

1.Description

The AD8613/AD8617/AD8619 are single, dual, and quad micro-power, rail-to-rail input and output amplifiers that feature low supply current, as well as low input voltage and current noise. The parts are fully specified to operate from 1.8 V to 5 V single supply, or ± 0.9 V and ± 2.5 V dual supply. The combination of low noise, very low input bias currents, and low power consumption make the AD8613/AD8617/AD8619 especially useful in portable and loop-powered instrumentation.

The ability to swing rail-to-rail at both the input and output enables designers to buffer CMOS ADCs, DACs, ASICs, and other wide output swing devices in low power, single supply systems.

3.Applications

- Battery-powered instrumentation
- Multipole filters
- Current shunt sense
- Sensors

2.Features

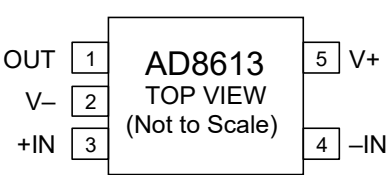
- Offset voltage: 2.2 mV maximum
- Low input bias current: 1 pA maximum
- Single-supply operation: 1.8 V to 5.5 V
- Low noise: 22 nV/ $\sqrt{\text{Hz}}$
- Micropower: 50 μA /amplifier maximum over temperature
- No phase reversal
- Unity gain stable
- Qualified for automotive applications

- ADC predrivers
- DAC drivers/level shifters
- Low power ASIC input or output amplifiers



Low Cost Micropower, Low Noise CMOS Rail-to-Rail
Input/Output Operational Amplifiers

4.Pinning Information



SC70-5

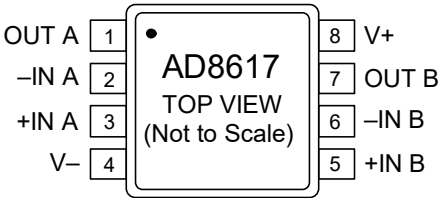
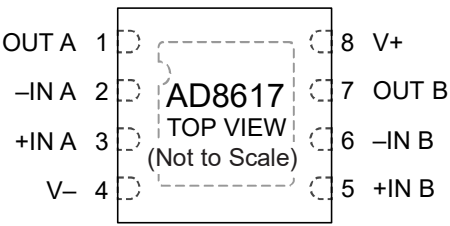


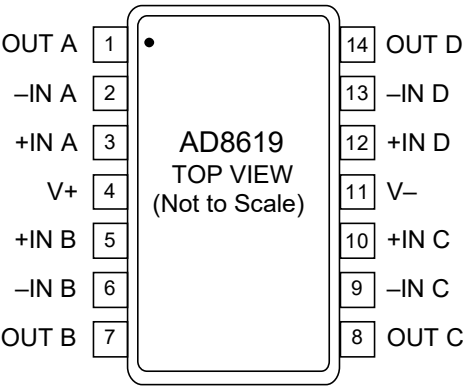
Figure 2. 8-Lead MSOP and 8-Lead SOIC_N

SOP-8



NOTES
1. PIN 4 AND THE EXPOSED PAD
MUST BE CONNECTED TO V-.

SOP-8



TSSOP-14/SOP-14



5. Absolute Maximum Ratings ($T_A = 25^\circ\text{C}$)

Description		Rating
Supply Voltage		6 V
Input Voltage		$V_{SS} - 0.3\text{ V}$ to $V_{DD} + 0.3\text{ V}$
Input Current		$\pm 10\text{ mA}$
Differential Input Voltage		$\pm 6\text{ V}$
Output Short-Circuit Duration to GND		Indefinite
Storage Temperature Range		-65°C to $+150^\circ\text{C}$
Operating Temperature Range		-40°C to $+125^\circ\text{C}$
Junction Temperature Range		-65°C to $+150^\circ\text{C}$
Lead Temperature (soldering, 60 sec)		300°C
ESD AD8613	HBM	$\pm 4000\text{V}$
	FICDM	$\pm 1000\text{V}$
ESD AD8617	HBM	$\pm 3000\text{V}$
	FICDM	$\pm 1000\text{V}$
	MM	$\pm 100\text{V}$
ESD AD8619	HBM	$\pm 4000\text{V}$
	FICDM	$\pm 1250\text{V}$
	MM	$\pm 200\text{V}$

$T_A = 25^\circ\text{C}$, unless otherwise noted



6.1 Electrical Characteristics

$V_{SY}=5\text{ V}$, $V_{CM}=V_{SY}/2$, $T_A=25^\circ\text{C}$, unless otherwise noted

Parameter	Symbol	Conditions	Min	Typ	Max	Units
INPUT CHARACTERISTICS						
Offset Voltage	V _{OS}	−0.3V<V _{CM} <+5.3 V		0.4	2.2	mV
		−40°C<T _A <125°C, −0.3V<V _{CM} <5.2 V			2.2	
Offset Voltage Drift	ΔV _{OS} /ΔT	−40°C<T _A <125°C		1	4.5	μV/°C
AD8613				2.5	7	
Input Bias Current	I _B			0.2	1	pA
		−40°C<T _A <85°C			110	pA
		−40°C<T _A <125°C			780	pA
Input Offset Current	I _{OS}			0.1	0.5	pA
		−40°C<T _A <85°C			50	pA
		−40°C<T _A <125°C			250	pA
Input Voltage Range	IVR		0		5	V
Common-Mode Rejection Ratio	CMRR	0<V _{CM} <5V		95		dB
		−40°C<T _A <125°C	68			
Large Signal Voltage Gain	A _{VO}	R _L =10kΩ, 0.5V<V _O <4.5V	235	500		V/mV
Input Capacitance	C _{DIFF}			1.9		pF
	C _{CM}			2.5		
OUTPUT CHARACTERISTICS						
Output Voltage High	V _{OH}	I _L =1mA	4.95	4.98		V
		−40°C to 125°C	4.9			
		I _L =10mA		4.7		
		−40°C to 125°C	4.5			
Output Voltage Low	V _{OL}	I _L =1mA		20	30	mV
		−40°C to 125°C			50	
		I _L =10mA		190	275	
		−40°C to 125°C			335	



Parameter	Symbol	Conditions	Min	Typ	Max	Units
Short-Circuit Current	I _{SC}			±80		mA
Closed-Loop Output Impedance	Z _{OUT}	f=10kHz, A _V =1		15		Ω
POWER SUPPLY						
Power Supply Rejection Ratio	PSRR	1.8V<V _{SY} <5V	67	94		dB
		−40°C<T _A <+125°C	64			dB
Supply Current/Amplifier	I _{SY}	V _O =V _{SY} /2		38		μA
		−40°C<T _A <+125°C			50	μA
DYNAMIC PERFORMANCE						
Slew Rate	SR	R _L =10kΩ		0.1		V/μs
Settling Time to 0.1%	t _s	G=±1, V _{IN} =2V step, C _L =20pF, R _L =1kΩ		23		μs
Gain Bandwidth Product	GBP	R _L =100kΩ		400		kHz
		R _L =10kΩ		350		kHz
Phase Margin	Ø _M	R _L =10kΩ, R _L =100kΩ, C _L =20pF		70		Degrees
NOISE PERFORMANCE						
Peak-to-Peak Noise	e _n p-p	0.1Hz to 10Hz		2.3	3.5	μV
Voltage Noise Density	e _n	f=1kHz		25		nV/√Hz
		f=10kHz		22		nV/√Hz
Current Noise Density	i _n	f=1kHz		0.05		pA/√Hz



6.2 Electrical Characteristics

$V_{SY}=1.8V$, $V_{CM}=V_{SY}/2$, $T_A=25^{\circ}C$, unless otherwise noted

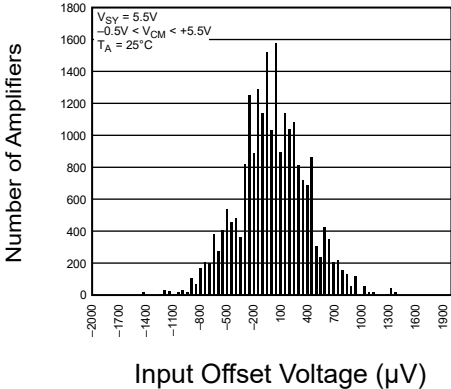
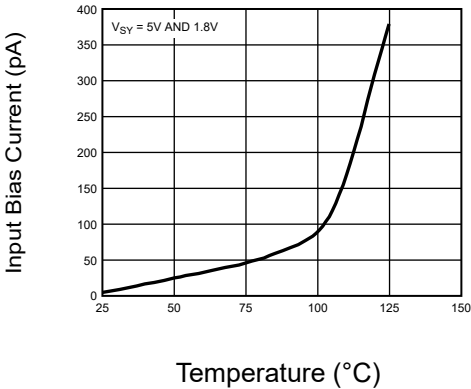
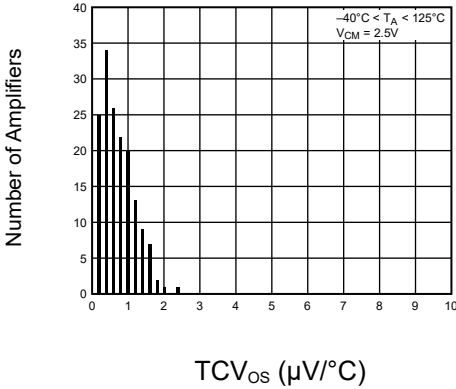
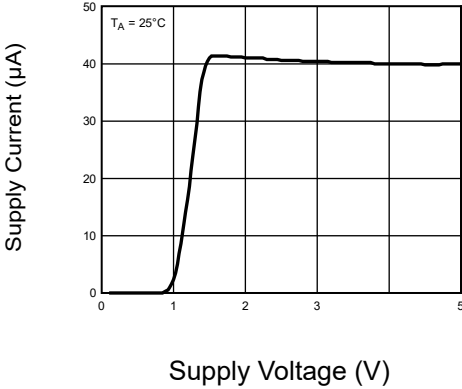
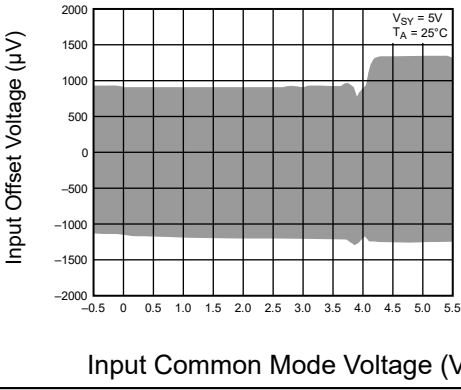
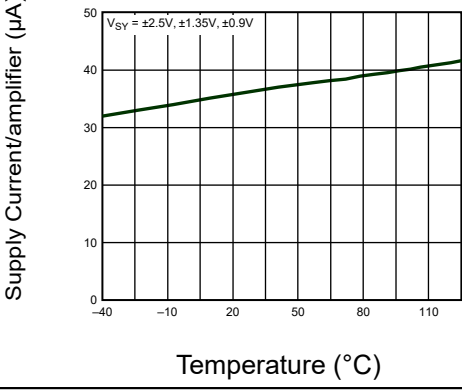
Parameter	Symbol	Conditions	Min	Typ	Max	Units
INPUT CHARACTERISTICS						
Offset Voltage	V _{OS}	−0.3V<V _{CM} <1.9V		0.4	2.2	mV
		−40°C<T _A <125°C, −0.3V<V _{CM} <1.8V			2.2	
Offset Voltage Drift	ΔV _{OS} /ΔT	−40°C<T _A <125°C		1	8.5	μV/°C
AD8613				3.7	9	
Input Bias Current	I _B			0.2	1	pA
		−40°C<T _A <85°C			110	pA
		−40°C<T _A <125°C			780	pA
Input Offset Current	I _{OS}			0.1	0.5	pA
		−40°C<T _A <85°C			50	pA
		−40°C<T _A <125°C			250	pA
Input Voltage Range	IVR		0		1.8	V
Common-Mode Rejection Ratio	CMRR	0<V _{CM} <1.8V	58	86		dB
		−40°C<T _A <125°C	55			
Large Signal Voltage Gain	A _{VO}	R _L =10kΩ, 0.5V<V _O <1.3V	85	1000		V/mV
Input Capacitance	C _{DIFF}			2.1		pF
	C _{CM}			3.8		
OUTPUT CHARACTERISTICS						
Output Voltage High	V _{OH}	I _L =1mA	1.65	1.73		V
		−40°C to 125°C	1.6			
Output Voltage Low	V _{OL}	I _L =10mA		44	60	
		−40°C to 125°C			80	



Parameter	Symbol	Conditions	Min	Typ	Max	Units
Short-Circuit Current	I _{SC}			±7		mA
Closed-Loop Output Impedance	Z _{OUT}	f=10kHz, A _V =1		15		Ω
POWER SUPPLY						
Power Supply Rejection Ratio	PSRR	1.8V<V _{SY} <5V	67	94		dB
Supply Current/Amplifier	I _{SY}	V _O =V _{SY} /2		38		μA
		−40°C<T _A <+125°C			50	μA
DYNAMIC PERFORMANCE						
Slew Rate	SR	R _L =10kΩ		0.1		V/μs
Settling Time to 0.1%	t _s	G=±1, V _{IN} =1V step, C _L =20pF, R _L =1kΩ		6.5		μs
Gain Bandwidth Product	GBP	R _L =100kΩ		400		kHz
		R _L =10kΩ		350		kHz
Phase Margin	Ø _M	R _L =10kΩ, R _L =100kΩ, C _L =20pF		70		Degrees
NOISE PERFORMANCE						
Peak-to-Peak Noise	e _n p-p	0.1Hz to 10Hz		2.3	3.5	μV
Voltage Noise Density	e _n	f=1kHz		25		nV/√Hz
		f=10kHz		22		nV/√Hz
Current Noise Density	i _n	f=1kHz		0.05		pA/√Hz



7.1Typical Characteristic

	
Figure 1: Input Offset Voltage Distribution	Figure 2: Input Bias Current vs. Temperature
	
Figure 3: Input Offset Voltage Drift Distribution	Figure 4: Supply Current vs. Supply Voltage
	
Figure 5: Input Offset Voltage vs. Input Common-Mode Voltage	Figure 6: Supply Current vs. Temperature



7.2 Typical Characteristic

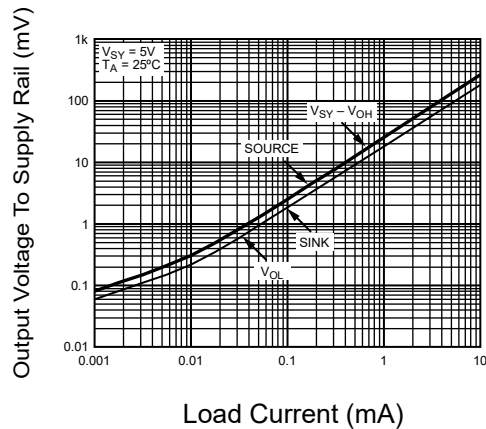


Figure 7: Output Voltage to Supply Rail vs. Load Current

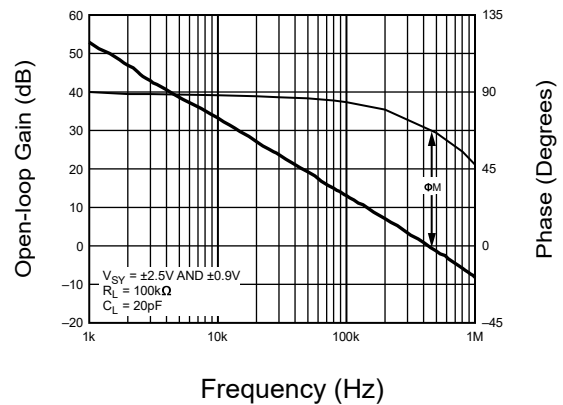


Figure 8: Open-Loop Gain and Phase vs. Frequency

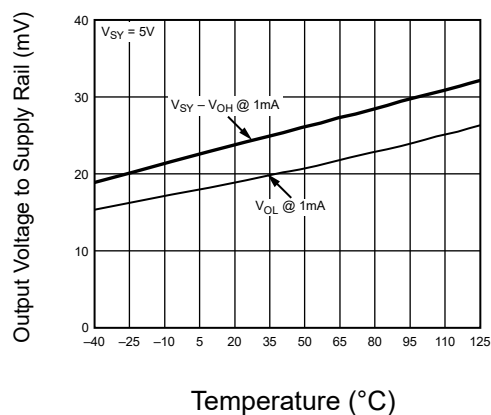


Figure 9: Output Voltage to Supply Rail vs. Temperature ($I_L = 1 \text{ mA}$)

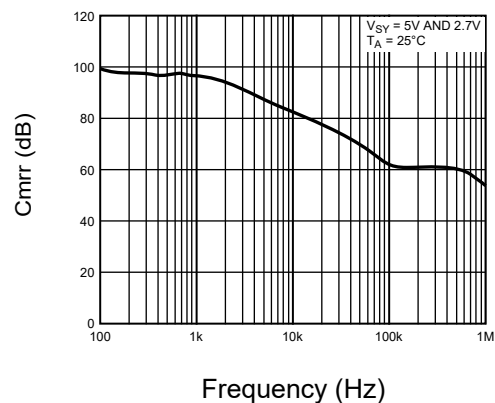


Figure 10: CMRR vs. Frequency

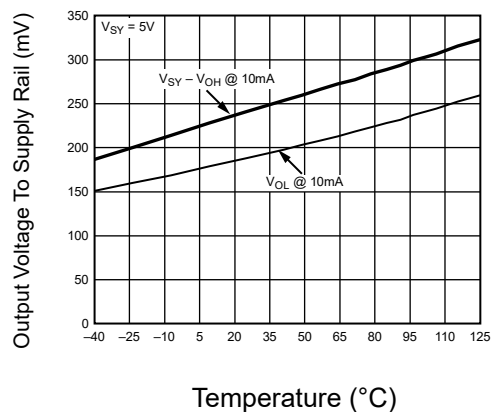


Figure 11: Output Voltage to Supply Rail vs. Temperature ($I_L = 10 \text{ mA}$)

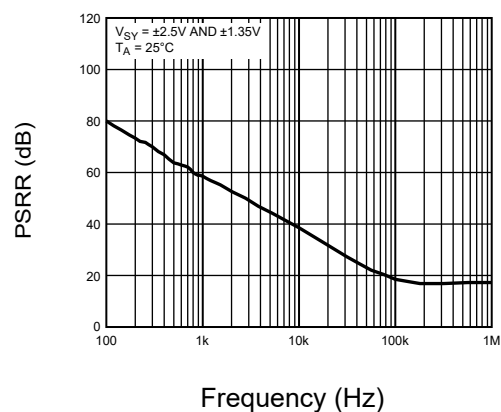


Figure 12: PSRR vs. Frequency



7.3 Typical Characteristic

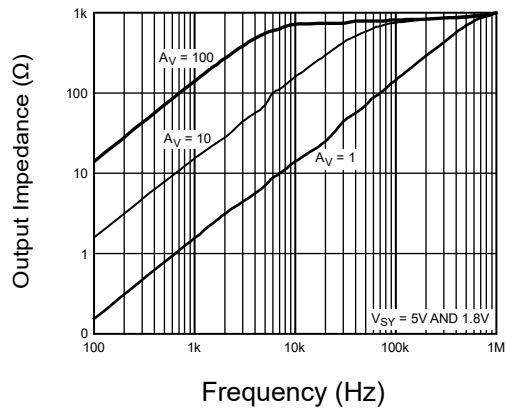


Figure 13: Output Impedance vs. Frequency

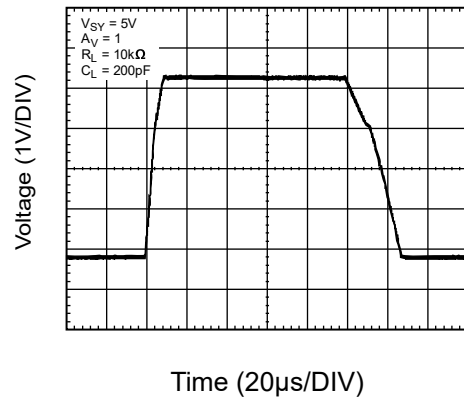


Figure 14: Large Signal Transient Response

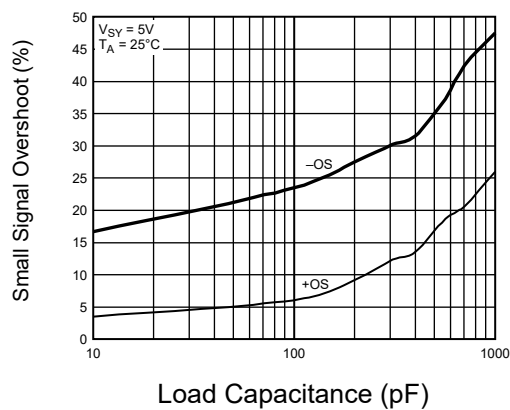
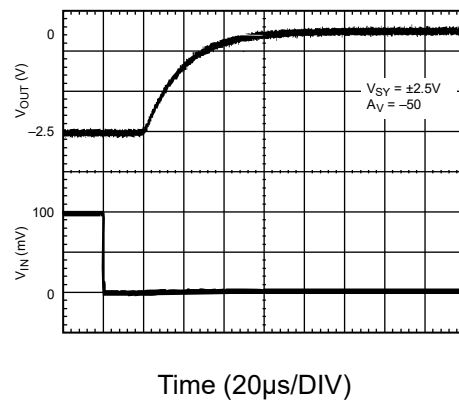
Figure 15: Small Signal Overshoot vs.
Load Capacitance

Figure 16: Positive Overload Recovery

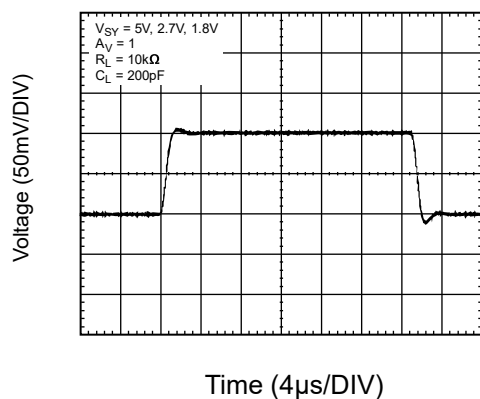


Figure 17: Small Signal Transient Response

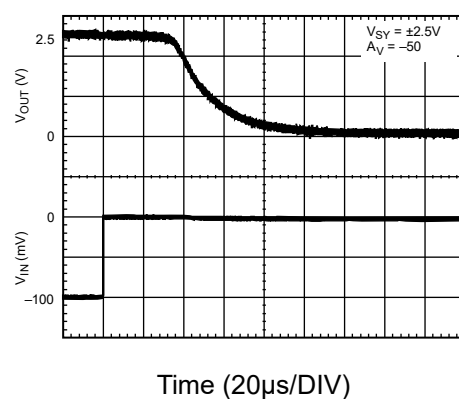
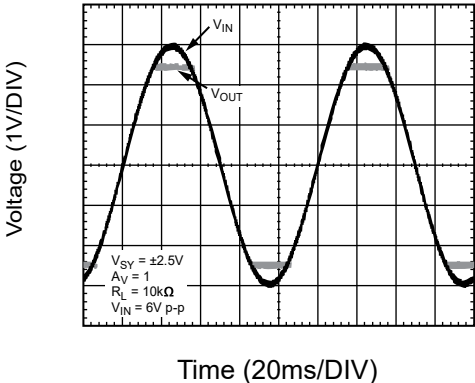
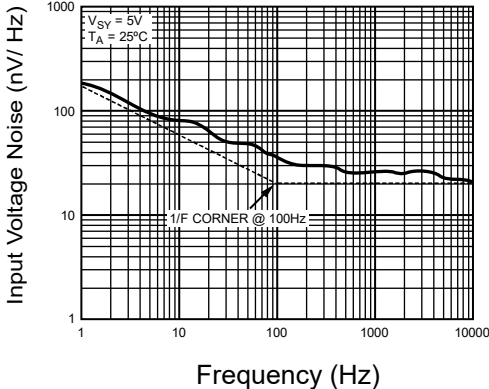
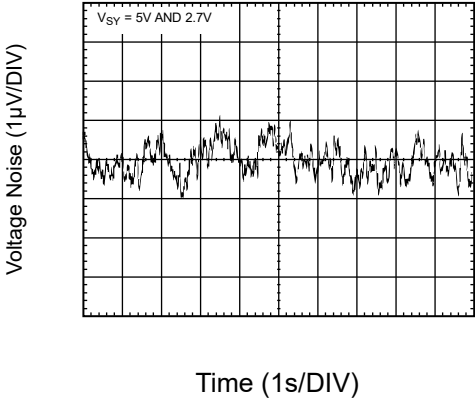
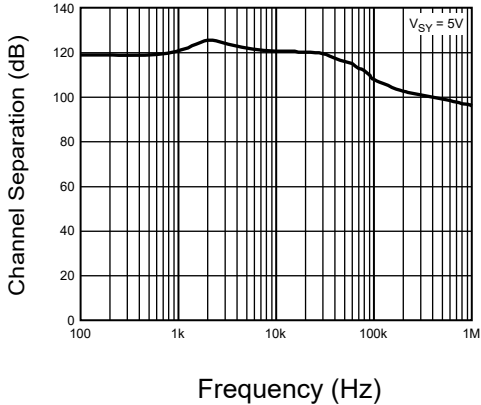


Figure 18: Negative Overload Recovery



7.4Typical Characteristic

 Figure 19: No Phase Reversal	 Figure 20: Voltage Noise Density
 Figure 21: 0.1 Hz to 10 Hz Input Voltage Noise	 Figure 22: Channel Separation



7.5 Typical Characteristic

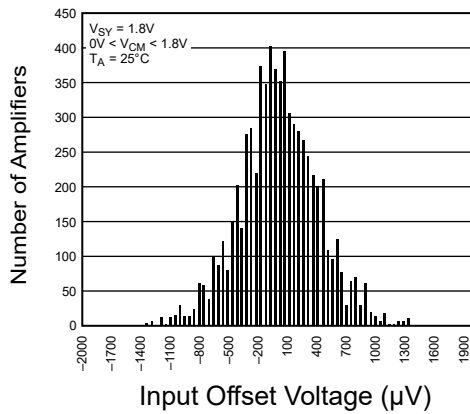


Figure 23: Input Offset Voltage Distribution

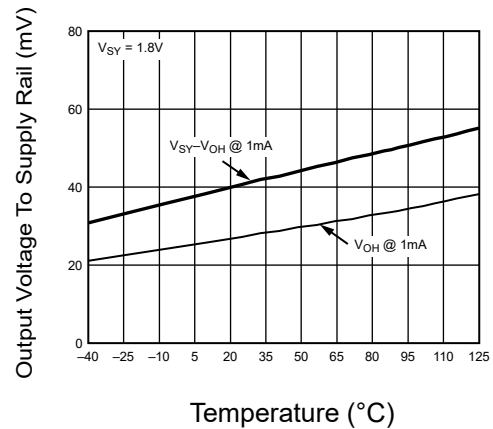
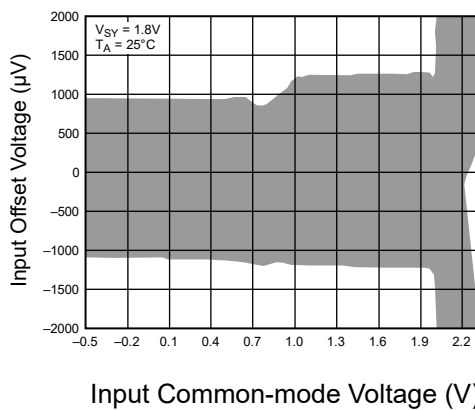
Figure 24: Output Voltage to Supply Rail vs. Temperature ($I_L = 1\text{ mA}$)

Figure 25: Input Offset Voltage vs. Input Common-Mode Voltage

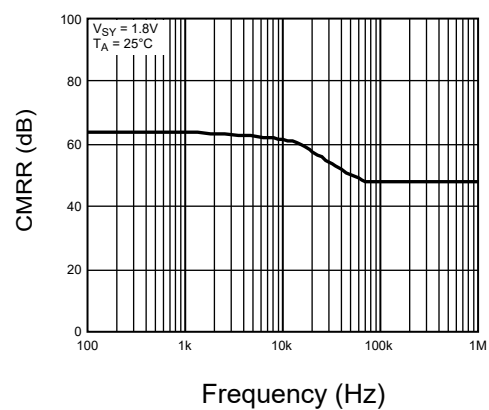


Figure 26: CMRR vs. Frequency

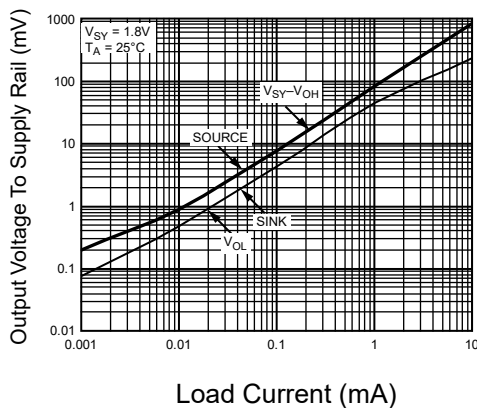


Figure 27: Output Voltage to Supply Rail vs. Load Current

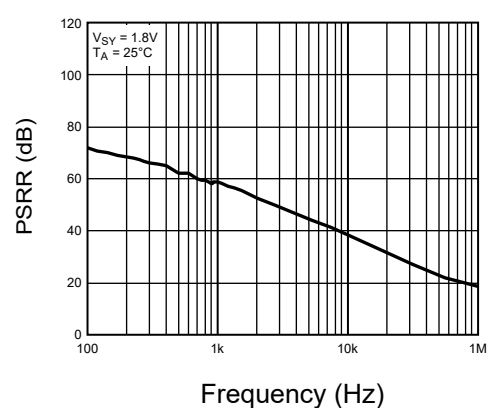
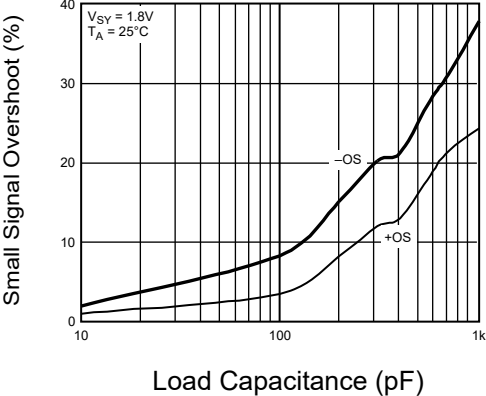
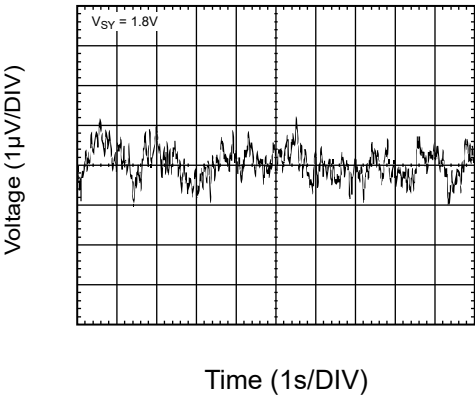
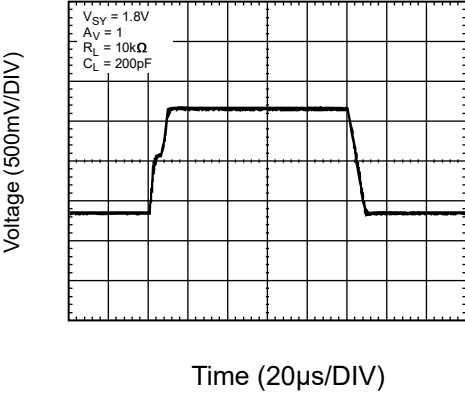
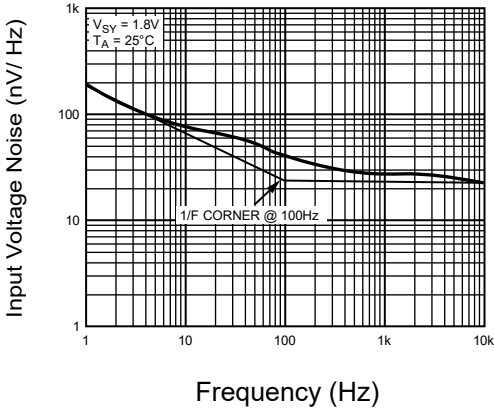


Figure 28: PSRR vs. Frequency



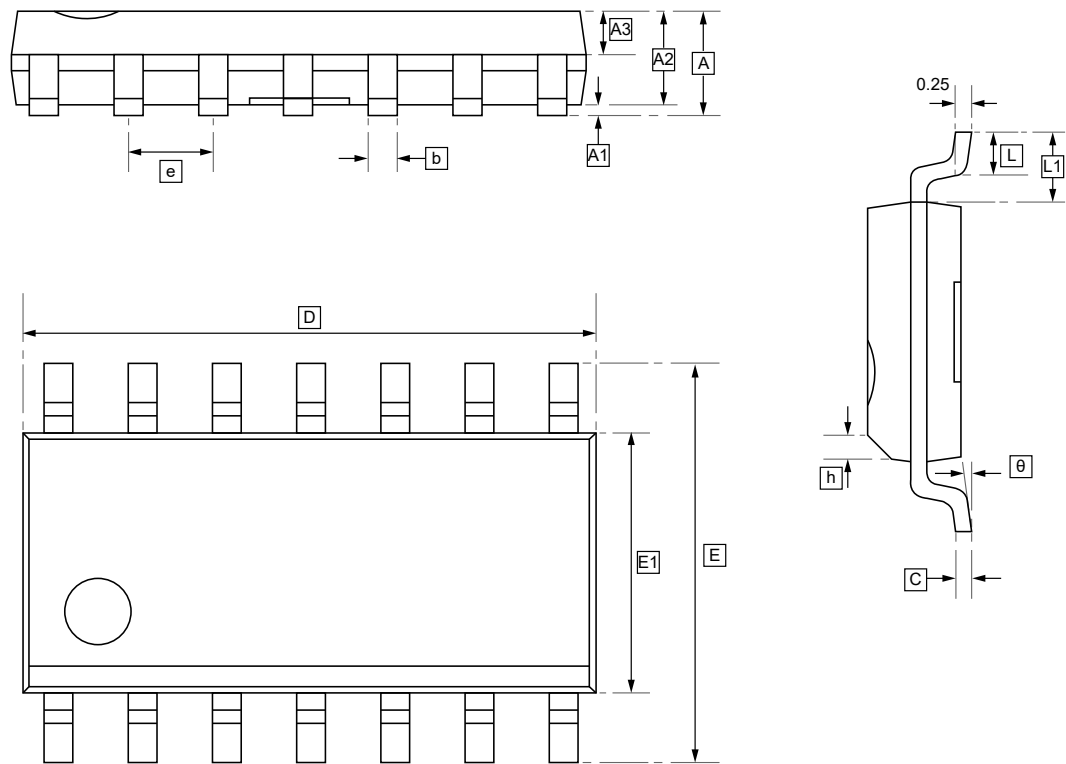
7.6Typical Characteristic

	
Figure 29: Small Signal Overshoot vs. Load Capacitance	Figure 30: 0.1 Hz to 10 Hz Input Voltage Noise
	
Figure 31: Large Signal Transient Response	Figure 32: Voltage Noise Density



Low Cost Micropower, Low Noise CMOS Rail-to-Rail
Input/Output Operational Amplifiers

8.1 SOP-14 Package Outline Dimensions



DIMENSIONS (mm are the original dimensions)

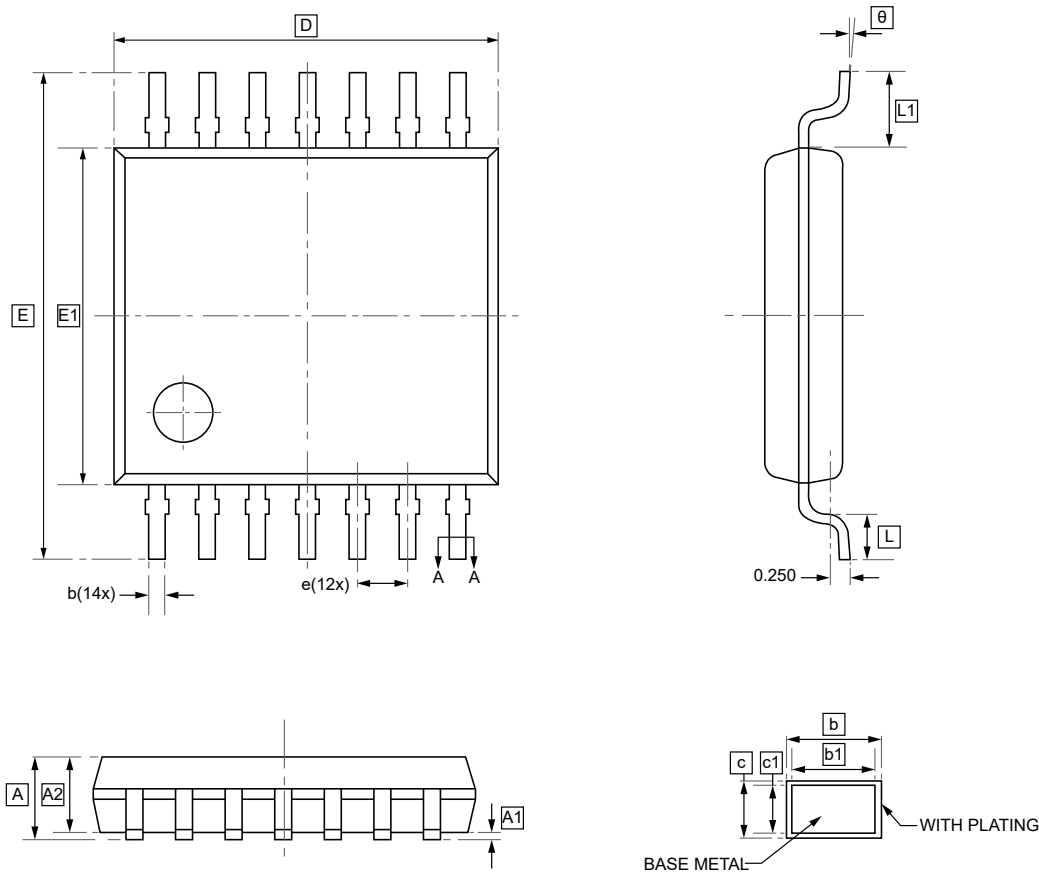
Symbol	A	A1	A2	A3	b	C	D	E	E1	e	h	L
Min	-	0.05	1.35	0.65	0.203	0.17	8.45	5.80	3.80	1.24	0.25	0.40
Max	1.75	0.25	1.55	0.75	0.305	0.25	8.85	6.20	4.00	1.30	0.50	0.80

Symbol	L1	θ
Min	1.00	0°
Max	1.10	8°



Low Cost Micropower, Low Noise CMOS Rail-to-Rail
Input/Output Operational Amplifiers

8.2 TSSOP-14 Package Outline Dimensions



DIMENSIONS (mm are the original dimensions)

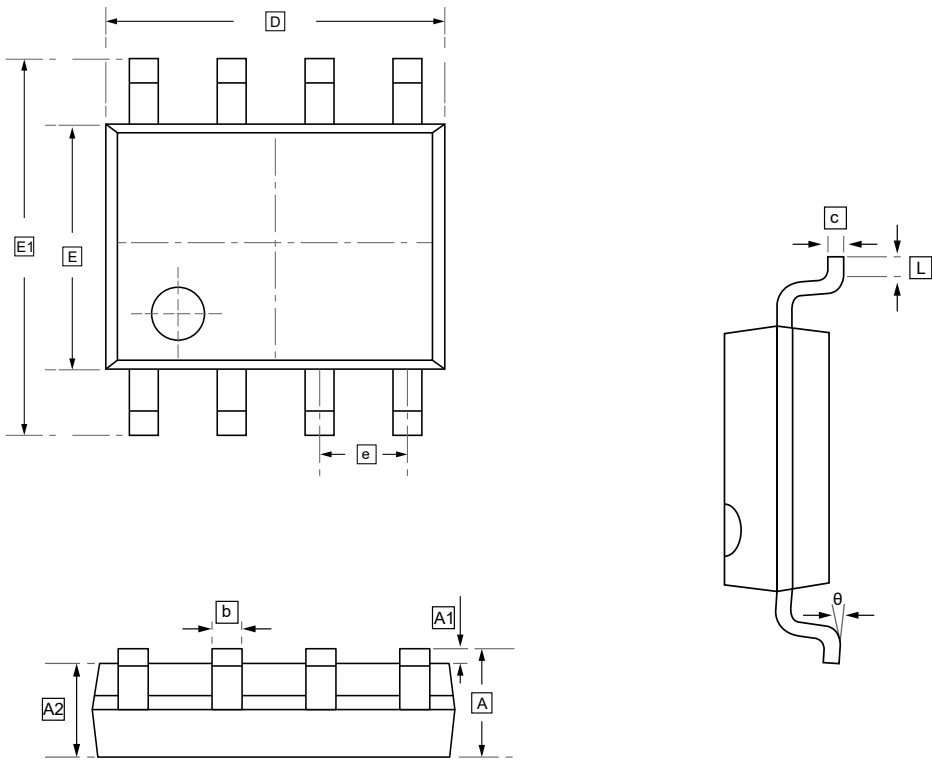
Symbol	A	A1	A2	b	b1	c	c1	D	E	E1	e	L1
Min	-	0.05	0.90	0.20	0.19	0.13	0.120	4.90	6.20	4.30	0.65	0.85
Max	1.20	0.15	1.05	0.28	0.25	0.17	0.14	5.10	6.60	4.50	BSC	1.15

Symbol	L	θ
Min	0.45	0°
Max	0.75	8°



Low Cost Micropower, Low Noise CMOS Rail-to-Rail
Input/Output Operational Amplifiers

8.3 SOP-8 Package Outline Dimensions

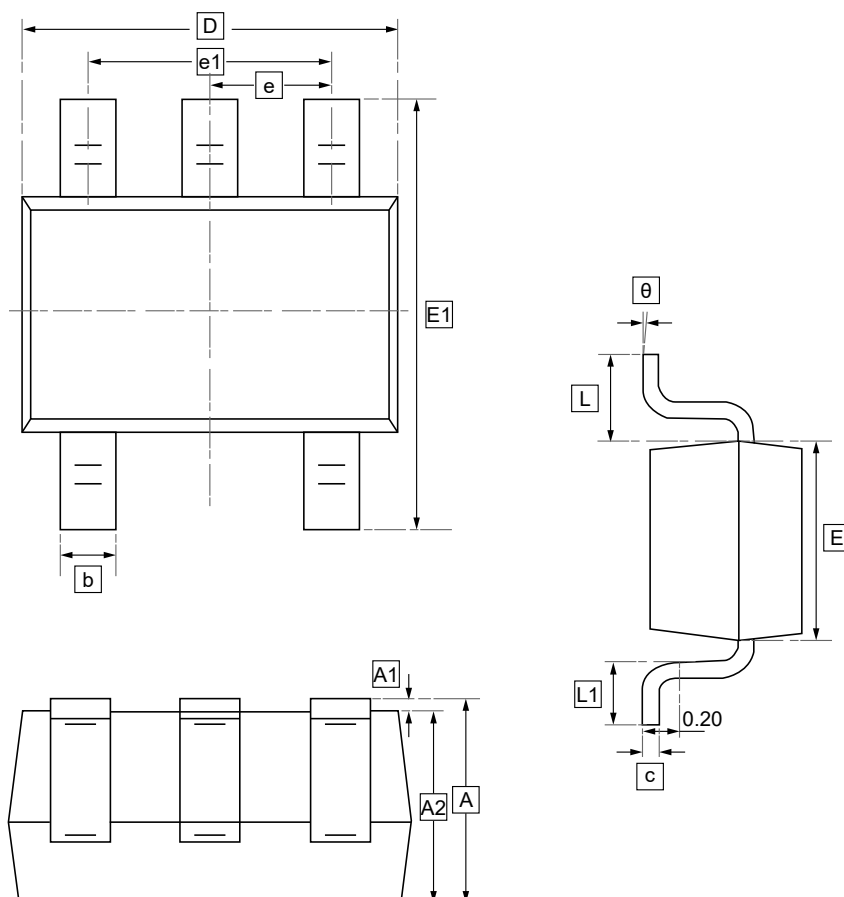


DIMENSIONS (mm are the original dimensions)

Symbol	A	A1	A2	b	c	D	E	E1	e	L	θ
Min	1.350	0.000	1.350	0.330	0.170	4.700	3.800	5.800	1.270	0.400	0°
Max	1.750	0.100	1.550	0.510	0.250	5.100	4.000	6.200	BSC	1.270	8°



8.4 SC70-5 Package Outline Dimensions



DIMENSIONS (mm are the original dimensions)

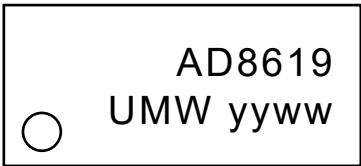
Symbol	A	A1	A2	b	c	D	E	E1	e	e1	L	θ
Min	0.90	0.00	0.90	0.15	0.08	1.80	1.15	2.15	0.65	1.20	0.26	7°
Max	1.10	0.10	1.00	0.35	0.15	2.25	1.35	2.45	TYP	1.40	0.46	REF.



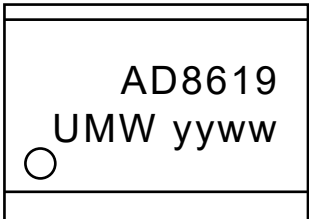
Low Cost Micropower, Low Noise CMOS Rail-to-Rail
Input/Output Operational Amplifiers

9.Ordering Information

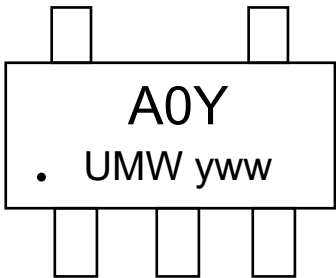
SOP-14



TSSOP-14

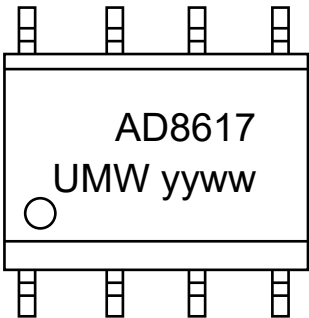


SC70-5



yyww: Batch Code

SOP-8



yy: Year Code
ww: Week Code

Order Code	Marking	Package	Base QTY	Delivery Mode
UMW AD8613AKSZ	A0Y	SC70-5	3000	Tape and reel
UMW AD8617ARZ	AD8617	SOP-8	2500	Tape and reel
UMW AD8619ARZ	AD8619	SOP-14	2500	Tape and reel
UMW AD8619ARUZ	AD8619	TSSOP-14	4000	Tape and reel



10.Disclaimer

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