To our customers,

Old Company Name in Catalogs and Other Documents

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April 1st, 2010
Renesas Electronics Corporation

Issued by: Renesas Electronics Corporation (http://www.renesas.com)

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HA1630D04/05/06 Series

Ultra-Small Low Voltage Operation CMOS Dual Operational Amplifier

REJ03D0801-0200
Rev.2.00
Feb 07, 2007

Description

The HA1630D04/05/06 are high slew rate dual CMOS Operational Amplifiers realizing low voltage operation, low input offset voltage and low supply current. In addition to a low operating voltage from 1.8V, these device output can achieve full swing output voltage capability extending to either supply. Available in an ultra-small TSSOP-8 and MMPAK-8 package that occupy more small area against the SOP-8.

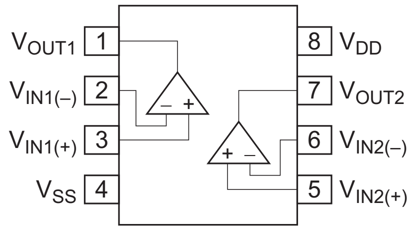
Features

• Low power and single supply operation	V_{DD} = 1.8 to 5.5 V
• Low input offset voltage	V_{IO} = 4.0 mV Max
• Low supply current (per channel)	I_{DD} = 200 µA Typ (HA1630D04)
	I_{DD} = 400 µA Typ (HA1630D05)
	I_{DD} = 800 µA Typ (HA1630D06)
• High slew rate	SR = 2 V/µs Typ (HA1630D04)
	SR = 4 V/µs Typ (HA1630D05)
	SR = 8 V/µs Typ (HA1630D06)
• Maximum output voltage	V_{OH} = 2.9 V Min (at V_{DD} = 3.0 V)
• Low input bias current	I_{IB} = 1 pA Typ

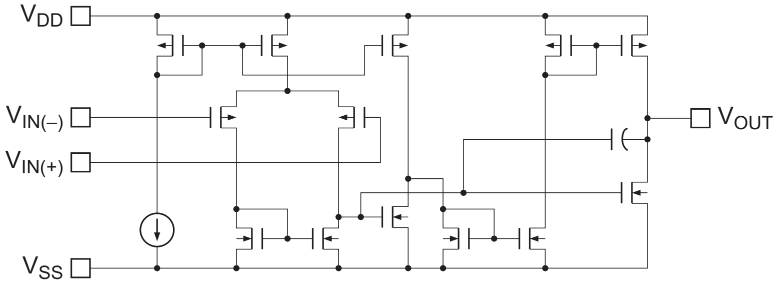
Ordering Information

Type No.	Package Name	Package Code
HA1630D04T	TTP-8DA	PTSP0008JC-B
HA1630D05T		
HA1630D06T		
HA1630D04MM	MMPAK-8	PLSP0008JC-A
HA1630D05MM		
HA1630D06MM		

Pin Arrangement



Equivalent Circuit (per one channel)



Absolute Maximum Ratings

(Ta = 25°C)

Items	Symbol	Ratings	Unit	Note
Supply voltage	V_{DD}	7	V	
Differential input voltage	$V_{IN(diff)}$	$-V_{DD}$ to $+V_{DD}$	V	
Input voltage	V_{IN}	-0.3 to $+V_{DD}$	V	*1
Power dissipation	P_T	240/145	mW	TTP-8DA/MMPAK-8 *2
Operating temp. Range	Topr	–40 to +85	°C	
Storage temp. Range	Tstg	–55 to +125	°C	

Notes: 1. Do not apply Input Voltage exceeding V_{DD} or 7 V.
2. The value of PTSP0008JC-B (TTP-8DAV) / PLSP0008JC-A (MMPAK-8). It computes from heat resistance θja = 520°C/W, and 690°C/W each other.

Electrical Characteristics

(V_{DD} = 3.0 V, Ta = 25°C)

Items	Symbol	Min	Typ	Max	Unit	Test Condition
Input offset voltage	V_{IO}	—	—	4.0	mV	Vin = 1.5 V
Input offset current	I_{IO}	—	(1.0)	—	pA	Vin = 1.5 V
Input bias current	I_{IB}	—	(1.0)	—	pA	Vin = 1.5 V
Output high voltage	V_{OH}	2.9	—	—	V	R_L = 100 kΩ
Output source current	$I_{O\ SOURCE}$	100	200	—	µA	V_{OH} = 2.5 V (HA1630D04)
		200	400	—		V_{OH} = 2.5 V (HA1630D05)
		400	800	—		V_{OH} = 2.5 V (HA1630D06)
Output low voltage	V_{OL}	—	—	0.1	V	R_L = 100 kΩ
Output sink current	$I_{O\ SINK}$	—	(5.0)	—	mA	V_{OL} = 0.5 V (HA1630D04)
		—	(6.0)	—		V_{OL} = 0.5 V (HA1630D05)
		—	(6.5)	—		V_{OL} = 0.5 V (HA1630D06)
Common mode input voltage range	V_{CM}	–0.05 to 2.1	—	—	V	(HA1630D04, HA1630D05)
		0 to 1.9	—	—		(HA1630D06)
Slew rate	SR	—	(2.0)	—	V/µs	C_L = 20 pF (HA1630D04)
		—	(4.0)	—		C_L = 20 pF (HA1630D05)
		—	(8.0)	—		C_L = 20 pF (HA1630D06)
Voltage gain	A_V	60	90	—	dB	
Gain bandwidth product	BW	—	(2100)	—	kHz	C_L = 20 pF (HA1630D04)
		—	(3300)	—		C_L = 20 pF (HA1630D05)
		—	(3600)	—		C_L = 20 pF (HA1630D06)
Power supply rejection ratio	PSRR	50	70	—	dB	
Common mode rejection ratio	CMRR	50	70	—	dB	
Supply current	I_{DD}	—	400	800	µA	$R_L = \infty$ (HA1630D04)
		—	800	1600		$R_L = \infty$ (HA1630D05)
		—	1600	3400		$R_L = \infty$ (HA1630D06)

Notes: 1. In the case of continuous current flow, use a sink current of under 4 mA.
2. ( ) : Design specification

Table of Graphs

Electrical Characteristics			HA1630D04 Figure	HA1630D05 Figure	HA1630D06 Figure	Test Circuit
Supply current	I_{DD}	vs Supply voltage	1-1	2-1	3-1	2
		vs Ambient temperature	1-2	2-2	3-2	
Output high voltage	V_{OH}	vs Output source current	1-3	2-3	3-3	4
		vs Supply voltage	1-4	2-4	3-4	
Output source current	$I_{O\ SOURCE}$	vs Ambient temperature	1-5	2-5	3-5	6
Output low voltage	V_{OL}	vs Output sink current	1-6	2-6	3-6	5
Output sink current	$I_{O\ SINK}$	vs Ambient temperature	1-7	2-7	3-7	6
Input offset voltage	V_{IO}	Distribution	1-8	2-8	3-8	1
		vs Supply voltage	1-9	2-9	3-9	
		vs Ambient temperature	1-10	2-10	3-10	
Common mode input voltage range	V_{CM}	vs Ambient temperature	1-11	2-11	3-11	7
Power supply rejection ratio	PSRR	vs Frequency	1-12	2-12	3-12	1
Common mode rejection ratio	CMRR	vs Frequency	1-13	2-13	3-13	7
Voltage gain & phase angle	A_V	vs Frequency	1-14	2-14	3-14	10
Input bias current	I_{IB}	vs Ambient temperature	1-15	2-15	3-15	3
		vs Input voltage	1-16	2-16	3-16	
Slew Rate (rising)	SRr	vs Ambient temperature	1-17	2-17	3-17	9
Slew Rate (falling)	SRf	vs Ambient temperature	1-18	2-18	3-18	
Slew rate		Large signal transient response	1-19	2-19	3-19	
		Small signal transient response	1-20	2-20	3-20	
Total harmonic distortion + noise	(0 dB)	vs. Output voltage p-p	1-21	2-21	3-21	8
	(40 dB)	vs. Output voltage p-p	1-22	2-22	3-22	
Maximum p-p output voltage		vs Frequency	1-23	2-23	3-23	
Voltage noise density		vs Frequency	1-24	2-24	3-24	
Channel separation		vs Frequency	1-25	2-25	3-25	

Main Characteristics (HA1630D04)

Figure 1-1. HA1630D04
Supply Current vs. Supply Voltage

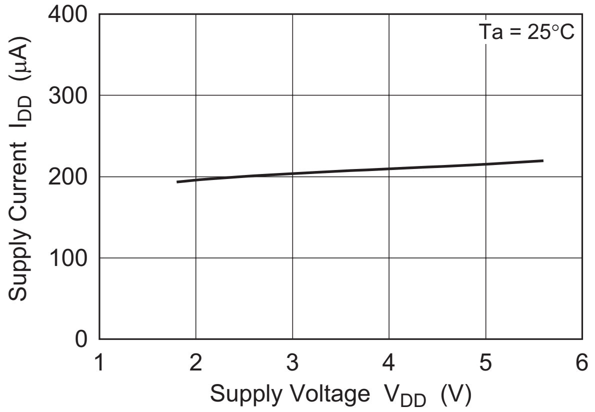


Figure 1-2. HA1630D04
Supply Current vs. Ambient Temperature

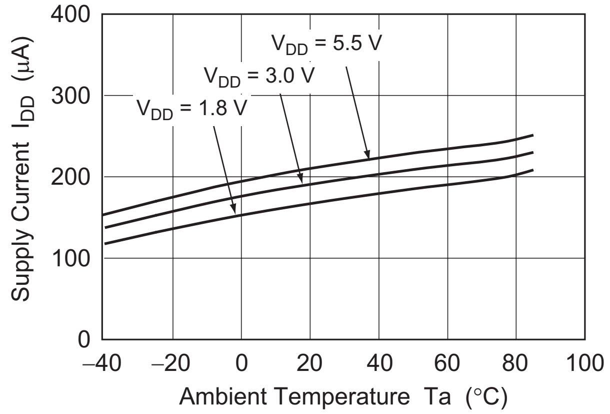


Figure 1-3. HA1630D04
Output High Voltage vs. Output Source Current

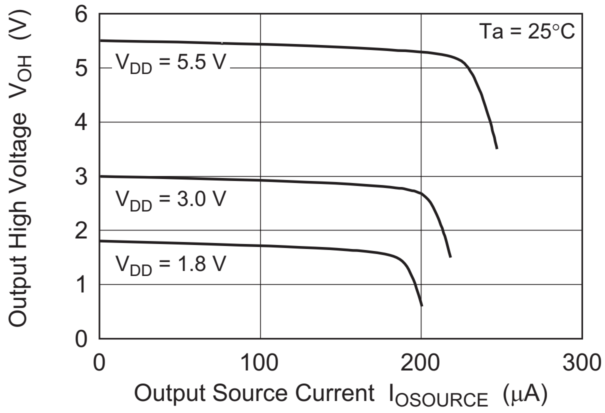


Figure 1-4. HA1630D04
Output High Voltage vs. Supply Voltage

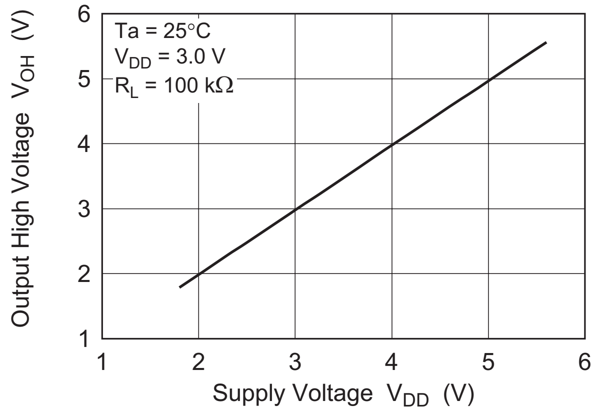


Figure 1-5. HA1630D04
Output Source Current vs. Ambient Temperature

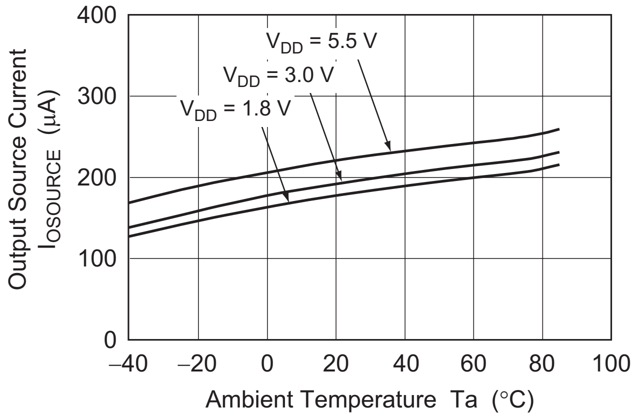


Figure 1-6. HA1630D04
Output Low Voltage vs. Output Sink Current

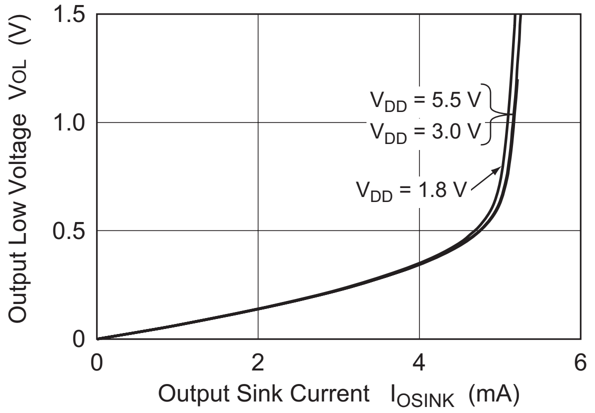


Figure 1-7. HA1630D04
Output Sink Current vs. Ambient Temperature

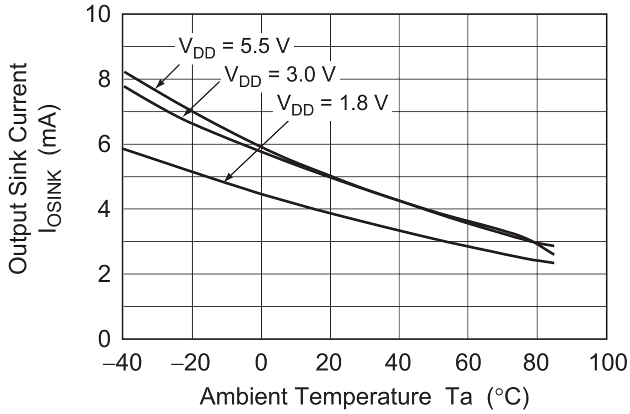


Figure 1-8. HA1630D04
Input Offset Voltage Distribution

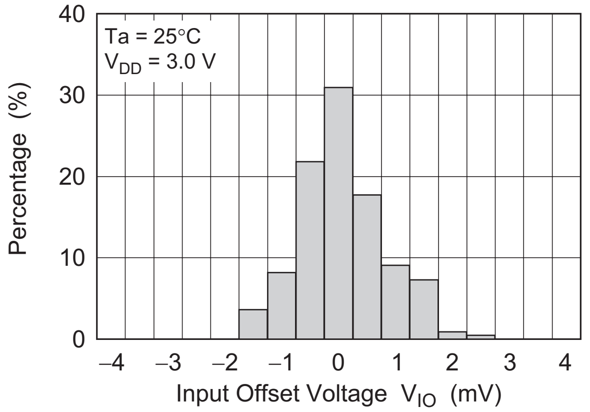


Figure 1-9. HA1630D04
Input Offset Voltage vs. Supply Voltage

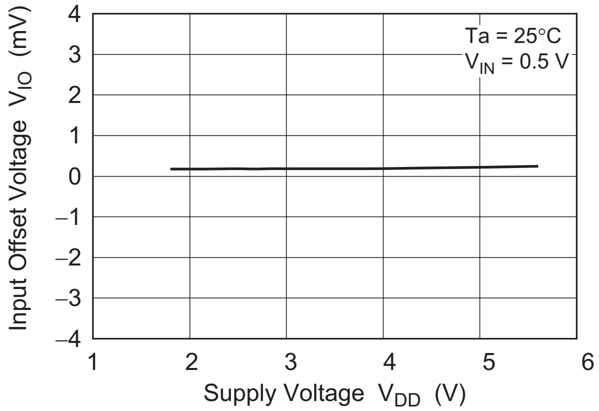


Figure 1-10. HA1630D04
Input Offset Voltage vs. Ambient Temperature

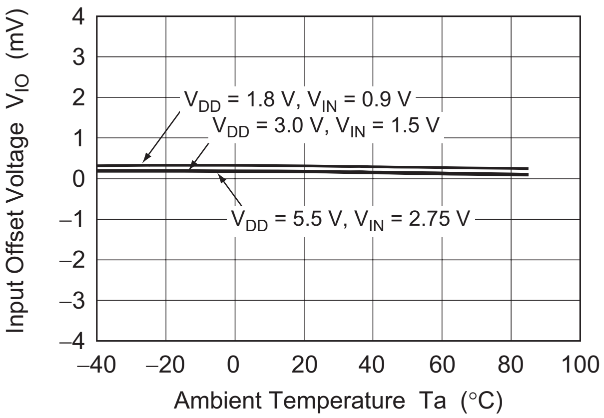


Figure 1-11. HA1630D04
Common Mode Input Voltage vs.
Ambient Temperature

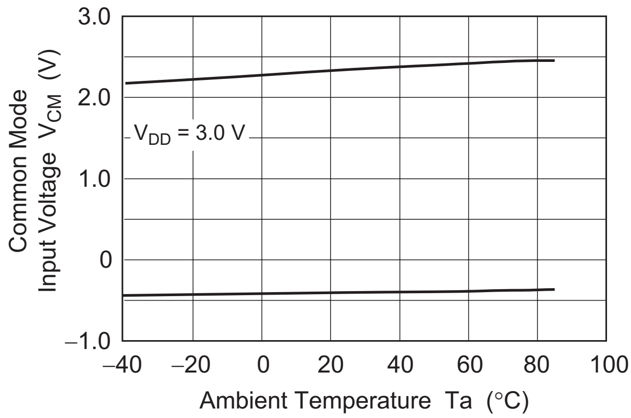


Figure 1-12. HA1630D04
Power Supply Rejection Ratio vs. Frequency

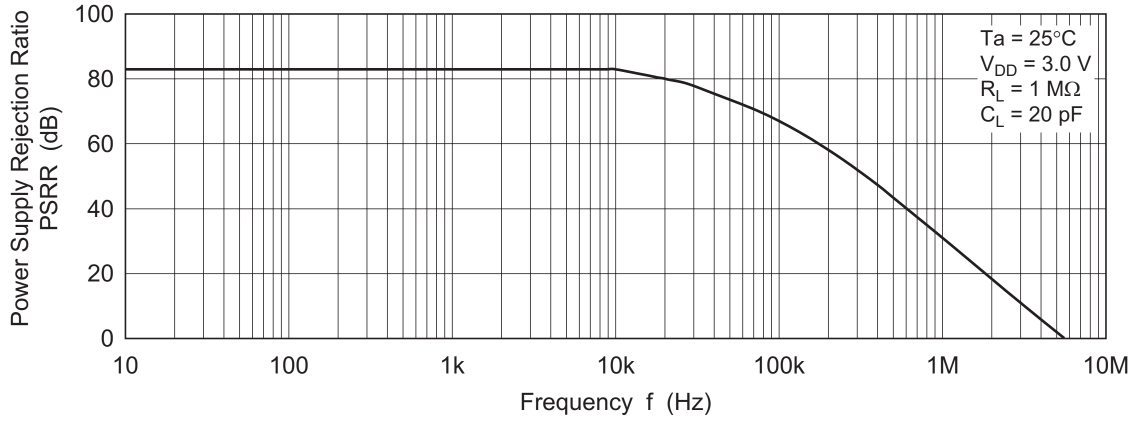


Figure 1-13. HA1630D04
Common Mode Rejection Ratio vs. Frequency

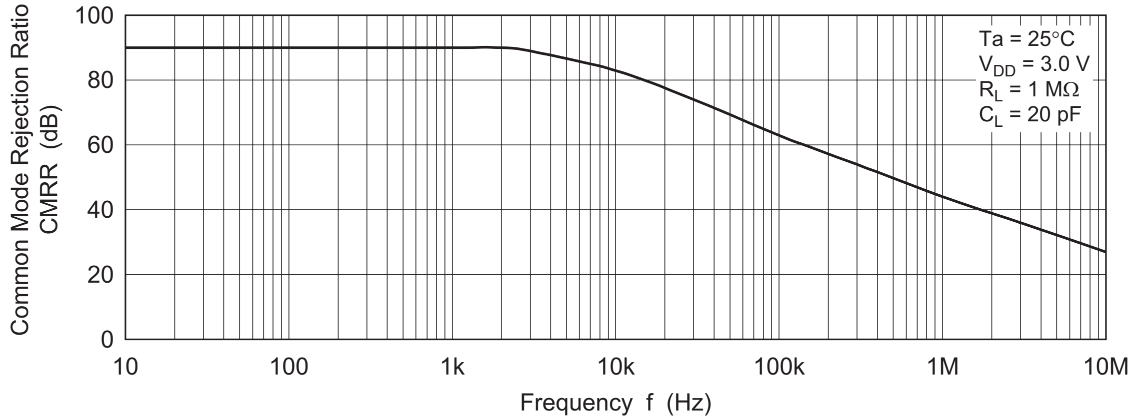


Figure 1-14. HA1630D04
Open Loop Voltage Gain and Phase Angle vs. Frequency

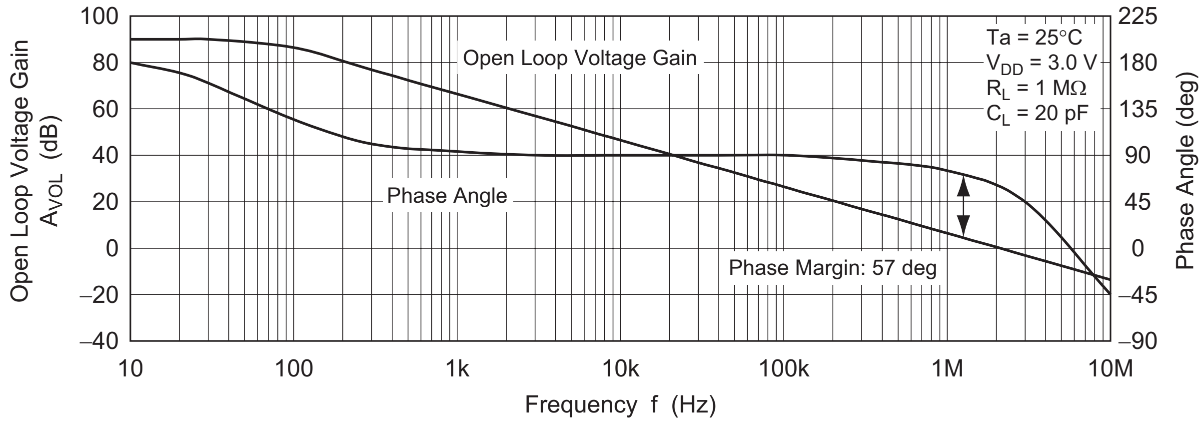


Figure 1-15. HA1630D04
Input Bias Current vs. Ambient Temperature

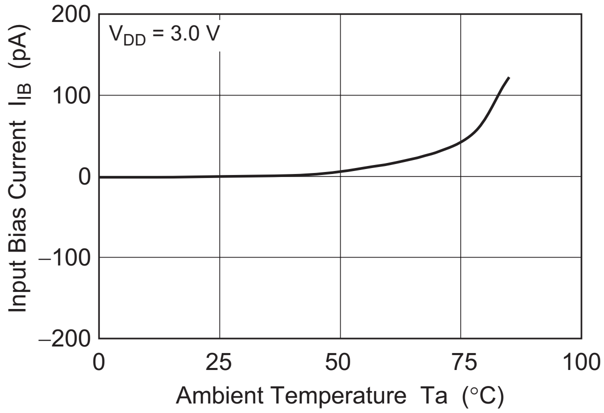


Figure 1-16. HA1630D04
Input Bias Current vs. Input Voltage

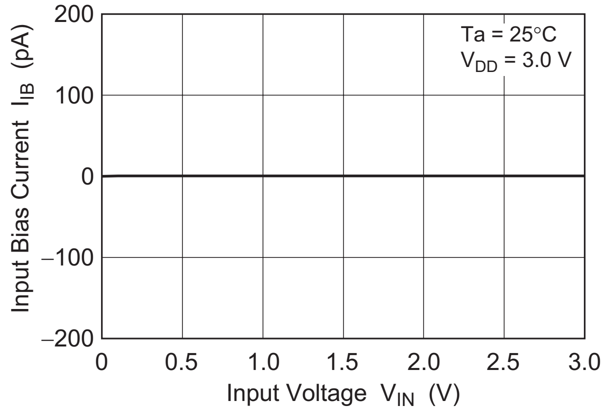


Figure 1-17. HA1630D04
Slew Rate (rising) vs. Ambient Temperature

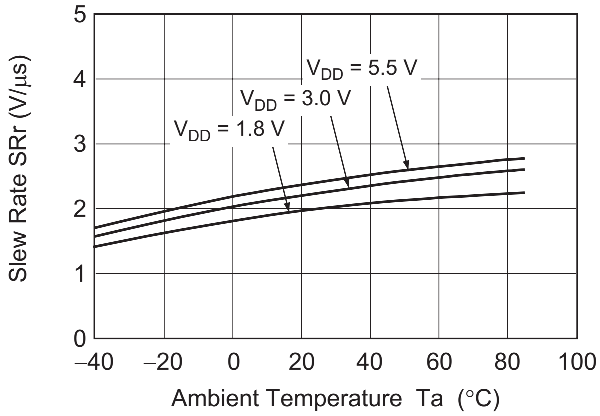


Figure 1-18. HA1630D04
Slew Rate (falling) vs. Ambient Temperature

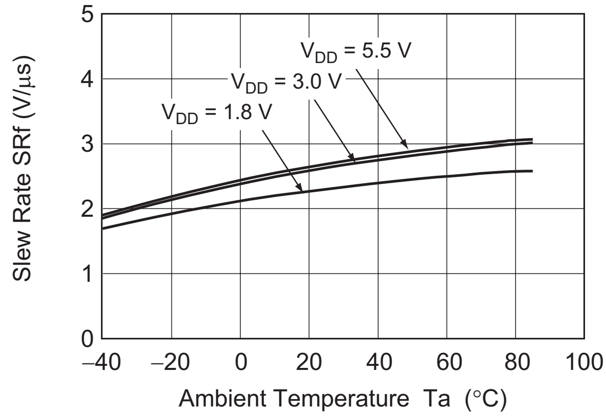


Figure 1-19. HA1630D04
Large Signal Transient Response

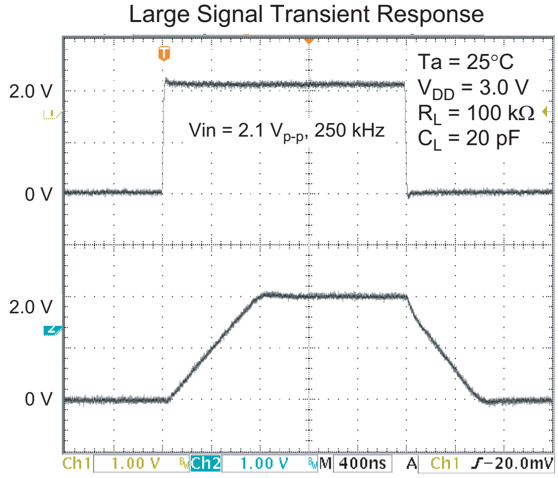


Figure 1-20. HA1630D04
Small Signal Transient Response

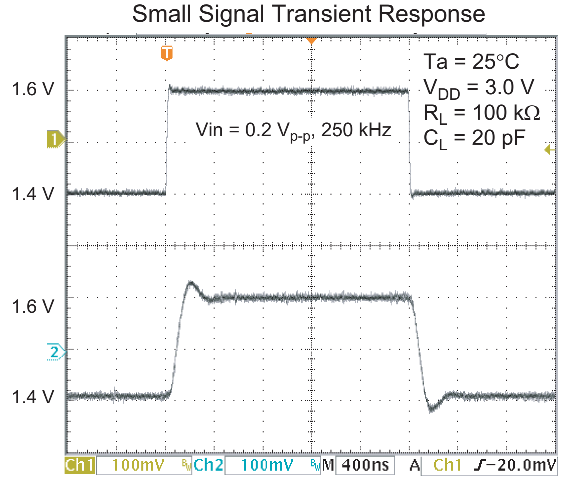


Figure 1-21. HA1630D04
Total Harmonic Distortion + Noise vs.
Output Voltage p-p

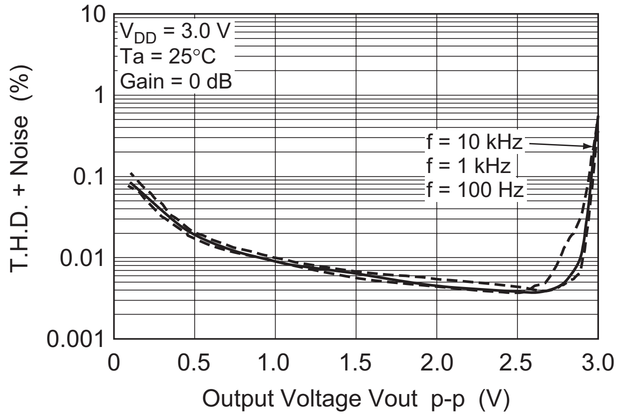


Figure 1-22. HA1630D04
Total Harmonic Distortion + Noise vs.
Output Voltage p-p

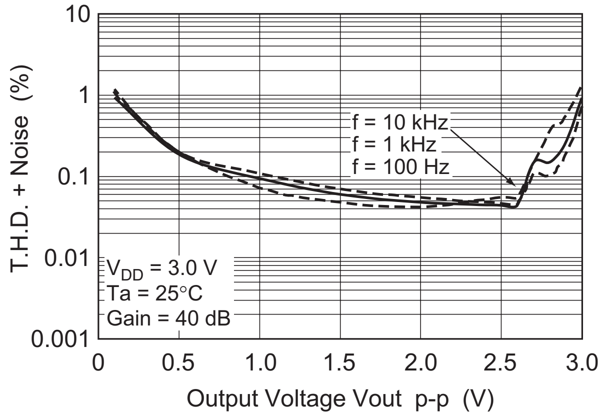


Figure 1-23. HA1630D04
Voltage Output p-p vs. Frequency

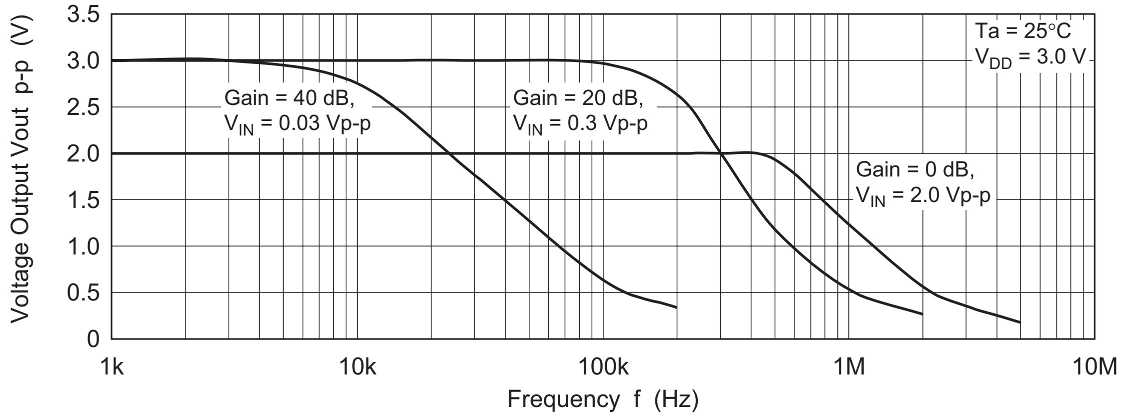


Figure 1-24. HA1630D04
Voltage Noise Density vs. Frequency

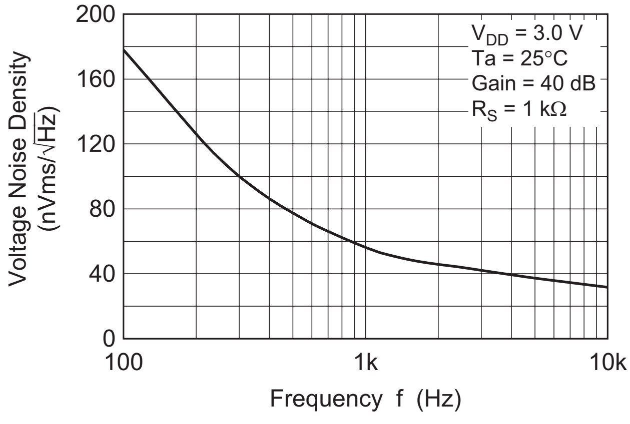
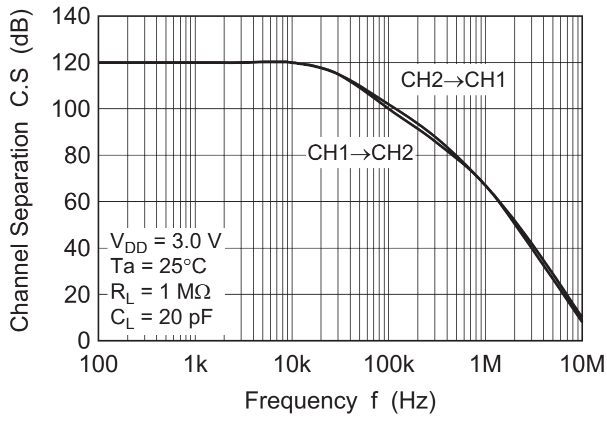


Figure 1-25. HA1630D04
Channel Separation vs. Frequency



RENESAS

Main Characteristics (HA1630D05)

Figure 2-1. HA1630D05
Supply Current vs. Supply Voltage

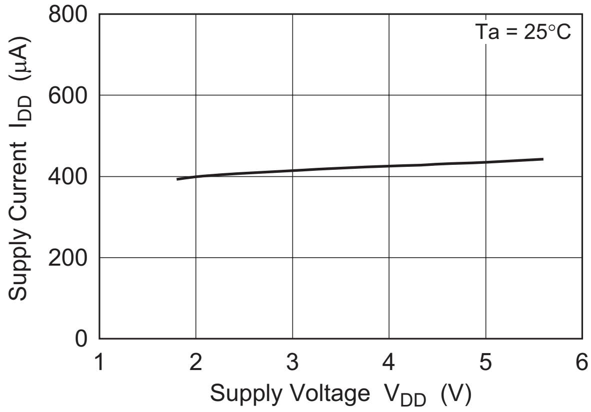


Figure 2-2. HA1630D05
Supply Current vs. Ambient Temperature

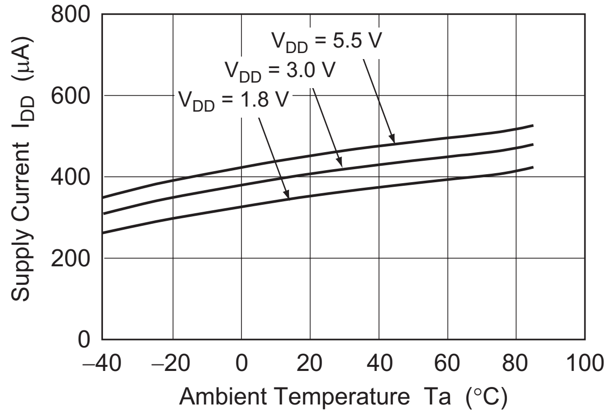


Figure 2-3. HA1630D05
Output High Voltage vs. Output Source Current

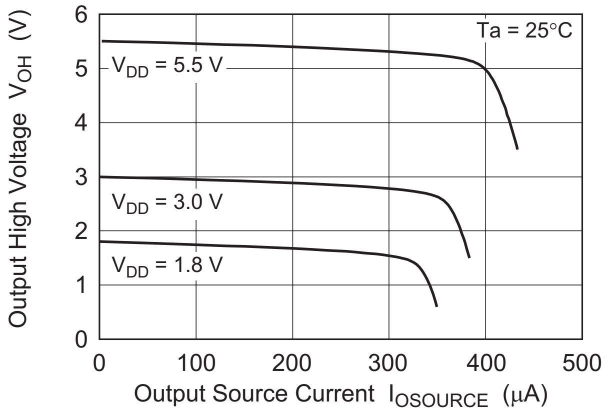


Figure 2-4. HA1630D05
Output High Voltage vs. Supply Voltage

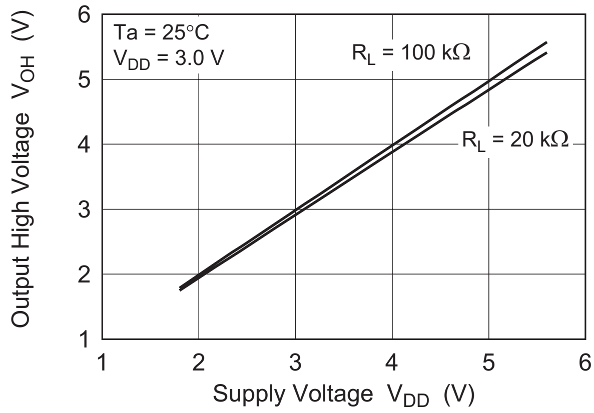


Figure 2-5. HA1630D05
Output Source Current vs. Ambient Temperature

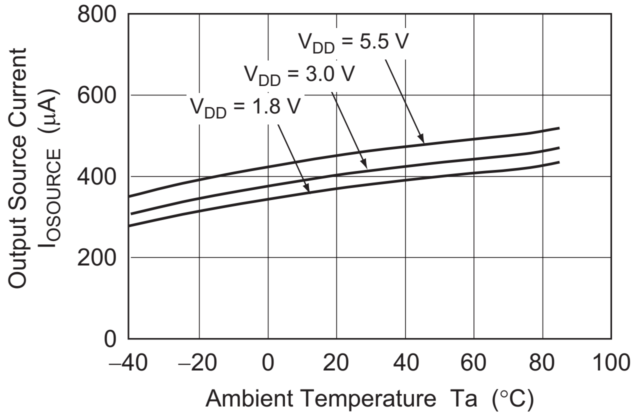


Figure 2-6. HA1630D05
Output Low Voltage vs. Output Sink Current

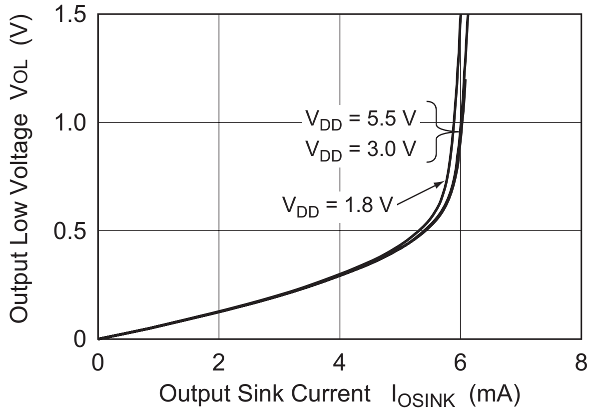


Figure 2-7. HA1630D05
Output Sink Current vs. Ambient Temperature

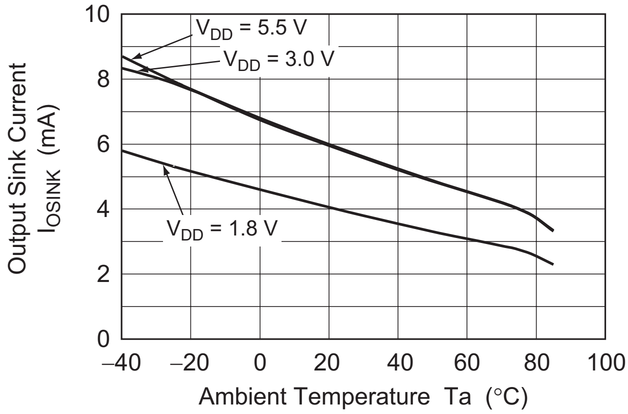


Figure 2-8. HA1630D05
Input Offset Voltage Distribution

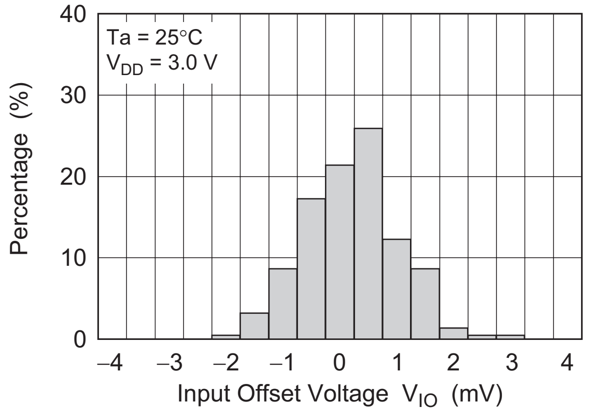


Figure 2-9. HA1630D05
Input Offset Voltage vs. Supply Voltage

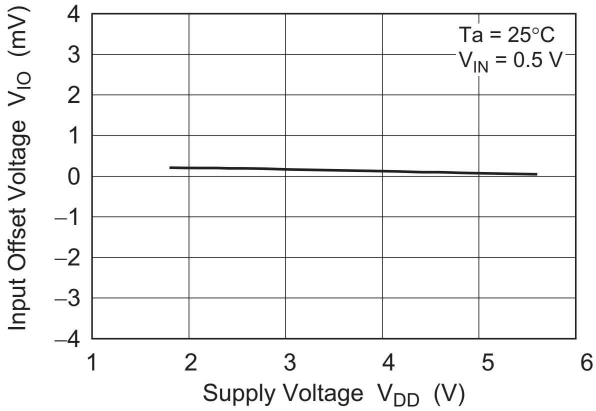


Figure 2-10. HA1630D05
Input Offset Voltage vs. Ambient Temperature

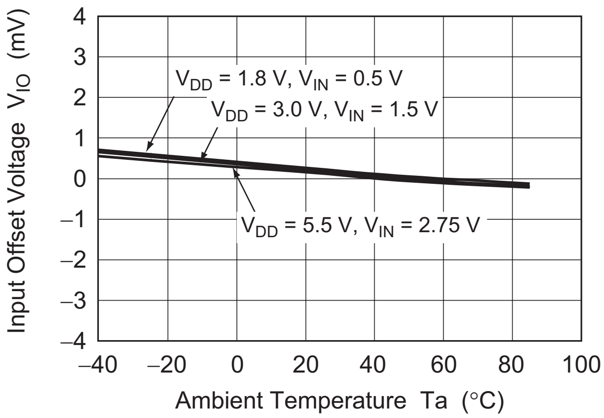


Figure 2-11. HA1630D05
Common Mode Input Voltage vs.
Ambient Temperature

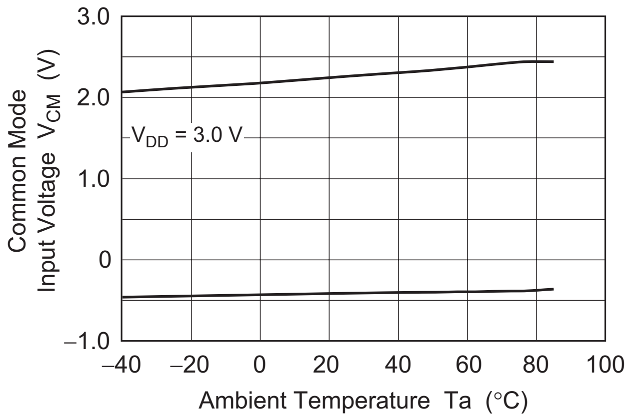


Figure 2-12. HA1630D05
Power Supply Rejection Ratio vs. Frequency

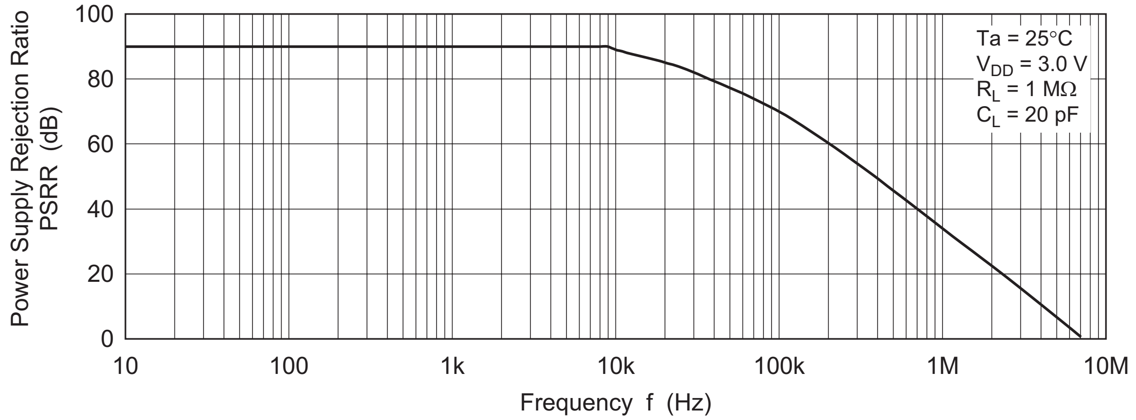


Figure 2-13. HA1630D05
Common Mode Rejection Ratio vs. Frequency

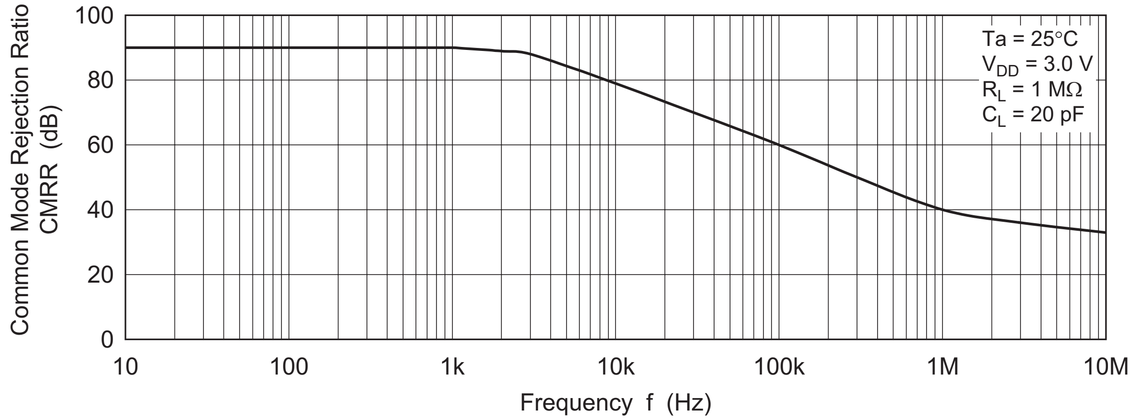


Figure 2-14. HA1630D05
Open Loop Voltage Gain and Phase Angle vs. Frequency

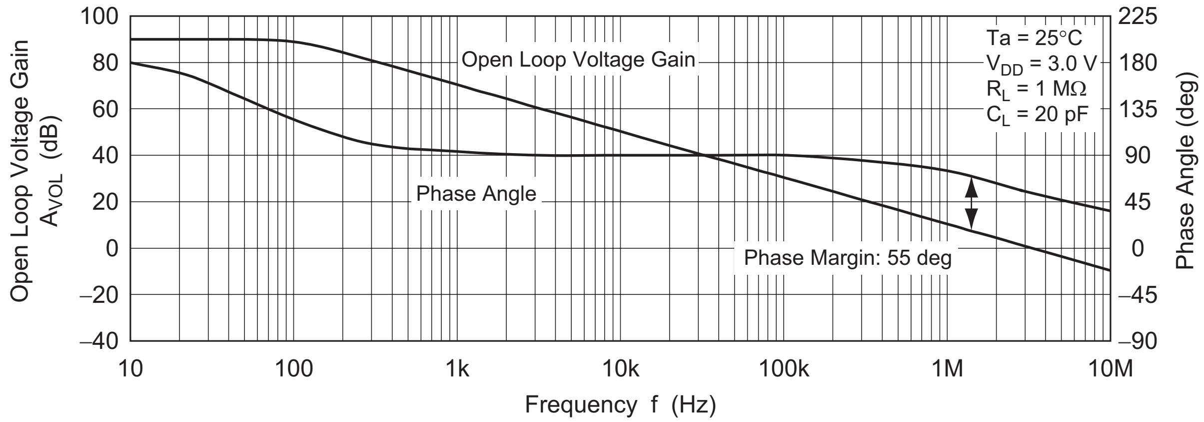


Figure 2-15. HA1630D05
Input Bias Current vs. Ambient Temperature

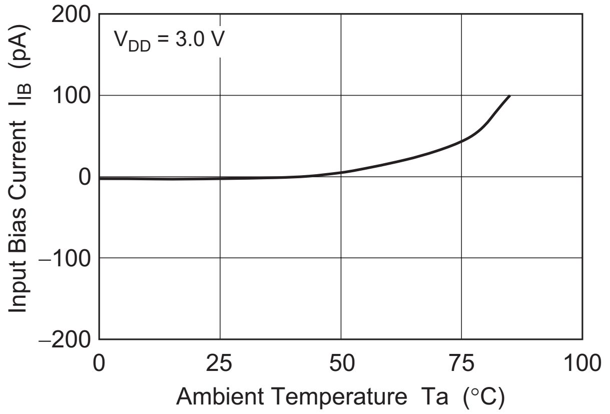


Figure 2-16. HA1630D05
Input Bias Current vs. Input Voltage

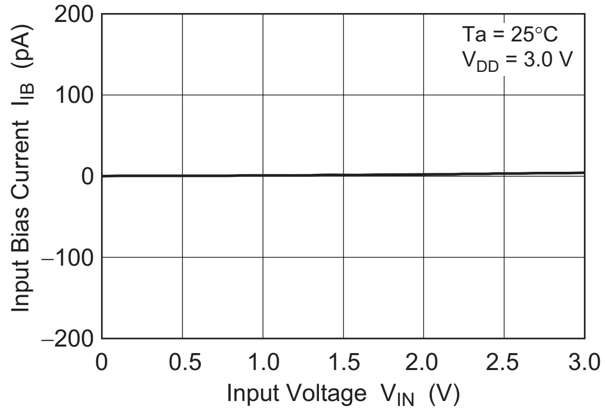


Figure 2-17. HA1630D05
Slew Rate (rising) vs. Ambient Temperature

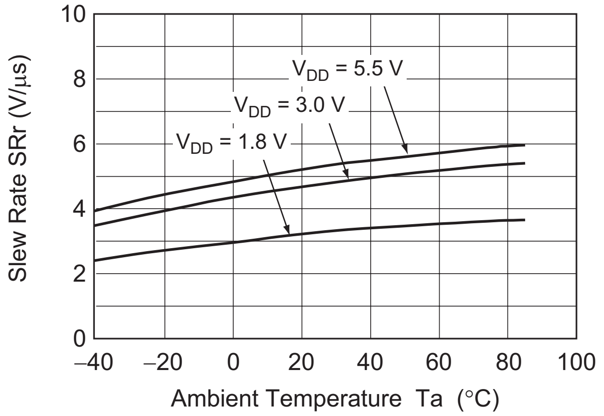


Figure 2-18. HA1630D05
Slew Rate (falling) vs. Ambient Temperature

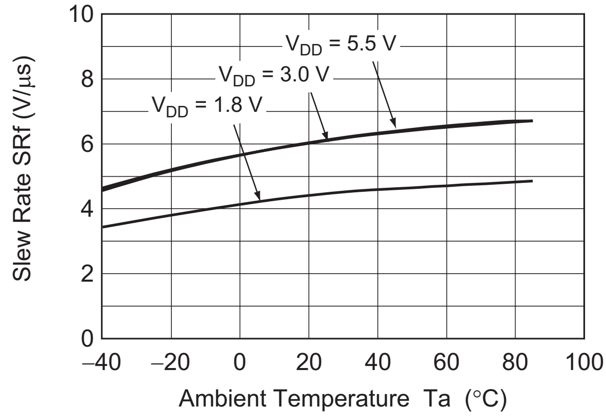


Figure 2-19. HA1630D05
Large Signal Transient Response

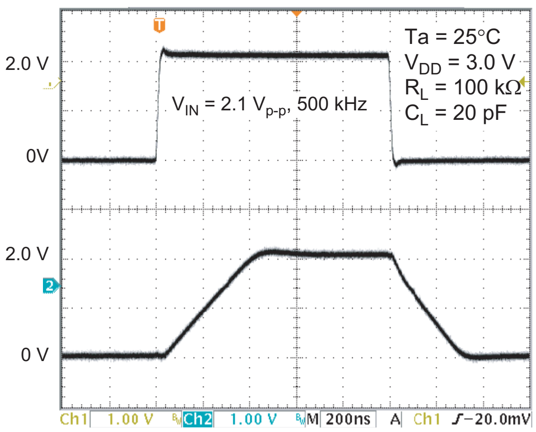


Figure 2-20. HA1630D05
Small Signal Transient Response

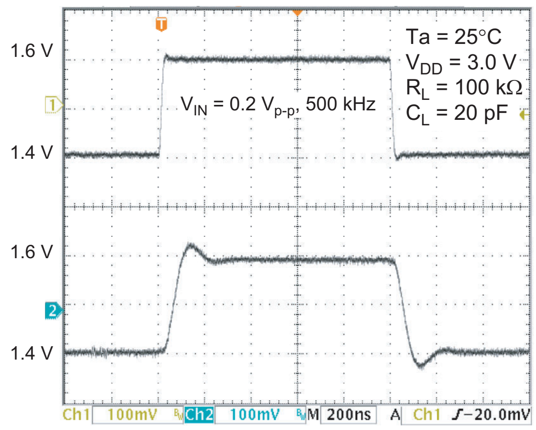


Figure 2-21. HA1630D05
Total Harmonic Distortion + Noise vs.
Output Voltage p-p

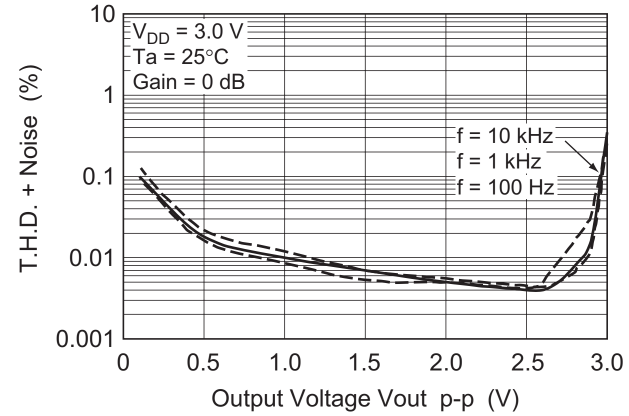


Figure 2-22. HA1630D05
Total Harmonic Distortion + Noise vs.
Output Voltage p-p

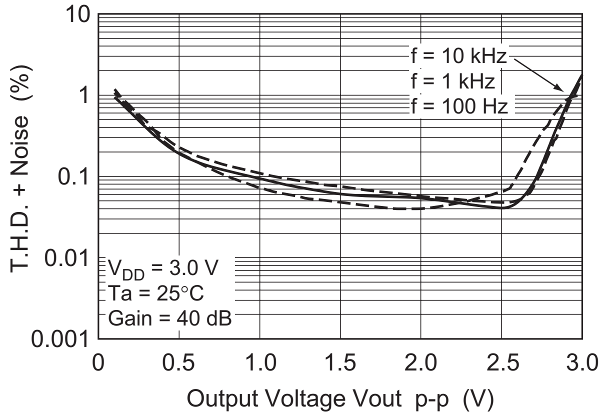


Figure 2-23. HA1630D05
Voltage Output p-p vs. Frequency

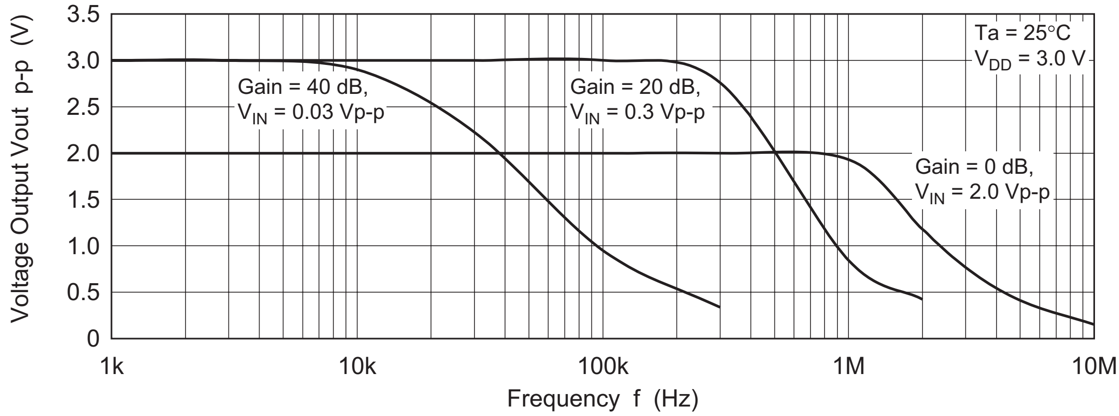


Figure 2-24. HA1630D05
Voltage Noise Density vs. Frequency

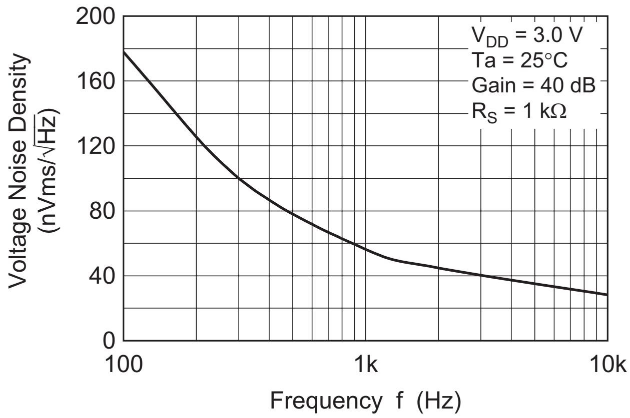
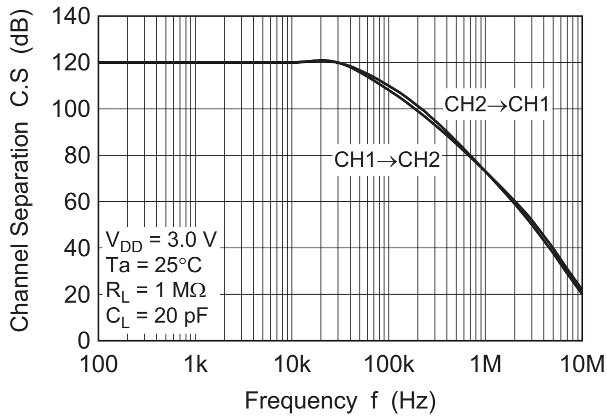


Figure 2-25. HA1630D05
Channel Separation vs. Frequency



Main Characteristics (HA1630D06)

Figure 3-1. HA1630D06
Supply Current vs. Supply Voltage

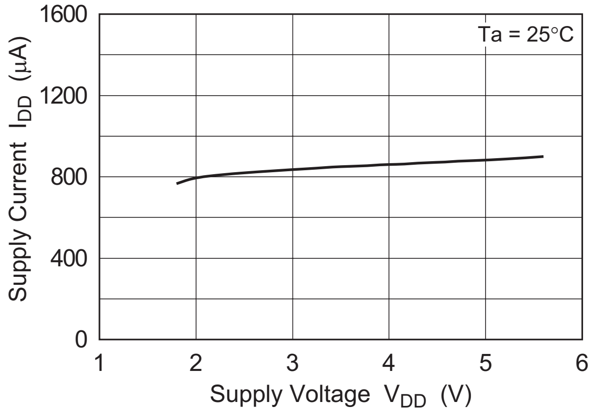


Figure 3-2. HA1630D06
Supply Current vs. Ambient Temperature

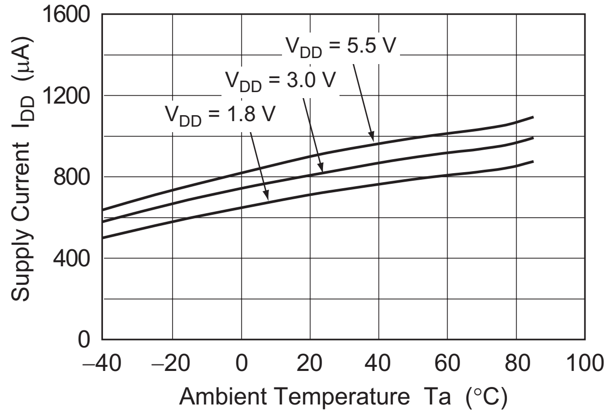


Figure 3-3. HA1630D06
Output High Voltage vs. Output Source Current

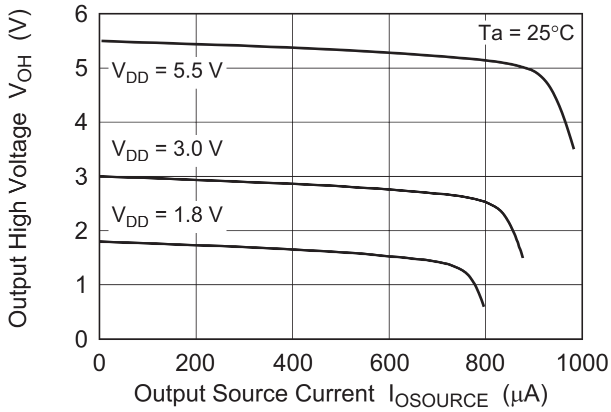


Figure 3-4. HA1630D06
Output High Voltage vs. Supply Voltage

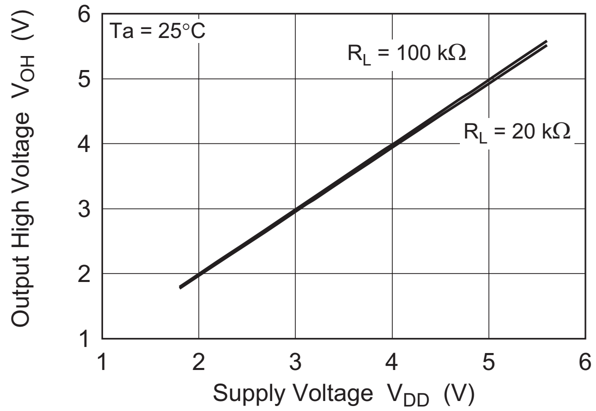


Figure 3-5. HA1630D06
Output Source Current vs. Ambient Temperature

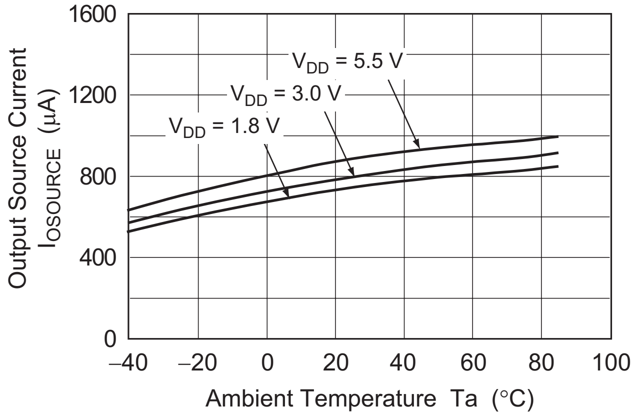


Figure 3-6. HA1630D06
Output Low Voltage vs. Output Sink Current

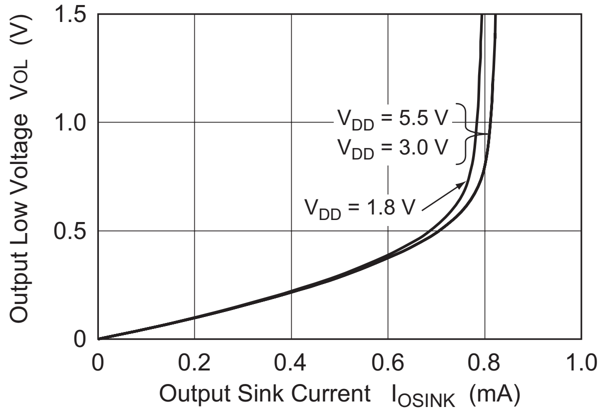


Figure 3-7. HA1630D06
Output Sink Current vs. Ambient Temperature

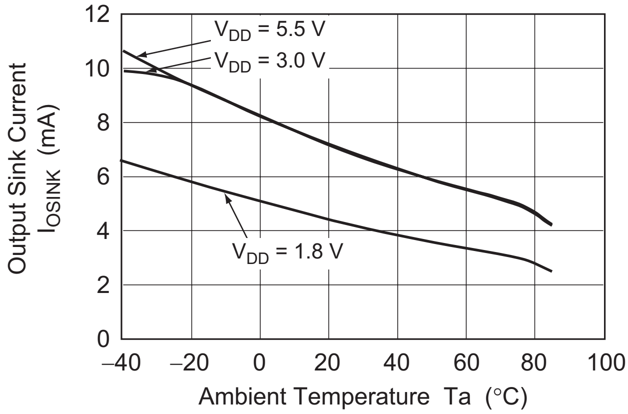


Figure 3-8. HA1630D06
Input Offset Voltage Distribution

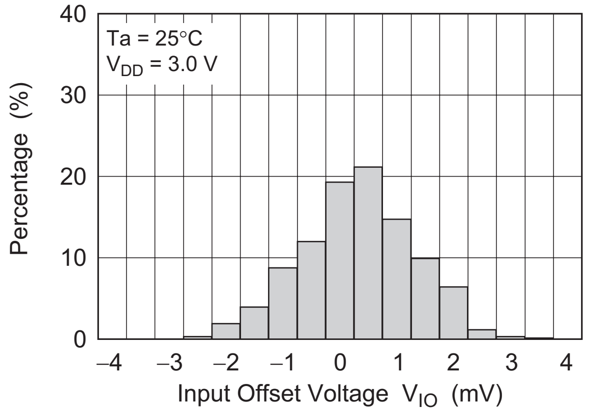


Figure 3-9. HA1630D06
Input Offset Voltage vs. Supply Voltage

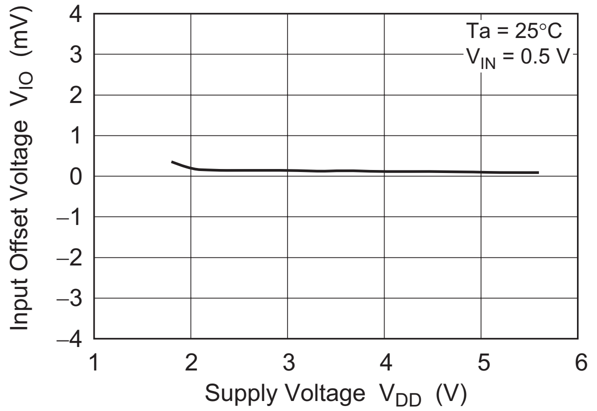


Figure 3-10. HA1630D06
Input Offset Voltage vs. Ambient Temperature

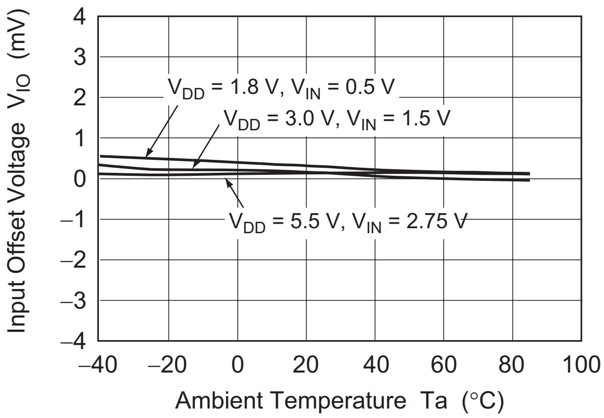


Figure 3-11. HA1630D06
Common Mode Input Voltage vs.
Ambient Temperature

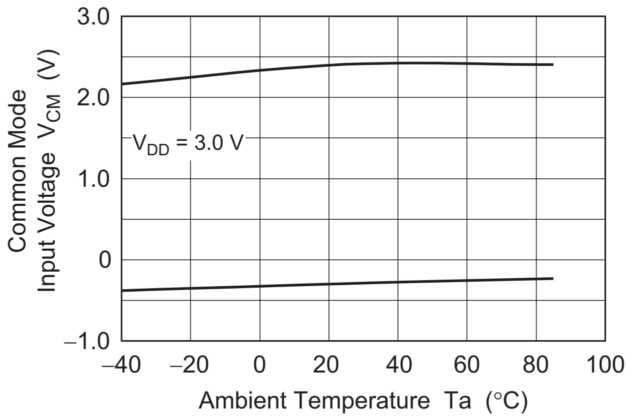


Figure 3-12. HA1630D06
Power Supply Rejection Ratio vs. Frequency

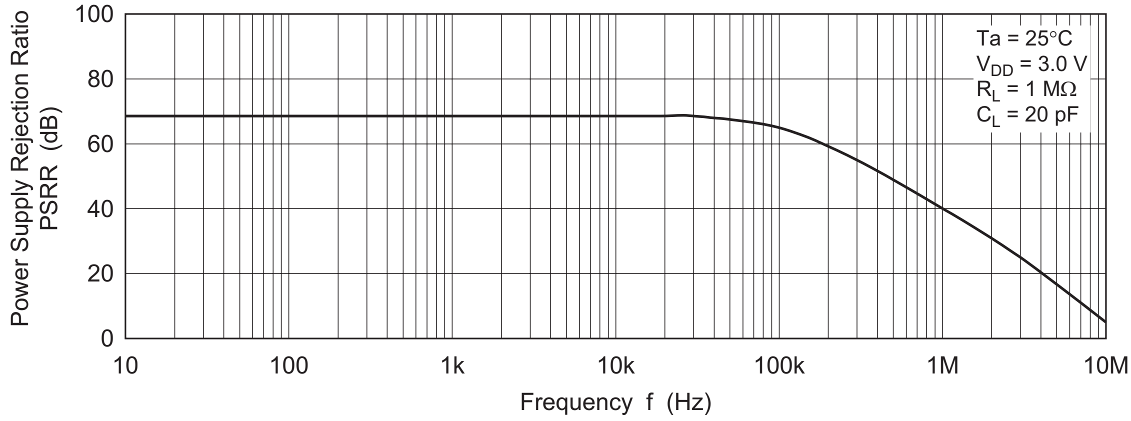


Figure 3-13. HA1630D06
Common Mode Rejection Ratio vs. Frequency

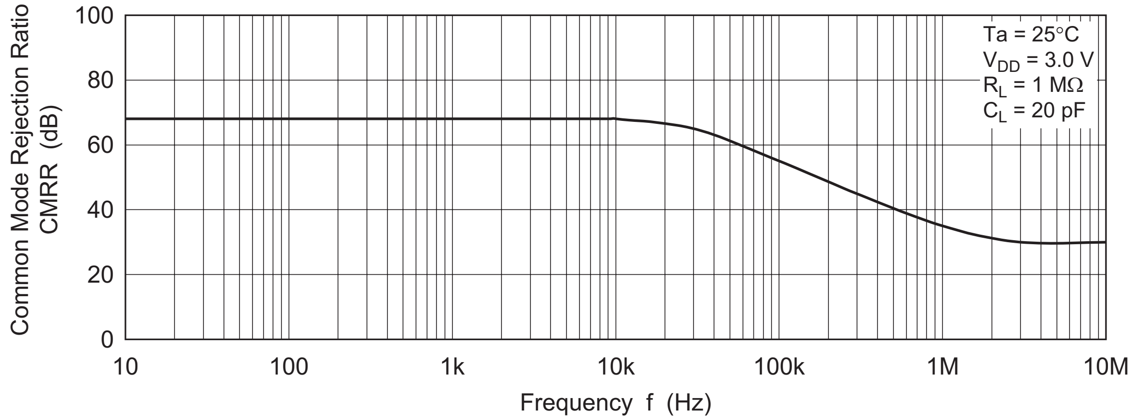


Figure 3-14. HA1630D06
Open Loop Voltage Gain and Phase Angle vs. Frequency

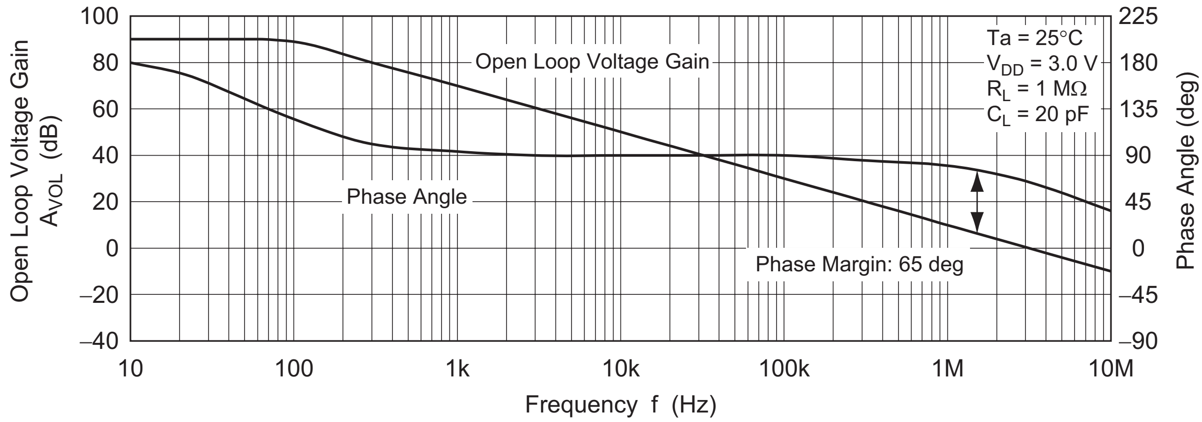


Figure 3-15. HA1630D06
Input Bias Current vs. Ambient Temperature

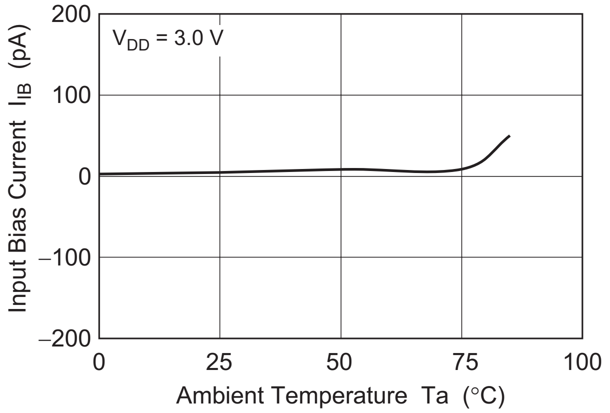


Figure 3-16. HA1630D06
Input Bias Current vs. Input Voltage

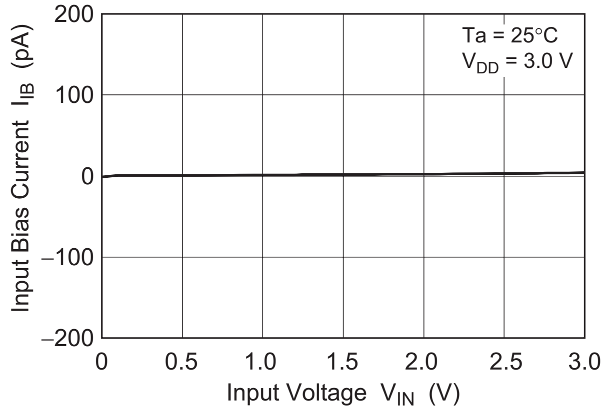


Figure 3-17. HA1630D06
Slew Rate (rising) vs. Ambient Temperature

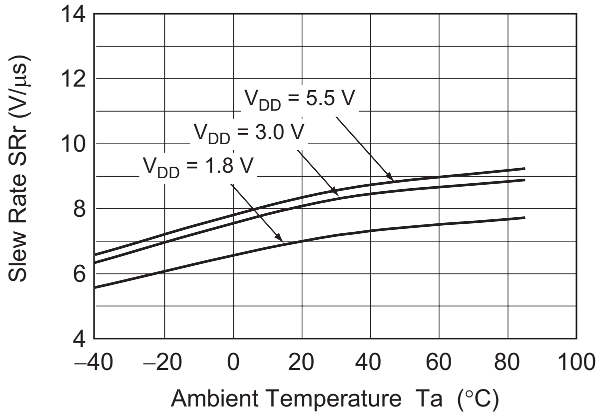


Figure 3-18. HA1630D06
Slew Rate (falling) vs. Ambient Temperature

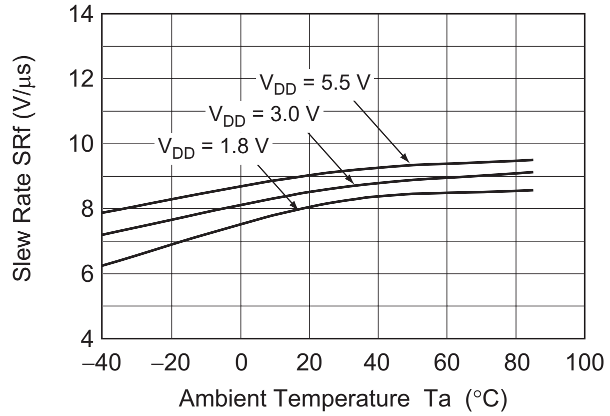


Figure 3-19. HA1630D06
Large Signal Transient Response

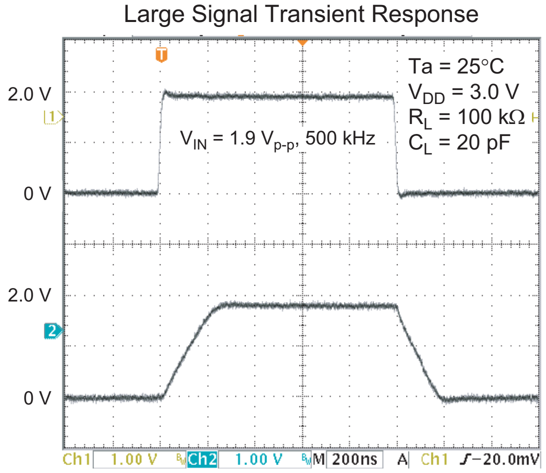
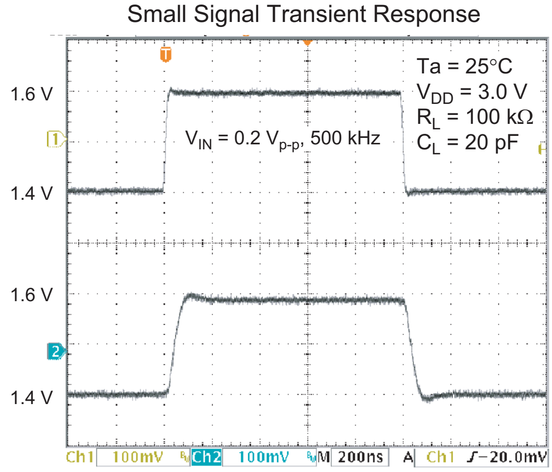


Figure 3-20. HA1630D06
Small Signal Transient Response



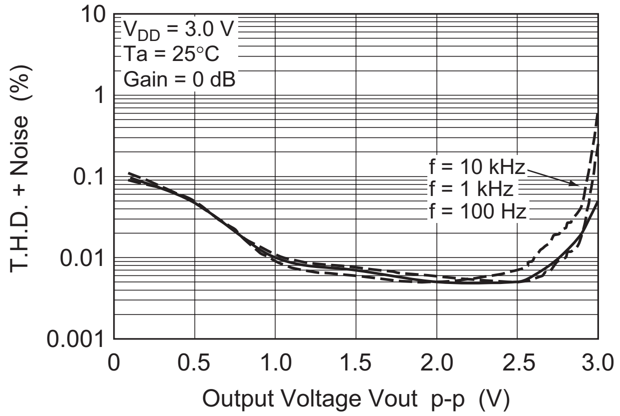


Figure 3-21. HA1630D06
Total Harmonic Distortion + Noise vs.
Output Voltage p-p

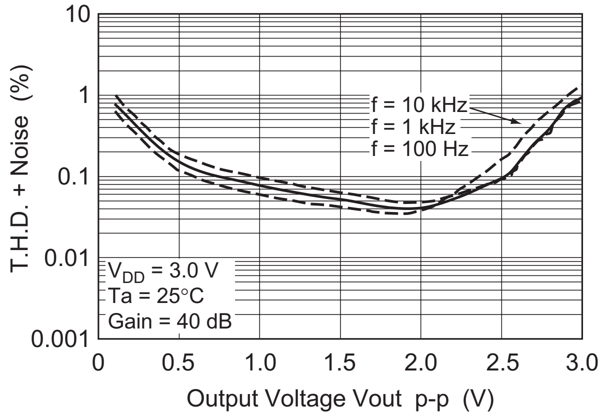


Figure 3-22. HA1630D06
Total Harmonic Distortion + Noise vs.
Output Voltage p-p

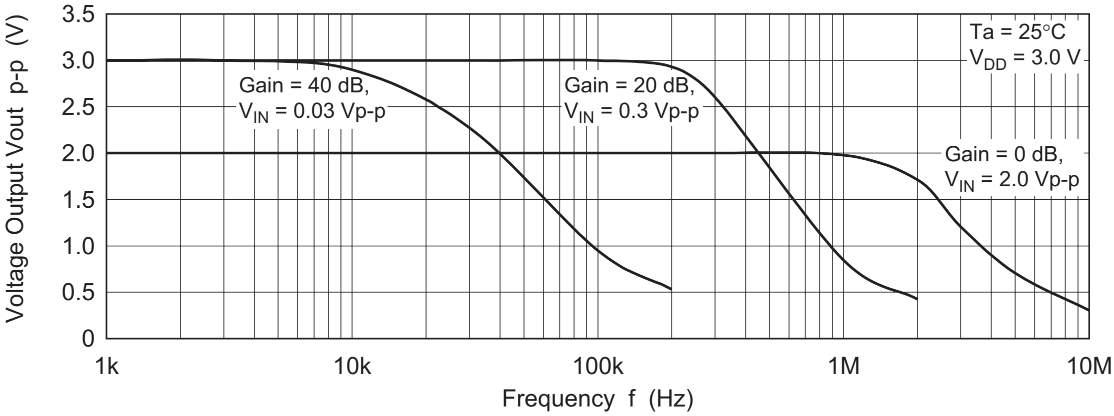


Figure 3-23. HA1630D06
Voltage Output p-p vs. Frequency

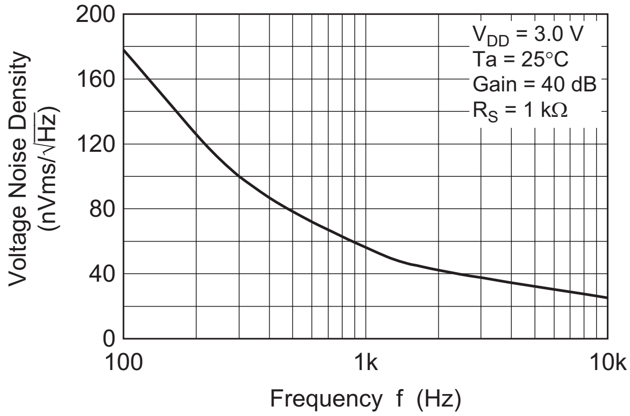


Figure 3-24. HA1630D06
Voltage Noise Density vs. Frequency

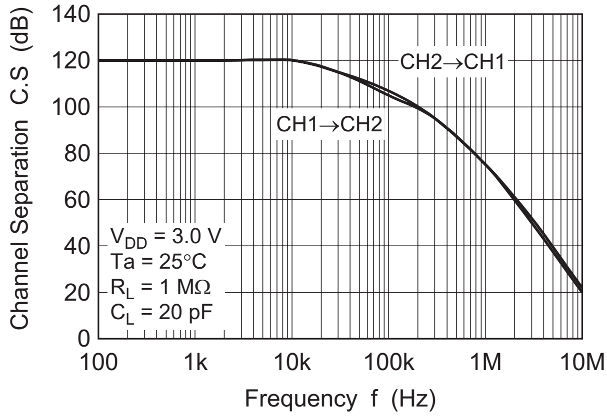
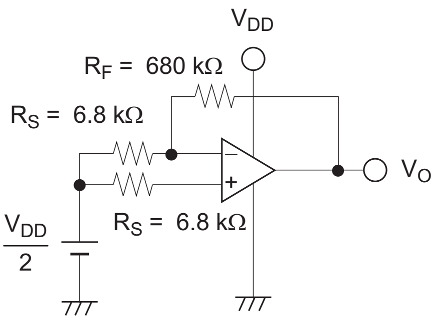


Figure 3-25. HA1630D06
Channel Separation vs. Frequency

RENESAS

Test Circuits

1. Power Supply Rejection Ratio, PSRP & Voltage Offset, V_{IO}



V_{IO}

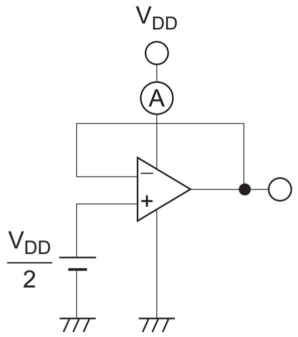
$$V_{IO} = \left(V_O - \frac{V_{DD}}{2}\right) \times \frac{R_S}{R_S + R_F}$$

PSRR

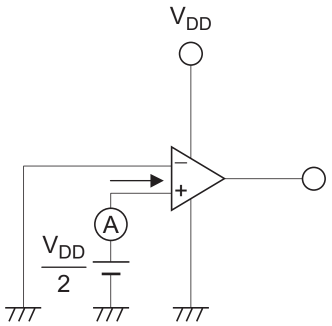
$$PSRR = -20\log\left(\left|\frac{V_{DD1} - V_{DD2}}{V_{O1} - V_{O2}}\right| \times \frac{R_S}{R_S + R_F}\right)$$

Measure V_O corresponding to V_{DD1} = 2.95 V and V_{DD2} = 3.05 V

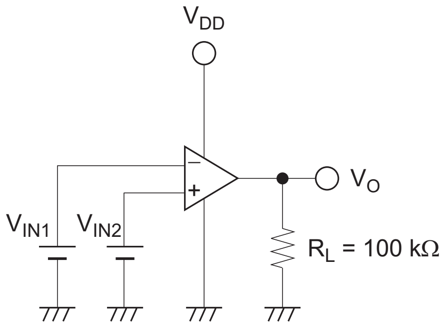
2. Supply Current, I_{DD}



3. Input Bias Current, I_{IB}



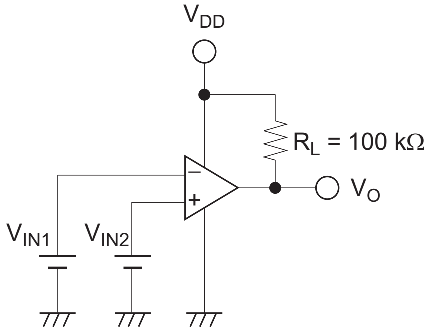
4. Output High Voltage, V_{OH}



V_{OH}

$V_{IN1} = V_{DD} / 2 - 0.05$ V
$V_{IN2} = V_{DD} / 2 + 0.05$ V

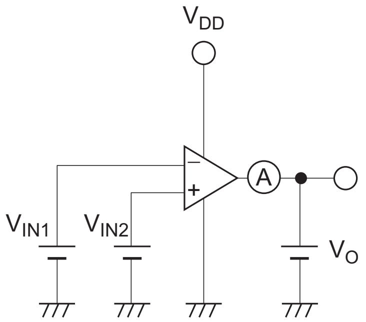
5. Output Low Voltage, V_{OL}



V_{OL}

$V_{IN1} = V_{DD} / 2 + 0.05$ V
$V_{IN2} = V_{DD} / 2 - 0.05$ V

6. Output Source Current, $I_{OSOURCE}$ & Output Sink Current, I_{OSINK}



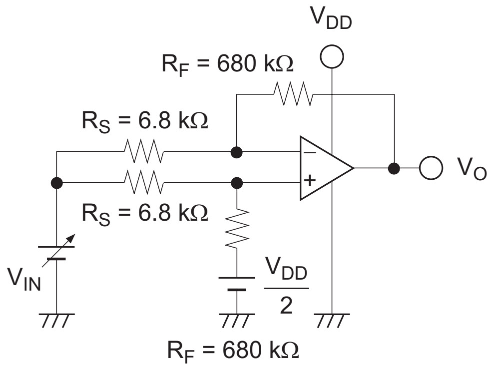
$\underline{I_{OSOURCE}}$

$V_O = V_{DD} - 0.5$ V
$V_{IN1} = V_{DD} / 2 - 0.05$ V
$V_{IN2} = V_{DD} / 2 + 0.05$ V

$\underline{I_{OSINK}}$

$V_O = +0.5$ V
$V_{IN1} = V_{DD} / 2 + 0.05$ V
$V_{IN2} = V_{DD} / 2 - 0.05$ V

7. Common Mode Input Voltage, V_{CM} & Common Mode Rejection Ratio, CMRR

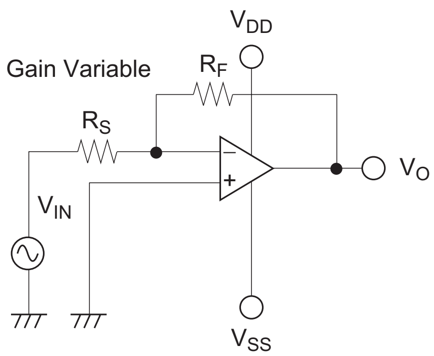


CMRR

$$CMRR = -20\log\left(\left|\frac{V_{IN1} - V_{IN2}}{V_{O1} - V_{O2}}\right| \times \frac{R_S}{R_S + R_F}\right)$$

Measure V_O corresponding to $V_{IN1} = 1.45$ V and $V_{IN2} = 1.55$ V

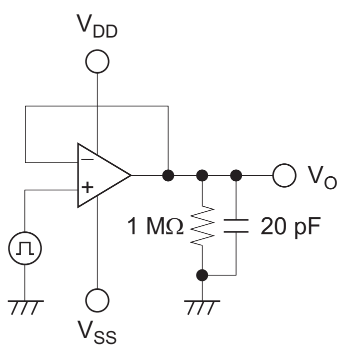
8. Total Harmonic Distortion, THD



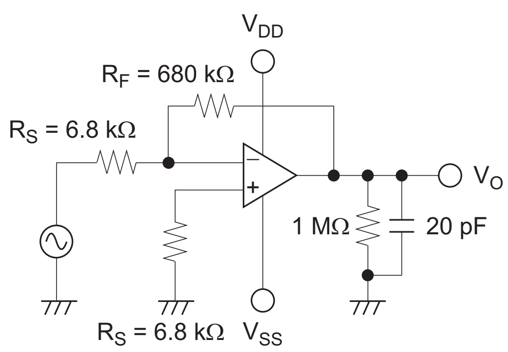
THD

Gain Variable
$R_F / R_S = 20\log(100\ k\Omega / 1\ k\Omega) = 40$ dB
$R_F / R_S = 20\log(100\ k\Omega / 100\ k\Omega) = 0$ dB
freq = 100 Hz, 1 kHz, 10 kHz
30 kHz LPF ON

9. Slew Rate, SR

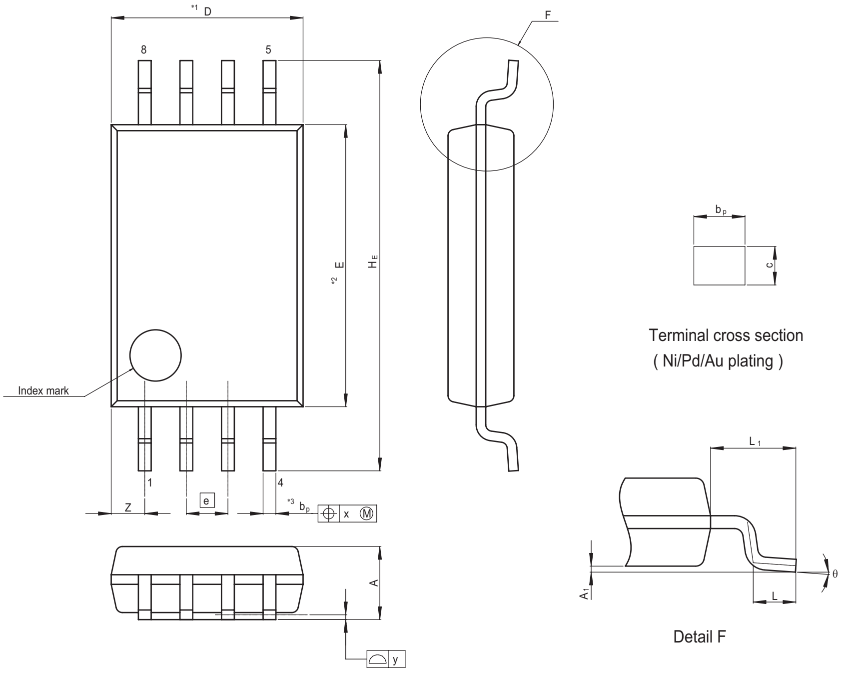


10. Gain, A_V & Phase, GBW



Package Dimensions

JEITA Package Code	RENESAS Code	Previous Code	MASS[Typ.]
P-TSSOP8-4.4x3-0.65	PTSP0008JC-B	TTP-8DAV	0.034g

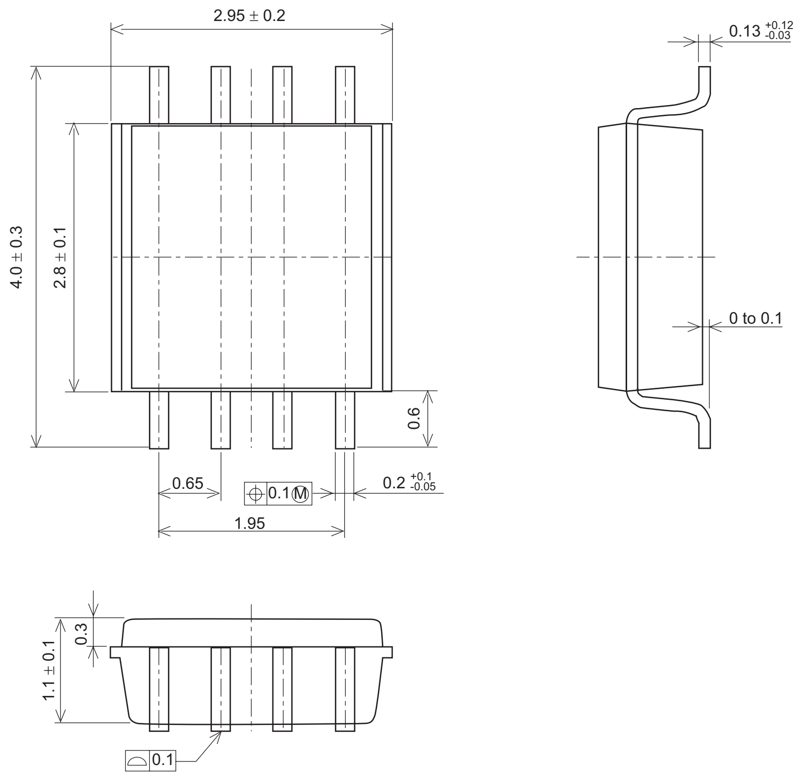


NOTE)
1. DIMENSIONS"*1 (Nom)"AND"*2" DO NOT INCLUDE MOLD FLASH.
2. DIMENSION"*3"DOES NOT INCLUDE TRIM OFFSET.

Reference Symbol	Dimension in Millimeters		
	Min	Nom	Max
D	—	3.00	3.30
E	—	4.40	—
A_2	—	—	—
A_1	0.03	0.07	0.10
A	—	—	1.10
b_p	0.15	0.20	0.25
b_1	—	—	—
c	0.10	0.15	0.20
c_1	—	—	—
θ	0°	—	8°
H_E	6.20	6.40	6.60
e	—	0.65	—
x	—	—	0.13
y	—	—	0.10
Z	—	—	0.805
L	0.40	0.50	0.60
L_1	—	1.00	—

Package Name	JEITA Package Code	RENESAS Code	Previous Code	MASS[Typ.]
MMPAK-8	P-LSOP8-2.8 x 2.95 - 0.65	PLSP0008JC-A	—	0.02 g

Unit: mm



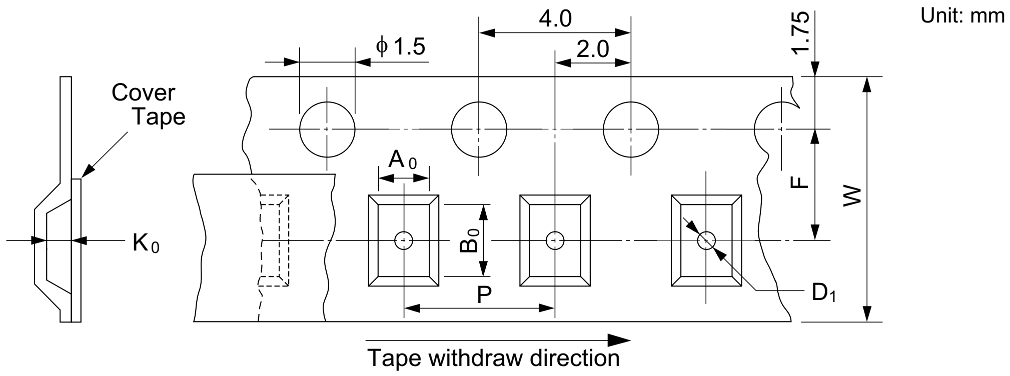
RENESAS

Taping & Reel Specification

[Taping]

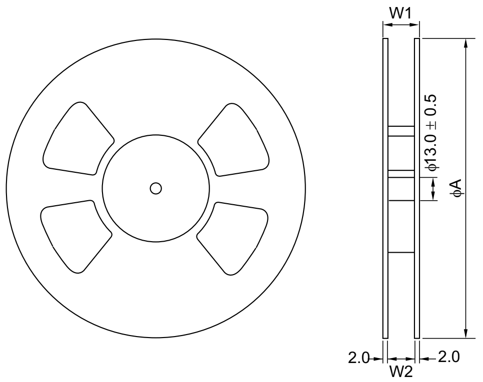
Package Code	W	P	Ao	Bo	Ko	E	F	D1	Maximum Storage No.
TSSOP-8	12	8	6.9	3.6	1.7	1.75	5.5	1.5	3,000 pcs/reel
MMPAK-8	12	4.0	3.15	4.35	—	—	5.5	1.05	3,000 pcs/reel

Unit: mm



[Reel]

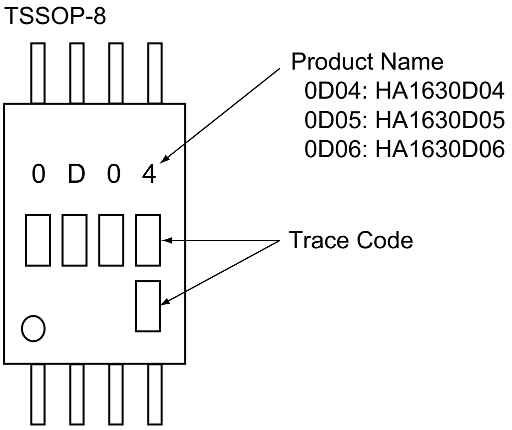
Package	Tape width	W1	W2	A
TSSOP-8	12	17.4	13.4	330
MMPAK-8	12	17.0	13.0	178

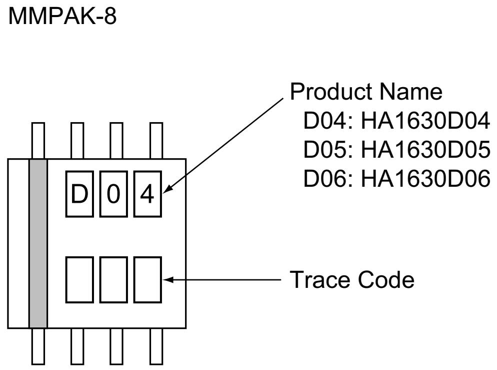


[Ordering Information]

Ordering Unit
3,000 pcs

Mark Indication





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Renesas Technology Europe Limited
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Tel: <44> (1628) 585-100, Fax: <44> (1628) 585-900

Renesas Technology (Shanghai) Co., Ltd.
Unit 204, 205, AZIACenter, No.1233 Lujiazui Ring Rd, Pudong District, Shanghai, China 200120
Tel: <86> (21) 5877-1818, Fax: <86> (21) 6887-7898

Renesas Technology Hong Kong Ltd.
7th Floor, North Tower, World Finance Centre, Harbour City, 1 Canton Road, Tsimshatsui, Kowloon, Hong Kong
Tel: <852> 2265-6688, Fax: <852> 2730-6071

Renesas Technology Taiwan Co., Ltd.
10th Floor, No.99, Fushing North Road, Taipei, Taiwan
Tel: <886> (2) 2715-2888, Fax: <886> (2) 2713-2999

Renesas Technology Singapore Pte. Ltd.
1 Harbour Front Avenue, #06-10, Keppel Bay Tower, Singapore 098632
Tel: <65> 6213-0200, Fax: <65> 6278-8001

Renesas Technology Korea Co., Ltd.
Kukje Center Bldg. 18th Fl., 191, 2-ka, Hangang-ro, Yongsan-ku, Seoul 140-702, Korea
Tel: <82> (2) 796-3115, Fax: <82> (2) 796-2145

Renesas Technology Malaysia Sdn. Bhd
Unit 906, Block B, Menara Amcorp, Amcorp Trade Centre, No.18, Jalan Persiaran Barat, 46050 Petaling Jaya, Selangor Darul Ehsan, Malaysia
Tel: <603> 7955-9390, Fax: <603> 7955-9510

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