



# 1:5 Clock Driver with Selectable LVPECL Inputs/Single-Ended Inputs and LVDS Outputs

## General Description

The MAX9310A is a fast, low-skew 1:5 differential driver with selectable LVPECL inputs and LVDS outputs, designed for clock distribution applications. This device features an ultra-low propagation delay of 340ps with 48mA of supply current.

The MAX9310A operates from a 3V to 3.6V power supply for use in 3.3V systems. A 2:1 input multiplexer is used to select one of two differential inputs. The input selection is controlled through the CLKSEL pin.

This device features a synchronous enable function. The MAX9310A LVPECL inputs can be driven by either a differential or single-ended signal. A  $V_{BB}$  reference voltage output is provided for use with single-ended inputs. The device can also accept differential HSTL signals.

The MAX9310A is offered in a space-saving 20-pin TSSOP package and operates over the extended temperature range from  $-40^{\circ}\text{C}$  to  $+85^{\circ}\text{C}$ .

## Applications

Data and Clock Drivers and Buffers  
Central-Office Backplane Clock Distribution  
DSLAM  
Base Stations  
ATE

## Features

- ◆ Guaranteed 1.0GHz Operating Frequency
- ◆ 8.0ps Output-to-Output Skew
- ◆ 340ps Propagation Delay
- ◆ Accepts LVPECL and Differential HSTL Inputs
- ◆ Synchronous Output Enable/Disable
- ◆ Two Selectable Differential Inputs
- ◆ 3V to 3.6V Supply Voltage
- ◆ On-Chip Reference for Single-Ended Operation
- ◆ ESD Protection:  $\pm 2\text{kV}$  (Human Body Model)
- ◆ Input Bias Resistors Drive Output Low for Open Inputs

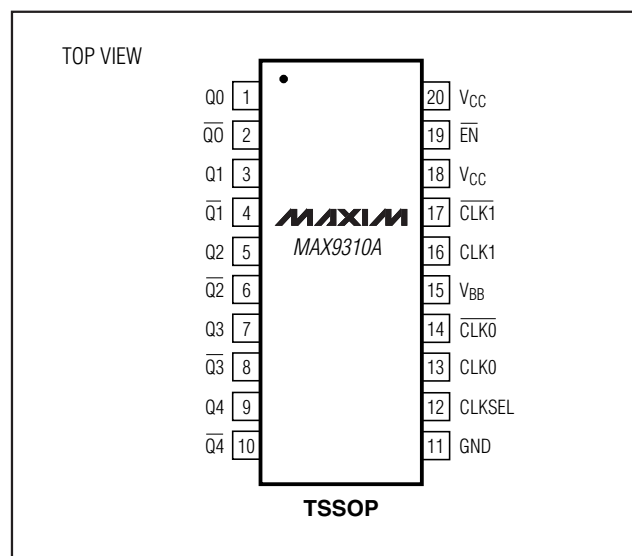
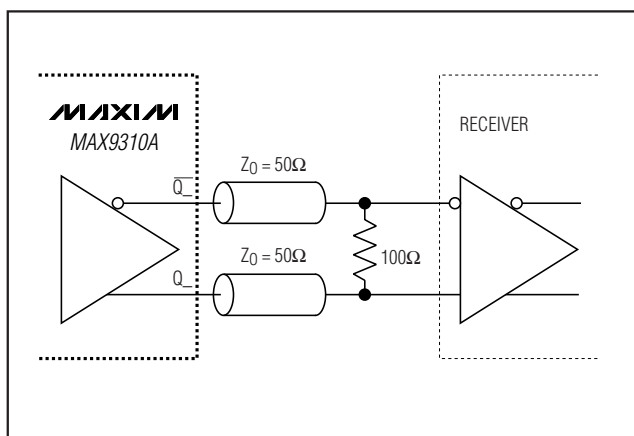
## Ordering Information

PART	TEMP RANGE	PIN-PACKAGE
MAX9310AEUP	$-40^{\circ}\text{C}$ to $+85^{\circ}\text{C}$	20 TSSOP

## Pin Configuration

Functional Diagram appears at end of data sheet.

## Typical Application Circuit



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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](http://www.maxim-ic.com).

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## ABSOLUTE MAXIMUM RATINGS

$V_{CC}$ to GND .....	-0.3V to +4.1V
$\overline{EN}$ , CLKSEL, CLK_, $\overline{CLK}_-$ to GND .....	-0.3V to ( $V_{CC} + 0.3V$ )
CLK_ to $\overline{CLK}_-$ .....	$\pm 3V$
Continuous Output Current .....	24mA
Surge Output Current .....	50mA
$V_{BB}$ Sink/Source Current .....	$\pm 0.65mA$
Continuous Power Dissipation ( $T_A = +70^\circ C$ )	
Single-Layer PC Board	
20-Pin TSSOP (derate 7.69mW/ $^\circ C$ above $+70^\circ C$ ) .....	615mW
Multilayer PC Board	
20-Pin TSSOP (derate 11mW/ $^\circ C$ above $+70^\circ C$ ) .....	879mW
Junction-to-Ambient Thermal Resistance in Still Air	
Single-Layer PC Board	
20-Pin TSSOP .....	$+130^\circ C/W$

Multilayer PC Board	
20-Pin TSSOP .....	$+91^\circ C/W$
Junction-to-Ambient Thermal Resistance with 500LFPM	
Airflow Single-Layer PC board	
20-Pin TSSOP .....	$+96^\circ C/W$
Junction-to-Case Thermal Resistance	
20-Pin TSSOP .....	$+20^\circ C/W$
Operating Temperature Range .....	$-40^\circ C$ to $+85^\circ C$
Junction Temperature .....	$+150^\circ C$
Storage Temperature Range .....	$-65^\circ C$ to $+150^\circ C$
ESD Protection	
Human Body Model (inputs and outputs) .....	$\pm 2kV$
Lead Temperature (soldering, 10s) .....	$+300^\circ C$

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

( $V_{CC} - GND = 3V$  to  $3.6V$ , outputs terminated with  $100\Omega \pm 1\%$ , unless otherwise noted. Typical values are at  $V_{CC} - GND = 3.3V$ ,  $V_{IHD} = V_{CC} - 1.0V$ ,  $V_{ILD} = V_{CC} - 1.5V$ , unless otherwise noted.) (Notes 1, 2, and 3)

PARAMETER	SYMBOL	CONDITIONS	-40°C			+25°C			+85°C			UNITS
			MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX	
SINGLE-ENDED INPUTS (CLKSEL, $\overline{EN}$ )												
Input High Voltage	V <sub>IH</sub>		V <sub>CC</sub> - 1.165	V <sub>CC</sub> - 0.88		V <sub>CC</sub> - 1.165	V <sub>CC</sub> - 0.88		V <sub>CC</sub> - 1.165	V <sub>CC</sub> - 0.88		V
Input Low Voltage	V <sub>IL</sub>		V <sub>CC</sub> - 1.81	V <sub>CC</sub> - 1.475		V <sub>CC</sub> - 1.81	V <sub>CC</sub> - 1.475		V <sub>CC</sub> - 1.81	V <sub>CC</sub> - 1.475		V
Input Current	I <sub>IN</sub>	V <sub>IH</sub> (MAX), V <sub>IL</sub> (MAX)	-10	+70		-10	+70		-10	+70		μA
DIFFERENTIAL INPUTS (CLK <sub>-</sub> , $\overline{CLK_-}$ )												
Single-Ended Input High Voltage	V <sub>IH</sub>	Figure 1	V <sub>CC</sub> - 1.125	V <sub>CC</sub> - 0.88		V <sub>CC</sub> - 1.165	V <sub>CC</sub> - 0.88		V <sub>CC</sub> - 1.165	V <sub>CC</sub> - 0.88		V
Single-Ended Input Low Voltage	V <sub>IL</sub>	Figure 1	V <sub>CC</sub> - 1.81	V <sub>CC</sub> - 1.475		V <sub>CC</sub> - 1.81	V <sub>CC</sub> - 1.475		V <sub>CC</sub> - 1.81	V <sub>CC</sub> - 1.495		V
Differential Input High Voltage	V <sub>IHD</sub>	Figure 2	1.2	V <sub>CC</sub>		1.2	V <sub>CC</sub>		1.2	V <sub>CC</sub>		V
Differential Input Low Voltage	V <sub>ILD</sub>	Figure 2	GND	V <sub>CC</sub> - 0.095		GND	V <sub>CC</sub> - 0.095		GND	V <sub>CC</sub> - 0.095		V
Differential Input Voltage	V <sub>ID</sub>	V <sub>IHD</sub> - V <sub>ILD</sub>	0.095	3.0		0.095	3.0		0.095	3.0		V
Input Current	I <sub>IH</sub> , I <sub>IL</sub>	CLK <sub>-</sub> , or $\overline{CLK_-}$ = V <sub>IHD</sub> or V <sub>ILD</sub>	-100	+100		-100	+100		-100	+100		μA

# 1:5 Clock Driver with Selectable LVPECL Inputs/Single-Ended Inputs and LVDS Outputs

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## DC ELECTRICAL CHARACTERISTICS (continued)

( $V_{CC} - GND = 3V$  to  $3.6V$ , outputs terminated with  $100\Omega \pm 1\%$ , unless otherwise noted. Typical values are at  $V_{CC} - GND = 3.3V$ ,  $V_{IHD} = V_{CC} - 1.0V$ ,  $V_{ILD} = V_{CC} - 1.5V$ , unless otherwise noted.) (Notes 1, 2, and 3)

PARAMETER	SYMBOL	CONDITIONS	-40°C			+25°C			+85°C			UNITS
			MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX	
OUTPUTS (Q <sub>+</sub> , Q <sub>-</sub> )												
Output High Voltage	V <sub>OH</sub>	Figure 2	1.6			1.6			1.6			V
Output Low Voltage	V <sub>OL</sub>	Figure 2	0.9			0.9			0.9			V
Differential Output Voltage	V <sub>OD</sub>	V <sub>OH</sub> - V <sub>OL</sub> , Figure 2	250	350	450	250	350	450	250	350	450	mV
Change in V <sub>OD</sub> Between Complementary Output States	ΔV <sub>OD</sub>		50			50			50			mV
Output Offset Voltage	V <sub>OS</sub>		1.125	1.25	1.375	1.125	1.25	1.375	1.125	1.25	1.375	mV
Change in V <sub>OS</sub> Between Complementary Output States	ΔV <sub>OCM</sub>		25			25			25			mV
Output Short-Circuit Current	I <sub>OSC</sub>	Q <sub>+</sub> shorted to Q <sub>-</sub>	12			12			12			mA
		Q <sub>+</sub> or Q <sub>-</sub> shorted to GND	29			29			29			
REFERENCE												
Reference Voltage Output	V <sub>BB</sub>	I <sub>BB</sub> = ±0.65mA (Note 4)	V <sub>CC</sub> - 1.38		V <sub>CC</sub> - 1.22	V <sub>CC</sub> - 1.38		V <sub>CC</sub> - 1.26	V <sub>CC</sub> - 1.40		V <sub>CC</sub> - 1.26	V
POWER SUPPLY												
Power-Supply Current	I <sub>CC</sub>	(Note 5)	45		75	48		75	51		75	mA

# 1:5 Clock Driver with Selectable LVPECL Inputs/Single-Ended Inputs and LVDS Outputs

## AC ELECTRICAL CHARACTERISTICS

( $V_{CC} - GND = 3V$  to  $3.6V$ , outputs terminated with  $100\Omega \pm 1\%$ ,  $f_{IN} \leq 1.0GHz$ , input transition time =  $125ps$  (20% to 80%),  $V_{IHD} - V_{ILD} = 0.15V$  to  $V_{CC}$ , unless otherwise noted. Typical values are at  $V_{CC} - GND = 3.3V$ ,  $V_{IHD} = V_{CC} - 1.0V$ ,  $V_{ILD} = V_{CC} - 1.5V$ , unless otherwise noted.) (Notes 1 and 6)

PARAMETER	SYMBOL	CONDITIONS	-40°C			+25°C			+85°C			UNITS
			MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX	
Propagation Delay $CLK_{+}$ , $CLK_{-}$ to $Q_{+}$ , $Q_{-}$	$t_{PHL}$ , $t_{PLH}$	Figure 2	250	340	600	250	340	600	250	340	600	ps
Output-to-Output Skew	$t_{SKOO}$	(Note 7)		10	30		8	25		20	45	ps
Part-to-Part Skew	$t_{SKPP}$	(Note 8)			145			145			145	ps
Added Random Jitter	$t_{RJ}$	$f_{IN} = 1.0GHz$ , clock pattern (Note 9)		0.3	1.0		0.3	1.0		0.3	1.0	ps (RMS)
Added Deterministic Jitter	$t_{DJ}$	$f_{IN} = 1.0Gbps$ , $2^{23} - 1$ PRBS pattern (Note 9)		50	60		50	60		50	60	ps (P-P)
Operating Frequency	$f_{MAX}$	$V_{OD} \geq 250mV$	1.0			1.0			1.0			GHz
Differential Output Rise/Fall Time	$t_{R/F}$	20% to 80%, Figure 2	140	205	300	140	205	300	140	205	300	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 are production tested at +25°C. DC limits are guaranteed by design and characterized over the full operating temperature range.

**Note 4:** Use  $V_{BB}$  only for inputs that are on the same device as the  $V_{BB}$  reference.

**Note 5:** All pins are open except  $V_{CC}$  and GND, all outputs are loaded with  $100\Omega$  differentially.

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

**Note 7:** Measured between outputs of the same part at the signal crossing points for a same-edge transition.

**Note 8:** Measured between outputs of different parts at the signal crossing points under identical conditions for a same-edge transition.

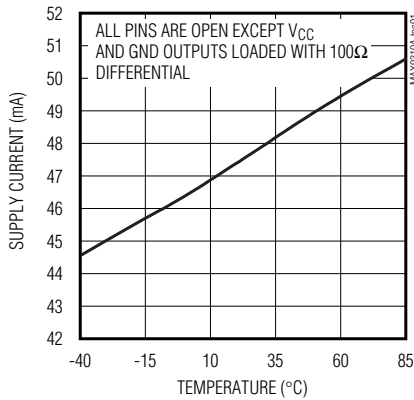
**Note 9:** Device jitter added to the input signal.

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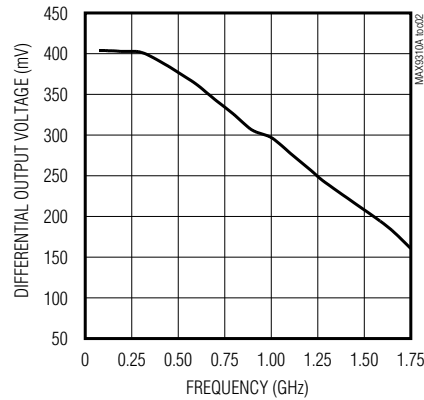
## Typical Operating Characteristics

( $V_{CC} - GND = 3.3V$ , outputs terminated with  $100\Omega \pm 1\%$ ,  $f_{IN} = 1.0GHz$ , input transition time = 125ps (20% to 80%),  $V_{IHD} = V_{CC} - 1.0V$ ,  $V_{ILD} = V_{CC} - 1.5V$ , unless otherwise noted.)

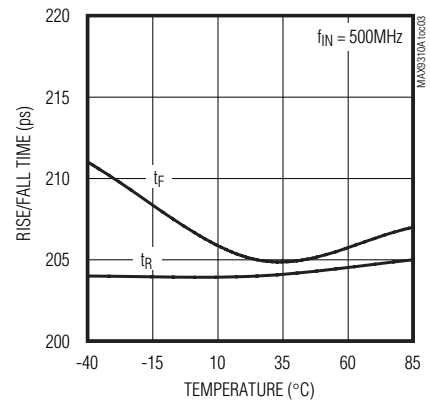
**SUPPLY CURRENT vs. TEMPERATURE**



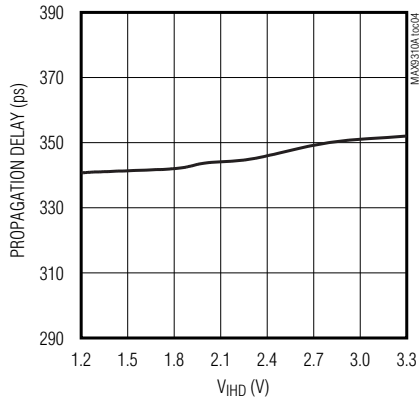
**DIFFERENTIAL OUTPUT VOLTAGE ( $V_{OH} - V_{OL}$ ) vs. FREQUENCY**



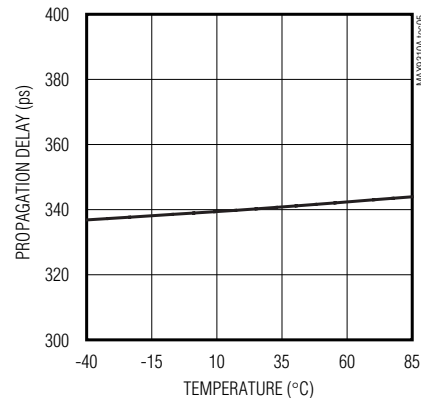
**OUTPUT RISE/FALL vs. TEMPERATURE**



**PROPAGATION DELAY vs. HIGH VOLTAGE OF DIFFERENTIAL INPUT ( $V_{IHD}$ )**



**PROPAGATION DELAY vs. TEMPERATURE**



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# 1:5 Clock Driver with Selectable LVPECL Inputs/Single-Ended Inputs and LVDS Outputs

## Pin Description

PIN	NAME	FUNCTION
1	Q0	Noninverting Differential Output 0. Typically terminated with 100Ω to $\overline{Q0}$ .
2	$\overline{Q0}$	Inverting Differential Output 0. Typically terminated with 100Ω to Q0.
3	Q1	Noninverting Differential Output 1. Typically terminated with 100Ω to $\overline{Q1}$ .
4	$\overline{Q1}$	Inverting Differential Output 1. Typically terminated with 100Ω to Q1.
5	Q2	Noninverting Differential Output 2. Typically terminated with 100Ω to $\overline{Q2}$ .
6	$\overline{Q2}$	Inverting Differential Output 2. Typically terminated with 100Ω to Q2.
7	Q3	Noninverting Differential Output 3. Typically terminated with 100Ω to $\overline{Q3}$ .
8	$\overline{Q3}$	Inverting Differential Output 3. Typically terminated with 100Ω to Q3.
9	Q4	Noninverting Differential Output 4. Typically terminated with 100Ω to $\overline{Q4}$ .
10	$\overline{Q4}$	Inverting Differential Output 4. Typically terminated with 100Ω to Q4.
11	GND	Ground
12	CLKSEL	Clock Select Input. Drive low to select the CLK0, $\overline{CLK0}$ input. Drive high to select the CLK1, $\overline{CLK1}$ input. The CLKSEL threshold is equal to $V_{BB}$ . Internal 60kΩ pulldown to GND.
13	CLK0	Noninverting Differential Clock Input 0. Internal 75kΩ pulldown to GND.
14	$\overline{CLK0}$	Inverting Differential Clock Input 0. Internal 75kΩ pullup to $V_{CC}$ and 75kΩ pulldown to GND.
15	$V_{BB}$	Reference Output Voltage. Connect to the inverting or noninverting clock input to provide a reference for single-ended operation. When used, bypass with a 0.01μF ceramic capacitor to $V_{CC}$ ; otherwise, leave open.
16	CLK1	Noninverting Differential Input 1. Internal 75kΩ pulldown to GND.
17	$\overline{CLK1}$	Inverting Differential Input 1. Internal 75kΩ pullup to $V_{CC}$ and 75kΩ pulldown to GND.
18, 20	$V_{CC}$	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.
19	$\overline{EN}$	Output Enable Input. Outputs are synchronously enabled on the falling edge of the selected clock input when $\overline{EN}$ is low. Outputs are synchronously driven to a differential low state on the falling edge of the selected clock input when $\overline{EN}$ is high. Internal 60kΩ pulldown to GND (Figure 3).

# 1:5 Clock Driver with Selectable LVPECL Inputs/Single-Ended Inputs and LVDS Outputs

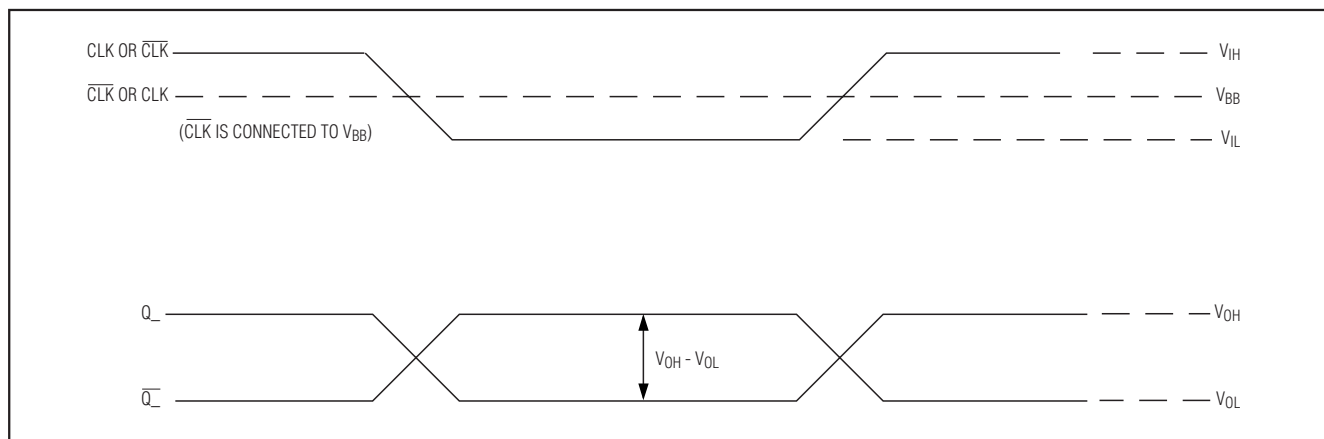


Figure 1. MAX9310A Switching Characteristics with Single-Ended Input

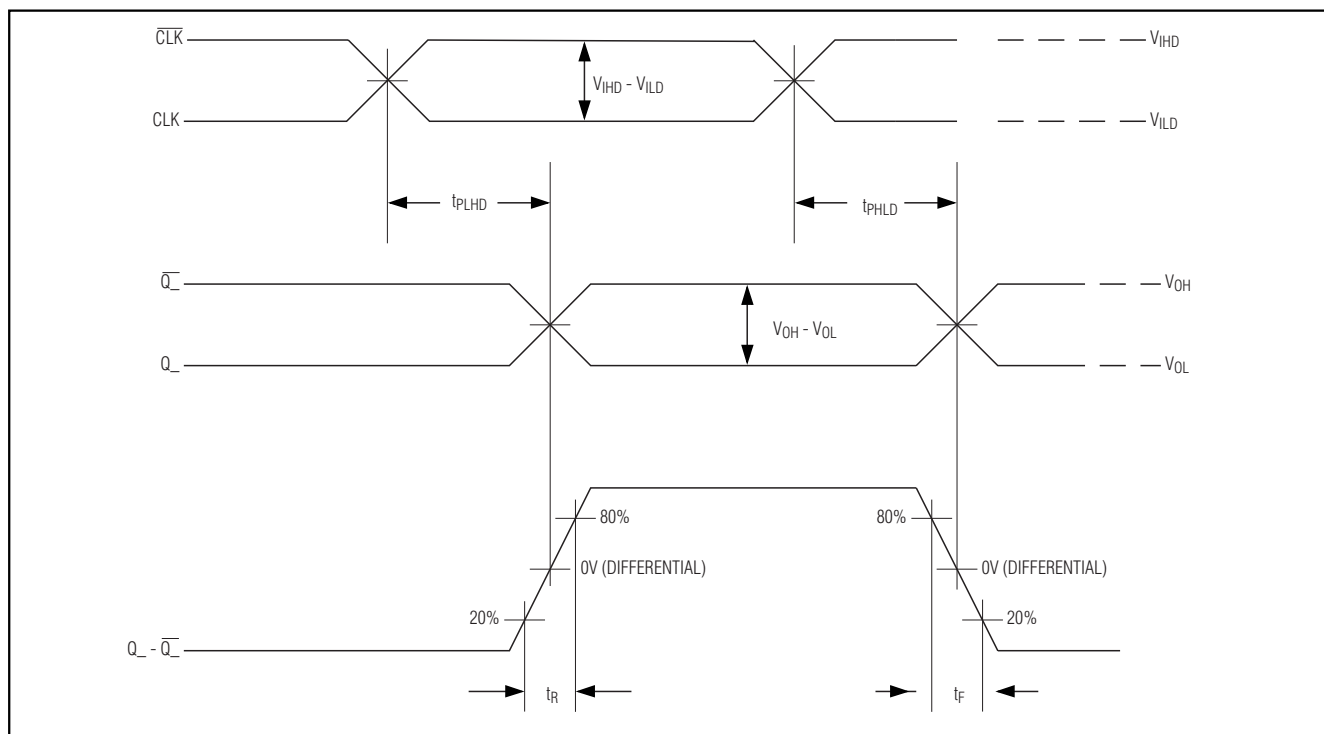


Figure 2. MAX9310A Timing Diagram

# 1:5 Clock Driver with Selectable LVPECL Inputs/Single-Ended Inputs and LVDS Outputs

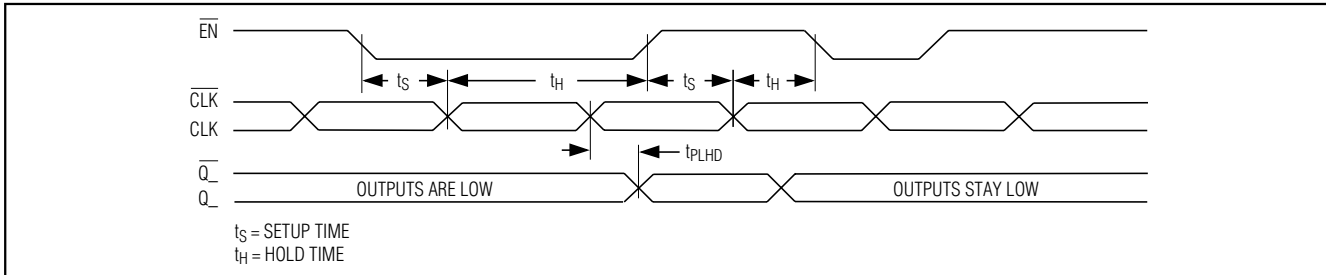


Figure 3. MAX9310A Timing  $\overline{EN}$  Diagram

## Detailed Description

The MAX9310A is a low-skew 1:5 differential driver with two selectable LVPECL inputs and LVDS outputs, designed for clock distribution applications. The selected clock accepts a differential input signal and reproduces it on five separate differential LVDS outputs. 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 device is guaranteed to operate at frequencies up to 1.0GHz with LVDS output levels conforming to the EIA/TIA-644 standard.

The MAX9310A is designed for 3V to 3.6V operation in systems with a nominal 3.3V supply.

### Differential LVPECL Input

The MAX9310A has two input differential pairs that accept differential LVPECL/HSTL inputs, and can be configured to accept single-ended LVPECL inputs through the use of the  $V_{BB}$  voltage-reference output. Each differential input pair has to be independently terminated. A select pin (CLKSEL) is used to activate the desired input. The maximum magnitude of the differential signal applied to the input is 3V. 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  $CLK_$  input and applying a single-ended signal to the  $CLK_$  input. Similarly, an inverting input is produced by connecting  $V_{BB}$  to the  $CLK_$  input and applying the signal to the  $CLK_$  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 the single-ended input must be at least  $V_{BB} \pm 95mV$  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 (Figure 1).

When using the  $V_{BB}$  reference output, bypass it with a 0.01 $\mu F$  ceramic capacitor to  $V_{CC}$ . If the  $V_{BB}$  reference is not used, leave unconnected. The  $V_{BB}$  reference can source or sink 500 $\mu A$ . Use  $V_{BB}$  only for inputs that are on the same device as the  $V_{BB}$  reference.

### Synchronous Enable

The MAX9310A is synchronously enabled and disabled with outputs in a differential low state to eliminate shortened clock pulses.  $\overline{EN}$  is connected to the input of an edge-triggered D flip-flop. After power-up, drive  $\overline{EN}$  low and toggle the selected clock input to enable the outputs. The outputs are enabled on the falling edge of the selected clock input after  $\overline{EN}$  goes low. The outputs are set to a differential low state on the falling edge of the selected clock input after  $\overline{EN}$  goes high (Figure 3).

### Input Bias Resistors

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

### Differential LVDS Output

The LVDS outputs must be terminated with 100 $\Omega$  across  $Q$  and  $Q_$ , as shown in the *Typical Application Circuit*. The outputs are short-circuit protected.



# 1:5 Clock Driver with Selectable LVPECL Inputs/Single-Ended Inputs and LVDS Outputs

## Applications Information

### Supply Bypassing

Bypass each  $V_{CC}$  to GND with high-frequency surface-mount ceramic 0.1 $\mu$ F and 0.01 $\mu$ F capacitors in parallel as close to the device as possible, with the 0.01 $\mu$ F 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 $\mu$ F 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 MAX9310A. Connect high-frequency input and output signals to 50 $\Omega$  characteristic impedance traces. Minimize the number of vias to prevent

impedance discontinuities. Reduce reflections by maintaining the 50 $\Omega$  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 $\Omega$  across  $Q_-$  and  $\overline{Q_-}$ , as shown in the *Typical Application Circuit*.

## Chip Information

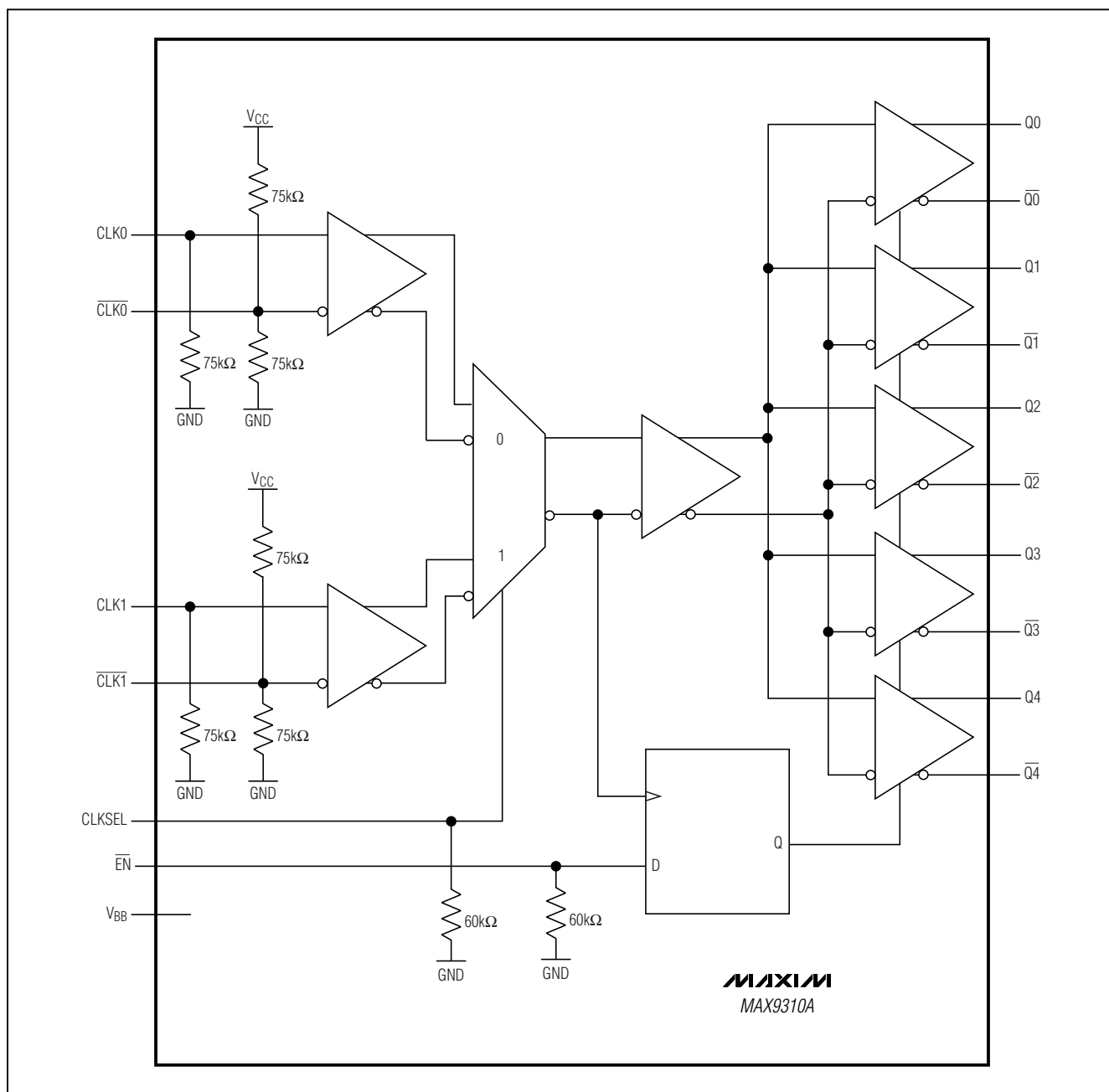
TRANSISTOR COUNT: 716

PROCESS: Bipolar

MAX9310A

# 1:5 Clock Driver with Selectable LVPECL Inputs/Single-Ended Inputs and LVDS Outputs

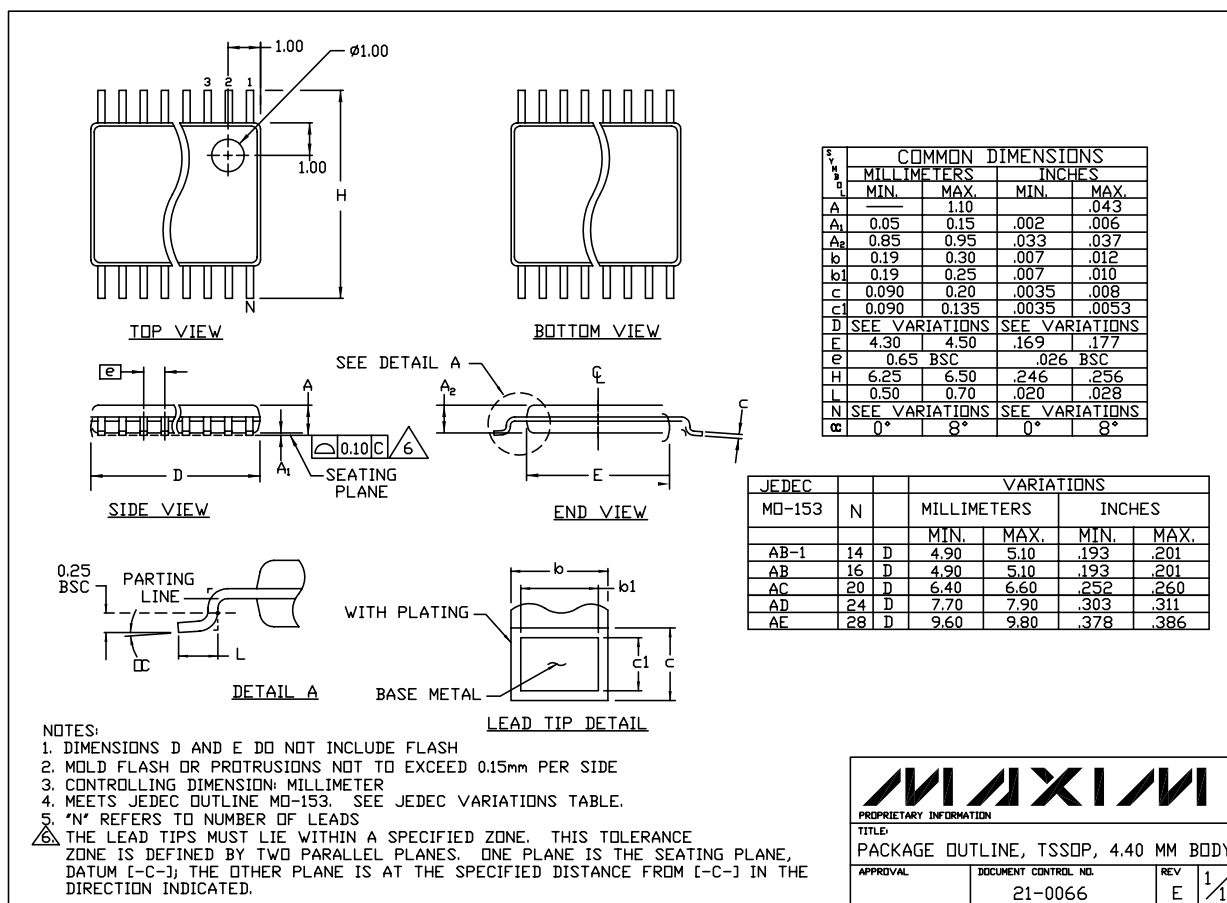
Functional Diagram



# 1:5 Clock Driver with Selectable LVPECL Inputs/Single-Ended Inputs and LVDS Outputs

## 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).)



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