Operational Amplifiers

Ground Sense Operational Amplifiers

BA10358xx, BA10324Axx, BA2904xxx, BA2904Sxxx, BA2904Wxx BA2902xx, BA2902Sxx

●General Description

General purpose BA10358/BA10324A and high reliability BA2904/BA2902 integrate two or four independent Op-Amps on a single chip and have some features of high-gain, low power consumption, and wide operating voltage range of 3V to 36V (single power supply).
BA2904W have low input offset voltage(2mV max.).

●Features

- Operable with a single power supply
- Wide operating supply voltage range
- Input and output are operable GND sense
- Low supply current
- High open loop voltage gain
- Internal ESD protection circuit
- Wide temperature range

●Application

- Current sense application
- Buffer application amplifier
- Active filter
- Consumer electronics

●Key Specification

- Wide Operating Supply Voltage (single supply):

BA10358/BA10324A	+3.0V to +32.0V
BA2904/BA2902	+3.0V to +36.0V

- Wide Temperature Range:

BA10358/ BA10324A	-40°C~+85°C
BA2904S/ BA2902S	-40°C~+105°C
BA2904/ BA2902	-40°C~+125°C
BA2904W	-40°C~+125°C

- Input Offset Voltage:

BA10358/ BA10324A	7mV (Max.)
BA2904S/ BA2902S	7mV (Max.)
BA2904/ BA2902	7mV (Max.)
BA2904W	2mV (Max.)

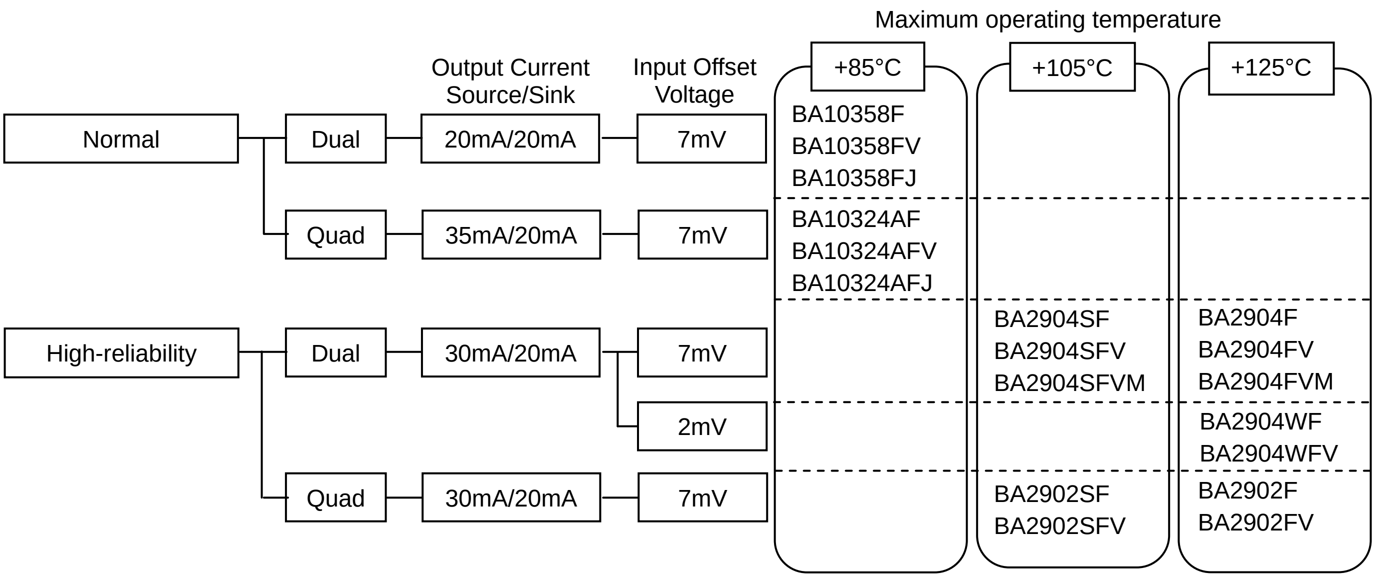
- Low Input Bias Current:

BA10358	45nA (Typ.)
BA10324A	20nA (Typ.)
BA2904S/ BA2902S	20nA (Typ.)
BA2904/ BA2902	20nA (Typ.)
BA2904W	20nA (Typ.)

●Packages

Packages	W(Typ.)xD(Typ.) xH(Max.)
SOP8	5.00mm x 6.20mm x 1.71mm
SOP-J8	4.90mm x 6.00mm x 1.65mm
SSOP-B8	3.00mm x 6.40mm x 1.35mm
MSOP8	2.90mm x 4.00mm x 0.90mm
SOP14	8.70mm x 6.20mm x 1.71mm
SOP-J14	8.65mm x 6.00mm x 1.65mm
SSOP-B14	5.00mm x 6.40mm x 1.35mm

●Selection Guide



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

●Simplified schematic

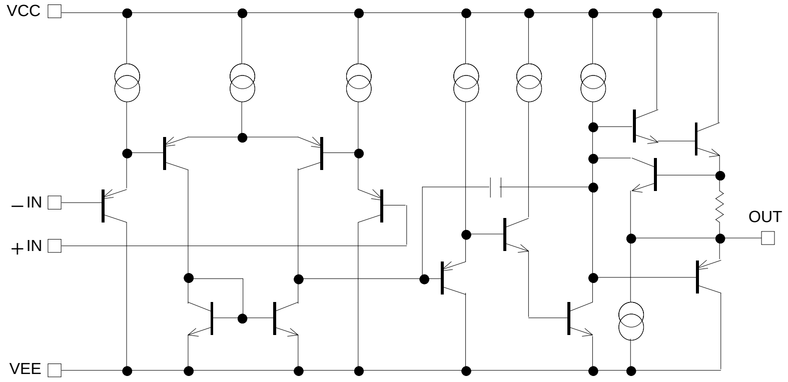
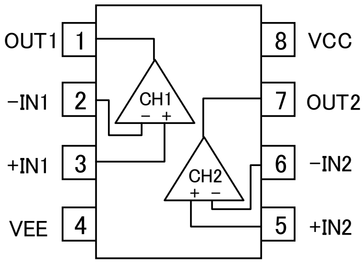


Figure 1. Simplified schematic（one channel only）

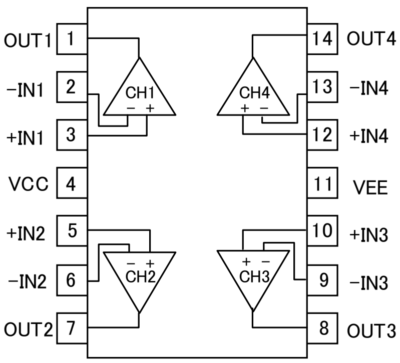
●Pin Configuration(TOP VIEW)

BA10358F,BA2904SF,BA2904F,BA2904WF :SOP8
BA10358FV,BA2904SFV,BA2904FV,BA2904WFV :SSOP-B8
BA2904SFVM,BA2904FVM :MSOP8
BA10358FJ :SOP-J8



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

BA10324AF,BA2902SF,BA2902F :SOP14
BA10324AFV,BA2902SFV,BA2902FV :SSOP-B14
BA10324AFJ :SOP-J14



Pin No.	Symbol
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

Package						
SOP8	SSOP-B8	MSOP8	SOP-J8	SOP14	SSOP-B14	SOP-J14
BA10358F BA2904SF BA2904F BA2904WF	BA10358FV BA2904SFV BA2904FV BA2904WFV	BA2904SFVM BA2904FVM	BA10358FJ	BA10324AF BA2902SF BA2902F	BA10324AFV BA2902SFV BA2902FV	BA10324AFJ

●Ordering Information

B A x x x x x x x x - x x

Part Number.
BA10358xx
BA10324Axx
BA2904xxx
BA2904Sxxx
BA2904Wxx
BA2902xx
BA2902Sxx

Package
F : SOP8
SOP14
FV : SSOP-B8
SSOP-B14
FVM : MSOP8
FJ : SOP-J8
SOP-J14

Packaging and forming specification
E2: Embossed tape and reel
(SOP8/SOP14/SSOP-B8/
SSOP-B14/SOP-J8/SOP-J14)
TR: Embossed tape and reel
(MSOP8)

●Line-up

Topr	Input Offset Voltage (Max.)	Supply Current (Typ.)	Package		Orderable Part Number
-40°C to +85°C	7mV	0.5mA	SOP8	Reel of 2500	BA10358F-E2
			SOP-J8	Reel of 2500	BA10358FJ-E2
			SSOP-B8	Reel of 2500	BA10358FV-E2
		0.6mA	SOP14	Reel of 2500	BA10324AF-E2
			SOP-J14	Reel of 2500	BA10324AFJ-E2
			SSOP-B14	Reel of 2500	BA10324AFV-E2
-40°C to +105°C		0.5mA	SOP8	Reel of 2500	BA2904SF-E2
			SSOP-B8	Reel of 2500	BA2904SFV-E2
			MSOP8	Reel of 3000	BA2904SFVM-TR
		0.7mA	SOP14	Reel of 2500	BA2902SF-E2
			SSOP-B14	Reel of 2500	BA2902SFV-E2
-40°C to +125°C		0.5mA	SOP8	Reel of 2500	BA2904F-E2
			SSOP-B8	Reel of 2500	BA2904FV-E2
			MSOP8	Reel of 3000	BA2904FVM-TR
		0.7mA	SOP14	Reel of 2500	BA2902F-E2
			SSOP-B14	Reel of 2500	BA2902FV-E2
	2mV	0.5mA	SOP8	Reel of 2500	BA2904WF-E2
			SSOP-B8	Reel of 2500	BA2904WFV-E2

●Absolute Maximum Ratings (Ta=25℃)

○BA10358, BA10324A

Parameter	Symbol		Ratings	Unit
Supply Voltage	VCC-VEE		+32	V
Power dissipation	Pd	SOP8	620[*1*7]	mW
		SOP-J8	540[*2*7]	
		SSOP-B8	500[*3*7]	
		SOP14	450[*4*7]	
		SOP-J14	820[*5*7]	
		SSOP-B14	700[*6*7]	
Differential Input Voltage[*6]	Vid		VCC – VEE	V
Input Common-mode Voltage Range	Vicm		VEE – VCC	V
Wide Operating Supply Voltage	Vopr		+3.0 to +32.0	V
Operating Temperature Range	Topr		-40 to +85	℃
Storage Temperature Range	Tstg		-55 to +125	℃
Maximum Junction Temperature	Tjmax		+125	℃

Note: Absolute maximum rating item indicates the condition which must not be exceeded. Application if voltage in excess of absolute maximum rating or use out of absolute maximum rated temperature environment may cause deterioration of characteristics.
*1 To use at temperature above Ta＝25℃ reduce 6.2mW.
*2 To use at temperature above Ta＝25℃ reduce 5.4mW
*3 To use at temperature above Ta＝25℃ reduce 5.0mW.
*4 To use at temperature above Ta＝25℃ reduce 4.5mW.
*5 To use at temperature above Ta＝25℃ reduce 8.2mW
*6 To use at temperature above Ta＝25℃ reduce 7.0mW.
*7 Mounted on a FR4 glass epoxy PCB(70mm×70mm×1.6mm).
*8 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.

○BA2904, BA2902

Parameter	Symbol		Ratings		Unit
			BA2904S BA2902S	BA2904, BA2904W BA2902	
Supply Voltage	VCC-VEE		+36		V
Power dissipation	Pd	SOP8	775[*9*14]		mW
		SSOP-B8	625[*10*14]		
		MSOP8	600[*11*14]		
		SOP14	560[*12*14]		
		SSOP-B14	870[*13*14]		
Differential Input Voltage[*15]	Vid		+36		V
Input Common-mode Voltage Range	Vicm		(VEE-0.3) to (VEE+36)		V
Wide Operating Supply Voltage	Vopr		+3.0 to +36.0		V
Operating Temperature Range	Topr		-40 to +105	-40 to +125	℃
Storage Temperature Range	Tstg		-55 to +150		℃
Maximum Junction Temperature	Tjmax		+150		℃

Note: Absolute maximum rating item indicates the condition which must not be exceeded. Application if voltage in excess of absolute maximum rating or use out of absolute maximum rated temperature environment may cause deterioration of characteristics.
*9 To use at temperature above Ta＝25℃ reduce 6.2mW.
*10 To use at temperature above Ta＝25℃ reduce 5.0mW.
*11 To use at temperature above Ta＝25℃ reduce 4.8mW.
*12 To use at temperature above Ta＝25℃ reduce 4.5mW.
*13 To use at temperature above Ta＝25℃ reduce 7.0mW.
*14 Mounted on a FR4 glass epoxy PCB(70mm×70mm×1.6mm)..
*15 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

○BA10358 (Unless otherwise specified VCC=+5V, VEE=0V, Ta=25℃)

Parameter	Symbol	Limits			Unit	Condition
		Min.	Typ.	Max.		
Input Offset Voltage *16	Vio	-	2	7	mV	OUT=1.4V
Input Offset Current *16	Iio	-	5	50	nA	OUT=1.4V
Input Bias Current *17	Ib	-	45	250	nA	OUT=1.4V
Supply Current	ICC	-	0.5	1.2	mA	RL=∞, All Op-Amps
Maximum Output Voltage(High)	VOH	3.5	-	-	V	RL=2kΩ
Maximum Output Voltage(Low)	VOL	-	-	250	mV	RL=∞, All Op-Amps
Large Signal Voltage Gain	Av	25	100	-	V/mV	RL≧2kΩ, VCC=15V OUT=1.4 to 11.4V
		88	100	-	dB	
Input Common-mode Voltage Range	Vicm	0	-	VCC-1.5	V	(VCC-VEE)=5V OUT=VEE+1.4V
Common-mode Rejection Ratio	CMRR	65	80	-	dB	OUT=1.4V
Power Supply Rejection Ratio	PSRR	65	100	-	dB	VCC=5 to 30V
Output Source Current	Isource	10	20	-	mA	VIN+=1V, VIN-=0V OUT=0V, 1CH is short circuit
Output Sink Current	Isink	10	20	-	mA	VIN+=0V, VIN-=1V OUT=5V, 1CH is short circuit
Channel Separation	CS	-	120	-	dB	f=1kHz, input referred
Slew Rate	SR	-	0.2	-	V/μs	VCC=15V, Av=0dB RL=2kΩ, CL=100pF
Gain Band Width	GBW	-	0.5	-	MHz	VCC=30V, RL=2kΩ CL=100pF

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

○BA10324A (Unless otherwise specified VCC=+5V, VEE=0V, Ta=25℃)

Parameter	Symbol	Limits			Unit	Condition
		Min.	Typ.	Max.		
Input Offset Voltage *18	Vio	-	2	7	mV	OUT=1.4V
Input Offset Current *18	Iio	-	5	50	nA	OUT=1.4V
Input Bias Current *19	Ib	-	20	250	nA	OUT=1.4V
Supply Current	ICC	-	0.6	2	mA	RL=∞, All Op-Amps
Maximum Output Voltage(High)	VOH	3.5	-	-	V	RL=2kΩ
Maximum Output Voltage(Low)	VOL	-	-	250	mV	RL=∞, All Op-Amps
Large Signal Voltage Gain	Av	25	100	-	V/mV	RL≧2kΩ, VCC=15V OUT=1.4 to 11.4V
Input Common-mode Voltage range	Vicm	0	-	VCC-1.5	V	(VCC-VEE)=5V OUT=VEE+1.4V
Common-mode Rejection Ratio	CMRR	65	75	-	dB	OUT=1.4V
Power Supply Rejection Ratio	PSRR	65	100	-	dB	VCC=5 to 30V
Output Source Current	Isource	20	35	-	mA	VIN+=1V, VIN-=0V OUT=0V, 1CH is short circuit
Output Sink Current	Isink	10	20	-	mA	VIN+=0V, VIN-=1V OUT=5V, 1CH is short circuit
Channel Separation	CS	-	120	-	dB	f=1kHz, input referred
Slew Rate	SR	-	0.2	-	V/μs	VCC=15V, Av=0dB RL=2kΩ, CL=100pF
Gain Band Width	GBW	-	0.5	-	MHz	VCC=30V, RL=2kΩ CL=100pF

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

○BA2904, BA2904S (Unless otherwise specified VCC=+5V, VEE=0V)

Parameter	Symbol	Temperature Range	Limits			Unit	Condition
			Min.	Typ.	Max.		
Input Offset Voltage *20 *21	Vio	25℃	-	2	7	mV	OUT=1.4V
		Full range	-	-	10		VCC=5 to 30V, OUT=1.4V
Input Offset Voltage Drift	△Vio/△T	-	-	±7	-	μV/℃	OUT=1.4V
Input Offset Current *20 *21	Iio	25℃	-	2	50	nA	OUT=1.4V
		Full range	-	-	200		
Input Offset Current Drift	△Iio/△T	-	-	±10	-	pA/℃	OUT=1.4V
Input Bias Current *20 *21	Ib	25℃	-	20	250	nA	OUT=1.4V
		Full range	-	-	250		
Supply Current *21	ICC	25℃	-	0.5	1.2	mA	RL=∞, All Op-Amps
		Full range	-	-	2		
Maximum Output Voltage(High) *21	VOH	25℃	3.5	-	-	V	RL=2kΩ
		Full range	27	28	-		VCC=30V, RL=10kΩ
Maximum Output Voltage(Low) *21	VOL	Full range	-	5	20	mV	RL=∞, All Op-Amps
Large Signal Voltage Gain	Av	25℃	25	100	-	V/mV	RL≧2kΩ, VCC=15V OUT=1.4 to 11.4V
Input Common-mode Voltage Range	Vicm	25℃	0	-	VCC-1.5	V	(VCC-VEE)=5V OUT=VEE+1.4V
Common-mode Rejection Ratio	CMRR	25℃	50	80	-	dB	OUT=1.4V
Power Supply Rejection Ratio	PSRR	25℃	65	100	-	dB	VCC=5 to 30V
Output Source Current *21 *22	Isource	25℃	20	30	-	mA	VIN+=1V, VIN-=0V OUT=0V, 1CH is short circuit
		Full range	10	-	-		
Output Sink Current *21 *22	Isink	25℃	10	20	-	mA	VIN+=0V, VIN-=1V OUT=5V, 1CH is short circuit
		Full range	2	-	-		
		25℃	12	40	-	μA	VIN+=0V, VIN-=1V OUT=200mV
Channel Separation	CS	25℃	-	120	-	dB	f=1kHz, input referred
Slew rate	SR	25℃	-	0.2	-	V/μs	VCC=15V, Av=0dB RL=2kΩ, CL=100pF
Gain Band Width	GBW	25℃	-	0.5	-	MHz	VCC=30V, RL=2kΩ CL=100pF
Input referred noise voltage	Vn	25℃	-	40	-	$nV/\sqrt{Hz}$	VCC=15V, VEE=-15V RS=100Ω, Vi=0V, f=1kHz

*20 Absolute value
*21 BA2904S :Full range -40 to +105℃ BA2904 :Full range -40 to +125℃
*22 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.

○BA2904W (Unless otherwise specified VCC=+5V, VEE=0V)

Parameter	Symbol	Temperature Range	Limits Min.	Limits Typ.	Limits Max.	Unit	Condition
Input Offset Voltage [*23]	Vio	25℃	-	0.5	2	mV	OUT=1.4V
Input Offset Voltage Drift	△Vio/△T	-	-	±7	-	μV/℃	OUT=1.4V
Input Offset Current [*23]	Iio	25℃	-	2	50	nA	OUT=1.4V
Input Offset Current Drift	△Iio/△T	-	-	±10	-	pA/℃	OUT=1.4V
Input Bias Current [*23]	Ib	25℃	-	20	250	nA	OUT=1.4V
		Full range	-	-	250		
Supply Current	ICC	25℃	-	0.5	1.2	mA	RL=∞, All Op-Amps
		Full range	-	-	1.2		
Maximum Output Voltage(High)	VOH	25℃	3.5	-	-	V	RL=2kΩ
		Full range	27	28	-		VCC=30V, RL=10kΩ
Maximum Output Voltage(Low)	VOL	Full range	-	5	20	mV	RL=∞, All Op-Amps
Large Signal Voltage Gain	Av	25℃	25	100	-	V/mV	RL≧2kΩ, VCC=15V OUT=1.4 to 11.4V
Input Common-mode Voltage Range	Vicm	25℃	0	-	VCC-1.5	V	(VCC-VEE)=5V OUT=VEE+1.4V
Common-mode Rejection Ratio	CMRR	25℃	50	80	-	dB	OUT=1.4V
Power Supply Rejection Ratio	PSRR	25℃	65	100	-	dB	VCC=5 to 30V
Output Source Current [*24]	Isource	25℃	20	30	-	mA	VIN+=1V, VIN-=0V OUT=0V, 1CH is short circuit
		Full range	10	-	-		
Output Sink Current [*24]	Isink	25℃	10	20	-	mA	VIN+=0V, VIN-=1V OUT=5V, 1CH is short circuit
		Full range	2	-	-		
		25℃	12	40	-	μA	VIN+=0V, VIN-=1V OUT=200mV
Channel Separation	CS	25℃	-	120	-	dB	f=1kHz, input referred
Slew rate	SR	25℃	-	0.2	-	V/μs	VCC=15V, Av=0dB RL=2kΩ, CL=100pF
Gain Band Width	GBW	25℃	-	0.5	-	MHz	VCC=30V, RL=2kΩ CL=100pF
Input referred noise voltage	Vn	25℃	-	40	-	$nV/\sqrt{Hz}$	VCC=15V, VEE=-15V RS=100Ω, Vi=0V, f=1kHz

*23 Absolute value
*24 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.

○BA2902, BA2902S (Unless otherwise specified VCC=+5V, VEE=0V)

Parameter	Symbol	Temperature Range	Limits			Unit	Condition
			Min.	Typ.	Max.		
Input Offset Voltage *25 *26	Vio	25℃	-	2	7	mV	OUT=1.4V
		Full range	-	-	10		VCC=5 to 30V, OUT=1.4V
Input Offset Voltage Drift	△Vio/△T	-	-	±7	-	μV/℃	OUT=1.4V
Input Offset Current *25 *26	Iio	25℃	-	2	50	nA	OUT=1.4V
		Full range	-	-	200		
Input Offset Current Drift	△Iio/△T	-	-	±10	-	pA/℃	OUT=1.4V
Input Bias Current *25 *26	Ib	25℃	-	20	250	nA	OUT=1.4V
		Full range	-	-	250		
Supply Current *26	ICC	25℃	-	0.7	2	mA	RL=∞, All Op-Amps
		Full range	-	-	3		
Maximum Output Voltage(High) *26	VOH	25℃	3.5	-	-	V	RL=2kΩ
		Full range	27	28	-		VCC=30V, RL=10kΩ
Maximum Output Voltage(Low) *26	VOL	Full range	-	5	20	mV	RL=∞, All Op-Amps
Large Signal Voltage Gain	Av	25℃	25	100	-	V/mV	RL≧2kΩ, VCC=15V OUT=1.4 to 11.4V
Input Common-mode Voltage Range	Vicm	25℃	0	-	VCC-1.5	V	(VCC-VEE)=5V OUT=VEE+1.4V
Common-mode Rejection Ratio	CMRR	25℃	50	80	-	dB	OUT=1.4V
Power Supply Rejection Ratio	PSRR	25℃	65	100	-	dB	VCC=5 to 30V
Output Source Current *26 *27	Isource	25℃	20	30	-	mA	VIN+=1V, VIN-=0V OUT=0V 1CH is short circuit
		Full range	10	-	-		
Output Sink Current *26 *27	Isink	25℃	10	20	-	mA	VIN+=0V, VIN-=1V OUT=5V, 1CH is short circuit
		Full range	2	-	-		
		25℃	12	40	-	μA	VIN+=0V, VIN-=1V OUT=200mV
Channel Separation	CS	25℃	-	120	-	dB	f=1kHz, input referred
Slew rate	SR	25℃	-	0.2	-	V/μs	VCC=15V, Av=0dB RL=2kΩ, CL=100pF
Gain Band Width	GBW	25℃	-	0.5	-	MHz	VCC=30V, RL=2kΩ CL=100p
Input referred noise voltage	Vn	25℃	-	40	-	$nV/\sqrt{Hz}$	VCC=15V, VEE=-15V RS=100Ω, Vi=0V, f=1kHz

*25 Absolute value
*26 BA2902S :Full range -40 to +105℃ ,BA2902 :Full range -40 to +125℃
*27 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.

1.1 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 and inverting terminals without damaging the IC.

1.3 Input common-mode voltage range (Vicm)
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.

1.4 Power dissipation (Pd)
Indicates the power that can be consumed by the IC when mounted on a specific board at the ambient temperature 25℃ (normal temperature). As for package product, Pd 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

2.1 Input offset voltage (Vio)
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.

2.2 Input offset voltage drift (△Vio/△T)
Denotes the ratio of the input offset voltage fluctuation to the ambient temperature fluctuation.

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

2.4 Input offset current drift (△Iio/△T)
Signifies the ratio of the input offset current fluctuation to the ambient temperature fluctuation.

2.5 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 currents at the non-inverting and inverting terminals.

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

2.7 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 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.

2.8 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)

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

2.10 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)

2.11 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)

2.12 Output source current/ output sink current (Isource/Isink)

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.

2.13 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.

2.14 Slew rate (SR)

Indicates the ratio of the change in output voltage with time when a step input signal is applied.

2.15 Gain Band Width (GBW)

The product of the open-loop voltage gain and the frequency at which the voltage gain decreases 6dB/octave.

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**

○BA10358

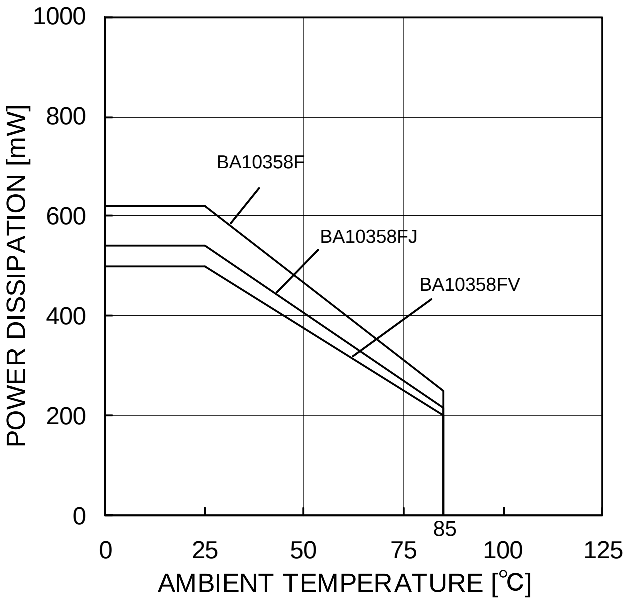


Figure 2.
Derating Curve

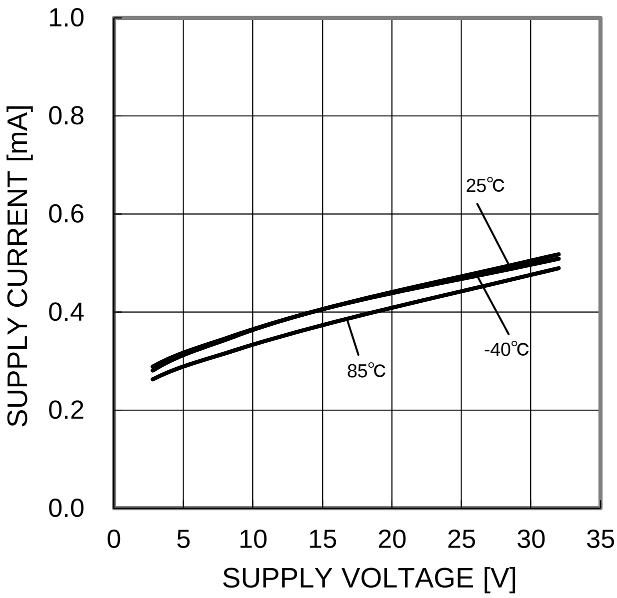


Figure 3.
Supply Current – Supply Voltage

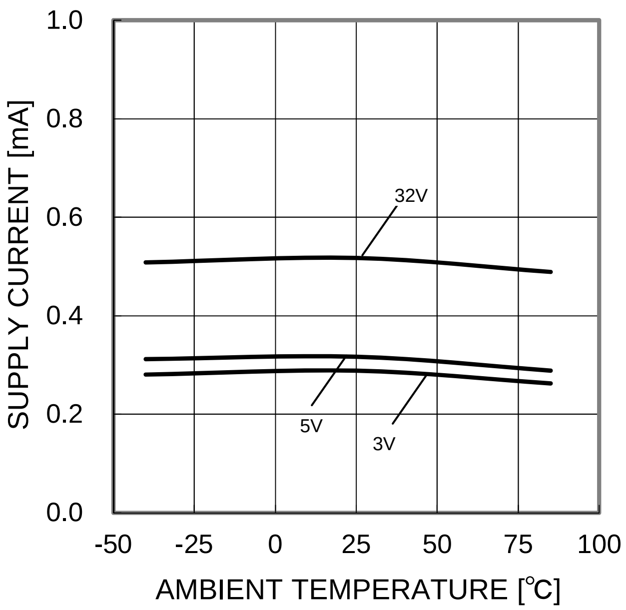


Figure 4.
Supply Current – Ambient Temperature

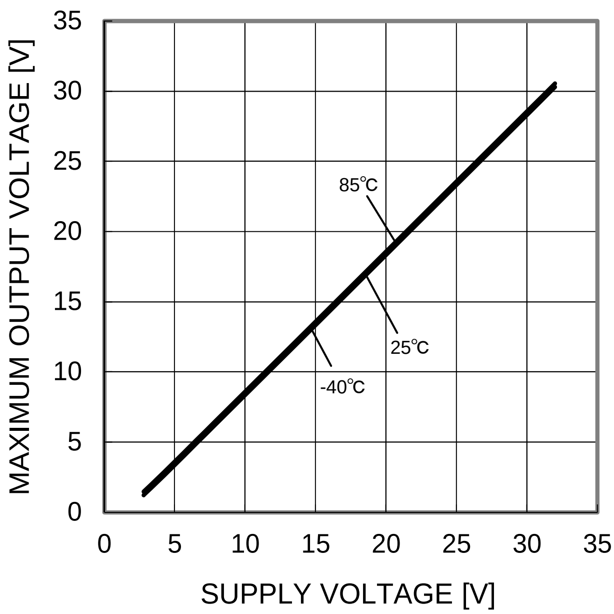


Figure 5.
Maximum Output Voltage - Supply Voltage
(RL=10kΩ)

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

○BA10358

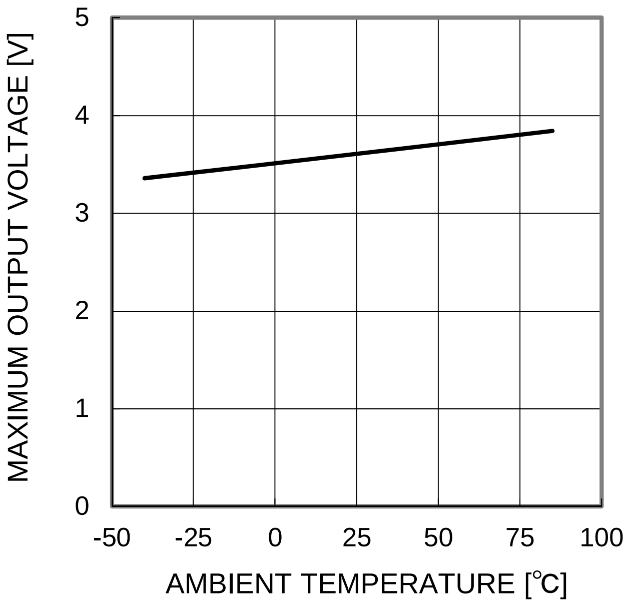


Figure 6.
Maximum Output Voltage - Ambient Temperature
(VCC=5V, RL=2kΩ)

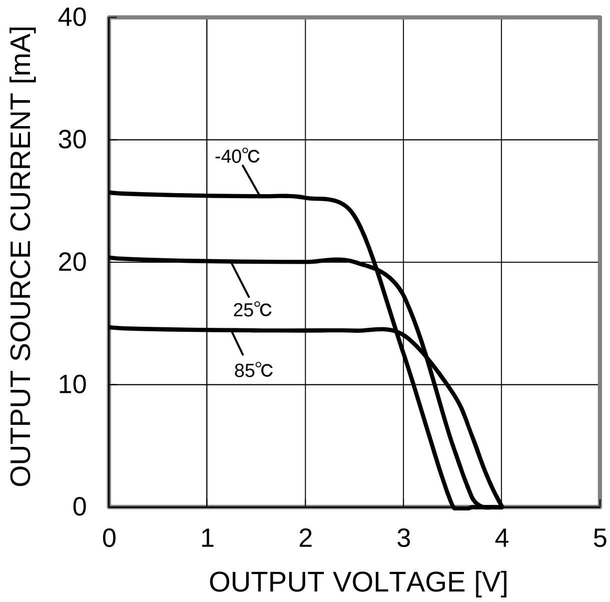


Figure 7.
Output Source Current - Output Voltage
(VCC=5V)

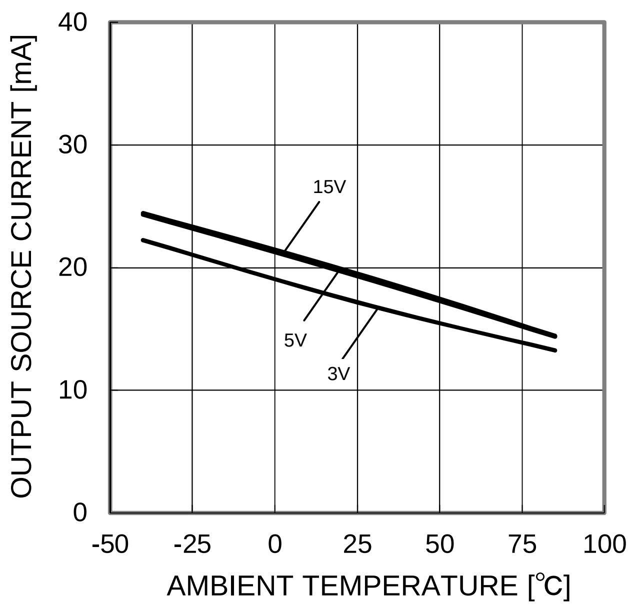


Figure 8.
Output Source Current - Ambient Temperature
(OUT=0V)

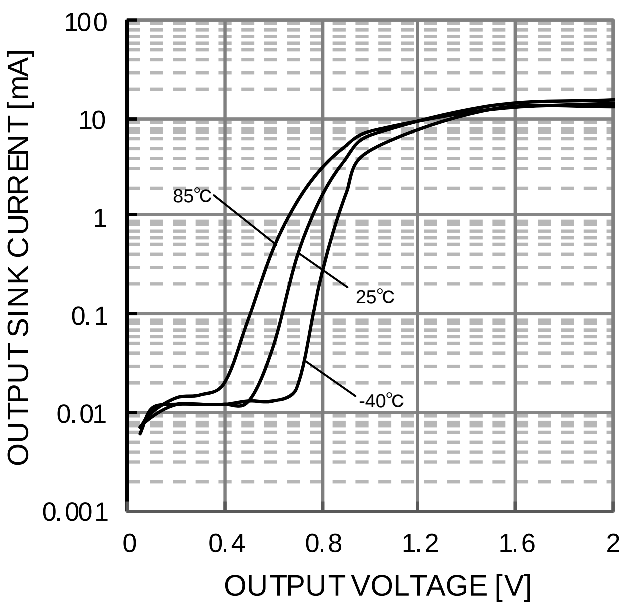


Figure 9.
Output Sink Current - Output Voltage
(VCC=5V)

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

○BA10358

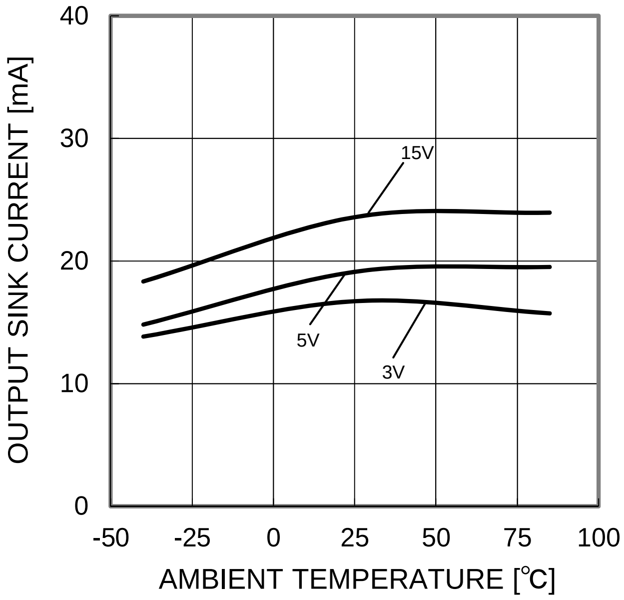


Figure 10.
Output Sink Current - Ambient Temperature
(OUT=VCC)

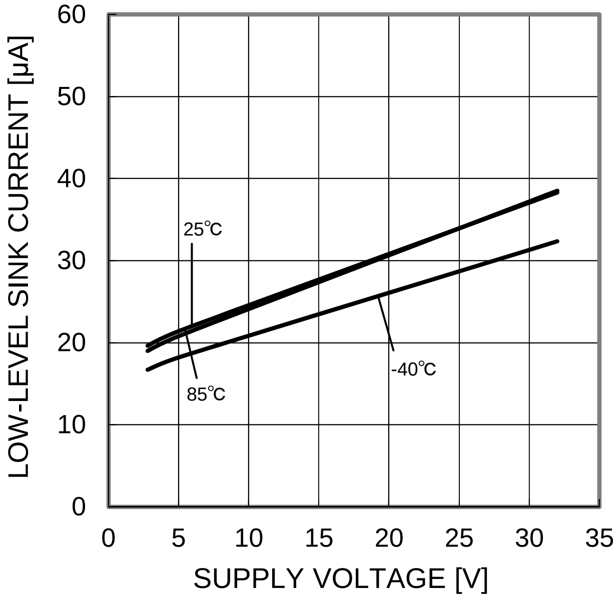


Figure 11.
Low Level Sink Current - Supply Voltage
(OUT=0.2V)

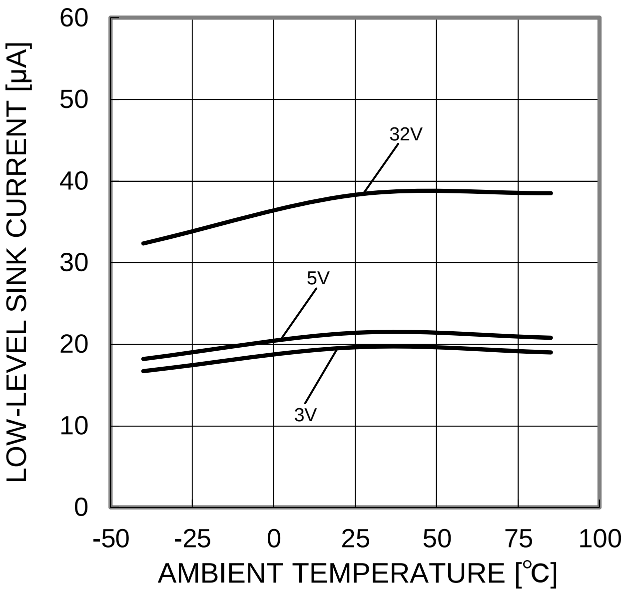


Figure 12.
Low Level Sink Current - Ambient Temperature
(OUT=0.2V)

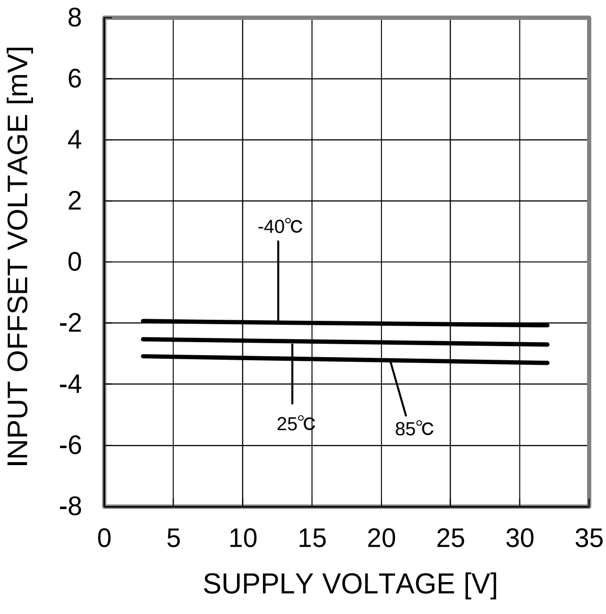


Figure 13.
Input Offset Voltage - Supply Voltage
(Vicm=0V, OUT=1.4V)

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

○BA10358

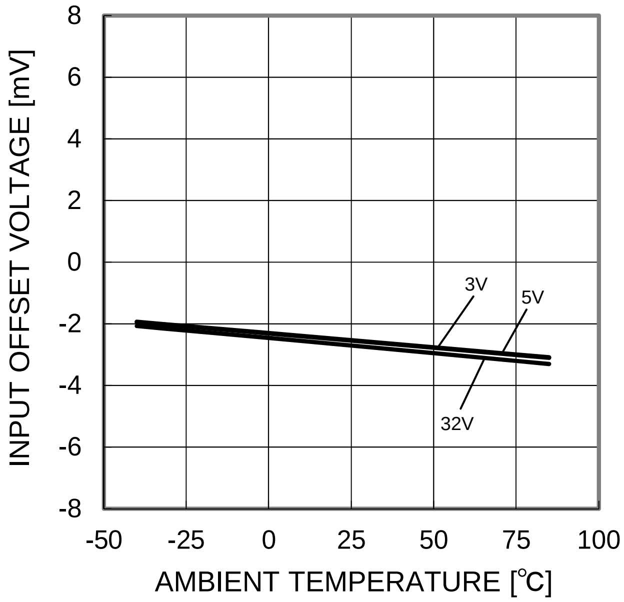


Figure 14.
Input Offset Voltage - Ambient Temperature
(Vicm=0V, OUT=1.4V)

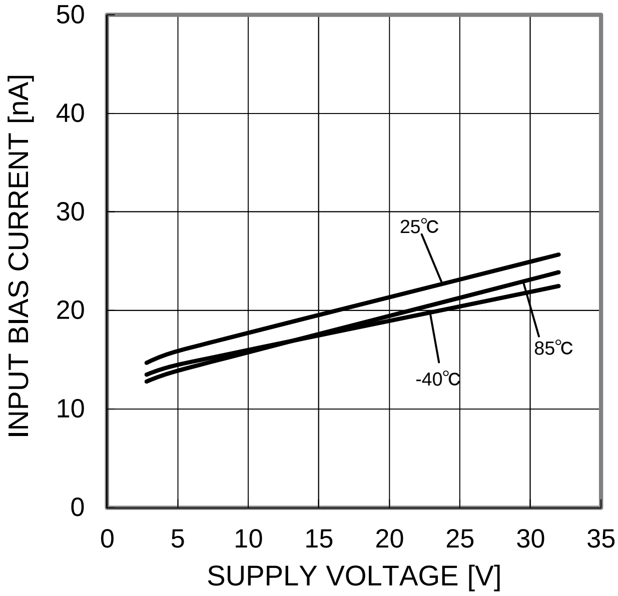


Figure 15.
Input Bias Current - Supply Voltage
(Vicm=0V, OUT=1.4V)

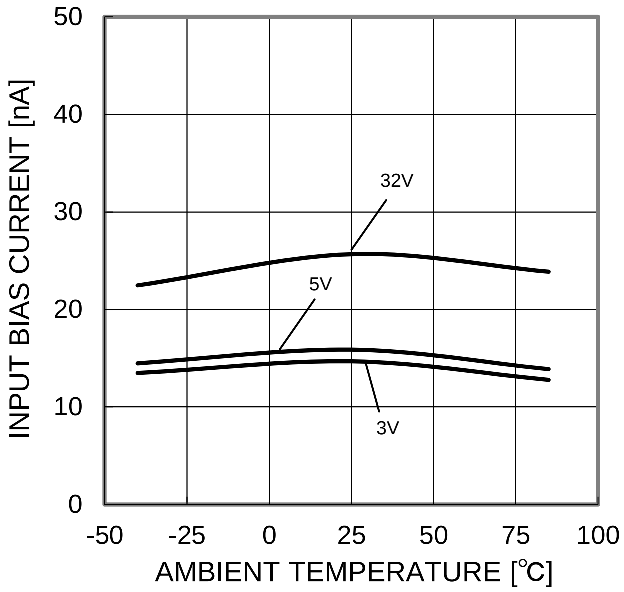


Figure 16.
Input Bias Current - Ambient Temperature
(Vicm=0V, OUT=1.4V)

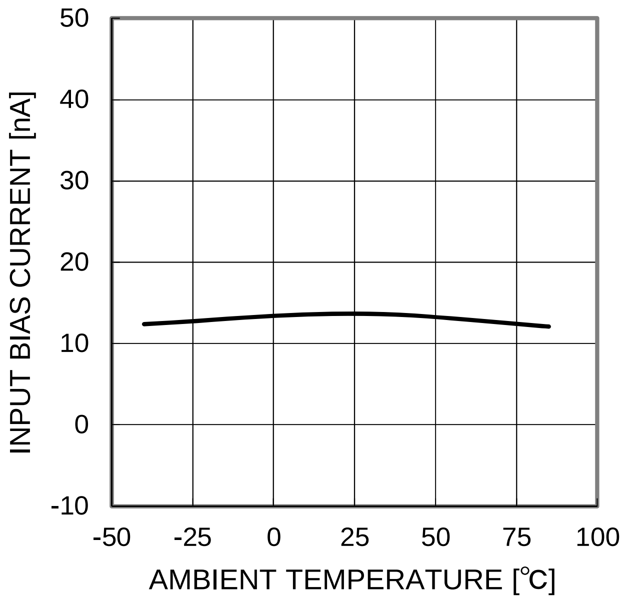


Figure 17.
Input Bias Current - Ambient Temperature
(VCC=30V, Vicm=28V, OUT=1.4V)

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

○BA10358

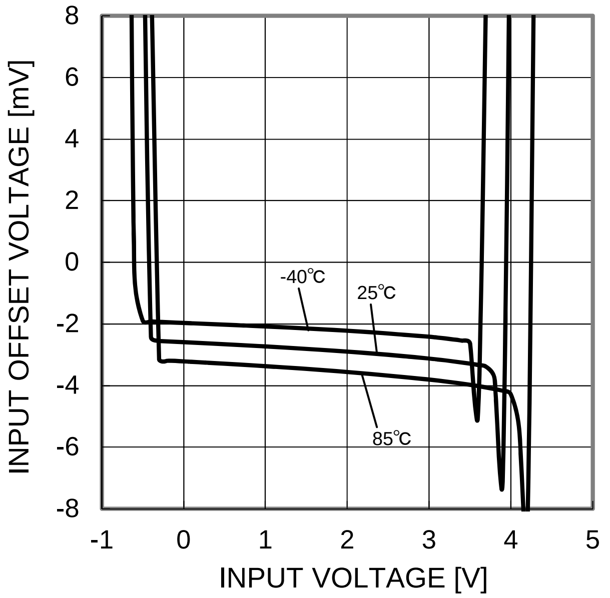


Figure 18.
Input Offset Voltage - Common Mode Input Voltage
(VCC=5V)

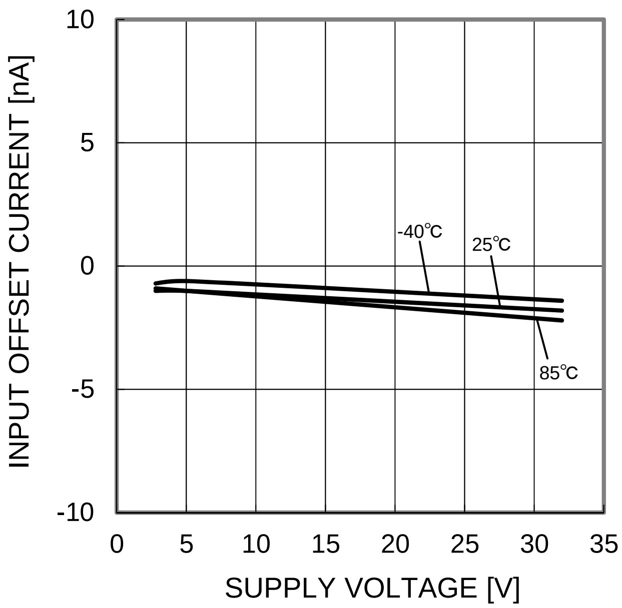


Figure 19.
Input Offset Current - Supply Voltage
(Vicm=0V, OUT=1.4V)

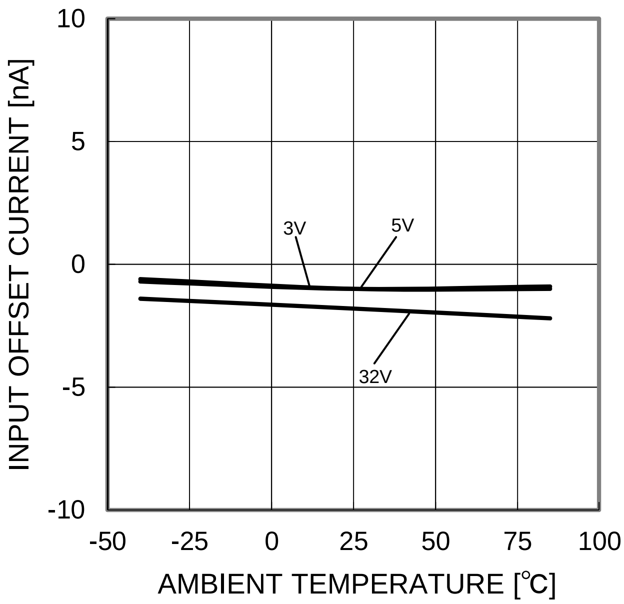


Figure 20.
Input Offset Current - Ambient Temperature
(Vicm=0V, OUT=1.4V)

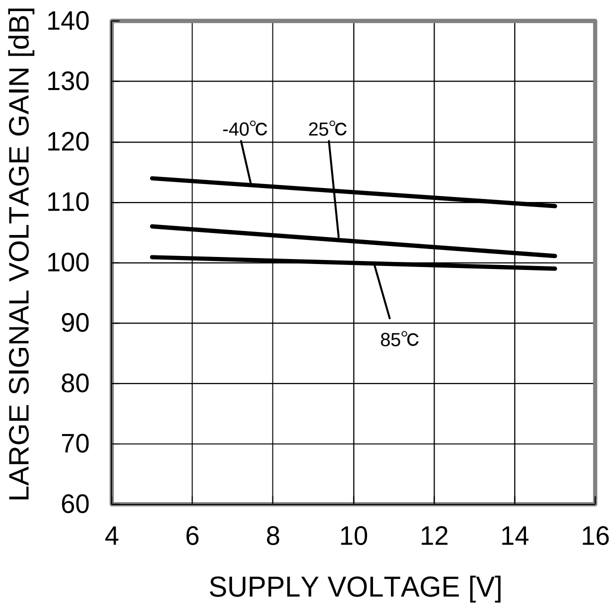


Figure 21.
Large Signal Voltage Gain - Supply Voltage
(RL=2kΩ)

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

○BA10358

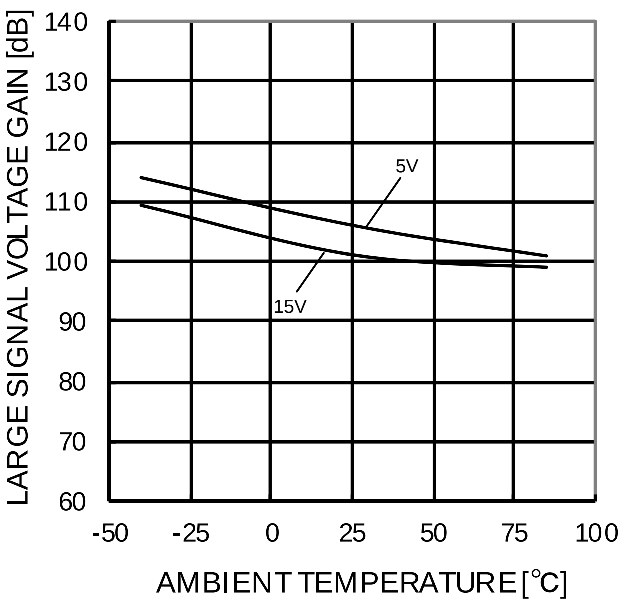


Figure 22.
Large Signal Voltage Gain - Ambient Temperature
(RL=2kΩ)

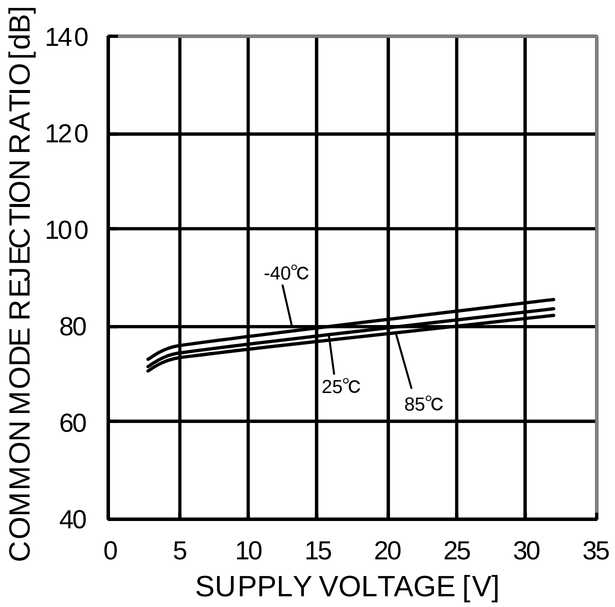


Figure 23.
Common Mode Rejection Ratio
- Supply Voltage

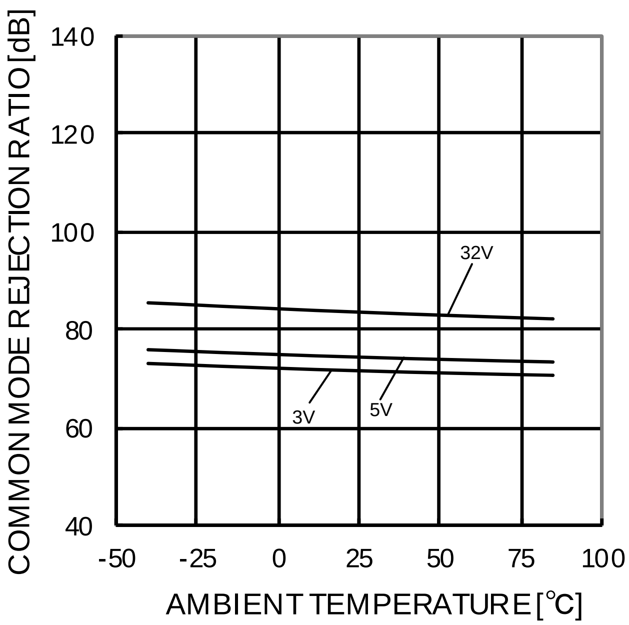


Figure 24.
Common Mode Rejection Ratio
- Ambient Temperature

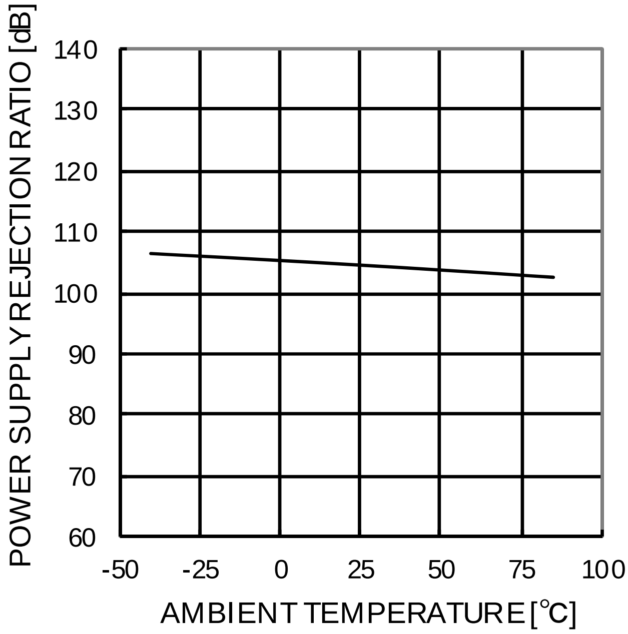


Figure 25.
Power Supply Rejection Ratio
- Ambient Temperature

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

○BA10324A

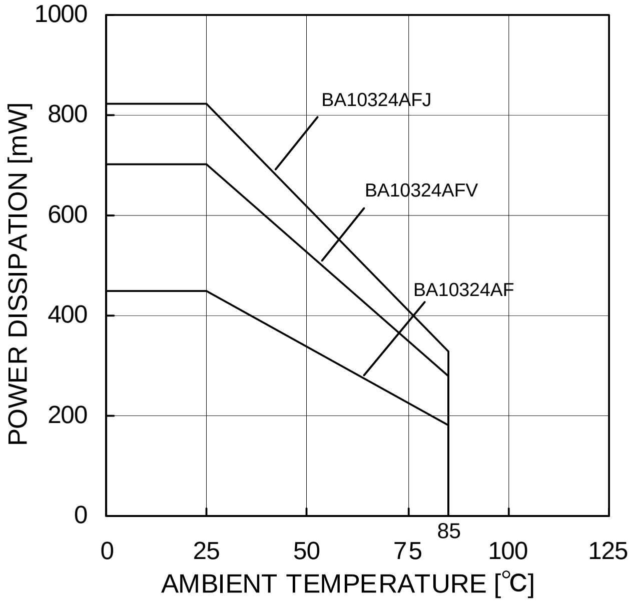


Figure 26.
Derating Curve

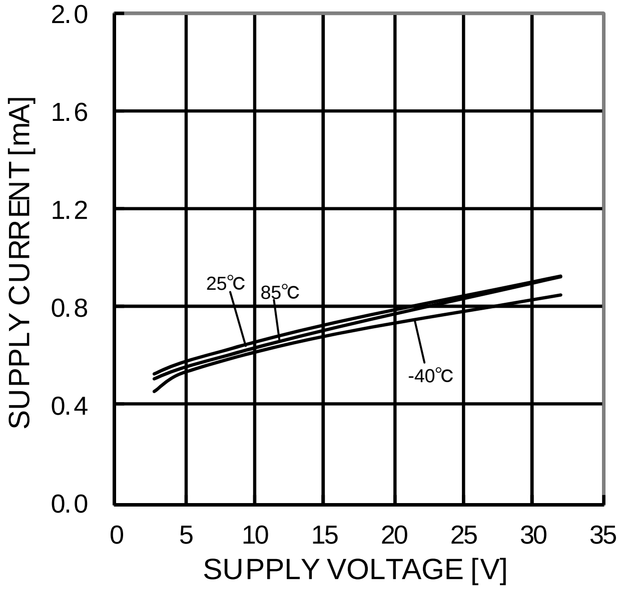


Figure 27.
Supply Current - Supply Voltage

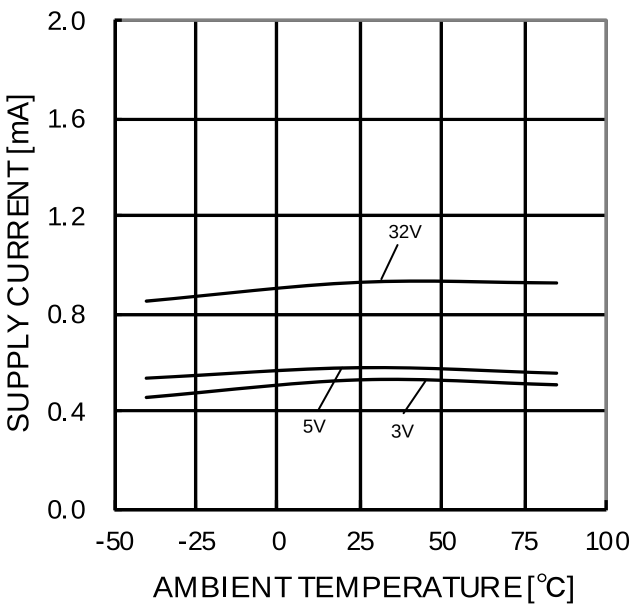


Figure 28.
Supply Current - Ambient Temperature

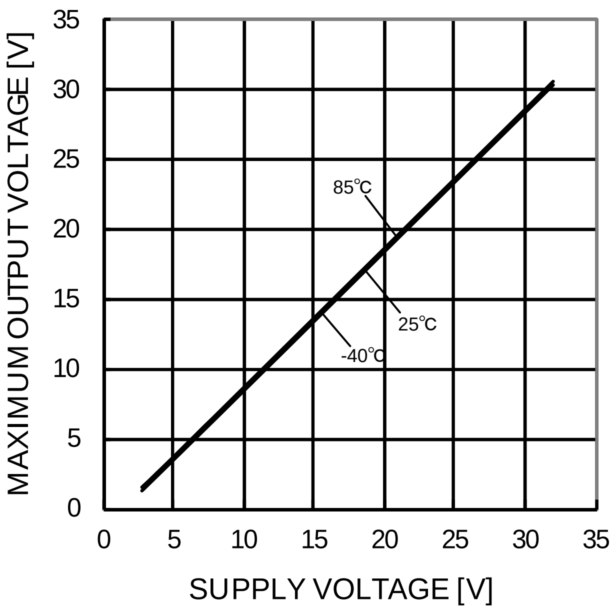


Figure 29.
Maximum Output Voltage - Supply Voltage
(RL=10kΩ)

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

○BA10324A

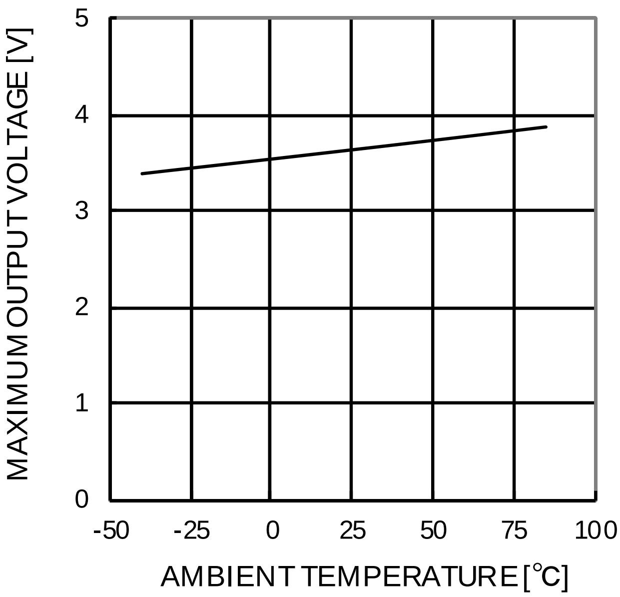


Figure 30.
Maximum Output Voltage - Ambient Temperature
(VCC=5V, RL=2kΩ)

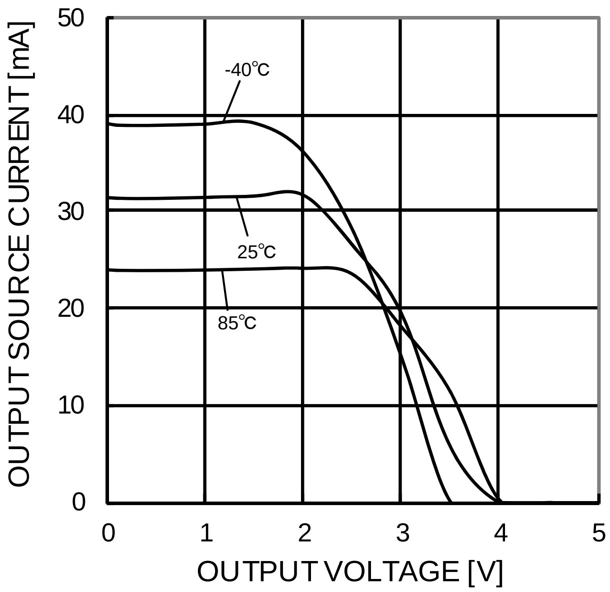


Figure 31.
Output Source Current - Output Voltage
(VCC=5V)

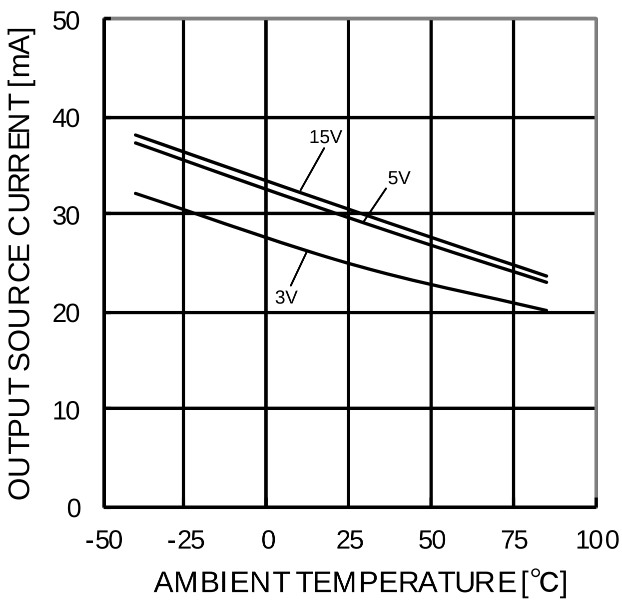


Figure 32.
Output Source Current - Ambient Temperature
(OUT=0V)

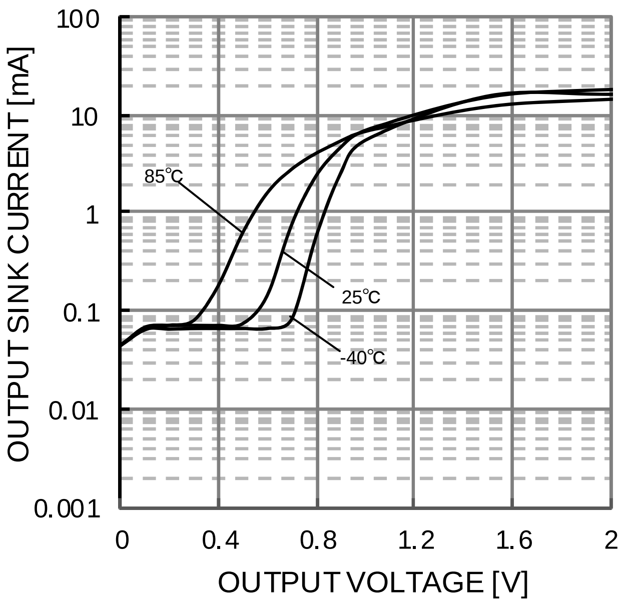


Figure 33.
Output Sink Current - Output Voltage
(VCC=5V)

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

○BA10324A

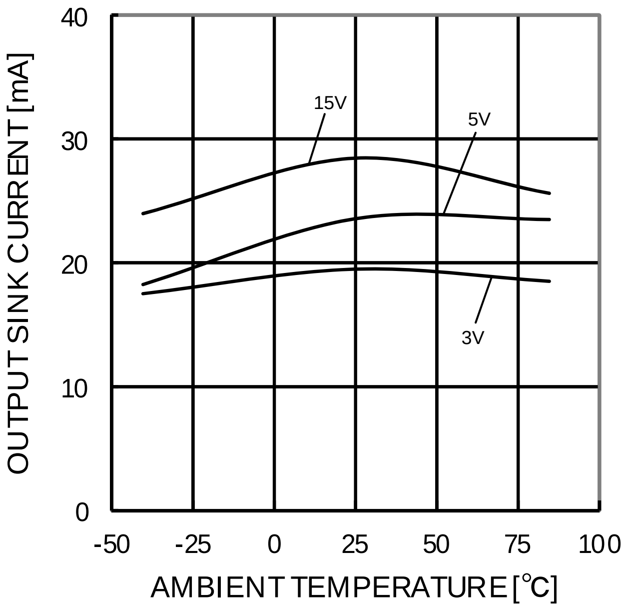


Figure 34.
Output Sink Current - Ambient Temperature
(OUT=VCC)

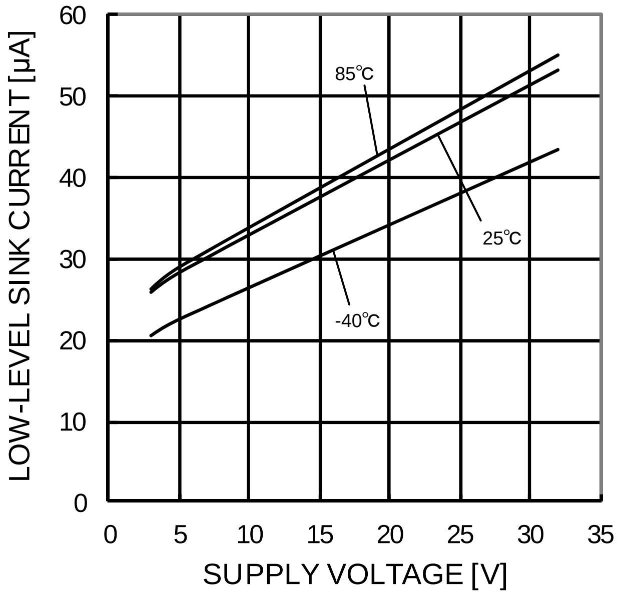


Figure 35.
Low Level Sink Current - Supply Voltage
(OUT=0.2V)

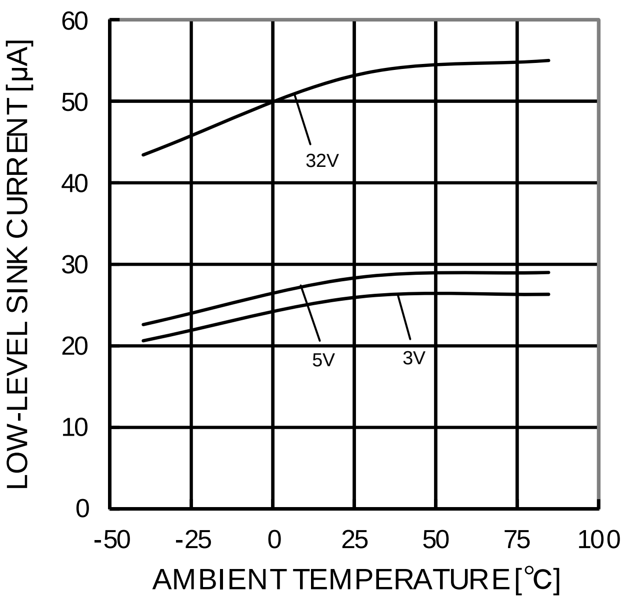


Figure 36.
Low Level Sink Current - Ambient Temperature
(OUT=0.2V)

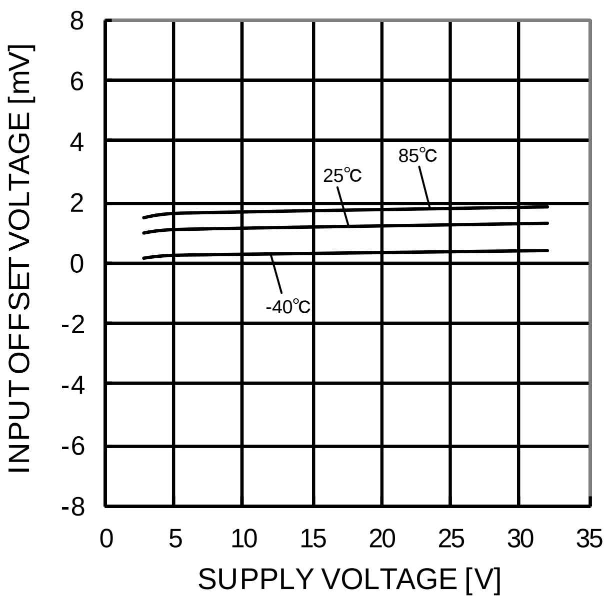


Figure 37.
Input Offset Voltage - Supply Voltage
(Vicm=0V, OUT=1.4V)

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

○BA10324A

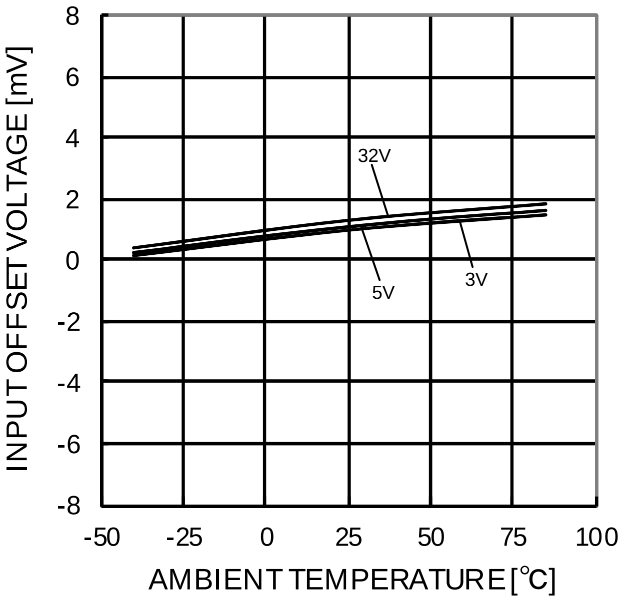


Figure 38.
Input Offset Voltage - Ambient Temperature
(Vicm=0V, OUT=1.4V)

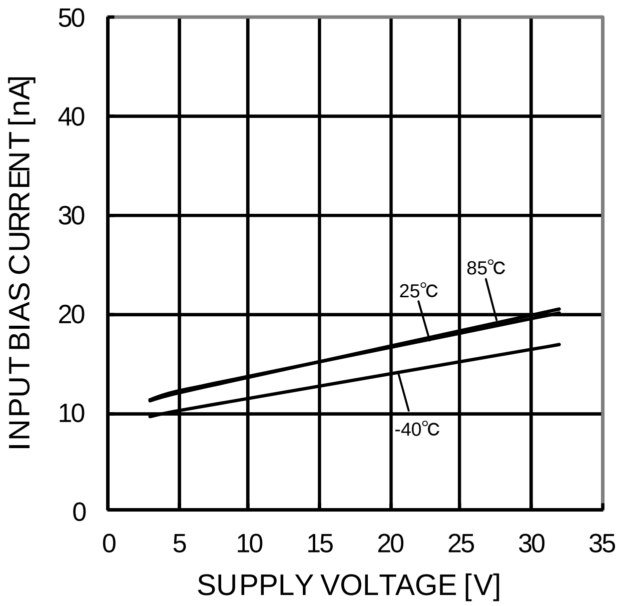


Figure 39.
Input Bias Current - Supply Voltage
(Vicm=0V, OUT=1.4V)

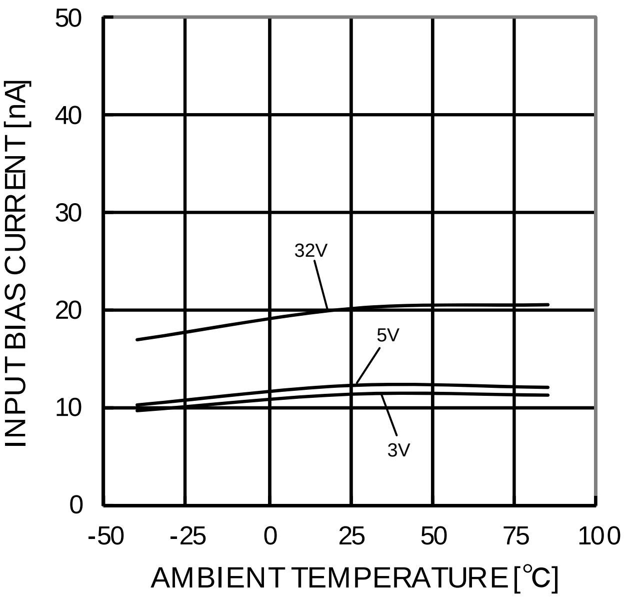


Figure 40.
Input Bias Current - Ambient Temperature
(Vicm=0V, OUT=1.4V)

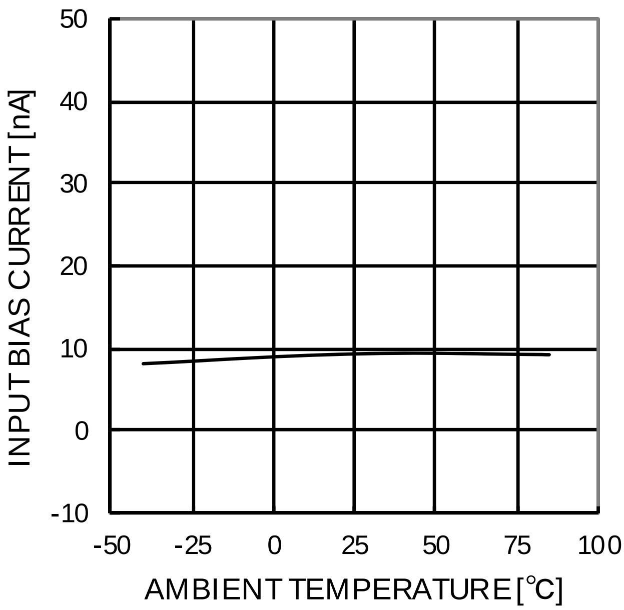


Figure 41.
Input Bias Current - Ambient Temperature
(VCC=30V, Vicm=28V, OUT=1.4V)

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

○BA10324A

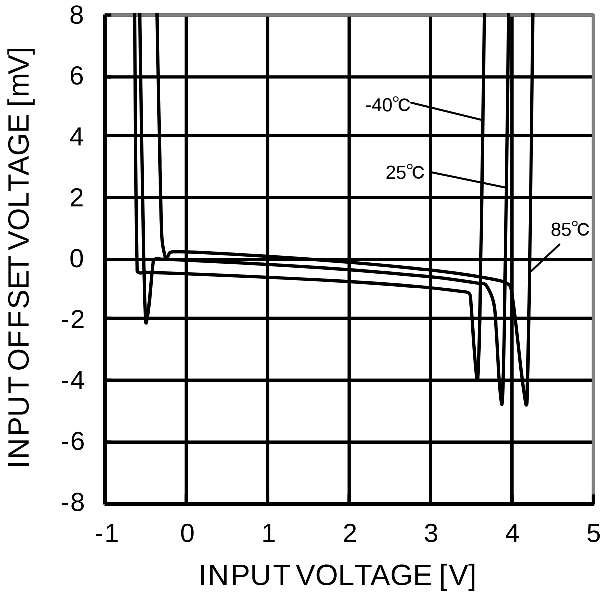


Figure 42.
Input Offset Voltage
- Common Mode Input Voltage
(VCC=5V)

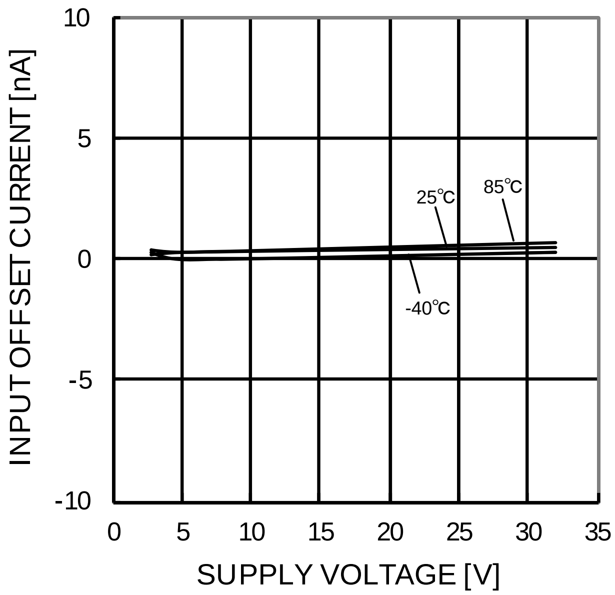


Figure 43.
Input Offset Current - Supply Voltage
(Vicm=0V, OUT=1.4V)

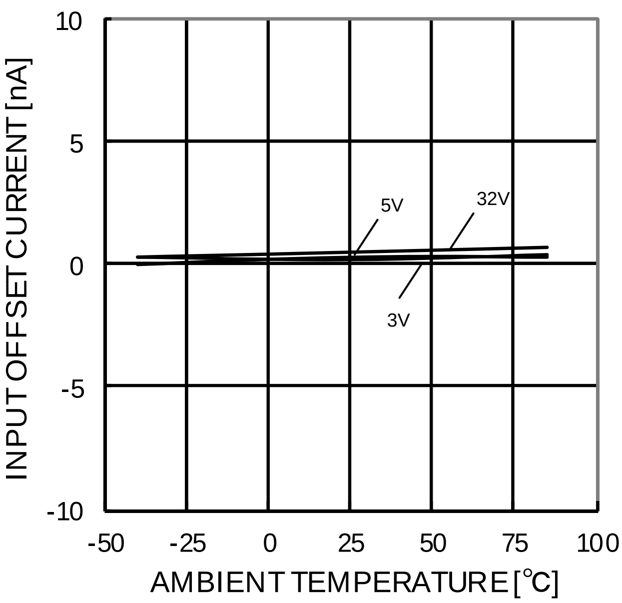


Figure 44.
Input Offset Current - Ambient Temperature
(Vicm=0V, OUT=1.4V)

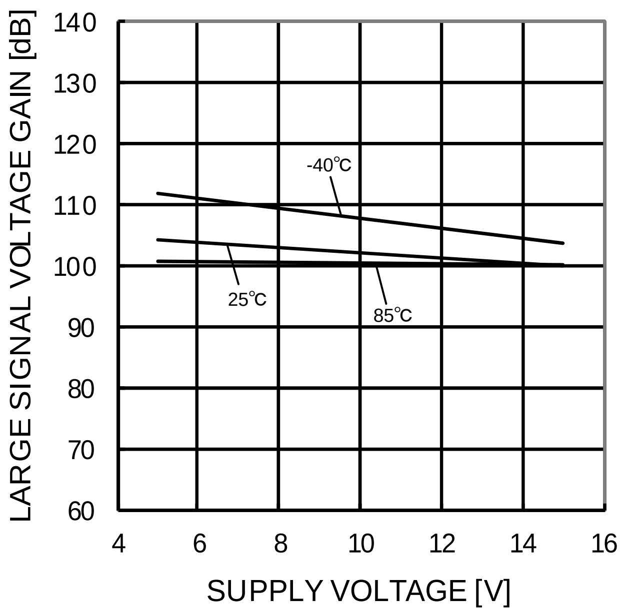


Figure 45.
Large Signal Voltage Gain - Supply Voltage
(RL=2kΩ)

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

○BA10324A

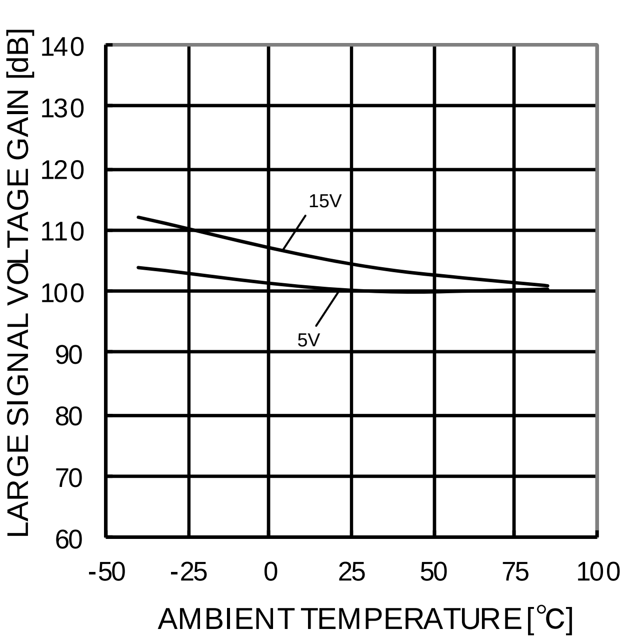


Figure 46.
Large Signal Voltage Gain
- Ambient Temperature
(RL=2kΩ)

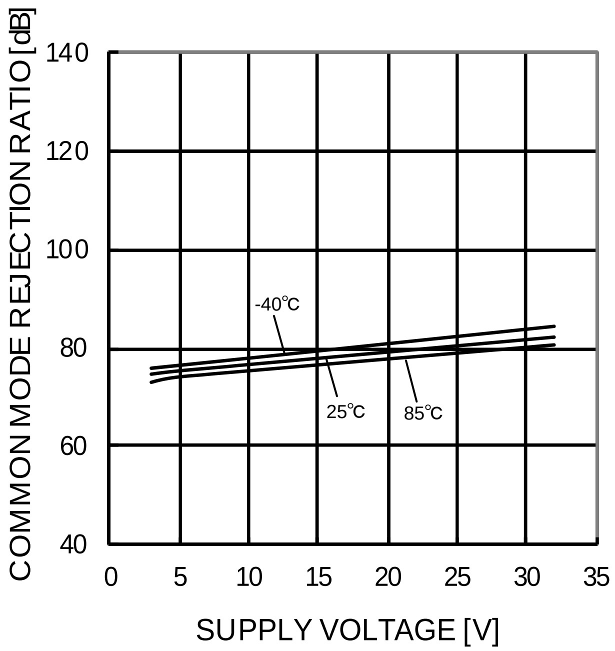


Figure 47.
Common Mode Rejection Ratio
- Supply Voltage

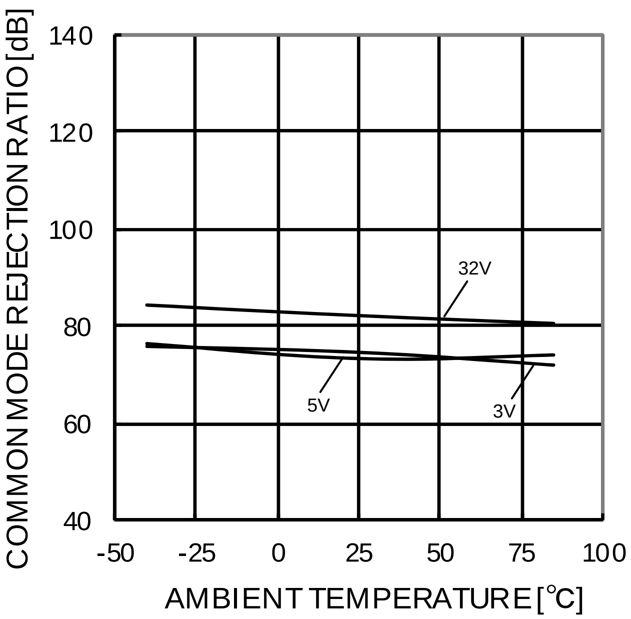


Figure 48.
Common Mode Rejection Ratio
- Ambient Temperature

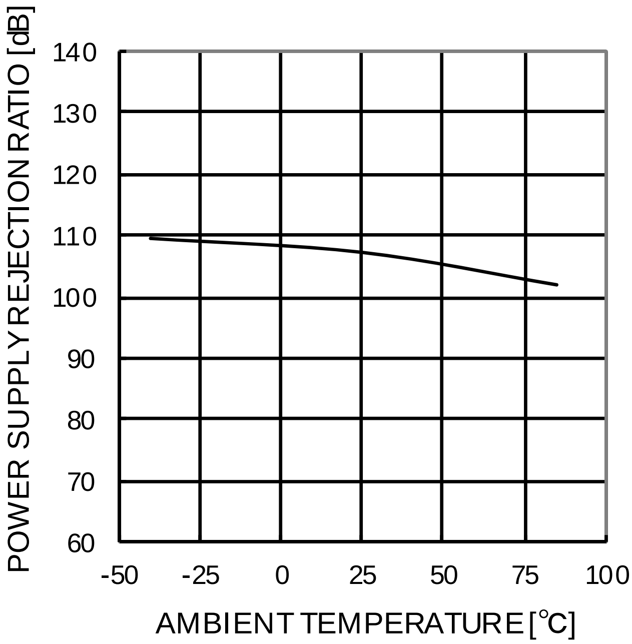


Figure 49.
Power Supply Rejection Ratio
- Ambient Temperature

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

○BA2904, BA2904S, BA2904W

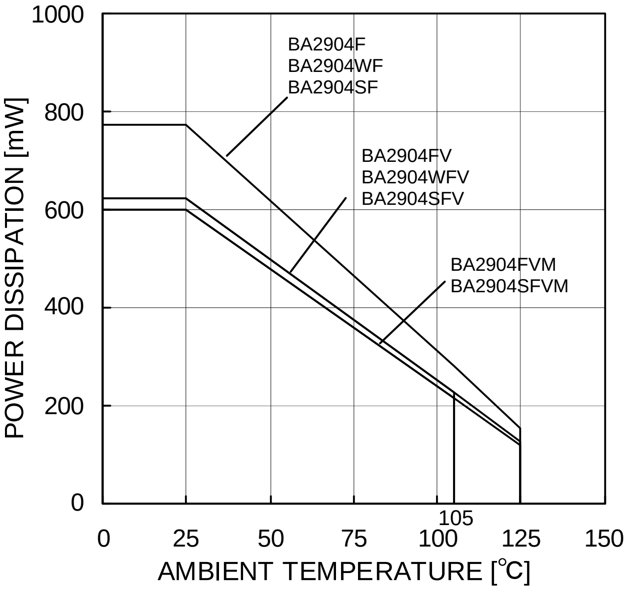


Figure 50.
Derating Curve

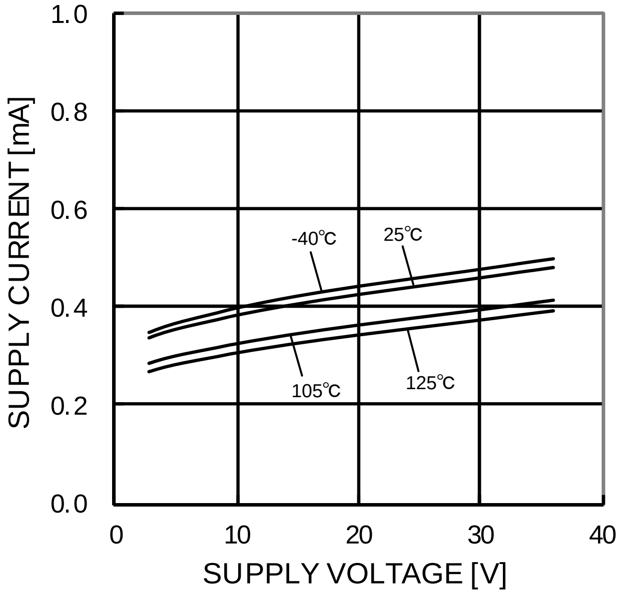


Figure 51.
Supply Current- Supply Voltage

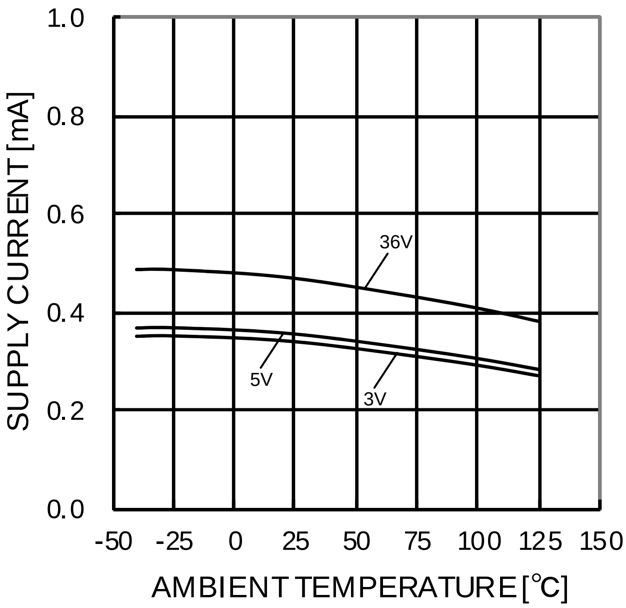


Figure 52.
Supply Current – Ambient Temperature

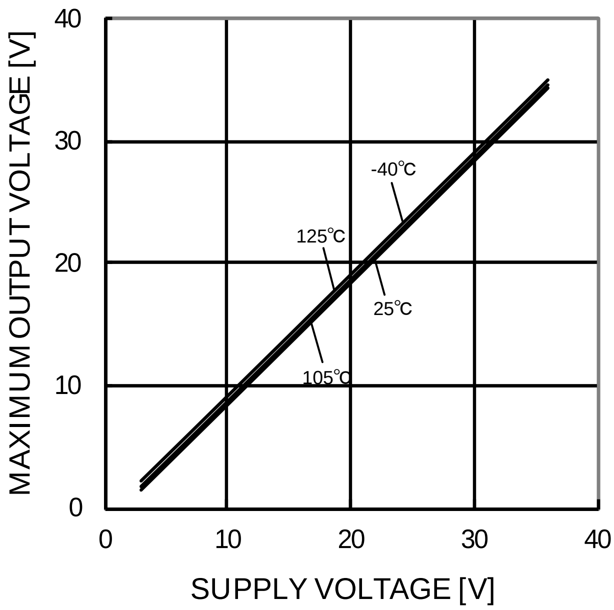


Figure 53.
Maximum Output Voltage - Supply Voltage
(RL=10kΩ)

(*) The above data is measurement value of typical sample, it is not guaranteed.
BA2904, BA2904W : -40℃ to ＋125℃　BA2904S : -40℃ to ＋105℃

○BA2904, BA2904S, BA2904W

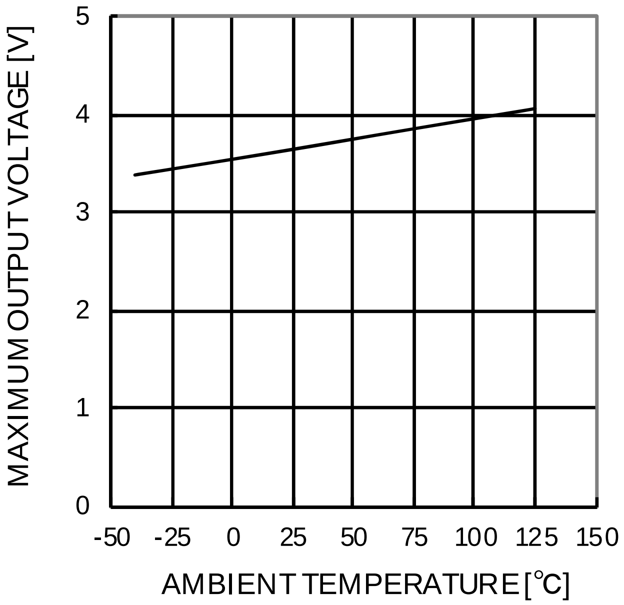


Figure 54.
Maximum Output Voltage - Ambient Temperature
(VCC=5V, RL=2kΩ)

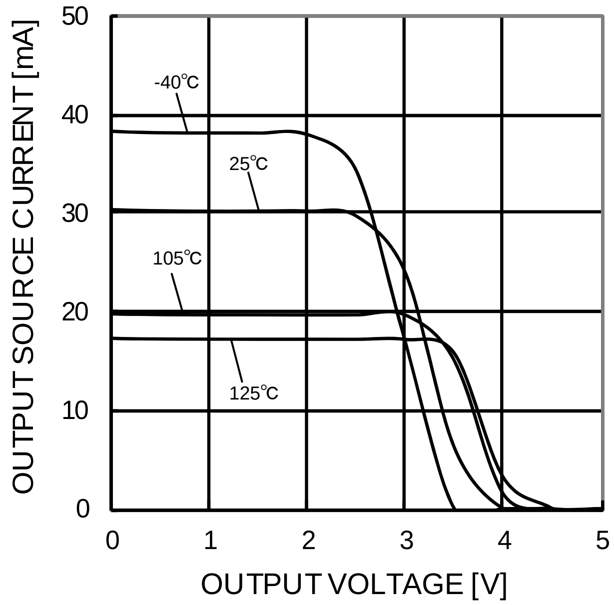


Figure 55.
Output Source Current - Output Voltage
(VCC=5V)

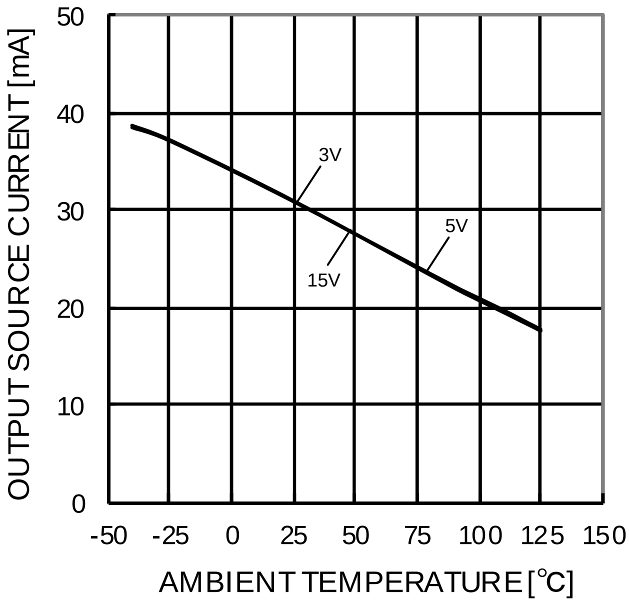


Figure 56.
Output Source Current - Ambient Temperature
(OUT=0V)

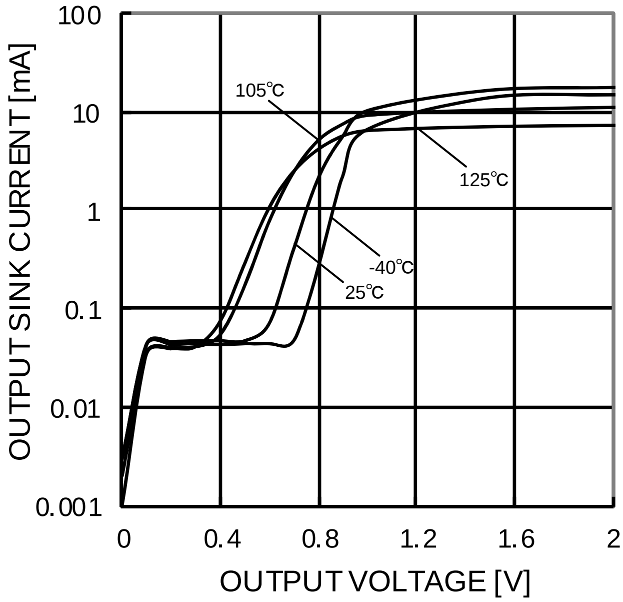


Figure 57.
Output Sink Current - Output Voltage
(VCC=5V)

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

○BA2904, BA2904S, BA2904W

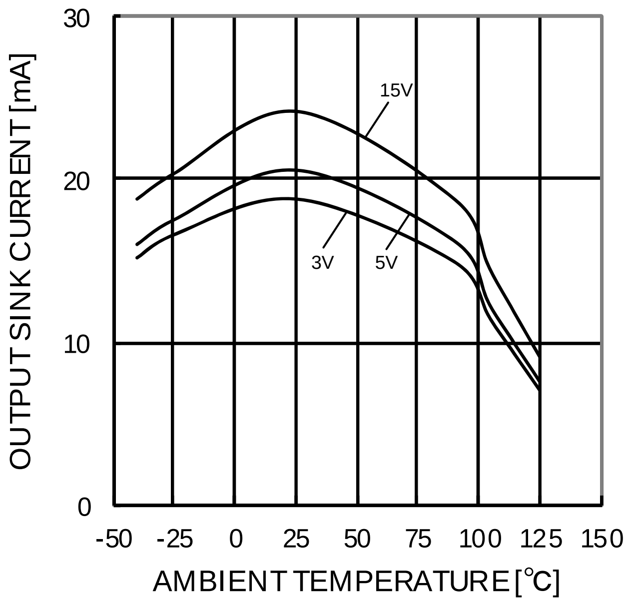


Figure 58.
Output Sink Current - Ambient Temperature
(OUT=VCC)

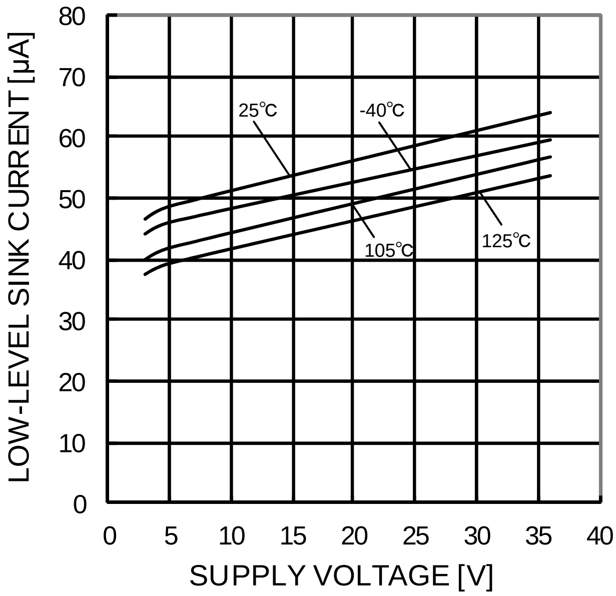


Figure 59.
Low Level Sink Current - Supply Voltage
(OUT=0.2V)

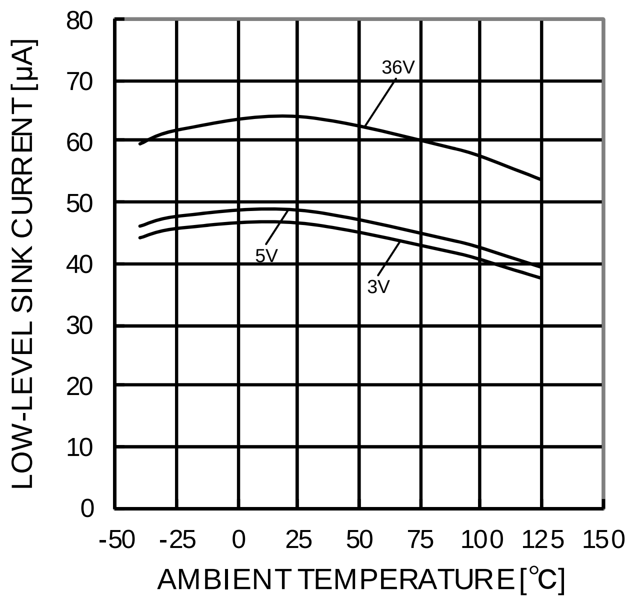


Figure 60.
Low Level Sink Current - Ambient Temperature
(OUT=0.2V)

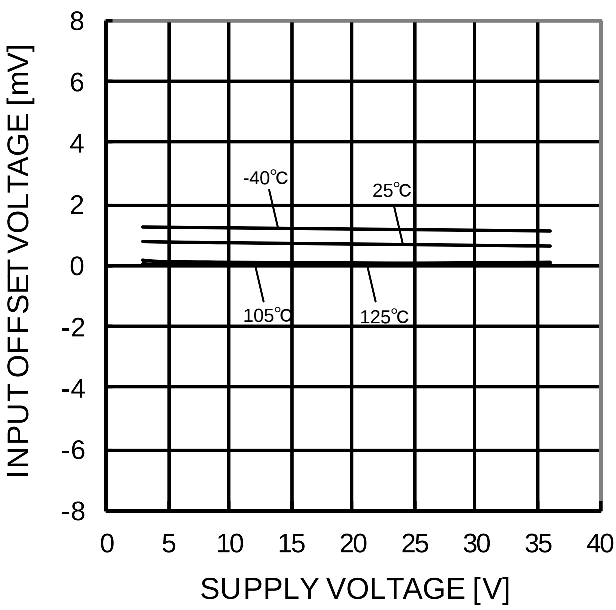


Figure 61.
Input Offset Voltage - Supply Voltage
(Vicm=0V, OUT=1.4V)

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

○BA2904, BA2904S, BA2904W

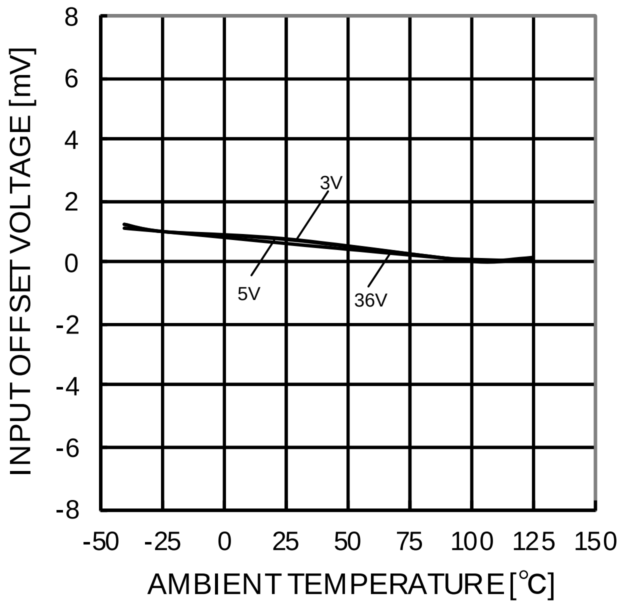


Figure 62.
Input Offset Voltage - Ambient Temperature
(Vicm=0V, OUT=1.4V)

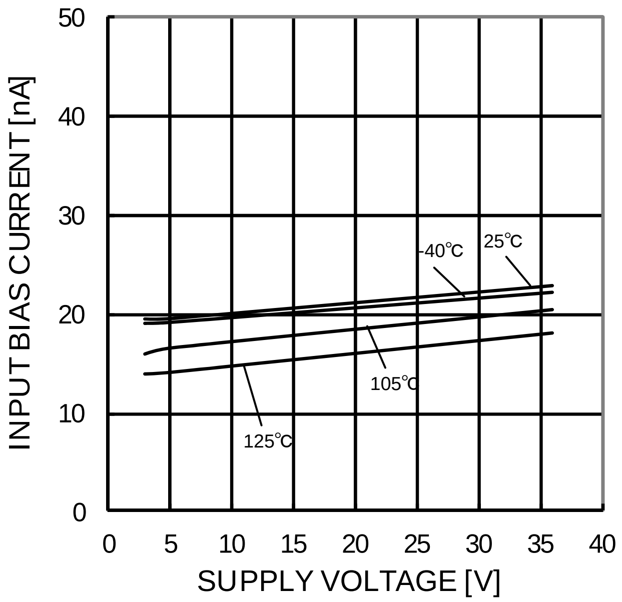


Figure 63.
Input Bias Current - Supply Voltage
(Vicm=0V, OUT=1.4V)

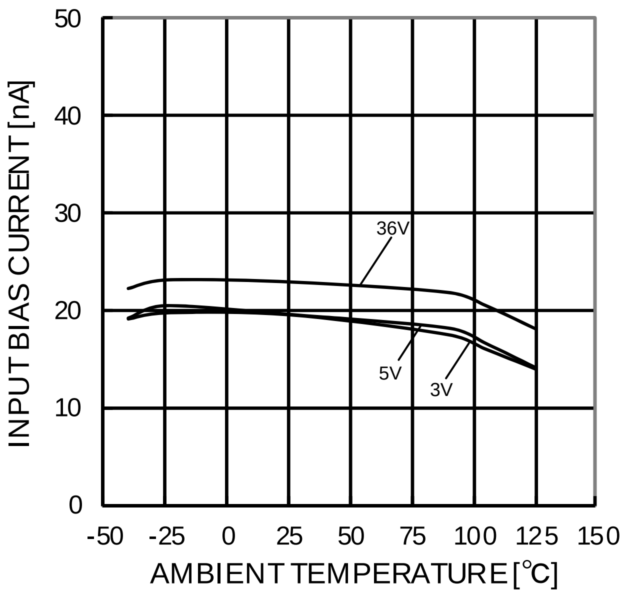


Figure 64.
Input Bias Current - Ambient Temperature
(Vicm=0V, OUT=1.4V)

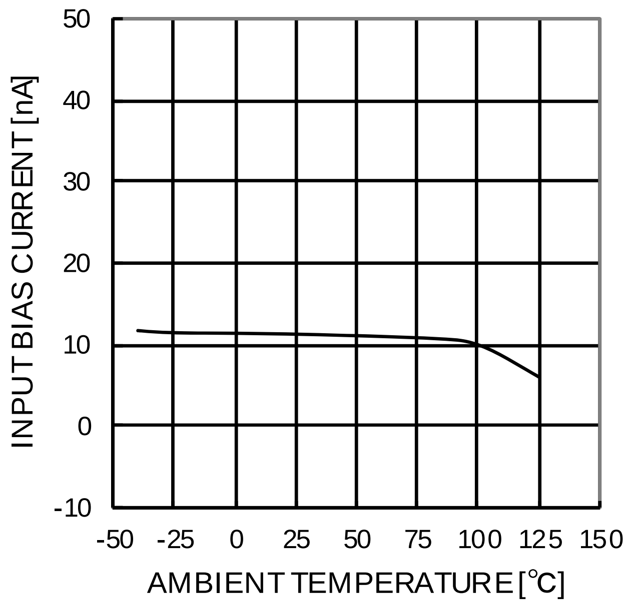


Figure 65.
Input Bias Current - Ambient Temperature
(VCC=30V, Vicm=28V, OUT=1.4V)

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

○BA2904, BA2904S, BA2904W

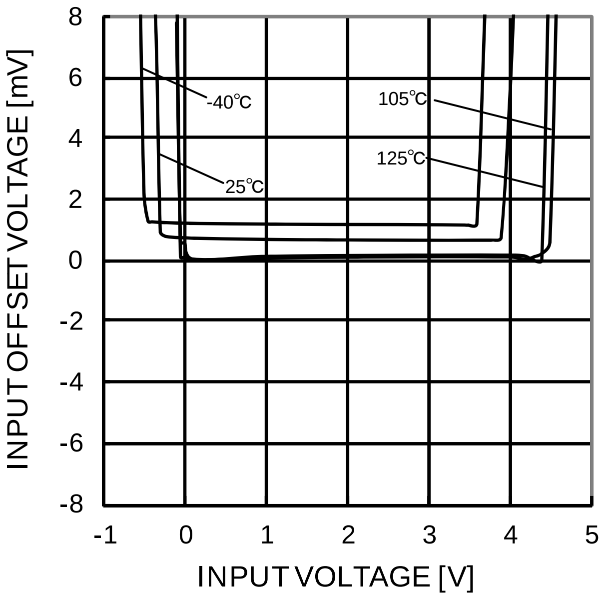


Figure 66.
Input Offset Voltage - Common Mode Input Voltage
(VCC=5V)

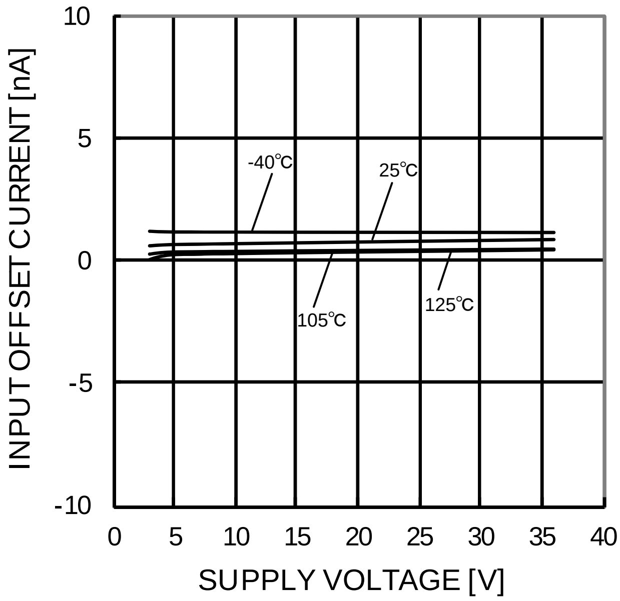


Figure 67.
Input Offset Current - Supply Voltage
(Vicm=0V, OUT=1.4V)

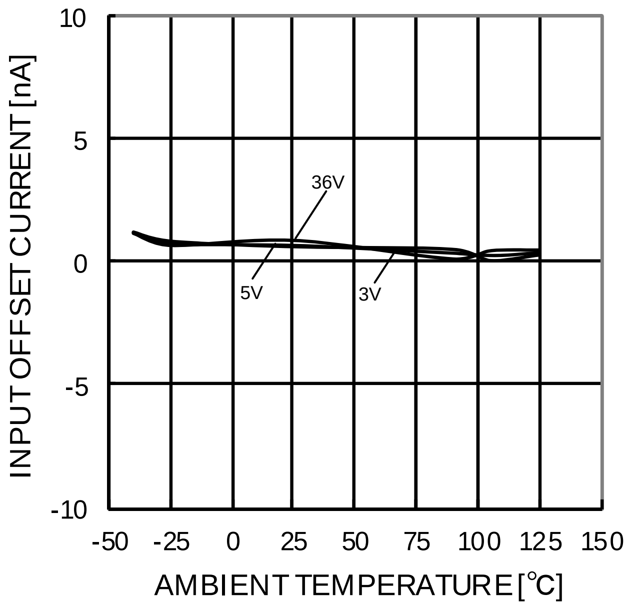


Figure 68.
Input Offset Current - Ambient Temperature
(Vicm=0V, OUT=1.4V)

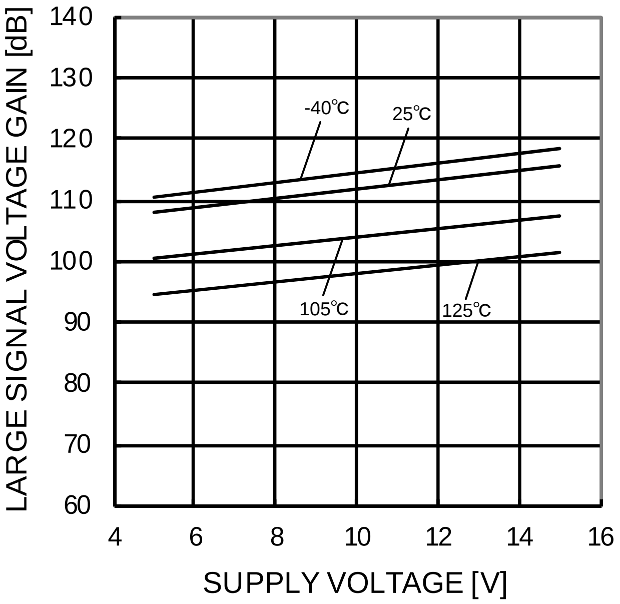


Figure 69.
Large Signal Voltage Gain - Supply Voltage
(RL=2kΩ)

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

○BA2904, BA2904S, BA2904W

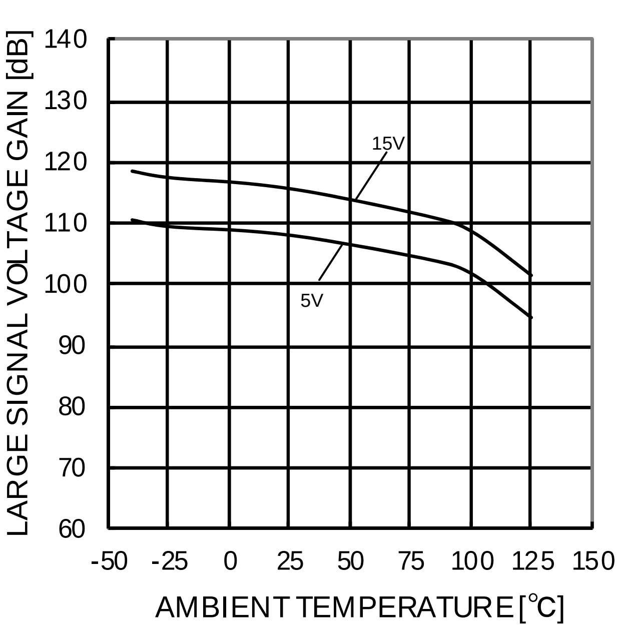


Figure 70.
Large Signal Voltage Gain
- Ambient Temperature
(RL=2kΩ)

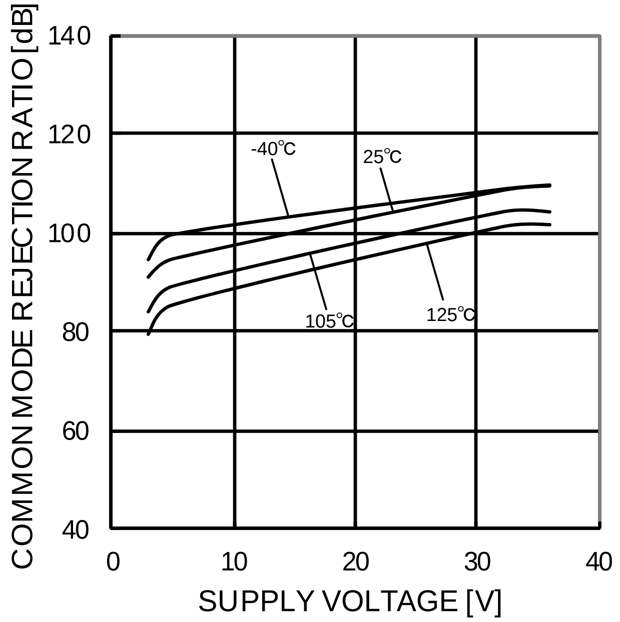


Figure 71.
Common Mode Rejection Ratio
- Supply Voltage

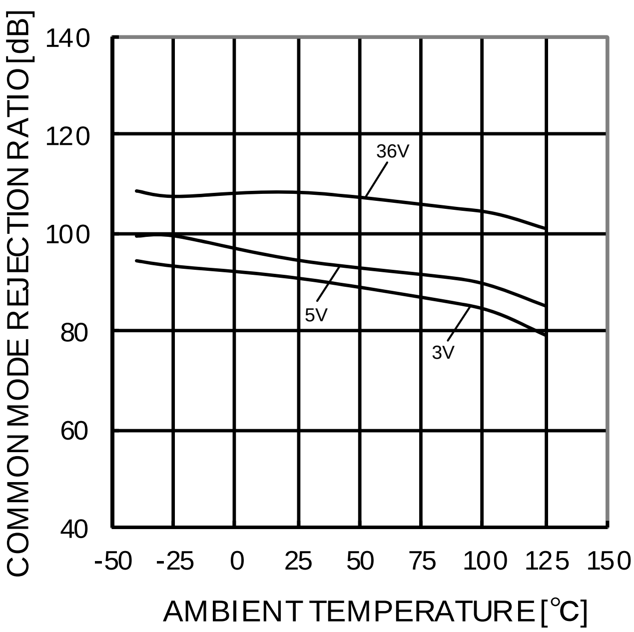


Figure 72.
Common Mode Rejection Ratio
- Ambient Temperature

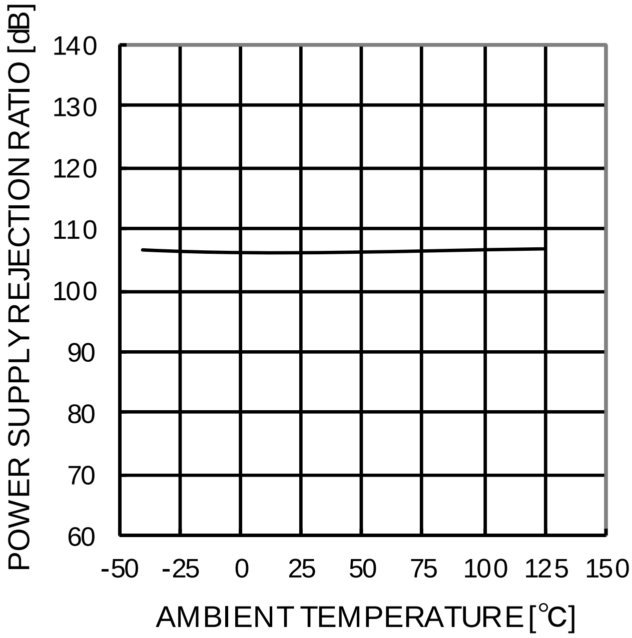


Figure 73.
Power Supply Rejection Ratio
- Ambient Temperature

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

○BA2902, BA2902S

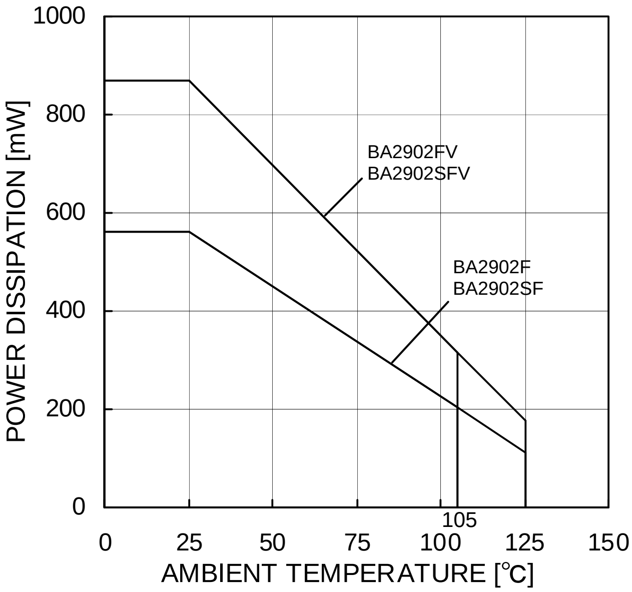


Figure 74.
Derating Curve

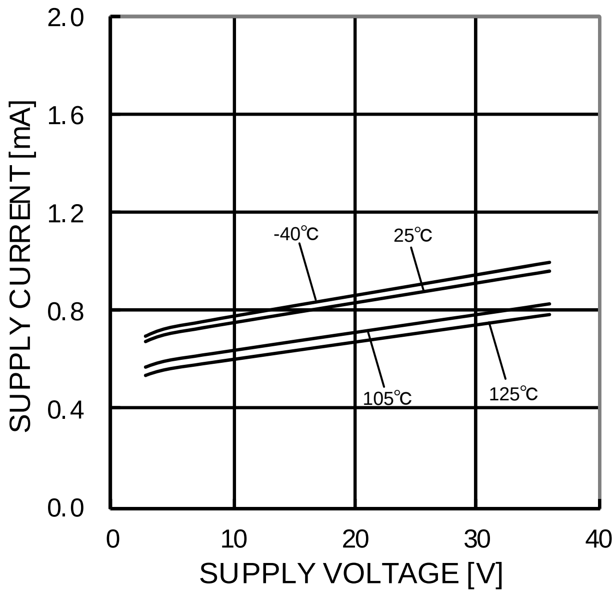


Figure 75.
Supply Current - Supply Voltage

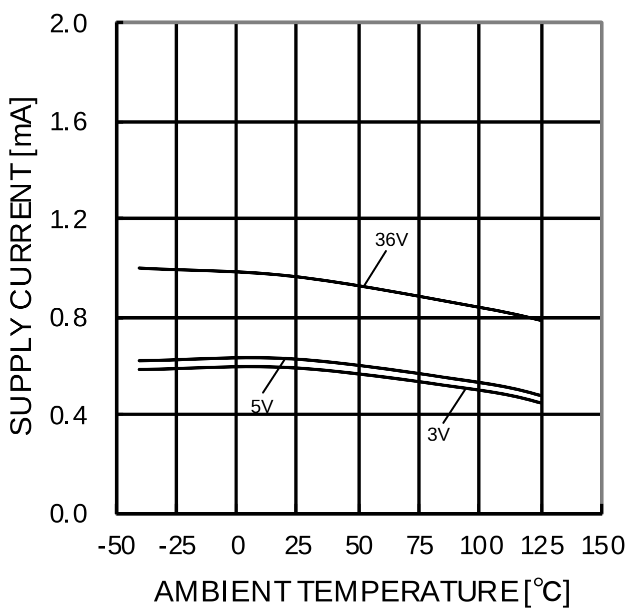


Figure 76.
Supply Current - Ambient Temperature

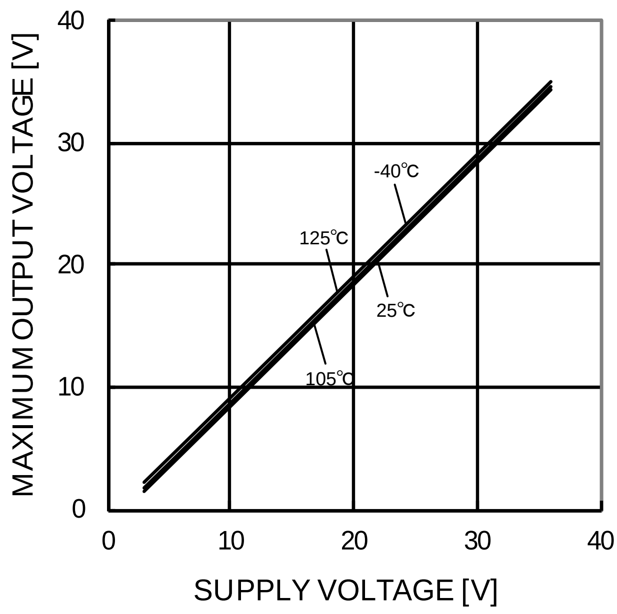


Figure 77.
Maximum Output Voltage - Supply Voltage
(RL=10kΩ)

(*) The above data is measurement value of typical sample, it is not guaranteed.
BA2902 : -40℃ to +125℃ BA2902S : -40℃ to +105℃

○BA2902, BA2902S

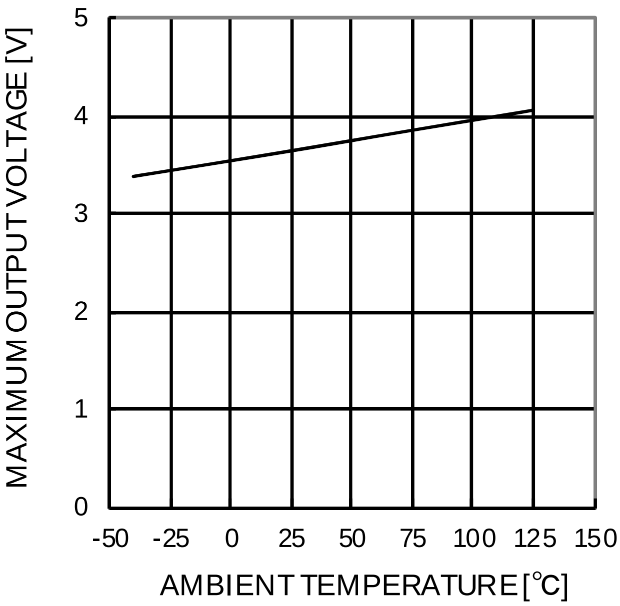


Figure 78.
Maximum Output Voltage - Ambient Temperature (VCC=5V, RL=2kΩ)

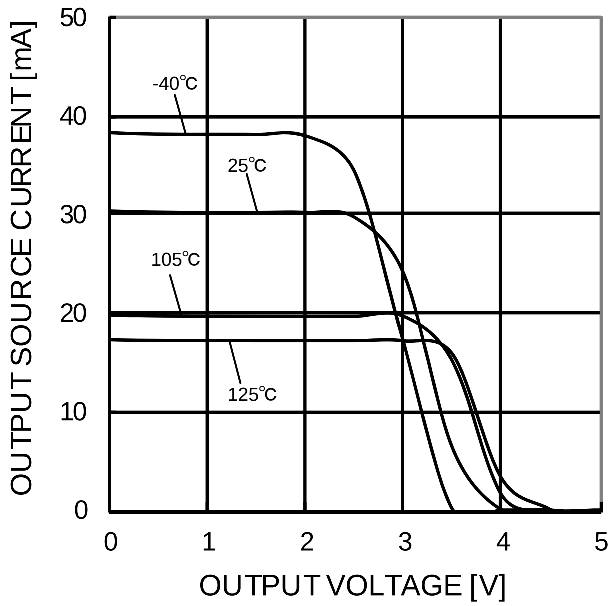


Figure 79.
Output Source Current - Output Voltage (VCC=5V)

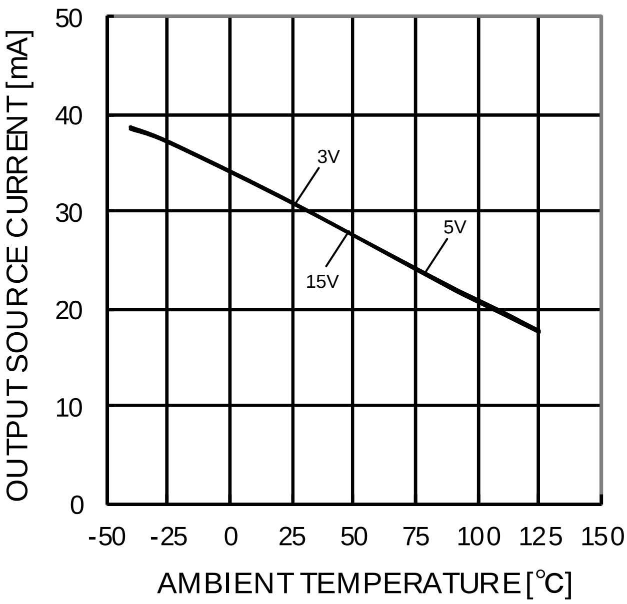


Figure 80.
Output Source Current - Ambient Temperature (OUT=0V)

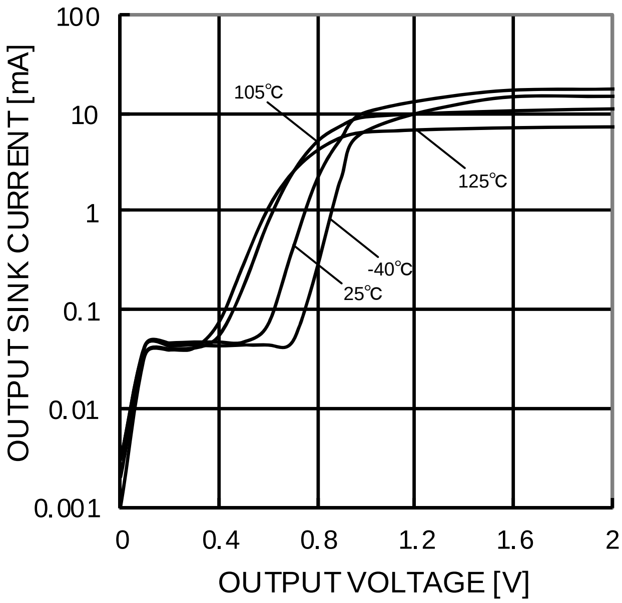


Figure 81.
Output Sink Current - Output Voltage (VCC=5V)

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

○BA2902, BA2902S

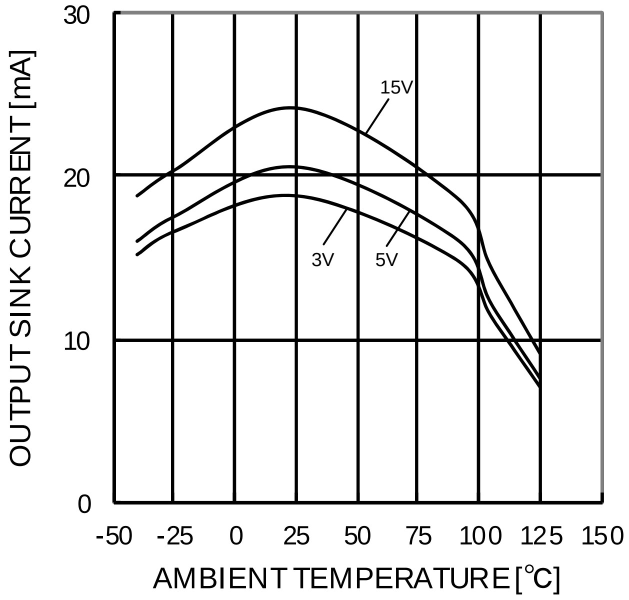


Figure 82.
Output Sink Current - Ambient Temperature
(OUT=VCC)

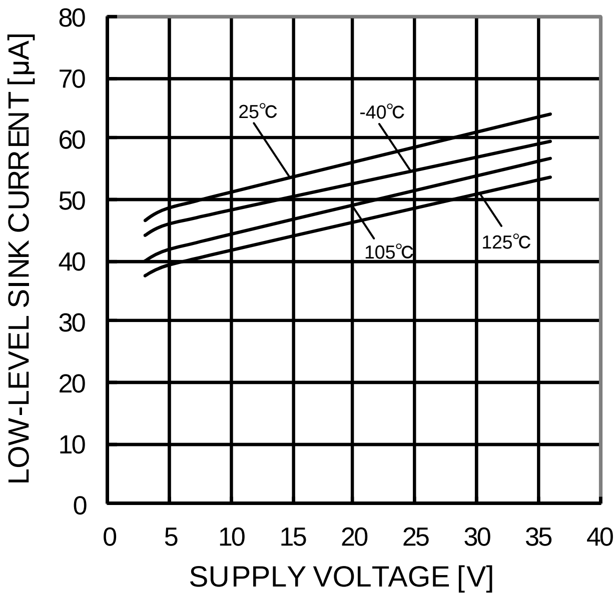


Figure 83.
Low Level Sink Current - Supply Voltage
(OUT=0.2V)

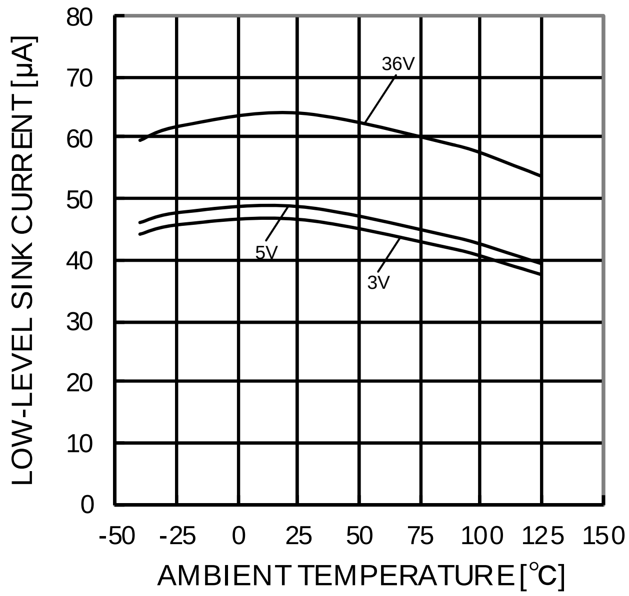


Figure 84.
Low Level Sink Current - Ambient Temperature
(OUT=0.2V)

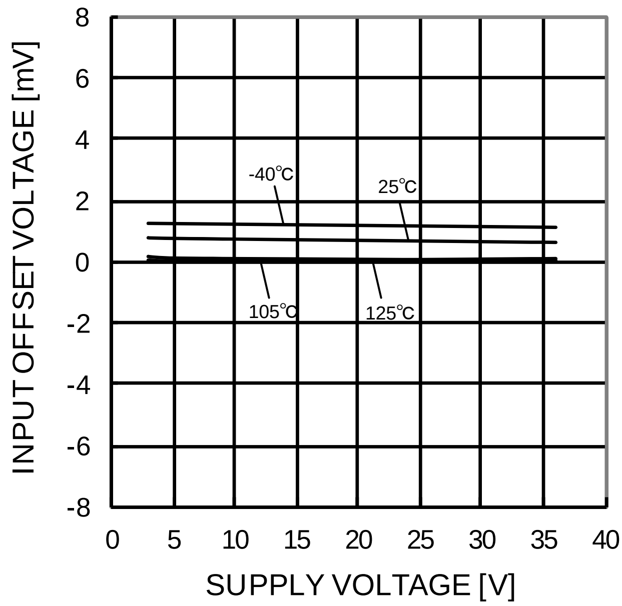


Figure 85.
Input Offset Voltage - Supply Voltage
(Vicm=0V, OUT=1.4V)

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

○BA2902, BA2902S

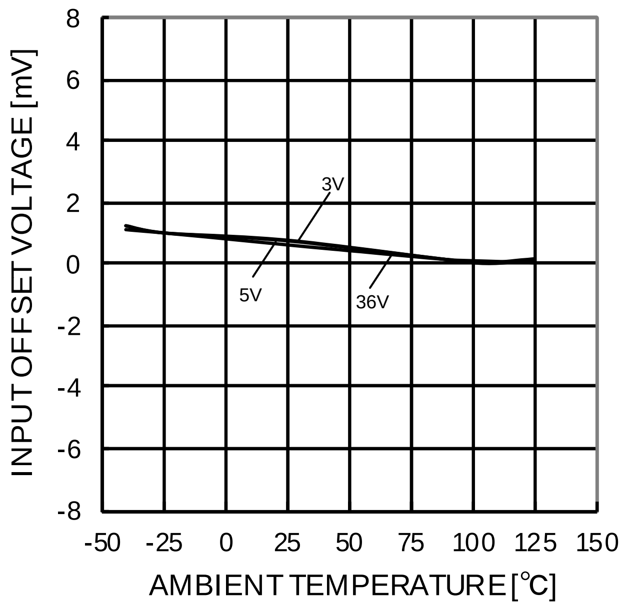


Figure 86.
Input Offset Voltage - Ambient Temperature
(Vicm=0V, OUT=1.4V)

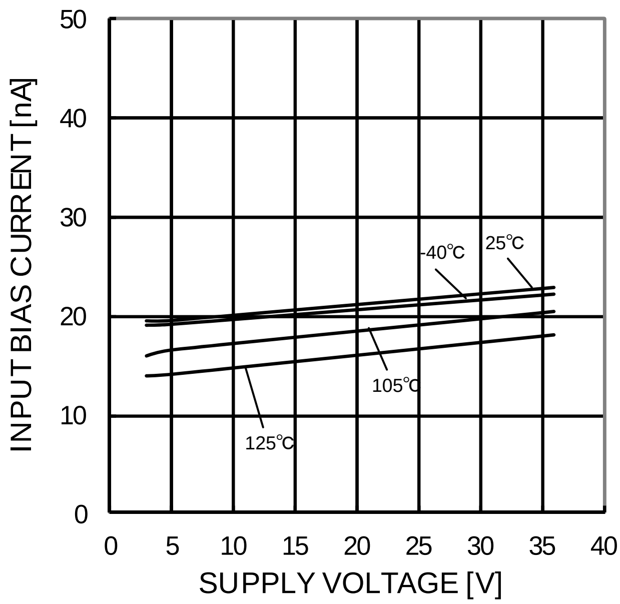


Figure 87.
Input Bias Current - Supply Voltage
(Vicm=0V, OUT=1.4V)

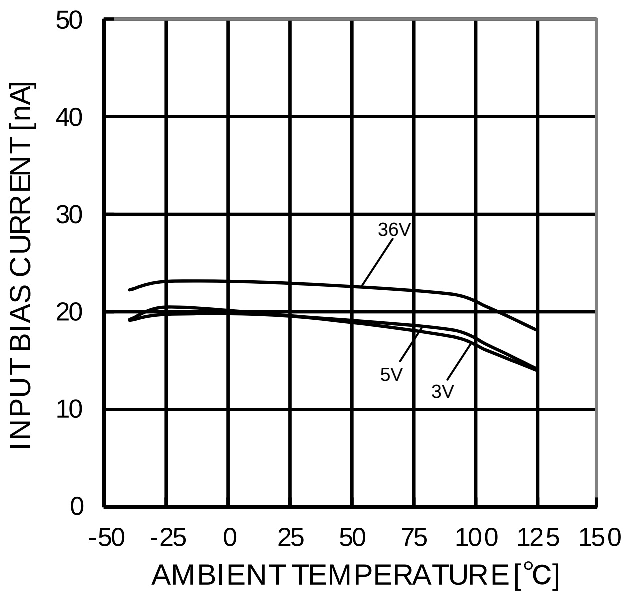


Figure 88.
Input Bias Current - Ambient Temperature
(Vicm=0V, OUT=1.4V)

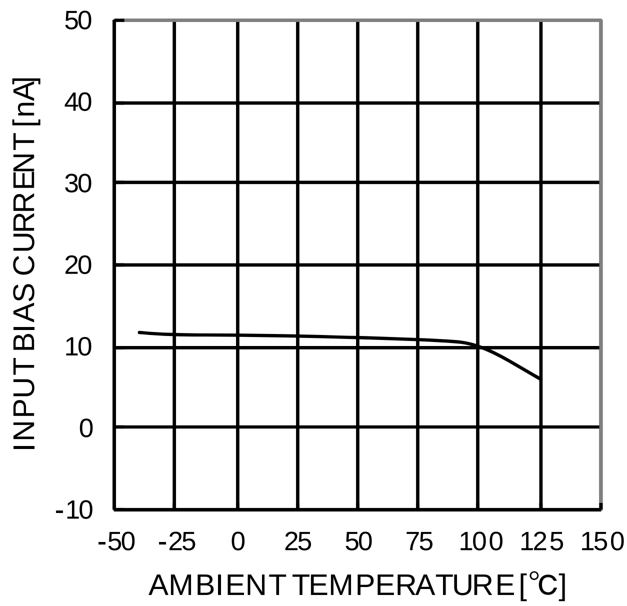


Figure 89.
Input Bias Current - Ambient Temperature
(VCC=30V, Vicm=28V, OUT=1.4V)

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

○BA2902, BA2902S

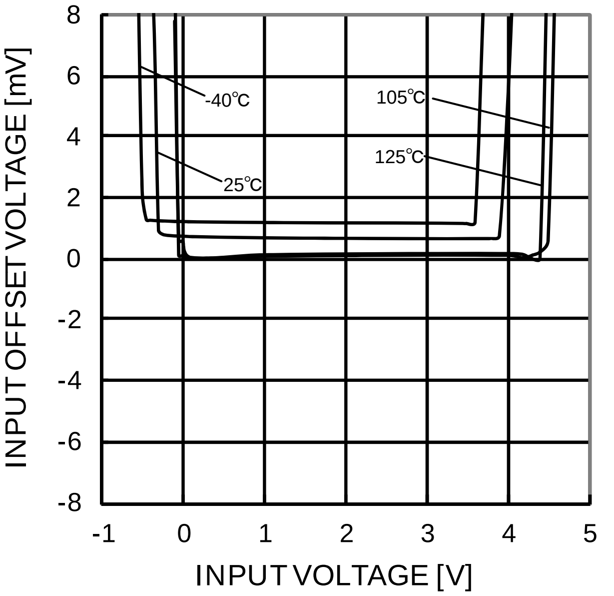


Figure 90.
Input Offset Voltage - Common Mode Input Voltage
(VCC=5V)

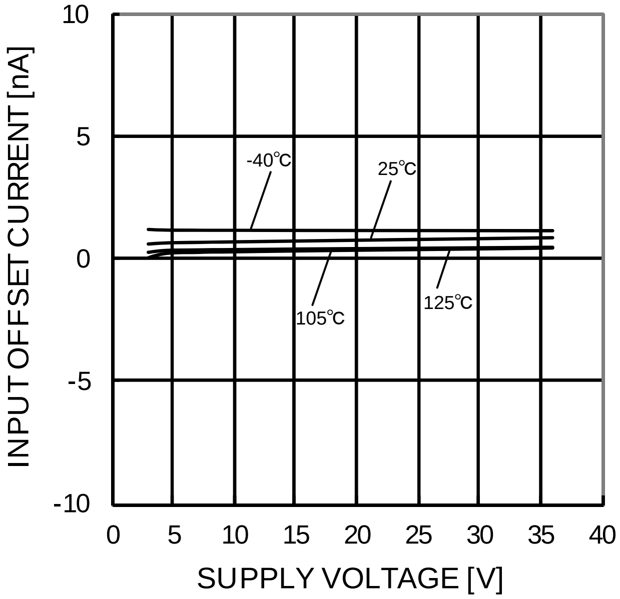


Figure 91.
Input Offset Current - Supply Voltage
(Vicm=0V, OUT=1.4V)

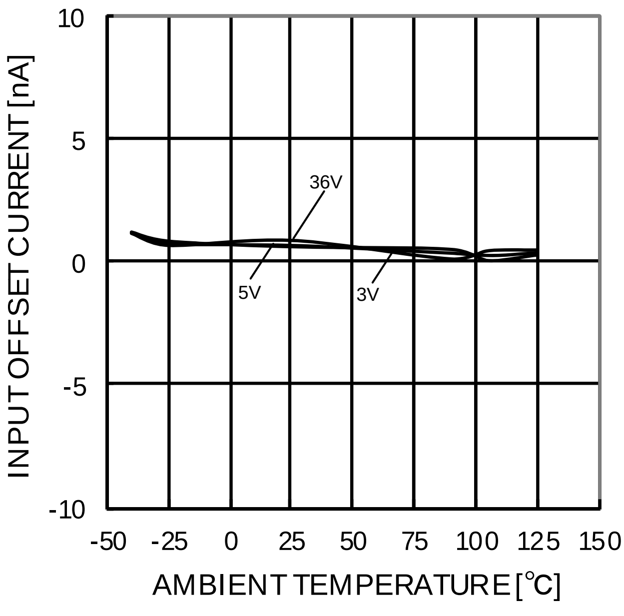


Figure 92.
Input Offset Current - Ambient Temperature
(Vicm=0V, OUT=1.4V)

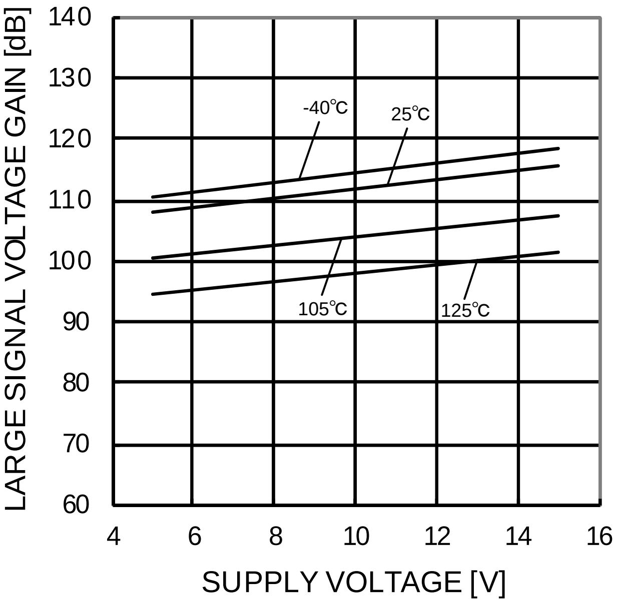


Figure 93.
Large Signal Voltage Gain - Supply Voltage
(RL=2kΩ)

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

○BA2902, BA2902S

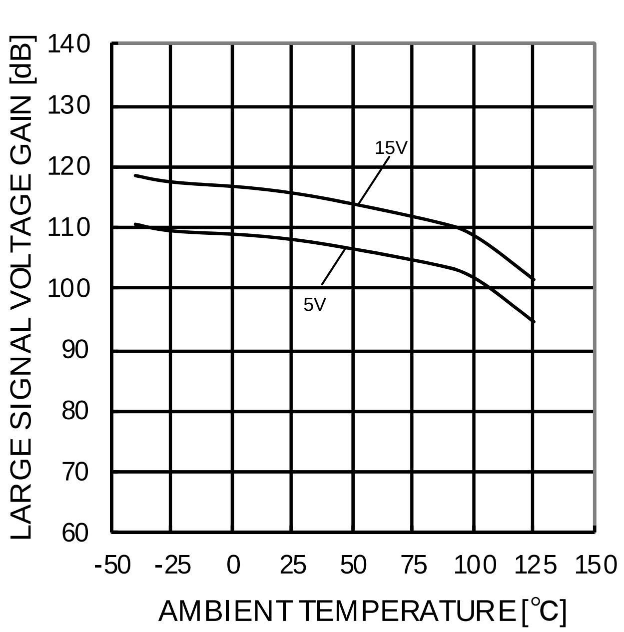


Figure 94.
Large Signal Voltage Gain - Ambient Temperature
(RL=2kΩ)

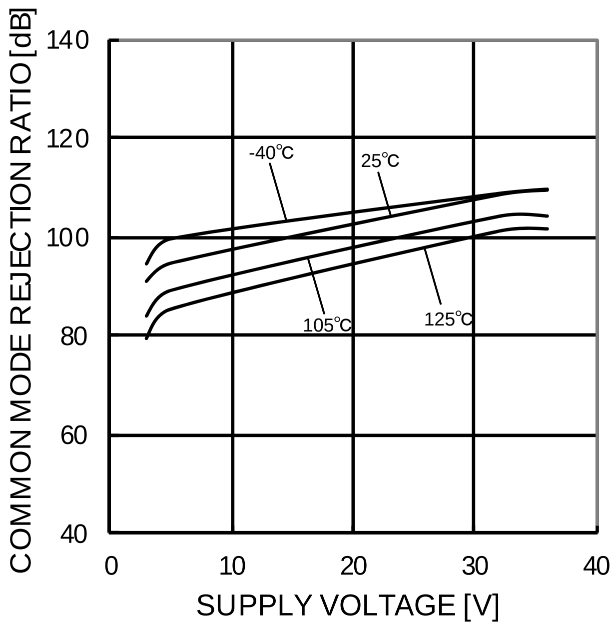


Figure 95.
Common Mode Rejection Ratio
- Supply Voltage

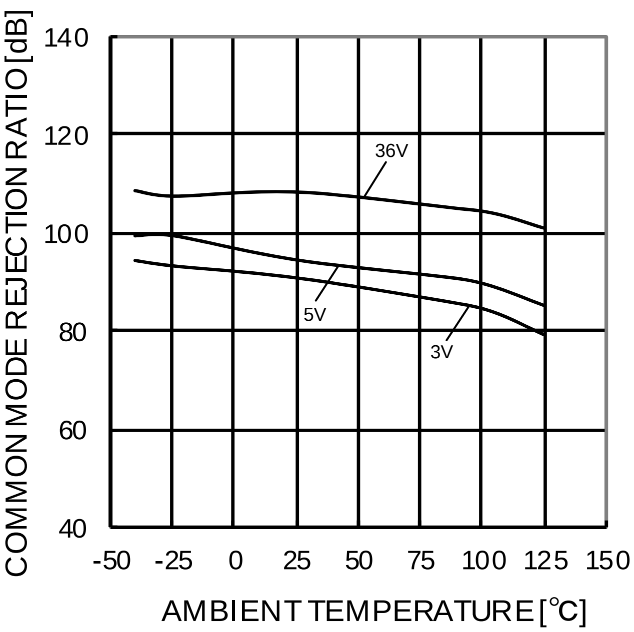


Figure 96.
Common Mode Rejection Ratio
- Ambient Temperature

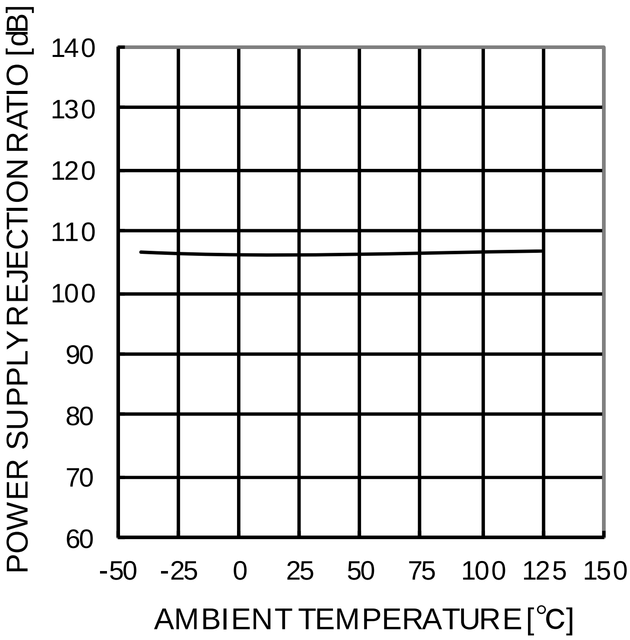


Figure 97.
Power Supply Rejection Ratio
- Ambient Temperature

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

●Application Information

NULL method condition for Test Circuit 1

VCC, VEE, EK, Vicm Unit : V

Parameter	VF	S1	S2	S3	BA10358 BA10324A				BA2904 BA2902				calculation
					VCC	VEE	EK	Vicm	VCC	VEE	EK	Vicm	
Input Offset Voltage	VF1	ON	ON	OFF	5	0	-1.4	0	5 to 30	0	-1.4	0	1
Input Offset Current	VF2	OFF	OFF	OFF	5	0	-1.4	0	5	0	-1.4	0	2
Input Bias Current	VF3	OFF	ON	OFF	5	0	-1.4	0	5	0	-1.4	0	3
	VF4	ON	OFF										
Large Signal Voltage Gain	VF5	ON	ON	ON	15	0	-1.4	0	15	0	-1.4	0	4
	VF6				15	0	-11.4	0	15	0	-11.4	0	
Common-mode Rejection Ratio (Input common-mode Voltage Range)	VF7	ON	ON	OFF	5	0	-1.4	0	5	0	-1.4	0	5
	VF8				5	0	-1.4	3.5	5	0	-1.4	3.5	
Power Supply Rejection Ratio	VF9	ON	ON	OFF	5	0	-1.4	0	5	0	-1.4	0	6
	VF10				30	0	-1.4	0	30	0	-1.4	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)

$$Av = 20Log \frac{10 \times (1+RF/RS)}{|VF5-VF6|} \quad [dB]$$

5. Common-mode Rejection Ration (CMRR)

$$CMRR = 20Log \frac{3.5 \times (1+RF/RS)}{|VF8-VF7|} \quad [dB]$$

6. Power supply rejection ratio (PSRR)

$$PSRR = 20Log \frac{25 \times (1+ RF/RS)}{|VF10 - VF9|} \quad [dB]$$

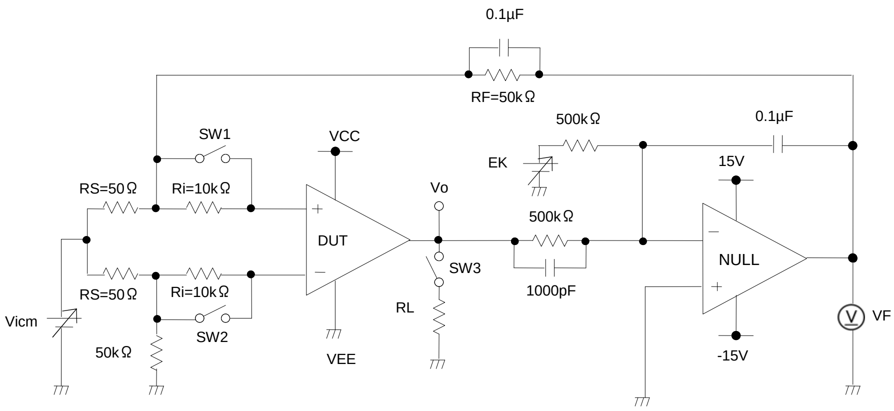


Figure . 98 Test circuit1 (one channel only)

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

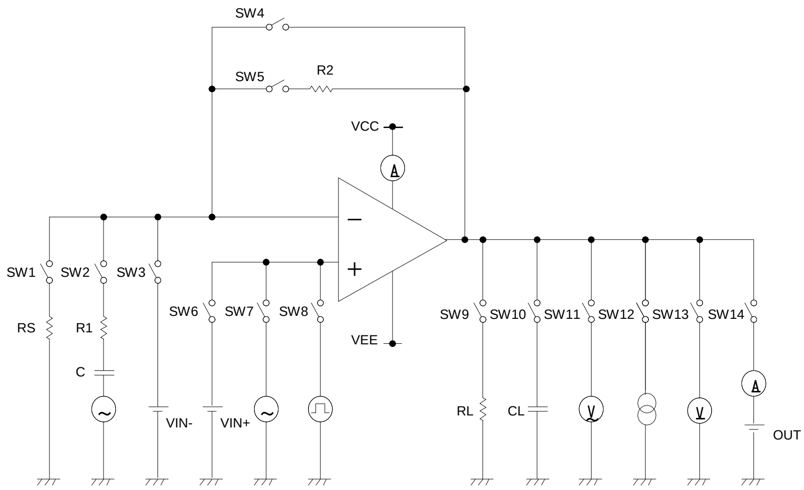


Figure 99. Test Circuit 2 (each Op-Amp)

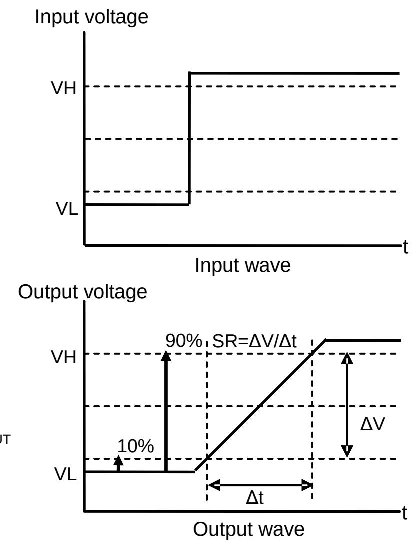
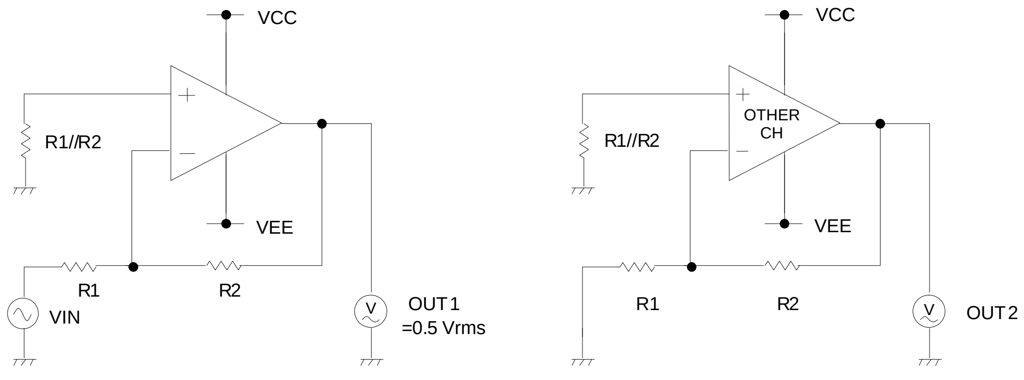


Figure 100. Slew Rate Input Waveform

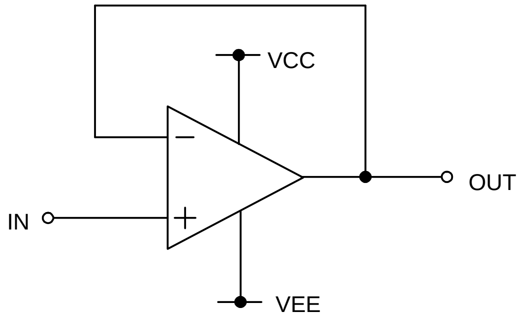


$$CS = 20 \times \log \frac{100 \times OUT1}{OUT2}$$

Figure 101. Test Circuit 3(Channel Separation)
(R1=1kΩ,R2=100kΩ)

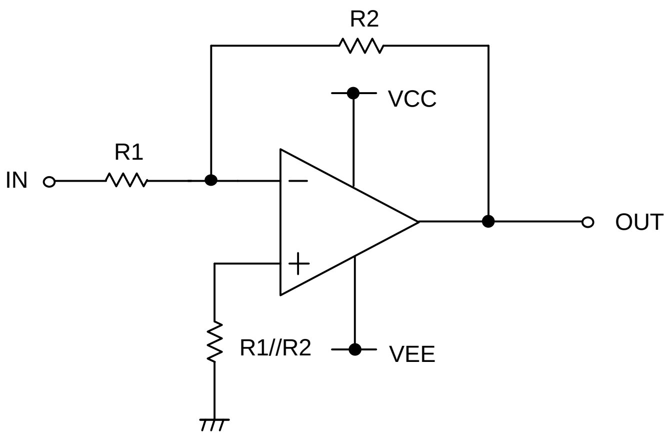
Examples of circuit

○Voltage follower



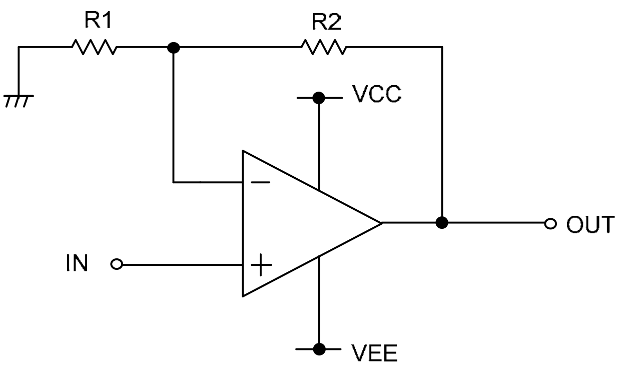
Voltage gain is 0 dB.
This circuit controls output voltage (OUT) equal input voltage (IN), and keeps OUT with stable because of high input impedance and low output impedance.
OUT is shown next formula.
OUT=IN

○Inverting amplifier



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

○Non-inverting amplifier



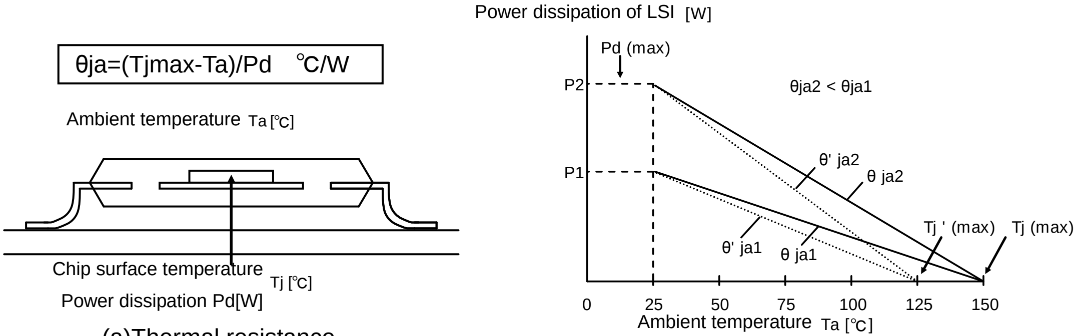
For non-inverting amplifier, IN is amplified by voltage gain decided R1 and R2, and phase is same with IN.
OUT is shown next formula.
OUT= (1+R2/R1)・IN
This circuit realizes high input impedance because Input impedance is operational amplifier's input Impedance.

●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 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. Figure 102. (a) shows the model of thermal resistance of the package. Thermal resistance θja, ambient temperature Ta, maximum junction temperature Tjmax, and power dissipation Pd can be calculated by the equation below:

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

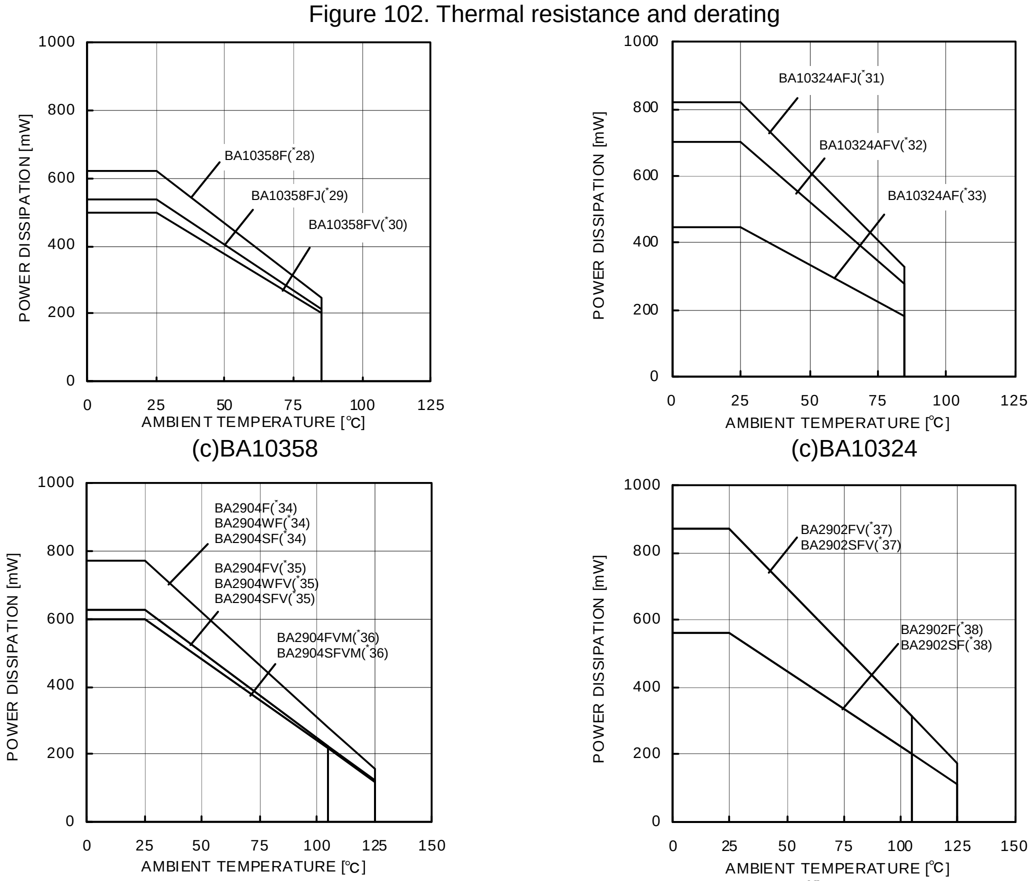
Derating curve in Figure 102. (b) indicates power that can be consumed by IC with reference to ambient temperature. Power that can be consumed by IC begins to attenuate at certain ambient temperature. This gradient is determined by thermal resistance θja. Thermal resistance θja depends on chip size, 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. Figure 103. (c) to (f) show a derating curve for an example of BA10358, BA10324A, BA2904S, BA2904, BA2904W, BA2902S, BA2902.



(a)Thermal resistance

(b) Derating curve

Figure 102. Thermal resistance and derating



(c)BA10358

(c)BA10324

(e)BA2904

(f)BA2902

(*28)	(*29)	(*30)	(*31)	(*32)	(*33)	(*34)	(*35)	(*36)	(*37)	(*38)	Unit
6.2	5.4	5.0	8.2	7.0	4.5	6.2	5.0	4.7	7.0	4.5	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 103. Derating curve

●Operational Notes

1) Unused circuits
When there are unused op-amps, it is recommended that they are connected as in Figure 104, setting the non-inverting input terminal to a potential within the in-phase input voltage range (Vicm).

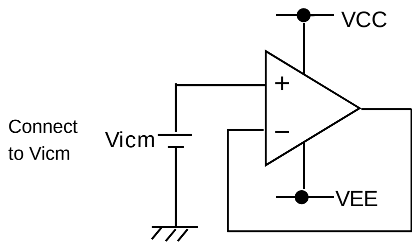


Figure 104. Example of application circuit for unused op-amp

2) Input voltage
Applying VEE +32V 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 of the electrical characteristics due to piezo resistance effects.

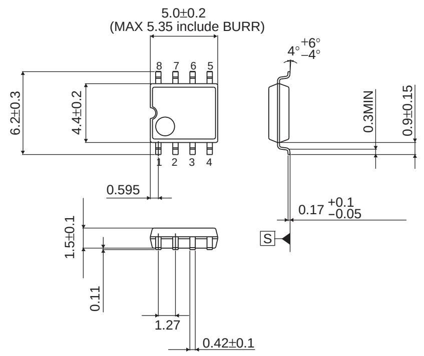
9) IC operation
The output stage of the IC is configured using Class C push-pull circuits. Therefore, when the load resistor is connected to the middle potential of VCC and VEE, crossover distortion occurs at the changeover between discharging and charging of the output current. Connecting a resistor between the output terminal and GND, and increasing the bias current for Class A operation will suppress crossover distortion.

10) 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.

11) Output capacitor
If a large capacitor is connected between the output pin and GND pin, current from the charged capacitor will flow into the output pin and may destroy the IC when the VCC or VIN pin is shorted to ground or pulled down to 0V. Use a capacitor smaller than 1uF between output and GND.

●Physical Dimensions Tape and Reel Information

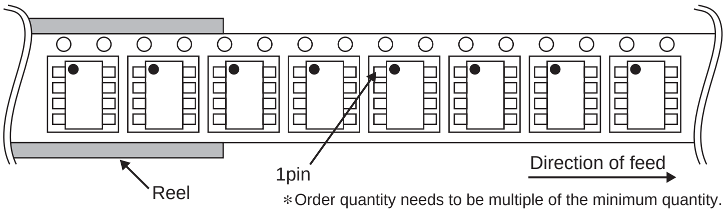
SOP8



(Unit : mm)

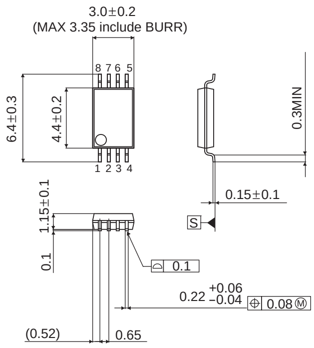
<Tape and Reel information>

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)



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

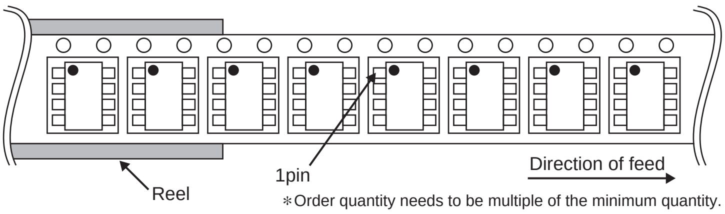
SSOP-B8



(Unit : mm)

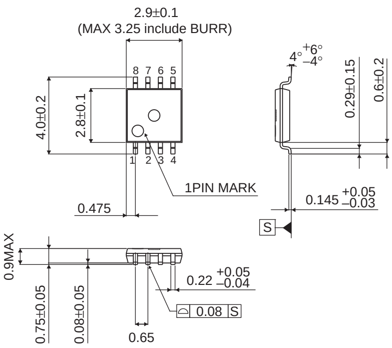
<Tape and Reel information>

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)



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

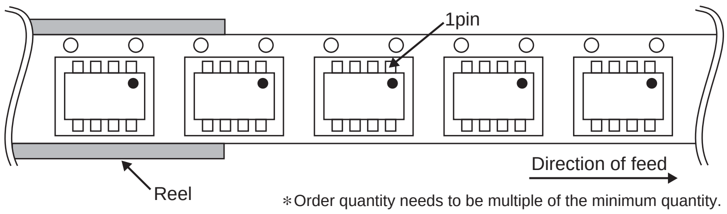
MSOP8



(Unit : mm)

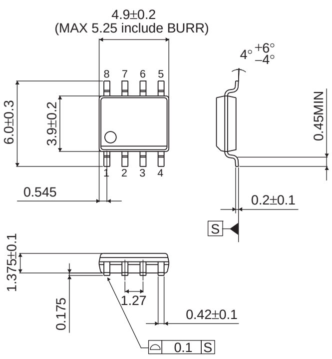
<Tape and Reel information>

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)



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

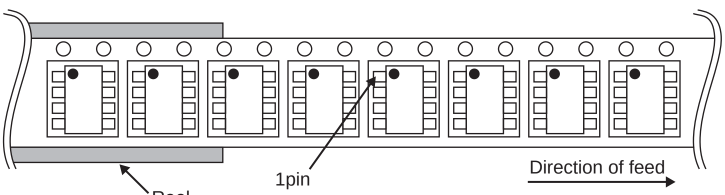
SOP-J8



(Unit : mm)

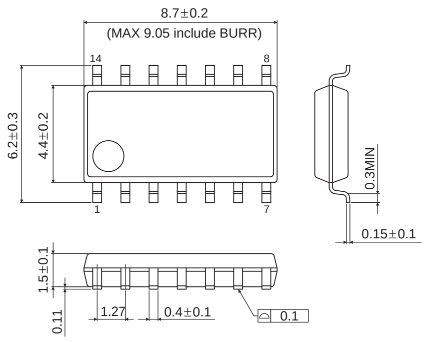
<Tape and Reel information>

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)



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

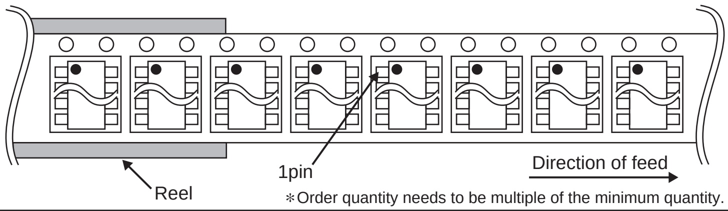
SOP14



(Unit : mm)

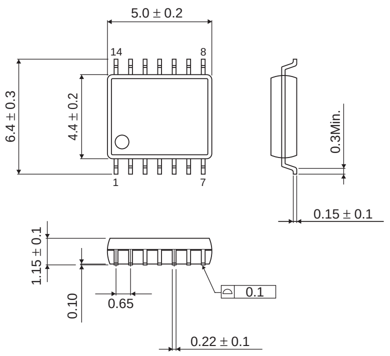
<Tape and Reel information>

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)



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

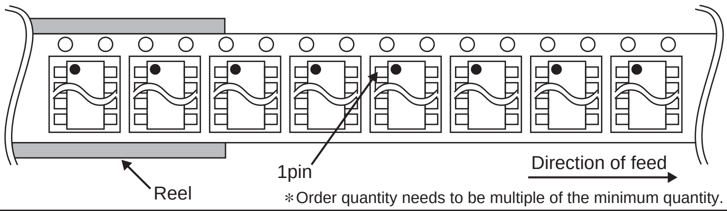
SSOP-B14



(Unit : mm)

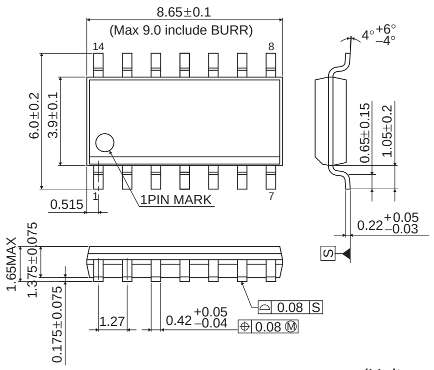
<Tape and Reel information>

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)



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

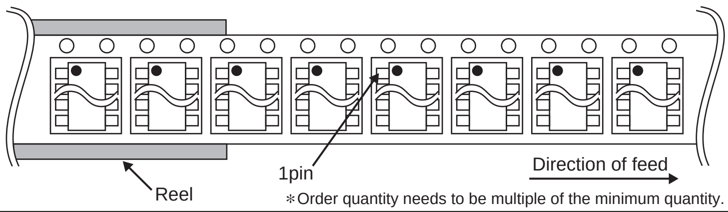
SOP-J14



(Unit : mm)

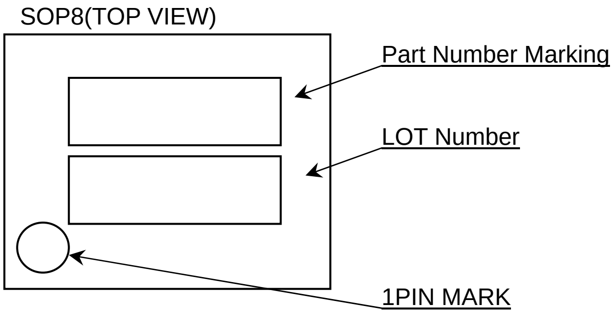
<Tape and Reel information>

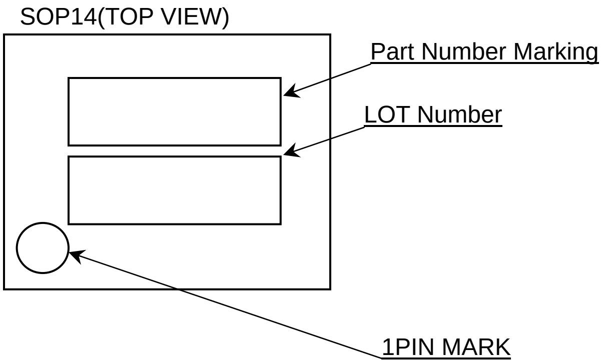
Tape	Embossed carrier tape
Quantity	2500pcs
Direction of feed	E2 (The direction is the 1pin of product is at the upper left when you hold reel on the left hand and you pull out the tape on the right hand)

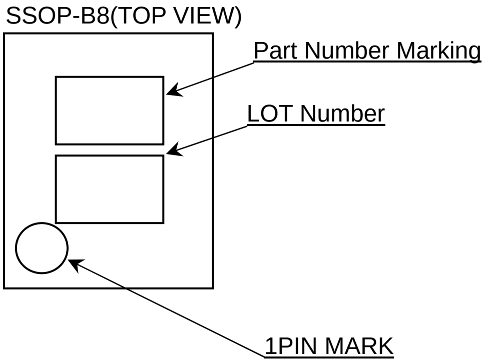


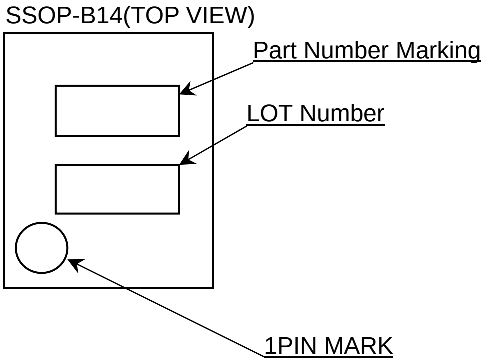
∗Order quantity needs to be multiple of the minimum quantity.

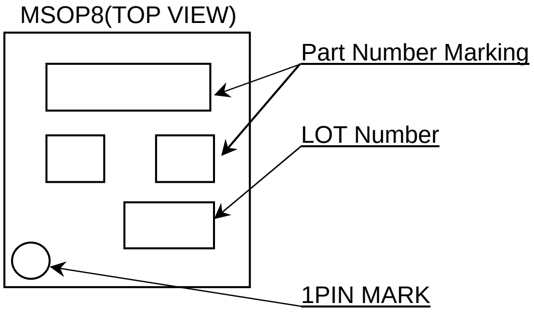
●**Marking Diagrams**

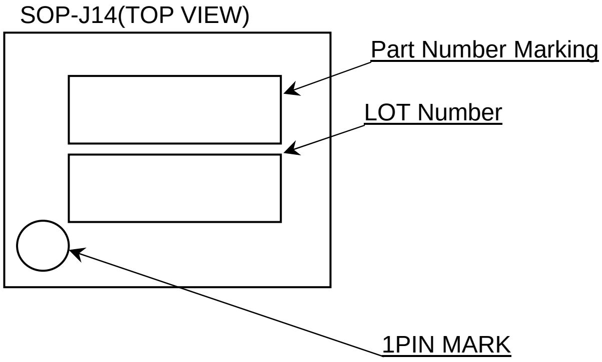


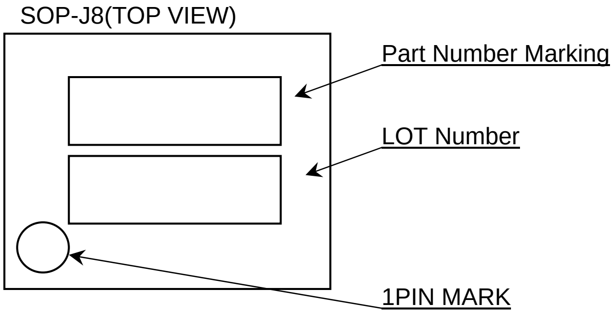










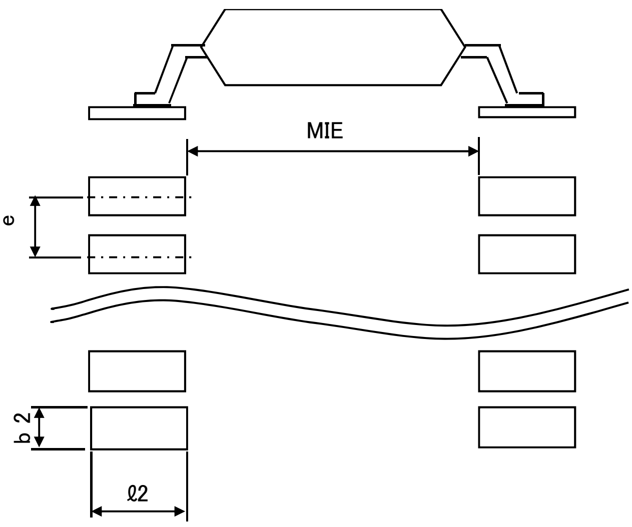


Product Name		Package Type	Marking
BA10358	F	SOP8	10358
	FJ	SOP-J8	
	FV	SSOP-B8	358
BA10324A	F	SOP14	BA10324AF
	FJ	SOP-J14	BA10324A
	FV	SSOP-B14	324A
BA2904	F	SOP8	2904
	FV	SSOP-B8	
	FVM	MSOP8	
BA2904W	F	SOP8	
	FV	SSOP-B8	
BA2904S	F	SOP8	2904S
	FV	SSOP-B8	04S
	FVM	MSOP8	2904S
BA2902	F	SOP14	BA2902F
	FV	SSOP-B14	2902
BA2902S	F	SOP14	2902S
	FV	SSOP-B14	

●Land pattern data

all dimensions in mm

PKG	Land pitch e	Land space MIE	Land length ≧ℓ 2	Land width b2
SOP8	1.27	4.60	1.10	0.76
SSOP-B8	0.65	4.60	1.20	0.35
SOP-J8	1.27	3.90	1.35	0.76
MSOP8	0.65	2.62	0.99	0.35
SOP14	1.27	4.60	1.10	0.76
SSOP-B14	0.65	4.60	1.20	0.35
SOP-J14	1.27	3.90	1.35	0.76



SOP8, SSOP-B8, SOP-J8, MSOP8
SOP14, SSOP-B14, SOP-J14

●**Revision History**

Date	Revision	Changes
14.SEP.2012	001	New Release
11.Jan.2013	002	Land pattern data inserted.

Notice

●General Precaution

1) Before you use our Products, you are requested to carefully read this document and fully understand its contents. ROHM shall not be in any way responsible or liable for failure, malfunction or accident arising from the use of any ROHM's Products against warning, caution or note contained in this document.

2) All information contained in this document is current as of the issuing date and subject to change without any prior notice. Before purchasing or using ROHM's Products, please confirm the latest information with a ROHM sales representative.

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   [a] Installation of protection circuits or other protective devices to improve system safety
   [b] Installation of redundant circuits to reduce the impact of single or multiple circuit failure

3) Our Products are designed and manufactured for use under standard conditions and not under any special or extraordinary environments or conditions, as exemplified below. Accordingly, ROHM shall not be in any way responsible or liable for any damages, expenses or losses arising from the use of any ROHM's Products under any special or extraordinary environments or conditions. If you intend to use our Products under any special or extraordinary environments or conditions (as exemplified below), your independent verification and confirmation of product performance, reliability, etc, prior to use, must be necessary:
   [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; if flow soldering method is preferred, 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.

●Precaution for Product Label

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.

●Precaution for Foreign Exchange and Foreign Trade act

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