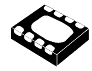
High Output Current, Rail-to-Rail Input/Output Dual CMOS Operational Amplifier

■ GENERAL DESCRIPTION

The NJU77902 is a Rail-to-Rail input and output dual CMOS operational amplifier that features high output current drive.
This device is stable to capacitive load and can charge and discharge capacitance quickly by high output current up to 1000mA. In addition, it is ideal for buffer amplifiers as the output stage can supply a respectable amount of current with minimal headroom from either rail.

■ PACKAGE OUTLINE



NJU77902KW2
(ESON8-W2)

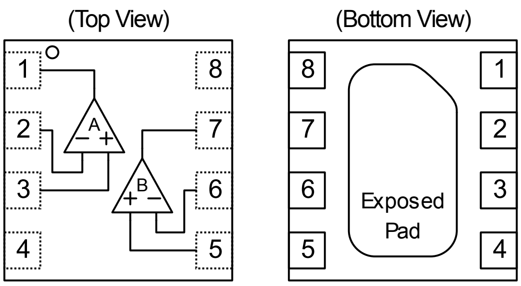
■ FEATURES

•Output Peak Current	1000mA (typ.)
•Rail-to-Rail Input/Output	
•Wide Operating Voltage	6V to 18V
•Slew Rate	9V/µs (typ.)
•Package	ESON8-W2 (3.0mm x 3.0mm)
•Enhanced RF Noise Immunity	
•CMOS Process	

■ APPLICATION

•TFT-LCD panel V_{COM} driver
•Instrument Control Voltage Source

■ PIN CONFIGURATION



NJU77902KW2

About Exposed Pad
Connect the Exposed Pad on the V_{SS}.

PIN FUNCTION

1. A OUTPUT
2. A -INPUT
3. A +INPUT
4. V_{SS}
5. B +INPUT
6. B –INPUT
7. B OUTPUT
8. V_{DD}

■ ABSOLUTE MAXIMUM RATINGS (Ta=25°C, unless otherwise noted.)

PARAMETER	SYMBOL	RATINGS	UNIT
Supply Voltage	V_{DD}	+20	V
Power Dissipation	P_D	560(Note1), 750(Note2), 910(Note3), 2500(Note4)	mW
Output Peak Current	I_{OP}	1000	mA
Input Common Mode Voltage	V_{ICM}	V_{SS}-0.3 to V_{DD}+0.3	V
Differential Input Voltage	V_{ID}	18 (Note5)	V
Operating Temperature Range	T_{opr}	-40 to +85	°C
Storage Temperature Range	T_{stg}	-55 to +150	°C

(Note1) Mounted on glass epoxy board. (101.5×114.5×1.6mm: based on EIA/JEDEC standard, 2Layers FR-4)
(Note2) Mounted on glass epoxy board. (101.5×114.5×1.6mm: based on EIA/JEDEC standard, 2Layers FR-4, with Exposed Pad)
(Note3) Mounted on glass epoxy board. (101.5×114.5×1.6mm: based on EIA/JEDEC standard, 4Layers FR-4)
(Note4) Mounted on glass epoxy board. (101.5×114.5×1.6mm: based on EIA/JEDEC standard, 4Layers FR-4, with Exposed Pad)
(For 4Layers: Applying 99.5×99.5mm inner Cu area and a thermal via hole to a board based on JEDEC standard JESD51-5)
(Note5) For supply voltage less than 18V, the absolute maximum rating is equal to the supply voltage.

■ RECOMMENDED OPERATING CONDITION (Ta=25°C)

PARAMETER	SYMBOL	RATING	UNIT
Supply Voltage	V_{DD}	6.0 to 18.0	V

■ ELECTRICAL CHARACTERISTICS

(V_{DD}=15V, V_{SS}=0V, V_{IC}=7.5V,R_L=10kΩ to V_{DD}/2,Ta=25°C, unless otherwise noted.)

PARAMETER	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
• DC CHARACTERISTICS						
Maximum Output Voltage	$V_{OH}1$	R_L = 10kΩ	14.8	14.9	-	V
	$V_{OH}2$	Isource = 200mA	14.2	14.5	-	V
	$V_{OL}1$	R_L = 10kΩ	-	0.1	0.2	V
	$V_{OL}2$	Isink = 200mA	-	0.5	0.8	V
Input Offset Voltage	V_{IO}	R_S = 50Ω	-	1	10	mV
Input Bias Current	I_B		-	1	-	pA
Input Offset Current	I_{IO}		-	1	-	pA
Large Signal Voltage Gain	A_V	V_O = 13V/2V, R_L=10kΩ	65	90	-	dB
Common Mode Rejection Ratio	CMR	V_{IC} = 0V → 7.5V V_{IC} = 7.5V → 15V	50	75	-	dB
Supply Voltage Rejection Ratio	SVR	V_{DD} = 6V → 18V	60	75	-	dB
Input Common Mode Voltage Range	V_{ICM}	CMR ≥ 50dB	0	-	15	V
Operating Current	I_{DD}	No Signal, R_L = open	-	7.0	9.0	mA
• AC CHARACTERISTICS						
Unity Gain Frequency	ft	C_L = 10pF	-	3	-	MHz
Phase Margin	Φ_M	C_L = 10pF	-	50	-	deg
Equivalent Input Noise Voltage	V_{NI}	f = 1kHz, R_S = 100Ω	-	80	-	nV/√Hz
Total Harmonic Distortion+Noise	THD＋N	G_V = 6dB, C_L = 10pF, fin = 1kHz, P_O = 0.1W	-	0.02	-	%
Output Power	P_O	fin=1kHz, C_L=10pF, THD≤5%	-	3	-	mW
Channel Separation	CS	f = 1kHz	-	120	-	dB
• TRANSIENT CHARACTERISTICS						
Output Peak Current	I_{OP}	(Note6)	-	1000	-	mA
Slew Rate	SR	G_V = 0dB, C_L = 10pF, Vin = 4Vpp, (Note7)	5	9	-	V/μs

(Note6) Output peak current is defined by the lower value of the output source current or output sink current.
(Note7) Slew rate is defined by the lower value of the rise or fall.

■ Application Notes

•Package Power, Power Dissipation and Output Power

IC is heated by own operation and possibly gets damage when the junction power exceeds the acceptable value called Power Dissipation P_D. The dependence of the NJU77902 P_D on ambient temperature is shown in Fig 1. The plots are depended on following two points. The first is P_D on ambient temperature 25 ºC, which is the maximum power dissipation. And the second is 0W, which means that the IC cannot radiate any more. The second point derives from the relation that maximum junction temperature Tj_{max} is the same as storage temperature T_{stg}. Fig.1 is drawn by connecting those points and by the definition that the P_D lower than 25 ºC is constant. Therefore, the P_D is shown following formula as a function of the ambient temperature between those points.

Dissipation Power $P_D = \frac{Tj\max - Ta}{\theta ja}$ [W] (Ta = 25 ºC to Ta = 150 ºC)

Where, θja is heat thermal resistance which depends on parameters such as package material, frame material and so on. Therefore, P_D is different in each package.

While, the actual measurement of dissipation power on NJU77902 is obtained using following equation.

(Actual Dissipation Power) = (Supply Voltage V_{DD}) X (Supply Current I_{DD}) – (Output Power Po)

The NJU77902 should be operated in lower than P_D of the actual dissipation power.

To sustain the steady state operation, take account of the Dissipation Power and thermal design.

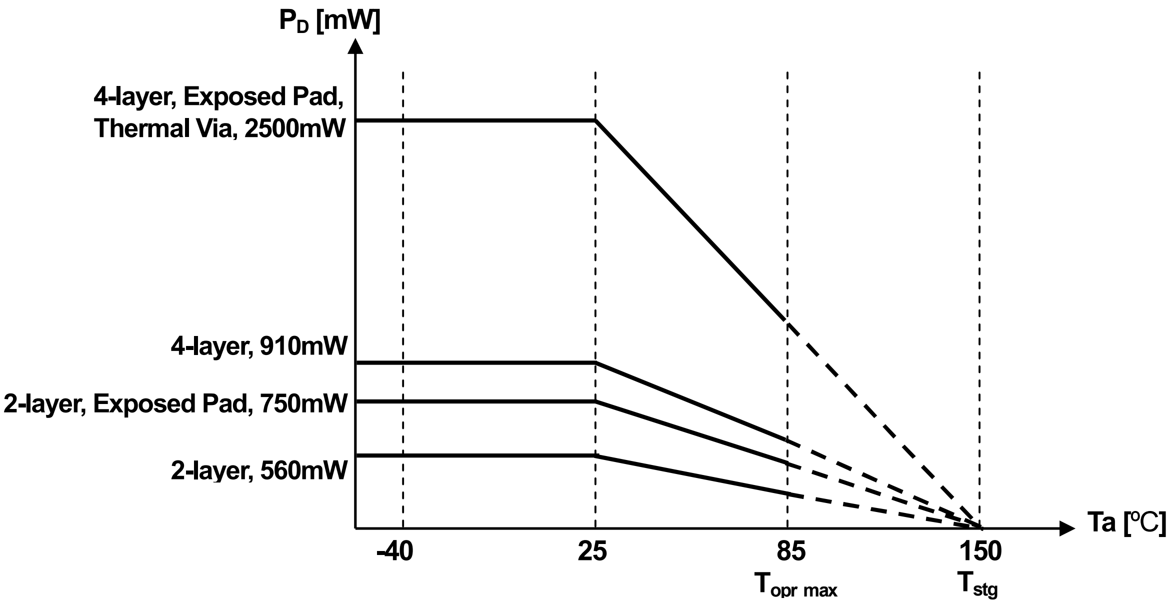
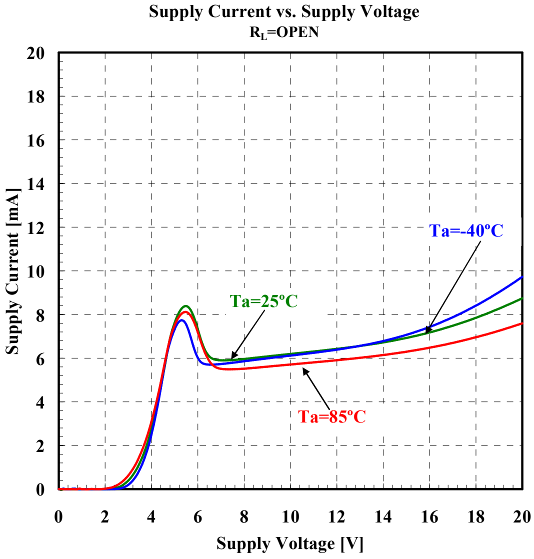
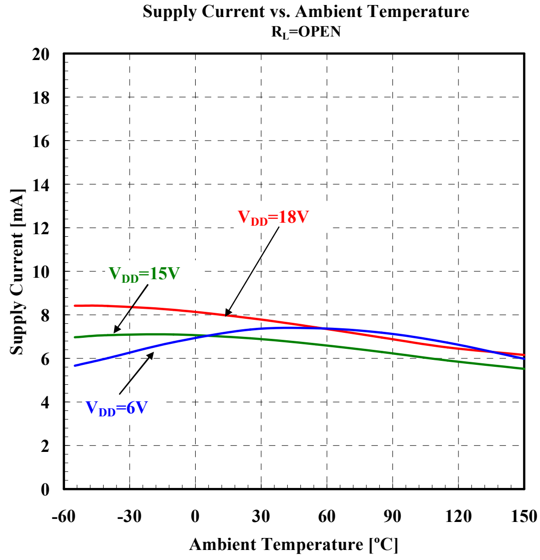
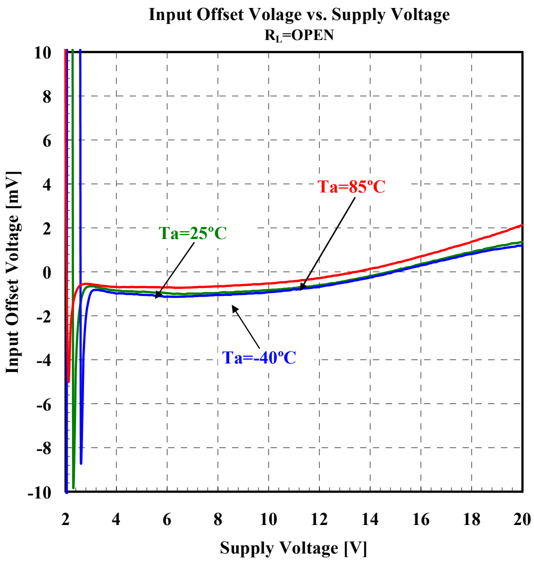


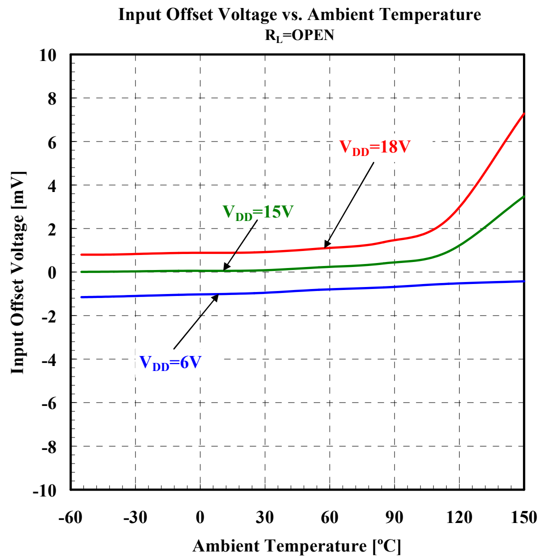
Fig1. Dependence of NJU77902 Power Dissipations on ambient temperature

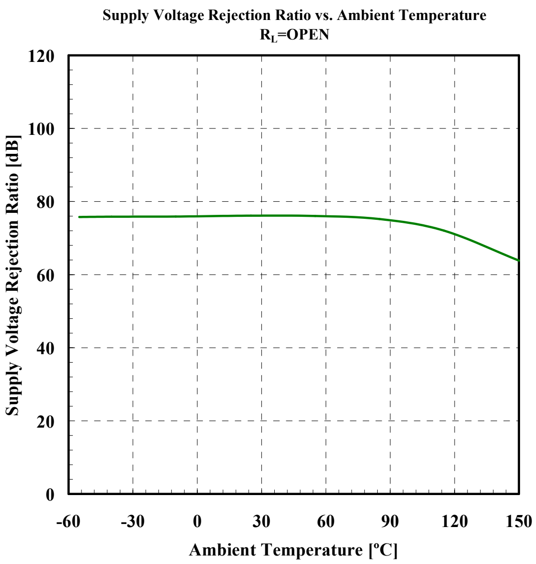
■ TYPICAL CHARACTERISTICS

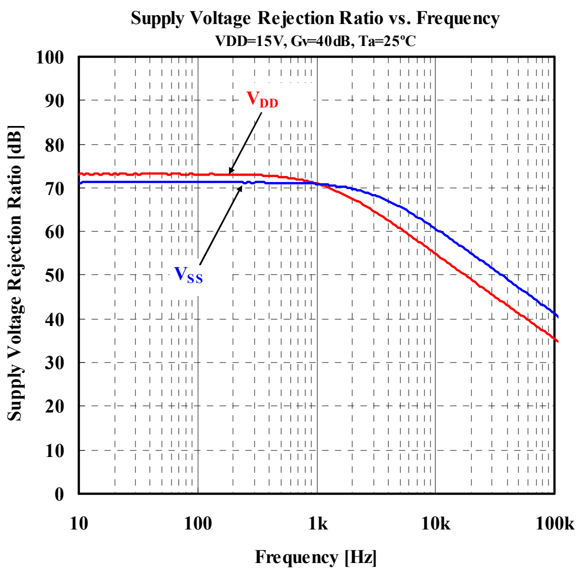


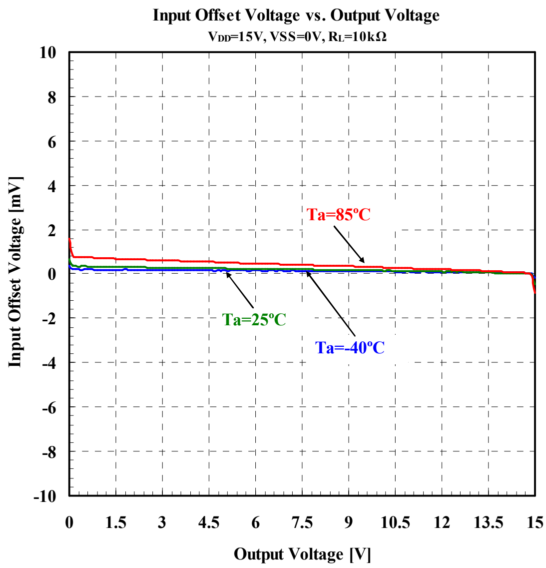


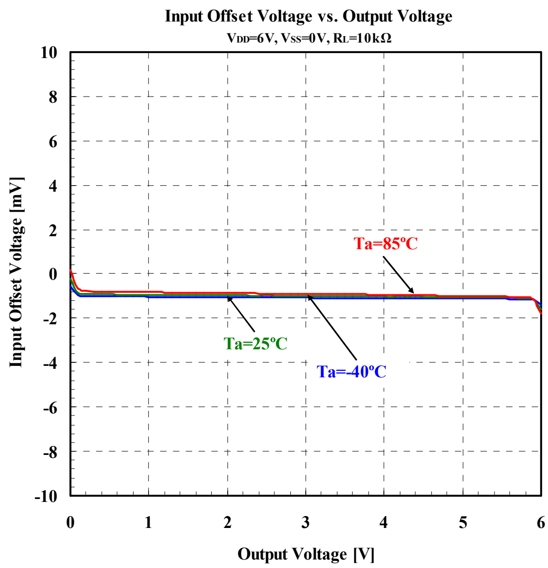


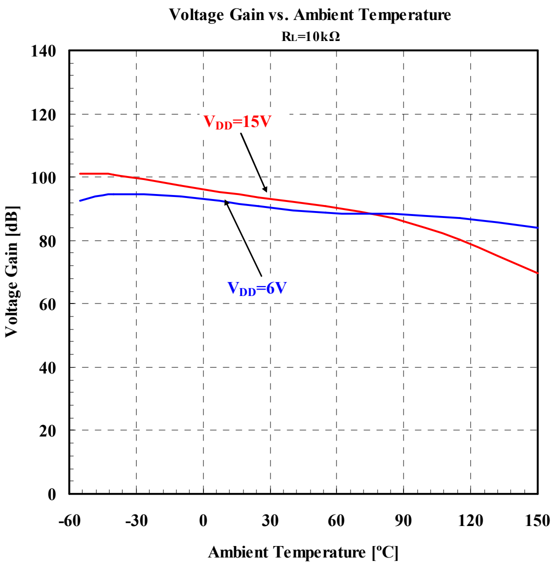


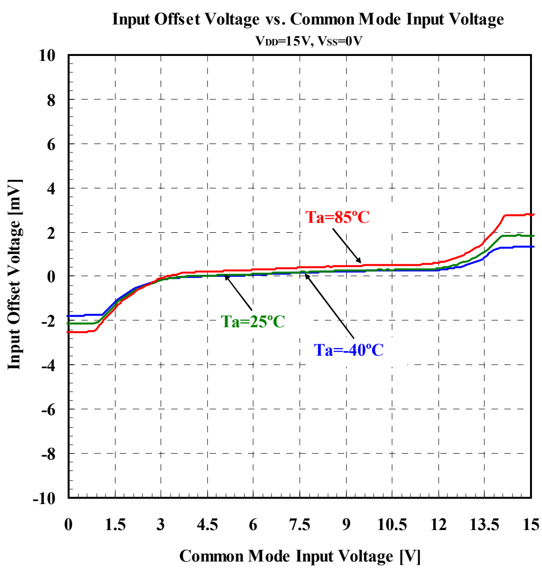


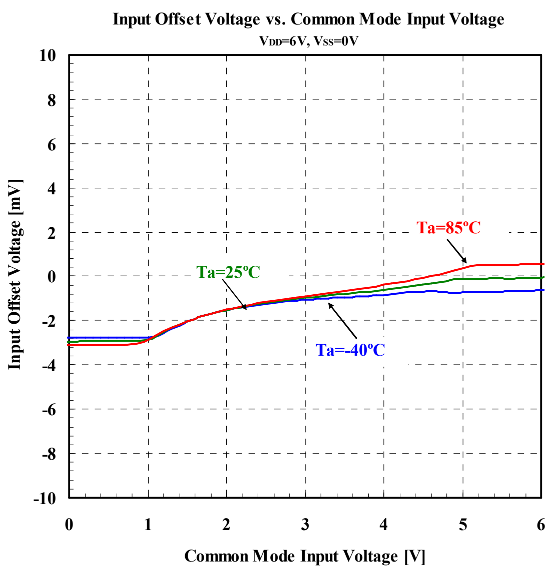


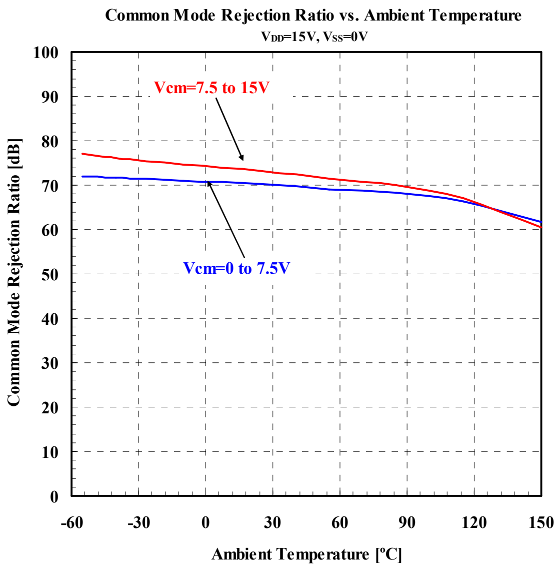

Input Offset Voltage vs. Output Voltage
VDD=15V, VSS=0V, RL=10kΩ
Input Offset Voltage [mV]
Output Voltage [V]
Ta=85ºC
Ta=25ºC
Ta=-40ºC


Input Offset Voltage vs. Output Voltage
VDD=6V, VSS=0V, RL=10kΩ
Input Offset Voltage [mV]
Output Voltage [V]
Ta=85ºC
Ta=25ºC
Ta=-40ºC

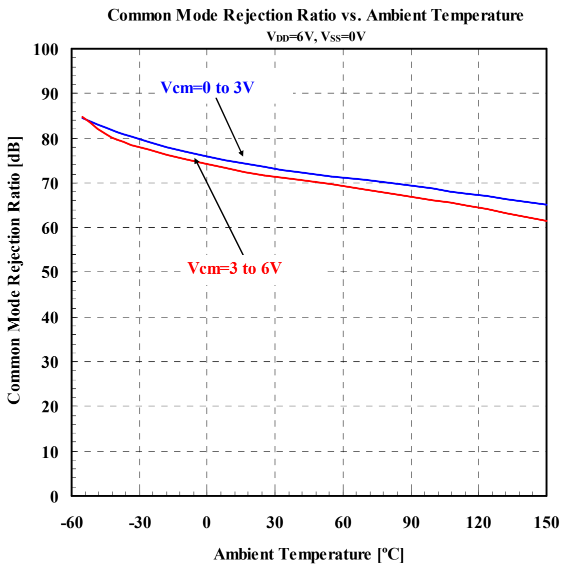

Voltage Gain vs. Ambient Temperature
RL=10kΩ
Voltage Gain [dB]
Ambient Temperature [ºC]
VDD=15V
VDD=6V


Input Offset Voltage vs. Common Mode Input Voltage
VDD=15V, VSS=0V
Input Offset Voltage [mV]
Common Mode Input Voltage [V]
Ta=85ºC
Ta=25ºC
Ta=-40ºC

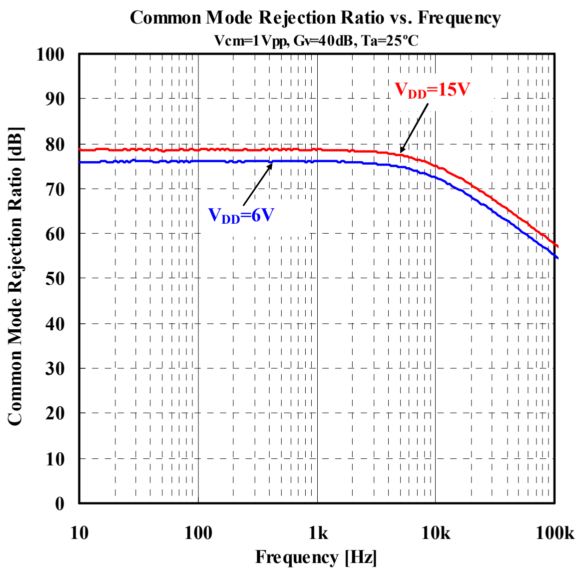

Input Offset Voltage vs. Common Mode Input Voltage
VDD=6V, VSS=0V
Input Offset Voltage [mV]
Common Mode Input Voltage [V]
Ta=85ºC
Ta=25ºC
Ta=-40ºC



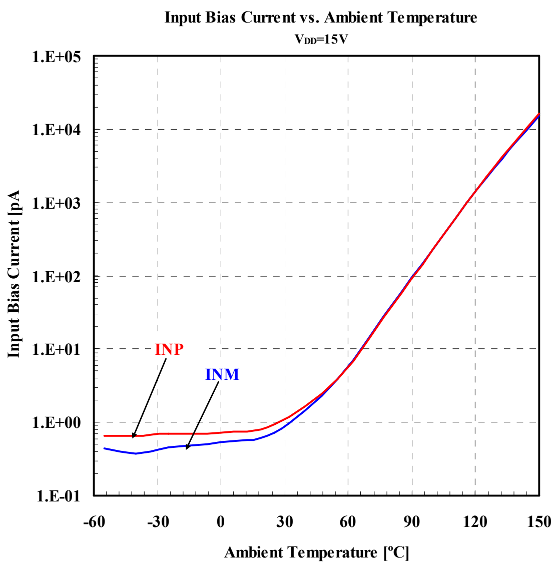
Common Mode Rejection Ratio vs. Ambient Temperature
VDD=15V, VSS=0V
Vcm=7.5 to 15V
Vcm=0 to 7.5V
Common Mode Rejection Ratio [dB]
Ambient Temperature [ºC]



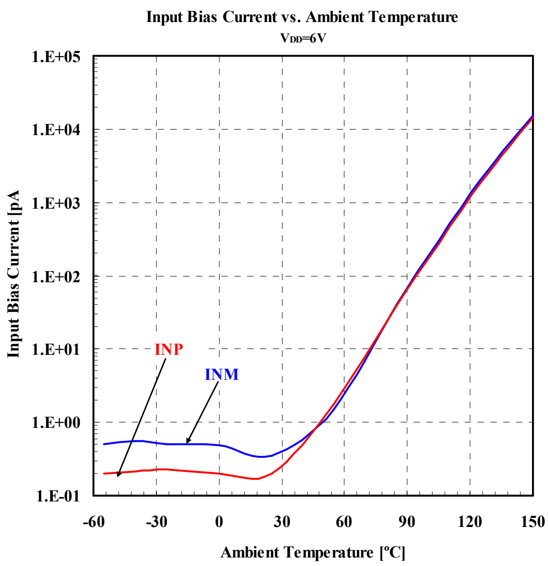
Common Mode Rejection Ratio vs. Ambient Temperature
VDD=6V, VSS=0V
Vcm=0 to 3V
Vcm=3 to 6V
Common Mode Rejection Ratio [dB]
Ambient Temperature [ºC]



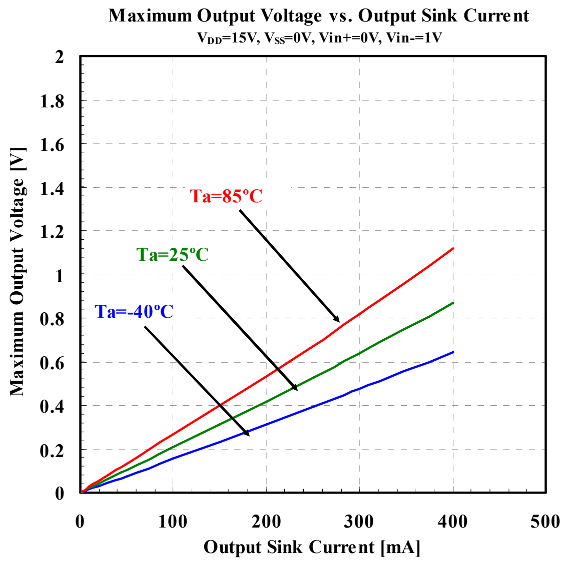
Common Mode Rejection Ratio vs. Frequency
Vcm=1Vpp, Gv=40dB, Ta=25ºC
VDD=15V
VDD=6V
Common Mode Rejection Ratio [dB]
Frequency [Hz]

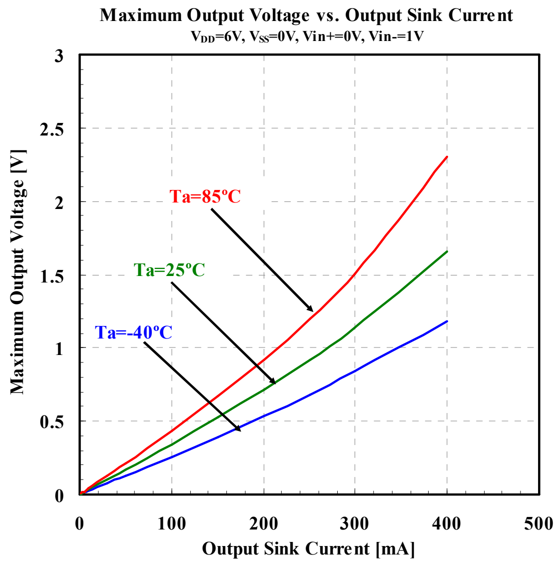


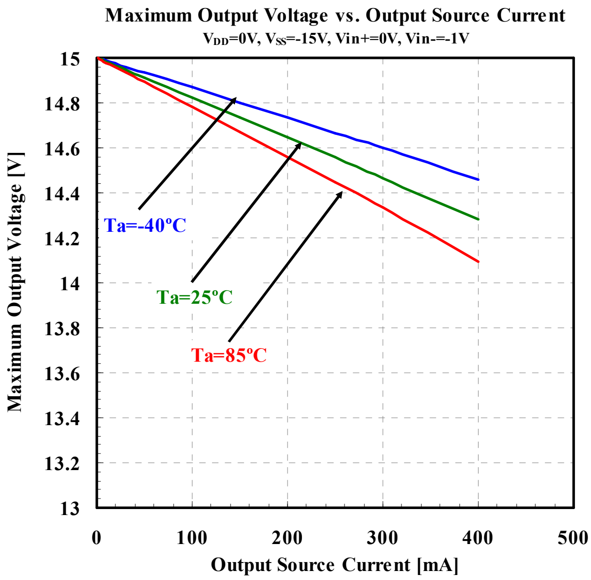
Input Bias Current vs. Ambient Temperature
VDD=15V
INP
INM
Input Bias Current [pA
Ambient Temperature [ºC]

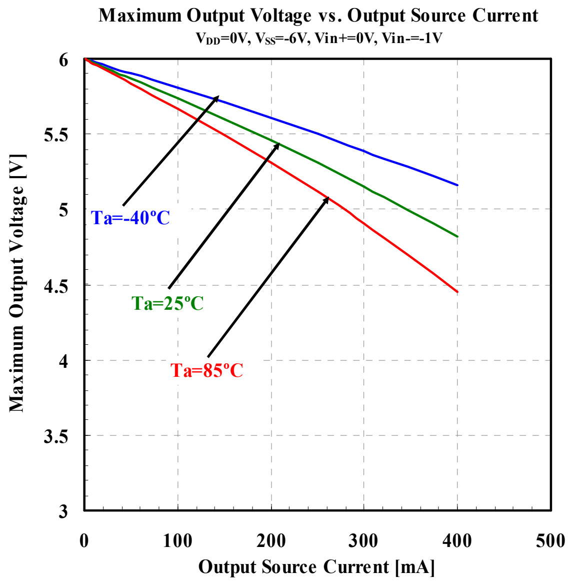


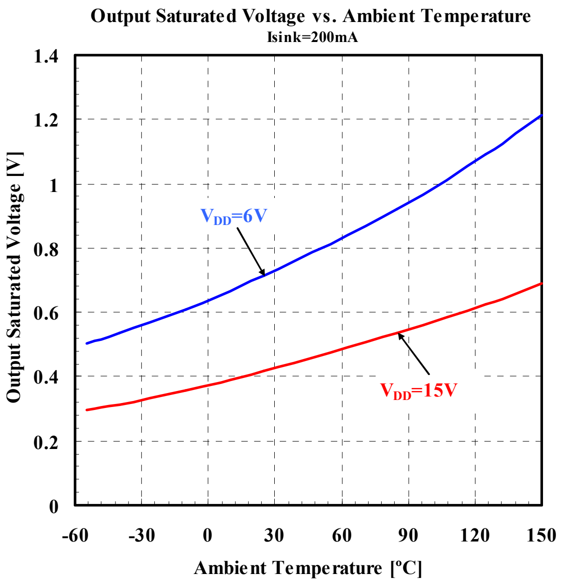
Input Bias Current vs. Ambient Temperature
VDD=6V
INP
INM
Input Bias Current [pA
Ambient Temperature [ºC]

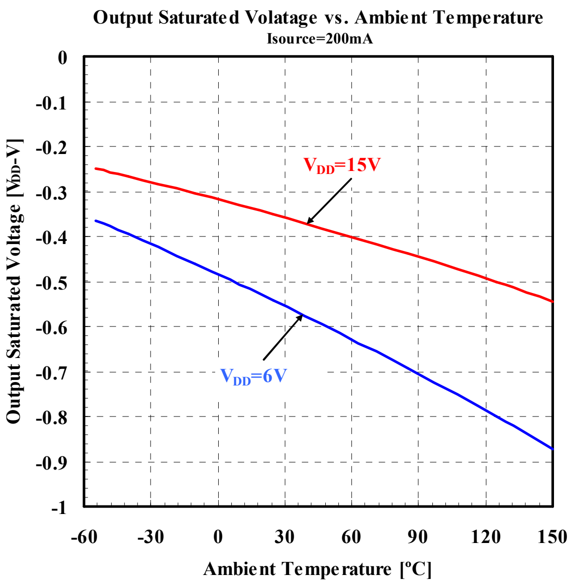

Maximum Output Voltage vs. Output Sink Current
VDD=15V, VSS=0V, Vin+=0V, Vin-=1V
Maximum Output Voltage [V]
Output Sink Current [mA]
Ta=85°C
Ta=25°C
Ta=-40°C
0
0.2
0.4
0.6
0.8
1
1.2
1.4
1.6
1.8
2
0
100
200
300
400
500

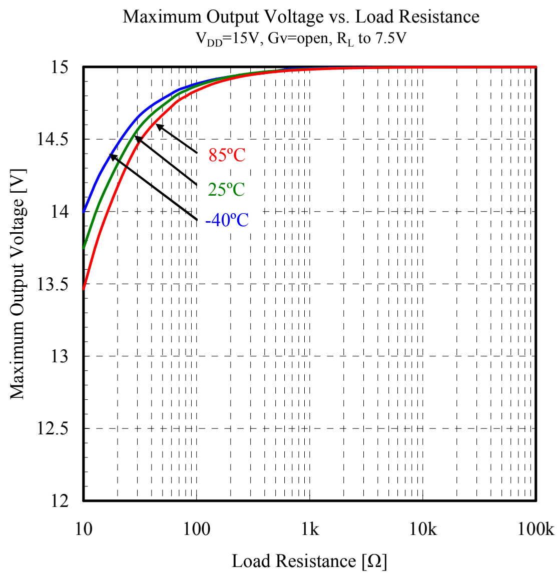

Maximum Output Voltage vs. Output Sink Current
VDD=6V, VSS=0V, Vin+=0V, Vin-=1V
Maximum Output Voltage [V]
Output Sink Current [mA]
Ta=85°C
Ta=25°C
Ta=-40°C
0
0.5
1
1.5
2
2.5
3
0
100
200
300
400
500

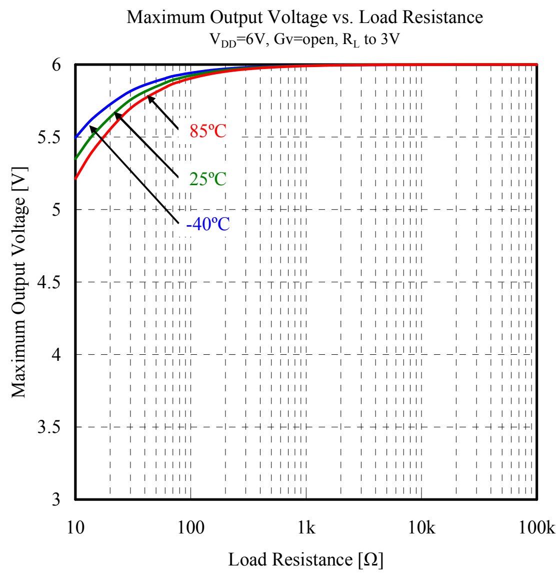

Maximum Output Voltage vs. Output Source Current
VDD=0V, VSS=-15V, Vin+=0V, Vin-=-1V
Maximum Output Voltage [V]
Output Source Current [mA]
Ta=-40°C
Ta=25°C
Ta=85°C
13
13.2
13.4
13.6
13.8
14
14.2
14.4
14.6
14.8
15
0
100
200
300
400
500

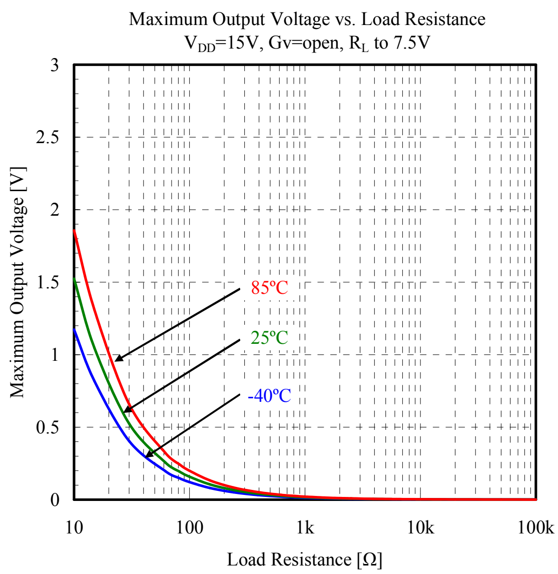

Maximum Output Voltage vs. Output Source Current
VDD=0V, VSS=-6V, Vin+=0V, Vin-=-1V
Maximum Output Voltage [V]
Output Source Current [mA]
Ta=-40°C
Ta=25°C
Ta=85°C
3
3.5
4
4.5
5
5.5
6
0
100
200
300
400
500

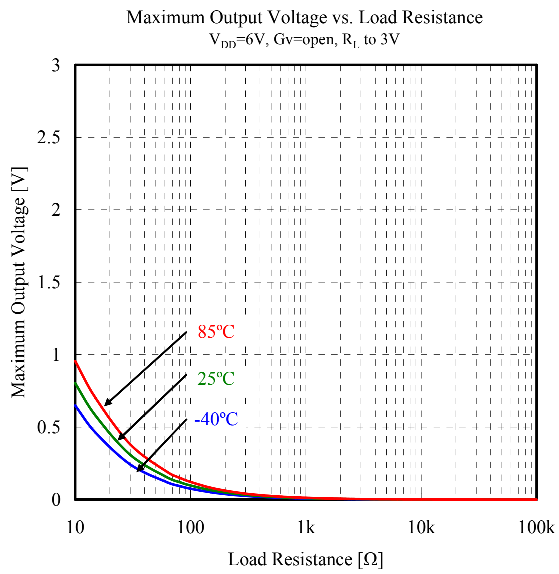

Output Saturated Voltage vs. Ambient Temperature
Isink=200mA
Output Saturated Voltage [V]
Ambient Temperature [°C]
VDD=6V
VDD=15V
0
0.2
0.4
0.6
0.8
1
1.2
1.4
-60
-30
0
30
60
90
120
150

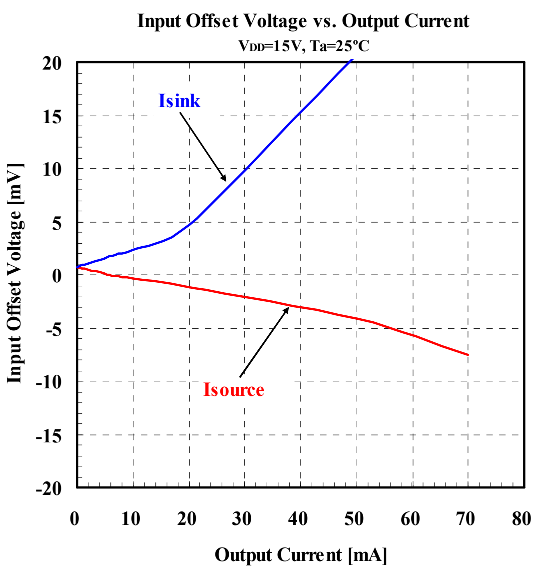

Output Saturated Volatage vs. Ambient Temperature
Isource=200mA
Output Saturated Voltage [VDD-V]
Ambient Temperature [°C]
VDD=15V
VDD=6V
0
-0.1
-0.2
-0.3
-0.4
-0.5
-0.6
-0.7
-0.8
-0.9
-1
-60
-30
0
30
60
90
120
150

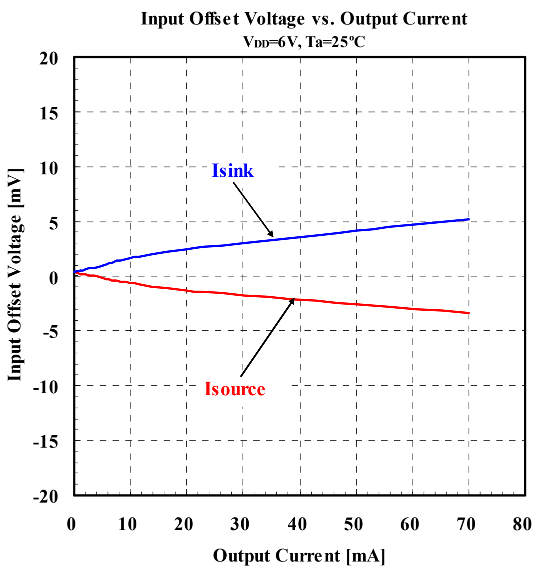

Maximum Output Voltage vs. Load Resistance
VDD=15V, Gv=open, RL to 7.5V
Maximum Output Voltage [V]
15
14.5
14
13.5
13
12.5
12
10
100
1k
10k
100k
Load Resistance [Ω]
85ºC
25ºC
-40ºC

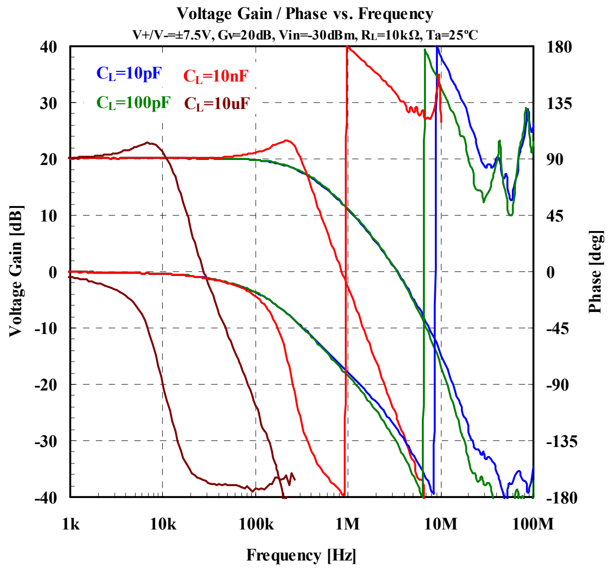

Maximum Output Voltage vs. Load Resistance
VDD=6V, Gv=open, RL to 3V
Maximum Output Voltage [V]
6
5.5
5
4.5
4
3.5
3
10
100
1k
10k
100k
Load Resistance [Ω]
85ºC
25ºC
-40ºC

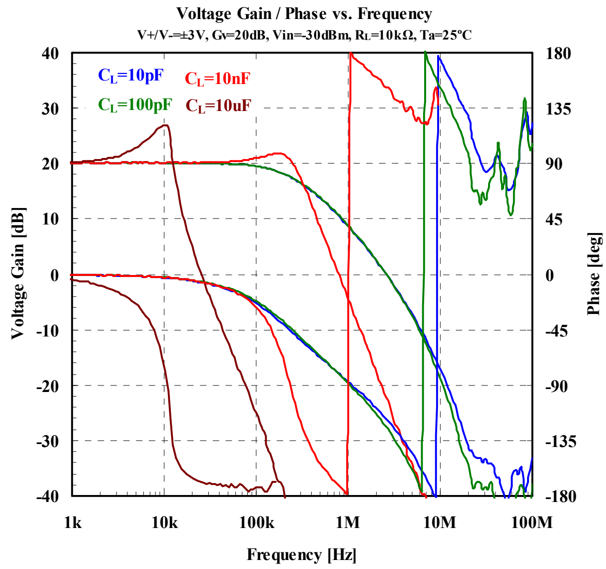

Maximum Output Voltage vs. Load Resistance
VDD=15V, Gv=open, RL to 7.5V
Maximum Output Voltage [V]
3
2.5
2
1.5
1
0.5
0
10
100
1k
10k
100k
Load Resistance [Ω]
85ºC
25ºC
-40ºC

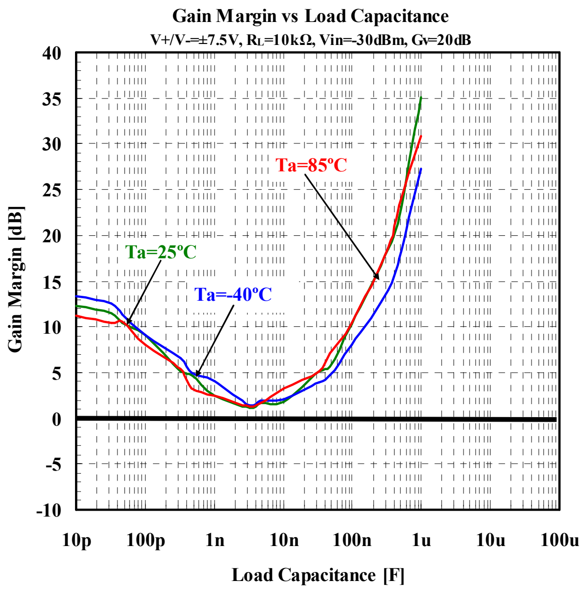

Maximum Output Voltage vs. Load Resistance
VDD=6V, Gv=open, RL to 3V
Maximum Output Voltage [V]
3
2.5
2
1.5
1
0.5
0
10
100
1k
10k
100k
Load Resistance [Ω]
85ºC
25ºC
-40ºC

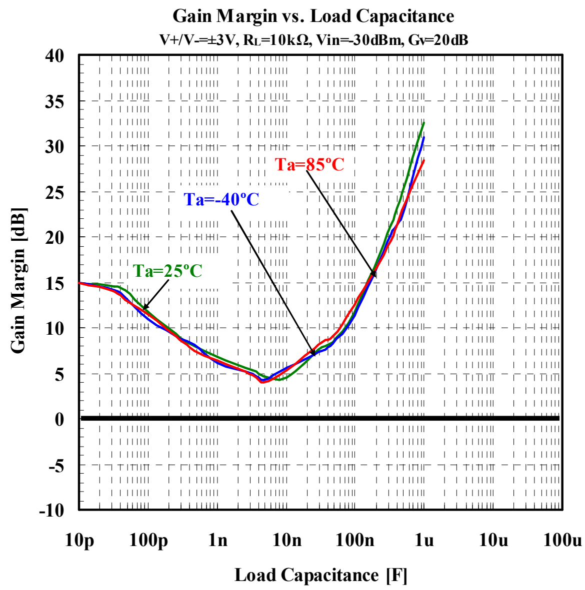

Input Offset Voltage vs. Output Current
VDD=15V, Ta=25ºC
Input Offset Voltage [mV]
20
15
10
5
0
-5
-10
-15
-20
0
10
20
30
40
50
60
70
80
Output Current [mA]
Isink
Isource

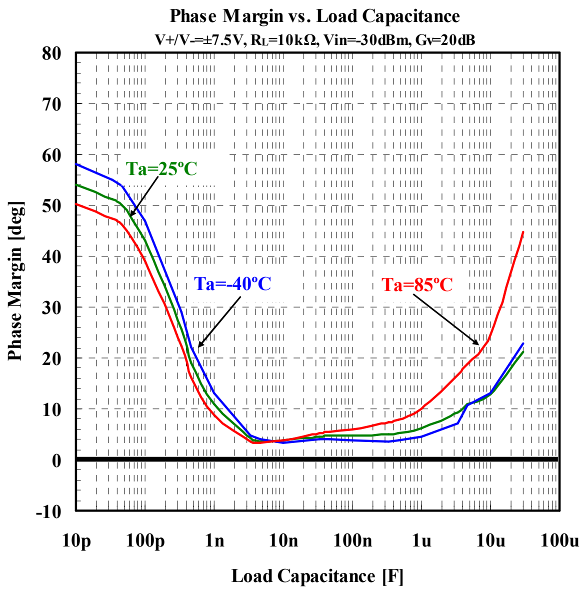

Input Offset Voltage vs. Output Current
VDD=6V, Ta=25ºC
Input Offset Voltage [mV]
20
15
10
5
0
-5
-10
-15
-20
0
10
20
30
40
50
60
70
80
Output Current [mA]
Isink
Isource

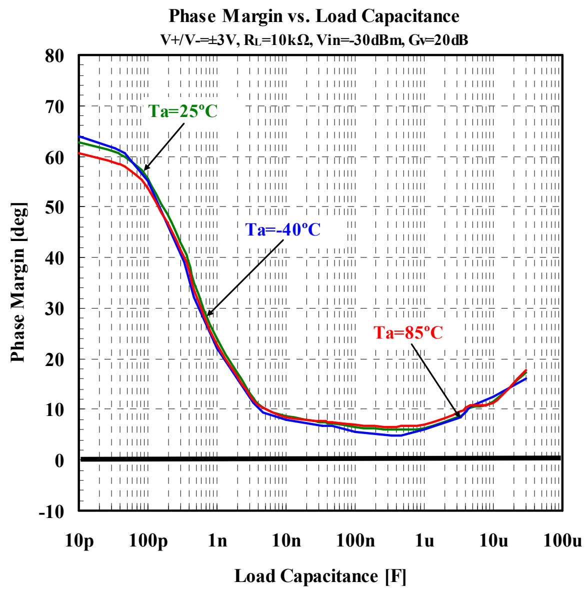

Voltage Gain / Phase vs. Frequency
V+/V-=±7.5V, Gv=20dB, Vin=-30dBm, RL=10kΩ, Ta=25°C
CL=10pF
CL=10nF
CL=100pF
CL=10uF
Voltage Gain [dB]
Phase [deg]
Frequency [Hz]
1k
10k
100k
1M
10M
100M

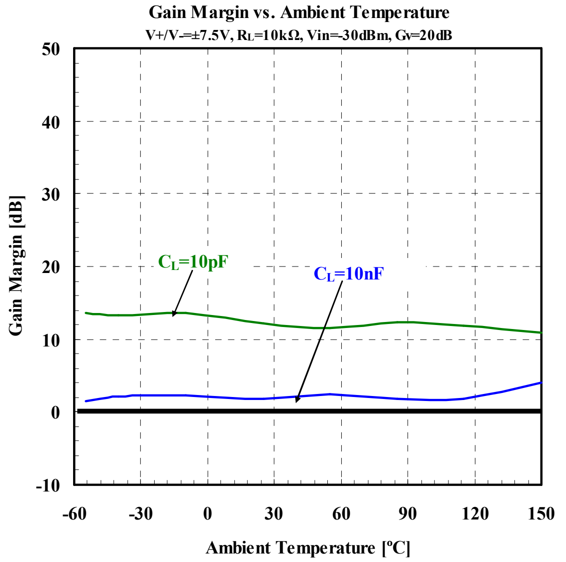

Voltage Gain / Phase vs. Frequency
V+/V-=±3V, Gv=20dB, Vin=-30dBm, RL=10kΩ, Ta=25°C
CL=10pF
CL=10nF
CL=100pF
CL=10uF
Voltage Gain [dB]
Phase [deg]
Frequency [Hz]

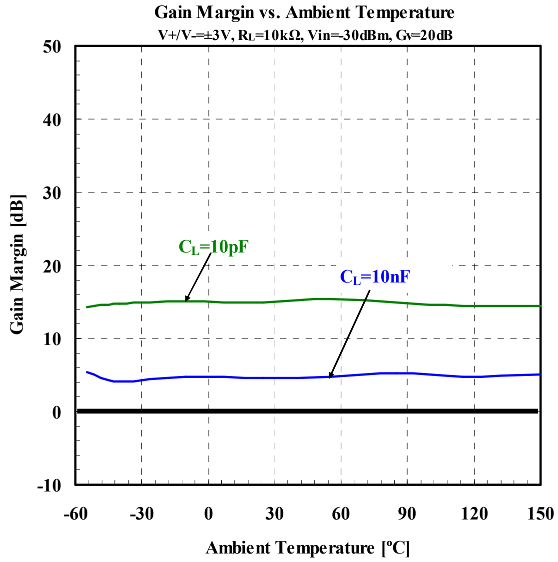

Gain Margin vs Load Capacitance
V+/V-=±7.5V, RL=10kΩ, Vin=-30dBm, Gv=20dB
Ta=85°C
Ta=25°C
Ta=-40°C
Gain Margin [dB]
Load Capacitance [F]
10p
100p
1n
10n
100n
1u
10u
100u

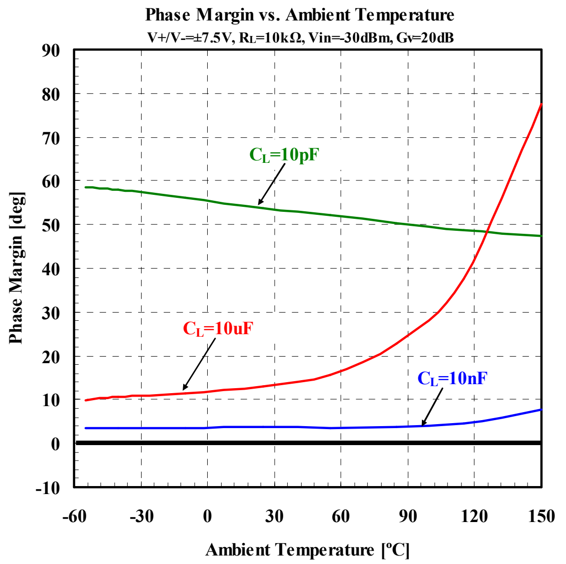

Gain Margin vs. Load Capacitance
V+/V-=±3V, RL=10kΩ, Vin=-30dBm, Gv=20dB
Ta=85°C
Ta=-40°C
Ta=25°C
Gain Margin [dB]
Load Capacitance [F]

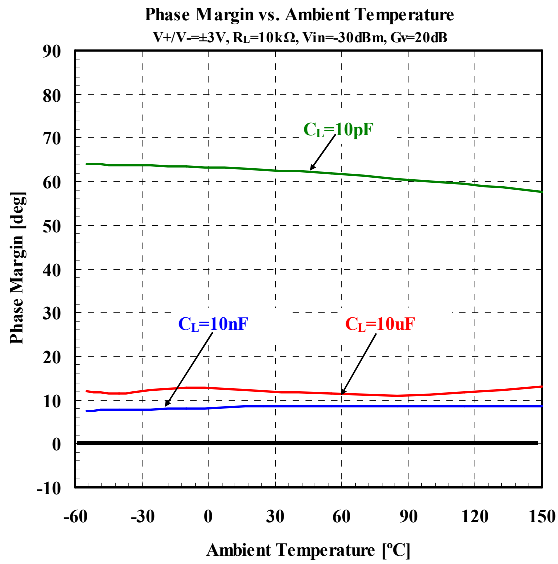

Phase Margin vs. Load Capacitance
V+/V-=±7.5V, RL=10kΩ, Vin=-30dBm, Gv=20dB
Ta=25°C
Ta=-40°C
Ta=85°C
Phase Margin [deg]
Load Capacitance [F]

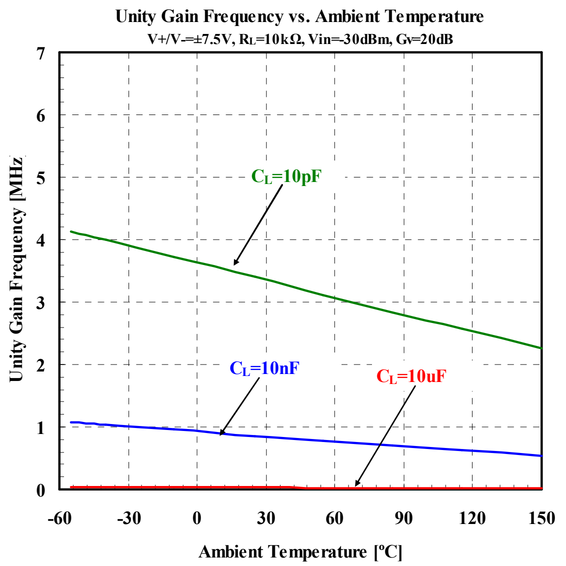

Phase Margin vs. Load Capacitance
V+/V-=±3V, RL=10kΩ, Vin=-30dBm, Gv=20dB
Ta=25°C
Ta=-40°C
Ta=85°C
Phase Margin [deg]
Load Capacitance [F]

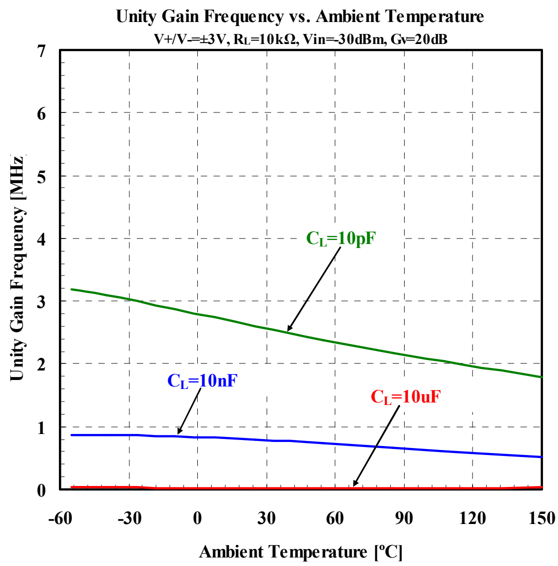

Gain Margin vs. Ambient Temperature
V+/V-=±7.5V, RL=10kΩ, Vin=-30dBm, Gv=20dB
Gain Margin [dB]
Ambient Temperature [ºC]
CL=10pF
CL=10nF

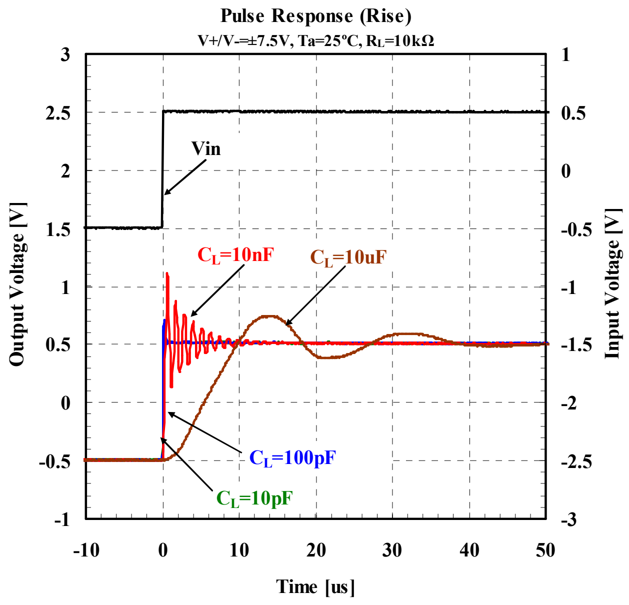

Gain Margin vs. Ambient Temperature
V+/V-=±3V, RL=10kΩ, Vin=-30dBm, Gv=20dB
Gain Margin [dB]
Ambient Temperature [ºC]
CL=10pF
CL=10nF

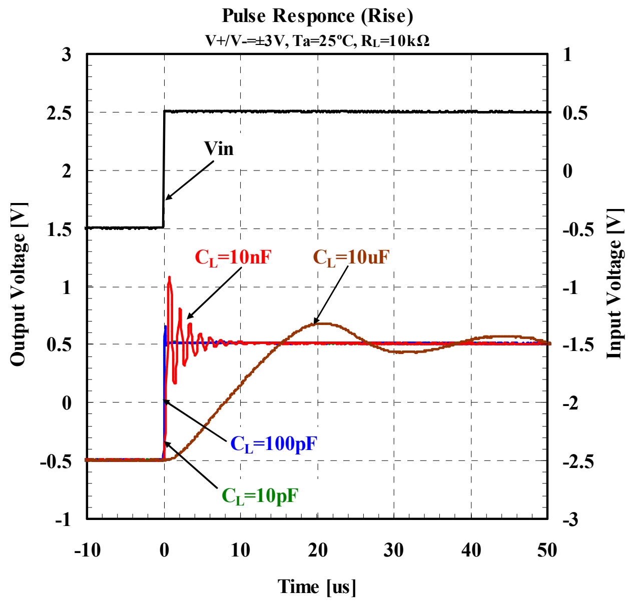

Phase Margin vs. Ambient Temperature
V+/V-=±7.5V, RL=10kΩ, Vin=-30dBm, Gv=20dB
Phase Margin [deg]
Ambient Temperature [ºC]
CL=10pF
CL=10uF
CL=10nF

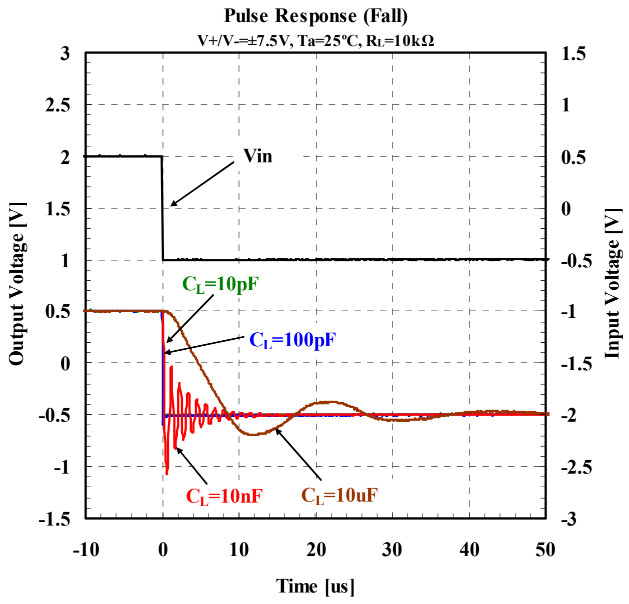

Phase Margin vs. Ambient Temperature
V+/V-=±3V, RL=10kΩ, Vin=-30dBm, Gv=20dB
Phase Margin [deg]
Ambient Temperature [ºC]
CL=10pF
CL=10nF
CL=10uF

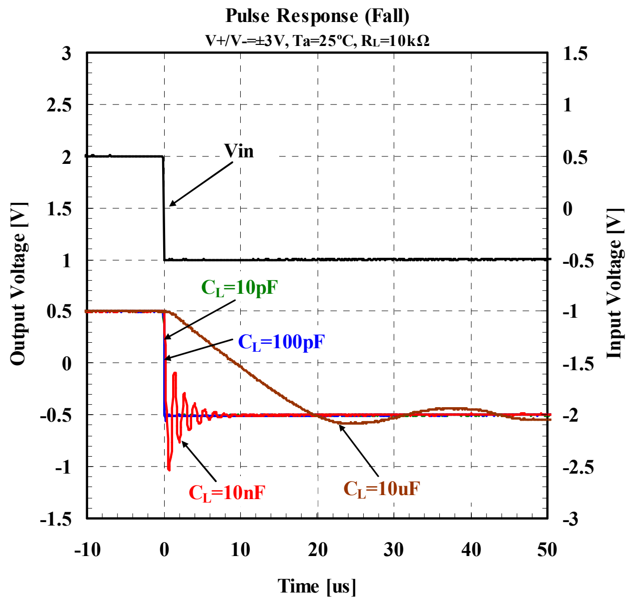

Unity Gain Frequency vs. Ambient Temperature
V+/V-=±7.5V, RL=10kΩ, Vin=-30dBm, Gv=20dB
Unity Gain Frequency [MHz]
Ambient Temperature [ºC]
CL=10pF
CL=10nF
CL=10uF

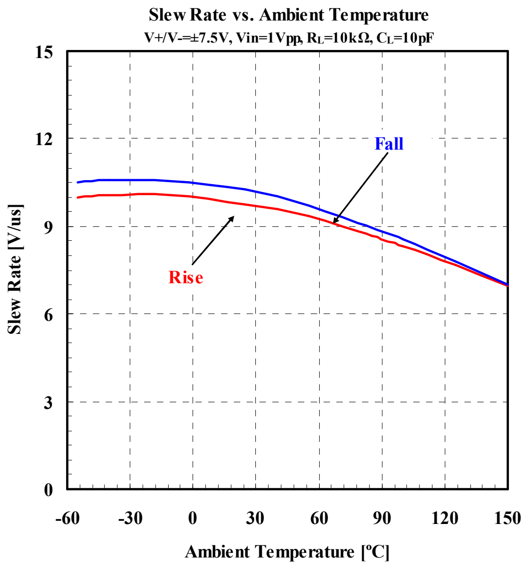

Unity Gain Frequency vs. Ambient Temperature
V+/V-=±3V, RL=10kΩ, Vin=-30dBm, Gv=20dB
Unity Gain Frequency [MHz]
Ambient Temperature [ºC]
CL=10pF
CL=10nF
CL=10uF

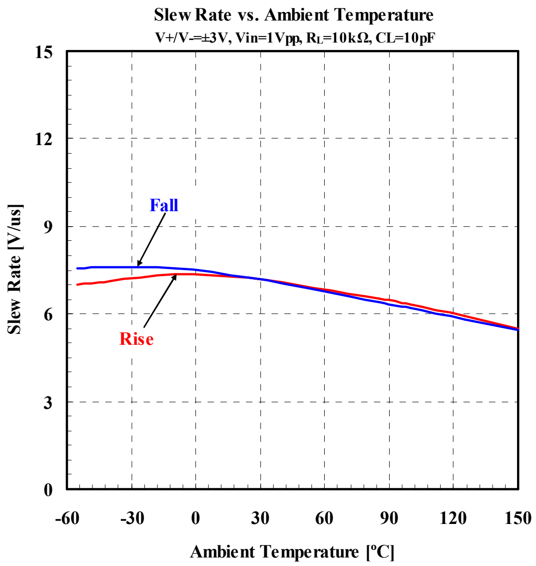

Pulse Response (Rise)
V+/V-=±7.5V, Ta=25°C, RL=10kΩ
Vin
CL=10nF
CL=10uF
CL=100pF
CL=10pF
Output Voltage [V]
Input Voltage [V]
Time [us]

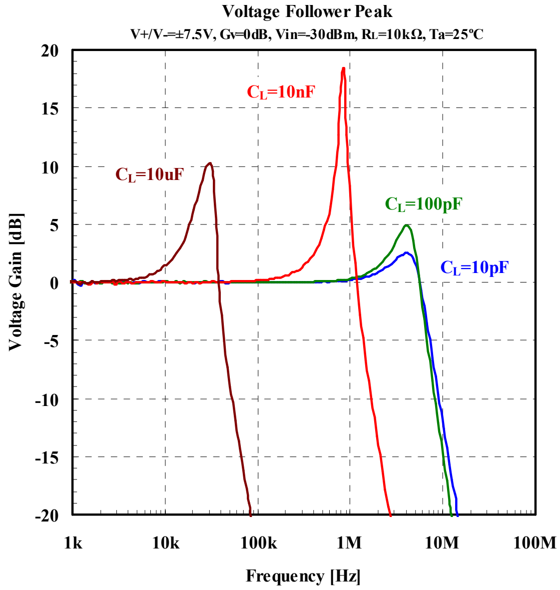

Pulse Responce (Rise)
V+/V-=±3V, Ta=25°C, RL=10kΩ
Vin
CL=10nF
CL=10uF
CL=100pF
CL=10pF
Output Voltage [V]
Input Voltage [V]
Time [us]

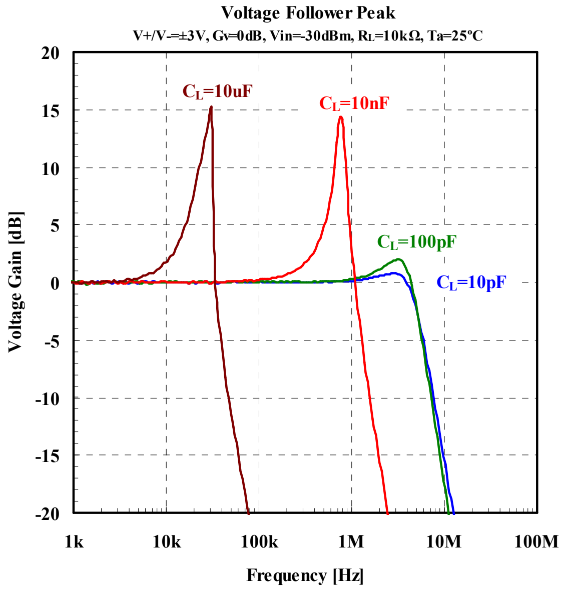

Pulse Response (Fall)
V+/V-=±7.5V, Ta=25°C, RL=10kΩ
Vin
CL=10pF
CL=100pF
CL=10nF
CL=10uF
Output Voltage [V]
Input Voltage [V]
Time [us]

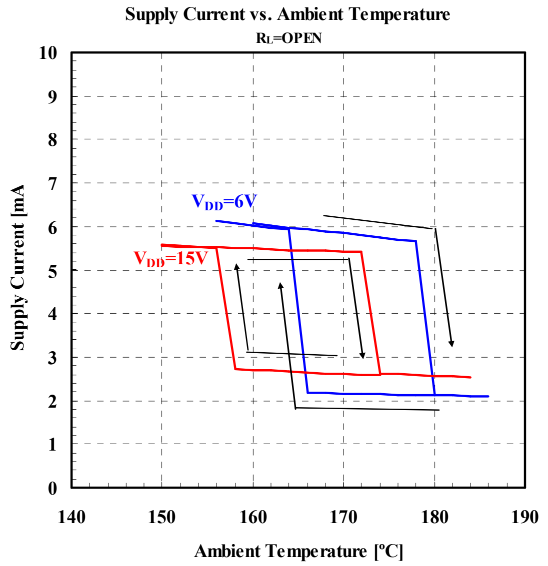

Pulse Response (Fall)
V+/V-=±3V, Ta=25°C, RL=10kΩ
Vin
CL=10pF
CL=100pF
CL=10nF
CL=10uF
Output Voltage [V]
Input Voltage [V]
Time [us]

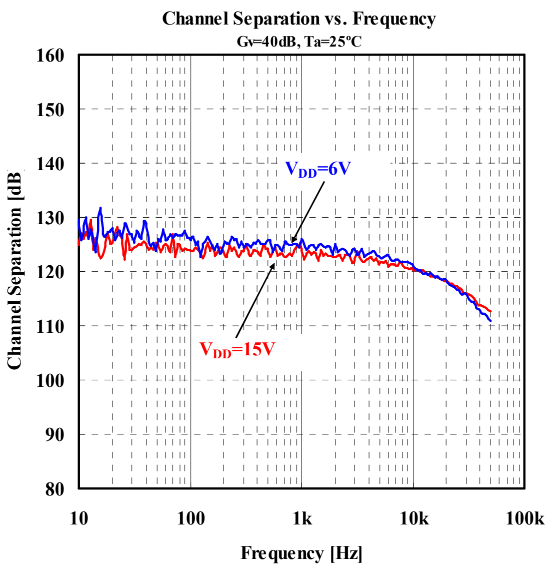

Slew Rate vs. Ambient Temperature
V+/V-=±7.5V, Vin=1Vpp, RL=10kΩ, CL=10pF
Fall
Rise
Slew Rate [V/us]
Ambient Temperature [ºC]

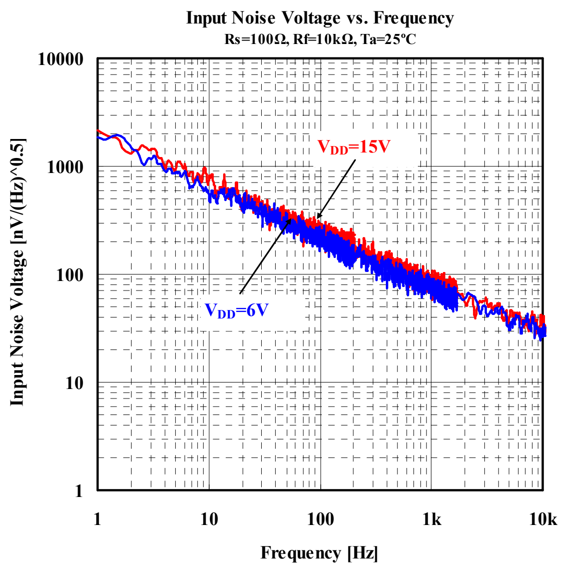

Slew Rate vs. Ambient Temperature
V+/V-=±3V, Vin=1Vpp, RL=10kΩ, CL=10pF
Fall
Rise
Slew Rate [V/us]
Ambient Temperature [ºC]

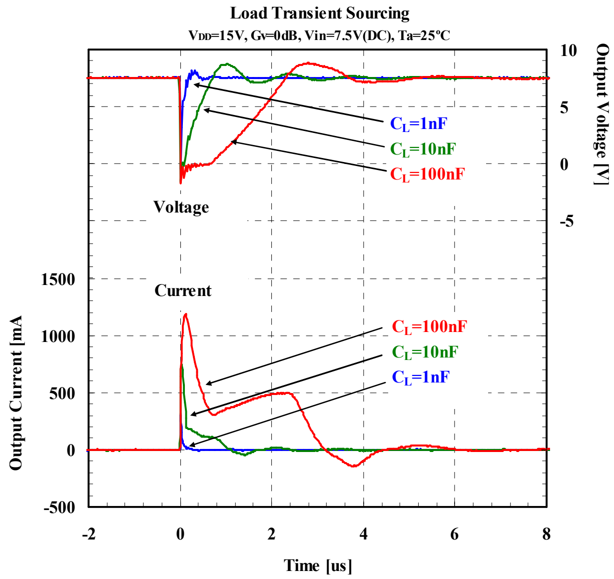

Voltage Follower Peak
V+/V-=±7.5V, Gv=0dB, Vin=-30dBm, RL=10kΩ, Ta=25°C
CL=10nF
CL=10uF
CL=100pF
CL=10pF
Voltage Gain [dB]
Frequency [Hz]
20
15
10
5
0
-5
-10
-15
-20
1k
10k
100k
1M
10M
100M

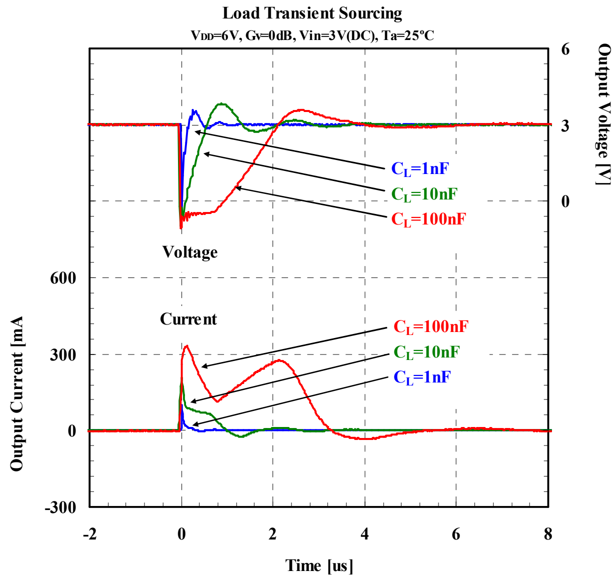

Voltage Follower Peak
V+/V-=±3V, Gv=0dB, Vin=-30dBm, RL=10kΩ, Ta=25°C
CL=10uF
CL=10nF
CL=100pF
CL=10pF
Voltage Gain [dB]
Frequency [Hz]
20
15
10
5
0
-5
-10
-15
-20
1k
10k
100k
1M
10M
100M

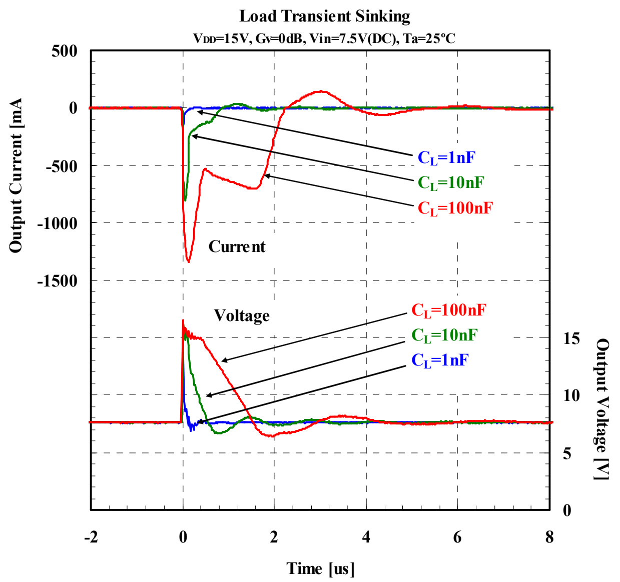

Supply Current vs. Ambient Temperature
RL=OPEN
VDD=6V
VDD=15V
Supply Current [mA
Ambient Temperature [°C]
10
9
8
7
6
5
4
3
2
1
0
140
150
160
170
180
190

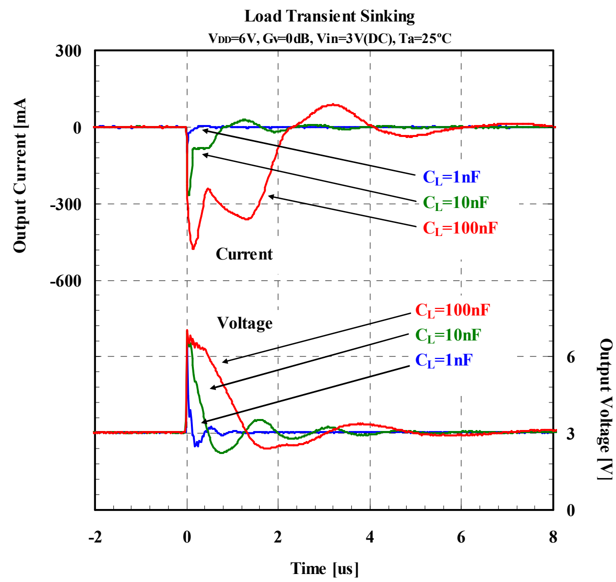

Channel Separation vs. Frequency
Gv=40dB, Ta=25°C
VDD=6V
VDD=15V
Channel Separation [dB
Frequency [Hz]
160
150
140
130
120
110
100
90
80
10
100
1k
10k
100k

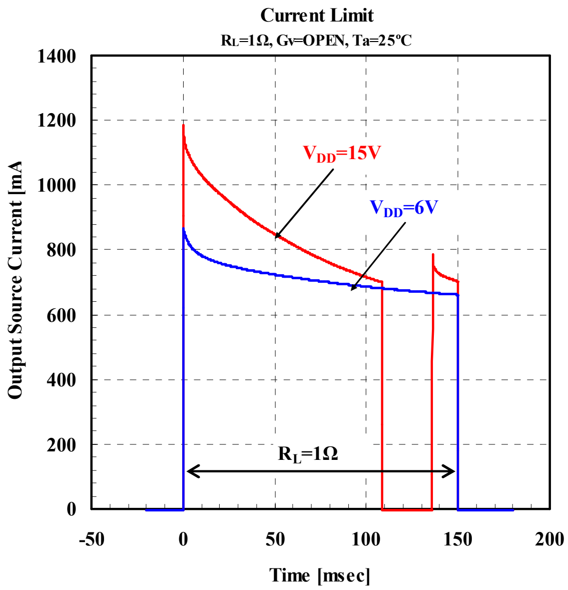

Input Noise Voltage vs. Frequency
Rs=100Ω, Rf=10kΩ, Ta=25°C
VDD=15V
VDD=6V
Input Noise Voltage [nV/(Hz)^0.5]
Frequency [Hz]
10000
1000
100
10
1
1
10
100
1k
10k

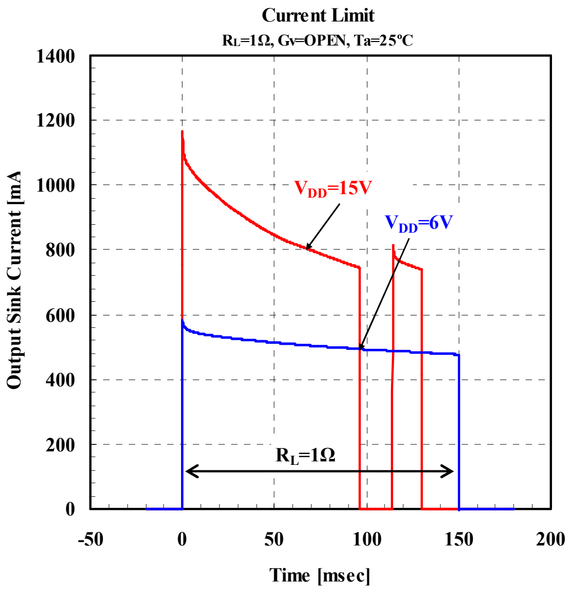

Load Transient Sourcing
VDD=15V, Gv=0dB, Vin=7.5V(DC), Ta=25°C
CL=1nF
CL=10nF
CL=100nF
Voltage
Current
CL=100nF
CL=10nF
CL=1nF
Output Current [mA]
Output Voltage [V]
Time [us]
1500
1000
500
0
-500
10
5
0
-5
-2
0
2
4
6
8

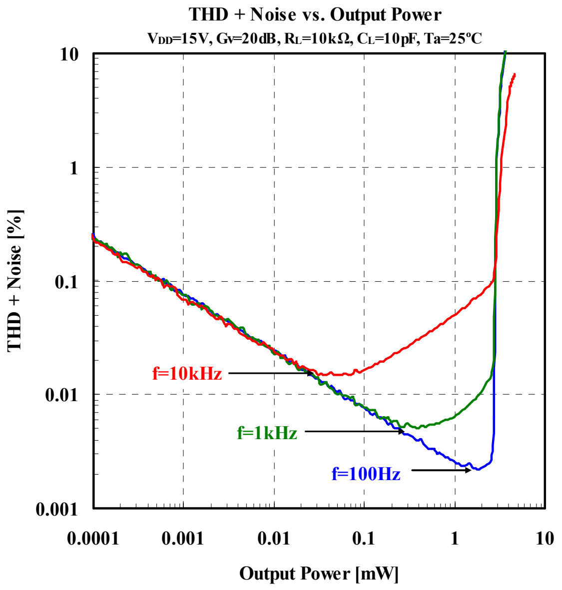

Load Transient Sourcing
VDD=6V, Gv=0dB, Vin=3V(DC), Ta=25°C
CL=1nF
CL=10nF
CL=100nF
Voltage
Current
CL=100nF
CL=10nF
CL=1nF
Output Current [mA]
Output Voltage [V]
Time [us]
600
300
0
-300
6
3
0
-2
0
2
4
6
8

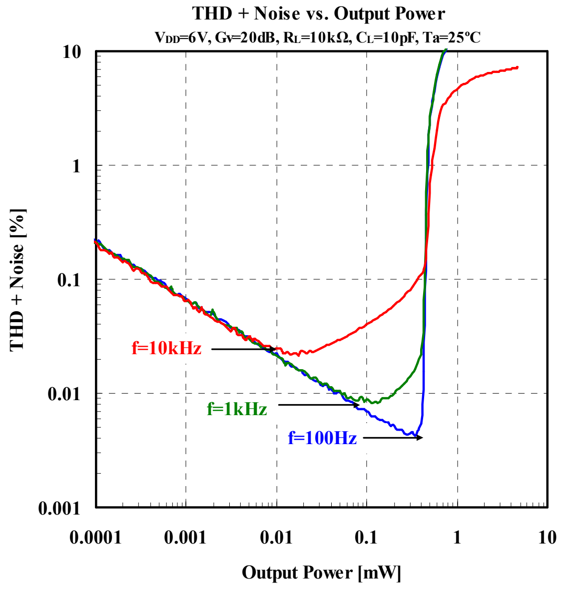

Load Transient Sinking
VDD=15V, Gv=0dB, Vin=7.5V(DC), Ta=25°C
CL=1nF
CL=10nF
CL=100nF
Current
Voltage
CL=100nF
CL=10nF
CL=1nF
Output Current [mA]
Output Voltage [V]
Time [us]
500
0
-500
-1000
-1500
15
10
5
0
-2
0
2
4
6
8

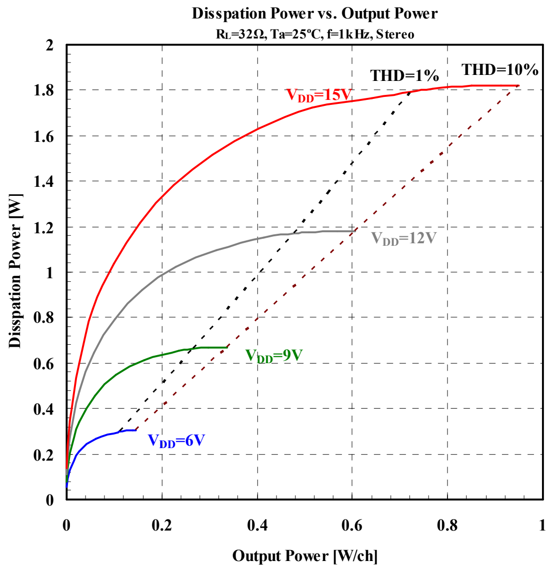

Load Transient Sinking
VDD=6V, Gv=0dB, Vin=3V(DC), Ta=25°C
CL=1nF
CL=10nF
CL=100nF
Current
Voltage
CL=100nF
CL=10nF
CL=1nF
Output Current [mA]
Output Voltage [V]
Time [us]
300
0
-300
-600
6
3
0
-2
0
2
4
6
8

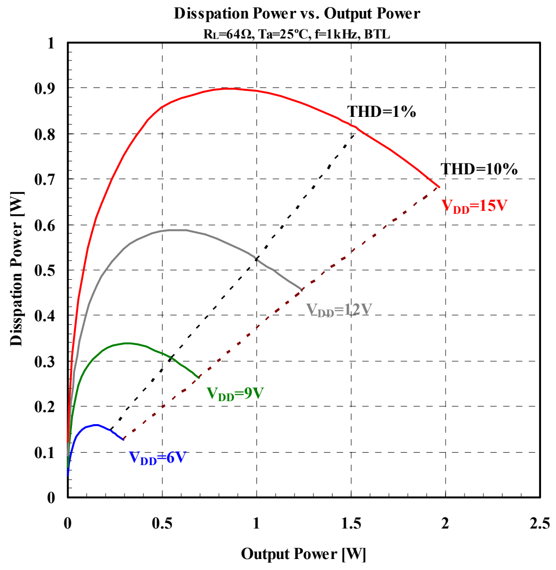

Current Limit
RL=1Ω, Gv=OPEN, Ta=25°C
VDD=15V
VDD=6V
RL=1Ω
Output Source Current [mA]
Time [msec]
1400
1200
1000
800
600
400
200
0
-50
0
50
100
150
200


Current Limit
RL=1Ω, Gv=OPEN, Ta=25°C
VDD=15V
VDD=6V
RL=1Ω
Output Sink Current [mA]
Time [msec]
1400
1200
1000
800
600
400
200
0
-50
0
50
100
150
200


THD + Noise vs. Output Power
VDD=15V, Gv=20dB, RL=10kΩ, CL=10pF, Ta=25°C
THD + Noise [%]
Output Power [mW]
f=10kHz
f=1kHz
f=100Hz
10
1
0.1
0.01
0.001
0.0001
0.001
0.01
0.1
1
10


THD + Noise vs. Output Power
VDD=6V, Gv=20dB, RL=10kΩ, CL=10pF, Ta=25°C
THD + Noise [%]
Output Power [mW]
f=10kHz
f=1kHz
f=100Hz
10
1
0.1
0.01
0.001
0.0001
0.001
0.01
0.1
1
10


Disspation Power vs. Output Power
RL=32Ω, Ta=25°C, f=1kHz, Stereo
Disspation Power [W]
Output Power [W/ch]
THD=1%
THD=10%
VDD=15V
VDD=12V
VDD=9V
VDD=6V
2
1.8
1.6
1.4
1.2
1
0.8
0.6
0.4
0.2
0
0
0.2
0.4
0.6
0.8
1


Disspation Power vs. Output Power
RL=64Ω, Ta=25°C, f=1kHz, BTL
Disspation Power [W]
Output Power [W]
THD=1%
THD=10%
VDD=15V
VDD=12V
VDD=9V
VDD=6V
1
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
0
0.5
1
1.5
2
2.5