

# HA1630S07

R03DS0083EJ0200

Rev.2.00

## Single CMOS High Drive Operational Amplifier

Jan 10, 2014

### Description

HA1630S07 is a low power single CMOS operational amplifier featuring high output current with typical current supply of 60  $\mu$ A (2.7 V to 5.5 V). This IC designed to operate from a single power supply and have full swing outputs. Available in CMPAK-5 and MPAK-5 package, the miniature size of this IC not only allows compact integration in portable devices but also minimizes distance of signal sources (sensors), thus reducing external noise pick up prior to amplification. This IC exhibit excellent current drive-power ratio capable of 2 k $\Omega$  load driving and yet resistant to oscillation for capacitive loads up to 200 pF.

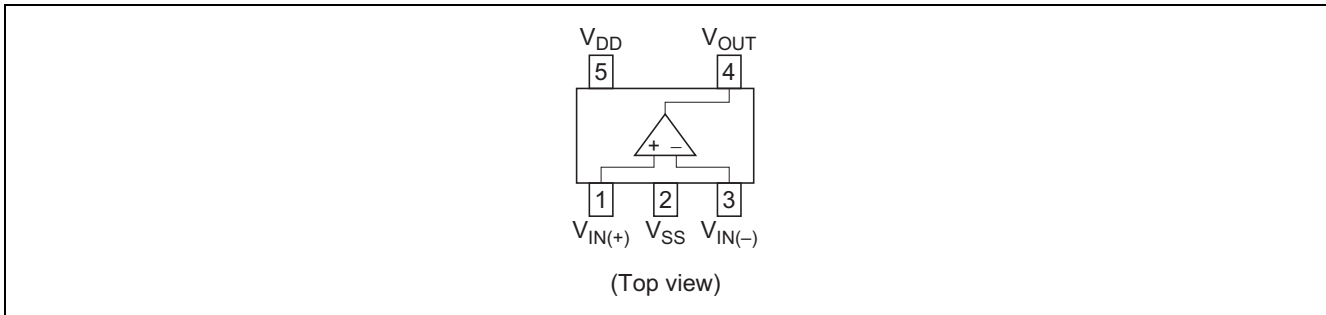
### Features

- Low supply current  $I_{DD} = 60 \mu\text{A Typ (}V_{DD} = 3 \text{ V, }R_L = \text{No load)}$
- Low voltage operation  $V_{DD} = 2.7 \text{ V to } 5.5 \text{ V}$
- Low input offset voltage  $V_{IO} = 6 \text{ mV Max}$
- Low input bias current  $I_{IB} = 1 \text{ pA Typ}$
- High output current  $I_{OSOURCE} = 15 \text{ mA Typ (}V_{DD} = 3.0 \text{ V, }V_{OH} = 2.5 \text{ V)}$   
 $I_{OSINK} = 15 \text{ mA Typ (}V_{DD} = 3.0 \text{ V, }V_{OL} = 0.5 \text{ V)}$
- Input common voltage range includes ground

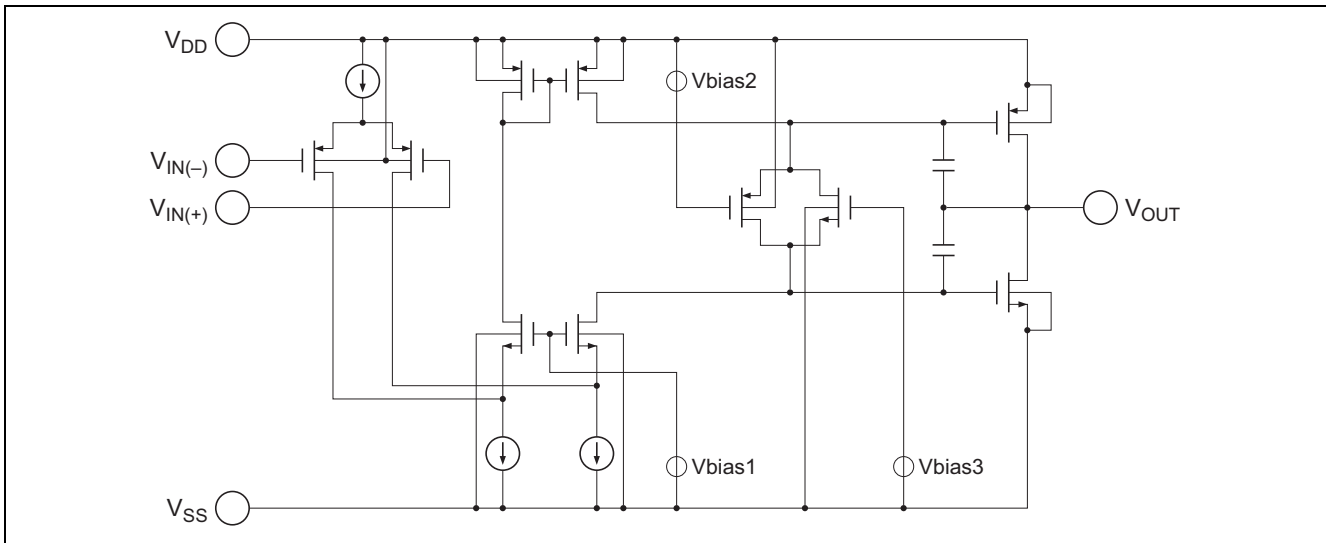
### Ordering Information

Part No.	Package Name	Package Code
HA1630S07CM	CMPAK-5	PTSP0005ZC-A
HA1630S07LP	MPAK-5	PLSP0005ZB-A

## Pin Arrangement



## Equivalent Circuit



## Absolute Maximum Ratings

(Ta = 25°C)

Item	Symbol	Ratings	Unit	Note
Supply voltage	V <sub>DD</sub>	7.0	V	
Differential input voltage	V <sub>IN(diff)</sub>	-V <sub>DD</sub> to +V <sub>DD</sub>	V	1
Input voltage	V <sub>IN</sub>	-0.1 to +V <sub>DD</sub>	V	
Output current	I <sub>OUT</sub>	40	mA	
Power dissipation	P <sub>T</sub>	80 (CMPAK-5)	mW	2
		120 (MPAK-5)		
Operating temperature	T <sub>opr</sub>	-40 to +85	°C	
Storage temperature	T <sub>stg</sub>	-55 to +125	°C	

Note: 1. Do not apply input voltage exceeding V<sub>DD</sub> or 7 V.

2. If Ta > 25°C,

CMPAK-5: -0.8 mW/°C

MPAK-5: -1.2 mW/°C

## Electrical Characteristics

### DC Characteristics

(Ta = 25°C, V<sub>DD</sub> = 3.0 V, V<sub>SS</sub> = 0 V)

Item	Symbol	Min	Typ	Max	Unit	Test Conditions
Input offset voltage	V <sub>IO</sub>	—	—	6	mV	V <sub>IN</sub> = 1.5 V, R <sub>L</sub> = 1 MΩ
Input bias current	I <sub>IB</sub>	—	(1)	—	pA	V <sub>IN</sub> = 1.5 V
Input offset current	I <sub>IO</sub>	—	(1)	—	pA	V <sub>IN</sub> = 1.5 V
Common mode input voltage range	V <sub>CM</sub>	-0.1	—	1.8	V	
Supply current	I <sub>DD</sub>	—	60	170	μA	V <sub>IN(+)</sub> = 1.0 V, R <sub>L</sub> = ∞
Output source current	I <sub>OSOURCE</sub>	7.5	15	—	mA	V <sub>OUT</sub> = 2.5 V
Output sink current	I <sub>OSINK</sub>	7.5	15	—	mA	V <sub>OUT</sub> = 0.5 V
Open loop voltage gain	A <sub>V</sub>	55	80	—	dB	R <sub>L</sub> = 100 kΩ
Common mode rejection ratio	CMRR	50	80	—	dB	V <sub>IN1</sub> = 0 V, V <sub>IN2</sub> = 1.8 V
Power supply rejection ratio	PSRR	55	80	—	dB	V <sub>DD1</sub> = 2.7 V, V <sub>DD2</sub> = 5.5 V
Output high voltage	V <sub>OH</sub>	2.9	—	—	V	R <sub>L</sub> = 2 kΩ to V <sub>SS</sub>
Output low voltage	V <sub>OL</sub>	—	—	0.1	V	R <sub>L</sub> = 2 kΩ to V <sub>DD</sub>

Note: ( ) : Design specification

### AC Characteristics

(Ta = 25°C, V<sub>DD</sub> = 3.0 V, V<sub>SS</sub> = 0 V)

Item	Symbol	Min	Typ	Max	Unit	Test Conditions
Slew rate	SR <sub>r</sub>	—	(1)	—	V/μs	V <sub>IN</sub> = 1.5 V, C <sub>L</sub> = 15 pF (V <sub>INL</sub> = 0.2 V, V <sub>INH</sub> = 1.7 V)
	SR <sub>f</sub>	—	(1)	—		
Gain bandwidth product	GBW	—	(1.5)	—	MHz	V <sub>IN</sub> = 1.5 V, C <sub>L</sub> = 15 pF

Note: ( ) : Design specification

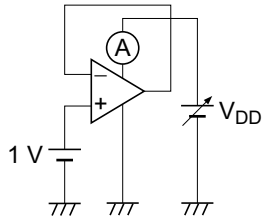
## Table of Graphs

Electrical Characteristics			Characteristic Curves	Test Circuit No.
Supply current	$I_{DD}$	vs. Supply voltage	1	1
		vs. Temperature	2	1
Output high voltage	$V_{OH}$	vs. Rload	3	2
Output low voltage	$V_{OL}$	vs. Rload	4	3
Output source current	$I_{OSOURCE}$	vs. Output high voltage	5	4
		vs. Temperature	6	4
Output sink current	$I_{OSINK}$	vs. Output low voltage	7	5
		vs. Temperature	8	5
Input offset voltage	$V_{IO}$	vs. Supply voltage	9	6
		vs. Input voltage	10	6
		vs. Temperature	11	7
Common mode input voltage range	$V_{CM}$	vs. Supply voltage	12	8
		vs. Temperature	13	8
Common mode rejection ratio	CMRR	vs. Input voltage	14	9
Power supply rejection ratio	PSRR	vs. Supply voltage	15	10
Input bias current	$I_{IB}$	vs. Input voltage	16	11, 12
		vs. Temperature	17	11, 12
Slew rate (rising)	SRr	vs. Cload	18	13
		vs. Temperature	19	13
		Time waveform	20	13
Slew rate (falling)	SRf	vs. Cload	21	13
		vs. Temperature	22	13
		Time waveform	23	13
Open loop gain	$A_V$	vs. Rload	24	14
		vs. Frequency	25, 26	14
Phase margin	PM	vs. Cload	27	14
Noise input voltage	VNI	vs. Frequency	28	15

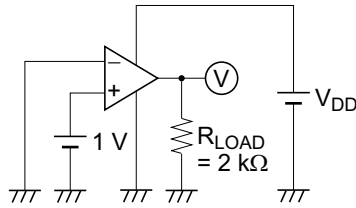
**Test Circuits**

(Unless otherwise noted,  $V_{DD} = 3\text{ V}$ ,  $V_{SS} = 0\text{ V}$ ,  $T_a = 25^\circ\text{C}$ )

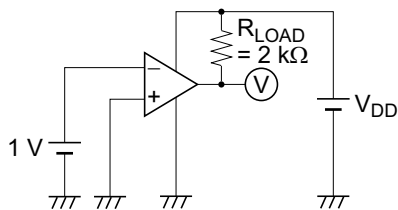
1. Supply Current,  $I_{DD}$



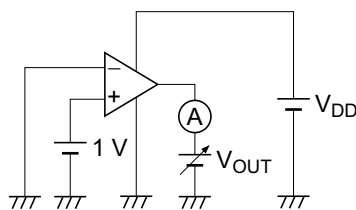
2. Output High Voltage,  $V_{OH}$



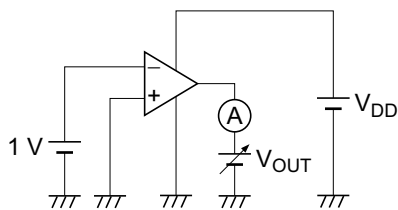
3. Output Low Voltage,  $V_{OL}$



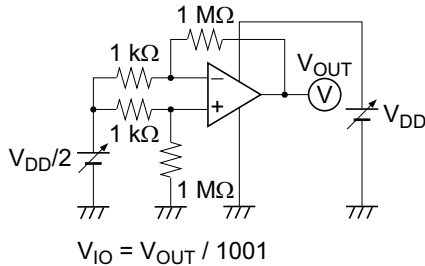
4. Output Source Current,  $I_{OSOURCE}$



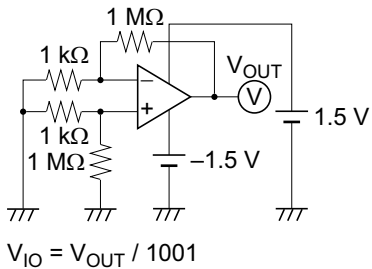
5. Output Sink Current,  $I_{OSINK}$



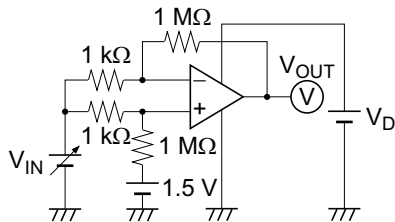
6. Input Offset Voltage vs. Operating Voltage



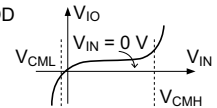
7. Input Offset Voltage,  $V_{IO}$



8. Common Mode Input Voltage Range,  $V_{CM}$



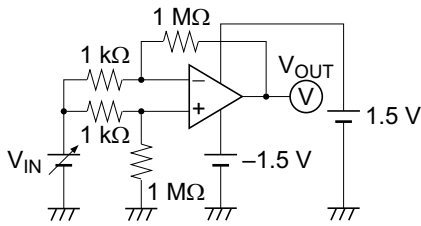
Note:  
 $V_{CML}$  and  $V_{CMH}$  are values of  $V_{IN}$  when  $V_{IO}$  changes more than 50 dB taking  $V_{IN} = 0\text{ V}$  as reference.



**Test Circuits (cont.)**

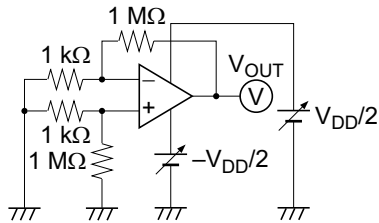
(Unless otherwise noted,  $V_{DD} = 3\text{ V}$ ,  $V_{SS} = 0\text{ V}$ ,  $T_a = 25^\circ\text{C}$ )

**9. Common Mode Rejection Ratio, CMRR**



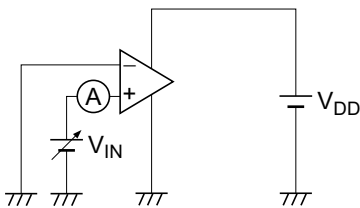
$V_{IN}$	Measure Point	Calculate $V_{IO}$	CMRR Calculation
-1.5 V	$V_{OUT1}$	$V_{IO1} = V_{OUT1} / 1001$	$\text{CMRR} = \left  20 \log_{10} \frac{ V_{IO2} - V_{IO1} }{0.3 - (-1.5\text{ V})} \right $
0.3 V	$V_{OUT2}$	$V_{IO2} = V_{OUT2} / 1001$	

**10. Power Supply Rejection Ratio, PSRR**

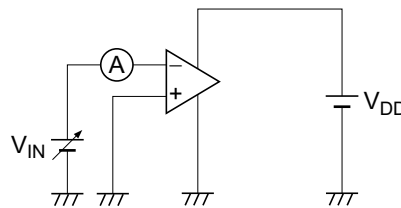


$V_{DD}$	Measure Point	Calculate $V_{IO}$	CMRR Calculation
2.7 V	$V_{OUT1}$	$V_{IO1} = V_{OUT1} / 1001$	$\text{PSRR} = \left  20 \log_{10} \frac{ V_{IO2} - V_{IO1} }{5.5\text{ V} - 2.7\text{ V}} \right $
5.5 V	$V_{OUT2}$	$V_{IO2} = V_{OUT2} / 1001$	

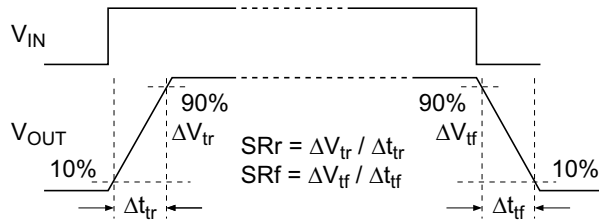
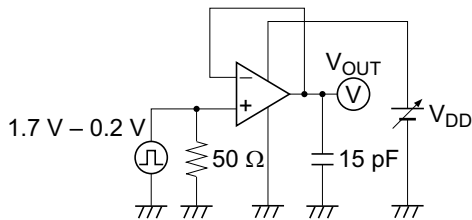
**11. Input Bias Current,  $I_{B+}$**



**12. Input Bias Current,  $I_{B-}$**



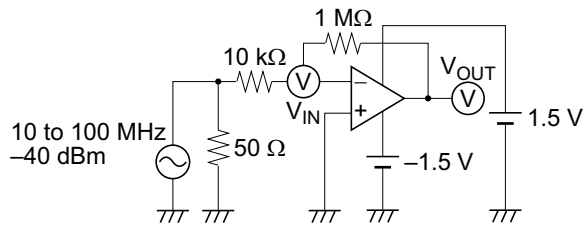
**13. Slew Rate (Large Signal Input)**



## Test Circuits (cont.)

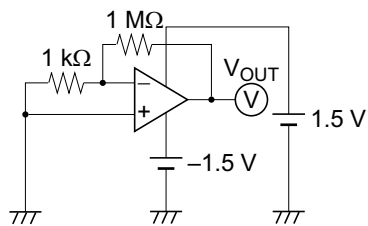
(Unless otherwise noted,  $V_{DD} = 3\text{ V}$ ,  $V_{SS} = 0\text{ V}$ ,  $T_a = 25^\circ\text{C}$ )

### 14. Open Loop Voltage Gain, $A_V$



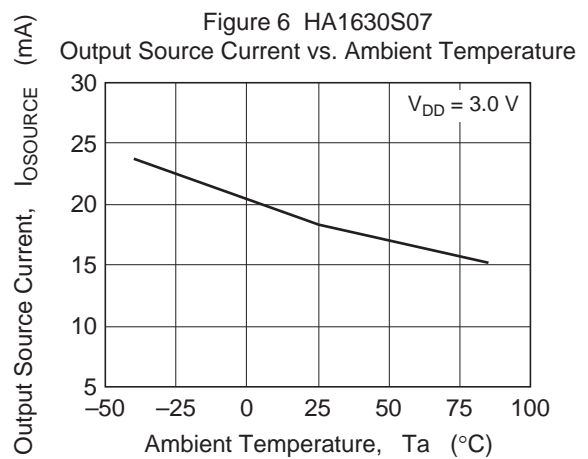
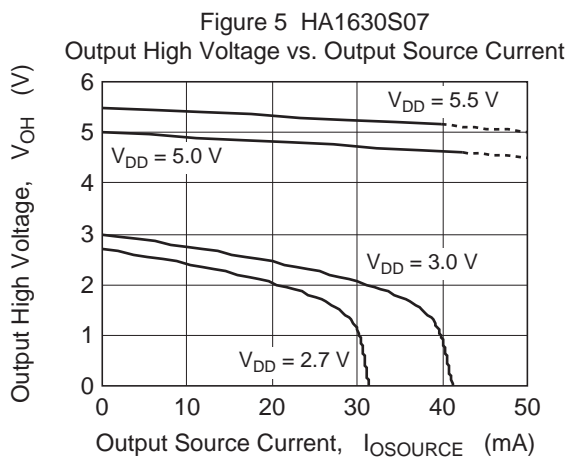
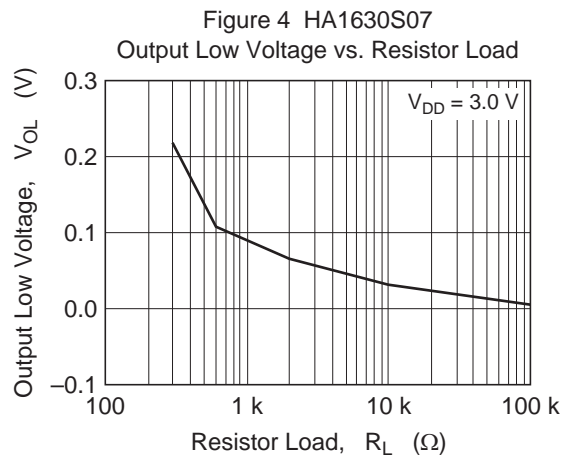
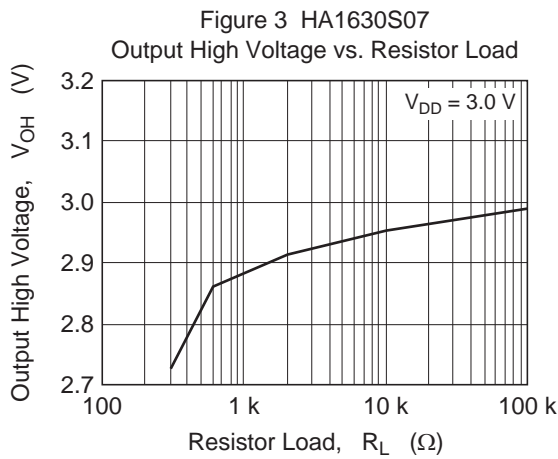
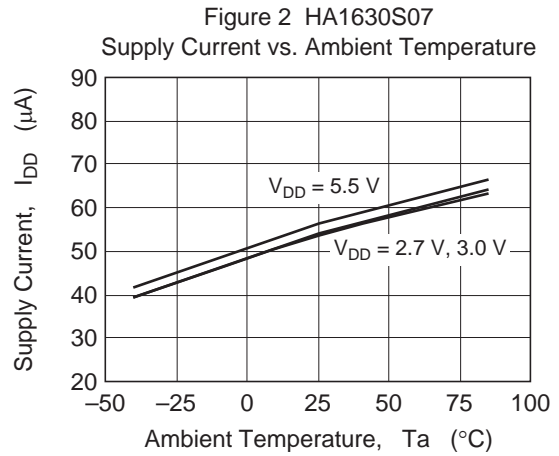
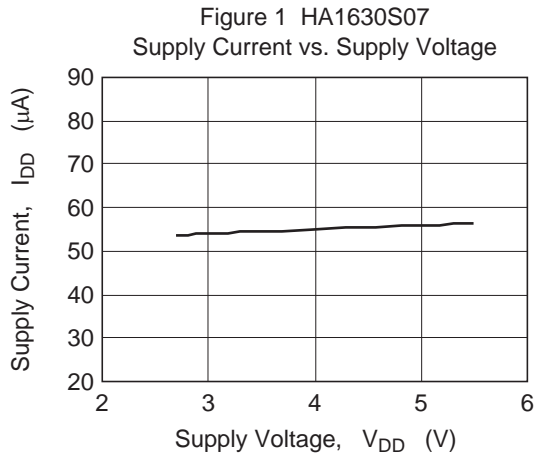
$$A_V = \left| 20 \log_{10} \frac{101 \times |V_{OUT}|}{|V_{IN}|} \right|$$

### 15. Noise Input Voltage, VNI



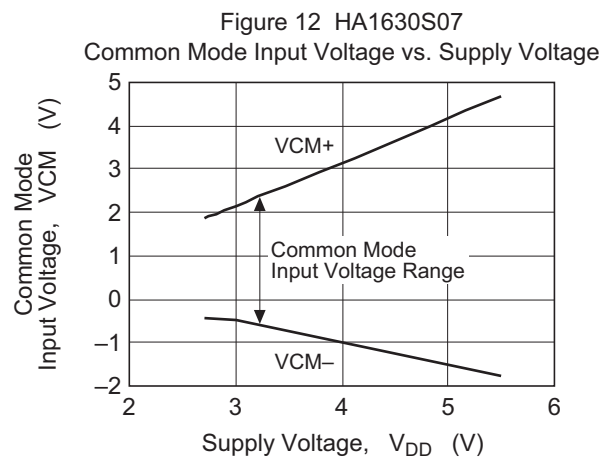
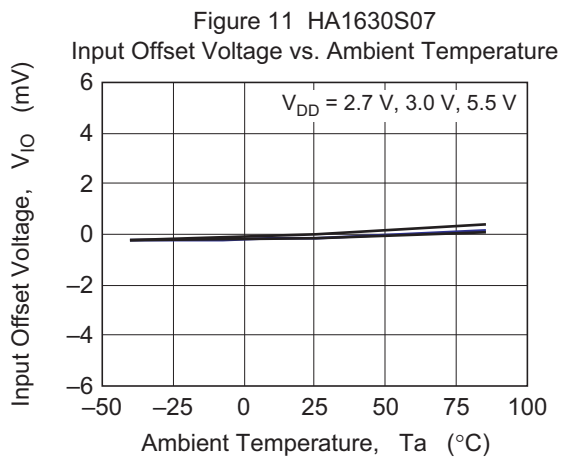
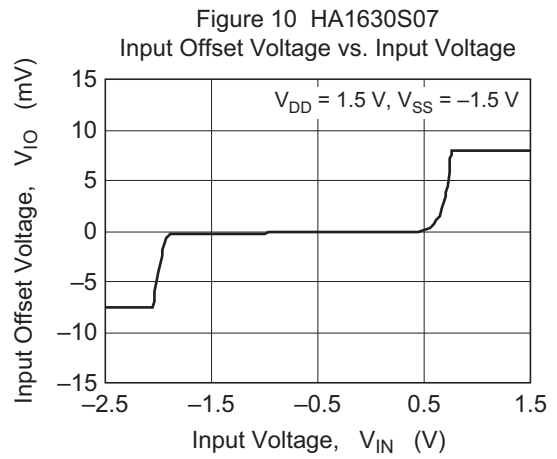
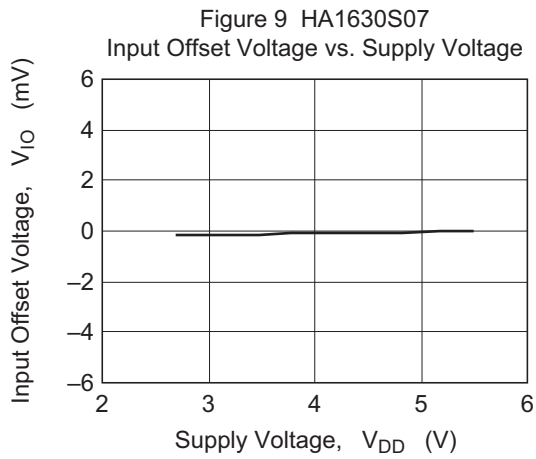
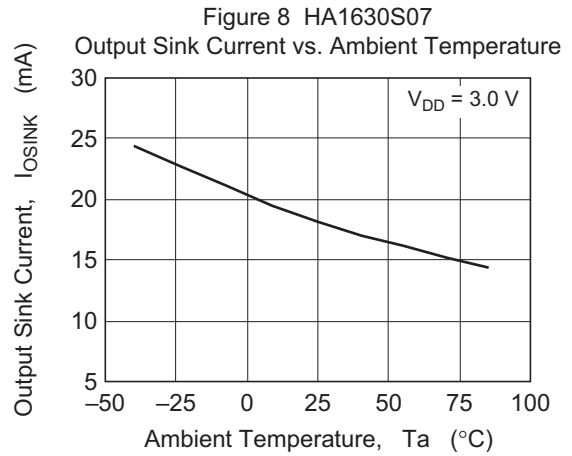
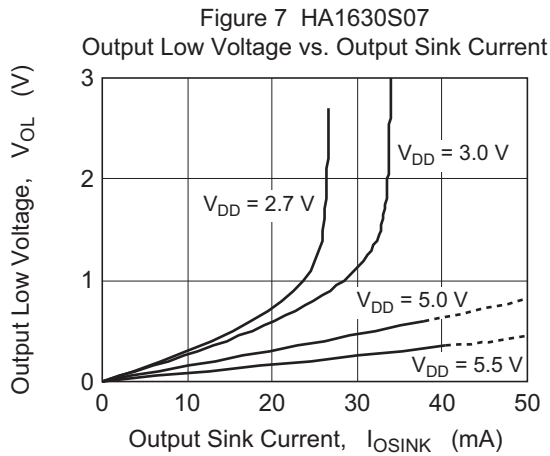
$$VNI = \frac{V_{OUT}}{1001}$$

Characteristic Curves

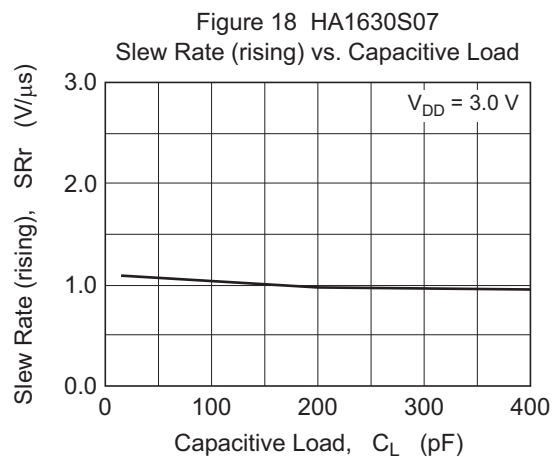
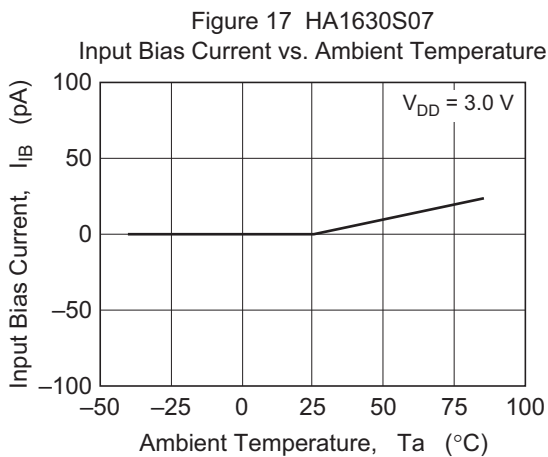
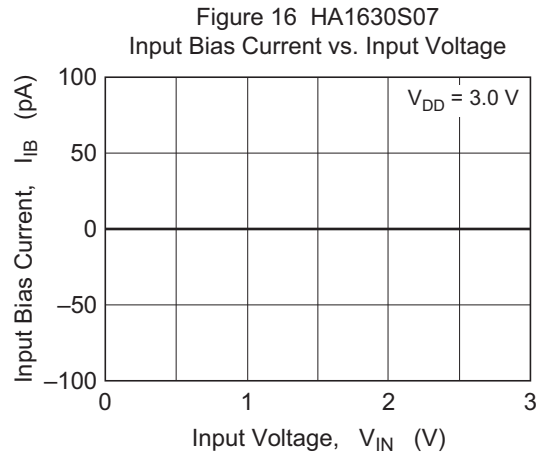
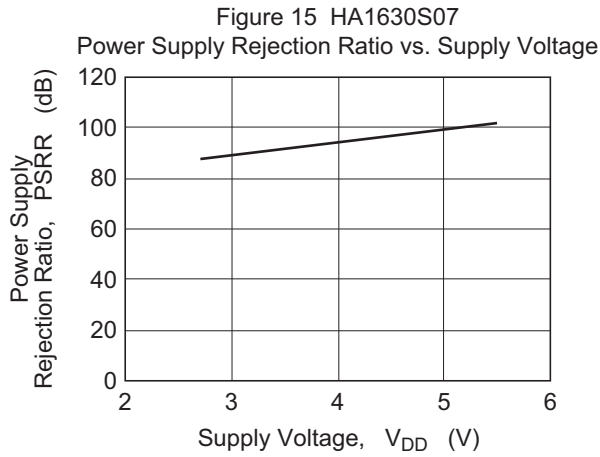
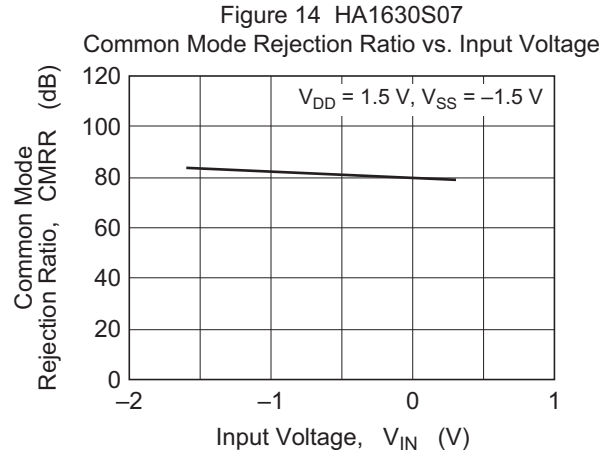
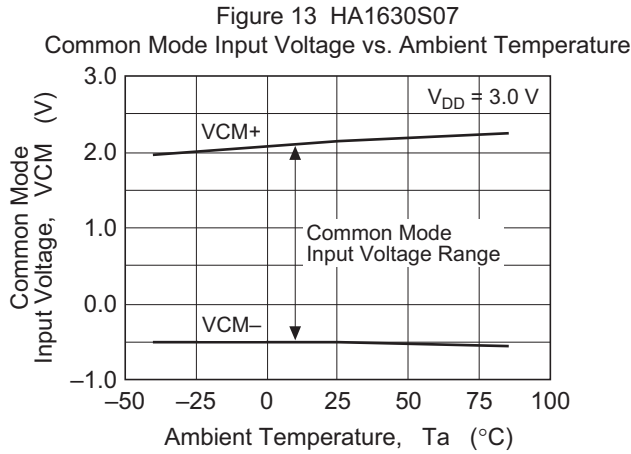




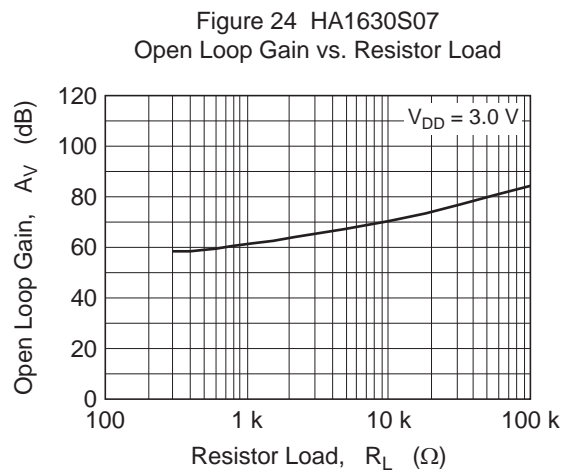
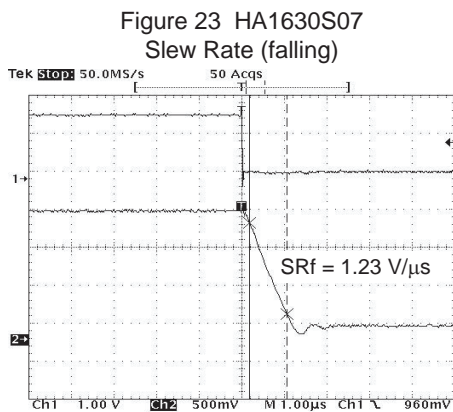
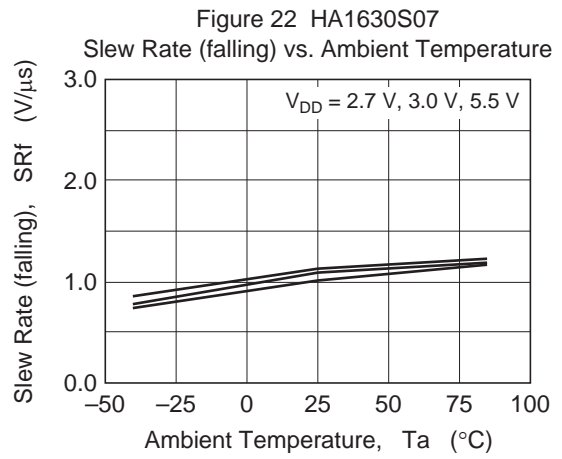
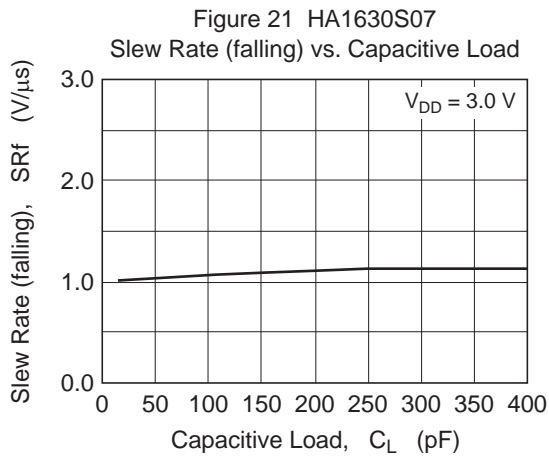
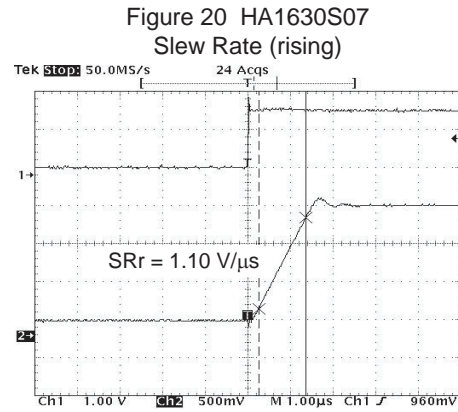
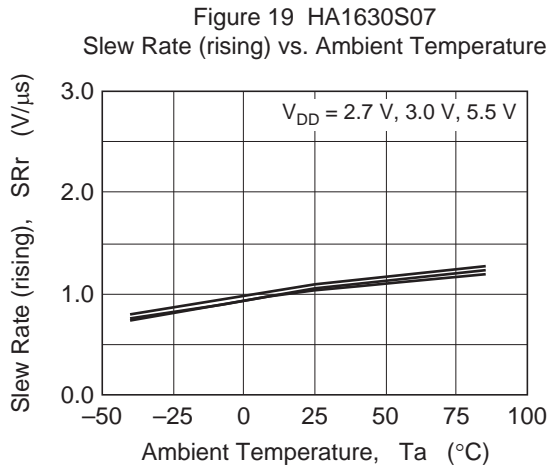
Characteristic Curves (cont.)



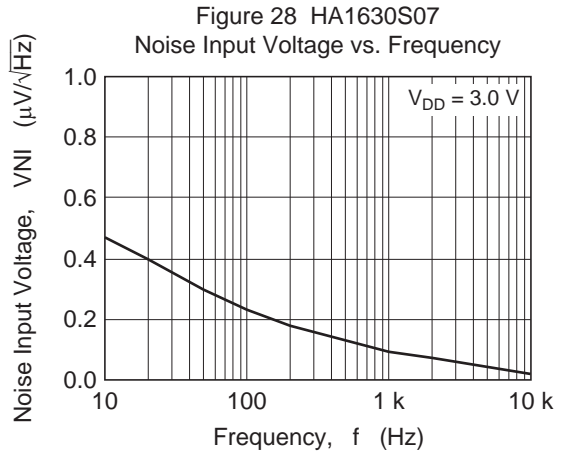
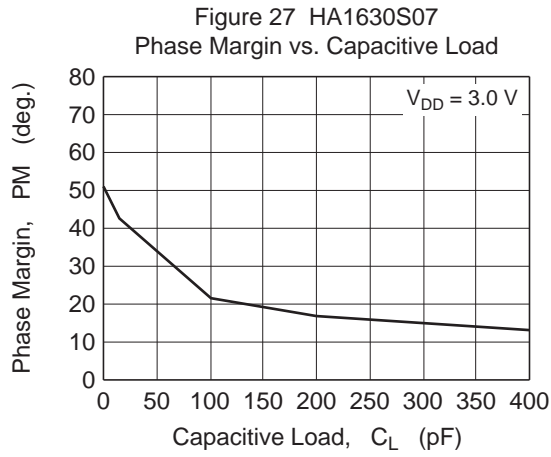
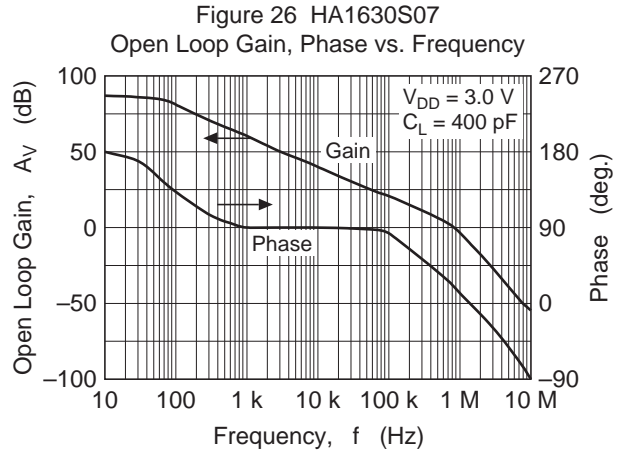
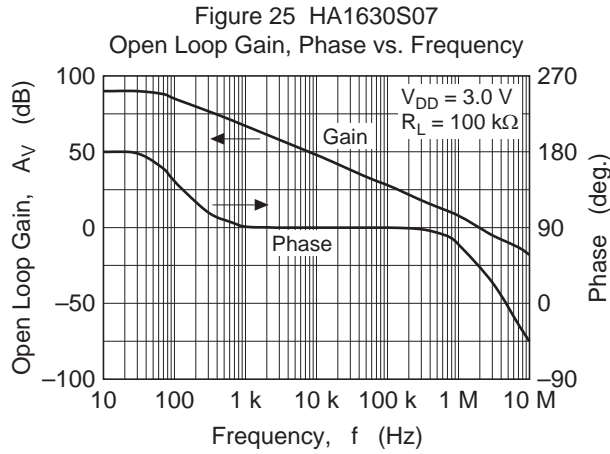
Characteristic Curves (cont.)



Characteristic Curves (cont.)

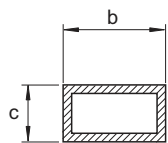
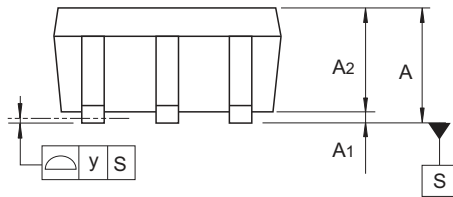
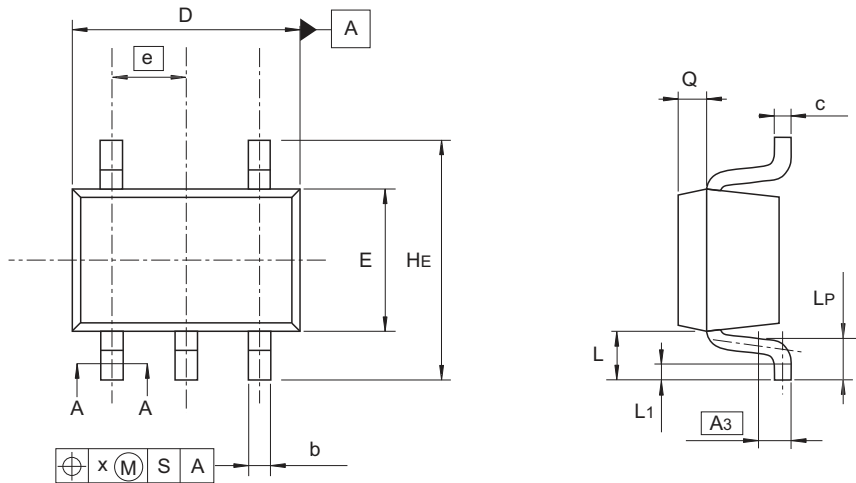


Characteristic Curves (cont.)



### Package Dimensions

JEITA Package Code	RENESAS Code	Previous Code	MASS (Typ) [g]
SC-88A	PTSP0005ZC-A	CMPAK-5 / CMPAK-5V	0.006

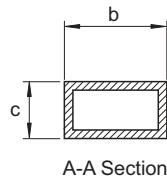
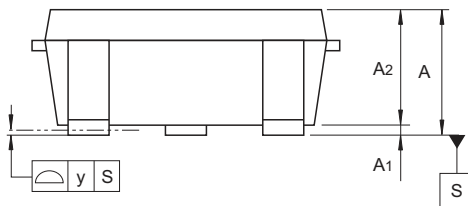
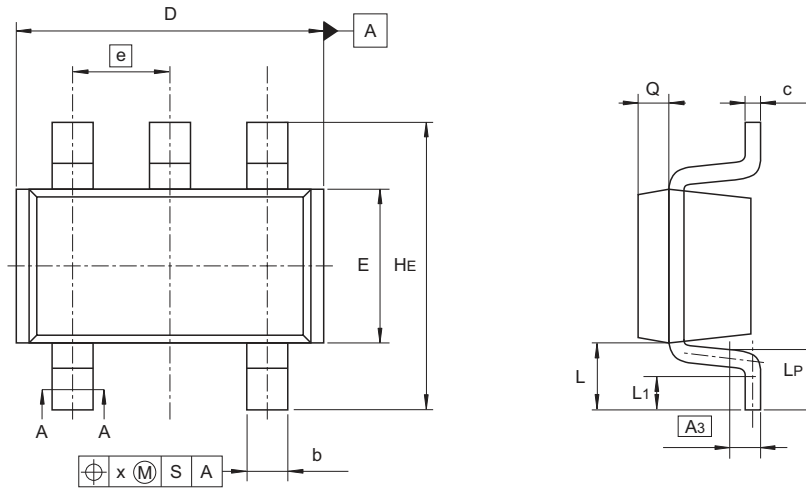


A-A Section

Reference Symbol	Dimensions in millimeters		
	Min	Nom	Max
A	0.8	—	1.1
A <sub>1</sub>	0	—	0.1
A <sub>2</sub>	0.8	0.9	1.0
A <sub>3</sub>	—	0.25	—
b	0.15	0.22	0.3
c	0.1	0.13	0.15
D	1.8	2.0	2.2
E	1.15	1.25	1.35
e	—	0.65	—
HE	1.8	2.1	2.4
L	0.3	—	0.7
L <sub>1</sub>	0.1	—	0.5
LP	0.2	—	0.6
x	—	—	0.05
y	—	—	0.05
Q	—	0.25	—

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JEITA Package Code	RENESAS Code	Previous Code	MASS (Typ) [g]
SC-74A	PLSP0005ZB-A	MPAK-5 / MPAK-5V	0.015



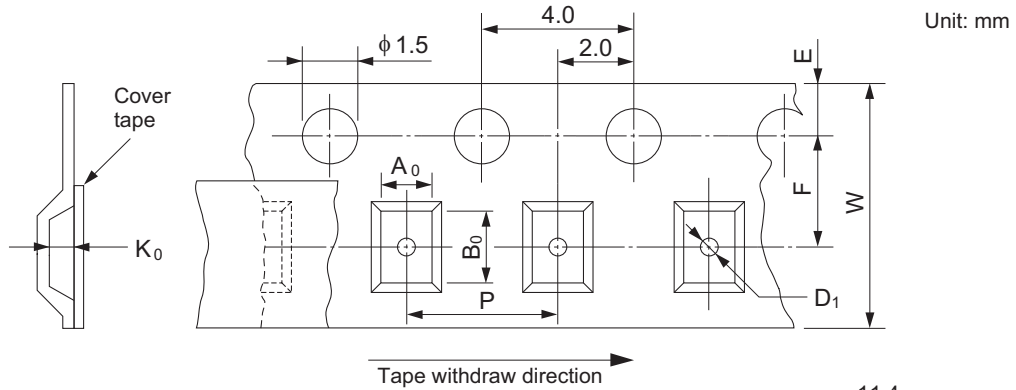
Reference Symbol	Dimensions in millimeters		
	Min	Nom	Max
A	1.0	—	1.4
A <sub>1</sub>	0	—	0.1
A <sub>2</sub>	1.0	1.1	1.3
A <sub>3</sub>	—	0.25	—
b	0.35	0.4	0.5
c	0.11	0.16	0.26
D	2.8	2.95	3.1
E	1.5	1.6	1.8
e	—	0.95	—
H <sub>E</sub>	2.5	2.8	3.0
L	0.3	—	0.7
L <sub>1</sub>	0.1	—	0.5
LP	0.2	—	0.6
x	—	—	0.05
y	—	—	0.05
Q	—	0.3	—

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### Taping & Reel Specification

[Taping]

Package Code	W	P	Ao	Bo	Ko	E	F	D1	Maximum Storage No.
MPAK-5	8	4	3.3	3.3	1.5	1.75	3.5	1.05	3,000 pcs/reel
CMPAK-5	8	4	2.25	2.45	1.1	1.75	3.5	1.05	3,000 pcs/reel

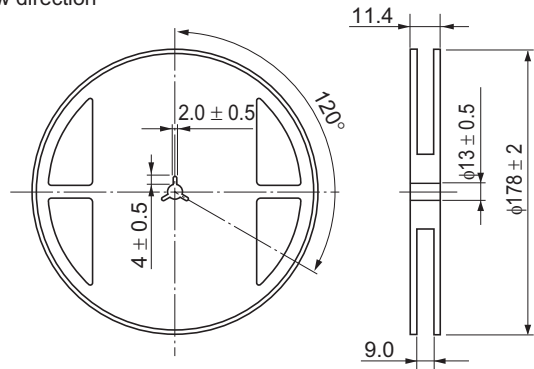


[Reel]

Package	Tape width	W1	W2
MPAK-5	8	11.4	9
CMPAK-5	8	11.4	9

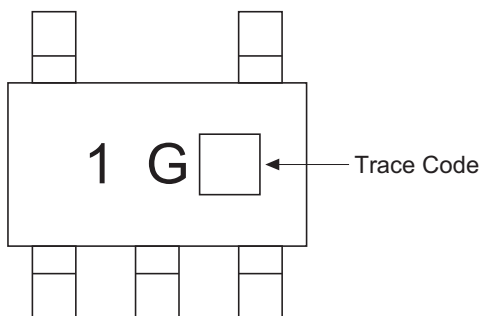
[Ordering Information]

Ordering Unit
3,000 pcs

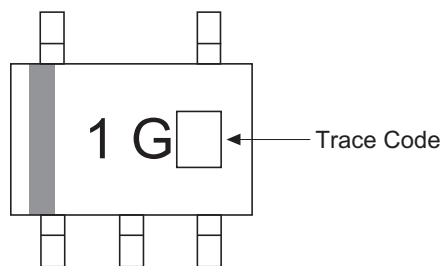


### Mark Indication

• MPAK-5



• CMPAK-5



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2880 Scott Boulevard Santa Clara, CA 95050-2554, U.S.A.  
Tel: +1-408-586-6000, Fax: +1-408-588-6130

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1101 Nicholson Road, Newmarket, Ontario L3Y 9C3, Canada  
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Dukes Meadow, Millboard Road, Bourne End, Buckinghamshire, SL8 5FH, U.K.  
Tel: +44-1628-651-700, Fax: +44-1628-651-804

**Renesas Electronics Europe GmbH**  
Arcadiastrasse 10, 40472 Düsseldorf, Germany  
Tel: +49-211-65030, Fax: +49-211-6503-1327

**Renesas Electronics (China) Co., Ltd.**  
7th Floor, Quantum Plaza, No.27 ZhiChunLu Haidian District, Beijing 100083, P.R.China  
Tel: +86-10-8235-1155, Fax: +86-10-8235-7679

**Renesas Electronics (Shanghai) Co., Ltd.**  
Unit 301, Tower A, Central Towers, 555 LanGao Rd., Putuo District, Shanghai, China  
Tel: +86-21-2226-0888, Fax: +86-21-2226-0999

**Renesas Electronics Hong Kong Limited**  
Unit 1601-1613, 16/F., Tower 2, Grand Century Place, 193 Prince Edward Road West, Mongkok, Kowloon, Hong Kong  
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**Renesas Electronics Taiwan Co., Ltd.**  
13F, No. 363, Fu Shing North Road, Taipei, Taiwan  
Tel: +886-2-8175-9600, Fax: +886 2-8175-9670

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Unit 906, Block B, Menara Amcorp, Amcorp Trade Centre, No. 18, Jln Persiaran Barat, 46050 Petaling Jaya, Selangor Darul Ehsan, Malaysia  
Tel: +60-3-7955-9390, Fax: +60-3-7955-9510

**Renesas Electronics Korea Co., Ltd.**  
12F., 234 Teheran-ro, Gangnam-Gu, Seoul, 135-080, Korea  
Tel: +82-2-558-3737, Fax: +82-2-558-5141