

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 ($\pm 0.9V$ to $\pm 2.5V$ 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 $-40^{\circ}C$ to $125^{\circ}C$. The MS8628 has lead SOT23-5 and SOP8 packages. The MS8629 has lead SOP8, MSOP8 and DFN8 packages. The MS8630 has SOP14 and TSSOP14 packages.

FEATURES

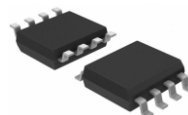
- Lowest Noise Auto-zero Amplifier
- Low Offset Voltage: $2\mu V$ (TYP.)
- Input Offset Drift: $0.03\mu V/^{\circ}C$
- Rail-To-Rail Input/Output
- Single Power Supply : 1.8V to 5.5V
- Open-Loop Gain: 145dB(TYP.)
- Power Supply Rejection Ratio: 130dB (TYP.)
- Common-mode Rejection Ratio: 140dB (TYP.)
- Ultra-low Input Bias Current
- Low Operating Current
- Overload Recovery Time: $50\mu s$
- No Need for External Components

PRODUCT SPECIFICATION

Part Number	Package	Marking
MS8628S	SOT23-5	8628S
MS8628	SOP8	MS8628
MS8629	SOP8	MS8629
MS8629M	MSOP8	MS8629M
MS8629D	DFN8	8629D
MS8630	SOP14	MS8630
MS8630T	TSSOP14	MS8630T



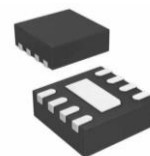
SOT23-5



SOP8



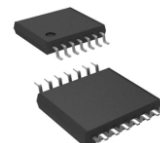
MSOP8



DFN8



SOP14

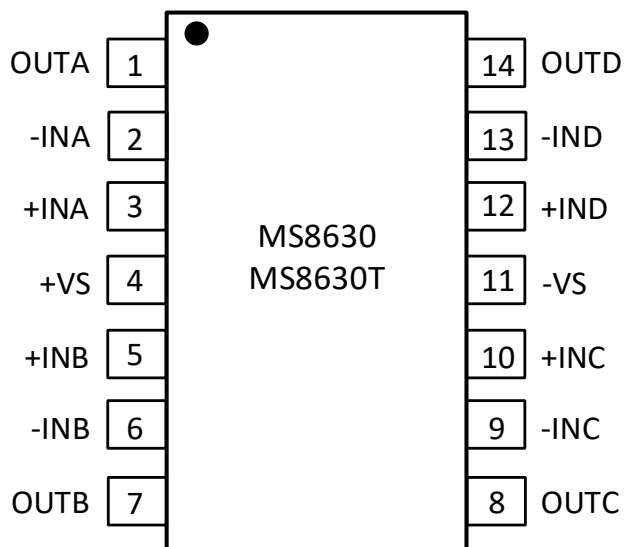
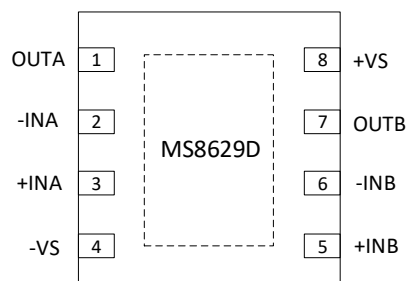
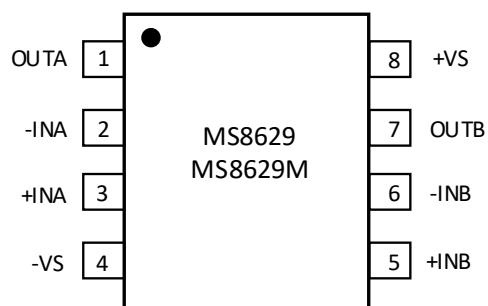
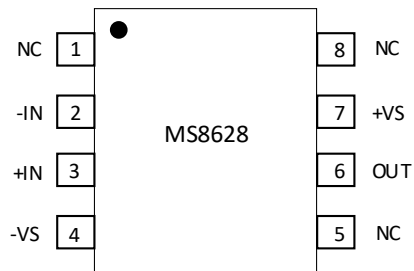
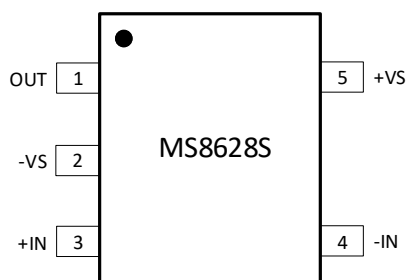


TSSOP14

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
MS8628S			
1	OUT	O	Channel Output
2	-VS	-	Negative Power Supply
3	+IN	I	Non-inverting Input
4	-IN	I	Inverting Input
5	+VS	-	Positive Power Supply
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

Pin	Name	Type	Description
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	V_S	6	V
Input Voltage	V_I	$-V_S-0.3 \sim +V_S+0.3$	V
Differential Input Voltage		-5 ~ 5 (or Power Supply, Base on Lower Value)	V
Maximum Junction Temperature	T_{JMAX}	150	°C
Operating Temperature	T_A	-40 ~ 125	°C
Storage Temperature	T_{STG}	-65 ~ 150	°C
Soldering Temperature (10s)	T_{SOLDER}	260	°C
ESD (HBM)	V_{HBM}	±4000	V

ELECTRICAL CHARACTERISTICS (5V)

Unless otherwise noted, $V_S = +5V$, $V_{CM} = +2.5V$, $V_O = +2.5V$, $T_A = 25^\circ C$.

Parameter		Symbol	Condition	Min	Typ	Max	Unit
Input Characteristics							
Input Offset Voltage		V _{OS}			2	5	μV
Input Bias Current	MS8628/MS8629	I _B			30		pA
	MS8630				100		pA
Input Offset Current		I _{OS}			40		pA
Input Voltage				0		5	V
Common-mode Rejection Ratio		CMRR	V _{CM} = 0V to 5V	110	140		dB
Open-Loop Gain		A _{VO}	R _L = 10kΩ, V _O = 0.3V to 4.7V	110	145		dB
Input Offset Voltage Drift		ΔV _{OS} /ΔT _A			0.03		μV/°C
Output Characteristics							
Output High Voltage		V _{OH}	R _L = 100kΩ to -V _S	4.99	4.996		V
			R _L = 10kΩ to -V _S	4.99	4.995		V
Output Low Voltage		V _{OL}	R _L = 100kΩ to +V _S		1	5	mV
			R _L = 10kΩ to +V _S		10	20	mV
Short-circuit Current		I _{SC}	V _O = 2.5V, R _L = 10Ω to GND	25	50		mA
Output Current		I _O			30		mA
Power Dissipation							
Power Supply Rejection Ratio		PSRR	V _S =1.8V to 5.5V	105	130		dB
Quiescent Current (Each Amplifier)	MS8628	I _Q	V _O = V _S /2		1.7	2.2	mA
	MS8629, MS8630				0.85	1.1	mA
Dynamic Characteristics							
Gain Bandwidth Product		GBP	A _V = +100		3.8		MHz
Slew Rate		SR	A _V = +1, R _L = 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/√Hz
Current Noise Density		i _n	f = 10Hz		5		fA/√Hz

ELECTRICAL CHARACTERISTICS (2.7V)

Unless otherwise noted, $V_S = +2.7V$, $V_{CM} = +1.35V$, $V_O = +1.35V$, $T_A = 25^\circ C$.

Parameter		Symbol	Condition	Min	Typ	Max	Unit
Input Characteristics							
Input Offset Voltage		V _{OS}			0.5	5	μV
Input Bias	MS8628/MS8629	I _B			30		pA
Current	MS8630				100		pA
Input Offset Current		I _{OS}			50		pA
Input Voltage				0		2.7	V
Common-mode Rejection Ratio		CMRR	V _{CM} = 0V to 2.7V	110	130		dB
Open-Loop Gain		A _{VO}	R _L = 10kΩ, V _O = 0.3V to 2.4V	110	140		dB
Input Offset Voltage Drift		ΔV _{OS} /ΔT _A			0.03		μV/°C
Output Characteristics							
Output High Voltage		V _{OH}	R _L = 100kΩ to -V _S	2.68	2.695		V
			R _L = 10kΩ to -V _S	2.67	2.68		V
Output Low Voltage		V _{OL}	R _L = 100kΩ to +V _S		1	5	mV
			R _L = 10kΩ to +V _S		10	20	mV
Short-circuit Current		I _{SC}	V _O = 2.5V, R _L = 10Ω to GND	10	15		mA
Output Current		I _O			10		mA
Power Dissipation							
Power Supply Rejection Ratio		PSRR	V _S =1.8V to 5.5V	110	130		dB
Quiescent	MS8628	I _Q	V _O = V _S /2		1.5	2	mA
Current (Each Amplifier)	MS8629, MS8630				0.75	1	mA
Dynamic Characteristics							
Gain Bandwidth Product		GBP	A _V = +100		3.3		MHz
Slew Rate		SR	A _V = +1, R _L = 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/√Hz
Current Noise Density		i _n	f = 10Hz		5		fA/√Hz

TYPICAL CHARACTERISTICS CURVES

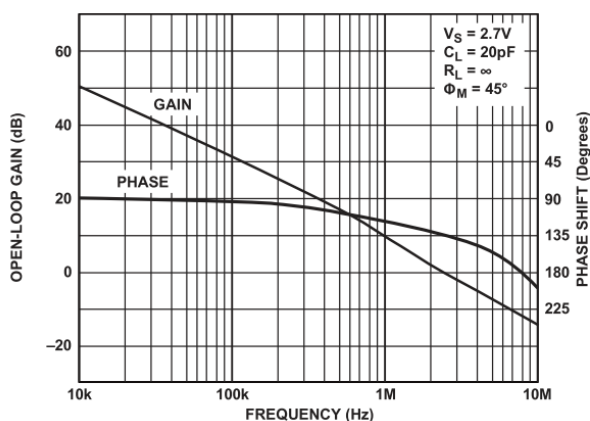


Figure 1. Open-Loop Gain, Phase VS. Frequency

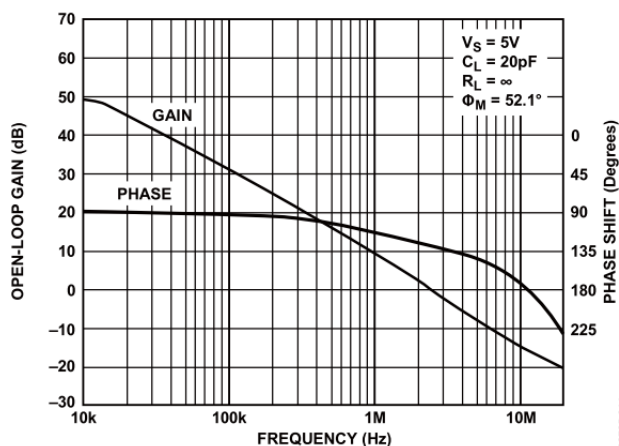


Figure 2. Open-Loop Gain, Phase VS. Frequency

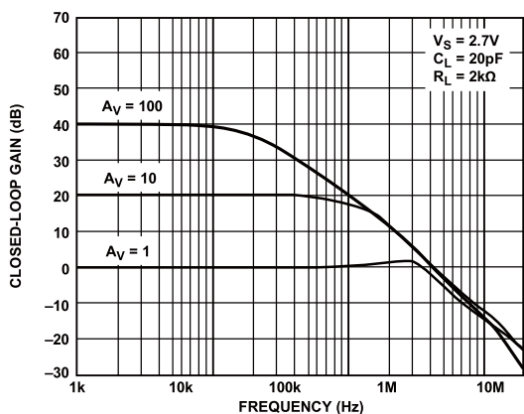


Figure 3. Closed-Loop Gain VS. Frequency

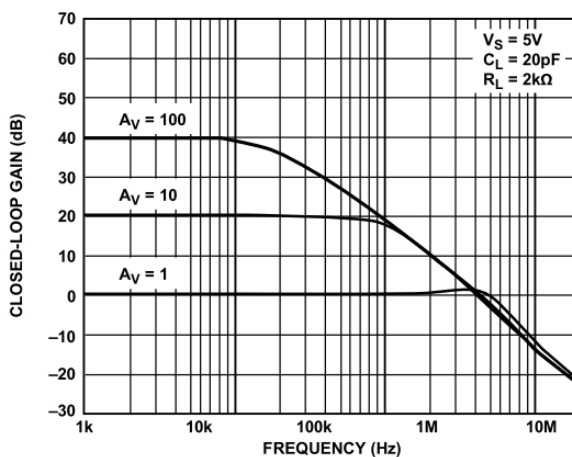


Figure 4. Closed-Loop Gain VS. Frequency

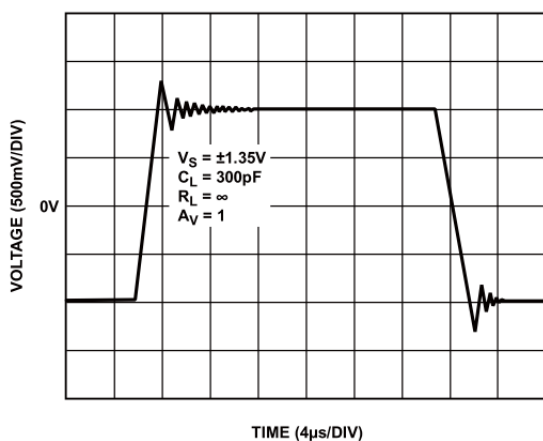


Figure 5. Large Signal Transient Response

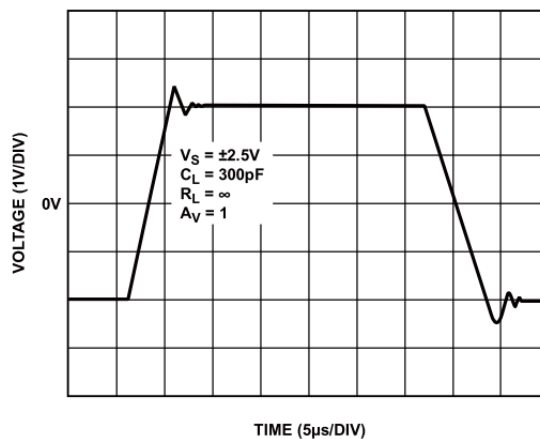


Figure 6. Large Signal Transient Response

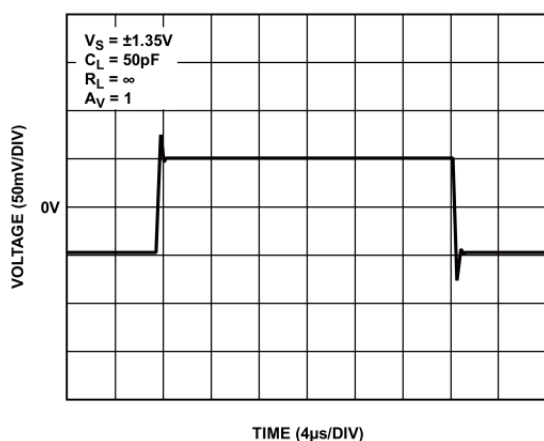


Figure 7. Small Signal Transient Response

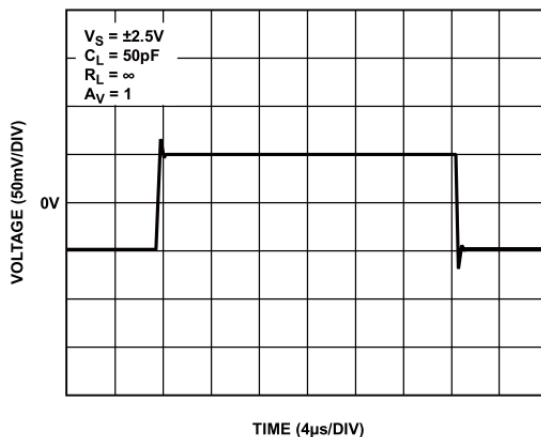


Figure 8. Small Signal Transient Response

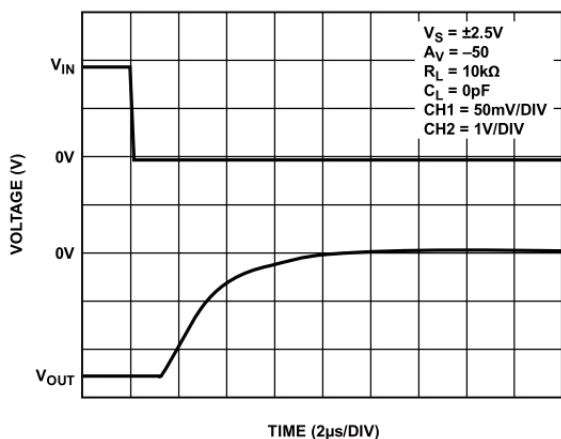


Figure 9. Positive Overvoltage Recovery Time

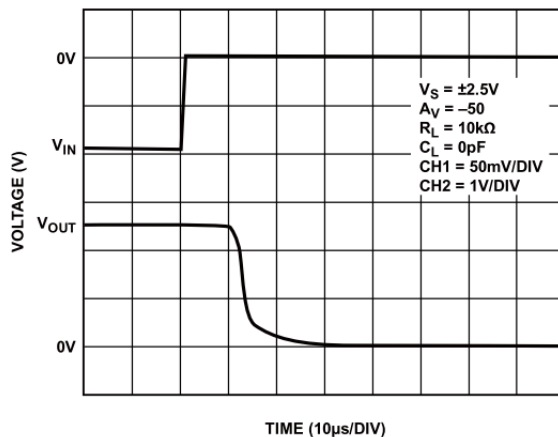


Figure 10. Negative Overvoltage Recovery Time

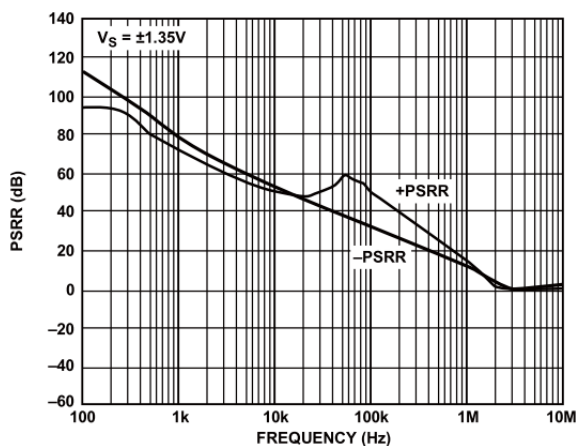


Figure 11. PSRR VS. Frequency

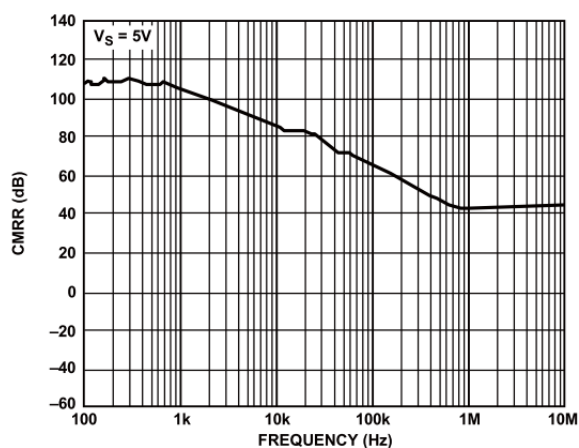


Figure 12. CMRR VS. Frequency

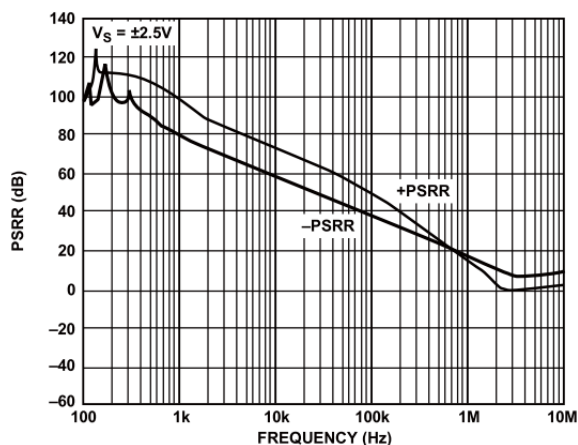


Figure 13. PSRR VS. Frequency

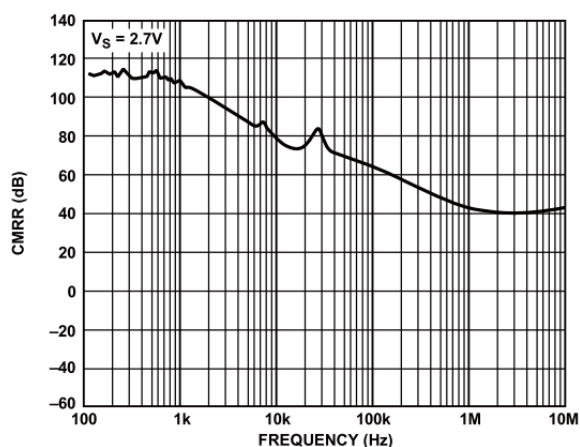


Figure 14. CMRR VS. Frequency

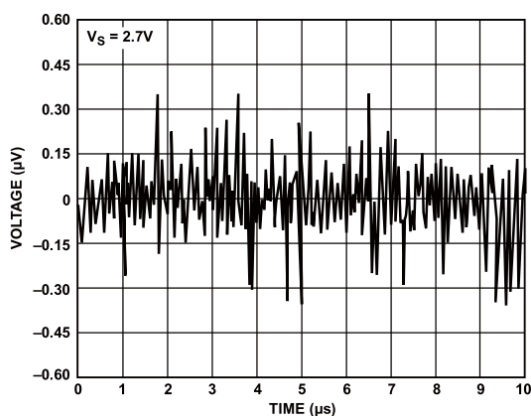


Figure 15. 0.1Hz to 10Hz Noise

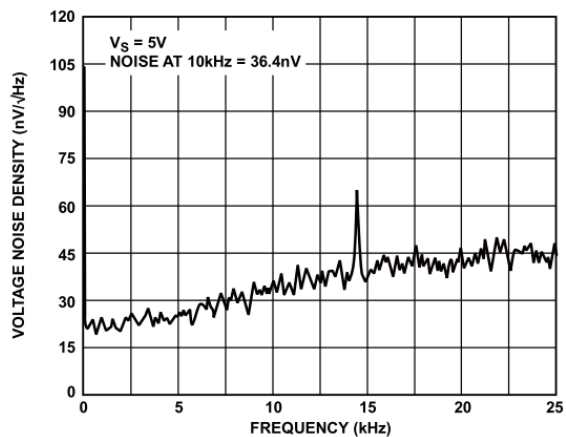


Figure 16. 0Hz to 25kHz Voltage Noise Density at 5V

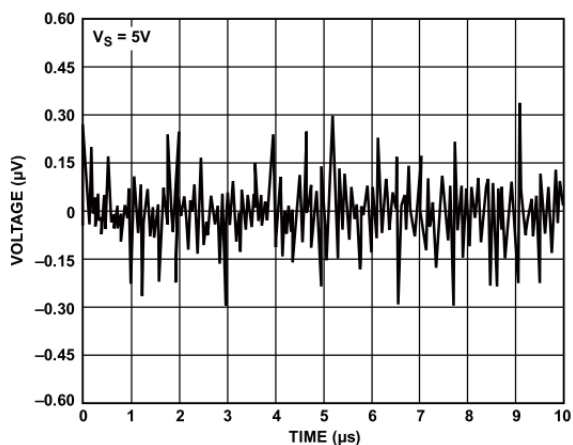


Figure 17. 0.1Hz to 10Hz Noise

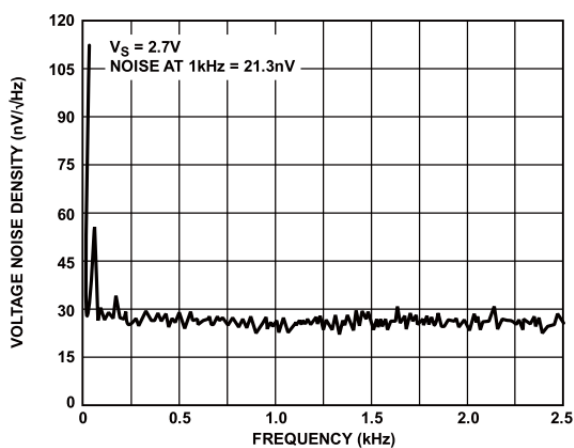


Figure 18. 0Hz to 2.5kHz Voltage Noise Density at 2.7V

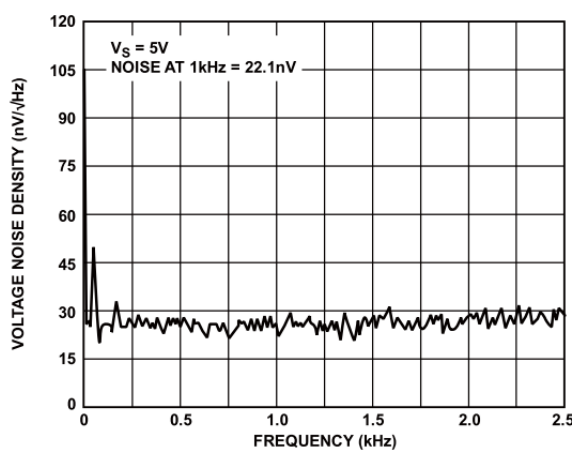


Figure 19. 0Hz to 2.5kHz Voltage Noise Density at 5V

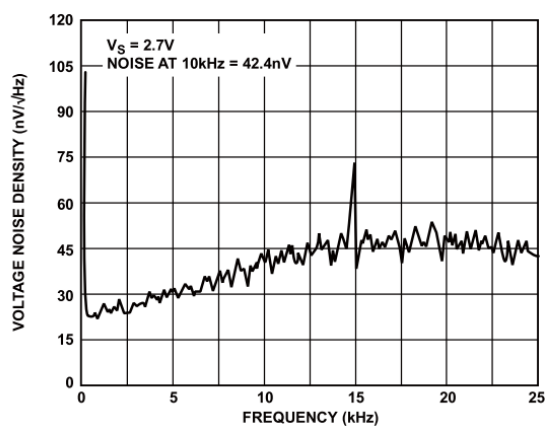


Figure 20. 0Hz to 25kHz Voltage Noise Density at 2.7V

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 $100\mu\text{V}$ to $300\mu\text{V}$ to 1V to 3V , used in precision analog-to-digital conversion.

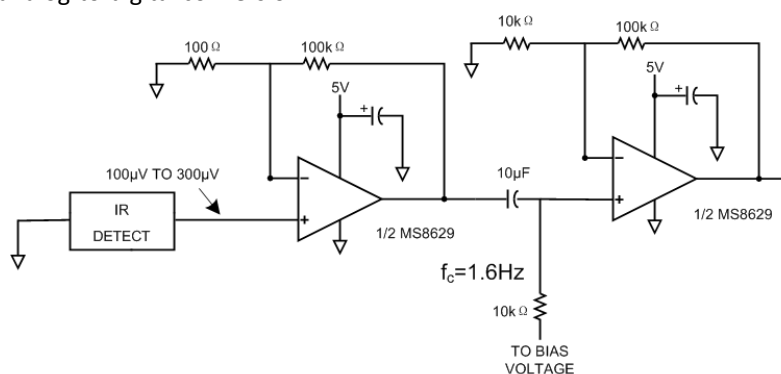


Figure 21. MS8629 as Pre-amplifier for Infrared Temperature Sensor

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.

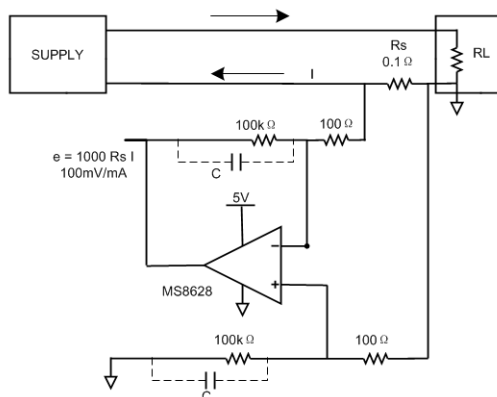


Figure 22. Low-side Current Detection

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 MS5541 is 1μs. The total setup time is about 1.4μs calculated by the formula below:

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

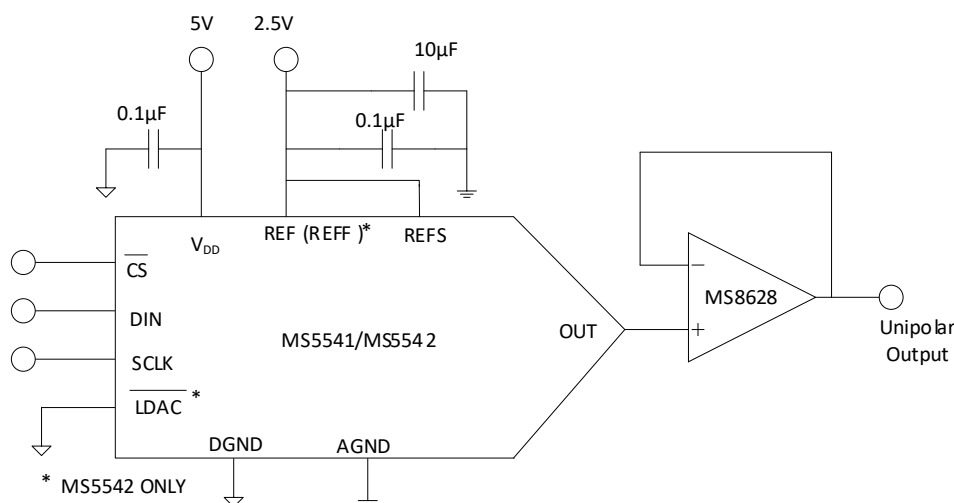
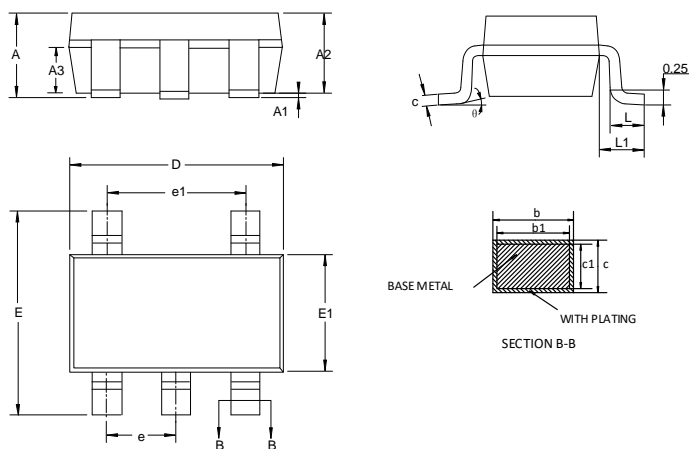


Figure 23. MS8628 as Output Amplifier

PACKAGE OUTLINE DIMENSIONS

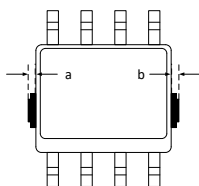
SOT23-5



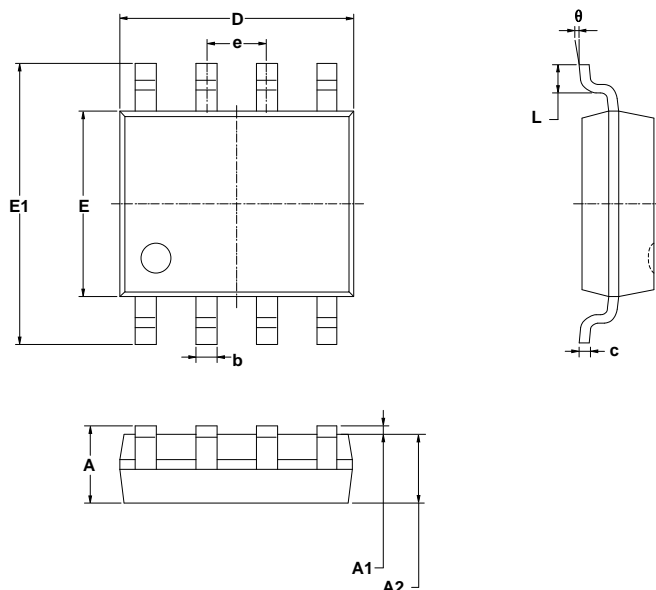
Symbol	Dimensions in Millimeters		
	Min	Typ	Max
A	-	-	1.25
A1	0.04	-	0.10
A2	1.00	1.10	1.20
A3	0.60	0.65	0.70
b	0.33	-	0.41
b1	0.32	0.35	0.38
c	0.15	-	0.19
c1	0.14	0.15	0.16
D	2.82	2.92	3.02
E	2.60	2.80	3.00
E1	1.50	1.60	1.70
e	0.95BSC		
e1	1.90BSC		
L	0.30	-	0.60
L1	0.60REF		
θ	0°	-	8°

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

The diagram is as follows: taking SOP8 package as an example.

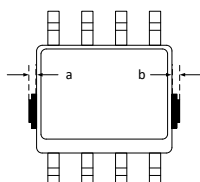


SOP8

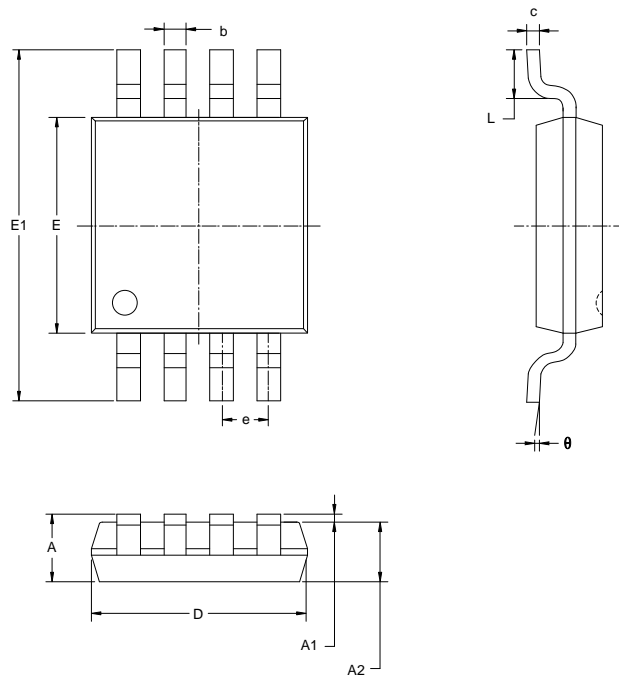


Symbol	Dimensions in Millimeters		Dimensions in Inches	
	Min	Max	Min	Max
A	1.350	1.750	0.053	0.069
A1	0.100	0.250	0.004	0.010
A2	1.350	1.550	0.053	0.061
b	0.330	0.510	0.013	0.020
c	0.170	0.250	0.006	0.010
D	4.700	5.100	0.185	0.200
E	3.800	4.000	0.150	0.157
E1	5.800	6.200	0.228	0.244
e	1.27 BSC		0.050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

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



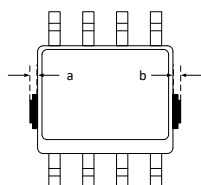
MSOP8



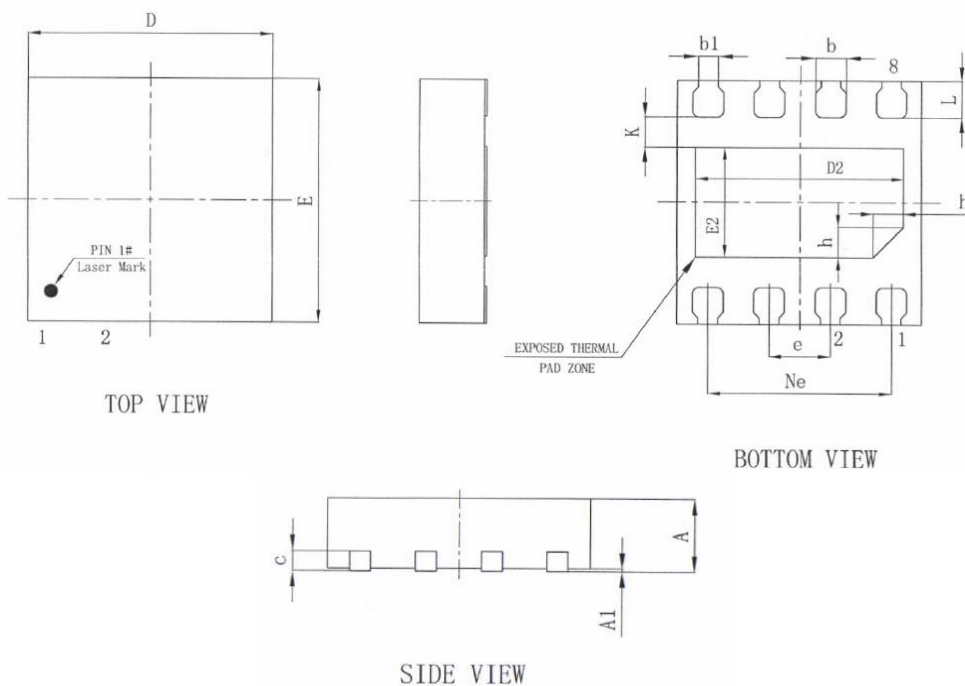
Symbol	Dimensions in Millimeters		Dimensions in Inches	
	Min	Max	Min	Max
A	0.820	1.100	0.032	0.043
A1	0.020	0.150	0.001	0.006
A2	0.750	0.950	0.030	0.037
b	0.250	0.380	0.010	0.015
c	0.090	0.230	0.004	0.009
D	2.900	3.100	0.114	0.122
E	2.900	3.100	0.114	0.122
E1	4.750	5.050	0.187	0.199
e	0.650BSC		0.026BSC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

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

The diagram is as follows: taking SOP8 package as an example.

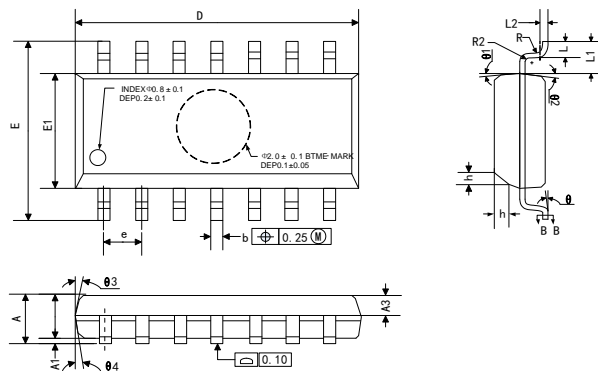


DFN8



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		

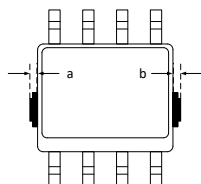
SOP14



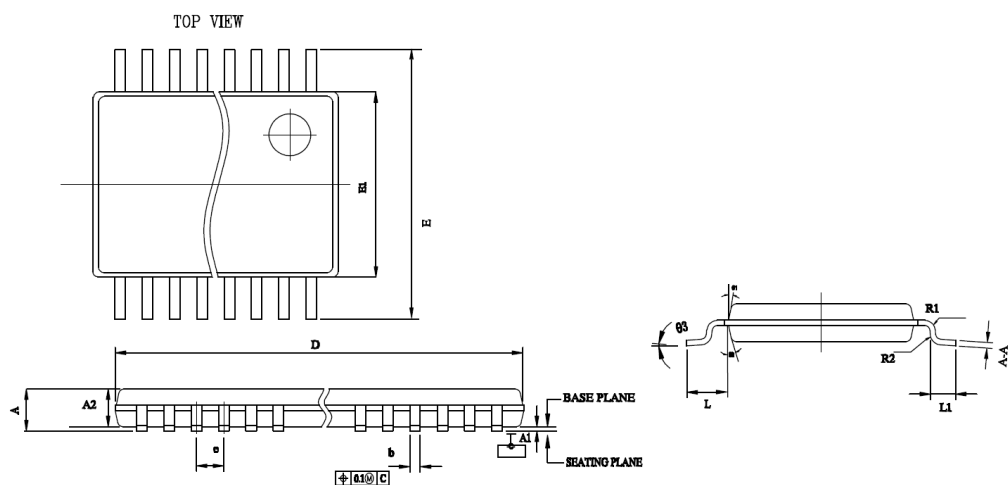
Symbol	Dimensions in Millimeters		
	Min	Typ	Max
A	1.35		1.75
A1	0.10		0.25
A2	1.25		1.65
A3	0.55		0.75
D	8.53		8.73
E	5.80		6.20
E1	3.80		4.00
e	1.27 BSC		
L	0.45		0.80
L1	1.04 REF		
L2	0.25 BSC		
R	0.07		
R1	0.07		
h	0.30		0.50
θ	0 °		8 °
θ1	6 °	8 °	10 °
θ2	6 °	8 °	10 °
θ3	5 °	7 °	9 °
θ4	5 °	7 °	9 °

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

The diagram is as follows: taking SOP8 package as an example.



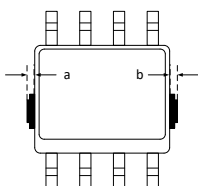
TSSOP14



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°

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

The diagram is as follows: taking SOP8 package as an example.



MARKING and PACKAGING SPECIFICATION

1. Marking Drawing Description



Product Name: 8628S, MS8628, MS8629, MS8629M, 8629D, MS8630, MS8630T

Product Code: XXXX, XXXXX, 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
MS8628S	SOT23-5	3000	10	30000	4	120000
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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