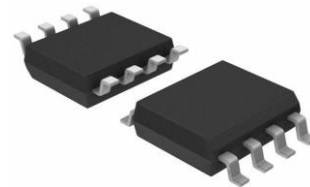


Dual-Channel, Low Offset Operational Amplifier

PRODUCT DESCRIPTION

The MS8228 is an operational amplifier with two channels and low offset voltage, which uses wafer level adjustments to eliminate offset. It also has low bias current and high open-loop gain. All of these characteristics make the MS8228 suitable to be used as a high-gain instrumentation amplifier.

The MS8228 has $\pm 14\text{V}$ wide input voltage range, 106dB common-mode rejection ratio (CMRR) and high input impedance. These features make the amplifier high-precise when amplifying signals. Excellent linearity and precision are guaranteed even at high closed-loop gain.



SOP8

FEATURES

- Low Offset Voltage Drift: $0.3\mu\text{V}/^{\circ}\text{C}$
- Low Noise: $0.35\mu\text{Vp-p}$ (Max)
- Wide Input Voltage Range: $\pm 14\text{V}$ (Typ)
- Wide Supply Voltage: $\pm 3\text{V}$ to $\pm 18\text{V}$

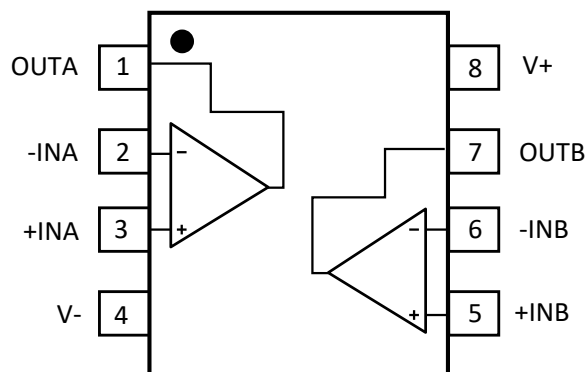
APPLICATIONS

- Wireless Base Station Control Circuit
- Optical Fiber Network Control Circuit
- Instrumentation Amplifier
- Sensor, Controller and Thermocouple
- Thermal Resistance Monitoring
- Strain Bridge
- Parallel Current Monitoring
- Precision Filter

PRODUCT SPECIFICATION

Part Number	Package	Marking
MS8228	SOP8	MS8228

PIN CONFIGURATION



PIN DESCRIPTION

Pin	Name	Type	Description
1	OUTA	O	Channel A Output
2	-INA	I	Negative Input (Channel A)
3	+INA	I	Positive Input (Channel A)
4	V-	-	Negative Power Supply
5	+INB	I	Positive Input (Channel B)
6	-INB	I	Negative Input (Channel B)
7	OUTB	O	Channel B Output
8	V+	-	Positive Power Supply

ABSOLUTE MAXIMUM RATINGS

Any exceeding absolute maximum rating application causes permanent damage to device. Because long-time absolute operation state affects device reliability. Absolute ratings just conclude from a series of extreme tests. It doesn't represent chip can operate normally in these extreme conditions.

Parameter	Symbol	Ratings	Unit
Power Supply	$V_S=(V_+)-(V_-)$	40	V
Input Voltage		$V_- \sim V_+$	V
Differential Input Voltage		± 30	V
Maximum Junction Temperature	T_{JMAX}	150	°C
Operating Temperature Range	T_A	-40 ~ 125	°C
Storage Temperature Range	T_{STG}	-65 ~ 150	°C
Lead Temperature(10s)		260	°C

ELECTRICAL CHARACTERISTICS

V+=+15V, V=-15V, unless otherwise noted.

Parameter	Symbol	Condition	Min	Typ	Max	Unit
Input Characteristics						
Input Offset Voltage	V _{OS}	T _A =25°C, Grade A			25	μV
		T _A =25°C, Grade B			75	
		T _A =25°C, Grade C			150	
Offset Voltage Stability	V _{OS} /Time			0.3		μV/mon
Input Offset Voltage Drift	ΔV _{OS} /ΔT _A	-0°C ≤ T _A ≤ +70°C		0.3		μV/°C
Input Bias Current	I _B			22		nA
Input Offset Current	I _{OS}			7		nA
Input Difference-mode Resistance	R _{IN}		15	50		MΩ
Input Common-mode Resistance	R _{INCM}			160		GΩ
Input Voltage Range	V _{CMR}		±13	±14		V
		-0°C ≤ T _A ≤ +70°C	±13	±13.5		
Common-mode Rejection Ratio	CMRR	V _{CM} = ±13V	106	123		dB
		-0°C ≤ T _A ≤ +70°C	103	123		
Voltage Gain	A _{VO}	R _L ≥2kΩ, V _O = ±10V	106	114		dB
		R _L ≥500Ω, V _O = ±10V	103	112		
		-0°C ≤ T _A ≤ +70°C, R _L ≥2kΩ, V _O = ±10V	105	113		
Output Characteristics						
Output Voltage	V _O	R _L ≥10kΩ	±12.5	±13.0		V
		R _L ≥2kΩ	±12.0	±12.8		
		R _L ≥1kΩ	±10.5	±12.0		
		-0°C ≤ T _A ≤ +70°C, R _L ≥2kΩ	±12.0	±12.6		
Output Short-circuit Current	I _{SC}			21		mA

Parameters	Symbol	Condition	Min	Typ	Max	Unit
Power Supply						
Power Supply Rejection Ratio	PSRR	V _S =±3V to ±18V	94	106		dB
		-0°C ≤ T _A ≤ +70°C	90	103		
Quiescent Power Dissipation for Single Amplifier	P _Q	V _S = ±15V, No load		80	120	mW
		V _S = ±3V, No load		5.5	8	
Dynamic Characteristics						
Gain Bandwidth Product	GBP	A _V = 1		1.3		MHz
Slew Rate	SR	R _L ≥2kΩ		0.3		V/μs
Offset Voltage Regulation Range		R _p =20kΩ		±3.6		mV
Noise Characteristics						
Voltage Noise	e _{nP-P}	0.1Hz to 10Hz		0.35		μV _{P-P}
Voltage Noise Density	e _n	f ₀ = 10Hz		10.3		nV/√Hz
		f ₀ = 100Hz		10.0		
		f ₀ = 1kHz		9.6		
Current Noise	I _{nP-P}			14		pA _{P-P}
Current Noise Density	I _n	f ₀ = 10Hz		0.32		pA/√Hz
		f ₀ = 100Hz		0.14		
		f ₀ = 1kHz		0.12		

TYPICAL CHARACTERISTICS CURVE

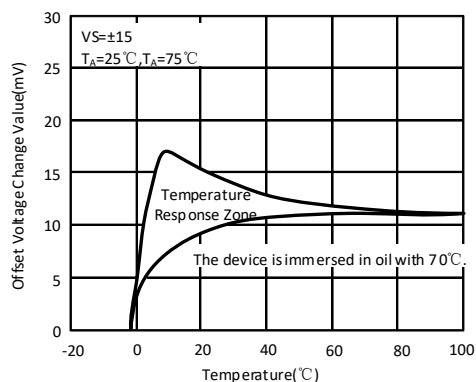


Figure 1. The Influence of Temperature Abrupt Change on the Offset Voltage

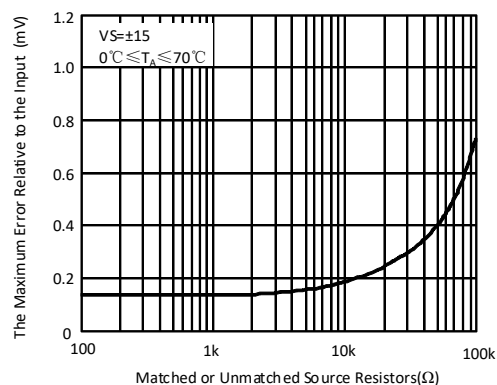


Figure 2. Maximum Error VS. Source Resistance

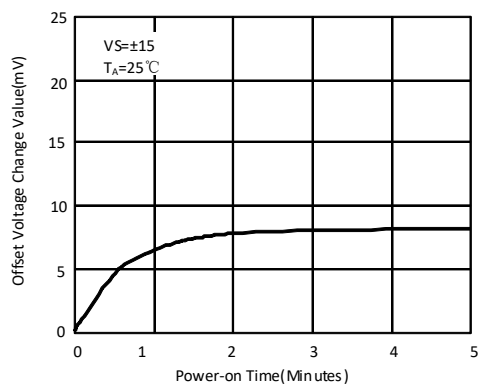


Figure 3. The Influence of Heating Device on the Offset Voltage

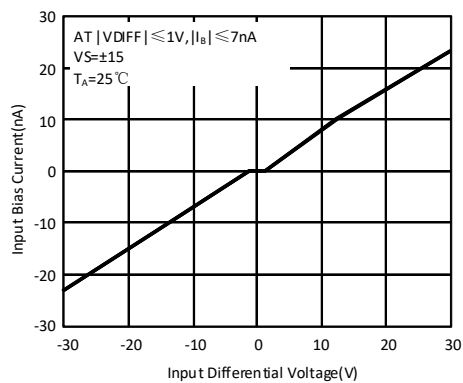


Figure 4. Input Bias Current VS. Differential Voltage

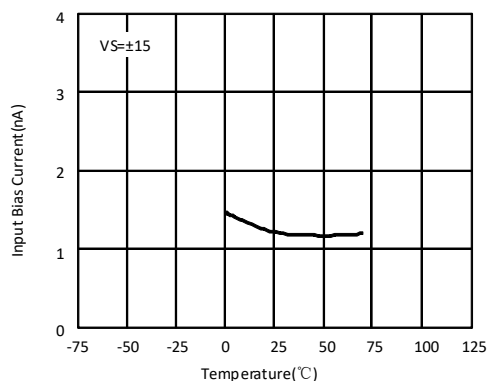


Figure 5. Input Bias Current VS. Temperature

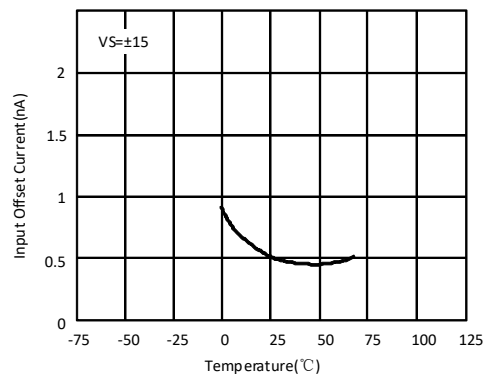


Figure 6. Input Offset Current VS. Temperature

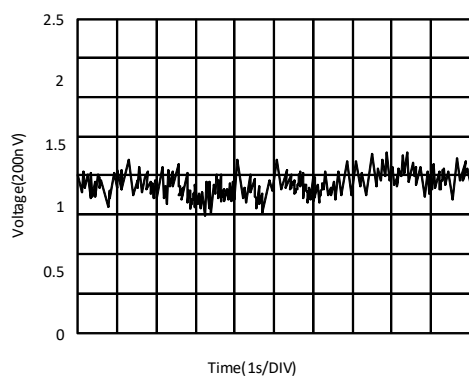


Figure 7. Low-frequency Noise

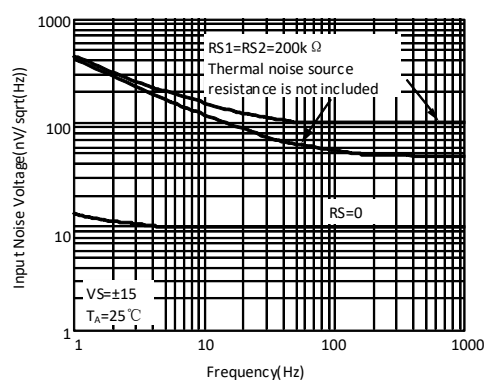


Figure 8. Total Input Noise Voltage VS. Frequency

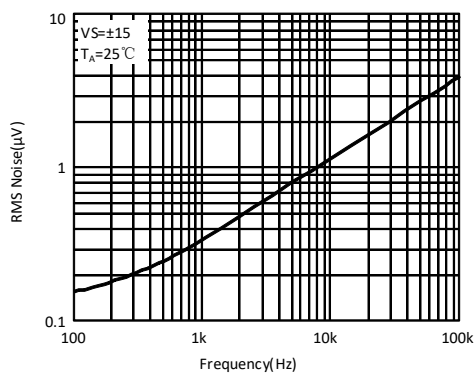


Figure 9. Input Band Noise VS. Frequency

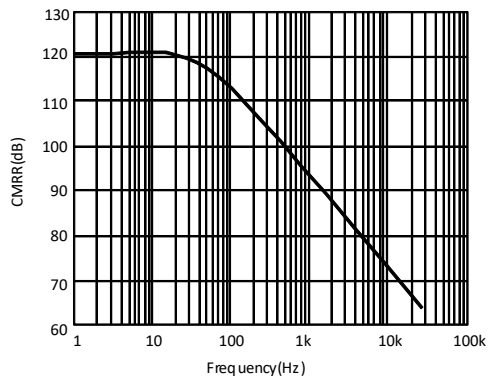


Figure 10. CMRR VS. Frequency

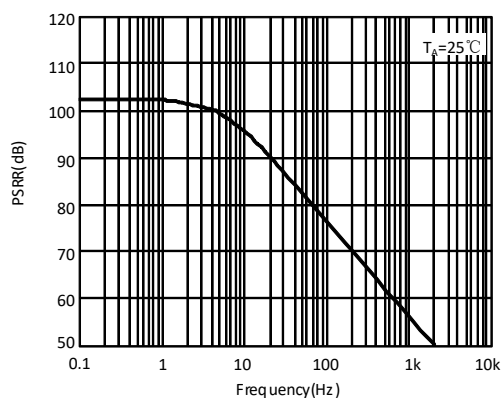


Figure 11. PSRR VS. Frequency

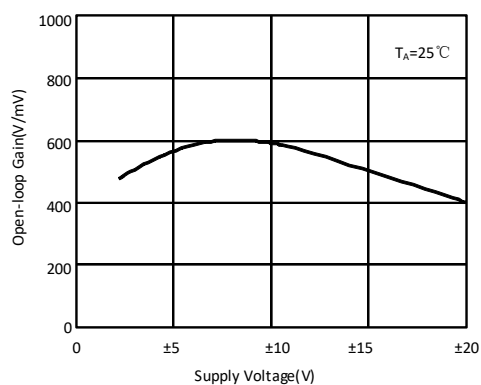


Figure 12. Open-loop Gain VS. Supply Voltage

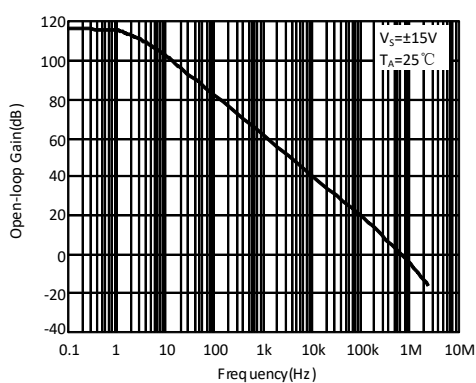


Figure 13. Open-loop Gain Frequency Response

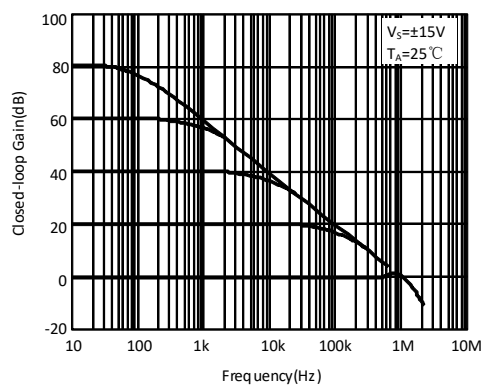


Figure 14. Closed-loop Gain with Different Gain Configurations

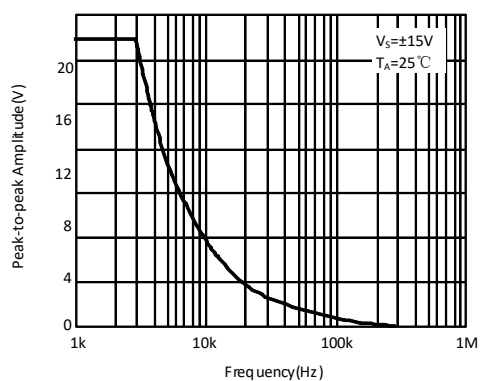


Figure 15. Output Voltage Amplitude in Different Frequency

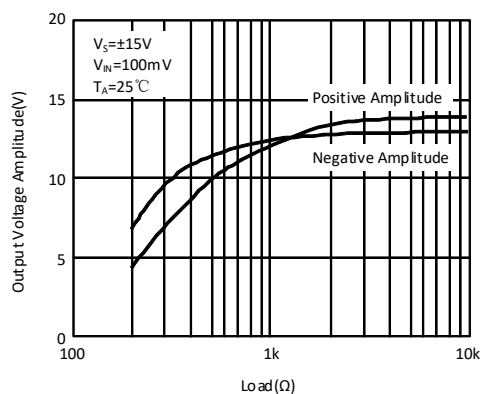


Figure 16. Output Voltage Amplitude VS. Load

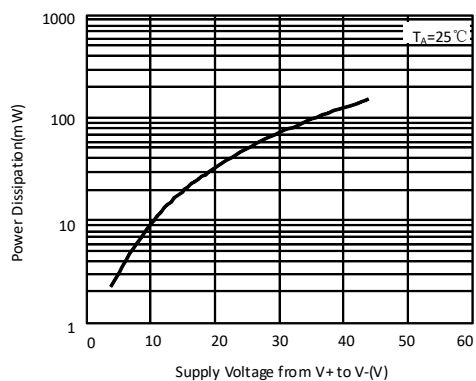


Figure 17. Power Dissipation VS. Supply Voltage

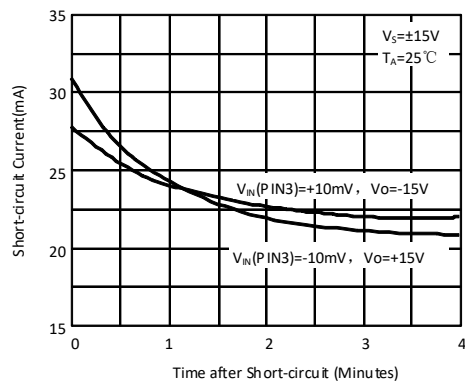


Figure 18. Short-circuit Current VS. Time

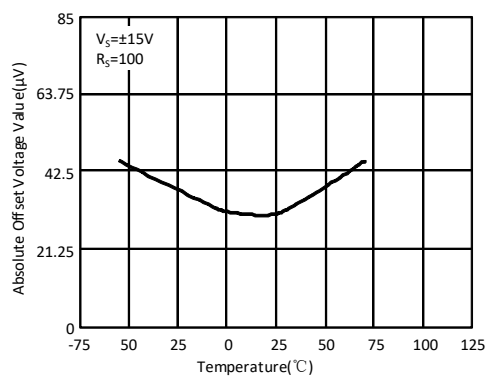


Figure 19. Unadjusted Offset Voltage VS. Temperature

TYPICAL APPLICATION

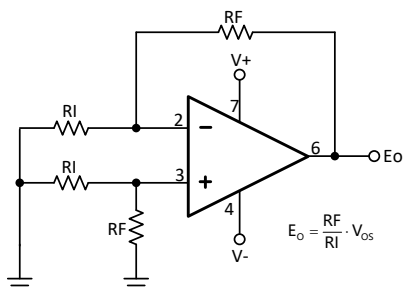


Figure 20. Typical Offset Voltage Measurement Circuit

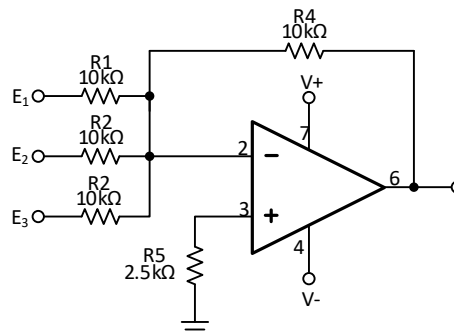


Figure 21. Precise Summing Circuit

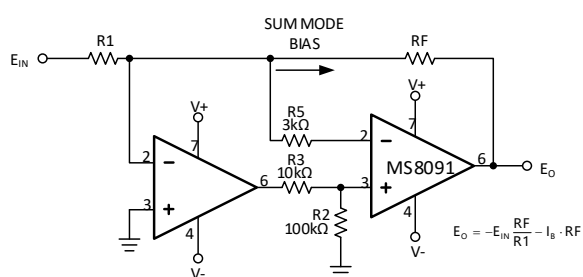


Figure 22. High-speed, Low Offset Compound Amplifier

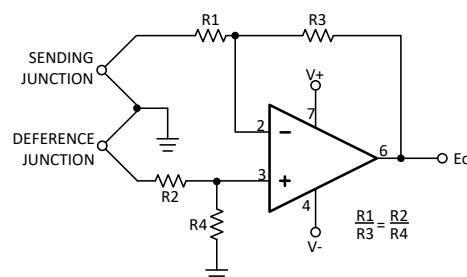


Figure 23. High-Stable Thermocouple Amplifier

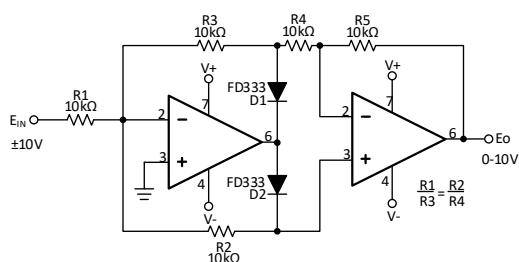
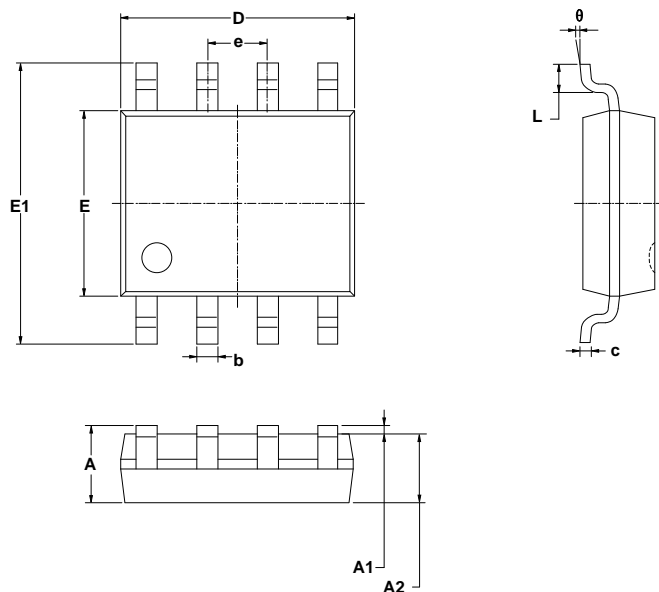


Figure 24. Precise Absolute Value Circuit

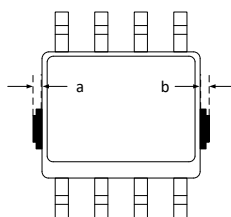
PACKAGE OUTLINE DIMENSIONS

SOP8



Symbol	Dimensions in Millimeters		Dimensions in Inches	
	Min	Max	Min	Max
A	1.350	1.750	0.053	0.069
A1	0.100	0.250	0.004	0.010
A2	1.350	1.550	0.053	0.061
b	0.330	0.510	0.013	0.020
c	0.170	0.250	0.006	0.010
D	4.700	5.100	0.185	0.200
E	3.800	4.000	0.150	0.157
E1	5.800	6.200	0.228	0.244
e	1.27 BSC		0.050 BSC	
L	0.400	1.270	0.016	0.050
θ	0 °	8 °	0 °	8 °

Note: In addition to the package size, a, b are allowed to have the maximum size of 0.15mm for waste glue simultaneously.



MARKING and PACKAGING SPECIFICATION

1. Marking Drawing Description



Product Name: MS8228

Product Code: XXXXXXXX

2. Marking Drawing Demand

Laser printing, contents in the middle, font type Arial.

3. Packaging Specification

Device	Package	Piece/Reel	Reel/Box	Piece/Box	Box/Carton	Piece/Carton
MS8228	SOP8	4000	1	4000	8	32000

STATEMENT

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- The process of improving product is endless. And our company would sincerely provide more excellent product for customer.

**MOS CIRCUIT OPERATION PRECAUTIONS**

Static electricity can be generated in many places. The following precautions can be taken to effectively prevent the damage of MOS circuit caused by electrostatic discharge:

- 1、The operator shall ground through the anti-static wristband.
- 2、The equipment shell must be grounded.
- 3、The tools used in the assembly process must be grounded.
- 4、Must use conductor packaging or anti-static materials packaging or transportation.



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