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April 1st, 2010
Renesas Electronics Corporation

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HA1631S01/02/03/04 Series

Single CMOS Comparator (Push Pull/Open Drain Output)

REJ03D0056-0200
Rev.2.00
Mar 10, 2006

Description

The HA1631S01/02/03/04 are low power single CMOS Comparator featuring low voltage operation with typical current supply of 5 µA/50 µA. They are designed to operate from a single power supply. HA1631S01/02 have push-pull full swing outputs that allow direct connections to logic devices. The Open Drain version HA1631S03/04 enable Output Level shifting through external pull up resistors. Available in an ultra-small CMPAK-5 package, they occupy only 1/8 the area of the SOP-8 package.

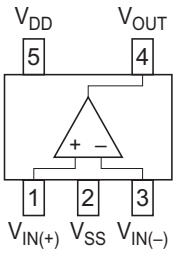
Features

- Low supply current
  HA1631S01/03 : I_{DDtyp} = 5 µA (V_{DD} = 3.0 V)
  HA1631S02/04 : I_{DDtyp} = 50 µA (V_{DD} = 3.0 V)
- 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 CMPAK-5 and MPAK-5 package using Pb free lead frame

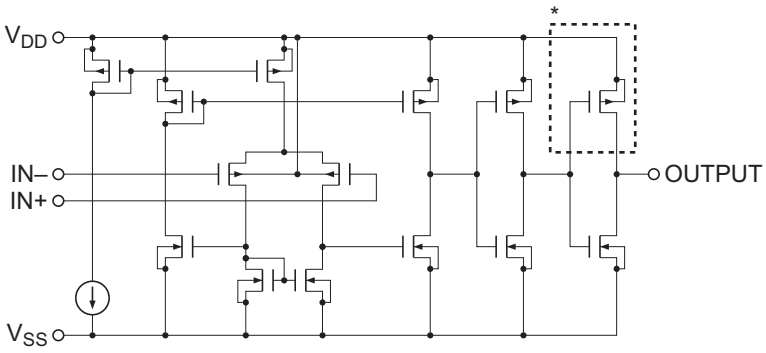
Ordering Information

Type No.	Package Name	Package Code
HA1631S01CM	CMPAK-5	PTSP0005ZC-A
HA1631S02CM		
HA1631S03CM		
HA1631S04CM		
HA1631S01LP	MPAK-5	PLSP0005ZB-A
HA1631S02LP		
HA1631S03LP		
HA1631S04LP		

Pin Arrangement



Equivalent Circuit



* Not available in Open Drain version (HA1631S03/04)

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	80/120	mW	CMPAK-5/MPAK-5
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 = 1MΩ
Input bias current		I_{IB}	—	(1)	100	pA	$V_{IN} = V_{DD}/2$
Input offset current		I_{IO}	—	(1)	100	pA	$V_{IN} = V_{DD}/2$
Common mode input voltage range		V_{CM}	–0.1	—	2.1	V	
Supply current	HA1631S01/03	I_{DD}	—	5	10	µA	V_{DD} = 3V, V_{IN}+ = 1V, V_{IN}– = 0V
	HA1631S02/04		—	50	100	µA	
Response time	HA1631S01	TP_{LH}	—	(1.20)	—	µs	1V DC bias, 100mV overdrive, C_L = 15pF
	HA1631S01/03	TP_{HL}	—	(0.55)	—	µs	
	HA1631S01	t_r	—	(24)	—	ns	
	HA1631S01/03	t_f	—	(7)	—	ns	
	HA1631S02	TP_{LH}	—	(0.33)	—	µs	
	HA1631S02/04	TP_{HL}	—	(0.17)	—	µs	
	HA1631S02	t_r	—	(12)	—	ns	
	HA1631S02/04	t_f	—	(7)	—	ns	
Output source current (HA1631S01/02)		$I_{OSOURCE}$	6	13	—	mA	Vout = 2.5V
Output sink current		I_{OSINK}	7	14	—	mA	Vout = 0.5V
Common mode rejection ratio	HA1631S01/03	CMRR	60	80	—	dB	V_{IN}1 = 0V, V_{IN}2 = 2V
	HA1631S02/04		50	70	—	dB	
Power supply rejection ratio		PSRR	60	80	—	dB	V_{DD}1 = 1.8V, V_{DD}2 = 5.5V
Output voltage high		V_{OH}	V_{DD}–0.1	—	—	V	R_L = 10kΩ to V_{SS}
Output voltage low		V_{OL}	—	—	0.1	V	R_L = 10kΩ to V_{DD}
Output leakage current (Only for HA1631S03/04)		I_{LO}	—	(0.1)	—	nA	V_{IN}+ = 1V, V_{IN}– = 0V, V_O = 3V
Operating voltage range		Vopr	1.8	—	5.5	V	

Note: ( ): Design specification

Table of Graphs

Electrical Characteristics			HA1631S01 Figure	HA1631S02 Figure	HA1631S03 Figure	HA1631S04 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
Output high voltage	V_{OH}	vs. Rload	1-18	2-18	3-4	4-4	4
Output source current	$I_{OSOURCE}$	vs. Output high voltage	1-4	2-4	—	—	5
Output low voltage	V_{OL}	vs. Rload	1-17	2-17	3-14	4-14	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	1-12	2-12	3-11	4-11	10
Falling time	t_f	vs. Temperature	1-13	2-13	3-12	4-12	13
		vs. Cload	1-15	2-15	3-13	4-13	13
		Time waveform	1-20	2-20	3-15	4-15	13
Rising time	t_r	vs. Temperature	1-14	2-14	—	—	13
		vs. Cload	1-16	2-16	—	—	13
		Time waveform	1-19	2-19	—	—	13
Propagation delay time	TP_{LH}	Time waveform	1-21	2-21	—	—	13
	TP_{HL}	Time waveform	1-22	2-22	3-16, 3-17	4-16, 4-17	13

Main Characteristics

Figure 1-1 HA1631S01
Supply Current vs. Supply Voltage
(Output High)

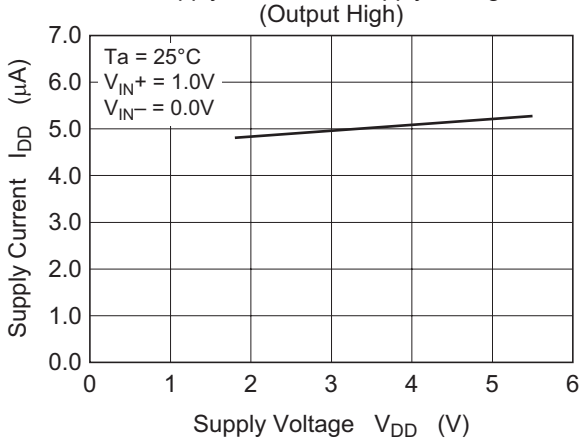


Figure 1-2 HA1631S01
Supply Current vs. Supply Voltage
(Output Low)

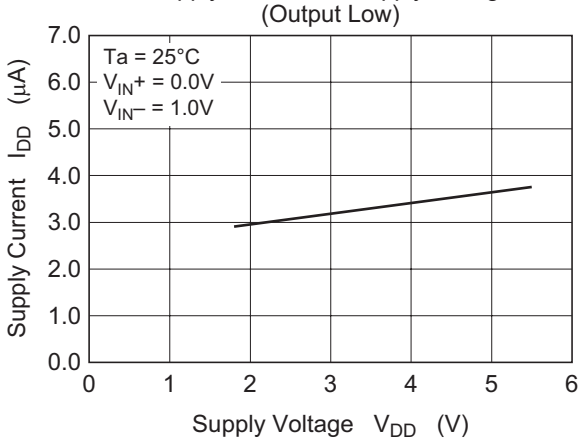


Figure 1-3 HA1631S01
Supply Current vs. Ambient Temperature

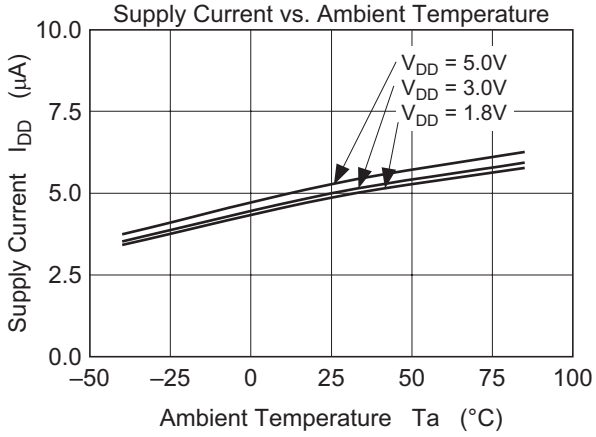


Figure 1-4 HA1631S01
Output High Voltage vs. Output Source Current

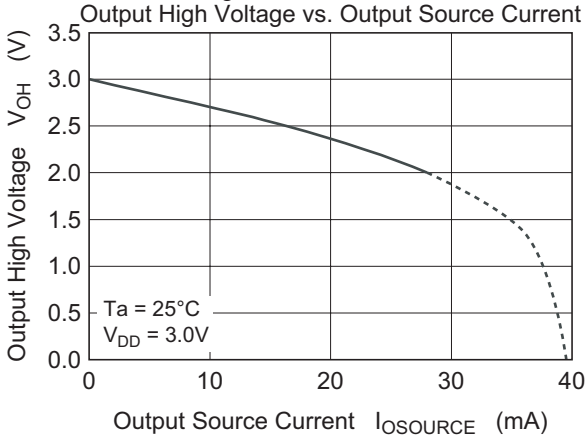


Figure 1-5 HA1631S01
Output Low Voltage vs. Output Sink Current

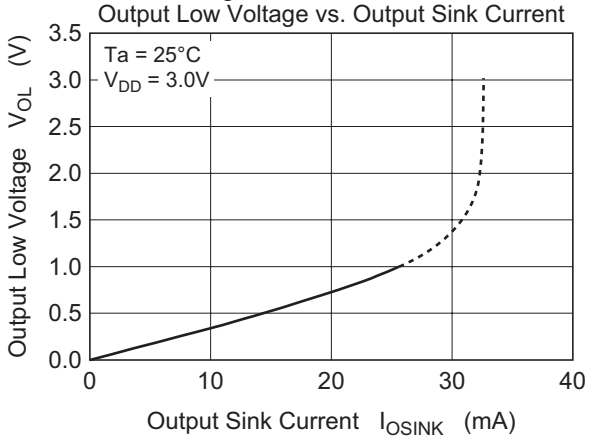


Figure 1-6 HA1631S01
Input Offset Voltage vs. Supply Voltage

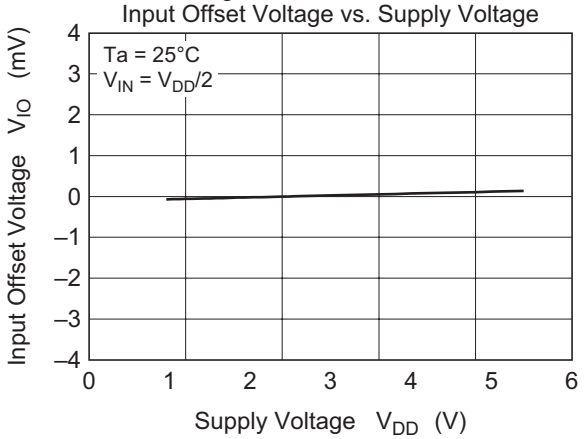


Figure 1-7 HA1631S01
Input Offset Voltage vs. Ambient Temperature

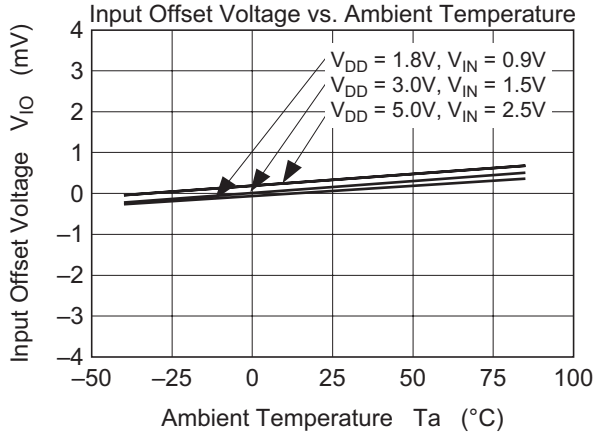


Figure 1-8 HA1631S01
Common Mode Input Voltage vs. Ambient Temperature

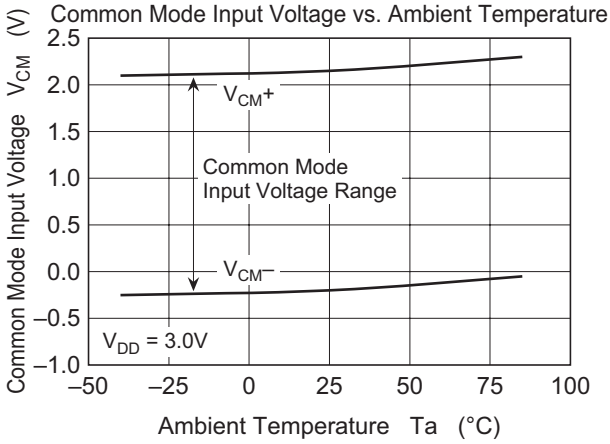


Figure 1-9 HA1631S01
Power Supply Rejection Ratio vs. Supply Voltage

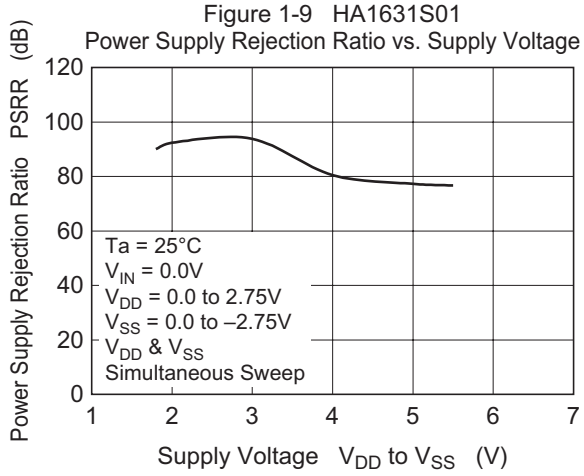


Figure 1-10 HA1631S01
Common Mode Rejection Ratio vs. Input Voltage

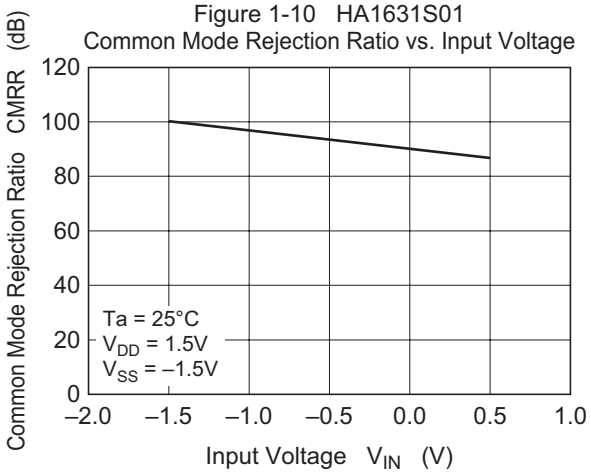


Figure 1-11 HA1631S01
Input Bias Current vs. Ambient Temperature

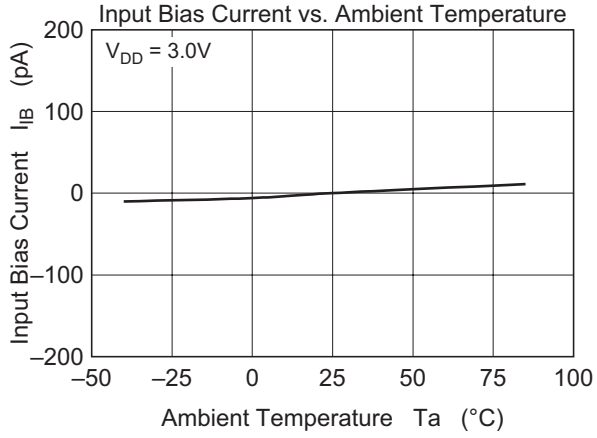


Figure 1-12 HA1631S01
Input Bias Current vs. Input Voltage

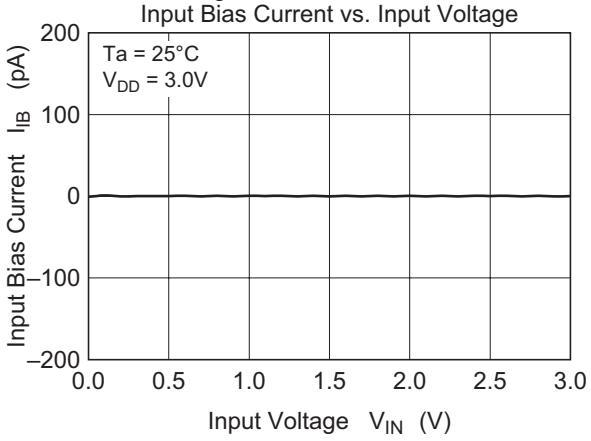


Figure 1-13 HA1631S01
Falling Time vs. Ambient Temperature

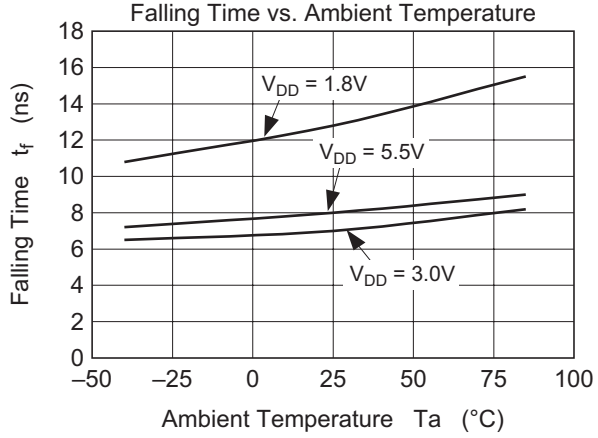


Figure 1-14 HA1631S01
Rising Time vs. Ambient Temperature

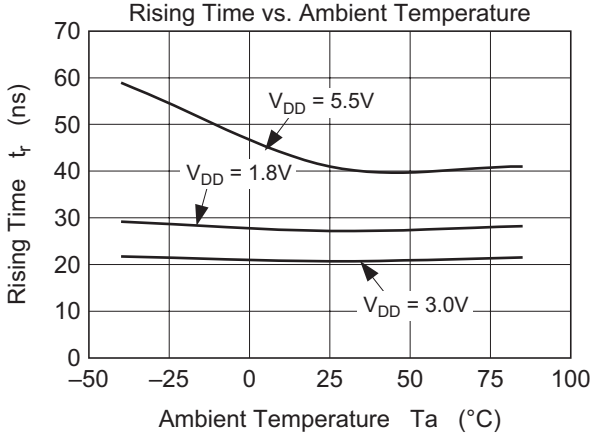


Figure 1-15 HA1631S01
Falling Time vs. Capacitor Load

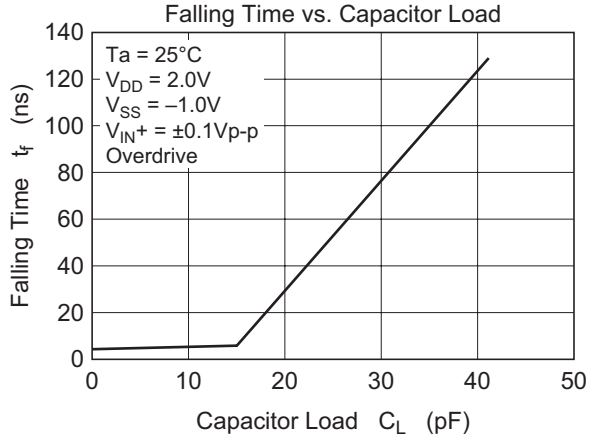


Figure 1-16 HA1631S01
Rising Time vs. Capacitor Load

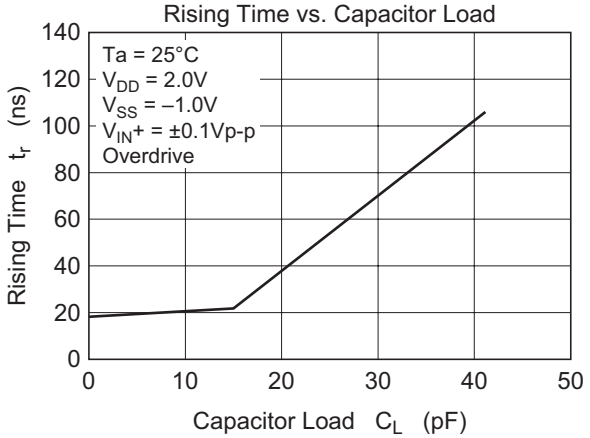


Figure 1-17 HA1631S01
Output Low Voltage vs. Resistor Load

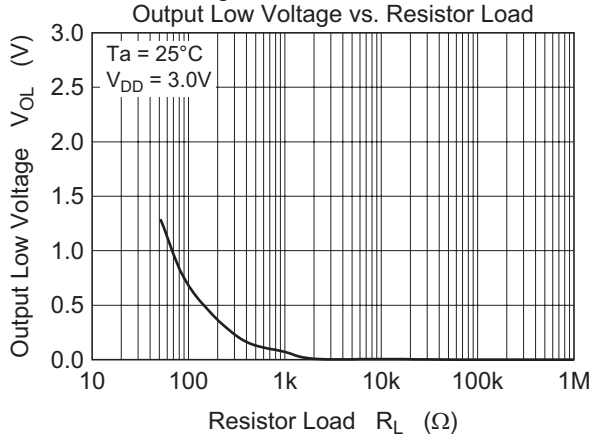


Figure 1-18 HA1631S01
Output High Voltage vs. Resistor Load

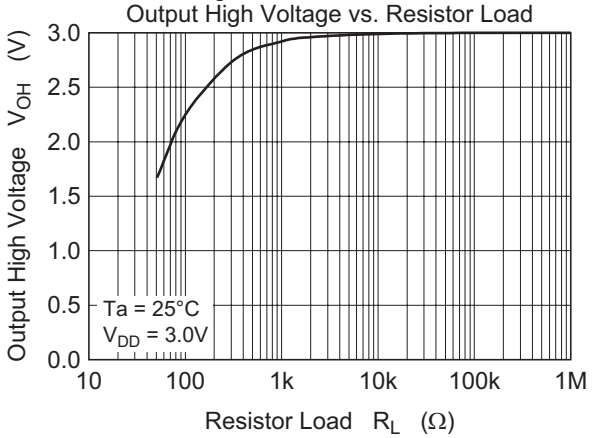


Figure 1-19 HA1631S01
Rising Time, t_r
(Overdrive = ±0.1Vp-p)

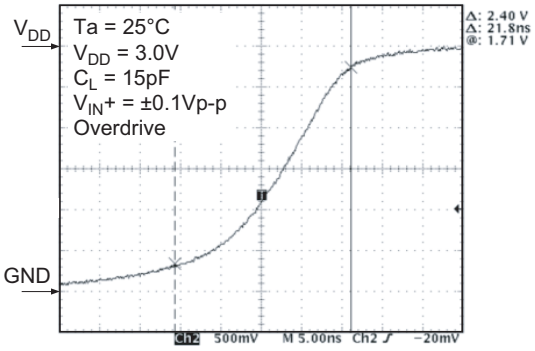


Figure 1-20 HA1631S01
Falling Time, t_f
(Overdrive = ±0.1Vp-p)

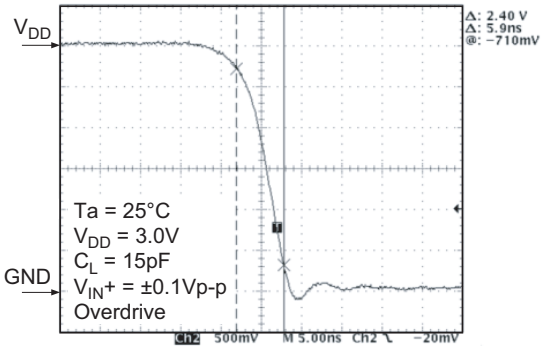


Figure 1-21 HA1631S01
TP_{LH} Transient Response
(Overdrive = ±0.1Vp-p)

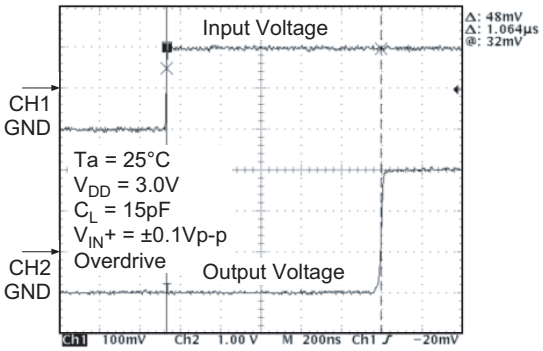


Figure 1-22 HA1631S01
TP_{HL} Transient Response
(Overdrive = ±0.1Vp-p)

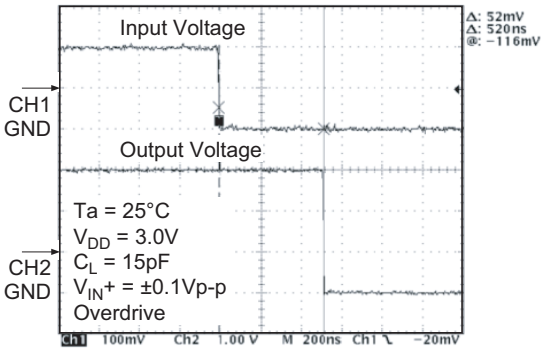


Figure 2-1 HA1631S02
Supply Current vs. Supply Voltage
(Output High)

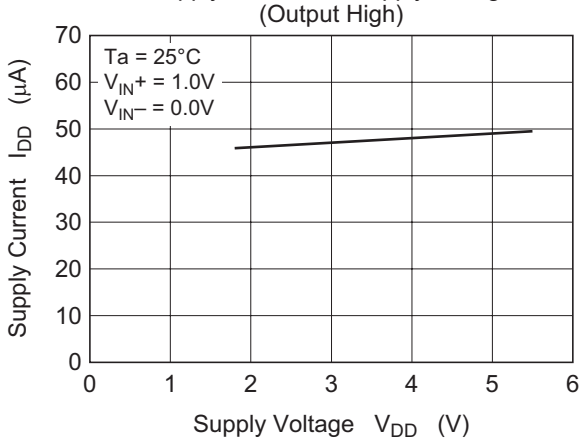


Figure 2-2 HA1631S02
Supply Current vs. Supply Voltage
(Output Low)

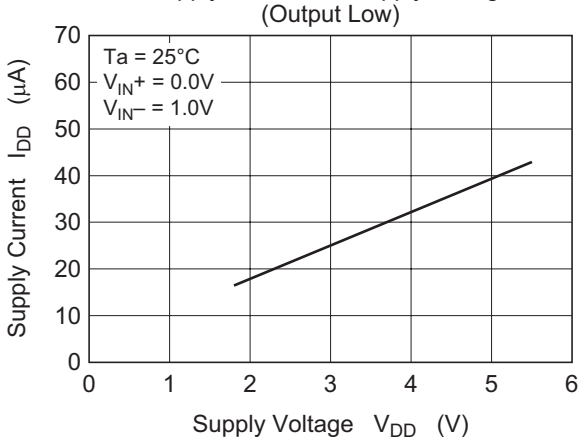


Figure 2-3 HA1631S02
Supply Current vs. Ambient Temperature

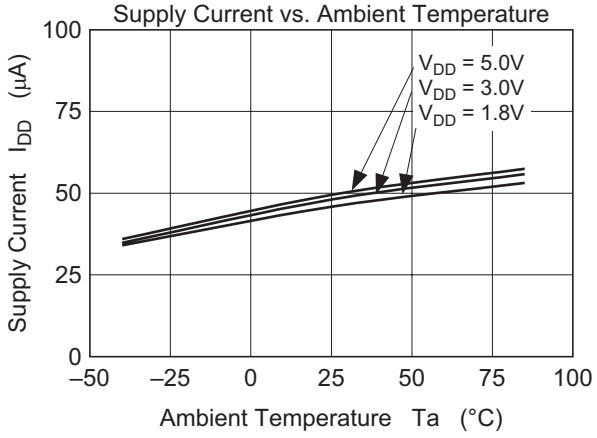


Figure 2-4 HA1631S02
Output High Voltage vs. Output Source Current

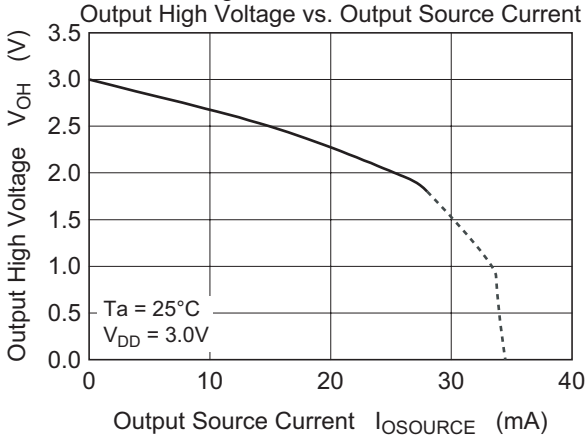


Figure 2-5 HA1631S02
Output Low Voltage vs. Output Sink Current

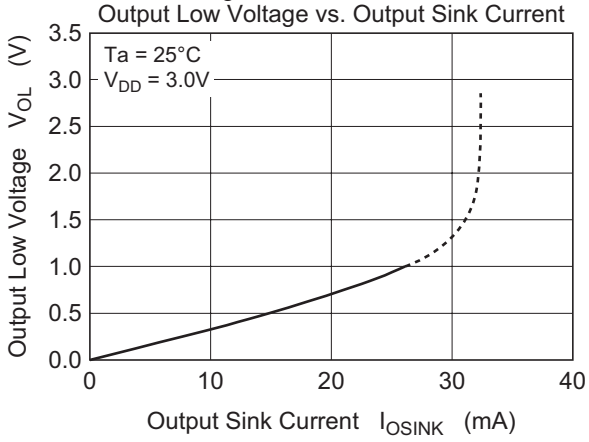


Figure 2-6 HA1631S02
Input Offset Voltage vs. Supply Voltage

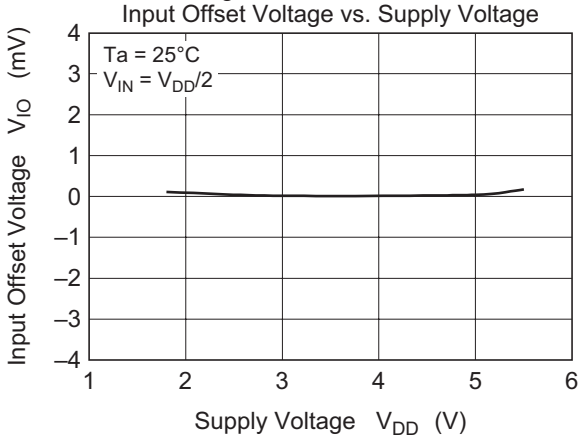


Figure 2-7 HA1631S02
Input Offset Voltage vs. Ambient Temperature

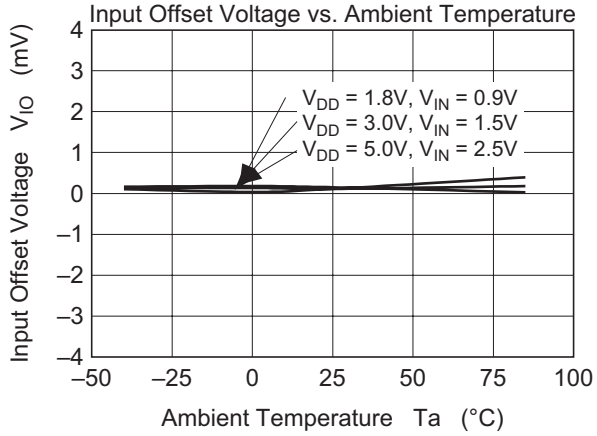


Figure 2-8 HA1631S02
Common Mode Input Voltage vs. Ambient Temperature

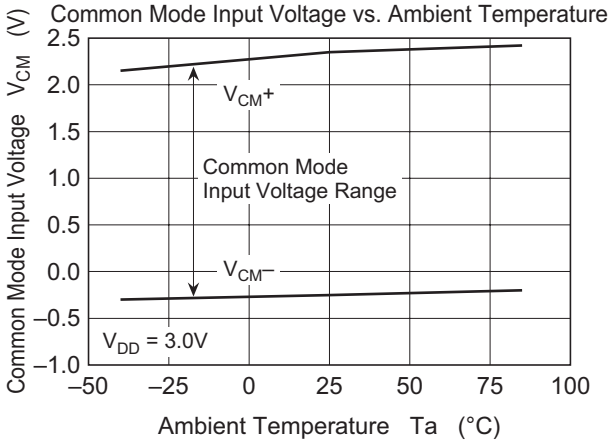


Figure 2-9 HA1631S02
Power Supply Rejection Ratio vs. Supply Voltage

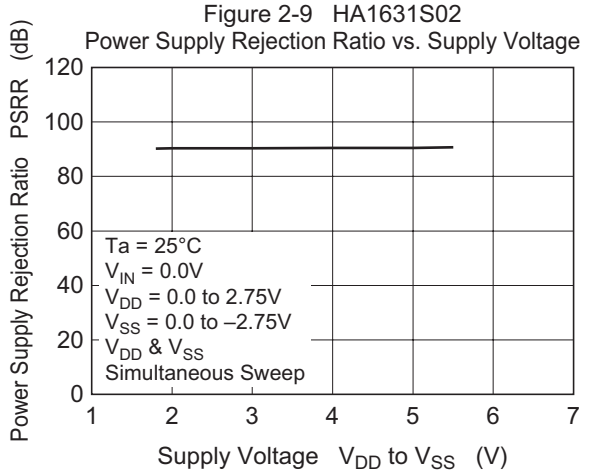


Figure 2-10 HA1631S02
Common Mode Rejection Ratio vs. Input Voltage

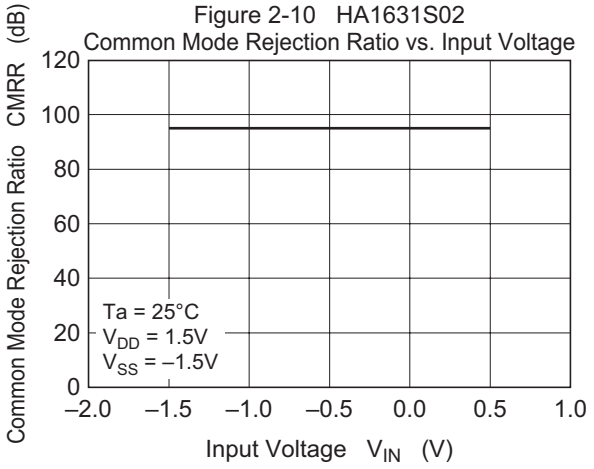


Figure 2-11 HA1631S02
Input Bias Current vs. Ambient Temperature

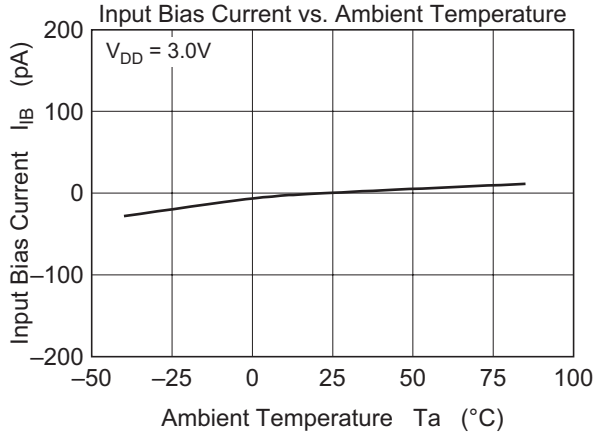


Figure 2-12 HA1631S02
Input Bias Current vs. Input Voltage

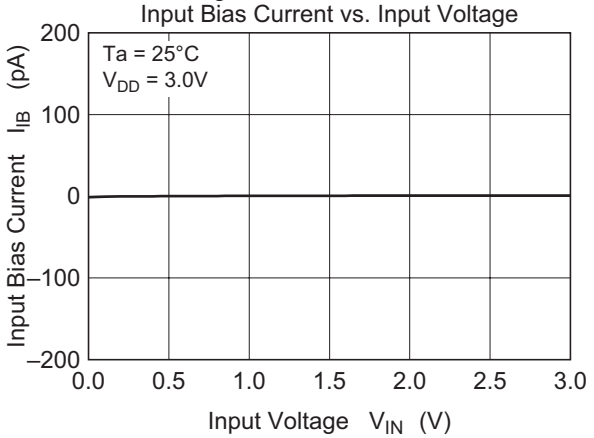


Figure 2-13 HA1631S02
Falling Time vs. Ambient Temperature

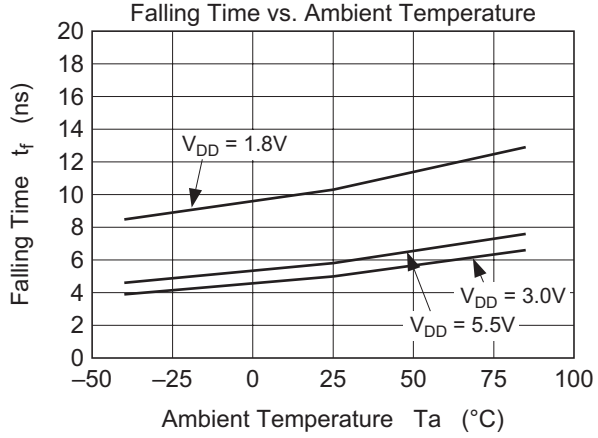


Figure 2-14 HA1631S02
Rising Time vs. Ambient Temperature

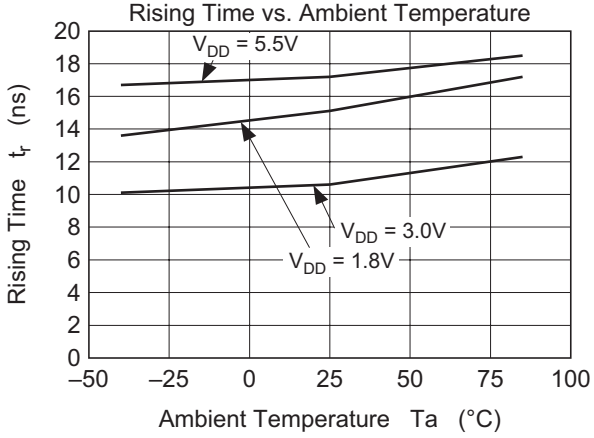


Figure 2-15 HA1631S02
Falling Time vs. Capacitor Load

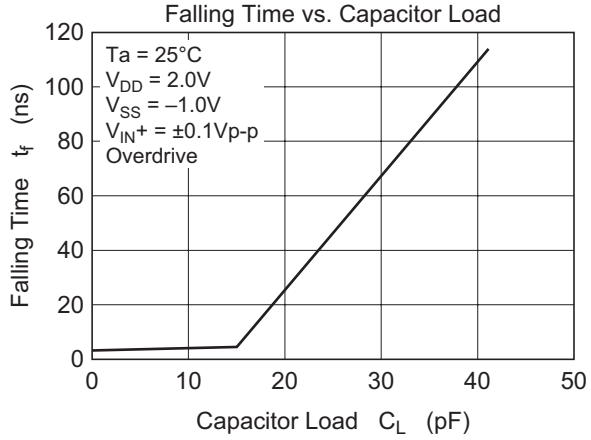


Figure 2-16 HA1631S02
Rising Time vs. Capacitor Load

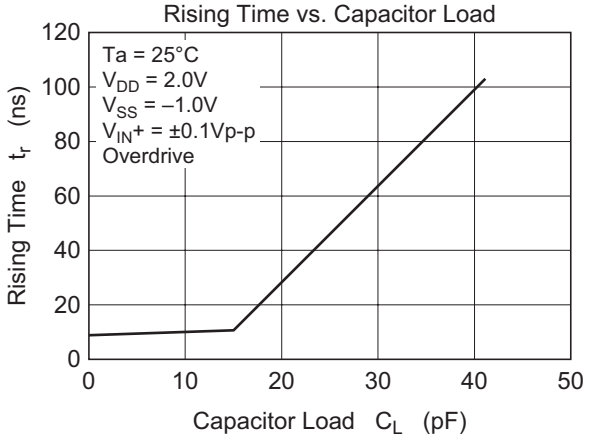


Figure 2-17 HA1631S02
Output Low Voltage vs. Resistor Load

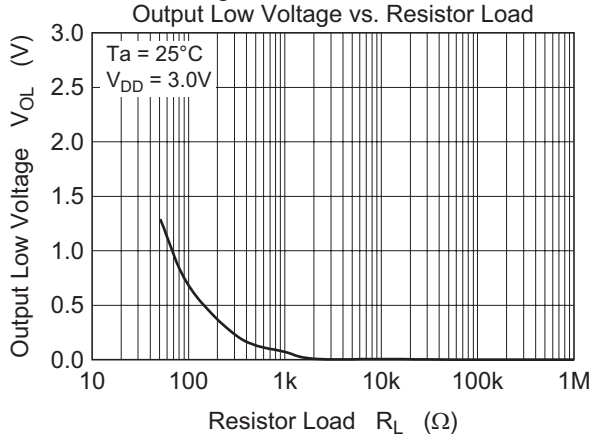


Figure 2-18 HA1631S02
Output High Voltage vs. Resistor Load

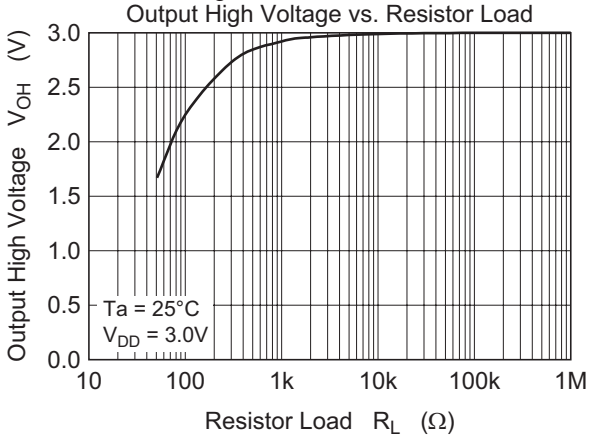


Figure 2-19 HA1631S02
Rising Time, t_r
(Overdrive = ±0.1Vp-p)

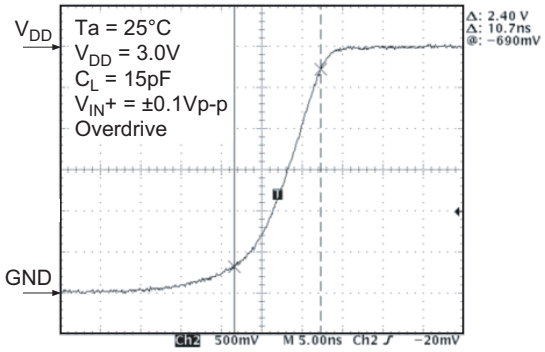


Figure 2-20 HA1631S02
Falling Time, t_f
(Overdrive = ±0.1Vp-p)

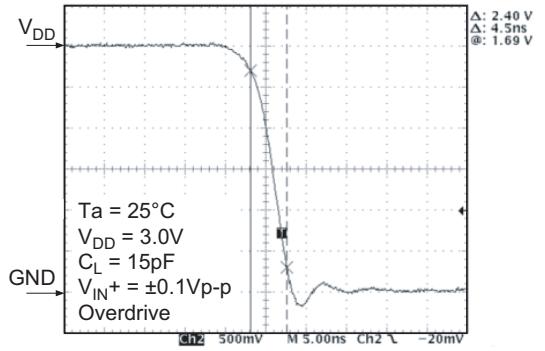


Figure 2-21 HA1631S02
TP_{LH} Transient Response
(Overdrive = ±0.1Vp-p)

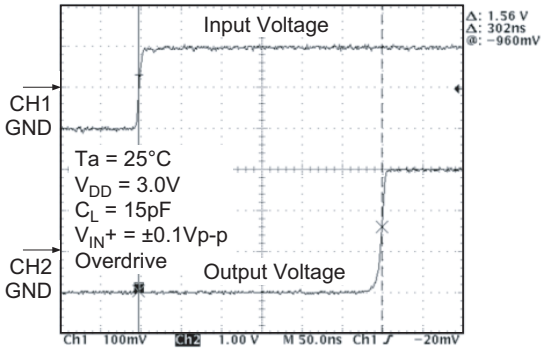


Figure 2-22 HA1631S02
TP_{HL} Transient Response
(Overdrive = ±0.1Vp-p)

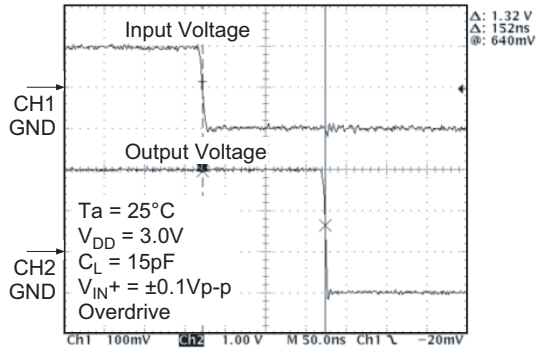


Figure 3-1 HA1631S03
Supply Current vs. Supply Voltage
(Output High)

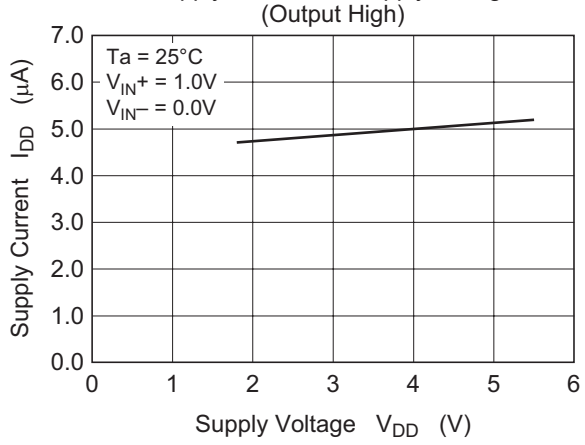


Figure 3-2 HA1631S03
Supply Current vs. Supply Voltage
(Output Low)

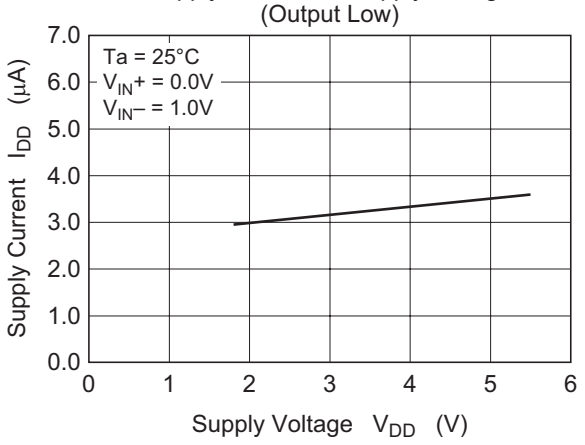


Figure 3-3 HA1631S03
Supply Current vs. Ambient Temperature

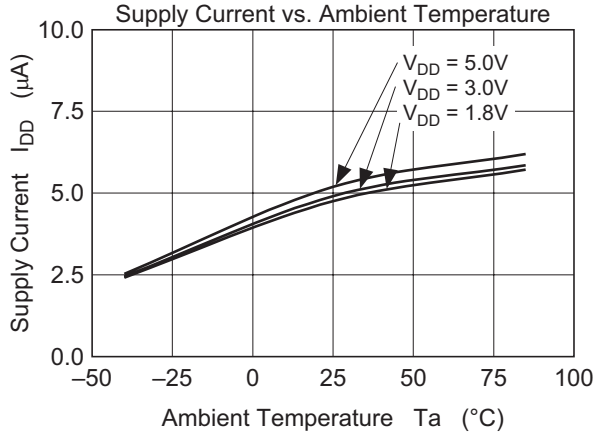


Figure 3-4 HA1631S03
Output Low Voltage vs. Output Sink Current

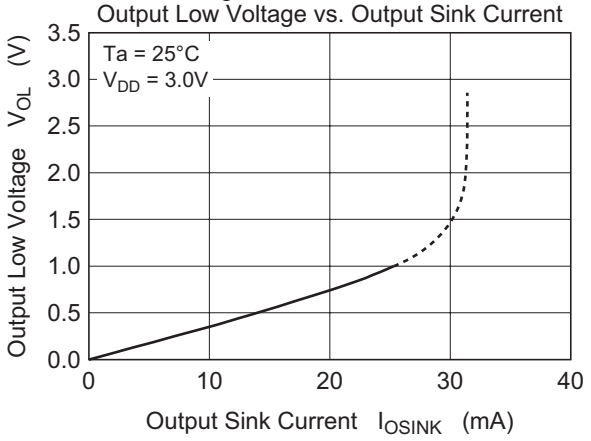


Figure 3-5 HA1631S03
Input Offset Voltage vs. Supply Voltage

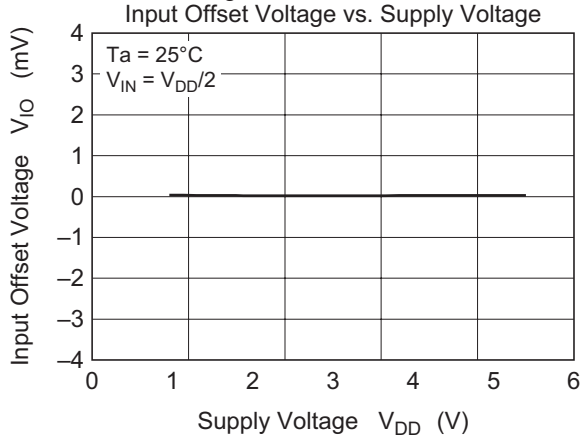


Figure 3-6 HA1631S03
Input Offset Voltage vs. Ambient Temperature

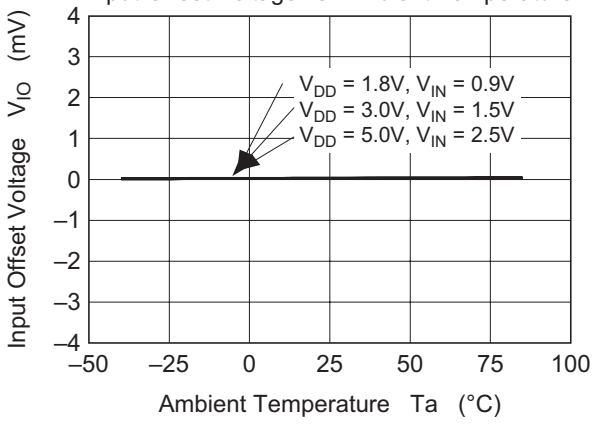


Figure 3-7 HA1631S03
Common Mode Input Voltage vs. Ambient Temperature

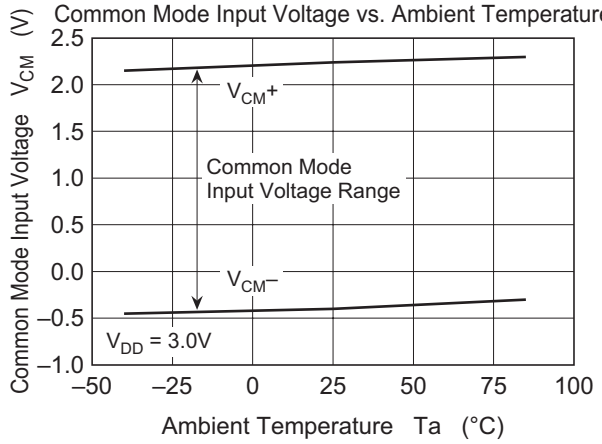


Figure 3-8 HA1631S03
Power Supply Rejection Ratio vs. Supply Voltage

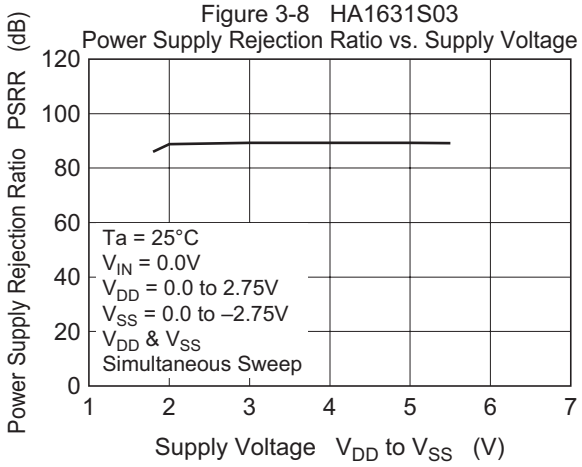


Figure 3-9 HA1631S03
Common Mode Rejection Ratio vs. Input Voltage

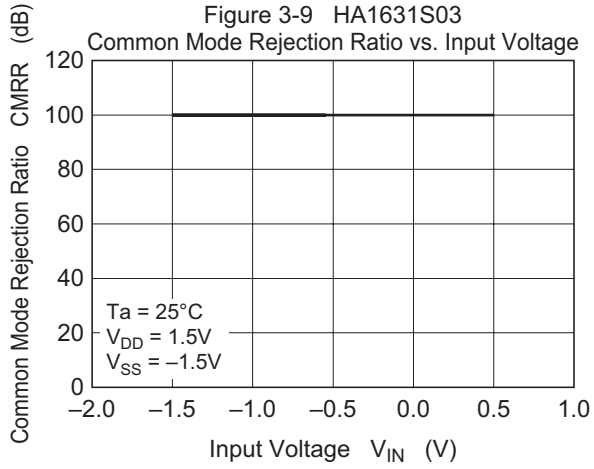


Figure 3-10 HA1631S03
Input Bias Current vs. Ambient Temperature

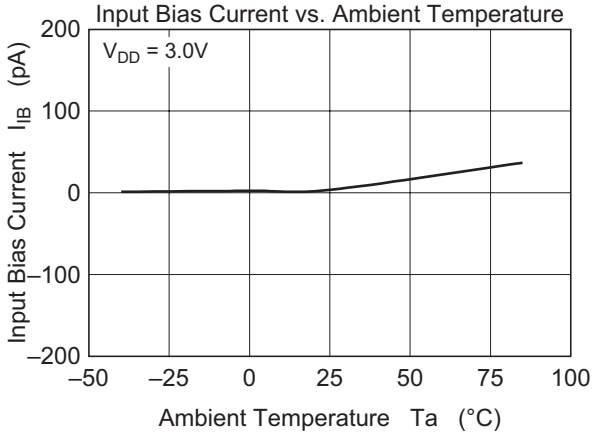


Figure 3-11 HA1631S03
Input Bias Current vs. Input Voltage

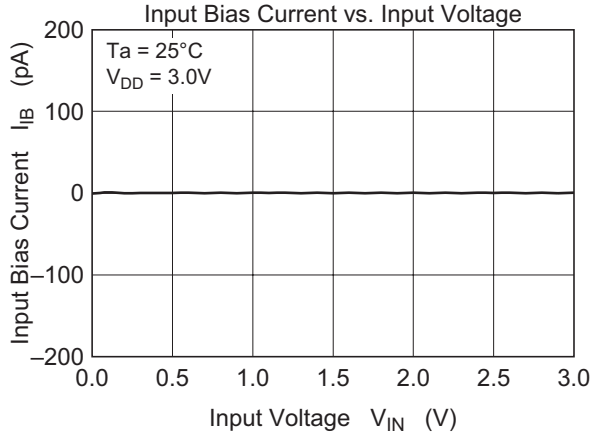


Figure 3-12 HA1631S03
Falling Time vs. Ambient Temperature

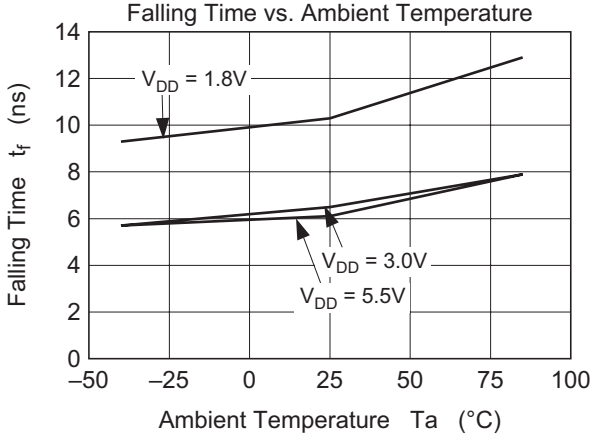


Figure 3-13 HA1631S03
Falling Time vs. Capacitor Load

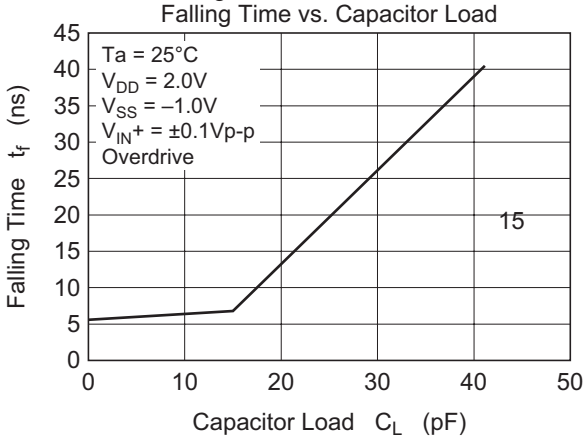


Figure 3-14 HA1631S03
Output Low Voltage vs. Resistor Load

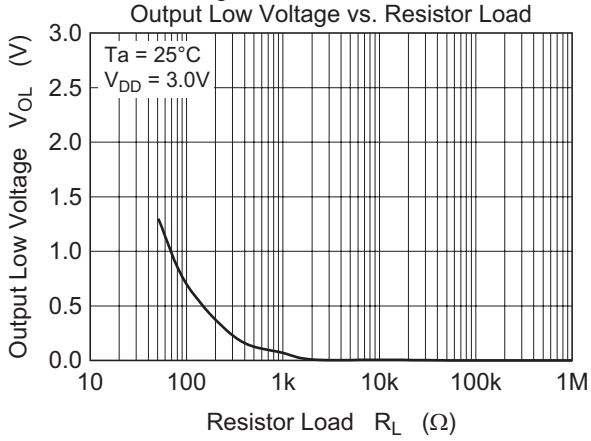


Figure 3-15 HA1631S03
Falling Time, t_f

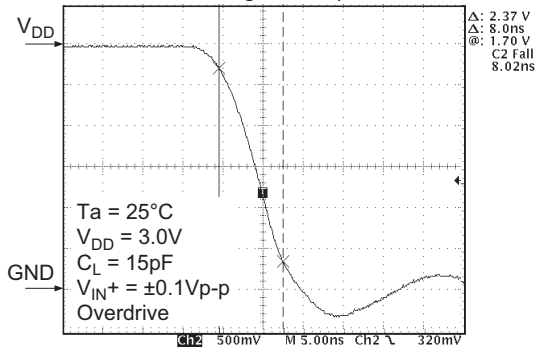


Figure 3-16 HA1631S03
TP_{HL} Transient Response
(Overdrive = ±0.1Vp-p)

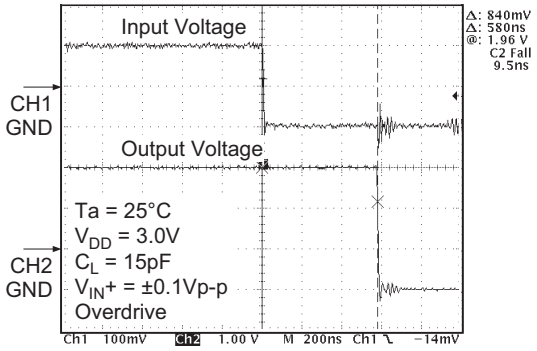


Figure 3-17 HA1631S03
TP_{HL} Transient Response
(Overdrive = ±0.1Vp-p)

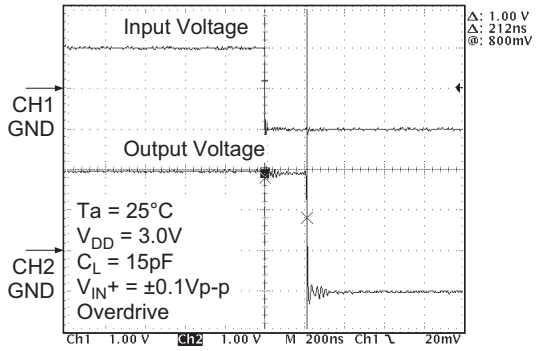


Figure 4-1 HA1631S04
Supply Current vs. Supply Voltage
(Output High)

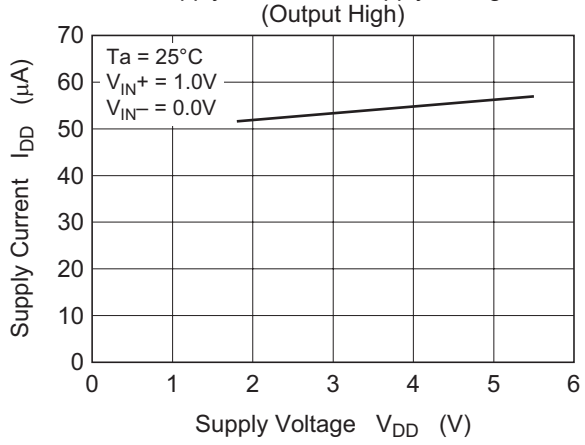


Figure 4-2 HA1631S04
Supply Current vs. Supply Voltage
(Output Low)

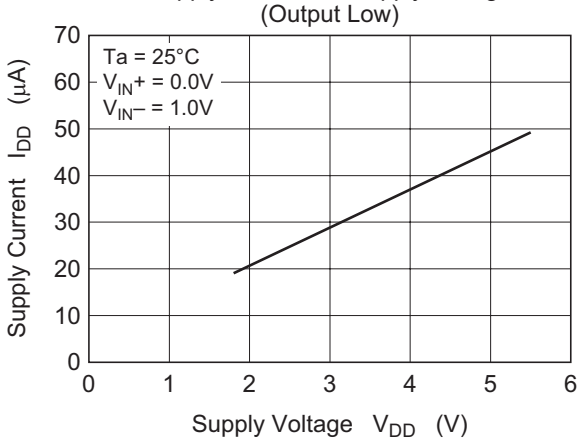


Figure 4-3 HA1631S04
Supply Current vs. Ambient Temperature

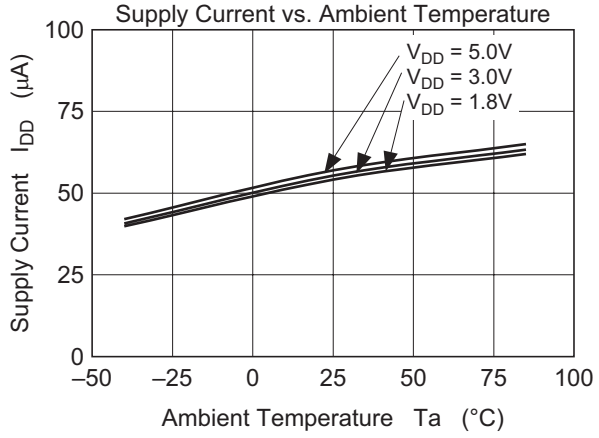


Figure 4-4 HA1631S04
Output Low Voltage vs. Output Sink Current

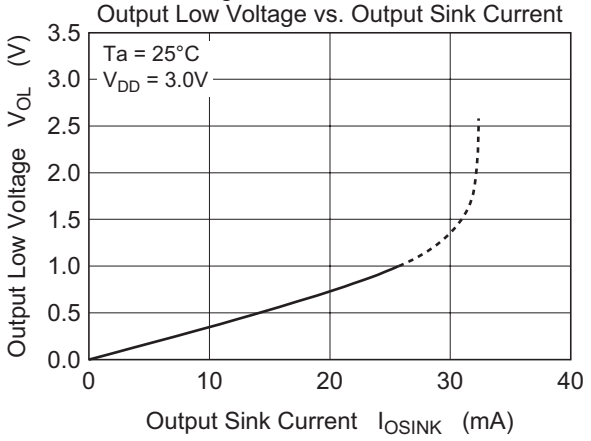


Figure 4-5 HA1631S04
Input Offset Voltage vs. Supply Voltage

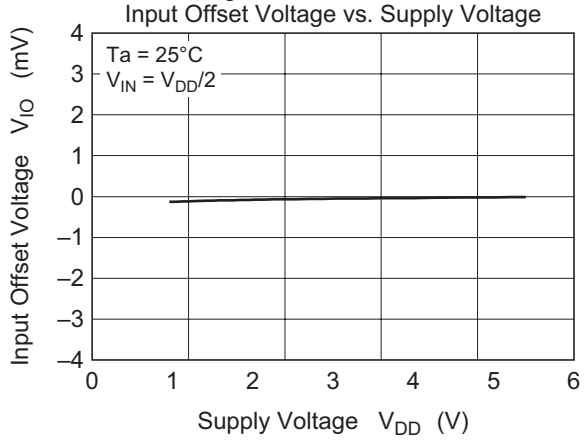


Figure 4-6 HA1631S04
Input Offset Voltage vs. Ambient Temperature

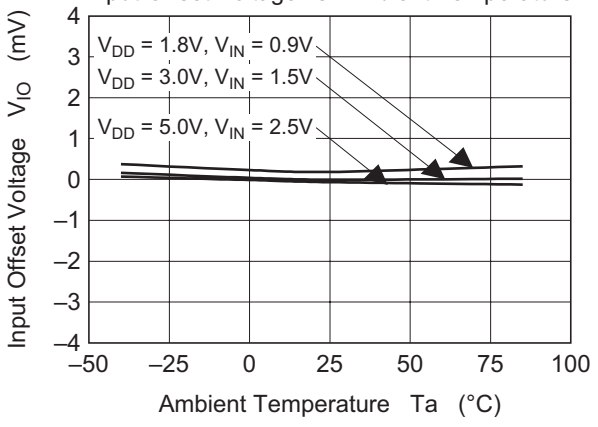


Figure 4-7 HA1631S04
Common Mode Input Voltage vs. Ambient Temperature

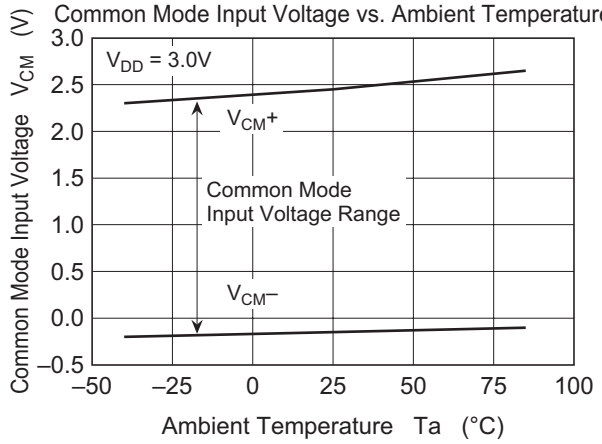


Figure 4-8 HA1631S04
Power Supply Rejection Ratio vs. Supply Voltage

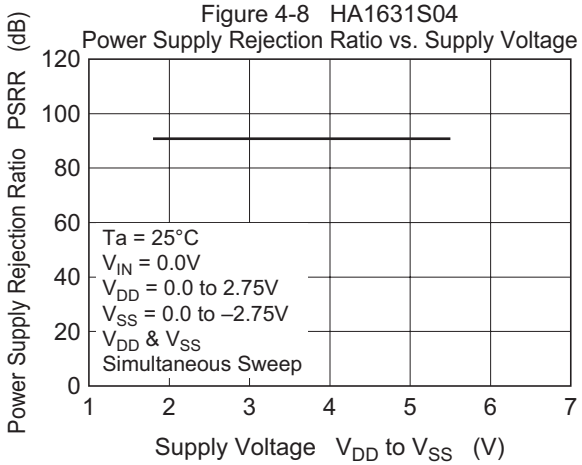


Figure 4-9 HA1631S04
Common Mode Rejection Ratio vs. Input Voltage

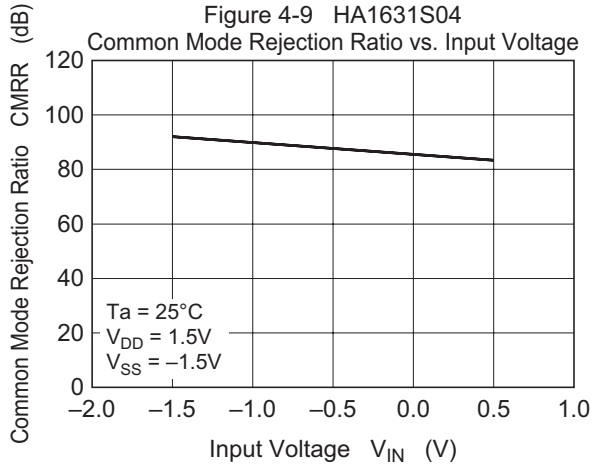


Figure 4-10 HA1631S04
Input Bias Current vs. Ambient Temperature

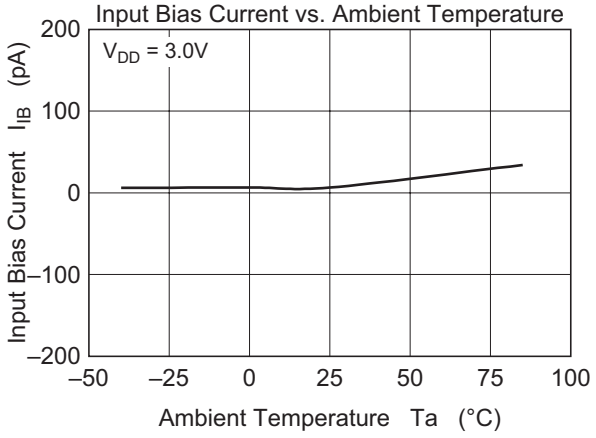


Figure 4-11 HA1631S04
Input Bias Current vs. Input Voltage

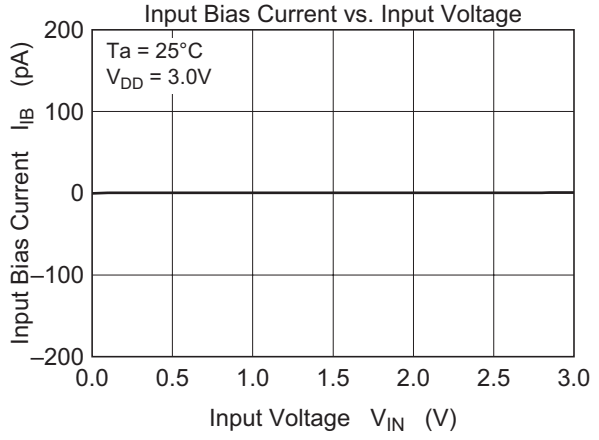


Figure 4-12 HA1631S04
Falling Time vs. Ambient Temperature

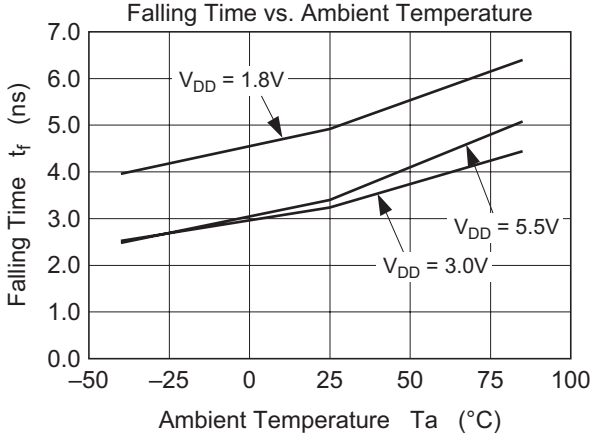


Figure 4-13 HA1631S04
Falling Time vs. Capacitor Load

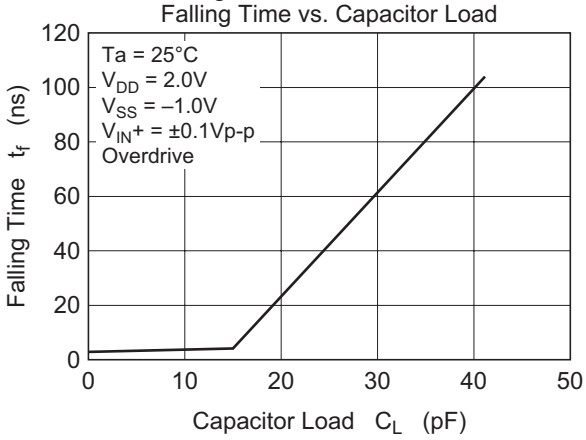


Figure 4-14 HA1631S04
Output Low Voltage vs. Resistor Load

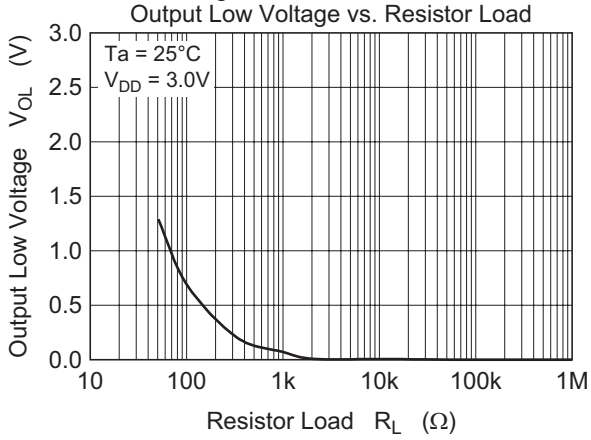


Figure 4-15 HA1631S04
Falling Time, t_f
(Overdrive = ±0.1Vp-p)

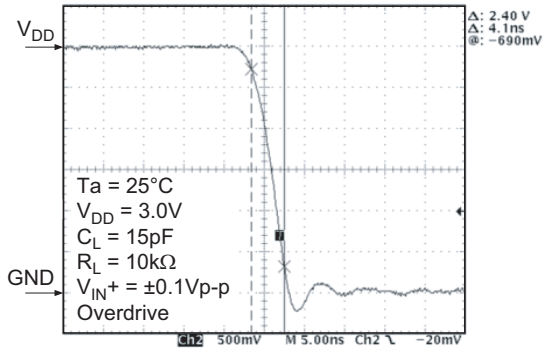


Figure 4-16 HA1631S04
TP_{HL} Transient Response
(Overdrive = ±0.1Vp-p)

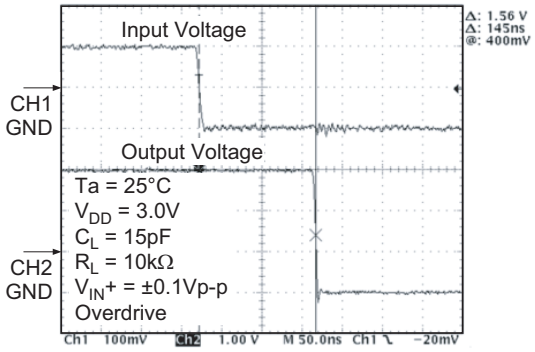
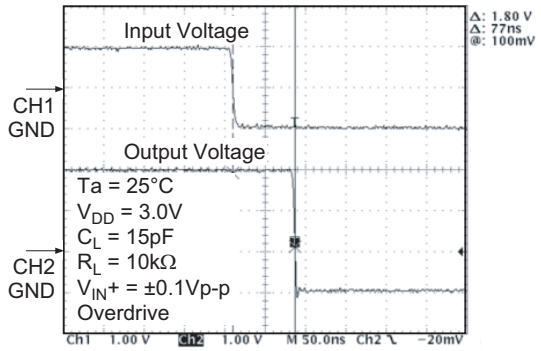
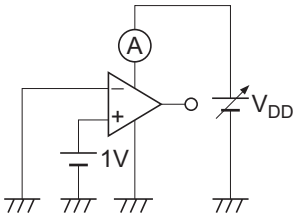


Figure 4-17 HA1631S04
TP_{HL} Transient Response
(Overdrive = ±0.1Vp-p)

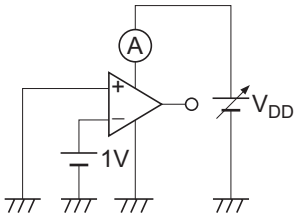


Test Circuits

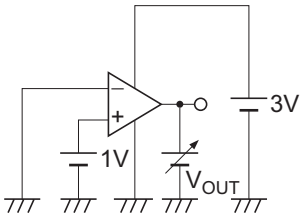
1. Supply Current, I_{DD} (Output High)



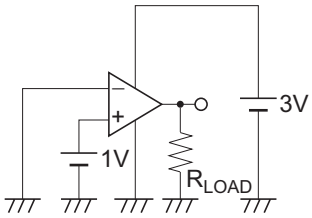
2. Supply Current, I_{DD} (Output Low)



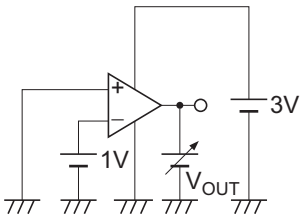
3. Output Source Current, $I_{OSOURCE}$



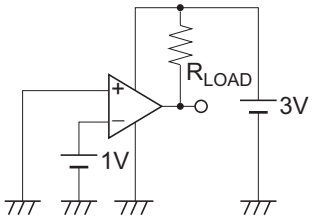
4. Output Voltage High, V_{OH}



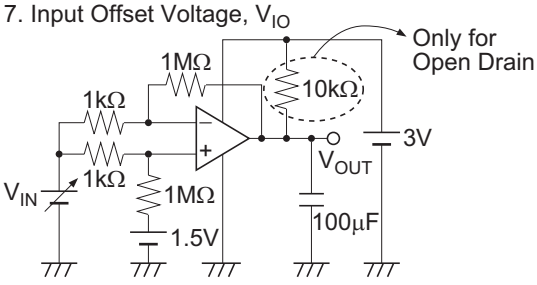
5. Output Sink Current, I_{OSINK}



6. Output Voltage Low, V_{OL}

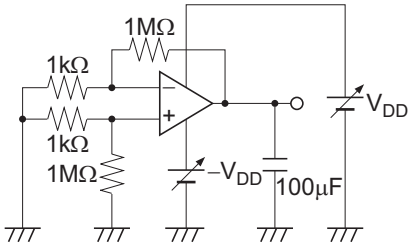


7. Input Offset Voltage, V_{IO}

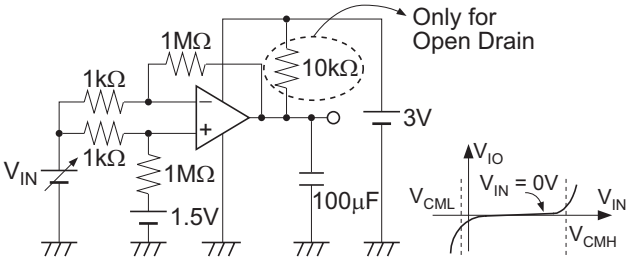


Note: $V_{IO} = V_{OUT} - 1.5V$

8. Input Offset Voltage vs. V_{DD}

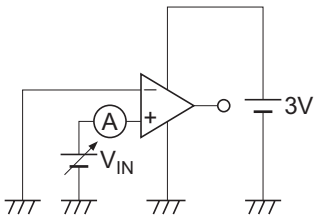


9. Common Mode Input Voltage Range, V_{CM}

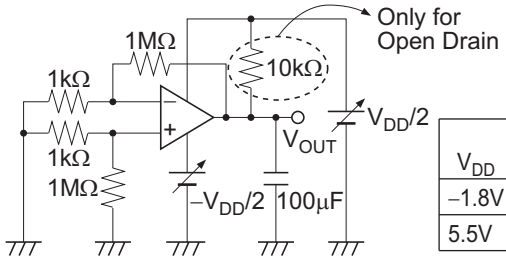


Note: V_{CML} and V_{CMH} are values of V_{IN} when V_{IO} changes more than 50dB taking V_{IN} = 0V as reference.

10. Input Bias Current, I_{IB}

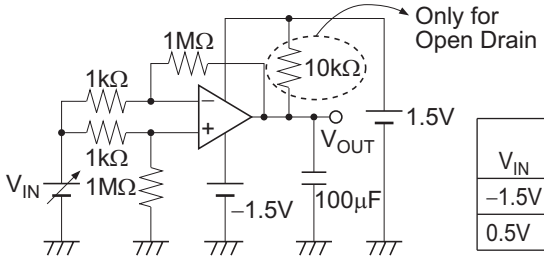


11. Power Supply Rejection Ratio, PSRR



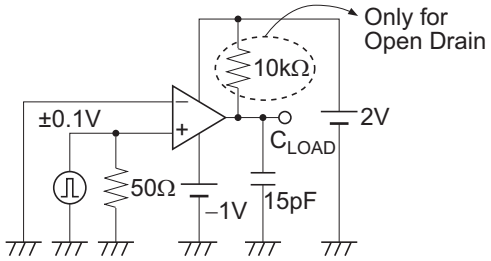
V_{DD}	Measure Point	Calculate V_{IO}	PSRR Calculation
–1.8V	V_{OUT1}	$V_{IO1} = V_{OUT1}/1000$	$PSRR = \left\| 20\log_{10} \frac{\|(V_{IO2} - V_{IO1})\|}{5.5V - 1.8V} \right\|$
5.5V	V_{OUT2}	$V_{IO2} = V_{OUT2}/1000$	

12. Common Mode Rejection Ratio, CMRR

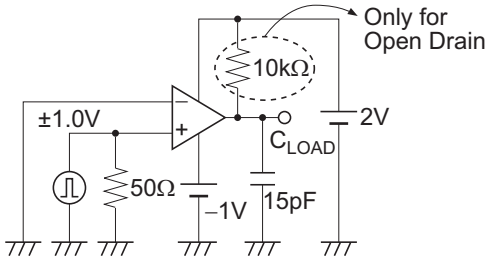


V_{IN}	Measure Point	Calculate V_{IO}	CMRR Calculation
–1.5V	V_{OUT1}	$V_{IO1} = V_{OUT1}/1000$	$CMRR = \left\| 20\log_{10} \frac{\|(V_{IO2} - V_{IO1})\|}{0.5V - (-1.5V)} \right\|$
0.5V	V_{OUT2}	$V_{IO2} = V_{OUT2}/1000$	

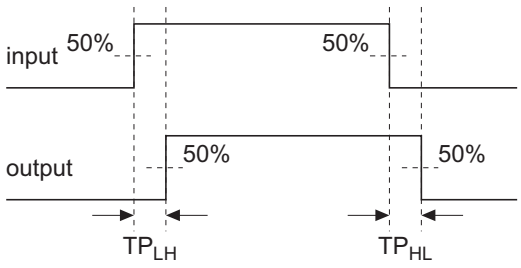
13. Falling Time, Rising Time, Propagation Delay Time TP_{LH}, TP_{HL}

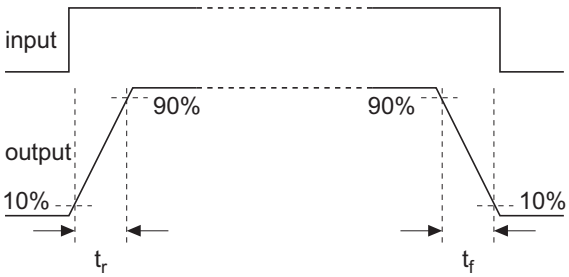


Overdrive = ±0.1V

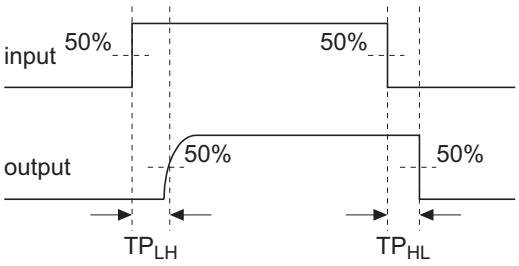


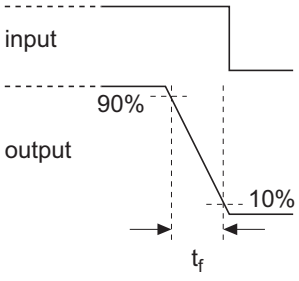
Overdrive = ±1.0V





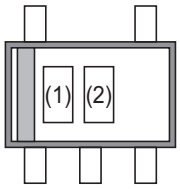
Only for Push Pull HA1631S01/02





Only for Open Drain HA1631S03/04

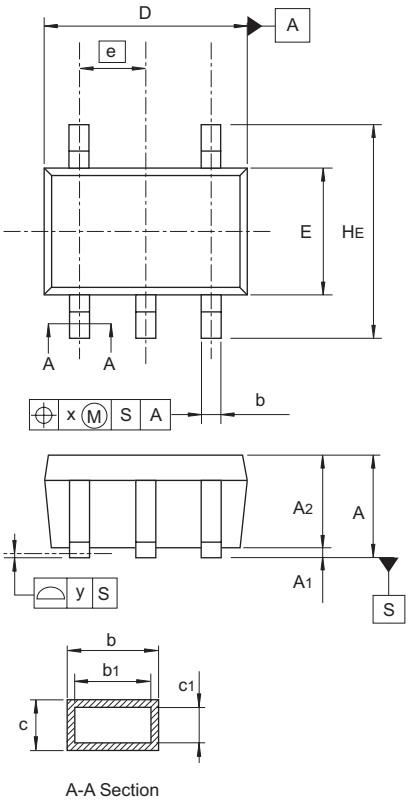
Mark Indication



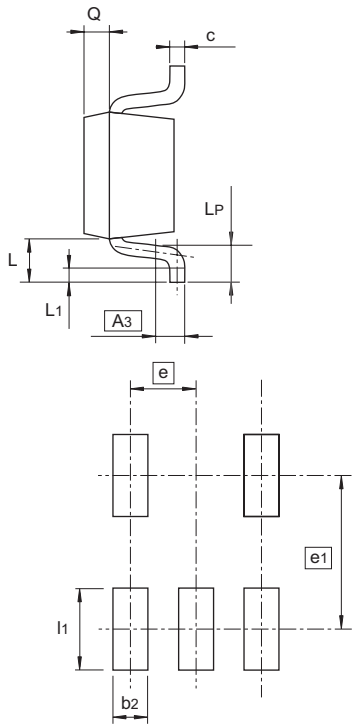
		(1)	(2)
HA1631S01CM	HA1631S01LP	0	A
HA1631S02CM	HA1631S01LP	0	B
HA1631S03CM	HA1631S01LP	0	C
HA1631S04CM	HA1631S01LP	0	D

Package Dimensions

JEITA Package Code	RENESAS Code	Previous Code	MASS[Typ.]
SC-88A	PTSP0005ZC-A	CMPAK-5 / CMPAK-5V	0.006g



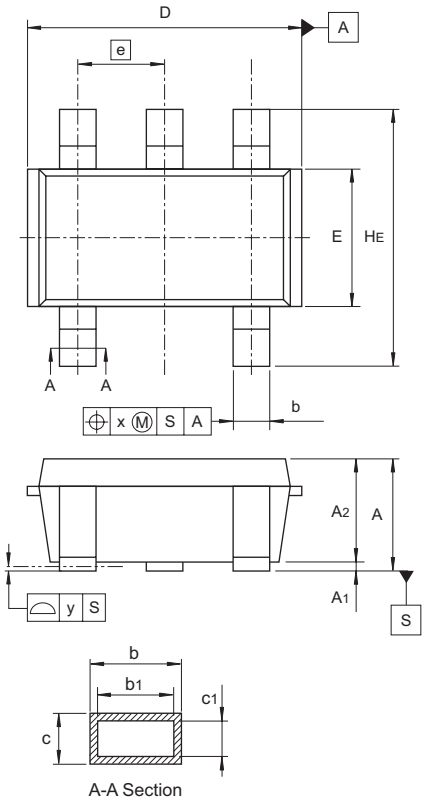
A-A Section



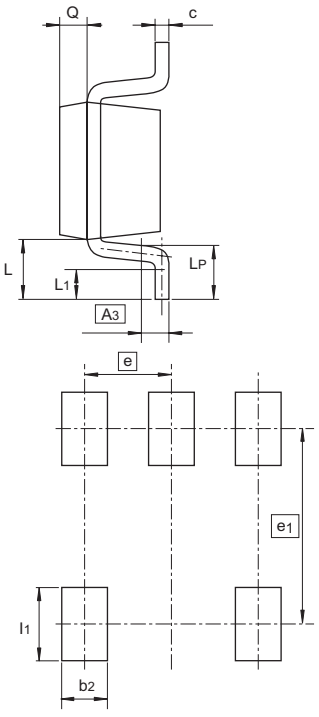
Pattern of terminal position areas

Reference Symbol	Dimension in Millimeters		
	Min	Nom	Max
A	0.8	–	1.1
A_1	0	–	0.1
A_2	0.8	0.9	1.0
A_3	–	0.25	–
b	0.15	0.22	0.3
b_1	–	0.2	–
c	0.1	0.13	0.15
c_1	–	0.11	–
D	1.8	2.0	2.2
E	1.15	1.25	1.35
e	–	0.65	–
H_E	1.8	2.1	2.4
L	0.3	–	0.7
L_1	0.1	–	0.5
L_P	0.2	–	0.6
x	–	–	0.05
y	–	–	0.05
b_2	–	–	0.35
e_1	–	1.5	–
l_1	–	–	0.9
Q	–	0.25	–

Package Name	JEITA Package Code	RENESAS Code	Previous Code	MASS[Typ.]
MPAK-5	SC-74A	PLSP0005ZB-A	MPAK-5 / MPAK-5V	0.015g



A-A Section



Pattern of terminal position areas

Reference Symbol	Dimension in Millimeters		
	Min	Nom	Max
A	1.0	–	1.3
A_1	0	–	0.1
A_2	1.0	1.1	1.2
A_3	–	0.25	–
b	0.35	0.42	0.5
b_1	–	0.4	–
c	0.1	0.13	0.15
c_1	–	0.11	–
D	2.8	2.95	3.1
E	1.5	1.6	1.8
e	–	0.95	–
H_E	2.5	2.8	3.0
L	0.3	–	0.7
L_1	0.1	–	0.5
L_P	0.2	–	0.6
x	–	–	0.05
y	–	–	0.05
b_2	–	–	0.55
e_1	–	2.15	–
l_1	–	–	0.85
Q	–	0.3	–

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Colophon .6.0