Micropower Single-Supply Rail-to-Rail Input/Output Op Amps

OP191/OP291/OP491

FEATURES

Single-Supply Operation: 2.7 V to 12 V
Wide Input Voltage Range
Rail-to-Rail Output Swing
Low Supply Current: 300 μA/Amp
Wide Bandwidth: 3 MHz
Slew Rate: 0.5 V/μs
Low Offset Voltage: 700 μV
No Phase Reversal

APPLICATIONS

Industrial Process Control
Battery-Powered Instrumentation
Power Supply Control and Protection
Telecommunications
Remote Sensors
Low Voltage Strain Gage Amplifiers
DAC Output Amplifiers

GENERAL DESCRIPTION

The OP191, OP291, and OP491 are single, dual, and quad micropower, single-supply, 3 MHz bandwidth amplifiers featuring rail-to-rail inputs and outputs. All are guaranteed to operate from a +3 V single supply as well as ±5 V dual supplies.

Fabricated on Analog Devices' CBCMOS process, the OP191 family has a unique input stage that allows the input voltage to safely extend 10 V beyond either supply without any phase inversion or latch-up. The output voltage swings to within millivolts of the supplies and continues to sink or source current all the way to the supplies.

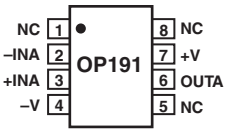
Applications for these amplifiers include portable telecommunications equipment, power supply control and protection, and interface for transducers with wide output ranges. Sensors requiring a rail-to-rail input amplifier include Hall effect, piezo electric, and resistive transducers.

The ability to swing rail-to-rail at both the input and output enables designers to build multistage filters in single-supply systems and to maintain high signal-to-noise ratios.

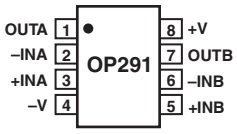
The OP191/OP291/OP491 are specified over the extended industrial –40°C to +125°C temperature range. The OP191 single and OP291 dual amplifiers are available in 8-lead plastic SOIC surface-mount packages. The OP491 quad is available in 14-lead PDIP, narrow 14-lead SOIC, and 14-lead TSSOP packages.

PIN CONFIGURATIONS

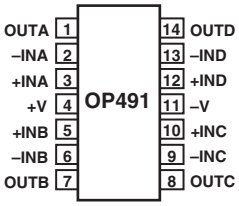
8-Lead Narrow-Body SOIC



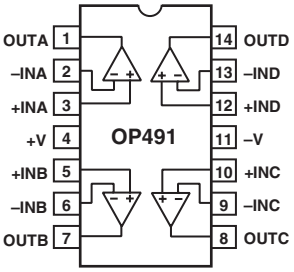
8-Lead Narrow-Body SOIC



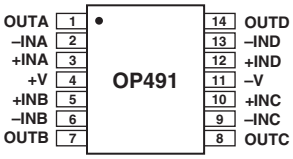
14-Lead Narrow-Body SOIC



14-Lead PDIP



14-Lead TSSOP



REV. C

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OP191/OP291/OP491–SPECIFICATIONS

ELECTRICAL SPECIFICATIONS (@ V_S = 3.0 V, V_{CM} = 0.1 V, V_O = 1.4 V, T_A = 25°C, unless otherwise noted.)

Parameter	Symbol	Conditions	Min	Typ	Max	Unit
INPUT CHARACTERISTICS						
Offset Voltage OP191G	V_{OS}			80	500	µV
		–40°C ≤ T_A ≤ +125°C			1	mV
OP291G/OP491G	V_{OS}			80	700	µV
		–40°C ≤ T_A ≤ +125°C			1.25	mV
Input Bias Current	I_B			30	65	nA
		–40°C ≤ T_A ≤ +125°C			95	nA
Input Offset Current	I_{OS}			0.1	11	nA
		–40°C ≤ T_A ≤ +125°C			22	nA
Input Voltage Range			0		3	V
Common-Mode Rejection Ratio	CMRR	V_{CM} = 0 V to 2.9 V	70	90		dB
		–40°C ≤ T_A ≤ +125°C	65	87		dB
Large Signal Voltage Gain	A_{VO}	R_L = 10 kΩ, V_O = 0.3 V to 2.7 V	25	70		V/mV
		–40°C ≤ T_A ≤ +125°C		50		V/mV
Offset Voltage Drift	$\Delta V_{OS}/\Delta T$			1.1		µV/°C
Bias Current Drift	$\Delta I_B/\Delta T$			100		pA/°C
Offset Current Drift	$\Delta I_{OS}/\Delta T$			20		pA/°C
OUTPUT CHARACTERISTICS						
Output Voltage High	V_{OH}	R_L = 100 kΩ to GND	2.95	2.99		V
		–40°C to +125°C	2.90	2.98		V
		R_L = 2 kΩ to GND	2.8	2.9		V
		–40°C to +125°C	2.70	2.80		V
Output Voltage Low	V_{OL}	R_L = 100 kΩ to V+		4.5	10	mV
		–40°C to +125°C			35	mV
		R_L = 2 kΩ to V+		40	75	mV
		–40°C to +125°C			130	mV
Short-Circuit Limit	I_{SC}	Sink/Source	±8.75	±13.50		mA
		–40°C to +125°C	±6.0	±10.5		mA
Open-Loop Impedance	Z_{OUT}	f = 1 MHz, A_V = 1		200		Ω
POWER SUPPLY						
Power Supply Rejection Ratio	PSRR	V_S = 2.7 V to 12 V	80	110		dB
		–40°C ≤ T_A ≤ +125°C	75	110		dB
Supply Current/Amplifier	I_{SY}	V_O = 0 V		200	350	µA
		–40°C ≤ T_A ≤ +125°C		330	480	µA
DYNAMIC PERFORMANCE						
Slew Rate	+SR	R_L = 10 kΩ		0.4		V/µs
Slew Rate	–SR	R_L = 10 kΩ		0.4		V/µs
Full-Power Bandwidth	BW_P	1% Distortion		1.2		kHz
Settling Time	t_S	To 0.01%		22		µs
Gain Bandwidth Product	GBP			3		MHz
Phase Margin	θ_O			45		Degrees
Channel Separation	CS	f = 1 kHz, R_L = 10 kΩ		145		dB
NOISE PERFORMANCE						
Voltage Noise	e_n p-p	0.1 Hz to 10 Hz		2		µV p-p
Voltage Noise Density	e_n	f = 1 kHz		35		nV/√Hz
Current Noise Density	i_n			0.8		pA/√Hz

Specifications subject to change without notice.

ELECTRICAL SPECIFICATIONS (@ V_S = 5.0 V, V_{CM} = 0.1 V, V_O = 1.4 V, T_A = 25°C, unless otherwise noted.)

Parameter	Symbol	Conditions	Min	Typ	Max	Unit
INPUT CHARACTERISTICS						
Offset Voltage OP191	V_{OS}			80	500	µV
		–40°C ≤ T_A ≤ +125°C			1.0	mV
OP291/OP491	V_{OS}			80	700	µV
		–40°C ≤ T_A ≤ +125°C			1.25	mV
Input Bias Current	I_B			30	65	nA
		–40°C ≤ T_A ≤ +125°C			95	nA
Input Offset Current	I_{OS}			0.1	11	nA
		–40°C ≤ T_A ≤ +125°C			22	nA
Input Voltage Range			0		5	V
Common-Mode Rejection Ratio	CMRR	V_{CM} = 0 V to 4.9 V	70	93		dB
		–40°C ≤ T_A ≤ +125°C	65	90		dB
Large Signal Voltage Gain	A_{VO}	R_L = 10 kΩ, V_O = 0.3 V to 4.7 V	25	70		V/mV
		–40°C ≤ T_A ≤ +125°C		50		V/mV
Offset Voltage Drift	$\Delta V_{OS}/\Delta T$	–40°C ≤ T_A ≤ +125°C		1.1		µV/°C
Bias Current Drift	$\Delta I_B/\Delta T$			100		pA/°C
Offset Current Drift	$\Delta I_{OS}/\Delta T$			20		pA/°C
OUTPUT CHARACTERISTICS						
Output Voltage High	V_{OH}	R_L = 100 kΩ to GND	4.95	4.99		V
		–40°C to +125°C	4.90	4.98		V
		R_L = 2 kΩ to GND	4.8	4.85		V
		–40°C to +125°C	4.65	4.75		V
Output Voltage Low	V_{OL}	R_L = 100 kΩ to V+		4.5	10	mV
		–40°C to +125°C			35	mV
		R_L = 2 kΩ to V+		40	75	mV
		–40°C to +125°C			155	mV
Short-Circuit Limit	I_{SC}	Sink/Source	±8.75	±13.5		mA
		–40°C to +125°C	±6.0	±10.5		mA
Open-Loop Impedance	Z_{OUT}	f = 1 MHz, A_V = 1		200		Ω
POWER SUPPLY						
Power Supply Rejection Ratio	PSRR	V_S = 2.7 V to 12 V	80	110		dB
		–40°C ≤ T_A ≤ +125°C	75	110		dB
Supply Current/Amplifier	I_{SY}	V_O = 0 V		220	400	µA
		–40°C ≤ T_A ≤ +125°C		350	500	µA
DYNAMIC PERFORMANCE						
Slew Rate	+SR	R_L = 10 kΩ		0.4		V/µs
Slew Rate	–SR	R_L = 10 kΩ		0.4		V/µs
Full-Power Bandwidth	BW_P	1% Distortion		1.2		kHz
Settling Time	t_S	To 0.01%		22		µs
Gain Bandwidth Product	GBP			3		MHz
Phase Margin	θ_O			45		Degrees
Channel Separation	CS	f = 1 kHz, R_L = 10 kΩ		145		dB
NOISE PERFORMANCE						
Voltage Noise	e_n p-p	0.1 Hz to 10 Hz		2		µV p-p
Voltage Noise Density	e_n	f = 1 kHz		35		nV/$\sqrt{\text{Hz}}$
Current Noise Density	i_n			0.8		pA/$\sqrt{\text{Hz}}$

NOTE
+5 V specifications are guaranteed by +3 V and ±5 V testing.

Specifications subject to change without notice.

ELECTRICAL SPECIFICATIONS (@ V_O = ±5.0 V, –4.9 V ≤ V_{CM} ≤ +4.9 V, T_A = 25°C, unless otherwise noted.)

Parameter	Symbol	Conditions	Min	Typ	Max	Unit
INPUT CHARACTERISTICS						
Offset Voltage OP191	V_{OS}			80	500	µV
		–40°C ≤ T_A ≤ +125°C			1	mV
OP291/OP491	V_{OS}			80	700	µV
		–40°C ≤ T_A ≤ +125°C			1.25	mV
Input Bias Current	I_B			30	65	nA
		–40°C ≤ T_A ≤ +125°C			95	nA
Input Offset Current	I_{OS}			0.1	11	nA
		–40°C ≤ T_A ≤ +125°C			22	nA
Input Voltage Range			–5		+5	V
Common-Mode Rejection	CMR	V_{CM} = ±5 V	75	100		dB
		–40°C ≤ T_A ≤ +125°C	67	97		dB
Large Signal Voltage Gain	A_{VO}	R_L = 10 kΩ, V_O = ±4.7 V,	25	70		
		–40°C ≤ T_A ≤ +125°C		50		V/mV
Offset Voltage Drift	$\Delta V_{OS}/\Delta T$			1.1		µV/°C
Bias Current Drift	$\Delta I_B/\Delta T$			100		pA/°C
Offset Current Drift	$\Delta I_{OS}/\Delta T$			20		pA/°C
OUTPUT CHARACTERISTICS						
Output Voltage Swing	V_O	R_L = 100 kΩ to GND	±4.93	±4.99		V
		–40°C to +125°C	±4.90	±4.98		V
		R_L = 2 kΩ to GND	±4.80	±4.95		V
		–40°C ≤ T_A ≤ +125°C	±4.65	±4.75		V
Short-Circuit Limit	I_{SC}	Sink/Source	±8.75	±16.00		mA
		–40°C to +125°C	±6	±13		mA
Open-Loop Impedance	Z_{OUT}	f = 1 MHz, A_V = 1		200		Ω
POWER SUPPLY						
Power Supply Rejection Ratio	PSRR	V_S = ±5 V	80	110		dB
		–40°C ≤ T_A ≤ +125°C	70	100		dB
Supply Current/Amplifier	I_{SY}	V_O = 0 V		260	420	µA
		–40°C ≤ T_A ≤ +125°C		390	550	µA
DYNAMIC PERFORMANCE						
Slew Rate	±SR	R_L =10 kΩ		0.5		V/µs
Full-Power Bandwidth	BW_P	1% Distortion		1.2		kHz
Settling Time	t_S	To 0.01%		22		µs
Gain Bandwidth Product	GBP			3		MHz
Phase Margin	θ_O			45		Degrees
Channel Separation	CS	f = 1 kHz		145		dB
NOISE PERFORMANCE						
Voltage Noise	e_n p-p	0.1 Hz to 10 Hz		2		µV p-p
Voltage Noise Density	e_n	f = 1 kHz		35		nV/√Hz
Current Noise Density	i_n			0.8		pA/√Hz

Specifications subject to change without notice.

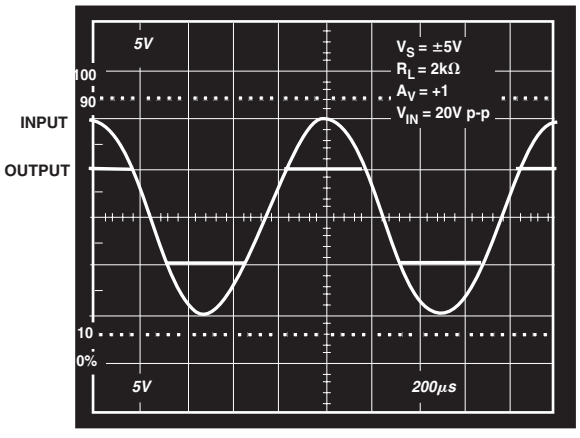

Figure 1. Input and Output with Inputs Overdriven by 5 V

ABSOLUTE MAXIMUM RATINGS[1, 2]

Supply Voltage . . . . . 16 V
Input Voltage . . . . . GND to V_S 10 V
Differential Input Voltage . . . . . 7 V
Output Short-Circuit Duration to GND . . . . . Indefinite
Storage Temperature Range
N, R, RU Packages . . . . . –65°C to +150°C
Operating Temperature Range
OP191G/OP291G/OP491G . . . . . –40°C to +125°C
Junction Temperature Range
N, R, RU Packages . . . . . –65°C to +150°C
Lead Temperature Range (Soldering, 60 sec) . . . . . 300°C

Package Type	θ_{JA}[3]	θ_{JC}	Unit
8-Lead SOIC (R)	158	43	°C/W
14-Lead PDIP (N)	76	33	°C/W
14-Lead SOIC (R)	120	36	°C/W
14-Lead TSSOP (RU)	180	35	°C/W

NOTES

[1]Stresses above those listed under Absolute Maximum Ratings may cause permanent damage to the device. This is a stress rating only and functional operation of the device at these or any other conditions above those indicated in the operational section of this specification is not implied. Exposure to absolute maximum rating conditions for extended periods may affect device reliability.

[2]Absolute maximum ratings apply to both DICE and packaged parts, unless otherwise noted.

[3]θ_{JA} is specified for the worst-case conditions; i.e., θ_{JA} is specified for device in socket for PDIP packages; θ_{JA} is specified for device soldered in circuit board for TSSOP and SOIC packages.

ORDERING GUIDE

Model	Temperature Range	Package Description	Package Option
OP191GS	–40°C to +125°C	8-Lead SOIC	R-8 [S-Suffix]
OP191GS-REEL	–40°C to +125°C	8-Lead SOIC	R-8 [S-Suffix]
OP191GS-REEL7	–40°C to +125°C	8-Lead SOIC	R-8 [S-Suffix]
OP291GS	–40°C to +125°C	8-Lead SOIC	R-8 [S-Suffix]
OP291GS-REEL	–40°C to +125°C	8-Lead SOIC	R-8 [S-Suffix]
OP291GS-REEL7	–40°C to +125°C	8-Lead SOIC	R-8 [S-Suffix]
OP291GSZ*	–40°C to +125°C	8-Lead SOIC	R-8 [S-Suffix]
OP291GSZ-REEL*	–40°C to +125°C	8-Lead SOIC	R-8 [S-Suffix]
OP291GSZ-REEL7*	–40°C to +125°C	8-Lead SOIC	R-8 [S-Suffix]
OP491GP	–40°C to +125°C	14-Lead PDIP	N-14 [P-Suffix]
OP491GS	–40°C to +125°C	14-Lead SOIC	R-14 [S-Suffix]
OP491GS-REEL	–40°C to +125°C	14-Lead SOIC	R-14 [S-Suffix]
OP491GS-REEL7	–40°C to +125°C	14-Lead SOIC	R-14 [S-Suffix]
OP491GSZ*	–40°C to +125°C	14-Lead SOIC	R-14 [S-Suffix]
OP491GSZ-REEL*	–40°C to +125°C	14-Lead SOIC	R-14 [S-Suffix]
OP491GSZ-REEL7*	–40°C to +125°C	14-Lead SOIC	R-14 [S-Suffix]
OP491GRU-REEL	–40°C to +125°C	14-Lead TSSOP	RU-14
OP491GBC			DIE form

*Z = Pb-free part.

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 OP191/OP291/OP491 features 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.