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April 1st, 2010
Renesas Electronics Corporation

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HA1630Q01/02/03 Series

Low Voltage Operation CMOS Quad Operational Amplifier

REJ03D0802-0100
Rev.1.00
Mar 10, 2006

Description

The HA1630Q01/02/03 are 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-14 package that occupies only 1/2 the area of the SOP-14 package.

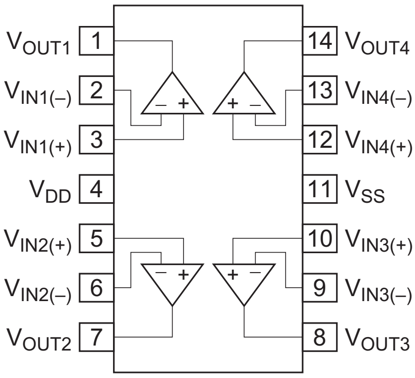
Features

- 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} = 15 µA Typ (HA1630Q01)
  I_{DD} = 50 µA Typ (HA1630Q02)
  I_{DD} = 100 µA Typ (HA1630Q03)
- Maximum output voltage — V_{OH} = 2.9 V Min (at V_{DD} = 3.0 V)
- Low input bias current — I_{IB} = 1 pA Typ

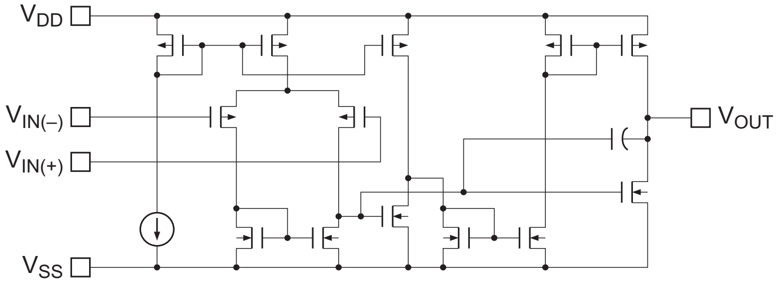
Ordering Information

Type No.	Package Name	Package Code
HA1630Q01T	TTP-14D	PTSP0014JA-B
HA1630Q02T	TTP-14D	PTSP0014JA-B
HA1630Q03T	TTP-14D	PTSP0014JA-B

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	400	mW	
Operating temp. Range	Topr	–40 to +85	°C	
Storage temp. Range	Tstg	–55 to +125	°C	

Note: 1. Do not apply Input Voltage exceeding V_{DD} or 7 V.

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 = 1 MΩ
Output source current	$I_{O\ SOURCE}$	6	12	—	µA	V_{OH} = 2.5 V (HA1630Q01)
		25	50	—		V_{OH} = 2.5 V (HA1630Q02)
		50	100	—		V_{OH} = 2.5 V (HA1630Q03)
Output low voltage	V_{OL}	—	—	0.1	V	R_L = 1 MΩ
Output sink current	$I_{O\ SINK}$	—	(0.8)	—	mA	V_{OL} = 0.5 V (HA1630Q01)
		—	(1.0)	—		V_{OL} = 0.5 V (HA1630Q02)
		—	(1.2)	—		V_{OL} = 0.5 V (HA1630Q03)
Common mode input voltage range	V_{CM}	–0.1 to 2.1	—	—	V	
Slew rate	SR	—	(0.125)	—	V/µs	C_L = 20 pF (HA1630Q01)
		—	(0.50)	—		C_L = 20 pF (HA1630Q02)
		—	(1.00)	—		C_L = 20 pF (HA1630Q03)
Voltage gain	A_V	60	80	—	dB	
Gain bandwidth product	BW	—	(200)	—	kHz	C_L = 20 pF (HA1630Q01)
		—	(680)	—		C_L = 20 pF (HA1630Q02)
		—	(1200)	—		C_L = 20 pF (HA1630Q03)
Power supply rejection ratio	PSRR	60	80	—	dB	
Common mode rejection ratio	CMRR	60	80	—	dB	
Supply current	I_{DD}	—	60	120	µA	R_L = ∞ (HA1630Q01)
		—	200	400		R_L = ∞ (HA1630Q02)
		—	400	800		R_L = ∞ (HA1630Q03)

Note: 1. ( ) : Design specification

Table of Graphs

Electrical Characteristics			HA1630Q01 Figure	HA1630Q02 Figure	HA1630Q03 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	—	2-21	3-21	8
	(40 dB)	vs. Output voltage p-p	—	2-22	3-22	
Maximum p-p output voltage		vs Frequency	1-21	2-23	3-23	
Voltage noise density		vs Frequency	1-22	2-24	3-24	

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Main Characteristics (HA1630Q01)

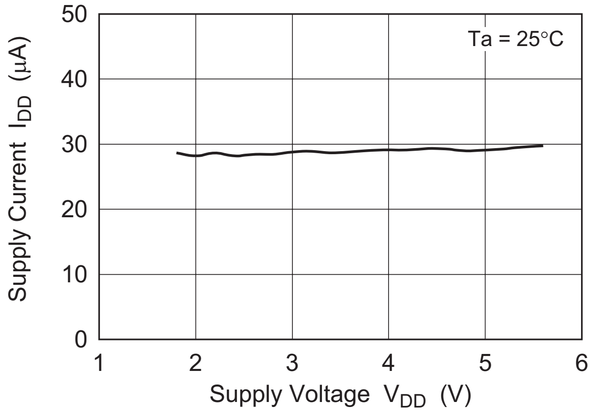


Figure 1-1. HA1630Q01
Supply Current vs. Supply Voltage

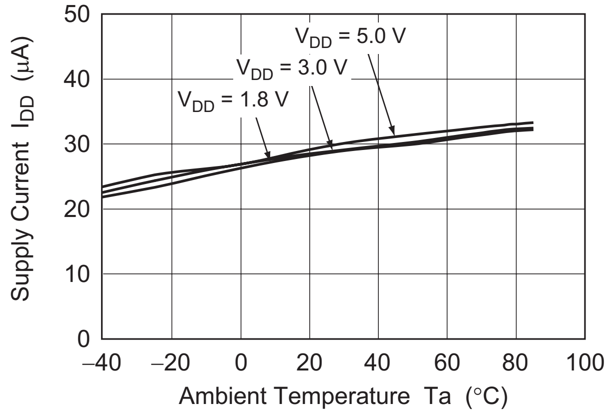


Figure 1-2. HA1630Q01
Supply Current vs. Ambient Temperature

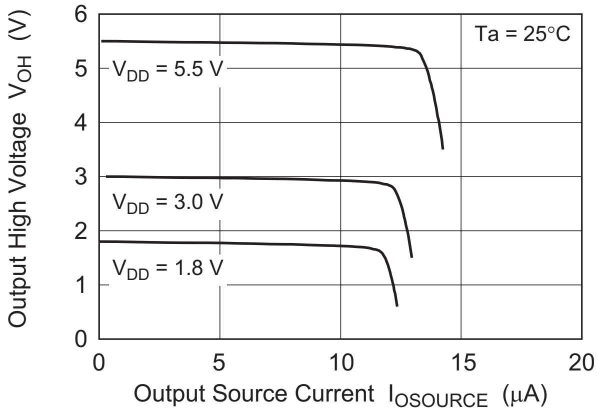


Figure 1-3. HA1630Q01
Output High Voltage vs. Output Source Current

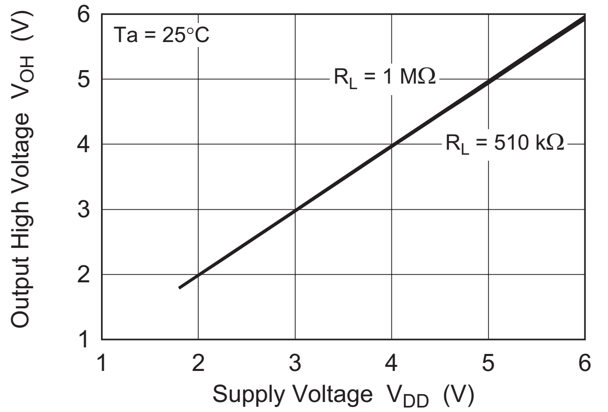


Figure 1-4. HA1630Q01
Output High Voltage vs. Supply Voltage

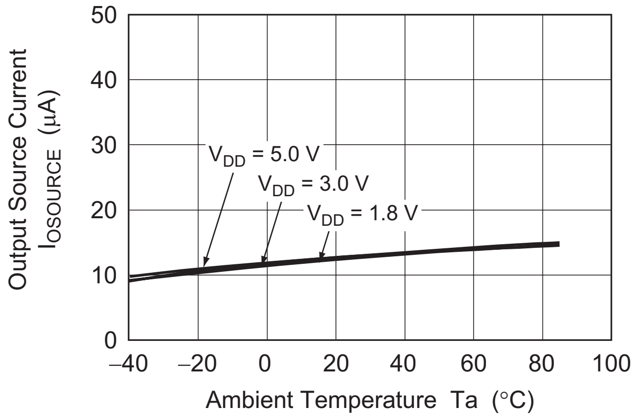


Figure 1-5. HA1630Q01
Output Source Current vs. Ambient Temperature

Figure 1-6. HA1630Q01
Output Low Voltage vs. Output Sink Current

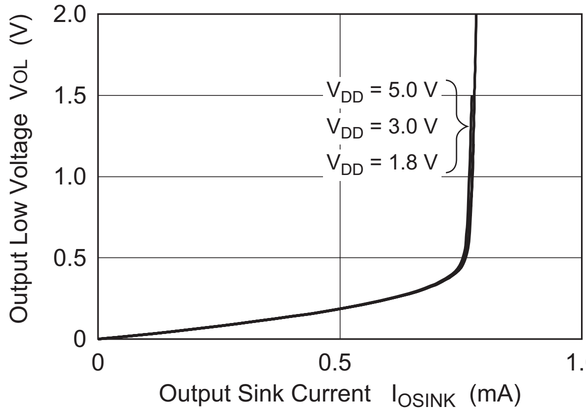


Figure 1-7. HA1630Q01
Output Sink Current vs. Ambient Temperature

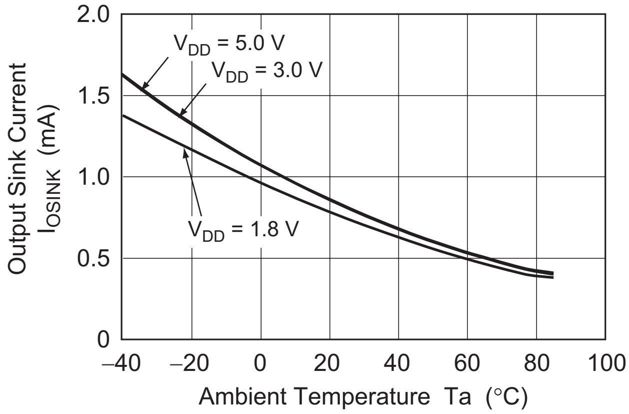


Figure 1-8. HA1630Q01
Input Offset Voltage Distribution

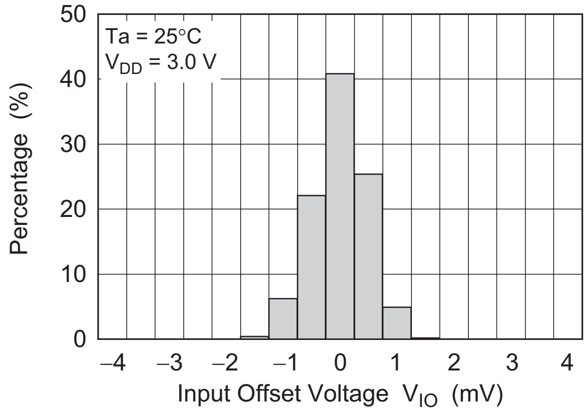


Figure 1-9. HA1630Q01
Input Offset Voltage vs. Supply Voltage

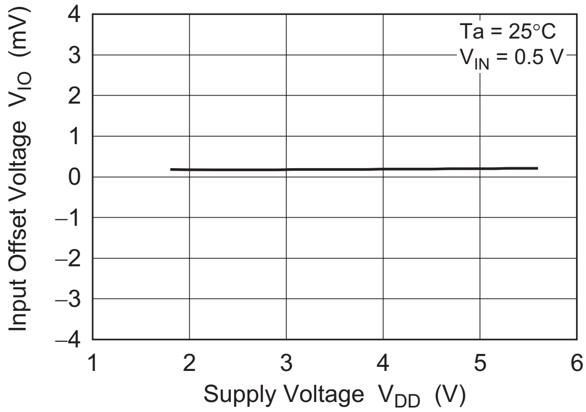


Figure 1-10. HA1630Q01
Input Offset Voltage vs. Ambient Temperature

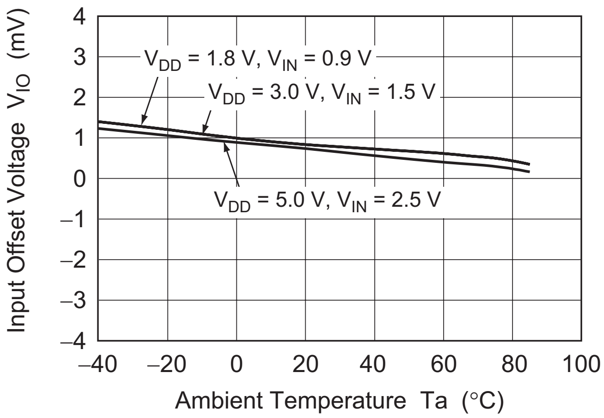


Figure 1-11. HA1630Q01
Common Mode Input Voltage vs.
Ambient Temperature

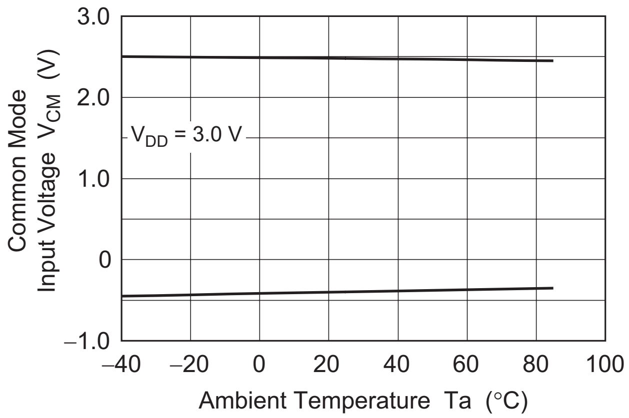


Figure 1-12. HA1630Q01
Power Supply Rejection Ratio vs. Frequency

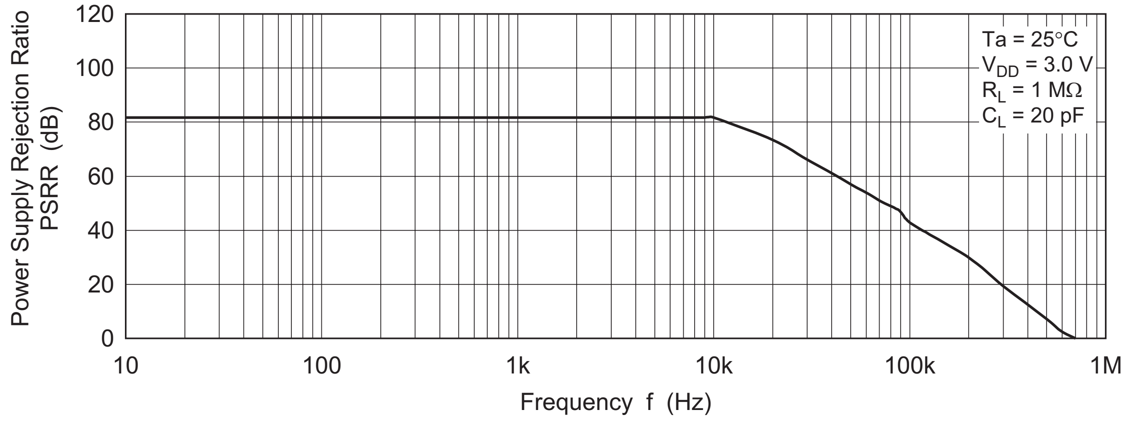


Figure 1-13. HA1630Q01
Common Mode Rejection Ratio vs. Frequency

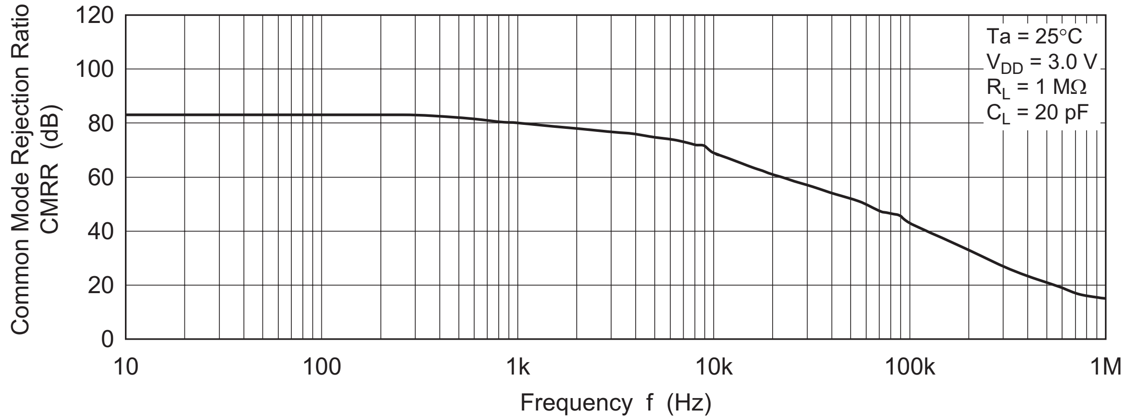


Figure 1-14. HA1630Q01
Open Loop Voltage Gain and Phase Angle vs. Frequency

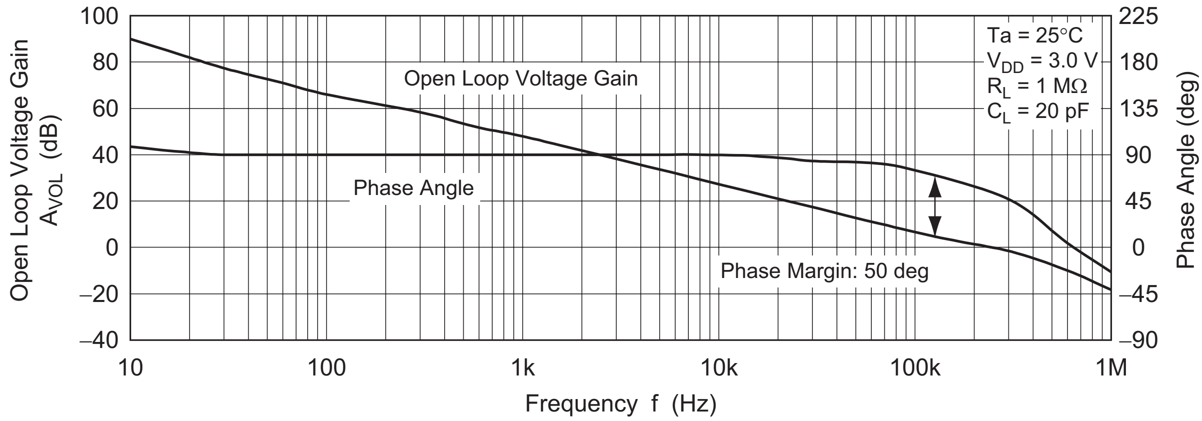


Figure 1-15. HA1630Q01
Input Bias Current vs. Ambient Temperature

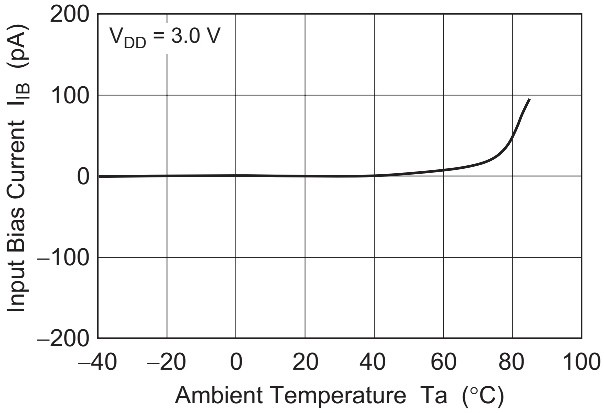


Figure 1-16. HA1630Q01
Input Bias Current vs. Input Voltage

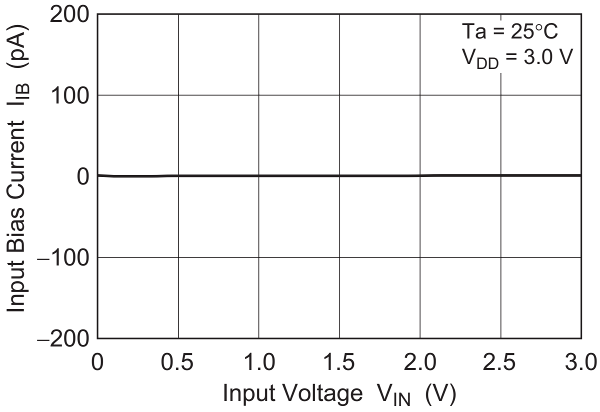


Figure 1-17. HA1630Q01
Slew Rate (rising) vs. Ambient Temperature

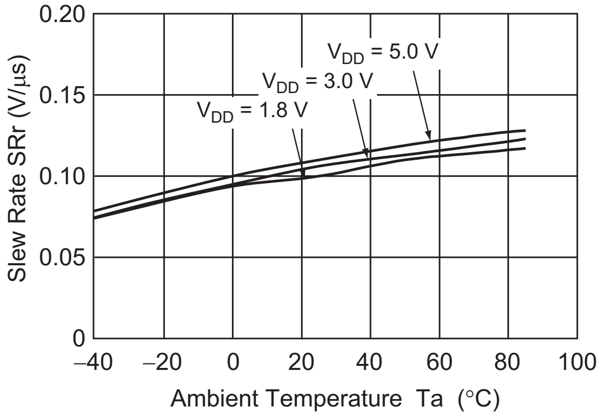


Figure 1-18. HA1630Q01
Slew Rate (falling) vs. Ambient Temperature

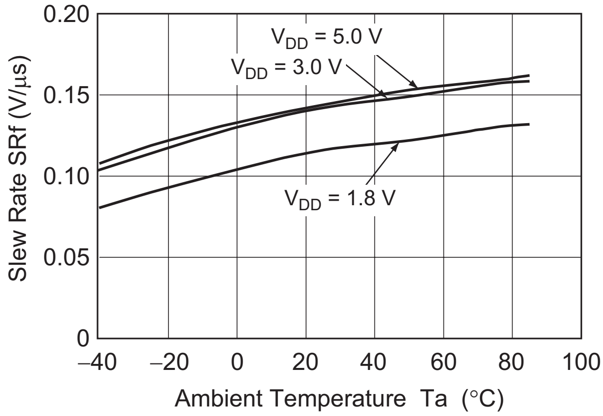


Figure 1-19. HA1630Q01
Large Signal Transient Response

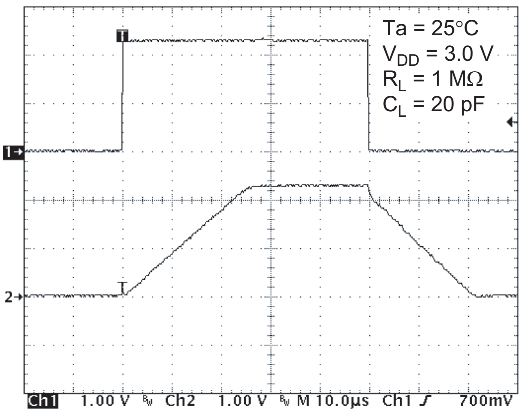


Figure 1-20. HA1630Q01
Small Signal Transient Response

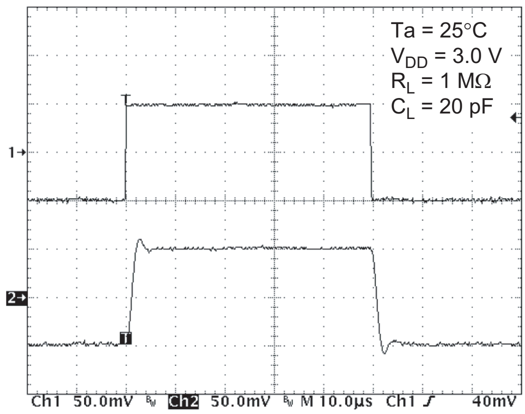


Figure 1-21. HA1630Q01
Voltage Output p-p vs. Frequency

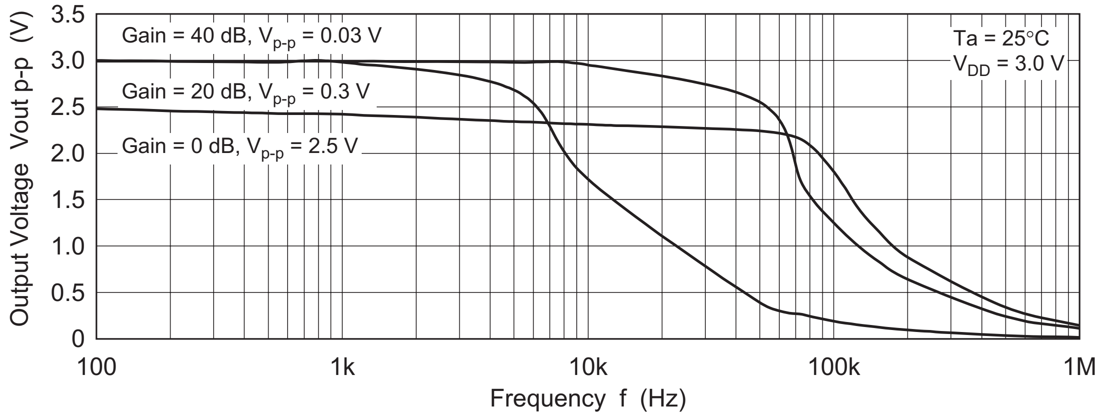
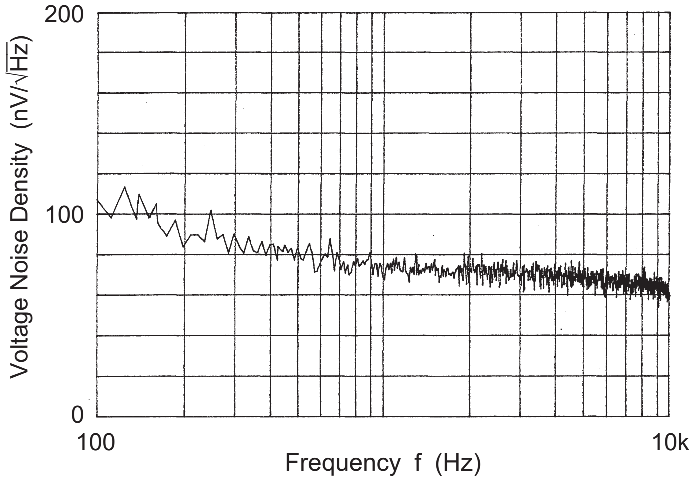


Figure 1-22. HA1630Q01
Voltage Noise Density vs. Frequency



Main Characteristics (HA1630Q02)

Figure 2-1. HA1630Q02
Supply Current vs. Supply Voltage

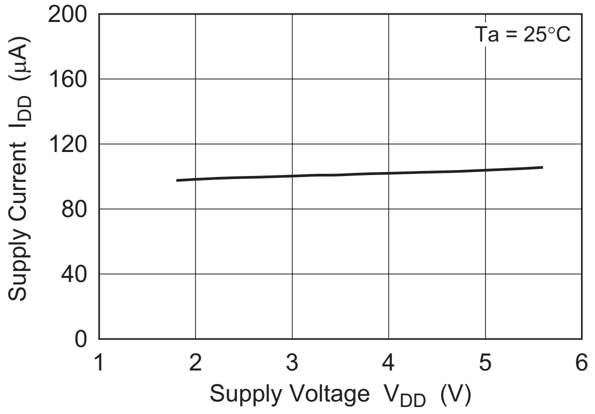


Figure 2-2. HA1630Q02
Supply Current vs. Ambient Temperature

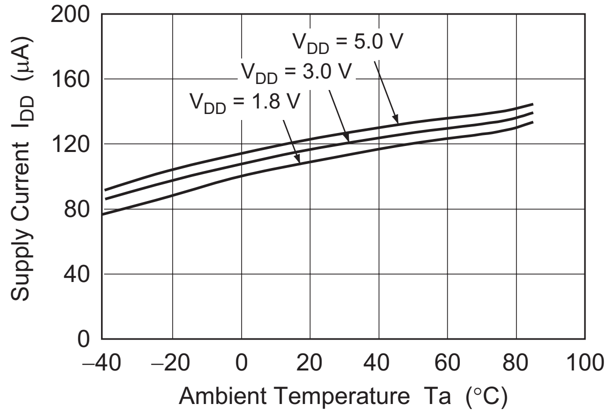


Figure 2-3. HA1630Q02
Output High Voltage vs. Output Source Current

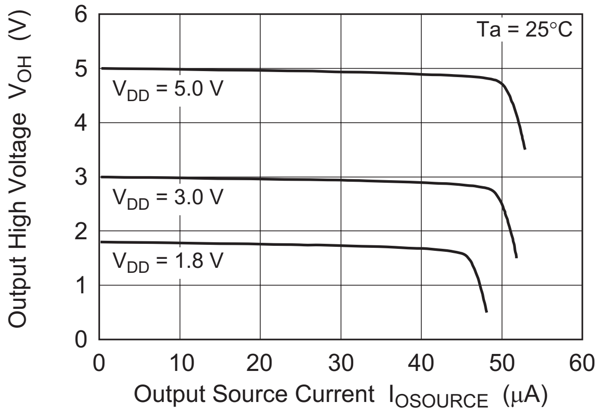


Figure 2-4. HA1630Q02
Output High Voltage vs. Supply Voltage

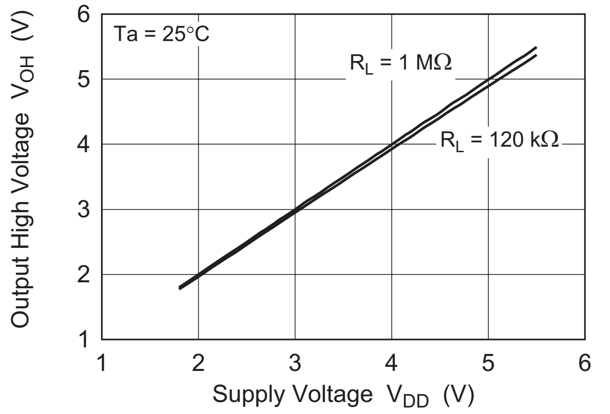


Figure 2-5. HA1630Q02
Output Source Current vs. Ambient Temperature

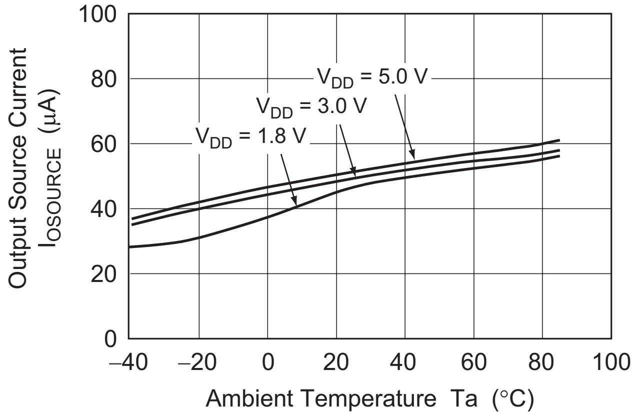


Figure 2-6. HA1630Q02
Output Low Voltage vs. Output Sink Current

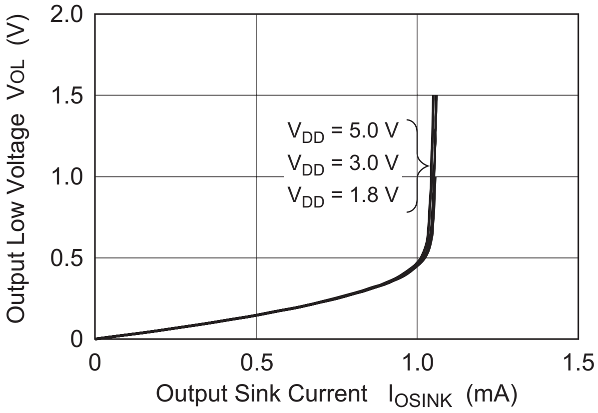


Figure 2-7. HA1630Q02
Output Sink Current vs. Ambient Temperature

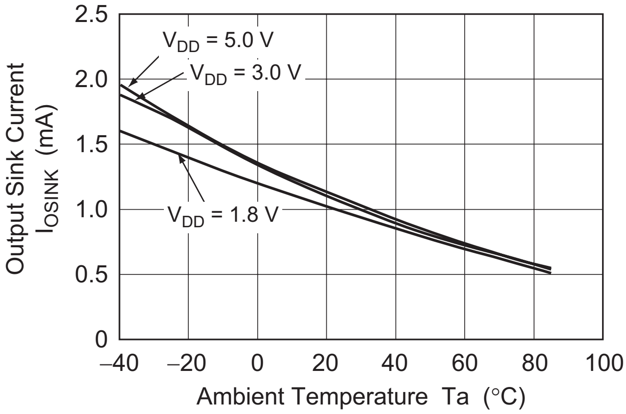


Figure 2-8. HA1630Q02
Input Offset Voltage Distribution

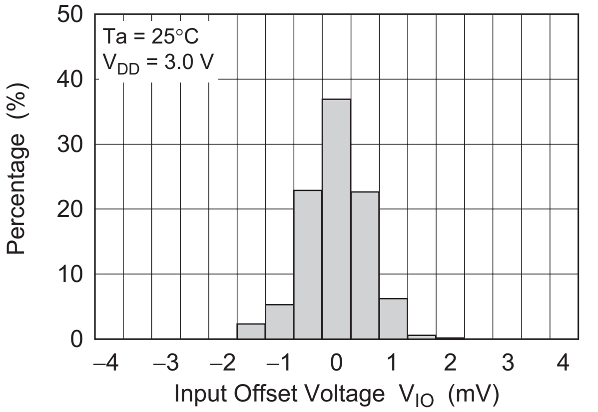


Figure 2-9. HA1630Q02
Input Offset Voltage vs. Supply Voltage

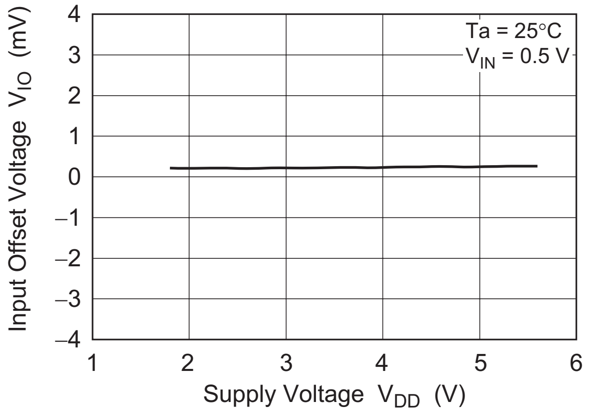


Figure 2-10. HA1630Q02
Input Offset Voltage vs. Ambient Temperature

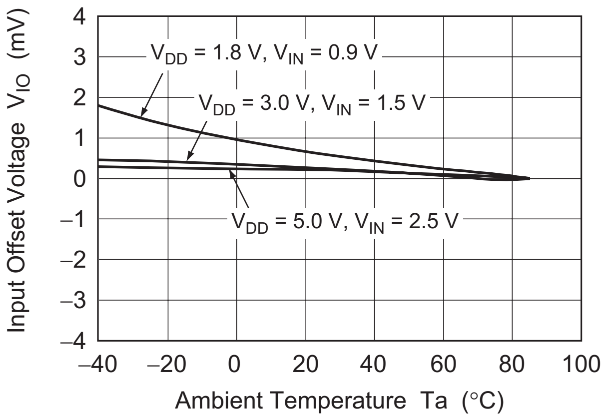


Figure 2-11. HA1630Q02
Common Mode Input Voltage vs.
Ambient Temperature

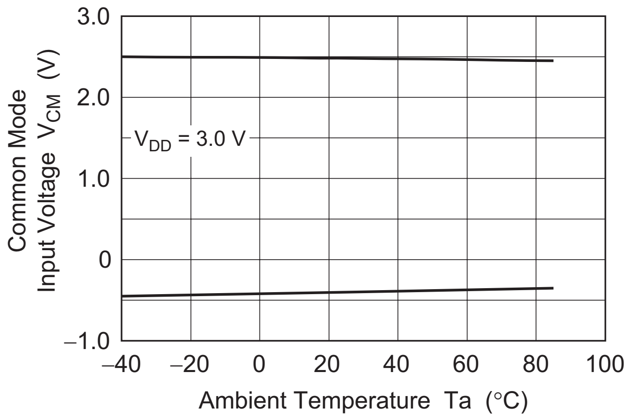


Figure 2-12. HA1630Q02
Power Supply Rejection Ratio vs. Frequency

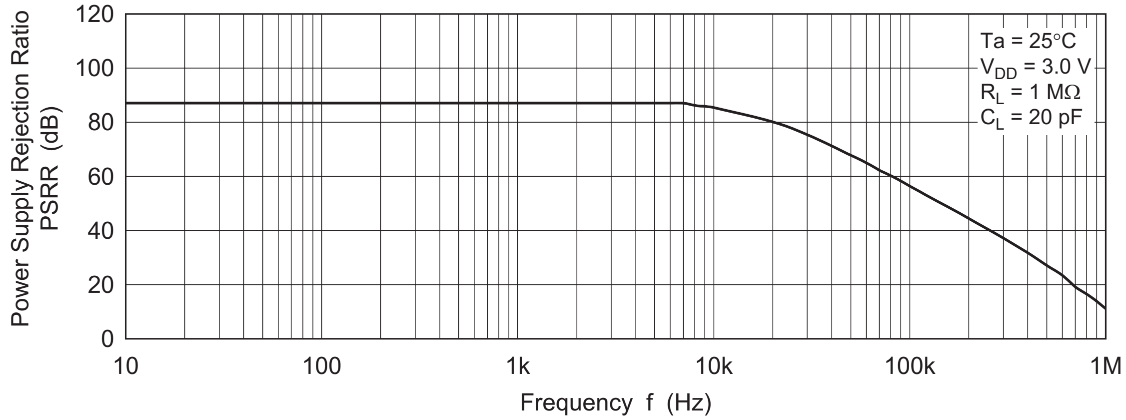


Figure 2-13. HA1630Q02
Common Mode Rejection Ratio vs. Frequency

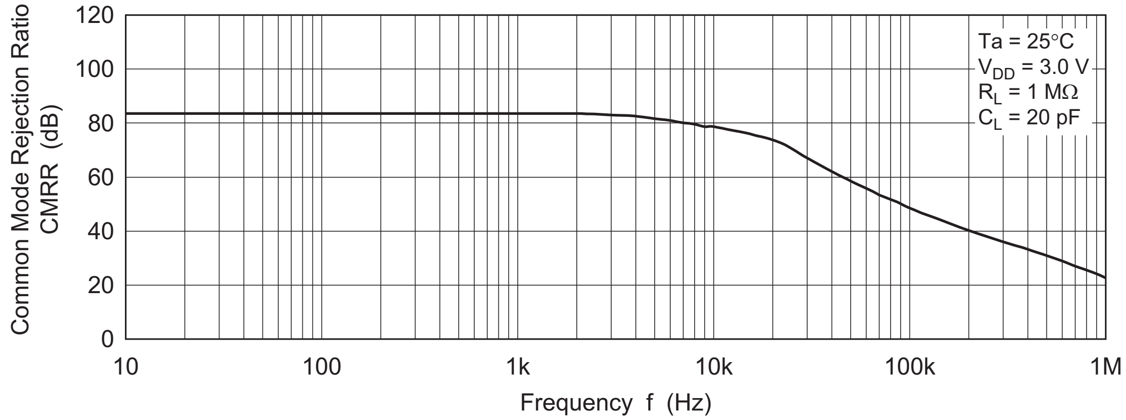


Figure 2-14. HA1630Q02
Open Loop Voltage Gain and Phase Angle vs. Frequency

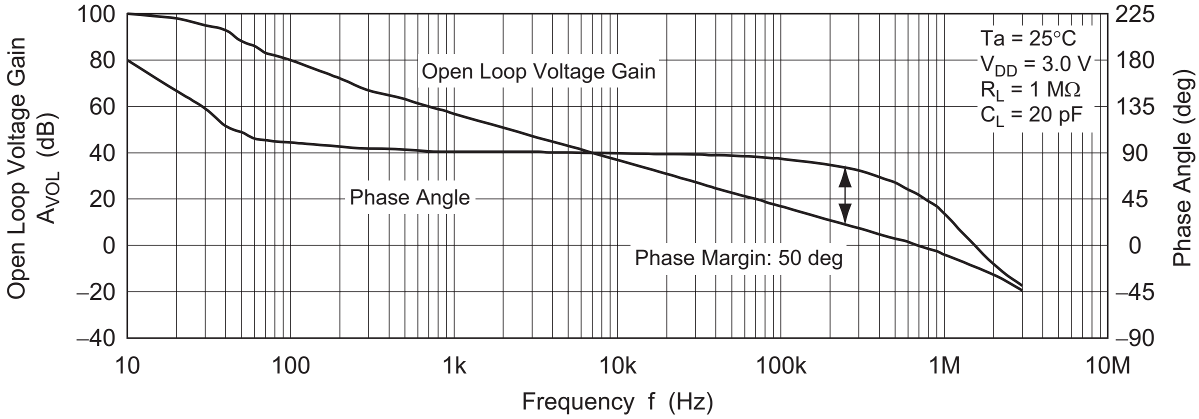


Figure 2-15. HA1630Q02
Input Bias Current vs. Ambient Temperature

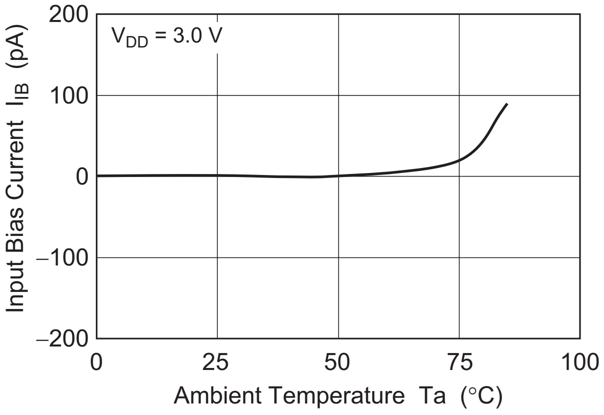


Figure 2-16. HA1630Q02
Input Bias Current vs. Input Voltage

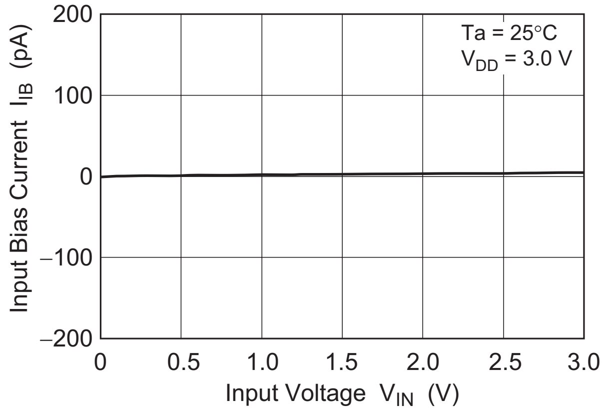


Figure 2-17. HA1630Q02
Slew Rate (rising) vs. Ambient Temperature

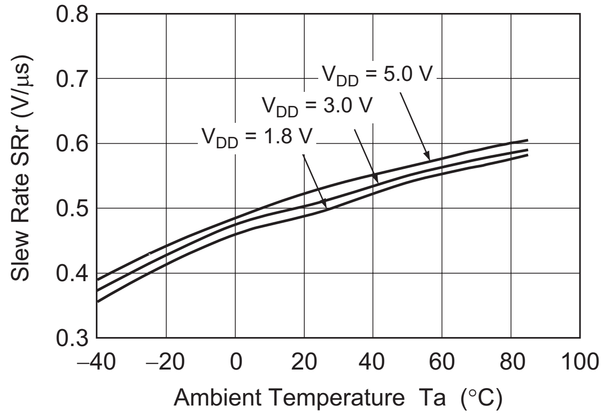


Figure 2-18. HA1630Q02
Slew Rate (falling) vs. Ambient Temperature

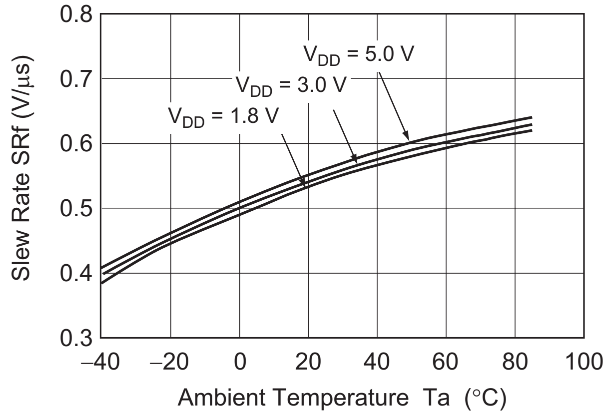


Figure 2-19. HA1630Q02
Large Signal Transient Response

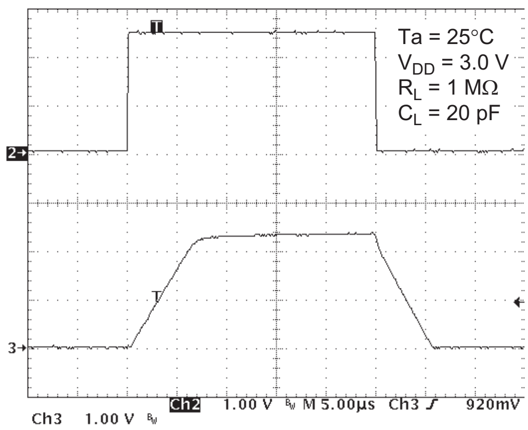


Figure 2-20. HA1630Q02
Small Signal Transient Response

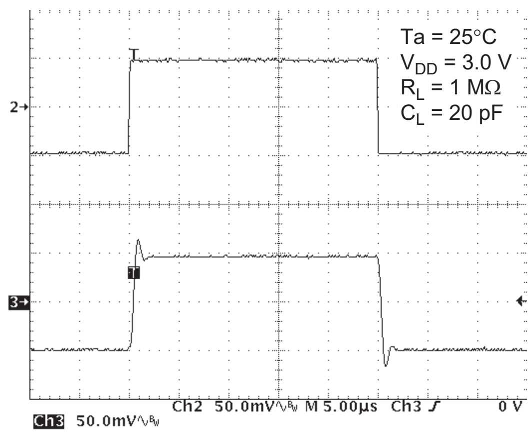


Figure 2-21. HA1630Q02
Total Harmonic Distortion + Noise vs.
Output Voltage p-p

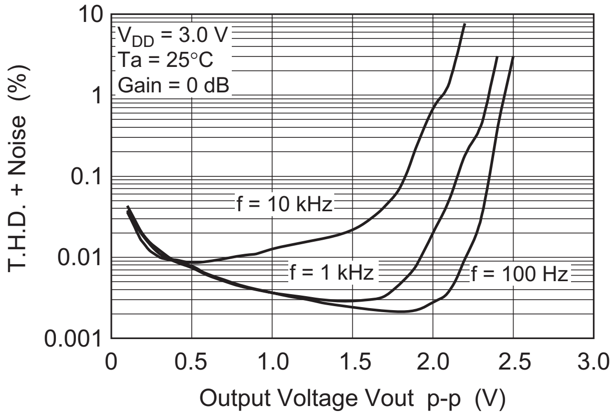


Figure 2-22. HA1630Q02
Total Harmonic Distortion + Noise vs.
Output Voltage p-p

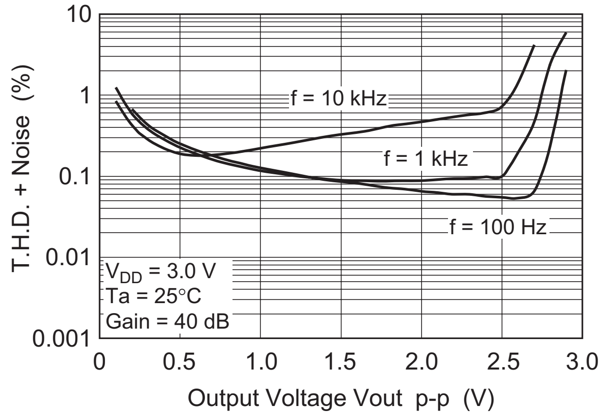


Figure 2-23. HA1630Q02
Voltage Output p-p vs. Frequency

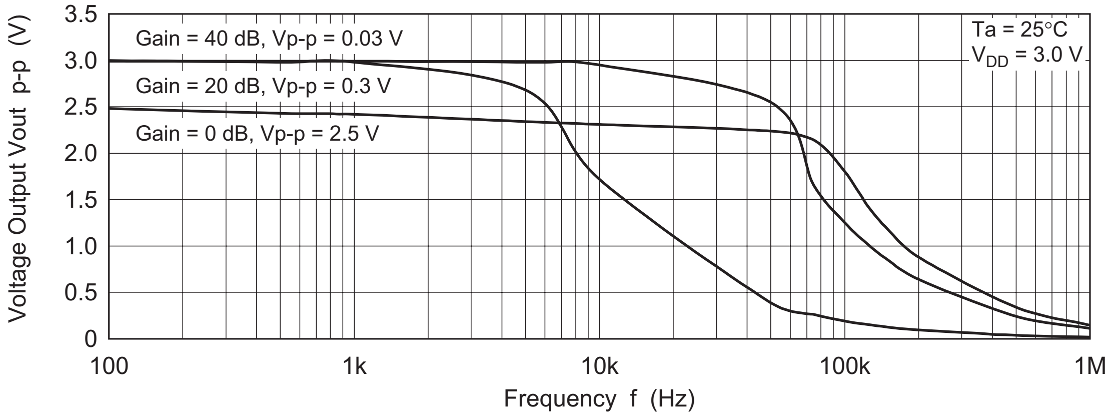
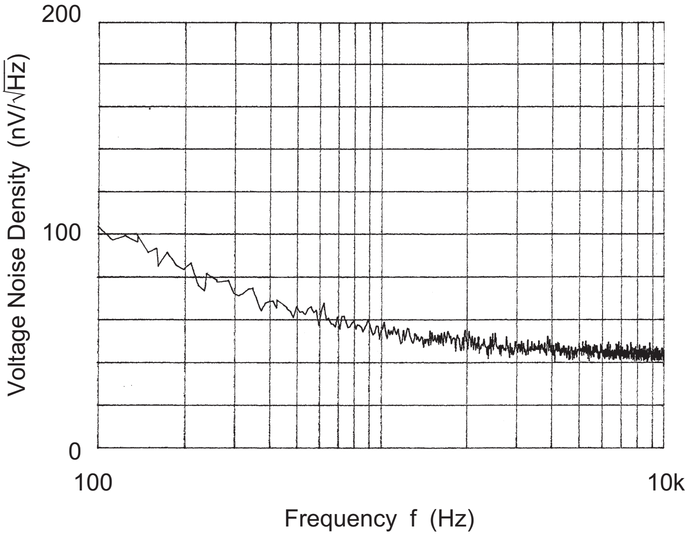


Figure 2-24. HA1630Q02
Voltage Noise Density vs. Frequency



Main Characteristics (HA1630Q03)

Figure 3-1. HA1630Q03
Supply Current vs. Supply Voltage

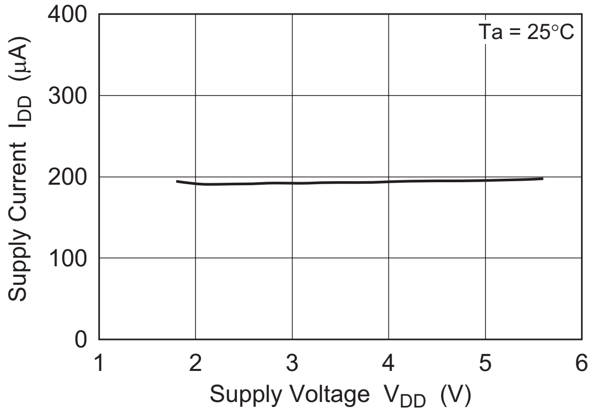


Figure 3-2. HA1630Q03
Supply Current vs. Ambient Temperature

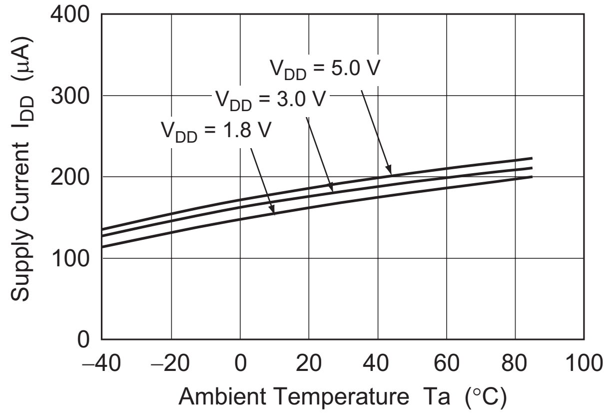


Figure 3-3. HA1630Q03
Output High Voltage vs. Output Source Current

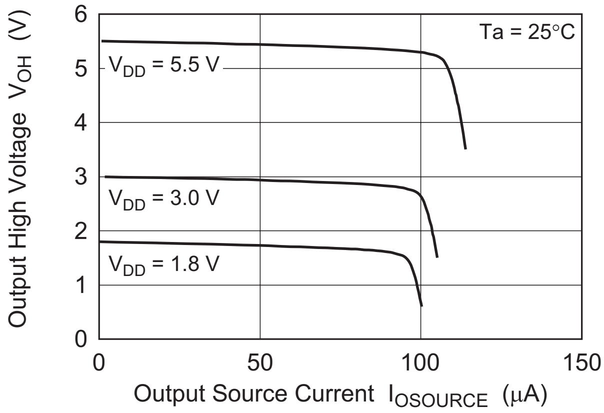


Figure 3-4. HA1630Q03
Output High Voltage vs. Supply Voltage

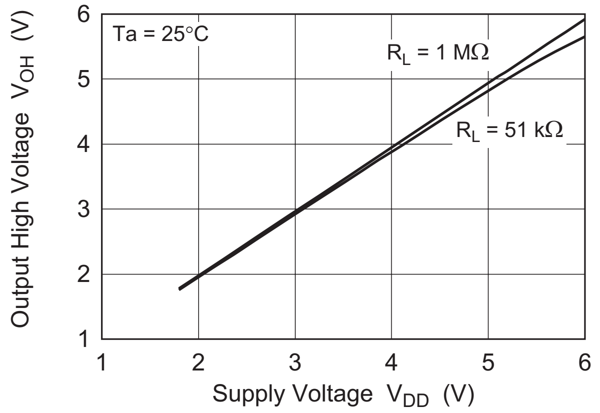


Figure 3-5. HA1630Q03
Output Source Current vs. Ambient Temperature

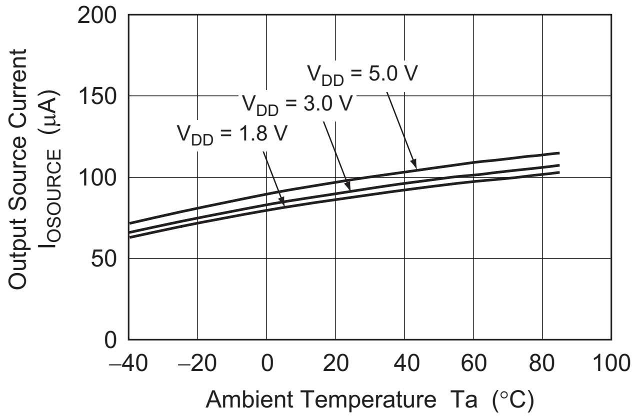


Figure 3-6. HA1630Q03
Output Low Voltage vs. Output Sink Current

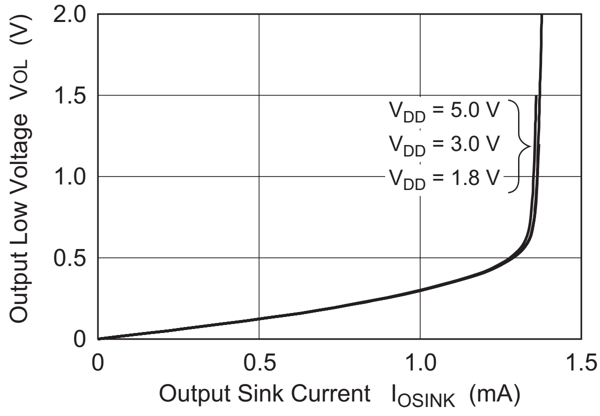


Figure 3-7. HA1630Q03
Output Sink Current vs. Ambient Temperature

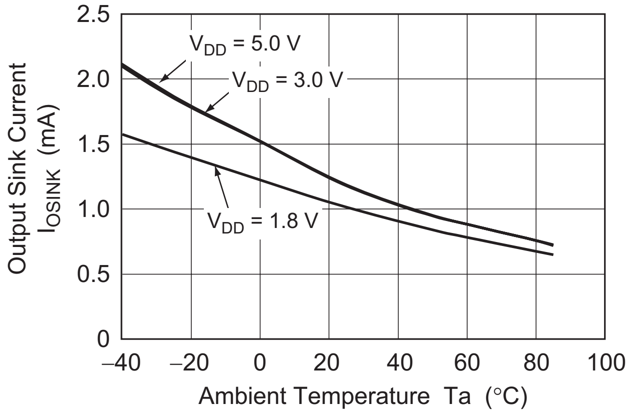


Figure 3-8. HA1630Q03
Input Offset Voltage Distribution

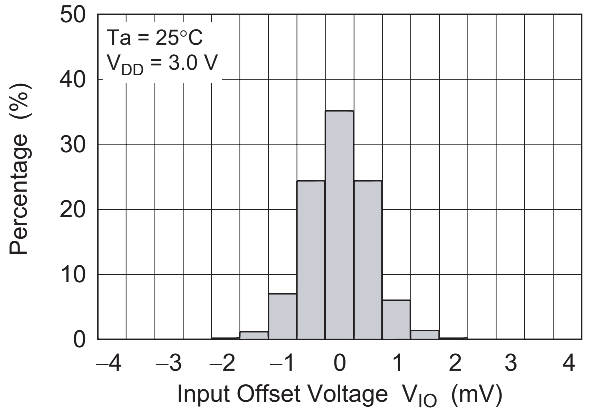


Figure 3-9. HA1630Q03
Input Offset Voltage vs. Supply Voltage

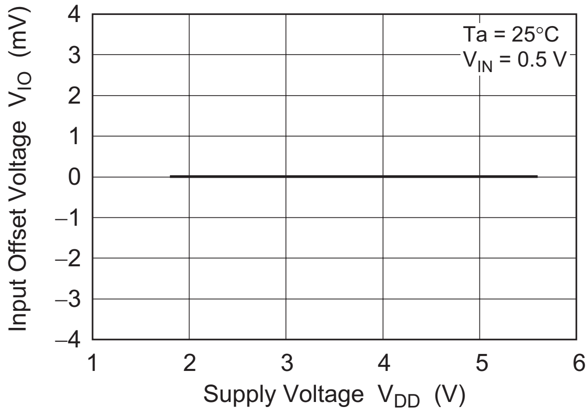


Figure 3-10. HA1630Q03
Input Offset Voltage vs. Ambient Temperature

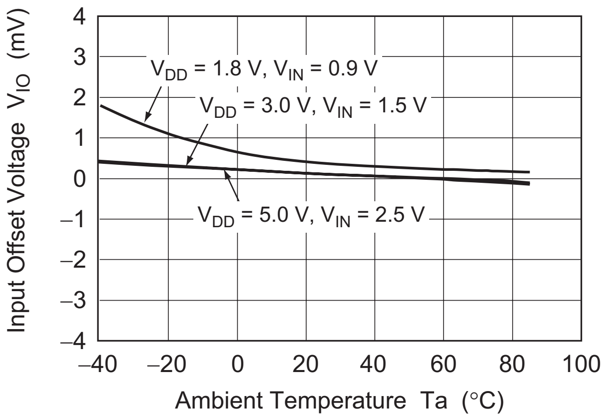


Figure 3-11. HA1630Q03
Common Mode Input Voltage vs.
Ambient Temperature

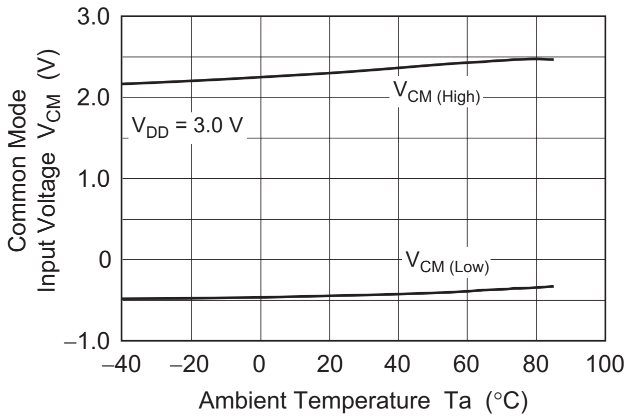


Figure 3-12. HA1630Q03
Power Supply Rejection Ratio vs. Frequency

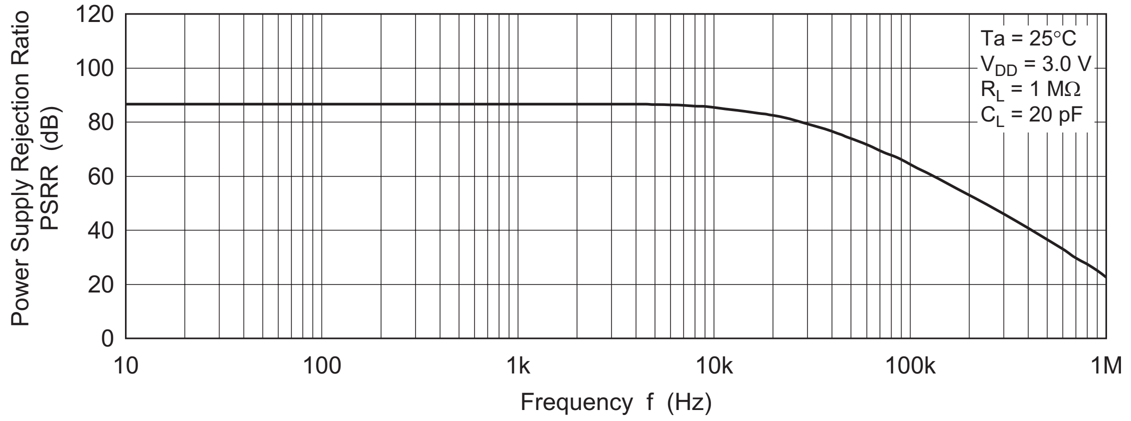


Figure 3-13. HA1630Q03
Common Mode Rejection Ratio vs. Frequency

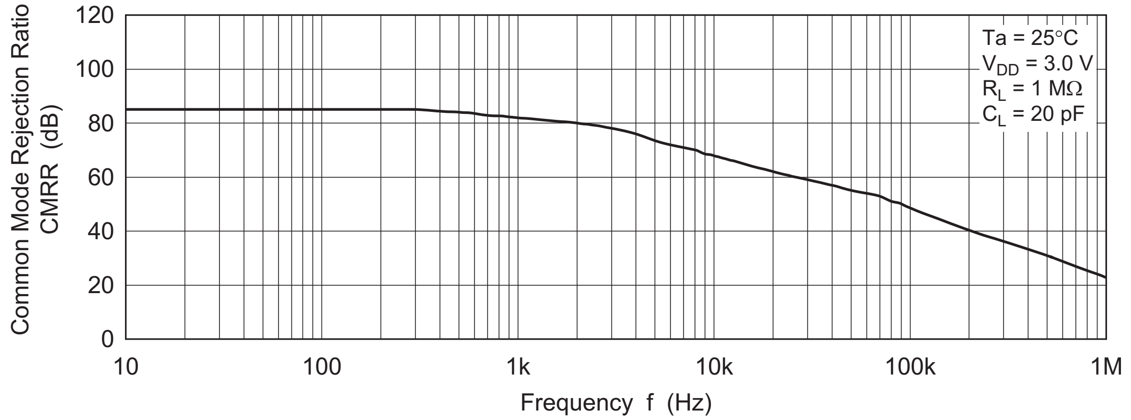


Figure 3-14. HA1630Q03
Open Loop Voltage Gain and Phase Angle vs. Frequency

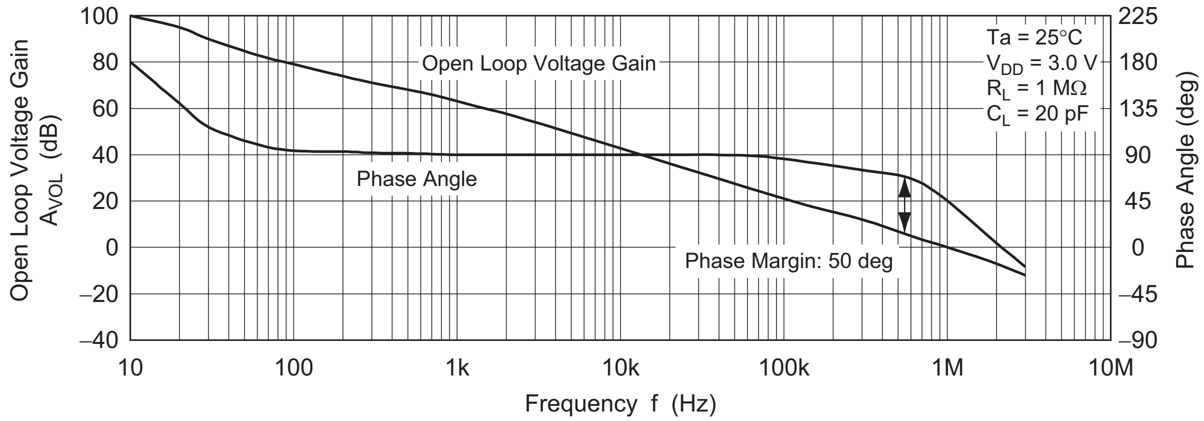


Figure 3-15. HA1630Q03
Input Bias Current vs. Ambient Temperature

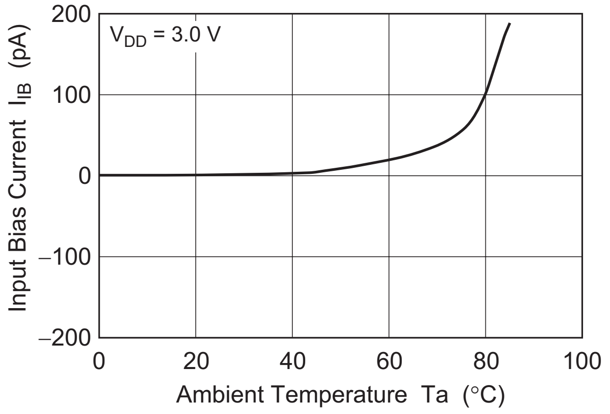


Figure 3-16. HA1630Q03
Input Bias Current vs. Input Voltage

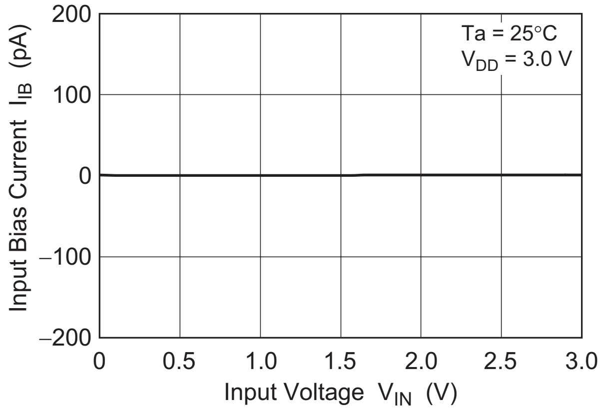


Figure 3-17. HA1630Q03
Slew Rate (rising) vs. Ambient Temperature

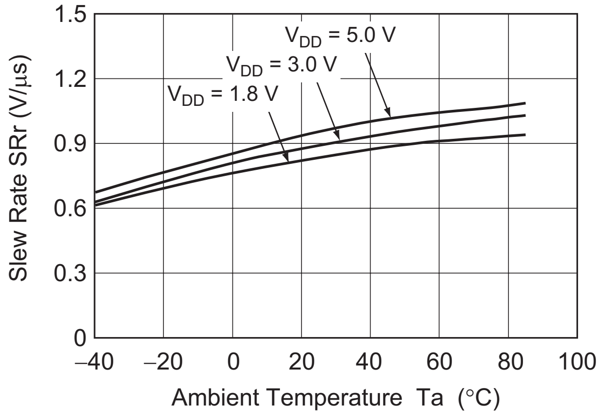


Figure 3-18. HA1630Q03
Slew Rate (falling) vs. Ambient Temperature

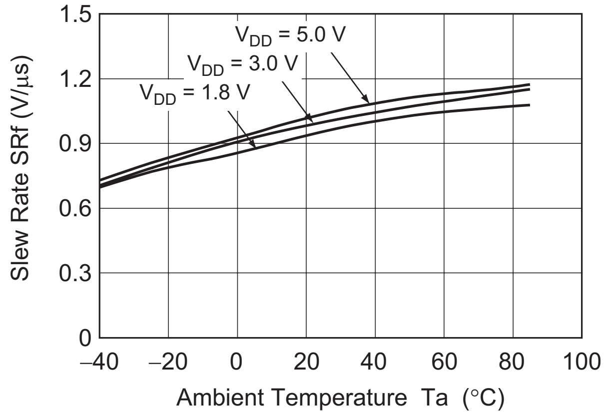


Figure 3-19. HA1630Q03
Large Signal Transient Response

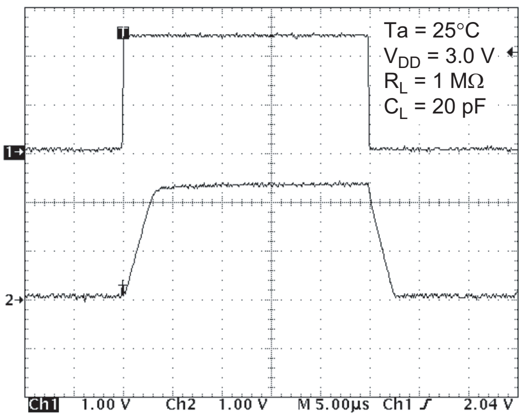


Figure 3-20. HA1630Q03
Small Signal Transient Response

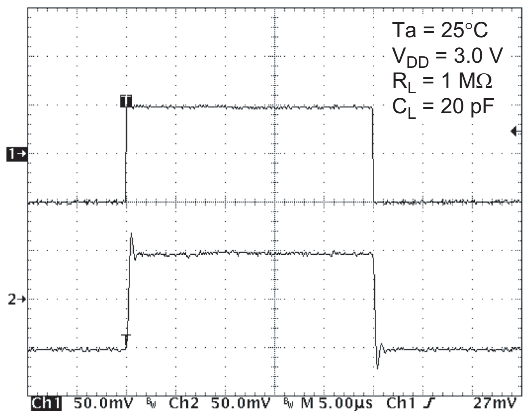


Figure 3-21. HA1630Q03
Total Harmonic Distortion + Noise vs.
Output Voltage p-p

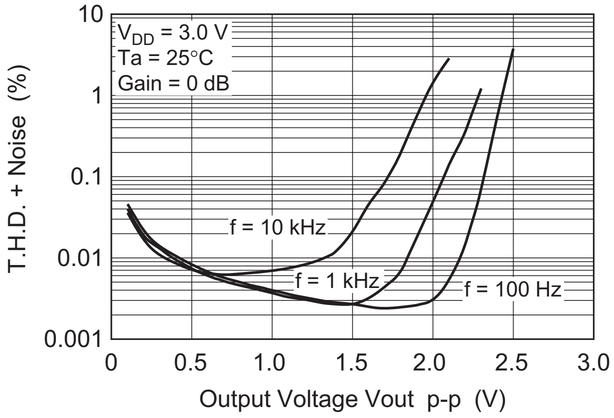


Figure 3-22. HA1630Q03
Total Harmonic Distortion + Noise vs.
Output Voltage p-p

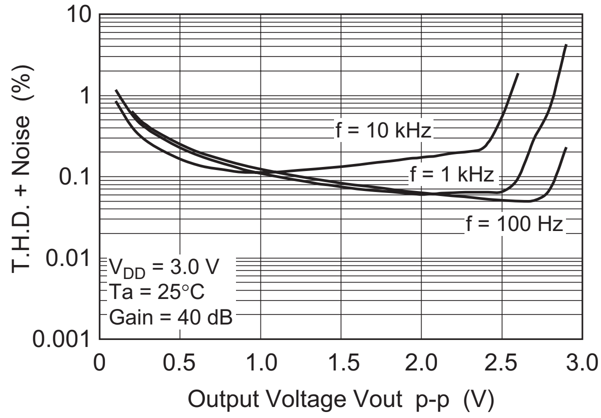


Figure 3-23. HA1630Q03
Voltage Output p-p vs. Frequency

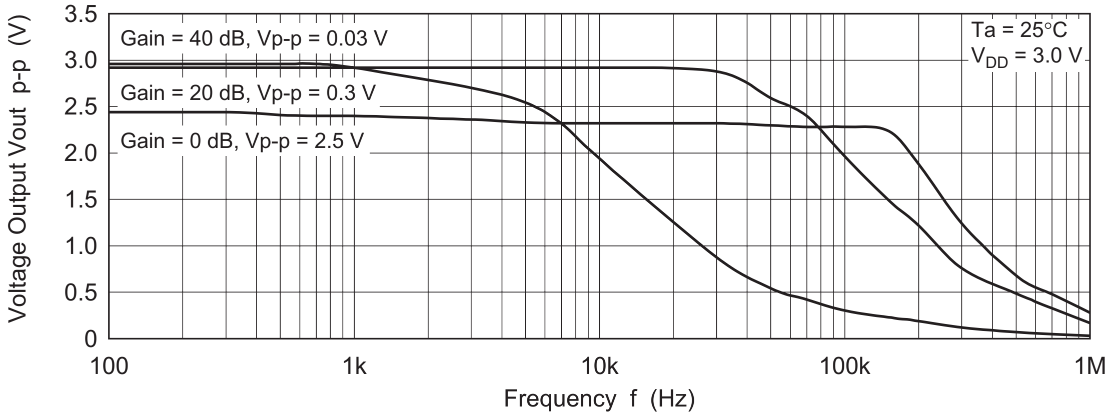
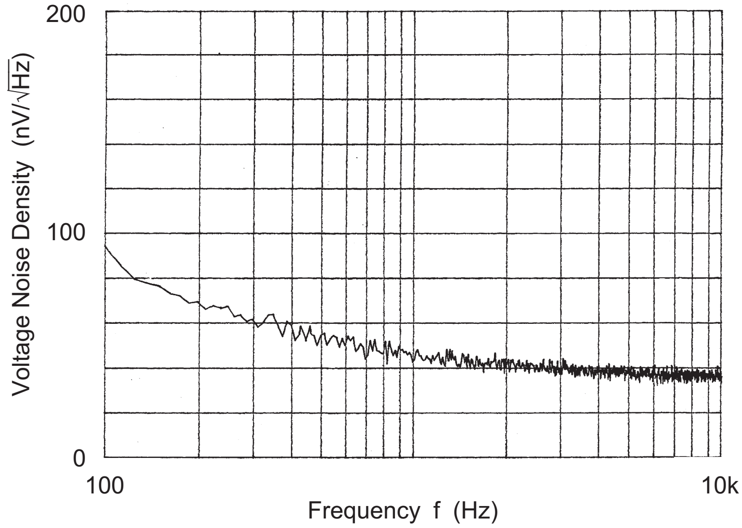
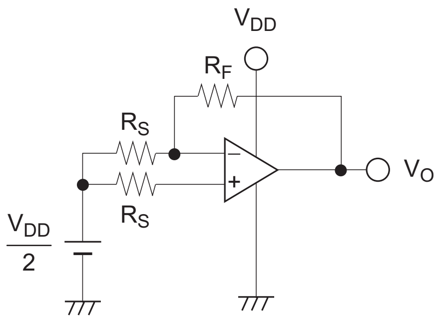


Figure 3-24. HA1630Q03
Voltage Noise Density vs. Frequency



Test Circuits

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



$\underline{V_{IO}}$

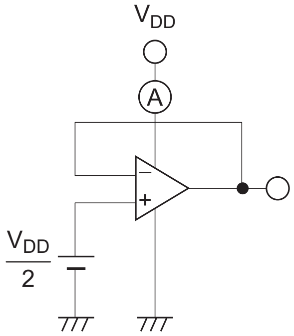
$$V_{IO} = \left(V_O - \frac{V_{DD}}{2}\right) \times \frac{R_S}{R_S + R_F}$$

PSRR

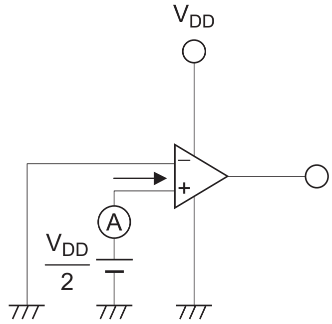
$$PSRR = -20\log\left(\left|\frac{V_{O1} - V_{O2}}{V_{DD1} - V_{DD2}}\right| \times \frac{R_S}{R_S + R_F}\right)$$

Measure V_O corresponding to V_{DD1} = 1.8 V and V_{DD2} = 5.5 V

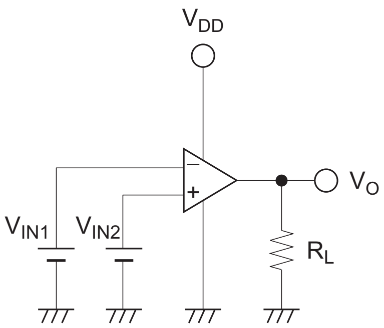
2. Supply Current, I_{DD}



3. Input Bias Current, I_{IB}



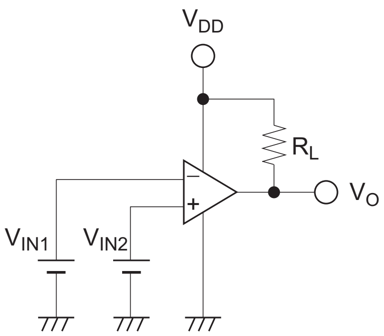
4. Output High Voltage, V_{OH}



$\underline{V_{OH}}$

R_L = 1 MΩ
$V_{IN1} = V_{DD}$ / 2 – 0.05 V
$V_{IN2} = V_{DD}$ / 2 + 0.05 V

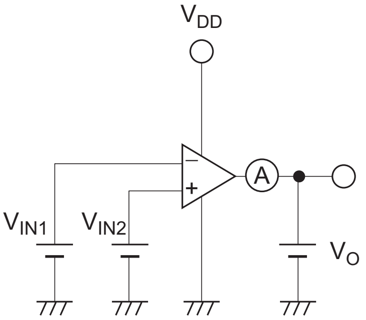
5. Output Low Voltage, V_{OL}



$\underline{V_{OL}}$

R_L = 1 MΩ
$V_{IN1} = V_{DD}$ / 2 + 0.05 V
$V_{IN2} = V_{DD}$ / 2 – 0.05 V

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



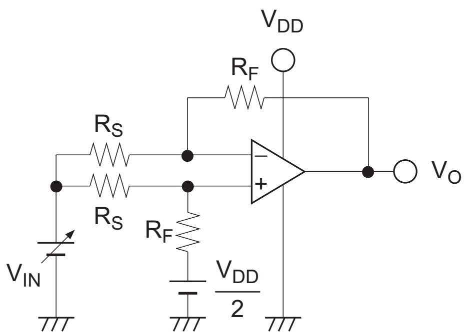
$I_{OSOURCE}$

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

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

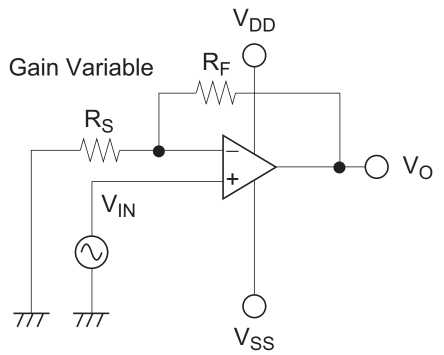


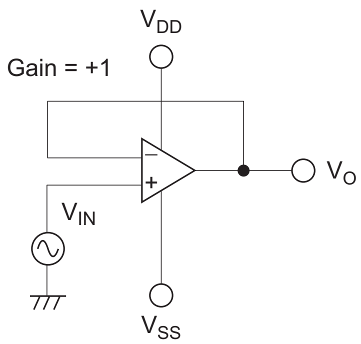
CMRR

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

Measure V_O corresponding to $V_{IN1} = 0$ V and $V_{IN2} = 2.1$ V

8. Total Harmonic Distortion, THD

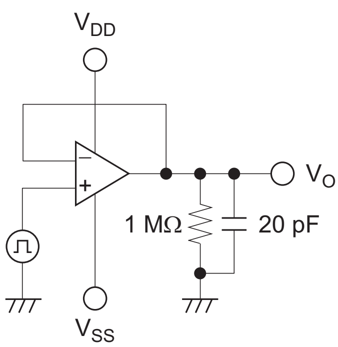




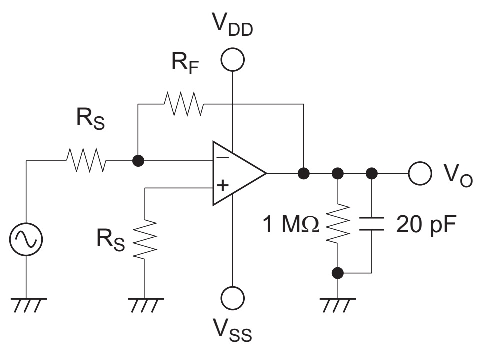
THD

Gain Variable
$1 + R_F / R_S = 100$
freq = 100 Hz, 1 kHz, 10 kHz

9. Slew Rate, SR

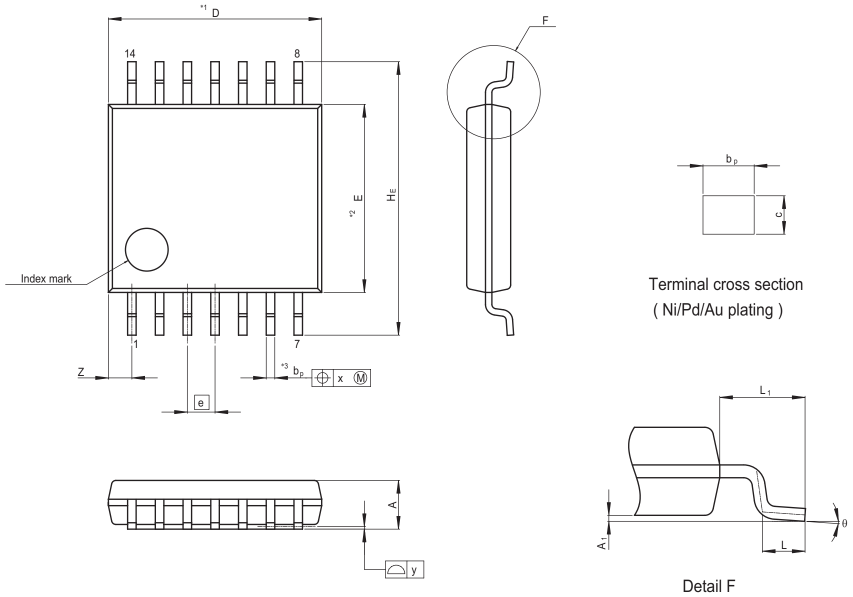


10. Gain, A_V & Phase, GBW



Package Dimensions

JEITA Package Code	RENESAS Code	Previous Code	MASS[Typ.]
P-TSSOP14-4.4x5-0.65	PTSP0014JA-B	TTP-14DV	0.05g



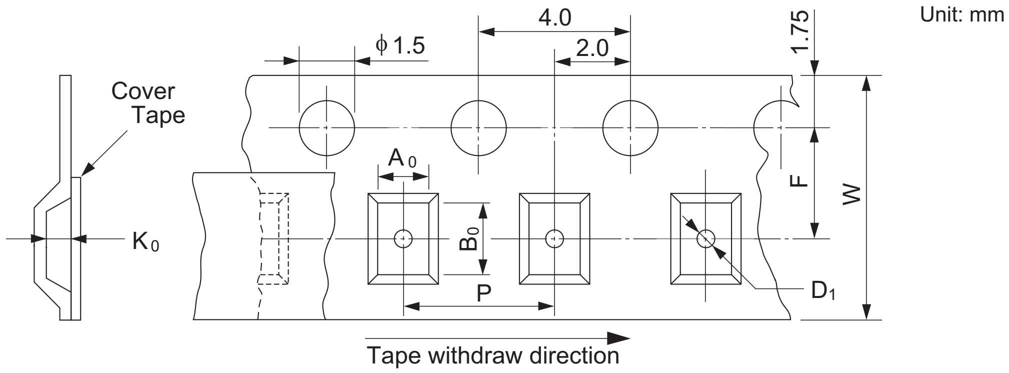
NOTE)
1. DIMENSIONS"*1 (Nom)"AND"*2" DO NOT INCLUDE MOLD FLASH.
2. DIMENSION"*3"DOES NOT INCLUDE TRIM OFFSET.

Reference Symbol	Dimension in Millimeters		
	Min	Nom	Max
D	—	5.00	5.30
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	—	—	0.83
L	0.4	0.5	0.6
L_1	—	1.0	—

Taping & Reel Specification

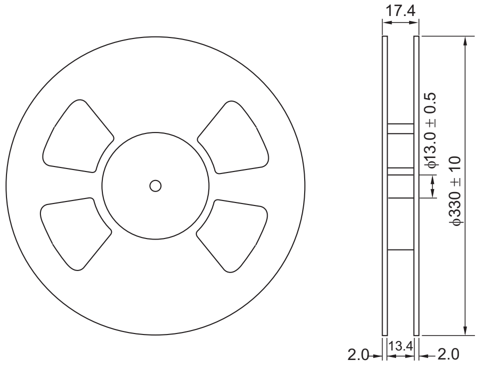
[Taping]

Package Code	W	P	Ao	Bo	Ko	E	F	D1	Maximum Storage No.
TSSOP-14	12	8	6.5	5.1	1.5	—	5.5	1.6	2,000 pcs/reel



[Reel]

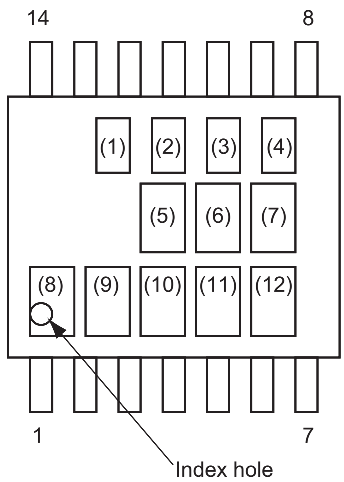
Package	Tape width	W1	W2
TSSOP-14	12	17.4	13.4



[Ordering Information]

Ordering Unit
2,000 pcs

Mark Indication



(1) to (4)	Week code		
(5),(8) to (10)	Space		
(6), (7) (11), (12)	Product Name	0Q01	HA1630Q01
		0Q02	HA1630Q02
		0Q03	HA1630Q03

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Tel: <603> 7955-9390, Fax: <603> 7955-9510

Colophon .6.0