19-2201; Rev 0; 8/01

MAXIM

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

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* and industry-standard TSSOP* and SO packages.

Applications

Precision Clock Distribution

Low-Jitter Data Repeater

Protection Switching

Features

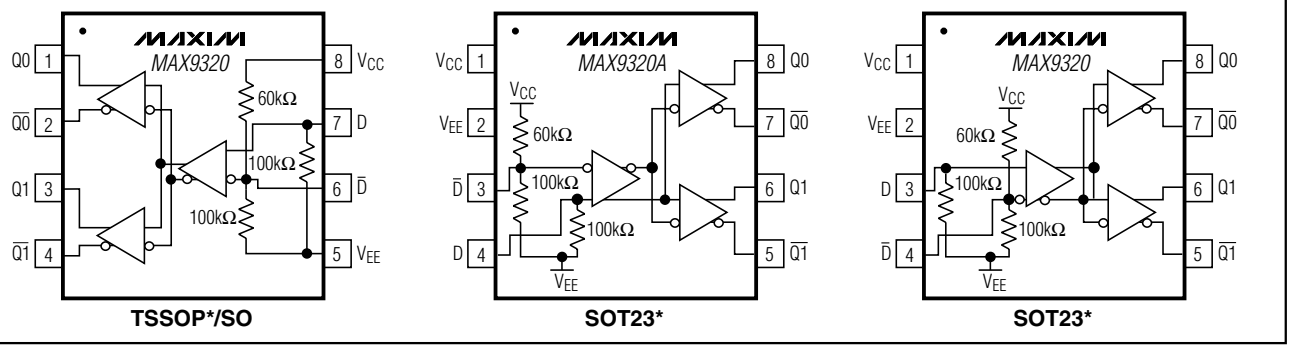
- **Improved Second Source of the MC10LVEP11 (MAX9320)**
- **+2.25V to +3.8V Differential HSTL/LVPECL Operation**
- **-2.25V to -3.8V LVECL Operation**
- **Low 22mA (typ) Supply Current**
- **20ps (typ) Part-to-Part Skew**
- **6ps (typ) Output-to-Output Skew**
- **208ps (typ) Propagation Delay**
- **Minimum 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	—
MAX9320ESA	-40°C to +85°C	8 SO-EP**	—
MAX9320EUA*	-40°C to +85°C	8 TSSOP	—
MAX9320AEKA*	-40°C to +85°C	8 SOT23	AAIW

**Future product—contact factory for availability.*
***EP-Exposed pad.*

Pin Configurations



TSSOP*/SO SOT23* SOT23*

For pricing delivery, and ordering information please contact Maxim/Dallas Direct! at 1-888-629-4642, or visit Maxim's website at www.maxim-ic.com.

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

ABSOLUTE MAXIMUM RATINGS

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

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_{CC} - V_{EE} = +2.25V to +3.8V, outputs loaded with 50Ω ±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	
DIFFERENTIAL INPUT (D, $\overline{D}$)												
High Voltage of Differential Input	V_{IHD}		V_{EE} + 1.2		V	V_{EE} + 1.2		V_{CC}	V_{EE} + 1.2		V_{CC}	V
Low Voltage of Differential Input	V_{ILD}		V_{EE}		V_{CC} - 0.1	V_{EE}		V_{CC} - 0.1	V_{EE}		V_{CC} - 0.1	V
Differential Input Voltage	V_{IHD} - V_{ILD}	For V_{CC} - V_{EE} < +3.0V	0.1		V_{CC} - V_{EE}	0.1		V_{CC} - V_{EE}	0.1		V_{CC} - V_{EE}	V
		For V_{CC} - V_{EE} ≥ +3.0V	0.1		3.0	0.1		3.0	0.1		3.0	
Input High Current	I_{IH}				150			150			150	µA
D Input Low Current	I_{ILD}		-10		100	-10		100	-10		100	µA
$\overline{D}$ Input Low Current	I_{ILD}		-150			-150			-150			µA
DIFFERENTIAL OUTPUTS (Q_, $\overline{Q}$_)												
Single-Ended Output High Voltage	V_{OH}	Figure 1	V_{CC} - 1.135		V_{CC} - 0.885	V_{CC} - 1.07		V_{CC} - 0.82	V_{CC} - 1.01		V_{CC} - 0.76	V

DC ELECTRICAL CHARACTERISTICS (continued)

(V_{CC} - V_{EE} = +2.25V to +3.8V, outputs loaded with 50Ω ±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
POWER SUPPLY												
Supply Current (Note 4)	I_{EE}			20	28		22	28		23	30	mA

AC ELECTRICAL CHARACTERISTICS

(V_{CC} - V_{EE} = +2.25V to +3.8V, outputs loaded with 50Ω ±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 (Note 6)	t_{SKOO}			6	30		6	30		6	30	ps
Part-to-Part Skew (Note 7)	t_{SKPP}			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 (Note 8)	t_{DJ}	3.0Gbps 2^{23}-1 PRBS pattern		57	80		57	80		57	80	ps (p-p)

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

AC ELECTRICAL CHARACTERISTICS (continued)

(V_{CC} - V_{EE} = +2.25V to +3.8V, outputs loaded with 50Ω ±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)

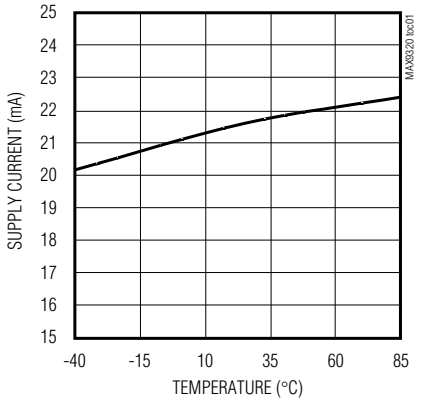
PARAMETER	SYMBOL	CONDITIONS	-40°C			+25°C			+85°C			UNITS
			MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX	
Switching Frequency	f_{MAX}	V_{OH} - V_{OL} ≥ 300mV, Clock pattern, Figure 1	3.0			3.0			3.0			GHz
		V_{OH} - V_{OL} ≥ 550mV, Clock pattern, Figure 1	2.0			2.0			2.0			
Output Rise/Fall Time (20% to 80%)	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°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 ±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.

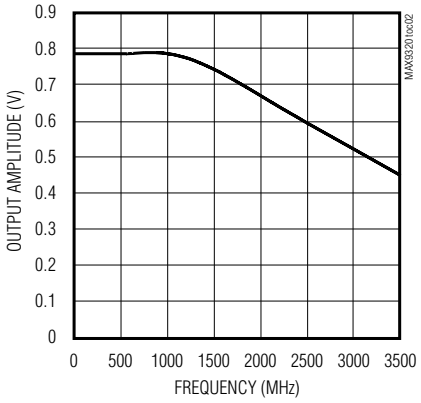
Typical Operating Characteristics

(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 50Ω to V_{CC} - 2V, T_A = +25°C, unless otherwise noted.)

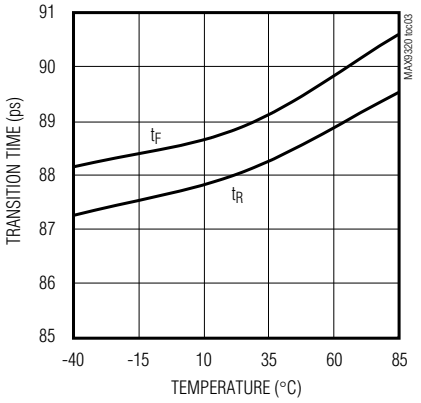
SUPPLY CURRENT, I_{EE} vs. TEMPERATURE



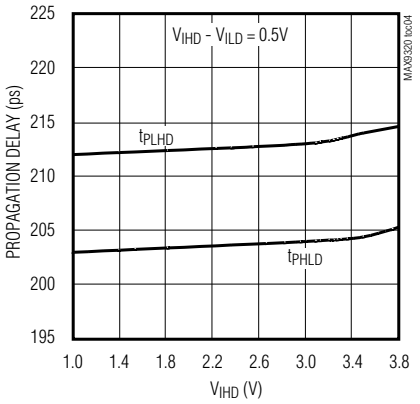
OUTPUT AMPLITUDE, V_{OH} - V_{OL} vs. FREQUENCY



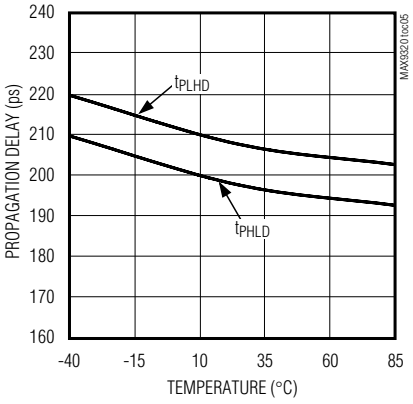
TRANSITION TIME vs. TEMPERATURE



PROPAGATION DELAY vs. HIGH VOLTAGE OF DIFFERENTIAL INPUT, V_{IHD}



PROPAGATION DELAY vs. TEMPERATURE



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

Pin Description (MAX9320)

PIN		NAME	FUNCTION
TSSOP/SO	SOT23		
1	8	Q0	Noninverting Q0 Output. Typically terminate with 50Ω resistor to V_{CC} - 2V.
2	7	$\overline{Q0}$	Inverting Q0 Output. Typically terminate with 50Ω resistor to V_{CC} - 2V.
3	6	Q1	Noninverting Q1 Output. Typically terminate with 50Ω resistor to V_{CC} - 2V.
4	5	$\overline{Q1}$	Inverting Q1 Output. Typically terminate with 50Ω resistor to V_{CC} - 2V.
5	2	V_{EE}	Negative Supply Voltage
6	4	$\overline{D}$	Inverting Differential Input. 60kΩ pullup to V_{CC} and 100kΩ pulldown to V_{EE}.
7	3	D	Noninverting Differential Input. 100kΩ pulldown to V_{EE}.
8	1	V_{CC}	Positive Supply Voltage. Bypass from V_{CC} to V_{EE} with 0.1µF and 0.01µF 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 0.1µF and 0.01µF 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. 60kΩ pullup to V_{CC} and 100kΩ pulldown to V_{EE}.
4	D	Noninverting Differential Input. 100kΩ pulldown to V_{EE}.
5	$\overline{Q1}$	Inverting Q1 Output. Typically terminate with 50Ω resistor to V_{CC} - 2V.
6	Q1	Noninverting Q1 Output. Typically terminate with 50Ω resistor to V_{CC} - 2V.
7	$\overline{Q0}$	Inverting Q0 Output. Typically terminate with 50Ω resistor to V_{CC} - 2V.
8	Q0	Noninverting Q0 Output. Typically terminate with 50Ω resistor to V_{CC} - 2V.

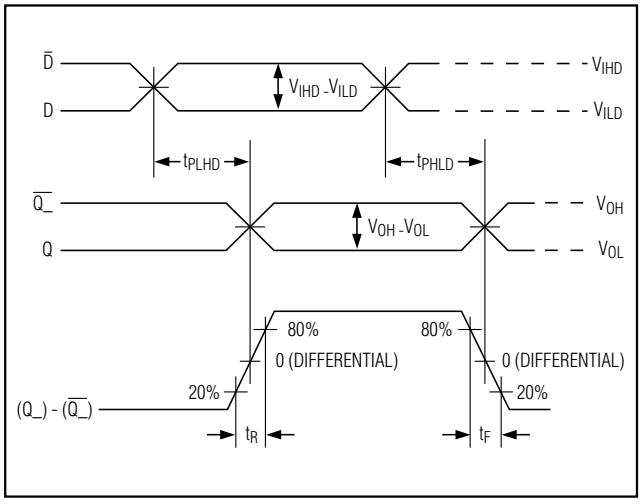


Figure 1. Differential Transition Time and Propagation Delay Timing Diagram

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 D to $\overline{D}$ 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, $\overline{D}$, is biased with a 60kΩ pullup to V_{CC} and a 100kΩ pulldown to V_{EE}. The noninverting input, D, is biased with a 100kΩ 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 ±100mV around a reference voltage or a differential input of at least ±100mV 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 0.1µF and 0.01µF capacitors in parallel as close to the device as possible, with the 0.01µF 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 50Ω characteristic impedance trace. Minimize the number of vias to prevent impedance discontinuities. Reduce reflections by maintaining the 50Ω 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

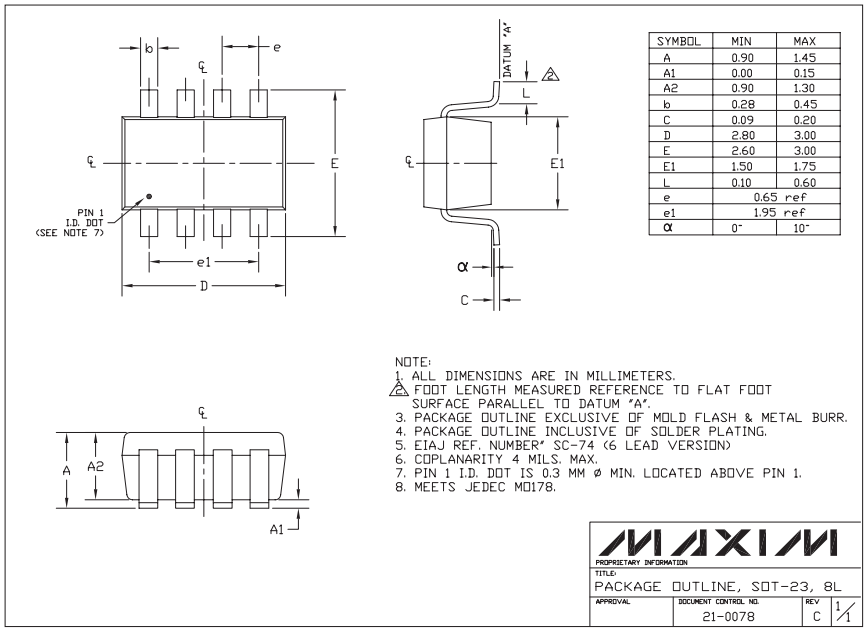
Terminate outputs through 50Ω to V_{CC} - 2V or use an equivalent Thevenin termination. Terminate both outputs and use the same termination on each for the lowest output-to-output skew. When a single-ended signal is taken from a differential output, terminate both outputs. For example, if Q0 is used as a single-ended output, terminate both Q0 and $\overline{Q0}$.

Chip Information

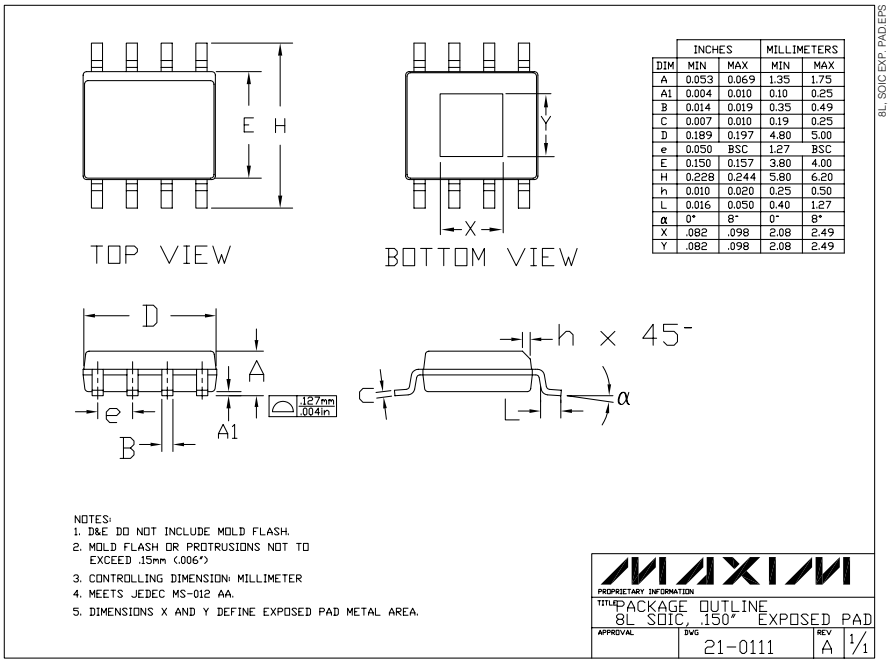
TRANSISTOR COUNT: 182

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

Package Information

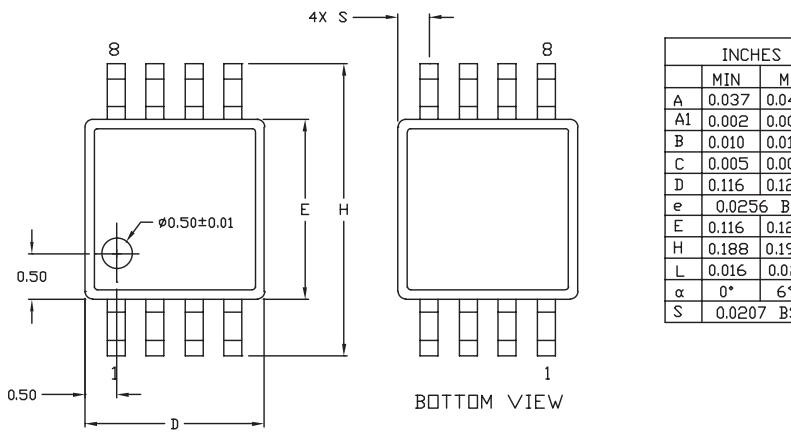


SYMBOL	MIN	MAX
A	0.90	1.45
A1	0.00	0.15
A2	0.90	1.30
b	0.28	0.45
C	0.09	0.20
D	2.80	3.00
E	2.60	3.00
E1	1.50	1.75
L	0.10	0.60
e	0.65 ref	
e1	1.95 ref	
α	0°	10°



	INCHES		MILLIMETERS	
DIM	MIN	MAX	MIN	MAX
A	0.053	0.069	1.35	1.75
A1	0.004	0.010	0.10	0.25
B	0.014	0.019	0.35	0.49
C	0.007	0.010	0.19	0.25
D	0.189	0.197	4.80	5.00
e	0.050	BSC	1.27	BSC
E	0.150	0.157	3.80	4.00
H	0.228	0.244	5.80	6.20
h	0.010	0.020	0.25	0.50
L	0.016	0.050	0.40	1.27
α	0°	8°	0°	8°
X	.082	.098	2.08	2.49
Y	.082	.098	2.08	2.49

Package Information (continued)



	INCHES		MILLIMETERS		JEDEC INCHES		JEDEC MILLIMETERS	
	MIN	MAX	MIN	MAX	MIN	MAX	MIN	MAX
A	0.037	0.043	0.94	1.10	---	0.043	---	1.10
A1	0.002	0.006	0.05	0.15	0.002	0.006	0.05	0.15
B	0.010	0.014	0.25	0.36	0.010	0.016	0.25	0.40
C	0.005	0.007	0.13	0.18	0.005	0.009	0.13	0.23
D	0.116	0.120	2.95	3.05	0.114	0.122	2.9	3.1
e	0.0256 BSC		0.65 BSC		0.0256 BSC		0.64 BSC	
E	0.116	0.120	2.95	3.05	0.114	0.122	2.9	3.1
H	0.188	0.198	4.78	5.03	0.193 BSC		4.9 BSC	
L	0.016	0.026	0.41	0.66	0.016	0.027	0.40	0.70
α	0°	6°	0°	6°	0°	6°	0°	6°
S	0.0207 BSC		0.5250 BSC					

8LUMAXD.EPS

NOTES:
1. D&E DO NOT INCLUDE MOLD FLASH.
2. MOLD FLASH OR PROTRUSIONS NOT TO EXCEED 0.15MM (.006").
3. CONTROLLING DIMENSION: MILLIMETERS.
4. MEETS JEDEC MO-187.

MAXIM
PROPRIETARY INFORMATION
TITLE: PACKAGE OUTLINE, 8L uMAX
APPROVAL | DOCUMENT CONTROL NO. 21-0036 | REV I | 1/1

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