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Ultra Low Power Rail-to-Rail Output Operational Amplifier

Preliminary

OP186

FEATURES

- Low Supply Current: 4 μ A Max
- Single-Supply Operation: 2.7 to 12 Volts
- Wide Input Voltage Range
- Rail-to-Rail Output Swing
- No Phase Reversal

APPLICATIONS

- Comparator
- Battery Powered Instrumentation
- Safety Monitoring
- Remote Sensors
- Low Voltage Strain Gage Amplifiers

GENERAL DESCRIPTION

The OP186 is a single **ultra low power** single-supply, amplifier featuring rail-to-rail outputs. Specified at 3 volt, and **5 volt single supply** as well as ± 5 volt dual supplies, it is guaranteed to operate from as low as 2.7 volts.

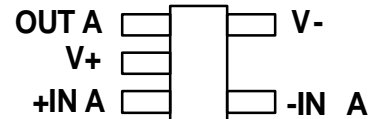
Fabricated on Analog Device's CBCMOS process, the OP186 features a bipolar input and an output that swings to within millivolts of the supplies and continues to sink or source current all the way to the supplies.

Applications for these amplifiers include safety monitoring, portable equipment, battery and power supply control, and as signal conditioning and interface for transducers in very low power systems.

The output's ability to swing rail-to-rail and not increase supply current when the output is driven to a supply, enables the OP186 to be used as a comparator in very low power systems.

The OP186 is specified over the extended industrial (-40° to $+125^{\circ}\text{C}$) temperature range. The OP186 is available in the SOT23 package.

5-Lead SOT (RT Suffix)



OP186

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REV. 0

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ELECTRICAL SPECIFICATIONS (@ $V_S=+3.0V$, $V_{CM} = 0.1V$, $T_A=+25^\circ C$ unless otherwise noted)

Parameter	Symbol	Conditions	Min	Typ	Max	Units
INPUT CHARACTERISTICS						
Offset Voltage	V_{OS}	$-40^\circ \leq T_A \leq +125^\circ C$			4	mV
Input Bias Current	I_B	$-40^\circ \leq T_A \leq +125^\circ C$		3.2		nA
Input Offset Current	I_{OS}	$-40^\circ \leq T_A \leq +125^\circ C$				nA
Input Voltage Range			0			V
Common-Mode Rejection Ratio	CMRR	$V_{CM} = 0$ to 2.0V $-40^\circ \leq T_A \leq +125^\circ C$			2	dB
Large Signal Voltage Gain	A_{VO}	$R_L = 1M\Omega$, $V_O = 0.3$ to 2.7V $-40^\circ \leq T_A \leq +125^\circ C$				V/mV
Offset Voltage Drift	$\Delta V_{OS}/\Delta T$					$\mu V/^\circ C$
Bias Current Drift	$\Delta I_B/\Delta T$					pA/^\circ C
Offset Current Drift	$\Delta I_{OS}/\Delta T$					pA/^\circ C
OUTPUT CHARACTERISTICS						
Output Voltage High	V_{OH}	$R_L = 100k\Omega$ to Gnd. $-40^\circ C$ to $+125^\circ C$	2.95 2.90	2.99 2.98		V
Output Voltage Low	V_{OL}	$R_L = 100k\Omega$ to V+ $-40^\circ C$ to $+125^\circ C$		10	35	mV
Short Circuit Limit	I_{SC}	$-40^\circ C$ to $+125^\circ C$		± 2		nA
POWER SUPPLY						
Power Supply Rejection Ratio	PSRR	$V_S = 2.7V$ to 12 V $-40^\circ \leq T_A \leq +125^\circ C$				dB
Supply Current/Amplifier	I_{SY}	$-40^\circ \leq T_A \leq +125^\circ C$		4		μA
DYNAMIC PERFORMANCE						
Slew Rate	SR	$R_L = 100 k\Omega$, $C_L = 50pF$		28		V/ms
Turn On Time		$A_V = 1$, $V_O = 1$				μs
Turn On Time		$A_V = 20$, $V_O = 1$				μs
Settling Time	t_s	To 0.01%				μs
Gain Bandwidth Product	GBP					kHz
Phase Margin	ϕ_o					degrees
NOISE PERFORMANCE						
Voltage Noise	e_{n-p-p}	0.1 to 10 Hz				μV_{p-p}
Voltage Noise Density	e_n	$f = 1kHz$		110		nV/ \sqrt{Hz}
Current Noise Density	i_n					pA/ \sqrt{Hz}

ELECTRICAL SPECIFICATIONS (@ $V_S=+5.0V$, $V_{CM} = 0.1V$, $T_A=+25^\circ C$ unless otherwise noted. Note 1)

Parameter	Symbol	Conditions	Min	Typ	Max	Units
INPUT CHARACTERISTICS						
Offset Voltage	V_{OS}	Note 2 $-40^\circ \leq T_A \leq +125^\circ C$			4 1.0	mV mV
Input Bias Current	I_B	$-40^\circ \leq T_A \leq +125^\circ C$		3.2		nA nA
Input Offset Current	I_{OS}	$-40^\circ \leq T_A \leq +125^\circ C$		0.1	8 16	nA nA
Input Voltage Range			0		4	V
Common-Mode Rejection Ratio	CMRR	$V_{CM} = 0$ to 4.0V $-40^\circ \leq T_A \leq +125^\circ C$	76 76			dB dB
Large Signal Voltage Gain	A_{VO}	$R_L = 1 M\Omega$, $V_O = 0.5$ to 4.5V $-40^\circ \leq T_A \leq +125^\circ C$				V/mV V/mV
Offset Voltage Drift	$\Delta V_{OS}/\Delta T$	$-40^\circ \leq T_A \leq +125^\circ C$				$\mu V/^\circ C$
Bias Current Drift	$\Delta I_B/\Delta T$					$pA/^\circ C$
Offset Current Drift	$\Delta I_{OS}/\Delta T$					$pA/^\circ C$
OUTPUT CHARACTERISTICS						
Output Voltage High	V_{OH}	$R_L = 100k\Omega$ to Gnd. $-40^\circ C$ to $+125^\circ C$	4.95 4.90	4.99 4.98		V V
Output Voltage Low	V_{OL}	$R_L = 100k\Omega$ to $V+$, $-40^\circ C$ to $+125^\circ C$		4.5	10 35	mV mV
Short Circuit Limit	I_{SC}	$-40^\circ C$ to $+125^\circ C$		± 2		mA mA
POWER SUPPLY						
Power Supply Rejection Ratio	PSRR	$V_S = 2.7V$ to 12V $-40^\circ \leq T_A \leq +125^\circ C$	76 76	96 95		dB dB
Supply Current/Amplifier	I_{SY}	$-40^\circ \leq T_A \leq +125^\circ C$		3.5		μA
DYNAMIC PERFORMANCE						
Slew Rate	SR	$R_L = 100 k\Omega$, $C_L = 50pF$		26		V/ms
Gain Bandwidth Product	GBP					kHz
Phase Margin	ϕ_o					degrees
NOISE PERFORMANCE						
Voltage Noise	$e_{n,p-p}$	0.1 to 10 Hz				μV_{p-p}
Voltage Noise Density	e_n	$f = 1$ kHz		110		nV/\sqrt{Hz}
Voltage Noise Density	e_n	$f = 10$ kHz				nV/\sqrt{Hz}
Current Noise Density	i_n					pA/\sqrt{Hz}

NOTE 1: +5 volt specifications are guaranteed by +3 and ± 5 volt testing.

Note 2: V_{OS} is tested under a no load condition.

ELECTRICAL SPECIFICATIONS (@ $V_S = \pm 5V$, $T_A = +25^\circ C$ unless otherwise noted.)

Parameter	Symbol	Conditions	Min	Typ	Max	Units
INPUT CHARACTERISTICS						
Offset Voltage	V_{OS}	$-40^\circ \leq T_A \leq +125^\circ C$			4	mV
Input Bias Current	I_B	$-40^\circ \leq T_A \leq +125^\circ C$		3.2		nA
Input Offset Current	I_{OS}	$-40^\circ \leq T_A \leq +125^\circ C$		0.1	8	nA
Input Voltage Range			-5		16	V
Common-Mode Rejection	CMRR	$V_{CM} = -5.0$ to $+4.0V$ $-40^\circ \leq T_A \leq +125^\circ C$	75		+4	dB
Large Signal Voltage Gain	A_{VO}	$R_L = 1 M\Omega$, $V_O = \pm 4.0V$, $-40^\circ \leq T_A \leq +125^\circ C$	67	6.5		dB
Offset Voltage Drift	$\Delta V_{OS}/\Delta T$					$\mu V/^\circ C$
Bias Current Drift	$\Delta I_B/\Delta T$					$pA/^\circ C$
Offset Current Drift	$\Delta I_{OS}/\Delta T$					$pA/^\circ C$
OUTPUT CHARACTERISTICS						
Output Voltage Swing	V_O	$R_L = 100k\Omega$ to Gnd. $-40^\circ C$ to $+125^\circ C$	± 4.93 ± 4.90	± 4.99 ± 4.98		V
Short Circuit Limit	I_{SC}	$-40^\circ C$ to $+125^\circ C$				mA
POWER SUPPLY						
Power Supply Rejection Ratio	PSRR	$V_S = \pm 25.V$ to $\pm 6V$ $-40^\circ \leq T_A \leq +125^\circ C$	76 70			dB
Supply Current/Amplifier	I_{SY}	$V_O = 0V$ $-40^\circ \leq T_A \leq +125^\circ C$		3.3	5	μA
DYNAMIC PERFORMANCE						
Slew Rate	$\pm SR$	$R_L = 100 k\Omega$, $C_L = 50pF$		35		V/ms
Saturation Recovery Time						ms
Gain Bandwidth Product	GBP			58		kHz
Phase Margin	ϕ_o			56		degrees
NOISE PERFORMANCE						
Voltage Noise	e_{n-p-p}	0.1 to 10 Hz				μV_{p-p}
Voltage Noise Density	e_n	$f = 1kHz$		110		nV/\sqrt{Hz}
Voltage Noise Density	e_n	$f = 10kHz$		80		nV/\sqrt{Hz}
Current Noise Density	i_n					pA/\sqrt{Hz}

ABSOLUTE MAXIMUM RATINGS

Supply Voltage..... +16V
 Input Voltage..... Gnd to Vs+10V
 Differential Input Voltage..... ±3.5V
 Output Short-Circuit Duration to Gnd¹..... Indefinite
 Storage Temperature Range
 RT Package..... -65°C to +150°C
 Operating Temperature Range
 OP186G..... -40°C to +125°C
 Junction Temperature Range
 RT Package..... -65°C to +150°C
 Lead Temperature Range (Soldering, 60 sec.)..... +300°C

Package Type	θ_{JA} ¹	θ_{JC}	Units
5-Lead SOT23 (RT)			°C/W

NOTES

¹ θ_{JA} is specified for the worst case conditions i.e., θ_{JA} is specified for device soldered in circuit board for SOT packages.

ORDERING GUIDE

Model	Temperature Range	Package Description	Package Option
OP186GRT	-40°C to +125°C	5-Lead SOT23	RT-5

