Low Noise, Low Offset Voltage Drift Rail-to-Rail Output CMOS Operational Amplifier

■FEATURES(V^+=5V, V^-=0V, Ta=25°C)

●Low Noise	15nV/√Hz
●Low Offset Voltage Drift	0.7μV/°C typ.
●Offset Voltage	4mV max.
●Rail-to-Rail Output	
R_L=10kΩ	50mV from rail
R_L=600Ω	140mV from rail
●Gain Bandwidth Product	2.1MHz
●Slew Rate	0.8V/μs
●Supply Current	260μA/ch typ.
●Supply Voltage	1.8V to 5.5V
●Thin and Ultra Small Package	
DFN8-U1(ESON8-U1)	2.0 x 2.0 x 0.4 mm
●RF noise Immunity	
●Ground sense	
●Unity-Gain Stable	
●Package	
NJU7056	SOT-23-5, SC-88A
NJU7057	MSOP8(TVSP8)*
	DFN8-U1(ESON8-U1)
*meet JEDEC MO-187-DA / thin type	
NJU7058	SSOP14

●AEC-Q100 : Cf. order information page

※This product meets the reliability level required by AEC-Q100

■GENERAL DESCRIPTION

The NJU7056/NJU7057/NJU7058 are Single/Dual/ Quad rail-to-rail output CMOS operational amplifiers. Low noise of 15nV/√Hz and low offset drift of 0.7μV/°C typ. make them suitable for several sensor amplifiers and preamplifiers.

NJU7056/NJU7057/NJU7058 operate from 1.8V to 5.5V supply voltage. They are optimized for 2-cell battery systems and 1-cell li-ion battery systems. The NJU7056/NJU7057/NJU7068 have high-impedance inputs with ground sense, rail-to-rail output that swings within 50mV from rail with 10kΩ load at 1.8V supply, 2.1MHz Gain bandwidth and 0.8V/μs Slew rate. These characteristics make them excellent performance for general-purpose applications.

The NJU7056 is available in 5-pin SC-88A and SOT-23 package. NJU7057 is available in 8-pin MSOP (TVSP): meet JEDEC MO-187-DA / thin type package and DFN that is thin and 2mm square small package. NJU7058 is available in 14-pin SSOP package.

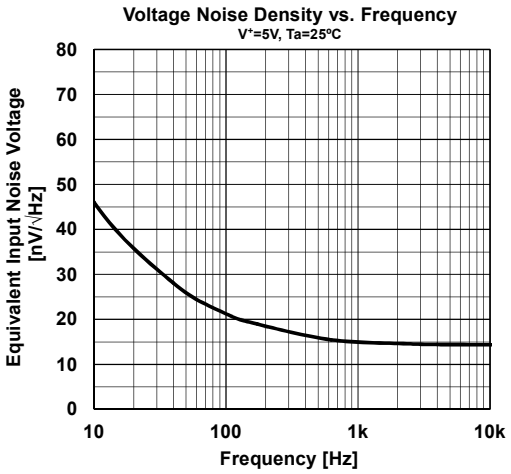
■APPLICATION

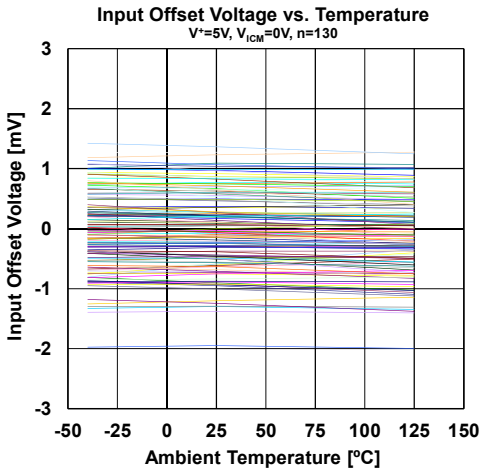
●Battery-powered instruments
●Current sensor amplifiers
●Audio pre/mic. amplifiers
●Power line monitoring
●Current to Voltage converter

■RELATED PRODUCTS

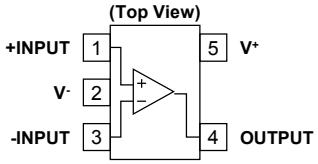
Features	Single	Dual	Quad
13μA/ch, Rail-to-rail Output (Low power type)	NJU7026	NJU7027	NJU7028
9V/μs, 5MHz, Rail-to-rail I/O (High slew rate type)	NJU7046	NJU7047	NJU7048

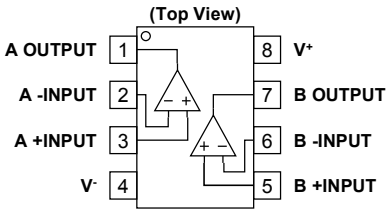
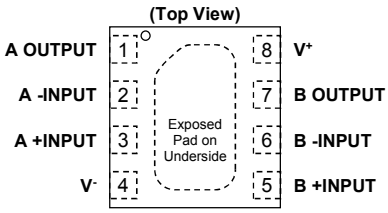
■TYPICAL CHARACTERISTICS



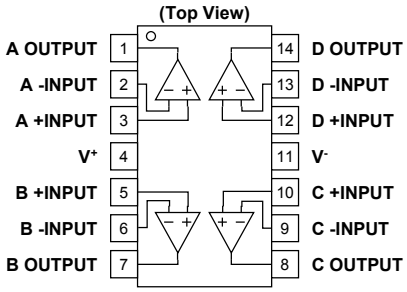


■PIN CONFIGURATION

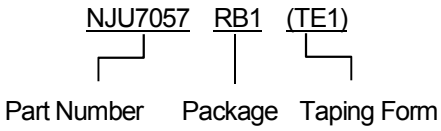
PART NUMBER	NJU7056F	NJU7056F3
Package Outline	SOT-23-5	SC-88A
Pin Function		

PART NUMBER	NJU7057RB1	NJU7057KU1
Package Outline	MSOP8(TVSP8)	ESON8-U1
Pin Function		

*Connect to exposed pad to V-

PART NUMBER	NJU7058V
Package Outline	SSOP14
Pin Function	

■MARK INFORMATION



■ORDERING INFORMATION

PART NUMBER	PACKAGE OUTLINE	AEC-Q100	RoHS	HALOGEN-FREE	TERMINAL FINISH	MARKING	WEIGHT (mg)	MOQ (pcs)
NJU7056F	SOT-23-5	yes	yes	yes	Sn2Bi	119	15	3,000
NJU7056F3	SC-88A	–	yes	yes	Sn2Bi	AG	7.5	3,000
NJU7057RB1	MSOP8(TVSP8)	yes	yes	yes	Sn2Bi	7057	18	2,000
NJU7057KU1	ESON8-U1	–	yes	yes	Sn2Bi	7057	5.3	3,000
NJU7058V	SSOP14	yes	yes	yes	Sn2Bi	7058	65	2,000

※ This product meets the reliability level required by AEC-Q100.

※ "-" is non-evaluation. Please contact your sales representative for more information.

■ABSOLUTE MAXIMUM RATINGS

PARAMETER	SYMBOL	RATINGS	UNIT
Supply Voltage	$V^+ - V^-$	7	V
Input Voltage (1)	V_{IN}	V^- - 0.3 to V^+ + 0.3	V
Input Current (2)	I_{IN}	10	mA
Differential Input Voltage (3)	V_{ID}	±7	V
Power Dissipation(Ta=25°C) SOT-23-5(4) SC-88A(4) MSOP8(TVSP8)(4) DFN8-U1(ESON8-U1)(5) SSOP14(4)	P_D	(2-layer / 4-layer) 480 / 650 360 / 490 510 / 680 450 / 1200 500 / 620	mW
Junction Temperature	T_{jmax}	+150	°C
Storage Temperature Range	T_{stg}	- 55 to +150	°C

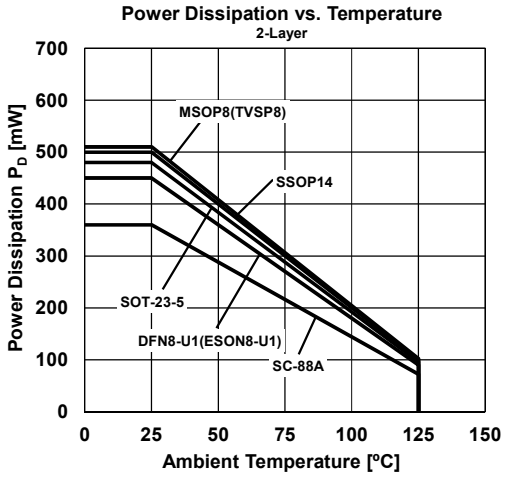
(1) The absolute maximum input voltage is limited at 7V.
(2) Input voltages outside the supply voltage will be clamped by ESD protection diodes. If the input voltage exceeds the supply voltage, the input current must be limited 10 mA or less by using a restriction resistance.
(3) Differential voltage is the voltage difference between +INPUT and - INPUT.
For supply voltage less than +7V, the absolute maximum rating is equal to the supply voltage.

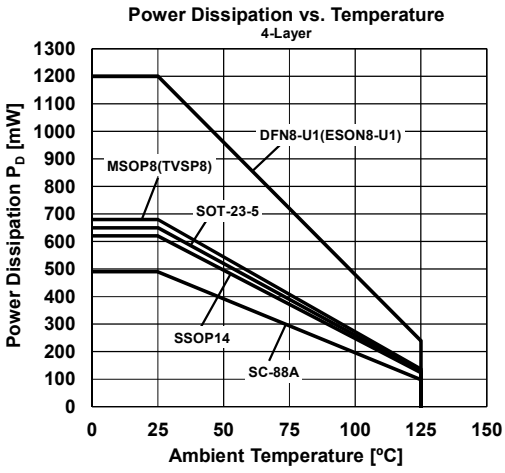
■THERMAL CHARACTERISTICS

PARAMETER	SYMBOL	VALUE	UNIT
Junction-to-ambient thermal resistance SOT-23-5(4) SC-88A(4) MSOP8(TVSP8)(4) DFN8-U1(ESON8-U1)(5) SSOP14(5)	θja	(2-layer / 4-layer) 259 / 193 352 / 256 244 / 185 278 / 107 249 / 201	°C /W
Junction-to-Top of package characterization parameter SOT-23-5(4) SC-88A(4) MSOP8(TVSP8)(4) DFN8-U1(ESON8-U1)(5) SSOP14(4)	ψjt	(2-layer / 4-layer) 67.1 / 57.8 90.8 / 73.2 50.9 / 45.1 42.4 / 24.8 53.4 / 52.4	°C /W

(4) Mounted on glass epoxy board. (76.2×114.3×1.6mm:based on EIA/JDEC standard, 2Layers FR4)
Mounted on glass epoxy board. (76.2×114.3×1.6mm:based on EIA/JDEC standard, 4Layers FR$), internal Cu area: 74.2 x 74.2mm
(5) Mounted on glass epoxy board. (101.5×114.5×1.6mm: based on EIA/JEDEC standard, 2Layers FR-4, with Exposed Pad)
Mounted on glass epoxy board. (101.5×114.5×1.6mm: based on EIA/JEDEC standard, 4Layers FR-4, with Exposed Pad)
*For 4Layers: Applying 99.5×99.5mm inner Cu area and a thermal via hole to a board based on JEDEC standard JESD51-5)

■POWER DISSIPATION vs. AMBIENT TEMPERATURE





■RECOMMENDED OPERATING CONDITIONS

PARAMETER	SYMBOL	RATINGS	UNIT
Supply Voltage Single Supply Dual Supply	 V^+- V^- V^+ / V^-	 +1.8 to +5.5 ±0.9 to ±2.75	V
Operating Ambient Temperature	T_{opr}	- 40 to +125	°C

■ELECTRICAL CHARACTERISTICS

(V^+=5V, V^-=0V, Ta=25°C, unless otherwise noted.)

PARAMETER	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
DC CHARACTERISTICS						
Input Offset Voltage	V_{IO}	V_{COM}=0V	-	0.8	4	mV
Input Offset Voltage Drift	$\Delta V_{IO}/\Delta T$	Ta = -40°C to 125°C	-	0.7	-	µV/°C
Input Bias Current	I_B		-	1	-	pA
Input Offset Current	I_{IO}		-	1	-	pA
Open-Loop Voltage Gain	A_V	R_L=10kΩ 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^+=1.8V to 5.5V	70	90	-	dB
Common-Mode Input Voltage Range	V_{ICM}	CMR≥65dB	0	-	4.1	V
High-level Output Voltage	V_{OH}	R_L=10kΩ to 2.5V R_L=10kΩ to 0V I_{SOURCE}=2mA	4.9 4.9 4.8	4.95 4.95 4.85	- - -	V
Low-level Output Voltage	V_{OL}	R_L=10kΩ to 2.5V R_L=10kΩ to 0V I_{SINK}=2mA	- - -	0.05 0.02 0.15	0.1 0.05 0.2	V
Supply Current (All Amplifiers) NJU7056 NJU7057 NJU7058	I_{SUPPLY}	No Signal	 - - -	 0.26 0.52 1.1	 0.42 0.84 1.7	mA
AC CHARACTERISTICS						
Slew Rate(6)	SR	G_V=0dB, R_L=10kΩ to 2.5V, C_L=20pF, V_{IN}=3V_{PP} (1V to 4V)	-	0.8	-	V/µs
Gain Bandwidth Product	GBW	R_L=10kΩ to 2.5V, C_L=20pF, f=100kHz	-	2.1	-	MHz
Phase Margin	Φ_M	R_L=10kΩ to 2.5V, C_L=20pF	-	80	-	deg
Gain Margin	G_M	R_L=10kΩ to 2.5V, C_L=20pF	-	10	-	dB
Equivalent Input Noise Voltage	V_{NI}	f=1kHz	-	15	-	nV/√Hz
Total Harmonic Distortion + Noise	THD+N	G_V=6dB, V_O=4V_{PP}, f=1kHz	-	0.002	-	%
Channel Separation	CS	f=1kHz, NJU7057/NJU7058	-	-120	-	dB

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

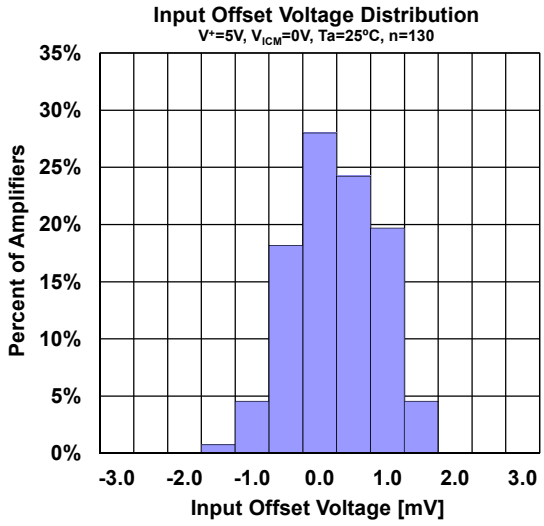
ELECTRICAL CHARACTERISTICS (continued)

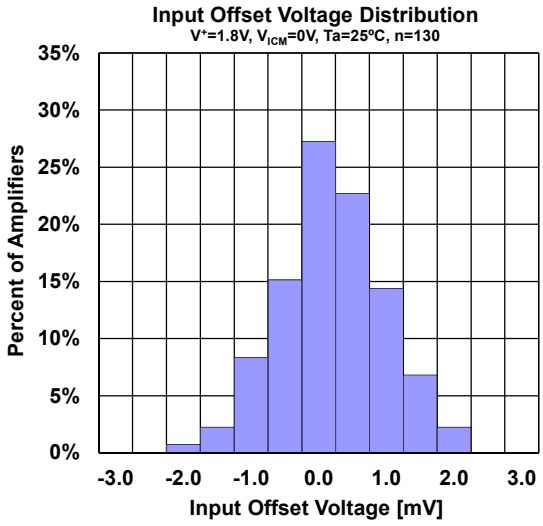
(V^+=1.8V, V^-=0V, Ta=25°C, unless otherwise noted.)

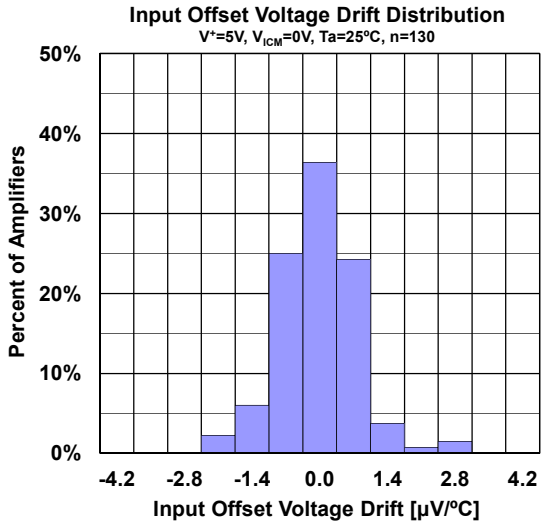
PARAMETER	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
DC CHARACTERISTICS						
Input Offset Voltage	V_{IO}	V_{COM}=0V	-	0.8	4	mV
Input Offset Voltage Drift	$\Delta V_{IO}/\Delta T$	Ta = -40°C to 125°C	-	0.8	-	μV/°C
Input Bias Current	I_B		-	1	-	pA
Input Offset Current	I_{IO}		-	1	-	pA
Open-Loop Voltage Gain	A_V	R_L=10kΩ to 0.9V	65	90	-	dB
Common-Mode Rejection Ratio	CMR	V_{ICM}=0V to 0.9V	65	80	-	dB
Supply Voltage Rejection Ratio	SVR	V^+=1.8V to 5.5V	70	90	-	dB
Common-Mode Input Voltage Range	V_{ICM}	CMR≥65dB	0	-	0.9	V
High-level Output Voltage	V_{OH}	R_L=10kΩ to 0.9V R_L=10kΩ to 0V I_{SOURCE}=1mA	1.7 1.7 1.5	1.75 1.75 1.55	- - -	V
Low-level Output Voltage	V_{OL}	R_L=10kΩ to 0.9V R_L=10kΩ to 0V I_{SINK}=1mA	- - -	0.05 0.02 0.25	0.1 0.05 0.3	V
Supply Current (All Amplifiers) NJU7056 NJU7057 NJU7058	I_{SUPPLY}	No Signal	 - - -	 0.22 0.44 0.9	 0.38 0.76 1.5	mA
AC CHARACTERISTICS						
Slew Rate(6)	SR	R_L=10kΩ to 0.9V, C_L=20pF, f=100kHz	-	0.6	-	V/μs
Gain Bandwidth Product	GBW	R_L=10kΩ to 0.9V, C_L=20pF	-	1.7	-	MHz
Phase Margin	Φ_M	R_L=10kΩ to 0.9V, C_L=20pF	-	80	-	deg
Gain Margin	G_M	f=1kHz	-	13	-	dB
Equivalent Input Noise Voltage	V_{NI}	f=1kHz	-	18	-	nV/√Hz
Total Harmonic Distortion + Noise	THD+N	G_V=6dB, V_O=1V_{PP}, f=1kHz	-	0.005	-	%
Channel Separation	CS	f=1kHz, NJU7057/NJU7058	-	-110	-	dB

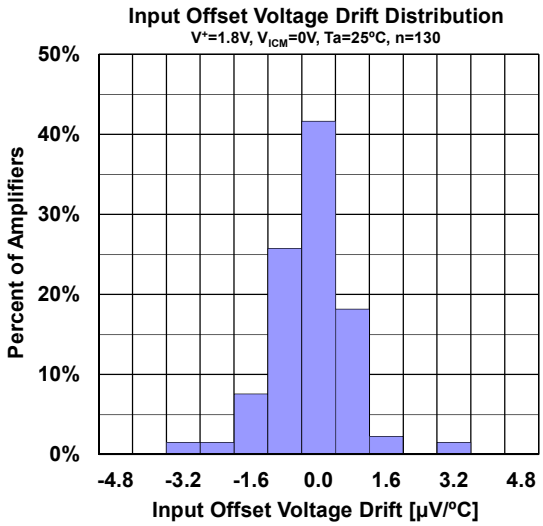
(6) Slew rate is defined by the lower value of the rise or fall.

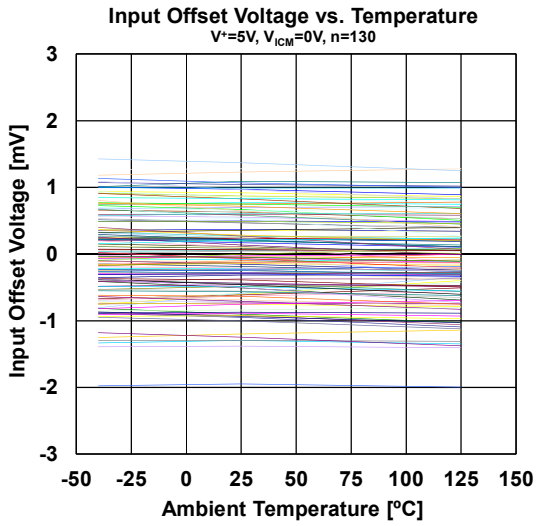
■TYPICAL CHARACTERISTICS

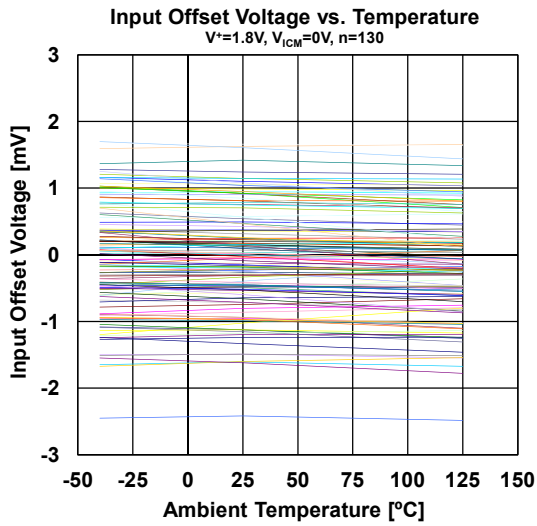






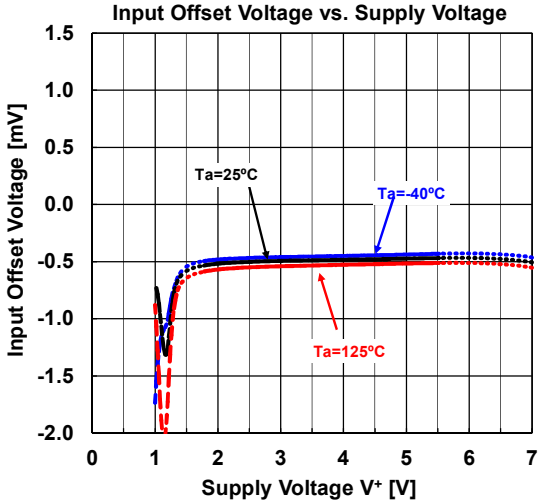




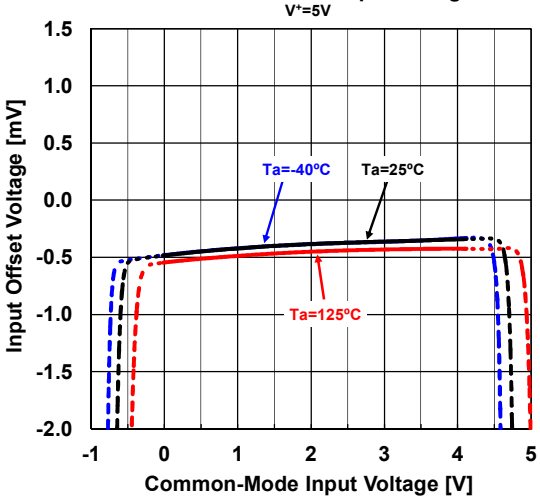


■TYPICAL CHARACTERISTICS

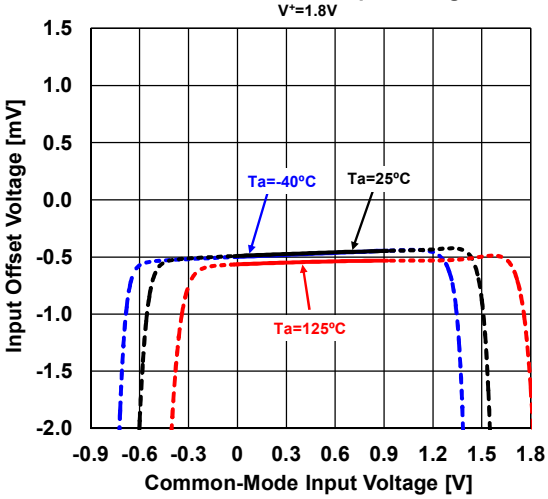
Input Offset Voltage vs. Supply Voltage



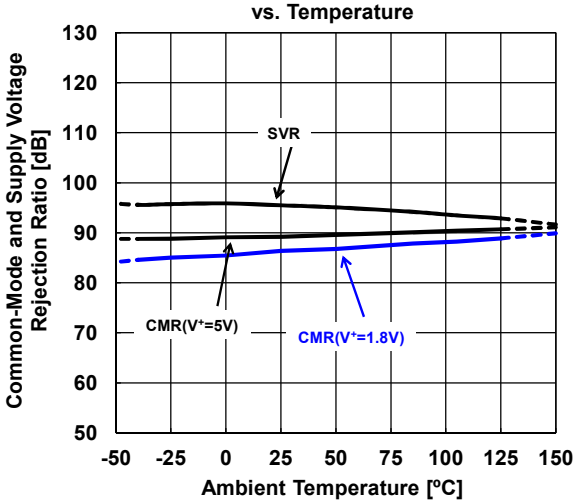
Input Offset Voltage vs. Common-Mode Input Voltage V+=5V



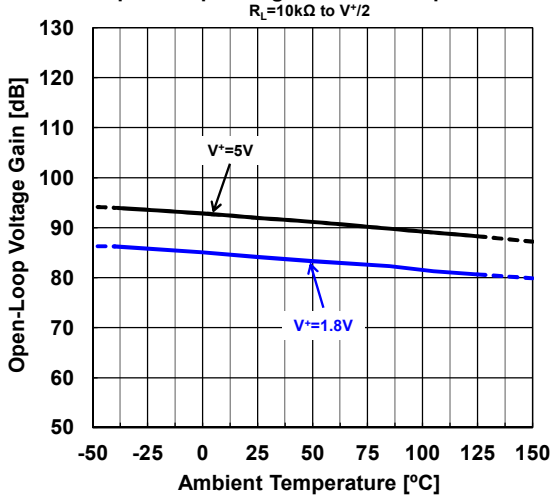
Input Offset Voltage vs. Common-Mode Input Voltage V+=1.8V



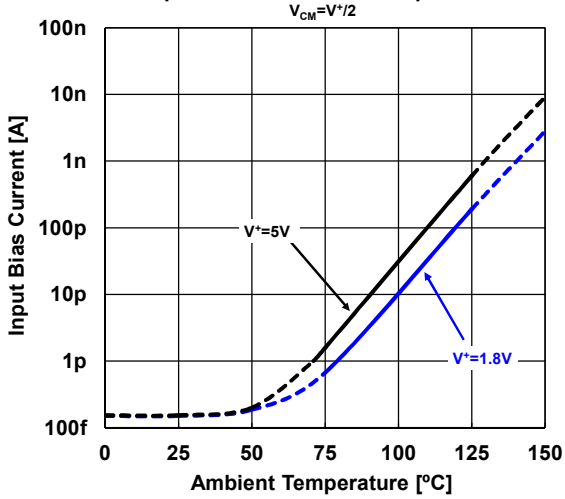
Common-Mode and Supply Voltage Rejection Ratio vs. Temperature



Open-Loop Voltage Gain vs. Temperature R_L=10kΩ to V+/2

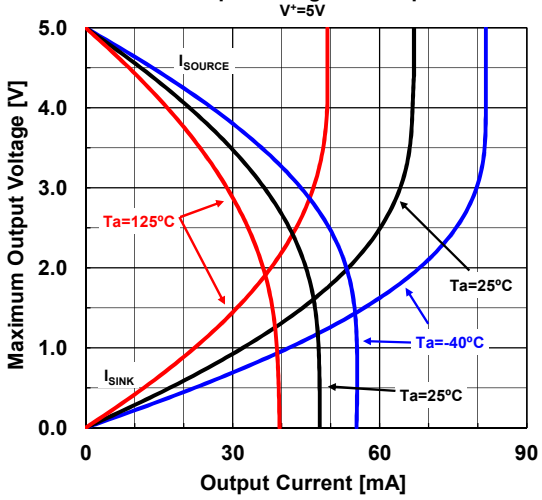


Input Bias Current vs. Temperature V_{CM}=V+/2

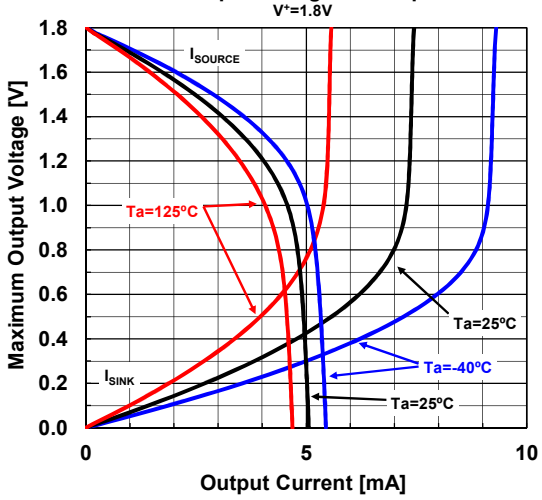


■TYPICAL CHARACTERISTICS

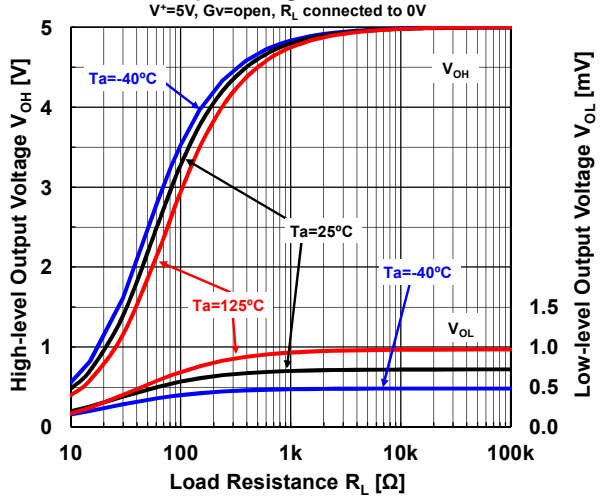
Maximum Output Voltage vs. Output Current
V⁺=5V



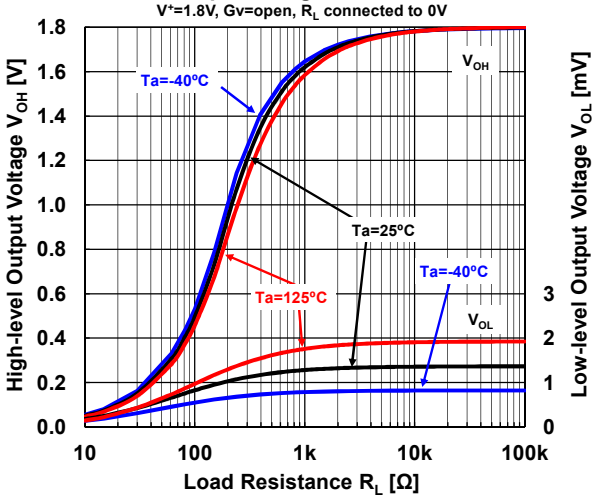
Maximum Output Voltage vs. Output Current
V⁺=1.8V



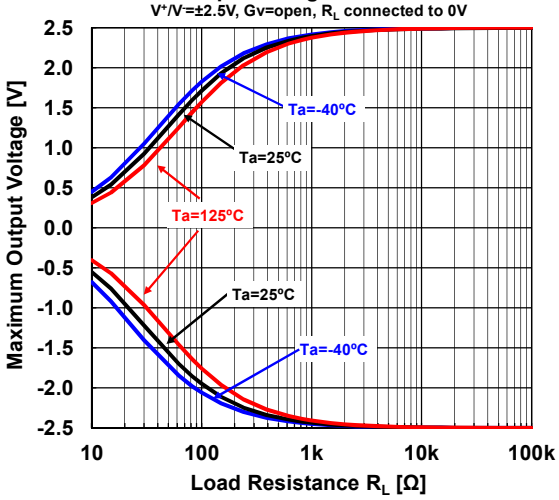
Maximum Output Voltage vs. Load Resistance
V⁺=5V, Gv=open, R_L connected to 0V



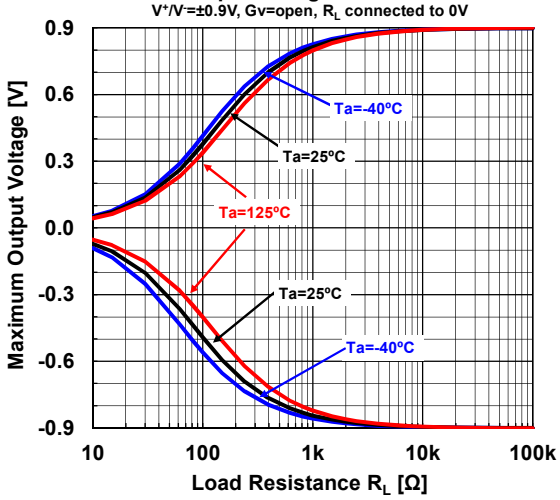
Maximum Output Voltage vs. Load Resistance
V⁺=1.8V, Gv=open, R_L connected to 0V



Maximum Output Voltage vs. Load Resistance
V⁺/V⁻=±2.5V, Gv=open, R_L connected to 0V

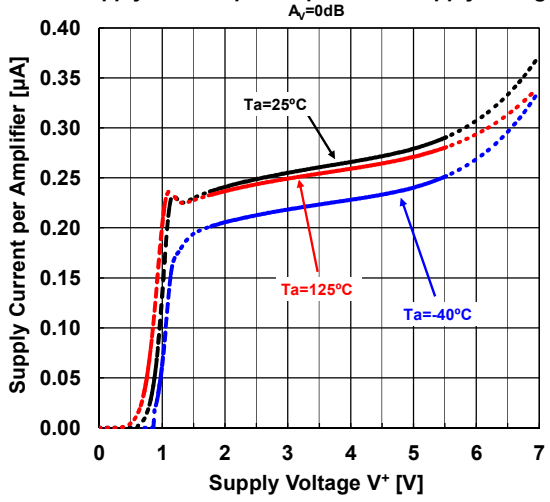


Maximum Output Voltage vs. Load Resistance
V⁺/V⁻=±0.9V, Gv=open, R_L connected to 0V

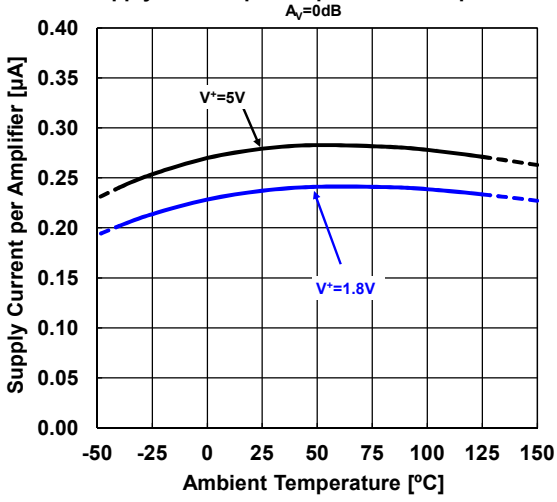


■TYPICAL CHARACTERISTICS

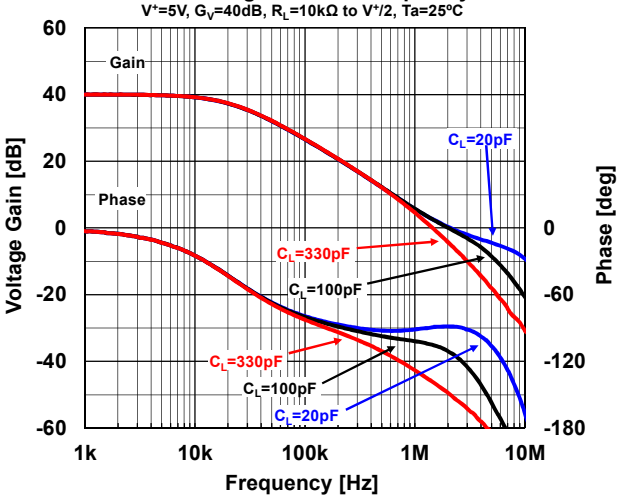
Supply Current per Amplifier vs. Supply Voltage
A_V=0dB



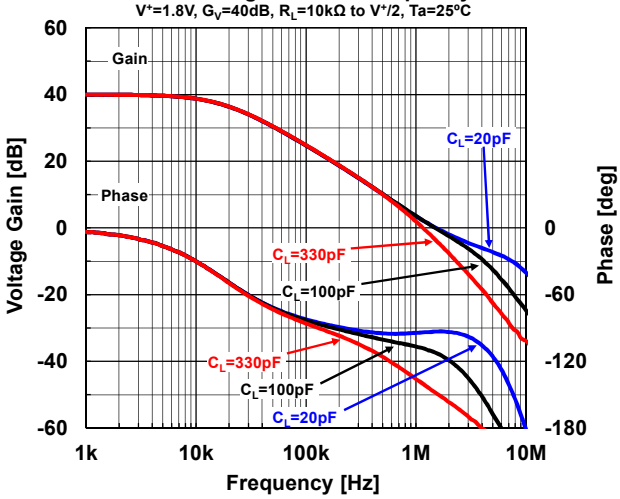
Supply Current per Amplifier vs. Temperature
A_V=0dB



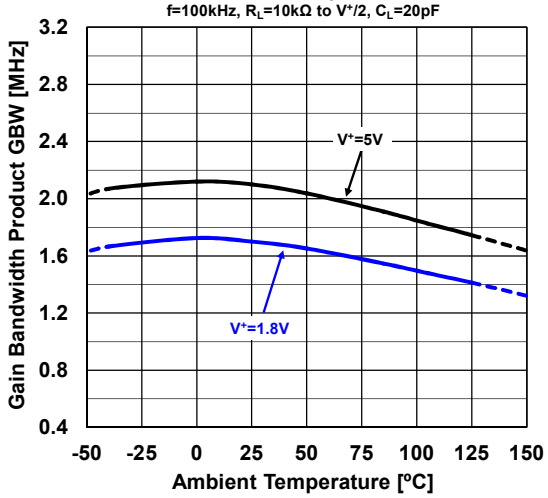
40dB Voltage Gain vs. Frequency
V^+=5V, G_V=40dB, R_L=10kΩ to V^+/2, Ta=25°C



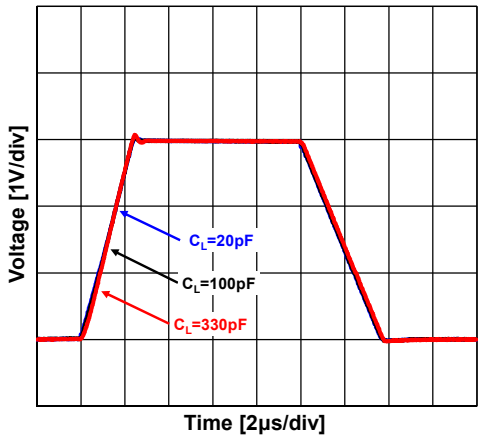
40dB Voltage Gain vs. Frequency
V^+=1.8V, G_V=40dB, R_L=10kΩ to V^+/2, Ta=25°C



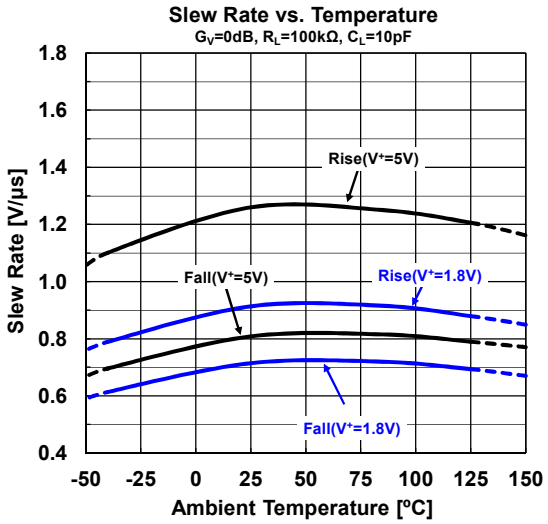
GBW vs. Temperature
f=100kHz, R_L=10kΩ to V^+/2, C_L=20pF

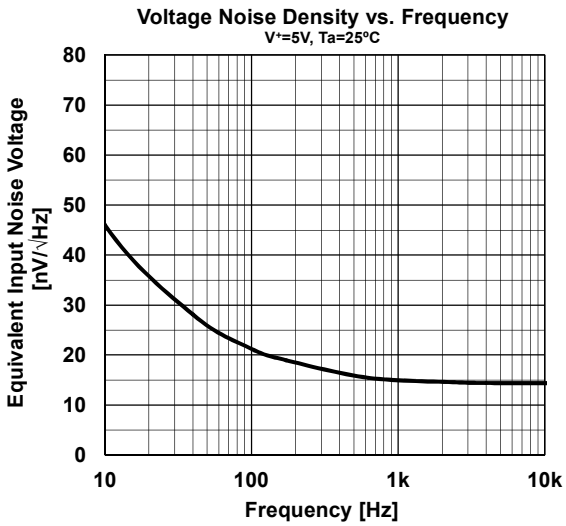


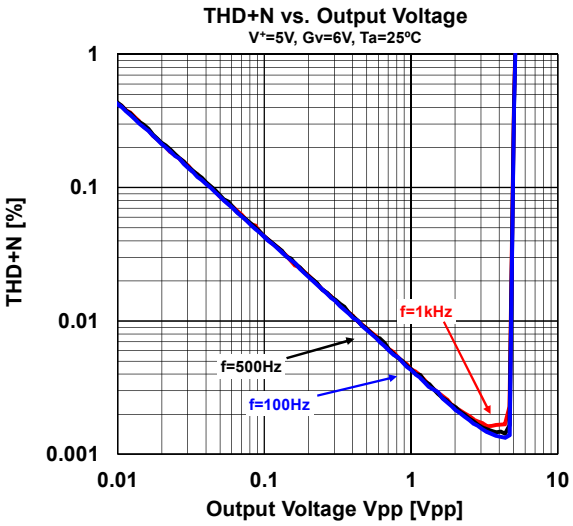
Pulse Response
V^+=5V, G_V=0dB, R_L=10kΩ to V^+/2, Ta=25°C



■TYPICAL CHARACTERISTICS





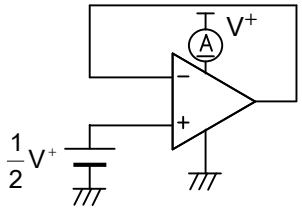


■TYPICAL TEST CIRCUIT

●Supply Current (I_{SUPPLY})

V^+=+1.8V,V^- =0V

V^+=+5.0V,V^- =0V



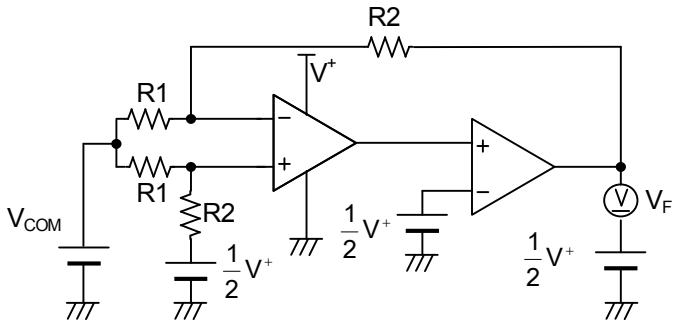
●Input Offset Voltage (V_{IO})

V^+=+1.8V,V^- =0V

V^+=+5.0V,V^- =0V

R1=50Ω,R2=50kΩ

$$V_{IO}=\frac{R1}{R1+R2}\times V_F \quad [V]$$



●Open-Loop Voltage Gain (A_V)

V^+=+1.8V,V^- =0V

CONDITION 1: R1=50Ω,R2=50kΩ,R_L=10kΩ,V_{IN}=V_{IN1}=+1.3V,V_F=V_{F1}

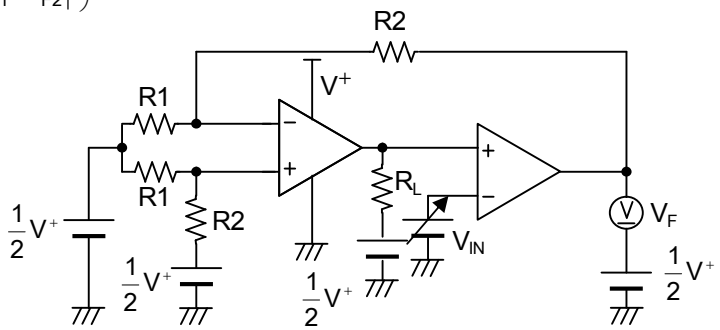
CONDITION 2: R1=50Ω,R2=50kΩ,R_L=10kΩ,V_{IN}=V_{IN2}=+0.5V,V_F=V_{F2}

V^+=+5.0V,V^- =0V

CONDITION: R1=50Ω,R2=50kΩ,R_L=10kΩ,V_{IN}=V_{IN1}=+4.5V,V_F=V_{F1}

CONDITION: R1=50Ω,R2=50kΩ,R_L=10kΩ,V_{IN}=V_{IN2}=+0.5V,V_F=V_{F2}

$$A_V = 20\log\left(\left(1+\frac{R2}{R1}\right)\times\frac{V_{IN1}-V_{IN2}}{|V_{F1}-V_{F2}|}\right)[dB]$$



●**Common-Mode Rejection Ratio (CMR)**

●**Common-Mode Input Voltage Range (V_{ICM})**

V^+=+1.8V,V^- =0V

CONDITION 1 : R1=50Ω,R2=50kΩ,V_{IN}=V_{IN1}=+0.9V,V_F=V_{F1}

CONDITION 2 : R1=50Ω,R2=50kΩ,V_{IN}=V_{IN2}= 0V ,V_F=V_{F2}

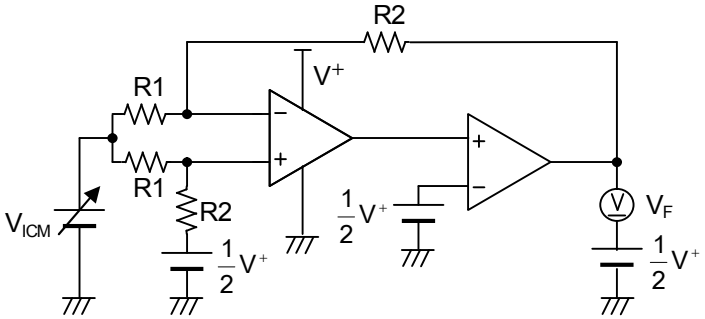
V^+=+5.0V,V^- =0V

CONDITION 1 : R1=50Ω,R2=50kΩ,V_{IN}=V_{IN1}=+4.1V,V_F=V_{F1}

CONDITION 2 : R1=50Ω,R2=50kΩ,V_{IN}=V_{IN2}= 0V ,V_F=V_{F2}

$$CMR = 20\log\left(\left(1+\frac{R2}{R1}\right)\times\frac{V_{IN1}-V_{IN2}}{|V_{F1}-V_{F2}|}\right)[dB]$$

V_{ICM} = V_{IN2} to V_{IN1}

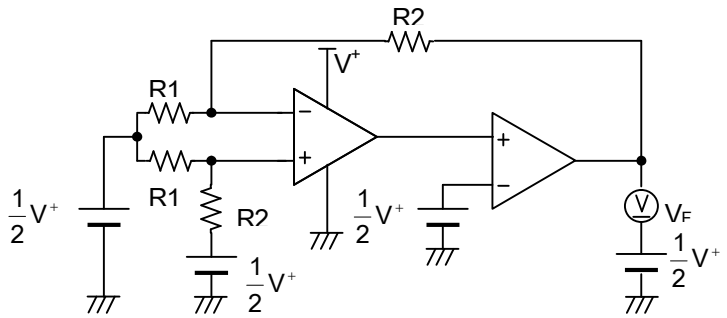


●**Supply Voltage Rejection Ratio (SVR)**

CONDITION 1 : V^+= V^+1=+1.8V, V^- =0V ,R1=50Ω,R2=50kΩ, V_F=V_{F1}

CONDITION 2 : V^+= V^+2=+5.5V, V^- =0V ,R1=50Ω,R2=50kΩ, V_F=V_{F2}

$$SVR = 20\log\left(\left(1+\frac{R2}{R1}\right)\times\frac{V^+2-V^+1}{|V_{F2}-V_{F1}|}\right)[dB]$$

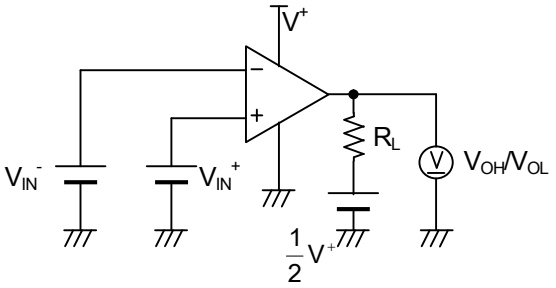


●**High-level Output Voltage (V_{OH},V_{OL})** @ R_L=10kΩ to 1/2 V^+

※pulse measurement

V^+=+1.8V,V^- =0V
V_{OH}: R_L=10kΩ, V_{IN}^+=+1.2V, V_{IN}^-=+0.9V
V_{OL}: R_L=10kΩ, V_{IN}^+=+0.9V, V_{IN}^-=+1.2V

V^+=+5.0V, V^- =0V
V_{OH}: R_L=10kΩ, V_{IN}^+=+2.8V, V_{IN}^-=+2.5V
V_{OL}: R_L=10kΩ, V_{IN}^+=+2.5V, V_{IN}^-=+2.8V

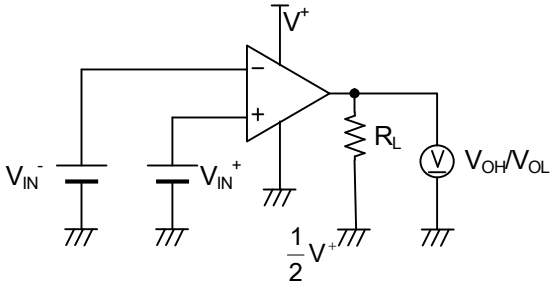


●**High-level Output Voltage (V_{OH},V_{OL})** @R_L=10kΩ to 0V

※pulse measurement

V^+=+1.8V,V^- =0V
V_{OH}: R_L=10kΩ, V_{IN}^+=+1.2V, V_{IN}^-=+0.9V
V_{OL}: R_L=10kΩ, V_{IN}^+=+0.9V, V_{IN}^-=+1.2V

V^+=+1.8V,V^- =0V
V_{OH}: R_L=10kΩ, V_{IN}^+=+2.8V, V_{IN}^-=+2.5V
V_{OL}: R_L=10kΩ, V_{IN}^+=+2.5V, V_{IN}^-=+2.8V

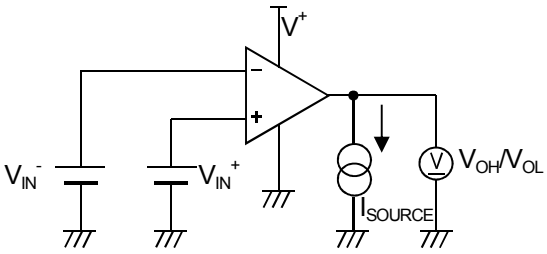


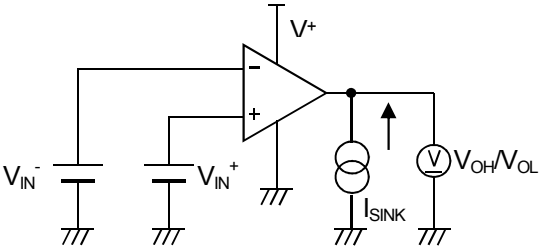
●**High-level Output Voltage (V_{OH},V_{OL})** @ Isink=Isource=1mA , Isink=Isource=2mA

※pulse measurement

V^+=+1.8V,V^- =0V
V_{OH}: I_{SOURCE}=1mA, V_{IN}^+=+1.2V, V_{IN}^-=+0.9V
V_{OL}: I_{SINK}=1mA, V_{IN}^+=+0.9V, V_{IN}^-=+1.2V

V^+=+1.8V,V^- =0V
V_{OH}: I_{SOURCE}=2mA, V_{IN}^+=+2.8V, V_{IN}^-=+2.5V
V_{OL}: I_{SINK}=2mA, V_{IN}^+=+2.5V, V_{IN}^-=+2.8V





■APPLICATION NOTE

Single and Dual Supply Voltage Operation

The NJU7056/NJU7057/NJU7058 works with both single supply and dual supply when the voltage supplied is between V^+ and V^-. These amplifiers operate from single +1.8 to +5.5V supply and dual ±0.9V to ±2.75V supply.

Common-Mode Input Voltage Range

When the supply voltage does not meet the condition of electrical characteristics, the range of common-mode input voltage is as follows:
V_{ICM} (typ.) = V^- to V^+-0.9 (Ta = 25°C)
Difference of V_{ICM} when Temperature change, refer to typical characteristic graph.
During designing, consider variations in characteristics for use with allowance.

Maximum Output Voltage Range

When the supply voltage does not meet the condition of electrical characteristics, the range of the typ. value of the maximum output voltage is as follows:
V_{OM} (typ.) = V^-+50mV to V^+-50mV (R_L=20kΩ to V^+/2, Ta=25°C)
During designing, consider variations in characteristics and temperature characteristics for use with allowance. In addition, also note that the output voltage range becomes narrow as shown in typical characteristics graph when an output current increases.

Input Voltage Exceeding the Supply Voltage

Inputs of the NJU7056/NJU7057/NJU7058 are protected by ESD diodes (shown in Figure1) that will conduct if the input voltages exceed the power supplies by more than approximately 300mV. Momentary voltages greater than 300mV beyond the power supply, inputs can be tolerated if the current is limited to 10mA. Figure2 is easily accomplished with an input resistor. If the input voltage exceeds the supply voltage, the input current must be limited 10mA or less by using a restriction resistance (R_{LIMIT}) as shown in figure2.

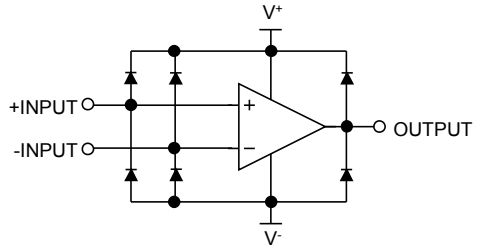


Figure1. Simplified Schematic

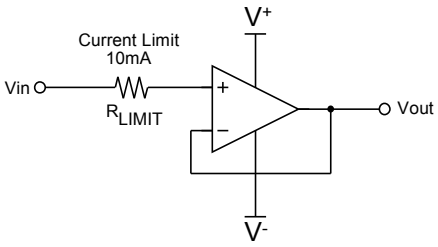


Figure2. Input Current Protection for Voltages exceeding the Supply Voltage.

Capacitive load

The NJU7056/NJU7057/NJU7058 can use at unity gain follower, but the unity gain follower is the most sensitive configuration to capacitive loading. The combination of capacitive load placed directly on the output of an amplifier along with the output impedance of the amplifier creates a phase lag which in turn reduces the phase margin of the amplifier. If phase margin is significantly reduced, the response will cause overshoot and ringing in the step response.
The NJU7056/NJU7057/NJU7058 is unity gain stable for capacitive loads of 200pF. To drive heavier capacitive loads, an isolation resistor, R_{ISO} as shown Figure3, should be used. R_{ISO} improves the feedback loop's phase margin by making the output load resistive at higher frequencies. The larger the value of R_{ISO}, the more stable the output voltage will be. However, larger values of R_{ISO} result in reduced output swing, reduced output current drive and reduced frequency bandwidth.

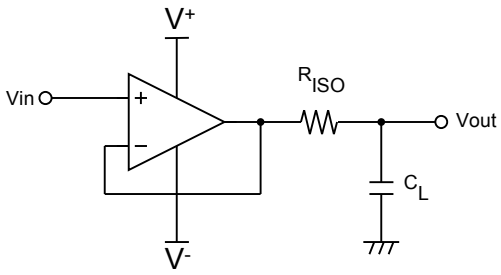
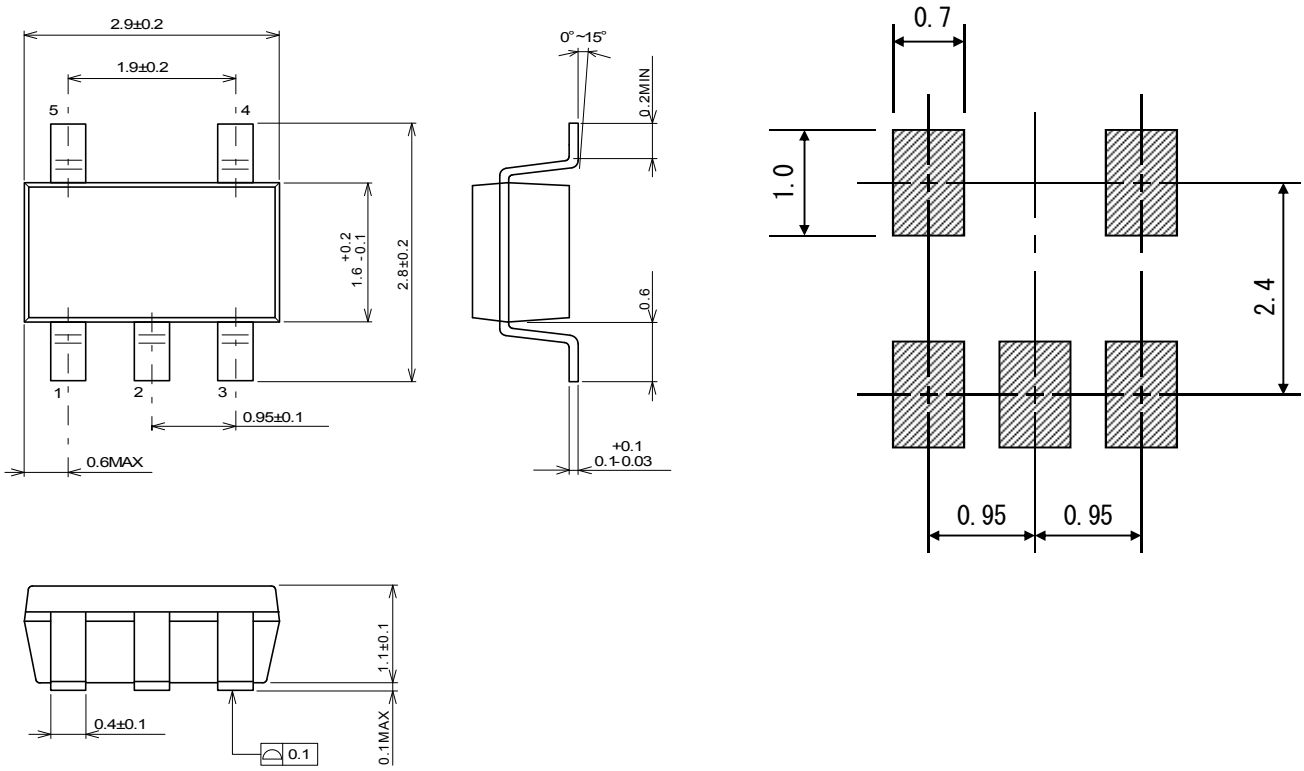


Figure3. Isolating capacitive load

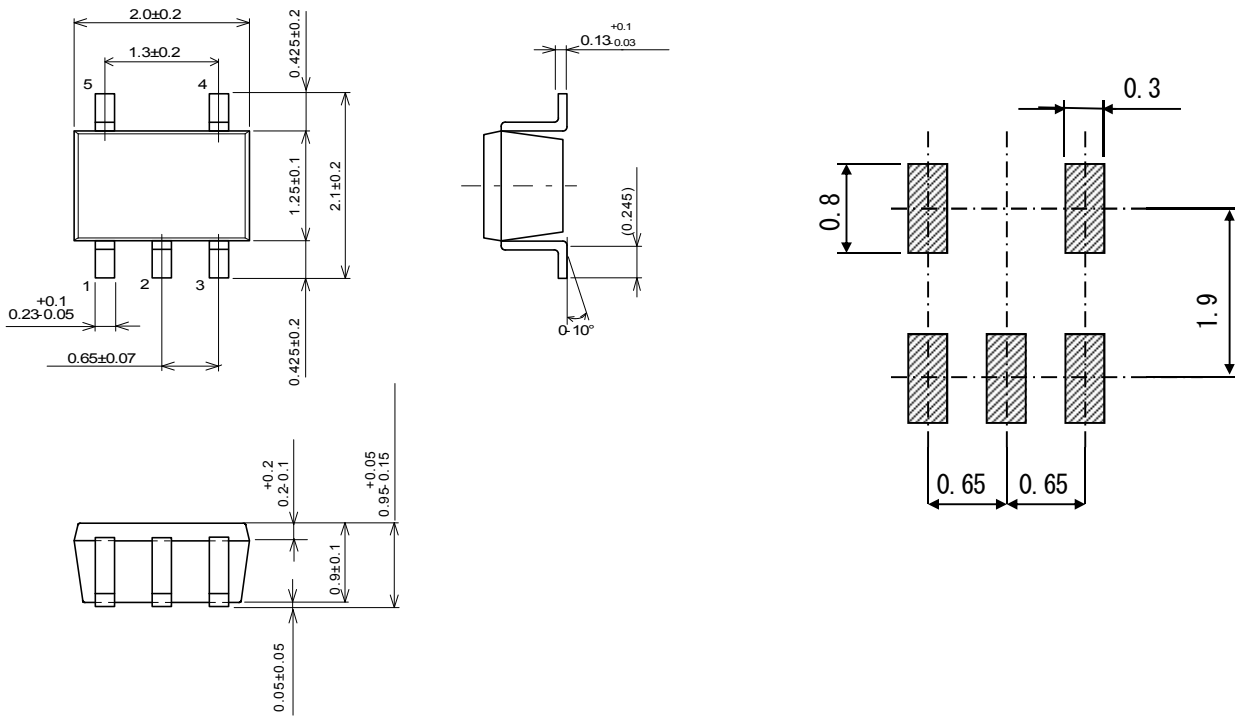
■PACKAGE OUTLINE /SOLDER FOOT PRINT

SOT-23-5

Unit: mm



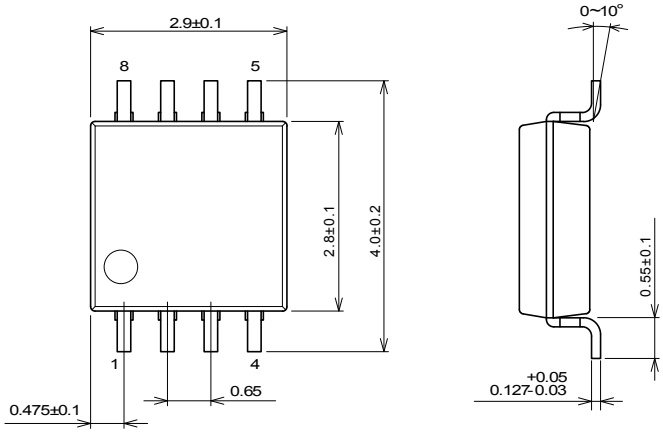
SC-88A

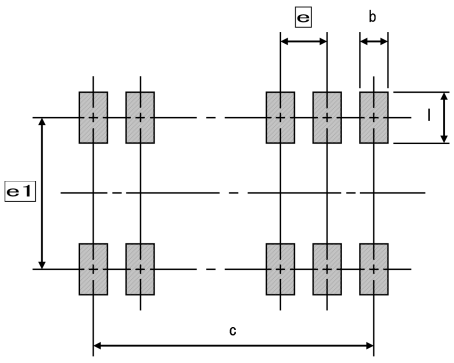


■PACKAGE OUTLINE /SOLDER FOOT PRINT

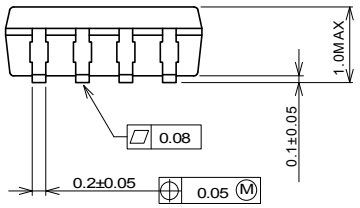
MSOP8(TVSP8)

Unit: mm

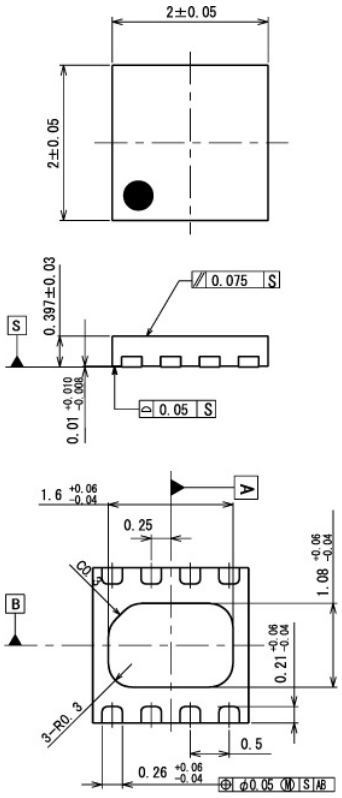


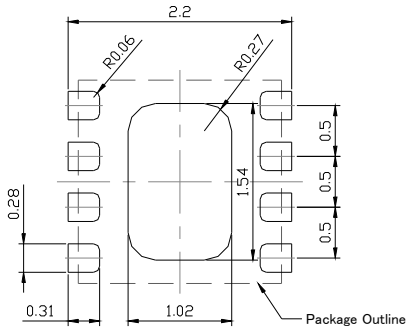


PKG	b	l	c	e1	e
TVSP8	0.23	1.00	1.95	3.50	0.65



DFN8-U1(ESON8-U1)

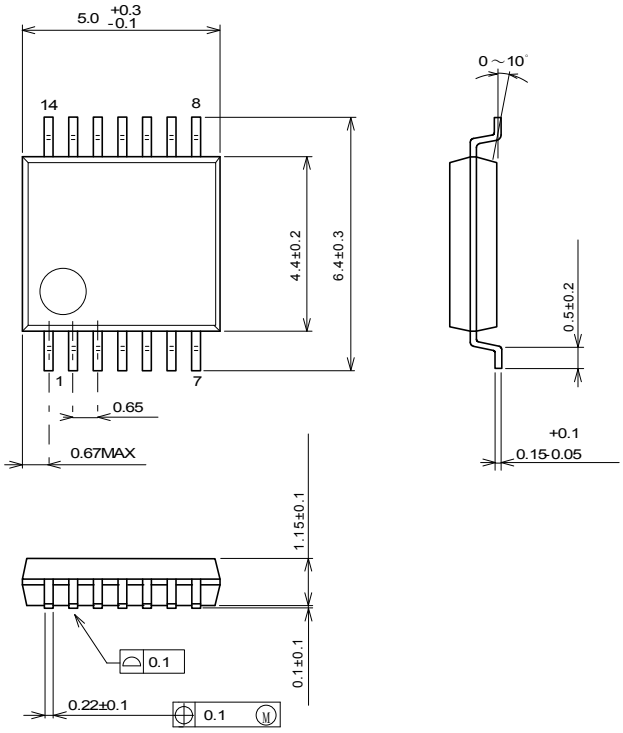


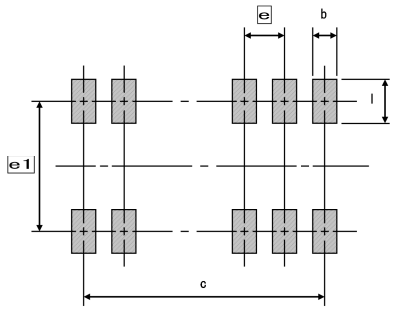


■PACKAGE OUTLINE /SOLDER FOOT PRINT

SSOP14

Unit: mm





PKG	b	l	c	e1	e
SSOP14	0.35	1.00	3.90	5.90	0.65

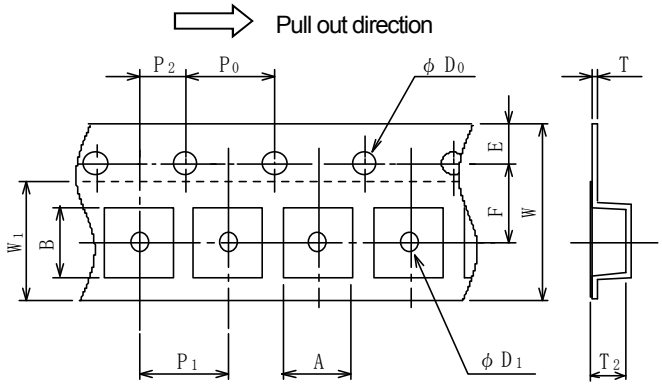
■PACKING SPECIFICATION

NJRC delivers ICs in 4 methods, plastic tube container, two kinds of Taping, tray and vinyl bag packing.Except adhesive tape treated anti electrostatic and contain carbon are using as the ESD (Electrostatic Discharge Damage) protection.

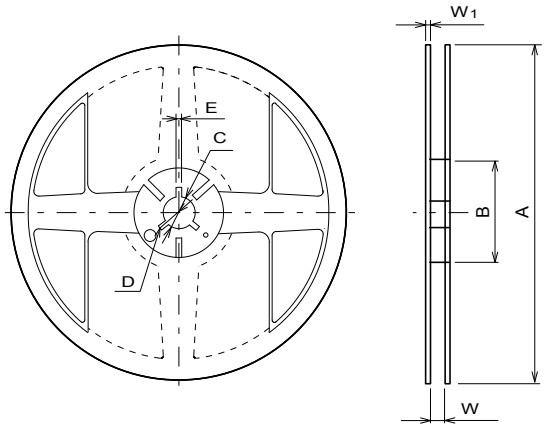
SOT-23-5 Emboss Taping (TE1)

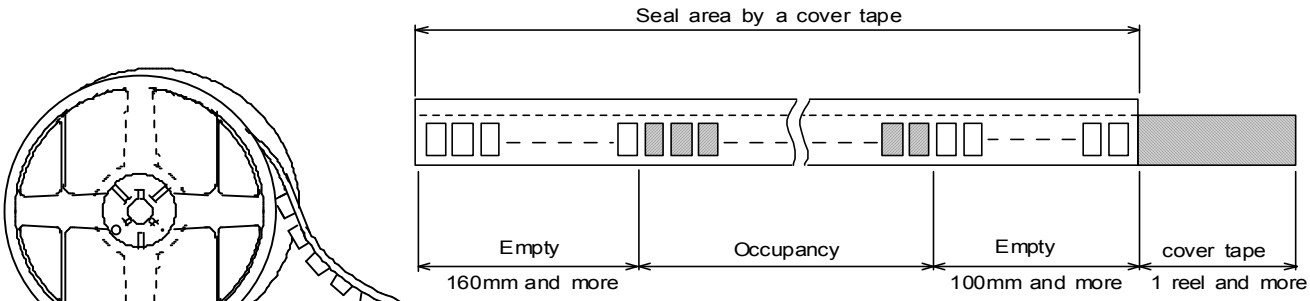
Unit : mm

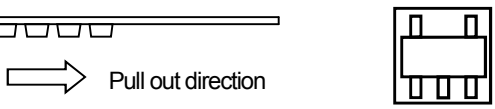
Symbol	SOT-23-5	Remark
A	3.3±0.1	Bottom size
B	3.2±0.1	Bottom size
D_0	1.55	
D_1	1.05	
E	1.75±0.1	
F	3.5±0.05	
P_0	4.0±0.1	
P_1	4.0±0.1	
P_2	2.0±0.05	
T	0.25±0.05	
T_2	1.57	
W	8.0±0.3	
W_1	5.5	Thickness 0.1MAX



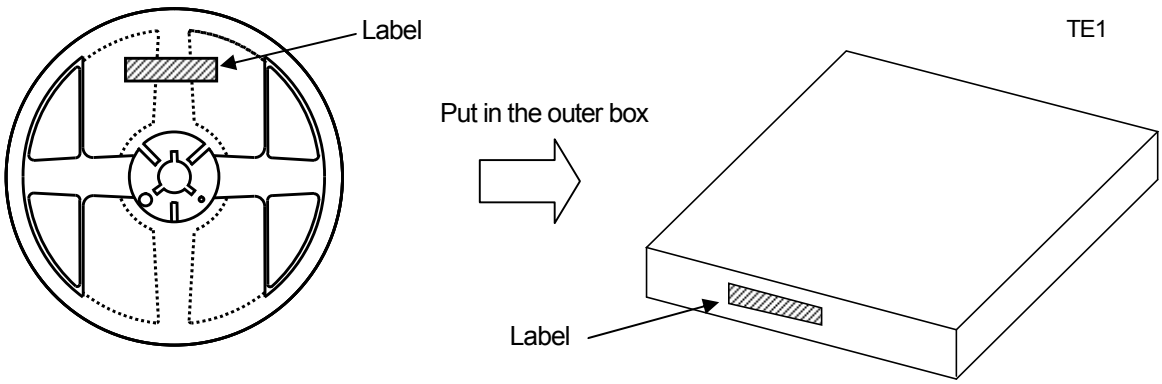
Symbol	SOT-23-5
A	Ø180±1
B	Ø 60±1
C	Ø 13±0.2
D	Ø 21±0.8
E	2±0.5
W	9±0.5
W_1	1.2±0.2
Contents	3,000pcs







TE1

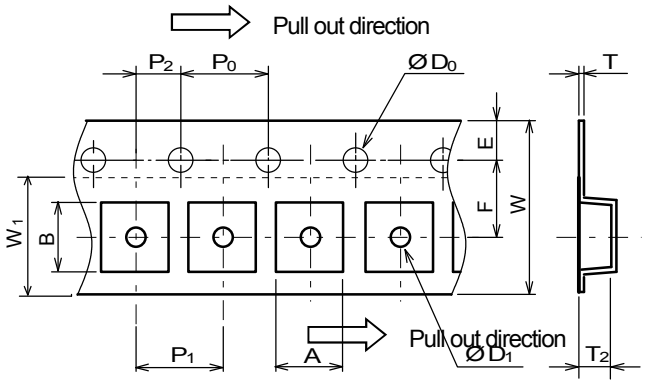


■PACKING SPECIFICATION

SC-88A Emboss Taping (TE1)

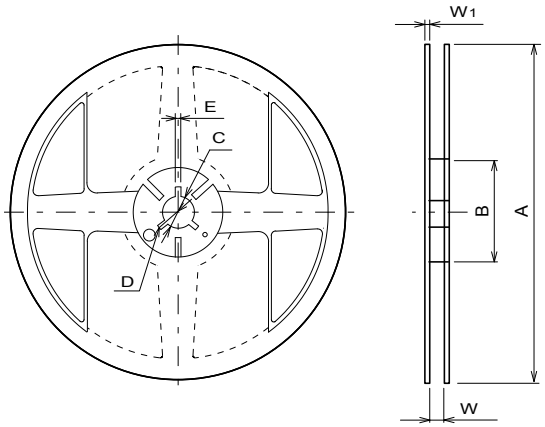
Unit : mm

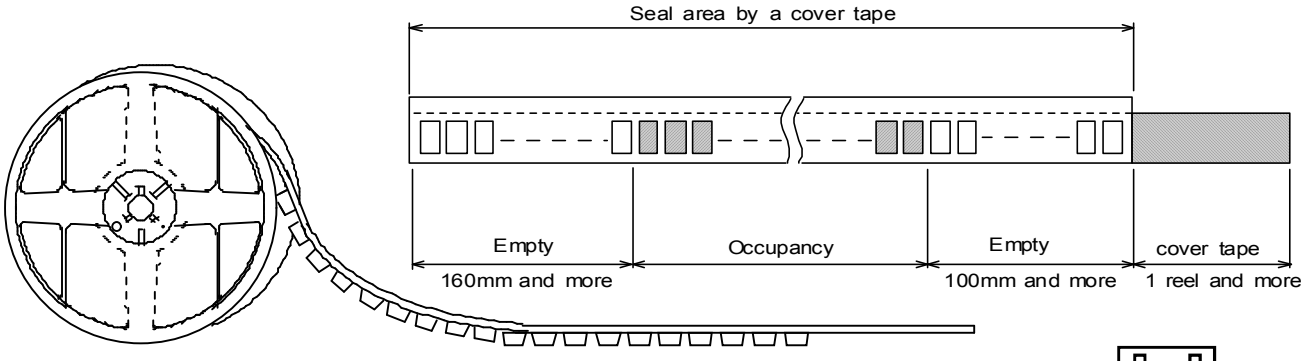
Symbol	SC-88A	Remark
A	2.30±0.1	Bottom size
B	2.50±0.1	Bottom size
D_0	1.55±0.05	
D1	1.05±0.05	
E	1.75±0.1	
F	3.50±0.05	
P_0	4.00±0.1	
P_1	4.00±0.1	
P_2	2.00±0.05	
T	0.25±0.05	
T_2	1.05	
W	8.0±0.2	
W_1	5.5	Thickness 0.1MAX

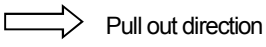


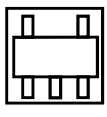
Symbol	SC-82AB	SC-88A
A	Ø180±1	
B	Ø 60±1	
C	Ø 13±0.2	
D	Ø 21±0.8	
E	2±0.5	
W	9±0.5	
W_1	1.2±0.2	
Contents	3,000 pcs	

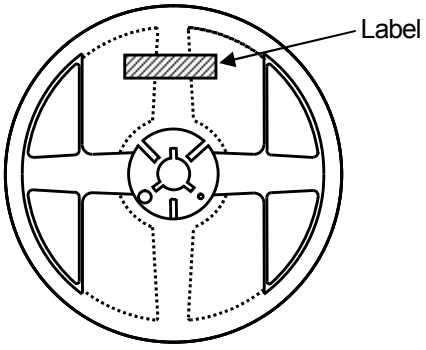
Unit : mm



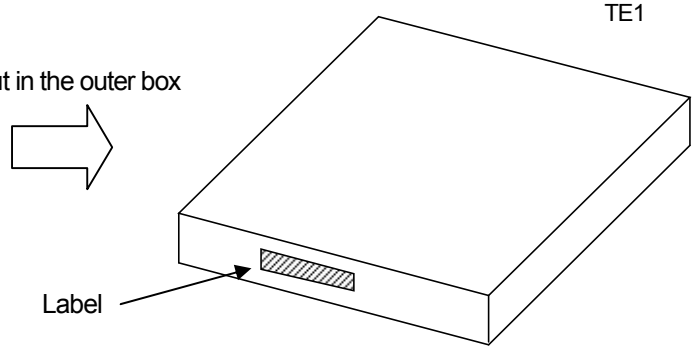








Put in the outer box

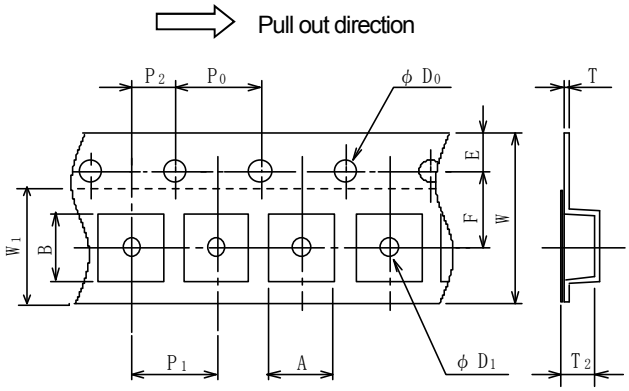


■PACKING SPECIFICATION

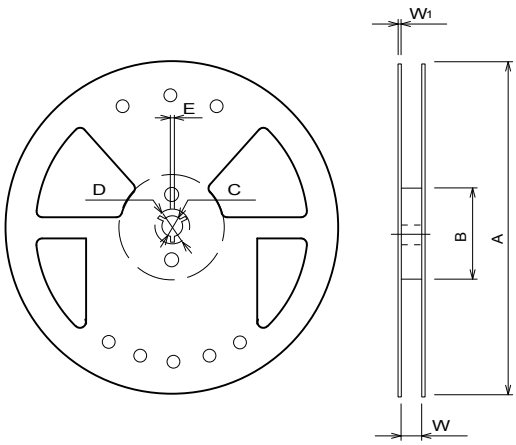
MSOP8(TVSP8) Emboss Taping (TE1)

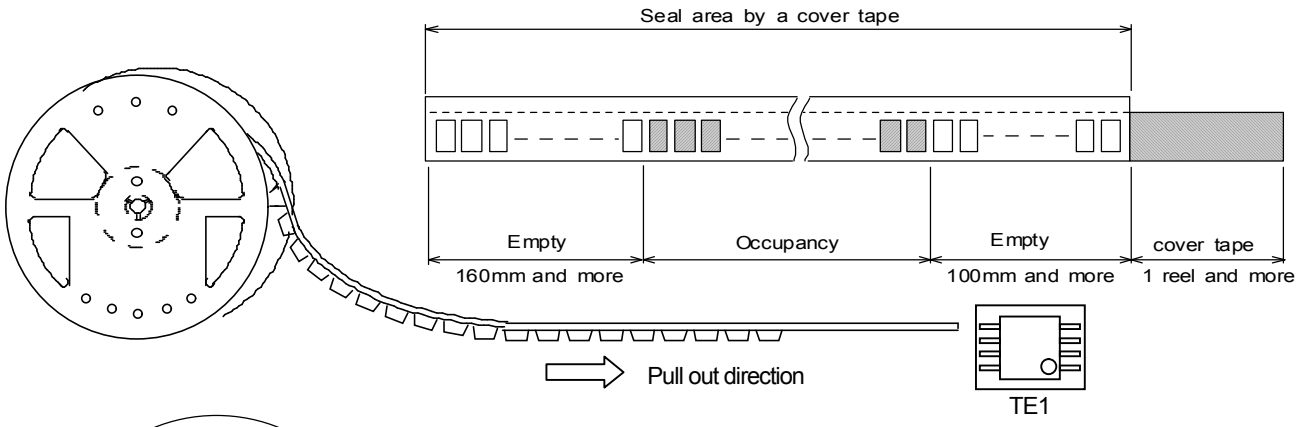
Unit : mm

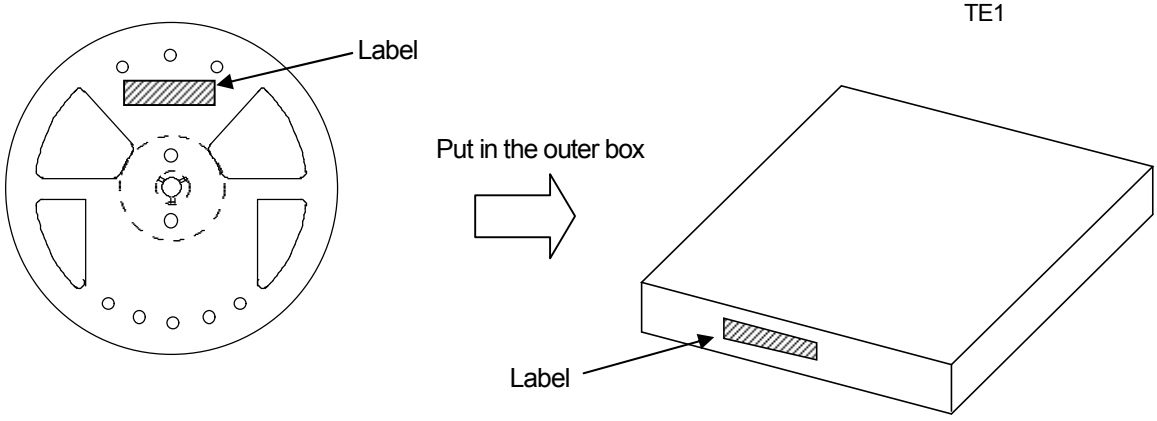
Symbol	MSOP8 (TVSP8/) * *MEETJEDEC MO-187-DA / THIN TYPE	Remark
A	4.4	Bottom size
B	3.2	Bottom size
D_0	1.5+0.1/-0	
D_1	1.5+0.1/-0	
E	1.75±0.1	
F	5.5±0.05	
P_0	4.0±0.1	
P_1	8.0±0.1	
P_2	2.0±0.05	
T	0.3±0.05	
T_2	1.45	
W	12.0±0.3	
W_1	9.5	Thickness 0.1MAX



Symbol	MSOP8 (TVSP8/) * *MEETJEDEC MO-187-DA / THIN TYPE
A	Ø254±2
B	Ø100±1
C	Ø13±0.2
D	Ø21±0.8
E	2±0.5
W	13.5±0.5
W_1	2±0.2
Contents	2,000 pcs





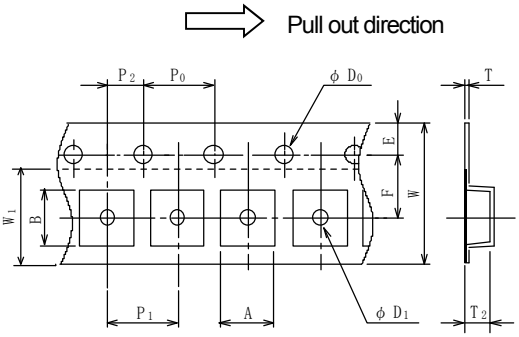


■PACKING SPECIFICATION

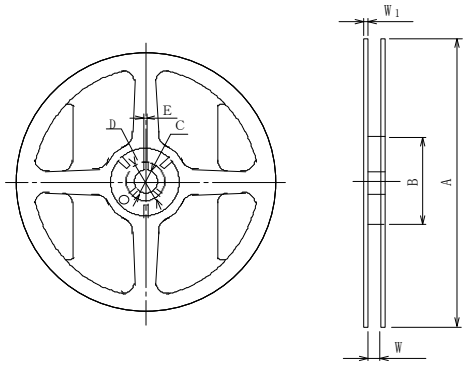
DFN8-U1 (ESON8-U1)　Emboss Taping (TE3)

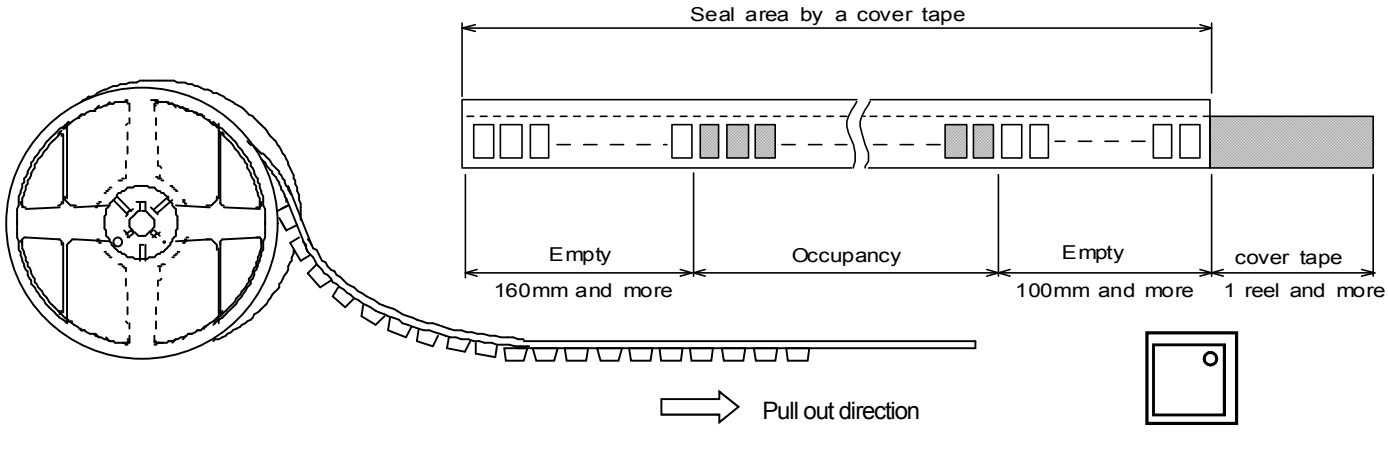
Unit : mm

Symbol	DFN8-U1 (ESON8-U1)	Remark
A	2.25±0.05	Bottom size
B	2.25±0.05	Bottom size
D_0	1.5+0.1/-0	
D1	0.5±0.1	
E	1.75±0.1	
F	3.5 ±0.05	
P_0	4.0 ±0.1	
P_1	4.0 ±0.1	
P_2	2.0 ±0.05	
T	0.25±0.05	
T_2	0.75	
W	8.0 ±0.2	
W_1	5.5	Thickness 0.1MAX

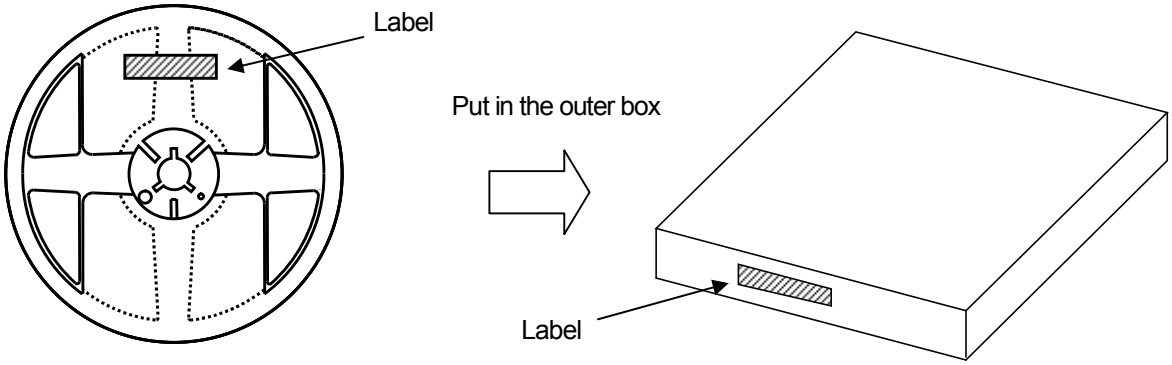


Symbol	DFN8-U1 (ESON8-U1)
A	φ180 +0/-1.5
B	φ 60 +1/-0
C	φ13.0±0.2
D	φ21.0±0.8
E	2.0±0.5
W	9.0 +0.3/-0
W_1	1.2
Contents	3,000pcs





TE3

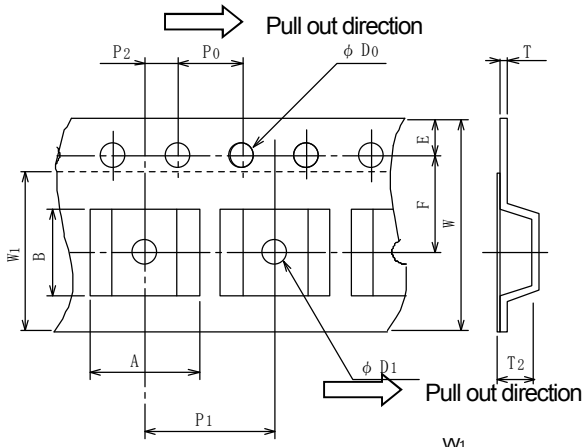


■PACKING SPECIFICATION

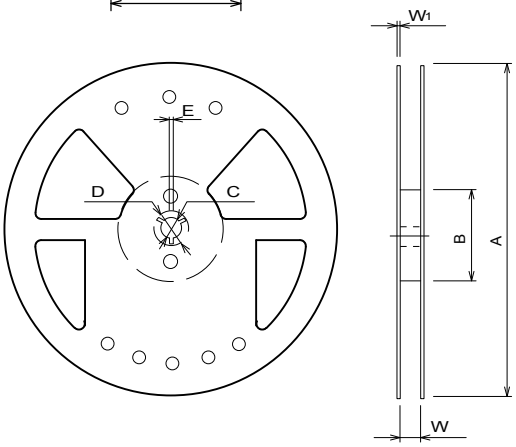
SSOP14 Emboss Taping (TE1)

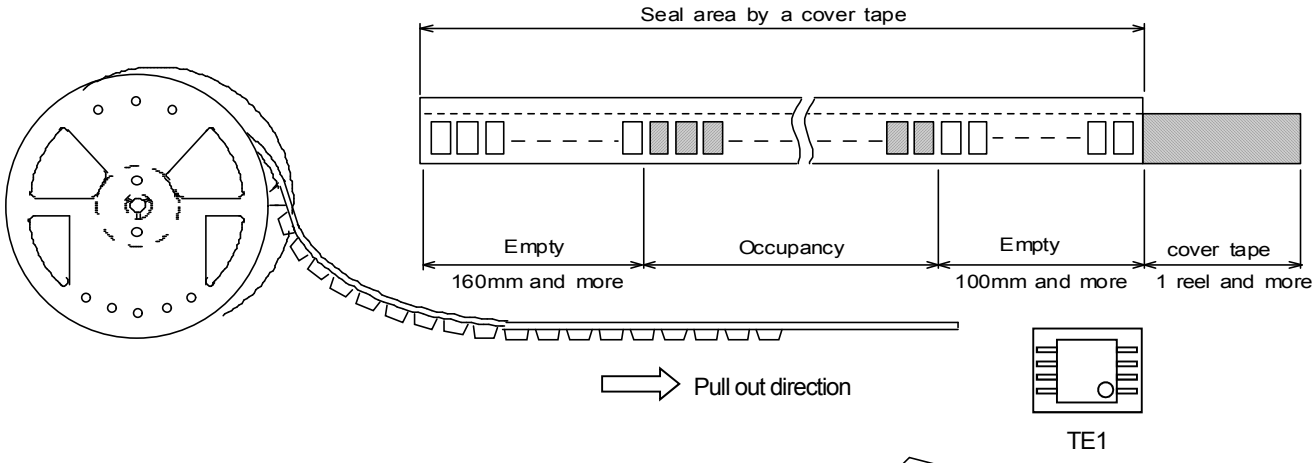
Unit : mm

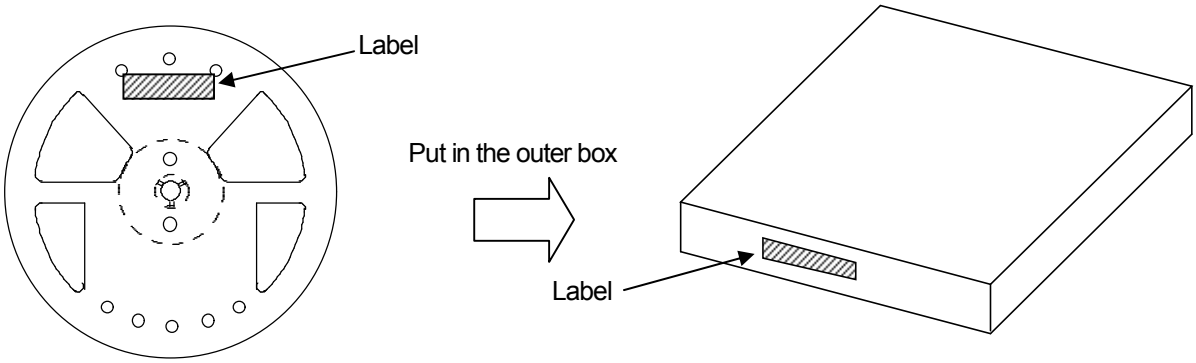
Symbol	SSOP14	Remark
A	6.95	Bottom size
B	5.4	Bottom size
D_0	1.55±0.05	
D_1	1.55±0.1	
E	1.75±0.1	
F	5.5±0.05	
P_0	4.0±0.1	
P_1	8.0±0.1	
P_2	2.0±0.05	
T	0.3±0.05	
T_2	1.9	
W	12.0±0.3	
W_1	9.5	Thickness 0.1MAX



Symbol	SSOP14
A	Ø254±2
B	Ø100±1
C	Ø13±0.2
D	Ø21±0.8
E	2±0.5
W	13.5±0.5
W_1	2±0.2
Contents	2,000 pcs

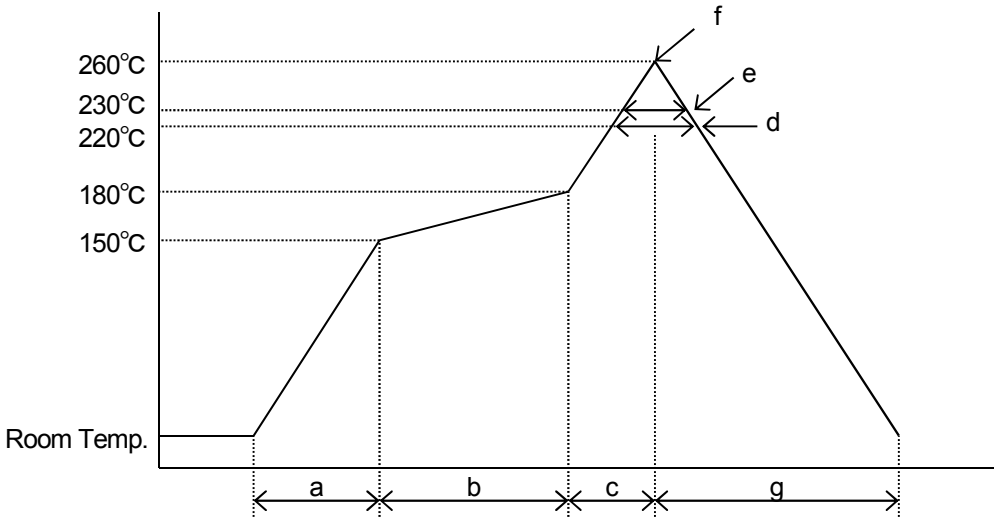






■RECOMMENDED MOUNTING METHOD

*Recommended reflow soldering procedure



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

*The temperature indicates at the surface of mold package.

■REVISION HISTORY

Date	Revision	Changes
2.Aug.2016	Ver.6	Data sheet format revision

[CAUTION]

1. New JRC strives to produce reliable and high quality semiconductors. New JRC's semiconductors are intended for specific applications and require proper maintenance and handling. To enhance the performance and service of New JRC's semiconductors, the devices, machinery or equipment into which they are integrated should undergo preventative maintenance and inspection at regularly scheduled intervals. Failure to properly maintain equipment and machinery incorporating these products can result in catastrophic system failures

2. The specifications on this datasheet are only given for information without any guarantee as regards either mistakes or omissions. The application circuits in this datasheet are described only to show representative usages of the product and not intended for the guarantee or permission of any right including the industrial rights.
   All other trademarks mentioned herein are property of their respective companies.

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

4. New JRC offers a variety of semiconductor products intended for particular applications. It is important that you select the proper component for your intended application. You may contact New JRC's Sale's Office if you are uncertain about the products listed in this catalog.

5. Special care is required in designing devices, machinery or equipment which demand high levels of reliability. This is particularly important when designing critical components or systems whose failure can foreseeably result in situations that could adversely affect health or safety. In designing such critical devices, equipment or machinery, careful consideration should be given to amongst other things, their safety design, fail-safe design, back-up and redundancy systems, and diffusion design.

6. The products listed in the catalog may not be appropriate for use in certain equipment where reliability is critical or where the products may be subjected to extreme conditions. You should consult our sales office before using the products in any of the following types of equipment.

   Aerospace Equipment
   Equipment Used in the Deep sea
   Power Generator Control Equipment (Nuclear, Steam, Hydraulic)
   Life Maintenance Medical Equipment
   Fire Alarm/Intruder Detector
   Vehicle Control Equipment (airplane, railroad, ship, etc.)
   Various Safety devices

7. New JRC's products have been designed and tested to function within controlled environmental conditions. Do not use products under conditions that deviate from methods or applications specified in this catalog. Failure to employ New JRC products in the proper applications can lead to deterioration, destruction or failure of the products. New JRC shall not be responsible for any bodily injury, fires or accident, property damage or any consequential damages resulting from misuse or misapplication of its products. Products are sold without warranty of any kind, either express or implied, including but not limited to any implied warranty of merchantability or fitness for a particular purpose.

8. Warning for handling Gallium and Arsenic(GaAs) Products (Applying to GaAs MMIC, Photo Reflector). This Products uses Gallium(Ga) and Arsenic(As) which are specified as poisonous chemicals by law. For the prevention of a hazard, do not burn, destroy, or process chemically to make them as gas or power. When the product is disposed, please follow the related regulation and do not mix this with general industrial waste or household waste.

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