

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 $0.4\text{V}/\mu\text{s}$ slew rate, the quiescent current is only $430\mu\text{A}/\text{amplifier}$ (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

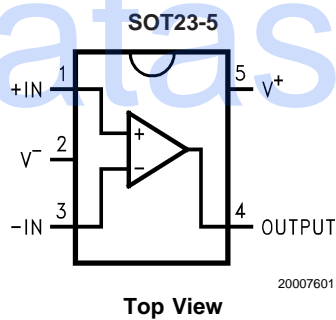
($V_{CC} = 5\text{V}$, $T_A = 25^\circ\text{C}$. Typical values unless specified).

- Gain-Bandwidth product 1MHz
- Low supply current $430\mu\text{A}$
- Low input bias current 45nA
- Wide supply voltage range +3V to +32V
- Stable with high capacitive loads
- Single version of LM324

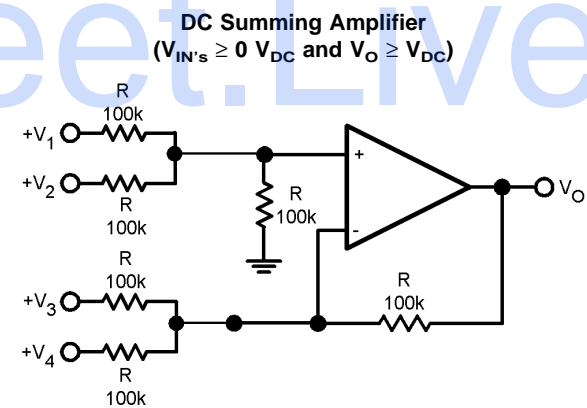
Applications

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

Connection Diagram



Application Circuit



Where: $V_O = V_1 + V_2 - V_3 - V_4$, $(V_1 + V_2) \geq (V_3 + V_4)$ 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)

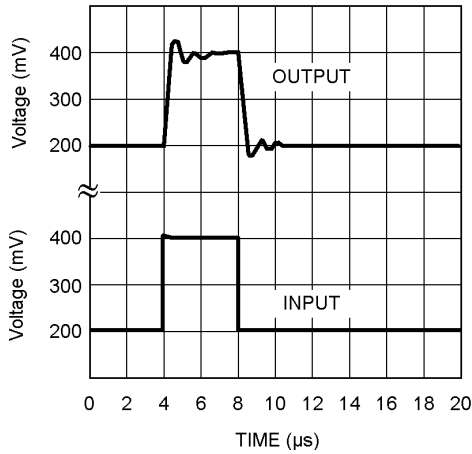
Temperature Range	-40°C to 85°C
Supply Voltage	3V to 30V

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 $CMRR \geq 50dB$	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
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
ϕ_m	Phase Margin			60		deg

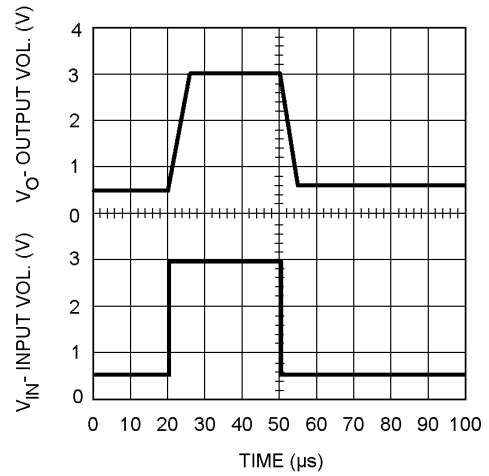
Typical Performance Characteristics Unless otherwise specified, $V_S = +5V$, single supply, $T_A = 25^\circ C$.

Small Signal Pulse Response



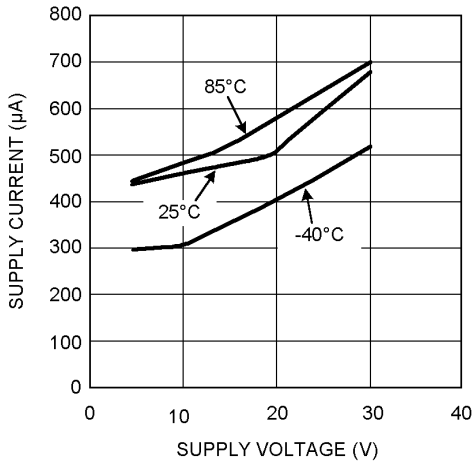
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Large Signal Pulse Response



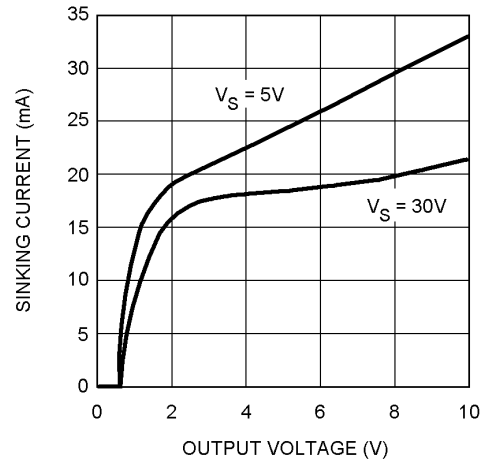
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Supply Current vs. Supply Voltage



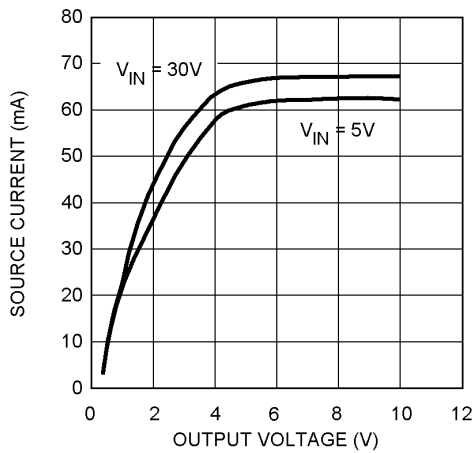
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Sinking Current vs. Output Voltage



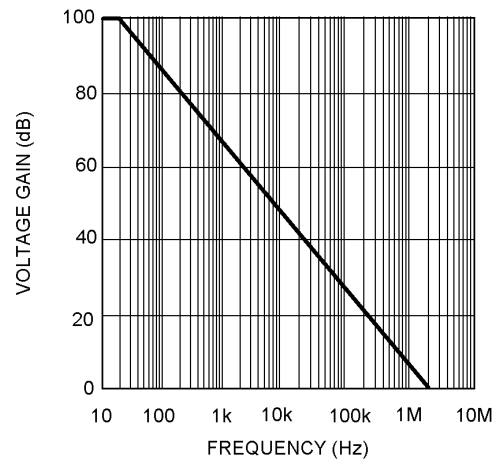
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Source Current vs. Output Voltage



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Open Loop Frequency Response



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Application Hints

The LM321 op amp can operate with a single or dual power supply voltage, has true-differential inputs, and remain in the linear mode with an input common-mode voltage of $0 V_{DC}$. This amplifier operates over a wide range of power supply voltages, with little change in performance characteristics. At 25°C amplifier operation is possible down to a minimum supply voltage of 3V.

Large differential input voltages can be easily accommodated and, as input differential voltage protection diodes are not needed, no large input currents result from large differential input voltages. The differential input voltage may be larger than V^+ without damaging the device. Protection should be provided to prevent the input voltages from going negative more than $-0.3 V_{DC}$ (at 25°C). An input clamp diode with a resistor to the IC input terminal can be used.

To reduce the power supply drain, the amplifier has a class A output stage for small signal levels which converts to class B in a large signal mode. This allows the amplifiers to both source and sink large output currents. Therefore both NPN and PNP external current boost transistors can be used to extend the power capability of the basic amplifiers. The output voltage needs to raise approximately 1 diode drop above ground to bias the on-chip vertical PNP transistor for output current sinking applications.

For AC applications, where the load is capacitively coupled to the output of the amplifier, a resistor should be used, from the output of the amplifier to ground to increase the class A bias current and to reduce distortion.

Capacitive loads which are applied directly to the output of the amplifier reduce the loop stability margin. Values of 50pF

can be accommodated using the worst-case non-inverting unity gain connection. Large closed loop gains or resistive isolation should be used if large load capacitance must be driven by the amplifier.

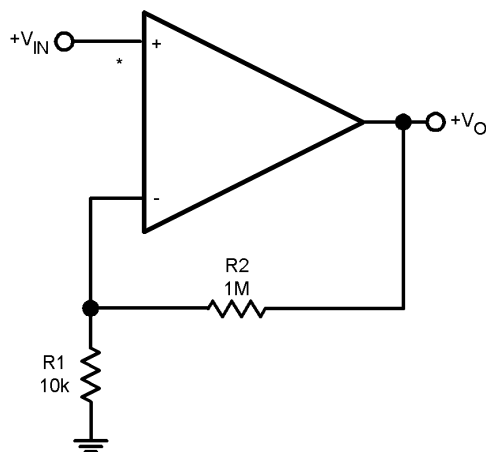
The bias network of the LM321 establishes a supply current which is independent of the magnitude of the power supply voltage over the range of from $3 V_{DC}$ to $30 V_{DC}$.

Output short circuits either to ground or to the positive power supply should be of short time duration. Units can be destroyed, not as a result of the short circuit current causing metal fusing, but rather due to the large increase in IC chip dissipation which will cause eventual failure due to excessive junction temperatures. The larger value of output source current which is available at 25°C provides a larger output current capability at elevated temperatures than a standard IC op amp.

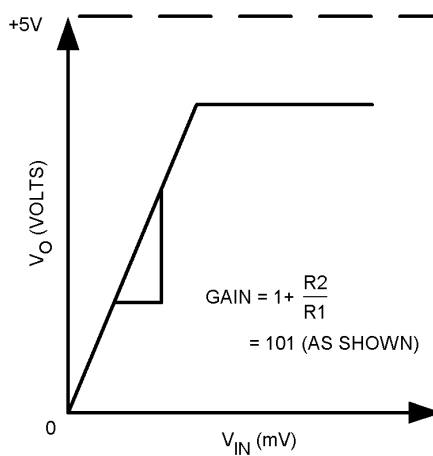
The circuits presented in the section on typical applications emphasize operation on only a single power supply voltage. If complementary power supplies are available, all of the standard op amp circuits can be used. In general, introducing a pseudo-ground (a bias voltage reference of $V^+/2$) will allow operation above and below this value in single power supply systems. Many application circuits are shown which take advantage of the wide input common-mode voltage range which includes ground. In most cases, input biasing is not required and input voltages which range to ground can easily be accommodated.

Typical Applications

Non-Inverting DC Gain (0V Input = 0V Output)



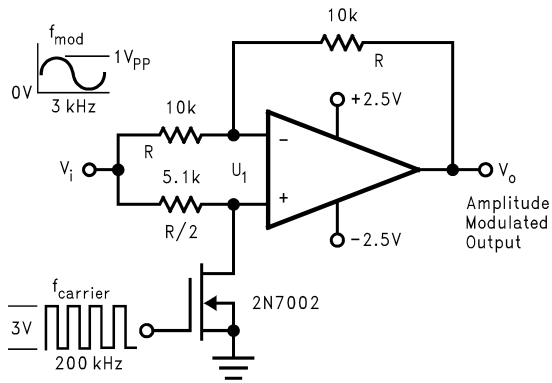
* R NOT NEEDED DUE TO TEMPERATURE INDEPENDENT I_{IN}



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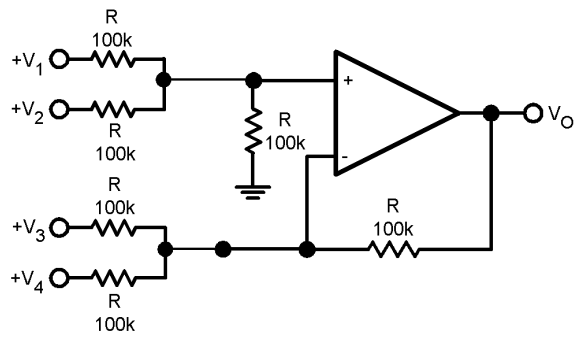
Typical Applications (Continued)

Amplitude Modulator Circuit



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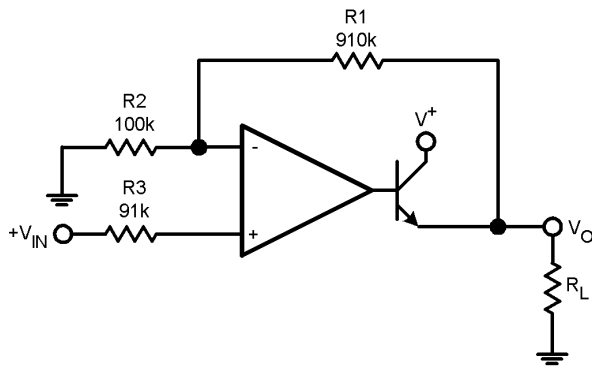
DC Summing Amplifier
($V_{IN}'s \geq 0 V_{DC}$ and $V_O \geq V_{DC}$)



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

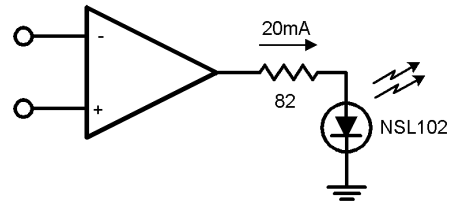
Power Amplifier



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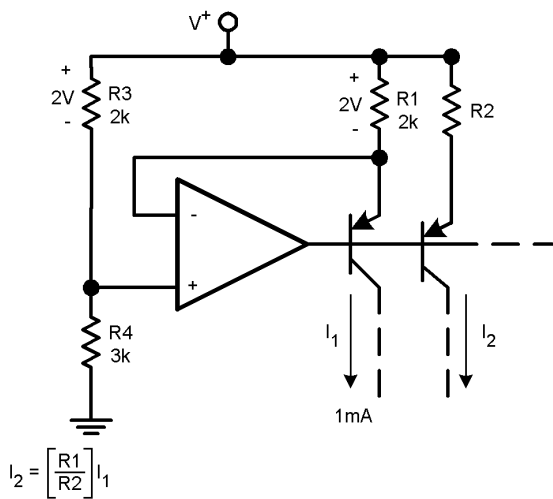
$V_O = 0 V_{DC}$ for $V_{IN} = 0 V_{DC}$. $A_v = 10$

LED Driver



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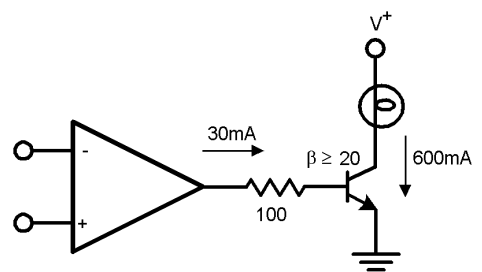
Fixed Current Sources



$$I_2 = \left[\frac{R_1}{R_2} \right] I_1$$

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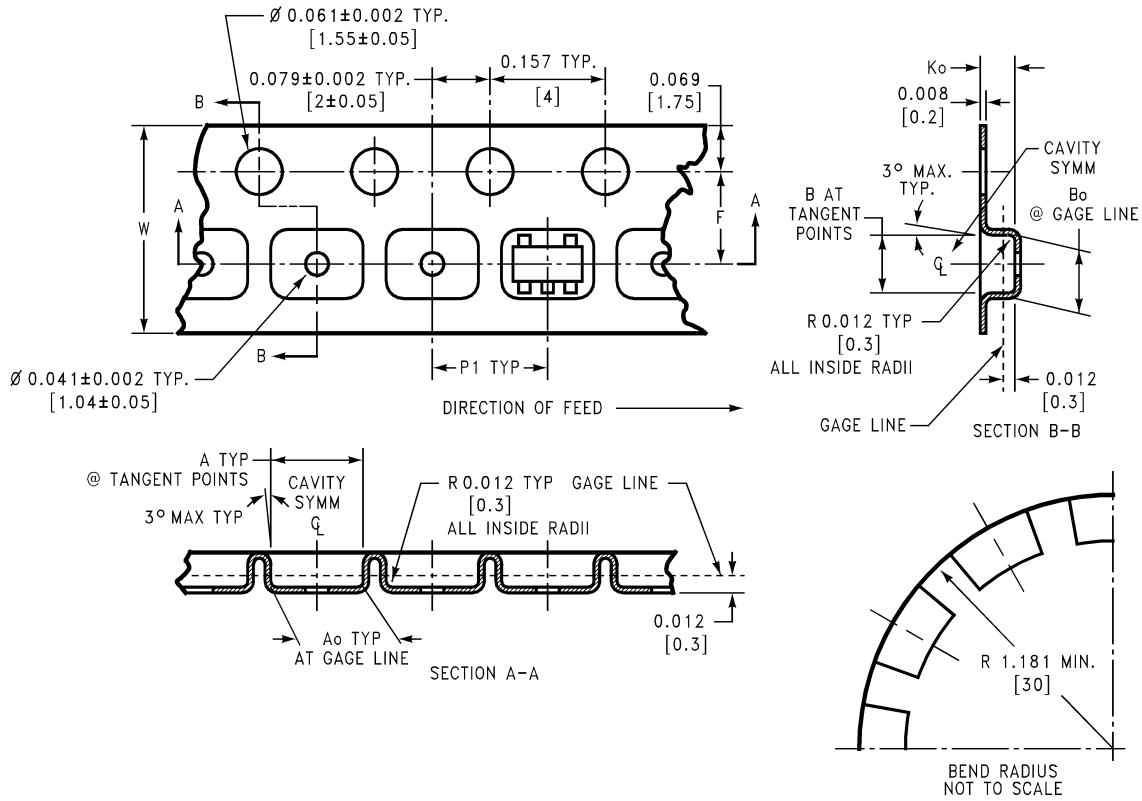
Lamp Driver



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SOT23-5 Tape and Reel Specification

TAPE DIMENSIONS

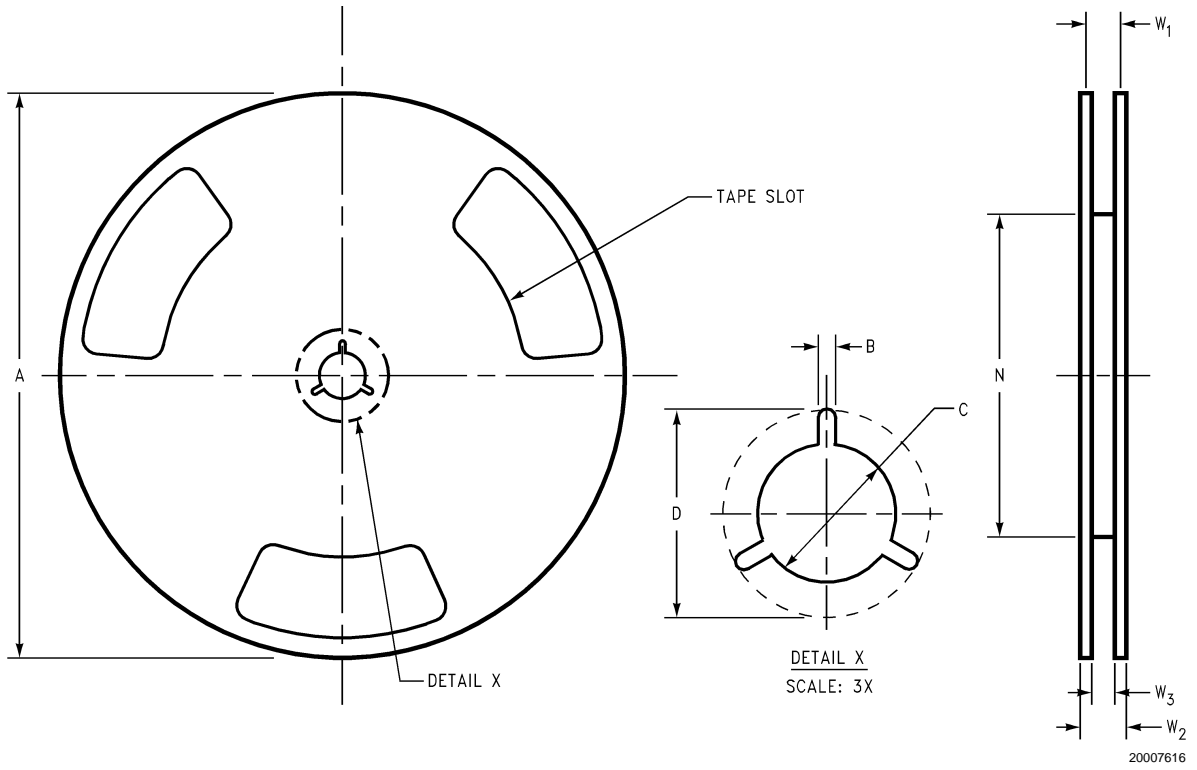


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8mm	0.130 (3.3)	0.124 (3.15)	0.130 (3.3)	0.126 (3.2)	0.138 ± 0.002 (3.5 ± 0.05)	0.055 ± 0.004 (1.4 ± 0.11)	0.157 (4)	0.315 ± 0.012 (8 ± 0.3)
Tape Size	DIM A	DIM A _o	DIM B	DIM B _o	DIM F	DIM K _o	DIM P1	DIM W

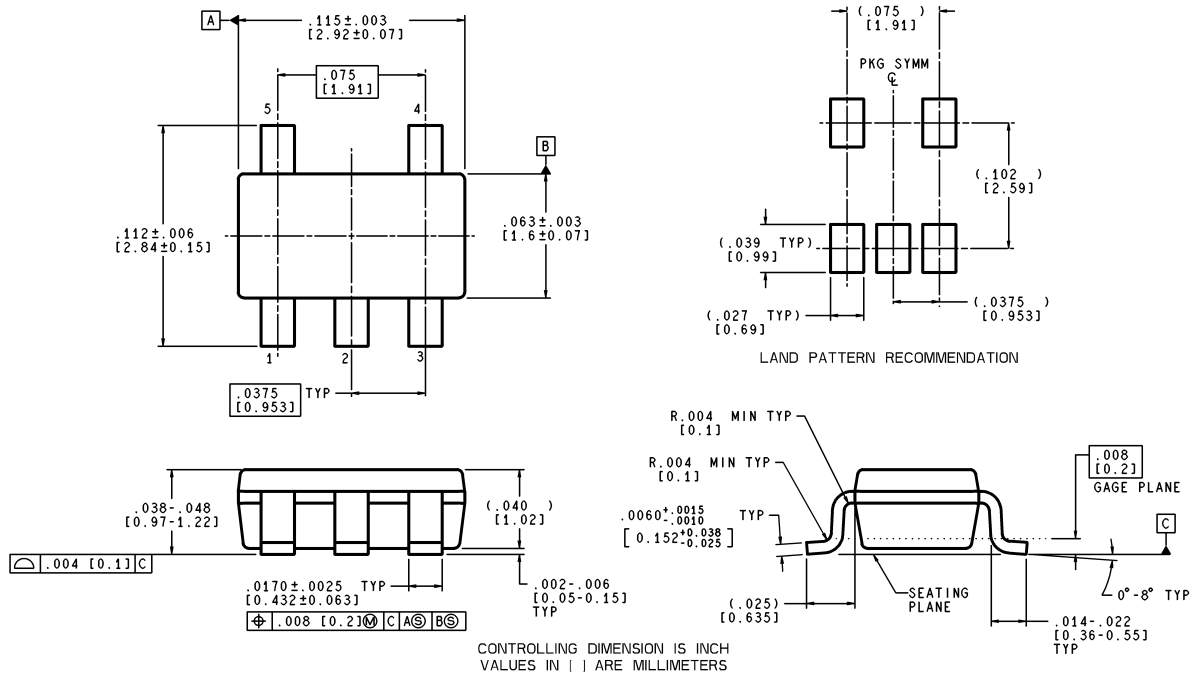
SOT23-5 Tape and Reel Specification (Continued)

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



MF05A (Rev A)

**5-Pin SOT23
NS Package Number MF05A**

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