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.

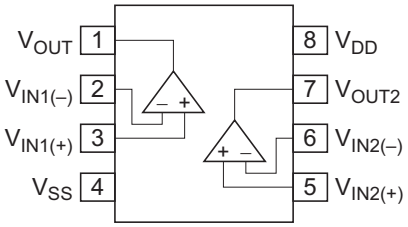
Features

- 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

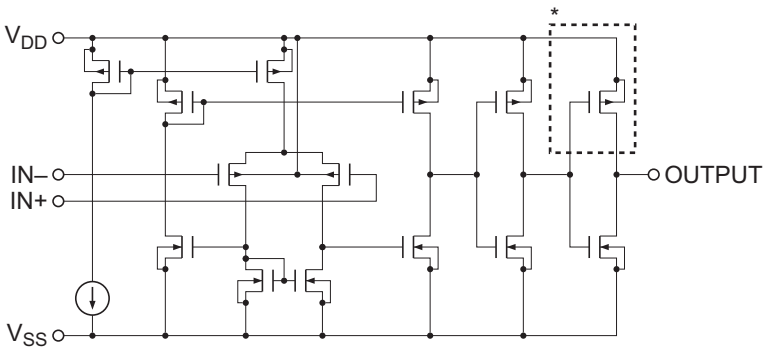
Type No.	Package Name	Package Code
HA1631D01T	TTP-8DAV	PTSP0008JC-B
HA1631D02T		
HA1631D03T		
HA1631D04T		
HA1631D01MM	MMPAK-8	PLSP0008JC-A
HA1631D02MM		
HA1631D03MM		
HA1631D04MM		

Pin Arrangement



(Top view)

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)

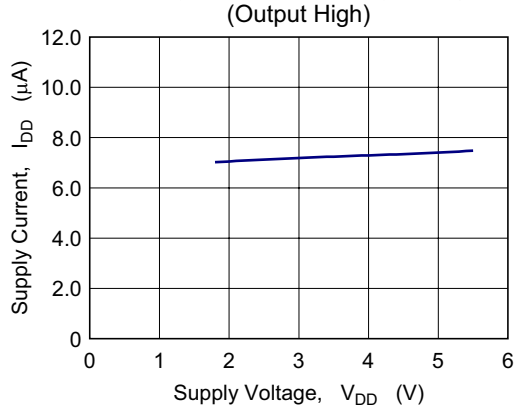


Figure 1-2 HA1631D01
Supply Current vs. Supply Voltage
(Output Low)

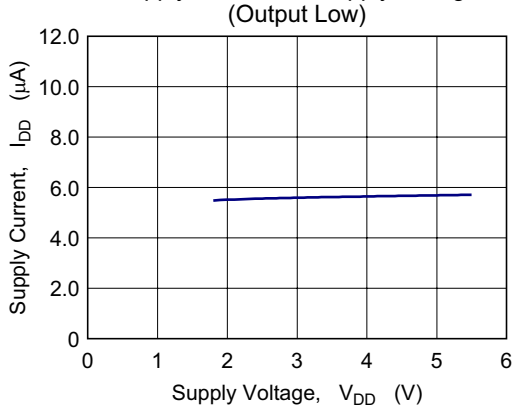


Figure 1-3 HA1631D01
Supply Current vs. Ambient Temperature

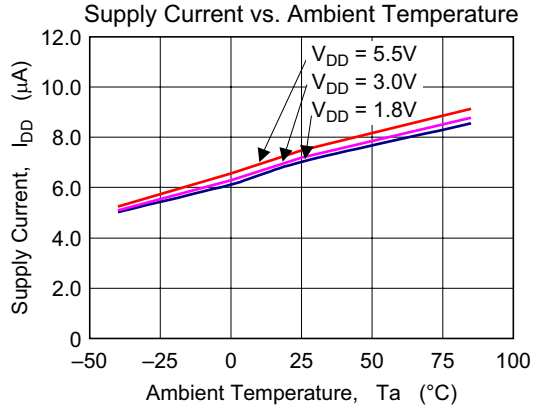


Figure 1-4 HA1631D01
Output High Voltage vs. Output Source Current

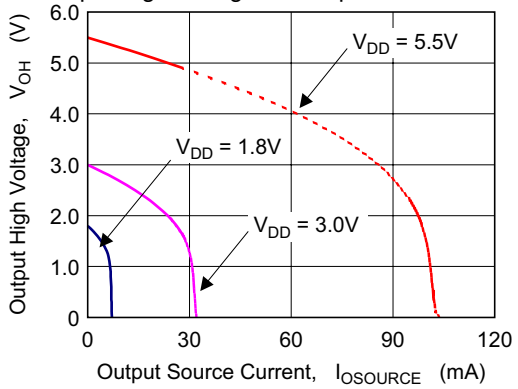


Figure 1-5 HA1631D01
Output Low Voltage vs. Output Sink Current

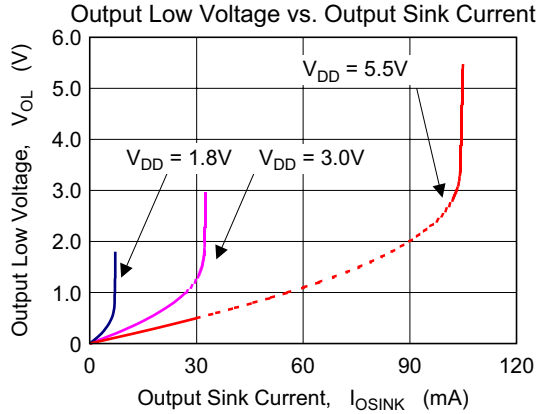
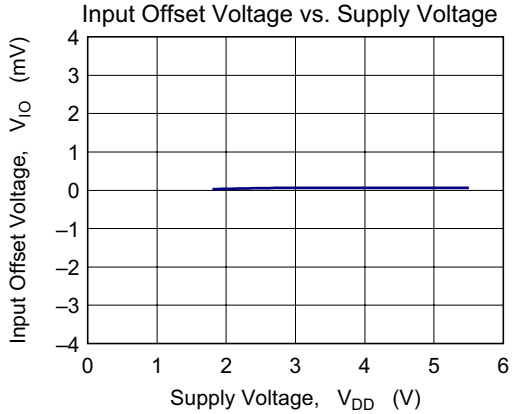


Figure 1-6 HA1631D01
Input Offset Voltage vs. Supply Voltage



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

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

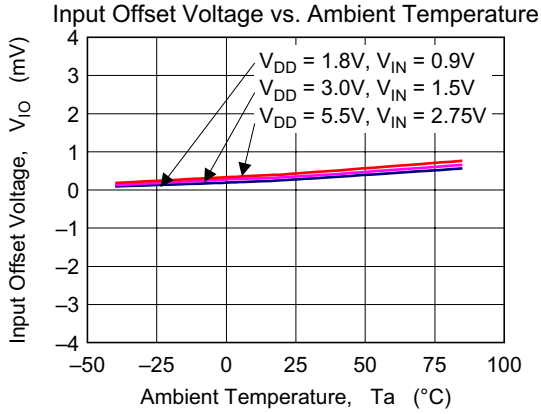


Figure 1-8 HA1631D01
Common Mode Input Voltage vs. Ambient Temperature

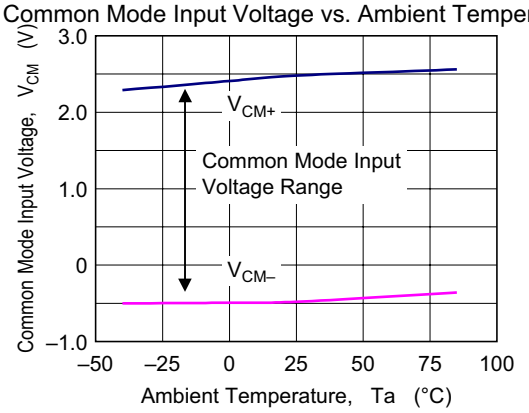


Figure 1-9 HA1631D01
Power Supply Rejection Ratio vs. Supply Voltage

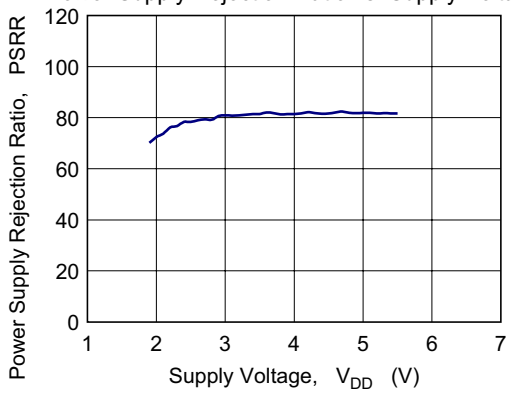


Figure 1-10 HA1631D01
Common Mode Rejection Ratio vs. Input Voltage

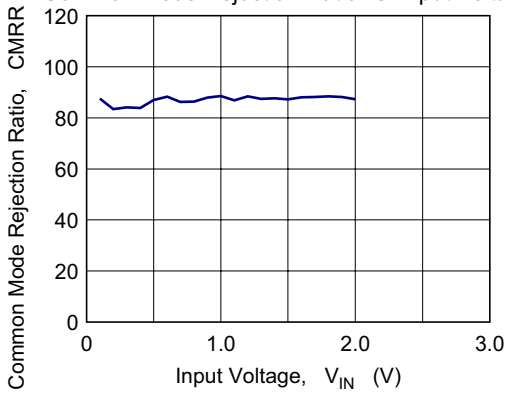


Figure 1-11 HA1631D01
Input Bias Current vs. Ambient Temperature

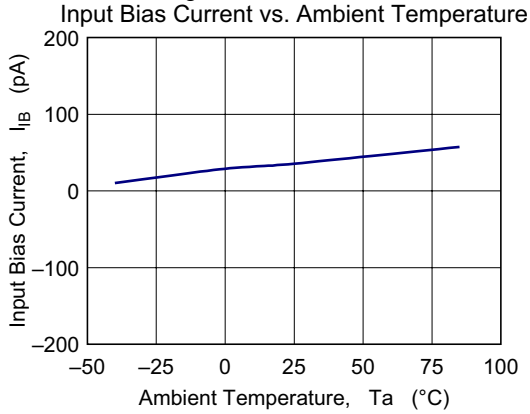
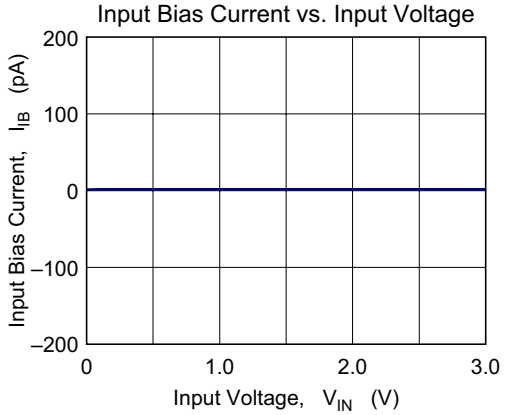


Figure 1-12 HA1631D01
Input Bias Current vs. Input Voltage



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

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

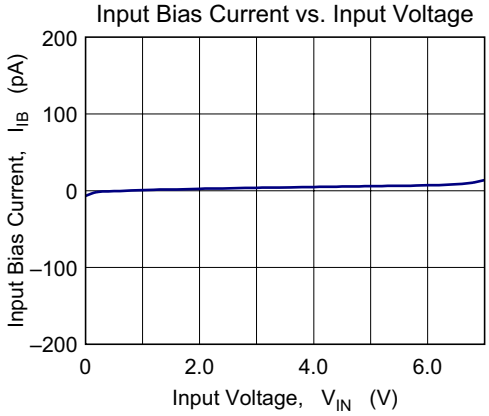


Figure 1-14 HA1631D01
Falling Time vs. Ambient Temperature

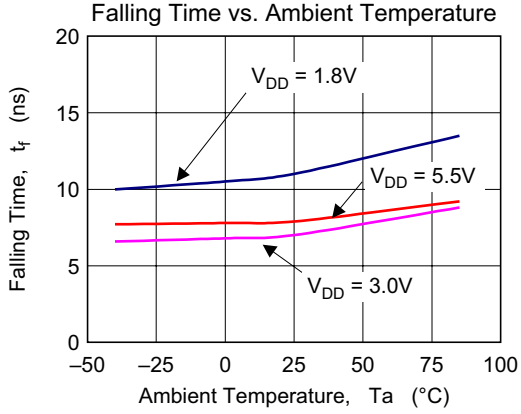


Figure 1-15 HA1631D01
Rising Time vs. Ambient Temperature

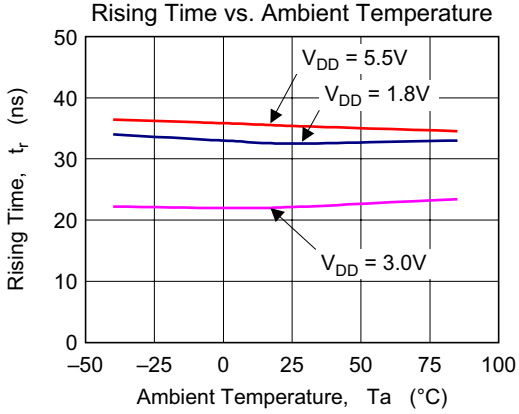


Figure 1-16 HA1631D01
Falling Time vs. Capacitive Load

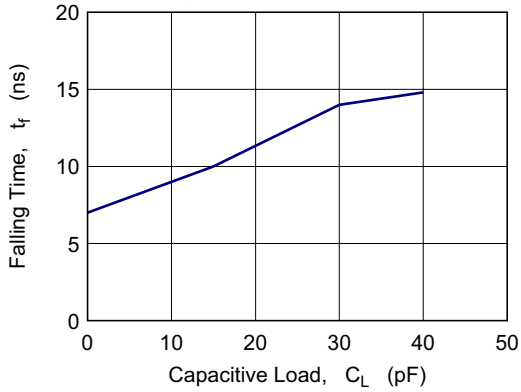


Figure 1-17 HA1631D01
Rising Time vs. Capacitive Load

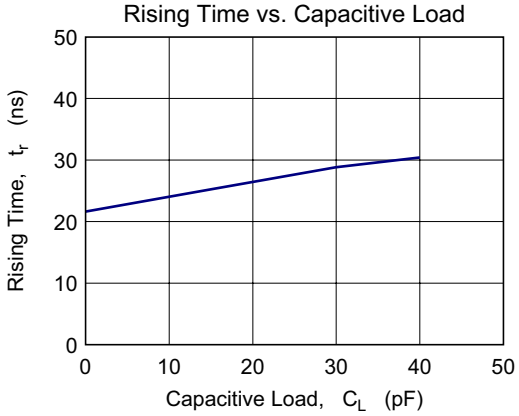
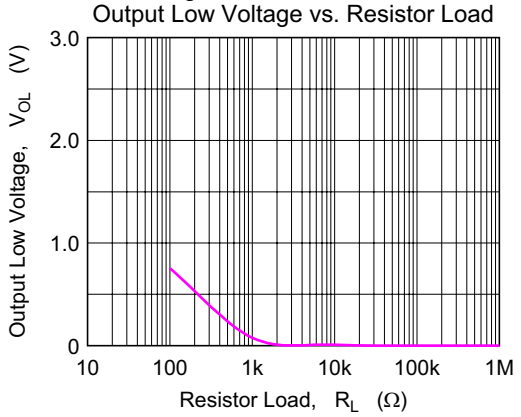


Figure 1-18 HA1631D01
Output Low Voltage vs. Resistor Load



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

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

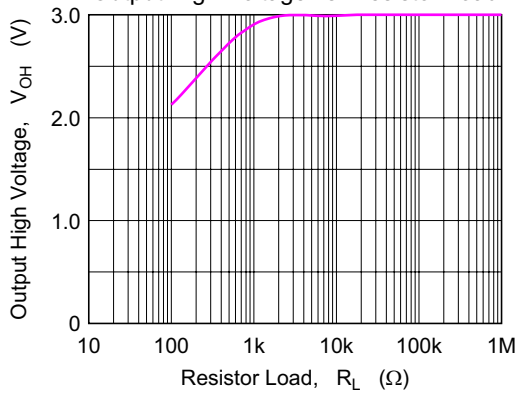


Figure 1-20 HA1631D01
Rising Time t_r
(Overdrive, ±0.1Vp-p)

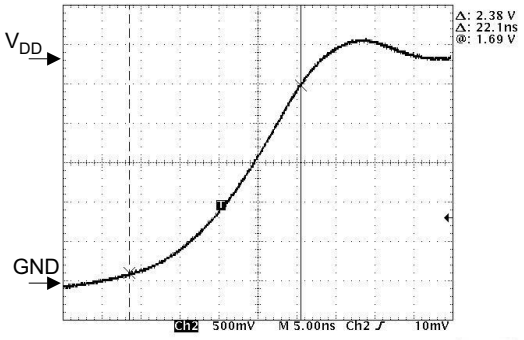


Figure 1-21 HA1631D01
Falling Time t_f
(Overdrive, ±0.1Vp-p)

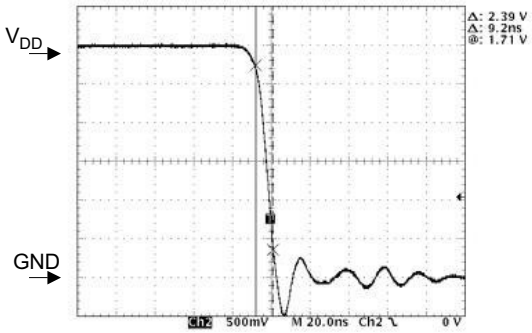


Figure 1-22 HA1631D01
TP_{LH} Transient Response
(Overdrive, ±0.1Vp-p)

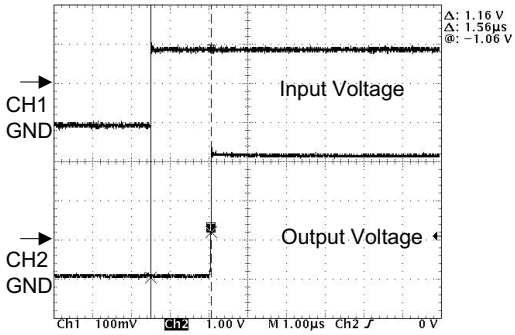


Figure 1-23 HA1631D01
TP_{HL} Transient Response
(Overdrive, ±0.1Vp-p)

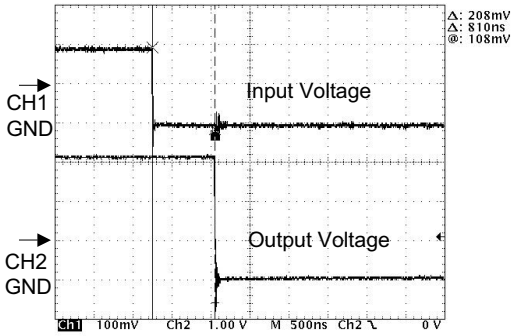
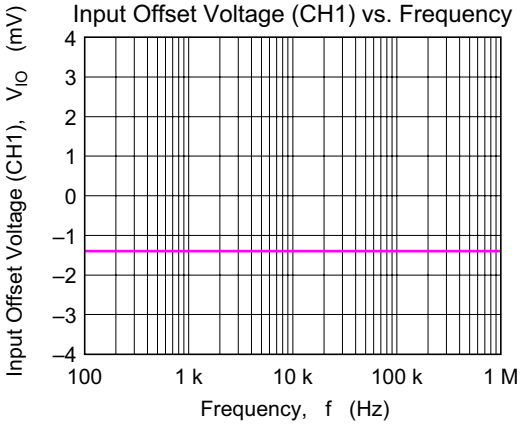


Figure 1-24 HA1631D01
Input Offset Voltage (CH1) vs. Frequency



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

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

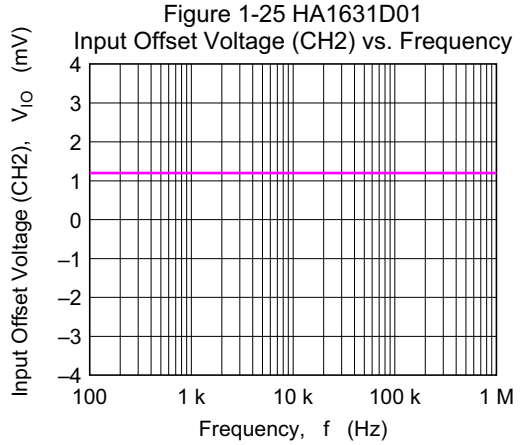
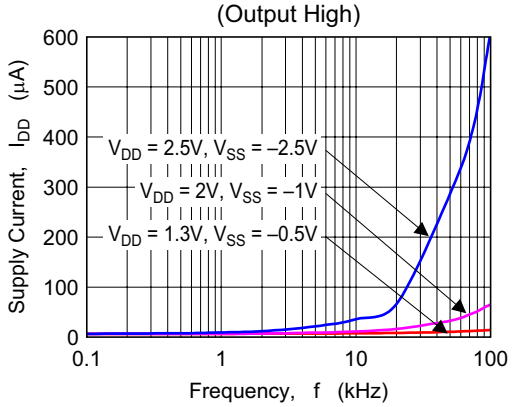


Figure 1-26 HA1631D01
Supply Current vs. Frequency
(Output High)



(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)

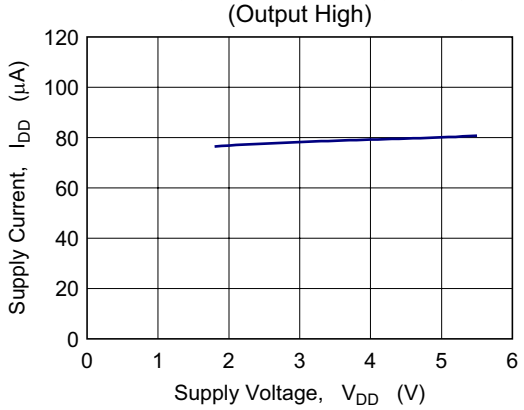


Figure 2-2 HA1631D02
Supply Current vs. Supply Voltage
(Output Low)

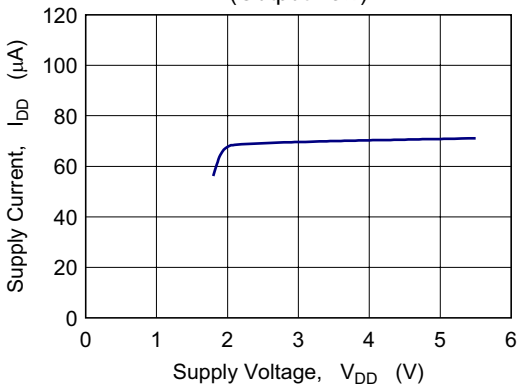


Figure 2-3 HA1631D02
Supply Current vs. Ambient Temperature

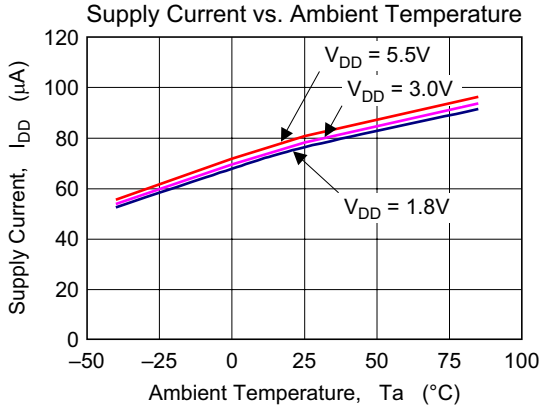


Figure 2-4 HA1631D02
Output High Voltage vs. Output Source Current

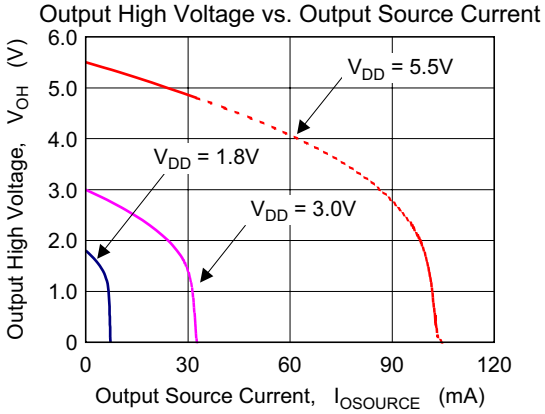


Figure 2-5 HA1631D02
Output Low Voltage vs. Output Sink Current

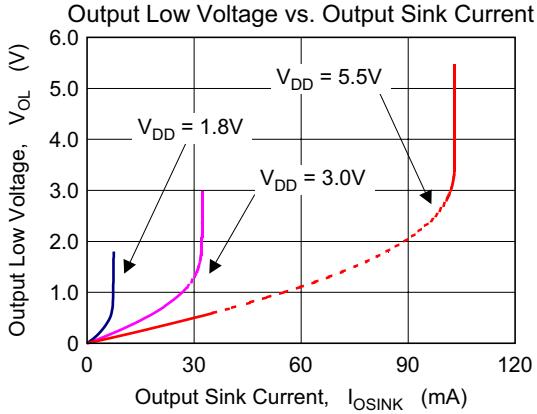
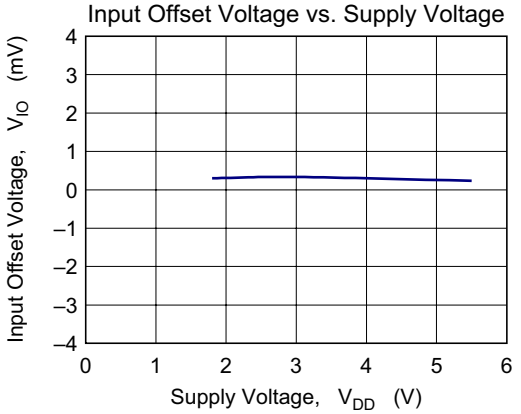


Figure 2-6 HA1631D02
Input Offset Voltage vs. Supply Voltage



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

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

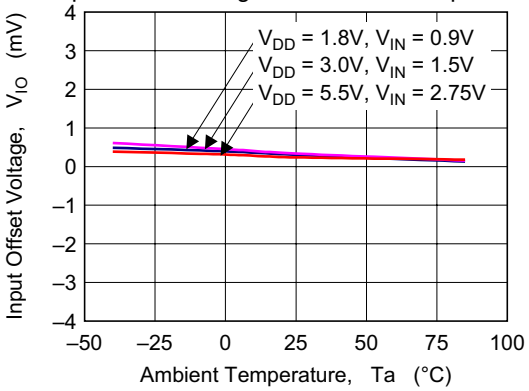


Figure 2-8 HA1631D02
Common Mode Input Voltage vs. Ambient Temperature

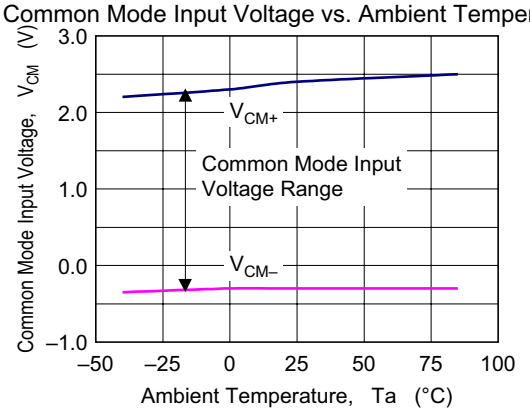


Figure 2-9 HA1631D02
Power Supply Rejection Ratio vs. Supply Voltage

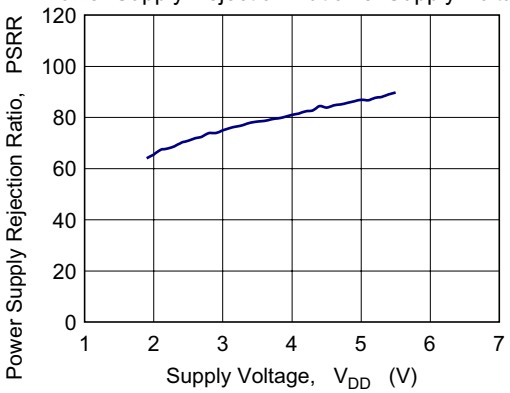


Figure 2-10 HA1631D02
Common Mode Rejection Ratio vs. Input Voltage

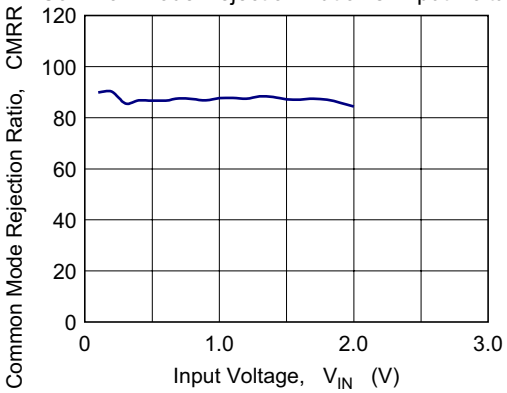


Figure 2-11 HA1631D02
Input Bias Current vs. Ambient Temperature

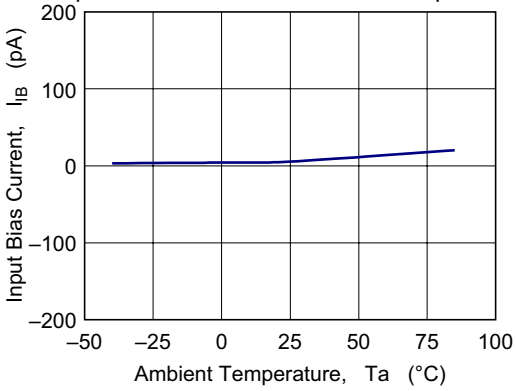
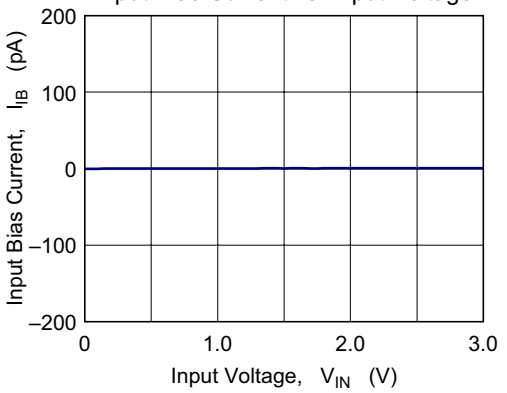


Figure 2-12 HA1631D02
Input Bias Current vs. Input Voltage



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

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

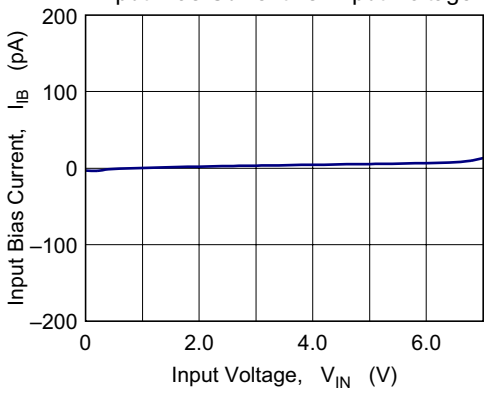


Figure 2-14 HA1631D02
Falling Time vs. Ambient Temperature

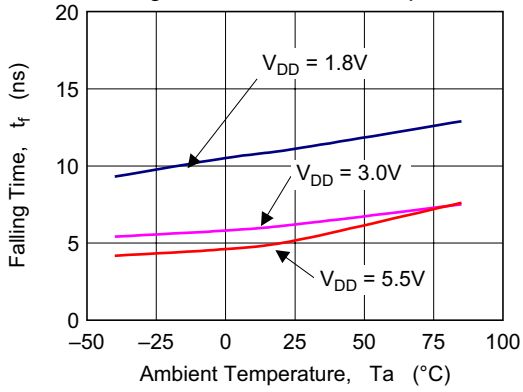


Figure 2-15 HA1631D02
Rising Time vs. Ambient Temperature

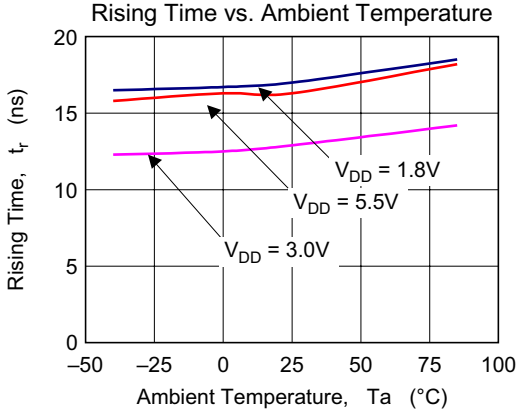


Figure 2-16 HA1631D02
Falling Time vs. Capacitive Load

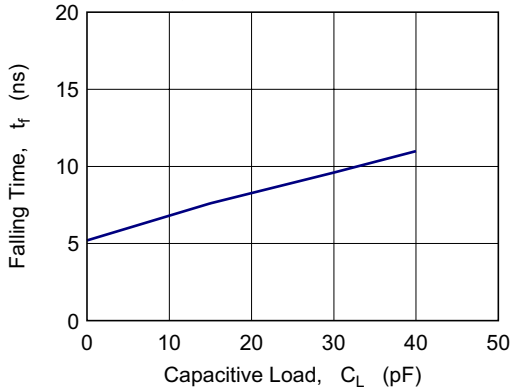


Figure 2-17 HA1631D02
Rising Time vs. Capacitive Load

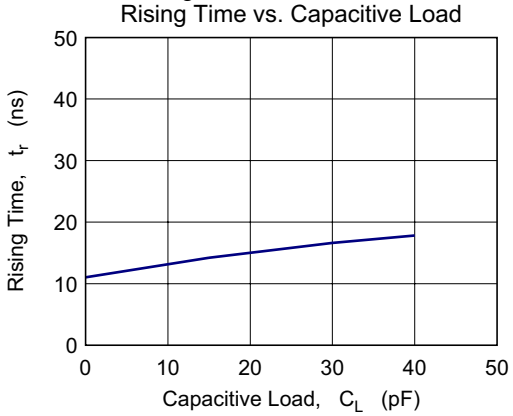
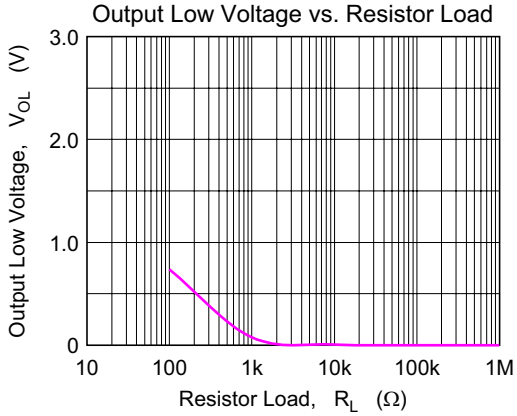


Figure 2-18 HA1631D02
Output Low Voltage vs. Resistor Load



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

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

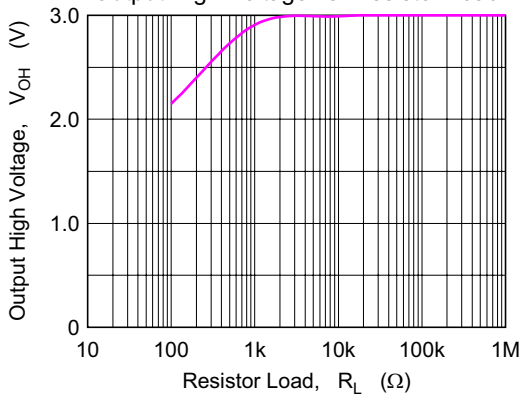


Figure 2-20 HA1631D02
Rising Time t_r
(Overdrive, ±0.1Vp-p)

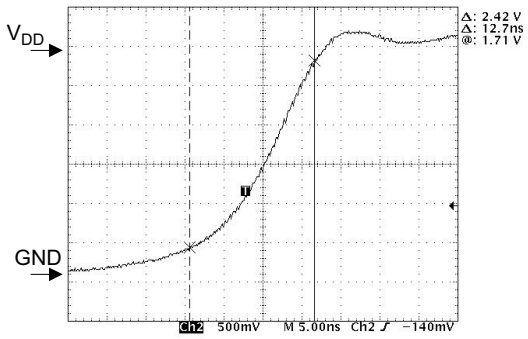


Figure 2-21 HA1631D02
Falling Time t_f
(Overdrive, ±0.1Vp-p)

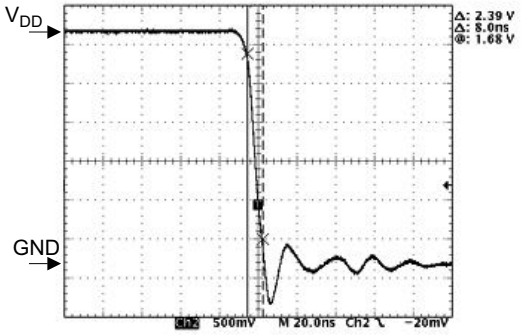


Figure 2-22 HA1631D02
TP_{LH} Transient Response
(Overdrive, ±0.1Vp-p)

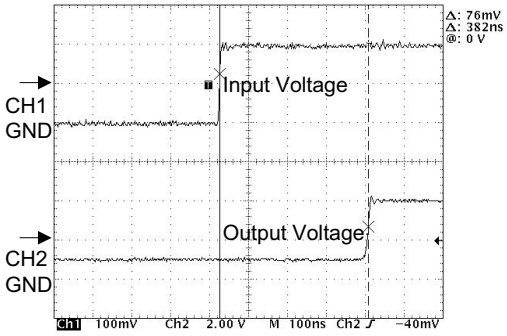


Figure 2-23 HA1631D02
TP_{HL} Transient Response
(Overdrive, ±0.1Vp-p)

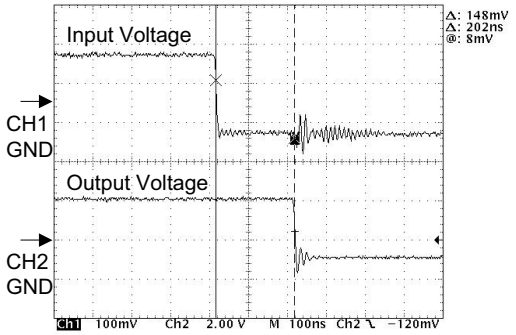
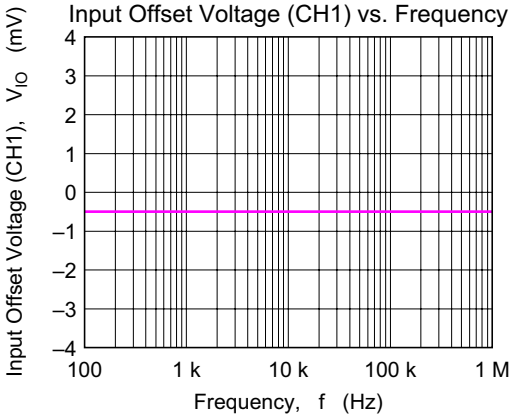


Figure 2-24 HA1631D02
Input Offset Voltage (CH1) vs. Frequency



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

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

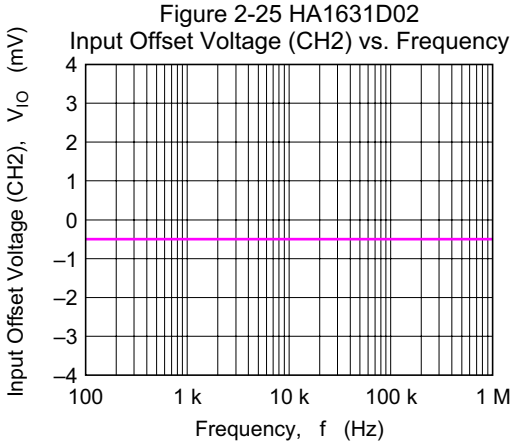
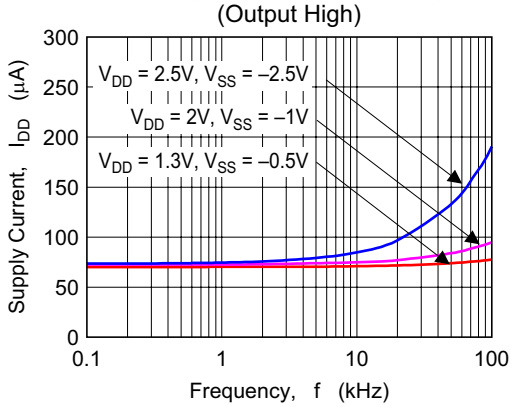


Figure 2-26 HA1631D02
Supply Current vs. Frequency
(Output High)



(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)

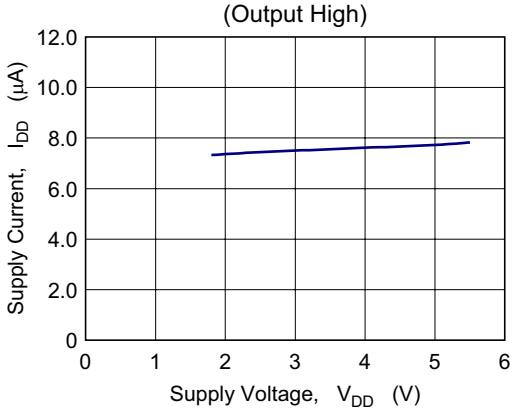


Figure 3-2 HA1631D03
Supply Current vs. Supply Voltage
(Output Low)

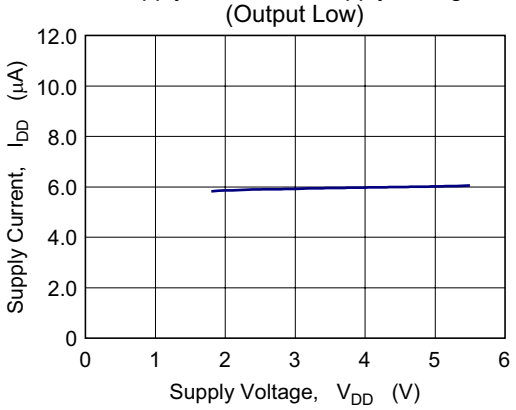


Figure 3-3 HA1631D03
Supply Current vs. Ambient Temperature

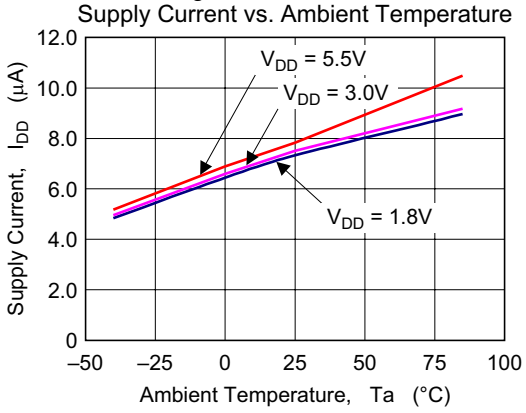


Figure 3-4 HA1631D03
Output Low Voltage vs. Output Sink Current

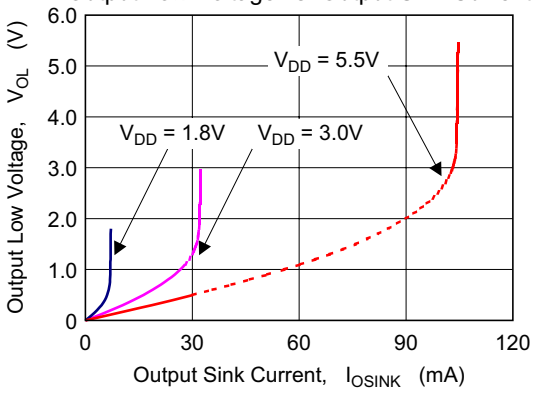


Figure 3-5 HA1631D03
Input Offset Voltage vs. Supply Voltage

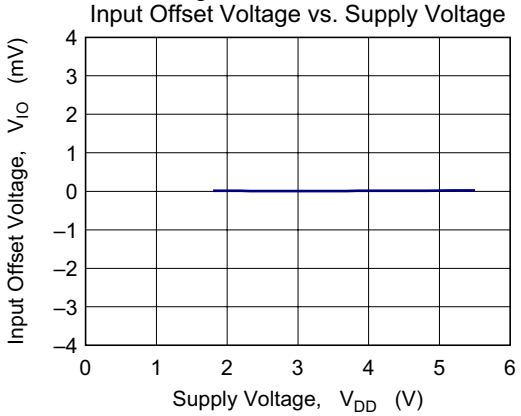
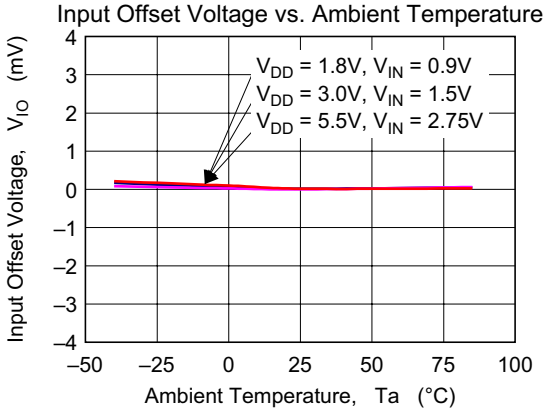


Figure 3-6 HA1631D03
Input Offset Voltage vs. Ambient Temperature



(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

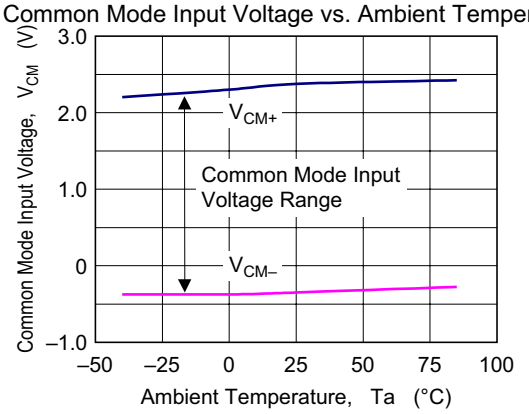


Figure 3-8 HA1631D03
Power Supply Rejection Ratio vs. Supply Voltage

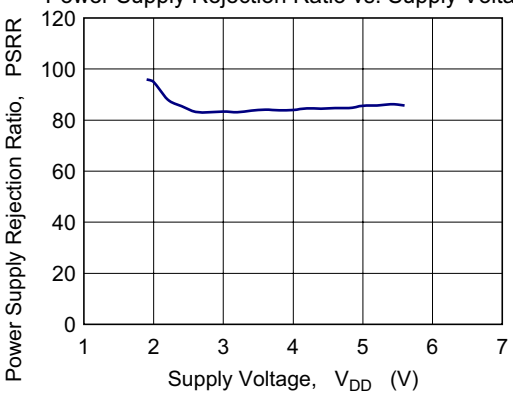


Figure 3-9 HA1631D03
Common Mode Rejection Ratio vs. Input Voltage

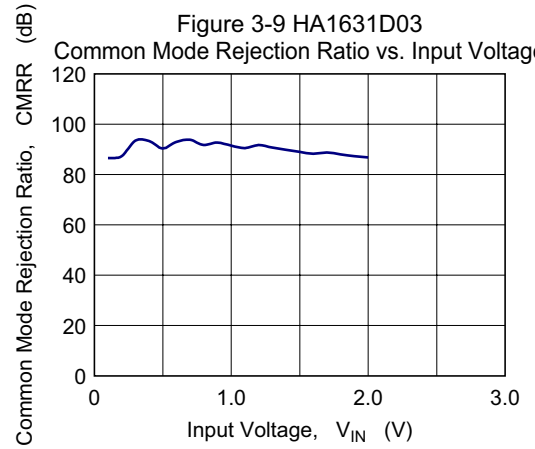


Figure 3-10 HA1631D03
Input Bias Current vs. Ambient Temperature

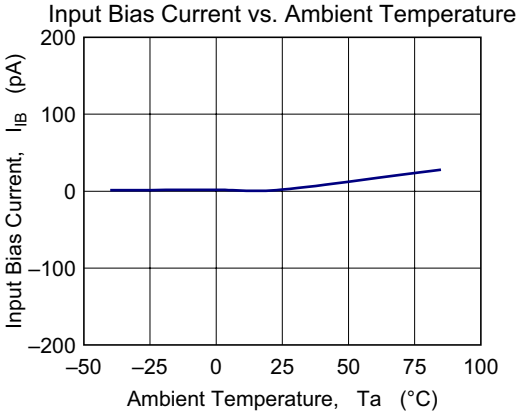


Figure 3-11 HA1631D03
Input Bias Current vs. Input Voltage

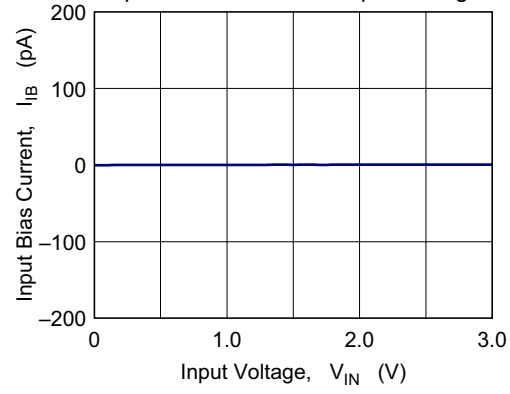
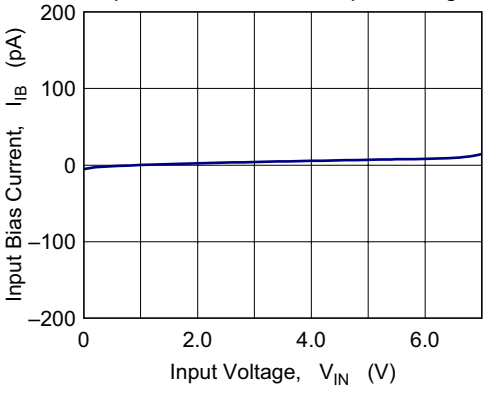


Figure 3-12 HA1631D03
Input Bias Current vs. Input Voltage



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

Figure 3-13 HA1631D03
Falling Time vs. Ambient Temperature

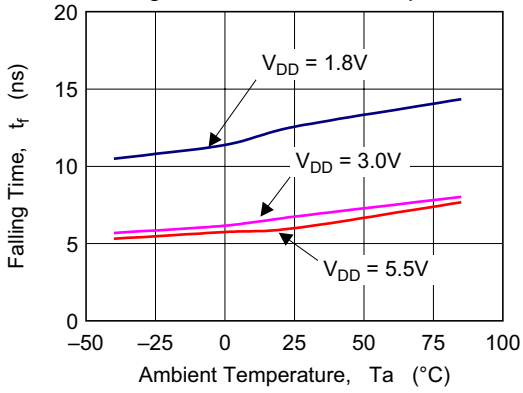


Figure 3-14 HA1631D03
Falling Time vs. Capacitive Load

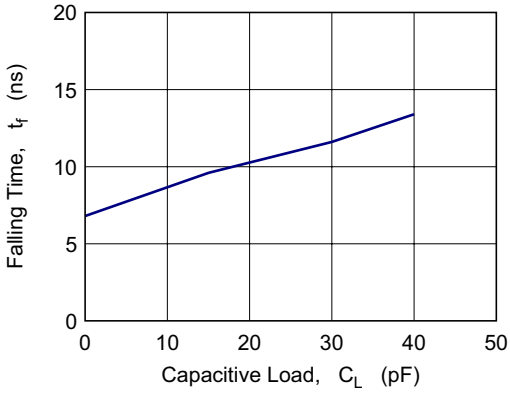


Figure 3-15 HA1631D03
Output Low Voltage vs. Resistor Load

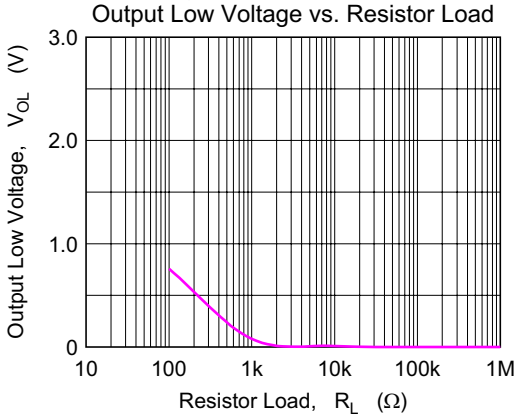


Figure 3-16 HA1631D03
Falling Time t_f
(Overdrive, ±0.1Vp-p)

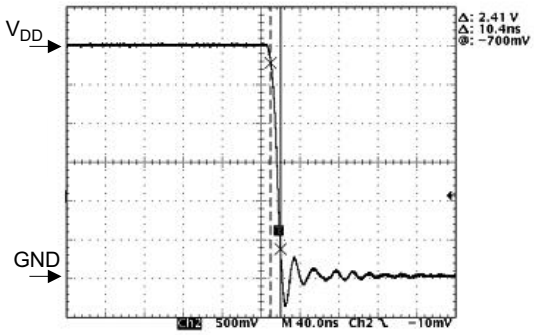


Figure 3-17 HA1631D03
TP_{HL} Transient Response
(Overdrive, ±0.1Vp-p)

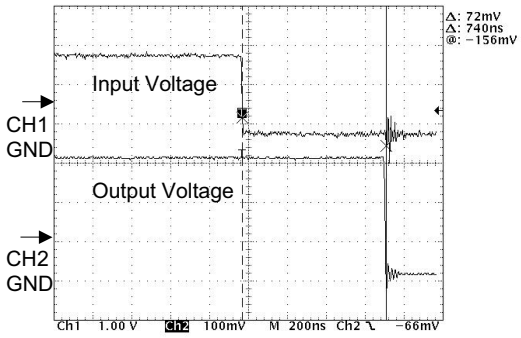
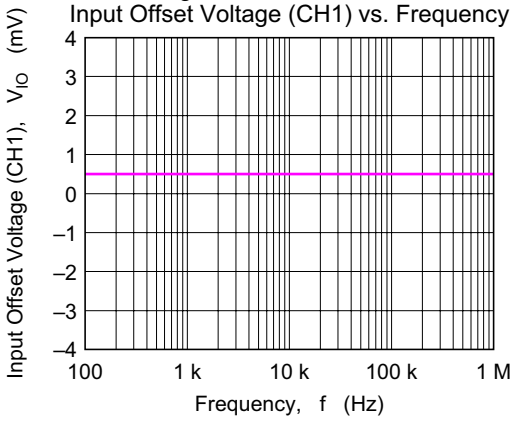


Figure 3-18 HA1631D03
Input Offset Voltage (CH1) vs. Frequency



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

Figure 3-19 HA1631D03
Input Offset Voltage (CH2) vs. Frequency

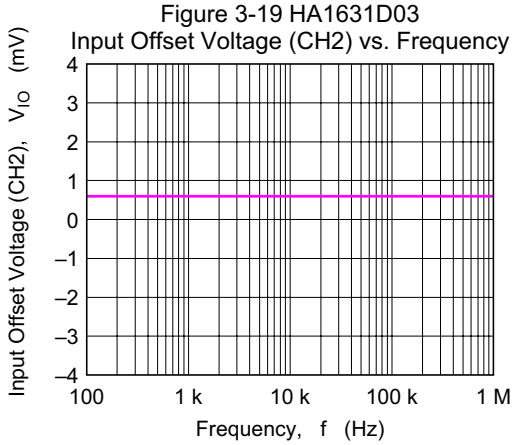
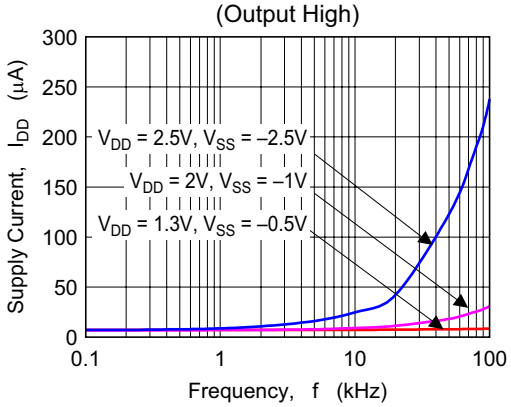


Figure 3-20 HA1631D03
Supply Current vs. Frequency
(Output High)



(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)

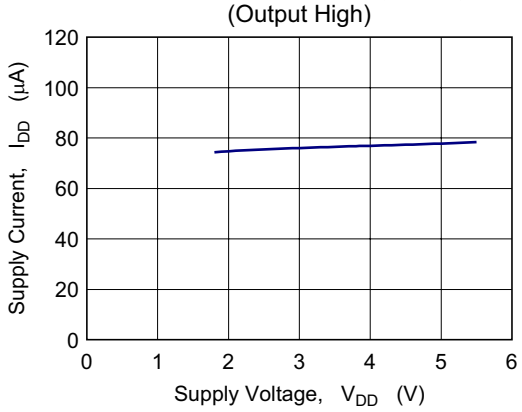


Figure 4-2 HA1631D04
Supply Current vs. Supply Voltage
(Output Low)

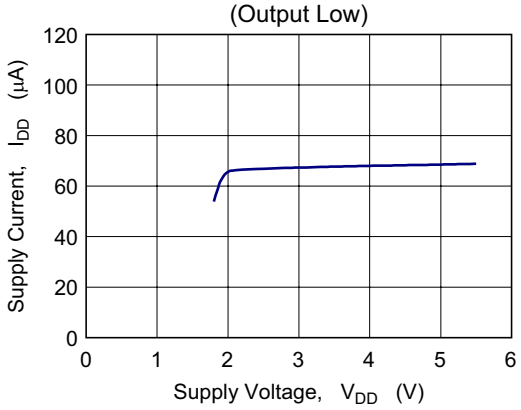


Figure 4-3 HA1631D04
Supply Current vs. Ambient Temperature

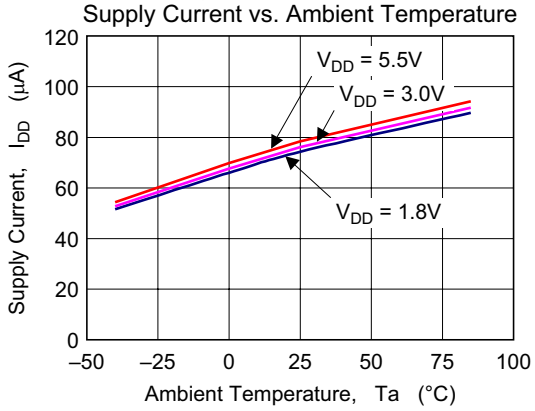


Figure 4-4 HA1631D04
Output Low Voltage vs. Output Sink Current

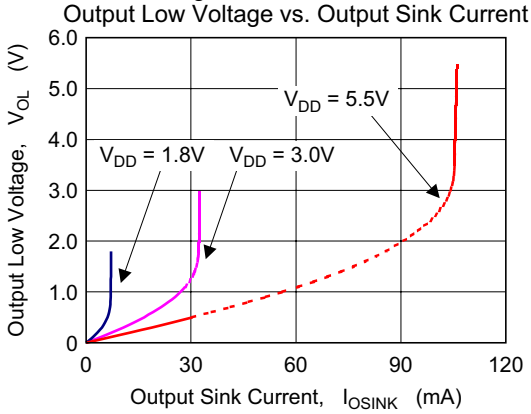


Figure 4-5 HA1631D04
Input Offset Voltage vs. Supply Voltage

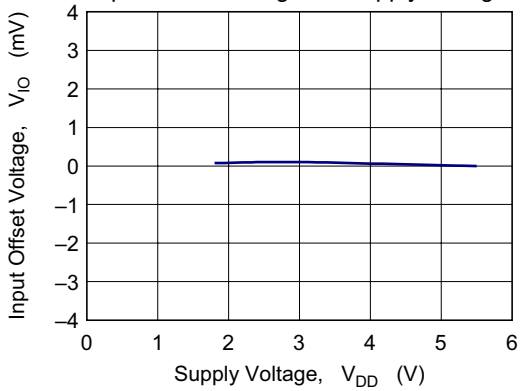
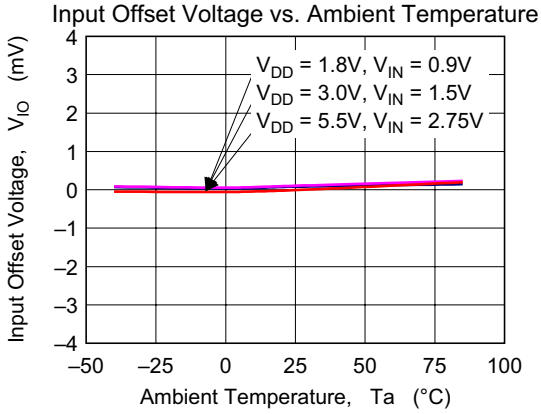


Figure 4-6 HA1631D04
Input Offset Voltage vs. Ambient Temperature



(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

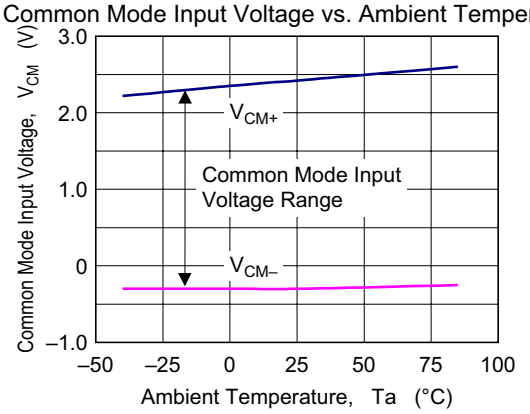


Figure 4-8 HA1631D04
Power Supply Rejection Ratio vs. Supply Voltage

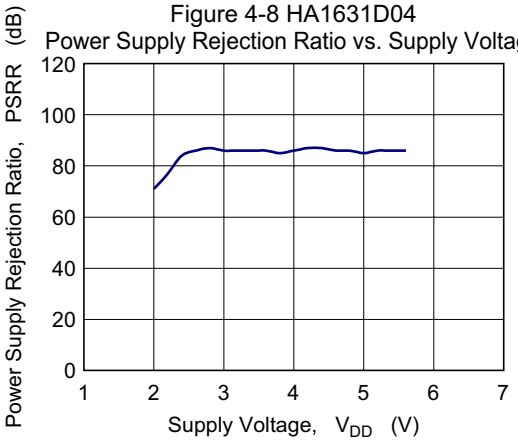


Figure 4-9 HA1631D04
Common Mode Rejection Ratio vs. Input Voltage

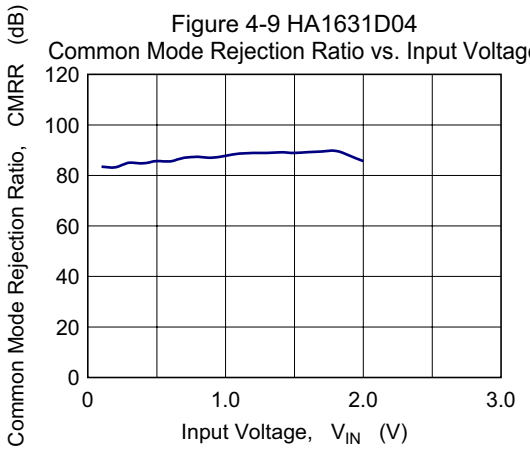


Figure 4-10 HA1631D04
Input Bias Current vs. Ambient Temperature

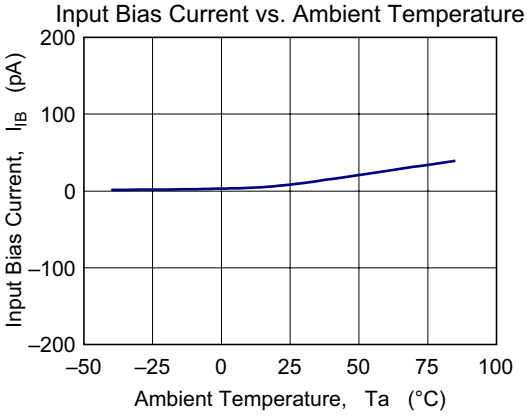


Figure 4-11 HA1631D04
Input Bias Current vs. Input Voltage

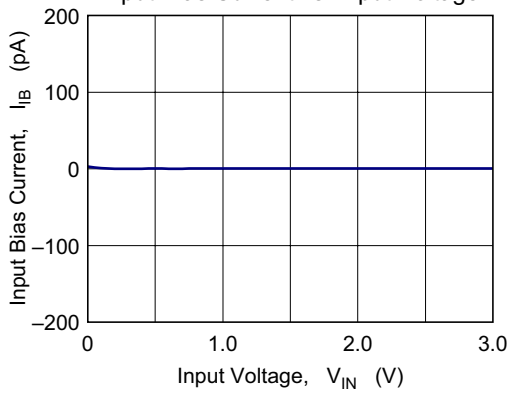
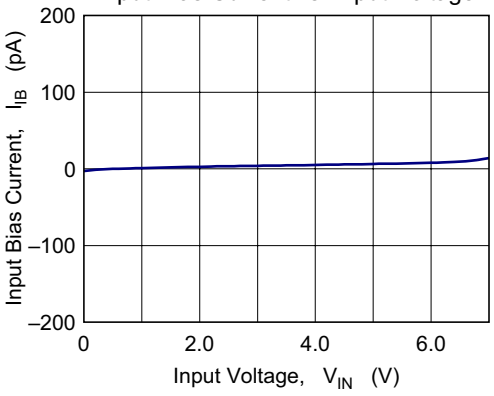


Figure 4-12 HA1631D04
Input Bias Current vs. Input Voltage



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

Figure 4-13 HA1631D04
Falling Time vs. Ambient Temperature

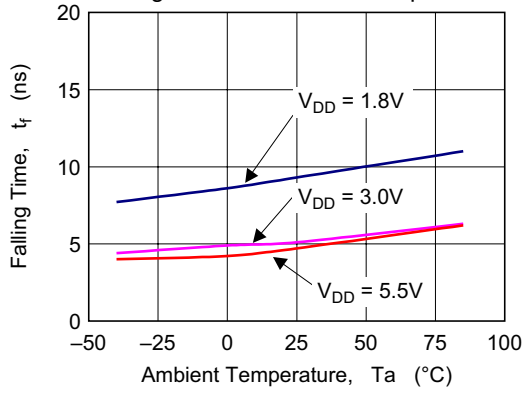


Figure 4-14 HA1631D04
Falling Time vs. Capacitive Load

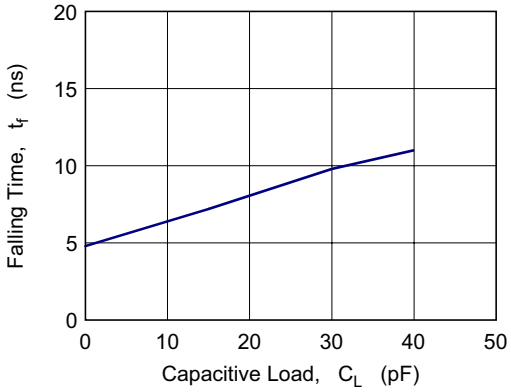


Figure 4-15 HA1631D04
Output Low Voltage vs. Resistor Load

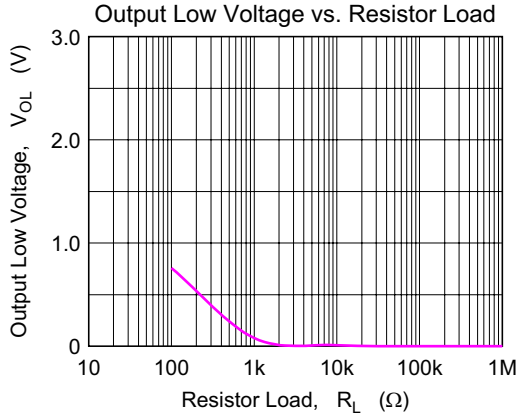


Figure 4-16 HA1631D04
Falling Time t_f
(Overdrive, ±0.1Vp-p)

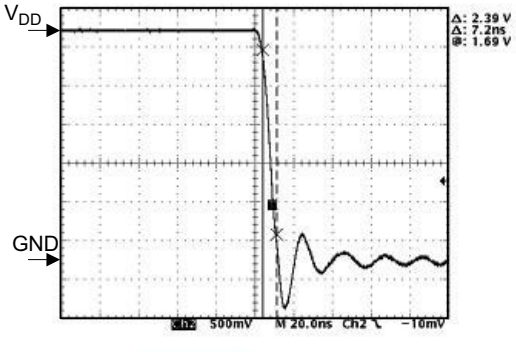


Figure 4-17 HA1631D04
TP_{HL} Transient Response
(Overdrive, ±0.1Vp-p)

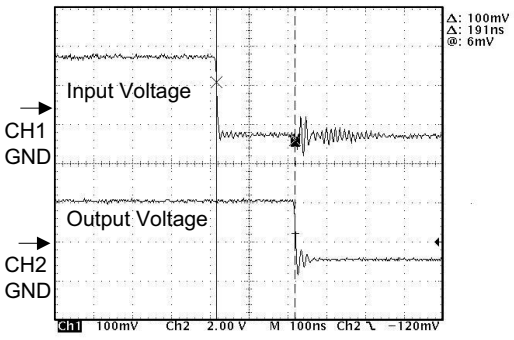
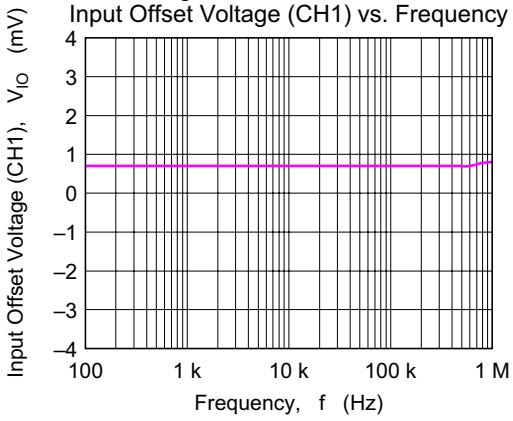


Figure 4-18 HA1631D04
Input Offset Voltage (CH1) vs. Frequency



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

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

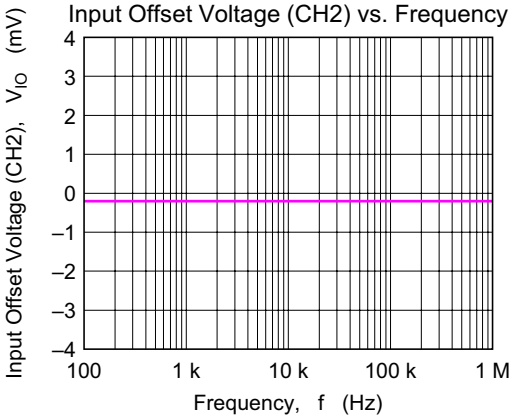
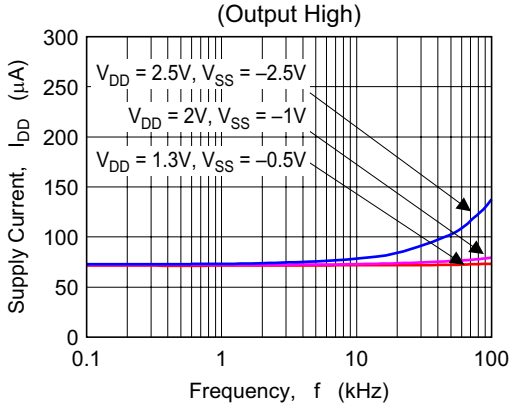


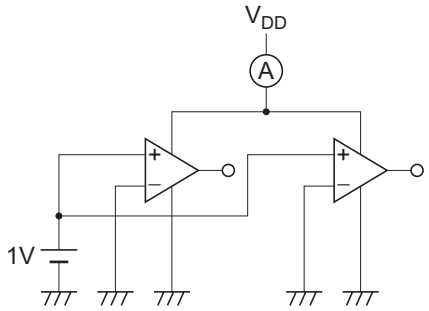
Figure 4-20 HA1631D04
Supply Current vs. Frequency
(Output High)



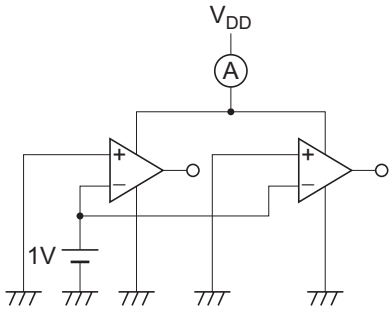
Test Circuits

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

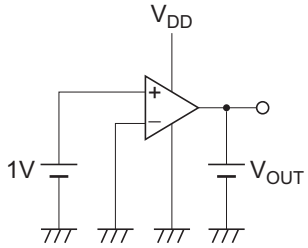
1. Supply Current, I_{DD} (Output High)



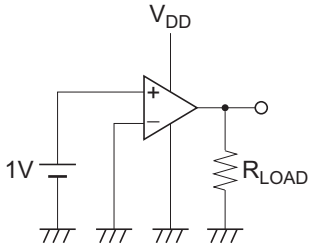
2. Supply Current, I_{DD} (Output Low)



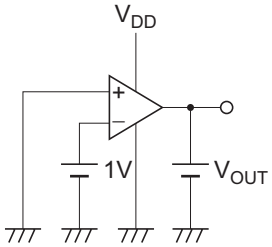
3. Output Source Current, $I_{OSOURCE}$



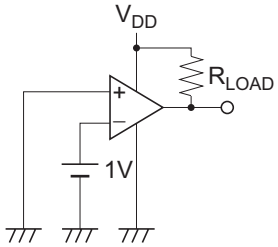
4. Output Voltage High, V_{OH}



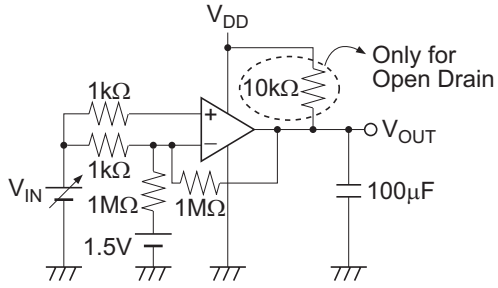
5. Output Sink Current, I_{OSINK}



6. Output Voltage Low, V_{OL}

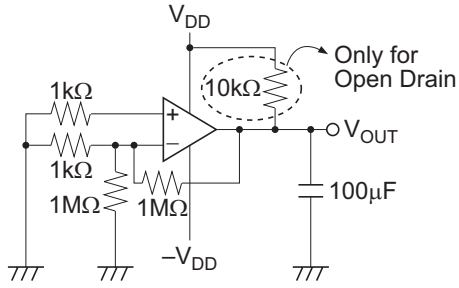


7. Input Offset Voltage, V_{IO}



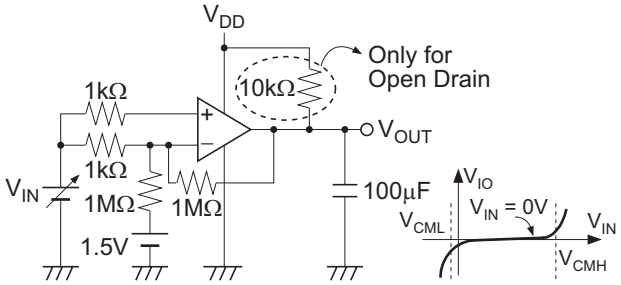
Note: $V_{IO} = V_{OUT} – 1.5$ V

8. Input Offset Voltage vs. Supply Voltage



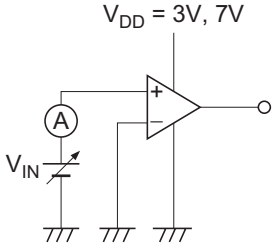
(unless otherwise noted, V_{DD} = 3 V, V_{SS} = 0 V, Ta = 25°C)

9. Common Mode Input Voltage, V_{CM}

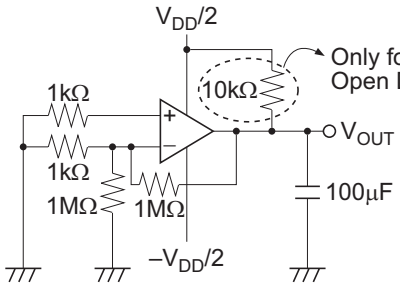


Note: V_{CML} and V_{CMH} are values of V_{IN} when V_{IO} changes more than 50dB taking V_{IN} = 0V as reference.

10. Input Bias Current, I_{IB}

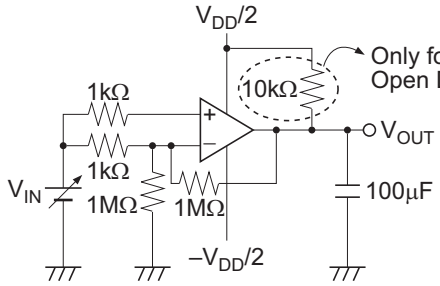


11. Power Supply Rejection Ratio, PSRR



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

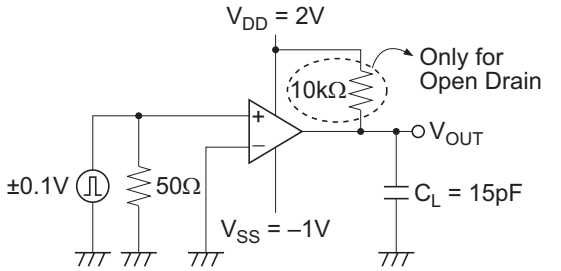
12. Common Mode Rejection Ratio, CMRR

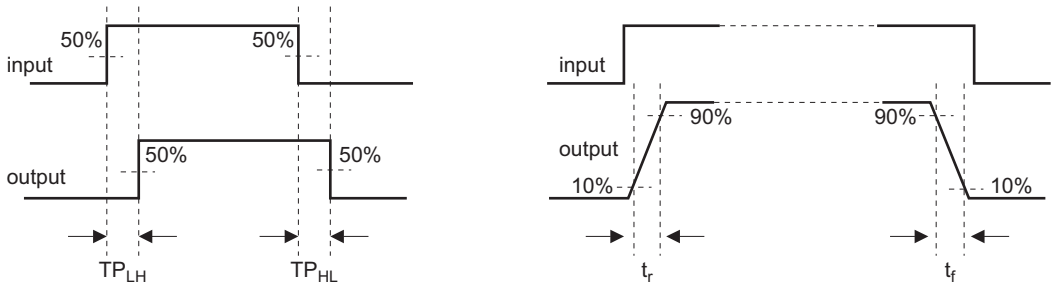


V_{IN}	Measure Point	Calculate V_{IO}	CMRR Calculation
–1.5V	V_{OUT1}	$V_{IO1} = V_{OUT1}/1000$	$CMRR = \left\| 20\log \frac{\|(V_{IO2} - V_{IO1})\|}{0.5V - (-1.5V)} \right\|$
0.5V	V_{OUT2}	$V_{IO2} = V_{OUT2}/1000$	

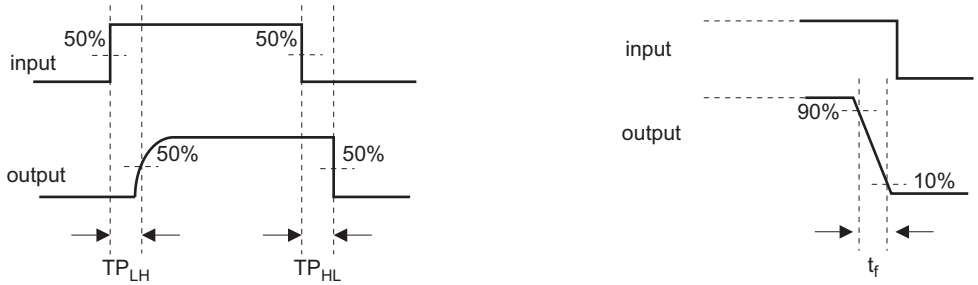
(unless otherwise noted, V_{DD} = 3 V, V_{SS} = 0 V, Ta = 25°C)

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



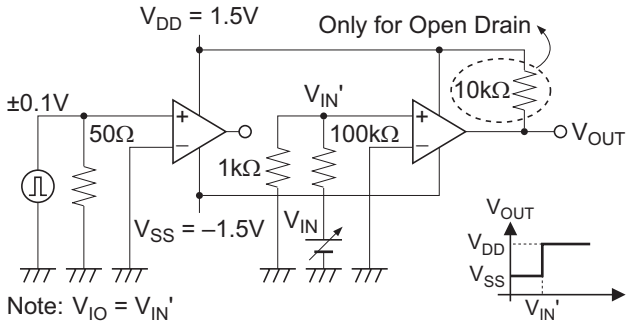


Only for Push Pull HA1631D01/02



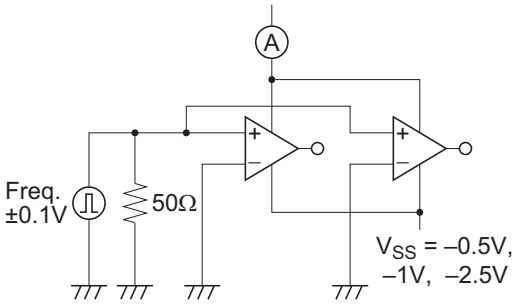
Only for Open Drain HA1631D03/04

14. Cross Talk



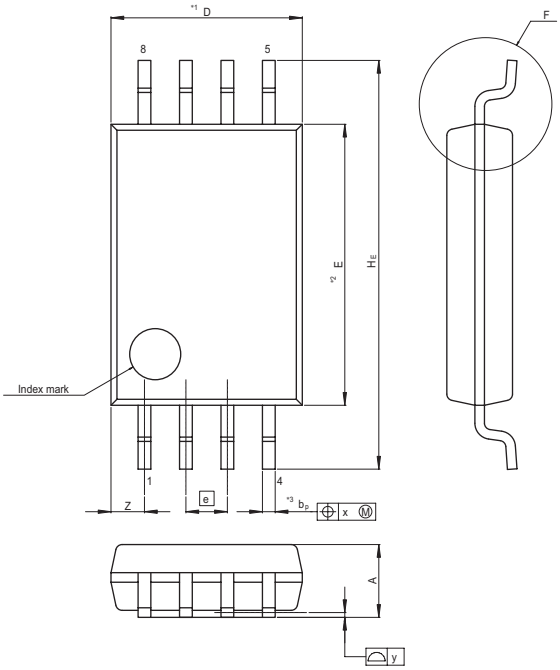
Note: $V_{IO} = V_{IN}'$

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

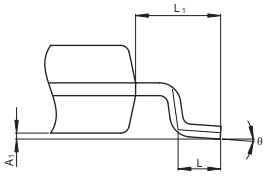


Package Dimensions

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



Terminal cross section
(Ni/Pd/Au plating)



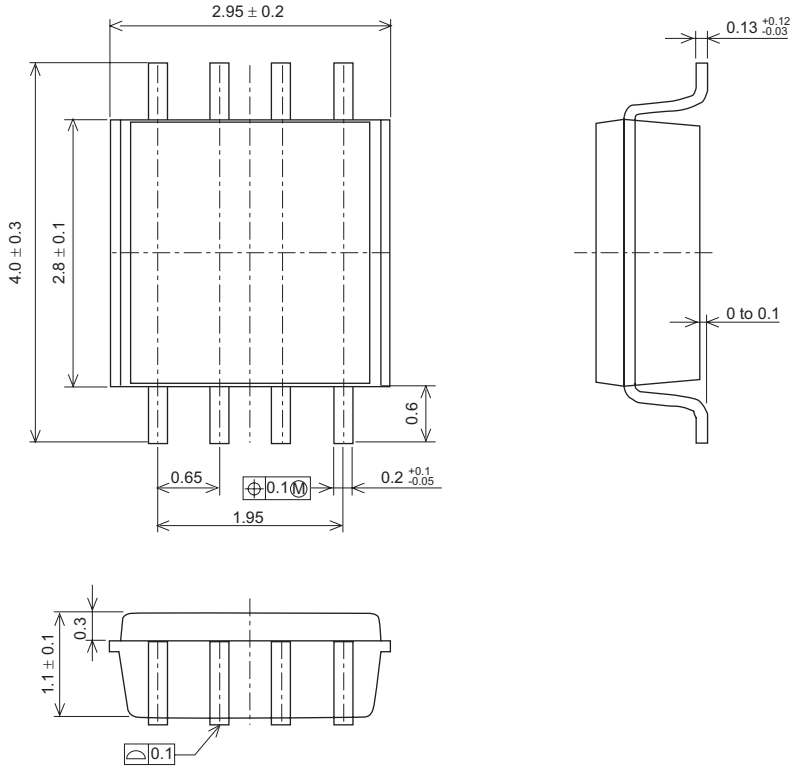
Detail F

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	—	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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April 1st, 2010
Renesas Electronics Corporation

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