13μA/ch, Rail-to-Rail Output Dual CMOS Operational Amplifier

■ GENERAL DESCRIPTION

The NJU7027 is a low power, dual CMOS operational amplifier. It is tolerant to RF noise. The NJU7027 can operate from a single-supply voltage of +1.8V to +5.5V. In addition, this amplifier features Rail-to-Rail output and low input bias current (1pA). Because of these features, the NJU7027 is ideal for low side current sense amplifier. The very low supply current of the NJU7027 (13μA/ch) makes it suitable for battery-operated application.

■ PACKAGE OUTLINE

NJU7027RB1

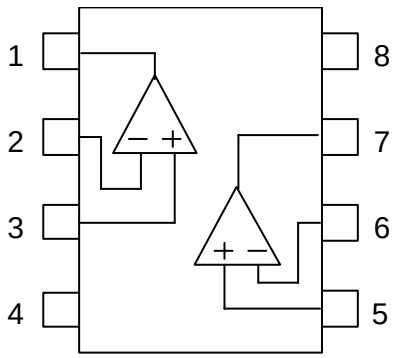
■ FEATURES

- •Low Supply Current 13μA/ch typ. (at V_{DD}= 5V), 12μA/ch typ. (at V_{DD}= 3V)
  11μA/ch typ. (at V_{DD}= 1.8V)
- •Low Operating Voltage Vopr= 1.8V to 5.5V
- •Rail-to-Rail Output V_{OH}=4.9V min./ V_{OL}=0.1V max. (at V_{DD}= 5V, R_L=100kΩ)
  V_{OH}=4.8V min./ V_{OL}=0.2V max. (at V_{DD}= 5V, I_O=1mA)
- •Package TVSP8
- •Enhanced RF Noise Immunity
- •CMOS Process

■ APPLICATION

- •Battery-operated application
- •Battery monitor
- •Current sensor
- •Photodiode amplification

■ PIN CONFIGURATION (Top View)



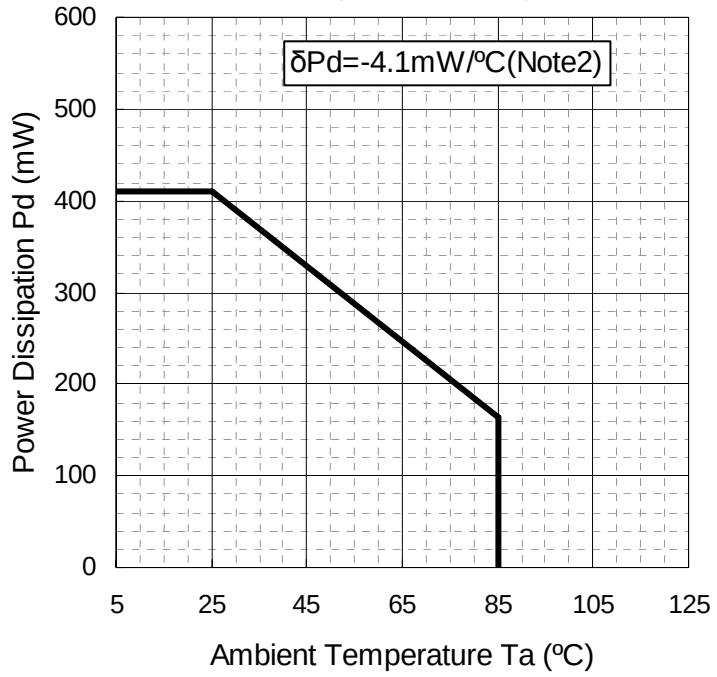
PIN FUNCTION
1. A OUTPUT
2. A -INPUT
3. A +INPUT
4. GND
5. B +INPUT
6. B –INPUT
7. B OUTPUT
8. V^+

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

PARAMETER	SYMBOL	RATINGS	UNIT
Supply Voltage	V_{DD}	+7	V
Input Common Mode Voltage	V_{ICM}	V_{SS}-0.3 to V_{DD}+0.3	V
Differential Input Voltage	V_{ID}	±7 (Note1)	V
Power Dissipation	P_D	410 (Note2)	mW
Operating Temperature Range	T_{opr}	-40 to +85	°C
Storage Temperature Range	T_{stg}	-55 to +125	°C

(Note1) For supply voltage less than +7V, the absolute maximum rating is equal to the supply voltage.
(Note2) EIA/JEDEC STANDARD Test board (76.2 x 114.3 x 1.6mm, 2layers, FR-4) mounting.
(Note3) Do not exceed "Power dissipation: P_D" 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}	1.8 to 5.5	V

■ ELECTRICAL CHARACTERISTICS

DC CHARACTER (V_{DD}=5V, V_{SS}=0V, Ta=25˚C, unless otherwise noted.)

PARAMETER	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Supply Current	I_{DD}	No Signal	-	26	40	µA
Input Offset Voltage	V_{IO}	Vic=0V, R_S=50Ω	-	0.9	4	mV
Input Offset Voltage drift	ΔVio/ΔT		-	1.5	-	µV/ºC
Input Bias Current	I_B		-	1	-	pA
Input Offset Current	I_{IO}		-	1	-	pA
Open loop gain	A_V	Vo=0.5V to 4.5V, R_L=100kΩ to 2.5V	70	90	-	dB
Common Mode Rejection Ratio	CMR	V_{ICM}=0V to 4.1V	65	80	-	dB
Supply Voltage Rejection Ratio	SVR	V_{DD}=1.8V to 5.5V	70	90	-	dB
Maximum Output Voltage 1	V_{OH}1	R_L=100kΩ to 2.5V	4.9	4.95	-	V
	V_{OL}1	R_L=100kΩ to 2.5V	-	0.05	0.1	V
Maximum Output Voltage 2	V_{OH}2	R_L=100kΩ to 0V	4.9	4.95	-	V
	V_{OL}2	R_L=100kΩ to 0V	-	0.02	0.05	V
Maximum Output Voltage 3	V_{OH}3	Isource=1mA	4.8	4.85	-	V
	V_{OL}3	Isink=1mA	-	0.15	0.2	V
Common Mode Input Voltage Range	V_{ICM}	CMR≥65dB	0	-	4.1	V

AC CHARACTER (V_{DD}=5V, V_{SS}=0V, Ta=25˚C, unless otherwise noted.)

PARAMETER	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Gain Bandwidth Product	GBW	R_L=100kΩ to 2.5V, C_L=20pF, f=10kHz	-	160	-	kHz
Phase Margin	ϕ_M	R_L=100kΩ to 2.5V, C_L=20pF	-	80	-	deg
Gain Margin	G_M	R_L=100kΩ to 2.5V, C_L=20pF	-	15	-	dB
Equivalent Input Noise Voltage	e_n	f=1kHz	-	50	-	nV/√Hz
Channel Separation	CS	f=1kHz	-	120	-	dB
Slew Rate	SR	G_V=0dB, R_L=100kΩ to 2.5V, C_L=20pF, Vin=3Vpp (1V to 4V) (Note4) (Note5)	-	0.05	-	V/us
Power Bandwidth	PBW	G_V=6dB, R_F=50kΩ, R_G=50kΩ, C_L=20pF, Vin=2.5Vpp (1.25V to 3.75V), Vo≥4.8Vpp (Note6)	-	5	-	kHz
Total Harmonic Distortion	THD	G_V=6dB, R_F=50kΩ, R_G=50kΩ, C_L=20pF, Vo=4Vpp, f=100Hz (Note6)	-	0.01	-	%

(Note4) Slew rate is defined by the lower value of the rise or fall.

(Note5) See figure2-1 for test circuit.

(Note6) See figure2-3 for test circuit.

■ ELECTRICAL CHARACTERISTICS

DC CHARACTER (V_{DD}=3V, V_{SS}=0V, Ta=25˚C, unless otherwise noted.)

PARAMETER	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Supply Current	I_{DD}	No Signal	-	24	36	µA
Input Offset Voltage	V_{IO}	Vic=0V, R_S=50Ω	-	0.9	4	mV
Input Offset Voltage drift	ΔVio/ΔT		-	1.5	-	µV/ºC
Input Bias Current	I_B		-	1	-	pA
Input Offset Current	I_{IO}		-	1	-	pA
Open loop gain	A_V	Vo=0.5V to 2.5V, R_L=100kΩ to 1.5V	70	90	-	dB
Common Mode Rejection Ratio	CMR	V_{ICM}=0V to 2.1V	65	80	-	dB
Supply Voltage Rejection Ratio	SVR	V_{DD}=1.8V to 5.5V	70	90	-	dB
Maximum Output Voltage 1	V_{OH}1	R_L=100kΩ to 1.5V	2.9	2.95	-	V
	V_{OL}1	R_L=100kΩ to 1.5V	-	0.05	0.1	V
Maximum Output Voltage 2	V_{OH}2	R_L=100kΩ to 0V	2.9	2.95	-	V
	V_{OL}2	R_L=100kΩ to 0V	-	0.02	0.05	V
Maximum Output Voltage 3	V_{OH}3	Isource=1mA	2.8	2.85	-	V
	V_{OL}3	Isink=1mA	-	0.15	0.2	V
Common Mode Input Voltage Range	V_{ICM}	CMR≥65dB	0	-	2.1	V

AC CHARACTER (V_{DD}=3V, V_{SS}=0V, Ta=25˚C, unless otherwise noted.)

PARAMETER	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Gain Bandwidth Product	GBW	R_L=100kΩ to 1.5V, C_L=20pF, f=10kHz	-	150	-	kHz
Phase Margin	ϕ_M	R_L=100kΩ to 1.5V, C_L=20pF	-	80	-	deg
Gain Margin	G_M	R_L=100kΩ to 1.5V, C_L=20pF	-	15	-	dB
Equivalent Input Noise Voltage	e_n	f=1kHz	-	50	-	nV/√Hz
Channel Separation	CS	f=1kHz	-	115	-	dB
Slew Rate	SR	G_V=0dB, R_L=100kΩ to 1.5V, C_L=20pF, Vin=1Vpp (1V to 2V) (Note4) (Note5)	-	0.05	-	V/us
Power Bandwidth	PBW	G_V=6dB, R_F=50kΩ, R_G=50kΩ, C_L=20pF, Vin=1.5Vpp (0.75V to 2.25V), Vo≥2.8Vpp (Note6)	-	8	-	kHz
Total Harmonic Distortion	THD	G_V=6dB, R_F=50kΩ, R_G=50kΩ, C_L=20pF, Vo=2Vpp, f=100Hz (Note6)	-	0.01	-	%

(Note4) Slew rate is defined by the lower value of the rise or fall.

(Note5) See figure2-1 for test circuit.

(Note6) See figure2-3 for test circuit.

■ ELECTRICAL CHARACTERISTICS

DC CHARACTER (V_{DD}=1.8V, V_{SS}=0V, Ta=25˚C, unless otherwise noted.)

PARAMETER	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Supply Current	I_{DD}	No Signal	-	22	34	μA
Input Offset Voltage	V_{IO}	Vic=0V, R_S=50Ω	-	0.9	4	mV
Input Offset Voltage drift	ΔVio/ΔT		-	1.5	-	μV/ºC
Input Bias Current	I_B		-	1	-	pA
Input Offset Current	I_{IO}		-	1	-	pA
Open loop gain	A_V	Vo=0.5V to 2.5V, R_L=100kΩ to 0.9V	70	90	-	dB
Common Mode Rejection Ratio	CMR	V_{ICM}=0V to 0.9V	65	80	-	dB
Supply Voltage Rejection Ratio	SVR	V_{DD}=1.8V to 5.5V	70	90	-	dB
Maximum Output Voltage 1	V_{OH}1	R_L=100kΩ to 0.9V	1.7	1.75	-	V
	V_{OL}1	R_L=100kΩ to 0.9V	-	0.05	0.1	V
Maximum Output Voltage 2	V_{OH}2	R_L=100kΩ to 0V	1.7	1.75	-	V
	V_{OL}2	R_L=100kΩ to 0V	-	0.02	0.05	V
Maximum Output Voltage 3	V_{OH}3	Isource=0.5mA	1.5	1.55	-	V
	V_{OL}3	Isink=0.5mA	-	0.25	0.3	V
Common Mode Input Voltage Range	V_{ICM}	CMR≥65dB	0	-	0.9	V

AC CHARACTER (V_{DD}=1.8V, V_{SS}=0V, Ta=25˚C, unless otherwise noted.)

PARAMETER	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Gain Bandwidth Product	GBW	R_L=100kΩ to 0.9V, C_L=20pF, f=10kHz	-	140	-	kHz
Phase Margin	ϕ_M	R_L=100kΩ to 0.9V, C_L=20pF	-	80	-	deg
Gain Margin	G_M	R_L=100kΩ to 0.9V, C_L=20pF	-	15	-	dB
Equivalent Input Noise Voltage	e_n	f=1kHz	-	50	-	nV/√Hz
Channel Separation	CS	f=1kHz	-	110	-	dB
Slew Rate	SR	G_V=0dB, R_L=100kΩ to 1.5V, C_L=20pF, Vin=0.5Vpp (0.3V to 0.8V) (Note4) (Note7)	-	0.05	-	V/us
Power Bandwidth	PBW	G_V=6dB, R_F=50kΩ, R_G=50kΩ, C_L=20pF, Vin=0.9Vpp (0V to 0.9V), Vo≥1.6Vpp (Note8)	-	14	-	kHz
Total Harmonic Distortion	THD	G_V=6dB, R_F=50kΩ, R_G=50kΩ, C_L=20pF, Vo=1Vpp, f=100Hz (Note8)	-	0.01	-	%

(Note4) Slew rate is defined by the lower value of the rise or fall.

(Note7) See figure2-2 for test circuit.

(Note8) See figure2-4 for test circuit..

■ MEASUREMENT CIRCUITS

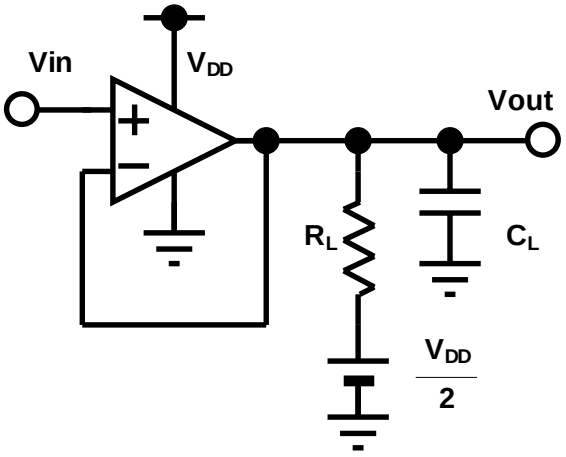


Figure 2-1:Measurement circuit 1

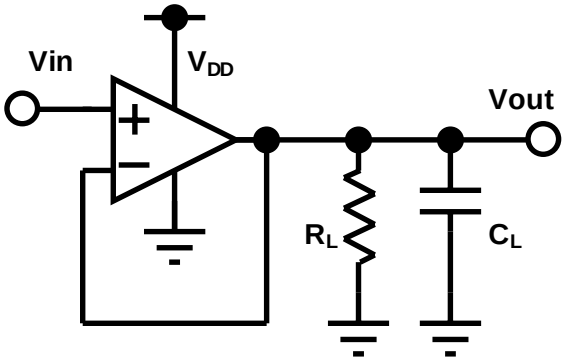


Figure 2-2:Measurement circuit 2

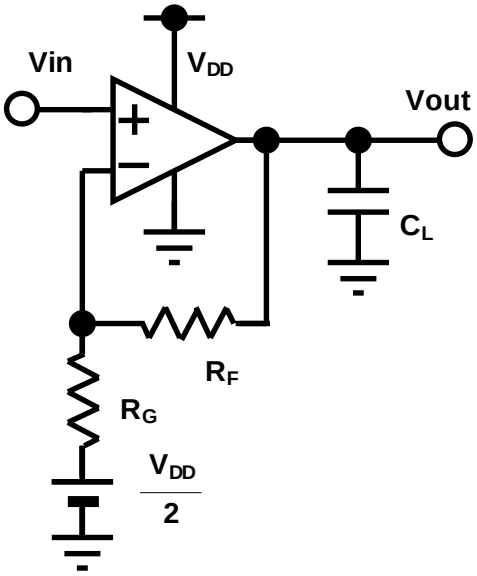


Figure 2-3:Measurement circuit 3

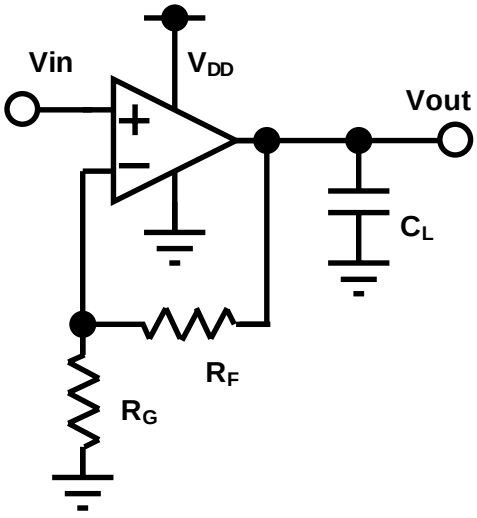
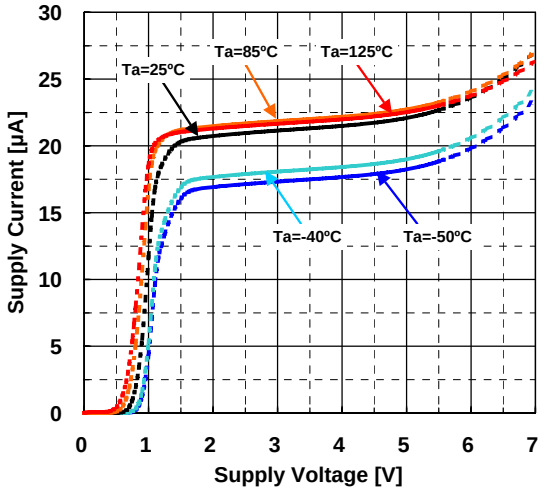


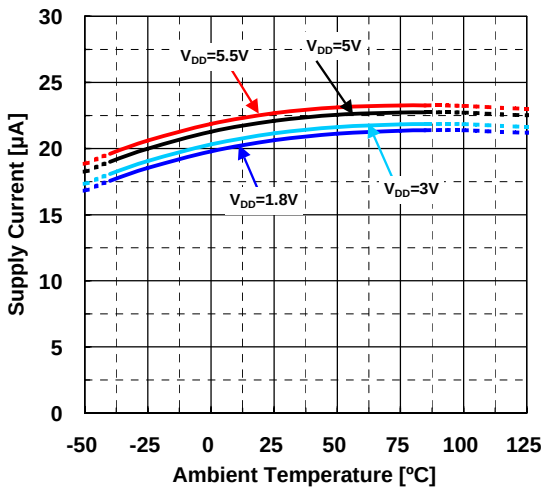
Figure 2-4:Measurement circuit 4

■ TYPICAL CHARACTERISTICS

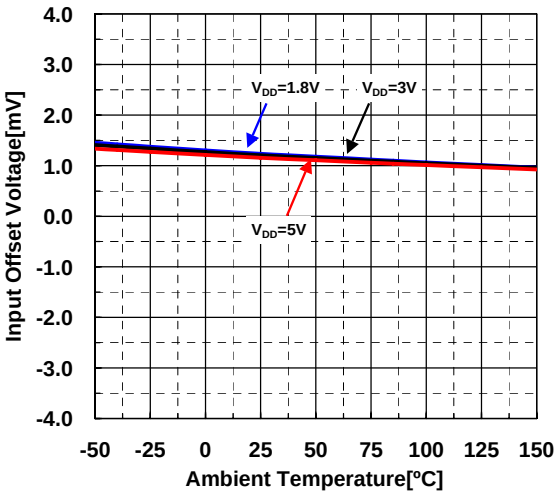
Supply Current vs. Supply Voltage (Temperature)
G_V=0dB



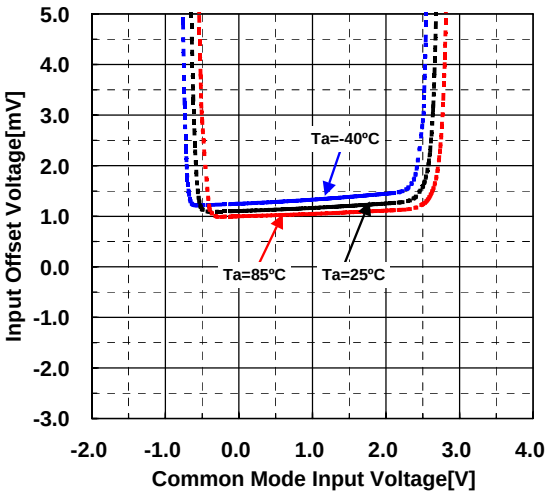
Supply Current vs. Temperature (Supply Voltage)
G_V=0dB



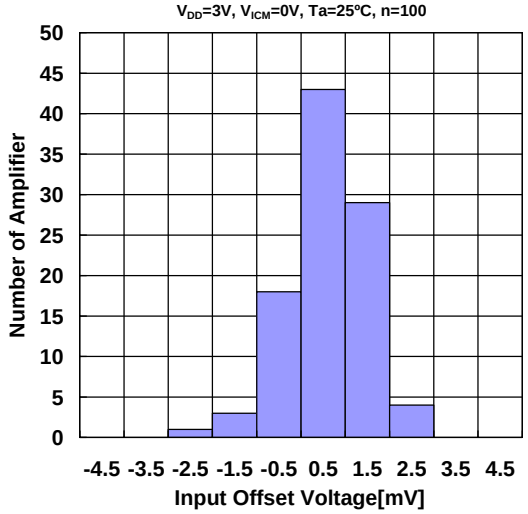
Input Offset Voltage vs. Temperature
(Supply Voltage)
$V_{ICM}=V_{DD}/2$



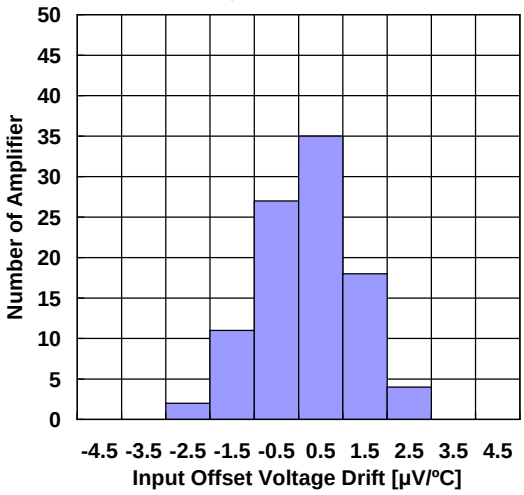
Input Offset Voltage vs. Common Mode Input Voltage
(Temperature)
V_{DD}=3V



Input Offset Voltage Distribution
V_{DD}=3V, V_{ICM}=0V, Ta=25°C, n=100

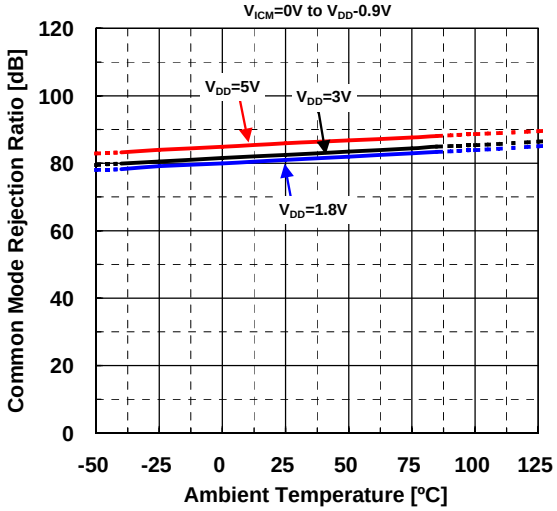


Input Offset Voltage Drift Distribution
V_{DD}=3V, V_{ICM}=0V, Ta=-40 to 85°C, n=100

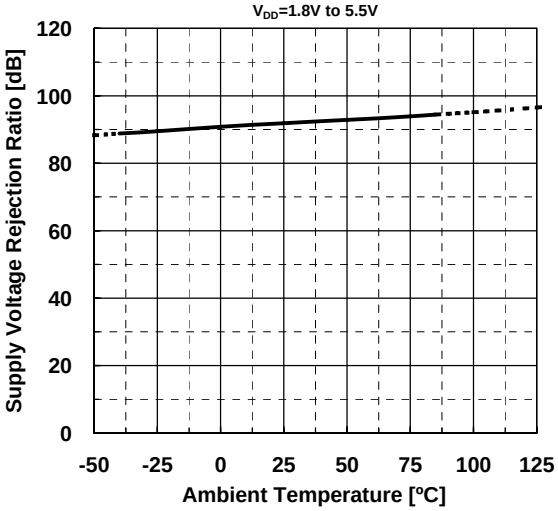


■ TYPICAL CHARACTERISTICS

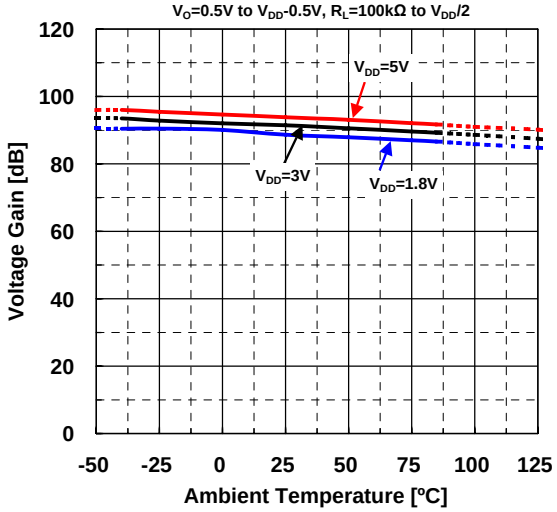
CMR vs. Temperature (Supply Voltage)
V_{ICM}=0V to V_{DD}-0.9V



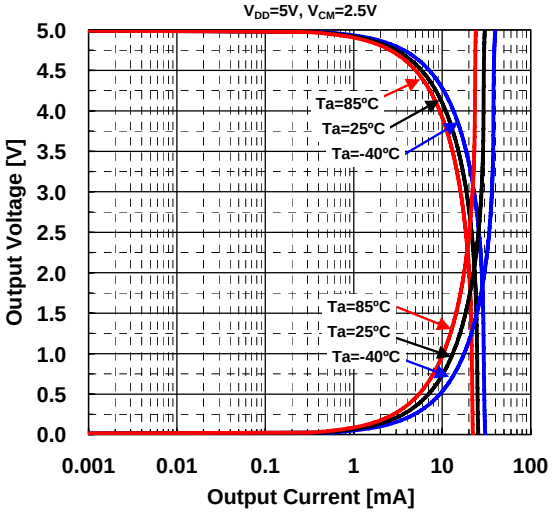
SVR vs. Temperature
V_{DD}=1.8V to 5.5V



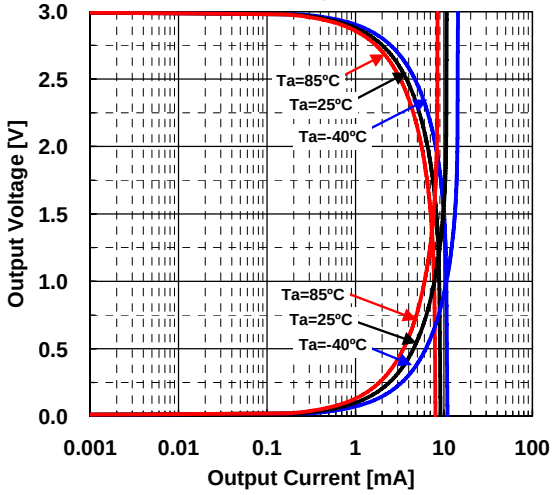
Gain vs. Temperature
V_O=0.5V to V_{DD}-0.5V, R_L=100kΩ to V_{DD}/2



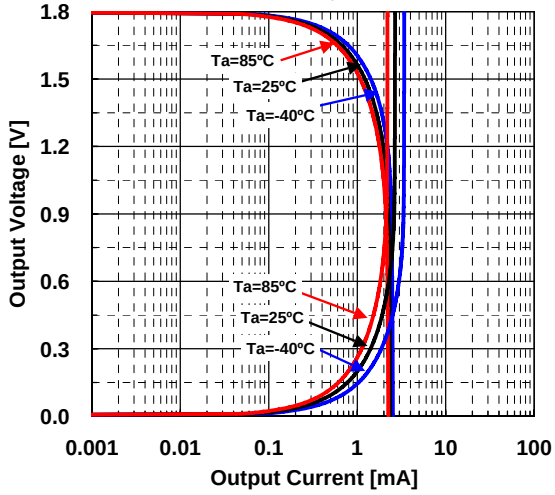
Output Voltage vs. Output Current (Temperature)
V_{DD}=5V, V_{CM}=2.5V



Output Voltage vs. Output Current (Temperature)
V_{DD}=3V, V_{CM}=1.5V

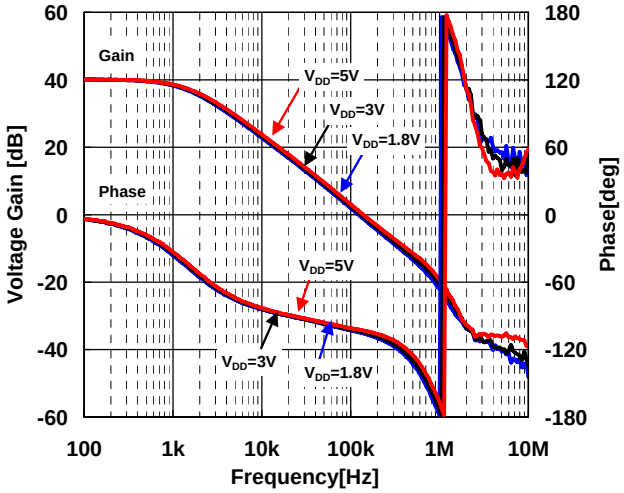


Output Voltage vs. Output Current (Temperature)
V_{DD}=1.8V, V_{CM}=0.9V

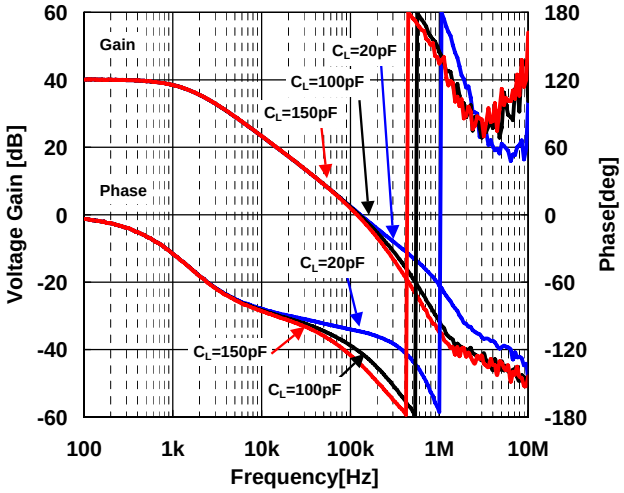


■ TYPICAL CHARACTERISTICS

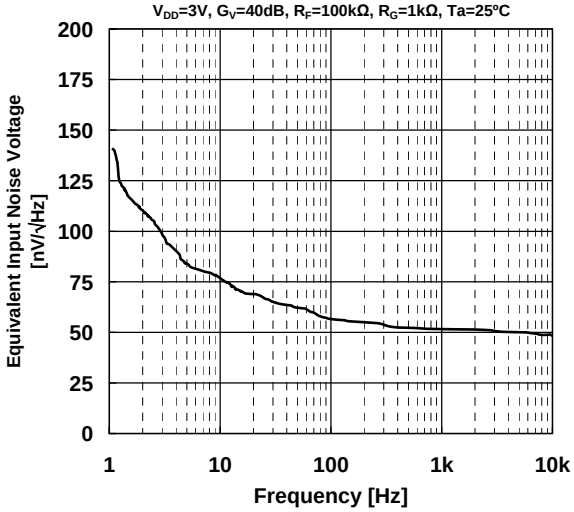
Closed-Loop Gain/Phase vs. Frequency
(Supply Voltage)
R_F=1MΩ, R_G=1KΩ, R_L=100KΩ, C_L=20pF, Ta=25ºC



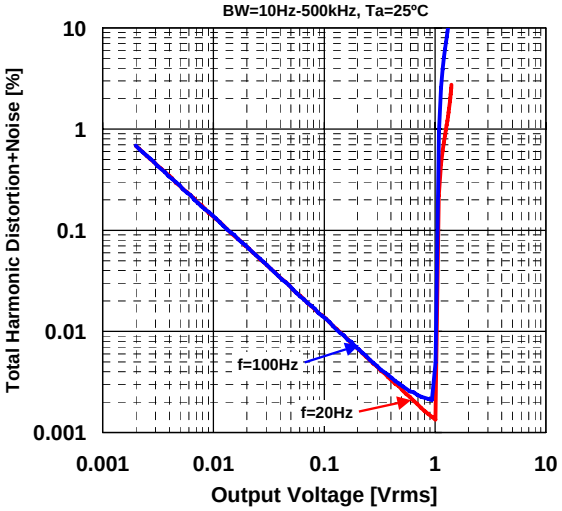
Open-Loop Gain/Phase vs. Frequency
(Load Capacitance)
V_{DD}=3V, R_F=1MΩ, R_G=1kΩ, R_L=100kΩ, Ta=25ºC



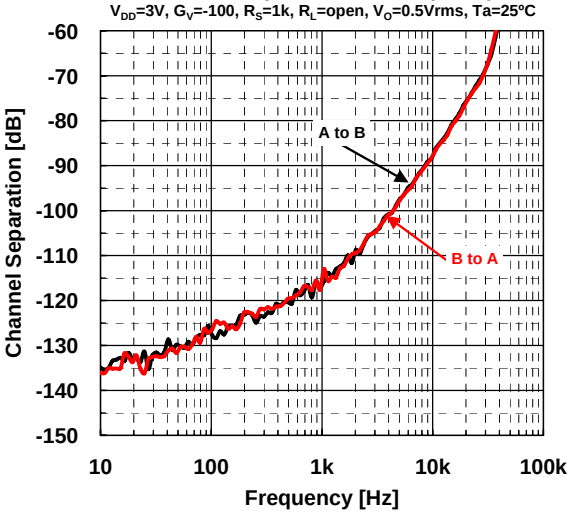
Voltage Noise vs. Frequency
V_{DD}=3V, G_V=40dB, R_F=100kΩ, R_G=1kΩ, Ta=25ºC



THD+Noise vs. Output Voltage
V_{DD}=3V, Gv=6dB, R_F=50kΩ, C_L=20pF
BW=10Hz-500kHz, Ta=25ºC

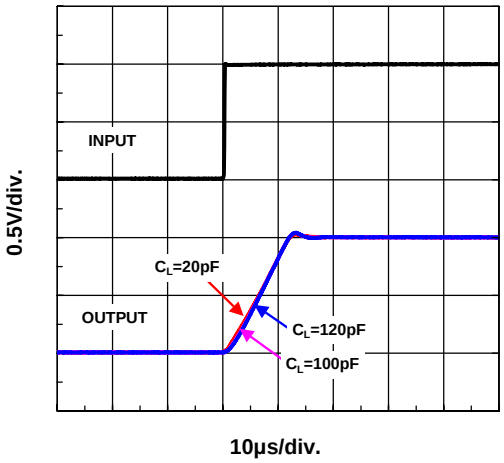


Channel Separation vs. Frequency
V_{DD}=3V, G_V=-100, R_S=1k, R_L=open, V_O=0.5Vrms, Ta=25ºC

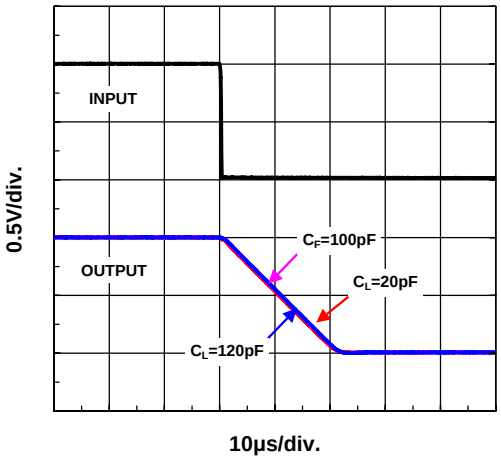


■ TYPICAL CHARACTERISTICS

Pulse Response (Load Capacitance)
V_{DD}=3V, Gv=0dB, R_L=100kΩ, Ta=25ºC



Pulse Response (Load Capacitance)
V_{DD}=3V, Gv=0dB, R_L=100kΩ, Ta=25ºC



■ MEMO