



# 1:5 Clock Driver with Selectable LVPECL Inputs and LVDS Outputs

## General Description

The MAX9310 is a fast, low-skew 1:5 differential driver with selectable LVPECL/HSTL inputs and LVDS outputs, designed for clock distribution applications. This device features an ultra-low propagation delay of 345ps with 45.5mA of supply current.

The MAX9310 operates from a 2.375V to 2.625V power supply for use in 2.5V 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 also features a synchronous enable function.

The MAX9310 is offered in a space-saving 20-pin TSSOP package and operates over the extended temperature range from -40°C to +85°C.

## Applications

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

## Features

- ◆ Guaranteed 1.0GHz Operating Frequency
- ◆ 8ps Output-to-Output Skew
- ◆ 345ps Propagation Delay
- ◆ Accepts LVPECL and Differential HSTL Inputs
- ◆ Synchronous Output Enable/Disable
- ◆ Two Selectable Differential Inputs
- ◆ 2.375V to 2.625V Supply Voltage
- ◆ ESD Protection: ±2kV (Human Body Model)
- ◆ Input Bias Resistors Drive Output Low for Open Inputs

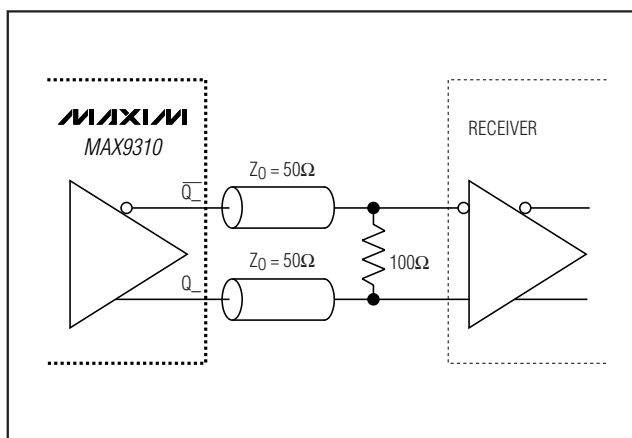
MAX9310

## Ordering Information

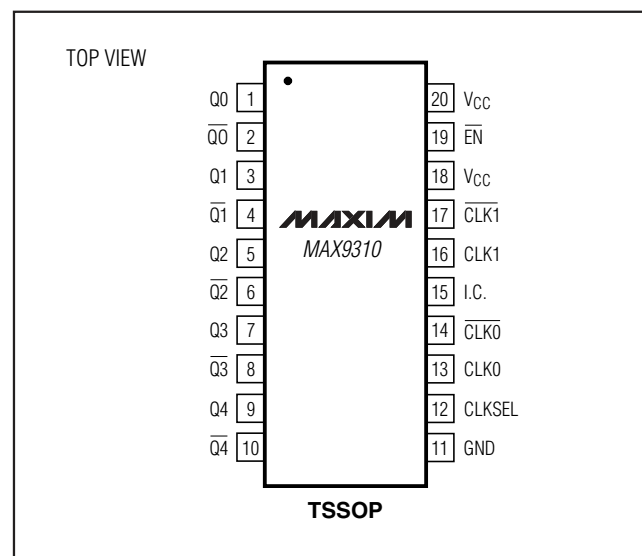
PART	TEMP RANGE	PIN-PACKAGE
MAX9310EUP	-40°C to +85°C	20 TSSOP

Functional diagram appears at end of data sheet.

## Typical Application Circuit



## Pin Configuration



# 1:5 Clock Driver with Selectable LVPECL Inputs and LVDS Outputs

## ABSOLUTE MAXIMUM RATINGS

$V_{CC}$ to GND	-0.3V to +4.1V	Multilayer PC Board	
$\overline{EN}$ , CLKSEL, CLK_, $\overline{CLK}_$ , to GND	-0.3V to ( $V_{CC} + 0.3V$ )	20-Pin TSSOP	+91°C/W
CLK_ to $\overline{CLK}_$	$V_{CC} - GND$	Junction-to-Ambient Thermal Resistance with 500LFPM Airflow Single-Layer PC board	
Continuous Output Current	24mA	20-Pin TSSOP	+96°C/W
Surge Output Current	50mA	Junction-to-Case Thermal Resistance	
Continuous Power Dissipation ( $T_A = +70^\circ\text{C}$ )		20-Pin TSSOP	+20°C/W
Single-Layer PC Board		Operating Temperature Range	
20-Pin TSSOP (derate 7.69mW/°C above +70°C)	615mW	-40°C to +85°C	
Multilayer PC Board		Junction Temperature	
20-Pin TSSOP (derate 11mW/°C above +70°C)	879mW	+150°C	
Junction-to-Ambient Thermal Resistance in Still Air		Storage Temperature Range	
Single-Layer PC Board		ESD Protection	
20-Pin TSSOP	+130°C/W	Human Body Model (inputs and outputs)	
		±2kV	
		Lead Temperature (soldering, 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

( $V_{CC} - GND = 2.375V$  to  $2.625V$ , outputs terminated with  $100\Omega \pm 1\%$ , unless otherwise noted. Typical values are at  $V_{CC} - GND = 2.5V$ ,  $V_{IH} = V_{CC} - 1.0V$ ,  $V_{ILD} = V_{CC} - 1.5V$ , 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	
<b>SINGLE-ENDED INPUTS (CLKSEL, <math>\overline{EN}</math>)</b>												
Input High Voltage	$V_{IH}$		$V_{CC} - 1.165$	$V_{CC} - 0.88$	$V_{CC} - 1.165$	$V_{CC} - 0.88$	$V_{CC} - 1.165$	$V_{CC} - 0.88$	$V_{CC} - 1.165$	$V_{CC} - 0.88$	V	
Input Low Voltage	$V_{IL}$		$V_{CC} - 1.81$	$V_{CC} - 1.475$	$V_{CC} - 1.81$	$V_{CC} - 1.475$	$V_{CC} - 1.81$	$V_{CC} - 1.475$	$V_{CC} - 1.81$	$V_{CC} - 1.475$	V	
Input Current	$I_{IN}$	$V_{IH}(\text{MAX})$ , $V_{IL}(\text{MAX})$	-150	+50	-150	+50	-150	+50	-150	+50	$\mu\text{A}$	
<b>DIFFERENTIAL INPUTS (CLK_, <math>\overline{CLK}_</math>)</b>												
Differential Input High Voltage	$V_{IHD}$	Figure 1	1.2	$V_{CC}$	1.2	$V_{CC}$	1.2	$V_{CC}$	1.2	$V_{CC}$	V	
Differential Input Low Voltage	$V_{ILD}$	Figure 1	GND	$V_{CC} - 0.095$	GND	$V_{CC} - 0.095$	GND	$V_{CC} - 0.095$	GND	$V_{CC} - 0.095$	V	
Differential Input Voltage	$V_{ID}$	$V_{IHD} - V_{ILD}$	0.095	$V_{CC}$	0.095	$V_{CC}$	0.095	$V_{CC}$	0.095	$V_{CC}$	V	
Input Current	$I_{IH}$ , $I_{IL}$	$\overline{CLK}_$ , or $\overline{CLK}_ = V_{IHD}$ or $V_{ILD}$	-60	+50	-60	+50	-60	+50	-60	+60	$\mu\text{A}$	
<b>OUTPUTS (<math>Q_</math>, <math>\overline{Q}_</math>)</b>												
Output High Voltage	$V_{OH}$	Figure 1		1.6		1.6		1.6		1.6	V	
Output Low Voltage	$V_{OL}$	Figure 1	0.9		0.9		0.9		0.9		V	
Differential Output Voltage	$V_{OD}$	$V_{OH} - V_{OL}$ , Figure 1	250	350	450	250	350	450	250	350	450	mV

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## DC ELECTRICAL CHARACTERISTICS (continued)

(V<sub>CC</sub> - GND = 2.375V to 2.625V, outputs terminated with 100Ω ±1%, unless otherwise noted. Typical values are at V<sub>CC</sub> - GND = 2.5V, 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, and 3)

PARAMETER	SYMBOL	CONDITIONS	-40°C			+25°C			+85°C			UNITS
			MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX	
Change in V <sub>OD</sub> Between Complementary Output States	ΔV <sub>OD</sub>				40			40			40	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 $\overline{Q}_-$			12			12			12	mA
		Q <sub>-</sub> or $\overline{Q}_-$ shorted to GND			28			28			28	
<b>POWER SUPPLY</b>												
Power-Supply Current	I <sub>CC</sub>	(Note 4)		42	75		45.5	75		48.5	75	mA

## AC ELECTRICAL CHARACTERISTICS

(V<sub>CC</sub> - GND = 2.375V to 2.625V, outputs terminated with 100Ω ±1%, f<sub>IN</sub> ≤ 1.0GHz, input transition time = 125ps (20% to 80%), V<sub>IHD</sub> - V<sub>ILD</sub> = 0.15V to V<sub>CC</sub>, unless otherwise noted. Typical values are at V<sub>CC</sub> - GND = 2.5V, 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 and 5)

PARAMETER	SYMBOL	CONDITIONS	-40°C			+25°C			+85°C			UNITS
			MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX	
Propagation Delay CLK <sub>-</sub> , $\overline{CLK}_-$ to Q <sub>-</sub> , $\overline{Q}_-$	t <sub>PHL</sub> , t <sub>PLH</sub>	Figure 1	250	335	600	250	345	600	250	345	600	ps
Output-to-Output Skew	t <sub>SKOO</sub>	(Note 6)		10	25		8	25		5	25	ps
Part-to-Part Skew	t <sub>SKPP</sub>	(Note 7)			145			145			145	ps
Added Random Jitter	t <sub>RJ</sub>	f <sub>IN</sub> = 1.0GHz, clock pattern (Note 8)		0.4	1.0		0.4	1.0		0.4	1.0	ps (RMS)
Added Deterministic Jitter	t <sub>DJ</sub>	f <sub>IN</sub> = 1.0Gbps, 2 <sup>23</sup> - 1 PRBS pattern (Note 8)		41	52		41	52		41	52	ps (P-P)

# 1:5 Clock Driver with Selectable LVPECL Inputs and LVDS Outputs

## AC ELECTRICAL CHARACTERISTICS (continued)

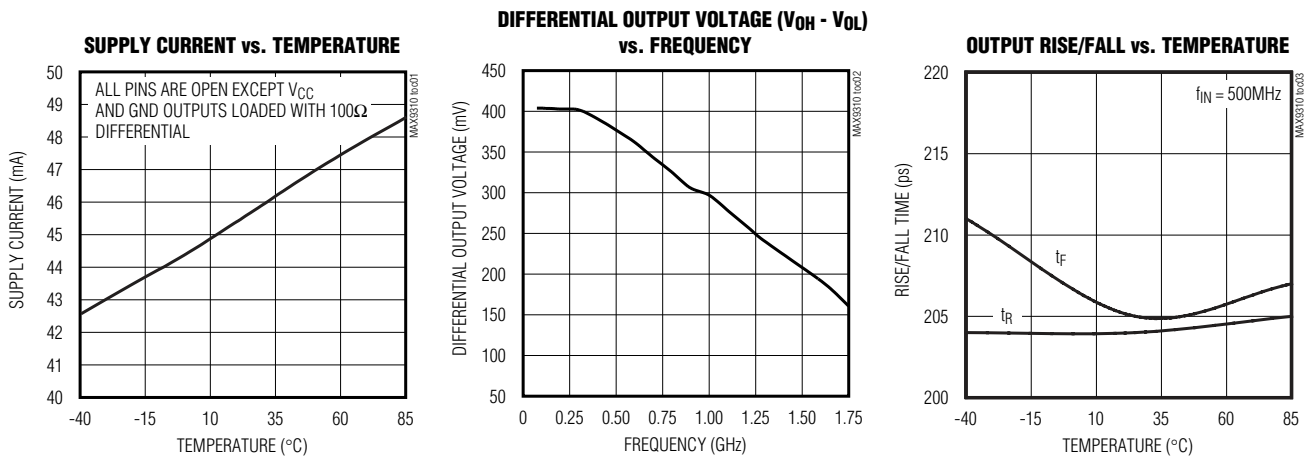
( $V_{CC} - GND = 2.375V$  to  $2.625V$ , outputs terminated with  $100\Omega \pm 1\%$ ,  $f_{IN} \leq 1.0GHz$ , input transition time = 125ps (20% to 80%),  $V_{IHD} - V_{ILD} = 0.15V$  to  $V_{CC}$ , unless otherwise noted. Typical values are at  $V_{CC} - GND = 2.5V$ ,  $V_{IHD} = V_{CC} - 1.0V$ ,  $V_{ILD} = V_{CC} - 1.5V$ , unless otherwise noted.) (Notes 1 and 5)

PARAMETER	SYMBOL	CONDITIONS	-40°C			+25°C			+85°C			UNITS
			MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX	
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 1	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:** All pins are open except  $V_{CC}$  and GND, all outputs are loaded with  $100\Omega$  differentially.
- Note 5:** Guaranteed by design and characterization. Limits are set to  $\pm 6$  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.

## Typical Operating Characteristics

( $V_{CC} - GND = 2.5V$ , 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.)

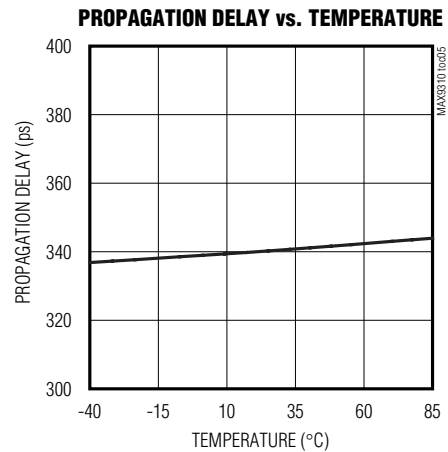
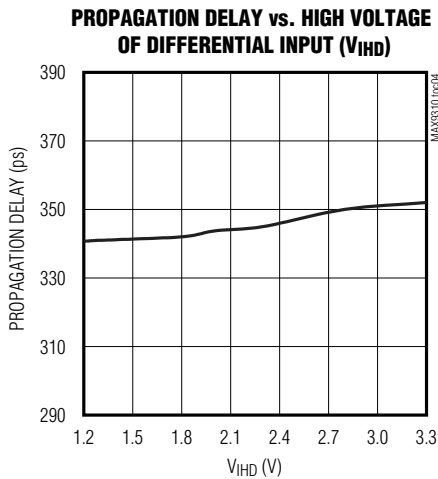


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## Typical Operating Characteristics (continued)

( $V_{CC} - GND = 2.5V$ , 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.)



## Pin Description

PIN	NAME	FUNCTION
1	Q0	Noninverting Differential Output 0. Typically terminated with $100\Omega$ to $\overline{Q0}$ .
2	$\overline{Q0}$	Inverting Differential Output 0. Typically terminated with $100\Omega$ to Q0.
3	Q1	Noninverting Differential Output 1. Typically terminated with $100\Omega$ to $\overline{Q1}$ .
4	$\overline{Q1}$	Inverting Differential Output 1. Typically terminated with $100\Omega$ to Q1.
5	Q2	Noninverting Differential Output 2. Typically terminated with $100\Omega$ to $\overline{Q2}$ .
6	$\overline{Q2}$	Inverting Differential Output 2. Typically terminated with $100\Omega$ to Q2.
7	Q3	Noninverting Differential Output 3. Typically terminated with $100\Omega$ to $\overline{Q3}$ .
8	$\overline{Q3}$	Inverting Differential Output 3. Typically terminated with $100\Omega$ to Q3.
9	Q4	Noninverting Differential Output 4. Typically terminated with $100\Omega$ to $\overline{Q4}$ .
10	$\overline{Q4}$	Inverting Differential Output 4. Typically terminated with $100\Omega$ 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. Internal $60k\Omega$ pulldown to GND.
13	CLK0	Noninverting Differential Clock Input 0. Internal $75k\Omega$ pulldown to GND.
14	$\overline{CLK0}$	Inverting Differential Clock Input 0. Internal $75k\Omega$ pullup to $V_{CC}$ and $75k\Omega$ pulldown to GND.
15	I.C.	Internally Connect. Do not connect externally.
16	CLK1	Noninverting Differential Input 1. Internal $75k\Omega$ pulldown to GND.
17	$\overline{CLK1}$	Inverting Differential Input 1. Internal $75k\Omega$ pullup to $V_{CC}$ and $75k\Omega$ pulldown to GND.

# 1:5 Clock Driver with Selectable LVPECL Inputs and LVDS Outputs

## Pin Description (continued)

PIN	NAME	FUNCTION
18, 20	V <sub>CC</sub>	Positive Supply Voltage. Bypass each V <sub>CC</sub> 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	$\overline{\text{EN}}$	Output Enable Input. Outputs are synchronously enabled on the falling edge of the selected clock input when $\overline{\text{EN}}$ is low. Outputs are synchronously driven to a differential low state on the falling edge of the selected clock input when $\overline{\text{EN}}$ is high. Internal 60kΩ pulldown to GND (Figure 2).

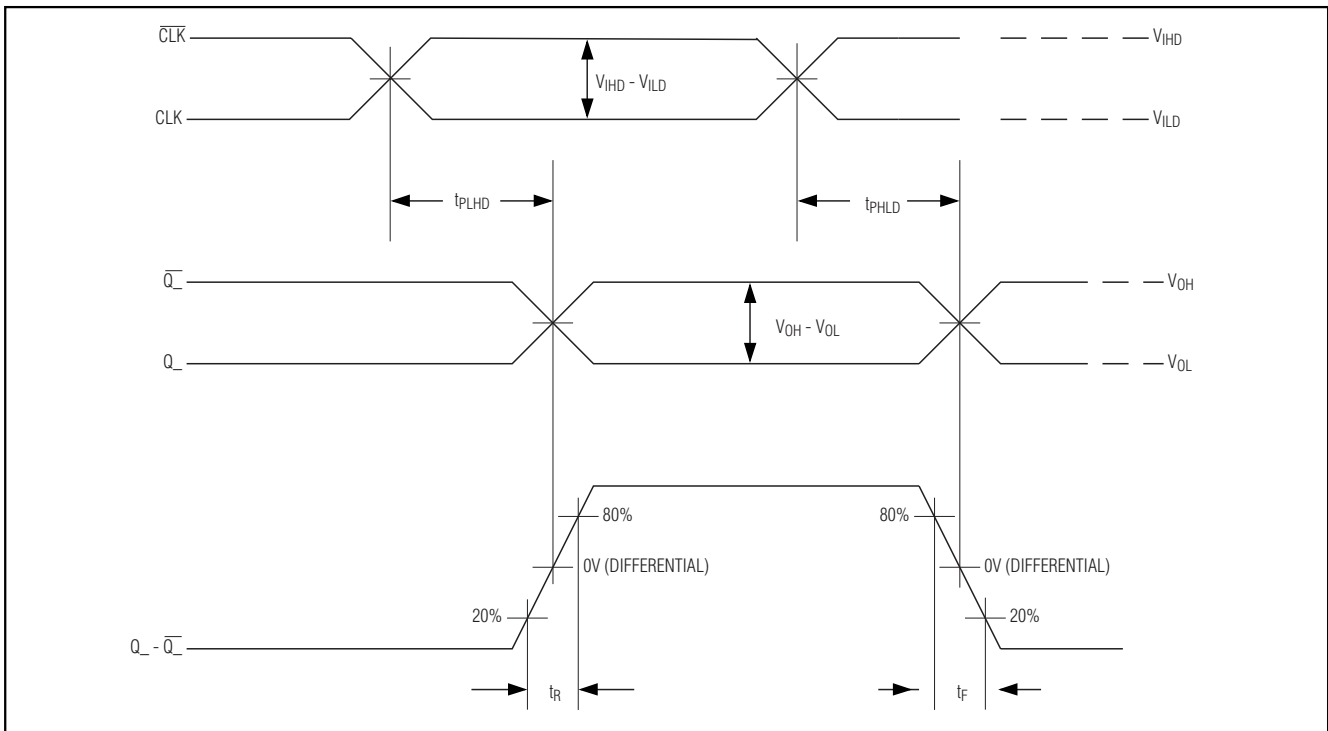


Figure 1. MAX9310 Timing Diagram

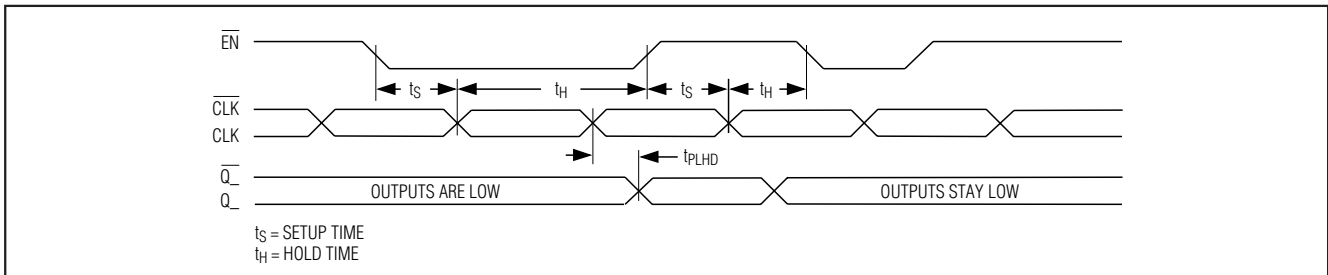


Figure 2. MAX9310  $\overline{\text{EN}}$  Timing Diagram

# 1:5 Clock Driver with Selectable LVPECL Inputs and LVDS Outputs

## Detailed Description

The MAX9310 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. The output drivers are guaranteed to operate at frequencies up to 1.0GHz with LVDS output levels conforming to the EIA/TIA-644 standard.

The MAX9310 is designed for 2.375V to 2.625V operation in systems with a nominal 2.5V supply.

### Differential LVPECL Input

The MAX9310 has two input differential pairs that accept differential LVPECL/HSTL inputs. 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  $V_{CC}$ . 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.

### Synchronous Enable

The MAX9310 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 2).

### Input Bias Resistors

Internal biasing resistors ensure a (differential) output low condition in the event that the inputs are not connected. The inverting input ( $\overline{CLK}_-$ ) 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 $\Omega$  pull-down to GND.

### Differential LVDS Output

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

## 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 and reduce power-supply bounce with high-current transients.

### Controlled-Impedance Traces

Input and output trace characteristics affect the performance of the MAX9310. 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*.

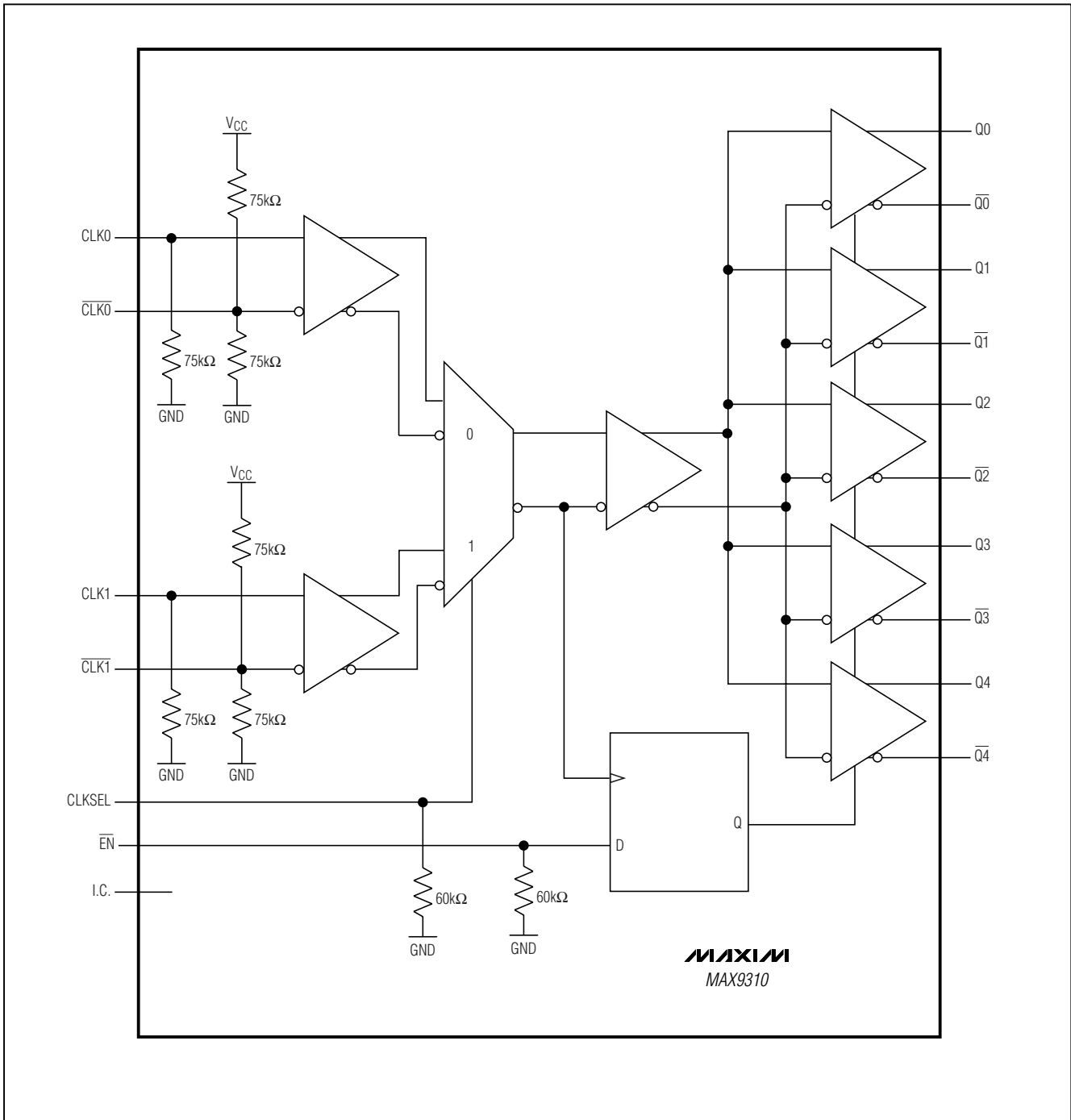
## Chip Information

TRANSISTOR COUNT: 716

PROCESS: Bipolar

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**Functional Diagram**





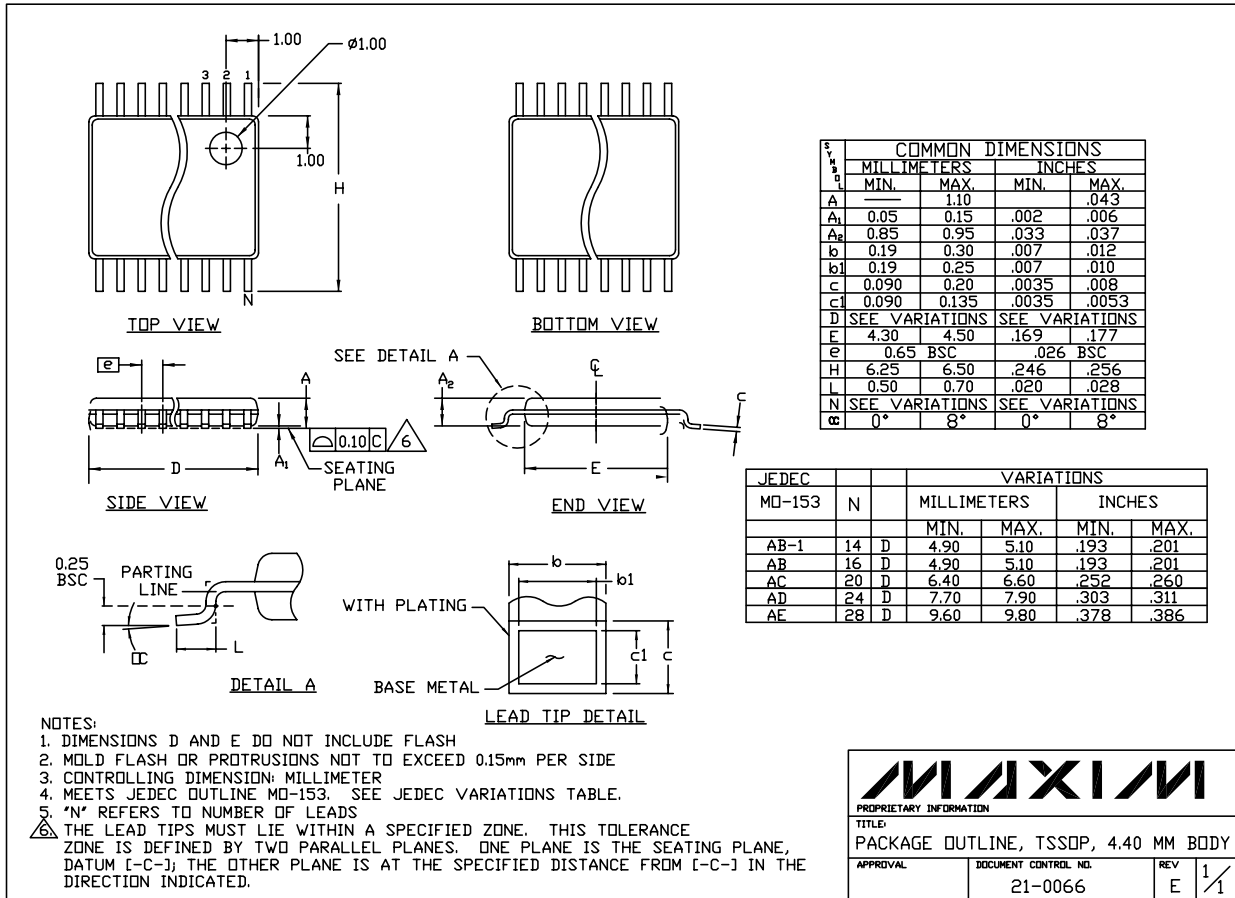
# 1:5 Clock Driver with Selectable LVPECL Inputs and LVDS Outputs

## 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).)

**MAX9310**

TSSOP, NO PADS, EPS



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