

SN75LVPE3101 デュアルチャネル PCI Express 3.0 リニアリドライバ

1 特長

- PCI Express 3.0、SATA Express、SATA Gen3 をサポート
- 超低消費電力アーキテクチャ:
 - アクティブ: 330mW 未満
 - シャットダウン: < 700μW
- 4GHz において、14dB まで 16 通りの設定によるリニアイコライゼーションが可能
- ホットプラグ対応
- 温度範囲: -40°C ~ 85°C (産業用)
- ESD HBM 定格: ±5kV
- 単一の 3.3V 電源で利用可能
- 4mm × 4mm VQFN で供給

2 アプリケーション

- デスクトップ PC またはマザーボード
- ノート PC
- データストレージ
- モジュール搭載産業用コンピュータ

3 概要

SN75LVPE3101 は、デュアルチャネル PCI Express (PCIe) 3.0 x1 リドライバです。このデバイスは 3.3V 電源で低消費電力を実現し、PCIe 1.0、2.0、3.0 のデータレートをサポートするように設計されています。

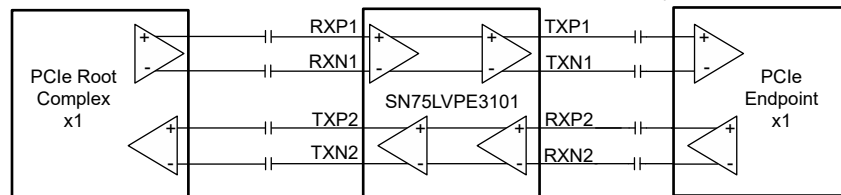
SN75LVPE3101 にはリニアイコライザが実装されており、シンボル間干渉 (ISI) による 14dB までの損失に対応できます。PCIe 信号がプリント基板 (PCB) やケーブル上で伝送される時、損失やシンボル間干渉によりシグナルインテグリティが低下します。リニアイコライザがチャンネル損失を補正するので、チャンネル長を延長し、システムで PCIe 準拠を達成できるようになります。デュアルチャネル実装と小型のパッケージにより、SN75LVPE3101 は PCIe 3.0 のデータパス内に柔軟に配置できます。

SN75LVPE3101 は、24 ピンの 4mm × 4mm VQFN で供給されます。

製品情報

| 部品番号 ⁽¹⁾ | 温度 | パッケージ |
|---------------------|-------------------------------|----------------|
| SN75LVPE3101 | T _A = -40°C ~ 85°C | RGE (VQFN, 24) |

(1) 供給されているすべてのパッケージについては、[セクション 10](#) を参照してください。



概略回路図



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4 Pin Configuration and Functions

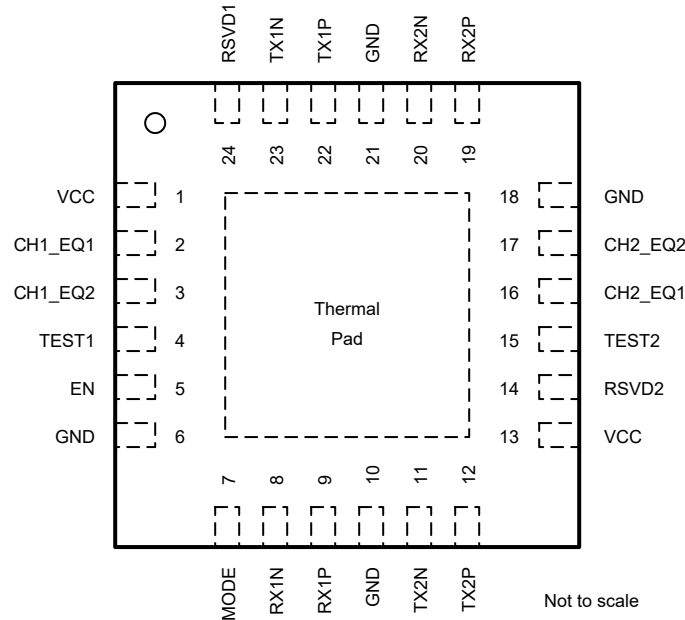


図 4-1. RGE Package 24-Pin VQFN (Top View)

表 4-1. Pin Functions

| PIN | | TYPE | INTERNAL PULLUP PULLDOWN | DESCRIPTION |
|---------|---------------|------------------------|-------------------------------------|---|
| NAME | NO. | | | |
| CH1_EQ1 | 2 | I (4-level) | PU (approx 45K) PD (approx 95K) | CH1_EQ1. Configuration pin used to control RX EQ level for RX1P/N. The state of this pin is sampled after the rising edge of EN. Refer to 5-1 for details of timing. This pin along with CH1_EQ2 allows for up to 16 equalization settings. |
| CH1_EQ2 | 3 | I (4-level) | | CH1_EQ2. Configuration pin used to control RX EQ level for RX1P/N. The state of this pin is sampled after the rising edge of EN. Refer to 5-1 for details of timing. This pin along with CH1_EQ1 allows for up to 16 equalization settings. |
| CH2_EQ1 | 16 | I (4-level) | | CH2_EQ1. Configuration pin used to control RX EQ level for RX2P/N. The state of this pin is sampled after the rising edge of EN. Refer to 5-1 for details of timing. This pin along with CH2_EQ2 allows for up to 16 equalization settings. |
| CH2_EQ2 | 17 | I (4-level) | | CH2_EQ2. Configuration pin used to control RX EQ level for RX2P/N. The state of this pin is sampled after the rising edge of EN. Refer to 5-1 for details of timing. This pin along with CH2_EQ1 allows for up to 16 equalization settings. |
| EN | 5 | I (2-level) | PU (approx 400K) | EN. Places SN75LVPE3101 into shutdown mode when asserted low. Normal operation when pin is asserted high. When in shutdown, the receiver terminations of the device are high impedance and the TX/RX channels are disabled. |
| GND | 6, 10, 18, 21 | GND | — | Ground |
| MODE | 7 | I | PU (approx 45 K) PD (approx 95K) | MODE. The state of this pin is sampled after the rising edge of EN. Connect to GND through 20kΩ resistor. |
| RSVD1 | 24 | O | — | RSVD1. Leave the pin unconnected. |
| RSVD2 | 14 | I | PU (approx 400K) | RSVD2. Leave the pin unconnected. |
| RX1N | 8 | 90Ω Differential Input | — | Inverting differential high-speed input for Channel 1 |
| RX1P | 9 | | | Noninverting differential high-speed input for Channel 1 |
| RX2N | 20 | 90Ω Differential Input | — | Inverting differential high-speed input for Channel 2 |
| RX2P | 19 | | | Noninverting differential high-speed input for Channel 2 |

表 4-1. Pin Functions (続き)

| PIN | | TYPE | INTERNAL PULLUP PULLDOWN | DESCRIPTION |
|-------------|-------|----------------------------|------------------------------------|--|
| NAME | NO. | | | |
| TEST1 | 4 | I | PU (approx 45K) PD (approx 95K) | TEST1. Must connect to GND directly or through 1kΩ resistor. |
| TEST2 | 15 | I | PU (approx 45K) PD (approx 95K) | TEST2. Must connect to GND directly or through 1kΩ resistor. |
| TX1N | 23 | 90Ω Differential Output | — | Inverting differential high-speed output for Channel 1 |
| TX1P | 22 | | | Noninverting differential high-speed output for Channel 1 |
| TX2N | 11 | 90Ω Differential Output | — | Inverting differential high-speed output for Channel 2 |
| TX2P | 12 | | | Noninverting differential high-speed output for Channel 2 |
| VCC | 1, 13 | Power | — | 3.3V (±10%) supply |
| Thermal pad | | | — | Thermal pad. Recommend connecting to a solid ground plane. |

5 Specifications

5.1 Absolute Maximum Ratings

over operating free-air temperature range (unless otherwise noted)⁽¹⁾

| | | MIN | MAX | UNIT |
|------------------|--|------|-----|------|
| V _{CC} | Supply Voltage Range | -0.3 | 4 | V |
| V _{IO} | Differential voltage for RX1P/N and RX2P/N | -2.5 | 2.5 | V |
| | Voltage at RX pins | -0.5 | 4 | V |
| | Voltage on control pins | -0.5 | 4 | V |
| T _{stg} | Storage temperature | -65 | 150 | °C |

- (1) Operation outside the Absolute Maximum Ratings may cause permanent device damage. Absolute Maximum Ratings do not imply functional operation of the device at these or any other conditions beyond those listed under Recommended Operating Conditions. If used outside the Recommended Operating Conditions but within the Absolute Maximum Ratings, the device may not be fully functional, and this may affect device reliability, functionality, performance, and shorten the device lifetime.

5.2 ESD Ratings

| | | | VALUE | UNIT |
|--------------------|-------------------------|--|-------|------|
| V _(ESD) | Electrostatic discharge | Human body model (HBM), per ANSI/ESDA/ JEDEC JS-001, all pins ⁽¹⁾ | ±5000 | V |
| | | Charged device model (CDM), per ANSI/ESDA/ JEDEC JS-002, all pins ⁽²⁾ | ±1500 | |

- (1) JEDEC document JEP155 states that 500V HBM allows safe manufacturing with a standard ESD control process.
(2) JEDEC document JEP157 states that 250V CDM allows safe manufacturing with a standard ESD control process.

5.3 Recommended Operating Conditions

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

| | | MIN | NOM | MAX | UNIT |
|------------------|--------------------------------------|-----|-----|-----|------|
| V _{CC} | Supply voltage | 3 | 3.3 | 3.6 | V |
| V _{PSN} | Supply noise on V _{CC} pins | | | 100 | mV |
| T _A | Ambient temperature | -40 | | 85 | °C |
| T _J | Junction temperature | -40 | | 105 | °C |

5.4 Thermal Information

| THERMAL METRIC ⁽¹⁾ | | SN75LVPE3101 | UNIT |
|-------------------------------|--|--------------|------|
| | | RGE (VQFN) | |
| | | 24 PINS | |
| R _{θJA} | Junction-to-ambient thermal resistance | 38.5 | °C/W |
| R _{θJC(top)} | Junction-to-case (top) thermal resistance | 41.6 | °C/W |
| R _{θJB} | Junction-to-board thermal resistance | 16.3 | °C/W |
| Ψ _{JT} | Junction-to-top characterization parameter | 1.0 | °C/W |
| Ψ _{JB} | Junction-to-board characterization parameter | 16.4 | °C/W |
| R _{θJC(bot)} | Junction-to-case (bottom) thermal resistance | 6.9 | °C/W |

- (1) For more information about traditional and new thermal metrics, see the [Semiconductor and IC Package Thermal Metrics](#) application note.

5.5 Electrical Characteristics

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

| PARAMETER | | TEST CONDITIONS | MIN | TYP | MAX | UNIT |
|---|---|--|------|------|-----|------|
| POWER | | | | | | |
| P _{ACTIVE_1200mV} | Device power consumption when all channels are active | All channels enabled , V _{CC} = 3.3V; EN = 1; | | 330 | | mW |
| P _{SHUTDOWN} | Shutdown power when EN = 0. | V _{CC} = 3.3V; EN = 0 | | 0.7 | | mW |
| 4-level Inputs (TEST[2:1], MODE, CH1_EQ[2:1], CH2_EQ[2:1]) | | | | | | |
| V _{TH} | Threshold "0" / "R" | V _{CC} = 3.3V | | 0.55 | | V |
| | Threshold "R" / "F" | V _{CC} = 3.3V | | 1.65 | | V |
| | Threshold "F" / "1" | V _{CC} = 3.3V | | 2.8 | | V |
| I _{IH} | High-level input current | V _{CC} = 3.6V; V _{IN} = 3.6V | 20 | | 80 | μA |
| I _{IL} | Low-level input current | V _{CC} = 3.6V; V _{IN} = 0V | -160 | | -40 | μA |
| R _{PU} | Internal pullup resistance | | | 45 | | kΩ |
| R _{PD} | Internal pulldown resistance | | | 95 | | kΩ |
| EN, RSVD2 | | | | | | |
| V _{IH} | High-level input voltage | V _{CC} = 3.3V | 1.7 | | 3.6 | V |
| V _{IL} | Low-level input voltage | V _{CC} = 3.3V | 0 | | 0.7 | V |
| I _{IH} | High-level input current | V _{CC} = 3.6V; V _{IN} = 3.6V | -10 | | 10 | μA |
| I _{IL} | Low-level input current | V _{CC} = 3.6V; V _{IN} = 0V | -15 | | 15 | μA |
| R _{PU_EN} | Internal pullup resistance for EN and RSVD2 | | | 400 | | kΩ |
| High-Speed Receiver Interface (RX1P/N and RX2P/N) | | | | | | |
| R _{L_100 MHz} | RX Differential return loss at 100MHz to 2.5GHz | SDD11, 100MHz to 2.5GHz | | -18 | | dB |
| R _{L_5 GHz} | RX Differential return loss at 5GHz | SDD11, 5GHz | | -14 | | dB |
| R _{L_10 GHz} | RX Differential return loss from 5GHz to 10GHz | SDD11, 5GHz to 10GHz | | -6 | | dB |
| R _{L_CM} | RX common-mode return loss | SCC11, 0.5GHz to 5GHz | | -12 | | dB |
| X-Talk | Differential crosstalk between TX and RX signal pairs | | | -50 | | dB |
| E _{ACGAIN_4 GHz} | Maximum AC equalization gain | 50mVpp CP10 at 4GHz; V _{CC} = 3.3V | | 14 | | dB |
| E _{ACGAIN_5 GHz} | Maximum AC equalization gain | 50mVpp CP10 at 5GHz; V _{CC} = 3.3V | | 16 | | dB |
| E _{DC_GAIN0} | DC gain at 0dB setting | 200mVpp VID at 100MHz | | 0.7 | | dB |
| V _{DIFF_IN} | Input differential peak-peak voltage swing range | | | 1200 | | mV |
| V _{RX-DC-CM} | RX DC common-mode voltage | | | 0 | | V |
| R _{RX-DC-CM} | RX DC common-mode impedance | Measured at connector; Present when far-end termination is detected on TXP/N | 18 | | 30 | Ω |
| R _{RX-DC-DIFF} | RX DC differential impedance | Measured at connector; Present when far-end termination is detected on TXP/N | 72 | | 120 | Ω |
| Z _{RX-DC-DIFF} | DC Input CM Input Impedance V > 0 during RESET or power down. | 1. RX DC CM Impedance with RX terminations not powered. 2. Measured over the range 0mV to 500mV with respect to GND. 3. Only DC input CM Input impedance V > 0 is specified. | 35 | | | kΩ |
| V _{RX-SIGNAL-DET} | Input differential peak-to-peak signal detect assert level | At 10Gbps; No loss input channel and PRBS7 pattern. | | 85 | | mV |
| V _{RX-IDLE-DET} | Input differential peak-to-peak signal detect deassert level | At 10Gbps; No loss input channel and PRBS7 pattern. | | 60 | | mV |

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

| PARAMETER | | TEST CONDITIONS | MIN | TYP | MAX | UNIT |
|---|--|---|-----|------|------|----------|
| $V_{RX-CM-AC-P}$ | Peak RX AC common-mode voltage | Measured at package pin. | | | 150 | mV |
| High-Speed Transmitter Interface (TX1P/N and TX2P/N) | | | | | | |
| $R_{L_TX_100\text{ MHz}}$ | TX Differential return loss at 100MHz to 2.5GHz | SDD22, 100MHz to 2.5GHz | | -20 | | dB |
| $R_{L_TX_2.5\text{ GHz}}$ | TX Differential return loss at 5GHz | SDD22, 5GHz | | -16 | | dB |
| $R_{L_TX_10\text{ GHz}}$ | TX Differential return loss from 5GHz to 10GHz | SDD22, 5GHz to 10GHz | | -8.5 | | dB |
| $R_{L_TX_CM}$ | TX common-mode return loss | SCC22, 0.5GHz to 5 GHz | | -6.7 | | dB |
| $V_{TX-DIFFPP-1200}$ | Differential peak-to-peak TX voltage swing linear dynamic range at 100MHz | 100MHz; Measured at -1dB compression point = $20 \times \log(VOD/VOD_{linear})$ | | 1000 | | mV |
| | Differential peak-to-peak TX voltage swing linear dynamic range at 5GHz | 5GHz; Measured at -1dB compression point = $20 \times \log(VOD/VOD_{linear})$ | | 1300 | | mV |
| $V_{TX-RCV-DETECT}$ | Amount of voltage change allowed during RX Detection. | Measured at package pins. | | | 600 | mV |
| $V_{TX-DC-CM}$ | TX DC common-mode voltage | | 0 | 1.85 | 2.05 | V |
| $V_{TX-CM-AC-PP-ACTIVE}$ | Transmitter AC common mode peak-peak voltage when active. Maximum mismatch from TXP+TXN for both time and amplitude. | CHx_EQ setting matches input channel insertion loss | | | 116 | mV |
| $V_{TX-IDLE-DIFF-AC-PP}$ | AC electrical idle differential peak-to-peak output voltage | | 0 | | 10 | mV |
| $R_{TX-DC-CM}$ | TX DC common-mode impedance | | 18 | | 30 | Ω |
| $R_{TX-DC-DIFF}$ | TX DC differential impedance | | 72 | | 120 | Ω |
| $I_{TX-SHORT}$ | Transmitter short-circuit current limit. | | | | 107 | mA |
| $C_{AC-COUPLING}$ | External AC-coupling capacitor on differential pairs. | | 75 | | 265 | nF |

5.6 Timing Requirements

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

| | | MIN | NOM | MAX | UNIT |
|-----------------|--|-----|-----|-----|---------|
| t_{d_pg} | Internal power good asserted high when V_{CC} is at 2.5V | | | 5 | μ s |
| t_{VCC_RAMP} | V_{CC} supply ramp requirement | 0.1 | | 50 | ms |

5.7 Switching Characteristics

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

| PARAMETER | | TEST CONDITIONS | MIN | TYP | MAX | UNIT |
|----------------------|--|---|-----|-----|-----|------|
| t_{DIFF_DLY} | Differential propagation delay | $V_{CC} = 3.0V$; EN = 1 | | | 150 | ps |
| t_{PWRUP_ACTIVE} | Time from assertion of EN to device active and performing Rx. Detect on both ports | $V_{CC} = 3.0V$; EN = 1 | | | 8 | ms |
| $t_{TX_RISE_FALL}$ | Transmitter rise/fall time | $V_{CC} = 3.3V$; EN = 1; 10Gbps; 20% to 80% of differential output; 1200mVpp linear range setting; Fast Input rise/fall time | | 27 | | ps |

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

| PARAMETER | | TEST CONDITIONS | MIN | TYP | MAX | UNIT |
|--------------------|---|--|-----|------|-----|------|
| $t_{RF_MISMATCH}$ | Transmitter rise/fall mismatch | $V_{CC} = 3.3V$; $EN = 1$; 10Gbps; 20% to 80% of differential output; 1200mVpp linear range setting; 1000mVpp VID | | 0.6 | | ps |
| t_{TX_DJ} | Transmitter residual deterministic jitter | $V_{CC} = 3.3V$; $EN = 1$; 10Gbps; 1200mVpp linear range setting; Input channel loss of 12dB; Output channel loss of 1.5dB; Optimized EQ | | 0.05 | | UI |

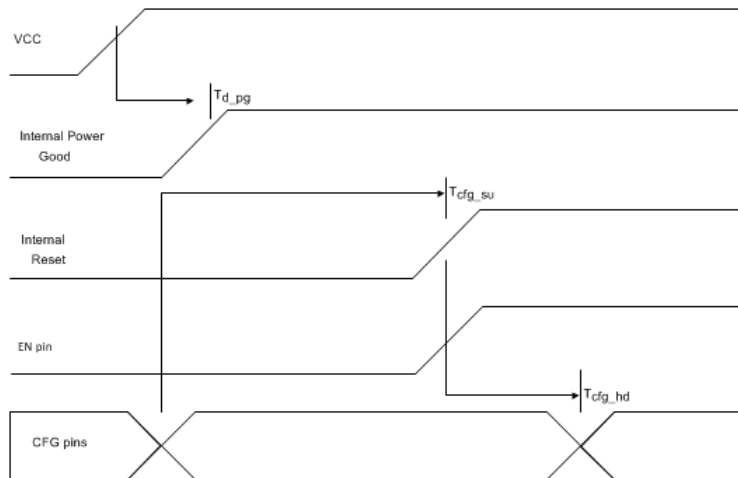


図 5-1. Power-Up Diagram

5.8 Typical Characteristics

$V_{CC} = 3.3V$, $25^{\circ}C$, $200mV_{pp}$ V_{ID} sine wave, $Z_O = 100\Omega$, RGE package

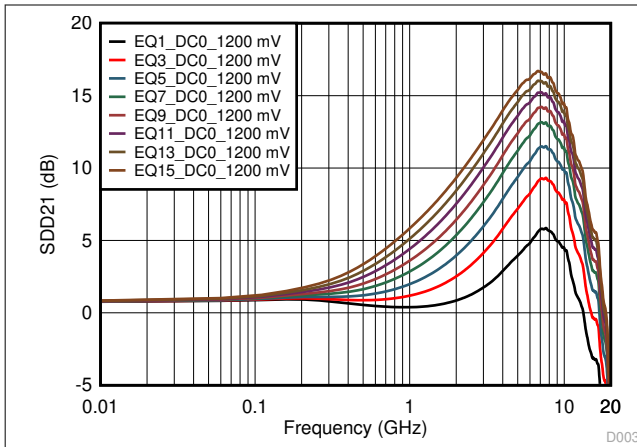


图 5-2. 1200mV DC0 Gain Odd EQ Settings Curves

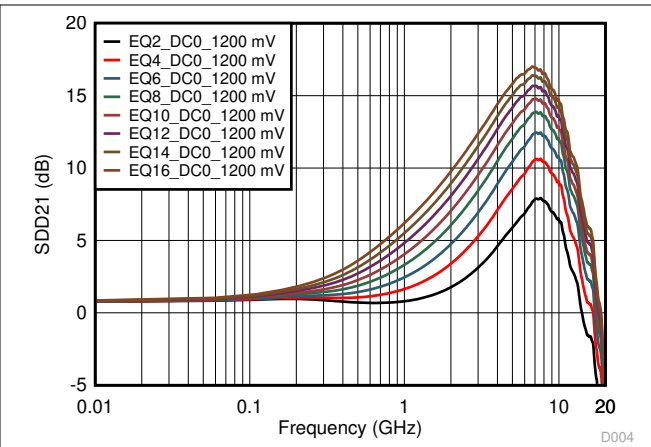


图 5-3. 1200mV DC0 Even EQ Settings Curves

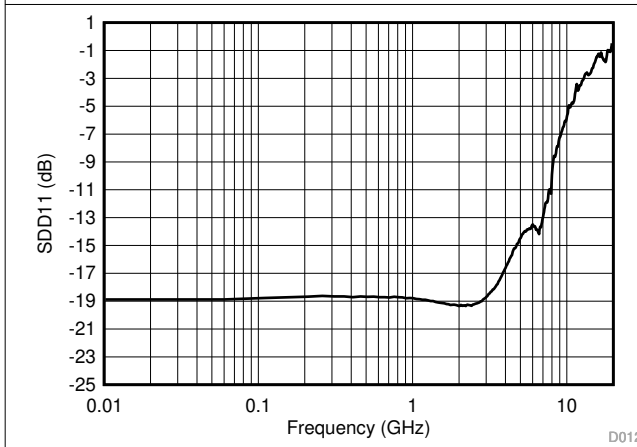


图 5-4. SDD11 Return Loss

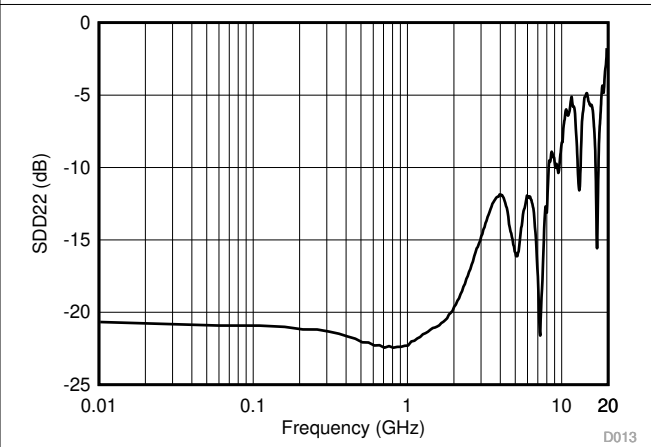


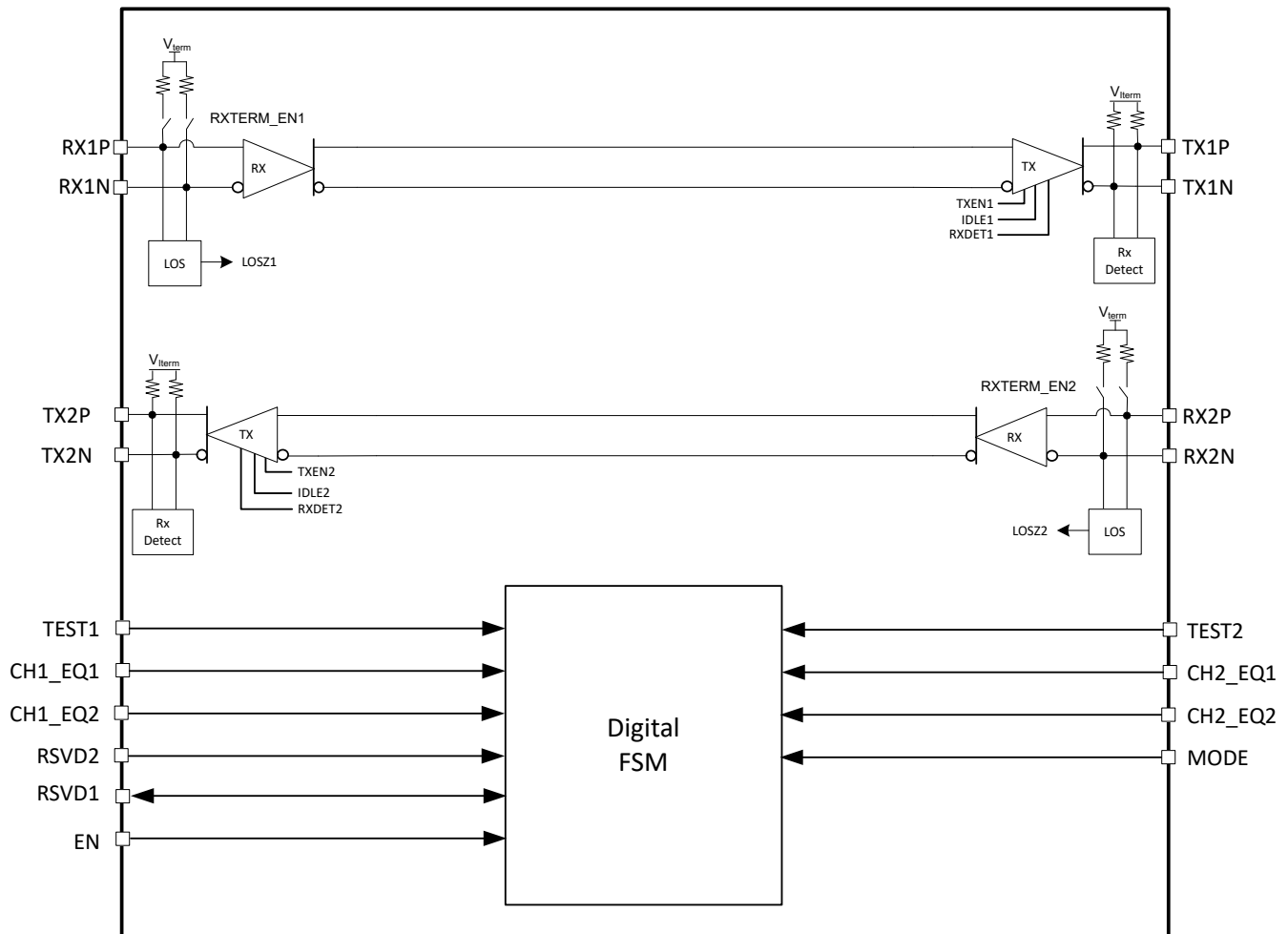
图 5-5. SDD22 Return Loss

6 Detailed Description

6.1 Overview

The SN75LVPE3101 is a PCIe 3.0 x1 redriver. As signals traverse through a channel (like FR4 trace) the amplitude of the signal is attenuated. The attenuation varies depending on the frequency content of the signal. Depending the length of the channel, this attenuation can be large enough to result in signal integrity issues at a PCIe 3.0 receiver. By placing a SN75LVPE3101 between PCIe 3.0 root complex and endpoint, the attenuation effect of the channel can be eliminated or minimized. The result is a PCIe 3.0-compatible eye at the receiver of the endpoint. With up to 16 receiver equalization settings, the SN75LVPE3101 can support many different channel loss combinations. The SN75LVPE3101 ultra-low power architecture offers low power consumption on a single 3.3V supply. The SN75LVPE3101 settings are configurable through pins.

6.2 Functional Block Diagram



6.3 Feature Description

6.3.1 4-Level Control Inputs

The SN75LVPE3101 has (MODE, CH1_EQ1, CH1_EQ2, CH2_EQ1, and CH2_EQ2) 4-level inputs pins that are used to control the equalization gain and the output voltage swing dynamic range. These 4-level inputs use a resistor divider to help set the four valid levels and provide a wider range of control settings. These resistors together with the external resistor connection combine to achieve the desired voltage level.

表 6-1. 4-Level Control Pin Settings

| LEVEL | SETTINGS |
|-------|---|
| 0 | Option 1: Tie 1 kΩ 5% to GND. Option 2: Tie directly to GND. |
| R | Tie 20 kΩ 5% to GND. |
| F | Float (leave pin open) |
| 1 | Tie 1 kΩ 5% to V _{CC} . |

注

To conserve power, the SN75LVPE3101 disables the internal pullup and pull-down resistors of the 4-level input after the state of 4-level pins are sampled on the rising edge of the EN pin. A change of state for any four level input pin is not applied to the SN75LVPE3101 until after the EN pin transitions from low to high.

6.3.2 Linear Equalization

With a linear equalizer, the SN75LVPE3101 can electrically shorten a particular channel allowing for longer run lengths.

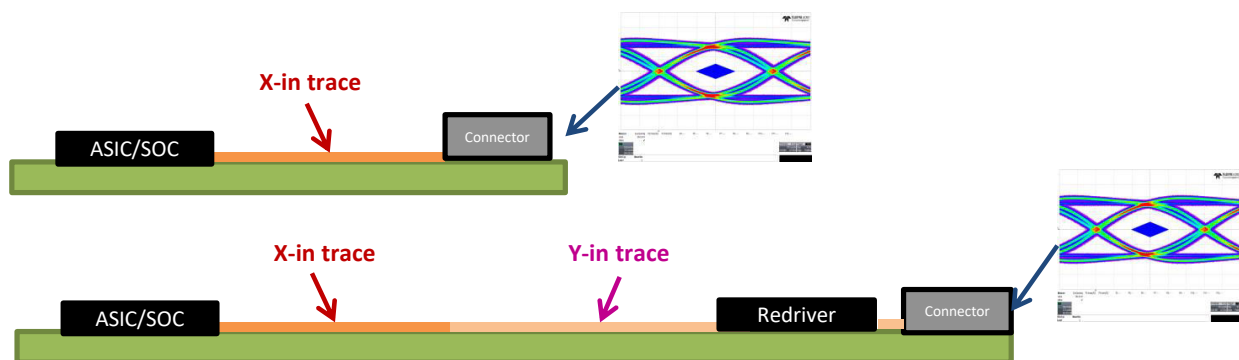


図 6-1. Linear Equalizer

With a SN75LVPE3101, a longer trace can be made to have similar insertion loss as a shorter trace. For example, a long trace of X + Y inches can be made to have similar loss characteristics of a shorter trace of X inches.

The receiver equalization level for each channel is determined by the state of the CH_x_EQ1 and CH_x_EQ2 pins, where x = 1 or 2.

表 6-2. EQ Configuration Options

| EQ SETTING # | CHx_EQ2 PIN LEVEL | CHx_EQ1 PIN LEVEL | EQ GAIN at 2.5 GHz / 4 GHz / 5 GHz (dB) |
|--------------|-------------------|-------------------|---|
| 1 | 0 | 0 | 1.0 / 2.3 / 3.6 |
| 2 | 0 | R | 2.1 / 4.0 / 5.5 |
| 3 | 0 | F | 3.0 / 5.2 / 6.8 |
| 4 | 0 | 1 | 4.0 / 6.4 / 8.1 |
| 5 | R | 0 | 4.6 / 7.2 / 9.0 |
| 6 | R | R | 5.5 / 8.2 / 10.0 |
| 7 | R | F | 6.2 / 9.0 / 10.8 |
| 8 | R | 1 | 6.9 / 9.8 / 11.6 |
| 9 | F | 0 | 7.3 / 10.2 / 11.9 |
| 10 | F | R | 7.9 / 10.9 / 12.6 |
| 11 | F | F | 8.4 / 11.4 / 13.1 |
| 12 | F | 1 | 9.0 / 12.0 / 13.7 |
| 13 | 1 | 0 | 9.4 / 12.3 / 14.1 |
| 14 | 1 | R | 9.9 / 12.8 / 14.6 |
| 15 | 1 | F | 10.3 / 13.2 / 14.9 |
| 16 | 1 | 1 | 10.7 / 13.6 / 15.3 |

6.3.3 PCIe/SATA/SATA Express Redriver Operation

When operating in a PCI Express (PCIe) Gen3, SATA Gen3, or SATA Express application, the SN75LVPE3101 enables both channels (upstream and downstream) receiver and transmitter paths upon detecting far-end termination on both TX1 and TX2. Both upstream and downstream paths remain enabled until the EN pin is deasserted low. In this mode, the SN75LVPE3101 is transparent to PCIe link power management (L0s, L1) and SATA interface power states. When far-end termination is detected on both TX1 and TX2, the SN75LVPE3101 power is at $P_{(ACTIVE_1200mV)}$ regardless of the PCIe or SATA power state. To save power during system S3/S4/S5 states, TI recommends to deassert the EN pin to conserve power.

6.4 Device Functional Modes

6.4.1 Shutdown Mode

The device enters Shutdown mode when the EN pin is low and V_{CC} is active and stable. Shutdown mode is the lowest power state of the SN75LVPE3101. While in Shutdown mode, the SN75LVPE3101 receiver terminations are disabled.

6.4.2 Disconnect Mode

Next to Shutdown mode, the Disconnect mode is the lowest power state of the SN75LVPE3101. The SN75LVPE3101 enters Disconnect mode when exiting Shutdown mode. In the Disconnect state, the SN75LVPE3101 periodically checks for far-end receiver termination on both TX1 and TX2. When the far-end receiver termination is detected on both ports, the SN75LVPE3101 transitions to Active mode.

6.4.3 Active Mode

Active mode is the highest power state of the SN75LVPE3101. Any time high-speed traffic is received, the SN75LVPE3101 remains in Active mode. The SN75LVPE3101 only exits Active mode if electrical idle is detected on both RX1 and RX2. While in Active mode, the SN75LVPE3101 high-speed receivers and transmitters are powered and active.

7 Application and Implementation

注

Information in the following applications sections is not part of the TI component specification, and TI does not warrant its accuracy or completeness. TI's customers are responsible for determining suitability of components for their purposes, as well as validating and testing their design implementation to confirm system functionality.

7.1 Application Information

The SN75LVPE3101 is a linear redriver designed specifically to compensation for ISI jitter caused by attenuation through a passive medium like traces and cables. The SN75LVPE3101 has two independent channels, therefore the device can be optimized to correct ISI in both the upstream and downstream direction through 16 different equalization choices. Designers can place the SN75LVPE3101 between two port partners to correct signal integrity issues, resulting in a more robust system.

7.2 Typical SATA, PCIe and SATA Express Application

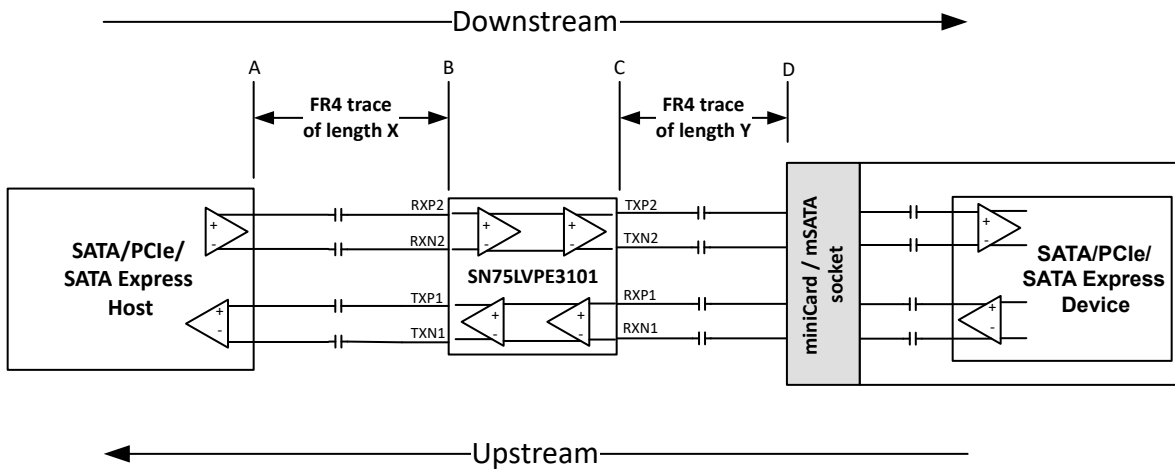


図 7-1. SATA/PCIe/SATA Express Typical Application

7.2.1 Design Requirements

For this design example, use the parameters shown in 表 7-1.

表 7-1. Design Parameters

| PARAMETER | VALUE |
|--|--|
| VCC supply (3 V to 3.6 V) | 3.3 V |
| PCIe Support Required (Yes/No) | Yes |
| SATA Express Support Required (Yes/No) | Yes |
| SATA Support Required (Yes/No) | Yes, then ferrite beads (FB1 and FB2) and 49.9 Ω required. No, then ferrite bead (FB1 and FB2) and 49.9 Ω not required. |
| TX1, TX2, RX2 AC-coupling Capacitor (176 nF to 265 nF) | 220 nF \pm 10% |
| RX1 AC-coupling Capacitor (297 nF to 363 nF) | Optional. But if implemented suggest 330 nF \pm 10% |
| A to B FR4 Length (inches) | 8 |
| A to B FR4 Trace Width (mils) | 4 |
| C to D FR4 length (inches) | 2 |
| C to D FR4 Trace Width (mils) | 4 |

7.2.2 Detailed Design Procedure

In this example, the SN75LVPE3101 has a DC gain fixed at 0dB and a linearity range fixed at 1200mV. The SN75LVPE3101 performs far-end receiver termination detection and enables both upstream and downstream paths when far-end termination is detected on both TX1 and TX2.

The AC-coupling capacitor range defined for a SATA device is a lot smaller than the AC-coupling capacitor range defined for SATA Express and PCI Express (PCIe) as indicated by [Figure 7-2](#). While the SN75LVPE3101 can usually detect the receiver termination of the PCIe and SATA Express device, a SATA 12nF (maximum) AC-coupling capacitor prevents the SN75LVPE3101 from detecting the SATA device receiver termination. To correct this problem, a ferrite bead along with 49.9Ω resistor must be placed between C_{TX2} and the miniCard/mSATA socket. These components can be isolated from the high-speed channel when PCIe or SATA Express is active by using an NFET as shown in [Figure 7-4](#). TI recommends to enable the NFET whenever a SATA device is present. The ferrite bead chosen must present at least 600Ω impedance at 100MHz so as to not impact high-speed signaling. TI recommends to use Murata BLM03AG601SN1 or BLM03HD601SN1D or a ferrite bead with similar characteristics from a different vendor. For applications which only require support for PCIe and SATA Express and do not need to support SATA, the ferrite beads and 49.9Ω resistors are not needed.

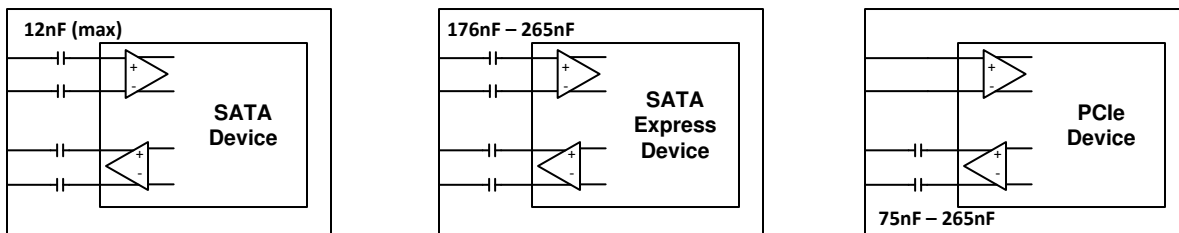
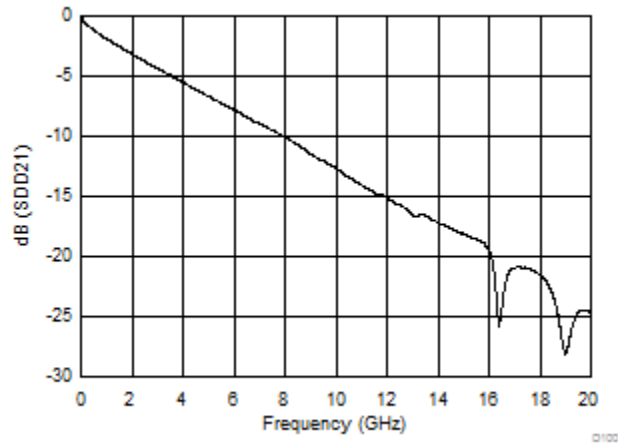


Figure 7-2. AC-Coupling Capacitor Implementation for SATA, SATA Express, and PCIe Devices

The SN75LVPE3101 power is at $P_{(ACTIVE_1200mV)}$ when both the upstream and downstream paths are enabled. To save system power in system S3/S4/S5 states, TI recommends to control the SN75LVPE3101 EN pin. Any time the system enters a low power state (S3, S4, or S5), TI recommends to deassert the EN pin. While the EN pin is deasserted, the SN75LVPE3101 consumes $P_{(SHUTDOWN)}$. Assertion of this pin is necessary any time the system exits a lower power state.

The SN75LVPE3101 compensates for channel loss in both the upstream (C to D) and downstream direction (A to B). Configure the CH1_EQ[2:1] and CH2_EQ[2:1] pins to the equalization setting that matches as close possible to the channel insertion loss. In this particular example, CH2_EQ[2:1] is for path A to B which is the channel between the PCIe/SATA/SATA Express host and the SN75LVPE3101, and CH1_EQ[2:1] is for path C to D which is the channel between the SN75LVPE3101 and the miniCard/mSATA socket.

In this particular example, the channel A-B has a trace length of 8 inches with a 4mil trace width. This particular channel has about 0.83dB per inch of insertion loss at 5GHz. This equates to approximately 6.7dB of loss for the entire 8 inches of trace as depicted in [Figure 7-3](#). An additional 1.5dB of loss is added due to package of the PCIe/SATA/SATA Express host, SN75LVPE3101, and the AC-coupling capacitor. This brings the entire channel loss at 5GHz to 6.7dB + 1.5dB = 8.2dB. The channel A-B for this example is connected to SN75LVPE3101 RX2P/N input and therefore CH2_EQ[2:1] pins are used for adjusting SN75LVPE3101 RX2P/N equalization settings. Set the CH2_EQ[2:1] pins such that SN75LVPE3101 equalization is between 5dB and 8dB. A value closer to 5dB may be best if the host has transmitter de-emphasis.



Freq = 5GHz

dB(SDD21) = -6.666

7-3. Insertion Loss for 8in FR4 Trace Length and 4mil FR4 Trace Width

Use a similar method for the upstream path (C to D). In this particular example, C to D has a trace length of 2 inches with a 4mil trace width. This equates to approximately 1.5dB at 5GHz. The SATA/SATA Express/PCIe device has a channel loss that can be added to the C to D channel loss. For this example, assume a value of 5dB is acceptable to compensate for C to D channel loss as well as loss associated with the SATA/SATA Express/PCIe device. Set the CH1_EQ[2:1] pins such that the SN75LVPE3101 equalization is 5dB.

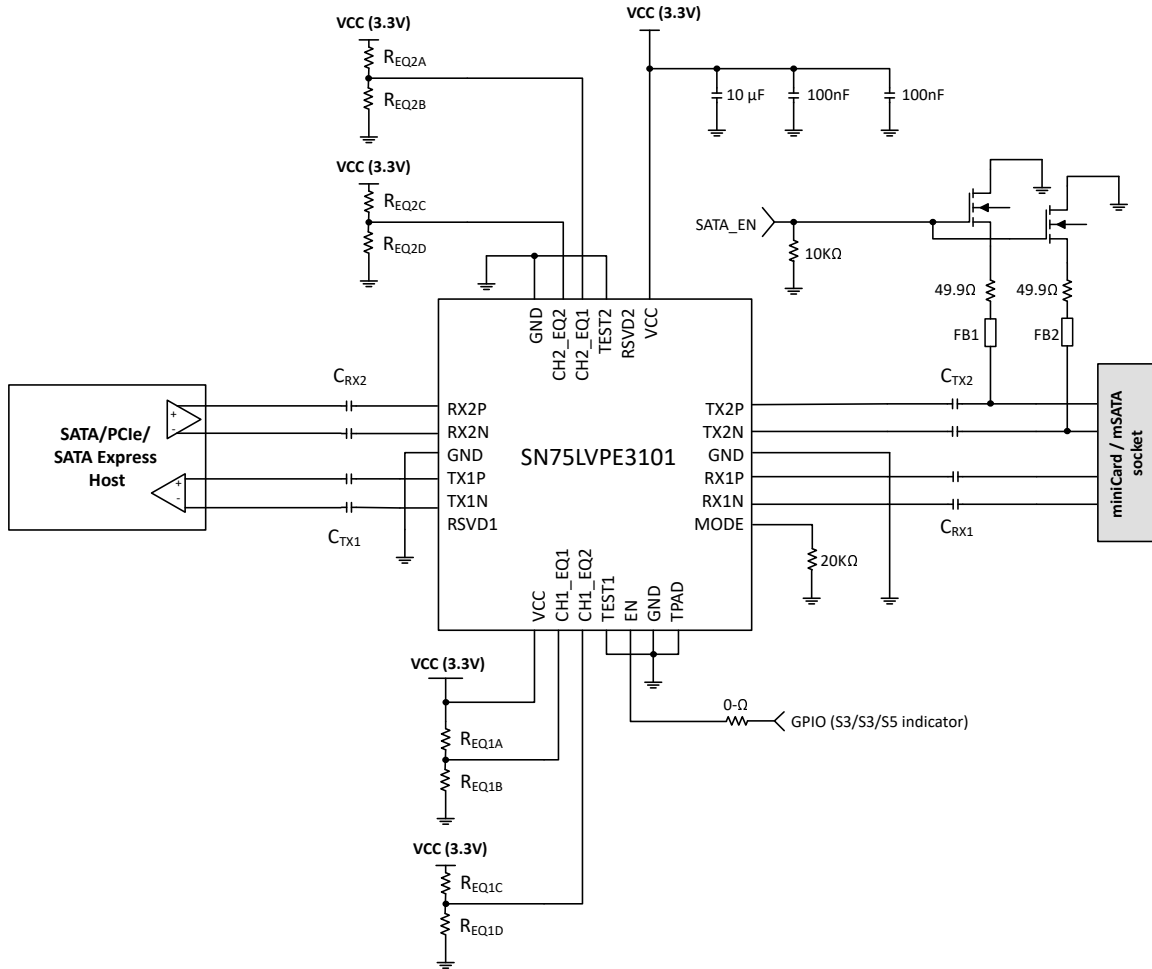


图 7-4. Example SATA/PCIe/SATA Express Schematic

7.2.3 Application Curves

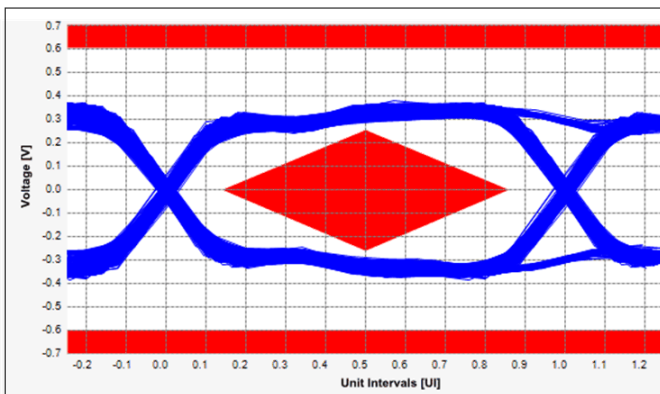


图 7-5. PCIe Gen1 TX Eye Diagram

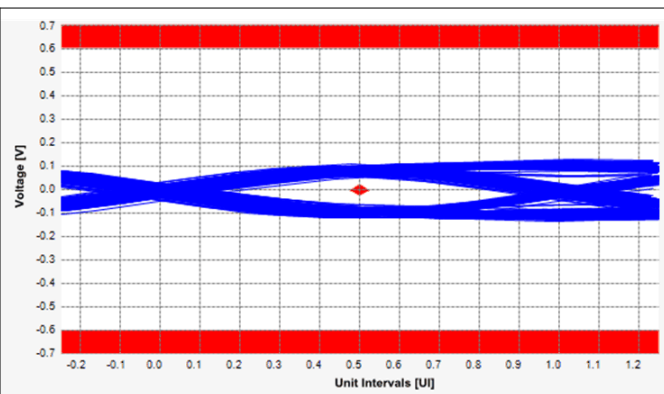


图 7-6. PCIe Gen 3 TX Eye Diagram

7.3 Power Supply Recommendations

The SN75LVPE3101 has two V_{CC} supply pins. TI recommends to place a 100nF decoupling capacitor near each of the V_{CC} pins. TI also recommends to have at least one bulk capacitor of at least 10 μ F on the V_{CC} plane near the SN75LVPE3101.

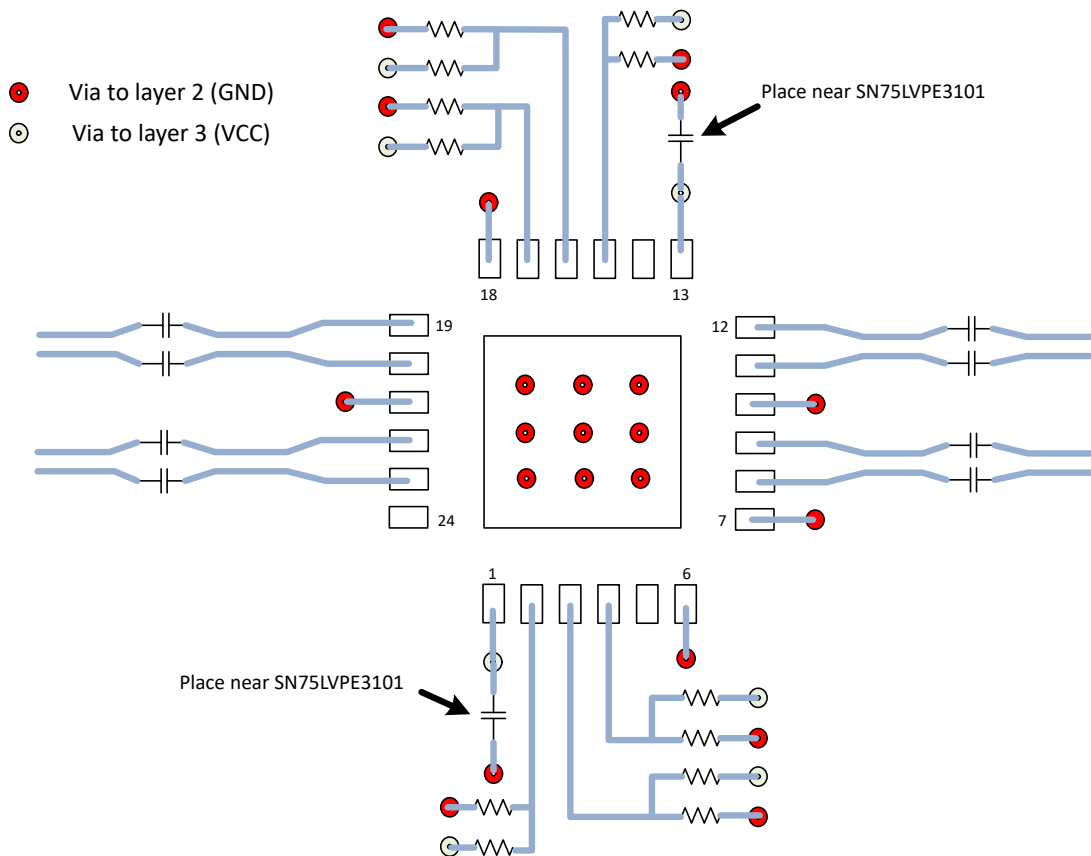
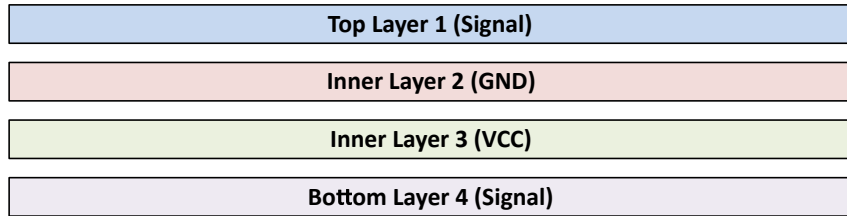
7.4 Layout

7.4.1 Layout Guidelines

- Route RXP/N and TXP/N pairs with controlled differential impedance. The differential impedance of the high speed traces depend on the specific design. PCIe allows differential impedances ranging from 70 Ω to 100 Ω , with 85 Ω typically recommended for Card ElectroMechanical (CEM) specification interoperability.
- Keep away from other high speed signals.
- In PCIe applications, maintaining polarity through the SN75LVPE3101 is not necessary. Therefore, TI recommends connecting polarity in such a way that produces the best routing.
- Keep intra-pair routing to within 2 mils.
- Intra-pair length matching must be near the location of mismatch.
- Inter-pair length matching is not necessary.
- Separate each pair at least by 3 times the signal trace width.
- Keep the use of bends in differential traces to a minimum. When bends are used, make sure the number of left and right bends are as equal as possible and the angle of the bend \geq 135 degrees. This minimizes any length mismatch causes by the bends; and therefore, minimize the impact bends have on EMI.
- Route all differential pairs on the same of layer.
- The number of vias must be kept to a minimum. TI recommends keeping the vias count to 2 or less.
- Keep traces on layers adjacent to ground plane.
- Do NOT route differential pairs over any plane split.
- When using through-hole high-speed connectors, TI recommends to route differential pairs on bottom layer to minimize the stub created by the through-hole connector.
- Adding test points causes impedance discontinuity; and therefore, negatively impact signal performance. If test points are used, place the test points in series and symmetrically. The test points must not be placed in a manner that causes a stub on the differential pair.

7.4.2 Layout Example

Example 4 layer PCB Stackup



7-7. Example Layout

8 Device and Documentation Support

8.1 ドキュメントの更新通知を受け取る方法

ドキュメントの更新についての通知を受け取るには、www.tij.co.jp のデバイス製品フォルダを開いてください。[通知] をクリックして登録すると、変更されたすべての製品情報に関するダイジェストを毎週受け取ることができます。変更の詳細については、改訂されたドキュメントに含まれている改訂履歴をご覧ください。

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8.5 用語集

[テキサス・インスツルメンツ用語集](#) この用語集には、用語や略語の一覧および定義が記載されています。

9 Revision History

資料番号末尾の英字は改訂を表しています。その改訂履歴は英語版に準じています。

| DATE | REVISION | NOTES |
|--------------|----------|-----------------|
| October 2024 | * | Initial Release |

10 Mechanical, Packaging, and Orderable Information

The following pages include mechanical, packaging, and orderable information. This information is the most current data available for the designated devices. This data is subject to change without notice and revision of this document. For browser-based versions of this data sheet, refer to the left-hand navigation.

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PACKAGING INFORMATION

| Orderable Device | Status (1) | Package Type | Package Drawing | Pins | Package Qty | Eco Plan (2) | Lead finish/ Ball material (6) | MSL Peak Temp (3) | Op Temp (°C) | Device Marking (4/5) | Samples |
|------------------|---------------|--------------|-----------------|------|-------------|-----------------|--------------------------------------|----------------------|--------------|-------------------------|-------------------------|
| SN75LVPE3101RGER | ACTIVE | VQFN | RGE | 24 | 3000 | RoHS & Green | NIPDAU | Level-1-260C-UNLIM | -40 to 85 | PX101 | Samples |
| SN75LVPE3101RGET | ACTIVE | VQFN | RGE | 24 | 250 | RoHS & Green | NIPDAU | Level-1-260C-UNLIM | -40 to 85 | PX101 | Samples |

(1) The marketing status values are defined as follows:

ACTIVE: Product device recommended for new designs.

LIFEBUY: TI has announced that the device will be discontinued, and a lifetime-buy period is in effect.

NRND: Not recommended for new designs. Device is in production to support existing customers, but TI does not recommend using this part in a new design.

PREVIEW: Device has been announced but is not in production. Samples may or may not be available.

OBSOLETE: TI has discontinued the production of the device.

(2) **RoHS:** TI defines "RoHS" to mean semiconductor products that are compliant with the current EU RoHS requirements for all 10 RoHS substances, including the requirement that RoHS substance do not exceed 0.1% by weight in homogeneous materials. Where designed to be soldered at high temperatures, "RoHS" products are suitable for use in specified lead-free processes. TI may reference these types of products as "Pb-Free".

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Green: TI defines "Green" to mean the content of Chlorine (Cl) and Bromine (Br) based flame retardants meet JS709B low halogen requirements of <=1000ppm threshold. Antimony trioxide based flame retardants must also meet the <=1000ppm threshold requirement.

(3) MSL, Peak Temp. - The Moisture Sensitivity Level rating according to the JEDEC industry standard classifications, and peak solder temperature.

(4) There may be additional marking, which relates to the logo, the lot trace code information, or the environmental category on the device.

(5) Multiple Device Markings will be inside parentheses. Only one Device Marking contained in parentheses and separated by a "~" will appear on a device. If a line is indented then it is a continuation of the previous line and the two combined represent the entire Device Marking for that device.

(6) Lead finish/Ball material - Orderable Devices 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.

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GENERIC PACKAGE VIEW

RGE 24

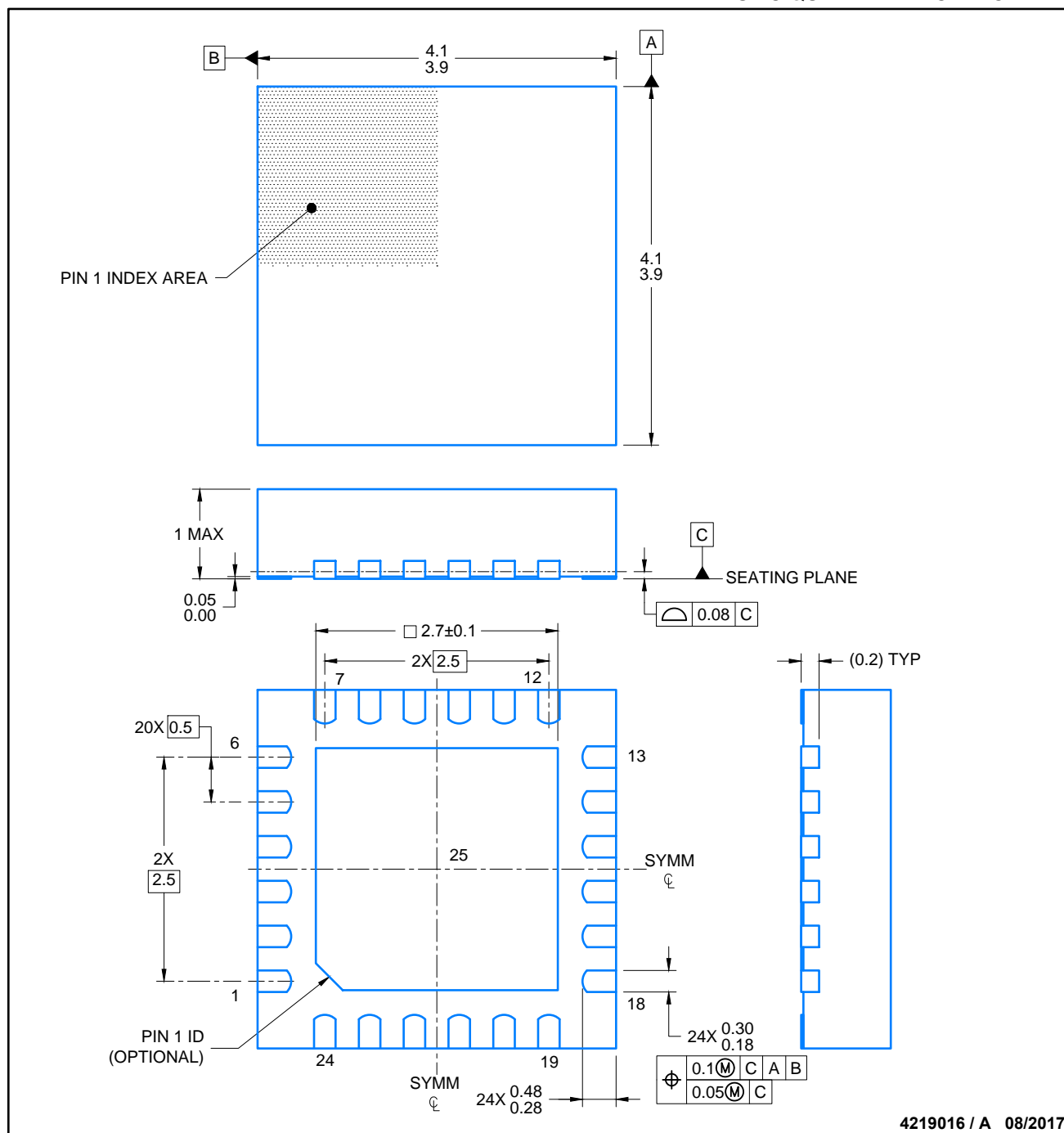
VQFN - 1 mm max height

PLASTIC QUAD FLATPACK - NO LEAD



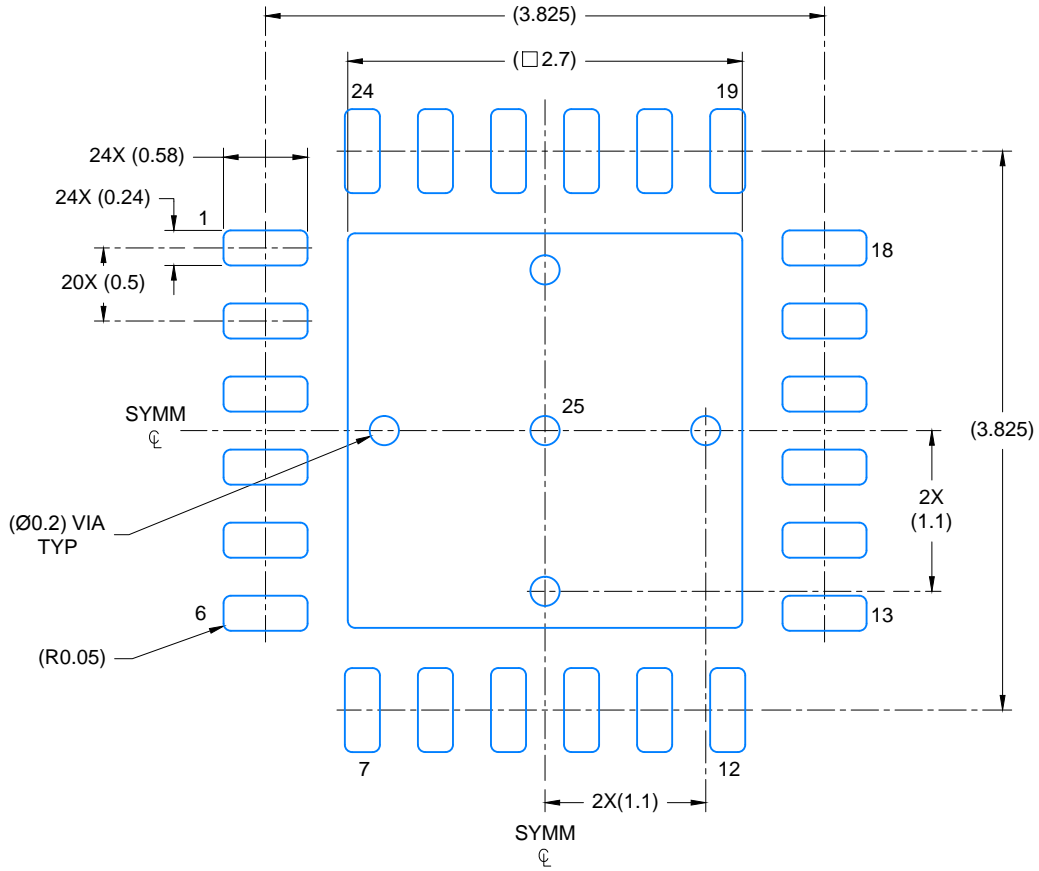
Images above are just a representation of the package family, actual package may vary.
Refer to the product data sheet for package details.

4204104/H



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. The package thermal pad must be soldered to the printed circuit board for thermal and mechanical performance.



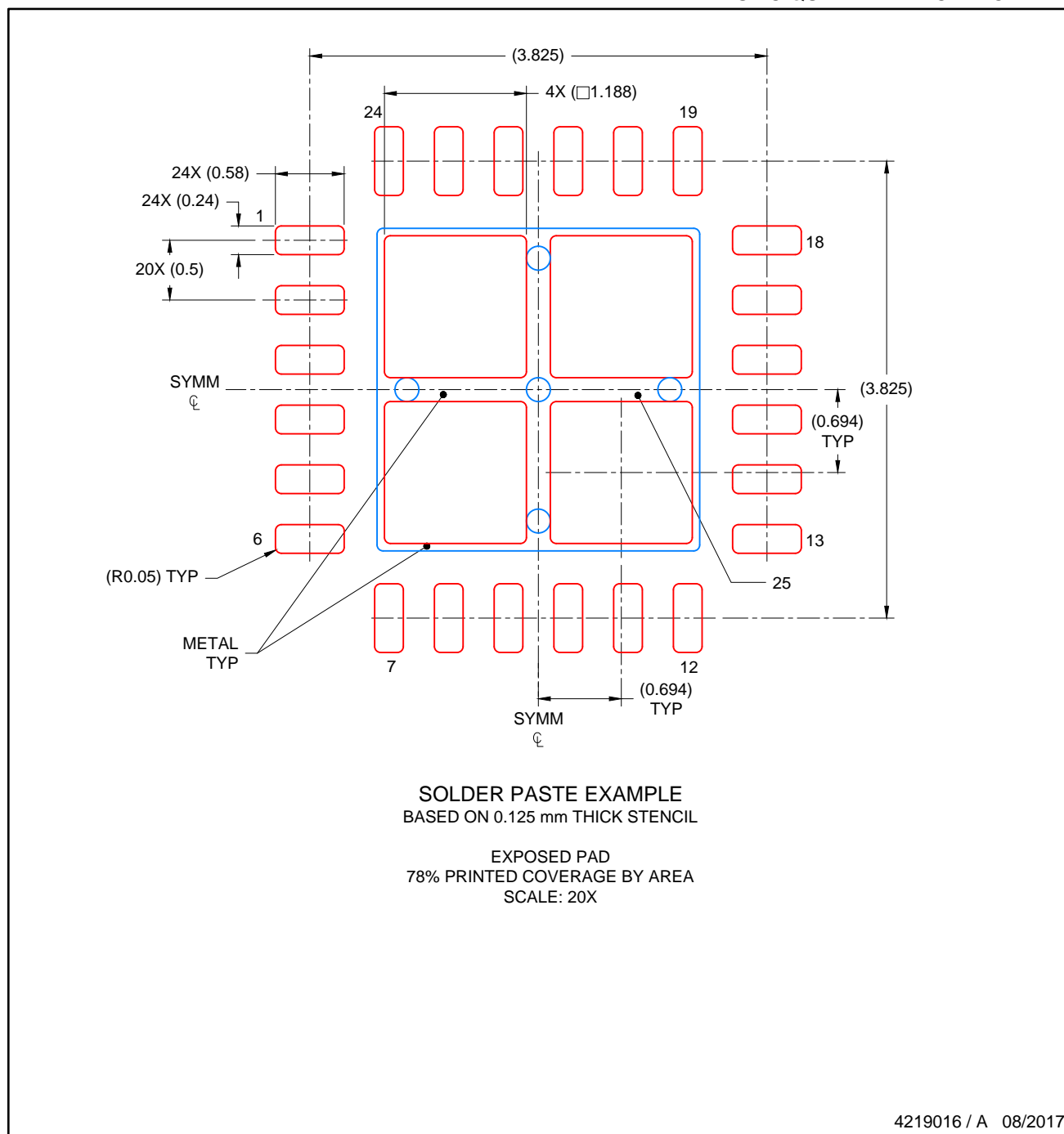
LAND PATTERN EXAMPLE
SCALE: 20X



4219016 / A 08/2017

NOTES: (continued)

4. 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/slua271).
5. Solder mask tolerances between and around signal pads can vary based on board fabrication site.



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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