



## NJMOP277/NJMOP2277

\* NJMOP2277FE and NJMOP2277FR are discontinued products.

### High EMC Performance, Low Noise, Precision Operational Amplifiers

#### FEATURES

- (V<sup>+</sup> = 5V, V<sup>-</sup> = 0V, T<sub>a</sub> = 25°C)
- Precision Refer to Input offset voltage grade
  - Integrated EMI filter EMIRR = 78dB typ. @ f = 900MHz
  - Low Bias Current 2.5nA max.
  - Low Noise 8nV/√Hz typ. @ f = 1kHz
  - Unity Gain Stable
  - No Phase Reversal
  - Supply Voltage ±2.25V to ±18V
  - Operating Temperature -40°C to +125°C
  - Package SOP8 JEDEC 150mil (EMP8)  
MSOP8 (VSP8)  
DFN8-W2 (ESON8-W2) (3mm x 3mm)

#### APPLICATIONS

- Temperature Sensor
- Current Sensor
- Bridge Amplifier
- Battery Monitor
- Photodiode Amplification
- Automatic Test Equipment

#### GENERAL DESCRIPTION

The NJMOP277 / NJMOP2277 are single / dual high precision operational amplifiers featuring low offset voltage drift of top-class, low offset voltage and low noise and high voltage gain. The NJMOP277 / NJMOP2277 excellent electrical characteristics are guaranteed over a wide operating range -40°C to +125°C, ±5V to ±15V.

Therefore, it is suitable for measuring instruments that require stability against ambient temperature change and/or for applications such as configuring high gain circuits to process very small signals.

Moreover, they have the advantage very small package and high RF noise immunity. It is easy to replacement from defect standard precision operational amplifier: OP-177 series and to design against RF immunity, too.

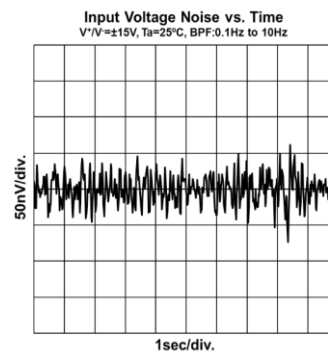
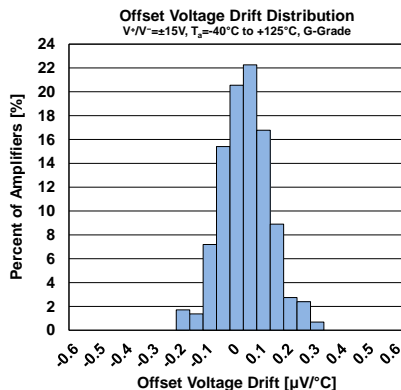
#### Related Products

Features	Single	Dual	Quad
JFET Input Precision (V <sub>IO</sub> =400μV, SR=20V/μs)	—	NJM8512	NJM8513
CMOS Precision RRO (V <sub>IO</sub> =150μV)	NJU7076	NJU7077	NJU7078

#### Input Offset Voltage Grade

Grade	Product Name		Input Offset Voltage (T <sub>a</sub> = 25°C)	Input Offset Voltage Drift (T <sub>a</sub> = -40°C to 125°C)	Input Offset Current (T <sub>a</sub> = -40°C to 125°C)
F-Grade	NJMOP277FE NJMOP2277FE*	NJMOP277FR NJMOP2277FR*	20μV max	0.15μV/°C max	2nA max
G-Grade	NJMOP277GE NJMOP2277GE	NJMOP277GR NJMOP2277GR	50μV max	0.6μV/°C max	3nA max
-	NJMOP2277KW2		100μV max	0.7μV/°C max	3nA max

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■ PRODUCT NAME INFORMATION

NJMOPxxx a b (ccc)

Description of configuration

Composition	Item	Description
xxxx	Number of circuits	Indicates number of circuits. 277: 1ch 2277: 2ch
a	Grade	Product Grade. Refer to the Grade List.
b	Package code	Indicates the package. E: SOP8 JEDEC 150mil (EMP8) R: MSOP8 (VSP8) KW2: DFN8-W2 (ESON8-W2)
ccc	Packing	Insert Direction. Refer to the packing specifications.

Grade

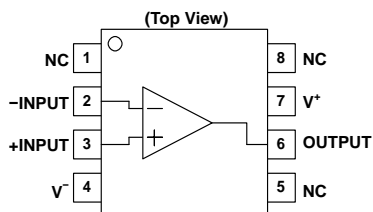
Grade	Package	Input Offset Voltage ( $\mu\text{V}$ max) $T_a = 25^\circ\text{C}$	Input Offset Voltage Drift ( $\mu\text{V}/^\circ\text{C}$ max) $T_a = -40$ to $125^\circ\text{C}$	Input Offset Current (nA max) $T_a = -40$ to $125^\circ\text{C}$
F	SOP8 JEDEC 150mil (EMP8) MSOP8 (VSP8)	20	0.15	2
G	SOP8 JEDEC 150mil (EMP8) MSOP8 (VSP8)	50	0.6	3
-	DFN8-W2(ESON8-W2)	100	0.7	3

■ ORDER INFORMATION

Product Name	Package	RoHS	Halogen-Free	Terminal Finish	Weight (mg)	Quantity per Reel (pcs/reel)
NJMOP277GE (TE1)	SOP8 JEDEC 150mil (EMP8)	✓	✓	Sn2Bi	76	2000
NJMOP277GR (TE1)	MSOP8 (VSP8)	✓	✓	Sn2Bi	21	2000
NJMOP2277GE (TE1)	SOP8 JEDEC 150mil (EMP8)	✓	✓	Sn2Bi	76	2000
NJMOP2277GR (TE1)	MSOP8 (VSP8)	✓	✓	Sn2Bi	21	2000
NJMOP2277KW2 (TE3)	DFN8-W2 (ESON8-W2)	✓	✓	Sn2Bi	18	1500
NJMOP277FE (TE1)	SOP8 JEDEC 150mil (EMP8)	✓	✓	Sn2Bi	76	2000
NJMOP277FR (TE1)	MSOP8 (VSP8)	✓	✓	Sn2Bi	21	2000

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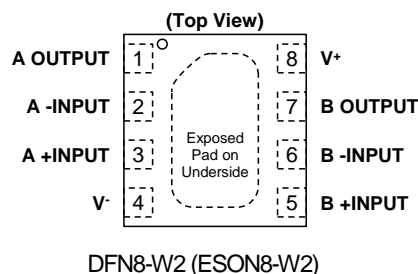
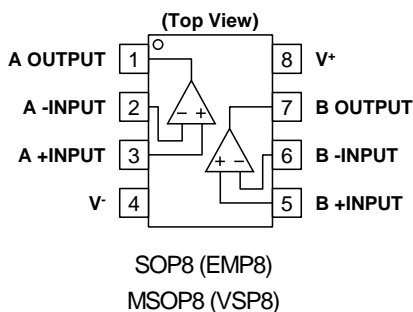
■ PIN DESCRIPTIONS (NJMOP277)



Pin No.		Symbol	I/O	Description
SOP8 JEDEC 150mil (EMP8)	MSOP8 (VSP8)			
6	6	OUTPUT	O	Output channel
2	2	-INPUT	I	Inverting input channel
3	3	+INPUT	I	Non-inverting input channel
7	7	V+	-	Positive supply
4	4	V-	-	Negative supply or GND (single supply)
1,5,8	1,5,8	NC	-	-

NC: It is recommended to make it open to prevent short circuit with adjacent pins during mounting.

■ PIN DESCRIPTIONS (NJMOP2277)



Pin No.			Symbol	I/O	Description
SOP8 JEDEC 150mil (EMP8)	MSOP8 (VSP8)	DFN8-W2 (ESON8-W2)			
1	1	1	A OUTPUT	O	Output channel A
2	2	2	A -INPUT	I	Inverting input channel A
3	3	3	A +INPUT	I	Non-inverting input channel A
7	7	7	B OUTPUT	O	Output channel B
6	6	6	B -INPUT	I	Inverting input channel B
5	5	5	B +INPUT	I	Non-inverting input channel B
8	8	8	V+	-	Positive supply
4	4	4	V-	-	Negative supply or GND (single supply)

\*Connect exposed pad to V-

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■ ABSOLUTE MAXIMUM RATINGS

	Symbol	Rating	Unit
Supply Voltage $V_S = V^+ - V^-$	$V^+ - V^-$	40	V
Differential Input Voltage <sup>*1</sup>	$V_{ID}$	$\pm 40$ <sup>*2</sup>	V
Input Voltage <sup>*3</sup>	$V_{IN}$	$V^- - 0.3$ to $V^+ + 0.3$	V
Input Current <sup>*4</sup>	$I_{IN}$	10	mA
Output Short-Circuit Duration <sup>*5</sup>	-	Continuous ( $T_a \leq 25^\circ\text{C}$ )	
Storage Temperature	$T_{stg}$	-55 to 150	$^\circ\text{C}$
Junction Temperature <sup>*6</sup>	$T_j$	150	$^\circ\text{C}$

<sup>\*1</sup> Differential voltage is the voltage difference between +INPUT and -INPUT.

<sup>\*2</sup> For supply voltage less than 40V, the absolute maximum rating is equal to the supply voltage.

<sup>\*3</sup> The absolute maximum input voltage is limited at 40V.

<sup>\*4</sup> 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.

<sup>\*5</sup> Continuous short-circuits from output to GND is guaranteed only when  $V^+ \leq 11\text{V}$  ( $\pm 5.5\text{V}$ ) and into 1ch.

<sup>\*6</sup> Calculate the power consumption of the IC from the operating conditions, and calculate the junction temperature with the thermal resistance. Please refer to "Thermal characteristics" for the thermal resistance under our measurement board conditions.

ABSOLUTE MAXIMUM RATINGS

Electronic and mechanical stress momentarily exceeded absolute maximum ratings may cause permanent damage and may degrade the lifetime and safety for both device and system using the device in the field. The functional operation at or over these absolute maximum ratings is not assured.

■ THERMAL CHARACTERISTICS

Package	Measurement Result		Unit
	Thermal Resistance ( $\theta_{ja}$ )	Thermal Characterization Parameter ( $\psi_{jt}$ )	
NJMOP277 SOP8 JEDEC 150mil (EMP8) *1 MSOP8 (VSP8) *1	122	27	$^\circ\text{C/W}$
	189	53	
NJMOP2277 SOP8 JEDEC 150mil (EMP8) *1 MSOP8 (VSP8) *1 DFN8-W2 (ESON8-W2) *2	104	13	$^\circ\text{C/W}$
	152	24	
	58	7	

$\theta_{ja}$ : Junction-to-Ambient Thermal Resistance

$\psi_{jt}$ : Junction-to-Top Thermal Characterization Parameter

<sup>\*1</sup> Mounted on glass epoxy board (76.2 mm x 114.3 mm x 1.6 mm: based on EIA/JEDEC standard, 4-layer FR-4), internal Cu area: 74.2 mm x 74.2 mm.

<sup>\*2</sup> Mounted on glass epoxy board (101.5 mm x 114.5 mm x 1.6 mm: based on EIA/JEDEC standard, 4-layer FR-4) with exposed pad. (For 4-layer, applying 99.5 mm x 99.5 mm inner Cu area and a thermal via hole to a board based on JEDEC standard JESD51-5.)

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■ ELECTROSTATIC DISCHARGE (ESD) PROTECTION VOLTAGE

	Conditions	Protection Voltage
HBM	C = 100 pF, R = 1.5 kΩ	±1000 V
CDM		±1000 V

**ELECTROSTATIC DISCHARGE RATINGS**

The electrostatic discharge test is done based on JEITA ED-4701.  
In the HBM method, ESD is applied using the power supply pin and GND pin as reference pins.

■ RECOMMENDED OPERATING CONDITIONS

	Symbol	Conditions	Rating	Unit
Supply Voltage Single Supply Dual Supply	V <sup>+</sup> - V <sup>-</sup> V <sup>+</sup> / V <sup>-</sup>	T <sub>a</sub> = 25°C	4.5 to 36 ±2.25 to ±18	V
Operating Temperature	T <sub>a</sub>		-40 to 125	°C

**RECOMMENDED OPERATING CONDITIONS**

All of electronic equipment should be designed that the mounted semiconductor devices operate within the recommended operating conditions. The semiconductor devices cannot operate normally over the recommended operating conditions, even if they are used over such conditions by momentary electronic noise or surge. And the semiconductor devices may receive serious damage when they continue to operate over the recommended operating conditions.

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### ■ ELECTRICAL CHARACTERISTICS (NJMOP277FE / NJMOP277FR)

$V^+ / V^- = \pm 5V$  to  $\pm 15V$ ,  $T_a = 25^\circ\text{C}$ ,  $V_{\text{COM}} = 0V$ , unless otherwise specified.

Parameter	Symbol	Conditions	MIN	TYP	MAX	Unit
<b>INPUT CHARACTERISTICS *1</b>						
Input Offset Voltage	$V_{\text{IO}}$	$V_{\text{COM}}=0V$ , $R_s=50\Omega$ $T_a = -40^\circ\text{C}$ to $125^\circ\text{C}$	-	10	20	$\mu\text{V}$
			-	-	50	$\mu\text{V}$
Input Offset Voltage Drift	$\Delta V_{\text{IO}}/\Delta T$	$V_{\text{COM}}=0V$ , $R_s=50\Omega$ , $T_a = -40^\circ\text{C}$ to $125^\circ\text{C}$	-	0.1	0.15	$\mu\text{V}/^\circ\text{C}$
Input Bias Current	$I_B$	$V_{\text{COM}}=0V$ $T_a = -40^\circ\text{C}$ to $125^\circ\text{C}$	-	0.5	2.5	nA
			-	-	4	nA
Input Offset Current	$I_{\text{IO}}$	$V_{\text{COM}}=0V$ $T_a = -40^\circ\text{C}$ to $125^\circ\text{C}$	-	0.5	1	nA
			-	-	2	nA
Open-Loop Voltage Gain	$A_{\text{V1}}$	$V_{\text{O}}=(V^+-0.5V)$ to $(V^+-1.5V)$ , $R_L=10\text{k}\Omega$ to $0V$	126	140	-	dB
	$A_{\text{V2}}$	$V_{\text{O}}=(V^+-1.5V)$ to $(V^+-2V)$ , $R_L=2\text{k}\Omega$ to $0V$ $T_a = -40^\circ\text{C}$ to $125^\circ\text{C}$	126 120	134 -	- -	dB
Common-Mode Rejection Ratio	CMR	$V_{\text{ICM}}=(V^+-2V)$ to $(V^+-2V)$ $T_a = -40^\circ\text{C}$ to $125^\circ\text{C}$	115	140	-	dB
			115	-	-	dB
Common-Mode Input Voltage Range	$V_{\text{ICM}}$	CMR $\geq 115\text{dB}$ $T_a = -40^\circ\text{C}$ to $125^\circ\text{C}$	$V^+-2$	-	$V^+-2$	V
			$V^+-2$	-	$V^+-2$	V
<b>OUTPUT CHARACTERISTICS</b>						
High-level Output Voltage	$V_{\text{OH1}}$	$R_L=10\text{k}\Omega$ to $0V$ $T_a = -40^\circ\text{C}$ to $125^\circ\text{C}$	$V^+-1.5$	$V^+-1.25$	-	V
			$V^+-1.5$	-	-	V
	$V_{\text{OH2}}$	$R_L=2\text{k}\Omega$ to $0V$ $T_a = -40^\circ\text{C}$ to $125^\circ\text{C}$	$V^+-2$	$V^+-1.3$	-	V
			$V^+-2$	-	-	V
Low-level Output Voltage	$V_{\text{OL1}}$	$R_L=10\text{k}\Omega$ to $0V$ $T_a = -40^\circ\text{C}$ to $125^\circ\text{C}$	-	$V^++0.2$	$V^++0.5$	V
			-	-	$V^++0.5$	V
	$V_{\text{OL2}}$	$R_L=2\text{k}\Omega$ to $0V$ $T_a = -40^\circ\text{C}$ to $125^\circ\text{C}$	-	$V^++0.5$	$V^++1.5$	V
			-	-	$V^++1.5$	V
Output Short-Circuit Current	$I_{\text{SC}}$	Short to $0V$	-	$\pm 30$	-	mA
<b>POWER SUPPLY</b>						
Supply Current	$I_{\text{SUPPLY}}$	No Signal, $R_L=\text{OPEN}$ $T_a = -40^\circ\text{C}$ to $125^\circ\text{C}$	-	760	800	$\mu\text{A}$
			-	-	900	$\mu\text{A}$
Supply Voltage Rejection Ratio	SVR	$V^+ / V^- = \pm 2.25V$ to $\pm 15V$ $T_a = -40^\circ\text{C}$ to $125^\circ\text{C}$	120	140	-	dB
			120	-	-	dB

\*1 Input offset voltage and drift, Input bias and offset current are positive or negative, its absolute values are listed in electrical characteristics.

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### ■ ELECTRICAL CHARACTERISTICS (NJMOP277FE / NJMOP277FR) (Continued)

$V^+ / V^- = \pm 5V$  to  $\pm 15V$ ,  $T_a = 25^\circ C$ ,  $V_{COM} = 0V$ , unless otherwise specified.

Parameter	Symbol	Conditions	MIN	TYP	MAX	Unit
<b>AC CHARACTERISTICS</b>						
Gain Bandwidth Product	GBW	$R_L=2k\Omega$ to $0V$ , $C_L=20pF$ , $f=10kHz$	-	1	-	MHz
Phase Margin	$\Phi_m$	$R_L=2k\Omega$ to $0V$ , $C_L=20pF$	-	65	-	deg
Gain Margin	$G_m$	$R_L=2k\Omega$ to $0V$ , $C_L=20pF$	-	20	-	dB
Slew Rate	SR	$G_v=0dB$ , $R_L=2k\Omega$ to $0V$ , $C_L=20pF$ $V_{IN}=5V_{pp}$	-	0.7	-	$V/\mu s$
Settling Time 0.1%	$t_s$	$G_v=0dB$ , $R_L=2k\Omega$ to $0V$ , $C_L=20pF$ $V_{IN}=10V_{pp}$	-	14	-	$\mu s$
Equivalent Input Noise Voltage	$e_n$	$f=1kHz$	-	8	-	$nV/\sqrt{Hz}$
	$V_n$	$f=0.1Hz$ to $10Hz$	-	0.2	-	$\mu V_{pp}$
Equivalent Input Noise Current	$I_n$	$f=1kHz$	-	0.2	-	$pA/\sqrt{Hz}$
Total Harmonic Distortion + Noise	THD+N	$G_v=0dB$ , $R_L=2k\Omega$ to $0V$ , $C_L=20pF$ $V_o=10V_{pp}$ , $f=1kHz$	-	0.002	-	%

### OUTPUT CHARACTERISTICS

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■ ELECTRICAL CHARACTERISTICS (NJMOP277GE / NJMOP277GR)

$V^+ / V^- = \pm 5V$  to  $\pm 15V$ ,  $T_a = 25^\circ C$ ,  $V_{COM} = 0V$ , unless otherwise specified.

Parameter	Symbol	Conditions	MIN	TYP	MAX	Unit
<b>INPUT CHARACTERISTICS *1</b>						
Input Offset Voltage	$V_{IO}$	$V_{COM}=0V$ , $R_s=50\Omega$ $T_a = -40^\circ C$ to $125^\circ C$	-	20	50	$\mu V$
			-	-	100	$\mu V$
Input Offset Voltage Drift	$\Delta V_{IO}/\Delta T$	$V_{COM}=0V$ , $R_s=50\Omega$ , $T_a = -40^\circ C$ to $125^\circ C$	-	0.1	0.6	$\mu V/^\circ C$
Input Bias Current	$I_B$	$V_{COM}=0V$ $T_a = -40^\circ C$ to $125^\circ C$	-	0.5	2.5	nA
			-	-	4	nA
Input Offset Current	$I_{IO}$	$V_{COM}=0V$ $T_a = -40^\circ C$ to $125^\circ C$	-	0.5	2	nA
			-	-	3	nA
Open-Loop Voltage Gain	$A_{V1}$	$V_O=(V^++0.5V)$ to $(V^+-1.5V)$ , $R_L=10k\Omega$ to $0V$	126	140	-	dB
	$A_{V2}$	$V_O=(V^++1.5V)$ to $(V^+-2V)$ , $R_L=2k\Omega$ to $0V$ $T_a = -40^\circ C$ to $125^\circ C$	126 120	134 -	- -	dB
Common-Mode Rejection Ratio	CMR	$V_{ICM}=(V^++2V)$ to $(V^+-2V)$ $T_a = -40^\circ C$ to $125^\circ C$	115	140	-	dB
			115	-	-	dB
Common-Mode Input Voltage Range	$V_{ICM}$	CMR $\geq 115dB$ $T_a = -40^\circ C$ to $125^\circ C$	$V^++2$	-	$V^+-2$	V
			$V^+-2$	-	$V^+-2$	V
<b>OUTPUT CHARACTERISTICS</b>						
High-level Output Voltage	$V_{OH1}$	$R_L=10k\Omega$ to $0V$ $T_a = -40^\circ C$ to $125^\circ C$	$V^+-1.5$	$V^+-1.25$	-	V
			$V^+-1.5$	-	-	V
	$V_{OH2}$	$R_L=2k\Omega$ to $0V$ $T_a = -40^\circ C$ to $125^\circ C$	$V^+-2$	$V^+-1.3$	-	V
			$V^+-2$	-	-	V
Low-level Output Voltage	$V_{OL1}$	$R_L=10k\Omega$ to $0V$ $T_a = -40^\circ C$ to $125^\circ C$	-	$V^++0.2$	$V^++0.5$	V
			-	-	$V^++0.5$	V
	$V_{OL2}$	$R_L=2k\Omega$ to $0V$ $T_a = -40^\circ C$ to $125^\circ C$	-	$V^++0.5$	$V^++1.5$	V
			-	-	$V^++1.5$	V
Output Short-Circuit Current	$I_{SC}$	Short to $0V$	-	$\pm 30$	-	mA
<b>POWER SUPPLY</b>						
Supply Current	$I_{SUPPLY}$	No Signal, $R_L=OPEN$ $T_a = -40^\circ C$ to $125^\circ C$	-	760	800	$\mu A$
			-	-	900	$\mu A$
Supply Voltage Rejection Ratio	SVR	$V^+ / V^- = \pm 2.25V$ to $\pm 15V$ $T_a = -40^\circ C$ to $125^\circ C$	120	140	-	dB
			120	-	-	dB

\*1 Input offset voltage and drift, Input bias and offset current are positive or negative, its absolute values are listed in electrical characteristics.



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### ■ ELECTRICAL CHARACTERISTICS (NJMOP277GE / NJMOP277GR) (Continued)

$V^+ / V^- = \pm 5V$  to  $\pm 15V$ ,  $T_a = 25^\circ C$ ,  $V_{COM} = 0V$ , unless otherwise specified.

Parameter	Symbol	Conditions	MIN	TYP	MAX	Unit
<b>AC CHARACTERISTICS</b>						
Gain Bandwidth Product	GBW	$R_L=2k\Omega$ to $0V$ , $C_L=20pF$ , $f=10kHz$	-	1	-	MHz
Phase Margin	$\Phi_m$	$R_L=2k\Omega$ to $0V$ , $C_L=20pF$	-	65	-	deg
Gain Margin	$G_m$	$R_L=2k\Omega$ to $0V$ , $C_L=20pF$	-	20	-	dB
Slew Rate	SR	$G_V=0dB$ , $R_L=2k\Omega$ to $0V$ , $C_L=20pF$ $V_{IN}=5V_{pp}$	-	0.7	-	$V/\mu s$
Settling Time 0.1%	$t_s$	$G_V=0dB$ , $R_L=2k\Omega$ to $0V$ , $C_L=20pF$ $V_{IN}=10V_{pp}$	-	14	-	$\mu s$
Equivalent Input Noise Voltage	$e_n$	$f=1kHz$	-	8	-	$nV/\sqrt{Hz}$
	$V_n$	$f=0.1Hz$ to $10Hz$	-	0.2	-	$\mu V_{pp}$
Equivalent Input Noise Current	$I_n$	$f=1kHz$	-	0.2	-	$pA/\sqrt{Hz}$
Total Harmonic Distortion + Noise	THD+N	$G_V=0dB$ , $R_L=2k\Omega$ to $0V$ , $C_L=20pF$ $V_O=10V_{pp}$ , $f=1kHz$	-	0.002	-	%

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■ ELECTRICAL CHARACTERISTICS (NJMOP2277GE / NJMOP2277GR)

$V^+ / V^- = \pm 5V$  to  $\pm 15V$ ,  $T_a = 25^\circ C$ ,  $V_{COM} = 0V$ , unless otherwise specified.

Parameter	Symbol	Conditions	MIN	TYP	MAX	Unit
<b>INPUT CHARACTERISTICS *1</b>						
Input Offset Voltage	$V_{IO}$	$V_{COM}=0V$ , $R_s=50\Omega$ $T_a = -40^\circ C$ to $125^\circ C$	-	20	50	$\mu V$
			-	-	100	$\mu V$
Input Offset Voltage Drift	$\Delta V_{IO}/\Delta T$	$V_{COM}=0V$ , $R_s=50\Omega$ , $T_a = -40^\circ C$ to $125^\circ C$	-	0.1	0.6	$\mu V/^\circ C$
Input Bias Current	$I_B$	$V_{COM}=0V$ $T_a = -40^\circ C$ to $125^\circ C$	-	0.5	2.5	nA
			-	-	4	nA
Input Offset Current	$I_{IO}$	$V_{COM}=0V$ $T_a = -40^\circ C$ to $125^\circ C$	-	0.5	2	nA
			-	-	3	nA
Open-Loop Voltage Gain	$A_{V1}$	$V_O=(V^++0.5V)$ to $(V^+-1.5V)$ , $R_L=10k\Omega$ to $0V$	126	140	-	dB
	$A_{V2}$	$V_O=(V^++1.5V)$ to $(V^+-2V)$ , $R_L=2k\Omega$ to $0V$ $T_a = -40^\circ C$ to $125^\circ C$	126 120	134 -	- -	dB
Common-Mode Rejection Ratio	CMR	$V_{ICM}=(V^++2V)$ to $(V^+-2V)$ $T_a = -40^\circ C$ to $125^\circ C$	115	140	-	dB
			115	-	-	dB
Common-Mode Input Voltage Range	$V_{ICM}$	CMR $\geq 115dB$ $T_a = -40^\circ C$ to $125^\circ C$	$V^++2$	-	$V^+-2$	V
			$V^+-2$	-	$V^+-2$	V
<b>OUTPUT CHARACTERISTICS</b>						
High-level Output Voltage	$V_{OH1}$	$R_L=10k\Omega$ to $0V$ $T_a = -40^\circ C$ to $125^\circ C$	$V^+-1.5$	$V^+-1.25$	-	V
			$V^+-1.5$	-	-	V
	$V_{OH2}$	$R_L=2k\Omega$ to $0V$ $T_a = -40^\circ C$ to $125^\circ C$	$V^+-2$	$V^+-1.3$	-	V
			$V^+-2$	-	-	V
Low-level Output Voltage	$V_{OL1}$	$R_L=10k\Omega$ to $0V$ $T_a = -40^\circ C$ to $125^\circ C$	-	$V^++0.2$	$V^++0.5$	V
			-	-	$V^++0.5$	V
	$V_{OL2}$	$R_L=2k\Omega$ to $0V$ $T_a = -40^\circ C$ to $125^\circ C$	-	$V^++0.5$	$V^++1.5$	V
			-	-	$V^++1.5$	V
Output Short-Circuit Current	$I_{SC}$	Short to $0V$	-	$\pm 30$	-	mA
<b>POWER SUPPLY</b>						
Supply Current per Amplifier	$I_{SUPPLY}$	No Signal, $R_L=OPEN$ $T_a = -40^\circ C$ to $125^\circ C$	-	760	800	$\mu A$
			-	-	900	$\mu A$
Supply Voltage Rejection Ratio	SVR	$V^+ / V^- = \pm 2.25V$ to $\pm 15V$ $T_a = -40^\circ C$ to $125^\circ C$	120	140	-	dB
			120	-	-	dB

\*1 Input offset voltage and drift, Input bias and offset current are positive or negative, its absolute values are listed in electrical characteristics.

\* NJMOP2277FE and NJMOP2277FR are discontinued products.

### ■ ELECTRICAL CHARACTERISTICS (NJMOP2277GE / NJMOP2277GR) (Continued)

$V^+ / V^- = \pm 5V$  to  $\pm 15V$ ,  $T_a = 25^\circ C$ ,  $V_{COM} = 0V$ , unless otherwise specified.

Parameter	Symbol	Conditions	MIN	TYP	MAX	Unit
<b>AC CHARACTERISTICS</b>						
Gain Bandwidth Product	GBW	$R_L=2k\Omega$ to $0V$ , $C_L=20pF$ , $f=10kHz$	-	1	-	MHz
Phase Margin	$\Phi_m$	$R_L=2k\Omega$ to $0V$ , $C_L=20pF$	-	65	-	deg
Gain Margin	$G_m$	$R_L=2k\Omega$ to $0V$ , $C_L=20pF$	-	20	-	dB
Slew Rate	SR	$G_V=0dB$ , $R_L=2k\Omega$ to $0V$ , $C_L=20pF$ $V_{IN}=5V_{pp}$	-	0.7	-	$V/\mu s$
Settling Time 0.1%	$t_s$	$G_V=0dB$ , $R_L=2k\Omega$ to $0V$ , $C_L=20pF$ $V_{IN}=10V_{pp}$	-	14	-	$\mu s$
Equivalent Input Noise Voltage	$e_n$	$f=1kHz$	-	8	-	$nV/\sqrt{Hz}$
	$V_n$	$f=0.1Hz$ to $10Hz$	-	0.2	-	$\mu V_{pp}$
Equivalent Input Noise Current	$I_n$	$f=1kHz$	-	0.2	-	$pA/\sqrt{Hz}$
Total Harmonic Distortion + Noise	THD+N	$G_V=0dB$ , $R_L=2k\Omega$ to $0V$ , $C_L=20pF$ $V_o=10V_{pp}$ , $f=1kHz$	-	0.002	-	%
Channel Separation	CS	$f=1kHz$	-	120	-	dB

\* NJMOP2277FE and NJMOP2277FR are discontinued products.

### ■ ELECTRICAL CHARACTERISTICS (NJMOP2277KW2)

$V^+ / V^- = \pm 5V$  to  $\pm 15V$ ,  $T_a = 25^\circ\text{C}$ ,  $V_{\text{COM}} = 0V$ , unless otherwise specified.

Parameter	Symbol	Conditions	MIN	TYP	MAX	Unit
<b>INPUT CHARACTERISTICS *1</b>						
Input Offset Voltage	$V_{\text{IO}}$	$V_{\text{COM}}=0V$ , $R_s=50\Omega$ $T_a = -40^\circ\text{C}$ to $125^\circ\text{C}$	-	20	100	$\mu\text{V}$
			-	-	150	$\mu\text{V}$
Input Offset Voltage Drift	$\Delta V_{\text{IO}}/\Delta T$	$V_{\text{COM}}=0V$ , $R_s=50\Omega$ , $T_a = -40^\circ\text{C}$ to $125^\circ\text{C}$	-	0.15	0.7	$\mu\text{V}/^\circ\text{C}$
Input Bias Current	$I_B$	$V_{\text{COM}}=0V$ $T_a = -40^\circ\text{C}$ to $125^\circ\text{C}$	-	0.5	2.5	nA
			-	-	6	nA
Input Offset Current	$I_{\text{IO}}$	$V_{\text{COM}}=0V$ $T_a = -40^\circ\text{C}$ to $125^\circ\text{C}$	-	0.5	2	nA
			-	-	3	nA
Open-Loop Voltage Gain	$A_{v1}$	$V_O=(V^++0.5V)$ to $(V^+-1.5V)$ , $R_L=10k\Omega$ to $0V$	126	140	-	dB
	$A_{v2}$	$V_O=(V^++1.5V)$ to $(V^+-2V)$ , $R_L=2k\Omega$ to $0V$ $T_a = -40^\circ\text{C}$ to $125^\circ\text{C}$	126 120	134 -	- -	dB
Common-Mode Rejection Ratio	CMR	$V_{\text{ICM}}=(V^++2V)$ to $(V^+-2V)$ $T_a = -40^\circ\text{C}$ to $125^\circ\text{C}$	115	140	-	dB
			115	-	-	dB
Common-Mode Input Voltage Range	$V_{\text{ICM}}$	CMR $\geq 115\text{dB}$ $T_a = -40^\circ\text{C}$ to $125^\circ\text{C}$	$V^++2$	-	$V^+-2$	V
			$V^+-2$	-	$V^+-2$	V
<b>OUTPUT CHARACTERISTICS</b>						
High-level Output Voltage	$V_{\text{OH1}}$	$R_L=10k\Omega$ to $0V$ $T_a = -40^\circ\text{C}$ to $125^\circ\text{C}$	$V^+-1.5$	$V^+-1.25$	-	V
			$V^+-1.5$	-	-	V
	$V_{\text{OH2}}$	$R_L=2k\Omega$ to $0V$ $T_a = -40^\circ\text{C}$ to $125^\circ\text{C}$	$V^+-2$	$V^+-1.3$	-	V
			$V^+-2$	-	-	V
Low-level Output Voltage	$V_{\text{OL1}}$	$R_L=10k\Omega$ to $0V$ $T_a = -40^\circ\text{C}$ to $125^\circ\text{C}$	-	$V^++0.2$	$V^++0.5$	V
			-	-	$V^++0.5$	V
	$V_{\text{OL2}}$	$R_L=2k\Omega$ to $0V$ $T_a = -40^\circ\text{C}$ to $125^\circ\text{C}$	-	$V^++0.5$	$V^++1.5$	V
			-	-	$V^++1.5$	V
Output Short-Circuit Current	$I_{\text{SC}}$	Short to $0V$	-	$\pm 30$	-	mA
<b>POWER SUPPLY</b>						
Supply Current per Amplifier	$I_{\text{SUPPLY}}$	No Signal, $R_L=\text{OPEN}$ $T_a = -40^\circ\text{C}$ to $125^\circ\text{C}$	-	760	800	$\mu\text{A}$
			-	-	900	$\mu\text{A}$
Supply Voltage Rejection Ratio	SVR	$V^+ / V^- = \pm 2.25V$ to $\pm 15V$ $T_a = -40^\circ\text{C}$ to $125^\circ\text{C}$	120	140	-	dB
			120	-	-	dB

\*1 Input offset voltage and drift, Input bias and offset current are positive or negative, its absolute values are listed in electrical characteristics.

\* NJMOP2277FE and NJMOP2277FR are discontinued products.

### ■ ELECTRICAL CHARACTERISTICS (NJMOP2277KW2) (Continued)

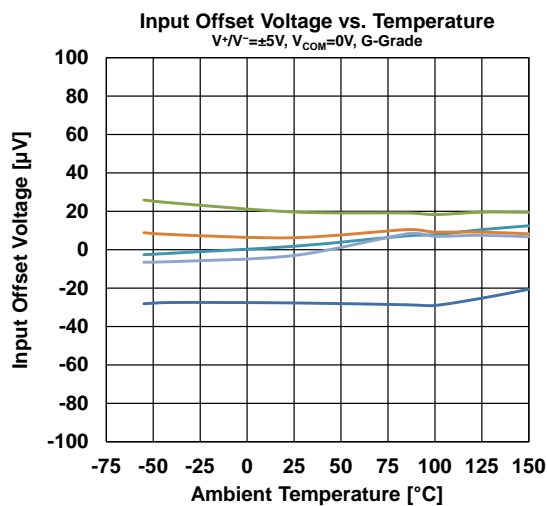
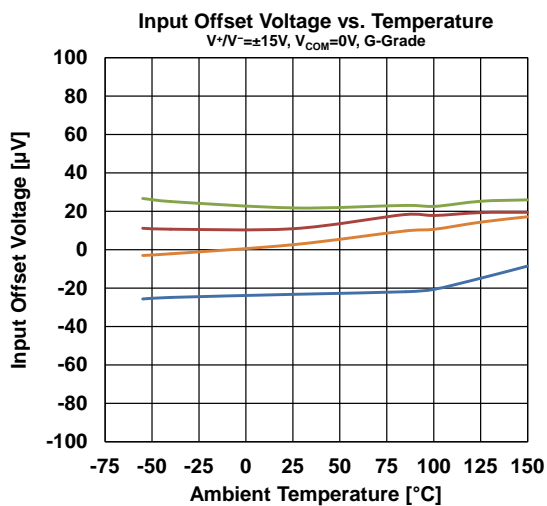
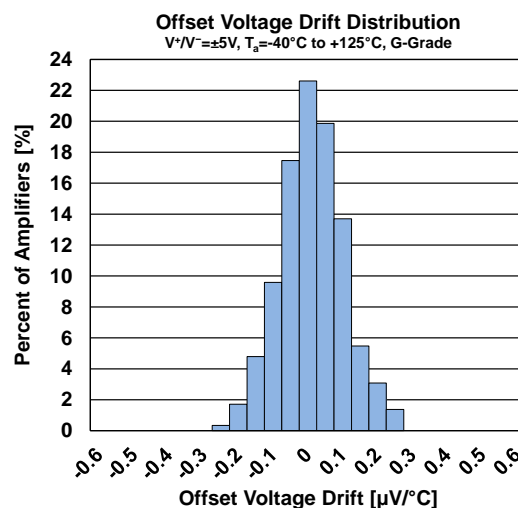
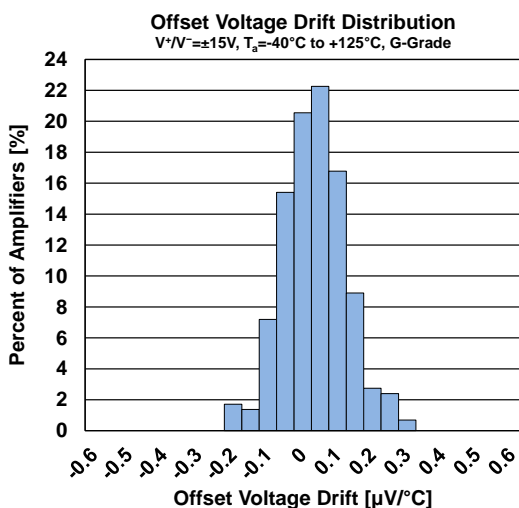
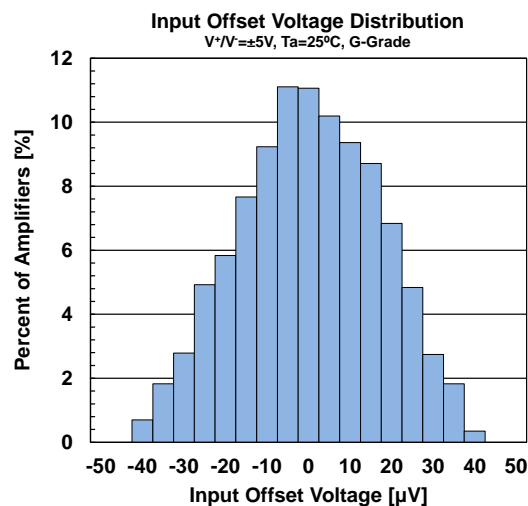
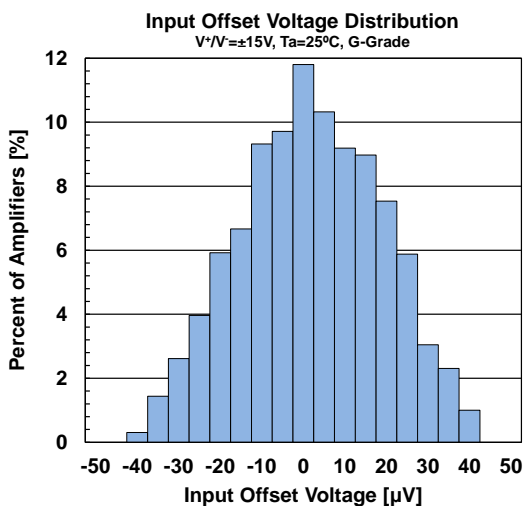
$V^+ / V^- = \pm 5V$  to  $\pm 15V$ ,  $T_a = 25^\circ\text{C}$ ,  $V_{\text{COM}} = 0V$ , unless otherwise specified.

Parameter	Symbol	Conditions	MIN	TYP	MAX	Unit
<b>AC CHARACTERISTICS</b>						
Gain Bandwidth Product	GBW	$R_L=2k\Omega$ to $0V$ , $C_L=20pF$ , $f=10kHz$	-	1	-	MHz
Phase Margin	$\Phi_m$	$R_L=2k\Omega$ to $0V$ , $C_L=20pF$	-	65	-	deg
Gain Margin	$G_m$	$R_L=2k\Omega$ to $0V$ , $C_L=20pF$	-	20	-	dB
Slew Rate	SR	$G_v=0dB$ , $R_L=2k\Omega$ to $0V$ , $C_L=20pF$ $V_{IN}=5V_{pp}$	-	0.7	-	$V/\mu s$
Settling Time 0.1%	$t_s$	$G_v=0dB$ , $R_L=2k\Omega$ to $0V$ , $C_L=20pF$ $V_{IN}=10V_{pp}$	-	14	-	$\mu s$
Equivalent Input Noise Voltage	$e_n$	$f=1kHz$	-	8	-	$nV/\sqrt{Hz}$
	$V_n$	$f=0.1Hz$ to $10Hz$	-	0.2	-	$\mu V_{pp}$
Equivalent Input Noise Current	$I_n$	$f=1kHz$	-	0.2	-	$pA/\sqrt{Hz}$
Total Harmonic Distortion + Noise	THD+N	$G_v=0dB$ , $R_L=2k\Omega$ to $0V$ , $C_L=20pF$ $V_o=10V_{pp}$ , $f=1kHz$	-	0.002	-	%
Channel Separation	CS	$f=1kHz$	-	120	-	dB

\* NJMOP2277FE and NJMOP2277FR are discontinued products.

■ TYPICAL CHARACTERISTICS

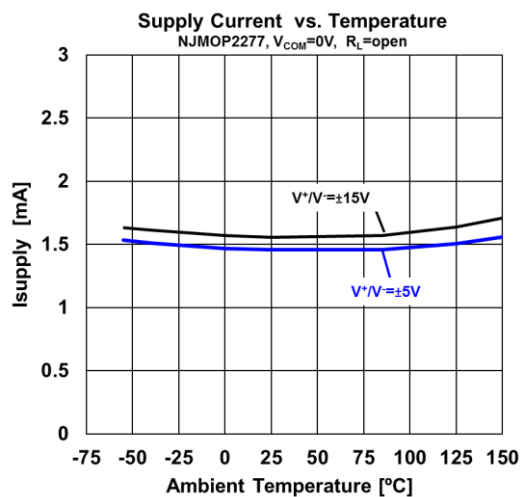
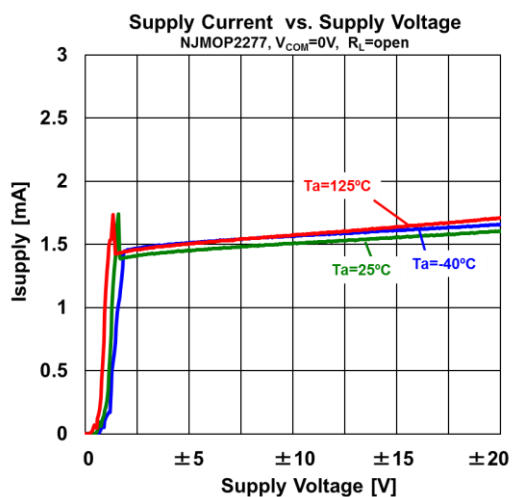
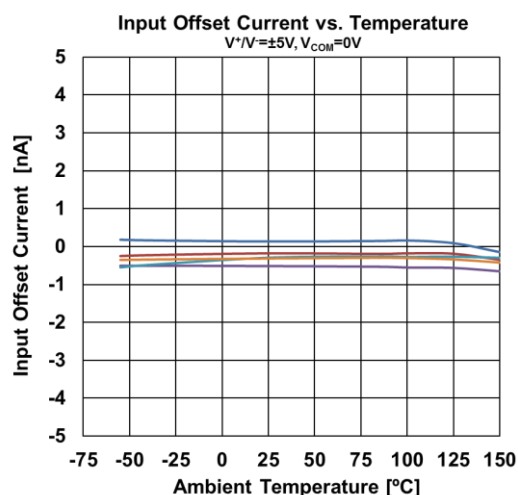
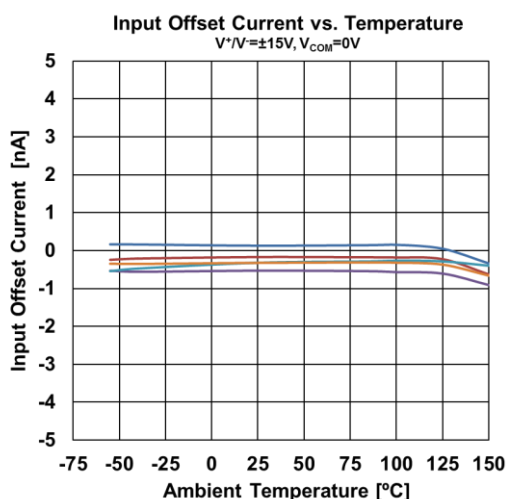
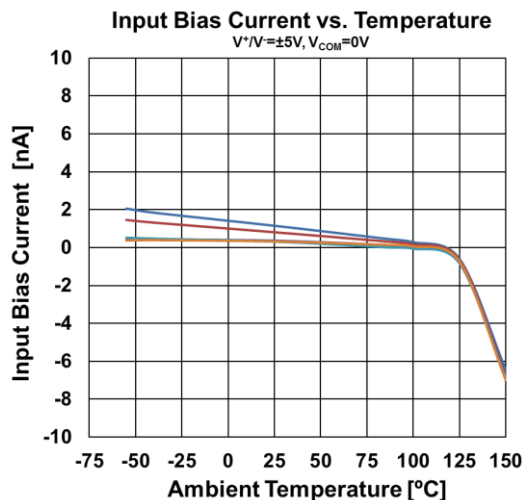
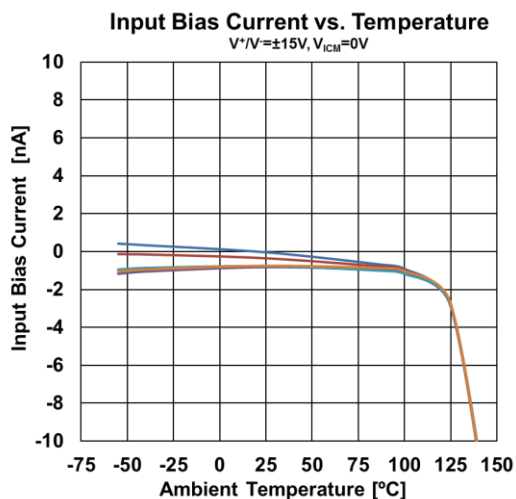
Note: Typical Characteristics are intended to be used as reference data; they are not guaranteed.



\* NJMOP2277FE and NJMOP2277FR are discontinued products.

■ TYPICAL CHARACTERISTICS

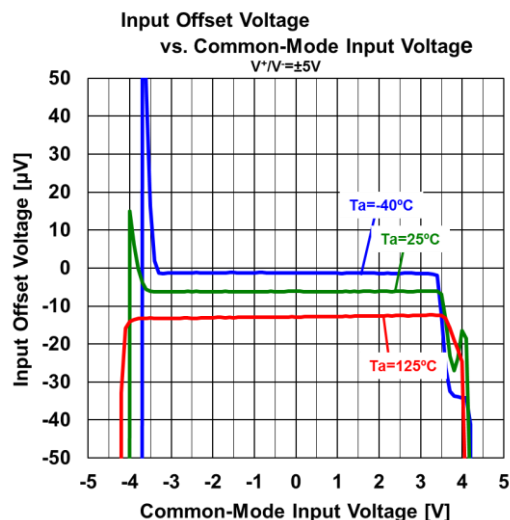
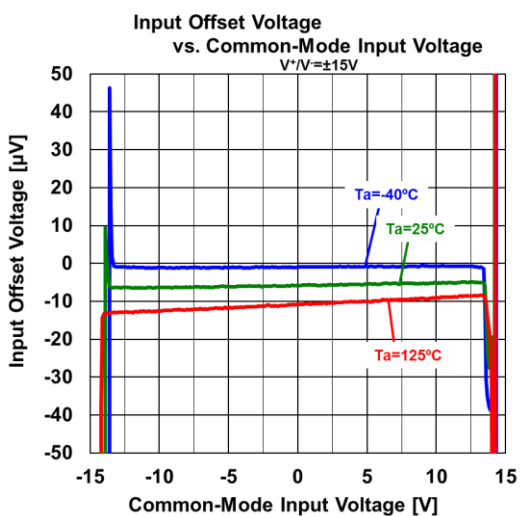
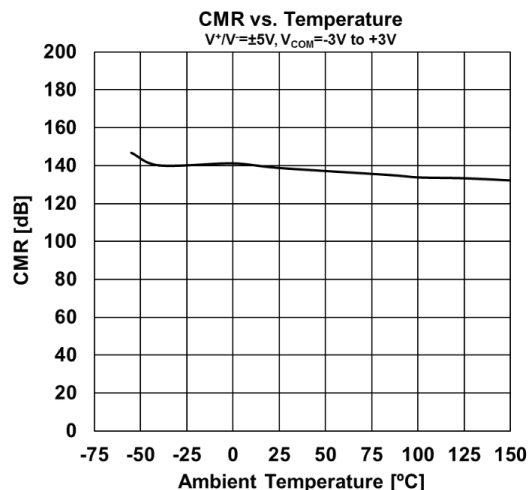
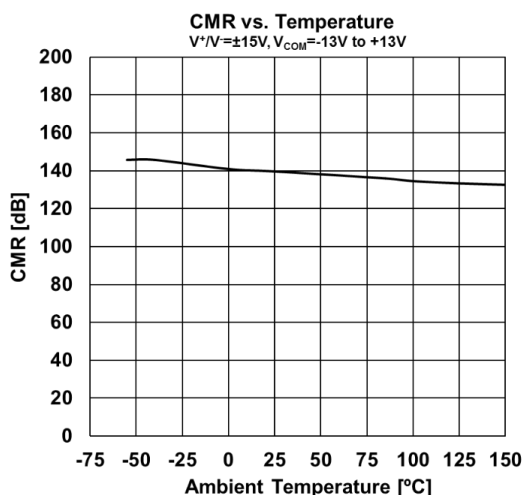
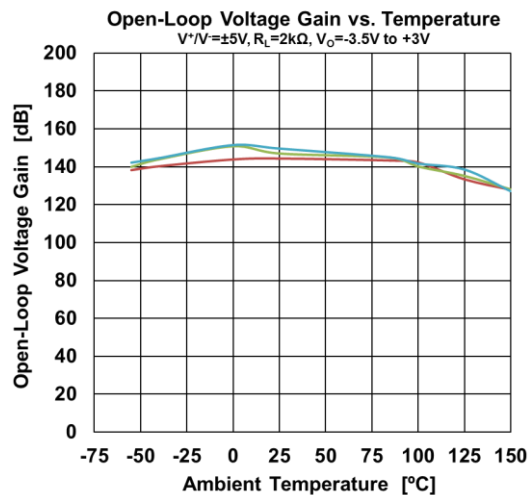
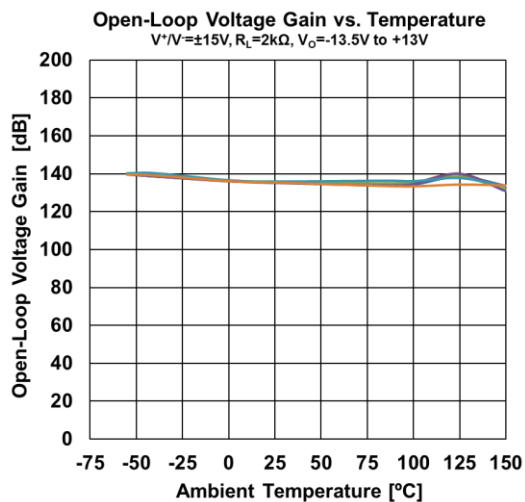
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■ TYPICAL CHARACTERISTICS

Note: Typical Characteristics are intended to be used as reference data; they are not guaranteed.

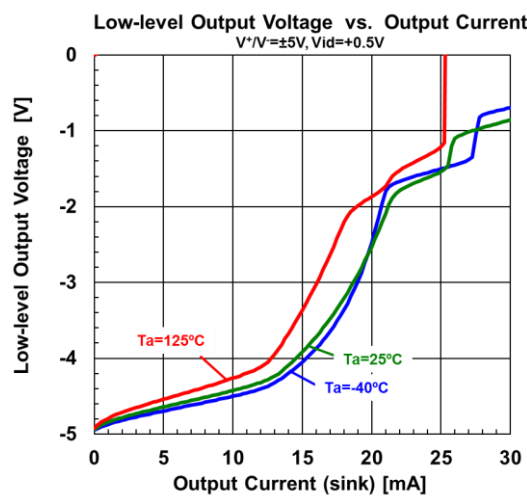
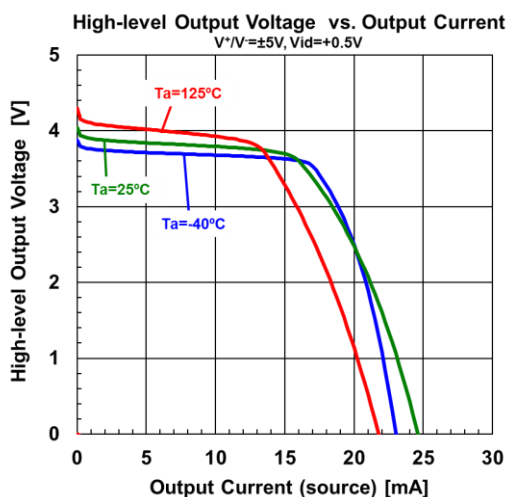
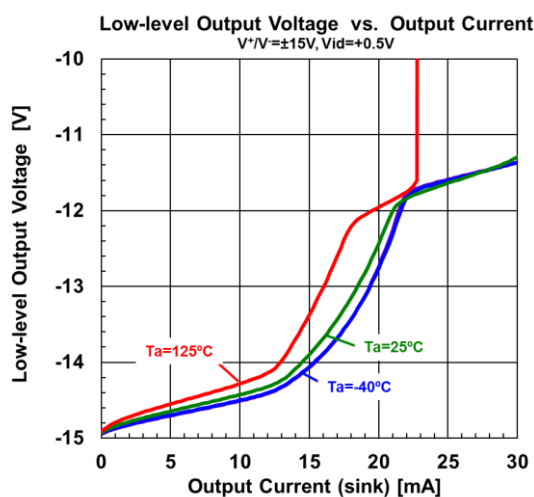
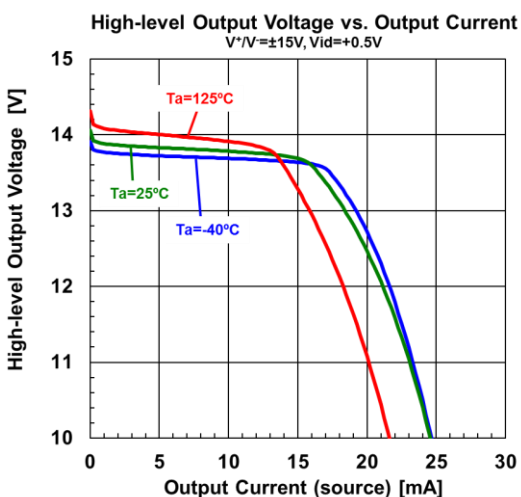
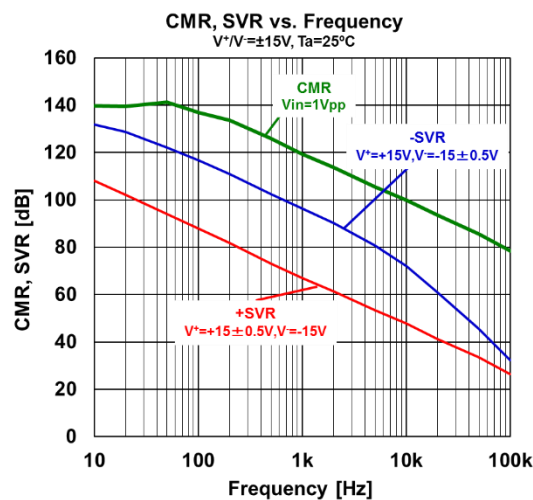
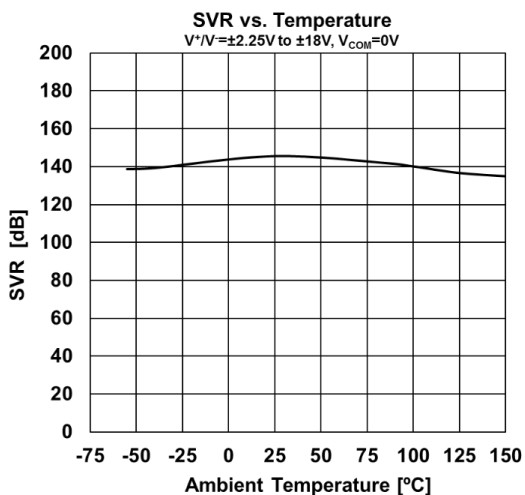




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■ TYPICAL CHARACTERISTICS

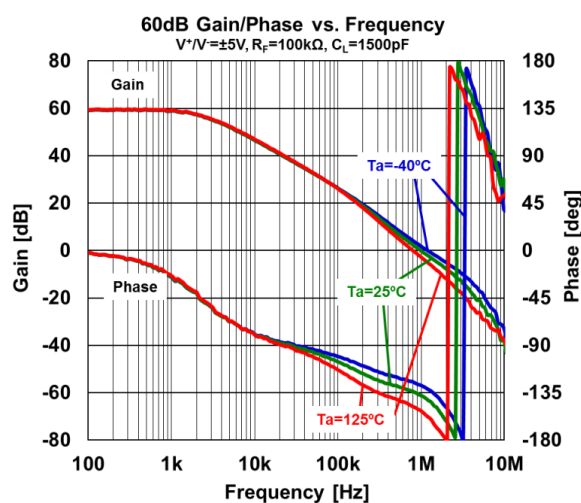
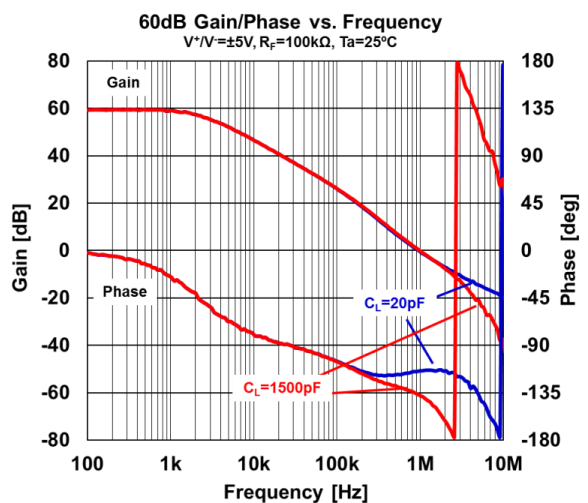
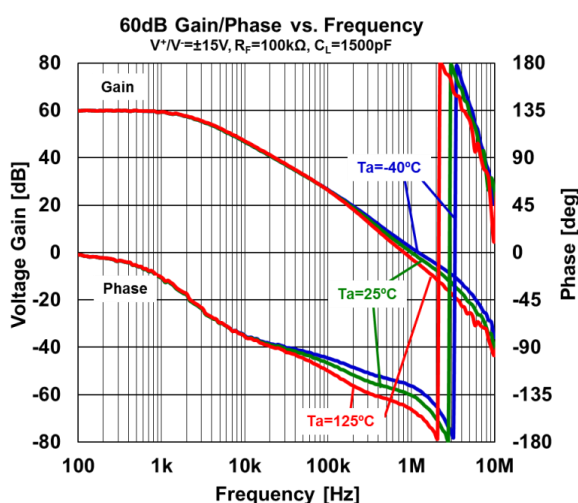
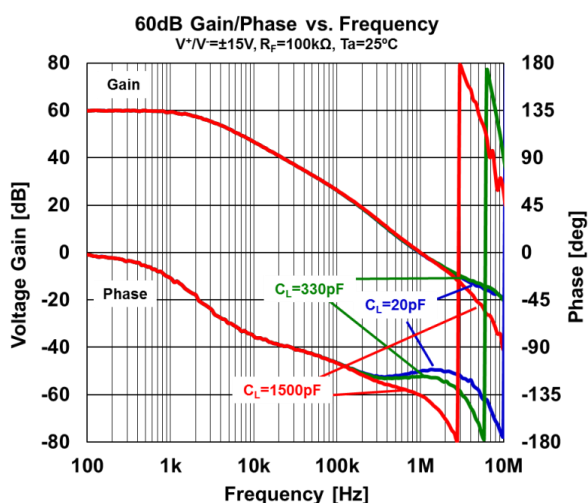
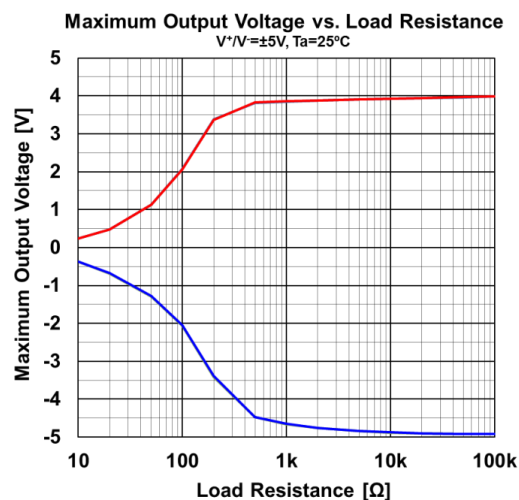
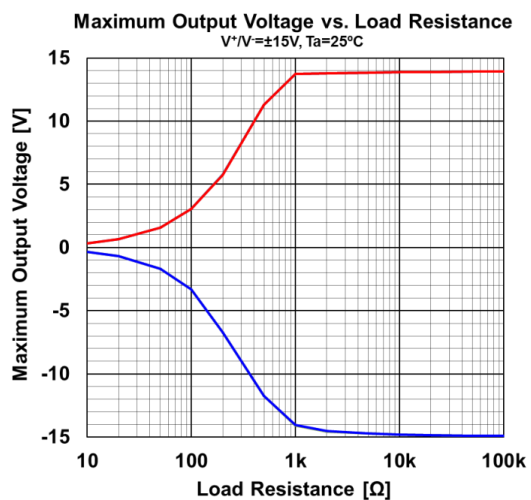
Note: Typical Characteristics are intended to be used as reference data; they are not guaranteed.



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■ TYPICAL CHARACTERISTICS

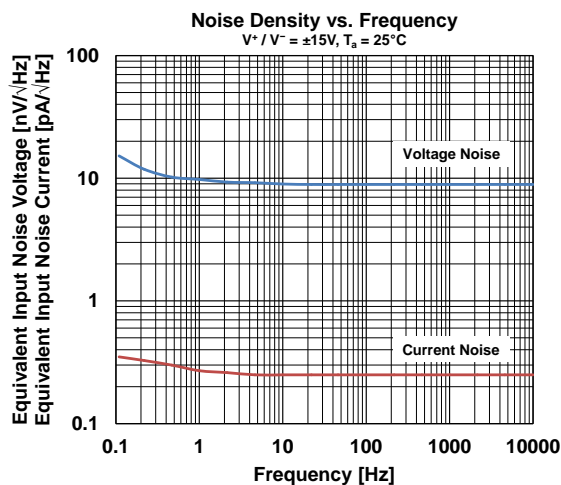
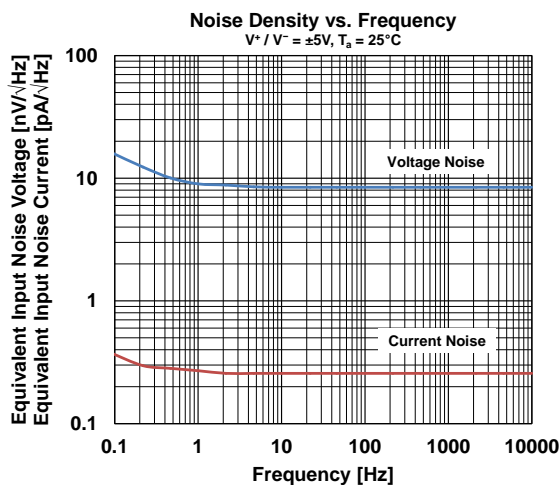
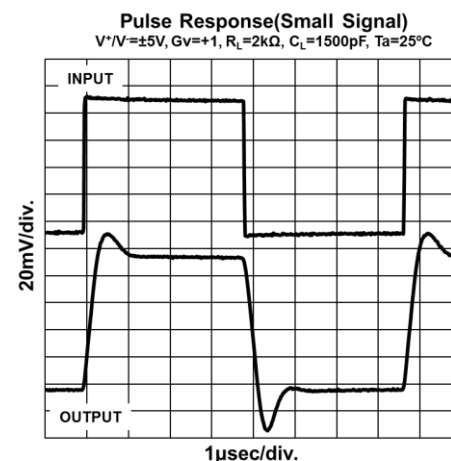
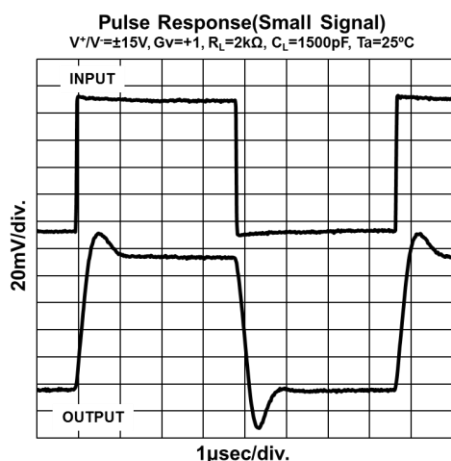
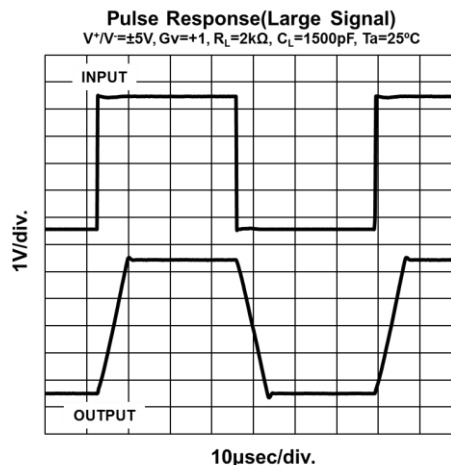
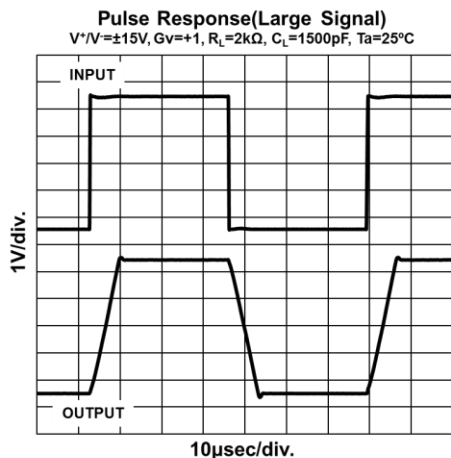
Note: Typical Characteristics are intended to be used as reference data; they are not guaranteed.



\* NJMOP2277FE and NJMOP2277FR are discontinued products.

■ TYPICAL CHARACTERISTICS

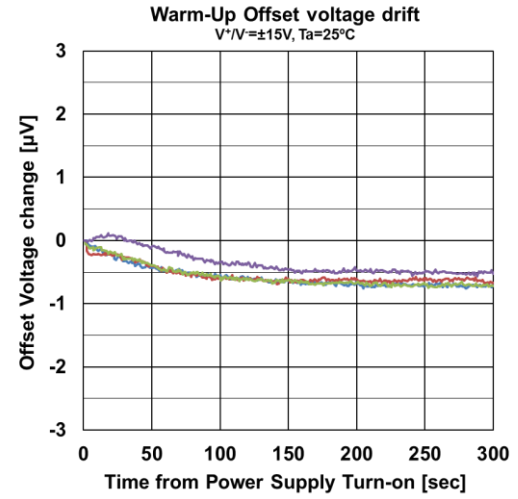
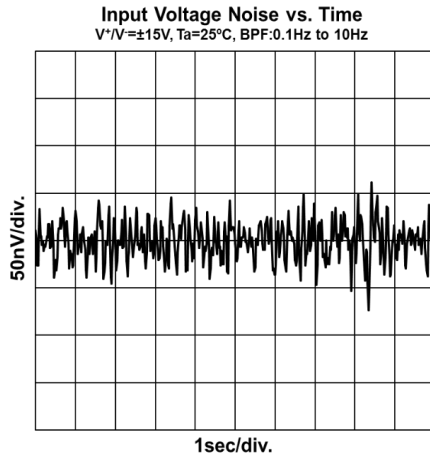
Note: Typical Characteristics are intended to be used as reference data; they are not guaranteed.



\* NJMOP2277FE and NJMOP2277FR are discontinued products.

■ TYPICAL CHARACTERISTICS

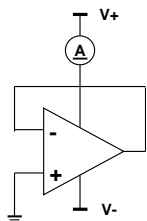
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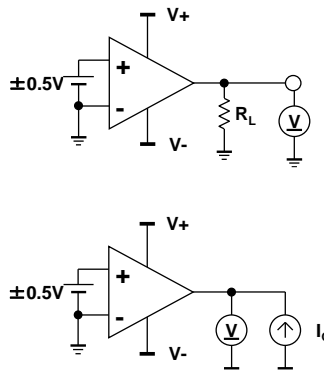
\* NJMOP2277FE and NJMOP2277FR are discontinued products.

■ TEST CIRCUIT

•  $I_{SUPPLY}$

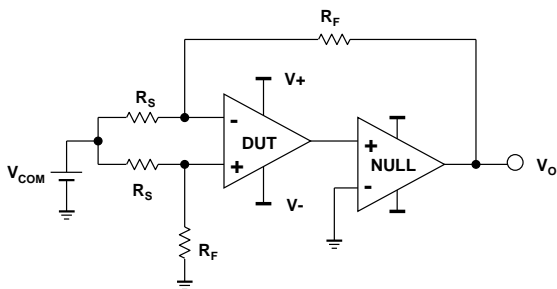


•  $V_{OH}, V_{OL}$

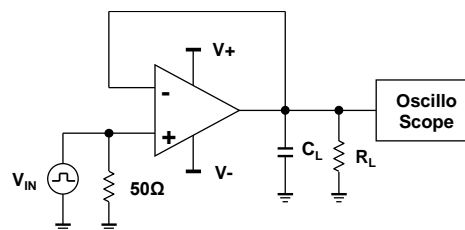


•  $V_{IO}$

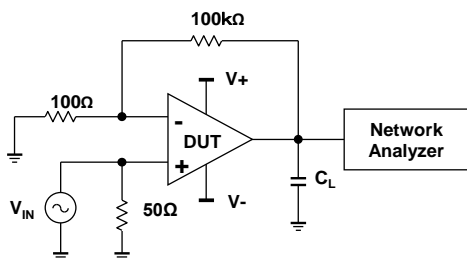
$$R_S=50\Omega, R_F=500k\Omega \quad V_{IO} = \frac{R_S}{R_S + R_F} \times V_o [V]$$



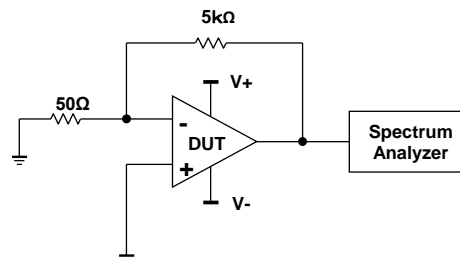
• SR



• GBW



•  $e_n$



\* NJMOP2277FE and NJMOP2277FR are discontinued products.

■ APPLICATION NOTE

Regarding High Precision Operational Amplifier

The NJMOP277 / NJMOP2277 are High Precision Operational Amplifiers featuring low offset voltage and low offset voltage thermal drift. To maximize such a high performance with stable operation, please pay attention to thermocouple effect (Seebeck Effect) and/or Piezo effect.

Thermoelectronic Effect [Seebeck Effect]

The thermoelectromotive force is generated by a temperature gradient when there is contact with dissimilar metals such as relays and switches. The difference in thermoelectromotive force (EMF) between both input pins is output as the input offset voltage. In addition, it is effective to take care to generate an equivalent thermoelectromotive force (EMF) at both input pins in order to reduce the influence of thermoelectromotive force (EMF) on the input offset voltage.

Piezoelectric Effect

When IC is mounted, when stress is applied to the IC, such as warping or bending of the board, a transistor characteristics inside the IC may fluctuate by the piezoelectric effect. Mainly the input offset voltage fluctuates. For high-precision operational amplifiers, chip layout design has been carefully designed to reduce the influence of stress, but the input offset voltage of several  $\mu\text{V}$  to several tens  $\mu\text{V}$  may fluctuate due to stress at the time of mounting.

Attention: the specification value guarantees the characteristics at the time of factory shipment. The characteristic values after mounting may vary depending on the package type, component placement on the board, material of the board and mounting conditions etc., you should evaluate sufficiently with the actual application.

Single and Dual Supply Voltage Operation

NJMOP277 / NJMOP2277 works with both single supply and dual supply when the voltage supplied is between  $V^+$  and  $V^-$ . These amplifiers operate from single +4.5 to +36V supply and dual  $\pm 2.25\text{V}$  to  $\pm 18\text{V}$  supply.

Power Supply Bypassing

The NJMOP277 / NJMOP2277 are high precision operational amplifier featuring low offset voltage, high voltage gain, high CMR, high SVR and so on. To maximize such a high performance with stable operation, the NJMOP277 / NJMOP2277 should be operated by clean and low impedance supply voltage. So, the bypass capacitor should be connected to these both power supply terminals ( $V^+$  and  $V^-$ ) as shown in figure 1. The bypass capacitors should be placed as close as possible to IC package.

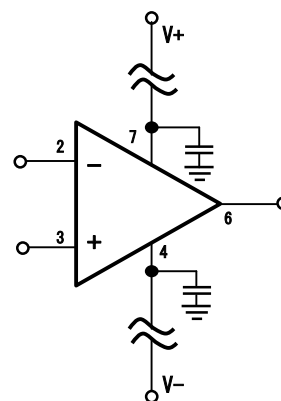


Figure 1.

Differential Amplifier

NJMOP277 / NJMOP2277 are Operational Amplifier featuring  $\text{CMR}=140\text{ dB typ.}$  Differential amplifier (see below figure 2) is used in high accuracy circuit to improve common mode rejection ratio (CMR). A matching between the ratio  $R_1/R_2 = R_3/R_4$  and  $R_1=R_3$  makes the high CMR. For example, acceptable error range to obtain CMR of 130dB or more is about 0.1ppm.

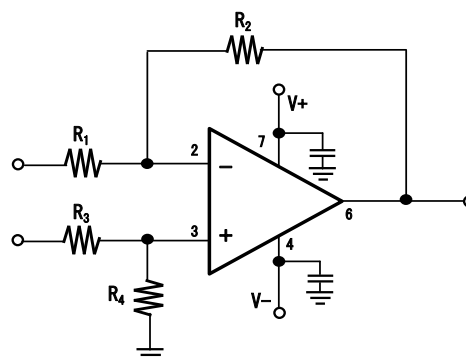


Figure 2.

\* NJMOP2277FE and NJMOP2277FR are discontinued products.

■ APPLICATION NOTE

Input Voltage Exceeding the Supply Voltage

NJMOP277 / NJMOP2277 are protected by ESD diodes (shown in figure 3) 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. Figure 4 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<sub>LIMIT</sub>) as shown in figure4.

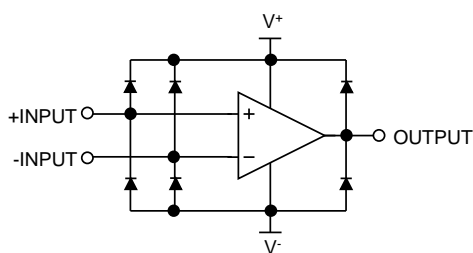


Figure 3. Simplified Schematic

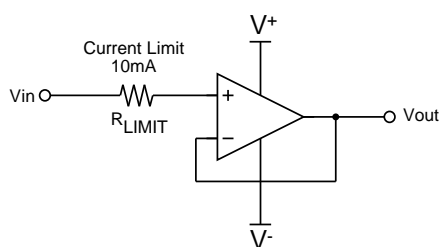


Figure 4. Input Current Protection

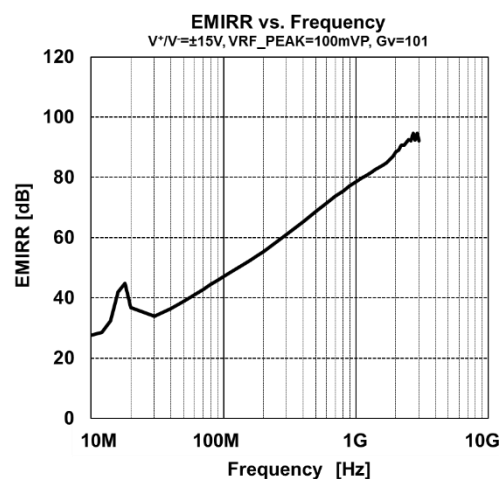
EMIRR (EMI Rejection Ratio) Definition

EMIRR is a parameter indicating the EMI robustness of an OP-Amp. The definition of EMIRR is given by the following formula (1). We can grasp the tolerance of the RF signal by measuring an RF signal and offset voltage shift quantity.

$$EMIRR = 20 \cdot \log \left( \frac{V_{RF\_PEAK}}{|\Delta V_{IO}|} \right) \quad \dots(1)$$

V<sub>RF\_PEAK</sub> :RF Signal Amplitude [V<sub>P</sub>]  
 ΔV<sub>IO</sub> :Input offset voltage shift quantity [V]

Offset voltage shift is small so that a value of EMIRR is big. And it understands that the tolerance for the RF signal is high. In addition, about the input offset voltage shift with the RF signal, there is the thinking that influence applied to the input terminal is dominant. Therefore, generally the EMIRR becomes value that applied an RF signal to +INPUT terminal.

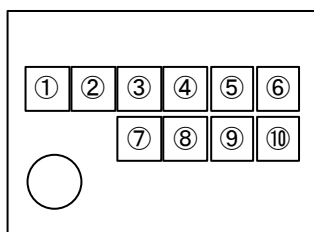


\*For details, refer to "Application Note for EMI Immunity" in our HP.

\* NJMOP2277FE and NJMOP2277FR are discontinued products.

■ MARKING SPECIFICATION (SOP8 JEDEC 150mil (EMP8))

① to ⑥      Product Code      Refer to *Part Marking List*  
 ⑦ to ⑩      Lot Number          Alphanumeric Serial Number



1Pin

**NOTICE**

There can be variation in the marking when different AOI (Automated Optical Inspection) equipment is used. In the case of recognizing the marking characteristic with AOI, please contact our sales or distributor before attempting to use AOI.

**Part Marking List**

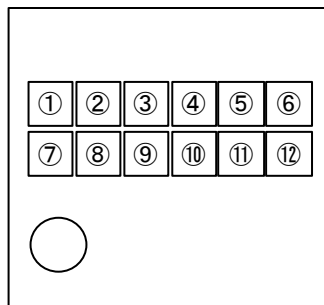
Product Name	①	②	③	④	⑤	⑥
NJMOP277GE		P	2	7	7	G
NJMOP2277GE	P	2	2	7	7	G
NJMOP277FE		P	2	7	7	F



\* NJMOP2277FE and NJMOP2277FR are discontinued products.

■ MARKING SPECIFICATION (MSOP8 (VSP8))

- ① to ⑥      Product Code      Refer to *Part Marking List*
- ⑦ to ⑫      Lot Number              Alphanumeric Serial Number



1Pin

**NOTICE**

There can be variation in the marking when different AOI (Automated Optical Inspection) equipment is used. In the case of recognizing the marking characteristic with AOI, please contact our sales or distributor before attempting to use AOI.

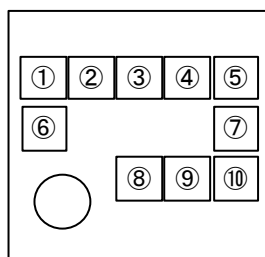
**Part Marking List**

Product Name	①	②	③	④	⑤	⑥
NJMOP277GR			2	7	7	G
NJMOP2277GR		2	2	7	7	G
NJMOP277FR			2	7	7	F

\* NJMOP2277FE and NJMOP2277FR are discontinued products.

■ MARKING SPECIFICATION (DFN8-W2 (ESON8-W2))

① to ⑤      Product Code      Refer to *Part Marking List*  
 ⑥ to ⑩      Lot Number      Alphanumeric Serial Number



1Pin

**NOTICE**

There can be variation in the marking when different AOI (Automated Optical Inspection) equipment is used. In the case of recognizing the marking characteristic with AOI, please contact our sales or distributor before attempting to use AOI.

**Part Marking List**

Product Name	①	②	③	④	⑤
NJMOP2277KW2		2	2	7	7

\* NJMOP2277FE and NJMOP2277FR are discontinued products.

**■ REVISION HISTORY**

Date	Revision	Contents of Changes
April 6, 2017	Ver.1.0	Initial Version
January 25, 2018	Ver.1.1	Updated order information.
August 25, 2020	Ver.2.0	Updated Product lineup.
July 11, 2023	Ver.3.0	Updated datasheet format. Discontinued: NJMOP277FE, NJMOP2277FR
October 30, 2023	Ver.3.1	Collected : "Discontinued : NJMOP2277FE, NJMOP2277FR"

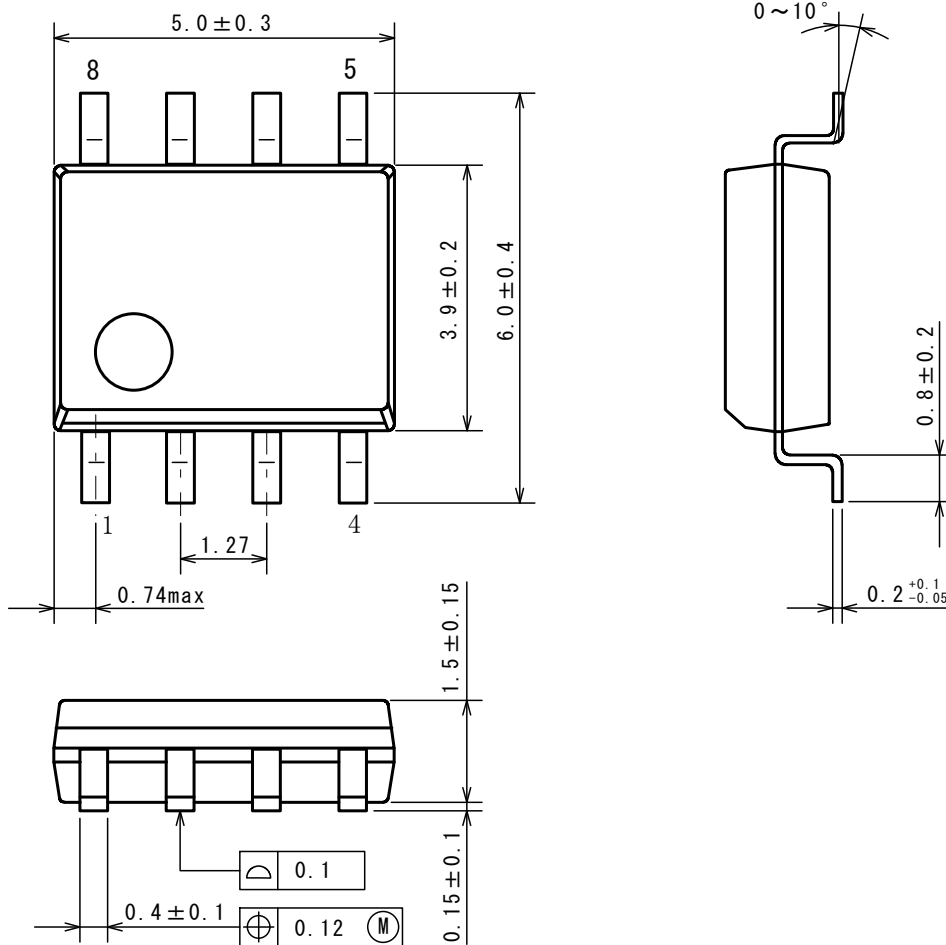
# Nisshinbo Micro Devices Inc.

## SOP8 JEDEC 150mil(EMP8)

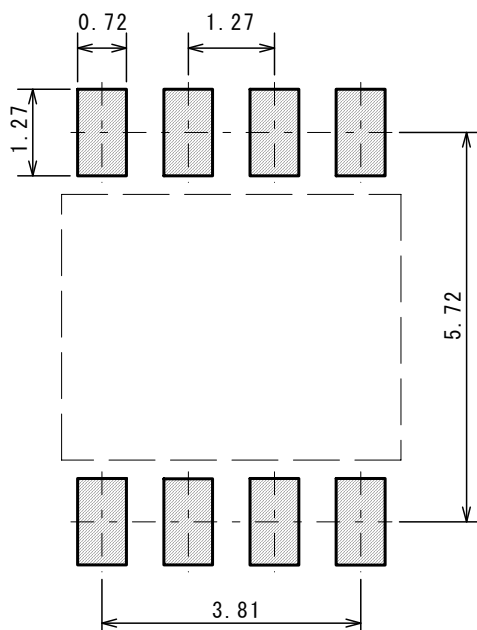
PI-SOP8 JEDEC 150mil-E-B

### ■ PACKAGE DIMENSIONS

UNIT: mm



### ■ EXAMPLE OF SOLDER PADS DIMENSIONS



# Nisshinbo Micro Devices Inc.

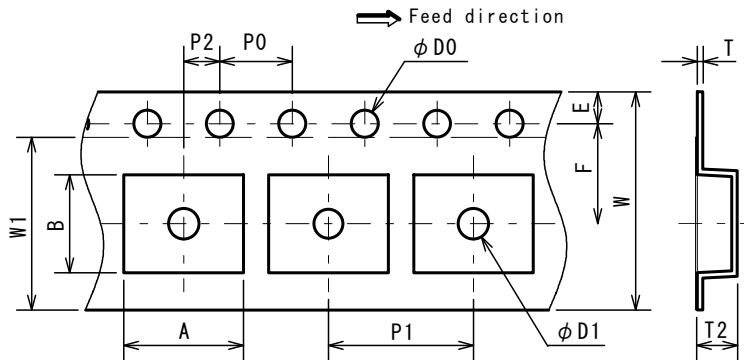
## SOP8 JEDEC 150mil(EMP8)

PI-SOP8 JEDEC 150mil-E-B

### PACKING SPEC

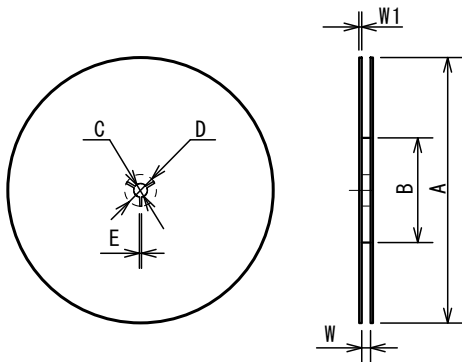
UNIT: mm

#### TAPING DIMENSIONS



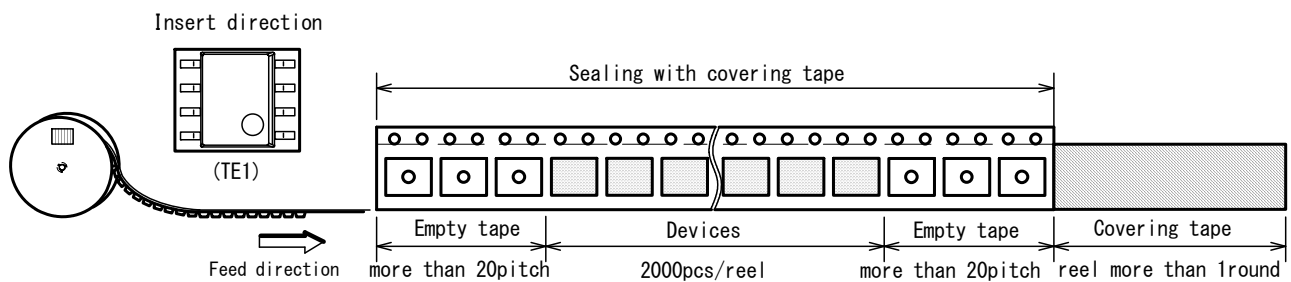
SYMBOL	DIMENSION	REMARKS
A	6.6	BOTTOM DIMENSION
B	5.4	BOTTOM DIMENSION
D0	1.5 <sup>+0.1</sup> <sub>0</sub>	
D1	1.7±0.1	
E	1.75±0.1	
F	5.5±0.05	
P0	4.0±0.1	
P1	8.0±0.1	
P2	2.0±0.05	
T	0.30±0.05	
T2	2.2	
W	12.0±0.3	
W1	9.5	THICKNESS 0.1max

#### REEL DIMENSIONS

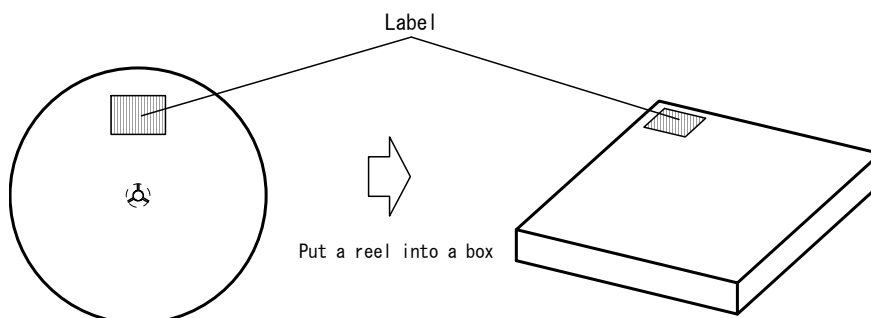


SYMBOL	DIMENSION
A	φ 330±2
B	φ 80±1
C	φ 13±0.2
D	φ 21±0.8
E	2±0.5
W	13.5±0.5
W1	2.0±0.2

#### TAPING STATE



#### PACKING STATE



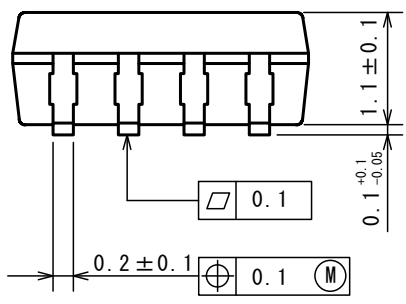
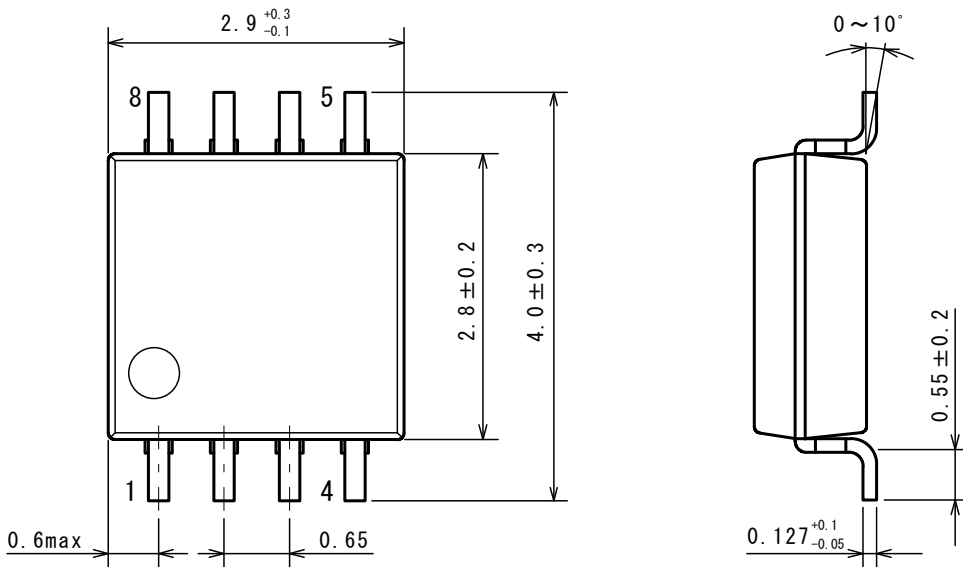
# Nisshinbo Micro Devices Inc.

## MSOP8 (VSP8)

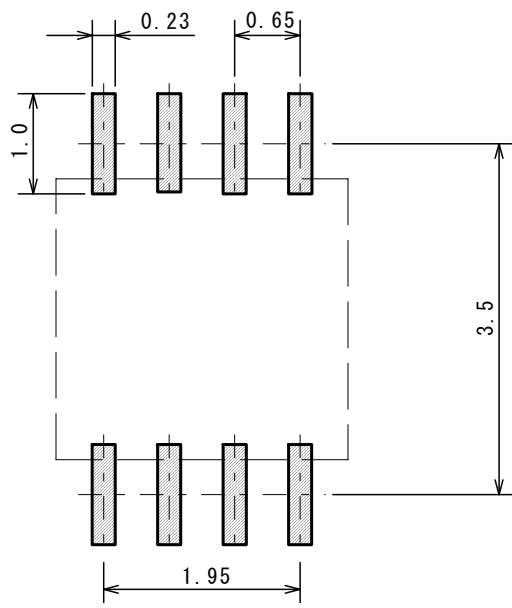
PI-VSP8-E-B

### ■ PACKAGE DIMENSIONS

UNIT: mm



### ■ EXAMPLE OF SOLDER PADS DIMENSIONS



# Nisshinbo Micro Devices Inc.

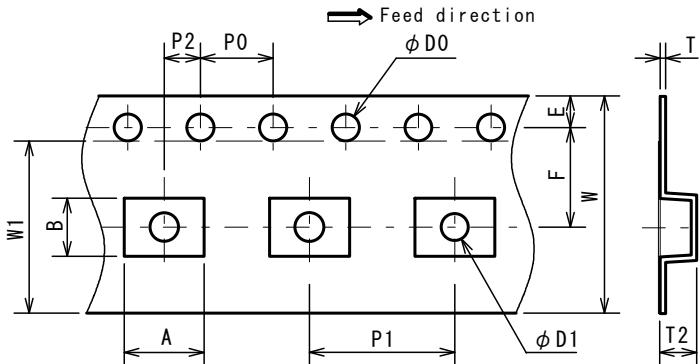
## MSOP8 (VSP8)

PI-VSP8-E-B

### PACKING SPEC

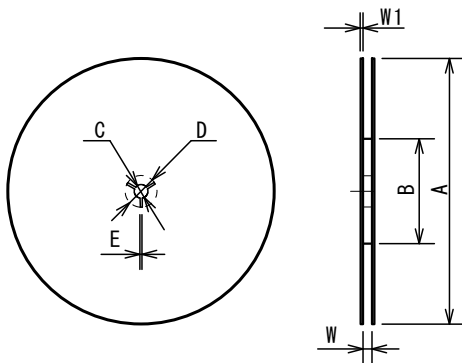
UNIT: mm

#### TAPING DIMENSIONS



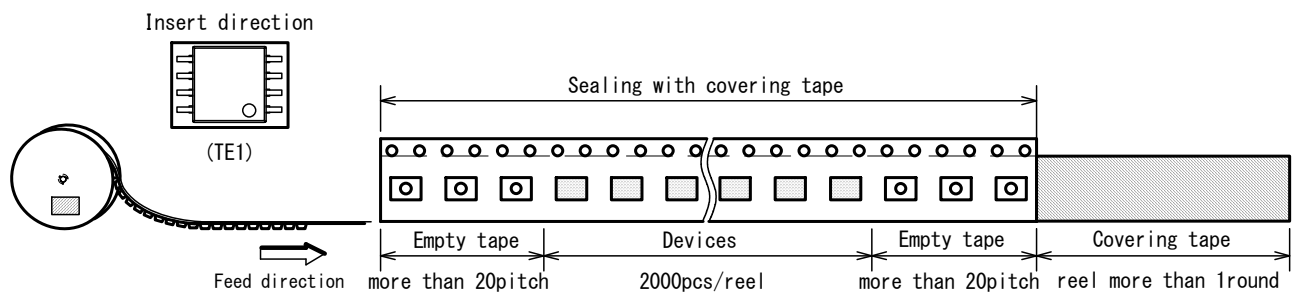
SYMBOL	DIMENSION	REMARKS
A	4.4	BOTTOM DIMENSION
B	3.2	BOTTOM DIMENSION
D0	1.5 <sup>+0.1</sup> <sub>0</sub>	
D1	1.5 <sup>+0.1</sup> <sub>0</sub>	
E	1.75±0.1	
F	5.5±0.05	
P0	4.0±0.1	
P1	8.0±0.1	
P2	2.0±0.05	
T	0.30±0.05	
T2	2.0 (MAX.)	
W	12.0±0.3	
W1	9.5	THICKNESS 0.1max

#### REEL DIMENSIONS

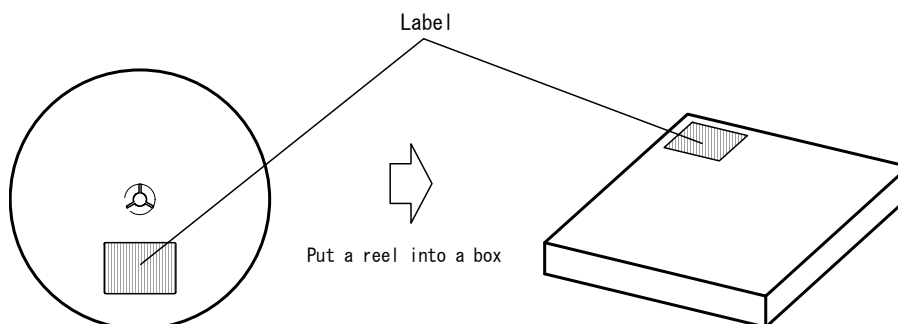


SYMBOL	DIMENSION
A	φ 254±2
B	φ 100±1
C	φ 13±0.2
D	φ 21±0.8
E	2±0.5
W	13.5±0.5
W1	2.0±0.2

#### TAPING STATE



#### PACKING STATE



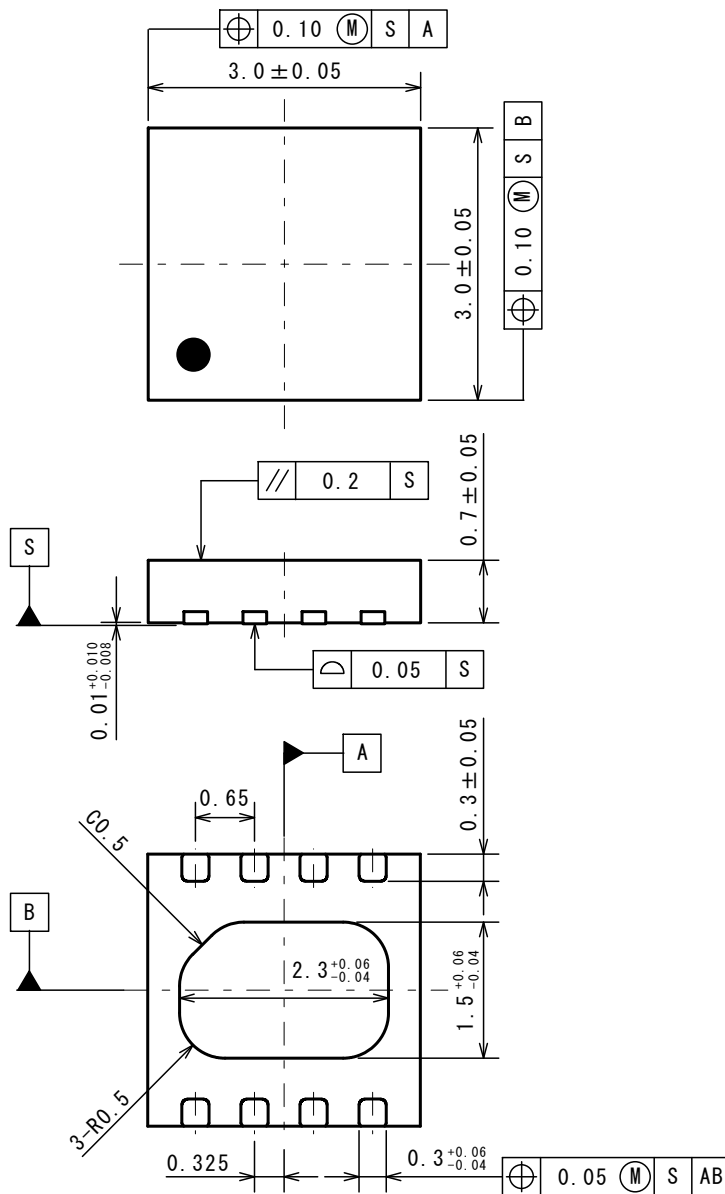
# Nisshinbo Micro Devices Inc.

DFN8-W2(ESON8-W2)

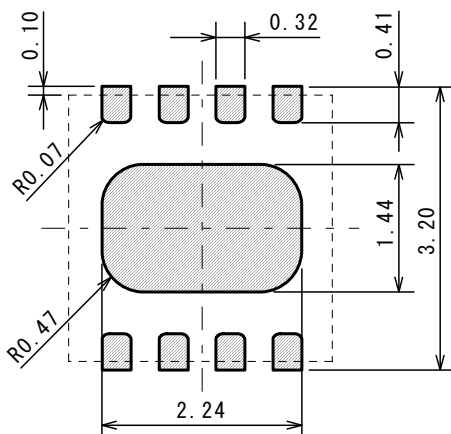
PI-DFN8-W2-E-C

## ■ PACKAGE DIMENSIONS

UNIT: mm



## ■ EXAMPLE OF SOLDER PADS DIMENSIONS





# Nisshinbo Micro Devices Inc.

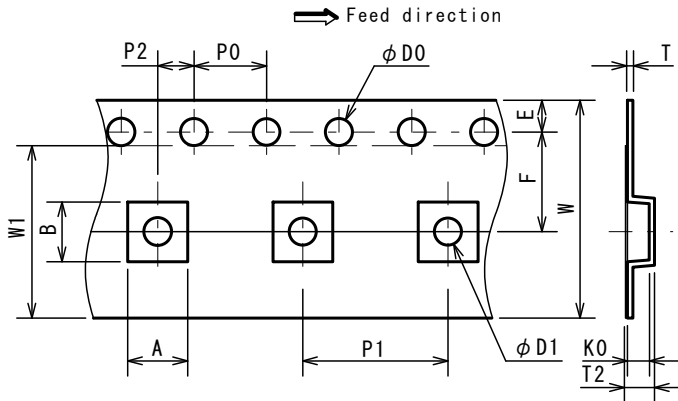
DFN8-W2(ESON8-W2)

PI-DFN8-W2-E-C

■ PACKING SPEC

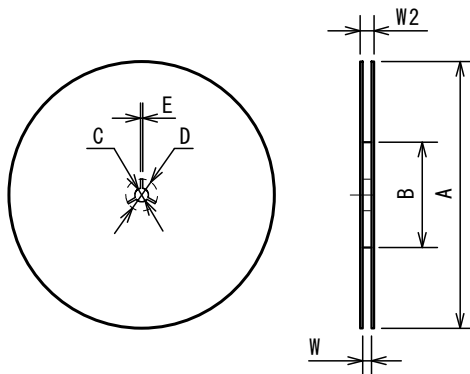
UNIT: mm

TAPING DIMENSIONS



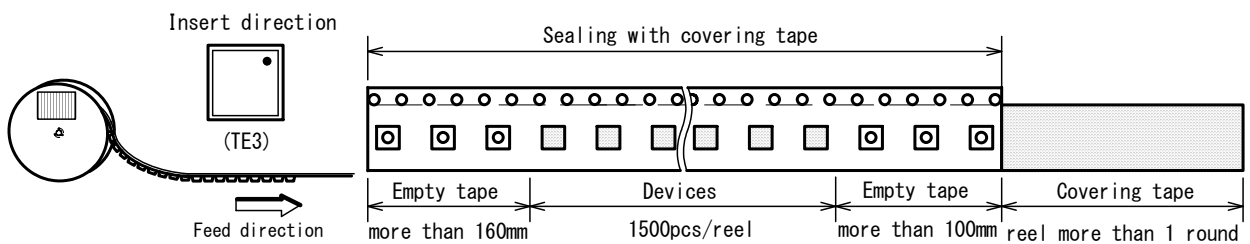
SYMBOL	DIMENSION	REMARKS
A	3.3±0.1	BOTTOM DIMENSION
B	3.3±0.1	BOTTOM DIMENSION
D0	1.5 <sup>+0.1</sup> <sub>0</sub>	
D1	1.5 <sup>+0.1</sup> <sub>0</sub>	
E	1.75±0.1	
F	5.5±0.05	
P0	4.0±0.1	
P1	8.0±0.1	
P2	2.0±0.05	
T	0.30±0.05	
T2	1.3±0.07	
K0	0.9±0.05	
W	12.0 <sup>+0.3</sup> <sub>-0.1</sub>	
W1	9.5	THICKNESS 0.1max

REEL DIMENSIONS

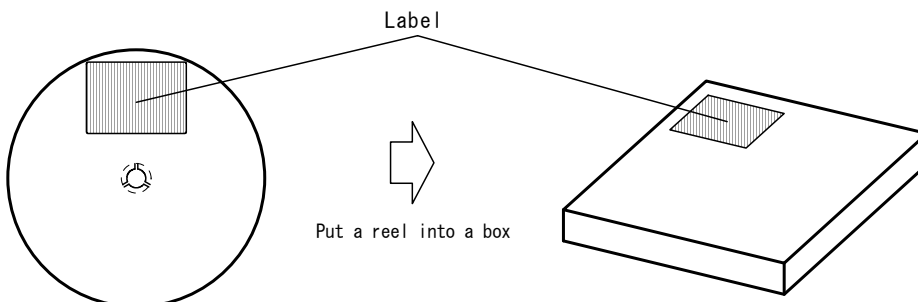


SYMBOL	DIMENSION
A	φ 180 <sup>0</sup> <sub>-3</sub>
B	φ 60 <sup>+1</sup> <sub>0</sub>
C	φ 13±0.2
D	φ 21±0.8
E	2±0.5
W	13 <sup>+1</sup> <sub>0</sub>
W2	15.4±1.0

TAPING STATE



PACKING STATE



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  - Equipment Used in the Deep Sea
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  - Vehicle Control Equipment (automotive, airplane, railroad, ship, etc.)
  - Various Safety Devices
  - Traffic control system
  - Combustion equipment

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7. The 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 datasheet. Failure to employ the products in the proper applications can lead to deterioration, destruction or failure of the products. We shall not be responsible for any bodily injury, fires or accident, property damage or any consequential damages resulting from misuse or misapplication of the products.
8. **Quality Warranty**
  - 8-1. **Quality Warranty Period**

In the case of a product purchased through an authorized distributor or directly from us, the warranty period for this product shall be one (1) year after delivery to your company. For defective products that occurred during this period, we will take the quality warranty measures described in section 8-2. However, if there is an agreement on the warranty period in the basic transaction agreement, quality assurance agreement, delivery specifications, etc., it shall be followed.
  - 8-2. **Quality Warranty Remedies**

When it has been proved defective due to manufacturing factors as a result of defect analysis by us, we will either deliver a substitute for the defective product or refund the purchase price of the defective product.

Note that such delivery or refund is sole and exclusive remedies to your company for the defective product.
  - 8-3. **Remedies after Quality Warranty Period**

With respect to any defect of this product found after the quality warranty period, the defect will be analyzed by us. On the basis of the defect analysis results, the scope and amounts of damage shall be determined by mutual agreement of both parties. Then we will deal with upper limit in Section 8-2. This provision is not intended to limit any legal rights of your company.
9. Anti-radiation design is not implemented in the products described in this document.
10. The X-ray exposure can influence functions and characteristics of the products. Confirm the product functions and characteristics in the evaluation stage.
11. WLCSP products should be used in light shielded environments. The light exposure can influence functions and characteristics of the products under operation or storage.
12. Warning for handling Gallium and Arsenic (GaAs) products (Applying to GaAs MMIC, Photo Reflector). These products use 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 of, please follow the related regulation and do not mix this with general industrial waste or household waste.
13. Please contact our sales representatives should you have any questions or comments concerning the products or the technical information.



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