UMW ADA4505-1/ADA4505-4

10 μA, Rail-to-Rail I/O, Zero Input Crossover Distortion Amplifiers

1.Description

The ADA4505-1/ADA4505-4 are singleand quad micropower amplifiers featuring rail-to-rail input and output swings while operating from a single 1.8 V to 5 V power supply or from dual ±0.9 V to ±2.5 V power supplies.Employing a new circuit technology, these low cost amplifiers offer zero input crossover distortion (excellent PSRR and CMRR performance) and very low bias current, while operating with a supply current of less than 10 μA per amplifier.

This combination of features makes the ADA4505-x amplifiers ideal choices for battery-powered applications because they minimize errors due to power supply voltage variations over the lifetime of the battery and maintain high CMRR even for a rail-to-rail op amp.

Remote battery-powered sensors, handheld instrumentation and consumer equipment, hazard detectors (for example, smoke, fire, and gas), and patient monitors can benefit from the features of the ADA4505-x amplifiers.

The ADA4505-x family is specified for both the industrial temperature range (-40°C to +85°C) and the extended industrial temperature range (-40°C to +125°C)

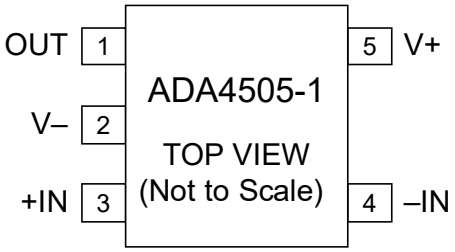
2.Features

- PSRR: 100 dB minimum
- CMRR: 105 dB typical
- Very low supply current: 10 μA per amplifier maximum 1.8 V to 5 V single-supply or ±0.9V to ±2.5 V dual-supply
- operation Rail-to-rail input and output 3 mV offset voltage maximum
- Very low input bias current: 0.5 pA typical

3.Applications

- Pressure and position sensors
- Remote security
- Medical monitors
- Battery-powered consumer equipment
- Hazard detectors

4.Pinning Information



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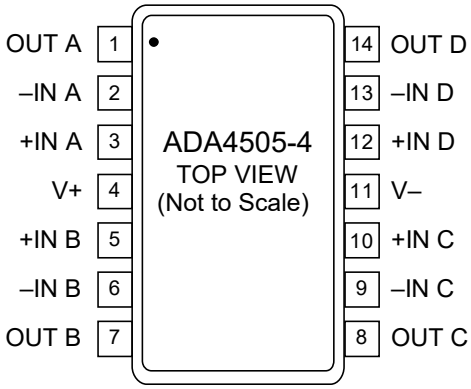


TSSOP-14

5.Absolute Maximum Ratings(T_A= 25°C)

Description	Rating
Supply Voltage	5.5V
Input Voltage	±Vsy±0.1V
Input Current [1]	+10 mA
Differential input Voltage [2]	±Vsy
Output Short-Circuit Duration to GND	Indefinite
Storage Temperature Range	-65°C to+150°C
Operating Temperature Range	-40°C to +125°C
Junction Temperature Range	-65°C to+150°C
Lead Temperature (Soldering,60 sec)	300°C

[1] Input pins have clamp diodes to the supply pins. Limit input current to 10 mA or less whenever the input signal exceeds the power supply rail by 0.1 V.

[2] Differential input voltage is limited to 5 V or the supply voltage, whichever is less.

6.1Electrical Characteristics

V_{SY}=1.8V, V_{CM}=V_{SY}/2, T_A=25°C, R_L=100kΩ to GND, unless otherwise specified.

Parameter	Symbol	Conditions	Min	Typ	Max	Units
Input Characteristics						
Offset Voltage	V_{OS}	0V≤V_{CM}≤1.8V		0.5	3	mV
		−40°C ≤T_A≤+125°C			4	mV
Input Bia s Current	I_S			0.5	2	pA
		−40°C ≤T_A≤+85°C			50	pA
		−40°C ≤T_A≤+125°C			375	pA
Input Offset Current	I_{OS}			0.05	1	pA
		−40°C ≤T_A≤+85°C			25	pA
		−40°C ≤T_A≤+125°C			130	pA
Input Voltage Range		−40°C ≤T_A≤+125°C	0		1.8	V
Common -Mode Reject ion Ratio	CMRR	0V≤V_{CM}≤1.8V	85	100		dB
		−40°C ≤T_A≤+85°C	85			dB
		−40°C ≤T_A≤+125°C	80			dB
Large Signal Voltage Gain	A_{VO}	0.05V≤V_{OUT}≤1.75V,R_L=100kΩ to V_{CM}	95	115		dB
		−40°C ≤T_A≤+125°C	95			dB
Offset Voltage Drift	$\Delta V_{OS}/\Delta T$	−40°C ≤T_A≤+125°C		2.5		μV/°C
Input Resistance	R_{IN}			220		GΩ
Input Capacitance Differential Mode	C_{INDM}			2.5		pF
Input Capacitance Common Mode	C_{INCM}			4.7		pF
Output Characteristics						
Output Voltage High	V_{OH}	R_L=100kΩ to GND	1.78	1.79		V
		−40°C ≤T_A≤+125°C	1.78			V
		R_L=10kΩ to GND	1.65	1.75		V
		−40°C ≤T_A≤+125°C	1.65			V

Parameter	Symbol	Conditions	Min	Typ	Max	Units
Output Voltage Low	V_{OL}	R_L=100kΩ to V_{SY}		2	5	mV
		−40°C ≤T_A≤+125°C			5	mV
		R_L=10kΩ to V_{SY}		12	25	mV
		−40°C ≤T_A≤+125°C			25	mV
Short-Circuit Limit	I_{SC}	V_{OUT}=V_{SY} or GND		±3.8		mA
Power Supply						
Power Supply Rejection Ratio	PSRR	V_{SY}=1.8V to 5V	100	110		dB
		−40°C ≤T_A≤+85°C	100			dB
		−40°C ≤T_A≤+125°C	95			dB
Supply Current per Amplifier	I_{SY}	V_{OUT}=V_{SY}/2				
ADA4505-1				10	11.5	μA
		−40°C ≤T_A≤+125°C			15	μA
ADA4505-4				7	10	μA
		−40°C ≤T_A≤+125°C			15	μA
Dynamic Performance						
Slew Rate	SR	R_L=100kΩ, C_L=20pF, G=1		6.5		mV/μs
Gain Bandwidth Product	GBP	R_L=1MΩ, C_L=20pF, G=1		50		kHz
Phase Margin	$Ø_M$	R_L=1MΩ, C_L=20pF, G=1		52		Degrees
Noise Performance						
Voltage Noise	e_np-p	f=0.1Hz to 10Hz		2.95		$μV_{p-p}$
Voltage Noise Density	e_n	f=1kHz		65		nV/√Hz
Current Noise Density	i_n	f=1kHz		20		pA/√Hz

6.2Electrical Characteristics

V_{SY}=5V, V_{CM}=V_{SY}/2, T_A=25°C, R_L=100kΩ to GND, unless otherwise specified.

Parameter	Symbol	Conditions	Min	Typ	Max	Units
Input Characteristics						
Offset Voltage	V_{OS}	0V≤V_{CM}≤5V		0.5	3	mV
		−40°C ≤T_A≤+125°C			4	mV
Input Bia s Current	I_S			0.5	2	pA
		−40°C ≤T_A≤+85°C			50	pA
		−40°C ≤T_A≤+125°C			375	pA
Input Offset Current	I_{OS}			0.05	1	pA
		−40°C ≤T_A≤+85°C			25	pA
		−40°C ≤T_A≤+125°C			130	pA
Input Voltage Range		−40°C ≤T_A≤+125°C	0		5	V
Common -Mode Reject ion Ratio	CMRR	0V≤V_{CM}≤5V	90	105		dB
		−40°C ≤T_A≤+85°C	90			dB
		−40°C ≤T_A≤+125°C	85			dB
Large Signal Voltage Gain	A_{VO}	0.05V≤V_{OUT}≤4.95V,R_L=100kΩ to V_{CM}	105	120		dB
		−40°C ≤T_A≤+125°C	100			dB
Offset Voltage Drift	$\Delta V_{OS}/\Delta T$	−40°C ≤T_A≤+125°C		2		μV/°C
Input Resistance	R_{IN}			220		GΩ
Input Capacitance Differential Mode	C_{INDM}			2.5		pF
Input Capacitance Common Mode	C_{INCM}			4.7		pF
Output Characteristics						
Output Voltage High	V_{OH}	R_L=100kΩ to GND	4.98	4.99		V
		−40°C ≤T_A≤+125°C	4.98			V
		R_L=10kΩ to GND	4.9	4.95		V
		−40°C ≤T_A≤+125°C	4.9			V

Parameter	Symbol	Conditions	Min	Typ	Max	Units
Output Voltage Low	V_{OL}	R_L=100kΩ to V_{SY}		2	5	mV
		−40°C ≤T_A≤+125°C			5	mV
		R_L=10kΩ to V_{SY}		10	25	mV
		−40°C ≤T_A≤+125°C			25	mV
Short-Circuit Limit	I_{SC}	V_{OUT}=V_{SY} or GND		±40		mA
POWER SUPPLY						
Power Supply Rejection Ratio	PSRR	V_{SY}=1.8V to 5V	100	110		dB
		−40°C ≤T_A≤+85°C	100			dB
		−40°C ≤T_A≤+125°C	95			dB
Supply Current per Amplifier	I_{SY}	V_{OUT}=V_{SY}/2				
ADA4505-1				9	10.5	μA
		−40°C ≤T_A≤+125°C			15	μA
ADA4505-4				7	10	μA
		−40°C ≤T_A≤+125°C			15	μA
DYNAMIC PERFORMANCE						
Slew Rate	SR	R_L=100kΩ, C_L=20pF, G=1		6		mV/μs
Gain Bandwidth Product	GBP	R_L=1MΩ, C_L=20pF, G=1		50		kHz
Phase Margin	$Ø_M$	R_L=1MΩ, C_L=20pF, G=1		52		Degrees
NOISE PERFORMANCE						
Voltage Noise	e_np-p	f=0.1Hz to 10Hz		2.95		$μV_{p-p}$
Voltage Noise Density	e_n	f=1kHz		65		nV/√Hz
Current Noise Density	i_n	f=1kHz		20		pA/√Hz

7.1Typical Characteristic

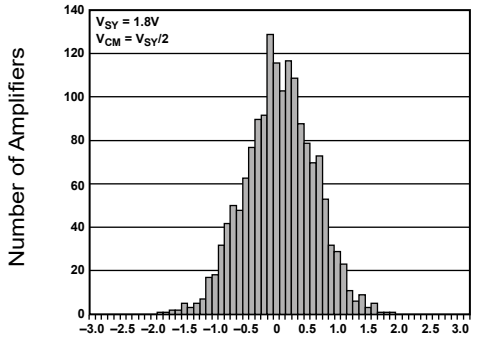


Figure 1: Input Offset Voltage Distribution

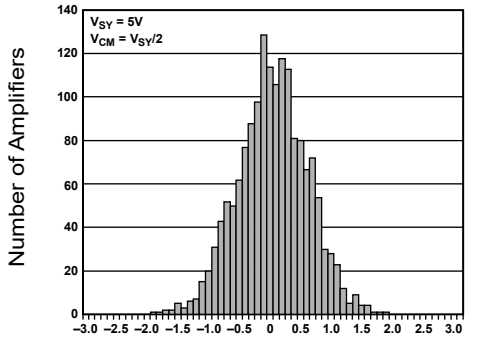


Figure 2: Input Offset Voltage Distribution

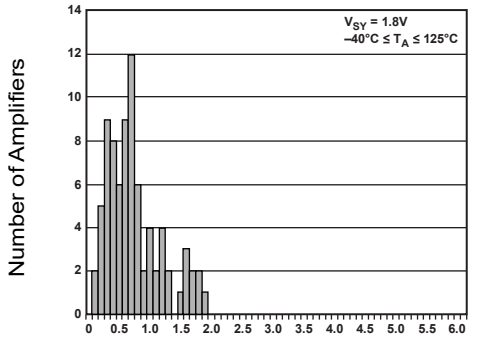


Figure 3: Input Offset Voltage Drift Distribution

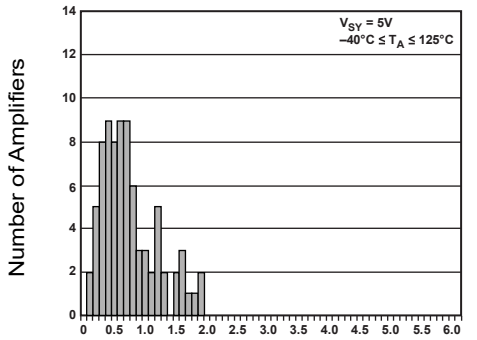


Figure 4: Input Offset Voltage Drift Distribution

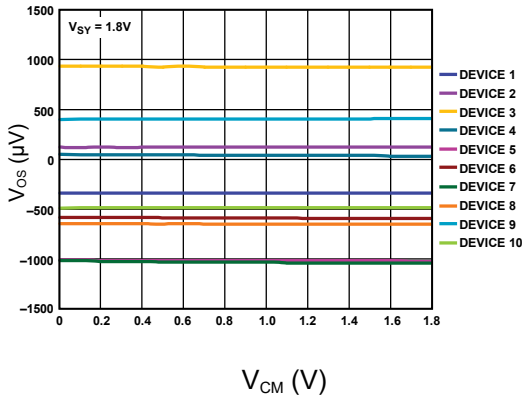


Figure 5: Input Offset Voltage vs. Common-Mode Voltage

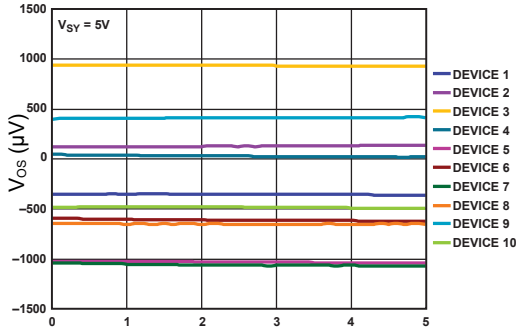


Figure 6: Input Offset Voltage vs. Common-Mode Voltage

7.2Typical Characteristic

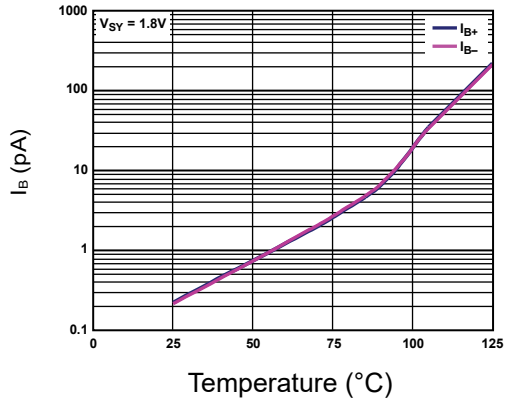


Figure 7: Input Bias Current vs. Temperature

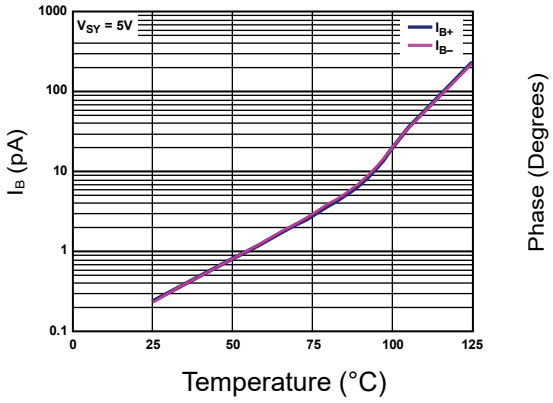


Figure 8: Input Bias Current vs. Temperature

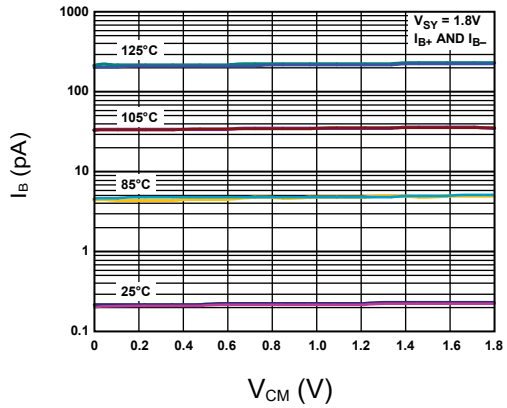


Figure 9: Input Bias Current vs. Common-Mode Voltage and Temperature

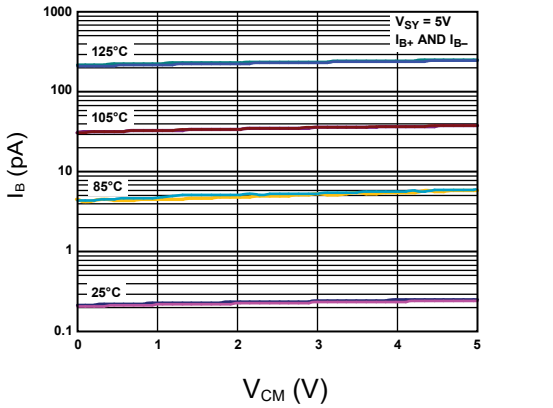


Figure 10: Input Bias Current vs. Common-Mode Voltage and Temperature

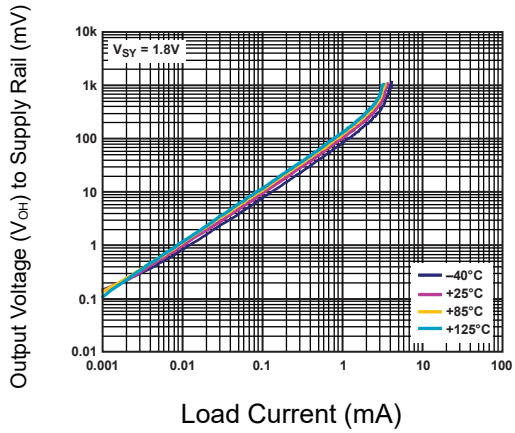


Figure 11: Output Voltage (V_{OH}) to Supply Rail vs. Load Current and Temperature

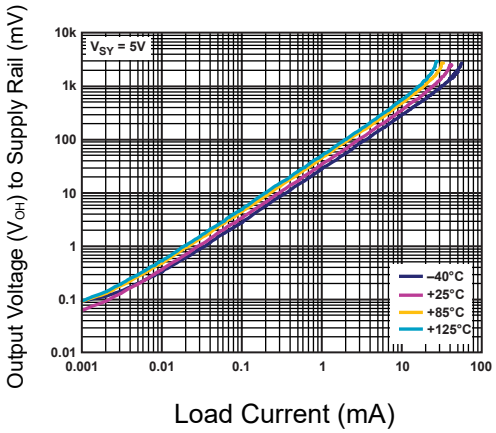


Figure 12: Output Voltage (V_{OH}) to Supply Rail vs. Load Current and Temperature

7.3Typical Characteristic

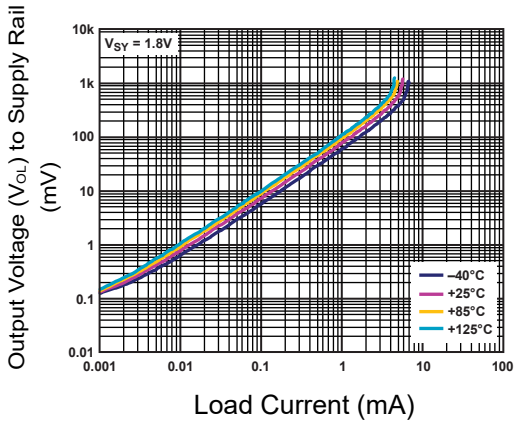


Figure 13: Output Voltage (V_{OL}) to Supply Rail vs. Load Current and Temperature

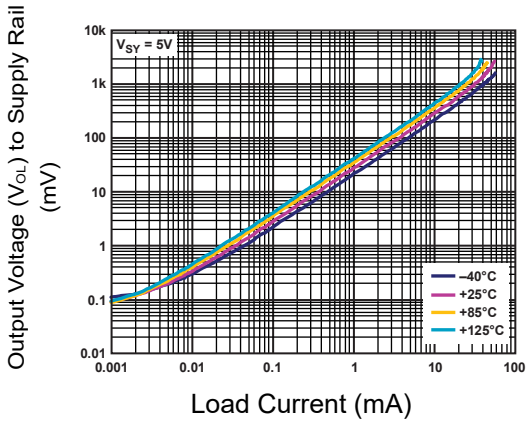


Figure 14: Output Voltage (V_{OL}) to Supply Rail vs. Load Current and Temperature

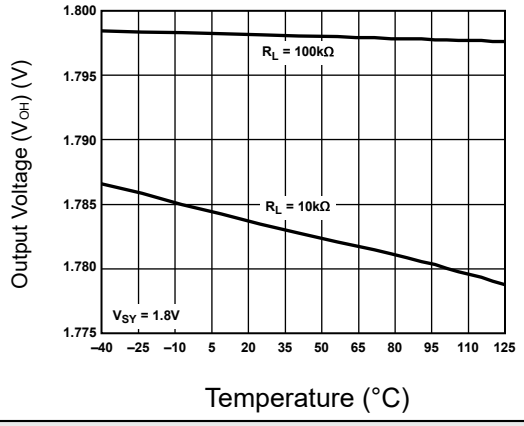


Figure 15: Output Voltage (V_{OH}) vs. Temperature

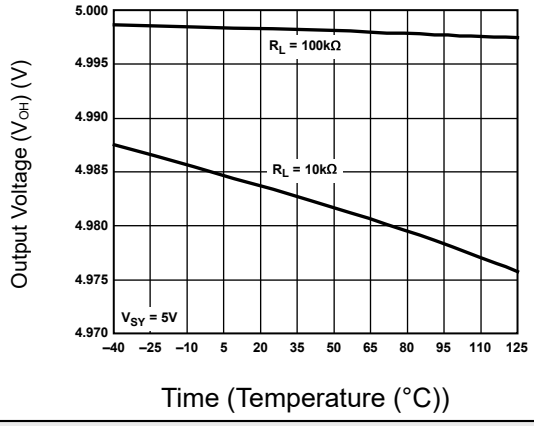


Figure 16: Output Voltage (V_{OH}) vs. Temperature

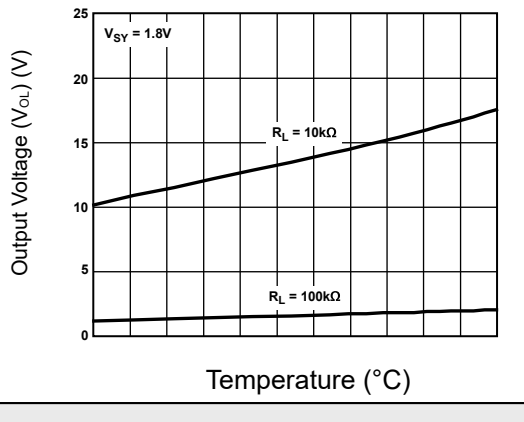


Figure 17: Output Voltage (V_{OL}) vs. Temperature

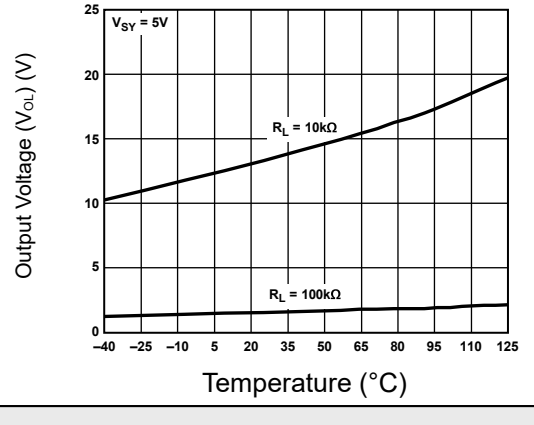


Figure 18: Output Voltage (V_{OL}) vs. Temperature

7.4Typical Characteristic

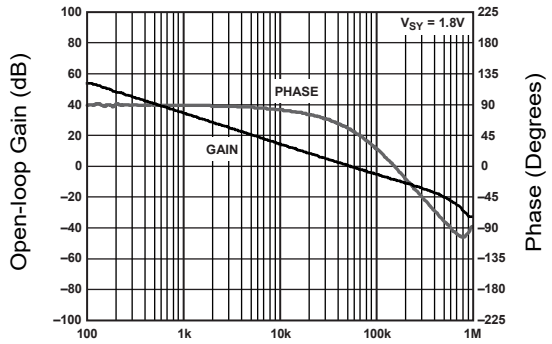


Figure 19: Open-Loop Gain and Phase vs. Frequency

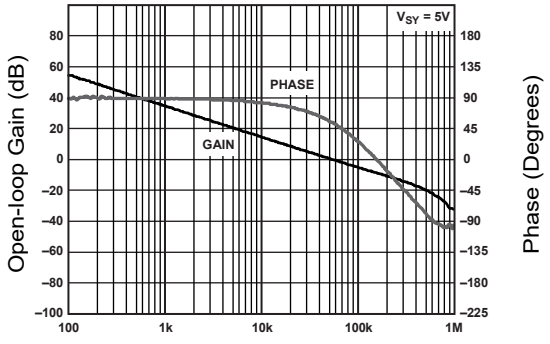


Figure 20: Open-Loop Gain and Phase vs. Frequency

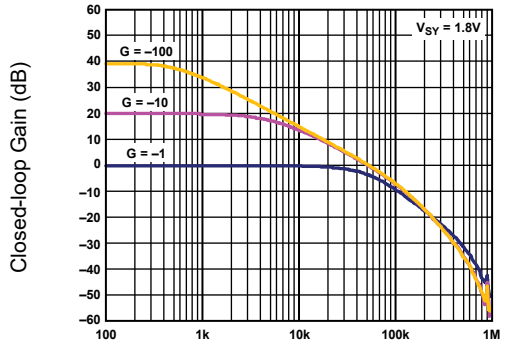


Figure 21: Closed-Loop Gain vs. Frequency

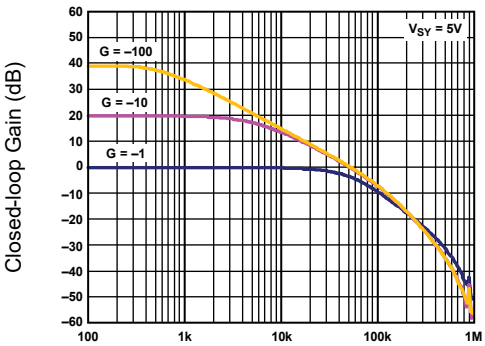


Figure 22: Closed-Loop Gain vs. Frequency

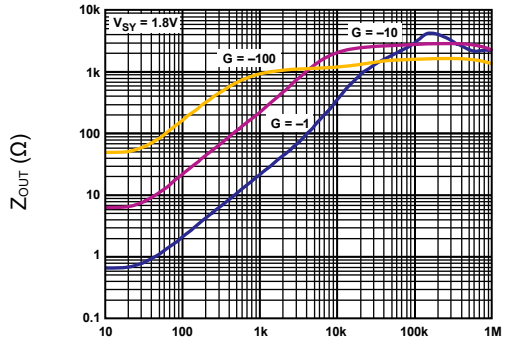


Figure 23: Output Im pedance vs. Frequency

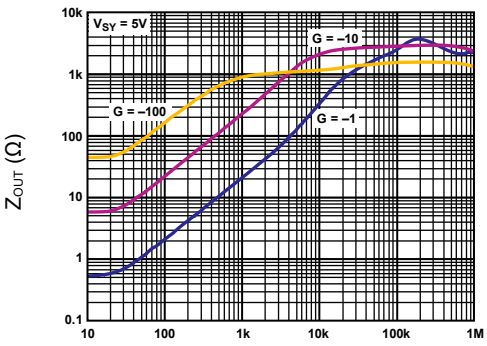


Figure 24: Output Im pedance vs. Frequency

7.5Typical Characteristic

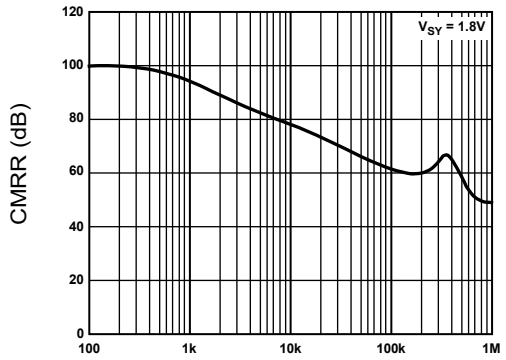


Figure 25: CMRR vs. Frequency

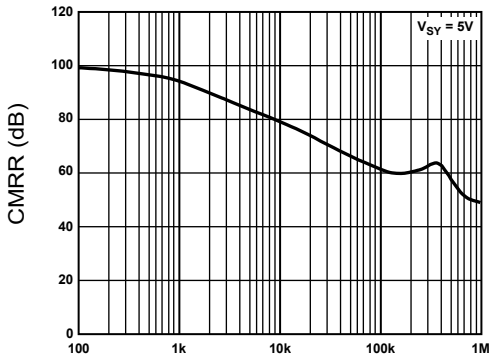


Figure 26: CMRR vs. Frequency

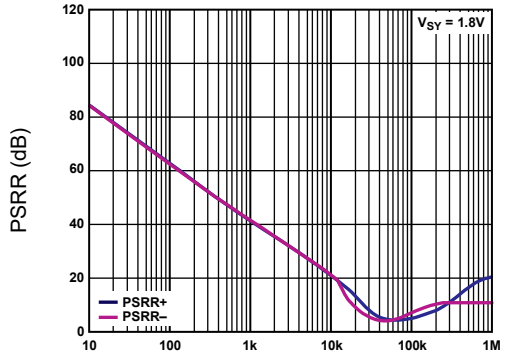


Figure 27: PSRR vs. Frequency

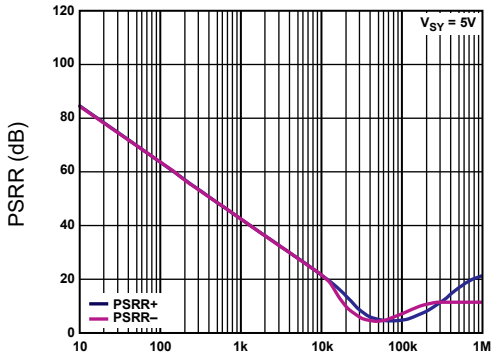


Figure 28: PSRR vs. Frequency

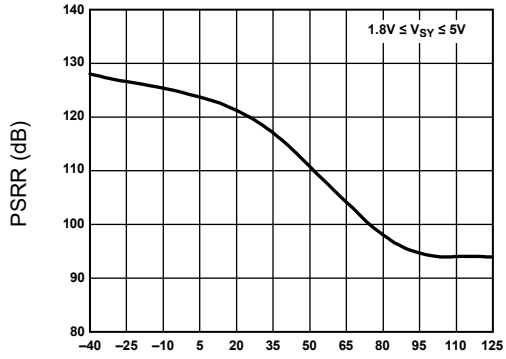


Figure 29: PSRR vs. Temperature

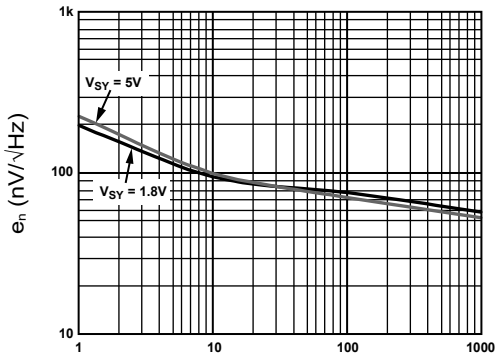


Figure 30: Voltage Noise Density vs. Frequency

7.6Typical Characteristic

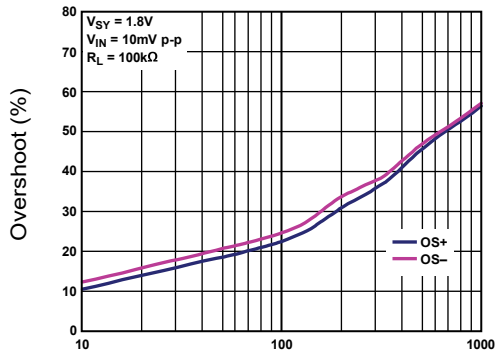


Figure 31: Small Signal Overshoot vs. Load Capacitance

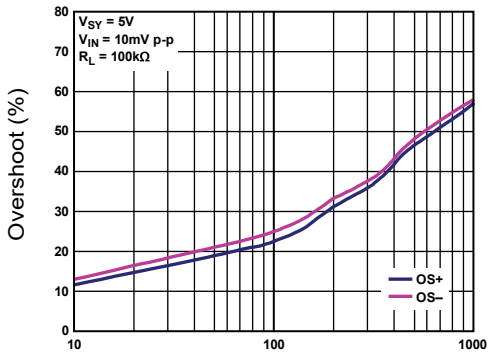


Figure 32: Small Signal Overshoot vs. Load Capacitance

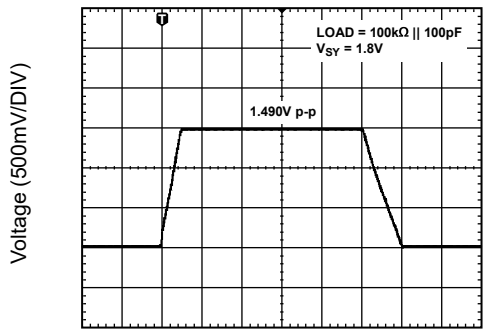


Figure 33: Large Signal Transient Response

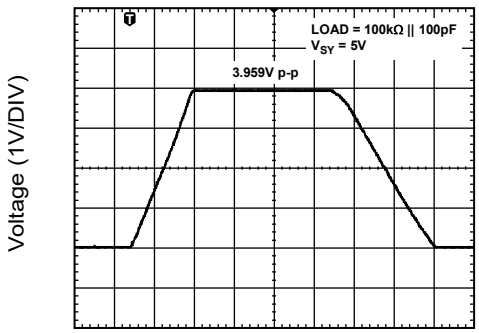


Figure 34: Large Signal Transient Response

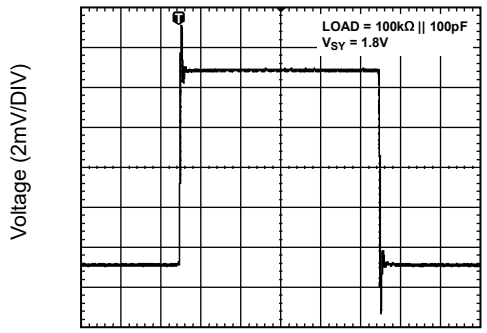


Figure 35: Small Signal Transient Response

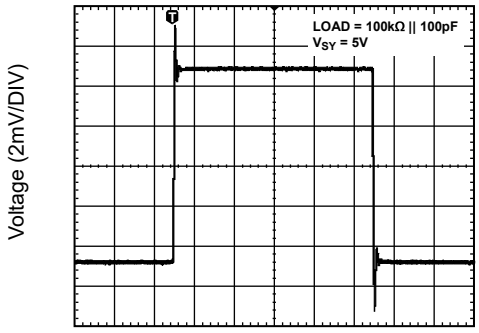


Figure 36: Small Signal Transient Response

7.7Typical Characteristic

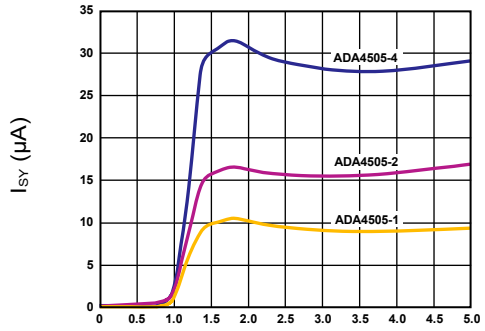


Figure 37: Supply Current vs. Supply Voltage

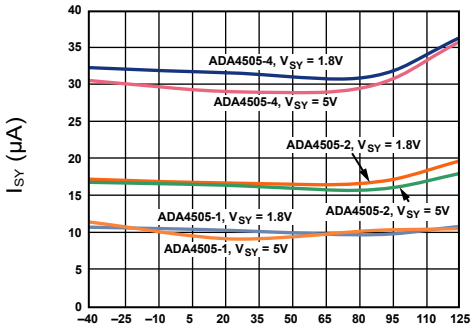


Figure 38: Total Supply Current vs. Temperature

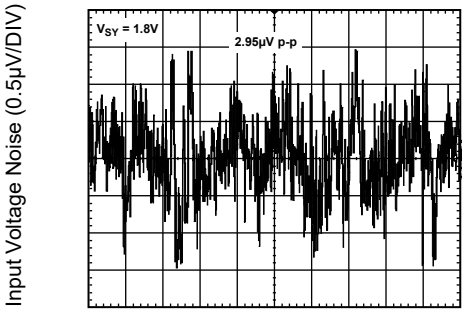


Figure 39: Input Voltage Noise, 0.1 Hz to 10 Hz Noise

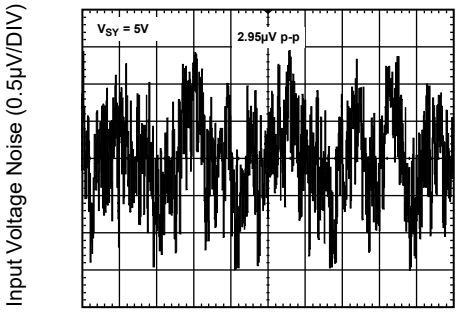


Figure 40: Input Voltage Noise, 0.1 Hz to 10 Hz Noise

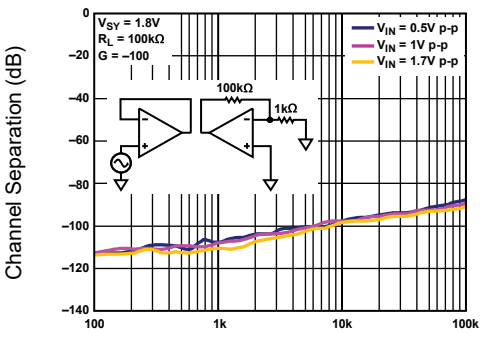


Figure 41: Channel Separation vs. Frequency

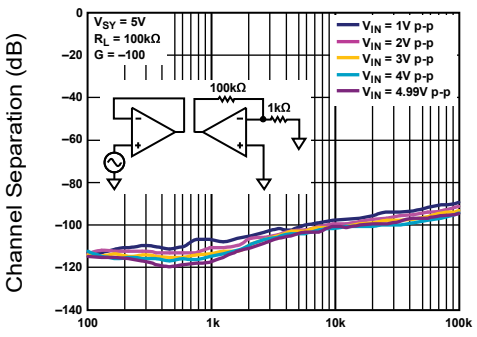


Figure 42: Channel Separation vs. Frequency

7.8Typical Characteristic

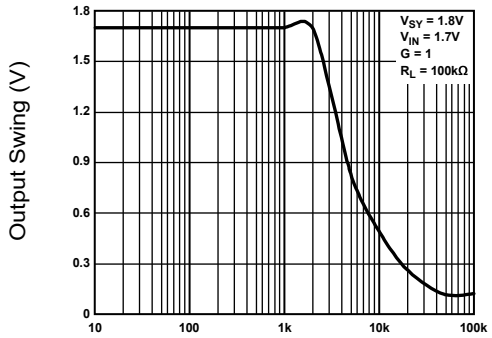


Figure 43: Output Swing vs. Frequency

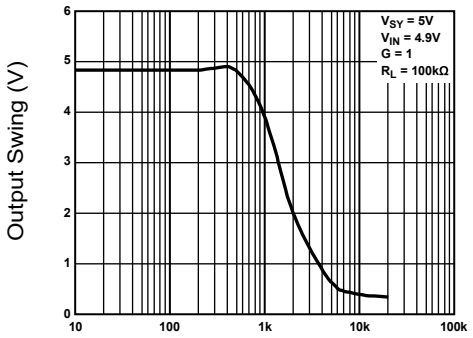


Figure 44: Output Swing vs. Frequency

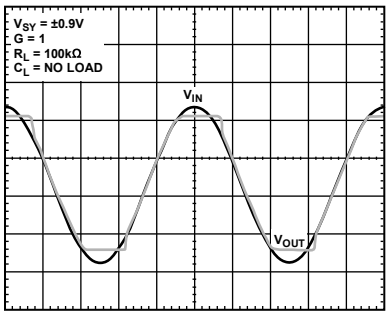


Figure 45: No Phase Reversal

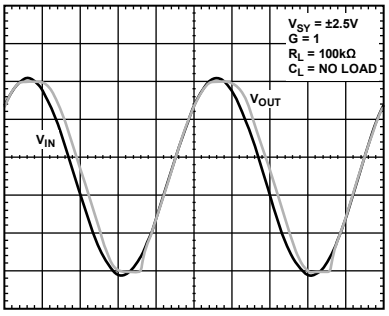
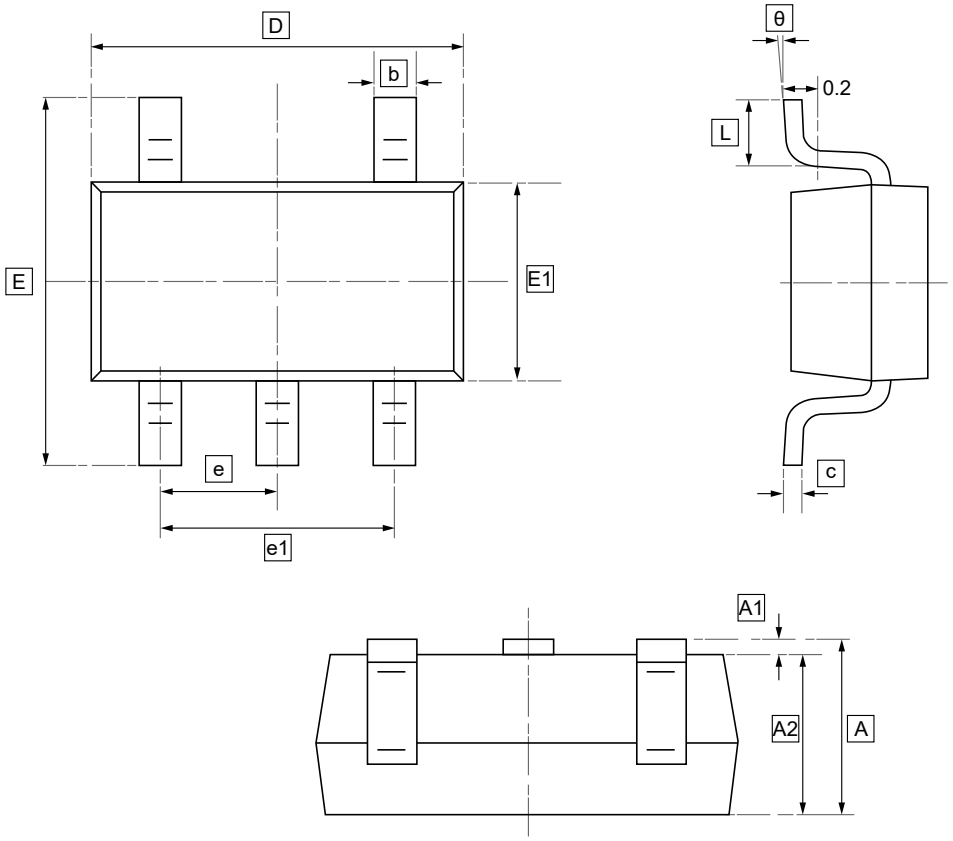


Figure 46: No Phase Reversal

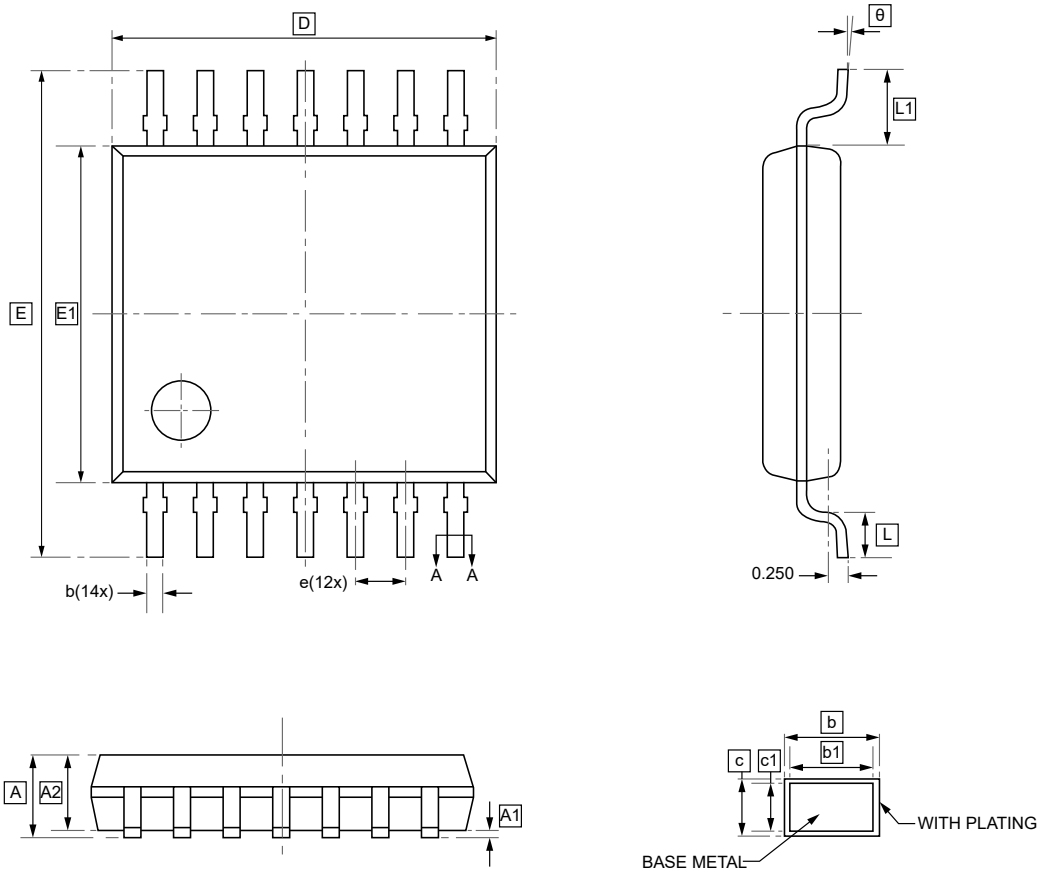
8.1SOT23-5 Package Outline Dimensions



DIMENSIONS (mm are the original dimensions)

Symbol	A	A1	A2	b	c	D	E1	E	e	e1	L	θ
Min	1.050	0.000	1.050	0.300	0.100	2.820	1.500	2.650	0.950	1.800	0.300	0°
Max	1.250	0.100	1.150	0.500	0.200	3.020	1.700	2.950	BSC	2.000	0.600	8°

8.2TSSOP-14 Package Outline Dimensions



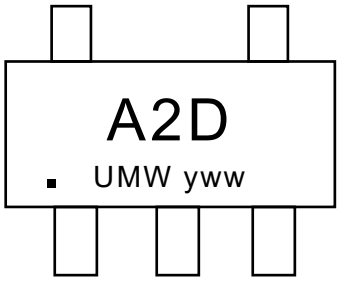
DIMENSIONS (mm are the original dimensions)

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°

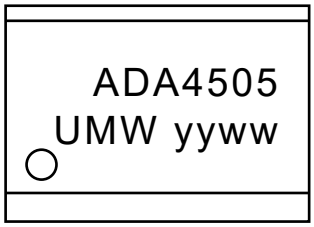
9.Ordering information

SOT23-5



y: Year Code
ww: Week Code

TSSOP-14



yy: Year Code
ww: Week Code

Order Code	Marking	Package	Base QTY	Delivery Mode
UMW ADA4505-1ARJZ	A2D	SOT-23-5	3000	Tape and reel
UMW ADA4505-4ARUZ	ADA4505	TSSOP-14	4000	Tape and reel

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