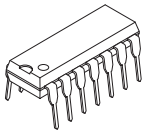
High Output Current, Rail-to-Rail Input/Output Quad CMOS Operational Amplifier

■GENERAL DESCRIPTION

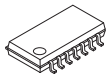
The NJU7044 is a Rail-to-Rail Input/Output quad CMOS operational amplifier.

Based on C-MOS technology, there are excellent features such as high output current, low current consumption, low operating voltage, and very high input impedance.

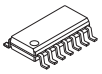
■PACKAGE OUTLINE



NJU7044D



NJU7044M



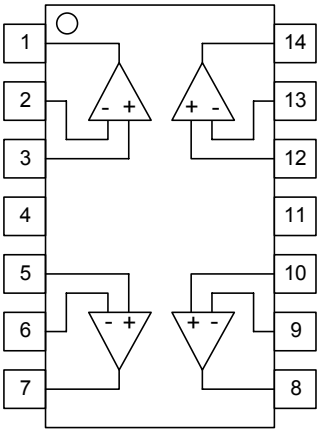
NJU7044E

NJU7044V

■ FEATURES

- ●Operating Voltage: 2.2V to 5.5V
- ●Rail-to-Rail Input/Output
- ●High Output Current: 40mA at V_O=0V
- ●Input Offset Voltage: V_{IO}=10mV max.
- ●Wide Input Common Mode Voltage Range: V_{SS} to V_{DD}
- ●Operating Current: I_{DD}=1.4mA typ. (at V_{DD}=3V)
- ●High Input Impedance: 1TΩ Typ.
- ●Low Input Bias Current: I_{IB}=1pA typ.
- ●Ground Sensing
- ●Tiny Package: NJM7044D : DIP14, NJM7044M : DMP14
  NJM7044E : EMP14, NJM7044V : SSOP14

■ PIN CONFIGURATION



NJU7044D
NJU7044M
NJM7044E
NJU7044V

Pin Function

1. OUTPUT 1	8. OUTPUT 3
2. -INPUT 2	9. -INPUT 3
3. +INPUT 2	10. +INPUT 3
4. V_{DD}	11. V_{SS}
5. +INPUT 2	12. +INPUT 4
6. -INPUT 2	13. -INPUT 4
7. OUTPUT 2	14. OUTPUT 4

■ ABSOLUTE MAXIMUM RATINGS

PARAMETER	SYMBOL	RATINGS	UNIT
Supply Voltage	V_{DD}	7	V
Common Mode Input Voltage Range	V_{ICM}	0 to 7 (Note 1)	V
Differential Input Voltage Range	V_{ID}	±7	V
Power Dissipation	P_D	DIP14 700 DMP14 300, 500(Note 2), 660(Note 3) EMP14 300, 720(Note 2), 1100(Note 3) SSOP14 300, 450(Note 2), 570(Note 3)	mW
Output Sink/Source Current for each one output terminal	Ioport	±75 [DIP14, DMP14, SSOP14]	mA
Sum total of Output Sink/Source Current of all output terminal	Iototal	180 [DIP14, DMP14, SSOP14] (Note 4)	mA
Operating Temperature Range	T_{opr}	-40 to +85	˚C
Storage Temperature Range	T_{stg}	-55 to +125	˚C

(Note 1) For supply voltage less than 7V, the absolute maximum input voltage is equal to the supply voltage.

(Note 2) On the PCB " EIA/JEDEC (76.2x11.43x1.6mm, two layers, FR-4) "

(Note 3) On the PCB " EIA/JEDEC (76.2x11.43x1.6mm, four layers, FR-4) "

(Note 4) It individually takes the absolute value of the sink current and the source current of each output terminal, and it is assumed the sum total.
Calculation type: Iototal=|Ioport1|+|Ioport2|+|Ioport3|+|Ioport4|

(Note 5) Do not exceed "Power dissipation: P_D" in which power dissipation in IC is shown by the absolute maximum rating.
Refer to following Figure 1 and Figure 2 for a permissible loss when ambient temperature (Ta) is Ta≥25°C.

Figure 1 : Power Dissipation - Ambient Temperature

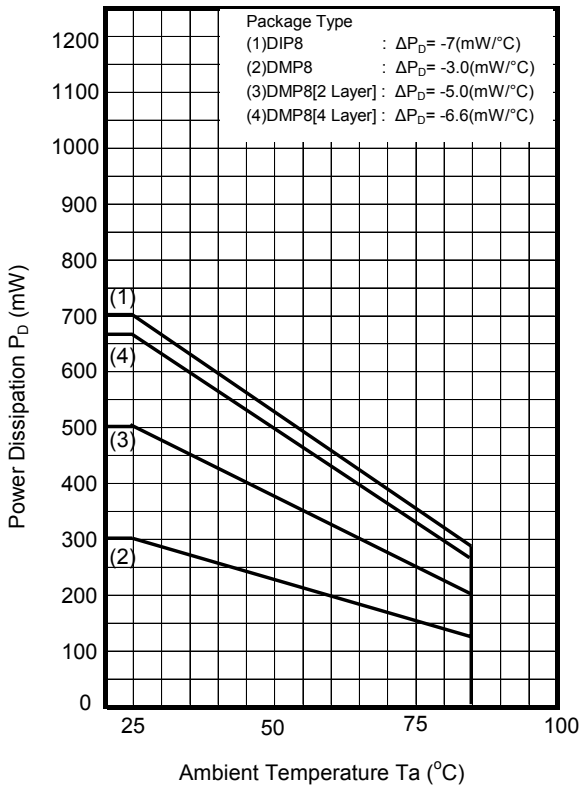
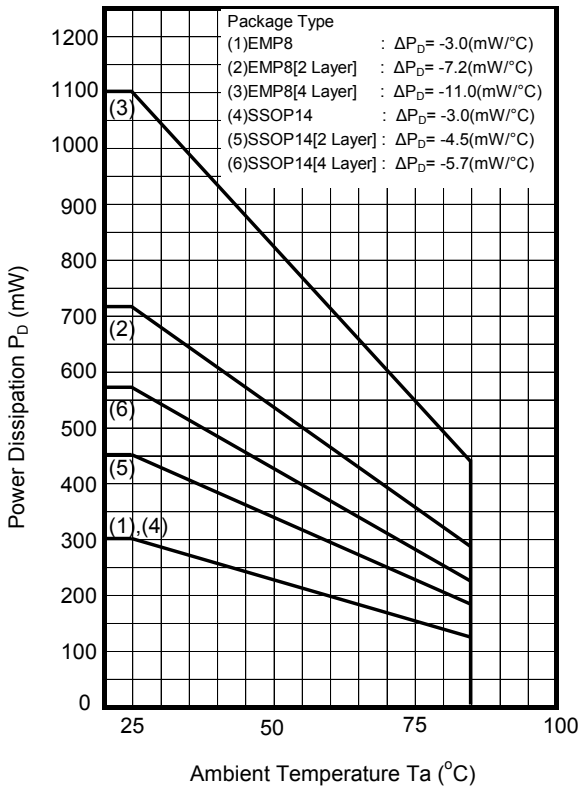


Figure 2 : Power Dissipation - Ambient Temperature



■ OPERATING VOLTAGE (Ta=25˚C)

PARAMETER	SYMBOL	RATINGS	UNIT
Supply Voltage	V_{DD}	2.2 to 5.5	V

■ ELECTRICAL CHARACTERISTICS

●DC CHARACTERISTICS (V_{DD}=5V, Ta=25˚C)

PARAMETER	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Operating Current	I_{DD}	No Signal Apply	-	1.8	2.8	mA
Input Offset Voltage	V_{IO}		-	-	10	mV
Input Bias Current	I_B		-	1	-	pA
Input Offset Current	I_{IO}		-	1	-	pA
Large Signal Voltage Gain	A_V	R_L=10kΩ to 2.5V, V_O=2.5V±2.4V	70	90	-	dB
Common Mode Rejection Ratio	CMR	CMR+: 2.5V ≤ V_{CM} ≤ 5V CMR-: 0V ≤ V_{CM} ≤ 2.5V (Note 6)	44	60	-	dB
Supply Voltage Rejection Ratio	SVR	4.0V ≤ V_{DD} ≤ 5.5V, V_{CM}=V_{DD}/2	55	85	-	dB
Output Voltage1	V_{OH}1	R_L=10kΩ to 2.5V	4.95	-	-	V
	V_{OL}1	R_L=10kΩ to 2.5V	-	-	0.05	V
Output Voltage2	V_{OH}2	R_L=600Ω to 2.5V	4.88	-	-	V
	V_{OL}2	R_L=600Ω to 2.5V	-	-	0.12	V
Output Source Current	I_{SOURCE}	V_O=3.5V (Note 7)	50	-	-	mA
Output Sink Current	I_{SINK}	V_O=1.5V (Note 7)	50	-	-	mA
Input Common Mode Voltage Range	V_{ICM}	CMR ≥ 44dB	0	-	5	V

(Note 6) CMR is represented by either CMR+ or CMR- has lower value.
(Note 7) Please note the output current value to exceed neither Ioport nor Iototal the absolute maximum rating.

●AC CHARACTERISTICS (V_{DD}=5V, Ta=25˚C)

PARAMETER	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Unity Gain Bandwidth	GB	R_L=10kΩ to 2.5V	-	0.8	-	MHz
Total Harmonic Distortion	THD	f=1kHz, V_O=0.7Vrms, A_V=+1, R_L=10kΩ to 2.5V	-	0.001	-	%
Equivalent Input Noise Voltage	V_{NI}	f=1kHz	-	40	-	nV/√Hz
Amp to Amp Separation	CS	f=1kHz, Vo=3Vpp R_L=10kΩ to 2.5V	-	120	-	dB

●TRANSIENT CHARACTERISTICS (V_{DD}=5V, Ta=25˚C)

PARAMETER	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Slew Rate	SR	R_L=10kΩ to 2.5V	-	0.8	-	V/μs

■ ELECTRICAL CHARACTERISTICS

●DC CHARACTERISTICS (V_{DD}=3V, Ta=25˚C)

PARAMETER	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Operating Current	I_{DD}	No Signal Apply	-	1.4	2.4	mA
Input Offset Voltage	V_{IO}		-	-	10	mV
Input Bias Current	I_B		-	1	-	pA
Input Offset Current	I_{IO}		-	1	-	pA
Large Signal Voltage Gain	A_V	R_L=10kΩ to 1.5V, Vo=1.5V±1.4V	70	90	-	dB
Common Mode Rejection Ratio	CMR	CMR+: 1.5V ≤ V_{CM} ≤ 3V CMR-: 0V ≤ V_{CM} ≤ 1.5V (Note 8)	42	60	-	dB
Supply Voltage Rejection Ratio	SVR	2.7V ≤ V_{DD} ≤ 4.0V, V_{CM}=V_{DD}/2	50	80	-	dB
Output Voltage1	V_{OH}1	R_L=10kΩ to 1.5V	2.95	-	-	V
	V_{OL}1	R_L=10kΩ to 1.5V	-	-	0.05	V
Output Voltage2	V_{OH}2	R_L=600Ω to 1.5V	2.9	-	-	V
	V_{OL}2	R_L=600Ω to 1.5V	-	-	0.1	V
Output Source Current	I_{SOURCE}	V_O=1.5V	30	40	-	mA
Output Sink Current	I_{SINK}	V_O=1.5V	30	40	-	mA
Input Common Mode Voltage Range	V_{ICM}	CMR ≥ 42dB	0	-	3	V

(Note 8) CMR is represented by either CMR+ or CMR- has lower value.

●AC CHARACTERISTICS (V_{DD}=3V, Ta=25˚C)

PARAMETER	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Unity Gain Bandwidth	GB	R_L=10kΩ to 1.5V	-	0.8	-	MHz
Total Harmonic Distortion	THD	f=1kHz, V_O=0.35Vrms, A_V=+1, R_L=10kΩ to 1.5V	-	0.002	-	%
Equivalent Input Noise Voltage	V_{NI}	f=1kHz	-	40	-	nV/√Hz
Amp to Amp Separation	CS	f=1kHz, Vo=1.8Vpp R_L=10kΩ to 1.5V	-	115	-	dB

●TRANSIENT CHARACTERISTICS (V_{DD}=3V, Ta=25˚C)

PARAMETER	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Slew Rate	SR	R_L=10kΩ to 1.5V	-	0.7	-	V/μs

●DC CHARACTERISTICS (V_{DD}=2.2V, Ta=25˚C)

PARAMETER	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Operating Current	I_{DD}	No Signal Apply	-	1.2	2	mA
Input Offset Voltage	V_{IO}		-	-	10	mV
Input Bias Current	I_B		-	1	-	pA
Input Offset Current	I_{IO}		-	1	-	pA
Large Signal Voltage Gain	A_V	R_L=10kΩ to 1.1V, Vo=1.1V±1.0V	70	90	-	dB
Common Mode Rejection Ratio	CMR	CMR+: 1.1V ≤ V_{CM} ≤ 2.2V CMR-: 0V ≤ V_{CM} ≤ 1.1V (Note 9)	30	60	-	dB
Supply Voltage Rejection Ratio	SVR	2.2V ≤ V_{DD} ≤ 2.7V, V_{CM}=V_{DD}/2	45	70	-	dB
Output Voltage1	V_{OH}1	R_L=10kΩ to 1.1V	2.15	-	-	V
	V_{OL}1	R_L=10kΩ to 1.1V	-	-	0.05	V
Output Voltage2	V_{OH}2	R_L=600Ω to 1.1V	2.1	-	-	V
	V_{OL}2	R_L=600Ω to 1.1V	-	-	0.1	V
Output Source Current	I_{SOURCE}	V_O=1.1V	10	15	-	mA
Output Sink Current	I_{SINK}	V_O=1.1V	10	15	-	mA
Input Common Mode Voltage Range	V_{ICM}	CMR ≥ 30dB	0	-	2.2	V

(Note 9) CMR is represented by either CMR+ or CMR- has lower value.

●AC CHARACTERISTICS (V_{DD}=2.2V, Ta=25˚C)

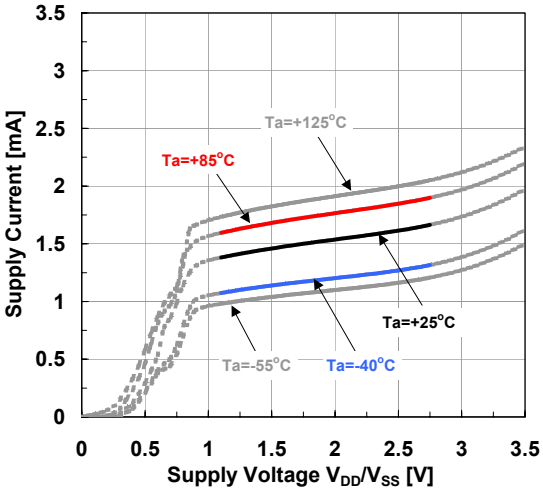
PARAMETER	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Unity Gain Bandwidth	GB	R_L=10kΩ to 1.1V	-	0.8	-	MHz
Total Harmonic Distortion	THD	f=1kHz, V_O=0.18Vrms, A_V=+1, R_L=10kΩ to 1.1V	-	0.004	-	%
Equivalent Input Noise Voltage	V_{NI}	f=1kHz	-	40	-	nV/√Hz
Amp to Amp Separation	CS	f=1kHz, Vo=1.2Vpp R_L=2kΩ to 1.1V	-	110	-	dB

●TRANSIENT CHARACTERISTICS (V_{DD}=2.2V, Ta=25˚C)

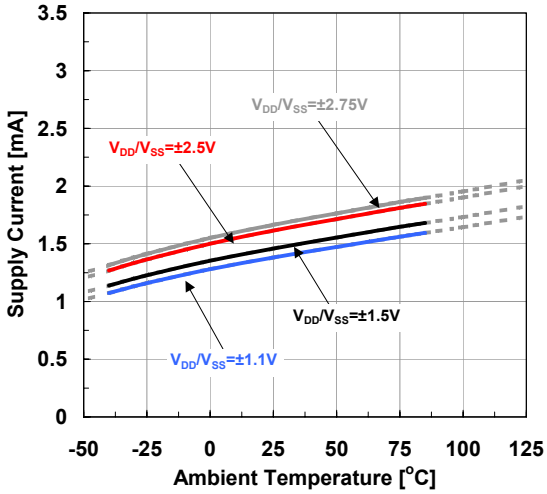
PARAMETER	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Slew Rate	SR	R_L=10kΩ to 1.1V	-	0.6	-	V/μs

●Typical Characteristics

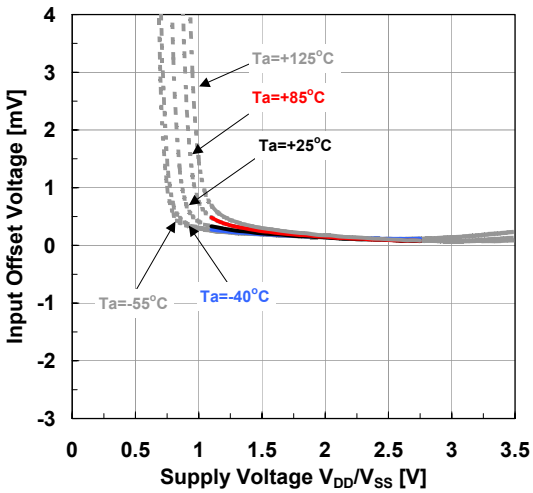
Supply Current vs. Supply Voltage
(Ambient Temperature)
No Signal, A_V=0dB



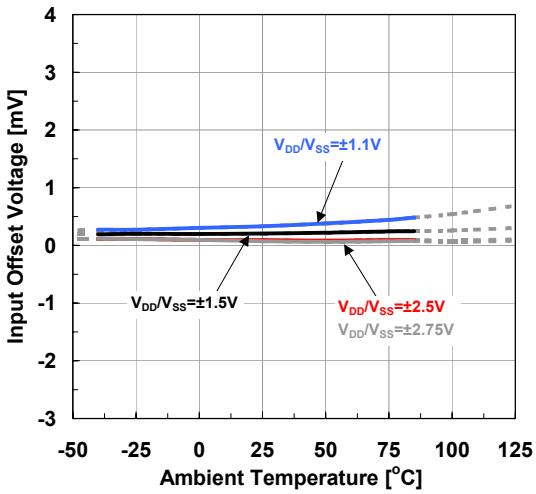
Supply Current vs. Ambient Temperature
No Signal, A_V=0dB



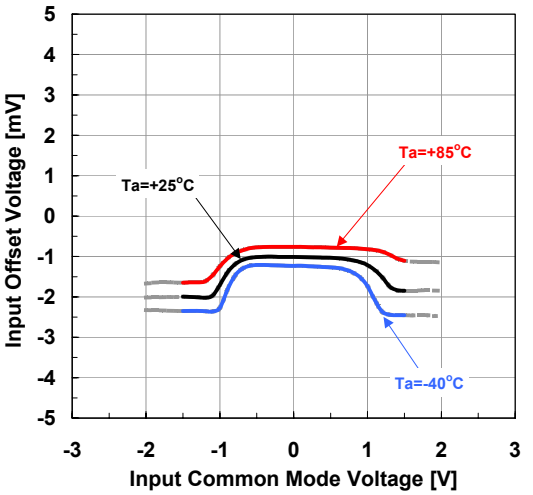
Input Offset Voltage vs. Supply Voltage
(Ambient Temperature)
No Signal, A_V=0dB



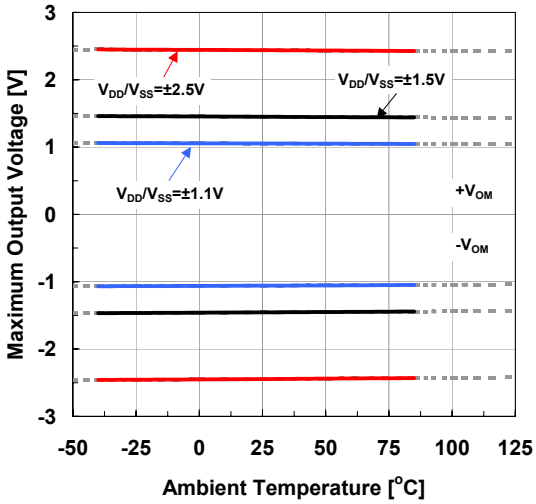
Input Offset Voltage
vs. Ambient Temperature
No Signal, A_V=0dB



Input Offset Voltage
vs. Input Common Mode Voltage
V_{DD}/V_{SS}=±1.5V, R_L=10kΩ

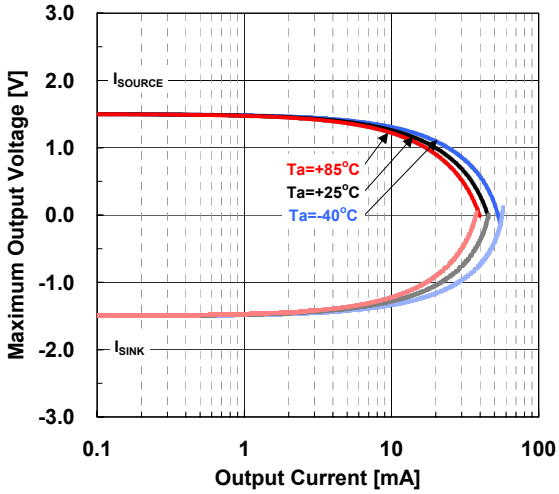


Maximum Output Voltage
vs. Ambient Temperature
G_V=OPEN, R_L=600Ω

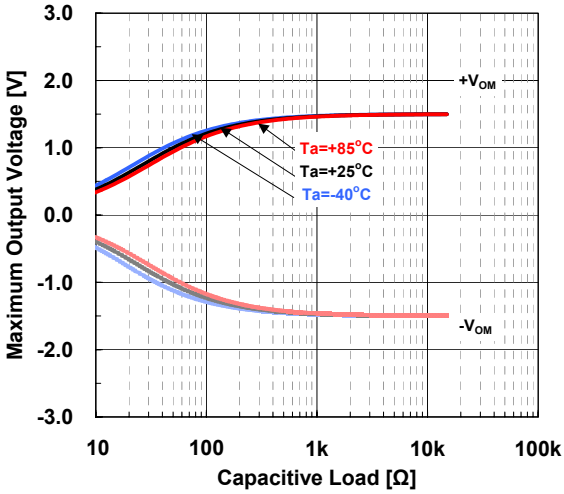


●Typical Characteristics

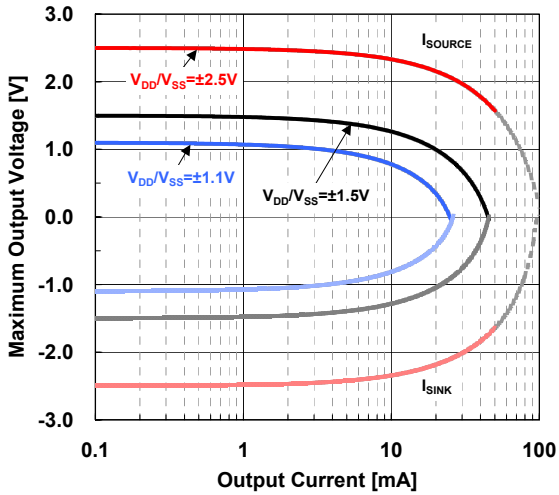
Maximum Output Voltage vs. Output Current
(Ambient Tmeperature)
V_{DD}/V_{SS}=±1.5V, G_V=OPEN



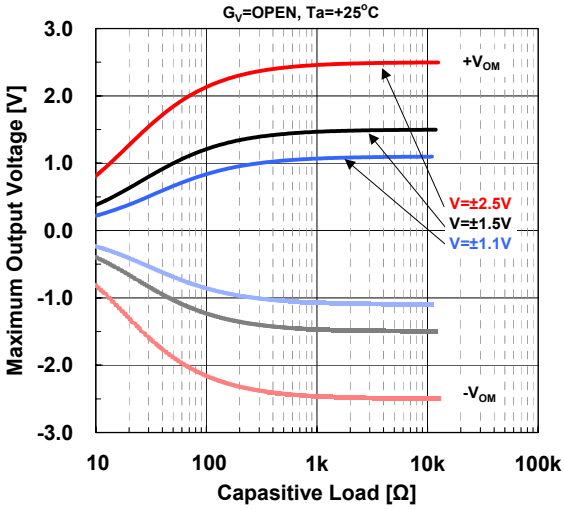
Maximum Output Voltage
vs. Capacitive Load
(Ambient Temperature)
V_{DD}/V_{SS}=±1.5V, G_V=OPEN



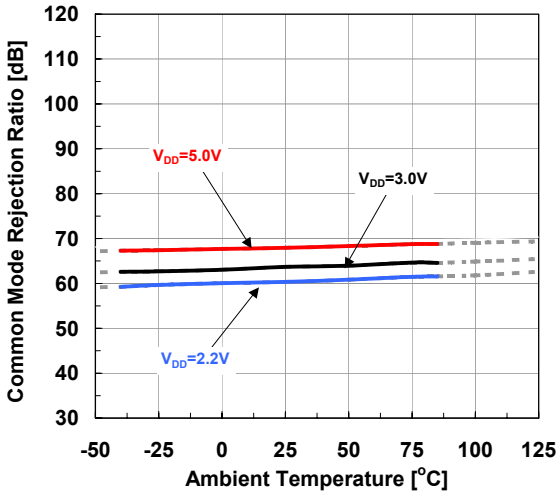
Maximum Output Voltage vs. Output Current
G_V=OPEN, Ta=+25°C



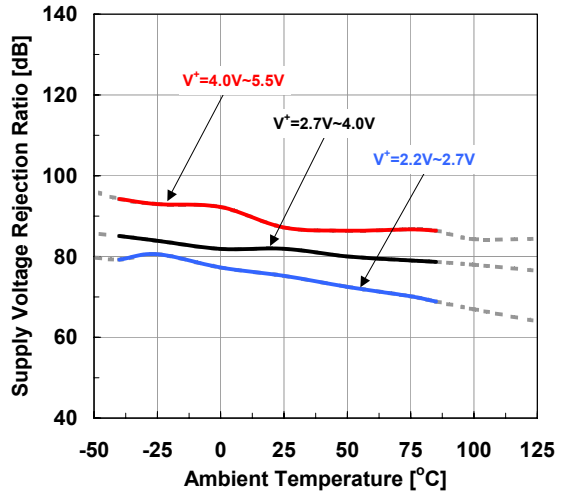
Maximum Output Voltage
vs. Capacitive Load
(Supply Voltage)
G_V=OPEN, Ta=+25°C



Common Mode Rejection Ratio
vs. Ambient Temperature
CMR- : GND≤V_{CM}≤V_{DD}/2



Supply Voltage Rejection Ratio
vs. Ambient Temperature
No Signal, A_V=0dB

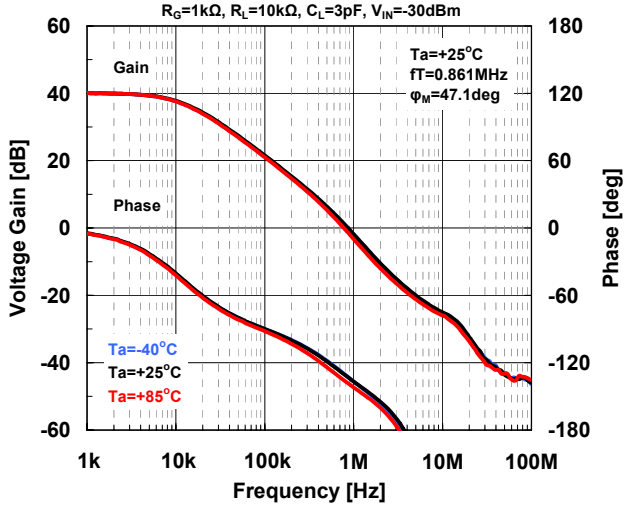


●Typical Characteristics

Voltage Gain/Phase vs. Frequency

(Ambient Temperature)

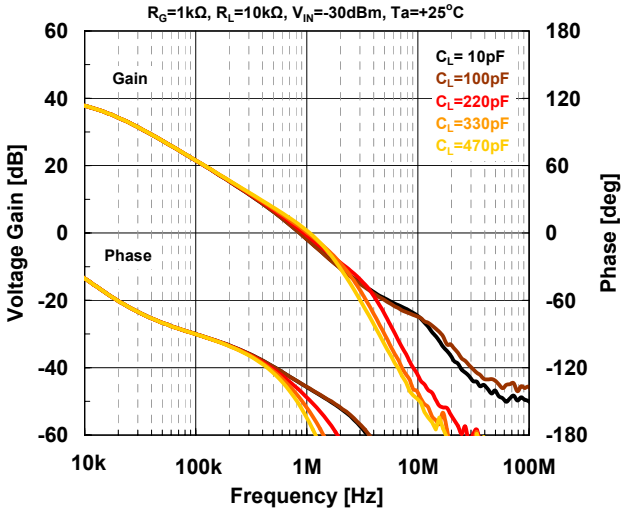
V_{DD}/V_{SS}=±1.5V, G_V=40dB, R_F=100kΩ,
R_G=1kΩ, R_L=10kΩ, C_L=3pF, V_{IN}=-30dBm



Voltage Gain/Phase vs. Frequency

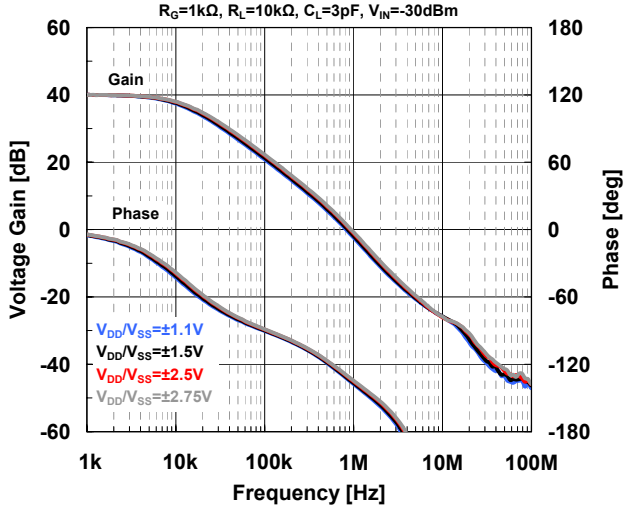
(Load Capacitance)

V_{DD}/V_{SS}=±1.5V, G_V=40dB, R_F=100kΩ,
R_G=1kΩ, R_L=10kΩ, V_{IN}=-30dBm, Ta=+25°C



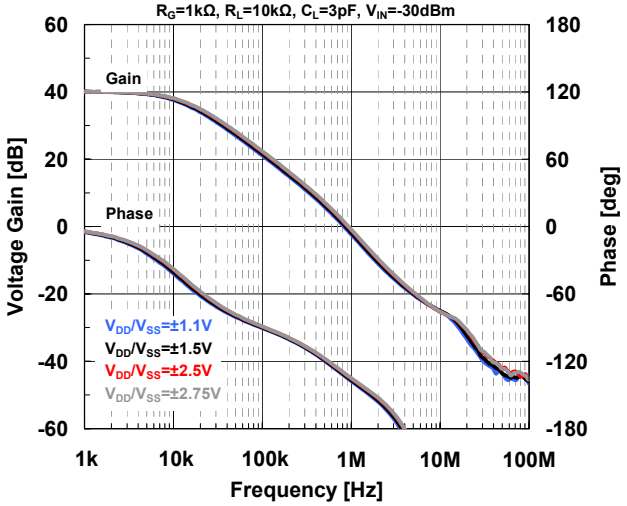
Voltage Gain/Phase vs. Frequency

G_V=40dB, R_F=100kΩ, Ta=-40°C
R_G=1kΩ, R_L=10kΩ, C_L=3pF, V_{IN}=-30dBm



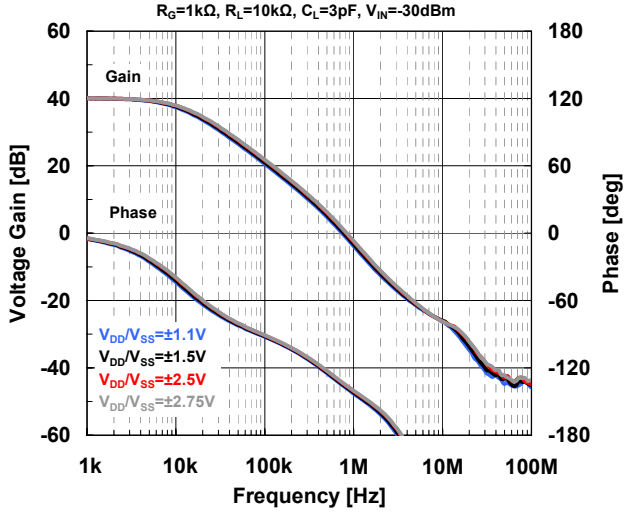
Voltage Gain/Phase vs. Frequency

G_V=40dB, R_F=100kΩ, Ta=+25°C
R_G=1kΩ, R_L=10kΩ, C_L=3pF, V_{IN}=-30dBm



Voltage Gain/Phase vs. Frequency

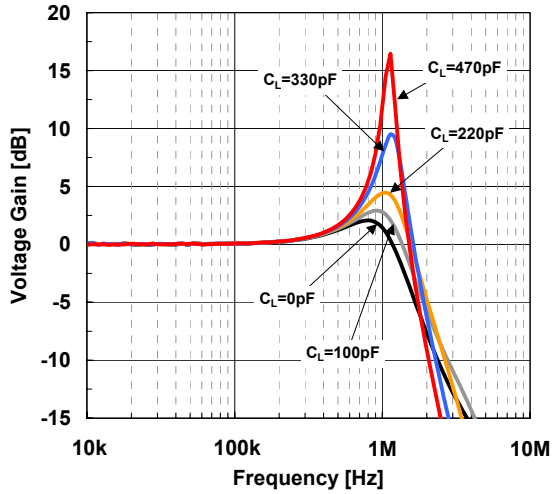
G_V=40dB, R_F=100kΩ, Ta=+85°C
R_G=1kΩ, R_L=10kΩ, C_L=3pF, V_{IN}=-30dBm



●Typical Characteristics

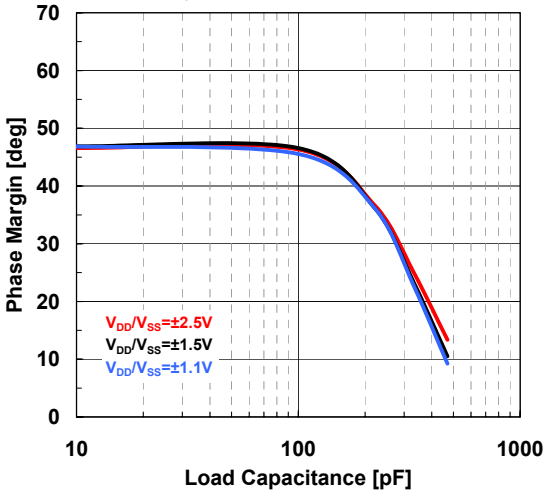
Frequency Response (Load Capacitance)

V_{DD}/V_{SS}=±1.5V, G_V=0dB, R_L=10kΩ,
Vin=-30dBm,Ta=+25°C



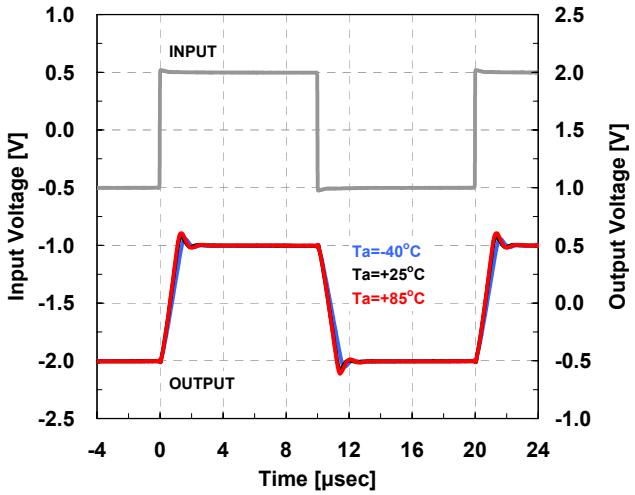
Phase Margin vs. Load Capacitance

G_V=40dB, R_F=100kΩ, R_G=1kΩ, R_L=10kΩ,
R_S=50Ω, Vin=-30dBm, Ta=+25°C



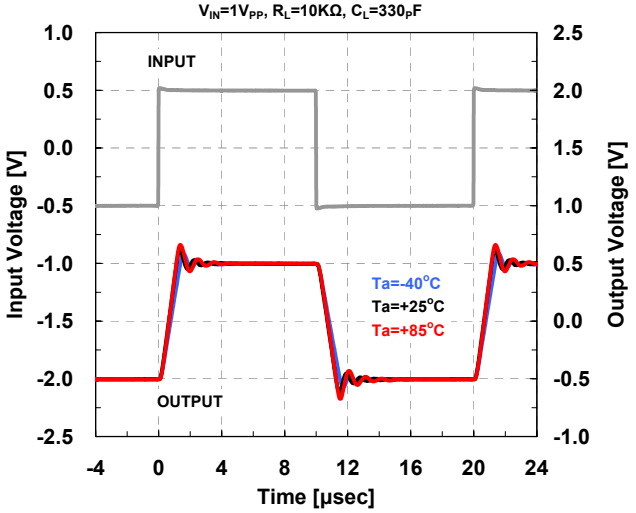
Pulse Response

V_{DD}/V_{SS}=±1.5V, A_V=0dB, f=50kHz,
V_{IN}=1V_{PP}, R_L=10kΩ, C_L=15pF



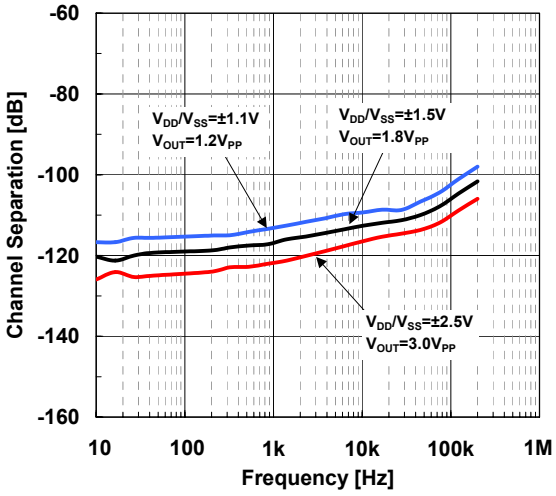
Pulse Response

V_{DD}/V_{SS}=±1.5V, A_V=0dB, f=50kHz,
V_{IN}=1V_{PP}, R_L=10KΩ, C_L=330pF



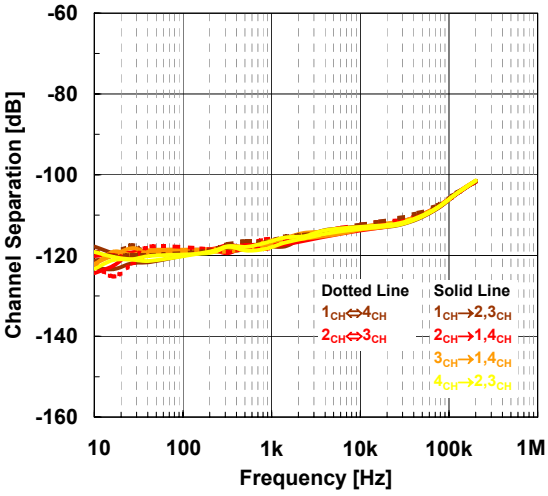
Channel Separation vs. Frequency

G_V=40dB, R_L=10kΩ, R_F=100kΩ, V_{IN}=1ch⇒4ch, Ta=25°C



Channel Separation vs. Frequency

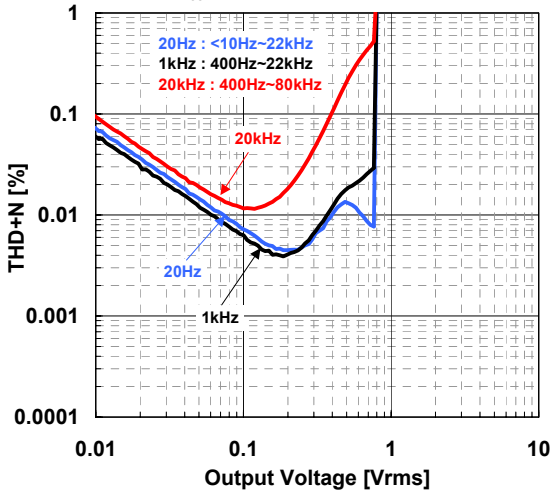
V_{DD}/V_{SS}=±1.5V, G_V=40dB, R_L=10kΩ,
R_F=100kΩ, Vo=1.8V_{PP}, Ta=25°C



●Typical Characteristics

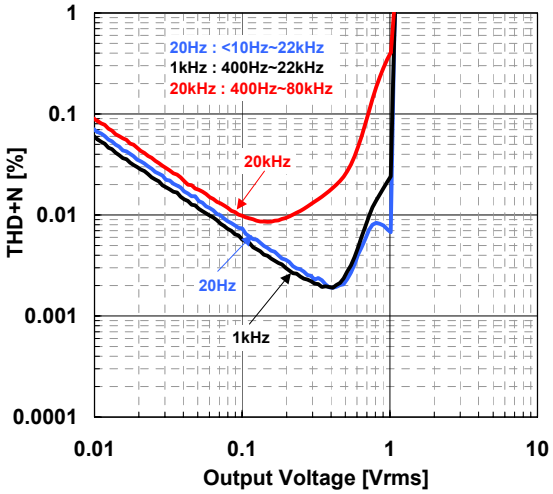
THD+N vs. Output Voltage

V_{DD}/V_{SS}=±1.1V, G_V=0dB, R_L=10KΩ, Ta=25°C



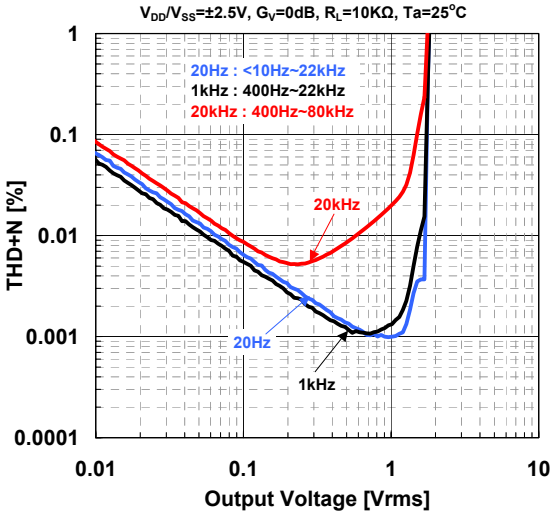
THD+N vs. Output Voltage

V_{DD}/V_{SS}=±1.5V, G_V=0dB, R_L=10KΩ, Ta=25°C



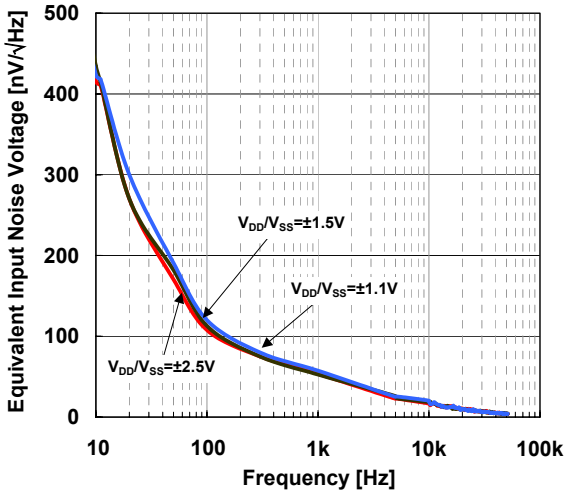
THD+N vs. Output Voltage

V_{DD}/V_{SS}=±2.5V, G_V=0dB, R_L=10KΩ, Ta=25°C



Equivalent Input Noise Voltage vs. Frequency

G_V=40dB, R_L=10kΩ, C_L=10pF, Ta=25°C



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