

Description

The 9FGL6241 / 9FGL6251 are intelligent buffer/clock generators tailored for single and dual-ported nVME SSDs. They support Common (CC) and Independent Reference (IR) clocking architectures and are ideal for U.2 and M.2 form factors. The devices are also useful in PCIe master/slave and clock multiplexing applications, with an internal clock generator as a third input channel.

Typical Applications

- 1 × 4 and 2 × 2 nVME SSDs
- 3:2 PCIe clock multiplexing

Output Features

- Two 100MHz Low-Power HCSL (LP-HCSL) outputs with $Z_o = 100\Omega$ or 85Ω
- One 33 1/3MHz or 25MHz 1.8V LVCMOS REF output
- One open drain CC_IR output indicates PCIe clock mode

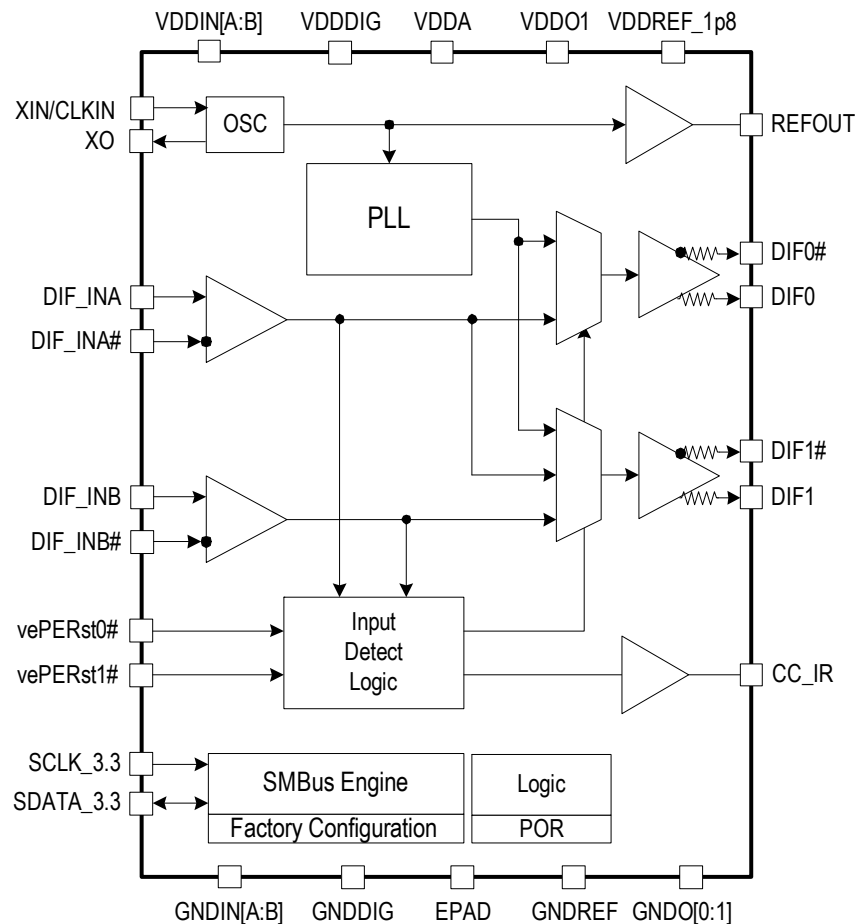
Features

- Supports single or dual-ported nVME drives
- Automatically detects presence or absence of input clocks
- Integrated terminations on LP-HCSL outputs save 8 resistors
- Choice of spread off (0% SRnS) or spread on (-0.5% SRIS) default
- Choice of 25MHz or 33 1/3MHz reference clock
- REF clock output; saves external XO
- 2.5V to 3.3V operating voltage
- 1.8V compatible, 3.3V tolerant single-ended I/O signaling
- Open-drain CC_IR output; maximum system flexibility
- 4 × 4 mm 28-VQFP-N package with external crystal
- 4 × 4 mm 28-LGA package with optional internal crystal

Key Specifications

- DIF cycle-to-cycle jitter < 50ps
- PCIe Gen1–4 (CC) compliant; Gen2–3 (IR) compliant

Block Diagram

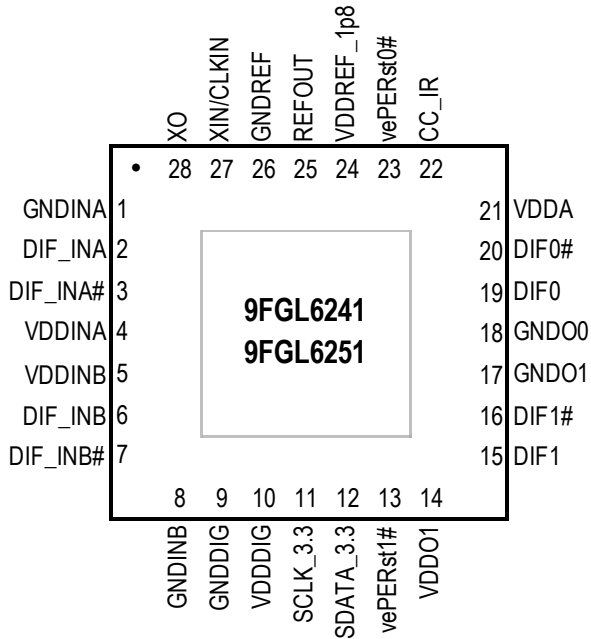


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Pin Assignments

Figure 1. Pin Assignments for 4 × 4 mm NDG28 28-VQFP-N Package – Top View

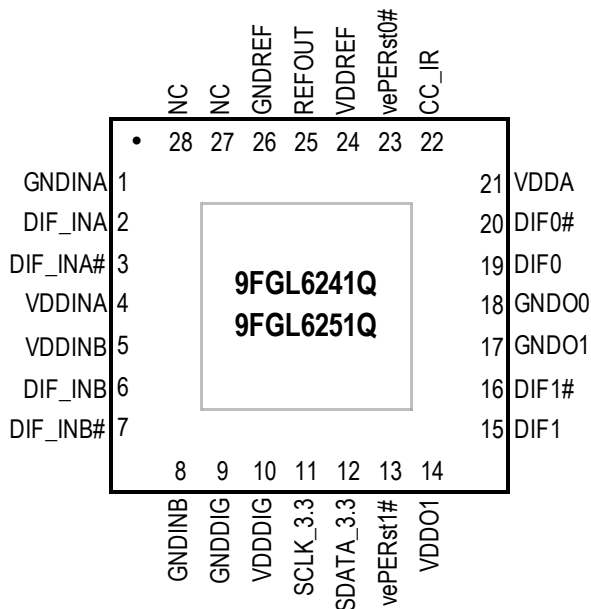


28-VQFP-N, 4 × 4 mm, 0.4mm pitch

^ prefix indicates internal 120kohm pull-up resistor

v prefix indicates internal 120kohm pull-down resistor

Figure 2. Pin Assignments for 4 × 4 mm LTG28 28-LGA Package – Top View



28-LGA, 4 × 4 mm, 0.4mm pitch

^ prefix indicates internal 120kohm pull-up resistor

v prefix indicates internal 120kohm pull-down resistor

Pin Descriptions

Table 1. Pin Descriptions

| Number | Name | Type | Description |
|--------|------------|-------------------|--|
| 1 | GNDINA | GND | Ground pin for input A. |
| 2 | DIF_INA | Input | True input of differential clock. |
| 3 | DIF_INA# | Input | Complement input of differential clock. |
| 4 | VDDINA | Power | Power supply for input A. |
| 5 | VDDINB | Power | Power supply for input B. |
| 6 | DIF_INB | Input | True input of differential clock. |
| 7 | DIF_INB# | Input | Complement input of differential clock. |
| 8 | GNDINB | GND | Ground pin for input B. |
| 9 | GNDDIG | GND | Ground pin for digital circuitry. |
| 10 | VDDDIG | Power | Digital power. |
| 11 | SCLK_3.3 | Input | Clock pin of SMBus circuitry, 3.3V tolerant. |
| 12 | SDATA_3.3 | I/O | Data pin for SMBus circuitry, 3.3V tolerant. |
| 13 | vePERst1# | Input | Enterprise PCIe Reset for Port B eSSD drives configured as 2 x 2. This active low signal indicates when the power supply is within specified voltage limits and is used to reset internal circuitry. The rising edge is used to determine the clocking mode. It is logically equivalent to PERST# reset signal. See the PCIe CEM specification for additional details. |
| 14 | VDDO1 | Power | Power supply for output 1. |
| 15 | DIF1 | Output | Differential true clock output. |
| 16 | DIF1# | Output | Differential complementary clock output. |
| 17 | GNDO1 | GND | Ground pin for output 1. |
| 18 | GNDO0 | GND | Ground pin for output 0. |
| 19 | DIF0 | Output | Differential true clock output. |
| 20 | DIF0# | Output | Differential complementary clock output. |
| 21 | VDDA | Power | Power supply for PLL core. See Power Connections table for additional information. |
| 22 | CC_IR | Open Drain Output | Output indicating which mode (CC or IR) is active. Input clocks are present and are being directed to the outputs in CC mode. Input clocks are absent and internally generated clocks are being directed to the outputs in IR mode. This pin is an open drain output and requires an external pull up resistor for proper functionality. The polarity of this pin is programmable. Consult the General SMBus Serial Interface Information registers for details. |
| 23 | vePERst0# | Input | Enterprise PCIe Reset for Port A eSSD drives configured as 1x4 or 2x2. This active low signal indicates when the power supply is within specified voltage limits and is used to reset internal circuitry. The rising edge is used to determine the clocking mode. It is logically equivalent to PERST# reset signal. See the PCIe CEM specification for additional details. |
| 24 | VDDREF_1p8 | Power | Power supply for XTAL and REF clocks, nominally 1.8V. |
| 25 | REFOUT | Output | Reference clock output. |
| 26 | GNDREF | GND | Ground pin for the REF outputs. |

Table 1. Pin Descriptions (Cont.)

| Number | Name | Type | Description |
|-------------------|-----------|--------|---|
| 27 ^[a] | XIN/CLKIN | Input | Crystal input or reference clock input. |
| 28 ^[a] | XO | Output | Crystal output. |
| 29 | EPAD | GND | Connect to ground. |

[a] These pins are no connect (NC) on devices with integrated crystal (9FGL6241Q and 9FGL6251Q).

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 9FGL6241 / 9FGL6251 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 | Units | Notes |
|---------------------------|-------------|----------------------------|---------|--------------|-------|-------|
| Supply Voltage | V_{DDx} | | | 4.6 | V | 1,2 |
| Input Voltage | V_{IN} | | -0.5 | $V_{DD}+0.5$ | 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 4.6V.

Thermal Characteristics

Table 3. Thermal Characteristics

| Symbol | Parameter | Package | Typical Values | Units | Notes |
|----------------|----------------------------------|---------|----------------|-------|-------|
| θ_{JC} | Junction to case. | LTG28 | 51.4 | °C/W | 1 |
| θ_{Jb} | Junction to base. | | 26.9 | °C/W | 1 |
| θ_{JA0} | Junction to air, still air. | | 68.6 | °C/W | 1 |
| θ_{JA1} | Junction to air, 1 m/s air flow. | | 63.5 | °C/W | 1 |
| θ_{JA3} | Junction to air, 3 m/s air flow. | | 58.6 | °C/W | 1 |
| θ_{JA5} | Junction to air, 5 m/s air flow. | | 56.2 | °C/W | 1 |

Table 3. Thermal Characteristics (Cont.)

| Symbol | Parameter | Package | Typical Values | Units | Notes |
|----------------|----------------------------------|---------|----------------|-------|-------|
| θ_{JC} | Junction to case. | NDG28 | 42 | °C/W | 1 |
| θ_{Jb} | Junction to base. | | 2.4 | °C/W | 1 |
| θ_{JA0} | Junction to air, still air. | | 39 | °C/W | 1 |
| θ_{JA1} | Junction to air, 1 m/s air flow. | | 33 | °C/W | 1 |
| θ_{JA3} | Junction to air, 3 m/s air flow. | | 28 | °C/W | 1 |
| θ_{JA5} | Junction to air, 5 m/s air flow. | | 27 | °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 | Units | Notes |
|---------------------------|--------------|---|---------|---------|---------|-------|-------|
| SMBus Input Low Voltage | V_{ILSMB} | | | | 0.63 | V | |
| SMBus Input High Voltage | V_{IHSMB} | | 1.17 | | 3.6 | 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} | | 1.8 | | 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. | | | 400 | kHz | 2 |

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

² The device must be powered up for the SMBus to function.

Table 5. Input/Supply/Common Parameters – Normal Operating Conditions

| Parameter | Symbol | Conditions | Minimum | Typical | Maximum | Units | Notes |
|-------------------------------|--------------|--|-----------------------|---------|-----------------------|-------|-------|
| Supply Voltage | $V_{DDx2.5}$ | 2.5V supply voltage for all V_{DD} pins except V_{DDREF} | 2.375 | 2.5 | 3.465 | V | |
| | $V_{DDx3.3}$ | 3.3V supply voltage for all V_{DD} pins except V_{DDREF} | 3.135 | 3.3 | 3.465 | V | |
| | V_{DDREF} | Supply voltage for crystal oscillator and REFOUT. | 1.71 | 1.8 | 1.89 | V | |
| Ambient Operating Temperature | T_{AMB} | Industrial range. | -40 | 25 | 85 | °C | |
| Input High Voltage | V_{IH} | Single-ended inputs, except SMBus and XIN/CLKIN. | $0.65 \times V_{DDx}$ | 1.6 | $V_{DDx} + 0.3$ | V | 4 |
| Input Low Voltage | V_{IL} | | -0.3 | | $0.35 \times V_{DDx}$ | V | 4 |

Table 5. Input/Supply/Common Parameters – Normal Operating Conditions (Cont.)

| Parameter | Symbol | Conditions | Minimum | Typical | Maximum | Units | Notes |
|--------------------------------|-----------------|--|-------------------------|---------|-------------------------|---------|-------|
| Input High Voltage | $V_{IHCLKIN}$ | XIN/CLKIN. | $0.65 \times V_{DDREF}$ | 1.6 | $V_{DDREF} + 0.3$ | V | 6 |
| Input Low Voltage | $V_{ILCLKIN}$ | | -0.3 | | $0.35 \times V_{DDREF}$ | V | 6 |
| Output High Voltage | V_{OHCC_IR} | CC_IR at default polarity. | V_{DDPU} | | V_{DDPU} | V | 5 |
| Output Low Voltage | V_{OLCC_IR} | CC_IR at default polarity. | | | 0.45 | V | |
| Input Current | I_{IN} | Single-ended inputs, $V_{IN} = GND$, $V_{IN} = V_{DD}$. | -5 | | 5 | μA | |
| | I_{INP} | Single-ended inputs. $V_{IN} = 0V$; inputs with internal pull-up resistors. $V_{IN} = V_{DD}$; inputs with internal pull-down resistors. | -50 | | 50 | μA | |
| Input Frequency | F_{IN} | Differential inputs (DIF_IN). | | 100 | | MHz | |
| | | Crystal input or clock input, 3xx devices. | | 33 1/3 | | MHz | |
| | | Crystal input or clock input, 2xx devices. | | 25 | | MHz | |
| 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 |
| | C_{OUT} | Output pin capacitance. | | | 6 | pF | 1 |
| Clk Stabilization | t_{STAB} | From V_{DD} power-up and after input clock stabilization or deassertion of PD# to 1st clock. | | | 1 | ms | 1,2 |
| Output SS Modulation Frequency | f_{MOD} | Modulation frequency (triangular modulation). | 30 | 31.6 | 33 | kHz | |
| 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 |

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 The single-ended control inputs are 1.8V compatible and 3.3V tolerant.

⁵ The V_{OH} of CC_IR is determined by the external pull-up voltage, since this is an open drain output.

⁶ When driven by an external clock or XO, it must be AC coupled to the CLKIN pin.

Table 6. Differential Clock Input Parameters

| Parameter | Symbol | Conditions | Minimum | Typical | Maximum | Units | Notes |
|----------------------------------|-------------|---|---------|---------|---------|---------|-------|
| Input Crossover Voltage – DIF_IN | V_{CROSS} | Cross over 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 $\pm 75mV$ window centered around differential zero.

Table 7. Current Consumption

| Parameter | Symbol | Conditions | Minimum | Typical | Maximum | Units | Notes |
|--------------------------|------------------|---|---------|---------|---------|-------|-------|
| Operating Supply Current | I_{DD_REF} | V_{DDREF} at 1.8V | | 1.7 | 2.6 | mA | |
| | $I_{DD_VDD2.5}$ | 2.5V operation in IR mode, V_{DDREF} at 1.8V. | | 37 | 47 | mA | |
| | $I_{DD_VDD3.3}$ | 3.3V operation in IR mode, V_{DDREF} at 1.8V. | | 40 | 50 | mA | |
| | $I_{DD_VDD2.5}$ | 2.5V operation in CC mode, V_{DDREF} at 1.8V. | | 23 | 28 | mA | |
| | $I_{DD_VDD3.3}$ | 3.3V operation in CC mode, V_{DDREF} at 1.8V. | | 25 | 31 | mA | |

Table 8. Output Duty Cycle, Jitter, Skew and PLL Characteristics

| Parameter | Symbol | Conditions | Minimum | Typical | Maximum | Units | Notes |
|------------------------|---------------|------------------------------------|---------|---------|---------|-------|-------|
| Duty Cycle | t_{DC} | Measured differentially, IR Mode. | 45 | 49 | 55 | % | 1 |
| Duty Cycle Distortion | t_{DCD} | Measured differentially, CC Mode. | -1.5 | -0.3 | 0.7 | % | 1,3 |
| Skew, Input to Output | t_{pdBYP} | Fanout Mode, $V_T = 50\%$. | 3300 | 3962 | 4600 | ps | 1 |
| Skew, Output to Output | t_{sk3} | IR Mode, $V_T = 50\%$. | | 17 | 50 | ps | 1,4 |
| Jitter, Cycle to Cycle | $t_{jyc-cyc}$ | IR Mode. | | 20 | 50 | ps | 1,2 |
| | | <i>Additive</i> jitter in CC Mode. | | 0.3 | 10 | 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 when the device is operating in Common Clock Mode.

⁴ All outputs at default slew rate.

Table 9. DIF Low-Power HCSL Outputs

| Parameter | Symbol | Conditions | Minimum | Typical | Maximum | Units | Notes |
|------------------------|------------------------------|---|---------|---------|---------|-------|-------|
| Slew Rate | dV/dt | Scope averaging on, fast setting. | 1.3 | 2.2 | 3.2 | V/ns | 1,2,3 |
| | dV/dt | Scope averaging on, slow setting. | 0.7 | 1.5 | 2.5 | V/ns | 1,2,3 |
| Slew Rate Matching | Δ dV/dt | Slew rate matching. | | 9 | 20 | % | 1,4 |
| Voltage High | V _{HIGH} | Statistical measurement on single-ended signal using oscilloscope math function (scope averaging on). | 660 | 778 | 850 | mV | 7 |
| Voltage Low | V _{LOW} | | -150 | -4 | 150 | | 7 |
| Max Voltage | V _{max} | Measurement on single-ended signal using absolute value (scope averaging off). | | 799 | 1150 | mV | 7 |
| Min Voltage | V _{min} | | -300 | -35 | | | 7 |
| Crossing Voltage (abs) | V _{cross_abs} | Scope averaging off. | 250 | 412 | 550 | mV | 1,5 |
| Crossing Voltage (var) | Δ -V _{cross} | Scope averaging off. | | 29 | 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 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 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 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.

Table 10. PCIe Filtered Additive Phase Jitter Parameters–Common Clocked (CC) Architectures, 3.3V Fanout Mode

| Parameter | Symbol | Conditions | Minimum | Typical | Maximum | Industry Limits | Units | Notes |
|--|----------------------------|--|---------|---------|---------|-----------------|----------|---------|
| Additive Phase Jitter, CC (fanout buffer) Mode V _{DDREF} = 1.8V Other V _{DDs} = 3.3V | t _{jph} PCleG1-CC | PCIe Gen1. | | 0.0 | 4.5 | N/A | ps (p-p) | 1,2,5 |
| | t _{jph} PCleG2-CC | PCIe Gen2 Low Band 10kHz < f < 1.5MHz (PLL BW of 5–16MHz or 8–16MHz, CDR = 5MHz). | | 0.01 | 0.02 | | ps (rms) | 1,2,4,5 |
| | | PCIe Gen2 High Band 1.5MHz < f < Nyquist (50MHz) (PLL BW of 5–16MHz or 8–16MHz, CDR = 5MHz). | | 0.2 | 0.31 | | ps (rms) | 1,2,4,5 |
| | t _{jph} PCleG3-CC | PCIe Gen3 (PLL BW of 2–4MHz or 2–5MHz, CDR = 10MHz). | | 0.10 | 0.19 | | ps (rms) | 1,2,4,5 |
| | t _{jph} PCleG4-CC | PCIe Gen4 (PLL BW of 2–4MHz or 2–5MHz, CDR = 10MHz). | | 0.10 | 0.19 | | ps (rms) | 1,2,4,5 |

Table 11. PCIe Filtered Additive Phase Jitter Parameters–Common Clocked (CC) Architectures, 2.5V Fanout Mode

| Parameter | Symbol | Conditions | Minimum | Typical | Maximum | Industry Limits | Units | Notes |
|--|--------------------|--|---------|---------|---------|-----------------|----------|---------|
| Additive Phase Jitter, CC (fanout buffer) Mode $V_{DDREF} = 1.8V$ Other $V_{DDs} = 2.5V$ | $t_{jphPCIeG1-CC}$ | PCIe Gen1. | | 0.7 | 3.9 | N/A | ps (p-p) | 1,2,5 |
| | $t_{jphPCIeG2-CC}$ | PCIe Gen2 Low Band $10kHz < f < 1.5MHz$ (PLL BW of 5–16MHz or 8–16MHz, CDR = 5MHz). | | 0.01 | 0.02 | | ps (rms) | 1,2,4,5 |
| | | PCIe Gen2 High Band $1.5MHz < f < Nyquist (50MHz)$ (PLL BW of 5–16MHz or 8–16MHz, CDR = 5MHz). | | 0.2 | 0.33 | | ps (rms) | 1,2,4,5 |
| | $t_{jphPCIeG3-CC}$ | PCIe Gen3 (PLL BW of 2–4MHz or 2–5MHz, CDR = 10MHz). | | 0.12 | 0.20 | | ps (rms) | 1,2,4,5 |
| | $t_{jphPCIeG4-CC}$ | PCIe Gen4 (PLL BW of 2–4MHz or 2–5MHz, CDR = 10MHz). | | 0.12 | 0.20 | | ps (rms) | 1,2,4,5 |

¹ Applies to all outputs.

² Based on PCIe Base Specification Rev 4.0 version 1.0. See <http://www.pcisig.com> for latest specifications.

³ Sample size of at least 100K cycles. This figure extrapolates to 108ps pk-pk at 1M cycles for a BER of 1^{-12} .

⁴ For RMS values additive jitter is calculated by solving the following equation for b [$a^2 + b^2 = c^2$] where “a” is rms input jitter and “c” is rms total jitter.

⁵ Driven by 9FGL0841 or equivalent.

Table 12. PCIe Filtered Phase Jitter Parameters–3.3V Clock Generator Mode ^{4,5}

| Parameter | Symbol | Conditions | Minimum | Typical | Maximum | Industry Limits | Units | Notes | |
|--|--------------------|--|---------|---------|---------|-----------------|-------------|-------------|---------|
| PCIe Gen1 (Common Clock) | $t_{jphPCIeG1-CC}$ | SSC on or off, $V_{DDx} = 3.3V$, $V_{DDREF} = 1.8V$ | | 16 | 28 | 86 | ps (p-p) | 1,2,5 | |
| PCIe Gen2 Lo Band (Common Clock) 10kHz < f < 1.5MHz (PLL BW of 5–16MHz or 8–5MHz, CDR = 5MHz) | $t_{jphPCIeG2-CC}$ | | | 0.43 | 0.55 | 3 | ps (rms) | 1,2,4,5 | |
| PCIe Gen2 High Band (Common Clock) 1.5MHz < f < Nyquist (50MHz) (PLL BW of 5–16MHz or 8–5MHz, CDR = 5MHz) | | | | 0.9 | 1.37 | 3.1 | ps (rms) | 1,2,4,5 | |
| PCIe Gen3 (Common Clock) (PLL BW of 2–4MHz or 2–5MHz, CDR = 10MHz) | $t_{jphPCIeG3-CC}$ | | | | 0.25 | 0.38 | 1 | ps (rms) | 1,2,4,5 |
| PCIe Gen4 (Common Clock) (PLL BW of 2–4MHz or 2–5MHz, CDR = 10MHz) | $t_{jphPCIeG4-CC}$ | | | | 0.25 | 0.38 | 0.5 | ps (rms) | 1,2,4,5 |
| PCIe Gen2 (SRIS) (PLL BW of 16MHz, CDR = 5MHz) | $t_{jphPCIeG2-IR}$ | -0.5% spread, $V_{DDx} = 3.3V$, $V_{DDREF} = 1.8V$ | | 0.7 | 0.81 | 2 | ps (rms) | 1,2 | |
| PCIe Gen3 (SRIS) (PLL BW of 2–4MHz or 2–5MHz, CDR = 10MHz) | $t_{jphPCIeG3-IR}$ | | | | 0.6 | 0.67 | 0.7 | ps (rms) | 1,2 |
| PCIe Gen2 (SRIS) (PLL BW of 16MHz, CDR = 5MHz) | $t_{jphPCIeG2-IR}$ | -0.25% spread, $V_{DDx} = 3.3V$, $V_{DDREF} = 1.8V$ | | 0.7 | 0.75 | 2 | ps (rms) | 1,2 | |
| PCIe Gen3 (SRIS) (PLL BW of 2–4MHz or 2–5MHz, CDR = 10MHz) | $t_{jphPCIeG3-IR}$ | | | | 0.4 | 0.44 | 0.7 | ps (rms) | 1,2 |

Table 13. PCIe Filtered Phase Jitter Parameters–2.5V Clock Generator Mode ^{4,5}

| Parameter | Symbol | Conditions | Minimum | Typical | Maximum | Industry Limits | Units | Notes | |
|--|--------------------|--|---------|---------|---------|-----------------|-------------|-------------|---------|
| PCIe Gen1 (Common Clock) | $t_{jphPCIeG1-CC}$ | SSC on or off, $V_{DDx} = 2.5V$, $V_{DDREF} = 1.8V$ | | 17 | 29 | 86 | ps (p-p) | 1,2,5 | |
| PCIe Gen2 Lo Band (Common Clock) 10kHz < f < 1.5MHz (PLL BW of 5–16MHz or 8–5MHz, CDR = 5MHz) | $t_{jphPCIeG2-CC}$ | | | 0.44 | 0.56 | 3 | ps (rms) | 1,2,4,5 | |
| PCIe Gen2 High Band (Common Clock) 1.5MHz < f < Nyquist (50MHz) (PLL BW of 5–16MHz or 8–5MHz, CDR = 5MHz) | | | | 1.0 | 1.5 | 3.1 | ps (rms) | 1,2,4,5 | |
| PCIe Gen3 (Common Clock) (PLL BW of 2–4MHz or 2–5MHz, CDR = 10MHz) | $t_{jphPCIeG3-CC}$ | | | | 0.29 | 0.41 | 1 | ps (rms) | 1,2,4,5 |
| PCIe Gen4 (Common Clock) (PLL BW of 2–4MHz or 2–5MHz, CDR = 10MHz) | $t_{jphPCIeG4-CC}$ | | | | 0.29 | 0.41 | 0.5 | ps (rms) | 1,2,4,5 |
| PCIe Gen2 (SRIS) (PLL BW of 16MHz, CDR = 5MHz) | $t_{jphPCIeG2-IR}$ | -0.5% spread, $V_{DDx} = 2.5V$, $V_{DDREF} = 1.8V$ | | 0.9 | 1.1 | 2 | ps (rms) | 1,2 | |
| PCIe Gen3 (SRIS) (PLL BW of 2–4MHz or 2–5MHz, CDR = 10MHz) | $t_{jphPCIeG3-IR}$ | | | | 0.62 | 0.70 | 0.7 | ps (rms) | 1,2 |
| PCIe Gen2 (SRIS) (PLL BW of 16MHz, CDR = 5MHz) | $t_{jphPCIeG2-IR}$ | -0.25% spread, $V_{DDx} = 2.5V$, $V_{DDREF} = 1.8V$ | | 0.80 | 1.01 | 2 | ps (rms) | 1,2 | |
| PCIe Gen3 (SRIS) (PLL BW of 2–4MHz or 2–5MHz, CDR = 10MHz) | $t_{jphPCIeG3-IR}$ | | | | 0.42 | 0.49 | 0.7 | ps (rms) | 1,2 |

¹ Applies to all outputs.

² Based on PCIe Base Specification Rev3.1a. These filters are different than common clock filters. See <http://www.pcisig.com> for latest specifications.

³ Sample size of at least 100K cycles. This figure extrapolates to 108ps pk-pk at 1M cycles for a BER of 1^{-12} .

⁴ As of PCIe Base Specification Rev4.0 version 1.0, IR is the new name for Separate Reference Independent Spread (SRIS) and Separate Reference no Spread (SRnS). Industry limits for IR clocking are not specified in the Base Specification; limits are commonly agreed upon with major customers.

⁵ All outputs at default slew rate (fast).

Table 14. REF Output

| Parameter | Symbol | Conditions | Minimum | Typical | Maximum | Units | Notes |
|------------------------|-------------------------------|---|---------|---------|---------|-------|-------|
| Long Accuracy | ppm | Independent Reference Mode. | -100 | 0 | 100 | ppm | 1,2 |
| Long Accuracy | ppm | Common Clock Mode. | 0 | | | ppm | 1,2 |
| Clock Period | $T_{\text{period}25\text{M}}$ | 25MHz reference input. | | 40 | | ns | 2 |
| | $T_{\text{period}33\text{M}}$ | 33 1/3MHz reference input. | | 30 | | ns | 2 |
| Rise/Fall Slew Rate | $t_{\text{rf}1}$ | Slowest slew rate, 20% to 80% of V_{DDREF} . | 0.5 | 0.89 | 1.6 | V/ns | 1 |
| | $t_{\text{rf}2}$ | Slow slew rate, 20% to 80% of V_{DDREF} . | 0.8 | 1.5 | 2.3 | V/ns | 1,3 |
| | $t_{\text{rf}3}$ | Fast slew rate, 20% to 80% of V_{DDREF} . | 0.8 | 1.5 | 2.3 | V/ns | 1 |
| | $t_{\text{rf}4}$ | Fastest slew rate, 20% to 80% of V_{DDREF} . | 1.0 | 1.7 | 2.4 | V/ns | 1 |
| Duty Cycle | d_{t1X} | $V_T = V_{\text{DD}}/2$ V. | 45 | 48.2 | 55 | % | 1,4 |
| Duty Cycle Distortion | d_{tcd} | $V_T = V_{\text{DD}}/2$ V. | -0.75 | 0.00 | 0 | % | 1,5 |
| Jitter, Cycle to Cycle | $t_{\text{jcc-cyc}}$ | $V_T = V_{\text{DD}}/2$ V. | | 52 | 250 | ps | 1,4 |

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

² Internal crystal, external crystal may be tuned to 0ppm.

³ Default SMBus value.

⁴ When driven by a crystal.

⁵ When driven by an external oscillator via the XIN/CLKIN pin, XO should be floating.

Power Management

Table 15. Operating Configuration Table (Byte0, bit 5 = 0)

| ePERst0# | DIF_INA | ePERst1# | DIF_INB | DIF0 | DIF1 | CC_IR ^{1,2} |
|----------|------------------|----------|------------------|----------|----------|----------------------|
| ↑ | No clock present | 0 | X | From PLL | From PLL | IR Mode |
| ↑ | Clock present | 0 | X | Input A | Input B | CC Mode |
| 0 | X | ↑ | No clock present | From PLL | From PLL | IR Mode |
| 0 | X | ↑ | Clock present | Input A | Input B | CC Mode |

¹ Polarity of CC_IR is determined by Byte3[3].

² CC_IR Mode is determined by the status of the input clock associated with the first ePERstn# to deassert.

³ Rising arrow indicates first ePERst# to deassert. Once an ePERst# has gone high, the other ePERst# is ignored.

Table 16. Operating Configuration Table (Byte0, bit 5 = 1)

| ePERst0# | DIF_INA | ePERst1# | DIF_INB | DIF0 | DIF1 | CC_IR ^{1,2} |
|----------|------------------|----------|---------|----------|----------|----------------------|
| ↑ | No clock present | X | X | From PLL | From PLL | IR Mode |
| ↑ | Clock present | X | X | Input A | Input A | CC Mode |

¹ Polarity of CC_IR is determined by Byte3[3].

² When set to 1, the device only responds to DIF_INA and ePERst0#. ePERst1# must remain low and never deassert.

Table 17. SMBus Address

| Address | + Read/Write Bit |
|---------|------------------|
| 1101000 | X |

Table 18. Power Connections

| Pin Number | | Description |
|-----------------|-----|----------------------|
| V _{DD} | GND | |
| 4 | 1 | DIF_INA |
| 5 | 8 | DIF_INB |
| 10 | 9 | Digital Power, SMBus |
| 14 | 17 | DIF1 |
| 21 | 18 | DIF0, PLL analog |
| 24 | 25 | XTAL, REF |

Timing Diagrams

Figure 3. Independent Reference Clock Mode from ePERst0# Deassertion

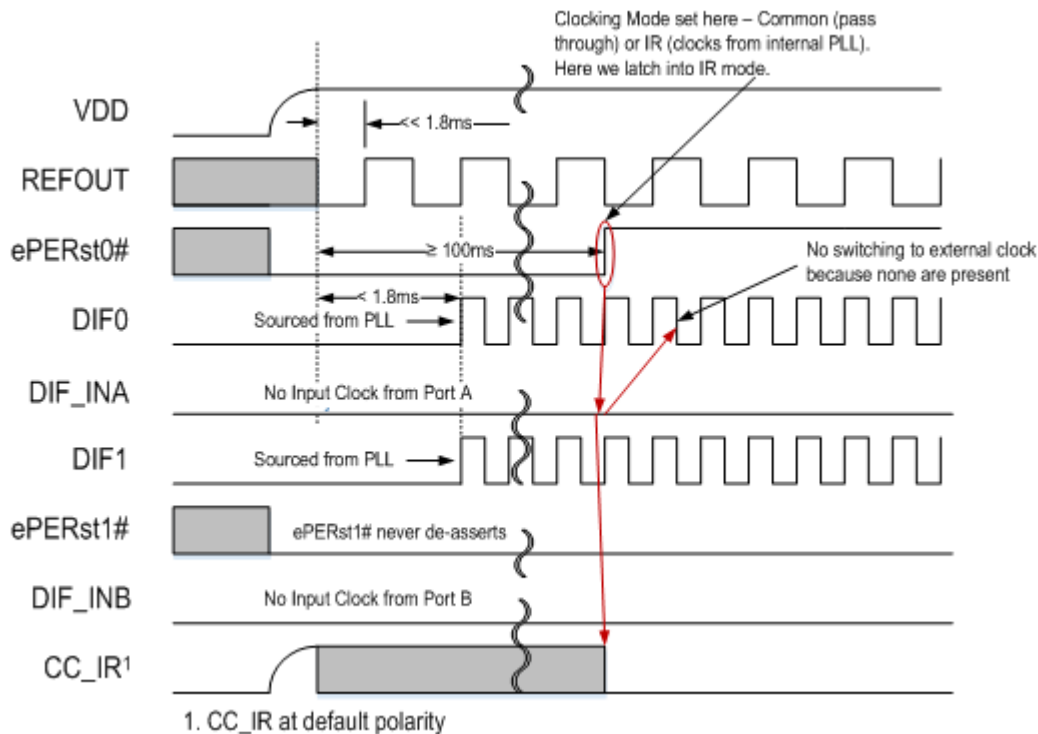
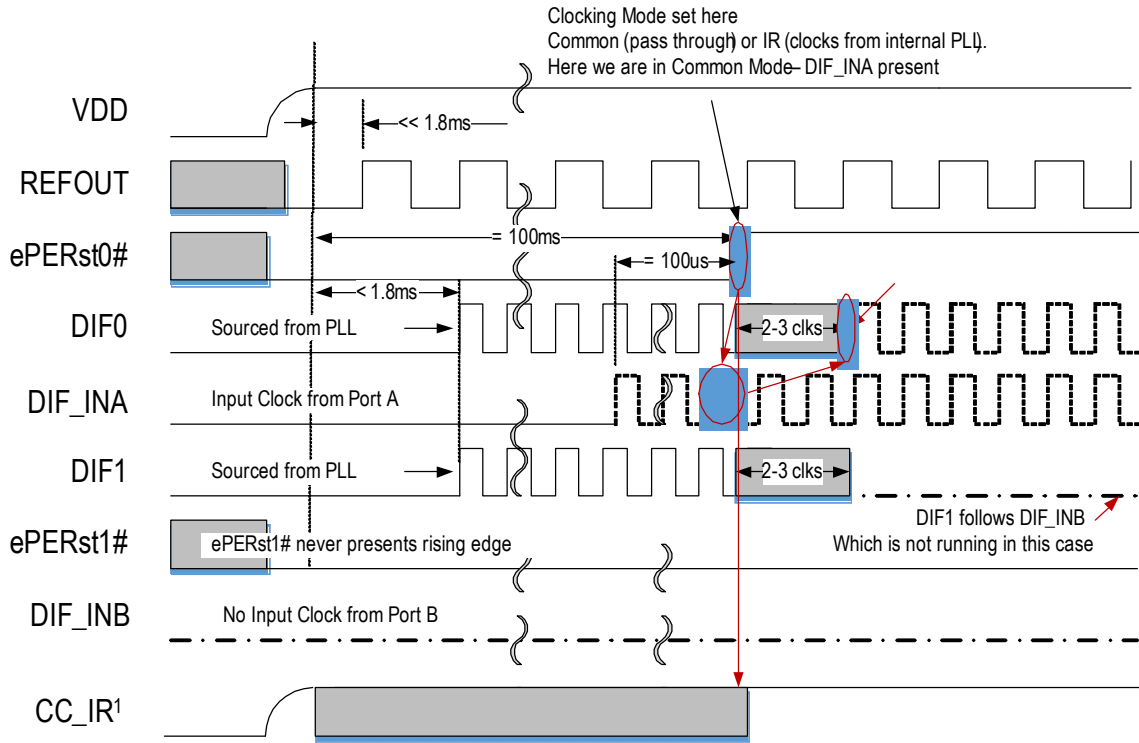
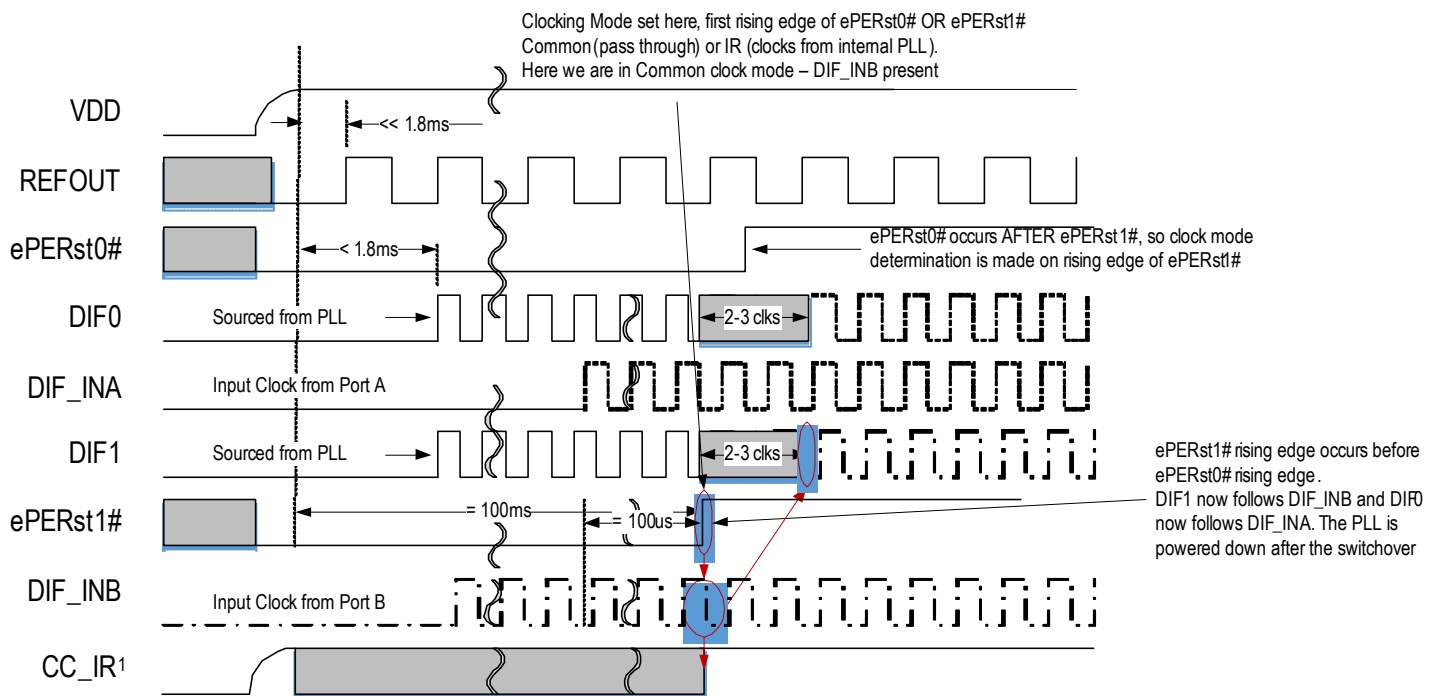


Figure 4. Common Clock Mode from ePERst0# Deassertion



1. CC_IR at default polarity

Figure 5. Common Clock Mode from ePERst1# Deassertion



1. CC_IR at default polarity

Test Loads

Figure 6. LVCMOS AC/DC Test Load

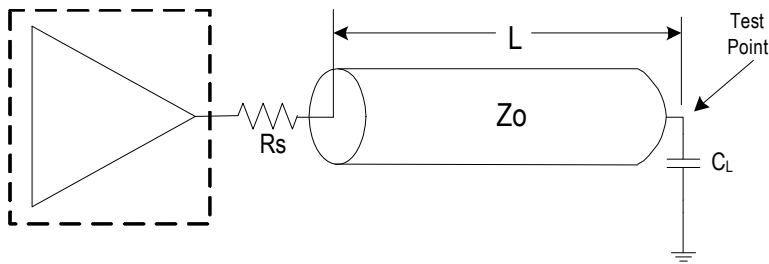


Figure 7. LP-HCSL AC/DC Test Load (standard PCIe source-terminated test load)

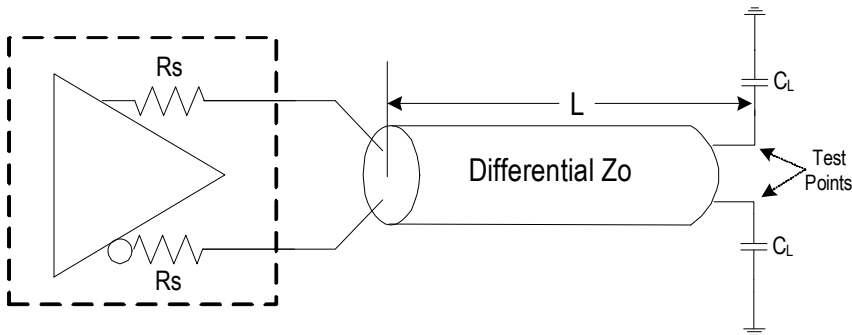


Figure 8. Test Setup for PCIe Jitter Measurements

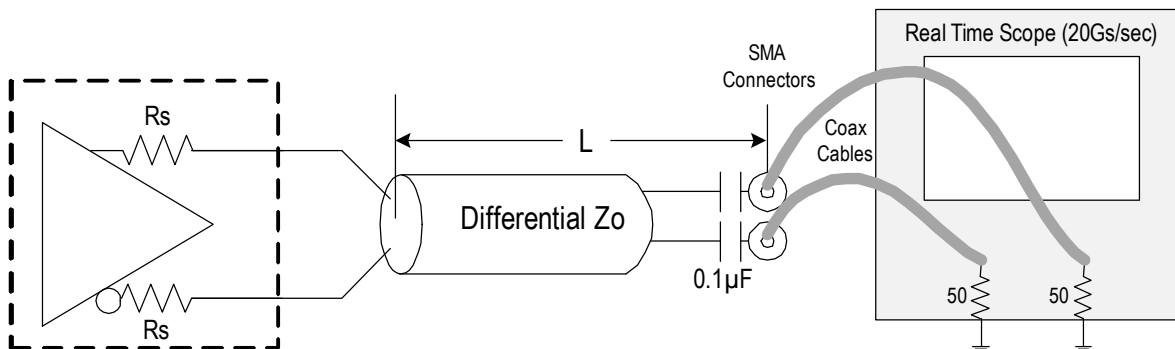


Table 19. Terminations

| Device | L (inches) | Zo (Ω) | Rs (Ω) | LVCMOS C_L (pF) | LP-HCSL C_L (pF) |
|----------|------------|-----------------|-----------------|-------------------|--------------------|
| 9FGL6241 | 10 | 100 | None needed | 4.7 | 2 |
| 9FGL6251 | 10 | 100 | 7.5 | | |
| 9FGL6251 | 10 | 85 | None needed | | |

Alternate Terminations

The 9FGL family can easily drive LVPECL, LVDS, and CML logic. See [“AN-891 Driving LVPECL, LVDS, and CML Logic with IDT’s “Universal” Low-Power HCSL Outputs”](#) for details.

Crystal Characteristics

Table 20. Recommended Crystal Characteristics

| Parameter | Value | Units |
|---|--------------------|-------------|
| Frequency | 25MHz or 33 1/3MHz | MHz |
| Resonance Mode | Fundamental | — |
| Frequency Tolerance @ 25°C | ±20 | ppm maximum |
| Frequency Stability, reference at 25°C over operating temperature range | ±20 | ppm maximum |
| Temperature Range (industrial) | -40–85 | °C |
| Equivalent Series Resistance (ESR) | 50 | Ω maximum |
| Shunt Capacitance (C _O) | 7 | pF maximum |
| Load Capacitance (C _L) | 6 | pF maximum |
| Drive Level | 0.3 | mW maximum |
| Aging per year | ±5 | ppm maximum |

Spread Spectrum Selection

Table 21. Spread Spectrum Selection for 201 and 301 Configurations

| Byte 1[4:3] | Description | Spread Amount | Notes |
|-------------|--------------|---------------|------------------------------------|
| 00 | SRnS Mode | 0 | Default configuration at power up. |
| 01 | CC Mode | 0 | Accessible via SMBus. |
| 10 | CC/SRIS Mode | -0.25% | Accessible via SMBus. |
| 11 | CC/SRIS Mode | -0.50% | Accessible via SMBus. |

The 201/301 devices are designed for Separate Reference clock No Spread applications. They power up in a special mode for this application (configuration 00). Using the SMBus to change to one of the other configurations will require a system reset. Transitioning back to configuration 00 from one of the other configurations will also require a system reset. Contact the factory if a different default configuration set is desired.

Table 22. Spread Spectrum Selection for 202 and 302 Configurations

| Byte 1[4:3] | Description | Spread Amount | Notes |
|-------------|--------------|---------------|------------------------------------|
| 00 | Reserved | 0 | Reserved. |
| 01 | CC Mode | 0 | Accessible via SMBus. |
| 10 | CC/SRIS Mode | -0.25% | Accessible via SMBus. |
| 11 | CC/SRIS Mode | -0.50% | Default configuration at power up. |

The 202/302 devices are configured for Common Clock/Separate Reference clock Independent Spread applications. They power up in configuration 11. The SMBus may be used to change cleanly between configuration 01 or 10 without requiring a system reset. Contact the factory if a different default configuration set is desired.

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 **acknowledge** 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: See [Ordering Information](#) for additional details on bits labeled "OTP Configured".

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 | X Byte | | |
| Slave Address | | | | |
| RD | ReaD | | | |
| | | | | ACK |
| | | | | |
| | | | Data Byte Count=X | |
| | | | | |
| | | | ACK | |
| | | | | |
| | | | Beginning Byte N | |
| | | | | |
| | | | O | |
| | | | O | |
| | | | O | |
| | | | | |
| | | | Byte N + X - 1 | |
| N | Not acknowledge | | | |
| P | stoP bit | | | |

SMBus Table: Output Enable and Status Readback Register

| Byte 0 | Name | Control Function | Type | 0 | 1 | Default |
|--------|--|---|------|-------------------------------------|---|------------------------|
| Bit 7 | DIF_INA Status | Presence of DIF_INA | R | DIF_INA not running | DIF_INA running | Real Time ² |
| Bit 6 | DIF_INB Status | Presence of DIF_INB | R | DIF_INB not running | DIF_INB running | Real Time ² |
| Bit 5 | 1x4 CC Mode Configuration ³ | Allows DIF_INA to drive both DIF0 and DIF1 in CC mode | RW | DIF_INA only drives DIF0 in CC Mode | DIF_INA drives both DIF[1:0] in CC Mode | 0 |
| Bit 4 | ePERst1# PD_EN | Enable pull-down on ePERst1# | RW | Pull-down disabled | Pull-down enabled | 1 |
| Bit 3 | ePERst0# PD_EN | Enable pull-down on ePERst0# | RW | Pull-down disabled | Pull-down enabled | 1 |
| Bit 2 | Reference Frequency | Specifies input frequency | RW | 25MHz | 33 1/3MHz | Part Number Dependent |
| Bit 1 | DIF1 OE | Output Enable | RW | Disabled ¹ | Enabled | 1 |
| Bit 0 | DIF0 OE | Output Enable | RW | Disabled ¹ | Enabled | 1 |

¹ The disabled state depends on Byte2[3:2]. '00' = Low, '01' = HiZ, '10' = Low, '11' = High.

² The state of both of these inputs at the time of the first rising edge of ePERst0# or ePERst1# determines the operating mode of the device.

³ Setting this bit to '1', allows the device to drive both DIF0 and DIF1 from DIF_INA in Common Clock mode. When set to '1', the device only responds to DIF_INA and ePERst0#. ePERst1# must remain low and never deassert.

SMBus Table: Spread Spectrum and V_{HIGH} Control Register

| Byte 1 | Name | Control Function | Type | 0 | 1 | Default |
|--------|---|----------------------------------|------|--|----------------------------------|-----------------------|
| Bit 7 | CC_IR Status ¹ | CC-IR Readback | R | Common Clock Mode | Independent RefClk Mode | Latched |
| Bit 6 | CC_IR_Mode Override ² | Forces desired CC_IR Mode | RW | Common Clock Mode | Independent RefClk Mode | 0 |
| Bit 5 | CC_IR_Override_Enable | Enable SW override of CC_IR Mode | RW | CC_IR controlled by ePERst logic | Byte1, bit 6 controls CC_IR Mode | 0 |
| Bit 4 | Spread Spectrum Default[1] ³ | Spread Spectrum default | RW | 00' = SS Off, '01' = -0.25% SS, '10' = Reserved, '11' = -0.5% SS | | Part Number Dependent |
| Bit 3 | Spread Spectrum Default[0] ³ | | RW | | | |
| Bit 2 | Reserved | | | | | X |
| Bit 1 | DIF Amplitude[1] | Controls output amplitude | RW | 00 = 0.6V | 01 = 0.68V | 1 |
| Bit 0 | DIF Amplitude[0] | | RW | 10 = 0.75V | 11 = 0.85V | 0 |

¹ This bit indicates the state of the input clock (operating mode) associated with the first ePERst# signal to deassert and is latched upon its deassertion.

² Byte 1, bit 5 must be set to '1' for this bit to control operation of the part.

³ Setting this bit to '1', allows the device to drive both DIF0 and DIF1 from DIF_INA in Common Clock mode. When set to '1', the device only responds to DIF_INA and ePERst0#. ePERst1# must remain low and never de-assert.

SMBus Table: Slew Rate and Output Configuration Register

| Byte 2 | Name | Control Function | Type | 0 | 1 | Default |
|--------|--------------------|--|------|----------------|-----------------|--------------------------|
| Bit 7 | DIF[1]_IMP_1 | Differential output 1 impedance ^[a] | RW | ZOUT: 00 = 33Ω | ZOUT: 10 = 100Ω | Part Number Dependent |
| Bit 6 | DIF[1]_IMP_0 | | RW | ZOUT: 01 = 85Ω | 11 = Reserved | |
| Bit 5 | DIF[0]_IMP_1 | Differential output 0 impedance ^[a] | RW | ZOUT: 00 = 33Ω | ZOUT: 10 = 100Ω | |
| Bit 4 | DIF[0]_IMP_0 | | RW | ZOUT: 01 = 85Ω | 11 = Reserved | |
| Bit 3 | STOP_STOP[1] | Output stop state (True/Complement) | RW | 00 = Low/Low | 10 = High/Low | 00 |
| Bit 2 | STOP_STATE[0] | | RW | 01 = HiZ/HiZ | 11 = Low/High | |
| Bit 1 | DIF1 SLEW RATE SEL | Adjust slew rate of DIF1 | RW | Slow setting | Fast setting | 1 |
| Bit 0 | DIF0 SLEW RATE SEL | Adjust slew rate of DIF0 | RW | Slow setting | Fast setting | 1 |

[a] 9FGL624x devices default to '10' (100Ω). 9FGL625x devices default to '01' (85Ω).

SMBus Table: REF and Polarity Control Register

| Byte 3 | Name | Control Function | Type | 0 | 1 | Default |
|--------|----------------|---------------------------|------|--|---|---------|
| Bit 7 | REF Slew Rate | Slew rate control | RW | 00 = Slowest | 01 = Slow | 0 |
| Bit 6 | | | RW | 10 = Fast | 11 = Fastest | 1 |
| Bit 5 | Reserved | | | | | X |
| Bit 4 | REF OE | REF output enable | RW | Disabled ^[a] | Enabled | 1 |
| Bit 3 | CC_IR POLARITY | Determines CC_IR polarity | RW | Low when input detected (Common Mode) | Low when Input is NOT detected (IR Mode) | 1 |
| Bit 2 | Reserved | | | | | X |
| Bit 1 | Reserved | | | | | X |
| Bit 0 | Reserved | | | | | X |

[a] The disabled state depends on Byte2[3:2]. '00' = Low, '01' = HiZ, '10' = Low, '11' = High.

SMBus Table: Reserved Register

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

Note: Byte 4 is reserved and reads back 'hFF'.

SMBus Table: Revision and Vendor ID Register

| Byte 5 | Name | Control Function | Type | 0 | 1 | Default |
|--------|------|------------------|------|---|---|---------|
| Bit 7 | RID3 | Revision ID | R | 1st silicon = 0000 A revision = 0001 | | 0 |
| Bit 6 | RID2 | | R | | | 0 |
| Bit 5 | RID1 | | R | | | 0 |
| Bit 4 | RID0 | | R | | | 1 |
| 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 ID7 | Device ID | RW | Device with external crystal in NDG28 = 1C hex Device with internal crystal in LTG28 = 18 hex | | 0 |
| Bit 6 | Device ID6 | | RW | | | 0 |
| Bit 5 | Device ID5 | | RW | | | 0 |
| Bit 4 | Device ID4 | | RW | | | 1 |
| Bit 3 | Device ID3 | | RW | | | 1 |
| Bit 2 | Device ID2 | | RW | | | x |
| Bit 1 | Device ID1 | | RW | | | 0 |
| Bit 0 | Device ID0 | | RW | | | 0 |

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 |

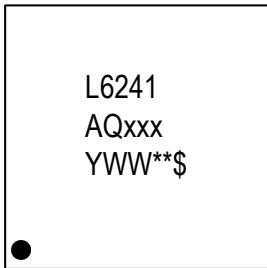
Package Outline Drawings

The package outline drawings are appended at the end of this document and are accessible from the link below. The package information is the most current data available.

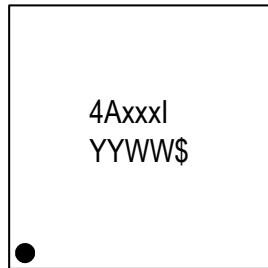
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www.idt.com/document/psc/lgt28-package-outline-40-x-40-mm-body-04-mm-pitch-lga

Marking Diagrams

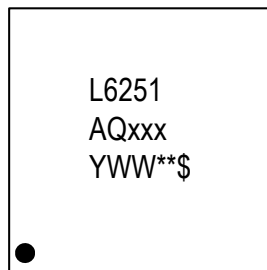


(for 9FGL6241
28-LGA devices)

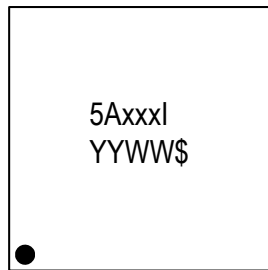


(for 9FGL6241
28-VQFP-N devices)

- Line 1 and 2 (Line 1 only on VQFP-N devices) is the truncated part number.
- “xxx” denotes dash code (201, 202, 301, 302)
- “YWW” or “YYWW” is the last digit(s) of the year and work-week that the part was assembled.
- “**” denotes sequential lot number.
- “\$” denotes mark code.



(for 9FGL6251
28-LGA devices)



(for 9FGL6251
28-VQFP-N devices)

Ordering Information

Table 23. Ordering Information

| Orderable Part Number | Crystal/XO | IR Spread Mode | DIF ZOUT | Package | Carrier Type | Temperature |
|-----------------------|-----------------------|----------------|----------|-----------|---------------|---------------|
| 9FGL6241AQ201LTGI | 25MHz internal | SSC off (SRNS) | 100Ω | 28-LGA | Trays | -40° to +85°C |
| 9FGL6241AQ201LTGI8 | | | | | Tape and Reel | |
| 9FGL6241AQ202LTGI | | SSC on (SRIS) | | | Trays | |
| 9FGL6241AQ202LTGI8 | | | | | Tape and Reel | |
| 9FGL6241AP201NDGI | 25MHz external | SSC off (SRNS) | | 28-VQFP-N | Trays | |
| 9FGL6241AP201NDGI8 | | | | | Tape and Reel | |
| 9FGL6241AP202NDGI | | SSC on (SRIS) | | | Trays | |
| 9FGL6241AP202NDGI8 | | | | | Tape and Reel | |
| 9FGL6241AQ301LTGI | 33 1/3MHz internal | SSC off (SRNS) | | 28-LGA | Trays | |
| 9FGL6241AQ301LTGI8 | | | | | Tape and Reel | |
| 9FGL6241AQ302LTGI | | SSC on (SRIS) | | | Trays | |
| 9FGL6241AQ302LTGI8 | | | | | Tape and Reel | |
| 9FGL6241AP301NDGI | 33 1/3MHz external | SSC off (SRNS) | | 28-VQFP-N | Trays | |
| 9FGL6241AP301NDGI8 | | | | | Tape and Reel | |
| 9FGL6241AP302NDGI | | SSC on (SRIS) | | | Trays | |
| 9FGL6241AP302NDGI8 | | | | | Tape and Reel | |
| 9FGL6251AQ201LTGI | 25MHz internal | SSC off (SRNS) | 85Ω | 28-LGA | Trays | |
| 9FGL6251AQ201LTGI8 | | | | | Tape and Reel | |
| 9FGL6251AQ202LTGI | | SSC on (SRIS) | | | Trays | |
| 9FGL6251AQ202LTGI8 | | | | | Tape and Reel | |
| 9FGL6251AP201NDGI | 25MHz external | SSC off (SRNS) | | 28-VQFP-N | Trays | |
| 9FGL6251AP201NDGI8 | | | | | Tape and Reel | |
| 9FGL6251AP202NDGI | | SSC on (SRIS) | | | Trays | |
| 9FGL6251AP202NDGI8 | | | | | Tape and Reel | |
| 9FGL6251AQ301LTGI | 33 1/3MHz internal | SSC off (SRNS) | | 28-LGA | Trays | |
| 9FGL6251AQ301LTGI8 | | | | | Tape and Reel | |
| 9FGL6251AQ302LTGI | | SSC on (SRIS) | | | Trays | |
| 9FGL6251AQ302LTGI8 | | | | | Tape and Reel | |
| 9FGL6251AP301NDGI | 33 1/3MHz external | SSC off (SRNS) | | 28-VQFP-N | Trays | |
| 9FGL6251AP301NDGI8 | | | | | Tape and Reel | |
| 9FGL6251AP302NDGI | | SSC on (SRIS) | | | Trays | |
| 9FGL6251AP302NDGI8 | | | | | Tape and Reel | |

“G” indicates RoHS 6 of 6 compliant.

Revision History

| Revision Date | Description of Change |
|------------------|-----------------------|
| October 11, 2018 | Initial release. |



Corporate Headquarters
 6024 Silver Creek Valley Road
 San Jose, CA 95138 USA
www.IDT.com

Sales
 1-800-345-7015 or 408-284-8200
 Fax: 408-284-2775
www.IDT.com/go/sales

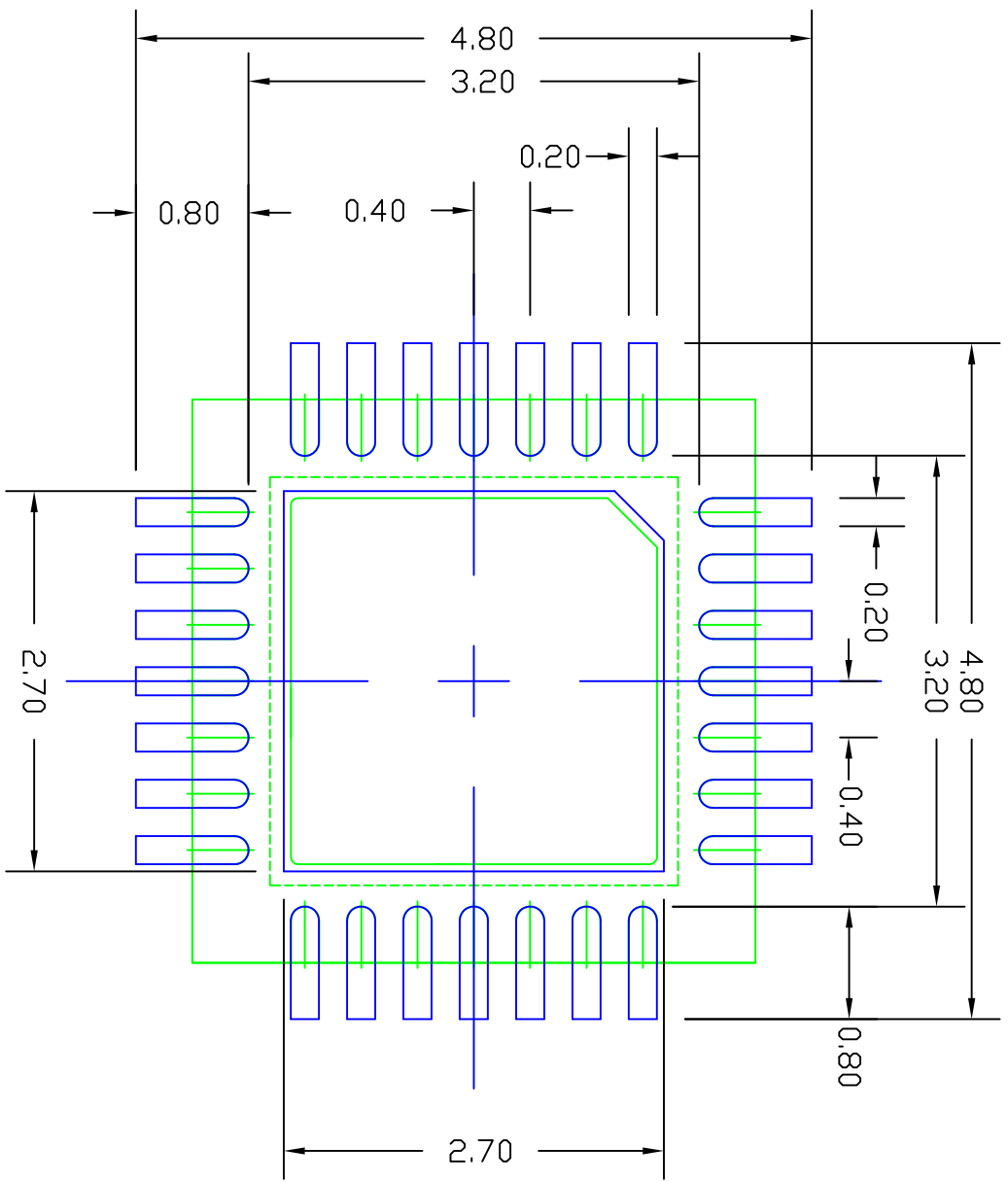
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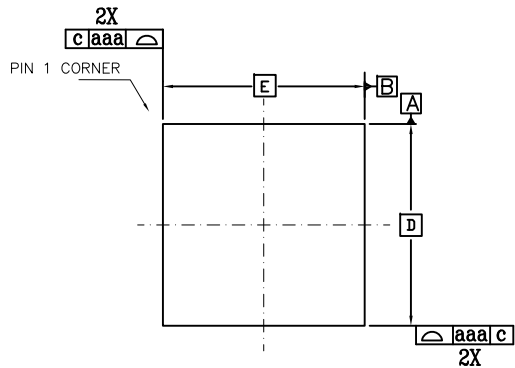
| REVISIONS | | | |
|-----------|----------------------------|----------|----------|
| REV | DESCRIPTION | DATE | APPROVED |
| 00 | INITIAL RELEASE | 03/13/09 | RT |
| 01 | COMBINE POD & LAND PATTERN | 12/13/13 | JH |



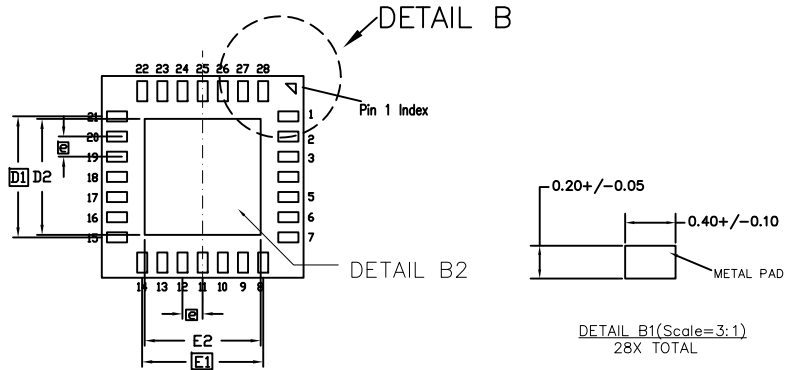
NOTES:

1. ALL DIMENSION ARE IN mm. ANGLES IN DEGREES.
2. TOP DOWN VIEW, AS VIEWED ON PCB.
3. COMPONENT OUTLINE SHOW 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.

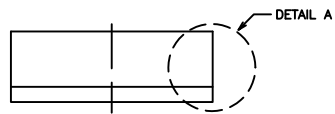
| | | | |
|---|--|---|------------|
| UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN MILLIMETERS DECIMAL XX.XX ±0.10 XXXX ±0.08 | | 6024 Silver Creek Valley Rd San Jose, CA 95138 PHONE: (408) 284-8333 FAX: (408) 284-8591 | |
| APPROVALS DRAWN: BAC CHECKED: | | DATE: 3/03/09 ND/NDG28 PACKAGE OUTLINE 4.0 X 4.0 X 0.9 mm BODY VQFP-N 0.4 mm Ball Pitch | |
| DRAWING No. PSC-4249 | | SIZE: C | SCALE: N/A |
| DO NOT SCALE DRAWING | | SHEET 2 | OF 2 |



TOP VIEW

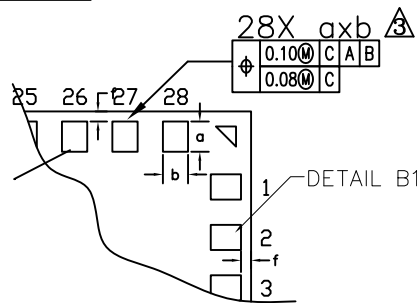


BOTTOM VIEW

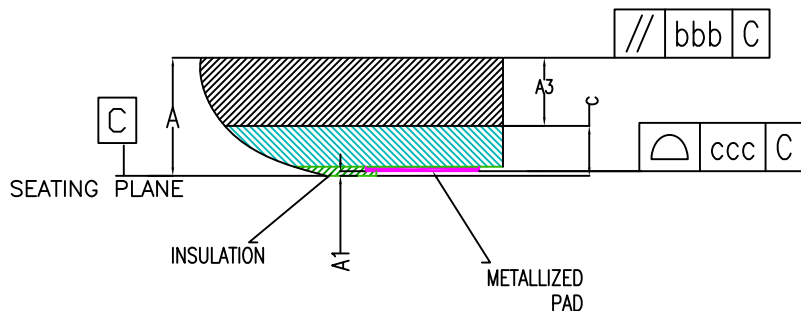


SIDE VIEW

METALLIZED PAD



DETAIL B1



DETAIL A

| REVISIONS HISTORY | | | |
|-------------------|-----|---|--------|
| DATE | REV | DESCRIPTION | AUTHOR |
| 02/15/17 | 00 | INITIAL RELEASE | CM |
| 03/08/17 | 01 | Updated total package thickness | CM |
| 03/22/17 | 02 | CORRECT PACKAGE DESCRIPTION FROM QFN to LGA | CM |

NOTE: REFER TO DCP FOR OFFICIAL RELEASE DATE.

| DIMENSIONAL REFERENCES | | | |
|------------------------|---|-----------|------|
| REF. | MIN. | NOM. | MAX. |
| A | 1.10 | 1.20 | 1.30 |
| A1 | - | - | 0.05 |
| A3 | | 1.00 REF. | |
| c | | 0.21 REF. | |
| D | | 4.00 BSC. | |
| D1 | | 2.40 BSC. | |
| D2 | | 2.30 REF. | |
| E | | 4.00 BSC. | |
| E1 | | 2.40 BSC. | |
| E2 | | 2.30 REF. | |
| a | Refer to metallized pad dim. (Details B1) | | |
| b | Refer to metallized pad dim. (Details B1) | | |
| f | | 0.10 REF. | |
| aaa | | 0.10 | |
| bbb | | 0.10 | |
| ccc | | 0.10 | |
| e | | 0.40 BSC. | |

NOTES:

1. ALL DIMENSIONS ARE IN MILLIMETERS.
2. 'e' REPRESENTS THE BASIC TERMINAL PITCH.
3. 'a x b' IS APPLIED TO METALLIZED TERMINAL.
4. DIMENSION 'ccc' IS MEASURED PARALLEL TO PRIMARY DATUM C.
5. METALLIZED PADS ARE Cu PAD WHICH EXPOSED SURFACE PLATED WITH Ni & Au.
6. DIMENSIONING AND TOLERANCING PER ASME Y14.5M 1994.
7. LEAD COUNT IS 28 EXCEPT CENTER PAD.

TOLERANCES UNLESS SPECIFIED
DECIMAL
XX±
XXX±
XXXX±
ANGULAR
±

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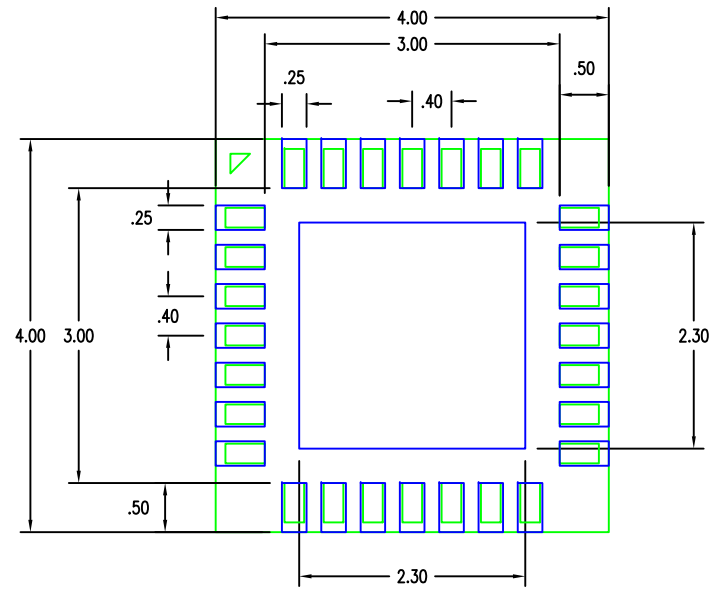
TITLE LTG28 PACKAGE OUTLINE
4.0 x 4.0 mm BODY
0.4 mm PITCH LGA

SIZE C DRAWING No. PSC-4687 REV 02

DO NOT SCALE DRAWING SHEET 1 OF 2

| REVISIONS HISTORY | | | |
|-------------------|-----|---|--------|
| DATE | REV | DESCRIPTION | AUTHOR |
| 02/15/17 | 00 | INITIAL RELEASE | CM |
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NOTE: REFER TO DCP FOR OFFICIAL RELEASE DATE.



RECOMMENDED LAND PATTERN DIMENSION

NOTES:

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| | | | |
|---|--|----------------------|--------------|
| TOLERANCES UNLESS SPECIFIED DECIMAL XX± XXX± XXXX± ANGULAR ± |  6024 Silver Creek Valley Road San Jose, CA 95138 PHONE: (408) 284-8200 www.IDT.com FAX: (408) 284-8591 | | |
| | TITLE LTG28 PACKAGE OUTLINE 4.0 x 4.0 mm BODY 0.4 mm PITCH LGA | | |
| | SIZE C | DRAWING No. PSC-4687 | REV 02 |
| | DO NOT SCALE DRAWING | | SHEET 2 OF 2 |