National Semiconductor

PRELIMINARY
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LPV531
Programmable CMOS Input, Rail-to-Rail Output Operational Amplifier

General Description

The LPV531 is an extremely versatile operational amplifier. A single external resistor gives the system designer the ability to program the quiescent current, gain bandwidth product and output short circuit current. This innovative feature gives the system designer a method to dynamically optimize the performance of the op amp to meet the system design requirements.

The LPV531 can be tailored to a wide variety of applications, it offers the system designer the ability to trade off supply current for bandwidth. The LPV531 is capable of operating from 73 kHz, consuming only 5 µA, to as fast as 4.6 MHz, consuming only 425 µA. The input offset voltage is relatively independent and therefore is not effected by the chosen power level.

Utilizing a CMOS input stage, the LPV531 achieves an input bias current of 50 fA and a common mode input voltage which extends from the negative rail to within 1.2V of the positive supply. The LPV531's rail-to-rail class AB output stage enables this op amp to offer maximum dynamic range at low supply voltage.

Available in the space saving 6-pin SOT23 package, the LPV531 is ideal for use in handheld electronics and portable applications. The LPV531 is manufactured using National's advanced VIP50 process.

A fixed supply current/gain bandwidth is available upon request.

Features

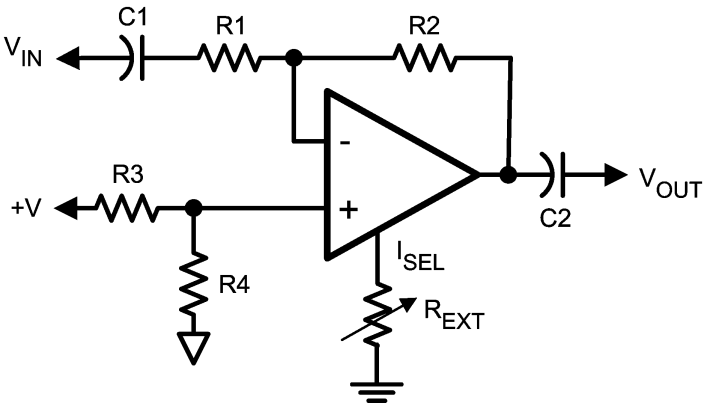
(Typical 5V supply, unless otherwise noted)

- Supply voltage 2.7V to 5.5V
- Supply current
  - — Low power mode 5 µA
  - — Mid power mode 42 µA
  - — Full power mode 425 µA
- Input common mode voltage range –0.3V to 3.8V
- CMRR 95 dB
- Output voltage swing Rail-to-rail
- Input offset voltage 1 mV
- Bandwidth
  - — Low power mode 73 kHz
  - — Mid power mode 625 kHz
  - — Full power mode 4.6 MHz

Applications

- AC coupled circuits
- Portable instrumentation
- Active filters

Typical Application



AC Coupled Application

Absolute Maximum Ratings (Note 1)

If Military/Aerospace specified devices are required, please contact the National Semiconductor Sales Office/ Distributors for availability and specifications.

ESD Tolerance (Note 2)	
Human Body Model	2000V
Machine Model	200V
V_{IN} Differential	±2V
Supply Voltage (V^+ - V^-)	6V
Storage Temperature Range	−65˚C to +150˚C
Junction Temperature (Note 5)	+150˚C
Soldering Information	
Infrared or Convection (20 sec)	235˚C
Wave Soldering Lead Temp. (10 sec)	260˚C

Operating Ratings (Note 1)

Operating Temperature Range	−40˚C to +85˚C
Supply Voltage ($V^+ - V^-$)	2.7V to 5.5V
Package Thermal Resistance (θ_{JA}) (Note 4)	
6-Pin SOT23	171˚C/W

5V Full Power Mode Electrical Characteristics

Unless otherwise specified, all limits are guaranteed for T_J = 25˚C, V^+ = 5V, V^- = 0V, $V_{CM} = V_O = V^+/2$, I_{SEL} pin connected to V^-, R_L = 100 kΩ. **Boldface** limits apply at the temperature extremes.

Symbol	Parameter	Conditions	Min (Note 6)	Typ (Note 5)	Max (Note 6)	Units
V_{OS}	Input Offset Voltage			±1	±4.5 **±5**	mV
ΔV_{OS}	Input Offset Voltage Difference	V_{OS} in Full Power Mode − V_{OS} in Low Power Mode		±0.1	±2	mV
TC V_{OS}	Input Offset Average Drift	(Note 8)		±2		µV/C
I_B	Input Bias Current			50		fA
CMRR	Common Mode Rejection Ratio	V_{CM} Stepped from 0V to 3.5V	72 **68**	95		dB
PSRR	Power Supply Rejection Ratio	V^+ = 2.7V to 5.5V V_{CM} = 1V	74 **70**	90		dB
CMVR	Input Common Mode Voltage Range	CMRR ≥ 50 dB	−0.3		3.8	V
A_{VOL}	Large Signal Voltage Gain	V_O = 0.5V to 4.5V R_L = 1 kΩ to $V^+/2$	87 **84**	96		dB
		V_O = 0.5V to 4.5V R_L = 10 kΩ to $V^+/2$	104 **100**	114		
		V_O = 0.5V to 4.5V R_L = 100 kΩ, to $V^+/2$	108 **104**	128		
V_O	Output Swing High	R_L = 1 kΩ to $V^+/2$	180 **195**	120		mV from V^+
		R_L = 10 kΩ to $V^+/2$	80 **85**	55		
		R_L = 100 kΩ to $V^+/2$	50 **60**	30		
	Output Swing Low	R_L = 1 kΩ to $V^+/2$		160	210 **230**	mV
		R_L = 10 kΩ to $V^+/2$		105	120 **135**	
		R_L = 100 kΩ to $V^+/2$		95	120 **135**	
I_{SC}	Output Short Circuit Current	Sourcing, V_O = 2.5V V_{ID} = 100 mV		−15	−8 **−3**	mA
		Sinking, V_O = 2.5V V_{ID} = −100 mV	13 **10**	24		
I_S	Supply Current			425	530 **650**	µA

5V Full Power Mode Electrical Characteristics (Continued)

Unless otherwise specified, all limits are guaranteed for T_J = 25˚C, V^+ = 5V, V^- = 0V, V_{CM} = V_O = $V^+/2$, I_{SEL} pin connected to V^-, R_L = 100 kΩ. **Boldface** limits apply at the temperature extremes.

Symbol	Parameter	Conditions	Min (Note 6)	Typ (Note 5)	Max (Note 6)	Units
SR	Slew Rate (Note 7)	A_V = +1, V_{IN} = 0.5V to 3.5V C_L = 15 pF	1.55 **1**	2.5		V/µs
GBW	Gain Bandwidth Product	C_L = 20 pF		4.6		MHz
e_n	Input-Referred Voltage Noise	f = 100 kHz		20		nV/ $\sqrt{Hz}$
		f = 1 kHz		25		
i_n	Input-Referred Current Noise	f = 1 kHz		0.006		pA/ $\sqrt{Hz}$

5V Mid Power Mode Electrical Characteristics

Unless otherwise specified, all limits are guaranteed for T_J = 25˚C, V^+ = 5V, V^- = 0V, V_{CM} = V_O = $V^+/2$, I_{SEL} pin connected to V^- through 100 kΩ resistor, R_L = 100 kΩ. **Boldface** limits apply at the temperature extremes.

Symbol	Parameter	Conditions	Min (Note 6)	Typ (Note 5)	Max (Note 6)	Units
V_{OS}	Input Offset Voltage			±1	±4.5 **±5**	mV
ΔV_{OS}	Input Offset Voltage Difference	V_{OS} in Full Power Mode – V_{OS} in Low Power Mode		±0.1	±2	mV
TC V_{OS}	Input Offset Average Drift	(Note 8)		±2		µV/C
I_B	Input Bias Current			50		fA
CMRR	Common Mode Rejection Ratio	V_{CM} Stepped from 0V to 3.5V	72 **68**	92		dB
PSRR	Power Supply Rejection Ratio	V^+ = 2.7V to 5.5V	72 **68**	88		dB
CMVR	Input Common Mode Voltage Range	CMRR ≥ 50 dB	–0.3		3.8	V
A_{VOL}	Large Signal Voltage Gain	V_O = 0.5V to 4.5V R_L = 10 kΩ	86 **82**	96		dB
		V_O = 0.5V to 4.5V R_L = 100 kΩ	100 **98**	114		
V_O	Output Swing High	R_L = 10 kΩ to $V^+/2$		115	160 **175**	mV from V^+
		R_L = 100 kΩ to $V^+/2$		65	110 **120**	
	Output Swing Low	R_L = 10 kΩ to $V^+/2$		150	165 **180**	mV
		R_L = 100 kΩ to $V^+/2$		105	120 **135**	
I_{SC}	Output Short Circuit Current	Sourcing, V_O = 2.5V V_{ID} = 100 mV		–4	–1.5 **–1**	mA
		Sinking, V_O = 2.5V V_{ID} = –100 mV	1.5 **1**	4		
I_S	Supply Current			42	55 **62**	µA
SR	Slew Rate (Note 7)	A_V = +1, V_{IN} = 0.5V to 3.5V	180 **100**	250		V/ms
GBW	Gain Bandwidth Product	C_L = 20 pF		625		kHz
e_n	Input-Referred Voltage Noise	f = 100 kHz		20		nV/ $\sqrt{Hz}$
		f = 1 kHz		25		

5V Mid Power Mode Electrical Characteristics (Continued)

Unless otherwise specified, all limits are guaranteed for T_J = 25˚C, V^+ = 5V, V^- = 0V, V_{CM} = V_O = V^+/2, I_{SEL} pin connected to V^- through 100 kΩ resistor, R_L = 100 kΩ. **Boldface** limits apply at the temperature extremes.

Symbol	Parameter	Conditions	Min (Note 6)	Typ (Note 5)	Max (Note 6)	Units
i_n	Input-Referred Current Noise	f = 1 kHz		0.006		pA/$\sqrt{Hz}$

5V Low Power Mode Electrical Characteristics

Unless otherwise specified, all limits are guaranteed for T_J = 25˚C, V^+ = 5V, V^- = 0V, V_{CM} = V_O = V^+/2, I_{SEL} connected to V^- through 1 MΩ resistor, R_L = 100 kΩ. **Boldface** limits apply at the temperature extremes.

Symbol	Parameter	Conditions	Min (Note 6)	Typ (Note 5)	Max (Note 6)	Units
V_{OS}	Input Offset Voltage			±1	±4.5 **±5**	mV
ΔV_{OS}	Input Offset Voltage Difference	V_{OS} in Full Power Mode – V_{OS} in Low Power Mode		±0.1	±2	mV
TC V_{OS}	Input Offset Average Drift	(Note 8)		±2		µV/C
I_B	Input Bias Current			50		fA
CMRR	Common Mode Rejection Ratio	V_{CM} Stepped from 0V to 3.5V	72 **68**	90		dB
PSRR	Power Supply Rejection Ratio	V^+ = 2.7V to 5.5V	72 **68**	85		dB
CMVR	Input Common-Mode Voltage Range	CMRR ≥ 50 dB	−0.3		3.8	V
A_{VOL}	Large Signal Voltage Gain	V_O = 0.5V to 4.5V R_L = 10 kΩ		90		dB
		V_O = 0.5V to 4.5V R_L = 100 kΩ	80 **78**	100		
V_O	Output Swing High	R_L = 10 kΩ		175	400 **1600**	mV from V^+
		R_L = 100 kΩ		115	200 **230**	
	Output Swing Low	R_L = 10 kΩ		250	1200 **1800**	mV
		R_L = 100 kΩ		150	165 **180**	
I_{SC}	Output Short Circuit Current	Sourcing, V_O = 2.5V V_{ID} = 100 mV		−400	−100 **−35**	µA
		Sinking, V_O = 2.5V V_{ID} = −100 mV	80 **35**	300		
I_S	Supply Current			5	7 **8**	µA
SR	Slew Rate (Note 7)	A_V = +1, V_{IN} = 0.5V to 3.5V	10 **8**	28		V/ms
GBW	Gain Bandwidth Product	C_L = 20 pF		73		kHz
e_n	Input-Referred Voltage Noise	f = 100 kHz		40		nV/$\sqrt{Hz}$
		f = 1 kHz		60		
i_n	Input-Referred Current Noise	f = 1 kHz		0.06		pA/$\sqrt{Hz}$

Power Select Electrical Characteristics

Unless otherwise specified, all limits are guaranteed for T_J = 25˚C, V^+ = 5V, V^- = 0V, $V_{CM} = V_O = V^+/2$, R_L = 100 kΩ. **Boldface** limits apply at the temperature extremes.

Symbol	Parameter	Conditions	Min (Note 6)	Typ (Note 5)	Max (Note 6)	Units
t_{LF}	Time from Low Power Mode to Full Power Mode			210		ns
t_{FL}	Time from Full Power Mode to Low Power Mode			500		ns
V_{REXT}	Voltage @ I_{SEL} Pin	I_{SEL} Pin Left Open	100	110	125	mV
R_{INT}			9	11	14.5	kΩ

Note 1: Absolute Maximum Ratings indicate limits beyond which damage to the device may occur. Operating Ratings indicate conditions for which the device is intended to be functional, but specific performance is not guaranteed. For guaranteed specifications and the test conditions, see the Electrical Characteristics Tables.

Note 2: Human Body Model is 1.5 kΩ in series with 100 pF. Machine Model is 0Ω in series with 200 pF.

Note 3: Continuous short circuit operation at elevated ambient temperature can result in exceeding the maximum allowed junction temperature of 150˚C.

Note 4: The maximum power dissipation is a function of $T_{J(MAX)}$, θ_{JA}, and T_A. The maximum allowable power dissipation at any ambient temperature is $P_D = (T_{J(MAX)} - T_A)/\theta_{JA}$. All numbers apply for packages soldered directly onto a PC board.

Note 5: Typical values represent the most likely parametric norm.

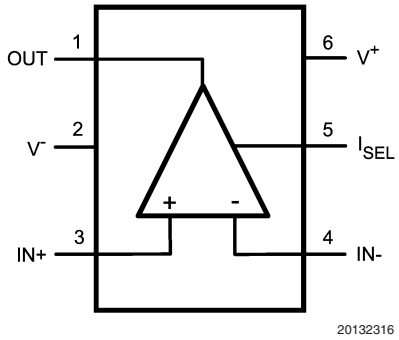
Note 6: All limits are guaranteed by testing or statistical analysis.

Note 7: Slew rate is the slower of the rising or falling slew rates.

Note 8: Offset voltage average drift is determined by dividing the change in V_{OS} at temperature extremes into the total temperature change.

Connection Diagram

6-Pin SOT23

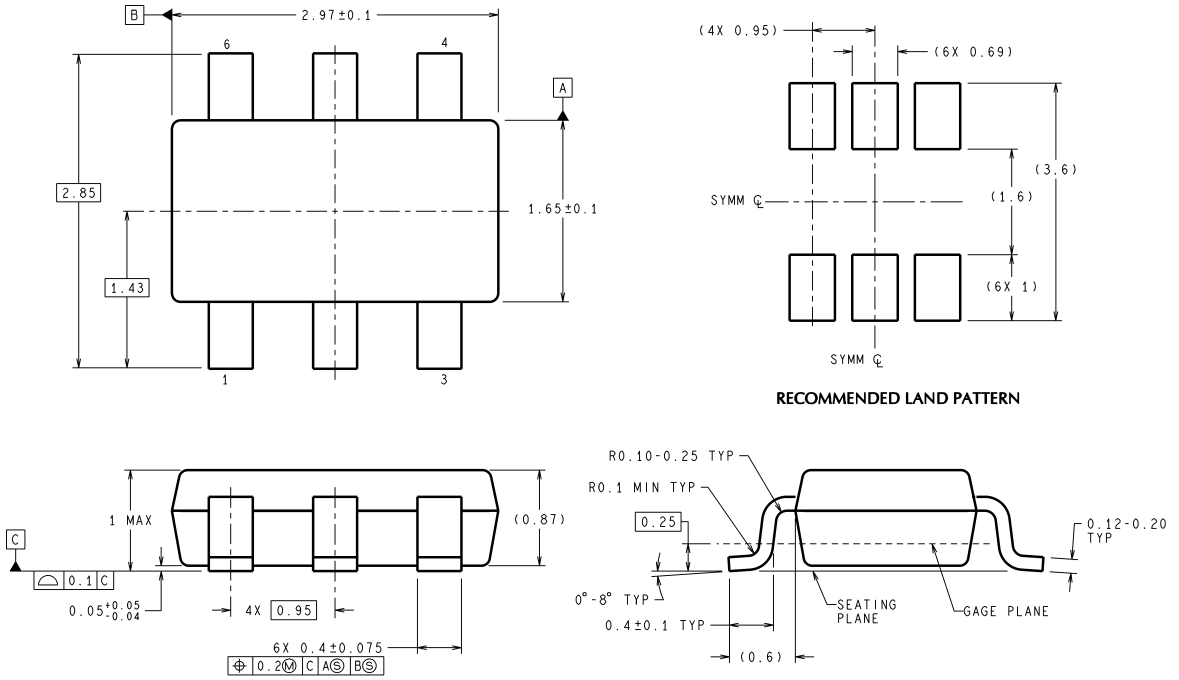


Top View

Ordering Information

Package	Part Number	Package Marking	Transport Media	NSC Drawing
6-Pin SOT23	LPV531MK	AV2A	1k Units Tape and Reel	MK06A
	LPV531MKX		3k Units Tape and Reel	

Physical Dimensions inches (millimeters) unless otherwise noted



6-Pin SOT23
NS Package Number MK06A

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