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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.

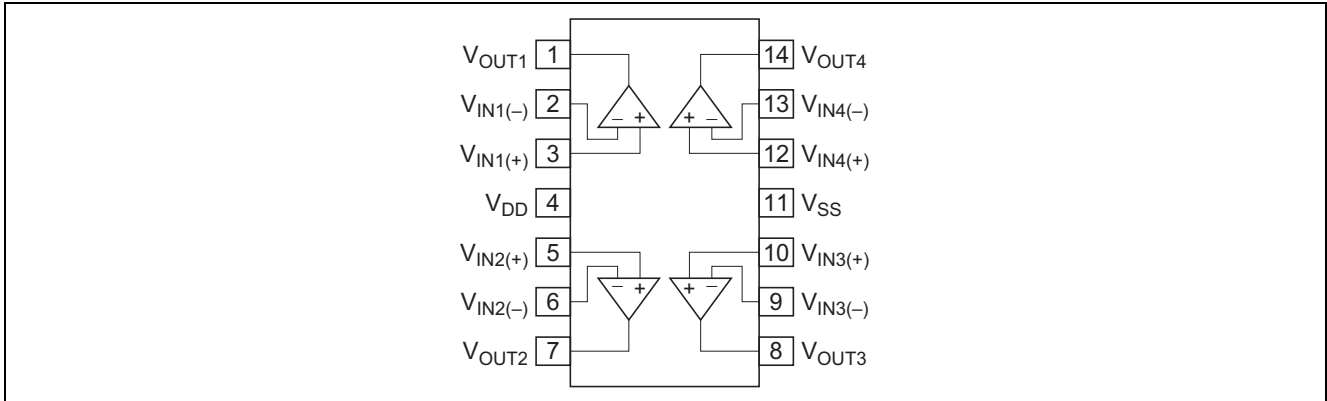
Features

- Low power and single supply operation $V_{DD} = 1.8 \text{ to } 5.5 \text{ V}$
- Low input offset voltage $V_{IO} = 4.0 \text{ mV Max}$
- Low supply current (per channel)
 - $I_{DD} = 15 \mu\text{A Typ (HA1630Q01)}$
 - $I_{DD} = 50 \mu\text{A Typ (HA1630Q02)}$
 - $I_{DD} = 100 \mu\text{A Typ (HA1630Q03)}$
- Maximum output voltage $V_{OH} = 2.9 \text{ V Min (at } V_{DD} = 3.0 \text{ V)}$
- Low input bias current $I_{IB} = 1 \text{ pA Typ}$

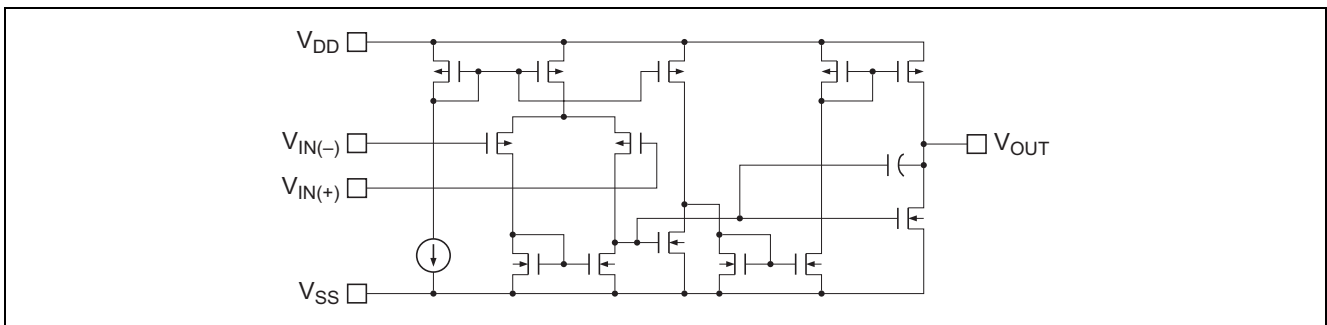
Ordering Information

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	V _{in} = 1.5 V
Input offset current	I _{IO}	—	(1.0)	—	pA	V _{in} = 1.5 V
Input bias current	I _{IB}	—	(1.0)	—	pA	V _{in} = 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	

Main Characteristics (HA1630Q01)

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

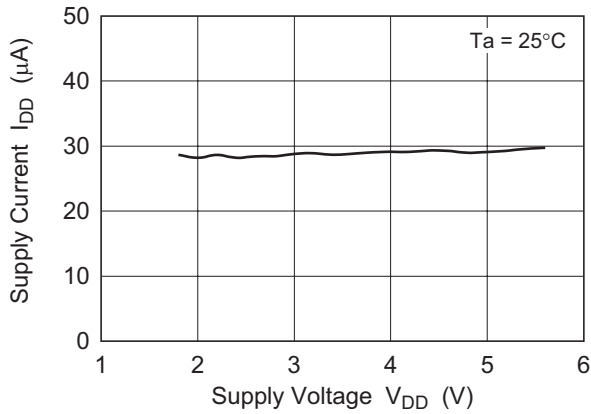


Figure 1-2. HA1630Q01
Supply Current vs. Ambient Temperature

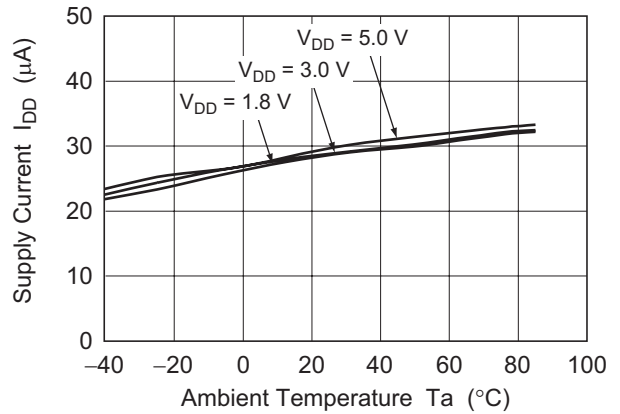


Figure 1-3. HA1630Q01
Output High Voltage vs. Output Source Current

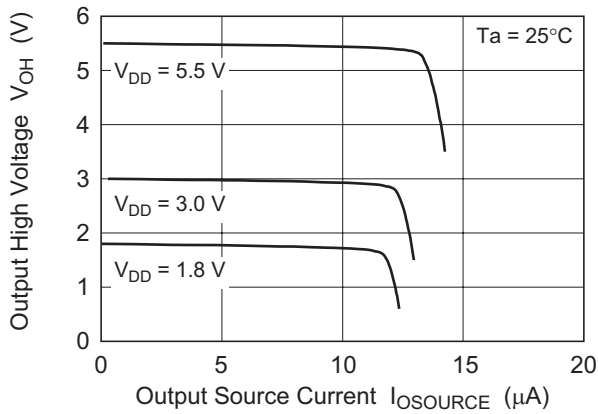


Figure 1-4. HA1630Q01
Output High Voltage vs. Supply Voltage

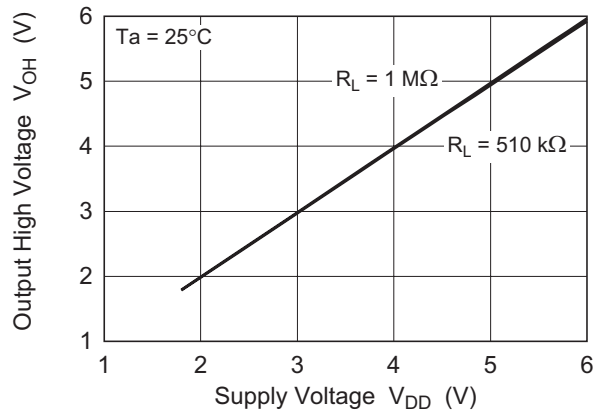
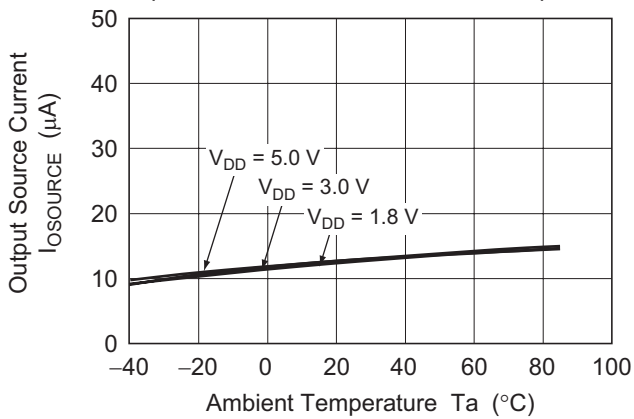


Figure 1-5. HA1630Q01
Output Source Current vs. Ambient Temperature



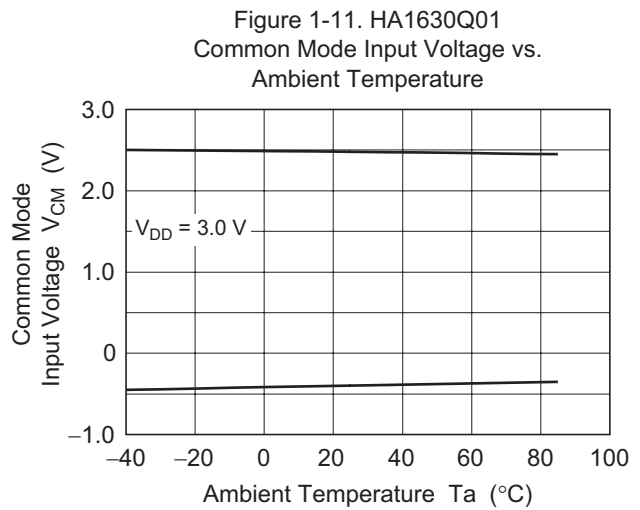
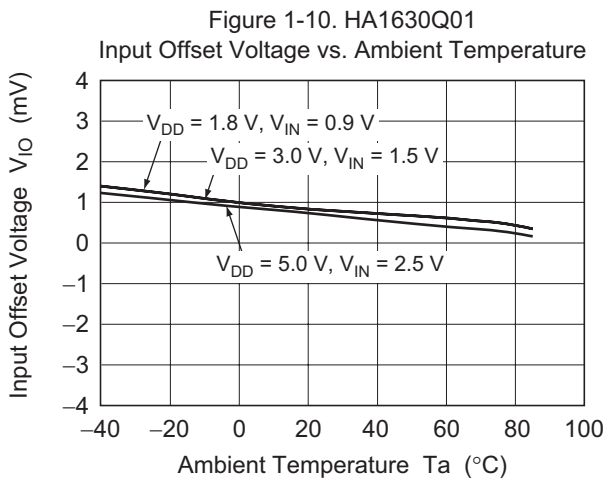
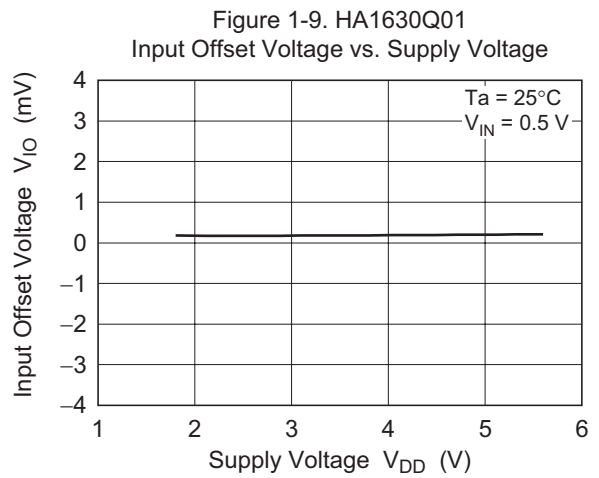
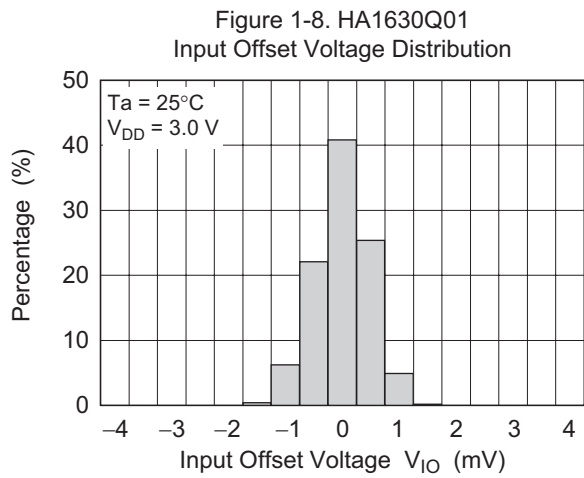
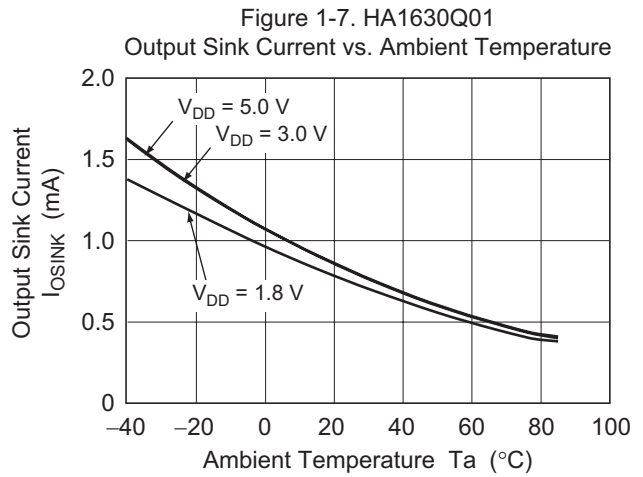
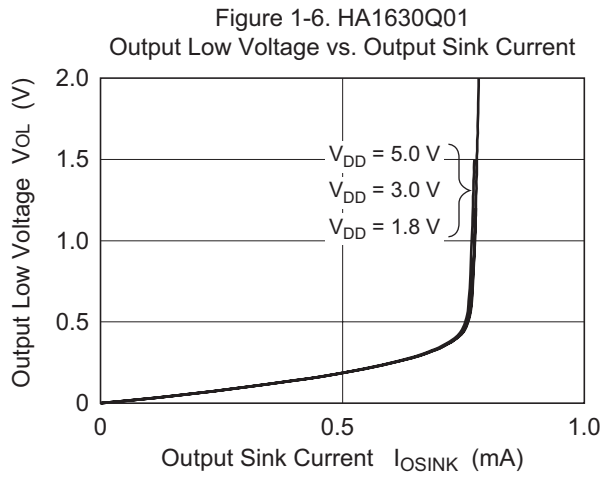


Figure 1-12. HA1630Q01
Power Supply Rejection Ratio vs. Frequency

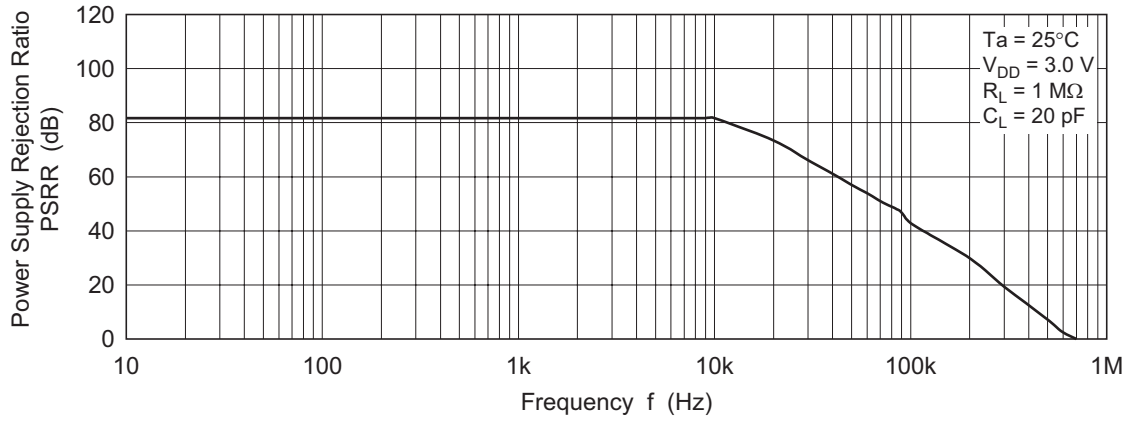


Figure 1-13. HA1630Q01
Common Mode Rejection Ratio vs. Frequency

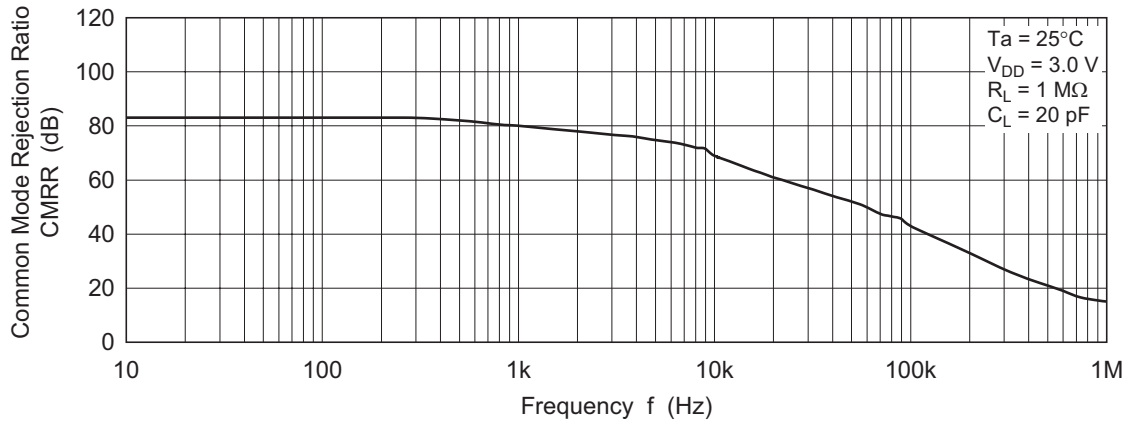
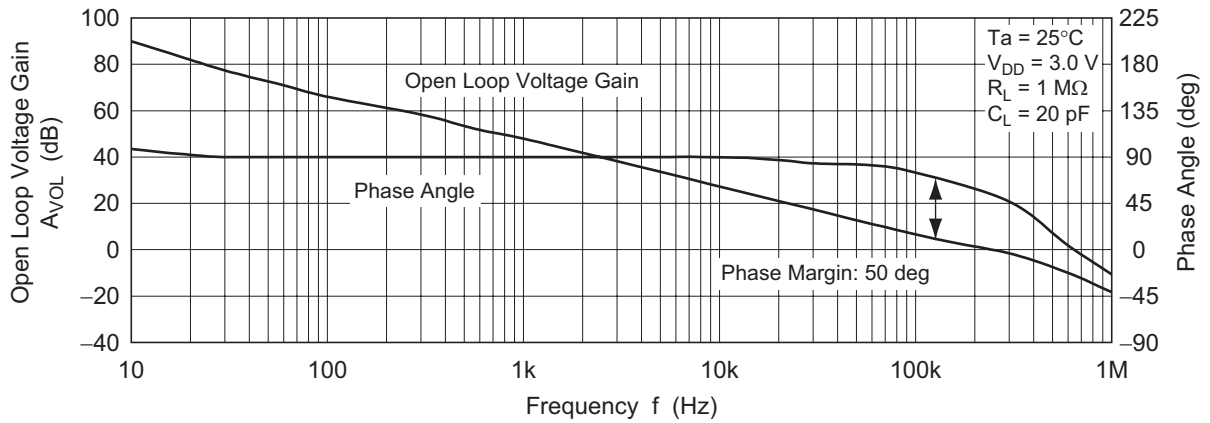


Figure 1-14. HA1630Q01
Open Loop Voltage Gain and Phase Angle vs. Frequency



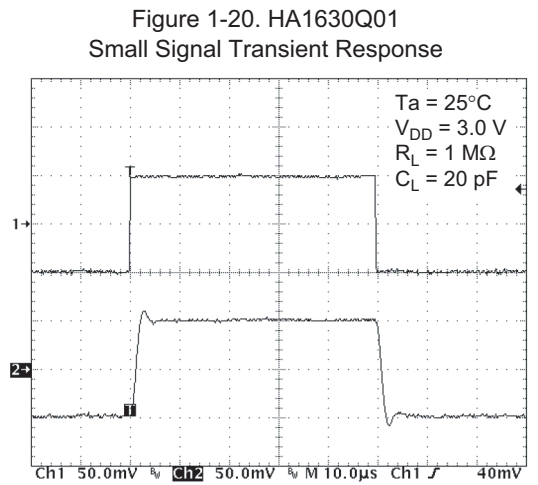
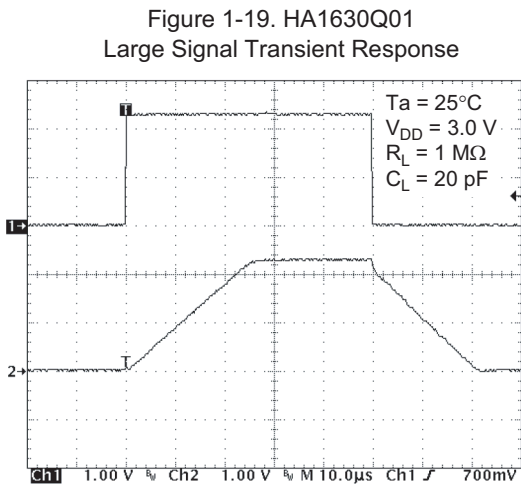
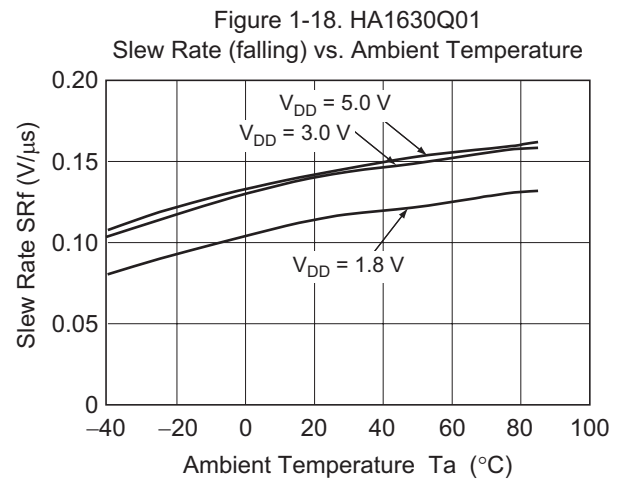
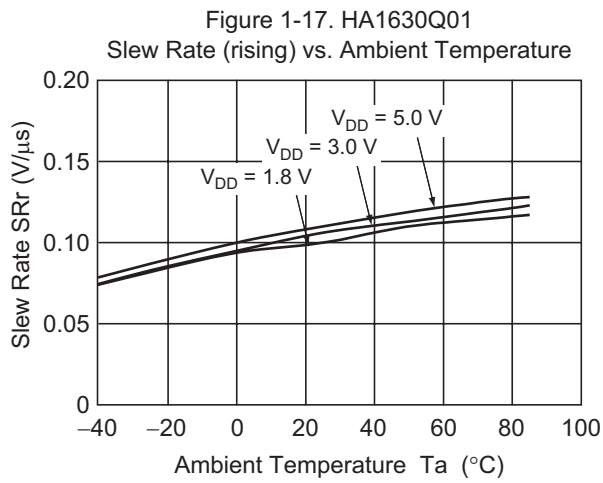
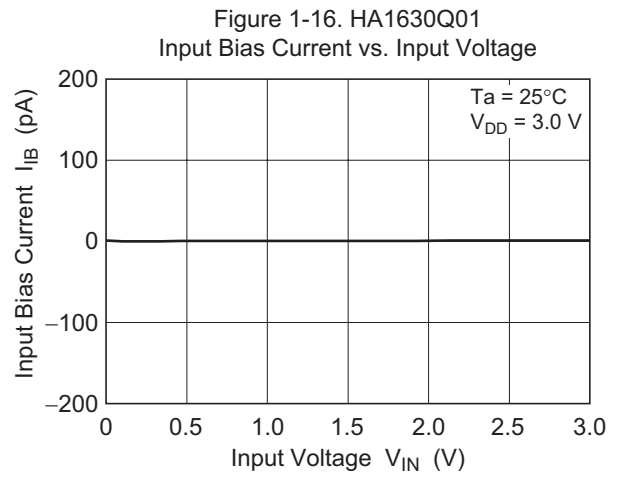
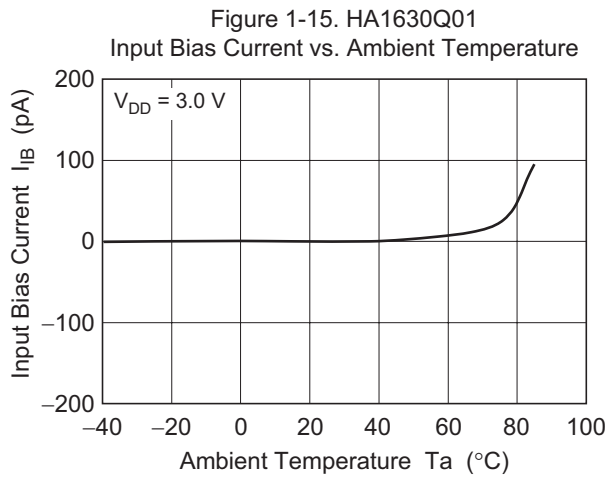


Figure 1-21. HA1630Q01
Voltage Output p-p vs. Frequency

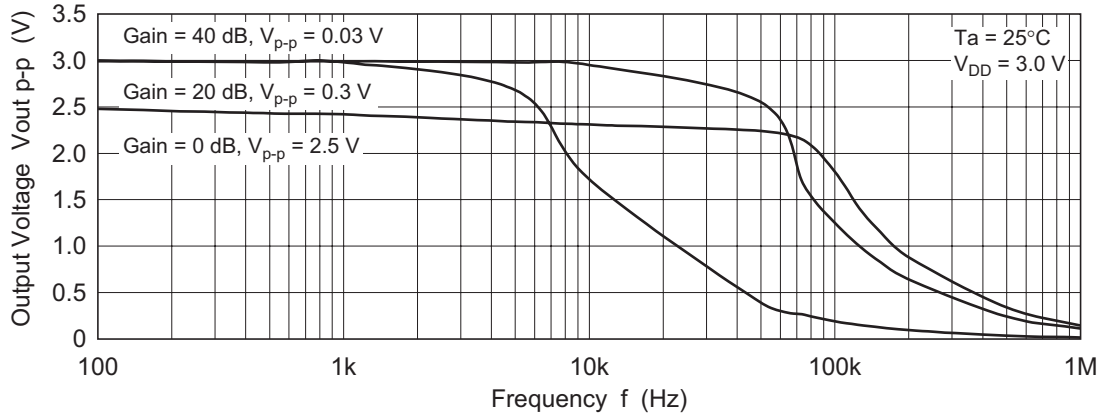
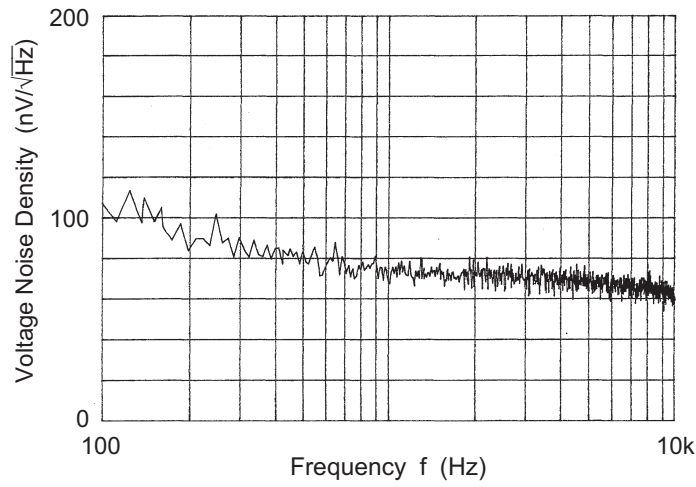


Figure 1-22. HA1630Q01
Voltage Noise Density vs. Frequency



Main Characteristics (HA1630Q02)

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

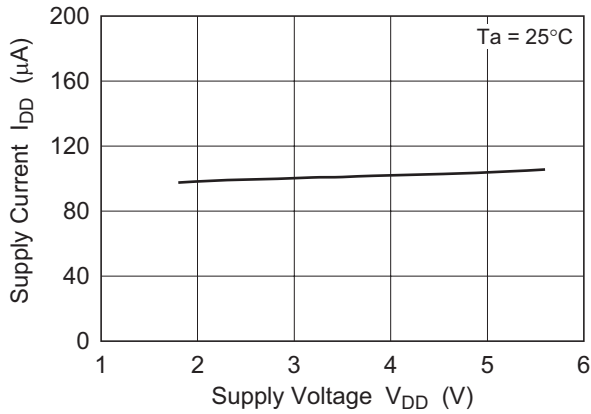


Figure 2-2. HA1630Q02
Supply Current vs. Ambient Temperature

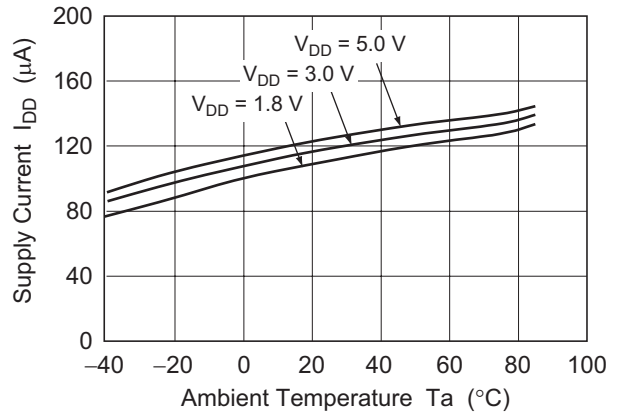


Figure 2-3. HA1630Q02
Output High Voltage vs. Output Source Current

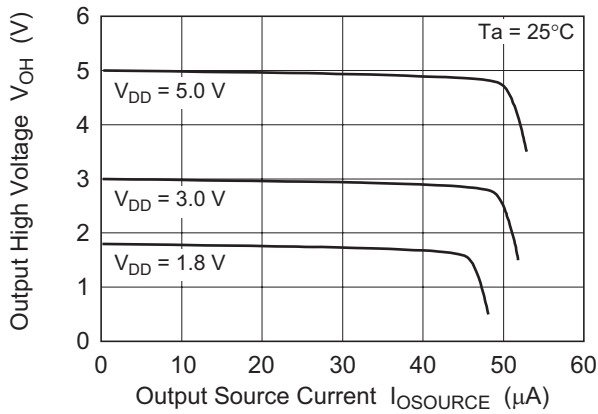


Figure 2-4. HA1630Q02
Output High Voltage vs. Supply Voltage

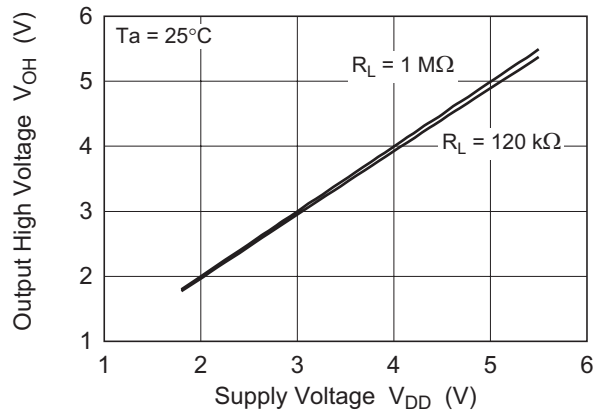
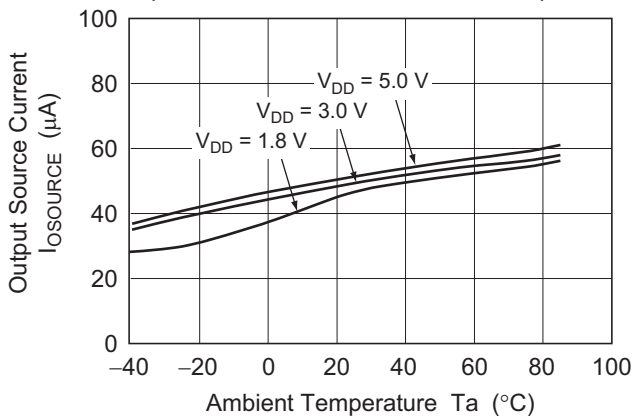


Figure 2-5. HA1630Q02
Output Source Current vs. Ambient Temperature



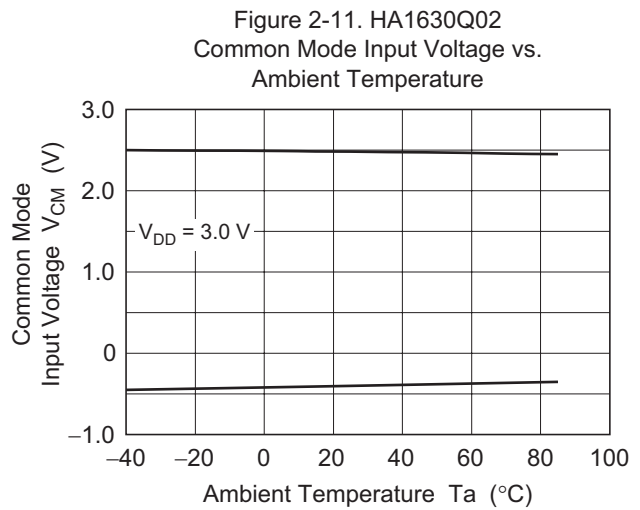
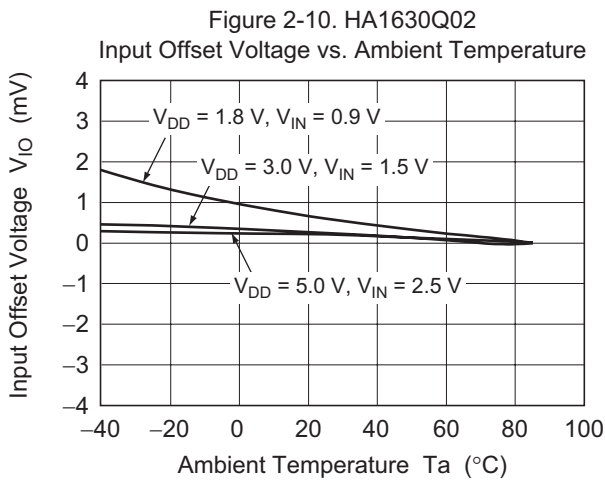
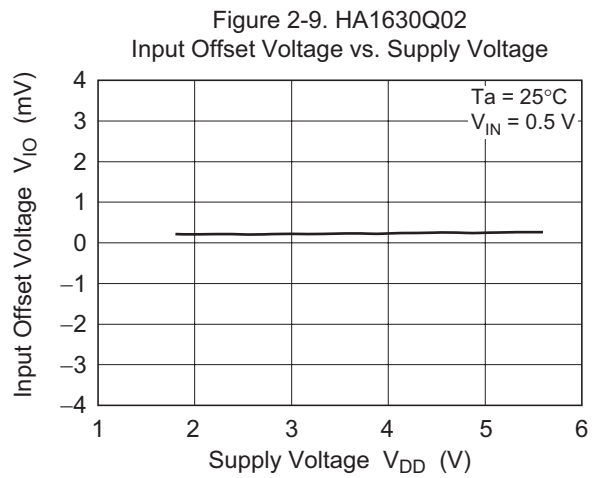
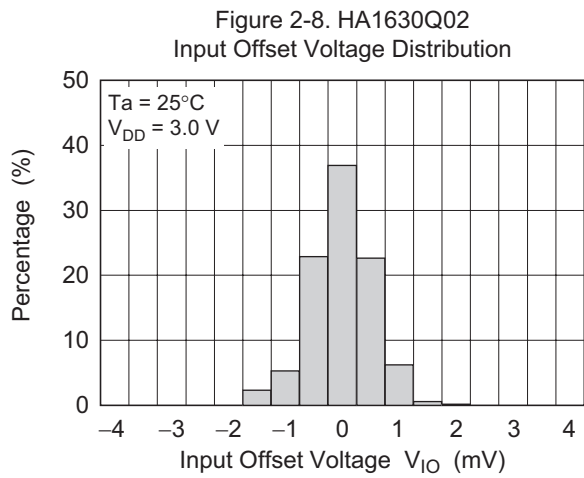
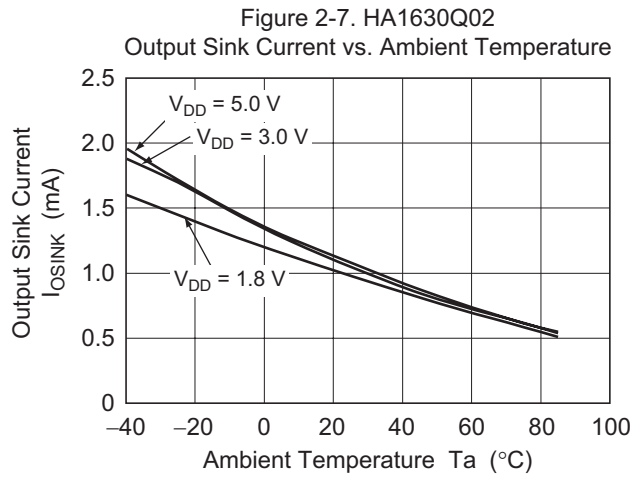
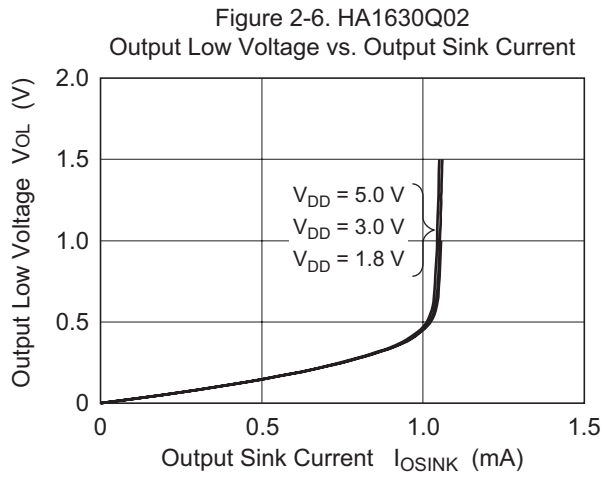


Figure 2-12. HA1630Q02
Power Supply Rejection Ratio vs. Frequency

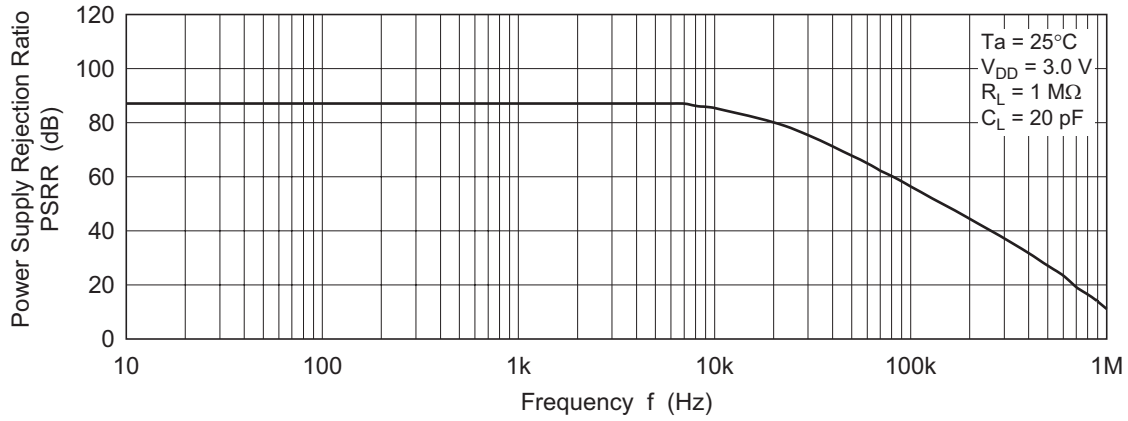


Figure 2-13. HA1630Q02
Common Mode Rejection Ratio vs. Frequency

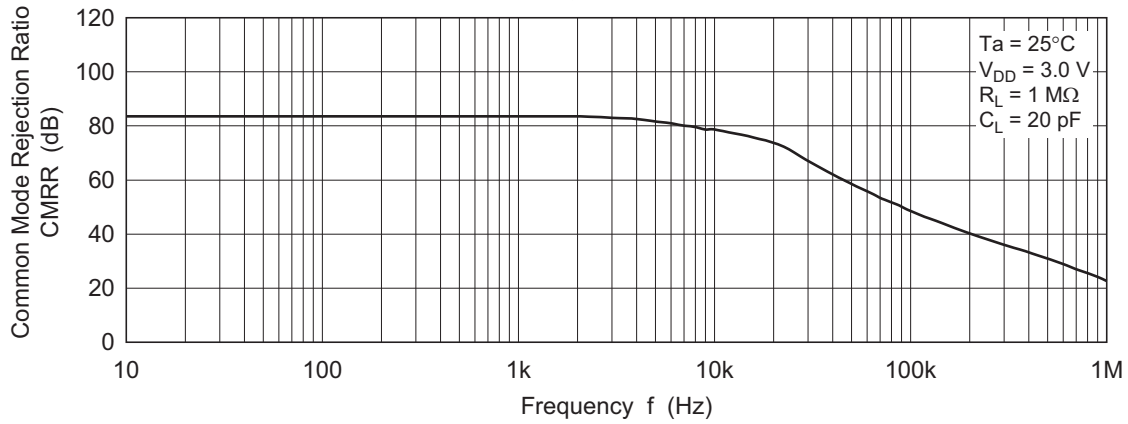
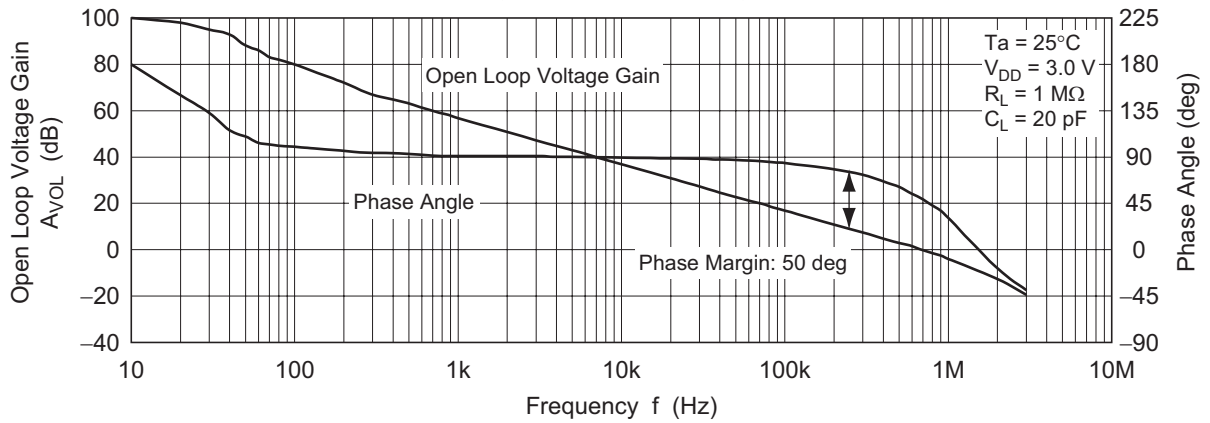


Figure 2-14. HA1630Q02
Open Loop Voltage Gain and Phase Angle vs. Frequency



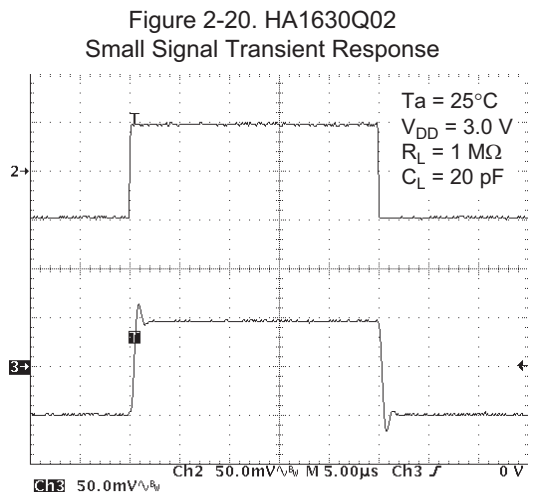
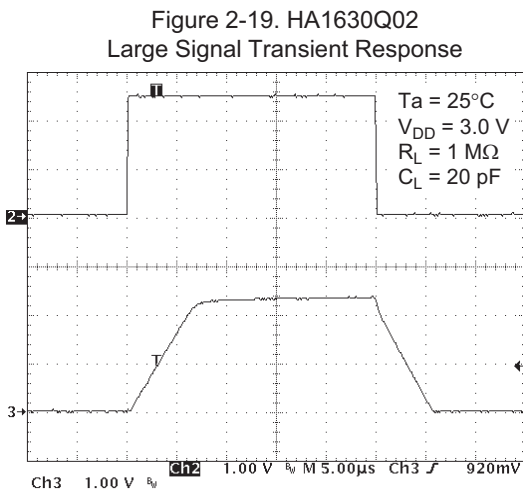
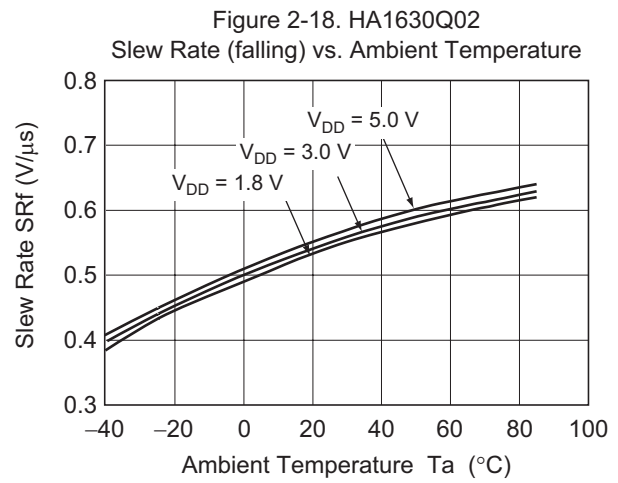
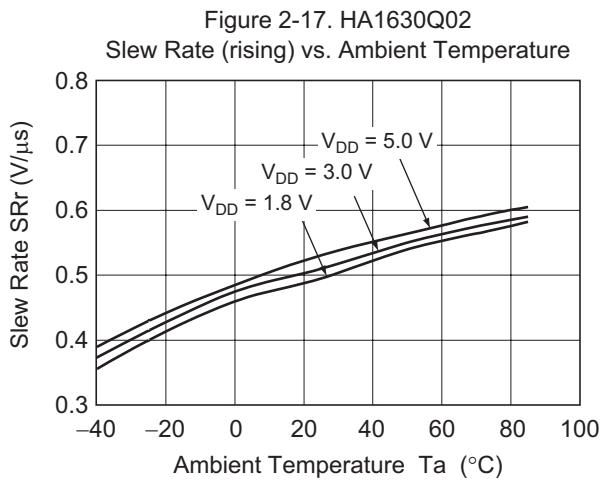
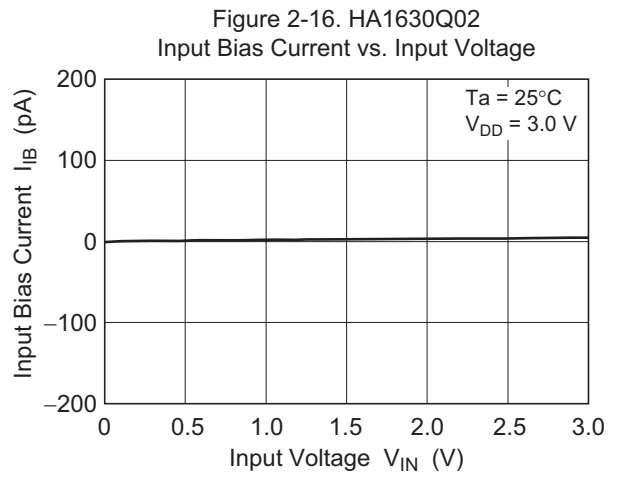
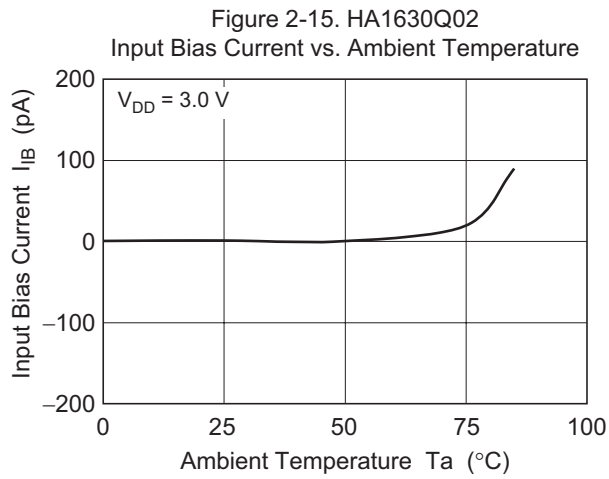


Figure 2-21. HA1630Q02
Total Harmonic Distortion + Noise vs.
Output Voltage p-p

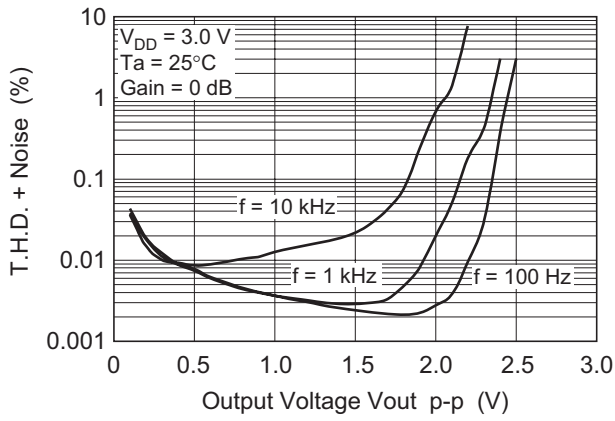


Figure 2-22. HA1630Q02
Total Harmonic Distortion + Noise vs.
Output Voltage p-p

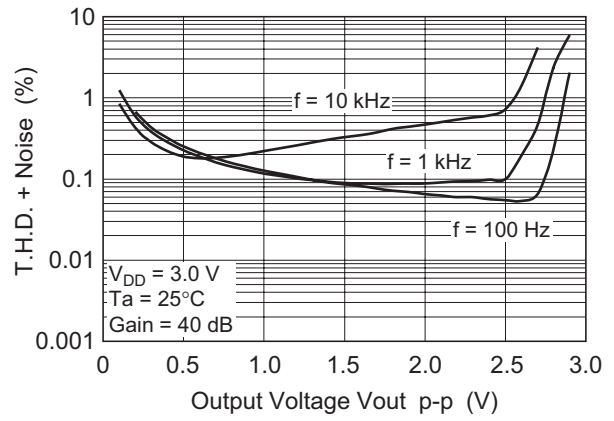


Figure 2-23. HA1630Q02
Voltage Output p-p vs. Frequency

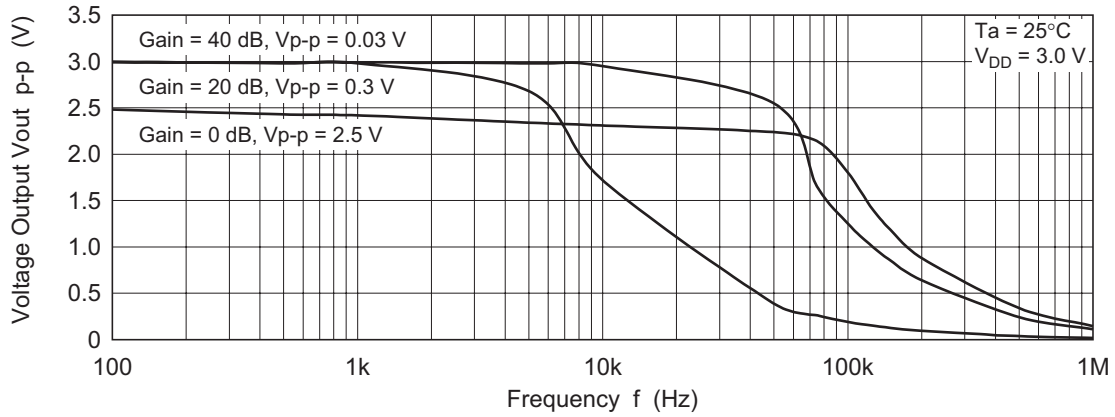
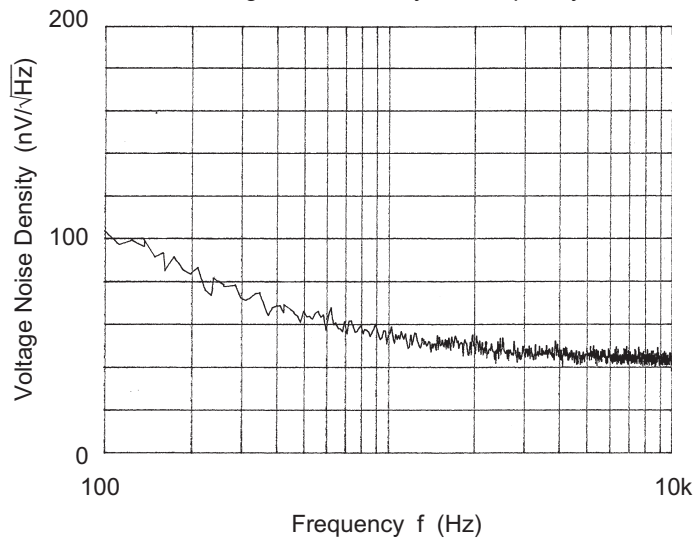
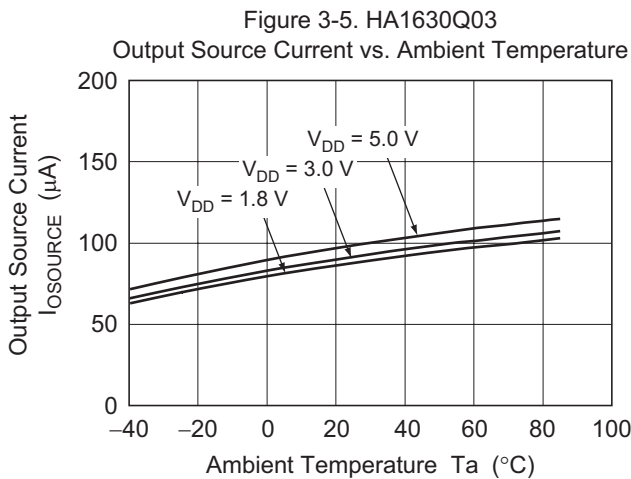
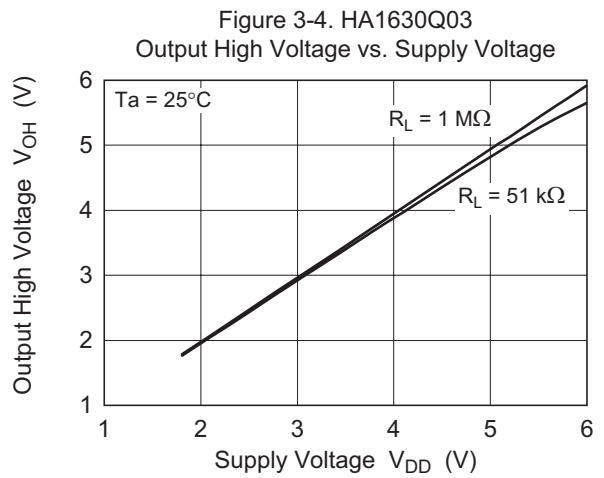
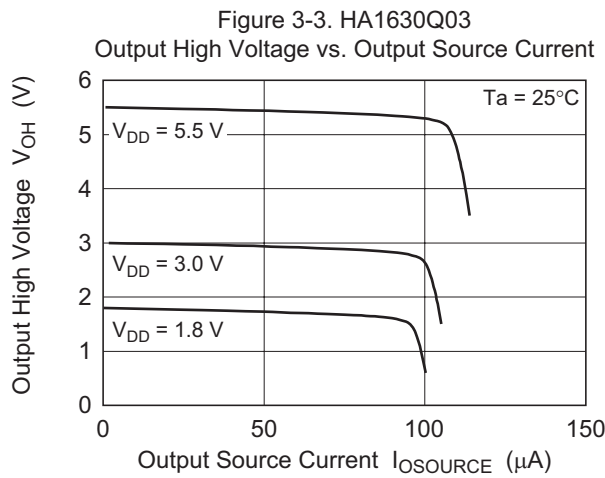
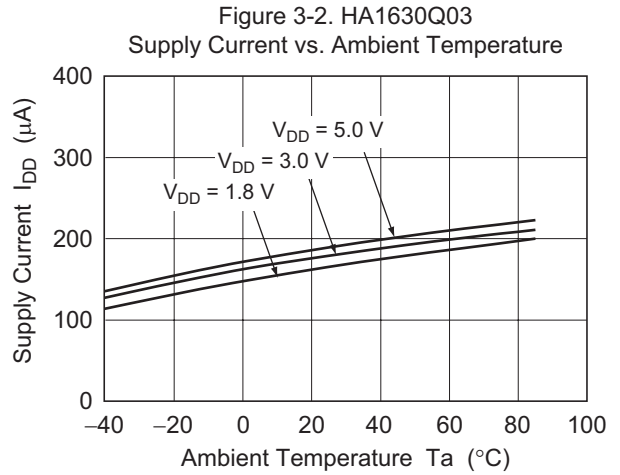
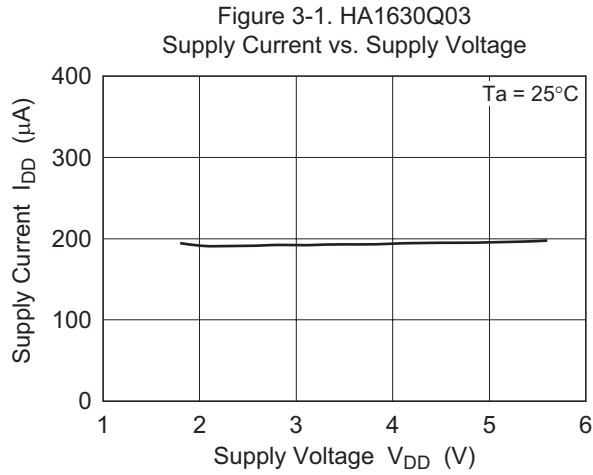


Figure 2-24. HA1630Q02
Voltage Noise Density vs. Frequency



Main Characteristics (HA1630Q03)



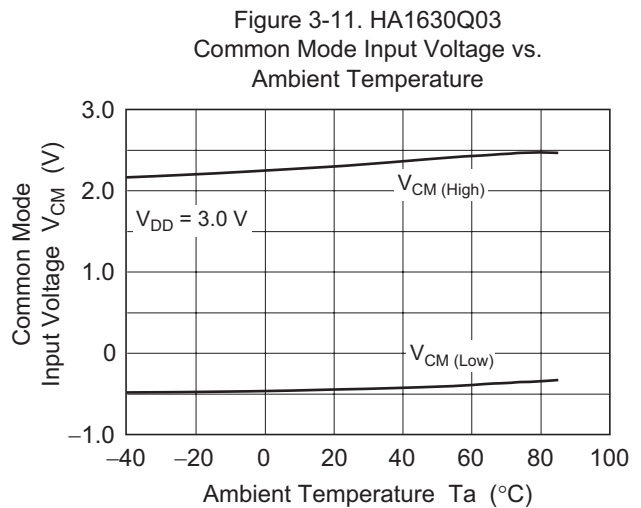
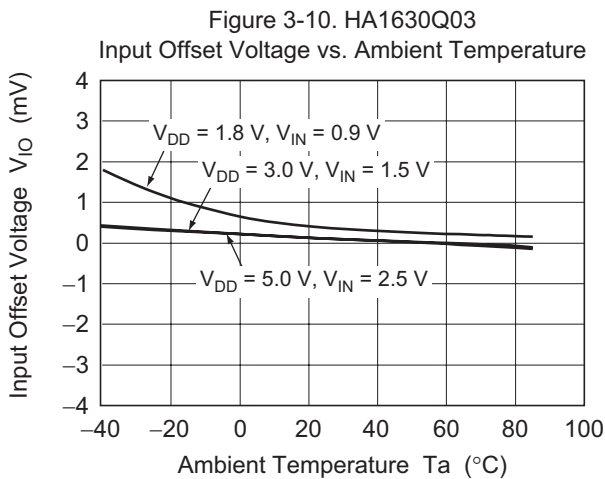
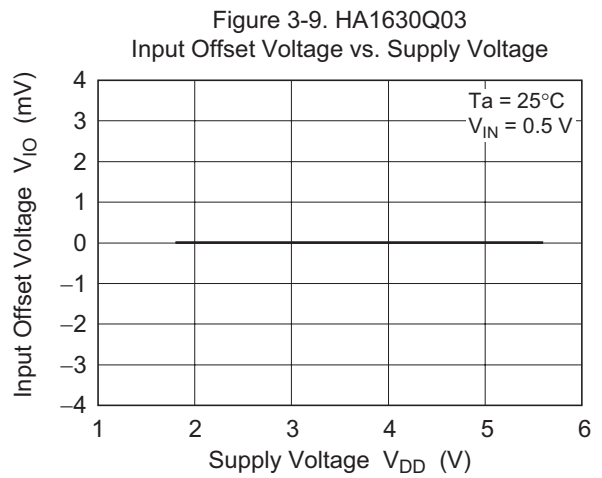
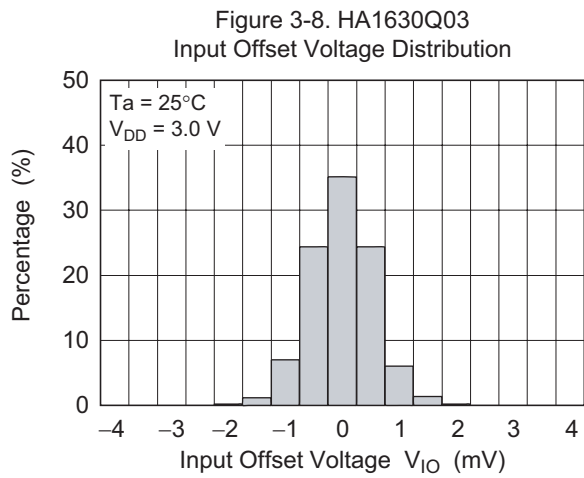
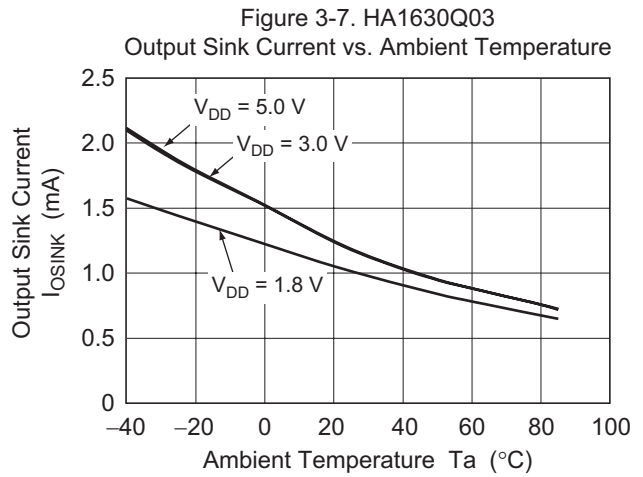
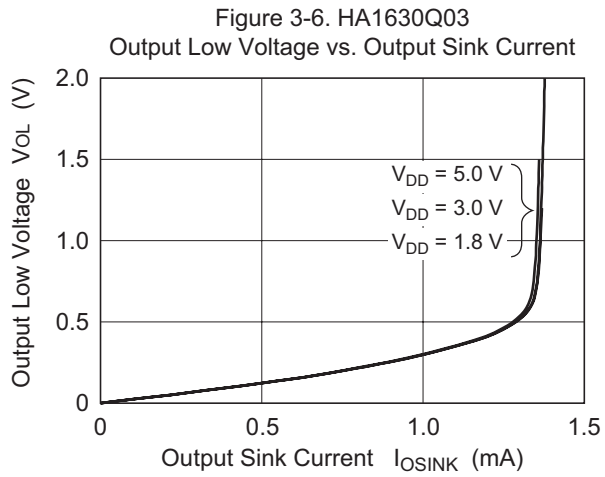


Figure 3-12. HA1630Q03
Power Supply Rejection Ratio vs. Frequency

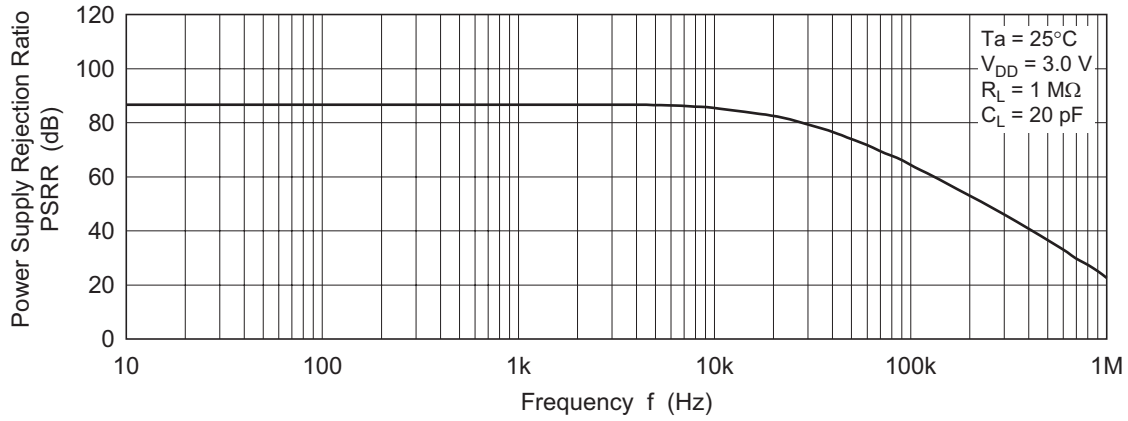


Figure 3-13. HA1630Q03
Common Mode Rejection Ratio vs. Frequency

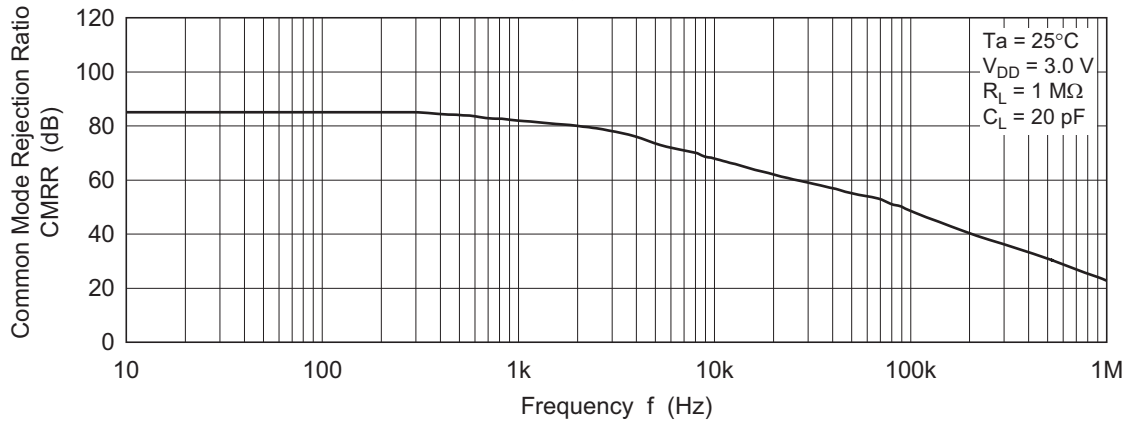
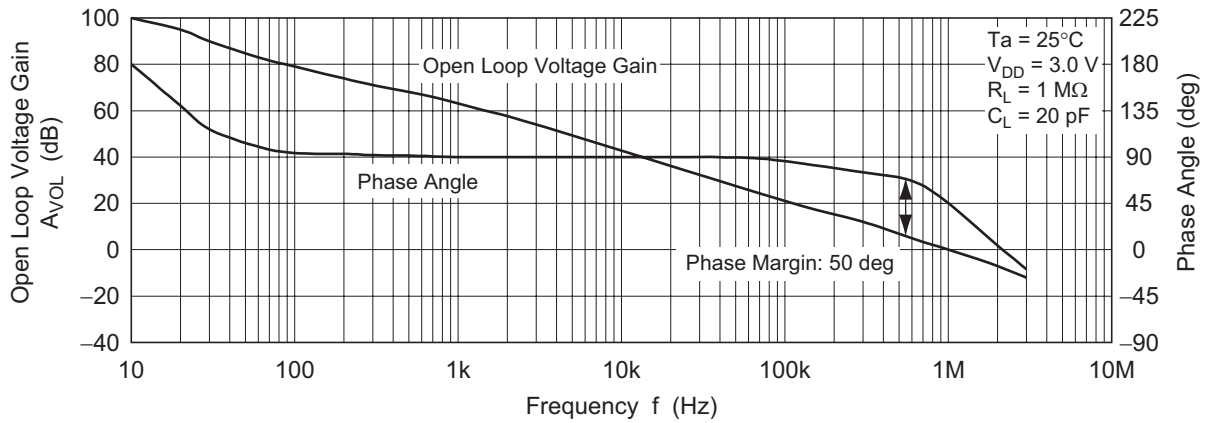


Figure 3-14. HA1630Q03
Open Loop Voltage Gain and Phase Angle vs. Frequency



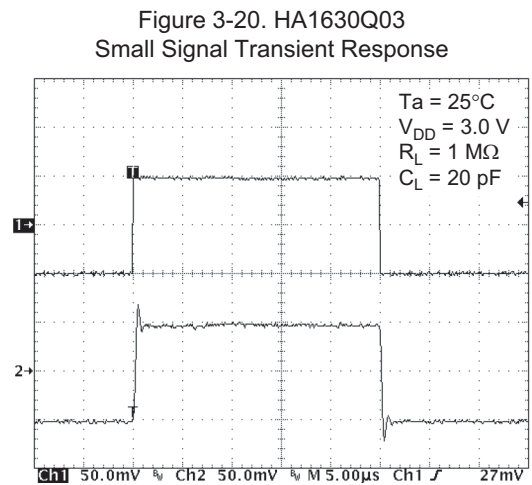
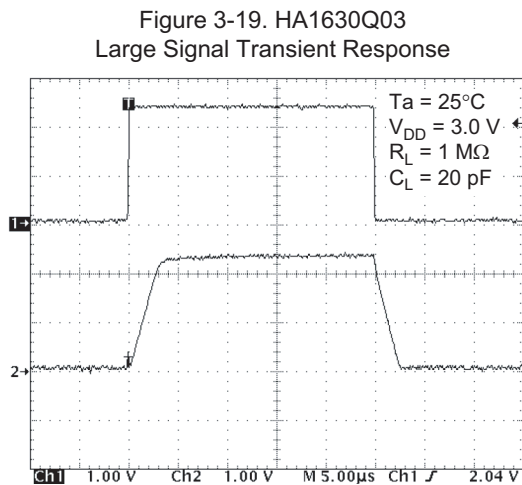
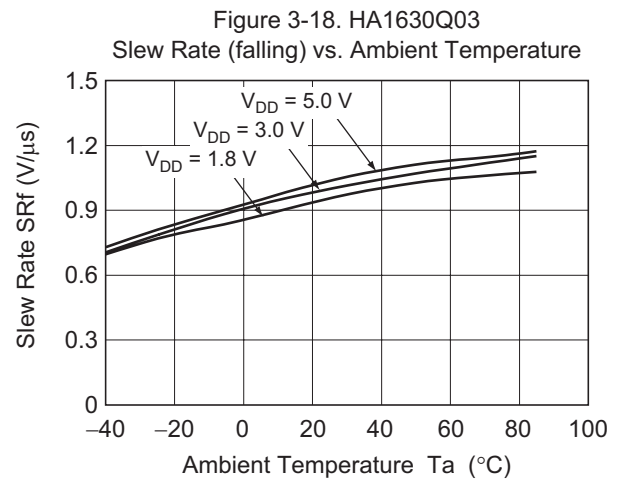
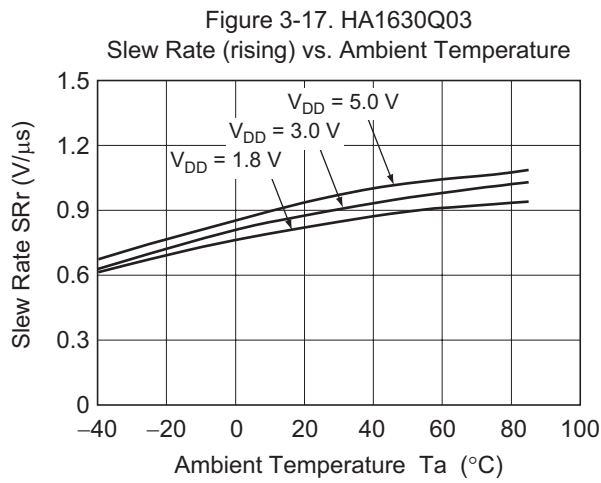
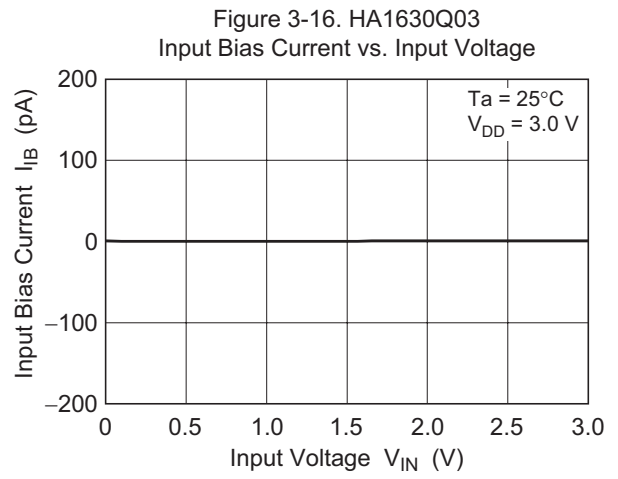
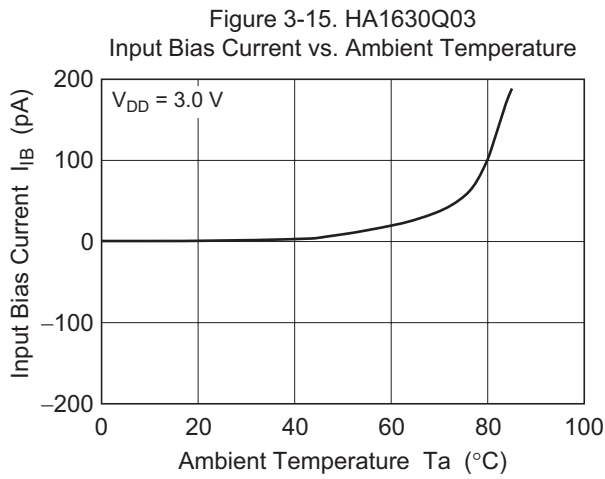


Figure 3-21. HA1630Q03
Total Harmonic Distortion + Noise vs.
Output Voltage p-p

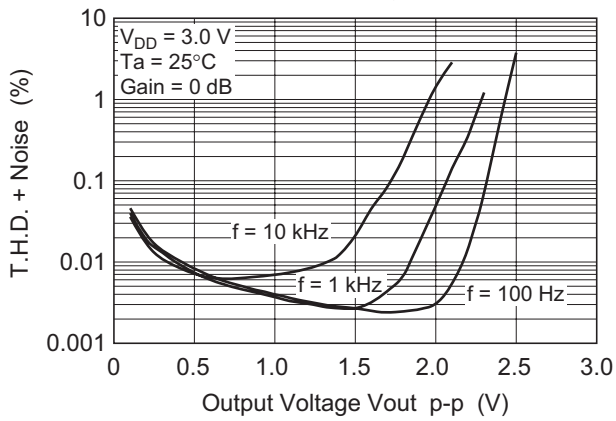


Figure 3-22. HA1630Q03
Total Harmonic Distortion + Noise vs.
Output Voltage p-p

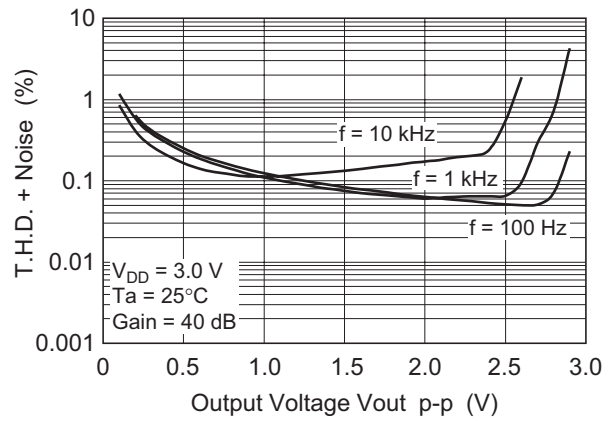


Figure 3-23. HA1630Q03
Voltage Output p-p vs. Frequency

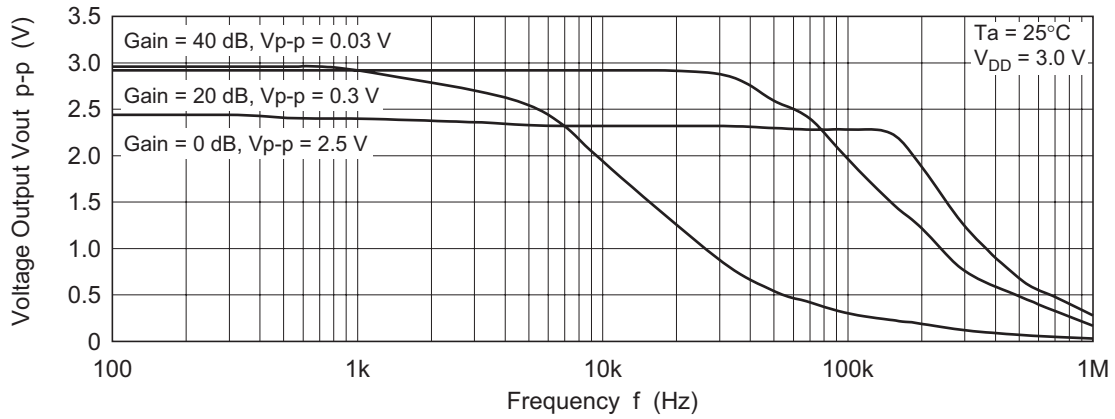
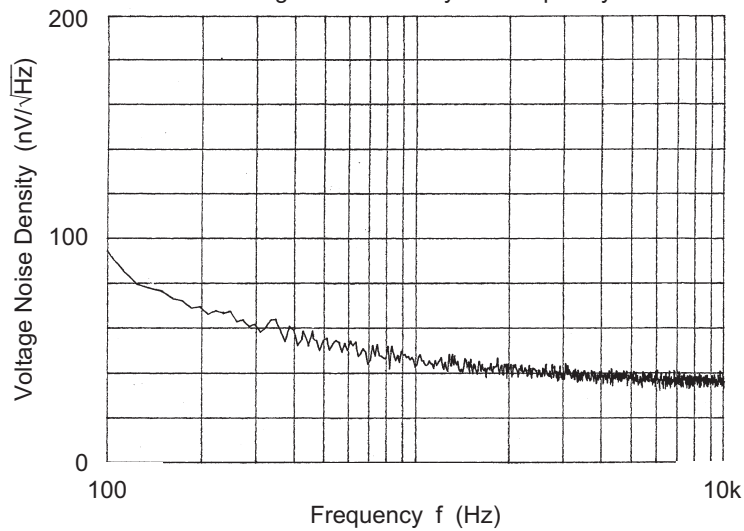
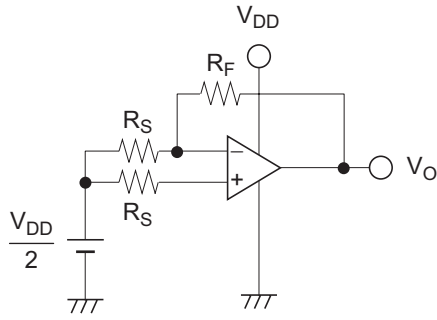


Figure 3-24. HA1630Q03
Voltage Noise Density vs. Frequency



Test Circuits

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



$$\underline{V_{IO}}$$

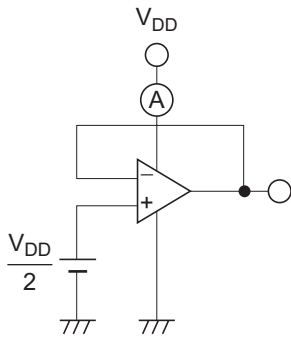
$$V_{IO} = \left(V_O - \frac{V_{DD}}{2} \right) \times \frac{R_S}{R_S + R_F}$$

$$\underline{PSRR}$$

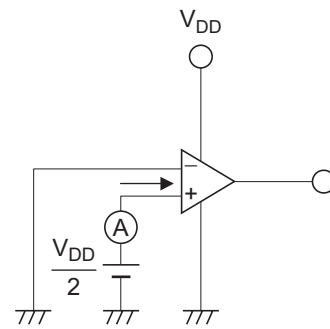
$$PSRR = -20 \log \left(\left| \frac{V_{O1} - V_{O2}}{V_{DD1} - V_{DD2}} \right| \times \frac{R_S}{R_S + R_F} \right)$$

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

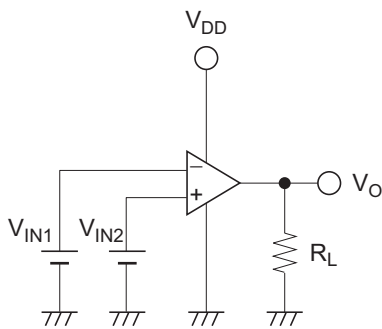
2. Supply Current, I_{DD}



3. Input Bias Current, I_B



4. Output High Voltage, V_{OH}



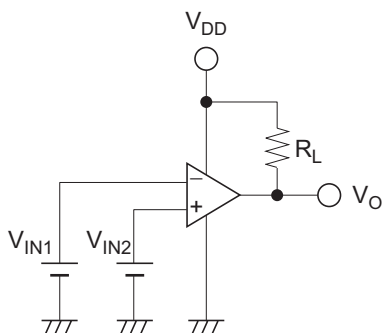
$$\underline{V_{OH}}$$

$$R_L = 1 \text{ M}\Omega$$

$$V_{IN1} = V_{DD} / 2 - 0.05 \text{ V}$$

$$V_{IN2} = V_{DD} / 2 + 0.05 \text{ V}$$

5. Output Low Voltage, V_{OL}



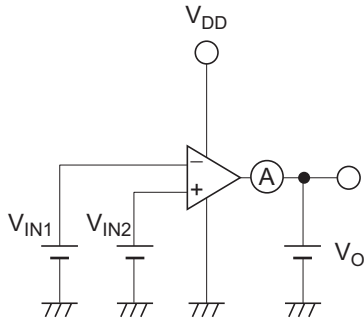
$$\underline{V_{OL}}$$

$$R_L = 1 \text{ M}\Omega$$

$$V_{IN1} = V_{DD} / 2 + 0.05 \text{ V}$$

$$V_{IN2} = V_{DD} / 2 - 0.05 \text{ V}$$

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



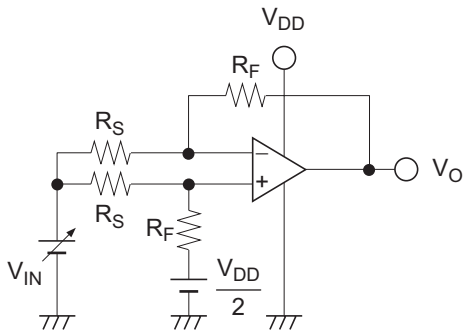
$I_{OSOURCE}$

$$\begin{aligned} V_O &= V_{DD} - 0.5 \text{ V} \\ V_{IN1} &= V_{DD} / 2 - 0.05 \text{ V} \\ V_{IN2} &= V_{DD} / 2 + 0.05 \text{ V} \end{aligned}$$

I_{OSINK}

$$\begin{aligned} V_O &= +0.5 \text{ V} \\ V_{IN1} &= V_{DD} / 2 + 0.05 \text{ V} \\ V_{IN2} &= V_{DD} / 2 - 0.05 \text{ V} \end{aligned}$$

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

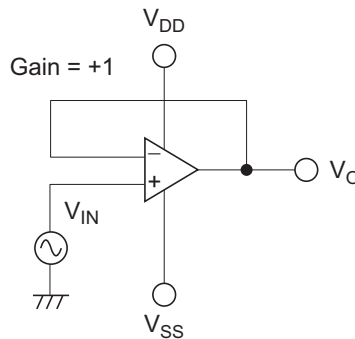
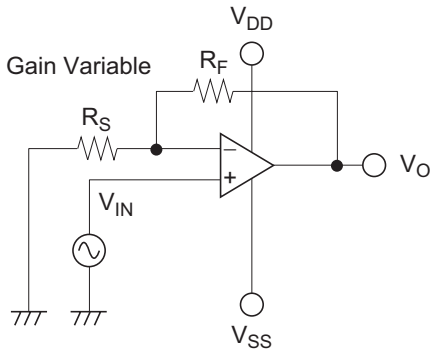


CMRR

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

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

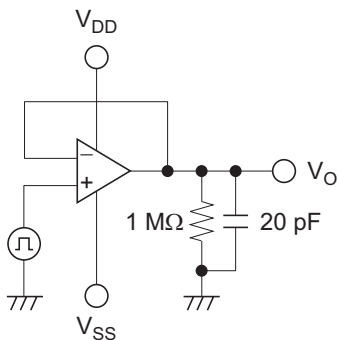
8. Total Harmonic Distortion, THD



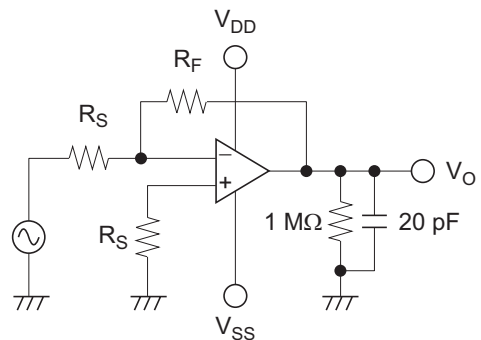
THD

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

9. Slew Rate, SR

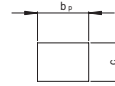
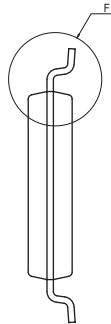
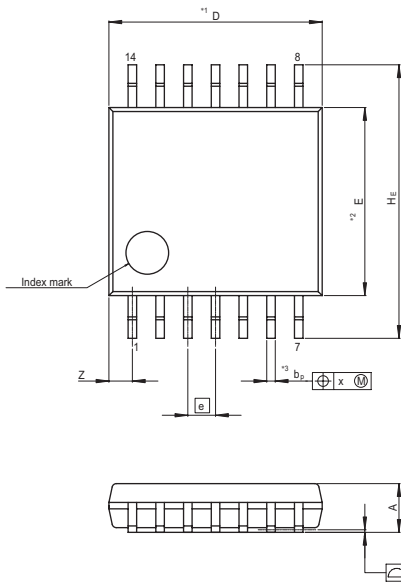


10. Gain, A_V & Phase, GBW

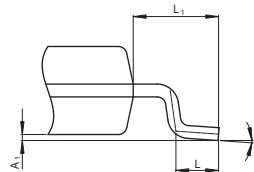


Package Dimensions

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



Terminal cross section
(Ni/Pd/Au plating)



Detail F

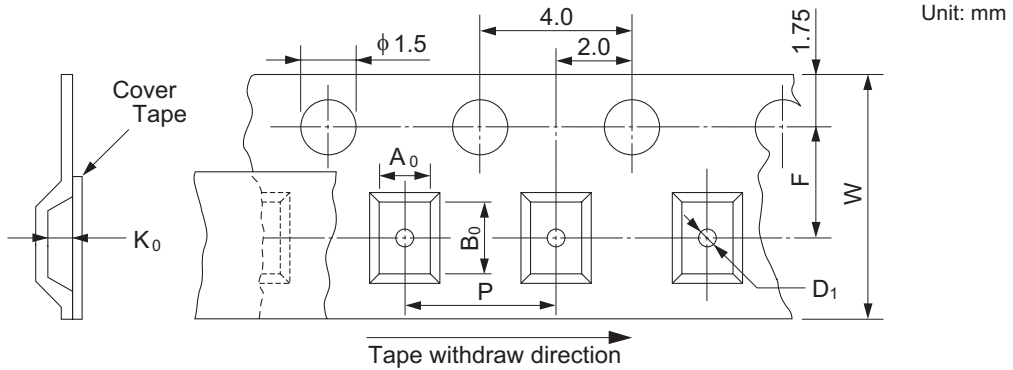
NOTE)
1. DIMENSIONS**1 (Nom)**AND**2"
DO NOT INCLUDE MOLD FLASH.
2. DIMENSION**3**DOES NOT
INCLUDE TRIM OFFSET.

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
⌀	—	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

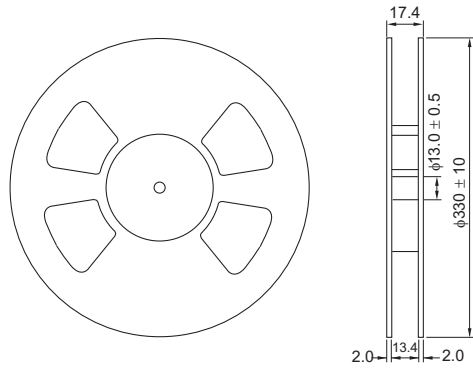
[Taping]

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]

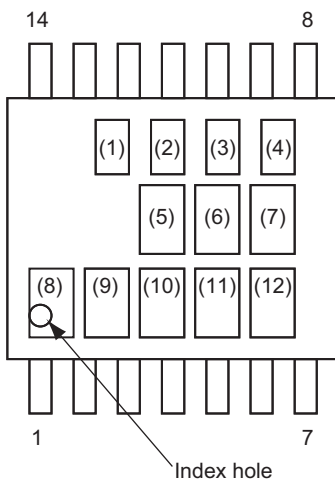
Package	Tape width	W1	W2
TSSOP-14	12	17.4	13.4



[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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Remember to give due consideration to safety when making your circuit designs, with appropriate measures such as (i) placement of substitutive, auxiliary circuits, (ii) use of nonflammable material or (iii) prevention against any malfunction or mishap.

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