



# 1:2 Differential LVPECL/LVECL/HSTL Clock and Data Drivers

MAX9320/MAX9320A

## General Description

The MAX9320/MAX9320A are low-skew, 1-to-2 differential drivers designed for clock and data distribution. The input is reproduced at two differential outputs. The differential input can be adapted to accept single-ended inputs by applying an external reference voltage.

The MAX9320/MAX9320A feature ultra-low propagation delay (208ps), part-to-part skew (20ps), and output-to-output skew (6ps) with 30mA maximum supply current, making these devices ideal for clock distribution. For interfacing to differential HSTL and LVPECL signals, these devices operate over a +2.25V to +3.8V supply range, allowing high-performance clock or data distribution in systems with a nominal +2.5V or +3.3V supply. For differential LVECL operation, these devices operate from a -2.25V to -3.8V supply.

The pinout is the only difference between the MAX9320 and MAX9320A. Multiple pinouts are provided to simplify routing across a backplane to either side of a double-sided board.

These devices are offered in space-saving 8-pin SOT23,  $\mu$ MAX, and SO packages.

## Applications

- Precision Clock Distribution
- Low-Jitter Data Repeater
- Protection Switching

## Features

- ◆ Improved Second Source of the MC10LVEP11 (MAX9320)
- ◆ +2.25V to +3.8V Differential HSTL/LVPECL Operation
- ◆ -2.25V to -3.8V LVECL Operation
- ◆ Low 22mA (typ) Supply Current
- ◆ 20ps (typ) Part-to-Part Skew
- ◆ 6ps (typ) Output-to-Output Skew
- ◆ 208ps (typ) Propagation Delay
- ◆ Minimum 300mV Output at 3GHz
- ◆ Outputs Low for Open Input
- ◆ ESD Protection >2kV (Human Body Model)
- ◆ Available in Thermally Enhanced Exposed-Pad SO Package

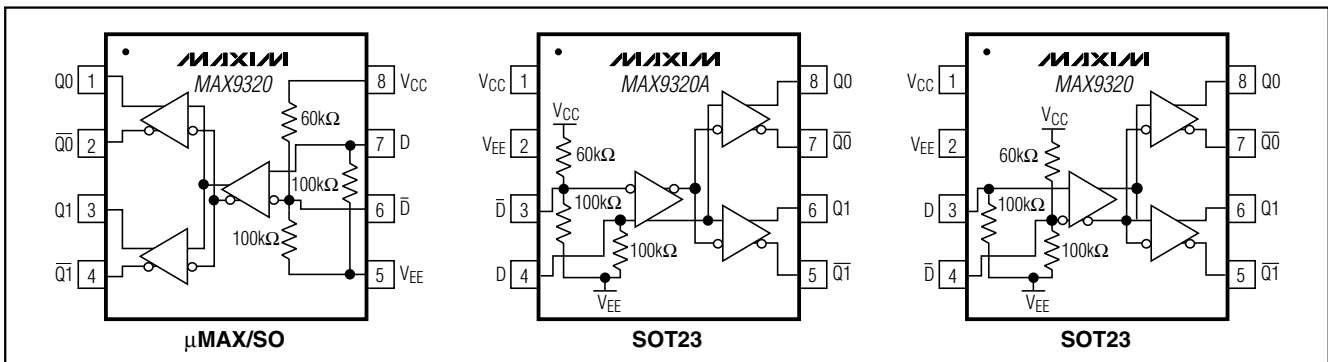
## Ordering Information

PART	TEMP RANGE	PIN-PACKAGE	TOP MARK
MAX9320EKA-T	-40°C to +85°C	8 SOT23-8	AALJ
MAX9320ESA	-40°C to +85°C	8 SO-EP**	—
MAX9320EUA*	-40°C to +85°C	8 $\mu$ MAX	—
MAX9320AEKA-T	-40°C to +85°C	8 SOT23-8	AAIW

\*Future product—Contact factory for availability.

\*\*EP = Exposed pad.

## Pin Configurations



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## ABSOLUTE MAXIMUM RATINGS

V <sub>CC</sub> to V <sub>EE</sub> .....	+4.1V	Junction-to-Case Thermal Resistance	
D or $\bar{D}$ .....	V <sub>EE</sub> - 0.3V to V <sub>CC</sub> + 0.3V	8-Pin SOT23 .....	+80°C/W
D to $\bar{D}$ .....	±3.0V	8-Pin $\mu$ MAX .....	+39°C/W
Continuous Output Current .....	50mA	8-Pin SO .....	+40°C/W
Surge Output Current .....	100mA	Operating Temperature Range .....	-40°C to +85°C
Junction-to-Ambient Thermal Resistance in Still Air		Junction Temperature .....	+150°C
8-Pin SOT23 .....	+112°C/W	Storage Temperature Range .....	-65°C to +150°C
8-Pin $\mu$ MAX .....	+221°C/W	ESD Protection	
8-Pin SO .....	+170°C/W	Human Body Model (D, $\bar{D}$ , Q <sub>-</sub> , $\bar{Q}$ <sub>-</sub> ) .....	>2kV
Junction-to-Ambient Thermal Resistance with 500 LFPM Airflow		Soldering Temperature (10s) .....	+300°C
8-Pin SOT23 .....	+78°C/W		
8-Pin $\mu$ MAX .....	+155°C/W		
8-Pin SO .....	+99°C/W		

Stresses beyond those listed under "Absolute Maximum Ratings" may cause permanent damage to the device. These are stress ratings only, and functional operation of the device at these or any other conditions beyond those indicated in the operational sections of the specifications is not implied. Exposure to absolute maximum rating conditions for extended periods may affect device reliability.

## DC ELECTRICAL CHARACTERISTICS

(V<sub>CC</sub> - V<sub>EE</sub> = +2.25V to +3.8V, outputs loaded with 50Ω ±1% to V<sub>CC</sub> - 2V. Typical values are at V<sub>CC</sub> - V<sub>EE</sub> = +3.3V, V<sub>IHD</sub> = V<sub>CC</sub> - 1.0V, V<sub>ILD</sub> = V<sub>CC</sub> - 1.5V, unless otherwise noted.) (Notes 1, 2, 3)

PARAMETER	SYMBOL	CONDITIONS	-40°C			+25°C			+85°C			UNITS
			MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX	
<b>DIFFERENTIAL INPUT (D, <math>\bar{D}</math>)</b>												
High Voltage of Differential Input	V <sub>IHD</sub>		V <sub>EE</sub> + 1.2	V <sub>CC</sub>		V <sub>EE</sub> + 1.2	V <sub>CC</sub>		V <sub>EE</sub> + 1.2	V <sub>CC</sub>		V
Low Voltage of Differential Input	V <sub>ILD</sub>		V <sub>EE</sub>	V <sub>CC</sub> - 0.1		V <sub>EE</sub>	V <sub>CC</sub> - 0.1		V <sub>EE</sub>	V <sub>CC</sub> - 0.1		V
Differential Input Voltage	V <sub>IHD</sub> - V <sub>ILD</sub>	For V <sub>CC</sub> - V <sub>EE</sub> < +3.0V	0.1	V <sub>CC</sub> - V <sub>EE</sub>		0.1	V <sub>CC</sub> - V <sub>EE</sub>		0.1	V <sub>CC</sub> - V <sub>EE</sub>		V
		For V <sub>CC</sub> - V <sub>EE</sub> ≥ +3.0V	0.1	3.0		0.1	3.0		0.1	3.0		
Input High Current	I <sub>IH</sub>			150			150			150		μA
D Input Low Current	I <sub>ILD</sub>		-10	100		-10	100		-10	100		μA
$\bar{D}$ Input Low Current	I <sub>ILD</sub>		-150	+150		-150	+150		-150	+150		μA
<b>DIFFERENTIAL OUTPUTS (Q<sub>-</sub>, <math>\bar{Q}</math><sub>-</sub>)</b>												
Single-Ended Output High Voltage	V <sub>OH</sub>	Figure 1	V <sub>CC</sub> - 1.135	V <sub>CC</sub> - 0.885		V <sub>CC</sub> - 1.07	V <sub>CC</sub> - 0.82		V <sub>CC</sub> - 1.01	V <sub>CC</sub> - 0.76		V

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## DC ELECTRICAL CHARACTERISTICS (continued)

( $V_{CC} - V_{EE} = +2.25V$  to  $+3.8V$ , outputs loaded with  $50\Omega \pm 1\%$  to  $V_{CC} - 2V$ . Typical values are at  $V_{CC} - V_{EE} = +3.3V$ ,  $V_{IHD} = V_{CC} - 1.0V$ ,  $V_{ILD} = V_{CC} - 1.5V$ , unless otherwise noted.) (Notes 1, 2, 3)

PARAMETER	SYMBOL	CONDITIONS	-40°C			+25°C			+85°C			UNITS	
			MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX		
Single-Ended Output Low Voltage	$V_{OL}$	Figure 1	$V_{CC} - 1.935$	$V_{CC} - 1.685$		$V_{CC} - 1.87$	$V_{CC} - 1.62$		$V_{CC} - 1.81$	$V_{CC} - 1.56$		V	
Differential Output Voltage	$V_{OH} - V_{OL}$	Figure 1	550			550			550			mV	
<b>POWER SUPPLY</b>													
Supply Current	$I_{EE}$	(Note 4)		20	28		22	28		23	30		mA

## AC ELECTRICAL CHARACTERISTICS

( $V_{CC} - V_{EE} = +2.25V$  to  $+3.8V$ , outputs loaded with  $50\Omega \pm 1\%$  to  $V_{CC} - 2V$ , input frequency = 1.5GHz, input transition time = 125ps (20% to 80%),  $V_{IHD} = V_{EE} + 1.2V$  to  $V_{CC}$ ,  $V_{ILD} = V_{EE}$  to  $V_{CC} - 0.15V$ ,  $V_{IHD} - V_{ILD} = 0.15V$  to the smaller of 3V or  $V_{CC} - V_{EE}$ . Typical values are at  $V_{CC} - V_{EE} = +3.3V$ ,  $V_{IHD} = V_{CC} - 1V$ ,  $V_{ILD} = V_{CC} - 1.5V$ , unless otherwise noted.) (Note 5)

PARAMETER	SYMBOL	CONDITIONS	-40°C			+25°C			+85°C			UNITS
			MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX	
Differential Input-to-Output Delay	$t_{PLHD}$ , $t_{PHLD}$	Figure 1	145	220	265	155	208	265	160	203	270	ps
Output-to-Output Skew	$t_{SKOO}$	(Note 6)		6	30		6	30		6	30	ps
Part-to-Part Skew	$t_{SKPP}$	(Note 7)		20	120		20	110		20	110	ps
Added Random Jitter (Note 8)	$t_{RJ}$	$f_{IN} = 1.5GHz$ , clock pattern		1.7	2.8		1.7	2.8		1.7	2.8	ps (RMS)
		$f_{IN} = 3.0GHz$ , clock pattern		0.6	1.5		0.6	1.5		0.6	1.5	
Added Deterministic Jitter	$t_{DJ}$	3.0Gbps $2^{23}-1$ PRBS pattern (Note 8)		57	80		57	80		57	80	ps (p-p)

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## AC ELECTRICAL CHARACTERISTICS (continued)

( $V_{CC} - V_{EE} = +2.25V$  to  $+3.8V$ , outputs loaded with  $50\Omega \pm 1\%$  to  $V_{CC} - 2V$ , input frequency =  $1.5GHz$ , input transition time =  $125ps$  (20% to 80%),  $V_{IHD} = V_{EE} + 1.2V$  to  $V_{CC}$ ,  $V_{ILD} = V_{EE}$  to  $V_{CC} - 0.15V$ ,  $V_{IHD} - V_{ILD} = 0.15V$  to the smaller of  $3V$  or  $V_{CC} - V_{EE}$ . Typical values are at  $V_{CC} - V_{EE} = +3.3V$ ,  $V_{IHD} = V_{CC} - 1V$ ,  $V_{ILD} = V_{CC} - 1.5V$ , unless otherwise noted.) (Note 5)

PARAMETER	SYMBOL	CONDITIONS	-40°C			+25°C			+85°C			UNITS
			MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX	
Switching Frequency	$f_{MAX}$	$V_{OH} - V_{OL} \geq 300mV$ , clock pattern, Figure 1	3.0			3.0			3.0			GHz
		$V_{OH} - V_{OL} \geq 550mV$ , clock pattern, Figure 1	2.0			2.0			2.0			
Output Rise/Fall Time (20% to 80%)	$t_R, t_F$	Figure 1	50	88	120	50	89	120	50	90	120	ps

**Note 1:** Measurements are made with the device in thermal equilibrium.

**Note 2:** Current into a pin is defined as positive. Current out of a pin is defined as negative.

**Note 3:** DC parameters production tested at  $T_A = +25^\circ C$ . Guaranteed by design and characterization over the full operating temperature range.

**Note 4:** All pins open except  $V_{CC}$  and  $V_{EE}$ .

**Note 5:** Guaranteed by design and characterization. Limits are set at  $\pm 6$  sigma.

**Note 6:** Measured between outputs of the same part at the signal crossing points for a same-edge transition.

**Note 7:** Measured between outputs of different parts at the signal crossing points under identical conditions for a same-edge transition.

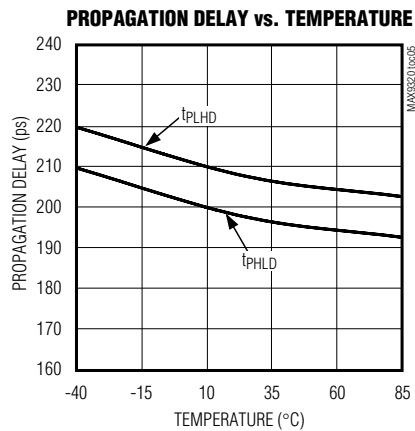
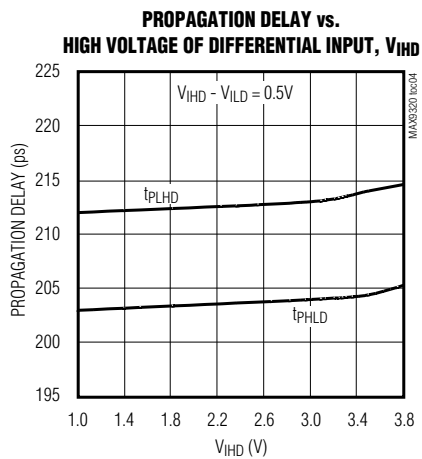
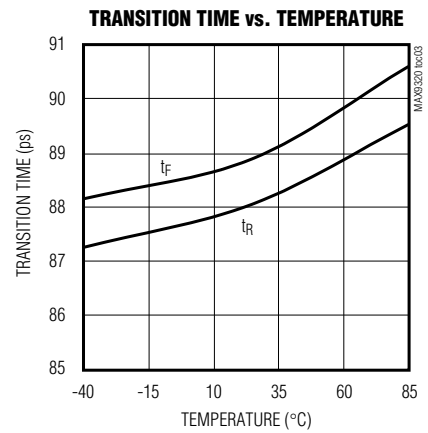
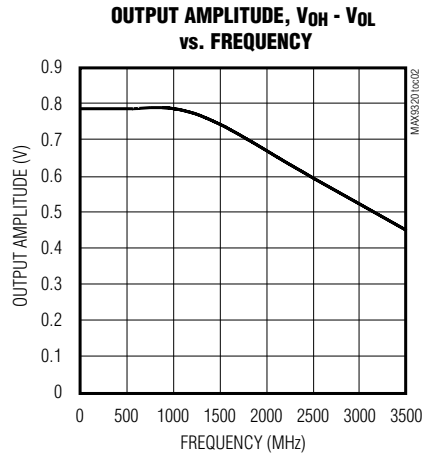
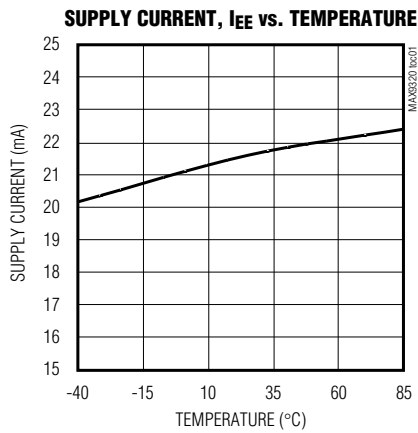
**Note 8:** Device jitter added to the input signal.

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## Typical Operating Characteristics

( $V_{CC} = +3.3V$ ,  $V_{EE} = 0$ , input transition time = 125ps (20% to 80%),  $V_{IHD} = V_{CC} - 1V$ ,  $V_{ILD} = V_{CC} - 1.5V$ ,  $f_{IN} = 1.5GHz$ , outputs loaded with  $50\Omega$  to  $V_{CC} - 2V$ ,  $T_A = +25^\circ C$ , unless otherwise noted.)

MAX9320/MAX9320A



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## Pin Description (MAX9320)

PIN		NAME	FUNCTION
$\mu$ MAX/SO	SOT23		
1	8	Q0	Noninverting Q0 Output. Typically terminate with 50 $\Omega$ resistor to $V_{CC} - 2V$ .
2	7	$\overline{Q0}$	Inverting Q0 Output. Typically terminate with 50 $\Omega$ resistor to $V_{CC} - 2V$ .
3	6	Q1	Noninverting Q1 Output. Typically terminate with 50 $\Omega$ resistor to $V_{CC} - 2V$ .
4	5	$\overline{Q1}$	Inverting Q1 Output. Typically terminate with 50 $\Omega$ resistor to $V_{CC} - 2V$ .
5	2	$V_{EE}$	Negative Supply Voltage
6	4	$\overline{D}$	Inverting Differential Input. 60k $\Omega$ pullup to $V_{CC}$ and 100k $\Omega$ pulldown to $V_{EE}$ .
7	3	D	Noninverting Differential Input. 100k $\Omega$ pulldown to $V_{EE}$ .
8	1	$V_{CC}$	Positive Supply Voltage. Bypass from $V_{CC}$ to $V_{EE}$ with 0.1 $\mu$ F and 0.01 $\mu$ F ceramic capacitors. Place the capacitors as close to the device as possible with the smaller value capacitor closest to the device.

## Pin Description (MAX9320A)

PIN		NAME	FUNCTION
SOT23			
1		$V_{CC}$	Positive Supply Voltage. Bypass from $V_{CC}$ to $V_{EE}$ with 0.1 $\mu$ F and 0.01 $\mu$ F ceramic capacitors. Place the capacitors as close to the device as possible with the smaller value capacitor closest to the device.
2		$V_{EE}$	Negative Supply Voltage
3		$\overline{D}$	Inverting Differential Input. 60k $\Omega$ pullup to $V_{CC}$ and 100k $\Omega$ pulldown to $V_{EE}$ .
4		D	Noninverting Differential Input. 100k $\Omega$ pulldown to $V_{EE}$ .
5		$\overline{Q1}$	Inverting Q1 Output. Typically terminate with 50 $\Omega$ resistor to $V_{CC} - 2V$ .
6		Q1	Noninverting Q1 Output. Typically terminate with 50 $\Omega$ resistor to $V_{CC} - 2V$ .
7		$\overline{Q0}$	Inverting Q0 Output. Typically terminate with 50 $\Omega$ resistor to $V_{CC} - 2V$ .
8		Q0	Noninverting Q0 Output. Typically terminate with 50 $\Omega$ resistor to $V_{CC} - 2V$ .

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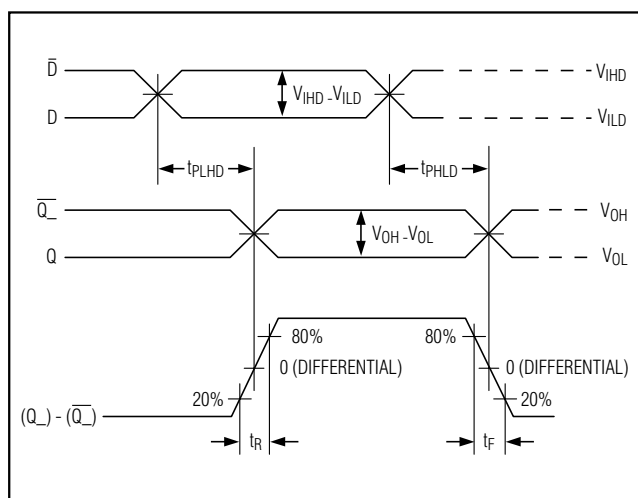


Figure 1. Differential Transition Time and Propagation Delay Timing Diagram

## Detailed Description

The MAX9320/MAX9320A low-skew, 1-to-2 differential drivers are designed for clock and data distribution. For interfacing to differential HSTL and LVPECL signals, these devices operate over a +2.25V to +3.8V supply range, allowing high-performance clock and data distribution in systems with a nominal +2.5V or +3.3V supply. For differential LVECL operation, these devices operate from a -2.25V to -3.8V supply.

### Inputs

The maximum magnitude of the differential input from  $\bar{D}$  to  $D$  is  $V_{CC} - V_{EE}$  or 3.0V, whichever is less. This limit also applies to the difference between any reference voltage input and a single-ended input.

The differential inputs have bias resistors that drive the outputs to a differential low when the inputs are open. The inverting input,  $\bar{D}$ , is biased with a 60k $\Omega$  pullup to  $V_{CC}$  and a 100k $\Omega$  pulldown to  $V_{EE}$ . The noninverting input,  $D$ , is biased with a 100k $\Omega$  pulldown to  $V_{EE}$ .

Specifications for the high and low voltages of the differential input ( $V_{IHD}$  and  $V_{ILD}$ ) and the differential input voltage ( $V_{IHD} - V_{ILD}$ ) apply simultaneously ( $V_{ILD}$  cannot be higher than  $V_{IHD}$ ).

### Outputs

Output levels are referenced to  $V_{CC}$  and are considered LVPECL or LVECL, depending on the level of the  $V_{CC}$  supply. With  $V_{CC}$  connected to a positive supply and  $V_{EE}$  connected to GND, the outputs are LVPECL. The outputs are LVECL when  $V_{CC}$  is connected to GND and  $V_{EE}$  is connected to a negative supply.

A single-ended input of  $\pm 100\text{mV}$  around a reference voltage or a differential input of at least  $\pm 100\text{mV}$  switches the outputs to the  $V_{OH}$  and  $V_{OL}$  levels specified in the *DC Electrical Characteristics* table.

## Applications Information

### Supply Bypassing

Bypass  $V_{CC}$  to  $V_{EE}$  with high-frequency surface-mount ceramic 0.1 $\mu\text{F}$  and 0.01 $\mu\text{F}$  capacitors in parallel as close to the device as possible, with the 0.01 $\mu\text{F}$  value capacitor closest to the device. Use multiple parallel vias for low inductance.

### Traces

Input and output trace characteristics affect the performance of the MAX9320/MAX9320A. Connect each signal of a differential input or output to a 50 $\Omega$  characteristic impedance trace. Minimize the number of vias to prevent impedance discontinuities. Reduce reflections by maintaining the 50 $\Omega$  characteristic impedance through connectors and across cables. Reduce skew within a differential pair by matching the electrical length of the traces.

The exposed-pad (EP) SO package can be soldered to the PC board for enhanced thermal performance. If the EP is not soldered to the PC board, the thermal resistance is the same as the regular SO package. The EP is connected to the chip  $V_{EE}$  supply. Be sure that the pad does not touch signal lines or other supplies.

Contact the Maxim Packaging department for guidelines on the use of EP packages.

### Output Termination

Terminate outputs through 50 $\Omega$  to  $V_{CC} - 2\text{V}$  or use an equivalent Thevenin termination. Terminate both outputs and use the same termination on each for the lowest output-to-output skew. When a single-ended signal is taken from a differential output, terminate both outputs. For example, if  $Q_0$  is used as a single-ended output, terminate both  $Q_0$  and  $\bar{Q}_0$ .

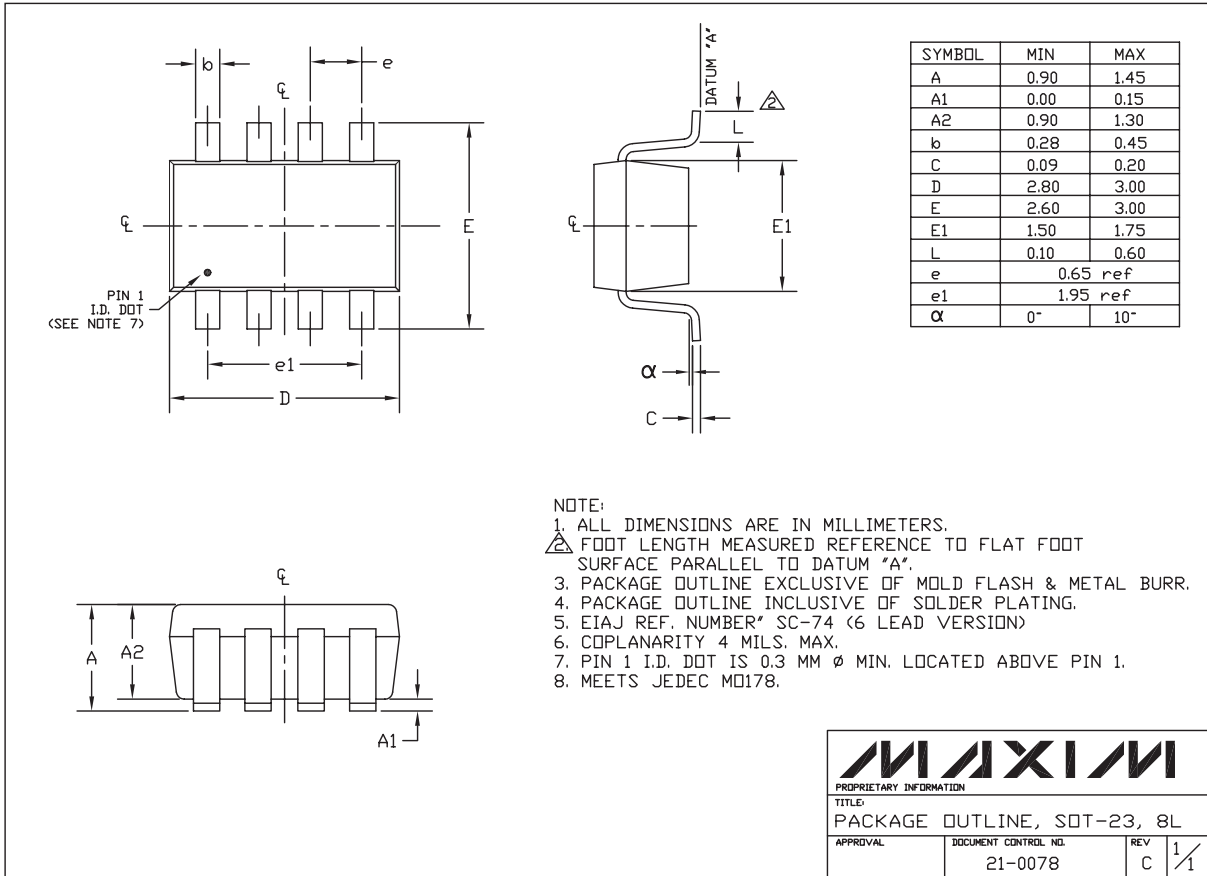
## Chip Information

TRANSISTOR COUNT: 182

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## Package Information

(The package drawing(s) in this data sheet may not reflect the most current specifications. For the latest package outline information, go to [www.maxim-ic.com/packages](http://www.maxim-ic.com/packages).)



SOT23, 8LEPS

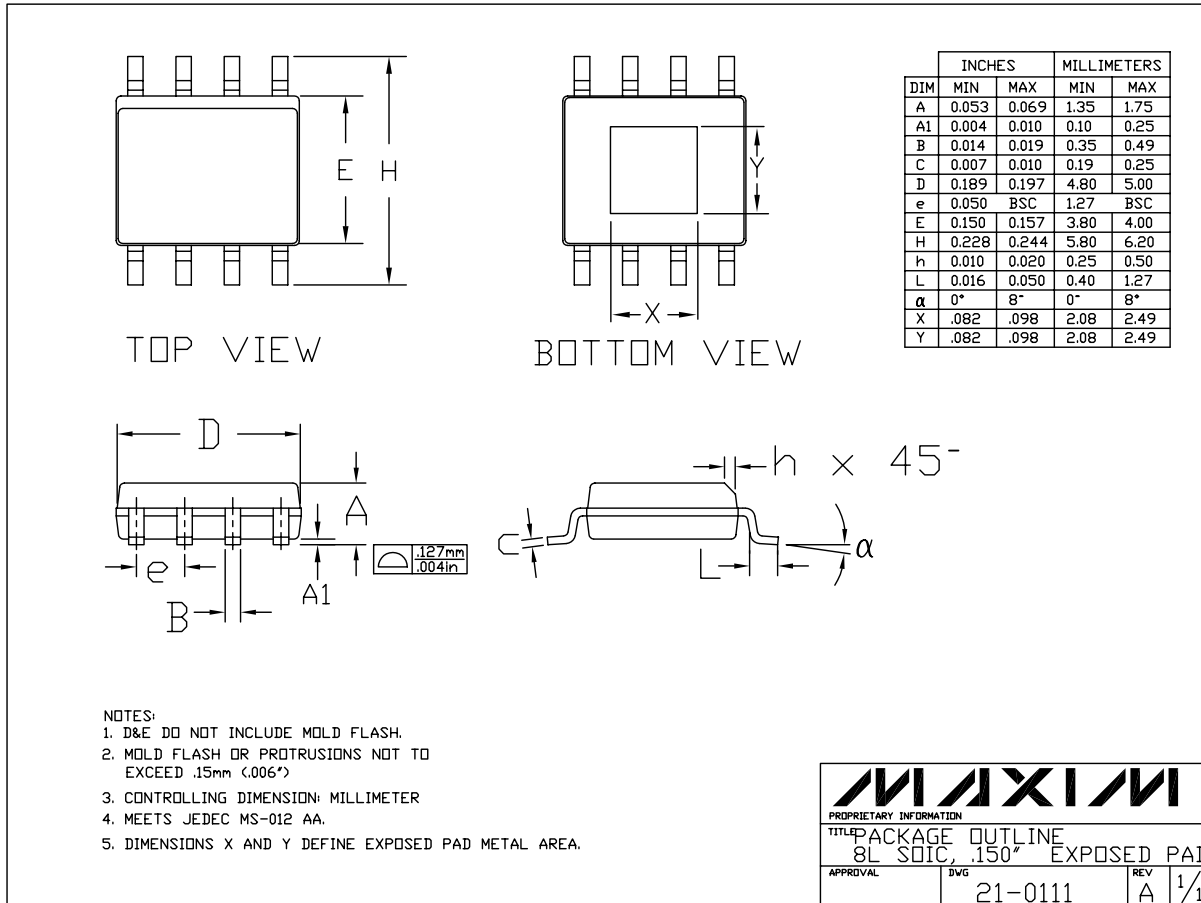
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## Package Information (continued)

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