Zero Drift, Single Supply, Rail-to-Rail Input /Output, High-Precision Operational Amplifier

PRODUCT DESCRIPTION

The MS8628/MS8629/MS8630 is rail-to-rail input/output, wide bandwidth, low noise, auto-zero amplifier, which is featured by ultra-low offset, drift and bias current. And it adopts 1.8V to 5V single power supply (±0.9V to ±2.5V dual power supply).

The MS8628/MS8629/MS8630 has features advantages that only previous expensive auto-zero or chopping amplifier has. In addition, it greatly reduces digital switch noise, which exist in most chopping stabilization amplifier. The ultra-low offset voltage, offset voltage drift and noise features, making the device drift approach zero throughout the operating temperature, are beneficial to many applications, such as position and pressure sensor, medical device and strain gauge. Many systems could apply the feature of rail-to-rail input/output to reduce input bias complexity and maximize the signal to noise ratio.

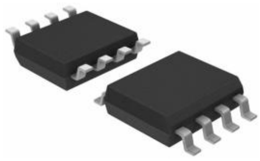
The operating temperature range of the MS8628/MS8629/MS8630 is -40°C to 125°C. The MS8628 has lead SOP8 package. The MS8629 has lead SOP8, MSOP8 and DFN8 packages. The MS8630 has SOP14 and TSSOP14 packages.

FEATURES

- Lowest Noise Auto-zero Amplifier
- Low Offset Voltage: 2μV (TYP)
- Input Offset Drift0.05μV/°C
- Rail-To-Rail Input/Output
- Single Power Supply : 1.8V to 5.5V
- Voltage Gain: 126dB(TYP) (5V Operating Voltage)
- Power Supply Rejection Ratio: 123dB (TYP)
- Common-mode Rejection Ratio: 136dB (TYP)
- Ultra-low Input Bias Current: 30pA (TYP)
- Low Operating Current: 0.8mA Each Channel (TYP)
- Overload Recovery Time: 50μs (5V Operating Voltage)
- No Need for External Components

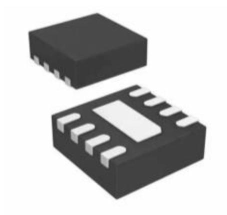
PRODUCT SPECIFICATION

Part Number	Package	Marking
MS8628	SOP8	MS8628
MS8629	SOP8	MS8629
MS8629M	MSOP8	MS8629M
MS8629D	DFN8	8629D
MS8630	SOP14	MS8630
MS8630T	TSSOP14	MS8630T



SOP8

MSOP8



DFN8

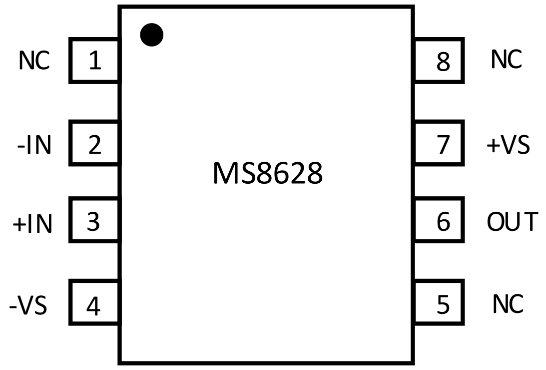
SOP14

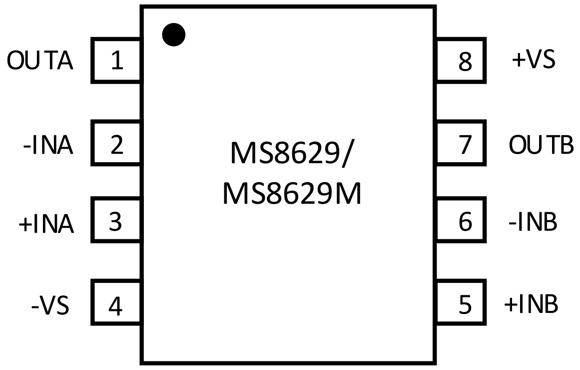
TSSOP14

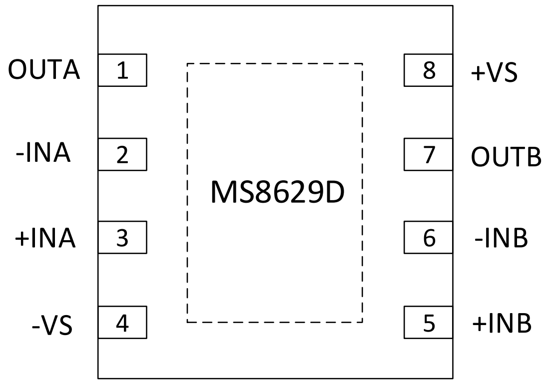
APPLICATIONS

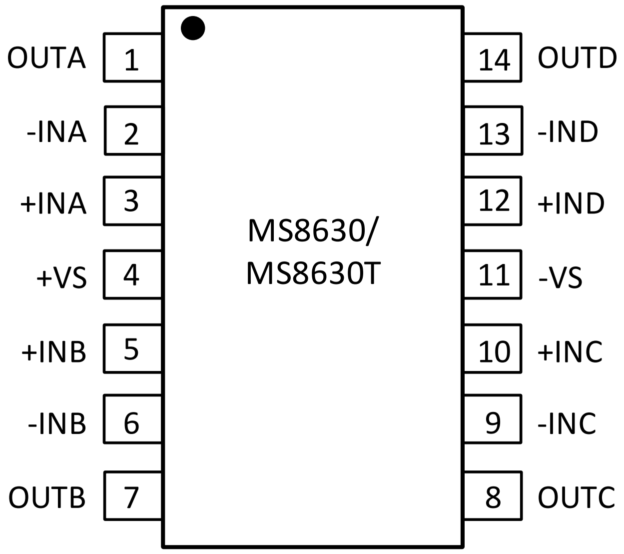
- Automobile Sensor
- Pressure and Position Sensor
- Strain Gauge Amplifier
- Medical Device
- Thermocouple Amplifier
- Precision Current Detection
- Photodiode Amplifier

PIN CONFIGURATION









PIN DESCRIPTION

Pin	Name	Type	Description
MS8628			
1	NC	-	Not Connection
2	-IN	I	Negative Input
3	+IN	I	Positive Input
4	-VS	-	Negative Power Supply
5	NC	-	Not Connection
6	OUT	O	Channel Output
7	+VS	-	Positive Power Supply
8	NC	-	Not Connection
MS8629/MS8629M/MS8629D			
1	OUTA	O	Channel A Output
2	-INA	I	Negative Input (Channel A)
3	+INA	I	Positive Input (Channel A)
4	-VS	-	Negative Power Supply
5	+INB	I	Positive Input (Channel B)
6	-INB	I	Negative Input (Channel B)
7	OUTB	O	Channel B Output
8	+VS	-	Positive Power Supply
MS8630/MS8630T			
1	OUTA	O	Channel A Output
2	-INA	I	Negative Input (Channel A)
3	+INA	I	Positive Input (Channel A)
4	+VS	-	Positive Power Supply
5	+INB	I	Positive Input (Channel B)
6	-INB	I	Negative Input (Channel B)
7	OUTB	O	Channel B Output
8	OUTC	O	Channel C Output
9	-INC	I	Negative Input (Channel C)
10	+INC	I	Positive Input (Channel C)
11	-VS	-	Negative Power Supply
12	+IND	I	Positive Input (Channel D)
13	-IND	I	Negative Input (Channel D)
14	OUTD	O	Channel D Output

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	VS	6	V
Input Voltage		-Vs-0.3 ~ +Vs+0.3	V
Differential Input Voltage		-5 ~ 5 (or power supply, base on lower value)	V
Junction Temperature		-65 ~ 150	°C
Operating Temperature	T_A	-40 ~ 125	°C
Storage Temperatur	Tstg	-65 ~ 150	°C
Lead Temperature (Soldering, 10s)		260	°C
ESD	HBM	4000	V
	MM	200	

ELECTRICAL CHARACTERISTICS (5V)

Unless otherwise noted,Vs = +5V,VCM = +2.5V,Vo = +2.5V,TA = 25°C.

Parameter		Symbol	Condition	Min	Typ	Max	Unit
Input Characteristics							
Input Offset Voltage		V_{OS}			2	5	µV
			-40°C ≤ TA ≤ +125°C			10	
Input Bias Current	MS8628/MS8629	I_B			30	100	pA
	MS8630				100	300	pA
			-40°C ≤ TA ≤ +125°C			1.5	nA
Input Offset Current		I_{OS}	-40°C ≤ TA ≤ +125°C		40	200 250	pA
Input Voltage				0		5	V
Common-mode Rejection Ratio		CMRR	VCM = 0V to 5V	120	140		dB
			-40°C ≤ TA ≤ +125°C	115	130		
Large Signal Gain		A_{VO}	RL= 10kΩ,Vo= 0.3V to 4.7V	127	145		dB
			-40°C ≤ TA ≤ +125°C	120	135		
Input Offset Voltage Drift		$\Delta V_{OS}/\Delta T_A$	-40°C ≤ TA ≤ +125°C		0.03	0.05	µV/°C
Output Characteristics							
Output High Voltage		V_{OH}	RL = 100kΩ to -Vs	4.99	4.996		V
			RL = 10kΩ to -Vs	4.99	4.995		V
Output Low Voltage		V_{OL}	RL = 100kΩ to +Vs		1	5	mV
			-40°C ≤ TA ≤ +125°C		2	5	
			RL = 10kΩ to +Vs		10	20	mV
			-40°C ≤ TA ≤ +125°C		15	20	
Short-circuit Current		I_{SC}	Vo= 2.5V,RL = 10Ω to GND	25	50		mA
Output Current		Io			30		mA
			-40°C ≤ TA ≤ +125°C		15		mA
Power Dissipation							
Power Supply Rejection Ratio		PSRR	Vs =1.8V to 5.5V,-40°C ≤ TA ≤+125°C	115	130		dB
Quiescent Current (Each Amplifier)		I_Q	Vo = Vs/2		0.85	1.1	mA
			-40°C ≤ TA ≤ +125°C		1.0	1.2	
Dynamic Characteristics							
Gain Bandwidth Product		GBP	Av = +100		3.8		MHz
Slew Rate		SR	Av = +1,RL = 10kΩ		1.25		V/µs
Overload Recovery Time					0.05		ms
Noise Characteristics							
Voltage Noise		$e_{n\ P-P}$	0.1Hz to 10Hz		0.50		μV_{p-p}
Voltage Noise Density		e_n	f = 1kHz		22		$nV/\sqrt{Hz}$
Current Noise Density		i_n	f = 10Hz		5		$fA/\sqrt{Hz}$

ELECTRICAL CHARACTERISTICS (2.7V)

Unless otherwise noted, Vs = +2.7V, VCM = +1.35V, Vo = +1.35V, T_A = 25°C.

Parameter	Symbol	Condition	Min	Typ	Max	Unit
Input Characteristics						
Input Offset Voltage	V_{OS}			0.5	5	µV
		-40°C ≤ T_A ≤ +125°C			10	
Input Bias Current MS8628/MS8629	I_B			30	100	PA
MS8630				100	300	PA
		-40°C ≤ T_A ≤ +125°C		1.0	1.5	nA
Input Offset Current	I_{OS}			50	200	pA
		-40°C ≤ T_A ≤ +125°C			250	
Input Voltage			0		2.7	V
Common-mode Rejection Ratio	CMRR	VCM = 0V to 2.7V	115	130		dB
		-40°C ≤ T_A ≤ +125°C	110	120		
Large Signal Gain	A_{VO}	RL= 10kΩ,Vo= 0.3V to 2.4V	110	140		dB
		-40°C ≤ T_A ≤ +125°C	105	130		
Input Offset Voltage Drift	$\Delta V_{OS}/\Delta T_A$	-40°C ≤ T_A ≤ +125°C		0.03	0.05	µV/°C
Output Characteristics						
Output High Voltage	V_{OH}	RL = 100kΩ to -Vs	2.68	2.695		V
		RL = 10kΩ to -Vs	2.67	2.68		V
Output Low Voltage	V_{OL}	RL = 100kΩ to +Vs		1	5	mV
		-40°C ≤ T_A ≤ +125°C		2	5	
		RL = 10kΩ to +Vs		10	20	mV
		-40°C ≤ T_A ≤ +125°C		15	20	
Short-circuit Current	I_{SC}	Vo= 2.5V,RL = 10Ω to GND	10	15		mA
Output Current	Io			10		mA
		-40°C ≤ T_A ≤ +125°C		5		mA
Power Dissipation						
Power Supply Rejection Ratio	PSRR	Vs =1.8V to 5.5V,-40°C ≤ T_A ≤ +125°C	115	130		dB
Quiescent Current	I_Q	Vo = Vs/2		0.75	1.0	mA
		-40°C ≤ T_A ≤ +125°C		0.9	1.2	
Dynamic Characteristics						
Gain Bandwidth Product	GBP	Av = +100		3.3		MHz
Slew Rate	SR	Av = +1,RL = 10kΩ		1.0		V/µs
Overload Recovery Time				0.05		ms
Noise Characteristics						
Voltage Noise	$e_{n\ P-P}$	0.1Hz to10Hz		0.50		μV_{p-p}
Voltage Noise Density	e_n	f = 1kHz		22		$nV/\sqrt{Hz}$
Current Noise Density	i_n	f = 10Hz		5		$fA/\sqrt{Hz}$

TYPICALC CHARACTERISTICS CURVES

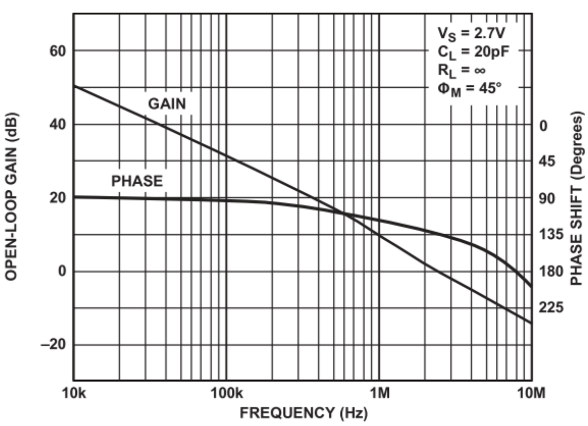


Figure 1. Open-Loop Gain, Phase VS. Frequency

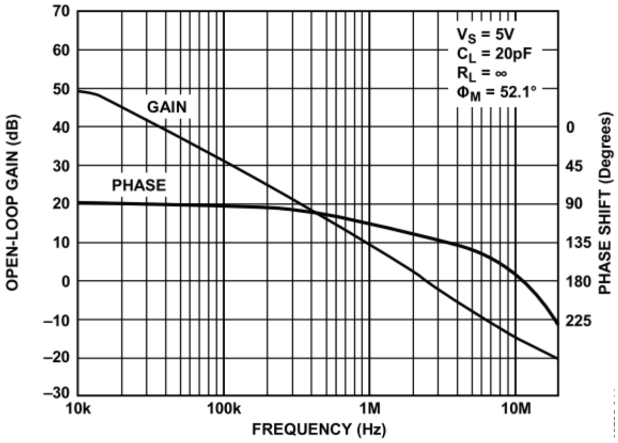


Figure 2. Open-Loop Gain, Phase VS. Frequency

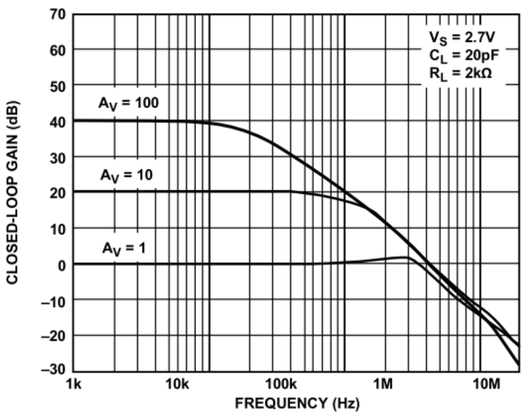


Figure 3. Closed-Loop Gain VS. Frequency

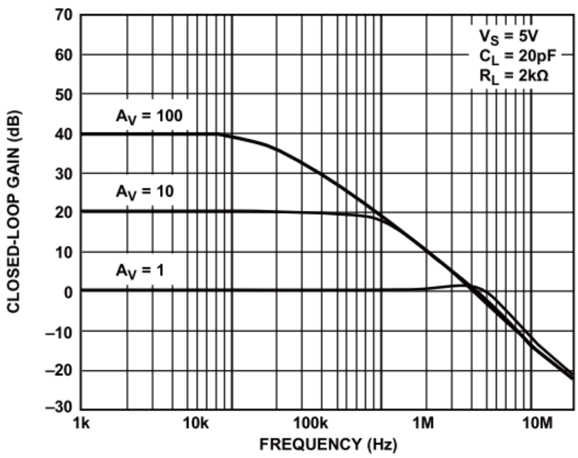


Figure 4. Closed-Loop Gain VS. Frequency

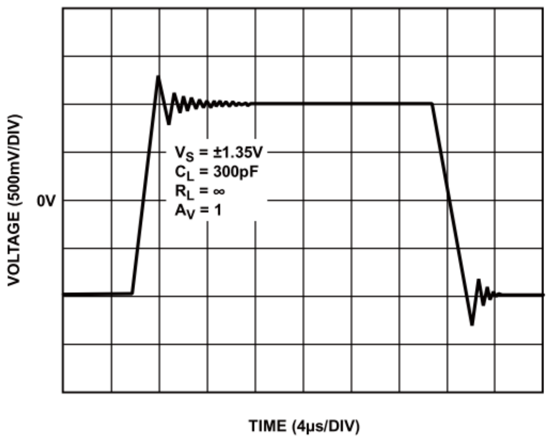


Figure 5. Large Signal Transient Response

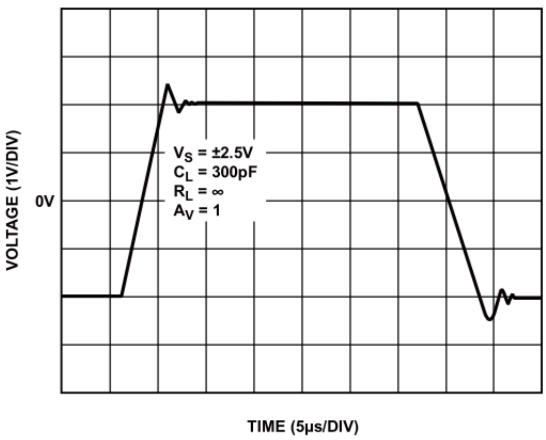


Figure 6. Large Signal Transient Response

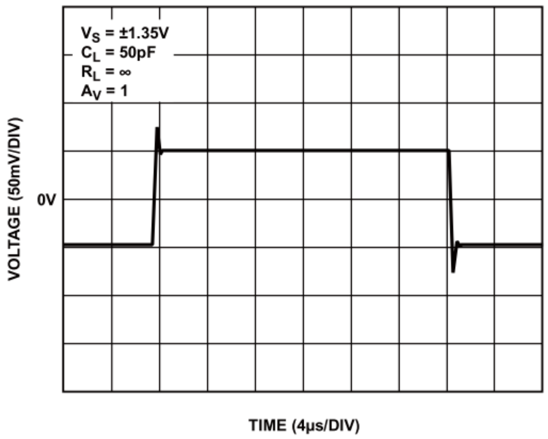


Figure 7. Small Signal Transient Response

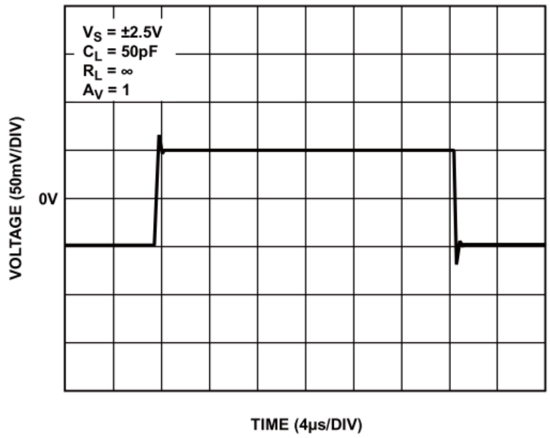


Figure 8. Small Signal Transient Response

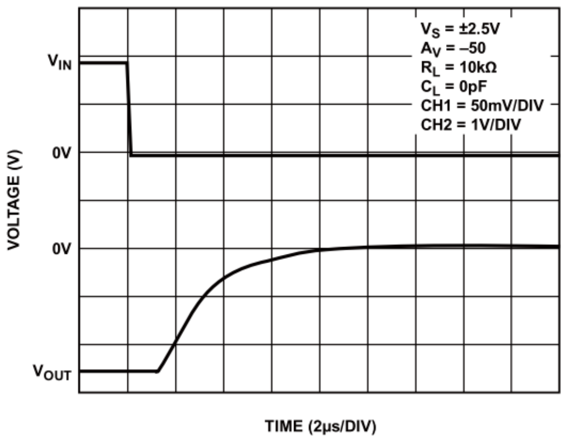


Figure 9. Positive Overvoltage Recovery Time

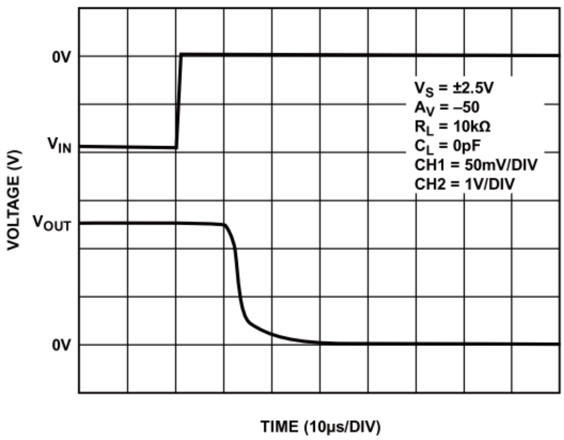


Figure 10. Negative Overvoltage Recovery Time

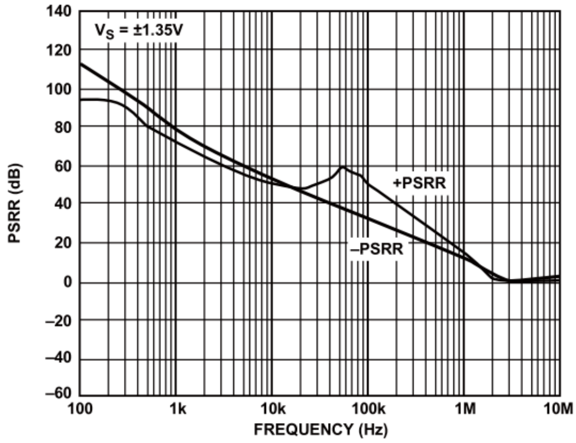


Figure 11. PSRR VS. Frequency

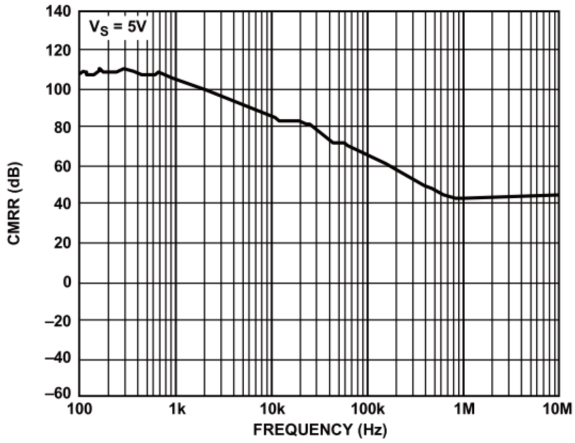


Figure 12. CMRR VS. Frequency

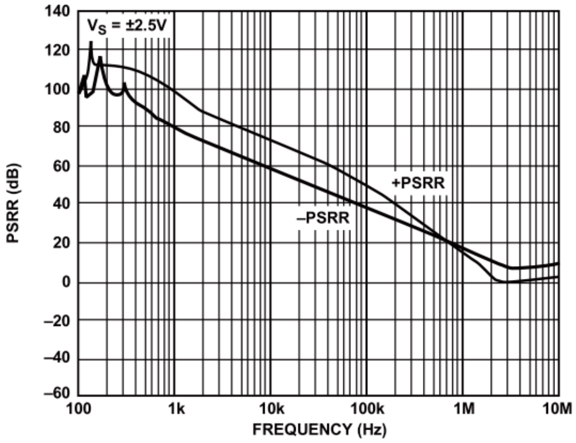


Figure 13. PSRR VS. Frequency

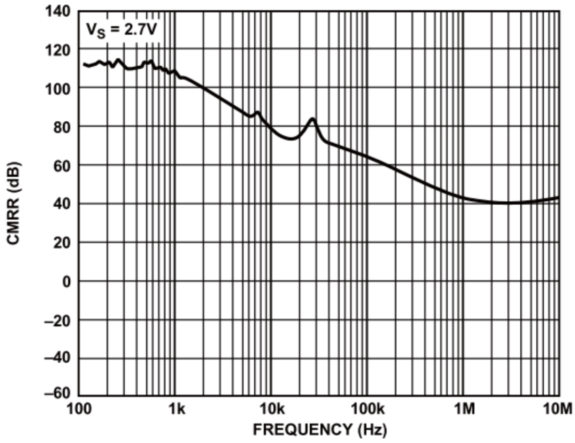


Figure 14. CMRR VS. Frequency

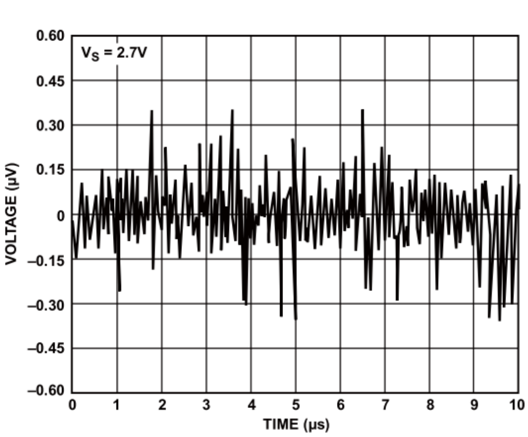


Figure 15. 0.1Hz to 10Hz Noise

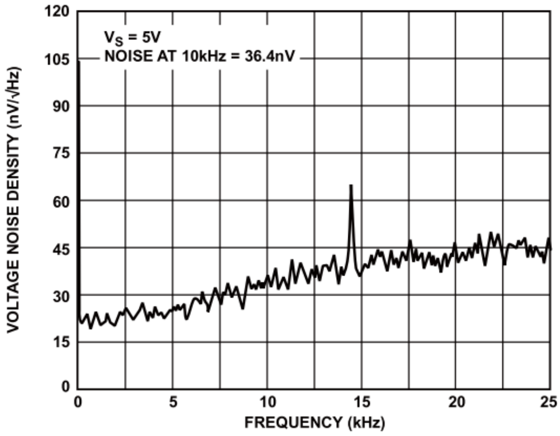


Figure 16. 0Hz to 25kHz Voltage Noise Density at 5V

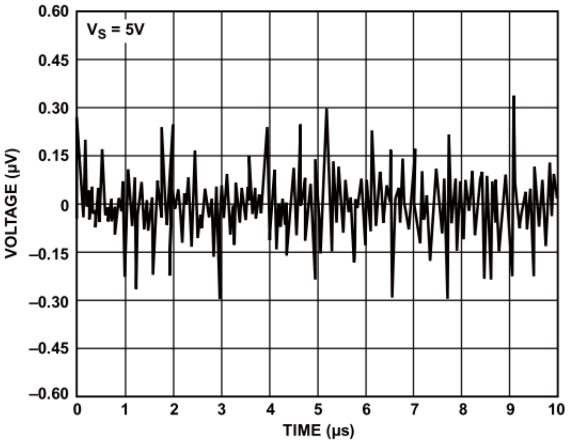


Figure 17. 0.1Hz to 10Hz Noise

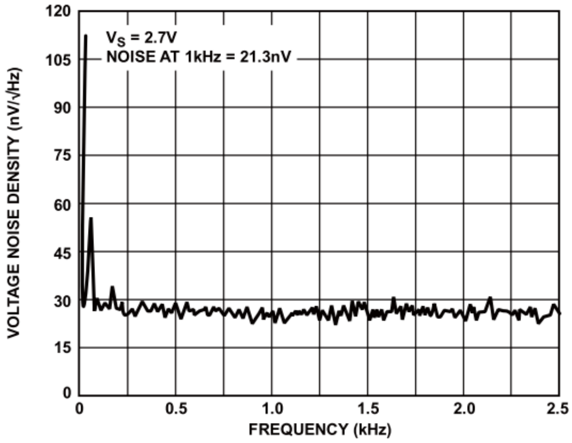


Figure 18. 0Hz to 2.5kHz Voltage Noise Density at 2.7V

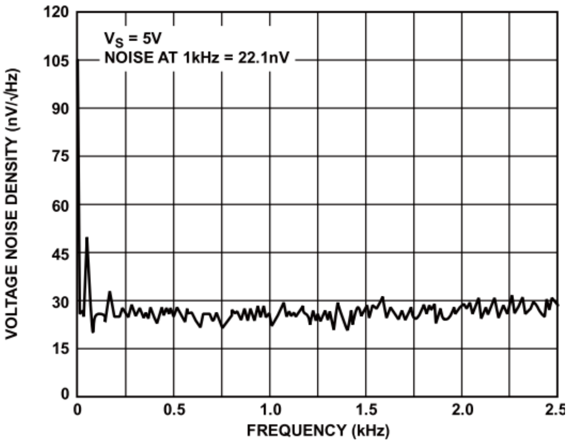


Figure 19. 0Hz to 2.5kHz Voltage Noise Density at 5V

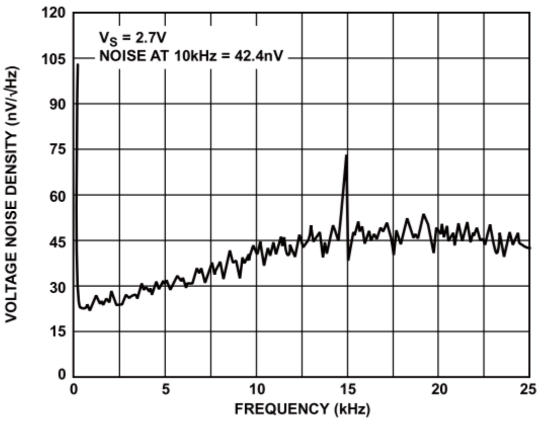


Figure 20. 0Hz to 25kHz Voltage Noise Density at 2.7V

TYPICAL APPLICATIONS

Infrared Sensor

Infrared sensor, especially infrared temperature sensor, widely used in various temperature measurement applications, such as automobile climate control, human ear thermometer, home insulation analysis and automobile repair diagnose. The output signal of the sensor is lower relatively, with need for high gain, ultra-low offset voltage and drift, in order to avoid DC errors.

When use stage-to-to AC couple (see figure 21), low drift and drift could prevent the output of the input amplifier from drifting near to saturation. Low input bias current make the errors ultra-small generated from the output impedance of the sensor. Like pressure sensor, after temperature measurement calibration, the ultra-low drift with time and temperature could remove extra errors. However, low 1/f noise improve SNR for DC measurement during the period (normally more than one fifth of a second).

The gain is 10,000 as shown in figure 21. The circuit could amplify the AC signal of 100μV to 300μV to 1V to 3V, used in precision analog-to-digital conversion.

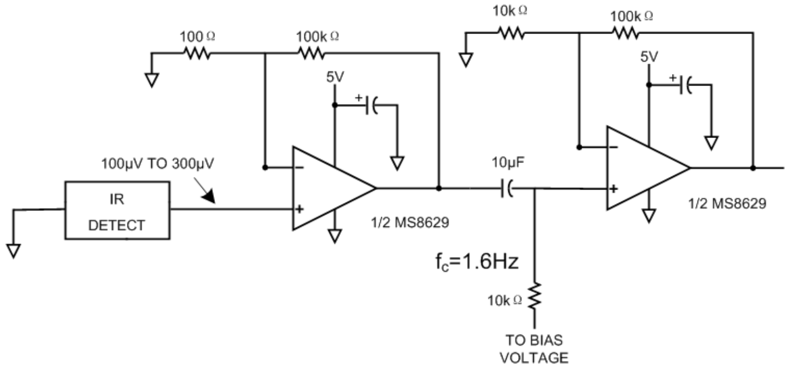


Figure 21. MS8629 as Pre-amplifier for Infrared Temperature Sensor

Precision Current Shunt Sensor

As shown in figure 22, precision current shunt sensor is applied to differencing configuration, benefiting from the unique characteristics of auto-zero amplifier. In feedback control system, precision current shunt sensor could use current shunt sensor. In addition, this type of sensors could also be used in several applications, such as battery life gauge, laser diode power dissipation measurement and control, torque feedback control and precision electrical energy measurement in electric steering.

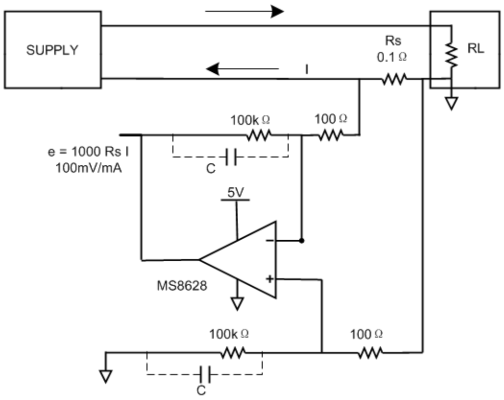


Figure 22. Low-side Current Detection

In this type of applications, it's better to use current shunt sensor with ultra-low resistance, thus reducing series voltage drop and power waste as far as possible and allowing high current measurement. The resistance of current shunt sensor is usually 0.1Ω. When the measured current value is 1A, the output signal of the current shunt sensor is hundreds of millimeter volts or several volts, thus amplifier is not main error source. However, when current measurement value is lower within 1mA range, the 100μV output voltage of current shunt sensor needs ultra-low offset voltage and drift to maintain absolute accuracy. In addition, low input bias current is required to ensure that injected bias current doesn't occupy much in measured current. High open-loop gain, CMRR and PSRR maintain whole accuracy. As long as current change rate is not too fast, auto-zero amplifier could provide perfect result.

Output Amplifier for High-Precision DAC

In unipolar configuration, the MS8628/MS8629/MS8630 could be used as output amplifier for 16-bit high-precision DAC. In this condition, selected operational amplifier must have ultra-low offset voltage (DAC LSB is 38μV with 2.5V reference voltage source) to eliminate the requirement for output offset adjustment. In addition, input bias current (normally dozens of picoamperes) must be very low, because when multiplied by DAC output impedance (about 6kΩ), the current would generate extra zero-code error.

Rail-to-rail input/output could provide full-scale output with ultra-low error. The DAC output impedance is constant and is irrelevant to code. But the high input impedance of the MS8628/MS8629/MS8630 could reduce the gain error to the minimum. In this condition, the wide bandwidth features of these amplifiers are very useful as well. Amplifier (setup time 1μs) adds another time constant to system). Therefore, the output setup time would be increased. For example, the setup time for AD5541 is 1μs. The total setup time is about 1.4μs calculated by the formula below:

$$t_s(\text{TOTAL})=\sqrt{(t_s\text{DAC})^2+(t_s\text{MS8628})^2}$$

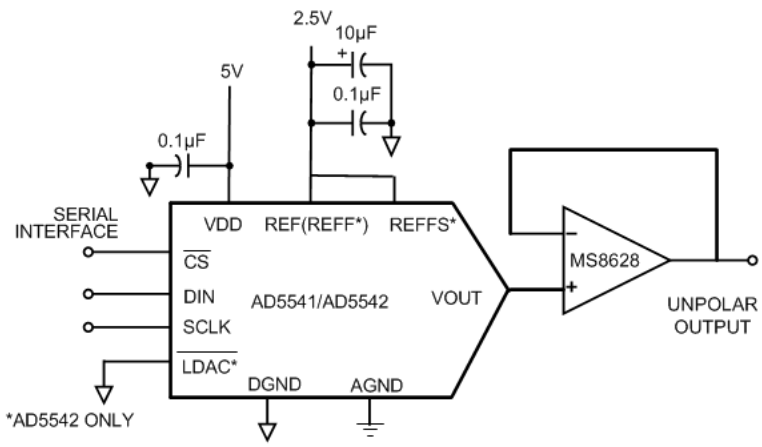
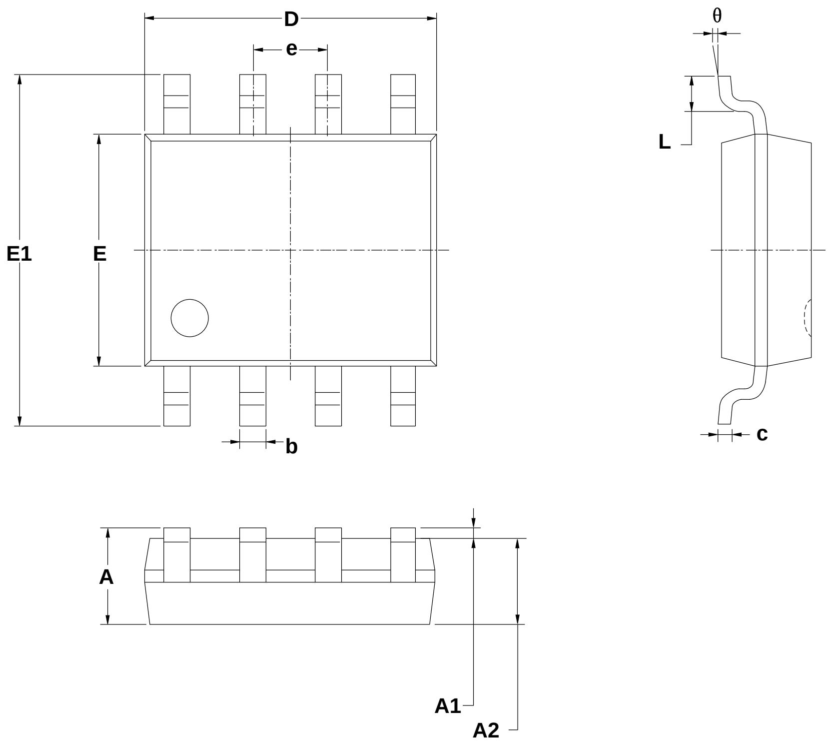


Figure 23. MS8628 as Output Amplifier

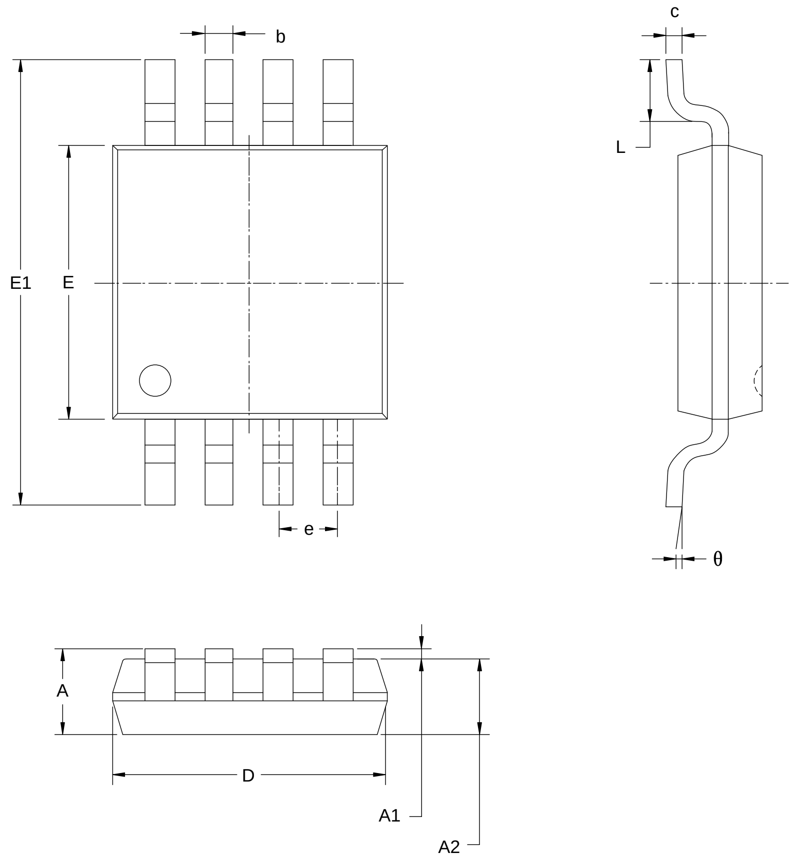
PACKAGE OUTLINE DIMENSIONS

SOP8



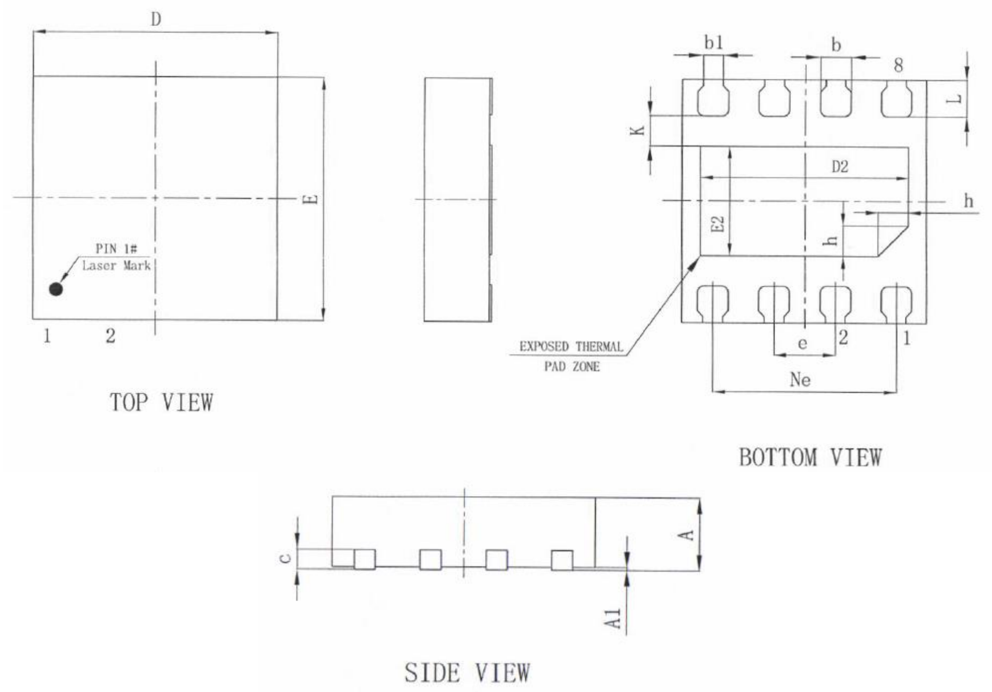
Symbol	Dimensions in Millimeters		Dimensions in Inches	
	Min	Max	Min	Max
A	1.350	1.750	0.053	0.069
A1	0.100	0.250	0.004	0.010
A2	1.350	1.550	0.053	0.061
b	0.330	0.510	0.013	0.020
c	0.170	0.250	0.006	0.010
D	4.700	5.100	0.185	0.200
E	3.800	4.000	0.150	0.157
E1	5.800	6.200	0.228	0.244
e	1.27 BSC		0.050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

MSOP8



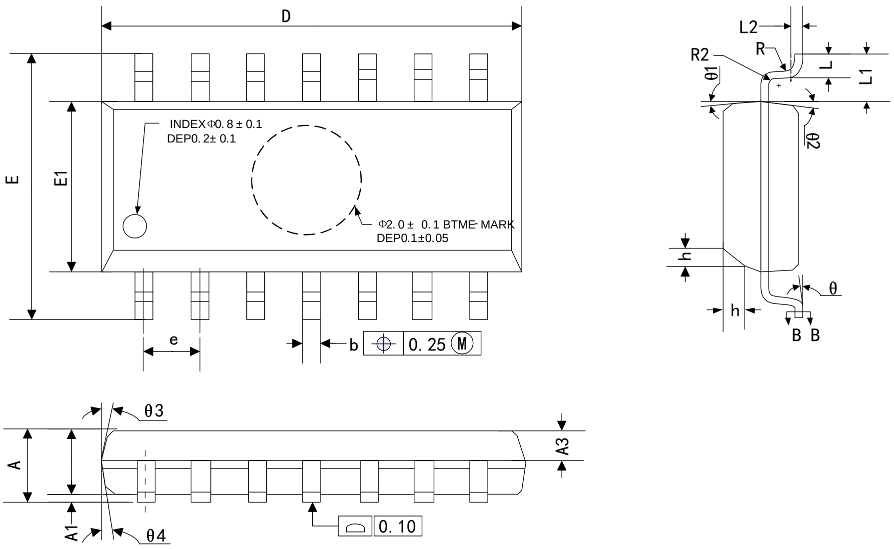
Symbol	Dimensions in Millimeters		Dimensions in Inches	
	Min	Max	Min	Max
A	0.820	1.100	0.032	0.043
A1	0.020	0.150	0.001	0.006
A2	0.750	0.950	0.030	0.037
b	0.250	0.380	0.010	0.015
c	0.090	0.230	0.004	0.009
D	2.900	3.100	0.114	0.122
E	2.900	3.100	0.114	0.122
E1	4.750	5.050	0.187	0.199
e	0.650BSC		0.026BSC	
L	0.400	0.800	0.016	0.031
θ	0º	6º	0º	6º

DFN8



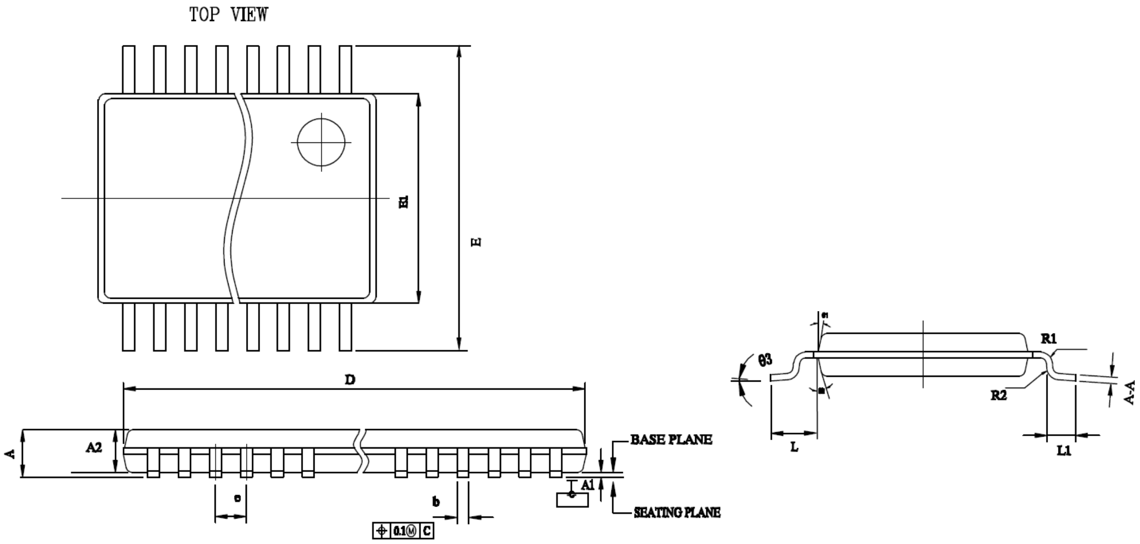
Symbol	Dimensions in Millimeters		
	Min	Typ	Max
A	0.50	0.55	0.60
A1	0	0.02	0.05
b	0.20	0.25	0.30
b1	0.11	0.16	0.21
c	0.10	0.15	0.20
D	1.90	2.00	2.10
D2	1.60	1.70	1.80
e	0.50BSC		
Ne	1.50BSC		
E	1.90	2.00	2.10
E2	0.80	0.90	1.00
L	0.25	0.30	0.35
h	0.20	0.25	0.30
K	0.20	0.25	0.30
L/F Carrier Size	1.75×1.15		

SOP14



Symbol	Dimensions in Millimeters		
	Min	Typ	Max
A	1.35		1.75
A1	0.10		0.25
A2	1.25		1.65
A3	0.55		0.75
D	8.53		8.73
E	5.80		6.20
E1	3.80		4.00
e	1.27 BSC		
L	0.45		0.80
L1	1.04 REF		
L2	0.25 BSC		
R	0.07		
R1	0.07		
h	0.30		0.50
θ	0 º		8 º
θ1	6 º	8º	10 º
θ2	6 º	8º	10 º
θ3	5 º	7º	9 º
θ4	5 º	7º	9 º

TSSOP14



Symbol	Dimensions in Millimeters	
	Min	Max
A		1.2
A1	0.05	0.15
A2	0.8	1.05
E	6.25	6.55
E1	4.3	4.5
D	4.9	5.1
L		1
L1	0.45	0.75
e	0.65	
b	0.19	0.3
R1	0.15TYP	
R2	0.15TYP	
A-A	0.09	0.2
θ1	12°TYP	
θ2	12°TYP	
θ3	0	8°

MARKING and PACKAGING SPECIFICATION

1. Marking Drawing Description

Product Name MS8628, MS8629, MS8629M, 8629D, MS8630, MS8630T

Product Code： XXXX, XXXXXX, 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
MS8628	SOP8	4000	1	4000	8	32000
MS8629	SOP8	2500	1	2500	8	20000
MS8629M	MSOP8	3000	1	3000	8	24000
MS8629D	DFN8	3000	10	30000	4	120000
MS8630	SOP14	2500	1	2500	8	20000
MS8630T	TSSOP14	3000	1	3000	8	24000

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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