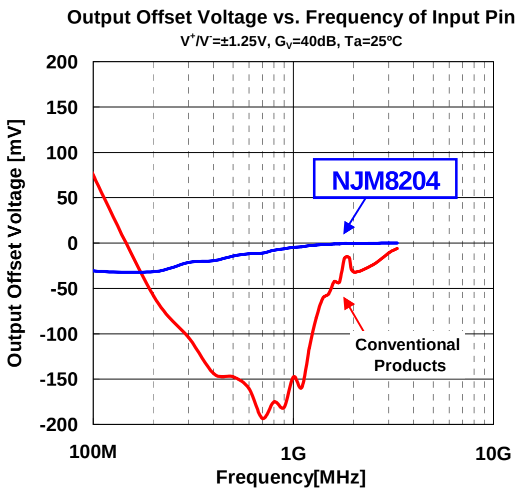
Single Supply, Rail-to-Rail Output Quad Operational Amplifier

■ FEATURES
- Integrated EMI Filter
- Rail-to-Rail Output — 0.1V to 4.9V typ. @V^+ = 5V, T_a = 25°C
- Operating Temperature — −40°C to 125°C
- Operation Voltage — 2.5V to 14V (±1.25 to ±7V)
- Slew Rate — 3.5V/µs typ.
- GBW — 10MHz typ.
- Equivalent Input Noise Voltage — 10nV/√Hz typ. @1kHz
- Input Offset Voltage — 6.0mV max. @ T_a = 25°C
- Supply Current — 11mA max. @ T_a = 25°C
- Package — SSOP14

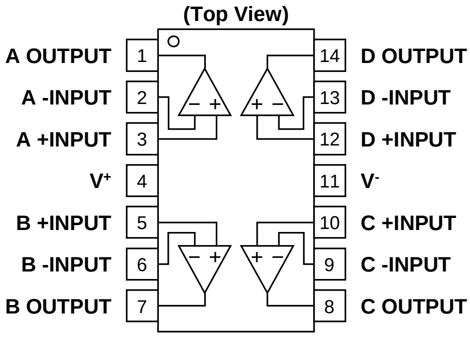
■ DESCRIPTION
The NJM8204 is a low noise Rail-to-Rail output quad operational amplifier. It is tolerant to EMI noise.
Rail-to-Rail output function provides wide dynamic range, is from ground to power supply level. And input range is from ground level.
It is suitable for audio section of portable sets, PC and any General-purpose applications.

■ APPLICATIONS
- Note PC, PDA
- Mobile phone
- Audio signal processing
- Current detect
- Buffer, Active filter

■ TYPICAL CHARACTERISTICS



■ PIN CONFIGURATION

PRODUCT NAME	NJM8204V
Package	SSOP14
Pin Function	

■ PRODUCT NAME INFORMATION

NJM8204 V (TE1)

Part Number — Package — Taping Form

■ ORDERING INFORMATION

PRODUCT NAME	PACKAGE	RoHS	HALOGEN-FREE	TERMINAL FINISH	MARKING	WEIGHT (mg)	MOQ (pcs)
NJM8204V (TE1)	SSOP14	Yes	-	Sn2Bi	8204	65	2000

■ ABSOLUTE MAXIMUM RATINGS

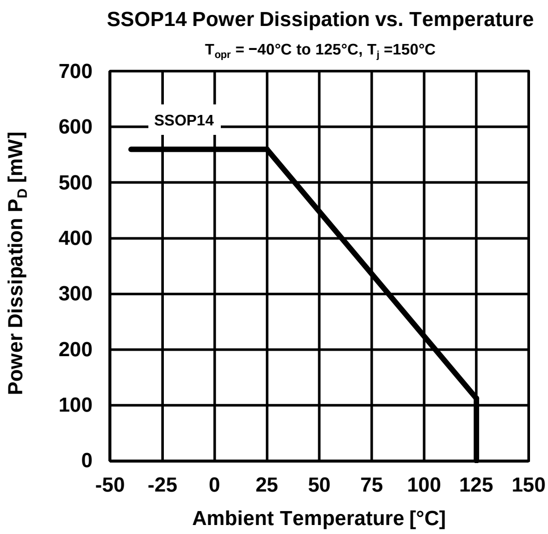
PARAMETER	SYMBOL	RATING	UNIT
Supply Voltage	$V^+ - V^-$	15	V
Common Mode Input Voltage	V_{ICM}	0 to 15 (1)	V
Differential Input Voltage	V_{ID}	±15 (2)	V
Power Dissipation (T_a = 25°C) SSOP14	P_D	2-Layer (3) 560	mW
Storage Temperature	T_{stg}	−50 to 150	°C
Junction Temperature	T_j	150	°C

■ THERMAL CHARACTERISTICS

PACKAGE	SYMBOL	VALUE	UNIT
Junction-to-Ambient Thermal Resistance SSOP14	θ_{ja}	2-Layer (3) 223	°C/W

(1) For supply voltage less than 15V, the absolute maximum input voltage is equal to supply voltage.
(2) Differential voltage is the voltage difference between +INPUT and −INPUT.
For supply voltage less than 15V, the absolute maximum rating is equal to the supply voltage.
(3) 2-Layer: Mounted on glass epoxy board (76.2 mm × 114.3 mm × 1.6 mm: based on EIA/JEDEC standard, 2-layer FR-4).

■ POWER DISSIPATION vs. AMBIENT TEMPERATURE



■ RECOMMENDED OPERATING CONDITIONS

PARAMETER	SYMBOL	CONDITIONS	VALUE	UNIT
Supply Voltage	$V^+ - V^-$	T_a = 25°C	2.5 to 14	V
Operating Temperature	T_{opr}		−40 to 125	°C

■ ELECTRICAL CHARACTERISTICS

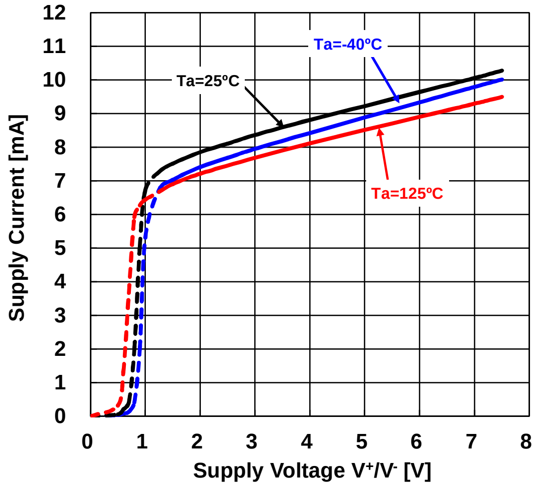
($V^+ = 5V$, $V^- = 0V$, $V_{CM} = V^+/2$, $R_L = 10k\Omega$ to V_{CM}, $T_a = 25°C$, unless otherwise noted.)

PARAMETER	SYMBOL	TEST CONDITIONS	MIN	TYP	MAX	UNIT
POWER SUPPLY CHARACTERISTICS						
Supply Current (All Amplifiers)	I_{SUPPLY}	$R_L = \infty$, No Signal, $V_{IN} = 2.5V$	-	8	11	mA
DC CHARACTERISTICS						
Input Offset Voltage	V_{IO}	$R_S = 10k\Omega$	-	1	6	mV
Input Bias Current	I_B		-	100	350	nA
Input Offset Current	I_{IO}		-	5	100	nA
Common-Mode Rejection Ratio	CMR	$0V \leq V_{CM} \leq 4V$	60	75	-	dB
Common-Mode Input Voltage Range	V_{ICM}	CMR ≥ 60dB	0	-	4	V
Open-Loop Voltage Gain	A_V	$R_L \geq 10k\Omega$ to 2.5V, $V_O = 0.5V$ to 4.5V	65	85	-	dB
Supply Voltage Rejection Ratio	SVR	$V^+ = 2.5V$ to 14V	60	80	-	dB
OUTPUT CHARACTERISTICS						
High-level Output Voltage1	V_{OH1}	$R_L \geq 5k\Omega$ to 2.5V	4.75	4.90	-	V
High-level Output Voltage2	V_{OH2}	$R_L \geq 5k\Omega$ to GND	4.75	4.90	-	V
Low-level Output Voltage1	V_{OL1}	$R_L \geq 5k\Omega$ to 2.5V	-	0.10	0.25	V
Low-level Output Voltage2	V_{OL2}	$R_L \geq 5k\Omega$ to GND	-	-	0.25	V
AC CHARACTERISTICS						
Phase Margin	Φ_M	$R_L = 10k\Omega$, $C_L = 10pF$	-	50	-	deg
Gain Bandwidth Product	GBW	f = 1MHz	-	10	-	MHz
Total Harmonic Distortion	THD	f = 1kHz, $G_V = 6dB$, $R_L = 10k\Omega$ to 2.5V, $V_O = 1.5Vrms$	-	0.001	-	%
Equivalent Input Noise Voltage	V_{NI}	f = 1kHz, $V_{CM} = 2.5V$	-	10	-	nV/√Hz
Channel Separation	CS	f = 1kHz, $R_L = 10k\Omega$ to 2.5V, $V_O = 1.5Vrms$	-	120	-	dB
PULSE RESPONSE CHARACTERISTICS						
Slew Rate (4)	SR	$G_V = 0dB$, $V_{IN} = 2V_{PP}$, $R_L = 10k\Omega$ to 2.5V, $C_L = 10pF$ to 2.5V	-	3.5	-	V/µs

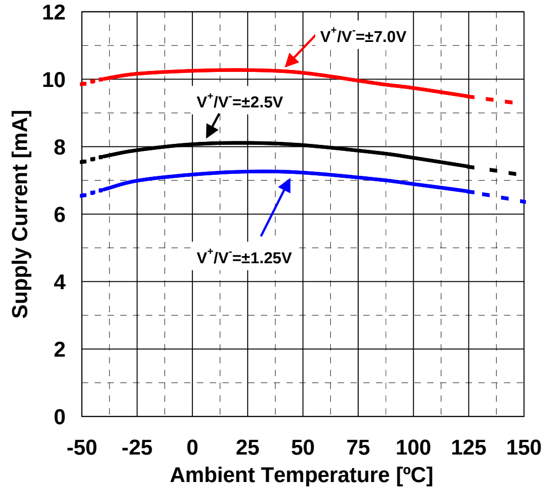
(4) Number specified is the slower of positive and negative slew rates.

■ TYPICAL CHARACTERISTICS

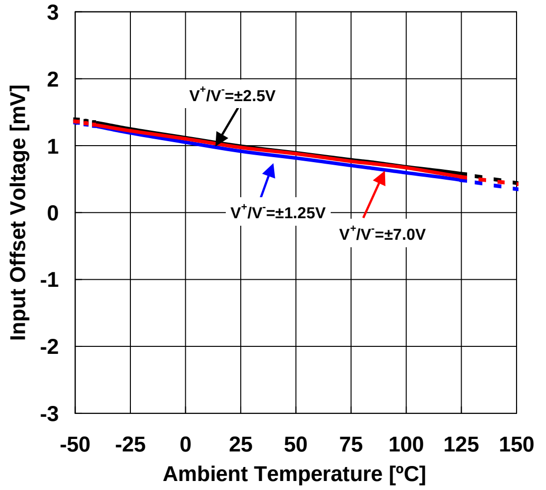
Supply Current vs. Supply Voltage
(Temperature)
Gv=0dB



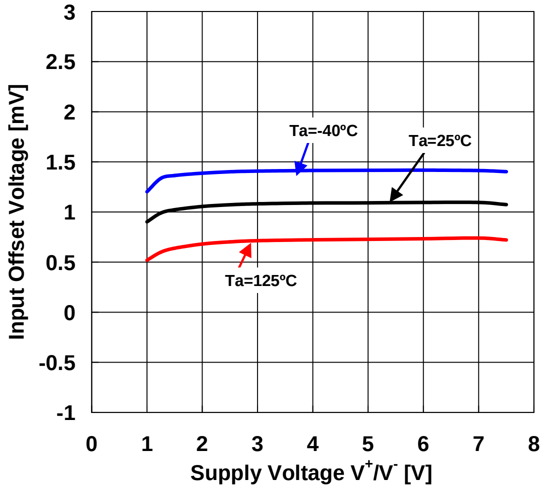
Supply Current vs. Temperature
(Supply Voltage)
Gv=0dB



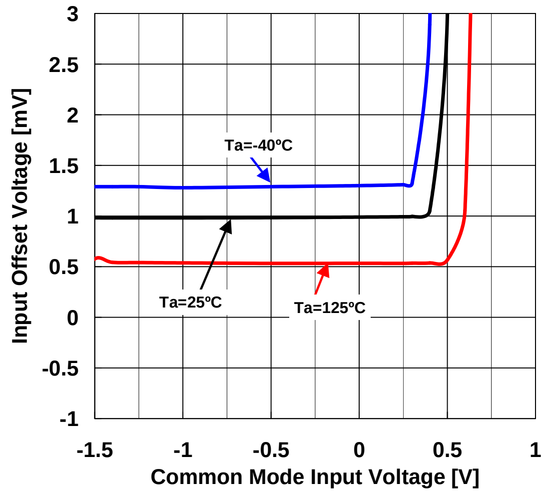
Input Offset Voltage vs. Temperature (Supply Voltage)
V_{CM}=0V



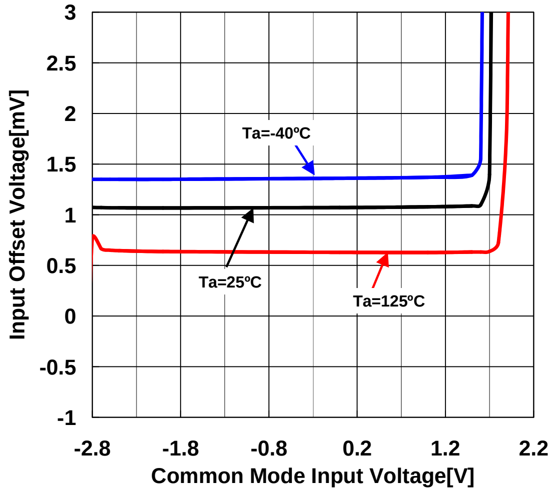
Input Offset Voltage vs. Supply Voltage (Temperature)
V_{CM}=0V



Input Offset Voltage
vs. Common Mode Input Voltage
(Temperature)
V+/V-=±1.25V

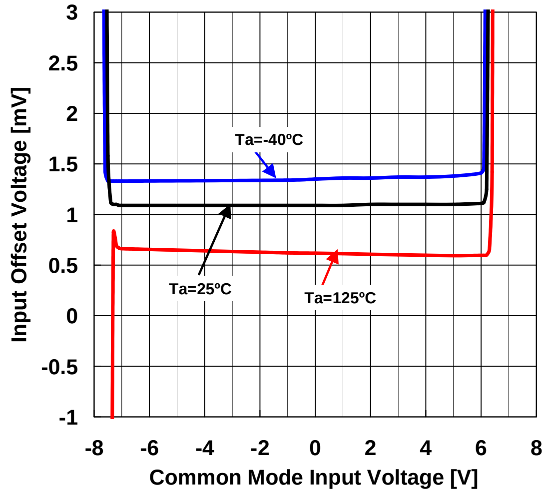


Input Offset Voltage
vs. Common Mode Input Voltage
(Temperature)
V+/V-=±2.5V

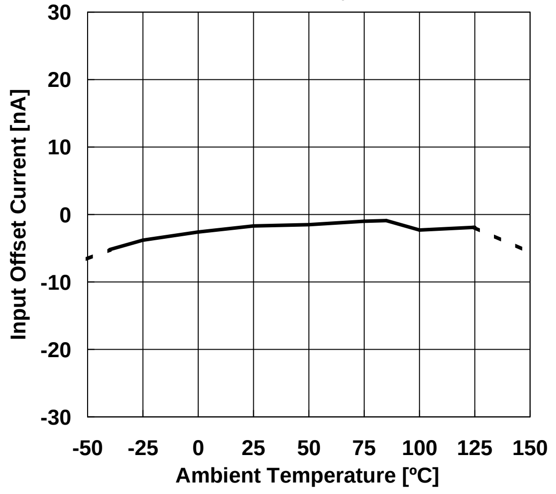


■ TYPICAL CHARACTERISTICS

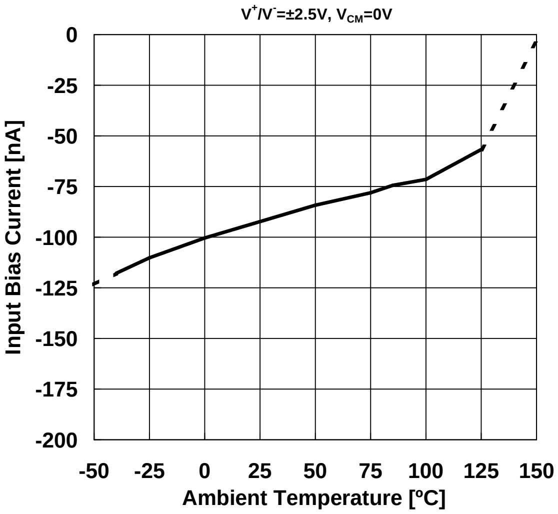
**Input Offset Voltage vs.
Common Mode Input Voltage**
(Temperature)
$V^+/V^-=\pm7.0V$



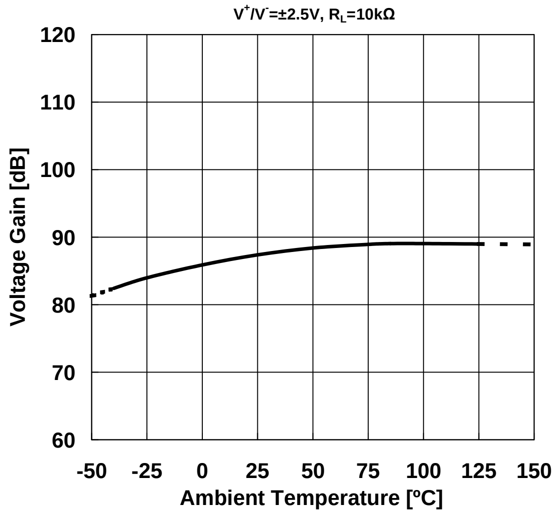
Input Offset Current vs. Temperature
$V^+/V^-=\pm2.5V, V_{CM}=0V$



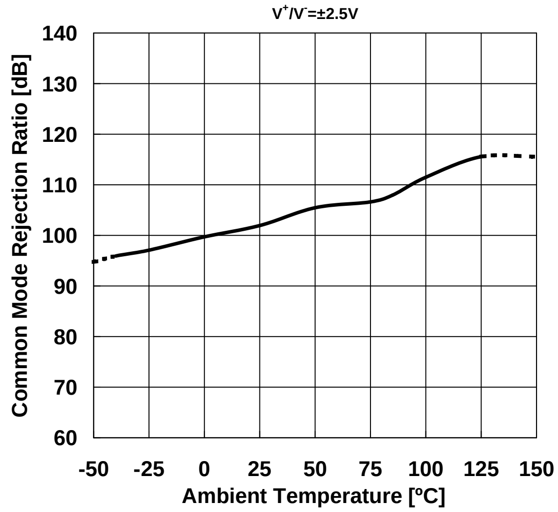
Input Bias Current vs. Temperature
$V^+/V^-=\pm2.5V, V_{CM}=0V$



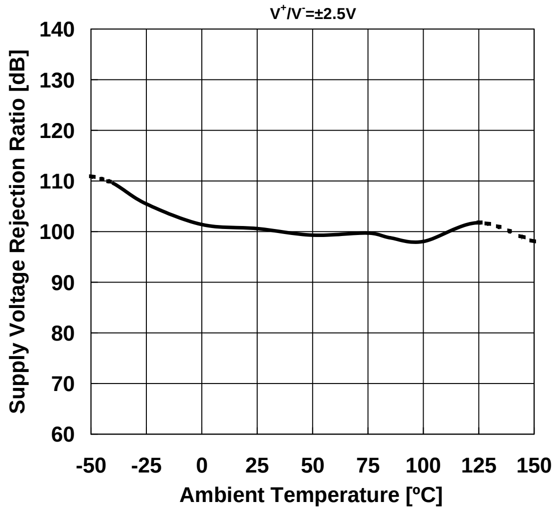
Gain vs. Temperature
$V^+/V^-=\pm2.5V, R_L=10k\Omega$



CMR vs. Temperature
$V^+/V^-=\pm2.5V$

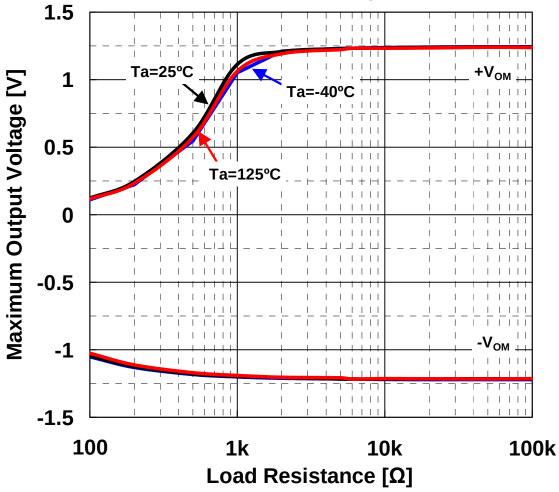


SVR vs. Temperature
$V^+/V^-=\pm2.5V$

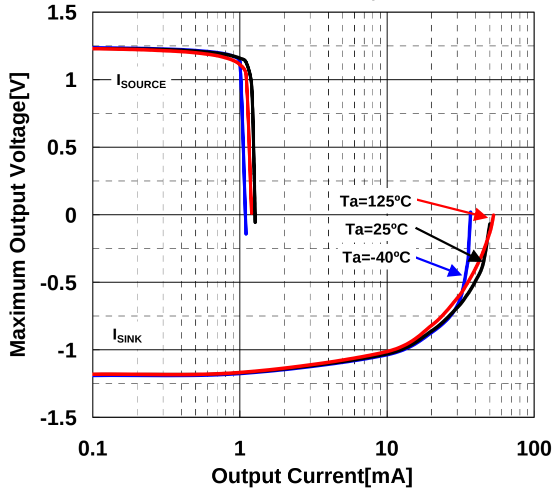


■ TYPICAL CHARACTERISTICS

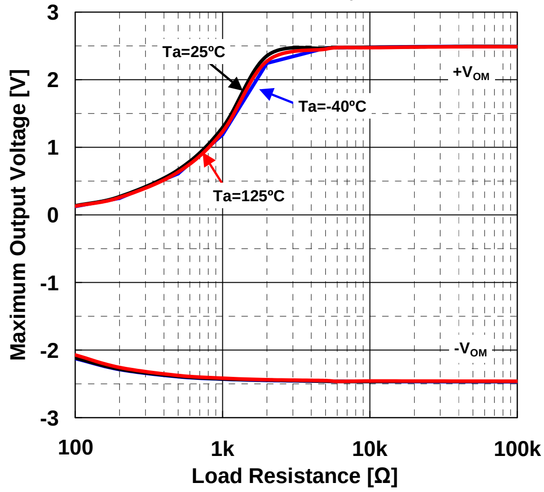
Maximum Output Voltage vs. Load Resistance
(Temperature)
$V^+/V^-=\pm1.25V$, Gv=open



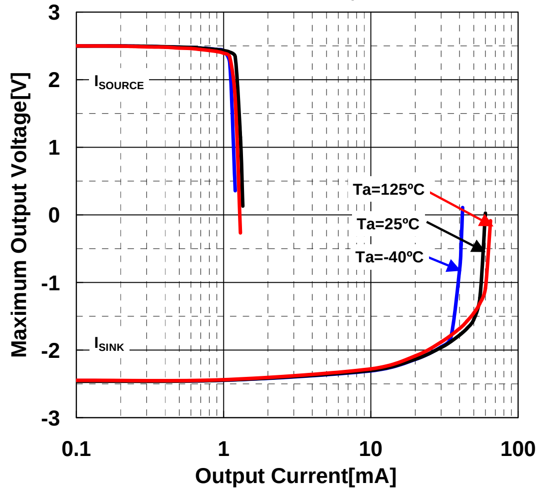
Maximum Output Voltage vs. Output Current
(Temperature)
$V^+/V^-=\pm1.25V$, Gv=open



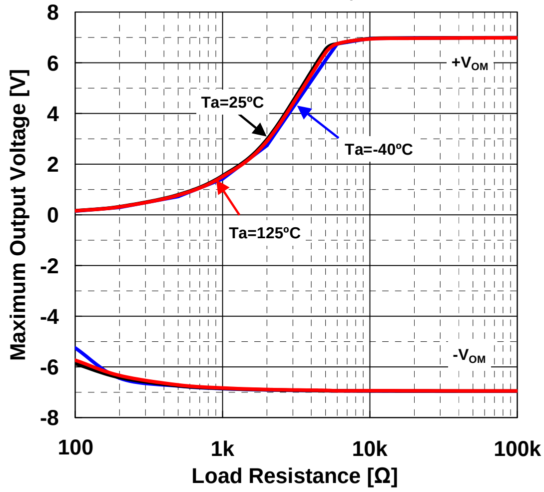
Maximum Output Voltage vs. Load Resistance
(Temperature)
$V^+/V^-=\pm2.5V$, Gv=open



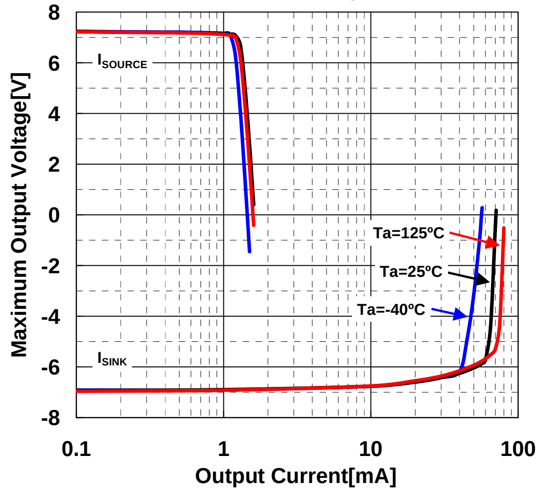
Maximum Output Voltage vs. Output Current
(Temperature)
$V^+/V^-=\pm2.5V$, Gv=open



Maximum Output Voltage vs. Load Resistance
(Temperature)
$V^+/V^-=\pm7.0V$, Gv=open

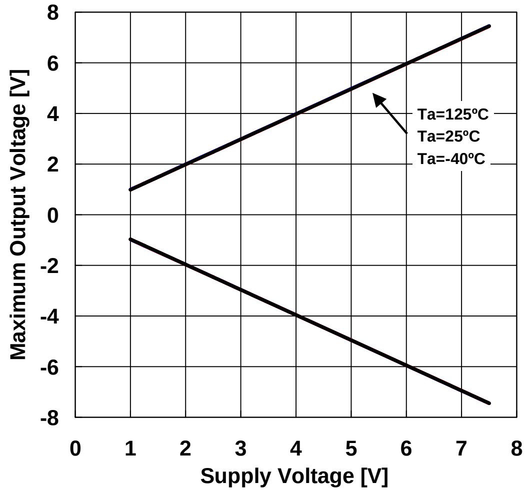


Maximum Output Voltage vs. Output Current
(Temperature)
$V^+/V^-=\pm7.0V$, Gv=open

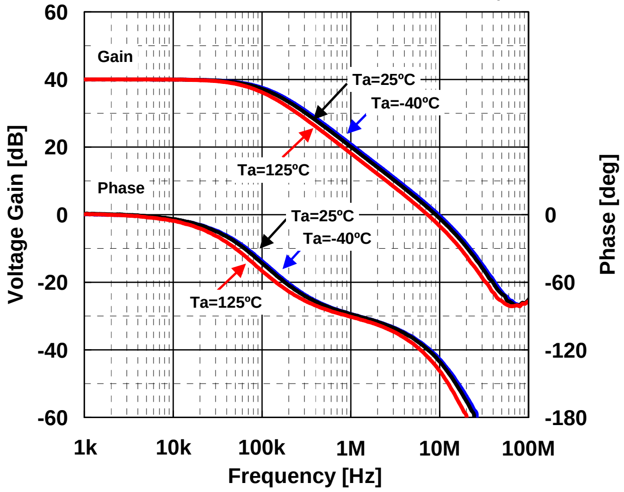


■ TYPICAL CHARACTERISTICS

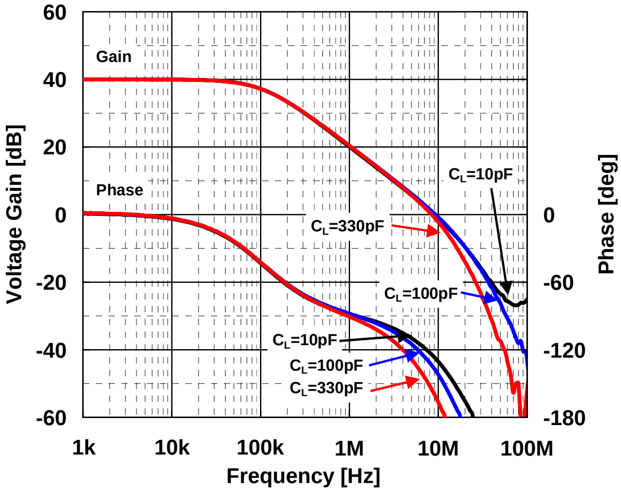
Maximum Output Voltage vs. Supply Voltage
(Temperature)
Gv=open, R_L=10kΩ



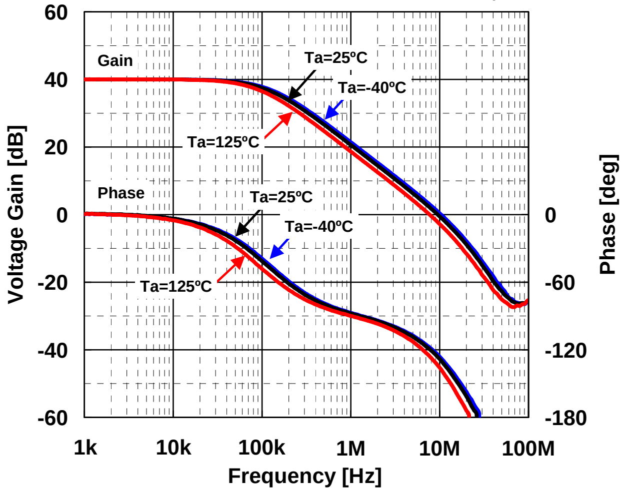
40dB Gain/Phase vs. Frequency (Temperature)
V^+/V^-=±1.25V, V_{IN}=-30dBm, G_V=40dB, R_F=10kΩ, C_L=10pF



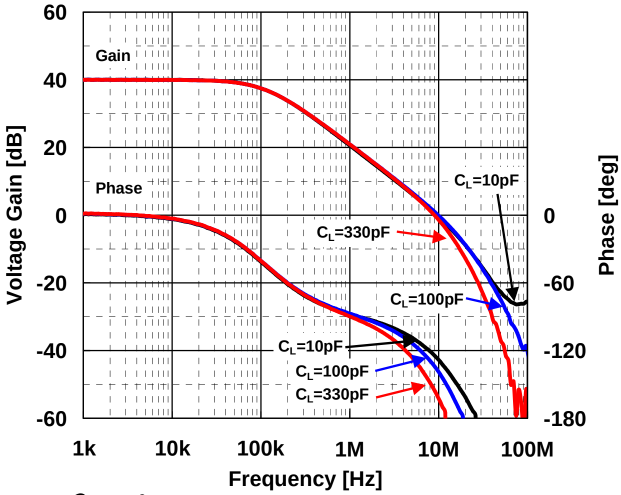
40dB Gain/Phase vs. Frequency (Load Capacitance)
V^+/V^-=±1.25V, V_{IN}=-30dBm, G_V=40dB, R_F=10kΩ, Ta=25ºC



40dB Gain/Phase vs. Frequency (Temperature)
V^+/V^-=±2.5V, V_{IN}=-30dBm, G_V=40dB, R_F=10kΩ, C_L=10pF

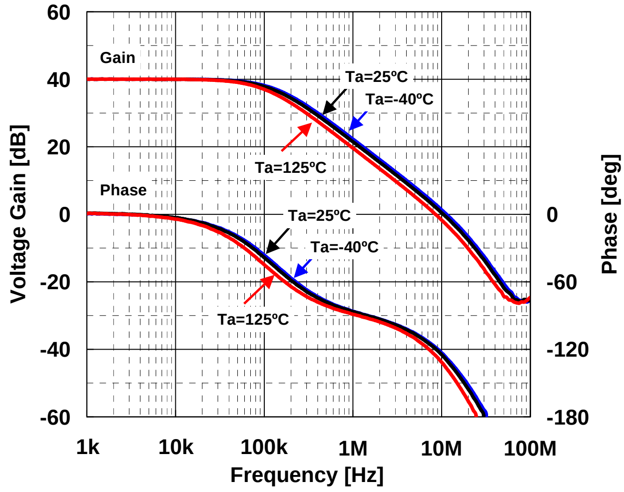


40dB Gain/Phase vs. Frequency (Load Capacitance)
V^+/V^-=±2.5V, V_{IN}=-30dBm, G_V=40dB, R_F=10kΩ, Ta=25ºC

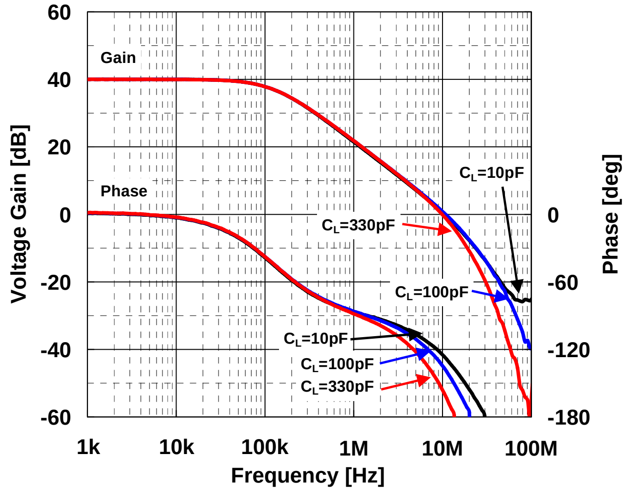


■ TYPICAL CHARACTERISTICS

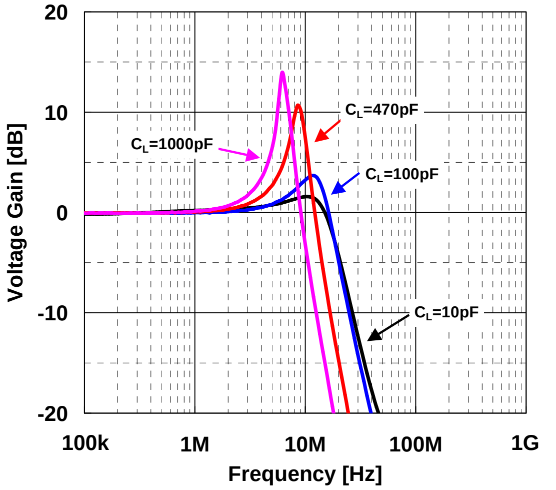
40dB Gain/Phase vs. Frequency (Temperature)
V^{+}/V^{-}=±7.0V, V_{IN}=-30dBm, G_V=40dB, R_F=10kΩ, C_L=10pF



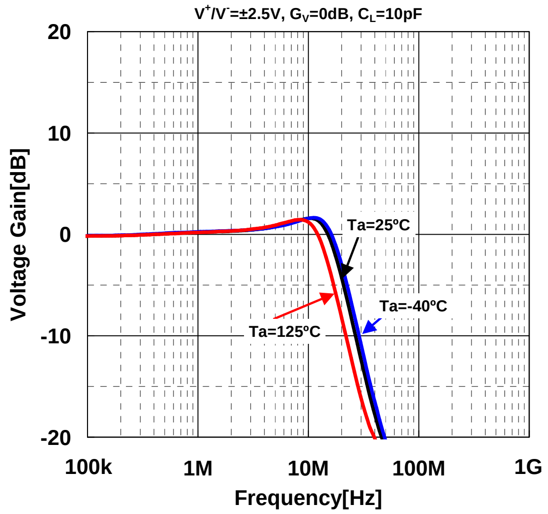
40dB Gain/Phase vs. Frequency (Load Capacitance)
V^{+}/V^{-}=±7.0V, V_{IN}=-30dBm, G_V=40dB, R_F=10kΩ, Ta=25ºC



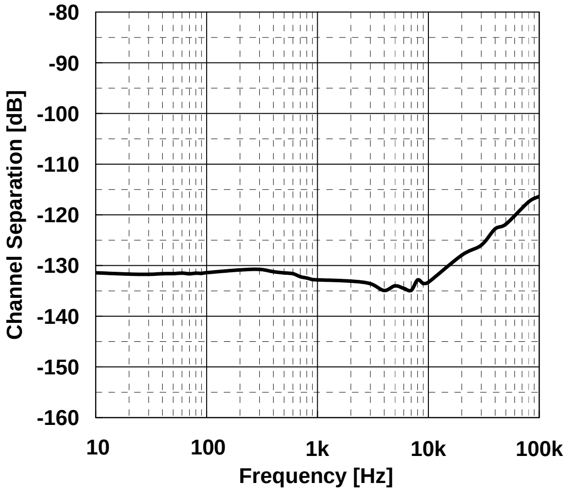
V.F. Peak vs. Frequency
(Load Capacitance)
V^{+}/V^{-}=±2.5V, G_V=0dB, Ta=25ºC



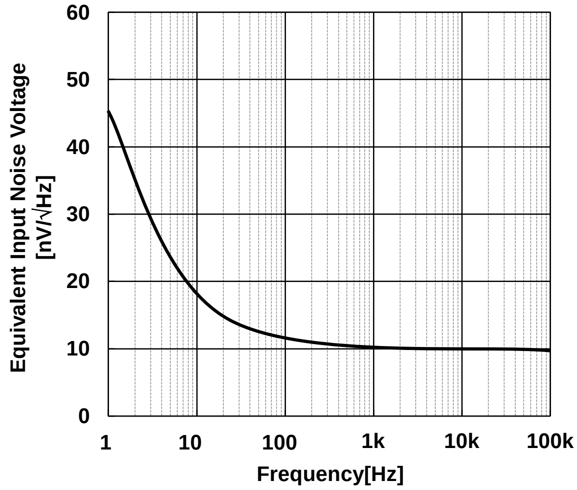
V.F. Peak vs. Frequency
(Temperature)
V^{+}/V^{-}=±2.5V, G_V=0dB, C_L=10pF



Channel Separation vs. Frequency
V^{+}/V^{-}=±2.5V, V_O=1.5Vrms, G_V=40dB, R_F=100kΩ,
R_L=10kΩ, Ta=25ºC

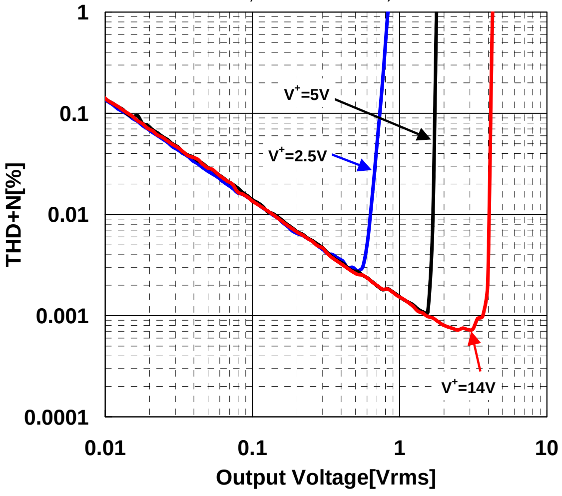


Equivalent Input Noise Voltage vs. Frequency
V^{+}/V^{-}=±2.5V, G_V=40dB, R_F=20kΩ,
R_L=10kΩ, Ta=25ºC

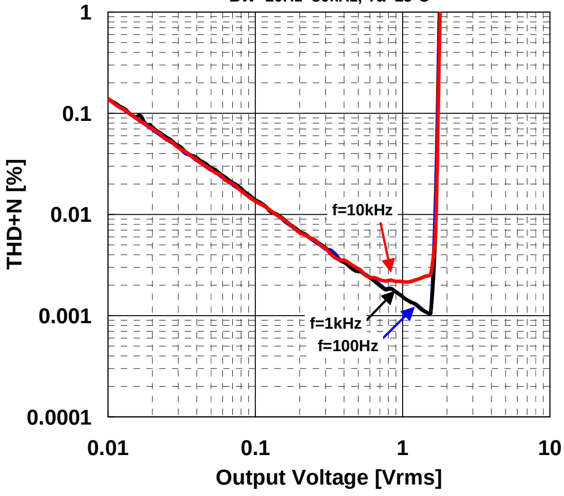


■ TYPICAL CHARACTERISTICS

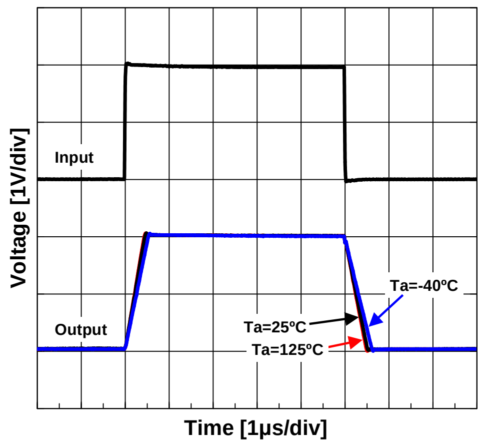
THD vs. Output Voltage
(Supply Voltage)
G_V=6dB, R_S=600Ω, R_F=5kΩ, R_G=5kΩ
f=1kHz, BW=10Hz~80kHz, Ta=25°C



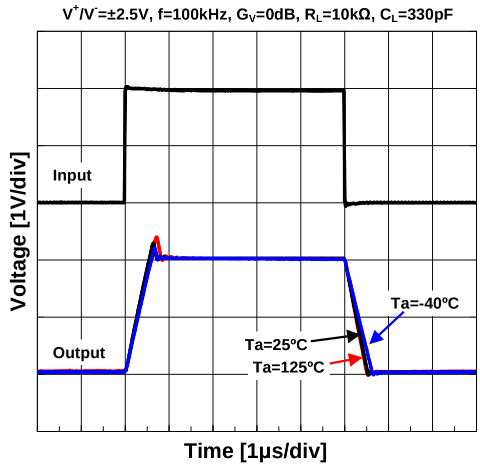
THD vs. Output Voltage (Frequency)
V^+/V^-=±2.5V, G_V=6dB, R_S=600Ω, R_F=5kΩ, R_G=5kΩ,
BW=10Hz~80kHz, Ta=25°C



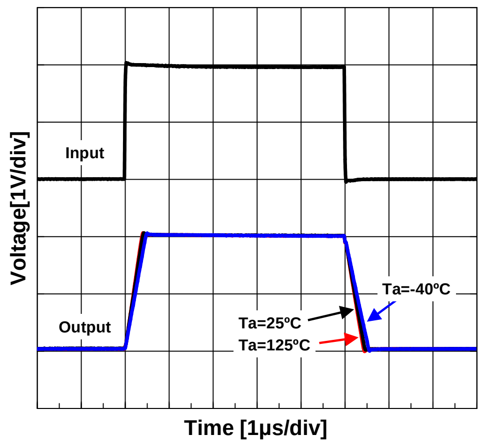
Pulse Response (Temperature)
V^+/V^-=±2.5V, f=100kHz, G_V=0dB, R_L=10kΩ, C_L=10pF



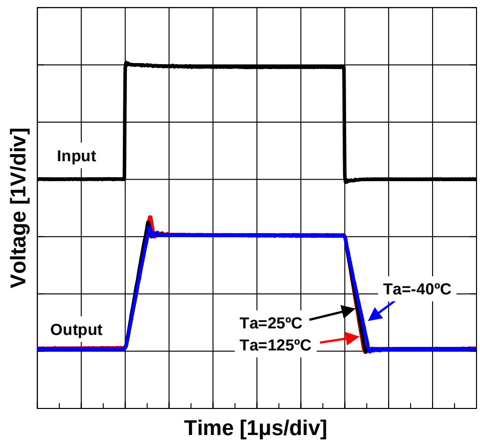
Pulse Response (Temperature)
V^+/V^-=±2.5V, f=100kHz, G_V=0dB, R_L=10kΩ, C_L=330pF



Pulse Response (Temperature)
V^+/V^-=±7.0V, f=100kHz, G_V=0dB, R_L=10kΩ, C_L=10pF

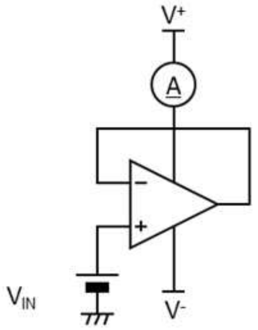


Pulse Response (Temperature)
V^+/V^-=±7.0V, f=100kHz, G_V=0dB, R_L=10kΩ, C_L=330pF



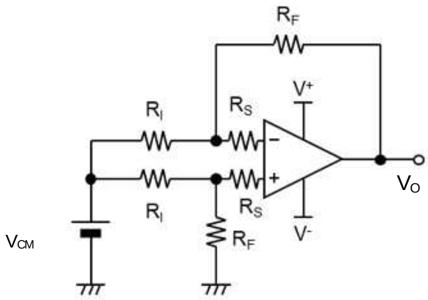
■ **TEST CIRCUITS**

● I_{SUPPLY}



● V_{IO}, CMR, SVR

$R_I = 50\Omega$, $R_F = 50k\Omega$



$$V_{IO} = \frac{R_I}{(R_I + R_F)} \times (V_o - V_{CM})$$

$$CMR = 20\log \frac{\Delta V_{CM}\left(1 + \frac{R_F}{R_I}\right)}{\Delta V_O}$$

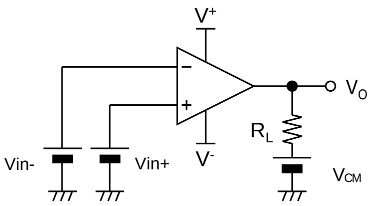
$$SVR = 20\log \frac{\Delta V_S\left(1 + \frac{R_F}{R_I}\right)}{\Delta V_O}$$

$$V_S = V^+ - V^-$$

● V_{OH}, V_{OL}

V_{OH}; $Vin+ = V^+/2 + 1V$, $Vin- = V^+/2$, $V_{CM} = V^+/2$

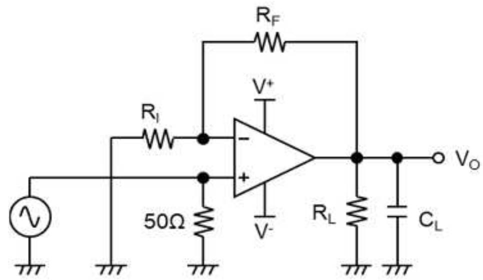
V_{OL}; $Vin+ = V^+/2$, $Vin- = V^+/2 + 1V$, $V_{CM} = V^+/2$



● GBW

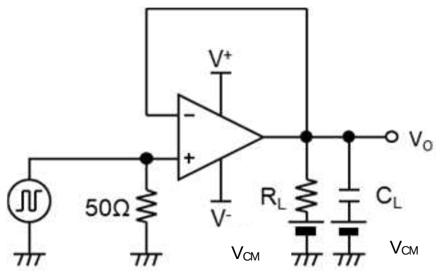
$R_L = 10k\Omega$, $C_L = 10pF$

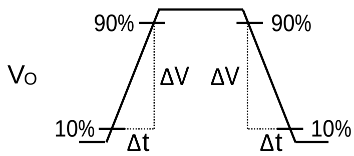
$R_I = 1k\Omega$, $R_F = 100k\Omega$



● SR

$R_L = 10k\Omega$, $C_L = 10pF$



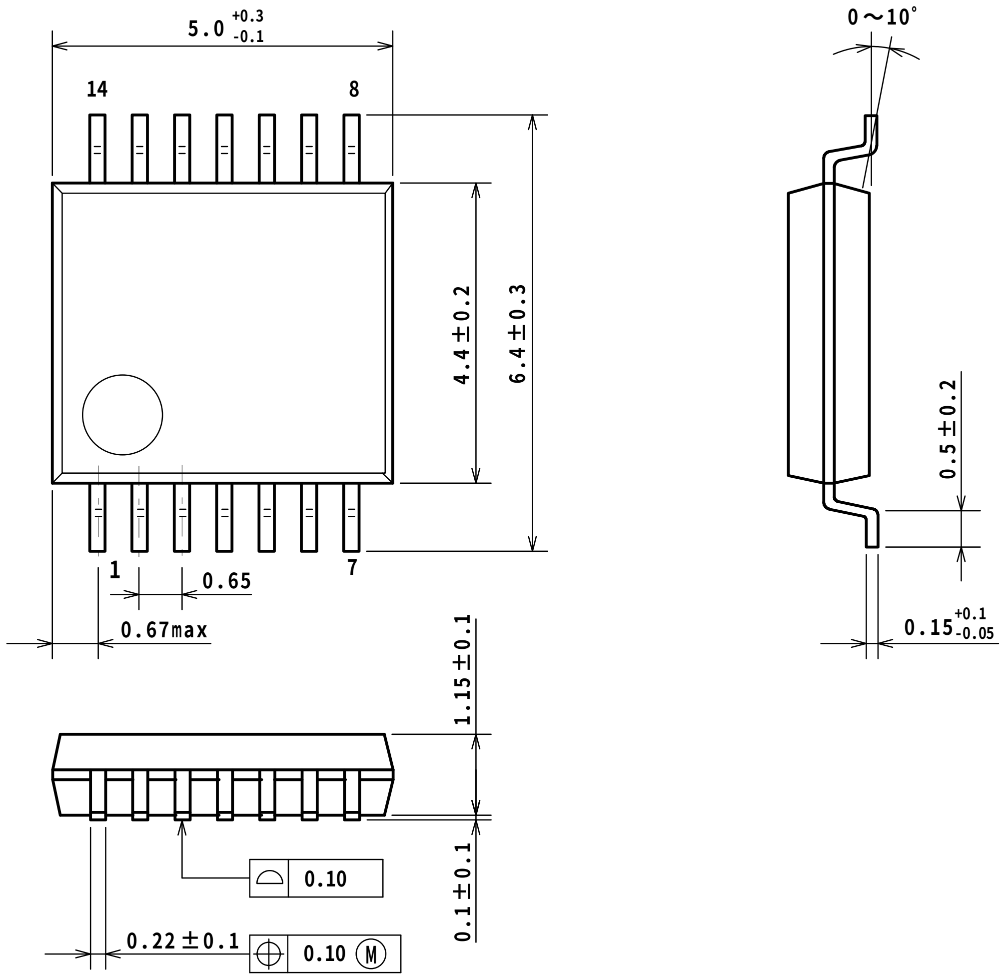


$$SR = \frac{\Delta V}{\Delta t}$$

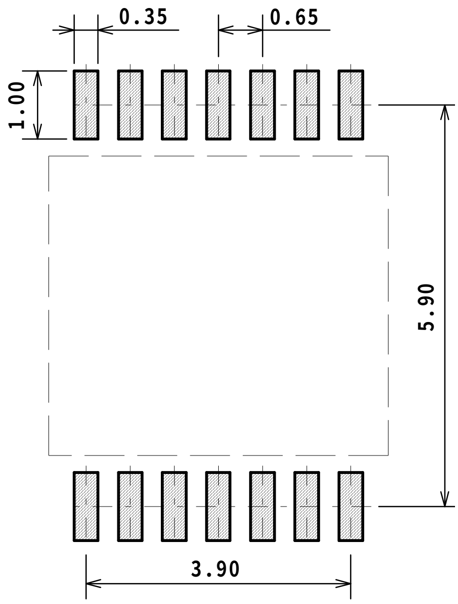
SSOP14

■ PACKAGE DIMENSIONS

Unit: mm



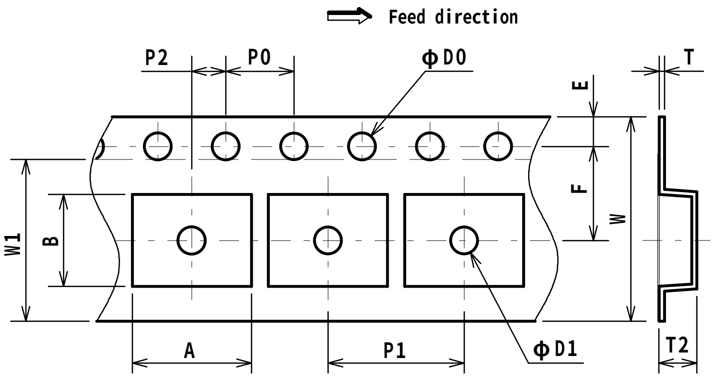
■ EXAMPLE OF SOLDER PADS DIMENSIONS



■ PACKING SPEC

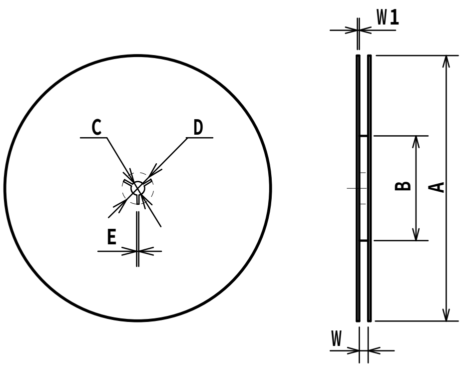
Unit: mm

TAPING DIMENSIONS



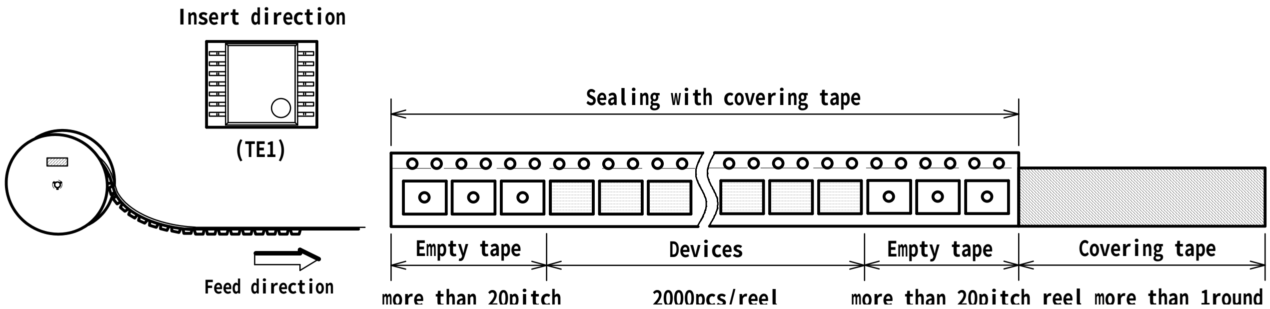
SYMBOL	DIMENSION	REMARKS
A	6.95	BOTTOM DIMENSION
B	5.4	BOTTOM DIMENSION
D0	1.55±0.05	
D1	1.55±0.1	
E	1.75±0.1	
F	5.5±0.05	
P0	4.0±0.1	
P1	8.0±0.1	
P2	2.0±0.05	
T	0.3±0.05	
T2	2.2	
W	12.0±0.3	
W1	9.5	THICKNESS 0.1max

REEL DIMENSIONS

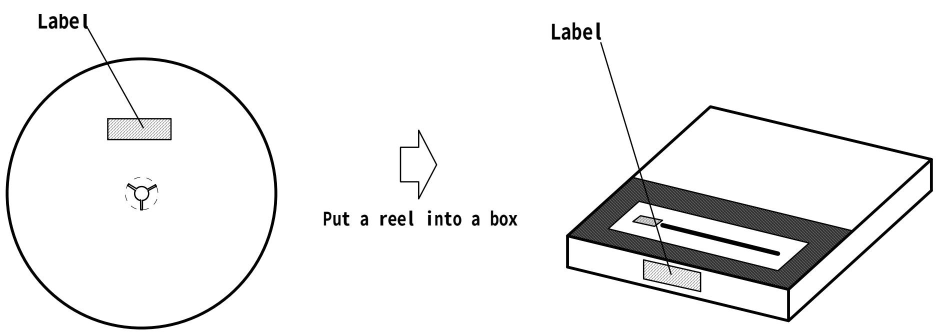


SYMBOL	DIMENSION
A	ϕ254±2
B	ϕ100±1
C	ϕ 13±0.2
D	ϕ 21±0.8
E	2±0.5
W	13.5±0.5
W1	2±0.2

TAPING STATE

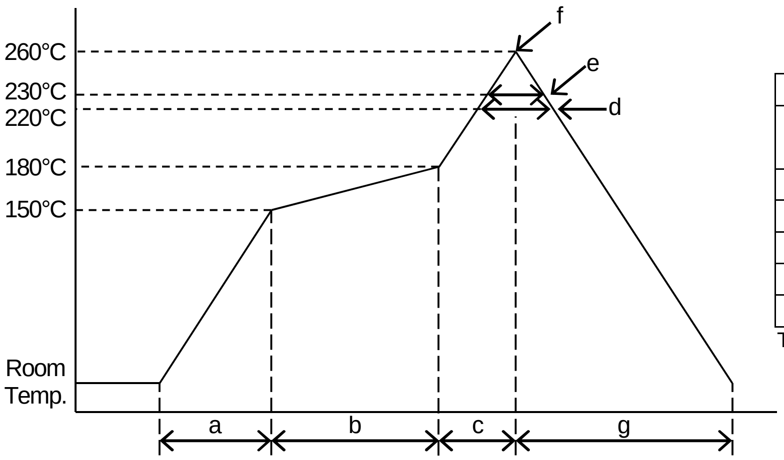


PACKING STATE



■ RECOMMENDED MOUNTING METHOD

INFRARED REFLOW SOLDERING PROFILE



a	Temperature ramping rate	1 to 4°C/s
b	Pre-heating temperature Pre-heating time	150 to 180°C 60 to 120s
c	Temperature ramp rate	1 to 4°C/s
d	220°C or higher time	shorter than 60s
e	230°C or higher time	shorter than 40s
f	Peak temperature	lower than 260°C
g	Temperature ramping rate	1 to 6°C/s

The temperature indicates at the surface of mold package.

■ REVISION HISTORY

DATE	REVISION	CHANGES
JANUARY 6, 2021	Ver.1.0	Initial release

[CAUTION]

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3. To ensure the highest levels of reliability, NJR products must always be properly handled.
   The introduction of external contaminants (e.g. dust, oil or cosmetics) can result in failures of semiconductor products.

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   ・Equipment Used in the Deep Sea
   ・Power Generator Control Equipment (Nuclear, steam, hydraulic, etc.)
   ・Life Maintenance Medical Equipment
   ・Fire Alarms / Intruder Detectors
   ・Vehicle Control Equipment (Airplane, railroad, ship, etc.)
   ・Various Safety Devices

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9. The product specifications and descriptions listed in this datasheet are subject to change at any time, without notice.