

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

Check for Samples: [SN65LV1023A](#) [SN65LV1224B](#)

## FEATURES

- 100-Mbps to 660-Mbps Serial LVDS Data Payload Bandwidth at 10-MHz to 66-MHz System Clock
- Pin-Compatible Superset of 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
- 28-Pin SSOP and Space Saving 5 × 5 mm QFN Packages Available
- 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

## APPLICATIONS

- Wireless Base Station
- Backplane Interconnect
- DSLAM

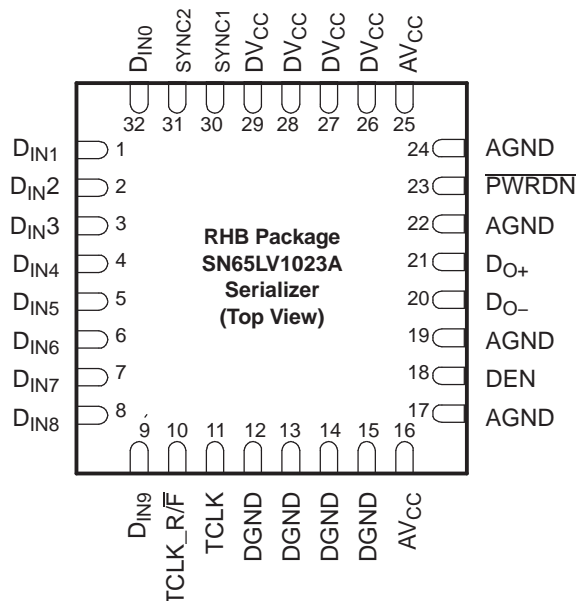
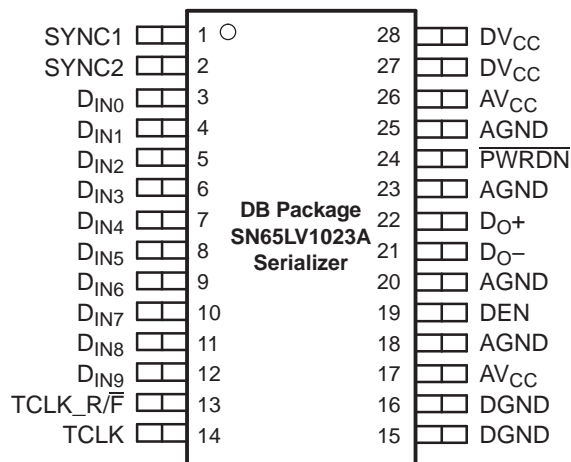
## DESCRIPTION

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  $85^{\circ}\text{C}$ .

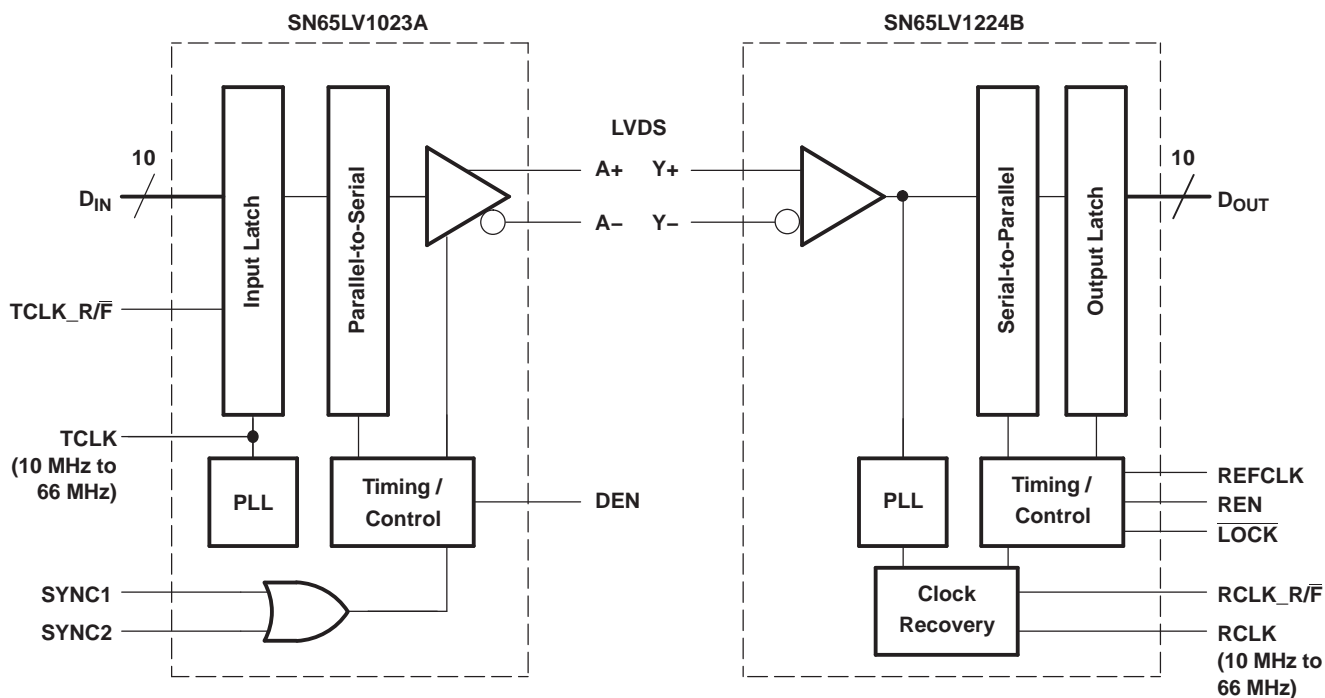


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These devices have limited built-in ESD protection. The leads should be shorted together or the device placed in conductive foam during storage or handling to prevent electrostatic damage to the MOS gates.

## 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.

### 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.

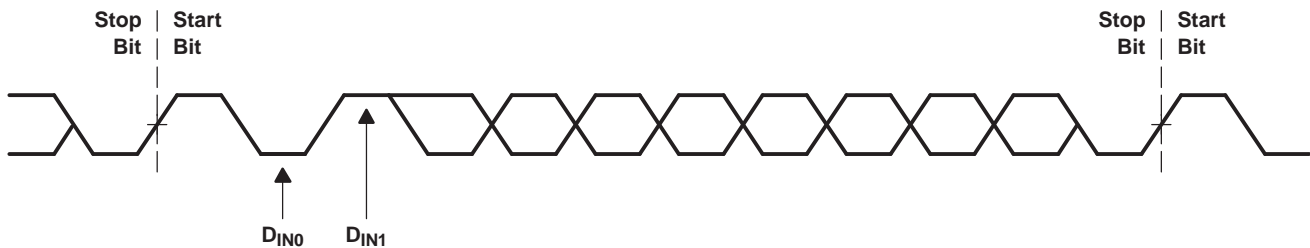
When the deserializer detects edge transitions at the LVDS input, it attempts to lock to the embedded clock information. The deserializer LOCK output remains high while its PLL locks to the incoming data or SYNC patterns present on the serial input. When the deserializer locks to the LVDS data, the LOCK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

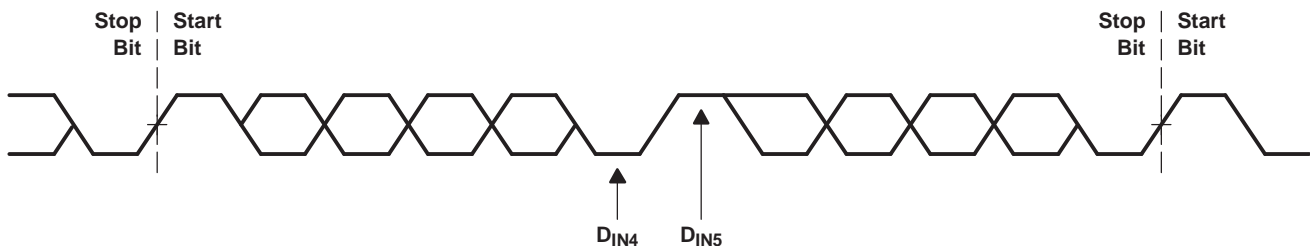
The data contained in the data stream can also affect lock time. If a specific pattern is repetitive, the deserializer could enter false lock—falsely recognizing the data pattern as the start/stop bits. This is referred to as repetitive multitransition (RMT); see [Figure 1](#) for RMT examples. This 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 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 LOCK pin output goes high and the outputs (including RCLK) enter a high-impedance state. The user's system should monitor the 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.

$D_{IN0}$  Held Low and  $D_{IN1}$  Held High



$D_{IN4}$  Held Low and  $D_{IN5}$  Held High



$D_{IN8}$  Held Low and  $D_{IN9}$  Held High

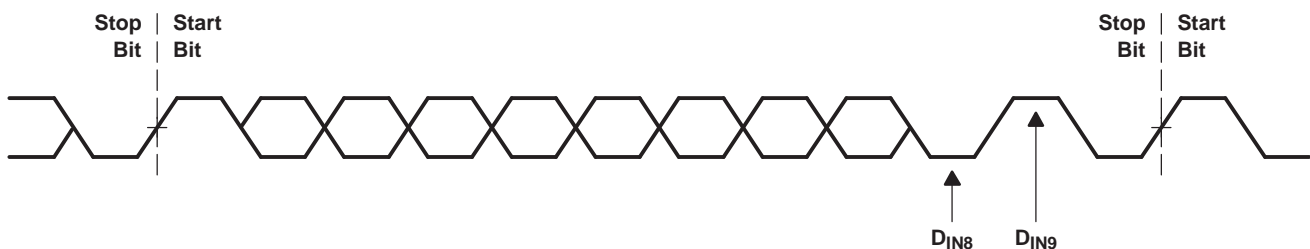


Figure 1. RMT Pattern Examples

## DATA TRANSMISSION MODE

After initialization and synchronization, the serializer accepts parallel data from inputs  $D_{IN0}$ – $D_{IN9}$ . The serializer uses the  $TCLK$  input to latch the incoming data. The  $TCLK\_R/\bar{F}$  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  $D_{IN0}$ – $D_{IN9}$  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 ( $DO_{\pm}$ ) 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.

The serializer outputs ( $DO_{\pm}$ ) can drive point-to-point connections or limited multipoint or multidrop backplanes. The outputs transmit data when the enable pin ( $DEN$ ) is high,  $PWRDN = \text{high}$ , 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  $\text{R}_{\text{OUT}0}\text{--}\text{R}_{\text{OUT}9}$  is invalid. The  $\text{R}_{\text{OUT}0}\text{--}\text{R}_{\text{OUT}9}$  data is strobed out by RCLK. The specific RCLK edge polarity to be used is selected by the RCLK\_R/F input. The  $\text{R}_{\text{OUT}0}\text{--}\text{R}_{\text{OUT}9}$ ,  $\overline{\text{LOCK}}$  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 ( $\text{R}_{\text{OUT}0}\text{--}\text{R}_{\text{OUT}9}$ ) and RCLK are placed into the high-impedance state. The  $\overline{\text{LOCK}}$  output remains active, reflecting the state of the PLL.

**Table 1. Deserializer Truth Table**

INPUTS		OUTPUTS		
$\overline{\text{PWRDN}}$	REB	$\text{ROUT}(0:9)^{(1)}$	$\overline{\text{LOCK}}^{(2)}$	$\text{RCLK}^{(3) (1)}$
H	H	Z	H	Z
H	H	Active	L	Active
L	X	Z	Z	Z
H	L	Z	Active	Z

(1) ROUT and RCLK are 3-stated when  $\overline{\text{LOCK}}$  is asserted high.

(2)  $\overline{\text{LOCK}}$  output reflects the state of the deserializer with regard to the selected data stream.

(3) 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.

## FAILSAFE BIASING FOR THE SN65LV1224B

The SN65LV1224B has an input threshold sensitivity of  $\pm 50$  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.

## PIN FUNCTIONS

PIN		I/O	DESCRIPTION
DB PACKAGE	RHB PACKAGE		
SERIALIZER			
18, 20, 23, 25	17, 19, 22, 24	AGND	Analog circuit ground (PLL and analog circuits)
17, 26	16, 25	AV <sub>CC</sub>	Analog circuit power supply (PLL and analog circuits)
19	18	DEN	LVTTTL logic input. Low puts the LVDS serial output into the high-impedance state. High enables serial data output.
15, 16	12, 13, 14, 15	DGND	Digital circuit ground
3–12	32, 1–9	D <sub>IN0</sub> – D <sub>IN9</sub>	Parallel LVTTTL data inputs
21	20	D <sub>O</sub> –	Inverting LVDS differential output
22	21	D <sub>O</sub> +	Noninverting LVDS differential output
27, 28	26, 27, 28, 29	DV <sub>CC</sub>	Digital circuit power supply
24	23	$\overline{\text{PWRDN}}$	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	30, 31	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	10	TCLK_R/ $\overline{\text{F}}$	LVTTTL logic input. Low selects a TCLK falling-edge data strobe; high selects a TCLK rising-edge data strobe.
14	11	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			
1, 12, 13	10, 11, 28, 29, 30	AGND	Analog circuit ground (PLL and analog circuits)
4, 11	1, 8, 9	AV <sub>CC</sub>	Analog circuit power supply (PLL and analog circuits)
14, 20, 22	12, 13, 19, 21	DGND	Digital circuit ground
21, 23	20, 22	DV <sub>CC</sub>	Digital circuit power supply
10	7	$\overline{\text{LOCK}}$	LVTTTL level output. $\overline{\text{LOCK}}$ goes low when the deserializer PLL locks onto the embedded clock edge.
7	4	$\overline{\text{PWRDN}}$	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 $\overline{\text{PWRDN}}$ is held low, the device is in the power down state.
2	31	RCLK_R/ $\overline{\text{F}}$	LVTTTL logic input. Low selects an RCLK falling-edge data strobe; high selects an RCLK rising-edge data strobe.
9	6	RCLK	LVTTTL level output recovered clock. Use RCLK to strobe ROUTx.
3	32	REFCLK	LVTTTL logic input. Use this pin to supply a REFCLK signal for the internal PLL frequency.
8	5	REN	LVTTTL logic input. Low places R <sub>OUT0</sub> –R <sub>OUT9</sub> and RCLK in the high-impedance state.
5	2	R <sub>I</sub> +	Serial data input. Noninverting LVDS differential input
6	3	R <sub>I</sub> –	Serial data input. Inverting LVDS differential input
28–24, 19–15	27–23, 18–14	R <sub>OUT0</sub> –R <sub>OUT9</sub>	Parallel LVTTTL data outputs

## ABSOLUTE MAXIMUM RATINGS

over operating free-air temperature range (unless otherwise noted)<sup>(1)</sup>

		UNIT
$V_{CC}$ to GND		–0.3 V to 4 V
LVTTTL input voltage		–0.3 V to ( $V_{CC} + 0.3$ V)
LVTTTL output voltage		–0.3 V to ( $V_{CC} + 0.3$ 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
DB package maximum package power dissipation	$T_A = 25^\circ\text{C}$	1.27 W
RHB package maximum package power dissipation	$T_A = 25^\circ\text{C}$	2.85 W
DB package derating		10.3 mW/°C above 25°C
RHB package derating		23.6 mW/°C above 25°C

(1) 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

over operating free-air temperature range (unless otherwise noted)

		MIN	NOM	MAX	UNIT
$V_{CC}$ <sup>(1)</sup>	Supply voltage	3	3.3	3.6	V
	Receiver input voltage range	0		2.4	V
$V_{CM}$	Receiver input common mode range	$\frac{V_{ID}}{2}$	$2.4 - \left(\frac{V_{ID}}{2}\right)$		V
	Supply noise voltage			100	mV <sub>PP</sub>
$T_A$	Operating free-air temperature	–40	25		°C

(1) 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.



## ELECTRICAL CHARACTERISTICS

over recommended operating supply and temperature ranges (unless otherwise specified)

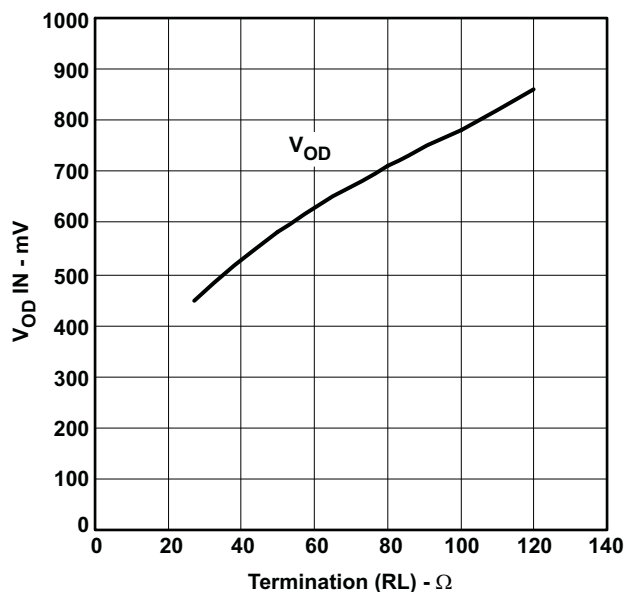
PARAMETER		TEST CONDITIONS	MIN	TYP	MAX	UNIT
<b>SERIALIZER LVCMOS/LVTTL DC SPECIFICATIONS<sup>(1)</sup></b>						
V <sub>IH</sub>	High-level input voltage		2		V <sub>CC</sub>	V
V <sub>IL</sub>	Low-level input voltage		GND		0.8	V
V <sub>CL</sub>	Input clamp voltage	I <sub>CL</sub> = -18 mA		-0.86	-1.5	V
I <sub>IN</sub>	Input current, <sup>(2)</sup>	V <sub>IN</sub> = 0 V or 3.6 V	-200	±100	200	µA
<b>DESERIALIZER LVCMOS/LVTTL DC SPECIFICATIONS<sup>(3)</sup></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	I <sub>CL</sub> = -18 mA		-0.62	-1.5	V
I <sub>IN</sub>	Input current (pull-up and pull-down resistors on inputs)	V <sub>IN</sub> = 0 V or 3.6 V	-200		200	µA
V <sub>OH</sub>	High-level output voltage	I <sub>OH</sub> = -5 mA	2.2	3	V <sub>CC</sub>	V
V <sub>OL</sub>	Low-level output voltage	I <sub>OL</sub> = 5 mA	GND	0.25	0.5	V
I <sub>OS</sub>	Output short-circuit current	V <sub>OUT</sub> = 0 V	-15	-47	-85	mA
I <sub>OZ</sub>	High-impedance output current	$\overline{\text{PWRDN}}$ or REN = 0.8 V, V <sub>OUT</sub> = 0 V or V <sub>CC</sub>	-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-)	R <sub>L</sub> = 27 Ω, See <a href="#">Figure 2</a>	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	DO = 0 V, D <sub>INx</sub> = high, $\overline{\text{PWRDN}}$ and DEN = 2.4 V		-10	-90	mA
I <sub>OZ</sub>	High-impedance output current	$\overline{\text{PWRDN}}$ or DEN = 0.8 V, DO = 0 V or V <sub>CC</sub>	-10	±1	10	µA
I <sub>OX</sub>	Power-off output current	V <sub>CC</sub> = 0 V, DO = 0 V or 3.6 V	-20	±1	25	µA
C <sub>O</sub>	Output single-ended capacitance				1±20%	pF
<b>DESERIALIZER LVDS DC SPECIFICATIONS (Apply to Pins RI+ and RI-)</b>						
V <sub>TH</sub>	Differential threshold high voltage	V <sub>CM</sub> = 1.1 V			50	mV
V <sub>TL</sub>	Differential threshold low voltage		-50			mV
I <sub>IN</sub>	Input current	V <sub>IN</sub> = 2.4 V, V <sub>CC</sub> = 3.6 V or 0 V	-10	±1	15	µA
		V <sub>IN</sub> = 0 V, V <sub>CC</sub> = 3.6 V or 0 V	-10	±0.05	10	
C <sub>I</sub>	Input single-ended capacitance				0.5±20%	pF
<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 <a href="#">Figure 5</a>	f = 10 MHz	20	25	mA
			f = 66 MHz	55	70	
I <sub>CCXD</sub>	Serializer supply current	$\overline{\text{PWRDN}}$ = 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 <a href="#">Figure 5</a>	f = 10 MHz	15	35	mA
			f = 66 MHz	80	95	
I <sub>CCXR</sub>	Deserializer supply current, power down	$\overline{\text{PWRDN}}$ = 0.8 V, REN = 0.8 V		0.36	1	mA

(1) Apply to D<sub>IN0</sub>-D<sub>IN9</sub>, TCLK,  $\overline{\text{PWRDN}}$ , TCLK\_R/ $\overline{\text{F}}$ , SYNC1, SYNC2, and DEN

(2) High I<sub>IN</sub> values are due to pullup and pulldown resistors on the inputs.

(3) Apply to pins  $\overline{\text{PWRDN}}$ , RCLK\_R/ $\overline{\text{F}}$ , REN, and REFCLK = inputs; apply to pins R<sub>OUTx</sub>, RCLK, and  $\overline{\text{LOCK}}$  = outputs





**Figure 2. Typical  $V_{OD}$  Curve**

## SERIALIZER TIMING REQUIREMENTS FOR TCLK

over recommended operating supply and temperature ranges (unless otherwise specified)

PARAMETER	TEST CONDITIONS	MIN	TYP	MAX	UNIT
$t_{TCP}$ Transmit clock period		15.15	T	100	ns
$t_{TCIH}$ Transmit clock high time		0.4T	0.5T	0.6T	ns
$t_{TCIL}$ Transmit clock low time		0.4T	0.5T	0.6T	ns
$t_{I(CLK)}$ TCLK input transition time			3	6	ns
$t_{JIT}$ TCLK input jitter	See <a href="#">Figure 19</a>			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
$t_{TLH(L)}$ LVDS low-to-high transition time	$R_L = 27\ \Omega$ , $C_L = 10\ \text{pF}$ to GND, See <a href="#">Figure 6</a>		0.2	0.4	ns
$t_{LTHL(L)}$ LVDS high-to-low transition time			0.25	0.4	ns
$t_{SU(DI)}$ DIN0–DIN9 setup to TCLK	See <a href="#">Figure 9</a>	0.5			ns
$t_{SU(DI)}$ DIN0–DIN9 hold from TCLK		4			ns
$t_{d(HZ)}$ DO± high-to-high impedance state delay	$R_L = 27\ \Omega$ , $C_L = 10\ \text{pF}$ to GND, See <a href="#">Figure 10</a>		2.5	5	ns
$t_{d(LZ)}$ DO± low-to-high impedance state delay			2.5	5	
$t_{d(ZH)}$ DO± high-to-high impedance state-to-high delay			5	10	
$t_{d(ZL)}$ DO± high-to-high impedance state-to-low delay			6.5	10	
$t_{w(SPW)}$ SYNC pulse duration	See <a href="#">Figure 12</a>	$6 \times t_{TCP}$			ns
$t_{(PLD)}$ Serializer PLL lock time		$1026 \times t_{TCP}$			ns
$t_{d(S)}$ Serializer delay	See <a href="#">Figure 13</a>	$t_{TCP+1}$	$t_{TCP+2}$	$t_{TCP+3}$	ns
$t_{DJIT}$ Deterministic jitter	$R_L = 27\ \Omega$ , $C_L = 10\ \text{pF}$ to GND			230	ps
				150	
$t_{RJIT}$ Random jitter	$R_L = 27\ \Omega$ , $C_L = 10\ \text{pF}$ to GND		10	19	ps (RMS)

## DESERIALIZER TIMING REQUIREMENTS FOR REFCLK

over recommended operating supply and temperature ranges (unless otherwise specified)

PARAMETER	TEST CONDITIONS	MIN	TYP	MAX	UNIT
$t_{RFCP}$ REFCLK period		15.15	T	100	ns
$t_{RFDC}$ REFCLK duty cycle		30%	50%	70%	
$t_{t(RF)}$ 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
$t_{(RCP)}$ Receiver out clock period	$t_{(RCP)} = t_{(TCP)}$ , See Figure 13	RCLK	15.15		100	ns
$t_{(LH(C))}$ CMOS/TTL low-to-high transition time	$C_L = 15\text{ pF}$ , $C_L = 15\text{ pF}$ , See Figure 7	ROUT0–ROUT9 LOCK, RCLK		1.2	2.5	ns
$t_{(HL(C))}$ CMOS/TTL high-to-low transition time				1.1	2.5	
$t_{(D)}$ Deserializer delay, See Figure 14	Room temperature, 3.3 V	10 MHz	$1.75 \times t_{(RCP)} + 4.2$		$1.75 \times t_{(RCP)} + 12.6$	ns
		66 MHz	$1.75 \times t_{(RCP)} + 7.4$		$1.75 \times t_{(RCP)} + 9.7$	ns
$t_{(ROS)}$ $R_{OUTx}$ data valid before RCLK	See Figure 15	RCLK 10 MHz	$0.4 \times t_{(RCP)}$	$0.5 \times t_{(RCP)}$		ns
		RCLK 66 MHz	$0.4 \times t_{(RCP)}$	$0.5 \times t_{(RCP)}$		
$t_{(ROH)}$ $R_{OUTx}$ data valid after RCLK		10 MHz	$-0.4 \times t_{(RCP)}$	$-0.5 \times t_{(RCP)}$		
		66 MHz	$-0.4 \times t_{(RCP)}$	$-0.5 \times t_{(RCP)}$		
$t_{(RDC)}$ RCLK duty cycle			40%	50%	60%	ns
$t_{(d(HZ))}$ High-to-high impedance state delay	See Figure 16	$R_{OUT0} - R_{OUT9}$		6.5	8	ns
$t_{(d(LZ))}$ Low-to-high impedance state delay				4.7	8	ns
$t_{(d(HR))}$ High-impedance state to high delay				5.3	8	ns
$t_{(d(ZL))}$ High-impedance state to low delay				4.7	8	ns
$t_{(DSR1)}$ Deserializer PLL lock time from PWRDN (with SYNCPAT)	See Figure 17, Figure 18, and <sup>(1)</sup>	10 MHz			$850 \times t_{(RCP)}$	$\mu\text{s}$
		66 MHz			$850 \times t_{(RCP)}$	
		10 MHz			2	
$t_{(DSR2)}$ Deserializer PLL lock time from SYNCPAT		66 MHz			0.303	
$t_{(d(ZHLK))}$ High-impedance state to high delay (power up)		LOCK			3	ns
$t_{(RNM)}$ Deserializer noise margin	See Figure 19 and <sup>(2)</sup>	10 MHz		3680		ps
		66 MHz		540		

- (1)  $t_{(DSR1)}$  represents the time required for the deserializer to register that a lock has occurred upon powerup or when leaving the powerdown mode.  $t_{(DSR2)}$  represents the time required to register that a lock has occurred for the powered up and enabled deserializer when the input (RI±) conditions change from not receiving data to receiving synchronization patterns (SYNCPATs). In order to specify deserializer PLL performance,  $t_{(DSR1)}$  and  $t_{(DSR2)}$  are specified with REFCLK active and stable and specific conditions of SYNCPATs.
- (2)  $t_{(RNM)}$  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

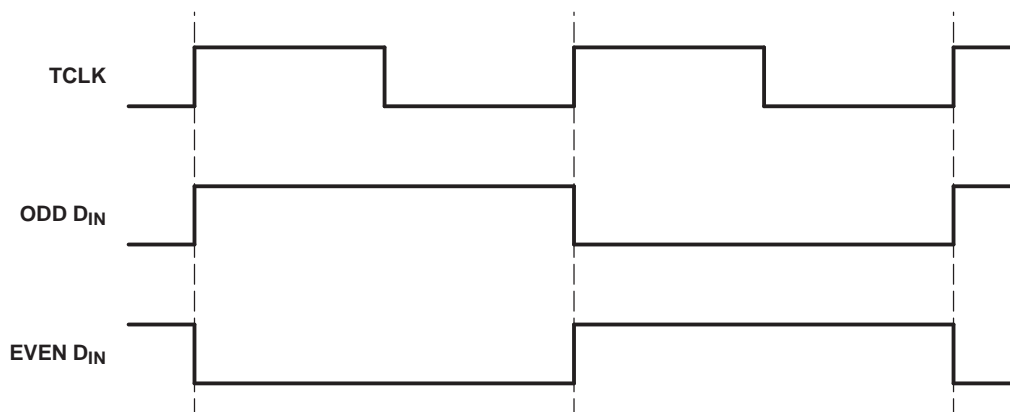


Figure 3. Worst-Case Serializer  $I_{CC}$  Test Pattern

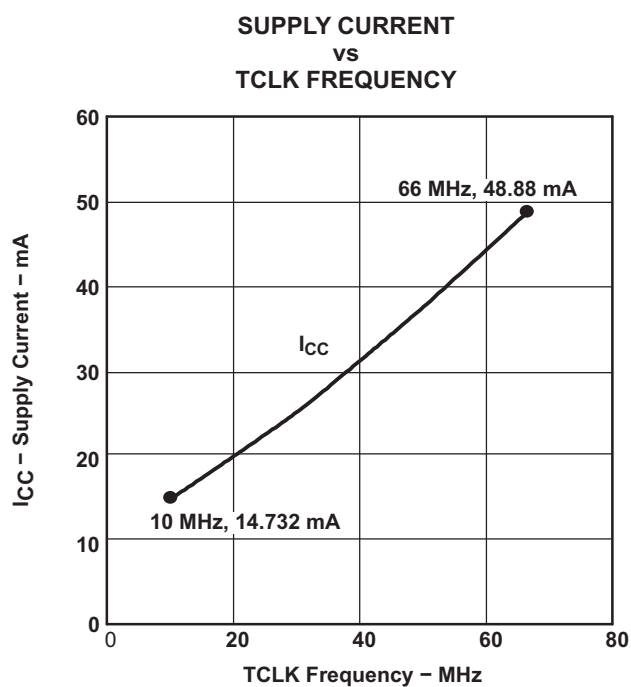


Figure 4.

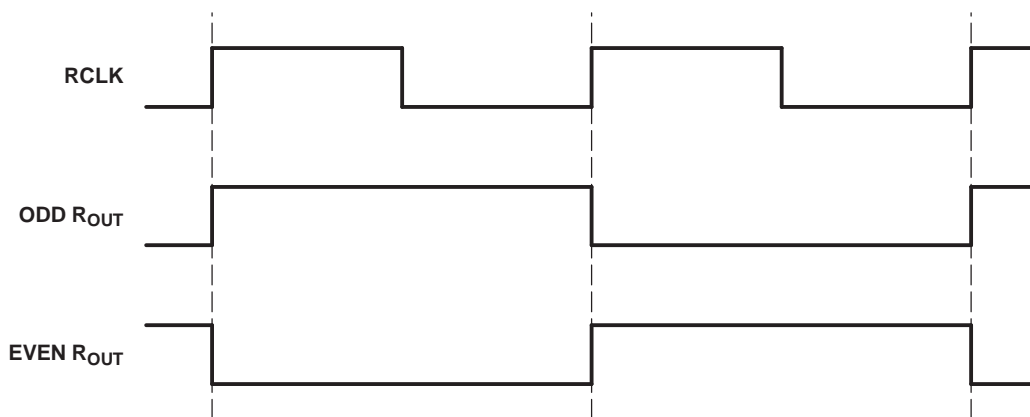


Figure 5. Worst-Case Deserializer  $I_{CC}$  Test Pattern

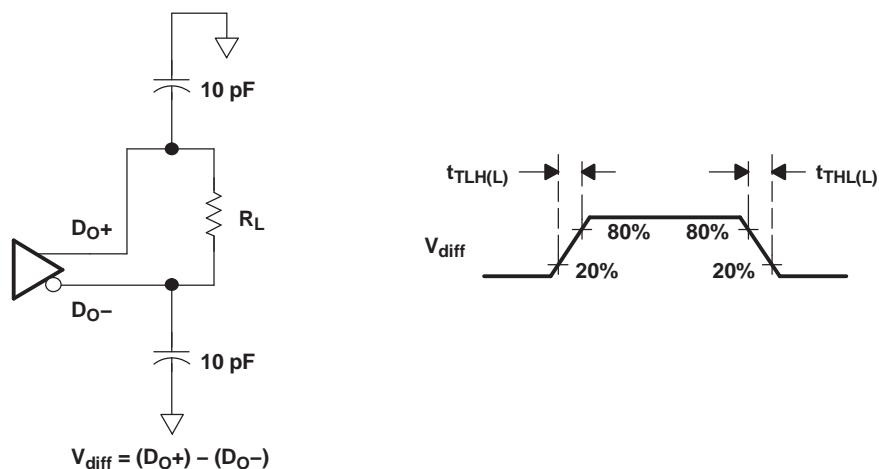


Figure 6. Serializer LVDS Output Load and Transition Times

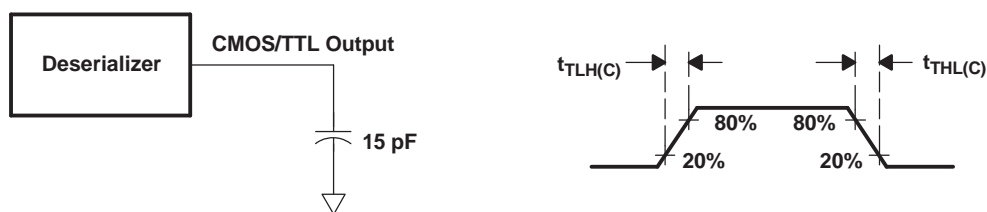


Figure 7. Deserializer CMOS/TTL Output Load and Transition Times

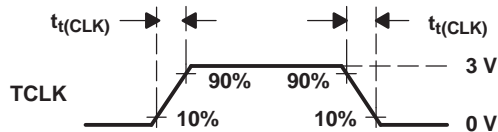


Figure 8. Serializer Input Clock Transition Time

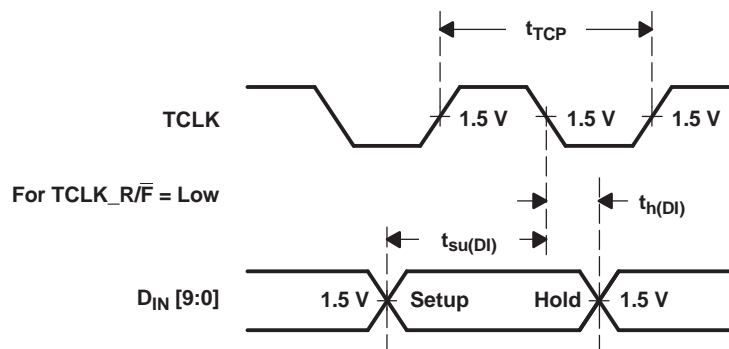


Figure 9. Serializer Setup/Hold Times

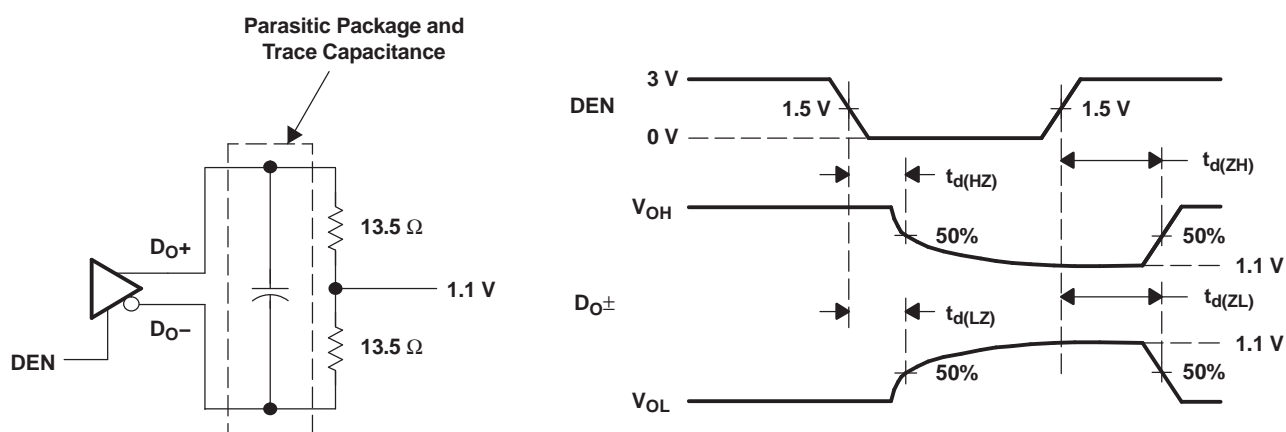


Figure 10. Serializer High-Impedance State Test Circuit and Timing

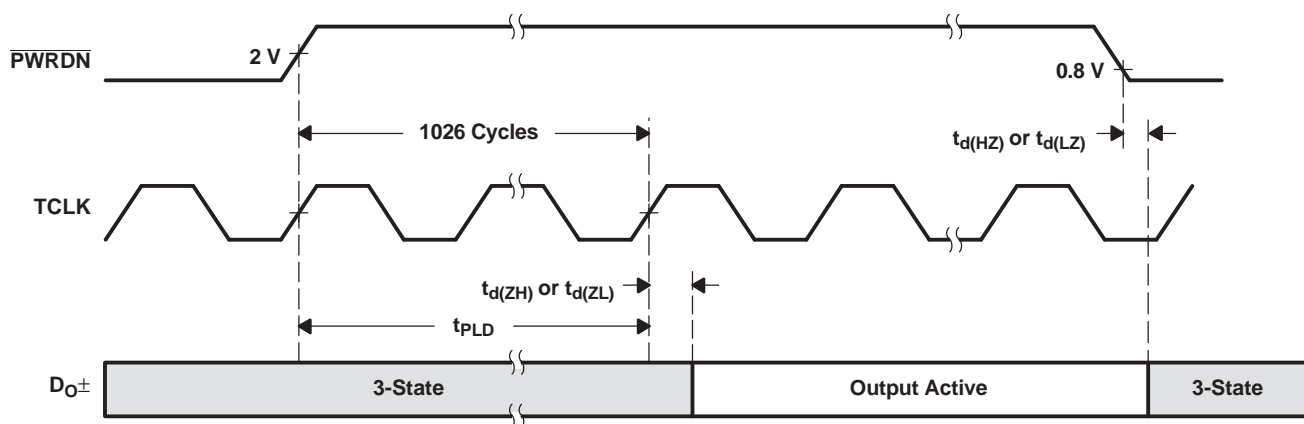
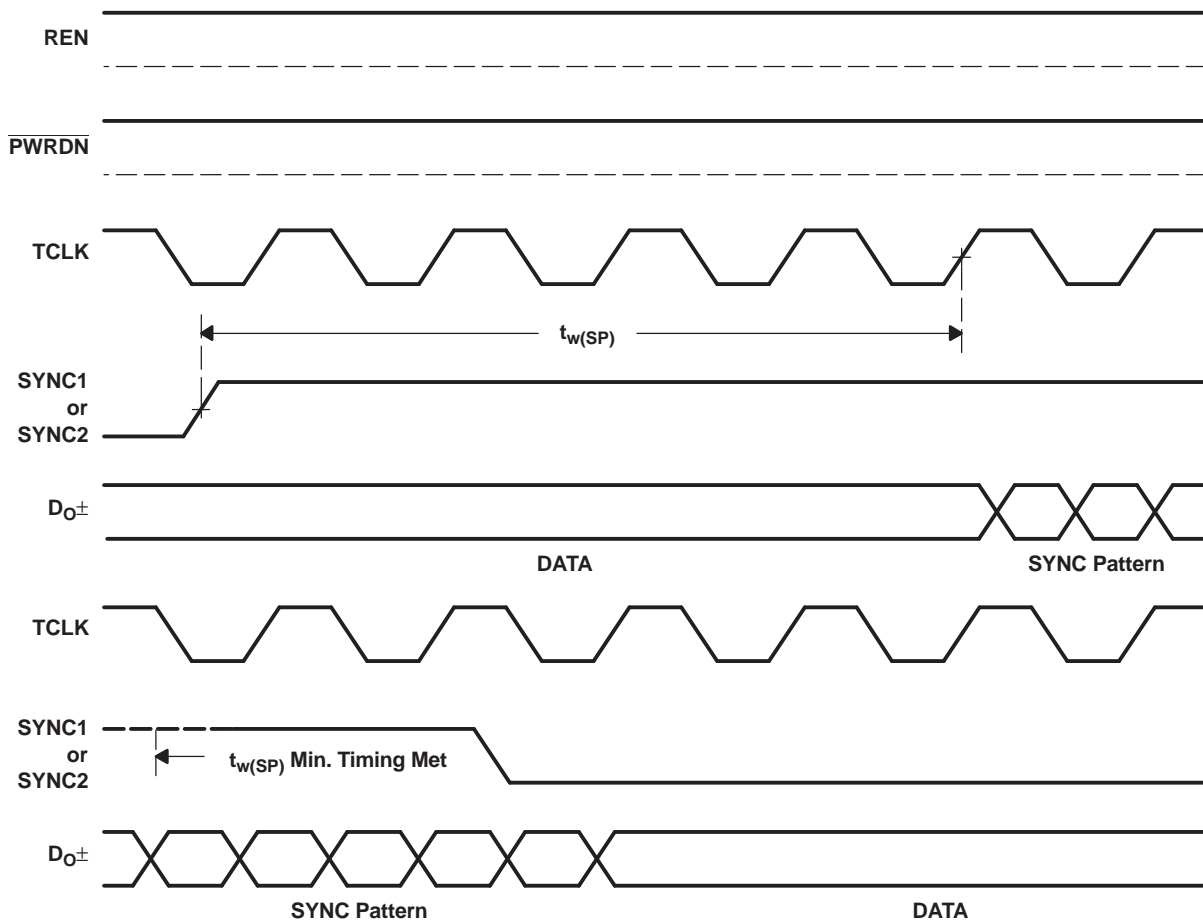
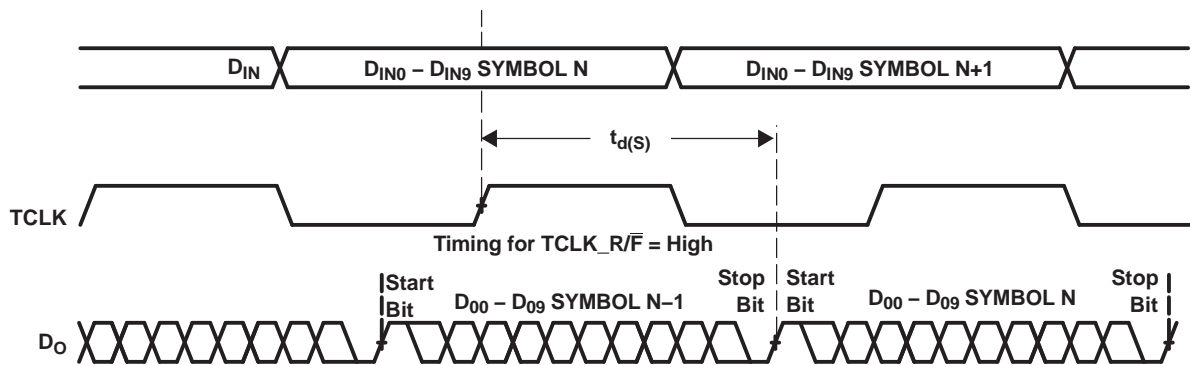


Figure 11. Serializer PLL Lock Time and PWRDN High-Impedance State Delays



**Figure 12. SYNC Timing Delays**



**Figure 13. Serializer Delay**



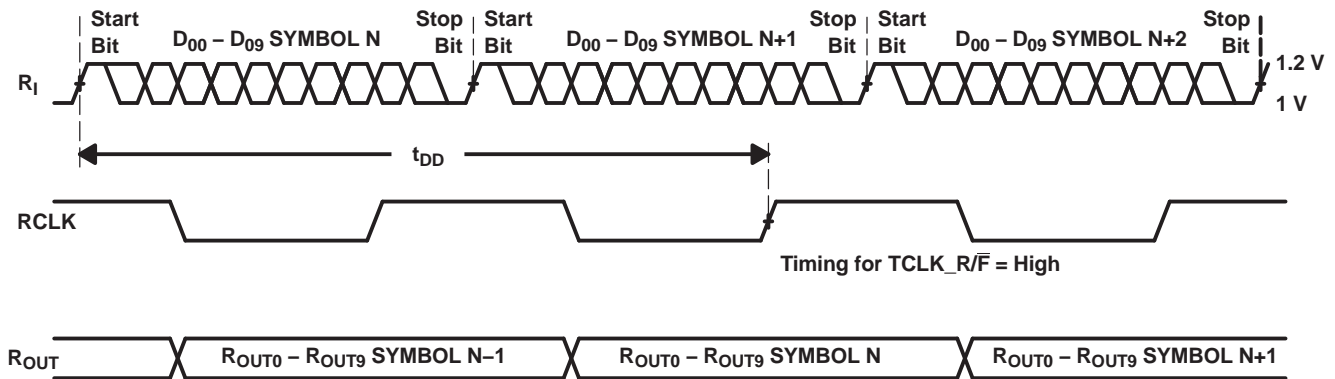


Figure 14. Deserializer Delay

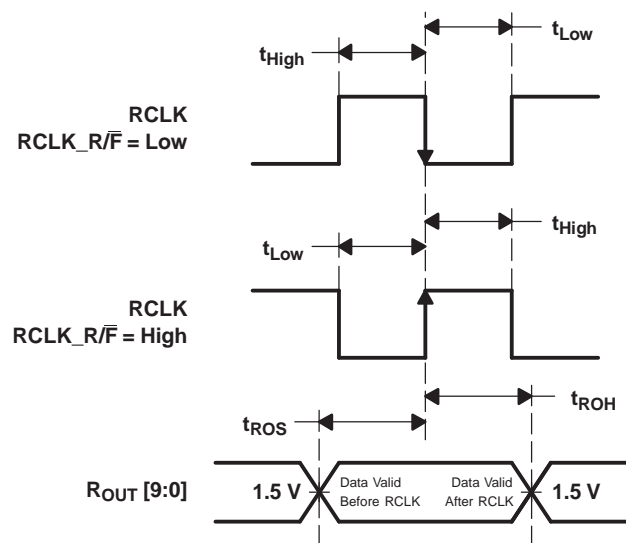


Figure 15. Deserializer Data Valid Out Times

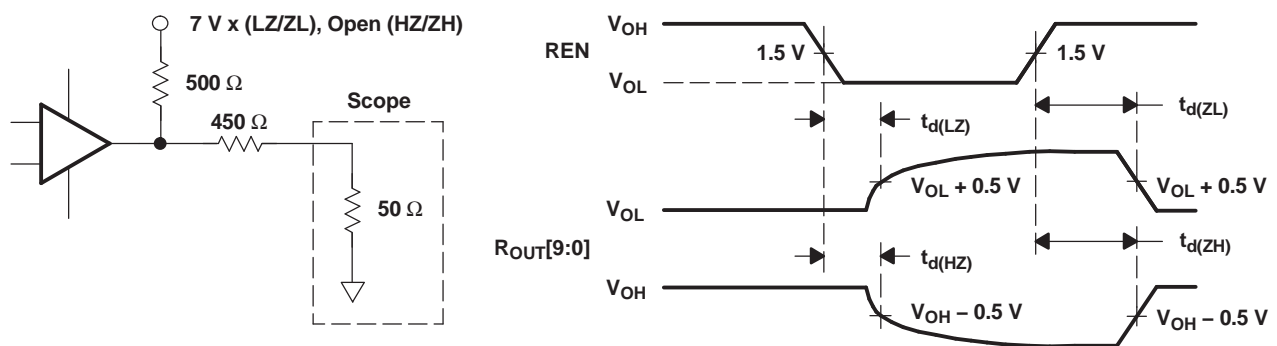


Figure 16. Deserializer High-Impedance State Test Circuit and Timing

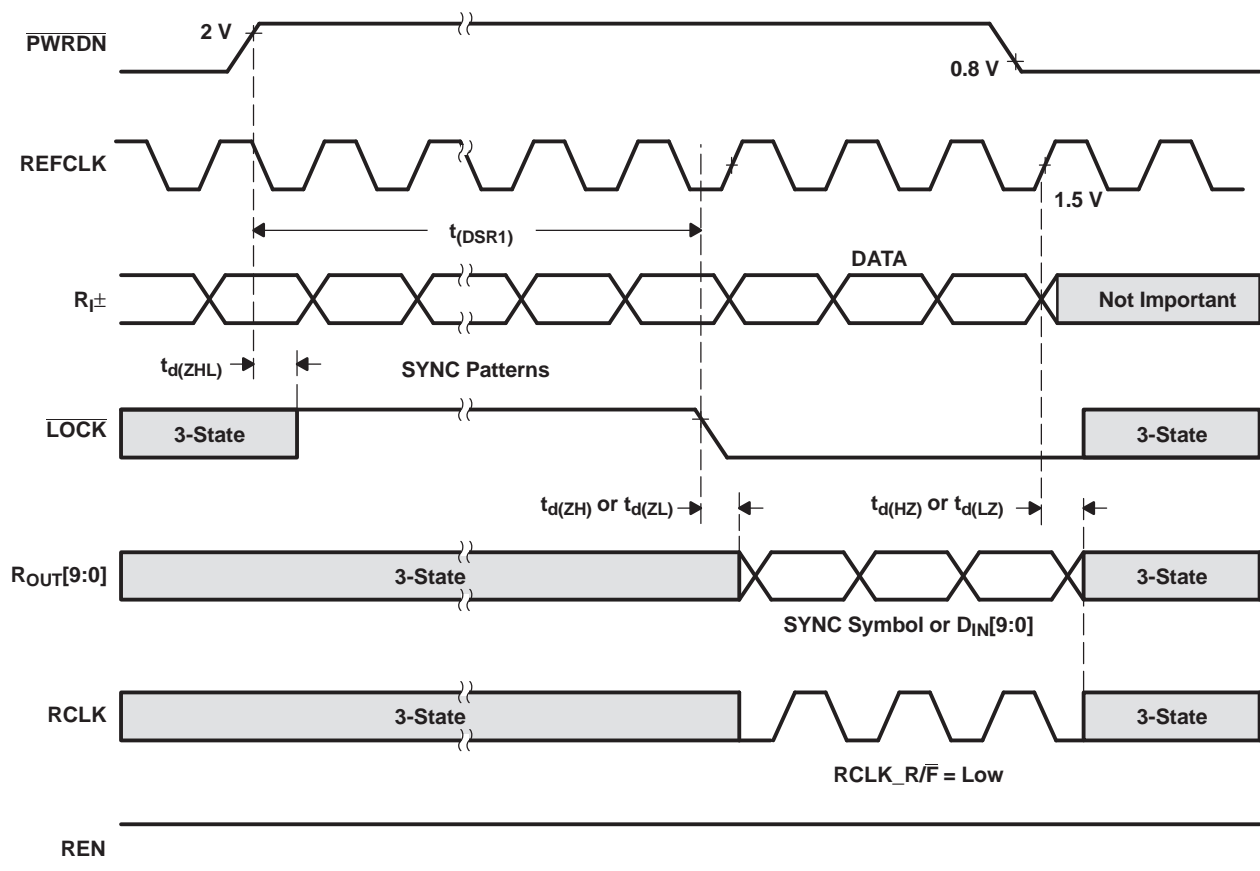


Figure 17. Deserializer PLL Lock Times and  $\overline{\text{PWRDN}}$  3-State Delays

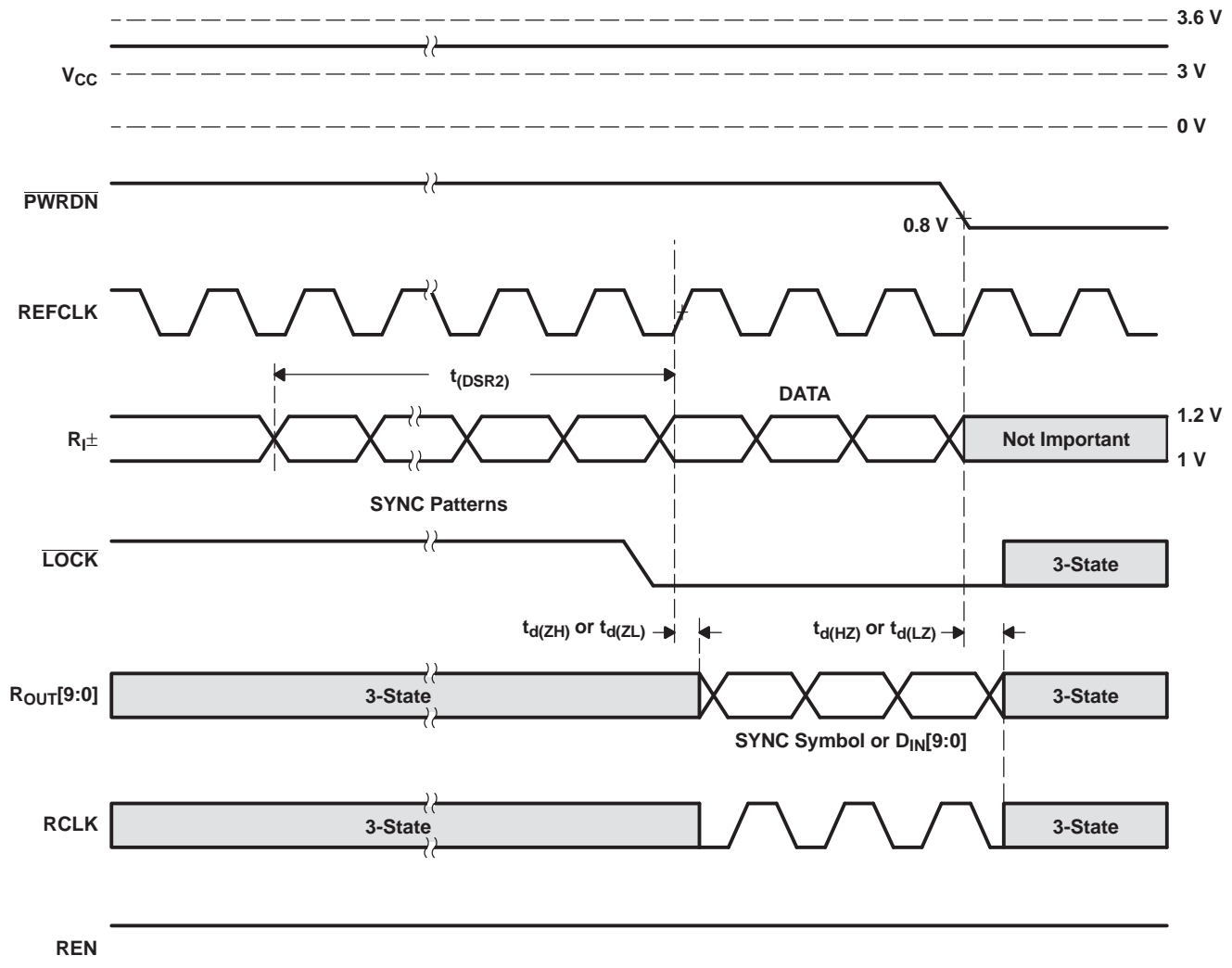
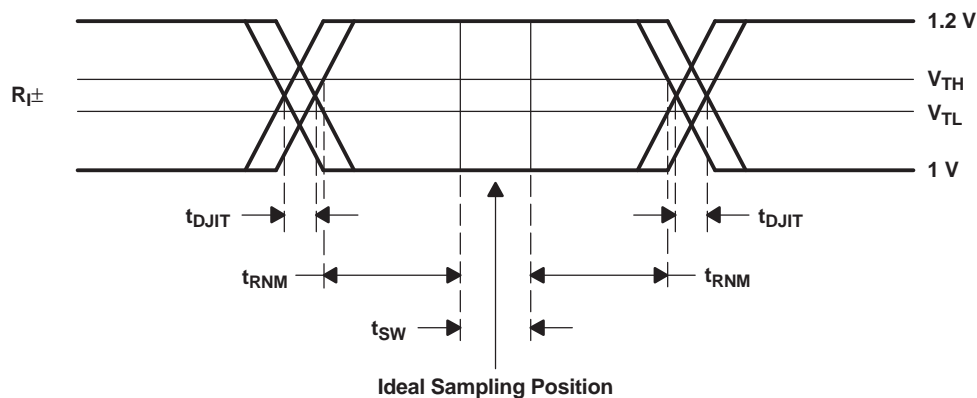
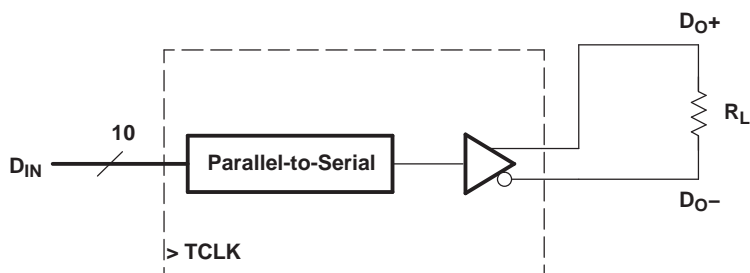


Figure 18. Deserializer PLL Lock Time From SyncPAT



$t_{sw}$ : 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 19. Receiver LVDS Input Skew Margin



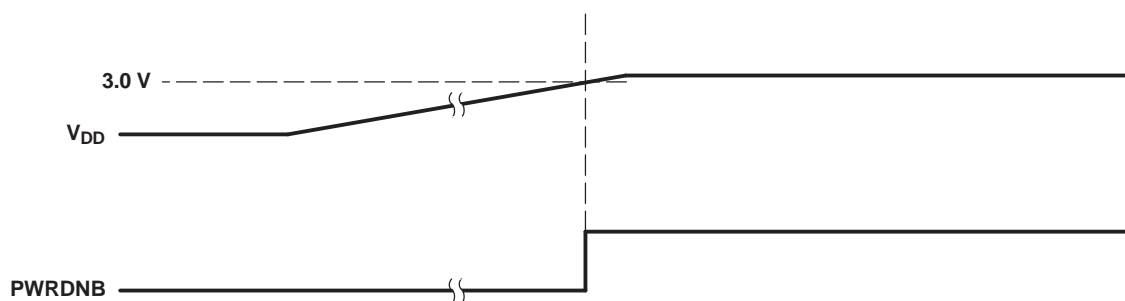
$$V_{OD} = (D_{O+}) - (D_{O-})$$

Differential Output Signal Is Shown as  $(D_{O+}) - (D_{O-})$

**Figure 20.  $V_{OD}$  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 21.



**Figure 21. 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.

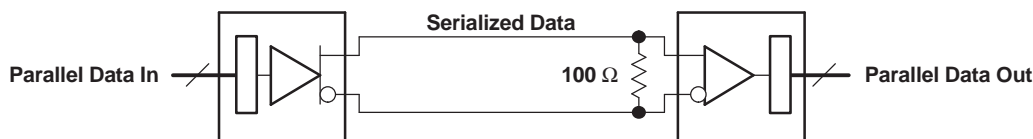
Running the differential traces close together helps cancel the external magnetic field, as well as maintain a constant impedance. Avoiding sharp turns and reducing the number of vias also helps.

### TOPOLOGIES

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

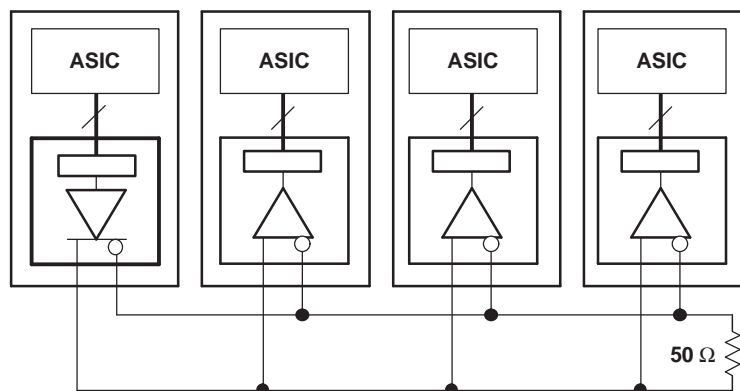
[Figure 22](#) shows an example of a single-terminated point-to-point connection. Here a single termination resistor is located at the deserializer end. The resistor value should match that of the characteristic impedance of the cable or PC board traces. The total load seen by the serializer is  $100\ \Omega$ . 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.



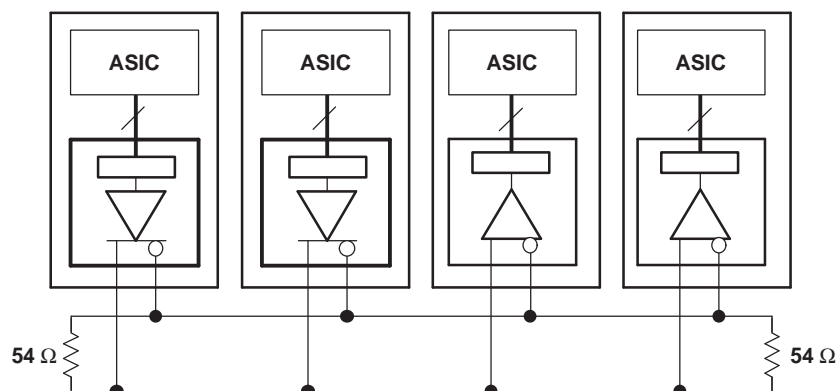
**Figure 22. Single-Terminated Point-to-Point Connection**

[Figure 23](#) 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 23. Multidrop Configuration**

[Figure 24](#) 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 24. Multiple Serializers and Deserializers on the Same Differential Bus**

## REVISION HISTORY

Changes from Original (September 2004) to Revision A	Page
• Changed <a href="#">Figure 17</a> .....	17
• Changed <a href="#">Figure 18</a> .....	18
Changes from Revision A (January 2005) to Revision B	Page
• Added RHB package information .....	1
Changes from Revision B (July 2005) to Revision C	Page
• Changed Package description in the Features list. ....	1
Changes from Revision C (February 2006) to Revision D	Page
• Added the Applications List .....	1
• Deleted the DB and RHB packages for Deserializer .....	1
• Added <a href="#">Figure 2</a> .....	9
• Changed <a href="#">Figure 4</a> Supply Current vs TCLK Frequency .....	12
Changes from Revision D (February 2009) to Revision E	Page
• Deleted footnote - "The deserializer delay time for all frequencies does not exceed two serial bit times" From $t_{d(D)}$ .....	11

## PACKAGING INFORMATION

Orderable part number	Status (1)	Material type (2)	Package   Pins	Package qty   Carrier	RoHS (3)	Lead finish/ Ball material (4)	MSL rating/ Peak reflow (5)	Op temp (°C)	Part marking (6)
<a href="#">SN65LV1023ADB</a>	Active	Production	SSOP (DB)   28	50   TUBE	Yes	NIPDAU	Level-1-260C-UNLIM	-40 to 85	LV1023A
SN65LV1023ADB.A	Active	Production	SSOP (DB)   28	50   TUBE	Yes	NIPDAU	Level-1-260C-UNLIM	-40 to 85	LV1023A
SN65LV1023ADB1G4	Active	Production	SSOP (DB)   28	50   TUBE	Yes	NIPDAU	Level-1-260C-UNLIM	-40 to 85	LV1023A
SN65LV1023ADB1G4.A	Active	Production	SSOP (DB)   28	50   TUBE	Yes	NIPDAU	Level-1-260C-UNLIM	-40 to 85	LV1023A
<a href="#">SN65LV1023ADBR</a>	Active	Production	SSOP (DB)   28	2000   LARGE T&R	Yes	NIPDAU	Level-1-260C-UNLIM	-40 to 85	LV1023A
SN65LV1023ADBR.A	Active	Production	SSOP (DB)   28	2000   LARGE T&R	Yes	NIPDAU	Level-1-260C-UNLIM	-40 to 85	LV1023A
<a href="#">SN65LV1023ARHBR</a>	Active	Production	VQFN (RHB)   32	3000   LARGE T&R	Yes	NIPDAU	Level-2-260C-1 YEAR	-40 to 85	SN65LV 1023A
SN65LV1023ARHBR.A	Active	Production	VQFN (RHB)   32	3000   LARGE T&R	Yes	NIPDAU	Level-2-260C-1 YEAR	-40 to 85	SN65LV 1023A
<a href="#">SN65LV1023ARHBT</a>	Active	Production	VQFN (RHB)   32	250   SMALL T&R	Yes	NIPDAU	Level-2-260C-1 YEAR	-40 to 85	SN65LV 1023A
SN65LV1023ARHBT.A	Active	Production	VQFN (RHB)   32	250   SMALL T&R	Yes	NIPDAU	Level-2-260C-1 YEAR	-40 to 85	SN65LV 1023A
SN65LV1023ARHBTG4	Active	Production	VQFN (RHB)   32	250   SMALL T&R	Yes	NIPDAU	Level-2-260C-1 YEAR	-40 to 85	SN65LV 1023A
SN65LV1023ARHBTG4.A	Active	Production	VQFN (RHB)   32	250   SMALL T&R	Yes	NIPDAU	Level-2-260C-1 YEAR	-40 to 85	SN65LV 1023A
<a href="#">SN65LV1224BDB</a>	Active	Production	SSOP (DB)   28	50   TUBE	Yes	NIPDAU	Level-1-260C-UNLIM	-40 to 85	LV1224B
SN65LV1224BDB.A	Active	Production	SSOP (DB)   28	50   TUBE	Yes	NIPDAU	Level-1-260C-UNLIM	-40 to 85	LV1224B
SN65LV1224BDBG4	Active	Production	SSOP (DB)   28	50   TUBE	Yes	NIPDAU	Level-1-260C-UNLIM	-40 to 85	LV1224B
<a href="#">SN65LV1224BDBR</a>	Active	Production	SSOP (DB)   28	2000   LARGE T&R	Yes	NIPDAU	Level-1-260C-UNLIM	-40 to 85	LV1224B
SN65LV1224BDBR.A	Active	Production	SSOP (DB)   28	2000   LARGE T&R	Yes	NIPDAU	Level-1-260C-UNLIM	-40 to 85	LV1224B
<a href="#">SN65LV1224BRHBR</a>	Active	Production	VQFN (RHB)   32	3000   LARGE T&R	Yes	NIPDAU	Level-2-260C-1 YEAR	-40 to 85	SN65LV 1224B
SN65LV1224BRHBR.A	Active	Production	VQFN (RHB)   32	3000   LARGE T&R	Yes	NIPDAU	Level-2-260C-1 YEAR	-40 to 85	SN65LV 1224B
<a href="#">SN65LV1224BRHBT</a>	Active	Production	VQFN (RHB)   32	250   SMALL T&R	Yes	NIPDAU	Level-2-260C-1 YEAR	-40 to 85	SN65LV 1224B
SN65LV1224BRHBT.A	Active	Production	VQFN (RHB)   32	250   SMALL T&R	Yes	NIPDAU	Level-2-260C-1 YEAR	-40 to 85	SN65LV 1224B



Orderable part number	Status (1)	Material type (2)	Package   Pins	Package qty   Carrier	RoHS (3)	Lead finish/ Ball material (4)	MSL rating/ Peak reflow (5)	Op temp (°C)	Part marking (6)
SN65LV1224BRHBT1G4	Active	Production	VQFN (RHB)   32	250   SMALL T&R	Yes	NIPDAU	Level-2-260C-1 YEAR	-40 to 85	SN65LV 1224B
SN65LV1224BRHBT1G4.A	Active	Production	VQFN (RHB)   32	250   SMALL T&R	Yes	NIPDAU	Level-2-260C-1 YEAR	-40 to 85	SN65LV 1224B

<sup>(1)</sup> **Status:** For more details on status, see our [product life cycle](#).

<sup>(2)</sup> **Material type:** When designated, preproduction parts are prototypes/experimental devices, and are not yet approved or released for full production. Testing and final process, including without limitation quality assurance, reliability performance testing, and/or process qualification, may not yet be complete, and this item is subject to further changes or possible discontinuation. If available for ordering, purchases will be subject to an additional waiver at checkout, and are intended for early internal evaluation purposes only. These items are sold without warranties of any kind.

<sup>(3)</sup> **RoHS values:** Yes, No, RoHS Exempt. See the [TI RoHS Statement](#) for additional information and value definition.

<sup>(4)</sup> **Lead finish/Ball material:** Parts may have multiple material finish options. Finish options are separated by a vertical ruled line. Lead finish/Ball material values may wrap to two lines if the finish value exceeds the maximum column width.

<sup>(5)</sup> **MSL rating/Peak reflow:** The moisture sensitivity level ratings and peak solder (reflow) temperatures. In the event that a part has multiple moisture sensitivity ratings, only the lowest level per JEDEC standards is shown. Refer to the shipping label for the actual reflow temperature that will be used to mount the part to the printed circuit board.

<sup>(6)</sup> **Part marking:** There may be an additional marking, which relates to the logo, the lot trace code information, or the environmental category of the part.

Multiple part markings will be inside parentheses. Only one part marking contained in parentheses and separated by a "~" will appear on a part. If a line is indented then it is a continuation of the previous line and the two combined represent the entire part marking for that device.

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## OTHER QUALIFIED VERSIONS OF SN65LV1023A, SN65LV1224B :

- Enhanced Product : [SN65LV1023A-EP](#), [SN65LV1224B-EP](#)

NOTE: Qualified Version Definitions:

- Enhanced Product - Supports Defense, Aerospace and Medical Applications

## TAPE AND REEL INFORMATION



\*All dimensions are nominal

Device	Package Type	Package Drawing	Pins	SPQ	Reel Diameter (mm)	Reel Width W1 (mm)	A0 (mm)	B0 (mm)	K0 (mm)	P1 (mm)	W (mm)	Pin1 Quadrant
SN65LV1023ADBR	SSOP	DB	28	2000	330.0	16.4	8.1	10.4	2.5	12.0	16.0	Q1
SN65LV1023ARHBR	VQFN	RHB	32	3000	330.0	12.4	5.3	5.3	1.5	8.0	12.0	Q2
SN65LV1023ARHBT	VQFN	RHB	32	250	180.0	12.4	5.3	5.3	1.5	8.0	12.0	Q2
SN65LV1023ARHBTG4	VQFN	RHB	32	250	180.0	12.4	5.3	5.3	1.5	8.0	12.0	Q2
SN65LV1224BDBR	SSOP	DB	28	2000	330.0	16.4	8.1	10.4	2.5	12.0	16.0	Q1
SN65LV1224BRHBR	VQFN	RHB	32	3000	330.0	12.4	5.3	5.3	1.5	8.0	12.0	Q2
SN65LV1224BRHBT	VQFN	RHB	32	250	180.0	12.4	5.3	5.3	1.5	8.0	12.0	Q2
SN65LV1224BRHBT1G4	VQFN	RHB	32	250	180.0	12.4	5.3	5.3	1.5	8.0	12.0	Q2

## TAPE AND REEL BOX DIMENSIONS



\*All dimensions are nominal

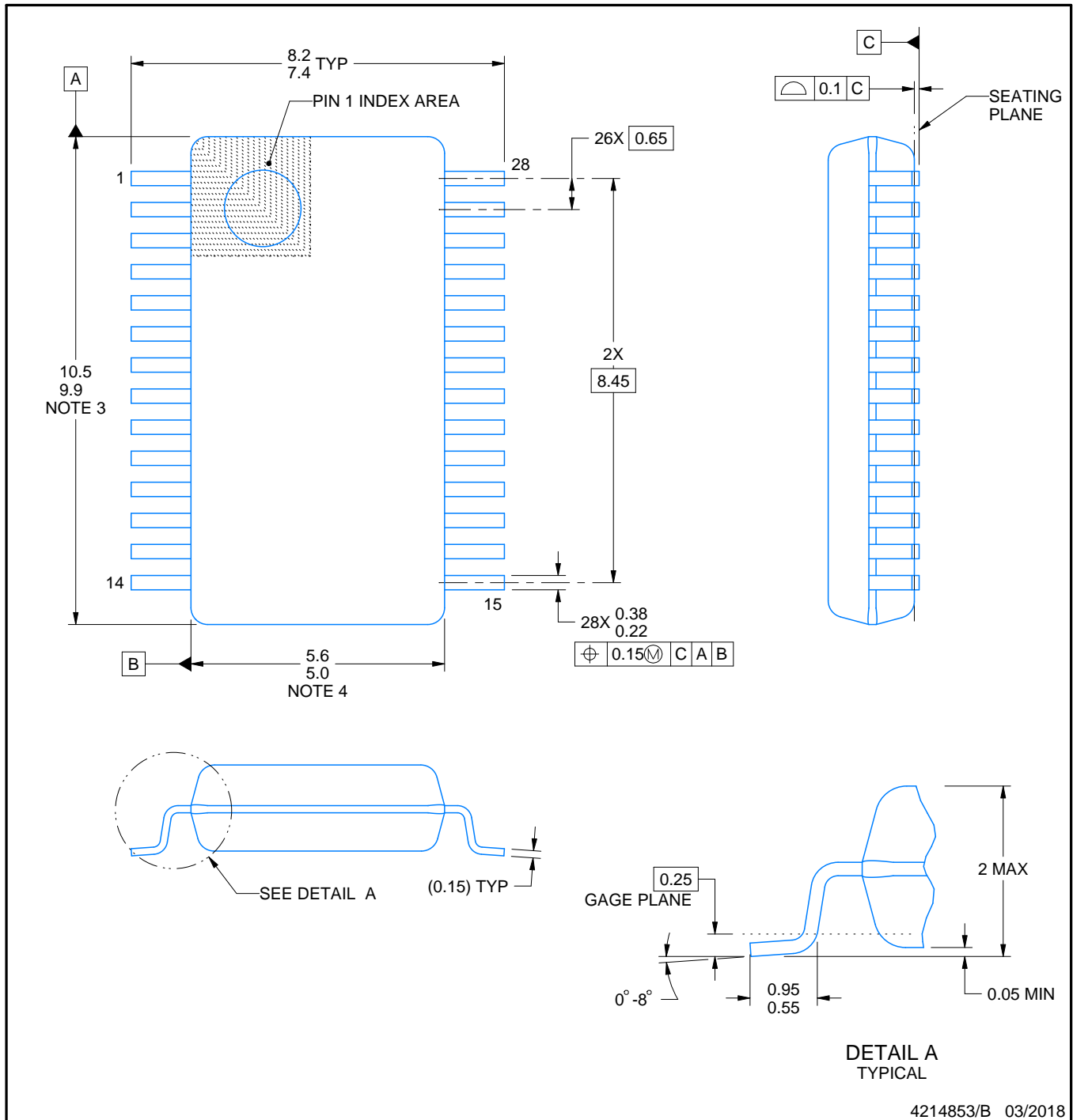
Device	Package Type	Package Drawing	Pins	SPQ	Length (mm)	Width (mm)	Height (mm)
SN65LV1023ADBR	SSOP	DB	28	2000	350.0	350.0	43.0
SN65LV1023ARHBR	VQFN	RHB	32	3000	350.0	350.0	43.0
SN65LV1023ARHBT	VQFN	RHB	32	250	210.0	185.0	35.0
SN65LV1023ARHBTG4	VQFN	RHB	32	250	210.0	185.0	35.0
SN65LV1224BDBR	SSOP	DB	28	2000	350.0	350.0	43.0
SN65LV1224BRHBR	VQFN	RHB	32	3000	350.0	350.0	43.0
SN65LV1224BRHBT	VQFN	RHB	32	250	210.0	185.0	35.0
SN65LV1224BRHBT1G4	VQFN	RHB	32	250	210.0	185.0	35.0

## TUBE



\*All dimensions are nominal

Device	Package Name	Package Type	Pins	SPQ	L (mm)	W (mm)	T (μm)	B (mm)
SN65LV1023ADB	DB	SSOP	28	50	530	10.5	4000	4.1
SN65LV1023ADB.A	DB	SSOP	28	50	530	10.5	4000	4.1
SN65LV1023ADB1G4	DB	SSOP	28	50	530	10.5	4000	4.1
SN65LV1023ADB1G4.A	DB	SSOP	28	50	530	10.5	4000	4.1
SN65LV1224BDB	DB	SSOP	28	50	530	10.5	4000	4.1
SN65LV1224BDB.A	DB	SSOP	28	50	530	10.5	4000	4.1
SN65LV1224BDBG4	DB	SSOP	28	50	530	10.5	4000	4.1



## NOTES:

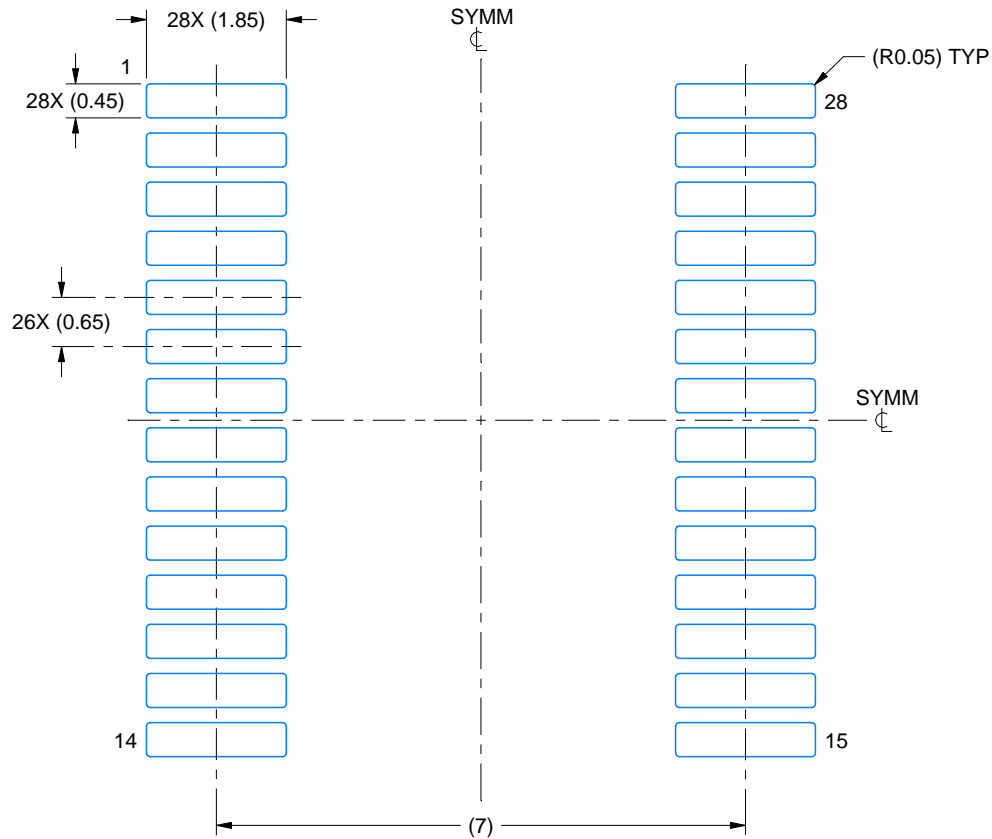
1. All linear dimensions are in millimeters. Any dimensions in parenthesis are for reference only. Dimensioning and tolerancing per ASME Y14.5M.
2. This drawing is subject to change without notice.
3. This dimension does not include mold flash, protrusions, or gate burrs. Mold flash, protrusions, or gate burrs shall not exceed 0.15 mm per side.
4. This dimension does not include interlead flash. Interlead flash shall not exceed 0.25 mm per side.
5. Reference JEDEC registration MO-150.

# EXAMPLE BOARD LAYOUT

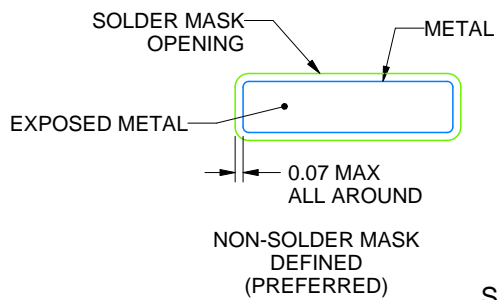
DB0028A

SSOP - 2 mm max height

SMALL OUTLINE PACKAGE



LAND PATTERN EXAMPLE  
EXPOSED METAL SHOWN  
SCALE: 10X



SOLDER MASK DETAILS

4214853/B 03/2018

NOTES: (continued)

6. Publication IPC-7351 may have alternate designs.

7. Solder mask tolerances between and around signal pads can vary based on board fabrication site.

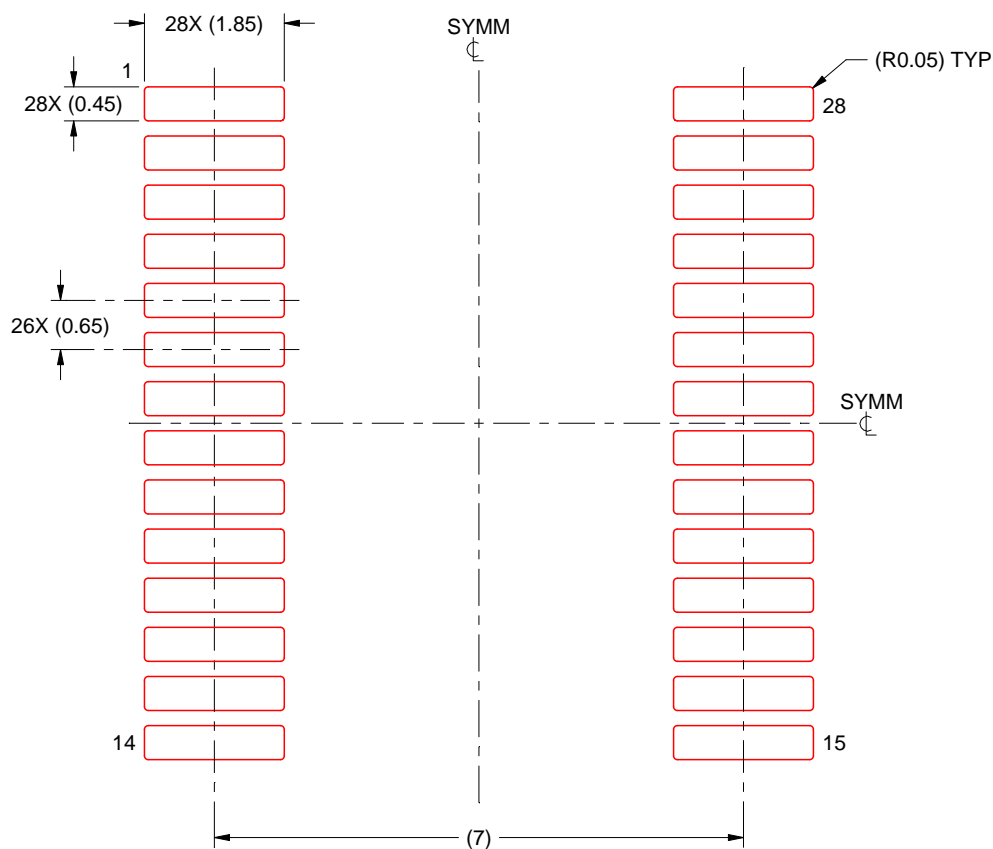


# EXAMPLE STENCIL DESIGN

DB0028A

SSOP - 2 mm max height

SMALL OUTLINE PACKAGE



SOLDER PASTE EXAMPLE  
BASED ON 0.125 mm THICK STENCIL  
SCALE: 10X

4214853/B 03/2018

NOTES: (continued)

8. Laser cutting apertures with trapezoidal walls and rounded corners may offer better paste release. IPC-7525 may have alternate design recommendations.
9. Board assembly site may have different recommendations for stencil design.

## GENERIC PACKAGE VIEW

**RHB 32**

**VQFN - 1 mm max height**

5 x 5, 0.5 mm pitch

PLASTIC QUAD FLATPACK - NO LEAD



Images above are just a representation of the package family, actual package may vary.  
Refer to the product data sheet for package details.

4224745/A

1. All linear dimensions are in millimeters. Any dimensions in parenthesis are for reference only. Dimensioning and tolerancing per ASME Y14.5M.
2. This drawing is subject to change without notice.
3. The package thermal pad must be soldered to the printed circuit board for thermal and mechanical performance.

# EXAMPLE BOARD LAYOUT

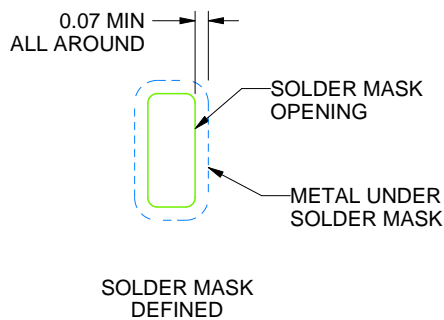
RHB0032E

VQFN - 1 mm max height

PLASTIC QUAD FLATPACK - NO LEAD



LAND PATTERN EXAMPLE  
SCALE:18X



SOLDER MASK DETAILS

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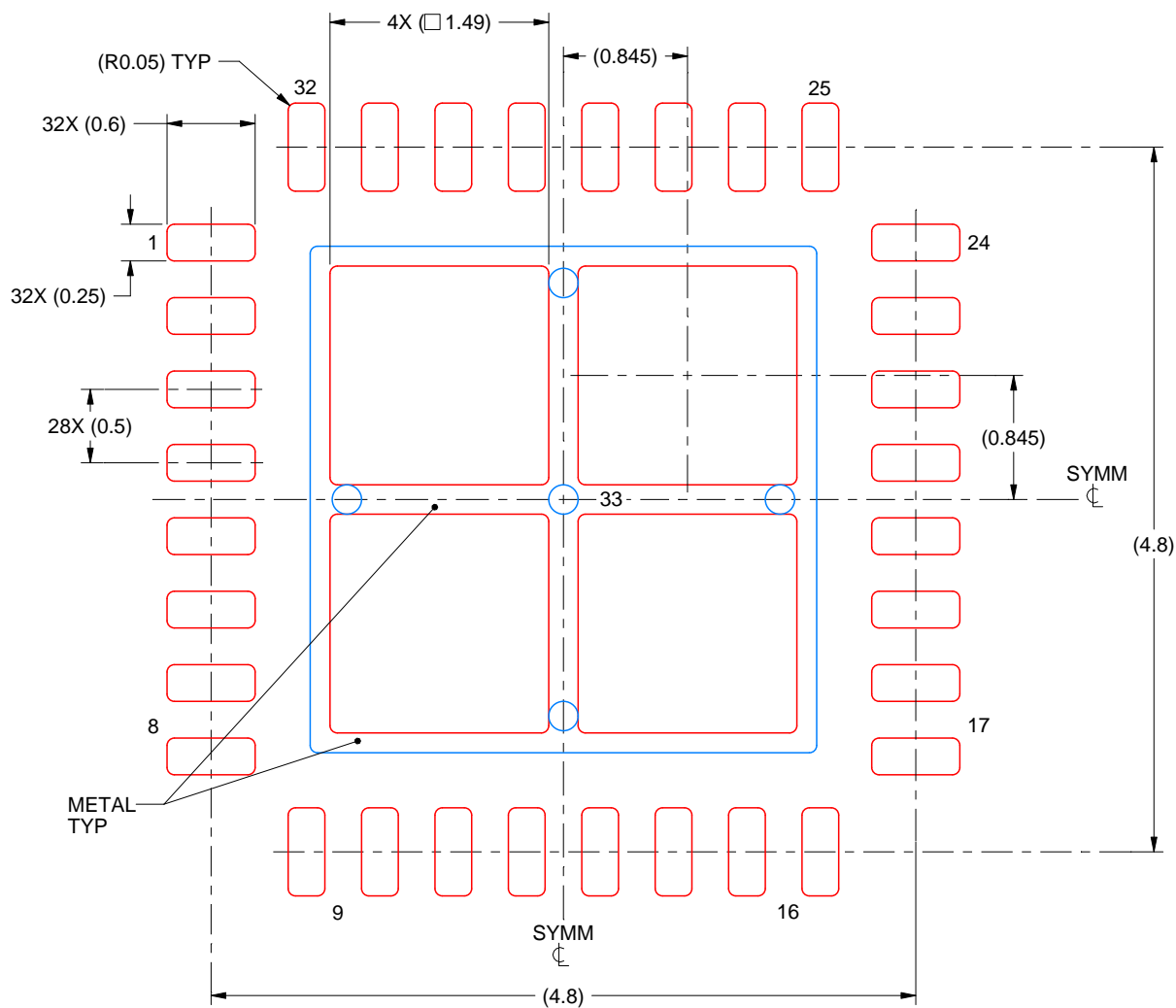
NOTES: (continued)

- This package is designed to be soldered to a thermal pad on the board. For more information, see Texas Instruments literature number SLUA271 ([www.ti.com/lit/sluea271](http://www.ti.com/lit/sluea271)).
- Vias are optional depending on application, refer to device data sheet. If any vias are implemented, refer to their locations shown on this view. It is recommended that vias under paste be filled, plugged or tented.

**RHB0032E**

## VQFN - 1 mm max height

PLASTIC QUAD FLATPACK - NO LEAD



## SOLDER PASTE EXAMPLE BASED ON 0.125 mm THICK STENCIL

EXPOSED PAD 33:  
75% PRINTED SOLDER COVERAGE BY AREA UNDER PACKAGE  
SCALE:20X

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NOTES: (continued)

6. Laser cutting apertures with trapezoidal walls and rounded corners may offer better paste release. IPC-7525 may have alternate design recommendations.

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