## Description

The 9DBU0731 is a member of IDT's 1.5V Ultra-Low-Power (ULP) PCIe family. The device has 7 output enables for clock management, and 3 selectable SMBus addresses.

## Recommended Application

1.5V PCIe Gen1-2-3 Fanout Buffer (FOB)

## Output Features

- 7 – 1–167MHz Low-Power (LP) HCSL DIF pairs

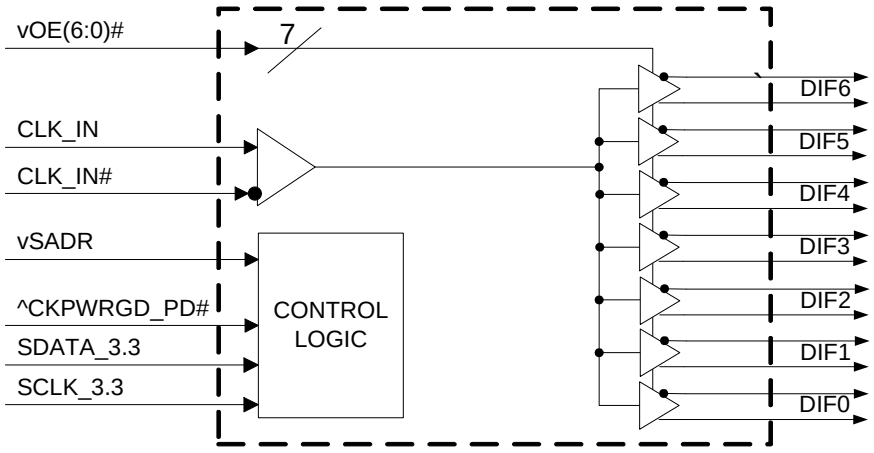
## Key Specifications

- DIF *additive* cycle-to-cycle jitter < 5ps
- DIF output-to-output skew < 60ps
- DIF *additive* phase jitter is < 300fs rms for PCIe Gen3
- DIF *additive* phase jitter < 350s rms for SGMII

## Features/Benefits

- LP-HCSL outputs; save 14 resistors compared to standard HCSL outputs
- 36mW typical power consumption; eliminates thermal concerns
- Outputs can optionally be supplied from any voltage between 1.05V and 1.5V; maximum power savings
- Spread Spectrum (SS) compatible; allows SS for EMI reduction
- OE# pins for each output; support DIF power management
- HCSL-compatible differential input; can be driven by common clock sources
- SMBus-selectable features; optimize signal integrity to application
  - slew rate for each output
  - differential output amplitude
- Device contains default configuration; SMBus interface not required for device operation
- 3.3V tolerant SMBus interface works with legacy controllers
- Three selectable SMBus addresses; multiple devices can easily share an SMBus segment
- 5 × 5 mm 40-VFQFPN package; minimal board space

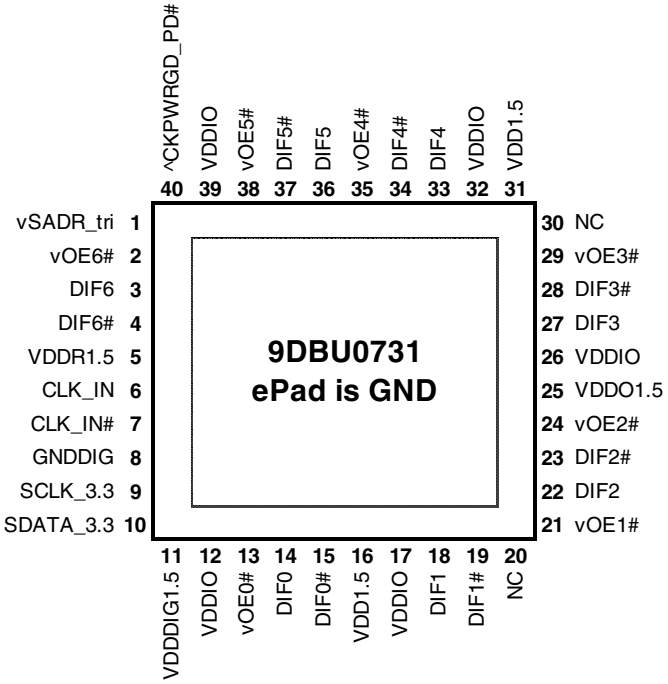
## Block Diagram





© 2019 Renesas Electronics Corporation

## Pin Configuration




**40-VFQFPN, 5mm x 5mm 0.4mm pin pitch**
^prefix indicates internal Pull-Up Resistor
v prefix indicates Internal Pull-Down Resistor

### SMBus Address Selection Table

| | SADR | Address | + Read/Write bit |
|---|---|---|---|
| State of SADR on first application of CKPWRGD_PD# | 0 | 1101011 | x |
| | M | 1101100 | x |
| | 1 | 1101101 | x |

### Power Management Table

| CKPWRGD_PD# | CLK_IN | SMBus OEx bit | OEx# Pin | DIFx | |
|---|---|---|---|---|---|
| | | | | True O/P | Comp. O/P |
| 0 | X | X | X | Low | Low |
| 1 | Running | 0 | X | Low | Low |
| 1 | Running | 1 | 0 | Running | Running |
| 1 | Running | 1 | 1 | Low | Low |

### Power Connections

| Pin Number | | | Description |
|---|---|---|---|
| VDD | VDDIO | GND | |
| 5 | | 41 | Input receiver analog |
| 11 | | 8 | Digital Power |
| 16,25,31 | 12,17,26,32, 39 | 41 | DIF outputs,Logic |

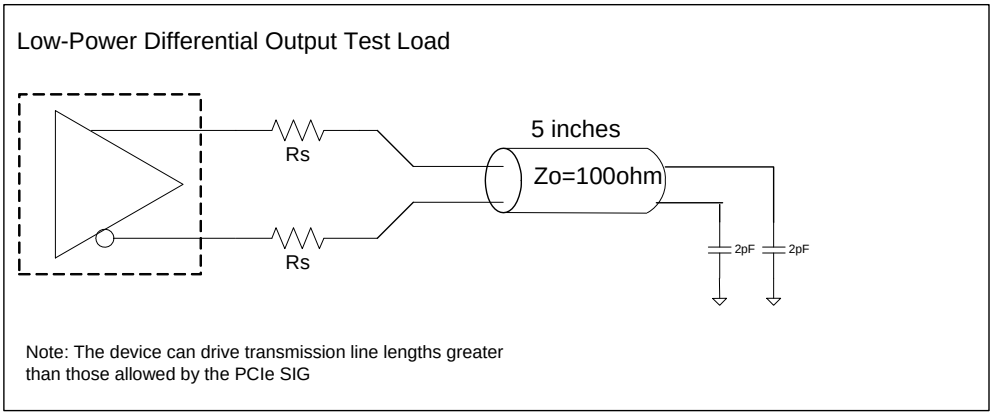

© 2019 Renesas Electronics Corporation

## Pin Descriptions

| PIN # | PIN NAME | PIN TYPE | DESCRIPTION |
|---|---|---|---|
| 1 | vSADR_tri | LATCHED IN | Tri-level latch to select SMBus Address. It has an internal 120kohm pull down resistor. See SMBus Address Selection Table. |
| 2 | vOE6# | IN | Active low input for enabling output 6. This pin has an internal 120kohm pull-down. 1 =disable outputs, 0 = enable outputs |
| 3 | DIF6 | OUT | Differential true clock output. |
| 4 | DIF6# | OUT | Differential complementary clock output. |
| 5 | VDDR1.5 | PWR | 1.5V power for differential input clock (receiver). This VDD should be treated as an Analog power rail and filtered appropriately. |
| 6 | CLK_IN | IN | True Input for differential reference clock. |
| 7 | CLK_IN# | IN | Complementary Input for differential reference clock. |
| 8 | GNDDIG | GND | Ground pin for digital circuitry. |
| 9 | SCLK_3.3 | IN | Clock pin of SMBus circuitry, 3.3V tolerant. |
| 10 | SDATA_3.3 | I/O | Data pin for SMBus circuitry, 3.3V tolerant. |
| 11 | VDDDIG1.5 | PWR | 1.5V digital power (dirty power) |
| 12 | VDDIO | PWR | Power supply for differential outputs |
| 13 | vOE0# | IN | Active low input for enabling output 0. This pin has an internal 120kohm pull-down. 1 =disable outputs, 0 = enable outputs |
| 14 | DIF0 | OUT | Differential true clock output. |
| 15 | DIF0# | OUT | Differential complementary clock output. |
| 16 | VDD1.5 | PWR | Power supply, nominally 1.5V |
| 17 | VDDIO | PWR | Power supply for differential outputs |
| 18 | DIF1 | OUT | Differential true clock output. |
| 19 | DIF1# | OUT | Differential complementary clock output. |
| 20 | NC | N/A | No connection. |
| 21 | vOE1# | IN | Active low input for enabling output 1. This pin has an internal 120kohm pull-down. 1 =disable outputs, 0 = enable outputs |
| 22 | DIF2 | OUT | Differential true clock output. |
| 23 | DIF2# | OUT | Differential complementary clock output. |
| 24 | vOE2# | IN | Active low input for enabling output 2. This pin has an internal 120kohm pull-down. 1 =disable outputs, 0 = enable outputs |
| 25 | VDDO1.5 | PWR | Power supply for outputs, nominally 1.5V. |
| 26 | VDDIO | PWR | Power supply for differential outputs |
| 27 | DIF3 | OUT | Differential true clock output. |
| 28 | DIF3# | OUT | Differential complementary clock output. |
| 29 | vOE3# | IN | Active low input for enabling output 3. This pin has an internal 120kohm pull-down. 1 =disable outputs, 0 = enable outputs |
| 30 | NC | N/A | No connection. |
| 31 | VDD1.5 | PWR | Power supply, nominally 1.5V |
| 32 | VDDIO | PWR | Power supply for differential outputs |
| 33 | DIF4 | OUT | Differential true clock output. |
| 34 | DIF4# | OUT | Differential complementary clock output. |
| 35 | vOE4# | IN | Active low input for enabling output 4. This pin has an internal 120kohm pull-down. 1 =disable outputs, 0 = enable outputs |
| 36 | DIF5 | OUT | Differential true clock output. |
| 37 | DIF5# | OUT | Differential complementary clock output. |
| 38 | vOE5# | IN | Active low input for enabling output 5. This pin has an internal 120kohm pull-down. 1 =disable outputs, 0 = enable outputs |
| 39 | VDDIO | PWR | Power supply for differential outputs |
| 40 | ^CKPWRGD_PD# | IN | 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 120kohm pull-up resistor. |
| 41 | EPAD | GND | Connect paddle to ground. |


© 2019 Renesas Electronics Corporation

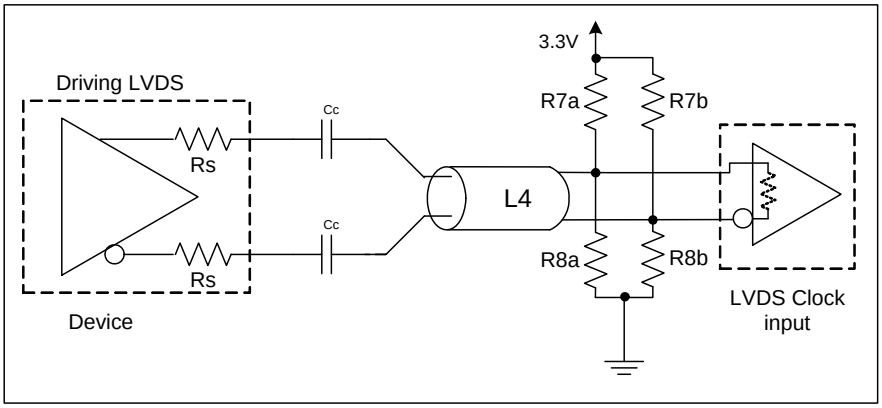
## Test Loads




**Alternate Differential Output Terminations**

| Rs | Zo | Units |
|---|---|---|
| 33 | 100 | Ohms |
| 27 | 85 | |

## Driving LVDS




**Driving LVDS inputs**

| Component | Value | | Note |
|---|---|---|---|
| | Receiver has termination | Receiver does not have termination | |
| R7a, R7b | 10K ohm | 140 ohm | |
| R8a, R8b | 5.6K ohm | 75 ohm | |
| Cc | 0.1 uF | 0.1 uF | |
| Vcm | 1.2 volts | 1.2 volts | |


© 2019 Renesas Electronics Corporation

## Absolute Maximum Ratings

Stresses above the ratings listed below can cause permanent damage to the 9DBU0731. These ratings, which are standard values for IDT commercially rated parts, are stress ratings only. Functional operation of the device at these or any other conditions above those indicated in the operational sections of the specifications is not implied. Exposure to absolute maximum rating conditions for extended periods can affect product reliability. Electrical parameters are guaranteed only over the recommended operating temperature range.

| PARAMETER | SYMBOL | CONDITIONS | MIN | TYP | MAX | UNITS | NOTES |
|---|---|---|---|---|---|---|---|
| Supply Voltage | VDDx | Applies to VDD, VDDA and VDDIO | -0.5 | | 2 | V | 1,2 |
| Input Voltage | $V_{IN}$ | | -0.5 | | $V_{DD}$+0.5 | V | 1, |
| Input High Voltage, SMBus | $V_{IHSMB}$ | SMBus clock and data pins | | | 3.3 | V | 1 |
| Storage Temperature | Ts | | -65 | | 150 | °C | 1 |
| Junction Temperature | Tj | | | | 125 | °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.

[3] Not to exceed 2.0V.

## Electrical Characteristics–Clock Input Parameters

TA = $T_{AMB,}$ Supply Voltages per normal operation conditions, See Test Loads for Loading Conditions

| PARAMETER | SYMBOL | CONDITIONS | MIN | TYP | MAX | UNITS | NOTES |
|---|---|---|---|---|---|---|---|
| Input Common Mode Voltage - DIF_IN | $V_{COM}$ | Common Mode Input Voltage | 200 | | 725 | mV | 1 |
| Input Swing - DIF_IN | $V_{SWING}$ | Differential 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 | µA | |
| Input Duty Cycle | $d_{tin}$ | Measurement from differential waveform | 45 | 50 | 55 | % | 1 |
| Input Jitter - Cycle to Cycle | $J_{DIFIn}$ | Differential Measurement | 0 | | 150 | ps | 1 |

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

[2] Slew rate measured through +/-75mV window centered around differential zero


© 2019 Renesas Electronics Corporation

# Electrical Characteristics–Input/Supply/Common Parameters–Normal Operating Conditions

TA = $T_{AMB}$; Supply Voltages per normal operation conditions, See Test Loads for Loading Conditions

| PARAMETER | SYMBOL | CONDITIONS | MIN | TYP | MAX | UNITS | NOTES |
|---|---|---|---|---|---|---|---|
| Supply Voltage | VDDx | Supply voltage for core and analog | 1.425 | 1.5 | 1.575 | V | |
| Output Supply Voltage | VDDIO | Low Voltage Supply LP-HCSL Outputs | 0.95 | 1.05-1.5 | 1.575 | V | |
| Ambient Operating Temperature | $T_{AMB}$ | Commercial range | 0 | 25 | 70 | °C | 1 |
| | | Industrial range | -40 | 25 | 85 | °C | 1 |
| Input High Voltage | $V_{IH}$ | Single-ended inputs, except SMBus | 0.75 $V_{DD}$ | | $V_{DD}$ + 0.3 | V | |
| Input Mid Voltage | $V_{IM}$ | Single-ended tri-level inputs ('_tri' suffix) | 0.4 $V_{DD}$ | | 0.6 $V_{DD}$ | V | |
| Input Low Voltage | $V_{IL}$ | Single-ended inputs, except SMBus | -0.3 | | 0.25 $V_{DD}$ | V | |
| Input Current | $I_{IN}$ | Single-ended inputs, $V_{IN}$ = GND, $V_{IN}$ = VDD | -5 | | 5 | µA | |
| | $I_{INP}$ | Single-ended inputs<br>$V_{IN}$ = 0 V; Inputs with internal pull-up resistors<br>$V_{IN}$ = VDD; Inputs with internal pull-down resistors | -200 | | 200 | µA | |
| Input Frequency | $F_{in}$ | | 1 | | 167 | 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 | 1,5 |
| | $C_{OUT}$ | 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 | ms | 1,2 |
| Input SS Modulation Frequency PCIe | $f_{MODINPCIe}$ | Allowable Frequency for PCIe Applications (Triangular Modulation) | 30 | | 33 | kHz | |
| Input SS Modulation Frequency non-PCIe | $f_{MODIN}$ | Allowable Frequency for non-PCIe Applications (Triangular Modulation) | 0 | | 66 | kHz | |
| OE# Latency | $t_{LATOE\#}$ | DIF start after OE# assertion<br>DIF stop after OE# deassertion | 1 | | 3 | clocks | 1,3 |
| Tdrive_PD# | $t_{DRVPD}$ | DIF output enable after PD# de-assertion | | | 300 | µs | 1,3 |
| Tfall | $t_F$ | Fall time of single-ended control inputs | | | 5 | ns | 2 |
| Trise | $t_R$ | Rise time of single-ended control inputs | | | 5 | ns | 2 |
| SMBus Input Low Voltage | $V_{ILSMB}$ | | | | 0.6 | V | |
| SMBus Input High Voltage | $V_{IHSMB}$ | $V_{DDSMB}$ = 3.3V, see note 4 for $V_{DDSMB}$ < 3.3V | 2.1 | | 3.3 | V | 4 |
| SMBus Output Low Voltage | $V_{OLSMB}$ | @ $I_{PULLUP}$ | | | 0.4 | V | |
| SMBus Sink Current | $I_{PULLUP}$ | @ $V_{OL}$ | 4 | | | mA | |
| Nominal Bus Voltage | $V_{DDSMB}$ | Bus Voltage | 1.425 | | 3.3 | V | |
| 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 | | | 400 | kHz | 6 |

[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] For $V_{DDSMB}$ < 3.3V, $V_{IHSMB}$ >= 0.8x$V_{DDSMB}$

[5]DIF_IN input

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


© 2019 Renesas Electronics Corporation

## Electrical Characteristics–DIF Low-Power HCSL Outputs

TA = $T_{AMB}$; Supply Voltages per normal operation conditions, See Test Loads for Loading Conditions

| PARAMETER | SYMBOL | CONDITIONS | MIN | TYP | MAX | UNITS | NOTES |
|---|---|---|---|---|---|---|---|
| Slew rate | dV/dt | Scope averaging on, fast setting | 1.4 | 2.3 | 3.5 | V/ns | 1,2,3 |
| | dV/dt | Scope averaging on, slow setting | 0.9 | 1.5 | 2.5 | V/ns | 1,2,3 |
| Slew rate matching | ΔdV/dt | Slew rate matching, Scope averaging on | | 9.3 | 20 | % | 1,2,4 |
| Voltage High | $V_{HIGH}$ | Statistical measurement on single-ended signal using oscilloscope math function. (Scope averaging on) | 630 | 750 | 850 | mV | 7 |
| Voltage Low | $V_{LOW}$ | | -150 | 26 | 150 | | 7 |
| Max Voltage | Vmax | Measurement on single ended signal using absolute value. (Scope averaging off) | | 763 | 1150 | mV | 7 |
| Min Voltage | Vmin | | -300 | 22 | | | 7 |
| Vswing | Vswing | Scope averaging off | 300 | 1448 | | mV | 1,2 |
| Crossing Voltage (abs) | Vcross_abs | Scope averaging off | 250 | 390 | 550 | mV | 1,5 |
| Crossing Voltage (var) | Δ-Vcross | Scope averaging off | | 11 | 140 | mV | 1,6 |

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

[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 Vcross_min/max (Vcross absolute) allowed. The intent is to limit Vcross induced modulation by setting Δ-Vcross to be smaller than Vcross absolute.

[7] At default SMBus settings.

## Electrical Characteristics–Current Consumption

TA = $T_{AMB}$; Supply Voltages per normal operation conditions, See Test Loads for Loading Conditions

| PARAMETER | SYMBOL | CONDITIONS | MIN | TYP | MAX | UNITS | NOTES |
|---|---|---|---|---|---|---|---|
| Operating Supply Current | $I_{DDA}$ | VDDO1.5+VDDR, @100MHz | | 2.2 | 3 | mA | |
| | $I_{DD}$ | VDD, All outputs active @100MHz | | 3.6 | 5 | mA | |
| | $I_{DDIO}$ | VDDIO, All outputs active @100MHz | | 26 | 31 | mA | |
| Powerdown Current | $I_{DDAPD}$ | VDDO1.5+VDDR, CKPWRGD_PD#=0 | | 0.4 | 1 | mA | 2 |
| | $I_{DDPD}$ | VDDx, CKPWRGD_PD#=0 | | 0.25 | 0.6 | mA | 2 |
| | $I_{DDIOPD}$ | VDDIO, CKPWRGD_PD#=0 | | 0.0006 | 0.1 | mA | 2 |

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

[2] Input clock stopped.


© 2019 Renesas Electronics Corporation

## Electrical Characteristics–Output Duty Cycle, Jitter, Skew and PLL Characteristics

TA = $T_{AMB}$; Supply Voltages per normal operation conditions, See Test Loads for Loading Conditions

| PARAMETER | SYMBOL | CONDITIONS | MIN | TYP | MAX | UNITS | NOTES |
|---|---|---|---|---|---|---|---|
| Duty Cycle Distortion | $t_{DCD}$ | Measured differentially, @100MHz | -1 | -0.2 | 0.5 | % | 1,3 |
| Skew, Input to Output | $t_{pdBYP}$ | $V_T$ = 50% | 2400 | 2862 | 3700 | ps | 1 |
| Skew, Output to Output | $t_{sk3}$ | $V_T$ = 50% | | 30 | 60 | ps | 1,4 |
| Jitter, Cycle to cycle | $t_{jcyc-cyc}$ | *Additive* Jitter | | 0.1 | 5 | ps | 1,2 |

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

[2] Measured from differential waveform

[3] Duty cycle distortion is the difference in duty cycle between the output and the input clock.

[4] All outputs at default slew rate

## Electrical Characteristics–Phase Jitter Parameters

TA = $T_{AMB}$; Supply Voltages per normal operation conditions, See Test Loads for Loading Conditions

| PARAMETER | SYMBOL | CONDITIONS | MIN | TYP | MAX | INDUSTRY LIMIT | UNITS | Notes |
|---|---|---|---|---|---|---|---|---|
| Additive Phase Jitter | $t_{jphPCIeG1}$ | PCIe Gen 1 | | 0.1 | 5 | N/A | ps (p-p) | 1,2,3,5 |
| | $t_{jphPCIeG2}$ | PCIe Gen 2 Lo Band 10kHz < f < 1.5MHz | | 0.1 | 0.4 | N/A | ps (rms) | 1,2,3,4,5 |
| | | PCIe Gen 2 High Band 1.5MHz < f < Nyquist (50MHz) | | 0.1 | 0.7 | N/A | ps (rms) | 1,2,3,4 |
| | $t_{jphPCIeG3}$ | PCIe Gen 3 (2-4MHz or 2-5MHz, CDR = 10MHz) | | 0.1 | 0.3 | N/A | ps (rms) | 1,2,3,4 |
| | $t_{jphSGMIIM0}$ | 125MHz, 1.5MHz to 10MHz, -20dB/decade rollover < 1.5MHz, -40db/decade rolloff > 10MHz | | 200 | 250 | N/A | fs (rms) | 1,6 |
| | $t_{jphSGMIIM1}$ | 125MHz, 12kHz to 20MHz, -20dB/decade rollover < 1.5MHz, -40db/decade rolloff > 10MHz | | 313 | 350 | N/A | fs (rms) | 1,6 |

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

[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.

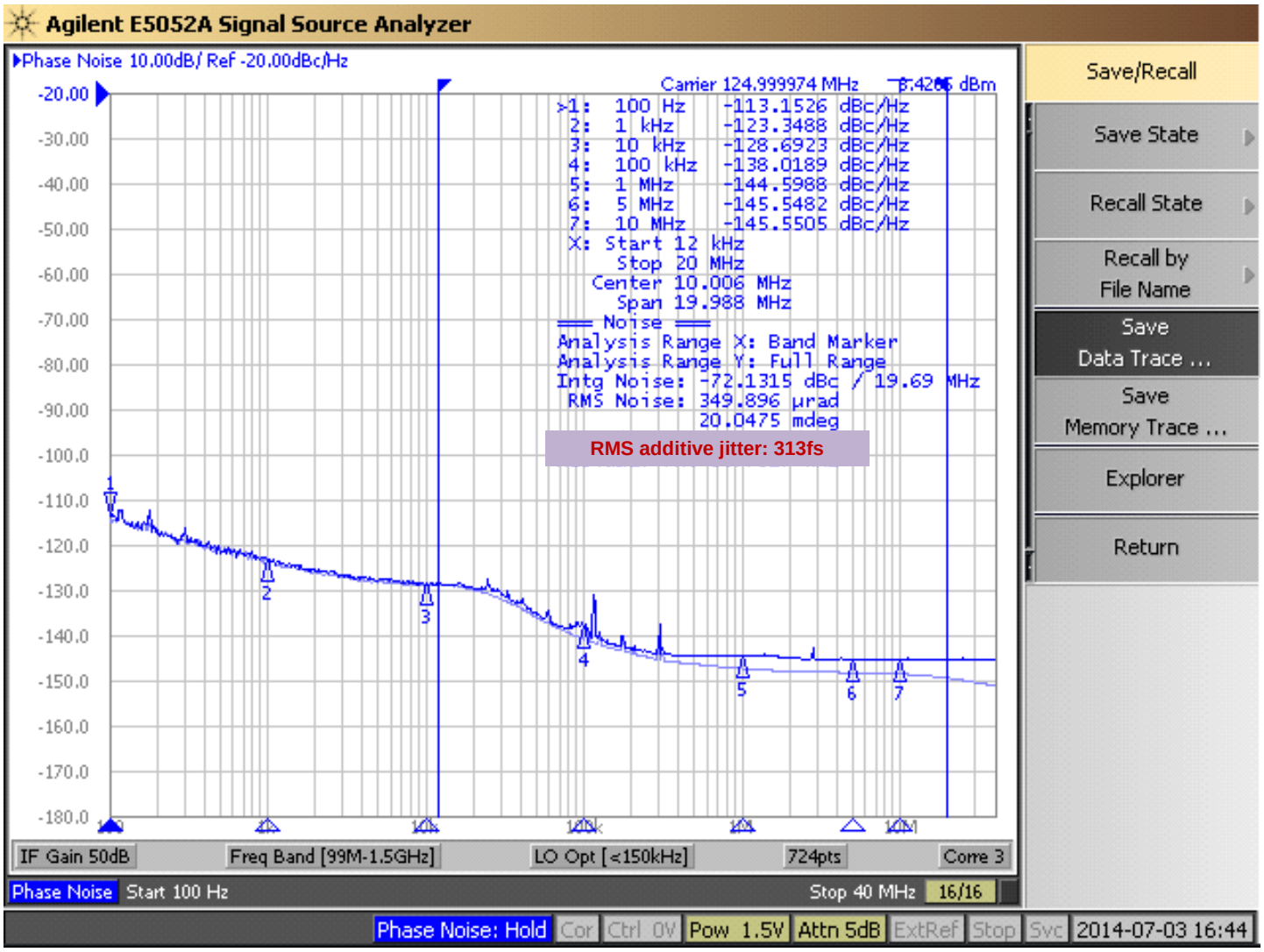
[4] For RMS figures, additive jitter is calculated by solving the following equation: Additive jitter = SQRT[(total jitter)^2 - (input jitter)^2]

[5] Driven by 9FGV0831 or equivalent

[6] Rohde & Schwarz SMA100


© 2019 Renesas Electronics Corporation

## Additive Phase Jitter Plot: 125M (12kHz to 20MHz)





© 2019 Renesas Electronics Corporation

# General SMBus Serial Interface Information

## How to Write

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

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

**Note: SMBus Address is Latched on SADR pin.**

## How to Read

- Controller (host) will send a start bit
- Controller (host) sends the write address
- IDT clock will **acknowledge**
- Controller (host) sends the beginning byte location = N
- IDT clock will **acknowledge**
- Controller (host) will send a separate start bit
- Controller (host) sends the read address
- 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
- Controller (host) will send a not acknowledge bit
- Controller (host) will send a stop bit

| Index Block Read Operation | | | |
|---|---|---|---|
| **Controller (Host)** | | | **IDT (Slave/Receiver)** |
| 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 | | | |
| | | X Byte | Beginning Byte N |
| ACK | | | |
| | | | O |
| O | | | O |
| O | | | O |
| O | | | |
| | | | Byte N + X - 1 |
| N | Not acknowledge | | |
| P | stoP bit | | |


© 2019 Renesas Electronics Corporation

**SMBus Table: Output Enable Register [1]**

| Byte 0 | Name | Control Function | Type | 0 | 1 | Default |
|---|---|---|---|---|---|---|
| **Bit 7** | DIF OE5 | Output Enable | RW | Low/Low | Enabled | 1 |
| **Bit 6** | DIF OE4 | Output Enable | RW | Low/Low | Enabled | 1 |
| **Bit 5** | Reserved | | | | | 1 |
| **Bit 4** | DIF OE3 | Output Enable | RW | Low/Low | Enabled | 1 |
| **Bit 3** | DIF OE2 | Output Enable | RW | Low/Low | Enabled | 1 |
| **Bit 2** | DIF OE1 | Output Enable | RW | Low/Low | Enabled | 1 |
| **Bit 1** | Reserved | | | | | 1 |
| **Bit 0** | DIF OE0 | Output Enable | RW | Low/Low | Enabled | 1 |

1. A low on these bits will override the OE# pin and force the differential output Low/Low

**SMBus Table: PLL Operating Mode and Output Amplitude Control Register**

| Byte 1 | Name | Control Function | Type | 0 | 1 | Default |
|---|---|---|---|---|---|---|
| **Bit 7** | Reserved | | | | | 0 |
| **Bit 6** | Reserved | | | | | 1 |
| **Bit 5** | DIF OE6 | Output Enable | RW | Low/Low | Enabled | 1 |
| **Bit 4** | Reserved | | | | | 0 |
| **Bit 3** | Reserved | | | | | 1 |
| **Bit 2** | Reserved | | | | | 1 |
| **Bit 1** | AMPLITUDE 1 | Controls Output Amplitude | RW | 00 = 0.55V | 01= 0.65V | 1 |
| **Bit 0** | AMPLITUDE 0 | | RW | 10 = 0.7V | 11 = 0.8V | 0 |

1. A low on the DIF OE bit will override the OE# pin and force the differential output Low/Low

**SMBus Table: DIF Slew Rate Control Register**

| Byte 2 | Name | Control Function | Type | 0 | 1 | Default |
|---|---|---|---|---|---|---|
| **Bit 7** | SLEWRATESEL DIF5 | Adjust Slew Rate of DIF5 | RW | Slow Setting | Fast Setting | 1 |
| **Bit 6** | SLEWRATESEL DIF4 | Adjust Slew Rate of DIF4 | RW | Slow Setting | Fast Setting | 1 |
| **Bit 5** | Reserved | | | | | 1 |
| **Bit 4** | SLEWRATESEL DIF3 | Adjust Slew Rate of DIF3 | RW | Slow Setting | Fast Setting | 1 |
| **Bit 3** | SLEWRATESEL DIF2 | Adjust Slew Rate of DIF2 | RW | Slow Setting | Fast Setting | 1 |
| **Bit 2** | SLEWRATESEL DIF1 | Adjust Slew Rate of DIF1 | RW | Slow Setting | Fast Setting | 1 |
| **Bit 1** | Reserved | | | | | 1 |
| **Bit 0** | SLEWRATESEL DIF0 | Adjust Slew Rate of DIF0 | RW | Slow Setting | Fast Setting | 1 |

**Note: See "DIF 0.7V Low-Power HCSL Outputs" table for slew rates.**

**SMBus Table: DIF Slew Rate Control Register**

| Byte 3 | Name | Control Function | Type | 0 | 1 | Default |
|---|---|---|---|---|---|---|
| **Bit 7** | Reserved | | | | | 1 |
| **Bit 6** | Reserved | | | | | 1 |
| **Bit 5** | Reserved | | | | | 0 |
| **Bit 4** | Reserved | | | | | 0 |
| **Bit 3** | Reserved | | | | | 0 |
| **Bit 2** | Reserved | | | | | 1 |
| **Bit 1** | Reserved | | | | | 1 |
| **Bit 0** | SLEWRATESEL DIF6 | Adjust Slew Rate of DIF6 | RW | Slow Setting | Fast Setting | 1 |

**Note: See "DIF 0.7V Low-Power HCSL Outputs" table for slew rates.**

**Byte 4 is Reserved and reads back 'hFF**


© 2019 Renesas Electronics Corporation

**SMBus Table: Revision and Vendor ID Register**

| Byte 5 | Name | Control Function | Type | 0 | 1 | Default |
|---|---|---|---|---|---|---|
| **Bit 7** | RID3 | Revision ID | **R** | A rev = 0000 | | 0 |
| **Bit 6** | RID2 | | **R** | | | 0 |
| **Bit 5** | RID1 | | **R** | | | 0 |
| **Bit 4** | RID0 | | **R** | | | 0 |
| **Bit 3** | VID3 | VENDOR ID | **R** | 0001 = IDT | | 0 |
| **Bit 2** | VID2 | | **R** | | | 0 |
| **Bit 1** | VID1 | | **R** | | | 0 |
| **Bit 0** | VID0 | | **R** | | | 1 |

**SMBus Table: Device Type/Device ID**

| Byte 6 | Name | Control Function | Type | 0 | 1 | Default |
|---|---|---|---|---|---|---|
| **Bit 7** | Device Type1 | Device Type | **R** | 00 = FGx, 01 = DBx, 10 = DMx, 11= DBx w/oPLL | | 1 |
| **Bit 6** | Device Type0 | | **R** | | | 1 |
| **Bit 5** | Device ID5 | Device ID | **R** | 000111 binary or 07 hex | | 0 |
| **Bit 4** | Device ID4 | | **R** | | | 0 |
| **Bit 3** | Device ID3 | | **R** | | | 0 |
| **Bit 2** | Device ID2 | | **R** | | | 1 |
| **Bit 1** | Device ID1 | | **R** | | | 1 |
| **Bit 0** | Device ID0 | | **R** | | | 1 |

**SMBus Table: Byte Count Register**

| Byte 7 | Name | Control Function | Type | 0 | 1 | Default |
|---|---|---|---|---|---|---|
| **Bit 7** | Reserved | | | | | 0 |
| **Bit 6** | Reserved | | | | | 0 |
| **Bit 5** | Reserved | | | | | 0 |
| **Bit 4** | BC4 | Byte Count Programming | RW | Writing to this register will configure how many bytes will be read back, default is = 8 bytes. | | 0 |
| **Bit 3** | BC3 | | RW | | | 1 |
| **Bit 2** | BC2 | | RW | | | 0 |
| **Bit 1** | BC1 | | RW | | | 0 |
| **Bit 0** | BC0 | | RW | | | 0 |


© 2019 Renesas Electronics Corporation

## Marking Diagrams







Notes:

1. “LOT” is the lot sequence number.
2. “COO” denotes country of origin.
3. YYWW is the last two digits of the year and week that the part was assembled.
4. Line 2: truncated part number
5. “L” denotes RoHS compliant package.
6. “I” denotes industrial temperature range device.

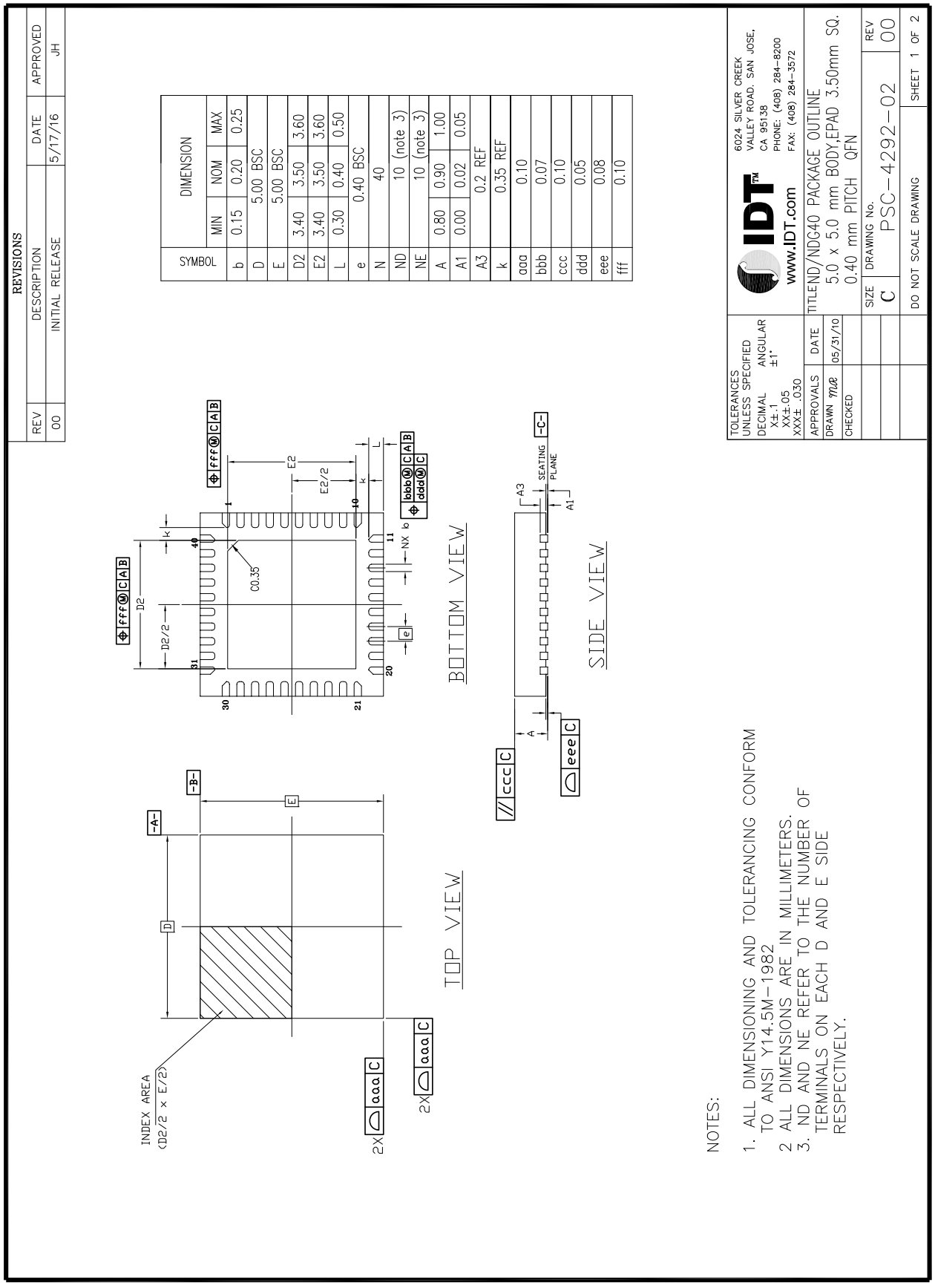
## Thermal Characteristics

| PARAMETER | SYMBOL | CONDITIONS | PKG | TYP VALUE | UNITS | NOTES |
|---|---|---|---|---|---|---|
| Thermal Resistance | $\theta_{JC}$ | Junction to Case | NDG40 | 42 | °C/W | 1 |
| | $\theta_{Jb}$ | Junction to Base | | 2.4 | °C/W | 1 |
| | $\theta_{JA0}$ | Junction to Air, still air | | 39 | °C/W | 1 |
| | $\theta_{JA1}$ | Junction to Air, 1 m/s air flow | | 33 | °C/W | 1 |
| | $\theta_{JA3}$ | Junction to Air, 3 m/s air flow | | 28 | °C/W | 1 |
| | $\theta_{JA5}$ | Junction to Air, 5 m/s air flow | | 27 | °C/W | 1 |

[1]ePad soldered to board


© 2019 Renesas Electronics Corporation

# Package Outline and Dimensions (NDG40)

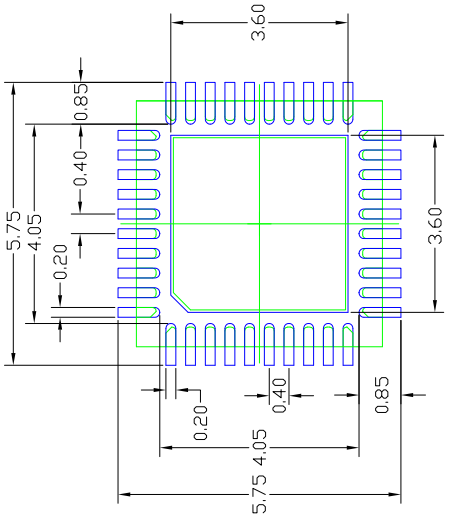




© 2019 Renesas Electronics Corporation

## Package Outline and Dimensions (NDG40), cont.

| REVISIONS | | | |
|---|---|---|---|
| REV | DESCRIPTION | DATE | APPROVED |
| 00 | INITIAL RELEASE | 5/17/16 | JH |




RECOMMENDED LAND PATTERN

NOTES:
1. ALL DIMENSIONS ARE IN mm. ANGLES IN DEGREES.
2. TOP DOWN VIEW AS VIEWED ON PCB.
3. COMPONENT OUTLINE SHOWS FOR REFERENCE IN GREEN.
4. LAND PATTERN IN BLUE, NSMD PATTERN ASSUMED.
5. LAND PATTERN RECOMMENDATION PER IPC-7351B GENERIC REQUIREMENT FOR SURFACE MOUNT DESIGN AND LAND PATTERN.

TOLERANCES
UNLESS SPECIFIED
DECIMAL ANGULAR
X±.1 ±1°
XX±.05
XXX± .030

| APPROVALS | DATE |
|---|---|
| DRAWN mue | 05/31/10 |
| CHECKED | |

IDT™
6024 SILVER CREEK VALLEY ROAD. SAN JOSE, CA 95138
PHONE: (408) 284-8200
FAX: (408) 284-3572
www.IDT.com

TITLE NDG40 PACKAGE OUTLINE
5.0 x 5.0 mm BODY,EPAD 3.50mm SQ.
0.40 mm PITCH QFN

SIZE C | DRAWING No. PSC-4292-02 | REV 00

DO NOT SCALE DRAWING | SHEET 2 OF 2


© 2019 Renesas Electronics Corporation

## Ordering Information

| Part / Order Number | Shipping Packaging | Package | Temperature |
|---|---|---|---|
| 9DBU0731AKLF | Trays | 40-pin VFQFPN | 0 to +70° C |
| 9DBU0731AKLFT | Tape and Reel | 40-pin VFQFPN | 0 to +70° C |
| 9DBU0731AKILF | Trays | 40-pin VFQFPN | -40 to +85° C |
| 9DBU0731AKILFT | Tape and Reel | 40-pin VFQFPN | -40 to +85° C |

**“LF” suffix to the part number are the Pb-Free configuration and are RoHS compliant.**
**“A” is the device revision designator (will not correlate with the datasheet revision).**

## Revision History

| Rev. | Initiator | Issue Date | Description | Page # |
|---|---|---|---|---|
| A | RDW | 7/16/2014 | 1. Updated electrical tables to final, and release | Various |
| B | RDW | 9/19/2014 | Updated SMBus Input High/Low parameters conditions, MAX values, and footnotes. | 6 |
| C | RDW | 4/17/2015 | 1. Updated pin out and pin descriptions to show ePad on package connected to ground.<br>2. Minor updates to front page text for family consistency.<br>3. Updated Clock Input Parameters table to be consistent with PCIe Vswing parameter. | 1-5 |
| D | RDW | 3/8/2017 | 1. Updated pin 25 from VDDA1.5 to VDDO1.5 to clearly indicate that this part has no PLL.<br>2. Removed "Bypass Mode" reference in "Output Duty Cycle..." and "Phase Jitter Parameters" tables; update note 3 under Output Duty Cycle table.<br>3. Changed VDDA to VDDO1.5 in Current Consumption table.<br>4. Updated Additive Phase Jitter conditions for PCIe Gen3. | 2,3,7,8 |


© 2019 Renesas Electronics Corporation

## IMPORTANT NOTICE AND DISCLAIMER

RENESAS ELECTRONICS CORPORATION AND ITS SUBSIDIARIES (“RENESAS”) PROVIDES TECHNICAL SPECIFICATIONS AND RELIABILITY DATA (INCLUDING DATASHEETS), DESIGN RESOURCES (INCLUDING REFERENCE DESIGNS), APPLICATION OR OTHER DESIGN ADVICE, WEB TOOLS, SAFETY INFORMATION, AND OTHER RESOURCES “AS IS” AND WITH ALL FAULTS, AND DISCLAIMS ALL WARRANTIES, EXPRESS OR IMPLIED, INCLUDING, WITHOUT LIMITATION, ANY IMPLIED WARRANTIES OF MERCHANTABILITY, FITNESS FOR A PARTICULAR PURPOSE, OR NON-INFRINGEMENT OF THIRD PARTY INTELLECTUAL PROPERTY RIGHTS.

These resources are intended for developers skilled in the art designing with Renesas products. You are solely responsible for (1) selecting the appropriate products for your application, (2) designing, validating, and testing your application, and (3) ensuring your application meets applicable standards, and any other safety, security, or other requirements. These resources are subject to change without notice. Renesas grants you permission to use these resources only for development of an application that uses Renesas products. Other reproduction or use of these resources is strictly prohibited. No license is granted to any other Renesas intellectual property or to any third party intellectual property. Renesas disclaims responsibility for, and you will fully indemnify Renesas and its representatives against, any claims, damages, costs, losses, or liabilities arising out of your use of these resources. Renesas' products are provided only subject to Renesas' Terms and Conditions of Sale or other applicable terms agreed to in writing. No use of any Renesas resources expands or otherwise alters any applicable warranties or warranty disclaimers for these products.

(Rev.1.0 Mar 2020)


### Corporate Headquarters

TOYOSU FORESIA, 3-2-24 Toyosu,
Koto-ku, Tokyo 135-0061, Japan
www.renesas.com

### Contact Information

For further information on a product, technology, the most up-to-date version of a document, or your nearest sales office, please visit:
www.renesas.com/contact/


### Trademarks

Renesas and the Renesas logo are trademarks of Renesas Electronics Corporation. All trademarks and registered trademarks are the property of their respective owners.

© 2020 Renesas Electronics Corporation. All rights reserved.