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# 19-Output Differential Zbuffer for PCIe Gen2/3 and QPI

## 9ZX21901C

## Description

The 9ZX21901 is Intel DB1900Z Differential Buffer suitable for PCI-Express Gen3 or QPI applications. The part is backwards compatible to PCIe Gen1 and Gen2. A fixed external feedback maintains low drift for critical QPI applications. In bypass mode, the 9ZX21901 can provide outputs up to 400MHz.

## Recommended Application

19 output PCIe Gen3/QPI buffer with fixed feedback for Romley platforms

## Output Features

- 19 - 0.7V current mode differential HCSL output pairs

## Features/Benefits

- Fixed feedback path/ 0ps input-to-output delay
- 9 Selectable SMBus addresses/ Multiple devices can share same SMBus segment
- 8 dedicated OE# pins/ hardware control of outputs
- PLL or bypass mode/ PLL can dejitter incoming clock
- Selectable PLL BW/ minimizes jitter peaking in downstream PLL's
- Spread spectrum compatible/tracks spreading input clock for EMI reduction
- SMBus Interface/ unused outputs can be disabled
- 100MHz & 133.33MHz PLL mode/ Legacy QPI support
- Undriven differential outputs in Power Down mode for maximum power savings
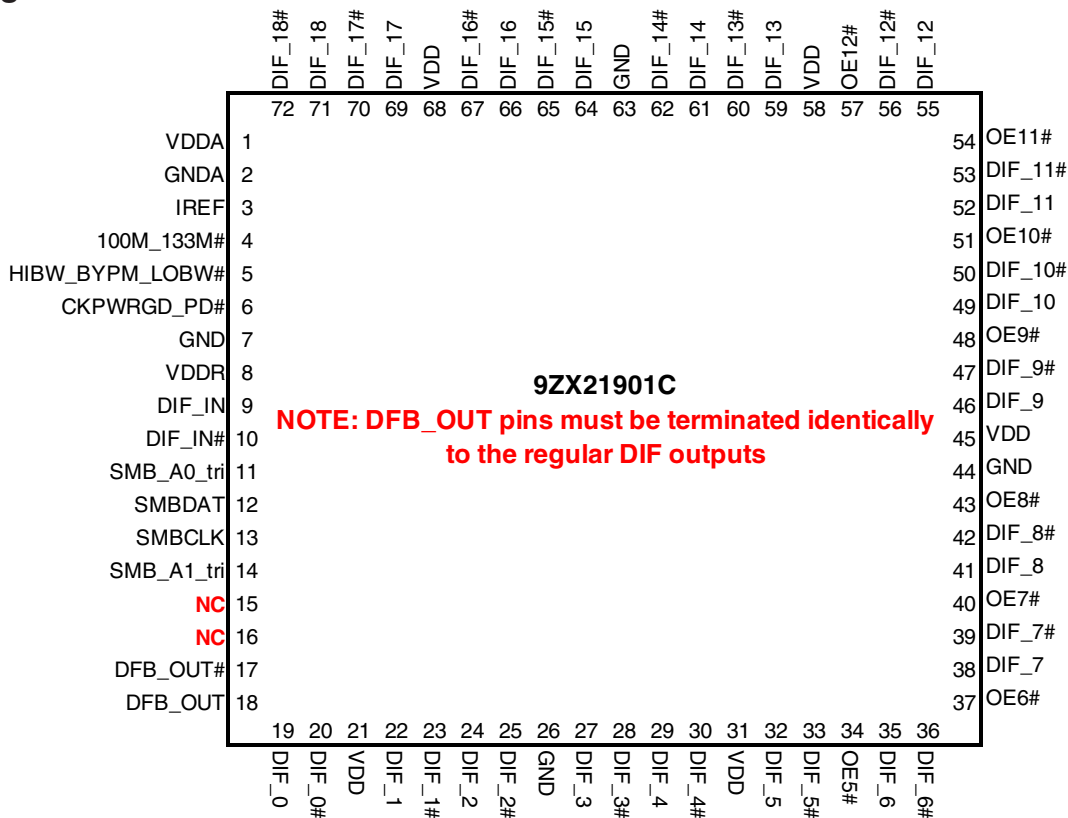
## Key Specifications

- Cycle-to-cycle jitter: < 50ps
- Output-to-output skew: <65ps
- Input-to-output delay: Fixed at 0 ps
- Input-to-output delay variation: <50ps
- Phase jitter: PCIe Gen3 < 1ps rms
- Phase jitter: QPI 9.6GB/s < 0.2ps rms

## Functional Block Diagram
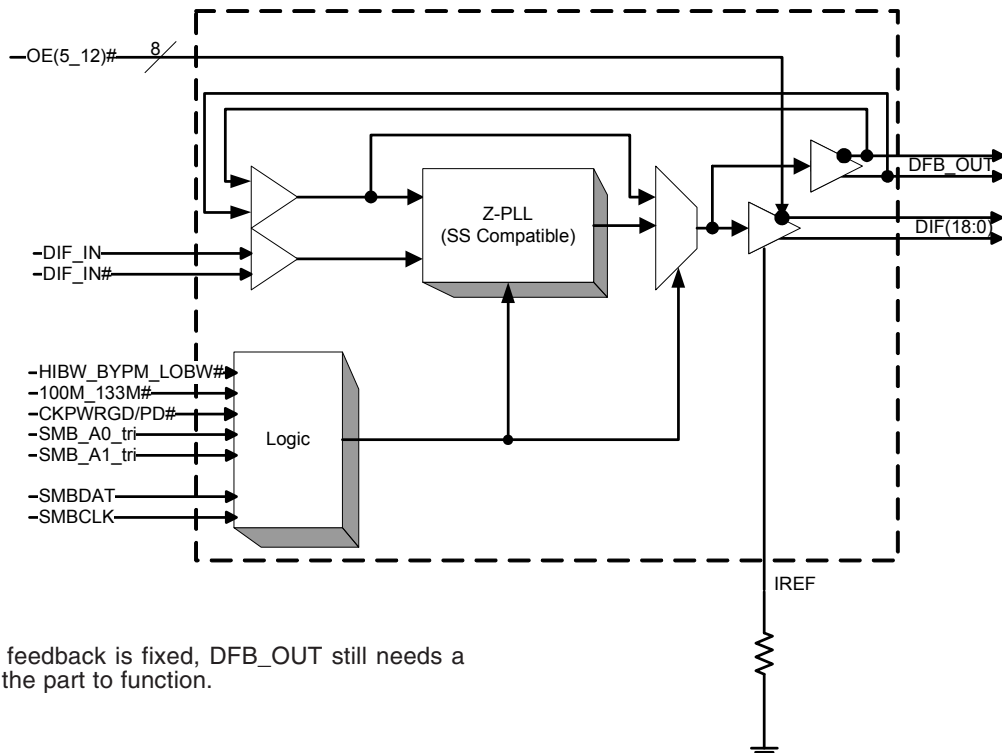


**Note:** Even though the feedback is fixed, DFB_OUT still needs a termination network for the part to function.

## Pin Configuration



**9ZX21901C**

**NOTE: DFB_OUT pins must be terminated identically to the regular DIF outputs**

Left side pins (top to bottom):
- 1 VDDA
- 2 GNDA
- 3 IREF
- 4 100M_133M#
- 5 HIBW_BYPM_LOBW#
- 6 CKPWRGD_PD#
- 7 GND
- 8 VDDR
- 9 DIF_IN
- 10 DIF_IN#
- 11 SMB_A0_tri
- 12 SMBDAT
- 13 SMBCLK
- 14 SMB_A1_tri
- 15 NC
- 16 NC
- 17 DFB_OUT#
- 18 DFB_OUT

Right side pins (top to bottom):
- 54 OE11#
- 53 DIF_11#
- 52 DIF_11
- 51 OE10#
- 50 DIF_10#
- 49 DIF_10
- 48 OE9#
- 47 DIF_9#
- 46 DIF_9
- 45 VDD
- 44 GND
- 43 OE8#
- 42 DIF_8#
- 41 DIF_8
- 40 OE7#
- 39 DIF_7#
- 38 DIF_7
- 37 OE6#

Top pins (left to right, 72–55): DIF_18#, DIF_18, DIF_17#, DIF_17, VDD, DIF_16#, DIF_16, DIF_15#, DIF_15, GND, DIF_14#, DIF_14, DIF_13#, DIF_13, VDD, OE12#, DIF_12#, DIF_12

Bottom pins (left to right, 19–36): DIF_0, DIF_0#, VDD, DIF_1, DIF_1#, DIF_2, DIF_2#, GND, DIF_3, DIF_3#, DIF_4, DIF_4#, VDD, DIF_5, DIF_5#, OE5#, DIF_6, DIF_6#

**72-pin MLF**

### Functionality at Power Up (PLL Mode)

| 100M_133M# | DIF_IN (MHz) | DIF (MHz) |
|---|---|---|
| 1 | 100.00 | DIF_IN |
| 0 | 133.33 | DIF_IN |

### PLL Operating Mode Readback Table

| HiBW_BypM_LoBW# | Byte0, bit 7 | Byte 0, bit 6 |
|---|---|---|
| Low (Low BW) | 0 | 0 |
| Mid (Bypass) | 0 | 1 |
| High (High BW) | 1 | 1 |

### PLL Operating Mode

| HiBW_BypM_LoBW# | MODE |
|---|---|
| Low | PLL Lo BW |
| Mid | Bypass |
| High | PLL Hi BW |

**NOTE: PLL is OFF in Bypass Mode**

### Tri-level Input Thresholds

| Level | Voltage |
|---|---|
| Low | <0.8V |
| Mid | 1.2<Vin<1.8V |
| High | Vin > 2.2V |

### Power Connections

| Pin Number | | Description |
|---|---|---|
| VDD | GND | |
| 1 | 2 | Analog PLL |
| 8 | 7 | Analog Input |
| 21, 31, 45, 58, 68 | 26, 44, 63 | DIF clocks |

### 9ZX21901 SMBus Addressing

| Pin | | SMBus Address |
|---|---|---|
| SMB_A1_tri | SMB_A0_tri | (Rd/Wrt bit = 0) |
| 0 | 0 | D8 |
| 0 | M | DA |
| 0 | 1 | DE |
| M | 0 | C2 |
| M | M | C4 |
| M | 1 | C6 |
| 1 | 0 | CA |
| 1 | M | CC |
| 1 | 1 | CE |

## Pin Description

| PIN # | PIN NAME | PIN TYPE | DESCRIPTION |
|---|---|---|---|
| 1 | VDDA | PWR | 3.3V power for the PLL core. |
| 2 | GNDA | PWR | Ground pin for the PLL core. |
| 3 | IREF | OUT | This pin establishes the reference for the differential current-mode output pairs. It requires a fixed precision resistor to ground. 475ohm is the standard value for 100ohm differential impedance. Other impedances require different values. See data sheet. |
| 4 | 100M_133M# | IN | Input to select operating frequency<br>1 = 100MHz, 0 = 133.33MHz |
| 5 | HIBW_BYPM_LOBW# | IN | Trilevel input to select High BW, Bypass or Low BW mode.<br>See PLL Operating Mode Table for Details. |
| 6 | CKPWRGD_PD# | IN | Notifies device to sample latched inputs and start up on first high assertion, or exit Power Down Mode on subsequent assertions. Low enters Power Down Mode. |
| 7 | GND | PWR | Ground pin. |
| 8 | VDDR | PWR | 3.3V power for differential input clock (receiver). This VDD should be treated as an analog power rail and filtered appropriately. |
| 9 | DIF_IN | IN | 0.7 V Differential TRUE input |
| 10 | DIF_IN# | IN | 0.7 V Differential Complementary Input |
| 11 | SMB_A0_tri | IN | SMBus address bit. This is a tri-level input that works in conjunction with the SMB_A1 to decode 1 of 9 SMBus Addresses. |
| 12 | SMBDAT | I/O | Data pin of SMBUS circuitry, 5V tolerant |
| 13 | SMBCLK | IN | Clock pin of SMBUS circuitry, 5V tolerant |
| 14 | SMB_A1_tri | IN | SMBus address bit. This is a tri-level input that works in conjunction with the SMB_A0 to decode 1 of 9 SMBus Addresses. |
| 15 | NC | N/A | No Connection. |
| 16 | NC | N/A | No Connection. |
| 17 | DFB_OUT# | OUT | Complementary half of differential feedback output, provides feedback signal to the PLL for synchronization with input clock to eliminate phase error. |
| 18 | DFB_OUT | OUT | True half of differential feedback output, provides feedback signal to the PLL for synchronization with the input clock to eliminate phase error. |
| 19 | DIF_0 | OUT | 0.7V differential true clock output |
| 20 | DIF_0# | OUT | 0.7V differential Complementary clock output |
| 21 | VDD | PWR | Power supply, nominal 3.3V |
| 22 | DIF_1 | OUT | 0.7V differential true clock output |
| 23 | DIF_1# | OUT | 0.7V differential Complementary clock output |
| 24 | DIF_2 | OUT | 0.7V differential true clock output |
| 25 | DIF_2# | OUT | 0.7V differential Complementary clock output |
| 26 | GND | PWR | Ground pin. |
| 27 | DIF_3 | OUT | 0.7V differential true clock output |
| 28 | DIF_3# | OUT | 0.7V differential Complementary clock output |
| 29 | DIF_4 | OUT | 0.7V differential true clock output |
| 30 | DIF_4# | OUT | 0.7V differential Complementary clock output |
| 31 | VDD | PWR | Power supply, nominal 3.3V |
| 32 | DIF_5 | OUT | 0.7V differential true clock output |
| 33 | DIF_5# | OUT | 0.7V differential Complementary clock output |
| 34 | OE5# | IN | Active low input for enabling DIF pair 5.<br>1 =disable outputs, 0 = enable outputs |
| 35 | DIF_6 | OUT | 0.7V differential true clock output |
| 36 | DIF_6# | OUT | 0.7V differential Complementary clock output |

## Pin Description (continued)

| PIN # | PIN NAME | PIN TYPE | DESCRIPTION |
|-------|----------|----------|-------------|
| 37 | OE6# | IN | Active low input for enabling DIF pair 6.<br>1 =disable outputs,  0 = enable outputs |
| 38 | DIF_7 | OUT | 0.7V differential true clock output |
| 39 | DIF_7# | OUT | 0.7V differential Complementary clock output |
| 40 | OE7# | IN | Active low input for enabling DIF pair 7.<br>1 =disable outputs,  0 = enable outputs |
| 41 | DIF_8 | OUT | 0.7V differential true clock output |
| 42 | DIF_8# | OUT | 0.7V differential Complementary clock output |
| 43 | OE8# | IN | Active low input for enabling DIF pair 8.<br>1 =disable outputs,  0 = enable outputs |
| 44 | GND | PWR | Ground pin. |
| 45 | VDD | PWR | Power supply, nominal 3.3V |
| 46 | DIF_9 | OUT | 0.7V differential true clock output |
| 47 | DIF_9# | OUT | 0.7V differential Complementary clock output |
| 48 | OE9# | IN | Active low input for enabling DIF pair 9.<br>1 =disable outputs,  0 = enable outputs |
| 49 | DIF_10 | OUT | 0.7V differential true clock output |
| 50 | DIF_10# | OUT | 0.7V differential Complementary clock output |
| 51 | OE10# | IN | Active low input for enabling DIF pair 10.<br>1 =disable outputs,  0 = enable outputs |
| 52 | DIF_11 | OUT | 0.7V differential true clock output |
| 53 | DIF_11# | OUT | 0.7V differential Complementary clock output |
| 54 | OE11# | IN | Active low input for enabling DIF pair 11.<br>1 =disable outputs,  0 = enable outputs |
| 55 | DIF_12 | OUT | 0.7V differential true clock output |
| 56 | DIF_12# | OUT | 0.7V differential Complementary clock output |
| 57 | OE12# | IN | Active low input for enabling DIF pair 12.<br>1 =disable outputs,  0 = enable outputs |
| 58 | VDD | PWR | Power supply, nominal 3.3V |
| 59 | DIF_13 | OUT | 0.7V differential true clock output |
| 60 | DIF_13# | OUT | 0.7V differential Complementary clock output |
| 61 | DIF_14 | OUT | 0.7V differential true clock output |
| 62 | DIF_14# | OUT | 0.7V differential Complementary clock output |
| 63 | GND | PWR | Ground pin. |
| 64 | DIF_15 | OUT | 0.7V differential true clock output |
| 65 | DIF_15# | OUT | 0.7V differential Complementary clock output |
| 66 | DIF_16 | OUT | 0.7V differential true clock output |
| 67 | DIF_16# | OUT | 0.7V differential Complementary clock output |
| 68 | VDD | PWR | Power supply, nominal 3.3V |
| 69 | DIF_17 | OUT | 0.7V differential true clock output |
| 70 | DIF_17# | OUT | 0.7V differential Complementary clock output |
| 71 | DIF_18 | OUT | 0.7V differential true clock output |
| 72 | DIF_18# | OUT | 0.7V differential Complementary clock output |

## Electrical Characteristics - Absolute Maximum Ratings

| PARAMETER | SYMBOL | CONDITIONS | MIN | TYP | MAX | UNITS | NOTES |
|---|---|---|---|---|---|---|---|
| 3.3V Core Supply Voltage | VDDA | | | | 4.6 | V | 1,2 |
| 3.3V Logic Supply Voltage | VDD | | | | 4.6 | V | 1,2 |
| Input Low Voltage | $V_{IL}$ | | GND-0.5 | | | V | 1 |
| Input High Voltage | $V_{IH}$ | Except for SMBus interface | | | $V_{DD}$+0.5V | V | 1 |
| Input High Voltage | $V_{IHSMB}$ | SMBus clock and data pins | | | 5.5V | V | 1 |
| Storage Temperature | Ts | | -65 | | 150 | °C | 1 |
| Junction Temperature | Tj | | | | 125 | °C | 1 |
| Case Temperature | Tc | | | | 110 | °C | 1 |
| Input ESD protection | ESD prot | Human Body Model | 2000 | | | V | 1 |

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

[2] Operation under these conditions is neither implied nor guaranteed.

## Electrical Characteristics - Input/Supply/Common Parameters

TA = $T_{COM;}$ Supply Voltage VDD/VDDA = 3.3 V +/-5%, See Test Loads for Loading Conditions

| PARAMETER | SYMBOL | CONDITIONS | MIN | TYP | MAX | UNITS | NOTES |
|---|---|---|---|---|---|---|---|
| Ambient Operating Temperature | $T_{COM}$ | Commmercial range | 0 | | 70 | °C | 1 |
| Input High Voltage | $V_{IH}$ | Single-ended inputs, except SMBus, low threshold and tri-level inputs | 2 | | $V_{DD}$ + 0.3 | V | 1 |
| Input Low Voltage | $V_{IL}$ | Single-ended inputs, except SMBus, low threshold and tri-level inputs | GND - 0.3 | | 0.8 | V | 1 |
| Input Current | $I_{IN}$ | Single-ended inputs, $V_{IN}$ = GND, $V_{IN}$ = VDD | -5 | | 5 | uA | 1 |
| | $I_{INP}$ | Single-ended inputs $V_{IN}$ = 0 V; Inputs with internal pull-up resistors $V_{IN}$ = VDD; Inputs with internal pull-down resistors | -200 | | 200 | uA | 1 |
| Input Frequency | $F_{ibyp}$ | $V_{DD}$ = 3.3 V, Bypass mode | 33 | | 400 | MHz | 2 |
| | $F_{ipll}$ | $V_{DD}$ = 3.3 V, 100MHz PLL mode | 90 | 100.00 | 105 | MHz | 2 |
| | $F_{ipll}$ | $V_{DD}$ = 3.3 V, 133.33MHz PLL mode | 120 | 133.33 | 140 | MHz | 2 |
| 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 | | | 1.8 | ms | 1,2 |
| Input SS Modulation Frequency | $f_{MODIN}$ | Allowable Frequency (Triangular Modulation) | 30 | | 33 | kHz | 1 |
| OE# Latency | $t_{LATOE\#}$ | DIF start after OE# assertion DIF stop after OE# deassertion | 1 | | 3 | cycles | 1,3 |
| Tdrive_PD# | $t_{DRVPD}$ | DIF output enable after PD# de-assertion | | | 300 | us | 1,3 |
| Tfall | $t_F$ | Fall time of control inputs | | | 5 | ns | 1,2 |
| Trise | $t_R$ | Rise time of control inputs | | | 5 | ns | 1,2 |
| SMBus Input Low Voltage | $V_{ILSMB}$ | | | | 0.8 | V | 1 |
| SMBus Input High Voltage | $V_{IHSMB}$ | | 2.1 | | $V_{DDSMB}$ | V | 1 |
| SMBus Output Low Voltage | $V_{OLSMB}$ | @ $I_{PULLUP}$ | | | 0.4 | V | 1 |
| SMBus Sink Current | $I_{PULLUP}$ | @ $V_{OL}$ | 4 | | | mA | 1 |
| Nominal Bus Voltage | $V_{DDSMB}$ | 3V to 5V +/- 10% | 2.7 | | 5.5 | V | 1 |
| SCLK/SDATA Rise Time | $t_{RSMB}$ | (Max VIL - 0.15) to (Min VIH + 0.15) | | | 1000 | ns | 1 |
| SCLK/SDATA Fall Time | $t_{FSMB}$ | (Min VIH + 0.15) to (Max VIL - 0.15) | | | 300 | ns | 1 |
| SMBus Operating Frequency | $f_{MAXSMB}$ | Maximum SMBus operating frequency | | | 100 | kHz | 1,5 |

[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 >200 mV

[4] DIF_IN input

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

## Electrical Characteristics - Clock Input Parameters

TA = T$_{COM}$; Supply Voltage VDD/VDDA = 3.3 V +/-5%, See Test Loads for Loading Conditions

| PARAMETER | SYMBOL | CONDITIONS | MIN | TYP | MAX | UNITS | NOTES |
|---|---|---|---|---|---|---|---|
| Input High Voltage - DIF_IN | V$_{IHDIF}$ | Differential inputs (single-ended measurement) | 600 | 750 | 1150 | mV | 1 |
| Input Low Voltage - DIF_IN | V$_{ILDIF}$ | Differential inputs (single-ended measurement) | V$_{SS}$ - 300 | 0 | 300 | mV | 1 |
| Input Common Mode Voltage - DIF_IN | V$_{COM}$ | Common Mode Input Voltage | 300 | | 1000 | mV | 1 |
| Input Amplitude - DIF_IN | V$_{SWING}$ | Peak to Peak value | 300 | | 1450 | 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 | uA | 1 |
| Input Duty Cycle | d$_{tin}$ | Measurement from differential wavefrom | 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

## Electrical Characteristics - DIF 0.7V Current Mode Differential Outputs

TA = T$_{COM}$; Supply Voltage VDD/VDDA = 3.3 V +/-5%, See Test Loads for Loading Conditions

| PARAMETER | SYMBOL | CONDITIONS | MIN | TYP | MAX | UNITS | NOTES |
|---|---|---|---|---|---|---|---|
| Slew rate | dV/dt | Scope averaging on | 1 | 2.5 | 4 | V/ns | 1, 2, 3 |
| Slew rate matching | ΔdV/dt | Slew rate matching, Scope averaging on | | | 20 | % | 1, 2, 4 |
| Rise/Fall Time Matching | Trf | Rise/fall matching, Scope averaging off | | | 125 | ps | 1, 7, 8 |
| Voltage High | VHigh | Statistical measurement on single-ended signal using oscilloscope math function. (Scope averaging on) | 660 | 750 | 850 | mV | 1 |
| Voltage Low | VLow | | -150 | | 150 | mV | 1 |
| Max Voltage | Vmax | Measurement on single ended signal using absolute value. (Scope averaging off) | | | 1150 | mV | 1 |
| Min Voltage | Vmin | | -300 | | | mV | 1 |
| Vswing | Vswing | Scope averaging off | 300 | | | mV | 1, 2 |
| Crossing Voltage (abs) | Vcross_abs | Scope averaging off | 250 | | 550 | mV | 1, 5 |
| Crossing Voltage (var) | Δ-Vcross | Scope averaging off | | | 140 | mV | 1, 6 |

[1] Guaranteed by design and characterization, not 100% tested in production. IREF = VDD/(3xR$_R$). For R$_R$ = 475Ω (1%), I$_{REF}$ = 2.32mA. I$_{OH}$ = 6 x I$_{REF}$ and V$_{OH}$ = 0.7V @ Z$_O$=50Ω (100Ω differential impedance).

[2] Measured from differential waveform

[3] Slew rate is measured through the Vswing voltage range centered around differential 0V. This results in a +/-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 +/-75mV 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] Vcross 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 Vcross 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 Vcross induced modulation by setting V_cross_delta to be smaller than V_cross absolute.

[7] Measured from single-ended waveform

[8] Measured with scope averaging off, using statistics function. Variation is difference between min and max.

## Electrical Characteristics - Current Consumption

TA = T$_{COM}$; Supply Voltage VDD/VDDA = 3.3 V +/-5%, See Test Loads for Loading Conditions

| PARAMETER | SYMBOL | CONDITIONS | MIN | TYP | MAX | UNITS | NOTES |
|---|---|---|---|---|---|---|---|
| Operating Supply Current | I$_{DD3.3OP}$ | All outputs active @100MHz, C$_L$ = Full load; | | 407 | 500 | mA | 1 |
| Powerdown Current | I$_{DD3.3PDZ}$ | All differential pairs tri-stated | | 12 | 36 | mA | 1 |

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

## Electrical Characteristics - Skew and Differential Jitter Parameters

TA = T$_{COM;}$ Supply Voltage VDD/VDDA = 3.3 V +/-5%, See Test Loads for Loading Conditions

| PARAMETER | SYMBOL | CONDITIONS | MIN | TYP | MAX | UNITS | NOTES |
|---|---|---|---|---|---|---|---|
| CLK_IN, DIF[x:0] | t$_{SPO\_PLL}$ | Input-to-Output Skew in PLL mode nominal value @ 25°C, 3.3V | -100 | 0 | 100 | ps | 1,2,4,5,8 |
| CLK_IN, DIF[x:0] | t$_{PD\_BYP}$ | Input-to-Output Skew in Bypass mode nominal value @ 25°C, 3.3V | 2.5 | 3.5 | 4.5 | ns | 1,2,3,5,8 |
| CLK_IN, DIF[x:0] | t$_{DSPO\_PLL}$ | Input-to-Output Skew Varation in PLL mode across voltage and temperature | -50 | 0 | 50 | ps | 1,2,3,5,8 |
| CLK_IN, DIF[x:0] | t$_{DSPO\_BYP}$ | Input-to-Output Skew Varation in Bypass mode across voltage and temperature | -250 | | 250 | ps | 1,2,3,5,8 |
| CLK_IN, DIF[x:0] | t$_{DTE}$ | Random Differential Tracking error beween two 9ZX devices in Hi BW Mode | | 3 | 5 | ps (rms) | 1,2,3,5,8 |
| CLK_IN, DIF[x:0] | t$_{DSSTE}$ | Random Differential Spread Spectrum Tracking error beween two 9ZX devices in Hi BW Mode | | 15 | 75 | ps | 1,2,3,5,8 |
| DIF{x:0] | t$_{SKEW\_ALL}$ | Output-to-Output Skew across all outputs (Common to Bypass and PLL mode) | | 37 | 65 | ps | 1,2,3,8 |
| PLL Jitter Peaking | j$_{peak-hibw}$ | LOBW#_BYPASS_HIBW = 1 | 0 | 1.3 | 2.5 | dB | 7,8 |
| PLL Jitter Peaking | j$_{peak-lobw}$ | LOBW#_BYPASS_HIBW = 0 | 0 | 0.8 | 2 | dB | 7,8 |
| PLL Bandwidth | pll$_{HIBW}$ | LOBW#_BYPASS_HIBW = 1 | 2 | 3 | 4 | MHz | 8,9 |
| PLL Bandwidth | pll$_{LOBW}$ | LOBW#_BYPASS_HIBW = 0 | 0.7 | 1.1 | 1.4 | MHz | 8,9 |
| Duty Cycle | t$_{DC}$ | Measured differentially, PLL Mode | 45 | 50 | 55 | % | 1 |
| Duty Cycle Distortion | t$_{DCD}$ | Measured differentially, Bypass Mode @100MHz | -2 | 0 | 2 | % | 1,10 |
| Jitter, Cycle to cycle | t$_{jcyc-cyc}$ | PLL mode | | 41 | 50 | ps | 1,11 |
| | | *Additive* Jitter in Bypass Mode | | 20 | 50 | ps | 1,11 |

**Notes for preceding table:**

[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. DIF_IN slew rate must be matched to DIF output slew rate.

[6] t is the period of the input clock

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

[8] Guaranteed by design and characterization, not 100% tested in production.

[9] Measured at 3 db down or half power point.

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

[11] Measured from differential waveform

## Electrical Characteristics - Phase Jitter Parameters

$T_A = T_{COM;}$ Supply Voltage VDD/VDDA = 3.3 V +/-5%, See Test Loads for Loading Conditions

| PARAMETER | SYMBOL | CONDITIONS | MIN | TYP | MAX | UNITS | Notes |
|---|---|---|---|---|---|---|---|
| Jitter, Phase | $t_{jphPCIeG1}$ | PCIe Gen 1 | | 39 | 86 | ps (p-p) | 1,2,3 |
| | $t_{jphPCIeG2}$ | PCIe Gen 2 Lo Band<br>10kHz < f < 1.5MHz | | 1.1 | 3 | ps (rms) | 1,2 |
| | | PCIe Gen 2 High Band<br>1.5MHz < f < Nyquist (50MHz) | | 2.6 | 3.1 | ps (rms) | 1,2 |
| | $t_{jphPCIeG3}$ | PCIe Gen 3<br>(PLL BW of 2-4MHz, CDR = 10MHz) | | 0.6 | 1 | ps (rms) | 1,2,4 |
| | $t_{jphQPI\_SMI}$ | QPI & SMI<br>(100MHz or 133MHz, 4.8Gb/s, 6.4Gb/s 12UI) | | 0.36 | 0.5 | ps (rms) | 1,5 |
| | | QPI & SMI<br>(100MHz, 8.0Gb/s, 12UI) | | 0.23 | 0.3 | ps (rms) | 1,5 |
| | | QPI & SMI<br>(100MHz, 9.6Gb/s, 12UI) | | 0.18 | 0.2 | ps (rms) | 1,5 |
| *Additive* Phase Jitter, Bypass mode | $t_{jphPCIeG1}$ | PCIe Gen 1 | | 4 | 10 | ps (p-p) | 1,2,3 |
| | $t_{jphPCIeG2}$ | PCIe Gen 2 Lo Band<br>10kHz < f < 1.5MHz | | 0.25 | 0.3 | ps (rms) | 1,2,6 |
| | | PCIe Gen 2 High Band<br>1.5MHz < f < Nyquist (50MHz) | | 0.57 | 0.7 | ps (rms) | 1,2,6 |
| | $t_{jphPCIeG3}$ | PCIe Gen 3<br>(PLL BW of 2-4MHz, CDR = 10MHz) | | 0.20 | 0.3 | ps (rms) | 1,2,4,6 |
| | $t_{jphQPI\_SMI}$ | QPI & SMI<br>(100MHz or 133MHz, 4.8Gb/s, 6.4Gb/s 12UI) | | 0.22 | 0.3 | ps (rms) | 1,5,6 |
| | | QPI & SMI<br>(100MHz, 8.0Gb/s, 12UI) | | 0.08 | 0.1 | ps (rms) | 1,5,6 |
| | | QPI & SMI<br>(100MHz, 9.6Gb/s, 12UI) | | 0.08 | 0.1 | ps (rms) | 1,5,6 |

[1] Applies to all outputs.

[2] See http://www.pcisig.com for complete specs

[3] Sample size of at least 100K cycles. This figures extrapolates to 108ps pk-pk @ 1M cycles for a BER of 1-12.

[4] Subject to final radification by PCI SIG.

[5] Calculated from Intel-supplied Clock Jitter Tool v 1.6.3

[6] For RMS figures, additive jitter is calculated by solving the following equation: (Additive jitter)^2 = (total jitter)^2 - (input jitter)^2

## Power Management Table

| Inputs | | Control Bits/Pins | | | | Outputs | PLL State |
|---|---|---|---|---|---|---|---|
| **CKPWRGD_PD#** | **DIF_IN/ DIF_IN#** | **SMBus EN bit** | **OE# Pin** | **DIF(5:12)/ DIF(5:12)#** | **Other DIF/ DIF#** | **DFB_OUT/ DFB_OUT#** | |
| 0 | X | X | X | Hi-Z[1] | Hi-Z[1] | Hi-Z[1] | OFF |
| 1 | Running | 0 | X | Hi-Z[1] | Hi-Z[1] | Running | ON |
| | | 1 | 0 | Running | Running | Running | ON |
| | | 1 | 1 | Hi-Z[1] | Running | Running | ON |

**NOTE:**

1. Due to external pull down resistors, HI-Z results in Low/Low on the True/Complement outputs

## Clock Periods - Differential Outputs with Spread Spectrum Disabled

| SSC OFF | Center Freq. MHz | Measurement Window | | | | | | | Units | Notes |
|---------|---|---|---|---|---|---|---|---|---|---|
| | | 1 Clock | 1us | 0.1s | 0.1s | 0.1s | 1us | 1 Clock | | |
| | | -c2c jitter AbsPer Min | -SSC Short-Term Average Min | - ppm Long-Term Average Min | 0 ppm Period Nominal | + ppm Long-Term Average Max | +SSC Short-Term Average Max | +c2c jitter AbsPer Max | | |
| DIF | 100.00 | 9.94900 | | 9.99900 | 10.00000 | 10.00100 | | 10.05100 | ns | 1,2,3 |
| | 133.33 | 7.44925 | | 7.49925 | 7.50000 | 7.50075 | | 7.55075 | ns | 1,2,4 |

## Clock Periods - Differential Outputs with Spread Spectrum Enabled

| SSC ON | Center Freq. MHz | Measurement Window | | | | | | | Units | Notes |
|--------|---|---|---|---|---|---|---|---|---|---|
| | | 1 Clock | 1us | 0.1s | 0.1s | 0.1s | 1us | 1 Clock | | |
| | | -c2c jitter AbsPer Min | -SSC Short-Term Average Min | - ppm Long-Term Average Min | 0 ppm Period Nominal | + ppm Long-Term Average Max | +SSC Short-Term Average Max | +c2c jitter AbsPer Max | | |
| DIF | 99.75 | 9.94906 | 9.99906 | 10.02406 | 10.02506 | 10.02607 | 10.05107 | 10.10107 | ns | 1,2,3 |
| | 133.00 | 7.44930 | 7.49930 | 7.51805 | 7.51880 | 7.51955 | 7.53830 | 7.58830 | ns | 1,2,4 |

**Notes:**

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

[2] All Long Term Accuracy specifications are guaranteed with the assumption that the input clock complies with CK420BQ/CK410B+ accuracy requirements (+/-100ppm). The 9ZX21901 itself does not contribute to ppm error.

[3] Driven by SRC output of main clock, 100 MHz PLL Mode or Bypass mode

[4] Driven by CPU output of main clock, 133 MHz PLL Mode or Bypass mode

## Thermal Characteristics

| Parameter | Symbol | Conditions | Min. | Typ. | Max. | Units |
|-----------|--------|-----------|------|------|------|-------|
| Thermal Resistance Junction to Ambient | θJA | Still air | | 26.2 | | °C/W |
| | θJA | 1 m/s air flow | | 23.1 | | °C/W |
| | θJA | 3 m/s air flow | | 19.6 | | °C/W |
| Thermal Resistance Junction to Case | θJC | | | 10.4 | | °C/W |
| Thermal Resistance Junction to Board | θJB | | | 0.3 | | °C/W |

## Differential Output Termination Table

| DIF Zo (Ω) | Iref (Ω) | Rs (Ω) | Rp (Ω) |
|-----------|---------|--------|--------|
| 100 | 475 | 33 | 50 |
| 85 | 412 | 27 | 43.2 |

9ZX21901 Differential Test Loads
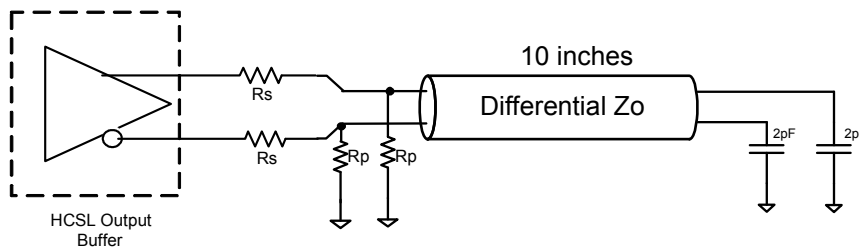
## General SMBus serial interface information for the 9ZX21901C
### (See also 9ZX21901 SMBus Addressing on page 2)

## How to Write:

- Controller (host) sends a start bit.
- Controller (host) sends the write address XX $_{(H)}$
- IDT clock will **acknowledge**
- Controller (host) sends the beginning byte location = N
- IDT clock will **acknowledge**
- Controller (host) sends the data byte count = X
- IDT clock will **acknowledge**
- Controller (host) starts sending **Byte N through Byte N + X -1**
- IDT clock will **acknowledge** each byte **one at a time**
- Controller (host) sends a Stop bit

## How to Read:

- Controller (host) will send start bit.
- Controller (host) sends the write address XX $_{(H)}$
- IDT clock will **acknowledge**
- Controller (host) sends the begining byte location = N
- IDT clock will **acknowledge**
- Controller (host) will send a separate start bit.
- Controller (host) sends the read address YY $_{(H)}$
- IDT clock will **acknowledge**
- IDT clock will send the data byte count = X
- IDT clock sends **Byte N + X - 1**
- IDT clock sends **Byte 0 through byte X (if X$_{(H)}$ was written to byte 8)**.
- Controller (host) will need to acknowledge each byte
- Controllor (host) will send a not acknowledge bit
- Controller (host) will send a stop bit

### Index Block Write Operation

| Controller (Host) | | IDT (Slave/Receiver) | |
|---|---|---|---|
| T | starT bit | | |
| Slave Address XX$_{(H)}$ | | | |
| WR | WRite | | |
| | | ACK | |
| Beginning Byte = N | | | |
| | | ACK | |
| Data Byte Count = X | | | |
| | | ACK | |
| Beginning Byte N | | | |
| | | ACK | |
| ◊ | | | |
| ◊ | X Byte | ◊ | |
| ◊ | | ◊ | |
| | | ◊ | |
| Byte N + X - 1 | | | |
| | | ACK | |
| P | stoP bit | | |

**Note: XX$_{(H)}$ is defined by SMBus address select pins.**

### Index Block Read Operation

| Controller (Host) | | IDT (Slave/Receiver) | |
|---|---|---|---|
| T | starT bit | | |
| Slave Address XX$_{(H)}$ | | | |
| WR | WRite | | |
| | | ACK | |
| Beginning Byte = N | | | |
| | | ACK | |
| RT | Repeat starT | | |
| Slave Address YY$_{(H)}$ | | | |
| RD | ReaD | | |
| | | ACK | |
| | | | |
| | | Data Byte Count = X | |
| ACK | | | |
| | | | Beginning Byte N |
| ACK | | | |
| | | X Byte | ◊ |
| ◊ | | | ◊ |
| ◊ | | | ◊ |
| ◊ | | | |
| | | | Byte N + X - 1 |
| N | Not acknowledge | | |
| P | stoP bit | | |

**SMBusTable: PLL Mode,  and  Frequency Select Register**

| Byte 0 | Pin # | Name | Control Function | Type | 0 | 1 | Default |
|--------|-------|------|------------------|------|---|---|---------|
| Bit 7 | 5 | PLL Mode 1 | PLL Operating Mode Rd back 1 | **R** | See PLL Operating Mode | | Latch |
| Bit 6 | 5 | PLL Mode 0 | PLL Operating Mode Rd back 0 | **R** | Readback Table | | Latch |
| Bit 5 | 72/71 | DIF_18_En | Output Control overrides OE# pin | RW | Hi-Z | Enable | 1 |
| Bit 4 | 70/69 | DIF_17_En | Output Control overrides OE# pin | RW | Hi-Z | Enable | 1 |
| Bit 3 | 67/66 | DIF_16_En | Output Control overrides OE# pin | RW | Hi-Z | Enable | 1 |
| Bit 2 | | Reserved | | | | | 0 |
| Bit 1 | | Reserved | | | | | 0 |
| Bit 0 | 4 | 100M_133M# | Frequency Select Readback | **R** | 133MHz | 100MHz | Latch |

**SMBusTable: Output Control Register**

| Byte 1 | Pin # | Name | Control Function | Type | 0 | 1 | Default |
|--------|-------|------|------------------|------|---|---|---------|
| Bit 7 | 39/38 | DIF_7_En | Output Control overrides OE# pin | RW | | | 1 |
| Bit 6 | 35/36 | DIF_6_En | Output Control overrides OE# pin | RW | | | 1 |
| Bit 5 | 32/33 | DIF_5_En | Output Control overrides OE# pin | RW | | | 1 |
| Bit 4 | 29/30 | DIF_4_En | Output Control overrides OE# pin | RW | Hi-Z | Enable | 1 |
| Bit 3 | 27/28 | DIF_3_En | Output Control overrides OE# pin | RW | | | 1 |
| Bit 2 | 24/25 | DIF_2_En | Output Control overrides OE# pin | RW | | | 1 |
| Bit 1 | 22/23 | DIF_1_En | Output Control overrides OE# pin | RW | | | 1 |
| Bit 0 | 19/20 | DIF_0_En | Output Control overrides OE# pin | RW | | | 1 |

**SMBusTable: Output Control Register**

| Byte 2 | Pin # | Name | Control Function | Type | 0 | 1 | Default |
|--------|-------|------|------------------|------|---|---|---------|
| Bit 7 | 65/64 | DIF_15_En | Output Control overrides OE# pin | RW | | | 1 |
| Bit 6 | 62/61 | DIF_14_En | Output Control overrides OE# pin | RW | | | 1 |
| Bit 5 | 60/59 | DIF_13_En | Output Control overrides OE# pin | RW | | | 1 |
| Bit 4 | 56/55 | DIF_12_En | Output Control overrides OE# pin | RW | Hi-Z | Enable | 1 |
| Bit 3 | 53/52 | DIF_11_En | Output Control overrides OE# pin | RW | | | 1 |
| Bit 2 | 50/49 | DIF_10_En | Output Control overrides OE# pin | RW | | | 1 |
| Bit 1 | 47/46 | DIF_9_En | Output Control overrides OE# pin | RW | | | 1 |
| Bit 0 | 42/41 | DIF_8_En | Output Control overrides OE# pin | RW | | | 1 |

**SMBusTable: Output Enable Pin Status Readback Register**

| Byte 3 | Pin # | Name | Control Function | Type | 0 | 1 | Default |
|--------|-------|------|------------------|------|---|---|---------|
| Bit 7 | 57 | OE_RB12 | Real Time readback of OE#12 | **R** | | | Real time |
| Bit 6 | 54 | OE_RB11 | Real Time readback of OE#11 | **R** | | | Real time |
| Bit 5 | 51 | OE_RB10 | Real Time readback of OE#10 | **R** | | | Real time |
| Bit 4 | 48 | OE_RB9 | Real Time readback of OE#9 | **R** | OE# pin Low | OE# Pin High | Real time |
| Bit 3 | 43 | OE_RB8 | Real Time readback of OE#8 | **R** | | | Real time |
| Bit 2 | 40 | OE_RB7 | Real Time readback of OE#7 | **R** | | | Real time |
| Bit 1 | 37 | OE_RB6 | Real Time readback of OE#6 | **R** | | | Real time |
| Bit 0 | 34 | OE_RB5 | Real Time readback of OE#5 | **R** | | | Real time |

### SMBusTable: Reserved Register

| Byte 4 | Pin # | Name | Control Function | Type | 0 | 1 | Default |
|--------|-------|------|------------------|------|---|---|---------|
| Bit 7 | | | Reserved | | | | 0 |
| Bit 6 | | | Reserved | | | | 0 |
| Bit 5 | | | Reserved | | | | 0 |
| Bit 4 | | | Reserved | | | | 0 |
| Bit 3 | | | Reserved | | | | 0 |
| Bit 2 | | | Reserved | | | | 0 |
| Bit 1 | | | Reserved | | | | 0 |
| Bit 0 | | | Reserved | | | | 0 |

### SMBusTable: Vendor & Revision ID Register

| Byte 5 | Pin # | Name | Control Function | Type | 0 | 1 | Default |
|--------|-------|------|------------------|------|---|---|---------|
| Bit 7 | - | RID3 | REVISION ID | R | | | X |
| Bit 6 | - | RID2 | | R | B rev = 0001 | | X |
| Bit 5 | - | RID1 | | R | C Rev = 0010 | | X |
| Bit 4 | - | RID0 | | R | | | X |
| Bit 3 | - | VID3 | VENDOR ID | R | - | - | 0 |
| Bit 2 | - | VID2 | | R | - | - | 0 |
| Bit 1 | - | VID1 | | R | - | - | 0 |
| Bit 0 | - | VID0 | | R | - | - | 1 |

### SMBusTable: DEVICE ID

| Byte 6 | Pin # | Name | Control Function | Type | 0 | 1 | Default |
|--------|-------|------|------------------|------|---|---|---------|
| Bit 7 | - | Device ID 7 (MSB) | | R | | | 1 |
| Bit 6 | - | Device ID 6 | | R | | | 1 |
| Bit 5 | - | Device ID 5 | | R | | | 0 |
| Bit 4 | - | Device ID 4 | | R | Device ID is 219 decimal or | | 1 |
| Bit 3 | - | Device ID 3 | | R | DB hex. | | 1 |
| Bit 2 | - | Device ID 2 | | R | | | 0 |
| Bit 1 | - | Device ID 1 | | R | | | 1 |
| Bit 0 | - | Device ID 0 | | R | | | 1 |

### SMBusTable: Byte Count Register

| Byte 7 | Pin # | Name | Control Function | Type | 0 | 1 | Default |
|--------|-------|------|------------------|------|---|---|---------|
| Bit 7 | | | Reserved | | | | 0 |
| Bit 6 | | | Reserved | | | | 0 |
| Bit 5 | | | Reserved | | | | 0 |
| Bit 4 | - | BC4 | Writing to this register configures how many bytes will be read back. | RW | Default value is 8 hex, so 9 bytes (0 to 8) will be read back by default. | | 0 |
| Bit 3 | - | BC3 | | RW | | | 1 |
| Bit 2 | - | BC2 | | RW | | | 0 |
| Bit 1 | - | BC1 | | RW | | | 0 |
| Bit 0 | - | BC0 | | RW | | | 0 |

### SMBusTable: Reserved Register

| Byte 8 | Pin # | Name | Control Function | Type | 0 | 1 | Default |
|--------|-------|------|------------------|------|---|---|---------|
| Bit 7 | | | Reserved | | | | 0 |
| Bit 6 | | | Reserved | | | | 0 |
| Bit 5 | | | Reserved | | | | 0 |
| Bit 4 | | | Reserved | | | | 0 |
| Bit 3 | | | Reserved | | | | 0 |
| Bit 2 | | | Reserved | | | | 0 |
| Bit 1 | | | Reserved | | | | 0 |
| Bit 0 | | | Reserved | | | | 0 |

| DIF Reference Clock | | | |
|---|---|---|---|
| Common Recommendations for Differential Routing | Dimension or Value | Unit | Figure |
| L1 length, route as non-coupled 50ohm trace | 0.5 max | inch | 1 |
| L2 length, route as non-coupled 50ohm trace | 0.2 max | inch | 1 |
| L3 length, route as non-coupled 50ohm trace | 0.2 max | inch | 1 |
| Rs | 33 | ohm | 1 |
| Rt | 49.9 | ohm | 1 |

| Down Device Differential Routing | | | |
|---|---|---|---|
| L4 length, route as coupled microstrip 100ohm differential trace | 2 min to 16 max | inch | 1 |
| L4 length, route as coupled stripline 100ohm differential trace | 1.8 min to 14.4 max | inch | 1 |

| Differential Routing to PCI Express Connector | | | |
|---|---|---|---|
| L4 length, route as coupled microstrip 100ohm differential trace | 0.25 to 14 max | inch | 2 |
| L4 length, route as coupled stripline 100ohm differential trace | 0.225 min to 12.6 max | inch | 2 |



Figure 1: Down Device Routing



Figure 2: PCI Express Connector Routing
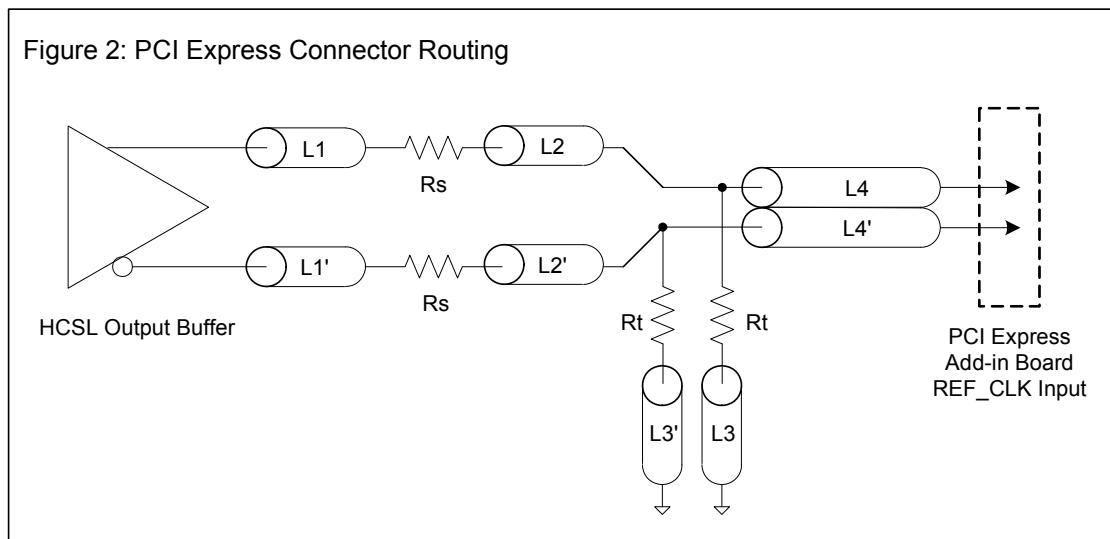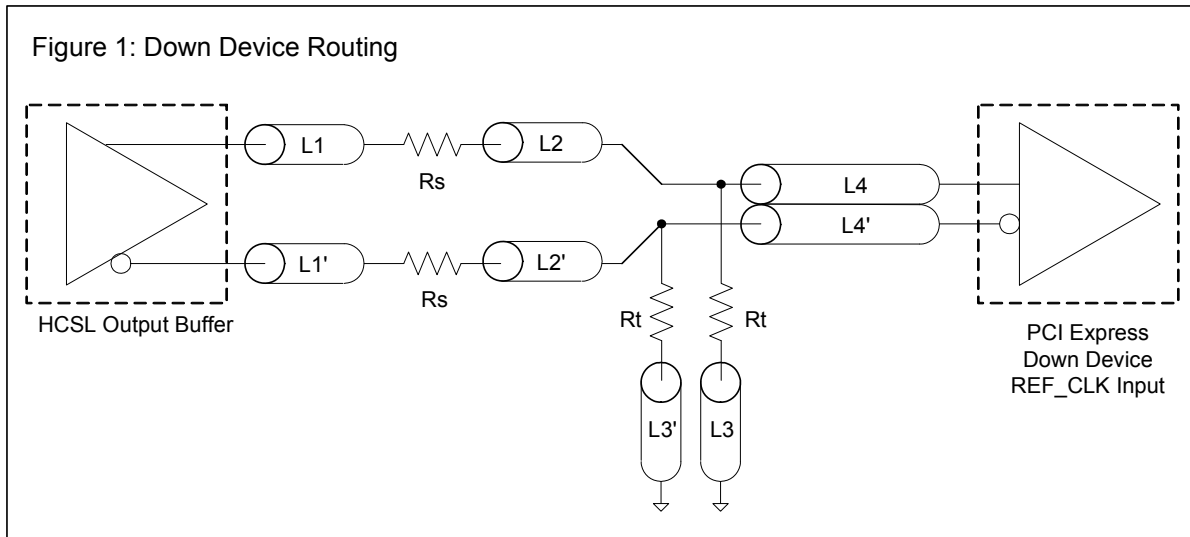
| Alternative Termination for LVDS and other Common Differential Signals (figure 3) | | | | | | | |
|---|---|---|---|---|---|---|---|
| Vdiff | Vp-p | Vcm | R1 | R2 | R3 | R4 | Note |
| 0.45v | 0.22v | 1.08 | 33 | 150 | 100 | 100 | |
| 0.58 | 0.28 | 0.6 | 33 | 78.7 | 137 | 100 | |
| 0.80 | 0.40 | 0.6 | 33 | 78.7 | none | 100 | ICS874003i-02 input compatible |
| 0.60 | 0.3 | 1.2 | 33 | 174 | 140 | 100 | Standard LVDS |

R1a = R1b = R1

R2a = R2b = R2
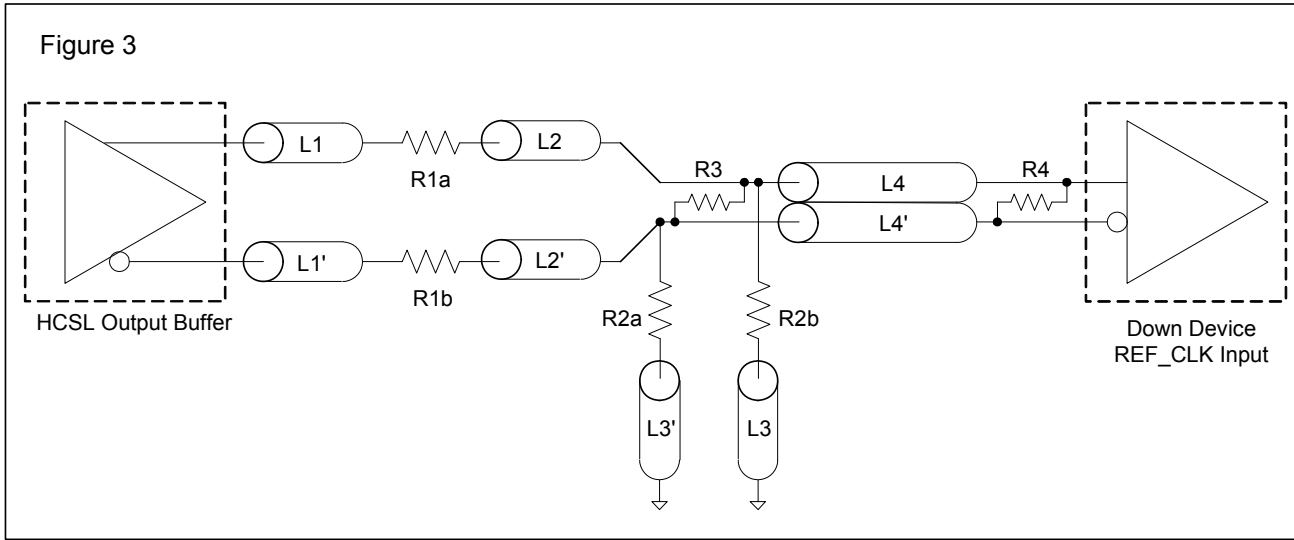
Figure 3



| Cable Connected AC Coupled Application (figure 4) | | |
|---|---|---|
| Component | Value | Note |
| R5a, R5b | 8.2K 5% | |
| R6a, R6b | 1K 5% | |
| Cc | 0.1 µF | |
| Vcm | 0.350 volts | |

Figure 4
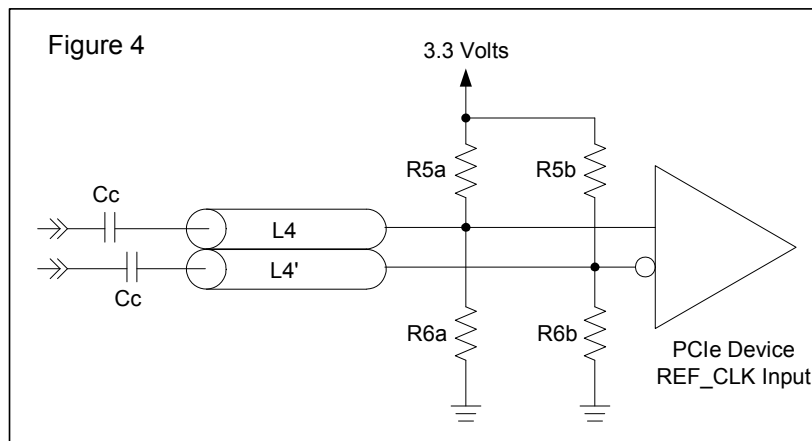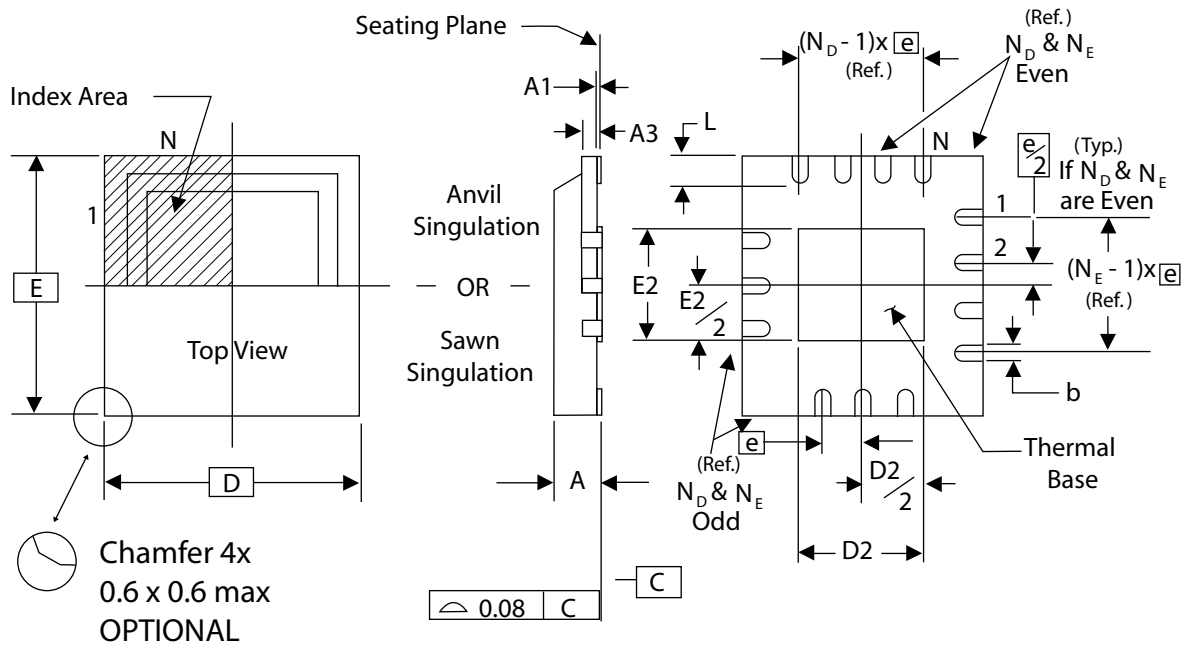
**THERMALLY ENHANCED, VERY THIN, FINE PITCH**
**QUAD FLAT / NO LEAD PLASTIC PACKAGE**

DIMENSIONS

| SYMBOL | 72L |
|--------|-----|
| N | 72 |
| $N_D$ | 18 |
| $N_E$ | 18 |

DIMENSIONS (mm)

| SYMBOL | MIN. | MAX. |
|--------|------|------|
| A | 0.8 | 1.0 |
| A1 | 0 | 0.05 |
| A3 | 0.25 Reference | |
| b | 0.18 | 0.3 |
| e | 0.50 BASIC | |
| D x E BASIC | 10.00 x 10.00 | |
| D2 MIN. / MAX. | 5.75 | 6.15 |
| E2 MIN. / MAX. | 5.75 | 6.15 |
| L MIN. / MAX. | 0.3 | 0.5 |

# Ordering Information

| Part / Order Number | Shipping Package | Package | Temperature |
|---------------------|------------------|---------|-------------|
| 9ZX21901CKLF | Trays | 72-pin MLF | 0 to +70°C |
| 9ZX21901CKLFT | Tape and Reel | 72-pin MLF | 0 to +70°C |

"LF" designates PB-free configuration, RoHS compliant.

## Revision History

| Rev. | Issue Date | Who | Description | Page # |
|------|-----------|-----|-------------|--------|
| 0.1 | 1/20/2010 | RDW | Initial release | Various |
| A | 6/10/2010 | RDW | 1. Corrected input clock on block diagram, updated QPI reference to 9.6GTs, added note about fixed feedback path, added comment about DFB_OUT needed termination network.<br>2. Reformatted electrical tables to fit new standard format<br>3. Added output termination/test load drawing and table<br>4. Released to final | 1,5,6,9 |
| B | 6/22/201 | RDW | 1. Merged Phase Jitter Tables into Single Table.<br>2. Reformatted Electrical Tables into common format for future datasheets. | 8 |
| C | 8/3/2010 | RDW | 1. Updated front page to standard 9ZX format.<br>2. Clarified that SMBus Address Selection table includes the Read/Write Bit. Minor clarifications to other tables.<br>3. Added additive phase jitter table for bypass mode. | 1-3, 5-11 |
| D | 3/2/2011 | RDW | 1. Added rise/fall varation spec to HCSL_Out table | 6 |
| E | 5/11/2011 | RDW | 1. Added note to pinout indicating that the DFB_OUT pins must be terminated. | 2 |
| F | 9/20/2011 | RDW | 1. Added "Case Temperature" to Abs Max specs.<br>2. Added Thermal Char data | Various |
| G | 10/24/2011 | LPL | 1. Updated Thermal Characteristics table. | 9 |
| H | 12/8/2011 | RDW | 1. Updated tDSPO_BYP parameter from +/-350 to +/-250ps. | 7 |

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