ROHM SEMICONDUCTOR

Technical Note

ROHM's Selection Operational Amplifier/Comparator Series

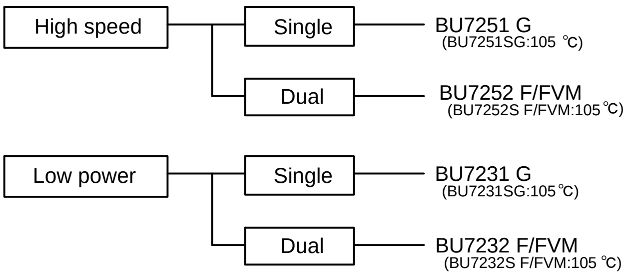
Comparators: Low Voltage CMOS

BU7251G,BU7251SG,BU7231G,BU7231SG, BU7252F/FVM,BU7252S F/FVM,BU7232F/FVM,BU7232S F/FVM

No.09049EAT06

●Description

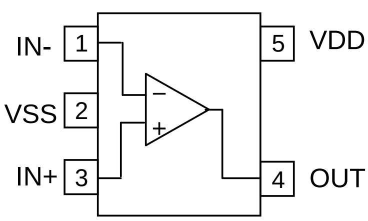
CMOS comparator BU7251/BU7231family and BU7252/BU7232 family are input full swing and push pull output comparator. These ICs integrate one op-amp or two independent op-amps and phase compensation capacitor on a single chip. The features of these ICs are low operating supplyVoltage that is +1.8V to +5.5V(single supply) and low supply current, extremely low input bias current.

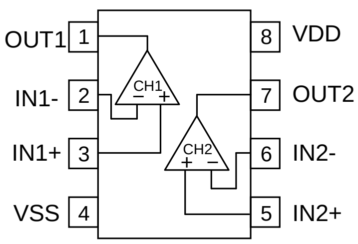


●Features

1) Low operating supply voltage (+1.8[V]～+5.5[V])
2) +1.8 [V]～+5.5[V](single supply)
   ±0.9[V]～±2.75[V](split supply)
3) Input and Output full swing
4) Push-pull output type
5) High speed operation (BU7251 family, BU7252 family)
6) Low supply current (BU7231 family, BU7232 family)
7) Internal ESD protection
   Human body model (HBM) ±4000[V](Typ.)
8) Wide temperature range
   -40[℃]～+85[℃] (BU7251G,BU7252 family, BU7231G, BU7232 family)
   -40[℃]～+105[℃] (BU7251SG,BU7252S family, BU7231SG,BU7232S family)

● Pin Assignments





SSOP5	SOP8	MSOP8
BU7251G	BU7252F	BU7252FVM
BU7251SG	BU7252SF	BU7252SFVM
BU7231G	BU7232F	BU7232FVM
BU7231SG	BU7232SF	BU7232SFVM

●Absolute maximum ratings (Ta=25[℃])

Parameter	Symbol	Rating		Unit
		BU7251G,BU7252 F/FVM BU7231G,BU7232 F/FVM	BU7251SG,BU7252S F/FVM BU7231SG,BU7232S F/FVM	
Supply Voltage	VDD-VSS	+7		V
Differential Input Voltage (*1)	Vid	VDD-VSS		V
Input Common-mode voltage range	Vicm	(VSS-0.3) to VDD+0.3		V
Operating Temperature	Topr	-40 to+85	-40 to+105	℃
Storage Temperature	Tstg	-55 to+125		℃
Maximum junction Temperature	Tjmax	+125		℃

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

○BU7251 family (Unless otherwise specified VDD=+3[V], VSS=0[V], Ta=25[℃])

Parameter	Symbol	Temperature range	Guaranteed Limit BU7251G,BU7251SG			Unit	Condition
			Min.	Typ.	Max.		
Input Offset Voltage (*2)(*4)	Vio	25℃	-	1	11	mV	-
Input Offset Current (*2)	Iio	25℃	-	1	-	pA	-
Input Bias Current (*2)	Ib	25℃	-	1	-	pA	-
Input Common-mode voltage Range	Vicm	25℃	0	-	3	V	(VDD-VSS)=3[V]
Large Signal Voltage Gain	AV	25℃	-	90	-	dB	RL=10[kΩ]
Supply current(*4)	IDD	25℃	-	15	35	μA	RL=∞
		full range	-	-	50		
Power supply rejection ratio	PSRR	25℃	-	80	-	dB	-
Common-mode rejection ratio	CMRR	25℃	-	80	-	dB	-
Output source current (*3)	IOH	25℃	1	2	-	mA	VDD-0.4
Output sink current (*3)	IOL	25℃	3	6	-	mA	VSS+0.4
High Level Output Voltage (*4)	VOH	25℃	VDD-0.1	-	-	V	RL=10[kΩ]
Low Level Output Voltage (*4)	VOL	25℃	-	-	VSS+0.1	V	RL=10[kΩ]
Output rise time	Tr	25℃	-	50	-	ns	CL=15pF 100mV over drive
Output fall time	Tf	25℃	-	20	-	ns	CL=15pF 100mV over drive
Propagation delay L to H	TPLH	25℃	-	0.55	-	μs	CL=15pF 100mV over drive
Propagation delay H to L	TPHL	25℃	-	0.25	-	μs	CL=15pF 100mV over drive

(*2) Abusolute values
(*3) Reference to power dissipation under the high temperature environment and decide the output current.
Continuous short circuit is occurring the degenerate of output current characteristics.
(*4) Full range BU7251：Ta=-40[℃] to +85[℃] BU7251S：Ta=-40[℃] to +105[℃]

○BU7252 family (Unless otherwise specified VDD=+3[V], VSS=0[V], Ta=25[℃])

Parameter	Symbol	Temperature range	Guaranteed Limit BU7252 F/FVM BU7252S F/FVM			Unit	Condition
			Min.	Typ.	Max.		
Input Offset Voltage (*2)(*4)	Vio	25℃	-	1	11	mV	-
Input Offset Current (*2)	Iio	25℃	-	1	-	pA	-
Input Bias Current (*2)	Ib	25℃	-	1	-	pA	-
Input Common-mode voltage Range	Vicm	25℃	0	-	3	V	(VDD-VSS)=3[V]
Large Signal Voltage Gain	AV	25℃	-	90	-	dB	RL=10[kΩ]
Supply current(*4)	IDD	25℃	-	35	65	μA	RL=∞
		full range	-	-	80		
Power supply rejection ratio	PSRR	25℃	-	80	-	dB	-
Common-mode rejection ratio	CMRR	25℃	-	80	-	dB	-
Output source current (*3)	IOH	25℃	1	2	-	mA	VDD-0.4
Output sink current (*3)	IOL	25℃	3	6	-	mA	VSS+0.4
High Level Output Voltage (*4)	VOH	25℃	VDD-0.1	-	-	V	RL=10[kΩ]
Low Level Output Voltage (*4)	VOL	25℃	-	-	VSS+0.1	V	RL=10[kΩ]
Output rise time	Tr	25℃	-	50	-	ns	CL=15pF 100mV over drive
Output fall time	Tf	25℃	-	20	-	ns	CL=15pF 100mV over drive
Propagation delay L to H	TPLH	25℃	-	0.55	-	μs	CL=15pF 100mV over drive
Propagation delay H to L	TPHL	25℃	-	0.25	-	μs	CL=15pF 100mV over drive

(*2) Abusolute values
(*3) Reference to power dissipation under the high temperature environment and decide the output current.
Continuous short circuit is occurring the degenerate of output current characteristics.
(*4) Full range BU7251,BU7252：Ta=-40[℃] to +85[℃] BU7251S,BU7252S：Ta=-40[℃] to +105[℃]

○BU7231 family (Unless otherwise specified VDD=+3[V], VSS=0[V], Ta=25[℃])

Parameter	Symbol	Temperature range	Guaranteed Limit BU7231G,BU7231SG Min.	Typ.	Max.	Unit	Condition
Input Offset Voltage (*5)	Vio	25℃	-	1	11	mV	-
Input Offset Current (*5)	Iio	25℃	-	1	-	pA	-
Input Bias Current (*5)	Ib	25℃	-	1	-	pA	-
Input Common-mode voltage Range	Vicm	25℃	0	-	3	V	(VDD-VSS)=3[V]
Large Signal Voltage Gain	AV	25℃	-	90	-	dB	RL=10[kΩ]
Supply current	IDD	25℃	-	5	15	μA	RL=∞
		full range	-	-	30		
Power supply rejection ratio	PSRR	25℃	-	80	-	dB	-
Common-mode rejection ratio	CMRR	25℃	-	80	-	dB	-
Output source current (*6)	IOH	25℃	1	2	-	mA	VDD-0.4
Output sink current (*6)	IOL	25℃	3	6	-	mA	VSS+0.4
High Level Output Voltage (*7)	VOH	25℃	VDD-0.1	-	-	V	RL=10[kΩ]
Low Level Output Voltage (*7)	VOL	25℃	-	-	VSS+0.1	V	RL=10[kΩ]
Output rise time	Tr	25℃	-	50	-	ns	CL=15pF 100mV over drive
Output fall time	Tf	25℃	-	20	-	ns	CL=15pF 100mV over drive
Propagation delay L to H	TPLH	25℃	-	1.7	-	μs	CL=15pF 100mV over drive
Propagation delay H to L	TPHL	25℃	-	0.5	-	mV	CL=15pF 100mV over drive

(*5) Abusolute values
(*6) Reference to power dissipation under the high temperature environment and decide the output current.
Continuous short circuit is occurring the degenerate of output current characteristics.
(*7) Full range BU7231：Ta=-40[℃] to +85[℃] BU7231S,BU7232S：Ta=-40[℃] to +105[℃]

○BU7232 family (Unless otherwise specified VDD=+3[V], VSS=0[V], Ta=25[℃])

Parameter	Symbol	Temperature range	Guaranteed Limit BU7232F/FVM BU7232S F/FVM Min.	Typ.	Max.	Unit	Condition
Input Offset Voltage (*5)	Vio	25℃	-	1	11	mV	-
Input Offset Current (*5)	Iio	25℃	-	1	-	pA	-
Input Bias Current (*5)	Ib	25℃	-	1	-	pA	-
Input Common-mode voltage Range	Vicm	25℃	0	-	3	V	(VDD-VSS)=3[V]
Large Signal Voltage Gain	AV	25℃	-	90	-	dB	RL=10[kΩ]
Supply current	IDD	25℃	-	10	25	μA	RL=∞
		full range	-	-	50		
Power supply rejection ratio	PSRR	25℃	-	80	-	dB	-
Common-mode rejection ratio	CMRR	25℃	-	80	-	dB	-
Output source current (*6)	IOH	25℃	1	2	-	mA	VDD-0.4
Output sink current (*6)	IOL	25℃	3	6	-	mA	VSS+0.4
High Level Output Voltage (*7)	VOH	25℃	VDD-0.1	-	-	V	RL=10[kΩ]
Low Level Output Voltage (*7)	VOL	25℃	-	-	VSS+0.1	V	RL=10[kΩ]
Output rise time	Tr	25℃	-	50	-	ns	CL=15pF 100mV over drive
Output fall time	Tf	25℃	-	20	-	ns	CL=15pF 100mV over drive
Propagation delay L to H	TPLH	25℃	-	1.7	-	μs	CL=15pF 100mV over drive
Propagation delay H to L	TPHL	25℃	-	0.5	-	mV	CL=15pF 100mV over drive

(*5) Abusolute values
(*6) Reference to power dissipation under the high temperature environment and decide the output current.
Continuous short circuit is occurring the degenerate of output current characteristics.
(*7) Full range,BU7232：Ta=-40[℃] to +85[℃] BU7232S：Ta=-40[℃] to +105[℃]

● Example of electrical characteristics

○ BU7251 family

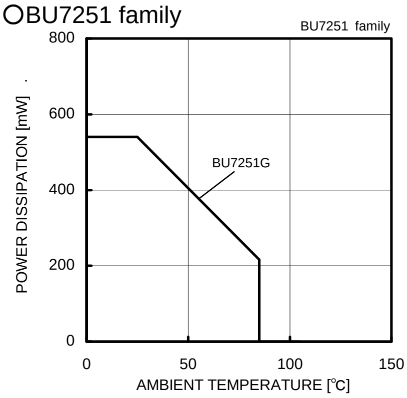


Fig. 1
Derating Curve

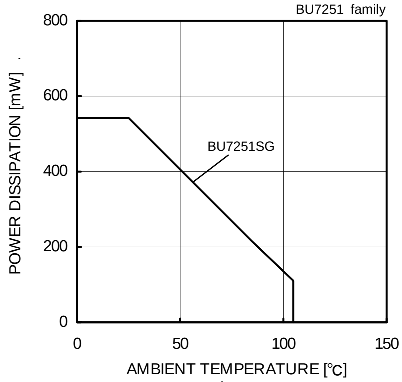


Fig. 2
Derating Curve

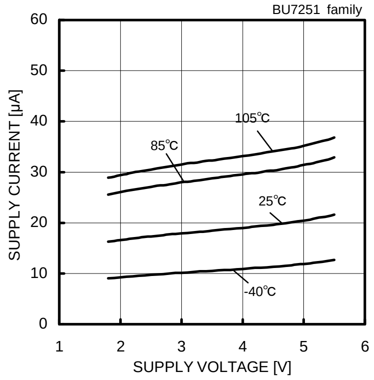


Fig. 3
Supply Current – Supply Voltage

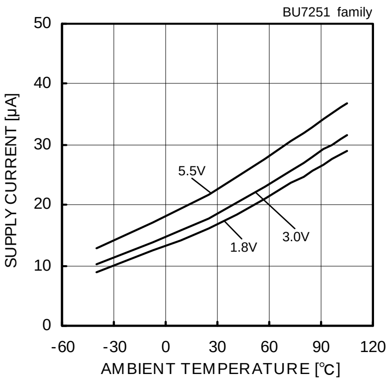


Fig. 4
Supply Current – Ambient Temperature

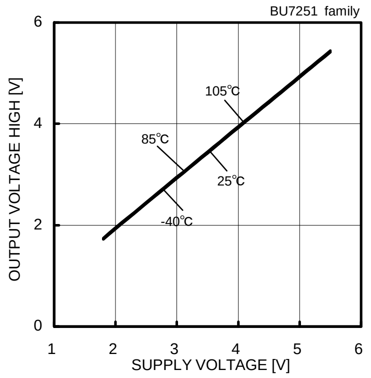


Fig. 5
Output Voltage High – Supply Voltage
(RL=10[kΩ])

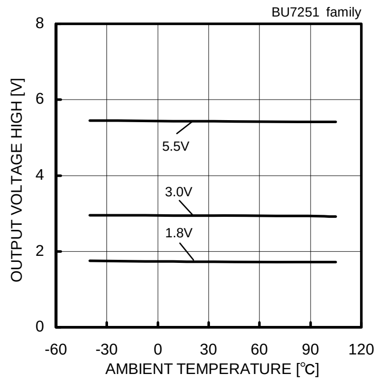


Fig. 6
Output Voltage High – Ambient Temperature
(RL=10[kΩ])

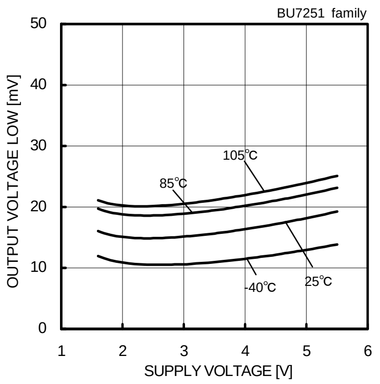


Fig. 7
Output Voltage Low – Supply Voltage
(RL=10[kΩ])

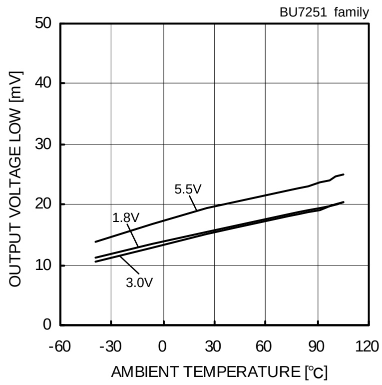


Fig. 8
Output Voltage Low – Ambient Temperature(RL=10[kΩ])

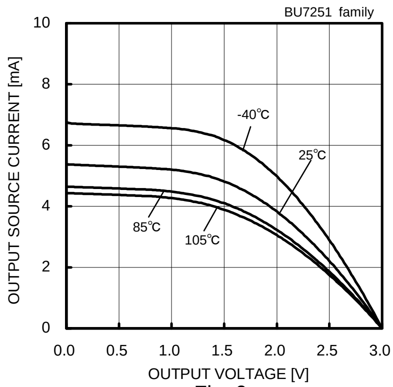


Fig. 9
Output Source Current – Supply Voltage(VDD=3[V])

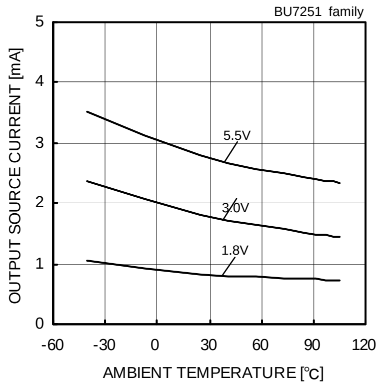


Fig. 10
Output Source Current – Ambient Temperature
(VOUT=VDD-0.4[V])

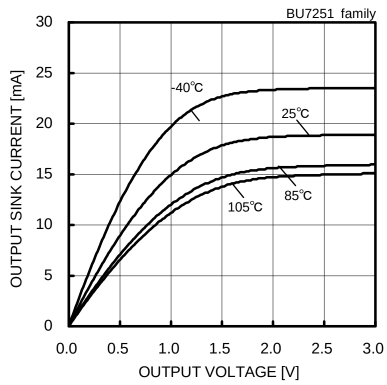


Fig. 11
Output Sink Current – Output Voltage
(VDD=3[V])

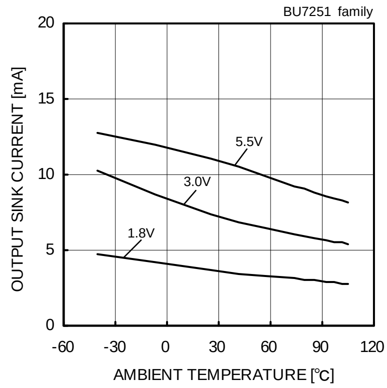


Fig. 12
Output Sink Current – Ambient Temperature
(VOUT=VSS+0.4[V])

(*) The above date is ability value of sample, it is not guaranteed. BU7251G：-40[℃] to+85[℃] BU7251SG：-40[℃] to+105[℃]

○BU7251 family

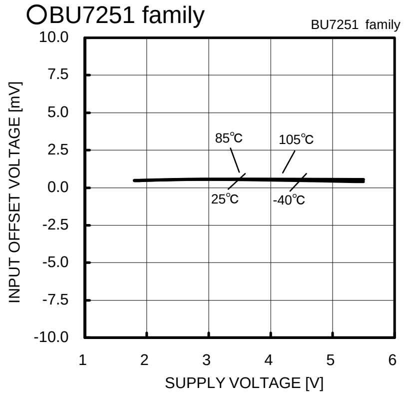


Fig. 13

Input Offset Voltage – Supply Voltage
(Vicm=VDD, Vout=0.1[V])

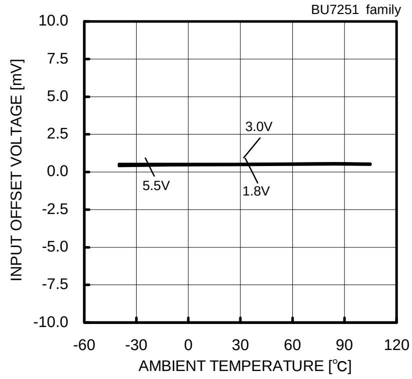


Fig. 14

Input Offset Voltage – Ambient Temperature
(Vicm=VDD, Vout=0.1[V])

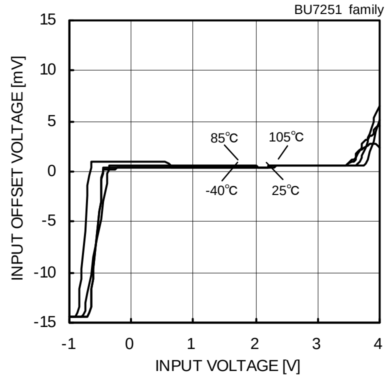


Fig. 15

Input offset voltage – Input Voltage
(VDD=3[V])

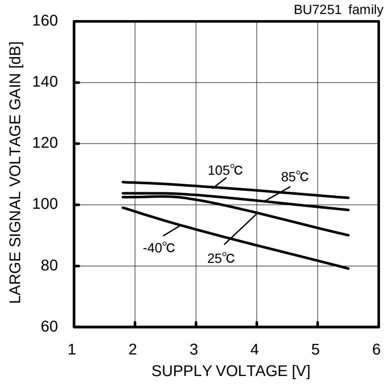


Fig. 16
Large Signal Voltage Gain – Supply Voltage

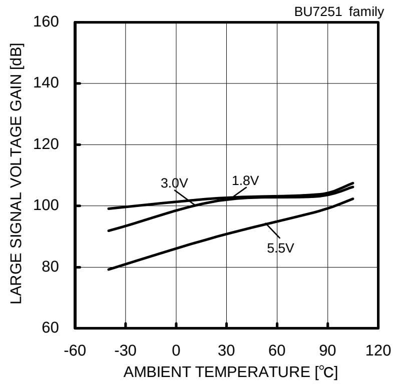


Fig. 17
Large Signal Voltage Gain
– Ambient Temperature

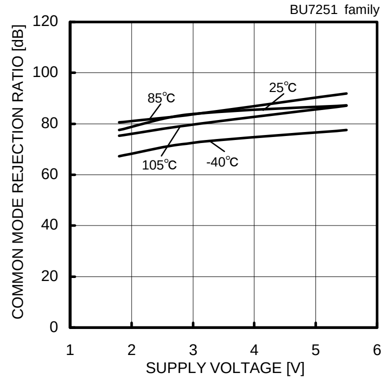


Fig. 18
Common Mode rejection Ratio
– Supply Voltage(VDD=3[V])

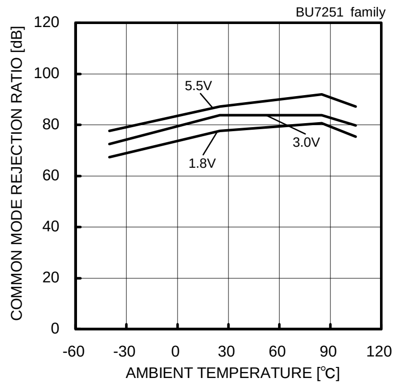


Fig. 19

Common Mode Rejection Ratio –
Ambient Temperature
(VDD=3[V])

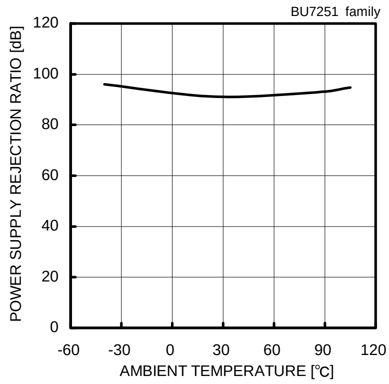


Fig. 20

Power Supply Rejection –
Ambient Temperature

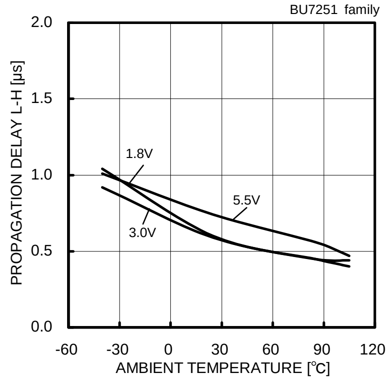


Fig. 21

Propagation Delay L-H –
Ambient Temperature

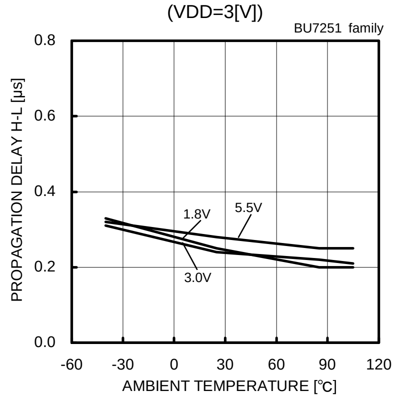


Fig. 22

Propagation Delay H-L – Ambient Temperature

(*) The above date is ability value of sample, it is not guaranteed.　BU7251G：-40[℃] to+85[℃]　BU7251SG：-40[℃] to+105[℃]

○BU7252 family

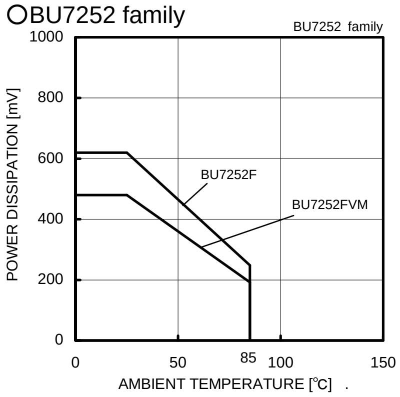


Fig. 23
Derating Curve

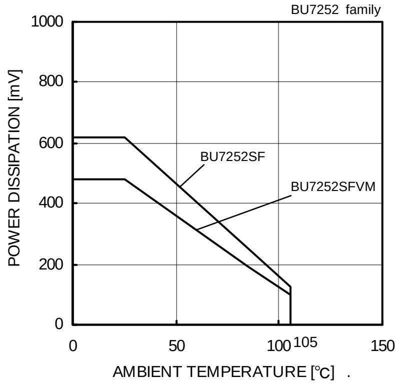


Fig. 24
Derating Curve

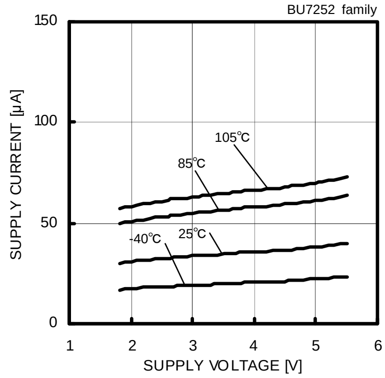


Fig. 25
Supply Current – Supply Voltage

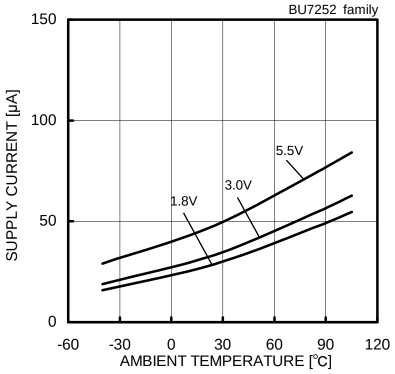


Fig. 26
Supply Curreny – Ambient Temperature

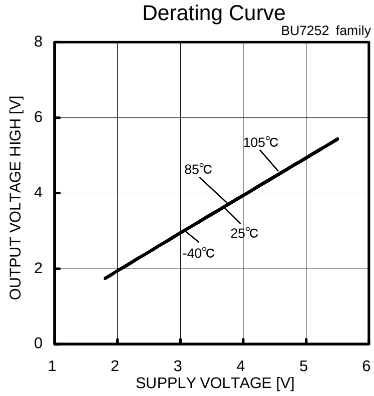


Fig. 27
Output Voltage High – Supply Voltage
(RL=10[kΩ])

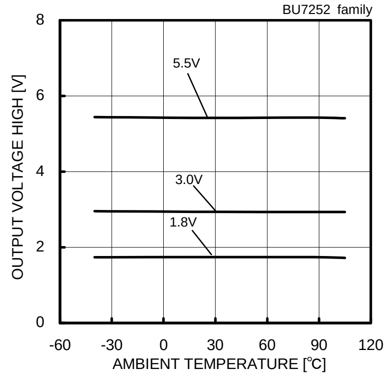


Fig. 28
Output Voltage High – Ambient Temperature
(RL=10[kΩ])

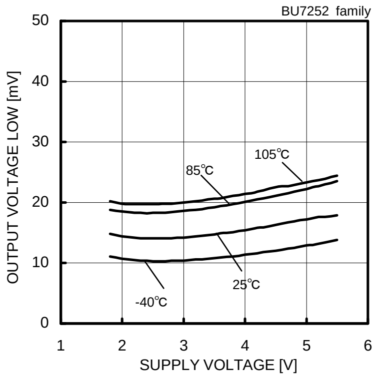


Fig. 29
Output Voltage Low – Supply Voltage(RL=10[kΩ])

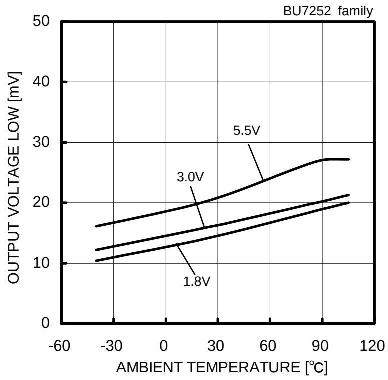


Fig. 30
Output Voltage Low – Ambient Temperature(RL=10[kΩ])

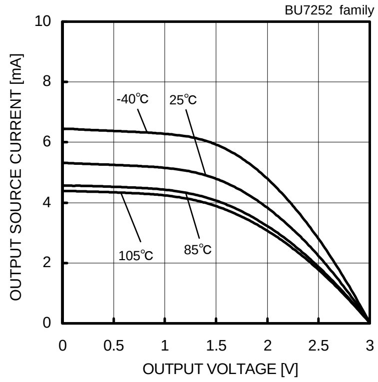


Fig. 31
Output Source Current – Output Voltage(VDD=3[V])

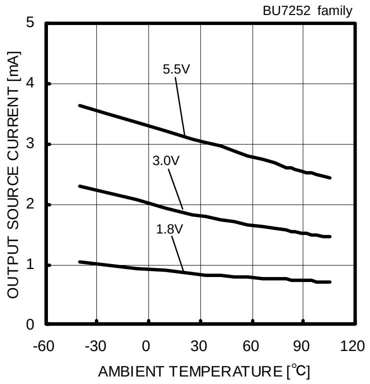


Fig. 32
Output Source Current – Ambient Temperature
(VOUT=VDD-0.4[V])

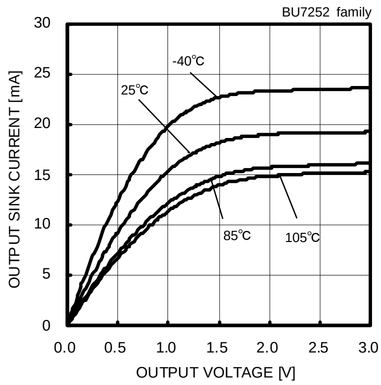


Fig. 33
Output Sink Current – Output Voltage
(VDD=3[V])

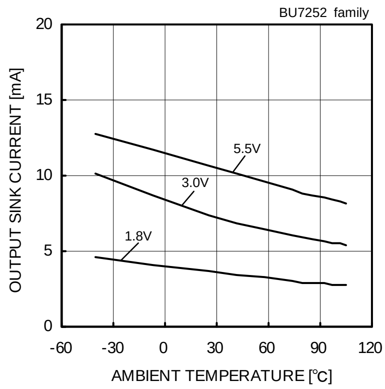


Fig. 34
Output Sink Current – Ambient Temperature
(VOUT=VSS+0.4[V])

(*) The above date is ability value of sample, it is not guaranteed. BU7252 F/FVM : -40[℃] to+85[℃] BU7252S F/FVM : -40[℃] to+105[℃]

○BU7252 family

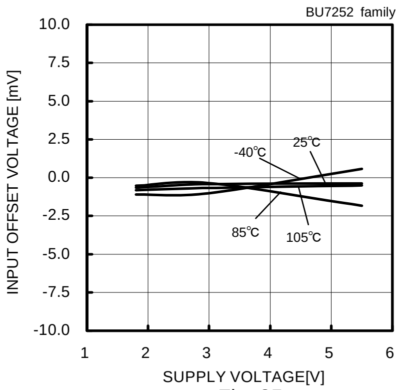


Fig. 35
Input Offset Voltage – Supply Voltage
(Vicm=VDD,VOUT=0.1[V])

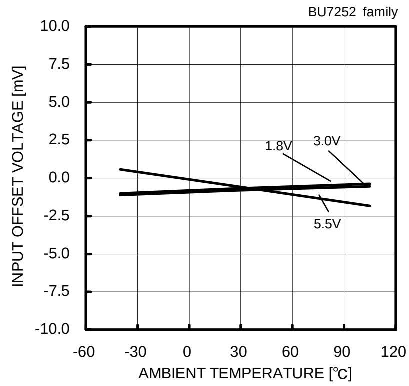


Fig. 36
Input Offset Voltage – Ambient Temperature
(Vicm=VDD,VOUT=0.1[V])

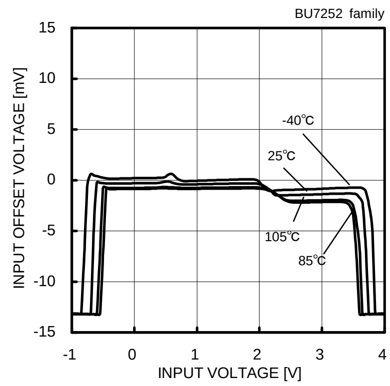


Fig. 37
Input Offset Voltage – Input Voltage
(VDD=3[V])

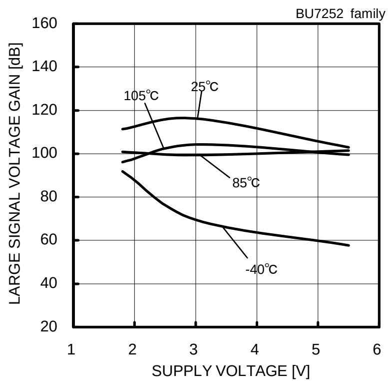


Fig. 38
Large Signal Voltage Gain – Supply Voltage

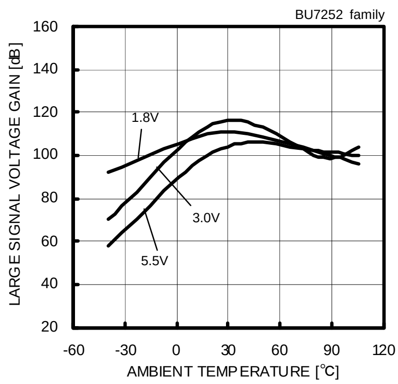


Fig. 39
Large Signal Voltage Gain – Ambient Temperature

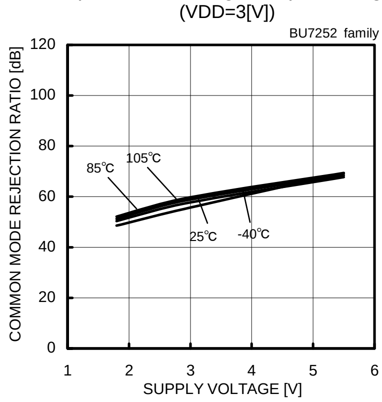


Fig. 40
Common Mode Rejection Ratio – Supply Voltage (VDD=3[V])

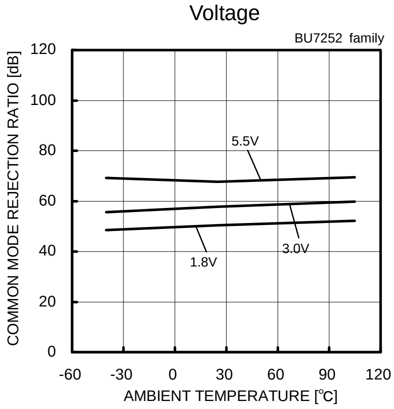


Fig. 41
Common Mode Rejection – Ambient Temperature (VDD=3[V])

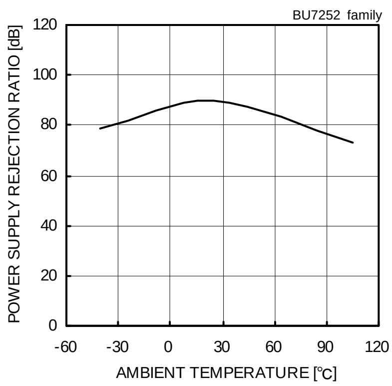


Fig. 42
Power Supply Rejection Ratio – Ambient Temperature

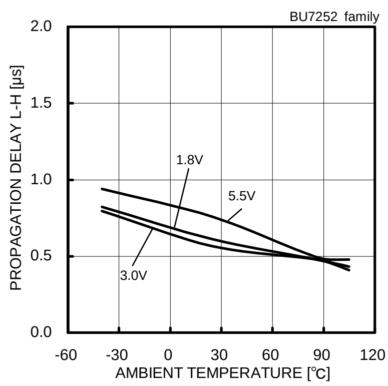


Fig. 43
Propagation Delay L-H – Ambient Temperature

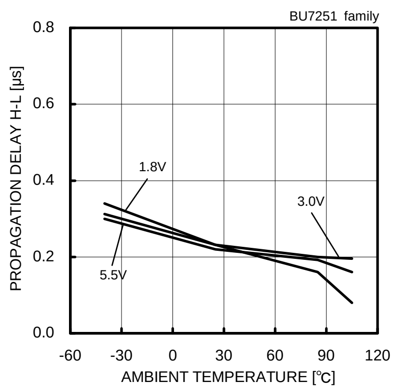


Fig. 44
Propagation Delay H-L – Ambient Temperature

(*) The above date is ability value of sample, it is not guaranteed. BU7252 F/FVM：-40[℃] to+85[℃] BU7252S F/FVM：-40[℃] to+105[℃]

5.5V

○BU7231 series

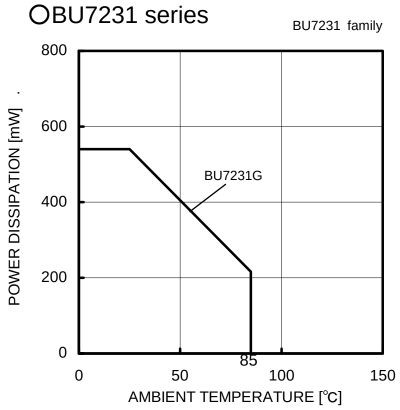


Fig. 45
Derating Curve

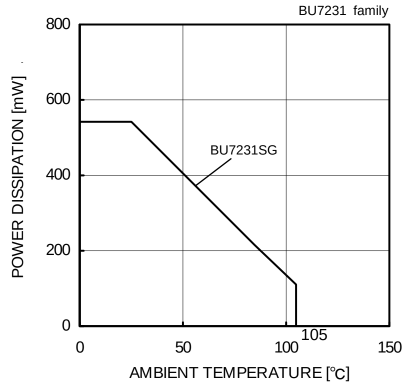


Fig. 46
Derating Curve

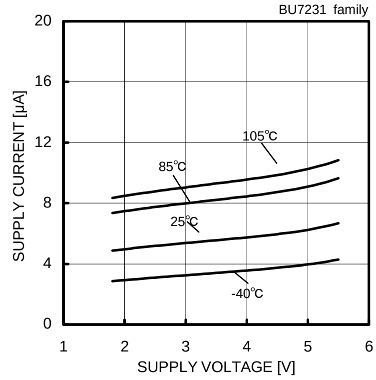


Fig. 47
Supply Current – Supply Voltage

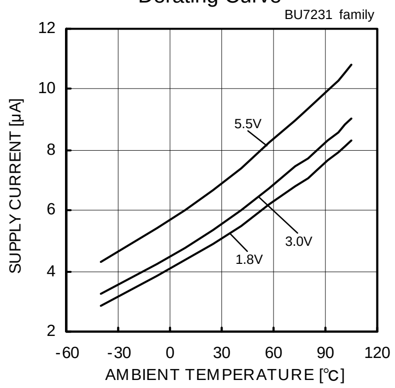


Fig. 48
Supply Current – Ambient Temperature

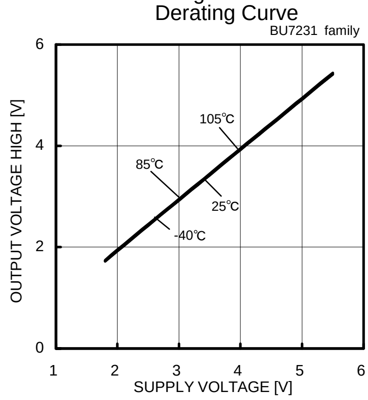


Fig. 49
Output Voltage – Supply Voltage
(RL=10[kΩ])

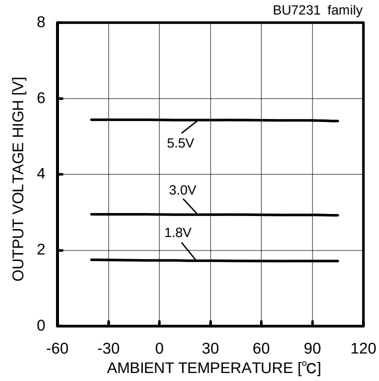


Fig. 50
Output Voltage High – Ambient Temperature
(RL=10[kΩ])

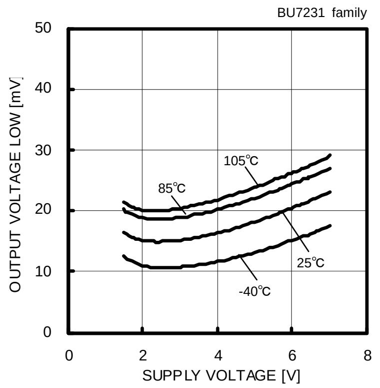


Fig. 51
Output Voltage Low – Supply Voltage
(RL=10[kΩ])

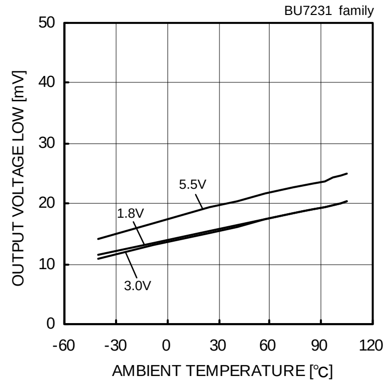


Fig. 52
Output Voltage Low – Ambient Temperature
(RL=10[kΩ])

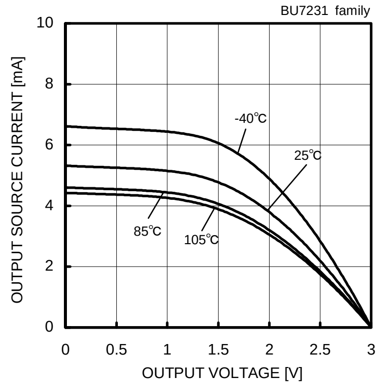


Fig. 53
Output Source Current – Output Voltage
(VDD=3[V])

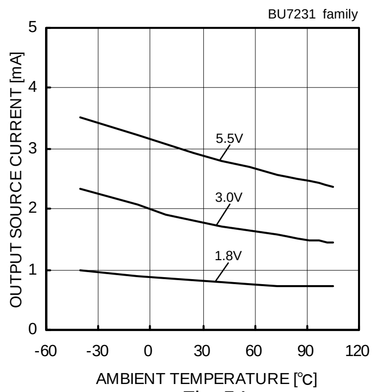


Fig. 54
Output Source Current – Ambient Temperature
(VOUT=VDD-0.4[V])

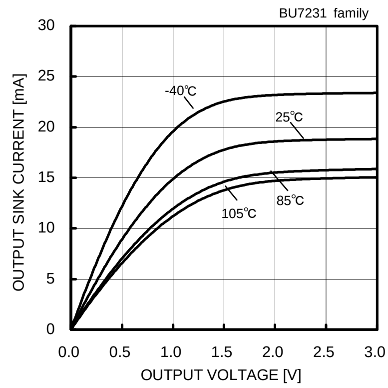


Fig. 55
Output Sink Current – Output Voltage
(VDD=3[V])

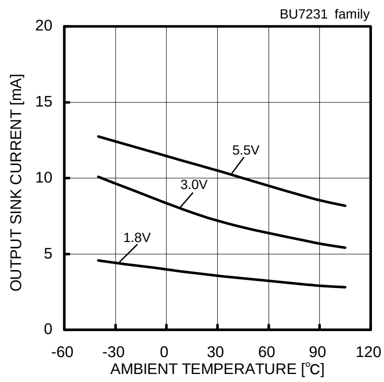


Fig. 56
Output Sink Current – Ambient Temperature
(VOUT=VSS+0.4[V])

(*) The above date is ability value of sample, it is not guaranteed. BU7231G：-40[℃] to+85[℃] BU7231SG：-40[℃] to+105[℃]

○BU7231 series

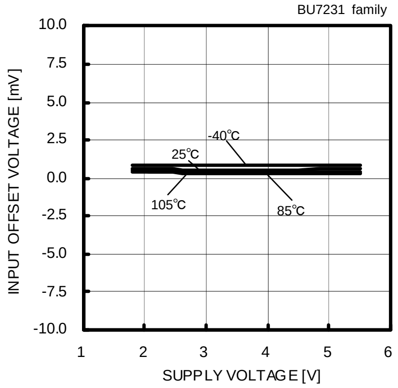


Fig. 57
Input Offset Voltage – Supply Voltage
(Vicm=VDD, Vout=0.1[V])

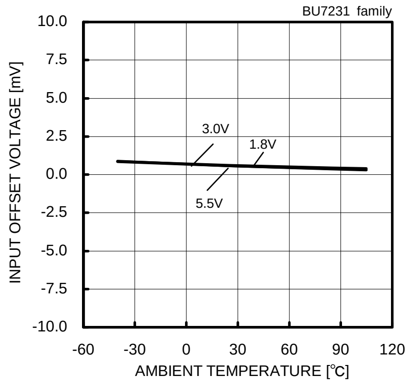


Fig. 58
Input Offset Voltage – Ambient Temperature
(Vicm=VDD, Vout=0.1[V])

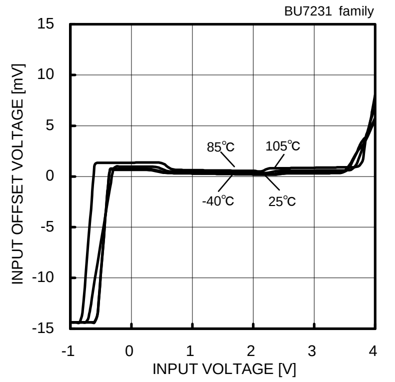


Fig. 59
Input Offset Voltage – Input Voltage
(VDD=3[V])

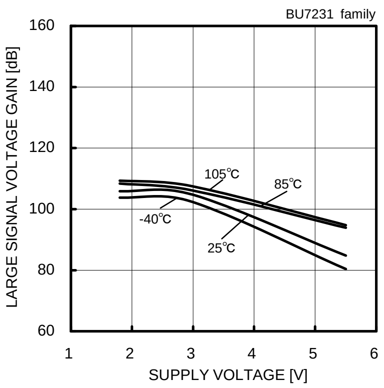


Fig. 60
Large Signal Voltage Gain – Supply Voltage

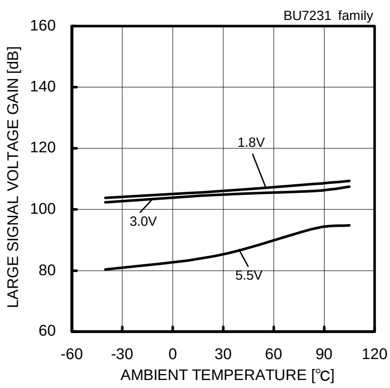


Fig. 61
Large Signal Voltage Gain
– Ambient Temperature

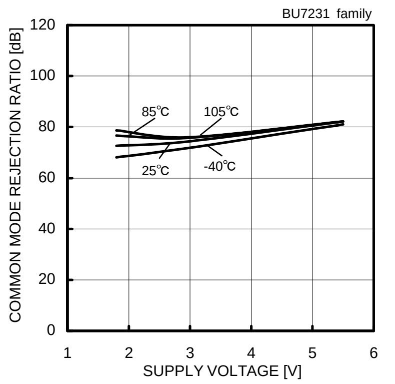


Fig. 62
Common Mode Rejection Ratio
– Supply Voltage (VDD=3[V])

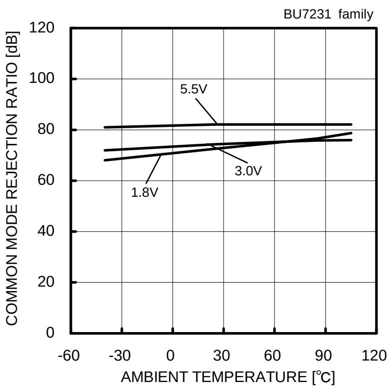


Fig. 63
Common Mode Rejection Ratio
– Ambient Temperature (VDD=3[V])

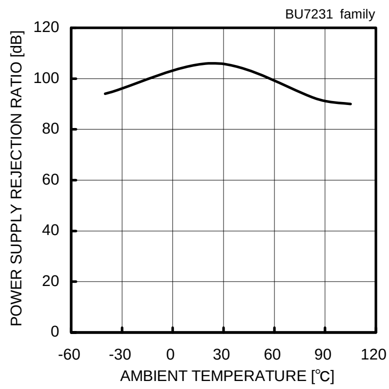


Fig. 64
Power Supply Rejection Ratio
– Ambient Temperature

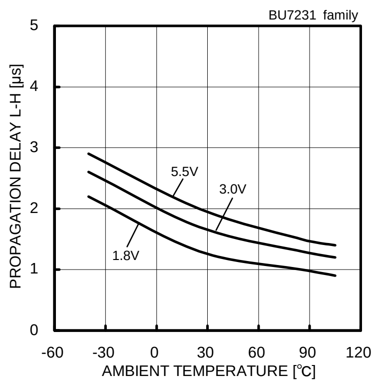


Fig. 65
Propagation Delay L-H
– Ambient Temperature

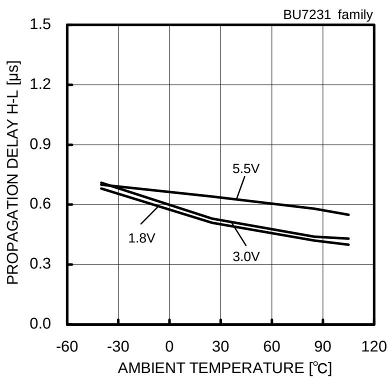


Fig. 66
Propagation Delay H-L– Ambient Temperature

(*) The above date is ability value of sample, it is not guaranteed. BU7231G : -40[℃] to+85[℃] BU7231SG : -40[℃] to+105[℃]

○BU7232 family

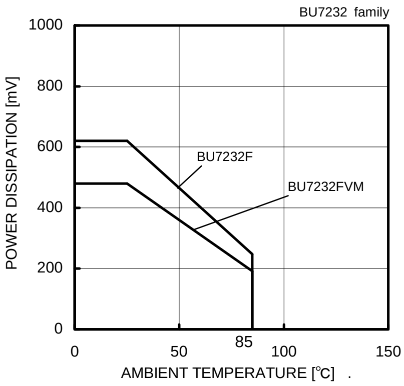


Fig. 67
Derating Curve

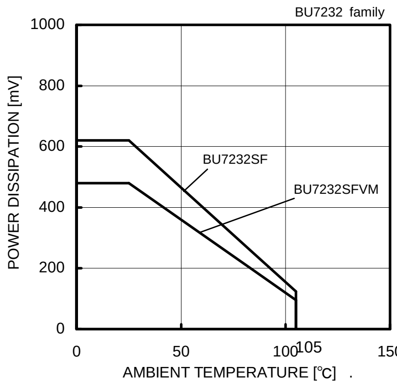


Fig. 68
Derating Curve

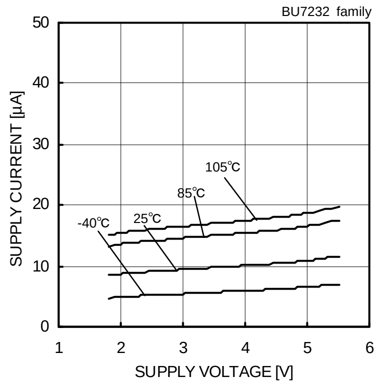


Fig. 69
Supply Current – Supply Voltage

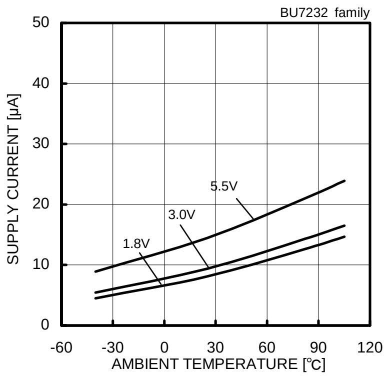


Fig. 70
Supply Current – Ambient emperature

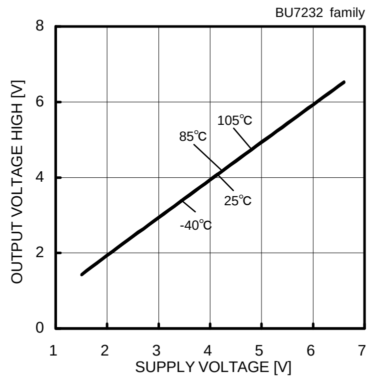


Fig. 71
Output Voltage High – Supply Voltage
(RL=10[kΩ])

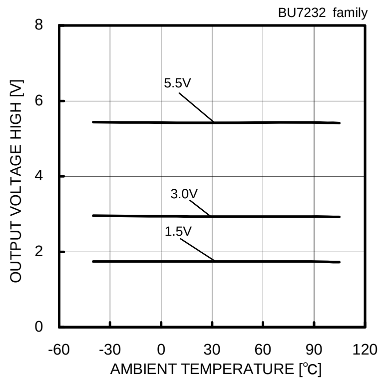


Fig. 72
Output Voltage – Ambient Temperature
(RL=10[kΩ])

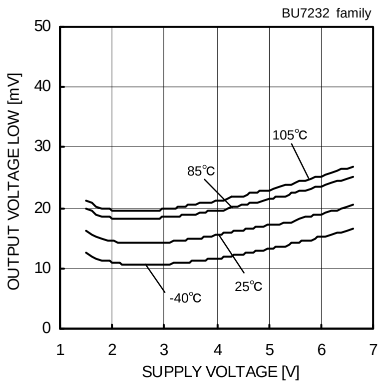


Fig. 73
Output Voltage Low – Supply Voltage
(RL=10[kΩ])

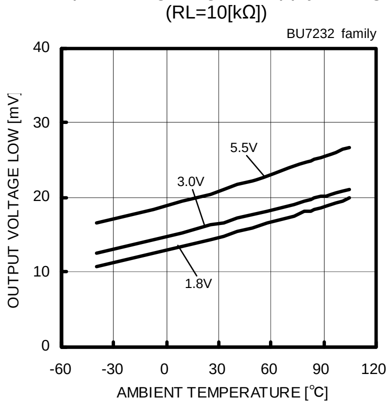


Fig. 74
Output Voltage Low – Ambient temperature
(RL=10[kΩ])

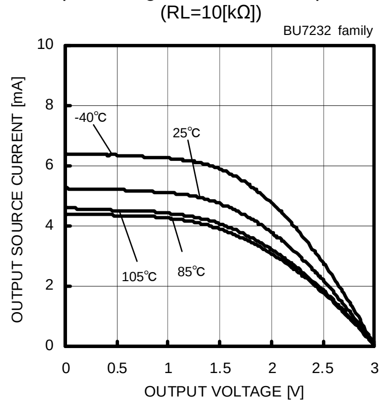


Fig. 75
Output Source Current – Output Voltage
(VDD=3[V])

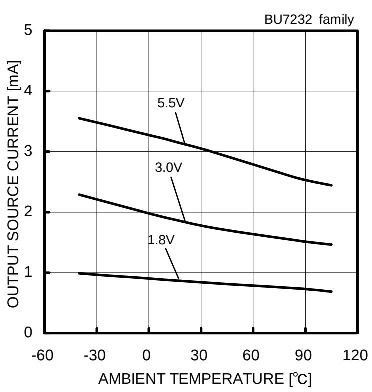


Fig. 76
Output Source Current – Ambient Temperature
(VOUT=VDD-0.4[V])

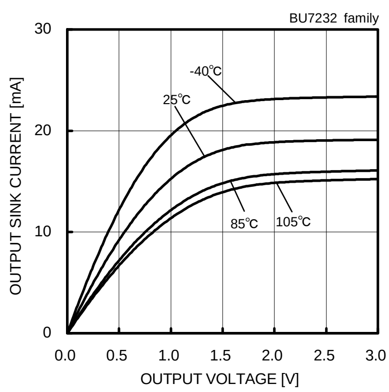


Fig. 77
Output Sink Current – Output Voltage
(VDD=3[V])

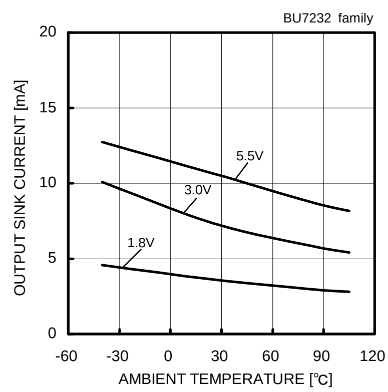


Fig. 78
Output Sink Current – Ambient Temperature
(VOUT=VSS+0.4[V])

(*) The above date is ability value of sample, it is not guaranteed. BU7232 F/FVM：-40[℃] to+85[℃] BU7232S F/FVM：-40[℃] to+105[℃]

○BU7232 family

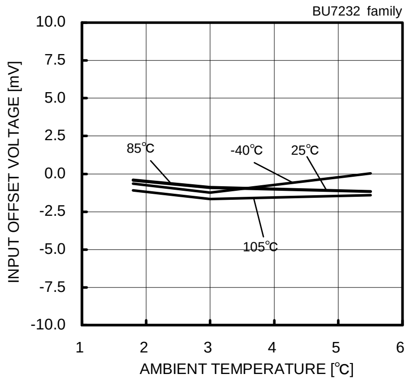


Fig. 79
Input Offset Voltage – Ambient Temperature
(Vicm=VDD,　VOUT=0.1[V])

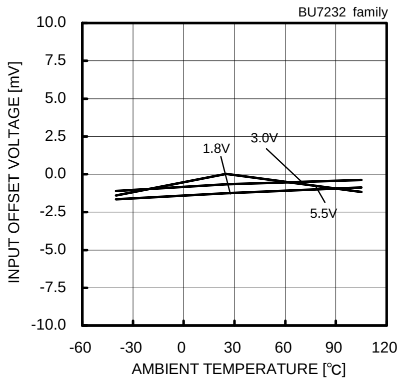


Fig. 80
Input Offset Voltage – Ambient Temperature
(Vicm=VDD,　VOUT=0.1[V])

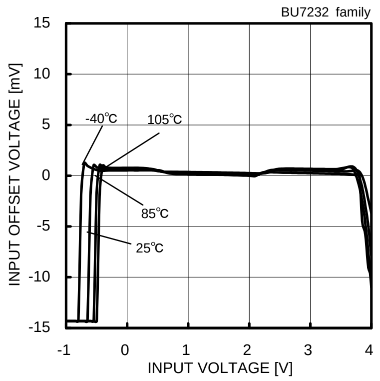


Fig. 81
Input Offset Voltage – Input Voltage
(VDD=3[V])

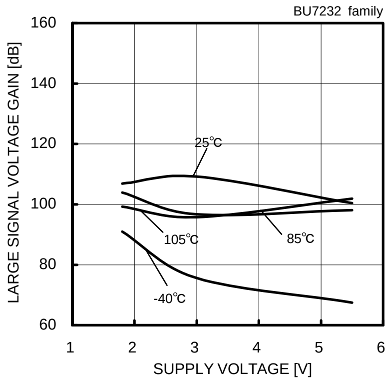


Fig. 82
Large Signal Voltage Gain － Supply Voltage

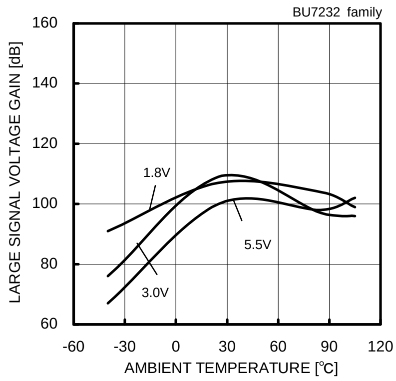


Fig. 83
Large Signal Voltage Gain
－ Ambient Temperature

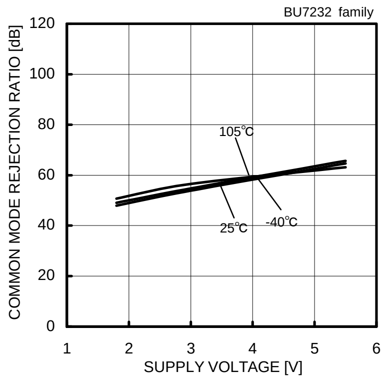


Fig. 84
Common Mode Rejection Ratio
– Supply Voltage (VDD=3[V])

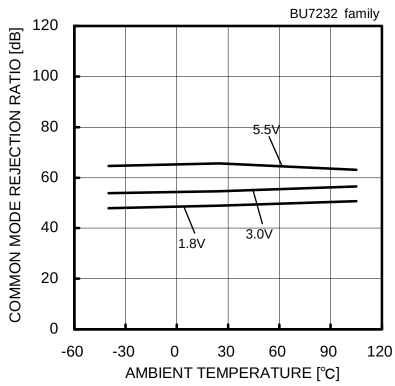


Fig. 85
Common Mode Rejection Ratio –
Ambient Temperature (VDD=3[V])

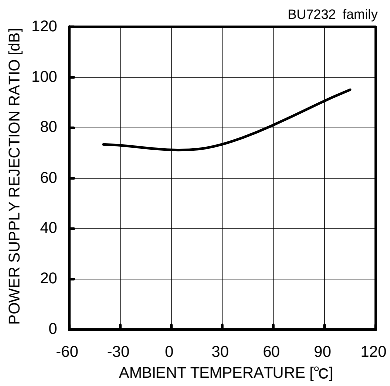


Fig. 86
Power Supply Rejection Ratio
– Ambient Temperature

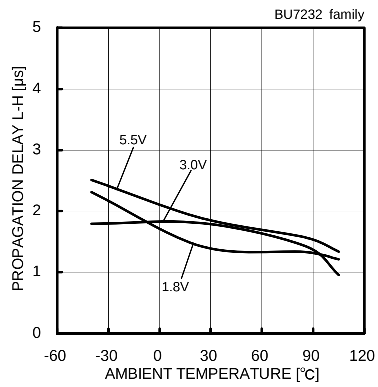


Fig. 87
Propagation Delay L-H – Ambient
temperature

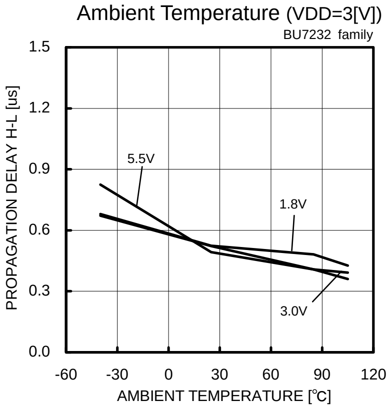


Fig. 88
Propagation Delay H-L – Ambient Temperature

(*) The above date is ability value of sample, it is not guaranteed.　BU7232 F/FVM：-40[℃] to+85[℃]　BU7232S F/FVM：-40[℃] to+105[℃]

●Schematic diagram

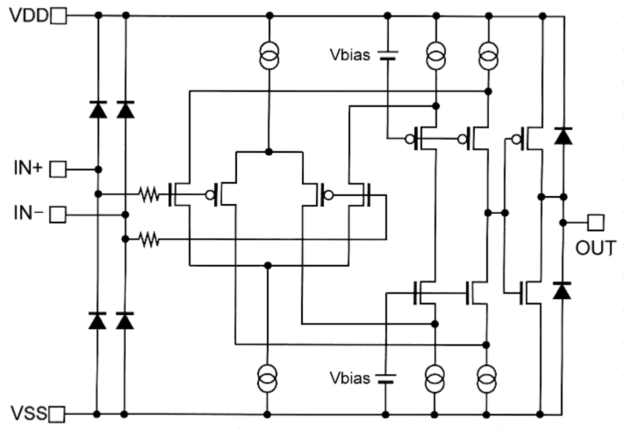


Fig. 89 Simplified schematic

●Test circuit1 NULL method

VDD,VSS,EK,Vicm, Unit : [V]

Parameter	VF	S1	S2	S3	VDD	VSS	EK	Vicm	Calculation
Input offset voltage	VF1	ON	ON	OFF	3	0	-0.1	0.3	1
Large signal voltage gain	VF2	ON	ON	ON	3	0	-0.3	0.3	2
	VF3						-2.7		
Common-mode rejection ratio (Input common-mode voltage range)	VF4	ON	ON	OFF	3	0	-0.1	0	3
	VF5							3	
Power supply rejection ratio	VF6	ON	ON	OFF	1.8	0	-0.1	0.3	4
	VF7				5.5				

-Calculation-

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

2. Large signal voltage gain (Av) $Av = 20Log\frac{2.4\times(1+Rf/Rs)}{|VF2-VF3|}$ [dB]

3. Common-mode rejection ratio (CMRR) $CMRR = 20Log\frac{3\times(1+Rf/Rs)}{|VF4-VF5|}$ [dB]

4. Power supply rejection ratio (PSRR) $PSRR = 20Log\frac{3.7\times(1+Rf/Rs)}{|VF6-VF7|}$ [dB]

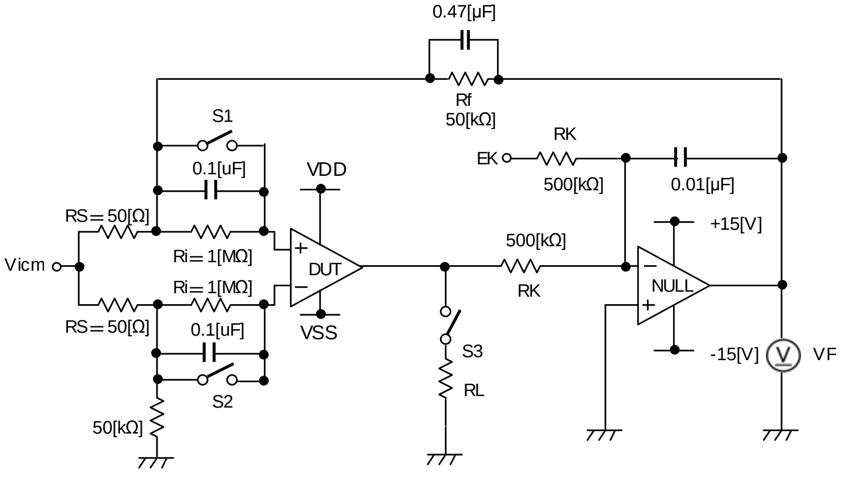


Fig. 90 Test Circuit 1 (one channel only)

●Test circuit2 switch condition

Unit : [V]

SW No.	SW 1	SW 2	SW 3	SW 4	SW 5	SW 6	SW 7	SW 8
supply current	OFF	ON	ON	OFF	OFF	OFF	OFF	OFF
maximum output voltage RL=10 [kΩ]	OFF	ON	ON	ON	OFF	OFF	ON	OFF
output current	OFF	OFF	OFF	OFF	OFF	ON	OFF	OFF
response time	ON	OFF	ON	OFF	ON	OFF	OFF	ON

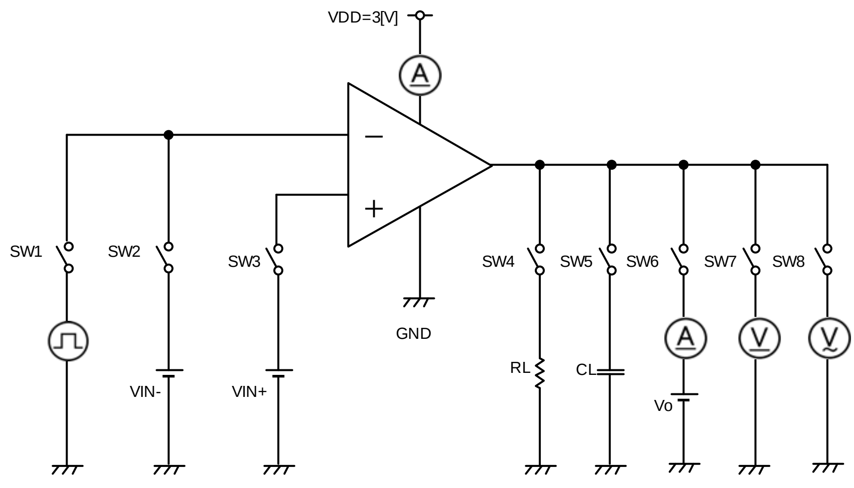


Fig. 91 Test circuit2 (one channel only)

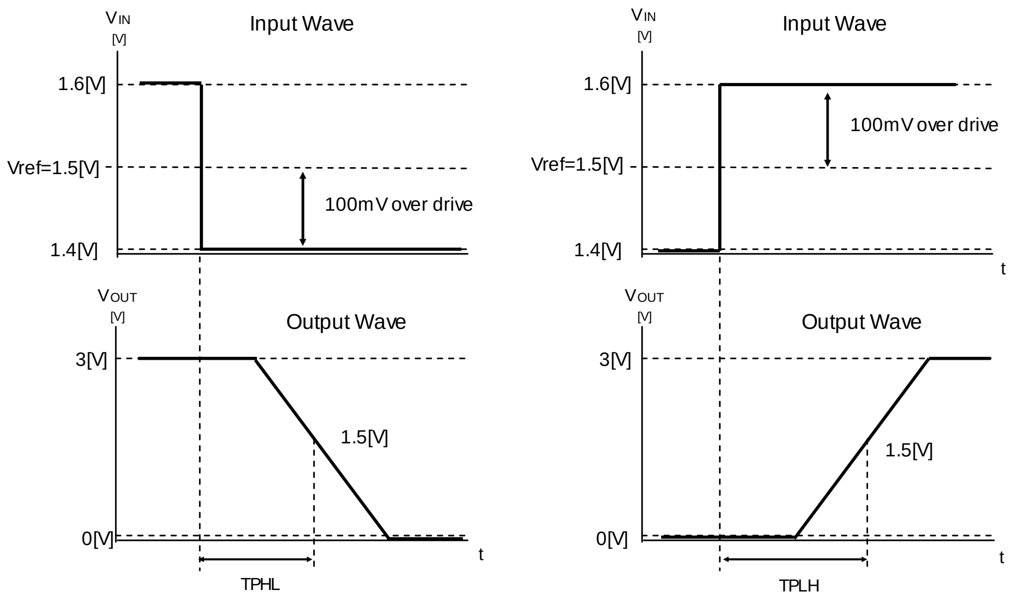


Fig. 92 Slew rate input output wave

●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(VDD/VSS)

Indicates the maximum voltage that can be applied between the positive power supply terminal and negative power supply terminal without deterioration or destruction of characteristics of internal circuit.

1.2 Differential input voltage (Vid)

Indicates the maximum voltage that can be applied between non-inverting terminal and inverting terminal without deterioration and destruction of characteristics of IC.

1.3 Input common-mode voltage range (Vicm)

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

1.4 Power dissipation (Pd)

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

2. Electrical characteristics item

2.1 Input offset voltage (Vio)

Indicates the voltage difference between non-inverting terminal and inverting terminal.
It can be translated into the input voltage difference required for setting the output voltage at 0 [V]

2.2 Input offset current (Iio)

Indicates the difference of input bias current between non-inverting terminal and inverting terminal.

2.3 Input bias current (Ib)

Indicates the current that flows into or out of the input terminal. It is defined by the average of input bias current at non-inverting terminal and input bias current at inverting terminal.

2.4 Input common-mode voltage range (Vicm)

Indicates the input voltage range where IC operates normally.

2.5 Large signal voltage gain (AV)

Indicates the amplifying rate (gain) of output voltage against the voltage difference between non-inverting terminal and inverting terminal. It is normally the amplifying rate (gain) with reference to DC voltage.
Av = (Output voltage fluctuation) / (Input offset fluctuation)

2.6 Circuit current (ICC)

Indicates the IC current that flows under specified conditions and no-load steady status.

2.7 Output sink current (OL)

Indicates the maximum current that can be output under specified output condition (such as output voltage and load condition).

2.8 Output saturation voltage, Low level output voltage (VOL)

Indicates the voltage range that can be output under specified load conditions.

2.9 Output leakage current, High level output current(I leak)

Indicates the current that flows into IC under specified input and output conditions.

2.10 Response Time (Tre)

The interval between the application of an input and output condition.

2.11 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)

2.12 Power supply rejection ratio (PSRR)

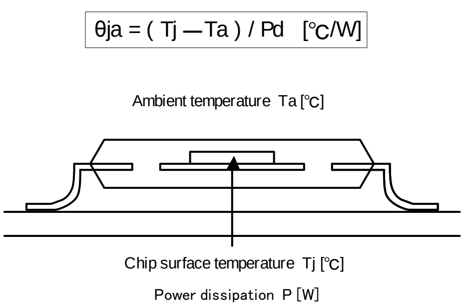
Indicates the ratio of fluctuation of input offset voltage when supply voltage is changed. It is normally the fluctuation of DC.
PSRR＝(Change of power supply voltage)/(Input offset fluctuation)

●Derating curve

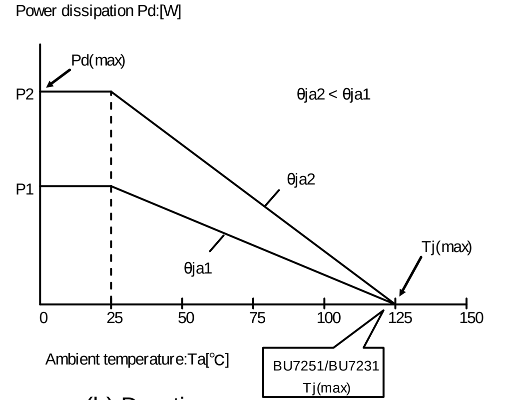
Power dissipation (total loss) indicates the power that can be consumed by IC at Ta=25℃(normal temperature).IC is heated when it consumed power, and the temperature of IC ship becomes higher than ambient temperature. The temperature that can be accepted by IC chip depends on circuit configuration, manufacturing 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 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.93 (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 :

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

Derating curve in Fig.93 (b) indicates power that can be consumed by IC with reference to ambient temperature. Power that can be consumed by IC begins to attenuate at certain ambient temperature. This gradient is determined by thermal resistance θja. Thermal resistance θja depends on chip size, power consumption, package, ambient temperature, package condition, wind velocity, etc even when the same of package is used. Thermal reduction curve indicates a reference value measured at a specified condition. Fig94(c)-(f) show a derating curve for an example of BU7251family, BU7252 family, BU7231 family, BU7232 family.

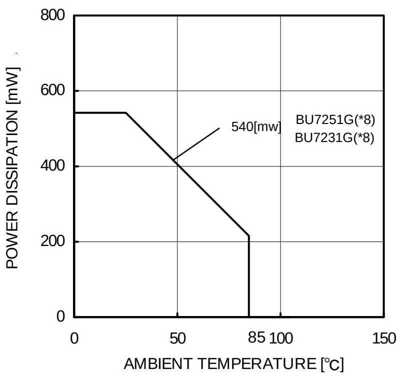


(a) Thermal resistance

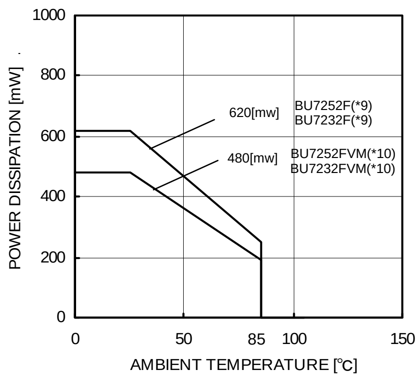


(b) Derating curve

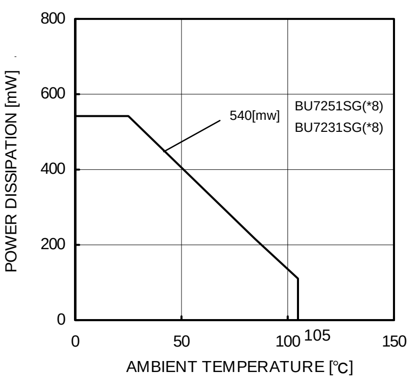
Fig. 93. Thermal resistance and power dissipation



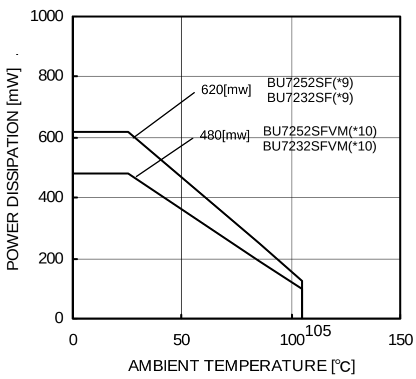
(c) BU7251G BU7231G



(d) BU7252F/FVM BU7232F/FVM



(e) BU7251SG BU7231SG



(f) BU7252S F/FVM BU72432S F/FVM

(*8)	(*9)	(*10)	Unit
5.4	6.2	4.8	[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. 94. Derating curve

●Notes for use

1) Absolute maximum ratings
Absolute maximum ratings are the values which indicate the limits, within which the given voltage range can be safely charged to the terminal.However, it does not guarantee the circuit operation.

2) Applied voltage to the input terminal
For normal circuit operation of voltage comparator, please input voltage for its input terminal within input common mode voltage VDD+0.3[V].Then, regardless of power supply voltage,VSS-0.3[V] can be applied to inputterminals without deterioration or destruction of its characteristics.

3) Operating power supply (split power supply/single power supply)
The voltage comparator operates if a given level of voltage is applied between VDD and VSS.
Therefore, the operational amplifier can be operated under single power supply or split power supply.

4) Power dissipation (pd)
If the IC is used under excessive power dissipation. An increase in the chip temperature will cause deterioration of the radical characteristics of IC. For example, reduction of current capability.
Take consideration of the effective power dissipation and thermal design with a sufficient margin. Pd is reference to the provided power dissipation curve.

5) Short circuits between pins and incorrect mounting
Short circuits between pins and incorrect mounting when mounting the IC on a printed circuits board, take notice of the direction and positioning of the IC.
If IC is mounted erroneously, It may be damaged. Also, when a foreign object is inserted between output, between output and VDD terminal or VSS terminal which causes short circuit, the IC may be damaged.

6) Using under strong electromagnetic field
Be careful when using the IC under strong electromagnetic field because it may malfunction.

7) Usage of IC
When stress is applied to the IC through warp of the printed circuit board,
The characteristics may fluctuate due to the piezo effect. Be careful of the warp of the printed circuit board.

8) Testing IC on the set board
When testing IC on the set board, in cases where the capacitor is connected to the low impedance,make sure to discharge per fabrication because there is a possibility that IC may be damaged by stress.
When removing IC from the set board, it is essential to cut supply voltage.
As a countermeasure against the static electricity, observe proper grounding during fabrication process and take due care when carrying and storage it.

9) The IC destruction caused by capacitive load
The transistors in circuits may be damaged when VDD terminal and VSS terminal is shorted with the charged output terminal capacitor.
When IC is used as a operational amplifier or as an application circuit,where oscillation is not activated by an output capacitor,the output capacitor must be kept below 0.1[μF] in order to prevent the damage mentioned above.

10) Decupling capacitor
Insert the deculing capacitance between VDD and VSS, for stable operation of operational amplifier.

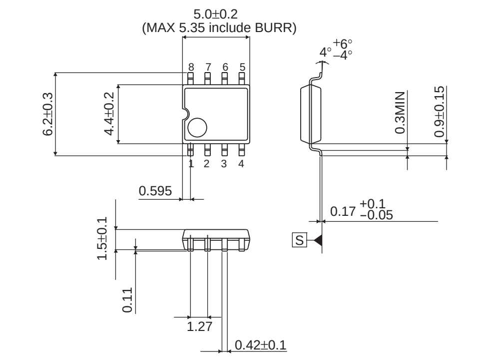
11) Latch up
Be careful of input vltage that exceed the VDD and VSS. When CMOS device have sometimes occur latch up operation.
And protect the IC from abnormaly noise

●Ordering part number

B	U		7	2	5	2		F	V	M	-	T	R

- Part No. (BU)
- Part No.: 7231 , 7231S / 7251 , 7251S / 7252 , 7252S / 7232 , 7232S
- Package: G: SSOP5 / F: SOP8 / FVM: MSOP8
- Packaging and forming specification: E2: Embossed tape and reel (SOP8) / TR: Embossed tape and reel (SSOP5/MSOP8)

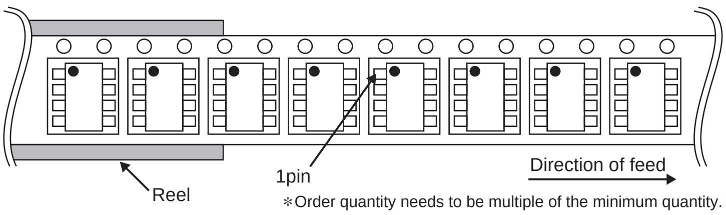
SOP8



(Unit : mm)

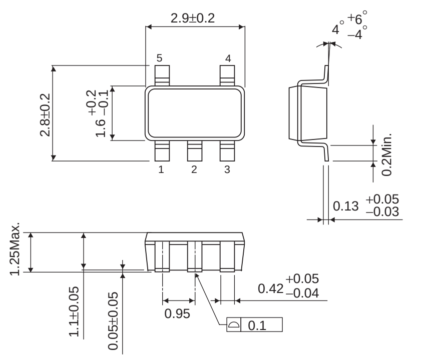
<Tape and Reel information>

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



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

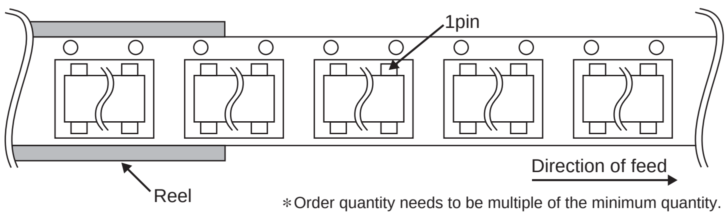
SSOP5



(Unit : mm)

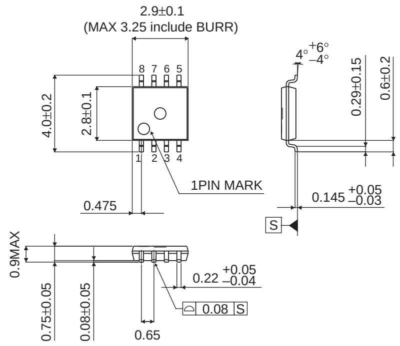
<Tape and Reel information>

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



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

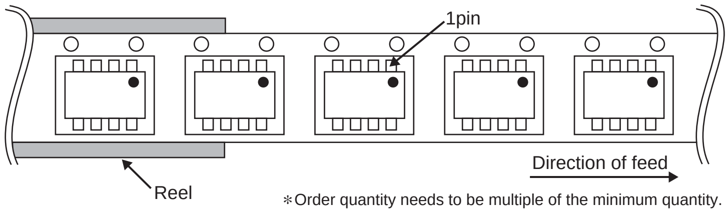
MSOP8



(Unit : mm)

<Tape and Reel information>

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



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

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

(Note1) Medical Equipment Classification of the Specific Applications

JAPAN	USA	EU	CHINA
CLASSⅢ	CLASSⅢ	CLASSⅡb	CLASSⅢ
CLASSⅣ		CLASSⅢ	

2. ROHM designs and manufactures its Products subject to strict quality control system. However, semiconductor products can fail or malfunction at a certain rate. Please be sure to implement, at your own responsibilities, adequate safety measures including but not limited to fail-safe design against the physical injury, damage to any property, which a failure or malfunction of our Products may cause. The following are examples of safety measures:
   [a] Installation of protection circuits or other protective devices to improve system safety
   [b] Installation of redundant circuits to reduce the impact of single or multiple circuit failure

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

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

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

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

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

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

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

Precaution for Mounting / Circuit board design

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

2. In principle, the reflow soldering method must be used; if flow soldering method is preferred, please consult with the ROHM representative in advance.

For details, please refer to ROHM Mounting specification

Precautions Regarding Application Examples and External Circuits

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

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

Precaution for Electrostatic

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

Precaution for Storage / Transportation

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

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

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

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

Precaution for Product Label

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

Precaution for Disposition

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

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Since our Products might fall under controlled goods prescribed by the applicable foreign exchange and foreign trade act, please consult with ROHM representative in case of export.

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