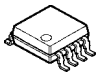
Low Noise Precision Rail-to-Rail Output Dual CMOS Operational Amplifier

■ GENERAL DESCRIPTION

The NJU7077 is a high precision Rail-to-Rail output dual CMOS operational amplifier featuring a low noise of 10nV/√Hz (typ.), low input offset voltage of 150μV (max.), low temperature drift of 0.5μV/°C (typ.) and low bias current of 1pA (typ.). The output swing can reach 50 mV from the rails, while driving a 10kΩ load (at 5V operation). The NJU7077 also has a high RF noise immunity which can reduce malfunctions caused by RF noises from mobile phones and others. The combination of theses specifications makes the NJU7077 well-sited for sensor applications such as a temperature sensor, weight sensor and others, high precision current sensing amplifiers and current voltage converters. The NJU7077 is available in a small surface mount package of MSOP8 (VSP8) meeting JEDEC MO-187-DA.

■ PACKAGE OUTLINE



NJU7077R
(MSOP8 (VSP8))

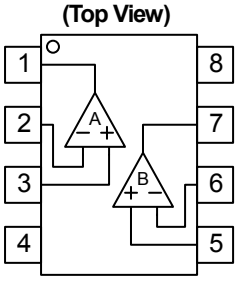
■ FEATURES

- Precision
  - Offset Voltage 150μV max.
  - Low Drift 0.5μV/°C typ.
- Noise Voltage 10nV/√Hz typ.
- Low Bias Current 1pA typ.
- Rail-to-rail Output + 0.05V to V_{DD} - 0.05V (R_L = 10kΩ)
- RF Immunity
- Operating Voltage +2.2V to +5.5V
- Package MSOP8 (VSP8) MEET JEDEC MO-187-DA

■ APPLICATIONS

- Thermocouple / Thermopile Amplifiers
- Strain Gauge / Pressure sensor Amplifiers
- Load Cell and Bridge Transducer Amplifiers
- High Resolution Data Acquisition
- Precision Current Sensing

■ Pin CONFIGURATION



PIN FUNCTION
1: A OUTPUT
2: A -INPUT
3: A +INPUT
4: VSS
5: B +INPUT
6: B -INPUT
7: B OUTPUT
8: VDD

■**ABSOLUTE MAXIMUM RATINGS** (Ta=25ºC, unless otherwise noted.)

PARAMETER	SYMBOL	RATING	UNIT
Supply Voltage	V_{DD}	+7	V
Common Mode Input Voltage Range	V_{ICM}	V_{SS} - 0.3 to V_{DD} + 0.3	V
Differential Input Voltage Range	V_{ID}	±7 (Note1)	V
Power Dissipation(Note3)	P_D	500(Note2)	mW
Operating Temperature Range	Topr	-40 to +125	ºC
Storage Temperature Range	Tstg	-55 to +150	ºC

(Note1) For supply voltage less than7V, the absolute maximum input voltage is equal to supply voltage.
(Note2) On the PCB "EIA/JEDEC(76.2×114.3×1.6mm, 2 layers, FR-4)"
(Note3) Do not exceed "Power dissipation: PD" in which power dissipation in IC is shown by the absolute maximum rating.
Refer to following Figure 1 for a permissible loss when ambient temperature (Ta) is Ta≥25ºC.

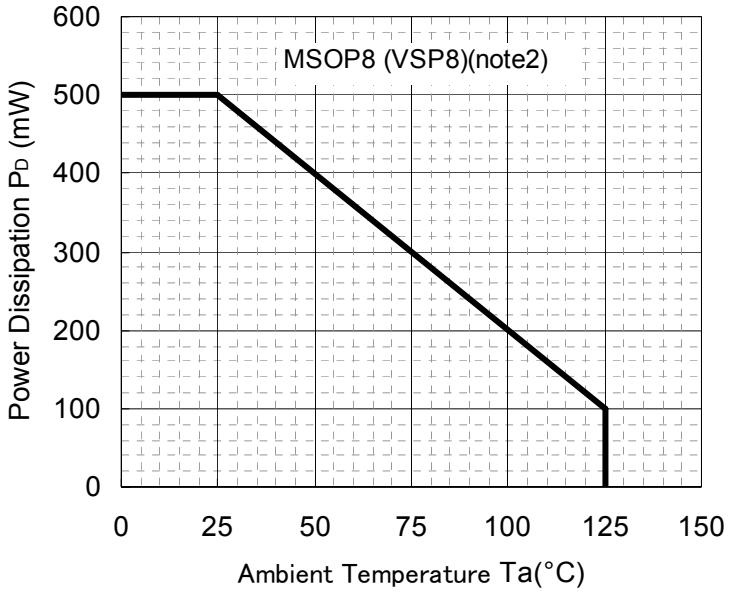


Figure1: PD – Temperature

■**RECOMMENDED OPERATING CONDITIONS** (Ta=25ºC)

PARAMETER	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Supply Voltage	V_{DD}		+2.2	-	+5.5	V

■ELECTRICAL CHARACTERISTICS

●DC CHARACTERISTICS (V_{DD}=5V, V_{SS}=0V, V_{ICM}=2.5V, Ta=25ºC, unless otherwise noted.)

PARAMETER	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Supply Current	I_{CC}	No Signal	-	1.2	1.8	mA
		No Signal, Ta=-40ºC to 125ºC	-	-	1.8	
Input Offset Voltage	V_{IO}		-	20	150	μV
		Ta=-40ºC to 125ºC	-	-	400	
Input Offset Voltage Drift	TCV_{IO}	Ta=-40ºC to 125ºC(Note4)	-	0.5	5.0	μV/ºC
Input Bias Current	I_B		-	1	-	pA
Input Offset Current	I_{IO}		-	1	-	pA
Voltage Gain	A_V	Vout=0.5V to 4.5V, R_L=10kΩ to 2.5V	100	130	-	dB
		Vout=0.5V to 4.5V, R_L=10kΩ to 2.5V, Ta=-40ºC to 125ºC	100	-	-	
Common Mode Rejection Ratio	CMR	V_{ICM}=0V to 4V	70	90	-	dB
		V_{ICM}=0V to 4V, Ta=-40ºC to 125ºC	70	-	-	
Supply Voltage Rejection Ratio	SVR	V_{DD}=2.2V to 5.5V	70	90	-	dB
		V_{DD}=2.2V to 5.5V, Ta=-40ºC to 125ºC	70	-	-	
Maximum Output Voltage	V_{OH}	R_L=10kΩ to 2.5V	4.95	4.98	-	V
		R_L=10kΩ to 2.5V, Ta=-40ºC to 125ºC	4.95	-	-	
		R_L=600Ω to 2.5V	4.85	4.92	-	
		R_L=600Ω to 2.5V, Ta=-40ºC to 125ºC	4.85	-	-	
		I_O=2mA	4.9	4.96	-	
		I_O=2mA, Ta=-40ºC to 125ºC	4.85	-	-	
	V_{OL}	R_L=10kΩ to 2.5V	-	0.02	0.05	V
		R_L=10kΩ to 2.5V, Ta=-40ºC to 125ºC	-	-	0.05	
		R_L=600Ω to 2.5V	-	0.08	0.15	
		R_L=600Ω to 2.5V, Ta=-40ºC to 125ºC	-	-	0.2	
		I_O=2mA	-	0.04	0.1	
		I_O=2mA, Ta=-40ºC to 125ºC	-	-	0.15	
Common Mode Input Voltage Range	V_{ICM}	CMR≥70dB	0	-	4	V
		CMR≥70dB, Ta=-40ºC to 125ºC	0	-	4	

(Note4) Guaranteed by two points of Temperature -40˚C and +125˚C

●AC CHARACTERISTICS (V_{DD}=5V, V_{SS}=0V, V_{ICM}=2.5V, Ta=25ºC, unless otherwise noted.)

PARAMETER	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Gain Bandwidth Product	GBW	G_V=40dB, R_F=100kΩ, R_L=10kΩ, C_L=20pF	-	1.3	-	MHz
Phase Margin	φ_M	G_V=40dB, R_F=100kΩ, R_L=10kΩ, C_L=20pF	-	60	-	deg
Gain Margin	G_M	G_V=40dB, R_F=100kΩ, R_L=10kΩ, C_L=20pF	-	12	-	dB
Equivalent Input Noise Voltage	V_{NI}	f=1kHz	-	10	-	nV/√Hz
Slew Rate	SR	G_V=0dB, R_L=10kΩ, C_L=20pF, V_{IN}=4V_{PP}	-	0.5	-	V/μs
Total Harmonic Distortion	THD	G_V=20dB, R_L=10kΩ, f=1kHz, V_O=3V_{PP}	-	0.01	-	%
Channel Separation	CS	f=1kHz	-	140	-	dB

●**DC CHARACTERISTICS** (V_{DD}=2.2V, V_{SS}=0V, V_{ICM}=1.1V, Ta=25ºC, unless otherwise noted.)

PARAMETER	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Supply Current	I_{CC}	No Signal	-	1.0	1.5	mA
		No Signal, Ta=-40ºC to 125ºC	-	-	1.5	
Input Offset Voltage	V_{IO}		-	60	250	μV
		Ta=-40ºC to 125ºC	-	-	400	
Input Offset Voltage Drift	TCVIO	Ta=-40ºC to 125ºC(Note4)	-	0.6	5.0	μV/ºC
Input Bias Current	I_B		-	1	-	pA
Input Offset Current	I_{IO}		-	1	-	pA
Voltage Gain	A_V	Vout=0.6V to 1.6V, R_L=10kΩ to 1.1V	100	130	-	dB
		Vout=0.6V to 1.6V, R_L=10kΩ to 1.1V, Ta=-40ºC to 125ºC	100	-	-	
Common Mode Rejection Ratio	CMR	V_{ICM}=0V to 1.2V	70	90	-	dB
		V_{ICM}=0V to 1.2V, Ta=-40ºC to 125ºC	70	-	-	
Maximum Output Voltage	V_{OH}	R_L=10kΩ to 1.1V	2.15	2.18	-	V
		R_L=10kΩ to 1.1V, Ta=-40ºC to 125ºC	2.15	-	-	
		R_L=600Ω to 1.1V	2.1	2.14	-	
		R_L=600Ω to 1.1V, Ta=-40ºC to 125ºC	2.05	-	-	
		I_O=2mA	2.05	2.13	-	
		I_O=2mA, Ta=-40ºC to 125ºC	2.0	-	-	
	V_{OL}	R_L=10kΩ to 1.1V	-	0.02	0.05	V
		R_L=10kΩ to 1.1V, Ta=-40ºC to 125ºC	-	-	0.05	
		R_L=600Ω to 1.1V	-	0.06	0.1	
		R_L=600Ω to 1.1V, Ta=-40ºC to 125ºC	-	-	0.15	
		I_O=2mA	-	0.07	0.15	
		I_O=2mA, Ta=-40ºC to 125ºC	-	-	0.2	
Common Mode Input Voltage Range	V_{ICM}	CMR≥70dB	0	-	1.2	V
		CMR≥70dB, Ta=-40ºC to 125ºC	0	-	1.2	

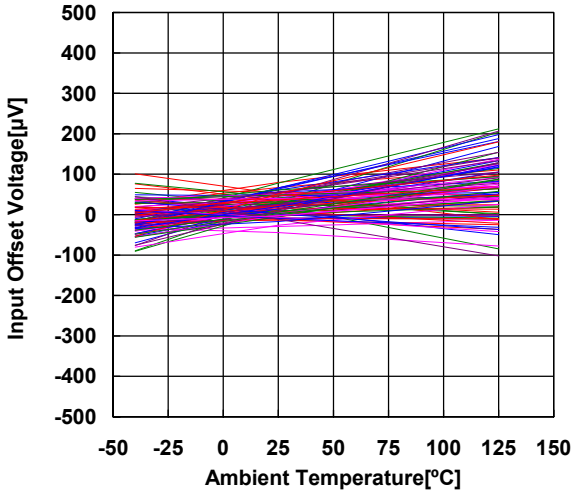
(Note4) Guaranteed by two points of Temperature -40˚C and +125˚C

●**AC CHARACTERISTICS** (V_{DD}=2.2V, V_{SS}=0V, V_{ICM}=1.1V, Ta=25ºC, unless otherwise noted.)

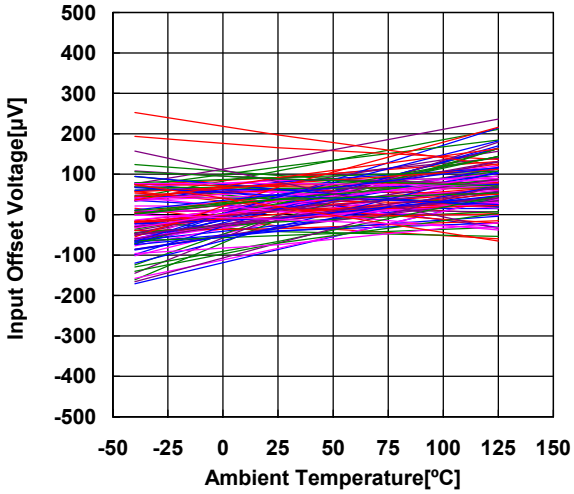
PARAMETER	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Gain Bandwidth Product	GBW	G_V=40dB, R_F=100kΩ, R_L=10kΩ, C_L=20pF	-	1.2	-	MHz
Phase Margin	φ_M	G_V=40dB, R_F=100kΩ, R_L=10kΩ, C_L=20pF	-	60	-	deg
Gain Margin	G_M	G_V=40dB, R_F=100kΩ, R_L=10kΩ, C_L=20pF	-	12	-	dB
Equivalent Input Noise Voltage	V_{NI}	f=1kHz	-	10	-	nV/√Hz
Slew Rate	SR	G_V=0dB, R_L=10kΩ, C_L=20pF, V_{IN}=1V_{PP}	-	0.5	-	V/μs
Total Harmonic Distortion	THD	G_V=20dB, R_L=10kΩ, f=1kHz, V_O=1V_{PP}	-	0.01	-	%
Channel Separation	CS	f=1kHz	-	140	-	dB

■ TYPICAL CHARACTERISTICS

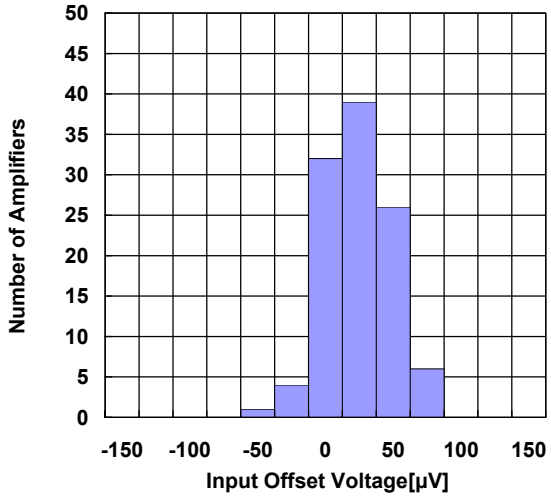
Input Offset Voltage vs. Temperature
V_{DD}=±2.5V V_{ICM}=0V



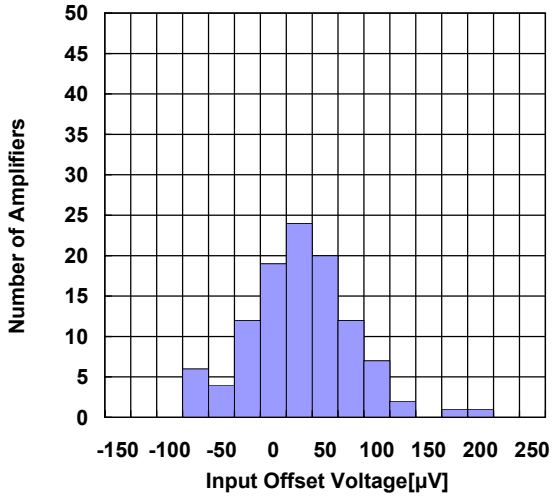
Input Offset Voltage vs. Temperature
V_{DD}=±1.1V V_{ICM}=0V



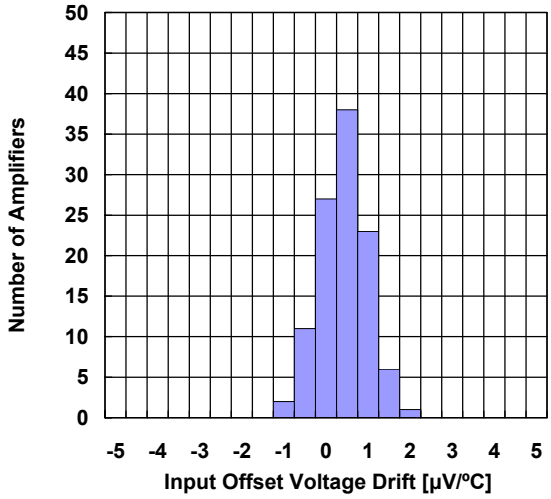
Input Offset Voltage Distribution
V_{DD}=±2.5V V_{ICM}=0V Ta=25ºC



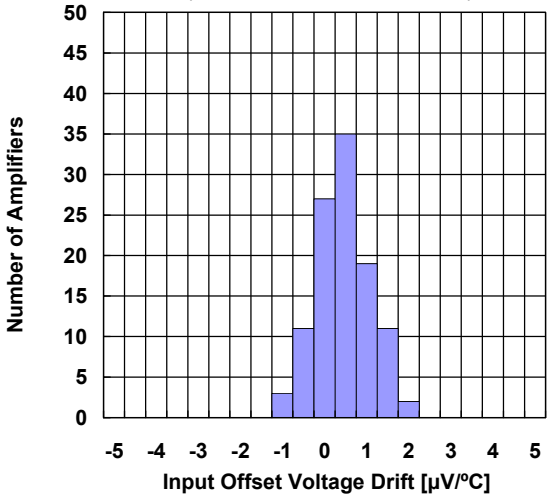
Input Offset Voltage Distribution
V_{DD}=±1.1V V_{ICM}=0V Ta=25ºC



Input Offset Voltage Drift Distribution
(V_{DD}=±2.5V V_{ICM}=0V Ta=-40ºC→125ºC)

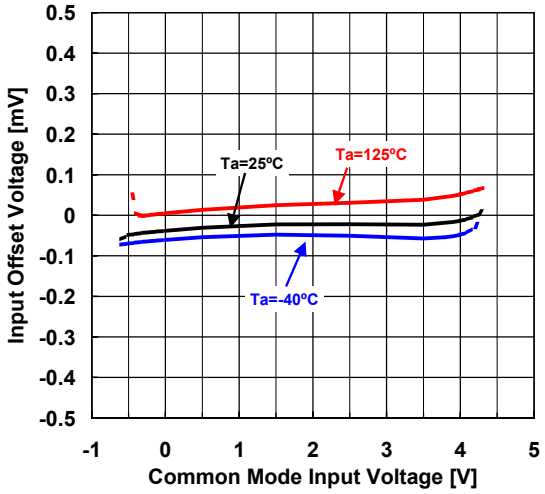


Input Offset Voltage Drift Distribution
(V_{DD}=±1.1V V_{ICM}=0V Ta=-40ºC→125ºC)

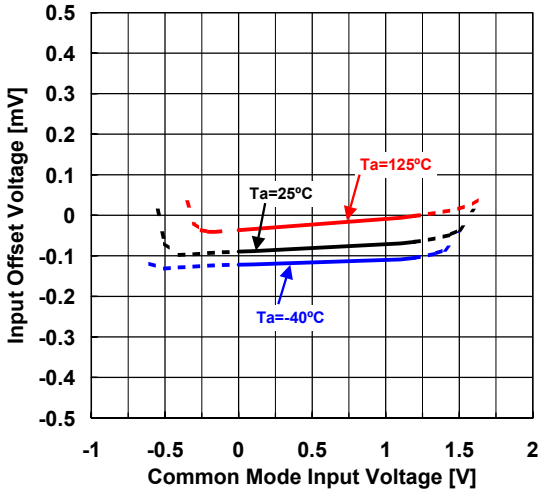


■ TYPICAL CHARACTERISTICS

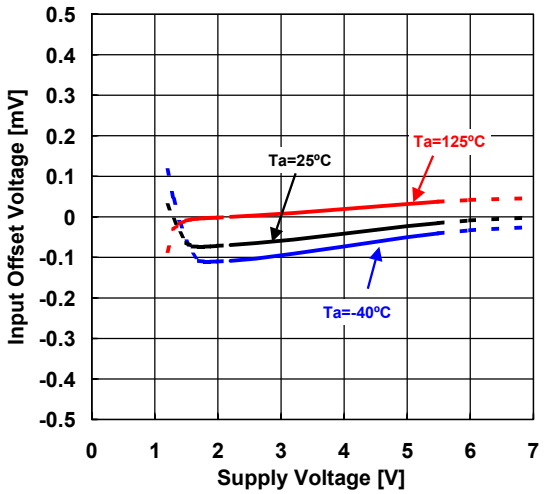
Input Offset Voltage
vs. Common Mode Input Voltage
(Temperature)
V_{DD}=+5V



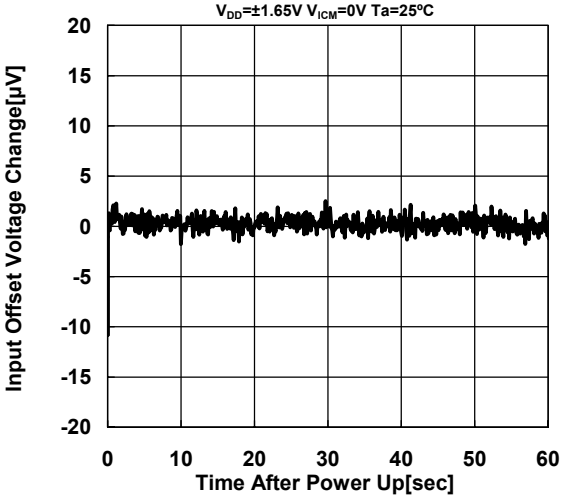
Input Offset Voltage
vs. Common Mode Input Voltage
(Temperature)
V_{DD}=+2.2V



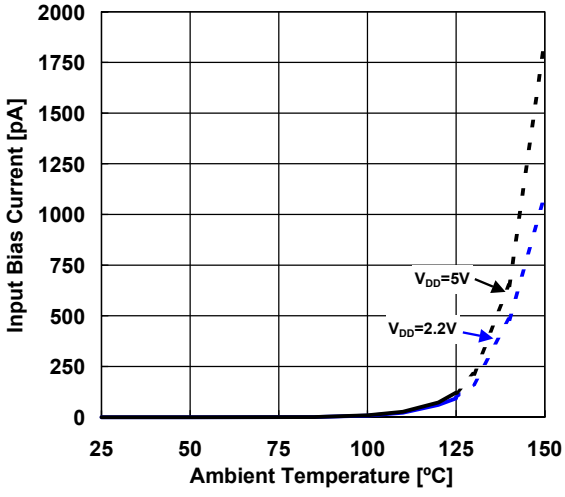
Input Offset Voltage vs. Supply Voltage (Temperature)
V_{ICM}=V_{DD}/2



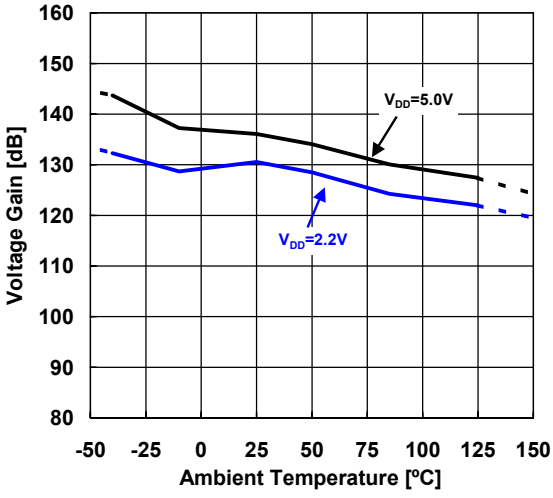
Warm-Up Vio Drift
V_{DD}=±1.65V V_{ICM}=0V Ta=25°C



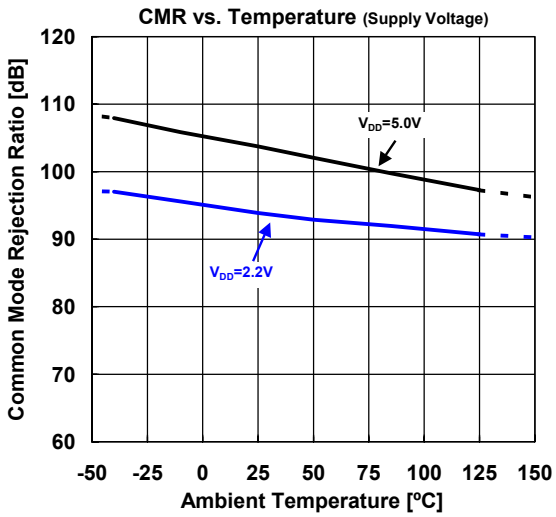
Input Bias Current vs. Temperature (Supply Voltage)
V_{ICM}=V_{DD}/2

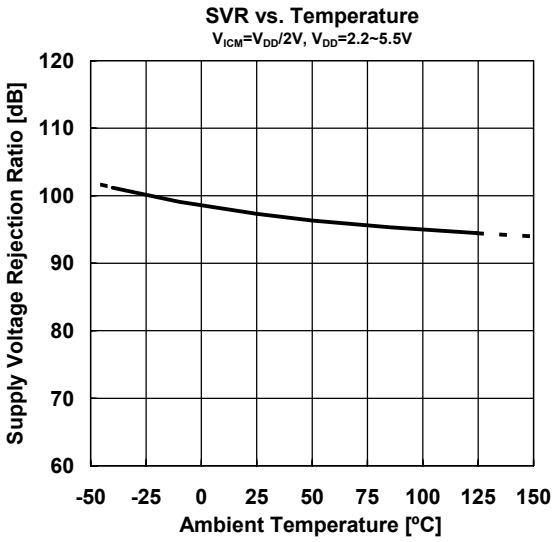


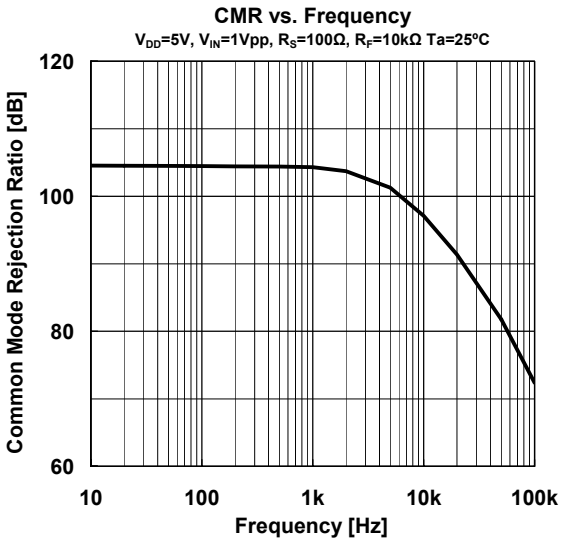
Open-Loop Gain vs. Temperature (Supply Voltage)
R_L=10kΩ

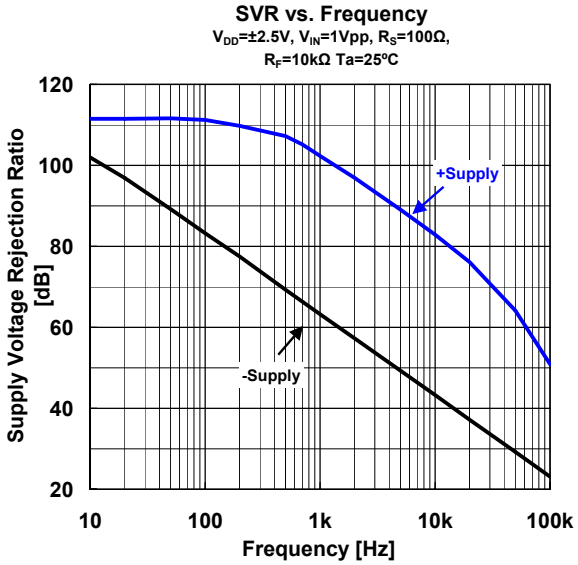


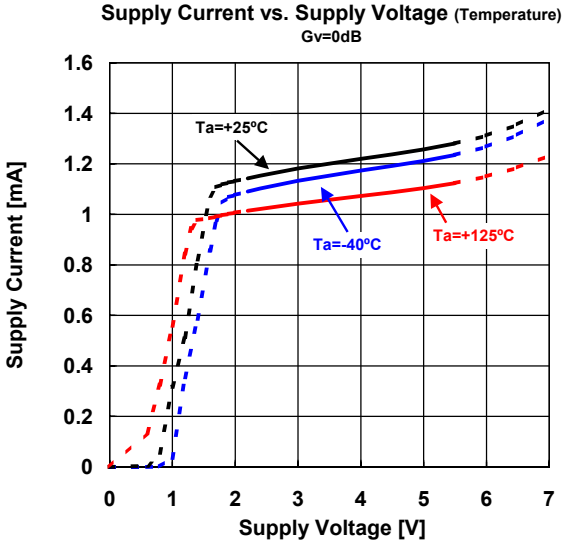
■TYPICAL CHARACTERISTICS

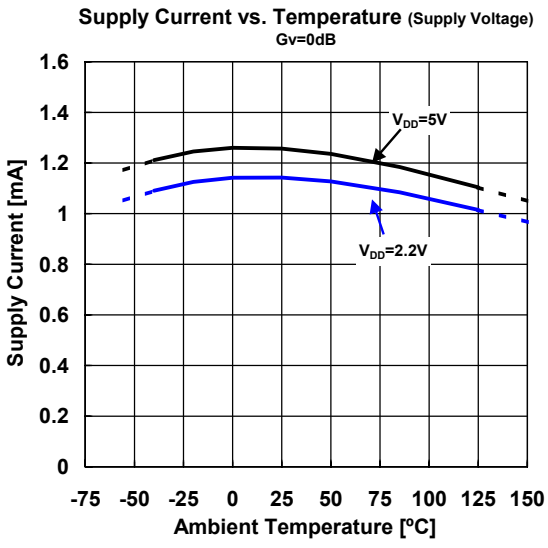






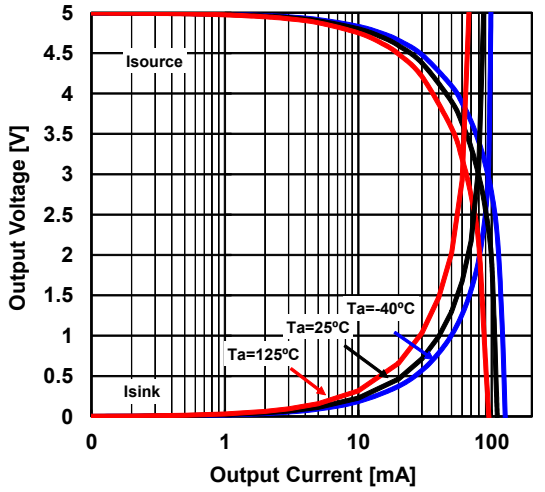




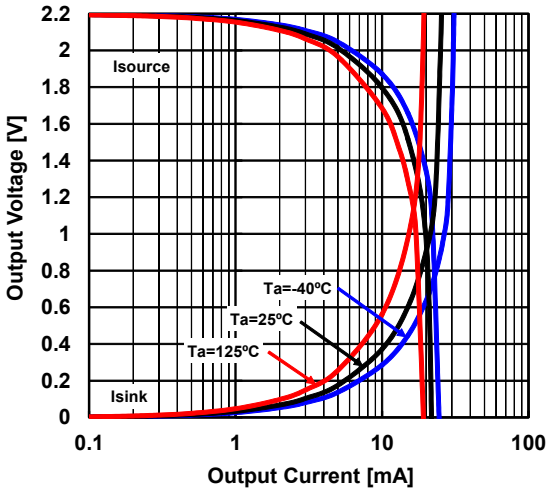


■TYPICAL CHARACTERISTICS

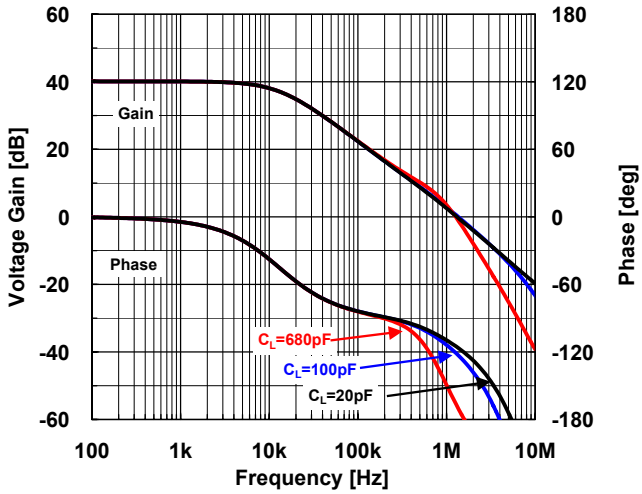
Maximum Output Voltage vs. Output Current
(Temperature)
V_{DD}=5V



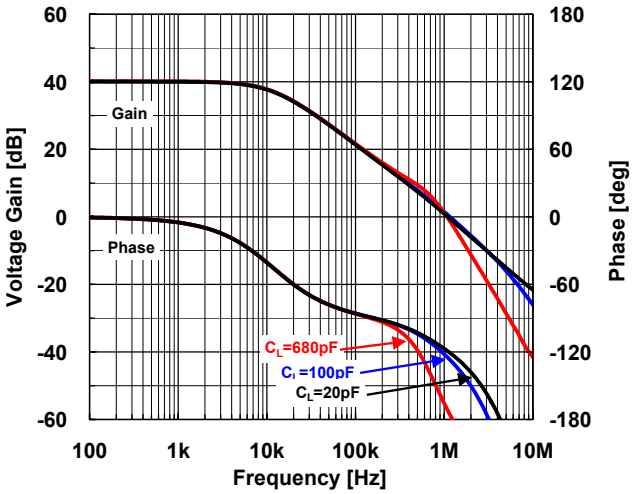
Maximum Output Voltage vs. Output Current
(Temperature)
V_{DD}=2.2V



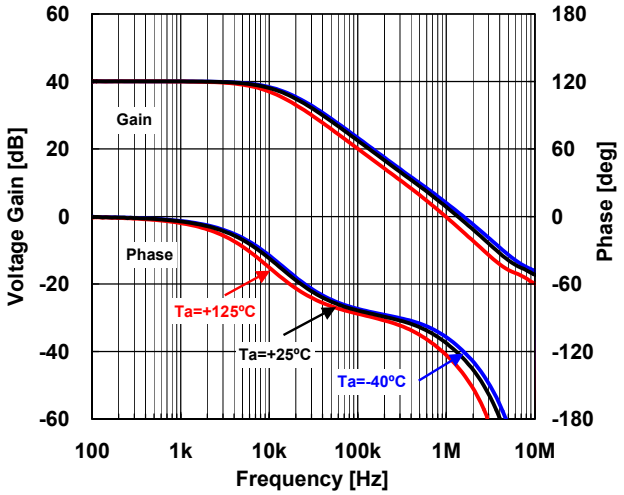
Gain/Phase vs. Frequency
V_{DD}=5V, Gv=40dB, R_F=100kΩ, R_S=1kΩ
R_L=10kΩ, Ta=25°C



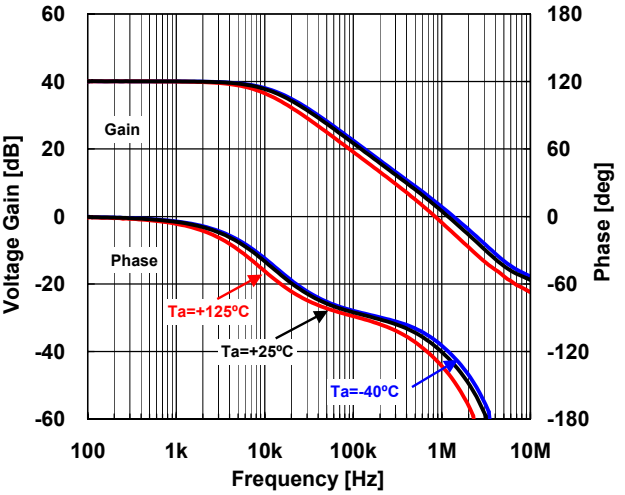
Gain/Phase vs. Frequency
V_{DD}=2.2V, Gv=40dB, R_F=100kΩ, R_S=1kΩ
R_L=10kΩ, Ta=25°C



Gain/Phase vs. Frequency (Temperature)
V_{DD}=5V, Gv=40dB, R_F=100kΩ, R_S=1kΩ
R_L=10kΩ, C_L=20pF

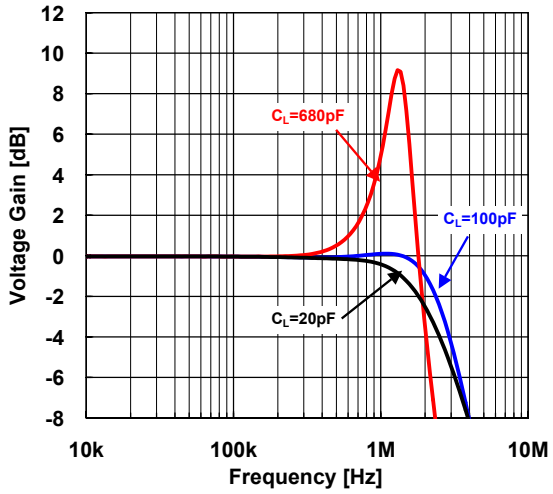


Gain/Phase vs. Frequency (Temperature)
V_{DD}=2.2V, Gv=40dB, R_F=100kΩ, R_S=1kΩ
R_L=10kΩ, C_L=20pF

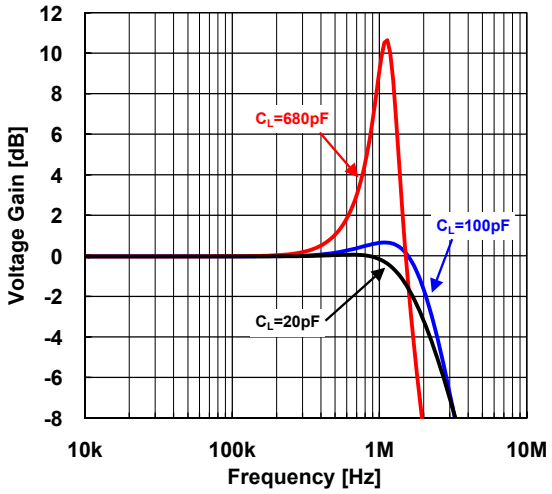


■TYPICAL CHARACTERISTICS

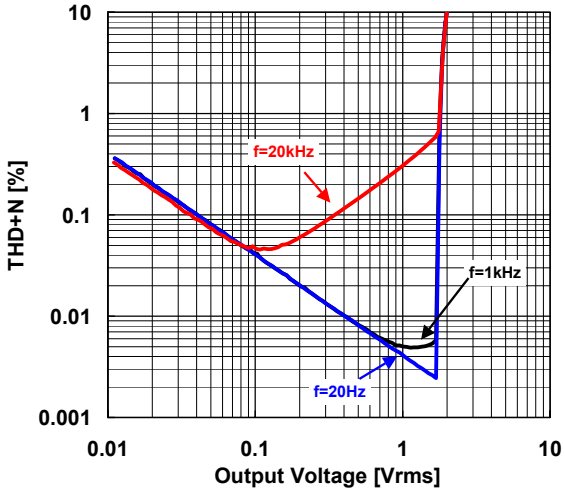
Gain vs. Frequency (Load Capacitance)
V_{DD}=5V, Gv=0dB, R_L=10kΩ, Ta=25ºC



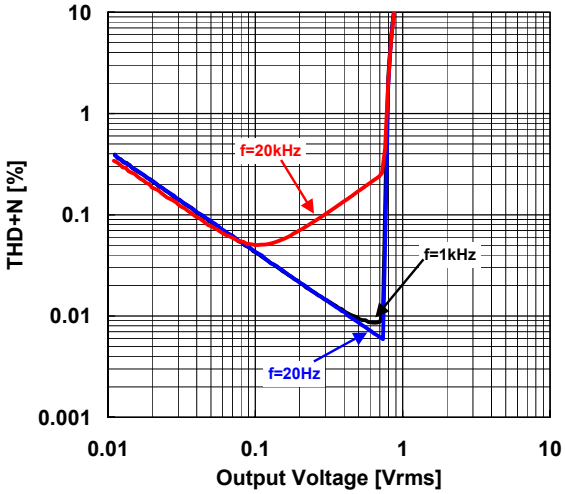
Gain vs. Frequency (Load Capacitance)
V_{DD}=2.2V, Gv=0dB, R_L=10kΩ, Ta=25ºC



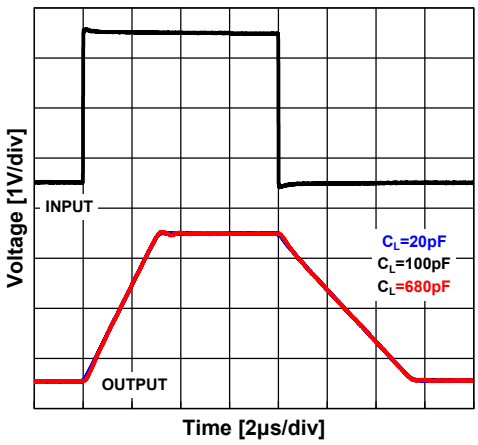
THD+N vs. Output Voltage
V_{DD}=5V, R_G=1kΩ, R_F=10kΩ, R_L=∞Ω



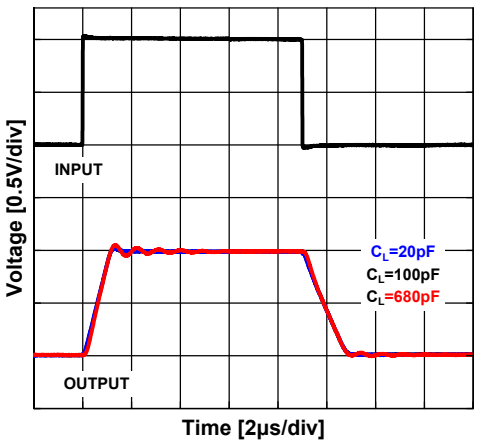
THD+N vs. Output Voltage
V_{DD}=2.2V, R_G=1kΩ, R_F=10kΩ, R_L=∞Ω



Pulse Response (Load Capacitance)
V^+/V^-=±2.5V, R_L=10kΩ, Gv=0dB, Ta=25ºC



Pulse Response (Load Capacitance)
V^+/V^-=±1.1V, R_L=10kΩ, Gv=0dB, Ta=25ºC



■ TYPICAL CHARACTERISTICS