Micropower, Rail-to-Rail Input and Output Operational Amplifiers

OP196/OP296/OP496

FEATURES
Rail-to-Rail Input and Output Swing
Low Power: 60 μA/Amplifier
Gain Bandwidth Product: 450 kHz
Single-Supply Operation: 3 V to 12 V
Low Offset Voltage: 300 μV max
High Open-Loop Gain: 500 V/mV
Unity-Gain Stable
No Phase Reversal

APPLICATIONS
Battery Monitoring
Sensor Conditioners
Portable Power Supply Control
Portable Instrumentation

GENERAL DESCRIPTION
The OP196 family of CBCMOS operational amplifiers features micropower operation and rail-to-rail input and output ranges.

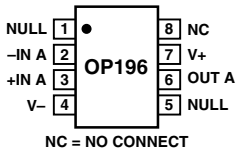
The extremely low power requirements and guaranteed operation from 3 V to 12 V make these amplifiers perfectly suited to monitor battery usage and to control battery charging. Their dynamic performance, including 26 nV/√Hz voltage noise density, recommends them for battery-powered audio applications. Capacitive loads to 200 pF are handled without oscillation.

The OP196/OP296/OP496 are specified over the HOT extended industrial (–40°C to +125°C) temperature range. 3 V operation is specified over the 0°C to 125°C temperature range.

The single OP196 and the dual OP296 are available in 8-lead SO-8 surface mount packages. The dual OP296 is available in 8-lead PDIP. The quad OP496 is available in 14-lead plastic DIP and narrow SO-14 surface-mount packages.

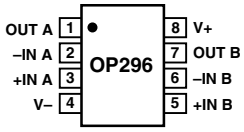
PIN CONFIGURATIONS

8-Lead Narrow-Body SO

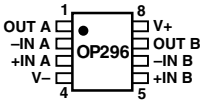


NC = NO CONNECT

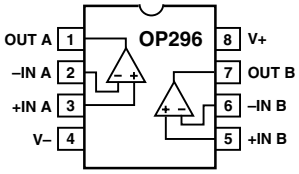
8-Lead Narrow-Body SO



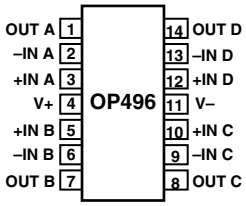
8-Lead TSSOP



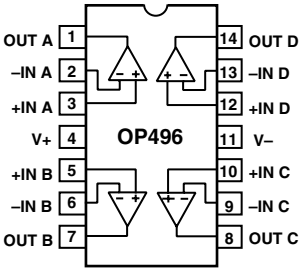
8-Lead Plastic DIP



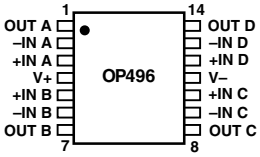
14-Lead Narrow-Body SO



14-Lead Plastic DIP



14-Lead TSSOP
(RU Suffix)



OP196/OP296/OP496–SPECIFICATIONS

ELECTRICAL SPECIFICATIONS (@ V_S = 5.0 V, V_{CM} = 2.5 V, T_A = 25°C, unless otherwise noted.)

Parameter	Symbol	Conditions	Min	Typ	Max	Unit
INPUT CHARACTERISTICS						
Offset Voltage	V_{OS}	OP196G, OP296G, OP496G		35	300	µV
		–40°C ≤ T_A ≤ +125°C			650	µV
		OP296H, OP496H			800	µV
		–40°C ≤ T_A ≤ +125°C			1.2	mV
Input Bias Current	I_B	–40°C ≤ T_A ≤ +125°C		±10	±50	nA
Input Offset Current	I_{OS}			±1.5	±8	nA
		–40°C ≤ T_A ≤ +125°C			±20	nA
Input Voltage Range	V_{CM}		0		5.0	V
Common-Mode Rejection Ratio	CMRR	0 V ≤ V_{CM} ≤ 5.0 V,				
		–40°C ≤ T_A ≤ +125°C	65			dB
Large Signal Voltage Gain	A_{VO}	R_L = 100 kΩ,				
		0.30 V ≤ V_{OUT} ≤ 4.7 V,				
		–40°C ≤ T_A ≤ +125°C	150	200		V/mV
Long-Term Offset Voltage	V_{OS}	G Grade, Note 1			550	µV
		H Grade, Note 1			1	mV
Offset Voltage Drift	$\Delta V_{OS}/\Delta T$	G Grade, Note 2		1.5		µV/°C
		H Grade, Note 2		2		µV/°C
OUTPUT CHARACTERISTICS						
Output Voltage Swing High	V_{OH}	I_L = –100 µA	4.85	4.92		V
		I_L = 1 mA	4.30	4.56		V
		I_L = 2 mA		4.1		V
Output Voltage Swing Low	V_{OL}	I_L = –1 mA		36	70	mV
		I_L = –1 mA		350	550	mV
		I_L = –2 mA		750		mV
Output Current	I_{OUT}			±4		mA
POWER SUPPLY						
Power Supply Rejection Ratio	PSRR	±2.5 V ≤ V_S ≤ ±6 V,				
		–40°C ≤ T_A ≤ +125°C	85			dB
Supply Current per Amplifier	I_{SY}	V_{OUT} = 2.5 V, R_L = ∞			60	µA
		–40°C ≤ T_A ≤ +125°C		45	80	µA
DYNAMIC PERFORMANCE						
Slew Rate	SR	R_L = 100 kΩ		0.3		V/µs
Gain Bandwidth Product	GBP			350		kHz
Phase Margin	$ø_m$			47		Degrees
NOISE PERFORMANCE						
Voltage Noise	e_n p-p	0.1 Hz to 10 Hz		0.8		µV p-p
Voltage Noise Density	e_n	f = 1 kHz		26		nV/√Hz
Current Noise Density	i_n	f = 1 kHz		0.19		pA/√Hz

NOTES

[1]Long-term offset voltage is guaranteed by a 1,000 hour life test performed on three independent lots at 125°C, with an LTPD of 1.3.

[2]Offset voltage drift is the average of the –40°C to +25°C delta and the +25°C to +125°C delta.

Specifications subject to change without notice.

ELECTRICAL SPECIFICATIONS (@ V_S = 3.0 V, V_{CM} = 1.5 V, T_A = 25°C, unless otherwise noted.)

Parameter	Symbol	Conditions	Min	Typ	Max	Unit
INPUT CHARACTERISTICS						
Offset Voltage	V_{OS}	OP196G, OP296G, OP496G		35	300	µV
		0°C ≤ T_A ≤ 125°C			650	µV
		OP296H, OP496H			800	µV
		0°C ≤ T_A ≤ 125°C			1.2	mV
Input Bias Current	I_B			±10	±50	nA
Input Offset Current	I_{OS}			±1	±8	nA
Input Voltage Range	V_{CM}		0		3.0	V
Common-Mode Rejection Ratio	CMRR	0 V ≤ V_{CM} ≤ 3.0 V,				
		0°C ≤ T_A ≤ 125°C	60			dB
Large Signal Voltage Gain	A_{VO}	R_L = 100 kΩ	80	200		V/mV
Long-Term Offset Voltage	V_{OS}	G Grade, Note 1			550	µV
		H Grade, Note 1			1	mV
Offset Voltage Drift	$\Delta V_{OS}/\Delta T$	G Grade, Note 2		1.5		µV/°C
		H Grade, Note 2		2		µV/°C
OUTPUT CHARACTERISTICS						
Output Voltage Swing High	V_{OH}	I_L = 100 µA	2.85			V
Output Voltage Swing Low	V_{OL}	I_L = –100 µA			70	mV
POWER SUPPLY						
Supply Current per Amplifier	I_{SY}	V_{OUT} = 1.5 V, R_L = ∞		40	60	µA
		0°C ≤ T_A ≤ 125°C			80	µA
DYNAMIC PERFORMANCE						
Slew Rate	SR	R_L = 100 kΩ		0.25		V/µs
Gain Bandwidth Product	GBP			350		kHz
Phase Margin	$ø_m$			45		Degrees
NOISE PERFORMANCE						
Voltage Noise	e_n p-p	0.1 Hz to 10 Hz		0.8		µV p-p
Voltage Noise Density	e_n	f = 1 kHz		26		nV/√Hz
Current Noise Density	i_n	f = 1 kHz		0.19		pA/√Hz

NOTES

[1]Long-term offset voltage is guaranteed by a 1,000 hour life test performed on three independent lots at 125°C, with an LTPD of 1.3.

[2]Offset voltage drift is the average of the 0°C to 25°C delta and the 25°C to 125°C delta.

Specifications subject to change without notice.

OP196/OP296/OP496

ELECTRICAL SPECIFICATIONS (@ V_S = 12.0 V, V_{CM} = 6 V, T_A = 25°C, unless otherwise noted.)

Parameter	Symbol	Conditions	Min	Typ	Max	Unit
INPUT CHARACTERISTICS						
Offset Voltage	V_{OS}	OP196G, OP296G, OP496G		35	300	µV
		0°C ≤ T_A ≤ 125°C			650	µV
		OP296H, OP496H			800	µV
		0°C ≤ T_A ≤ 125°C			1.2	mV
Input Bias Current	I_B	–40°C ≤ T_A ≤ +125°C		±10	±50	nA
Input Offset Current	I_{OS}			±1	±8	nA
		–40°C ≤ T_A ≤ +125°C			±15	nA
Input Voltage Range	V_{CM}		0		12	V
Common-Mode Rejection Ratio	CMRR	0 V ≤ V_{CM} ≤ 12 V,				
		–40°C ≤ T_A ≤ +125°C	65			dB
Large Signal Voltage Gain	A_{VO}	R_L = 100 kΩ	300	1000		V/mV
Long-Term Offset Voltage	V_{OS}	G Grade, Note 1			550	µV
		H Grade, Note 1			1	mV
Offset Voltage Drift	$\Delta V_{OS}/\Delta T$	G Grade, Note 2		1.5		µV/°C
		H Grade, Note 2		2		µV/°C
OUTPUT CHARACTERISTICS						
Output Voltage Swing High	V_{OH}	I_L = 100 µA	11.85			V
		I_L = 1 mA	11.30			V
Output Voltage Swing Low	V_{OL}	I_L = –1 mA			70	mV
		I_L = –1 mA			550	mV
Output Current	I_{OUT}			±4		mA
POWER SUPPLY						
Supply Current per Amplifier	I_{SY}	V_{OUT} = 6 V, R_L = ∞			60	µA
		–40°C ≤ T_A ≤ +125°C			80	µA
Supply Voltage Range	V_S		3		12	V
DYNAMIC PERFORMANCE						
Slew Rate	SR	R_L = 100 kΩ		0.3		V/µs
Gain Bandwidth Product	GBP			450		kHz
Phase Margin	$ø_m$			50		Degrees
NOISE PERFORMANCE						
Voltage Noise	e_n p-p	0.1 Hz to 10 Hz		0.8		µV p-p
Voltage Noise Density	e_n	f = 1 kHz		26		nV/√Hz
Current Noise Density	i_n	f = 1 kHz		0.19		pA/√Hz

NOTES

[1]Long-term offset voltage is guaranteed by a 1,000 hour life test performed on three independent lots at 125°C, with an LTPD of 1.3.

[2]Offset voltage drift is the average of the –40°C to +25°C delta and the +25°C to +125°C delta.

Specifications subject to change without notice.

ABSOLUTE MAXIMUM RATINGS[1]

Supply Voltage . . . . . 15 V
Input Voltage[2] . . . . . 15 V
Differential Input Voltage[2] . . . . . 15 V
Output Short Circuit Duration . . . . . Indefinite
Storage Temperature Range
P, S, RU Package . . . . . –65°C to +150°C
Operating Temperature Range
OP196G, OP296G, OP496G, H . . . . . –40°C to +125°C
Junction Temperature Range
P, S, RU Package . . . . . –65°C to +150°C
Lead Temperature Range (Soldering, 60 sec) . . . . . 300°C

Package Type	θ_{JA}[3]	θ_{JC}	Unit
8-Lead Plastic DIP	103	43	°C/W
8-Lead SOIC	158	43	°C/W
8-Lead TSSOP	240	43	°C/W
14-Lead Plastic DIP	83	39	°C/W
14-Lead SOIC	120	36	°C/W
14-Lead TSSOP	180	35	°C/W

NOTES
[1]Absolute maximum ratings apply to both DICE and packaged parts, unless otherwise noted.
[2]For supply voltages less than 15 V, the absolute maximum input voltage is equal to the supply voltage.
[3]θ_{JA} is specified for the worst case conditions, i.e., θ_{JA} is specified for device in socket for P-DIP package; θ_{JA} is specified for device soldered in circuit board for SOIC and TSSOP packages.

ORDERING GUIDE

Model	Temperature Range	Package Description	Package Option
OP196GS	–40°C to +125°C	8-Lead SOIC	SO-8
OP296GP*	–40°C to +125°C	8-Lead Plastic DIP	N-8
OP296GS	–40°C to +125°C	8-Lead SOIC	SO-8
OP296HRU	–40°C to +125°C	8-Lead TSSOP	RU-8
OP496GP*	–40°C to +125°C	14-Lead Plastic DIP	N-14
OP496GS	–40°C to +125°C	14-Lead SOIC	SO-14
OP496HRU	–40°C to +125°C	14-Lead TSSOP	RU-14

*Not for new design, obsolete April 2002.

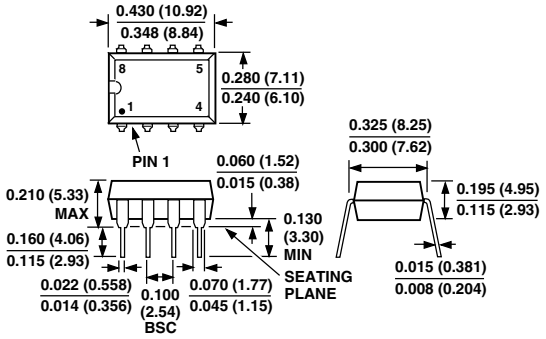
CAUTION

ESD (electrostatic discharge) sensitive device. Electrostatic charges as high as 4000 V readily accumulate on the human body and test equipment and can discharge without detection. Although the OP196/OP296/OP496 feature proprietary ESD protection circuitry, permanent damage may occur on devices subjected to high-energy electrostatic discharges. Therefore, proper ESD precautions are recommended to avoid performance degradation or loss of functionality.

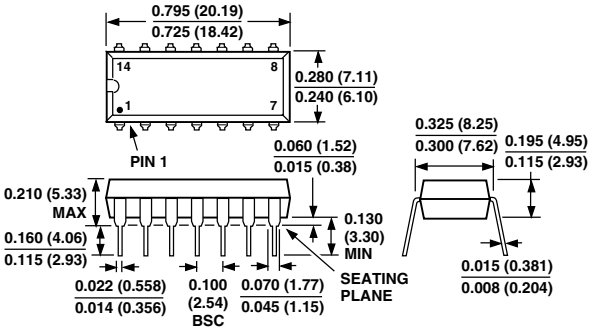
OUTLINE DIMENSIONS

Dimensions shown in inches and (mm).

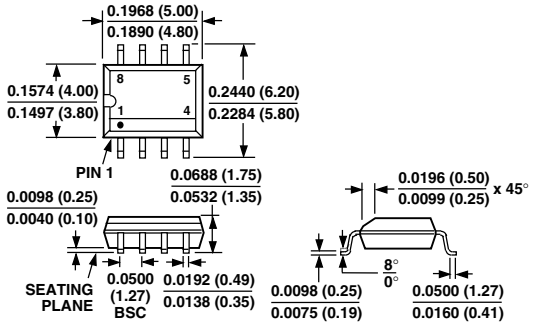
8-Lead Plastic DIP (N-8)



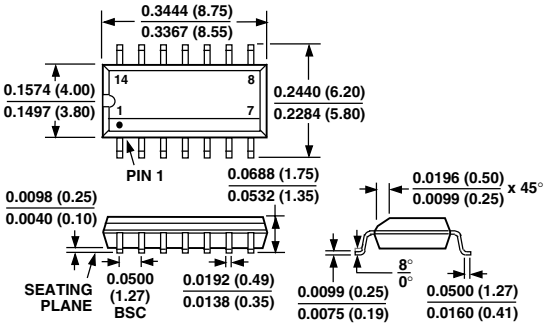
14-Lead Plastic DIP (N-14)



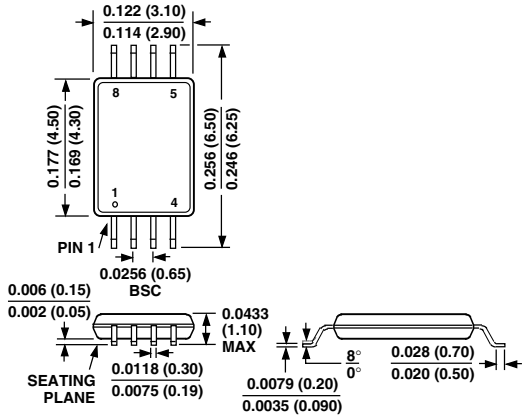
8-Lead Narrow Body SOIC (SO-8)



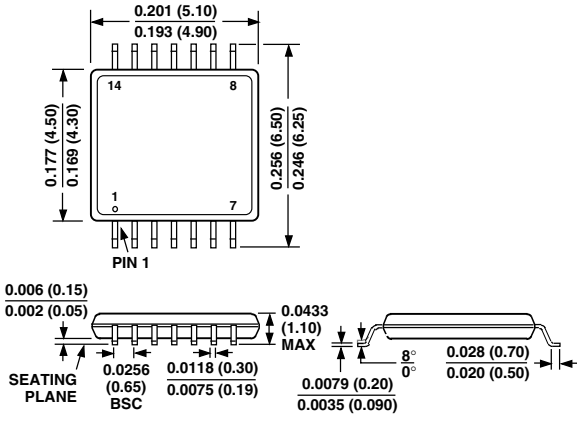
14-Lead Narrow-Body SOIC (SO-14)



8-Lead TSSOP (RU-8)



14-Lead TSSOP (RU-14)



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