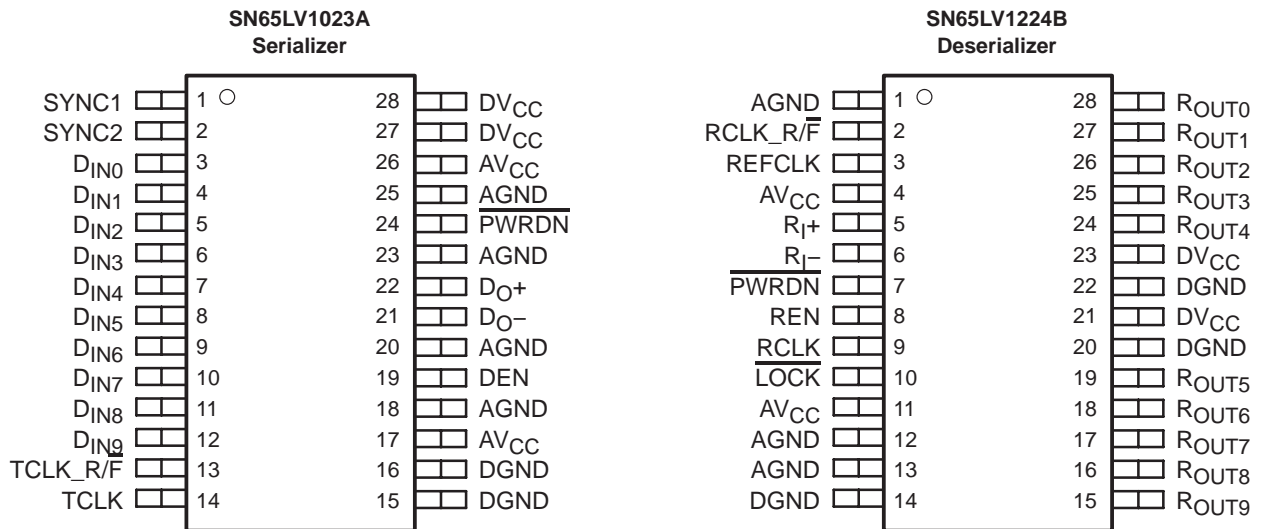


# SN65LV1023A/SN65LV1224B

## 10-MHz TO 66-MHz, 10:1 LVDS SERIALIZER/DESIALIZER

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- 100-Mbps to 660-Mbps Serial LVDS Data Payload Bandwidth at 10-MHz to 66-MHz System Clock
- Pin-Compatible Superset of NSM DS92LV1023/DS92LV1224
- Chipset (Serializer/Deserializer) Power Consumption <450 mW (Typ) at 66 MHz
- Synchronization Mode for Faster Lock
- Lock Indicator
- No External Components Required for PLL
- Low-Cost 28-Pin SSOP Package
- Industrial Temperature Qualified,  $T_A = -40^{\circ}\text{C}$  to  $85^{\circ}\text{C}$
- Programmable Edge Trigger on Clock
- Flow-Through Pinout for Easy PCB Layout



### description

The SN65LV1023A serializer and SN65LV1224B deserializer comprise a 10-bit serdes chipset designed to transmit and receive serial data over LVDS differential backplanes at equivalent parallel word rates from 10 MHz to 66 MHz. Including overhead, this translates into a serial data rate between 120-Mbps and 792-Mbps payload encoded throughput.

Upon power up, the chipset link can be initialized via a synchronization mode with internally generated SYNC patterns or the deserializer can be allowed to synchronize to random data. By using the synchronization mode, the deserializer establishes lock within specified, shorter time parameters.

The device can be entered into a power-down state when no data transfer is required. Alternatively, a mode is available to place the output pins in the high-impedance state without losing PLL lock.

The SN65LV1023A and SN65LV1224B are characterized for operation over ambient air temperature of  $-40^{\circ}\text{C}$  to  $85^{\circ}\text{C}$ .

### ORDERING INFORMATION

| DEVICE       | PART NUMBER   |
|--------------|---------------|
| Serializer   | SN65LV1023ADB |
| Deserializer | SN65LV1224BDB |



Please be aware that an important notice concerning availability, standard warranty, and use in critical applications of Texas Instruments semiconductor products and disclaimers thereto appears at the end of this data sheet.

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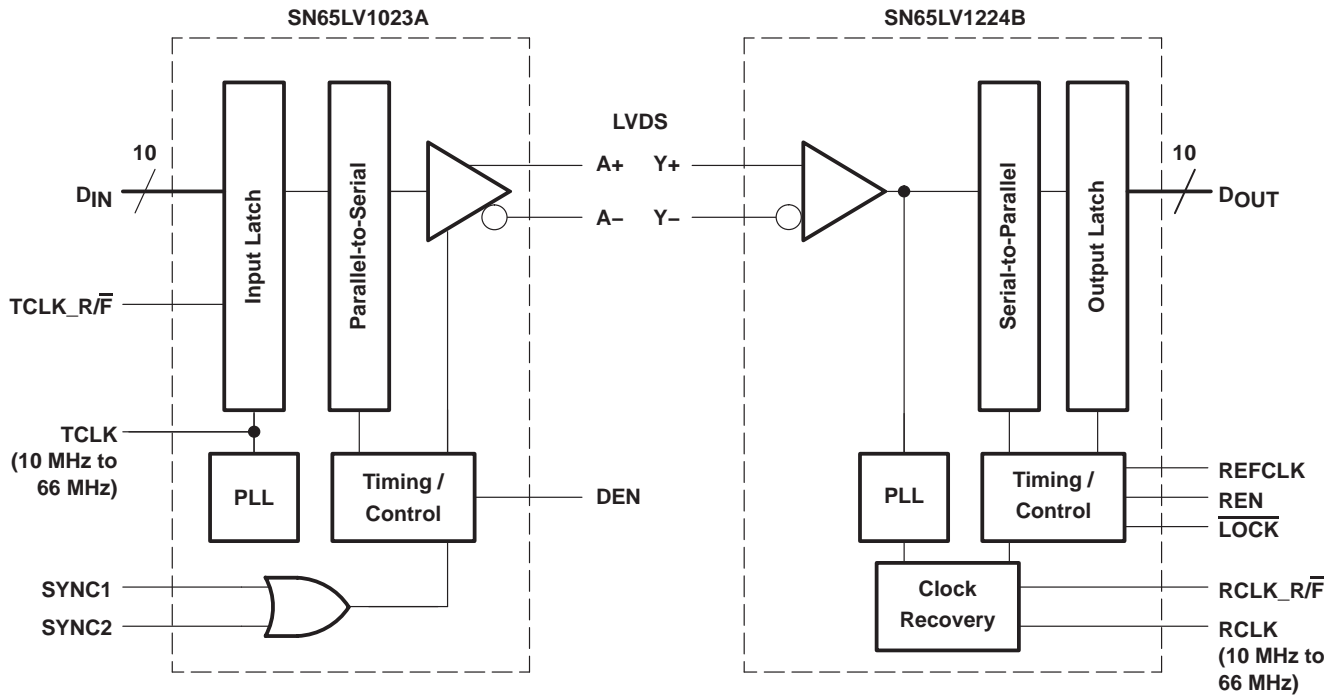
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# SN65LV1023A/SN65LV1224B 10-MHz TO 66-MHz, 10:1 LVDS SERIALIZER/DESERIALIZER

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## block diagrams



## functional description

The SN65LV1023A and SN65LV1224B are a 10-bit serializer/deserializer chipset designed to transmit data over differential backplanes or unshielded twisted pair (UTP) at clock speeds from 10 MHz to 66 MHz. The chipset has five states of operation: initialization mode, synchronization mode, data transmission mode, power-down mode, and high-impedance mode. The following sections describe each state of operation.

### initialization mode

Initialization of both devices must occur before data transmission can commence. Initialization refers to synchronization of the serializer and deserializer PLLs to local clocks.

When  $V_{CC}$  is applied to the serializer and/or deserializer, the respective outputs enter the high-impedance state, while on-chip power-on circuitry disables internal circuitry. When  $V_{CC}$  reaches 2.45 V, the PLL in each device begins locking to a local clock. For the serializer, the local clock is the transmit clock (TCLK) provided by an external source. For the deserializer, a local clock must be applied to the REFCLK pin. The serializer outputs remain in the high-impedance state, while the PLL locks to the TCLK.

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## functional description (continued)

### synchronization mode

The deserializer PLL must synchronize to the serializer in order to receive valid data. Synchronization can be accomplished in one of two ways:

- **Rapid Synchronization:** The serializer has the capability to send specific SYNC patterns consisting of six ones and six zeros switching at the input clock rate. The transmission of SYNC patterns enables the deserializer to lock to the serializer signal within a deterministic time frame. This transmission of SYNC patterns is selected via the SYNC1 and SYNC2 inputs on the serializer. Upon receiving valid SYNC1 or SYNC2 pulse (wider than 6 clock cycles), 1026 cycles of SYNC pattern are sent.

When the deserializer detects edge transitions at the LVDS input, it attempts to lock to the embedded clock information. The deserializer  $\overline{\text{LOCK}}$  output remains high while its PLL locks to the incoming data or SYNC patterns present on the serial input. When the deserializer locks to the LVDS data, the  $\overline{\text{LOCK}}$  output goes low. When  $\overline{\text{LOCK}}$  is low, the deserializer outputs represent incoming LVDS data. One approach is to tie the deserializer  $\overline{\text{LOCK}}$  output directly to SYNC1 or SYNC2.

- **Random-Lock Synchronization:** The deserializer can attain lock to a data stream without requiring the serializer to send special SYNC patterns. This allows the SN65LV1224B to operate in open-loop applications. Equally important is the deserializer's ability to support hot insertion into a running backplane. In the open-loop or hot-insertion case, it is assumed the data stream is essentially random. Therefore, because lock time varies due to data stream characteristics, the exact lock time cannot be predicted. The primary constraint on the random lock time is the initial phase relation between the incoming data and the REFCLK when the deserializer powers up.

The data contained in the data stream can also affect lock time. If a specific pattern is repetitive, the deserializer could enter false lock—falsely recognizing the data pattern as the start/stop bits. This is referred to as repetitive multitransition (RMT); see Figure 1 for RMT examples. This occurs when more than one low-high transition takes place per clock cycle over multiple cycles. In the worst case, the deserializer could become locked to the data pattern rather than the clock. Circuitry within the deserializer can detect that the possibility of false lock exists. Upon detection, the circuitry prevents the  $\overline{\text{LOCK}}$  output from becoming active until the potential false lock pattern changes. Notice that the RMT pattern only affects the deserializer lock time, and once the deserializer is in lock, the RMT pattern does not affect the deserializer state as long as the same data boundary happens each cycle. The deserializer does not go into lock until it finds a unique four consecutive cycles of data boundary (stop/start bits) at the same position.

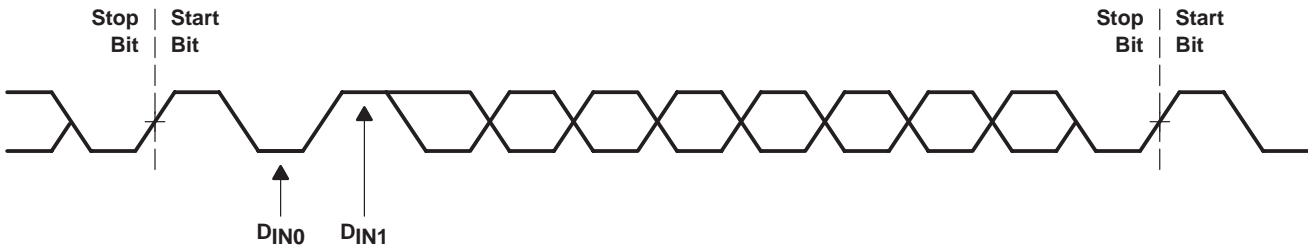
The deserializer stays in lock until it cannot detect the same data boundary (stop/start bits) for four consecutive cycles. Then the deserializer goes out of lock and hunts for the new data boundary (stop/start bits). In the event of loss of synchronization, the  $\overline{\text{LOCK}}$  pin output goes high and the outputs (including RCLK) enter a high-impedance state. The user's system should monitor the  $\overline{\text{LOCK}}$  pin in order to detect a loss of synchronization. Upon detection of loss of lock, sending sync patterns for resynchronization is desirable if reestablishing lock within a specific time is critical. However, the deserializer can lock to random data as previously noted.

# SN65LV1023A/SN65LV1224B 10-MHz TO 66-MHz, 10:1 LVDS SERIALIZER/DESERIALIZER

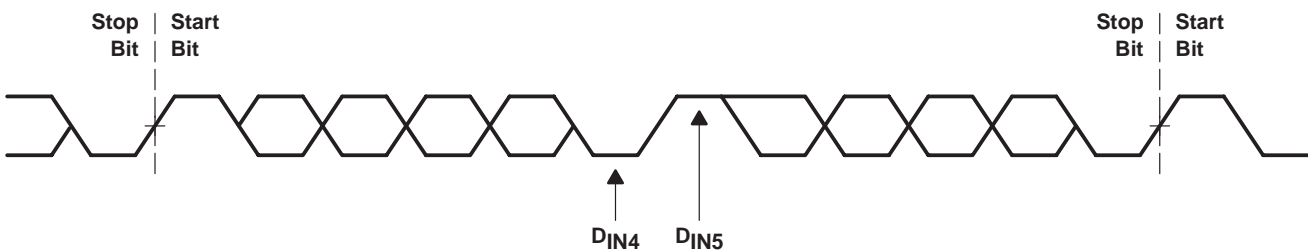
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## synchronization mode (continued)

D<sub>IN0</sub> Held Low and D<sub>IN1</sub> Held High



D<sub>IN4</sub> Held Low and D<sub>IN5</sub> Held High



D<sub>IN8</sub> Held Low and D<sub>IN9</sub> Held High

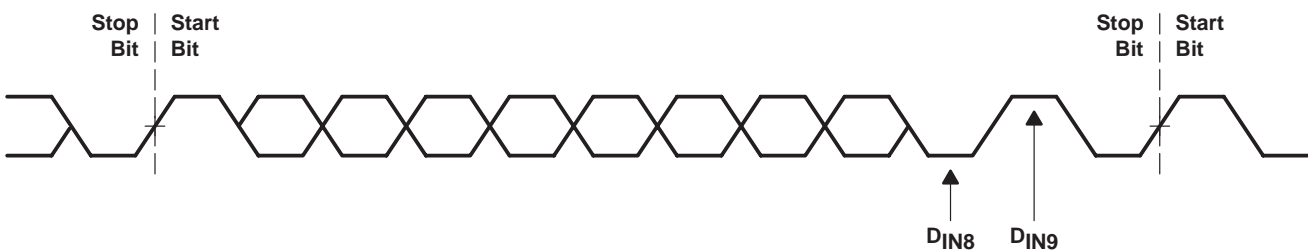


Figure 1. RMT Pattern Examples

## data transmission mode

After initialization and synchronization, the serializer accepts parallel data from inputs D<sub>IN0</sub>–D<sub>IN9</sub>. The serializer uses the TCLK input to latch the incoming data. The TCLK\_R/F pin selects which edge the serializer uses to strobe incoming data. If either of the SYNC inputs is high for six TCLK cycles, the data at D<sub>IN0</sub>–D<sub>IN9</sub> is ignored regardless of the clock edge selected and 1026 cycles of SYNC pattern are sent.

After determining which clock edge to use, a start and stop bit, appended internally, frames the data bits in the register. The start bit is always high and the stop bit is always low. The start and stop bits function as the embedded clock bits in the serial stream.

The serializer transmits serialized data and appended clock bits (10+2 bits) from the serial data output (DO±) at 12 times the TCLK frequency. For example, if TCLK is 66 MHz, the serial rate is  $66 \times 12 = 792$  Mbps. Because only 10 bits are input data, the useful data rate is 10 times the TCLK frequency. For instance, if TCLK = 66 MHz, the useful data rate is  $66 \times 10 = 660$  Mbps. The data source, which provides TCLK, must be in the range of 10 MHz to 66 MHz.

**functional description (continued)**

The serializer outputs (DO±) can drive point-to-point connections or limited multipoint or multidrop backplanes. The outputs transmit data when the enable pin (DEN) is high, PWRDN = high, and SYNC1 and SYNC2 are low. When DEN is driven low, the serializer output pins enter the high-impedance state.

Once the deserializer has synchronized to the serializer, the  $\overline{\text{LOCK}}$  pin transitions low. The deserializer locks to the embedded clock and uses it to recover the serialized data. ROUT data is valid when  $\overline{\text{LOCK}}$  is low, otherwise ROUT0–ROUT9 is invalid. The ROUT0–ROUT9 data is strobed out by RCLK. The specific RCLK edge polarity to be used is selected by the RCLK\_R/F input. The ROUT0–ROUT9,  $\overline{\text{LOCK}}$  and RCLK outputs can drive a maximum of three CMOS input gates (15-pF load, total for all three) with a 66-MHz clock.

**power down**

When no data transfer is required, the power-down mode can be used. The serializer and deserializer use the power-down state, a low-power sleep mode, to reduce power consumption. The deserializer enters power down when you drive  $\overline{\text{PWRDN}}$  and REN low. The serializer enters power down when you drive  $\overline{\text{PWRDN}}$  low. In power down, the PLL stops and the outputs enter a high-impedance state, which disables load current and reduces supply current to the milliampere range. To exit power down, you must drive the  $\overline{\text{PWRDN}}$  pin high.

Before valid data exchanges between the serializer and deserializer can resume, you must reinitialize and resynchronize the devices to each other. Initialization of the serializer takes 1026 TCLK cycles. The deserializer initialize and drives  $\overline{\text{LOCK}}$  high until lock to the LVDS clock occurs.

**high-impedance mode**

The serializer enters the high-impedance mode when the DEN pin is driven low. This puts both driver output pins (DO+ and DO–) into a high-impedance state. When you drive DEN high, the serializer returns to the previous state, as long as all other control pins remain static (SYNC1, SYNC2,  $\overline{\text{PWRDN}}$ , TCLK\_R/F). When the REN pin is driven low, the deserializer enters high-impedance mode. Consequently, the receiver output pins (ROUT0–ROUT9) and RCLK are placed into the high-impedance state. The  $\overline{\text{LOCK}}$  output remains active, reflecting the state of the PLL.

**Deserializer Truth Table**

| INPUTS                    |     | OUTPUTS   |                          |        |
|---------------------------|-----|-----------|--------------------------|--------|
| $\overline{\text{PWRDN}}$ | REN | ROUT[0:9] | $\overline{\text{LOCK}}$ | RCLK   |
| H                         | H   | Z         | H                        | Z      |
| H                         | H   | Active    | L                        | Active |
| L                         | X   | Z         | Z                        | Z      |
| H                         | L   | Z         | Active                   | Z      |

- NOTES:
1.  $\overline{\text{LOCK}}$  output reflects the state of the deserializer with regard to the selected data stream.
  2. RCLK active indicates the RCLK is running if the deserializer is locked. The timing of RCLK with respect to ROUT is determined by RCLK\_R/F.
  3. ROUT and RCLK are 3-stated when  $\overline{\text{LOCK}}$  is asserted high.

**failsafe biasing for the SN65LV1224B**

The SN65LV1224B has an input threshold sensitivity of ±50 mV. This allows for greater differential noise margin in the SN65LV1224B. However, in cases where the receiver input is not being actively driven, the increased sensitivity of the SN65LV1224B can pickup noise as a signal and cause unintentional locking. This may occur when the input cable is disconnected. The SN65LV1224B has an on-chip fail-safe circuit that drives the serial input and  $\overline{\text{LOCK}}$  signal high. The response time of the fail-safe circuit depends on interconnect characteristics.

# SN65LV1023A/SN65LV1224B

## 10-MHz TO 66-MHz, 10:1 LVDS SERIALIZER/DESERIALIZER

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### Terminal Functions

#### serializer

| PIN            | NAME                                | DESCRIPTION  |
|----------------|-------------------------------------|--|
| 18, 20, 23, 25 | AGND                                | Analog circuit ground (PLL and analog circuits)  |
| 17, 26         | AV <sub>CC</sub>                    | Analog circuit power supply (PLL and analog circuits)  |
| 19             | DEN                                 | LVTTTL logic input. Low puts the LVDS serial output into the high-impedance state. High enables serial data output.  |
| 15, 16         | DGND                                | Digital circuit ground   |
| 3–12           | D <sub>IN0</sub> – D <sub>IN9</sub> | Parallel LVTTTL data inputs  |
| 21             | D <sub>O-</sub>                     | Inverting LVDS differential output   |
| 22             | D <sub>O+</sub>                     | Noninverting LVDS differential output  |
| 27, 28         | DV <sub>CC</sub>                    | Digital circuit power supply   |
| 24             | PWRDN                               | LVTTTL logic input. Asserting this pin low turns off the PLL and places the outputs into the high-impedance state, putting the device into a low-power mode.   |
| 1, 2           | SYNC1, SYNC2                        | LVTTTL logic inputs SYNC1 and SYNC2 are ORed together. When at least one of the two pins is asserted high for 6 cycles of TCLK, the serializer initiates transmission of a minimum 1026 SYNC patterns. If after completion of the transmission of 1026 patterns SYNC continues to be asserted, then the transmission continues until SYNC is driven low and if the time SYNC holds > 6 cycles, another 1026 SYNC pattern transmission initiates. |
| 13             | TCLK_R/ $\bar{F}$                   | LVTTTL logic input. Low selects a TCLK falling-edge data strobe; high selects a TCLK rising-edge data strobe.  |
| 14             | TCLK                                | LVTTTL-level reference clock input. The SN65LV1023A accepts a 10-MHz to 66-MHz clock. TCLK strobes parallel data into the input latch and provides a reference frequency to the PLL.   |

#### deserializer

| PIN          | NAME                                 | DESCRIPTION  |
|--------------|--------------------------------------|--|
| 1, 12, 13    | AGND                                 | Analog circuit ground (PLL and analog circuits)  |
| 4, 11        | AV <sub>CC</sub>                     | Analog circuit power supply (PLL and analog circuits)  |
| 14, 20, 22   | DGND                                 | Digital circuit ground   |
| 21, 23       | DV <sub>CC</sub>                     | Digital circuit power supply   |
| 10           | LOCK                                 | LVTTTL level output. LOCK goes low when the deserializer PLL locks onto the embedded clock edge.   |
| 7            | PWRDN                                | LVTTTL logic input. Asserting this pin low turns off the PLL and places outputs into a high-impedance state, putting the device into a low-power mode. To initiate power down, this pin is held low for a minimum of 16 ns. As long as PWRDN is held low, the device is in the power down state. |
| 2            | RCLK_R/ $\bar{F}$                    | LVTTTL logic input. Low selects an RCLK falling-edge data strobe; high selects an RCLK rising-edge data strobe.  |
| 9            | RCLK                                 | LVTTTL level output recovered clock. Use RCLK to strobe R <sub>OUTx</sub> .  |
| 3            | REFCLK                               | LVTTTL logic input. Use this pin to supply a REFCLK signal for the internal PLL frequency.   |
| 8            | REN                                  | LVTTTL logic input. Low places R <sub>OUT0</sub> –R <sub>OUT9</sub> and RCLK in the high-impedance state.  |
| 5            | R <sub>I+</sub>                      | Serial data input. Noninverting LVDS differential input  |
| 6            | R <sub>I-</sub>                      | Serial data input. Inverting LVDS differential input   |
| 15–19, 24–28 | R <sub>OUT0</sub> –R <sub>OUT9</sub> | Parallel LVTTTL data outputs   |



# SN65LV1023A/SN65LV1224B

## 10-MHz TO 66-MHz, 10:1 LVDS SERIALIZER/DESERIALIZER

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### absolute maximum ratings (unless otherwise noted)†

|  |                                     |
|--|-------------------------------------|
| V <sub>CC</sub> to GND                                   | -0.3 V to 4 V                       |
| LVTTTL input voltage                                     | -0.3 V to (V <sub>CC</sub> + 0.3 V) |
| LVTTTL output voltage                                    | -0.3 V to (V <sub>CC</sub> + 0.3 V) |
| LVDS receiver input voltage                              | -0.3 V to 3.9 V                     |
| LVDS driver output voltage                               | -0.3 V to 3.9 V                     |
| LVDS output short circuit duration                       | 10 ms                               |
| Electrostatic discharge: HBM                             | up to 6 kV                          |
| MM   | up to 200 V                         |
| Junction temperature                                     | 150°C                               |
| Storage temperature                                      | -65°C to 150°C                      |
| Lead temperature (soldering, 4 seconds)                  | 260°C                               |
| Maximum package power dissipation, T <sub>A</sub> = 25°C | 1.27 W                              |
| Package derating   | 10.3 mW/°C above 25°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 under “recommended operating conditions” is not implied. Exposure to absolute-maximum-rated conditions for extended periods may affect device reliability.

### recommended operating conditions

|   | MIN                | NOM                                   | MAX | UNIT              |
|---|--------------------|---------------------------------------|-----|-------------------|
| Supply voltage, V <sub>CC</sub> ‡                 | 3                  | 3.3                                   | 3.6 | V                 |
| Receiver input voltage range                      | 0                  |                                       | 2.4 | V                 |
| Receiver input common mode range, V <sub>CM</sub> | $\frac{V_{ID}}{2}$ | $2.4 - \left(\frac{V_{ID}}{2}\right)$ |     | V                 |
| Supply noise voltage                              |                    |                                       | 100 | mV <sub>P-P</sub> |
| Operating free-air temperature, T <sub>A</sub>    | -40                | 25                                    | 85  | °C                |

‡ By design, DVCC and AVCC are separated internally and does not matter what the difference is for |DVCC–AVCC|, as long as both are within 3 V to 3.6 V.



# SN65LV1023A/SN65LV1224B

## 10-MHz TO 66-MHz, 10:1 LVDS SERIALIZER/DESERIALIZER

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electrical characteristics over recommended operating supply and temperature ranges (unless otherwise noted)

| PARAMETER  | TEST CONDITIONS   | MIN                                  | TYP        | MAX             | UNIT            |    |
|--|---|--------------------------------------|------------|-----------------|-----------------|----|
| <b>SERIALIZER LVCMOS/LVTTL DC SPECIFICATIONS (See Note 4)</b>          |   |                                      |            |                 |                 |    |
| V <sub>IH</sub>  | High-level input voltage                                  | 2                                    |            | V <sub>CC</sub> | V               |    |
| V <sub>IL</sub>  | Low-level input voltage                                   | GND                                  |            | 0.8             | V               |    |
| V <sub>CL</sub>  | Input clamp voltage                                       |                                      | -0.86      | -1.5            | V               |    |
| I <sub>IN</sub>  | Input current (see Note 5)                                |                                      | -200       | ±100            | 200             | μA |
| <b>DESERIALIZER LVCMOS/LVTTL DC SPECIFICATIONS (See Note 6)</b>        |   |                                      |            |                 |                 |    |
| V <sub>IH</sub>  | High-level input voltage                                  | 2                                    |            | V <sub>CC</sub> | V               |    |
| V <sub>IL</sub>  | Low-level input voltage                                   | GND                                  |            | 0.8             | V               |    |
| V <sub>CL</sub>  | Input clamp voltage                                       |                                      | -0.62      | -1.5            | V               |    |
| I <sub>IN</sub>  | Input current (pull-up and pull-down resistors on inputs) |                                      | -200       |                 | 200             | μA |
| V <sub>OH</sub>  | High-level output voltage                                 |                                      | 2.2        | 3               | V <sub>CC</sub> | V  |
| V <sub>OL</sub>  | Low-level output voltage                                  |                                      | GND        | 0.25            | 0.5             | V  |
| I <sub>OS</sub>  | Output short-circuit current                              |                                      | -15        | -47             | -85             | mA |
| I <sub>OZ</sub>  | High-impedance output current                             |                                      | -10        | ±1              | 10              | μA |
| <b>SERIALIZER LVDS DC SPECIFICATIONS (Apply to Pins DO+ and DO-)</b>   |   |                                      |            |                 |                 |    |
| V <sub>OD</sub>  | Output differential voltage (DO+)-(DO-)                   |                                      | 350        | 450             |                 | mV |
| ΔV <sub>OD</sub>   | Output differential voltage unbalance                     |                                      |            |                 | 35              | mV |
| V <sub>OS</sub>  | Offset voltage  |                                      | 1.1        | 1.2             | 1.3             | V  |
| ΔV <sub>OS</sub>   | Offset voltage unbalance                                  |                                      |            | 4.8             | 35              | mV |
| I <sub>OS</sub>  | Output short circuit current                              |                                      |            | -10             | -90             | mA |
| I <sub>OZ</sub>  | High-impedance output current                             |                                      | -10        | ±1              | 10              | μA |
| I <sub>OX</sub>  | Power-off output current                                  |                                      | -20        | ±1              | 25              | μA |
| <b>DESERIALIZER LVDS DC SPECIFICATIONS (Apply to Pins RI+ and RI-)</b> |   |                                      |            |                 |                 |    |
| V <sub>TH</sub>  | Differential threshold high voltage                       |                                      |            |                 | 50              | mV |
| V <sub>TL</sub>  | Differential threshold low voltage                        |                                      | -50        |                 |                 | mV |
| I <sub>IN</sub>  | Input current   |                                      | -10        | ±1              | 15              | μA |
|  |   |                                      | -10        | ±0.05           | 10              |    |
| <b>SERIALIZER SUPPLY CURRENT (Applies to Pins DVCC and AVCC)</b>       |   |                                      |            |                 |                 |    |
| I <sub>CCD</sub>   | Serializer supply current worst case                      | R <sub>L</sub> = 27 Ω, See Figure 4  | f = 10 MHz | 20              | 25              | mA |
|  |   |                                      | f = 66 MHz | 55              | 70              |    |
| I <sub>CCXD</sub>  | Serializer supply current                                 | PWRDN = 0.8 V                        |            | 200             | 500             | μA |
| <b>DESERIALIZER SUPPLY CURRENT (applies to pins DVCC and AVCC)</b>     |   |                                      |            |                 |                 |    |
| I <sub>CCR</sub>   | Deserializer supply current, worst case                   | C <sub>L</sub> = 15 pF, See Figure 4 | f = 10 MHz | 15              | 35              | mA |
|  |   |                                      | f = 66 MHz | 80              | 95              |    |
| I <sub>CCXR</sub>  | Deserializer supply current, power down                   | PWRDN = 0.8 V, REN = 0.8 V           |            | 0.36            | 1               | mA |

- NOTES: 4. Apply to D<sub>IN0</sub>-D<sub>IN9</sub>, TCLK, PWRDN, TCLK\_R/F, SYNC1, SYNC2, and DEN  
5. High I<sub>IN</sub> values are due to pullup and pulldown resistors on the inputs.  
6. Apply to pins PWRDN, RCLK\_R/F, REN, and REFCLK = inputs; apply to pins R<sub>OUTX</sub>, RCLK, and LOCK = outputs





# SN65LV1023A/SN65LV1224B

## 10-MHz TO 66-MHz, 10:1 LVDS SERIALIZER/DESERIALIZER

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**serializer timing requirements for TCLK over recommended operating supply and temperature ranges (unless otherwise specified)**

| PARAMETER           |                            | TEST CONDITIONS | MIN   | TYP  | MAX  | UNIT     |
|---------------------|----------------------------|-----------------|-------|------|------|----------|
| t <sub>TCP</sub>    | Transmit clock period      |                 | 15.15 | T    | 100  | ns       |
| t <sub>TCH</sub>    | Transmit clock high time   |                 | 0.4T  | 0.5T | 0.6T | ns       |
| t <sub>TCL</sub>    | Transmit clock low time    |                 | 0.4T  | 0.5T | 0.6T | ns       |
| t <sub>t(CLK)</sub> | TCLK input transition time |                 |       | 3    | 6    | ns       |
| t <sub>JIT</sub>    | TCLK input jitter          | See Figure 18   |       |      | 150  | ps (RMS) |
|                     | Frequency tolerance        |                 | -100  |      | +100 | ppm      |

**serializer switching characteristics over recommended operating supply and temperature ranges (unless otherwise specified)**

| PARAMETER           |   | TEST CONDITIONS  | MIN                   | TYP                 | MAX                 | UNIT     |
|---------------------|---|--|-----------------------|---------------------|---------------------|----------|
| t <sub>TLH(L)</sub> | LVDS low-to-high transition time                  | R <sub>L</sub> = 27 Ω, C <sub>L</sub> = 10 pF to GND, See Figure 5 |                       | 0.2                 | 0.4                 | ns       |
| t <sub>LTL(L)</sub> | LVDS high-to-low transition time                  |  |                       | 0.25                | 0.4                 | ns       |
| t <sub>su(DI)</sub> | D <sub>IN0</sub> –D <sub>IN9</sub> setup to TCLK  | R <sub>L</sub> = 27 Ω, C <sub>L</sub> = 10 pF to GND, See Figure 8 | 0.5                   |                     |                     | ns       |
| t <sub>su(DI)</sub> | D <sub>IN0</sub> –D <sub>IN9</sub> hold from TCLK |  | 4                     |                     |                     | ns       |
| t <sub>d(HZ)</sub>  | DO± high-to-high impedance state delay            | R <sub>L</sub> = 27 Ω, C <sub>L</sub> = 10 pF to GND, See Figure 9 |                       | 2.5                 | 5                   | ns       |
| t <sub>d(LZ)</sub>  | DO± low-to-high impedance state delay             |  |                       | 2.5                 | 5                   |          |
| t <sub>d(ZH)</sub>  | DO± high-to-high impedance state-to-high delay    |  |                       | 5                   | 10                  |          |
| t <sub>d(ZL)</sub>  | DO± high-to-high impedance state-to-low delay     |  |                       | 6.5                 | 10                  |          |
| t <sub>w(SPW)</sub> | SYNC pulse duration                               | R <sub>L</sub> = 27 Ω, See Figure 11                               | 6×t <sub>TCP</sub>    |                     |                     | ns       |
| t <sub>(PLD)</sub>  | Serializer PLL lock time                          |  | 1026×t <sub>TCP</sub> |                     |                     | ns       |
| t <sub>d(S)</sub>   | Serializer delay                                  | R <sub>L</sub> = 27 Ω, See Figure 12                               | t <sub>TCP</sub> +1   | t <sub>TCP</sub> +2 | t <sub>TCP</sub> +3 | ns       |
| t <sub>DJIT</sub>   | Deterministic jitter                              | 10 MHz   |                       |                     |                     | ps       |
|                     |   | 66 MHz   |                       |                     |                     |          |
| t <sub>RJIT</sub>   | Random jitter                                     | R <sub>L</sub> = 2.7 Ω, C <sub>L</sub> = 10 pF to GND              |                       | 10                  | 19                  | ps (RMS) |

# SN65LV1023A/SN65LV1224B

## 10-MHz TO 66-MHz, 10:1 LVDS SERIALIZER/DESERIALIZER

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### deserializer timing requirements for REFCLK over recommended operating supply and temperature ranges (unless otherwise specified)

| PARAMETER          |                        | TEST CONDITIONS | MIN   | TYP | MAX  | UNIT |
|--------------------|------------------------|-----------------|-------|-----|------|------|
| t <sub>RFCP</sub>  | REFCLK period          |                 | 15.15 | T   | 100  | ns   |
| t <sub>RFDC</sub>  | REFCLK duty cycle      |                 | 30%   | 50% | 70%  |      |
| t <sub>t(RF)</sub> | REFCLK transition time |                 |       | 3   | 6    | ns   |
|                    | Frequency tolerance    |                 | -100  |     | +100 | ppm  |

### deserializer switching characteristics over recommended operating supply and temperature ranges (unless otherwise specified)

| PARAMETER                      | TEST CONDITIONS                                      | PIN/FREQ   | MIN  | TYP                          | MAX                           | UNIT |
|--------------------------------|--|--|--|------------------------------|-------------------------------|------|
| t <sub>(RCP)</sub>             | Receiver out clock period                            | t <sub>(RCP)</sub> = t <sub>(TCP)</sub> ,<br>See Figure 12 | RCLK   | 15.15                        | 100                           | ns   |
| t <sub>TLH(C)</sub>            | CMOS/TTL low-to-high transition time                 | C <sub>L</sub> = 15 pF,<br>See Figure 6                    | R <sub>OUT0</sub> –R <sub>OUT9</sub> ,<br>LOCK, RCLK | 1.2                          | 2.5                           | ns   |
| t <sub>THL(C)</sub>            | CMOS/TTL high-to-low transition time                 |  |  | 1.1                          | 2.5                           |      |
| t <sub>d(D)</sub> <sup>†</sup> | Deserializer delay,<br>See Figure 13                 | Room temperature,<br>3.3 V                                 | 10 MHz   | 1.75×t <sub>(RCP)</sub> +4.2 | 1.75×t <sub>(RCP)</sub> +12.6 | ns   |
|                                |  |  | 66 MHz   | 1.75×t <sub>(RCP)</sub> +7.4 | 1.75×t <sub>(RCP)</sub> +9.7  |      |
| t <sub>(ROS)</sub>             | R <sub>OUTx</sub> data valid before RCLK             | See Figure 14  | RCLK 10 MHz  | 0.4×t <sub>(RCP)</sub>       | 0.5×t <sub>(RCP)</sub>        | ns   |
|                                |  |  | RCLK 66 MHz  | 0.4×t <sub>(RCP)</sub>       | 0.5×t <sub>(RCP)</sub>        |      |
| t <sub>(ROH)</sub>             | R <sub>OUTx</sub> data valid after RCLK              |  | 10 MHz   | -0.4×t <sub>(RCP)</sub>      | -0.5×t <sub>(RCP)</sub>       |      |
|                                |  |  | 66 MHz   | -0.4×t <sub>(RCP)</sub>      | -0.5×t <sub>(RCP)</sub>       |      |
| t <sub>(RDC)</sub>             | RCLK duty cycle                                      |  | 40%  | 50%                          | 60%                           |      |
| t <sub>d(HZ)</sub>             | High-to-high impedance state delay                   | See Figure 15  | R <sub>OUT0</sub> –R <sub>OUT9</sub>                 | 6.5                          | 8                             | ns   |
| t <sub>d(LZ)</sub>             | Low-to-high impedance state delay                    |  |  | 4.7                          | 8                             | ns   |
| t <sub>d(HR)</sub>             | High-impedance state to high delay                   |  |  | 5.3                          | 8                             | ns   |
| t <sub>d(ZL)</sub>             | High-impedance state to low delay                    |  |  | 4.7                          | 8                             | ns   |
| t <sub>(DSR1)</sub>            | Deserializer PLL lock time from PWRDN (with SYNCPAT) | See Figure 16,<br>Figure 17, and<br>Note 7                 | 10 MHz   | 850 × t <sub>RFCP</sub>      |                               | μs   |
|                                |  |  | 66 MHz   | 850 × t <sub>RFCP</sub>      |                               |      |
| t <sub>(DSR2)</sub>            | Deserializer PLL lock time from SYNCPAT              |  | 10 MHz   | 2                            |                               |      |
|                                |  |  | 66 MHz   | 0.303                        |                               |      |
| t <sub>d(ZHLK)</sub>           | High-impedance state to high delay (power up)        |  | LOCK   | 3                            |                               | ns   |

<sup>†</sup> The deserializer delay time for all frequencies does not exceed two serial bit times.

NOTE 7: t<sub>(DSR1)</sub> represents the time required for the deserializer to register that a lock has occurred upon powerup or when leaving the powerdown mode. t<sub>(DSR2)</sub> represents the time required to register that a lock has occurred for the powered up and enabled deserializer when the input (R<sub>I±</sub>) conditions change from not receiving data to receiving synchronization patterns (SYNCPATs). In order to specify deserializer PLL performance, t<sub>DSR1</sub> and t<sub>DSR2</sub> are specified with REFCLK active and stable and specific conditions of SYNCPATs.



**deserializer switching characteristics over recommended operating supply and temperature ranges (unless otherwise specified) (continued)**

| PARAMETER                           | TEST CONDITIONS          | PIN/FREQ | MIN | TYP  | MAX | UNIT |
|-------------------------------------|--------------------------|----------|-----|------|-----|------|
| $t_{RNM}$ Deserializer noise margin | See Figure 18 and Note 8 | 10 MHz   |     | 3680 |     | ps   |
|                                     |                          | 66 MHz   |     | 540  |     |      |

NOTE 8:  $t_{RNM}$  represents the phase noise or jitter that the deserializer can withstand in the incoming data stream before bit errors occur.

**timing diagrams and test circuits**

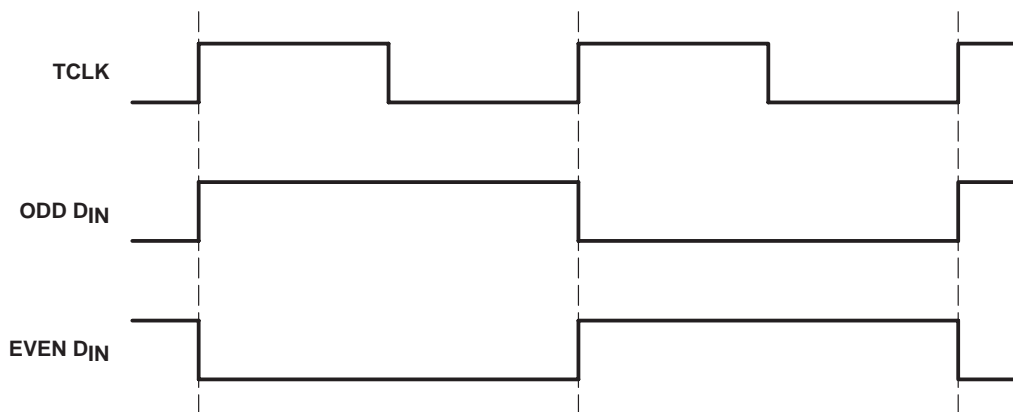


Figure 2. Worst-Case Serializer  $I_{CC}$  Test Pattern

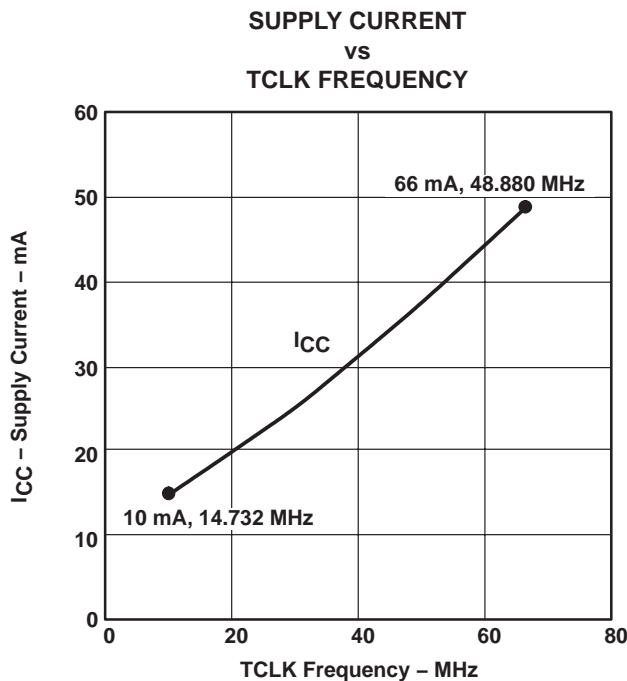


Figure 3.

# SN65LV1023A/SN65LV1224B 10-MHz TO 66-MHz, 10:1 LVDS SERIALIZER/DESERIALIZER

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## timing diagrams and test circuits (continued)

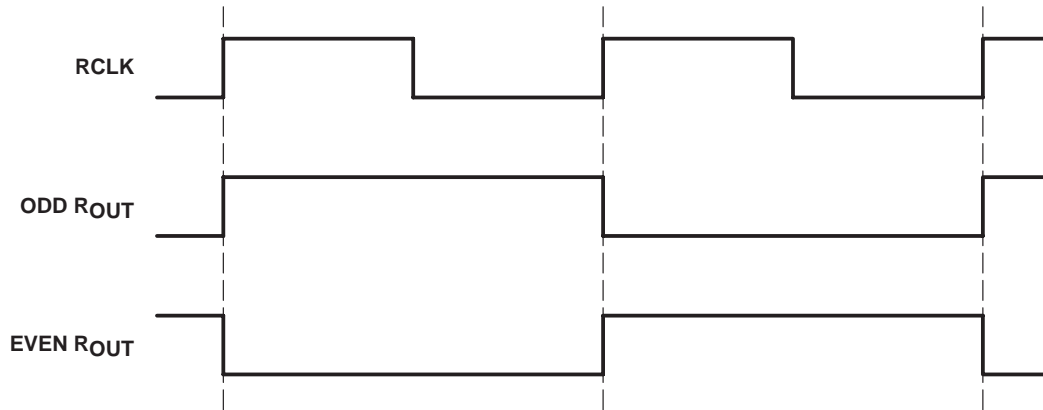


Figure 4. Worst-Case Deserializer  $I_{CC}$  Test Pattern

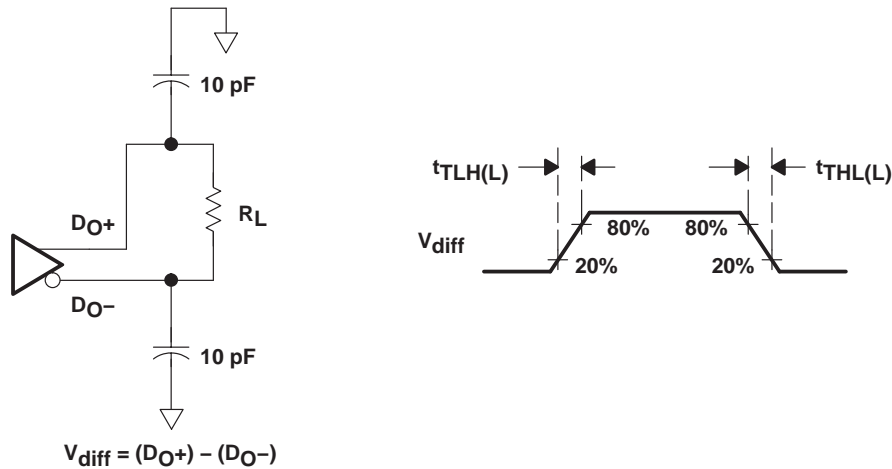


Figure 5. Serializer LVDS Output Load and Transition Times

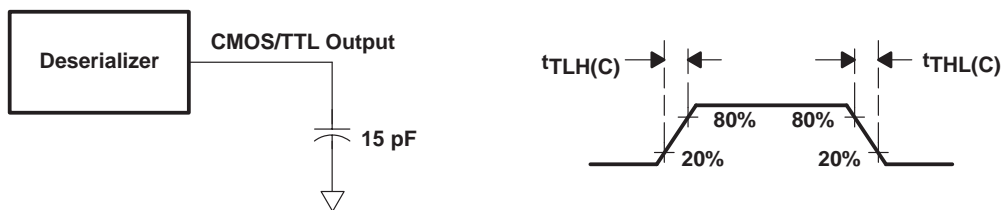


Figure 6. Deserializer CMOS/TTL Output Load and Transition Times

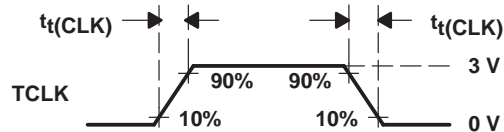


Figure 7. Serializer Input Clock Transition Time

timing diagrams and test circuits (continued)

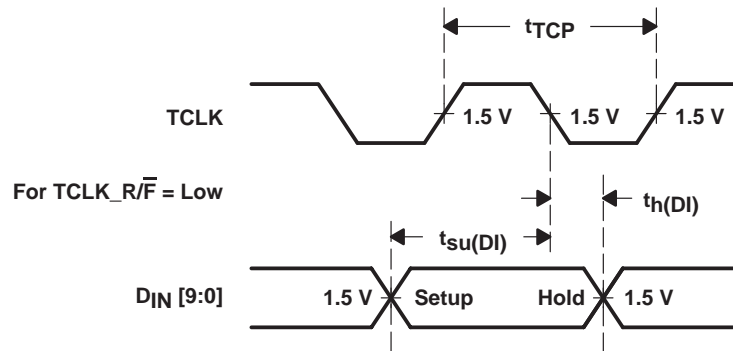


Figure 8. Serializer Setup/Hold Times

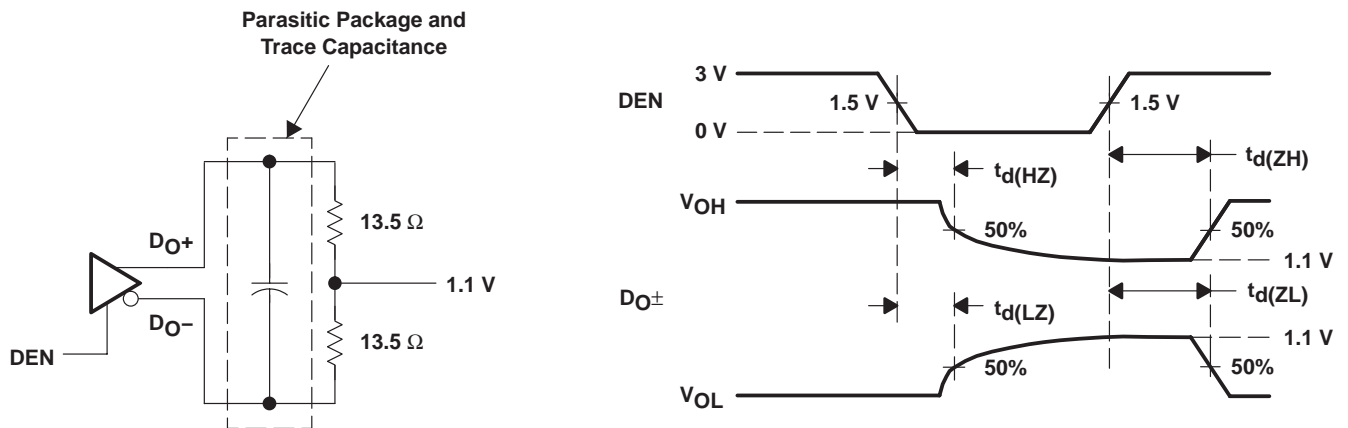


Figure 9. Serializer High-Impedance State Test Circuit and Timing

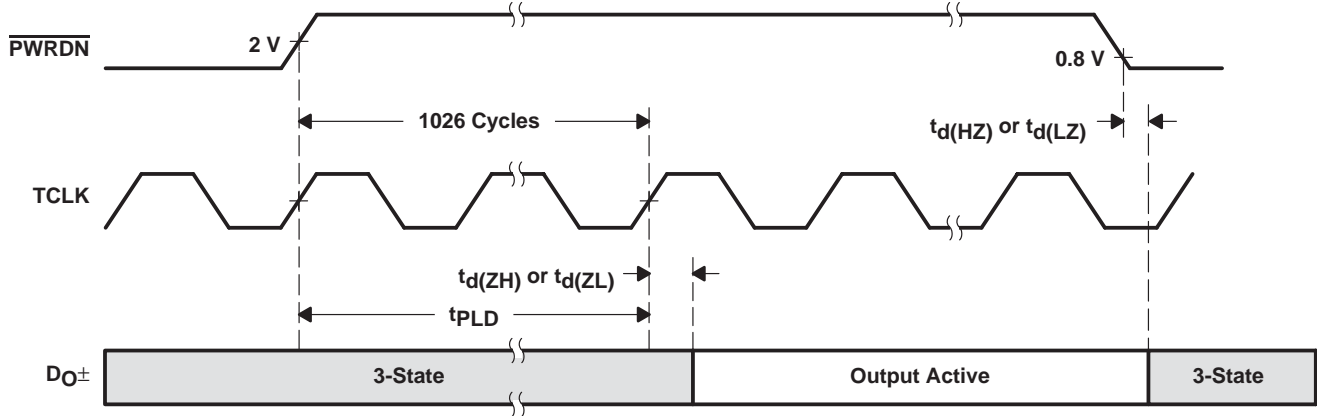


Figure 10. Serializer PLL Lock Time and  $\overline{\text{PWRDN}}$  High-Impedance State Delays

# SN65LV1023A/SN65LV1224B 10-MHz TO 66-MHz, 10:1 LVDS SERIALIZER/DESERIALIZER

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## timing diagrams and test circuits (continued)

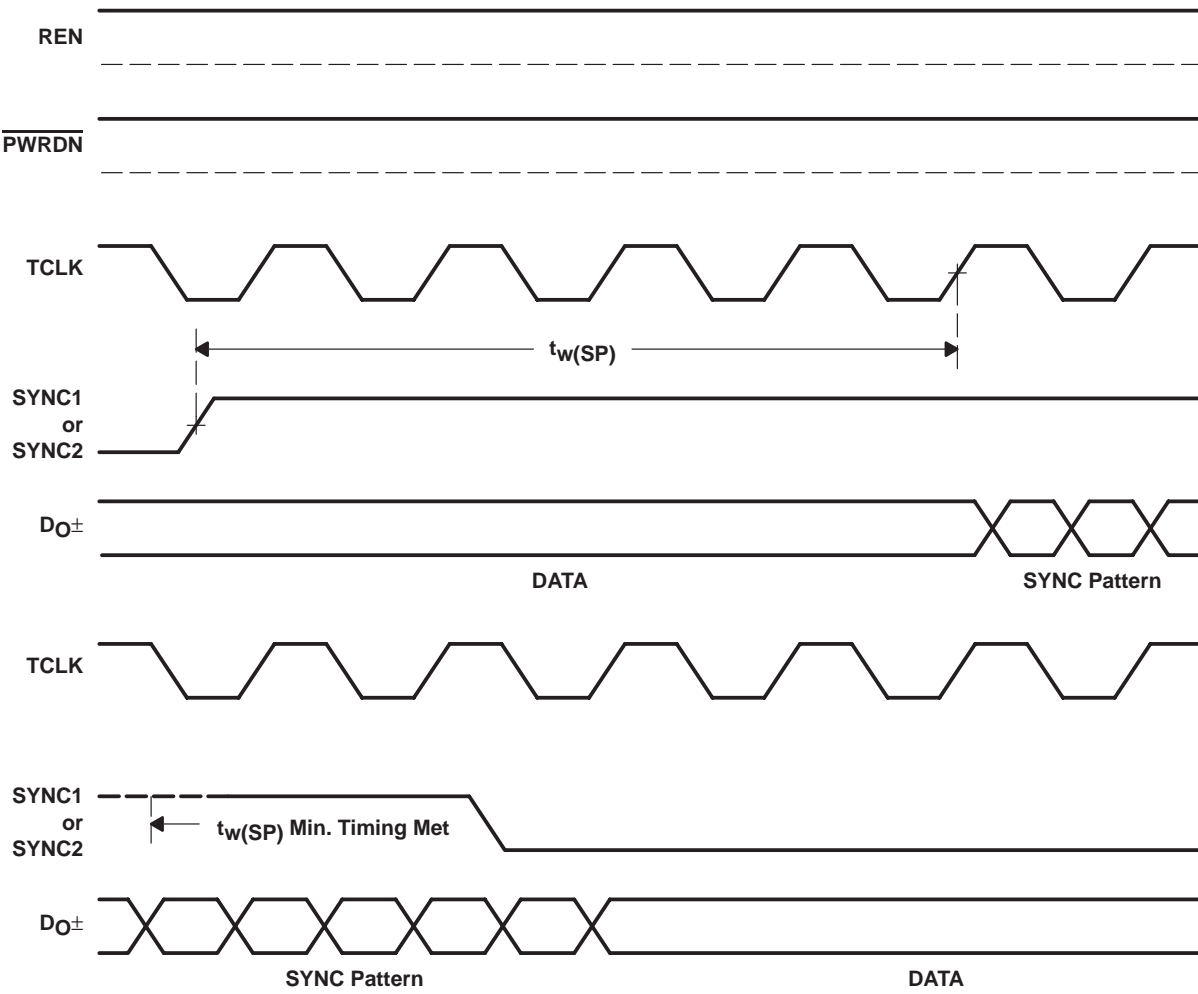


Figure 11. SYNC Timing Delays

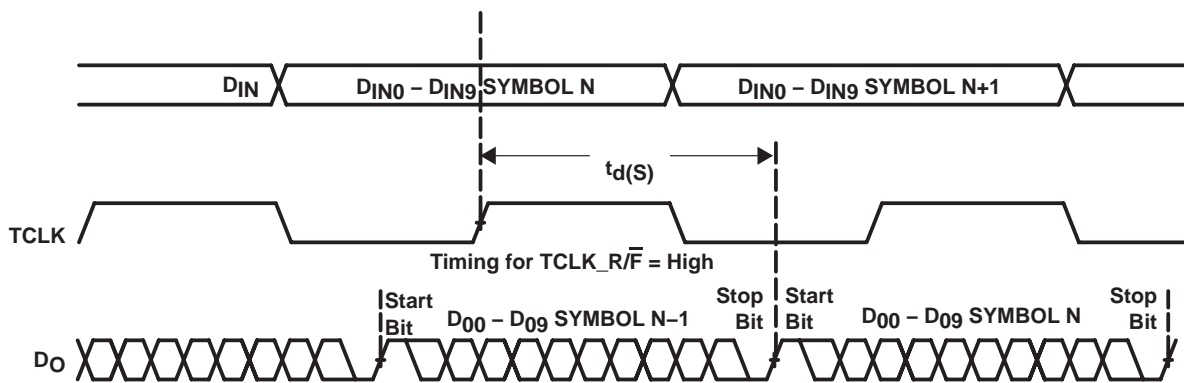


Figure 12. Serializer Delay



timing diagrams and test circuits (continued)

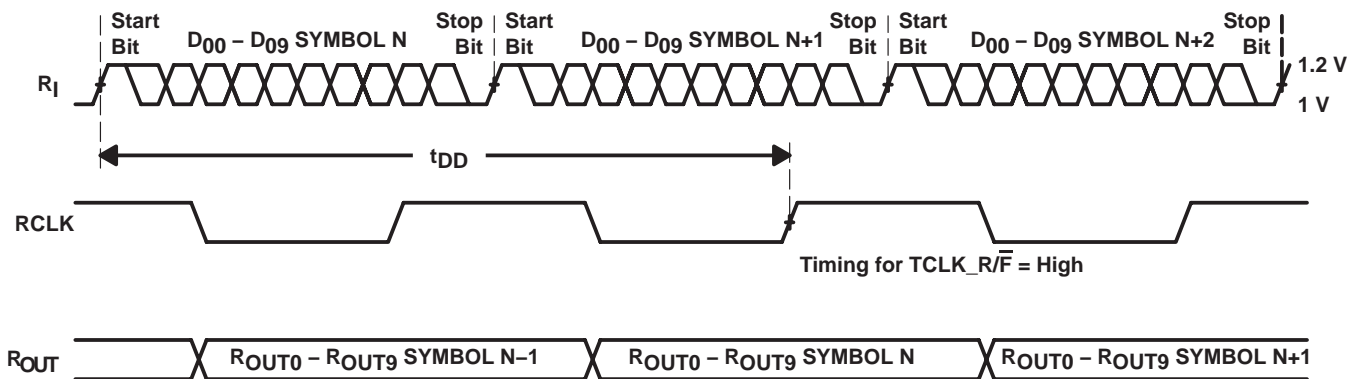


Figure 13. Deserializer Delay

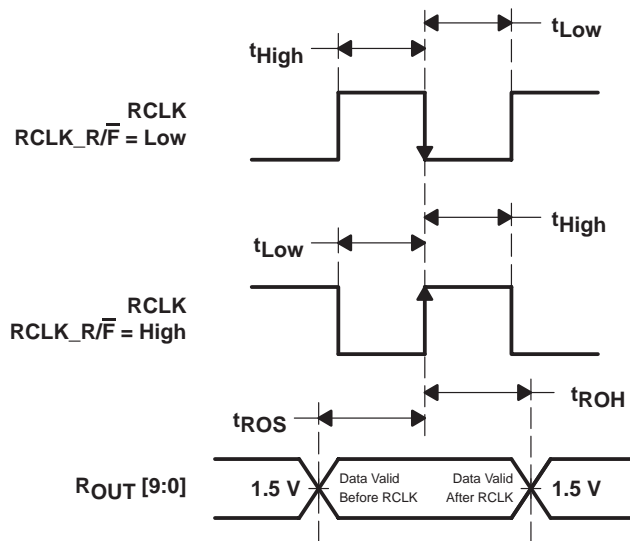


Figure 14. Deserializer Data Valid Out Times

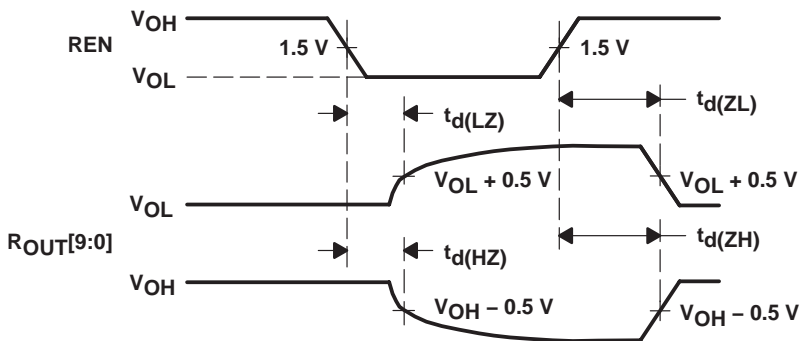
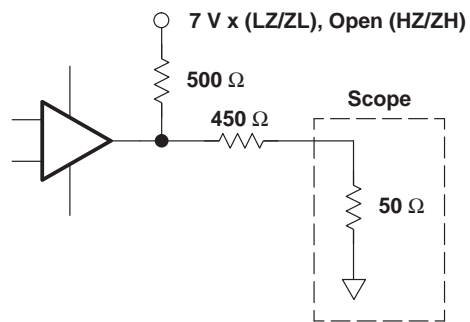


Figure 15. Deserializer High-Impedance State Test Circuit and Timing

# SN65LV1023A/SN65LV1224B

## 10-MHz TO 66-MHz, 10:1 LVDS SERIALIZER/DESERIALIZER

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### timing diagrams and test circuits (continued)

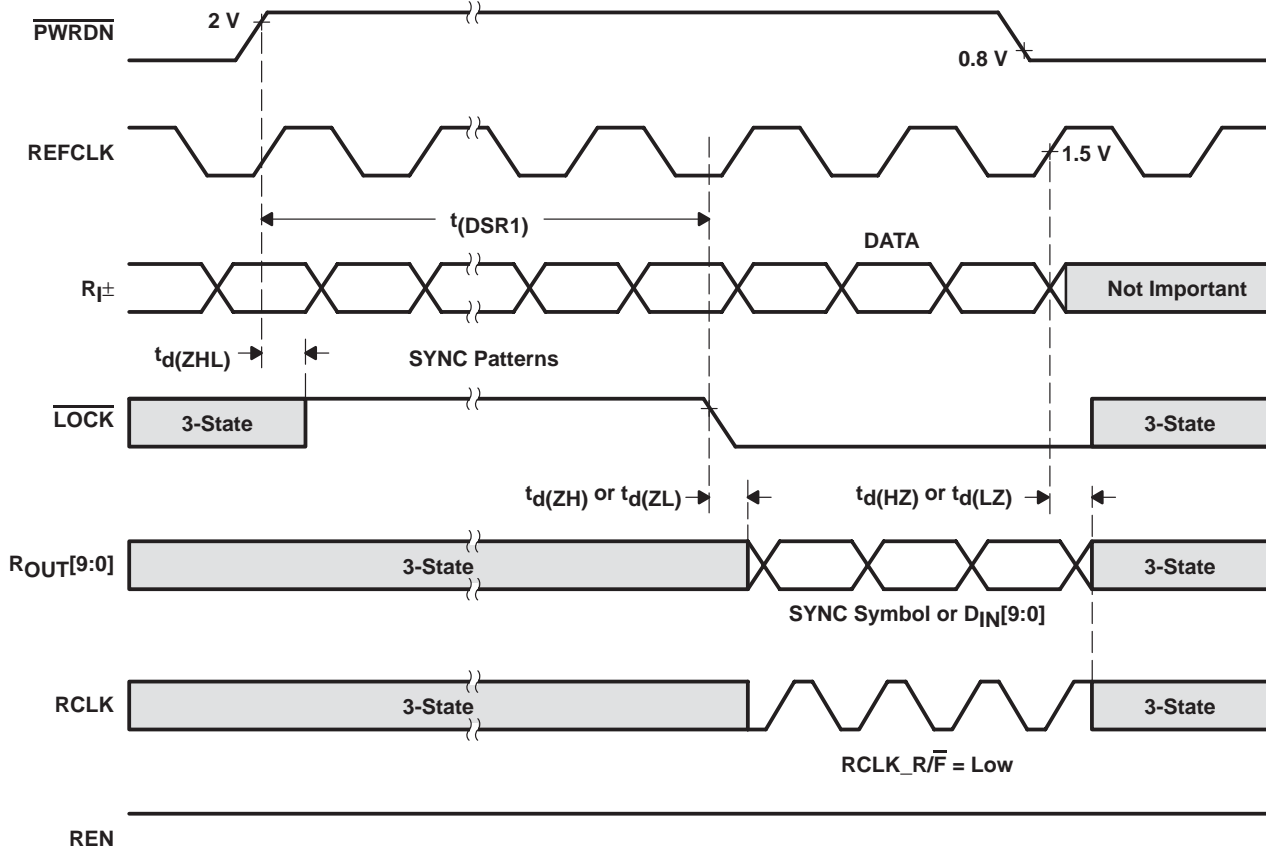


Figure 16. Deserializer PLL Lock Times and  $\overline{PWRDN}$  3-State Delays



timing diagrams and test circuits (continued)

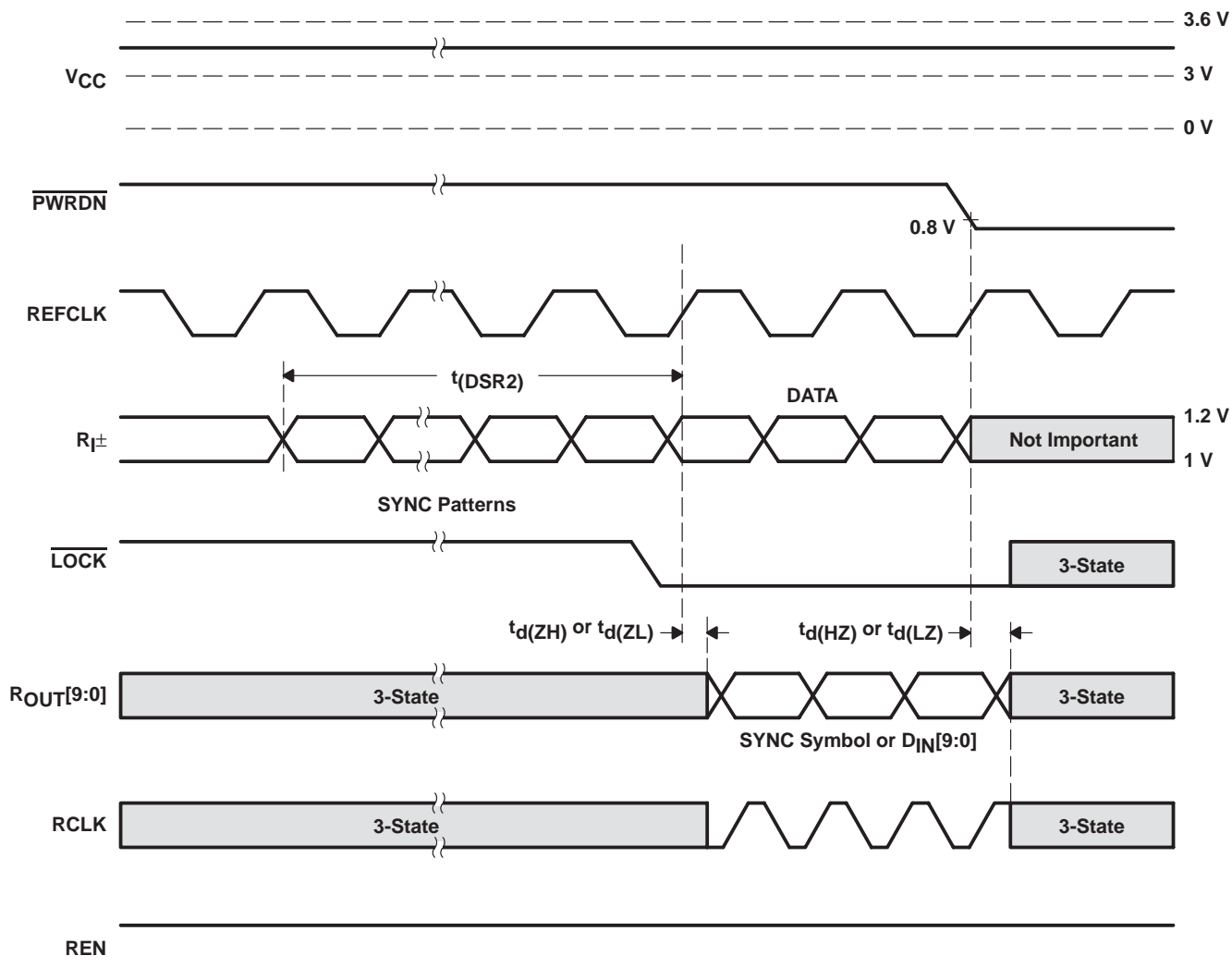
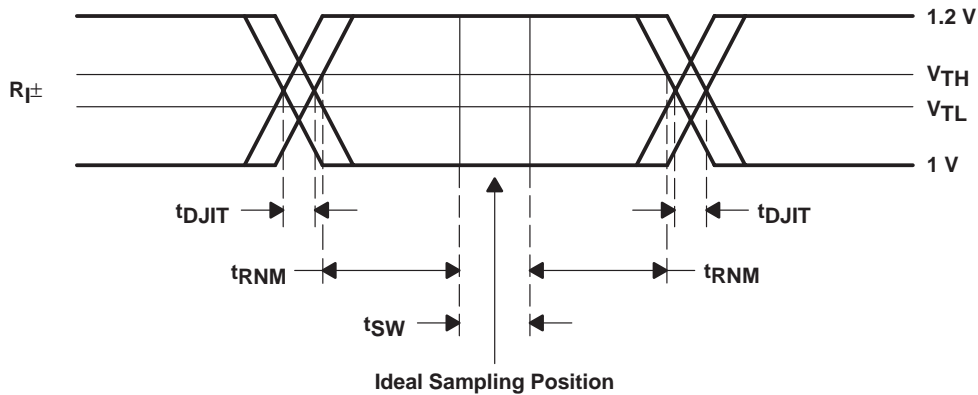


Figure 17. Deserializer PLL Lock Time From SyncPAT

# SN65LV1023A/SN65LV1224B 10-MHz TO 66-MHz, 10:1 LVDS SERIALIZER/DESERIALIZER

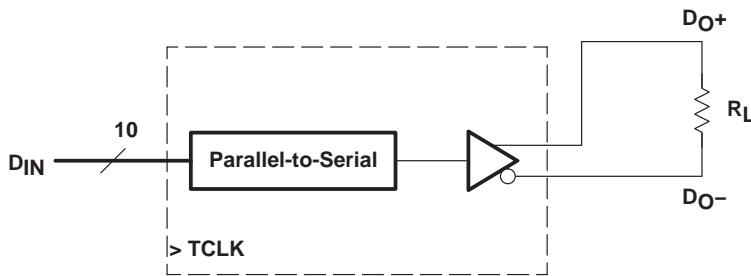
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## timing diagrams and test circuits (continued)



$t_{SW}$ : Setup and Hold Time (Internal Data Sampling Window)  
 $t_{DJIT}$ : Serializer Output Bit Position Jitter That Results From Jitter on TCLK  
 $t_{RNM}$ : Receiver Noise Margin Time

Figure 18. Receiver LVDS Input Skew Margin



$V_{OD} = (DO+) - (DO-)$   
 Differential Output Signal Is Shown as  $(DO+) - (DO-)$

Figure 19.  $V_{OD}$  Diagram

## device startup procedure

It is recommended that the PWRDNB pin on both the SN65LV1023A and the SN65LV1224B device be held to a logic LOW level until after the power supplies have powered up to at least 3 V as shown in Figure 20.

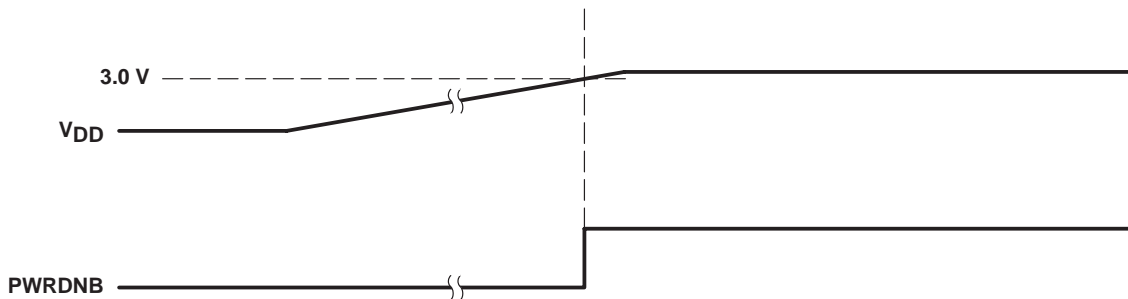


Figure 20. Device Startup

## APPLICATION INFORMATION

### differential traces and termination

The performance of the SN65LV1023A/SN65LV1224B is affected by the characteristics of the transmission medium. Use controlled-impedance media and termination at the receiving end of the transmission line with the media's characteristics impedance.

Use balanced cables such as twisted pair or differential traces that are ran close together. A balanced cable picks up noise together and appears to the receiver as common mode. Differential receivers reject common-mode noise. Keep cables or traces matched in length to help reduce skew.

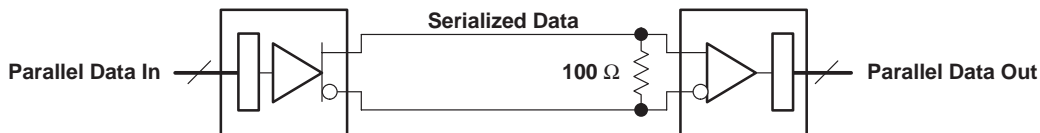
Running the differential traces close together helps cancel the external magnetic field, as well as maintain a constant impedance. Avoiding sharp turns and reducing the number of vias also helps.

### topologies

There are several topologies that the serializers can operate. Three common examples are shown below.

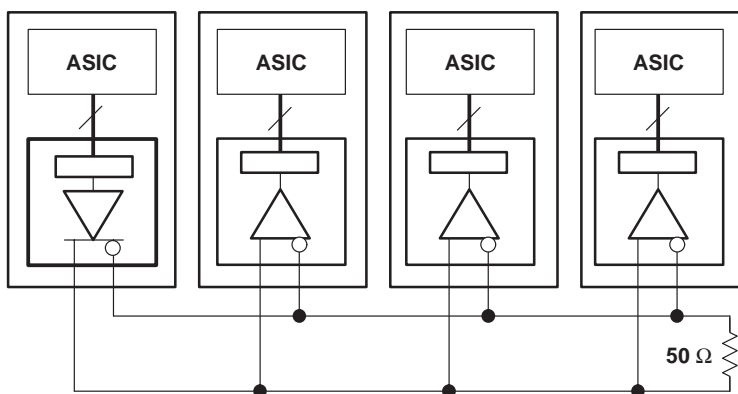
Figure 21 shows an example of a single-terminated point-to-point connection. Here a single termination resistor is located at the deserializer end. The resistor value should match that of the characteristic impedance of the cable or PC board traces. The total load seen by the serializer is 100  $\Omega$ . Double termination can be used and typically reduces reflections compared with single termination. However, it also reduces the differential output voltage swing.

AC-coupling is only recommended if the parallel TX data stream is encoded to achieve a dc-balanced data stream. Otherwise the ac-capacitors can induce common mode voltage drift due to the dc-unbalanced data stream.



**Figure 21. Single-Terminated Point-to-Point Connection**

Figure 22 shows an example of a multidrop configuration. Here there is one transmitter broadcasting data to multiple receivers. A 50-k $\Omega$  resistor at the far end terminates the bus.

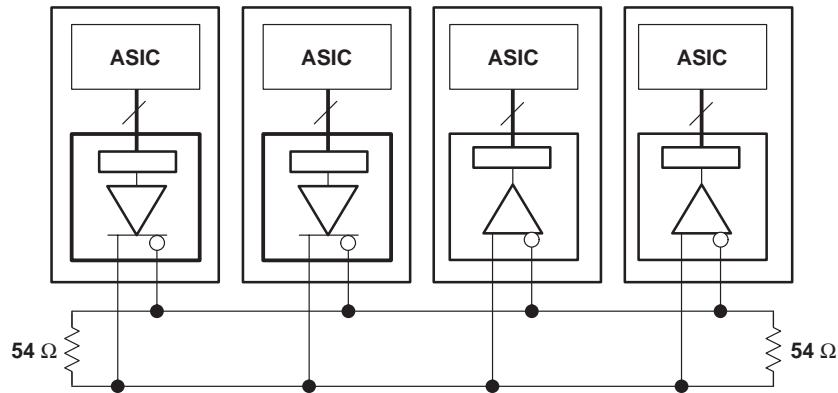


**Figure 22. Multidrop Configuration**

# SN65LV1023A/SN65LV1224B 10-MHz TO 66-MHz, 10:1 LVDS SERIALIZER/DESERIALIZER

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Figure 23 shows an example of multiple serializers and deserializers on the same differential bus, such as in a backplane. This is a multipoint configuration. In this situation, the characteristic impedance of the bus can be significantly less due to loading. Termination resistors that match the loaded characteristic impedance are required at each end of the bus. The total load seen by the serializer in this example is 27  $\Omega$ .



**Figure 23. Multiple Serializers and Deserializers on the Same Differential Bus**

DB (R-PDSO-G\*\*)

PLASTIC SMALL-OUTLINE

28 PINS SHOWN



- NOTES: A. All linear dimensions are in millimeters.  
 B. This drawing is subject to change without notice.  
 C. Body dimensions do not include mold flash or protrusion not to exceed 0,15.  
 D. Falls within JEDEC MO-150

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| Power Mgmt       | <a href="http://power.ti.com">power.ti.com</a>                     | Optical Networking  | <a href="http://www.ti.com/opticalnetwork">www.ti.com/opticalnetwork</a> |
| Microcontrollers | <a href="http://microcontroller.ti.com">microcontroller.ti.com</a> | Security            | <a href="http://www.ti.com/security">www.ti.com/security</a>             |
|                  |  | Telephony           | <a href="http://www.ti.com/telephony">www.ti.com/telephony</a>           |
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