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ROHM SEMICONDUCTOR

EMARMOUR™ Datasheet

Operational Amplifiers Series

Automotive High Speed Excellent EMI Immunity Operational Amplifiers

BA83472Yxxx-C BA83474YFV-C

General Description

BA83472Yxxx-C and BA83474YFV-C integrate dual/quad independent high voltage gain Op-amps on a single chip. An operating voltage range is wide with 3 V to 36 V. This operational amplifier is the most suitable for automotive requirements such as sensor amplifier, engine control unit, electric power steering, anti-lock braking system and so on because it has features of high gain bandwidth and high slew rate.
Furthermore, they have the advantage of EMI tolerance. It makes easier replacing with conventional products or simpler designing EMI.

Features

- EMARMOUR™ Series
- AEC-Q100 Qualified*(Note 1)*
- Single or Dual Power Supply Operation
- Wide Operating Supply Voltage Range
- Standard Op-Amp Pin-assignments
- High Open-loop Voltage Gain
- Internal ESD Protection Circuit
- Common-mode Input Voltage Range includes Ground Level, allowing Direct Ground Sensing
- Wide Output Voltage Range

(Note 1) Grade 1

Applications

- Engine Control Unit
- Electric Power Steering (EPS)
- Anti-Lock Braking System (ABS)
- All Automotive Application

Key Specifications

- Operating Supply Voltage Range
  - Single Supply: 3 V to 36 V
  - Dual Supply: ±1.5 V to ±18 V
- Temperature Range: -40 °C to +125 °C
- Input Offset Voltage: 10 mV (Max)
- Input Offset Current: 6 nA (Typ)
- Input Bias Current: 100 nA (Typ)
- Output Voltage Range:
  (V_S = 30 V) V_{EE} + 0.3 V to V_{CC} - 1.0 V (Typ)
- Slew Rate: 8.5 V/µs (Typ)
- Gain Bandwidth Product: 3 MHz (Typ)

Package

	W (Typ) x D (Typ) x H (Max)
SOP8	5.0 mm x 6.2 mm x 1.71 mm
MSOP8	2.9 mm x 4.0 mm x 0.9 mm
SSOP-B14	5.0 mm x 6.4 mm x 1.35 mm



SOP8

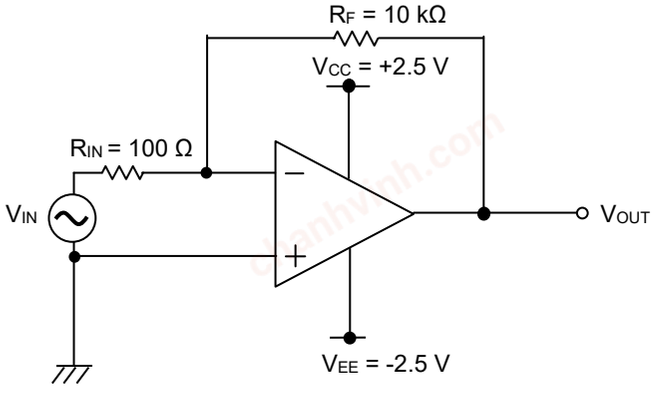


MSOP8



SSOP-B14

Typical Application Circuit



$$V_{OUT} = -\frac{R_F}{R_{IN}} V_{IN}$$

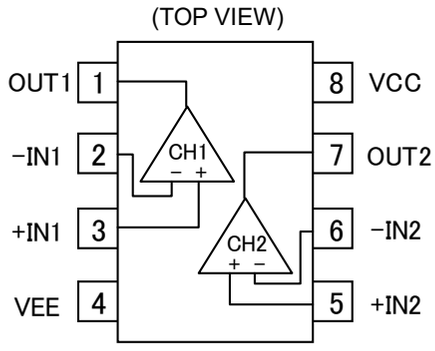
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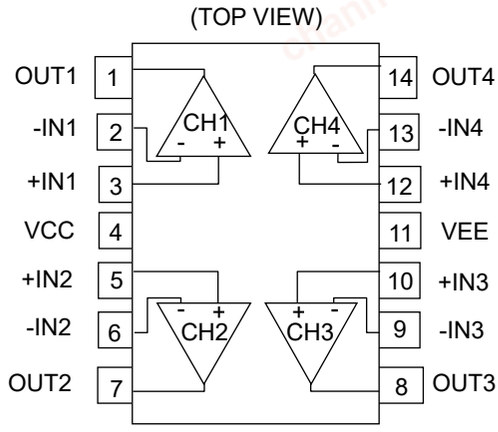
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Pin Configurations

BA83472YF-C: SOP8
BA83472YFVM-C: MSOP8



BA83474YFV-C: SSOP-B14



Pin Descriptions

BA83472YF-C: SOP8
BA83472YFVM-C: MSOP8

Pin No.	Pin Name	Function
1	OUT1	Output1
2	-IN1	Inverting input1
3	+IN1	Non-inverting input1
4	VEE	Negative power supply / Ground
5	+IN2	Non-inverting input2
6	-IN2	Inverting input2
7	OUT2	Output2
8	VCC	Positive power supply

BA83474YFV-C: SSOP-B14

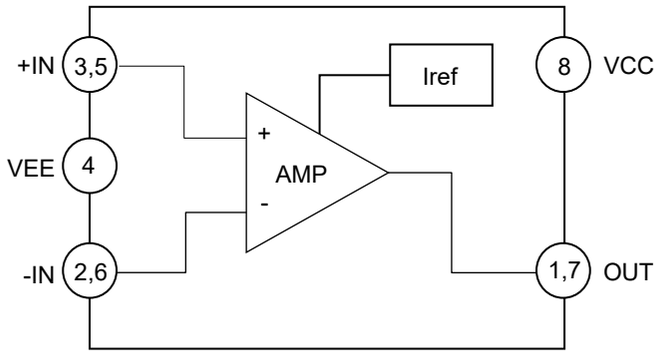
Pin No.	Pin Name	Function
1	OUT1	Output1
2	-IN1	Inverting input1
3	+IN1	Non-inverting input1
4	VCC	Positive power supply
5	+IN2	Non-inverting input2
6	-IN2	Inverting input2
7	OUT2	Output2
8	OUT3	Output3
9	-IN3	Inverting input3
10	+IN3	Non-inverting input3
11	VEE	Negative power supply / Ground
12	+IN4	Non-inverting input4
13	-IN4	Inverting input4
14	OUT4	Output4

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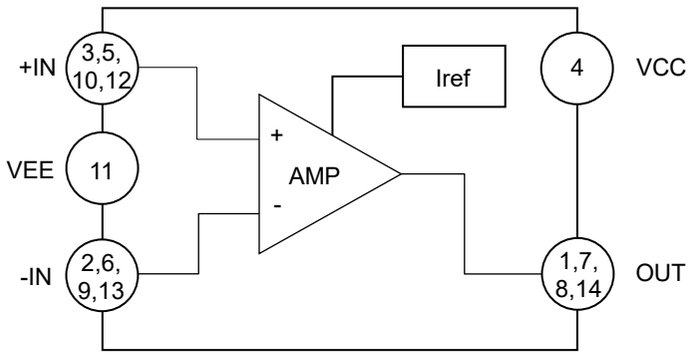
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Block Diagram

BA83472YF-C: SOP8
BA83472YFVM-C: MSOP8



BA83474YFV-C: SSOP-B14



Description of Blocks

1. OPAMP:
   This block is an operational amplifier with a wide operating supply voltage Range, a high slew rate (8.5 V/μs) and high-gain bandwidth product (3 MHz).

2. Iref:
   This block supplies reference current which is needed to operate OPAMP block.

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Absolute Maximum Ratings (Ta = 25 °C)

Parameter	Symbol	Rating	Unit
Supply Voltage (V_{CC} - V_{EE})	V_S	36	V
Differential Input Voltage*(Note 1)*	V_{ID}	36	V
Common-mode Input Voltage Range	V_{ICMR}	(V_{EE} - 0.3) to (V_{EE} + 36.0)	V
Input Current	I_I	±10	mA
Storage Temperature Range	Tstg	-55 to +150	°C
Maximum Junction Temperature	Tjmax	150	°C

Caution 1: *Operating the IC over the absolute maximum ratings may damage the IC. The damage can either be a short circuit between pins or an open circuit between pins and the internal circuitry. Therefore, it is important to consider circuit protection measures, such as adding a fuse, in case the IC is operated over the absolute maximum ratings.*

Caution 2: *Should by any chance the maximum junction temperature rating be exceeded the rise in temperature of the chip may result in deterioration of the properties of the chip. In case of exceeding this absolute maximum rating, design a PCB with thermal resistance taken into consideration by increasing board size and copper area so as not to exceed the maximum junction temperature rating.*

(Note 1) The differential input voltage indicates the voltage difference between inverting input and non-inverting input. The input pin voltage is set to V_{EE} or more.

Thermal Resistance*(Note 2)*

Parameter	Symbol	Thermal Resistance (Typ)		Unit
		1s*(Note 4)*	2s2p*(Note 5)*	
SOP8				
Junction to Ambient	θ_{JA}	197.4	109.8	°C/W
Junction to Top Characterization Parameter*(Note 3)*	Ψ_{JT}	21	19	°C/W
MSOP8				
Junction to Ambient	θ_{JA}	284.1	135.4	°C/W
Junction to Top Characterization Parameter*(Note 3)*	Ψ_{JT}	21	11	°C/W
SSOP-B14				
Junction to Ambient	θ_{JA}	159.6	92.8	°C/W
Junction to Top Characterization Parameter*(Note 3)*	Ψ_{JT}	13	9	°C/W

(Note 2) Based on JESD51-2A (Still-Air).
(Note 3) The thermal characterization parameter to report the difference between junction temperature and the temperature at the top center of the outside surface of the component package.
(Note 4) Using a PCB board based on JESD51-3.
(Note 5) Using a PCB board based on JESD51-7.

Layer Number of Measurement Board	Material	Board Size
Single	FR-4	114.3 mm x 76.2 mm x 1.57 mmt

Top	
Copper Pattern	Thickness
Footprints and Traces	70 µm

Layer Number of Measurement Board	Material	Board Size
4 Layers	FR-4	114.3 mm x 76.2 mm x 1.6 mmt

Top		2 Internal Layers		Bottom	
Copper Pattern	Thickness	Copper Pattern	Thickness	Copper Pattern	Thickness
Footprints and Traces	70 µm	74.2 mm x 74.2 mm	35 µm	74.2 mm x 74.2 mm	70 µm

Recommended Operating Conditions

Parameter		Symbol	Min	Typ	Max	Unit
Operating Supply Voltage (V_{CC} - V_{EE})	Single Supply	Vs	3	5	36	V
	Dual Supply		±1.5	±2.5	±18.0	
Operating Temperature		Topr	-40	+25	+125	°C

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Function Explanation

1. EMARMOUR™

EMARMOUR™ is the brand name given to ROHM products developed by leveraging proprietary technologies covering layout, process, and circuit design to achieve ultra-high noise immunity that limits output voltage fluctuation to ±300 mV or less across the entire noise frequency band during noise evaluation testing under the international ISO11452-2 standard. This unprecedented noise immunity reduces design load while improving reliability by solving issues related to noise in the development of vehicle electrical systems.

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Electrical Characteristics (Unless otherwise specified V_S = 30 V, V_{EE} = -15 V)

○BA83472Yxxx-C

Parameter	Symbol	Temperature Range	Limits			Unit	Condition
			Min	Typ	Max		
Input Offset Voltage	V_{IO}	25 °C	-	1	10	mV	V_{OUT} = 0 V Absolute value
		-40 °C to +125 °C	-	-	10		
			-	-	10		V_S = 5 V, V_{EE} = 0 V V_{OUT} = V_S / 2 Absolute value
Input Offset Current	I_{IO}	25 °C	-	6	75	nA	V_{OUT} = 0 V Absolute value
		-40 °C to +125 °C	-	-	100		
Input Bias Current*(Note 1)*	I_B	25 °C	-	100	150	nA	V_{OUT} = 0 V
		-40 °C to +125 °C	-	-	200		
Supply Current	I_{CC}	25 °C	-	4.3	5.5	mA	R_L = ∞
		-40 °C to +125 °C	-	-	6		
Output Voltage High	V_{OH}	25 °C	3.7	4	-	V	V_S = 5 V, V_{EE} = 0 V R_L = 2 kΩ
		-40 °C to +125 °C	3.5	-	-		
		25 °C	13.7	14	-		R_L = 10 kΩ
		-40 °C to +125 °C	13.5	-	-		
		25 °C	13.5	-	-		R_L = 2 kΩ
Output Voltage Low	V_{OL}	25 °C	-	0.1	0.3	V	V_S = 5 V, V_{EE} = 0 V R_L = 2 kΩ
		-40 °C to +125 °C	-	-	0.6		
		25 °C	-	-14.7	-14.3		R_L = 10 kΩ
		-40 °C to +125 °C	-	-	-14.0		
		25 °C	-	-	-13.5		R_L = 2 kΩ
Large Signal Voltage Gain	A_V	25 °C	80	100	-	dB	R_L ≥ 2 kΩ, V_{OUT} = ±10 V
		-40 °C to +125 °C	70	-	-		
Common-mode Input Voltage Range	V_{ICMR}	25 °C	0	-	3.0	V	V_S = 5 V, V_{EE} = 0 V V_{OUT} = V_S / 2
		-40 °C to +125 °C	0	-	2.4		
Common-mode Rejection Ratio	CMRR	25 °C	70	97	-	dB	V_{OUT} = 0 V
Power Supply Rejection Ratio	PSRR	25 °C	70	97	-	dB	V_{OUT} = 0 V
Output Source Current*(Note 2)*	I_{SOURCE}	25 °C	10	30	-	mA	V_S = 5 V, V_{EE} = 0 V V_{+IN} = 1 V, V_{-IN} = 0 V V_{OUT} = 0 V, 1 CH is short circuit
		-40 °C to +125 °C	10	-	-		
Output Sink Current*(Note 2)*	I_{SINK}	25 °C	10	30	-	mA	V_S = 5 V, V_{EE} = 0 V V_{+IN} = 0 V, V_{-IN} = 1 V V_{OUT} = 5 V, 1 CH is short circuit
		-40 °C to +125 °C	10	-	-		
Gain Bandwidth Product	GBW	25 °C	-	3	-	MHz	-
Slew Rate	SR	25 °C	-	8.5	-	V/μs	V_{IN} = -10 V to +10 V G = 0 dB, R_L = 2 kΩ
		-40 °C to +125 °C	5	-	-		
Channel Separation	CS	25 °C	-	120	-	dB	-

(Note 1) Current direction: Since first input stage is composed with PNP transistor, input bias current flows out of IC.

(Note 2) Under high temperatures, please consider the power dissipation when selecting the output current. When the output pin is continuously shorted the output current reduces the internal temperature by flushing.

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Electrical Characteristics (Unless otherwise specified VS = 30 V, VEE = -15 V) - continued

○BA83474YFV-C

Parameter	Symbol	Temperature Range	Limits			Unit	Condition
			Min	Typ	Max		
Input Offset Voltage	V_{IO}	25 °C	-	1	10	mV	V_{OUT} = 0 V Absolute value
		-40 °C to +125 °C	-	-	10		
			-	-	10		V_S = 5 V, V_{EE} = 0 V V_{OUT} = V_S / 2 Absolute value
Input Offset Current	I_{IO}	25 °C	-	6	75	nA	V_{OUT} = 0 V Absolute value
		-40 °C to +125 °C	-	-	100		
Input Bias Current(Note 1)	I_B	25 °C	-	100	150	nA	V_{OUT} = 0 V
		-40 °C to +125 °C	-	-	200		
Supply Current	I_{CC}	25 °C	-	8.6	11.0	mA	R_L = ∞
		-40 °C to +125 °C	-	-	12		
Output Voltage High	V_{OH}	25 °C	3.7	4	-	V	V_S = 5 V, V_{EE} = 0 V R_L = 2 kΩ
		-40 °C to +125 °C	3.5	-	-		
		25 °C	13.7	14	-		R_L = 10 kΩ
		-40 °C to +125 °C	13.5	-	-		
		25 °C	13.5	-	-		R_L = 2 kΩ
Output Voltage Low	V_{OL}	25 °C	-	0.1	0.3	V	V_S = 5 V, V_{EE} = 0 V R_L = 2 kΩ
		-40 °C to +125 °C	-	-	0.6		
		25 °C	-	-14.7	-14.3		R_L = 10 kΩ
		-40 °C to +125 °C	-	-	-14.0		
		25 °C	-	-	-13.5		R_L = 2 kΩ
Large Signal Voltage Gain	A_V	25 °C	80	100	-	dB	R_L ≥ 2 kΩ, V_{OUT} = ±10 V
		-40 °C to +125 °C	70	-	-		
Common-mode Input Voltage Range	V_{ICMR}	25 °C	0	-	3.0	V	V_S = 5 V, V_{EE} = 0 V V_{OUT} = V_S / 2
		-40 °C to +125 °C	0	-	2.4		
Common-mode Rejection Ratio	CMRR	25 °C	70	97	-	dB	V_{OUT} = 0 V
Power Supply Rejection Ratio	PSRR	25 °C	70	97	-	dB	V_{OUT} = 0 V
Output Source Current(Note 2)	I_{SOURCE}	25 °C	10	30	-	mA	V_S = 5 V, V_{EE} = 0 V V_{+IN} = 1 V, V_{-IN} = 0 V V_{OUT} = 0 V, 1 CH is short circuit
		-40 °C to +125 °C	10	-	-		
Output Sink Current(Note 2)	I_{SINK}	25 °C	10	30	-	mA	V_S = 5 V, V_{EE} = 0 V V_{+IN} = 0 V, V_{-IN} = 1 V V_{OUT} = 5 V, 1 CH is short circuit
		-40 °C to +125 °C	10	-	-		
Gain Bandwidth Product	GBW	25 °C	-	3	-	MHz	-
Slew Rate	SR	25 °C	-	8.5	-	V/μs	V_{IN} = -10 V to +10 V G = 0 dB, R_L = 2 kΩ
		-40 °C to +125 °C	5	-	-		
Channel Separation	CS	25 °C	-	120	-	dB	-

(Note 1) Current direction: Since first input stage is composed with PNP transistor, input bias current flows out of IC.

(Note 2) Under high temperatures, please consider the power dissipation when selecting the output current. When the output pin is continuously shorted the output current reduces the internal temperature by flushing.

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Typical Performance Curves

V_{EE} = -15 V

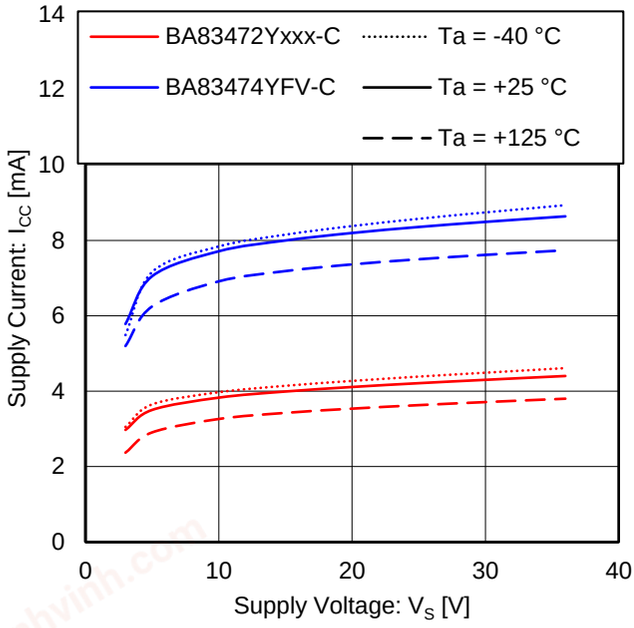


Figure 1. Supply Current vs Supply Voltage

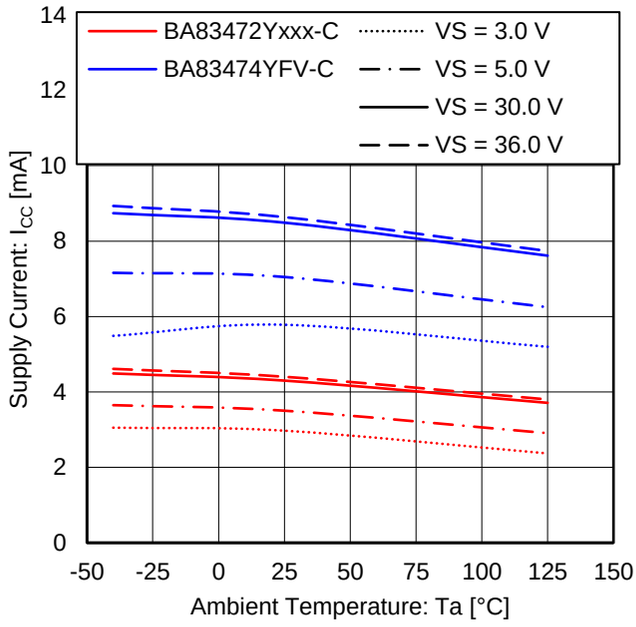


Figure 2. Supply Current vs Ambient Temperature

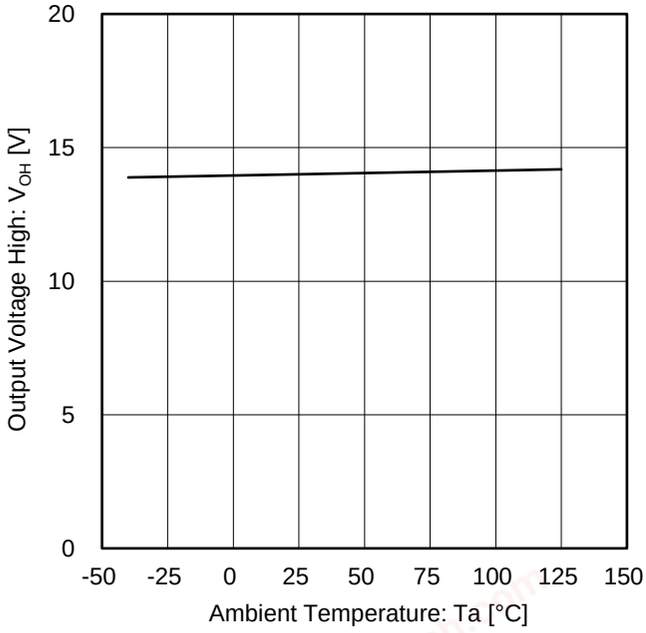


Figure 3. Output Voltage High vs Ambient Temperature
(V_S = 30 V, R_L = 10 kΩ)

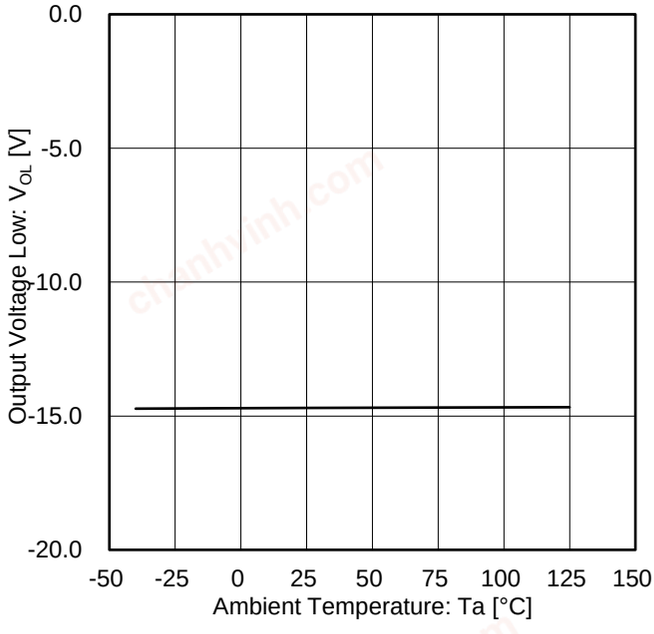


Figure 4. Output Voltage Low vs Ambient Temperature
(V_S = 30 V, R_L = 10 kΩ)

(Note) The above data are measurement value of typical sample; it is not guaranteed.

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Typical Performance Curves - continued

V_{EE} = -15 V

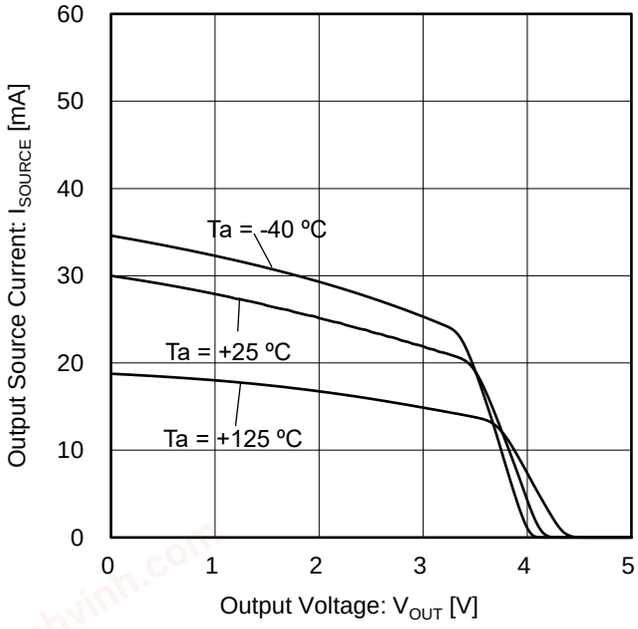


Figure 5. Output Source Current vs Output Voltage
(V_S = 5 V, V_{EE} = 0 V)

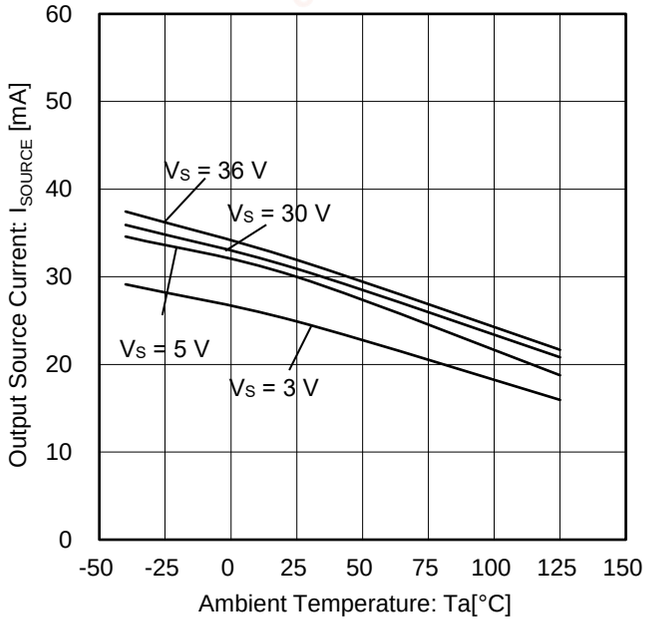


Figure 6. Output Source Current vs Ambient Temperature
(V_{OUT} = 0 V, V_{EE} = 0 V)

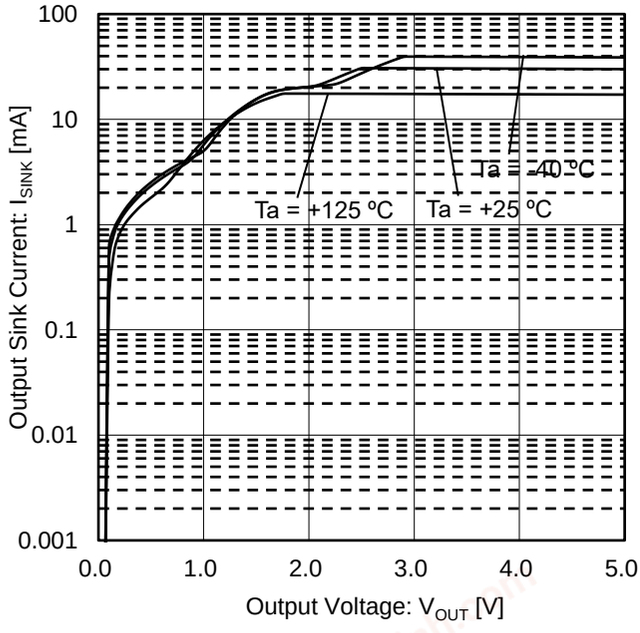


Figure 7. Output Sink Current vs Output Voltage
(V_S = 5 V, V_{EE} = 0 V)

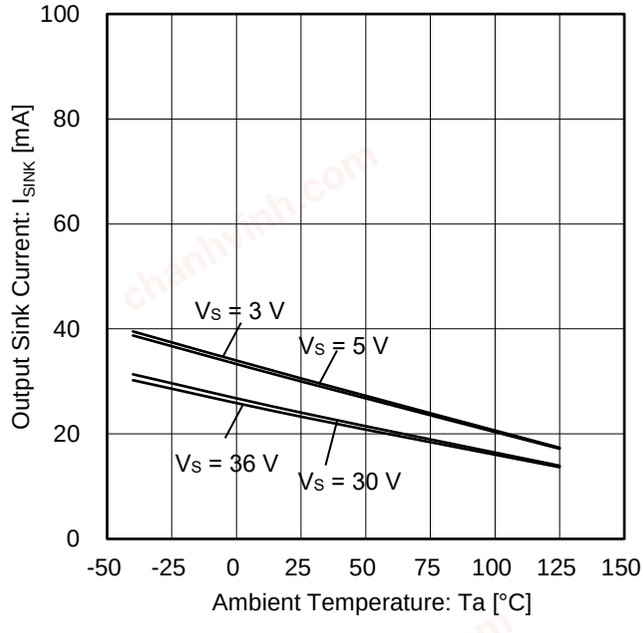


Figure 8. Output Sink Current vs Ambient Temperature
(V_{OUT} = V_S, V_{EE} = 0 V)

(Note) The above data are measurement value of typical sample; it is not guaranteed.

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Typical Performance Curves - continued

V_{EE} = -15 V

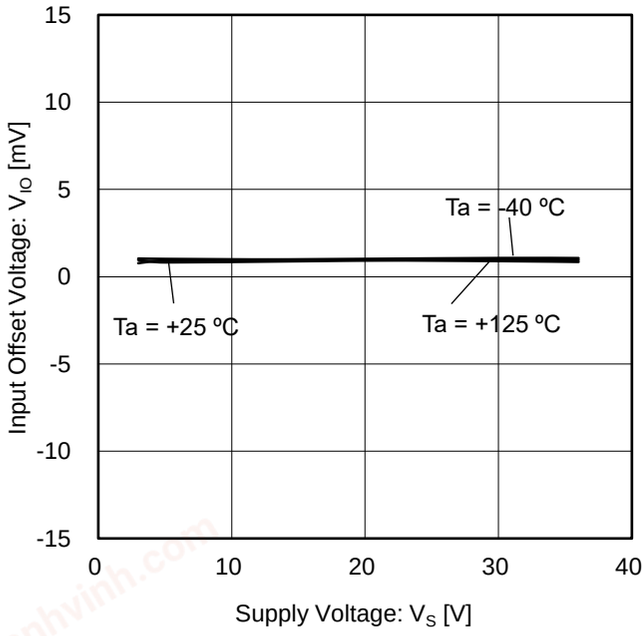


Figure 9. Input Offset Voltage vs Supply Voltage
(V_{ICM} = V_S / 2, V_{OUT} = V_S / 2)

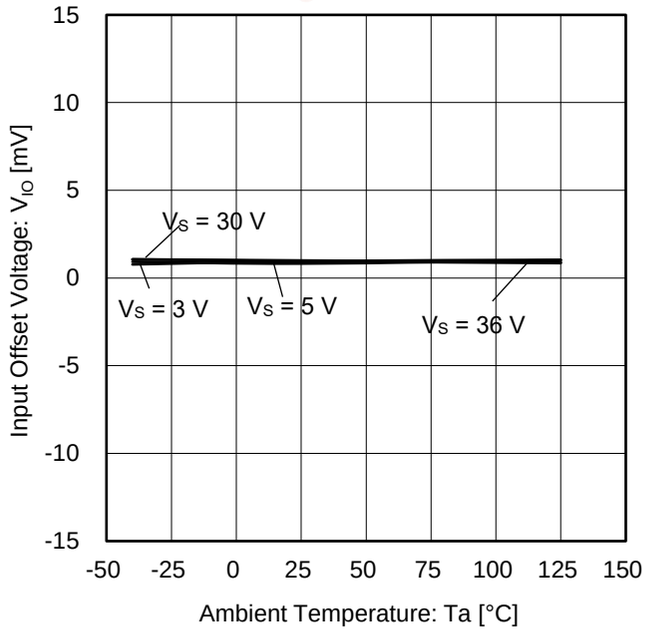


Figure 10. Input Offset Voltage vs Ambient Temperature
(V_{ICM} = V_S / 2, V_{OUT} = V_S / 2)

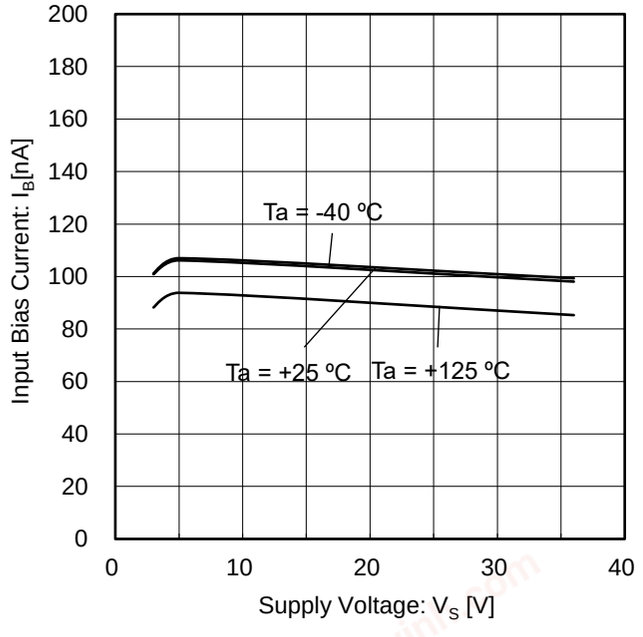


Figure 11. Input Bias Current vs Supply Voltage
(V_{ICM} = V_S / 2, V_{OUT} = V_S / 2)

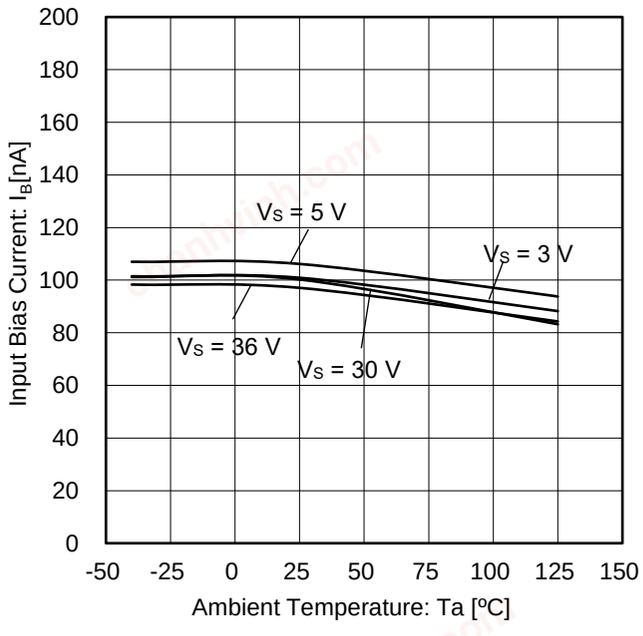


Figure 12. Input Bias Current vs Ambient Temperature
(V_{ICM} = V_S / 2, V_{OUT} = V_S / 2)

(Note) The above data are measurement value of typical sample; it is not guaranteed.

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Typical Performance Curves - continued

V_{EE} = -15 V

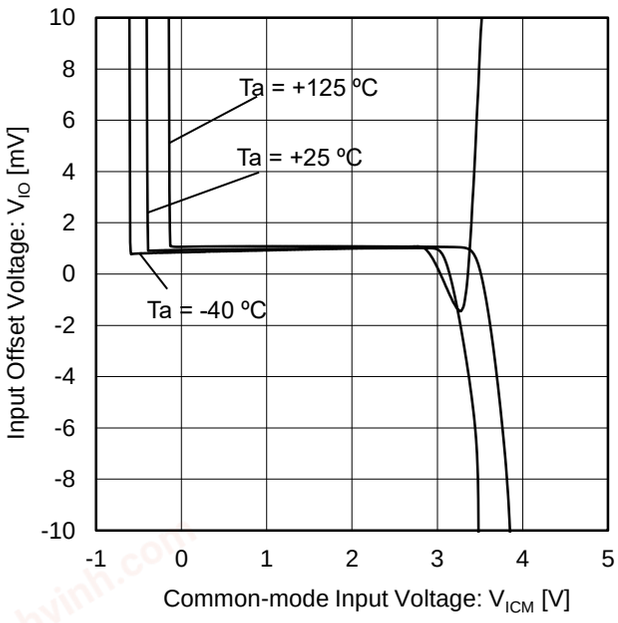


Figure 13. Input Offset Voltage vs Common-mode Input Voltage
(V_S = 5 V)

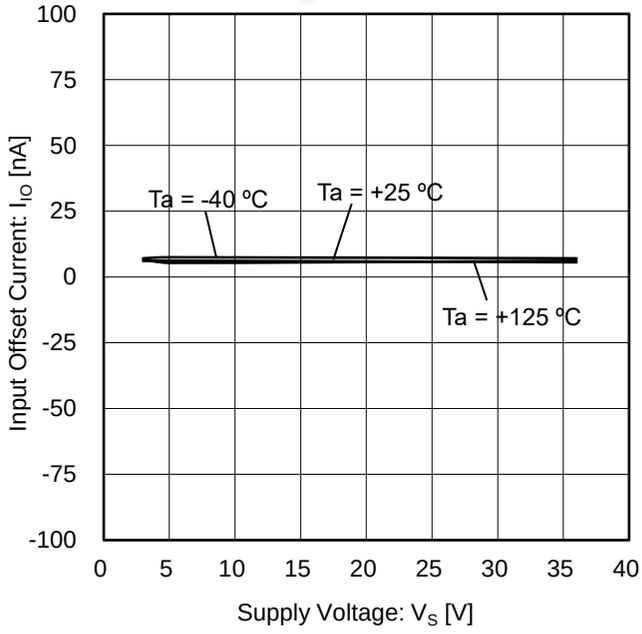


Figure 14. Input Offset Current vs Supply Voltage
(V_{ICM} = V_S / 2, V_{OUT} = V_S / 2)

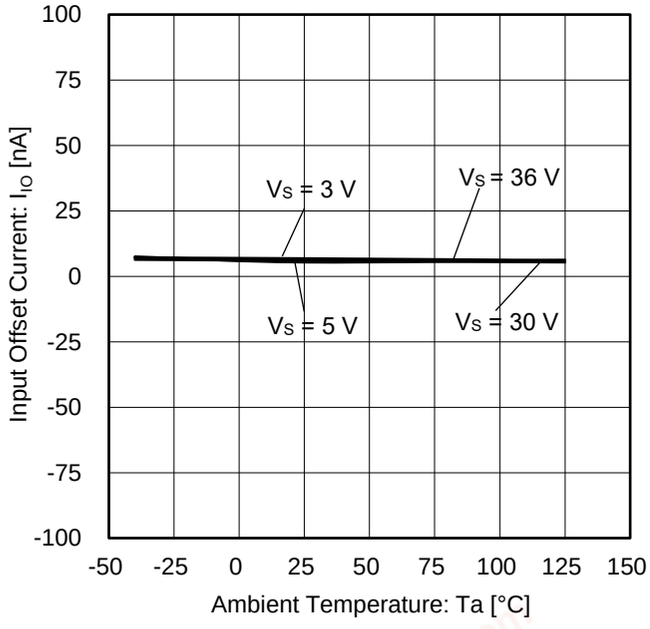


Figure 15. Input Offset Current vs Ambient Temperature
(V_{ICM} = V_S / 2, V_{OUT} = V_S / 2)

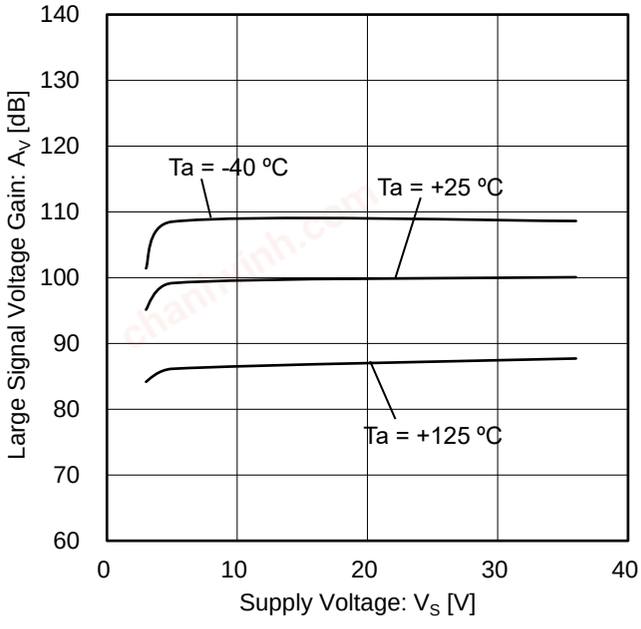


Figure 16. Large Signal Voltage Gain vs Supply Voltage
(R_L = 2 kΩ)

(Note) The above data are measurement value of typical sample; it is not guaranteed.

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Typical Performance Curves - continued

V_{EE} = -15 V

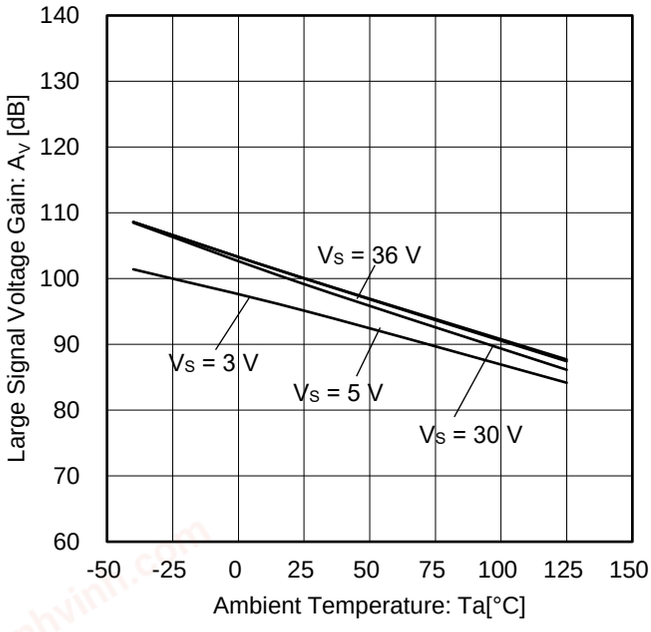


Figure 17. Large Signal Voltage Gain vs Ambient Temperature (R_L=2 kΩ)

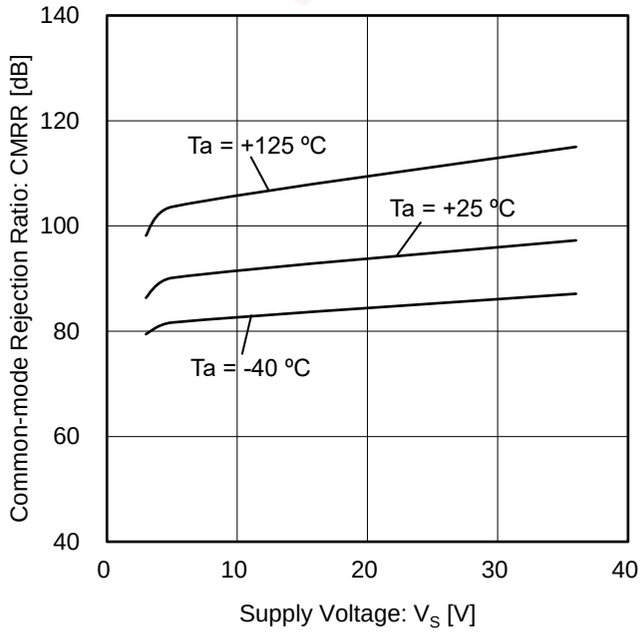


Figure 18. Common-mode Rejection Ratio vs Supply Voltage

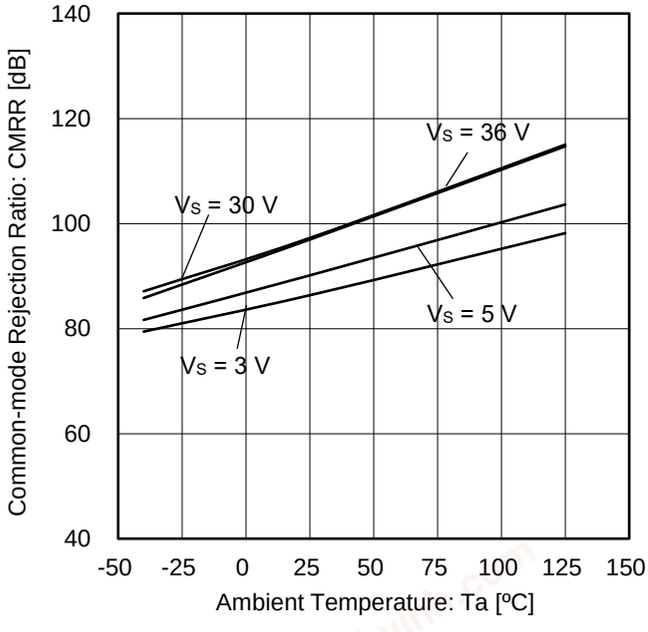


Figure 19. Common-mode Rejection Ratio vs Ambient Temperature

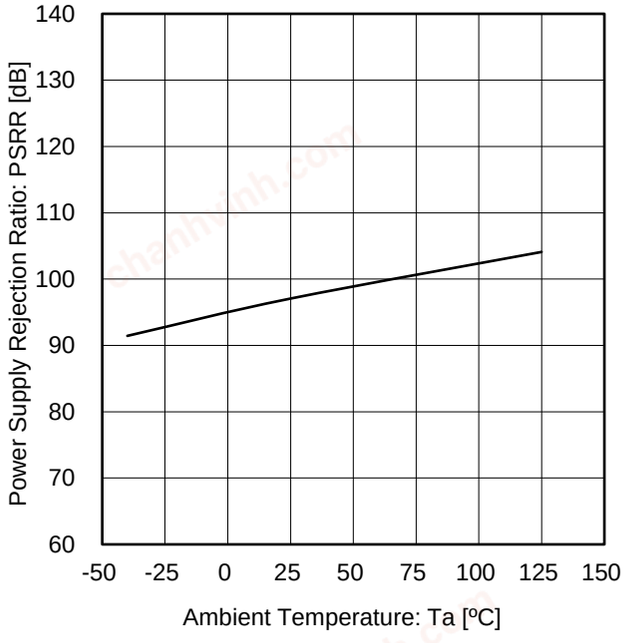


Figure 20. Power Supply Rejection Ratio vs Ambient Temperature

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Typical Performance Curves - continued

V_{EE} = -15 V

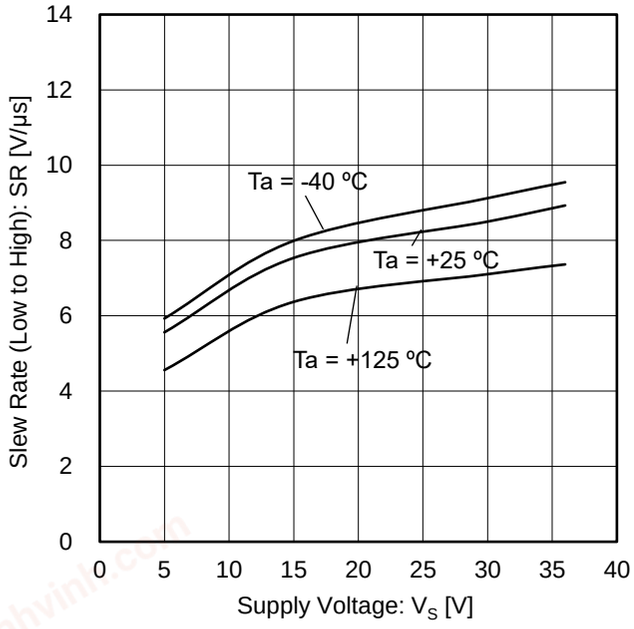


Figure 21. Slew Rate (Low to High) vs Supply Voltage
(R_L = 2 kΩ)

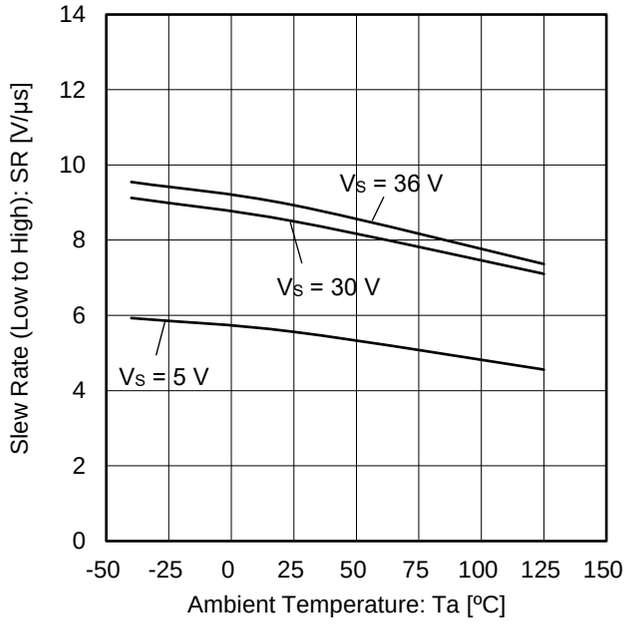


Figure 22. Slew Rate (Low to High) vs Ambient Temperature
(R_L = 2 kΩ)

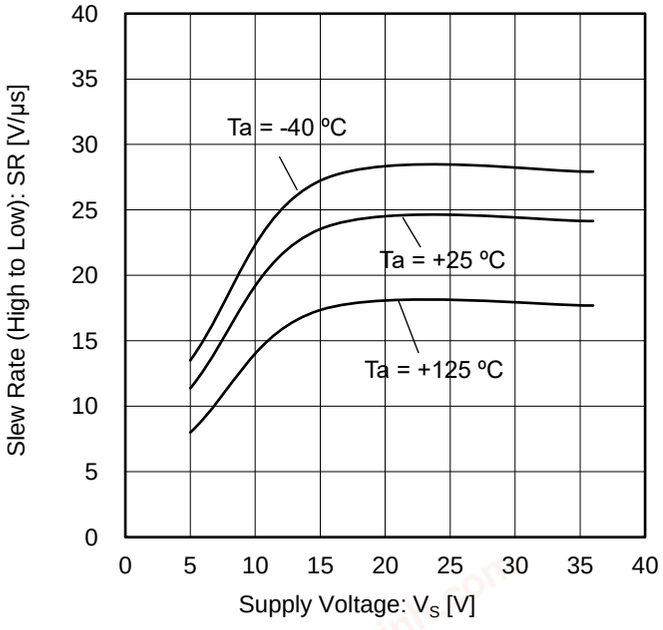


Figure 23. Slew Rate (High to Low) vs Supply Voltage
(R_L = 2 kΩ)

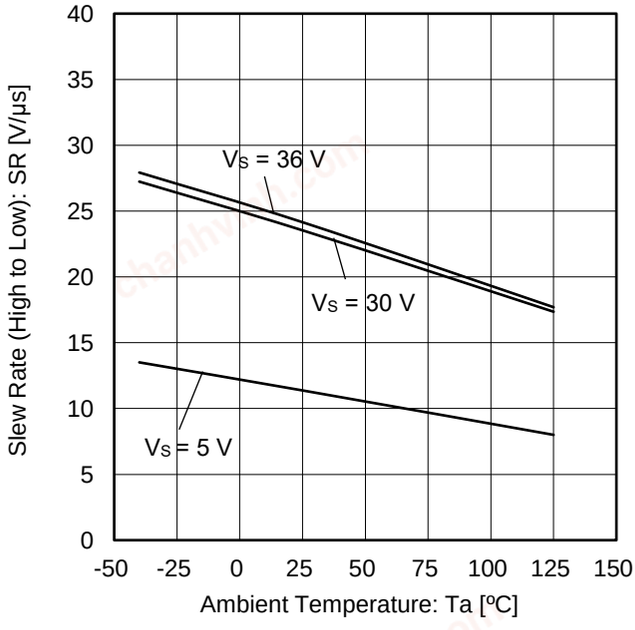


Figure 24. Slew Rate (High to Low) vs Ambient Temperature
(R_L = 2 kΩ)

(Note) The above data are measurement value of typical sample; it is not guaranteed.

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Typical Performance Curves - continued

V_{EE} = -15 V

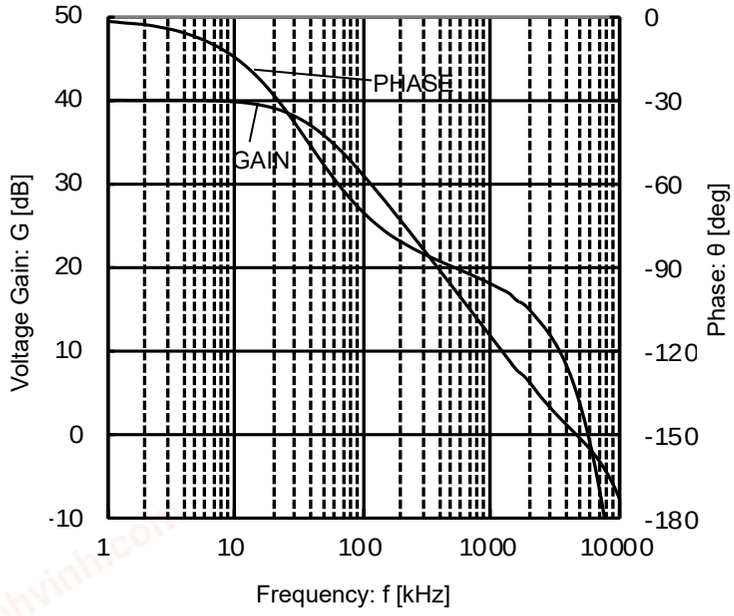


Figure 25.
Voltage Gain, Phase vs Frequency
(V_S = 30 V, A_V = 40 dB
R_L = 2 kΩ, C_L = 100 pF, Ta = 25 °C)

(Note) The above data are measurement value of typical sample; it is not guaranteed.

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Application Information

Test Circuit 1

V_{CC}, V_{EE}, V_{EK}, V_{ICM} Unit: V

Parameter	V_F	SW1	SW2	SW3	V_{CC}	V_{EE}	V_{EK}	V_{ICM}	Calculation
Input Offset Voltage	V_{F1}	ON	ON	OFF	+15	-15	0	0	1
Input Offset Current	V_{F2}	OFF	OFF	OFF	+15	-15	0	0	2
Input Bias Current	V_{F3}	OFF	ON	OFF	+15	-15	0	0	3
	V_{F4}	ON	OFF						
Large Signal Voltage Gain	V_{F5}	ON	ON	ON	+15	-15	+10	0	4
	V_{F6}				+15	-15	-10	0	
Common-mode Rejection Ratio (Common-mode Input Voltage Range)	V_{F7}	ON	ON	OFF	+15	-15	0	-15	5
	V_{F8}				+15	-15	0	+13	
Power Supply Rejection Ratio	V_{F9}	ON	ON	OFF	+2	-2	0	0	6
	V_{F10}				+18	-18	0	0	

—Calculation—

1. Input Offset Voltage (V_{IO})

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

2. Input Offset Current (I_{IO})

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

3. Input Bias Current (I_B)

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

4. Large Signal Voltage Gain (A_V)

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

5. Common-mode Rejection Ratio (CMRR)

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

6. Power Supply Rejection Ratio (PSRR)

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

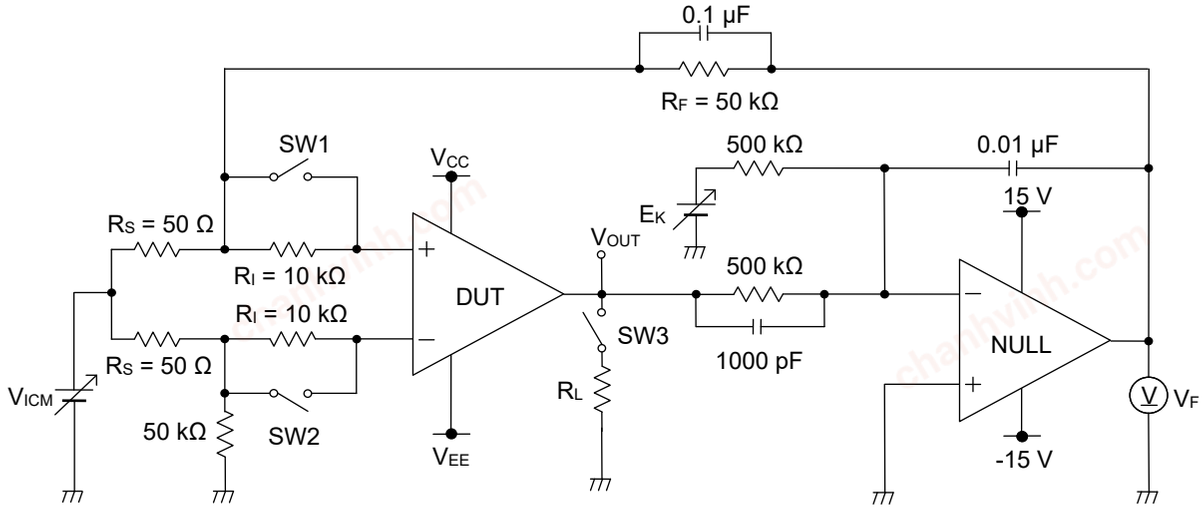


Figure 26. Test Circuit 1 (One Channel Only)

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Application Information - continued

Test Circuit 2

SW No.	SW1	SW2	SW3	SW4	SW5	SW6	SW7	SW8	SW9	SW10	SW11	SW12
Supply Current	OFF	OFF	OFF	ON	OFF	ON	OFF	OFF	OFF	OFF	OFF	OFF
Output Voltage High	OFF	OFF	ON	OFF	OFF	ON	OFF	ON	OFF	OFF	ON	OFF
Output Voltage Low	OFF	OFF	ON	OFF	OFF	ON	OFF	OFF	OFF	OFF	ON	OFF
Output Source Current	OFF	OFF	ON	OFF	OFF	ON	OFF	OFF	OFF	OFF	OFF	ON
Output Sink Current	OFF	OFF	ON	OFF	OFF	ON	OFF	OFF	OFF	OFF	OFF	ON
Slew Rate	OFF	OFF	OFF	ON	OFF	OFF	ON	ON	ON	ON	OFF	OFF
Gain Bandwidth Product	OFF	ON	OFF	OFF	ON	ON	OFF	ON	ON	ON	OFF	OFF

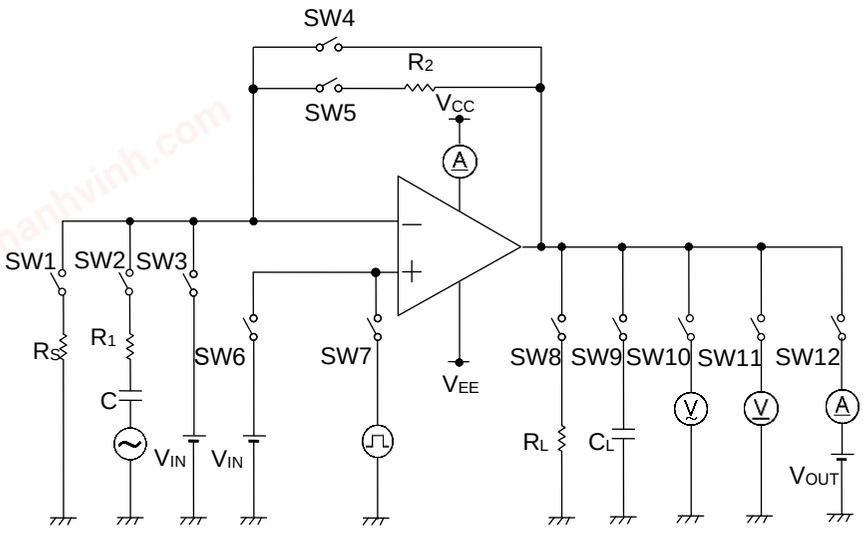


Figure 27. Test Circuit 2 (Each Op-Amp)

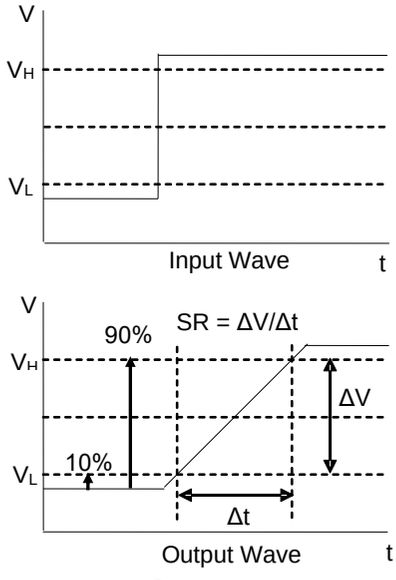
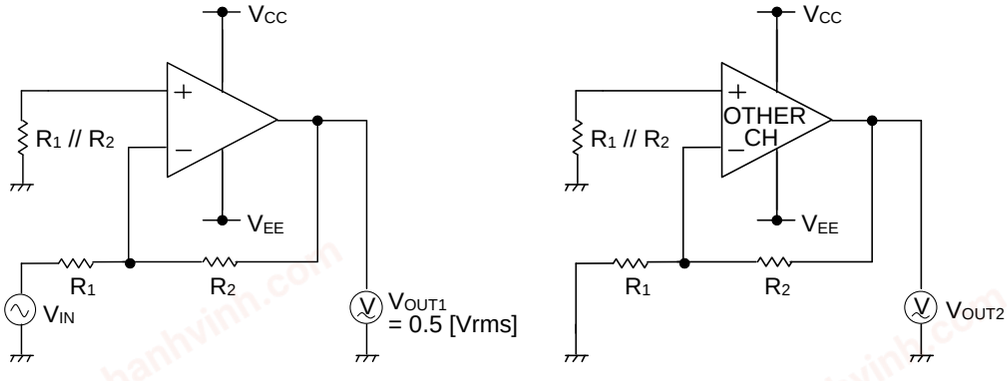


Figure 28. Slew Rate Input Output Wave



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

Figure 29. Test Circuit 3 (Channel Separation)

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Application Information - continued

EMI Immunity

BA8347xYxxx-C series have high tolerance from electromagnetic interference because they have integrated EMI filter, and the EMI design is simple. The data on ROHM board in the IC simple substance are as follows. They are most suitable for the replacement from conventional products. The test condition is based on ISO11452-2.

<Test Condition> Based on ISO11452-2
Test Circuit : Voltage Follower
V_{CC} : 12V
V_{+IN} : 6V
Test Method : Substituted Law
(Progressive Wave)
Field Intensity : 200V/m
Test Wave : CW (Continuous Wave)
Frequency : 200MHz – 1000MHz (2% step)

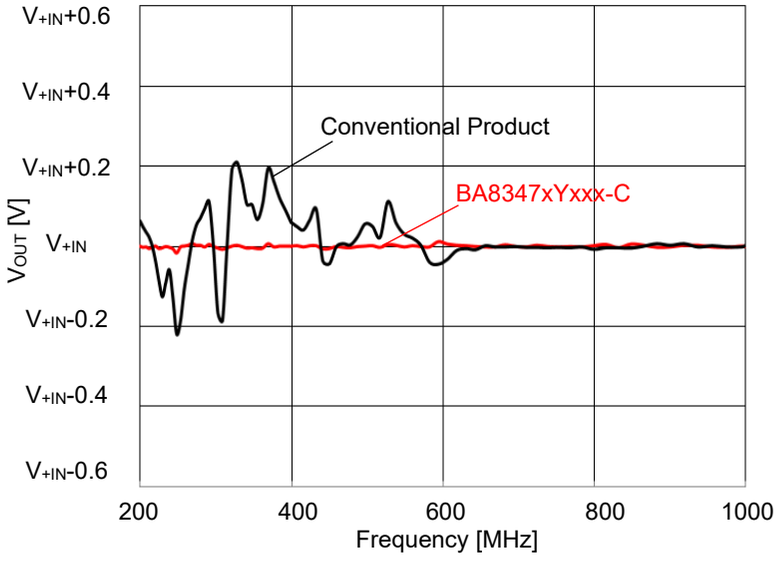
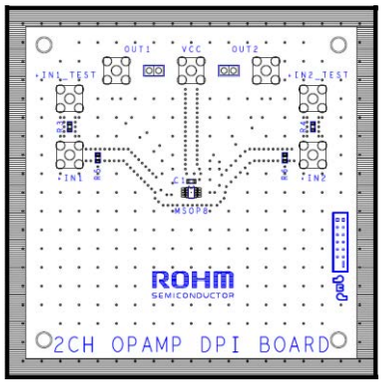
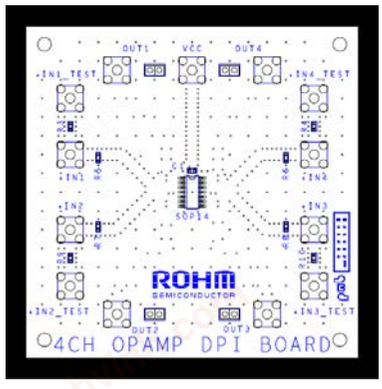


Figure 30. EMI Characteristics



EMI Evaluation Board (BA83472Yxxx-C)



EMI Evaluation Board (BA83474YFV-C)

Figure 31. EMI Evaluation Board

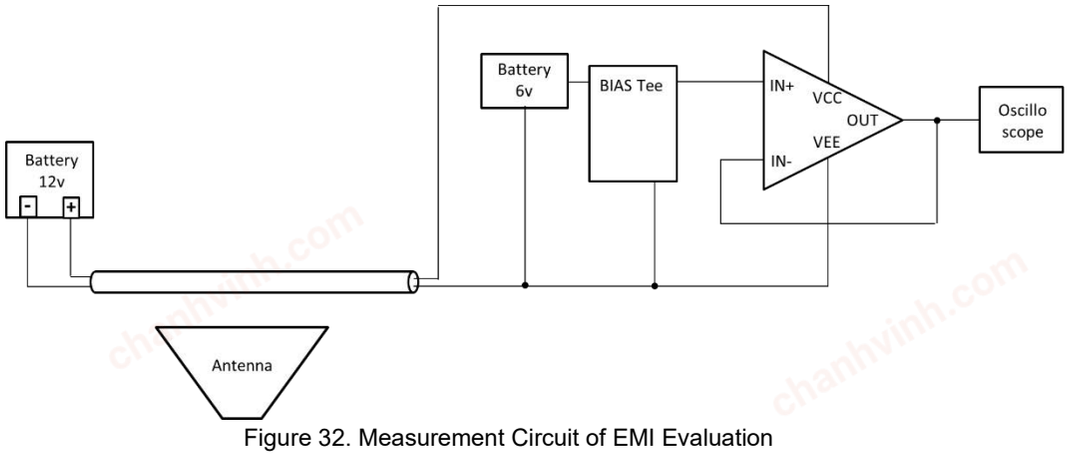


Figure 32. Measurement Circuit of EMI Evaluation

(Note) The above data is obtained using typical sample on ROHM board. These values are not guaranteed. Please confirm characteristics when used in actual application.

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Application Information – continued

1) Unused Circuits
When there are unused op-amps, it is recommended that they are connected as in Figure 33, setting the non-inverting input pin within the Common-mode Input Voltage Range (V_{ICMR}).

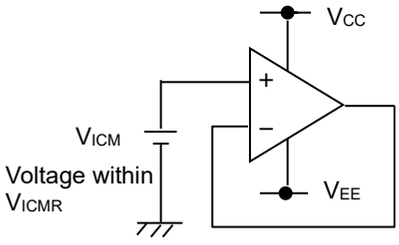


Figure 33. Example of application circuit for unused op-amp

2) Input Voltage
Applying V_{EE} + 36 V to the input pin is possible without causing deterioration of the electrical characteristics or destruction, regardless of the supply voltage. However, this does not ensure normal circuit operation. Please note that the circuit operates normally only when the input voltage is within the Common-mode Input Voltage range of the electric characteristics.

3) Power Supply (Single / Dual)
The op-amp operates when the voltage supplied is between V_{CC} and V_{EE}. Therefore, the single supply op-amp can be used as dual supply op-amp as well.

4) IC Handling
Applying mechanical stress to the IC by deflecting or bending the board may cause fluctuations of the electrical characteristics due to piezo resistance effects. Please pay attention to defecting or bending the board.

5) Output Capacitor
When the VCC pin is shorted to V_{EE} (GND) electric potential in a state where electric charge is accumulated in the external capacitor that is connected to the output pin, the accumulated electric charge will flow through parasitic elements or pin protection elements inside the circuit and discharges to the VCC pin and thus may cause damage to the internal circuit (by thermal destruction). When using this IC as a comparator, when not used in a negative feedback circuit, and when used in an application circuit where an output capacitive load does not cause oscillations, please set the value of the capacitor connected to the output pin to 0.1 µF or less to prevent IC damage caused by the accumulation of electric charge as mentioned above.

6) Oscillation by Output Capacitor
Please pay attention to the oscillation by capacitive load and in designing an application of constitutes a negative feedback loop circuit with these ICs.

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Application Examples

○Voltage Follower

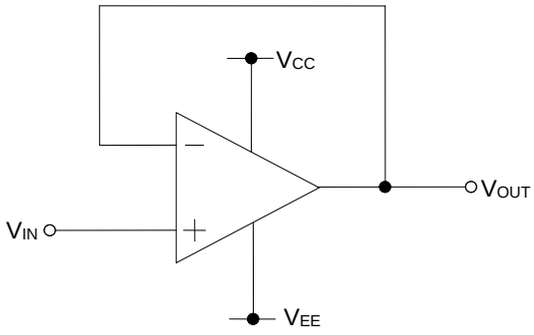


Figure 34. Voltage Follower Circuit

Using this circuit, the output voltage (V_{OUT}) is configured to be equal to the input voltage (V_{IN}). This circuit also stabilizes the output voltage due to high input impedance and low output impedance. Computation for output voltage is shown below.

$$V_{OUT} = V_{IN}$$

○Inverting Amplifier

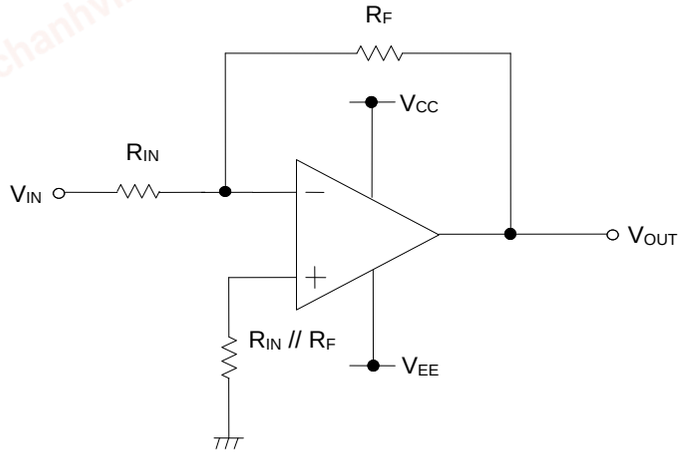


Figure 35. Inverting Amplifier Circuit

For inverting amplifier, input voltage (V_{IN}) is amplified by a voltage gain which depends on the ratio of R_{IN} and R_F, and then it outputs phase-inverted voltage (V_{OUT}). The output voltage is shown in the next expression.

$$V_{OUT} = -\frac{R_F}{R_{IN}} V_{IN}$$

This circuit has input impedance equal to R_{IN}.

○Non-inverting Amplifier

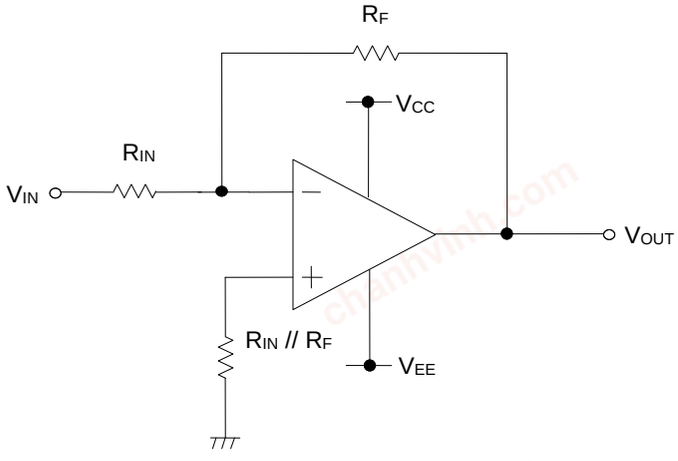


Figure 36. Non-inverting Amplifier Circuit

For non-inverting amplifier, input voltage (V_{IN}) is amplified by a voltage gain, which depends on the ratio of R_{IN} and R_F. The output voltage (V_{OUT}) is in-phase with the input voltage and is shown in the next expression.

$$V_{OUT} = \left(1 + \frac{R_F}{R_{IN}}\right) V_{IN}$$

Effectively, this circuit has high input impedance since its input side is the same as that of the operational amplifier.

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Operational Notes

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

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

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

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

5. **Recommended Operating Conditions**
The function and operation of the IC are guaranteed within the range specified by the recommended operating conditions. The characteristic values are guaranteed only under the conditions of each item specified by the electrical characteristics.

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

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

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

9. **Unused Input Pins**
Input pins of an IC are often connected to the gate of a MOS transistor. The gate has extremely high impedance and extremely low capacitance. If left unconnected, the electric field from the outside can easily charge it. The small charge acquired in this way is enough to produce a significant effect on the conduction through the transistor and cause unexpected operation of the IC. So unless otherwise specified, unused input pins should be connected to the power supply or ground line.

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Operational Notes – continued

10. Regarding the Input Pin of the IC

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

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

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

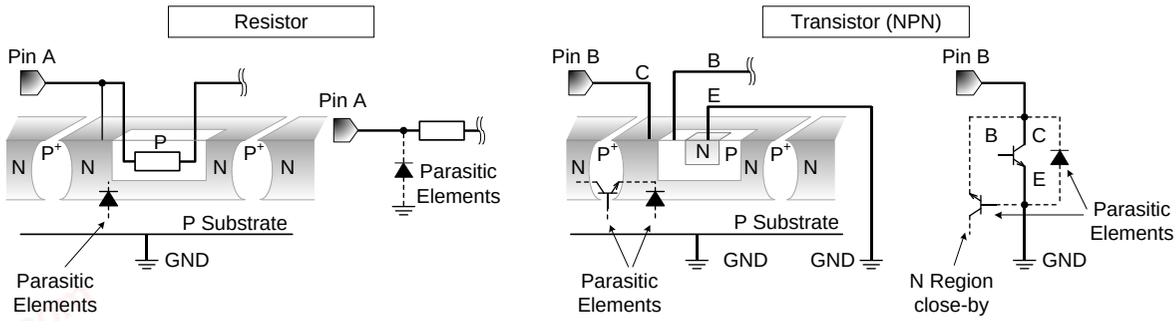


Figure 37. Example of Monolithic IC Structure

11. Ceramic Capacitor

When using a ceramic capacitor, determine a capacitance value considering the change of capacitance with temperature and the decrease in nominal capacitance due to DC bias and others.

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Ordering Information

B A 8 3 4 7 x Y x x x - C x x

Number of Channels
2: Dual
4: Quad

Package
F: SOP8
FVM: MSOP8
FV: SSOP-B14

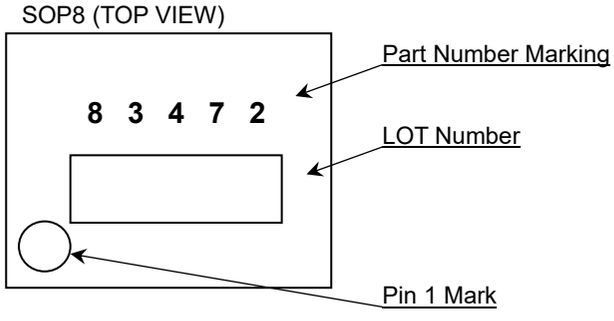
Product Rank
C: for Automotive
Packaging and forming specification
E2: Embossed tape and reel
TR: Embossed tape and reel

Lineup

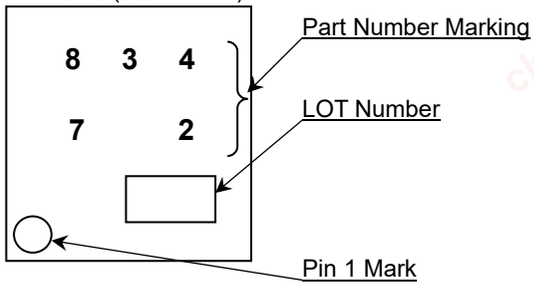
Temperature Range	Operating Supply Voltage Range	Number of Channels	Package		Orderable Part Number
-40 °C to +125 °C	3 V to 36 V	Dual	SOP8	Reel of 2500	BA83472YF-CE2
			MSOP8	Reel of 3000	BA83472YFVM-CTR
		Quad	SSOP-B14	Reel of 2500	BA83474YFV-CE2

Marking Diagram

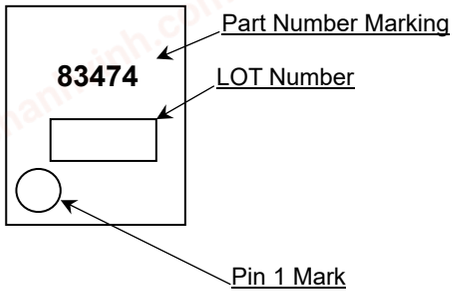
SOP8 (TOP VIEW)



MSOP8 (TOP VIEW)



SSOP-B14 (TOP VIEW)

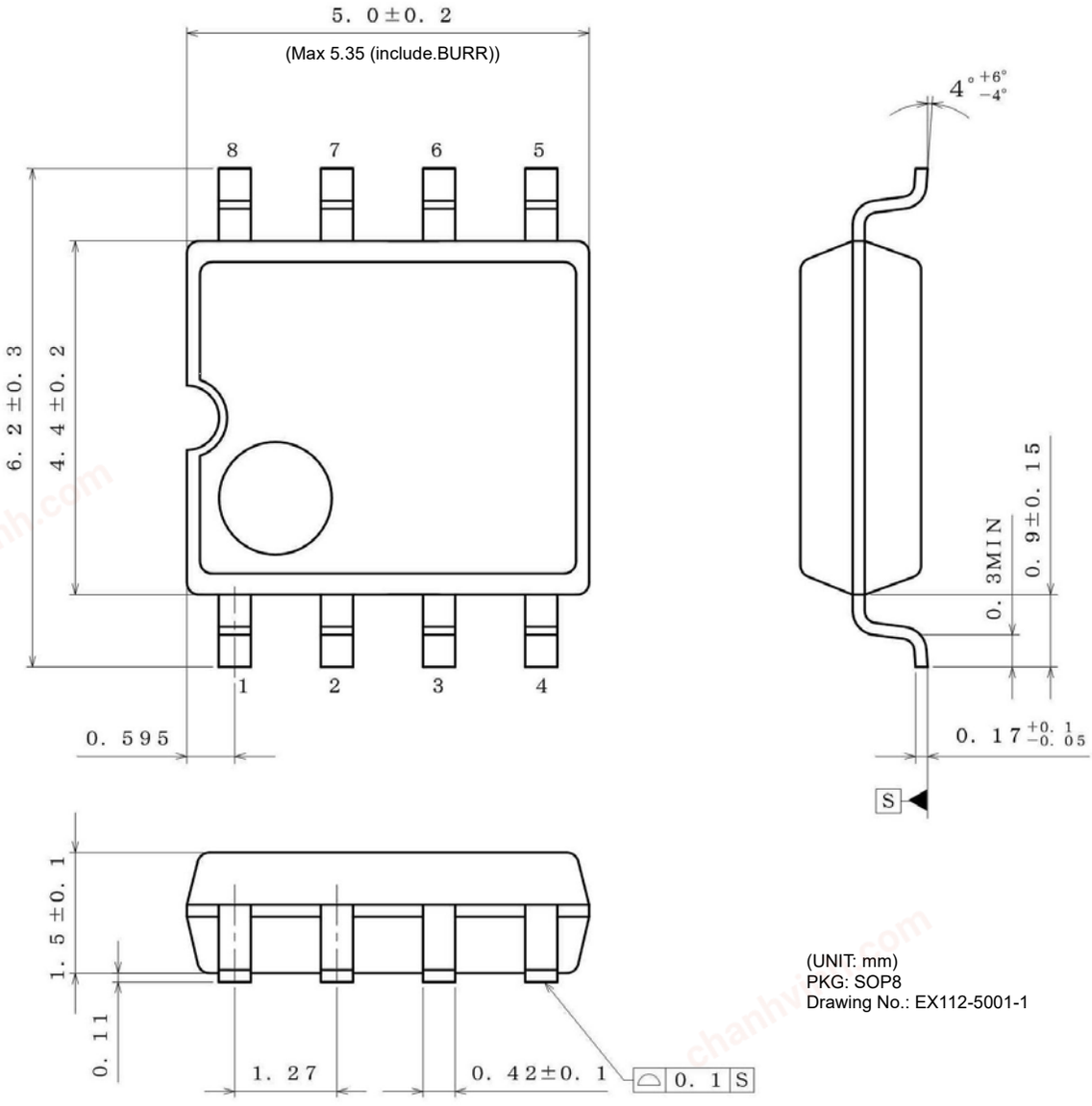


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Physical Dimension and Packing Information

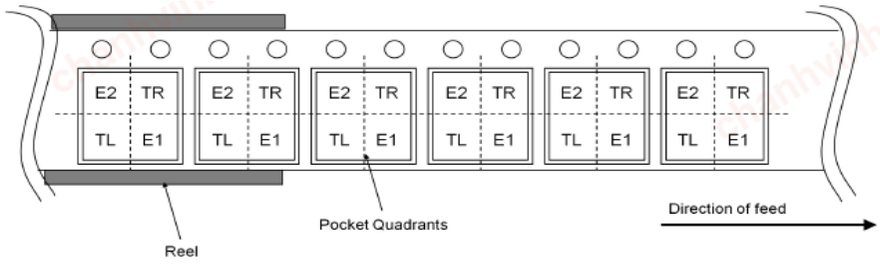
Package Name	SOP8



(UNIT: mm)
PKG: SOP8
Drawing No.: EX112-5001-1

< Tape and Reel Information >

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

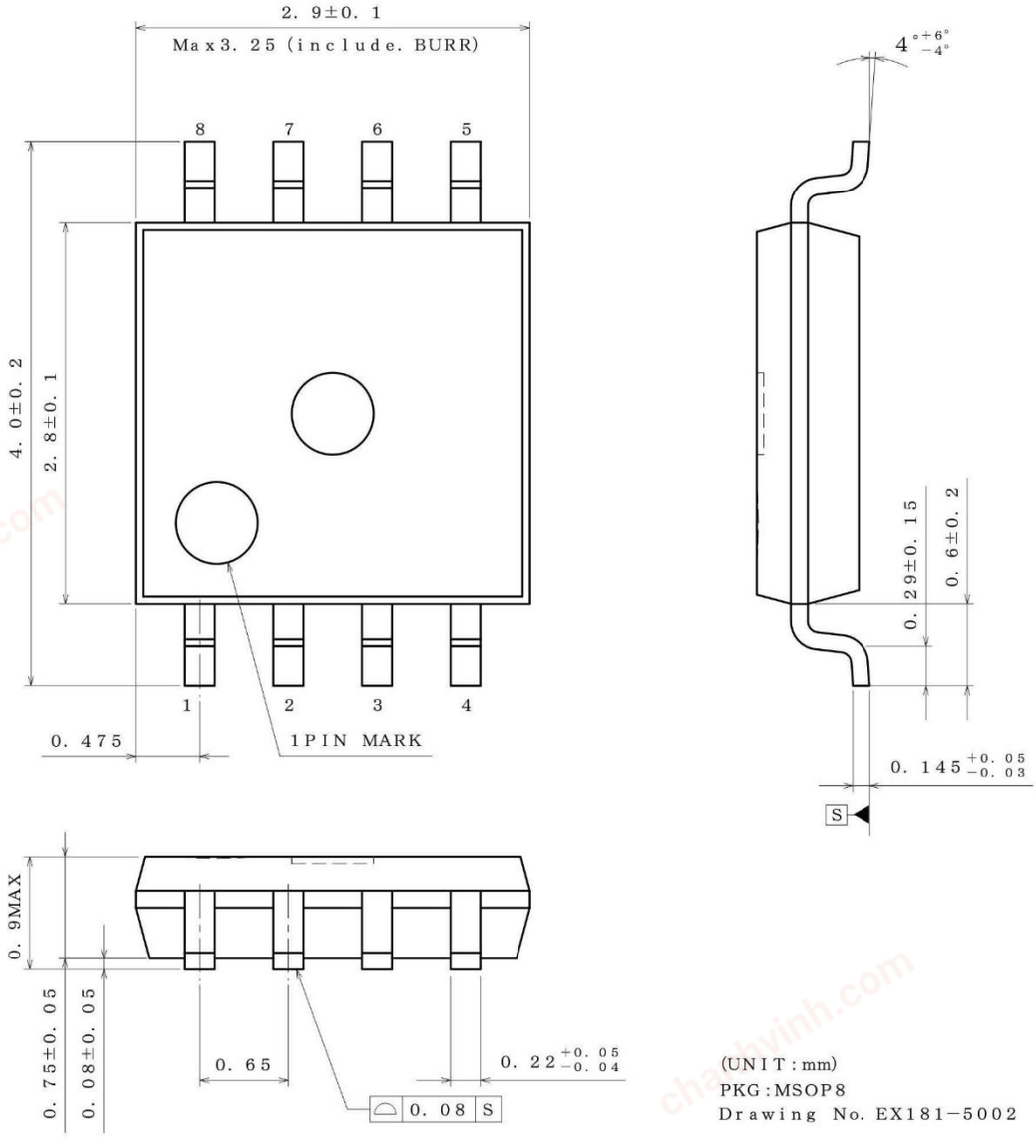


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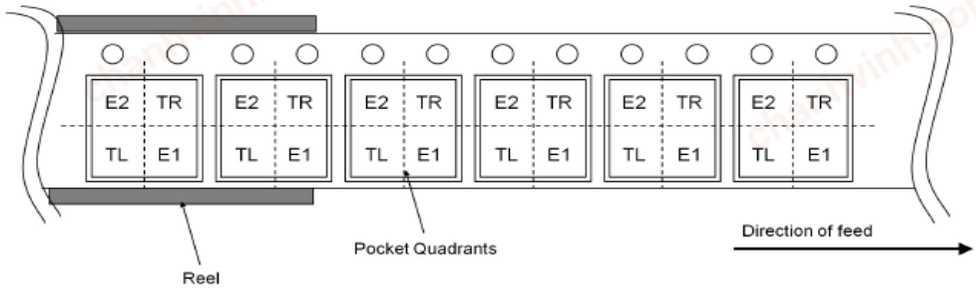
Physical Dimension and Packing Information – continued

Package Name	MSOP8



< 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)

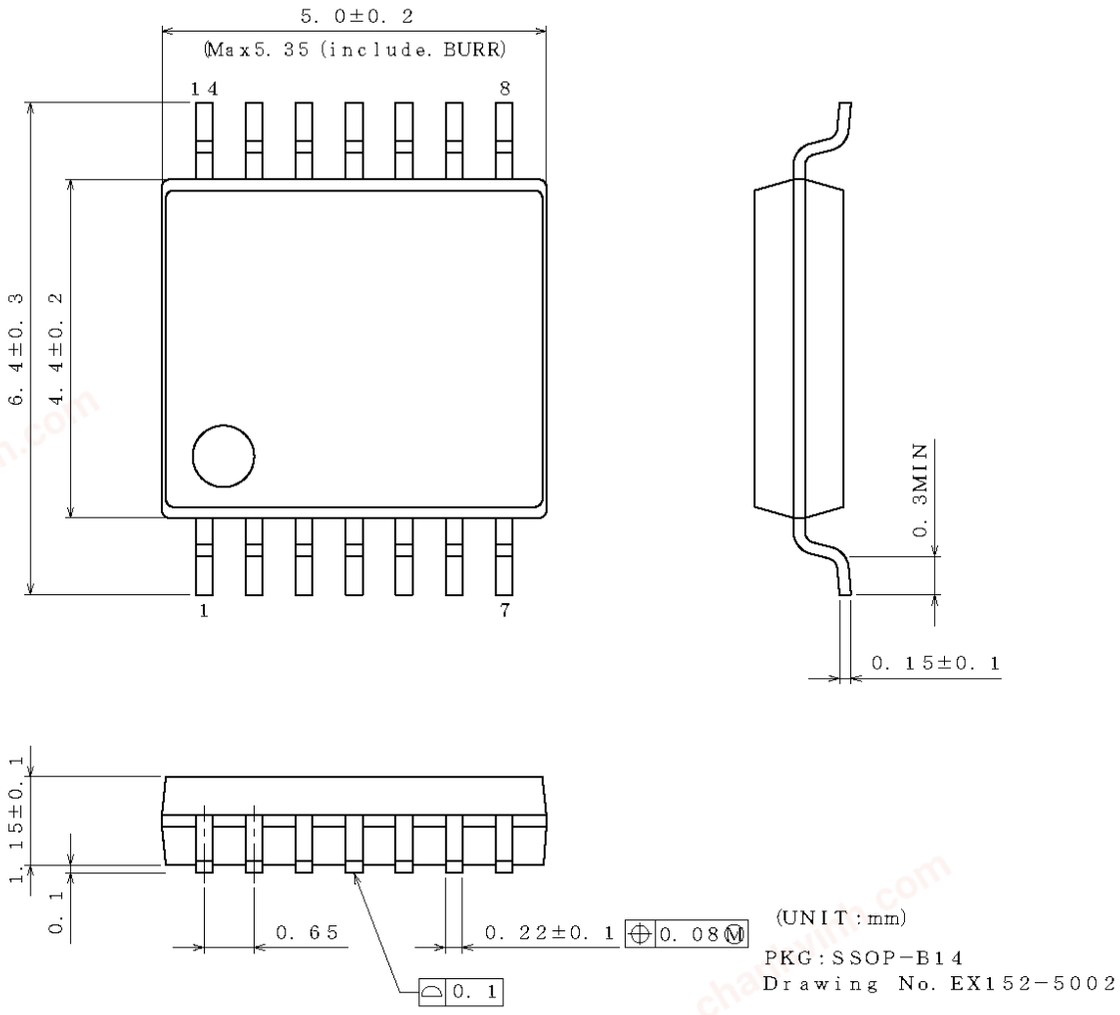


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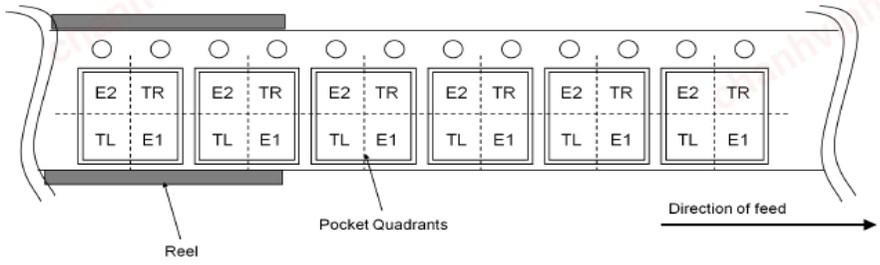
Physical Dimension and Packing Information – continued

Package Name	SSOP-B14



< Tape and Reel Information >

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



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Revision History

Date	Revision	Changes
14.Feb.2020	001	New Release
18.Sep.2020	002	Add Lineup (BA83472YFVM-C)
09.Nov.2020	003	Add Lineup (BA83474YFV-C)
01.Oct.2022	004	Modified title

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Notice

Precaution on using ROHM Products

1. If you intend to use our Products in devices requiring extremely high reliability (such as medical equipment (Note 1), aircraft/spacecraft, nuclear power controllers, 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

3. Our Products are not designed under any special or extraordinary environments or conditions, as exemplified below. Accordingly, ROHM shall not be in any way responsible or liable for any damages, expenses or losses arising from the use of any ROHM's Products under any special or extraordinary environments or conditions. If you intend to use our Products under any special or extraordinary environments or conditions (as exemplified below), your independent verification and confirmation of product performance, reliability, etc, prior to use, must be necessary:
   [a] Use of our Products in any types of liquid, including water, oils, chemicals, and organic solvents
   [b] Use of our Products outdoors or in places where the Products are exposed to direct sunlight or dust
   [c] Use of our Products in places where the Products are exposed to sea wind or corrosive gases, including Cl_2, H_2S, NH_3, SO_2, and NO_2
   [d] Use of our Products in places where the Products are exposed to static electricity or electromagnetic waves
   [e] Use of our Products in proximity to heat-producing components, plastic cords, or other flammable items
   [f] Sealing or coating our Products with resin or other coating materials
   [g] Use of our Products without cleaning residue of flux (Exclude cases where no-clean type fluxes is used. However, recommend sufficiently about the residue.); 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 depending on ambient temperature. When used in sealed area, confirm that it is the use in the range that does not exceed the maximum junction 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 on a surface-mount products, the flow soldering method must be used on a through hole mount products. If the flow soldering method is preferred on a surface-mount products, please consult with the ROHM representative in advance.

For details, please refer to ROHM Mounting specification

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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 Cl_2, H_2S, NH_3, SO_2, and NO_2
   - [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

A two-dimensional barcode printed on ROHM Products label is for ROHM's internal use only.

Precaution for Disposition

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

Precaution for Foreign Exchange and Foreign Trade act

Since concerned goods might be fallen under listed items of export control prescribed by Foreign exchange and Foreign trade act, please consult with ROHM in case of export.

Precaution Regarding Intellectual Property Rights

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