National Semiconductor

LM321
Low Power Single Op Amp

General Description

The LM321 brings performance and economy to low power systems. With a high unity gain frequency and a guaranteed 0.4V/µs slew rate, the quiescent current is only 430µA/amplifier (5V). The input common mode range includes ground and therefore the device is able to operate in single supply applications as well as in dual supply applications. It is also capable of comfortably driving large capacitive loads.

The LM321 is available in the SOT23-5 package. Overall the LM321 is a low power, wide supply range performance op amp that can be designed into a wide range of applications at an economical price without sacrificing valuable board space.

Features

(V_{CC} = 5V, T_A = 25˚C. Typical values unless specified).

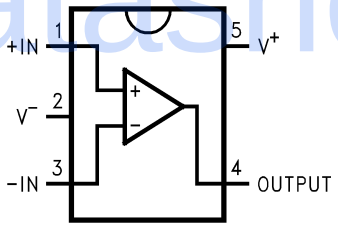
- Gain-Bandwidth product 1MHz
- Low supply current 430µA
- Low input bias current 45nA
- Wide supply voltage range +3V to +32V
- Stable with high capacitive loads
- Single version of LM324

Applications

- Chargers
- Power supplies
- Industrial: controls, instruments
- Desktops
- Communications infrastructure

Connection Diagram

SOT23-5



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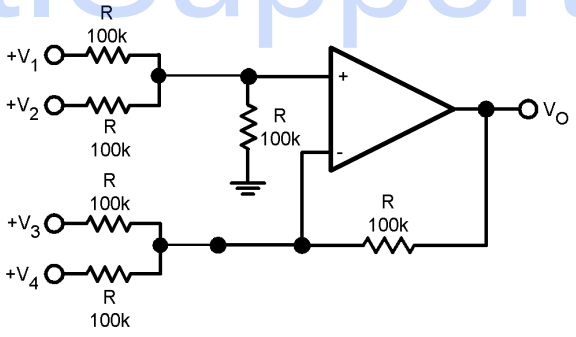
Top View

Application Circuit

DC Summing Amplifier
(V_{IN}'s ≥ 0 V_{DC} and V_O ≥ V_{DC})



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Where: $V_0 = V_1 + V_2 - V_3 - V_4$, $(V_1 + V_2) \geq (V_3 + V_4)$ to keep $V_O > 0\ V_{DC}$

Ordering Information

Package	Part Number	Package Marking	Transport Media	NSC Drawing
5-Pin SOT-23	LM321MF	A63A	1k Units Tape and Reel	MF05A
	LM321MFX		3k Units Tape and Reel	

Absolute Maximum Ratings (Note 1)

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

Differential Input Voltage	±Supply Voltage
Input Current (V_{IN} < −0.3V) (Note 6)	50mA
Supply Voltage (V^+ - V^-)	32V
Input Voltage	−0.3V to +32V
Output Short Circuit to GND, $V^+ \leq 15V$ and $T_A = 25^\circ C$ (Note 2)	Continuous
Storage Temperature Range	−65˚C to 150˚C
Junction Temperature (Note 3)	150˚C
Mounting Temperature	
Lead Temp (Soldering, 10 sec)	260˚C
Infrared (10 sec)	215˚C
Thermal Resistance to Ambient (θ_{JA})	265˚C/W
ESD Tolerance (Note 10)	300V

Operating Ratings (Note 1)

Temperature Range	−40˚C to 85˚C
Supply Voltage	3V to 30V

Electrical Characteristics

Unless otherwise specified, all limits guaranteed for at $T_A = 25^\circ C$; $V^+ = 5V$, $V^- = 0V$, $V_O = 1.4V$. **Boldface** limits apply at temperature extremes.

Symbol	Parameter		Conditions	Min (Note 5)	Typ (Note 4)	Max (Note 5)	Units
V_{OS}	Input Offset Voltage		(Note 7)		2	7 **9**	mV
I_{OS}	Input Offset Current				5	50 **150**	nA
I_B	Input Bias Current (Note 8)				45	250 **500**	nA
V_{CM}	Input Common-Mode Voltage Range		$V^+ = 30V$ (Note 9) For CMRR > = 50dB	0		V^+ - 1.5 **V^+ -2**	V
A_V	Large Signal Voltage Gain		($V^+ = 15V$, $R_L = 2k\Omega$ $V_O = 1.4V$ to 11.4V)	25 **15**	100		V/mV
PSRR	Power Supply Rejection Ratio		$R_S \leq 10k\Omega$, $V^+ \leq 5V$ to 30V	65	100		dB
CMRR	Common Mode Rejection Ratio		$R_S \leq 10k\Omega$	65	85		dB
V_O	Output Swing	V_{OH}	$V^+ = 30V$, $R_L = 2k\Omega$	**26**			V
			$V^+ = 30V$, $R_L = 10k\Omega$	**27**	**28**		
		V_{OL}	$V^+ = 5V$, $R_L = 10k\Omega$		**5**	**20**	mV
I_S	Supply Current, No Load		$V^+ = 5V$		0.430 **0.7**	1.15 **1.2**	mA
			$V^+ = 30V$		0.660 **1.5**	2.85 **3**	
I_{SOURCE}	Output Current Sourcing		$V_{ID} = +1V$, $V^+ = 15V$, $V_O = 2V$	20 **10**	40 **20**		mA
I_{SINK}	Output Current Sinking		$V_{ID} = -1V$ $V^+ = 15V$, $V_O = 2V$	10 **5**	20 **8**		mA
			$V_{ID} = -1V$ $V^+ = 15V$, $V_O = 0.2V$	12	100		µA
I_O	Output Short Circuit to Ground (Note 2)		$V^+ = 15V$		40	85	mA
SR	Slew Rate		$V^+ = 15V$, $R_L = 2k\Omega$, $V_{IN} = 0.5$ to 3V $C_L = 100pF$, Unity Gain		0.4		V/µs
GBW	Gain Bandwidth Product		$V^+ = 30V$, f = 100kHz, $V_{IN} = 10mV$, $R_L = 2k\Omega$, $C_L = 100pF$		1		MHz
ϕm	Phase Margin				60		deg

Electrical Characteristics

Unless otherwise specified, all limits guaranteed for at T_A = 25˚C; V^+ = 5V, V^- = 0V, V_O = 1.4V. **Boldface** limits apply at temperature extremes. (Continued)

Symbol	Parameter	Conditions	Min (Note 5)	Typ (Note 4)	Max (Note 5)	Units
THD	Total Harmonic Distortion	f = 1kHz, A_V = 20dB R_L = 2kΩ, V_O = $2V_{PP}$, C_L = 100pF, V^+ = 30V		0.015		%
e_n	Equivalent Input Noise Voltage	f = 1kHz, R_S = 100Ω V^+ = 30V		40		nV/ $\sqrt{Hz}$

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.

Note 2: Short circuits from the output V^+ can cause excessive heating and eventual destruction. When considering short circuits to ground the maximum output current is approximately 40mA independent of the magnitude of V^+. At values of supply voltage in excess of +15V, continuous short circuits can exceed the power dissipation ratings and cause eventual destruction.

Note 3: 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 4: Typical values represent the most likely parametric norm.

Note 5: All limits are guaranteed by testing or statistical analysis.

Note 6: This input current will only exist when the voltage at any of the input leads is driven negative. It is due to the collector base junction of the input PNP transistors becoming forward biased and thereby acting as input diode clamps. In addition to this diode action, there is also lateral NPN parasitic transistor action on the IC chip. This transistor action can cause the output voltages of the op amps to go to the V^+ voltage level (or to ground for a large overdrive) for the time duration that an input is driven negative. This is not destructive and normal output states will re-establish when the input voltage, which was negative, again returns to a value greater than −0.36V (at 25˚C).

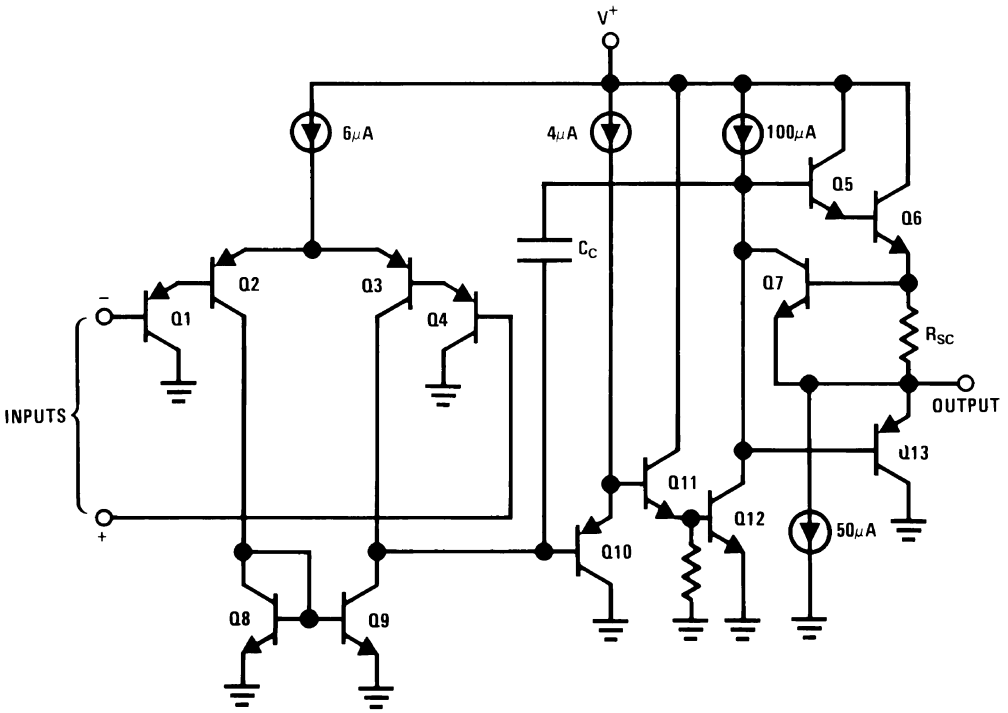
Note 7: $V_O \cong$ 1.4V, R_S = 0Ω with V^+ from 5V to 30V; and over the full input common-mode range (0V to V^+ - 1.5V) at 25˚C.

Note 8: The direction of the input current is out of the IC due to the PNP input stage. This current is essentially constant, independent of the state of the output so no loading change exists on the input lines.

Note 9: The input common-mode voltage of either input signal voltage should not be allowed to go negative by more than 0.3V (at 25˚C). The upper end of the common-mode voltage range is V^+ - 1.5V at 25˚C, but either or both inputs can go to +32V without damage, independent of the magnitude of V^+.

Note 10: Human Body Model, 1.5kΩ in series with 100pF.

Simplified Schematic



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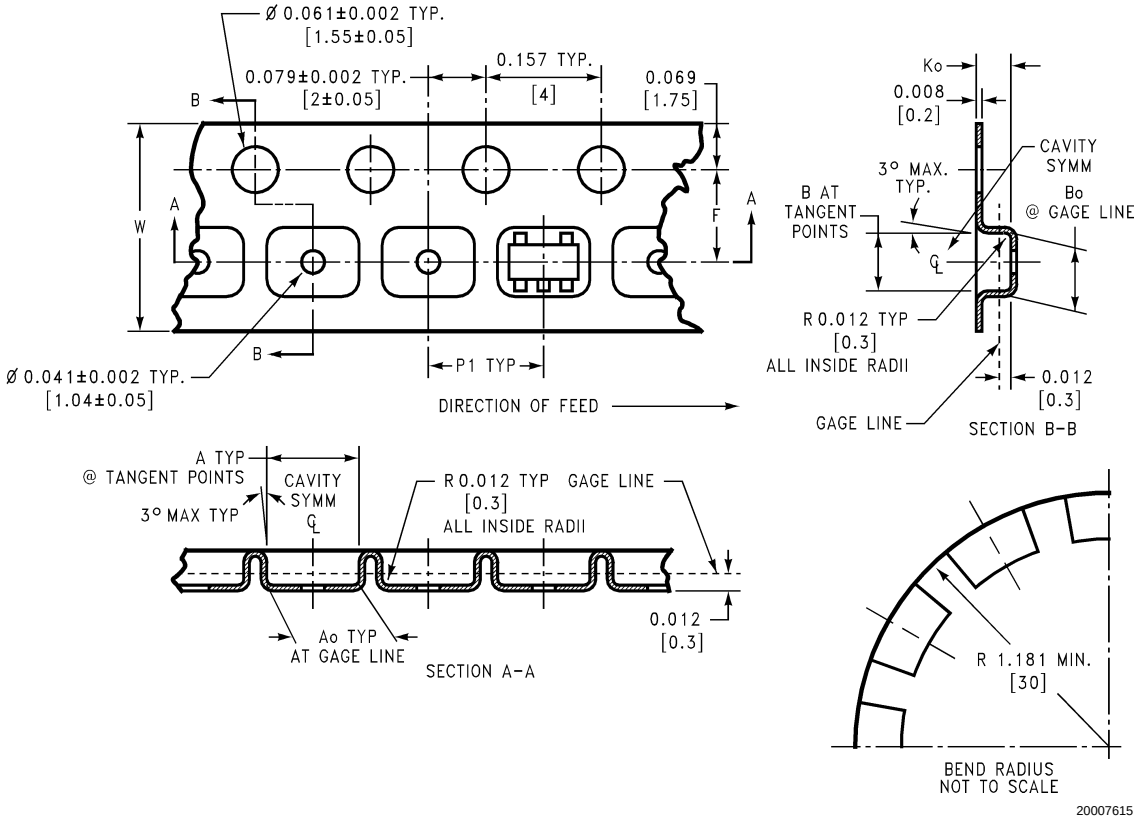
SOT23-5 Tape and Reel Specification

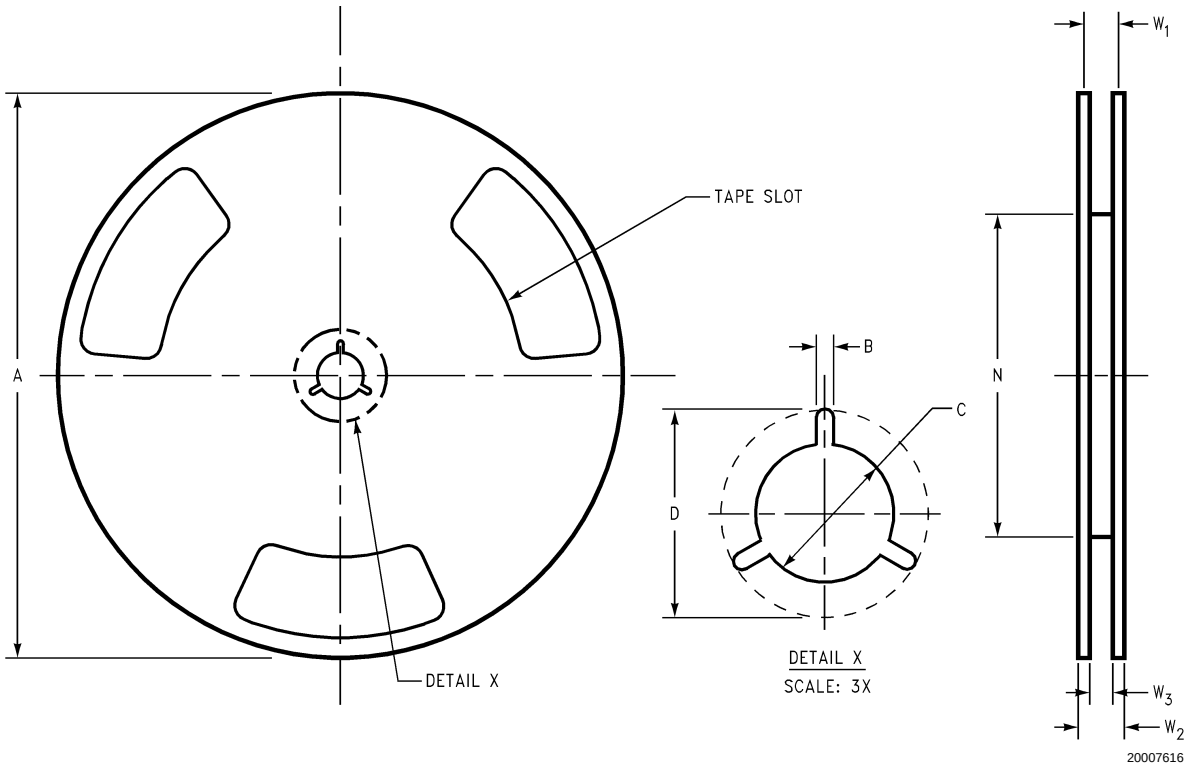
TAPE DIMENSIONS



8mm	0.130 (3.3)	0.124 (3.15)	0.130 (3.3)	0.126 (3.2)	0.138 ± 0.002 (3.5 ± 0.05)	0.055 ± 0.004 (1.4 ± 0.11)	0.157 (4)	0.315 ± 0.012 (8 ± 0.3)
Tape Size	DIM A	DIM Ao	DIM B	DIM Bo	DIM F	DIM Ko	DIM P1	DIM W

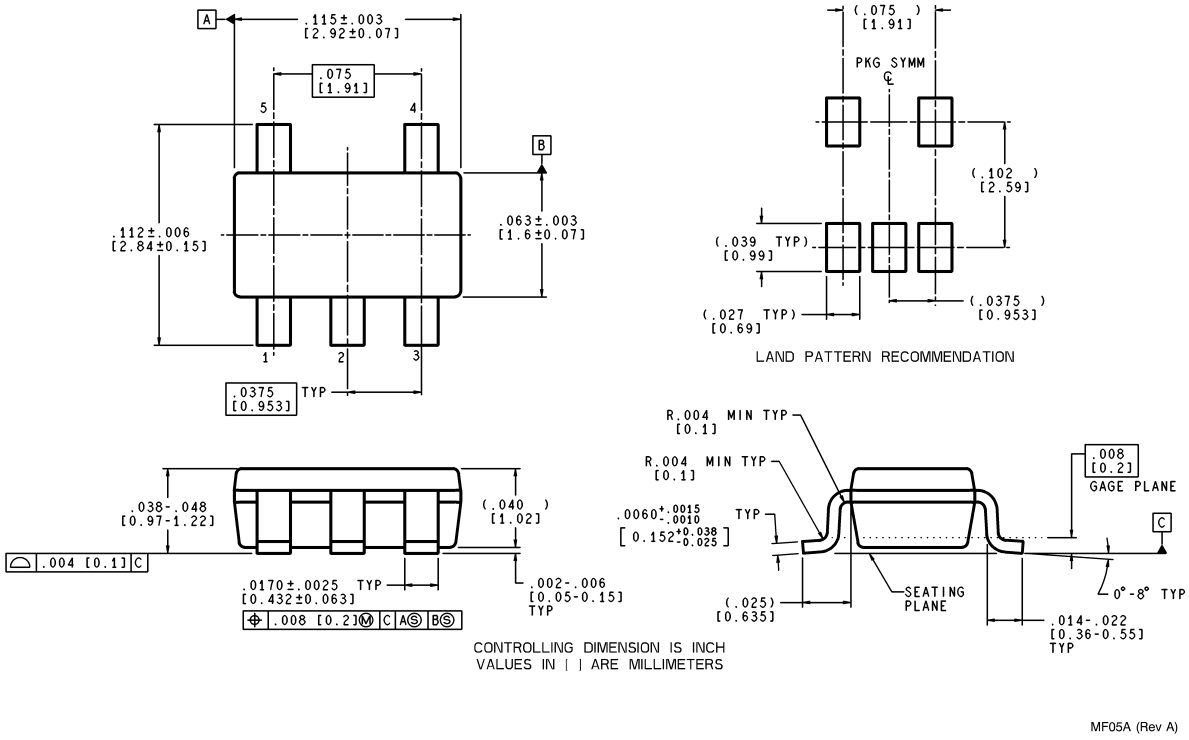
SOT23-5 Tape and Reel Specification (Continued)

REEL DIMENSIONS



8mm	7.00 330.00	0.059 1.50	0.512 13.00	0.795 20.20	2.165 55.00	0.331 + 0.059/−0.000 8.40 + 1.50/−0.00	0.567 14.40	W1 + 0.078/−0.039 W1 + 2.00/−1.00
Tape Size	A	B	C	D	N	W1	W2	W3

Physical Dimensions inches (millimeters) unless otherwise noted



5-Pin SOT23
NS Package Number MF05A

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