
Chipsmall
深圳市津利帝科技有限公司
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采购部

Datasheet

Operational Amplifier

Ground Sense Operational Amplifiers

BA2904YF-LB BA2902YF-LB

General Description

This is the product guarantees long time support in Industrial market.
BA2904YF-LB and BA2902YF-LB are operational amplifiers that can operate in single power supply. It features low power consumption, input common-mode voltage range includes ground, and can operate from +3V to +36V.
Applications are Car Navigation System, Car Audio, Automotive Body and Exteriors.

Features

- Long Time Support a Product for Industrial Applications
- Single or Dual Power Supply Operation
- Wide Operating Supply Voltage
- Common-mode Input Voltage Range includes ground level
- Low Supply Current
- Wide Temperature Range

Applications

- Industrial Equipment
- Current sense application
- Buffer application amplifier
- Active filter

Key Specifications

■ Operating Supply Voltage	
Single Supply :	+3.0V to +36V
Dual Supply :	±1.5V to ±18V
■ Supply Current	
BA2904YF-LB (Dual)	0.5mA(Typ)
BA2902YF-LB (Quad)	0.7mA(Typ)
■ Input Bias Current :	20nA(Typ)
■ Input Offset Current :	2nA(Typ)
■ Operating Temperature Range :	-40°C to +125°C

Packages

	W(Typ) x D(Typ) x H(Max)
SOP8	5.00mm x 6.20mm x 1.71mm
SOP14	8.70mm x 6.20mm x 1.71mm

Simplified Schematic

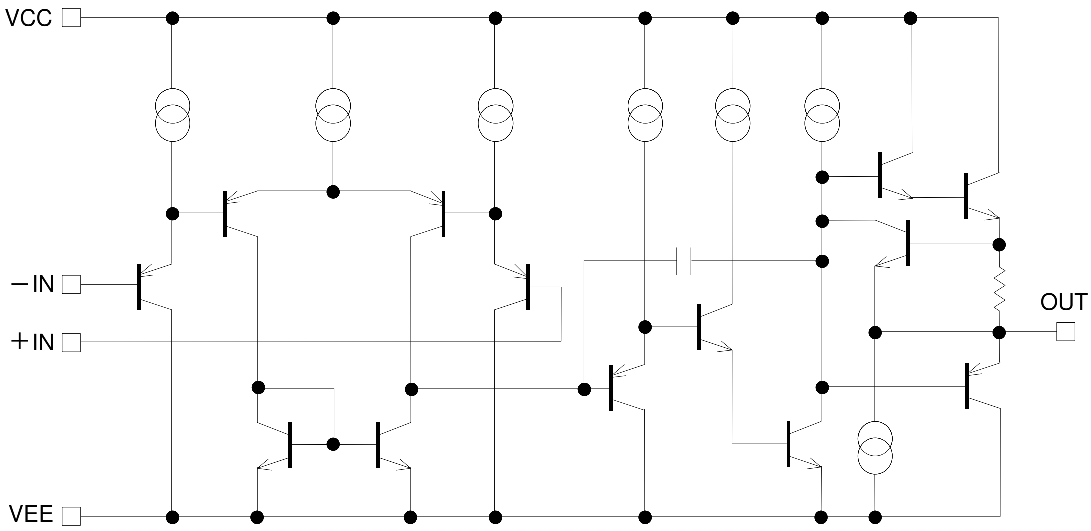
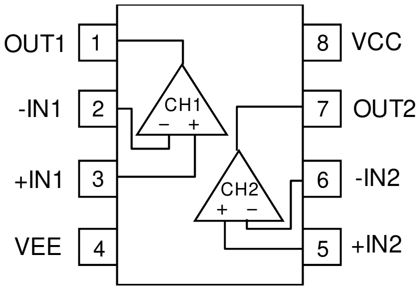


Figure 1. Simplified Schematic (1 Channel Only)

○Product structure : Silicon monolithic integrated circuit ○This product has no designed protection against radioactive rays

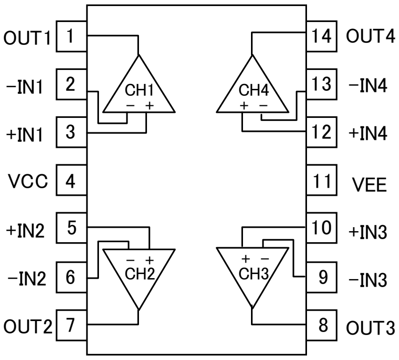
Pin Configuration

BA2904YF-LB : SOP8



Pin No.	Pin Name
1	OUT1
2	-IN1
3	+IN1
4	VEE
5	+IN2
6	-IN2
7	OUT2
8	VCC

BA2902YF-LB : SOP14



Pin No.	Pin Name
1	OUT1
2	-IN1
3	+IN1
4	VCC
5	+IN2
6	-IN2
7	OUT2
8	OUT3
9	-IN3
10	+IN3
11	VEE
12	+IN4
13	-IN4
14	OUT4

SOP8	SOP14
BA2904YF-LB	BA2902YF-LB

Ordering Information

B A 2 9 0 x Y F - LB H2

Parts Number	Package	Product class
BA2904YF BA2902YF	F : SOP8 SOP14	LB for Industrial applications Packaging and forming specification H2: Embossed tape and reel (SOP8/SOP14)

Line-up

Topr	Supply Voltage	Number of Channels	Package		Orderable Part Number
-40°C to +125°C	+3V to +36V	Dual	SOP8	Reel of 250	BA2904YF-LBH2
		Quad	SOP14	Reel of 250	BA2902YF-LBH2

Absolute Maximum Ratings (T_A=25°C)

Parameter	Symbol		Ratings		Unit
			BA2904YF-LB	BA2902YF-LB	
Supply Voltage	VCC-VEE		+36		V
Power Dissipation	P_D	SOP8	0.77 (Note 1,3)	-	W
		SOP14	-	0.56 (Note 2,3)	
Differential Input Voltage(Note 4)	V_{ID}		+36		V
Input Common-mode Voltage Range	V_{ICM}		(VEE-0.3) to (VEE+36)		V
Input Current(Note 5)	I_I		-10		mA
Operating Supply Voltage	V_{opr}		+3.0 to +36 (±1.5 to ±18)		V
Operating Temperature Range	T_{opr}		-40 to +125		°C
Storage Temperature Range	T_{stg}		-55 to +150		°C
Maximum Junction Temperature	T_{Jmax}		+150		°C

(Note 1) To use at temperature above T_A=25°C reduce 6.2mW/°C.
(Note 2) To use at temperature above T_A=25°C reduce 4.5mW/°C.
(Note 3) Mounted on a FR4 glass epoxy PCB 70mm×70mm×1.6mm (copper foil area less than 3%).
(Note 4) 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.
(Note 5) An excessive input current will flow when input voltages of less than VEE-0.6V are applied. The input current can be set to less than the rated current by adding a limiting resistor.

Caution: Operating the IC over the absolute maximum ratings may damage the IC. The damage can either be a short circuit between pins or an open circuit between pins and the internal circuitry. Therefore, it is important to consider circuit protection measures, such as adding a fuse, in case the IC is operated over the absolute maximum ratings.

Electrical Characteristics

○BA2904YF-LB (Unless otherwise specified VCC=+5V, VEE=0V)

Parameter	Symbol	Temperature Range	Limit			Unit	Conditions
			Min	Typ	Max		
Input Offset Voltage(Note 6,7)	V_{IO}	25°C	-	2	7	mV	E_K=-1.4V
		Full range	-	-	10		VCC=5 to 30V, E_K=-1.4V
Input Offset Voltage Drift	$\Delta V_{IO}/\Delta T$	-	-	±7	-	μV/°C	E_K=-1.4V
Input Offset Current(Note 6,7)	I_{IO}	25°C	-	2	50	nA	E_K=-1.4V
		Full range	-	-	200		
Input Offset Current Drift	$\Delta I_{IO}/\Delta T$	-	-	±10	-	pA/°C	E_K=-1.4V
Input Bias Current(Note 7,8)	I_B	25°C	-	20	250	nA	E_K=-1.4V
		Full range	-	-	250		
Supply Current(Note 7)	I_{CC}	25°C	-	0.5	1.2	mA	R_L=∞, All Op-Amps
		Full range	-	-	2		
Maximum Output Voltage(High)(Note 7)	V_{OH}	25°C	3.5	-	-	V	R_L=2kΩ
		Full range	27	28	-		VCC=30V, R_L=10kΩ
Maximum Output Voltage(Low)(Note 7)	V_{OL}	Full range	-	5	20	mV	R_L=∞, All Op-Amps
Large Signal Voltage Gain	A_V	25°C	25	100	-	V/mV	R_L≥2kΩ, VCC=15V E_K=-1.4V to -11.4V
			88	100	-	dB	
Input Common-mode Voltage Range	V_{ICM}	25°C	0	-	VCC-1.5	V	(VCC-VEE)=5V E_K=VEE-1.4V
Common-mode Rejection Ratio	CMRR	25°C	50	80	-	dB	E_K=-1.4V
Power Supply Rejection Ratio	PSRR	25°C	65	100	-	dB	VCC=5 to 30V
Output Source Current (Note 7,9)	I_{SOURCE}	25°C	20	30	-	mA	+IN=1V, -IN=0V OUT=0V, Short Current
		Full range	10	-	-		
Output Sink Current (Note 7,9)	I_{SINK}	25°C	10	20	-	mA	+IN=0V, -IN=1V OUT=5V, Short Current
		Full range	2	-	-		
		25°C	12	40	-	μA	+IN=0V, -IN=1V OUT=200mV
Slew Rate	SR	25°C	-	0.2	-	V/μs	VCC=15V, A_V=0dB R_L=2kΩ, C_L=100pF
Gain Bandwidth Product	GBW	25°C	-	0.5	-	MHz	VCC=30V, R_L=2kΩ C_L=100pF
Input Referred Noise Voltage	V_N	25°C	-	40	-	$nV/\sqrt{Hz}$	VCC=15V, VEE=-15V A_V=40dB, V_{ICM}=0V R_S=100Ω, f=1kHz
Channel Separation	CS	25°C	-	120	-	dB	A_V=40dB, f=1kHz OUT=0.5Vrms

(Note 6) Absolute value
(Note 7) Full range T_A=-40°C to +125°C
(Note 8) Current Direction: Since first input stage is composed with PNP transistor, input bias current flows out of IC.
(Note 9) Under high temperatures, please consider the power dissipation when selecting the output current.
When the output terminal is continuously shorted the output current reduces the internal temperature by flushing.

Electrical Characteristics

○BA2902YF-LB (Unless otherwise specified VCC=+5V, VEE=0V)

Parameter	Symbol	Temperature Range	Limit			Unit	Conditions
			Min	Typ	Max		
Input Offset Voltage (Note 10,11)	V_{IO}	25°C	-	2	7	mV	E_K=-1.4V
		Full range	-	-	10		VCC=5 to 30V, E_K=-1.4V
Input Offset Voltage Drift	$\Delta V_{IO}/\Delta T$	-	-	±7	-	μV/°C	E_K=-1.4V
Input Offset Current (Note 10,11)	I_{IO}	25°C	-	2	50	nA	E_K=-1.4V
		Full range	-	-	200		
Input Offset Current Drift	$\Delta I_{IO}/\Delta T$	-	-	±10	-	pA/°C	E_K=-1.4V
Input Bias Current (Note 11,12)	I_B	25°C	-	20	250	nA	E_K=-1.4V
		Full range	-	-	250		
Supply Current(Note 11)	I_{CC}	25°C	-	0.7	2	mA	R_L=∞, All Op-Amps
		Full range	-	-	3		
Maximum Output Voltage(High)(Note 11)	V_{OH}	25°C	3.5	-	-	V	R_L=2kΩ
		Full range	27	28	-		VCC=30V, R_L=10kΩ
Maximum Output Voltage(Low)(Note 11)	V_{OL}	Full range	-	5	20	mV	R_L=∞, All Op-Amps
Large Signal Voltage Gain	A_V	25°C	25	100	-	V/mV	R_L≥2kΩ, VCC=15V E_K=-1.4V to -11.4V
			88	100	-	dB	
Input Common-mode Voltage Range	V_{ICM}	25°C	0	-	VCC-1.5	V	(VCC-VEE)=5V E_K=VEE-1.4V
Common-mode Rejection Ratio	CMRR	25°C	50	80	-	dB	E_K=-1.4V
Power Supply Rejection Ratio	PSRR	25°C	65	100	-	dB	VCC=5 to 30V
Output Source Current(Note 11,13)	I_{SOURCE}	25°C	20	30	-	mA	+IN=1V, -IN=0V OUT=0V, Short Current
		Full range	10	-	-		
Output Sink Current (Note 11,13)	I_{SINK}	25°C	10	20	-	mA	+IN=0V, -IN=1V OUT=5V, Short Current
		Full range	2	-	-		
		25°C	12	40	-	μA	+IN=0V, -IN=1V OUT=200mV
Slew Rate	SR	25°C	-	0.2	-	V/μs	VCC=15V, A_V=0dB R_L=2kΩ, C_L=100pF
Gain Bandwidth Product	GBW	25°C	-	0.5	-	MHz	VCC=30V, R_L=2kΩ C_L=100pF
Input Referred Noise Voltage	V_N	25°C	-	40	-	$nV/\sqrt{Hz}$	VCC=15V, VEE=-15V A_V=40dB, V_{ICM}=0V R_S=100Ω, f=1kHz
Channel Separation	CS	25°C	-	120	-	dB	A_V=40dB, f=1kHz OUT=0.5Vrms

(Note 10) Absolute value
(Note 11) Full range T_A=-40°C to +125°C
(Note 12) Current Direction: Since first input stage is composed with PNP transistor, input bias current flows out of IC.
(Note 13) Under high temperatures, please consider the power dissipation when selecting the output current.
When the output terminal is continuously shorted the output current reduces the internal temperature by flushing.

Description of Electrical Characteristics

Described below are descriptions of the relevant electrical terms 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 manufacturer's document or general document.

1. Absolute maximum ratings

Absolute maximum rating items indicate 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) Supply Voltage (VCC/VEE)
Indicates the maximum voltage that can be applied between VCC and VEE without deterioration or destruction of characteristics of internal circuit.

(2) Differential Input Voltage (V_{ID})
Indicates the maximum voltage that can be applied between non-inverting and inverting terminals without damaging the IC.

(3) Input Common-mode Voltage Range (V_{ICM})
Indicates the maximum voltage that can be applied to the non-inverting and inverting terminals without deterioration or destruction of electrical characteristics. Input common-mode voltage range of the maximum ratings does not assure normal operation of IC. For normal operation, use the IC within the input common-mode voltage range characteristics.

(4) Operating and Storage Temperature Ranges (T_{opr}, T_{stg})
The operating temperature range indicates the temperature range within which the IC can operate. The higher the ambient temperature, the lower the power consumption of the IC. The storage temperature range denotes the range of temperatures the IC can be stored under without causing excessive deterioration of the electrical characteristics.

(5) Power Dissipation (P_D)
Indicates the power that can be consumed by the IC when mounted on a specific board at the ambient temperature 25°C (normal temperature). As for package product, P_D is determined by the temperature that can be permitted by the IC in the package (maximum junction temperature) and the thermal resistance of the package.

2. Electrical characteristics

(1) Input Offset Voltage (V_{IO})
Indicates the voltage difference between non-inverting terminal and inverting terminals. It can be translated into the input voltage difference required for setting the output voltage at 0 V.

(2) Input Offset Voltage Drift ($\triangle V_{IO}/\triangle T$)
Denotes the ratio of the input offset voltage fluctuation to the ambient temperature fluctuation.

(3) Input Offset Current (I_{IO})
Indicates the difference of input bias current between the non-inverting and inverting terminals.

(4) Input Offset Current Drift ($\triangle I_{IO} /\triangle T$)
Denotes the ratio of the input offset current fluctuation to the ambient temperature fluctuation.

(5) Input Bias Current (I_B)
Indicates the current that flows into or out of the input terminal. It is defined by the average of input bias currents at the non-inverting and inverting terminals.

(6) Supply Current (I_{CC})
Indicates the current that flows within the IC under specified no-load conditions.

(7) Maximum Output Voltage(High) / Maximum Output Voltage(Low) (V_{OH}/V_{OL})
Indicates the voltage range of the output under specified load condition. It is typically divided into high-level output voltage and low-level output voltage. High-level output voltage indicates the upper limit of output voltage while Low-level output voltage indicates the lower limit.

(8) Large Signal Voltage Gain (A_V)
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.
A_V = (Output voltage) / (Differential Input voltage)

(9) Input Common-mode Voltage Range (V_{ICM})
Indicates the input voltage range where IC normally operates.

(10) Common-mode Rejection Ratio (CMRR)
Indicates the ratio of fluctuation of input offset voltage when the input common mode voltage is changed. It is normally the fluctuation of DC.
CMRR = (Change of Input common-mode voltage) / (Input offset fluctuation)

(11) 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)

(12) Output Source Current/ Output Sink Current (I_{SOURCE} / I_{SINK})
The maximum current that can be output from the IC under specific output conditions. The output source current indicates the current flowing out from the IC, and the output sink current indicates the current flowing into the IC.

(13) Slew Rate (SR)
Indicates the ratio of the change in output voltage with time when a step input signal is applied.

(14) Gain Bandwidth Product (GBW)
The product of the open-loop voltage gain and the frequency at which the voltage gain decreases 6dB/octave.

(15) Input Referred Noise Voltage (V_N)
Indicates a noise voltage generated inside the operational amplifier equivalent by ideal voltage source connected in series with input terminal.

(16) Channel Separation (CS)
Indicates the fluctuation in the output voltage of the driven channel with reference to the change of output voltage of the channel which is not driven.

Typical Performance Curves

○BA2904YF-LB

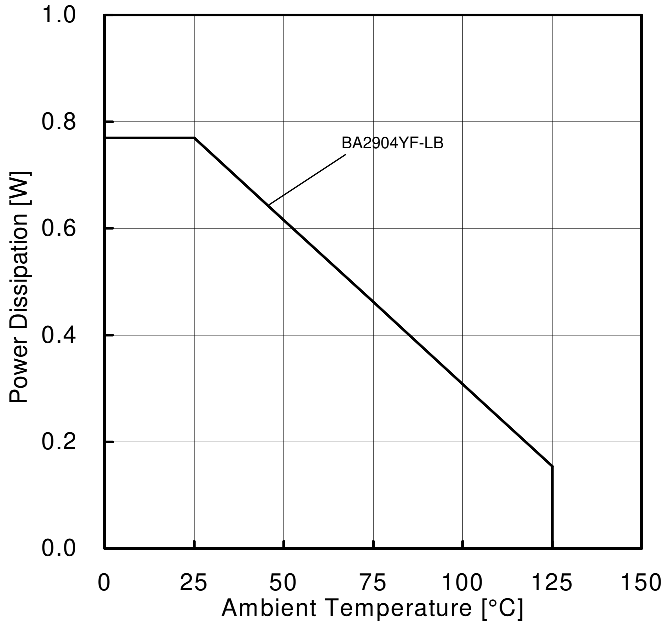


Figure 2.
Derating Curve

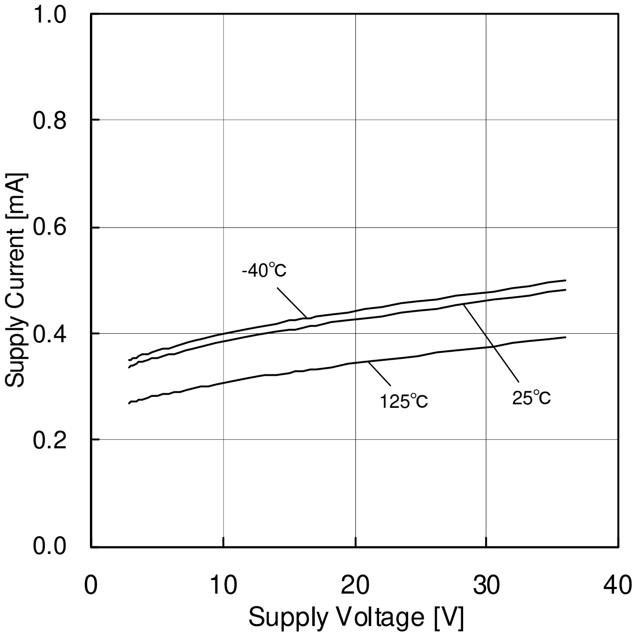


Figure 3.
Supply Current vs Supply Voltage

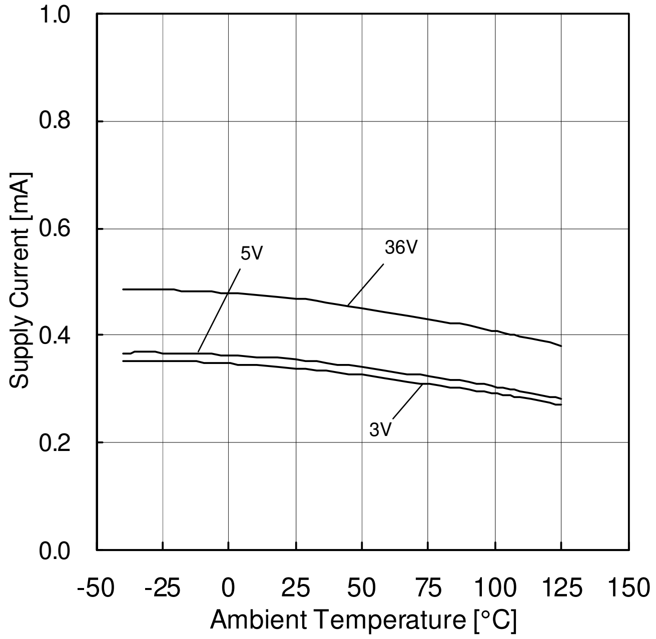


Figure 4.
Supply Current vs Ambient Temperature

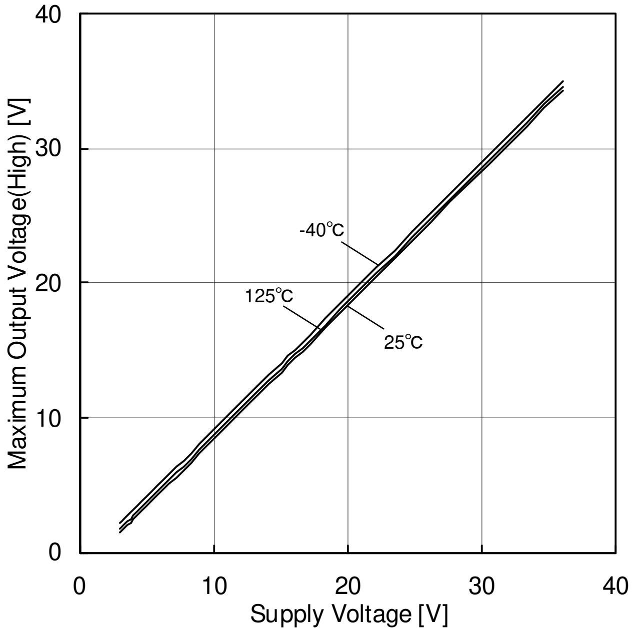


Figure 5.
Maximum Output Voltage(High) vs Supply Voltage
(R_L=10kΩ)

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

○BA2904YF-LB

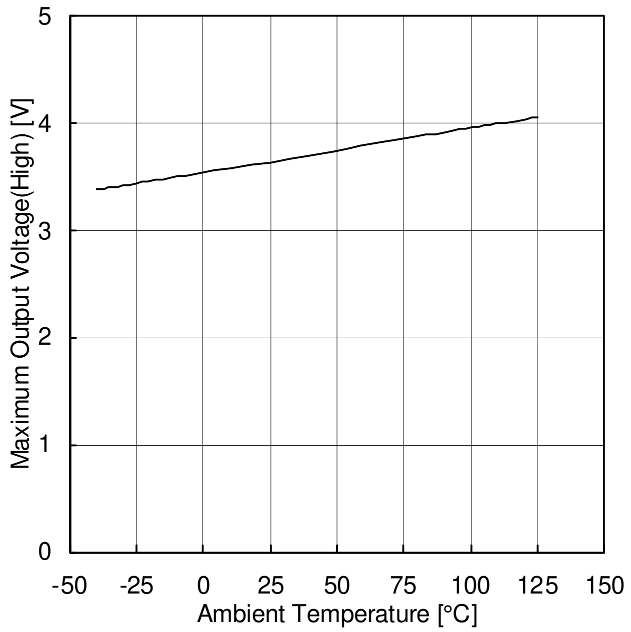


Figure 6.
Maximum Output Voltage(High) vs Ambient Temperature
(VCC=5V, R_L=2kΩ)

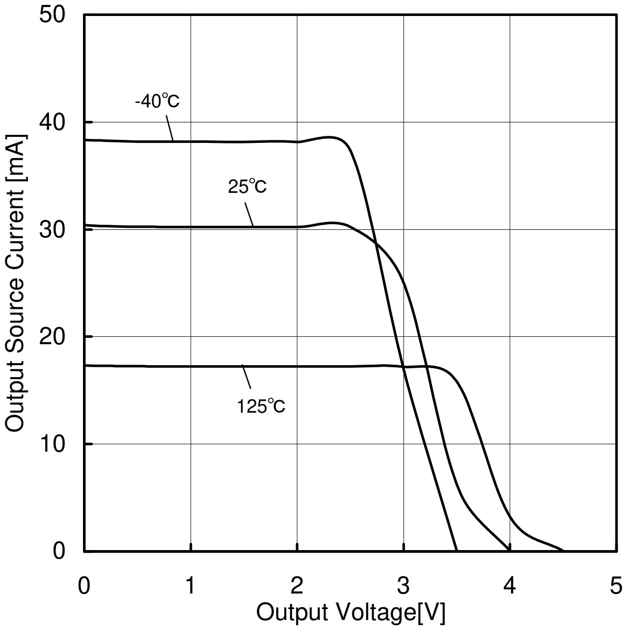


Figure 7.
Output Source Current vs Output Voltage
(VCC=5V)

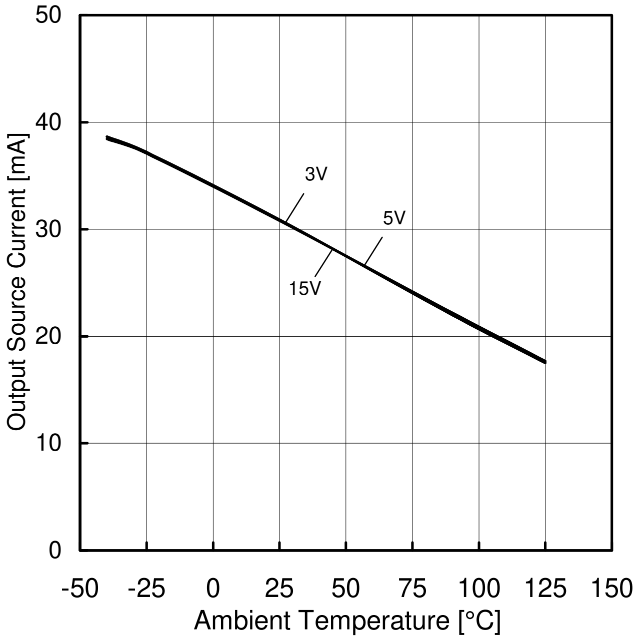


Figure 8.
Output Source Current vs Ambient Temperature
(OUT=0V)

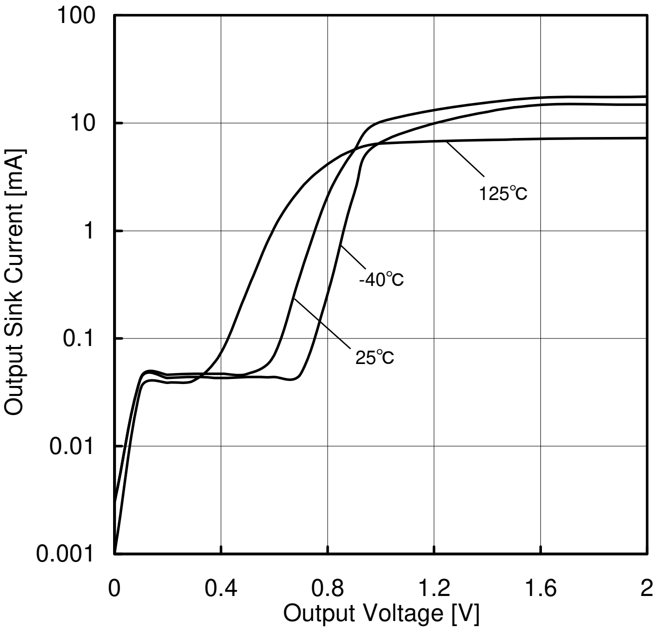


Figure 9.
Output Sink Current vs Output Voltage
(VCC=5V)

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

○BA2904YF-LB

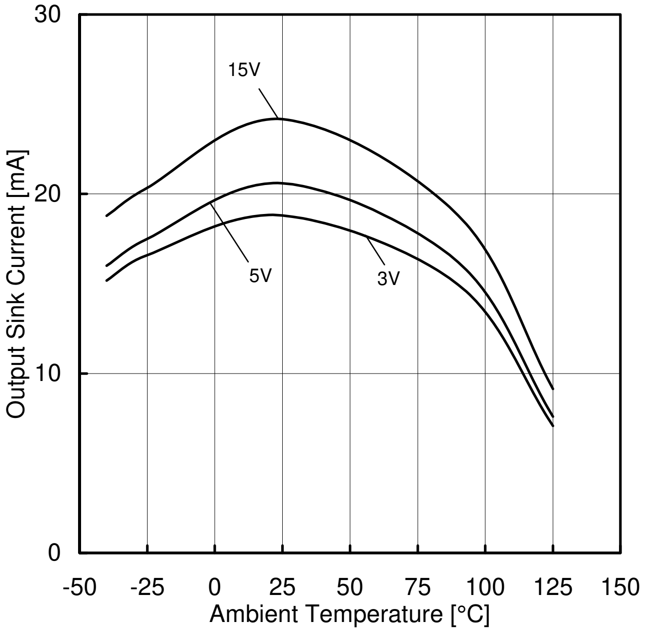


Figure 10.
Output Sink Current vs Ambient Temperature
(OUT=VCC)

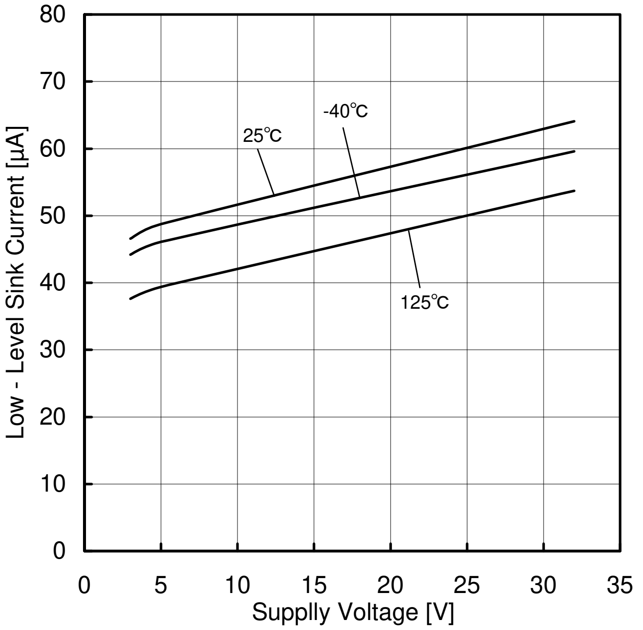


Figure 11.
Low Level Sink Current vs Supply Voltage
(OUT=0.2V)

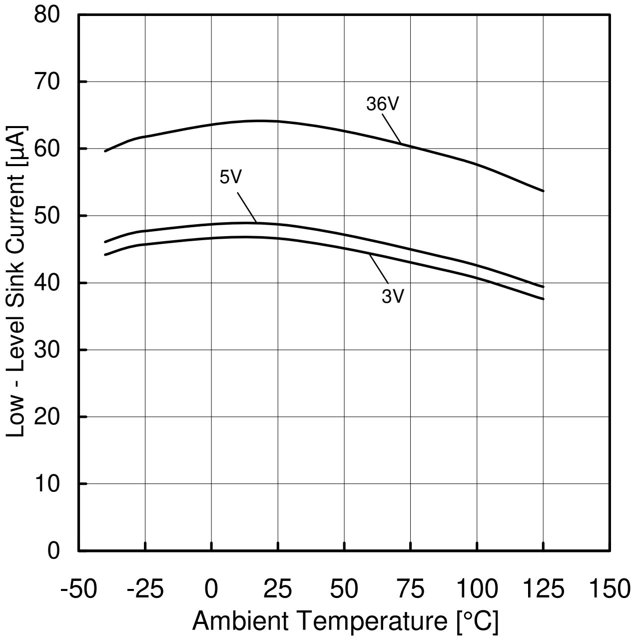


Figure 12.
Low Level Sink Current vs Ambient Temperature
(OUT=0.2V)

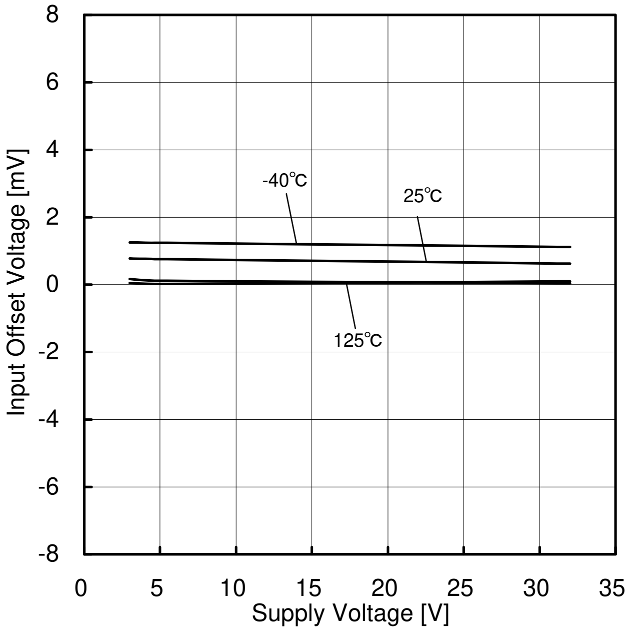


Figure 13.
Input Offset Voltage vs Supply Voltage
(V_{ICM}=0V, E_K=-1.4V)

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

○BA2904YF-LB

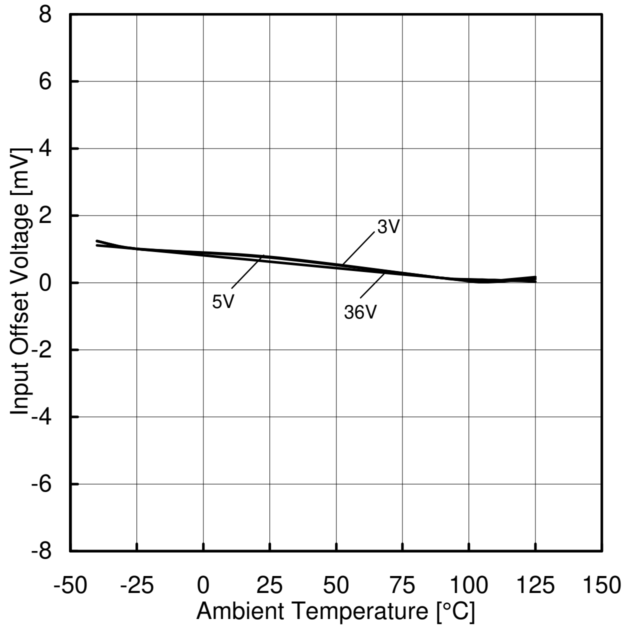


Figure 14.
Input Offset Voltage vs Ambient Temperature
(V_{ICM}=0V, E_K=-1.4V)

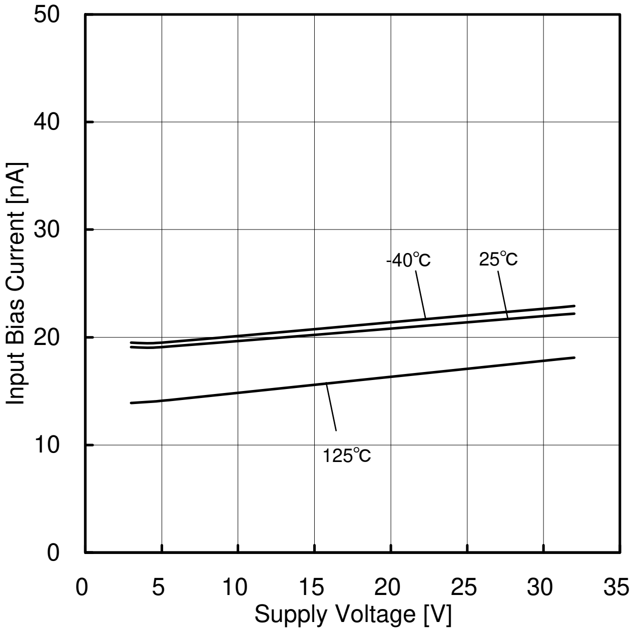


Figure 15.
Input Bias Current vs Supply Voltage
(V_{ICM}=0V, E_K=-1.4V)

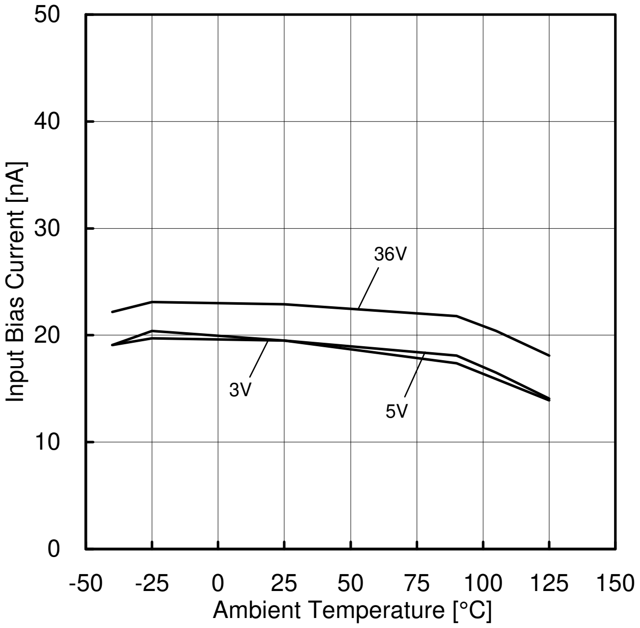


Figure 16.
Input Bias Current vs Ambient Temperature
(V_{ICM}=0V, E_K=-1.4V)

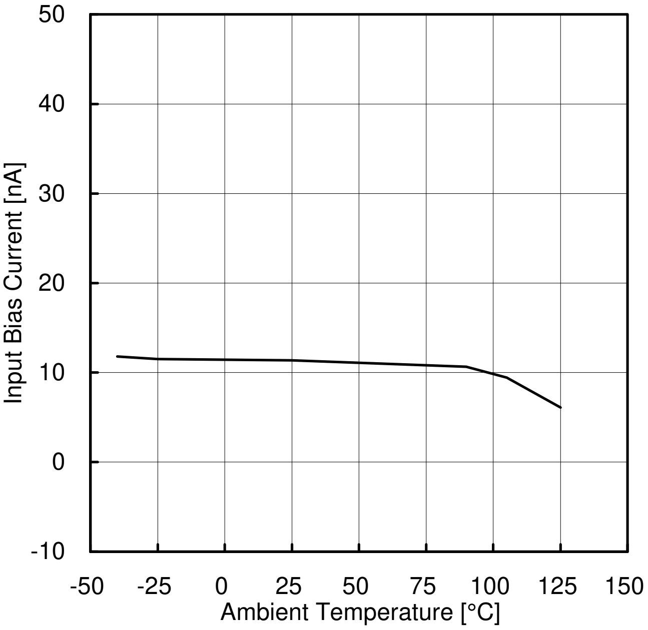


Figure 17.
Input Bias Current vs Ambient Temperature
(VCC=30V, V_{ICM}=28V, E_K=-1.4V)

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

○BA2904YF-LB

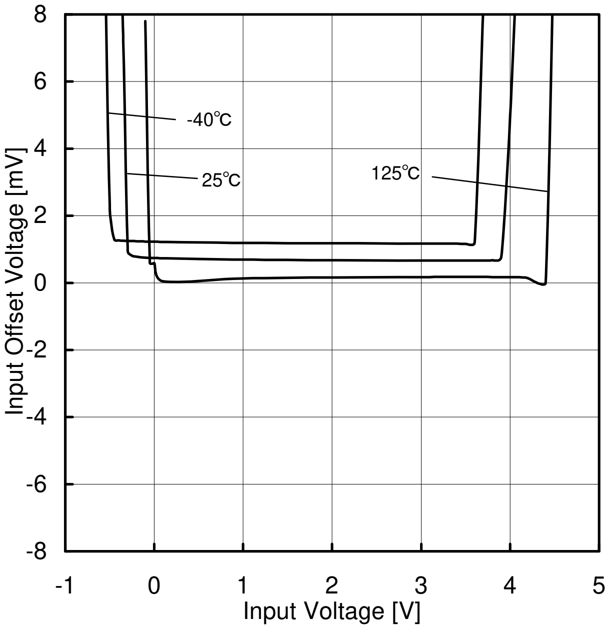


Figure 18.
Input Offset Voltage vs Input Voltage
(VCC=5V)

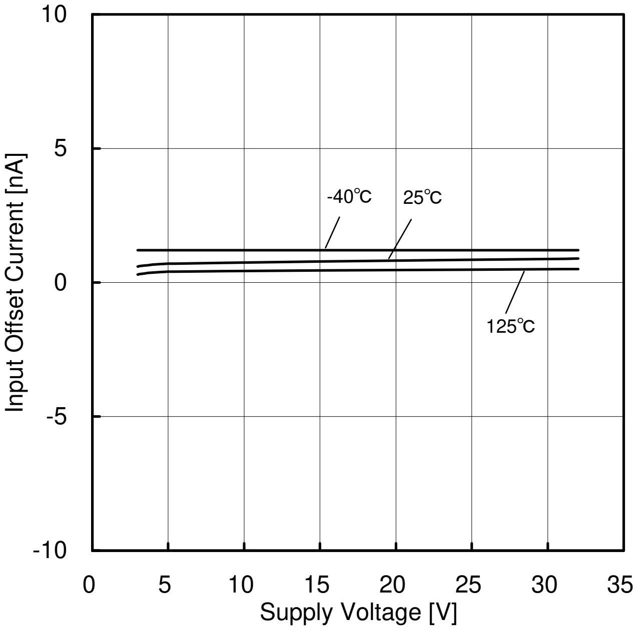


Figure 19.
Input Offset Current vs Supply Voltage
(V_{ICM}=0V, E_K=-1.4V)

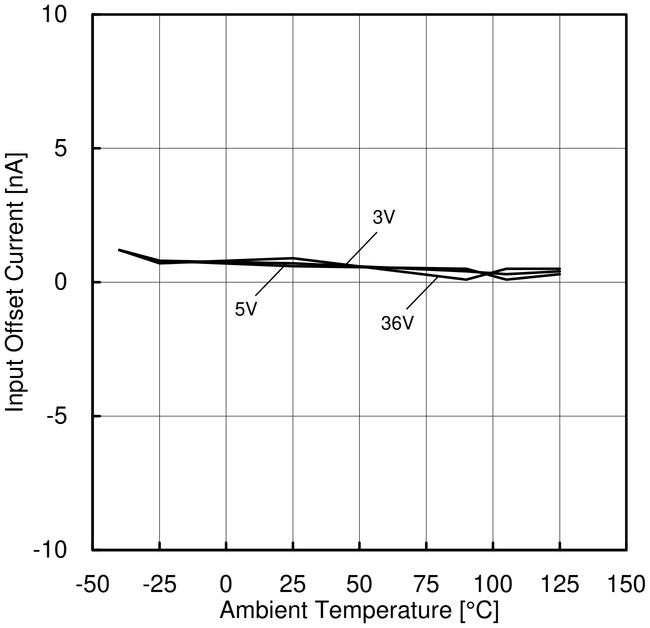


Figure 20.
Input Offset Current vs Ambient Temperature
(V_{ICM}=0V, E_K=-1.4V)

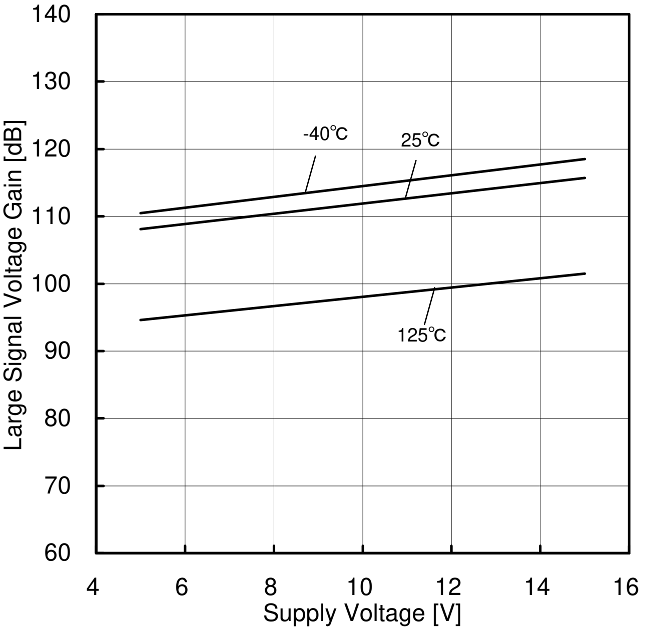


Figure 21.
Large Signal Voltage Gain vs Supply Voltage
(R_L=2kΩ)

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

○BA2904YF-LB

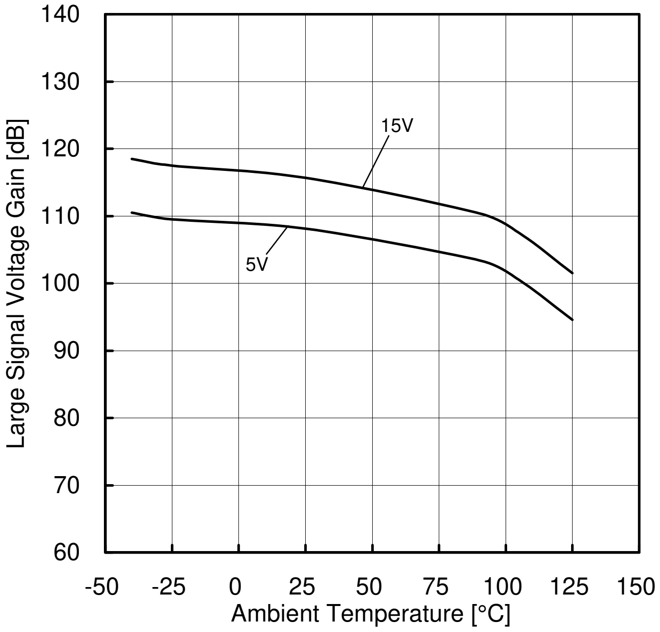


Figure 22.
Large Signal Voltage Gain vs Ambient Temperature
(R_L=2kΩ)

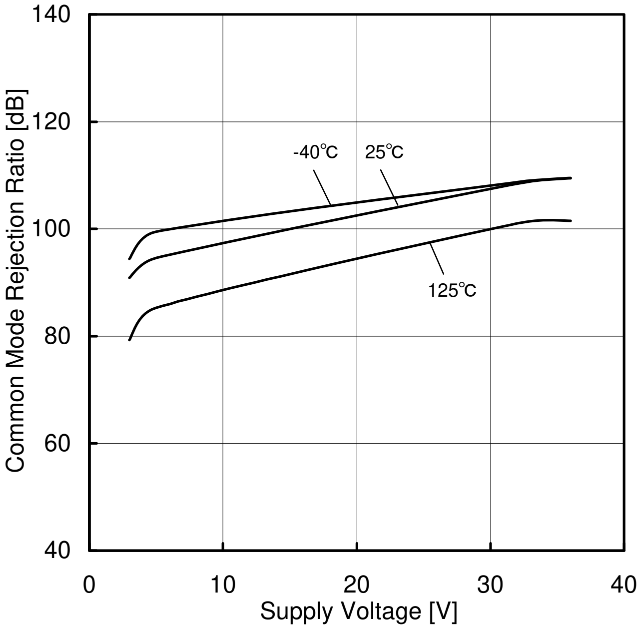


Figure 23.
Common Mode Rejection Ratio vs Supply Voltage

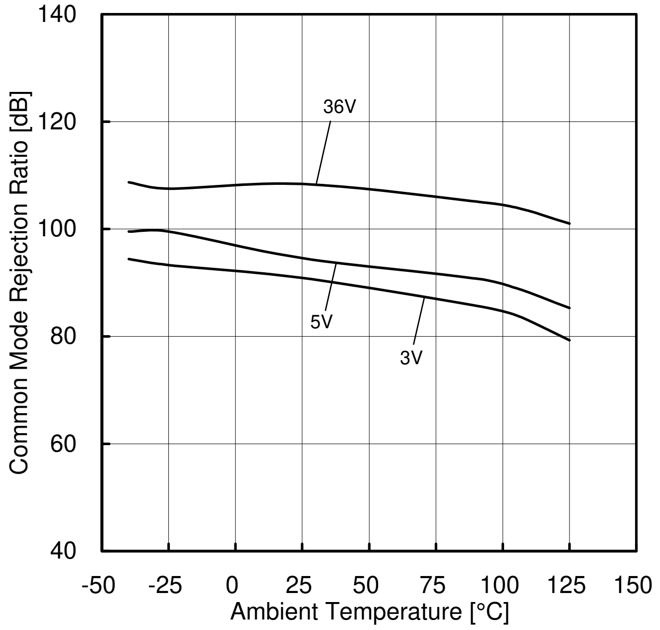


Figure 24.
Common Mode Rejection Ratio vs Ambient Temperature

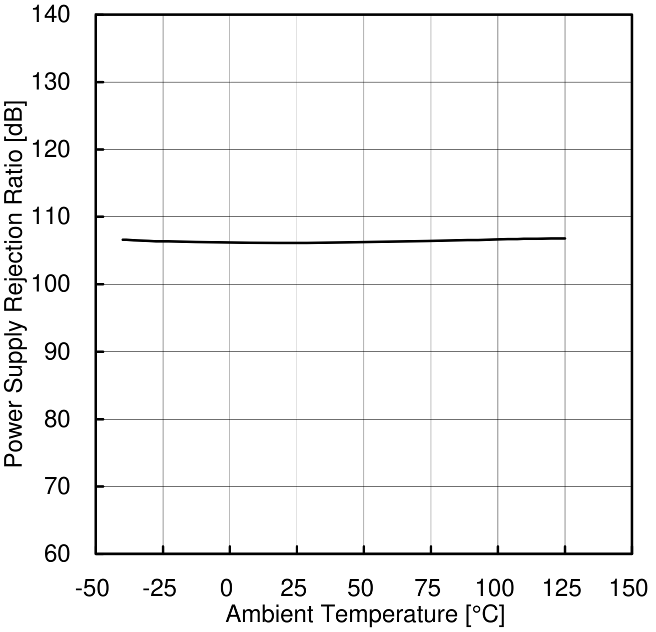


Figure 25.
Power Supply Rejection Ratio vs Ambient Temperature

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

○BA2902YF-LB

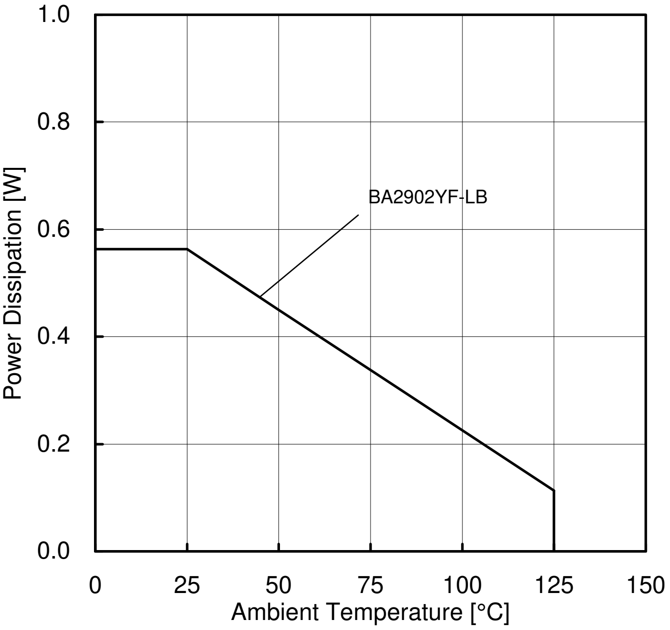


Figure 26.
Derating Curve

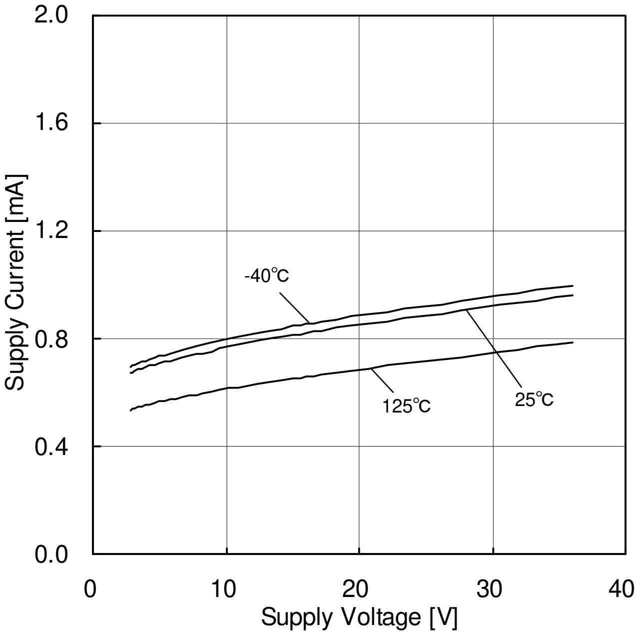


Figure 27.
Supply Current vs Supply Voltage

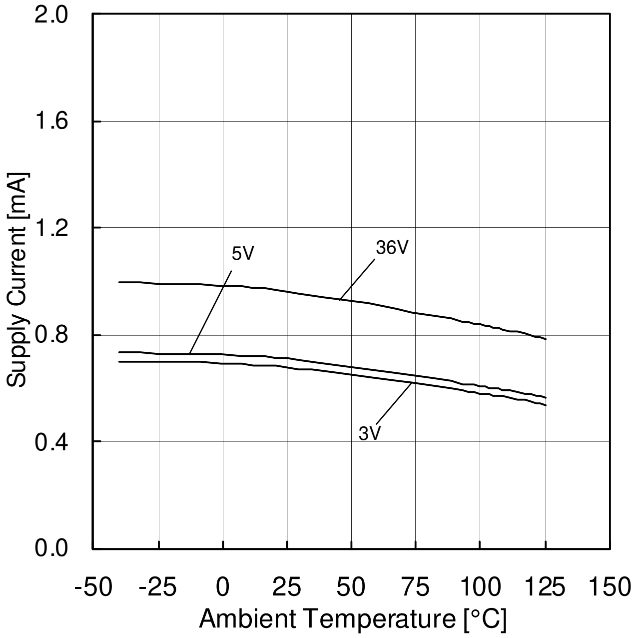


Figure 28.
Supply Current vs Ambient Temperature

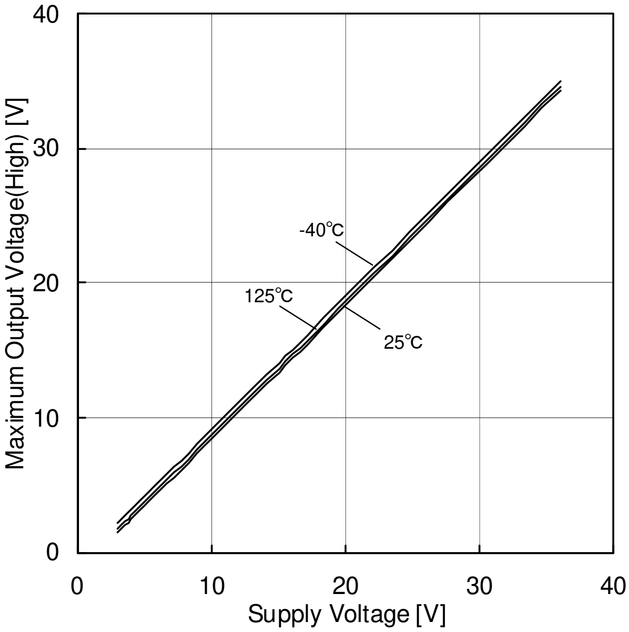


Figure 29.
Maximum Output Voltage(High) vs Supply Voltage
(R_L=10kΩ)

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

○BA2902YF-LB

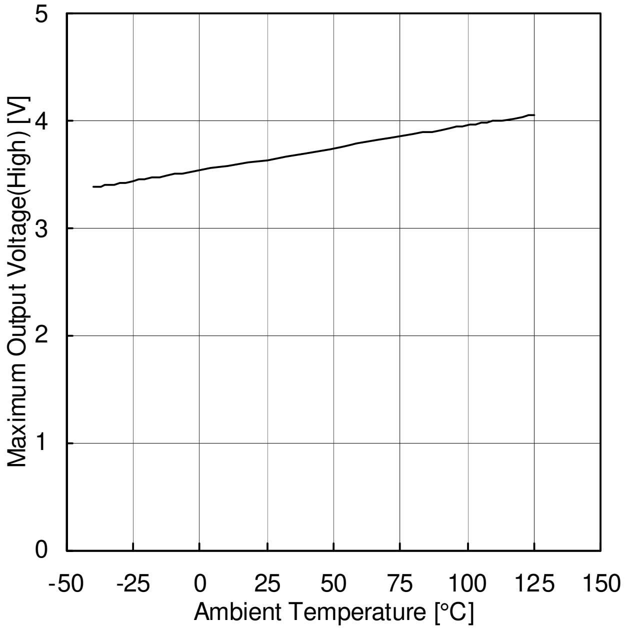


Figure 30.
Maximum Output Voltage(High) vs Ambient Temperature
(VCC=5V, R_L=2kΩ)

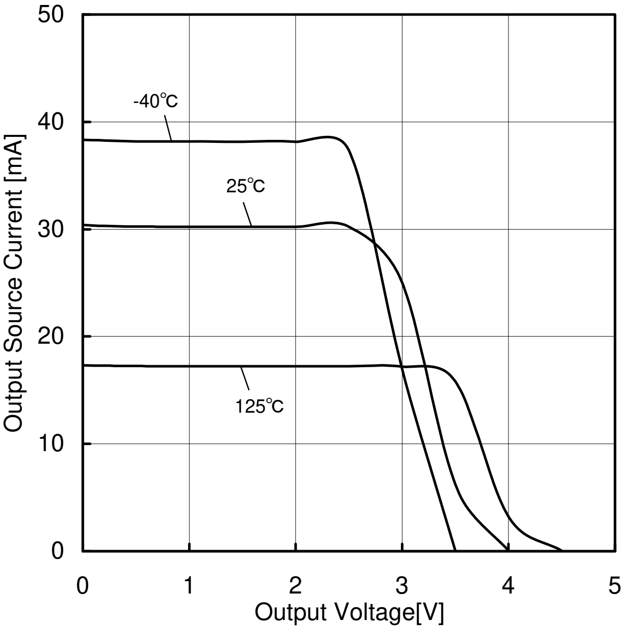


Figure 31.
Output Source Current vs Output Voltage
(VCC=5V)

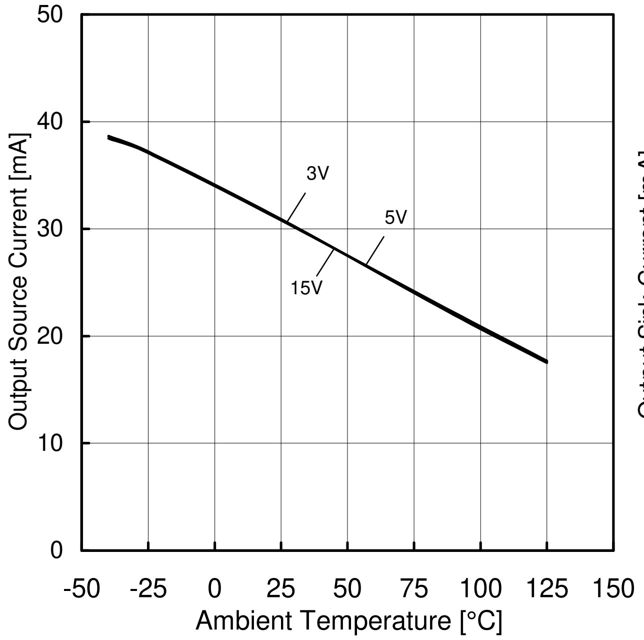


Figure 32.
Output Source Current vs Ambient Temperature
(OUT=0V)

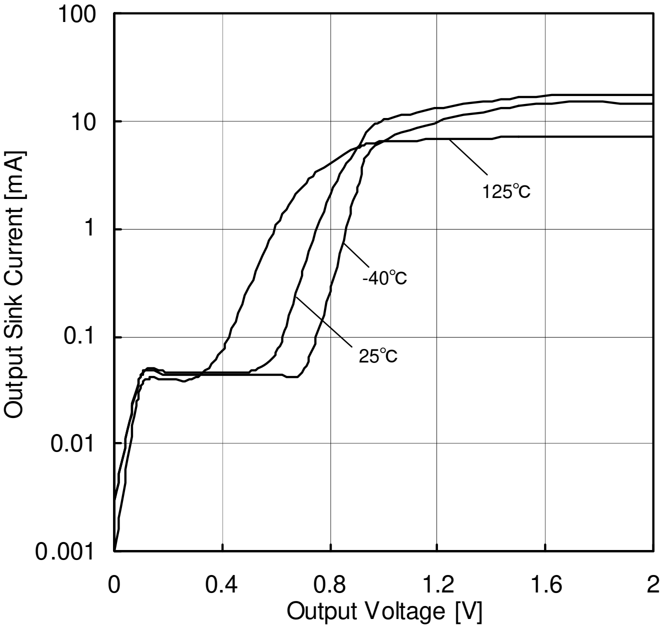


Figure 33.
Output Sink Current vs Output Voltage
(VCC=5V)

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

○BA2902YF-LB

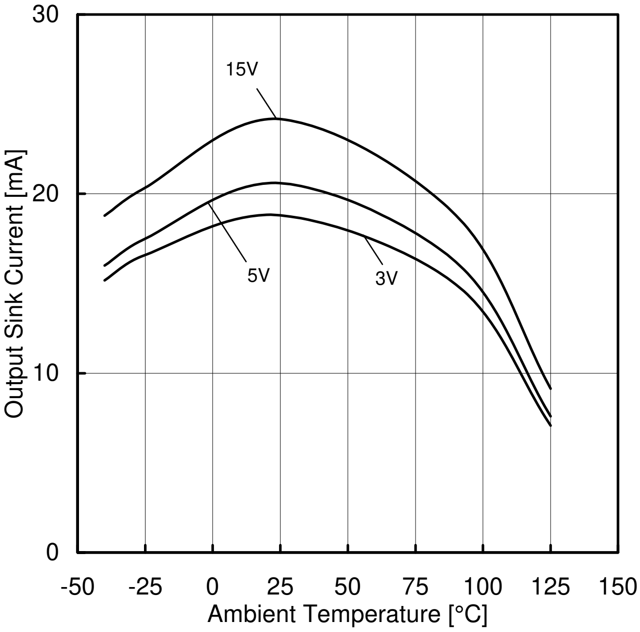


Figure 34.
Output Sink Current vs Ambient Temperature
(OUT=VCC)

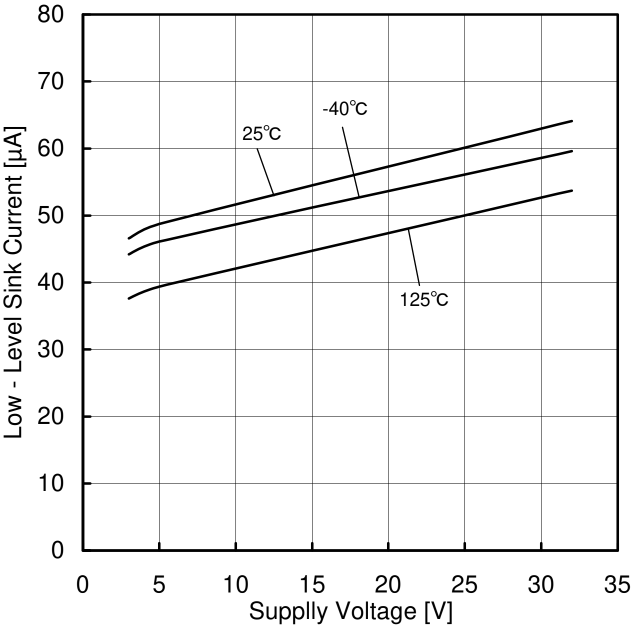


Figure 35.
Low Level Sink Current vs Supply Voltage
(OUT=0.2V)

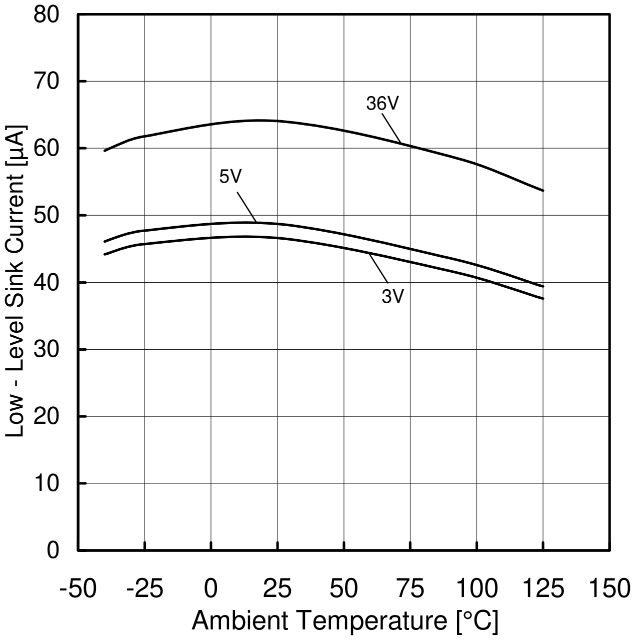


Figure 36.
Low Level Sink Current vs Ambient Temperature
(OUT=0.2V)

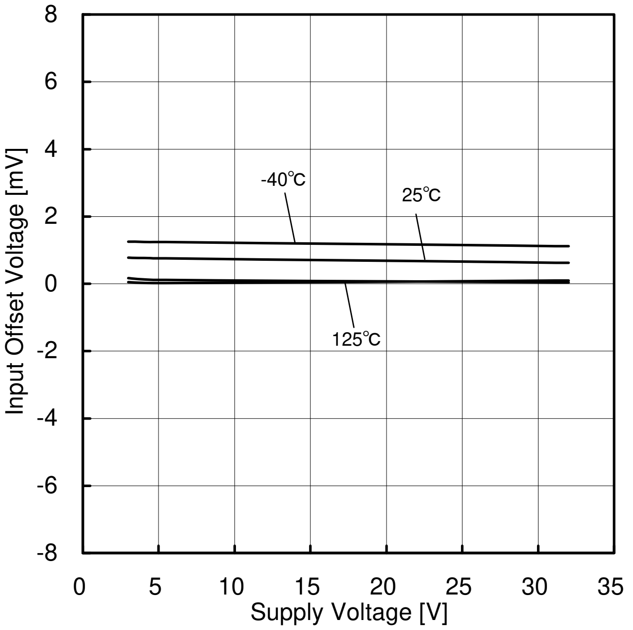


Figure 37.
Input Offset Voltage vs Supply Voltage
(V_{ICM}=0V, OUT=1.4V)

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

○BA2902YF-LB

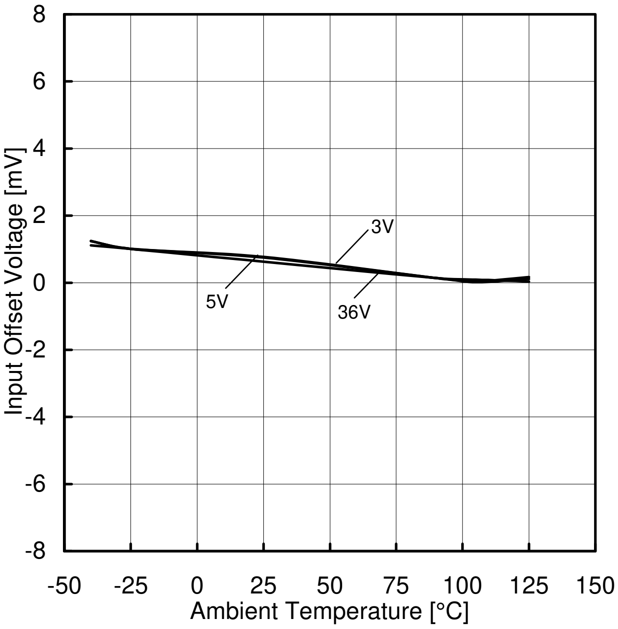


Figure 38.
Input Offset Voltage vs Ambient Temperature
(V_{ICM}=0V, E_K=-1.4V)

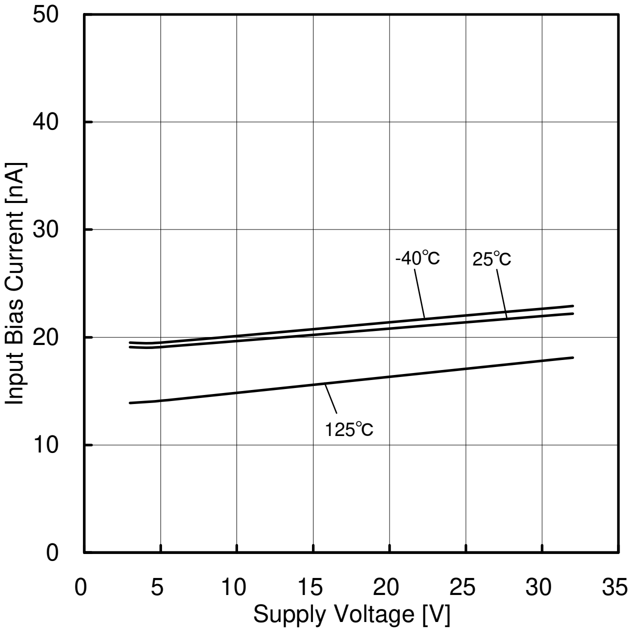


Figure 39.
Input Bias Current vs Supply Voltage
(V_{ICM}=0V, E_K=-1.4V)

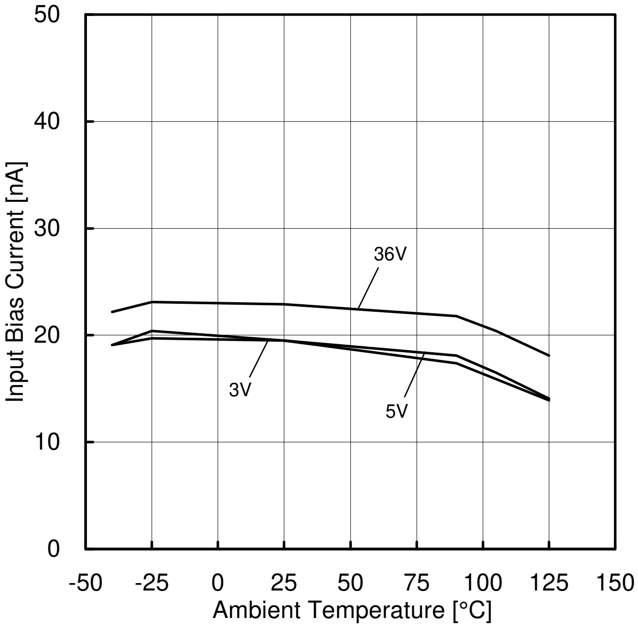


Figure 40.
Input Bias Current vs Ambient Temperature
(V_{ICM}=0V, E_K=-1.4V)

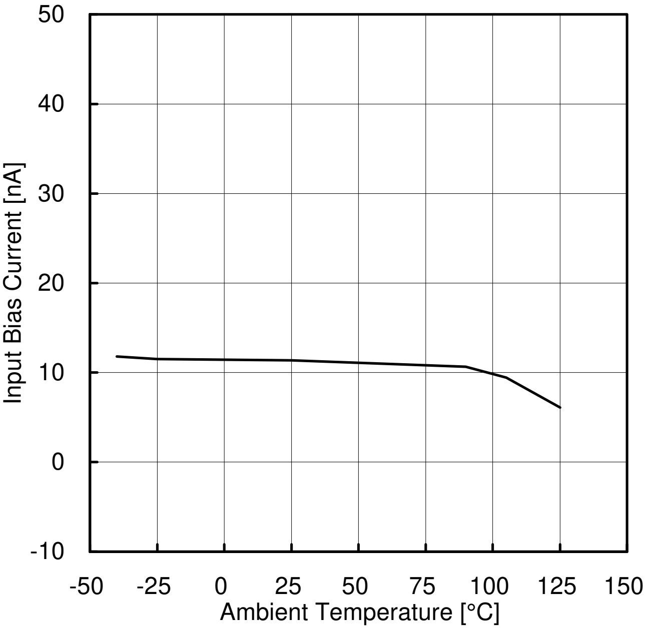


Figure 41.
Input Bias Current vs Ambient Temperature
(VCC=30V, V_{ICM}=28V, E_K=-1.4V)

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

○BA2902YF-LB

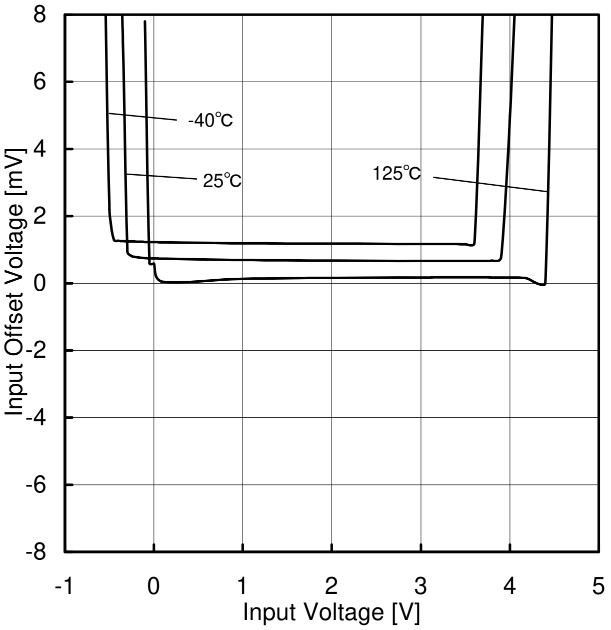


Figure 42.
Input Offset Voltage vs Input Voltage
(VCC=5V)

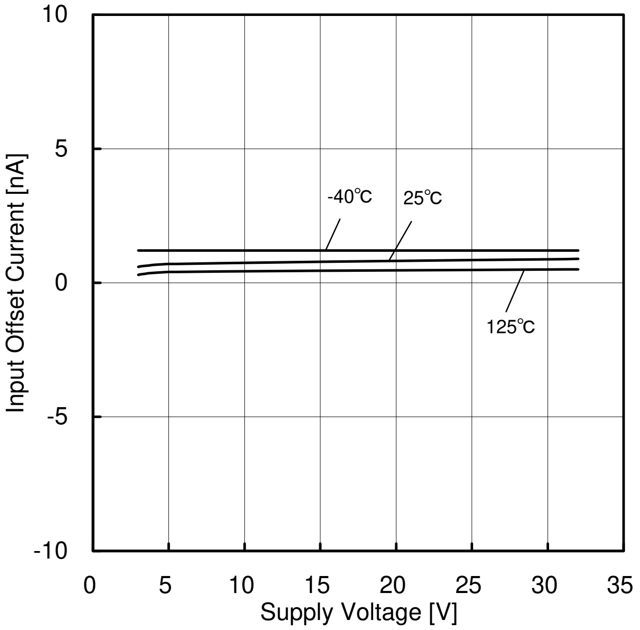


Figure 43.
Input Offset Current vs Supply Voltage
(V_{ICM}=0V, E_K=-1.4V)

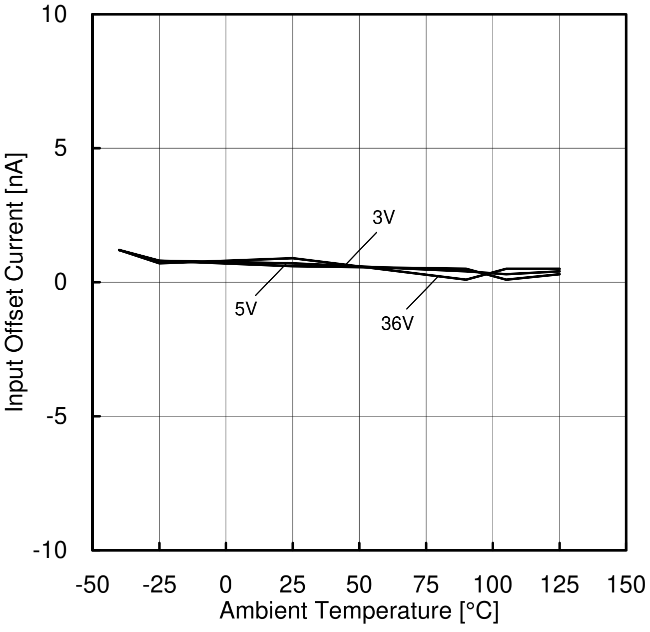


Figure 44.
Input Offset Current vs Ambient Temperature
(V_{ICM}=0V, E_K=-1.4V)

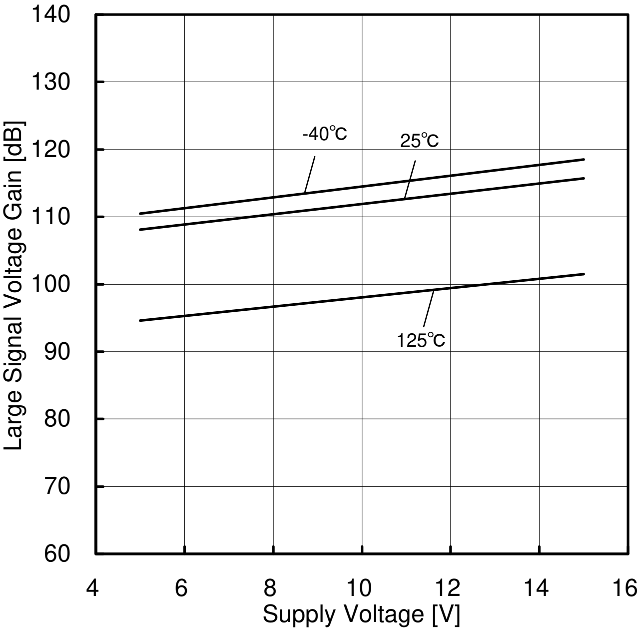


Figure 45.
Large Signal Voltage Gain vs Supply Voltage
(R_L=2kΩ)

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

○BA2902YF-LB

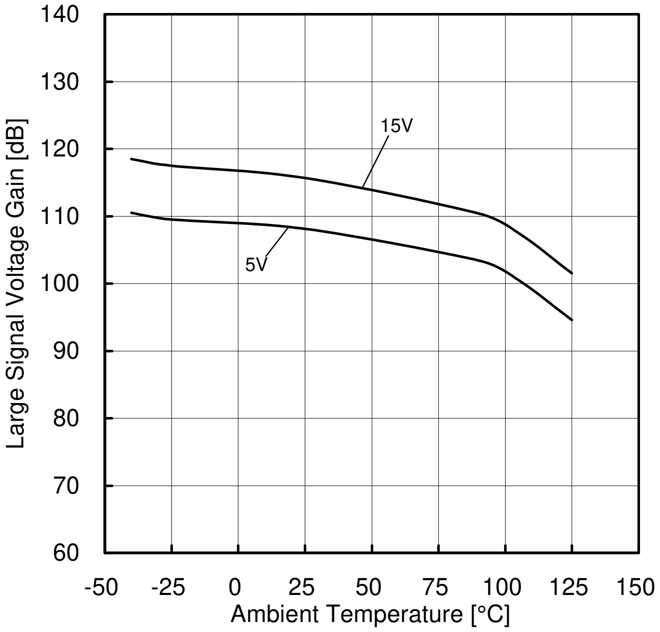


Figure 46.
Large Signal Voltage Gain vs Ambient Temperature
(R_L=2kΩ)

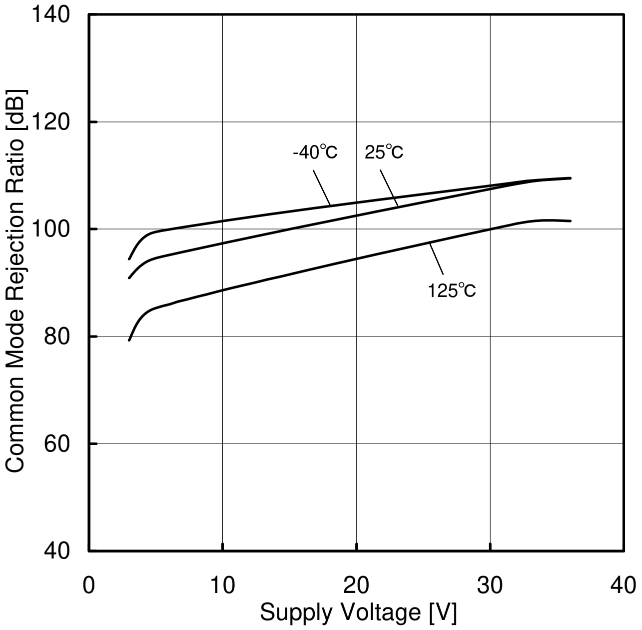


Figure 47.
Common Mode Rejection Ratio vs Supply Voltage

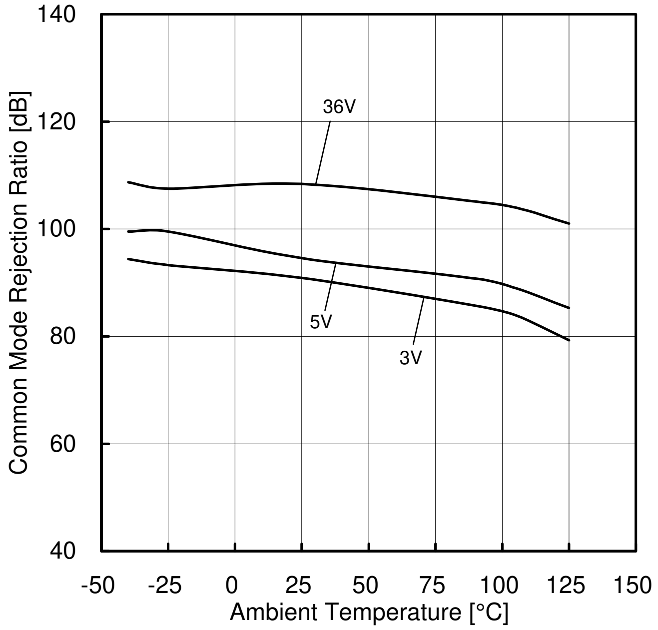


Figure 48.
Common Mode Rejection Ratio vs Ambient Temperature

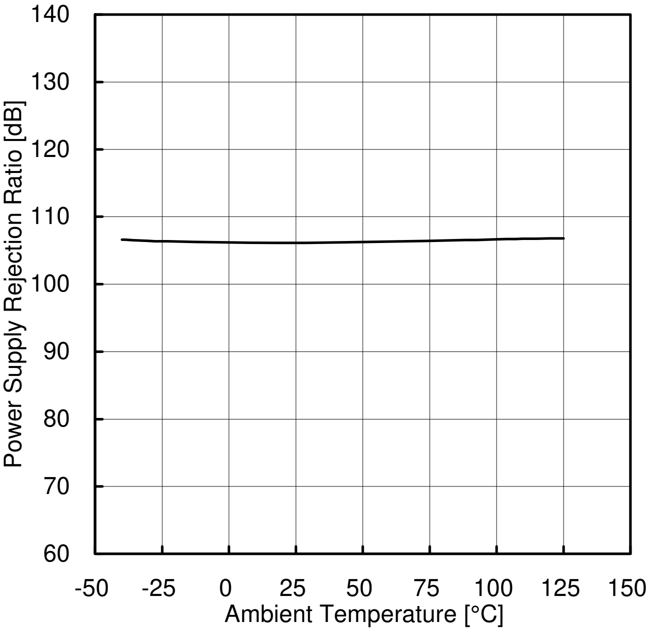


Figure 49.
Power Supply Rejection Ratio vs Ambient Temperature

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

Power Dissipation

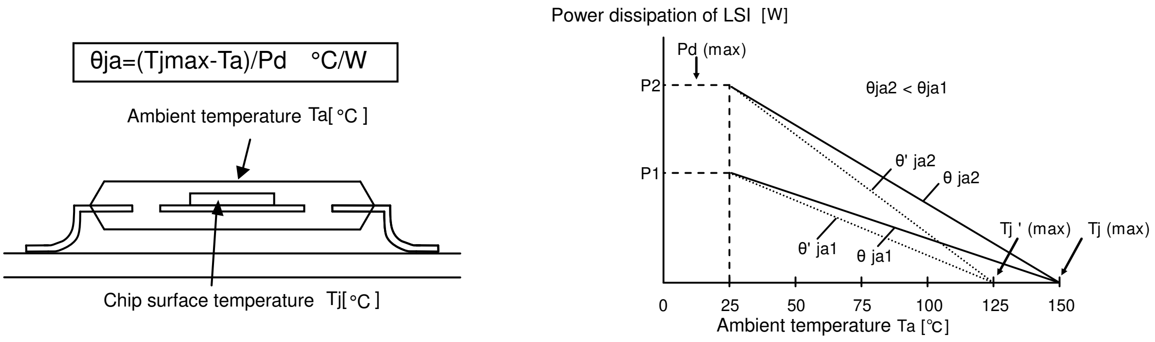
Power dissipation (total loss) indicates the power that the IC can consume at T_A=25°C (normal temperature). As the IC consumes power, it heats up, causing its temperature to be higher than the ambient temperature. The allowable temperature that the IC can accept is limited. This depends on the circuit configuration, manufacturing process, and consumable power.

Power dissipation is determined by the allowable temperature within the IC (maximum junction temperature) and the thermal resistance of the package used (heat dissipation capability). Maximum junction temperature is typically equal to the maximum storage temperature. The heat generated through the consumption of power by the IC radiates from the mold resin or lead frame of the package. Thermal resistance, represented by the symbol θ_{JA}°C/W, indicates this heat dissipation capability. Similarly, the temperature of an IC inside its package can be estimated by thermal resistance.

Figure 50 (a) shows the model of the thermal resistance of a package. The equation below shows how to compute for the Thermal resistance (θ_{JA}), given the ambient temperature (T_A), maximum junction temperature (T_{Jmax}), and power dissipation (P_D).

$$\theta_{JA} = (T_{Jmax} - T_A) / P_D \quad °C/W$$

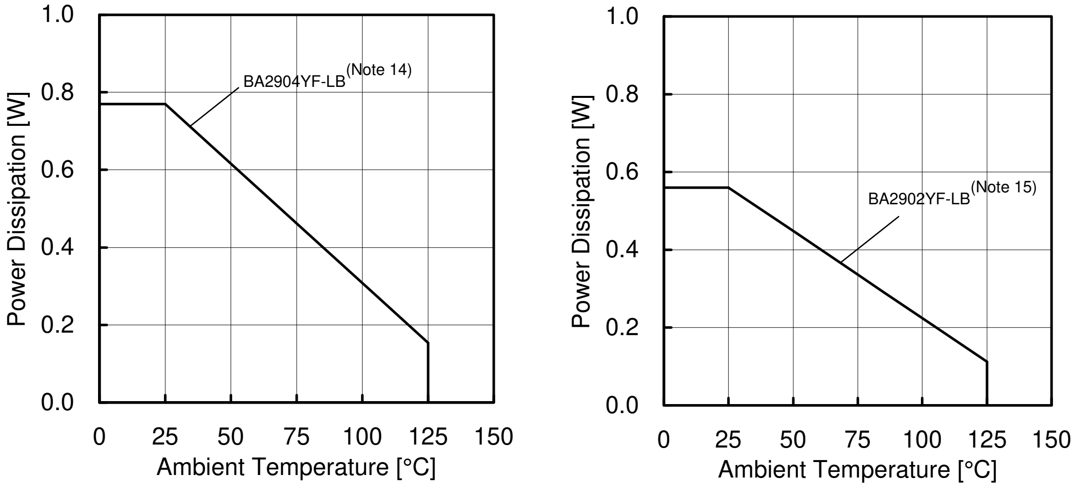
The Derating curve in Figure 50 (b) indicates the power that the IC can consume with reference to ambient temperature. Power consumption of the IC begins to attenuate at certain temperatures. This gradient is determined by Thermal resistance (θ_{JA}), which depends on the chip size, power consumption, package, ambient temperature, package condition, wind velocity, etc. This may also vary even when the same of package is used. Thermal reduction curve indicates a reference value measured at a specified condition. Figure 50(c) and 50(d) shows an example of the derating curve for BA2904YF-LB, BA2902YF-LB.



(a) Thermal resistance

(b) Derating curve

Figure 89. Thermal resistance and Derating Curve



(c) BA2904YF-LB

(d) BA2902YF-LB

(Note14)	(Note15)	Unit
6.2	4.5	mW/°C

When using the unit above T_A=25°C, subtract the value above per Celsius degree .
Mounted on a FR4 glass epoxy board 70mm×70mm×1.6mm (copper foil area less than 3%)

Figure 50. Thermal resistance and derating

Application Information

NULL method condition for Test circuit1

VCC, VEE, E_K, V_{ICM} Unit: V

Parameter	V_F	S1	S2	S3	VCC	VEE	E_K	V_{ICM}	calculation
Input Offset Voltage	V_{F1}	ON	ON	OFF	5 to 30	0	-1.4	0	1
Input Offset Current	V_{F2}	OFF	OFF	OFF	5	0	-1.4	0	2
Input Bias Current	V_{F3}	OFF	ON	OFF	5	0	-1.4	0	3
	V_{F4}	ON	OFF						
Large Signal Voltage Gain	V_{F5}	ON	ON	ON	15	0	-1.4	0	4
	V_{F6}				15	0	-11.4	0	
Common-mode Rejection Ratio (Input common-mode Voltage Range)	V_{F7}	ON	ON	OFF	5	0	-1.4	0	5
	V_{F8}				5	0	-1.4	3.5	
Power Supply Rejection Ratio	V_{F9}	ON	ON	OFF	5	0	-1.4	0	6
	V_{F10}				30	0	-1.4	0	

- Calculation -

1. Input Offset Voltage (V_{IO})

$$V_{IO} = \frac{|V_{F1}|}{1+R_F/R_S} \quad [V]$$

2. Input Offset Current (I_{IO})

$$I_{IO} = \frac{|V_{F2}-V_{F1}|}{R_I \times (1+R_F/R_S)} \quad [A]$$

3. Input Bias Current (I_B)

$$I_B = \frac{|V_{F4}-V_{F3}|}{2 \times R_I \times (1+R_F/R_S)} \quad [A]$$

4. Large Signal Voltage Gain (A_V)

$$A_V = 20\mathrm{Log}\frac{\Delta E_K \times (1+R_F/R_S)}{|V_{F5}-V_{F6}|} \quad [dB]$$

5. Common-mode Rejection Ration (CMRR)

$$CMRR = 20 \times \mathrm{Log}\frac{\Delta V_{ICM} \times (1+R_F/R_S)}{|V_{F8}-V_{F7}|} \quad [dB]$$

6. Power supply rejection ratio (PSRR)

$$PSRR = 20 \times \mathrm{Log}\frac{\Delta Vcc \times (1+R_F/R_S)}{|V_{F10}-V_{F9}|} \quad [dB]$$

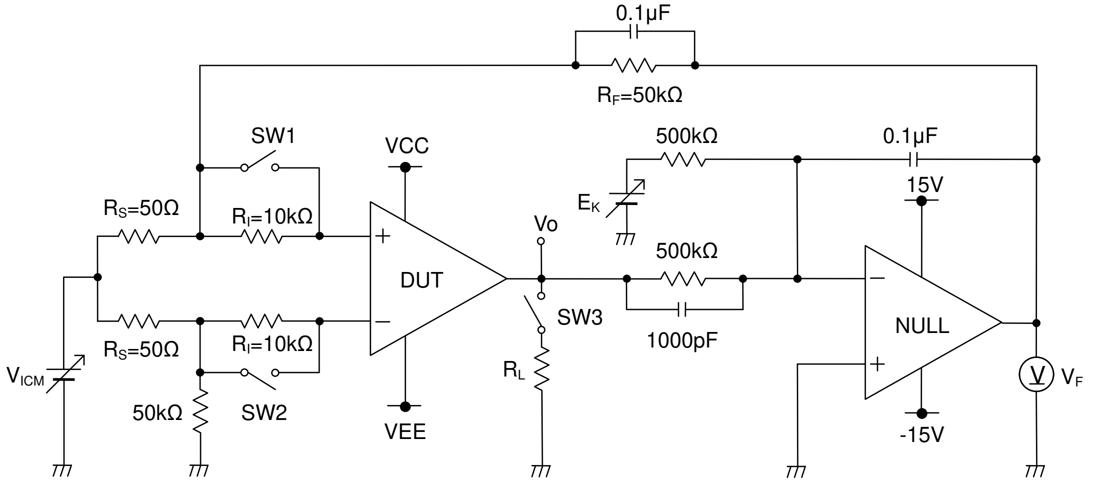


Figure 51. Test circuit1 (one channel only)

Switch Condition for Test Circuit 2

SW No.	SW 1	SW 2	SW 3	SW 4	SW 5	SW 6	SW 7	SW 8	SW 9	SW 10	SW 11	SW 12	SW 13	SW 14
Supply Current	OFF	OFF	OFF	ON	OFF	ON	OFF	OFF	OFF	OFF	OFF	OFF	OFF	OFF
Maximum Output Voltage (high)	OFF	OFF	ON	OFF	OFF	ON	OFF	OFF	ON	OFF	OFF	OFF	ON	OFF
Maximum Output Voltage (Low)	OFF	OFF	ON	OFF	OFF	ON	OFF	OFF	OFF	OFF	OFF	OFF	ON	OFF
Output Source Current	OFF	OFF	ON	OFF	OFF	ON	OFF	OFF	OFF	OFF	OFF	OFF	OFF	ON
Output Sink Current	OFF	OFF	ON	OFF	OFF	ON	OFF	OFF	OFF	OFF	OFF	OFF	OFF	ON
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

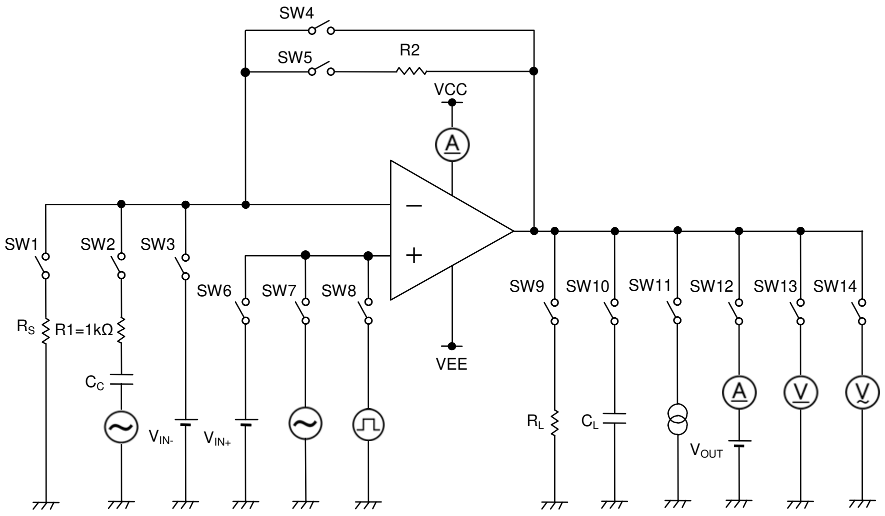


Figure 52. Test Circuit 2 (each Op-Amp)

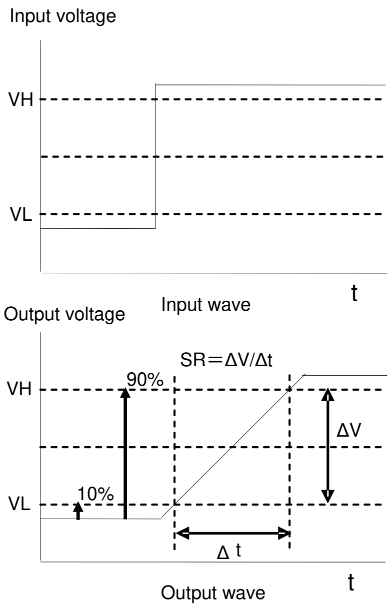
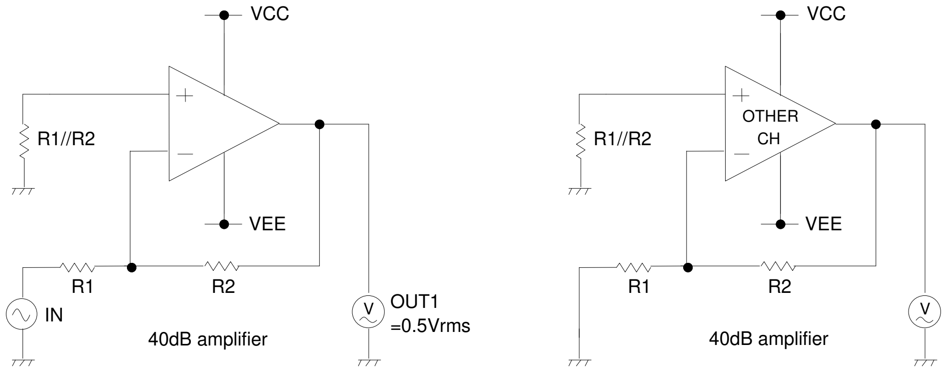


Figure 53. Slew Rate Input Waveform



100×OUT1

CS=20×log

(R1=1kΩ, R2=100kΩ)

OUT2

Figure 54. Test Circuit 3(Channel Separation)

Operational Notes

1. **Reverse Connection of Power Supply**
   Connecting the power supply in reverse polarity can damage the IC. Take precautions against reverse polarity when connecting the power supply, such as mounting an external diode between the power supply and the IC's power supply terminals.

2. **Power Supply Lines**
   Design the PCB layout pattern to provide low impedance ground and supply lines. Separate the ground and supply lines of the digital and analog blocks to prevent noise in the ground and supply lines of the digital block from affecting the analog block. Furthermore, connect a capacitor to ground at all power supply pins. Consider the effect of temperature and aging on the capacitance value when using electrolytic capacitors.

3. **Ground Voltage**
   Ensure that no pins are at a voltage below that of the ground pin at any time, even during transient condition.

4. **Ground Wiring Pattern**
   When using both small-signal and large-current GND traces, the two ground traces should be routed separately but connected to a single ground at the reference point of the application board to avoid fluctuations in the small-signal ground caused by large currents. Also ensure that the GND traces of external components do not cause variations on the GND voltage. The power supply and ground lines must be as short and thick as possible to reduce line impedance.

5. **Thermal Consideration**
   Should by any chance the power dissipation rating be exceeded, the rise in temperature of the chip may result in deterioration of the properties of the chip. The absolute maximum rating of the Pd stated in this specification is when the IC is mounted on a 70mm x 70mm x 1.6mm glass epoxy board. In case of exceeding this absolute maximum rating, increase the board size and copper area to prevent exceeding the Pd rating.

6. **Recommended Operating Conditions**
   These conditions represent a range within which the expected characteristics of the IC can be approximately obtained. The electrical characteristics are guaranteed under the conditions of each parameter.

7. **Inrush Current**
   When power is first supplied to the IC, it is possible that the internal logic may be unstable and inrush current may flow instantaneously due to the internal powering sequence and delays, especially if the IC has more than one power supply. Therefore, give special consideration to power coupling capacitance, power wiring, width of GND wiring, and routing of connections.

8. **Operation Under Strong Electromagnetic Field**
   Operating the IC in the presence of a strong electromagnetic field may cause the IC to malfunction.

9. **Testing on Application Boards**
   When testing the IC on an application board, connecting a capacitor directly to a low-impedance output pin may subject the IC to stress. Always discharge capacitors completely after each process or step. The IC's power supply should always be turned off completely before connecting or removing it from the test setup during the inspection process. To prevent damage from static discharge, ground the IC during assembly and use similar precautions during transport and storage.

10. **Inter-pin Short and Mounting Errors**
    Ensure that the direction and position are correct when mounting the IC on the PCB. Incorrect mounting may result in damaging the IC. Avoid nearby pins being shorted to each other especially to ground. Inter-pin shorts could be due to many reasons such as metal particles, water droplets (in very humid environment) and unintentional solder bridge deposited in between pins during assembly to name a few.

Operational Notes – continued

11. **Regarding Input Pins of the IC**
    This monolithic IC contains P+ isolation and P substrate layers between adjacent elements in order to keep them isolated. P-N junctions are formed at the intersection of the P layers with the N layers of other elements, creating a parasitic diode or transistor. For example (refer to figure below):

    When GND > Pin A and GND > Pin B, the P-N junction operates as a parasitic diode.
    When GND > Pin B, the P-N junction operates as a parasitic transistor.

    Parasitic diodes inevitably occur in the structure of the IC. The operation of parasitic diodes can result in mutual interference among circuits, operational faults, or physical damage. Therefore, conditions that cause these diodes to operate, such as applying a voltage lower than the GND voltage to an input pin (and thus to the P substrate) should be avoided.

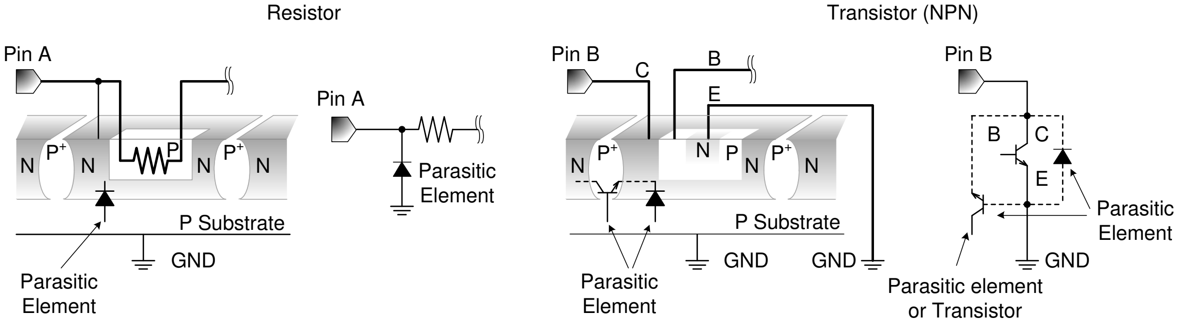


Figure 55. Example of Monolithic IC Structure

12. **Unused Circuits**
    When there are unused circuits it is recommended that they be connected as in Figure 56, setting the non-inverting input terminal to a potential within the in-phase input voltage range (V_{ICM}).

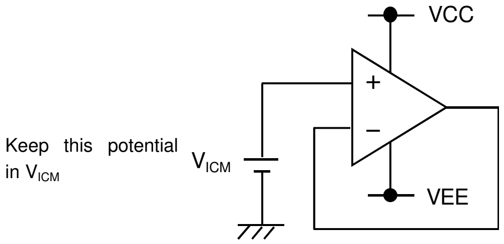


Figure 56. Disable Circuit Example

13. **Input Terminal Voltage**
    (BA2904 / BA2902) Applying VEE + 36V 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.

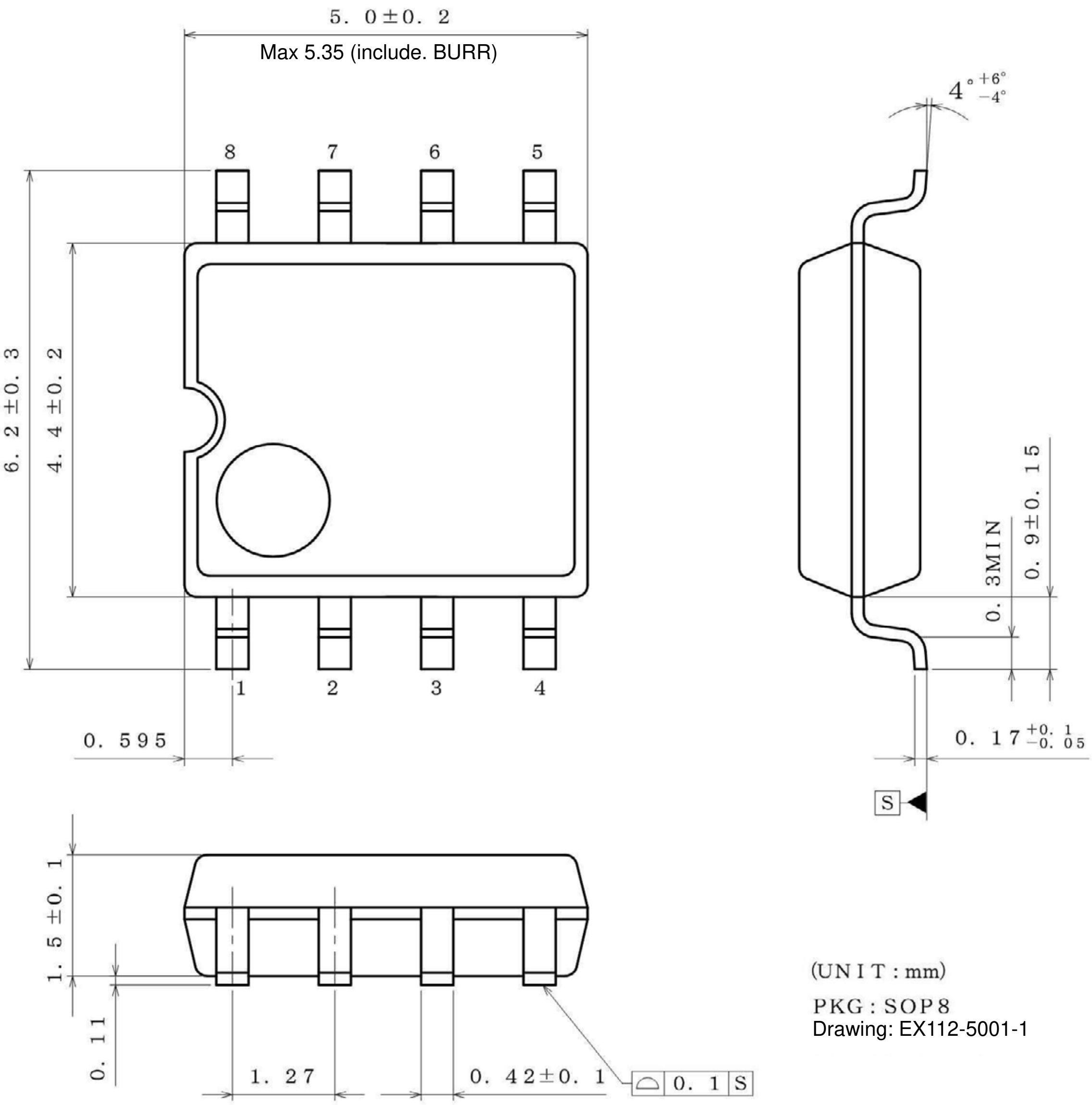
14. **Power Supply (signal / dual)**
    The op-amp operates when the specified voltage supplied is between VCC and VEE. Therefore, the single supply op-amp can be used as a dual supply op-amp as well.

15. **Terminal short-circuits**
    When the output and VCC terminals are shorted, excessive output current may flow, resulting in undue heat generation and, subsequently, destruction.

16. **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.

Physical Dimensions Tape and Reel Information

Package Name	SOP8



< Tape and Reel Information >

Tape	Embossed carrier tape
Quantity	250pcs
Direction of feed	H2 The direction is the pin 1 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