HA1631D01/02/03/04 Series

Dual CMOS Comparator (Push Pull/Open Drain Output)

REJ03D0804-0200
Rev.2.00
Nov 20, 2006

Description

The HA1631D01/02/03/04 are low power dual CMOS Comparator featuring low voltage operation with typical current supply of 10 μA/100 μA. They are designed to operate from a single power supply and have push-pull full swing outputs that allow direct connections to logic devices. The Open Drain version HA1631D03/04 enable Output Level shifting through external pull up resistors. Available in MMPAK-8 and TSSOP-8 package.

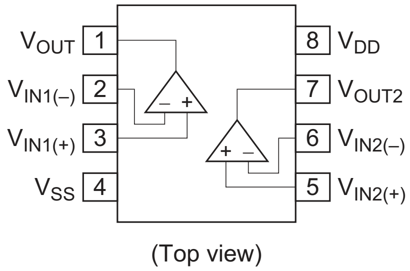
Features

- Low supply current
  HA1631D01/03 : I_{DDtyp} = 5 μA (per comparators)
  HA1631D02/04 : I_{DDtyp} = 50 μA (per comparators)
- Low voltage operation : V_{DD} = 1.8 to 5.5 V
- Low input offset voltage : V_{IOmax} = 5 mV
- Low input bias current : I_{IBtyp} = 1 pA
- Maximum output voltage : V_{OHmin} = 2.9 V (at V_{DD} = 3.0 V)
- Input common voltage range includes ground
- On-chip ESD protection
- Available in MMPAK-8, TSSOP-8 package using Pb free lead frame

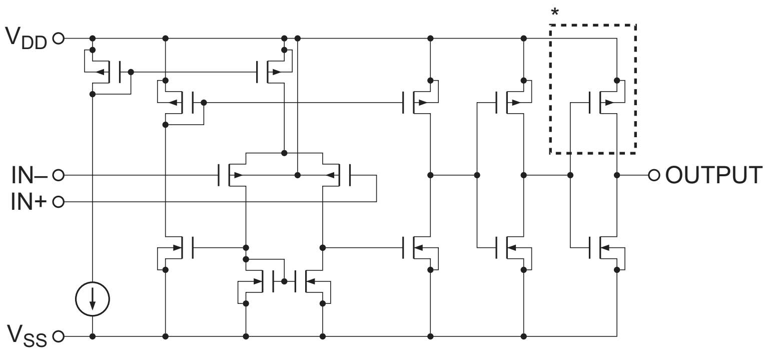
Ordering Information

Type No.	Package Name	Package Code
HA1631D01T	TTP-8DAV	PTSP0008JC-B
HA1631D02T		
HA1631D03T		
HA1631D04T		
HA1631D01MM	MMPAK-8	PLSP0008JC-A
HA1631D02MM		
HA1631D03MM		
HA1631D04MM		

Pin Arrangement



Equivalent Circuit (1/2)



Note: * Not available in Open Drain version (HA1631D03/04)

Absolute Maximum Ratings

(Ta = 25°C)

Item	Symbol	Ratings	Unit	Remarks
Supply voltage	V_{DD}	7.0	V	
Differential input voltage	$V_{IN(diff)}$	$-V_{DD}$ to $+V_{DD}$	V	Note 1
Input voltage	V_{IN}	–0.1 to $+V_{DD}$	V	
Output current	I_{OUT}	28	mA	Note 2
Power dissipation	P_T	192	mW	TSSOP-8
Operating temperature	Topr	–40 to +85	°C	
Storage temperature	Tstg	–55 to +125	°C	

Notes: 1. Do not apply input voltage exceeding V_{DD} or 7 V.
2. The maximum output current is the maximum allowable value for continuous operation.

Electrical Characteristics

($Ta = 25°C$, $V_{DD} = 3.0$ V, $V_{SS} = 0$ V)

Item		Symbol	Min	Typ	Max	Unit	Test Conditions
Input offset voltage		V_{IO}	—	—	5	mV	$V_{IN} = V_{DD}/2$, R_L = 1 MΩ
Input bias current		I_{IB}	—	(1)	—	pA	$V_{IN} = V_{DD}/2$
Input offset current		I_{IO}	—	(1)	—	pA	$V_{IN} = V_{DD}/2$
Common mode input voltage range		V_{CM}	–0.1	—	2.1	V	
Supply current	HA1631D01/03	I_{DD}	—	10	20	µA	V_{DD} = 3 V, $V_{IN}+$ = 1 V, $V_{IN}-$ = 0 V
	HA1631D02/04		—	100	200	µA	
Response time	HA1631D01	TP_{LH}	—	(1.20)	—	µs	1 V DC bias, 100 mV overdrive, C_L = 15 pF
	HA1631D01/03	TP_{HL}	—	(0.55)	—	µs	
	HA1631D01	t_r	—	(24)	—	ns	
	HA1631D01/03	t_f	—	(7)	—	ns	
	HA1631D02	TP_{LH}	—	(0.33)	—	µs	
	HA1631D02/04	TP_{HL}	—	(0.17)	—	µs	
	HA1631D02	t_r	—	(12)	—	ns	
	HA1631D02/04	t_f	—	(7)	—	ns	
Output source current (Only for HA1631D01/02)		$I_{OSOURCE}$	6	13	—	mA	Vout = 2.5 V
Output sink current		I_{OSINK}	7	14	—	mA	Vout = 0.5 V
Common mode rejection ratio	HA1631D01/03	CMRR	60	80	—	dB	$V_{IN}1$ = 0 V, $V_{IN}2$ = 2 V
	HA1631D02/04		50	70	—	dB	
Power supply rejection ratio		PSRR	60	80	—	dB	$V_{DD}1$ = 1.8 V, $V_{DD}2$ = 5 V
Output voltage high (Only for HA1631D01/02)		V_{OH}	V_{DD}–0.1	—	—	V	R_L = 10 kΩ to V_{SS}
Output voltage low		V_{OL}	—	—	0.1	V	R_L = 10 kΩ to V_{DD}
Output leakage current (Only for HA1631D03/04)		I_{LO}	—	—	0.1	µA	$V_{IN}+$ = 1 V, $V_{IN}-$ = 0 V, V_O = 3 V
Operating voltage range		Vopr	1.8	—	5.5	V	

Note: ( ): Design specification

Table of Graphs

Electrical Characteristics			HA1631D01 Figure	HA1631D02 Figure	HA1631D03 Figure	HA1631D04 Figure	Test Circuit No.
Supply current	I_{DD}	vs. Supply voltage(Out H)	1-1	2-1	3-1	4-1	1
		vs. Supply voltage(Out L)	1-2	2-2	3-2	4-2	2
		vs. Temperature(Out H)	1-3	2-3	3-3	4-3	1
		vs. Frequency(Out H)	1-26	2-26	3-20	4-20	15
Output high voltage	V_{OH}	vs. Rload	1-19	2-19	—	—	4
Output source current	$I_{OSOURCE}$	vs. Output high voltage	1-4	2-4	—	—	3
Output low voltage	V_{OL}	vs. Rload	1-18	2-18	3-15	4-15	6
Output sink current	I_{OSINK}	vs. Output low voltage	1-5	2-5	3-4	4-4	5
Input offset voltage	V_{IO}	vs. Supply voltage	1-6	2-6	3-5	4-5	8
		vs. Temperature	1-7	2-7	3-6	4-6	7
Common mode input voltage range	V_{CM}	vs. Temperature	1-8	2-8	3-7	4-7	9
Power supply rejection ratio	PSRR	vs. Supply voltage	1-9	2-9	3-8	4-8	11
Common mode rejection ratio	CMRR	vs. Input voltage	1-10	2-10	3-9	4-9	12
Input bias current	I_{IB}	vs. Temperature	1-11	2-11	3-10	4-10	10
		vs. Input voltage(V_{DD} = 3 V)	1-12	2-12	3-11	4-11	10
		vs. Input voltage(V_{DD} = 7 V)	1-13	2-13	3-12	4-12	10
Falling time	t_f	vs. Temperature	1-14	2-14	3-13	4-13	13
		vs. Cload	1-16	2-16	3-14	4-14	13
		Time waveform	1-21	2-21	3-16	4-16	13
Rising time	t_r	vs. Temperature	1-15	2-15	—	—	13
		vs. Cload	1-17	2-17	—	—	13
		Time waveform	1-20	2-20	—	—	13
Propagation delay time	TP_{LH}	Time waveform	1-22	2-22	—	—	13
	TP_{HL}	Time waveform	1-23	2-23	3-17	4-17	13
Cross talk	V_{OUT}(CH1)	vs. Input voltage	1-24	2-24	3-18	4-18	14
	V_{OUT}(CH2)	vs. Input voltage	1-25	2-25	3-19	4-19	14

Main Characteristics

(unless otherwise noted, V_{DD} = 3 V, V_{SS} = 0 V, Ta = 25°C)

Figure 1-1 HA1631D01
Supply Current vs. Supply Voltage
(Output High)

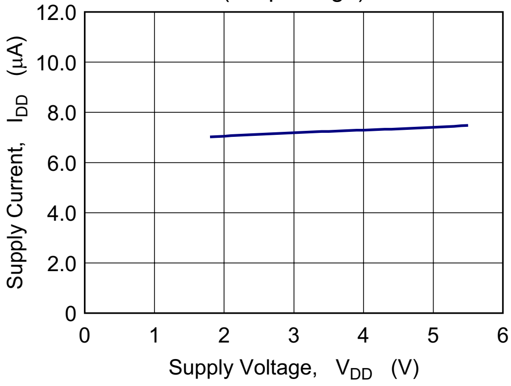


Figure 1-2 HA1631D01
Supply Current vs. Supply Voltage
(Output Low)

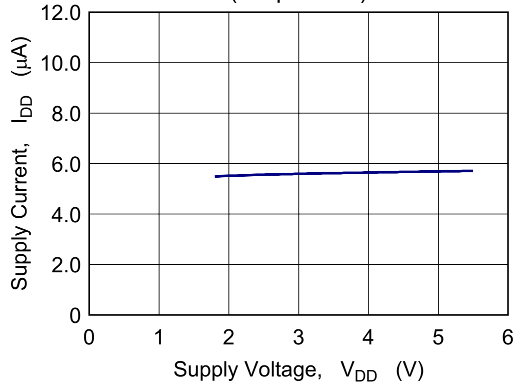


Figure 1-3 HA1631D01
Supply Current vs. Ambient Temperature

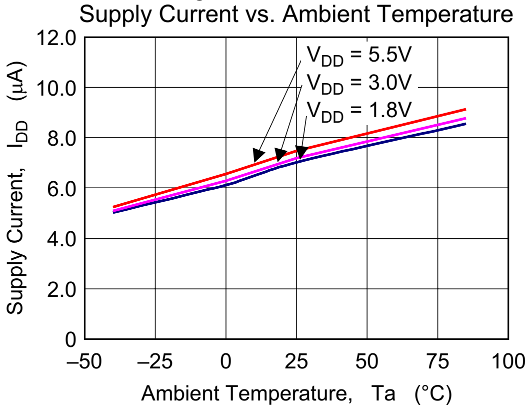


Figure 1-4 HA1631D01
Output High Voltage vs. Output Source Current

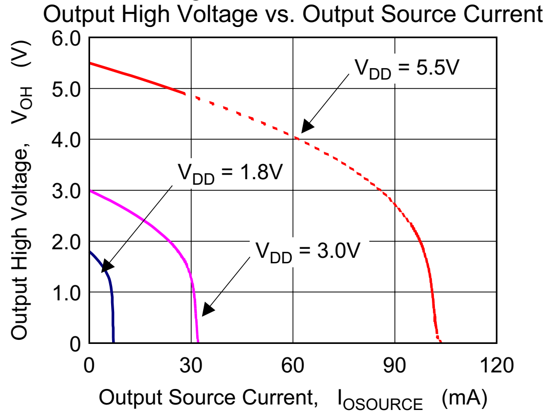


Figure 1-5 HA1631D01
Output Low Voltage vs. Output Sink Current

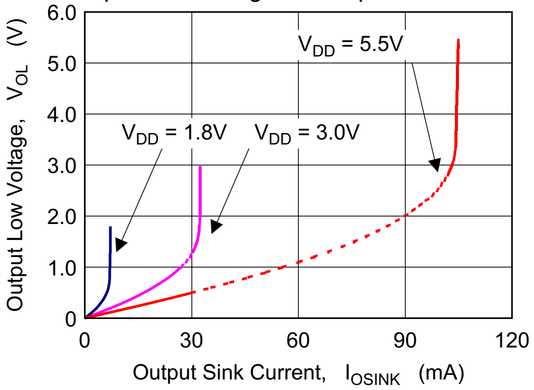
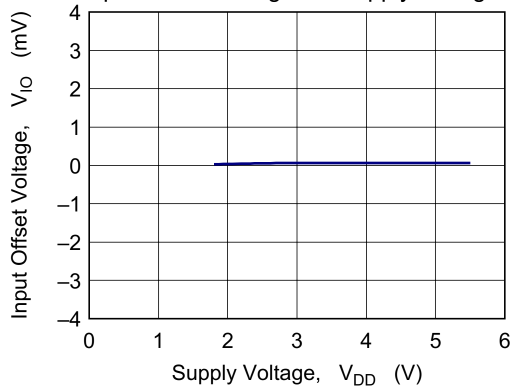


Figure 1-6 HA1631D01
Input Offset Voltage vs. Supply Voltage



(unless otherwise noted, V_{DD} = 3 V, V_{SS} = 0 V, Ta = 25°C)

Figure 1-7 HA1631D01
Input Offset Voltage vs. Ambient Temperature

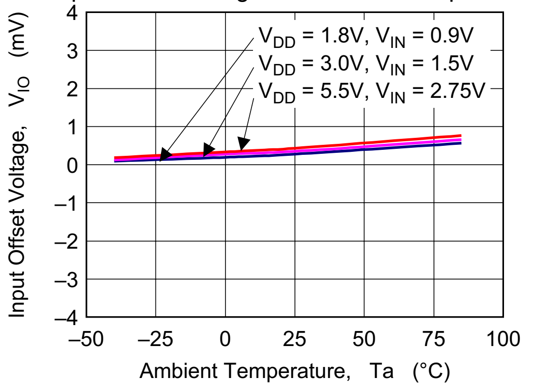


Figure 1-8 HA1631D01
Common Mode Input Voltage vs. Ambient Temperature

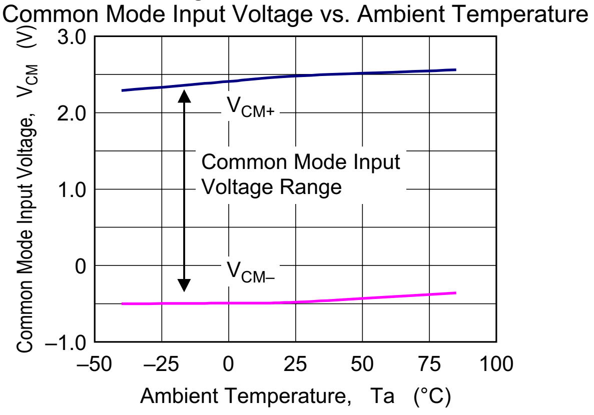


Figure 1-9 HA1631D01
Power Supply Rejection Ratio vs. Supply Voltage

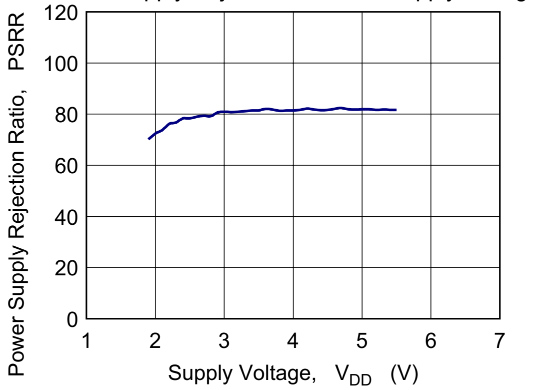


Figure 1-10 HA1631D01
Common Mode Rejection Ratio vs. Input Voltage

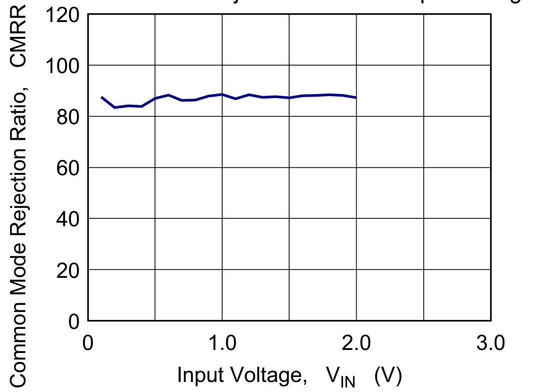


Figure 1-11 HA1631D01
Input Bias Current vs. Ambient Temperature

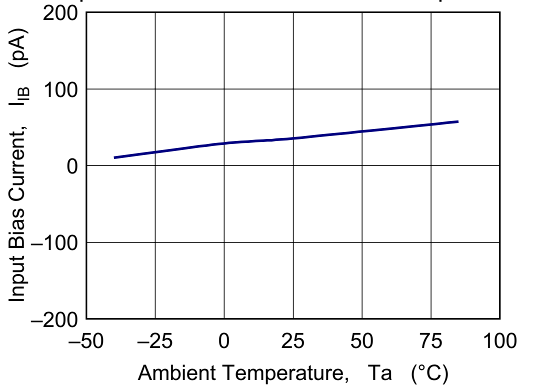
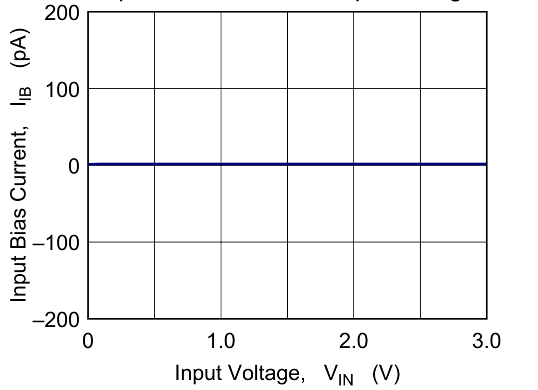


Figure 1-12 HA1631D01
Input Bias Current vs. Input Voltage



(unless otherwise noted, V_{DD} = 3 V, V_{SS} = 0 V, Ta = 25°C)

Figure 1-13 HA1631D01
Input Bias Current vs. Input Voltage

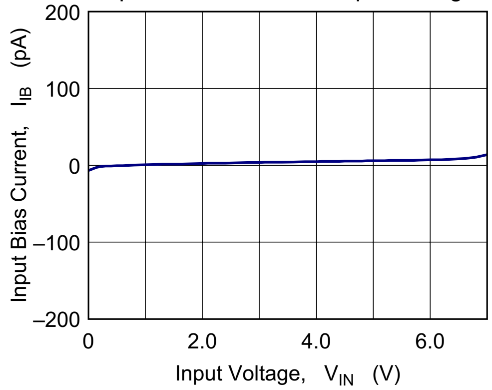


Figure 1-14 HA1631D01
Falling Time vs. Ambient Temperature

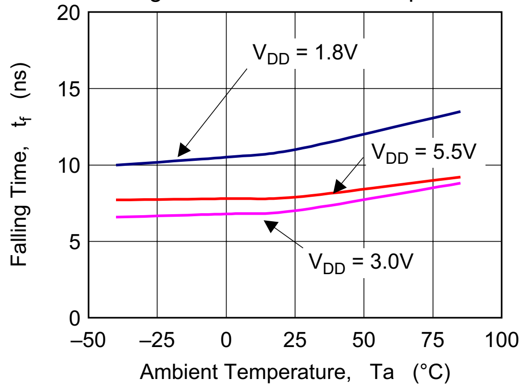


Figure 1-15 HA1631D01
Rising Time vs. Ambient Temperature

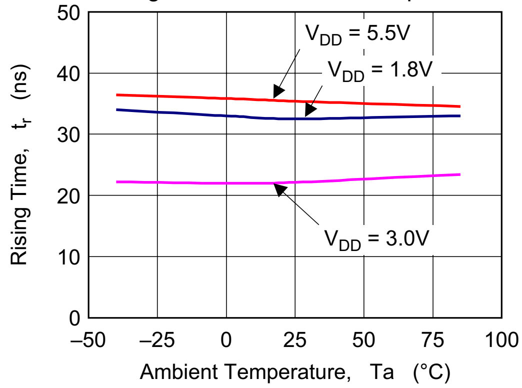


Figure 1-16 HA1631D01
Falling Time vs. Capacitive Load

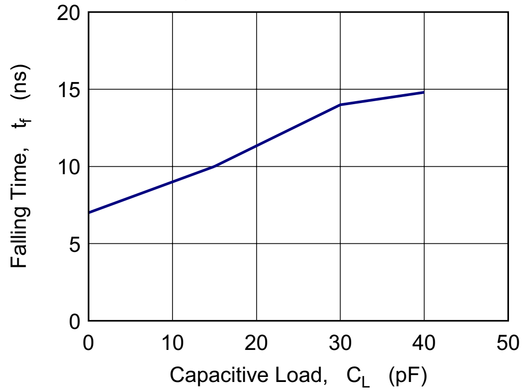


Figure 1-17 HA1631D01
Rising Time vs. Capacitive Load

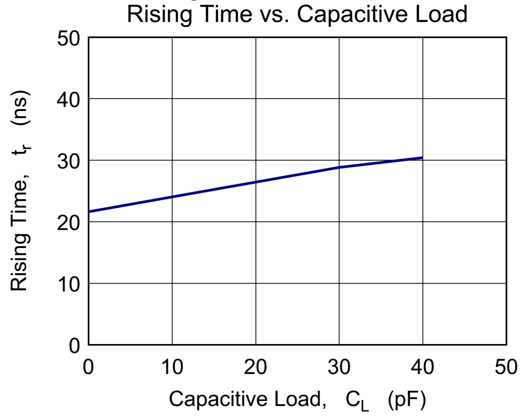
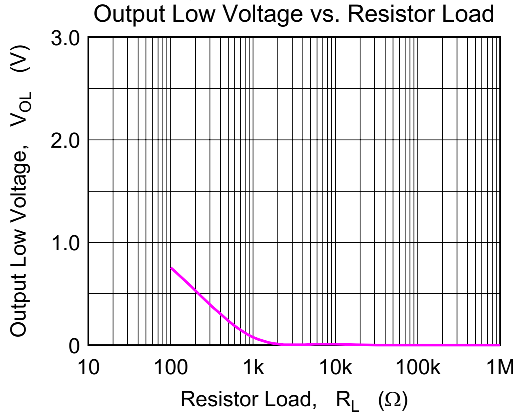


Figure 1-18 HA1631D01
Output Low Voltage vs. Resistor Load



(unless otherwise noted, V_{DD} = 3 V, V_{SS} = 0 V, Ta = 25°C)

Figure 1-19 HA1631D01
Output High Voltage vs. Resistor Load

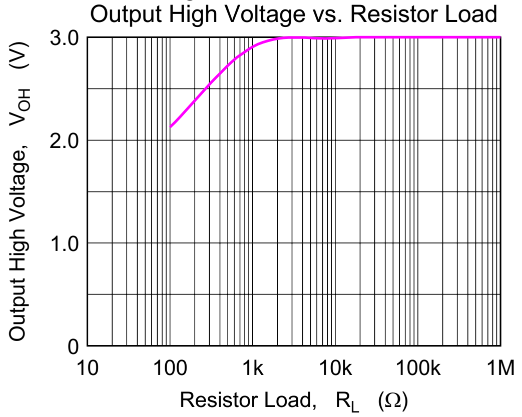


Figure 1-20 HA1631D01
Rising Time t_r
(Overdrive, ±0.1Vp-p)

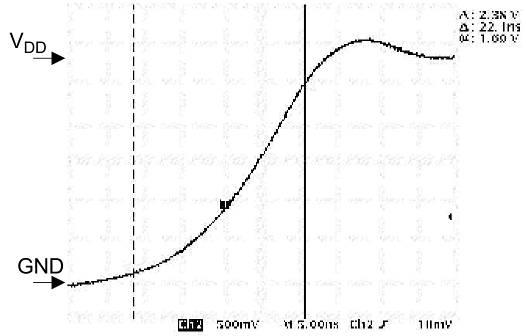


Figure 1-21 HA1631D01
Falling Time t_f
(Overdrive, ±0.1Vp-p)

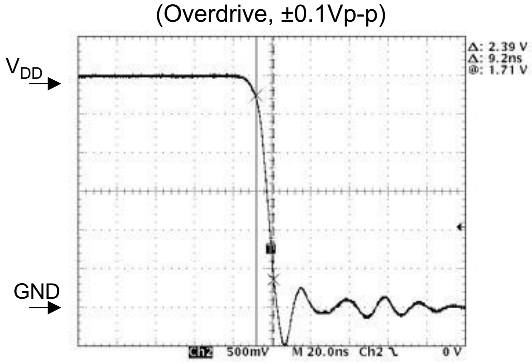


Figure 1-22 HA1631D01
TP_{LH} Transient Response
(Overdrive, ±0.1Vp-p)

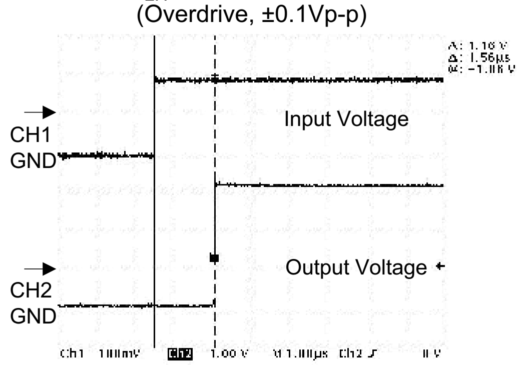


Figure 1-23 HA1631D01
TP_{HL} Transient Response
(Overdrive, ±0.1Vp-p)

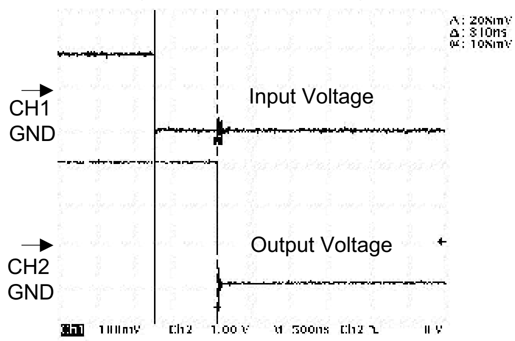
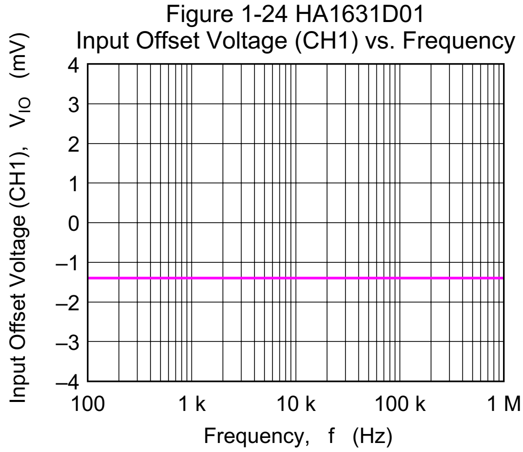


Figure 1-24 HA1631D01
Input Offset Voltage (CH1) vs. Frequency



(unless otherwise noted, V_{DD} = 3 V, V_{SS} = 0 V, Ta = 25°C)

Figure 1-25 HA1631D01
Input Offset Voltage (CH2) vs. Frequency

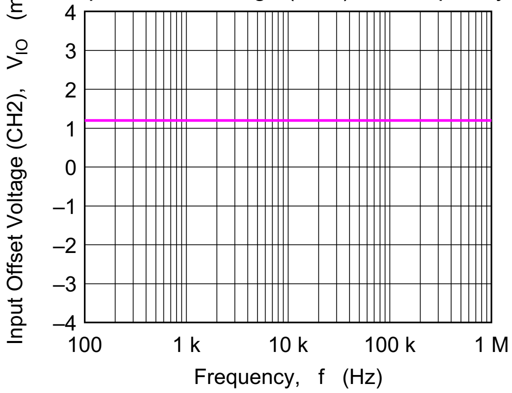
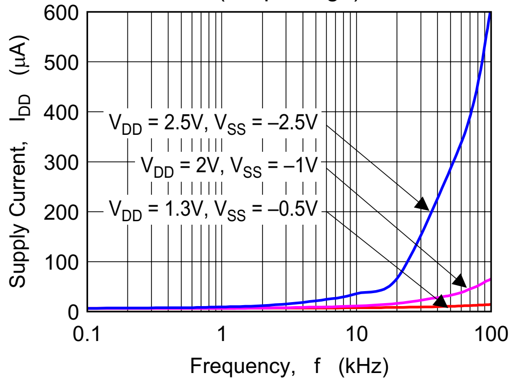


Figure 1-26 HA1631D01
Supply Current vs. Frequency
(Output High)



(unless otherwise noted, V_{DD} = 3 V, V_{SS} = 0 V, Ta = 25°C)

Figure 2-1 HA1631D02
Supply Current vs. Supply Voltage
(Output High)

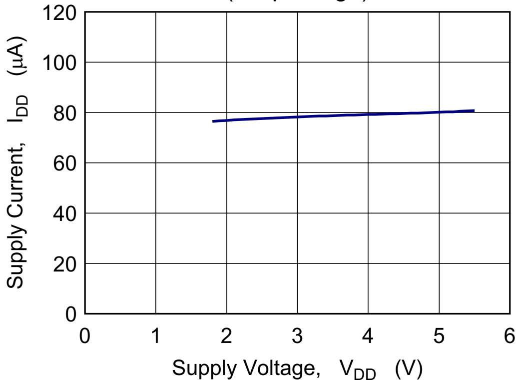


Figure 2-2 HA1631D02
Supply Current vs. Supply Voltage
(Output Low)

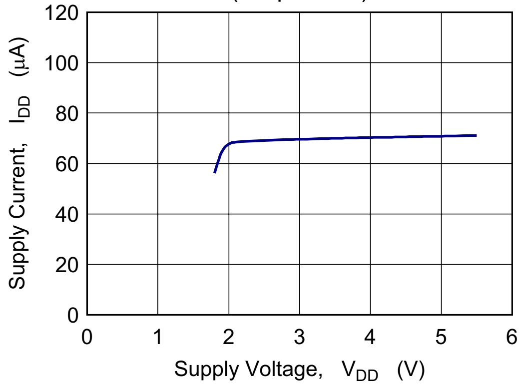


Figure 2-3 HA1631D02
Supply Current vs. Ambient Temperature

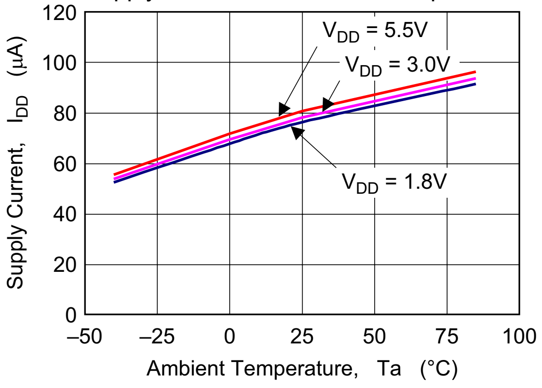


Figure 2-4 HA1631D02
Output High Voltage vs. Output Source Current

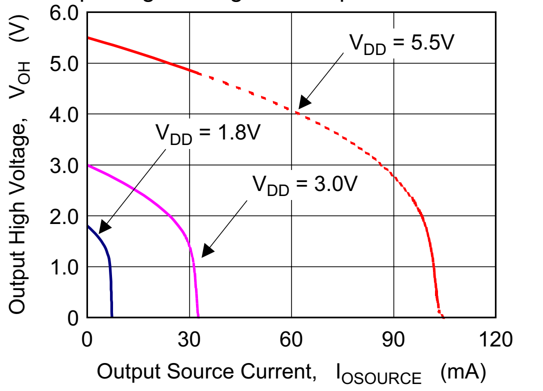


Figure 2-5 HA1631D02
Output Low Voltage vs. Output Sink Current

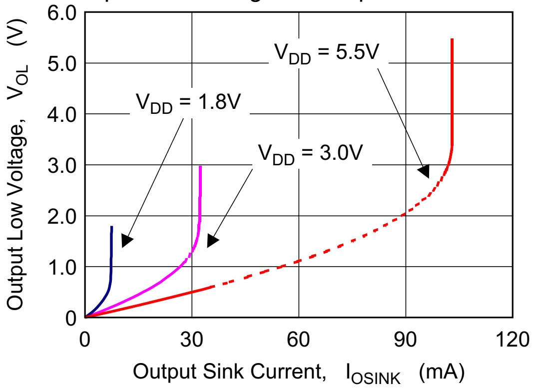
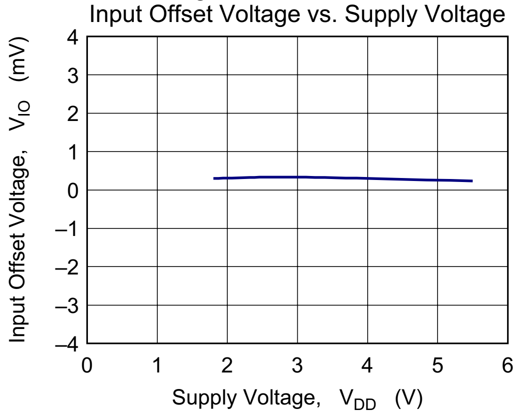


Figure 2-6 HA1631D02
Input Offset Voltage vs. Supply Voltage



(unless otherwise noted, V_{DD} = 3 V, V_{SS} = 0 V, Ta = 25°C)

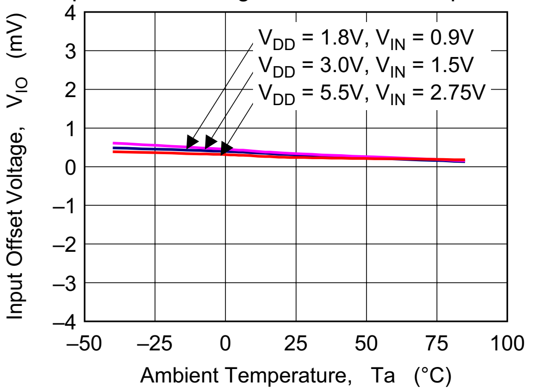


Figure 2-7 HA1631D02
Input Offset Voltage vs. Ambient Temperature

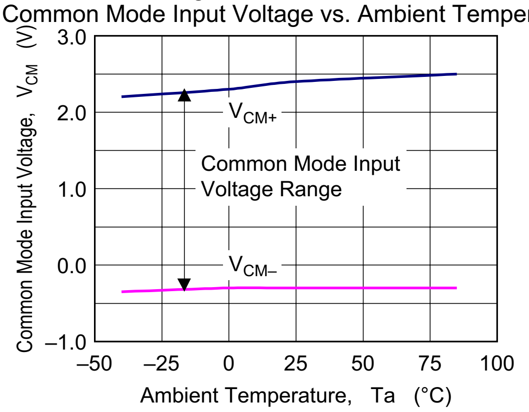


Figure 2-8 HA1631D02
Common Mode Input Voltage vs. Ambient Temperature

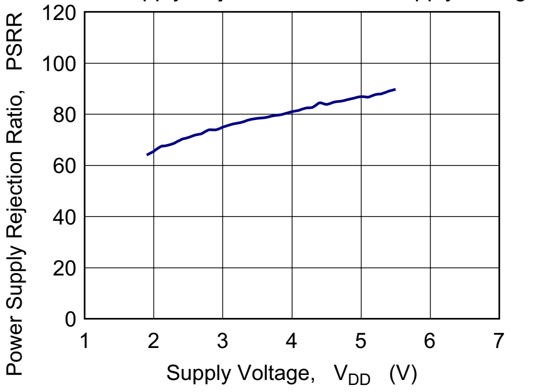


Figure 2-9 HA1631D02
Power Supply Rejection Ratio vs. Supply Voltage

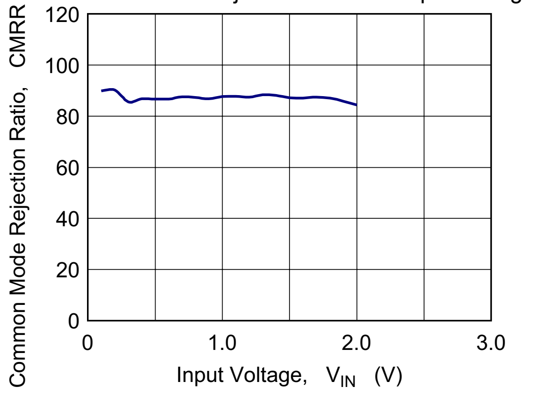


Figure 2-10 HA1631D02
Common Mode Rejection Ratio vs. Input Voltage

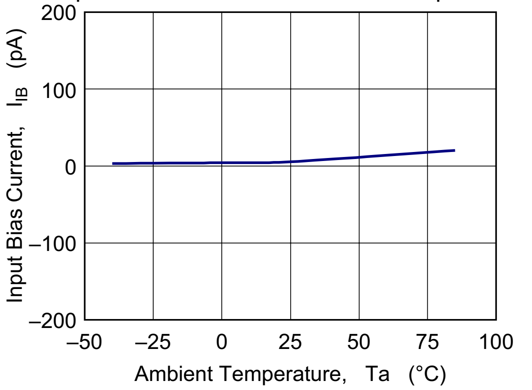


Figure 2-11 HA1631D02
Input Bias Current vs. Ambient Temperature

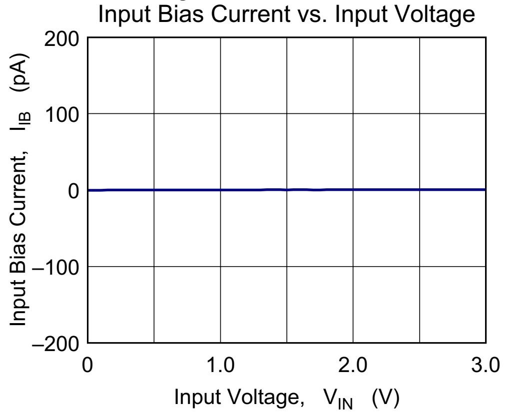


Figure 2-12 HA1631D02
Input Bias Current vs. Input Voltage

(unless otherwise noted, V_{DD} = 3 V, V_{SS} = 0 V, Ta = 25°C)

Figure 2-13 HA1631D02
Input Bias Current vs. Input Voltage

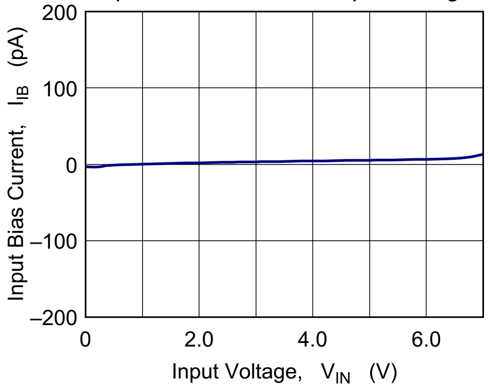


Figure 2-14 HA1631D02
Falling Time vs. Ambient Temperature

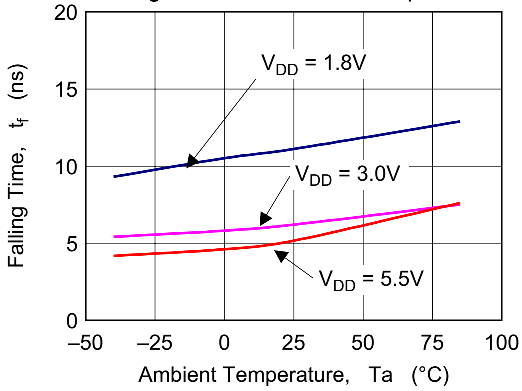


Figure 2-15 HA1631D02
Rising Time vs. Ambient Temperature

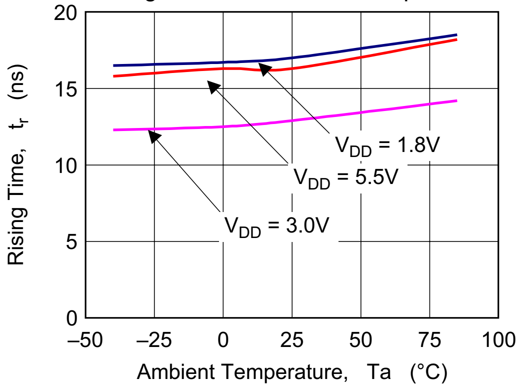


Figure 2-16 HA1631D02
Falling Time vs. Capacitive Load

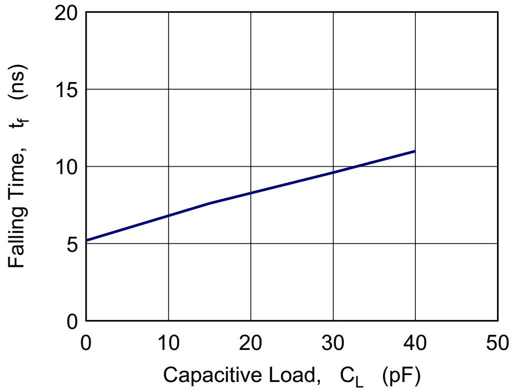


Figure 2-17 HA1631D02
Rising Time vs. Capacitive Load

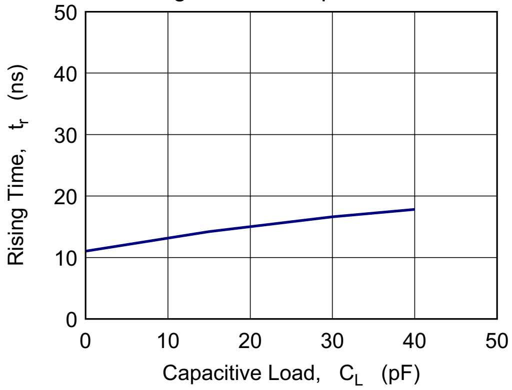
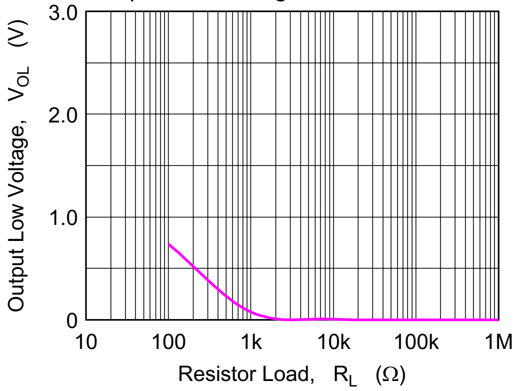


Figure 2-18 HA1631D02
Output Low Voltage vs. Resistor Load



RENESAS

(unless otherwise noted, V_{DD} = 3 V, V_{SS} = 0 V, Ta = 25°C)

Figure 2-19 HA1631D02
Output High Voltage vs. Resistor Load

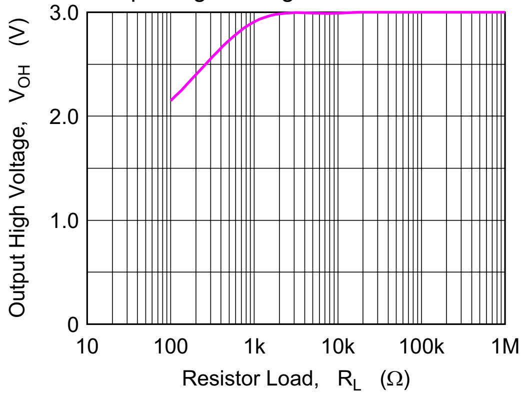


Figure 2-20 HA1631D02
Rising Time t_r
(Overdrive, ±0.1Vp-p)

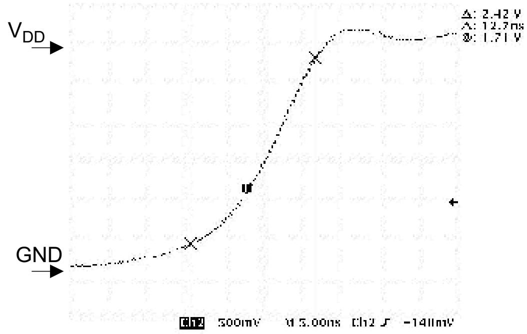


Figure 2-21 HA1631D02
Falling Time t_f
(Overdrive, ±0.1Vp-p)

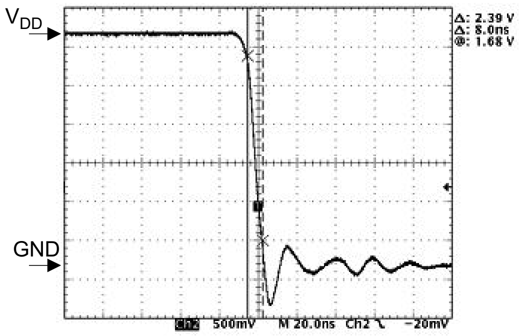


Figure 2-22 HA1631D02
TP_{LH} Transient Response
(Overdrive, ±0.1Vp-p)

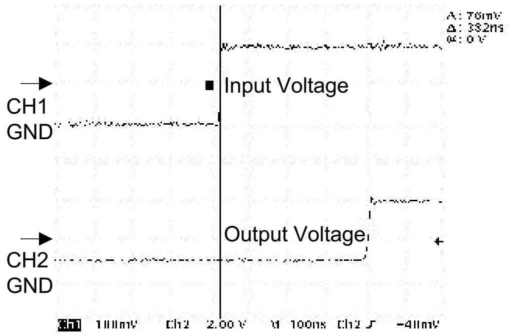


Figure 2-23 HA1631D02
TP_{HL} Transient Response
(Overdrive, ±0.1Vp-p)

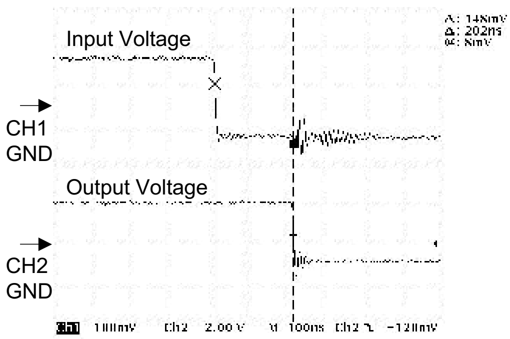
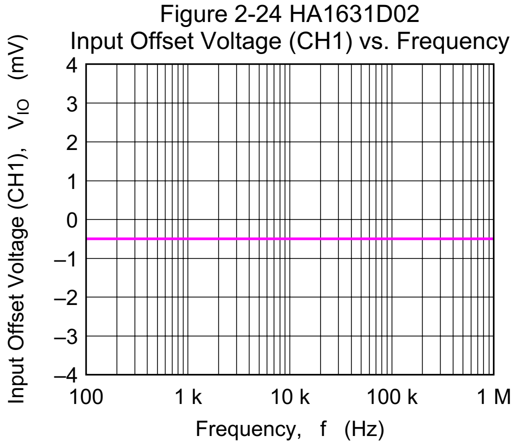


Figure 2-24 HA1631D02
Input Offset Voltage (CH1) vs. Frequency



RENESAS

(unless otherwise noted, V_{DD} = 3 V, V_{SS} = 0 V, Ta = 25°C)

Figure 2-25 HA1631D02
Input Offset Voltage (CH2) vs. Frequency

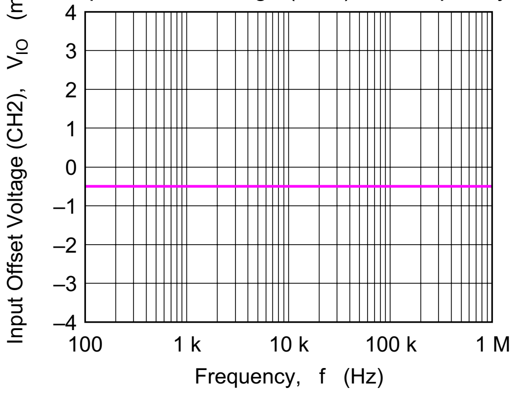
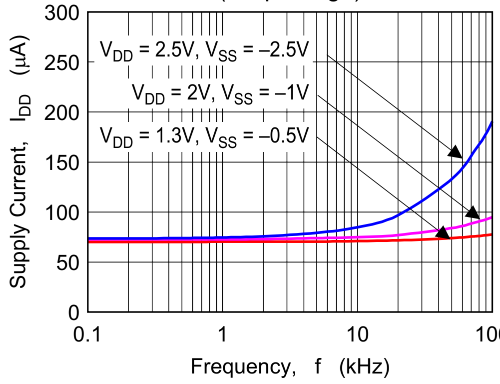


Figure 2-26 HA1631D02
Supply Current vs. Frequency
(Output High)



RENESAS

(unless otherwise noted, V_{DD} = 3 V, V_{SS} = 0 V, Ta = 25°C)

Figure 3-1 HA1631D03
Supply Current vs. Supply Voltage
(Output High)

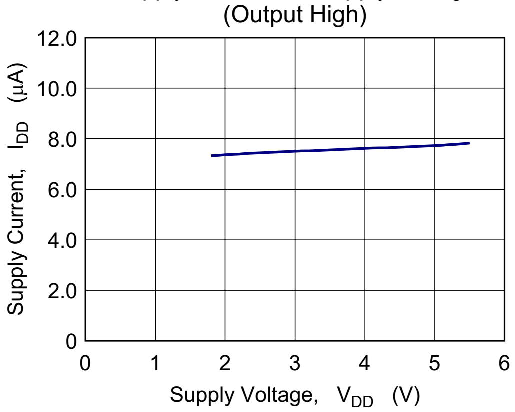


Figure 3-2 HA1631D03
Supply Current vs. Supply Voltage
(Output Low)

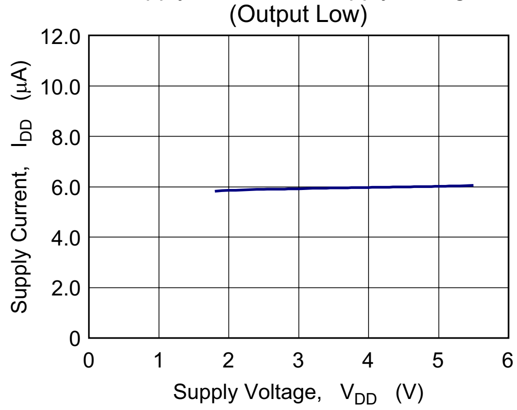


Figure 3-3 HA1631D03
Supply Current vs. Ambient Temperature

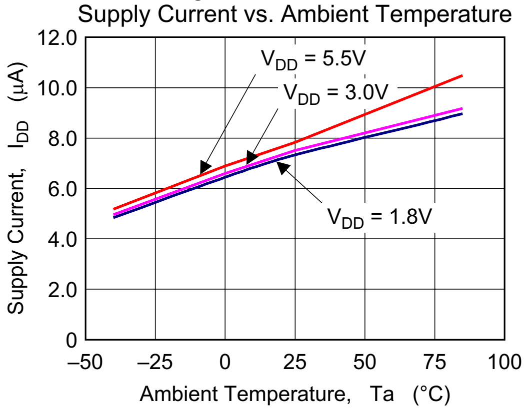


Figure 3-4 HA1631D03
Output Low Voltage vs. Output Sink Current

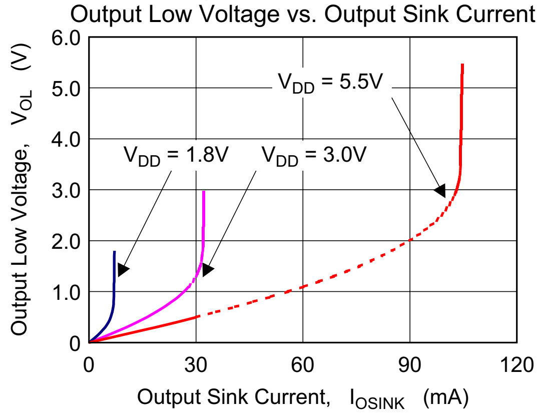


Figure 3-5 HA1631D03
Input Offset Voltage vs. Supply Voltage

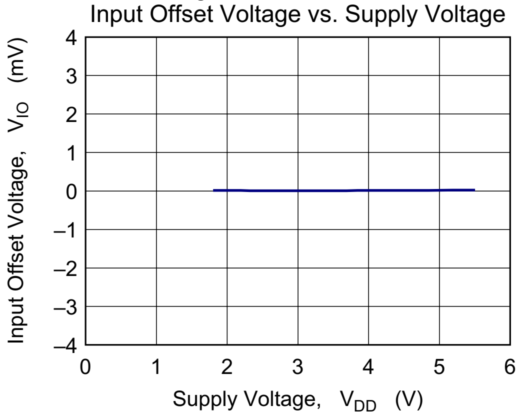
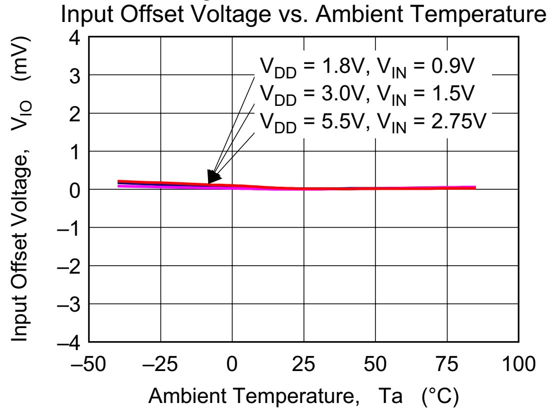


Figure 3-6 HA1631D03
Input Offset Voltage vs. Ambient Temperature



(unless otherwise noted, V_{DD} = 3 V, V_{SS} = 0 V, Ta = 25°C)

Figure 3-7 HA1631D03
Common Mode Input Voltage vs. Ambient Temperature

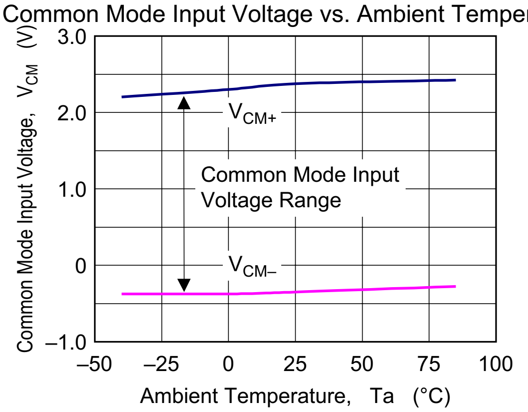


Figure 3-8 HA1631D03
Power Supply Rejection Ratio vs. Supply Voltage

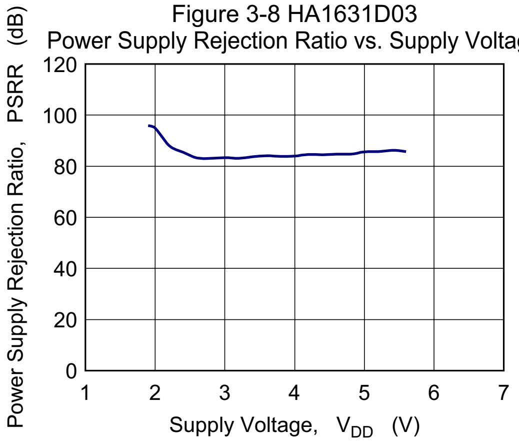


Figure 3-9 HA1631D03
Common Mode Rejection Ratio vs. Input Voltage

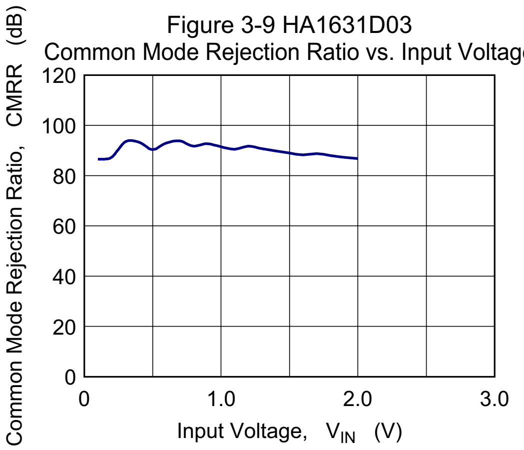


Figure 3-10 HA1631D03
Input Bias Current vs. Ambient Temperature

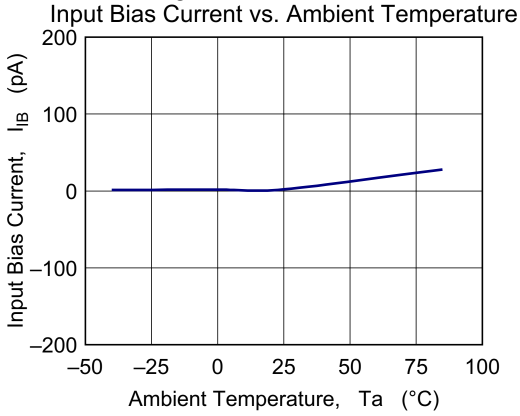


Figure 3-11 HA1631D03
Input Bias Current vs. Input Voltage

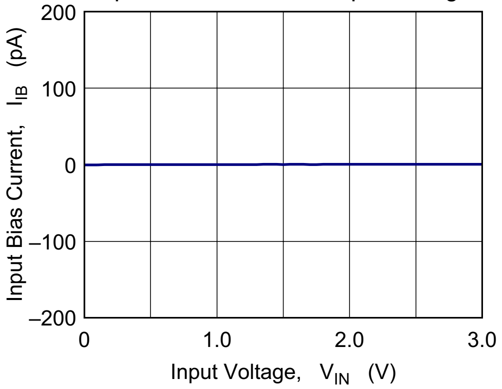
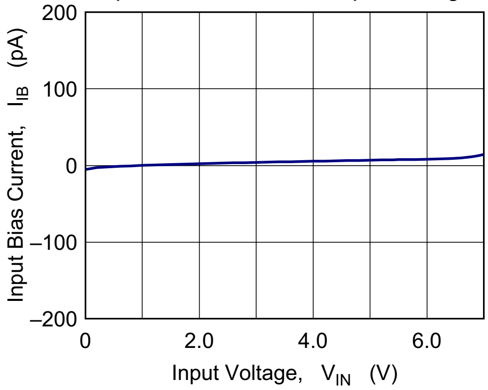


Figure 3-12 HA1631D03
Input Bias Current vs. Input Voltage



(unless otherwise noted, V_{DD} = 3 V, V_{SS} = 0 V, Ta = 25°C)

Figure 3-13 HA1631D03
Falling Time vs. Ambient Temperature

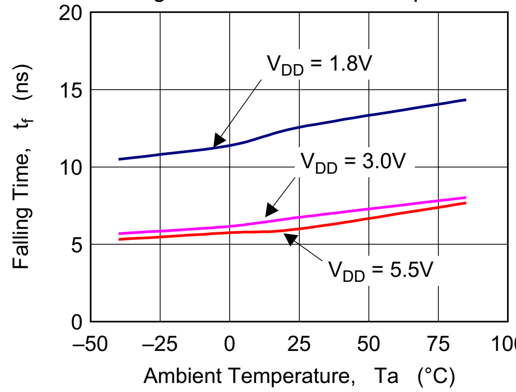


Figure 3-14 HA1631D03
Falling Time vs. Capacitive Load

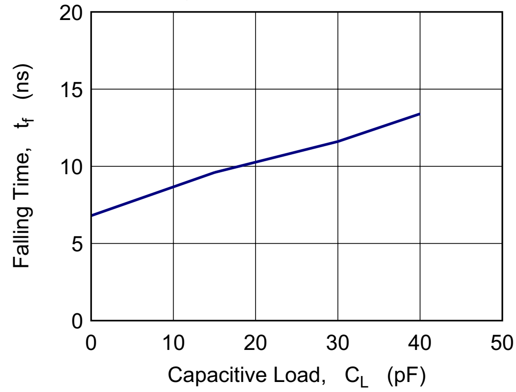


Figure 3-15 HA1631D03
Output Low Voltage vs. Resistor Load

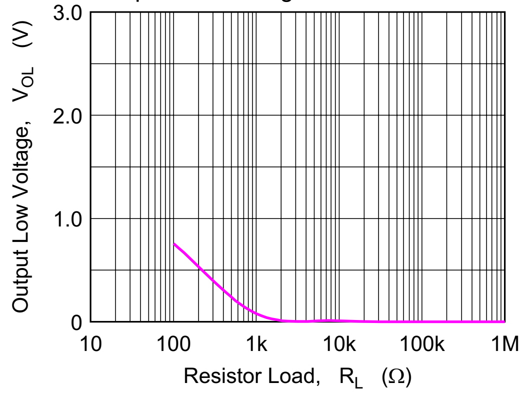


Figure 3-16 HA1631D03
Falling Time t_f
(Overdrive, ±0.1Vp-p)

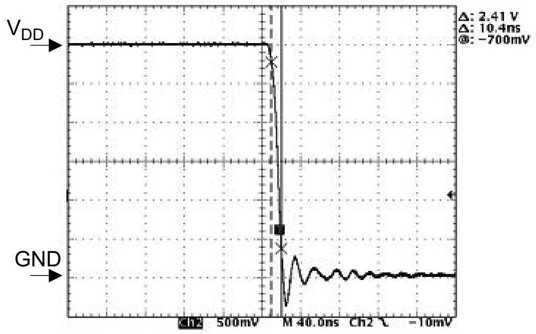


Figure 3-17 HA1631D03
TP_{HL} Transient Response
(Overdrive, ±0.1Vp-p)

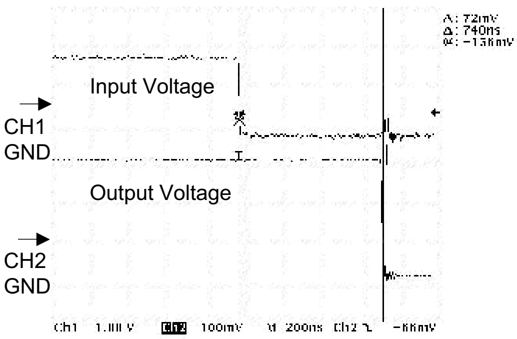
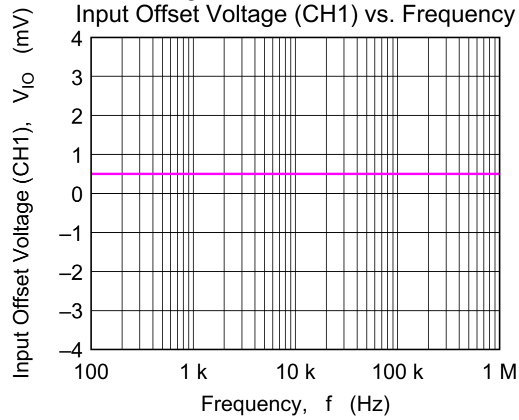
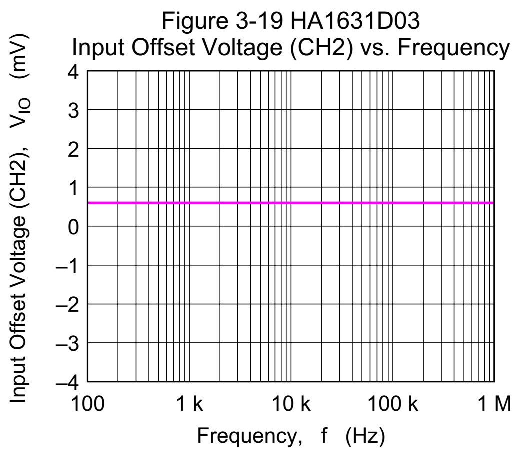
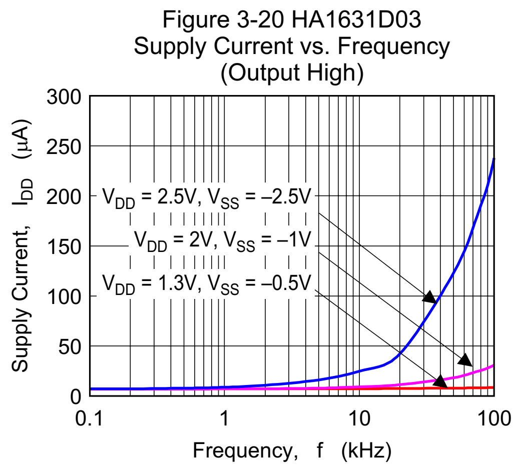


Figure 3-18 HA1631D03
Input Offset Voltage (CH1) vs. Frequency



(unless otherwise noted, V_{DD} = 3 V, V_{SS} = 0 V, Ta = 25°C)





(unless otherwise noted, V_{DD} = 3 V, V_{SS} = 0 V, Ta = 25°C)

Figure 4-1 HA1631D04
Supply Current vs. Supply Voltage
(Output High)

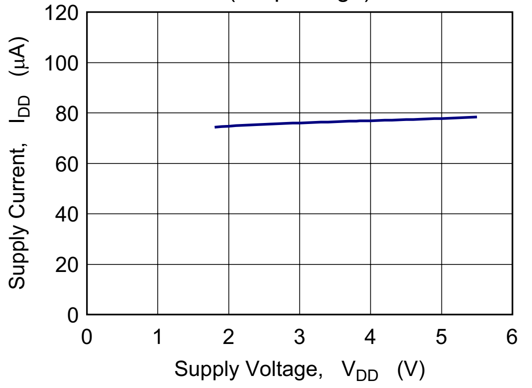


Figure 4-2 HA1631D04
Supply Current vs. Supply Voltage
(Output Low)

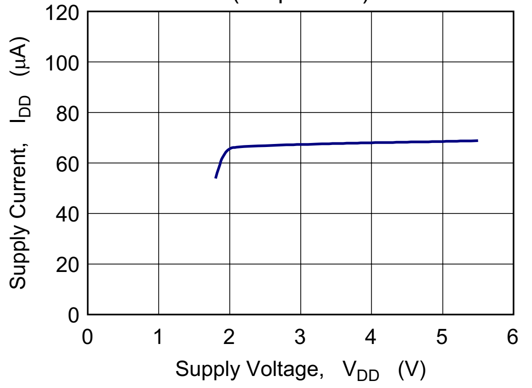


Figure 4-3 HA1631D04
Supply Current vs. Ambient Temperature

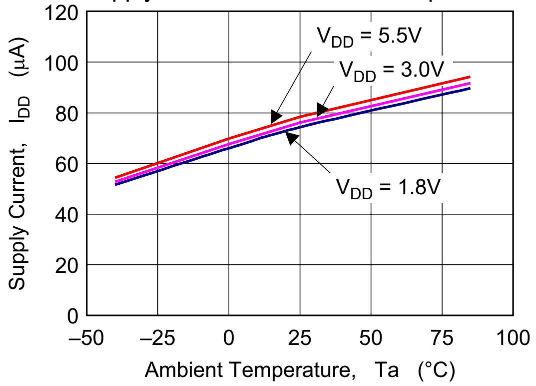


Figure 4-4 HA1631D04
Output Low Voltage vs. Output Sink Current

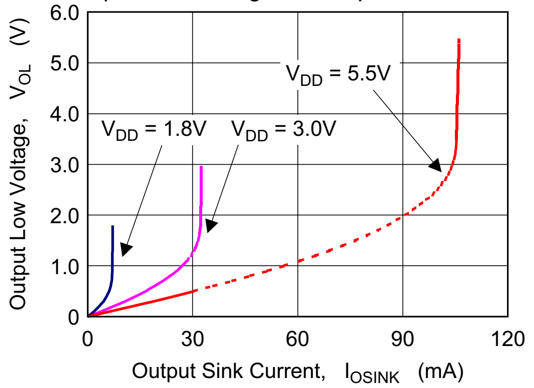


Figure 4-5 HA1631D04
Input Offset Voltage vs. Supply Voltage

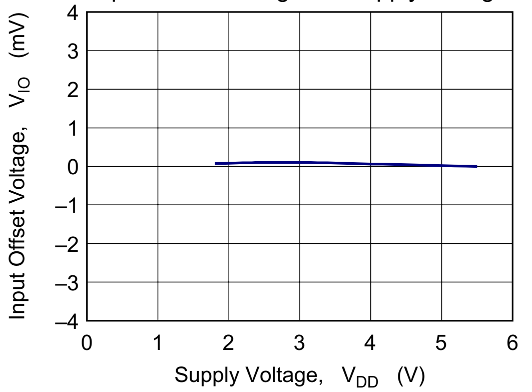
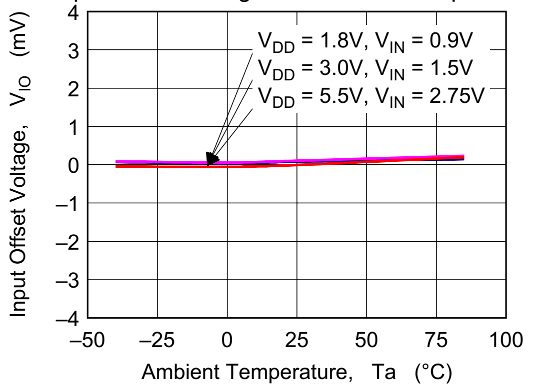


Figure 4-6 HA1631D04
Input Offset Voltage vs. Ambient Temperature



(unless otherwise noted, V_{DD} = 3 V, V_{SS} = 0 V, Ta = 25°C)

Figure 4-7 HA1631D04
Common Mode Input Voltage vs. Ambient Temperature

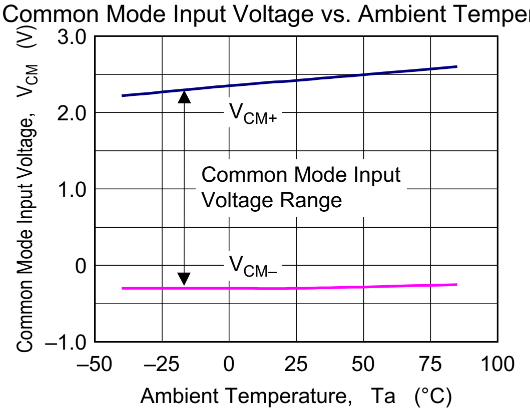


Figure 4-8 HA1631D04
Power Supply Rejection Ratio vs. Supply Voltage

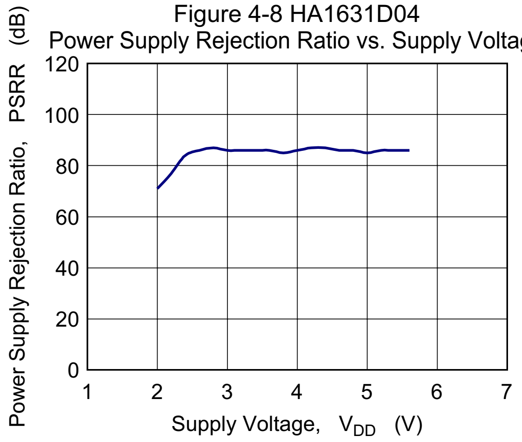


Figure 4-9 HA1631D04
Common Mode Rejection Ratio vs. Input Voltage

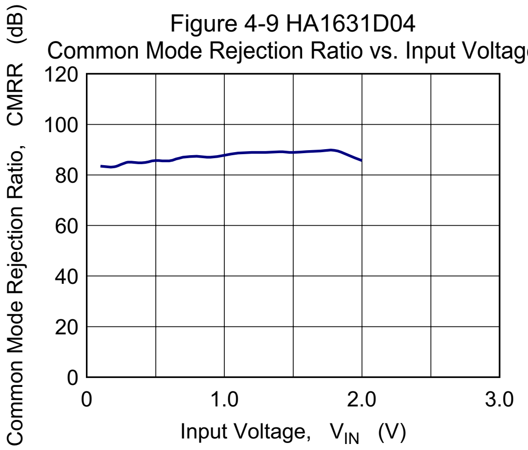


Figure 4-10 HA1631D04
Input Bias Current vs. Ambient Temperature

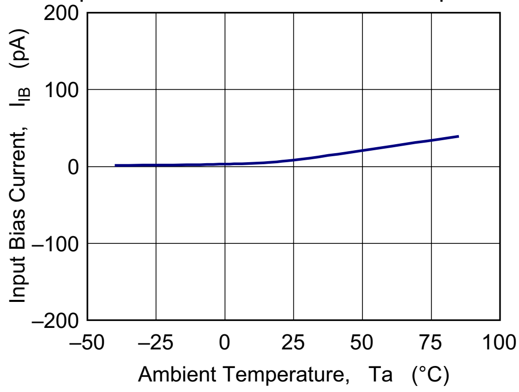


Figure 4-11 HA1631D04
Input Bias Current vs. Input Voltage

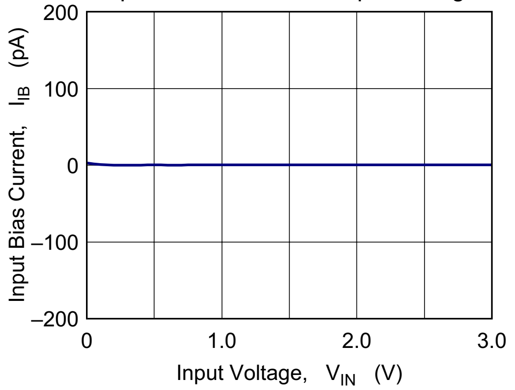
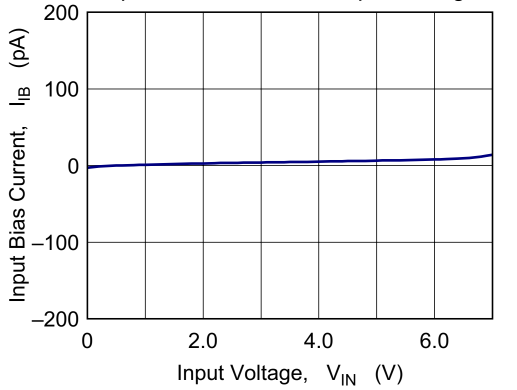


Figure 4-12 HA1631D04
Input Bias Current vs. Input Voltage



(unless otherwise noted, V_{DD} = 3 V, V_{SS} = 0 V, Ta = 25°C)

Figure 4-13 HA1631D04
Falling Time vs. Ambient Temperature

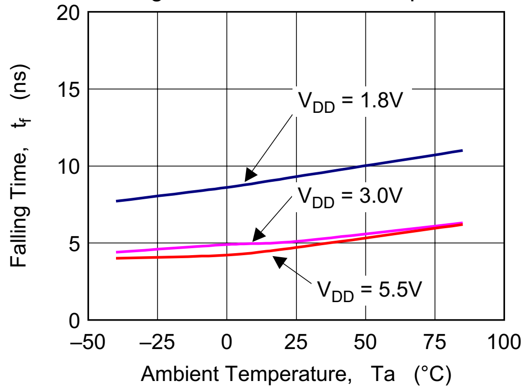


Figure 4-14 HA1631D04
Falling Time vs. Capacitive Load

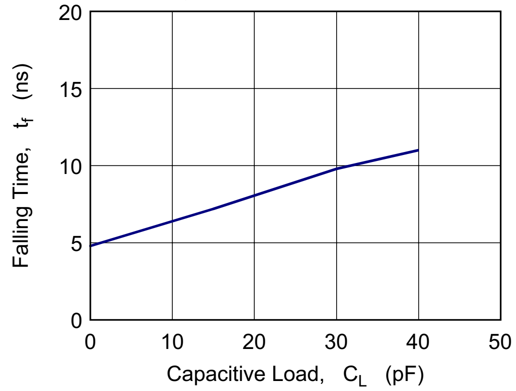


Figure 4-15 HA1631D04
Output Low Voltage vs. Resistor Load

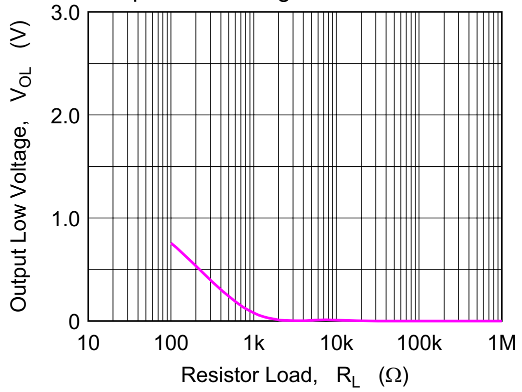


Figure 4-16 HA1631D04
Falling Time t_f
(Overdrive, ±0.1Vp-p)

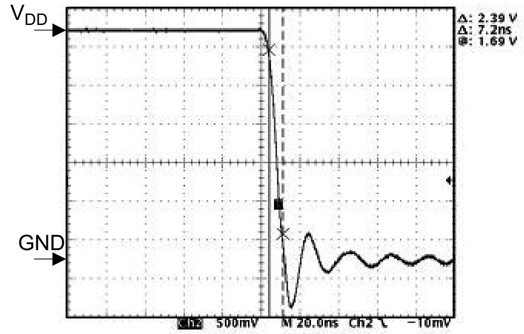


Figure 4-17 HA1631D04
TP_{HL} Transient Response
(Overdrive, ±0.1Vp-p)

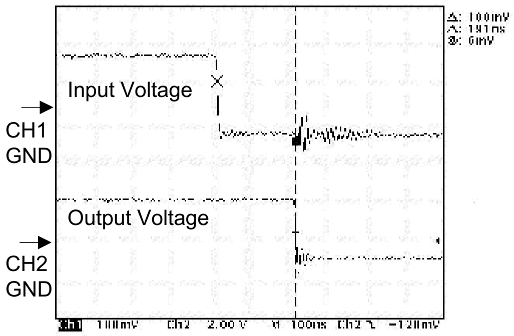
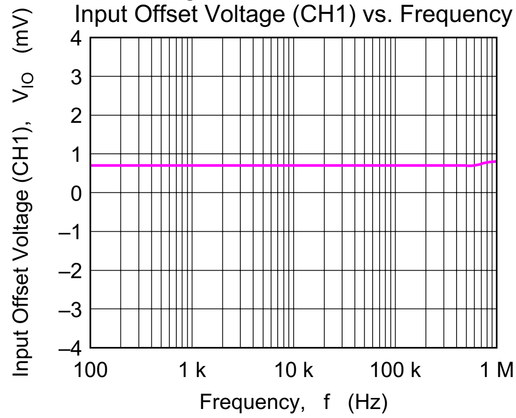


Figure 4-18 HA1631D04
Input Offset Voltage (CH1) vs. Frequency



(unless otherwise noted, V_{DD} = 3 V, V_{SS} = 0 V, Ta = 25°C)

Figure 4-19 HA1631D04
Input Offset Voltage (CH2) vs. Frequency

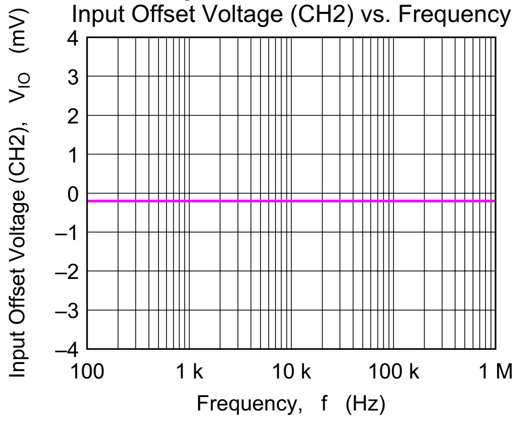
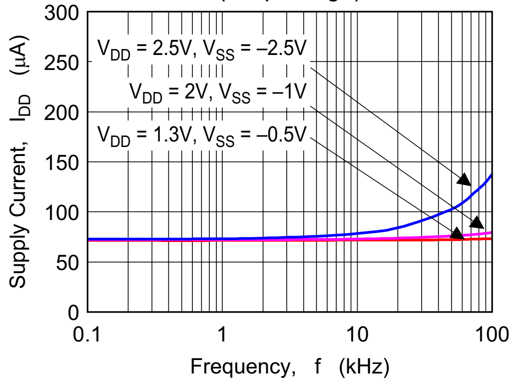


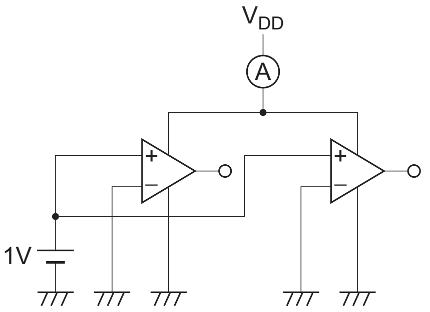
Figure 4-20 HA1631D04
Supply Current vs. Frequency
(Output High)



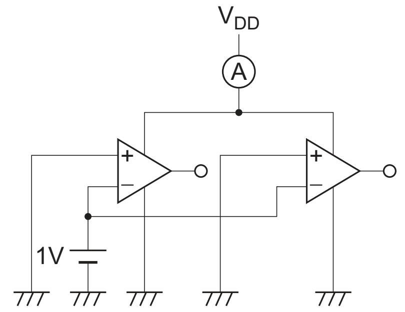
Test Circuits

(unless otherwise noted, V_{DD} = 3 V, V_{SS} = 0 V, Ta = 25°C)

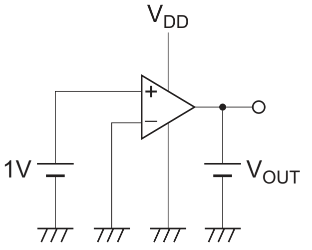
1. Supply Current, I_{DD} (Output High)



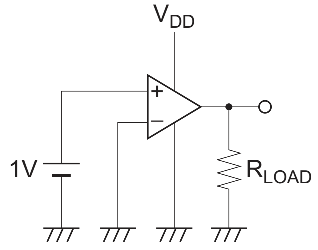
2. Supply Current, I_{DD} (Output Low)



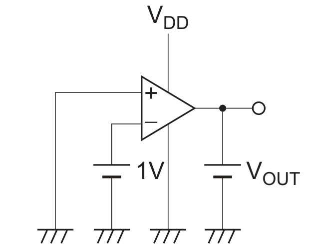
3. Output Source Current, $I_{OSOURCE}$



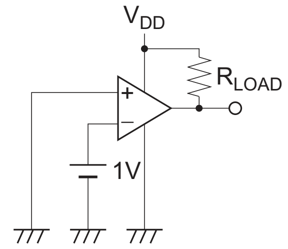
4. Output Voltage High, V_{OH}



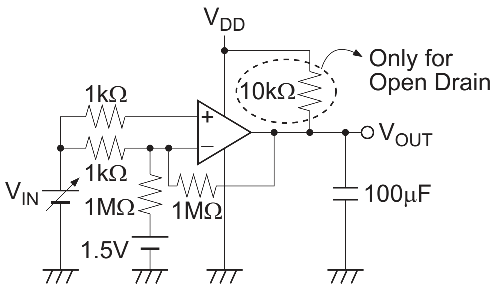
5. Output Sink Current, I_{OSINK}



6. Output Voltage Low, V_{OL}

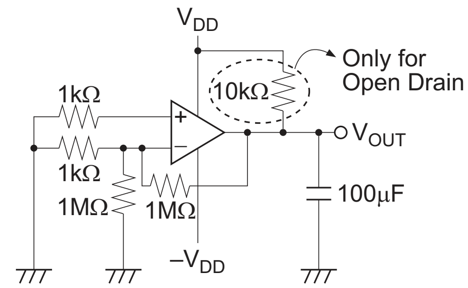


7. Input Offset Voltage, V_{IO}



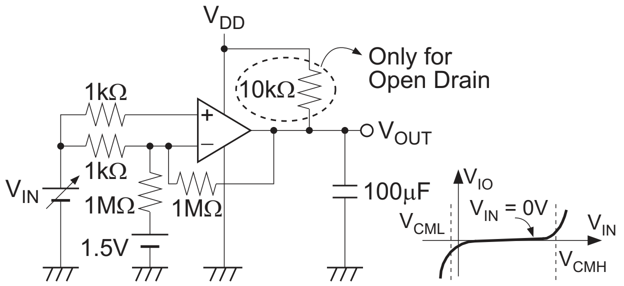
Note: $V_{IO} = V_{OUT} - 1.5$ V

8. Input Offset Voltage vs. Supply Voltage



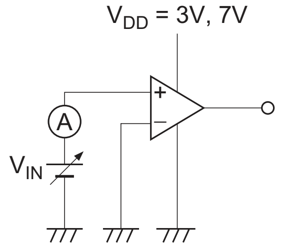
(unless otherwise noted, V_{DD} = 3 V, V_{SS} = 0 V, Ta = 25°C)

9. Common Mode Input Voltage, V_{CM}

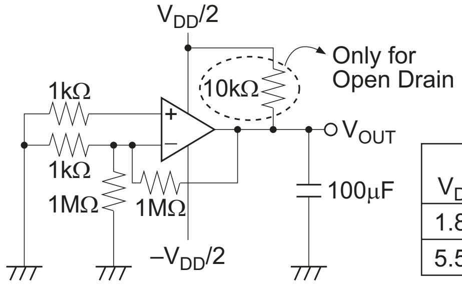


Note: V_{CML} and V_{CMH} are values of V_{IN} when V_{IO} changes more than 50dB taking V_{IN} = 0V as reference.

10. Input Bias Current, I_{IB}

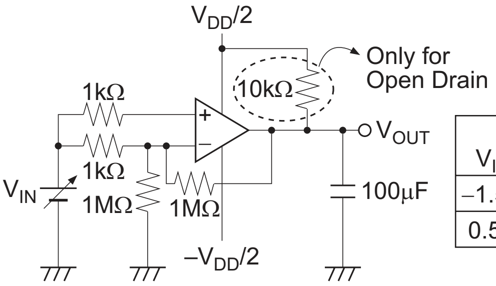


11. Power Supply Rejection Ratio, PSRR



V_{DD}	Measure Point	Calculate V_{IO}	PSRR Calculation
1.8V	V_{OUT1}	$V_{IO1} = V_{OUT1}/1000$	$PSRR = \left\lvert 20\log \frac{\lvert(V_{IO2} - V_{IO1})\rvert}{5.5V - 1.8V} \right\rvert$
5.5V	V_{OUT2}	$V_{IO2} = V_{OUT2}/1000$	

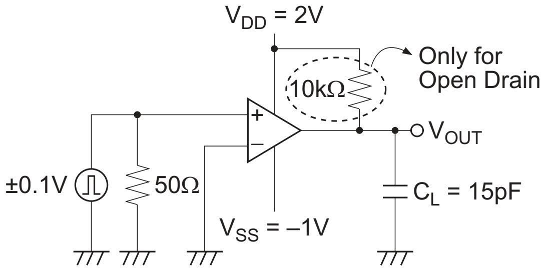
12. Common Mode Rejection Ratio, CMRR

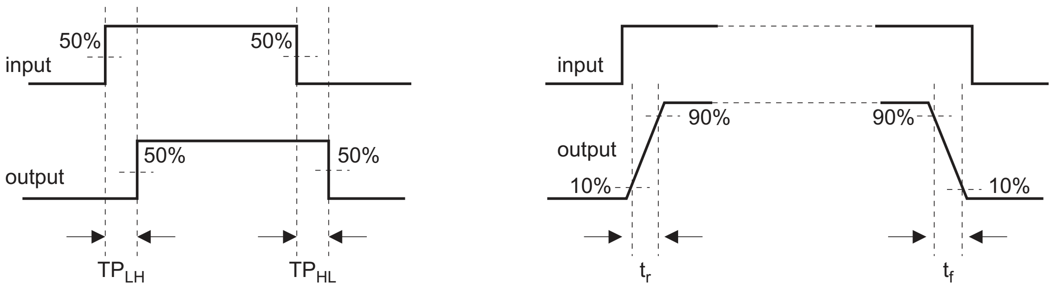


V_{IN}	Measure Point	Calculate V_{IO}	CMRR Calculation
–1.5V	V_{OUT1}	$V_{IO1} = V_{OUT1}/1000$	$CMRR = \left\lvert 20\log \frac{\lvert(V_{IO2} - V_{IO1})\rvert}{0.5V - (-1.5V)} \right\rvert$
0.5V	V_{OUT2}	$V_{IO2} = V_{OUT2}/1000$	

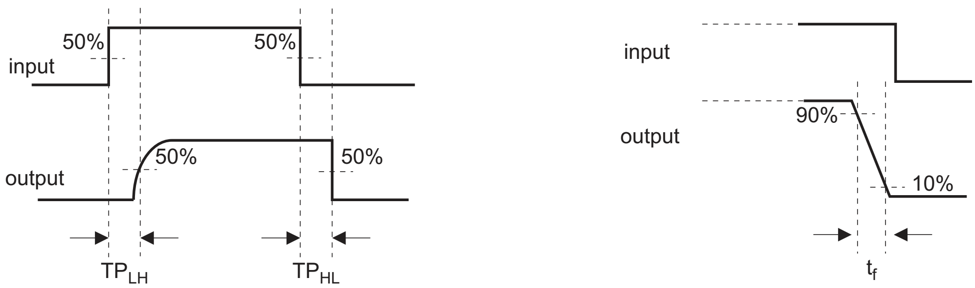
(unless otherwise noted, V_{DD} = 3 V, V_{SS} = 0 V, Ta = 25°C)

13. Response Time t_r, t_f and Delay Time TP_{HL}, TP_{LH}



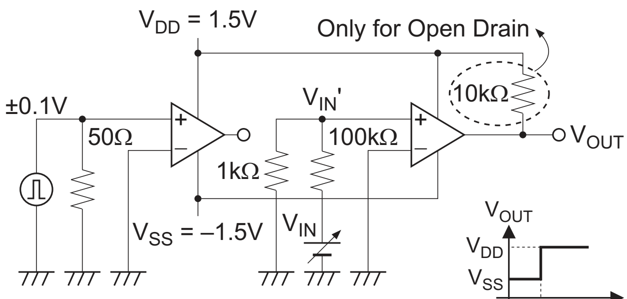


Only for Push Pull HA1631D01/02



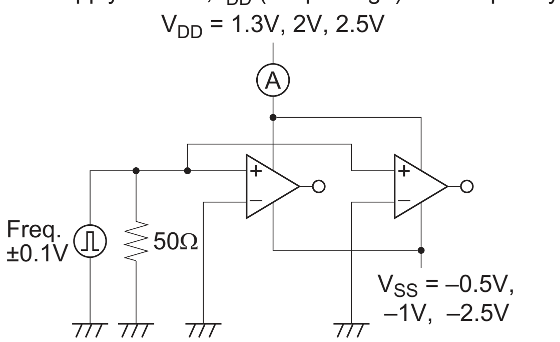
Only for Open Drain HA1631D03/04

14. Cross Talk



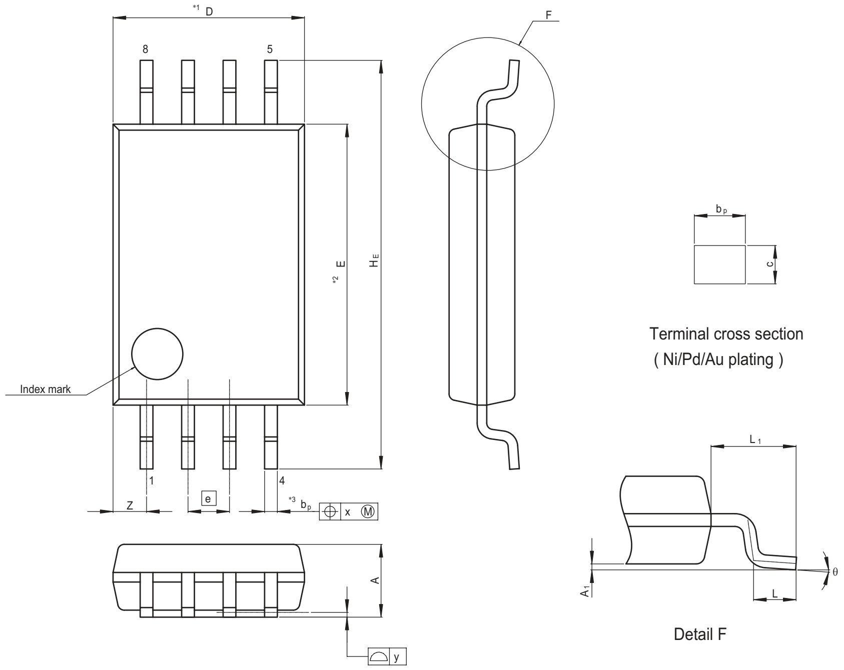
Note: $V_{IO} = V_{IN}'$

15. Supply Current, I_{DD} (Output High) vs. Frequency



Package Dimensions

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

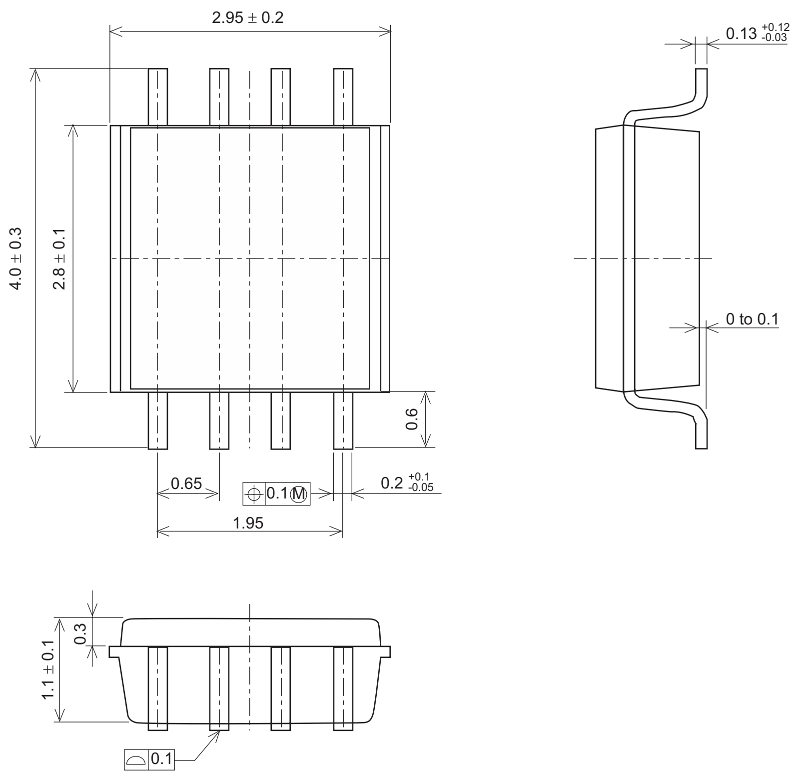


NOTE)
1. DIMENSIONS"*1 (Nom)"AND"*2" DO NOT INCLUDE MOLD FLASH.
2. DIMENSION"*3"DOES NOT INCLUDE TRIM OFFSET.

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



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Colophon .7.0

To our customers,

Old Company Name in Catalogs and Other Documents

On April 1st, 2010, NEC Electronics Corporation merged with Renesas Technology Corporation, and Renesas Electronics Corporation took over all the business of both companies. Therefore, although the old company name remains in this document, it is a valid Renesas Electronics document. We appreciate your understanding.

Renesas Electronics website: http://www.renesas.com

April 1st, 2010
Renesas Electronics Corporation

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

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