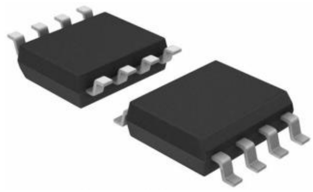
Dual-Channel, Low Offset Operational Amplifier



SOP8

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 ultra-low bias current (only 4nA) and high open-loop gain (lowest 200V/mV, 106dB). All of these characteristics make the MS8228 suitable to be used as an high-gain instrumentation amplifier.

The MS8228 has ±14V 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. The parameters, such as time stability of offset and gain, rate of change with temperature are also excellent. After removal of external offset, the precision and stability of the MS8228 make itself become the industry standard for instrument applications.

FEATURES

- Low Offset Voltage Drift：1.3μV/°C (Max)
- Time Stability of Offset Voltage: 1.5μV/Month (Max)
- Low Noise: 0.6μVp-p (Max)
- Wide Input Voltage Range: ±14V (Typ)
- Wide Supply Voltage: ±3V to ±18V

APPLICATIONS

- Wireless Base Station Control Circuit
- Optical Fiber Network Control Circuit
- Instrumentation Amplifier
- Sensor, Controller and Thermocouple

  Thermal Resistance Monitoring

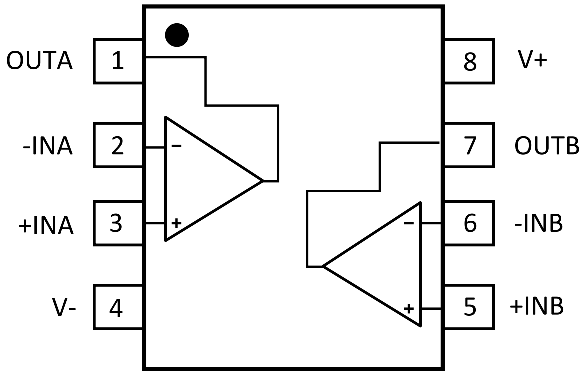
  Strain Bridge

  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- ~ V+	V
Differential Input Voltage		±30	V
Junction Temperature		-65 ~ 150	°C
Operating Temperature Range	T_A	-40 ~ 125	°C
Storage Temperature Range	T_{STG}	-65 ~ 150	°C
Lead Temperature		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	1.5	µV/mon
Input Offset Voltage Drift	$\Delta V_{OS}/\Delta T_A$	-0°C ≤ T_A ≤ +70°C		0.3	1.3	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	1.3		MHz
Slew Rate	SR	R_L≥2kΩ	0.1	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	0.6	$µV_{P-P}$
Voltage Noise Density	e_n	f_O= 10Hz		10.3	18.0	$nV/\sqrt{Hz}$
		f_O = 100Hz		10.0	13.0	
		f_O = 1kHz		9.6	11.0	
Current Noise	I_{nP-P}			14	30	pA_{P-P}
Current Noise Density	I_n	f_O = 10Hz		0.32	0.80	$pA/\sqrt{Hz}$
		f_O = 100Hz		0.14	0.23	
		f_O = 1kHz		0.12	0.17	

TYPICAL CHARACTERISTICS CURVE

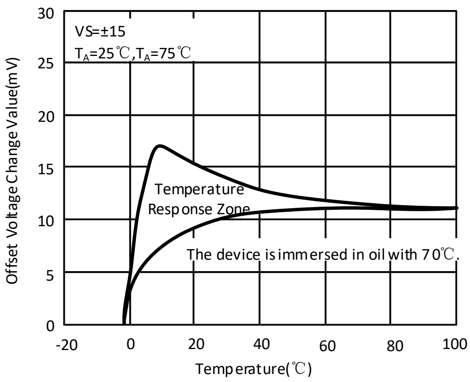


Figure 1. The Influence of Temperature Abrupt Change on the Offset Voltage

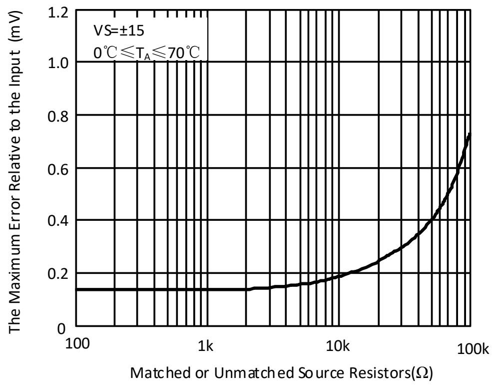


Figure 2. Maximum Error VS. Source Resistance

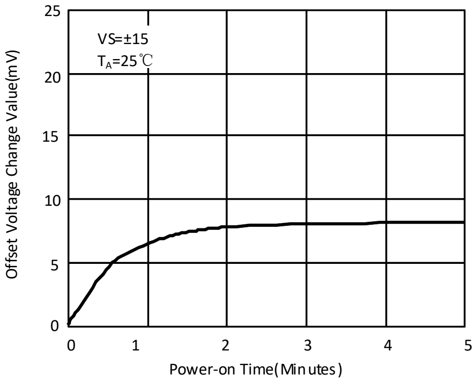


Figure 3. The Influence of Heating Device on the Offset Voltage

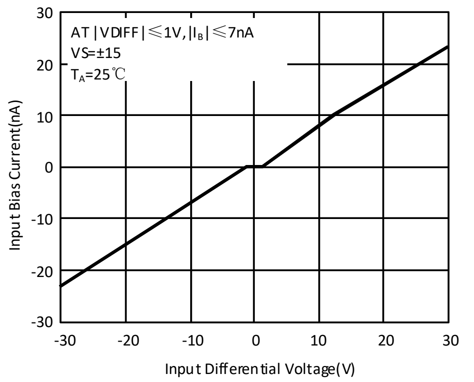


Figure 4. Input Bias Current VS. Differential Voltage

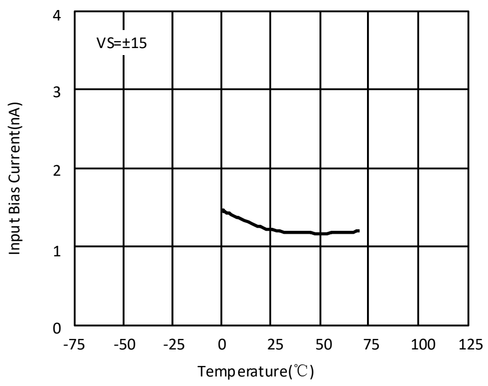


Figure 5. Input Bias Current VS. Temperature

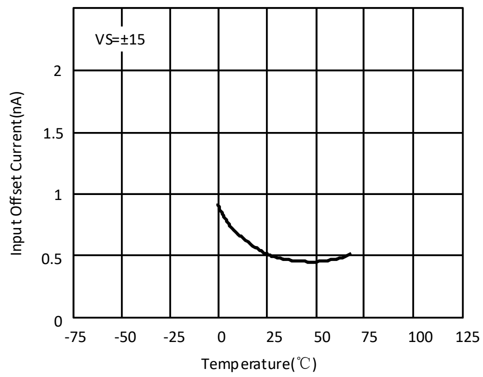


Figure 6. Input Offset Current VS. Temperature

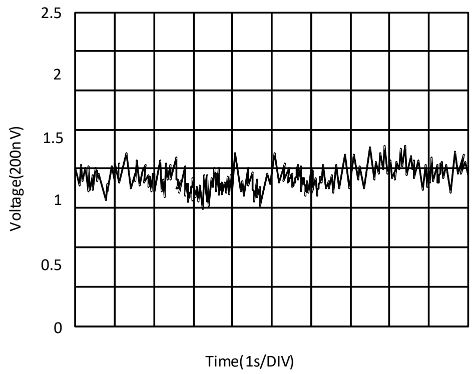


Figure 7. Low-frequency Noise

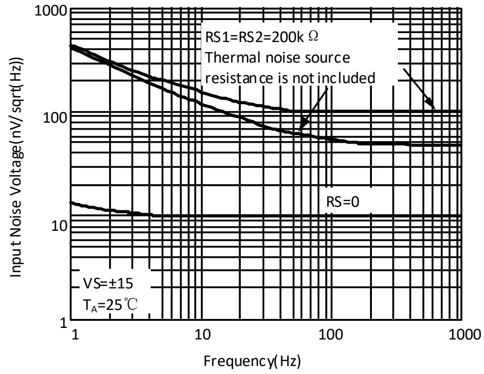


Figure 8. Total Input Noise Voltage VS. Frequency

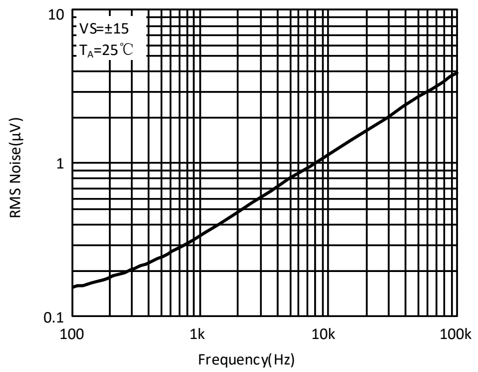


Figure 9. Input Band Noise VS. Frequency

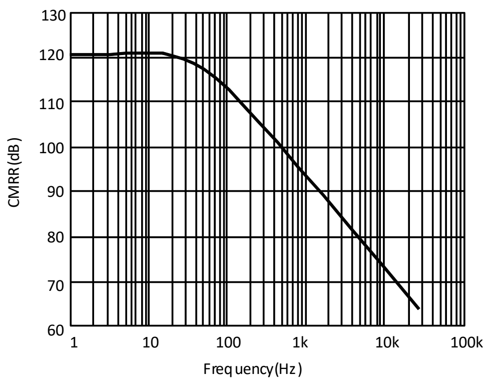


Figure 10. CMRR VS. Frequency

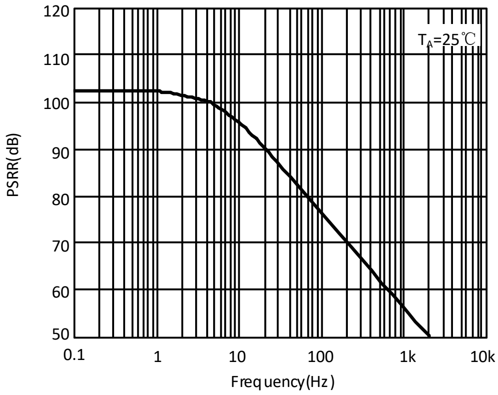


Figure 11. PSRR VS. Frequency

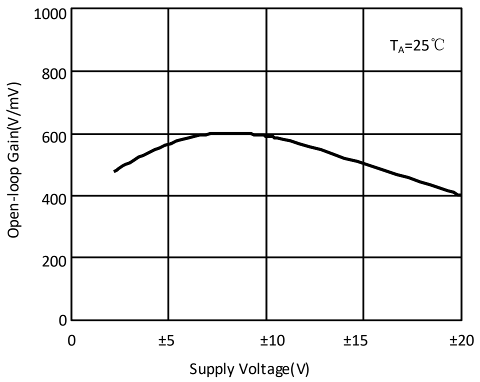


Figure 12. Open-loop Gain VS. Supply Voltage

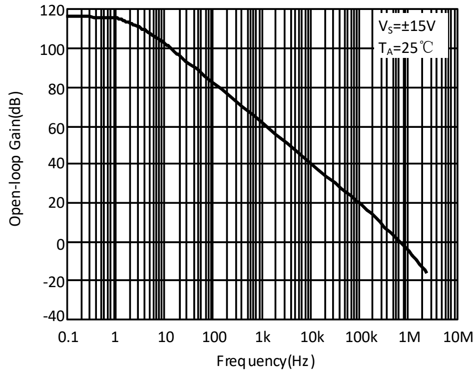


Figure 13. Open-loop Gain Frequency Response

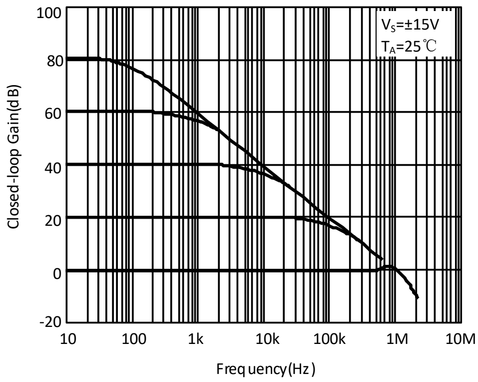


Figure 14. Closed-loop Gain
with Different Gain Configurations

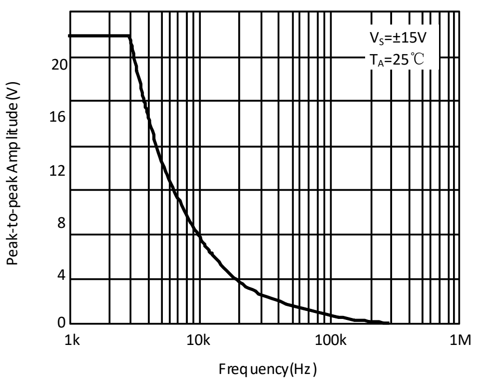


Figure 15. Output Voltage Amplitude
in Different Frequency

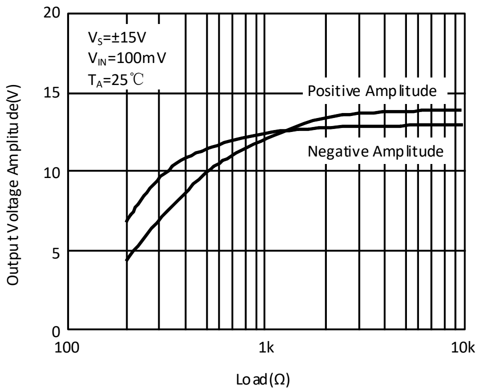


Figure 16. Output Voltage Amplitude VS. Load

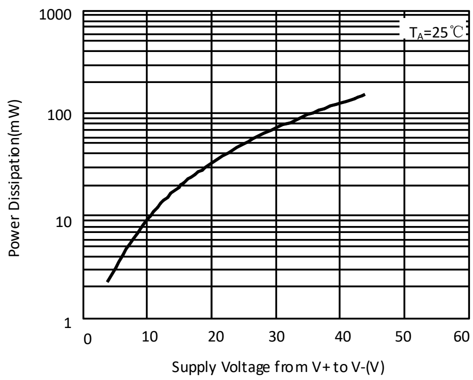


Figure 17. Power Dissipation VS. Supply Voltage

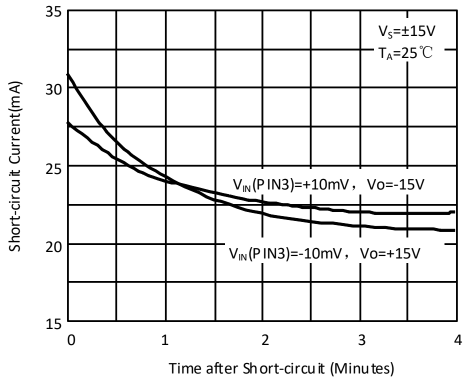


Figure 18. Short-circuit Current VS. Time

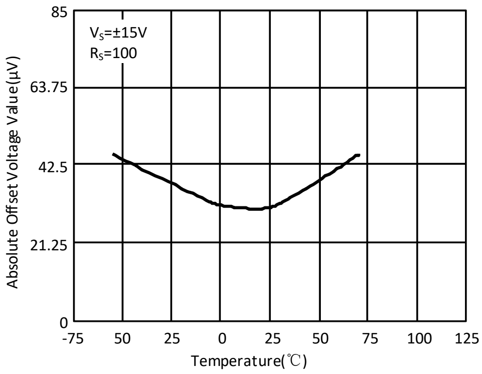


Figure 19. Unadjusted Offset Voltage VS. Temperature

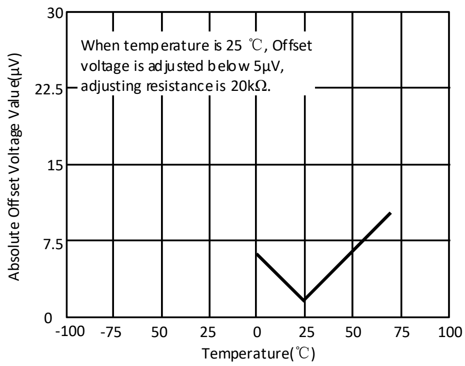


Figure 20. Adjusted Offset Voltage VS. Temperature

TYPICAL APPLICATION

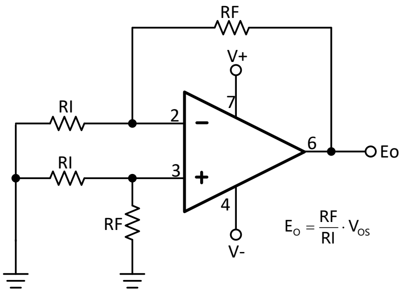


Figure 21. Typical Offset Voltage Measurement Circuit

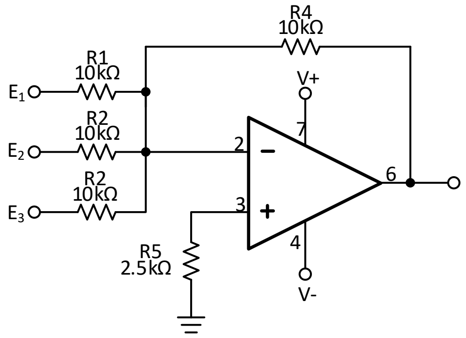


Figure 22. Precise Summing Circuit

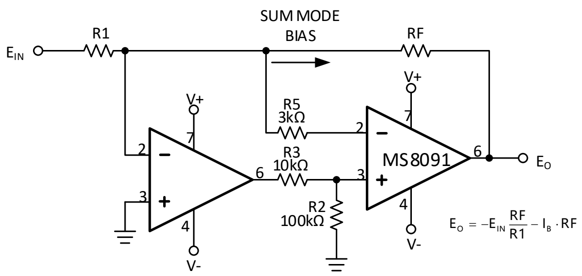


Figure 23. High-speed, Low Offset Compound Amplifier

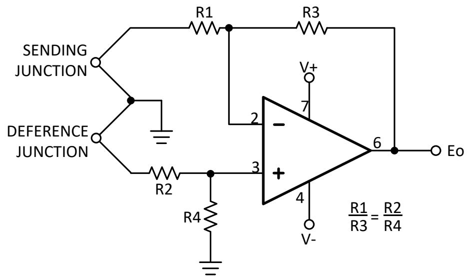


Figure 24. High-Stable Thermocouple Amplifier

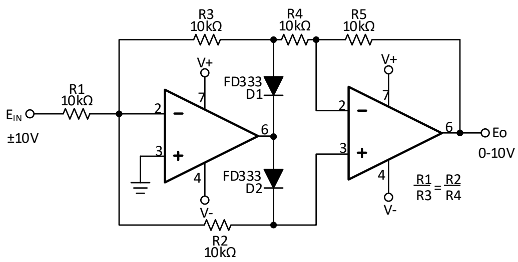
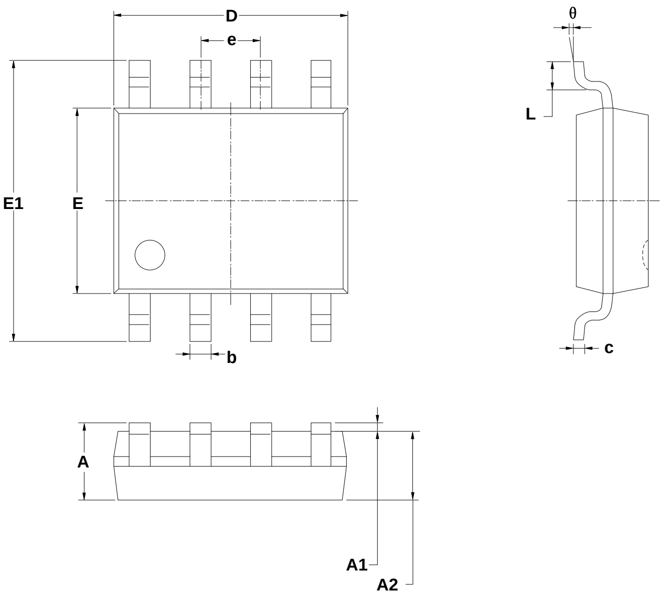


Figure 25. Precise Absolute Value Circuit

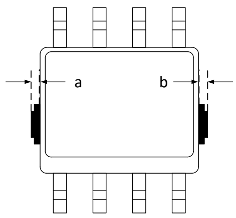
PACKAGE OUTLINE DIMENSIONS

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 º	8 º	0 º	8 º

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: XXXXXXX

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

- All Revision Rights of Datasheets Reserved for Ruimeng. Don't release additional notice.
  Customer should get latest version information and verify the integrity before placing order.
- When using Ruimeng products to design and produce, purchaser has the responsibility to observe safety standard and adopt corresponding precautions, in order to avoid personal injury and property loss caused by potential failure risk.
- 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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