

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 μ A/100 μ A. 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.

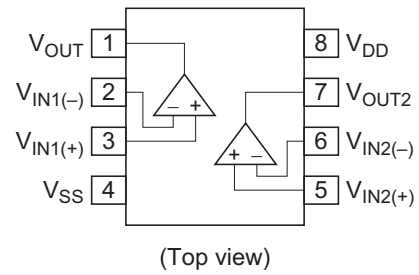
Features

- Low supply current
HA1631D01/03 : $I_{DDtyp} = 5 \mu A$ (per comparators)
HA1631D02/04 : $I_{DDtyp} = 50 \mu A$ (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

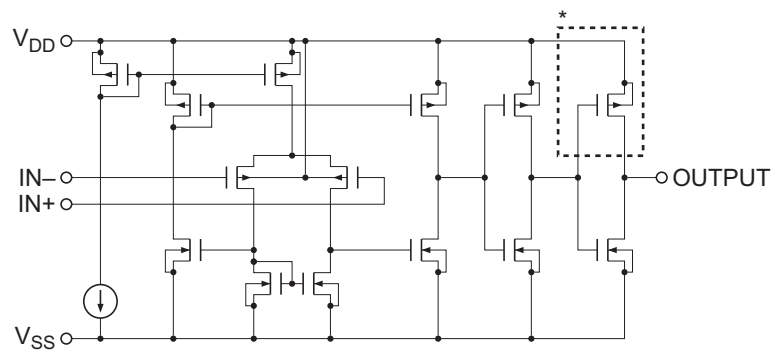
Ordering Information

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	T _{opr}	−40 to +85	°C	
Storage temperature	T _{stg}	−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	V _{out} = 2.5 V
Output sink current		I _{OSINK}	7	14	—	mA	V _{out} = 0.5 V
Common mode rejection ratio	HA1631D01/03	CMRR	60	80	—	dB	V _{IN1} = 0 V, V _{IN2} = 2 V
	HA1631D02/04		50	70	—	dB	
Power supply rejection ratio		PSRR	60	80	—	dB	V _{DD1} = 1.8 V, V _{DD2} = 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		V _{opr}	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($V_{DD} = 3\text{ V}$)	1-12	2-12	3-11	4-11	10
		vs. Input voltage($V_{DD} = 7\text{ V}$)	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, $V_{DD} = 3\text{ V}$, $V_{SS} = 0\text{ V}$, $T_a = 25^\circ\text{C}$)

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

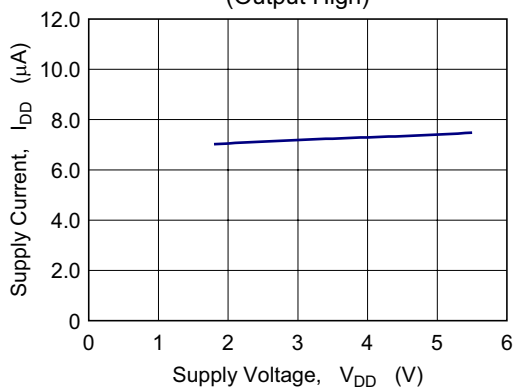


Figure 1-2 HA1631D01
Supply Current vs. Supply Voltage
(Output Low)

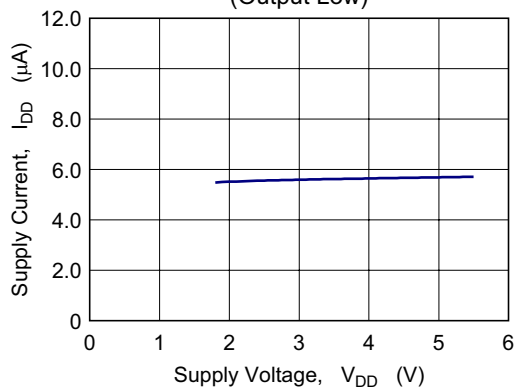


Figure 1-3 HA1631D01
Supply Current vs. Ambient Temperature

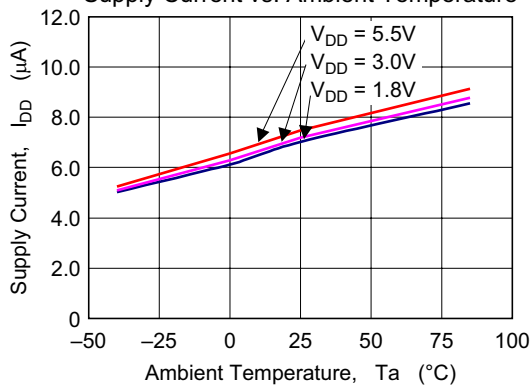


Figure 1-4 HA1631D01
Output High Voltage vs. Output Source Current

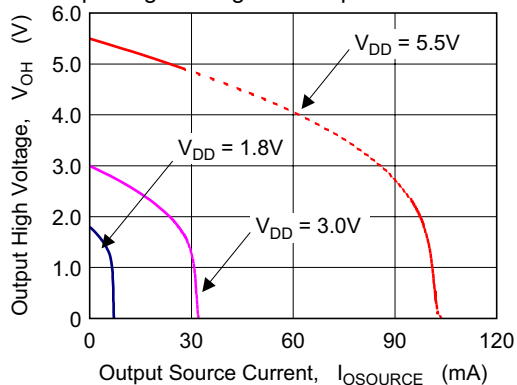


Figure 1-5 HA1631D01
Output Low Voltage vs. Output Sink Current

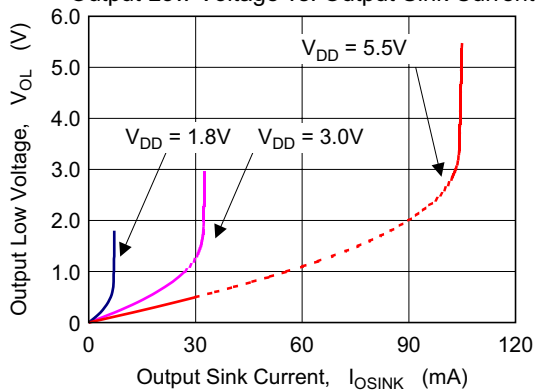
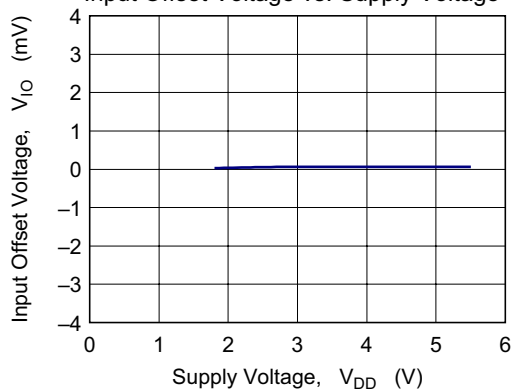
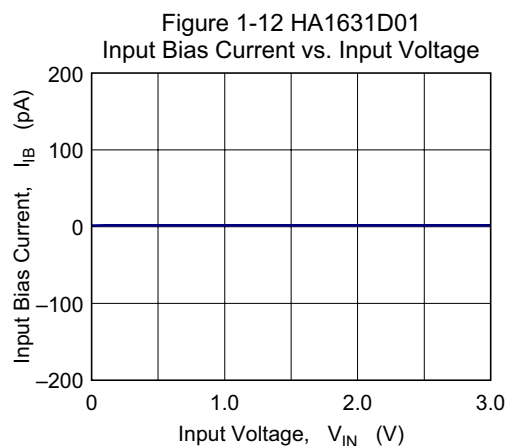
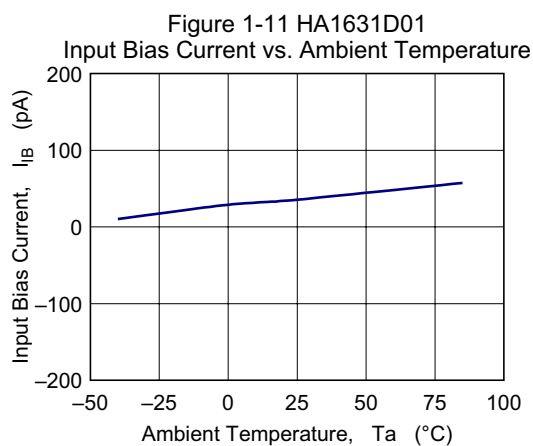
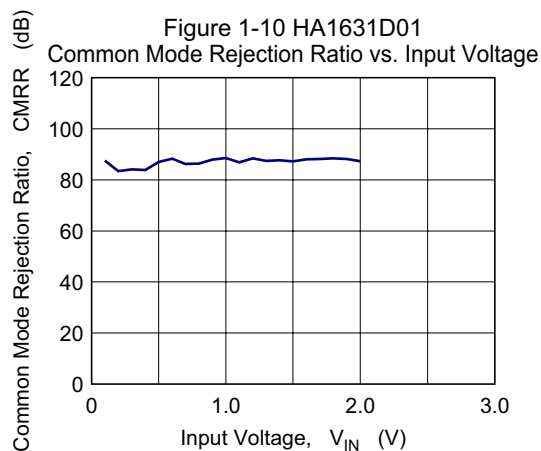
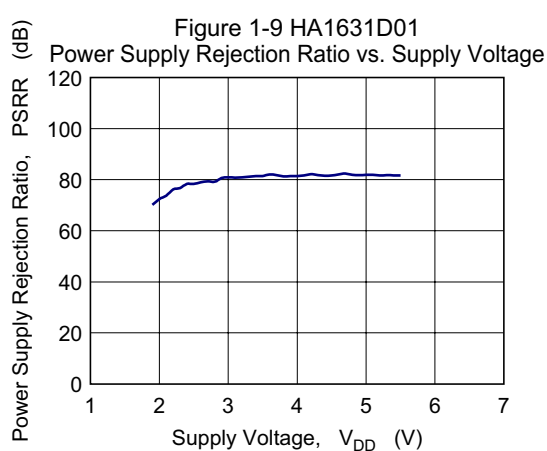
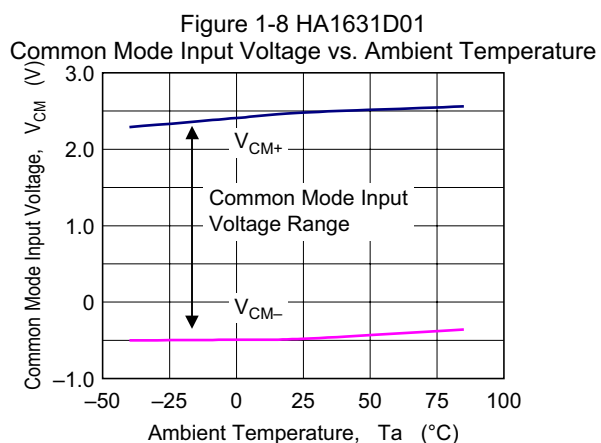
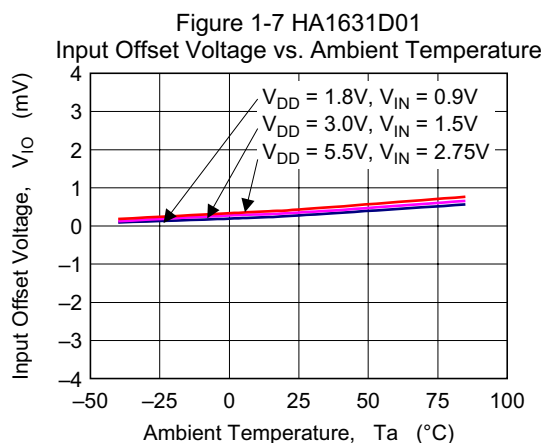
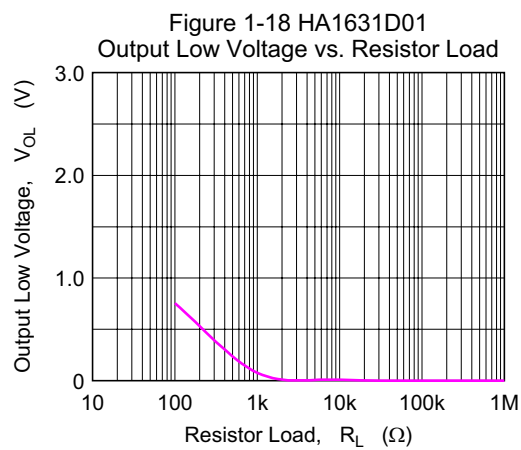
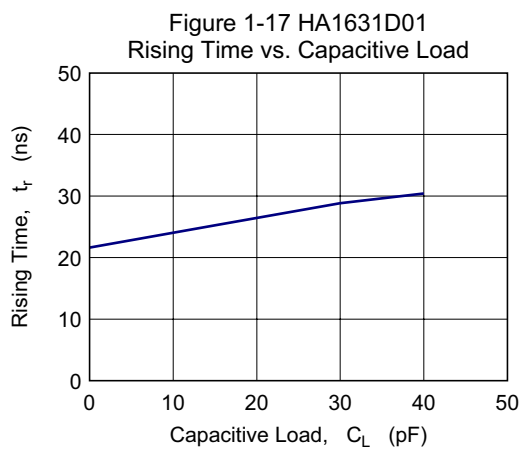
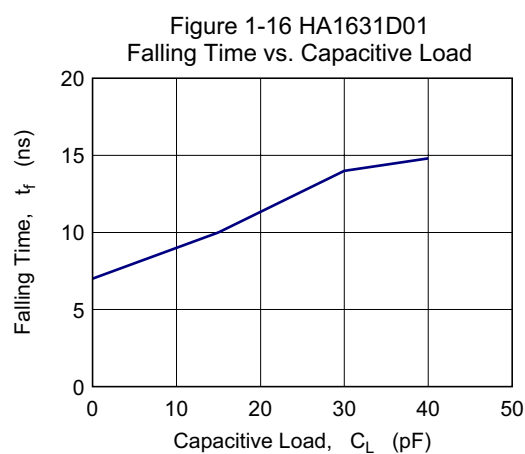
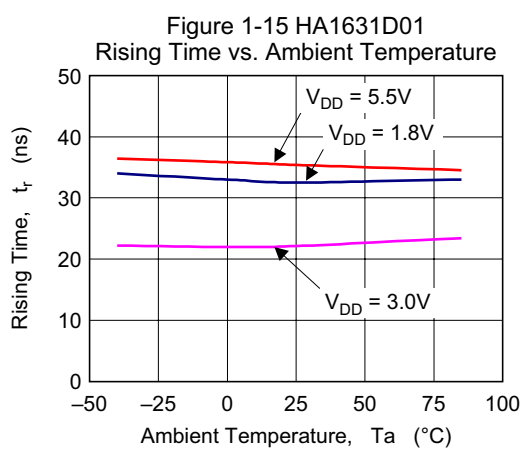
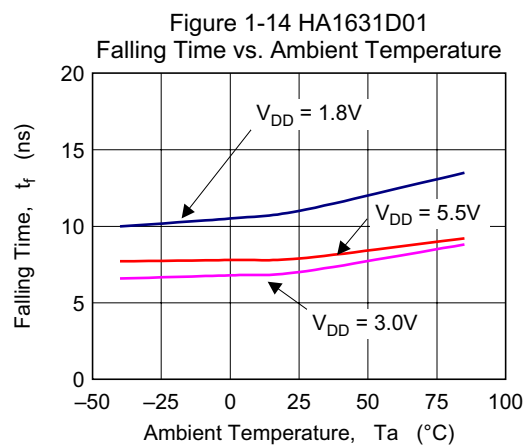
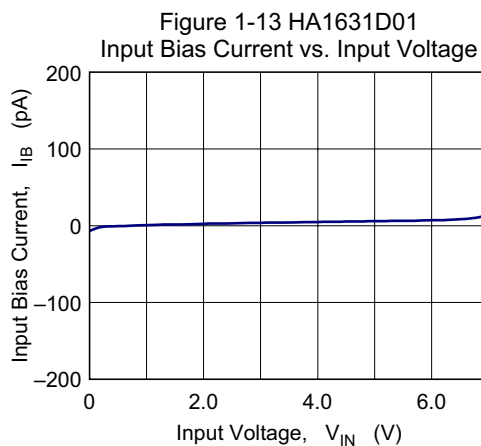
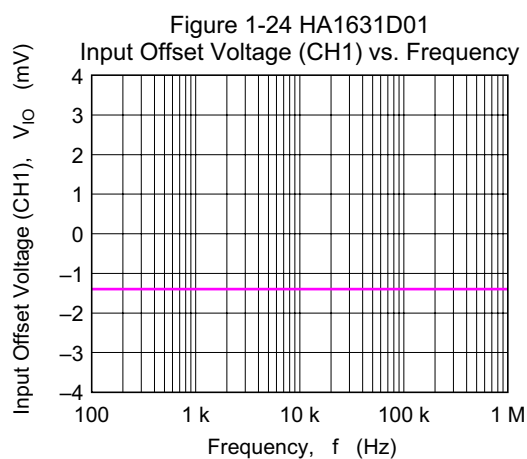
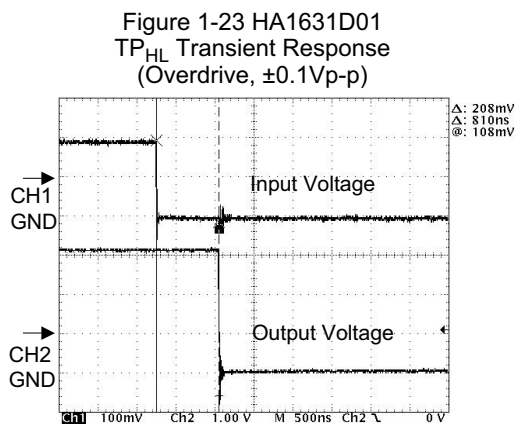
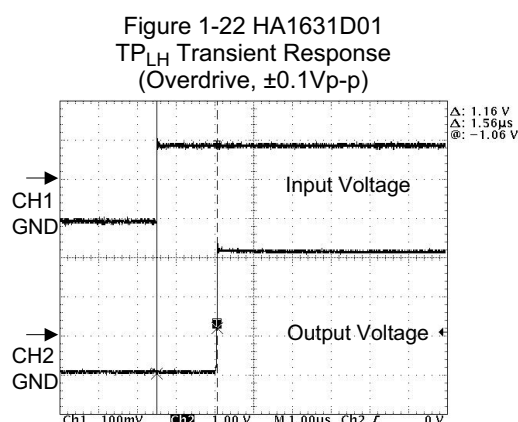
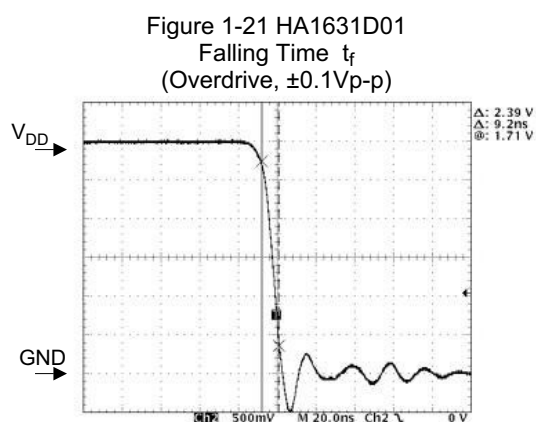
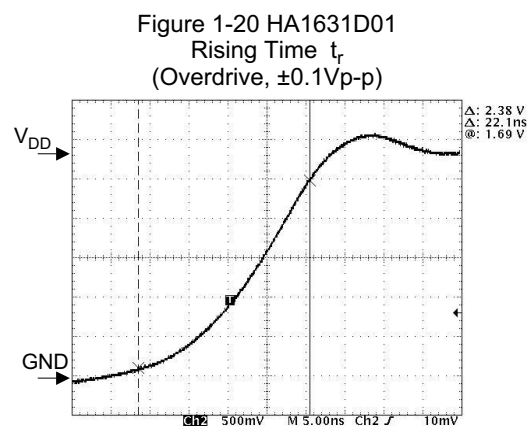
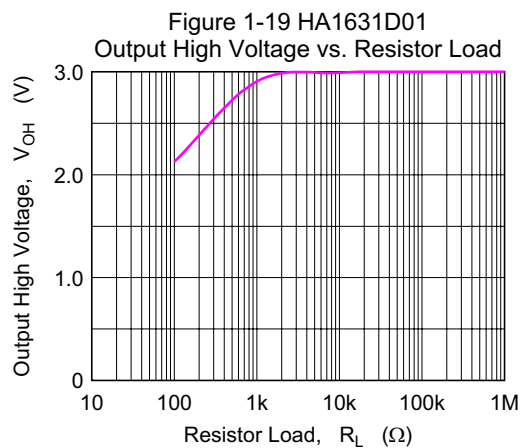


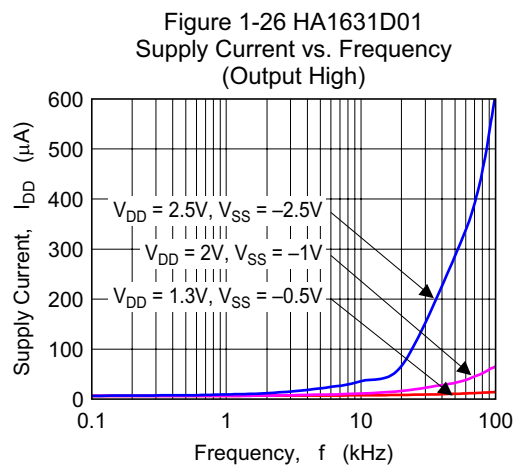
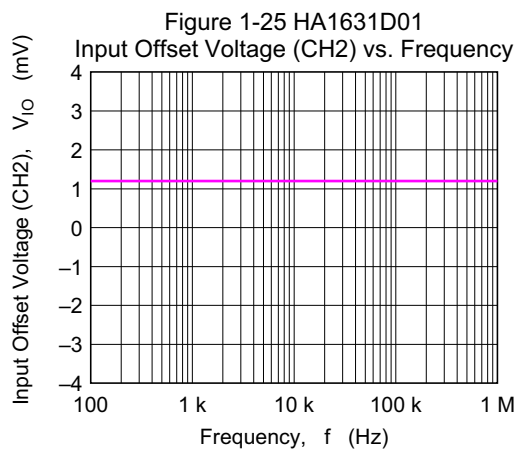
Figure 1-6 HA1631D01
Input Offset Voltage vs. Supply Voltage



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

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

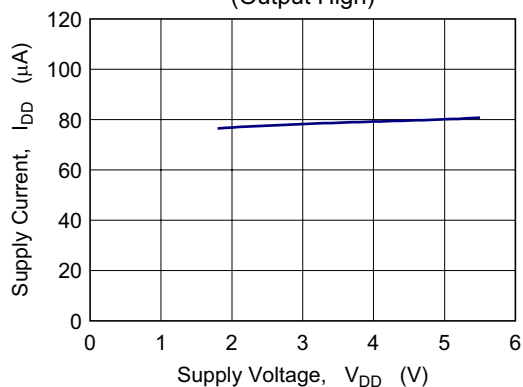


Figure 2-2 HA1631D02
Supply Current vs. Supply Voltage
(Output Low)

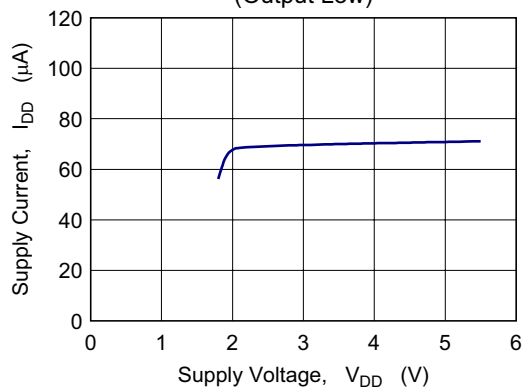


Figure 2-3 HA1631D02
Supply Current vs. Ambient Temperature

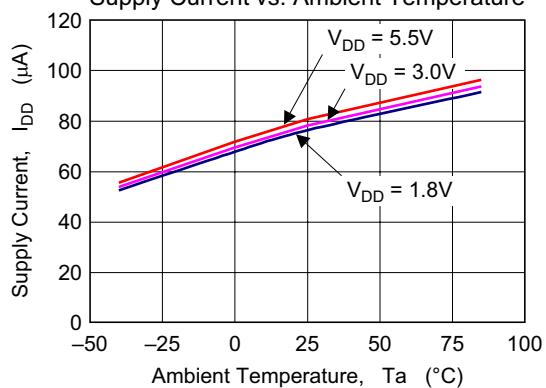


Figure 2-4 HA1631D02
Output High Voltage vs. Output Source Current

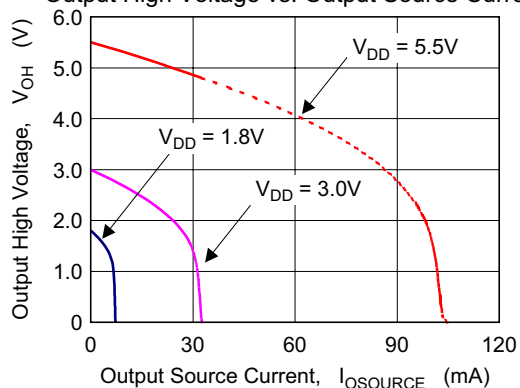


Figure 2-5 HA1631D02
Output Low Voltage vs. Output Sink Current

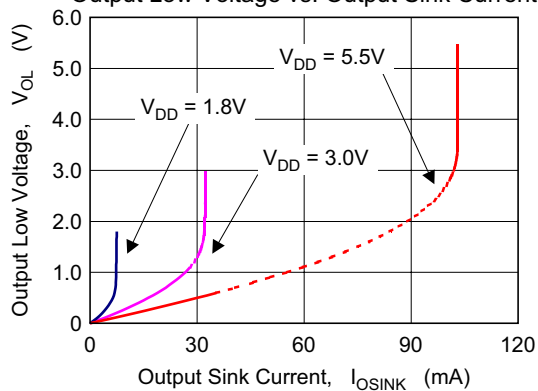
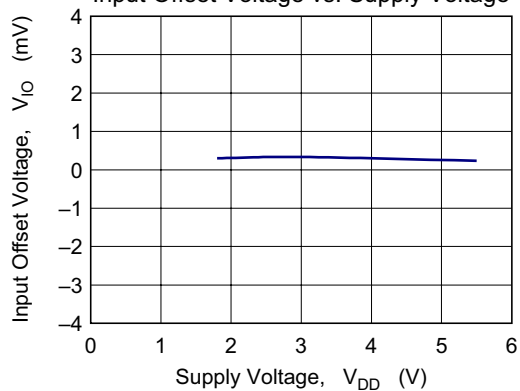
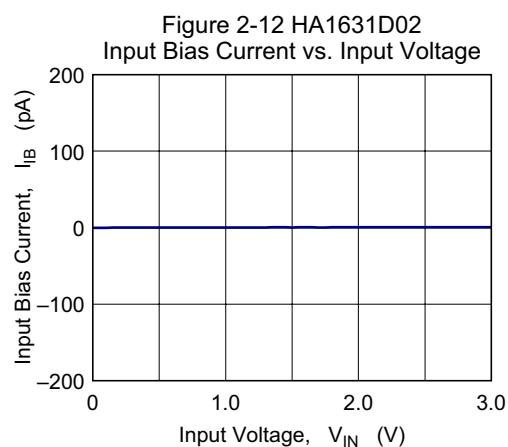
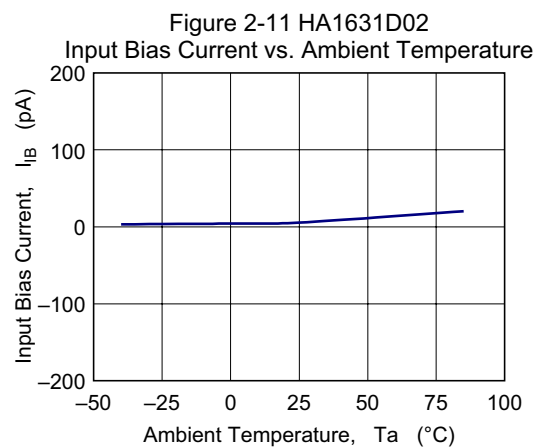
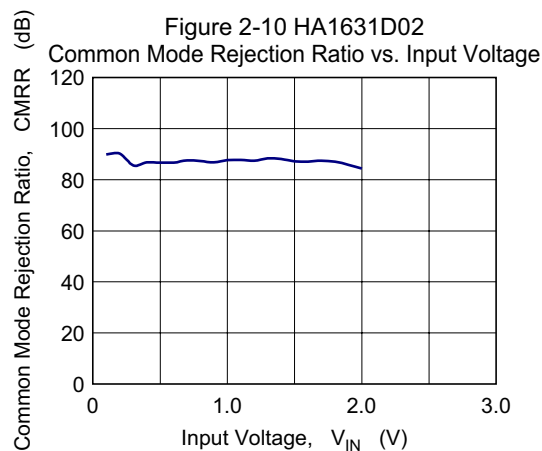
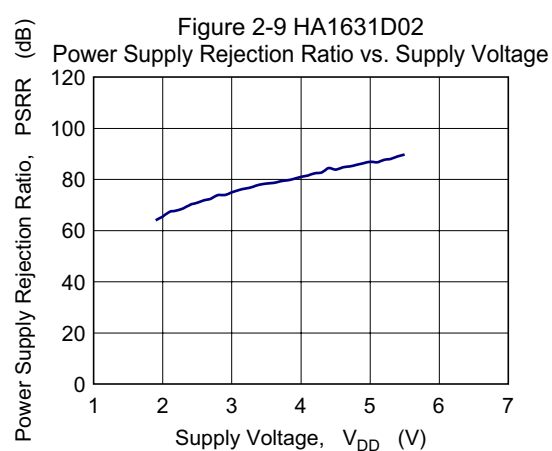
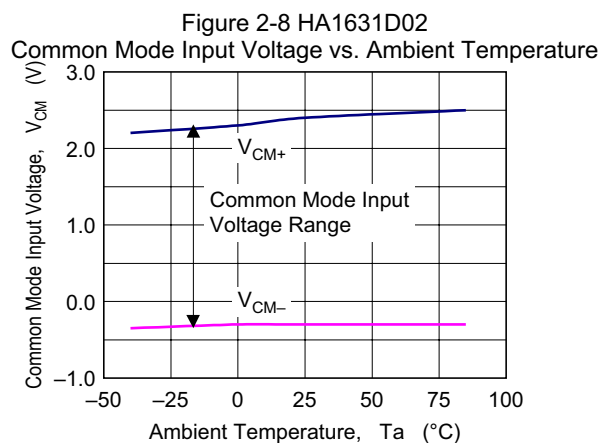
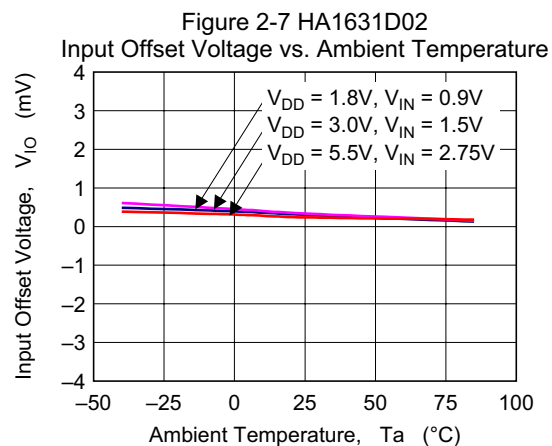
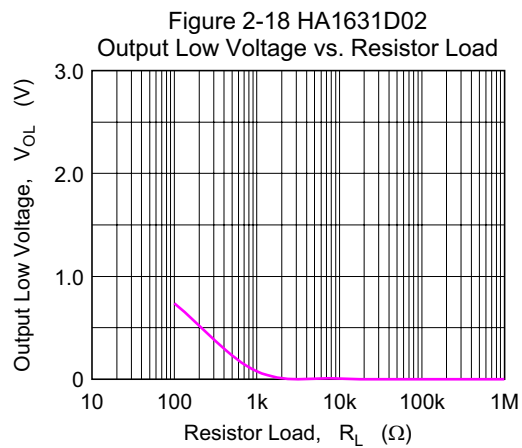
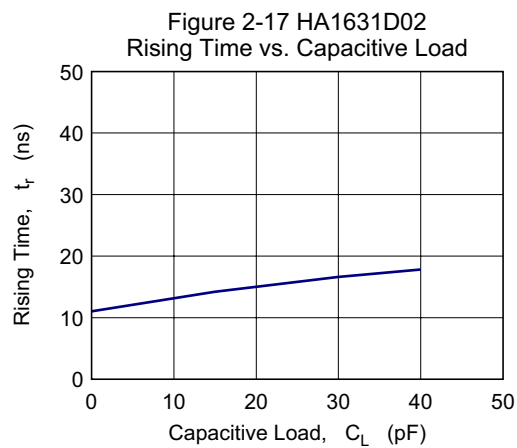
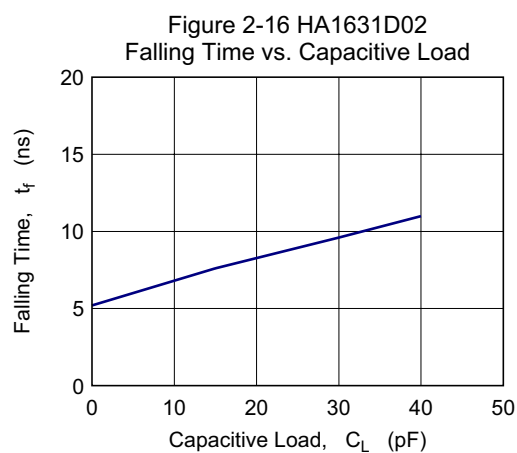
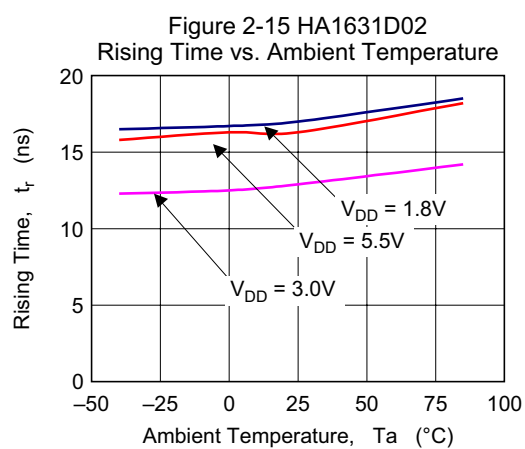
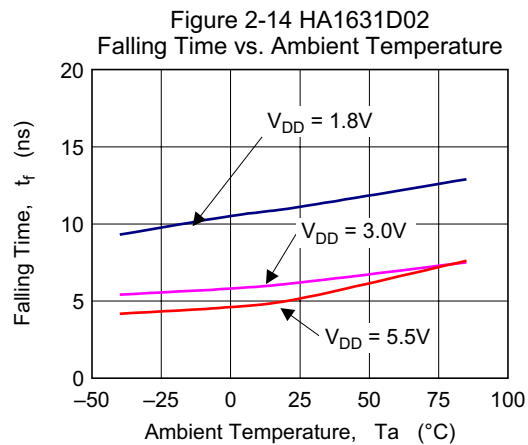
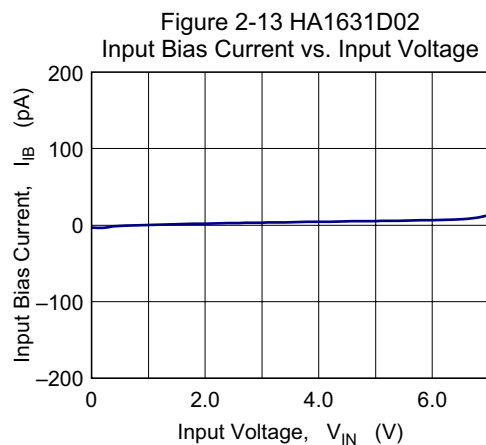
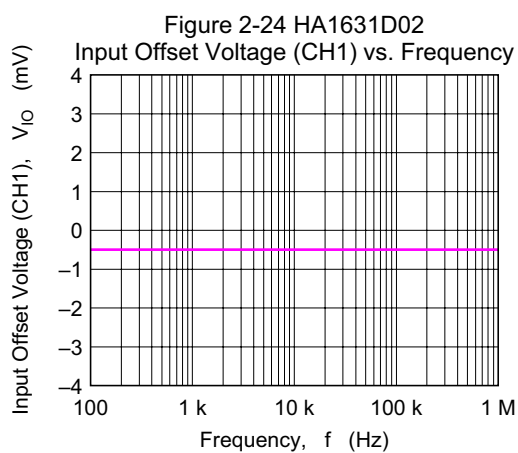
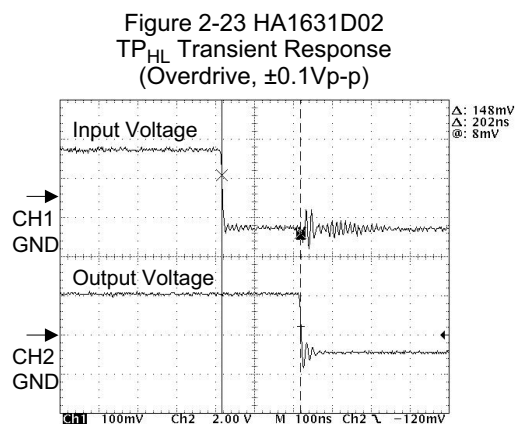
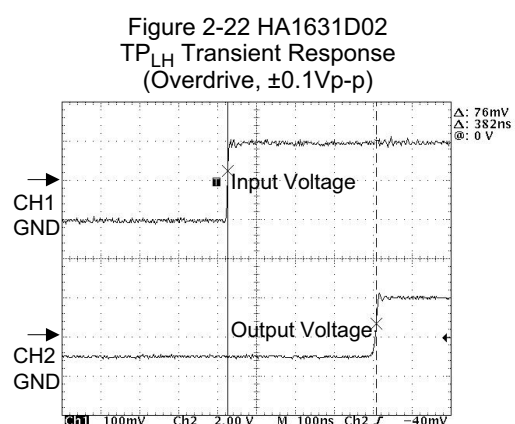
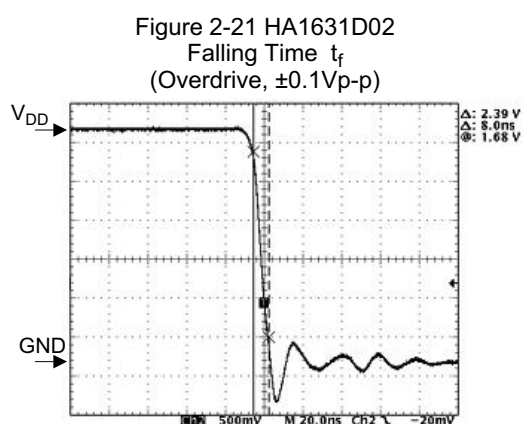
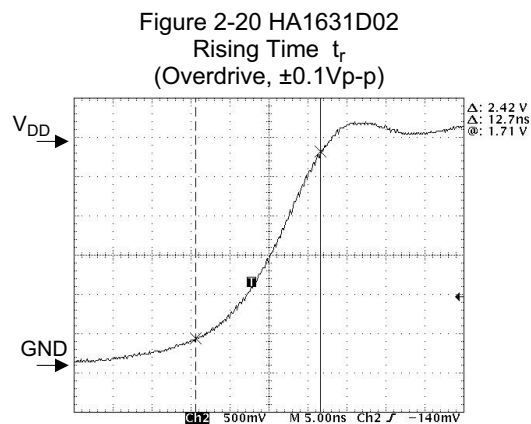
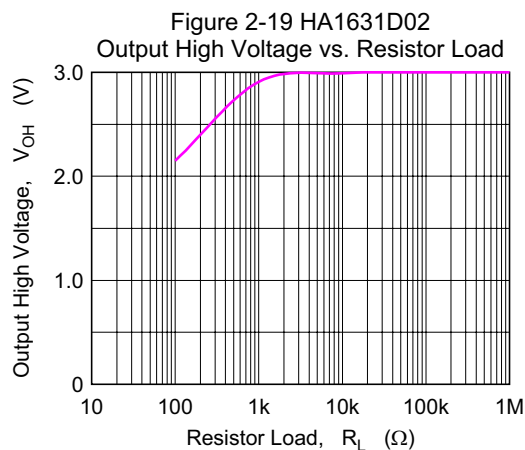


Figure 2-6 HA1631D02
Input Offset Voltage vs. Supply Voltage

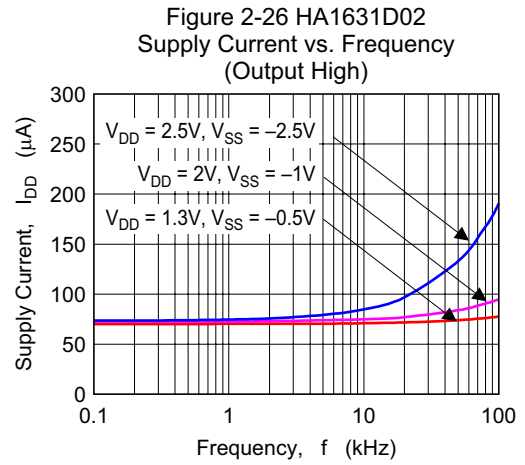
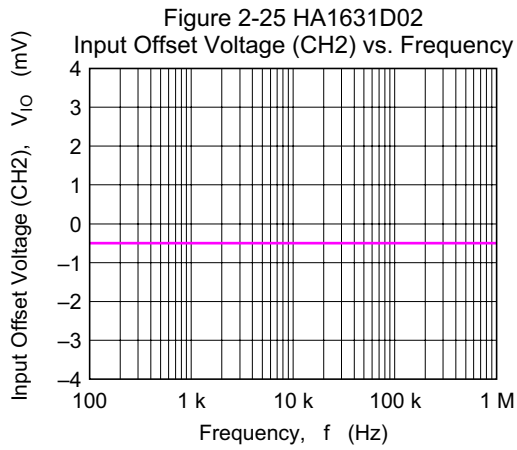


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Figure 3-1 HA1631D03
Supply Current vs. Supply Voltage
(Output High)

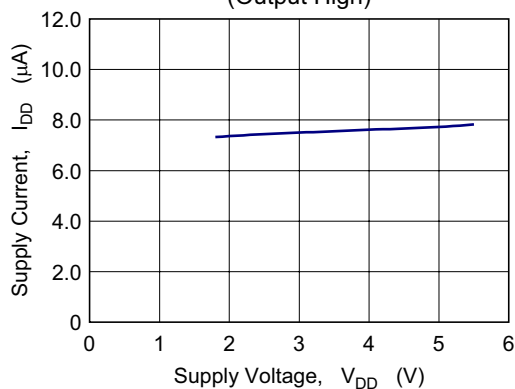


Figure 3-2 HA1631D03
Supply Current vs. Supply Voltage
(Output Low)

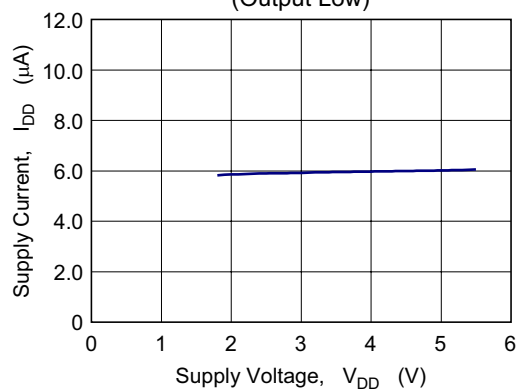


Figure 3-3 HA1631D03
Supply Current vs. Ambient Temperature

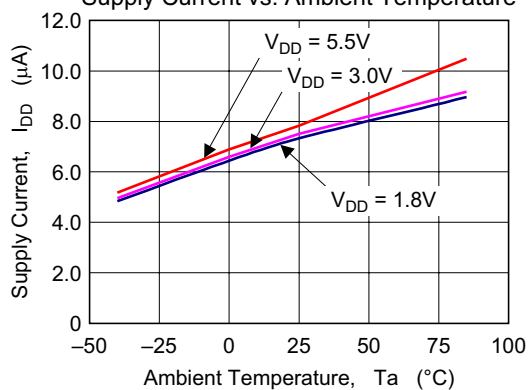


Figure 3-4 HA1631D03
Output Low Voltage vs. Output Sink Current

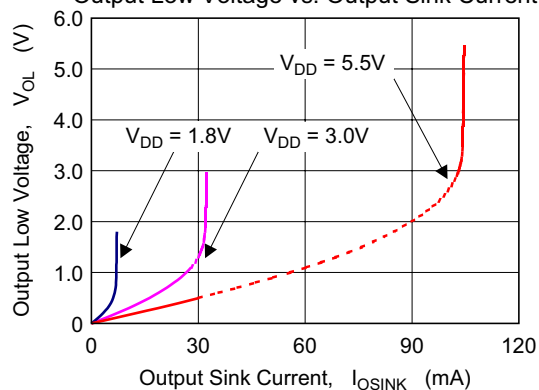


Figure 3-5 HA1631D03
Input Offset Voltage vs. Supply Voltage

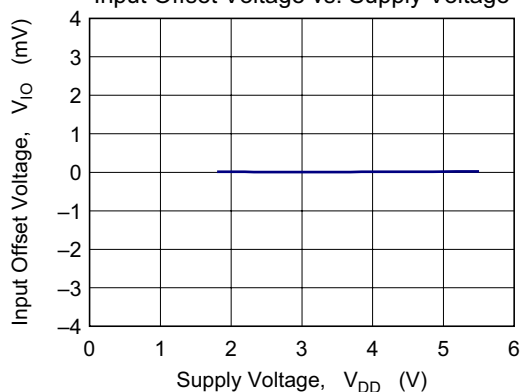
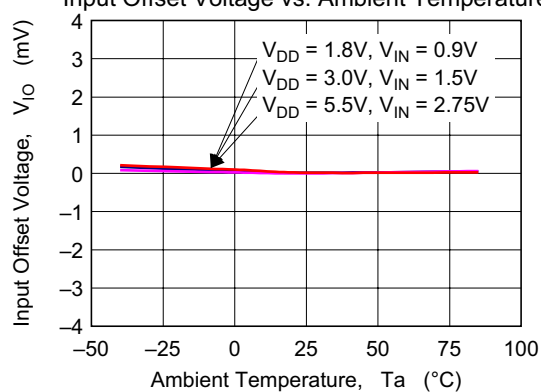


Figure 3-6 HA1631D03
Input Offset Voltage vs. Ambient Temperature



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

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

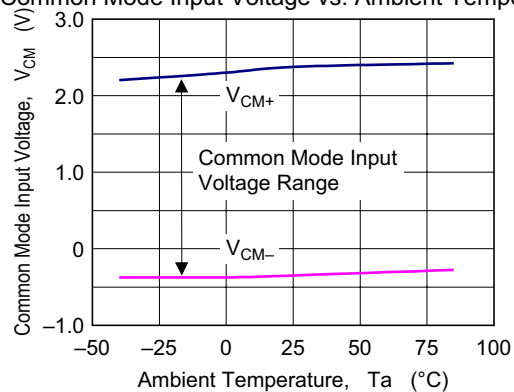


Figure 3-8 HA1631D03
Power Supply Rejection Ratio vs. Supply Voltage

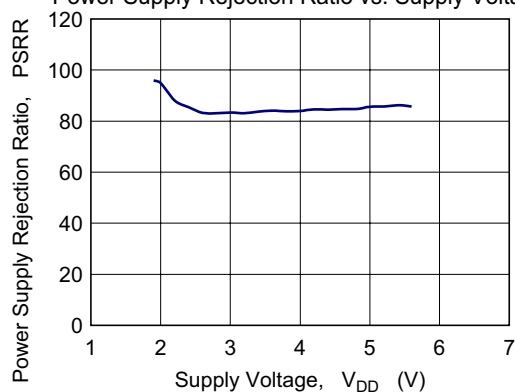


Figure 3-9 HA1631D03
Common Mode Rejection Ratio vs. Input Voltage

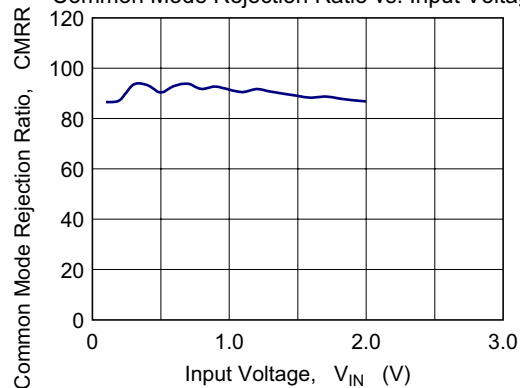


Figure 3-10 HA1631D03
Input Bias Current vs. Ambient Temperature

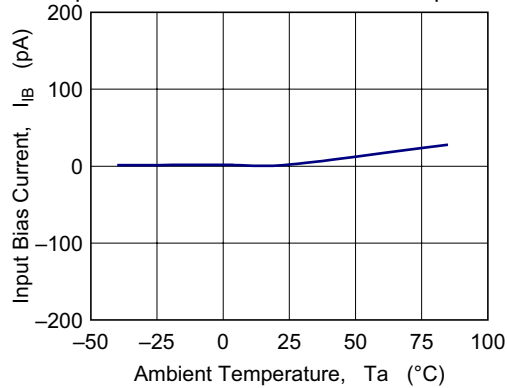


Figure 3-11 HA1631D03
Input Bias Current vs. Input Voltage

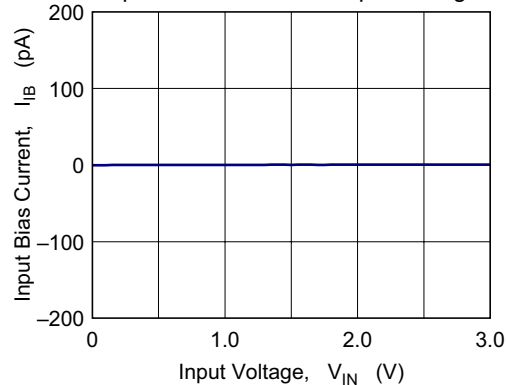
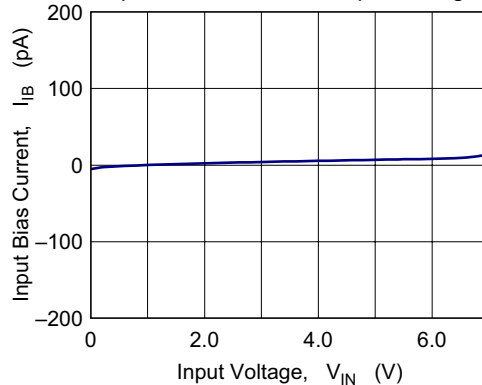
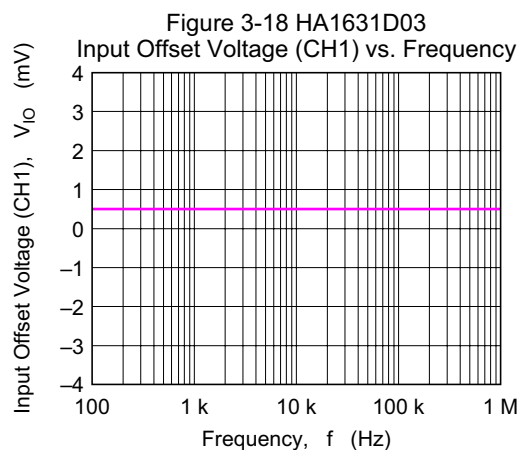
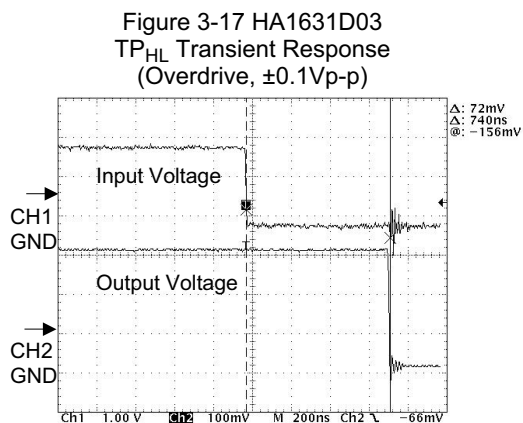
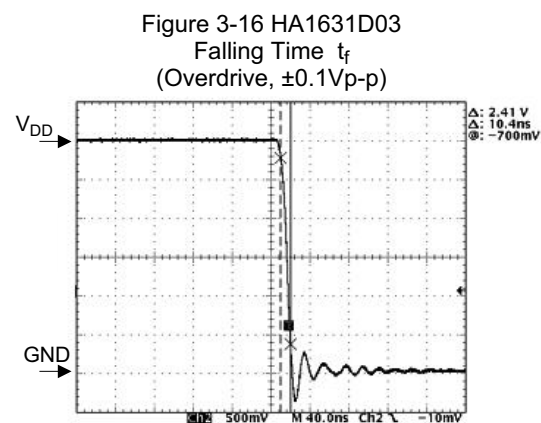
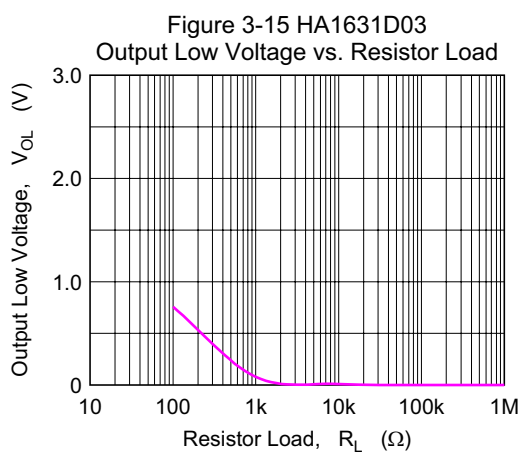
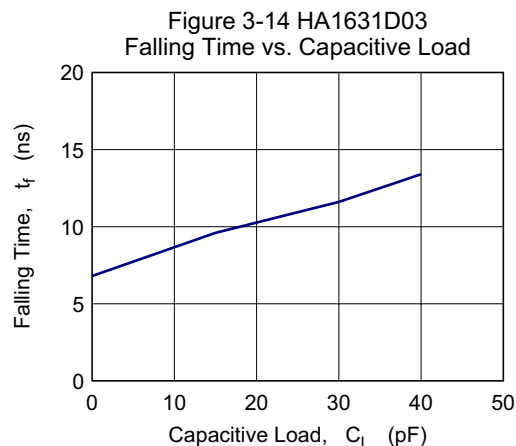
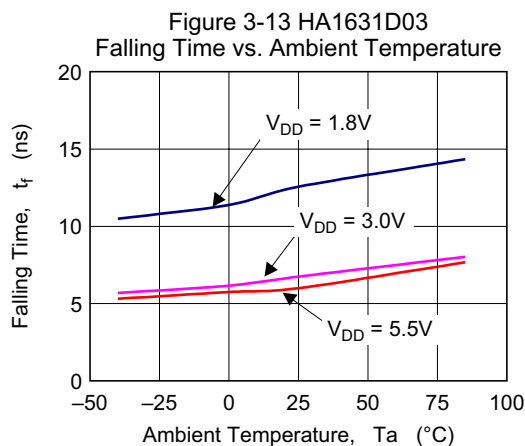
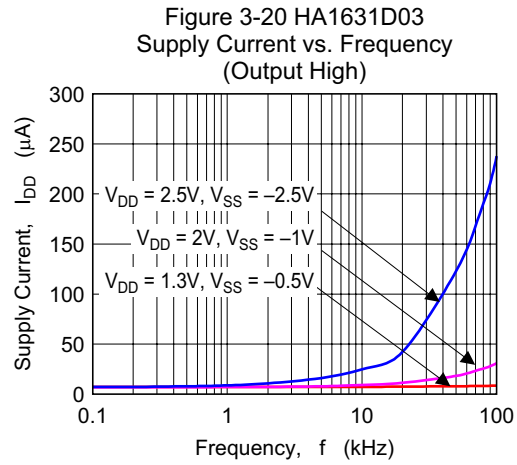
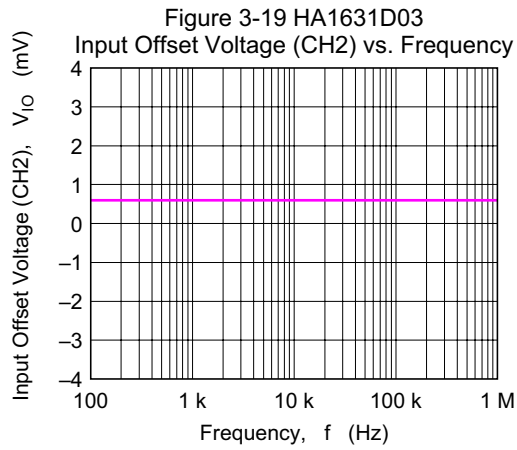


Figure 3-12 HA1631D03
Input Bias Current vs. Input Voltage



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

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



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

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

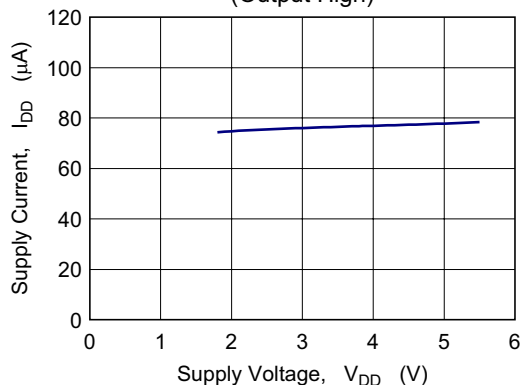


Figure 4-2 HA1631D04
Supply Current vs. Supply Voltage
(Output Low)

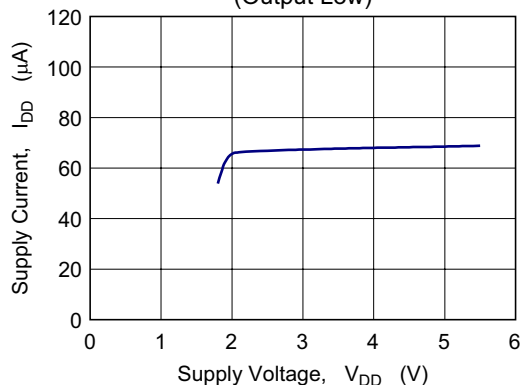


Figure 4-3 HA1631D04
Supply Current vs. Ambient Temperature

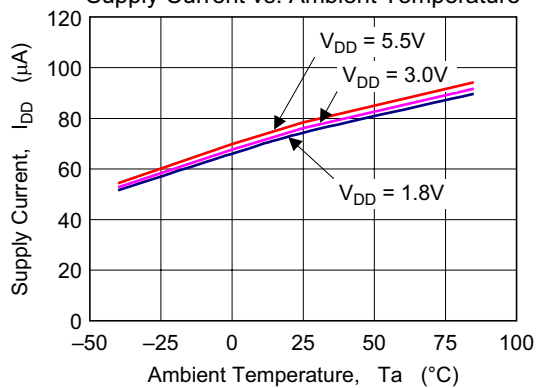


Figure 4-4 HA1631D04
Output Low Voltage vs. Output Sink Current

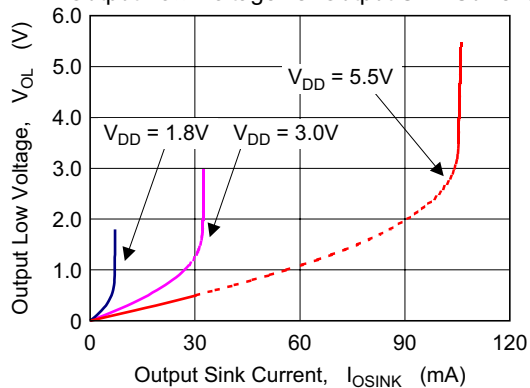


Figure 4-5 HA1631D04
Input Offset Voltage vs. Supply Voltage

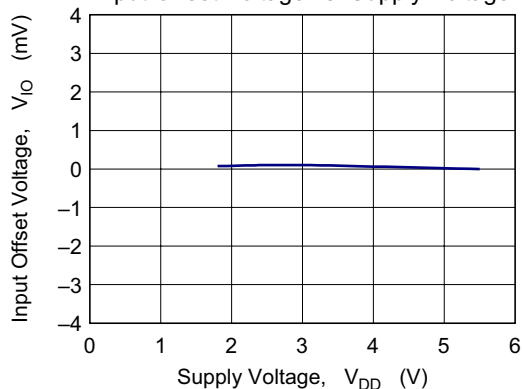
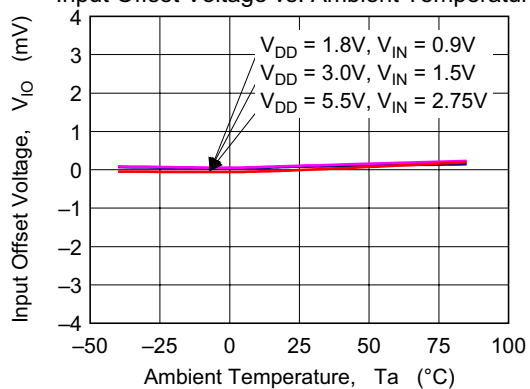


Figure 4-6 HA1631D04
Input Offset Voltage vs. Ambient Temperature



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

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

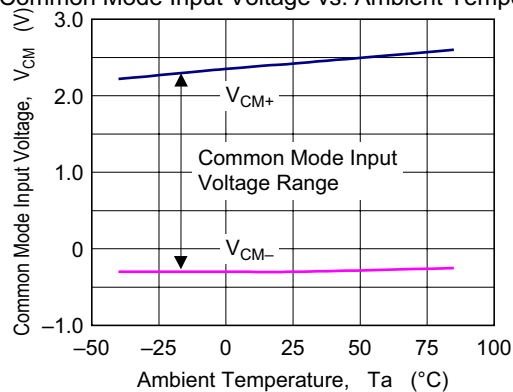


Figure 4-8 HA1631D04
Power Supply Rejection Ratio vs. Supply Voltage

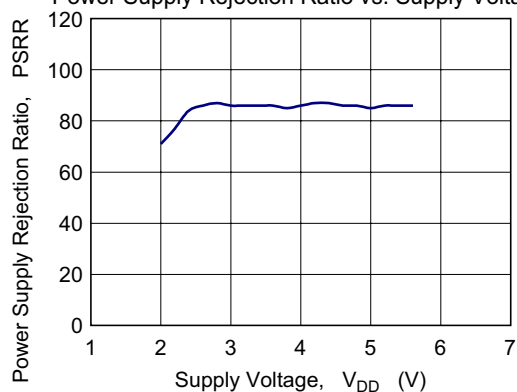


Figure 4-9 HA1631D04
Common Mode Rejection Ratio vs. Input Voltage

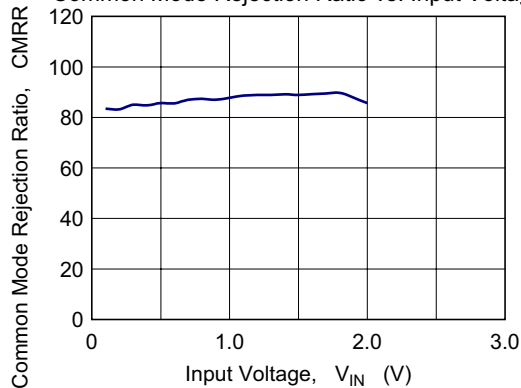


Figure 4-10 HA1631D04
Input Bias Current vs. Ambient Temperature

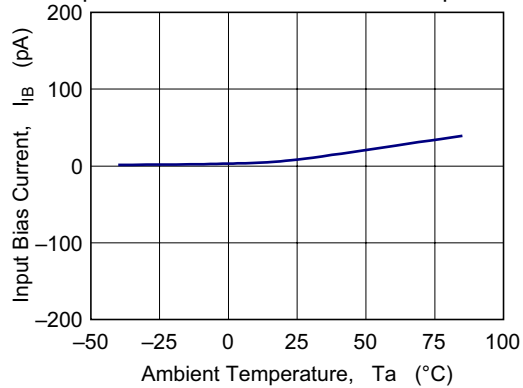


Figure 4-11 HA1631D04
Input Bias Current vs. Input Voltage

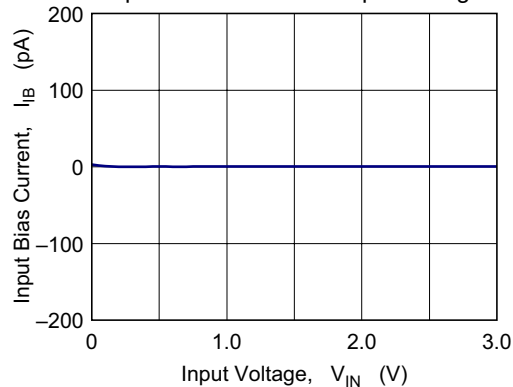
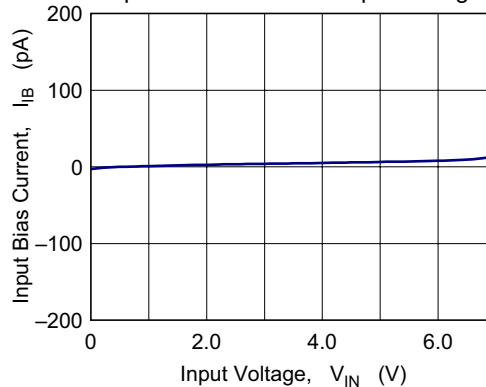
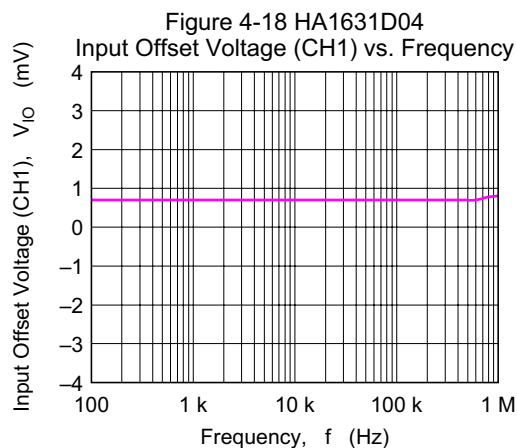
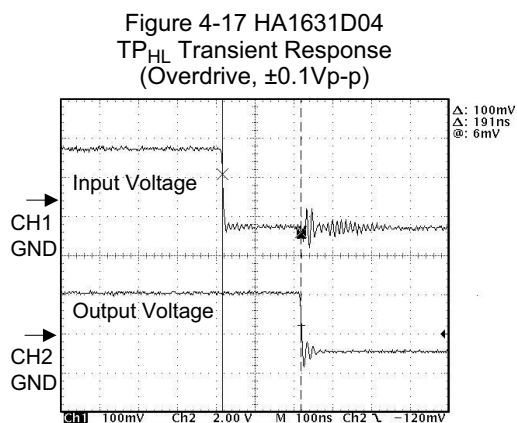
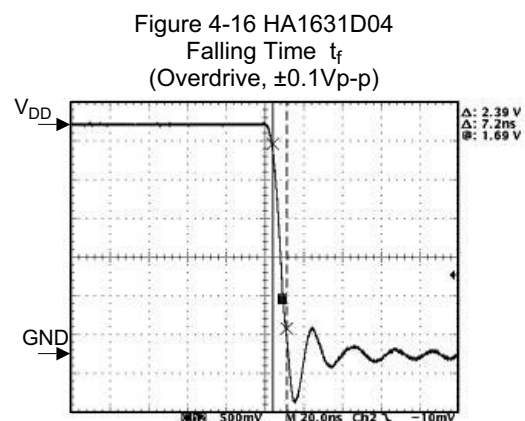
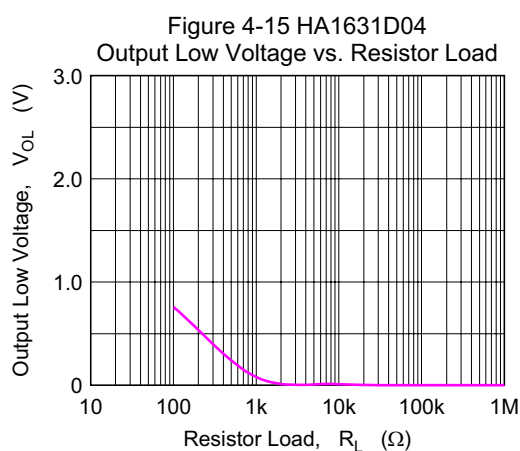
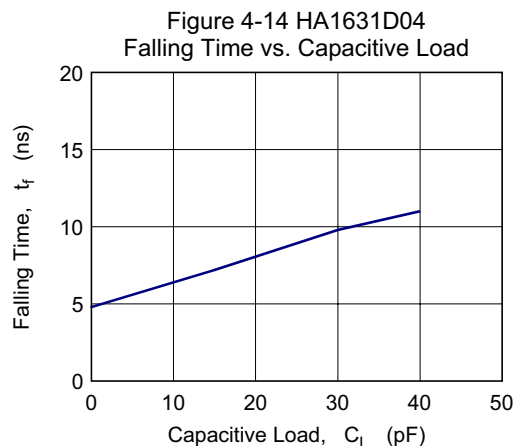
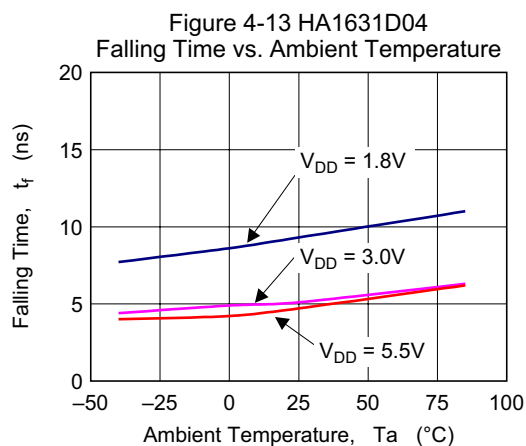
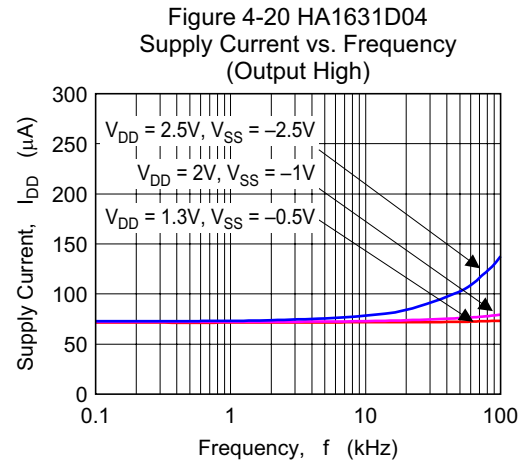
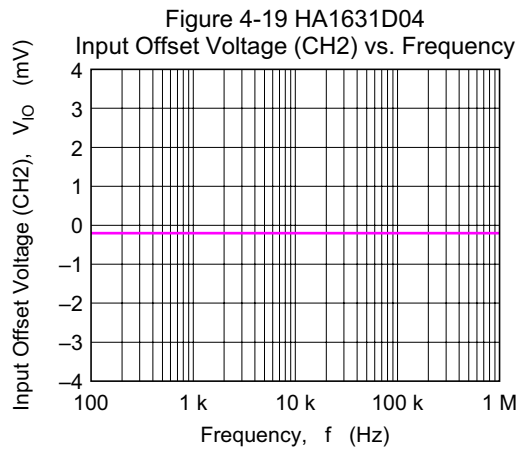


Figure 4-12 HA1631D04
Input Bias Current vs. Input Voltage

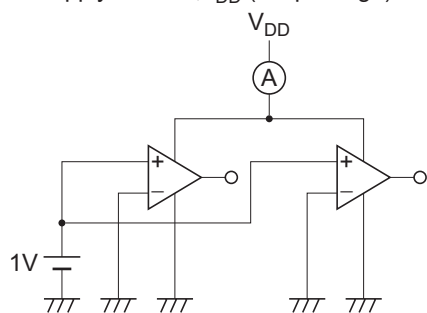
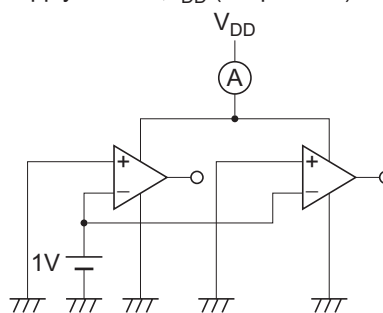
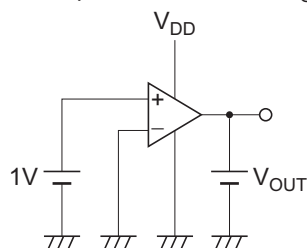
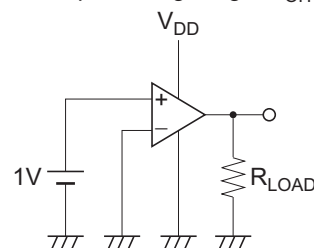
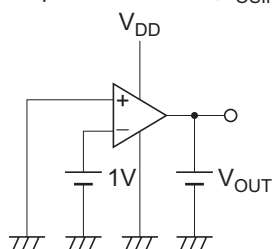
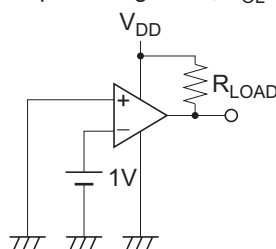
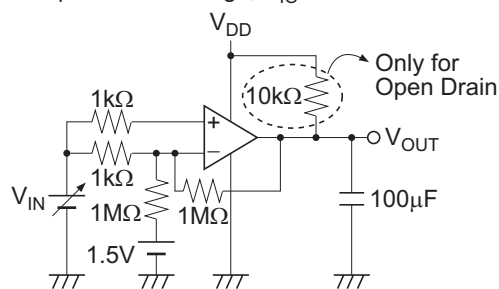


(unless otherwise noted, $V_{DD} = 3\text{ V}$, $V_{SS} = 0\text{ V}$, $T_a = 25^\circ\text{C}$)

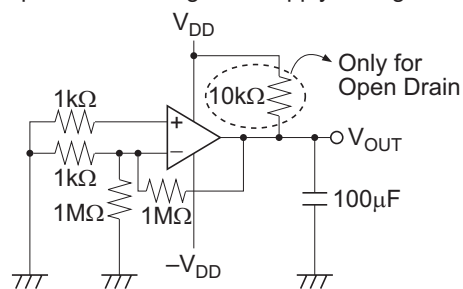
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Test Circuits

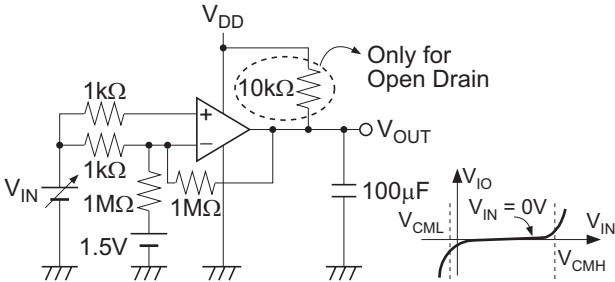
(unless otherwise noted, $V_{DD} = 3\text{ V}$, $V_{SS} = 0\text{ V}$, $T_a = 25^\circ\text{C}$)1. Supply Current, I_{DD} (Output High)2. Supply Current, I_{DD} (Output Low)3. Output Source Current, $I_{OSOURCE}$ 4. Output Voltage High, V_{OH} 5. Output Sink Current, I_{OSINK} 6. Output Voltage Low, V_{OL} 7. Input Offset Voltage, V_{IO} Note: $V_{IO} = V_{OUT} - 1.5\text{ V}$

8. Input Offset Voltage vs. Supply Voltage



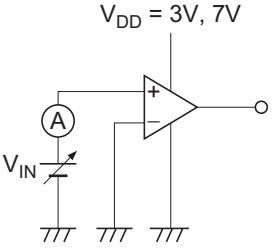
(unless otherwise noted, $V_{DD} = 3\text{ V}$, $V_{SS} = 0\text{ V}$, $T_a = 25^\circ\text{C}$)

9. Common Mode Input Voltage, V_{CM}

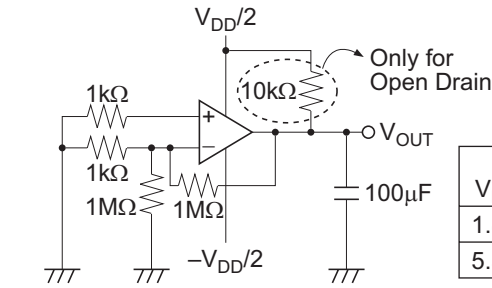


Note: V_{CML} and V_{CMH} are values of V_{IN} when V_{IO} changes more than 50dB taking $V_{IN} = 0\text{ V}$ as reference.

10. Input Bias Current, I_{IB}

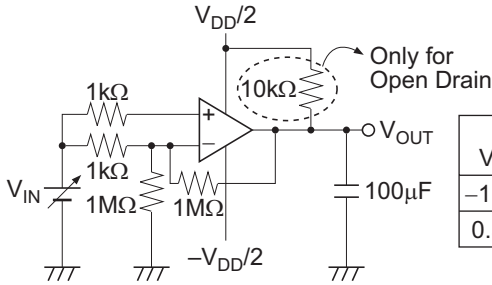


11. Power Supply Rejection Ratio, PSRR

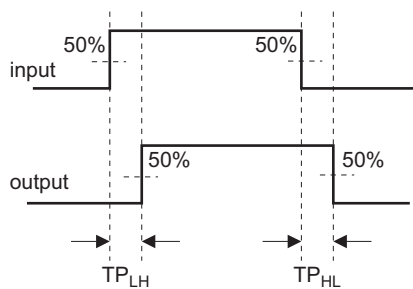
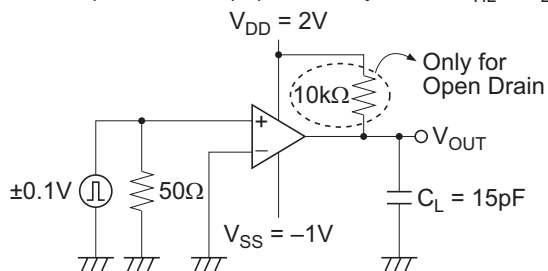


V_{DD}	Measure Point	Calculate V_{IO}	PSRR Calculation
1.8V	V_{OUT1}	$V_{IO1} = V_{OUT1}/1000$	$PSRR = \left 20 \log \frac{ (V_{IO2} - V_{IO1}) }{5.5\text{V} - 1.8\text{V}} \right $
5.5V	V_{OUT2}	$V_{IO2} = V_{OUT2}/1000$	

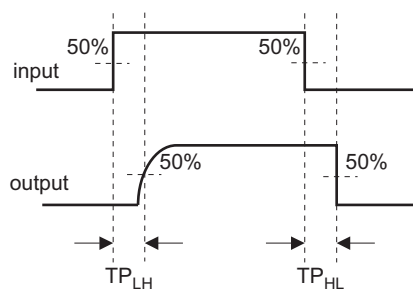
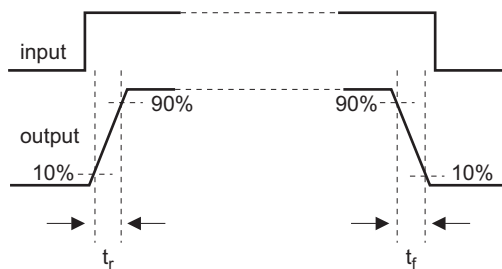
12. Common Mode Rejection Ratio, CMRR



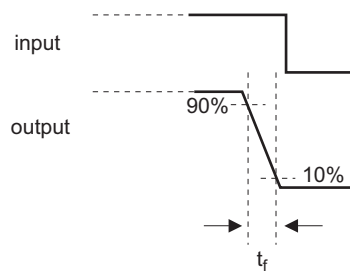
V_{IN}	Measure Point	Calculate V_{IO}	CMRR Calculation
-1.5V	V_{OUT1}	$V_{IO1} = V_{OUT1}/1000$	$CMRR = \left 20 \log \frac{ (V_{IO2} - V_{IO1}) }{0.5\text{V} - (-1.5\text{V})} \right $
0.5V	V_{OUT2}	$V_{IO2} = V_{OUT2}/1000$	

(unless otherwise noted, $V_{DD} = 3\text{ V}$, $V_{SS} = 0\text{ V}$, $T_a = 25^\circ\text{C}$)13. Response Time t_r , t_f and Delay Time TP_{HL} , TP_{LH} 

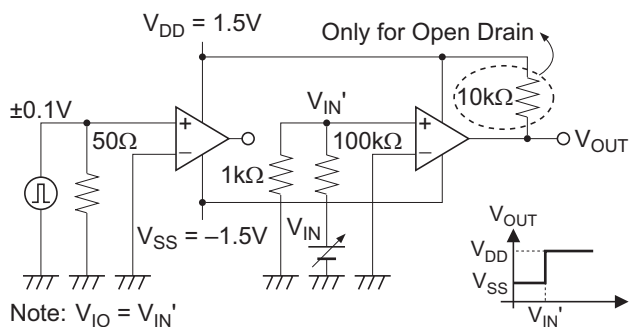
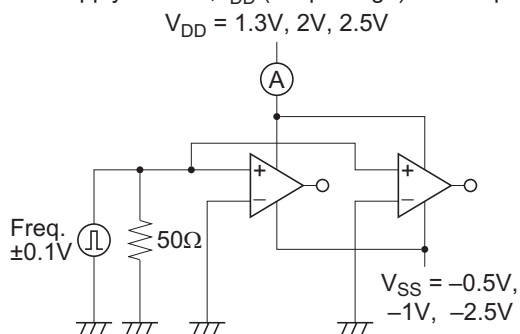
Only for Push Pull HA1631D01/02



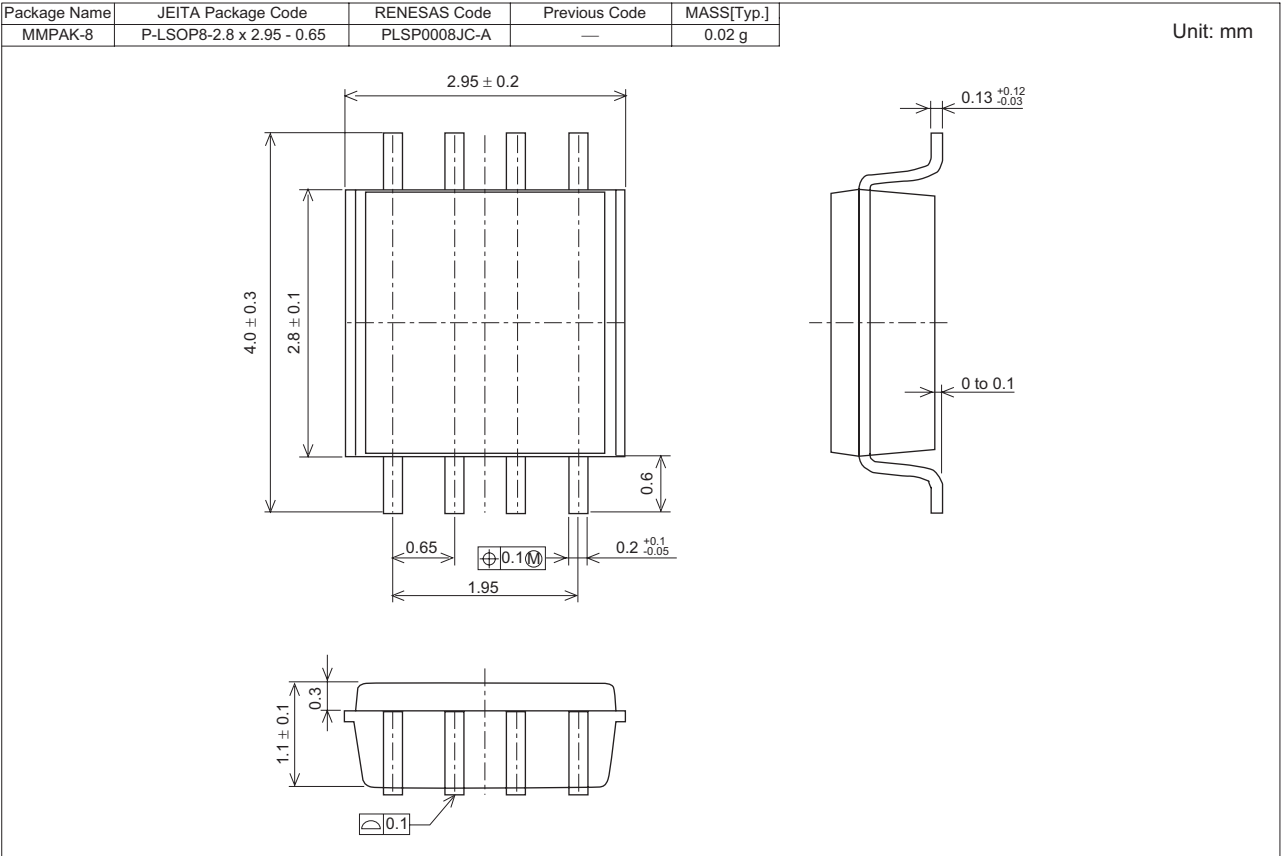
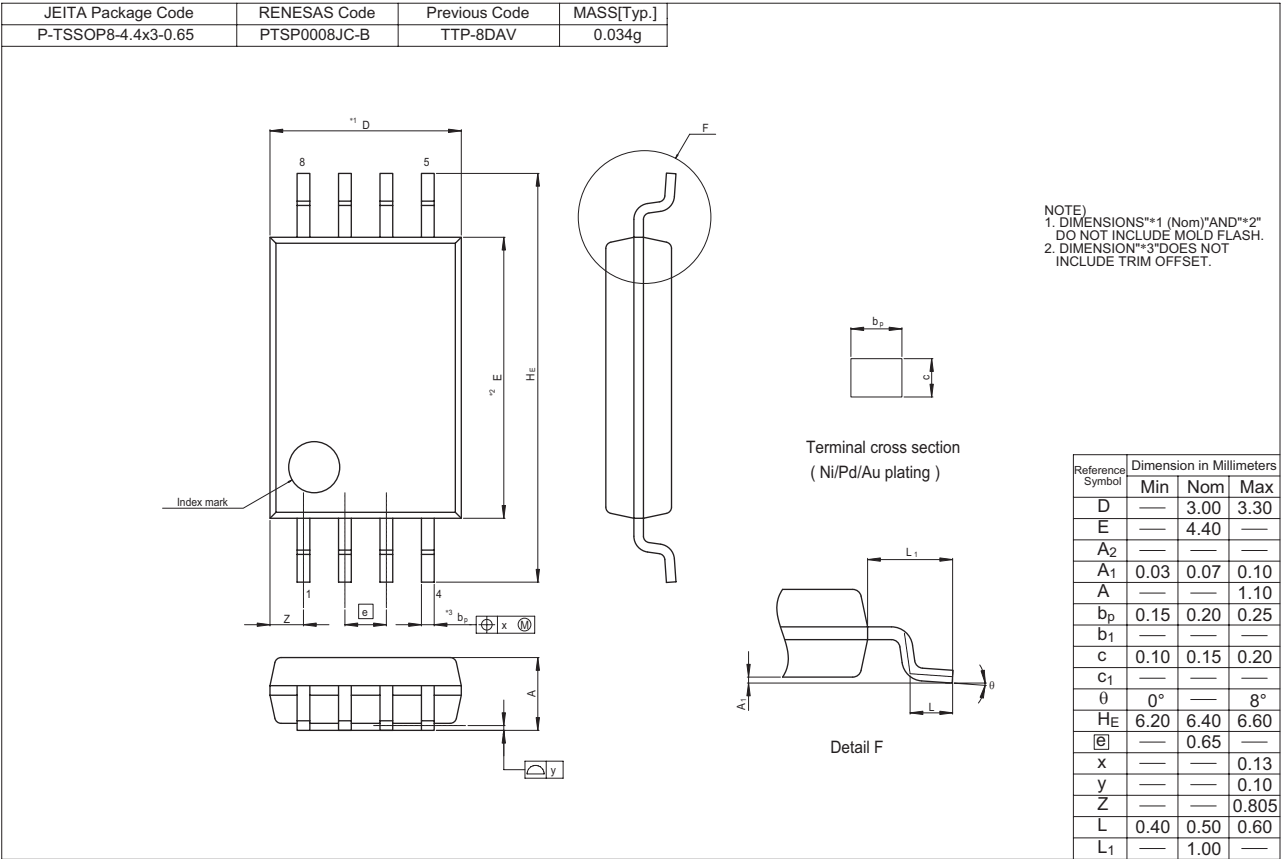
Only for Open Drain HA1631D03/04



14. Cross Talk

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

Package Dimensions



Notes:

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