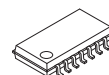


14μA/ch, 16V Operation, Rail-to-Rail Output Quad CMOS Operational Amplifier

■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)

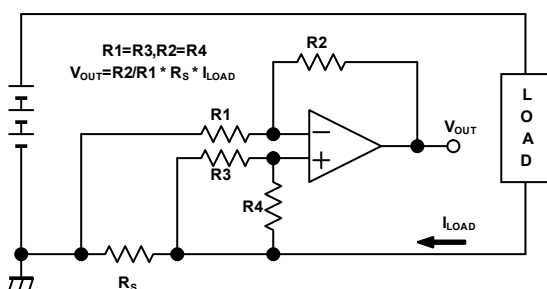
■FEATURES

- | | |
|-----------------------------|---|
| •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 $V_{DD} - 0.1V$ min. ($R_L=10k\Omega$ to 0V) |
| •Wide Operating Voltage | $V_{opr}= 4V$ 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

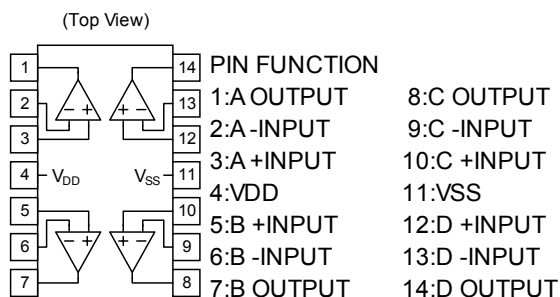
- Battery-operated application
- Battery Monitor
- Current Sensor
- Photodiode application

■APPLICATION CIRCUIT



Low-side Current Sensor

■PIN CONFIGURATION



■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

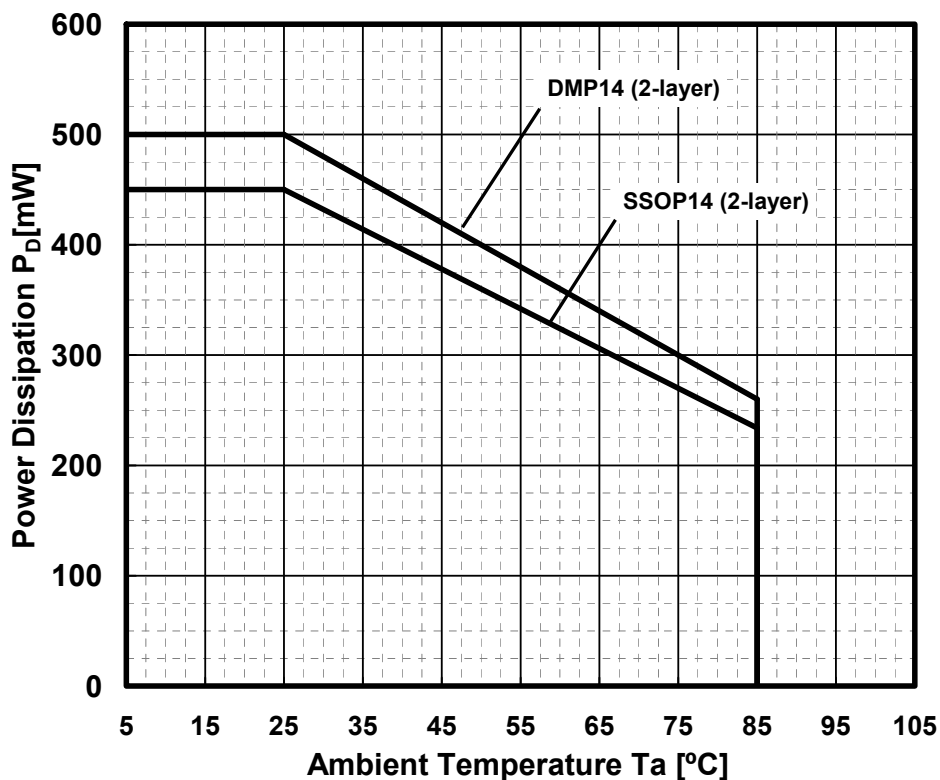
(Note 1) For supply voltage less than +18V, the absolute maximum rating is equal to the supply voltage.

(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 CHARACTERISTICS

● DC CHARACTERISTICS

($V_{DD}=5V, V_{SS}=0V, T_a=25^{\circ}C$, 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}	$V_{IC}=0V, R_S=50\Omega$	-	1	4	mV
Input Offset Voltage Drift	$\Delta V_{IO}/\Delta T$	$T_a = -40^{\circ}C$ to $+85^{\circ}C$	-	3.3	-	$\mu V/^{\circ}C$
Input Bias Current	I_B	$V_{IC}=0V, R_S=50\Omega$	-	1	-	pA
Input Offset Current	I_{IO}	$V_{IC}=0V, R_S=50\Omega$	-	1	-	pA
Large Signal Voltage Gain	A_V	$V_O=1V$ to $4V, R_L=10k\Omega$ 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_{OH1}	$R_L=10k\Omega$ to $2.5V$	4.95	4.98	-	V
	V_{OL1}		-	0.02	0.05	
Maximum Output Voltage 2	V_{OH2}	$R_L=10k\Omega$ to $0V$	4.90	4.96	-	V
	V_{OL2}		-	0.01	0.05	
Maximum Output Voltage 3	V_{OH3}	$I_{source} = 3mA$	4.65	4.75	-	V
	V_{OL3}	$I_{sink} = 3mA$	-	0.20	0.30	
Common Mode Input Voltage Range	V_{ICM}	CMR $\geq 65dB$	0	-	3.4	V

● AC CHARACTERISTICS

($V_{DD}=5V, V_{SS}=0V, T_a=25^{\circ}C$, unless otherwise noted.)

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

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

■ ELECTRICAL CHARACTERISTICS

● DC CHARACTERISTICS

($V_{DD}=10V, V_{SS}=0V, T_a=25^{\circ}C$, 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}	$V_{IC}=0V, R_S=50\Omega$	-	1	4	mV
Input Offset Voltage Drift	$\Delta V_{IO}/\Delta T$	$T_a = -40^{\circ}C$ to $+85^{\circ}C$	-	2.7	-	$\mu V/^{\circ}C$
Input Bias Current	I_B	$V_{IC}=0V, R_S=50\Omega$	-	1	-	pA
Input Offset Current	I_{IO}	$V_{IC}=0V, R_S=50\Omega$	-	1	-	pA
Large Signal Voltage Gain	A_V	$V_O=2V$ to $8V, R_L=10k\Omega$ 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_{OH1}	$R_L=10k\Omega$ to $5V$	9.95	9.98	-	V
	V_{OL1}		-	0.02	0.05	
Maximum Output Voltage 2	V_{OH2}	$R_L=10k\Omega$ to $0V$	9.90	995	-	V
	V_{OL2}		-	0.01	0.05	
Maximum Output Voltage 3	V_{OH3}	$I_{source} = 3mA$	9.70	9.80	-	V
	V_{OL3}	$I_{sink} = 3mA$	-	0.15	0.30	
Common Mode Input Voltage Range	V_{ICM}	CMR $\geq 65dB$	0	-	8.4	V

● AC CHARACTERISTICS

($V_{DD}=10V, V_{SS}=0V, T_a=25^{\circ}C$, unless otherwise noted.)

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

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

■ ELECTRICAL CHARACTERISTICS

● DC CHARACTERISTICS

($V_{DD}=15V, V_{SS}=0V, T_a=25^{\circ}C$, 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}	$V_{IC}=0V, R_S=50\Omega$	-	1	4	mV
Input Offset Voltage Drift	$\Delta V_{IO}/\Delta T$	$T_a = -40^{\circ}C$ to $+85^{\circ}C$	-	2.7	-	$\mu V/^{\circ}C$
Input Bias Current	I_B	$V_{IC}=0V, R_S=50\Omega$	-	1	-	pA
Input Offset Current	I_{IO}	$V_{IC}=0V, R_S=50\Omega$	-	1	-	pA
Large Signal Voltage Gain	A_V	$V_O=2V$ to $13V, R_L=10k\Omega$ 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_{OH1}	$R_L=10k\Omega$ to $7.5V$	14.95	14.98	-	V
	V_{OL1}		-	0.02	0.05	
Maximum Output Voltage 2	V_{OH2}	$R_L=10k\Omega$ to $0V$	14.90	14.93	-	V
	V_{OL2}		-	0.01	0.05	
Maximum Output Voltage 3	V_{OH3}	$I_{source} = 3mA$	14.70	14.85	-	V
	V_{OL3}	$I_{sink} = 3mA$	-	0.15	0.30	
Common Mode Input Voltage Range	V_{ICM}	CMR $\geq 65dB$	0	-	13.4	V

● AC CHARACTERISTICS

($V_{DD}=15V, V_{SS}=0V, T_a=25^{\circ}C$, unless otherwise noted.)

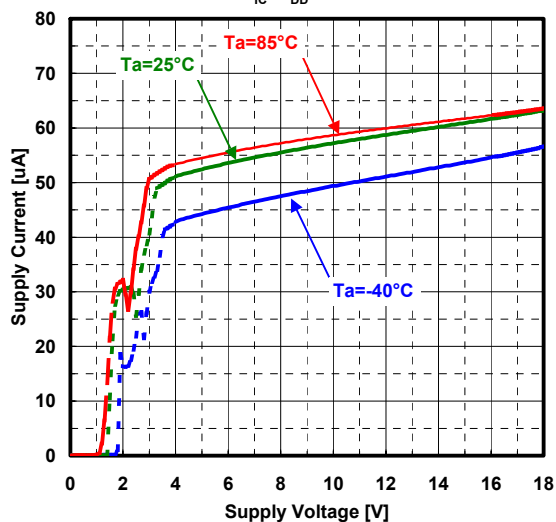
PARAMETER	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Gain Bandwidth Product	GBW	$R_L=10k\Omega$ to $7.5V, C_L=20pF, f=1kHz$	-	90	-	kHz
Phase Margin	ϕ_M	$R_L=10k\Omega$ to $7.5V, C_L=20pF$	-	75	-	deg
Gain Margin	G_M	$R_L=10k\Omega$ to $7.5V, C_L=20pF$	-	23	-	dB
Equivalent Input Noise Voltage	V_{NI}	$f=1kHz$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

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

■ TYPICAL CHARACTERISTICS

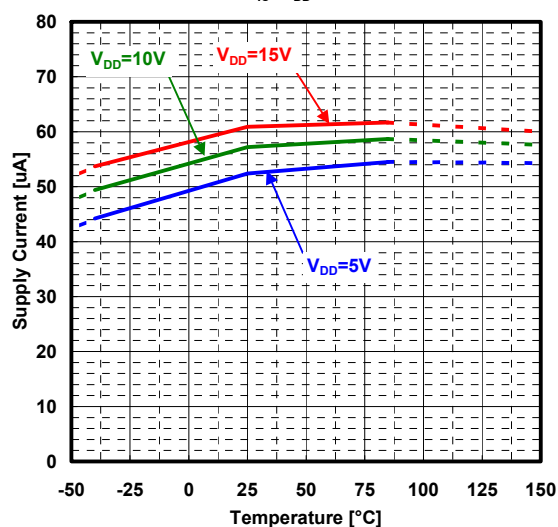
Supply Current vs. Supply Voltage

$$V_{IC}=V_{DD}/2$$



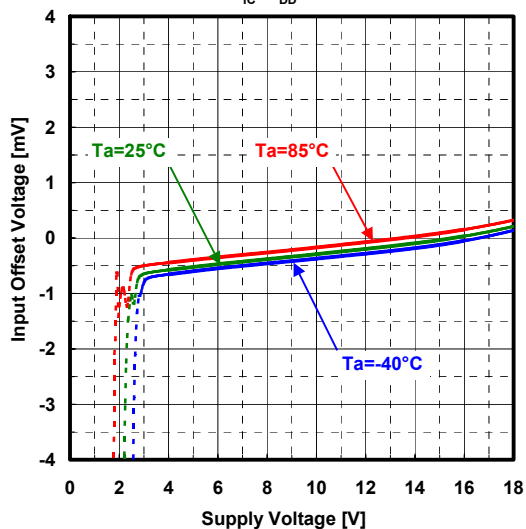
Supply Current vs. Temperature

$$V_{IC}=V_{DD}/2$$



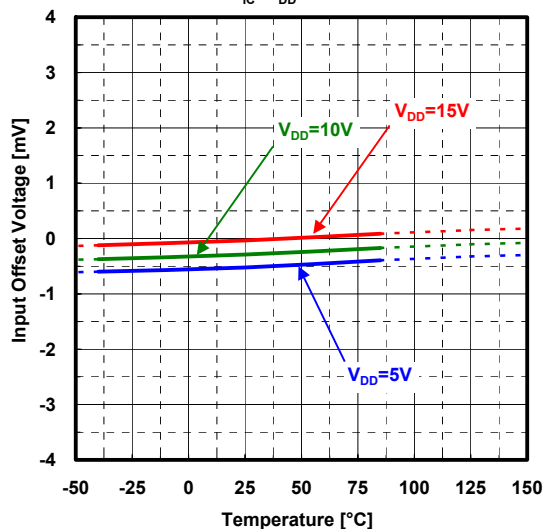
Input Offset Voltage vs. Supply Voltage

$$V_{IC}=V_{DD}/2$$



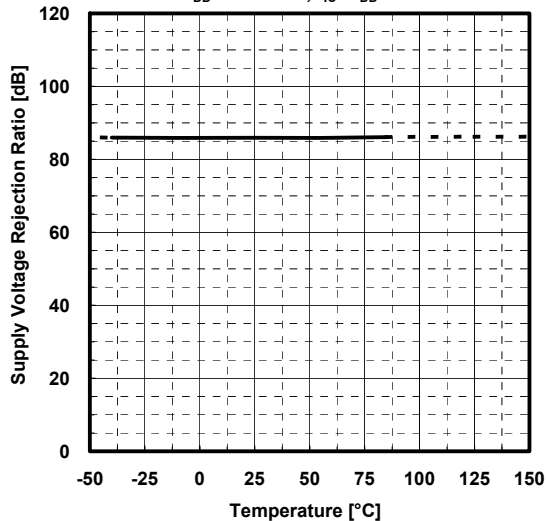
Input Offset Voltage vs. Temperature

$$V_{IC}=V_{DD}/2$$

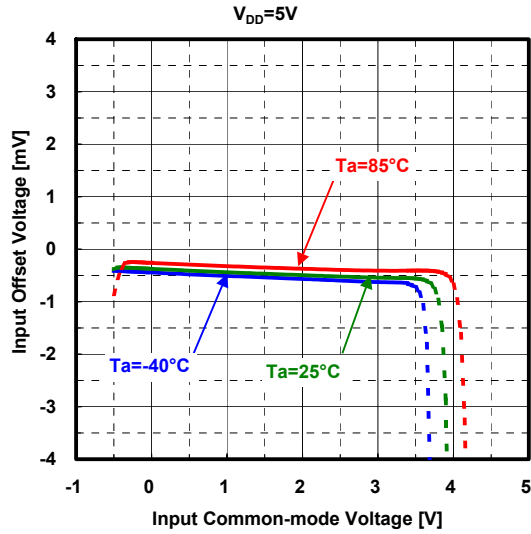


Supply Voltage Rejection Ratio vs. Temperature

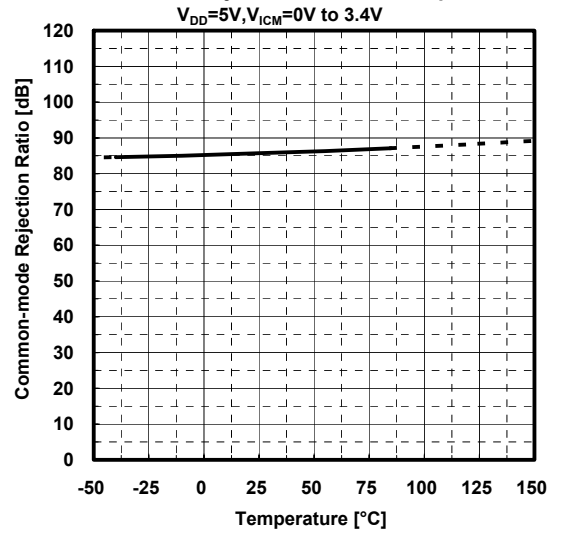
$$V_{DD}=4V \text{ to } 16V, V_{IC}=V_{DD}/2$$



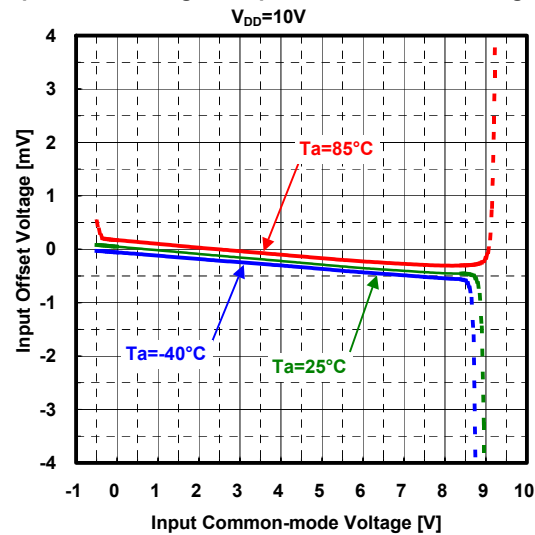
Input Offset Voltage vs. Input Common-mode Voltage



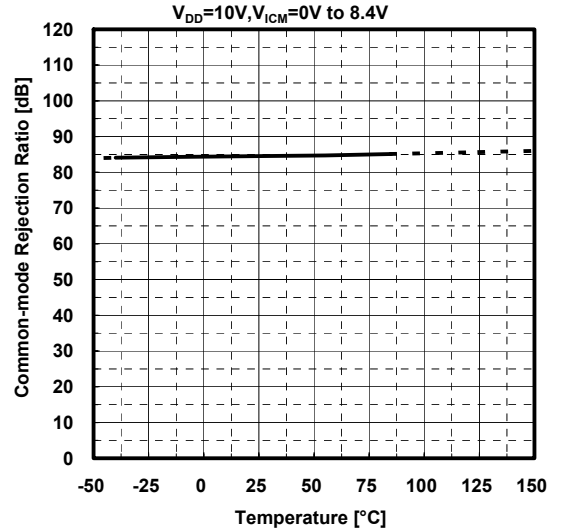
Common-mode Rejection Ratio vs. Temperature



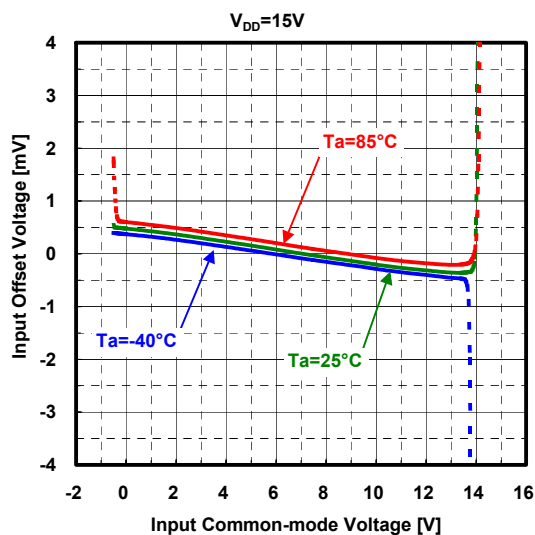
Input Offset Voltage vs. Input Common-mode Voltage



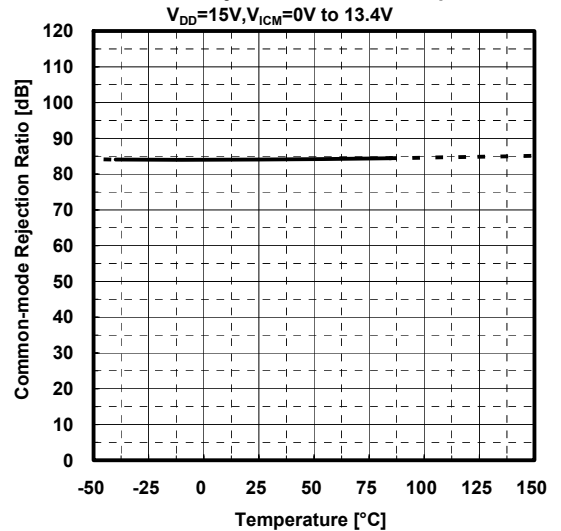
Common-mode Rejection Ratio vs. Temperature

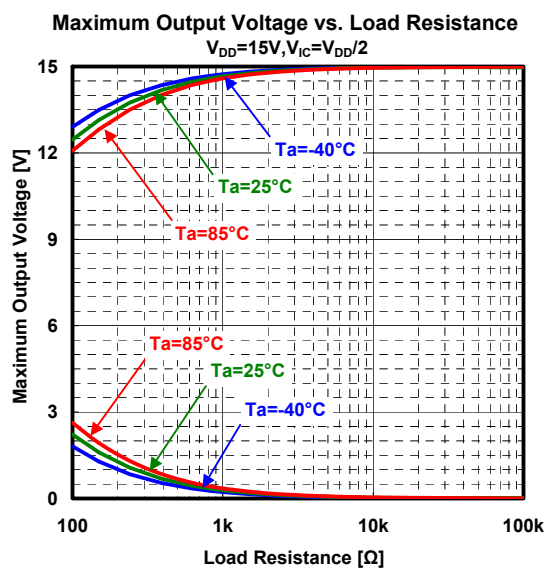
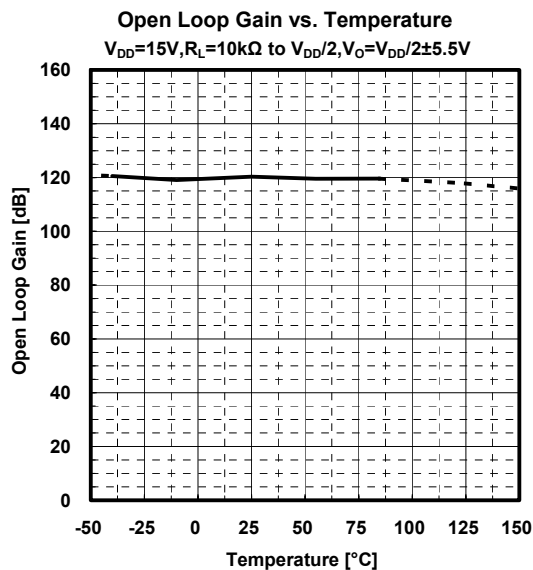
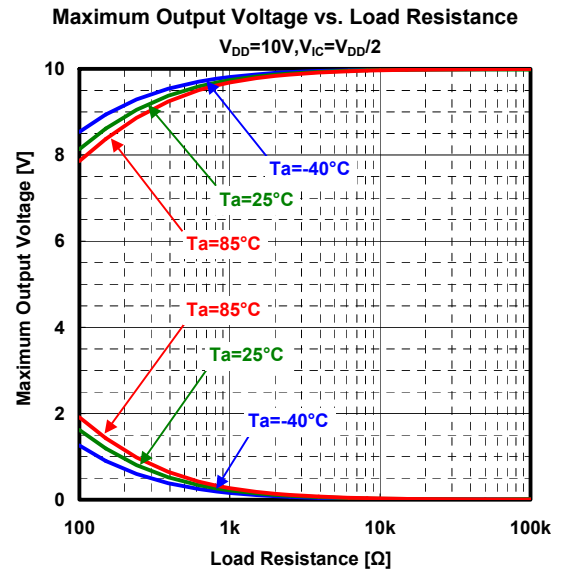
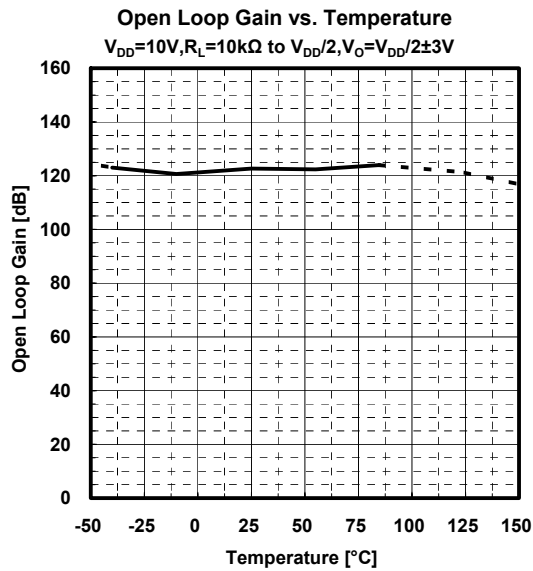
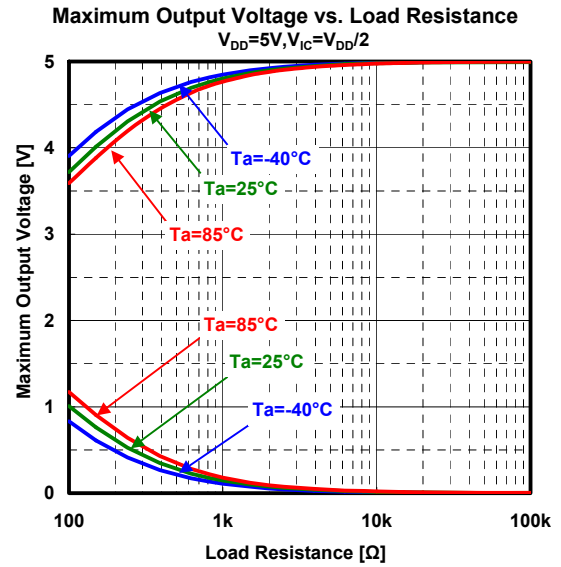
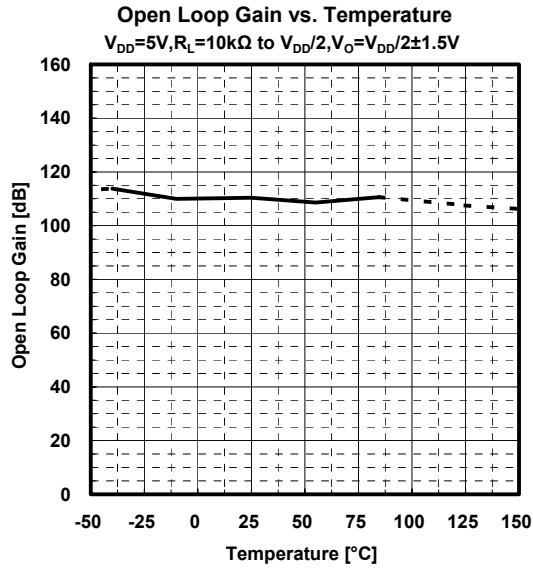


Input Offset Voltage vs. Input Common-mode Voltage



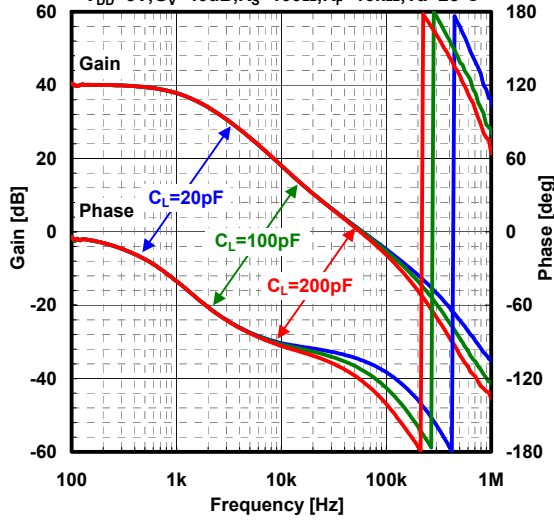
Common-mode Rejection Ratio vs. Temperature





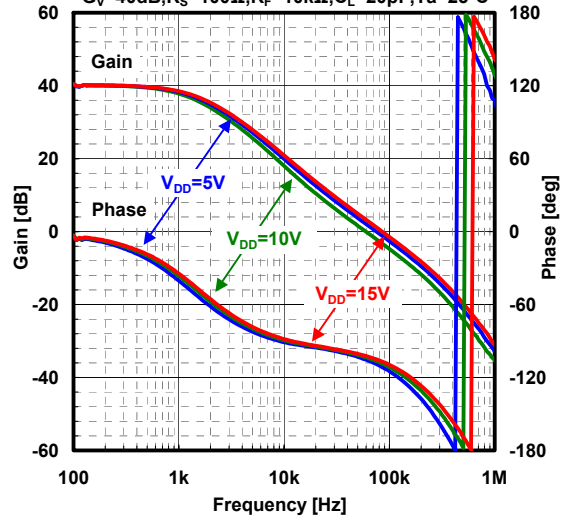
Gain/Phase vs. Frequency

$V_{DD}=5V, G_V=40dB, R_S=100\Omega, R_F=10k\Omega, T_a=25^\circ C$



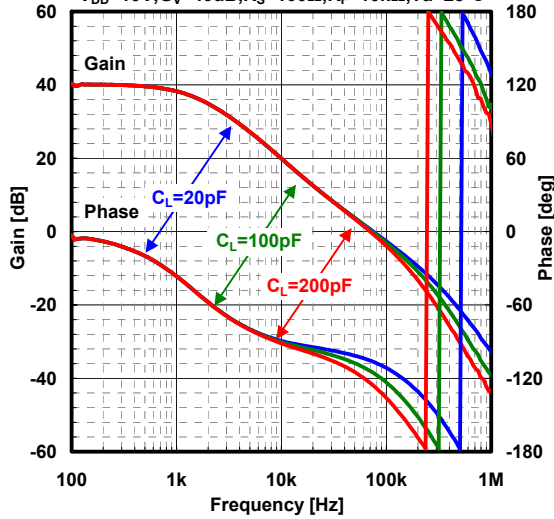
Gain/Phase vs. Frequency

$G_V=40dB, R_S=100\Omega, R_F=10k\Omega, C_L=20pF, T_a=25^\circ C$



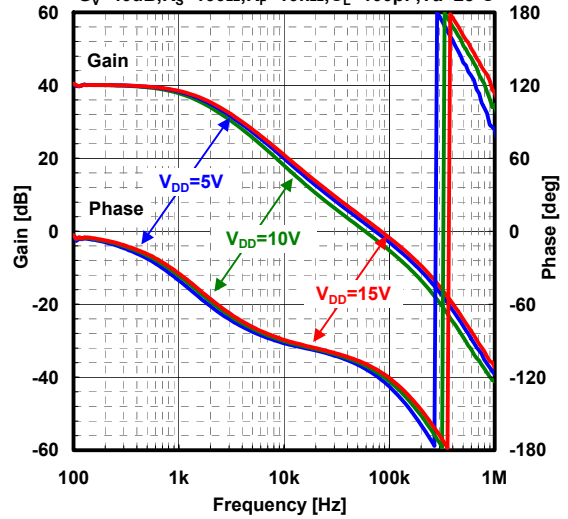
Gain/Phase vs. Frequency

$V_{DD}=10V, G_V=40dB, R_S=100\Omega, R_F=10k\Omega, T_a=25^\circ C$



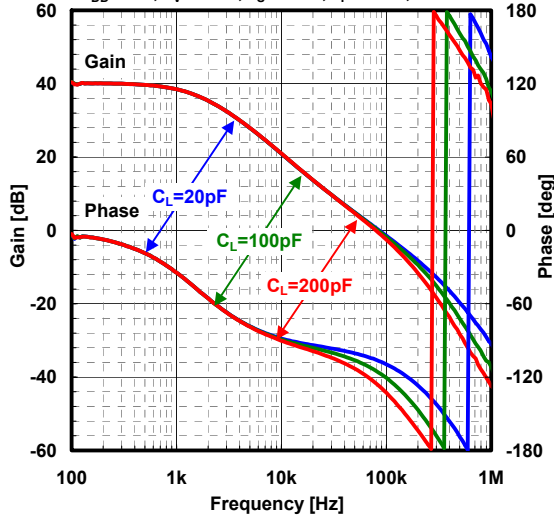
Gain/Phase vs. Frequency

$G_V=40dB, R_S=100\Omega, R_F=10k\Omega, C_L=100pF, T_a=25^\circ C$



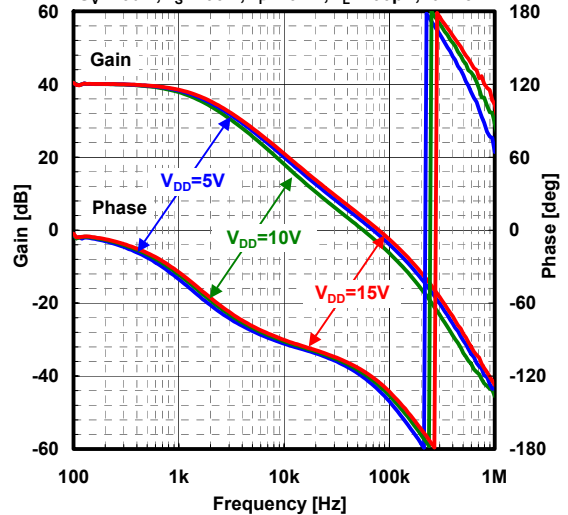
Gain/Phase vs. Frequency

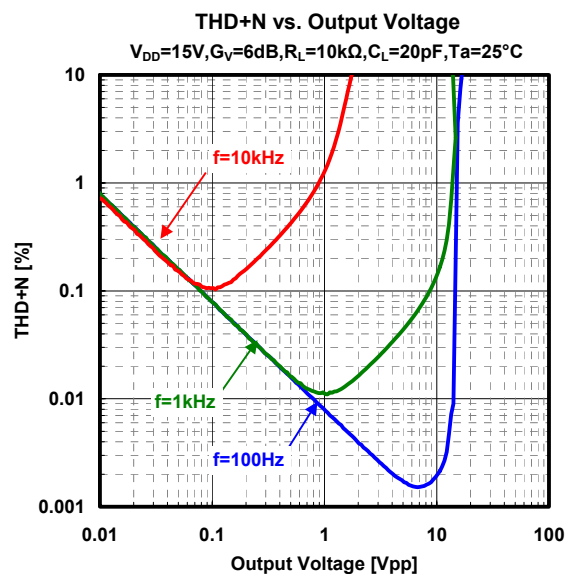
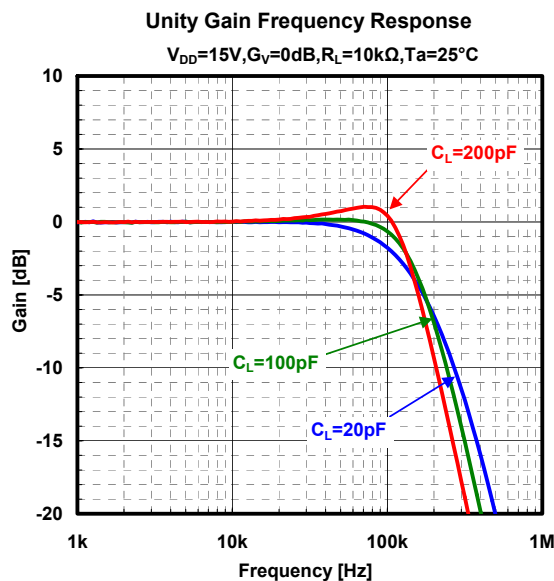
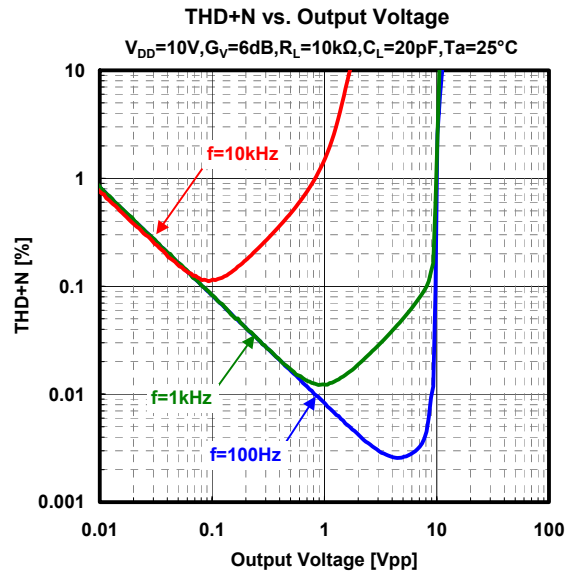
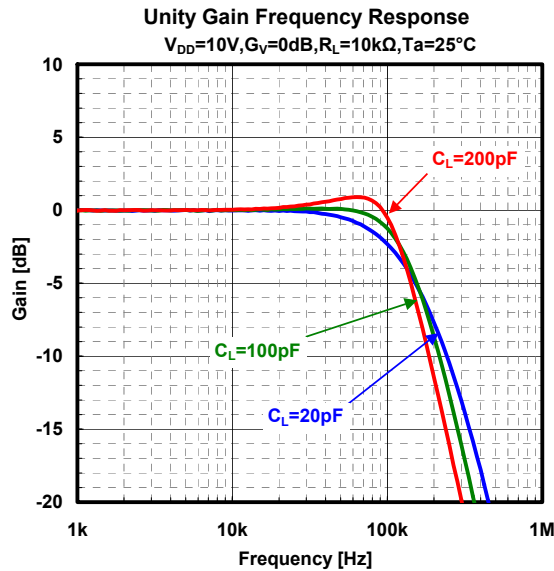
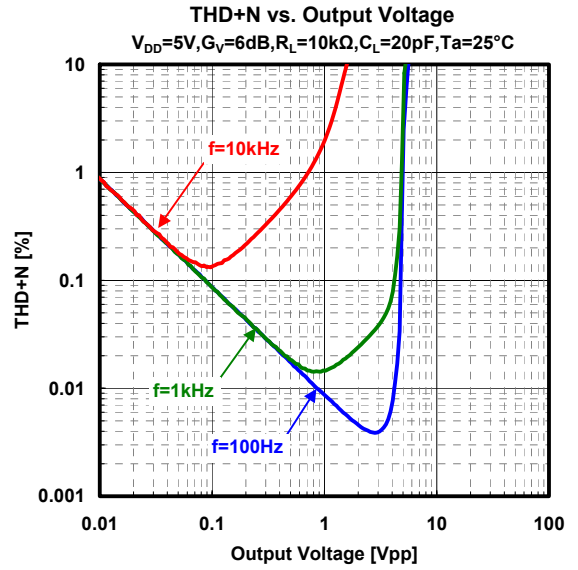
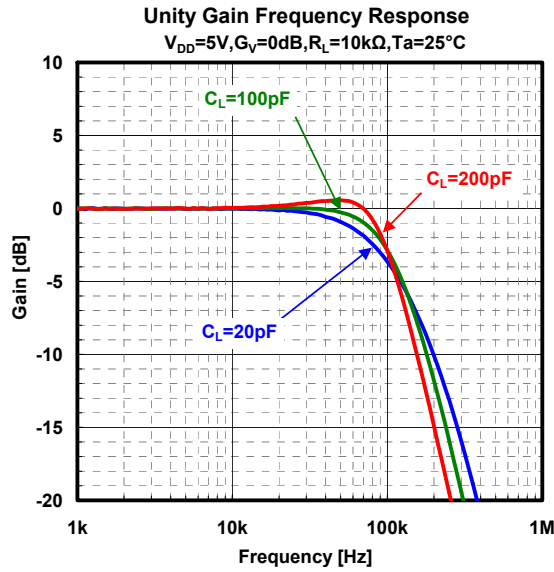
$V_{DD}=15V, G_V=40dB, R_S=100\Omega, R_F=10k\Omega, T_a=25^\circ C$



Gain/Phase vs. Frequency

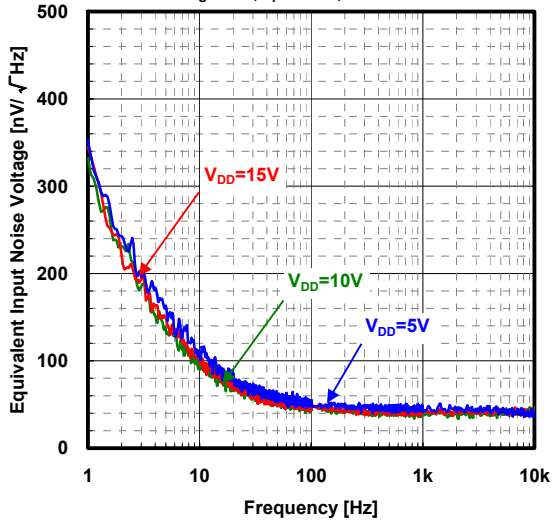
$G_V=40dB, R_S=100\Omega, R_F=10k\Omega, C_L=200pF, T_a=25^\circ C$





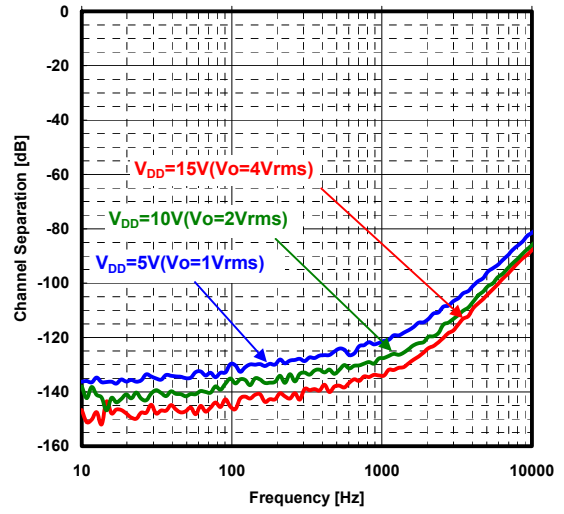
Equivalent Input Noise Voltage

$R_S=1k\Omega, R_F=10k\Omega, T_a=25^\circ C$



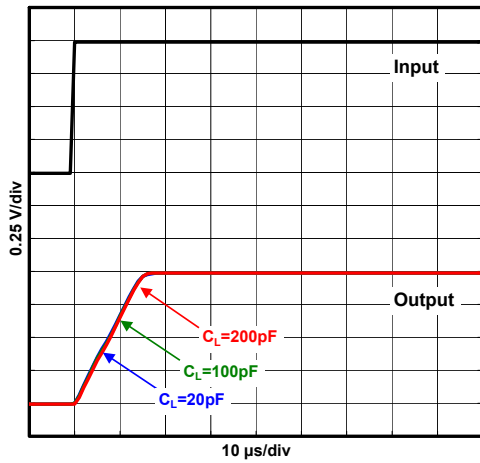
Channel Separation vs. Frequency

$R_S=1k\Omega, R_F=100k\Omega, R_I=1k\Omega, R_L=open, T_a=25^\circ C$



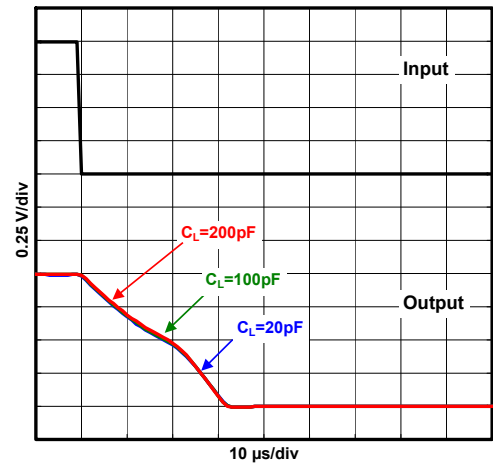
Transient Response

$V_{DD}=5V, G_V=0dB, V_{IN}=1V_{PP}, R_L=10k\Omega, T_a=25^\circ C$



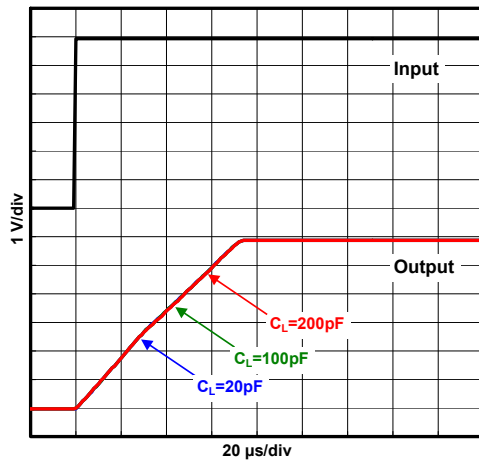
Transient Response

$V_{DD}=5V, G_V=0dB, V_{IN}=1V_{PP}, R_L=10k\Omega, T_a=25^\circ C$



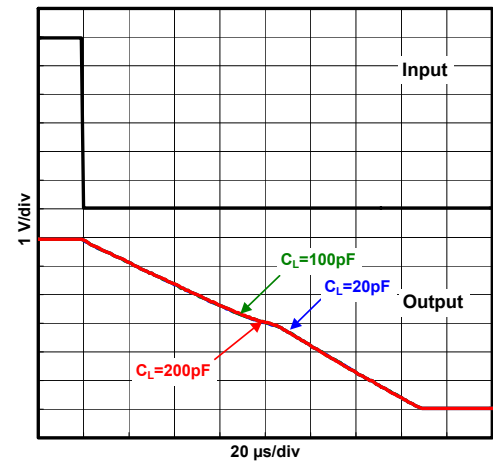
Transient Response

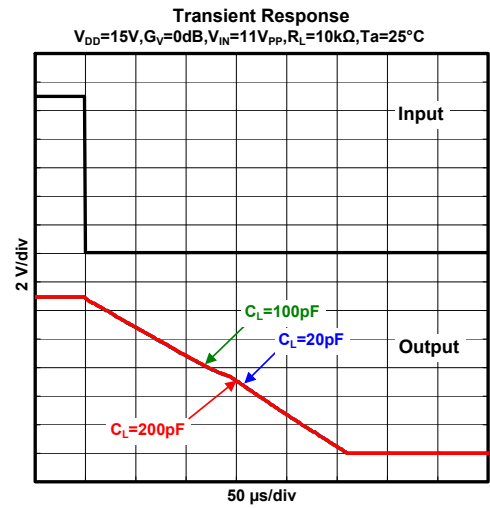
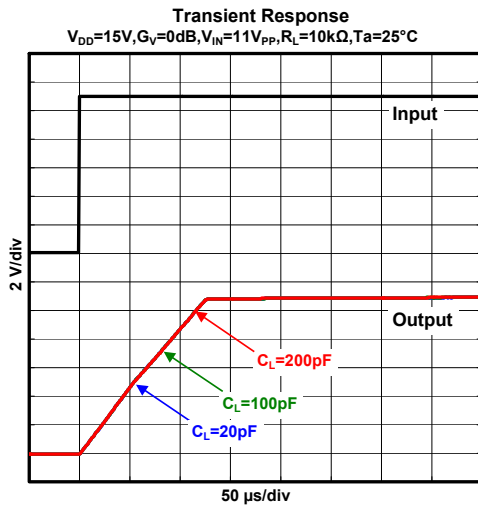
$V_{DD}=10V, G_V=0dB, V_{IN}=6V_{PP}, R_L=10k\Omega, T_a=25^\circ C$



Transient Response

$V_{DD}=10V, G_V=0dB, V_{IN}=6V_{PP}, R_L=10k\Omega, T_a=25^\circ C$





[CAUTION]

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