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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.

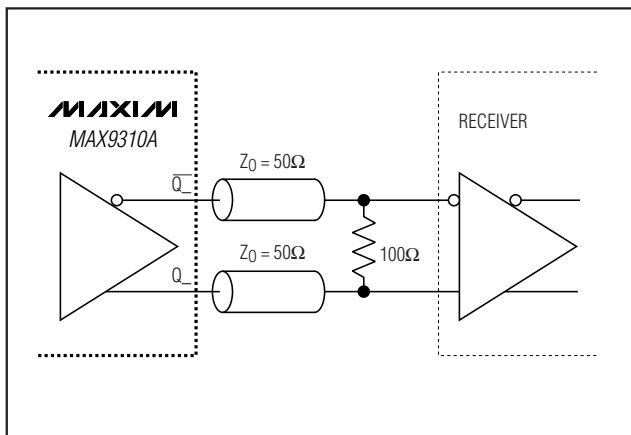
The MAX9310A is offered in a space-saving 20-pin TSSOP package and operates over the extended temperature range from -40°C to $+85^{\circ}\text{C}$.

Applications

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

Functional Diagram appears at end of data sheet.

Typical Application Circuit



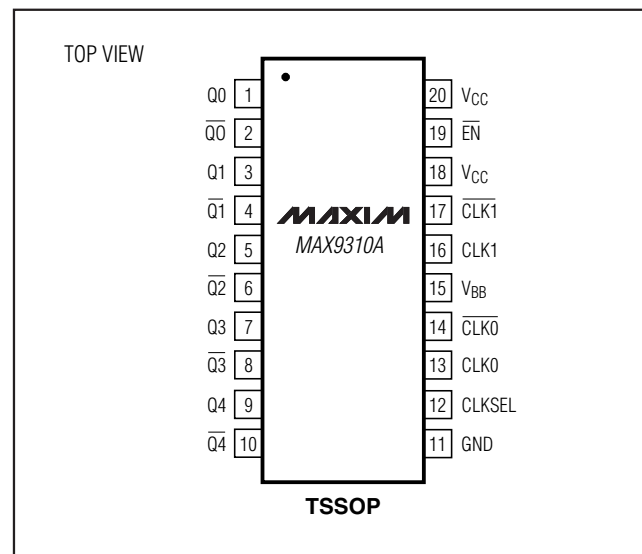
Features

- ◆ 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°C to $+85^{\circ}\text{C}$ | 20 TSSOP |

Pin Configuration



1:5 Clock Driver with Selectable LVPECL Inputs/Single-Ended 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}_- | $\pm 3V$ | Junction-to-Ambient Thermal Resistance with 500LFPM | |
| Continuous Output Current | 24mA | Airflow Single-Layer PC board | |
| Surge Output Current | 50mA | 20-Pin TSSOP | +96°C/W |
| V_{BB} Sink/Source Current | $\pm 0.65mA$ | Junction-to-Case Thermal Resistance | |
| Continuous Power Dissipation ($T_A = +70^\circ C$) | | 20-Pin TSSOP | +20°C/W |
| Single-Layer PC Board | | Operating Temperature Range | -40°C to +85°C |
| 20-Pin TSSOP (derate 7.69mW/°C above +70°C) | 615mW | Junction Temperature | +150°C |
| Multilayer PC Board | | Storage Temperature Range | -65°C to +150°C |
| 20-Pin TSSOP (derate 11mW/°C above +70°C) | 879mW | ESD Protection | |
| Junction-to-Ambient Thermal Resistance in Still Air | | Human Body Model (inputs and outputs) | $\pm 2kV$ |
| Single-Layer PC Board | | Lead Temperature (soldering, 10s) | +300°C |
| 20-Pin TSSOP | +130°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

($V_{CC} - GND = 3V$ to $3.6V$, outputs terminated with $100\Omega \pm 1\%$, unless otherwise noted. Typical values are at $V_{CC} - GND = 3.3V$, $V_{IH} = V_{CC} - 1.0V$, $V_{ILD} = V_{CC} - 1.5V$, 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 | |
| SINGLE-ENDED INPUTS (CLKSEL, \overline{EN}) | | | | | | | | | | | | |
| 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} | $V_{IH}(MAX)$, $V_{IL}(MAX)$ | -10 | +70 | -10 | +70 | -10 | +70 | -10 | +70 | | μA |
| DIFFERENTIAL INPUTS (CLK_, \overline{CLK}_-) | | | | | | | | | | | | |
| Single-Ended Input High Voltage | V_{IH} | Figure 1 | $V_{CC} - 1.125$ | $V_{CC} - 0.88$ | $V_{CC} - 1.165$ | $V_{CC} - 0.88$ | $V_{CC} - 1.165$ | $V_{CC} - 0.88$ | $V_{CC} - 1.165$ | $V_{CC} - 0.88$ | | V |
| Single-Ended Input Low Voltage | V_{IL} | Figure 1 | $V_{CC} - 1.81$ | $V_{CC} - 1.475$ | $V_{CC} - 1.81$ | $V_{CC} - 1.475$ | $V_{CC} - 1.81$ | $V_{CC} - 1.475$ | $V_{CC} - 1.81$ | $V_{CC} - 1.495$ | | V |
| Differential Input High Voltage | V_{IHD} | Figure 2 | 1.2 | V_{CC} | 1.2 | V_{CC} | 1.2 | V_{CC} | 1.2 | V_{CC} | | V |
| Differential Input Low Voltage | V_{ILD} | Figure 2 | 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 | 3.0 | 0.095 | 3.0 | 0.095 | 3.0 | 0.095 | 3.0 | | V |
| Input Current | I_{IH} , I_{IL} | CLK_, or \overline{CLK}_- = V_{IHD} or V_{ILD} | -100 | +100 | -100 | +100 | -100 | +100 | -100 | +100 | | μA |

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

MAX9310A

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₊, Q₋) | | | | | | | | | | | | |
| Output High Voltage | V _{OH} | Figure 2 | | | 1.6 | | | 1.6 | | | 1.6 | V |
| Output Low Voltage | V _{OL} | Figure 2 | 0.9 | | | 0.9 | | | 0.9 | | | V |
| Differential Output Voltage | V _{OD} | V _{OH} - V _{OL} , Figure 2 | 250 | 350 | 450 | 250 | 350 | 450 | 250 | 350 | 450 | mV |
| Change in V _{OD} Between Complementary Output States | ΔV _{OD} | | | | 50 | | | 50 | | | 50 | mV |
| Output Offset Voltage | V _{OS} | | 1.125 | 1.25 | 1.375 | 1.125 | 1.25 | 1.375 | 1.125 | 1.25 | 1.375 | mV |
| Change in V _{OS} Between Complementary Output States | ΔV _{OCM} | | | | 25 | | | 25 | | | 25 | mV |
| Output Short-Circuit Current | I _{OSC} | Q ₊ shorted to Q ₋ | | | 12 | | | 12 | | | 12 | mA |
| | | Q ₊ or Q ₋ shorted to GND | | | 29 | | | 29 | | | 29 | |
| REFERENCE | | | | | | | | | | | | |
| Reference Voltage Output | V _{BB} | I _{BB} = ±0.65mA (Note 4) | V _{CC} - 1.38 | | V _{CC} - 1.22 | V _{CC} - 1.38 | | V _{CC} - 1.26 | V _{CC} - 1.40 | | V _{CC} - 1.26 | V |
| POWER SUPPLY | | | | | | | | | | | | |
| Power-Supply Current | I _{CC} | (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} = 1.0Gsp/s, 2 ²³ - 1 PRBS pattern (Note 9) | | 50 | 60 | | 50 | 60 | | 50 | 60 | ps (P-P) |
| Operating Frequency | f _{MAX} | V _{OD} ≥ 250mV | 1.0 | | | 1.0 | | | 1.0 | | | GHz |
| Differential Output Rise/Fall Time | t _R /t _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 100Ω differentially.

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

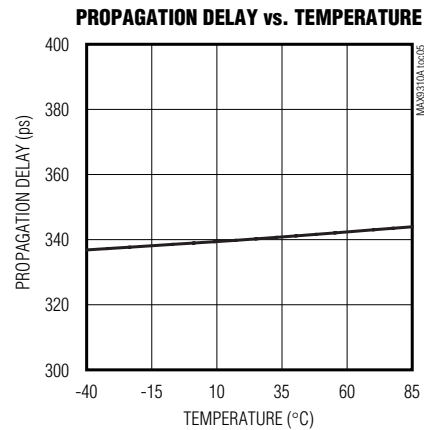
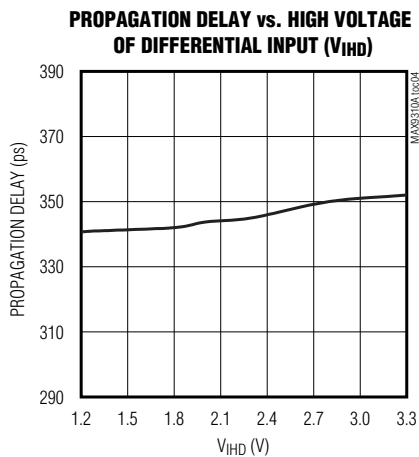
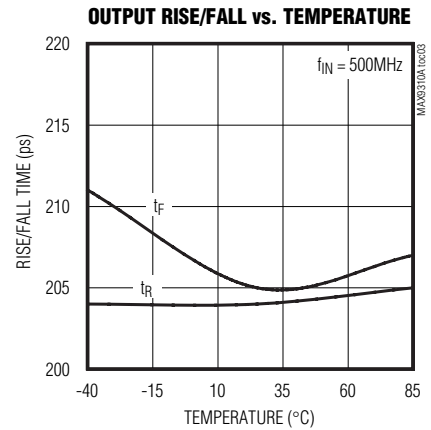
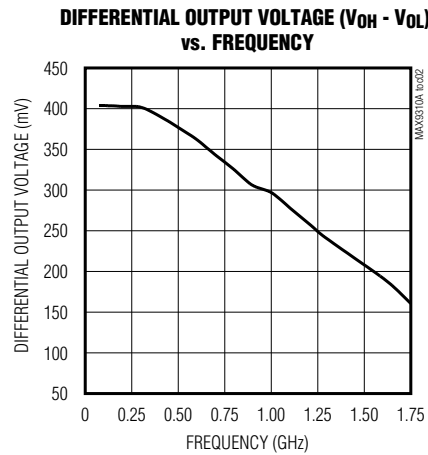
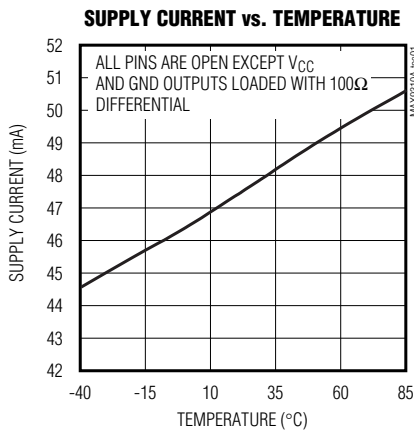
Note 9: Device jitter added to the input signal.

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

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.)

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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

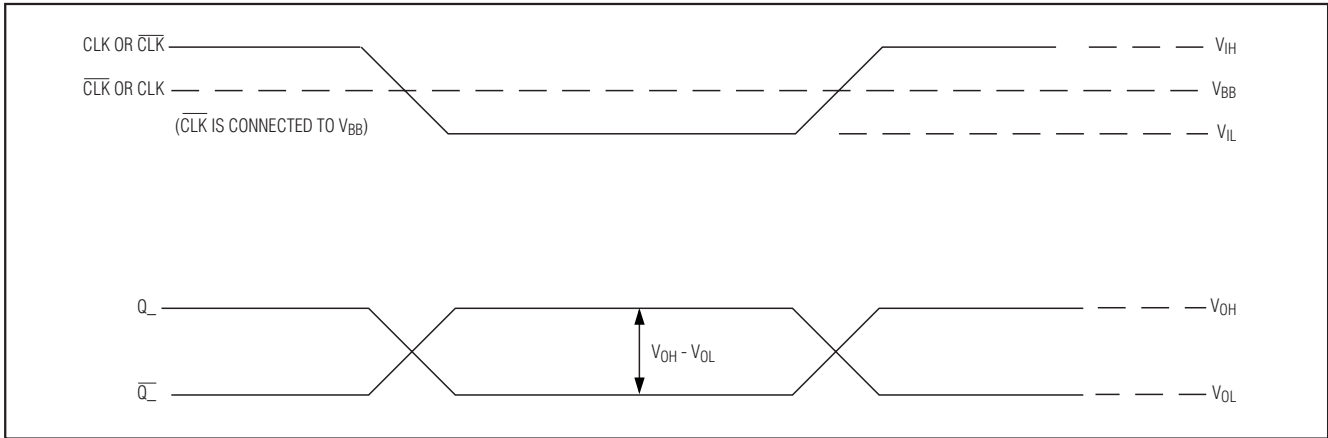


Figure 1. MAX9310A Switching Characteristics with Single-Ended Input

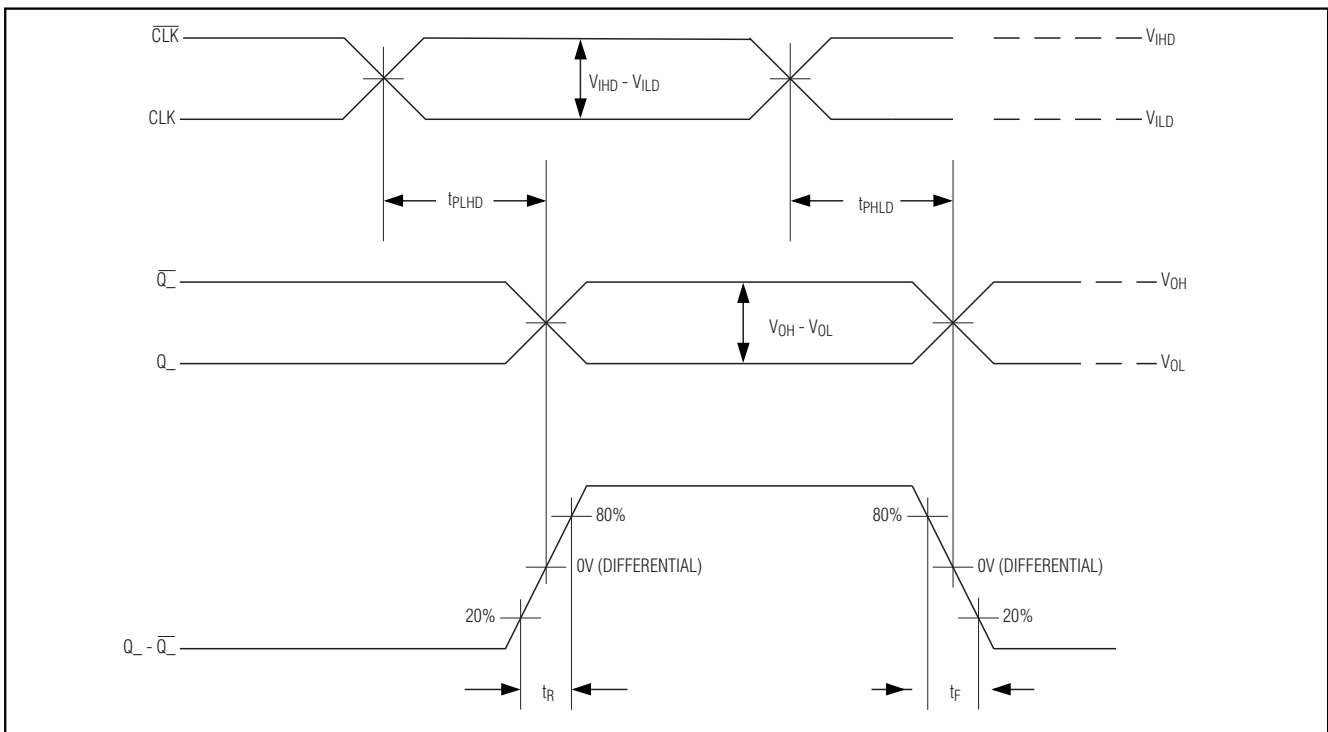


Figure 2. MAX9310A Timing Diagram

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

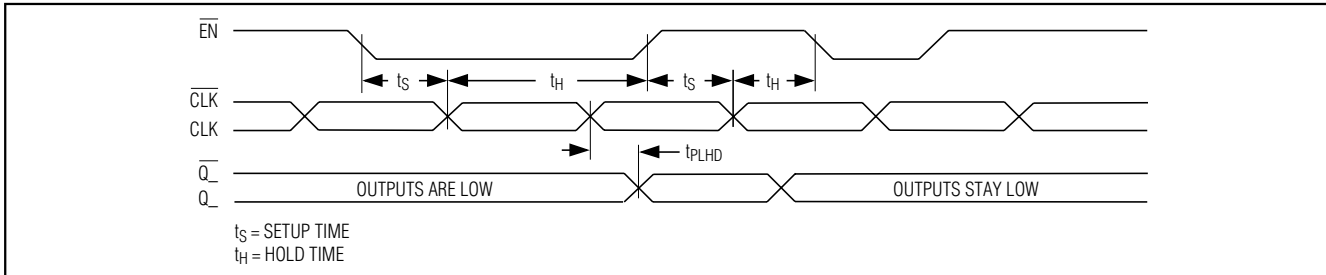


Figure 3. MAX9310A Timing \overline{EN} Diagram

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 \overline{CLK}_- input and applying a single-ended signal to the \overline{CLK}_+ input. Similarly, an inverting input is produced by connecting V_{BB} to the \overline{CLK}_+ input and applying the signal to the \overline{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 μF ceramic capacitor to V_{CC} . If the V_{BB} reference is not used, leave unconnected. The V_{BB} reference can source or sink 500 μA . 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 (\overline{CLK}_-) is biased with a 75k Ω pulldown to GND and a 75k Ω pullup to V_{CC} . The noninverting input (\overline{CLK}_+) is biased with a 75k Ω pulldown to GND.

Differential LVDS Output

The LVDS outputs must be terminated with 100 Ω across Q and \overline{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 μ F and 0.01 μ F capacitors in parallel as close to the device as possible, with the 0.01 μ 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 μ 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 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 \overline{Q} ₋, as shown in the *Typical Application Circuit*.

Chip Information

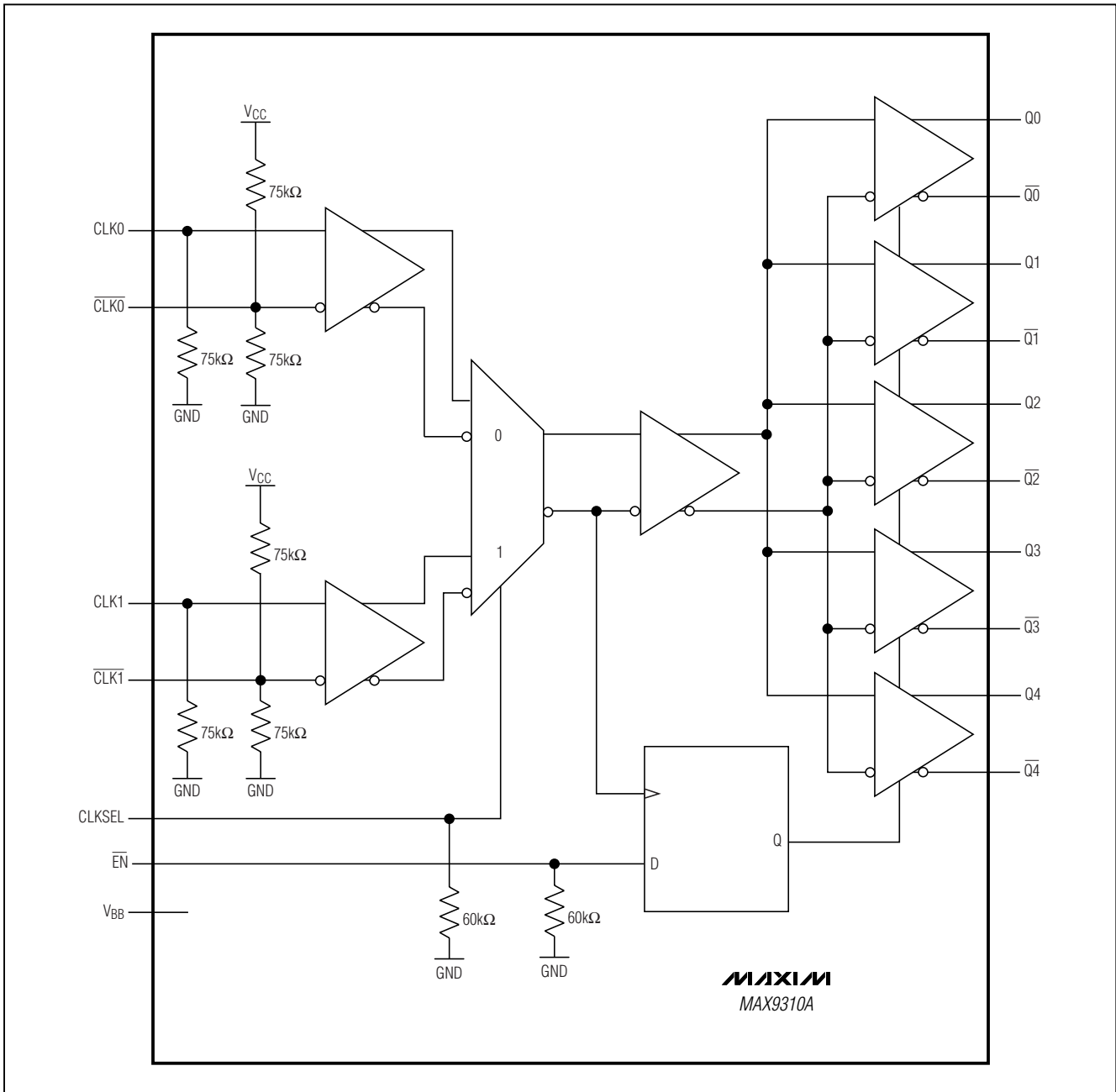
TRANSISTOR COUNT: 716

PROCESS: Bipolar

MAX9310A

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

Functional Diagram

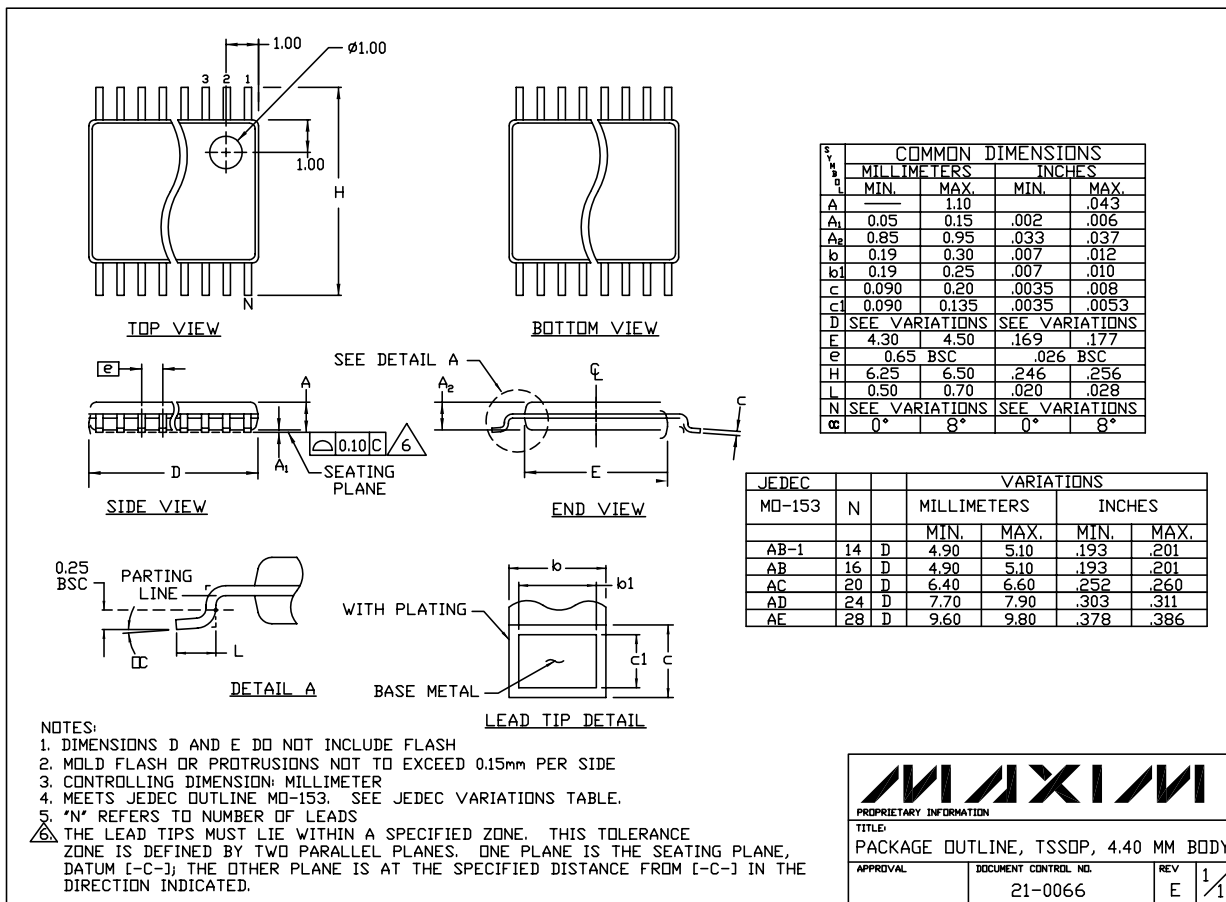


1:5 Clock Driver with Selectable LVPECL Inputs/Single-Ended Inputs and LVDS Outputs

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.)

MAX9310A



TSSOP, NO PADS, EPS

Maxim cannot assume responsibility for use of any circuitry other than circuitry entirely embodied in a Maxim product. No circuit patent licenses are implied. Maxim reserves the right to change the circuitry and specifications without notice at any time.

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