

Description

The 9ZXL04x1E/9ZXL06x1E/9ZXL08x1E/9ZXL12x1E family of Zero-Delay/Fanout Buffers (ZDB, FOB) are 2nd-generation enhanced performance buffers for PCIe and CPU applications. The family meets all published QPI/UPI, DB2000Q and PCIe Gen1-5 jitter specifications. Devices range from 4 to 12 outputs, with each output having an OE# pin to support the PCIe CLKREQ# function for low power states. All devices meet DB2000Q, DB1200ZL and DB800ZL jitter and skew requirements.

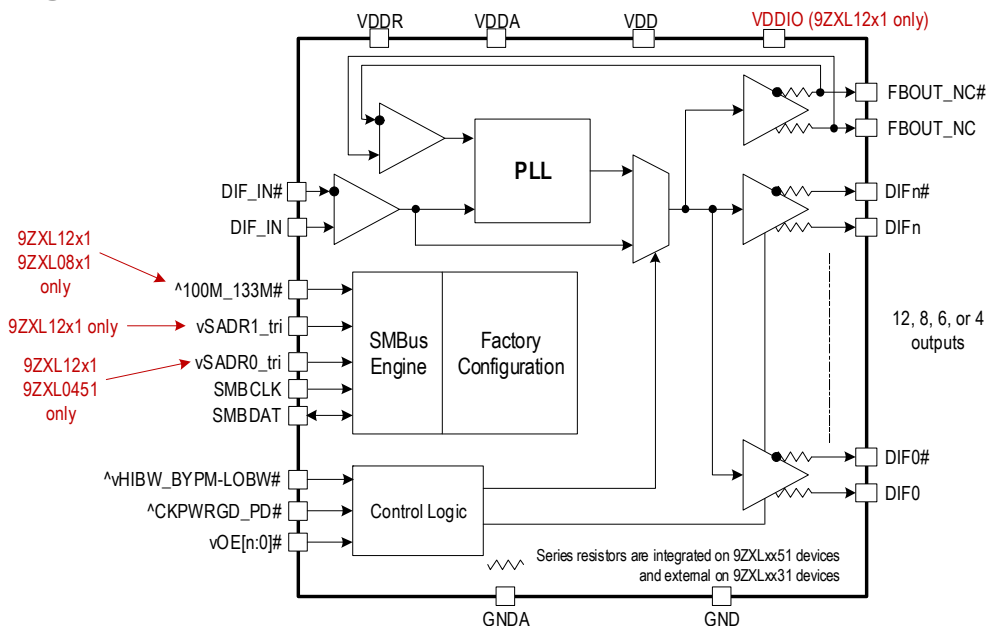
PCIe Clocking Architectures

- Common Clocked (CC)
- Independent Reference (IR) with and without spread spectrum (SRIS, SRNS)

Key Specifications

- Fanout Buffer Mode additive phase jitter:
 - PCIe Gen5 CC < 24fs RMS
 - DB2000Q additive jitter < 40fs RMS
 - QPI/UPI 11.4GB/s < 40fs RMS
 - IF-UPI additive jitter < 70fs RMS
- ZDB Mode phase jitter:
 - PCIe Gen5 CC < 22fs RMS
 - QPI/UPI 11.4GB/s < 120fs RMS
 - IF-UPI additive jitter < 130fs RMS
- Cycle-to-cycle jitter < 50ps
- Output-to-output skew < 50 ps

Block Diagram



Features

- 4-12 Low-power HCSL (LP-HCSL) outputs
- Integrated terminations eliminate up to 4 resistors per output pair
- Dedicated OE# pins support PCIe CLKREQ# function
- Up to 9 selectable SMBus addresses (9ZXL12)
- Selectable PLL bandwidths minimizes jitter peaking in cascaded PLL topologies
- Hardware/SMBus control of ZDB and FOB modes
- Spread-spectrum compatible
- 1-400MHz FOB operation (all devices)
- 100MHz and 133.33MHz ZDB mode (9ZXL12, 9ZXL08)
- 100MHz ZDB mode (9ZXL06, 9ZXL04)
- 40°C to +85°C operating temperature range (all devices)
- 40°C to +105°C operating temperature range (9ZXL08)
- Package information: see [Ordering Information](#) for details

Applications

- Servers/High-performance Computing
- nVME Storage
- Networking
- Accelerators
- Industrial Control

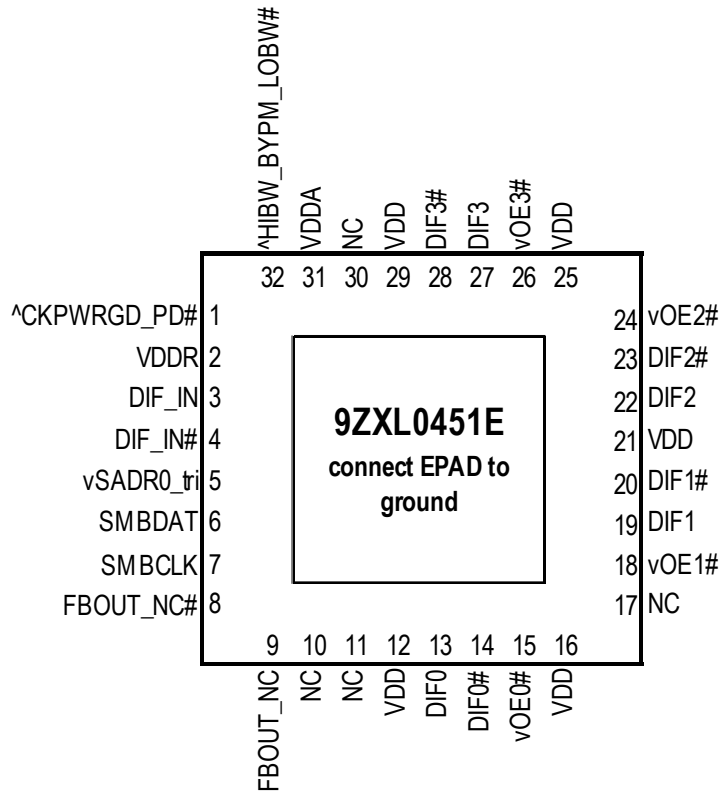
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Pin Assignments

9ZXL0451E Pin Assignment

Figure 1. Pin Assignments for 5 × 5 mm 32-VFQFPN Package – Top View

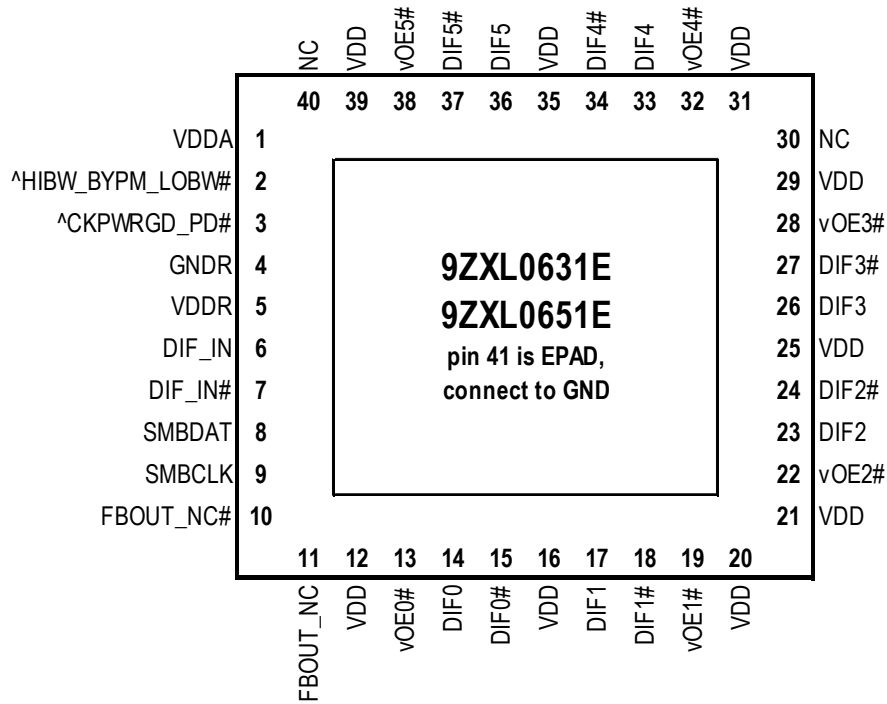


5 × 5mm, 32-VFQFPN, 0.5mm pitch

^ prefix indicates internal 120kOhm pull-up resistor
 v prefix indicates internal 120kOhm pull-down resistor

9ZXL06x1E Pin Assignment

Figure 2. Pin Assignments for 5 × 5 mm 40-VFQFPN Package – Top View

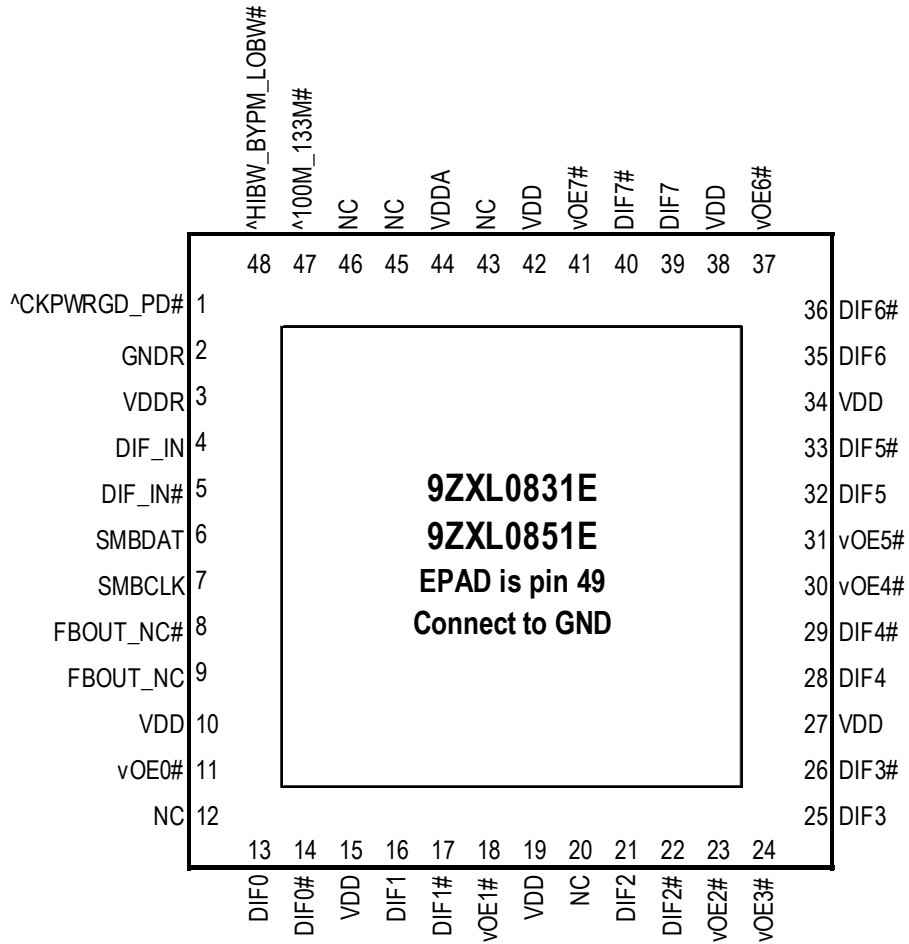


5 × 5mm, 40-VFQFPN, 0.4mm pad pitch

Pins with ^ prefix have internal 120kOhm pull-up
 Pins with v prefix have internal 120kOhm pull-down

9ZXL08x1E Pin Assignment

Figure 3. Pin Assignments for 6 × 6 mm 48-VFQFPN Package – Top View

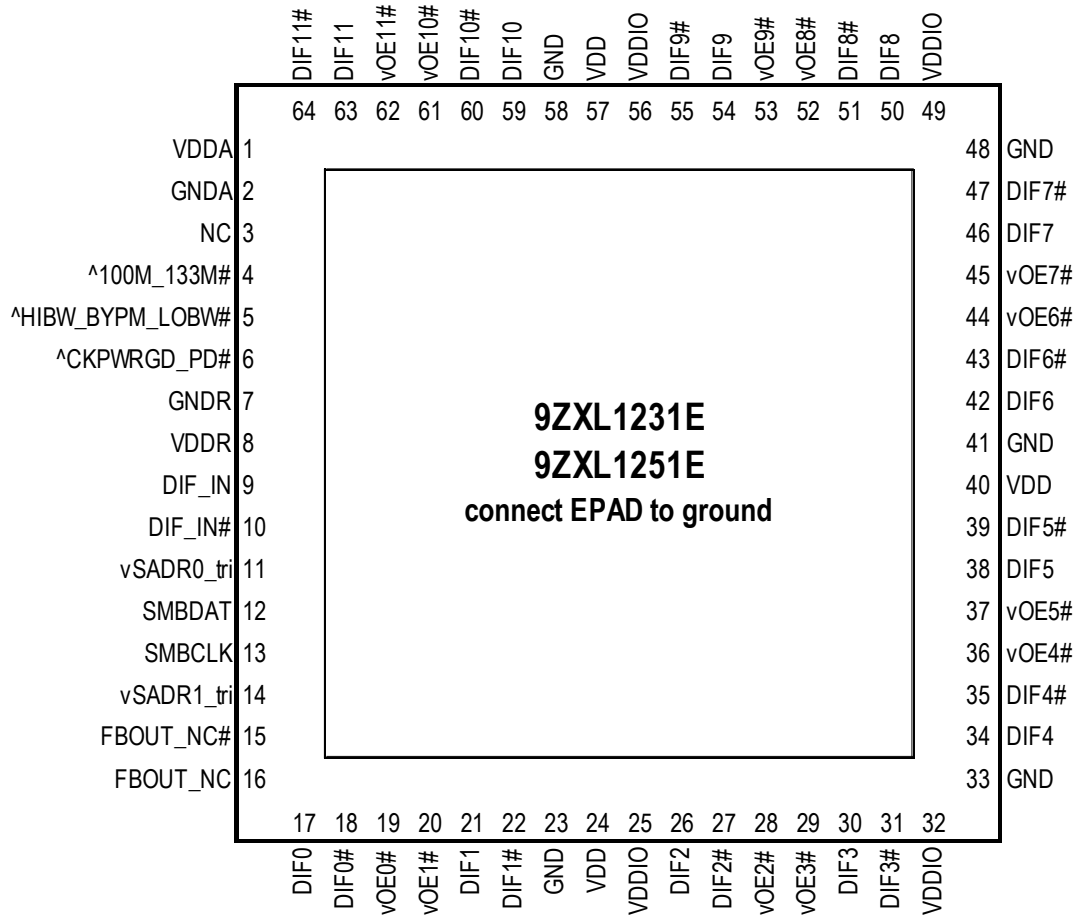


6 × 6mm, 48-VFQFPN, 0.4mm pad pitch

Pins with ^ prefix have internal 120kOhm pull-up
Pins with v prefix have internal 120kOhm pull-down

9ZXL12x1E Pin Assignment

Figure 4. Pin Assignments for 9 × 9 mm 64-VFQFPN Package – Top View



9 × 9mm 64-VFQFPN, 0.5mm pad pitch

Pins with ^ prefix have internal 120kOhm pull-up

Pins with v prefix have internal 120kOhm pull-down

Pin Descriptions

Table 1. Pin Descriptions

| Name | Type | Description | 9ZXL12x1 Pin No. | 9ZXL08x1 Pin No. | 9ZXL06x1 Pin No. | 9ZXL04x1 Pin No. |
|------------------|------------|---|---------------------|---------------------|---------------------|---------------------|
| ^100M_133M# | Latched In | 3.3V Input to select operating frequency. This pin has an internal pull-up resistor. See Frequency Selection (PLL Mode) for definition. | 4 | 47 | - | - |
| ^CKPWRGD_PD# | Input | Input notifies device to sample latched inputs and start up on first high assertion. Low enters Power Down Mode, subsequent high assertions exit Power Down Mode. This pin has internal pull-up resistor. | 6 | 1 | 3 | 1 |
| ^HIBW_BYPM_LOBW# | Latched In | Tri-level input to select High BW, Bypass or Low BW Mode. This pin has an internal pull-up resistor. See PLL Operating Mode table for details. | 5 | 48 | 2 | 32 |
| DIF_IN | Input | HCSL true input. | 9 | 4 | 6 | 3 |
| DIF_IN# | Input | HCSL complementary input. | 10 | 5 | 7 | 4 |
| DIF0 | Output | Differential true clock output. | 17 | 13 | 14 | 13 |
| DIF0# | Output | Differential complementary clock output. | 18 | 14 | 15 | 14 |
| DIF1 | Output | Differential true clock output. | 21 | 16 | 17 | 19 |
| DIF1# | Output | Differential complementary clock output. | 22 | 17 | 18 | 20 |
| DIF10 | Output | Differential true clock output. | 59 | - | - | - |
| DIF10# | Output | Differential complementary clock output. | 60 | - | - | - |
| DIF11 | Output | Differential true clock output. | 63 | - | - | - |
| DIF11# | Output | Differential complementary clock output. | 64 | - | - | - |
| DIF2 | Output | Differential true clock output. | 26 | 21 | 23 | 22 |
| DIF2# | Output | Differential complementary clock output. | 27 | 22 | 24 | 23 |
| DIF3 | Output | Differential true clock output. | 30 | 25 | 26 | 27 |
| DIF3# | Output | Differential complementary clock output. | 31 | 26 | 27 | 28 |
| DIF4 | Output | Differential true clock output. | 34 | 28 | 33 | n/a |
| DIF4# | Output | Differential complementary clock output. | 35 | 29 | 34 | n/a |
| DIF5 | Output | Differential true clock output. | 38 | 32 | 36 | n/a |
| DIF5# | Output | Differential complementary clock output. | 39 | 33 | 37 | n/a |
| DIF6 | Output | Differential true clock output. | 42 | 35 | - | - |
| DIF6# | Output | Differential complementary clock output. | 43 | 36 | - | - |
| DIF7 | Output | Differential true clock output. | 46 | 39 | - | - |
| DIF7# | Output | Differential complementary clock output. | 47 | 40 | - | - |
| DIF8 | Output | Differential true clock output. | 50 | - | - | - |
| DIF8# | Output | Differential complementary clock output. | 51 | - | - | - |
| DIF9 | Output | Differential true clock output. | 54 | - | - | - |
| DIF9# | Output | Differential complementary clock output. | 55 | - | - | - |

Table 1. Pin Descriptions (Cont.)

| Name | Type | Description | 9ZXL12x1 Pin No. | 9ZXL08x1 Pin No. | 9ZXL06x1 Pin No. | 9ZXL04x1 Pin No. |
|-----------|--------|---|---------------------|----------------------------------|--|-----------------------|
| EPAD | GND | Connect epad to ground. | 65 | 49 | 41 | 33 |
| FBOUT_NC | Output | True half of differential feedback output. This pin should NOT be connected to anything outside the chip. It exists to provide delay path matching to get 0 propagation delay. | 16 | 9 | 11 | 9 |
| FBOUT_NC# | Output | Complementary half of differential feedback output. This pin should NOT be connected to anything outside the chip. It exists to provide delay path matching to get 0 propagation delay. | 15 | 8 | 10 | 8 |
| GND | GND | Ground pin. | 23 | 49 | 41 | 33 |
| GND | GND | Ground pin. | 33 | 49 | 41 | n/a |
| GND | GND | Ground pin. | 41 | 49 | - | - |
| GND | GND | Ground pin. | 48 | 49 | - | - |
| GND | GND | Ground pin. | 58 | - | - | - |
| GND | GND | Ground pin for the PLL core. | 2 | 49 | 41 | 33 |
| GND | GND | Analog ground pin for the differential input (receiver). | 7 | 2 | 4 | 33 |
| NC | — | No connection. | 3 | 12, 20, 43, 45, 46 | 30, 40 | 10, 11, 17, 30 |
| SMBCLK | Input | Clock pin of SMBUS circuitry. | 13 | 7 | 9 | 7 |
| SMBDAT | I/O | Data pin of SMBUS circuitry. | 12 | 6 | 8 | 6 |
| VDD | Power | Power supply, nominally 3.3V. | 24 | 10, 15, 19, 27, 34, 38, 42 | 12, 16, 20, 21, 25, 29, 31, 35, 39 | 12, 16, 21, 25, 29 |
| VDD | Power | Power supply, nominally 3.3V. | 40 | - | - | - |
| VDD | Power | Power supply, nominally 3.3V. | 57 | - | - | - |
| VDDA | Power | Power supply for PLL core. | 1 | 44 | 1 | 31 |
| VDDIO | Power | Power supply for differential outputs. | 25 | - | - | - |
| VDDIO | Power | Power supply for differential outputs. | 32 | - | - | - |
| VDDIO | Power | Power supply for differential outputs. | 49 | - | - | - |
| VDDIO | Power | Power supply for differential outputs. | 56 | - | - | - |
| VDDR | Power | Power supply for differential input clock (receiver). This VDD should be treated as an analog power rail and filtered appropriately. Nominally 3.3V. | 8 | 3 | 5 | 2 |
| vOE0# | Input | Active low input for enabling output 0. This pin has an internal pull-down. 1 = disable output, 0 = enable output. | 19 | 11 | 13 | 15 |
| vOE1# | Input | Active low input for enabling output 1. This pin has an internal pull-down. 1 = disable output, 0 = enable output. | 20 | 18 | 19 | 18 |
| vOE10# | Input | Active low input for enabling output 10. This pin has an internal pull-down. 1 = disable output, 0 = enable output. | 61 | - | - | - |

Table 1. Pin Descriptions (Cont.)

| Name | Type | Description | 9ZXL12x1 Pin No. | 9ZXL08x1 Pin No. | 9ZXL06x1 Pin No. | 9ZXL04x1 Pin No. |
|------------|-------|---|------------------|------------------|------------------|------------------|
| vOE11# | Input | Active low input for enabling output 11. This pin has an internal pull-down. 1 = disable output, 0 = enable output. | 62 | - | - | - |
| vOE2# | Input | Active low input for enabling output 2. This pin has an internal pull-down. 1 = disable output, 0 = enable output. | 28 | 23 | 22 | 24 |
| vOE3# | Input | Active low input for enabling output 3. This pin has an internal pull-down. 1 = disable output, 0 = enable output. | 29 | 24 | 28 | 26 |
| vOE4# | Input | Active low input for enabling output 4. This pin has an internal pull-down. 1 = disable output, 0 = enable output. | 36 | 30 | 32 | - |
| vOE5# | Input | Active low input for enabling output 5. This pin has an internal pull-down. 1 = disable output, 0 = enable output. | 37 | 31 | 38 | - |
| vOE6# | Input | Active low input for enabling output 6. This pin has an internal pull-down. 1 = disable output, 0 = enable output. | 44 | 37 | - | - |
| vOE7# | Input | Active low input for enabling output 7. This pin has an internal pull-down. 1 = disable output, 0 = enable output. | 45 | 41 | - | - |
| vOE8# | Input | Active low input for enabling output 8. This pin has an internal pull-down. 1 = disable output, 0 = enable output. | 52 | n/a | - | - |
| vOE9# | Input | Active low input for enabling output 9. This pin has an internal pull-down. 1 = disable output, 0 = enable output. | 53 | - | - | - |
| vSADR0_tri | Input | SMBus address bit. This is a tri-level input that works in conjunction with other SADR pins, if present, to decode SMBus Addresses. It has an internal pull down resistor. See the SMBus Addresses table. | 11 | - | - | 5 |
| vSADR1_tri | Input | SMBus address bit. This is a tri-level input that works in conjunction with other SADR pins, if present, to decode SMBus Addresses. It has an internal pull down resistor. See the SMBus Addresses table. | 14 | - | - | - |

Absolute Maximum Ratings

The absolute maximum ratings are stress ratings only. Stresses greater than those listed below can cause permanent damage to the device. Functional operation of the 9ZXL04x1E/9ZXL06x1E/9ZXL08x1E/9ZXL12x1E at absolute maximum ratings is not implied. Exposure to absolute maximum rating conditions may affect device reliability.

Table 2. Absolute Maximum Ratings

| Parameter | Symbol | Conditions | Minimum | Maximum | Unit | Notes |
|---------------------------|-------------|----------------------------|-----------|----------------|------|-------|
| Supply Voltage | V_{DDX} | | | 3.9 | V | 1,2 |
| Input Low Voltage | V_{IL} | | GND - 0.5 | - | V | 1 |
| Input High Voltage | V_{IH} | Except for SMBus interface | - | $V_{DD} + 0.5$ | V | 1,3 |
| Input High Voltage, SMBus | V_{IHSMB} | SMBus clock and data pins. | - | 3.9 | V | 1 |
| Storage Temperature | T_s | | -65 | 150 | °C | 1 |
| Junction Temperature | T_j | | - | 125 | °C | 1 |
| Input ESD Protection | ESD prot | Human Body Model. | 2500 | - | V | 1 |

¹ Guaranteed by design and characterization, not 100% tested in production.

² Operation under these conditions is neither implied nor guaranteed.

³ Not to exceed 3.9V.

Thermal Characteristics

Table 3. Thermal Characteristics

| Parameter | Symbol | Conditions | Package | Typical Values | Unit | Notes |
|-----------------------------------|----------------|----------------------------------|---------|----------------|------|-------|
| 9ZXL04x1 Thermal Resistance | θ_{JC} | Junction to case. | NLG32 | 32 | °C/W | 1 |
| | θ_{Jb} | Junction to base. | | 2 | °C/W | 1 |
| | θ_{JA0} | Junction to air, still air. | | 44 | °C/W | 1 |
| | θ_{JA1} | Junction to air, 1 m/s air flow. | | 37 | °C/W | 1 |
| | θ_{JA3} | Junction to air, 3 m/s air flow. | | 32.5 | °C/W | 1 |
| | θ_{JA5} | Junction to air, 5 m/s air flow. | | 30.9 | °C/W | 1 |
| 9ZXL06x1 Thermal Resistance | θ_{JC} | Junction to case. | NDG40 | 32 | °C/W | 1 |
| | θ_{Jb} | Junction to base. | | 2 | °C/W | 1 |
| | θ_{JA0} | Junction to air, still air. | | 44 | °C/W | 1 |
| | θ_{JA1} | Junction to air, 1 m/s air flow. | | 37 | °C/W | 1 |
| | θ_{JA3} | Junction to air, 3 m/s air flow. | | 33 | °C/W | 1 |
| | θ_{JA5} | Junction to air, 5 m/s air flow. | | 31 | °C/W | 1 |
| 9ZXL08x1 Thermal Resistance | θ_{JC} | Junction to case. | NDG48 | 19 | °C/W | 1 |
| | θ_{Jb} | Junction to base. | | 0 | °C/W | 1 |
| | θ_{JA0} | Junction to air, still air. | | 30 | °C/W | 1 |
| | θ_{JA1} | Junction to air, 1 m/s air flow. | | 23 | °C/W | 1 |
| | θ_{JA3} | Junction to air, 3 m/s air flow. | | 20 | °C/W | 1 |
| | θ_{JA5} | Junction to air, 5 m/s air flow. | | 19 | °C/W | 1 |

Table 3. Thermal Characteristics (Cont.)

| Parameter | Symbol | Conditions | Package | Typical Values | Unit | Notes |
|-----------------------------------|----------------|----------------------------------|---------|----------------|------|-------|
| 9ZXL12x1 Thermal Resistance | θ_{JC} | Junction to case. | NLG64 | 14 | °C/W | 1 |
| | θ_{Jb} | Junction to base. | | 1 | °C/W | 1 |
| | θ_{JA0} | Junction to air, still air. | | 28 | °C/W | 1 |
| | θ_{JA1} | Junction to air, 1 m/s air flow. | | 21 | °C/W | 1 |
| | θ_{JA3} | Junction to air, 3 m/s air flow. | | 19 | °C/W | 1 |
| | θ_{JA5} | Junction to air, 5 m/s air flow. | | 18 | °C/W | 1 |

¹ EPAD soldered to board.

Electrical Characteristics

$T_A = T_{AMB}$. Supply voltages per normal operation conditions; see [Test Loads](#) for loading conditions.

Table 4. SMBus Parameters

| Parameter | Symbol | Conditions | Minimum | Typical | Maximum | Unit | Notes |
|---------------------------|--------------|---|---------|---------|-------------|------|-------|
| SMBus Input Low Voltage | V_{ILSMB} | | - | - | 0.8 | V | |
| SMBus Input High Voltage | V_{IHSMB} | | 2.1 | - | V_{DDSMB} | V | |
| SMBus Output Low Voltage | V_{OLSMB} | At I_{PULLUP} . | - | - | 0.4 | V | |
| SMBus Sink Current | I_{PULLUP} | At V_{OL} . | 4 | - | - | mA | |
| Nominal Bus Voltage | V_{DDSMB} | | 2.7 | - | 3.6 | V | |
| SCLK/SDATA Rise Time | t_{RSMB} | (Max. $V_{IL} - 0.15V$) to (Min. $V_{IH} + 0.15V$). | - | - | 1000 | ns | 1 |
| SCLK/SDATA Fall Time | t_{FSMB} | (Min. $V_{IH} + 0.15V$) to (Max. $V_{IL} - 0.15V$). | - | - | 300 | ns | 1 |
| SMBus Operating Frequency | f_{SMB} | SMBus operating frequency. | - | - | 500 | kHz | 5 |

¹ Guaranteed by design and characterization, not 100% tested in production.

² Control input must be monotonic from 20% to 80% of input swing.

³ Time from deassertion until outputs are > 200mV.

⁴ DIF_IN input.

⁵ The differential input clock must be running for the SMBus to be active.

Table 5. DIF_IN Clock Input Parameters

| Parameter | Symbol | Conditions | Minimum | Typical | Maximum | Unit | Notes |
|--------------------------------|-------------|---|---------|---------|---------|------|-------|
| Input Crossover Voltage–DIF_IN | V_{CROSS} | Crossover voltage. | 150 | - | 900 | mV | 1 |
| Input Swing–DIF_IN | V_{SWING} | Differential value. | 300 | - | - | mV | 1 |
| Input Slew Rate–DIF_IN | dv/dt | Measured differentially. | 0.4 | - | 8 | V/ns | 1,2 |
| Input Leakage Current | I_{IN} | $V_{IN} = V_{DD}$, $V_{IN} = GND$. | -5 | - | 5 | μA | |
| Input Duty Cycle | d_{tin} | Measurement from differential waveform. | 45 | - | 55 | % | 1 |
| Input Jitter–Cycle to Cycle | J_{DIFin} | Differential measurement. | 0 | - | 125 | ps | 1 |

¹ Guaranteed by design and characterization, not 100% tested in production.

² Slew rate measured through ±75mV window centered around differential zero.

Table 6. Input/Supply/Common Parameters – Normal Operating Conditions

| Parameter | Symbol | Conditions | Minimum | Typical | Maximum | Unit | Notes |
|------------------------------------|-----------------|--|-----------|------------|----------------|--------|-------|
| Supply Voltage | V_{DDX} | Supply voltage for core and analog. | 3.135 | 3.3 | 3.465 | V | |
| Output Supply Voltage | V_{DDIO} | Supply voltage for DIF outputs, if present. | 0.95 | 1.05 | 3.465 | V | 5 |
| Ambient Operating Temperature | T_{AMB} | Extended Industrial range (T_{EXIND}). | -40 | 25 | 105 | °C | 7 |
| | | Industrial range (T_{IND}). | -40 | 25 | 85 | °C | |
| Input High Voltage | V_{IH} | Single-ended inputs, except SMBus, tri-level inputs. | 2 | - | $V_{DD} + 0.3$ | V | |
| Input Low Voltage | V_{IL} | Single-ended inputs, except SMBus, tri-level inputs. | GND - 0.3 | - | 0.8 | V | |
| Input High Voltage | V_{IHtri} | Tri-level inputs. | 2.2 | - | $V_{DD} + 0.3$ | V | |
| Input Mid Voltage | V_{IMtri} | Tri-level inputs. | 1.2 | $V_{DD}/2$ | 1.8 | V | |
| Input Low Voltage | V_{ILtri} | Tri-level inputs. | GND - 0.3 | - | 0.8 | V | |
| Input Current | I_{IN} | Single-ended inputs, $V_{IN} = \text{GND}$, $V_{IN} = V_{DD}$. | -5 | - | 5 | μA | |
| | I_{INP} | Single-ended inputs $V_{IN} = 0 \text{ V}$; inputs with internal pull-up resistors. $V_{IN} = V_{DD}$; inputs with internal pull-down resistors. | -50 | - | 50 | μA | |
| Input Frequency | F_{ibyp} | $V_{DD} = 3.3 \text{ V}$, Bypass Mode. | 1 | - | 400 | MHz | |
| | F_{ipll} | $V_{DD} = 3.3 \text{ V}$, 100MHz PLL Mode. | 98.5 | 100.00 | 102.5 | MHz | |
| | F_{ipll} | $V_{DD} = 3.3 \text{ V}$, 133.33MHz PLL Mode. | 132 | 133.33 | 135 | MHz | 6 |
| ppm Error Contribution | ppm | ppm error contributed to input clock. | 0 | | | ppm | |
| Pin Inductance | L_{pin} | | | - | 7 | nH | 1 |
| Capacitance | C_{IN} | Logic inputs, except DIF_IN. | 1.5 | - | 5 | pF | 1 |
| | C_{INDIF_IN} | DIF_IN differential clock inputs. | 1.5 | - | 2.7 | pF | 1,4 |
| | C_{OUT} | Output pin capacitance. | - | - | 6 | pF | 1 |
| CLK Stabilization | t_{STAB} | From V_{DD} power-up and after input clock stabilization or de-assertion of PD# to 1st clock. | - | 1 | 1.8 | ms | 1,2 |
| Input SS Modulation Frequency PCIe | $f_{MODINPCIe}$ | Allowable frequency for PCIe applications (Triangular modulation). | 30 | - | 33 | kHz | |
| OE# Latency | $t_{LATOE\#}$ | DIF start after OE# assertion. DIF stop after OE# deassertion. | 4 | 5 | 10 | clocks | 1,2,3 |
| Tdrive_PD# | t_{DRVPD} | DIF output enable after. PD# de-assertion. | - | 49 | 300 | μs | 1,3 |
| Fall Time | t_F | Fall time of control inputs. | - | - | 5 | ns | 2 |
| Rise Time | t_R | Rise time of control inputs. | - | - | 5 | ns | 2 |

¹ Guaranteed by design and characterization, not 100% tested in production.

² Control input must be monotonic from 20% to 80% of input swing.

³ Time from deassertion until outputs are > 200mV.

⁴ DIF_IN input.

⁵ 9ZXL12x1 only.

⁶ 9ZXL12x1 and 9ZXL08x1 only.

⁷ Not all devices are available in this temperature range. See ordering information for details.

Table 7. LP-HCSL Outputs

| Parameter | Symbol | Conditions | Minimum | Typical | Maximum | Specification Limit | Unit | Notes |
|------------------------|------------------------------|---|---------|---------|---------|---------------------|------|-------|
| Slew Rate | dV/dt | Scope averaging on. | 2 | 2.9 | 4 | 1 – 4 | V/ns | 1,2,3 |
| Slew Rate Matching | Δ dV/dt | Single-ended measurement. | - | 7.1 | 20 | 20 | % | 1,4,7 |
| Maximum Voltage | V _{MAX} | Measurement on single ended signal using absolute value. (Scope averaging off). | 700 | 792 | 850 | 660 – 1150 | mV | 7,8 |
| Minimum Voltage | V _{MIN} | | -150 | -35 | 150 | -300 | mV | 7,8 |
| Crossing Voltage (abs) | V _{cross_abs} | Scope averaging off. | 300 | 372 | 462 | 250 – 550 | mV | 1,5,7 |
| Crossing Voltage (var) | Δ -V _{cross} | Scope averaging off. | - | 15 | 50 | 140 | mV | 1,6,7 |

¹ Guaranteed by design and characterization, not 100% tested in production.

² Measured from differential waveform.

³ Slew rate is measured through the V_{swing} voltage range centered around differential 0V. This results in a \pm 150mV window around differential 0V.

⁴ Matching applies to rising edge rate for Clock and falling edge rate for Clock#. It is measured using a \pm 75 mV window centered on the average cross point where Clock rising meets Clock# falling. The median cross point is used to calculate the voltage thresholds the oscilloscope is to use for the edge rate calculations.

⁵ V_{cross} is defined as voltage where Clock = Clock# measured on a component test board and only applies to the differential rising edge (i.e. Clock rising and Clock# falling).

⁶ The total variation of all V_{cross} measurements in any particular system. Note that this is a subset of V_{cross_min/max} (V_{cross absolute}) allowed. The intent is to limit V_{cross} induced modulation by setting Δ -V_{cross} to be smaller than V_{cross absolute}.

⁷ At default SMBus settings.

⁸ Includes previously separate values of +300mV overshoot and -300mV of undershoot.

Table 8. Current Consumption – 9ZXL04x1

| Parameter | Symbol | Conditions | Minimum | Typical | Maximum | Unit | Notes |
|--------------------------|--------------------|---|---------|---------|---------|------|-------|
| Operating Supply Current | I _{DDA} | V _{DDA} , ZDB Mode at 100MHz. | - | 37 | 44 | mA | 1 |
| | | V _{DDA} , Fanout Buffer Mode at 100MHz. | - | 4 | 5 | mA | 1 |
| | I _{DD} | All other V _{DD} pins, any mode at 100MHz. | - | 33 | 40 | mA | |
| Power Down Current | I _{DDAPD} | V _{DDA} pin, CKPWRGD_PD# = 0. | - | 3 | 5 | mA | 1 |
| | I _{DDPD} | All other V _{DD} pins, CKPWRGD_PD# = 0. | - | 1 | 2 | mA | |

¹ Includes V_{DDR}.

Table 9. Current Consumption – 9ZXL06x1

| Parameter | Symbol | Conditions | Minimum | Typical | Maximum | Unit | Notes |
|--------------------------|--------------------|--|---------|---------|---------|------|-------|
| Operating Supply Current | I _{DDA} | V _{DDA} , PLL Mode at 100MHz. | - | 37 | 45 | mA | 1 |
| | | V _{DDA} , Fanout Buffer Mode at 100MHz. | - | 4 | 5 | mA | 1 |
| | I _{DD} | All other V _{DD} pins at 100MHz. | - | 41 | 50 | mA | |
| Power Down Current | I _{DDAPD} | V _{DDA} , CKPWRGD_PD# = 0. | - | 3 | 4 | mA | 1 |
| | I _{DDPD} | All other V _{DD} pins, CKPWRGD_PD# = 0. | - | 1 | 2 | mA | |

¹ Includes V_{DDR}.

Table 10. Current Consumption – 9ZXL08x1

| Parameter | Symbol | Conditions | Minimum | Typical | Maximum | Unit | Notes |
|--------------------------|--------------------|--|---------|---------|---------|------|-------|
| Operating Supply Current | I _{DDA} | V _{DDA} , PLL Mode at 100MHz. | - | 37 | 45 | mA | 1 |
| | | V _{DDA} , Fanout Buffer Mode at 100MHz. | - | 4 | 5 | mA | 1 |
| | I _{DD} | All other V _{DD} pins at 100MHz. | - | 55 | 68 | mA | |
| Power Down Current | I _{DDAPD} | V _{DDA} , CKPWRGD_PD# = 0. | - | 3 | 4 | mA | 1 |
| | I _{DDPD} | All other V _{DD} pins, CKPWRGD_PD# = 0. | - | 1 | 2 | mA | |

¹ Includes V_{DDR}.

Table 11. Current Consumption – 9ZXL12x1

| Parameter | Symbol | Conditions | Minimum | Typical | Maximum | Unit | Notes |
|--------------------------|--------------------|---|---------|---------|---------|------|-------|
| Operating Supply Current | I _{DDA} | V _{DDA} , PLL Mode at 100MHz. | - | 38 | 46 | mA | 1 |
| | | V _{DDA} , Fanout Buffer Mode at 100MHz. | - | 4 | 5 | mA | 1 |
| | I _{DD} | All other V _{DD} pins. | - | 25 | 34 | mA | |
| | I _{DDIO} | V _{DDIO} for LP-HCSL outputs, if applicable. | - | 83 | 107 | mA | |
| Power Down Current | I _{DDAPD} | V _{DDA} , CKPWRGD_PD# = 0. | - | 3 | 4 | mA | 1 |
| | I _{DDPD} | All other V _{DD} pins, CKPWRGD_PD# = 0. | - | 1 | 2 | mA | |

¹ Includes V_{DDR}.

Table 12. PCIe Phase Jitter

T_{AMB} = over the specified operating range. Supply voltages per normal operation conditions. See [Test Loads](#) for loading conditions.

| Parameter | Symbol | Conditions | Minimum | Typical | Maximum | Limit | Unit | Notes |
|---|-----------------------------|------------------------------|---------|---------|---------|-------|----------|---------|
| PCIe Phase Jitter, Low Bandwidth ZDB Mode (Common Clocked Architecture) | t _{jphPCIeG1-CC} | PCIe Gen1 (2.5 GT/s) | - | 2.6 | 6.8 | 86 | ps (p-p) | 1,2 |
| | t _{jphPCIeG2-CC} | PCIe Gen2 Hi Band (5.0 GT/s) | - | 0.09 | 0.16 | 3 | ps (RMS) | 1,2 |
| | | PCIe Gen2 Lo Band (5.0 GT/s) | - | 0.08 | 0.12 | 3.1 | ps (RMS) | 1,2 |
| | t _{jphPCIeG3-CC} | PCIe Gen3 (8.0 GT/s) | - | 0.05 | 0.07 | 1 | ps (RMS) | 1,2 |
| | t _{jphPCIeG4-CC} | PCIe Gen4 (16.0 GT/s) | - | 0.05 | 0.07 | 0.5 | ps (RMS) | 1,2,3,4 |
| | t _{jphPCIeG5-CC} | PCIe Gen5 (32.0 GT/s) | - | 0.018 | 0.022 | 0.15 | ps (RMS) | 1,2,3,5 |
| PCIe Phase Jitter, Low Bandwidth ZDB Mode (SRIS Architecture) | t _{jphPCIeG1-SRIS} | PCIe Gen1 (2.5 GT/s) | - | 8.71 | 8.73 | N/A | ps (RMS) | 1,2,6 |
| | t _{jphPCIeG2-SRIS} | PCIe Gen2 (5.0 GT/s) | - | 0.81 | 0.83 | | ps (RMS) | 1,2,6 |
| | t _{jphPCIeG3-SRIS} | PCIe Gen3 (8.0 GT/s) | - | 0.329 | 0.335 | | ps (RMS) | 1,2,6 |
| | t _{jphPCIeG4-SRIS} | PCIe Gen4 (16.0 GT/s) | - | 0.222 | 0.235 | | ps (RMS) | 1,2,6 |
| | t _{jphPCIeG5-SRIS} | PCIe Gen5 (32.0 GT/s) | - | 0.084 | 0.091 | | ps (RMS) | 1,2,6 |

Table 12. PCIe Phase Jitter (Cont.)

T_{AMB} = over the specified operating range. Supply voltages per normal operation conditions. See [Test Loads](#) for loading conditions.

| Parameter | Symbol | Conditions | Minimum | Typical | Maximum | Limit | Unit | Notes |
|--|-----------------------------|------------------------------|---------|---------|---------|----------|----------|---------|
| PCIe Phase Jitter, High Bandwidth ZDB Mode (Common Clocked Architecture) | t _{jphPCIeG1-CC} | PCIe Gen1 (2.5 GT/s) | - | 5.4 | 6.9 | 86 | ps (p-p) | 1,2 |
| | t _{jphPCIeG2-CC} | PCIe Gen2 Hi Band (5.0 GT/s) | - | 0.19 | 0.25 | 3 | ps (RMS) | 1,2 |
| | | PCIe Gen2 Lo Band (5.0 GT/s) | - | 0.09 | 0.13 | 3.1 | ps (RMS) | 1,2 |
| | t _{jphPCIeG3-CC} | PCIe Gen3 (8.0 GT/s) | - | 0.10 | 0.13 | 1 | ps (RMS) | 1,2 |
| | t _{jphPCIeG4-CC} | PCIe Gen4 (16.0 GT/s) | - | 0.10 | 0.13 | 0.5 | ps (RMS) | 1,2,3,4 |
| t _{jphPCIeG5-CC} | PCIe Gen5 (32.0 GT/s) | - | 0.032 | 0.042 | 0.15 | ps (RMS) | 1,2,3,5 | |
| PCIe Phase Jitter, High Bandwidth ZDB Mode (SRIS Architecture) | t _{jphPCIeG1-SRIS} | PCIe Gen1 (2.5 GT/s) | - | 8.61 | 8.63 | N/A | ps (RMS) | 1,2,6 |
| | t _{jphPCIeG2-SRIS} | PCIe Gen2 (5.0 GT/s) | - | 0.88 | 0.96 | | ps (RMS) | 1,2,6 |
| | t _{jphPCIeG3-SRIS} | PCIe Gen3 (8.0 GT/s) | - | 0.354 | 0.375 | | ps (RMS) | 1,2,6 |
| | t _{jphPCIeG4-SRIS} | PCIe Gen4 (16.0 GT/s) | - | 0.271 | 0.305 | | ps (RMS) | 1,2,6 |
| | t _{jphPCIeG5-SRIS} | PCIe Gen5 (32.0 GT/s) | - | 0.097 | 0.109 | | ps (RMS) | 1,2,6 |

¹ The REFCLK jitter is measured after applying the filter functions found in PCI Express Base Specification 5.0, Revision 1.0. See the [Test Loads](#) section of the data sheet for the exact measurement setup. The worst case results for each data rate are summarized in this table. Equipment noise is removed from all results.

² Jitter measurements shall be made with a capture of at least 100,000 clock cycles captured by a real-time oscilloscope (RTO) with a sample rate of 20 GS/s or greater. Broadband oscilloscope noise must be minimized in the measurement. The measured PP jitter is used (no extrapolation) for RTO measurements. Alternately, jitter measurements may be used with a Phase Noise Analyzer (PNA) extending (flat) and integrating and folding the frequency content up to an offset from the carrier frequency of at least 200MHz (at 300MHz absolute frequency) below the Nyquist frequency. For PNA measurements for the 2.5 GT/s data rate, the RMS jitter is converted to peak to peak jitter using a multiplication factor of 8.83. In the case where real-time oscilloscope and PNA measurements have both been done and produce different results, the RTO result must be used.

³ SSC spurs from the fundamental and harmonics are removed up to a cutoff frequency of 2MHz taking care to minimize removal of any non-SSC content.

⁴ Note that 0.7ps RMS is to be used in channel simulations to account for additional noise in a real system.

⁵ Note that 0.25ps RMS is to be used in channel simulations to account for additional noise in a real system.

⁶ The PCI Express Base Specification 5.0, Revision 1.0 provides the filters necessary to calculate SRIS jitter values, however, it does not provide specification limits, hence the N/A in the "Limit" column. In general, a clock operating in an SRIS system must be twice as good as a clock operating in a Common Clock system. For RMS values, twice as good is equivalent to dividing the CC value by $\sqrt{2}$. An additional consideration is the value for which to divide by $\sqrt{2}$. The conservative approach is to divide the ref clock jitter limit, and the case can be made for dividing the channel simulation values by $\sqrt{2}$, if the ref clock is close to the Tx clock input. An example for Gen4 is as follows. A "rule-of-thumb" SRIS limit would be either $0.5\text{ps RMS}/\sqrt{2} = 0.35\text{ps RMS}$ if the clock chip is far from the clock input, or $0.7\text{ps RMS}/\sqrt{2} = 0.5\text{ps RMS}$ if the clock chip is near the clock input.

Table 13. Additive PCIe Phase Jitter for Fanout Buffer Mode

T_{AMB} = over the specified operating range. Supply voltages per normal operation conditions. See [Test Loads](#) for loading conditions.

| Parameter | Symbol | Conditions | Minimum | Typical | Maximum | Limit | Unit | Notes |
|--|-----------------------------|------------------------------|---------|---------|---------|-------|----------|---------|
| Additive PCIe Phase Jitter, Fanout Buffer Mode ⁷ (Common Clocked Architecture) | t _{jphPCIeG1-CC} | PCIe Gen1 (2.5 GT/s) | - | 1.3 | 1.9 | 86 | ps (p-p) | 1,2 |
| | t _{jphPCIeG2-CC} | PCIe Gen2 Hi Band (5.0 GT/s) | - | 0.089 | 0.126 | 3 | ps (RMS) | 1,2 |
| | | PCIe Gen2 Lo Band (5.0 GT/s) | - | 0.023 | 0.034 | 3.1 | ps (RMS) | 1,2 |
| | t _{jphPCIeG3-CC} | PCIe Gen3 (8.0 GT/s) | - | 0.044 | 0.062 | 1 | ps (RMS) | 1,2 |
| | t _{jphPCIeG4-CC} | PCIe Gen4 (16.0 GT/s) | - | 0.044 | 0.062 | 0.5 | ps (RMS) | 1,2,3,4 |
| | t _{jphPCIeG5-CC} | PCIe Gen5 (32.0 GT/s) | - | 0.017 | 0.024 | 0.15 | ps (RMS) | 1,2,3,5 |
| Additive PCIe Phase Jitter, Fanout Buffer Mode ⁷ (SRIS Architecture) | t _{jphPCIeG1-SRIS} | PCIe Gen1 (2.5 GT/s) | - | 0.127 | 0.181 | N/A | ps (RMS) | 1,2,6 |
| | t _{jphPCIeG2-SRIS} | PCIe Gen2 (5.0 GT/s) | - | 0.112 | 0.159 | | ps (RMS) | 1,2,6 |
| | t _{jphPCIeG3-SRIS} | PCIe Gen3 (8.0 GT/s) | - | 0.029 | 0.042 | | ps (RMS) | 1,2,6 |
| | t _{jphPCIeG4-SRIS} | PCIe Gen4 (16.0 GT/s) | - | 0.031 | 0.043 | | ps (RMS) | 1,2,6 |
| | t _{jphPCIeG5-SRIS} | PCIe Gen5 (32.0 GT/s) | - | 0.027 | 0.038 | | ps (RMS) | 1,2,6 |

¹ The REFCLK jitter is measured after applying the filter functions found in PCI Express Base Specification 5.0, Revision 1.0. See the [Test Loads](#) section of the data sheet for the exact measurement setup. The total Ref Clk jitter limits for each data rate are listed for convenience. The worst case results for each data rate are summarized in this table. If oscilloscope data is used, equipment noise is removed from all results.

² Jitter measurements shall be made with a capture of at least 100,000 clock cycles captured by a real-time oscilloscope (RTO) with a sample rate of 20 GS/s or greater. Broadband oscilloscope noise must be minimized in the measurement. The measured PP jitter is used (no extrapolation) for RTO measurements. Alternately, jitter measurements may be used with a Phase Noise Analyzer (PNA) extending (flat) and integrating and folding the frequency content up to an offset from the carrier frequency of at least 200MHz (at 300MHz absolute frequency) below the Nyquist frequency. For PNA measurements for the 2.5 GT/s data rate, the RMS jitter is converted to peak to peak jitter using a multiplication factor of 8.83. In the case where real-time oscilloscope and PNA measurements have both been done and produce different results, the RTO result must be used.

³ SSC spurs from the fundamental and harmonics are removed up to a cutoff frequency of 2MHz taking care to minimize removal of any non-SSC content.

⁴ Note that 0.7ps RMS is to be used in channel simulations to account for additional noise in a real system.

⁵ Note that 0.25ps RMS is to be used in channel simulations to account for additional noise in a real system.

⁶ The PCI Express Base Specification 5.0, Revision 1.0 provides the filters necessary to calculate SRIS jitter values, however, it does not provide specification limits, hence the N/A in the "Limit" column. In general, a clock operating in an SRIS system must be twice as good as a clock operating in a Common Clock system. For RMS values, twice as good is equivalent to dividing the CC value by $\sqrt{2}$. An additional consideration is the value for which to divide by $\sqrt{2}$. The conservative approach is to divide the ref clock jitter limit, and the case can be made for dividing the channel simulation values by $\sqrt{2}$, if the ref clock is close to the Tx clock input. An example for Gen4 is as follows. A "rule-of-thumb" SRIS limit would be either $0.5\text{ps RMS}/\sqrt{2} = 0.35\text{ps RMS}$ if the clock chip is far from the clock input, or $0.7\text{ps RMS}/\sqrt{2} = 0.5\text{ps RMS}$ if the clock chip is near the clock input.

⁷ Additive jitter for RMS values is calculated by solving for "b" where $b = \sqrt{(c^2 - a^2)}$ and where "a" is rms input jitter and "c" is rms output jitter.

Table 14. Filtered Phase Jitter Parameters – QPI/UPI, IF-UPI and DB2000Q

| Parameter | Symbol | Conditions | Minimum | Typical | Maximum | Specification Limit | Unit | Notes |
|---------------------------------------|-------------------|---|---------|---------|---------|---------------------|----------|-------|
| Phase Jitter, ZDB Mode | t_{jphQPI_UPI} | QPI and UPI (100MHz or 133MHz, 4.8Gb/s, 6.4Gb/s 12UI) | - | 0.16 | 0.37 | 0.5 | ps (rms) | 1,2 |
| | | QPI and UPI (100MHz, 8.0Gb/s, 12UI) | - | 0.10 | 0.15 | 0.3 | ps (rms) | 1,2 |
| | | QPI and UPI (100MHz, ≤ 11.4 Gb/s, 12UI) | - | 0.08 | 0.12 | 0.2 | ps (rms) | 1,2 |
| Additive Phase Jitter, Fanout Mode | t_{jphQPI_UPI} | QPI and UPI (100MHz or 133MHz, 4.8Gb/s, 6.4Gb/s 12UI) | - | 0.03 | 0.05 | N/A | ps (rms) | 1,2,3 |
| | | QPI and UPI (100MHz, 8.0Gb/s, 12UI) | - | 0.03 | 0.05 | | ps (rms) | 1,2,3 |
| | | QPI and UPI (100MHz, ≤ 11.4 Gb/s, 12UI) | - | 0.02 | 0.04 | | ps (rms) | 1,2,3 |
| | t_{jphIF_UPI} | IF-UPI, Fanout Mode | - | 0.06 | 0.07 | 1 | ps (rms) | 1,4 |
| | $t_{jphDB2000Q}$ | DB2000Q, Fanout Mode | - | 28 | 39 | 80 | fs (rms) | 1,4,5 |

¹ Applies to all differential outputs, guaranteed by design and characterization. See [Test Loads](#) for measurement setup details

² Calculated from Intel-supplied Clock Jitter Tool.

³ For RMS values, additive jitter is calculated by solving for “b” where $b = \sqrt{c^2 - a^2}$ and where “a” is rms input jitter and “c” is rms output jitter.

⁴ Calculated from phase noise analyzer with Intel-specified brick-wall filter applied. This is an additive jitter specification regardless of buffer operating mode.

⁵ The IF-UPI specification is an additive specification, regardless of the buffer operating mode. The enhanced 9ZXL devices meet this specification in all operating modes.

Table 15. Phase Jitter Parameters – 12kHz to 20MHz

| Parameter | Symbol | Conditions | Minimum | Typical | Maximum | Specification Limit | Unit | Notes |
|---|---------------------|--|---------|---------|---------|---------------------|----------|-------|
| 12k–20M Additive Phase Jitter, Fanout Buffer Mode | $t_{jph12k-20MFOB}$ | Fanout Buffer Mode, SSC OFF, 100MHz | - | 98 | 125 | N/A | fs (rms) | 1,2,3 |

¹ Applies to all differential outputs, guaranteed by design and characterization. See [Test Loads](#) for measurement setup details

² 12kHz to 20MHz brick wall filter.

³ For RMS values, additive jitter is calculated by solving for “b” where $b = \sqrt{c^2 - a^2}$ and where “a” is rms input jitter and “c” is rms output jitter.

Table 16. Skew and Differential Jitter Parameters

| Parameter | Symbol | Conditions | Minimum | Typical | Maximum | Unit | Notes |
|------------------------|-----------------|---|---------|---------|---------|----------|-----------|
| CLK_IN, DIF[x:0] | t_{SPO_PLL} | Input-to-output skew in PLL Mode at 100MHz, nominal temperature and voltage. | -100 | -21.3 | 100 | ps | 1,2,4,5,7 |
| CLK_IN, DIF[x:0] | t_{PD_BYP} | Input-to-output skew in Bypass Mode at 100MHz, nominal temperature and voltage. | 2 | 2.6 | 3 | ns | 1,2,3,5,7 |
| CLK_IN, DIF[x:0] | t_{DSPO_PLL} | Input-to-output skew variation in PLL Mode at 100MHz, across voltage and temperature. | -50 | 0.0 | 50 | ps | 1,2,3,5,7 |
| CLK_IN, DIF[x:0] | t_{DSPO_BYP} | Input-to-output skew variation in Bypass Mode at 100MHz, across voltage and temperature, $T_{AMB} = 0^{\circ}C$ to $+70^{\circ}C$. | -250 | - | 250 | ps | 1,2,3,5,7 |
| | | Input-to-Output Skew variation in Bypass mode at 100MHz, across voltage and temperature, $T_{AMB} = -40^{\circ}C$ to $+85^{\circ}C$. | -350 | - | 350 | ps | 1,2,3,5,7 |
| CLK_IN, DIF[x:0] | t_{DTE} | Random differential tracking error between two 9ZX devices in Hi BW Mode. | - | 3 | 5 | ps (rms) | 1,2,3,5,7 |
| CLK_IN, DIF[x:0] | t_{DSSTE} | Random differential spread spectrum tracking error between two 9ZX devices in Hi BW Mode. | - | 23 | 50 | ps | 1,2,3,5,7 |
| DIF[x:0] | t_{SKEW_ALL} | Output-to-output skew across all outputs, common to PLL and Bypass Mode, at 100MHz. | - | - | 50 | ps | 1,2,3,7 |
| PLL Jitter Peaking | $j_{peak-hibw}$ | LOBW#_BYPASS_HIBW = 1. | 0 | 1.3 | 2.5 | dB | 6.7 |
| PLL Jitter Peaking | $j_{peak-lobw}$ | LOBW#_BYPASS_HIBW = 0. | 0 | 1.3 | 2 | dB | 6.7 |
| PLL Bandwidth | p_{llHIBW} | LOBW#_BYPASS_HIBW = 1. | 2 | 2.6 | 4 | MHz | 7,8 |
| PLL Bandwidth | p_{llLOBW} | LOBW#_BYPASS_HIBW = 0. | 0.7 | 1.0 | 1.4 | MHz | 7,8 |
| Duty Cycle | t_{DC} | Measured differentially, PLL Mode. | 45 | 50.3 | 55 | % | 1 |
| Duty Cycle Distortion | t_{DCD} | Measured differentially, Bypass Mode at 100MHz. | -1 | 0 | 1 | % | 1,9 |
| Jitter, Cycle to Cycle | $t_{jyc-cyc}$ | PLL Mode. | - | 14 | 50 | ps | 1,10 |
| | | Additive jitter in Bypass Mode. | - | 0.1 | 5 | ps | 1,10 |

¹ Measured into fixed 2 pF load cap. Input to output skew is measured at the first output edge following the corresponding input.

² Measured from differential cross-point to differential cross-point. This parameter can be tuned with external feedback path, if present.

³ All Bypass Mode Input-to-Output specs refer to the timing between an input edge and the specific output edge created by it.

⁴ This parameter is deterministic for a given device.

⁵ Measured with scope averaging on to find mean value.

⁶ Measured as maximum pass band gain. At frequencies within the loop BW, highest point of magnification is called PLL jitter peaking.

⁷ Guaranteed by design and characterization, not 100% tested in production.

⁸ Measured at 3db down or half power point.

⁹ Duty cycle distortion is the difference in duty cycle between the output and the input clock when the device is operated in bypass mode.

¹⁰ Measured from differential waveform.

Power Management

Table 17. Power Management

| CKPWRGD_PD# | DIF_IN | SMBus EN bit | OE[x]# Pin | DIF[x] | PLL State (in ZDB Mode) |
|-------------|---------|--------------|------------|---------|-------------------------|
| 0 | X | X | X | Low/Low | OFF |
| 1 | Running | 0 | 0 | Low/Low | ON |
| | | 0 | 1 | Low/Low | ON |
| | | 1 | 0 | Running | ON |
| | | 1 | 1 | Low/Low | ON |

Table 18. Frequency Selection (PLL Mode)

| 100M_133M# | DIF_IN MHz | DIF[x] |
|------------|------------|--------|
| 1 | 100.00 | DIF_IN |
| 0 | 133.33 | DIF_IN |

Note: 9ZXL12x1 and 9ZXL08x1 only. 9ZXL06x1 and 9ZXL0451 are 100MHz only.

Table 19. PLL Operating Mode

| HiBW_BypM_LoBW# | Mode | PLL |
|-----------------|-----------|---------|
| Low | PLL Lo BW | Running |
| Mid | Bypass | Off |
| High | PLL Hi BW | Running |

Note: See SMBus Byte 0, bits 7 and 6 for additional information.

Test Loads

Figure 5. Test Load for AC/DC Measurements

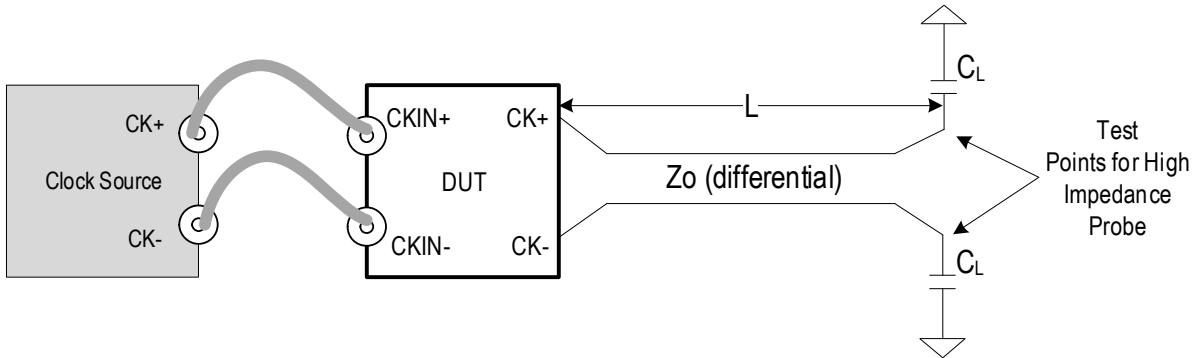


Table 20. Parameters for AC/DC Measurements

| Clock Source | Device Under Test (DUT) | Rs (Ω) | Differential Zo (Ω) | L (cm) | CL (pF) |
|--------------|-------------------------|-------------|---------------------|--------|---------|
| SMA100B | 9ZXLxx3x | 27 External | 85 | 25.4 | 2 |
| SMA100B | 9ZXLxx5x | Internal | 85 | 25.4 | 2 |

Figure 6. Test Load for Phase Jitter Measurements using Phase Noise Analyzer

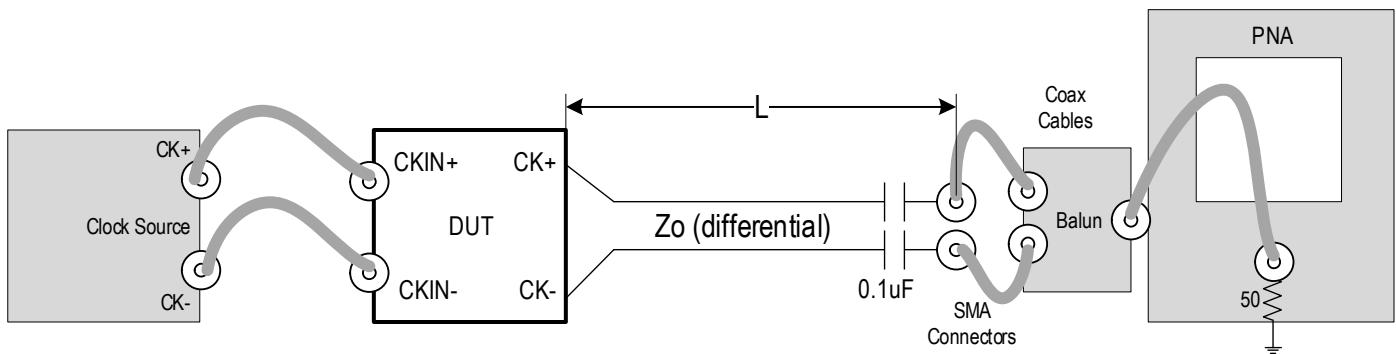


Table 21. Parameters for Phase Jitter Measurements using Phase Noise Analyzer

| Clock Source | Device Under Test (DUT) | Rs (Ω) | Differential Zo (Ω) | L (cm) | CL (pF) | Notes | Parameters Measured |
|--------------|-------------------------|-------------|---------------------|--------|---------|-------------|-----------------------|
| SMA100B | 9ZXLxx3x | 27 External | 85 | 25.4 | N/A | Fanout Mode | PCIe, IF-UPI, DB2000Q |
| 9FGV1006 | 9ZXLxx3x | 27 External | 85 | 25.4 | N/A | ZDB Mode | |
| SMA100B | 9ZXLxx5x | Internal | 85 | 25.4 | N/A | Fanout Mode | |
| 9FGV1006 | 9ZXLxx5x | Internal | 85 | 25.4 | N/A | ZDB Mode | |

Figure 7. Test Load for Phase Jitter Measurements using Oscilloscope

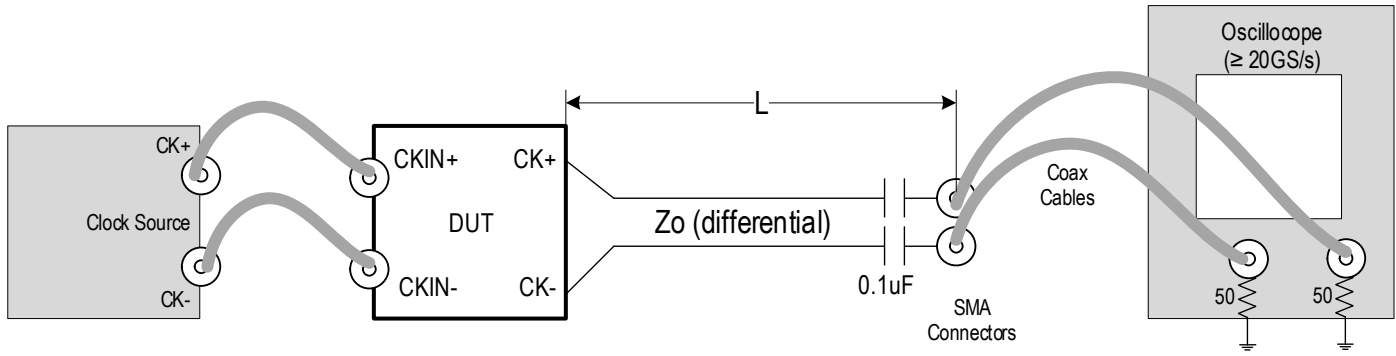


Table 22. Parameters for Phase Jitter Measurements using Oscilloscope

| Clock Source | Device Under Test (DUT) | Rs (Ω) | Differential Zo (Ω) | L (cm) | CL (pF) | Notes | Parameters Measured |
|--------------|-------------------------|-------------|---------------------|--------|---------|-------------|---------------------|
| SMA100B | 9ZXLxx3x | 27 External | 85 | 25.4 | N/A | Fanout Mode | QPI/UPI |
| 9FGV1006 | 9ZXLxx3x | 27 External | 85 | 25.4 | N/A | ZDB Mode | |
| SMA100B | 9ZXLxx5x | Internal | 85 | 25.4 | N/A | Fanout Mode | |
| 9FGV1006 | 9ZXLxx5x | Internal | 85 | 25.4 | N/A | ZDB Mode | |

General SMBus Serial Interface Information

How to Write

- Controller (host) sends a start bit
- Controller (host) sends the write address
- Renesas clock will **acknowledge**
- Controller (host) sends the beginning byte location = N
- Renesas clock will **acknowledge**
- Controller (host) sends the byte count = X
- Renesas clock will **acknowledge**
- Controller (host) starts sending Byte N through Byte N+X-1
- Renesas clock will **acknowledge** each byte **one at a time**
- Controller (host) sends a stop bit

| Index Block Write Operation | | |
|-----------------------------|-----------|--------------------------|
| Controller (Host) | | Renesas (Slave/Receiver) |
| T | starT bit | |
| Slave Address | | |
| WR | WRite | |
| | | ACK |
| Beginning Byte = N | | |
| | | ACK |
| Data Byte Count = X | | |
| | | ACK |
| Beginning Byte N | | |
| | | ACK |
| 0 | X Byte | 0 |
| 0 | | 0 |
| 0 | | 0 |
| | | 0 |
| Byte N + X - 1 | | |
| | | ACK |
| P | stoP bit | |

Note: Address is latched on SADR pin.

How to Read

- Controller (host) will send a start bit
- Controller (host) sends the write address
- Renesas clock will **acknowledge**
- Controller (host) sends the beginning byte location = N
- Renesas clock will **acknowledge**
- Controller (host) will send a separate start bit
- Controller (host) sends the read address
- Renesas clock will **acknowledge**
- Renesas clock will send the data byte count = X
- Renesas clock sends Byte N+X-1
- Renesas clock sends **Byte 0 through Byte X (if X_(H) was written to Byte 8)**
- Controller (host) will need to acknowledge each byte
- Controller (host) will send a not acknowledge bit
- Controller (host) will send a stop bit

| Index Block Read Operation | | |
|----------------------------|-----------------|---------------------|
| Controller (Host) | | Renesas |
| T | starT bit | |
| Slave Address | | |
| WR | WRite | |
| | | ACK |
| Beginning Byte = N | | |
| | | ACK |
| RT | Repeat starT | |
| Slave Address | | |
| RD | ReaD | |
| | | ACK |
| | | Data Byte Count = X |
| ACK | | |
| ACK | | Beginning Byte N |
| 0 | X Byte | 0 |
| 0 | | 0 |
| 0 | | 0 |
| 0 | | 0 |
| | | Byte N + X - 1 |
| N | Not acknowledge | |
| P | stoP bit | |

Table 23. SMBus Addresses

| Pin | | SMBus Address | | | |
|-----------|-----------|---------------|----------|----------|----------|
| SADR1_tri | SADR0_tri | 9ZXL12x1 | 9ZXL08x1 | 9ZXL06x1 | 9ZXL04x1 |
| 0 | 0 | D8 | D8 | D8 | D8 |
| 0 | M | DA | N/A | N/A | DA |
| 0 | 1 | DE | N/A | N/A | DE |
| M | 0 | C2 | N/A | N/A | N/A |
| M | M | C4 | N/A | N/A | N/A |
| M | 1 | C6 | N/A | N/A | N/A |
| 1 | 0 | CA | N/A | N/A | N/A |
| 1 | M | CC | N/A | N/A | N/A |
| 1 | 1 | CE | N/A | N/A | N/A |

Note: 9ZXL08x1 and 9ZXL06x1 do not have SMBus address select pins. Their address is D8.

Table 24. Byte 0: PLL Mode, and Frequency Select Register

| Byte 0 | Bit7 | Bit6 | Bit5 | Bit4 | Bit3 | Bit2 | Bit1 | Bit0 |
|-------------------------|-------------------------------|-------------------------------|----------|----------|-----------------------------------|----------------------|-----------------------------|---------------------------|
| Control Function | PLL Operating Mode Readback 1 | PLL Operating Mode Readback 0 | Reserved | Reserved | Enable software control of PLL BW | PLL Operating Mode 1 | PLL Operating Mode 0 | Frequency Select Readback |
| Type | R | R | | | RW | RW | RW | R |
| 0 | 00 = Low BW ZDB Mode | 01 = Bypass (Fanout Buffer) | | | HW Latch | 00 = Low BW ZDB Mode | 01 = Bypass (Fanout Buffer) | 133MHz |
| 1 | 10 = Reserved | 11 = High BW ZDB Mode | | | SMBus Control | 10 = Reserved | 11 = High BW ZDB Mode | 100MHz |
| Name | PLL Rdbk[1] | PLL Rdbk[0] | | | PLL_SW_EN | PLL Mode[1] | PLL Mode[0] | 100M_133M# |
| Default | Latch | Latch | 0 | 0 | 0 | 1 | 1 | Latch |

Note: Setting bit 3 to '1' allows the user to override the latch value from pin 5 via use of bits 2 and 1. A warm system reset is required if the user changes these bits. Bit 0 defaults to 1 on the 9ZXL0451 and 9ZXL06x1 devices.

Table 25. Byte 1: Output Control Register 1

| Byte 1 | Bit7 | Bit6 | Bit5 | Bit4 | Bit3 | Bit2 | Bit1 | Bit0 |
|------------------|-----------------|---------|---------|----------|----------|---------|----------|----------|
| Control Function | Output Enable | | | | | | | |
| Type | RW | | | | | | | |
| 0 | Low/Low | | | | | | | |
| 1 | OE# Pin Control | | | | | | | |
| 9ZXL12x1 Name | DIF7_en | DIF6_en | DIF5_en | DIF4_en | DIF3_en | DIF2_en | DIF1_en | DIF0_en |
| 9ZXL12x1 Default | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| 9ZXL08x1 Name | DIF5_en | DIF4_en | DIF3_en | DIF2_en | Reserved | DIF1_en | DIF0_en | Reserved |
| 9ZXL08x1 Default | 1 | 1 | 1 | 1 | 0 | 1 | 1 | 0 |
| 9ZXL06x1 Name | Reserved | DIF3_en | DIF2_en | Reserved | Reserved | DIF1_en | DIF0_en | Reserved |
| 9ZXL06x1 Default | 0 | 1 | 1 | 0 | 0 | 1 | 1 | 0 |
| 9ZXL0451 Name | Reserved | DIF2_en | DIF1_en | Reserved | Reserved | DIF0_en | Reserved | Reserved |
| 9ZXL0451 Default | 0 | 1 | 1 | 0 | 0 | 1 | 0 | 0 |

Table 26. Byte 2: Output Control Register 2

| Byte 2 | Bit7 | Bit6 | Bit5 | Bit4 | Bit3 | Bit2 | Bit1 | Bit0 |
|------------------|-----------------|----------|----------|----------|----------|----------|----------|----------|
| Control Function | Output_enable | | | | | | | |
| Type | RW | | | | | | | |
| 0 | Low/Low | | | | | | | |
| 1 | OE# Pin Control | | | | | | | |
| 9ZXL12x1 Name | Reserved | Reserved | Reserved | Reserved | DIF11_en | DIF10_en | DIF9_en | DIF8_en |
| 9ZXL12x1 Default | 0 | 0 | 0 | 0 | 1 | 1 | 1 | 1 |
| 9ZXL08x1 Name | Reserved | Reserved | Reserved | Reserved | Reserved | DIF7_en | Reserved | DIF6_en |
| 9ZXL08x1 Default | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 1 |
| 9ZXL06x1 Name | Reserved | Reserved | Reserved | Reserved | Reserved | DIF5_en | DIF4_en | Reserved |

Table 26. Byte 2: Output Control Register 2 (Cont.)

| Byte 2 | Bit7 | Bit6 | Bit5 | Bit4 | Bit3 | Bit2 | Bit1 | Bit0 |
|------------------|----------|----------|----------|----------|----------|----------|---------|----------|
| 9ZXL06x1 Default | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 0 |
| 9ZXL0451 Name | Reserved | Reserved | Reserved | Reserved | Reserved | Reserved | DIF3_en | Reserved |
| 9ZXL0451 Default | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 |

Bytes 3 and 4 are Reserved

Table 27. Byte 5: Revision and Vendor ID Register

| Byte 5 | Bit7 | Bit6 | Bit5 | Bit4 | Bit3 | Bit2 | Bit1 | Bit0 |
|------------------|--------------|------|------|------|--------------------|------|------|------|
| Control Function | Revision ID | | | | Vendor ID | | | |
| Type | R | R | R | R | R | R | R | R |
| 0 | E rev = 0010 | | | | 0001 = IDT/Renesas | | | |
| 1 | | | | | | | | |
| Name | RID3 | RID2 | RID1 | RID0 | VID3 | VID2 | VID1 | VID0 |
| Default | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 1 |

Table 28. Byte 6: Device ID Register

| Byte 6 | Bit7 | Bit6 | Bit5 | Bit4 | Bit3 | Bit2 | Bit1 | Bit0 |
|------------------|-----------|---------|---------|---------|---------|---------|---------|---------|
| Control Function | N/A | | | | | | | |
| Type | R | R | R | R | R | R | R | R |
| 0 | Device ID | | | | | | | |
| 1 | | | | | | | | |
| Name | DevID 7 | DevID 6 | DevID 5 | DevID 4 | DevID 3 | DevID 2 | DevID 1 | DevID 0 |
| 9ZXL1231E | 0hE7 | | | | | | | |
| 9ZXL1251E | 0hF7 | | | | | | | |
| 9ZXL0831E | 0hE5 | | | | | | | |
| 9ZXL0851E | 0hF5 | | | | | | | |
| 9ZXL0631E | 0hE3 | | | | | | | |
| 9ZXL0651E | 0hF3 | | | | | | | |
| 9ZXL0451E | 0hF3 | | | | | | | |

Table 29. Byte 7: Byte Count Register

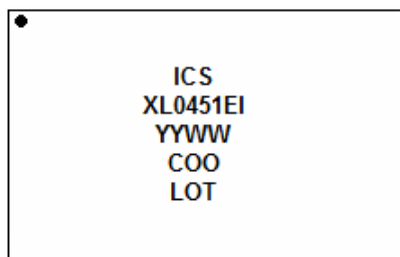
| Byte 7 | Bit7 | Bit6 | Bit5 | Bit4 | Bit3 | Bit2 | Bit1 | Bit0 |
|------------------|----------|----------|----------|---|------|------|------|------|
| Control Function | Reserved | Reserved | Reserved | Writing to this register configures how many bytes will be read back on a block read. | | | | |
| Type | | | | RW | RW | RW | RW | RW |
| 0 | | | | Default value is 8. | | | | |
| 1 | | | | | | | | |
| Name | | | | BC4 | BC3 | BC2 | BC1 | BC0 |
| Default | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 |

Package Outline Drawings

The package outline drawings are located at the end of this document and are accessible from the Renesas website (see [Ordering Information](#) for POD links). The package information is the most current data available and is subject to change without revision of this document.

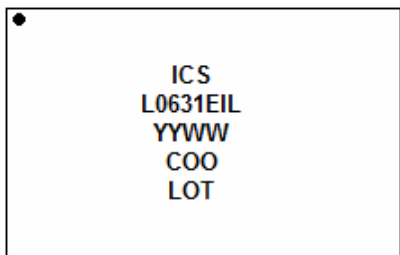
Marking Diagrams

9ZXL04x1

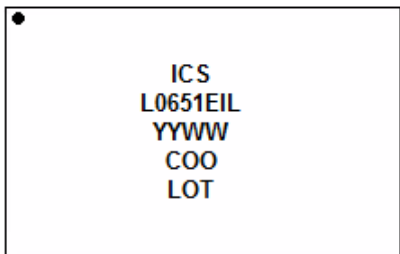


- Lines 1 and 2: truncated part number.
- Line 3: “YYWW” is the last two digits of the year and the work week the part was assembled.
- Line 4: “COO” denotes country of origin.
- Line 5: “LOT” denotes the lot number.

9ZXL06x1



- Lines 1 and 2: truncated part number
- Line 3: “YYWW” is the last two digits of the year and the work week the part was assembled.
- Line 4: “COO” denotes country of origin.
- Line 5: “LOT” denotes the lot number.



9ZXL08x1 (industrial temperature range)

•

```

ICS
XL0831EIL
YYWW
COO
LOT
    
```

- Lines 1 and 2: truncated part number
- Line 3: "YYWW" is the last two digits of the year and the work week the part was assembled.
- Line 4: "COO" denotes country of origin.
- Line 5: "LOT" denotes the lot number.

•

```

ICS
XL0851EIL
YYWW
COO
LOT
    
```

9ZXL08x1 (extended temperature range)

•

```

ICS
XL0831EK
YYWW
COO
LOT
    
```

- Lines 1 and 2: truncated part number ("K" denotes -40°C to +105°C)
- Line 3: "YYWW" is the last two digits of the year and the work week the part was assembled.
- Line 4: "COO" denotes country of origin.
- Line 5: "LOT" denotes the lot number.

•

```

ICS
XL0851EK
YYWW
COO
LOT
    
```

9ZXL12x1

•

```

ICS
9ZXL1231EIL
LOT
COO YYWW
    
```

- Lines 1 and 2: truncated part number
- Line 3: "LOT" denotes the lot number.
- Line 4: "COO" denotes country of origin; "YYWW" is the last two digits of the year and the work week the part was assembled.

•

```

ICS
9ZXL1251EIL
LOT
COO YYWW
    
```

Ordering Information

Table 30. Ordering Information

| Number of Clock Outputs | Output Impedance | Orderable Part Number | Temperature | Package | Part Number Suffix and Shipping Method |
|-------------------------|------------------|-----------------------|----------------|-----------------------|--|
| 4 | 85Ω | 9ZXL0451EKILF | -40° to +85°C | 5 × 5 mm 32-VFQFPN | None = Trays "T" = Tape and Reel, Pin 1 Orientation: EIA-481C (see Table 31 for more details) "W" = Tape and Reel, Pin 1 Orientation: EIA-481D (see Table 31 for more details) "-1K/W" = 1K Tape and Reel Quantity, Pin 1 Orientation: EIA-481D |
| | | 9ZXL0451EKILFT | | | |
| 6 | 33Ω | 9ZXL0631EKILF | -40° to +85°C | 5 × 5 mm 40-VFQFPN | |
| | | 9ZXL0631EKILFT | | | |
| | 85Ω | 9ZXL0651EKILF | | | |
| | | 9ZXL0651EKILFT | | | |
| 8 | 33Ω | 9ZXL0831EKILF | -40° to +85°C | 6 × 6 mm 48-VFQFPN | |
| | | 9ZXL0831EKILFT | -40° to +105°C | | |
| | | 9ZXL0831EKILF/W | | | |
| | | 9ZXL0831EKILFT/W | | | |
| | 85Ω | 9ZXL0851EKILF | -40° to +85°C | | |
| | | 9ZXL0851EKILFT | | | |
| | | 9ZXL0851EKILF/W | -40° to +105°C | | |
| | | 9ZXL0851EKILFT/W | | | |
| 12 | 33Ω | 9ZXL1231EKILF | -40° to +85°C | 9 × 9 mm 64-VFQFPN | |
| | | 9ZXL1231EKILF/W | | | |
| | | 9ZXL1231EKILF-1K/W | | | |
| | | 9ZXL1231EKILFT | | | |
| | 85Ω | 9ZXL1251EKILF | | | |
| | | 9ZXL1251EKILFT | | | |

"E" is the device revision designator (will not correlate with the datasheet revision).

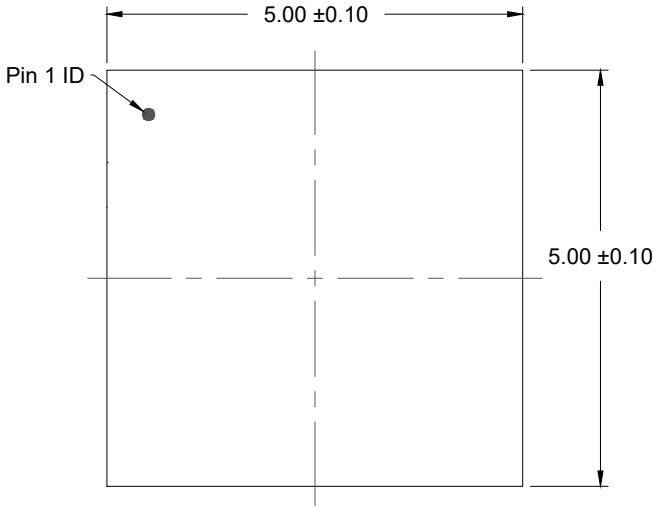
"LF" denotes Pb-free configuration, RoHS compliant; "T" or "W" is the orderable suffix for Tape and Reel packaging.

Table 31. Pin 1 Orientation in Tape and Reel Packaging

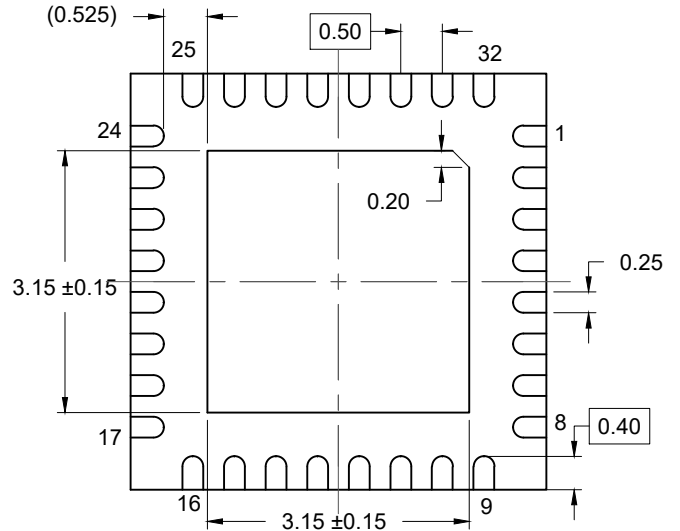
| Part Number Suffix | Pin 1 Orientation | Illustration |
|--------------------|------------------------|--------------|
| T | Quadrant 1 (EIA-481-C) | |
| /W | Quadrant 2 (EIA-481-D) | |

Revision History

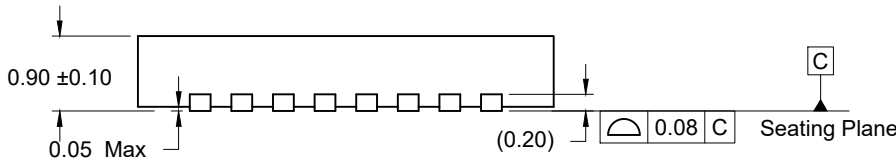
| Revision Date | Description of Change |
|-------------------|--|
| December 19, 2022 | Updated POD link for 40-VFQFPN package in Ordering Information . |
| October 12, 2022 | Added 9ZXL0851EKILF/W to Ordering Information . |
| September 9, 2022 | <ul style="list-style-type: none"> ▪ Deleted IF-UPI ZDB mode rows in Table 14. ▪ Moved <i>Skew and Differential Jitter Parameters</i> table to after <i>Phase Jitter Parameters – 12kHz to 20MHz</i> table. ▪ Updated Package Outline Drawings and Ordering Information sections. |
| March 1, 2022 | Fixed typo for unit in Key Specifications Fanout Buffer Mode section from '24s' to '24fs' and '40s' to '40fs'. |
| August 25, 2020 | Updated PCIe Gen5 CC, DB2000Q, and QPI/UPI specifications in <i>Key Specifications</i> section on front page. |
| February 13, 2020 | Updated Byte 1, bit7 and bit5 for 9ZXL0451 default. |
| January 31, 2020 | Typo correction - swapped VMIN and VMAX symbol designators in LP-HCSL Outputs table. |
| October 22, 2019 | Combined 9ZXL04x1E, 9ZXL06x1E, 9ZXL08x1E, and 9ZXL12x1E datasheets into a single document. |
| April 4, 2019 | Last revision date of the 9ZXL0451E datasheet. |
| November 30, 2018 | Last revision date of the 9ZXL0631E_0651E datasheet. |
| November 30, 2018 | Last revision date of the 9ZXL0831E_0851E datasheet. |
| November 30, 2018 | Last revision date of the 9ZXL1231E_1251E datasheet. |



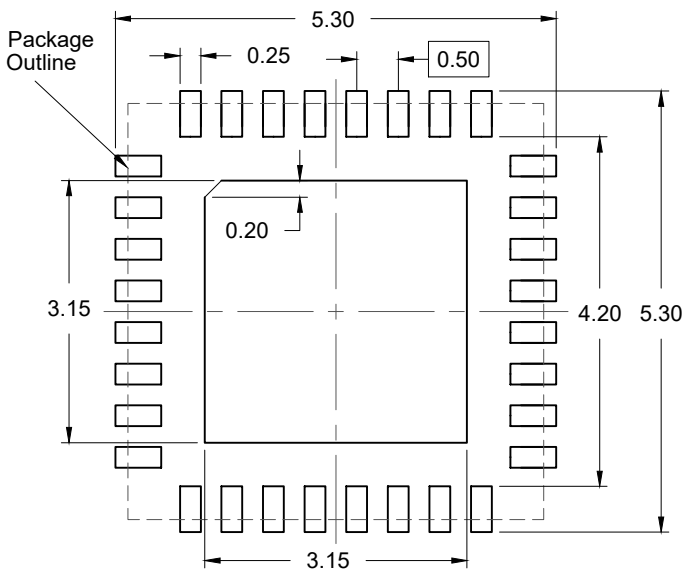
TOP VIEW



BOTTOM VIEW



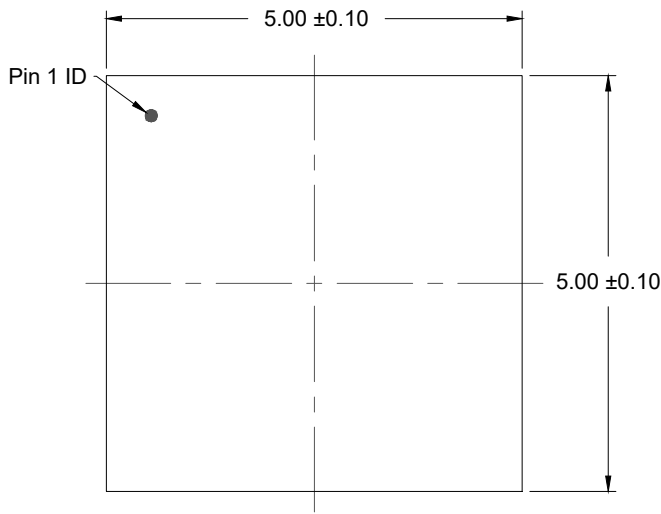
SIDE VIEW



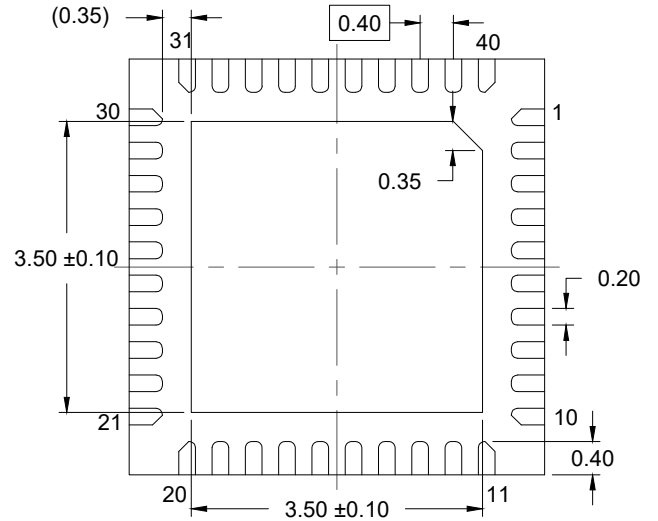
RECOMMENDED LAND PATTERN
(PCB Top View, NSMD Design)

NOTES:

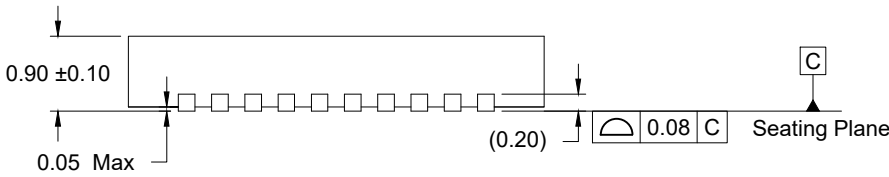
1. JEDEC compatible.
2. All dimensions are in mm and angles are in degrees.
3. Use ± 0.05 mm for the non-toleranced dimensions.
4. Numbers in () are for references only.



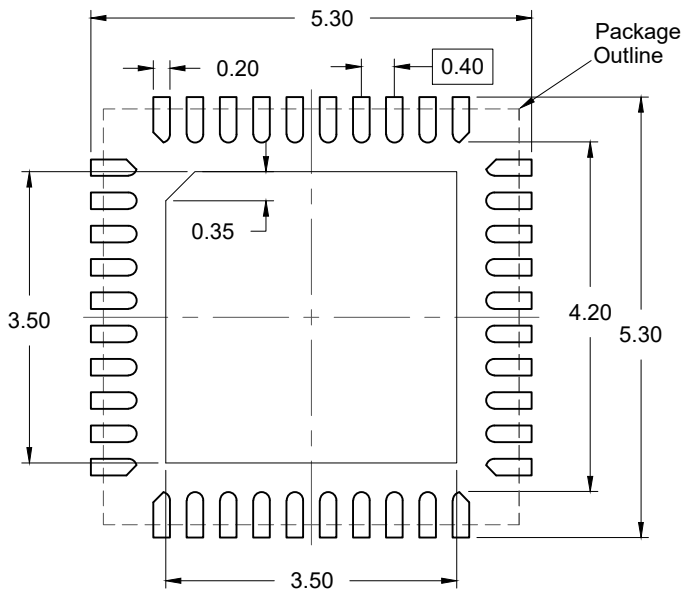
TOP VIEW



BOTTOM VIEW



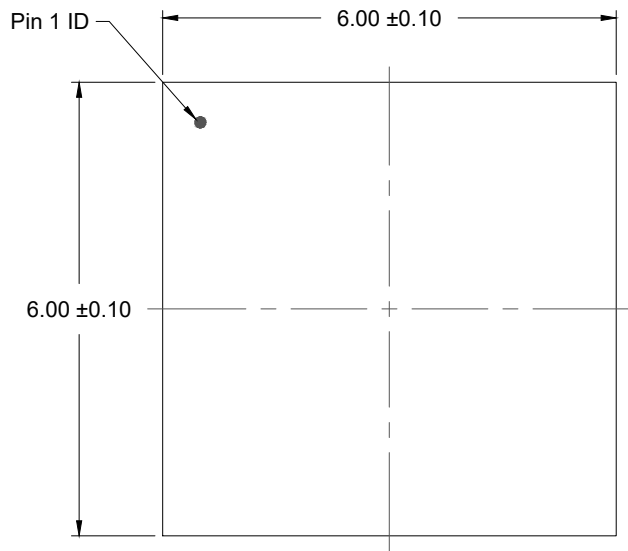
SIDE VIEW



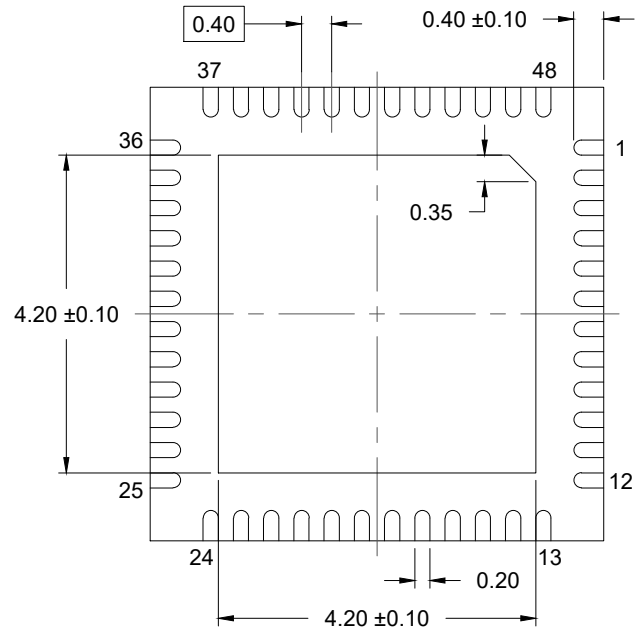
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(PCB Top View, NSMD Design)

NOTES:

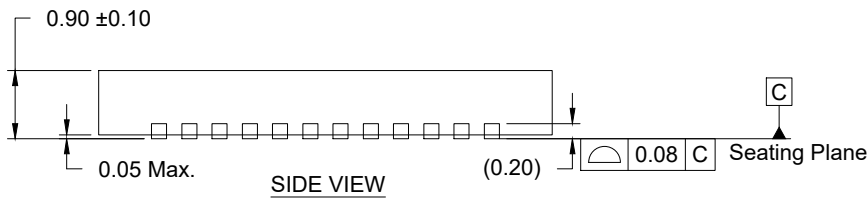
1. JEDEC compatible.
2. All dimensions are in mm and angles are in degrees.
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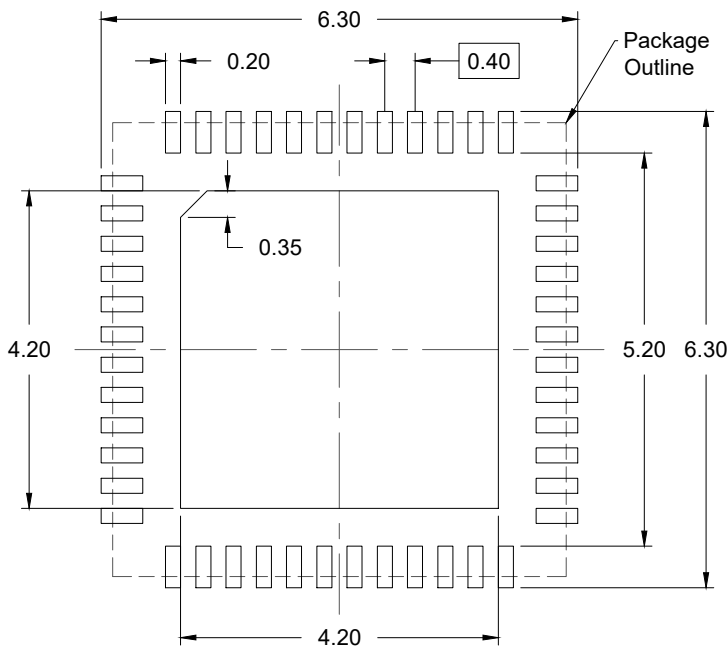
TOP VIEW



BOTTOM VIEW



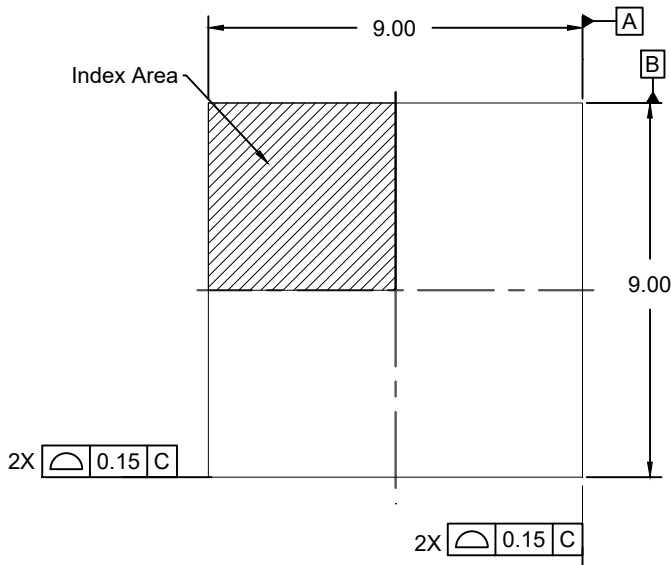
SIDE VIEW



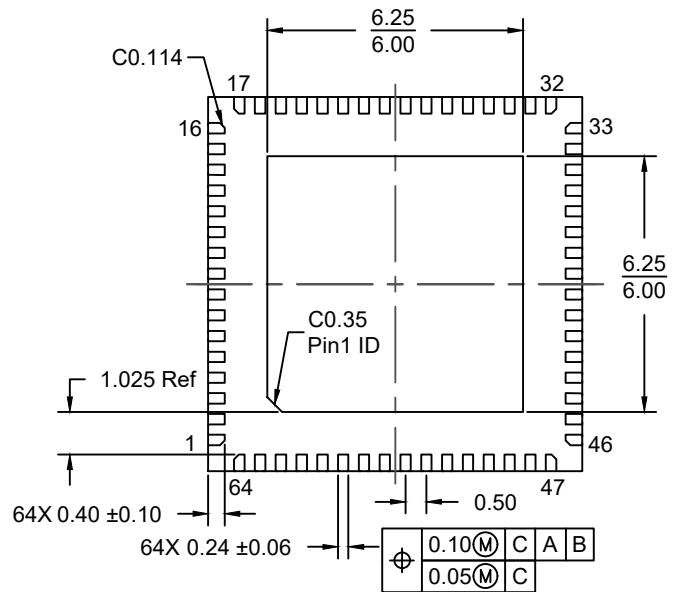
RECOMMENDED LAND PATTERN
(PCB Top View, NSMD Design)

NOTES:

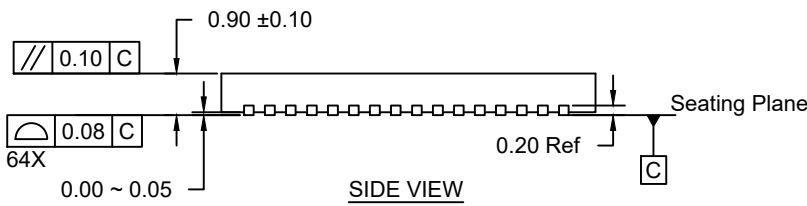
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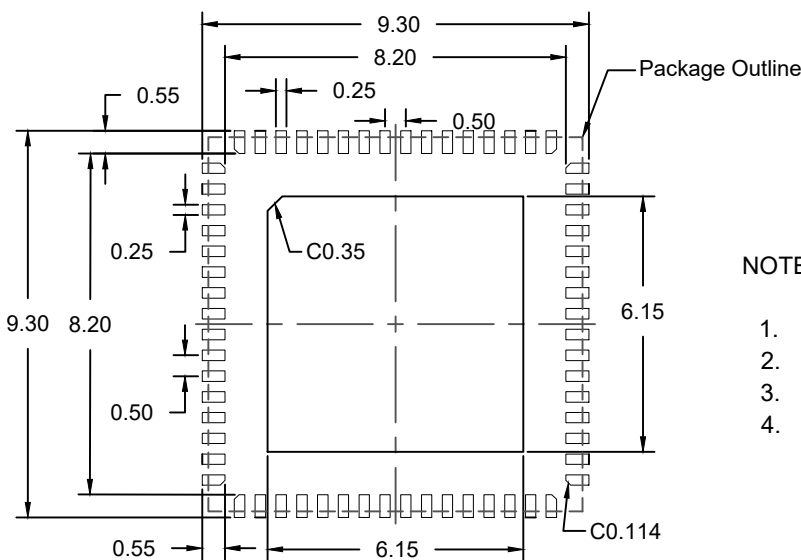
TOP VIEW



BOTTOM VIEW



SIDE VIEW



RECOMMENDED LAND PATTERN
(PCB Top View, NSMD Design)

NOTES:

1. JEDEC compatible.
2. All dimensions are in mm and angles are in degrees.
3. Use ± 0.05 mm for the non-toleranced dimensions.
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[9ZXL0451EKILFT](#) [9ZXL0851EKILF/W](#)