



Differential LVPECL-to-LVDS Translators

MAX9374/MAX9374A

General Description

The MAX9374 and MAX9374A are 2.0GHz differential LVPECL-to-LVDS translators and are designed for telecom applications. They feature 250ps propagation delay. The differential output conforms to the ANSI TIA/EIA-644 LVDS standard. The inputs are biased with internal resistors such that the output is differential low when inputs are open. An on-chip V_{BB} reference output is available for single-ended operation.

The MAX9374 is designed for low-voltage operation from a 2.375V to 2.625V power supply for use in 2.5V systems. The MAX9374A is designed for 3.0V to 3.6V operation in systems with a nominal 3.3V supply. Both devices are offered in industry-standard 8-pin SOT23 and SO packages.

Features

- ◆ Guaranteed 2.0GHz Operating Frequency
- ◆ 250ps (typ) Propagation Delay
- ◆ 1.0ps RMS Jitter (typ)
- ◆ 2.375V to 2.625V Low-Voltage Supply Range (MAX9374)
- ◆ On-Chip V_{BB} Reference for Single-Ended Input
- ◆ Output Low for Open Inputs
- ◆ Output Conforms to ANSI TIA/EIA-644 LVDS Standard
- ◆ ESD Protection >2.0kV (Human Body Model)
- ◆ Available in Small 8-Pin SOT23 Package

Applications

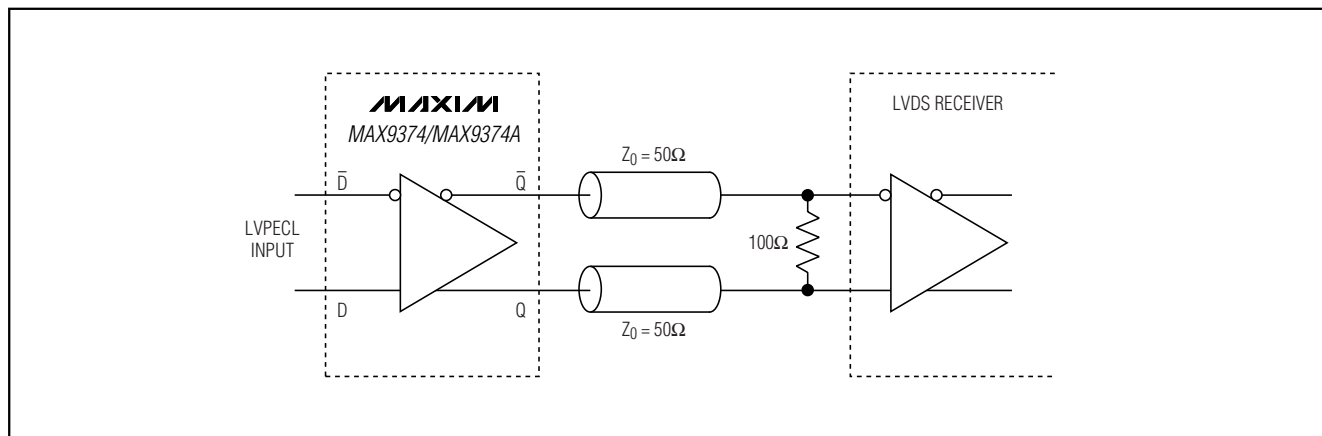
Precision Clock Buffer
Low-Jitter Data Repeater
Central Office Clock Distribution
DSLAM/DLC
Base Station
Mass Storage

Ordering Information

PART	TEMP RANGE	PIN-PACKAGE	TOP MARK
MAX9374EKA-T	-40°C to +85°C	8 SOT23-8	AAKU
MAX9374ESA	-40°C to +85°C	8 SO	—
MAX9374AEKA-T	-40°C to +85°C	8 SOT23-8	AAKV
MAX9374AESA	-40°C to +85°C	8 SO	—

Pin Configurations/Functional Diagrams appear at end of data sheet.

Typical Application Circuit



Differential LVPECL-to-LVDS Translators

ABSOLUTE MAXIMUM RATINGS

V_{CC} to GND	4.0V
$V_D, \overline{V_D}$ to GND	-0.3V to $V_{CC} + 0.3V$
V_D to $\overline{V_D}$	3.0V
V_{BB} Sink/Source Current	1mA
Short-Circuit Duration ($Q, \overline{Q}$ to GND)	Continuous
Short-Circuit Duration (Q to $\overline{Q}$)	Continuous
Continuous Power Dissipation ($T_A = +70^\circ\text{C}$)	
8-Pin SOT23 (derate 8.9mW/ $^\circ\text{C}$ above $+70^\circ\text{C}$)	714mW
8-Pin SO (derate 5.9mW/ $^\circ\text{C}$ above $+70^\circ\text{C}$)	470mW
Junction-to-Ambient Thermal Resistance	
8-Pin SOT23	+112 $^\circ\text{C}/\text{W}$
8-Pin SO	+170 $^\circ\text{C}/\text{W}$

Junction-to-Ambient Thermal Resistance with 500 LFPM Airflow	
8-Pin SOT23	+78 $^\circ\text{C}/\text{W}$
8-Pin SO	+99 $^\circ\text{C}/\text{W}$
Junction-to-Case Thermal Resistance	
8-Pin SOT23	+80 $^\circ\text{C}/\text{W}$
8-Pin SO	+40 $^\circ\text{C}/\text{W}$
Operating Temperature Range	-40 $^\circ\text{C}$ to +85 $^\circ\text{C}$
Junction Temperature	+150 $^\circ\text{C}$
Storage Temperature Range	-65 $^\circ\text{C}$ to +150 $^\circ\text{C}$
ESD Protection	
Human Body Model ($D, \overline{D}, Q, \overline{Q}$)	2kV
Soldering Temperature (10s)	+300 $^\circ\text{C}$

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

($V_{CC} = 2.375V$ to $2.625V$ for MAX9374, $V_{CC} = 3.0V$ to $3.6V$ for MAX9374A, $100\Omega \pm 1\%$ across outputs, $V_{ID} = 0.095V$ to V_{CC} or $3V$, whichever is less, $V_{IHD} = 1.2V$ to V_{CC} , $V_{ILD} = GND$ to $V_{CC} - 0.095V$, unless otherwise noted. Typical values are at $V_{IHD} = 2.0V$, $V_{ILD} = 1.85V$, $V_{CC} = 3.3V$ for MAX9374A, $V_{CC} = 2.5V$ for MAX9374.) (Notes 1, 2)

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}	Figure 1	1.2		V _{CC}	1.2		V _{CC}	1.2		V _{CC}	V
Low Voltage of Differential Input	V _{ILD}	Figure 1	GND		V _{CC} - 0.095	GND		V _{CC} - 0.095	GND		V _{CC} - 0.095	V
Single-Ended Input High Voltage	V _{IH}	V _{BB} connected to $\overline{D}$ (V _{IL} for V _{BB} connected to D), Figure 1	V _{CC} - 1.165		V _{CC}	V _{CC} - 1.165		V _{CC}	V _{CC} - 1.165		V _{CC}	V
Single-Ended Input Low Voltage	V _{IL}	V _{BB} connected to $\overline{D}$ (V _{IH} for V _{BB} connected to D), Figure 1	V _{EE}		V _{CC} - 1.475	V _{EE}		V _{CC} - 1.475	V _{EE}		V _{CC} - 1.475	V
Differential Input Voltage	V _{IHD} - V _{ILD}	V _{CC} < 3.0V	0.1		V _{CC}	0.1		V _{CC}	0.1		V _{CC}	V
		V _{CC} ≥ 3.0V	0.1		3.0	0.1		3.0	0.1		3.0	
Input Current	I _{IN}	V _{IHMAX} , V _{ILMIN} (Note 3)	-150		150	-150		150	-150		150	μA
DIFFERENTIAL OUTPUT (Q, $\overline{Q}$)												
Output High Voltage	V _{OH}	Figure 1			1.6			1.6			1.6	V
Output Low Voltage	V _{OL}	Figure 1	0.9			0.9			0.9			V
Differential Output Voltage	V _{OD}	Figure 1	250	350	450	250	350	450	250	350	450	mV

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DC ELECTRICAL CHARACTERISTICS (continued)

($V_{CC} = 2.375V$ to $2.625V$ for MAX9374, $V_{CC} = 3.0V$ to $3.6V$ for MAX9374A, $100\Omega \pm 1\%$ across outputs, $V_{ID} = 0.095V$ to V_{CC} or $3V$, whichever is less, $V_{IHD} = 1.2V$ to V_{CC} , $V_{ILD} = GND$ to $V_{CC} - 0.095V$, unless otherwise noted. Typical values are at $V_{IHD} = 2.0V$, $V_{ILD} = 1.85V$, $V_{CC} = 3.3V$ for MAX9374A, $V_{CC} = 2.5V$ for MAX9374.) (Notes 1, 2)

PARAMETER	SYMBOL	CONDITIONS	-40°C			+25°C			+85°C			UNITS
			MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX	
Change in V_{OD} Between Complementary Output States	ΔV_{OD}			1	25		1	25		1	25	mV
Output Offset Voltage	V_{OS}		1.125	1.25	1.375	1.125	1.25	1.375	1.125	1.25	1.375	V
Change in V_{OS} Between Complementary Output States	ΔV_{OS}			3	25		3	25		3	25	mV
Output Short-Circuit Current	I_{OSC}	Q or $\bar{Q}$ short to GND		23	30		23	30		23	30	mA
V_{BB} AND SUPPLY												
Reference Voltage	V_{BB}	$I_{BB} = \pm 0.6mA$ (Note 4)	$V_{CC} - 1.38$		$V_{CC} - 1.26$	$V_{CC} - 1.38$		$V_{CC} - 1.26$	$V_{CC} - 1.38$		$V_{CC} - 1.26$	V
Supply Current	I_{CC}	(Note 5)		16	30		18	30		20	30	mA

AC ELECTRICAL CHARACTERISTICS

($V_{CC} = 2.375V$ to $2.625V$ for MAX9374, $V_{CC} = 3.0V$ to $3.6V$ for MAX9374A, $100\Omega \pm 1\%$ across outputs, $V_{IHD} - V_{ILD} = 0.15V$ to V_{CC} or $3V$, whichever is less, $V_{IHD} = 1.2V$ to V_{CC} , $V_{ILD} = GND$ to $V_{CC} - 0.15V$, $f_{IN} = 1GHz$, input transition time = $125ps$, input duty cycle = 50%, unless otherwise noted. Typical values are at $V_{IHD} = 2.0V$, $V_{ILD} = 1.85V$, $V_{CC} = 3.3V$ for MAX9374A, $V_{CC} = 2.5V$ for MAX9374, unless otherwise noted.) (Notes 1, 6)

PARAMETER	SYMBOL	CONDITIONS	-40°C			+25°C			+85°C			UNITS
			MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX	
Differential Input to Differential Output Delay	t_{PLHD} , t_{PHLD}	Figure 1	116	240	420	128	250	403	145	260	440	ps
Single-Ended Input to Differential Output Delay	t_{PLHS} , t_{PHLS}	Figure 1	126	250	430	138	250	415	155	260	450	ps
Part-to-Part Skew	t_{SKPP}	(Note 7)			304			275			295	ps
Added Random Jitter (Note 8)	t_{RJ}	$f_{IN} = 1.0GHz$, clock pattern		0.9	2		1	2		1	2	ps(RMS)
		$f_{IN} = 2.0GHz$, clock pattern		0.8	2		0.9	2		0.9	2	
Added Deterministic Jitter (Note 8)	t_{DJ}	$f_{IN} = 2.0Gbps$, $2^{23} - 1$ PRBS pattern		45	75		46	75		38	75	ps(P-P)
Operating Frequency	f_{MAX}	$V_{OD} \geq 250mV$	2.0	2.2		2.0	2.2		2.0	2.2		MHz
Output Rise/Fall Time	t_R , t_F	20% to 80%, Figure 1		92	200		91	200		90	200	ps

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AC ELECTRICAL CHARACTERISTICS (continued)

($V_{CC} = 2.375V$ to $2.625V$ for MAX9374, $V_{CC} = 3.0V$ to $3.6V$ for MAX9374A, $100\Omega \pm 1\%$ across outputs, $V_{IHD} - V_{ILD} = 0.15V$ to V_{CC} or $3V$, whichever is less, $V_{IHD} = 1.2V$ to V_{CC} , $V_{ILD} = GND$ to $V_{CC} - 0.15V$, $f_{IN} = 1GHz$, input transition time = $125ps$, input duty cycle = 50% , unless otherwise noted. Typical values are at $V_{IHD} = 2.0V$, $V_{ILD} = 1.85V$, $V_{CC} = 3.3V$ for MAX9374A, $V_{CC} = 2.5V$ for MAX9374, unless otherwise noted.) (Notes 1, 6)

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

Note 2: DC parameters are production tested at $T_A = +25^\circ C$ and guaranteed by design over the full operating temperature range.

Note 3: Current into a pin is defined as positive. Current out of a pin is defined as negative.

Note 4: Use V_{BB} as a reference for inputs on the same device only.

Note 5: 100Ω across the outputs, all other pins open except V_{CC} and GND.

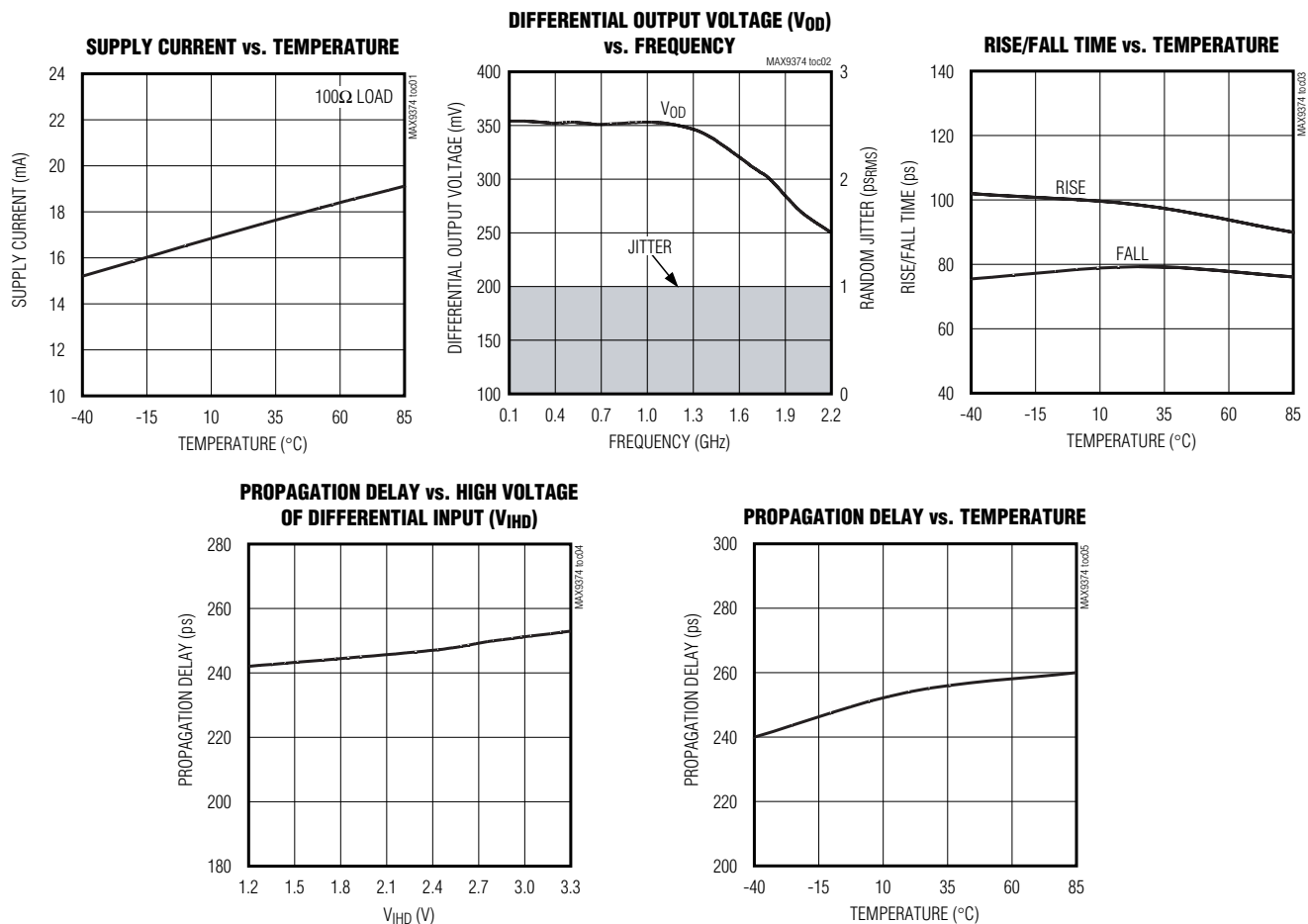
Note 6: Guaranteed by design and characterization. Limits are set at ± 6 sigma.

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

(MAX9374A, $100\Omega \pm 1\%$ across outputs, $f_{IN} = 1GHz$, input transition time = $125ps$, input duty cycle = 50% , $V_{CC} = 3.3V$, $V_{IHD} = 2.0V$, $V_{ILD} = 1.85V$, $T_A = +25^\circ C$, unless otherwise noted.)



Differential LVPECL-to-LVDS Translators

Pin Description

PIN		NAME	FUNCTION
SOT23	SO		
1	4	V _{BB}	Reference Output Voltage. Connect to the inverting or noninverting data input to provide a reference for single-ended operation. When used, bypass with a 0.01μF ceramic capacitor to V _{CC} ; otherwise, leave it open.
2	5	GND	Ground. Provide a low-impedance connection to the ground plane.
3	3	$\overline{D}$	Inverted LVPECL Data Input. 36.5kΩ pullup to V _{CC} and 75kΩ pulldown to GND.
4	2	D	Noninverted LVPECL Data Input. 75kΩ pullup to V _{CC} and 75kΩ pulldown to GND.
5	8	V _{CC}	Positive Supply Voltage. Bypass V _{CC} to GND 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.
6	7	Q	Noninverted LVDS Output. Typically terminate with 100Ω to $\overline{Q}$.
7	6	$\overline{Q}$	Inverted LVDS Output. Typically terminate with 100Ω to Q.
8	1	N.C.	No Connection. Not internally connected.

MAX9374/MAX9374A

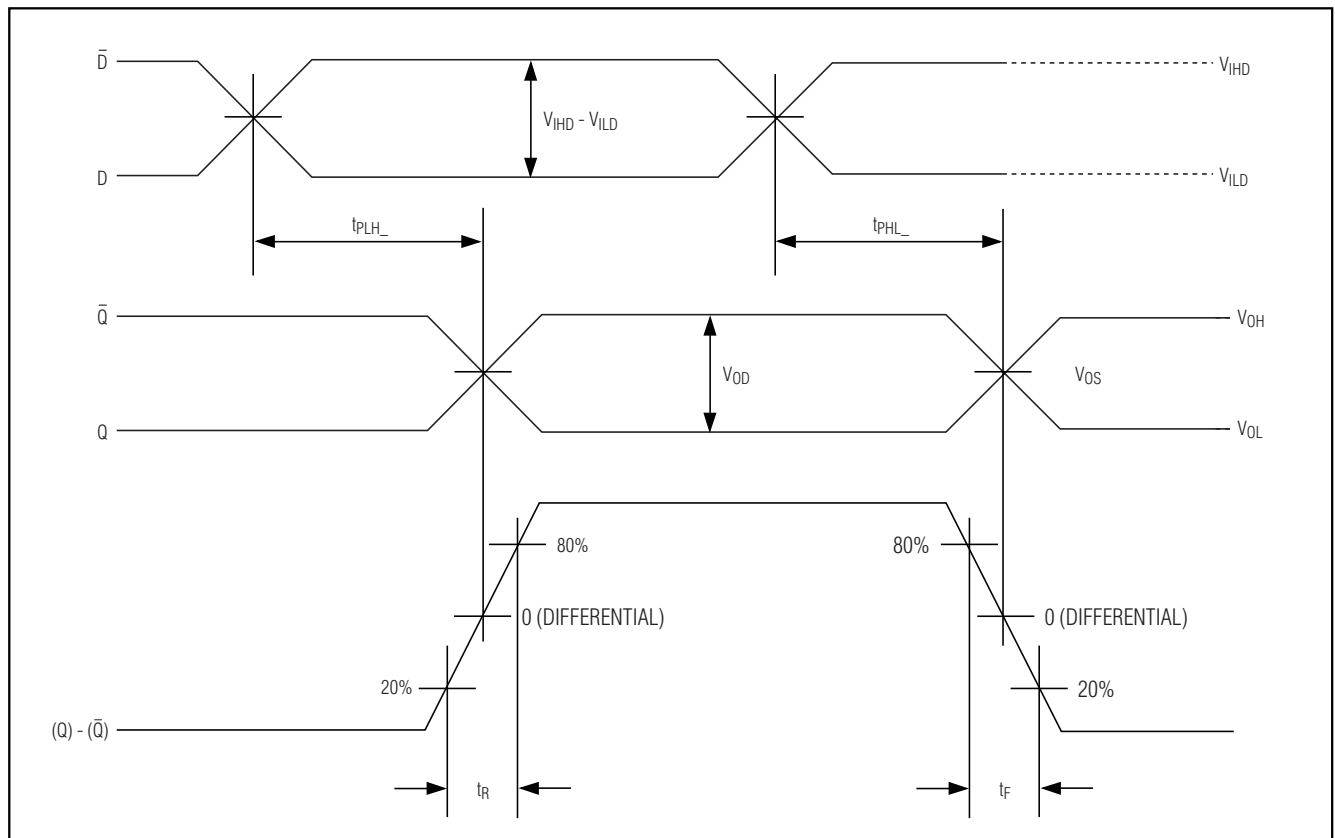


Figure 1. MAX9374/MAX9374A Timing Diagram

Differential LVPECL-to-LVDS Translators

Detailed Description

The MAX9374/MAX9374A are 2.0GHz differential LVPECL-to-LVDS translators. The output is differential LVDS and conforms to the ANSI TIA/EIA-644 LVDS standard. The inputs are biased with internal resistors such that the output is differential low when inputs are open. An on-chip V_{BB} reference output is available for single-ended input operation. The MAX9374 is designed for low-voltage operation from 2.375V to 2.625V in systems with a nominal 2.5V supply. The MAX9374A is designed for 3.0V to 3.6V operation in systems with a nominal 3.3V supply.

Differential LVPECL Input

The MAX9374/MAX9374A accept differential LVPECL inputs and can be configured to accept single-ended inputs through the use of the V_{BB} voltage reference output. The maximum magnitude of the differential signal applied to the input is 3.0V or V_{CC} , whichever is less. This limit also applies to the difference between any reference voltage input and a single-ended input. Specifications for the high and low voltages of a differential input (V_{IHD} and V_{ILD}) and the differential input voltage ($V_{IHD} - V_{ILD}$) apply simultaneously.

Single-Ended Inputs and V_{BB}

The differential inputs can be configured to accept a single-ended input through the use of the V_{BB} reference voltage. A noninverting, single-ended input is produced by connecting V_{BB} to the $\bar{D}$ input and applying a single-ended input signal to the D input. Similarly, an inverting input is produced by connecting V_{BB} to the D input and applying the input signal to the $\bar{D}$ input. With a differential input configured as single ended (using V_{BB}), the single-ended input can be driven to V_{CC} and GND or with a single-ended LVPECL signal. Note that a single-ended input must be at least $V_{BB} \pm 95\text{mV}$ or a differential input of at least 95mV to switch the outputs to the V_{OH} and V_{OL} levels specified in the *DC Electrical Characteristics* table.

When using the V_{BB} reference output, bypass it with a 0.01 μF ceramic capacitor to V_{CC} . If the V_{BB} reference is not used, leave it unconnected. Use V_{BB} only for inputs that are on the same device as the V_{BB} reference.

Input Bias Resistors

Internal biasing resistors ensure a (differential) output-low condition in the event that the inputs are not connected. The inverting input ($\bar{D}$) is biased with a 36.5k Ω pull-down to V_{CC} and a 75k Ω pullup to GND. The noninverting input (D) is biased with a 75k Ω pullup to V_{CC} and 75k Ω pulldown to GND.

Differential LVDS Output

The differential outputs conform to the ANSI TIA/EIA-644 LVDS standard. Typically, terminate the outputs with 100 Ω across Q and $\bar{Q}$, as shown in the *Typical Application Circuit*. The outputs are short-circuit protected.

Applications Information

Supply Bypassing

Bypass V_{CC} to GND with high-frequency surface-mount ceramic 0.1 μF and 0.01 μF capacitors in parallel and as close to the device as possible, with the 0.01 μF capacitor closest to the device. Use multiple parallel vias to minimize parasitic inductance. When using the V_{BB} reference output, bypass it with a 0.01 μF ceramic capacitor to V_{CC} (if the V_{BB} reference is not used, it can be left open).

Controlled-Impedance Traces

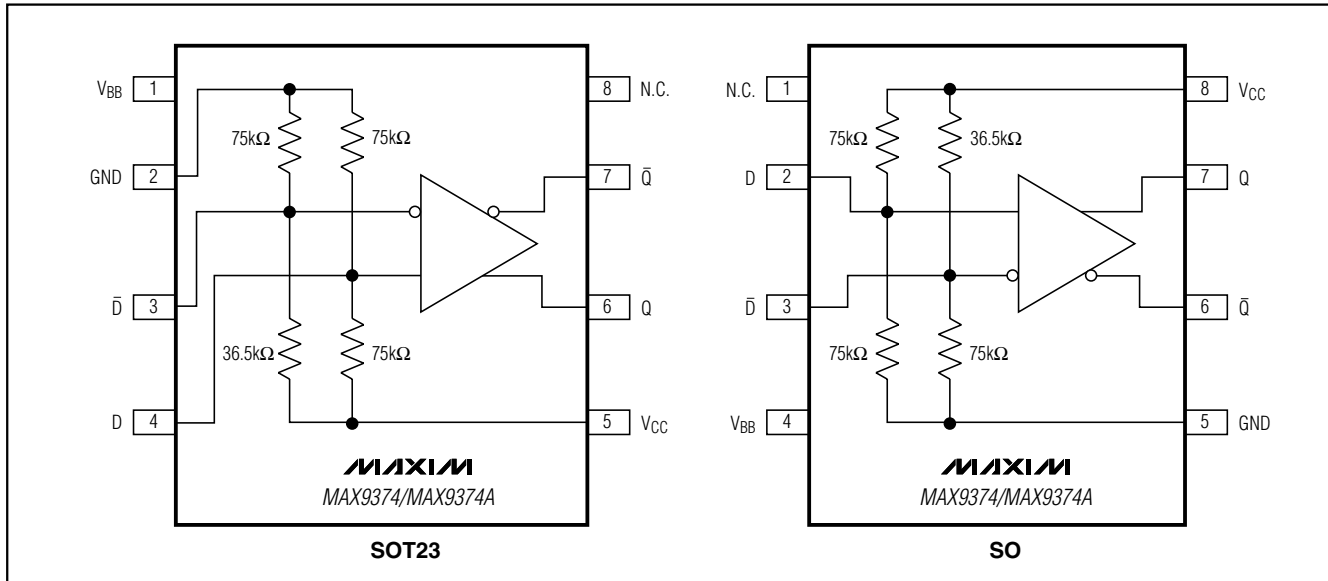
Input and output trace characteristics affect the performance of the MAX9374/MAX9374A. Connect high-frequency input and output signals to 50 Ω characteristic impedance traces. Minimize the number of vias to prevent impedance discontinuities. Reduce reflections by maintaining the 50 Ω characteristic impedance through cables and connectors. Reduce skew within a differential pair by matching the electrical length of the traces.

Output Termination

Terminate the outputs with 100 Ω across Q and $\bar{Q}$ as shown in the *Typical Application Circuit*. Both outputs must be terminated.

Differential LVPECL-to-LVDS Translators

Pin Configurations/Functional Diagrams



Chip Information

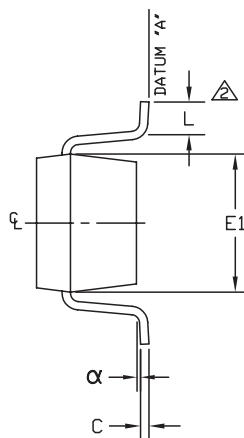
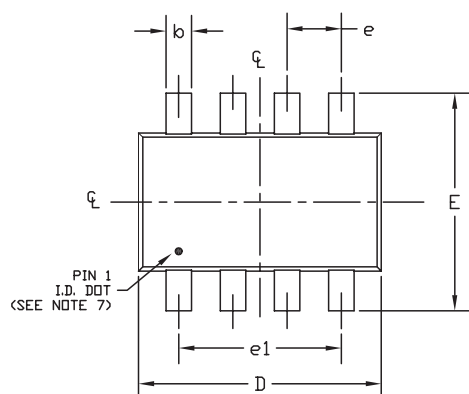
TRANSISTOR COUNT: 236

PROCESS: Bipolar

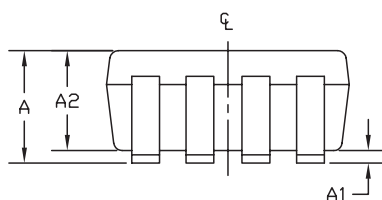
MAX9374/MAX9374A

Differential LVPECL-to-LVDS Translators

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°



NOTE:

1. ALL DIMENSIONS ARE IN MILLIMETERS.
2. FOOT LENGTH MEASURED REFERENCE TO FLAT FOOT SURFACE PARALLEL TO DATUM "A".
3. PACKAGE OUTLINE EXCLUSIVE OF MOLD FLASH & METAL BURR.
4. PACKAGE OUTLINE INCLUSIVE OF SOLDER PLATING.
5. EIAJ REF. NUMBER SC-74 (6 LEAD VERSION)
6. COPLANARITY 4 MILS. MAX.
7. PIN 1 I.D. DOT IS 0.3 MM Ø MIN. LOCATED ABOVE PIN 1.
8. MEETS JEDEC MO178.

MAXIM		
PROPRIETARY INFORMATION		
TITLE: PACKAGE OUTLINE, SOT-23, 8L		
APPROVAL	DOCUMENT CONTROL NO. 21-0078	REV C
		1/1

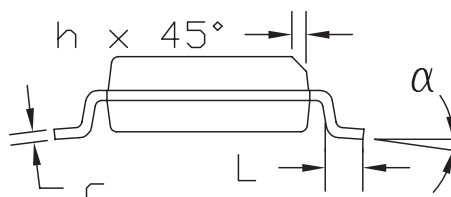
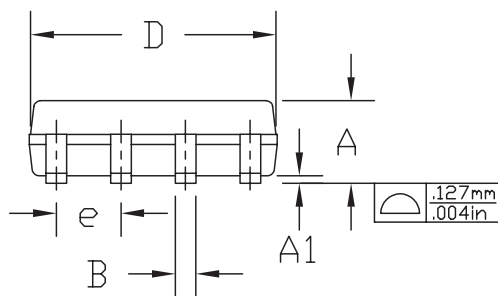
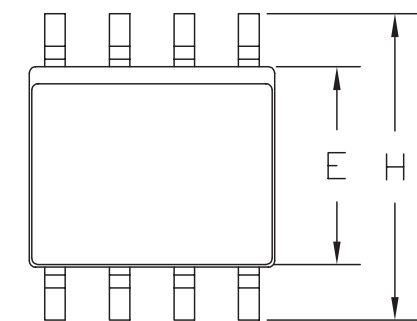
SOT23, 8LEPS

Differential LVPECL-to-LVDS Translators

Package Information (continued)

MAX9374/MAX9374A

9LUCSP, 3x3.EPS



DIM	INCHES		MILLIMETERS	
	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°

NOTES:

1. D&E DO NOT INCLUDE MOLD FLASH.
2. MOLD FLASH OR PROTRUSIONS NOT TO EXCEED .15mm (.006")
3. CONTROLLING DIMENSION: MILLIMETER
4. MEETS JEDEC MS-012 AA.

PROPRIETARY INFORMATION		
TITLE 8L SOIC OUTLINE		
APPROVAL	DWG 21-0325	REV A 1/1

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