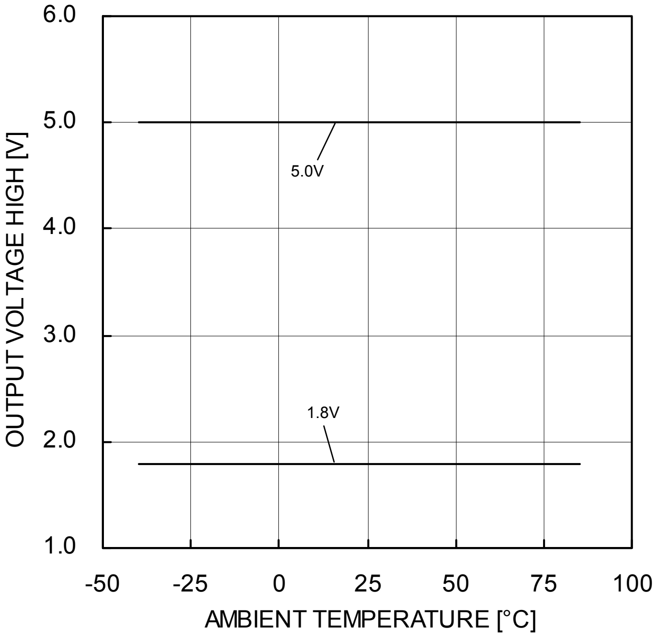


Figure 6.
Output Voltage High – Ambient Temperature
(RL=2kΩ)

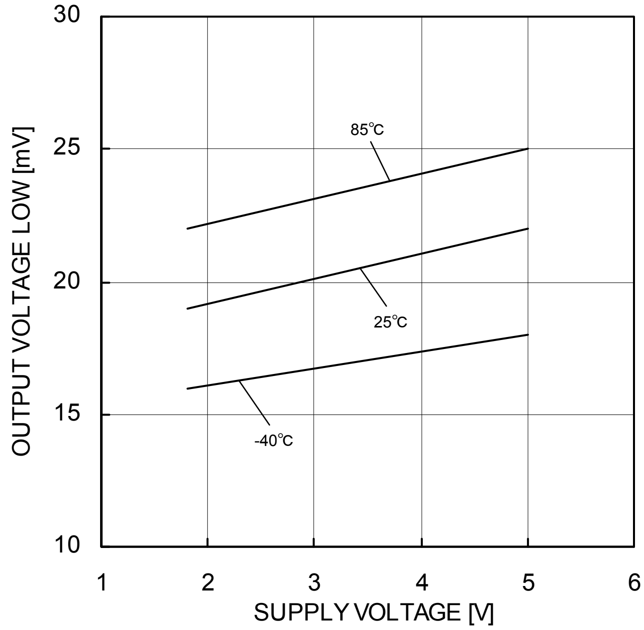


Figure 7.
Output Voltage Low – Supply Voltage
(RL=2kΩ)

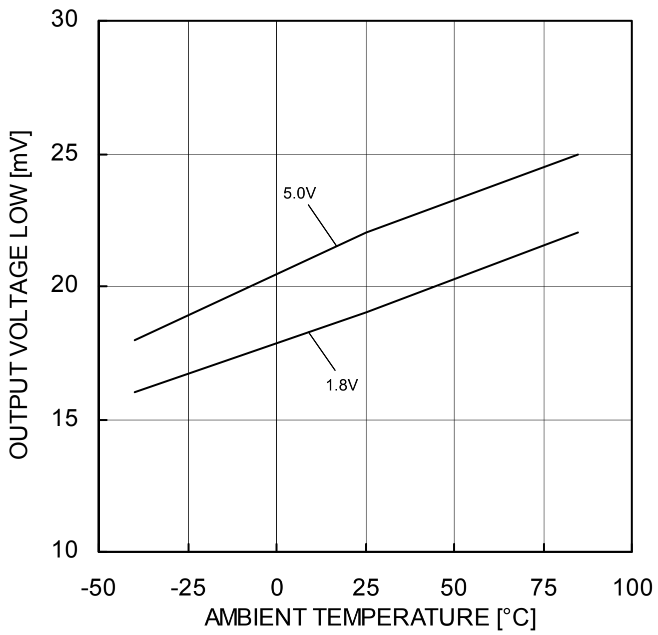


Figure 8.
Output Voltage Low –Ambient Temperature
(RL=2kΩ)

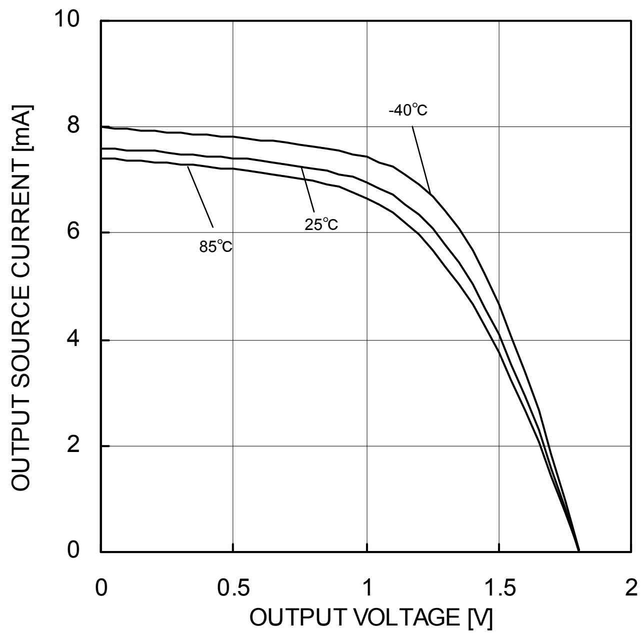


Figure 9.
Output Source Current – Output Voltage
(VCC=1.8V)

(*)The data above is measurement value of typical sample, it is not guaranteed.

●Typical Performance Curves (Reference data) – Continued

○**LM7101G**

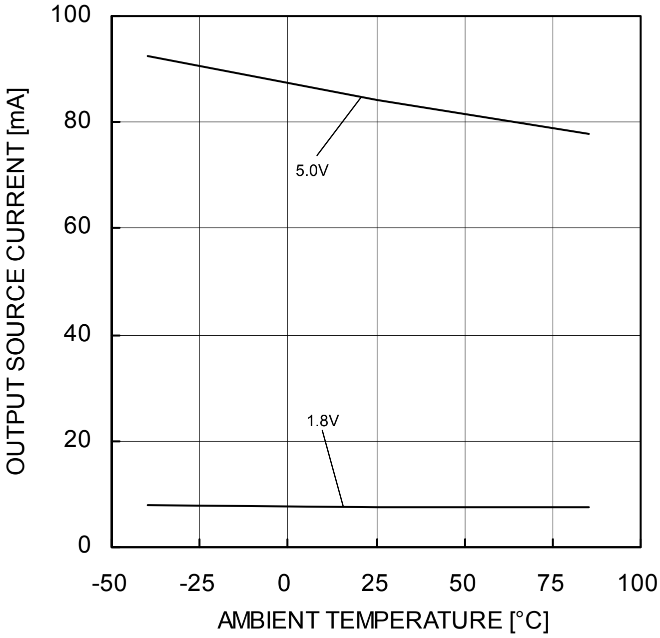


Figure 10.
Output Source Current –Ambient Temperature

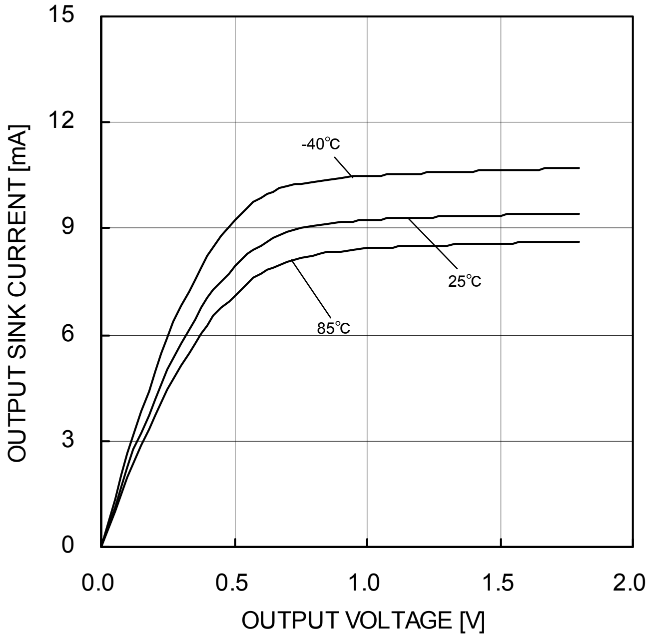


Figure 11.
Output Sink Current – Output Voltage
(VCC=1.8V)

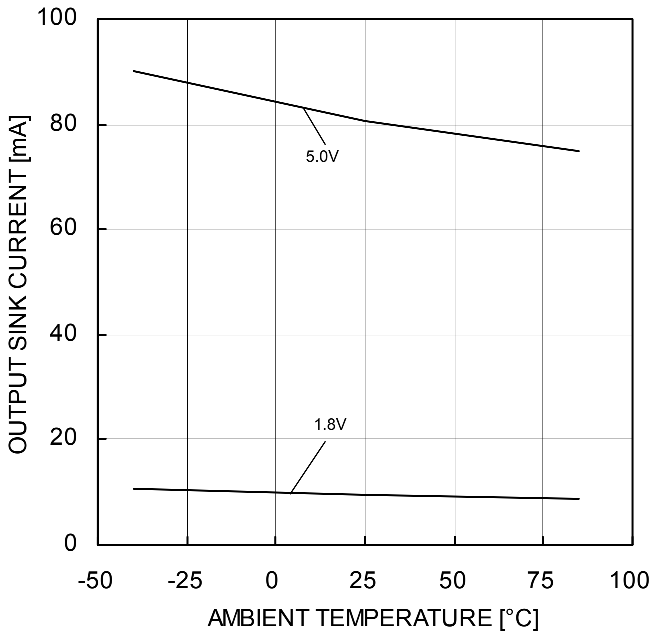


Figure 12.
Output Sink Current – Ambient Temperature

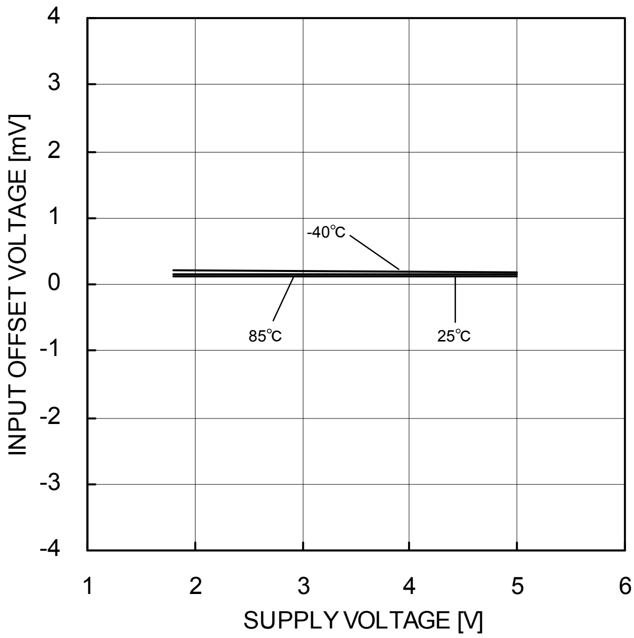


Figure 13.
Input Offset Voltage – Supply Voltage

(*)The data above is measurement value of typical sample, it is not guaranteed.

●Typical Performance Curves (Reference data) - Continued

○**LM7101G**

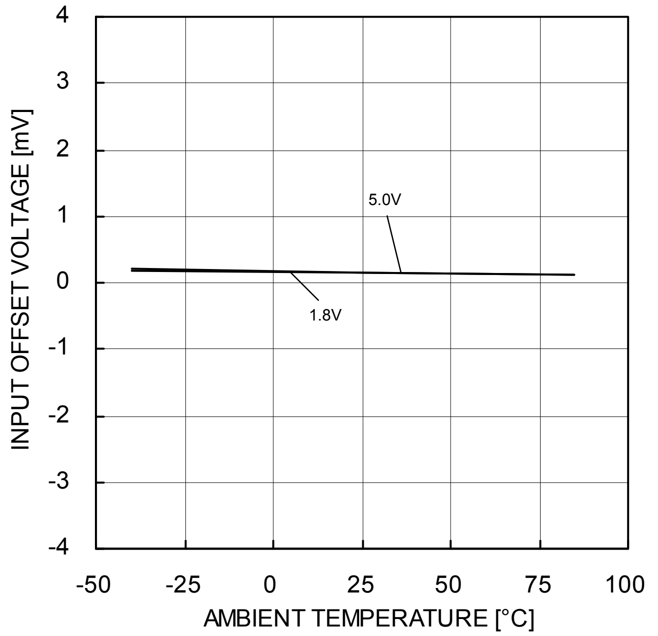


Figure 14.
Input Offset Voltage – Ambient Temperature

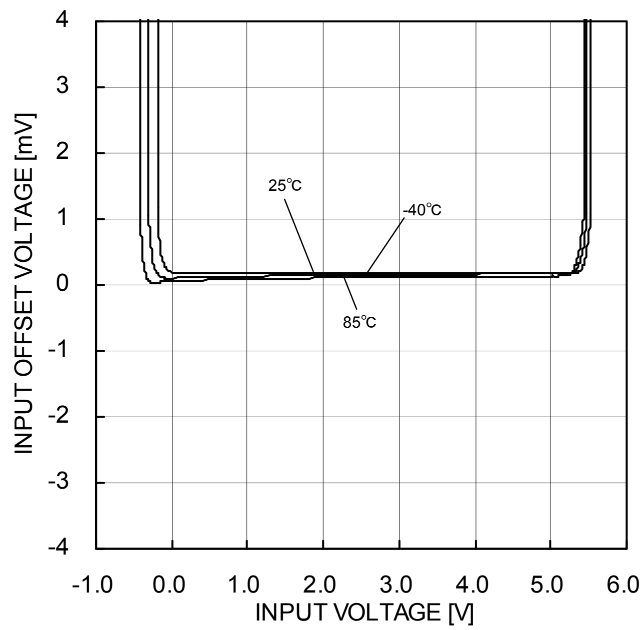


Figure 15.
Input Offset Voltage – Input Voltage
(VCC=5V)

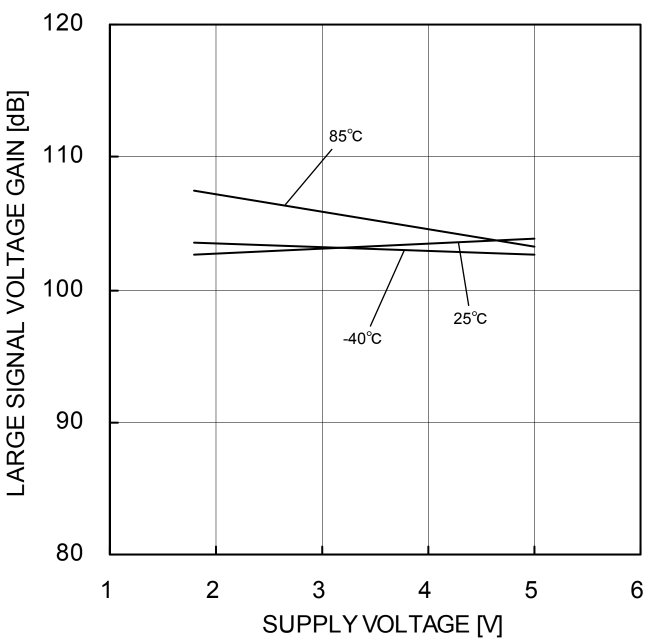


Figure 16.
Large Signal Voltage Gain – Supply Voltage

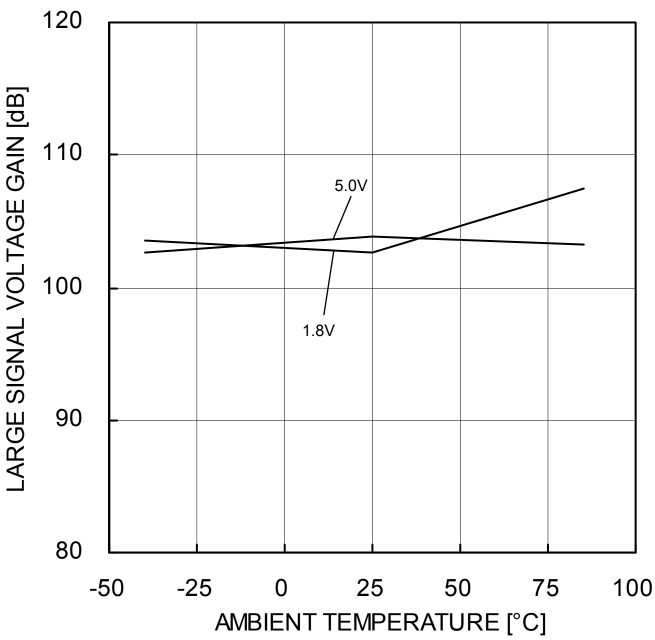


Figure 17.
Large Signal Voltage Gain – Ambient Temperature

(*)The data above is measurement value of typical sample, it is not guaranteed.

●Typical Performance Curves (Reference data) – Continued

○**LM7101G**

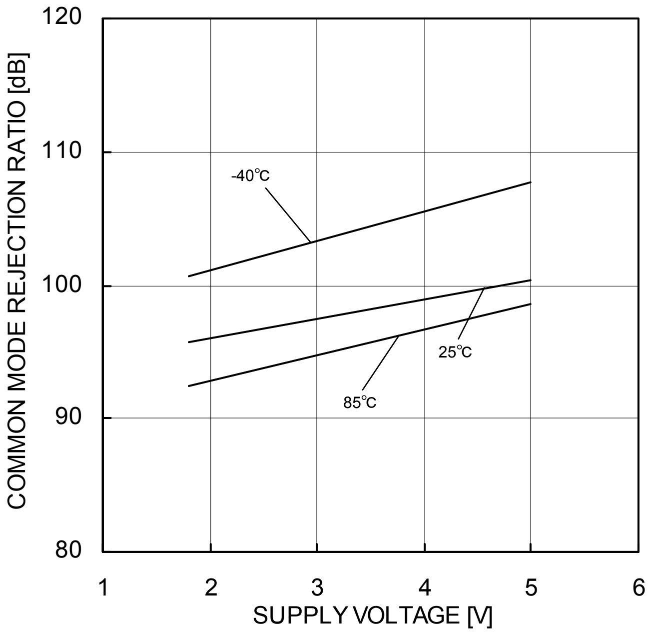


Figure 18.
Common Mode Rejection Ratio – Supply Voltage
(VCC=1.8V)

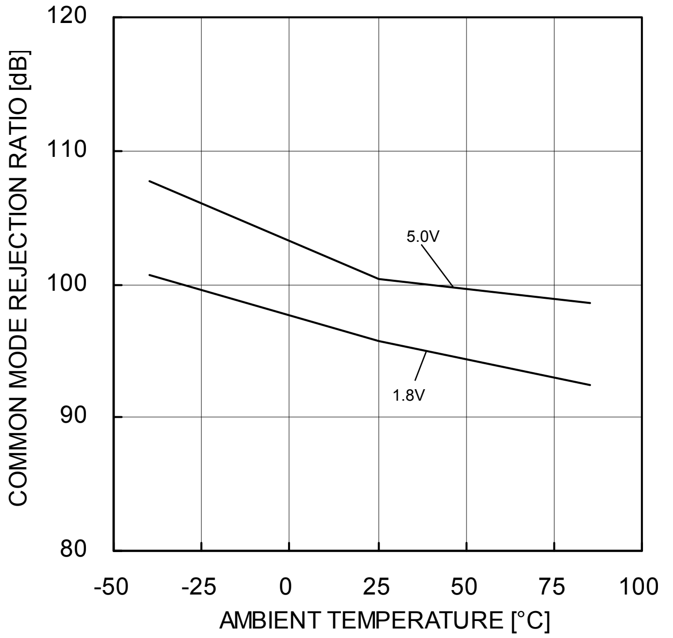


Figure 19.
Common Mode Rejection Ratio – Ambient Temperature

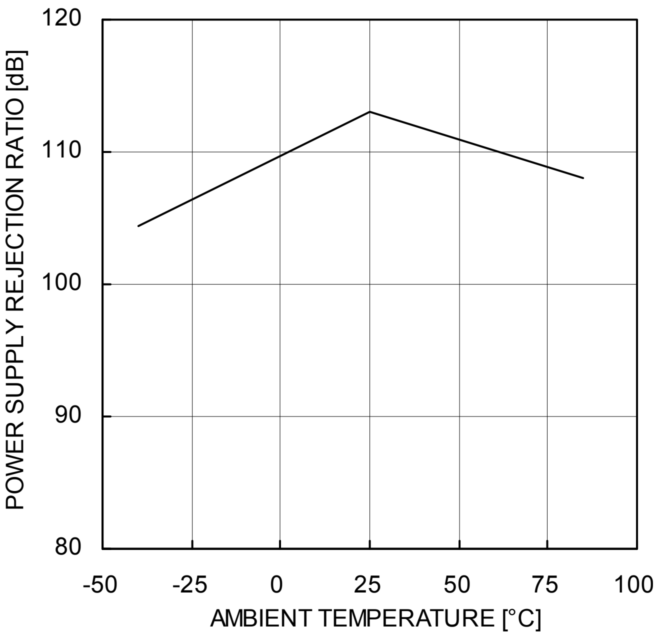


Figure 20.
Power Supply Rejection Ratio – Ambient Temperature
(VCC=1.8V ~ 5.0V)

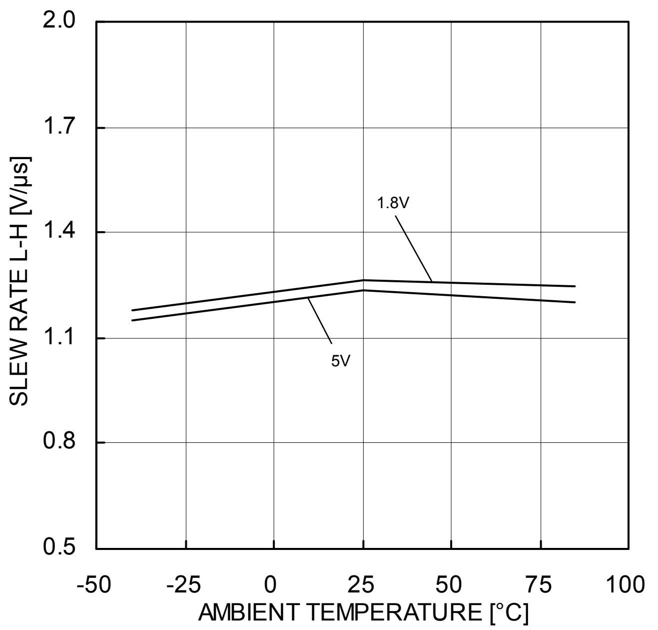


Figure 21.
Slew Rate L-H – Ambient Temperature

(*)The data above is measurement value of typical sample, it is not guaranteed.

●Typical Performance Curves (Reference data) - Continued

○**LM7101G**

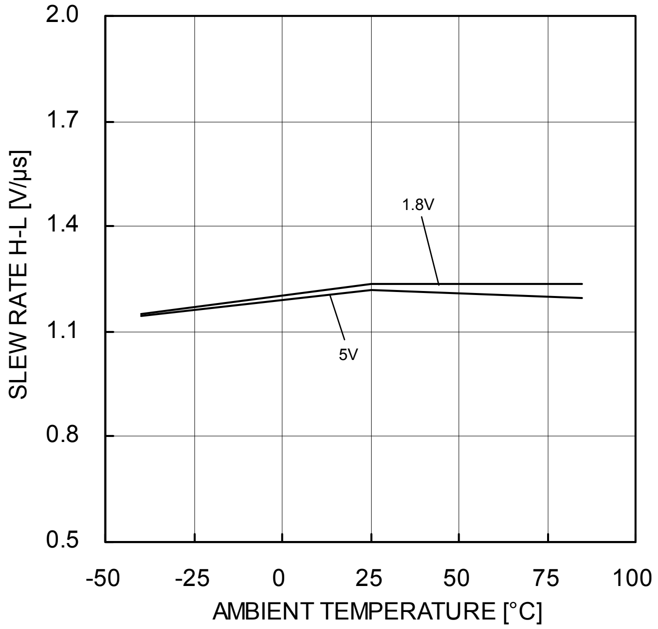


Figure 22.
Slew Rate H-L – Ambient Temperature

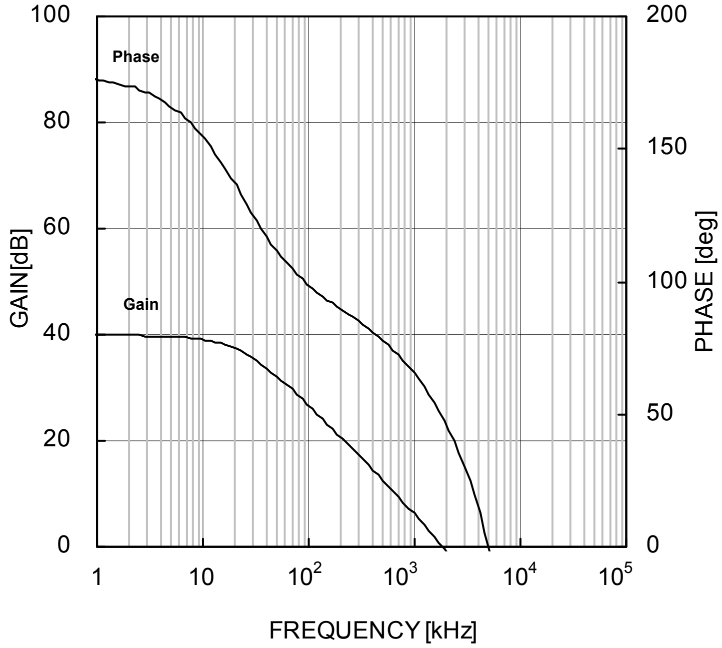


Figure 23.
Voltage Gain, Phase – Frequency

(*)The data above is measurement value of typical sample, it is not guaranteed.

Application Information

●Test circuit1 NULL method

VCC, VEE, EK, Vicm Unit:V

Parameter	VF	S1	S2	S3	VCC	VEE	EK	Vicm	Calculation
Input Offset Voltage	VF1	ON	ON	OFF	3	0	-1.5	3	1
Large Signal Voltage Gain	VF2	ON	ON	ON	3	0	-0.5	1.5	2
	VF3						-2.5		
Common-mode Rejection Ratio (Input Common-mode Voltage Range)	VF4	ON	ON	OFF	3	0	-1.5	0	3
	VF5							3	
Power Supply Rejection Ratio	VF6	ON	ON	OFF	2.5	0	-1.2	0	4
	VF7				5.0				

－ Calculation－

1. Input Offset Voltage (Vio)

$$Vio = \frac{|VF1|}{1+RF/RS} \ [V]$$

2. Large Signal Voltage Gain(Av)

$$Av = 20Log \frac{2 \times (1+RF/RS)}{|VF2-VF3|} \ [dB]$$

3. Common-mode Rejection Ratio (CMRR)

$$CMRR=20Log \frac{3 \times (1+RF/RS)}{|VF4 - VF5|} \ [dB]$$

4. Power Supply Rejection Ratio (PSRR)

$$PSRR = 20Log \frac{3.2 \times (1+ RF/RS)}{|VF6 - VF7|} \ [dB]$$

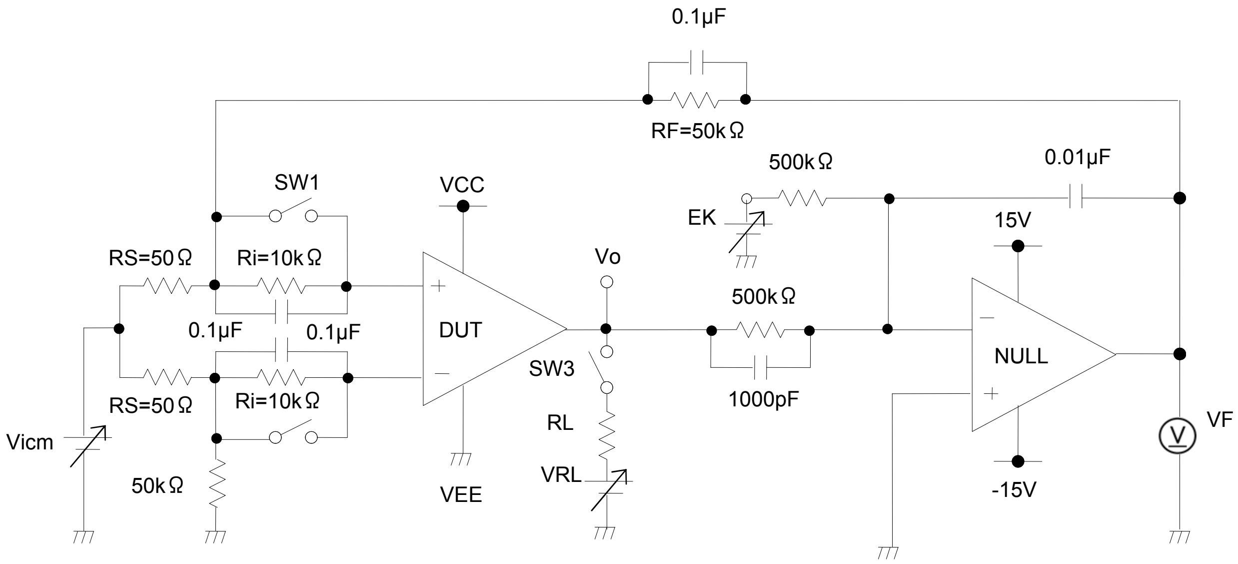


Figure 24.Test circuit1

Switch Condition for Test Circuit 2

SW No.	SW1	SW2	SW3	SW4	SW5	SW6	SW7	SW8	SW9	SW10	SW11	SW12
Supply Current	OFF	OFF	ON	OFF	ON	OFF	OFF	OFF	OFF	OFF	OFF	OFF
Maximum Output Voltage RL=10kΩ	OFF	ON	OFF	OFF	ON	OFF	OFF	ON	OFF	OFF	ON	OFF
Output Current	OFF	ON	OFF	OFF	ON	OFF	OFF	OFF	OFF	ON	OFF	OFF
Slew Rate	OFF	OFF	ON	OFF	OFF	OFF	ON	OFF	ON	OFF	OFF	ON
Unit Gain Frequency	ON	OFF	OFF	ON	ON	OFF	OFF	OFF	ON	OFF	OFF	ON

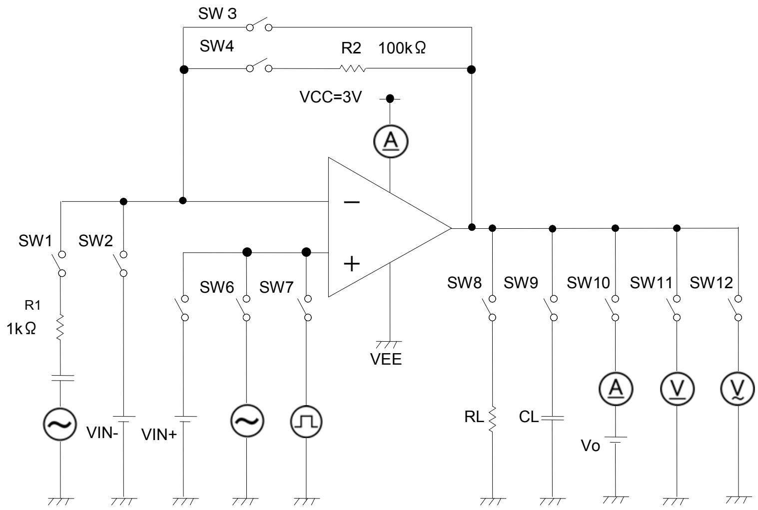


Figure 25. Test circuit2

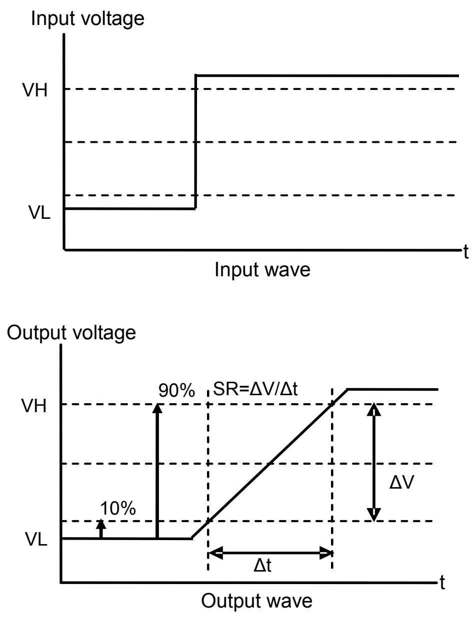


Figure 26. Slew rate input output wave

●Examples of circuit

○Voltage follower

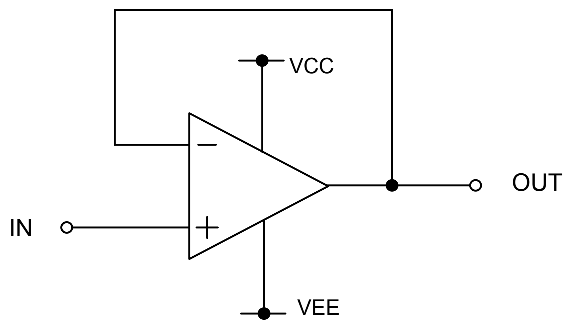


Figure 27. Voltage follower

Voltage gain is 0dB.
This circuit controls output voltage (OUT) equal input voltage (IN), and keeps OUT with stable because of high input impedance and low output impedance.
OUT is shown next formula.

OUT=IN

○Inverting amplifier

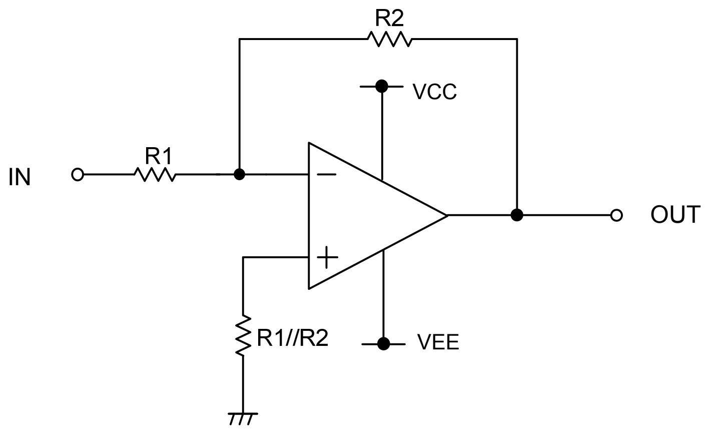


Figure 28. Inverting amplifier circuit

For inverting amplifier, IN is amplified by voltage gain decided R1 and R2, and phase reversed voltage is outputted. OUT is shown next formula.
OUT=-(R2/R1)・IN
Input impedance is R1.

○Non-inverting amplifier

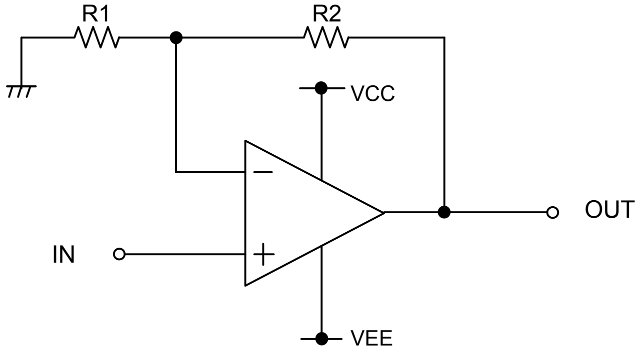


Figure 29. Non-inverting amplifier circuit

For non-inverting amplifier, IN is amplified by voltage gain decided R1 and R2, and phase is same with IN.
OUT is shown next formula.
OUT=(1+R2/R1)・IN
This circuit realizes high input impedance because Input impedance is operational amplifier’s input Impedance.

●**Power Dissipation**

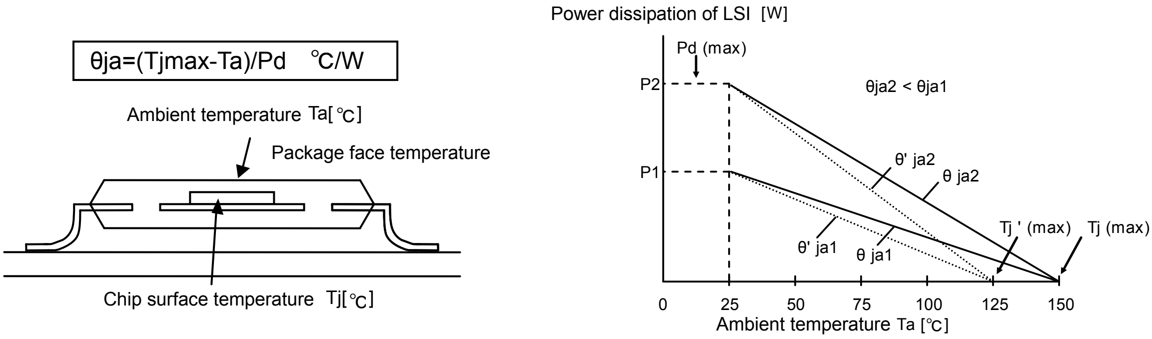
Power dissipation (total loss) indicates the power that can be consumed by IC at Ta=25□(normal temperature).IC is heated when it consumed power, and the temperature of IC ship becomes higher than ambient temperature. The temperature that can be accepted by IC chip depends on circuit configuration, manufacturing process, and consumable power is limited. Power dissipation is determined by the temperature allowed in IC chip (maximum junction temperature) and thermal resistance of package (heat dissipation capability). The maximum junction temperature is typically equal to the maximum value in the storage package (heat dissipation capability). The maximum junction temperature is typically equal to the maximum value in the storage temperature range. Heat generated by consumed power of IC radiates from the mold resin or lead frame of the package. The parameter which indicates this heat dissipation capability (hardness of heat release) is called thermal resistance, represented by the symbol θja℃/W. The temperature of IC inside the package can be estimated by this thermal resistance.

Figure30(a) shows the model of thermal resistance of the package. Thermal resistance θja, ambient temperature Ta, junction temperature Tj, and power dissipation Pd can be calculated by the equation below:

$$\theta ja = (Tjmax - Ta) / Pd \quad ℃/W \quad \cdots\cdots \quad (I)$$

Derating curve in Figure30. (b) indicates power that can be consumed by IC with reference to ambient temperature. Power that can be consumed by IC begins to attenuate at certain ambient temperature. This gradient is determined by thermal resistance θja. Thermal resistance θja depends on chip size, power consumption, package, ambient temperature, package condition, wind velocity, etc even when the same of package is used. Thermal reduction curve indicates a reference value measured at a specified condition. Figure31 show a derating curve for an example of LM7101

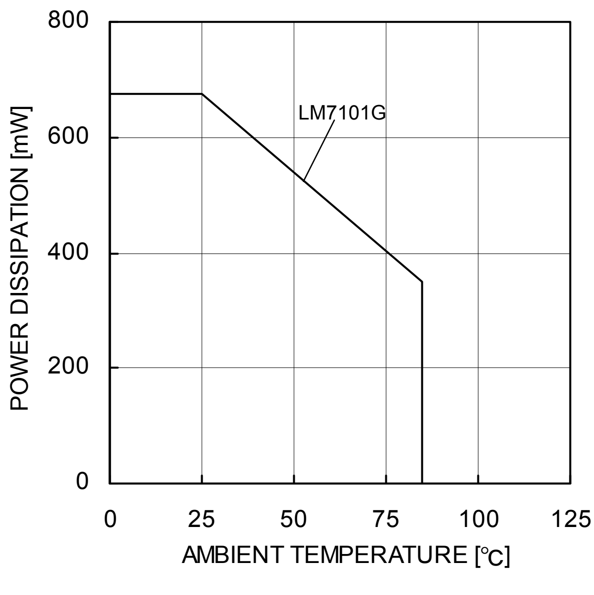
.



(a) Thermal resistance

(b) Derating curve

Figure 30. Thermal resistance and derating



5.4	mW/℃

When using the unit above Ta=25℃, subtract the value above per degree℃. Permissible dissipation is the value when FR4 glass epoxy board 70mm×70mm×1.6mm (cooper foil area below 3%) is mounted

Figure 31. Derating Curve

●**Operational Notes**

1) Unused circuits
When there are unused op-amps, it is recommended that they are connected as in Figure 32, setting the non-inverting input terminal to a potential within the in-phase input voltage range (Vicm).

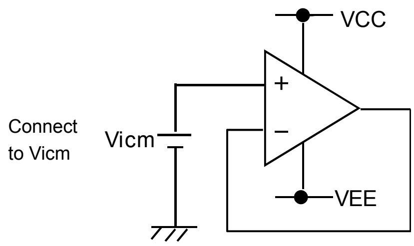


Figure 32. Example of application circuit for unused op-amp

2) Input voltage
Applying VEE-0.3V to the input terminal is possible without causing deterioration of the electrical characteristics or destruction, regardless of the supply voltage. However, this does not ensure normal circuit operation. Please note that the circuit operates normally only when the input voltage is within the common mode input voltage range of the electric characteristics.

3) Power supply (single / dual)
The op-amp operates when the voltage supplied is between VCC and VEE. Therefore, the single supply op-amp can be used as dual supply op-amp as well.

4) Power dissipation Pd
Using the unit in excess of the rated power dissipation may cause deterioration in electrical characteristics including reduced current capability due to the rise of chip temperature. Therefore, please take into consideration the power dissipation (Pd) under actual operating conditions and apply a sufficient margin in thermal design. Refer to the thermal derating curves for more information.

5) Short-circuit between pins and erroneous mounting
Be careful when mounting the IC on printed circuit boards. The IC may be damaged if it is mounted in a wrong orientation or if pins are shorted together. Short circuit may be caused by conductive particles caught between the pins.

6) Operation in a strong electromagnetic field
Operating the IC in the presence of a strong electromagnetic field may cause the IC to malfunction.

7) Radiation
This IC is not designed to withstand radiation.

8) IC handling
Applying mechanical stress to the IC by deflecting or bending the board may cause fluctuations in the electrical characteristics due to piezo resistance effects.

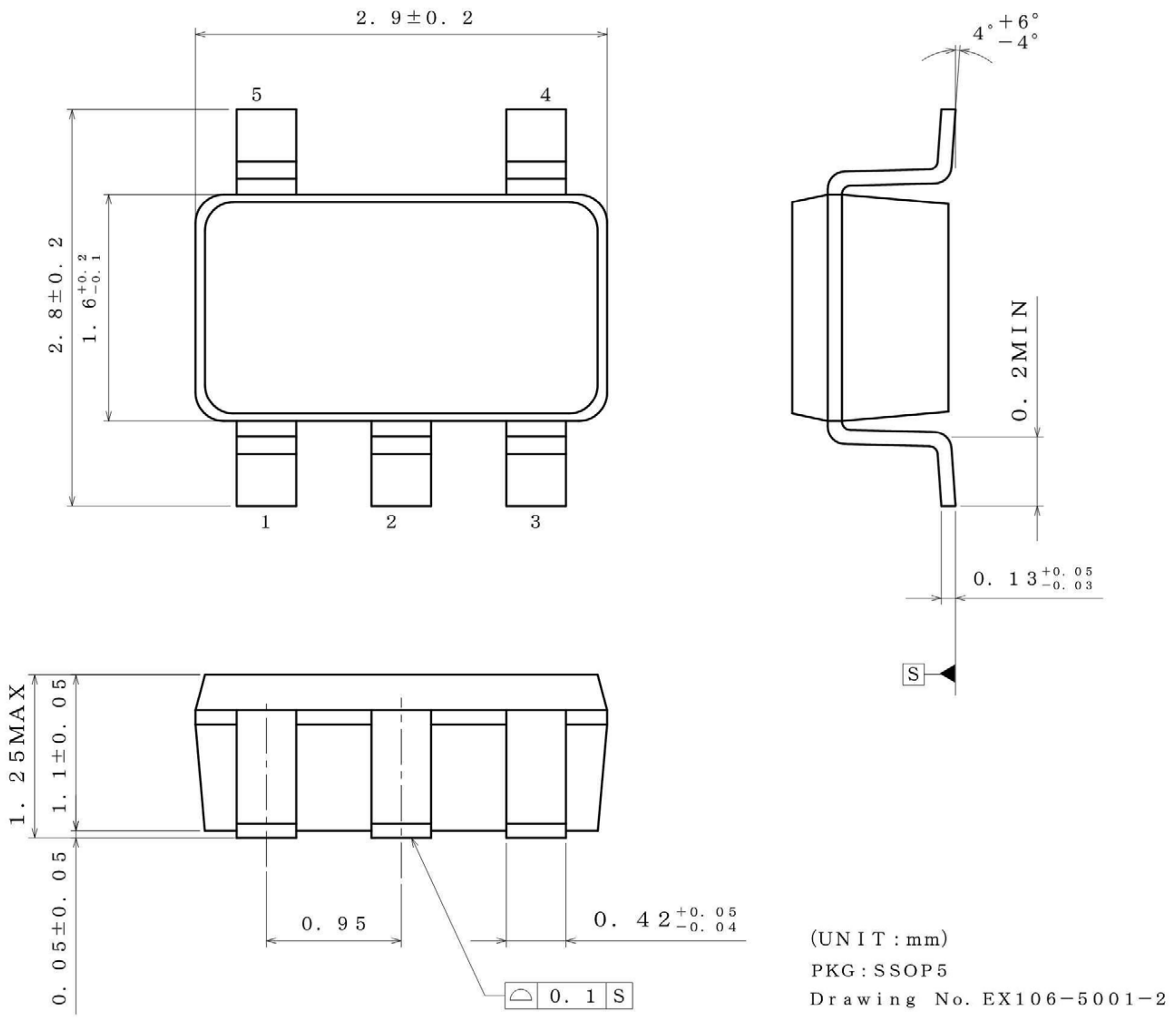
9) Board inspection
Connecting a capacitor to a pin with low impedance may stress the IC. Therefore, discharging the capacitor after every process is recommended. In addition, when attaching and detaching the jig during the inspection phase, make sure that the power is turned OFF before inspection and removal. Furthermore, please take measures against ESD in the assembly process as well as during transportation and storage.

10) Output capacitor
If a large capacitor is connected between the output pin and VEE pin, current from the charged capacitor will flow into the output pin and may destroy the IC when the VCC pin is shorted to ground or pulled down to 0V. Use a capacitor smaller than 0.1uF between output pin and VEE pin.

11) Oscillation by output capacitor
Please pay attention to the oscillation by output capacitor and in designing an application of negative feedback loop circuit with these ICs.

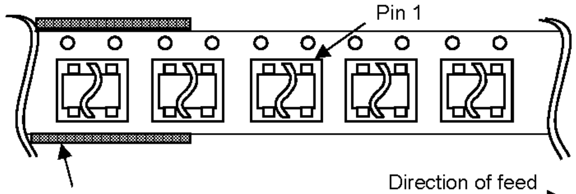
●Physical Dimensions Tape and Reel Information

Package Name	SSOP5

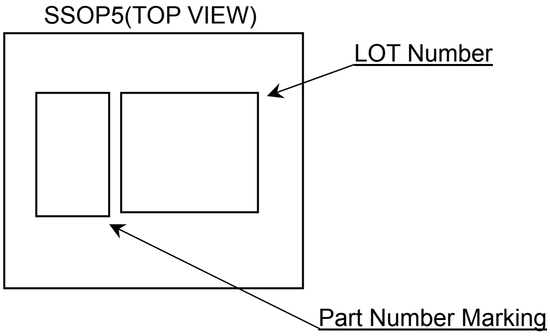


< Tape and Reel Information >

Tape	Embossed carrier tape
Quantity	3000pcs
Direction of feed	TR (The direction is the 1pin of product is at the upper right when you hold reel on the left hand and you pull out the tape on the right hand)

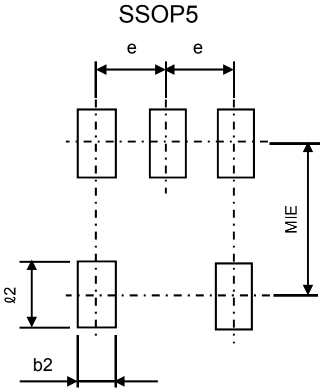


●Marking Diagram



Product Name		Package Type	Marking
LM7101	G	SSOP5	L0

●Land Pattern data



All dimensions in mm

PKG	Land Pitch e	Land Space MIE	Land Length ≧ℓ 2	Land Width b2
SSOP5	0.95	2.4	1.0	0.6

●Revision History

Date	Revision	Changes
12.APR.2013	001	New Release

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Precaution on using ROHM Products

1. Our Products are designed and manufactured for application in ordinary electronic equipments (such as AV equipment, OA equipment, telecommunication equipment, home electronic appliances, amusement equipment, etc.). If you intend to use our Products in devices requiring extremely high reliability (such as medical equipment (Note 1), transport equipment, traffic equipment, aircraft/spacecraft, nuclear power controllers, fuel controllers, car equipment including car accessories, safety devices, etc.) and whose malfunction or failure may cause loss of human life, bodily injury or serious damage to property ("Specific Applications"), please consult with the ROHM sales representative in advance. Unless otherwise agreed in writing by ROHM in advance, ROHM shall not be in any way responsible or liable for any damages, expenses or losses incurred by you or third parties arising from the use of any ROHM's Products for Specific Applications.

(Note1) Medical Equipment Classification of the Specific Applications

JAPAN	USA	EU	CHINA
CLASSⅢ	CLASSⅢ	CLASSⅡb	CLASSⅢ
CLASSⅣ		CLASSⅢ	

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   [a] Use of our Products in any types of liquid, including water, oils, chemicals, and organic solvents
   [b] Use of our Products outdoors or in places where the Products are exposed to direct sunlight or dust
   [c] Use of our Products in places where the Products are exposed to sea wind or corrosive gases, including Cl_2, H_2S, NH_3, SO_2, and NO_2
   [d] Use of our Products in places where the Products are exposed to static electricity or electromagnetic waves
   [e] Use of our Products in proximity to heat-producing components, plastic cords, or other flammable items
   [f] Sealing or coating our Products with resin or other coating materials
   [g] Use of our Products without cleaning residue of flux (even if you use no-clean type fluxes, cleaning residue of flux is recommended); or Washing our Products by using water or water-soluble cleaning agents for cleaning residue after soldering
   [h] Use of the Products in places subject to dew condensation

4. The Products are not subject to radiation-proof design.

5. Please verify and confirm characteristics of the final or mounted products in using the Products.

6. In particular, if a transient load (a large amount of load applied in a short period of time, such as pulse. is applied, confirmation of performance characteristics after on-board mounting is strongly recommended. Avoid applying power exceeding normal rated power; exceeding the power rating under steady-state loading condition may negatively affect product performance and reliability.

7. De-rate Power Dissipation (Pd) depending on Ambient temperature (Ta). When used in sealed area, confirm the actual ambient temperature.

8. Confirm that operation temperature is within the specified range described in the product specification.

9. ROHM shall not be in any way responsible or liable for failure induced under deviant condition from what is defined in this document.

Precaution for Mounting / Circuit board design

1. When a highly active halogenous (chlorine, bromine, etc.) flux is used, the residue of flux may negatively affect product performance and reliability.

2. In principle, the reflow soldering method must be used on a surface-mount products, the flow soldering method must be used on a through hole mount products. If the flow soldering method is preferred on a surface-mount products, please consult with the ROHM representative in advance.

For details, please refer to ROHM Mounting specification

Precautions Regarding Application Examples and External Circuits

1. If change is made to the constant of an external circuit, please allow a sufficient margin considering variations of the characteristics of the Products and external components, including transient characteristics, as well as static characteristics.

2. You agree that application notes, reference designs, and associated data and information contained in this document are presented only as guidance for Products use. Therefore, in case you use such information, you are solely responsible for it and you must exercise your own independent verification and judgment in the use of such information contained in this document. ROHM shall not be in any way responsible or liable for any damages, expenses or losses incurred by you or third parties arising from the use of such information.

Precaution for Electrostatic

This Product is electrostatic sensitive product, which may be damaged due to electrostatic discharge. Please take proper caution in your manufacturing process and storage so that voltage exceeding the Products maximum rating will not be applied to Products. Please take special care under dry condition (e.g. Grounding of human body / equipment / solder iron, isolation from charged objects, setting of Ionizer, friction prevention and temperature / humidity control).

Precaution for Storage / Transportation

1. Product performance and soldered connections may deteriorate if the Products are stored in the places where:
   [a] the Products are exposed to sea winds or corrosive gases, including Cl2, H2S, NH3, SO2, and NO2
   [b] the temperature or humidity exceeds those recommended by ROHM
   [c] the Products are exposed to direct sunshine or condensation
   [d] the Products are exposed to high Electrostatic

2. Even under ROHM recommended storage condition, solderability of products out of recommended storage time period may be degraded. It is strongly recommended to confirm solderability before using Products of which storage time is exceeding the recommended storage time period.

3. Store / transport cartons in the correct direction, which is indicated on a carton with a symbol. Otherwise bent leads may occur due to excessive stress applied when dropping of a carton.

4. Use Products within the specified time after opening a humidity barrier bag. Baking is required before using Products of which storage time is exceeding the recommended storage time period.

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QR code printed on ROHM Products label is for ROHM's internal use only.

Precaution for Disposition

When disposing Products please dispose them properly using an authorized industry waste company.

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