Zero drift, single power supply, input and output rail to rail high precision amplifier

description

MS8628/MS8629/MS8630 are all output amplitude rail-to-rail, broadband, low noise, self-stabilized zero amplifiers with ultra-low offset, drift and bias current characteristics. They are powered by a single power supply of 1.8V to 5V (or dual power supplies of ±0.9 V to ±2.5 V).

The MS8628/MS8629/MS8630 offers the characteri-stic advantages previously only available to expen-sive self-stabilizing zero or chopper amplifiers. Additionally, it significantly reduces the digital switch noise present in most chopper-stabilized amplifiers. The MS8629's ultra-low offset voltage, offset voltage drift, and noise ensure that drift within the operating temperature range is nearly zero, making it highly advantageous for position and pressure sensors, medical devices, and strain gauge amplifier applications. Many systems can leverage the MS8629's rail-to-rail input and output swing capability to reduce input bias complexity and maximize signal-to-noise ratio.

The rated temperature range of the MS8628/MS 8629/MS8630 is from-40° to 125°, extending the industrial temperature range. The MS8628 offers three plastic packages: a 5-pin SOT-23 and an 8-pin narrow SOP. The MS8629 provides two plastic packa-ges: a standard 8-pin narrow SOP and an MSOP. The MS8630 quad amplifier offers two plastic packages: a 14-pin narrow SOP and a 14-pin TSSOP.

main features

- ■ Minimum noise self-stabilized zero amplifier
- ■ Low derating voltage: 2μV (typ)
- ■ Input offset drift: 0.05μV/
- ■ Track-to-track input and output swing
- ■ Single power supply operating range of 1.8V to 5.5V
- ■ Voltage gain: 126dB (TYP) (working voltage 5V)
- ■ Power suppression ratio: 123dB (TYP)
- ■ Common-mode rejection ratio: 136dB (TYP)
- ■ Very low input bias current: 11pA
- ■ Low operating current: 0.8mA (TYP) per channel
- ■ Overload recovery time: 50us (working voltage 5

MS8628

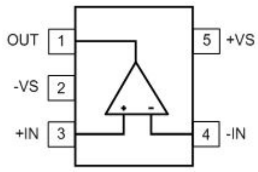


Figure 1.5 Pin

SOT-23 MS8628

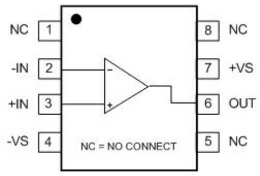


Figure 2.8 Pin SOP8 (R-8)

MS8629

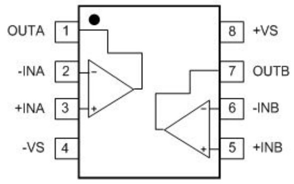


Figure 3.8 SOP8 pin and MSOP8 pin 8

MS8630

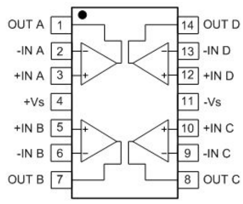


Figure 4.14 Pin SOP14 and pin TSSOP14

apply

- ■ Car sensors
- ■ Pressure and position sensors
- ■ Strain gauge amplifier
- ■ medical instruments
- ■ Thermocouple amplifier
- ■ Precision current detection
- ■ Photo diode amplifier

V)

- No external components required
- Pass automotive application certification

Product specification classification

Product	Packaging form	Print the name
MS8628	SOT23-5/SOP8	MS8628
MS8629	SOP8/MSOP8	MS8629
MS8630	SOP14	MS8630

Absolute rating

Parameter	Symbol	Parameter range	Unit
Supply voltage	VS	6	V
Input pin voltage		-Vs-0.3 to (+Vs) +0.3	V
Differential input voltage		-5 to 5 (or power supply voltage, whichever is smaller)	V
Range of junction temperature		—65～150	℃
Working temperature	TA	-40～125	℃
Storage temperature	Tstg	—65～150	℃
Pin temperature range (welding, 60 seconds)		300	℃
ESD protection: human body mode HBM machine mode MM		4000 200	V

pay attention to:

Exceeding the aforementioned absolute maximum values may cause permanent damage to the device. These are only the maximum values and do not indicate that the device will function properly under these conditions or any other conditions exceeding the specifications shown in the operational section of this technical specification. Long-term operation at the maximum absolute values can affect the reliability of the device.

Electrical parameters (5V) (If no special mention, Vs = +5V, VCM = +2.5V, Vo = +2.5V, TA = 25 .)

Parameter	Symbol	Test condition	Least value	Representative value	Crest value	Unit
Input characteristics						
Input offset voltage	V_{OS}			2	5	μV
		$-40℃ \le T_A \le +125℃$			10	
Input bias Apply current MS8628/ MS8629	I_B			30	100	PA
Input bias Apply current MS 8630				100	300	PA
		$-40℃ \le T_A \le +125℃$			1.5	nA
Input offset current	I_{OS}	$-40℃ \le T_A \le +125℃$		40	200 250	pA
Input voltage range			0		5	V
Cmrr	$CMRR$	VCM = 0V to 5V	120	140		dB
		$-40℃ \le T_A \le +125℃$	115	130		
Large signal gain	A_{VO}	RL= 10kΩ, Vo= 0.3V to 4.7V	127	145		dB
		$-40℃ \le T_A \le +125℃$	120	135		
Input offset voltage drift	$\Delta V_{OS}/\Delta_T$	$-40℃ \le T_A \le +125℃$		0.03	0.05	μV/℃
Output characteristic						
Output high level	V_{OH}	RL = 100kΩ to -Vs	4.99	4.996		V
		RL = 10kΩ to -Vs	4.99	4.995		V
Output low level	V_{OL}	RL = 100kΩ to +Vs		1	5	mV
		$-40℃ \le T_A \le +125℃$		2	5	
		RL = 10kΩ to +Vs		10	20	mV
		$-40℃ \le T_A \le +125℃$		15	20	
Short-circuit current	I_{SC}	Vo= 2.5V, RL = 10 Ω to GND	25	50		mA
Out put	Io			30		mA
		$-40℃ \le T_A \le +125℃$		15		mA
Power consumption						
Power supply rejection ratio	$PSRR$	Vs =1.8V to 5.5V, $-40℃ \le T_A \le +125℃$	115	130		dB
Quiescent current	IQ (per magnification Implement)	Vo = Vs/2		0.85	1.1	mA
		$-40℃ \le T_A \le +125℃$		1.0	1.2	
Dynamic characteristics						
Gain bandwidth product	GBP	Av = +100		3.8		MHz
Pumping rate	SR	Av = +1, RL = 10kΩ		1.25		V/μs
Overload recovery time				0.05		ms
Noise characteristic						
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 parameters (2.7V)

(If no special mention, Vs = +2.7V, VCM = +1.35V, Vo = +1.35V, TA = 25 .)

Parameter	Symbol	Test condition	Least value	Representative value	Crest value	Unit
Input characteristics						
Input offset voltage	V_{OS}			0.5	5	μV
		$-40℃ \le T_A \le +125℃$			10	
Input bias Apply current MS8628/MS8629	I_B			30	100	PA
MS 8630				100	300	PA
		$-40℃ \le T_A \le +125℃$		1.0	1.5	nA
Input offset current	I_{OS}	$-40℃ \le T_A \le +125℃$		50	200 250	pA
Input voltage range			0		2.7	V
Cmrr	$CMRR$	VCM = 0V to 2.7V	115	130		dB
		$-40℃ \le T_A \le +125℃$	110	120		
Large signal gain	A_{VO}	RL= 10kΩ, Vo= 0.3V to 2.4V	110	140		dB
		$-40℃ \le T_A \le +125℃$	105	130		
Input offset voltage drift	$\Delta V_{OS}/\Delta T$	$-40℃ \le T_A \le +125℃$		0.03	0.05	μV/℃
Output characteristic						
Output high level	V_{OH}	RL = 100kΩ to -Vs	2.68	2.695		V
		RL = 10kΩ to -Vs	2.67	2.68		V
Output low level	V_{OL}	RL = 100kΩ to +Vs		1	5	mV
		$-40℃ \le T_A \le +125℃$		2	5	
		RL = 10kΩ to +Vs		10	20	mV
		$-40℃ \le T_A \le +125℃$		15	20	
Short-circuit current	I_{SC}	Vo= 2.5V, RL = 10Ω to GND	10	15		mA
Output	Io			10		mA
		$-40℃ \le T_A \le +125℃$		5		mA
Power consumption						
Power supply rejection ratio	$PSRR$	Vs =1.8V to 5.5V, $-40℃ \le T_A \le +125℃$	115	130		dB
Quiescent current	I_Q	Vo = Vs/2		0.75	1.0	mA
		$-40℃ \le T_A \le +125℃$		0.9	1.2	
Dynamic characteristis						
Gain bandwidth product	GBP	Av = +100		3.3		MHz
Pumping rate	SR	Av = +1, RL = 10kΩ		1.0		$V/\mu s$
Overload recovery time				0.05		ms
Noise characteristic						
Voltage noise	$e_n p-p$	0.1Hz to 10Hz		0.50		μV_{P-P}
Voltage noise	e_n	f = 1kHz		22		$nV/\sqrt{Hz}$

density						
Current noise density	i_n	f = 10Hz		5		$fA/\sqrt{Hz}$

Typical performance parameters

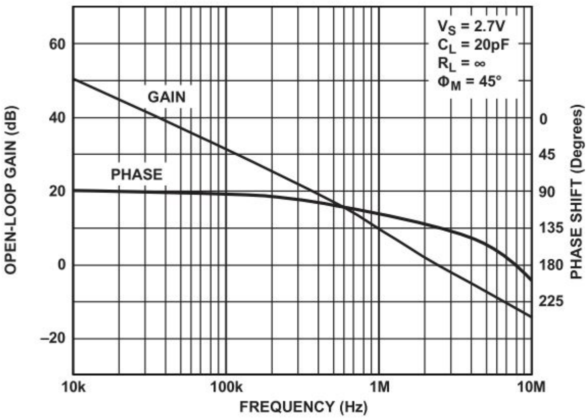


Figure 8. The relationship between open-loop gain, phase and frequency

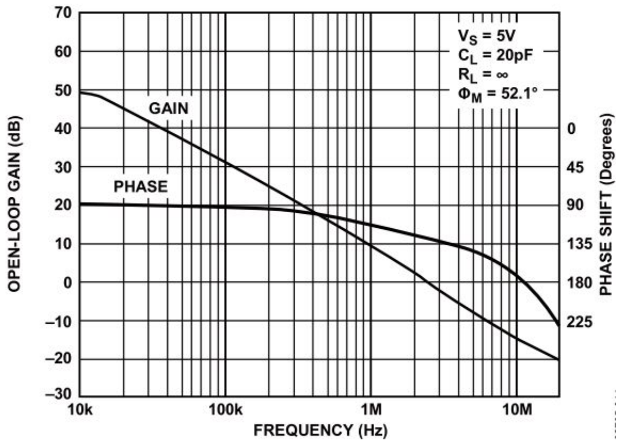


Figure 9. The relationship between open-loop gain, phase and frequency

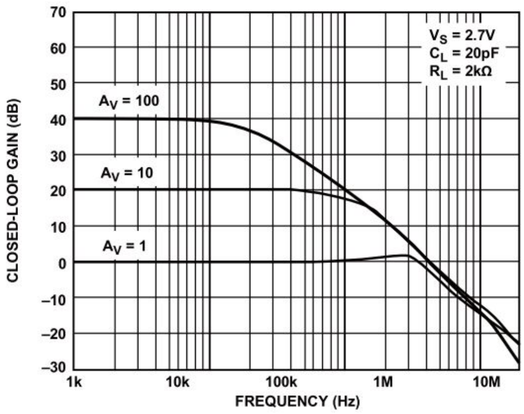


Figure 10. The relationship between closed-loop gain and frequency

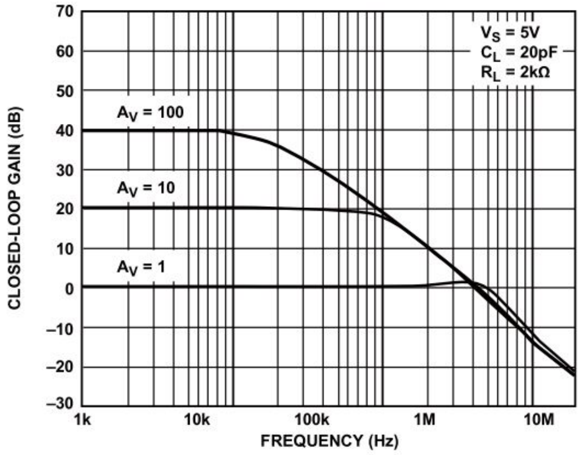
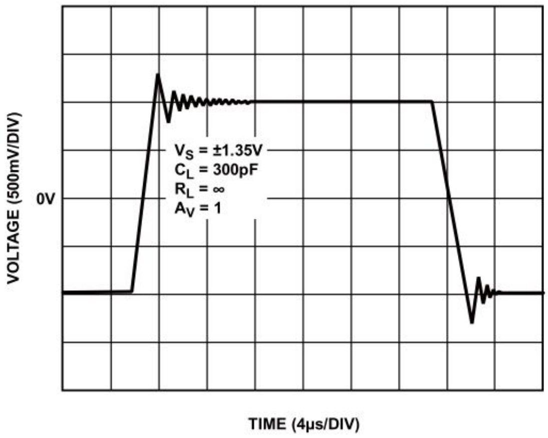


Figure 11. The relationship between closed-loop gain and frequency



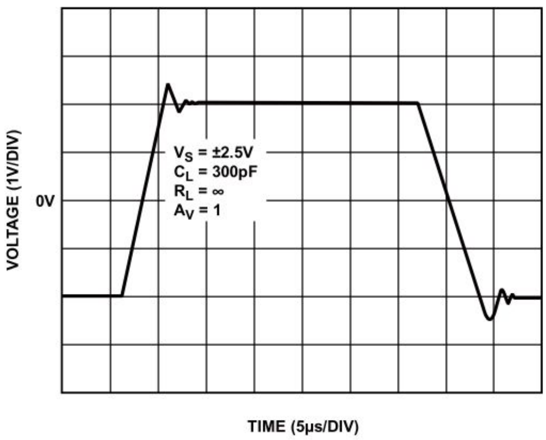


Figure 12. Large signal transient response

Figure 13. Large signal transient response

Typical performance parameters

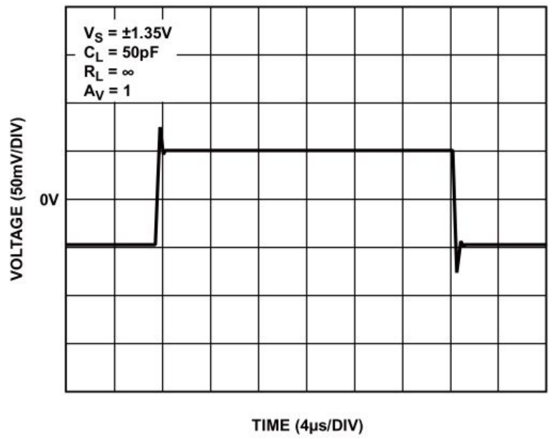


Figure 14. Small signal transient response

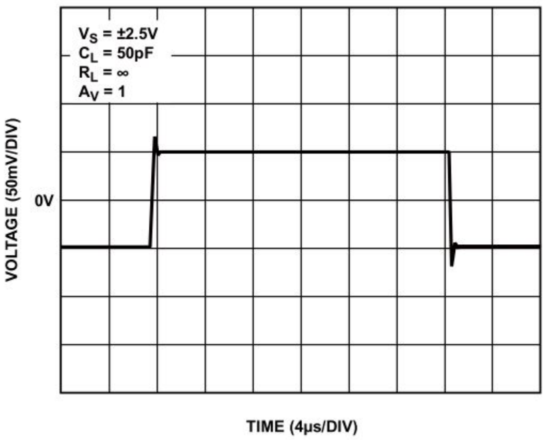


Figure 15. Small signal transient response

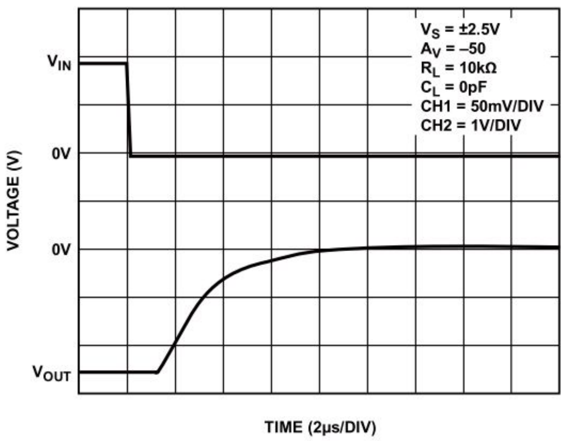


Figure 16. Recovery time for positive overvoltage

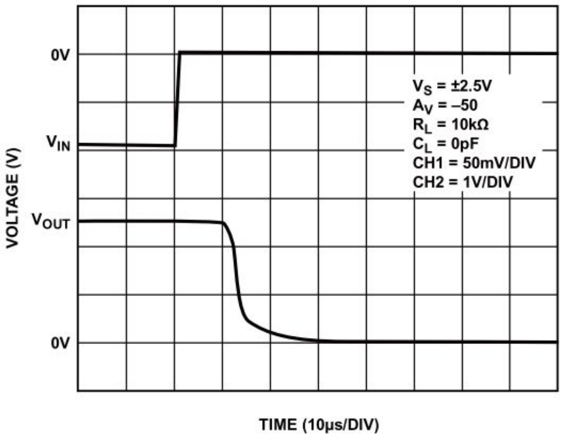


Figure 17. Recovery time for negative overvoltage

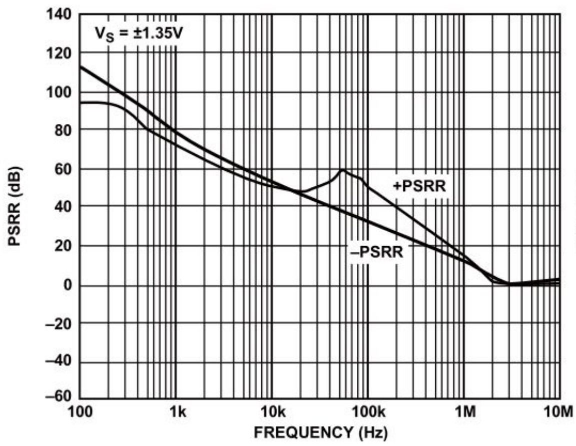


Figure 18.PSRR Relationship between frequency and amplitude

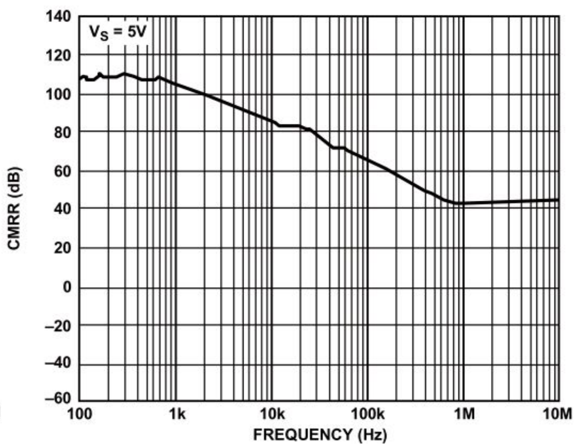


Figure 21.CMRR Relationship between frequency and amplitude

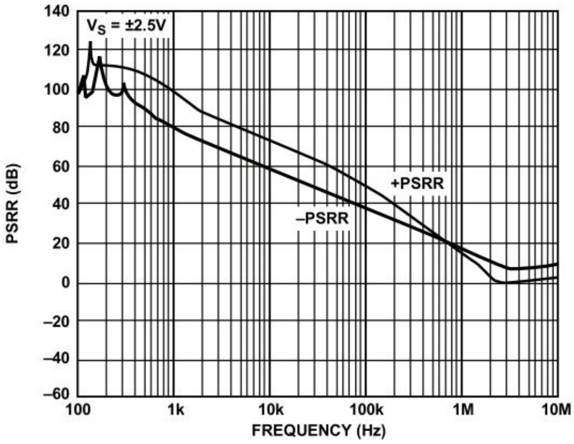


Figure 19.PSRR Relationship between freq-uency and amplitude

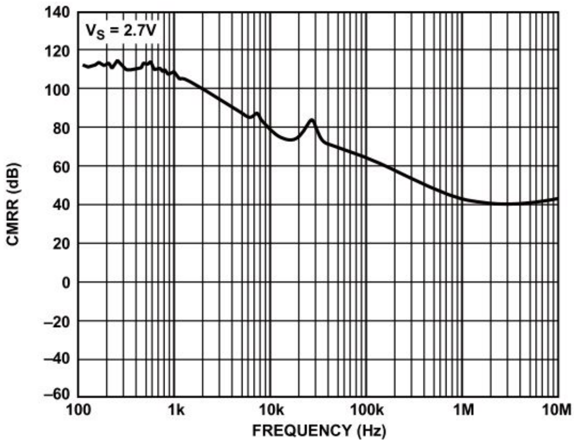


Figure 20.CMRR Relationship between freq-uency and amplitude

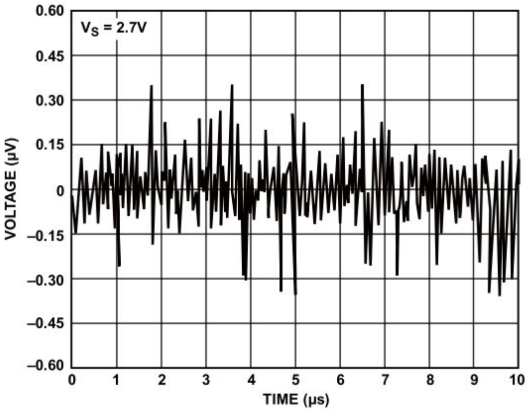


Figure 22.0. Noise from 1Hz to 10Hz

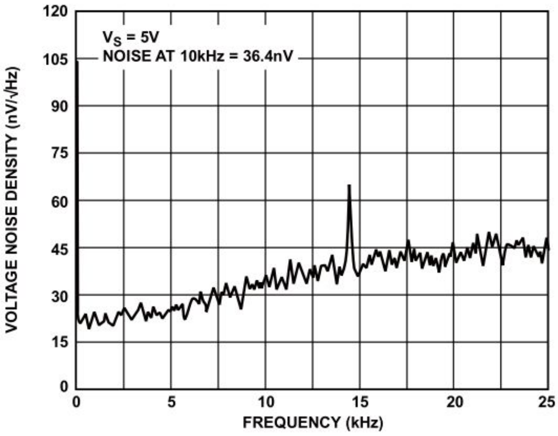
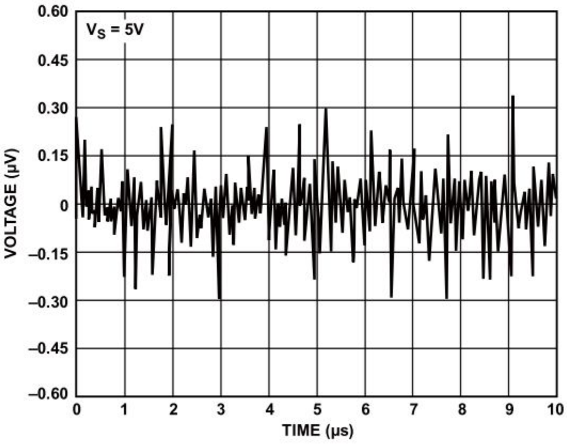


Figure 27. Voltage noise density from 0Hz to 25kHz at 5V



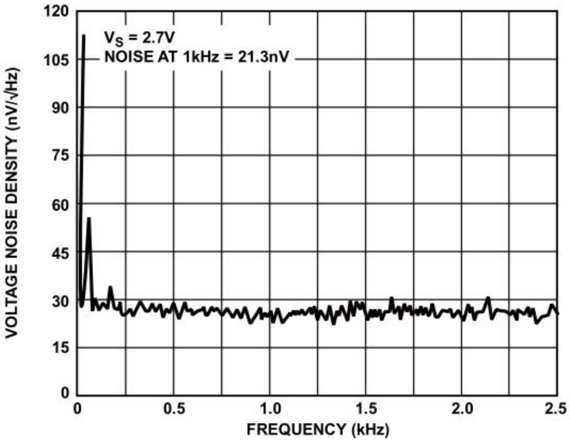


Figure 23.0. Noise from 1Hz to 10Hz

Figure 24.2 Voltage noise density from 0Hz to 2.5kHz at 7V

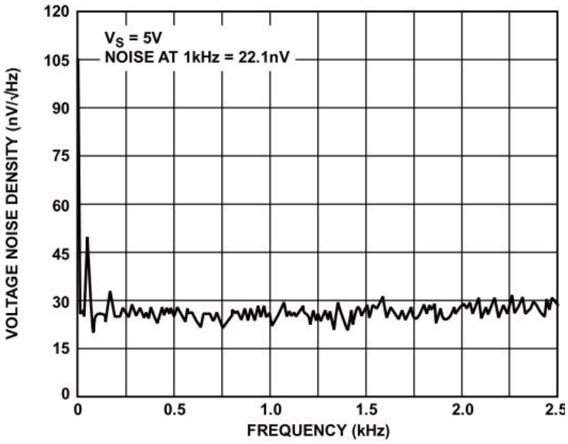


Figure 25. Voltage noise density from 0Hz to 2.5kHz at 5V

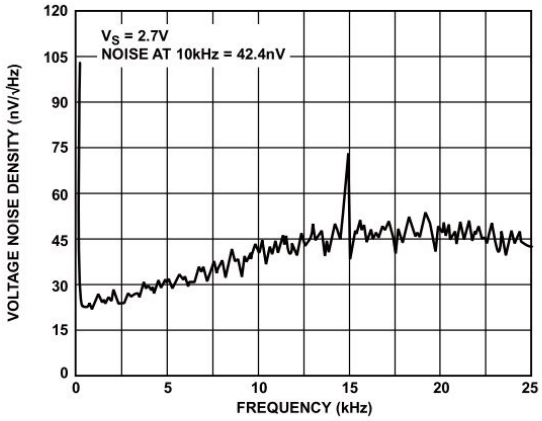


Figure 26.2. Voltage noise density from 0Hz to 25kHz at 7V

Typical application

infrared sensor

Infrared (IR) sensors, especially infrared temperature sensors, are increasingly used in temperature measurements across various applications, such as automotive climate control, ear thermometers, home insulation analysis, and automotive diagnostic maintenance. The output signal of these sensors is relatively weak, thus requiring high gain, and they have extremely low offset voltage and drift to avoid DC errors.

When using inter-stage AC coupling (see Figure 28), low offset and drift can prevent the output of the input amplifier from drifting to saturation. Low input bias current minimizes errors generated by the impedance of the sensor's output. Similar to pressure sensors, after temperature measurement calibration, the amplifier has extremely low time and temperature drift, which eliminates additional errors. The low 1/f noise also improves the SNR of DC measurements over periods (typically more than one-fifth of a second).

The circuit gain shown in Figure 62 is 10,000, which can amplify the AC signal from 100 μV to 300 μV to the level of 1V to 3V,
Used for accurate analog-to-digital conversion.

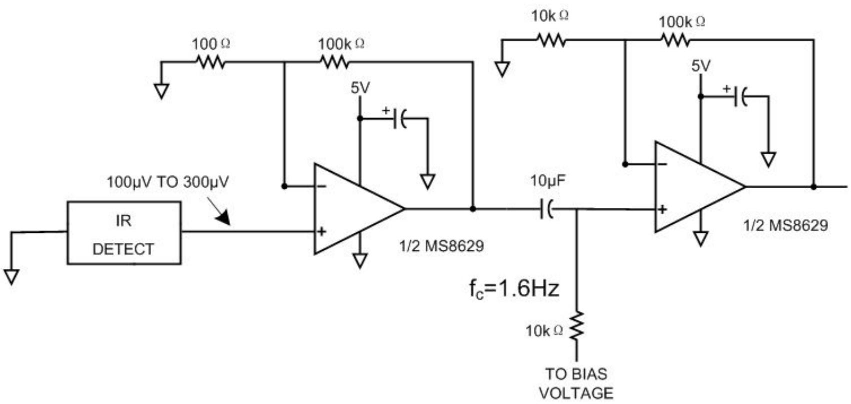


Figure 28.MS8629 is used as a preamplifier for an infrared temperature sensor

Precision flow sensor

As shown in Figure 29, the unique characteristics of self-stabilizing zero amplifiers used for differential configurations benefit the application of precision shunt sensors. Shunt sensors can be employed in precision current sources within feedback control systems. Additionally, these sensors can be utilized in various other applications, including battery level meters, laser diode power consumption measurement and control, torque feedback control in electric power steering, and precision

Electricity metering.

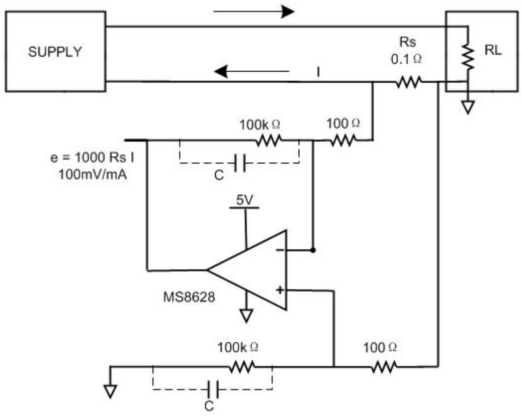


Figure 29. Low side current detection

In such applications, it is best to use shunt sensors with extremely low resistance to minimize series voltage drop; this can reduce power waste as much as possible, allowing for high current measurements while achieving low power consumption. The resistance of the shunt sensor is typically 0.1 Ω. When the measured current is 1A, the output signal from the shunt sensor can be several hundred millivolts or even a few volts, so the amplifier is not the primary source of error. However, when the current measurement is low, within the 1mA range, the 100 μV output voltage of the shunt sensor requires extremely low offset voltage and drift to maintain absolute accuracy. Additionally, there needs to be low input bias current to ensure that the injected bias current does not significantly affect the measured current. High open-loop gain, CMRR, and PSRR help maintain overall circuit accuracy. As long as the rate of current change is not too fast, a self-stabilizing zero amplifier can provide excellent results.

Output amplifier for high precision DAC

The MS8628/MS8629/MS8630 can all be used as output amplifiers for 16-bit single-pole configuration, high-precision DACs. In this case, the selected operational amplifier must have an extremely low offset voltage (the LSB of the DAC is 38 μV when using a 2.5V reference voltage source) to eliminate the need for output offset adjustment. Additionally, the input bias current (typically in the tens of picas) must be very low, as it can introduce additional zero-crossing errors when multiplied by the DAC output impedance (approximately 6k Ω).

Track-to-track input and output can provide full-scale output with extremely low error. The output impedance of the DAC is constant and code-independent, but the high input impedance of MS8628/MS8629/MS8630 can minimize gain error. In this case, the wide bandwidth of these amplifiers is also very useful. The amplifier (set time of 1 μs) adds another time constant to the system. This will extend the setup time of the output. For example, the setup time of AD5541 is 1 μs. The combined setup time is approximately 1.4 μs, which can be calculated using the following equation:

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

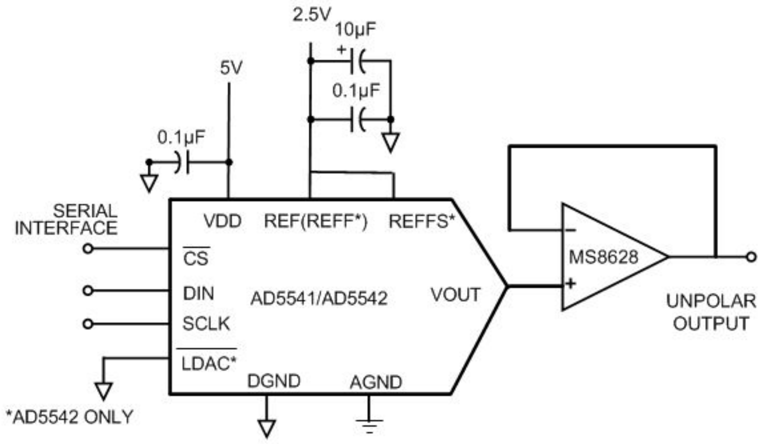
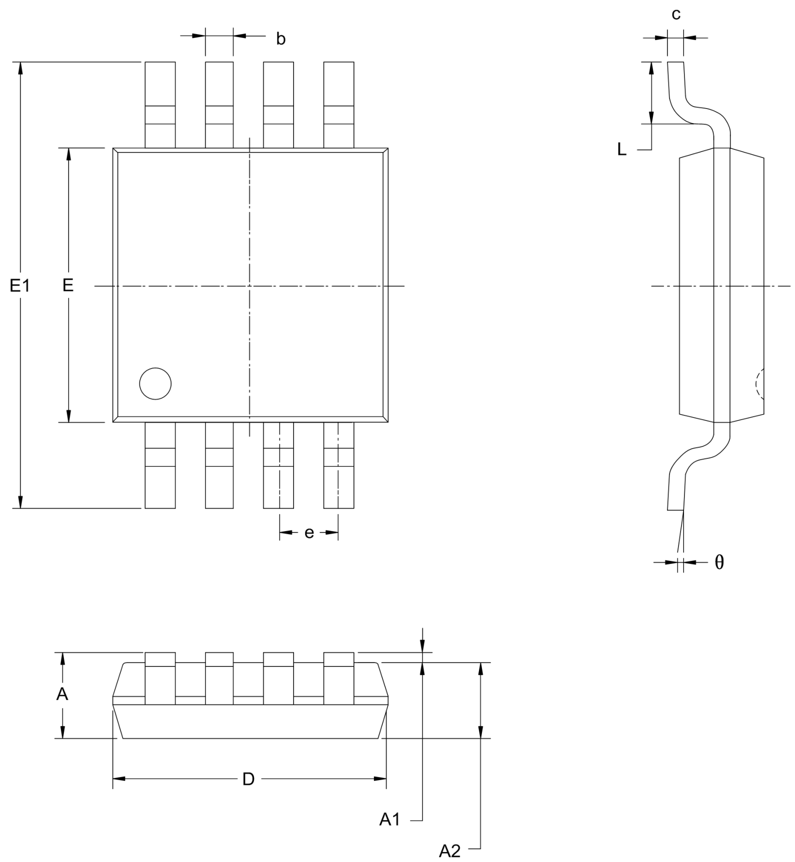


Figure 30.MS8628 is used as the output amplifier

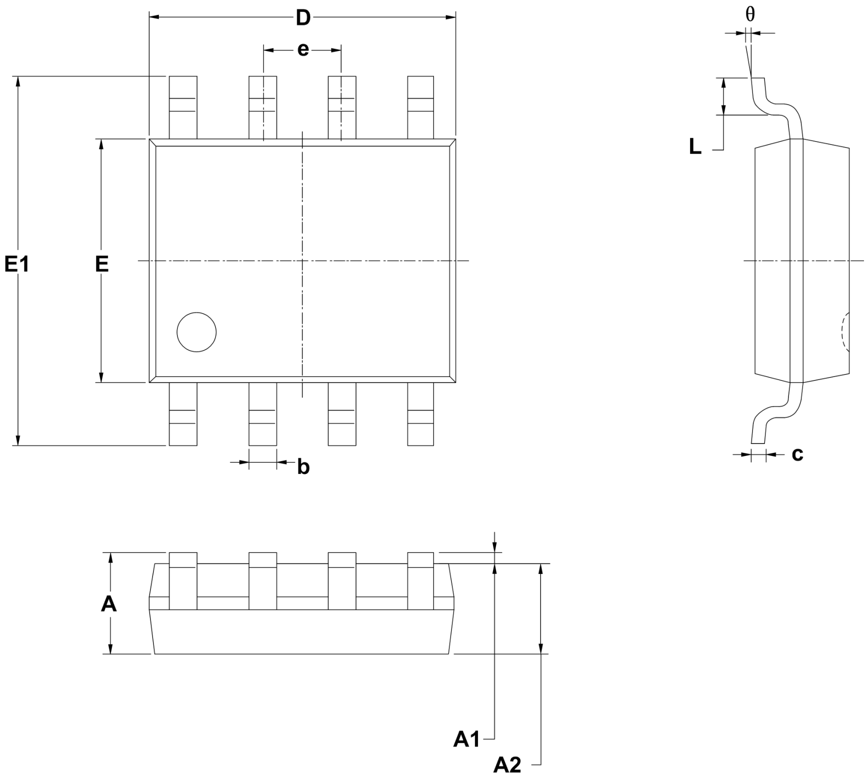
Encapsulate the shape diagram

MSOP8



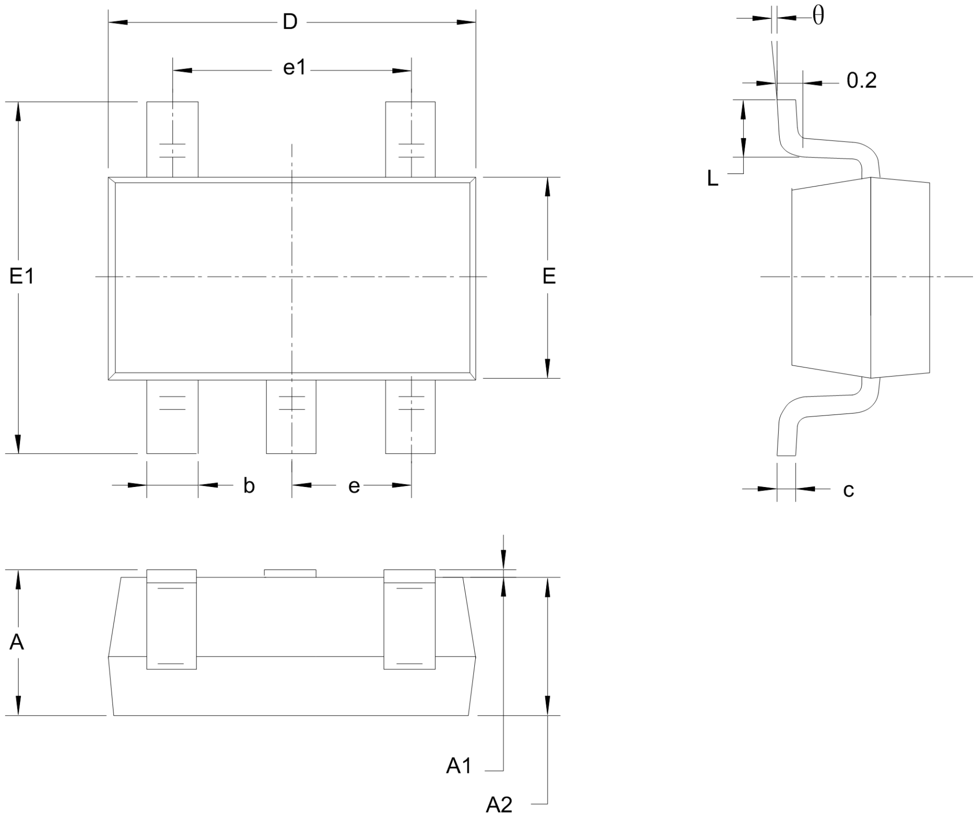
Symbol	Size (mm)		Size (ft.)	
	Minimum	Maximum	Minimum	Maximum
A	1.050	1.250	0.041	0.049
A1	0.000	0.100	0.000	0.004
A2	1.050	1.150	0.041	0.045
b	0.300	0.500	0.012	0.020
c	0.100	0.200	0.004	0.008
D	2.820	3.20	0.111	0.119
E	1.500	1.700	0.059	0.067
E1	2.650	2.950	0.104	0.116
e	0.950BSC		0.037BSC	
e1	1.900BSC		0.075BSC	
L	0.300	0.600	0.012	0.024
θ	0°	8°	0°	8°

SOP8



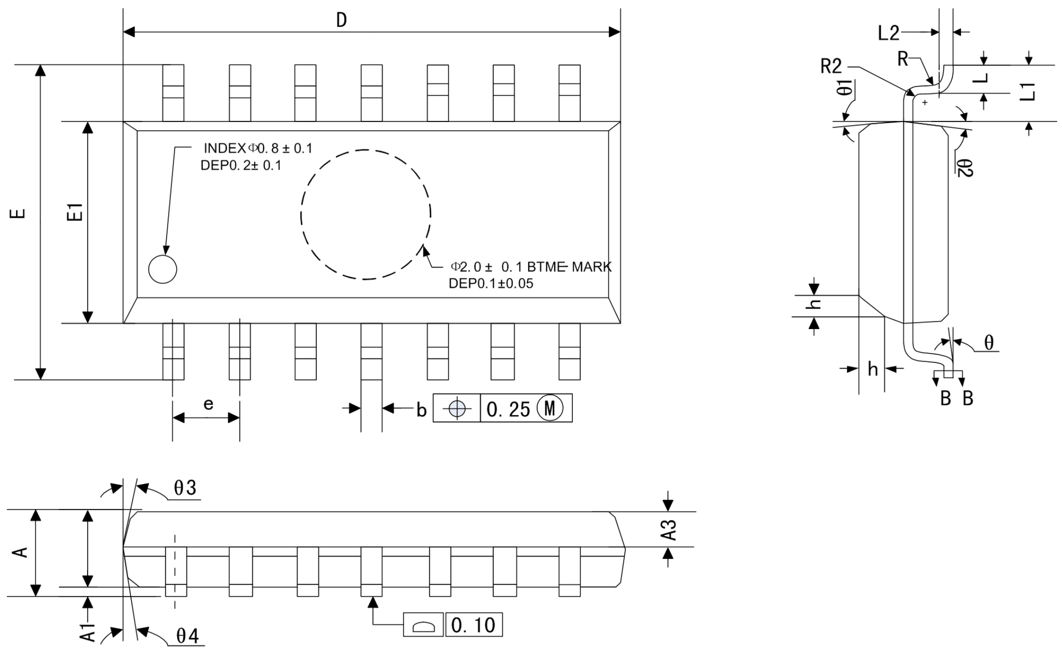
Symbol	Size (mm)		Size (inches)	
	Minimum	Maximum	Minimum	Maximum
A	1.350	1.750	0.053	0.069
A1	0.100	0.025	0.004	0.010
A2	1.350	1.550	0.053	0.061
b	0.330	0.510	0.013	0.020
c	0.170	0.250	0.006	0.010
D	4.700	5.100	0.185	0.200
E	3.800	4.000	0.150	0.157
E1	5.800	6.200	0.228	0.244
e	1.27 BSC		0.050 BSC	
L	0.400	1.270	0.016	0.050
θ	0°	8°	0°	8°

SOT23-5



Symbol	Size (mm)		Size (ft.)	
	Minimum	Maximum	Minimum	Maximum
A	1.050	1.250	0.041	0.049
A1	0.000	0.100	0.000	0.004
A2	1.050	1.150	0.041	0.045
b	0.300	0.500	0.012	0.020
c	0.100	0.200	0.004	0.008
D	2.820	3.020	0.111	0.119
E	1.500	1.700	0.059	0.067
E1	2.650	2.950	0.104	0.116
e	0.950 BSC		0.037 BSC	
e1	1.900 BSC		0.075 BSC	
L	0.300	0.600	0.012	0.024
θ	0°	8°	0°	8°

SOP14



Symbol	Size (mm)		
	Minimum	Custom made	Maximum
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 °

MOS circuit operation precautions:

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

The operator should be grounded through an anti-static wristband.

The equipment housing must be grounded.

The tools used in the assembly process must be grounded.

Conductive packaging or anti-static material packaging or transportation must be used