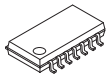
14μA/ch, 16V Operation, Rail-to-Rail Output Quad CMOS Operational Amplifier

■GENERAL DESCRIPTION

The NJU7068 is a low power, high Voltage operation, quad CMOS Operational Amplifier. It is tolerant to RF noise. The NJU7068 can operate wide voltage range from single-supply voltage of +4V to +16V. In addition, this amplifier features Rail-to-Rail output and low input bias current (1pA typ.). Because of these features, the NJU7068 is ideal for low side current sense amplifier.

■PACKAGE OUTLINE



NJU7068M
(DMP14)

NJU7068V
(SSOP14)

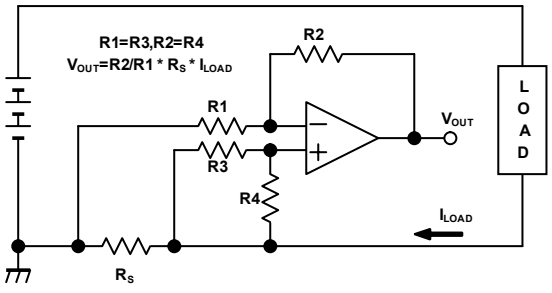
■FEATURES

●Low Supply Current	14μA/ch typ. (at V_{DD}=+5V),16.5μA/ch typ. (at V_{DD}=+15V)
●Rail-to-Rail Output	GND + 0.05V to VDD – 0.1V min. (R_L=10kΩ to 0V)
●Wide Operating Voltage	Vopr= 4V to 16V
●Input Offset Voltage	V_{IO}=4mV max.
●Low Input Bias Current	1pA typ.
●Slew Rate	0.04V/μs typ.
●Gain Bandwidth Product	90kHz
●Enhanced RF Noise Immunity	
●Package Outline	DMP14,SSOP14
●CMOS Process	

■APPLICATIONS

- ●Battery-operated application
- ●Battery Monitor
- ●Current Sensor
- ●Photodiode application

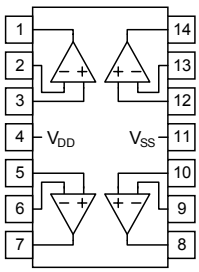
■APPLICATION CIRCUIT



Low-side Current Sensor

■PIN CONFIGURATION

(Top View)



PIN FUNCTION	
1:A OUTPUT	8:C OUTPUT
2:A -INPUT	9:C -INPUT
3:A +INPUT	10:C +INPUT
4:VDD	11:VSS
5:B +INPUT	12:D +INPUT
6:B -INPUT	13:D -INPUT
7:B OUTPUT	14:D OUTPUT

■ABSOLUTE MAXIMUM RATINGS

(Ta=25°C, unless otherwise noted.)

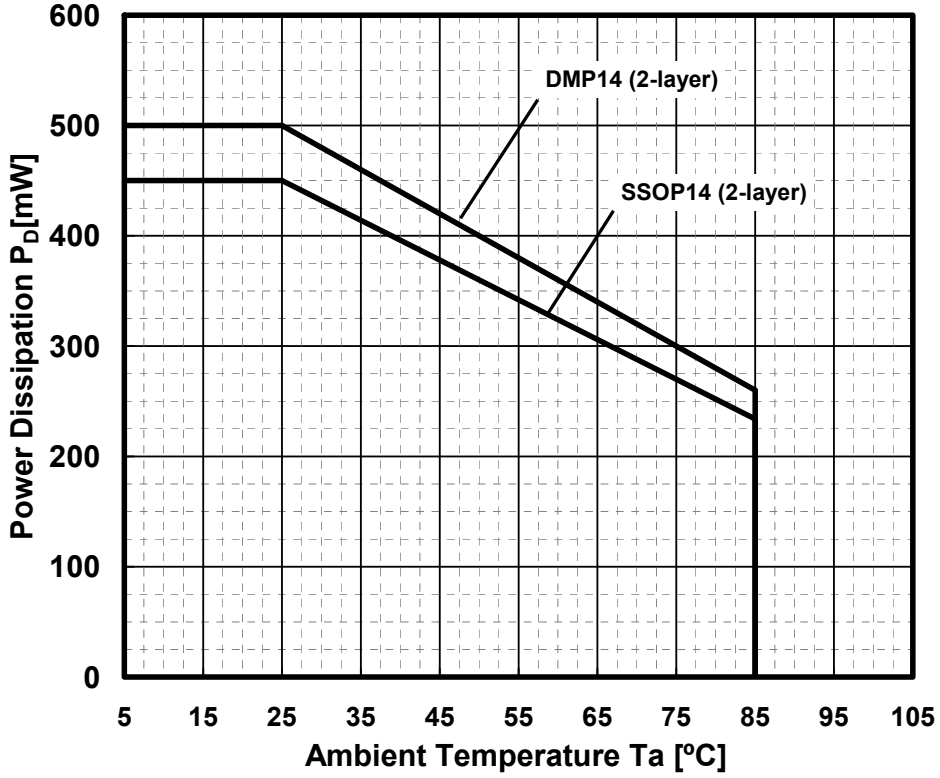
PARAMETER	SYMBOL	RATING	UNIT
Supply Voltage	V_{DD}	+18	V
Common Mode Input Voltage	V_{IC}	V_{SS} - 0.3 to V_{DD} + 0.3	V
Differential Input Voltage	V_{ID}	±18 (Note 1)	V
Power Dissipation	P_D	[DMP14]500 (Note2,3) [SSOP14]450 (Note2,3)	mW
Operating Temperature Range	T_{opr}	-40 to +85	°C
Storage Temperature Range	T_{stg}	-55 to +150	°C

(Note 1) For supply voltage less than +18V, the absolute maximum rating is equal to the supply voltage.

(Note 2) EIA/JEDEC STANDARD Test board (76.2x114.3x1.6mm, 2layer, FR-4) mounting

(Note 3) Do not exceed "Power dissipation: PD" in which power dissipation in IC is shown by the absolute maximum rating.
See Figure "Power Dissipation Curve" when ambient temperature is over 25°C.

Figure1.Power Dissipation Derating Curve



■RECOMMENDED OPERATING CONDITION

(Ta=25°C)

PARAMETER	SYMBOL	RATING	UNIT
Supply Voltage	V_{DD}	+4 to +16	V

■ ELECTRICAL CARACTERISTICS

● DC CHARACTERISTICS (V_{DD}=5V,V_{SS}=0V, Ta=25ºC,unless otherwise noted.)

PARAMETER	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Supply Current	I_{DD}	No Signal	-	56	96	µA
Input Offset Voltage	V_{IO}	V_{IC}= 0V, R_S=50Ω	-	1	4	mV
Input Offset Voltage Drift	ΔVio/ΔT	Ta = -40ºC to +85ºC	-	3.3	-	µV/ºC
Input Bias Current	I_B	V_{IC}= 0V, R_S=50Ω	-	1	-	pA
Input Offset Current	I_{IO}	V_{IC}= 0V, R_S=50Ω	-	1	-	pA
Large Signal Voltage Gain	A_V	V_O=1V to 4V, R_L=10kΩ to 2.5V	90	110	-	dB
Common Mode Rejection Ratio	CMR	V_{ICM}=0V to 3.4V	65	80	-	dB
Supply Voltage Rejection Ratio	SVR	V_{DD}=4V to 16V	70	85	-	dB
Maximum Output Voltage 1	V_{OH}1	R_L=10kΩ to 2.5V	4.95	4.98	-	V
	V_{OL}1		-	0.02	0.05	
Maximum Output Voltage 2	V_{OH}2	R_L=10kΩ to 0V	4.90	4.96	-	V
	V_{OL}2		-	0.01	0.05	
Maximum Output Voltage 3	V_{OH}3	Isource = 3mA	4.65	4.75	-	V
	V_{OL}3	Isink = 3mA	-	0.20	0.30	
Common Mode Input Voltage Range	V_{ICM}	CMR≥65dB	0	-	3.4	V

● AC CHARACTERISTICS (V_{DD}=5V,V_{SS}=0V, Ta=25ºC,unless otherwise noted.)

PARAMETER	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Gain Bandwidth Product	GBW	R_L=10kΩ to 2.5V, C_L=20pF, f=1kHz	-	60	-	kHz
Phase Margin	ϕ_M	R_L=10kΩ to 2.5V, C_L=20pF	-	75	-	deg
Gain Margin	G_M	R_L=10kΩ to 2.5V, C_L=20pF	-	22	-	dB
Equivalent Input Noise Voltage	V_{NI}	f=1kHz	-	45	-	nV/√Hz
Channel Separation	CS	f=1kHz	-	120	-	dB
Slew Rate	SR1	G_V=0dB, R_L=10kΩ to 2.5V, C_L=20pF, Vin=1Vpp (2V to 3V) (Note 4)	-	0.03	-	V/µs
	SR2	G_V=0dB, R_L=10kΩ to 0V, C_L=20pF, Vin=1Vpp (2V to 3V) (Note 4)	-	0.03	-	
Power Band	PBW1	G_V=+6dB, R_L=10kΩ to 2.5V, C_L=20pF, Vin=2.5Vpp (1.25V to 3.75V),Vo>4.8Vpp	-	3.6	-	kHz
	PBW2	G_V=+6dB, R_L=10kΩ to 0V, C_L=20pF, Vin=2.5Vpp (1.25V to 3.75V),Vo>4.8Vpp	-	3.2	-	
Total Harmonic Distortion	THD1	G_V=+6dB, R_L=10kΩ to 2.5V, C_L=20pF, f=100Hz,Vout=2Vpp	-	0.05	-	%
	THD2	G_V=+6dB, R_L=10kΩ to 0V, C_L=20pF, f=100Hz,Vout=2Vpp	-	0.005	-	%

(Note 4) Slew rate is defined by the lower value of the rise or fall.

■ ELECTRICAL CARACTERISTICS

● DC CHARACTERISTICS (V_{DD}=10V,V_{SS}=0V, Ta=25ºC,unless otherwise noted.)

PARAMETER	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Supply Current	I_{DD}	No Signal	-	62	114	µA
Input Offset Voltage	V_{IO}	V_{IC}= 0V, R_S=50Ω	-	1	4	mV
Input Offset Voltage Drift	ΔVio/ΔT	Ta = -40ºC to +85ºC	-	2.7	-	µV/ºC
Input Bias Current	I_B	V_{IC}= 0V, R_S=50Ω	-	1	-	pA
Input Offset Current	I_{IO}	V_{IC}= 0V, R_S=50Ω	-	1	-	pA
Large Signal Voltage Gain	A_V	V_O=2V to 8V, R_L=10kΩ to 5V	100	120	-	dB
Common Mode Rejection Ratio	CMR	V_{ICM}=0V to 8.4V	65	85	-	dB
Supply Voltage Rejection Ratio	SVR	V_{DD}=4V to 16V	70	85	-	dB
Maximum Output Voltage 1	V_{OH}1	R_L=10kΩ to 5V	9.95	9.98	-	V
	V_{OL}1		-	0.02	0.05	
Maximum Output Voltage 2	V_{OH}2	R_L=10kΩ to 0V	9.90	995	-	V
	V_{OL}2		-	0.01	0.05	
Maximum Output Voltage 3	V_{OH}3	Isource = 3mA	9.70	9.80	-	V
	V_{OL}3	Isink = 3mA	-	0.15	0.30	
Common Mode Input Voltage Range	V_{ICM}	CMR≥65dB	0	-	8.4	V

● AC CHARACTERISTICS (V_{DD}=10V,V_{SS}=0V, Ta=25ºC,unless otherwise noted.)

PARAMETER	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Gain Bandwidth Product	GBW	R_L=10kΩ to 5V, C_L=20pF, f=1kHz	-	80	-	kHz
Phase Margin	ϕ_M	R_L=10kΩ to 5V, C_L=20pF	-	75	-	deg
Gain Margin	G_M	R_L=10kΩ to 5V, C_L=20pF	-	23	-	dB
Equivalent Input Noise Voltage	V_{NI}	f=1kHz	-	45	-	nV/√Hz
Channel Separation	CS	f=1kHz	-	120	-	dB
Slew Rate	SR1	G_V=0dB, R_L=10kΩ to 5V, C_L=20pF, Vin=6Vpp (2V to 8V) (Note 4)	-	0.04	-	V/µs
	SR2	G_V=0dB, R_L=10kΩ to 0V, C_L=20pF, Vin=6Vpp (2V to 8V) (Note 4)	-	0.04	-	
Power Band	PBW1	G_V=+6dB, R_L=10kΩ to 5V, C_L=20pF, Vin=5Vpp (2.5V to 7.5V),Vo>9.8Vpp	-	1.6	-	kHz
	PBW2	G_V=+6dB, R_L=10kΩ to 0V, C_L=20pF, Vin=5Vpp (2.5V to 7.5V),Vo>9.8Vpp	-	1.6	-	
Total Harmonic Distortion	THD1	G_V=+6dB, R_L=10kΩ to 5V, C_L=20pF, f=100Hz,Vout=5Vpp	-	0.03	-	%
	THD2	G_V=+6dB, R_L=10kΩ to 0V, C_L=20pF, f=100Hz,Vout=5Vpp	-	0.003	-	%

(Note 4) Slew rate is defined by the lower value of the rise or fall.

■ ELECTRICAL CARACTERISTICS

● DC CHARACTERISTICS (V_{DD}=15V,V_{SS}=0V, Ta=25ºC,unless otherwise noted.)

PARAMETER	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Supply Current	I_{DD}	No Signal	-	66	136	µA
Input Offset Voltage	V_{IO}	V_{IC}= 0V, R_S=50Ω	-	1	4	mV
Input Offset Voltage Drift	ΔVio/ΔT	Ta = -40ºC to +85ºC	-	2.7	-	µV/ºC
Input Bias Current	I_B	V_{IC}= 0V, R_S=50Ω	-	1	-	pA
Input Offset Current	I_{IO}	V_{IC}= 0V, R_S=50Ω	-	1	-	pA
Large Signal Voltage Gain	A_V	V_O=2V to 13V, R_L=10kΩ to 7.5V	100	120	-	dB
Common Mode Rejection Ratio	CMR	V_{ICM}=0V to 13.4V	65	85	-	dB
Supply Voltage Rejection Ratio	SVR	V_{DD}=4V to 16V	70	85	-	dB
Maximum Output Voltage 1	V_{OH}1	R_L=10kΩ to 7.5V	14.95	14.98	-	V
	V_{OL}1		-	0.02	0.05	
Maximum Output Voltage 2	V_{OH}2	R_L=10kΩ to 0V	14.90	14.93	-	V
	V_{OL}2		-	0.01	0.05	
Maximum Output Voltage 3	V_{OH}3	Isource = 3mA	14.70	14.85	-	V
	V_{OL}3	Isink = 3mA	-	0.15	0.30	
Common Mode Input Voltage Range	V_{ICM}	CMR≥65dB	0	-	13.4	V

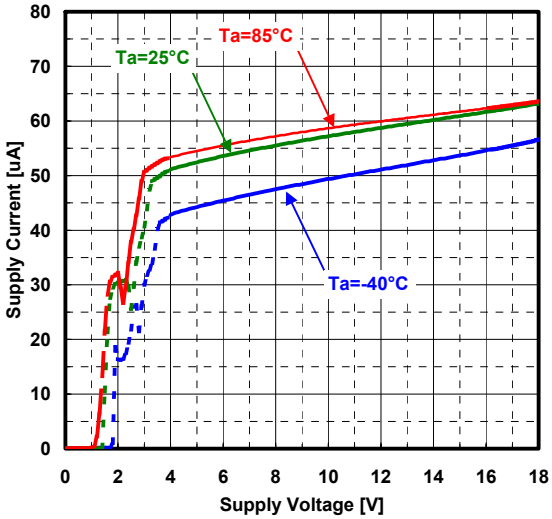
● AC CHARACTERISTICS (V_{DD}=15V,V_{SS}=0V, Ta=25ºC,unless otherwise noted.)

PARAMETER	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Gain Bandwidth Product	GBW	R_L=10kΩ to 7.5V, C_L=20pF, f=1kHz	-	90	-	kHz
Phase Margin	ϕ_M	R_L=10kΩ to 7.5V, C_L=20pF	-	75	-	deg
Gain Margin	G_M	R_L=10kΩ to 7.5V, C_L=20pF	-	23	-	dB
Equivalent Input Noise Voltage	V_{NI}	f=1kHz	-	40	-	nV/√Hz
Channel Separation	CS	f=1kHz	-	120	-	dB
Slew Rate	SR1	G_V=0dB, R_L=10kΩ to 7.5V, C_L=20pF, Vin=11Vpp (2V to 13V) (Note 4)	-	0.04	-	V/µs
	SR2	G_V=0dB, R_L=10kΩ to 0V, C_L=20pF, Vin=11Vpp (2V to 13V) (Note 4)	-	0.04	-	
Power Band	PBW1	G_V=+6dB, R_L=10kΩ to 7.5V, C_L=20pF, Vin=7.5Vpp (3.75V to 11.25V),Vo>14.8Vpp	-	1.1	-	kHz
	PBW2	G_V=+6dB, R_L=10kΩ to 0V, C_L=20pF, Vin=7.5Vpp (3.75V to 11.25V),Vo>14.8Vpp	-	0.8	-	
Total Harmonic Distortion	THD1	G_V=+6dB, R_L=10kΩ to 7.5V, C_L=20pF, f=100Hz,Vout=10Vpp	-	0.02	-	%
	THD2	G_V=+6dB, R_L=10kΩ to 0V, C_L=20pF, f=100Hz,Vout=10Vpp	-	0.003	-	%

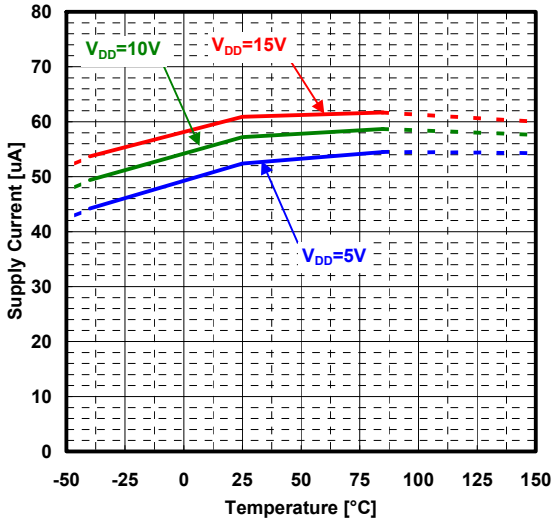
(Note 4) Slew rate is defined by the lower value of the rise or fall.

■ TYPICAL CHARACTERISTICS

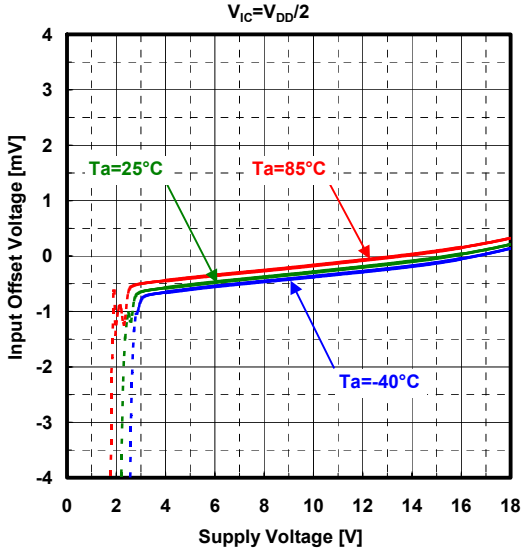
Supply Current vs. Supply Voltage
$V_{IC}=V_{DD}/2$



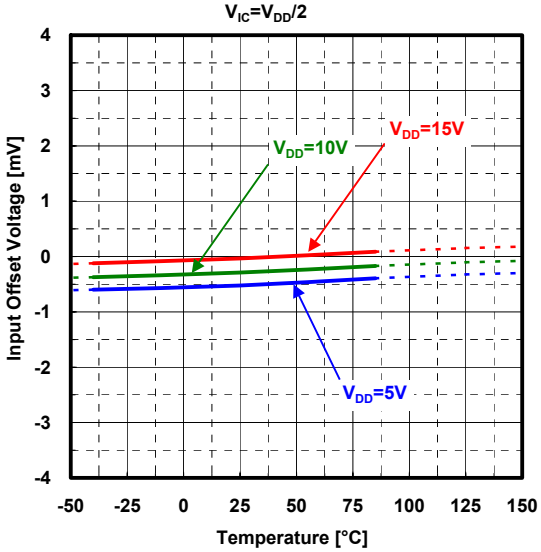
Supply Current vs. Temperature
$V_{IC}=V_{DD}/2$



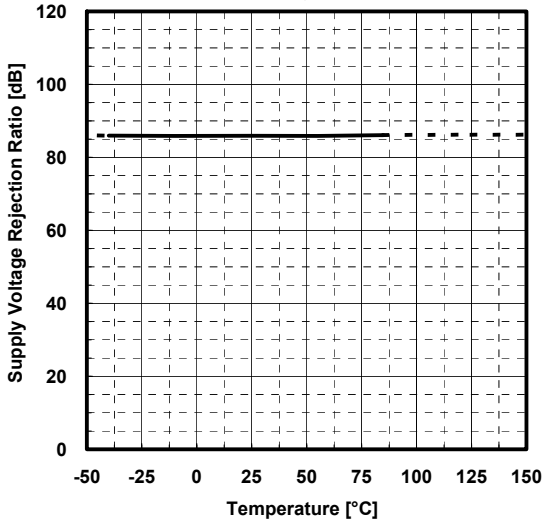
Input Offset Voltage vs.Supply Voltage
$V_{IC}=V_{DD}/2$



Input Offset Voltage vs. Temperature
$V_{IC}=V_{DD}/2$

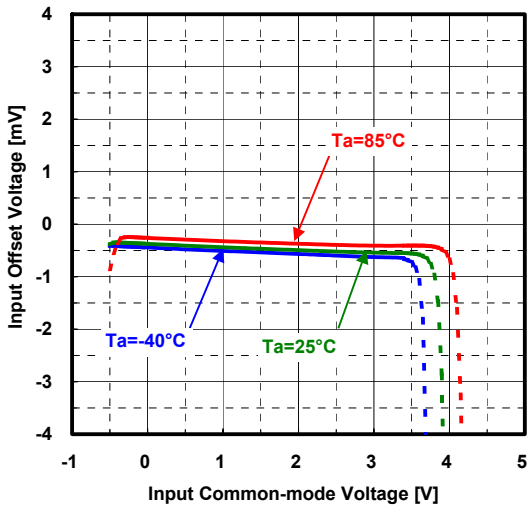


Supply Voltage Rejection Ratio vs. Temperature
V_{DD}=4V to 16V, $V_{IC}=V_{DD}/2$



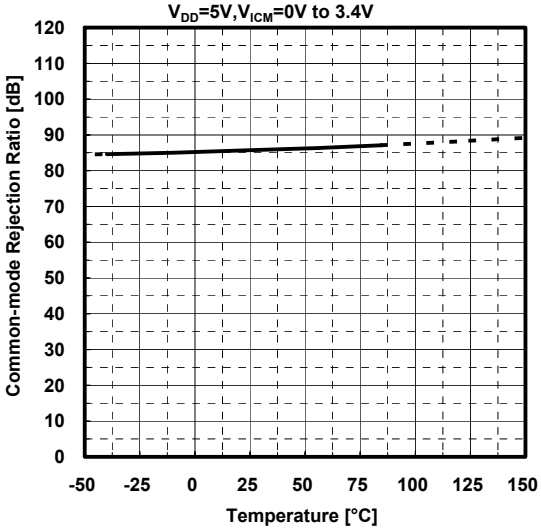
Input Offset Voltage vs.Input Common-mode Voltage

V_{DD}=5V



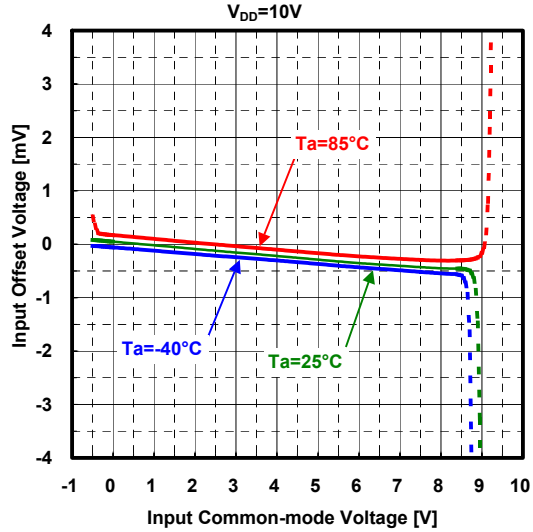
Common-mode Rejection Ratio vs. Temperature

V_{DD}=5V,V_{ICM}=0V to 3.4V



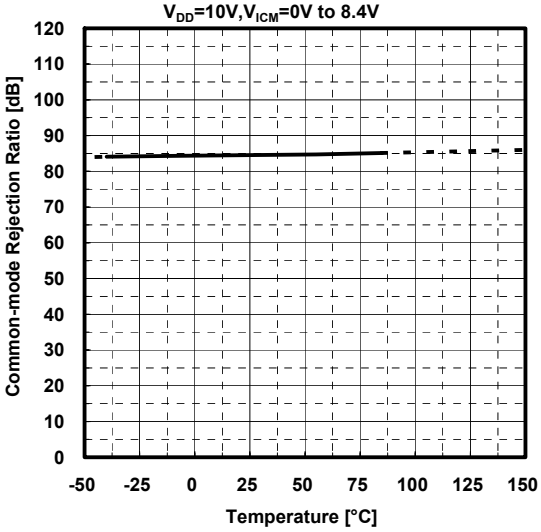
Input Offset Voltage vs.Input Common-mode Voltage

V_{DD}=10V



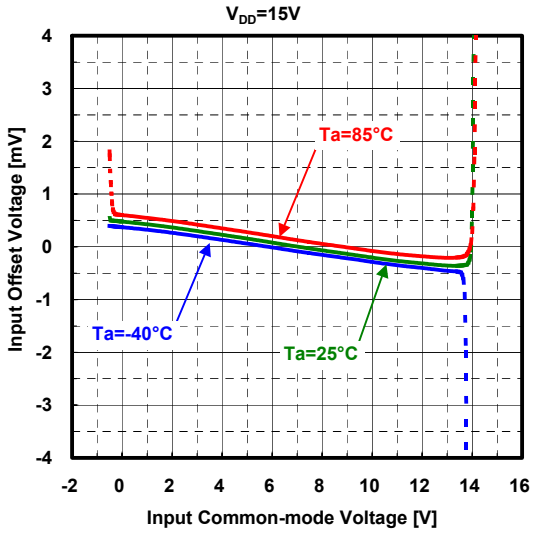
Common-mode Rejection Ratio vs. Temperature

V_{DD}=10V,V_{ICM}=0V to 8.4V



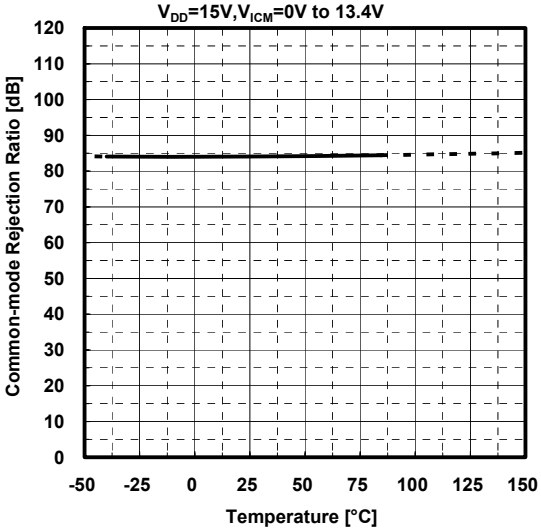
Input Offset Voltage vs.Input Common-mode Voltage

V_{DD}=15V



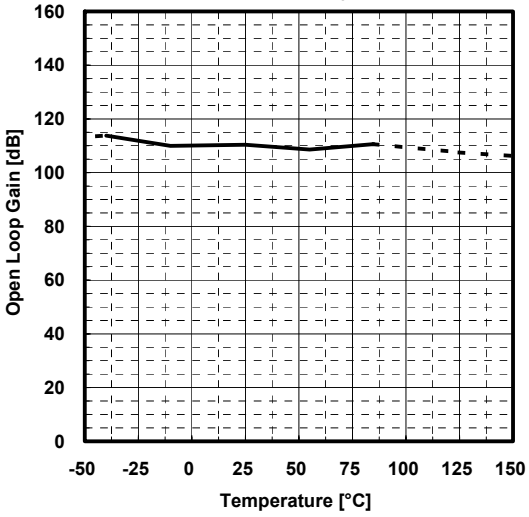
Common-mode Rejection Ratio vs. Temperature

V_{DD}=15V,V_{ICM}=0V to 13.4V



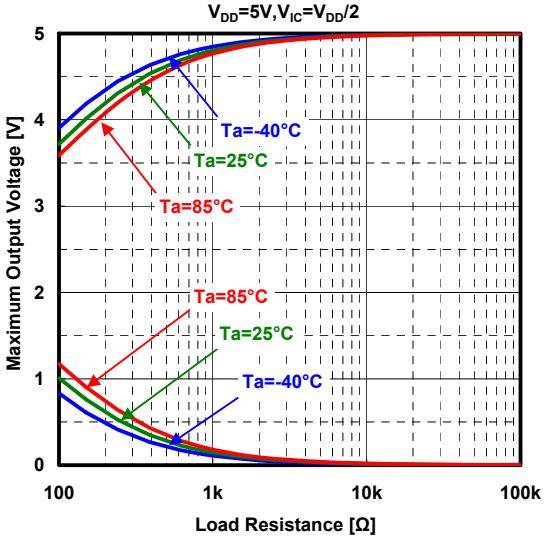
Open Loop Gain vs. Temperature

V_{DD}=5V,R_L=10kΩ to V_{DD}/2,V_O=V_{DD}/2±1.5V



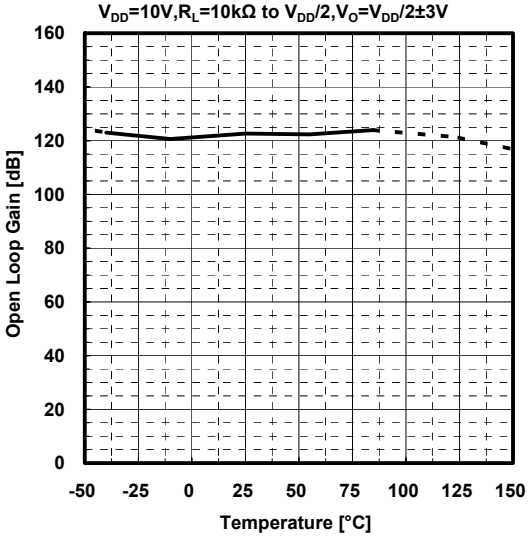
Maximum Output Voltage vs. Load Resistance

V_{DD}=5V,V_{IC}=V_{DD}/2



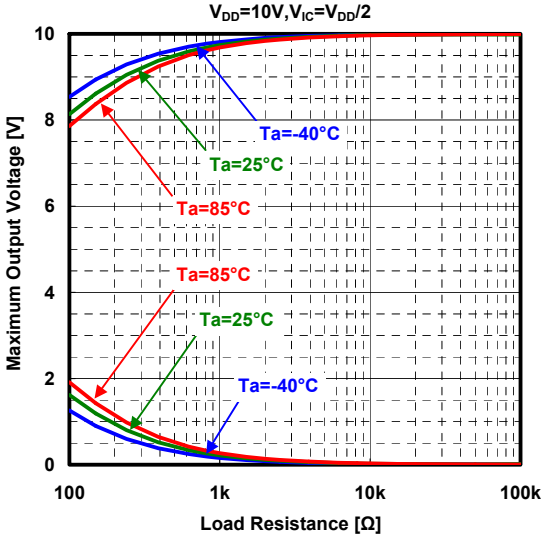
Open Loop Gain vs. Temperature

V_{DD}=10V,R_L=10kΩ to V_{DD}/2,V_O=V_{DD}/2±3V



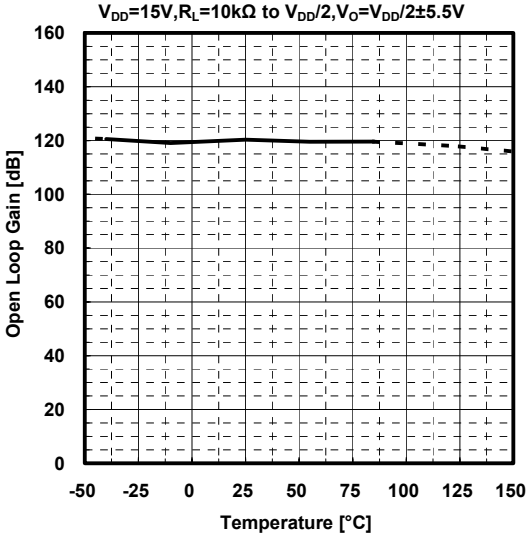
Maximum Output Voltage vs. Load Resistance

V_{DD}=10V,V_{IC}=V_{DD}/2



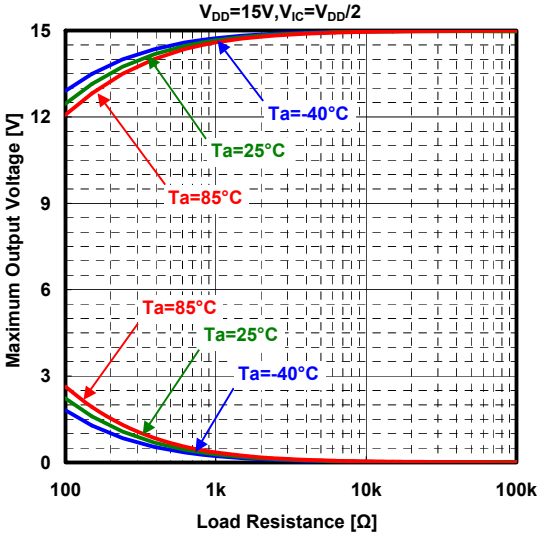
Open Loop Gain vs. Temperature

V_{DD}=15V,R_L=10kΩ to V_{DD}/2,V_O=V_{DD}/2±5.5V

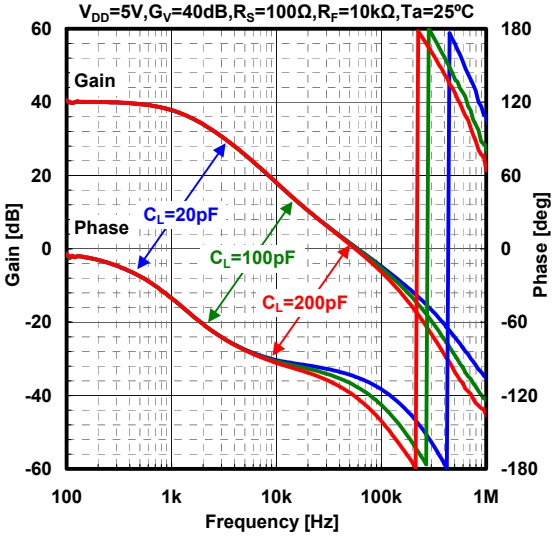


Maximum Output Voltage vs. Load Resistance

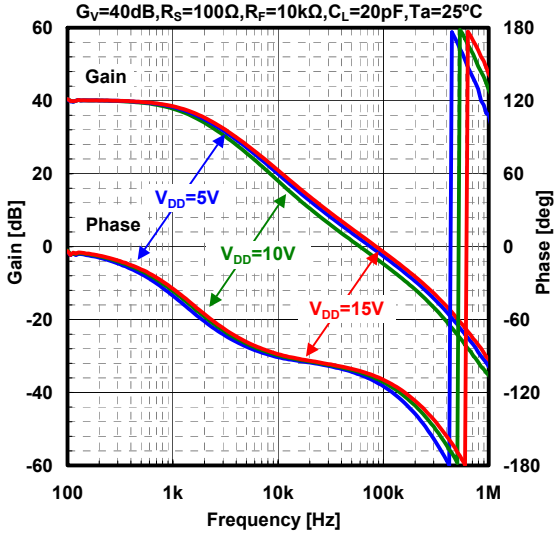
V_{DD}=15V,V_{IC}=V_{DD}/2



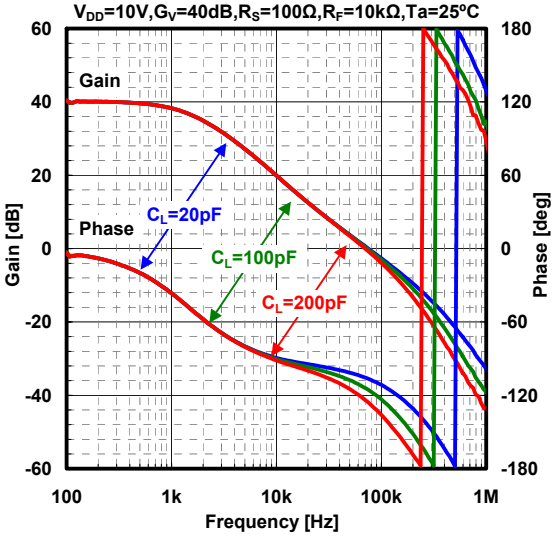
Gain/Phase vs. Frequency



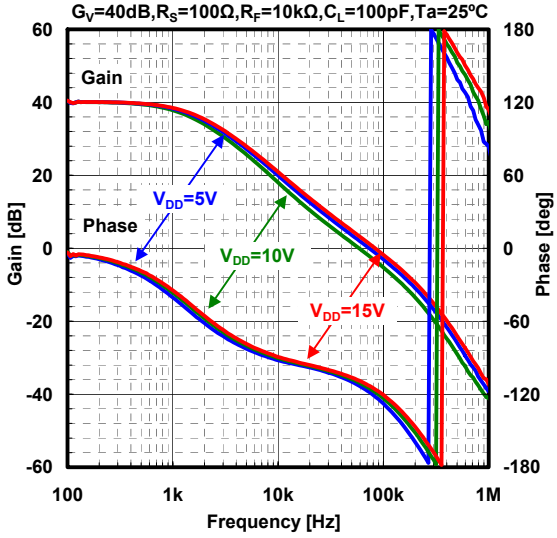
Gain/Phase vs. Frequency



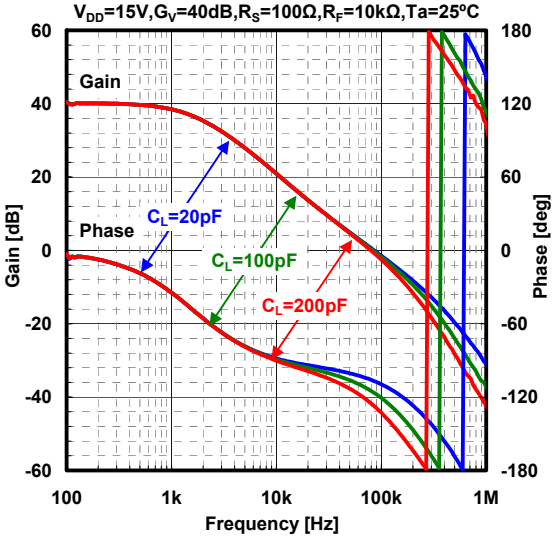
Gain/Phase vs. Frequency



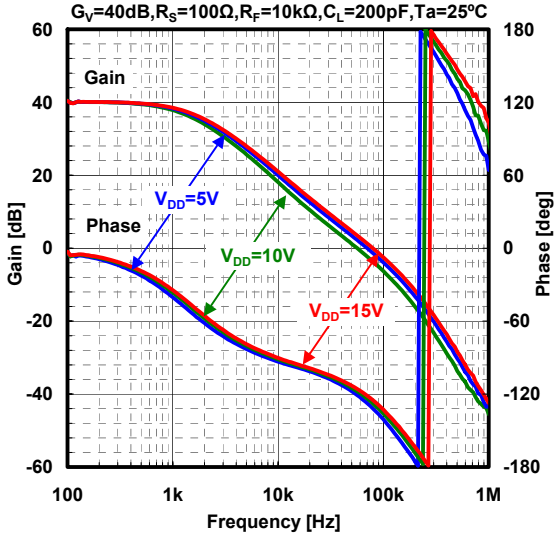
Gain/Phase vs. Frequency



Gain/Phase vs. Frequency

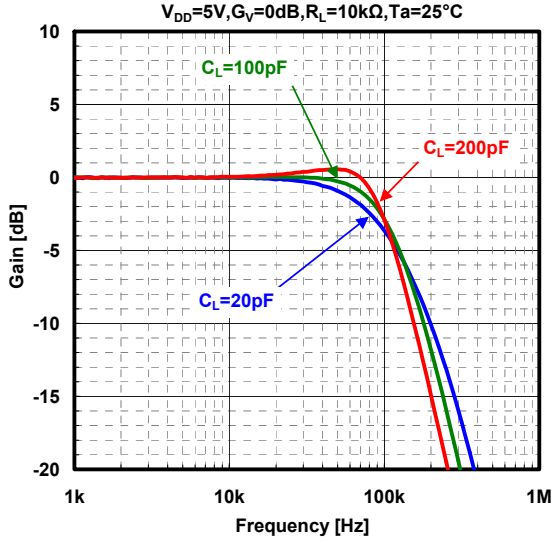


Gain/Phase vs. Frequency



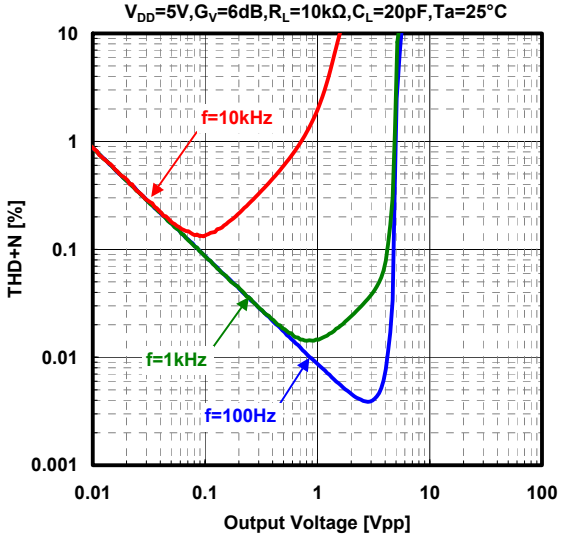
Unity Gain Frequency Response

V_{DD}=5V,G_V=0dB,R_L=10kΩ,Ta=25°C



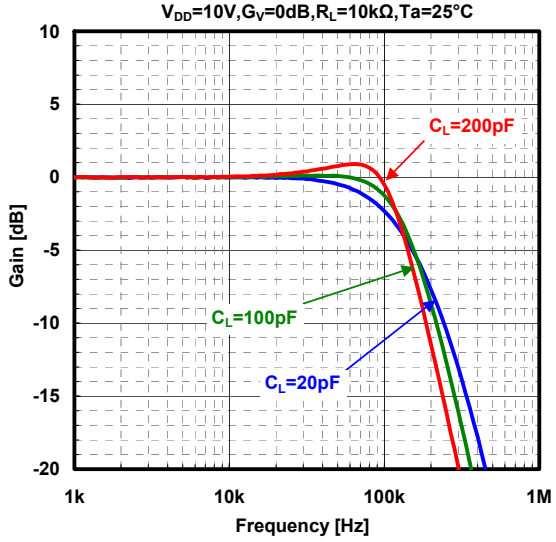
THD+N vs. Output Voltage

V_{DD}=5V,G_V=6dB,R_L=10kΩ,C_L=20pF,Ta=25°C



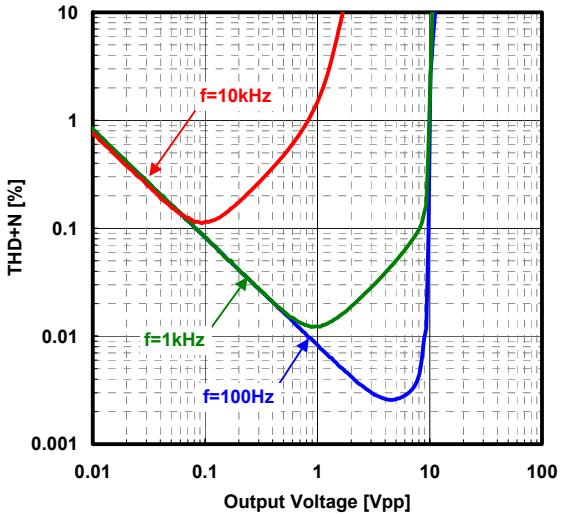
Unity Gain Frequency Response

V_{DD}=10V,G_V=0dB,R_L=10kΩ,Ta=25°C



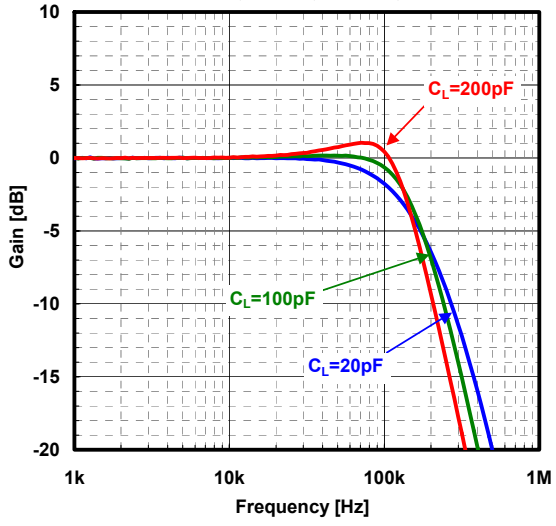
THD+N vs. Output Voltage

V_{DD}=10V,G_V=6dB,R_L=10kΩ,C_L=20pF,Ta=25°C



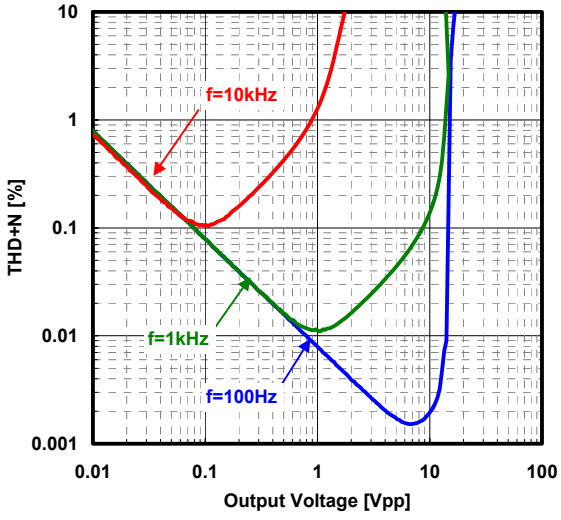
Unity Gain Frequency Response

V_{DD}=15V,G_V=0dB,R_L=10kΩ,Ta=25°C



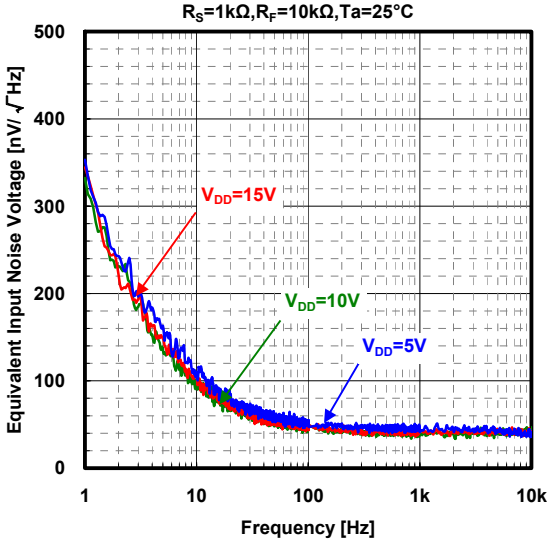
THD+N vs. Output Voltage

V_{DD}=15V,G_V=6dB,R_L=10kΩ,C_L=20pF,Ta=25°C



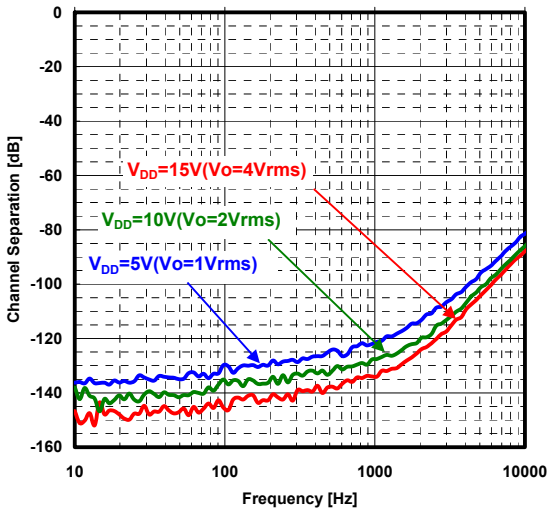
Equivalent Input Noise Voltage

R_S=1kΩ,R_F=10kΩ,Ta=25°C



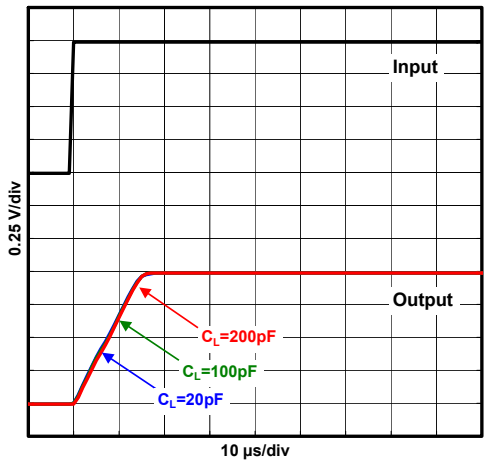
Channel Separation vs. Frequency

Rs=1kΩ,Rf=100kΩ,R_T=1kΩ,R_L=open,Ta=25°C



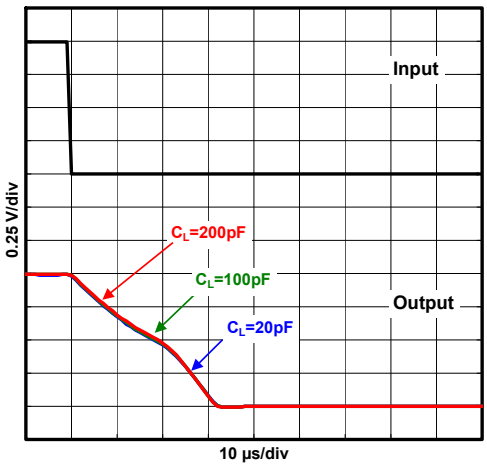
Transient Response

V_{DD}=5V,G_V=0dB,V_{IN}=1V_{PP},R_L=10kΩ,Ta=25°C



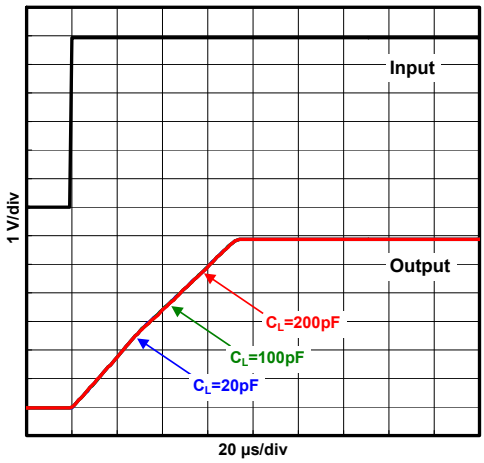
Transient Response

V_{DD}=5V,G_V=0dB,V_{IN}=1V_{PP},R_L=10kΩ,Ta=25°C



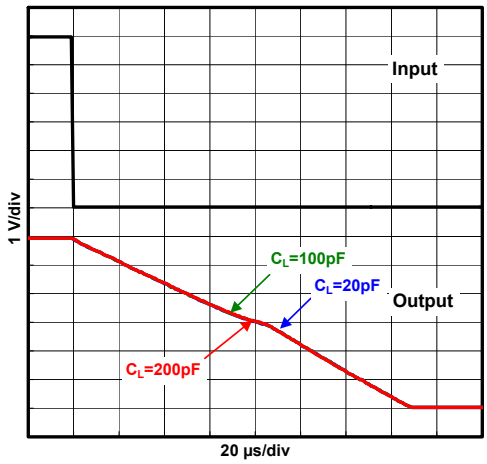
Transient Response

V_{DD}=10V,G_V=0dB,V_{IN}=6V_{PP},R_L=10kΩ,Ta=25°C



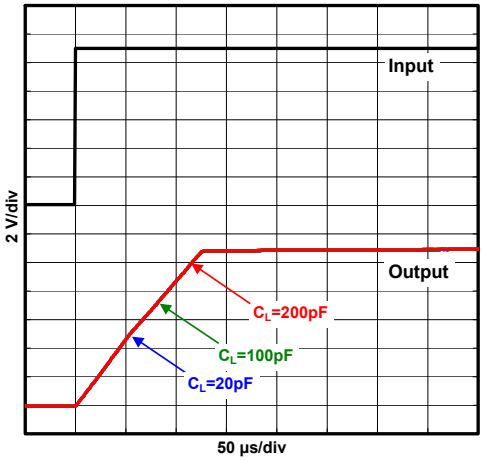
Transient Response

V_{DD}=10V,G_V=0dB,V_{IN}=6V_{PP},R_L=10kΩ,Ta=25°C



Transient Response

V_{DD}=15V,G_V=0dB,V_{IN}=11V_{PP},R_L=10kΩ,Ta=25°C



Transient Response

V_{DD}=15V,G_V=0dB,V_{IN}=11V_{PP},R_L=10kΩ,Ta=25°C