Precision, Dual, JFET Input Operational Amplifier

■ FEATURES

- Low Input Offset Voltage V_{IO}=400μV max.
  V_{IO}=700μV max. (Ta= -40ºC to +125ºC)
- Low Input Offset Voltage Drift $\Delta V_{IO}/\Delta T$=10μV/ºC max. (Ta= -40ºC to +125ºC)
- Small Package MSOP8(VSP8) MEET JEDEC MO-187-DA
- Low Supply Current Icc=3mA max.
- High Slew Rate SR=20V/μs typ.
- Wide Bandwidth GBP=7MHz typ.
- Low Noise en=10nV/√Hz at f=1kHz typ.
- Low Input Bias Current I_B=80pA max. at Ta=25ºC
- Guaranteed Temperature Topr= -40ºC to +125ºC
- Operating Voltage Vopr= ±4.5V to ±16V

■ PACKAGE OUTLINE

NJM8502R
(MSOP8(VSP8))

■ GENERAL DESCRIPTION

The NJM8502 is a dual high precision JFET input operational amplifier featuring low offset, low offset drift, low bias current, high slew rate, low noise and wide operating temperature range.

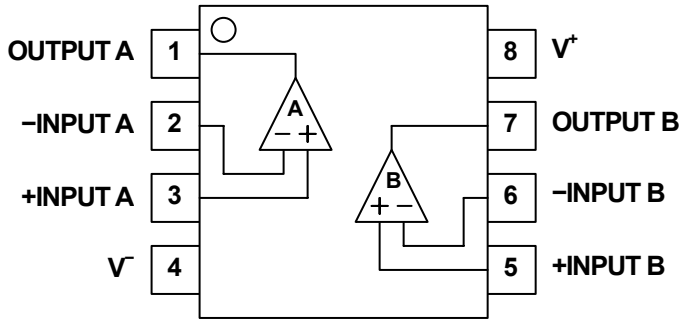
The precision performance, high speed and low noise make the NJM8502 especially suitable for filter and amplification of high speed and small signal in instruments, automated test equipment, sensors and other precision applications.

■ APPLICATIONS

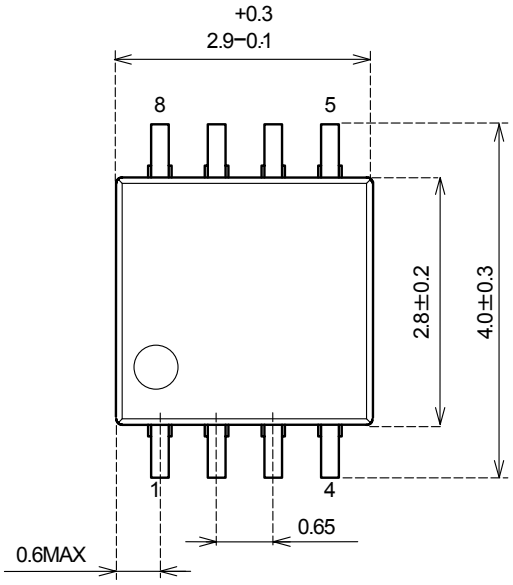
- Current Sensor
- Photodiode Amplification
- Reference Voltage Circuit
- Automatic Test Equipment

■ PIN CONFIGURATION

(Top View)



■ PACKAGE DESCRIPTION

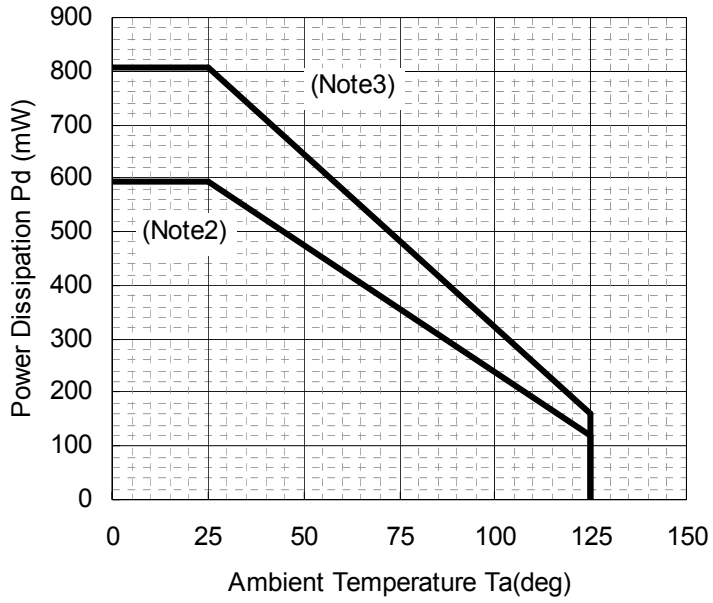


■ **ABSOLUTE MAXIMUM RATINGS** (Ta=25ºC, unless otherwise noted.)

PARAMETER	SYMBOL	RATING	UNIT
Supply Voltage	V^+/V^-	±18	V
Common-Mode Input Voltage Range	V_{IC}	±18 (Note1)	V
Differential Input Voltage Range	V_{ID}	±36	V
Power Dissipation(Note4)	P_D	595(Note2), 805(Note3)	mW
Operating Temperature Range	Topr	-40 to +125	ºC
Storage Temperature Range	Tstg	-55 to +150	ºC

(Note1) For supply voltage less than ±18V, the absolute maximum rating is equal to the supply voltage.
(Note2) EIA/JEDEC STANDARD Test board (114.3 x 76.2 x 1.57mm, 2layers, FR-4) mounting.
(Note3) EIA/JEDEC STANDARD Test board (114.3 x 76.2 x 1.6mm, 4layers, FR-4) mounting.
(Note4) See Figure "Power Dissipation Curve" when ambient temperature is over 25˚C.

Power Dissipation Derating Curve



■ **RECOMMENDED OPERATING VOLTAGE**

PARAMETER	SYMBOL	RATING	MIN	TYP	MAX	UNIT
Supply Voltage	V^+/V^-		±4.5	-	±16	V

■ ELECTRICAL CHARACTERISTICS

●DC CHARACTER (V^+/V^-=±15V, Ta=25ºC, V_{ICM}=0V, unless otherwise noted.)

PARAMETER	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Input Characteristics						
Input Offset Voltage	$V_{IO}1$		-	80	400	μV
	$V_{IO}2$	Ta=-40ºC to +125ºC	-	-	700	μV
Input Offset Voltage Drift (Note5)	ΔVio/ΔT	Ta=-40ºC to +125ºC	-	1.0	10	μV/ºC
Input Bias Current	I_B1		-	25	80	pA
	I_B2	Ta=-40ºC to +125ºC	-	-	15	nA
Input Offset Current	$I_{IO}1$		-	6	75	pA
	$I_{IO}2$	Ta=-40ºC to +125ºC	-	-	500	pA
Common Mode Input Voltage Range	$V_{ICM}1$	CMR≥ 86dB	-12.5	-	+12.5	V
	$V_{ICM}2$	CMR≥ 80dB, Ta=-40ºC to +125ºC	-12.5	-	+12.5	V
Common Mode Rejection Ratio	CMR1	V_{CM}=-12.5V to +12.5V	86	108	-	dB
	CMR2	V_{CM}=-12.5V to +12.5V, Ta=-40ºC to +125ºC	80	-	-	dB
Voltage Gain	Av1	R_L=2kΩ, Vo= -13.5V to +13.5V	90	100	-	dB
	Av2	R_L=2kΩ, Vo= -13.5V to +13.5V, Ta=-40ºC to +125ºC	82	-	-	dB
Channel Separation	CS	DC	-	125	-	dB
Output Characteristics						
Maximum Output Voltage	$V_{OH}1$	R_L=10kΩ, Ta=-40ºC to +125ºC	+14.0	+14.2	-	V
	$V_{OL}1$	R_L=10kΩ, Ta=-40ºC to +125ºC	-	-14.9	-14.6	V
	$V_{OH}2$	R_L=2kΩ, Ta=-40ºC to +125ºC	+13.8	+14.1	-	V
	$V_{OL}2$	R_L=2kΩ, Ta=-40ºC to +125ºC	-	-14.8	-14.5	V
	$V_{OH}31$	R_L=600Ω	+13.5	+13.9	-	V
	$V_{OH}32$	R_L=600Ω, Ta=-40ºC to +125ºC	+11.4	-	-	V
	$V_{OL}41$	R_L=600Ω	-	-14.3	-13.8	V
	$V_{OL}42$	R_L=600Ω, Ta=-40ºC to +125ºC	-	-	-12.1	V
Supply Characteristics						
Quiescent Current	$I_{CC}1$	G_V=+1, R_L=∞	-	2.6	3.0	mA
	$I_{CC}2$	G_V=+1, R_L=∞, Ta=-40ºC to +125ºC	-	-	3.3	mA
Supply Voltage Rejection Ratio	SVR1	V+/V-=±4.5V to ±16V	86	110	-	dB
	SVR2	V+/V-=±4.5V to ±16V, Ta=-40ºC to +125ºC	80	-	-	dB

(Note5) Guaranteed by endpoint limits.

●AC CHARACTER (V^+/V^-=±15V, Ta=25ºC, V_{ICM}=0V, unless otherwise noted.)

PARAMETER	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Dynamic Performance						
Unity Gain Frequency	f_T	G_V=+100, R_L=2kΩ, C_L=10pF	-	7.0	-	MHz
Slew Rate	+SR	RISE, G_V=+1, V_{IN}=1Vpp, R_L=2kΩ	-	20	-	V/μs
	-SR	FALL, G_V=+1, V_{IN}=1Vpp, R_L=2kΩ	-	20	-	V/μs
Total Harmonic Distortion	THD	f=1kHz, Gv=+1,R_L=2kΩ	-	0.0005	-	%
Noise Performance						
Input Voltage Noise	V_{NI}	fo=1Hz to 100Hz	-	0.18	-	μVrms
Input Voltage Noise Density	e_n	fo=1kHz	-	10	-	nV/√Hz

■ ELECTRICAL CHARACTERISTICS

●DC CHARACTER (V^+/V^-=±5V, Ta=25ºC, V_{ICM}=0V, unless otherwise noted.)

PARAMETER	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Input Characteristics						
Input Offset Voltage	$V_{IO}1$		-	80	400	μV
	$V_{IO}2$	Ta=-40ºC to +125ºC	-	-	700	μV
Input Offset Voltage Drift (Note5)	ΔVio/ΔT	Ta=-40ºC to +125ºC	-	1.0	10	μV/ºC
Input Bias Current	I_B1		-	21	75	pA
	I_B2	Ta=-40ºC to +125ºC	-	-	10	nA
Input Offset Current	$I_{IO}1$		-	5	50	pA
	$I_{IO}2$	Ta=-40ºC to +125ºC	-	-	500	pA
Common Mode Input Voltage Range	$V_{ICM}1$	CMR≥ 86dB	-2.0	-	+2.5	V
	$V_{ICM}2$	CMR≥ 80dB, Ta=-40ºC to +125ºC	-2.0	-	+2.5	V
Common Mode Rejection Ratio	CMR1	V_{CM}=-2V to +2.5V	86	108	-	dB
	CMR2	V_{CM}=-2V to +2.5V, Ta=-40ºC to +125ºC	80	-	-	dB
Voltage Gain	Av1	R_L=2kΩ, Vo= -3V to +3V	85	93	-	dB
	Av2	R_L=2kΩ, Vo= -3V to +3V, Ta=-40ºC to +125ºC	80	-	-	dB
Channel Separation	CS	DC	-	125	-	dB
Output Characteristics						
Maximum Output Voltage	$V_{OH}1$	R_L=10kΩ, Ta=-40ºC to +125ºC	+4.1	+4.3	-	V
	$V_{OL}1$	R_L=10kΩ, Ta=-40ºC to +125ºC	-	-4.9	-4.7	V
	$V_{OH}2$	R_L=2kΩ, Ta=-40ºC to +125ºC	+3.9	+4.2	-	V
	$V_{OL}2$	R_L=2kΩ, Ta=-40ºC to +125ºC	-	-4.9	-4.5	V
	$V_{OH}31$	R_L=600Ω	+3.7	+4.1	-	V
	$V_{OH}32$	R_L=600Ω, Ta=-40ºC to +125ºC	+3.6	-	-	V
	$V_{OL}41$	R_L=600Ω	-	-4.8	-4.3	V
	$V_{OL}42$	R_L=600Ω, Ta=-40ºC to +125ºC	-	-	-4.2	V
Supply Characteristics						
Quiescent Current	$I_{CC}1$	G_V=+1, R_L=∞	-	2.0	3.0	mA
	$I_{CC}2$	G_V=+1, R_L=∞, Ta=-40ºC to +125ºC	-	-	3.3	mA

(Note5) Guaranteed by endpoint limits.

●AC CHARACTER (V^+/V^-=±5V, Ta=25ºC, V_{ICM}=0V, unless otherwise noted.)

PARAMETER	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Dynamic Performance						
Unity Gain Frequency	f_T	G_V=+100, R_L=2kΩ, C_L=10pF	-	7.0	-	MHz
Slew Rate	+SR	RISE, G_V=+1, V_{IN}=1Vpp, R_L=2kΩ	-	18	-	V/μs
	-SR	FALL, G_V=+1, V_{IN}=1Vpp, R_L=2kΩ	-	18	-	V/μs
Total Harmonic Distortion	THD	f=1kHz, Gv=+1,R_L=2kΩ	-	0.0005	-	%
Noise Performance						
Input Voltage Noise	V_{NI}	fo=1Hz to 100Hz	-	0.18	-	μVrms
Input Voltage Noise Density	e_n	fo=1kHz	-	10	-	nV/√Hz

■ **TEST CIRCUIT**

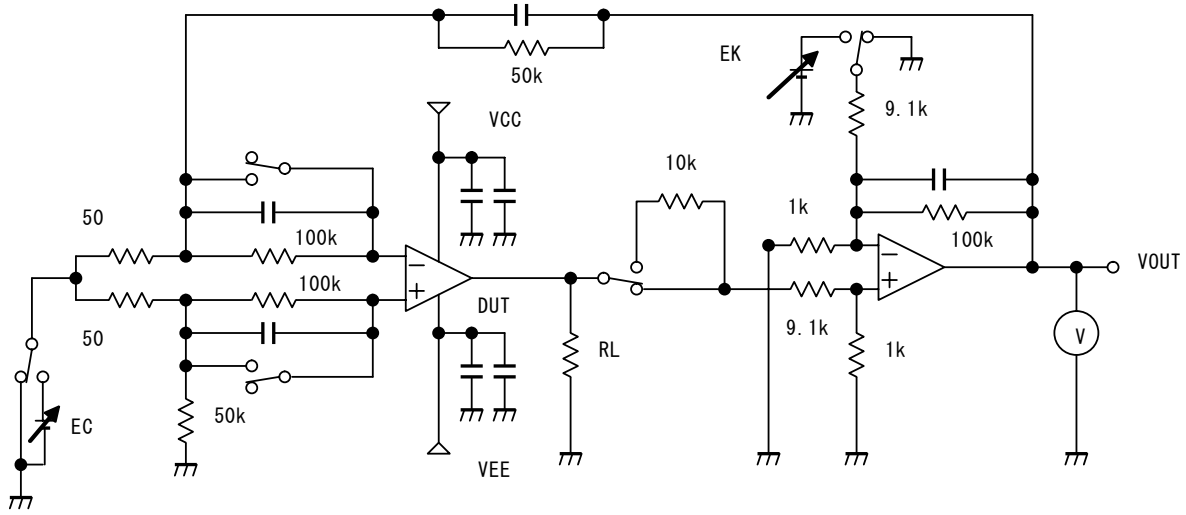


Fig.1 test circuit for Input Offset Voltage, Input Offset Current, Input Bias Current
Voltage Gain, Supply Voltage Rejection Ratio, Common Mode Rejection Ratio

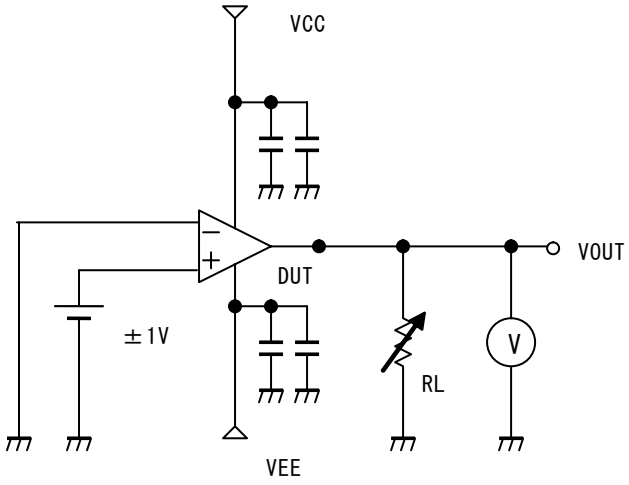


Fig.2 test circuit for Maximum Output Voltage

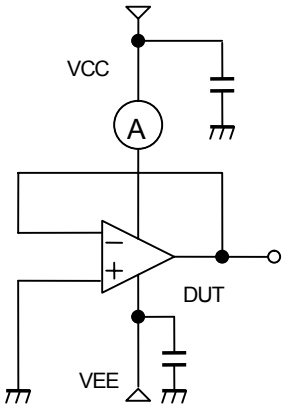
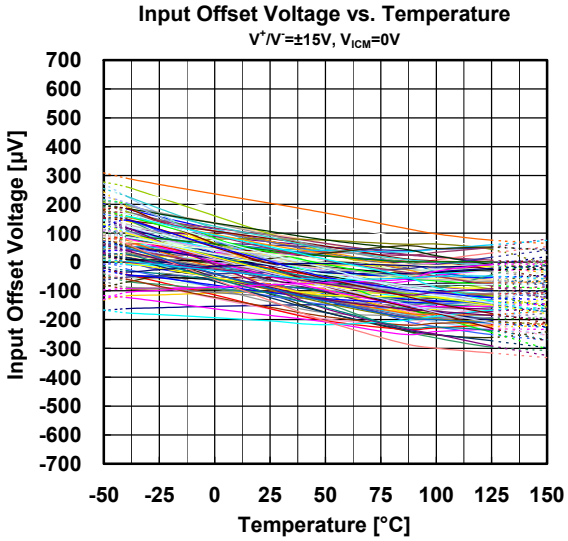
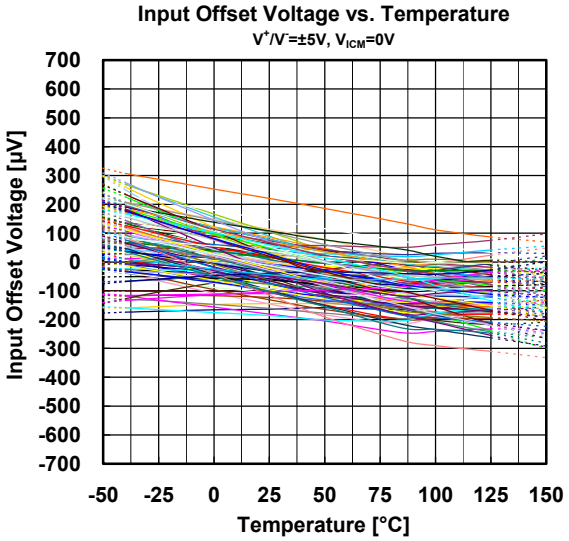
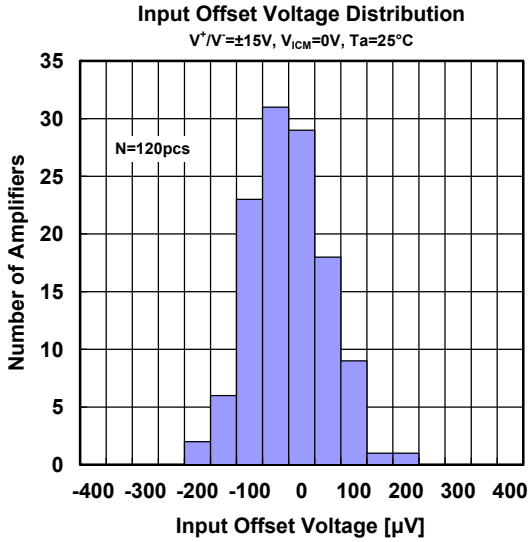


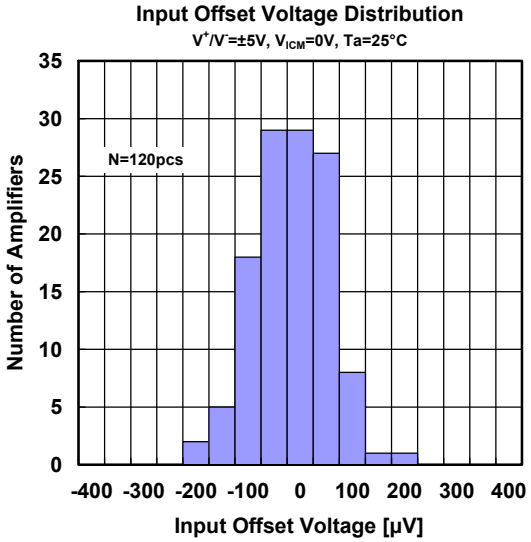
Fig.3 test circuit for Quiescent Current

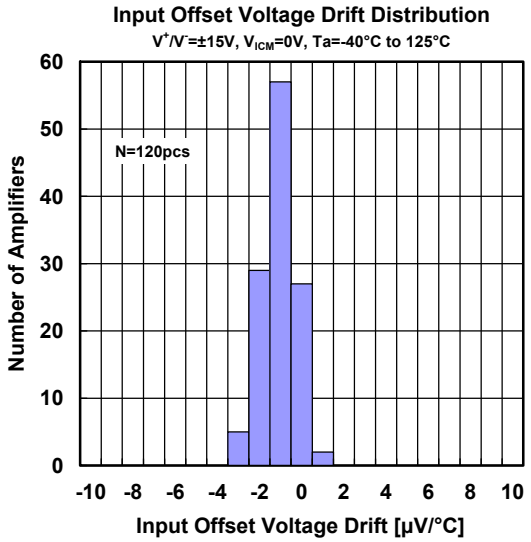
■ ELECTRICAL CHARACTERISTICS

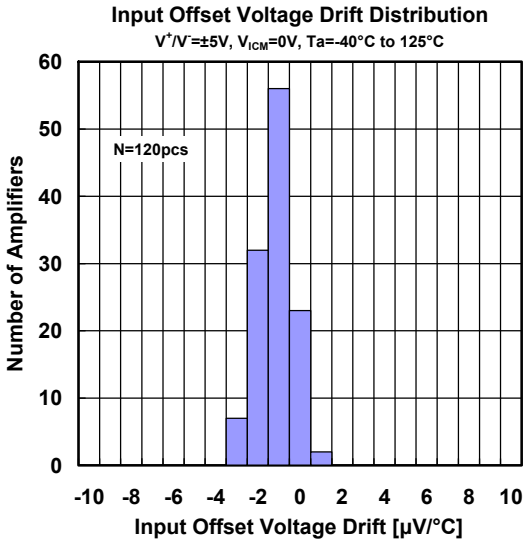






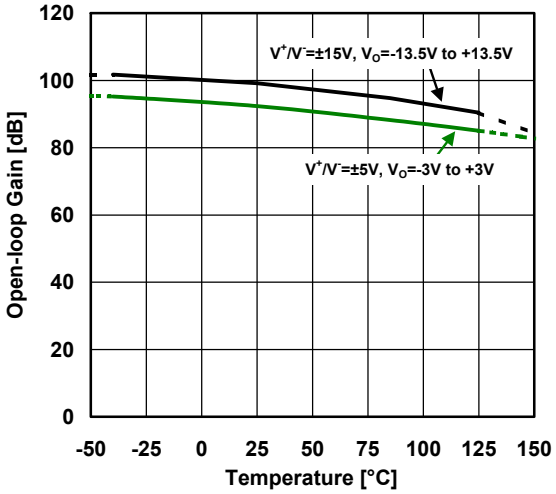






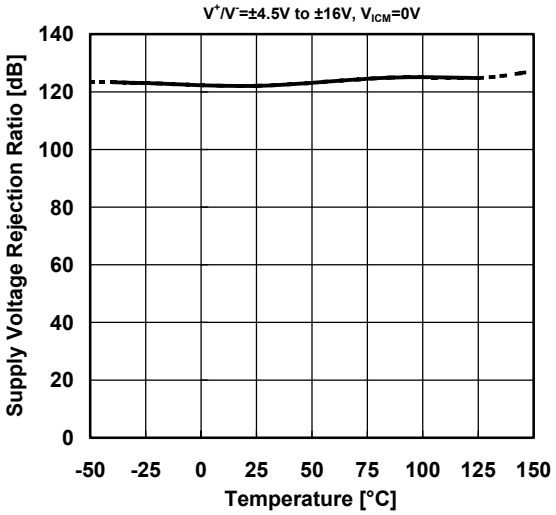
Open-loop Gain vs. Temperature

V_{ICM}=0V, R_L=2kΩ

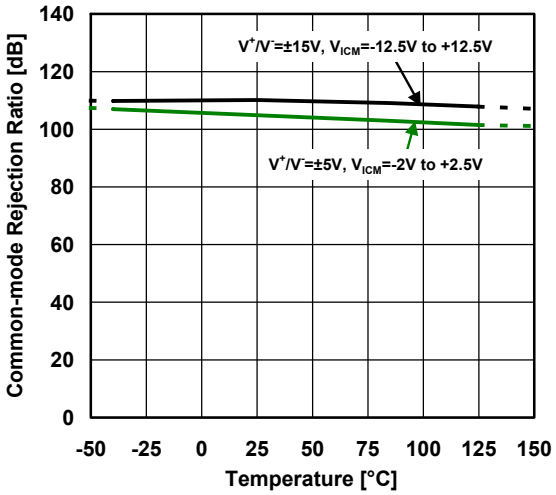


Supply Voltage Rejection Ratio vs. Temperature

V^+/V^-=±4.5V to ±16V, V_{ICM}=0V

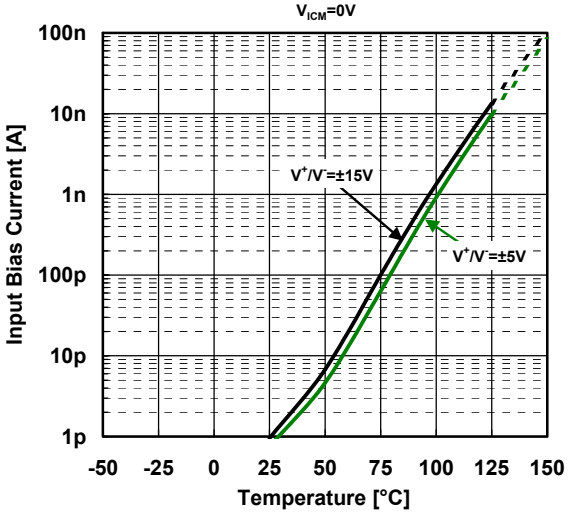


Common-mode Rejection Ratio vs. Temperature



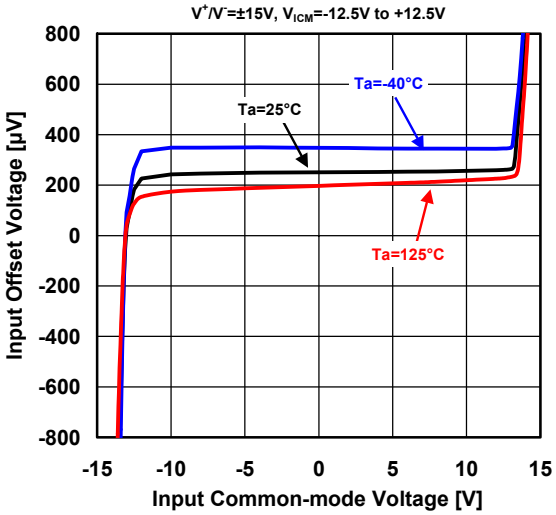
Input Bias Current vs. Temperature

V_{ICM}=0V



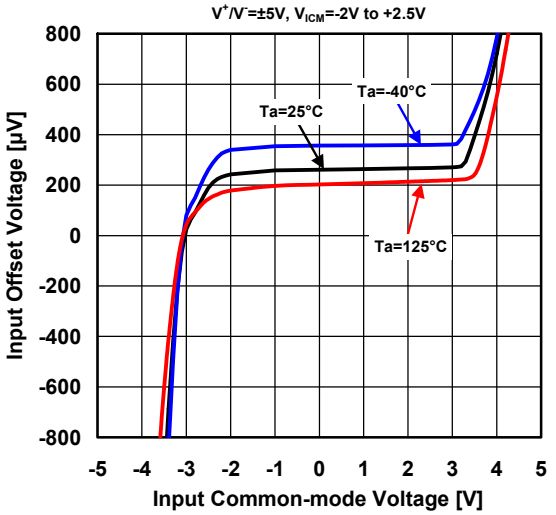
Input Offset Voltage vs. Common-mode Voltage

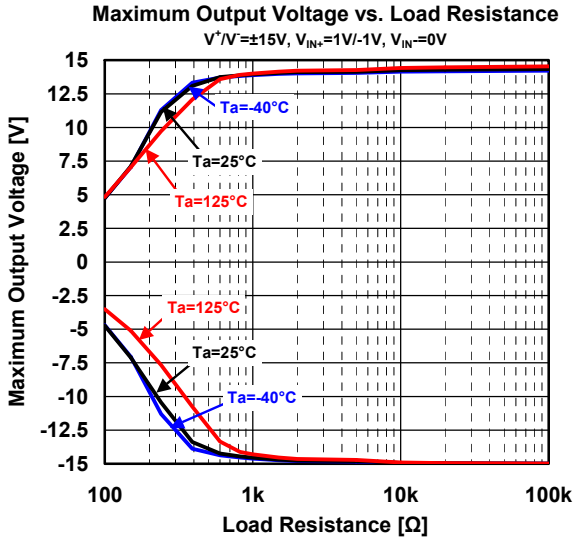
V^+/V^-=±15V, V_{ICM}=-12.5V to +12.5V

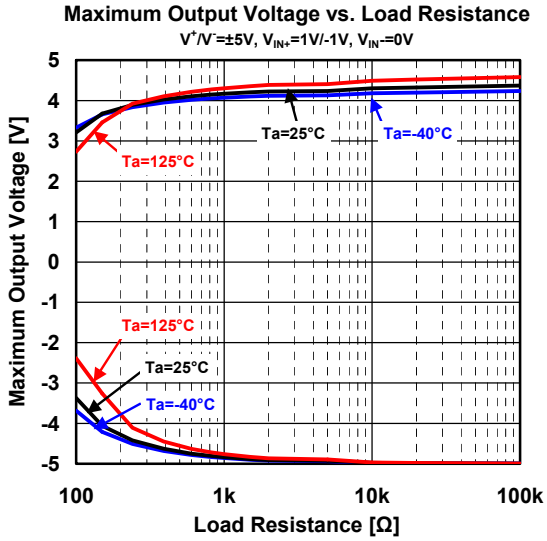


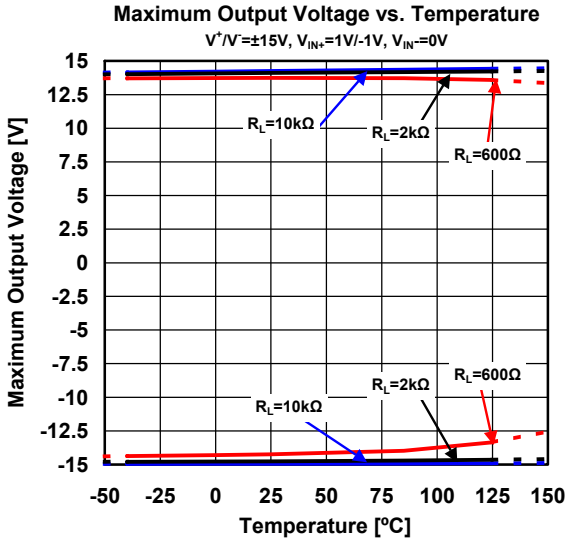
Input Offset Voltage vs. Common-mode Voltage

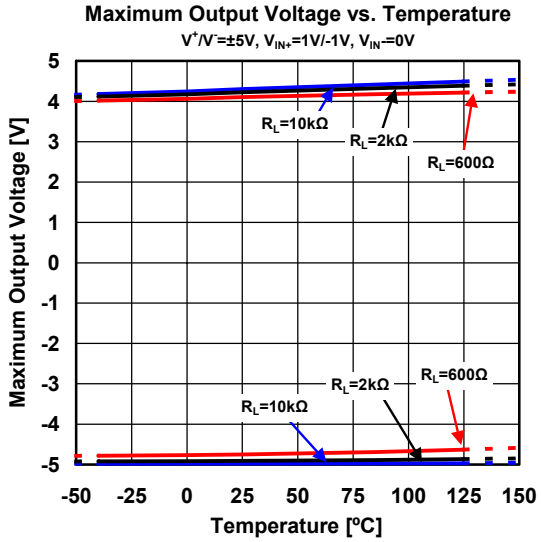
V^+/V^-=±5V, V_{ICM}=-2V to +2.5V

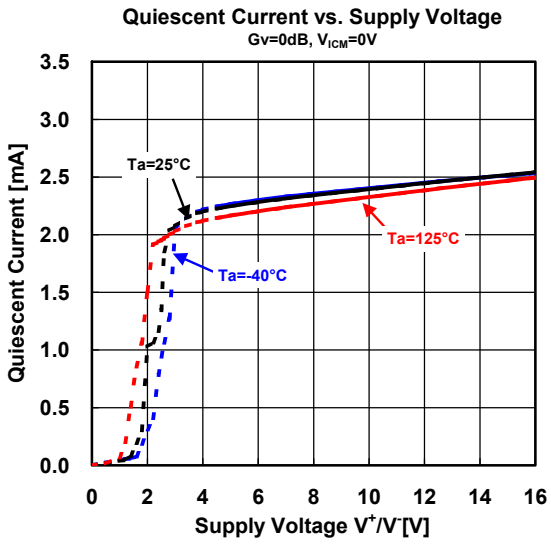


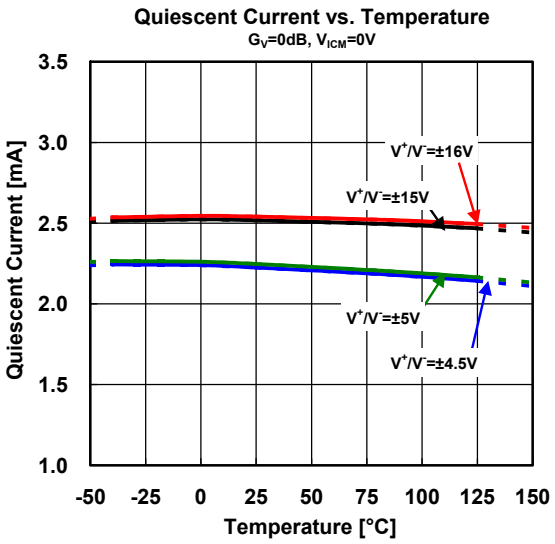

Maximum Output Voltage vs. Load Resistance
V+/V-=±15V, VIN+=1V/-1V, VIN-=0V
Maximum Output Voltage [V]
Load Resistance [Ω]
Ta=-40°C
Ta=25°C
Ta=125°C
Ta=125°C
Ta=25°C
Ta=-40°C
15
12.5
10
7.5
5
2.5
0
-2.5
-5
-7.5
-10
-12.5
-15
100
1k
10k
100k


Maximum Output Voltage vs. Load Resistance
V+/V-=±5V, VIN+=1V/-1V, VIN-=0V
Maximum Output Voltage [V]
Load Resistance [Ω]
Ta=25°C
Ta=-40°C
Ta=125°C
Ta=125°C
Ta=25°C
Ta=-40°C
5
4
3
2
1
0
-1
-2
-3
-4
-5
100
1k
10k
100k


Maximum Output Voltage vs. Temperature
V+/V-=±15V, VIN+=1V/-1V, VIN-=0V
Maximum Output Voltage [V]
Temperature [ºC]
RL=10kΩ
RL=2kΩ
RL=600Ω
RL=2kΩ
RL=600Ω
RL=10kΩ
15
12.5
10
7.5
5
2.5
0
-2.5
-5
-7.5
-10
-12.5
-15
-50
-25
0
25
50
75
100
125
150

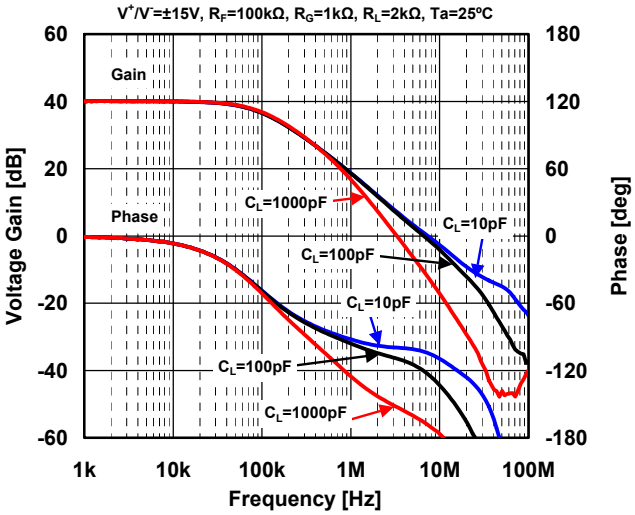

Maximum Output Voltage vs. Temperature
V+/V-=±5V, VIN+=1V/-1V, VIN-=0V
Maximum Output Voltage [V]
Temperature [ºC]
RL=10kΩ
RL=2kΩ
RL=600Ω
RL=2kΩ
RL=600Ω
RL=10kΩ
5
4
3
2
1
0
-1
-2
-3
-4
-5
-50
-25
0
25
50
75
100
125
150


Quiescent Current vs. Supply Voltage
Gv=0dB, VICM=0V
Quiescent Current [mA]
Supply Voltage V+/V-[V]
Ta=25°C
Ta=125°C
Ta=-40°C
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
0
2
4
6
8
10
12
14
16


Quiescent Current vs. Temperature
GV=0dB, VICM=0V
Quiescent Current [mA]
Temperature [°C]
V+/V-=±16V
V+/V-=±15V
V+/V-=±5V
V+/V-=±4.5V
3.5
3.0
2.5
2.0
1.5
1.0
-50
-25
0
25
50
75
100
125
150

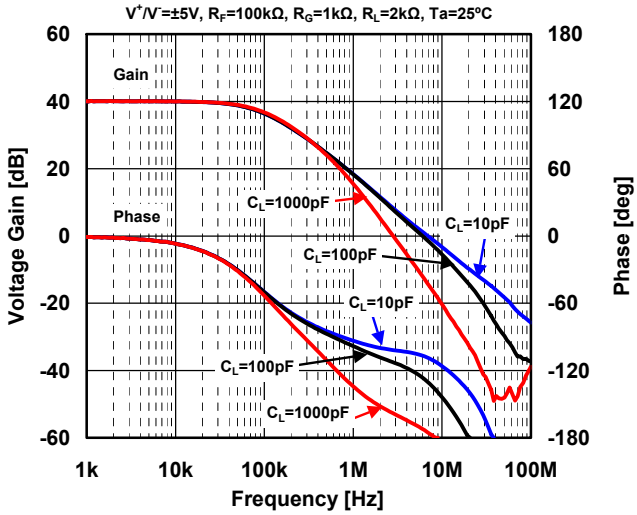
Gain/Phase vs. Frequency

V^+/V^-=±15V, R_F=100kΩ, R_G=1kΩ, R_L=2kΩ, Ta=25°C



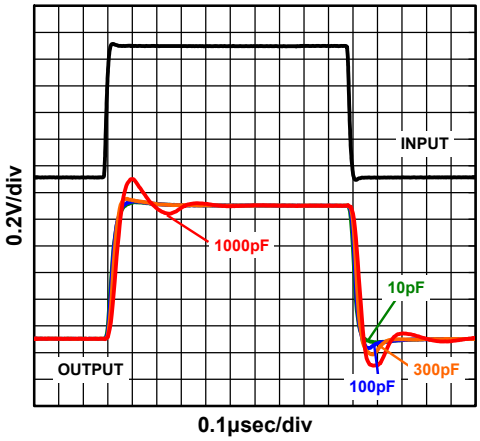
Gain/Phase vs. Frequency

V^+/V^-=±5V, R_F=100kΩ, R_G=1kΩ, R_L=2kΩ, Ta=25°C



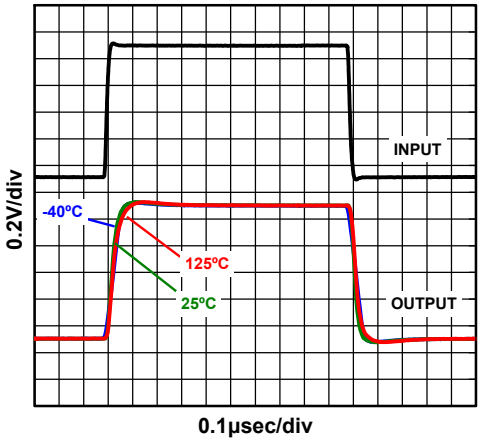
Small-Signal Step Response (Road Capacitance)

V^+/V^-=±15V, Gv=0dB, V_{IN}=1V_{PP}, R_L=2kΩ, Ta=25°C



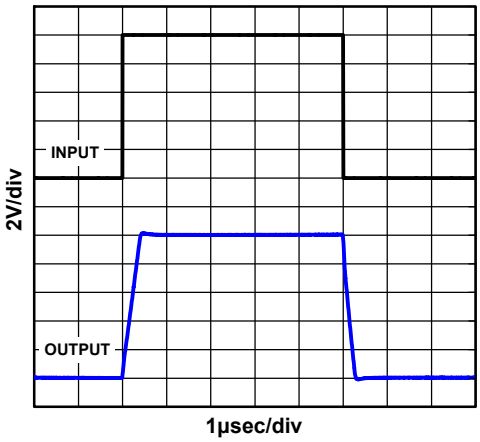
Small-Signal Step Response (Temperature)

V^+/V^-=±15V, Gv=0dB, V_{IN}=1V_{PP}, R_L=2kΩ, C_L=10pF



Large Signal Step Response

V^+/V^-=±15V, Gv=0dB, V_{IN}=10Vpp, R_L=2kΩ



CMR vs. Frequency

Gv=60dB, Ta=25°C