

# μPC451, μPC324

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## Single Power Supply Quad Operational Amplifiers

### DESCRIPTION

μPC451, μPC324 are quad operational amplifiers designed to operate on a single power supply. The features include low-voltage operation, a common-mode input voltage that range from  $V^-$  (GND) level, an output from a  $V^-$  (GND) level that is determined by the output stage of class C push-pull circuit and a 50 μA(TYP.) constant current, and a low current consumption.

In addition to that, these amplifiers can also operate in both positive and negative power supply and can be used extensively in various amplifier circuits.

The μPC451 is suited for wide operating ambient temperature use due to its temperature expansion type, while μPC324 is for general purposes usage.

A DC parameter selection that is compatible to operational amplifiers is also available.

μPC1251, μPC358 which are dual types with the same circuit configuration are also available under this series of operational amplifiers.

### FEATURES

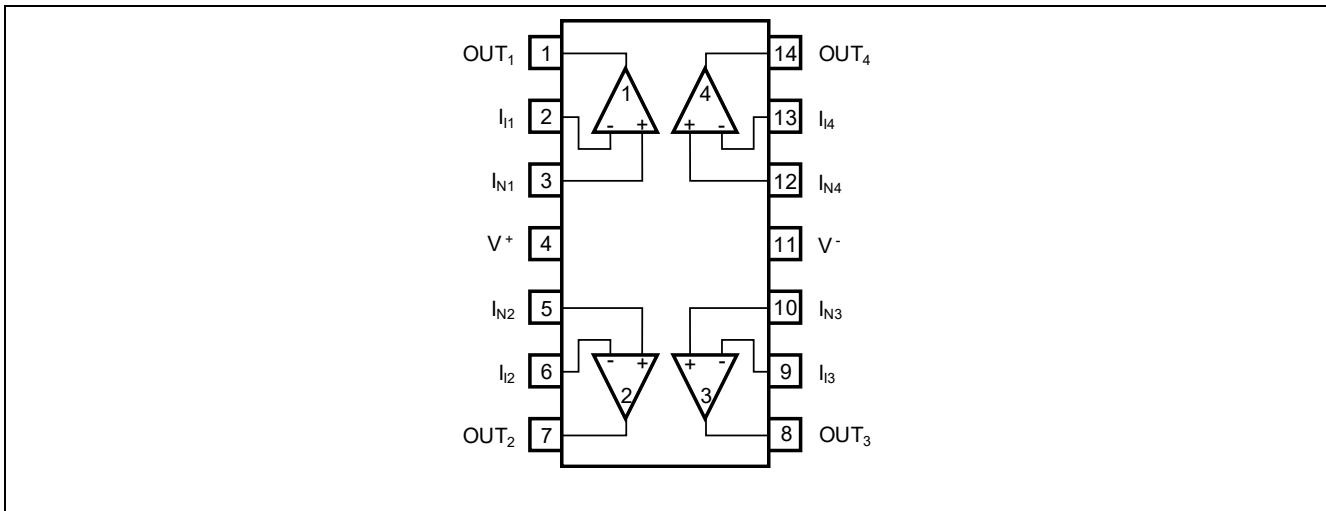
- Input Offset Voltage                    ±2 mV (TYP.)
- Input Offset Current                   ±5 nA (TYP.)
- Large Signal Voltage Gain   100000 (TYP.)
- Internal Frequency Compensation
- Output Short-Circuit Protection

### ORDERING INFORMATION

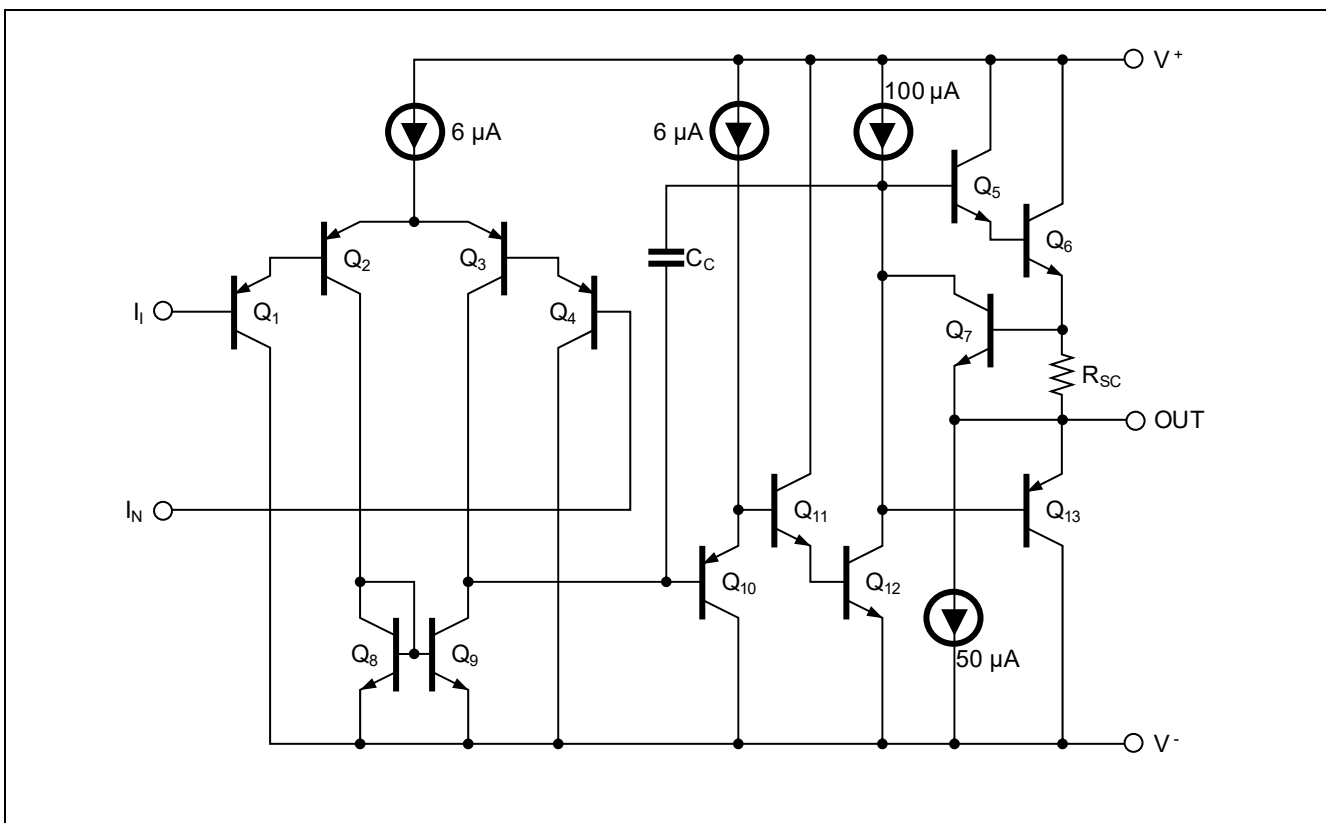
Ordering Name	Selection	Package
μPC451G2-A	General	14-pin plastic SOP ( 5.72 mm ( 225 ))
μPC451G2(5)-A	DC parameter selection	14-pin plastic SOP ( 5.72 mm ( 225 ))
μPC324G2-A	General	14-pin plastic SOP ( 5.72 mm ( 225 ))
μPC324G2(5)-A	DC parameter selection	14-pin plastic SOP ( 5.72 mm ( 225 ))
μPC451GR-9LG-A	General	14-pin plastic TSSOP ( 5.72 mm ( 225 ))
μPC451GR(5)-9LG-A	DC parameter selection	14-pin plastic TSSOP ( 5.72 mm ( 225 ))
μPC324GR-9LG-A	General	14-pin plastic TSSOP ( 5.72 mm ( 225 ))
μPC324GR(5)-9LG-A	DC parameter selection	14-pin plastic TSSOP ( 5.72 mm ( 225 ))

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**PIN CONFIGURATION (Marking side)**



**EQUIVALENT CIRCUIT (1/4 Circuit)**



## ABSOLUTE MAXIMUM RATINGS

(T<sub>A</sub> = 25 °C)

Parameter	Symbol	μPC451G2, μPC451G2(5)	μPC324G2, μPC324G2(5)	μPC451GR, μPC451GR(5)	μPC358GR, μPC358GR(5)	Unit
Voltage between V+ and V- <small>Note1</small>	V <sup>+</sup> - V <sup>-</sup>	-0.3 ~ +32				V
Differential Input Voltage	V <sub>ID</sub>	±32				V
Input Voltage <small>Note2</small>	V <sub>I</sub>	V <sup>-</sup> -0.3 ~ V <sup>-</sup> +32				V
Output applied Voltage <small>Note3</small>	V <sub>o</sub>	V <sup>-</sup> -0.3 ~ V <sup>+</sup> +0.3				V
Total Power Dissipation <small>Note4</small>	P <sub>T</sub>	550				mW
Output Short Circuit Duration <small>Note5</small>	t <sub>s</sub>	Indefinite				s
Operating Ambient Temperature	T <sub>A</sub>	-40 ~ +85	-20 ~ +80	-40 ~ +125	-40 ~ +85	°C
Storage Temperature	T <sub>stg</sub>	-55 ~ +125		-55 ~ +150	-55 ~ +125	°C

- 【Note】**
- Note that reverse connections of the power supply may damage the ICs.
  - The input voltage is allowed to input without damage or destruction independent of the magnitude of V<sup>+</sup>. Either input signal is not allowed to go negative by more than 0.3 V. In addition, the input voltage that operates normally as an operational amplifier is within the Common Mode Input Voltage range of an electrical characteristic.
  - A range where input voltage can be applied to an output pin externally with no deterioration or damage to the feature (characteristic). The input voltage can be applied regardless of the electric supply voltage. This specification which includes the transition state such as electric power ON/OFF must be kept.
  - This is the value when the glass epoxy substrate (size: 100 mm x 100 mm, thickness: 1 mm, 15% of the substrate area where only one side is copper foiled is filling wired) is mounted.  
Note that restrictions will be made to the following conditions for each product, and the derating ratio depending on the operating ambient temperature.

μPC451G2, 324G2: Derate at -5.5 mW/°C when T<sub>A</sub> > 25 °C

μPC451GR-9LG : Derate at -7.0 mW/°C when T<sub>A</sub> > 71 °C

(Junction - ambient thermal resistance R<sub>th(J-A)</sub> = 144°C/W)

μPC324GR-9LG : Derate at -7.0 mW/°C when T<sub>A</sub> > 46 °C

(Junction - ambient thermal resistance R<sub>th(J-A)</sub> = 144°C/W)

- Short circuits from the output to V<sup>+</sup> can cause destruction. (V<sup>+</sup> ≤ +15V, for any one channel only) Pay careful attention to the total power dissipation by not exceeding the absolute maximum ratings, **Note 4**.

## RECOMMENDED OPERATING CONDITIONS

Parameter	Symbol	MIN.	TYP.	MAX.	Unit
Power Supply Voltage (Split)	V <sup>±</sup>	±1.5		±15	V
Power Supply Voltage (V <sup>-</sup> = GND)	V <sup>+</sup>	+3		+30	V

## ELECTRICAL CHARACTERISTICS

μPC451, μPC324 (T<sub>A</sub> = 25 °C, V<sup>+</sup> = +5 V, V<sup>-</sup> = GND)

Parameter	Symbol	MIN	TYP.	MAX.	Unit	Test Condition
Input Offset Voltage	V <sub>IO</sub>		±2	±7	mV	R <sub>S</sub> = 0 Ω
Input Offset Current	I <sub>IO</sub>		±5	±50	nA	
Input Bias Current note 6	I <sub>B</sub>		15	250	nA	
Large Signal Voltage Gain	A <sub>V</sub>	25000	100000			R <sub>L</sub> ≥ 2 kΩ
Circuit Current note 7	I <sub>CC</sub>		1.2	2.0	mA	R <sub>L</sub> = ∞, I <sub>O</sub> = 0 A
Common Mode Rejection Ratio	CMR	65	85		dB	
Supply Voltage Rejection Ratio	SVR	65	100		dB	
Output Voltage Swing	V <sub>O</sub>	0		V <sup>+</sup> -1.5	V	R <sub>L</sub> = 2 kΩ (Connected to GND)
Common Mode Input Voltage Range	V <sub>ICM</sub>	0		V <sup>+</sup> -1.5	V	
Output Source Current	I <sub>O SOURCE</sub>	20	40		mA	V <sub>IN (+)</sub> = +1 V, V <sub>IN (-)</sub> = 0 V
Output Sink Current	I <sub>O SINK1</sub>	10	20		mA	V <sub>IN (-)</sub> = +1 V, V <sub>IN (+)</sub> = 0 V
	I <sub>O SINK2</sub>	12	50		μA	V <sub>IN (-)</sub> = +1 V, V <sub>IN (+)</sub> = 0 V, V <sub>O</sub> = 200 mV
Channel Separation			120		dB	f = 1 ~ 20 kHz

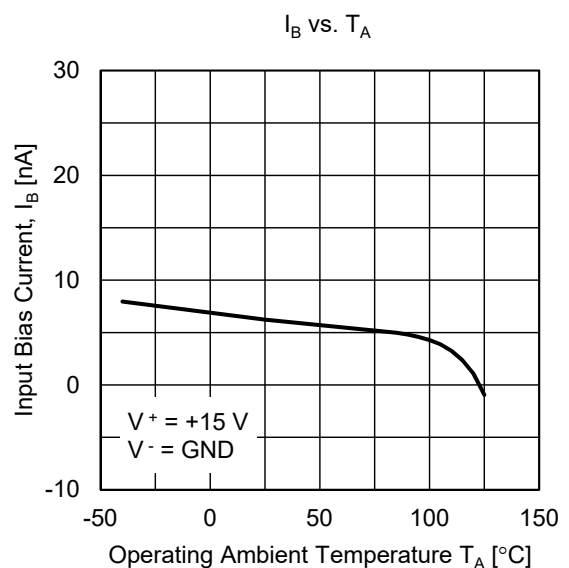
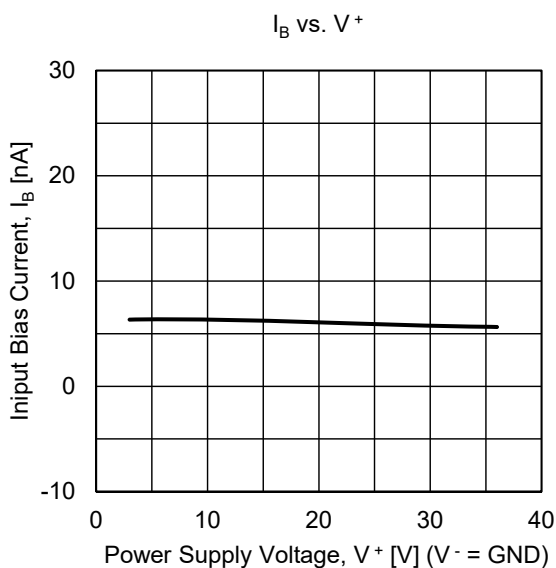
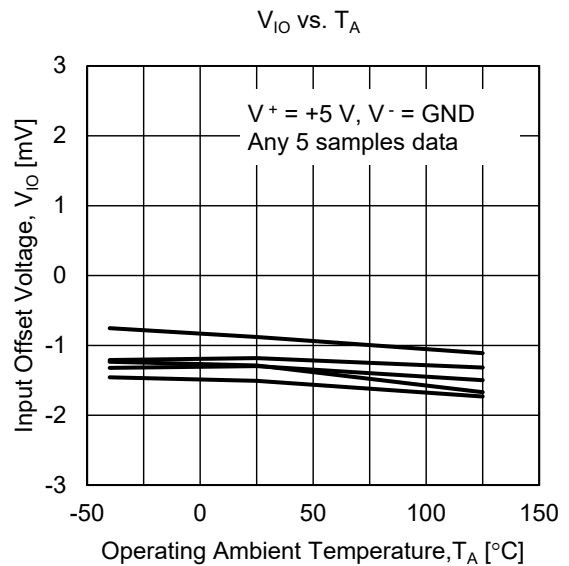
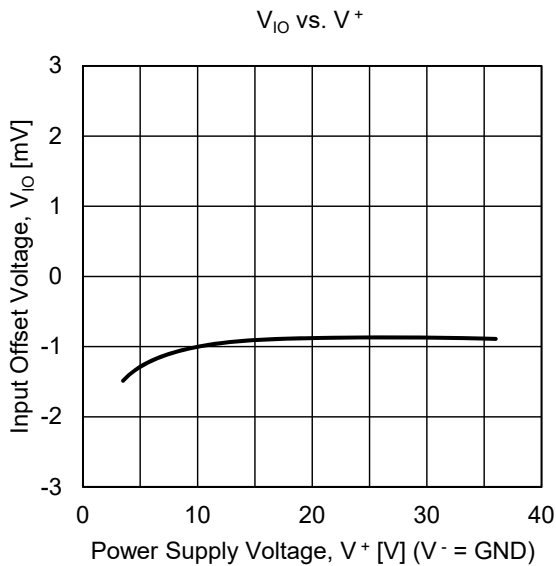
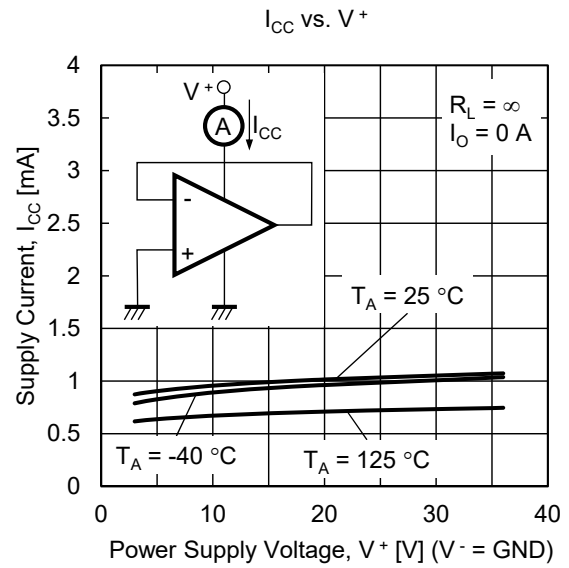
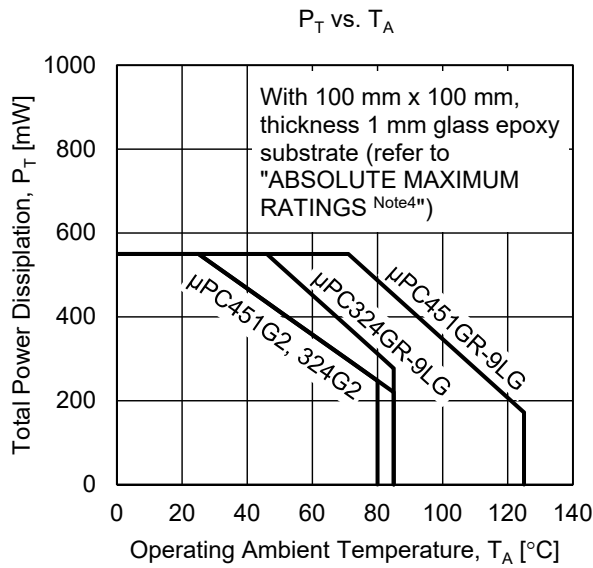
μPC451(5), μPC324(5) (T<sub>A</sub> = 25 °C, V<sup>+</sup> = +5 V, V<sup>-</sup> = GND)

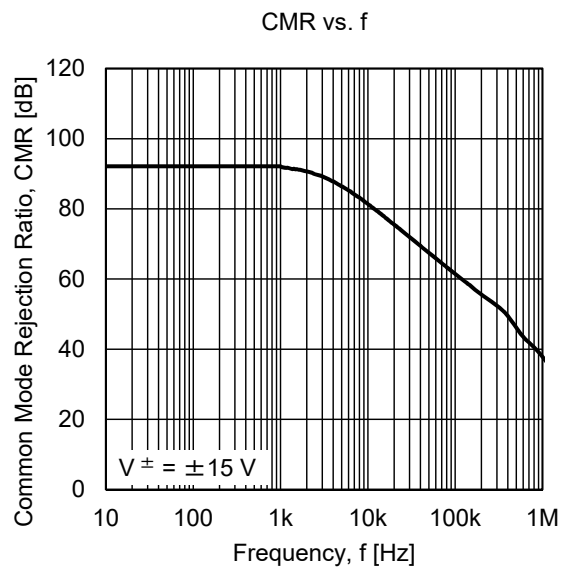
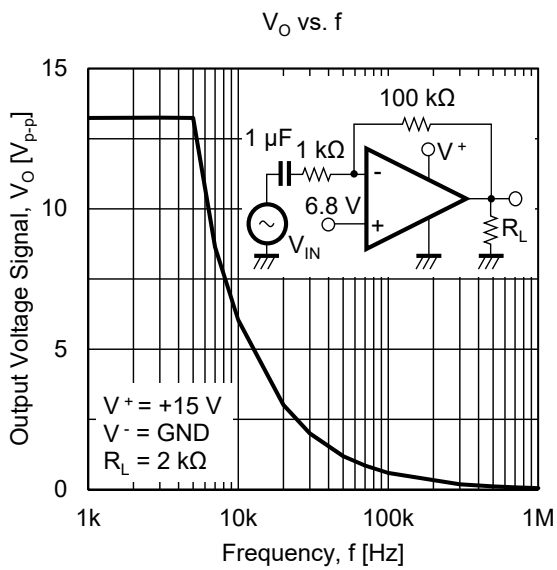
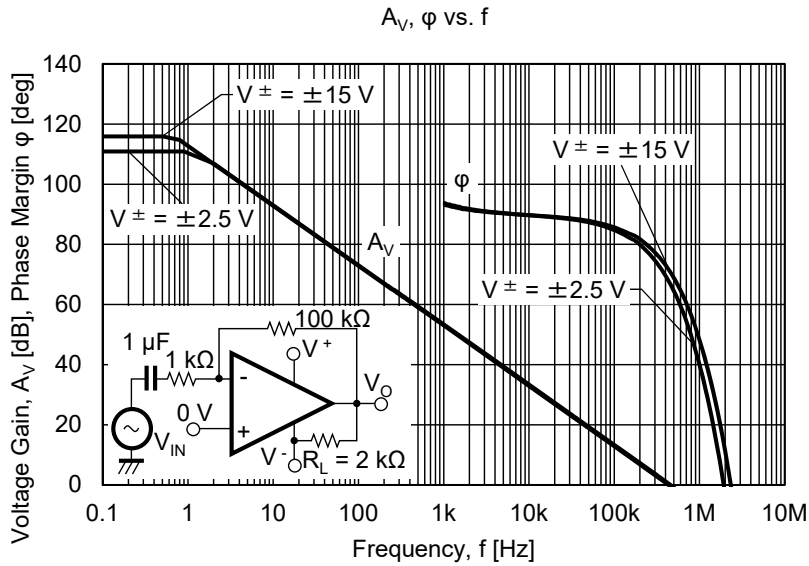
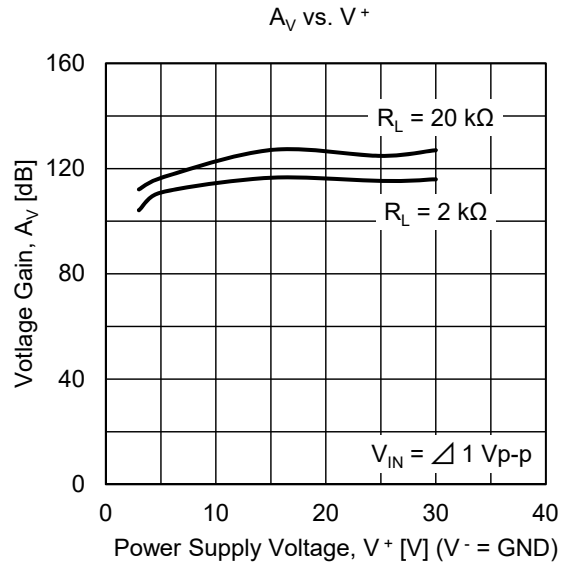
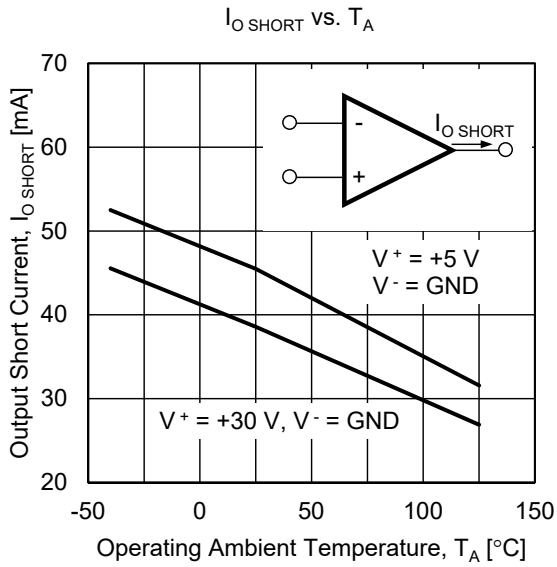
Parameter	Symbol	MIN.	TYP.	MAX.	Unit	Test Condition
Input Offset Voltage	V <sub>IO</sub>		±2	±3	mV	R <sub>S</sub> = 0 Ω
Input Offset Current	I <sub>IO</sub>		±5	±50	nA	
Input Bias Current Note 6	I <sub>B</sub>		15	60	nA	
Large Signal Voltage Gain	A <sub>V</sub>	50000	100000			R <sub>L</sub> ≥ 2 kΩ
Circuit Current Note7	I <sub>CC</sub>		1.2	1.5	mA	R <sub>L</sub> = ∞, I <sub>O</sub> = 0 A
Common Mode Rejection Ratio	CMR	65	85		dB	
Supply Voltage Rejection Ratio	SVR	65	100		dB	
Output Voltage Swing	V <sub>O</sub>	0		V <sup>+</sup> -1.5	V	R <sub>L</sub> = 2 kΩ (Connected to GND)
Common Mode Input Voltage Range	V <sub>ICM</sub>	0		V <sup>+</sup> -1.4	V	
Output Source Current	I <sub>O SOURCE</sub>	30	40		mA	V <sub>IN (+)</sub> = +1 V, V <sub>IN (-)</sub> = 0 V
Output Sink Current	I <sub>O SINK1</sub>	15	20		mA	V <sub>IN (-)</sub> = +1 V, V <sub>IN (+)</sub> = 0 V
	I <sub>O SINK2</sub>	30	50	70	μA	V <sub>IN (-)</sub> = +1 V, V <sub>IN (+)</sub> = 0 V, V <sub>O</sub> = 200 mV
Channel Separation			120		dB	f = 1 ~ 20 kHz

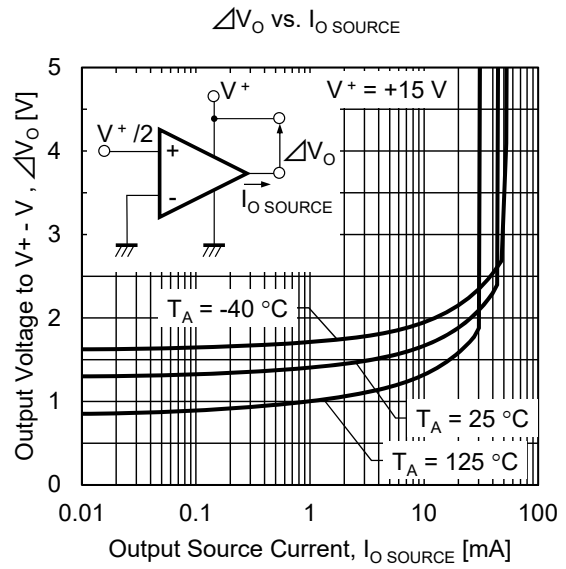
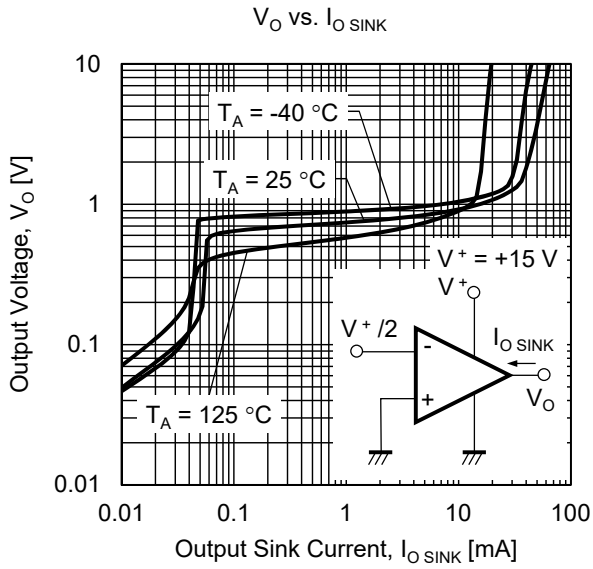
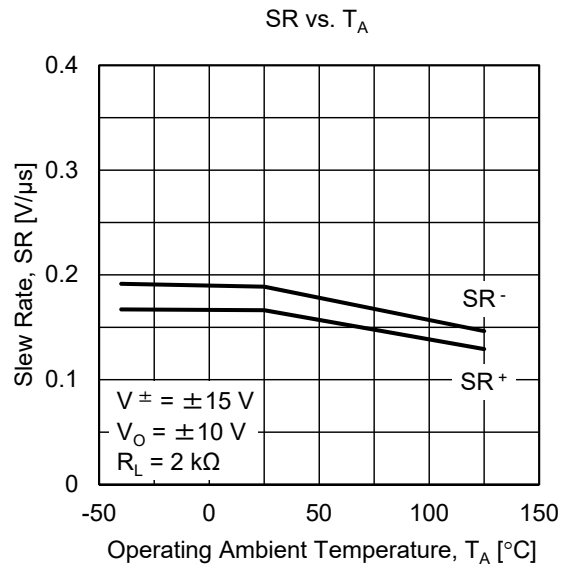
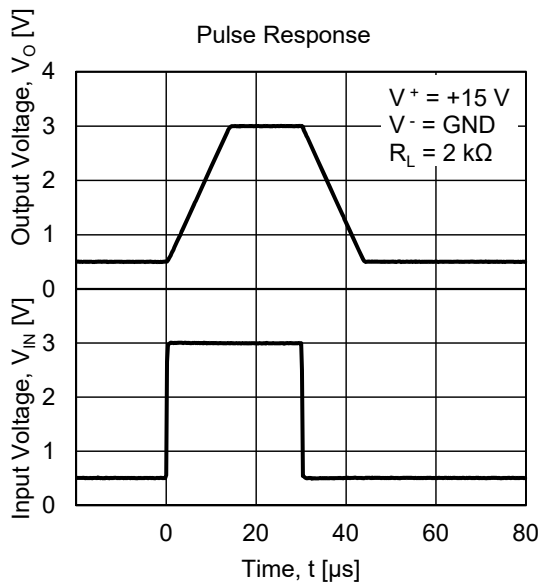
**[Note] 6.** The absolute value of the input bias current is small, thus the direction of the current flowing from the inside of the IC may be reversed due to variations in the product during high temperature.

**7.** This is a current that flows in the internal circuit. This current will flow irrespective of the channel used.

**TYPICAL PERFORMANCE CHARACTERISTICS (T<sub>A</sub> = 25 °C, TYP.) (Reference Value)**





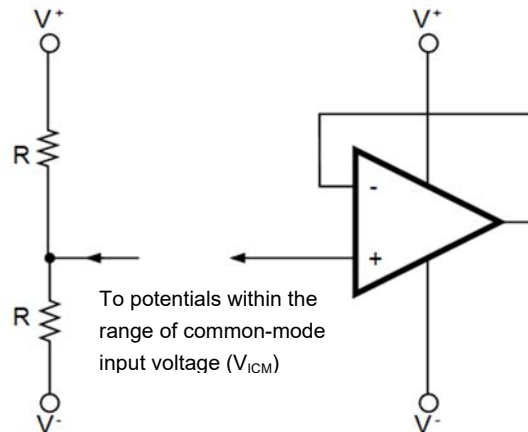


## PRECAUTIONS

- **The process of unused circuits**

If there is an unused circuit, the following connection is recommended.

### Process example of unused circuits



**Remark:** A midpoint potential of  $V^+$  and  $V^-$  is applied to this example.

- **Ratings of input/output pin voltage**

When the voltage of input/output pin exceeds the absolute maximum rating, it may cause degradation of characteristics or damage, by a conduction of a parasitic diode within an IC. In addition, if the input pin is lower than  $V^-$ , or the output pin exceeds the power supply voltage, it is recommended to make a clamp circuit using a diode with low forward voltage (e.g.: Schottky diode) as protection.

- **Range of common-mode input voltage**

When the supply voltage does not meet the condition of electrical characteristics, the range of common-mode input voltage is as follows.

$V_{ICM}$  (TYP.):  $V^-$  to  $V^+ - 1.5$  (V) ( $T_A = 25^\circ\text{C}$ ).

During designing, do include some tolerance by considering temperature characteristics and etc.

- **Maximum output voltage**

The TYP. value range of the maximum output voltage when the supply voltage does not meet the condition of electrical characteristics is as follows:

$V_{om}^+$  (TYP.):  $V^+ - 1.5$  (V) ( $T_A = 25^\circ\text{C}$ ),  $V_{om}^-$  (TYP.) ( $I_{O\ SINK} \leq 50\ \mu\text{A}$ ): Approx.  $V^-$  (V) ( $T_A = 25^\circ\text{C}$ ).

During designing, include some tolerance such as characteristics variation and temperature characteristics consideration and so forth. In addition, also note that the output voltage range ( $V_{om}^+ - V_{om}^-$ ) will become narrow when an output current increases.

- **Operation of output**

This IC output level consist of a class C push-pull. Therefore, when a load resistance is connected to the midpoint potential of  $V^+$ ,  $V^-$ , a crossover distortion occurs during the transition state of output current flow direction (source, sink).

- **Handling of ICs**

When stress is added to the ICs due to warpage or bending of a board, the characteristic may fluctuates due to piezoelectric effect. Therefore, pay attention to warpage or bending of a board.

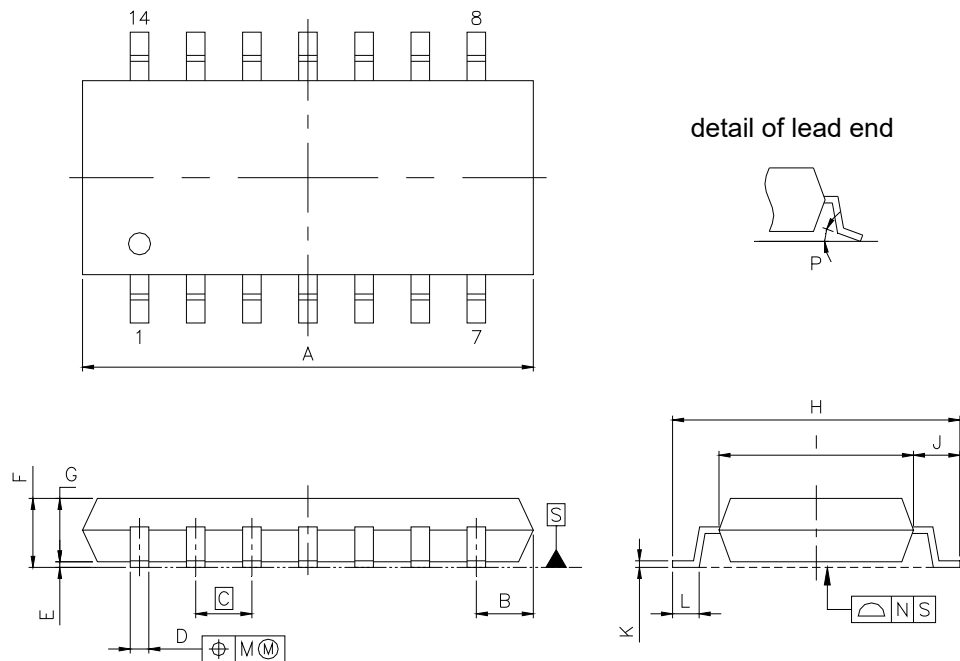


## PACKAGE DRAWINGS

### 14-PIN PLASTIC SOP

JEITA Package code	RENESAS code	Previous code	MASS (TYP.) [g]
P-SOP14-0225-1.27	PRSP0014DI-A	P14GR-50-225B	0.14

Unit : mm



#### NOTE

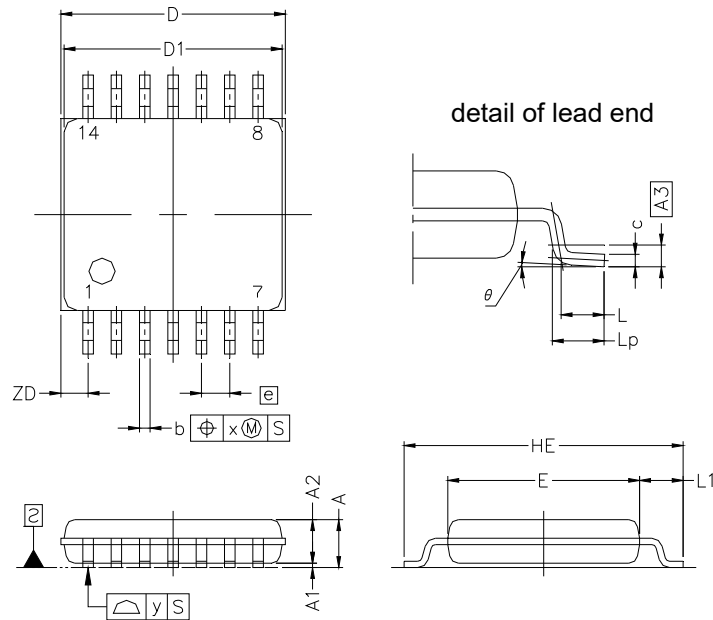
Each lead centerline is located within 0.12 mm of its true position (T.P.) at maximum material condition.

ITEM	MILLIMETERS
A	10.2 ±0.26
B	1.42 MAX
C	1.27 (T.P)
D	0.42 <sup>+0.08</sup> / <sub>-0.07</sub>
E	0.1 ±0.1
F	1.59 <sup>+0.21</sup> / <sub>-0.2</sub>
G	1.49
H	6.5 ±0.2
I	4.4 ±0.1
J	1.1 ±0.16
K	0.17 <sup>+0.08</sup> / <sub>-0.07</sub>
L	0.6 ±0.2
M	0.1
N	0.10
P	3° <sup>+7°</sup> / <sub>-3°</sub>

14-PIN PLASTIC TSSOP

JEITA Package code	RENESAS code	Previous code	MASS(TYP.) [g]
P-TSSOP14-0225-0.65	PTSP0014JB-A	P14GR-65-9LG-1	—

Unit : mm



**NOTE**

Each lead centerline is located within 0.10 mm of its true position at maximum material condition.

ITEM	MILLIMETERS
D	5.15 ±0.15
D1	5.00 ±0.10
E	4.40 ±0.10
HE	6.40 ±0.20
A	1.20 MAX.
A1	0.10 ±0.05
A2	1.00 ±0.05
A3	0.25
b	0.24 <sup>+0.06</sup> <sub>-0.05</sub>
c	0.145 ±0.055
L	0.5
Lp	0.60 ±0.15
L1	1.00 ±0.20
θ	3° <sup>+5°</sup> <sub>-3°</sub>
e	0.65
x	0.10
y	0.10
ZD	0.625

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标准等级：计算机、办公设备、通讯设备、测试和测量设备、视听设备、家用电器、机械工具、个人电子设备、工业机器人等。  
高质量等级：运输设备（汽车、火车、轮船等）、交通控制系统（交通信号灯）、大型通讯设备、关键金融终端系统、安全控制设备等。  
除非瑞萨电子产品数据表或其他瑞萨电子文档中明确指定为高可靠性产品或用于恶劣环境的产品，否则瑞萨电子产品不能用于、亦未授权用于可能对人类生命造成直接威胁的产品或系统及可能造成人身伤害的产品或系统（人工生命维持装置或系统、植入于体内的装置等）中，或者可能造成重大财产损失的产品或系统（太空系统、海底增音机、核能控制系统、飞机控制系统、关键装置系统、军用设备等）中。对于用户或任何第三方因使用不符合瑞萨电子产品数据表、使用说明书或其他瑞萨电子文档的瑞萨电子产品而遭受的任何损害或损失，瑞萨电子不承担任何责任。
6. 使用瑞萨电子产品时，请参阅最新产品信息（数据表、使用说明书、应用指南、可靠性手册中的“半导体元件处理和一般注意事项”等），并确保使用条件在瑞萨电子指定的最大额定值、电源工作电压范围、散热特性、安装条件等范围内使用。对于在上述指定范围之外使用瑞萨电子产品而产生的任何故障、失效或事故，瑞萨电子不承担任何责任。
7. 虽然瑞萨电子一直致力于提高瑞萨电子产品的质量和可靠性，但是，半导体产品有其自身的具体特性，如一定的故障发生率以及在某些使用条件下会发生故障等。除非瑞萨电子产品数据表或其他瑞萨电子文档中指定为高可靠性产品或用于恶劣环境的产品，否则瑞萨电子产品未进行防辐射设计。用户负责执行安全措施，以避免因瑞萨电子产品失效或发生故障而造成身体伤害、火灾导致伤害或损害和/或其他对公众构成危险事故。例如进行软硬件安全设计（包括但不限于冗余设计、防火控制以及故障预防等）、适当的老化处理或其他适当的措施等。由于对微机电软件单独进行评估非常困难且不实际，所以请用户自行负责对最终产品或系统进行安全评估。
8. 关于环境保护方面的详细内容，例如每种瑞萨电子产品的环境兼容性等，请与瑞萨电子的营业部门联系。用户负责仔细并充分查阅对管制物质的使用或含量进行管理的所有适用法律法规（包括但不限于《欧盟RoHS指令》），并在使用瑞萨电子产品时遵守所有适用法律法规。对于因用户未遵守相应适用法律法规而导致的损害或损失，瑞萨电子不承担任何责任。
9. 不可将瑞萨电子产品和技术用于或者嵌入日本国内或海外相应的法律法规所禁止生产、使用及销售的任何产品或系统中。也不可将其用于(1)与大规模杀伤性武器（例如核武器、化学武器、生物武器或运这些武器的导弹，包括无人机(UAV)的开发、设计、制造、使用、存储等相关的任何目的；(2)与常规武器的开发、设计、制造或使用相关的任何目的；(3)扰乱国际和平与安全的任何其他目的，并且不可向任何第三方销售、出口、租赁、转让、或让与瑞萨电子产品或技术，无论直接或间接知悉或者有理由知悉该第三方或任何其他方将从事上述活动。用户必须遵守对各方或交易行司法管辖权的任意国家和地区政府所公布和管理的任何适用出口管制法律法规。
10. 瑞萨电子产品的买方或分销商，或者分销、处置产品，或以其他方式向第三方出售或转让产品的任何其他方有责任事先向所述第三方通知本文件规定的内容和条件。
11. 在事先未得到瑞萨电子书面认可的情况下，不得以何形式部分或全部再版、转载或复制本文件。
12. 如果对本文件所记载的信息或瑞萨电子产品有任何疑问，请向瑞萨电子的营业部门咨询。  
(注1) 瑞萨电子：在本文件中指瑞萨电子株式会社及其控股子公司。  
(注2) 瑞萨电子产品：指瑞萨电子开发或生产的任何产品。

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