

To our customers,

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April 1<sup>st</sup>, 2010  
Renesas Electronics Corporation

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# HA1630D08

## Dual CMOS High Drive Operational Amplifier

REJ03D0860-0200

Rev.2.00

Nov 30, 2007

### Description

HA1630D08 is a low power dual CMOS operational amplifier featuring high output current with typical current supply of 340  $\mu$ A for both channels (2.7 - 5.5 V). This IC designed to operate from a single power supply and have full swing outputs. Available in MMPAK-8 and TSSOP-8 package, the miniature size of this IC not only allows compact integration in portable devices but also minimizes distance of signal sources (sensors), thus reducing external noise pick up prior to amplification. This IC exhibit excellent current drive-power ratio capable of 600  $\Omega$  load driving and yet resistant to oscillation for capacitive loads up to 400 pF.

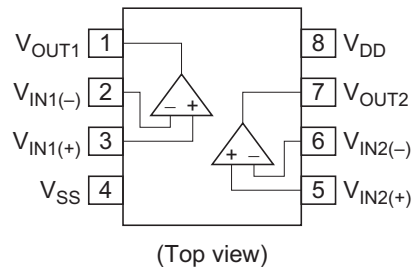
### Features

- Low supply current  $I_{DD} = 340 \mu A$  Typ ( $V_{DD} = 3 V$ ,  $R_L = \text{No load}$ )
- Low voltage operation  $V_{DD} = 2.7 V$  to  $5.5 V$
- Low input offset voltage  $V_{IO} = 6 mV$  Max
- Low input bias current  $I_{IB} = 1 pA$  Typ
- High output current  $I_{OSOURCE} = 30 mA$  Typ ( $V_{DD} = 3.0 V$ ,  $V_{OH} = 2.5 V$ )  
 $I_{OSINK} = 30 mA$  Typ ( $V_{DD} = 3.0 V$ ,  $V_{OL} = 0.5 V$ )
- Input common voltage range includes ground

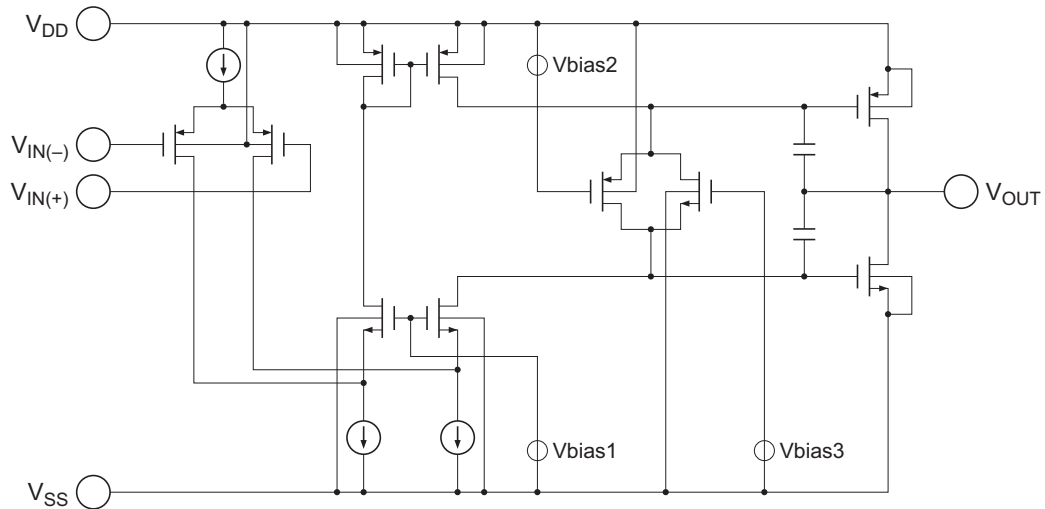
### Ordering Information

Part No.	Package Name	Package Code
HA1630D08MM	MMPAK-8	PLSP0008JC-A
HA1630D08T	TSSOP-8	PTSP0008JC-B

## Pin Arrangement



## Equivalent Circuit (1/2)



## Absolute Maximum Ratings

(Ta = 25°C)

Item	Symbol	Ratings	Unit	Note
Supply voltage	V <sub>DD</sub>	7.0	V	
Differential input voltage	V <sub>IN(diff)</sub>	−V <sub>DD</sub> to +V <sub>DD</sub>	V	1
Input voltage	V <sub>IN</sub>	−0.1 to +V <sub>DD</sub>	V	
Output current	I <sub>OUT</sub>	70	mA	
Power dissipation	P <sub>T</sub>	145 (MMPAK-8)	mW	2
		192 (TSSOP-8)		
Operating temperature	T <sub>opr</sub>	−40 to +85	°C	
Storage temperature	T <sub>stg</sub>	−55 to +125	°C	

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

2. If Ta &gt; 25°C,

MMPAK-8: derate by −1.45 mW/°C

TSSOP-8: derate by −1.92 mW/°C

## Electrical Characteristics

### DC Characteristics

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

Item	Symbol	Min	Typ	Max	Unit	Test Conditions
Input offset voltage	V <sub>IO</sub>	—	—	6	mV	V <sub>IN</sub> = 1.5 V, R <sub>L</sub> = 1 MΩ
Input bias current	I <sub>IB</sub>	—	(1)	—	pA	V <sub>IN</sub> = 1.5 V
Input offset current	I <sub>IO</sub>	—	(1)	—	pA	V <sub>IN</sub> = 1.5 V
Common mode input voltage range	V <sub>CM</sub>	−0.1	—	1.8	V	
Supply current	I <sub>DD</sub>	—	340	1000	μA	V <sub>IN(+)</sub> = 1.0 V, R <sub>L</sub> = ∞
Output source current	I <sub>OSOURCE</sub>	15	30	—	mA	V <sub>out</sub> = 2.5 V
Output sink current	I <sub>OSINK</sub>	15	30	—	mA	V <sub>out</sub> = 0.5 V
Open loop voltage gain	A <sub>V</sub>	55	80	—	dB	R <sub>L</sub> = 100 kΩ
Common mode rejection ratio	CMRR	50	80	—	dB	V <sub>IN1</sub> = 0 V, V <sub>IN2</sub> = 1.8 V
Power supply rejection ratio	PSRR	55	80	—	dB	V <sub>DD1</sub> = 2.7 V, V <sub>DD2</sub> = 5.5 V
Output high voltage	V <sub>OH</sub>	2.9	—	—	V	R <sub>L</sub> = 600 Ω to V <sub>SS</sub>
Output low voltage	V <sub>OL</sub>	—	—	0.1	V	R <sub>L</sub> = 600 Ω to V <sub>DD</sub>

Note: ( ) : Design specification

### AC Characteristics

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

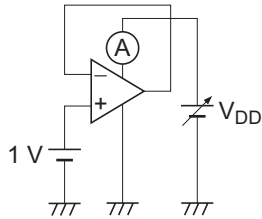
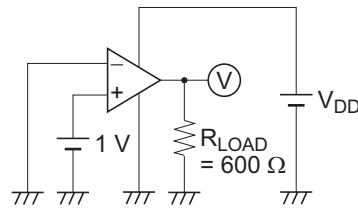
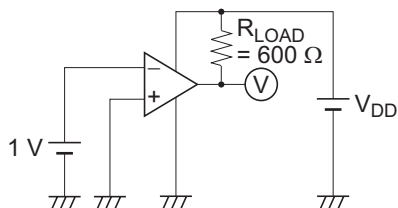
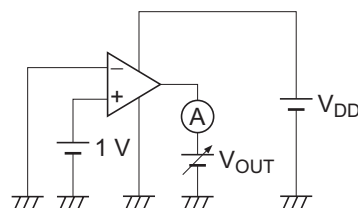
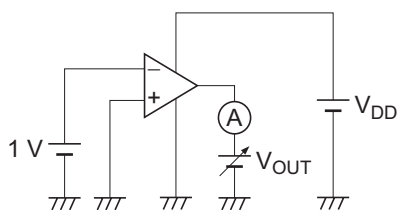
Item	Symbol	Min	Typ	Max	Unit	Test Conditions
Slew rate	SR <sub>r</sub>	—	(1.5)	—	V/μs	V <sub>IN</sub> = 1.5 V, C <sub>L</sub> = 15 pF
	SR <sub>f</sub>	—	(1.5)	—		(V <sub>INL</sub> = 0.2 V, V <sub>INH</sub> = 1.7 V)
Gain bandwidth product	GBW	—	(2.0)	—	MHz	V <sub>IN</sub> = 1.5 V, C <sub>L</sub> = 15 pF

Note: ( ) : Design specification

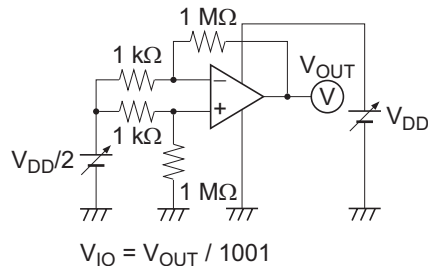
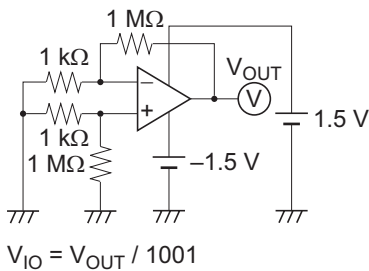
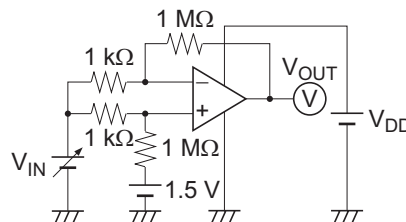
## Table of Graphs

Electrical Characteristics			Characteristic Curves	Test Circuit No.
Supply current	$I_{DD}$	vs. Supply voltage	1	1
		vs. Temperature	2	1
Output high voltage	$V_{OH}$	vs. Rload	3	2
Output low voltage	$V_{OL}$	vs. Rload	4	3
Output source current	$I_{OSOURCE}$	vs. Output high voltage	5	4
		vs. Temperature	6	4
Output sink current	$I_{OSINK}$	vs. Output low voltage	7	5
		vs. Temperature	8	5
Input offset voltage	$V_{IO}$	vs. Supply voltage	9	6
		vs. Input voltage	10	6
		vs. Temperature	11	7
Common mode input voltage range	$V_{CM}$	vs. Supply voltage	12	8
		vs. Temperature	13	8
Common mode rejection ratio	CMRR	vs. Input voltage	14	9
Power supply rejection ratio	PSRR	vs. Supply voltage	15	10
Input bias current	$I_{IB}$	vs. Input voltage	16	11, 12
		vs. Temperature	17	11, 12
Slew rate (rising)	SRr	vs. Cload	18	13
		vs. Temperature	19	13
		Time waveform	20	13
Slew rate (falling)	SRf	vs. Cload	21	13
		vs. Temperature	22	13
		Time waveform	23	13
Open loop gain	$A_V$	vs. Rload	24	14
		vs. Frequency	25, 26	14
Phase margin	PM	vs. Cload	27	14
Channel separation	CS	vs. Frequency	28	15
Noise input voltage	VNI	vs. Frequency	29	16

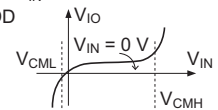
## Test Circuits

(Unless otherwise noted,  $V_{DD} = 3\text{ V}$ ,  $V_{SS} = 0\text{ V}$ ,  $T_a = 25^\circ\text{C}$ )1. Supply Current,  $I_{DD}$ 2. Output High Voltage,  $V_{OH}$  (Output High)3. Output Low Voltage,  $V_{OL}$  (Output Low)4. Output Source Current,  $I_{OSOURCE}$ 5. Output Sink Current,  $I_{OSINK}$ 

6. Input Offset Voltage vs. Operating Voltage

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

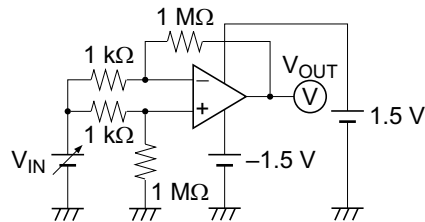
Note:  
 $V_{CML}$  and  $V_{CMH}$  are values  
of  $V_{IN}$  when  $V_{IO}$  changes  
more than 50 dB taking  
 $V_{IN} = 0\text{ V}$  as reference.



# Test Circuits (cont.)

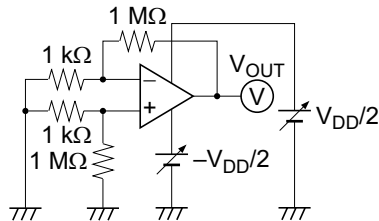
(Unless otherwise noted,  $V_{DD} = 3\text{ V}$ ,  $V_{SS} = 0\text{ V}$ ,  $T_a = 25^\circ\text{C}$ )

## 9. Common Mode Rejection Ratio, CMRR



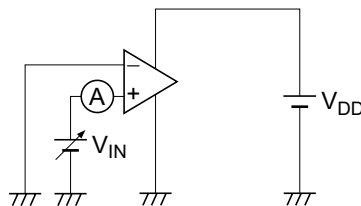
$V_{IN}$	Measure Point	Calculate $V_{IO}$	CMRR Calculation
-1.5 V	$V_{OUT1}$	$V_{IO1} = V_{OUT1} / 1001$	$CMRR = \left  20 \log_{10} \frac{ V_{IO2} - V_{IO1} }{0.3 - (-1.5\text{ V})} \right $
0.3 V	$V_{OUT2}$	$V_{IO2} = V_{OUT2} / 1001$	

## 10. Power Supply Rejection Ratio, PSRR

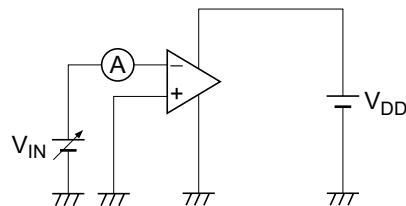


$V_{DD}$	Measure Point	Calculate $V_{IO}$	CMRR Calculation
2.7 V	$V_{OUT1}$	$V_{IO1} = V_{OUT1} / 1001$	$PSRR = \left  20 \log_{10} \frac{ V_{IO2} - V_{IO1} }{5.5\text{ V} - 2.7\text{ V}} \right $
5.5 V	$V_{OUT2}$	$V_{IO2} = V_{OUT2} / 1001$	

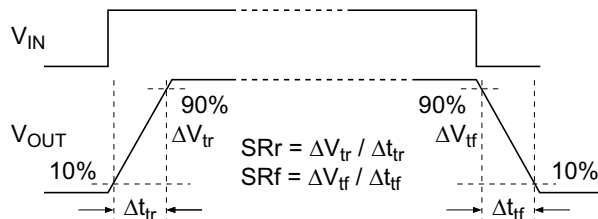
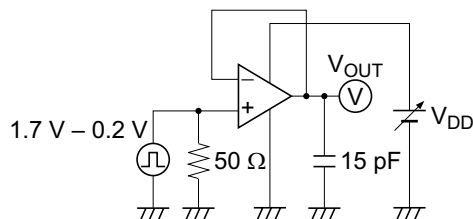
## 11. Input Bias Current, $I_{B+}$



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

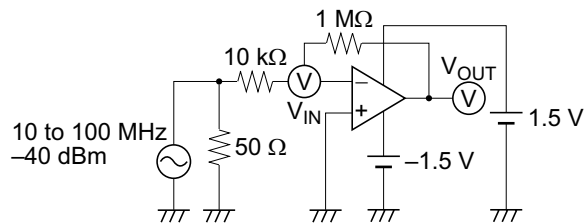


## 13. Slew Rate (Large Signal Input)



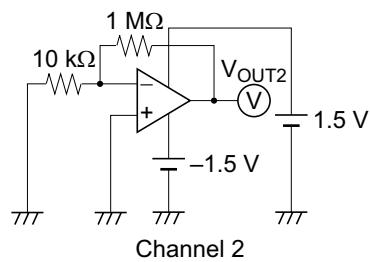
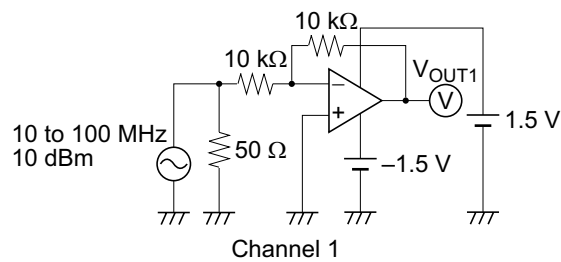


## Test Circuits (cont.)

(Unless otherwise noted,  $V_{DD} = 3\text{ V}$ ,  $V_{SS} = 0\text{ V}$ ,  $T_a = 25^\circ\text{C}$ )14. Open Loop Voltage Gain,  $A_V$ 

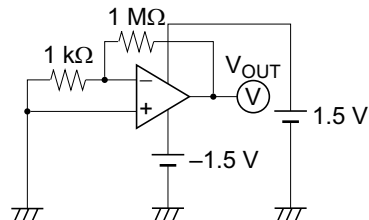
$$A_V = \left| 20 \log_{10} \frac{101 \times |V_{OUT}|}{|V_{IN}|} \right|$$

## 15. Channel Separation, CS



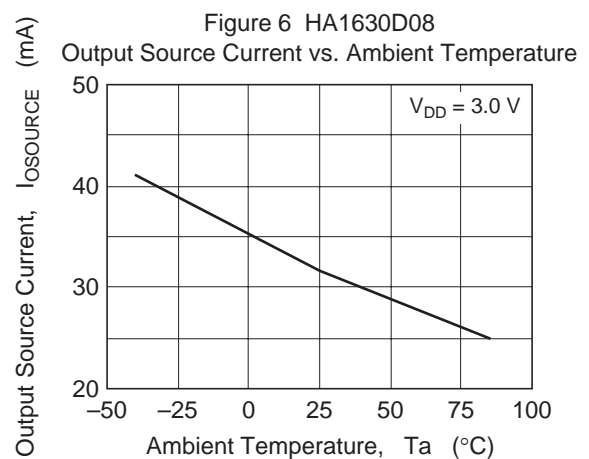
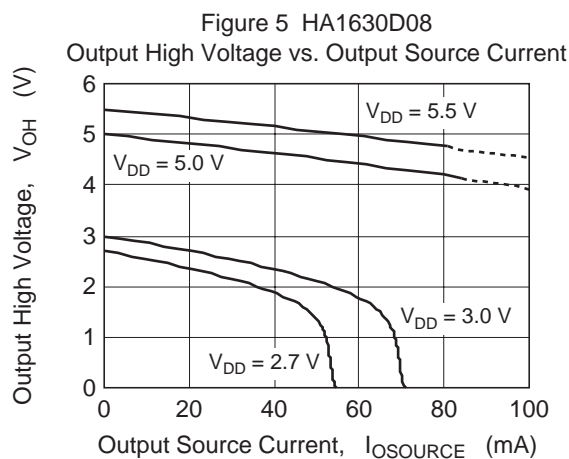
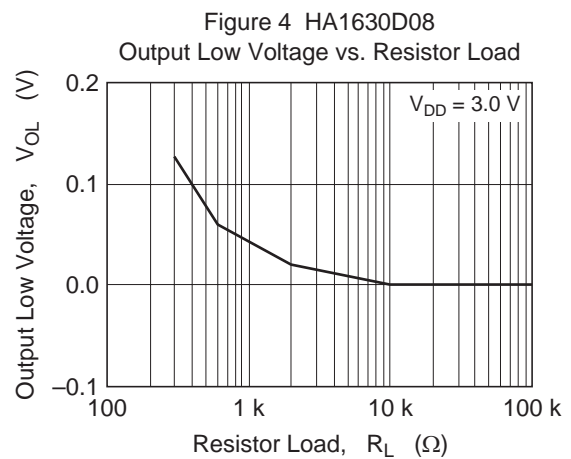
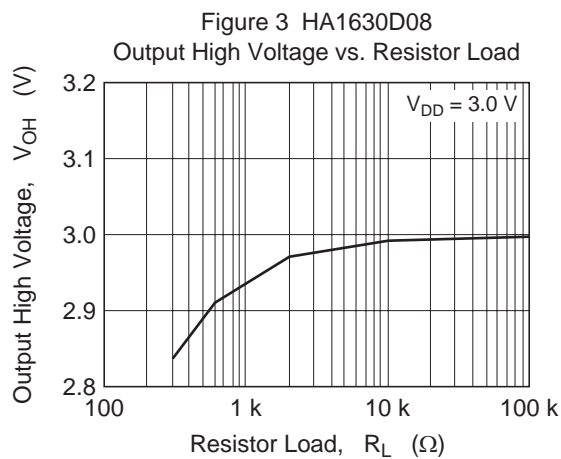
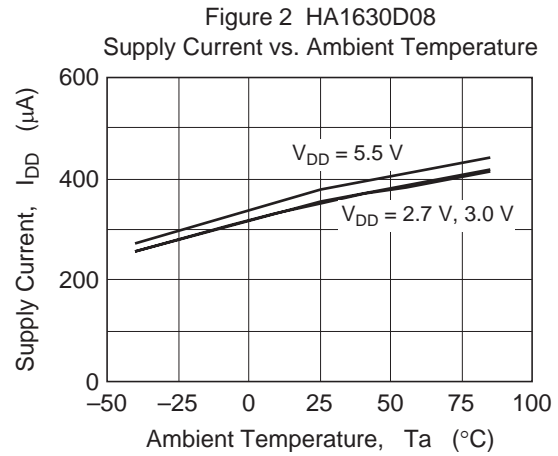
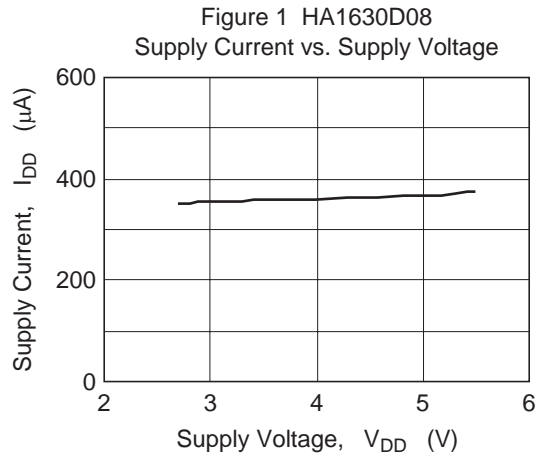
$$CS = \left| 20 \log_{10} \frac{101 \times |V_{OUT2}|}{|V_{OUT1}|} \right|$$

## 16. Noise Input Voltage, VNI

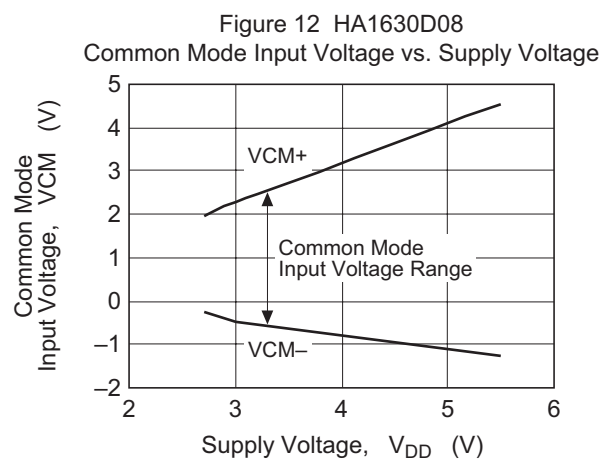
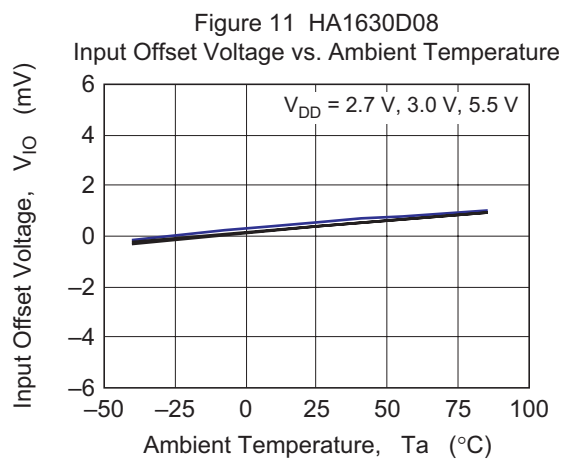
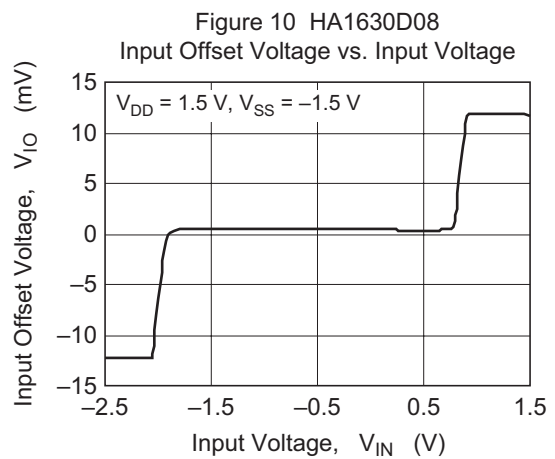
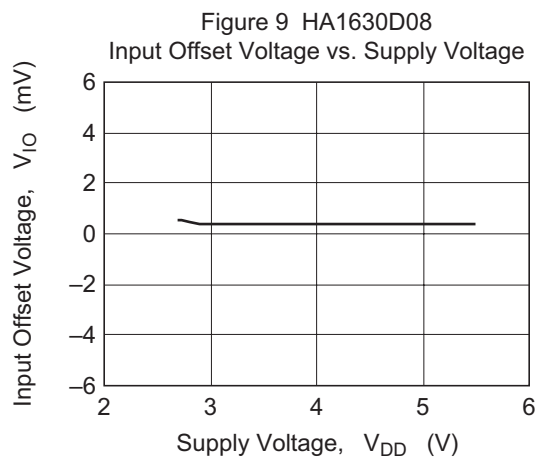
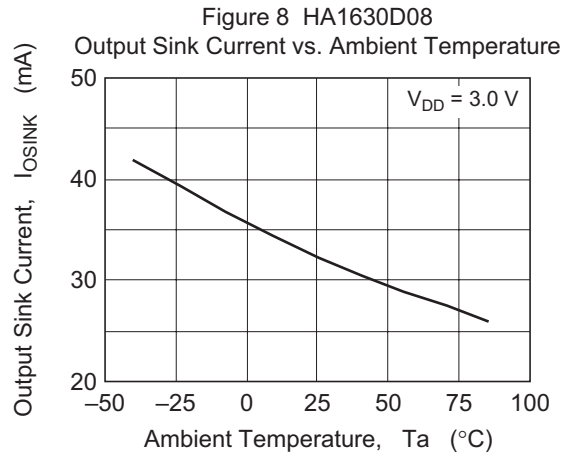
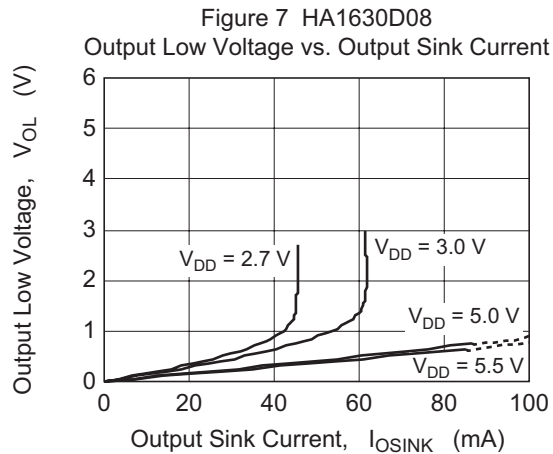


$$VNI = \frac{V_{OUT}}{1001}$$

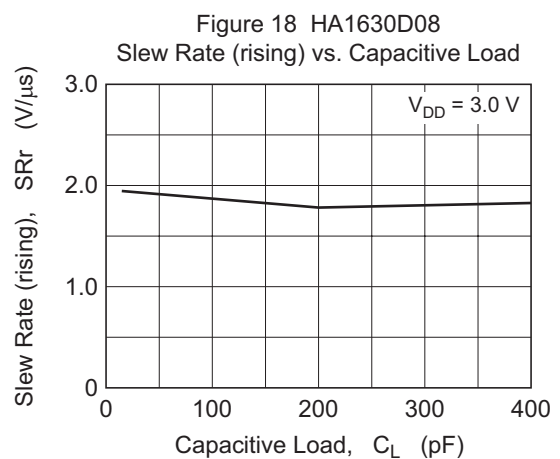
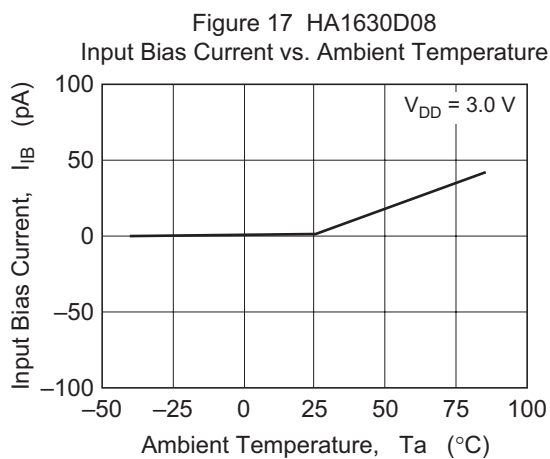
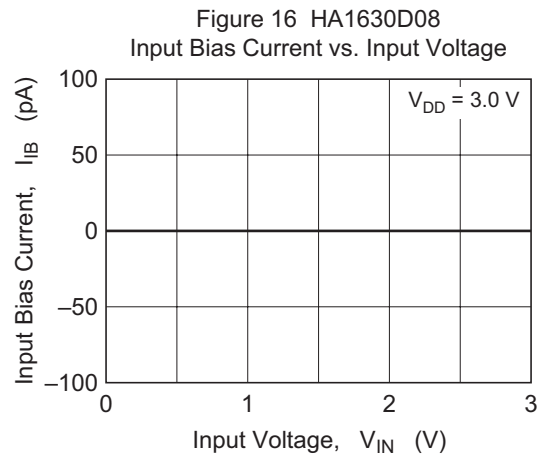
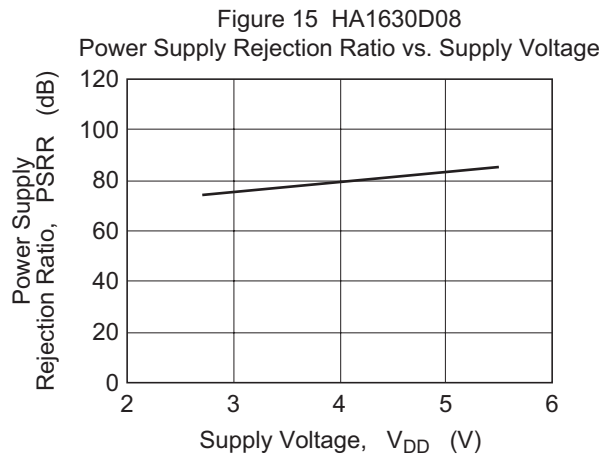
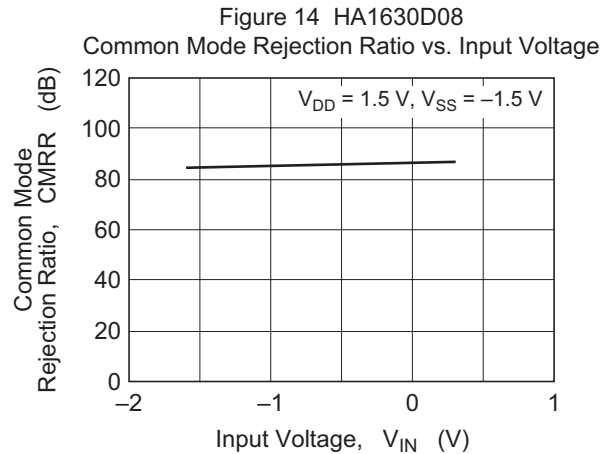
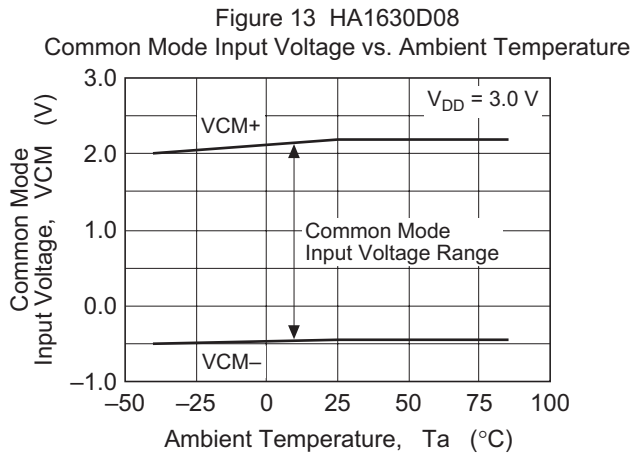
## Characteristic Curves



## Characteristic Curves (cont.)



## Characteristic Curves (cont.)



## Characteristic Curves (cont.)

Figure 19 HA1630D08  
Slew Rate (rising) vs. Ambient Temperature

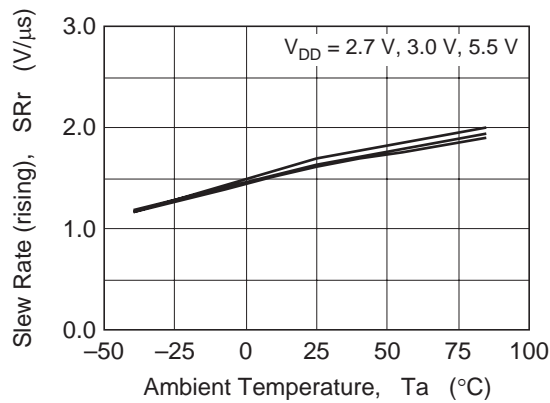


Figure 20 HA1630D08  
Slew Rate (rising)

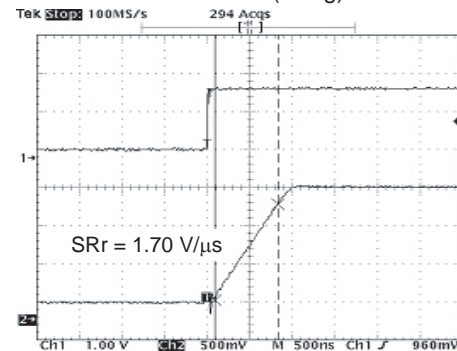


Figure 21 HA1630D08  
Slew Rate (falling) vs. Capacitive Load

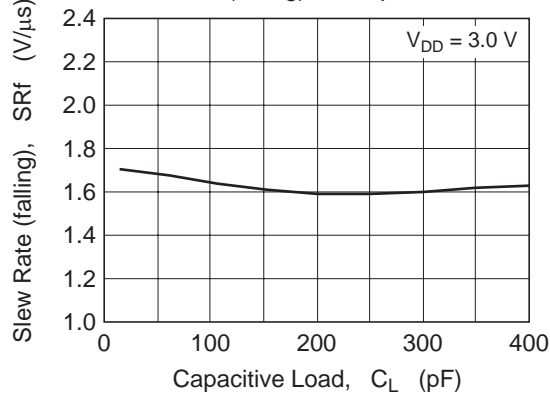


Figure 22 HA1630D08  
Slew Rate (falling) vs. Ambient Temperature

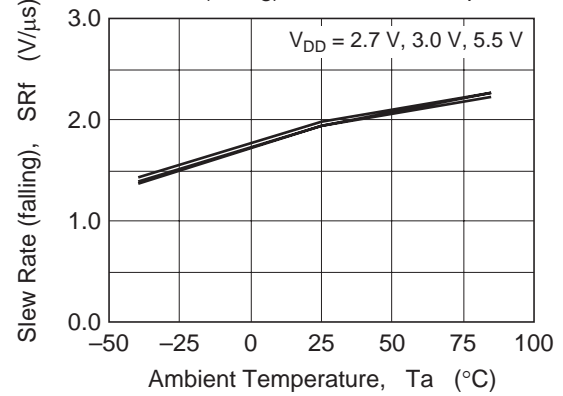


Figure 23 HA1630D08  
Slew Rate (falling)

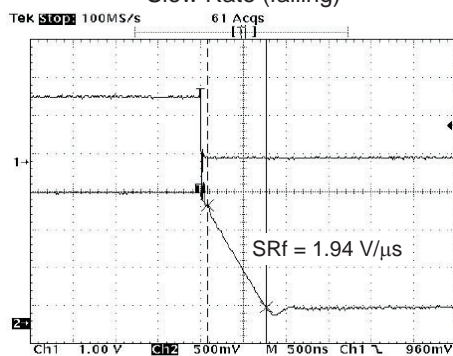
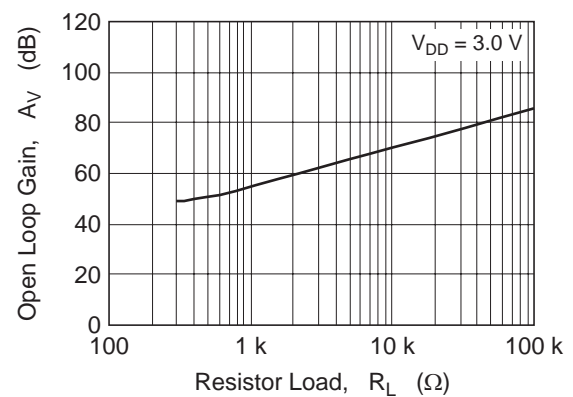
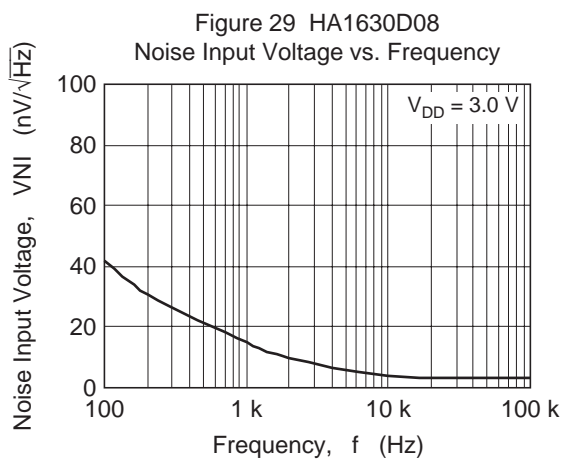
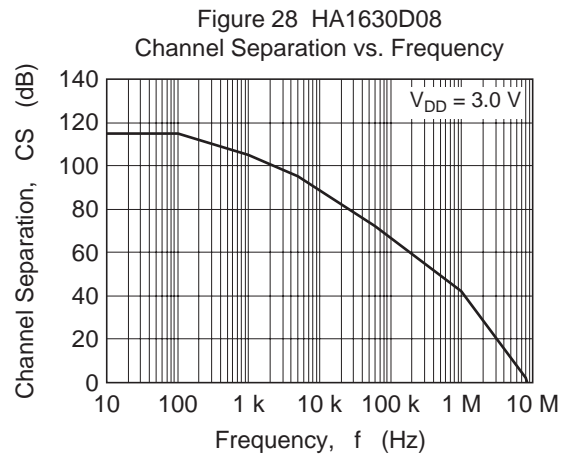
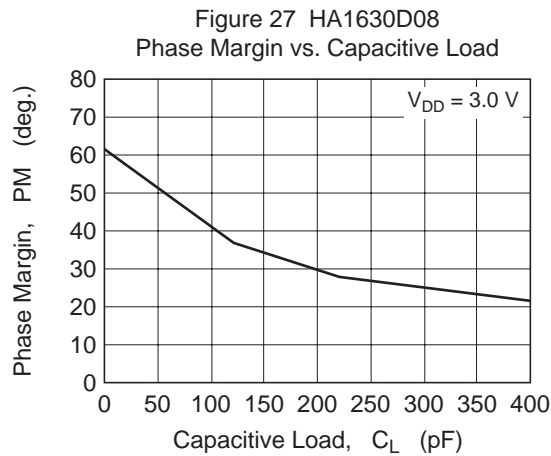
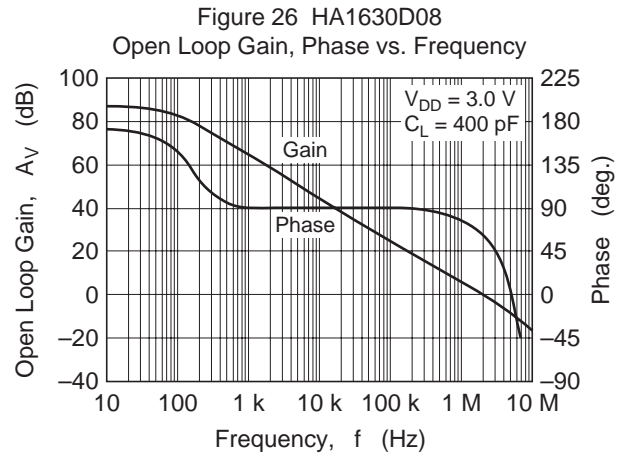
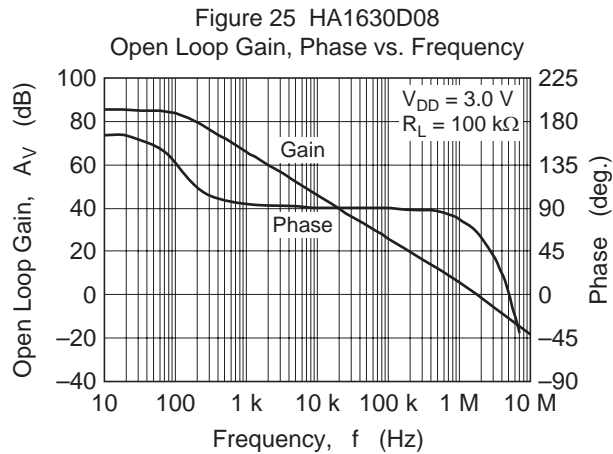


Figure 24 HA1630D08  
Open Loop Gain vs. Resistor Load



## Characteristic Curves (cont.)









Notes:

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