High Output Current, Single Supply, Rail-to-Rail Output Dual CMOS Operational Amplifier

■ GENERAL DESCRIPTION

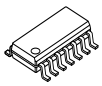
The NJU7036 is a Rail-to-Rail Output operational amplifier of single power supply operation.
It has the characteristic of high power output current and is suitable for driving heavy loads such as a small motor, LED, and speakers.
It has up to 0.15 V saturation voltages at an output current of 250mA.
Therefore it can reduce the electric power loss in IC and contribute to the design of low power consumption.
Moreover, micro leadless package (PCSP20-E3) is available for it, so that it can also contribute to the miniaturization of the equipment.

■ FEATURES

- •Rail-to-Rail Output Vo=4.7Vpp min. at VDD= 5V,Io=250mA
- •Single Supply
- •Operating Voltage Vopr= 2.7V to 5.5V
- • Package Outline PCSP20-E3 , EMP14
- •CMOS Process
- • Thermal Shutdown Circuit
- • Current Limit Circuit

■ PACKAGE OUTLINE

NJU7036SE3
(PCSP20-E3)



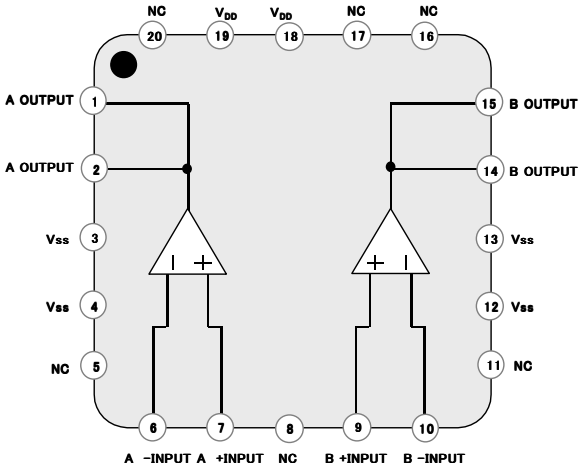
NJU7036E
(EMP14)

■ APPLICATION

•Motor Drivers , Audio Amplifiers , LED Drivers , etc.

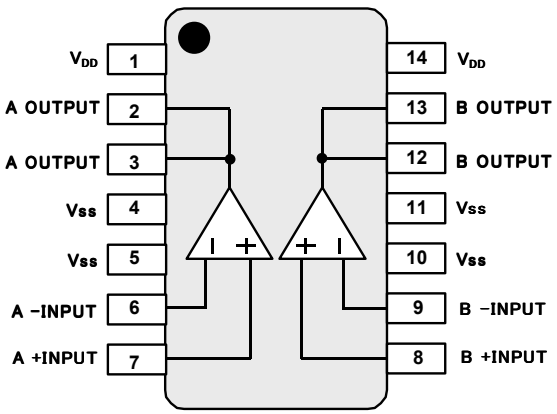
■ PIN CONFIGURATION (Top View)

NJU7036SE3



1,2	A OUTPUT	10	B -INPUT
3,4	V_{SS}	11	NC
5	NC	12,13	V_{SS}
6	A -INPUT	14,15	B OUTPUT
7	A +INPUT	16,17	NC
8	NC	18,19	V_{DD}
9	B +INPUT	20	NC

NJU7036E



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

VDD terminal, VSS terminal and OUTPUT terminal use two or more pins respectively and are lowering terminal resistance.
You shall connect each two pins (VDD, VSS and OUTPUT) with the same electric potential.
When only one pin is used, the internal terminal resistance becomes high and the maximum output voltage declines.

■ ABSOLUTE MAXIMUM RATINGS

Ta=25˚C

PARAMETER	SYMBOL	RATINGS	UNIT
Supply Voltage	V_{DD}	7.0	V
Power Dissipation	P_D	EMP14:890 *1) ,1300 *2) PCSP20 *3):550 *1), 1080 *2)	mW
Output Peak Current	I_{OP}	500	mA
Input Common Mode Voltage	V_{ICM}	-0.3 to 7.0 *4)	V
Differential Input Voltage	V_{ID}	±7 *4)	V
Operating Temperature Range	T_{opr}	-40 to +85	˚C
Storage Temperature Range	T_{stg}	-55 to +150	˚C

*1) EIA/JEDEC STANDARD Test board (76.2 x 114.3 x 1.6mm, 4layers, FR-4) mounting
*2) EIA/JEDEC STANDARD Test board (76.2 x 114.3 x 1.6mm, 2layers, FR-4) mounting
*3) The back pad is mounted.
*4) If the supply voltage V_{DD} is less than 7V, the input voltage must not over the V_{DD} level through 7V is limit specified.

■ RECOMMENDED OPERATING CONDITION

Ta=25˚C

PARAMETER	SYMBOL	RATING	UNIT
Supply Voltage	V_{DD}	2.7 to 5.5	V

■ ELECTRICAL CHARACTERISTICS

V_{DD}=5V, V_{SS}=0V, V_{IC}=2.5V, RL=8Ω(connected V_{DD} /2), Ta=25˚C

PARAMETER	SYMBOL	TEST CONDITION	MIN	TYP	MAX	UNIT
● DC CHARACTERISTICS						
	$V_{OH}1$	Isource=250mA	4.85	4.90	-	V
	$V_{OH}2$	Isource=150mA	4.88	4.94	-	V
Maximum Output Voltage	$V_{OH}3$	Isource=50mA	4.92	4.98	-	V
*RL=OPEN	$V_{OL}1$	Isink=250mA	-	0.10	0.15	V
	$V_{OL}2$	Isink=150mA	-	0.06	0.12	V
	$V_{OL}3$	Isink=50mA	-	0.02	0.08	V
Input Offset Voltage	V_{io}		-	2	10	mV
Input Bias Current	I_B		-	1	-	pA
Input Offset Current	I_{IO}		-	1	-	pA
Large Signal Voltage Gain	A_V	Vo= V_{DD} /2±2V	80	100	-	dB
Common Mode Rejection Ratio	CMR	V_{ICM}=0V to 3.8V	60	80	-	dB
Supply Voltage Rejection Ratio	SVR	V_{DD} =2.7V to 5.5V	60	80	-	dB
Input Common Mode Voltage Range	V_{ICM}	CMR≥60dB	0	-	3.8	V
Operating Current	I_{DD}	No Signal, RL=open	-	3.5	5.3	mA
● AC CHARACTERISTICS						
Unity Gain Bandwidth	f_T	G_V=6dB, C_L=10pF	-	0.4	-	MHz
Equivalent Input Noise Voltage	V_{NI}	f=1kHz, G_V=6dB, Rs=100Ω,	-	60	-	nV/√Hz
Total Harmonic Distortion (THD+N)	THD	G_V=6dB, C_L=10pF fin=1kHz, Po=250mW	-	0.03	-	%
Output Power	Po	G_V=6dB, C_L=10pF fin=1kHz, THD≤5%	-	400	-	mW
Channel Separasion	CS	f=1kHz	-	90	-	dB

PARAMETER	SYMBOL	TEST CONDITION	MIN	TYP	MAX	UNIT
●TRANSIENT CHARACTERISTICS Slew Rate	SR	G_V=0dB, C_L=10pF Vin=1.0Vpp	-	0.7	-	V/μs

V_{DD}=3V, V_{SS}=0V, V_{IC}=1.5V, RL=8Ω (connected V_{DD} /2), Ta=25°C

PARAMETER	SYMBOL	TEST CONDITION	MIN	TYP	MAX	UNIT
● DC CHARACTERISTICS						
	$V_{OH}1$	Isource=250mA	2.77	2.85	-	V
	$V_{OH}2$	Isource=150mA	2.83	2.91	-	V
Maximum Output Voltage	$V_{OH}3$	Isource=50mA	2.90	2.97	-	V
*RL=OPEN	$V_{OL}1$	Isink=250mA	-	0.15	0.23	V
	$V_{OL}2$	Isink=150mA	-	0.09	0.17	V
	$V_{OL}3$	Isink=50mA	-	0.03	0.10	V
Input Offset Voltage	V_{io}		-	2	10	mV
Input Bias Current	I_B		-	1	-	pA
Input Offset Current	I_{IO}		-	1	-	pA
Large Signal Voltage Gain	A_V	Vo= V_{DD} /2±1V	70	90	-	dB
Common Mode Rejection Ratio	CMR	V_{ICM}=0V to 1.8V	60	80	-	dB
Supply Voltage Rejection Ratio	SVR	V_{DD} =2.7V to 3.5V	58	70	-	dB
Input Common Mode Voltage Range	V_{ICM}	CMR≥60dB	0	-	1.8	V
Operating Current	I_{DD}	No Signal, RL=open	-	2.4	3.5	mA
● AC CHARACTERISTICS						
Unity Gain Bandwidth	f_T	G_V=6dB, C_L=10pF	-	0.4	-	MHz
Equivalent Input Noise Voltage	V_{NI}	f=1kHz, G_V=6dB, Rs=100Ω,	-	60	-	nV/√Hz
Total Harmonic Distortion (THD+N)	THD	G_V=6dB, C_L=10pF fin=1kHz, Po=60mW	-	0.06	-	%
Output Power	Po	G_V=6dB, C_L=10pF fin=1kHz, THD≤5%	-	150	-	mW
Channel Separasion	CS	f=1kHz	-	90	-	dB
●TRANSIENT CHARACTERISTICS Slew Rate	SR	G_V=0dB, C_L=10pF Vin=0.5Vpp	-	0.5	-	V/μs

■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 NJU7036 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℃, which is the maximum power dissipation. The second is 0W, which means that the IC cannot radiate any more. Conforming the maximum junction temperature Tjmax to the storage temperature Tstg derives this point. Fig.1 is drawn by connecting those points and conforming the P_D lower than 25℃ to it on 25℃. The P_D is shown following formula as a function of the ambient temperature between those points.

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

Where, θ ja 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 NJU7036 is obtained using following equation.

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

The NJU7036 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.

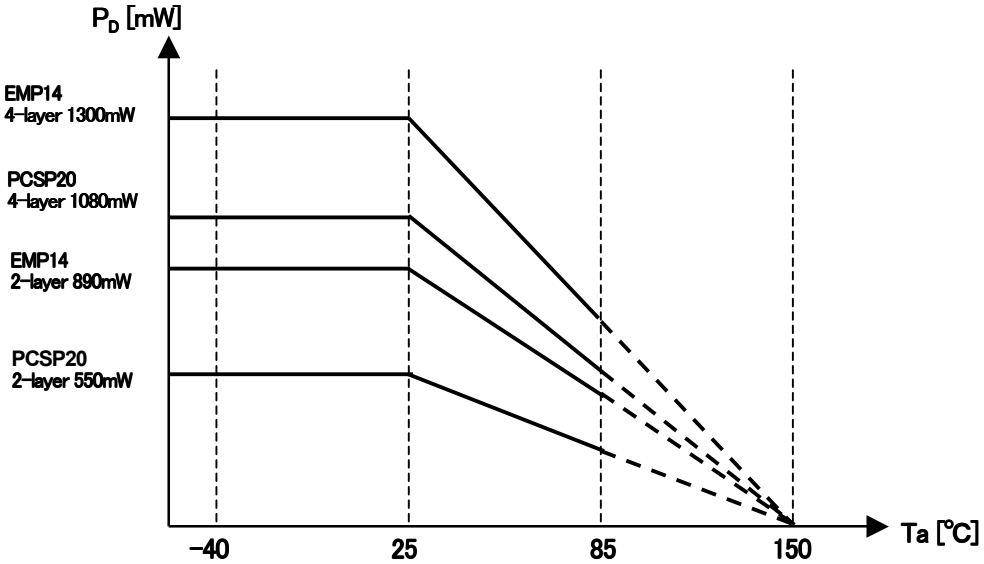


Fig.1 Power Dissipations vs. Ambient Temperature on the NJU7036.

•Thermal Protection

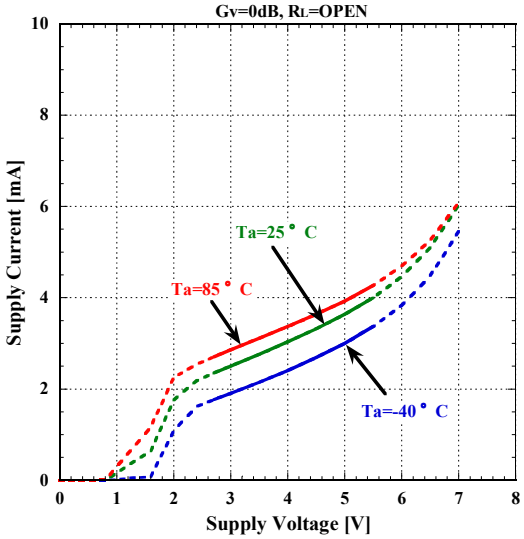
The NJU7036 is designed with Thermal Shut Down (TSD) circuitry that protects itself from damage caused by overload condition. The TSD circuitry is operated when the junction temperature reaches approximately 180℃, and the actual measurement of dissipation power is reduced by the stopped output current. When the junction temperature cools to approximately 150℃, the output circuitry is automatically re-enabled. Continuously running the NJU7036 into the thermal shutdown possibly damages device since the TSD circuit doesn't have active cooling function such as heat sinking. To sustain the steady state operation, the NJU7036 should be operated in lower than the Dissipation Power of the actual dissipation power.

•Current Limit

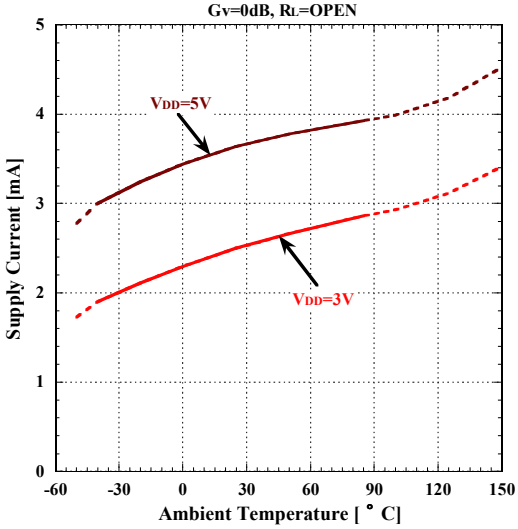
The NJU7036 should be operated in lower than 500mA of output current. The NJU7036 has current limiting circuitry that prevents from exceeding output current caused by grounding in order to enhance the safety of operation. The circuitry limits output current to approximately 1A. Although the output current is lower than 500mA, the device possibly gets damage duo to heating by output current. To sustain the steady state operation, the NJU7036 should be operated in lower than 500mA of output current and lower than the Dissipation Power of the actual dissipation power.

■ TYPICAL CHARACTERISTICS

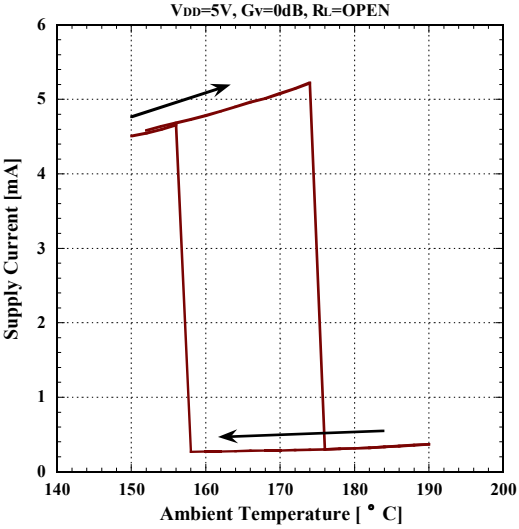
Supply Current vs. Supply Voltage
(Ambient Temperature)
Gv=0dB, RL=OPEN



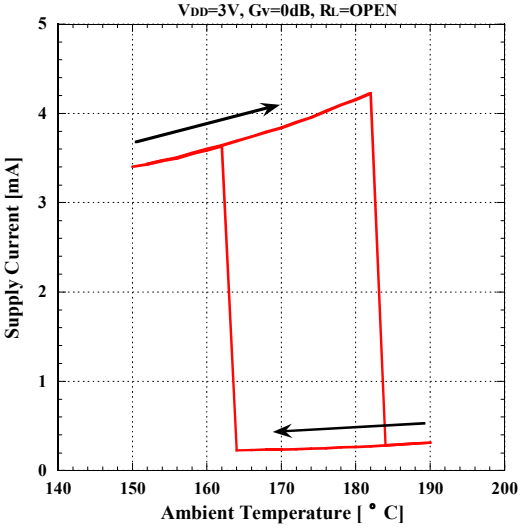
Supply Current vs. Ambient Temperature
(Supply Voltage)
Gv=0dB, RL=OPEN



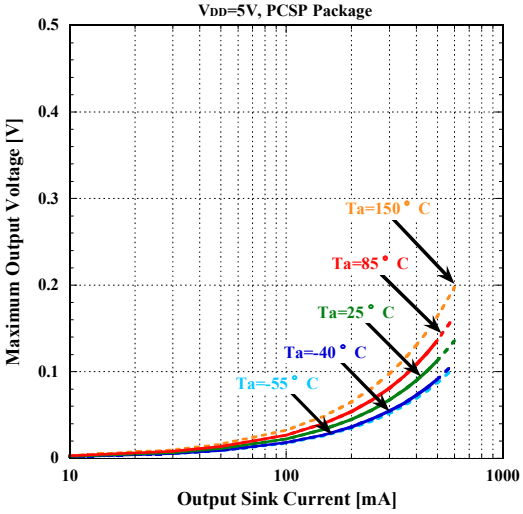
Supply Current vs. Ambient Temperature
(Thermal Shutdown)
VDD=5V, Gv=0dB, RL=OPEN



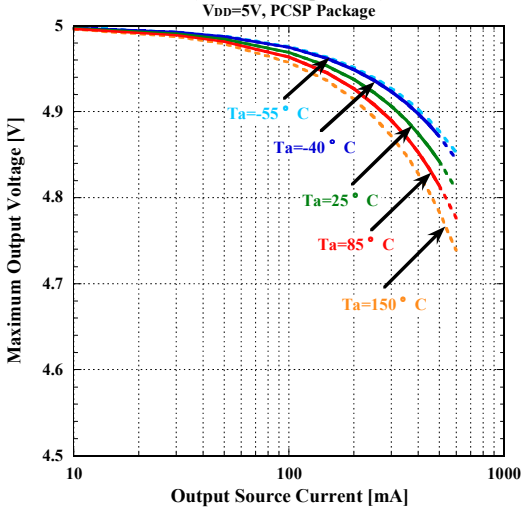
Supply Current vs. Ambient Temperature
(Thermal Shutdown)
VDD=3V, Gv=0dB, RL=OPEN



Maximum Output Voltage vs. Output Sink Current
(Ambient Temperature)
VDD=5V, PCSP Package

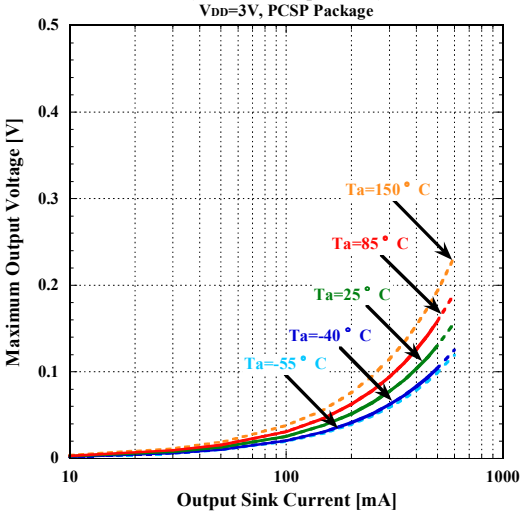


Maximum Output Voltage vs. Output Source Current
(Ambient Temperature)
VDD=5V, PCSP Package

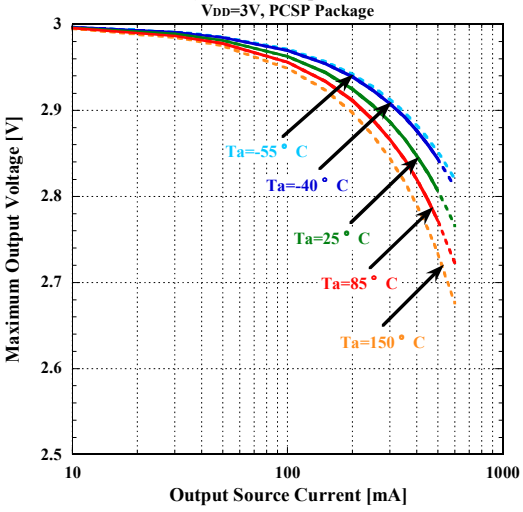


■ TYPICAL CHARACTERISTICS

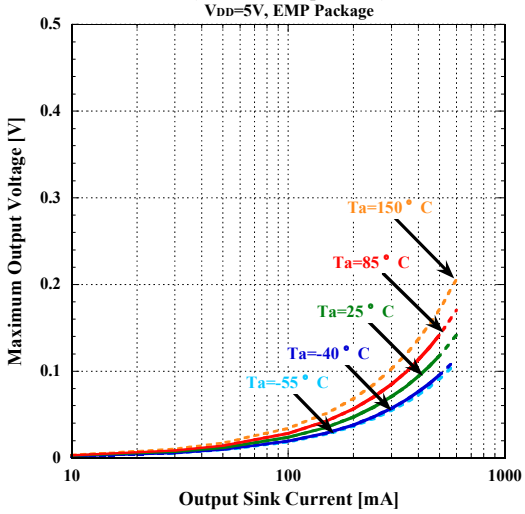
Maximum Output Voltage vs. Output Sink Current
(Ambient Temperature)
VDD=3V, PCSP Package



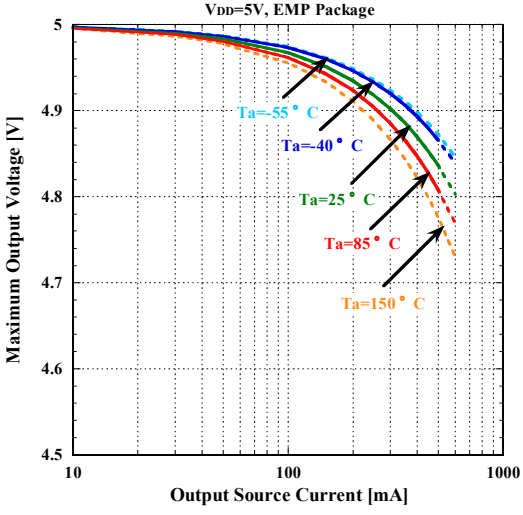
Maximum Output Voltage vs. Output Source Current
(Ambient Temperature)
VDD=3V, PCSP Package



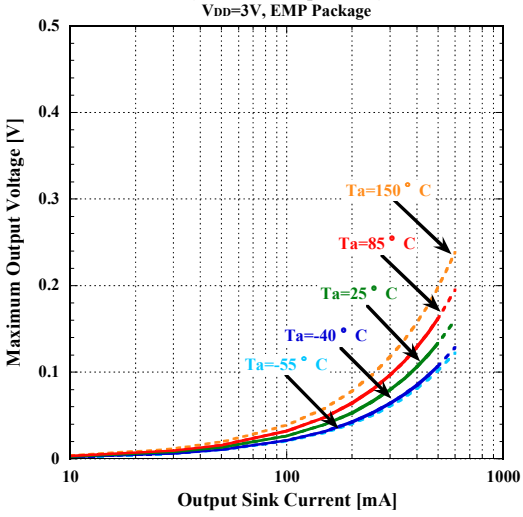
Maximum Output Voltage vs. Output Sink Current
(Ambient Temperature)
VDD=5V, EMP Package



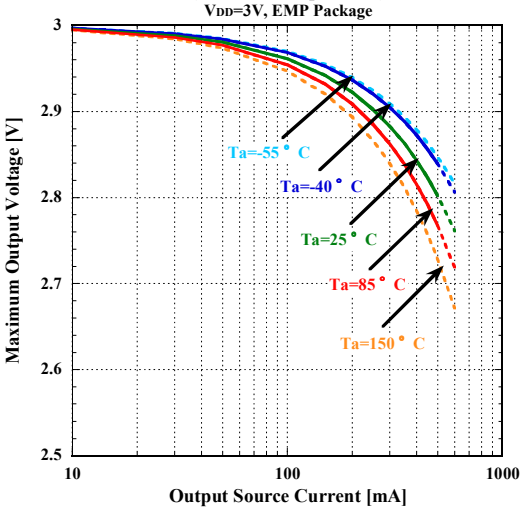
Maximum Output Voltage vs. Output Source Current
(Ambient Temperature)
VDD=5V, EMP Package



Maximum Output Voltage vs. Output Sink Current
(Ambient Temperature)
VDD=3V, EMP Package

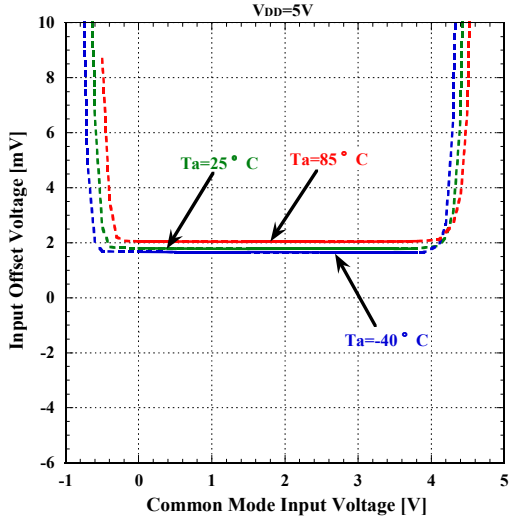


Maximum Output Voltage vs. Output Source Current
(Ambient Temperature)
VDD=3V, EMP Package

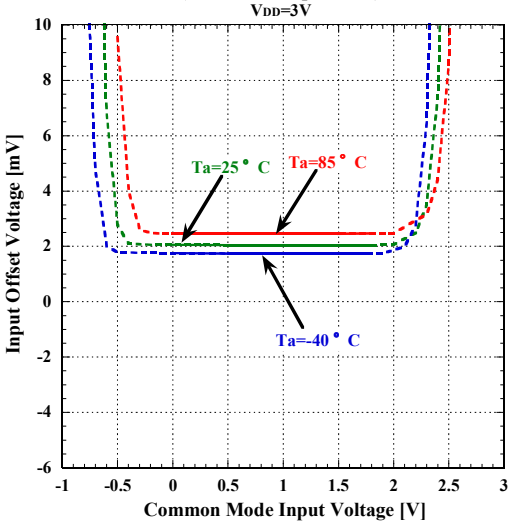


■ TYPICAL CHARACTERISTICS

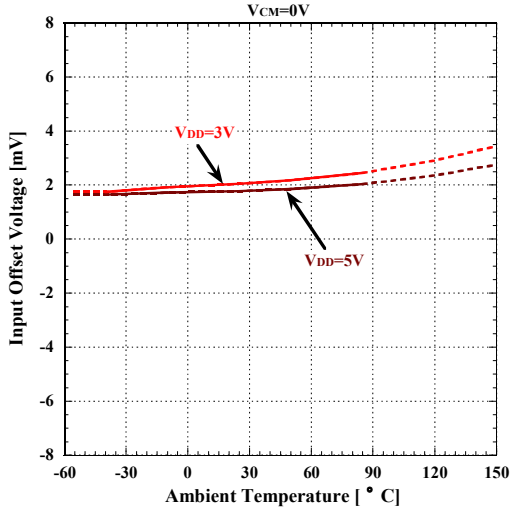
Input Offset Voltage vs. Common Mode Input Voltage
(Ambient Temperature)
V_{DD}=5V



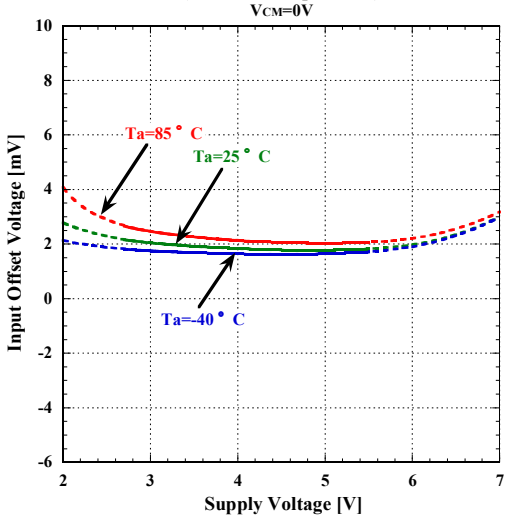
Input Offset Voltage vs. Common Mode Input Voltage
(Ambient Temperature)
V_{DD}=3V



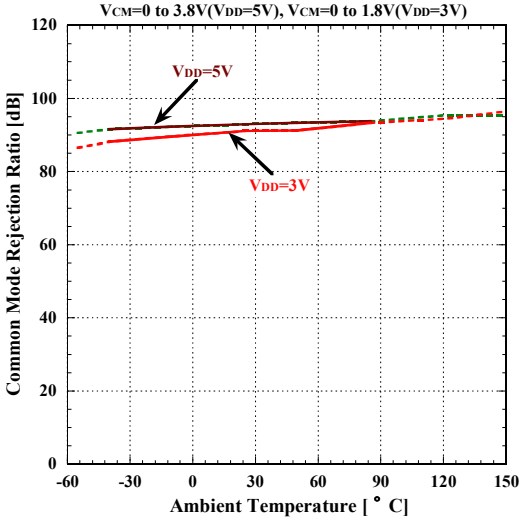
Input Offset Voltage vs. Ambient Temperature
(Supply Voltage)
V_{CM}=0V



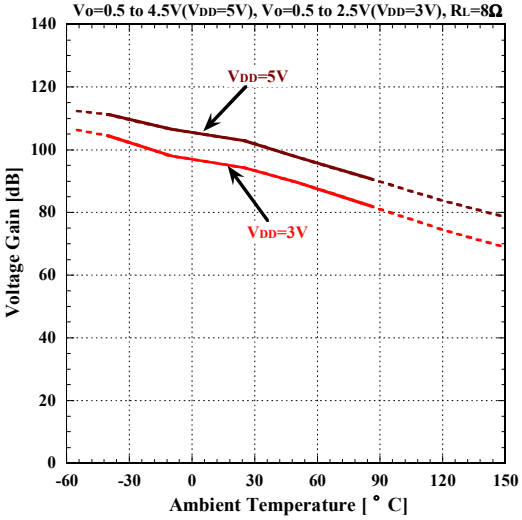
Input Offset Voltage vs. Supply Voltage
(Ambient Temperature)
V_{CM}=0V



Common Mode Rejection Ratio vs. Ambient Temperature
(Supply Voltage)
V_{CM}=0 to 3.8V(V_{DD}=5V), V_{CM}=0 to 1.8V(V_{DD}=3V)

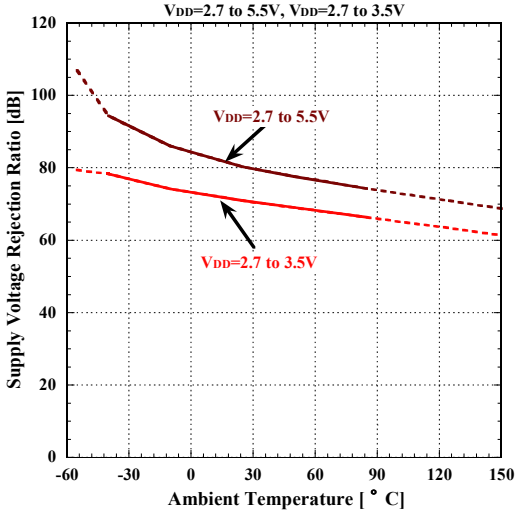


Voltage Gain vs. Ambient Temperature
(Supply Voltage)
V_O=0.5 to 4.5V(V_{DD}=5V), V_O=0.5 to 2.5V(V_{DD}=3V), R_L=8Ω

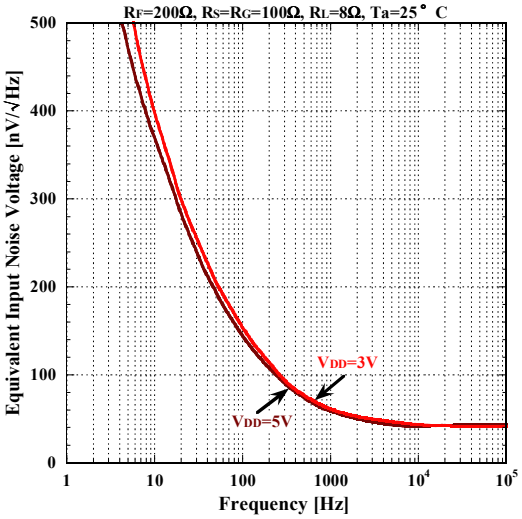


■ TYPICAL CHARACTERISTICS

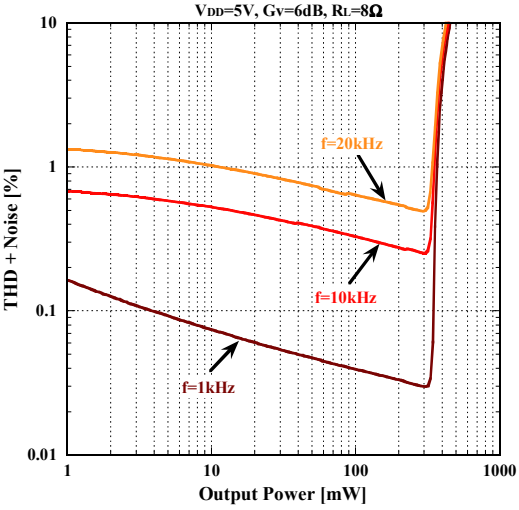
Supply Voltage Rejection Ratio vs. Ambient Temperature
V_{DD}=2.7 to 5.5V, V_{DD}=2.7 to 3.5V



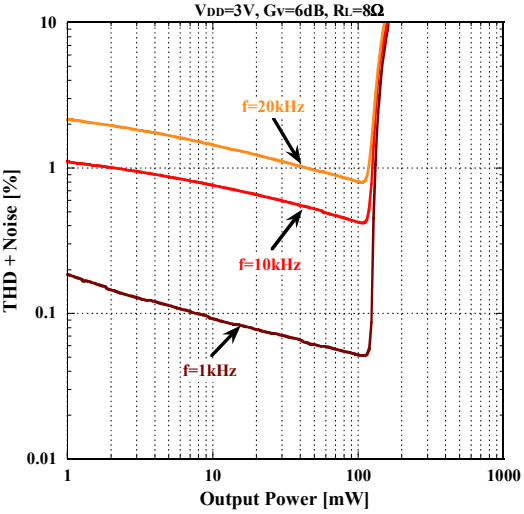
Equivalent Input Noise Voltage vs. Frequency
R_F=200Ω, R_S=R_G=100Ω, R_L=8Ω, Ta=25 ° C



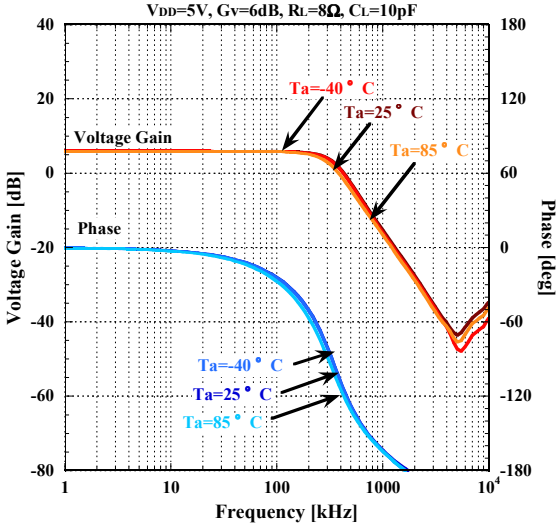
THD + Noise vs. Output Power
(Frequency)
V_{DD}=5V, G_V=6dB, R_L=8Ω



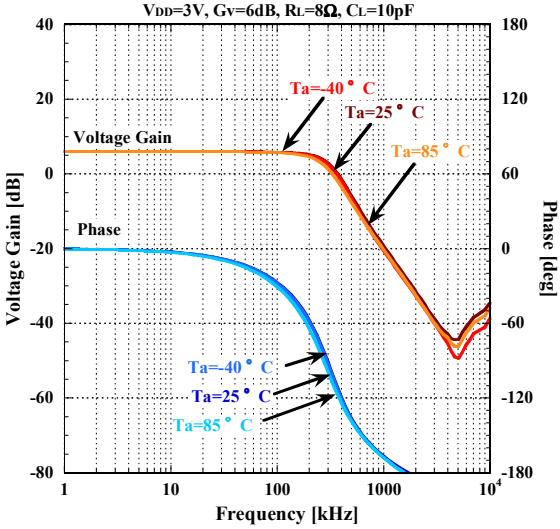
THD + Noise vs. Output Power
(Frequency)
V_{DD}=3V, G_V=6dB, R_L=8Ω



Voltage Gain / Phase vs. Frequency
(Ambient Temperature)
V_{DD}=5V, G_V=6dB, R_L=8Ω, C_L=10pF

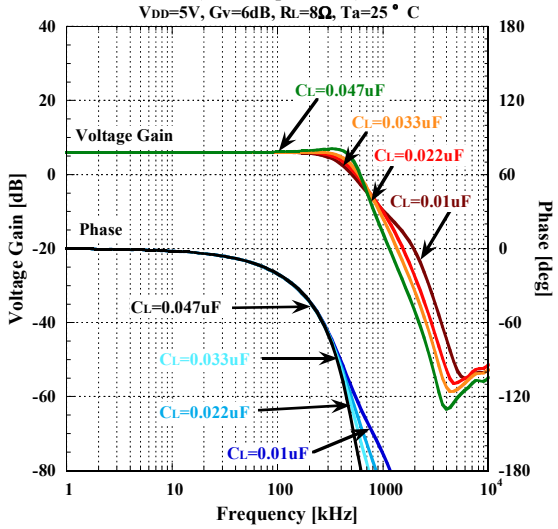


Voltage Gain / Phase vs. Frequency
(Ambient Temperature)
V_{DD}=3V, G_V=6dB, R_L=8Ω, C_L=10pF

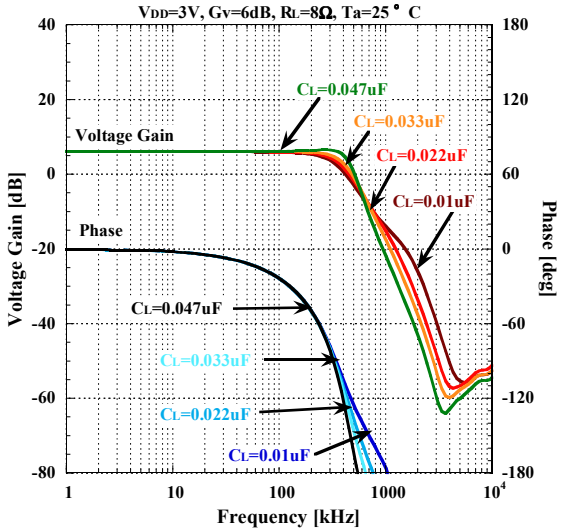


■ TYPICAL CHARACTERISTICS

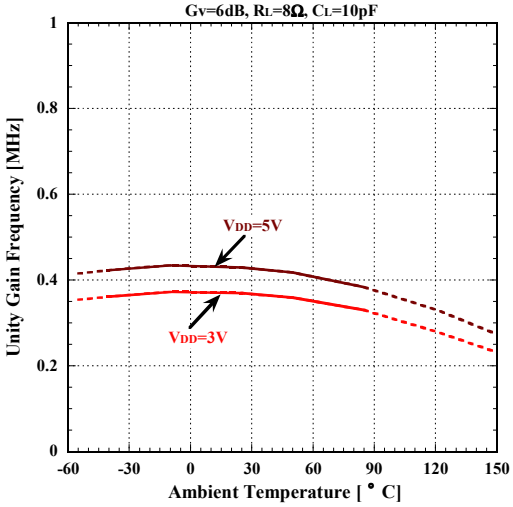
Voltage Gain / Phase vs. Frequency
(Load Capacitance)
VDD=5V, Gv=6dB, RL=8Ω, Ta=25 ° C



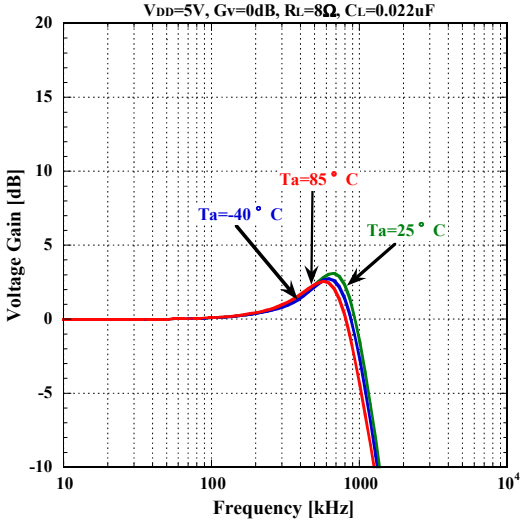
Voltage Gain / Phase vs. Frequency
(Load Capacitance)
VDD=3V, Gv=6dB, RL=8Ω, Ta=25 ° C



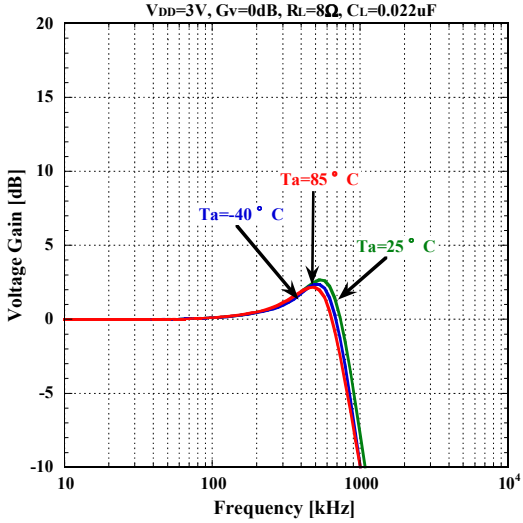
Unity Gain Frequency vs. Ambient Temperature
(Supply Voltage)
Gv=6dB, RL=8Ω, CL=10pF



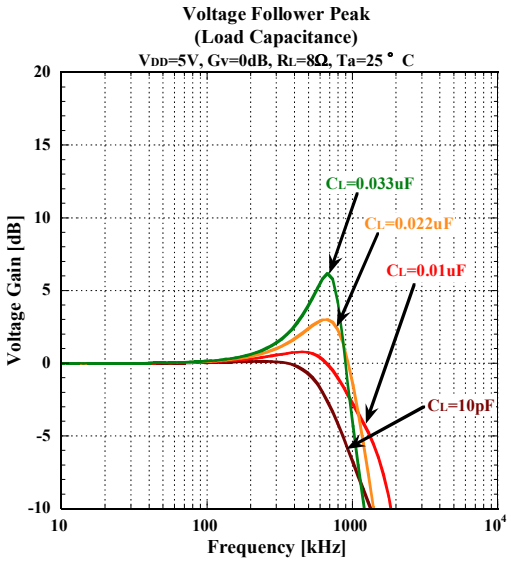
Voltage Follower Peak
(Ambient temperature)
VDD=5V, Gv=0dB, RL=8Ω, CL=0.022uF

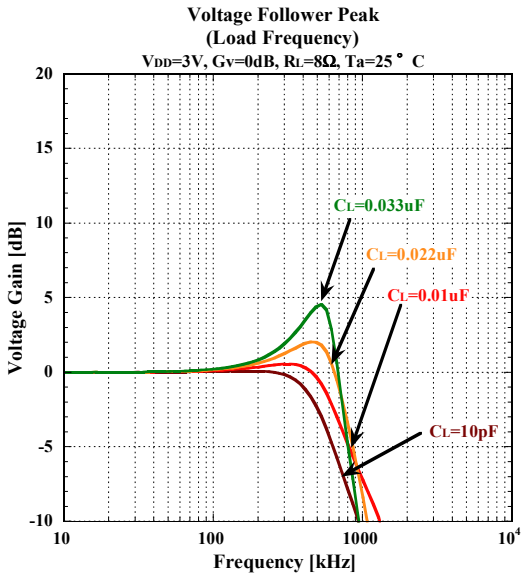


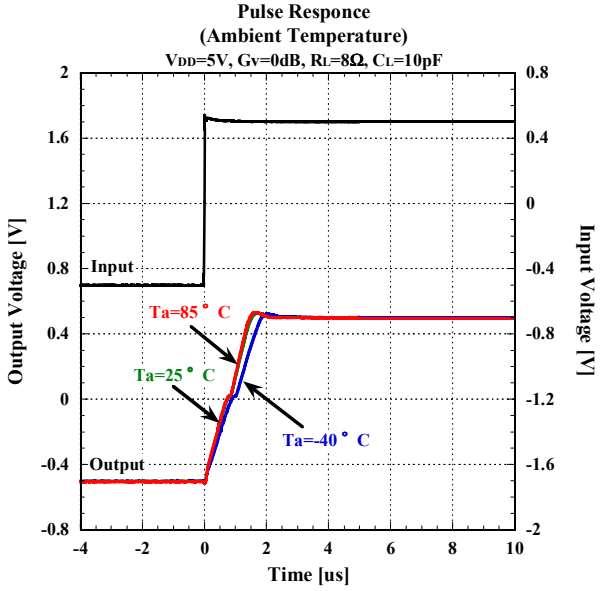
Voltage Follower Peak
(Ambient Temperature)
VDD=3V, Gv=0dB, RL=8Ω, CL=0.022uF

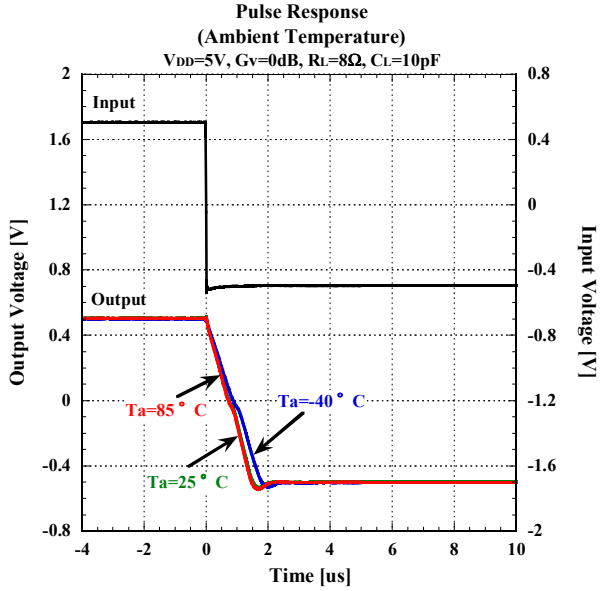


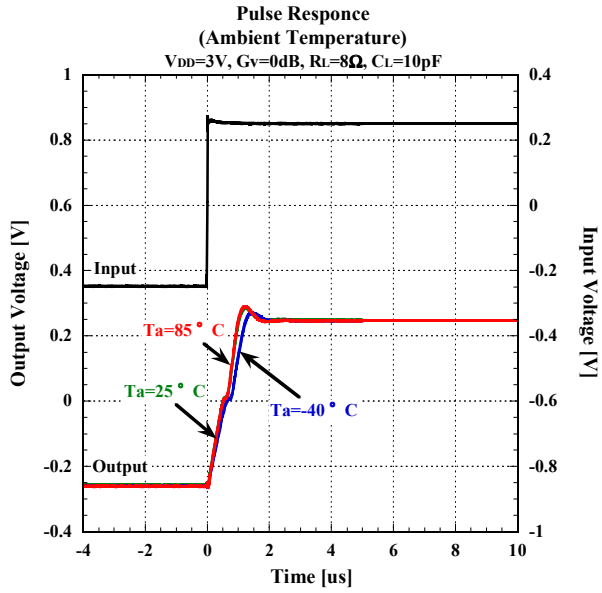
■ TYPICAL CHARACTERISTICS

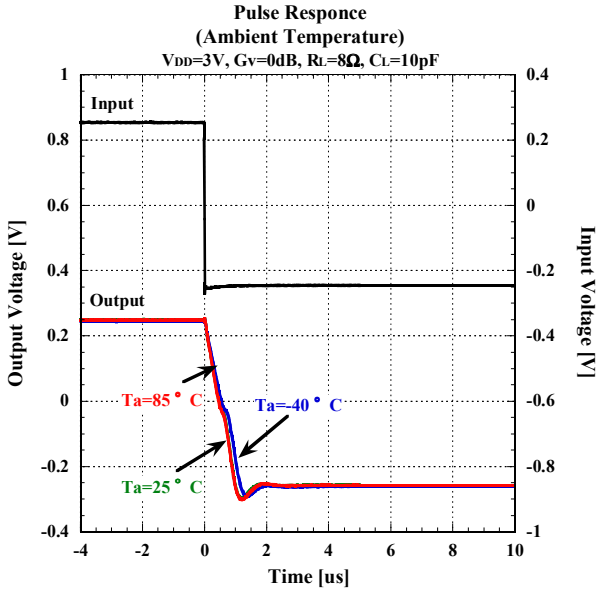






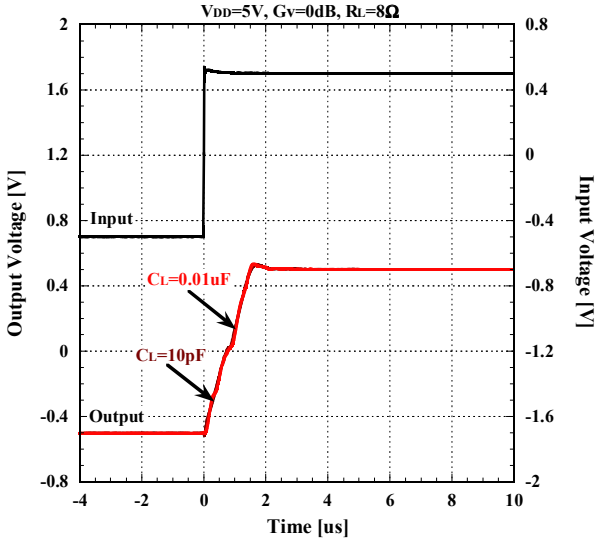




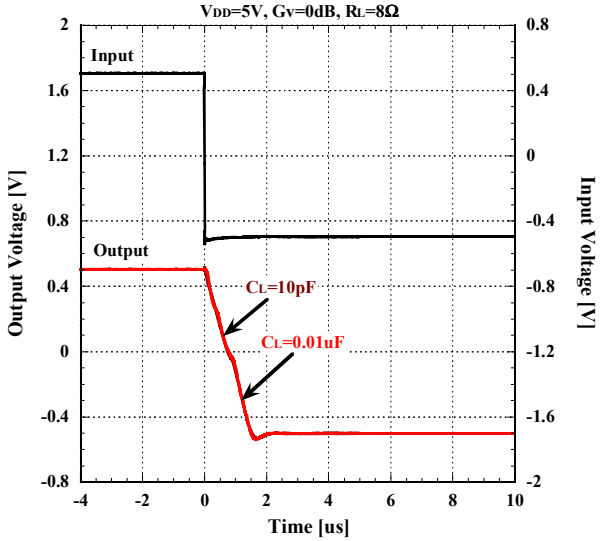


■ TYPICAL CHARACTERISTICS

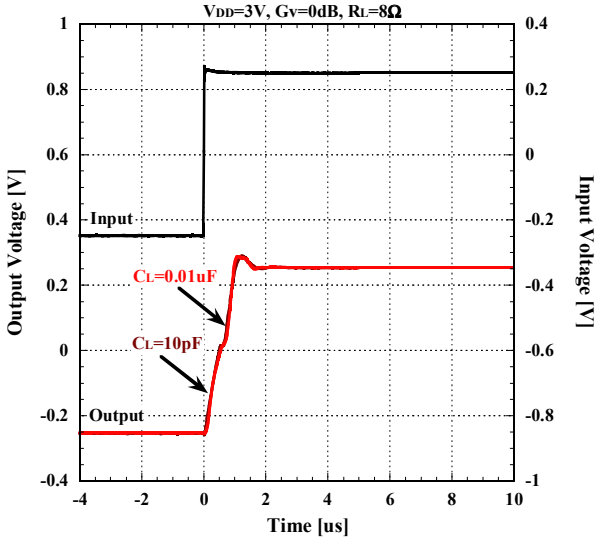
Pulse Responce
(Load Capacitance)
VDD=5V, Gv=0dB, RL=8Ω



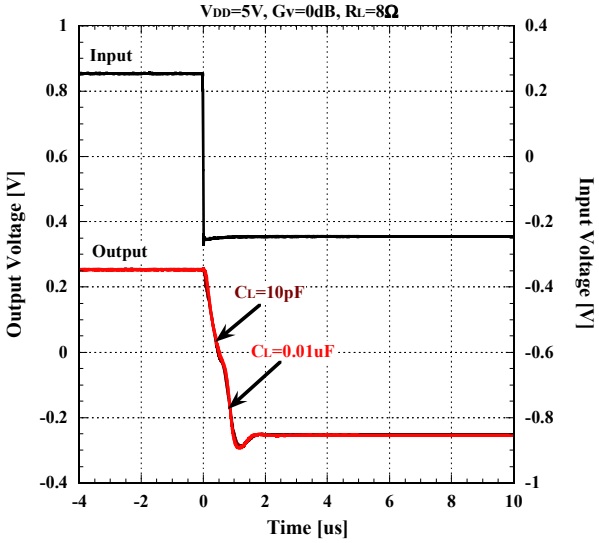
Pulse Responce
(Load Capacitance)
VDD=5V, Gv=0dB, RL=8Ω



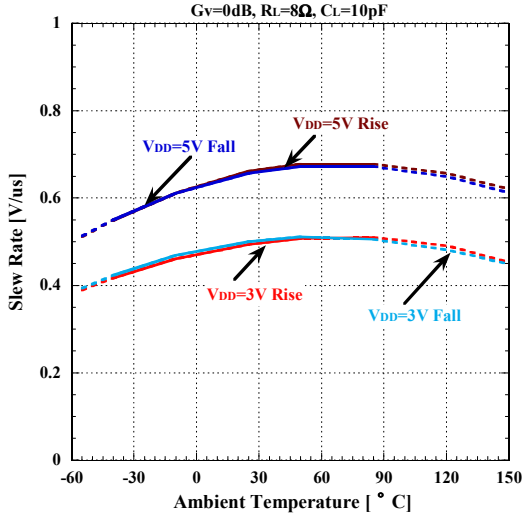
Pulse Responce
(Load Capacitance)
VDD=3V, Gv=0dB, RL=8Ω



Pulse Responce
(Load Capacitance)
VDD=5V, Gv=0dB, RL=8Ω

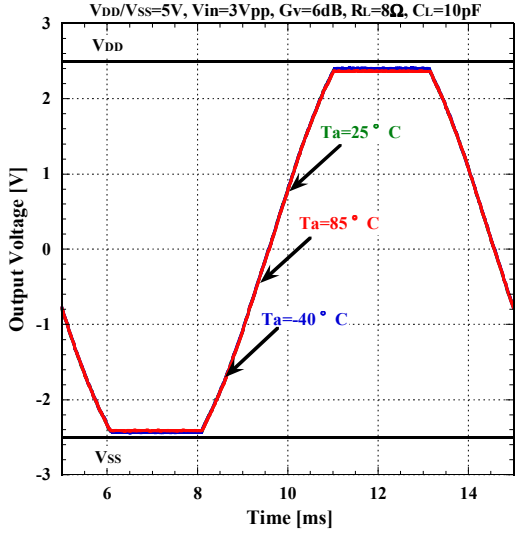


Slew Rate vs. Ambient Temperature
(Supply Voltage)
Gv=0dB, RL=8Ω, CL=10pF

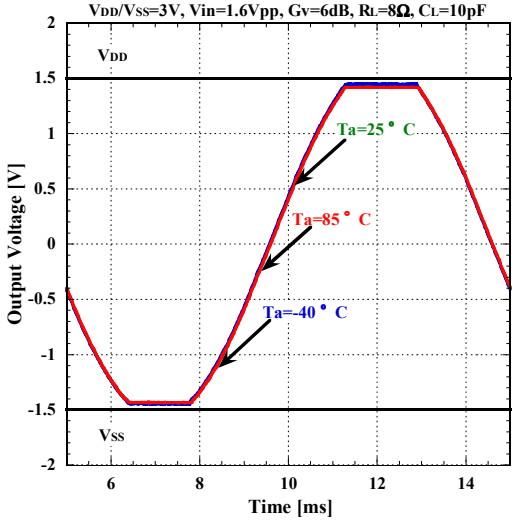


■ TYPICAL CHARACTERISTICS

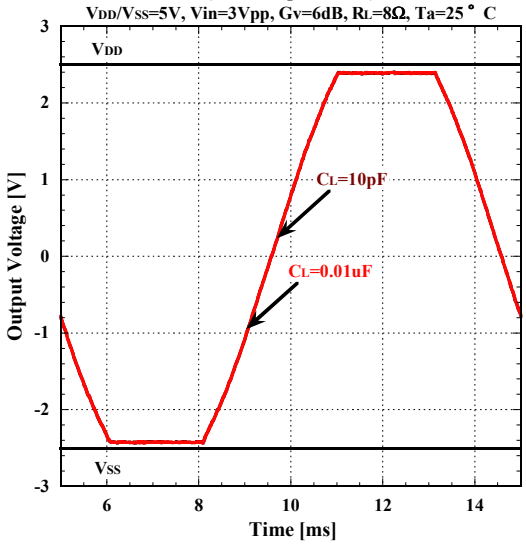
No Output Phase Reversal
(Ambient Temperature)
VDD/VSS=5V, Vin=3Vpp, Gv=6dB, RL=8Ω, CL=10pF



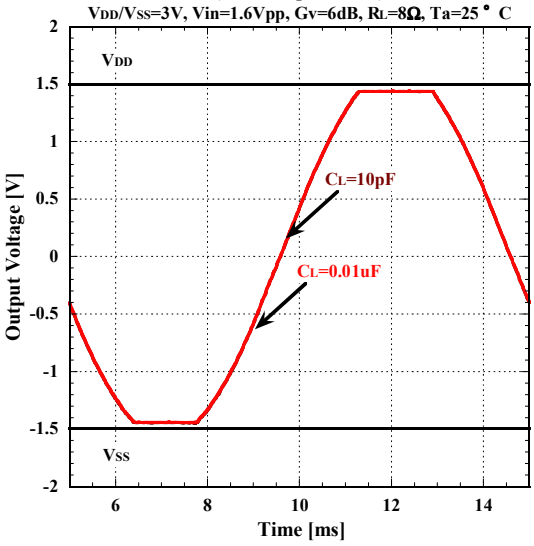
No Output Phase Reversal
(Ambient Temperature)
VDD/VSS=3V, Vin=1.6Vpp, Gv=6dB, RL=8Ω, CL=10pF



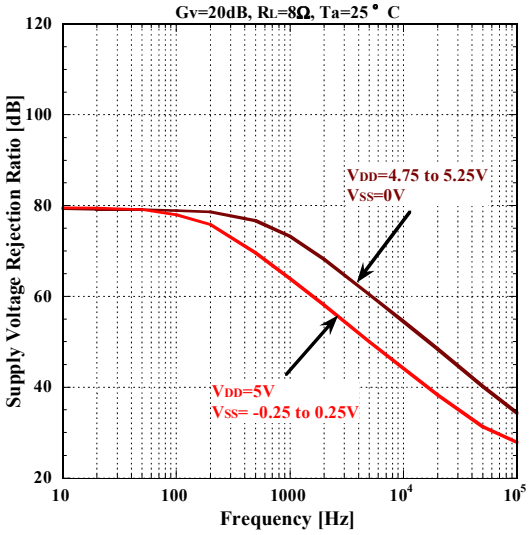
No Output Phase Reversal
(Load Capacitance)
VDD/VSS=5V, Vin=3Vpp, Gv=6dB, RL=8Ω, Ta=25° C



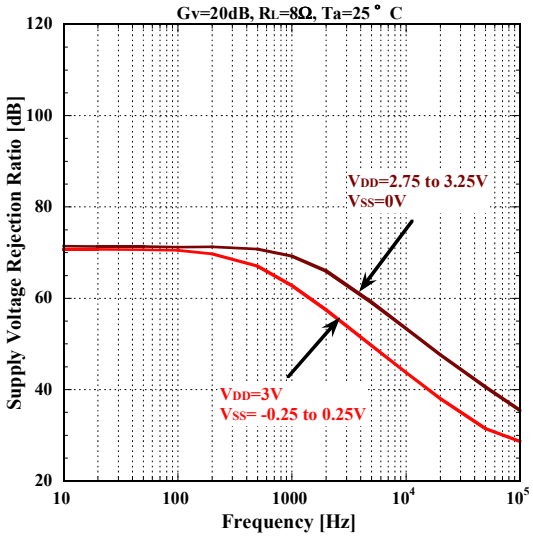
No Output Voltage Reversal
(Load Capacitance)
VDD/VSS=3V, Vin=1.6Vpp, Gv=6dB, RL=8Ω, Ta=25° C



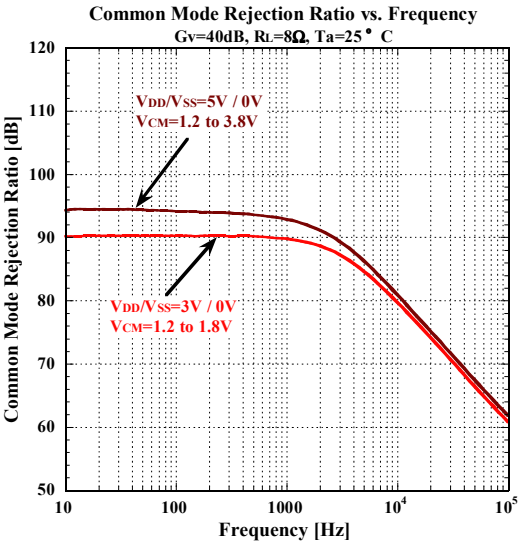
Supply Voltage Rejection Ratio vs. Frequency
Gv=20dB, RL=8Ω, Ta=25° C



Supply Voltage Rejection Ratio vs. Frequency
Gv=20dB, RL=8Ω, Ta=25° C

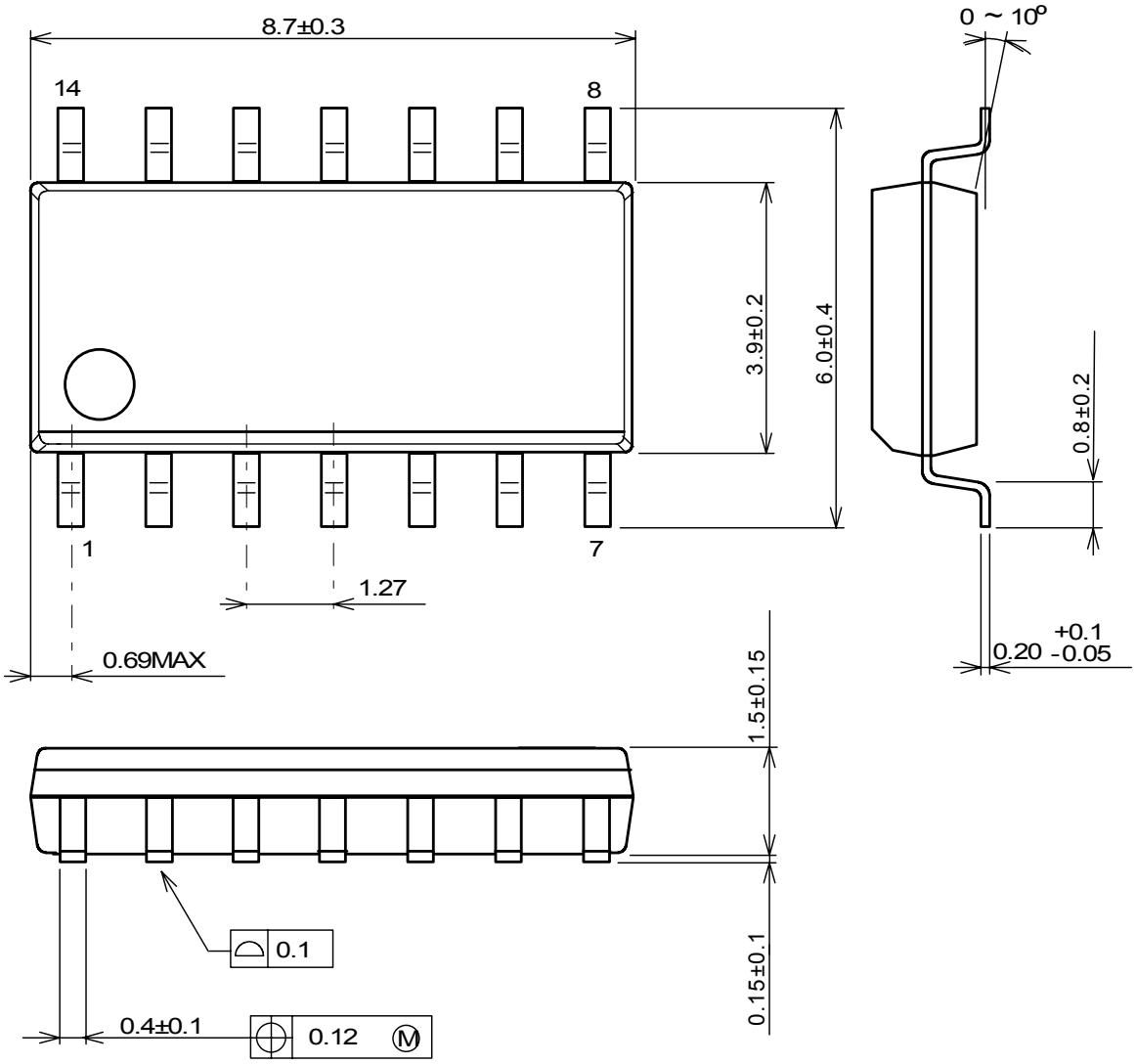


■ TYPICAL CHARACTERISTICS

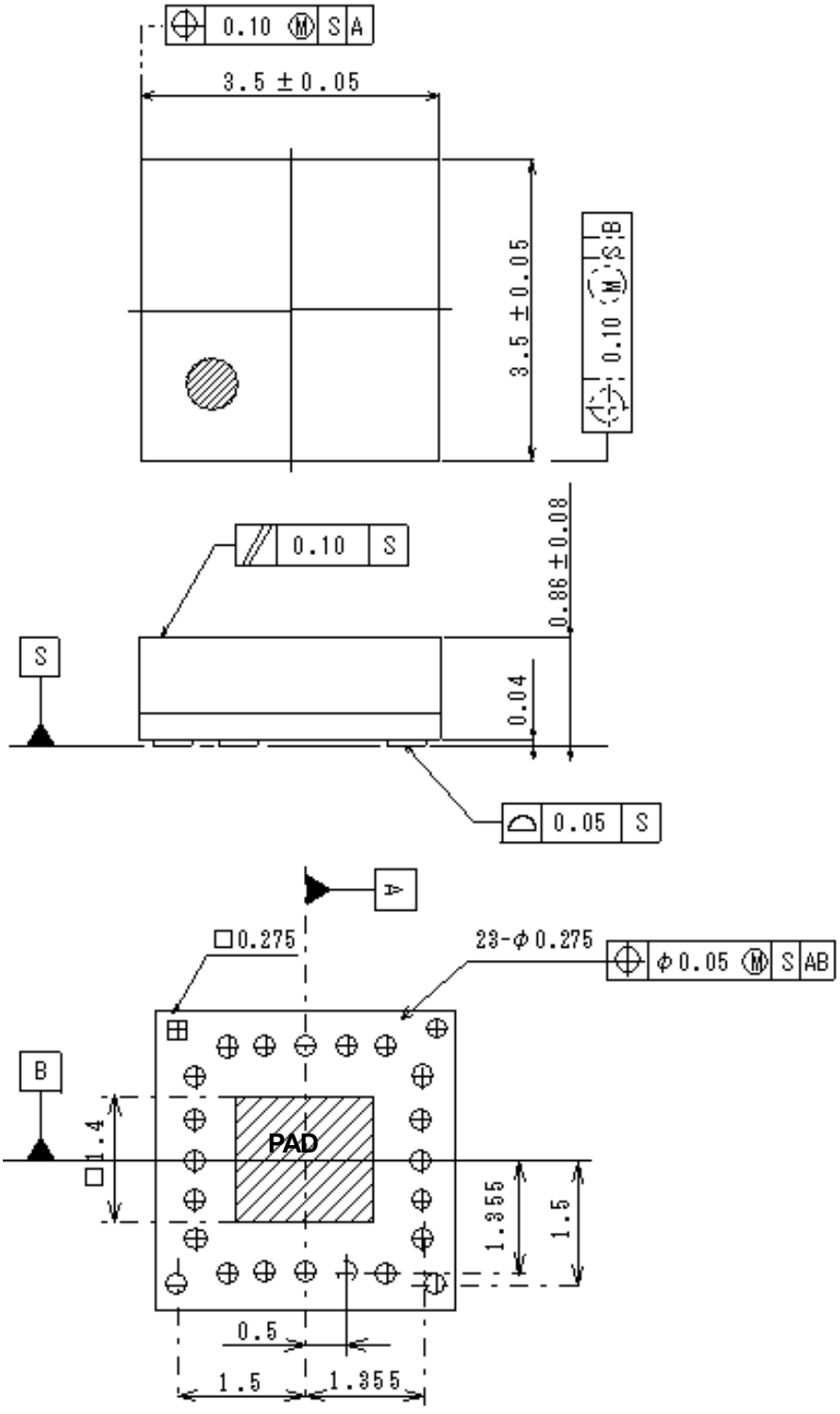


■ PACKAGE DIMENSIONS

EMP-14



PCSP-20E3



The PAD is electrically not connected to the backside of the die.
Moreover,Please mount PAD on plain GND to give heat radiation.

[CAUTION]
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