ROHM's Selection Operational Amplifier/Comparator Series

# Operational Amplifiers: Low Noise

**BA4558F,BA4558RF/FV/FVM,BA4560F,BA4560RF/FV/FVM,BA4580RF/FVM**
**BA2115F/FVM,BA15218F,BA14741F,BA15532FBA4510F/FV**

No.09049EAT02

## ●Description

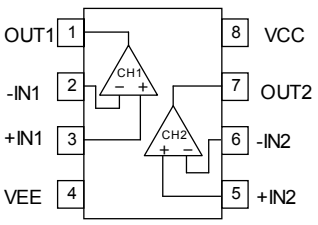
General-purpose BA4558 / BA4560 / BA15218 / BA14741 / BA15532 / BA4510 family and high-reliability BA4558R / BA4560R / BA4580R / BA2115 family integrate two or four independent Op-Amps on a single chip.
Especially, this series is suitable for any audio applications due to low noise and low distortion characteristics and are usable for other many applications by wide operating supply voltage range.
BA4558R/BA4560R/BA4580R/BA2115 are high-reliability products with extended operating temperature range and high ESD tolerance.

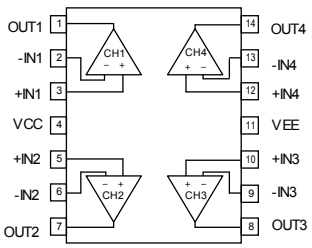
| | | |
|---|---|---|
| General-purpose | Dual | BA4558 family |
| | Dual | BA4560 family |
| | Dual | BA15218 family |
| | Quad | BA14741 family |
| | Dual | BA15532 family |
| | Dual | BA4510 family |
| High-reliability | Dual | BA4558R family |
| | Dual | BA4560R family |
| | Dual | BA4580R family |
| | Dual | BA2115 family |

## ●Features

1) High voltage gain, low noise, low distortion
2) Internal phase compensation
3) No latch up immunity
4) Wide operating supply voltage
   ±4.0[V]～±15.0[V](split supply) (BA4558/BA4560/BA4558R/BA4560R family)
   ±2.0[V]～±16.0[V](split supply) (BA4580R/BA15218 family)
   ±2.0[V]～±18.0[V](split supply) (BA14741 family)
   ±3.0[V]～±20.0[V](split supply) (BA15532 family)
   ±1.0[V]～±3.5[V](split supply) (BA4510 family)
   ±1.0[V]～±7.0[V](split supply) (BA2115 family)
5) Internal ESD protection
   Human body mode (HBM) ±5000[V](Typ.) (BA4558R/BA4560R/BA4580R/BA2115 family)
6) Wide temperature range
   -40[℃]～+85[℃] (BA4558/BA4560/BA15218/BA14741/BA2115 family)
   -40[℃]～+105[℃] (BA4558R/BA4560R/BA4580R family)

## ●Pin Assignments




| SOP8 | SSOP-B8 | MSOP8 | SOP14 |
|---|---|---|---|
| BA4558F BA4558R F<br>BA4560F BA4560R F<br>BA15218F BA4580R F<br>BA15532F BA2115F<br>BA4510F | BA4558R FV<br>BA4560R FV<br>BA4510FV | BA4558R FVM<br>BA4560R FVM<br>BA4580R FVM<br>BA2115FVM | BA14741F |

●Absolute maximum rating (Ta=25[℃])

○BA4558/BA4560 family,BA4558R/BA4560R/BA4580R family

| Parameter | Symbol | Rating | | | | | Unit |
|---|---|---|---|---|---|---|---|
| | | BA4558 family | BA4560 family | BA4558R family | BA4560R family | BA4580R family | |
| Supply Voltage | VCC-VEE | +36 | | | | | V |
| Differential Input Voltage(*1) | Vid | (VCC-VEE) | | 36 | | | V |
| Input Common-mode voltage range | Vicm | VEE～VCC | | (VEE-0.3)～VEE+36 | | | V |
| Operating Supply Voltage | Vopr | 8～30 (±4～±15) | | 8～30 (±4～±15) | | 4～32(±2～±16) | V |
| Output Current | Io | - | | - | | ±50 | mA |
| Operating Temperature | Topr | -40～+85 | | -40～+105 | | | ℃ |
| Storage Temperature | Tstg | -55～+125 | | -55～+150 | | | ℃ |
| Maximum Junction Temperature | Tjmax | +125 | | +150 | | | ℃ |

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

(*1) The voltage difference between inverting input and non-inverting input is the differential input voltage.
Then input terminal voltage is set to more then VEE.

●Electrical characteristics

○BA4558/BA4560 family (Unless otherwise specified VCC=+15[V], VEE=-15[V], Ta=25[℃])

| Parameter | Symbol | Temperature Range | Guaranteed limit | | | | | | Unit | Condition |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | BA4558 family | | | BA4560 family | | | | |
| | | | Min. | Typ. | Max. | Min. | Typ. | Max. | | |
| Input Offset Voltage (*2) | Vio | 25℃ | - | 0.5 | 6 | - | 0.5 | 6 | mV | Rs≦10[kΩ] |
| Input Offset Current (*2) | Iio | 25℃ | - | 5 | 200 | - | 5 | 200 | nA | - |
| Input Bias Current (*3) | Ib | 25℃ | - | 60 | 500 | - | 50 | 500 | nA | - |
| Supply Current | ICC | 25℃ | - | 3 | 6 | - | 4 | 7.5 | mA | RL=∞ All Op-Amps |
| Maximum Output Voltage | VOM | 25℃ | ±12 | ±14 | - | ±12 | ±14 | - | V | RL≧10[kΩ] |
| | | | ±10 | ±13 | - | ±10 | ±13 | - | | RL≧2[kΩ] |
| Large Single Voltage Gain | AV | 25℃ | 86 | 100 | - | 86 | 100 | - | dB | RL≧2[kΩ],VOUT=±10[V] |
| Input Common-mode Voltage Range | Vicm | 25℃ | ±12 | ±14 | - | ±12 | ±14 | - | V | - |
| Common-mode Rejection Ratio | CMRR | 25℃ | 70 | 90 | - | 70 | 90 | - | dB | Rs≦10[kΩ] |
| Power Supply Rejection Ratio | PSRR | 25℃ | 76.3 | 90 | - | 76.3 | 90 | 150 | dB | Rs≦10[kΩ] |
| Channel Separation | CS | 25℃ | - | 105 | - | - | - | - | dB | f=1[kHz] Input referred |
| Slew Rate | SR | 25℃ | - | 1.0 | - | - | 4 | - | V/μs | AV=0[dB],RL≧2[kΩ] |
| Gain Bandwidth Product | GBW | 25℃ | - | - | - | - | 10 | - | MHz | f=10[kHz] |
| Input Referred Noise Voltage | Vn | 25℃ | - | - | - | - | - | 2.2 | μV | Rs=2.2[kΩ], BW=10[Hz]～30[kHz],RIAA |

(*2) Absolute value

(*3) Current direction: Since first input stage is composed with PNP transistor, input bias current flows out of IC.

●Electrical characteristics

○BA4558R/BA4560R family (Unless otherwise specified VCC=+15[V], VEE=-15[V], Full range -40[℃]～+105[℃])

| Parameter | Symbol | Temperature Range | Guaranteed limit | | | | | | Unit | Condition |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | BA4558R family | | | BA4560R family | | | | |
| | | | Min. | Typ. | Max. | Min. | Typ. | Max. | | |
| Input Offset Voltage (*4) | Vio | 25℃ | - | 0.5 | 6 | - | 0.5 | 6 | mV | VOUT=0[V] |
| | | Full range | - | - | 7 | - | - | 7 | | |
| Input Offset Current (*4) | Iio | 25℃ | - | 5 | 200 | - | 5 | 200 | nA | VOUT=0[V] |
| | | Full range | - | - | 200 | - | - | 200 | | |
| Input Bias Current (*5) | Ib | 25℃ | - | 60 | 500 | - | 50 | 500 | nA | VOUT=0[V] |
| | | Full range | - | - | 800 | - | - | 800 | | |
| Supply Current | ICC | 25℃ | - | 3 | 6 | - | 3 | 7 | mA | RL=∞ All Op-Amps VIN+=0[V] |
| | | Full range | - | - | 6.5 | - | - | 7.5 | | |
| Maximum Output Voltage | VOM | 25℃ | ±10 | ±13 | - | ±12 | ±14 | - | V | RL≧2[kΩ] |
| | | Full range | ±10 | - | - | - | - | - | | |
| | | 25℃ | - | - | - | ±10 | ±11.5 | - | | Io=25[mA] |
| | | | ±12 | ±14 | - | - | - | - | | RL≧10[kΩ] |
| Large Single Voltage Gain | AV | 25℃ | 86 | 100 | - | 86 | 100 | - | dB | RL≧2[kΩ],VO=±10[V], Vicm=0[V] |
| | | Full range | 83 | - | - | 83 | - | - | | |
| Input Common-mode Voltage Range | Vicm | 25℃ | ±12 | ±14 | - | ±12 | ±14 | - | V | VOUT=±12[V] |
| | | Full range | ±12 | - | - | ±12 | - | - | | |
| Common-mode Rejection Ratio | CMRR | 25℃ | 70 | 90 | - | 70 | 90 | - | dB | VOUT=±12[V] |
| Power Supply Rejection Ratio | PSRR | 25℃ | 76.5 | 90 | - | 76.5 | 90 | - | dB | Ri≦10[kΩ] |
| Channel Separation | CS | 25℃ | - | 105 | - | - | 105 | - | dB | f=1[kHz] |
| Slew Rate | SR | 25℃ | - | 1 | - | - | 4 | - | V/μs | AV=0[dB],RL=10[kΩ] CL=100[pF] |
| Unity Gain Frequency | ft | 25℃ | - | 2 | - | - | 4 | - | MHz | RL=2[kΩ] |
| Total Harmonic Distortion | THD | 25℃ | - | 0.005 | - | - | 0.003 | - | % | AV=20[dB],RL=10[kΩ] VOUT=5[Vrms],f=1[kHz] |
| Input Referred Noise Voltage | Vn | 25℃ | - | 12 | - | - | 8 | - | $nV/\sqrt{Hz}$ | RS=100[Ω],Vi=0[V] ,f=1[kHz] |

(*4) Absolute value

(*5) Current direction: Since first input stage is composed with PNP transistor, input bias current flows out of IC.

●Electrical characteristics

○BA4580R family (Unless otherwise specified VCC=+15[V], VEE=-15[V], Ta=25[℃])

| Parameter | Symbol | Temperature Range | Guaranteed limit | | | Unit | Condition |
|---|---|---|---|---|---|---|---|
| | | | BA4580R family | | | | |
| | | | Min. | Typ. | Max. | | |
| Input Offset Voltage (*6) | Vio | 25℃ | - | 0.3 | 3 | mV | Rs≦10[kΩ] |
| Input Offset Current (*6) | Iio | 25℃ | - | 5 | 200 | nA | - |
| Input Bias Current (*7) | Ib | 25℃ | - | 100 | 500 | nA | - |
| Large Single Voltage Gain | AV | 25℃ | 90 | 110 | - | dB | RL≧10[kΩ],VOUT=±10[V] |
| Maximum Output Voltage | VOM | 25℃ | ±12 | ±13.5 | - | V | RL≧2[kΩ] |
| Input Common-mode Voltage Range | Vicm | 25℃ | ±12 | ±13.5 | - | V | - |
| Common-mode Rejection Ratio | CMRR | 25℃ | 80 | 110 | - | dB | Rs≦10[kΩ] |
| Power Supply Rejection Ratio | PSRR | 25℃ | 80 | 110 | - | dB | Rs≦10[kΩ] |
| Supply Current | ICC | 25℃ | - | 6 | 9 | mA | RL=∞ All Op-Amps,VIN+=0[V] |
| Slew Rate | SR | 25℃ | - | 5 | - | V/μs | RL≧2[kΩ] |
| Unity Gain Frequency | ft | 25℃ | - | 5 | - | MHz | RL=2[kΩ] |
| Total Harmonic Distortion | THD | 25℃ | - | 0.0005 | - | % | Av=20[dB],VOUT=5[Vrms],RL=2[kΩ] f=1[kHz],20[Hz]~20[kHz] BPF |
| Input Referred Noise Voltage | Vni | 25℃ | - | 0.8 | - | μVrms | RIAA,Rs=2.2 [kΩ],30[kHz] LPF |

(*6) Absolute value

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

●Absolute maximum rating (Ta=25[℃])

○BA15218/BA14741F/BA15532 family

| Parameter | Symbol | Rating | | | Unit |
|---|---|---|---|---|---|
| | | BA15218 family | BA14741 family | BA15532 family | |
| Supply Voltage | VCC-VEE | 36 | 36 | 42 | V |
| Differential Input Voltage | Vid | VCC-VEE(*8) | | ±0.5(*9) | V |
| Input Common-mode voltage range | Vicm | VEE~VCC | | | V |
| Operating Supply Voltage | Vopr | 4～32 (±2～±16) | 4～36 (±2～±18) | 6～40 (±3～±20) | V |
| Input Current | Ii | - | - | ±10 | mA |
| Operating Temperature | Topr | -40~+85 | | -20~+75 | ℃ |
| Storage Temperature | Tstg | -55~+125 | | | ℃ |
| Maximum junction Temperature | Tjmax | 125 | | | ℃ |
| Output Short Current (*10) | Iomax | ±50 | - | - | mA |
| Output Short Time (*10) | Ts | - | unlimited (only 1CH short) | unlimited | Sec |

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

(*8) The voltage difference between inverting input and non-inverting input is the differential input voltage.
Then input terminal voltage is set to more then VEE.

(*9) Don't over input current ±10mA. Built-in resistor for protection because of over current with differential input voltage above 0.5V.

(*10) Limit within Pd

●Electrical characteristics

○BA15218 family (Unless otherwise specified VCC=+15[V], VEE=-15[V], Ta=25[℃])

| Parameter | Symbol | Temperature Range | Guaranteed limit | | | Unit | Condition |
|---|---|---|---|---|---|---|---|
| | | | Min. | Typ. | Max. | | |
| Input Offset Voltage (*11) | Vio | 25℃ | - | 0.5 | 5.0 | mV | Rs≦10[kΩ] |
| Input Offset Current (*11) | Iio | 25℃ | - | 5 | 200 | nA | - |
| Input Bias Current (*12) | Ib | 25℃ | - | 50 | 500 | nA | - |
| Large Single Voltage Gain | Av | 25℃ | 86 | 110 | - | dB | RL≧2[kΩ],Vo=±10[V] |
| Input Common-mode Voltage Range | Vicm | 25℃ | ±12 | ±14 | - | V | - |
| Common-mode Rejection Ratio | CMRR | 25℃ | 70 | 90 | - | dB | Rs≦10[kΩ] |
| Power Supply Rejection Ratio | PSRR | 25℃ | 76 | 90 | - | dB | Rs≦10[kΩ] |
| Supply Current | ICC | 25℃ | - | 5.0 | 8.0 | mA | Vin=0,RL=∞ |
| Maximum Output Voltage | VOH | 25℃ | ±12 | ±14 | - | V | RL≧10[kΩ] |
| | VOL | 25℃ | ±10 | ±13 | - | V | RL≧2[kΩ] |
| Slew Rate | SR | 25℃ | - | 3.0 | - | V/μs | GV=0[dB],RL=2[kΩ] |
| Gain Bandwidth Product | GBW | 25℃ | - | 10 | - | MHz | f=10[kHz] |
| Input Referred Noise Voltage | Vn | 25℃ | - | 1.0 | - | μVrms | RS=1[kΩ], BW=20[Hz]～30[kHz],RIAA |
| Channel Separation | CS | 25℃ | - | 120 | - | dB | f=1[kHz] input referred |

(*11) Absolute value

(*12) Current direction: Since first input stage is composed with PNP transistor, input bias current flows out of IC.

●Electrical characteristics

○BA14741 family (Unless otherwise specified VCC=+15[V], VEE=-15[V], Ta=25[℃])

| Parameter | | Symbol | Temperature Range | Guaranteed limit | | | Unit | Condition |
|---|---|---|---|---|---|---|---|---|
| | | | | Min. | Typ. | Max. | | |
| Input Offset Voltage (*13) | | Vio | 25℃ | - | 1.0 | 5.0 | mV | Rs≦10[kΩ] |
| Input Offset Current (*13) | | Iio | 25℃ | - | 10 | 50 | nA | - |
| Input Bias Current (*14) | | Ib | 25℃ | - | 60 | 300 | nA | - |
| Large Single Voltage Gain | | Av | 25℃ | 20 | 100 | - | V/mV | RL≧2[kΩ],Vo=±10[V] |
| Common-mode Rejection Ratio | | CMRR | 25℃ | 80 | 100 | - | dB | - |
| Input Common-mode Voltage Range | | Vicm | 25℃ | ±12 | ±13.5 | - | V | - |
| Power Supply Rejection Ratio | | PSRR | 25℃ | 80 | 100 | - | dB | - |
| Supply Current | | ICC | 25℃ | - | 3.0 | 7.0 | mA | RL=∞,on all OpAmp |
| Maximum Output Voltage | High | VOH | 25℃ | 10 | 12.5 | - | V | Vin+=1[V],Vin-=0[V],RL=2[kΩ] |
| | Low | VOL | 25℃ | -10 | -12.5 | - | V | Vin+=0[V],Vin-=1[V],RL=2[kΩ] |
| Maximum Output Current | Source | IOH | 25℃ | 10 | 20 | - | mA | Vin+=1[V],Vin-=0[V],VO=0[V] |
| | Sink | IOL | 25℃ | 5 | 10 | - | mA | Vin+=0[V],Vin-=1[V],VO=0[V] |
| Slew Rate | | SR | 25℃ | - | 1.0 | - | V/μs | Av=1,RL=2[kΩ] |
| Input Referred Noise Voltage | | Vn | 25℃ | - | 2.0 | 4.0 | μVrms | RIAA,Rs=2.2[kΩ],10[Hz]~30[kHz] |
| Channel Separation | | CS | 25℃ | - | 100 | - | dB | f=1[kHz ] input referred |

(*13) Absolute value

(*14) Current direction: Since first input stage is composed with PNP transistor, input bias current flows out of IC.

●Electrical characteristics

○BA15532 family (Unless otherwise specified VCC=+15[V], VEE=-15[V], Ta=25[℃])

| Parameter | Symbol | Temperature Range | Guaranteed limit | | | Unit | Condition |
|---|---|---|---|---|---|---|---|
| | | | Min. | Typ. | Max. | | |
| Input Offset Voltage (*15) | Vio | 25℃ | - | 0.5 | 4.0 | mV | Rs=50[Ω],RL≧10[kΩ] |
| Input Offset Current (*15) | Iio | 25℃ | - | 10 | 150 | nA | RL≧10[kΩ] |
| Input Bias Current (*16) | Ib | 25℃ | - | 200 | 800 | nA | RL≧10[kΩ] |
| Large Single Voltage Gain | Av | 25℃ | 80 | 94 | - | dB | RL≧600[Ω],Vo=±10[V] |
| Common-mode Rejection Ratio | CMRR | 25℃ | 70 | 100 | - | dB | RL≧10[kΩ] |
| Input Common-mode Voltage Range | Vicm | 25℃ | ±12 | ±13 | - | V | RL≧10[kΩ] |
| Power Supply Rejection Ratio | PSRR | 25℃ | 80 | 100 | - | dB | Rs=50[Ω],RL≧10[kΩ] |
| Supply Current | Icc | 25℃ | - | 8.0 | 16.0 | mA | RL=∞,on all OpAmp |
| Maximum Output Voltage -1 | VOH/ VOL | 25℃ | ±12 | ±13 | - | V | RL≧600[Ω] |
| Maximum Output Voltage -2 | | 25℃ | ±15 | ±16 | - | V | RL≧600[Ω] VCC=18[V],VEE=-18[V] |
| Output Short Current | IOS | 25℃ | - | 38 | - | mA | (*17) |
| Slew Rate | SR | 25℃ | - | 8.0 | - | V/μs | Av=1,RL=600[Ω],CL=100[pF] |
| Gain Bandwidth Product | GBW | 25℃ | - | 20 | - | MHz | f=10[kHz],RL=600[Ω],CL=100[pF] |
| Input Referred Noise Voltage | Vn | 25℃ | - | 0.7 | 1.5 | μVrms | RIAA,Rs=100[Ω],20[Hz]~30[kHz] |
| Channel Separation | CS | 25℃ | - | 110 | - | dB | RIAA Input referred |

(*15 Absolute value

(*16) Current direction: Since first input stage is composed with NPN transistor, input bias current flows out of IC.

(*17) In the case of output pin shorting with VCC or VEE. But never over the maximum power dissipation

●Absolute maximum rating (Ta=25[℃])

○BA4510/BA2115 family

| Parameter | Symbol | Rating | | Unit |
|---|---|---|---|---|
| | | BA4510 family | BA2115 family | |
| Supply Voltage | VCC-VEE | 10 | 14 | V |
| Differential Input Voltage(*18) | Vid | VCC-VEE | 14 | V |
| Input Common-mode Voltage Range | Vicm | VEE~VCC | (VEE-0.3)~VEE+14 | V |
| Operating Supply Voltage | Vopr | 2～7(±1~±3.5) | 2～14(±1~±7) | V |
| Operating Temperature | Topr | -20~+75 | -40~+85 | ℃ |
| Storage Temperature | Tstg | -55~125 | -55~150 | ℃ |
| Maximum Junction Temperature | Tjmax | 125 | 150 | ℃ |

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

(*18) The voltage difference between inverting input and non-inverting input is the differential input voltage.
Then input terminal voltage is set to more then VEE.

●Electrical characteristics

○BA4510 family (Unless otherwise specified VCC=+2.5[V], VEE=-2.5[V], Ta=25[℃])

| Parameter | Symbol | Temperature Range | Guaranteed limit | | | Unit | Condition |
|---|---|---|---|---|---|---|---|
| | | | Min. | Typ. | Max. | | |
| Input Offset Voltage (*19) | Vio | 25℃ | - | 1 | 6 | mV | Rs=50[Ω] |
| Input Offset Current (*19) | Iio | 25℃ | - | 2 | 200 | nA | - |
| Input Bias Current (*20) | Ib | 25℃ | - | 80 | 500 | nA | - |
| Supply Current | ICC | 25℃ | 2.5 | 5.0 | 7.5 | mA | RL=∞ All Op-Amps |
| Maximum Output Voltage | VOH | 25℃ | +2.0 | +2.4 | - | V | RL=10[kΩ] |
| | VOL | 25℃ | - | -2.4 | -2.0 | V | RL=10[kΩ] |
| Large Single Voltage Gain | Av | 25℃ | 60 | 90 | - | dB | RL≧10[kΩ] |
| Input Common-mode Voltage Range | Vicm | 25℃ | -1.3 | - | +1.5 | V | - |
| Common-mode Rejection Ratio | CMRR | 25℃ | 60 | 80 | - | dB | - |
| Power Supply Rejection Ratio | PSRR | 25℃ | 60 | 80 | - | dB | Rs=50[Ω] |
| Slew Rate | SR | 25℃ | - | 5.0 | - | V/μs | Av=1 |

(*19) Absolute value

(*20) Current direction: Since first input stage is composed with PNP transistor, input bias current flows out of IC.

●Electrical characteristics

○BA2115 family (Unless otherwise specified VCC=+2.5[V], VEE=-2.5[V], Ta=25[℃])

| Parameter | Symbol | Temperature Range | Guaranteed limit | | | Unit | Condition |
|---|---|---|---|---|---|---|---|
| | | | Min. | Typ. | Max. | | |
| Input Offset Voltage (*21) | Vio | 25℃ | - | 1 | 6 | mV | VOUT=0[V], Vicm=0[V] |
| Input Offset Current (*21) | Iio | 25℃ | - | 2 | 200 | nA | VOUT=0[V], Vicm=0[V] |
| Input Bias Current (*22) | Ib | 25℃ | - | 150 | 400 | nA | VOUT=0[V], Vicm=0[V] |
| Supply Current | ICC | 25℃ | - | 3.5 | 5 | mA | RL=∞ All Op-Amps, VIN+=0[V] |
| Maximum Output Voltage | VOM | 25℃ | ±2.0 | ±2.2 | - | V | RL≧2.5[kΩ] |
| Large Single Voltage Gain | AV | 25℃ | 60 | 80 | - | dB | RL≧10[kΩ], VOUT=±2[V], Vicm=0[V] |
| Input Common-mode Voltage Range | Vicm | 25℃ | ±1.5 | - | - | V | - |
| Common-mode Rejection Ratio | CMRR | 25℃ | 60 | 74 | - | dB | Vicm=-1.5[V]～+1.5[V] |
| Power Supply Rejection Ratio | PSRR | 25℃ | 60 | 80 | - | dB | VCC=+2[V]～+14[V] |
| Slew Rate | SR | 25℃ | - | 4 | - | V/μs | AV=0[dB], VIN=±1[V] |
| Gain Bandwidth Product | GB | 25℃ | - | 12 | - | MHz | f=10[kHz] |

(*21) Absolute value

(*22) Current direction: Since first input stage is composed with PNP transistor, input bias current flows out of IC.

●Example of electrical characteristics

○BA4558 family

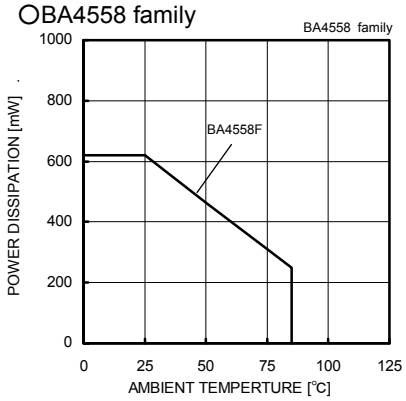



Fig. 1
Derating Curve

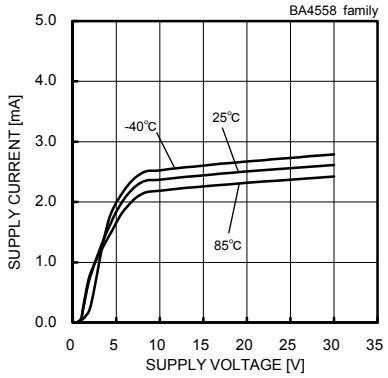



Fig. 2
Supply Current – Supply Voltage

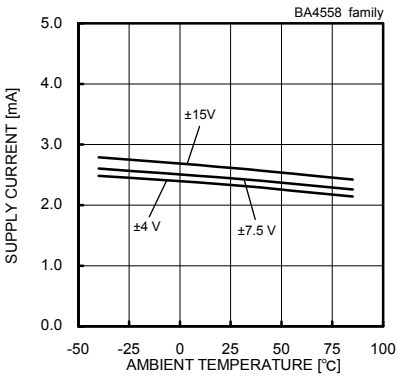



Fig. 3
Supply Current – Ambient Temperature

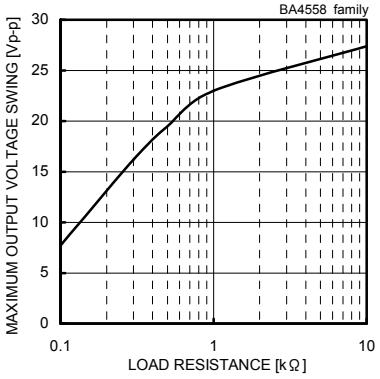



Fig. 4
Maximum Output Voltage Swing
– Load Resistance
(VCC/VEE=+15[V]/-15[V],Ta=25[℃])

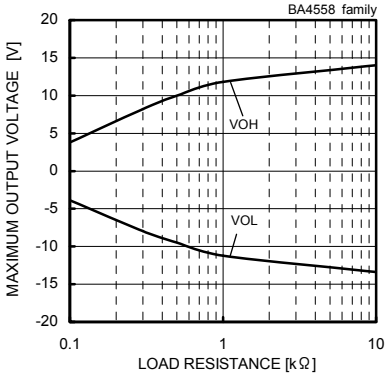



Fig. 5
Maximum Output Voltage
– Load Resistance
(VCC/VEE=+15[V]/-15[V],Ta=25[℃])

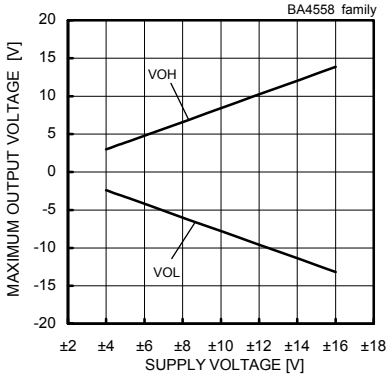



Fig. 6
Maximum Output Voltage
– Supply Voltage
(RL=2[kΩ],Ta=25[℃])

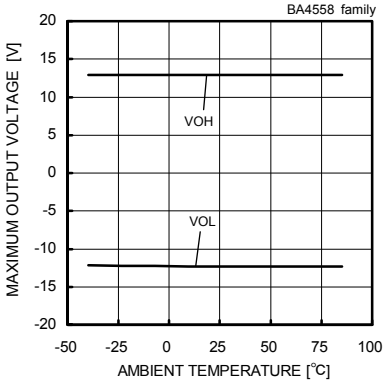



Fig. 7
Maximum Output Voltage
– Ambient Temperature
(VCC/VEE=+15[V]/-15[V],RL=2[kΩ])

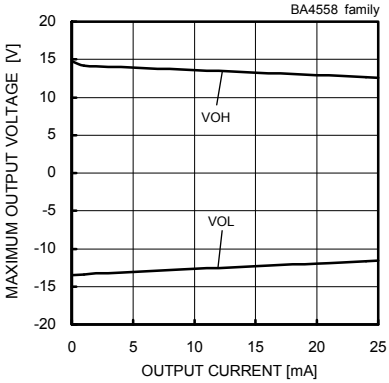



Fig. 8
Maximum Output Voltage
– Output Current
(VCC/VEE=+15[V]/-15[V],Ta=25[℃])

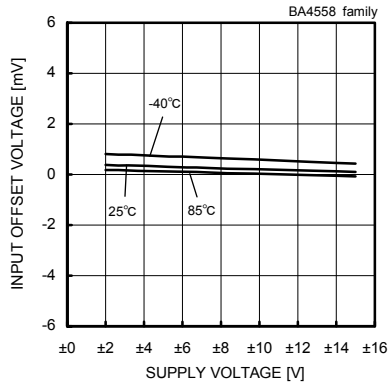



Fig. 9
Input Offset Voltage – Supply Voltage
(Vicm=0[V],Vout=0[V])

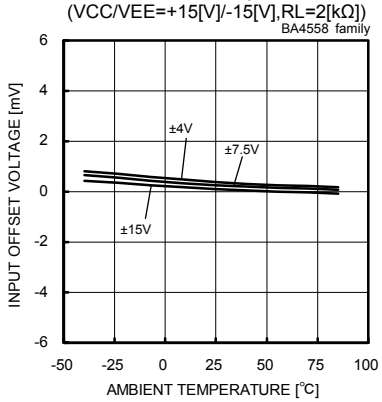



Fig. 10
Input Offset Voltage – Ambient Temperature
(Vicm=0[V],Vout=0[V])

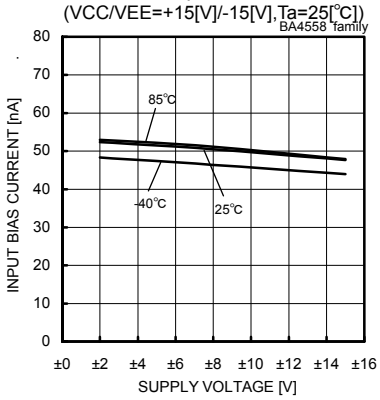



Fig. 11
Input Bias Current – Supply Voltage
(Vicm=0[V],Vout=0[V])

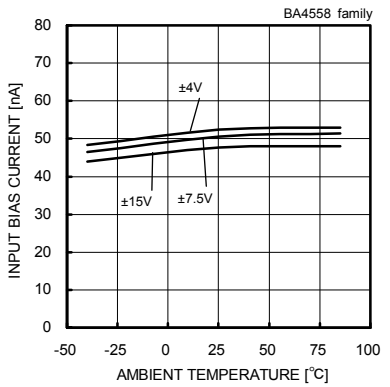



Fig. 12
Input Bias Current – Ambient Temperature
(Vicm=0[V],Vout=0[V])

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

○BA4558 family

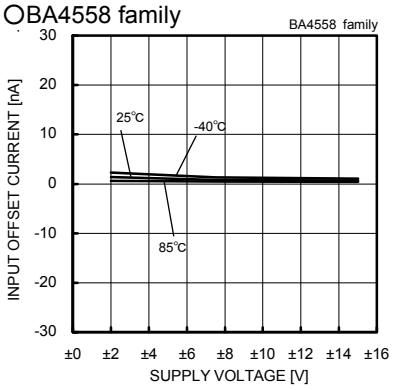



Fig. 13
Input Offset Current – Supply Voltage
(Vicm=0[V],Vout=0[V])

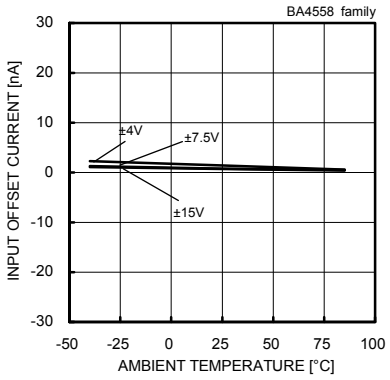



Fig. 14
Input Offset Current – Ambient Temperature
(Vicm=0[V],Vout=0[V])

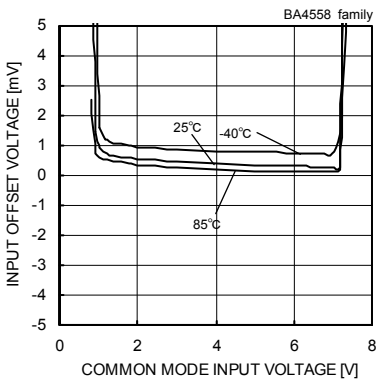



Fig. 15
Input Offset Voltage
– Common Mode Input Voltage
(VCC=8[V],Vout=4[V])

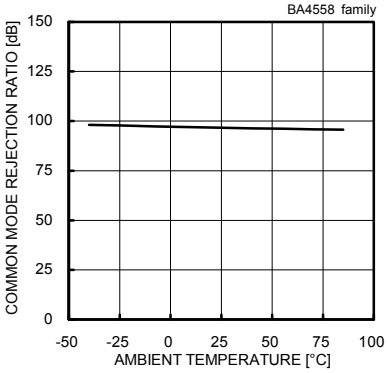



Fig. 16
Common Mode Rejection Ratio
– Ambient Temperature
(VCC/VEE=+15[V]/-15[V],Vicm=-12[V] to +12[V])

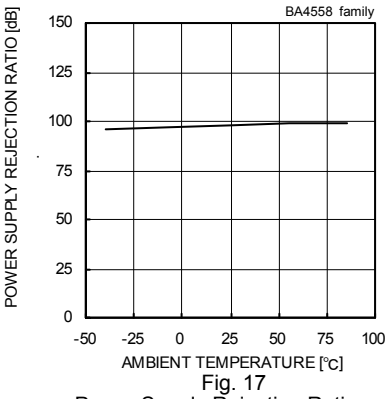



Fig. 17
Power Supply Rejection Ratio
– Ambient Temperature
(VCC/VEE=+4[V]/-4[V] to +15[V]/-15[V])

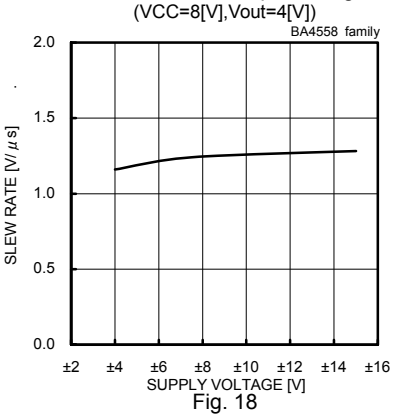



Fig. 18
Slew Rate – Supply Voltage
(CL=100[pF],RL=2[kΩ],Ta=25[℃])

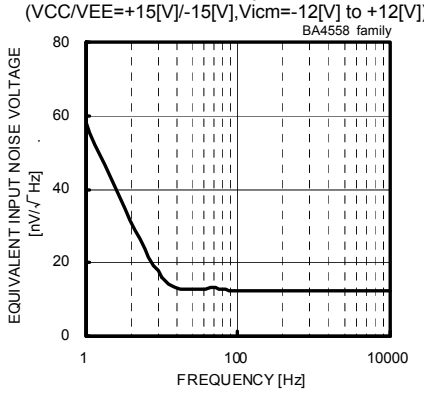



Fig. 19
Equivalent Input Noise Voltage – Frequency
(VCC/VEE=+15[V]/-15[V],Rs=100[Ω],Ta=25[℃])

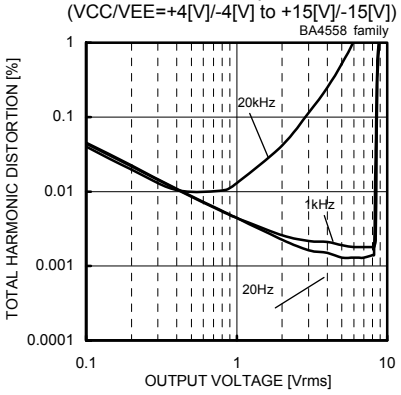



Fig. 20
Total Harmonic Distortion – Output Voltage
(VCC/VEE=+15[V]/-15[V],Av=20[dB],
RL＝2[kΩ],80[kHz]-LPF,Ta=25[℃])

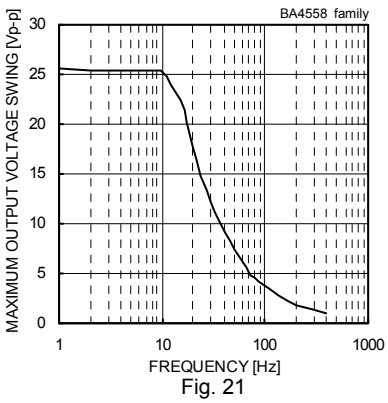



Fig. 21
Maximum Output Voltage Swing – Frequency
(VCC/VEE=+15[V]/-15[V],RL=2[kΩ],Ta=25[℃])

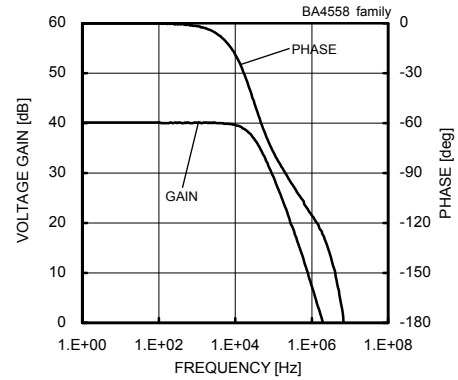



Fig. 22
Voltage Gain – Frequency
(VCC/VEE=+15[V]/-15[V],Av=40[dB],RL=2[kΩ],Ta=25[℃])

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

○BA4560 family

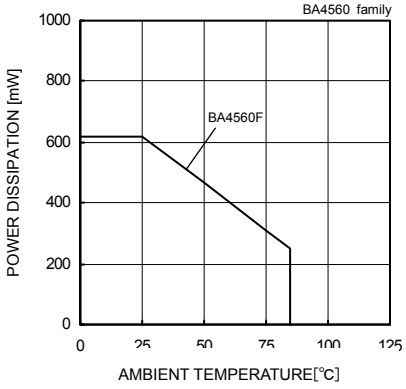



Fig. 23
Derating Curve

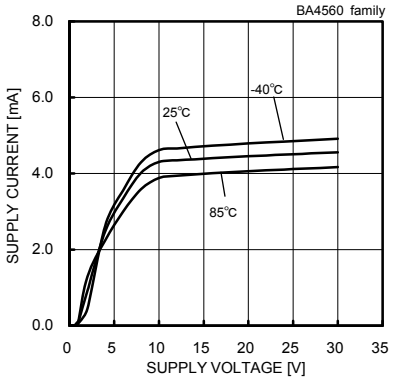



Fig. 24
Supply Current – Supply Voltage

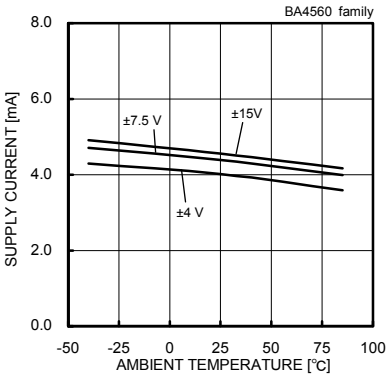



Fig. 25
Supply Current – Ambient Temperature

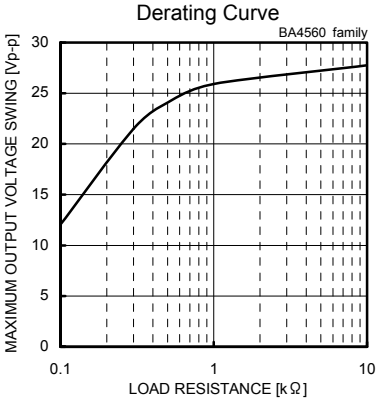



Fig. 26
Maximum Output Voltage Swing
– Load Resistance
(VCC/VEE=+15[V]/-15[V],Ta=25[℃])

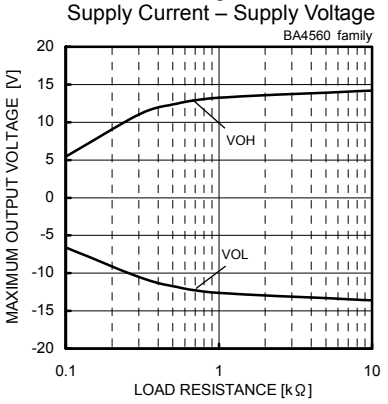



Fig. 27
Maximum Output Voltage
– Load Resistance
(VCC/VEE=+15[V]/-15[V],Ta=25[℃])

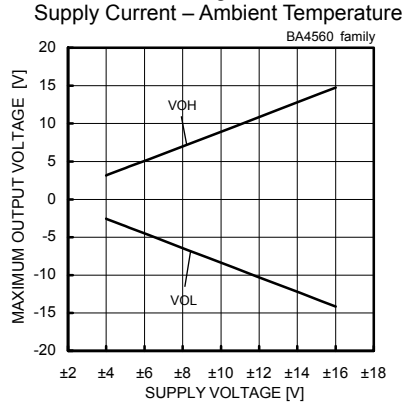



Fig. 28
Maximum Output Voltage
– Supply Voltage
(RL=2[kΩ],Ta=25[℃])

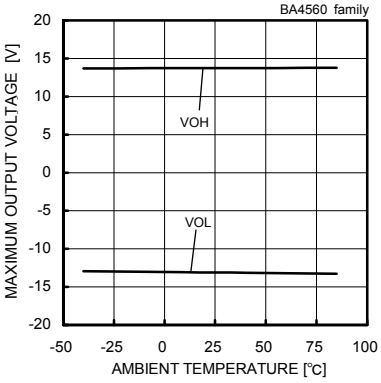



Fig. 29
Maximum Output Voltage
– Ambient Temperature
(VCC/VEE=+15[V]/-15[V],RL=2[kΩ])

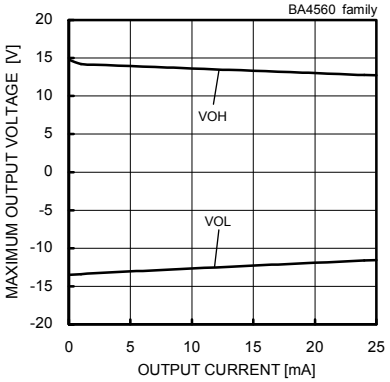



Fig. 30
Maximum Output Voltage
– Output Current
(VCC/VEE=+15[V]/-15[V],Ta=25[℃])

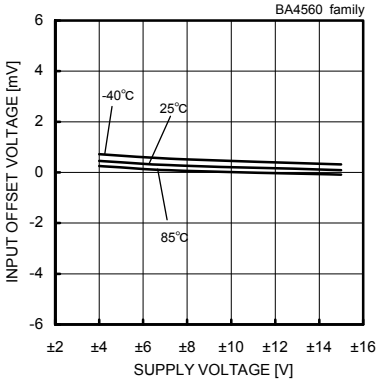



Fig. 31
Input Offset Voltage – Supply Voltage
(Vicm=0[V],Vout=0[V])

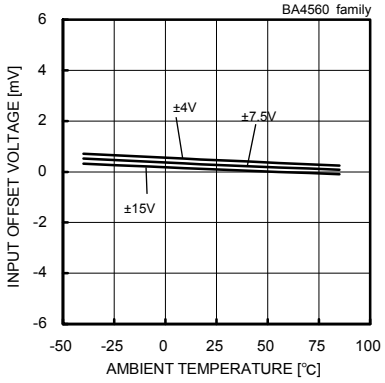



Fig. 32
Input Offset Voltage – Ambient Temperature
(Vicm=0[V],Vout=0[V])

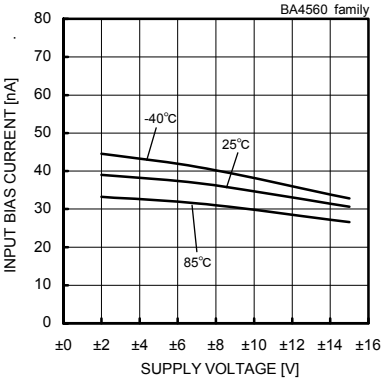



Fig. 33
Input Bias Current – Supply Voltage
(Vicm=0[V],Vout=0[V])

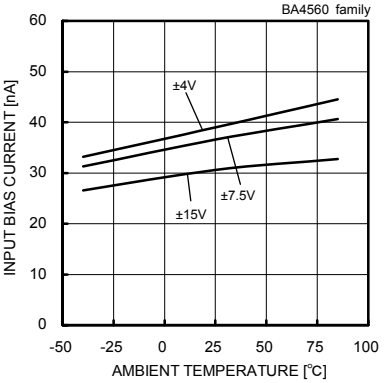



Fig. 34
Input Bias Current – Ambient Temperature
(Vicm=0[V],Vout=0[V])

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

○BA4560 family

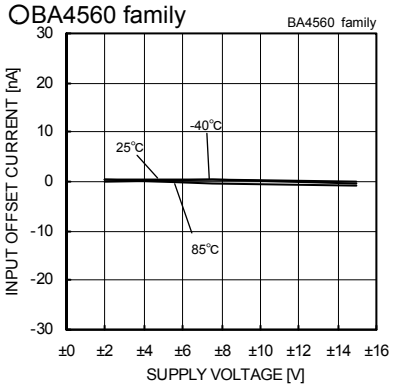



Fig. 35
Input Offset Current – Supply Voltage
(Vicm=0[V],Vout=0[V])

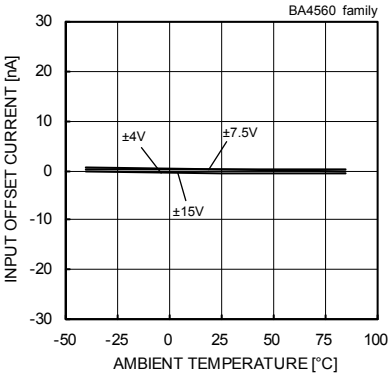



Fig. 36
Input Offset Current – Ambient Temperature
(Vicm=0[V],Vout=0[V])

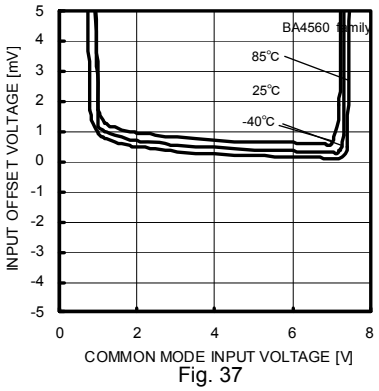



Fig. 37
Input Offset Voltage
– Common Mode Input Voltage
(VCC=8[V],Vout=4[V])

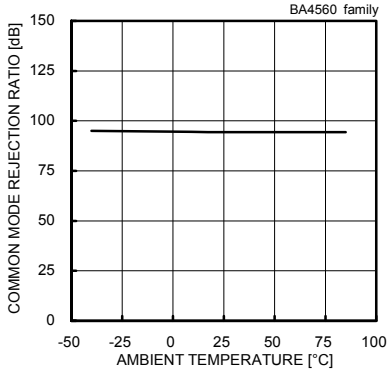



Fig. 38
Common Mode Rejection Ratio
– Ambient Temperature
(VCC/VEE=+15[V]/-15[V],Vicm=-12[V] to +12[V])

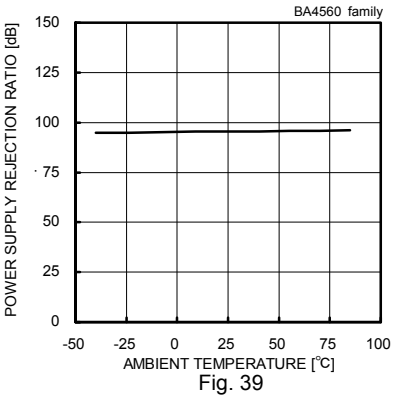



Fig. 39
Power Supply Rejection Ratio
– Ambient Temperature
(VCC/VEE=+4[V]/-4[V] to +15[V]/-15[V])

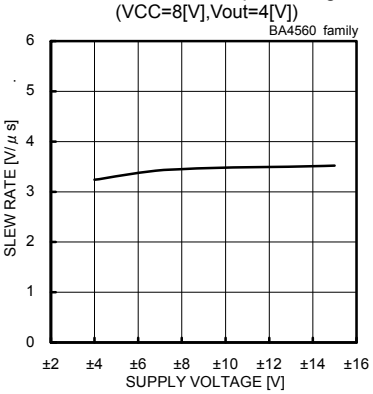



Fig. 40
Slew Rate – Supply Voltage
(CL=100[pF],RL=2[kΩ],Ta=25[℃])

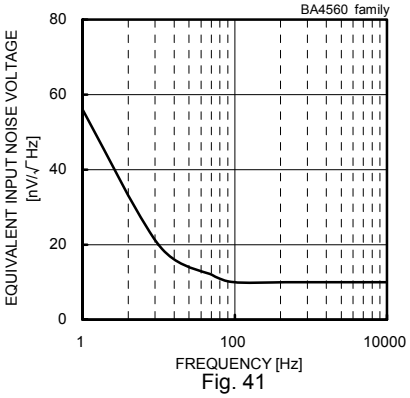



Fig. 41
Equivalent Input Noise Voltage – Frequency
(VCC/VEE=+15[V]/-15[V],Rs=100[Ω],Ta=25[℃])

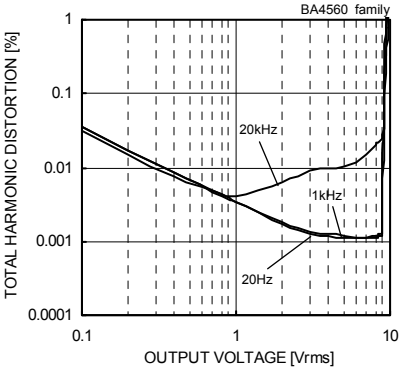



Fig. 42
Total Harmonic Distortion – Output Voltage
(VCC/VEE=+15[V]/-15[V],Av=20[dB],
RL＝2[kΩ],80[kHz]-LPF,Ta=25[℃])

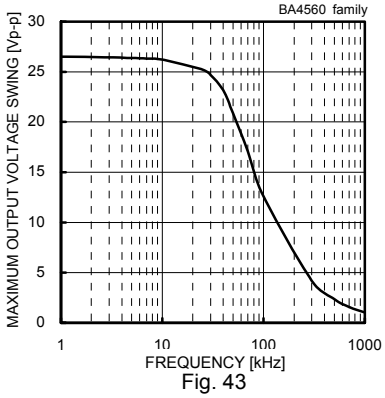



Fig. 43
Maximum Output Voltage Swing – Frequency
(VCC/VEE=+15[V]/-15[V],RL=2[kΩ],Ta=25[℃])

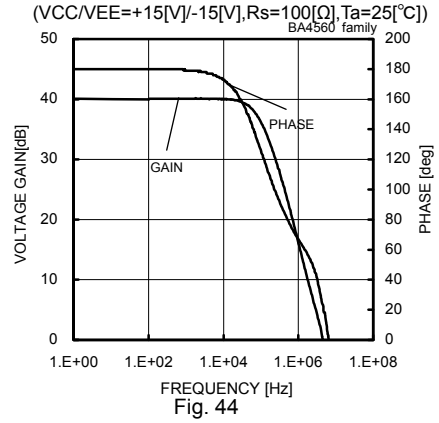



Fig. 44
Voltage Gain – Frequency
(VCC/VEE=+15[V]/-15[V],Av=40[dB],RL=2[kΩ],Ta=25[℃])

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

○BA4558R family

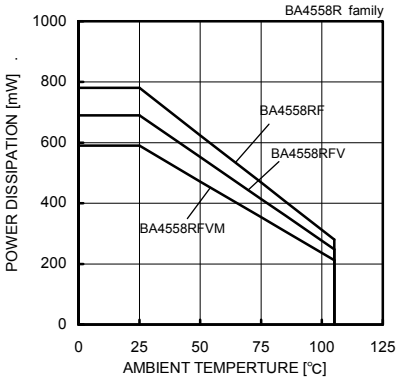



Fig. 45
Derating Curve

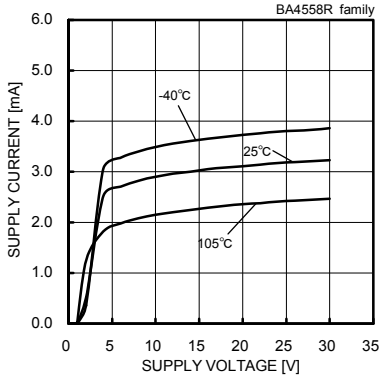



Fig. 46
Supply Current – Supply Voltage

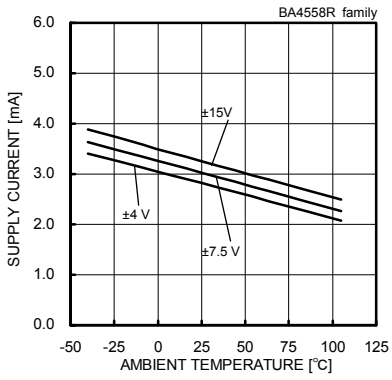



Fig. 47
Supply Current – Ambient Temperature

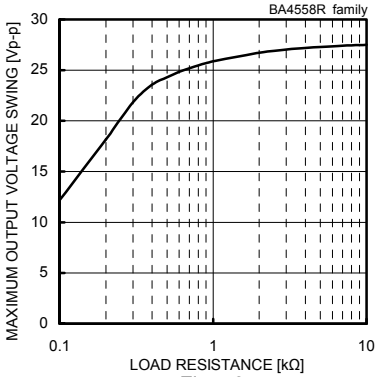



Fig. 48
Maximum Output Voltage Swing
– Load Resistance
(VCC/VEE=+15[V]/-15[V],Ta=25[℃])

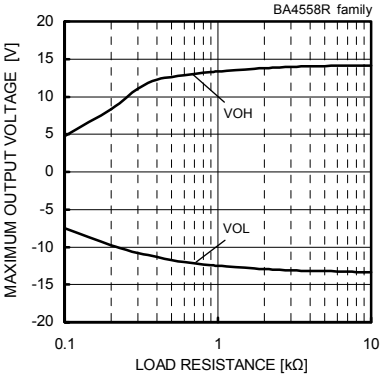



Fig. 49
Maximum Output Voltage
– Load Resistance
(VCC/VEE=+15[V]/-15[V],Ta=25[℃])

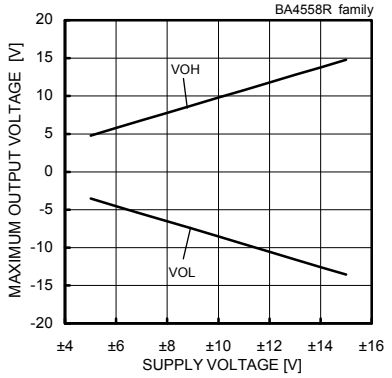



Fig. 50
Maximum Output Voltage
– Supply Voltage
(RL=2[kΩ],Ta=25[℃])

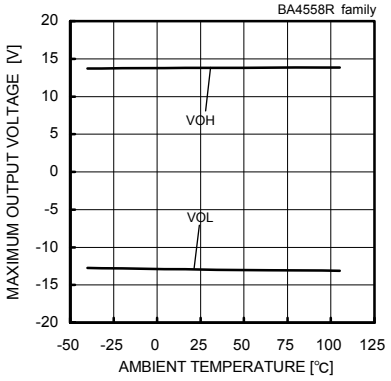



Fig. 51
Maximum Output Voltage
– Ambient Temperature
(VCC/VEE=+15[V]/-15[V],RL=2[kΩ])

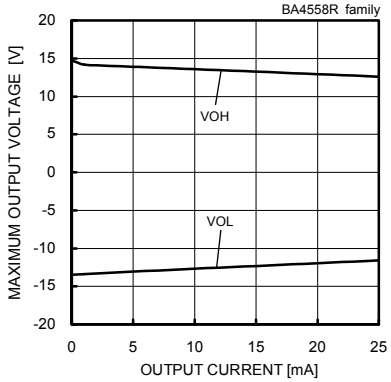



Fig. 52
Maximum Output Voltage
– Output Current
(VCC/VEE=+15[V]/-15[V],Ta=25[℃])

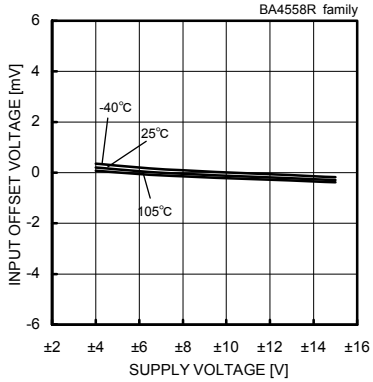



Fig. 53
Input Offset Voltage – Supply Voltage
(Vicm=0[V],Vout=0[V])

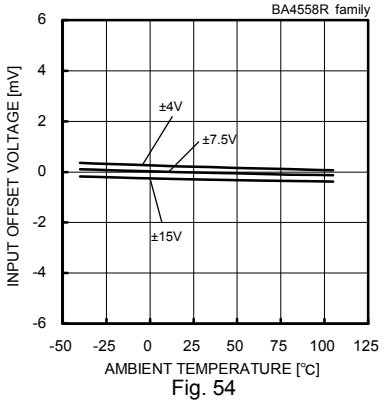



Fig. 54
Input Offset Voltage – Ambient Temperature
(Vicm=0[V],Vout=0[V])

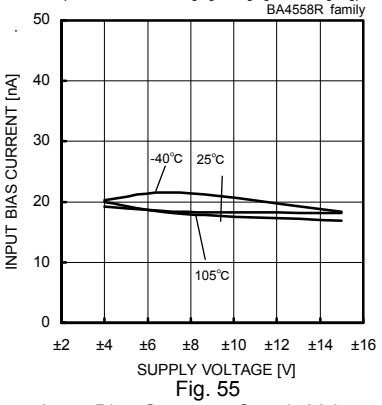



Fig. 55
Input Bias Current – Supply Voltage
(Vicm=0[V],Vout=0[V])

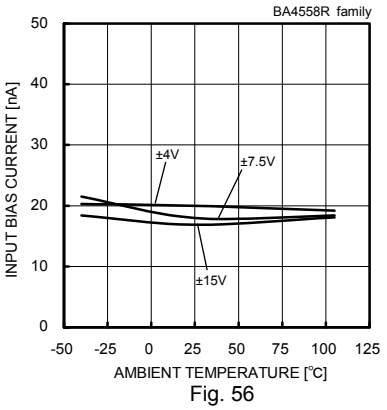



Fig. 56
Input Bias Current – Ambient Temperature
(Vicm=0[V],Vout=0[V])

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

○BA4558R family

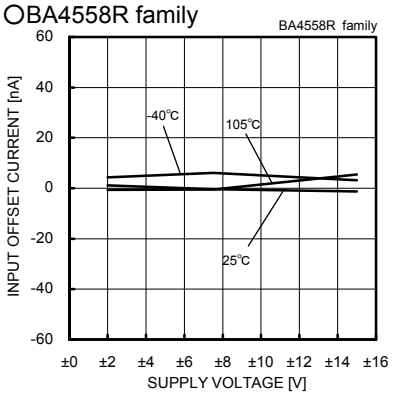



Fig. 57
Input Offset Current – Supply Voltage
(Vicm=0[V],Vout=0[V])

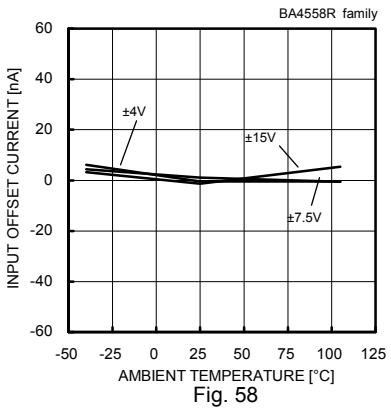



Fig. 58
Input Offset Current – Ambient Temperature
(Vicm=0[V],Vout=0[V])

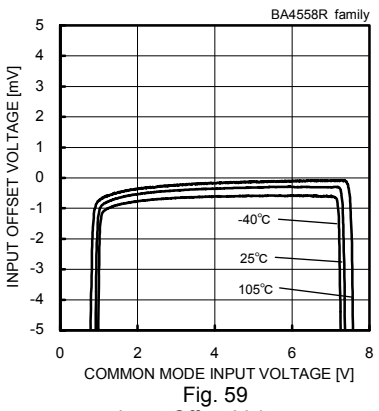



Fig. 59
Input Offset Voltage
– Common Mode Input Voltage
(VCC=8[V],Vout=4[V])

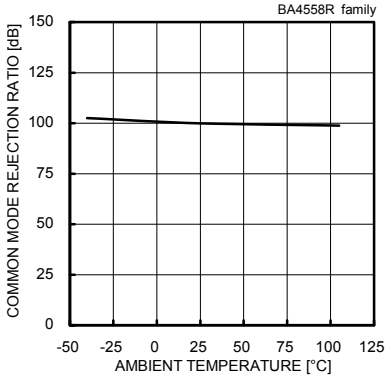



Fig. 60
Common Mode Rejection Ratio
– Ambient Temperature
(VCC/VEE=+15[V]/-15[V],Vicm=-12[V] to +12[V])

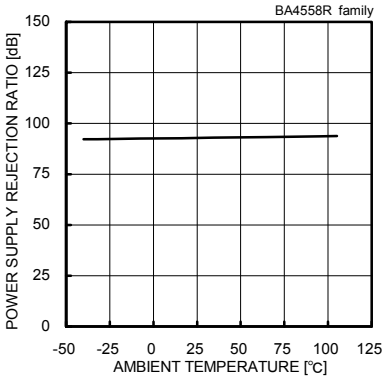



Fig. 61
Power Supply Rejection Ratio
– Ambient Temperature
(VCC/VEE=+4[V]/-4[V] to +15[V]/-15[V])

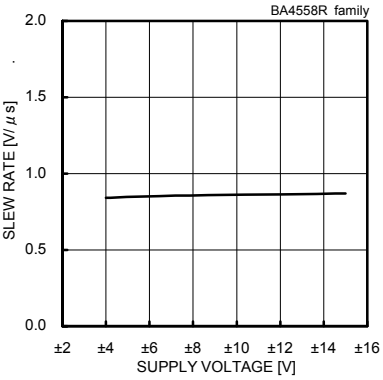



Fig. 62
Slew Rate – Supply Voltage
(CL=100[pF],RL=2[kΩ],Ta=25[℃])

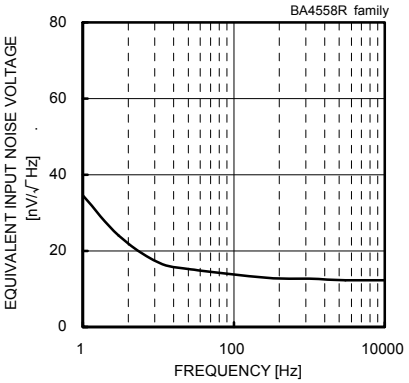



Fig. 63
Equivalent Input Noise Voltage – Frequency
(VCC/VEE=+15[V]/-15[V],Rs=100[Ω],Ta=25[℃])

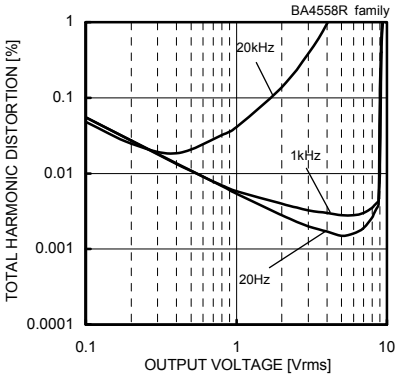



Fig. 64
Total Harmonic Distortion – Output Voltage
(VCC/VEE=+15[V]/-15[V],Av=20[dB],
RL=2[kΩ],80[kHz]-LPF,Ta=25[℃])

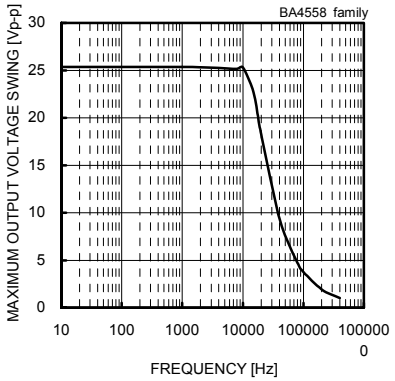



Fig. 65
Maximum Output Voltage Swing – Frequency
(VCC/VEE=+15[V]/-15[V],RL=2[kΩ],Ta=25[℃])

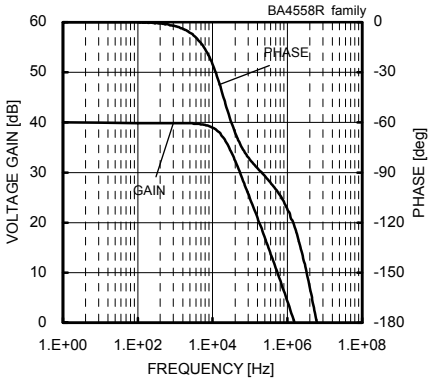



Fig. 66
Voltage Gain – Frequency
(VCC/VEE=+15[V]/-15[V],Av=40[dB],RL=2[kΩ],Ta=25[℃])

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

○BA4560R family

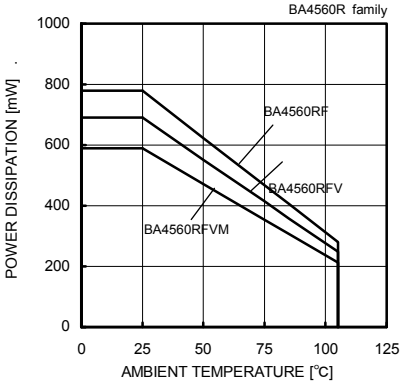



Fig. 67
Derating Curve

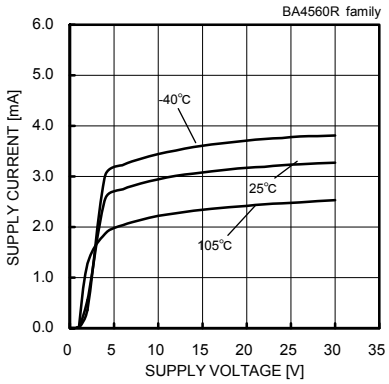



Fig. 68
Supply Current – Supply Voltage

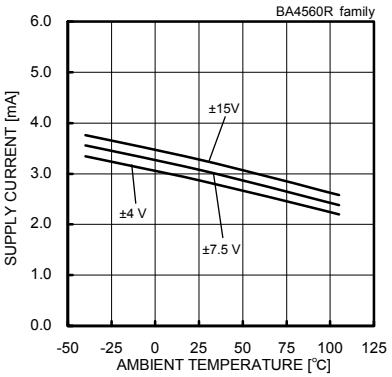



Fig. 69
Supply Current – Ambient Temperature

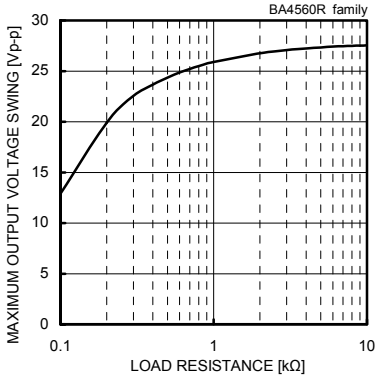



Fig. 70
Maximum Output Voltage Swing
– Load Resistance
(VCC/VEE=+15[V]/-15[V],Ta=25[℃])

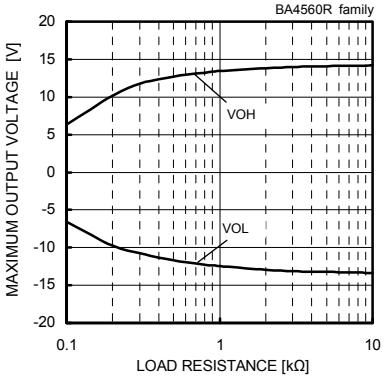



Fig. 71
Maximum Output Voltage
– Load Resistance
(VCC/VEE=+15[V]/-15[V],Ta=25[℃])

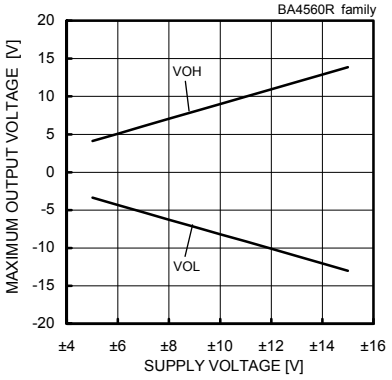



Fig. 72
Maximum Output Voltage
– Supply Voltage
(RL=2[kΩ],Ta=25[℃])

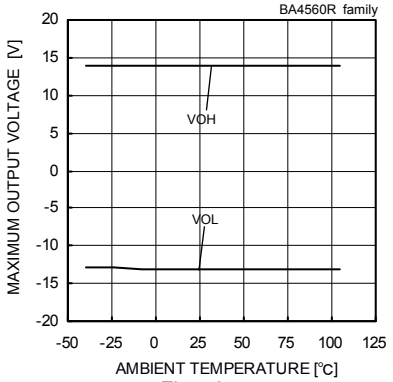



Fig. 73
Maximum Output Voltage
– Ambient Temperature
(VCC/VEE=+15[V]/-15[V],RL=2[kΩ])

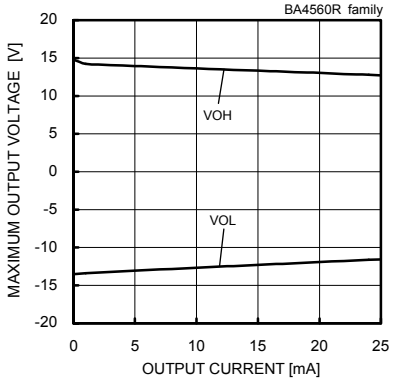



Fig. 74
Maximum Output Voltage
– Output Current
(VCC/VEE=+15[V]/-15[V],Ta=25[℃])

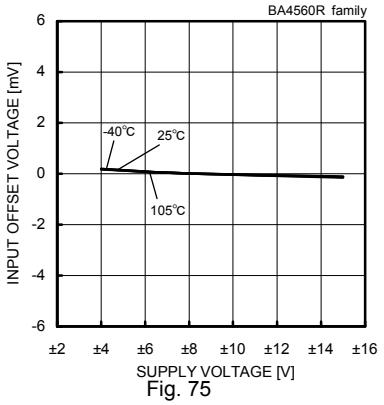



Fig. 75
Input Offset Voltage – Supply Voltage
(Vicm=0[V],Vout=0[V])

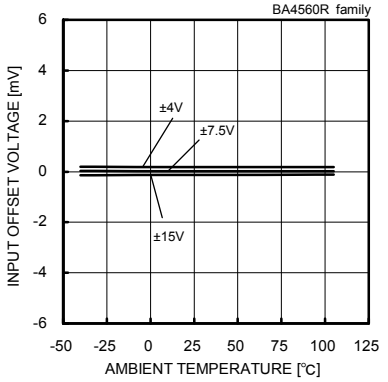



Fig. 76
Input Offset Voltage – Ambient Temperature
(Vicm=0[V],Vout=0[V])

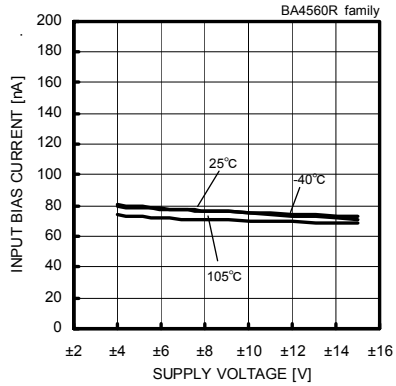



Fig. 77
Input Bias Current – Supply Voltage
(Vicm=0[V],Vout=0[V])

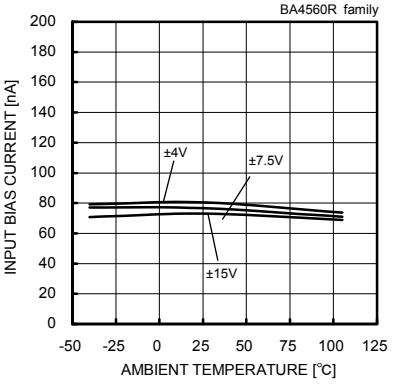



Fig. 78
Input Bias Current – Ambient Temperature
(Vicm=0[V],Vout=0[V])

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

○BA4560R family

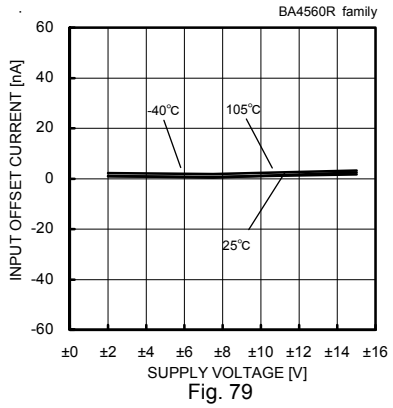



Fig. 79
Input Offset Current – Supply Voltage
(Vicm=0[V],Vout=0[V])

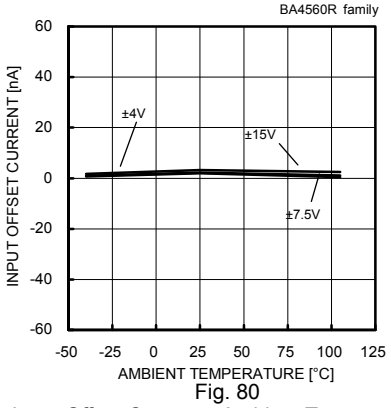



Fig. 80
Input Offset Current – Ambient Temperature
(Vicm=0[V],Vout=0[V])

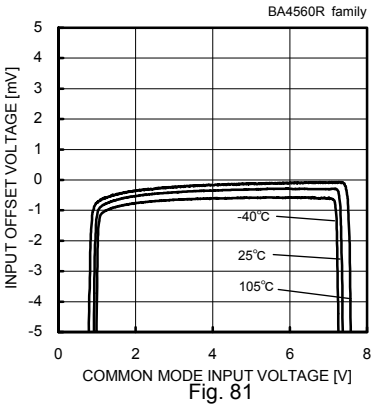



Fig. 81
Input Offset Voltage
- Common Mode Input Voltage
(VCC=8[V],Vout=4[V])

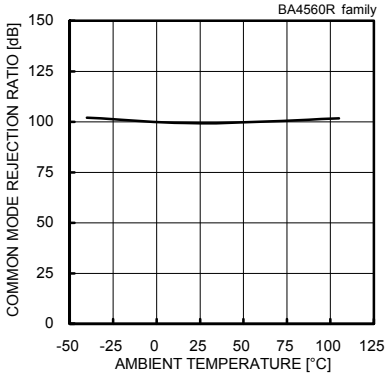



Fig. 82
Common Mode Rejection Ratio
– Ambient Temperature
(VCC/VEE=+15[V]/-15[V],Vicm=-12[V] to +12[V])

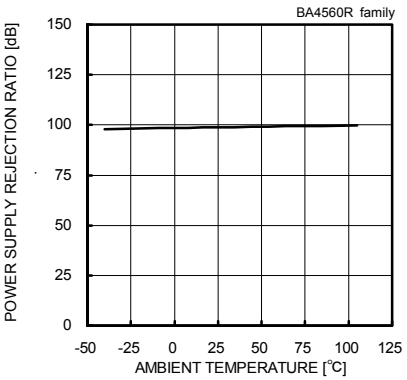



Fig. 83
Power Supply Rejection Ratio
– Ambient Temperature
(VCC/VEE=+4[V]/-4[V] to +15[V]/-15[V])

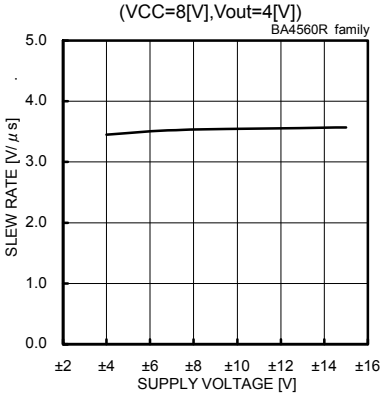



Fig. 84
Slew Rate – Supply Voltage
(CL=100[pF],RL=2[kΩ],Ta=25[℃])

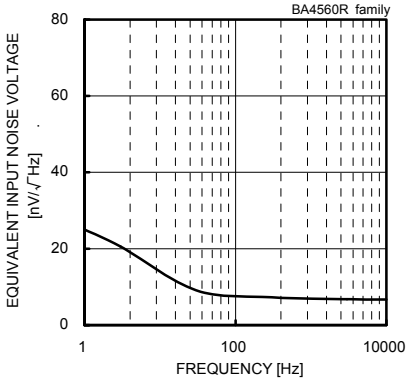



Fig. 85
Equivalent Input Noise Voltage – Frequency
(VCC/VEE=+15[V]/-15[V],Rs=100[Ω],Ta=25[℃])

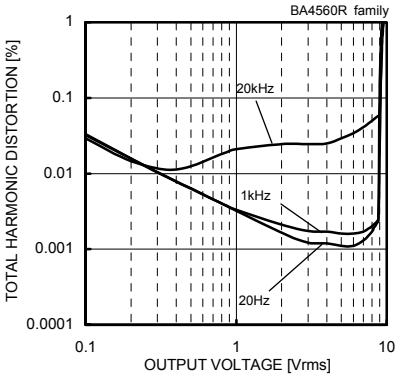



Fig. 86
Total Harmonic Distortion – Output Voltage
(VCC/VEE=+15[V]/-15[V],Av=20[dB],
RL＝2[kΩ],80[kHz]-LPF,Ta=25[℃])

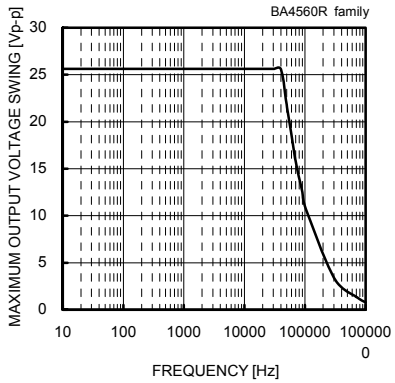



Fig. 87
Maximum Output Voltage Swing – Frequency
(VCC/VEE=+1 5[V]/-15[V],RL=2[kΩ],Ta=25[℃])

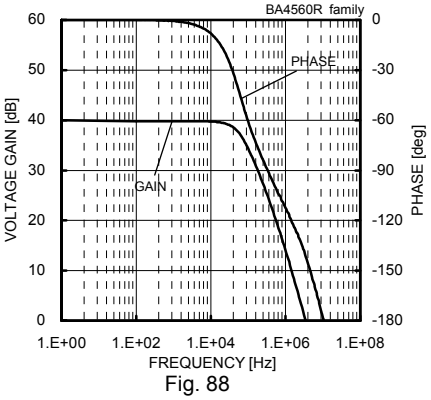



Fig. 88
Voltage Gain – Frequency
(VCC/VEE=+15[V]/-15[V],Av=40[dB],RL=2[kΩ],Ta=25[℃])

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

○BA4580R family

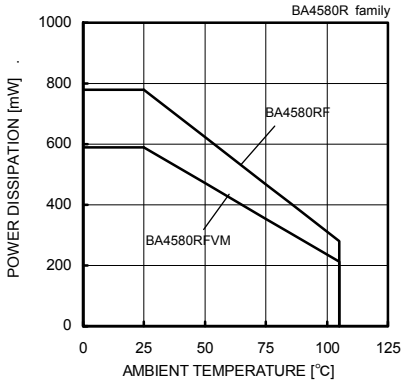



Fig. 89
Derating Curve

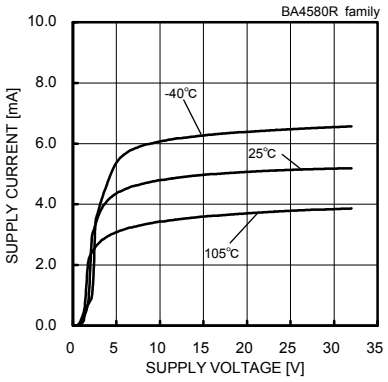



Fig. 90
Supply Current – Supply Voltage

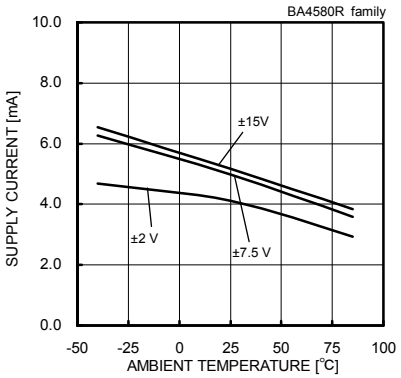



Fig. 91
Supply Current – Ambient Temperature

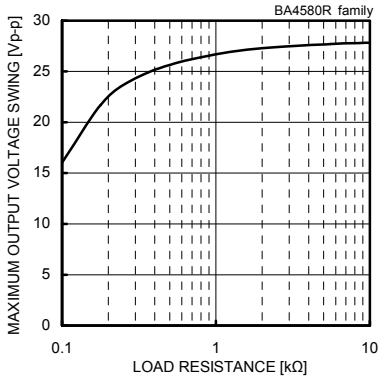



Fig. 92
Maximum Output Voltage Swing
– Load Resistance
(VCC/VEE=+15[V]/-15[V],Ta=25[℃])

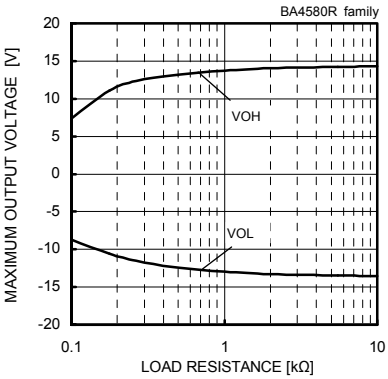



Fig. 93
Maximum Output Voltage
– Load Resistance
(VCC/VEE=+15[V]/-15[V],Ta=25[℃])

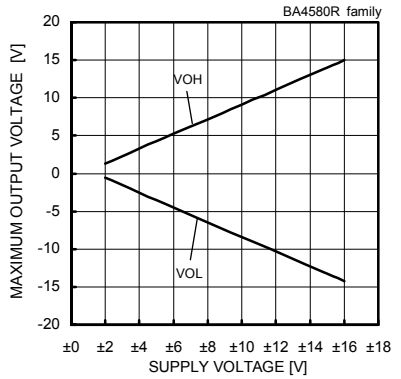



Fig. 94
Maximum Output Voltage
– Supply Voltage
(RL=2[kΩ],Ta=25[℃])

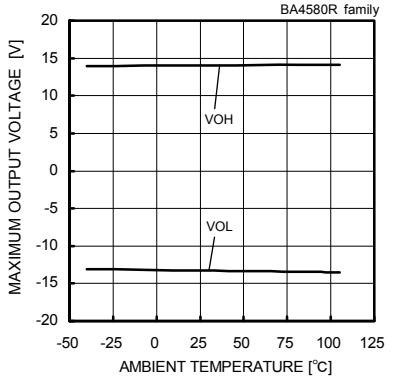



Fig. 95
Maximum Output Voltage
– Ambient Temperature
(VCC/VEE=+15[V]/-15[V],RL=2[kΩ])

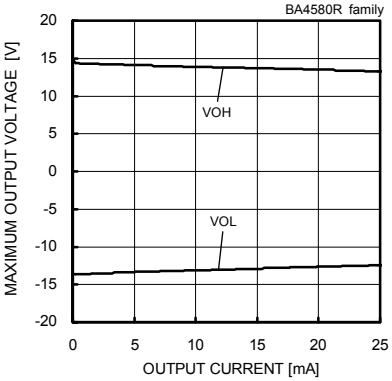



Fig. 96
Maximum Output Voltage
– Output Current
(VCC/VEE=+15[V]/-15[V],Ta=25[℃])

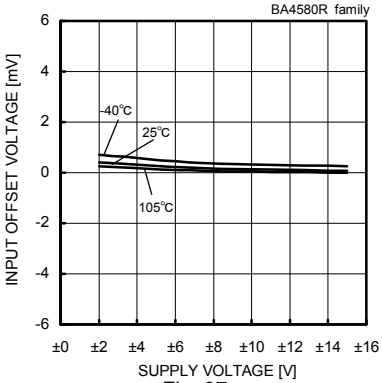



Fig. 97
Input Offset Voltage – Supply Voltage
(Vicm=0[V],Vout=0[V])

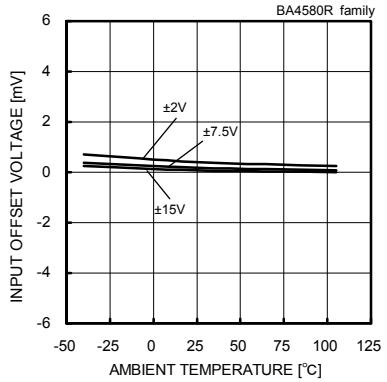



Fig. 98
Input Offset Voltage – Ambient Temperature
(Vicm=0[V],Vout=0[V])

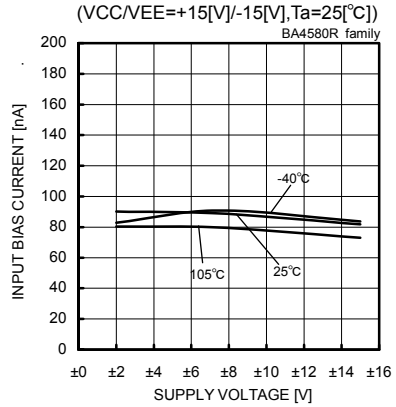



Fig. 99
Input Bias Current – Supply Voltage
(Vicm=0[V],Vout=0[V])

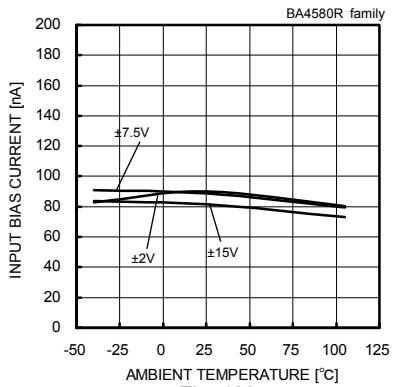



Fig. 100
Input Bias Current – Ambient Temperature
(Vicm=0[V],Vout=0[V])

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

○BA4580R family

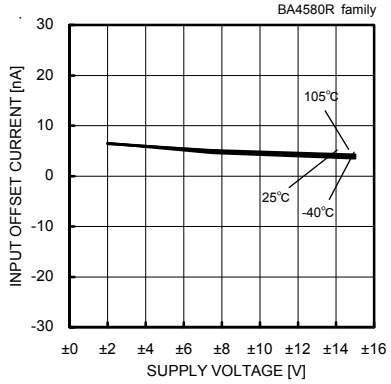



Fig. 101
Input Offset Current – Supply Voltage
(Vicm=0[V],Vout=0[V])

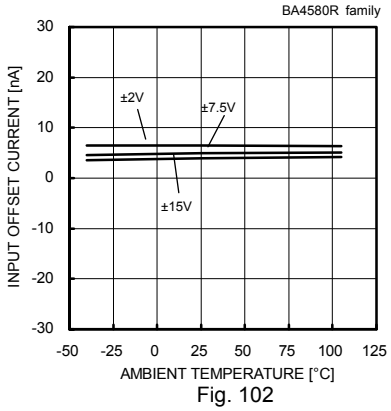



Fig. 102
Input Offset Current – Ambient Temperature
(Vicm=0[V],Vout=0[V])

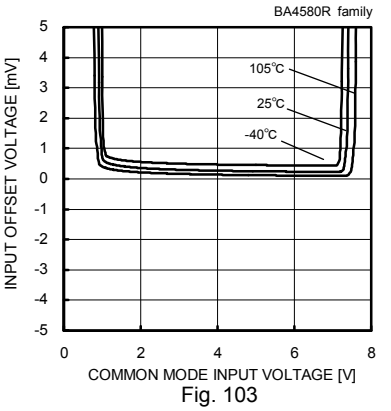



Fig. 103
Input Offset Voltage
– Common Mode Input Voltage
(VCC=8[V],Vout=4[V])

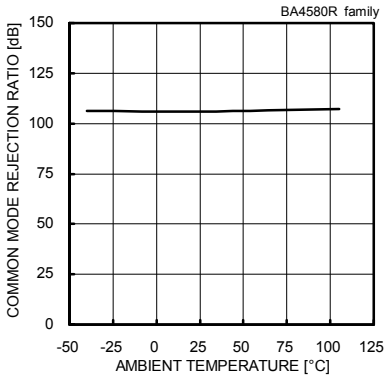



Fig. 104
Common Mode Rejection Ratio
– Ambient Temperature
(VCC/VEE=+15[V]/-15[V],Vicm=-12[V] to +12[V])

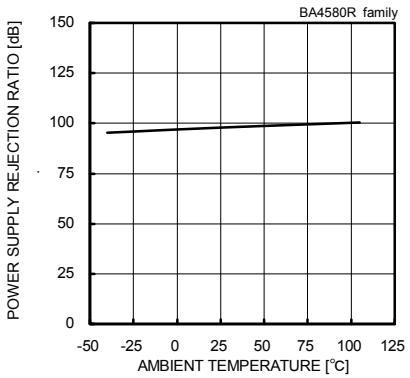



Fig. 105
Power Supply Rejection Ratio
– Ambient Temperature
(VCC/VEE=+2[V]/-2[V] to +15[V]/-15[V])

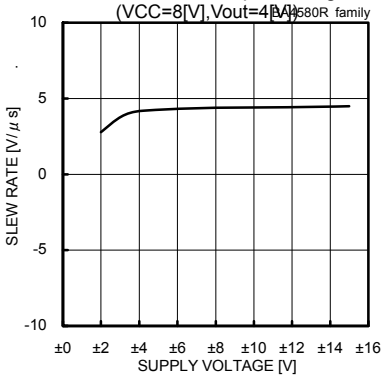



Fig. 106
Slew Rate – Supply Voltage
(CL=100[pF],RL=2[kΩ],Ta=25[℃])

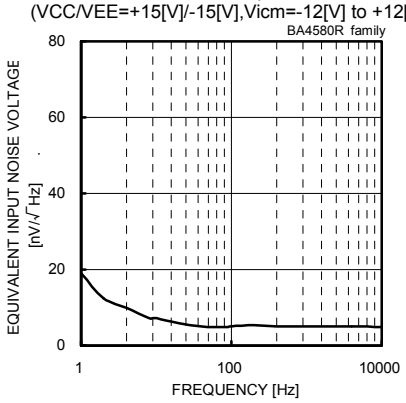



Fig. 107
Equivalent Input Noise Voltage – Frequency
(VCC/VEE=+15[V]/-15[V],Rs=100[Ω],Ta=25[℃])

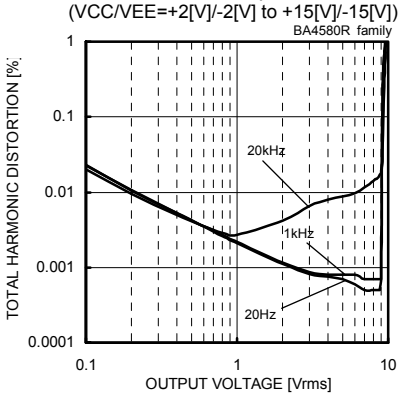



Fig. 108
Total Harmonic Distortion – Output Voltage
(VCC/VEE=+15[V]/-15[V],Av=20[dB],
RL＝2[kΩ],80[kHz]-LPF,Ta=25[℃])

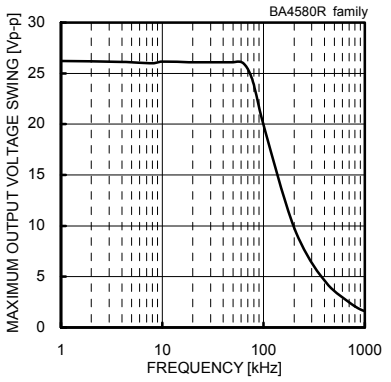



Fig. 109
Maximum Output Voltage Swing – Frequency
(VCC/VEE=+15[V]/-15[V],RL=2[kΩ],Ta=25[℃])

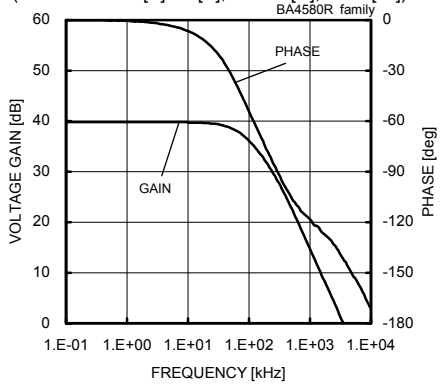



Fig. 110
Voltage Gain – Frequency
(VCC/VEE=+15[V]/-15[V],Av=40[dB],RL=2[kΩ],Ta=25[℃])

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

○BA15218 family

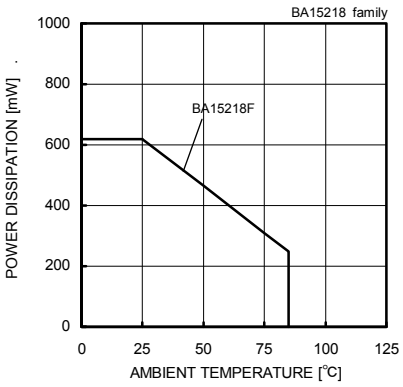



Fig. 111
Derating Curve

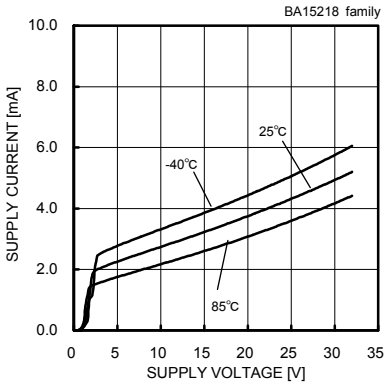



Fig. 112
Supply Current – Supply Voltage

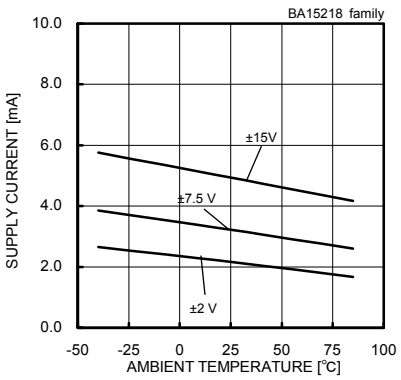



Fig. 113
Supply Current – Ambient Temperature

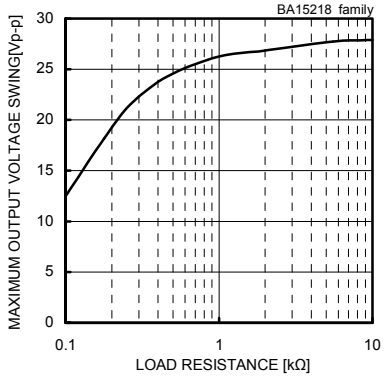



Fig. 114
Maximum Output Voltage Swing
– Load Resistance
(VCC/VEE=+15[V]/-15[V],Ta=25[℃])

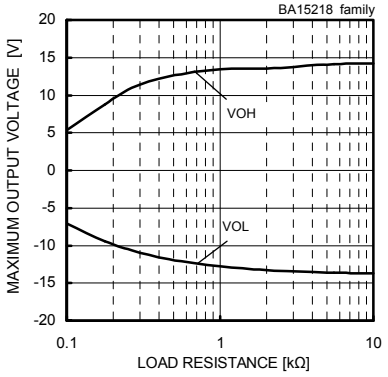



Fig. 115
Maximum Output Voltage
– Load Resistance
(VCC/VEE=+15[V]/-15[V],Ta=25[℃])

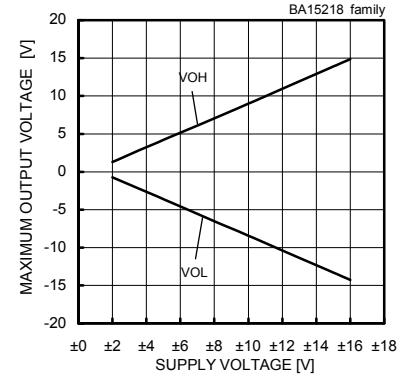



Fig. 116
Maximum Output Voltage
– Supply Voltage
(RL=2[kΩ],Ta=25[℃])

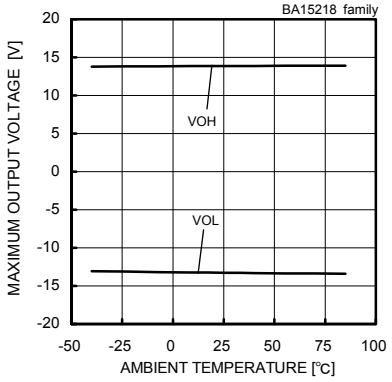



Fig. 117
Maximum Output Voltage
– Ambient Temperature
(VCC/VEE=+15[V]/-15[V],RL=2[kΩ])

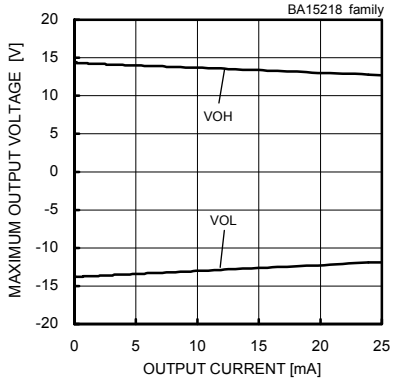



Fig. 118
Maximum Output Voltage
– Output Current
(VCC/VEE=+15[V]/-15[V],Ta=25[℃])

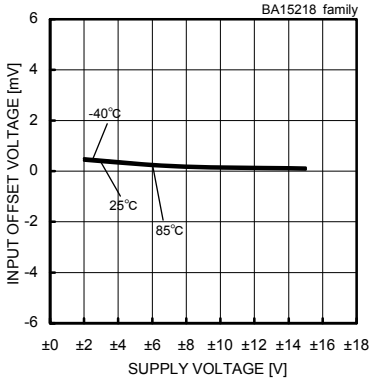



Fig. 119
Input Offset Voltage – Supply Voltage
(Vicm=0[V],Vout=0[V])

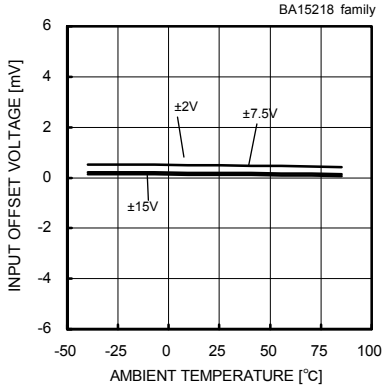



Fig. 120
Input Offset Voltage – Ambient Temperature
(Vicm=0[V],Vout=0[V])

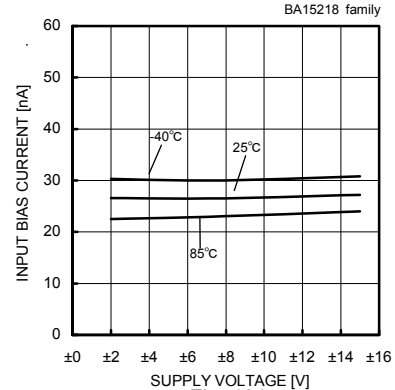



Fig. 121
Input Bias Current – Supply Voltage
(Vicm=0[V],Vout=0[V])

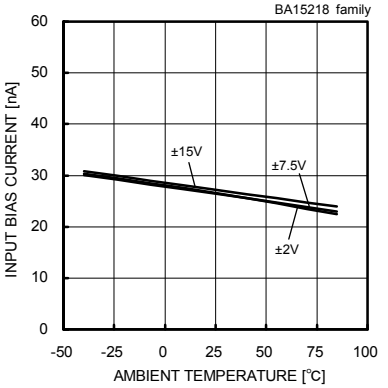



Fig. 122
Input Bias Current – Ambient Temperature
(Vicm=0[V],Vout=0[V])

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

○BA15218 family

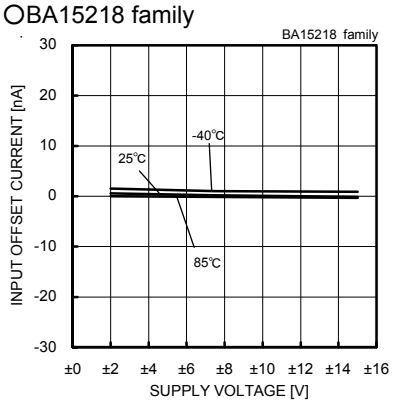



Fig. 123
Input Offset Current – Supply Voltage
(Vicm=0[V],Vout=0[V])

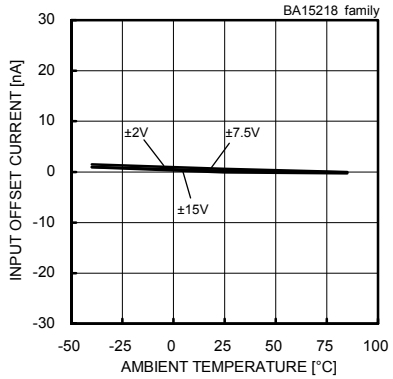



Fig. 124
Input Offset Current – Ambient Temperature
(Vicm=0[V],Vout=0[V])

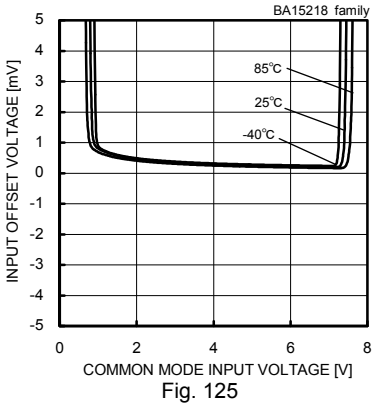



Fig. 125
Input Offset Voltage
– Common Mode Input Voltage
(VCC=8[V],Vout=4[V])

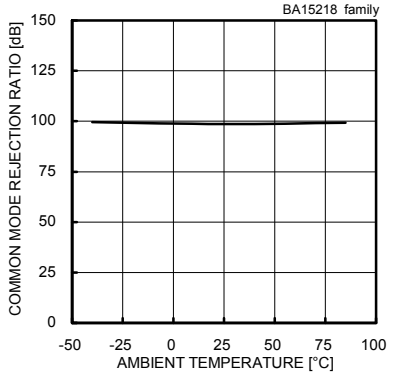



Fig. 126
Common Mode Rejection Ratio
– Ambient Temperature
(VCC/VEE=+15[V]/-15[V],Vicm=-12[V] to +12[V])

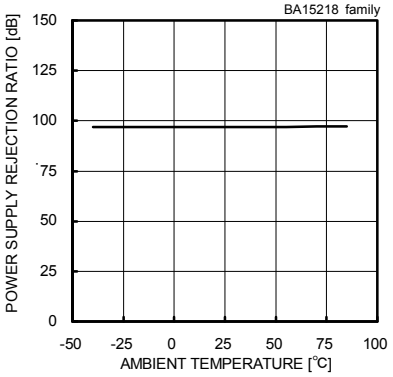



Fig. 127
Power Supply Rejection Ratio
– Ambient Temperature
(VCC/VEE=+2[V]/-2[V] to +15[V]/-15[V])

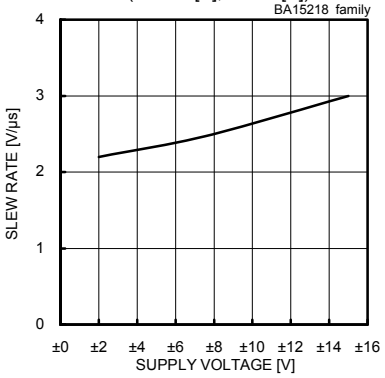



Fig. 128
Slew Rate – Supply Voltage
(CL=100[pF],RL=2[kΩ],Ta=25[℃])

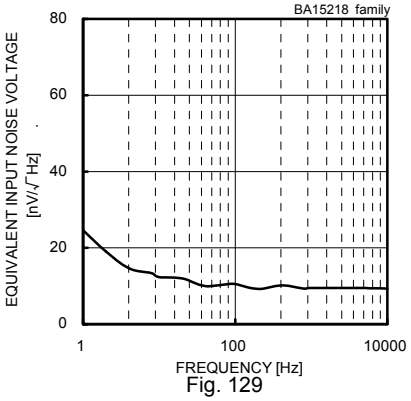



Fig. 129
Equivalent Input Noise Voltage – Frequency
(VCC/VEE=+15[V]/-15[V],Rs=100[Ω],Ta=25[℃])

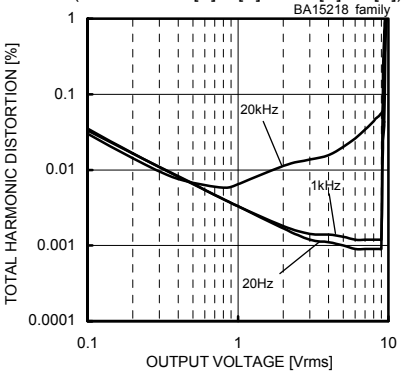



Fig. 130
Total Harmonic Distortion – Output Voltage
(VCC/VEE=+15[V]/-15[V],Av=20[dB],
RL＝2[kΩ],80[kHz]-LPF,Ta=25[℃])

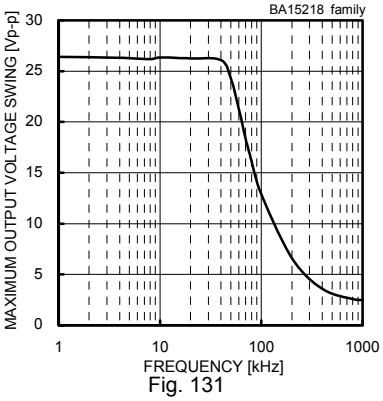



Fig. 131
Maximum Output Voltage Swing – Frequency
(VCC/VEE=+15[V]/-15[V],RL=2[kΩ],Ta=25[℃])

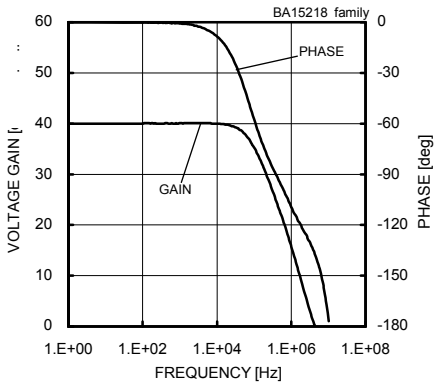



Fig. 132
Voltage Gain – Frequency
(VCC/VEE=+15[V]/-15[V],Av=40[dB],RL=2[kΩ],Ta=25[℃])

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

○BA14741 family

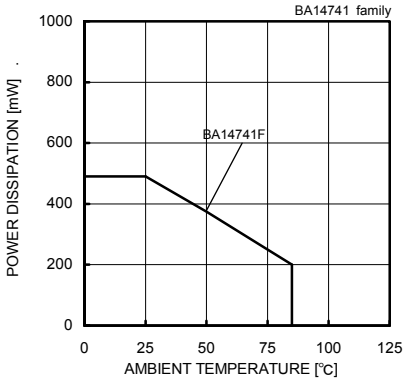



Fig. 133
Derating Curve

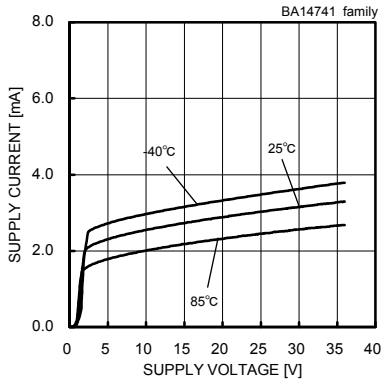



Fig. 134
Supply Current – Supply Voltage

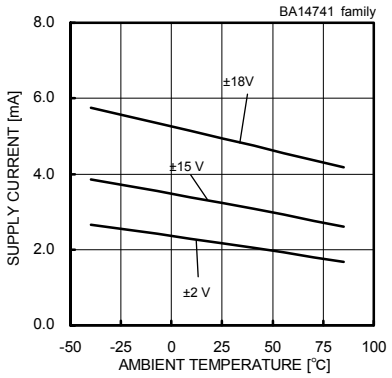



Fig. 135
Supply Current – Ambient Temperature

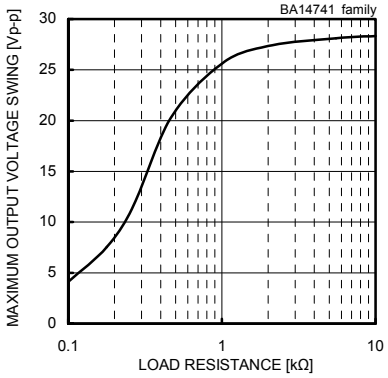



Fig. 136
Maximum Output Voltage Swing
– Load Resistance
(VCC/VEE=+15[V]/-15[V],Ta=25[℃])

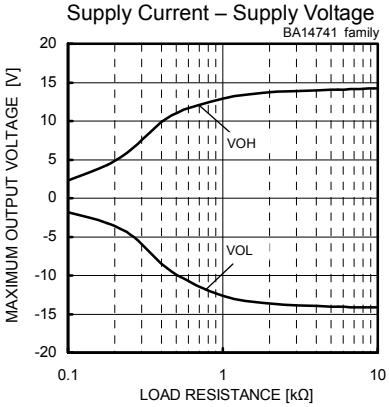



Fig. 137
Maximum Output Voltage
– Load Resistance
(VCC/VEE=+15[V]/-15[V],Ta=25[℃])

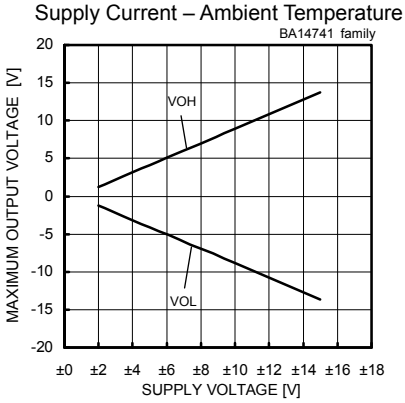



Fig. 138
Maximum Output Voltage
– Supply Voltage
(RL=2[kΩ],Ta=25[℃])

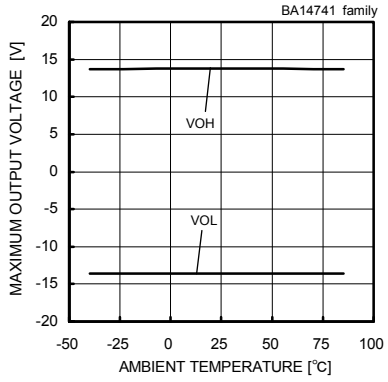



Fig. 139
Maximum Output Voltage
– Ambient Temperature
(VCC/VEE=+15[V]/-15[V],RL=2[kΩ])

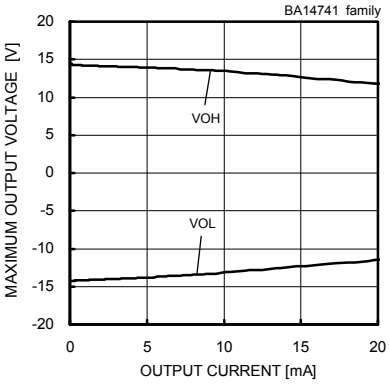



Fig. 140
Maximum Output Voltage
– Output Current
(VCC/VEE=+15[V]/-15[V],Ta=25[℃])

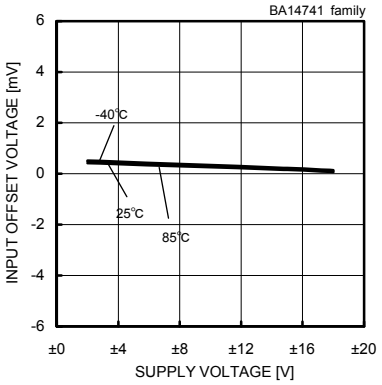



Fig. 141
Input Offset Voltage – Supply Voltage
(Vicm=0[V],Vout=0[V])

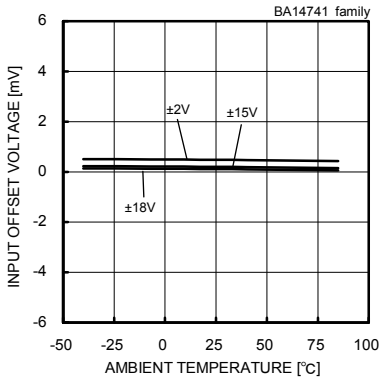



Fig. 142
Input Offset Voltage – Ambient Temperature
(Vicm=0[V],Vout=0[V])

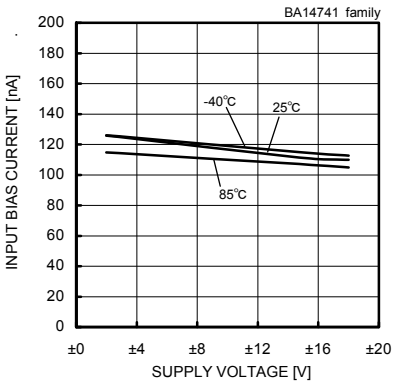



Fig. 143
Input Bias Current – Supply Voltage
(Vicm=0[V],Vout=0[V])

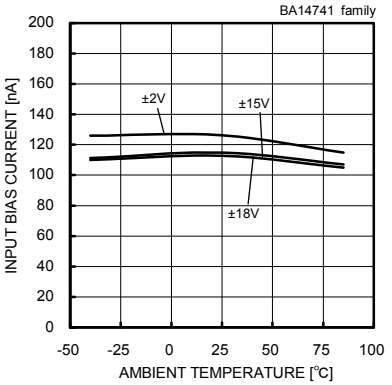



Fig. 144
Input Bias Current – Ambient Temperature
(Vicm=0[V],Vout=0[V])

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

○BA14741 family

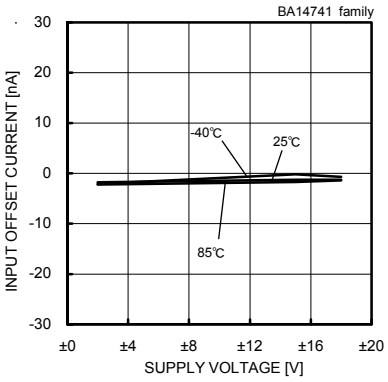



Fig. 145
Input Offset Current – Supply Voltage
(Vicm=0[V],Vout=0[V])

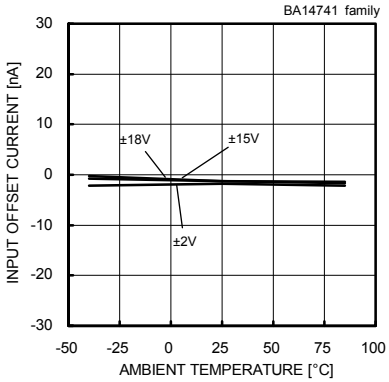



Fig. 146
Input Offset Current – Ambient Temperature
(Vicm=0[V],Vout=0[V])

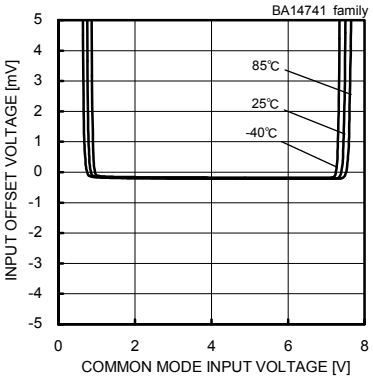



Fig. 147
Input Offset Voltage
– Common Mode Input Voltage
(VCC=8[V],Vout=4[V])

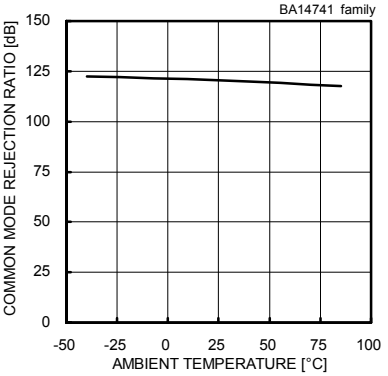



Fig. 148
Common Mode Rejection Ratio
– Ambient Temperature
(VCC/VEE=+15[V]/-15[V],Vicm=-12[V] to +12[V])

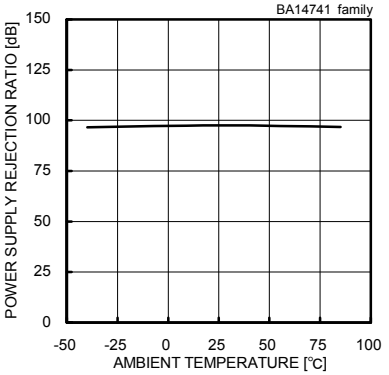



Fig. 149
Power Supply Rejection Ratio
– Ambient Temperature
(VCC/VEE=+2[V]/-2[V] to +15[V]/-15[V])

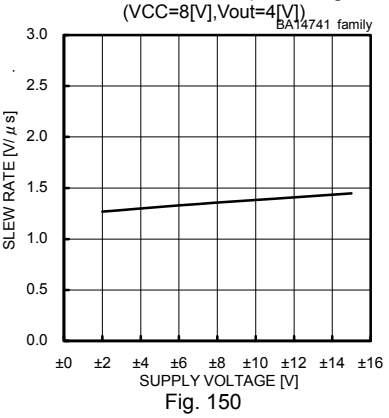



Fig. 150
Slew Rate – Supply Voltage
(CL=100[pF],RL=2[kΩ],Ta=25[℃])

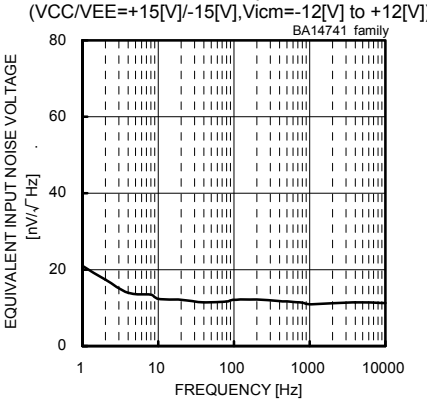



Fig. 151
Equivalent Input Noise Voltage – Frequency
(VCC/VEE=+15[V]/-15[V],Rs=100[Ω],Ta=25[℃])

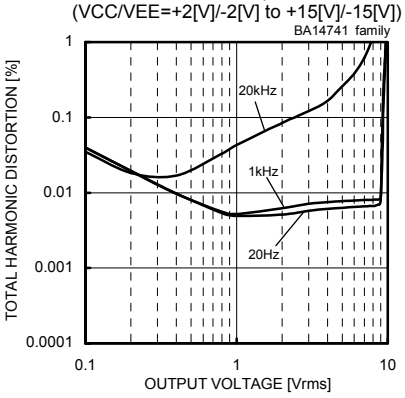



Fig. 152
Total Harmonic Distortion – Output Voltage
(VCC/VEE=+15[V]/-15[V],Av=20[dB],
RL＝2[kΩ],80[kHz]-LPF,Ta=25[℃])

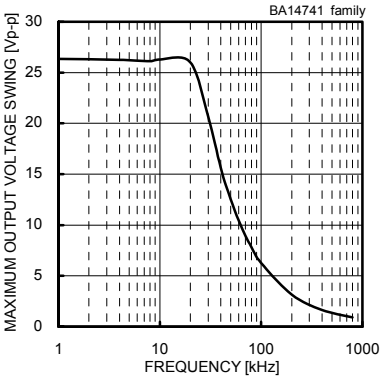



Fig. 153
Maximum Output Voltage Swing – Frequency
(VCC/VEE=+15[V]/-15[V],RL=2[kΩ],Ta=25[℃])

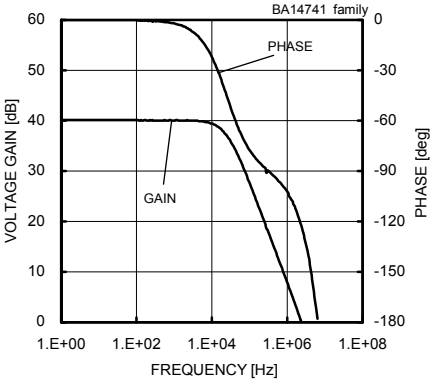



Fig. 154
Voltage Gain – Frequency
(VCC/VEE=+15[V]/-15[V],Av=40[dB],RL=2[kΩ],Ta=25[℃])

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

○BA15532 family

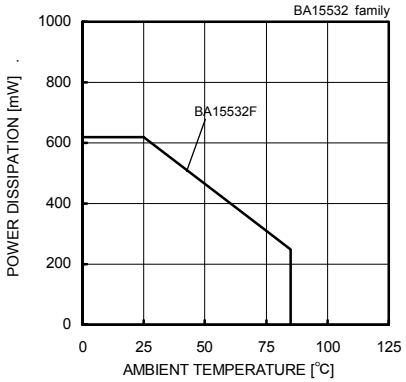



Fig. 155
Derating Curve

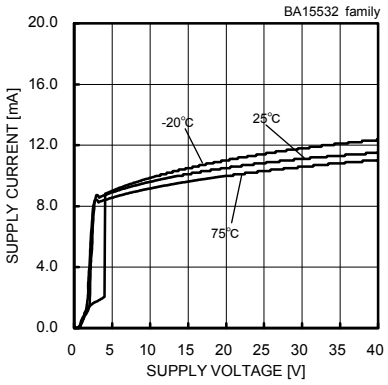



Fig. 156
Supply Current – Supply Voltage

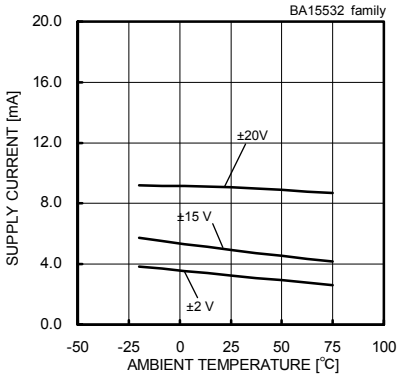



Fig. 157
Supply Current – Ambient Temperature

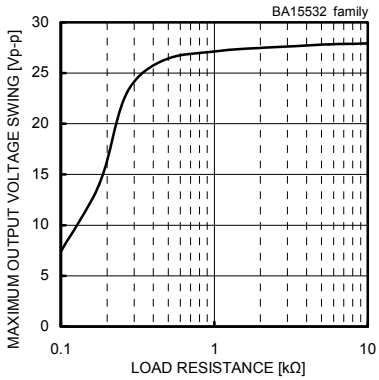



Fig. 158
Maximum Output Voltage Swing – Load Resistance
(VCC/VEE=+15[V]/-15[V],Ta=25[℃])

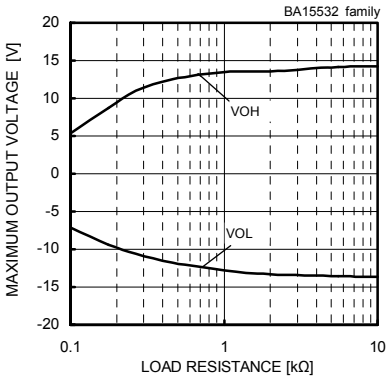



Fig. 159
Maximum Output Voltage– Load Resistance(VCC/VEE=+15[V]/-15[V],Ta=25[℃])

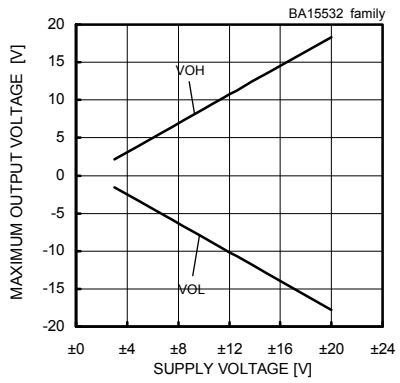



Fig. 160
Maximum Output Voltage– Supply Voltage(RL=2[kΩ],Ta=25[℃])

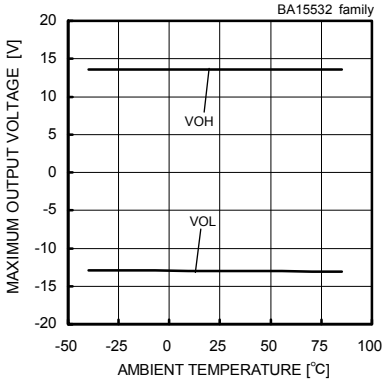



Fig. 161
Maximum Output Voltage– Ambient Temperature(VCC/VEE=+15[V]/-15[V],RL=2[kΩ])

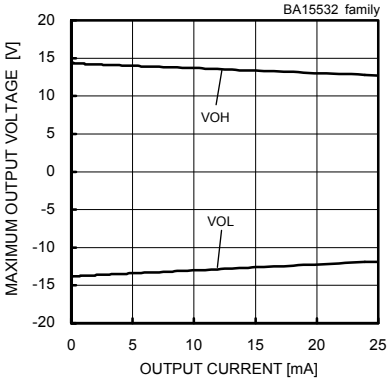



Fig. 162
Maximum Output Voltage– Output Current(VCC/VEE=+15[V]/-15[V],Ta=25[℃])

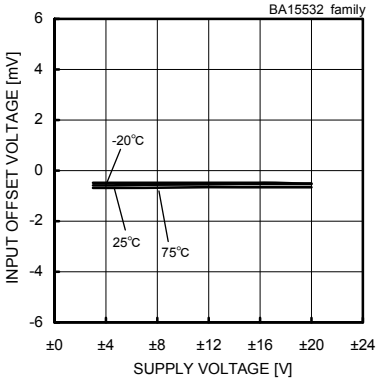



Fig. 163
Input Offset Voltage – Supply Voltage
(Vicm=0[V],Vout=0[V])

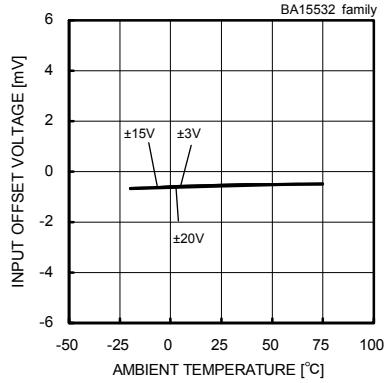



Fig. 164
Input Offset Voltage – Ambient Temperature
(Vicm=0[V],Vout=0[V])

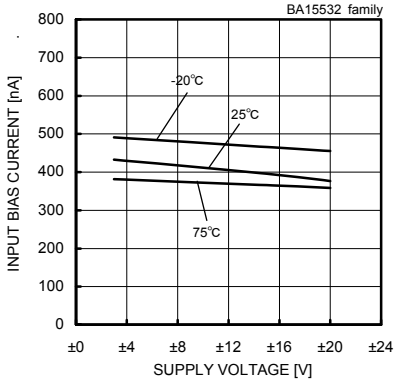



Fig. 165
Input Bias Current – Supply Voltage
(Vicm=0[V],Vout=0[V])

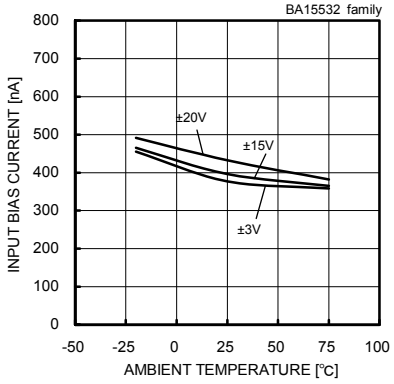



Fig. 166
Input Bias Current – Ambient Temperature
(Vicm=0[V],Vout=0[V])

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

○BA15532 family

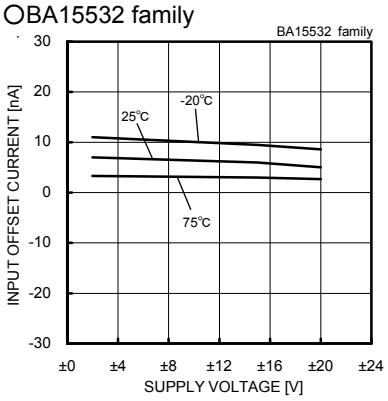



Fig. 167
Input Offset Current – Supply Voltage
(Vicm=0[V],Vout=0[V])

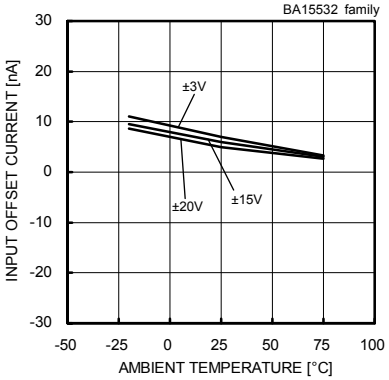



Fig. 168
Input Offset Current – Ambient Temperature
(Vicm=0[V],Vout=0[V])

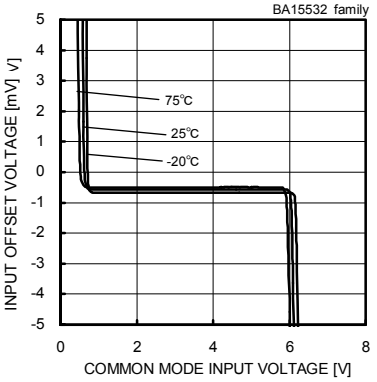



Fig. 169
Input Offset Voltage– Common Mode Input Voltage (VCC=8[V],Vout=4[V])

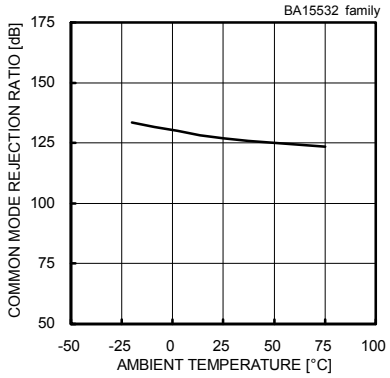



Fig. 170
Common Mode Rejection Ratio – Ambient Temperature
(VCC/VEE=+15[V]/-15[V],Vicm=-12[V] to +12[V])

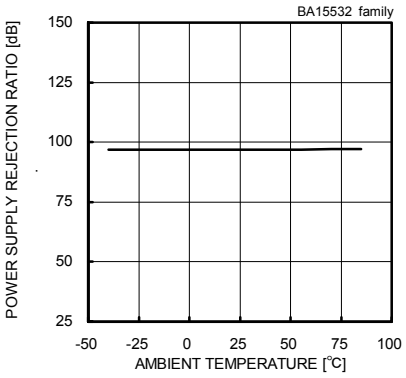



Fig. 171
Power Supply Rejection Ratio – Ambient Temperature
(VCC/VEE=+3[V]/-3[V] to +15[V]/-15[V])

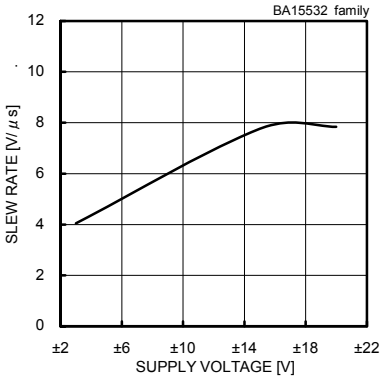



Fig. 172
Slew Rate – Supply Voltage
(CL=100[pF],RL=2[kΩ],Ta=25[℃])

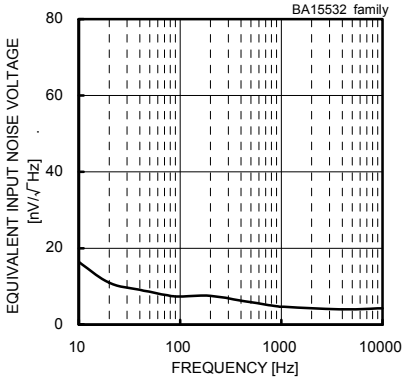



Fig. 173
Equivalent Input Noise Voltage – Frequency
(VCC/VEE=+15[V]/-15[V],Rs=100[Ω],Ta=25[℃])

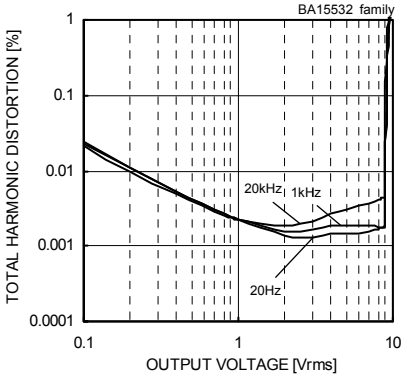



Fig. 174
Total Harmonic Distortion – Output Voltage
(VCC/VEE=+15[V]/-15[V],Av=20[dB],
RL＝600[Ω],80[kHz]-LPF,Ta=25[℃])

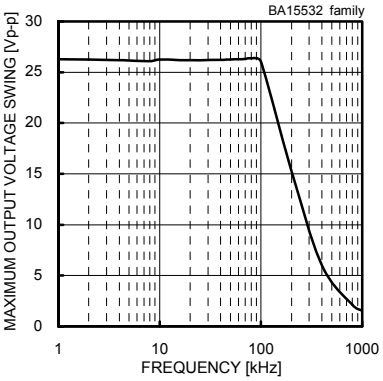



Fig. 175
Maximum Output Voltage Swing – Frequency
(VCC/VEE=+15[V]/-15[V],RL=600[Ω],Ta=25[℃])

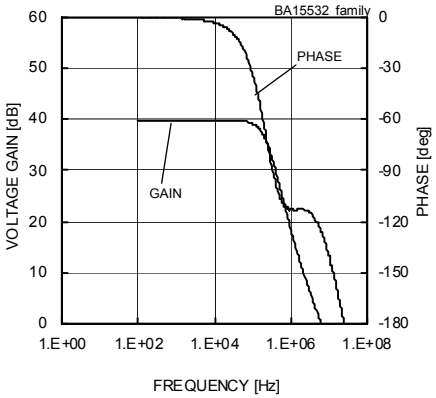



Fig. 176
Voltage Gain – Frequency (VCC/VEE=+15[V]/-15[V],Av=40[dB],RL=2[kΩ],Ta=25[℃])

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

○BA4510 family

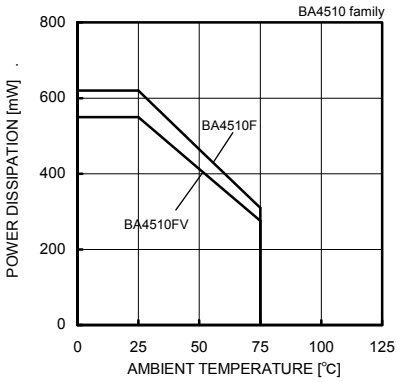



Fig. 177
Derating Curve

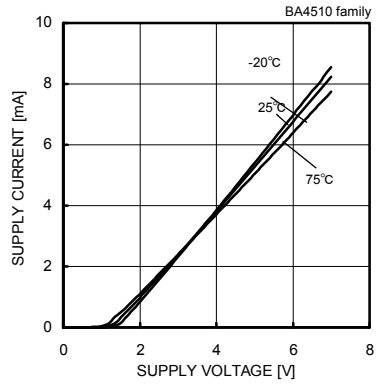



Fig. 178
Supply Current – Supply Voltage

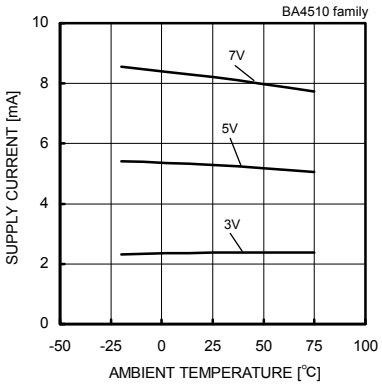



Fig. 179
Supply Current – Ambient Temperature

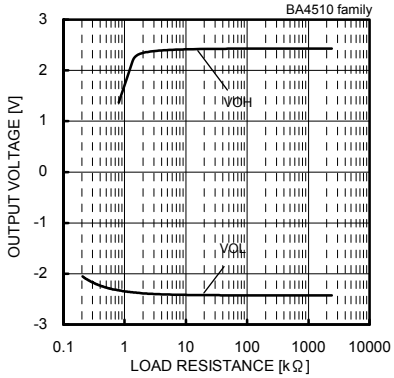



Fig. 180
Output Voltage – Load Resistance
(VCC/VEE=2.5[V]/-2.5[V],Ta=25[℃])

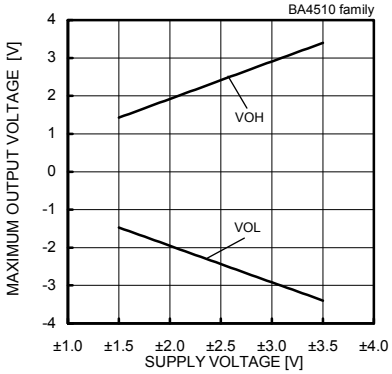



Fig. 181
Maximum Output Voltage
– Supply Voltage
(RL=10[kΩ],Ta=25[℃])

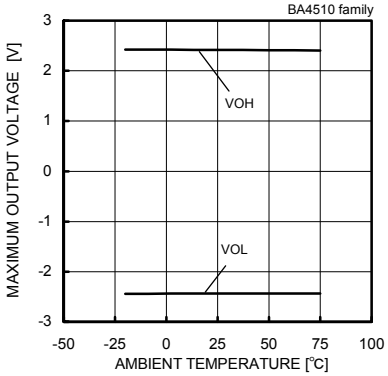



Fig. 182
Maximum Output Voltage
– Ambient Temperature
(VCC/VEE=2.5[V]/-2.5[V],RL=10[kΩ])

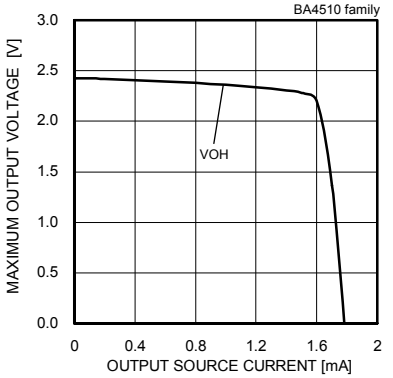



Fig. 183
Maximum Output Voltage– Output Source Current (VCC/VEE=2.5[V]/-2.5[V],Ta=25[℃])

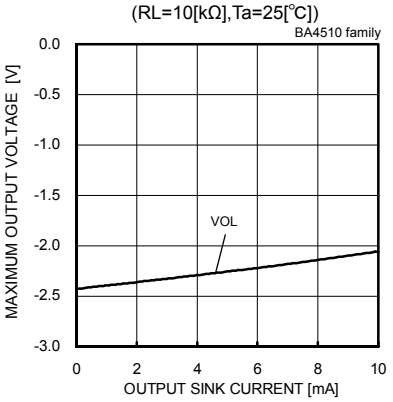



Fig. 184
Maximum Output Voltage– Output Sink Current (VCC/VEE=2.5[V]/-2.5[V],Ta=25[℃])

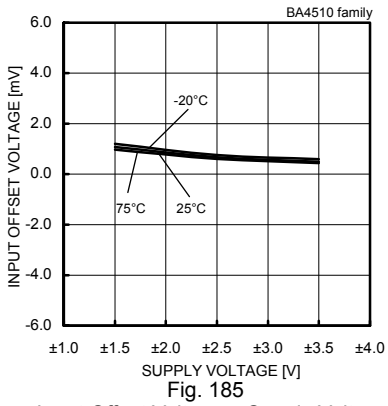



Fig. 185
Input Offset Voltage – Supply Voltage
(Vicm=0[V],Vout=0[V])

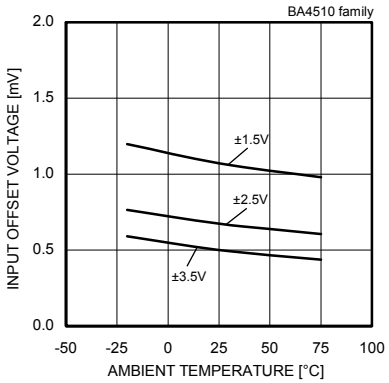



Fig. 186
Input Offset Voltage – Ambient Temperature
(Vicm=0[V],Vout=0[V])

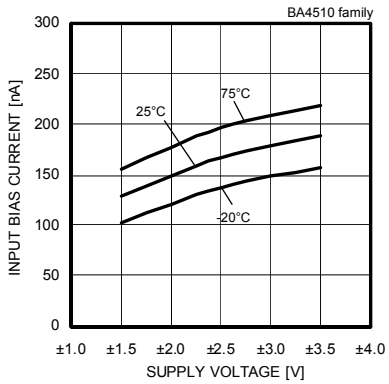



Fig. 187
Input Bias Current – Supply Voltage
(Vicm=0[V],Vout=0[V])

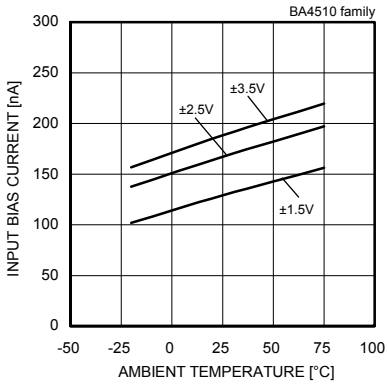



Fig. 188
Input Bias Current – Ambient Temperature
(Vicm=0[V],Vout=0[V])

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

○BA4510 family

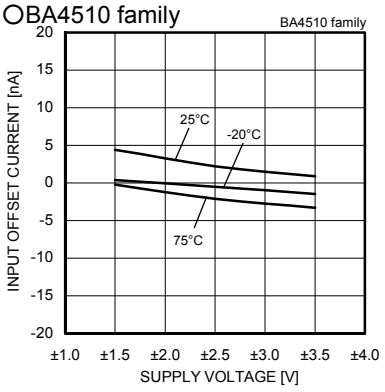



Fig. 189
Input Offset Current – Supply Voltage
(Vicm=0[V],Vout=0[V])

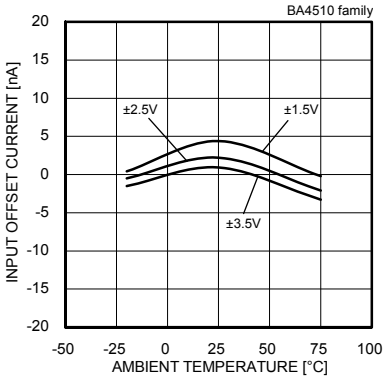



Fig. 190
Input Offset Current – Ambient Temperature
(Vicm=0[V],Vout=0[V])

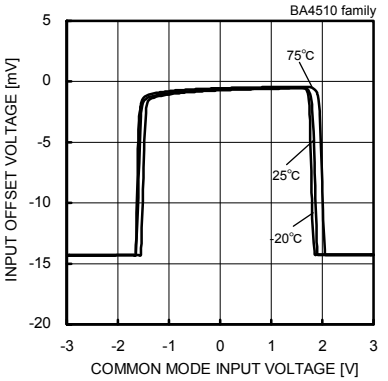



Fig. 191
Input Offset Voltage– Common Mode Input Voltage (VCC/VEE=2.5[V]/-2.5[V])

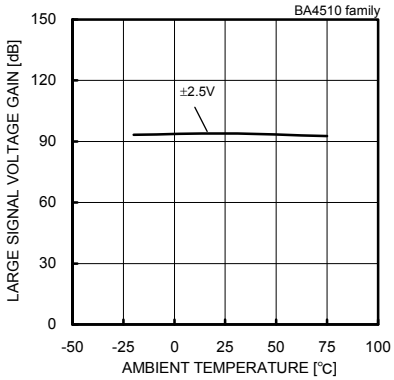



Fig. 192
Large Signal Voltage Gain – Ambient Temperature

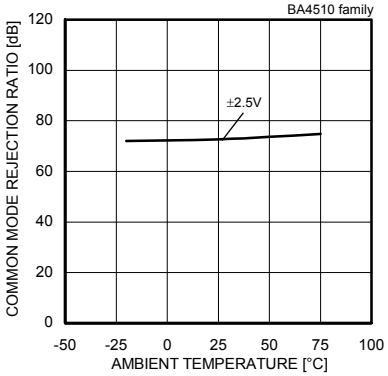



Fig. 193
Common Mode Rejection Ratio – Ambient Temperature

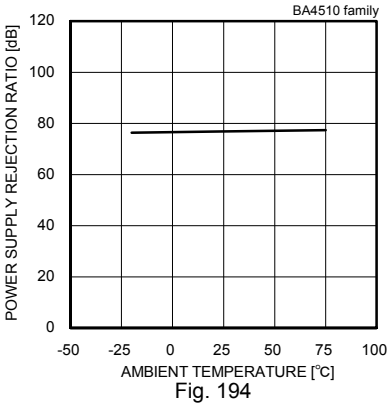



Fig. 194
Power Supply Rejection Ratio – Ambient Temperature

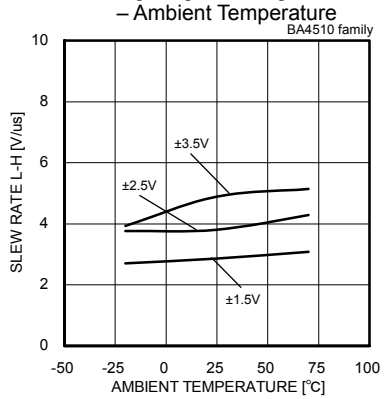



Fig. 195
Slew Rate L-H – Ambient Temperature

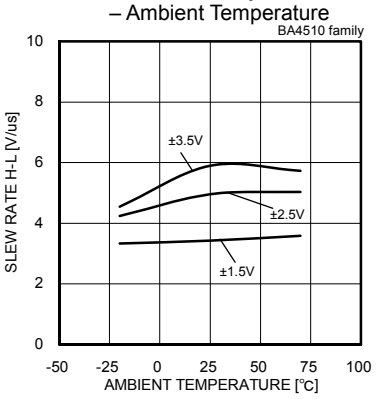



Fig. 196
Slew Rate H-L – Ambient Temperature

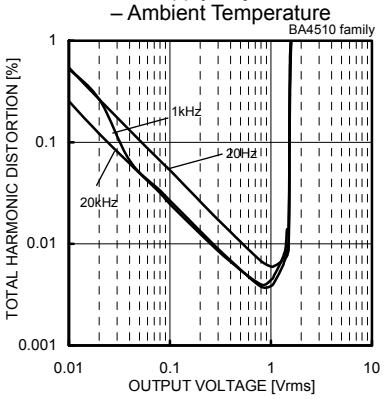



Fig. 197
Total Harmonic Distortion – Output Voltage
(VCC/VEE=2.5[V]/-2.5[V],RL=3[kΩ]
80[kHz]-LPF,Ta=25[°C])

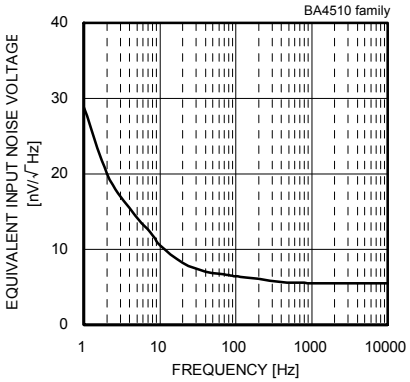



Fig. 198
Equivalent Input Noise Voltage – Frequency
(VCC/VEE=2.5[V]/-2.5[V])

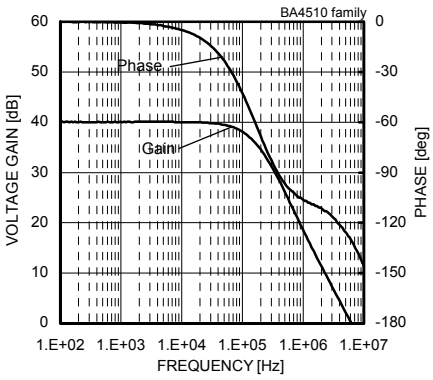



Fig. 199
Voltage Gain – Frequency
(VCC/VEE=2.5[V]/-2.5[V],Av=40[dB],RL=10[kΩ])

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

○BA2115 family

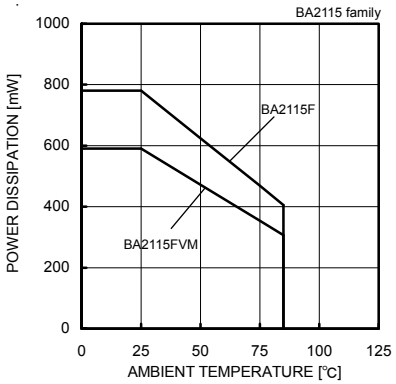



Fig. 200
Derating Curve

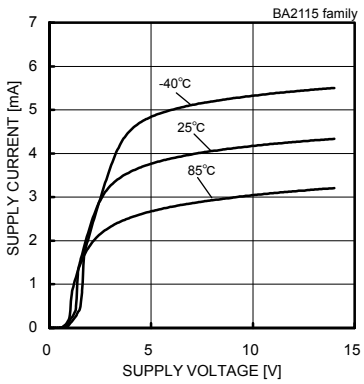



Fig. 201
Supply Current – Supply Voltage

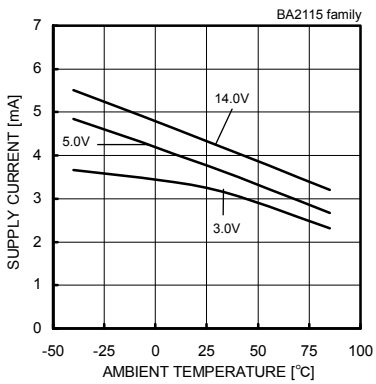



Fig. 202
Supply Current – Ambient Temperature

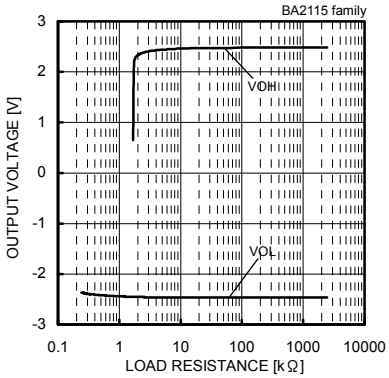



Fig. 203
Output Voltage – Load Resistance
(VCC/VEE=+2.5[V]/-2.5[V])

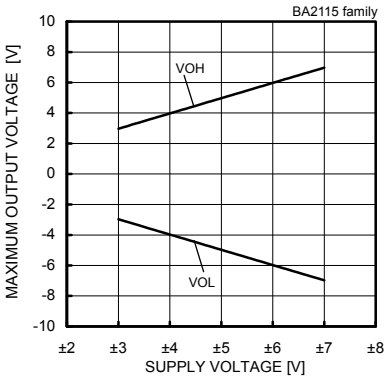



Fig. 204
Maximum Output Voltage
– Supply Voltage
(RL=10[kΩ])

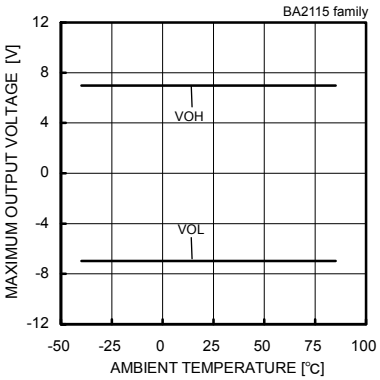



Fig. 205
Maximum Output Voltage
– Ambient Temperature
(VCC/VEE=+7.5[V]/-7.5[V],RL=10[kΩ])

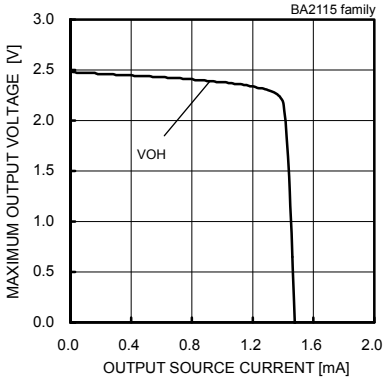



Fig. 206
Maximum Output Voltage
– Output Source Current
(VCC/VEE=+2.5[V]/-2.5[V])

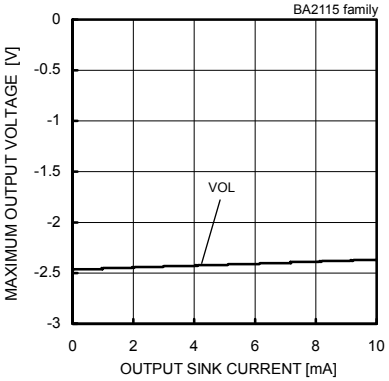



Fig. 207
Maximum Output Voltage
– Output Sink Current
(VCC/VEE=+2.5[V]/-2.5[V])

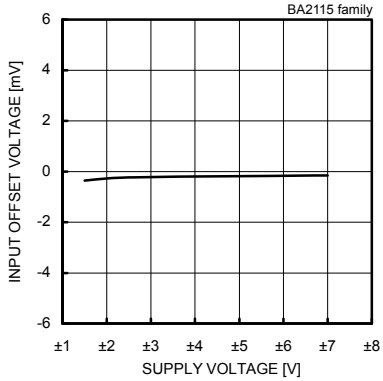



Fig. 208
Input Offset Voltage – Supply Voltage
(Vicm=0[V], Vout=0[V])

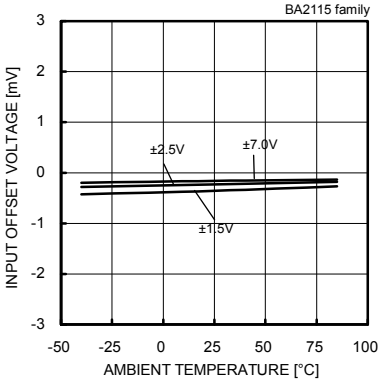



Fig. 209
Input Offset Voltage – Ambient Temperature
(Vicm=0[V], Vout=0[V])

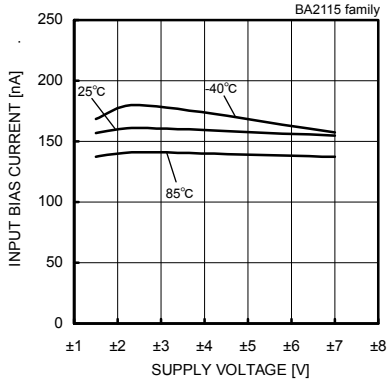



Fig. 210
Input Bias Current – Supply Voltage
(Vicm=0[V], Vout=0[V])

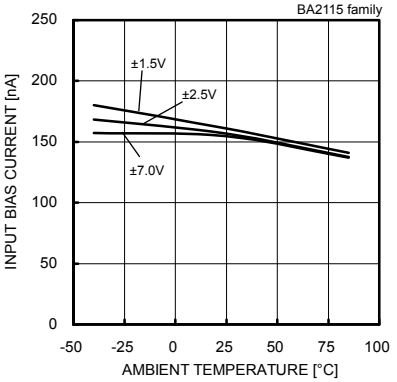



Fig. 211
Input Bias Current – Ambient Temperature
(Vicm=0[V], Vout=0[V])

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

OBA2115 family

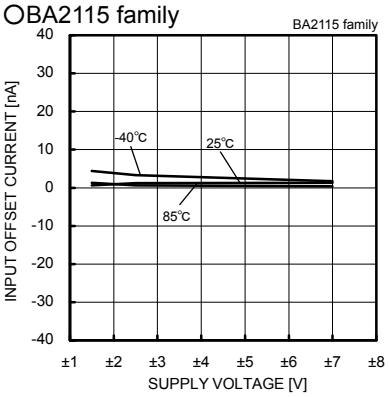



Fig. 212
Input Offset Current – Supply Voltage
(Vicm=0[V],Vout=0[V])

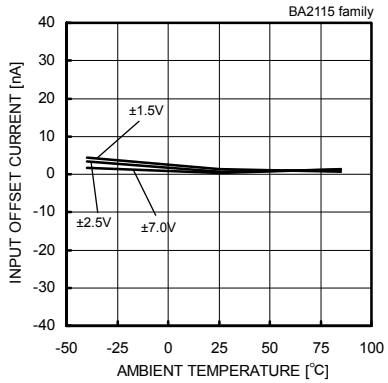



Fig. 213
Input Offset Current – Ambient Temperature
(Vicm=0[V],Vout=0[V])

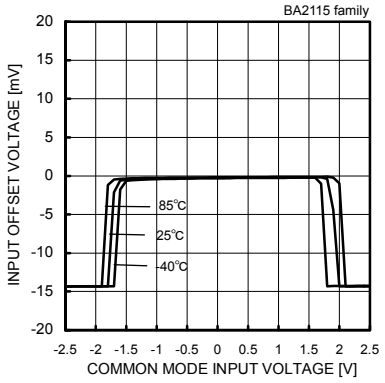



Fig. 214
Input Offset Voltage
– Common Mode Input Voltage
(VCC/VEE=+2.5[V]/-2.5[V],Vout=0[V])

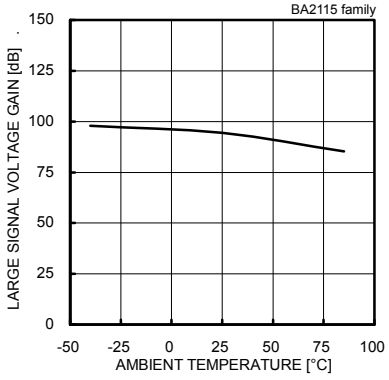



Fig. 215
Large Signal Voltage Gain
– Ambient Temperature
(VCC/VEE=+2.5[V]/-2.5[V])

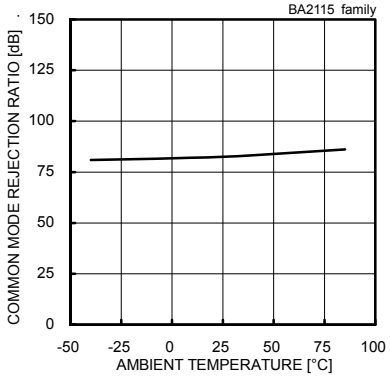



Fig. 216
Common Mode Rejection Ratio
– Ambient Temperature
(VCC/VEE=+2.5[V]/-2.5[V])

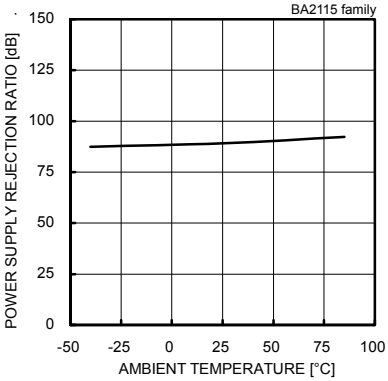



Fig. 217
Power Supply Rejection Ratio
– Ambient Temperature
(VCC/VEE=+2.5[V]/-2.5[V])

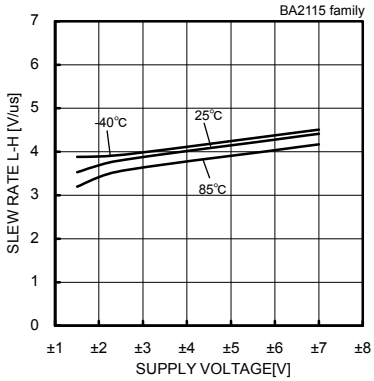



Fig. 218
Slew Rate L-H – Supply Voltage

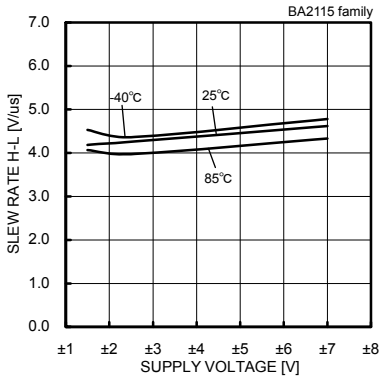



Fig. 219
Slew Rate H-L – Supply Voltage

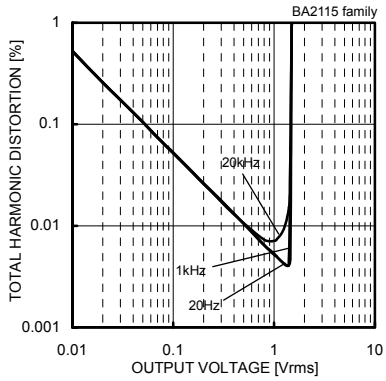



Fig. 220
Total Harmonic Distortion – Output Voltage
(VCC/VEE=2.5[V]/-2.5[V],RL=3[kΩ]
80[kHz]-LPF,Ta=25[℃])

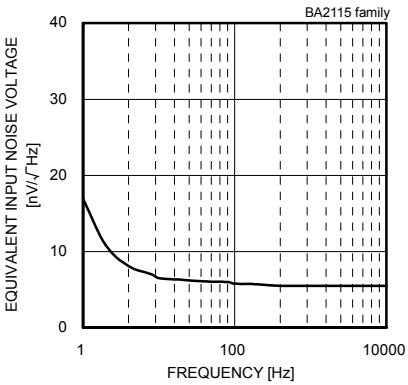



Fig. 221
Equivalent Input Noise Voltage – Frequency
(VCC/VEE=2.5[V]/-2.5[V])

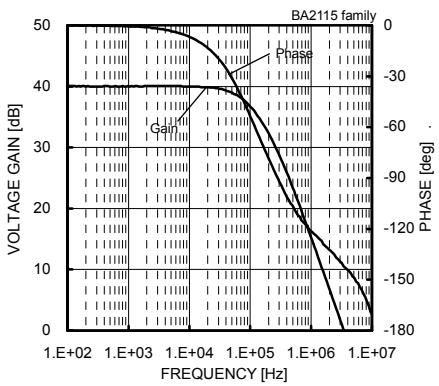



Fig. 222
Voltage Gain – Frequency
(VCC/VEE=2.5[V]/-2.5[V],Av=40[dB],RL=10[kΩ])

Fig. 223

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

●Schematic diagram

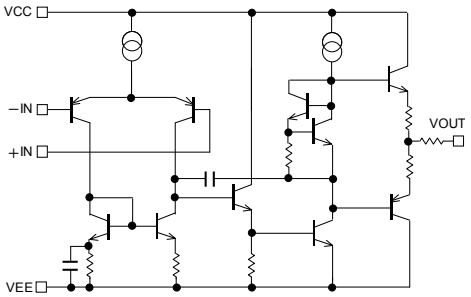



Fig. 224 Simplified schematic (BA4558/BA4558R/BA15218/ BA4560/BA4560R/BA4580R)

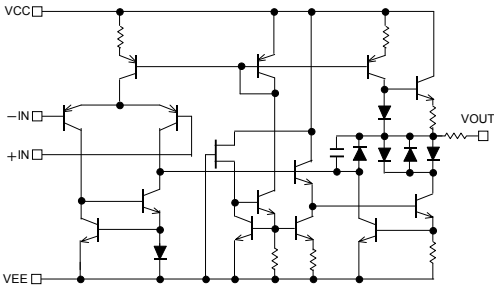



Fig. 225 Simplified schematic (BA14741)

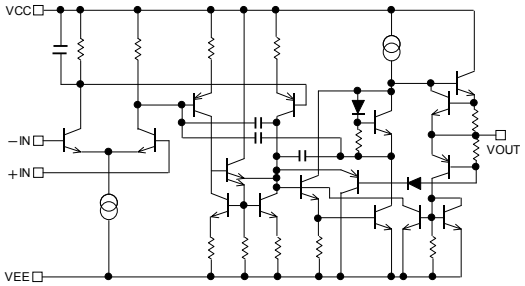



Fig. 226 Simplified schematic (BA15532)

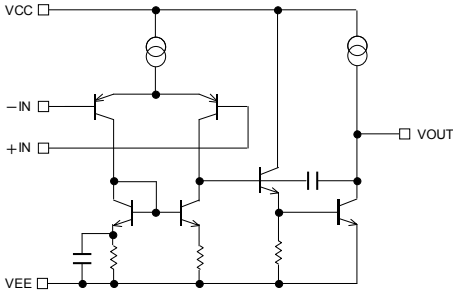



Fig. 227 Simplified schematic (BA4510/BA2115)

●Test circuit1 NULL method

VCC,VEE,EK,Vicm Unit : [V], Vicm=0[V] For all parameter

| Parameter | VF | S1 | S2 | S3(*23) | BA4558/BA4558R BA4560/BA4560R | | | BA4580R BA15218/BA14741 | | | BA15532 | | | BA4510 | | | BA2115 | | | Calculation |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | Vcc | VEE | EK | Vcc | VEE | EK | Vcc | VEE | EK | Vcc | VEE | EK | Vcc | VEE | EK | |
| Input Offset Voltage | VF1 | ON | ON | OFF | 15 | -15 | 0 | 15 | -15 | 0 | 15 | -15 | 0 | 2.5 | 2.5 | 0 | 2.5 | 2.5 | 0 | 1 |
| Input Offset Current | VF2 | OFF | OFF | OFF | 15 | -15 | 0 | 15 | -15 | 0 | 15 | -15 | 0 | 2.5 | 2.5 | 0 | 2.5 | 2.5 | 0 | 2 |
| Input Bias Current | VF3 | OFF | ON | OFF | 15 | -15 | 0 | 15 | -15 | 0 | 15 | -15 | 0 | 2.5 | 2.5 | 0 | 2.5 | 2.5 | 0 | 3 |
| | VF4 | ON | OFF | | 15 | -15 | 0 | 15 | -15 | 0 | 15 | -15 | 0 | 2.5 | 2.5 | 0 | 2.5 | 2.5 | 0 | |
| Large Signal Voltage Gain | VF5 | ON | ON | ON | 15 | -15 | -10 | 15 | -15 | -10 | 15 | -15 | -10 | 2.5 | 2.5 | -1.0 | 2.5 | 2.5 | -1.0 | 4 |
| | VF6 | | | | 15 | -15 | 10 | 15 | -15 | 10 | 15 | -15 | 10 | 2.5 | 2.5 | 1.0 | 2.5 | 2.5 | 1.0 | |
| Common-mode Rejection Ratio (Input Common-mode Voltage Range) | VF7 | ON | ON | OFF | 3 | -27 | 12 | 3 | -27 | 12 | 3 | -27 | 12 | 1.5 | 1.5 | -1.0 | 1.5 | 1.5 | -1.0 | 5 |
| | VF8 | | | | 27 | -3 | -12 | 27 | -3 | -12 | 27 | -3 | -12 | 3.5 | 3.5 | 1.0 | 3.5 | 3.5 | 1.0 | |
| Power Supply Rejection Ratio | VF9 | ON | ON | OFF | 4 | -4 | 0 | 2 | -2 | 0 | 3 | -3 | 0 | 1.25 | -1.25 | 0 | 0.75 | -1.25 | 0 | 6 |
| | VF10 | | | | 15 | -15 | 0 | 16 | -16 | 0 | 20 | -20 | 0 | 3.0 | -3.0 | 0 | 7.0 | 7.0 | 0 | |

(*23) S3 is always ON for BA15532.

-Calculation-

1. Input Offset Voltage (Vio) $Vio = \frac{|VF1|}{1 + Rf / Rs}$ [V]

2. Input Offset Current (Iio) $Iio = \frac{|VF2-VF1|}{Ri \times (1 + Rf / Rs)}$ [A]

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

4. Large Signal Voltage Gain (Av) $Av = 20 \times Log \frac{\Delta EK \times (1+Rf/Rs)}{|VF5-VF6|}$ [dB]

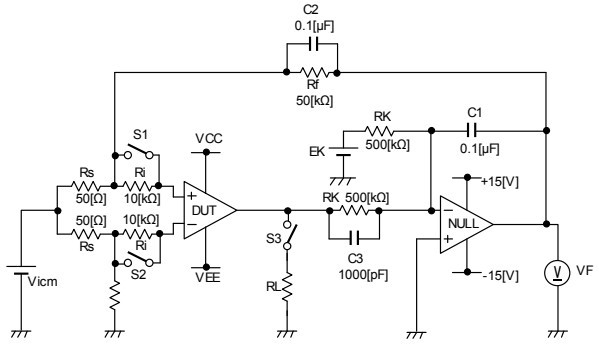



Fig. 228 Test circuit 1 (one channel only)

5. Common-mode Rejection Ratio (CMRR) $CMRR = 20 \times Log \frac{\Delta Vicm \times (1+Rf/Rs)}{|VF8-VF7|}$ [dB]

6. Power Supply Rejection Ratio (PSRR) $PSRR = 20 \times Log \frac{\Delta Vcc \times (1+Rf/Rs)}{|VF10-VF9|}$ [dB]

●Test circuit2 switch condition

| 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 | Load Resistance | OFF | OFF | ON | OFF | OFF | OFF | ON | OFF | ON | OFF | OFF | OFF | ON | ON |
| | Output Current | OFF | OFF | ON | OFF | OFF | OFF | ON | OFF | OFF | OFF | OFF | ON | ON | OFF |
| Slew Rate | | OFF | OFF | OFF | ON | OFF | OFF | OFF | ON | ON | ON | OFF | OFF | OFF | OFF |
| Gain Bandwidth Product | | OFF | ON | OFF | OFF | ON | ON | OFF | OFF | ON | ON | ON | OFF | OFF | OFF |
| Total Harmonic Distortion | | ON | OFF | OFF | OFF | ON | OFF | ON | OFF | ON | ON | ON | OFF | OFF | OFF |
| Input Noise Voltage (*24) | | ON | OFF | OFF | OFF | ON | ON | OFF | OFF | OFF | OFF | ON | OFF | OFF | OFF |

(*24) this condition refers only to BA4558Rfamily, BA4560Rfamily

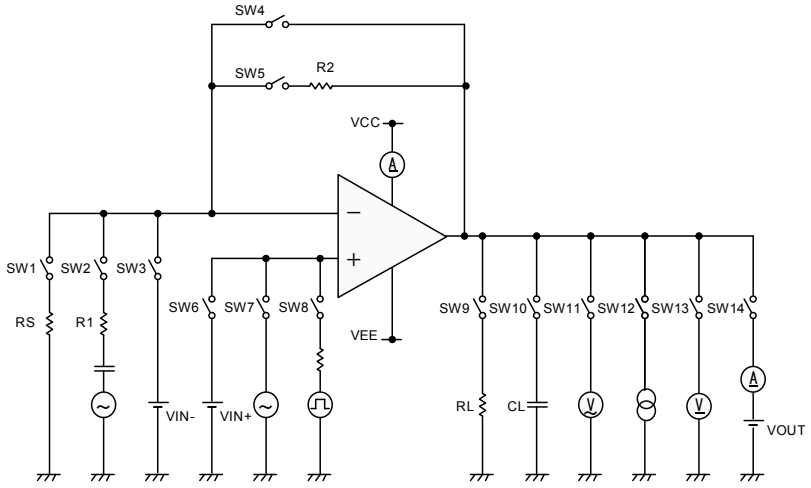



Fig. 229. Test circuit2 (one channel only)

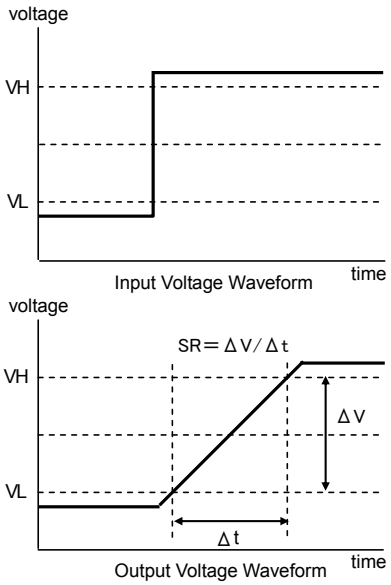
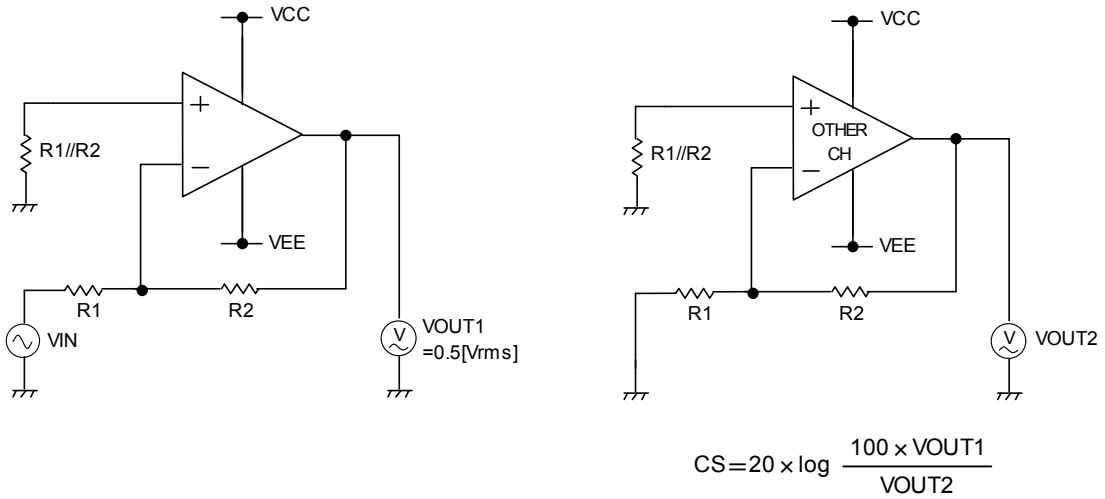



Fig. 230　Slew rate input output wave

●Test circuit3 Channel separation




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

Fig. 231Test circuit3
(VCC=+15[V],VEE=-15[V],R1=1[kΩ],R2=100[kΩ])

●Description of electrical characteristics

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

**1. Absolute maximum ratings**

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

1.1 Power supply voltage(VCC-VEE)
Indicates the maximum voltage that can be applied between the positive power supply terminal and negative power supply terminal without deterioration or destruction of characteristics of internal circuit.

1.2 Differential input voltage(Vid)
Indicates the maximum voltage that can be applied between non-inverting terminal and inverting terminal without deterioration and destruction of characteristics of IC.

1.3 Input common-mode voltage range(Vicm)
Indicates the maximum voltage that can be applied to non-inverting terminal and inverting terminal without deterioration or destruction ofcharacteristics. Input common-mode voltage range of the maximum ratings not assure normal operation of IC. When normal operation of IC is desired, the input common-mode voltage of characteristics item must be followed.

1.4 Power dissipation(Pd)
Indicates the power that can be consumed by specified mounted board at the ambient temperature 25°C(normal temperature). As forpackage product, Pd is determined by the temperature that can be permitted by IC chip in the package(maximum junction temperature)and thermal resistance of the package.

**2. Electrical characteristics item**

2.1 Input offset voltage(Vio)
Indicates the voltage difference between non-inverting terminal and inverting terminal. It can be translated into the input voltagedifference required for setting the output voltage at 0 [V] .

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

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 current at non-inverting terminaland input bias current at inverting terminal.

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

2.7 High level output voltage / Low level output voltage(VOH/VOL)
Indicates the voltage range that can be output by the IC under specified load condition. It is typically divided into high-level output voltageand low-level output voltage. High-level output voltage indicates the upper limit of output voltage. Low-level output voltage indicates thelower 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 operates normally.

2.10 Common-mode rejection ratio(CMRR)
Indicates the ratio of fluctuation of input offset voltage when in-phase input voltage is changed. It is normally the fluctuation of DC.
CMRR = (Change of Input common-mode voltage) / (Input offset fluctuation)

2.11 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)

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

2.14 Slew rate(SR)
Indicates the time fluctuation ratio of voltage output when step input signal is applied.

2.12 Unity gain frequency(ft)
Indicates a frequency where the voltage gain of Op-Amp is 1.

2.13 Total harmonic distortion + Noise(THD+N)
Indicates the fluctuation of input offset voltage or that of output voltage with reference to the change of output voltage of driven channel.

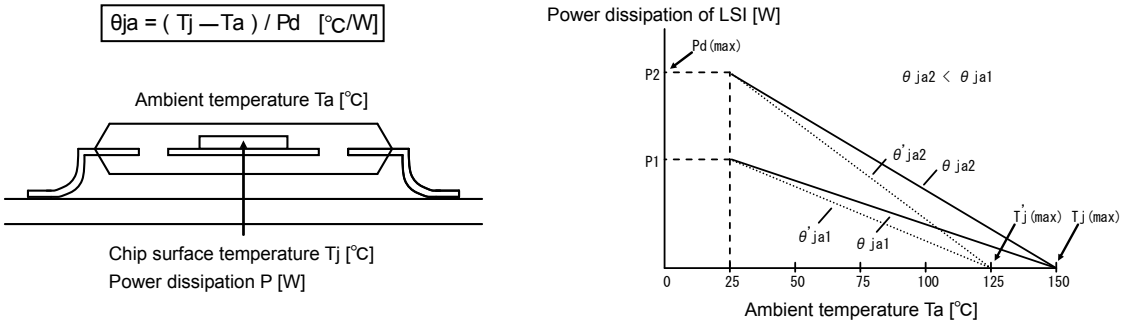
2.14 Input referred noise voltage(Vn)
Indicates a noise voltage generated inside the operational amplifier equivalent by ideal voltage source connected in series with input terminal.

●Derating curve

Power dissipation (total loss) indicates the power that can be consumed by IC at Ta=25℃(normal temperature).IC is heated when it consumed power, and the temperature of IC ship becomes higher than ambient temperature. The temperature that can be accepted by IC chip depends on circuit configuration, manufacturing process, and consumable power is limited. Power dissipation is determined by the temperature allowed in IC chip (maximum junction temperature) and thermal resistance of package (heat dissipation capability). The maximum junction temperature is typically equal to the maximum value in the storage 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 θj-a[℃ /W]. The temperature of IC inside the package can be estimated by this thermal resistance. Fig.232 (a) shows the model of thermal resistance of the package. Thermal resistance θja, ambient temperature Ta, junction temperature Tj, and power dissipation Pd can be calculated by the equation below :

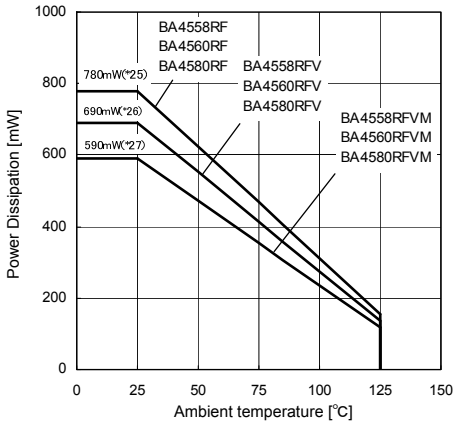
$$\theta ja = (Tj - Ta) / Pd \quad [℃/W] \qquad \cdots\cdots (I)$$

Derating curve in Fig.232 (b) indicates power that can be consumed by IC with reference to ambient temperature. Power that can be consumed by IC with reference to ambient temperature. Power that can be consumed by IC begins to attenuate at certain ambient temperature. This gradient, is determined by thermal resistance θja. Thermal resistance θja depends on chip size, power consumption, package, ambient temperature, package condition, wind velocity, etc even when the same of package is used. Thermal reduction curve indicates a reference value measured at a specified condition. Fig.233(a), (b) ,(c) ,(d) show a derating curve for an example of BA4558, BA4560, BA4558R, BA4560R, BA4580R, BA15218, BA14741, BA15532, BA4510, BA2115.

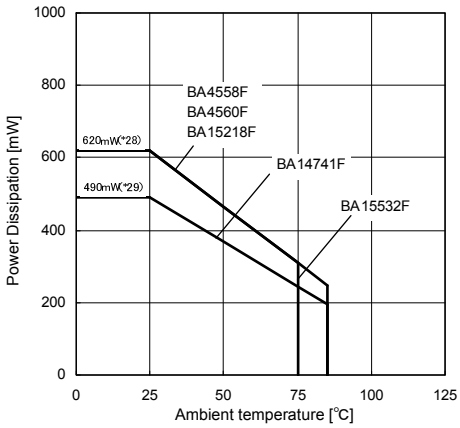



(a) Thermal resistance (b) Derating curve

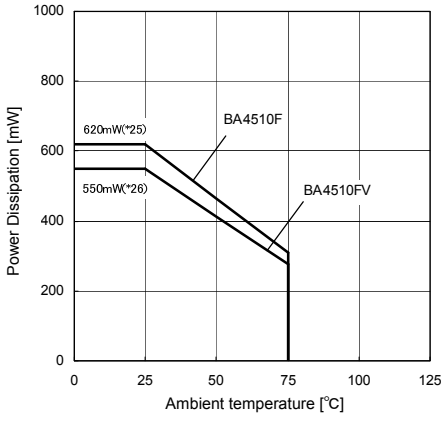
Fig. 232 Thermal resistance and derating curve



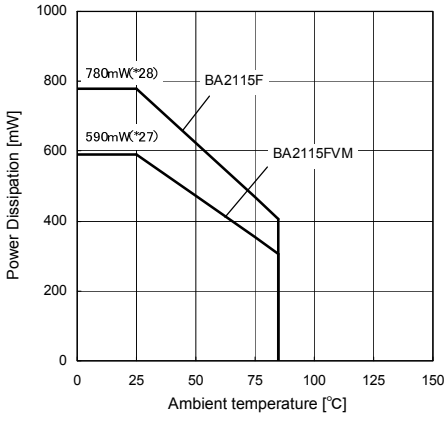

(a)BA4558R/BA4560R/BA4580R family




(b)BA4558/BA4560/BA15218/BA14741/BA15532 family




(c)BA4510 family




(d)BA2115 family

| (*25) | (*26) | (*27) | (*28) | (*29) | Unit |
|---|---|---|---|---|---|
| 6.2 | 5.5 | 4.7 | 6.2 | 4.9 | [mW/℃] |

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

Fig. 233 Derating curve

●Cautions on use

1) Processing of unused circuit
It is recommended to apply connection (see the Fig.234) and set the noninverting input terminal at the potential within input common-mode voltage range (Vicm), for any unused circuit.

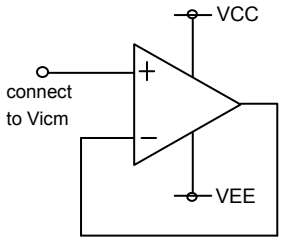



Fig. 234The example of application circuit for unused op-amp

2) Input voltage
Applying VEE+36[V](BA4550R,BA4560R,BA4580R family), VEE+14[V] (BA2115 family) to the input terminal is possible without causing deterioration of the electrical characteristics or destruction, irrespective of the supply voltage. However, this does not ensure normal circuit operation.
Please note that the circuit operates normally only when the input voltage is within the common mode input voltage range of the electric characteristics.

3) Maximum output voltage
Because the output voltage range becomes narrow as the output current Increases, design the application with margin by considering changes in electrical characteristics and temperature characteristics.

4) Short-circuit of output terminal
When output terminal and VCC or VEE terminal are shorted, excessive Output current may flow under some conditions, and heating may destroy IC. It is necessary to connect a resistor as shown in Fig.2, thereby Protecting against load shorting.

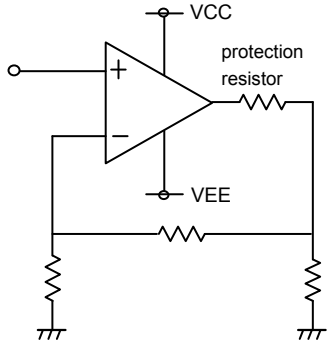



Fig. 235The example of output short protection

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

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

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

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

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

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

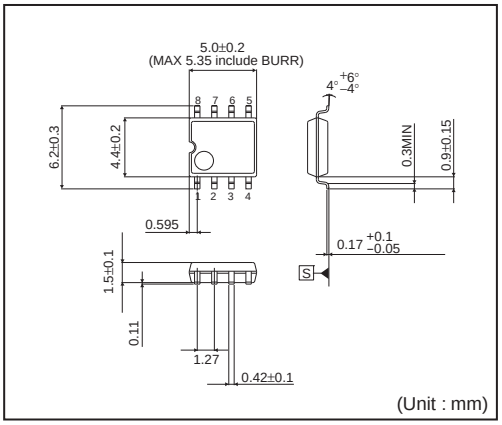
11) Inspection on set board
During testing, turn on or off the power before mounting or dismounting the board from the test Jig.
Do not power up the board without waiting for the output capacitors to discharge. The capacitors in the low output impedanceterminal can stress the device. Pay attention to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

12) Output capacitor
When VCC terminal is shorted to VEE (GND) potential and an electric charge has accumulated on the external capacitor, connected to output terminal, accumulated charge may be discharged VCC terminal via the parasitic element within the circuit or terminal protection element. The element in the circuit may be damaged (thermal destruction). When using this IC for an application circuit where there is oscillation, output capacitor load does not occur, as when using this IC as a voltage comparator. Set the capacitor connected to output terminal below 0.1[μF] in order to prevent damage to IC.

●Ordering part number

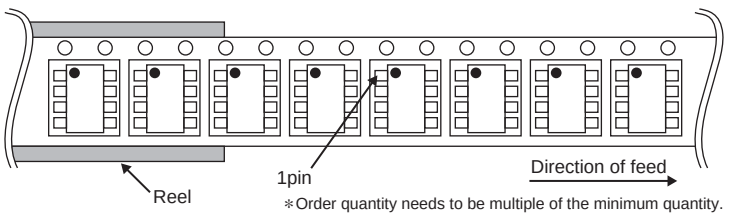
| B | A | | 4 | 5 | 6 | 0 | | F | V | - | E | 2 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Part No. | | | Part No.<br>4558 4558R<br>4560 4560R<br>4510 4580R<br>14741 15218<br>15532 2115 | | | | | Package<br>F: SOP8<br>SOP14<br>FV: SSOP-B8<br>FVM: MSOP8 | | | Packaging and forming specification<br>E2: Embossed tape and reel<br>(SOP8/SOP14/SSOP-B8)<br>TR: Embossed tape and reel<br>(MSOP8) | |

**SOP8**



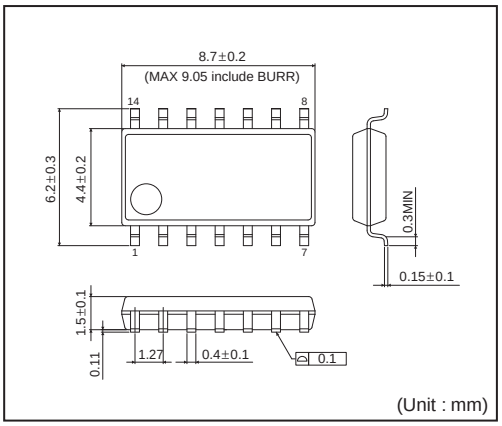

<Tape and Reel information>

| Tape | Embossed carrier tape |
|---|---|
| Quantity | 2500pcs |
| Direction of feed | E2<br>( 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 ) |



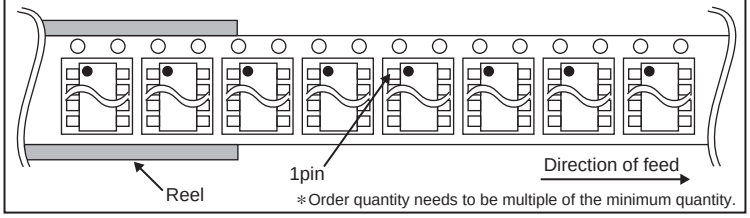

∗Order quantity needs to be multiple of the minimum quantity.

**SOP14**



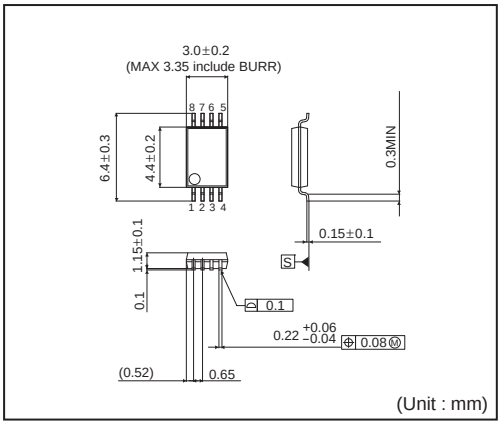

<Tape and Reel information>

| Tape | Embossed carrier tape |
|---|---|
| Quantity | 2500pcs |
| Direction of feed | E2<br>( 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 ) |



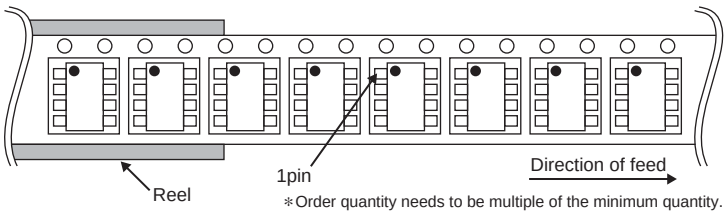

∗Order quantity needs to be multiple of the minimum quantity.

## SSOP-B8



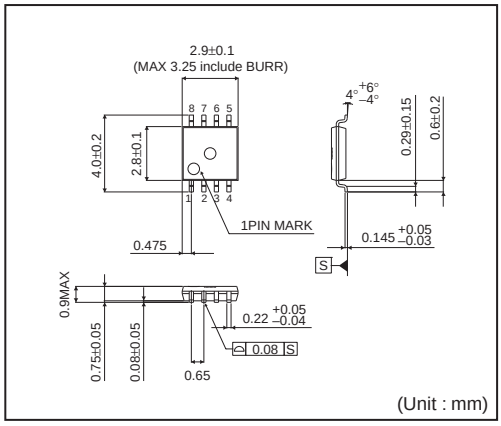

<Tape and Reel information>

| | |
|---|---|
| Tape | Embossed carrier tape |
| Quantity | 2500pcs |
| Direction of feed | E2<br>( 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 ) |



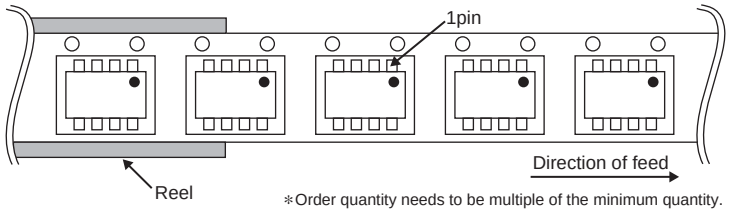

∗Order quantity needs to be multiple of the minimum quantity.

## MSOP8




<Tape and Reel information>

| | |
|---|---|
| Tape | Embossed carrier tape |
| Quantity | 3000pcs |
| Direction of feed | TR<br>( 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.

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