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## Precision Low noise CMOS Rail-to-Rail Input/Output Operational Amplifiers

### Preliminary Technical Data

### AD8605/AD8606/AD8608

#### FEATURES

**Low Offset Voltage: 300  $\mu$ V max**  
**Low Input Bias Currents**  
**Low Noise: 6.5 nV/ $\sqrt{\text{Hz}}$**   
**Low Supply Current: 1 mA/Amp**  
**Wide Bandwidth: 10 MHz**  
**Slew Rate: 5 V/ $\mu$ s**  
**Low Distortion**  
**No Phase Reversal**  
**High gain**  
**Unity Gain Stable**  
**Single-Supply Operation: 2.7 to 6 Volts**

#### APPLICATIONS

**Barcode Scanners**  
**Battery Powered Instrumentation**  
**Multi-pole Filters**  
**Sensors**  
**ASIC Input or Output Amplifier**  
**Audio**  
**Photodiode amplification**

#### GENERAL DESCRIPTION

The AD8605, AD8606 and AD8608 are single, dual and quad rail-to-rail input and output single supply amplifiers featuring very low offset voltage, low input voltage and current noise and wide signal bandwidth. These amplifiers use a patented trimming technique that achieves superior precision without laser trimming. All are fully specified to operate from +3V to +5V single supply.

The combination of low offsets, low noise, very low input bias currents, and high speed make these amplifiers useful in a wide variety of applications. Filters, integrators, photo-diode amplifiers and high

impedance sensors all benefit from the combination of performance features. Audio and other AC applications benefit from the wide bandwidth and low distortion.

Applications for these amplifiers include portable and loop-powered instrumentation, audio amplification for portable devices, portable phone headsets, bar code scanners, and multi-pole filters.

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 single supply systems.

The AD8605, AD8606 and AD8608 are specified over the extended industrial (-40° to +125°C) temperature range. The AD8605, single, is available in the tiny 5-lead SOT-23 package. The AD8606, dual, is available in the 8-lead micro-SOIC and narrow SOIC surface mount packages. The AD8608, quad, is available in 14-lead TSSOP and narrow 14-pin SOIC packages.

SOT, MSOP and TSSOP versions are available in tape and reel only.

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# PRELIMINARY TECHNICAL DATA

## AD8605/8606/8608

### ELECTRICAL CHARACTERISTICS ( $V_S=+2.7V$ , $V_{CM} = V_S/2$ , $T_A=+25^\circ C$ unless otherwise noted)

Parameter	Symbol	Conditions	Min	Typ	Max	Units
<b>INPUT CHARACTERISTICS</b>						
Offset Voltage	$V_{OS}$	$V_{CM} = 0V$ to $3V$ $-40^\circ < T_A < +125^\circ C$		80	300	$\mu V$
					750	$\mu V$
Input Bias Current	$I_B$	$-40^\circ < T_A < +85^\circ C$ $-40^\circ < T_A < +125^\circ C$		0.2	60	pA
					100	pA
					100	pA
Input Offset Current	$I_{OS}$	$-40^\circ < T_A < +85^\circ C$ $-40^\circ < T_A < +125^\circ C$		0.1	30	pA
					50	pA
					500	pA
Input Voltage Range			0		3	V
Common-Mode Rejection Ratio	CMRR	$V_{CM} = 0V$ to $2.7V$	80	95		dB
Large Signal Voltage Gain	$A_{VO}$	$R_L = 2 k\Omega$ $V_O = 0.5V$ to $2.5V$	200	350		V/mV
Offset Voltage Drift	$\Delta V_{OS}/\Delta T$			1		$\mu V/^\circ C$
<b>OUTPUT CHARACTERISTICS</b>						
Output Voltage High	$V_{OH}$	$I_L = 1mA$ $-40^\circ C < T_A < +125^\circ C$	2.65	2.67		V
			2.6			V
Output Voltage Low	$V_{OL}$	$I_L = 1mA$ $-40^\circ C < T_A < +125^\circ C$		20	30	mV
					50	mV
Output Current	$I_{OUT}$			$\pm 30$		mA
Closed Loop Output Impedance	$Z_{OUT}$	$f=1 MHz$ , $A_V = 1$		12		$\Omega$
<b>POWER SUPPLY</b>						
Power Supply Rejection Ratio	PSRR	$V_S = 2.7 V$ to $5.5 V$	80	95		dB
Supply Current/Amplifier	$I_{SY}$	$V_O = 0V$ $-40^\circ < T_A < +125^\circ C$		1150	1300	$\mu A$
					1500	$\mu A$
<b>DYNAMIC PERFORMANCE</b>						
Slew Rate	SR	$R_L = 2 k\Omega$		5		V/ $\mu s$
Settling Time	$t_s$	To 0.01%		<0.5		$\mu s$
Gain Bandwidth Product	GBP			9		MHz
Phase Margin	$\phi_o$			50		degrees
<b>NOISE PERFORMANCE</b>						
Voltage Noise Density	$e_n$	$f=1kHz$		8		nV/ $\sqrt{Hz}$
Voltage Noise Density	$e_n$	$f=10kHz$		6.5		nV/ $\sqrt{Hz}$
Current Noise Density	$i_n$	$f=1kHz$		0.05		pA/ $\sqrt{Hz}$

# PRELIMINARY TECHNICAL DATA

## AD8605/8606/8608

### ELECTRICAL CHARACTERISTICS (@ $V_S=+5.0V$ , $V_{CM} = V_S/2$ , $T_A=+25^\circ C$ unless otherwise noted)

Parameter	Symbol	Conditions	A Grade			Units
			Min	Typ	Max	
<b>INPUT CHARACTERISTICS</b>						
Offset Voltage	$V_{OS}$	$V_{CM} = 0V$ to $5V$ $-40^\circ < T_A < +125^\circ C$		80	300	$\mu V$
					750	$\mu V$
Input Bias Current	$I_B$	$-40^\circ < T_A < +85^\circ C$ $-40^\circ < T_A < +125^\circ C$		0.2	60	pA
					100	pA
					1000	pA
Input Offset Current	$I_{OS}$	$-40^\circ < T_A < +85^\circ C$ $-40^\circ < T_A < +125^\circ C$		0.1	30	pA
					50	pA
					500	pA
Input Voltage Range			0		5	V
Common-Mode Rejection Ratio	CMRR	$V_{CM} = 0V$ to $5V$	85	100		dB
Large Signal Voltage Gain	$A_{VO}$	$V_O = 0.5V$ to $4.5V$ , $R_L = 2\text{ k}\Omega$ , $V_{CM} = 0V$	1000	2000		V/mV
Offset Voltage Drift	$\Delta V_{OS}/\Delta T$			1		$\mu V/^\circ C$
<b>OUTPUT CHARACTERISTICS</b>						
Output Voltage High	$V_{OH}$	$I_L = 1\text{mA}$ $I_L = 10\text{mA}$ $-40^\circ C$ to $+125^\circ C$	4.97	4.98		V
			4.7	4.79		V
			4.6			V
Output Voltage Low	$V_{OL}$	$I_L = 1\text{mA}$		15	30	mV
Output Voltage High	$V_{OL}$	$I_L = 10\text{mA}$ $-40^\circ C$ to $+125^\circ C$		125	175	mV
					250	mV
Output Current	$I_{OUT}$			$\pm 80$		mA
Closed Loop Output Impedance	$Z_{OUT}$	$f=1\text{ MHz}$ , $A_V = 1$		10		$\Omega$
<b>POWER SUPPLY</b>						
Power Supply Rejection Ratio	PSRR	$V_S = 2.7\text{ V}$ to $5.5\text{ V}$	80	95		dB
Supply Current/Amplifier	$I_{SY}$	$V_O = 0V$ $-40^\circ < T_A < +125^\circ C$		1200	1400	$\mu A$
					1600	$\mu A$
<b>DYNAMIC PERFORMANCE</b>						
Slew Rate	SR	$R_L = 2\text{ k}\Omega$		5		V/ $\mu s$
Settling Time	$t_s$	To 0.01%		<1		$\mu s$
Full Power Bandwidth	BWp	<1% Distortion		360		kHz
Gain Bandwidth Product	GBP			10		MHz
Phase Margin	$\phi_o$			55		degrees
<b>NOISE PERFORMANCE</b>						
Voltage Noise Density	$e_n$	$f=1\text{kHz}$		8		nV/ $\sqrt{\text{Hz}}$
Voltage Noise Density	$e_n$	$f=10\text{kHz}$		6.5		nV/ $\sqrt{\text{Hz}}$
Current Noise Density	$i_n$	$f=1\text{kHz}$		0.05		pA/ $\sqrt{\text{Hz}}$

# PRELIMINARY TECHNICAL DATA

## AD8605/8606/8608

### ABSOLUTE MAXIMUM RATINGS<sup>1</sup>

Supply voltage .....	+6V
Input Voltage .....	Gnd to Vs
Differential Input Voltage .....	±6V
Output Short-Circuit Duration to Gnd <sup>2</sup> ... Observe Derating Curves	
Storage Temperature Range	
R, RT, RM, RU Package .....	-65°C to +150°C
Operating Temperature Range	
AD8605/AD8606/AD8608 .....	-40°C to +125°C
Junction Temperature Range	
R, RT, RM, RU Package .....	-65°C to +150°C
Lead Temperature Range (Soldering, 60 Sec) .....	+300°C

Package Type	$\theta_{JA}$	$\theta_{JC}$	Units
5-Pin SOT-23 (RT)	230	--	°C/W
8-Pin microSOIC (RM)	210	45	°C/W
8-Pin SOIC (R)	158	43	°C/W
14-Pin SOIC (R)	120	36	°C/W
14-Pin TSSOP (RU)	180	35	°C/W

### NOTES

<sup>1</sup> Absolute maximum ratings apply at 25°C, unless otherwise noted.

<sup>2</sup>  $\theta_{JA}$  is specified for the worst-case conditions, i.e.,  $\theta_{JA}$  is specified for device soldered in circuit board for surface mount packages.

### ORDERING GUIDE

Model	Temperature Range	Package Description	Package Option
AD8605ART	-40°C to +125°C	5-Pin SOT-23	RT-5
AD8606ARM	-40°C to +125°C	8-Pin micro-SOIC	RM-8
AD8606AR	-40°C to +125°C	8-Pin SOIC	R-8
AD8608AR	-40°C to +125°C	14-Pin SOIC	R-14
AD8608ARU	-40°C to +125°C	14-Pin TSSOP	RU-14