



1:2 Differential PECL/ECL/LVPECL/LVECL Clock and Data Driver

MAX9320B

General Description

The MAX9320B low-skew, 1-to-2 differential driver is 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 MAX9320B features ultra-low propagation delay (208ps), part-to-part skew (20ps), and output-to-output skew (6ps) with 30mA maximum supply current, making this device ideal for clock distribution. For interfacing to differential PECL and LVPECL signals, this device operates over a +3.0V to +5.5V supply range, allowing high-performance clock or data distribution in systems with a nominal 3.3V or 5V supply. For differential ECL and LVECL operation, this device operates from a -3.0V to -5.5V supply.

The MAX9320B is offered in industry-standard 8-pin TSSOP and SO packages.

Applications

- Precision Clock Distribution
- Low-Jitter Data Repeater
- Protection Switching

Features

- ◆ Improved Second Source of the MC10EP11D
- ◆ +3.0V to +5.5V Differential PECL/LVPECL Operation
- ◆ -3.0V to -5.5V ECL/LVECL Operation
- ◆ Low 22mA Supply Current
- ◆ 20ps Part-to-Part Skew
- ◆ 6ps Output-to-Output Skew
- ◆ 208ps Propagation Delay
- ◆ Minimum 300mV Output at 3GHz
- ◆ Outputs Low for Open Input
- ◆ ESD Protection >2kV (Human Body Model)

Ordering Information

| PART | TEMP RANGE | PIN-PACKAGE |
|-------------|----------------|-------------|
| MAX9320BESA | -40°C to +85°C | 8 SO |
| MAX9320BEUA | -40°C to +85°C | 8 TSSOP |

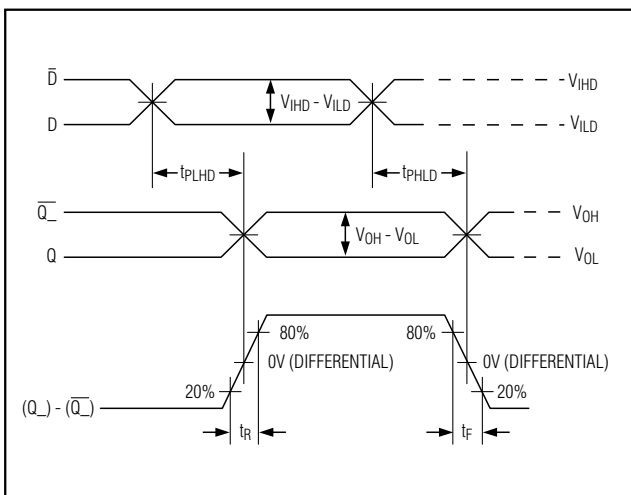
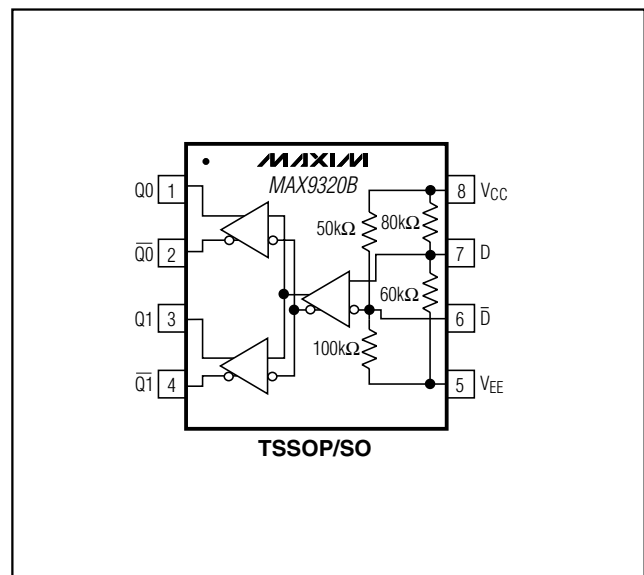


Figure 1. Differential Transition Time and Propagation Delay Timing Diagram

Pin Configuration



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ABSOLUTE MAXIMUM RATINGS

| | | |
|--|--|--|
| V _{CC} to V _{EE} | +6V | Junction-to-Ambient Thermal Resistance with 500 LFPM Airflow |
| D or \overline{D} | V _{EE} - 0.3V to V _{CC} + 0.3V | 8-Pin TSSOP |
| D or \overline{D} with the Other Floating | V _{CC} - 5.0V to V _{CC} + 0.3V | 8-Pin SO |
| D to \overline{D} | ±3.0V | Junction-to-Case Thermal Resistance |
| Continuous Output Current | 50mA | 8-Pin TSSOP |
| Surge Output Current | 100mA | 8-Pin SO |
| Continuous Output Power Dissipation (T _A = +70°C) | | Operating Temperature Range |
| 8-Pin TSSOP | | Junction Temperature |
| (derate 4.5mW/°C above +70°C) | 362mW | Storage Temperature Range |
| 8-Pin SO | | ESD Protection |
| (derate 5.9mW/°C above +70°C) | 471mW | Human Body Model (D, \overline{D} , Q ₊ , \overline{Q} ₋) |
| Junction-to-Ambient Thermal Resistance in Still Air | | Soldering Temperature (10s) |
| 8-Pin TSSOP | +221°C/W | |
| 8-Pin SO | +170°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} - V_{EE} = 3.0V to 5.5V, outputs loaded with 50Ω ±1% to V_{CC} - 2V. Typical values are at V_{CC} - V_{EE} = 5.0V, 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 _{CC} | 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} | | 0.1 | 3.0 | 0.1 | 3.0 | 0.1 | 3.0 | V | | | |
| Input High Current | I _{IH} | | | 150 | | 150 | | 150 | μA | | | |
| D Input Low Current | I _{ILD} | V _{CC} - V _{EE} ≤ 3.8V | -100 | +100 | -100 | +100 | -100 | +100 | μA | | | |
| | | V _{CC} - V _{EE} ≥ 3.8V | -140 | +140 | -140 | +140 | -140 | +140 | | | | |
| \overline{D} Input Low Current | I _{I\overline{D}} | V _{CC} - V _{EE} ≤ 3.8V | -150 | +150 | -150 | +150 | -150 | +150 | μA | | | |
| | | V _{CC} - V _{EE} ≥ 3.8V | -175 | +175 | -175 | +175 | -175 | +175 | | | | |
| 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 | | | |

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DC ELECTRICAL CHARACTERISTICS (continued)

($V_{CC} - V_{EE} = 3.0V$ to $5.5V$, outputs loaded with $50\Omega \pm 1\%$ to $V_{CC} - 2V$. Typical values are at $V_{CC} - V_{EE} = 5.0V$, $V_{IHD} = V_{CC} - 1.0V$, $V_{ILD} = V_{CC} - 1.5V$, 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 | I_{EE} | (Note 4) | | 20 | 28 | | 22 | 28 | | 23 | 30 | | mA |

AC ELECTRICAL CHARACTERISTICS

($V_{CC} - V_{EE} = 3.0V$ to $5.5V$, outputs loaded with $50\Omega \pm 1\%$ to $V_{CC} - 2V$, input frequency $\leq 1.5GHz$, 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 $3.0V$. Typical values are at $V_{CC} - V_{EE} = 5.0V$, $V_{IHD} = V_{CC} - 1V$, $V_{ILD} = V_{CC} - 1.5V$, 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 | t_{SKOO} | (Note 6) | | 6 | 30 | | 6 | 30 | | 6 | 30 | ps |
| Part-to-Part Skew | t_{SKPP} | (Note 7) | | 20 | 120 | | 20 | 110 | | 20 | 110 | ps |
| Added Random Jitter | t_{RJ} | $f_{IN} = 1.5GHz$, clock pattern (Note 8) | | 1.7 | 2.8 | | 1.7 | 2.8 | | 1.7 | 2.8 | ps (RMS) |
| | | $f_{IN} = 3.0GHz$, clock pattern (Note 8) | | 0.6 | 1.5 | | 0.6 | 1.5 | | 0.6 | 1.5 | |
| Added Deterministic Jitter | t_{DJ} | 3.0Gbps $2^{23} - 1$ PRBS pattern (Note 8) | | 57 | 80 | | 57 | 80 | | 57 | 80 | ps (P-P) |

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AC ELECTRICAL CHARACTERISTICS (continued)

($V_{CC} - V_{EE} = 3.0V$ to $5.5V$, outputs loaded with $50\Omega \pm 1\%$ to $V_{CC} - 2V$, input frequency $\leq 1.5GHz$, 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 $3.0V$. Typical values are at $V_{CC} - V_{EE} = 5.0V$, $V_{IHD} = V_{CC} - 1V$, $V_{ILD} = V_{CC} - 1.5V$, 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} | $V_{OH} - V_{OL} \geq 300mV$, clock pattern, Figure 1 | 3.0 | | | 3.0 | | | 3.0 | | | GHz |
| | | $V_{OH} - V_{OL} \geq 550mV$, clock pattern, Figure 1 | 2.0 | | | 2.0 | | | 2.0 | | | |
| Output Rise/Fall Time (20% to 80%) | t_R, t_F | Figure 1 | 50 | 95 | 120 | 50 | 98 | 120 | 50 | 105 | 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 $T_A = +25^\circ C$. 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.

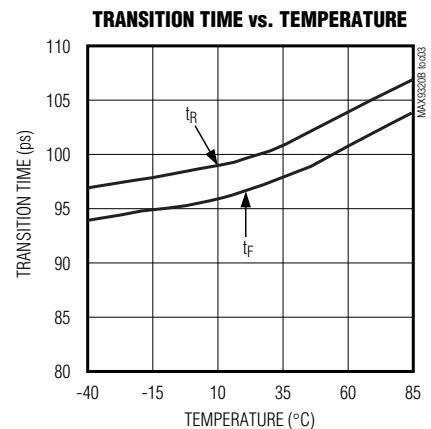
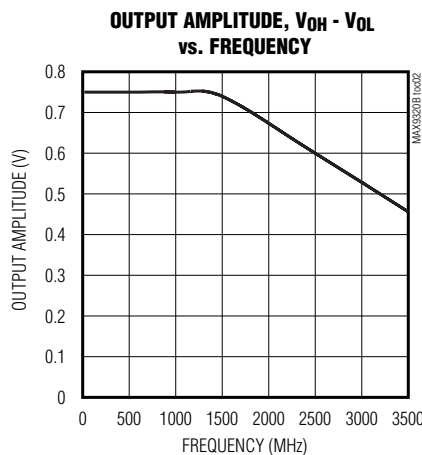
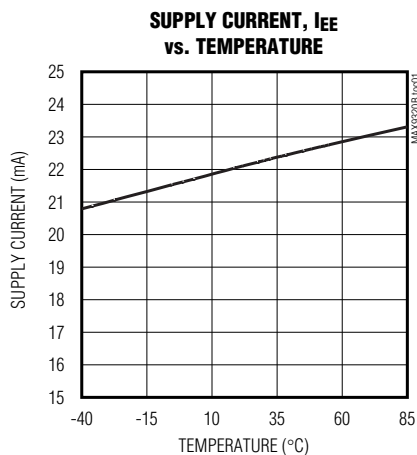
Note 6: Measured between outputs of the same part at the signal crossing points for a same-edge transition.

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

($V_{CC} = 5V$, $V_{EE} = 0$, 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 $V_{CC} - 2V$, $T_A = +25^\circ C$, unless otherwise noted.)

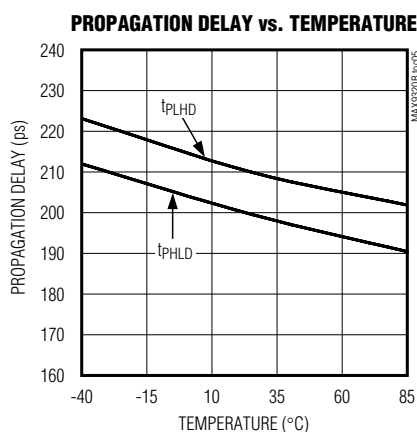
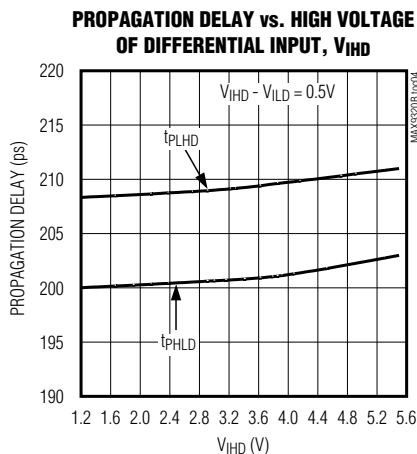


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Typical Operating Characteristics (continued)

($V_{CC} = 5V$, $V_{EE} = 0$, 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 $V_{CC} - 2V$, $T_A = +25^\circ C$, unless otherwise noted.)



Pin Description

| PIN | NAME | FUNCTION |
|-----|-----------------|---|
| 1 | Q0 | Noninverting Q0 Output. Typically terminate with 50Ω resistor to $V_{CC} - 2V$. |
| 2 | $\overline{Q0}$ | Inverting Q0 Output. Typically terminate with 50Ω resistor to $V_{CC} - 2V$. |
| 3 | Q1 | Noninverting Q1 Output. Typically terminate with 50Ω resistor to $V_{CC} - 2V$. |
| 4 | $\overline{Q1}$ | Inverting Q1 Output. Typically terminate with 50Ω resistor to $V_{CC} - 2V$. |
| 5 | V_{EE} | Negative Supply Voltage |
| 6 | \overline{D} | Inverting Differential Input. $50k\Omega$ pullup to V_{CC} and $100k\Omega$ pulldown to V_{EE} . |
| 7 | D | Noninverting Differential Input. $80k\Omega$ pullup to V_{CC} and $60k\Omega$ pulldown to V_{EE} . |
| 8 | V_{CC} | Positive Supply Voltage. Bypass from V_{CC} to V_{EE} with $0.1\mu F$ and $0.01\mu F$ ceramic capacitors. Place the capacitors as close to the device as possible with the smaller value capacitor closest to the device. |

1:2 Differential PECL/ECL/LVPECL/LVECL Clock and Data Driver

Detailed Description

The MAX9320B low-skew, 1-to-2 differential driver is designed for clock and data distribution. For interfacing to differential PECL and LVPECL signals, this device operates over a +3.0V to +5.5V supply range, allowing high-performance clock and data distribution in systems with a nominal 3.3V or 5V supply. For differential ECL and LVECL operation, this device operates from a -3.0V to -5.5V supply.

Inputs

The maximum magnitude of the differential input from D to \overline{D} is 3.0V. 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 50k Ω pullup to VCC and a 100k Ω pulldown to VEE. The noninverting input, D, is biased with an 80k Ω pullup to VCC and a 60k Ω pulldown to VEE.

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 VCC and are considered PECL/LVPECL or ECL/LVECL, depending on the level of the VCC supply. With VCC connected to a positive supply and VEE connected to GND, the outputs are PECL/LVPECL. The outputs are ECL/LVECL when VCC is connected to GND and VEE is connected to a negative supply.

A differential input of at least $\pm 100\text{mV}$ switches the outputs to the V_{OH} and V_{OL} levels specified in the DC Electrical Characteristics table.

Applications Information

Supply Bypassing

Bypass VCC to VEE with high-frequency surface-mount ceramic 0.1 μF and 0.01 μF capacitors in parallel as close to the device as possible, with the 0.01 μF value capacitor closest to the device. Use multiple parallel ground vias for low inductance.

Traces

Input and output trace characteristics affect the performance of the MAX9320B. Connect each signal of a differential input or output to a 50 Ω characteristic impedance trace. Minimize the number of vias to prevent impedance discontinuities. Reduce reflections by maintaining the 50 Ω characteristic impedance through connectors and across cables. Reduce skew within a differential pair by matching the electrical length of the traces.

Output Termination

Terminate outputs through 50 Ω to VCC - 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