Operational Amplifiers

Low Noise Operational Amplifiers

BA4558xxx, BA4558Rxxx

Pb Free
ROHM Electronic Components

RoHS
Directive Compliance

●General Description

Normal BA4558 and high-reliability BA4558R integrate two independent Op-Amps on a single chip Especially, this series is suitable for any audio applications due to low noise and low distortion characteristics and are usable for other many applications by wide operating supply voltage range.BA4558R is high-reliability products with extended operating temperature range and high ESD tolerance.

●Features

■ High voltage gain, low noise, low distortion
■ Wide operating supply voltage
■ Internal ESD protection
■ Wide operating temperature Range

●Packages

	W(Typ.) x D(Typ.) x H(Max.)
MSOP8	2.90mm x 4.00mm x 0.90mm
SSOP-B8	3.00mm x 6.40mm x 1.35mm
SOP8	5.00mm x 6.20mm x 1.71mm
TSSOP-B8	3.00mm x 6.40mm x 1.20mm
SOP-J8	4.90mm x 6.00mm x 1.65mm

●Key Specification

■ Wide Operating Supply Voltage
  (split supply):±4.0V to ±15V
■ Wide Temperature Range: BA4558: -40°C to +85°C
                           BA4558R: -40°C to +105°C
■ High Slew Rate: 1V/μs(Typ.)
■ Total Harmonic Distortion :   0.005%(Typ.)
■ Input Referred Noise Voltage : $12\,nV/\sqrt{Hz}$ (Typ.)

●Selection Guide

Maximum Operation Temperature

| Normal | Dual | Slew Rate 1V/μs | +85°C BA4558F BA4558FV BA4558FVT BA4558FVM BA4558FJ |

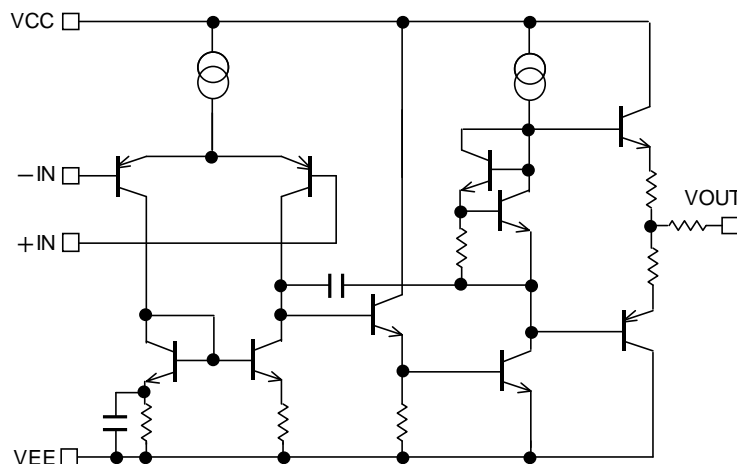| High Reliability | Dual | Slew Rate 1V/μs | +105°C BA4558RF BA4558RFV BA4558RFVT BA4558RFVM BA4558RFJ |

●Block Diagram

Fig. 1 Simplified schematic

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

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●**Pin Configuration(TOP VIEW)**

OUT1 — 1	8 — VCC
−IN1 — 2	7 — OUT2
+IN1 — 3	6 — −IN2
VEE — 4	5 — +IN2

SOP8	SSOP−B8	TSSOP−B8	MSOP8	SOP−J8
BA4558F BA4558RF	BA4558FV BA4558RFV	BA4558FVT BA4558RFVT	BA4558FVM BA4558RFVM	BA4558FJ BA4558RFJ

Package				
SOP8	SSOP-B8	TSSOP-B8	MSOP8	SOP-J8
BA4558F BA4558RF	BA4558FV BA4558RFV	BA4558FVT BA4558RFVT	BA4558FVM BA4558RFVM	BA4558FJ BA4558RFJ

●**Ordering Information**

B	A	4	5	5	8	x	x	x	x	-	x x

Part Number
BA4558xxx
BA4558Rxxx

Package
F: SOP8
FV: SSOP-B8
FJ: SOP-J8
FVT: TSSOP-B8
FVM: MSOP8

Packaging and forming specification
E2: Embossed tape and reel
      (SOP8/SSOP-B8/TSSOP-B8/SOP-J8)
TR: Embossed tape and reel
      (MSOP8)

●**Line-up**

Topr	Operating Supply Voltage (split supply)	Supply Current (Typ.)	Slew Rate (Typ.)	Package		Orderable Part Number
-40°C to +85°C	±4.0V to ±15.0V	3mA	1V/µs	SOP8	Reel of 2500	BA4558F-E2
				SSOP-B8	Reel of 2500	BA4558FV-E2
				TSSOP-B8	Reel of 3000	BA4558FVT-E2
				MSOP8	Reel of 3000	BA4558FVM-TR
				SOP-J8J	Reel of 2500	BA4558FJ-E2
-40°C to +105°C				SOP8	Reel of 2500	BA4558RF-E2
				SSOP-B8	Reel of 2500	BA4558RFV-E2
				TSSOP-B8	Reel of 3000	BA4558RFVT-E2
				MSOP8	Reel of 3000	BA4558RFVM-TR
				SOP-J8	Reel of 2500	BA4558RFJ-E2

●**Absolute Maximum Ratings** (Ta=25℃)
○BA4558, BA4558R

Parameter	Symbol		Ratings		Unit
			BA4558	BA4558R	
Supply Voltage	VCC-VEE		+36		V
Power dissipation	Pd	SOP8	552[*1*5]	690[*1*5]	mW
		SSOP-B8	500[*2*5]	625[*2*5]	
		TSSOP-B8	500[*2*5]	625[*2*5]	
		MSOP8	470[*3*5]	587[*3*5]	
		SOP-J8	540[*4*5]	675[*4*5]	
Differential Input Voltage[*5]	Vid		VCC-VEE	+36	V
Input common-mode voltage range	Vicm		VEE to VCC	(VEE-0.3) to VEE+36	V
Operating Supply Voltage	Vopr		+8 to +30 (±4 to ±15)		V
Operating Temperature	Topr		-40 to +85	-40 to +105	℃
Storage Temperature	Tstg		-55 to +125	-55 to +150	℃
Maximum Junction Temperature	Tjmax		+125	+150	℃

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℃ reduce 5.52mW.
*2   To use at temperature above Ta＝25℃ reduce 5mW.
*3   To use at temperature above Ta＝25℃ reduce 4.7mW.
*4   To use at temperature above Ta＝25℃ reduce 5.4mW.
*5   Mounted on a FR4 glass epoxy PCB(70mm×70mm×1.6mm).
*6   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.

●**Electrical Characteristics**

○BA4558 (Unless otherwise specified VCC=+15V, VEE=-15V)

Parameter	Symbol	Temperature Range	Limits			Unit	Condition
			Min.	Typ.	Max.		
Input Offset Voltage [*7]	Vio	25℃	-	0.5	6	mV	VOUT=0V
Input Offset Current [*7]	Iio	25℃	-	5	200	nA	VOUT=0V
Input Bias Current [*8]	Ib	25℃	-	60	500	nA	VOUT=0V
Supply Current	ICC	25℃	-	3	6	mA	RL=∞, All Op-Amps, VIN+=0V
Maximum Output Voltage	VOM	25℃	±10	±13	-	V	RL≧2kΩ
		25℃	±12	±14	-		RL≧10kΩ
Large Signal Voltage Gain	AV	25℃	86	100	-	dB	RL≧2kΩ, VOUT=±10V, Vicm=0V
Input Common-mode Voltage Range	Vicm	25℃	±12	±14	-	V	-
Common-mode Rejection Ratio	CMRR	25℃	70	90	-	dB	Ri≦10kΩ
Power Supply Rejection Ratio	PSRR	25℃	76.3	90	-	dB	Ri≦10kΩ
Slew Rate	SR	25℃	-	1	-	V/μs	AV=0dB, RL≧2kΩ
Unity Gain Frequency	ft	25℃	-	2	-	MHz	RL=2kΩ
Total Harmonic Distortion	THD＋N	25℃	-	0.005	-	%	AV=20dB, RL=10kΩ VIN=0.05Vrms, f=1kHz
Input Referred Noise Voltage	Vn	25℃	-	12	-	nV/√Hz	RS=100Ω, Vi=0V, f=1kHz
			-	1.8	-	μVrms	RS=100Ω, Vi=0V, DIN-AUDIO
Channel Separation	CS	25℃	-	105	-	dB	f=1kHz

*7   Absolute value
*8   Current direction: Since first input stage is composed with PNP transistor, input bias current flows out of IC.

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○BA4558R (Unless otherwise specified VCC=+15V, VEE=-15V, Full range -40℃ to +105℃)

Parameter	Symbol	Temperature Range	Limits			Unit	Condition
			Min.	Typ.	Max.		
Input Offset Voltage [*9]	Vio	25℃	-	0.5	6	mV	VOUT=0V
		Full range	-	-	7		
Input Offset Current [*9]	Iio	25℃	-	5	200	nA	VOUT=0V
		Full range	-	-	200		
Input Bias Current [*10]	Ib	25℃	-	60	500	nA	VOUT=0V
		Full range	-	-	800		
Supply Current	ICC	25℃	-	3	6	mA	RL=∞, All Op-Amps, VIN+=0V
		Full range	-	-	6.5		
Maximum Output Voltage	VOM	25℃	±10	±13	-	V	RL≧2kΩ
		Full range	±10	-	-		
		25℃	±12	±14	-		RL≧10kΩ
Large Signal Voltage Gain	AV	25℃	86	100	-	dB	RL≧2kΩ, VOUT=±10V, Vicm=0V
		Full range	83	-	-		
Input Common-mode Voltage Range	Vicm	25℃	±12	±14	-	V	-
		Full range	±12	-	-		
Common-mode Rejection Ratio	CMRR	25℃	70	90	-	dB	Ri≦10kΩ
Power Supply Rejection Ratio	PSRR	25℃	76.5	90	-	dB	Ri≦10kΩ
Slew Rate	SR	25℃	-	1	-	V/µs	AV=0dB, RL=2kΩ CL=100pF
Unity Gain Frequency	ft	25℃	-	2	-	MHz	RL=2kΩ
Total Harmonic Distortion	THD+N	25℃	-	0.005	-	%	AV=20dB, RL=10kΩ VIN=0.05Vrms, f=1kHz
Input Referred Noise Voltage	Vn	25℃	-	12	-	nV/√Hz	RS=100Ω, Vi=0V, f=1kHz
			-	1.8	-	µVrms	RS=100Ω, Vi=0V, DIN-AUDIO
Channel Separation	CS	25℃	-	105	-	dB	R1=100Ω, f=1kHz

*9   Absolute value
*10   Current direction: Since first input stage is composed with PNP transistor, input bias current flows out of 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 assure 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 0V.

2.2　Input offset current (Iio)
　　Indicates the difference of input bias current between non-inverting terminal and inverting terminal.

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　Input common-mode voltage range (Vicm)
　　Indicates the input voltage range where IC operates normally.

2.5　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 fluctuation) / (Input offset fluctuation)

2.6　Circuit current (ICC)
　　Indicates the IC current that flows under specified conditions and no-load steady status.

2.7　Output saturation voltage (VOM)
　　Signifies the voltage range that can be output under specific output conditions.

2.8　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)

2.9　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)

2.10　Channel Separation (CS)
　　Indicates the fluctuation of input offset voltage or that of output voltage with reference to the change of output voltage of driven channel.

2.11　Slew Rate (SR)
　　SR is a parameter that shows movement speed of operational amplifier. It indicates rate of variable output voltage as unit time.

2.12　Transition Frequency (ft)
　　Indicates a frequency where the voltage gain of operational amplifier is 1.

2.13 Total Harmonic Distortion (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.

2.14 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.
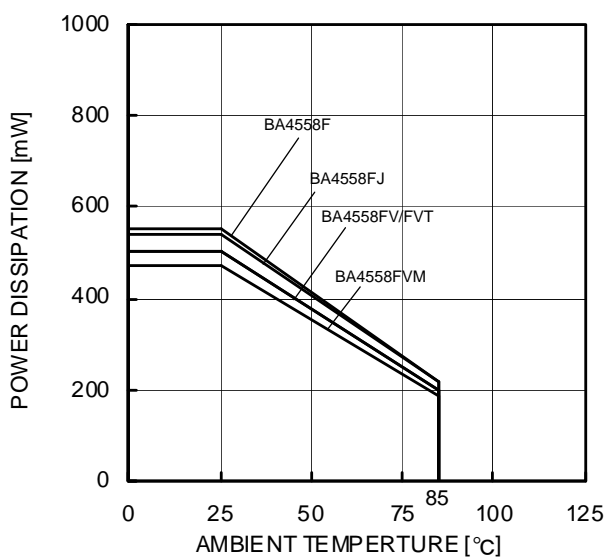
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●**Typical Performance Curves**

○ BA4558

Fig.2
Derating Curve

Fig.3
Supply Current – Supply Voltage

Fig.4
Supply Current – Ambient Temperature

Fig.5
Maximum Output Voltage Swing
- Load Resistance
(VCC/VEE=+15V/-15V, Ta=25℃)

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

○ BA4558

Fig.6
Maximum Output Voltage
– Load Resistance
(VCC/VEE=+15V/-15V, Ta=25℃)

Fig.7
Maximum Output Voltage
- Supply Voltage
(RL=2kΩ, Ta=25℃)

Fig.8
Maximum Output Voltage
- Ambient Temperature
(VCC/VEE=+15V/-15V, RL=2kΩ)
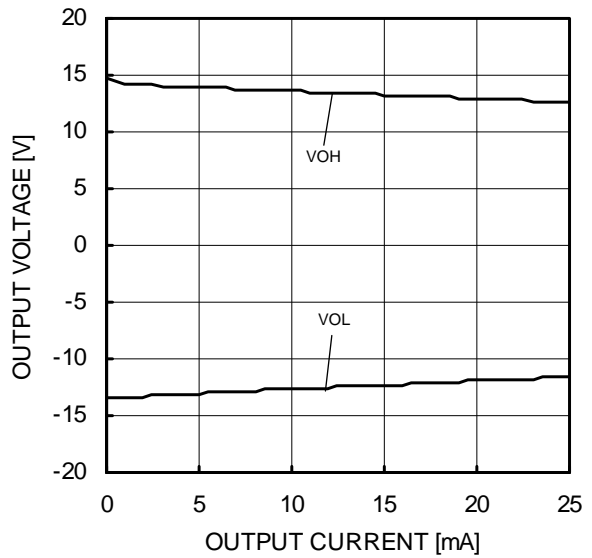
Fig.9
Maximum Output Voltage
- Output Current
(VCC/VEE=+15V/-15V, Ta=25℃)

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

○ BA4558
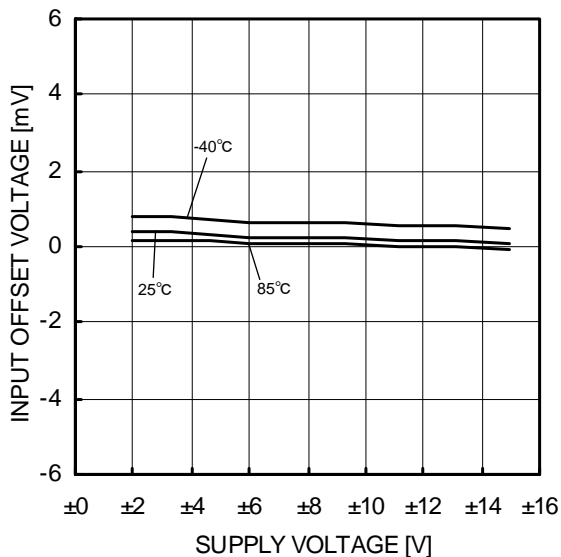
Fig.10
Input Offset Voltage - Supply Voltage
(Vicm=0V, Vout=0V)
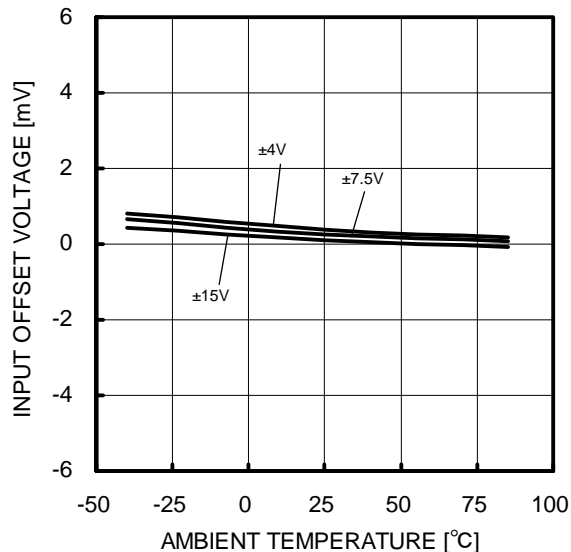
Fig.11
Input Offset Voltage - Ambient Temperature
(Vicm=0V, Vout=0V)
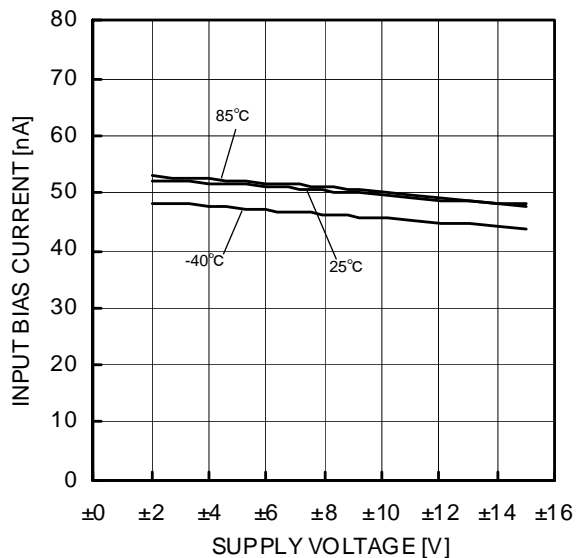
Fig.12
Input Bias Current - Supply Voltage
(Vicm=0V, Vout=0V)
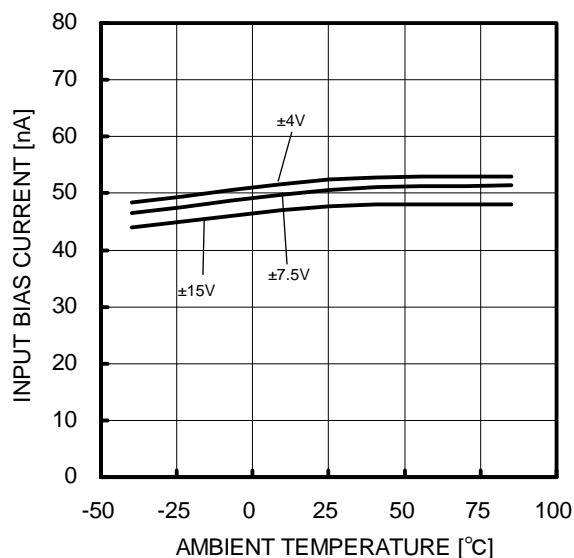
Fig.13
Input Bias Current - Ambient Temperature
(Vicm=0V, Vout=0V)

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

○ BA4558

Fig.14
Input Offset Current - Supply Voltage
(Vicm=0V, Vout=0V)

Fig.15
Input Offset Current -
Ambient Temperature
(Vicm=0V, Vout=0V)

Fig.16
Input Offset Voltage
- Common Mode Input Voltage
(VCC=8V, Vout=4V)

Fig.17
Common Mode Rejection Ratio
- Ambient Temperature
(VCC/VEE=+15V/-15V, Vicm=-12V to +12V)

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

○ BA4558

Fig.18
Power Supply Rejection Ratio
- Ambient Temperature
(VCC/VEE=+4V/-4V to +15V/-15V)

Fig.19
Slew Rate - Supply Voltage
(CL=100pF, RL=2kΩ, Ta=25℃)

Fig.20
Equivalent Input Noise Voltage - Frequency
(VCC/VEE=+15V/-15V, RS=100Ω, Ta=25℃)
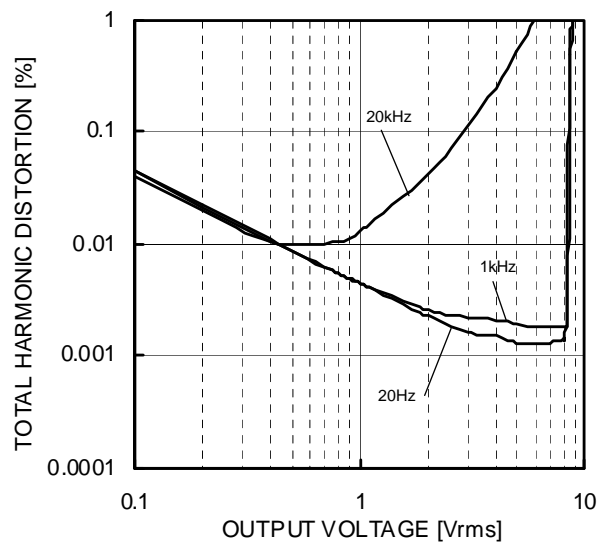
Fig.21
Total Harmonic Distortion -Output Voltage
RL=2kΩ, 80kHz-LPF, Ta=25℃)

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

○ BA4558

Fig.22
Maximum Output Voltage Swing - Frequency
(VCC/VEE=+15V/-15V, RL=2kΩ, Ta=25℃)

Fig.23
Voltage Gain - Frequency
(VCC/VEE=+15V/-15V, AV=40dB, RL=2kΩ, Ta=25℃)

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

○ BA4558R

Fig.24
Derating Curve
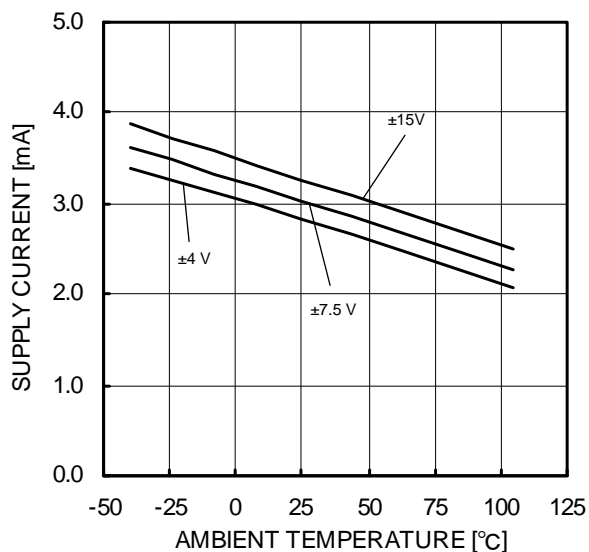

Fig.25
Supply Current - Supply Voltage

Fig.26
Supply Current - Ambient Temperature

Fig.27
Maximum Output Voltage Swing
- Load Resistance
(VCC/VEE=+15V/-15V, Ta=25℃)

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

○ BA4558R

Fig.28
Maximum Output Voltage
- Load Resistance
(VCC/VEE=+15V/-15V, Ta=25℃)

Fig.29
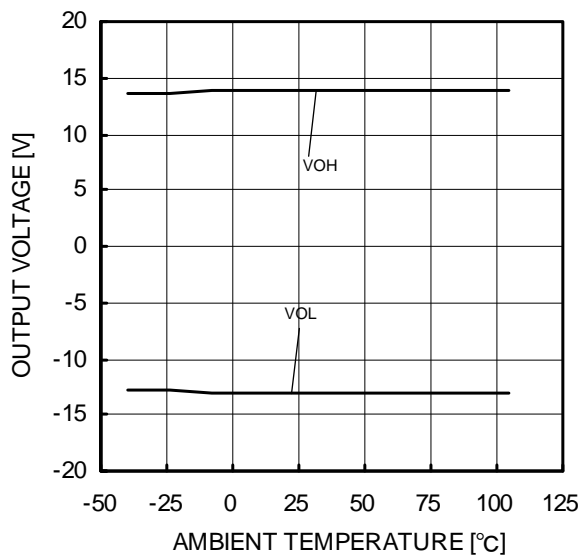Maximum Output Voltage
- Supply Voltage
(RL=2kΩ, Ta=25℃)

Fig.30
Maximum Output Voltage
- Ambient Temperature
(VCC/VEE=+15V/-15V, RL=2kΩ)
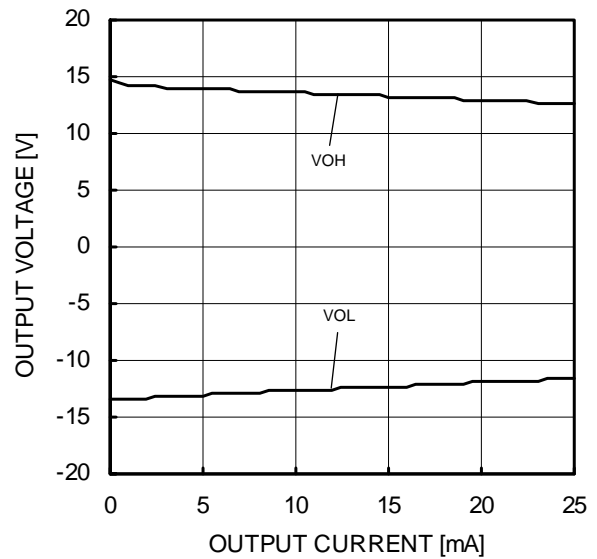

Fig.31
Maximum Output Voltage
- Output Current
(VCC/VEE=+15V/-15V, Ta=25℃)

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

○ BA4558R

Fig.32
Input Offset Voltage - Supply Voltage
(Vicm=0V, Vout=0V)

Fig.33
Input Offset Voltage - Ambient Temperature
(Vicm=0V, Vout=0V)

Fig.34
Input Bias Current - Supply Voltage
(Vicm=0V, Vout=0V)

Fig.35
Input Bias Current - Ambient Temperature
(Vicm=0V, Vout=0V)

(*) The above data is measurement value of typical sample, it is not guaranteed.
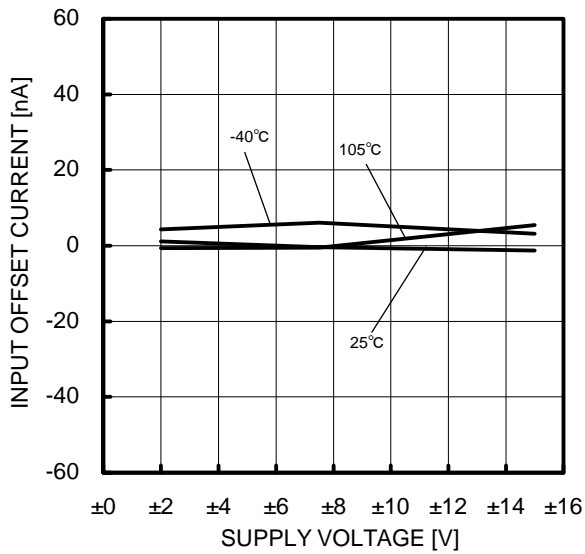
○ BA4558R

Fig.36
Input Offset Current - Supply Voltage
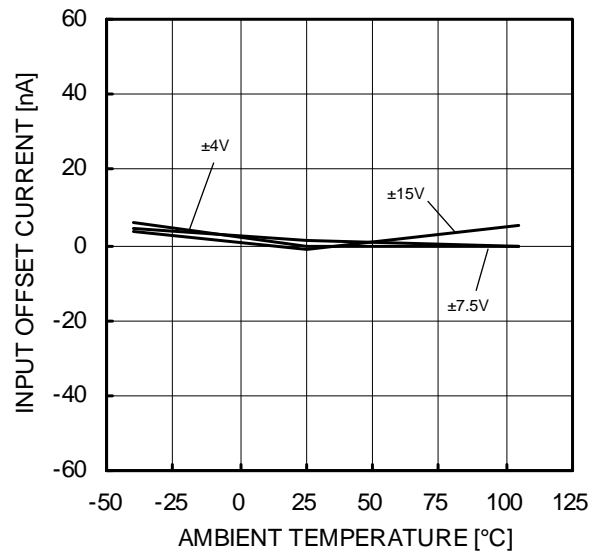(Vicm=0V, Vout=0V)

Fig.37
Input Offset Current - Ambient Temperature
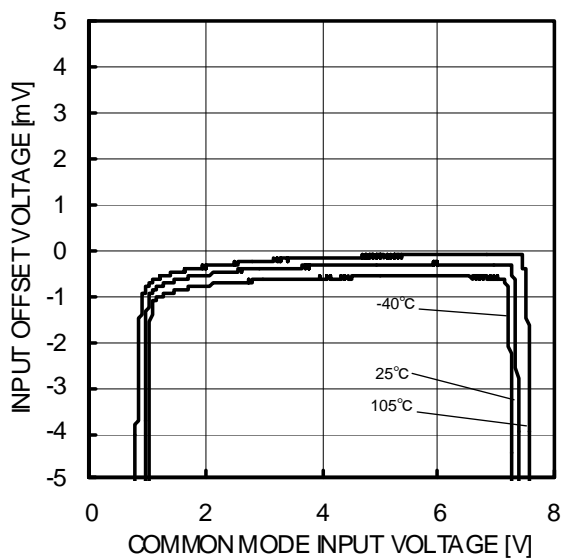(Vicm=0V, Vout=0V)

Fig.38
Input Offset Voltage
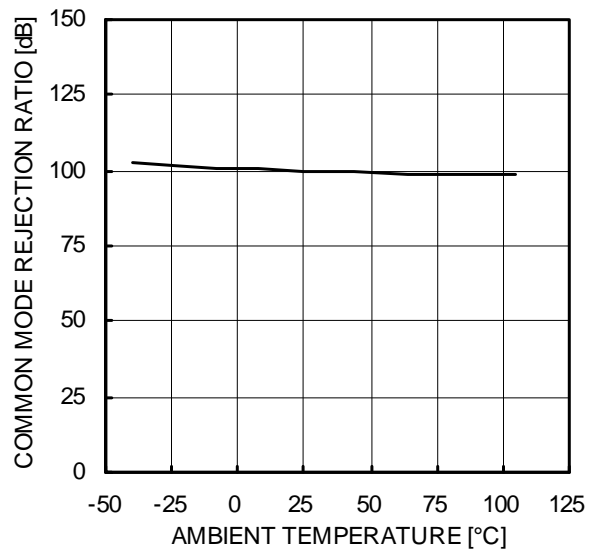- Common Mode Input Voltage
(VCC=8V, Vout=4V)

Fig.39
Common Mode Rejection Ratio
- Ambient Temperature
(VCC/VEE=+15V/-15V, Vicm=-12V to +12V)

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

○ BA4558R

Fig.40
Power Supply Rejection Ratio
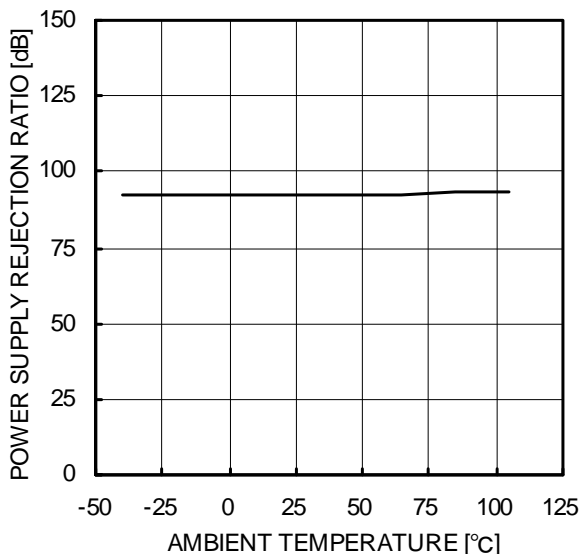- Ambient Temperature
(VCC/VEE=+4V/-4V to +15V/-15V)

Fig.41
Slew Rate - Supply Voltage
(CL=100pF, RL=2kΩ, Ta=25℃)

Fig.42
Equivalent Input Noise Voltage - Frequency
VCC/VEE=+15V/-15V, RS=100Ω, Ta=25℃)
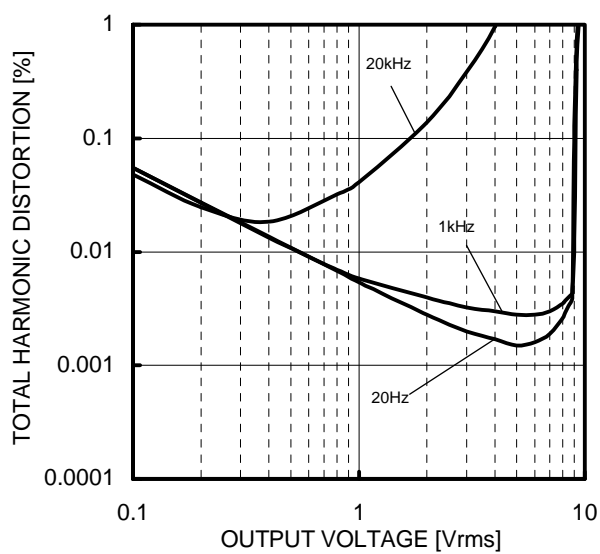
Fig.43
Total Harmonic Distortion - Output Voltage
(VCC/VEE=+15V/-15V,AV=20dB,
RL=2kΩ, 80kHz-LPF, Ta=25℃)

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

○ BA4558R

Fig.44
Maximum Output Voltage Swing – Frequency
(VCC/VEE=+15V/-15V, RL=2kΩ, Ta=25℃)

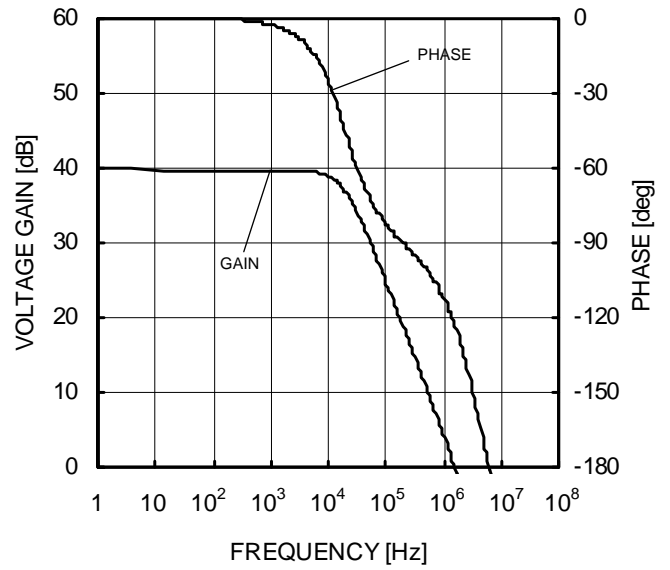Fig.45
Voltage Gain - Frequency
(VCC/VEE=+15V/-15V, AV=40dB, RL=2kΩ, Ta=25℃)

(*) The above data 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	15	-15	0	0	1
Input Offset Current	VF2	OFF	OFF	OFF	15	-15	0	0	2
Input Bias Current	VF3	OFF	ON	OFF	15	-15	0	0	3
	VF4	ON	OFF						
Large Signal Voltage Gain	VF5	ON	ON	ON	15	-15	0	0	4
	VF6				15	-15	0	0	
Common-mode Rejection Ratio (Input common-mode Voltage Range)	VF7	ON	ON	OFF	3	-27	0	0	5
	VF8				27	-3	0	0	
Power Supply Rejection Ratio	VF9	ON	ON	OFF	4	-4	0	0	6
	VF10				15	-15	0	0	

-Calculation-

1. Input Offset Voltage (Vio)

$$Vio = \frac{|VF1|}{1+Rf/Rs} \quad [V]$$

2. Input Offset Current (Iio)

$$Iio = \frac{|VF2 - VF1|}{Ri \times (1+Rf/Rs)} \quad [A]$$

3. Input Bias Current (Ib)

$$Ib = \frac{|VF4 - VF3|}{2 \times Ri \times (1+Rf/Rs)} \quad [A]$$

4. Large Signal Voltage Gain (Av)

$$Av = 20 \times Log\frac{\Delta EK \times (1+Rf/Rs)}{|VF5 - VF6|} \quad [dB]$$

5. Common-mode Rejection Ration (CMRR)

$$CMRR = 20 \times Log\frac{\Delta Vicm \times (1+Rf/Rs)}{|VF8 - VF7|} \quad [dB]$$

6. Power supply rejection ratio (PSRR)

$$PSRR = 20 \times Log\frac{\Delta Vcc \times (1+Rf/Rs)}{|VF10 - VF9|} \quad [dB]$$

Fig. 46 Test circuit1 (one channel only)

Test Circuit 2 Switch Condition

SW No.	SW1	SW2	SW3	SW4	SW5	SW6	SW7	SW8	SW9	SW10	SW11	SW12	SW13	SW14
Supply Current	OFF	OFF	OFF	ON	OFF	ON	OFF	OFF	OFF	OFF	OFF	OFF	OFF	OFF
High Level Output Voltage	OFF	OFF	ON	OFF	OFF	ON	OFF	OFF	ON	OFF	OFF	OFF	ON	OFF
Low Level Output Voltage	OFF	OFF	ON	OFF	OFF	ON	OFF	OFF	OFF	OFF	OFF	OFF	ON	OFF
Slew Rate	OFF	OFF	OFF	ON	OFF	OFF	OFF	ON	ON	ON	OFF	OFF	OFF	OFF
Gain Bandwidth Product	OFF	ON	OFF	OFF	ON	ON	OFF	OFF	ON	ON	OFF	OFF	OFF	OFF
Equivalent Input Noise Voltage	ON	OFF	OFF	OFF	ON	ON	OFF	OFF	OFF	OFF	ON	OFF	OFF	OFF

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Fig.47 Test Circuit 2 (each Op-Amp)

Fig. 48 Slew Rate Input Waveform

Test Circuit 3 Channel Separation

$$CS = 20 \times \log \frac{100 \times VOUT1}{VOUT2}$$

Fig. 49 Test circuit 3
(VCC=+15V, VEE=-15V, R1=1kΩ, R2=100kΩ)

●**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 chip 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 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. Fig.50(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:

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

Derating curve in Fig.50 (b) indicates power that can be consumed by IC with reference to ambient temperature. 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. Fig.51(c),(d) show a derating curve for an example of BA4558, BA4558R.
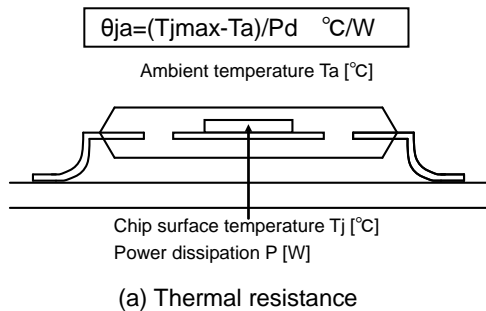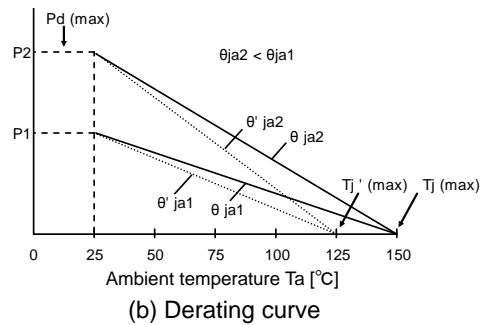

(a) Thermal resistance

(b) Derating curve

Fig. 50Thermal resistance and derating curve

(c)BA4558

(d)BA4558R
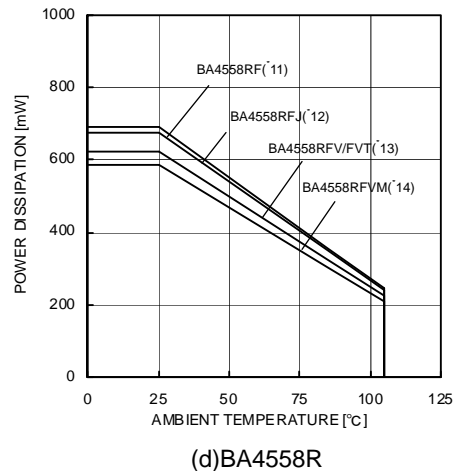
(*11)	(*12)	(*13)	(*14)	Unit
5.52	5.4	5	4.7	mW/℃

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

Fig. 51 Derating curve

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Examples of circuit

○Voltage follower

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

Fig. 52 Voltage follower circuit

○Inverting amplifier

For inverting amplifier, Vi(b) Derating curve voltage gain decided R1 and R2, and phase reversed voltage is outputted.
Vout is shown next formula.
Vout=-(R2/R1)・Vin
Input impedance is R1.

Fig. 53 Inverting amplifier circuit

○Non-inverting amplifier

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

Fig. 54 Non-inverting amplifier circuit

●**Operational Notes**

1) Processing of unused circuit
   It is recommended to apply connection (see the Fig.55) and set the non inverting input terminal at the potential within input common-mode voltage range (Vicm), for any unused circuit.

Fig. 55   The example of application circuit for unused op-amp

2) Input voltage
   Applying (VEE - 0.3) to (VEE + 36)V
   (BA4558R)   to the input terminal is possible without causing deterioration of the electrical characteristics or destruction, irrespective 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) Maximum output voltage
   Because the output voltage range becomes narrow as the output current Increases, design the application with margin by considering changes in electrical characteristics and temperature characteristics.

4) Short-circuit of output terminal
   When output terminal and VCC or VEE terminal are shorted, excessive Output current may flow under some conditions, and heating may destroy IC. It is necessary to connect a resistor as shown in Fig.56, thereby protecting against load shorting.

Fig. 56   The example of output short protection

5) Power supply (split supply / single supply) in used
   Op-amp operates when specified voltage is applied between VCC and VEE. Therefore, the single supply Op-Amp can be used for double supply Op-Amp as well.

6) Power dissipation (Pd)
   Use a thermal design that allows for a sufficient margin in light of the power dissipation (Pd) in actual operating conditions.

7) Short-circuit between pins and wrong mounting
   Pay attention to the assembly direction of the ICs. Wrong mounting direction or shorts between terminals, GND, or other components on the circuits, can damage the IC.

8) Use in strong electromagnetic field
   Using the ICs in strong electromagnetic field can cause operation malfunction.

9) Radiation
   This IC is not designed to be radiation-resistant.

10) IC Handling
    When stress is applied to IC because of deflection or bend of board, the characteristics may fluctuate due to piezoelectric (piezo) effect.

11) Inspection on set board
    During testing, turn on or off the power before mounting or dismounting the board from the test Jig. Do not power up the board without waiting for the output capacitors to discharge. The capacitors in the low output impedance terminal can stress the device. Pay attention to the electro static voltages during IC handling, transportation, and storage.

12) Output capacitor
    When VCC terminal is shorted to VEE (GND) potential and an electric charge has accumulated on the external capacitor, connected to output terminal, accumulated charge may be discharged VCC terminal via the parasitic element within the circuit or terminal protection element. The element in the circuit may be damaged (thermal destruction). When using this IC for an application circuit where there is oscillation, output capacitor load does not occur, as when using this IC as a voltage comparator. Set the capacitor connected to output terminal below 0.1µF in order to prevent damage to IC.
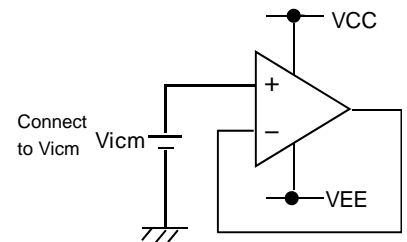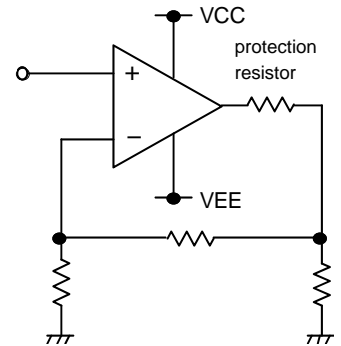
Status of this document
The Japanese version of this document is formal specification. A customer may use this translation version only for a reference to help reading the formal version.
If there are any differences in translation version of this document formal version takes priority.

●Physical Dimensions Tape and Reel Information

SOP8

5.0±0.2
(MAX 5.35 include BURR)
6.2±0.3　4.4±0.2
8 7 6 5
1 2 3 4
0.595
4°⁺⁶°₋₄°
0.3MIN　0.9±0.15
0.17 ⁺⁰·¹₋₀.₀₅
S
1.5±0.1
0.11
1.27
0.42±0.1
0.1 S
(Unit : mm)

<Tape and Reel information>

Tape	Embossed carrier tape
Quantity	2500pcs
Direction of feed	E2 (The direction is the 1pin of product is at the upper left when you hold reel on the left hand and you pull out the tape on the right hand)

Reel　1pin　Direction of feed
＊Order quantity needs to be multiple of the minimum quantity.

SSOP-B8

3.0±0.2
(MAX 3.35 include BURR)
8 7 6 5
1 2 3 4
6.4±0.3　4.4±0.2
0.3MIN
0.15±0.1
S
1.15±0.1
0.1　(0.52)　0.65　0.22 ⁺⁰·⁰⁶₋₀.₀₄
0.1 S
0.08 M
(Unit : mm)

<Tape and Reel information>

Tape	Embossed carrier tape
Quantity	2500pcs
Direction of feed	E2 (The direction is the 1pin of product is at the upper left when you hold reel on the left hand and you pull out the tape on the right hand)

Reel　1pin　Direction of feed
＊Order quantity needs to be multiple of the minimum quantity.

MSOP8

2.9±0.1
(MAX 3.25 include BURR)
8 7 6 5
1 2 3 4
4.0±0.2　2.8±0.1
1PIN MARK
0.475
4°⁺⁶°₋₄°　0.29±0.15　0.6±0.2
0.145 ⁺⁰·⁰⁵₋₀.₀₃
S
0.9MAX
0.75±0.05　0.08±0.05　0.65　0.22 ⁺⁰·⁰⁵₋₀.₀₄
0.08 S
(Unit : mm)

<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)

1pin　Reel　Direction of feed
＊Order quantity needs to be multiple of the minimum quantity.

TSSOP-B8

3.0±0.1
(MAX 3.35 include BURR)
8 7 6 5
1 2 3 4
6.4±0.2　4.4±0.1
1PIN MARK
0.525
4°± 4°　0.5±0.15　1.0±0.2
0.145 ⁺⁰·⁰⁵₋₀.₀₃
S
1.2MAX
1.0±0.05　0.1±0.05　0.65　0.245 ⁺⁰·⁰⁵₋₀.₀₄
0.08 S
0.08 M
(Unit : mm)

<Tape and Reel information>

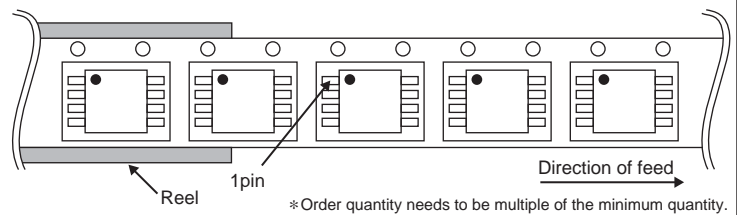| Tape	Embossed carrier tape
Quantity	3000pcs
Direction of feed	E2 (The direction is the 1pin of product is at the upper left when you hold reel on the left hand and you pull out the tape on the right hand)

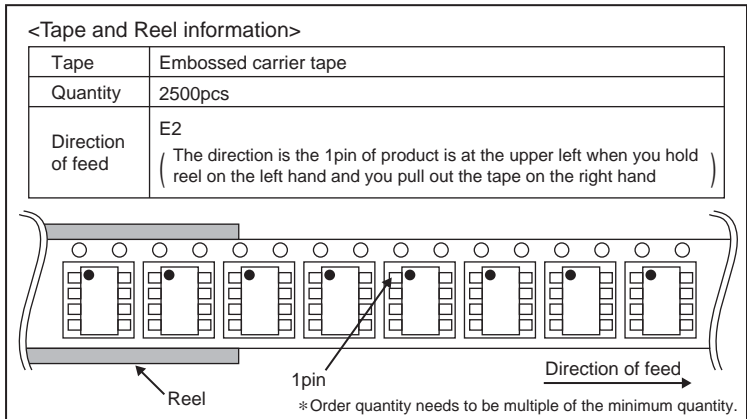Reel　1pin　Direction of feed
＊Order quantity needs to be multiple of the minimum quantity.

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SOP-J8

4.9±0.2
(MAX 5.25 include BURR)

6.0±0.3
3.9±0.2
0.545

4° +6°/−4°
0.45MIN
0.2±0.1
S

1.375±0.1
0.175
1.27
0.42±0.1
0.1 S

(Unit : mm)

<Tape and Reel information>

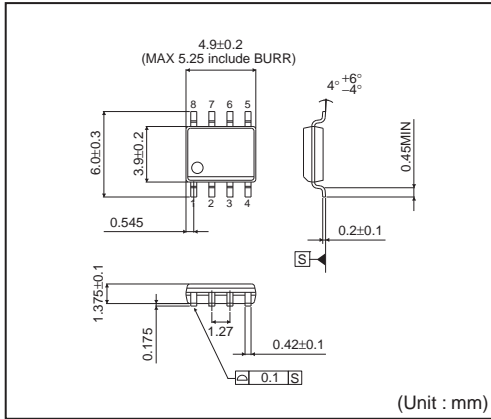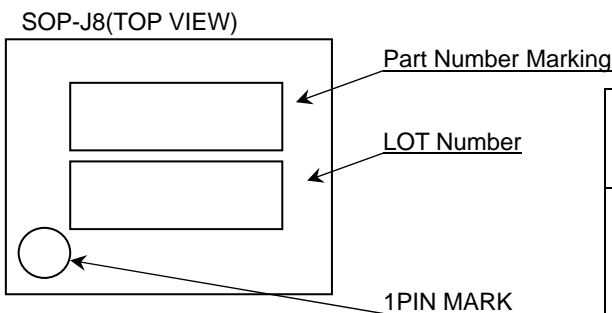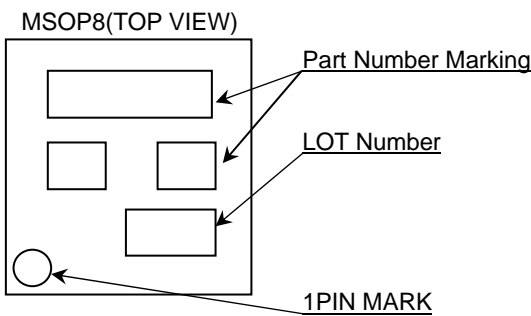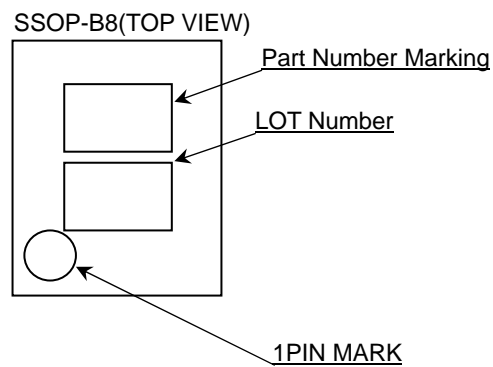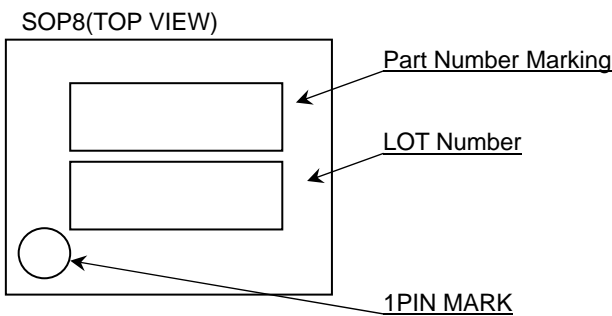| Tape	Embossed carrier tape
Quantity	2500pcs
Direction of feed	E2 (The direction is the 1pin of product is at the upper left when you hold reel on the left hand and you pull out the tape on the right hand)

Reel

1pin

Direction of feed

＊Order quantity needs to be multiple of the minimum quantity.

●**Marking Diagrams**

SOP8(TOP VIEW)

Part Number Marking

LOT Number

1PIN MARK

SSOP-B8(TOP VIEW)

Part Number Marking

LOT Number

1PIN MARK

MSOP8(TOP VIEW)

Part Number Marking

LOT Number

1PIN MARK

TSSOP-B8(TOP VIEW)

Part Number Marking

LOT Number

1PIN MARK

SOP-J8(TOP VIEW)

Part Number Marking

LOT Number

1PIN MARK

Product Name		Package Type	Marking
BA4558	F	SOP8	4558
	FV	SSOP-B8	
	FVT	TSSOP-B8	
	FVM	MSOP8	
	FJ	SOP-J8	
BA4558R	F	SOP8	4558R
	FV	SSOP-B8	
	FVT	TSSOP-B8	
	FVM	MSOP8	
	FJ	SOP-J8	

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JAPAN	USA	EU	CHINA
CLASSⅢ	CLASSⅢ	CLASSⅡb	CLASSⅢ
CLASSⅣ		CLASSⅢ	

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   [h] Use of the Products in places subject to dew condensation

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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.

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

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