

## Two Output, Integrated VCO, Low-Jitter Clock Generator

Check for Samples: [CDCM61002](#)

### FEATURES

- One Crystal/LVCMOS Reference Input Including 24.8832 MHz, 25 MHz, and 26.5625 MHz
- Input Frequency Range: 21.875 MHz to 28.47 MHz
- On-Chip VCO Operates in Frequency Range of 1.75 GHz to 2.05 GHz
- 2x Output Available:
  - Pin-Selectable Between LVPECL, LVDS, or 2-LVCMOS; Operates at 3.3 V
- LVCMOS Bypass Output Available
- Output Frequency Selectable by /1, /2, /3, /4, /6, /8 from a Single Output Divider
- Supports Common LVPECL/LVDS Output Frequencies:
  - 62.5 MHz, 74.25 MHz, 75 MHz, 77.76 MHz, 100 MHz, 106.25 MHz, 125 MHz, 150 MHz, 155.52 MHz, 156.25 MHz, 159.375 MHz, 187.5 MHz, 200 MHz, 212.5 MHz, 250 MHz, 311.04 MHz, 312.5 MHz, 622.08 MHz, 625 MHz
- Supports Common LVCMOS Output Frequencies:
  - 62.5 MHz, 74.25 MHz, 75 MHz, 77.76 MHz, 100 MHz, 106.25 MHz, 125 MHz, 150 MHz, 155.52 MHz, 156.25 MHz, 159.375 MHz, 187.5 MHz, 200 MHz, 212.5 MHz, 250 MHz
- Output Frequency Range: 43.75 MHz to 683.264 MHz (See [Table 3](#))
- Internal PLL Loop Bandwidth: 400 kHz
- High-Performance PLL Core:
  - Phase Noise typically at –146 dBc/Hz at 5-MHz Offset for 625-MHz LVPECL Output
  - Random Jitter typically at 0.509 ps, RMS (10 kHz to 20 MHz) for 625-MHz LVPECL Output
- Output Duty Cycle Corrected to 50% ( $\pm 5\%$ )
- Low Output Skew of 20 ps on LVPECL Outputs

- Divider Programming Using Control Pins:
  - Two Pins for Prescaler/Feedback Divider
  - Three Pins for Output Divider
  - Two Pins for Output Select
- Chip Enable Control Pin Available
- 3.3-V Core and I/O Power Supply
- Industrial Temperature Range: –40°C to +85°C
- 5-mm × 5-mm, 32-pin, QFN (RHB) Package
- ESD Protection Exceeds 2 kV (HBM)

### APPLICATIONS

- Low Jitter Clock Driver for High-End Datacom Applications Including SONET, Ethernet, Fibre Channel, Serial ATA, and HDTV
- Cost-Effective High-Frequency Crystal Oscillator Replacement

### DESCRIPTION

The CDCM61002 is a highly versatile, low-jitter frequency synthesizer that can generate two low-jitter clock outputs, selectable between low-voltage positive emitter coupled logic (LVPECL), low-voltage differential signaling (LVDS), or low-voltage complementary metal oxide semiconductor (LVCMOS) outputs, from a low-frequency crystal or LVCMOS input for a variety of wireline and data communication applications. The CDCM61002 features an onboard PLL that can be easily configured solely through control pins. The overall output random jitter performance is less than 1ps, RMS (from 10 kHz to 20 MHz), making this device a perfect choice for use in demanding applications such as SONET, Ethernet, Fibre Channel, and SAN. The CDCM61002 is available in a small, 32-pin, 5-mm × 5-mm QFN package.



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This integrated circuit can be damaged by ESD. Texas Instruments recommends that all integrated circuits be handled with appropriate precautions. Failure to observe proper handling and installation procedures can cause damage.

ESD damage can range from subtle performance degradation to complete device failure. Precision integrated circuits may be more susceptible to damage because very small parametric changes could cause the device not to meet its published specifications.

## DESCRIPTION, CONTINUED

The CDCM61002 is a high-performance, low phase noise, fully-integrated voltage-controlled oscillator (VCO) clock synthesizer with two universal output buffers that can be configured to be LVPECL, LVDS, or LVCMOS compatible. Each universal output can also be converted to two LVCMOS outputs. Additionally, an LVCMOS bypass output clock is available in an output configuration which can help with crystal loading in order to achieve an exact desired input frequency. It has one fully-integrated, low-noise, LC-based VCO that operates in the 1.75 GHz to 2.05 GHz range.

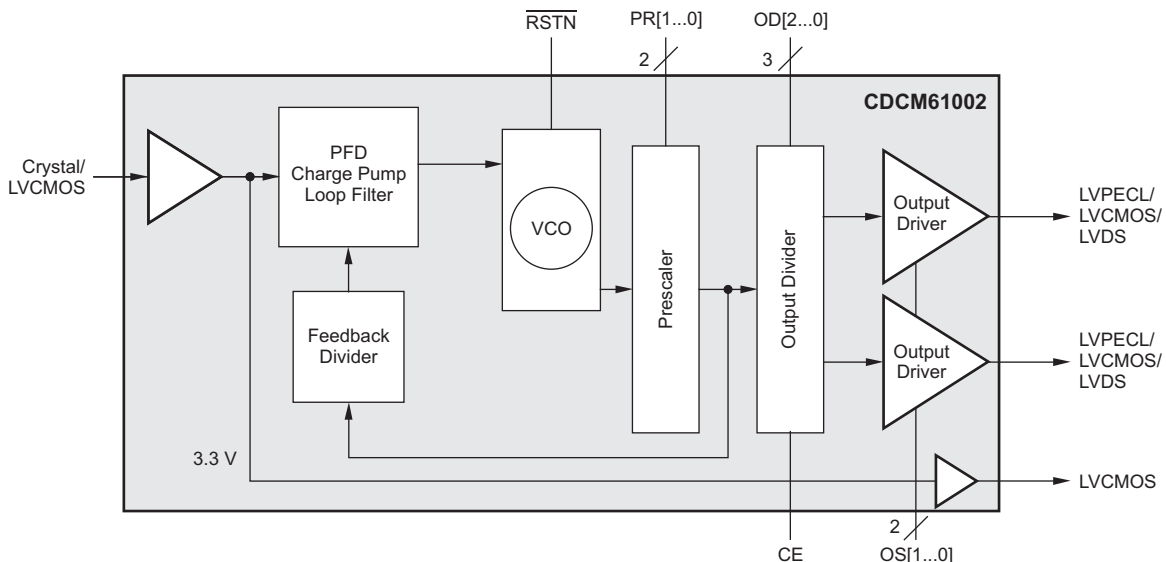
The phase-locked loop (PLL) synchronizes the VCO with respect to the input, which can either be a low-frequency crystal. The outputs share an output divider sourced from the VCO core. All device settings are managed through a control pin structure, which has two pins that control the prescaler and feedback divider, three pins that control the output divider, two pins that control the output type, and one pin that controls the output enable. Any time the PLL settings (including the input frequency, prescaler divider, or feedback divider) are altered, a reset must be issued through the Reset control pin (active low for device reset). The reset initiates a PLL recalibration process to ensure PLL lock. When the device is in reset, the outputs and divider are turned off.

The output frequency ( $f_{OUT}$ ) is proportional to the frequency of the input clock ( $f_{IN}$ ). The feedback divider, output divider, and VCO frequency set  $f_{OUT}$  with respect to  $f_{IN}$ . For a configuration setting for common wireline and datacom applications, refer to [Table 2](#). For other applications, use [Equation 1](#) to calculate the exact crystal oscillator frequency required for the desired output.

$$f_{IN} = \left( \frac{\text{Output Divider}}{\text{Feedback Divider}} \right) f_{OUT} \quad (1)$$

The output divider can be chosen from 1, 2, 3, 4, 6, or 8 through the use of control pins. Feedback divider and prescaler divider combinations can be chosen from 25 and 3, 24 and 3, 20 and 4, or 15 and 5, respectively, also through the use of control pins. [Figure 1](#) shows a high-level block diagram of the CDCM61002.

The device operates in a 3.3-V supply environment and is characterized for operation from  $-40^{\circ}\text{C}$  to  $+85^{\circ}\text{C}$ .



**Figure 1. CDCM61002 Block Diagram**

**AVAILABLE OPTIONS<sup>(1)</sup>**

| $T_A$          | PACKAGED DEVICES | FEATURES <sup>(2)</sup>                       |
|----------------|------------------|-----------------------------------------------|
| –40°C to +85°C | CDCM61002RHBT    | 32-pin QFN (RHB) package, small tape and reel |
|                | CDCM61002RHBR    | 32-pin QFN (RHB) package, tape and reel       |

- (1) For the most current specifications and package information, see the Package Option Addendum located at the end of this data sheet or refer to our web site at [www.ti.com](http://www.ti.com).
- (2) These packages conform to Lead (Pb)-free and green manufacturing specifications. Additional details including specific material content can be accessed at [www.ti.com/leadfree](http://www.ti.com/leadfree). GREEN: TI defines Green to mean Lead (Pb)-Free and in addition, uses less package materials that do not contain halogens, including bromine (Br), or antimony (Sb) above 0.1% of total product weight. N/A: Not yet available Lead (Pb)-Free; for estimated conversion dates, go to [www.ti.com/leadfree](http://www.ti.com/leadfree). Pb-FREE: TI defines Lead (Pb)-Free to mean RoHS compatible, including a lead concentration that does not exceed 0.1% of total product weight, and, if designed to be soldered, suitable for use in specified lead-free soldering processes.

**ABSOLUTE MAXIMUM RATINGS<sup>(1)</sup>**

Over operating free-air temperature range (unless otherwise noted).

| PARAMETER                                                                                                                      | VALUE                           | UNIT |
|--------------------------------------------------------------------------------------------------------------------------------|---------------------------------|------|
| $V_{CC\_OUT}$ ,<br>$V_{CC\_PLL1}$ ,<br>$V_{CC\_PLL2}$ ,<br>$V_{CC\_VCO}$ ,<br>$V_{CC\_IN}$ Supply voltage range <sup>(2)</sup> | –0.5 to 4.6                     | V    |
| $V_{IN}$ Input voltage range <sup>(3)</sup>                                                                                    | –0.5 to ( $V_{CC\_IN} + 0.5$ )  | V    |
| $V_{OUT}$ Output voltage range <sup>(3)</sup>                                                                                  | –0.5 to ( $V_{CC\_OUT} + 0.5$ ) | V    |
| $I_{IN}$ Input current                                                                                                         | 20                              | mA   |
| $I_{OUT}$ Output current                                                                                                       | 50                              | mA   |
| $T_{STG}$ Storage temperature range                                                                                            | –65 to +150                     | °C   |

- (1) Stresses beyond those listed under *absolute maximum ratings* may cause permanent damage to the device. These are stress ratings only, and functional operation of the device at these or any other conditions beyond those indicated under *recommended operating condition* is not implied. Exposure to absolute-maximum-rated conditions for extended periods may affect device reliability.
- (2) All supply voltages must be supplied simultaneously.
- (3) Input and output negative voltage ratings may be exceeded if the input and output clamp-current ratings are observed.

**RECOMMENDED OPERATING CONDITIONS**

Over operating free-air temperature range (unless otherwise noted).

| PARAMETER                                | MIN | NOM  | MAX  | UNIT |
|------------------------------------------|-----|------|------|------|
| $V_{CC\_OUT}$ Output supply voltage      | 3.0 | 3.30 | 3.60 | V    |
| $V_{CC\_PLL1}$ PLL supply voltage        | 3.0 | 3.30 | 3.60 | V    |
| $V_{CC\_PLL2}$ PLL supply voltage        | 3.0 | 3.30 | 3.60 | V    |
| $V_{CC\_VCO}$ On-chip VCO supply voltage | 3.0 | 3.30 | 3.60 | V    |
| $V_{CC\_IN}$ Input supply voltage        | 3.0 | 3.30 | 3.60 | V    |
| $T_A$ Ambient temperature                | –40 |      | +85  | °C   |

**DISSIPATION RATINGS<sup>(1)(2)</sup>**

| PARAMETER                                                        | TEST CONDITIONS | VALUE             | UNIT |
|------------------------------------------------------------------|-----------------|-------------------|------|
|                                                                  |                 | 4 × 4 VIAS ON PAD |      |
| $\theta_{JA}$ Thermal resistance, junction-to-ambient            | 0 LFM           | 35                | °C/W |
| $\theta_{JP}$ <sup>(3)</sup> Thermal resistance, junction-to-pad |                 | 4                 | °C/W |

- (1) The package thermal resistance is calculated in accordance with JESD 51 and JEDEC 2S2P (high-K board).
- (2) Connected to GND with nine thermal vias (0.3-mm diameter).
- (3)  $\theta_{JP}$  (junction-to-pad) is used for the QFN package, because the primary heat flow is from the junction to the GND pad of the QFN package.

## ELECTRICAL CHARACTERISTICS

At  $V_{CC} = 3\text{ V}$  to  $3.6\text{ V}$  and  $T_A = -40^\circ\text{C}$  to  $+85^\circ\text{C}$ , unless otherwise noted.

| PARAMETER                                                                  |                                  | TEST CONDITIONS                                                             | CDCM61002             |     |                       | UNIT    |
|----------------------------------------------------------------------------|----------------------------------|-----------------------------------------------------------------------------|-----------------------|-----|-----------------------|---------|
|                                                                            |                                  |                                                                             | MIN                   | TYP | MAX                   |         |
| Control Pin LVCMOS Input Characteristics                                   |                                  |                                                                             |                       |     |                       |         |
| V <sub>IH</sub>                                                            | Input high voltage               |                                                                             | 0.6V <sub>CC</sub>    |     |                       | V       |
| V <sub>IL</sub>                                                            | Input low voltage                |                                                                             |                       |     | 0.4V <sub>CC</sub>    | V       |
| I <sub>IH</sub>                                                            | Input high current               | V <sub>CC</sub> = 3.6 V, V <sub>IL</sub> = 0 V                              |                       |     | 200                   | μA      |
| I <sub>IL</sub>                                                            | Input low current                | V <sub>CC</sub> = 3 V, V <sub>IH</sub> = 3.6 V                              |                       |     | −200                  | μA      |
| LVCMOS Output Characteristics <sup>(1)</sup> (See Figure 9 and Figure 10)  |                                  |                                                                             |                       |     |                       |         |
| f <sub>OSC_OUT</sub>                                                       | Bypass output frequency          |                                                                             | 21.875                |     | 28.47                 | MHz     |
| f <sub>OUT</sub>                                                           | Output frequency                 |                                                                             | 43.75                 |     | 250                   | MHz     |
| V <sub>OH</sub>                                                            | Output high voltage              | V <sub>CC</sub> = min to max, I <sub>OH</sub> = −100 μA                     | V <sub>CC</sub> −0.5  |     |                       | V       |
| V <sub>OL</sub>                                                            | Output low voltage               | V <sub>CC</sub> = min to max, I <sub>OL</sub> = 100 μA                      |                       |     | 0.3                   | V       |
| t <sub>RJIT</sub>                                                          | RMS phase jitter                 | 250 MHz (10 kHz to 20 MHz)                                                  |                       |     | 0.85                  | ps, RMS |
| t <sub>SLEW-RATE</sub>                                                     | Output rise/fall slew rate       | 20% to 80%                                                                  | 2.4                   |     |                       | V/ns    |
| ODC                                                                        | Output duty cycle                |                                                                             | 45%                   |     | 55%                   |         |
| t <sub>SKEW</sub>                                                          | Skew between outputs             |                                                                             |                       |     | 50                    | ps      |
| I <sub>CC</sub> , LVCMOS                                                   | Device current, LVCMOS           | f <sub>IN</sub> = 25 MHz, f <sub>OUT</sub> = 250 MHz, C <sub>L</sub> = 5 pF | 120                   |     | 140                   | mA      |
| LVPECL Output Characteristics <sup>(2)</sup> (See Figure 11 and Figure 12) |                                  |                                                                             |                       |     |                       |         |
| f <sub>OUT</sub>                                                           | Output frequency                 |                                                                             | 43.75                 |     | 683.264               | MHz     |
| V <sub>OH</sub>                                                            | Output high voltage              |                                                                             | V <sub>CC</sub> −1.18 |     | V <sub>CC</sub> −0.73 | V       |
| V <sub>OL</sub>                                                            | Output low voltage               |                                                                             | V <sub>CC</sub> −2    |     | V <sub>CC</sub> −1.55 | V       |
| V <sub>OD</sub>                                                            | Differential output voltage      |                                                                             | 0.6                   |     | 1.23                  | V       |
| t <sub>RJIT</sub>                                                          | RMS phase jitter                 | 625 MHz (10 kHz to 20 MHz)                                                  |                       |     | 0.77                  | ps, RMS |
| t <sub>R</sub> /t <sub>F</sub>                                             | Output rise/fall time            | 20% to 80%                                                                  |                       |     | 175                   | ps      |
| ODC                                                                        | Output duty cycle                |                                                                             | 45%                   |     | 55%                   |         |
| t <sub>SKEW</sub>                                                          | Skew between outputs             |                                                                             |                       |     | 20                    | ps      |
| I <sub>CC</sub> , LVPECL                                                   | Device current, LVPECL           | f <sub>IN</sub> = 25 MHz, f <sub>OUT</sub> = 625 MHz                        | 126                   |     | 144                   | mA      |
| LVDS Output Characteristics <sup>(3)</sup> (See Figure 13 and Figure 14)   |                                  |                                                                             |                       |     |                       |         |
| f <sub>OUT</sub>                                                           | Output frequency                 |                                                                             | 43.75                 |     | 683.264               | MHz     |
| V <sub>OD</sub>                                                            | Differential output voltage      |                                                                             | 0.247                 |     | 0.454                 | V       |
| ΔV <sub>OD</sub>                                                           | V <sub>DD</sub> magnitude change |                                                                             |                       |     | 50                    | mV      |
| V <sub>OS</sub>                                                            | Common-mode voltage              |                                                                             | 1.125                 |     | 1.375                 | V       |
| ΔV <sub>OS</sub>                                                           | V <sub>OS</sub> magnitude change |                                                                             |                       |     | 50                    | mV      |
| t <sub>RJIT</sub>                                                          | RMS phase jitter                 | 625 MHz (10 kHz to 20 MHz)                                                  |                       |     | 0.73                  | ps, RMS |
| t <sub>R</sub> /t <sub>F</sub>                                             | Output rise/fall time            | 20% to 80%                                                                  |                       |     | 255                   | ps      |
| ODC                                                                        | Output duty cycle                |                                                                             | 45%                   |     | 55%                   |         |
| t <sub>SKEW</sub>                                                          | Skew between outputs             |                                                                             |                       |     | 30                    | ps      |
| I <sub>CC</sub> , LVDS                                                     | Device current, LVDS             | f <sub>IN</sub> = 25 MHz, f <sub>OUT</sub> = 625 MHz                        | 110                   |     | 125                   | mA      |

- (1) Figure 9 and Figure 10 show dc and ac test setups, respectively. Jitter measurements made using 25-MHz quartz crystal in.  
 (2) Figure 11 and Figure 12 show dc and ac test setups, respectively. Jitter measurements made using 25-MHz quartz crystal in.  
 (3) Figure 13 and Figure 14 show dc and ac test setups, respectively. Jitter measurements made using 25-MHz quartz crystal in.

## TYPICAL OUTPUT PHASE NOISE CHARACTERISTICS

Over operating free-air temperature range (unless otherwise noted).

| PARAMETER                                            |                                                                                    | TEST CONDITIONS | CDCM61002 |      |         | UNIT |
|------------------------------------------------------|------------------------------------------------------------------------------------|-----------------|-----------|------|---------|------|
|                                                      |                                                                                    |                 | MIN       | TYP  | MAX     |      |
| 250-MHz LVCMOS Output <sup>(1)</sup> (see Figure 10) |                                                                                    |                 |           |      |         |      |
| phn <sub>100</sub>                                   | Phase noise at 100-Hz offset                                                       |                 |           | –95  | dBc/Hz  |      |
| phn <sub>1k</sub>                                    | Phase noise at 1-kHz offset                                                        |                 |           | –110 | dBc/Hz  |      |
| phn <sub>10k</sub>                                   | Phase noise at 10-kHz offset                                                       |                 |           | –117 | dBc/Hz  |      |
| phn <sub>100k</sub>                                  | Phase noise at 100-kHz offset                                                      |                 |           | –120 | dBc/Hz  |      |
| phn <sub>1M</sub>                                    | Phase noise at 1-MHz offset                                                        |                 |           | –135 | dBc/Hz  |      |
| phn <sub>10M</sub>                                   | Phase noise at 10-MHz offset                                                       |                 |           | –148 | dBc/Hz  |      |
| phn <sub>20M</sub>                                   | Phase noise at 20-MHz offset                                                       |                 |           | –148 | dBc/Hz  |      |
| t <sub>RJIT</sub>                                    | RMS phase jitter from 10 kHz to 20 MHz                                             |                 |           | 544  | fs, RMS |      |
| t <sub>PJIT</sub>                                    | Total period jitter                                                                |                 |           | 27.4 | ps, PP  |      |
| t <sub>STARTUP</sub>                                 | Start-up time, power supply ramp time of 1 ms, final frequency accuracy of ±10 ppm |                 |           | 2.25 | ms      |      |
| 625-MHz LVPECL Output <sup>(2)</sup> (see Figure 12) |                                                                                    |                 |           |      |         |      |
| phn <sub>100</sub>                                   | Phase noise at 100-Hz offset                                                       |                 |           | –81  | dBc/Hz  |      |
| phn <sub>1k</sub>                                    | Phase noise at 1-kHz offset                                                        |                 |           | –101 | dBc/Hz  |      |
| phn <sub>10k</sub>                                   | Phase noise at 10-kHz offset                                                       |                 |           | –109 | dBc/Hz  |      |
| phn <sub>100k</sub>                                  | Phase noise at 100-kHz offset                                                      |                 |           | –112 | dBc/Hz  |      |
| phn <sub>1M</sub>                                    | Phase noise at 1-MHz offset                                                        |                 |           | –129 | dBc/Hz  |      |
| phn <sub>10M</sub>                                   | Phase noise at 10-MHz offset                                                       |                 |           | –146 | dBc/Hz  |      |
| phn <sub>20M</sub>                                   | Phase noise at 20-MHz offset                                                       |                 |           | –146 | dBc/Hz  |      |
| t <sub>RJIT</sub>                                    | RMS phase jitter from 10 kHz to 20 MHz                                             |                 |           | 509  | fs, RMS |      |
| t <sub>PJIT</sub>                                    | Total period jitter                                                                |                 |           | 26.9 | ps, PP  |      |
| t <sub>STARTUP</sub>                                 | Start-up time, power supply ramp time of 1 ms, final frequency accuracy of ±10 ppm |                 |           | 2.25 | ms      |      |
| 625-MHz LVDS Output <sup>(3)</sup> (see Figure 14)   |                                                                                    |                 |           |      |         |      |
| phn <sub>100</sub>                                   | Phase noise at 100-Hz offset                                                       |                 |           | –88  | dBc/Hz  |      |
| phn <sub>1k</sub>                                    | Phase noise at 1-kHz offset                                                        |                 |           | –102 | dBc/Hz  |      |
| phn <sub>10k</sub>                                   | Phase noise at 10-kHz offset                                                       |                 |           | –109 | dBc/Hz  |      |
| phn <sub>100k</sub>                                  | Phase noise at 100-kHz offset                                                      |                 |           | –112 | dBc/Hz  |      |
| phn <sub>1M</sub>                                    | Phase noise at 1-MHz offset                                                        |                 |           | –129 | dBc/Hz  |      |
| phn <sub>10M</sub>                                   | Phase noise at 10-MHz offset                                                       |                 |           | –146 | dBc/Hz  |      |
| phn <sub>20M</sub>                                   | Phase noise at 20-MHz offset                                                       |                 |           | –146 | dBc/Hz  |      |
| t <sub>RJIT</sub>                                    | RMS phase jitter from 10 kHz to 20 MHz                                             |                 |           | 510  | fs, RMS |      |
| t <sub>PJIT</sub>                                    | Total period jitter                                                                |                 |           | 27   | ps, PP  |      |
| t <sub>STARTUP</sub>                                 | Start-up time, power supply ramp time of 1 ms, final frequency accuracy of ±10 ppm |                 |           | 2.25 | ms      |      |

(1) Figure 10 shows test setup and uses 25-MHz quartz crystal in, V<sub>CC</sub> = 3.3 V, and T<sub>A</sub> = +25°C.

(2) Figure 12 shows test setup and uses 25-MHz quartz crystal in, V<sub>CC</sub> = 3.3 V, and T<sub>A</sub> = +25°C.

(3) Figure 14 shows test setup and uses 25-MHz quartz crystal, V<sub>CC</sub> = 3.3 V, and T<sub>A</sub> = +25°C.

**TYPICAL OUTPUT JITTER CHARACTERISTICS<sup>(1)</sup>**

| OUTPUT<br>FREQUENCY<br>(MHz) | INPUT (MHz) | LVCMOS OUTPUT     |                                       | LVPECL OUTPUT     |                                       | LVDS OUTPUT       |                                       |
|------------------------------|-------------|-------------------|---------------------------------------|-------------------|---------------------------------------|-------------------|---------------------------------------|
|                              |             | t <sub>RJIT</sub> | t <sub>PJIT</sub> (pS <sub>pp</sub> ) | t <sub>RJIT</sub> | t <sub>PJIT</sub> (pS <sub>pp</sub> ) | t <sub>RJIT</sub> | t <sub>PJIT</sub> (pS <sub>pp</sub> ) |
| 62.5                         | 25          | 592               | 32.9                                  | 611               | 20.7                                  | 667               | 28.4                                  |
| 75                           | 25          | 518               | 27.5                                  | 533               | 19.4                                  | 572               | 25.7                                  |
| 77.76                        | 24.8832     | 506               | 29.2                                  | 526               | 20.9                                  | 567               | 26.9                                  |
| 100                          | 25          | 507               | 24.5                                  | 510               | 20.7                                  | 533               | 26.5                                  |
| 106.25                       | 26.5625     | 535               | 23.5                                  | 524               | 20.2                                  | 553               | 26.5                                  |
| 125                          | 25          | 557               | 39.6                                  | 556               | 21.4                                  | 570               | 27.1                                  |
| 150                          | 25          | 518               | 38.4                                  | 493               | 18.9                                  | 515               | 26.2                                  |
| 155.52                       | 24.8832     | 498               | 36.9                                  | 486               | 19.8                                  | 502               | 26.7                                  |
| 156.25                       | 25          | 510               | 37.7                                  | 503               | 20.7                                  | 518               | 26.5                                  |
| 159.375                      | 26.5625     | 535               | 37.4                                  | 510               | 19.9                                  | 534               | 26.3                                  |
| 187.5                        | 25          | 506               | 32.8                                  | 506               | 20.3                                  | 509               | 25.5                                  |
| 200                          | 25          | 491               | 23.3                                  | 492               | 30                                    | 499               | 34.9                                  |
| 212.5                        | 26.5625     | 520               | 47.8                                  | 509               | 30.8                                  | 530               | 37.3                                  |
| 250                          | 25          | 544               | 27.4                                  | 541               | 21.4                                  | 550               | 27.5                                  |
| 311.04                       | 24.8832     |                   |                                       | 481               | 20.5                                  | 496               | 24.7                                  |
| 312.5                        | 25          |                   |                                       | 501               | 20.8                                  | 508               | 25.8                                  |
| 622.08                       | 24.8832     |                   |                                       | 492               | 27.2                                  | 500               | 27.2                                  |
| 625                          | 25          |                   |                                       | 515               | 26.9                                  | 509               | 27                                    |

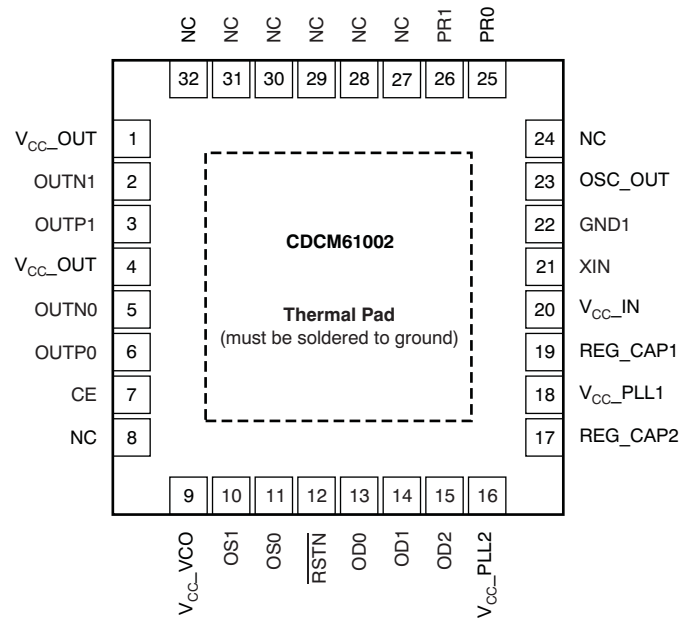
(1) [Figure 10](#), [Figure 12](#), and [Figure 14](#) show LVCMOS, LVPECL, and LVDS test setups (respectively) using appropriate quartz crystal in, V<sub>CC</sub> = 3.3 V, and T<sub>A</sub> = +25°C.

## CRYSTAL CHARACTERISTICS

| PARAMETER                          | MINIMUM     | TYPICAL | MAXIMUM | UNIT     |
|------------------------------------|-------------|---------|---------|----------|
| Mode of oscillation                | Fundamental |         |         | MHz      |
| Frequency                          | 21.875      |         | 28.47   | MHz      |
| Equivalent series resistance (ESR) |             |         | 50      | $\Omega$ |
| On-chip load capacitance           |             | 8       | 10      | pF       |
| Drive level                        | 0.1         |         | 1       | mW       |
| Maximum shunt capacitance          |             |         | 7       | pF       |

## DEVICE INFORMATION

### RHB PACKAGE QFN-32 (TOP VIEW)



## PIN FUNCTIONS

| PIN                      |                                     | TYPE   | DIRECTION <sup>(1)</sup> | DESCRIPTION                                                                |
|--------------------------|-------------------------------------|--------|--------------------------|----------------------------------------------------------------------------|
| NAME                     | PAD NO.                             |        |                          |                                                                            |
| VCC_OUT                  | 1, 4                                | Power  |                          | 3.3-V supply for the output buffer                                         |
| VCC_PLL1                 | 18                                  | Power  |                          | 3.3-V supply for the PLL circuitry                                         |
| VCC_PLL2                 | 16                                  | Power  |                          | 3.3-V supply for the PLL circuitry                                         |
| VCC_VCO                  | 9                                   | Power  |                          | 3.3-V supply for the internal VCO                                          |
| VCC_IN                   | 20                                  | Power  |                          | 3.3-V supply for the input buffers                                         |
| GND1                     | 22                                  | Ground |                          | Additional ground for device. (GND1 shorted on-chip to GND)                |
| GND                      | Pad                                 | Ground |                          | Ground is on thermal pad. See <a href="#">Thermal Management</a> .         |
| XIN                      | 21                                  | Input  |                          | Parallel resonant crystal/LVCMOS input                                     |
| OUTP0,<br>OUTN0          | 6, 5                                | Output |                          | Differential output pair or two single-ended outputs                       |
| OUTP1,<br>OUTN1          | 3, 2                                | Output |                          | Differential output pair or two single-ended outputs                       |
| OSC_OUT                  | 23                                  | Output |                          | Bypass LVCMOS output                                                       |
| REG_CAP1                 | 19                                  | Output |                          | Capacitor for internal regulator (connect to a 10-μF Y5V capacitor to GND) |
| REG_CAP2                 | 17                                  | Output |                          | Capacitor for internal regulator (connect to a 10-μF Y5V capacitor to GND) |
| PR1, PR0                 | 26, 25                              | Input  | Pull-up                  | Prescaler and Feedback divider control pins (see <a href="#">Table 4</a> ) |
| OD2, OD1,<br>OD0         | 15, 14, 13                          | Input  | Pull-up                  | Output divider control pins (see <a href="#">Table 5</a> )                 |
| OS1, OS0                 | 10, 11                              | Input  | Pull-up                  | Output type select control pin (see <a href="#">Table 6</a> )              |
| CE                       | 7                                   | Input  | Pull-up                  | Chip enable control pin (see <a href="#">Table 7</a> )                     |
| $\overline{\text{RSTN}}$ | 12                                  | Input  | Pull-up                  | Device reset (active low) (see <a href="#">Table 8</a> )                   |
| NC                       | 8, 24, 27, 28,<br>29, 30, 31,<br>32 |        |                          | No connection                                                              |

(1) Pull-up refers to internal input resistors; see [Pin Characteristics](#) for typical values.

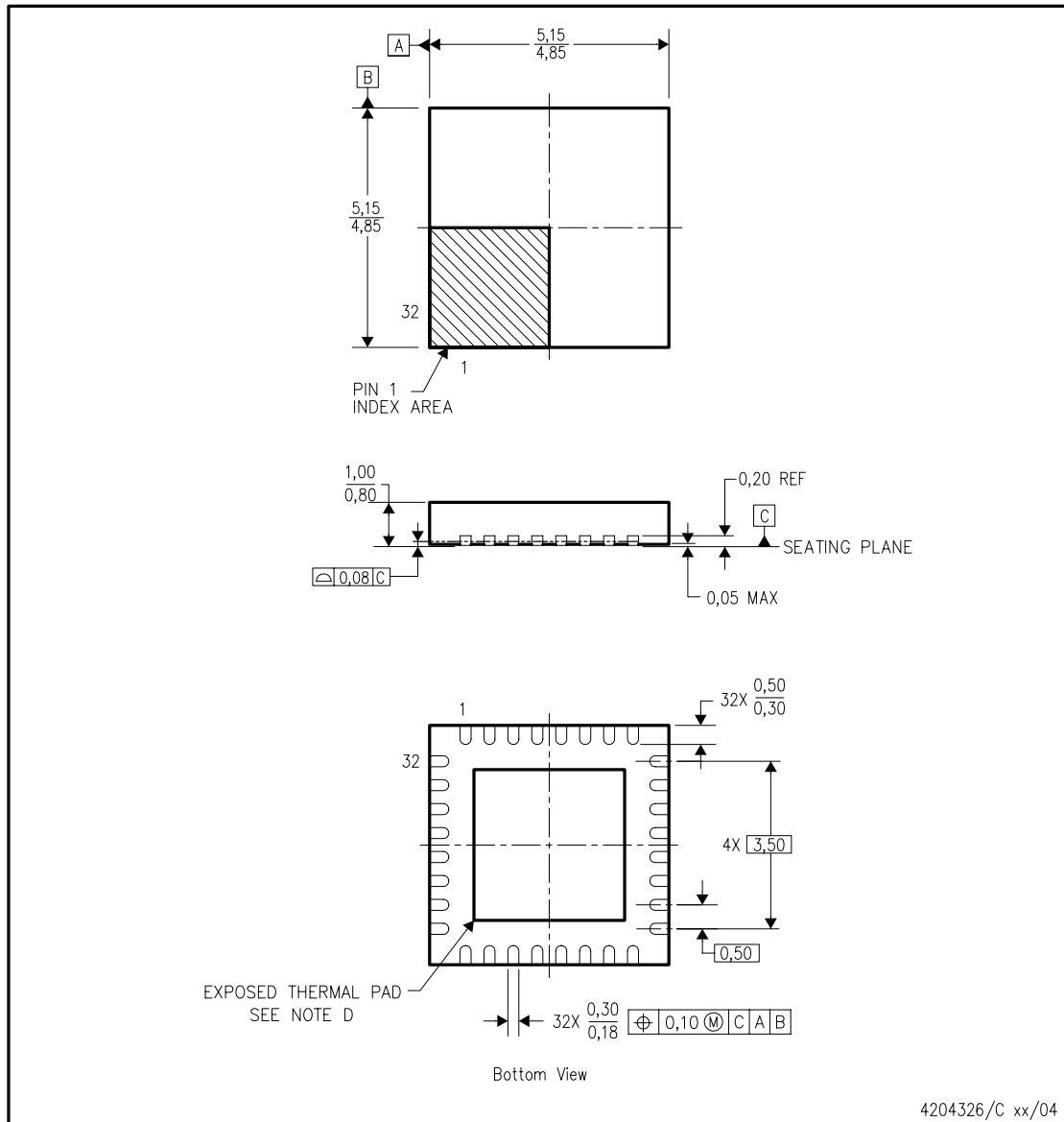
Table 1. PIN CHARACTERISTICS

| SYMBOL              | PARAMETER              | MIN | TYP | MAX | UNIT |
|---------------------|------------------------|-----|-----|-----|------|
| C <sub>IN</sub>     | Input capacitance      |     | 8   | 10  | pF   |
| R <sub>PULLUP</sub> | Input pull-up resistor |     | 150 |     | kΩ   |

**PACKAGE**

**RHB (S-PQFP-N32)**

**PLASTIC QUAD FLATPACK**



- NOTES:
- A. All linear dimensions are in millimeters.
  - B. This drawing is subject to change without notice.
  - C. QFN (Quad Flatpack No-Lead) Package configuration.
  - D. The Package thermal pad must be soldered to the board for thermal and mechanical performance. See product data sheet for details regarding the exposed thermal pad dimensions.
  - E. Falls within JEDEC MO-220.

**Figure 2. RHB Package**

The block diagram illustrates the internal architecture of the CDCM61002. It features several key components and signal paths:

- Power Supplies:**  $V_{CC\_IN}$ ,  $V_{CC\_PLL1}$ ,  $V_{CC\_PLL2}$ ,  $V_{CC\_VCO}$ ,  $V_{CC\_VDD}$ , and  $V_{CC\_OUT}$  are shown at the top.
- Input and Control:** Inputs include XIN, PR1, PR0, CAP1, CAP2, CE, and GND1. A control signal  $\overline{RSTN}$  is also present.
- PLL Core:**
  - XO LVCMOS:** Receives XIN.
  - Phase Frequency Detector:** Operates from 21.875 MHz to 28.47 MHz.
  - Charge Pump:** Provides 224  $\mu A$ .
  - Loop Filter:** Includes a graph showing a response curve with a 400 kHz characteristic frequency.
  - VCO:** Variable Frequency Oscillator operating from 1.75 GHz to 2.05 GHz.
- Dividers:**
  - Feedback Divider:** Contains dividers  $\div 15$ ,  $\div 20$ ,  $\div 24$ , and  $\div 25$ .
  - Prescaler Divider:** Contains dividers  $\div 5$ ,  $\div 4$ , and  $\div 3$ .
  - Output Divider:** Contains dividers  $\div 1$ ,  $\div 2$ ,  $\div 3$ ,  $\div 4$ ,  $\div 6$ , and  $\div 8$ .
  - DIV\_MUX:** A multiplexer that selects between the Feedback Divider and the Output Divider.
- Output Drivers:**
  - LVCMOS, LVPECL, LVDS:** Various output driver configurations.
  - Outputs:** OUTP[1...0], OUTN[1...0], and OSC\_OUT.
- Control Signals:** OD2, OD1, OD0, OS1, and OS0 are used to configure the dividers and output drivers.

## DEVICE CONFIGURATION

**Table 2. Common Configuration**

| INPUT (MHz) | PRESCALER DIVIDER | FEEDBACK DIVIDER | VCO FREQUENCY (MHz) | OUTPUT DIVIDER | OUTPUT FREQUENCY (MHz) | APPLICATION        |
|-------------|-------------------|------------------|---------------------|----------------|------------------------|--------------------|
| 25          | 4                 | 20               | 2000                | 8              | 62.5                   | GigE               |
| 24.75       | 3                 | 24               | 1782                | 8              | 74.25                  | HDTV               |
| 25          | 3                 | 24               | 1800                | 8              | 75                     | SATA               |
| 24.8832     | 3                 | 25               | 1866.24             | 8              | 77.76                  | SONET              |
| 25          | 3                 | 24               | 1800                | 6              | 100                    | PCI Express        |
| 26.5625     | 3                 | 24               | 1912.5              | 6              | 106.25                 | Fibre Channel      |
| 25          | 4                 | 20               | 2000                | 4              | 125                    | GigE               |
| 25          | 3                 | 24               | 1800                | 4              | 150                    | SATA               |
| 24.8832     | 3                 | 25               | 1866.24             | 4              | 155.52                 | SONET              |
| 25          | 3                 | 25               | 1875                | 4              | 156.25                 | 10 GigE            |
| 26.5625     | 3                 | 24               | 1912.5              | 4              | 159.375                | 10-G Fibre Channel |
| 25          | 5                 | 15               | 1875                | 2              | 187.5                  | 12 GigE            |
| 25          | 3                 | 24               | 1800                | 3              | 200                    | PCI Express        |
| 26.5625     | 3                 | 24               | 1912.5              | 3              | 212.5                  | 4-G Fibre Channel  |
| 25          | 4                 | 20               | 2000                | 2              | 250                    | GigE               |
| 24.8832     | 3                 | 25               | 1866.24             | 2              | 311.04                 | SONET              |
| 25          | 3                 | 25               | 1875                | 2              | 312.5                  | XGMII              |
| 24.8832     | 3                 | 25               | 1866.24             | 1              | 622.08                 | SONET              |
| 25          | 3                 | 25               | 1875                | 1              | 625                    | 10 GigE            |

**Table 3. Generic Configuration**

| INPUT FREQUENCY RANGE (MHz) | PRESCALER DIVIDER | FEEDBACK DIVIDER | VCO FREQUENCY RANGE (MHz) | OUTPUT DIVIDER | OUTPUT FREQUENCY RANGE (MHz) |
|-----------------------------|-------------------|------------------|---------------------------|----------------|------------------------------|
| 21.875 to 25.62             | 4                 | 20               | 1750 to 2050              | 8              | 54.6875 to 64.05             |
| 21.875 to 25.62             | 4                 | 20               | 1750 to 2050              | 6              | 72.92 to 85.4                |
| 21.875 to 25.62             | 4                 | 20               | 1750 to 2050              | 4              | 109.375 to 128.1             |
| 21.875 to 25.62             | 4                 | 20               | 1750 to 2050              | 3              | 145.84 to 170.8              |
| 21.875 to 25.62             | 4                 | 20               | 1750 to 2050              | 2              | 218.75 to 256.2              |
| 21.875 to 25.62             | 4                 | 20               | 1750 to 2050              | 1              | 437.5 to 512.4               |
| 23.33 to 27.33              | 3                 | 25               | 1750 to 2050              | 8              | 72.906 to 85.408             |
| 23.33 to 27.33              | 3                 | 25               | 1750 to 2050              | 6              | 97.21 to 113.875             |
| 23.33 to 27.33              | 3                 | 25               | 1750 to 2050              | 4              | 145.812 to 170.816           |
| 23.33 to 27.33              | 3                 | 25               | 1750 to 2050              | 3              | 194.42 to 227.75             |
| 23.33 to 27.33              | 3                 | 25               | 1750 to 2050              | 2              | 291.624 to 341.632           |
| 23.33 to 27.33              | 3                 | 25               | 1750 to 2050              | 1              | 583.248 to 683.264           |
| 23.33 to 27.33              | 5                 | 15               | 1750 to 2050              | 8              | 43.75 to 51.25               |
| 23.33 to 27.33              | 5                 | 15               | 1750 to 2050              | 6              | 58.33 to 68.33               |
| 23.33 to 27.33              | 5                 | 15               | 1750 to 2050              | 4              | 87.5 to 102.5                |
| 23.33 to 27.33              | 5                 | 15               | 1750 to 2050              | 3              | 116.66 to 136.66             |
| 23.33 to 27.33              | 5                 | 15               | 1750 to 2050              | 2              | 175 to 205                   |
| 23.33 to 27.33              | 5                 | 15               | 1750 to 2050              | 1              | 350 to 410                   |
| 24.305 to 28.47             | 3                 | 24               | 1750 to 2050              | 8              | 72.915 to 85.41              |
| 24.305 to 28.47             | 3                 | 24               | 1750 to 2050              | 6              | 97.22 to 113.88              |
| 24.305 to 28.47             | 3                 | 24               | 1750 to 2050              | 4              | 145.83 to 170.82             |

**Table 3. Generic Configuration (continued)**

| INPUT FREQUENCY RANGE (MHz) | PRESCALER DIVIDER | FEEDBACK DIVIDER | VCO FREQUENCY RANGE (MHz) | OUTPUT DIVIDER | OUTPUT FREQUENCY RANGE (MHz) |
|-----------------------------|-------------------|------------------|---------------------------|----------------|------------------------------|
| 24.305 to 28.47             | 3                 | 24               | 1750 to 2050              | 3              | 194.44 to 227.76             |
| 24.305 to 28.47             | 3                 | 24               | 1750 to 2050              | 2              | 291.66 to 341.64             |
| 24.305 to 28.47             | 3                 | 24               | 1750 to 2050              | 1              | 583.32 to 683.28             |

**Table 4. Programmable Prescaler and Feedback Divider Settings**

| CONTROL INPUTS |     | PRESCALER DIVIDER | FEEDBACK DIVIDER | PFD FREQUENCY |         |
|----------------|-----|-------------------|------------------|---------------|---------|
| PR1            | PR0 |                   |                  | MINIMUM       | MAXIMUM |
| 0              | 0   | 3                 | 24               | 24.305        | 28.47   |
| 0              | 1   | 5                 | 15               | 23.33         | 27.33   |
| 1              | 0   | 3                 | 25               | 23.33         | 27.33   |
| 1              | 1   | 4                 | 20               | 21.875        | 25.62   |

**Table 5. Programmable Output Divider**

| CONTROL INPUTS |     |     | OUTPUT DIVIDER |
|----------------|-----|-----|----------------|
| OD2            | OD1 | OD0 |                |
| 0              | 0   | 0   | 1              |
| 0              | 0   | 1   | 2              |
| 0              | 1   | 0   | 3              |
| 0              | 1   | 1   | 4              |
| 1              | 0   | 0   | Reserved       |
| 1              | 0   | 1   | 6              |
| 1              | 1   | 0   | Reserved       |
| 1              | 1   | 1   | 8              |

**Table 6. Programmable Output Type**

| CONTROL INPUTS |     | OUTPUT TYPE          |
|----------------|-----|----------------------|
| OS1            | OS0 |                      |
| 0              | 0   | LVC MOS, OSC_OUT Off |
| 0              | 1   | LVDS, OSC_OUT Off    |
| 1              | 0   | LVPECL, OSC_OUT Off  |
| 1              | 1   | LVPECL, OSC_OUT On   |

**Table 7. Output Enable**

| CONTROL INPUT | OPERATING CONDITION | OUTPUT |
|---------------|---------------------|--------|
| CE            |                     |        |
| 0             | Power Down          | Hi-Z   |
| 1             | Normal              | Active |

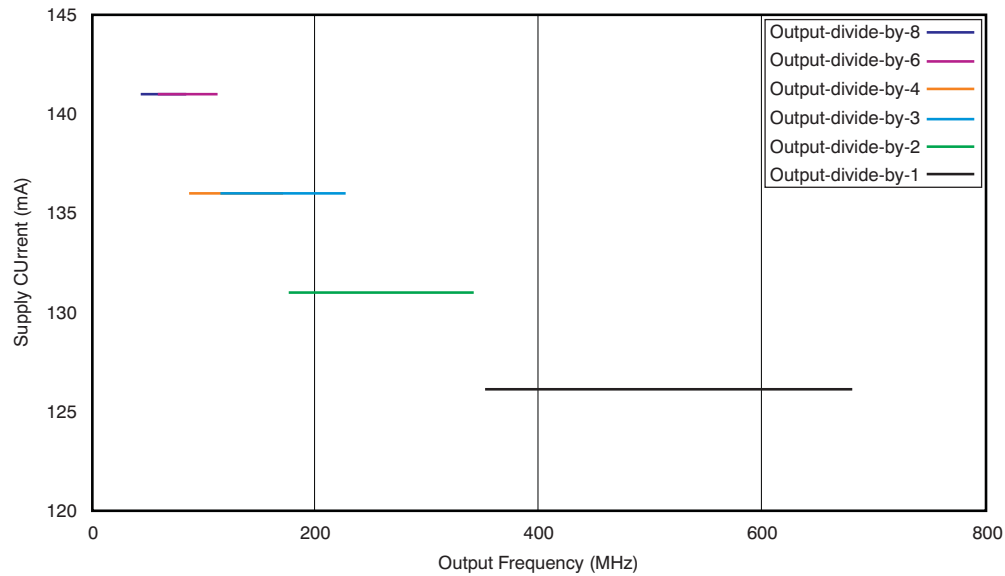
**Table 8. Reset**

| CONTROL INPUT | OPERATING CONDITION | OUTPUT |
|---------------|---------------------|--------|
| RSTN          |                     |        |
| 0             | Device Reset        | Hi-Z   |
| 0 → 1         | PLL Recalibration   | Hi-Z   |
| 1             | Normal              | Active |

## TYPICAL CHARACTERISTICS

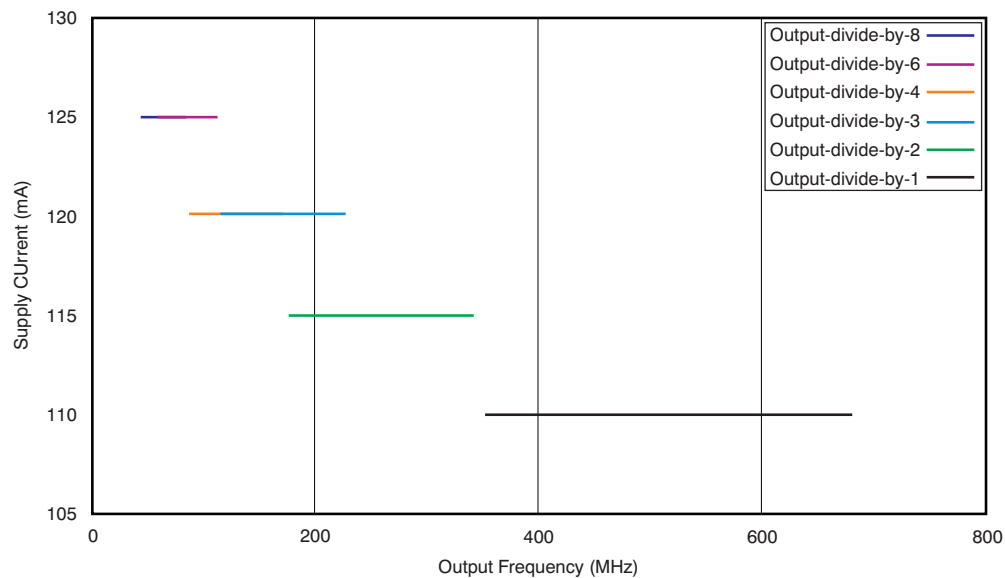
Over operating free-air temperature range (unless otherwise noted).

### TYPICAL CURRENT CONSUMPTION FOR LVPECL OUTPUT vs OUTPUT FREQUENCY



**Figure 3.**

### TYPICAL CURRENT CONSUMPTION FOR LVDS OUTPUT vs OUTPUT FREQUENCY



**Figure 4.**

## TYPICAL CHARACTERISTICS (continued)

Over operating free-air temperature range (unless otherwise noted).

### TYPICAL CURRENT CONSUMPTION FOR LVCMOS OUTPUT WITH 5-pF LOAD vs OUTPUT FREQUENCY

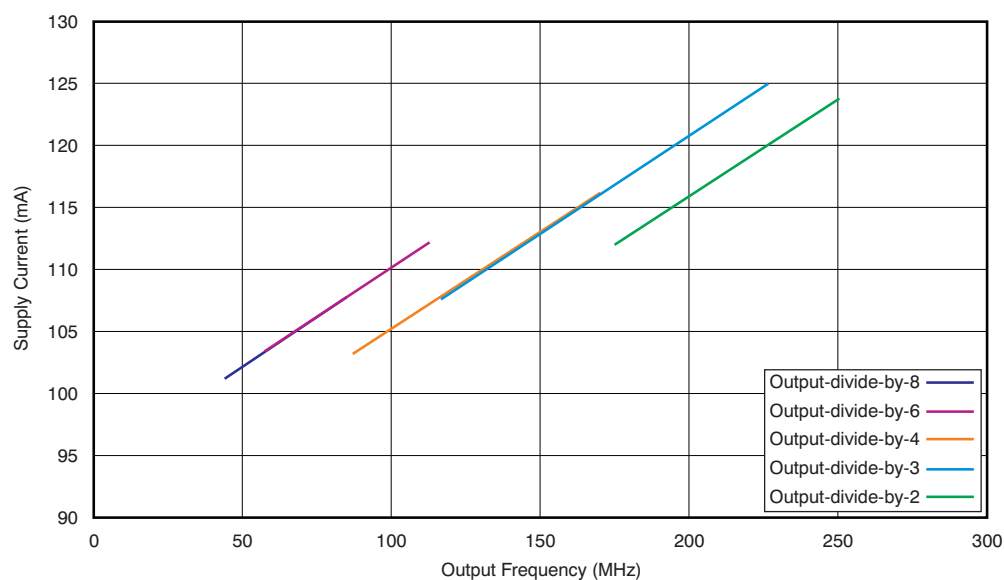


Figure 5.

### TYPICAL LVPECL DIFFERENTIAL OUTPUT VOLTAGE vs OUTPUT FREQUENCY

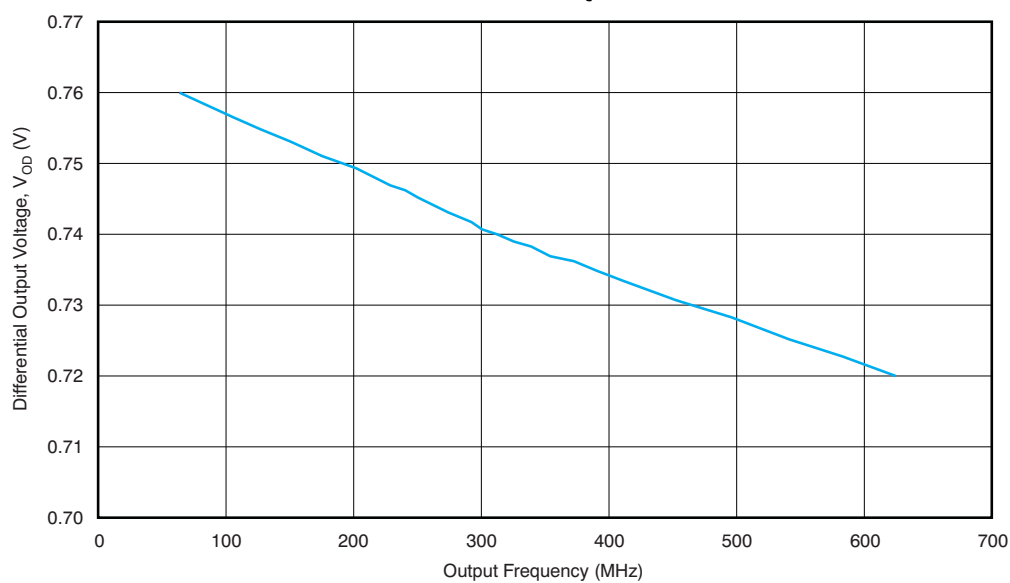


Figure 6.

## TYPICAL CHARACTERISTICS (continued)

Over operating free-air temperature range (unless otherwise noted).

### TYPICAL LVDS DIFFERENTIAL OUTPUT VOLTAGE vs OUTPUT FREQUENCY

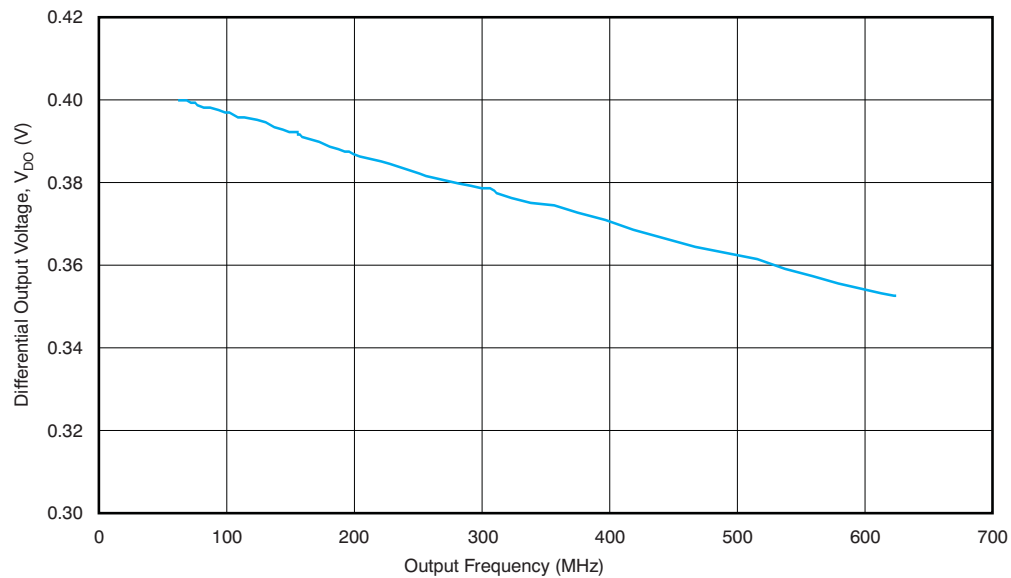


Figure 7.

### TYPICAL LVCMOS OUTPUT VOLTAGE WITH 5-pF LOAD vs OUTPUT FREQUENCY

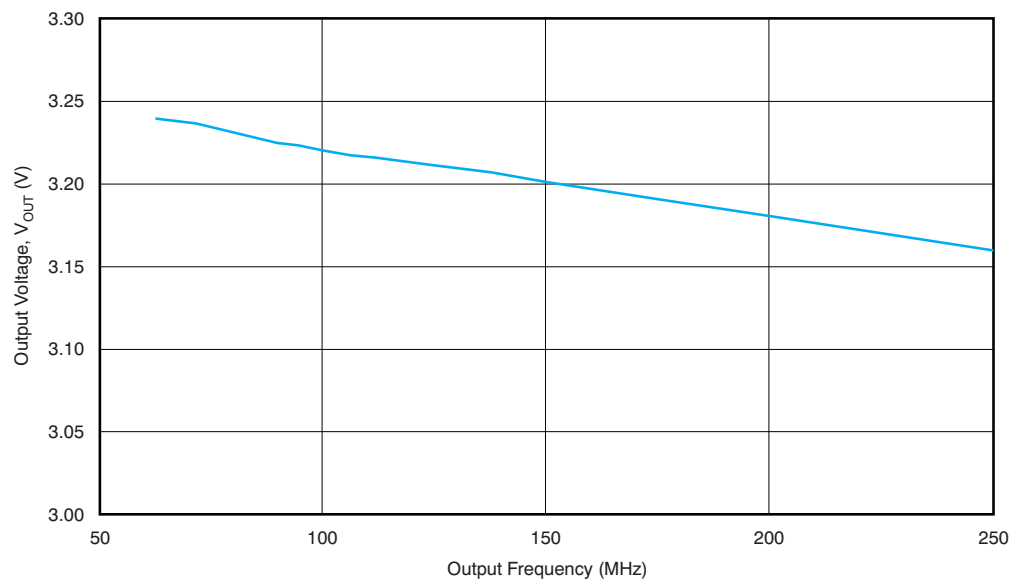
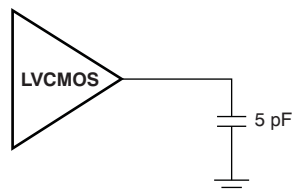


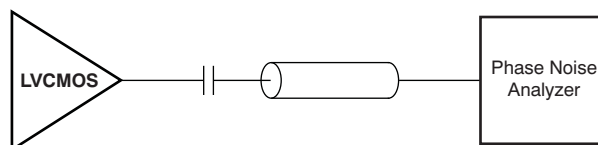
Figure 8.

## TEST CONFIGURATIONS

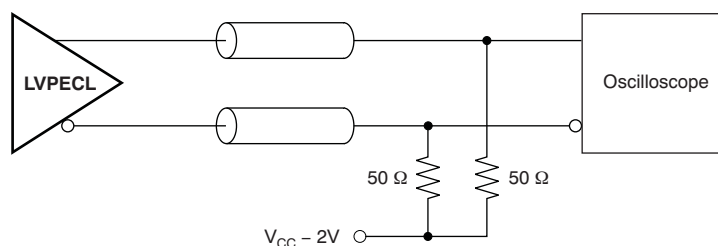
This section describes the function of each block for the CDCM61002. [Figure 9](#) through [Figure 15](#) illustrate how the device should be set up for a variety of output configurations.



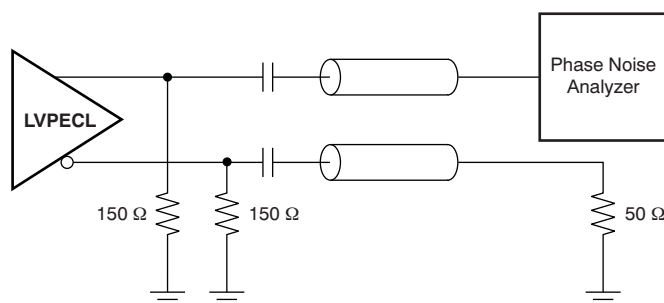
**Figure 9. LVC MOS Output Loading During Device Test**



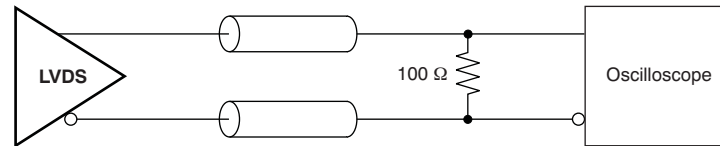
**Figure 10. LVC MOS AC Configuration During Device Test**



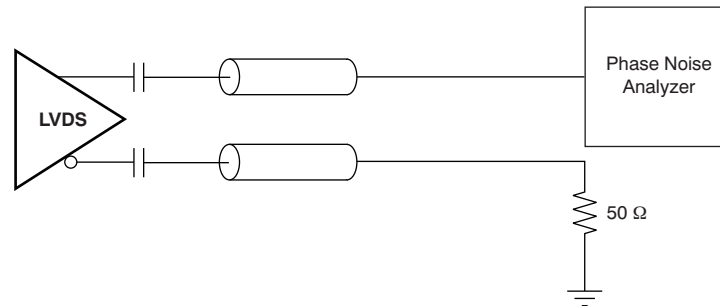
**Figure 11. LVPECL DC Configuration During Device Test**



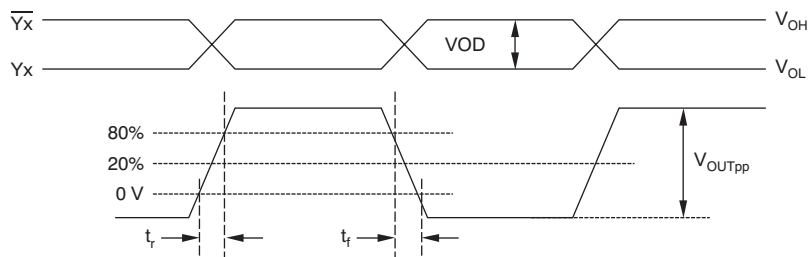
**Figure 12. LVPECL AC Configuration During Device Test**



**Figure 13. LVDS DC Configuration During Device Test**



**Figure 14. LVDS AC Configuration During Device Test**



**Figure 15. Output Voltage and Rise/Fall Times**

## FUNCTIONAL DESCRIPTION

### Phase-Locked Loop (PLL)

The CDCM61002 includes an on-chip PLL with an on-chip VCO. The PLL blocks consist of a crystal input interface, which can also accept an LVCMOS signal, a phase frequency detector (PFD), a charge pump, an on-chip loop filter, and prescaler and feedback dividers. Completing the CDCM61002 device are the output divider and universal output buffer.

The PLL is powered by on-chip, low-dropout (LDO) linear voltage regulators. The regulated supply network is partitioned such that the sensitive analog supplies are powered from separate LDOs rather than the digital supplies which use a separate LDO regulator. These LDOs provide isolation for the PLL from any noise in the external power-supply rail. The REG\_CAP1 and REG\_CAP2 pins should each be connected to ground by 10-μF capacitors to ensure stability.

### Configuring the PLL

The CDCM61002 permits PLL configurations to accommodate the various input and output frequencies listed in [Table 2](#) and [Table 3](#). These configurations are accomplished by setting the prescaler divider, feedback divider and output divider. The various dividers are managed by setting the device control pins as shown in [Table 4](#) and [Table 5](#).

### Crystal Input Interface

Fundamental mode is the recommended oscillation mode of operation for the input crystal and parallel resonance is the recommended type of circuit for the crystal.

A crystal load capacitance refers to all capacitances in the oscillator feedback loop. It is equal to the amount of capacitance seen between the terminals of the crystal in the circuit. For parallel resonant mode circuits, the correct load capacitance is necessary to ensure the oscillation of the crystal within the expected parameters.

The CDCM61002 implements an input crystal oscillator circuitry, known as the *Colpitts oscillator*, and requires one pad of the crystal to interface with the XIN pin; the other pad of the crystal is tied to ground. In this crystal interface, it is important to account for all sources of capacitance when calculating the correct value for the discrete capacitor component,  $C_L$ , for a design.

The CDCM61002 has been characterized with 10-pF parallel resonant crystals. The input crystal oscillator stage in the CDCM61002 is designed to oscillate at the correct frequency for all parallel resonant crystals with low-pull capability and rated with a load capacitance that is equal to the sum of the onchip load capacitance at the XIN pin (10-pF), crystal stray capacitance, and board parasitic capacitance between the crystal and XIN pin.

The normalized frequency error of the crystal, as a result of load capacitance mismatch, can be calculated as [Equation 2](#):

$$\frac{\Delta f}{f} = \frac{C_S}{2(C_{L,R} + C_O)} - \frac{C_S}{2(C_{L,A} + C_O)} \quad (2)$$

Where:

$C_S$  is the motional capacitance of the crystal,

$C_O$  is the shunt capacitance of the crystal,

$C_{L,R}$  is the rated load capacitance for the crystal,

$C_{L,A}$  is the actual load capacitance in the implemented PCB for the crystal,

$\Delta f$  is the frequency error of the crystal,

and  $f$  is the rated frequency of the crystal.

The first three parameters can be obtained from the crystal vendor.

In order to minimize the frequency error of the crystal to meet application requirements, the difference between the rated load capacitance and the actual load capacitance should be minimized and a crystal with low-pull capability (low  $C_S$ ) should be used.

For example, if an application requires less than  $\pm 50$  ppm frequency error and a crystal with less than  $\pm 50$  ppm frequency tolerance is picked, the characteristics are as follows:  $C_0 = 7$  pF,  $C_S = 10$  fF, and  $C_{L,R} = 12$  pF. In order to meet the required frequency error, calculate  $C_{L,A}$  using Equation 2 to be 17 pF. Subtracting  $C_{L,R}$  from  $C_{L,A}$ , results in 5 pF; care must be taken during printed circuit board (PCB) layout with the crystal and the CDCM61002 to ensure that the sum of the crystal stray capacitance and board parasitic capacitance is less than the calculated 5 pF.

Good layout practices are fundamental to the correct operation and reliability of the oscillator. It is critical to locate the crystal components very close to the XIN pin to minimize routing distances. Long traces in the oscillator circuit are a very common source of problems. Do not route other signals across the oscillator circuit. Also, make sure power and high-frequency traces are routed as far away as possible to avoid crosstalk and noise coupling. Avoid the use of vias; if the routing becomes very complex, it is much better to use 0- $\Omega$  resistors as bridges to go over other signals. Vias in the oscillator circuit should only be used for connections to the ground plane. Do not share ground connections; instead, make a separate connection to ground for each component that requires grounding. If possible, place multiple vias in parallel for each connection to the ground plane. Especially in the Colpitts oscillator configuration, the oscillator is very sensitive to capacitance in parallel with the crystal. Therefore, the layout must be designed to minimize stray capacitance across the crystal to less than 5 pF total under all circumstances to ensure proper crystal oscillation. Be sure to take into account both PCB and crystal stray capacitance.

Table 9 lists several recommended crystals and the respective manufacturer of each.

**Table 9. Recommended Crystal Manufacturers**

| MANUFACTURER | PART NUMBER |
|--------------|-------------|
| Vectron      | VXC1-1133   |
| Fox          | 218-3       |
| Saronix      | FP2650002   |

## Phase Frequency Detector (PFD)

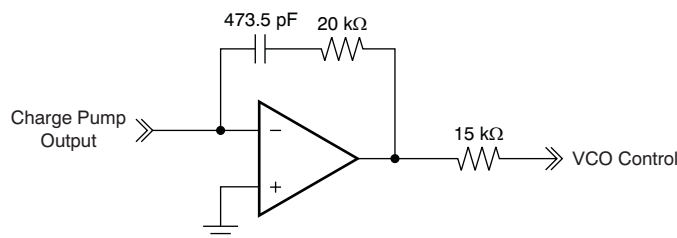
The PFD takes inputs from the input interface and the feedback divider and produces an output that depends on the phase and frequency differences between the two inputs. The allowable range of frequencies at the PFD inputs is 21.875 MHz to 28.47 MHz.

## Charge Pump (CP)

The charge pump is controlled by the PFD, which dictates either to pump up or down in order to charge or discharge the integrating section of the on-chip loop filter. The integrated and filtered charge pump current is then converted to a voltage that drives the control voltage node of the internal VCO through the on-chip loop filter. The charge pump current is preset to 224  $\mu$ A and cannot be changed.

## On-Chip PLL Loop Filter

Figure 16 shows the on-chip active loop filter topology implemented in the device. This design corresponds to a PLL bandwidth of 400 kHz for a PFD in the range of 21.875 MHz to 28.47 MHz, and a charge pump current of 224  $\mu$ A.



**Figure 16. On-Chip PLL Loop Filter Topology**

## Prescaler Divider and Feedback Divider

The VCO output is routed to the prescaler divider and then to the feedback divider. The prescaler divider and feedback divider are set in tandem with each other, according to the control pin settings given in [Table 4](#). The allowable combinations of the two dividers ensure that the VCO frequency and the PFD frequency are within the specified limits.

## On-Chip VCO

The CDCM61002 includes an on-chip, LC oscillator-based VCO with low phase noise covering a frequency range of 1.75 GHz to 2.05 GHz. The VCO must be calibrated to ensure proper operation over the valid device operating conditions. This calibration requires that the PLL be set up properly to lock the PLL loop and that the reference clock input be present. During the first device initialization after power-up, which occurs after the Power-On-Reset is released (2.64 V or lower, over valid device operating conditions) or a device reset with the  $\overline{\text{RSTN}}$  pin, a VCO calibration sequence is initiated after  $16,384 \times$  Reference Input Clock Cycles. The VCO calibration then takes about 20  $\mu\text{s}$  over the allowable range of the reference clock input.

The VCO calibration can also be reinitiated with a pulse on the  $\overline{\text{RSTN}}$  pin at any time after POR is released on power-up; the  $\overline{\text{RSTN}}$  pulse must be at least 100 ns wide

For proper device operation, the reference input must be stable at the start of VCO calibration. Since inputs from crystals or crystal oscillators can typically take up to 1-2ms to be stable, it is recommended to establish circuitry on the  $\overline{\text{RSTN}}$  pin that ensures device initialization including VCO calibration after a delay of greater than 5ms compared to the power up ramp, as shown in [Figure 17](#). A possible implementation of the delay circuitry on the  $\overline{\text{RSTN}}$  pin would be a 47nF capacitor to GND, and this in tandem with the 150k $\Omega$  on-chip pull-up resistor ensures the appropriate delay. The CE pin has an internal 150k $\Omega$  pull-up resistor and can be left unconnected or pulled to high for proper device operation.

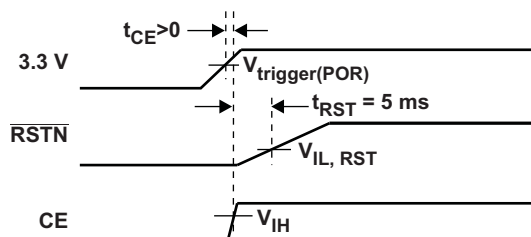


Figure 17. Suggested Timing Recommendations

## LVC MOS INPUT INTERFACE

Alternately, the CDCM61002 can be operated with an external ac-coupled 2.5-V LVCMOS or dc-coupled 3.3-V LVCMOS reference input applied to the XIN pin. For proper operation, the LVCMOS reference should be available and fairly stable by the time the power supply voltages or the  $\overline{\text{RSTN}}$  pin voltage on the CDCM61002 reaches 2.27 V. See the application report [SCAA111](#), available for download at [ti.com](http://ti.com), for more details about the LVCMOS input interface to the CDCM61002.

## Output Divider

The output from the prescaler divider is also routed to the output divider. The output divider can be set with control pins according to [Table 5](#).

## Output Buffer

Each output buffer can be set to LVPECL or LVDS or 2x LVCMOS, according to [Table 6](#). OSC\_OUT is an LVCMOS output that can be used to monitor proper loading of the input crystal in order to achieve the necessary crystal frequency with the least error. The OSC\_OUT turns on as soon as power is available and remains on during device calibration. The output buffers are disabled during VCO calibration and are enabled only after calibration is complete.

The output buffers on the CDCM61002 can also be disabled, along with other sections of the device, using the CE pin according to [Table 7](#).

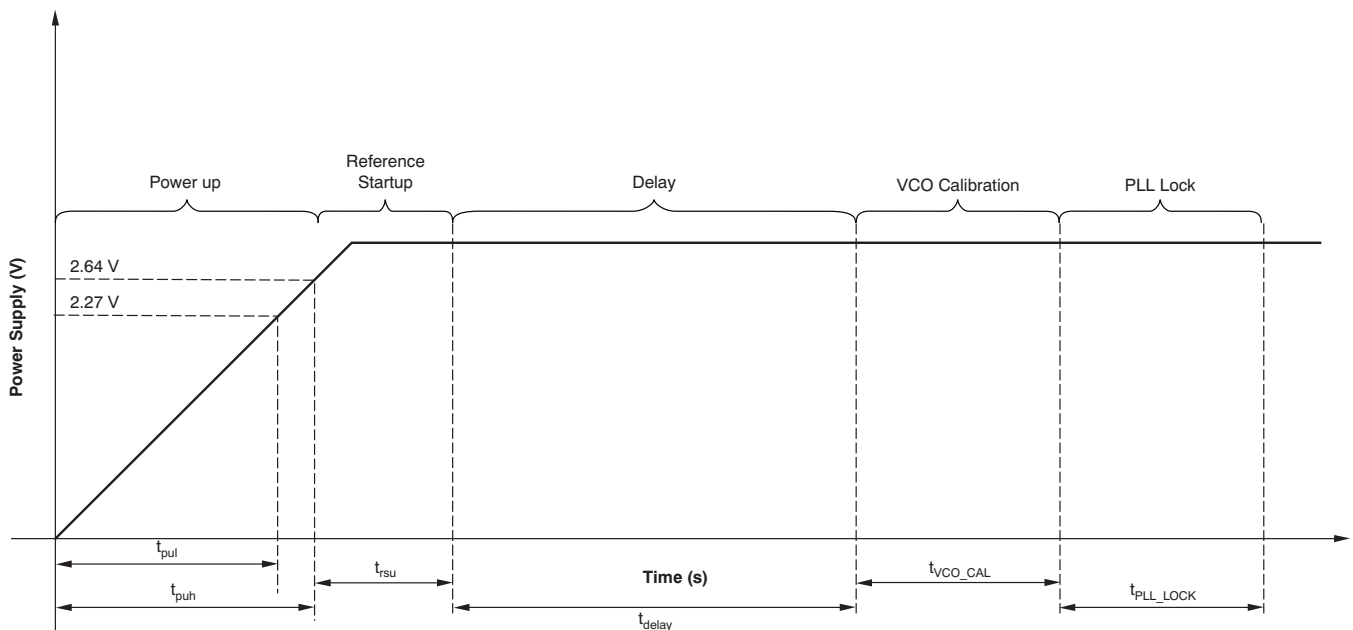
## APPLICATION INFORMATION

### Start-up Time Estimation

The CDCM61002 startup time can be estimated based on the parameters defined in [Table 10](#) and graphically shown in [Figure 18](#).

**Table 10. Start-up Time Dependencies**

| PARAMETER       | DEFINITION                 | DESCRIPTION                                                                                                                                                                                                | FORMULA/METHOD OF DETERMINATION                                                   |
|-----------------|----------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------|
| $t_{REF}$       | Reference clock period     | The reciprocal of the applied reference frequency in seconds.                                                                                                                                              | $t_{REF} = \frac{1}{f_{REF}}$                                                     |
| $t_{pul}$       | Power-up time (low limit)  | Power-supply rise time to low limit of Power On Reset (POR) trip point                                                                                                                                     | Time required for power supply to ramp to 2.27 V                                  |
| $t_{puh}$       | Power-up time (high limit) | Power supply rise time to high limit of POR trip point                                                                                                                                                     | Time required for power supply to ramp to 2.64 V                                  |
| $t_{rsu}$       | Reference start-up time    | After POR releases, the Colpits oscillator is enabled. This start-up time is required for the oscillator to generate the requisite signal levels for the delay block to be clocked by the reference input. | 500 $\mu$ s best-case and 800 $\mu$ s worst-case                                  |
| $t_{delay}$     | Delay time                 | Internal delay time generated from the reference clock. This delay provides time for the reference oscillator to stabilize.                                                                                | $t_{delay} = 16384 \times t_{ref}$                                                |
| $t_{VCO\_CAL}$  | VCO calibration time       | VCO Calibration Time generated from the reference clock. This process selects the operating point for the VCO based on the PLL settings.                                                                   | $t_{VCO\_CAL} = 550 \times t_{ref}$                                               |
| $t_{PLL\_LOCK}$ | PLL lock time              | Time required for PLL to lock within $\pm 10$ ppm of $f_{REF}$                                                                                                                                             | Based on the 400-kHz loop bandwidth, the PLL settles in 5 $\tau$ or 12.5 $\mu$ s. |



**Figure 18. Start-up Time Dependencies**

The CDCM61002 start-up time limits,  $t_{MAX}$  and  $t_{MIN}$ , can be calculated as follows:

$$t_{MAX} = t_{puh} + t_{rsu} + t_{delay} + t_{VCO\_CAL} + t_{PLL\_LOCK}$$

$$t_{MIN} = t_{pul} + t_{rsu} + t_{delay} + t_{VCO\_CAL} + t_{PLL\_LOCK}$$

## Power Considerations

As a result of the different possible configurations of the CDCM61002, [Table 11](#) is intended to provide enough information on the estimated current consumption of the device. Unless otherwise noted,  $V_{CC} = 3.3\text{ V}$  and  $T_A = +25^\circ\text{C}$ .

**Table 11. Estimated Block Power Consumption**

| BLOCK                       | CONDITION                                                                        | CURRENT CONSUMPTION (mA)                                         | IN-DEVICE POWER DISSIPATION (mW)                                   | EXTERNAL RESISTOR POWER DISSIPATION (mW) |
|-----------------------------|----------------------------------------------------------------------------------|------------------------------------------------------------------|--------------------------------------------------------------------|------------------------------------------|
| Entire device, core current | Output off, no termination resistors                                             | 65                                                               | 214.5                                                              |                                          |
| Output buffer               | LVPECL output, active mode                                                       | 28                                                               | 42.4                                                               | 50                                       |
|                             | LVC MOS output pair, static                                                      | 4.5                                                              | 14.85                                                              |                                          |
|                             | LVC MOS output pair, transient, 'C <sub>L</sub> ' load, 'f' MHz output frequency | $V \times f_{OUT} \times (C_L + 20 \times 10^{-12}) \times 10^3$ | $V^2 \times f_{OUT} \times (C_L + 20 \times 10^{-12}) \times 10^3$ |                                          |
|                             | LVDS output, active mode                                                         | 20                                                               | 66                                                                 |                                          |
| Divide circuitry            | Divide enabled, divide = 1                                                       | 5                                                                | 16.5                                                               |                                          |
|                             | Divide enabled, divide = 2                                                       | 10                                                               | 33                                                                 |                                          |
|                             | Divide enabled, divide = 3, 4                                                    | 15                                                               | 49.5                                                               |                                          |
|                             | Divide enabled, divide = 6, 8                                                    | 20                                                               | 66                                                                 |                                          |

From [Table 11](#), the current consumption can be calculated for any configuration. For example, the current for the entire device with one LVPECL output in active mode can be calculated by adding up the following blocks: core current, LVPECL output buffer current, and the divide circuitry current. The overall in-device power consumption can also be calculated by summing the in-device power dissipated in each of these blocks.

As an example scenario, let us consider the use case of a crystal input frequency of 25 MHz and device output frequency of 312.5 MHz in LVPECL mode. For this case, the typical overall power dissipation can be calculated as:

$$3.3\text{ V} \times (65 + 2 \times 28 + 10)\text{ mA} = 432.3\text{ mW}$$

Because the LVPECL output has external resistors and the power dissipated by these resistors is 50 mW, the typical overall in-device power dissipation is:

$$432.3\text{ mW} - 2 \times 50\text{ mW} = 332.3\text{ mW}$$

When the LVPECL output is active, the average voltage is approximately 1.9 V on each output as calculated from the LVPECL  $V_{OH}$  and  $V_{OL}$  specifications. Therefore, the power dissipated in each emitter resistor is approximately  $(1.9\text{ V})^2/150\Omega = 25\text{ mW}$ .

When the LVC MOS output is active and drives a load capacitance,  $C_L$ , the overall LVC MOS output current consumption is the sum of a static pre-driver current and a dynamic switching current (which is a function of the output frequency and the load capacitance).

Let us consider another use case of a crystal input frequency of 26.5625 MHz and device output frequency of 212.5 MHz in LVC MOS mode and driving a 5-pF load capacitance. For this case, the typical overall power dissipation can be calculated as:

$$3.3\text{ V} \times (65 + 15 + 2 \times 21.4)\text{ mA} = 405.24\text{ mW}$$

## Thermal Management

Power consumption of the CDCM61002 can be high enough to require attention to thermal management. For reliability and performance reasons, the die temperature should be limited to a maximum of +125°C. That is, as an estimate,  $T_A$  (ambient temperature) plus device power consumption times  $\theta_{JA}$  should not exceed +125°C.

The device package has an exposed pad that provides the primary heat removal path as well as an electrical grounding to the printed circuit board (PCB). To maximize the removal of heat from the package, a thermal land pattern including multiple vias to a ground plane must be incorporated on the PCB within the footprint of the package. The exposed pad must be soldered down to ensure adequate heat conduction out of the package. Check the mechanical data at the end of the data sheet for land and via pattern examples.

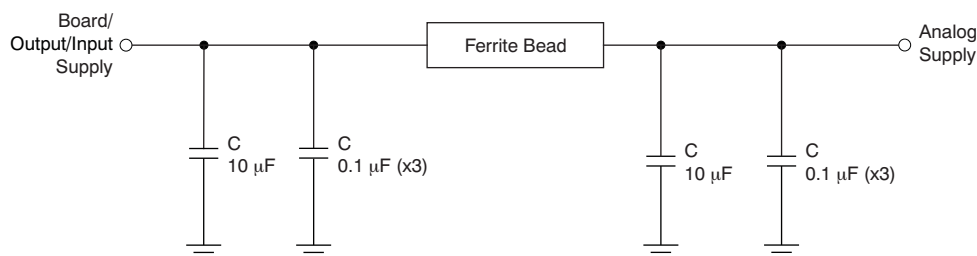
## Power-Supply Filtering

PLL-based frequency synthesizers are very sensitive to noise on the power supply, which can dramatically increase the jitter of the PLL. This characteristic is especially true for analog-based PLLs. Thus, it is essential to reduce noise from the system power supply, especially when jitter/phase noise is very critical to applications. A PLL would have attenuated jitter as a result of power-supply noise at frequencies beyond the PLL bandwidth because of attenuation by the loop response.

Filter capacitors are used to eliminate the low-frequency noise from the power supply, where the bypass capacitors provide the very low impedance path for high-frequency noise and guard the power-supply system against the induced fluctuations. These bypass capacitors also provide instantaneous current surges as required by the device and should have low equivalent series resistance (ESR). To properly use these bypass capacitors, they must be placed very close to the power-supply pins and laid out with short loops to minimize inductance. It is recommended to add as many high-frequency (for example, 0.1-μF) bypass capacitors as there are supply pins in the package.

The CDCM61002 power-supply requirements can be grouped into two sets: the analog supply line and the output/input supply line. The analog supply line consists of the following power-supply pins on the CDCM61002: VCC\_PLL1, VCC\_PLL2, and VCC\_VCO. These pins can be shorted together. The output/input supply line consists of the VCC\_OUT and the VCC\_IN power-supply pins on the CDCM61002. These pins can be shorted together. Inserting a ferrite bead between the analog supply line and the output/input supply line isolates the high-frequency switching noises generated by the device input and outputs, preventing them from leaking into the sensitive analog supply line. Choosing an appropriate ferrite bead with very low dc resistance is important because it is imperative to provide adequate isolation between the sensitive analog supply line and the other board supply lines, and to maintain a voltage at the analog power-supply pins of the CDCM61002 that is greater than the minimum voltage required for proper operation.

Figure 19 shows a general recommendation for decoupling the power supply.



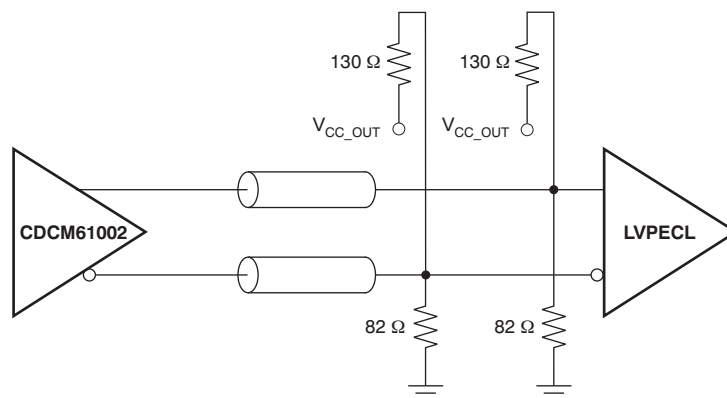
**Figure 19. Recommended Power-Supply Decoupling**

## Output Termination

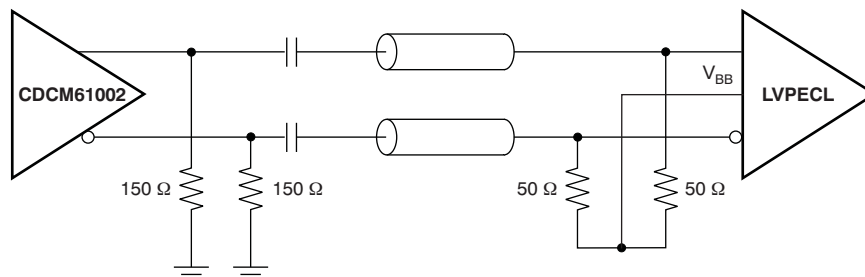
The CDCM61002 is a 3.3-V clock driver with the following output options: LVPECL, LVDS, or LVCMOS.

### LVPECL Termination

The CDCM61002 is an open emitter for LVPECL outputs. Therefore, proper biasing and termination are required to ensure correct operation of the device and to minimize signal integrity. The proper termination for LVPECL is  $50\ \Omega$  to  $(V_{CC}-2)\text{ V}$ , but this dc voltage is not readily available on most PCBs. Thus, a Thevenin equivalent circuit is worked out for the LVPECL termination in both direct-coupled (dc) and ac-coupled cases, as shown in Figure 20 and Figure 21. It is recommended to place all resistive components close to either the driver end or the receiver end. If the supply voltage of the driver and receiver are different, ac-coupling is required.



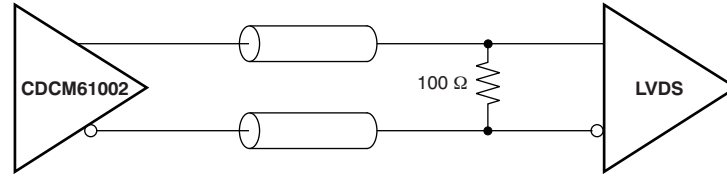
**Figure 20. LVPECL Output DC Termination**



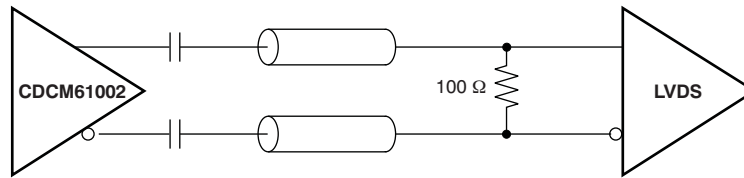
**Figure 21. LVPECL Output AC Termination**

## LVDS Termination

The proper LVDS termination for signal integrity over two 50  $\Omega$  lines is 100  $\Omega$  between the outputs on the receiver end. Either dc-coupled termination or ac-coupled termination can be used for LVDS outputs, as shown in Figure 22 and Figure 23. It is recommended to place all resistive components close to either the driver end or the receiver end. If the supply voltage of the driver and the receiver are different, ac-coupling is required.



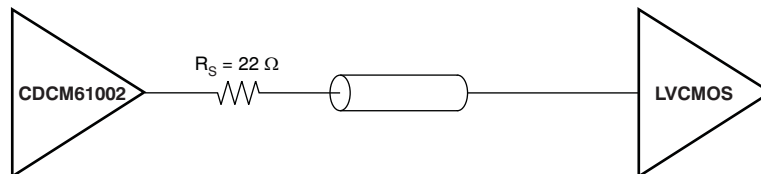
**Figure 22. LVDS Output DC Termination**



**Figure 23. LVDS Output AC Termination**

## LVC MOS Termination

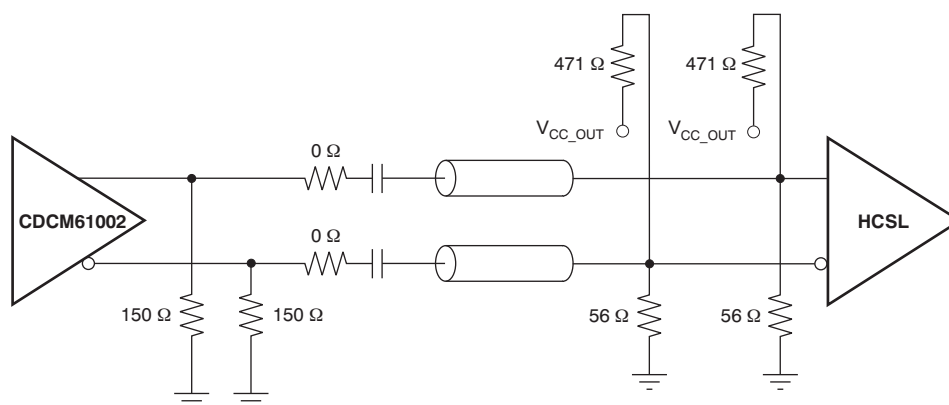
Series termination is a common technique used to maintain the signal integrity for LVC MOS drivers, if connected to a receiver with a high-impedance input with a pull-up or a pulldown resistor. For series termination, a series resistor ( $R_S$ ) is placed close to the driver, as shown in Figure 24. The sum of the driver impedance and  $R_S$  should be close to the transmission line impedance, which is usually 50  $\Omega$ . Because the LVC MOS driver in the CDCM61002 has an impedance of 30  $\Omega$ ,  $R_S$  is recommended to be 22  $\Omega$  to maintain proper signal integrity.



**Figure 24. LVC MOS Output Termination**

## Interfacing Between LVPECL and HCSL

Because the LVPECL common-mode voltage is different from the HCSL common-mode voltage, ac-coupled termination is used. The 150- $\Omega$  resistor ensures proper biasing of the CDCM61002 LVPECL output stage, while the 471- $\Omega$  and 56- $\Omega$  resistor network biases the HCSL receiver input stage, as shown in Figure 25.



**Figure 25. LVPECL to HCSL Interface**

## REVISION HISTORY

NOTE: Page numbers for previous revisions may differ from page numbers in the current version.

### Changes from Revision B (July, 2009) to Revision C Page

|                                                                                                         |    |
|---------------------------------------------------------------------------------------------------------|----|
| • Deleted references to <i>Single-Ended</i> and <i>LVC MOS input</i> throughout document .....          | 1  |
| • Deleted $f_{IN}$ , $\Delta V/\Delta T$ , and DutyREF parameters from Electrical Characteristics ..... | 4  |
| • Added <a href="#">LVC MOS Input Interface</a> section .....                                           | 20 |

### Changes from Revision C (February 2010) to Revision D Page

|                                                                                                                      |    |
|----------------------------------------------------------------------------------------------------------------------|----|
| • Added reference to LVC MOS reference in first Features bullet .....                                                | 1  |
| • Added reference to LVC MOS input in first paragraph of <i>Description</i> .....                                    | 1  |
| • Updated <a href="#">Figure 1</a> .....                                                                             | 2  |
| • Changed name of <i>Control Pin LVC MOS Input Characteristics</i> section in Electrical Characteristics table ..... | 4  |
| • Added reference to LVC MOS input in <i>XIN</i> parameter of Pin Functions table .....                              | 8  |
| • Changed description of <i>Crystal Input Interface</i> section .....                                                | 18 |
| • Changed description of <i>LVC MOS Input Interface</i> section .....                                                | 20 |

### Changes from Revision D (July 2010) to Revision E Page

|                                                                                                                                                                                                            |    |
|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----|
| • Changed Note 1 of the Pin Functions table From: Pull-up and Pull-down refer to...To: Pull-up refers to .....                                                                                             | 8  |
| • Deleted $R_{PULLDOWN}$ from <a href="#">Table 1</a> .....                                                                                                                                                | 8  |
| • Changed values in row 24.75 of <a href="#">Table 2</a> .....                                                                                                                                             | 11 |
| • Changed the text of Configuring the PLL, deleted the last sentence .....                                                                                                                                 | 18 |
| • Changed the On-Chip VCO section .....                                                                                                                                                                    | 20 |
| • Changed the Output Buffer section .....                                                                                                                                                                  | 20 |
| • Changed the power dissipation equation From: $3.3\text{ V} \times (65 + 2 \times 28 + 10)\text{ mA} = 429\text{ mW}$ To: $3.3\text{ V} \times (65 + 2 \times 28 + 10)\text{ mA} = 432.3\text{ mW}$ ..... | 22 |
| • Changed the power dissipation equation From: $439\text{ mW} - 2 \times 50\text{ mW} = 339\text{ mW}$ To: $432.3\text{ mW} - 2 \times 50\text{ mW} = 332.3\text{ mW}$ .....                               | 22 |
| • Deleted figure "Recommended PCB Layout for CDCM61001" from the Thermal Management section. Added text "See the mechanical data at the end of the data sheet.." .....                                     | 23 |

### Changes from Revision E (March 2011) to Revision F Page

|                                                                                       |    |
|---------------------------------------------------------------------------------------|----|
| • Changed the On-Chip VCO section .....                                               | 20 |
| • Changed <a href="#">Figure 17</a> .....                                             | 20 |
| • Moved the LVC MOS INPUT INTERFACE section prior to the Output Divider section ..... | 20 |

## PACKAGING INFORMATION

| Orderable Device | Status<br>(1) | Package Type | Package<br>Drawing | Pins | Package<br>Qty | Eco Plan<br>(2)            | Lead/Ball Finish<br>(6) | MSL Peak Temp<br>(3) | Op Temp (°C) | Device Marking<br>(4/5) | Samples                 |
|------------------|---------------|--------------|--------------------|------|----------------|----------------------------|-------------------------|----------------------|--------------|-------------------------|-------------------------|
| CDCM61002RHBR    | ACTIVE        | VQFN         | RHB                | 32   | 3000           | Green (RoHS<br>& no Sb/Br) | NIPDAU                  | Level-2-260C-1 YEAR  | -40 to 85    | CDCM<br>61002           | <a href="#">Samples</a> |
| CDCM61002RHBT    | ACTIVE        | VQFN         | RHB                | 32   | 250            | Green (RoHS<br>& no Sb/Br) | NIPDAU                  | Level-2-260C-1 YEAR  | -40 to 85    | CDCM<br>61002           | <a href="#">Samples</a> |

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

**ACTIVE:** Product device recommended for new designs.

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

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

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

**OBSOLETE:** TI has discontinued the production of the device.

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

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

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

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

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

(6) Lead/Ball Finish - Orderable Devices may have multiple material finish options. Finish options are separated by a vertical ruled line. Lead/Ball Finish values may wrap to two lines if the finish value exceeds the maximum column width.

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**TAPE AND REEL INFORMATION**


\*All dimensions are nominal

| Device        | Package Type | Package Drawing | Pins | SPQ  | Reel Diameter (mm) | Reel Width W1 (mm) | A0 (mm) | B0 (mm) | K0 (mm) | P1 (mm) | W (mm) | Pin1 Quadrant |
|---------------|--------------|-----------------|------|------|--------------------|--------------------|---------|---------|---------|---------|--------|---------------|
| CDCM61002RHBR | VQFN         | RHB             | 32   | 3000 | 330.0              | 12.4               | 5.3     | 5.3     | 1.5     | 8.0     | 12.0   | Q2            |
| CDCM61002RHBT | VQFN         | RHB             | 32   | 250  | 180.0              | 12.4               | 5.3     | 5.3     | 1.5     | 8.0     | 12.0   | Q2            |

## TAPE AND REEL BOX DIMENSIONS



\*All dimensions are nominal

| Device        | Package Type | Package Drawing | Pins | SPQ  | Length (mm) | Width (mm) | Height (mm) |
|---------------|--------------|-----------------|------|------|-------------|------------|-------------|
| CDCM61002RHBR | VQFN         | RHB             | 32   | 3000 | 367.0       | 367.0      | 35.0        |
| CDCM61002RHBT | VQFN         | RHB             | 32   | 250  | 210.0       | 185.0      | 35.0        |

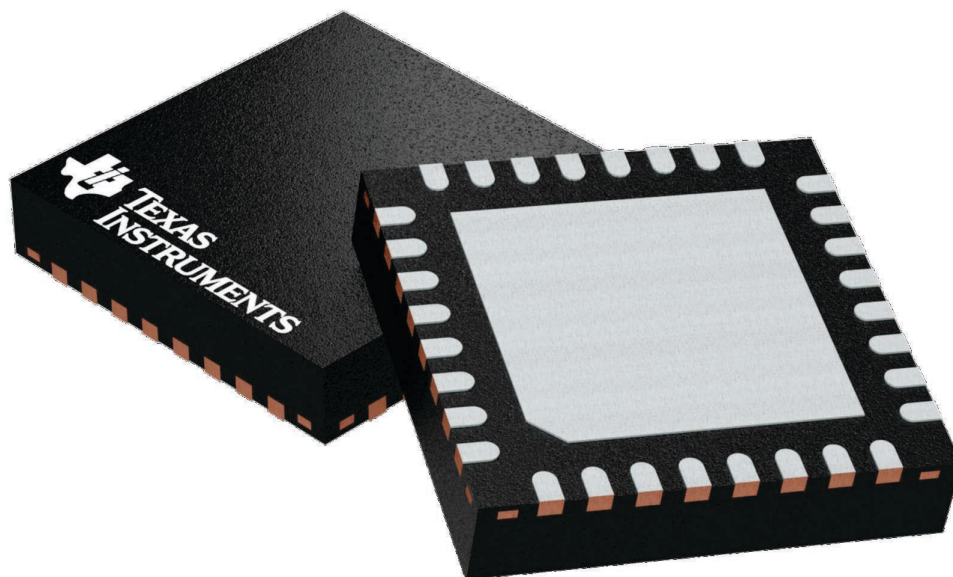
## GENERIC PACKAGE VIEW

**RHB 32**

**VQFN - 1 mm max height**

5 x 5, 0.5 mm pitch

PLASTIC QUAD FLATPACK - NO LEAD



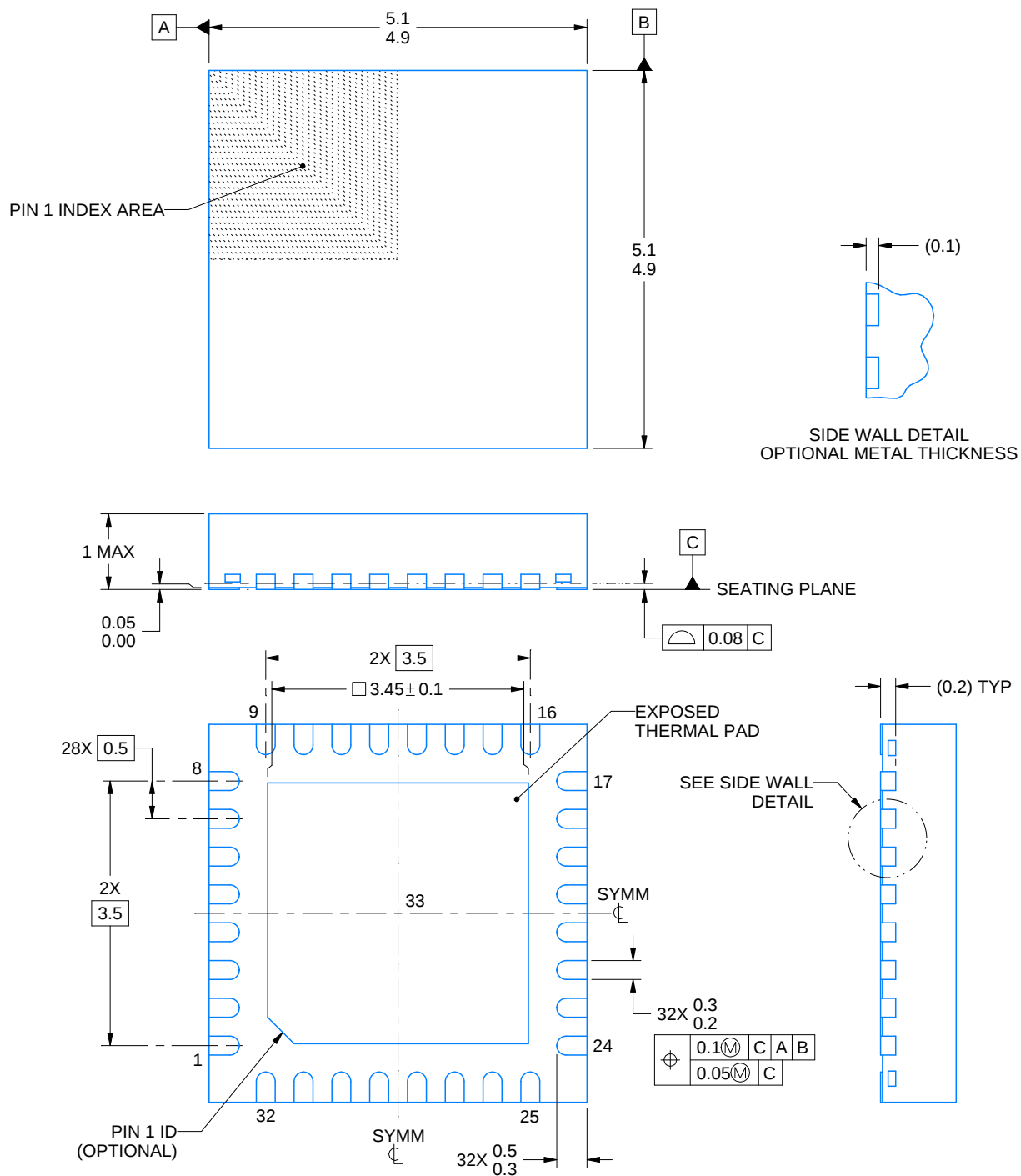
Images above are just a representation of the package family, actual package may vary.  
Refer to the product data sheet for package details.

4224745/A



## VQFN - 1 mm max height

PLASTIC QUAD FLATPACK - NO LEAD



4223442/B 08/2019

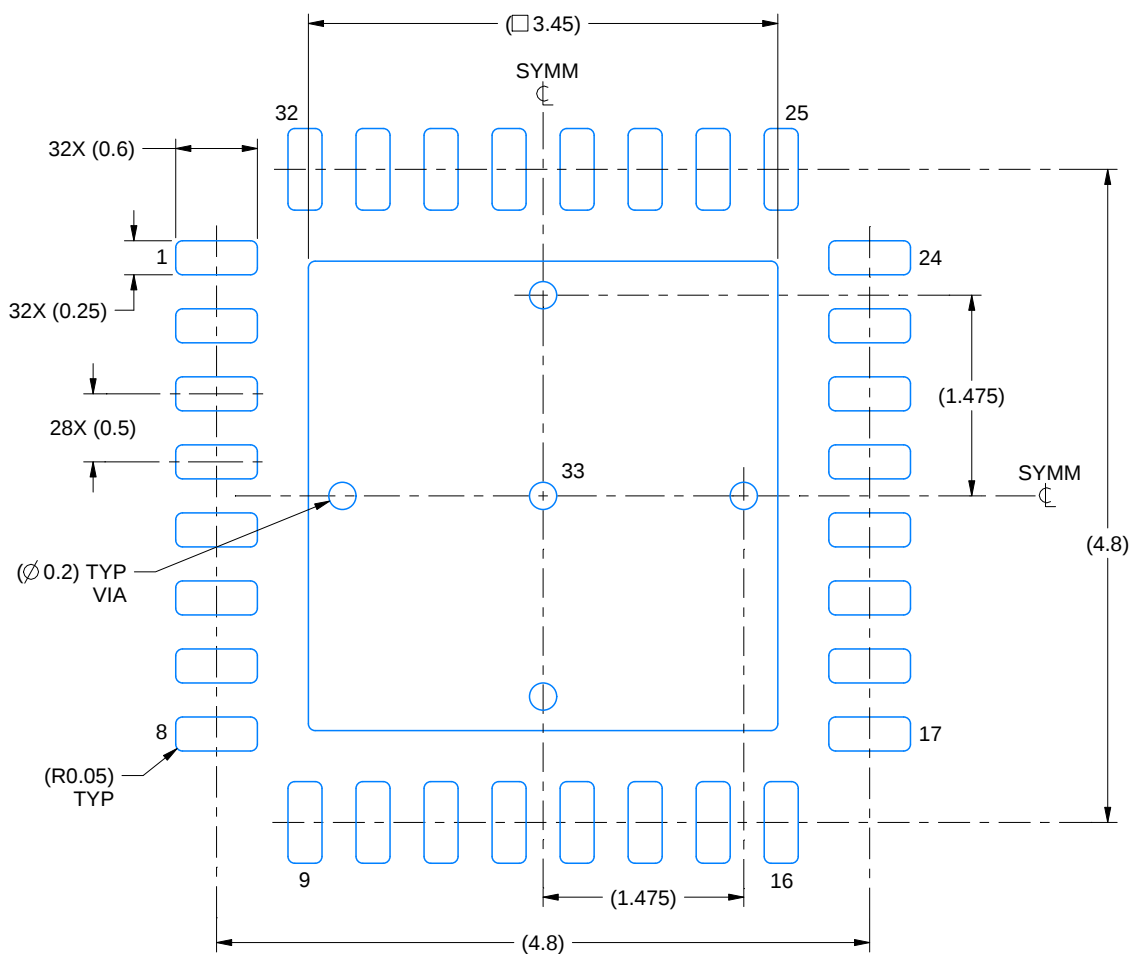
NOTES:

1. All linear dimensions are in millimeters. Any dimensions in parenthesis are for reference only. Dimensioning and tolerancing per ASME Y14.5M.
2. This drawing is subject to change without notice.
3. The package thermal pad must be soldered to the printed circuit board for thermal and mechanical performance.

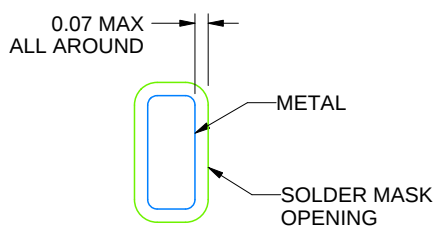
**RHB0032E**

### VQFN - 1 mm max height

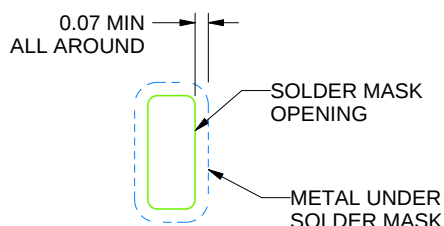
PLASTIC QUAD FLATPACK - NO LEAD



LAND PATTERN EXAMPLE  
SCALE:18X



NON SOLDER MASK  
DEFINED  
(PREFERRED)



SOLDER MASK  
DEFINED

## SOLDER MASK DETAILS

4223442/B 08/2019

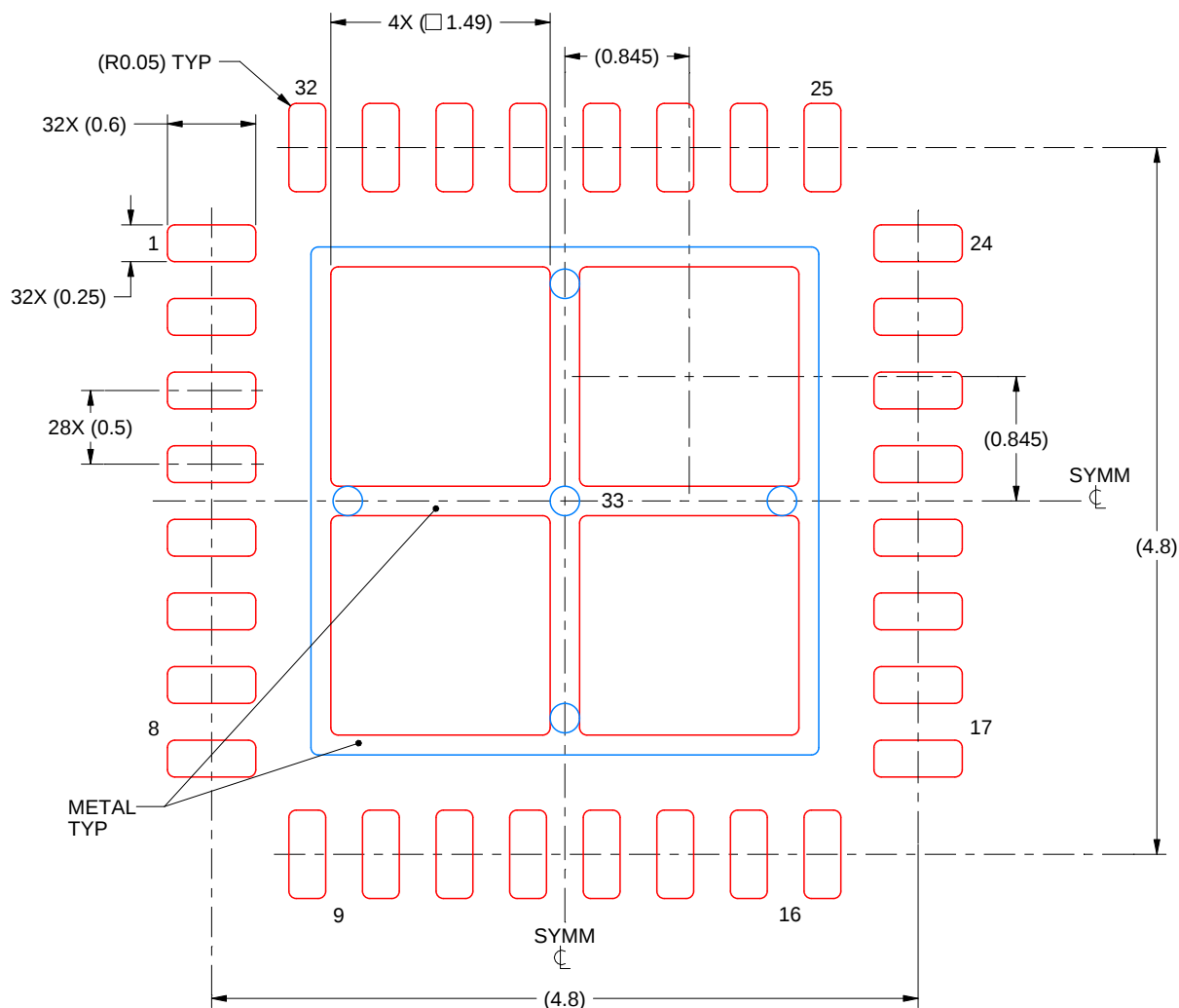
NOTES: (continued)

4. This package is designed to be soldered to a thermal pad on the board. For more information, see Texas Instruments literature number SLUA271 ([www.ti.com/lit/sluea271](http://www.ti.com/lit/sluea271)).
5. Vias are optional depending on application, refer to device data sheet. If any vias are implemented, refer to their locations shown on this view. It is recommended that vias under paste be filled, plugged or tented.

**RHB0032E**

**VQFN - 1 mm max height**

PLASTIC QUAD FLATPACK - NO LEAD



## SOLDER PASTE EXAMPLE BASED ON 0.125 mm THICK STENCIL

EXPOSED PAD 33:  
75% PRINTED SOLDER COVERAGE BY AREA UNDER PACKAGE  
SCALE:20X

4223442/B 08/2019

NOTES: (continued)

6. Laser cutting apertures with trapezoidal walls and rounded corners may offer better paste release. IPC-7525 may have alternate design recommendations.

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