

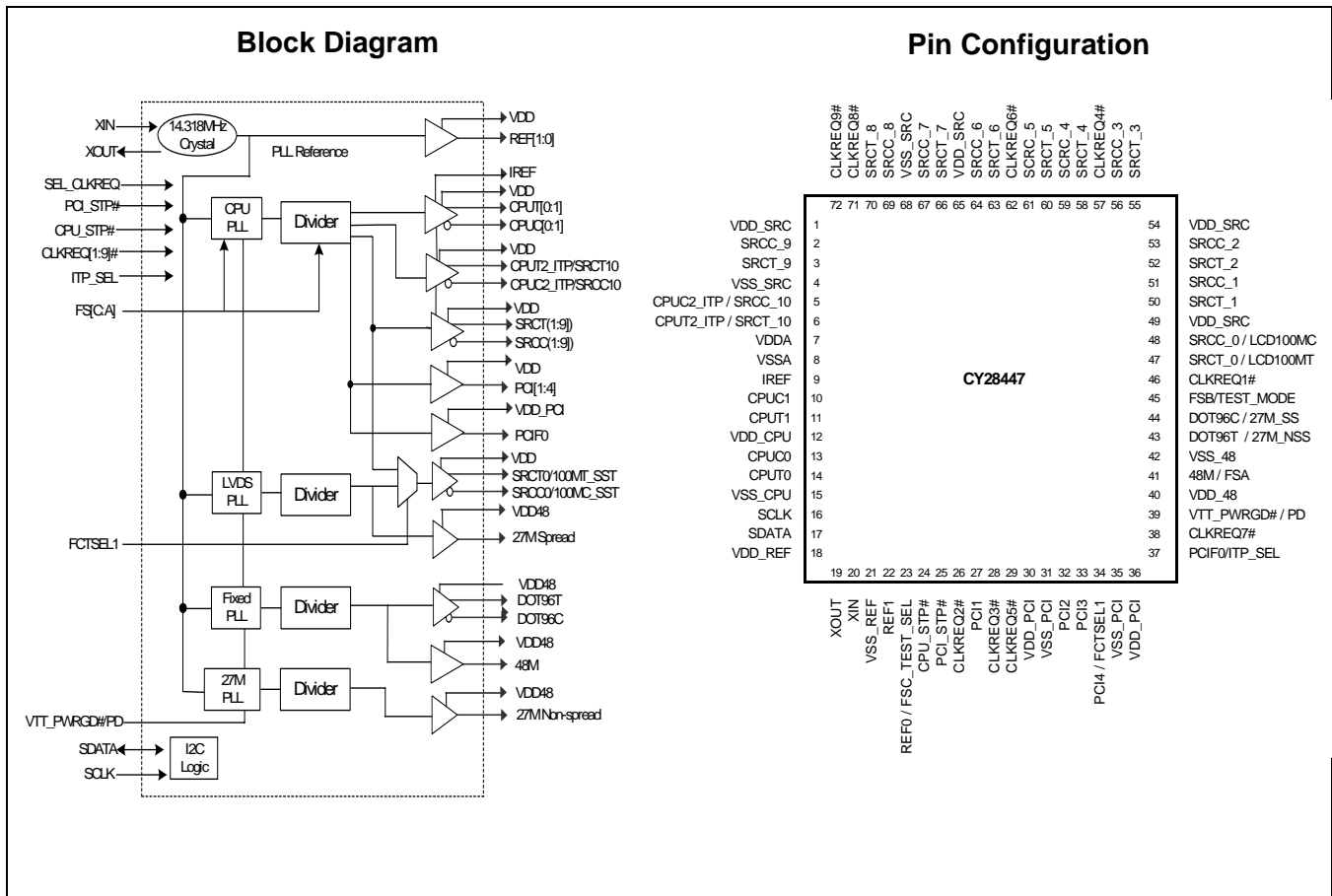


# Clock Generator for Intel® Calistoga Chipset

## Features

- Compliant to Intel® CK410M
- Selectable CPU frequencies
- Differential CPU clock pairs
- 100 MHz differential SRC clocks
- 96 MHz differential dot clock
- 27 MHz Spread and Non-spread video clock
- 48 MHz USB clock
- SRC clocks independently stoppable through CLKREQ#[1:9]
- 96/100 MHz spreadable differential video clock
- 33 MHz PCI clocks
- Buffered Reference Clock 14.318MHz
- Low-voltage frequency select inputs
- I<sup>2</sup>C support with readback capabilities
- Ideal Lexmark Spread Spectrum profile for maximum electromagnetic interference (EMI) reduction
- 3.3V power supply
- 72-pin QFN package

| CPU     | SRC   | PCI | REF | DOT96 | USB_48M | LCD | 27M |
|---------|-------|-----|-----|-------|---------|-----|-----|
| x2 / x3 | x9/11 | x5  | x 2 | x 1   | x 1     | x1  | x2  |



**Pin Description**

| Pin No.   | Name                                  | Type          | Description  |           |        |        |        |        |   |        |        |           |           |   |         |        |       |       |
|---|---------------------------------------|---------------|--|-----------|--------|--------|--------|--------|---|--------|--------|-----------|-----------|---|---------|--------|-------|-------|
| 1, 49, 54, 65   | VDD_SRC                               | PWR           | <b>3.3V power supply for outputs.</b>  |           |        |        |        |        |   |        |        |           |           |   |         |        |       |       |
| 2, 3, 50, 51,<br>52, 53, 55,<br>56, 58, 59,<br>60, 61, 63,<br>64, 66, 67,<br>69, 70 | SRCT/C[1:9]                           | O, DIF        | <b>100 MHz Differential serial reference clocks.</b>   |           |        |        |        |        |   |        |        |           |           |   |         |        |       |       |
| 4, 68   | VSS_SRC                               | GND           | <b>Ground for outputs.</b>   |           |        |        |        |        |   |        |        |           |           |   |         |        |       |       |
| 5, 6  | CPUT2_ITP/SRCT10,<br>CPUC2_ITP/SRCC10 | O, DIF        | <b>Selectable differential CPU or SRC clock output.</b><br>ITP_SEL = 0 @ VTT_PWRGD# assertion = SRC10<br>ITP_SEL = 1 @ VTT_PWRGD# assertion = CPU2   |           |        |        |        |        |   |        |        |           |           |   |         |        |       |       |
| 7   | VDDA                                  | PWR           | <b>3.3V power supply for PLL.</b>  |           |        |        |        |        |   |        |        |           |           |   |         |        |       |       |
| 8   | VSSA                                  | GND           | <b>Ground for PLL.</b>   |           |        |        |        |        |   |        |        |           |           |   |         |        |       |       |
| 9   | IREF                                  | I             | <b>A precision resistor is attached to this pin which is connected to the internal current reference.</b>  |           |        |        |        |        |   |        |        |           |           |   |         |        |       |       |
| 10, 11, 13, 14  | CPUT/C[0:1]                           | O, DIF        | <b>Differential CPU clock outputs.</b>   |           |        |        |        |        |   |        |        |           |           |   |         |        |       |       |
| 12  | VDD_CPU                               | PWR           | <b>3.3V power supply for outputs.</b>  |           |        |        |        |        |   |        |        |           |           |   |         |        |       |       |
| 15  | VSS_CPU                               | GND           | <b>Ground for outputs.</b>   |           |        |        |        |        |   |        |        |           |           |   |         |        |       |       |
| 16  | SCLK                                  | I             | <b>SMBus-compatible SCLOCK.</b>  |           |        |        |        |        |   |        |        |           |           |   |         |        |       |       |
| 17  | SDATA                                 | I/O, OD       | <b>SMBus-compatible SDATA.</b>   |           |        |        |        |        |   |        |        |           |           |   |         |        |       |       |
| 18  | VDD_REF                               | PWR           | <b>3.3V power supply for outputs.</b>  |           |        |        |        |        |   |        |        |           |           |   |         |        |       |       |
| 19  | XOUT                                  | O, SE         | <b>14.318 MHz crystal output.</b>  |           |        |        |        |        |   |        |        |           |           |   |         |        |       |       |
| 20  | XIN                                   | I             | <b>14.318 MHz crystal input.</b>   |           |        |        |        |        |   |        |        |           |           |   |         |        |       |       |
| 21  | VSS_REF                               | GND           | <b>Ground for outputs.</b>   |           |        |        |        |        |   |        |        |           |           |   |         |        |       |       |
| 22  | REF1                                  | O             | <b>Fixed 14.318 MHz clock output.</b>  |           |        |        |        |        |   |        |        |           |           |   |         |        |       |       |
| 23  | REF0/FSC_TESTSEL                      | I/O,PD        | <b>Fixed 14.318 clock output / 3.3V-tolerant input for CPU frequency selection/Selects test mode if pulled to V<sub>IMFS_C</sub> when VTT_PWRGD# is asserted LOW.</b><br><i>Refer to DC Electrical Specifications table for V<sub>ILFS_C</sub>, V<sub>IMFS_C</sub>, V<sub>IHFS_C</sub> specifications.</i>   |           |        |        |        |        |   |        |        |           |           |   |         |        |       |       |
| 24  | CPU_STP#                              | I, PU         | <b>3.3V LVTTTL input for CPU_STP# active LOW.</b>  |           |        |        |        |        |   |        |        |           |           |   |         |        |       |       |
| 25  | PCI_STP#                              | I, PU         | <b>3.3V LVTTTL input for PCI_STP# active LOW.</b>  |           |        |        |        |        |   |        |        |           |           |   |         |        |       |       |
| 26, 28, 29,<br>38, 46, 57,<br>62, 71, 72  | CLKREQ[1:9]#                          | I, PU         | <b>3.3V LVTTTL input for enabling assigned SRC clock (active LOW).</b>   |           |        |        |        |        |   |        |        |           |           |   |         |        |       |       |
| 27, 32, 33  | PCI[1:3]                              | O, SE         | <b>33 MHz clock outputs</b>  |           |        |        |        |        |   |        |        |           |           |   |         |        |       |       |
| 30, 36  | VDD_PCI                               | PWR           | <b>3.3V power supply for outputs.</b>  |           |        |        |        |        |   |        |        |           |           |   |         |        |       |       |
| 31, 35  | VSS_PCI                               | GND           | <b>Ground for outputs.</b>   |           |        |        |        |        |   |        |        |           |           |   |         |        |       |       |
| 34  | PCI4/FCTSEL1                          | I/O, PD       | <b>33 MHz clock output / 3.3V LVTTTL input for selecting pins 47,48 (SRC[T/C]0, 100M[T/C]) and pins 43,44 (DOT96[T/C] and 27M Spread and Non-spread) (sampled on the VTT_PWRGD# assertion).</b><br><table border="1"> <thead> <tr> <th>FCTSEL1</th> <th>Pin 43</th> <th>Pin 44</th> <th>Pin 47</th> <th>Pin 48</th> </tr> </thead> <tbody> <tr> <td>0</td> <td>DOT96T</td> <td>DOT96C</td> <td>96/100M_T</td> <td>96/100M_C</td> </tr> <tr> <td>1</td> <td>27M_NSS</td> <td>27M_SS</td> <td>SRCT0</td> <td>SRCC0</td> </tr> </tbody> </table> | FCTSEL1   | Pin 43 | Pin 44 | Pin 47 | Pin 48 | 0 | DOT96T | DOT96C | 96/100M_T | 96/100M_C | 1 | 27M_NSS | 27M_SS | SRCT0 | SRCC0 |
| FCTSEL1   | Pin 43                                | Pin 44        | Pin 47   | Pin 48    |        |        |        |        |   |        |        |           |           |   |         |        |       |       |
| 0   | DOT96T                                | DOT96C        | 96/100M_T  | 96/100M_C |        |        |        |        |   |        |        |           |           |   |         |        |       |       |
| 1   | 27M_NSS                               | 27M_SS        | SRCT0  | SRCC0     |        |        |        |        |   |        |        |           |           |   |         |        |       |       |
| 37  | ITP_SEL/PCIF0                         | I/O,PD,<br>SE | <b>3.3V LVTTTL input to enable SRC10 or CPU2_ITP / 33-MHz clock output.</b><br>(sampled on the VTT_PWRGD# assertion).<br>1 = CPU2_ITP, 0 = SRC10   |           |        |        |        |        |   |        |        |           |           |   |         |        |       |       |

**Pin Description** (continued)

| Pin No. | Name                              | Type   | Description  |
|---------|-----------------------------------|--------|--|
| 39      | VTT_PWRGD#/PD                     | I, PD  | <b>3.3V LVTTTL input.</b> This pin is a level sensitive strobe used to latch the FSA, FSB, FSC, FCTSEL1, and ITP_SEL. After VTT_PWRGD# (active LOW) assertion, this pin becomes a real-time input for asserting power down (active HIGH).                      |
| 40      | VDD_48                            | PWR    | <b>3.3V power supply for outputs.</b>  |
| 41      | 48M/FSA                           | I/O    | <b>Fixed 48-MHz clock output / 3.3V-tolerant input for CPU frequency selection</b><br><i>Refer to DC Electrical Specifications table for <math>V_{il\_FS}</math> and <math>V_{ih\_FS}</math> specifications.</i>   |
| 42      | VSS_48                            | GND    | <b>Ground for outputs.</b>   |
| 43, 44  | DOT96T/ 27M_NSS<br>DOT96C/ 27M_SS | O, DIF | <b>Fixed 96-MHz clock output or 27 Mhz Spread and Non-spread output</b><br>Selected via FCTSEL1 at VTT_PWRGD# assertion.   |
| 45      | FSB/TEST_MODE                     | I      | <b>3.3V-tolerant input for CPU frequency selection. Selects Ref/N or Tri-state when in test mode</b><br>0 = Tri-state, 1 = Ref/N<br><i>Refer to DC Electrical Specifications table for <math>V_{il\_FS}</math> and <math>V_{ih\_FS}</math> specifications.</i> |
| 47, 48  | SRC[T/C]0/<br>LCD100M[T/C]        | O,DIF  | <b>100 MHz differential serial reference clock output / Differential 96/100-MHz SS clock for flat-panel display</b><br>Selected via FCTSEL1 at VTT_PWRGD# assertion.   |

**Frequency Select Pins (FSA, FSB, and FSC)**

Host clock frequency selection is achieved by applying the appropriate logic levels to FSA, FSB, FSC inputs prior to VTT\_PWRGD# assertion (as seen by the clock synthesizer). Upon VTT\_PWRGD# being sampled LOW by the clock chip (indicating processor VTT voltage is stable), the clock chip samples the FSA, FSB, and FSC input values. For all logic levels of FSA, FSB, and FSC, VTT\_PWRGD# employs a one-shot functionality in that once a valid LOW on VTT\_PWRGD# has been sampled, all further VTT\_PWRGD#, FSA, FSB, and FSC transitions will be ignored, except in test mode.

**Serial Data Interface**

To enhance the flexibility and function of the clock synthesizer, a two-signal serial interface is provided. Through the Serial Data Interface, various device functions, such as individual clock output buffers, can be individually enabled or disabled. The registers associated with the Serial Data Interface

initialize to their default setting upon power-up, and therefore use of this interface is optional. Clock device register changes are normally made upon system initialization, if any are required. The interface cannot be used during system operation for power management functions.

**Data Protocol**

The clock driver serial protocol accepts byte write, byte read, block write, and block read operations from the controller. For block write/read operation, the bytes must be accessed in sequential order from lowest to highest byte (most significant bit first) with the ability to stop after any complete byte has been transferred. For byte write and byte read operations, the system controller can access individually indexed bytes. The offset of the indexed byte is encoded in the command code, as described in *Table 2*.

The block write and block read protocol is outlined in *Table 3* while *Table 4* outlines the corresponding byte write and byte read protocol. The slave receiver address is 11010010 (D2h)

**Table 1. Frequency Select Table FSA, FSB, and FSC<sup>[1]</sup>**

| FSC | FSB | FSA | CPU     | SRC     | PCIF/PCI | 27MHz  | REF0       | DOT96  | USB    |
|-----|-----|-----|---------|---------|----------|--------|------------|--------|--------|
| 1   | 0   | 1   | 100 MHz | 100 MHz | 33 MHz   | 27 MHz | 14.318 MHz | 96 MHz | 48 MHz |
| 0   | 0   | 1   | 133 MHz | 100 MHz | 33 MHz   | 27 MHz | 14.318 MHz | 96 MHz | 48 MHz |
| 0   | 1   | 1   | 166 MHz | 100 MHz | 33 MHz   | 27 MHz | 14.318 MHz | 96 MHz | 48 MHz |
| 0   | 1   | 0   | 200 MHz | 100 MHz | 33 MHz   | 27 MHz | 14.318 MHz | 96 MHz | 48 MHz |

**Table 2. Command Code Definition**

| Bit   | Description   |
|-------|---|
| 7     | 0 = Block read or block write operation, 1 = Byte read or byte write operation  |
| (6:0) | Byte offset for byte read or byte write operation. For block read or block write operations, these bits should be '0000000' |

**Note:**

1. 27-MHz and 96-MHz can not be output at the same time.

**Table 3. Block Read and Block Write Protocol**

| Block Write Protocol |  | Block Read Protocol |                                     |
|----------------------|--|---------------------|-------------------------------------|
| Bit                  | Description  | Bit                 | Description                         |
| 1                    | Start  | 1                   | Start                               |
| 8:2                  | Slave address – 7 bits   | 8:2                 | Slave address – 7 bits              |
| 9                    | Write  | 9                   | Write                               |
| 10                   | Acknowledge from slave   | 10                  | Acknowledge from slave              |
| 18:11                | Command Code – 8 bits  | 18:11               | Command Code – 8 bits               |
| 19                   | Acknowledge from slave   | 19                  | Acknowledge from slave              |
| 27:20                | Byte Count – 8 bits<br>(Skip this step if I <sup>2</sup> C_EN bit set) | 20                  | Repeat start                        |
| 28                   | Acknowledge from slave   | 27:21               | Slave address – 7 bits              |
| 36:29                | Data byte 1 – 8 bits   | 28                  | Read = 1                            |
| 37                   | Acknowledge from slave   | 29                  | Acknowledge from slave              |
| 45:38                | Data byte 2 – 8 bits   | 37:30               | Byte Count from slave – 8 bits      |
| 46                   | Acknowledge from slave   | 38                  | Acknowledge                         |
| ....                 | Data Byte/Slave Acknowledges   | 46:39               | Data byte 1 from slave – 8 bits     |
| ....                 | Data Byte N – 8 bits   | 47                  | Acknowledge                         |
| ....                 | Acknowledge from slave   | 55:48               | Data byte 2 from slave – 8 bits     |
| ....                 | Stop   | 56                  | Acknowledge                         |
|                      |  | ....                | Data bytes from slave / Acknowledge |
|                      |  | ....                | Data Byte N from slave – 8 bits     |
|                      |  | ....                | NOT Acknowledge                     |
|                      |  | ....                | Stop                                |

**Table 4. Byte Read and Byte Write Protocol**

| Byte Write Protocol |                        | Byte Read Protocol |                          |
|---------------------|------------------------|--------------------|--------------------------|
| Bit                 | Description            | Bit                | Description              |
| 1                   | Start                  | 1                  | Start                    |
| 8:2                 | Slave address – 7 bits | 8:2                | Slave address – 7 bits   |
| 9                   | Write                  | 9                  | Write                    |
| 10                  | Acknowledge from slave | 10                 | Acknowledge from slave   |
| 18:11               | Command Code – 8 bits  | 18:11              | Command Code – 8 bits    |
| 19                  | Acknowledge from slave | 19                 | Acknowledge from slave   |
| 27:20               | Data byte – 8 bits     | 20                 | Repeated start           |
| 28                  | Acknowledge from slave | 27:21              | Slave address – 7 bits   |
| 29                  | Stop                   | 28                 | Read                     |
|                     |                        | 29                 | Acknowledge from slave   |
|                     |                        | 37:30              | Data from slave – 8 bits |
|                     |                        | 38                 | NOT Acknowledge          |
|                     |                        | 39                 | Stop                     |

**Control Registers**
**Byte 0: Control Register 0**

| Bit | @Pup | Name  | Description  |
|-----|------|---|--|
| 7   | 1    | SRC[T/C]7   | SRC[T/C]7 Output Enable<br>0 = Disable (Tri-state), 1 = Enable               |
| 6   | 1    | SRC[T/C]6   | SRC[T/C]6 Output Enable<br>0 = Disable (Tri-state), 1 = Enable               |
| 5   | 1    | SRC[T/C]5   | SRC[T/C]5 Output Enable<br>0 = Disable (Tri-state), 1 = Enable               |
| 4   | 1    | SRC[T/C]4   | SRC[T/C]4 Output Enable<br>0 = Disable (Tri-state), 1 = Enable               |
| 3   | 1    | SRC[T/C]3   | SRC[T/C]3 Output Enable<br>0 = Disable (Tri-state), 1 = Enable               |
| 2   | 1    | SRC[T/C]2   | SRC[T/C]2 Output Enable<br>0 = Disable (Tri-state), 1 = Enable               |
| 1   | 1    | SRC[T/C]1   | SRC[T/C]1 Output Enable<br>0 = Disable (Tri-state), 1 = Enable               |
| 0   | 1    | SRC[T/C]0 / LCD_96_100M[T/C]<br>/LCD_96_100M[T/C] | SRC[T/C]0 / LCD_96_100M[T/C] Output Enable<br>0 = Disable (Hi-Z), 1 = Enable |

**Byte 1: Control Register 1**

| Bit | @Pup | Name                                 | Description   |
|-----|------|--------------------------------------|---|
| 7   | 1    | PCIF0                                | PCIF0 Output Enable<br>0 = Disabled, 1 = Enabled                                    |
| 6   | 1    | 27M NSS / DOT_96[T/C]                | 27M Non-spread and DOT_96 MHz Output Enable<br>0 = Disable (Tri-state), 1 = Enabled |
| 5   | 1    | USB_48MHz                            | USB_48M MHz Output Enable<br>0 = Disabled, 1 = Enabled                              |
| 4   | 1    | REF0                                 | REF0 Output Enable<br>0 = Disabled, 1 = Enabled                                     |
| 3   | 1    | REF1                                 | REF1 Output Enable<br>0 = Disabled, 1 = Enabled                                     |
| 2   | 1    | CPU[T/C]1                            | CPU[T/C]1 Output Enable<br>0 = Disable (Tri-state), 1 = Enabled                     |
| 1   | 1    | CPU[T/C]0                            | CPU[T/C]0 Output Enable<br>0 = Disable (Tri-state), 1 = Enabled                     |
| 0   | 0    | CPU, SRC, PCI, PCIF<br>Spread Enable | PLL1 (CPU PLL) Spread Spectrum Enable<br>0 = Spread off, 1 = Spread on              |

**Byte 2: Control Register 2**

| Bit | @Pup | Name      | Description   |
|-----|------|-----------|---|
| 7   | 1    | PCI4      | PCI4 Output Enable<br>0 = Disabled, 1 = Enabled             |
| 6   | 1    | PCI3      | PCI3 Output Enable<br>0 = Disabled, 1 = Enabled             |
| 5   | 1    | PCI2      | PCI2 Output Enable<br>0 = Disabled, 1 = Enabled             |
| 4   | 1    | PCI1      | PCI1 Output Enable<br>0 = Disabled, 1 = Enabled             |
| 3   | 1    | Reserved  | Reserved, Set = 1   |
| 2   | 1    | Reserved  | Reserved, Set = 1   |
| 1   | 1    | CPU[T/C]2 | CPU[T/C]2 Output Enable<br>0 = Disabled (Hi-Z), 1 = Enabled |
| 0   | 1    | Reserved  | Reserved, Set = 1   |

**Byte 3: Control Register 3**

| Bit | @Pup | Name | Description   |
|-----|------|------|---|
| 7   | 0    | SRC7 | Allow control of SRC[T/C]7 with assertion of PCI_STP# or SW PCI_STP#<br>0 = Free running, 1 = Stopped with PCI_STP# |
| 6   | 0    | SRC6 | Allow control of SRC[T/C]6 with assertion of PCI_STP# or SW PCI_STP#<br>0 = Free running, 1 = Stopped with PCI_STP# |
| 5   | 0    | SRC5 | Allow control of SRC[T/C]5 with assertion of PCI_STP# or SW PCI_STP#<br>0 = Free running, 1 = Stopped with PCI_STP# |
| 4   | 0    | SRC4 | Allow control of SRC[T/C]4 with assertion of PCI_STP# or SW PCI_STP#<br>0 = Free running, 1 = Stopped with PCI_STP# |
| 3   | 0    | SRC3 | Allow control of SRC[T/C]3 with assertion of PCI_STP# or SW PCI_STP#<br>0 = Free running, 1 = Stopped with PCI_STP# |
| 2   | 0    | SRC2 | Allow control of SRC[T/C]2 with assertion of PCI_STP# or SW PCI_STP#<br>0 = Free running, 1 = Stopped with PCI_STP# |
| 1   | 0    | SRC1 | Allow control of SRC[T/C]1 with assertion of PCI_STP# or SW PCI_STP#<br>0 = Free running, 1 = Stopped with PCI_STP# |
| 0   | 0    | SRC0 | Allow control of SRC[T/C]0 with assertion of PCI_STP# or SW PCI_STP#<br>0 = Free running, 1 = Stopped with PCI_STP# |

**Byte 4: Control Register 4**

| Bit | @Pup | Name             | Description  |
|-----|------|------------------|--|
| 7   | 0    | LCD_96_100M[T/C] | LCD_96_100M[T/C] PWRDWN Drive Mode<br>0 = Driven in PWRDWN, 1 = Tri-state                                  |
| 6   | 0    | DOT96[T/C]       | DOT PWRDWN Drive Mode<br>0 = Driven in PWRDWN, 1 = Tri-state   |
| 5   | 0    | RESERVED         | RESERVED, Set = 0  |
| 4   | 0    | RESERVED         | RESERVED, Set = 0  |
| 3   | 0    | PCIF0            | Allow control of PCIF0 with assertion of SW and HW PCI_STP#<br>0 = Free running, 1 = Stopped with PCI_STP# |
| 2   | 1    | CPU[T/C]2        | Allow control of CPU[T/C]2 with assertion of CPU_STP#<br>0 = Free running, 1 = Stopped with CPU_STP#       |
| 1   | 1    | CPU[T/C]1        | Allow control of CPU[T/C]1 with assertion of CPU_STP#<br>0 = Free running, 1 = Stopped with CPU_STP#       |
| 0   | 1    | CPU[T/C]0        | Allow control of CPU[T/C]0 with assertion of CPU_STP#<br>0 = Free running, 1 = Stopped with CPU_STP#       |

**Byte 5: Control Register 5**

| Bit | @Pup | Name          | Description  |
|-----|------|---------------|--|
| 7   | 0    | SRC[T/C]      | SRC[T/C] Stop Drive Mode<br>0 = Driven when PCI_STP# asserted, 1 = Tri-state when PCI_STP# asserted  |
| 6   | 0    | CPU[T/C]2     | CPU[T/C]2 Stop Drive Mode<br>0 = Driven when CPU_STP# asserted, 1 = Tri-state when CPU_STP# asserted |
| 5   | 0    | CPU[T/C]1     | CPU[T/C]1 Stop Drive Mode<br>0 = Driven when CPU_STP# asserted, 1 = Tri-state when CPU_STP# asserted |
| 4   | 0    | CPU[T/C]0     | CPU[T/C]0 Stop Drive Mode<br>0 = Driven when CPU_STP# asserted, 1 = Tri-state when CPU_STP# asserted |
| 3   | 0    | SRC[T/C][9:1] | SRC[T/C][9:1] PWRDWN Drive Mode<br>0 = Driven when PD asserted, 1 = Tri-state when PD asserted       |
| 2   | 0    | CPU[T/C]2     | CPU[T/C]2 PWRDWN Drive Mode<br>0 = Driven when PD asserted, 1 = Tri-state when PD asserted           |

**Byte 5: Control Register 5 (continued)**

| Bit | @Pup | Name      | Description  |
|-----|------|-----------|--|
| 1   | 0    | CPU[T/C]1 | CPU[T/C]1 PWRDWN Drive Mode<br>0 = Driven when PD asserted, 1 = Tri-state when PD asserted |
| 0   | 0    | CPU[T/C]0 | CPU[T/C]0 PWRDWN Drive Mode<br>0 = Driven when PD asserted, 1 = Tri-state when PD asserted |

**Byte 6: Control Register 6**

| Bit | @Pup | Name   | Description  |
|-----|------|--|--|
| 7   | 0    | TEST_SEL   | REF/N or Tri-state Select<br>0 = Tri-state, 1 = REF/N Clock  |
| 6   | 0    | TEST_MODE  | Test Clock Mode Entry Control<br>0 = Normal operation, 1 = REF/N or Tri-state mode,  |
| 5   | 1    | REF1   | REF1 Output Drive Strength<br>0 = Low, 1 = High  |
| 4   | 1    | REF0   | REF0 Output Drive Strength<br>0 = Low, 1 = High  |
| 3   | 1    | PCI, PCIF and SRC clock outputs except those set to free running | SW PCI_STP Function<br>0=SW PCI_STP assert, 1= SW PCI_STP deassert<br>When this bit is set to 0, all STOPPABLE PCI, PCIF and SRC outputs will be stopped in a synchronous manner with no short pulses.<br>When this bit is set to 1, all STOPPED PCI, PCIF and SRC outputs will resume in a synchronous manner with no short pulses. |
| 2   | HW   | FSC  | FSC Reflects the value of the FSC pin sampled on power up<br>0 = FSC was low during VTT_PWRGD# assertion   |
| 1   | HW   | FSB  | FSB Reflects the value of the FSB pin sampled on power up<br>0 = FSB was low during VTT_PWRGD# assertion   |
| 0   | HW   | FSA  | FSA Reflects the value of the FSA pin sampled on power up<br>0 = FSA was low during VTT_PWRGD# assertion   |

**Byte 7: Vendor ID**

| Bit | @Pup | Name                | Description         |
|-----|------|---------------------|---------------------|
| 7   | 0    | Revision Code Bit 3 | Revision Code Bit 3 |
| 6   | 0    | Revision Code Bit 2 | Revision Code Bit 2 |
| 5   | 0    | Revision Code Bit 1 | Revision Code Bit 1 |
| 4   | 1    | Revision Code Bit 0 | Revision Code Bit 0 |
| 3   | 1    | Vendor ID Bit 3     | Vendor ID Bit 3     |
| 2   | 0    | Vendor ID Bit 2     | Vendor ID Bit 2     |
| 1   | 0    | Vendor ID Bit 1     | Vendor ID Bit 1     |
| 0   | 0    | Vendor ID Bit 0     | Vendor ID Bit 0     |

**Byte 8: Control Register 8**

| Bit | @Pup | Name     | Description  |
|-----|------|----------|--|
| 7   | 0    | RESERVED | RESERVED, Set = 0                                  |
| 6   | 0    | RESERVED | RESERVED, Set = 0                                  |
| 5   | 0    | RESERVED | RESERVED, Set = 0                                  |
| 4   | 0    | RESERVED | RESERVED, Set = 0                                  |
| 3   | 0    | RESERVED | RESERVED, Set = 0                                  |
| 2   | 1    | USB_48M  | USB_48MHz Output Drive Strength<br>0= Low, 1= High |
| 1   | 1    | RESERVED | RESERVED, Set = 1                                  |
| 0   | 1    | PCIF0    | PCIF0 Output Drive Strength<br>0 = Low, 1 = High   |

**Byte 9: Control Register 9**

| Bit | @Pup | Name                 | Description   |
|-----|------|----------------------|---|
| 7   | 0    | RESERVED             | RESERVED  |
| 6   | 0    | RESERVED             | RESERVED  |
| 5   | 0    | S1                   | 27M_SS / LCD 96_100M SS Spread Spectrum Selection table:<br>S[1:0] SS%<br>'00' = -0.5%(Default value)<br>'01' = -1.0%<br>'10' = -1.5%<br>'11' = -2.0% |
| 4   | 0    | S0                   |   |
| 3   | 1    | RESERVED             | RESERVED, Set = 1   |
| 2   | 1    | 27M_SS               | 27M Spread Output Enable<br>0 = Disable (Tri-state), 1 = Enabled  |
| 1   | 1    | 27M_SS Spread Enable | 27M_SS Spread spectrum enable.<br>0 = Disable, 1 = Enable.  |
| 0   | 0    | RESERVED             | RESERVED set = 0  |

**Byte 10: Control Register 10**

| Bit | @Pup | Name       | Description  |
|-----|------|------------|--|
| 7   | 1    | RESERVED   | RESERVED, Set = 1  |
| 6   | 1    | RESERVED   | RESERVED, Set = 1  |
| 5   | 1    | SRC[T/C]9  | SRC[T/C]9 Output Enable<br>0 = Disable (Hi-Z), 1 = Enable  |
| 4   | 1    | SRC[T/C]8  | SRC[T/C]8 Output Enable<br>0 = Disable (Hi-Z), 1 = Enable  |
| 3   | 0    | RESERVED   | RESERVED, Set = 0  |
| 2   | 0    | SRC[T/C]10 | Allow control of SRC[T/C]10 with assertion of SW PCI_STP#<br>0 = Free running, 1 = Stopped with PCI_STP# |
| 1   | 0    | SRC[T/C]9  | Allow control of SRC[T/C]9 with assertion of SW PCI_STP#<br>0 = Free running, 1 = Stopped with PCI_STP#  |
| 0   | 0    | SRC[T/C]8  | Allow control of SRC[T/C]8 with assertion of SW PCI_STP#<br>0 = Free running, 1 = Stopped with PCI_STP#  |

**Byte 11: Control Register 11**

| Bit | @Pup | Name             | Description   |
|-----|------|------------------|---|
| 7   | 0    | RESERVED         | RESERVED  |
| 6   | HW   | RESERVED         | RESERVED  |
| 5   | HW   | RESERVED         | RESERVED  |
| 4   | HW   | RESERVED         | RESERVED  |
| 3   | 0    | 27M_SS / 27M_NSS | 27-MHz (spread and non-spread) Output Drive Strength<br>0 = Low, 1 = High |
| 2   | 0    | RESERVED         | RESERVED  |
| 1   | 0    | RESERVED         | RESERVED Set = 0  |
| 0   | HW   | RESERVED         | RESERVED  |



**Byte 12: Control Register 12**

| Bit | @Pup | Name     | Description                                     |
|-----|------|----------|---|
| 7   | 0    | CLKREQ#9 | CLKREQ#9 Input Enable<br>0 = Disable 1 = Enable |
| 6   | 0    | CLKREQ#8 | CLKREQ#8 Input Enable<br>0 = Disable 1 = Enable |
| 5   | 0    | CLKREQ#7 | CLKREQ#7 Input Enable<br>0 = Disable 1 = Enable |
| 4   | 0    | CLKREQ#6 | CLKREQ#6 Input Enable<br>0 = Disable 1 = Enable |
| 3   | 0    | CLKREQ#5 | CLKREQ#5 Input Enable<br>0 = Disable 1 = Enable |
| 2   | 0    | CLKREQ#4 | CLKREQ#4 Input Enable<br>0 = Disable 1 = Enable |
| 1   | 0    | CLKREQ#3 | CLKREQ#3 Input Enable<br>0 = Disable 1 = Enable |
| 0   | 0    | CLKREQ#2 | CLKREQ#2 Input Enable<br>0 = Disable 1 = Enable |

**Byte 13: Control Register 13**

| Bit | @Pup | Name                    | Description   |
|-----|------|-------------------------|---|
| 7   | 0    | CLKREQ#1                | CLKREQ#1 Input Enable<br>0 = Disable 1 = Enable                         |
| 6   | 1    | LCD 96_100M Clock Speed | LCD 96_100M Clock Speed<br>0 = 96 MHz 1 = 100 MHz                       |
| 5   | 1    | RESERVED                | RESERVED, Set = 1   |
| 4   | 1    | RESERVED                | RESERVED, Set = 1   |
| 3   | 1    | PCI4                    | PCI4 (Spread and Non-spread) Output Drive Strength<br>0 = Low, 1 = High |
| 2   | 1    | PCI3                    | PCI3 (Spread and Non-spread) Output Drive Strength<br>0 = Low, 1 = High |
| 1   | 1    | PCI2                    | PCI2 (Spread and Non-spread) Output Drive Strength<br>0 = Low, 1 = High |
| 0   | 1    | PCI1                    | PCI1 (Spread and Non-spread) Output Drive Strength<br>0 = Low, 1 = High |

**Table 5. Crystal Recommendations**

| Frequency (Fund) | Cut | Loading  | Load Cap | Drive (max.) | Shunt Cap (max.) | Motional (max.) | Tolerance (max.) | Stability (max.) | Aging (max.) |
|------------------|-----|----------|----------|--------------|------------------|-----------------|------------------|------------------|--------------|
| 14.31818 MHz     | AT  | Parallel | 20 pF    | 0.1 mW       | 5 pF             | 0.016 pF        | 35 ppm           | 30 ppm           | 5 ppm        |

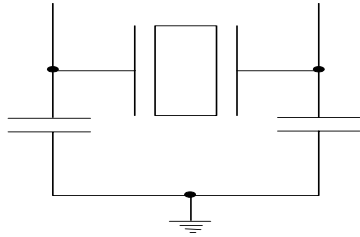
The CY28447 requires a Parallel Resonance Crystal. Substituting a series resonance crystal will cause the CY28447 to operate at the wrong frequency and violate the ppm specification. For most applications there is a 300-ppm frequency shift between series and parallel crystals due to incorrect loading.

### Crystal Loading

Crystal loading plays a critical role in achieving low ppm performance. To realize low ppm performance, the total capacitance

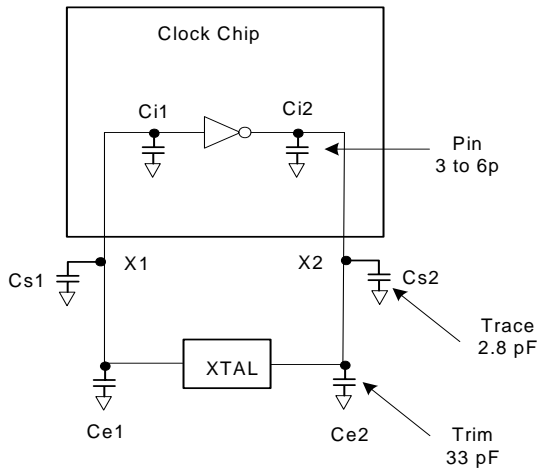
the crystal will see must be considered to calculate the appropriate capacitive loading (CL).

*Figure 1* shows a typical crystal configuration using the two trim capacitors. An important clarification for the following discussion is that the trim capacitors are in series with the crystal not parallel. It's a common misconception that load capacitors are in parallel with the crystal and should be approximately equal to the load capacitance of the crystal. This is not true.


**Figure 1. Crystal Capacitive Clarification**

### Calculating Load Capacitors

In addition to the standard external trim capacitors, trace capacitance and pin capacitance must also be considered to correctly calculate crystal loading. As mentioned previously, the capacitance on each side of the crystal is in series with the crystal. This means the total capacitance on each side of the crystal must be twice the specified crystal load capacitance (CL). While the capacitance on each side of the crystal is in series with the crystal, trim capacitors (Ce1,Ce2) should be calculated to provide equal capacitive loading on both sides.


**Figure 2. Crystal Loading Example**

As mentioned previously, the capacitance on each side of the crystal is in series with the crystal. This means the total capacitance on each side of the crystal must be twice the specified load capacitance (CL). While the capacitance on each side of the crystal is in series with the crystal, trim capacitors

(Ce1,Ce2) should be calculated to provide equal capacitance loading on both sides.

Use the following formulas to calculate the trim capacitor values for Ce1 and Ce2.

#### Load Capacitance (each side)

$$C_e = 2 * CL - (C_s + C_i)$$

#### Total Capacitance (as seen by the crystal)

$$CL_e = \frac{1}{\left(\frac{1}{C_{e1} + C_{s1} + C_{i1}} + \frac{1}{C_{e2} + C_{s2} + C_{i2}}\right)}$$

CL.....Crystal load capacitance

CL<sub>e</sub>..... Actual loading seen by crystal using standard value trim capacitors

C<sub>e</sub>..... External trim capacitors

C<sub>s</sub>..... Stray capacitance (terraced)

C<sub>i</sub> ..... Internal capacitance (lead frame, bond wires etc.)

### CLK\_REQ# Description

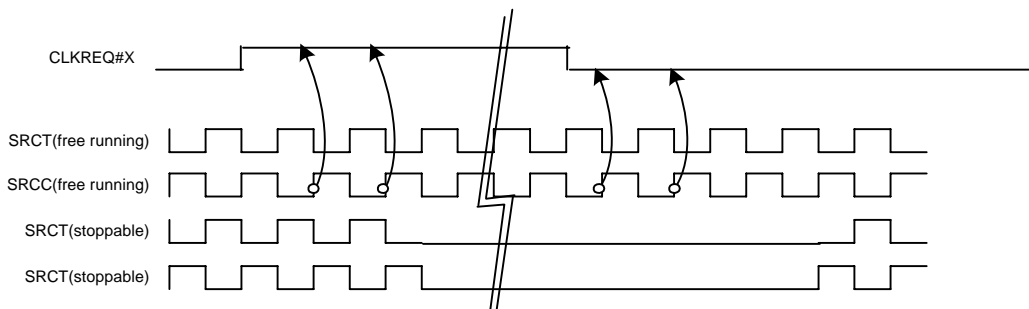
The CLKREQ# signals are active LOW inputs used for clean enabling and disabling selected SRC outputs. The outputs controlled by CLKREQ# are determined by the settings in register byte 8. The CLKREQ# signal is a de-bounced signal in that its state must remain unchanged during two consecutive rising edges of SRCC to be recognized as a valid assertion or deassertion. (The assertion and deassertion of this signal is absolutely asynchronous.)

#### CLK\_REQ[1:9]# Assertion (CLKREQ# -> LOW)

All differential outputs that were stopped are to resume normal operation in a glitch-free manner. The maximum latency from the assertion to active outputs is between 2 and 6 SRC clock periods (2 clocks are shown) with all SRC outputs resuming simultaneously. All stopped SRC outputs must be driven HIGH within 10 ns of CLKREQ# deassertion to a voltage greater than 200 mV.

#### CLK\_REQ[1:9]# Deassertion (CLKREQ# -> HIGH)

The impact of deasserting the CLKREQ# pins is that all SRC outputs that are set in the control registers to stoppable via deassertion of CLKREQ# are to be stopped after their next transition. The final state of all stopped DIF signals is LOW, both SRCT clock and SRCC clock outputs will not be driven.


**Figure 3. CLK\_REQ#[1:9] Deassertion/Assertion Waveform**

### PD (Power-down) Clarification

The VTT\_PWRGD# /PD pin is a dual-function pin. During initial power-up, the pin functions as VTT\_PWRGD#. Once VTT\_PWRGD# has been sampled LOW by the clock chip, the pin assumes PD functionality. The PD pin is an asynchronous active HIGH input used to shut off all clocks cleanly prior to shutting off power to the device. This signal is synchronized internal to the device prior to powering down the clock synthesizer. PD is also an asynchronous input for powering up the system. When PD is asserted HIGH, all clocks need to be driven to a LOW value and held prior to turning off the VCOs and the crystal oscillator.

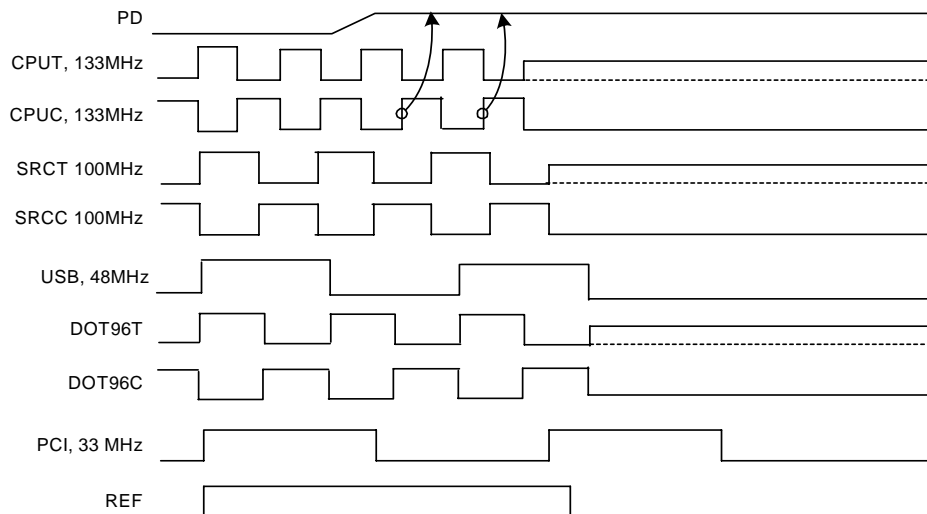
### PD (Power-down) Assertion

When PD is sampled HIGH by two consecutive rising edges of CPUC, all single-ended outputs will be held LOW on their next HIGH-to-LOW transition and differential clocks must be held HIGH or tri-stated (depending on the state of the control register drive mode bit) on the next diff clock# HIGH-to-LOW transition within 4 clock periods. When the SMBus PD drive mode bit corresponding to the differential (CPU, SRC, and DOT) clock output of interest is programmed to '0', the clock outputs are held with "Diff clock" pin driven HIGH at  $2 \times I_{ref}$ , and "Diff clock#" tri-state. If the control register PD drive mode

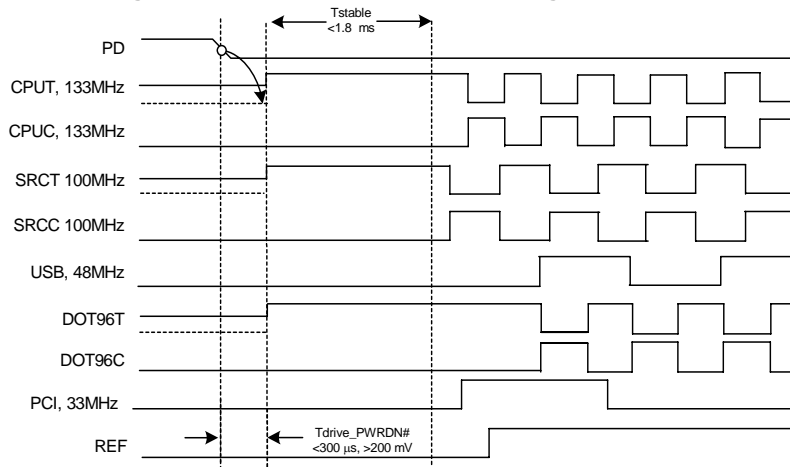
bit corresponding to the output of interest is programmed to "1", then both the "Diff clock" and the "Diff clock#" are tri-state. Note that *Figure 4* shows CPUC = 133 MHz and PD drive mode = '1' for all differential outputs. This diagram and description is applicable to valid CPU frequencies 100, 133, 166, and 200 MHz. In the event that PD mode is desired as the initial power-on state, PD must be asserted HIGH in less than  $10 \mu s$  after asserting Vt\_PwrGd#. It should be noted that 96\_100\_SSC will follow the DOT waveform is selected for 96 MHz and the SRC waveform when in 100-MHz mode.

### PD Deassertion

The power-up latency is less than 1.8 ms. This is the time from the deassertion of the PD pin or the ramping of the power supply until the time that stable clocks are output from the clock chip. All differential outputs stopped in a three-state condition resulting from power down will be driven high in less than  $300 \mu s$  of PD deassertion to a voltage greater than 200 mV. After the clock chip's internal PLL is powered up and locked, all outputs will be enabled within a few clock cycles of each other. *Figure 5* is an example showing the relationship of clocks coming up. It should be noted that 96\_100\_SSC will follow the DOT waveform is selected for 96 MHz and the SRC waveform when in 100-MHz mode.



**Figure 4. Power-down Assertion Timing Waveform**



**Figure 5. Power-down Deassertion Timing Waveform**

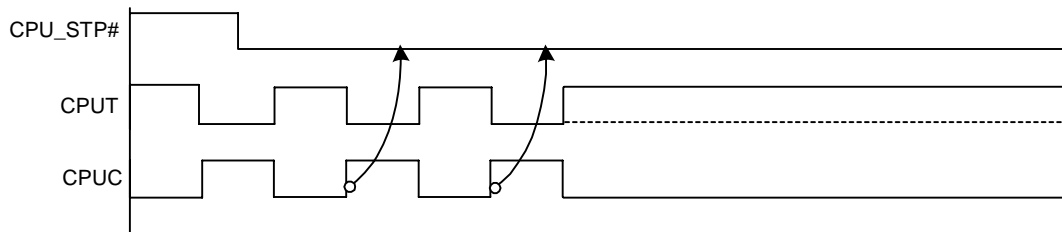
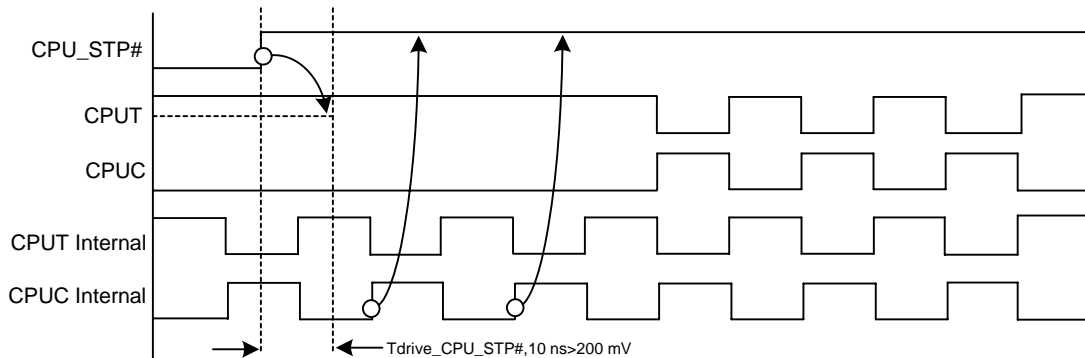
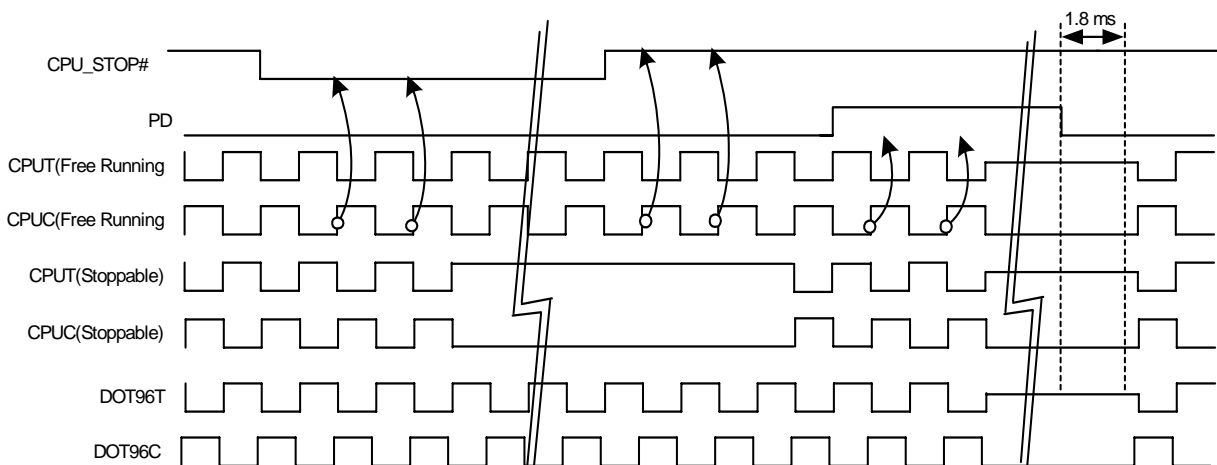
**CPU\_STP# Assertion**

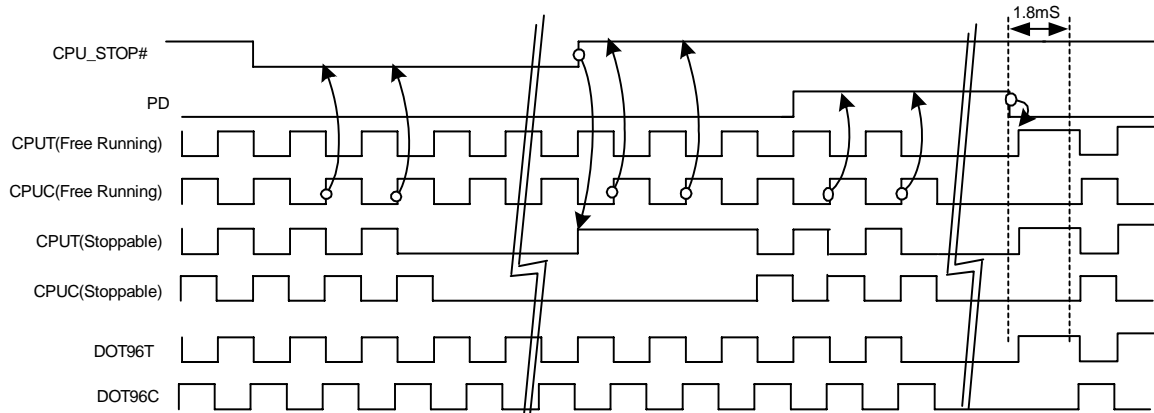
The CPU\_STP# signal is an active LOW input used for synchronous stopping and starting the CPU output clocks while the rest of the clock generator continues to function. When the CPU\_STP# pin is asserted, all CPU outputs that are set with the SMBus configuration to be stoppable via assertion of CPU\_STP# will be stopped within two–six CPU clock periods after being sampled by two rising edges of the internal CPUC clock. The final states of the stopped CPU signals are CPUT = HIGH and CPUC = LOW. There is no change to the output drive current values during the stopped state. The

CPUT is driven HIGH with a current value equal to  $6 \times (I_{ref})$ , and the CPUC signal will be tri-stated.

**CPU\_STP# Deassertion**

The deassertion of the CPU\_STP# signal will cause all CPU outputs that were stopped to resume normal operation in a synchronous manner, synchronous manner meaning that no short or stretched clock pulses will be produced when the clock resumes. The maximum latency from the deassertion to active outputs is no more than two CPU clock cycles.

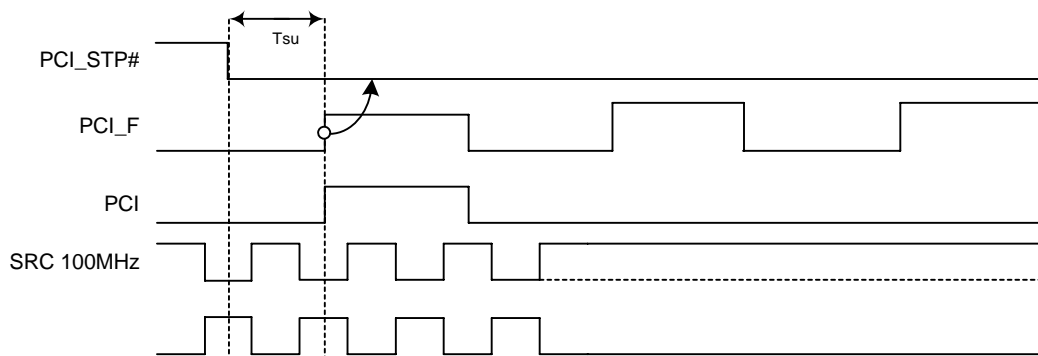

**Figure 6. CPU\_STP# Assertion Waveform**

**Figure 7. CPU\_STP# Deassertion Waveform**

**Figure 8. CPU\_STP# = Driven, CPU\_PD = Driven, DOT\_PD = Driven**



**Figure 9. CPU\_STOP# = Tri-state, CPU\_PD = Tri-state, DOT\_PD = Tri-state**

### PCI\_STOP# Assertion

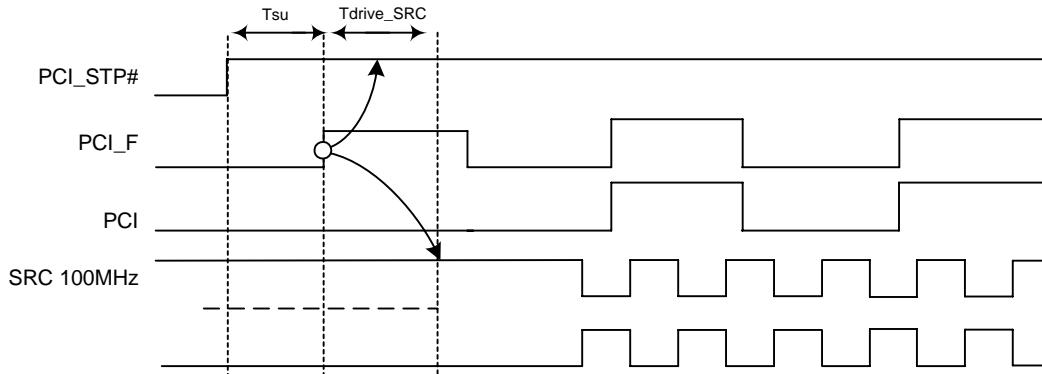
The PCI\_STOP# signal is an active LOW input used for synchronous stopping and starting the PCI outputs while the rest of the clock generator continues to function. The set-up time for capturing PCI\_STOP# going LOW is 10 ns ( $t_{SU}$ ). (See *Figure 10.*) The PCIF clocks will not be affected by this pin if their corresponding control bit in the SMBus register is set to allow them to be free running.



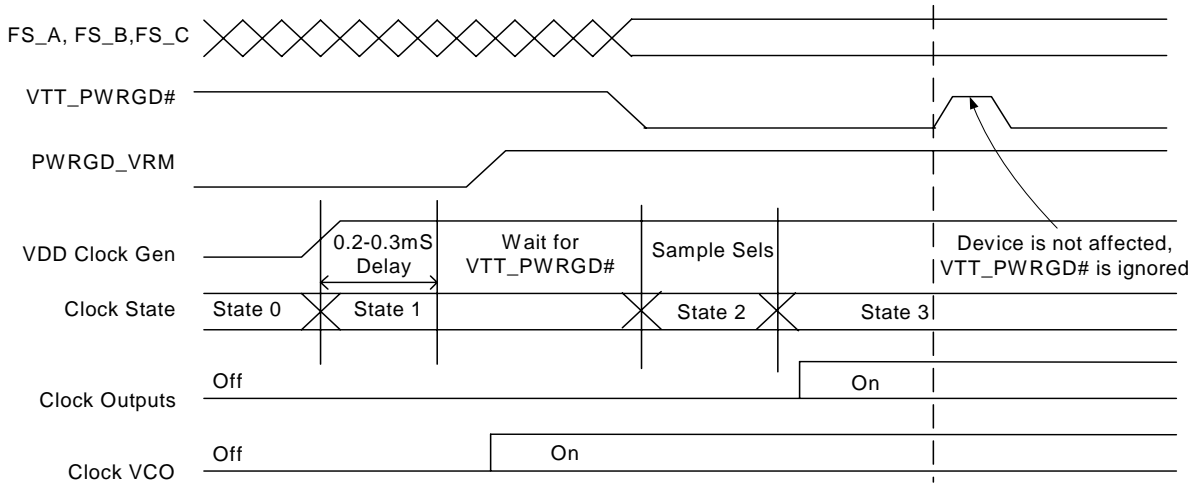
**Figure 10. PCI\_STOP# Assertion Waveform**

**PCI\_STP# Deassertion**

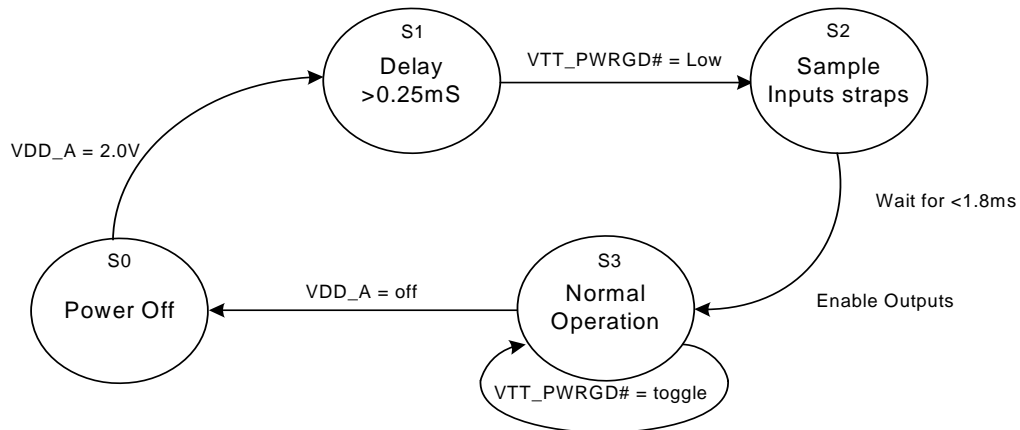
The deassertion of the PCI\_STP# signal will cause all PCI and stoppable PCIF clocks to resume running in a synchronous manner within two PCI clock periods after PCI\_STP# transitions to a HIGH level.



**Figure 11. PCI\_STP# Deassertion Waveform**



**Figure 12. VTT\_PWRGD# Timing Diagram**



**Figure 13. Single-ended Load Configuration**

**Absolute Maximum Conditions**

| Parameter          | Description                       | Condition                   | Min. | Max.                  | Unit |
|--------------------|-----------------------------------|-----------------------------|------|-----------------------|------|
| V <sub>DD</sub>    | Core Supply Voltage               |                             | -0.5 | 4.6                   | V    |
| V <sub>DD_A</sub>  | Analog Supply Voltage             |                             | -0.5 | 4.6                   | V    |
| V <sub>IN</sub>    | Input Voltage                     | Relative to V <sub>SS</sub> | -0.5 | V <sub>DD</sub> + 0.5 | VDC  |
| T <sub>S</sub>     | Temperature, Storage              | Non-functional              | -65  | 150                   | °C   |
| T <sub>A</sub>     | Temperature, Operating Ambient    | Functional                  | 0    | 85                    | °C   |
| T <sub>J</sub>     | Temperature, Junction             | Functional                  | -    | 150                   | °C   |
| ∅ <sub>JC</sub>    | Dissipation, Junction to Case     | Mil-STD-883E Method 1012.1  | -    | 20                    | °C/W |
| ∅ <sub>JA</sub>    | Dissipation, Junction to Ambient  | JEDEC (JESD 51)             | -    | 60                    | °C/W |
| ESD <sub>HBM</sub> | ESD Protection (Human Body Model) | MIL-STD-883, Method 3015    | 2000 | -                     | V    |
| UL-94              | Flammability Rating               | At 1/8 in.                  | V-0  |                       |      |
| MSL                | Moisture Sensitivity Level        |                             | 1    |                       |      |

**Multiple Supplies:** The Voltage on any input or I/O pin cannot exceed the power pin during power-up. Power supply sequencing is NOT required.

**DC Electrical Specifications**

| Parameter           | Description                   | Condition  | Min.                  | Max.                  | Unit |
|---------------------|-------------------------------|--|-----------------------|-----------------------|------|
| All VDDs            | 3.3V Operating Voltage        | 3.3 ± 5%   | 3.135                 | 3.465                 | V    |
| V <sub>IL12C</sub>  | Input Low Voltage             | SDATA, SCLK  | -                     | 1.0                   | V    |
| V <sub>IH12C</sub>  | Input High Voltage            | SDATA, SCLK  | 2.2                   | -                     | V    |
| V <sub>IL_FS</sub>  | FS_[A,B] Input Low Voltage    |  | V <sub>SS</sub> - 0.3 | 0.35                  | V    |
| V <sub>IH_FS</sub>  | FS_[A,B] Input High Voltage   |  | 0.7                   | V <sub>DD</sub> + 0.5 | V    |
| V <sub>ILFS_C</sub> | FS_C Input Low Voltage        |  | V <sub>SS</sub> - 0.3 | 0.35                  | V    |
| V <sub>IMFS_C</sub> | FS_C Input Middle Voltage     |  | 0.7                   | 1.7                   | V    |
| V <sub>IHFS_C</sub> | FS_C Input High Voltage       |  | 1.8                   | V <sub>DD</sub> + 0.5 | V    |
| V <sub>IL</sub>     | 3.3V Input Low Voltage        |  | V <sub>SS</sub> - 0.3 | 0.8                   | V    |
| V <sub>IH</sub>     | 3.3V Input High Voltage       |  | 2.0                   | V <sub>DD</sub> + 0.3 | V    |
| I <sub>IL</sub>     | Input Low Leakage Current     | Except internal pull-up resistors, 0 < V <sub>IN</sub> < V <sub>DD</sub>   | -5                    | 5                     | μA   |
| I <sub>IH</sub>     | Input High Leakage Current    | Except internal pull-down resistors, 0 < V <sub>IN</sub> < V <sub>DD</sub> | -                     | 5                     | μA   |
| V <sub>OL</sub>     | 3.3V Output Low Voltage       | I <sub>OL</sub> = 1 mA   | -                     | 0.4                   | V    |
| V <sub>OH</sub>     | 3.3V Output High Voltage      | I <sub>OH</sub> = -1 mA  | 2.4                   | -                     | V    |
| I <sub>OZ</sub>     | High-impedance Output Current |  | -10                   | 10                    | μA   |
| C <sub>IN</sub>     | Input Pin Capacitance         |  | 3                     | 5                     | pF   |
| C <sub>OUT</sub>    | Output Pin Capacitance        |  | 3                     | 6                     | pF   |
| L <sub>IN</sub>     | Pin Inductance                |  | -                     | 7                     | nH   |
| V <sub>XIH</sub>    | Xin High Voltage              |  | 0.7V <sub>DD</sub>    | V <sub>DD</sub>       | V    |
| V <sub>XIL</sub>    | Xin Low Voltage               |  | 0                     | 0.3V <sub>DD</sub>    | V    |
| I <sub>DD3.3V</sub> | Dynamic Supply Current        | At max. load in low drive mode per Figure 15 and Figure 17 @133 MHz        | -                     | 300                   | mA   |
| I <sub>PD3.3V</sub> | Power-down Supply Current     | PD asserted, Outputs Driven  | -                     | 70                    | mA   |
| I <sub>PD3.3V</sub> | Power-down Supply Current     | PD asserted, Outputs Tri-state   | -                     | 5                     | mA   |

**AC Electrical Specifications**

| Parameter                       | Description                                | Condition   | Min.     | Max.               | Unit |
|---------------------------------|--|---|----------|--------------------|------|
| <b>Crystal</b>                  |  |   |          |                    |      |
| T <sub>DC</sub>                 | XIN Duty Cycle                             | The device will operate reliably with input duty cycles up to 30/70 but the REF clock duty cycle will not be within specification | 47.5     | 52.5               | %    |
| T <sub>PERIOD</sub>             | XIN Period                                 | When XIN is driven from an external clock source  | 69.841   | 71.0               | ns   |
| T <sub>R</sub> / T <sub>F</sub> | XIN Rise and Fall Times                    | Measured between 0.3V <sub>DD</sub> and 0.7V <sub>DD</sub>  | –        | 10.0               | ns   |
| T <sub>CCJ</sub>                | XIN Cycle to Cycle Jitter                  | As an average over 1- $\mu$ s duration  | –        | 500                | ps   |
| L <sub>ACC</sub>                | Long-term Accuracy                         | Measured at crossing point V <sub>OX</sub>  | –        | 300                | ppm  |
| <b>CPU at 0.7V</b>              |  |   |          |                    |      |
| T <sub>DC</sub>                 | CPUT and CPUC Duty Cycle                   | Measured at crossing point V <sub>OX</sub>  | 45       | 55                 | %    |
| T <sub>PERIOD</sub>             | 100-MHz CPUT and CPUC Period               | Measured at crossing point V <sub>OX</sub>  | 9.997001 | 10.00300           | ns   |
| T <sub>PERIOD</sub>             | 133-MHz CPUT and CPUC Period               | Measured at crossing point V <sub>OX</sub>  | 7.497751 | 7.502251           | ns   |
| T <sub>PERIOD</sub>             | 166-MHz CPUT and CPUC Period               | Measured at crossing point V <sub>OX</sub>  | 5.998201 | 6.001801           | ns   |
| T <sub>PERIOD</sub>             | 200-MHz CPUT and CPUC Period               | Measured at crossing point V <sub>OX</sub>  | 4.998500 | 5.001500           | ns   |
| T <sub>PERIODSS</sub>           | 100-MHz CPUT and CPUC Period, SSC          | Measured at crossing point V <sub>OX</sub>  | 9.997001 | 10.05327           | ns   |
| T <sub>PERIODSS</sub>           | 133-MHz CPUT and CPUC Period, SSC          | Measured at crossing point V <sub>OX</sub>  | 7.497751 | 7.539950           | ns   |
| T <sub>PERIODSS</sub>           | 166-MHz CPUT and CPUC Period, SSC          | Measured at crossing point V <sub>OX</sub>  | 5.998201 | 6.031960           | ns   |
| T <sub>PERIODSS</sub>           | 200-MHz CPUT and CPUC Period, SSC          | Measured at crossing point V <sub>OX</sub>  | 4.998500 | 5.026634           | ns   |
| T <sub>PERIODAbs</sub>          | 100-MHz CPUT and CPUC Absolute period      | Measured at crossing point V <sub>OX</sub>  | 9.912001 | 10.08800           | ns   |
| T <sub>PERIODAbs</sub>          | 133-MHz CPUT and CPUC Absolute period      | Measured at crossing point V <sub>OX</sub>  | 7.412751 | 7.587251           | ns   |
| T <sub>PERIODAbs</sub>          | 166-MHz CPUT and CPUC Absolute period      | Measured at crossing point V <sub>OX</sub>  | 5.913201 | 6.086801           | ns   |
| T <sub>PERIODAbs</sub>          | 200-MHz CPUT and CPUC Absolute period      | Measured at crossing point V <sub>OX</sub>  | 4.913500 | 5.086500           | ns   |
| T <sub>PERIODSSAbs</sub>        | 100-MHz CPUT and CPUC Absolute period, SSC | Measured at crossing point V <sub>OX</sub>  | 9.912001 | 10.13827           | ns   |
| T <sub>PERIODSSAbs</sub>        | 133-MHz CPUT and CPUC Absolute period, SSC | Measured at crossing point V <sub>OX</sub>  | 7.412751 | 7.624950           | ns   |
| T <sub>PERIODSSAbs</sub>        | 166-MHz CPUT and CPUC Absolute period, SSC | Measured at crossing point V <sub>OX</sub>  | 5.913201 | 6.116960           | ns   |
| T <sub>PERIODSSAbs</sub>        | 200-MHz CPUT and CPUC Absolute period, SSC | Measured at crossing point V <sub>OX</sub>  | 4.913500 | 5.111634           | ns   |
| T <sub>CCJ</sub>                | CPUT/C Cycle to Cycle Jitter               | Measured at crossing point V <sub>OX</sub>  | –        | 85 <sup>[2]</sup>  | ps   |
| T <sub>CCJ2</sub>               | CPU2_ITP Cycle to Cycle Jitter             | Measured at crossing point V <sub>OX</sub>  | –        | 125 <sup>[2]</sup> | ps   |
| L <sub>ACC</sub>                | Long-term Accuracy                         | Measured at crossing point V <sub>OX</sub>  | –        | 300                | ppm  |
| T <sub>SKEW</sub>               | CPU1 to CPU0 Clock Skew                    | Measured at crossing point V <sub>OX</sub>  | –        | 100                | ps   |
| T <sub>SKEW2</sub>              | CPU2_ITP to CPU0 Clock Skew                | Measured at crossing point V <sub>OX</sub>  | –        | 150                | ps   |
| T <sub>R</sub> / T <sub>F</sub> | CPUT and CPUC Rise and Fall Time           | Measured from V <sub>OL</sub> = 0.175 to V <sub>OH</sub> = 0.525V   | 175      | 700                | ps   |
| T <sub>RFM</sub>                | Rise/Fall Matching                         | Determined as a fraction of $2 \cdot (T_R - T_F) / (T_R + T_F)$   | –        | 20                 | %    |
| $\Delta T_R$                    | Rise Time Variation                        |   | –        | 125                | ps   |
| $\Delta T_F$                    | Fall Time Variation                        |   | –        | 125                | ps   |

**Note:**

2. Measured with one REF on.



**AC Electrical Specifications** (continued)

| Parameter                       | Description                                | Condition   | Min.     | Max.                    | Unit |
|---------------------------------|--|---|----------|-------------------------|------|
| V <sub>HIGH</sub>               | Voltage High                               | Math averages <i>Figure 17</i>  | 660      | 850                     | mV   |
| V <sub>LOW</sub>                | Voltage Low                                | Math averages <i>Figure 17</i>  | -150     | -                       | mV   |
| V <sub>OX</sub>                 | Crossing Point Voltage at 0.7V Swing       |   | 250      | 550                     | mV   |
| V <sub>OVS</sub>                | Maximum Overshoot Voltage                  |   | -        | V <sub>HIGH</sub> + 0.3 | V    |
| V <sub>UDS</sub>                | Minimum Undershoot Voltage                 |   | -0.3     | -                       | V    |
| V <sub>RB</sub>                 | Ring Back Voltage                          | See <i>Figure 17</i> . Measure SE   | -        | 0.2                     | V    |
| <b>SRC at 0.7V</b>              |  |   |          |                         |      |
| T <sub>DC</sub>                 | SRCT and SRCC Duty Cycle                   | Measured at crossing point V <sub>OX</sub>  | 45       | 55                      | %    |
| T <sub>PERIOD</sub>             | 100-MHz SRCT and SRCC Period               | Measured at crossing point V <sub>OX</sub>  | 9.997001 | 10.00300                | ns   |
| T <sub>PERIODSS</sub>           | 100-MHz SRCT and SRCC Period, SSC          | Measured at crossing point V <sub>OX</sub>  | 9.997001 | 10.05327                | ns   |
| T <sub>PERIODAbs</sub>          | 100-MHz SRCT and SRCC Absolute Period      | Measured at crossing point V <sub>OX</sub>  | 9.872001 | 10.12800                | ns   |
| T <sub>PERIODSSAbs</sub>        | 100-MHz SRCT and SRCC Absolute Period, SSC | Measured at crossing point V <sub>OX</sub>  | 9.872001 | 10.17827                | ns   |
| T <sub>SKEW</sub>               | Any SRCT/C to SRCT/C Clock Skew            | Measured at crossing point V <sub>OX</sub>  | -        | 250                     | ps   |
| T <sub>CCJ</sub>                | SRCT/C Cycle to Cycle Jitter               | Measured at crossing point V <sub>OX</sub>  | -        | 125 <sup>[2]</sup>      | ps   |
| L <sub>ACC</sub>                | SRCT/C Long Term Accuracy                  | Measured at crossing point V <sub>OX</sub>  | -        | 300                     | ppm  |
| T <sub>R</sub> / T <sub>F</sub> | SRCT and SRCC Rise and Fall Time           | Measured from V <sub>OL</sub> = 0.175 to V <sub>OH</sub> = 0.525V                                   | 175      | 800                     | ps   |
| T <sub>RFM</sub>                | Rise/Fall Matching                         | Determined as a fraction of 2*(T <sub>R</sub> - T <sub>F</sub> )/(T <sub>R</sub> + T <sub>F</sub> ) | -        | 20                      | %    |
| ΔT <sub>R</sub>                 | Rise Time Variation                        |   | -        | 125                     | ps   |
| ΔT <sub>F</sub>                 | Fall Time Variation                        |   | -        | 125                     | ps   |
| V <sub>HIGH</sub>               | Voltage High                               | Math averages <i>Figure 17</i>  | 660      | 850                     | mV   |
| V <sub>LOW</sub>                | Voltage Low                                | Math averages <i>Figure 17</i>  | -150     | -                       | mV   |
| V <sub>OX</sub>                 | Crossing Point Voltage at 0.7V Swing       |   | 180      | 550                     | mV   |
| V <sub>OVS</sub>                | Maximum Overshoot Voltage                  |   | -        | V <sub>HIGH</sub> + 0.3 | V    |
| V <sub>UDS</sub>                | Minimum Undershoot Voltage                 |   | -0.3     | -                       | V    |
| V <sub>RB</sub>                 | Ring Back Voltage                          | See <i>Figure 17</i> . Measure SE   | -        | 0.2                     | V    |
| <b>LCD 96_100M_SSC at 0.7V</b>  |  |   |          |                         |      |
| T <sub>DC</sub>                 | SSCT and SSCC Duty Cycle                   | Measured at crossing point V <sub>OX</sub>  | 45       | 55                      | %    |
| T <sub>PERIOD</sub>             | 100-MHz SSCT and SSCC Period               | Measured at crossing point V <sub>OX</sub>  | 9.997001 | 10.00300                | ns   |
| T <sub>PERIODSS</sub>           | 100-MHz SSCT and SSCC Period, SSC          | Measured at crossing point V <sub>OX</sub>  | 9.997001 | 10.05327                | ns   |
| T <sub>PERIODAbs</sub>          | 100-MHz SSCT and SSCC Absolute Period      | Measured at crossing point V <sub>OX</sub>  | 9.872001 | 10.12800                | ns   |
| T <sub>PERIODSSAbs</sub>        | 100-MHz SRCT and SRCC Absolute Period, SSC | Measured at crossing point V <sub>OX</sub>  | 9.872001 | 10.17827                | ns   |
| T <sub>PERIOD</sub>             | 96-MHz SSCT and SSCC Period                | Measured at crossing point V <sub>OX</sub>  | 10.41354 | 10.41979                | ns   |
| T <sub>PERIODSS</sub>           | 96-MHz SSCT and SSCC Period, SSC           | Measured at crossing point V <sub>OX</sub>  | 10.41354 | 10.47215                | ns   |
| T <sub>PERIODAbs</sub>          | 96-MHz SSCT and SSCC Absolute Period       | Measured at crossing point V <sub>OX</sub>  | 10.16354 | 10.66979                | ns   |
| T <sub>PERIODSSAbs</sub>        | 96-MHz SRCT and SRCC Absolute Period, SSC  | Measured at crossing point V <sub>OX</sub>  | 10.16354 | 10.72266                | ns   |
| T <sub>CCJ</sub>                | SSCT/C Cycle to Cycle Jitter               | Measured at crossing point V <sub>OX</sub>  | -        | 125                     | ps   |
| L <sub>ACC</sub>                | SSCT/C Long Term Accuracy                  | Measured at crossing point V <sub>OX</sub>  | -        | 300                     | ppm  |

**AC Electrical Specifications** (continued)

| Parameter               | Description                           | Condition   | Min.     | Max.             | Unit |
|-------------------------|---------------------------------------|---|----------|------------------|------|
| $T_R / T_F$             | SSCT and SSCC Rise and Fall Time      | Measured from $V_{OL} = 0.175$ to $V_{OH} = 0.525V$     | 175      | 700              | ps   |
| $T_{RFM}$               | Rise/Fall Matching                    | Determined as a fraction of $2*(T_R - T_F)/(T_R + T_F)$ | -        | 20               | %    |
| $\Delta T_R$            | Rise Time Variation                   |   | -        | 125              | ps   |
| $\Delta T_F$            | Fall Time Variation                   |   | -        | 125              | ps   |
| $V_{HIGH}$              | Voltage High                          | Math averages <i>Figure 17</i>                          | 660      | 850              | mV   |
| $V_{LOW}$               | Voltage Low                           | Math averages <i>Figure 17</i>                          | -150     | -                | mV   |
| $V_{OX}$                | Crossing Point Voltage at 0.7V Swing  |   | 250      | 550              | mV   |
| $V_{OVS}$               | Maximum Overshoot Voltage             |   | -        | $V_{HIGH} + 0.3$ | V    |
| $V_{UDS}$               | Minimum Undershoot Voltage            |   | -0.3     | -                | V    |
| $V_{RB}$                | Ring Back Voltage                     | See <i>Figure 17</i> . Measure SE                       | -        | 0.2              | V    |
| <b>PCI/PCIF at 3.3V</b> |                                       |   |          |                  |      |
| $T_{DC}$                | PCI Duty Cycle                        | Measurement at 1.5V                                     | 45       | 55               | %    |
| $T_{PERIOD}$            | Spread Disabled PCIF/PCI Period       | Measurement at 1.5V                                     | 29.99100 | 30.00900         | ns   |
| $T_{PERIODSS}$          | Spread Enabled PCIF/PCI Period, SSC   | Measurement at 1.5V                                     | 29.9910  | 30.15980         | ns   |
| $T_{PERIODAbs}$         | Spread Disabled PCIF/PCI Period       | Measurement at 1.5V                                     | 29.49100 | 30.50900         | ns   |
| $T_{PERIODSSAbs}$       | Spread Enabled PCIF/PCI Period, SSC   | Measurement at 1.5V                                     | 29.49100 | 30.65980         | ns   |
| $T_{HIGH}$              | PCIF and PCI high time                | Measurement at 2.4V                                     | 12.0     | -                | ns   |
| $T_{LOW}$               | PCIF and PCI low time                 | Measurement at 0.4V                                     | 12.0     | -                | ns   |
| $T_R / T_F$             | PCIF/PCI rising and falling Edge Rate | Measured between 0.8V and 2.0V                          | 1.0      | 4.0              | V/ns |
| $T_{SKEW}$              | Any PCI clock to Any PCI clock Skew   | Measurement at 1.5V                                     | -        | 500              | ps   |
| $T_{CCJ}$               | PCIF and PCI Cycle to Cycle Jitter    | Measurement at 1.5V                                     | -        | 500              | ps   |
| $L_{ACC}$               | PCIF/PCI Long Term Accuracy           | Measured at crossing point $V_{OX}$                     | -        | 300              | ppm  |
| <b>DOT96 at 0.7V</b>    |                                       |   |          |                  |      |
| $T_{DC}$                | DOT96T and DOT96C Duty Cycle          | Measured at crossing point $V_{OX}$                     | 45       | 55               | %    |
| $T_{PERIOD}$            | DOT96T and DOT96C Period              | Measured at crossing point $V_{OX}$                     | 10.41354 | 10.41979         | ns   |
| $T_{PERIODAbs}$         | DOT96T and DOT96C Absolute Period     | Measured at crossing point $V_{OX}$                     | 10.16354 | 10.66979         | ns   |
| $T_{CCJ}$               | DOT96T/C Cycle to Cycle Jitter        | Measured at crossing point $V_{OX}$                     | -        | 250              | ps   |
| $L_{ACC}$               | DOT96T/C Long Term Accuracy           | Measured at crossing point $V_{OX}$                     | -        | 300              | ppm  |
| $T_R / T_F$             | DOT96T and DOT96C Rise and Fall Time  | Measured from $V_{OL} = 0.175$ to $V_{OH} = 0.525V$     | 175      | 900              | ps   |
| $T_{RFM}$               | Rise/Fall Matching                    | Determined as a fraction of $2*(T_R - T_F)/(T_R + T_F)$ | -        | 20               | %    |
| $\Delta T_R$            | Rise Time Variation                   |   | -        | 125              | ps   |
| $\Delta T_F$            | Fall Time Variation                   |   | -        | 125              | ps   |
| $V_{HIGH}$              | Voltage High                          | Math averages <i>Figure 17</i>                          | 660      | 850              | mV   |
| $V_{LOW}$               | Voltage Low                           | Math averages <i>Figure 17</i>                          | -150     | -                | mV   |
| $V_{OX}$                | Crossing Point Voltage at 0.7V Swing  |   | 250      | 550              | mV   |
| $V_{OVS}$               | Maximum Overshoot Voltage             |   | -        | $V_{HIGH} + 0.3$ | V    |
| $V_{UDS}$               | Minimum Undershoot Voltage            |   | -0.3     | -                | V    |
| $V_{RB}$                | Ring Back Voltage                     | See <i>Figure 17</i> . Measure SE                       | -        | 0.2              | V    |
| <b>48_M at 3.3V</b>     |                                       |   |          |                  |      |
| $T_{DC}$                | Duty Cycle                            | Measurement at 1.5V                                     | 45       | 55               | %    |

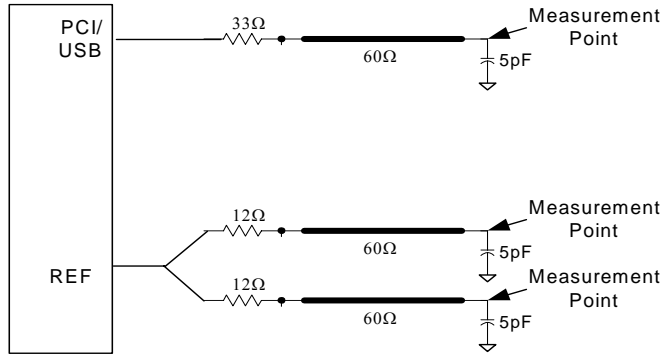
**AC Electrical Specifications** (continued)

| Parameter                        | Description                       | Condition                                  | Min.     | Max.     | Unit |
|----------------------------------|-----------------------------------|--|----------|----------|------|
| T <sub>PERIOD</sub>              | Period                            | Measurement at 1.5V                        | 20.83125 | 20.83542 | ns   |
| T <sub>PERIODAbs</sub>           | Absolute Period                   | Measurement at 1.5V                        | 20.48125 | 21.18542 | ns   |
| T <sub>HIGH</sub>                | 48_M High time                    | Measurement at 2.4V                        | 8.094    | 11.100   | ns   |
| T <sub>LOW</sub>                 | 48_M Low time                     | Measurement at 0.4V                        | 7.694    | 11.100   | ns   |
| T <sub>R</sub> / T <sub>F</sub>  | Rising and Falling Edge Rate      | Measured between 0.8V and 2.0V             | 1.0      | 2.0      | V/ns |
| T <sub>CCJ</sub>                 | Cycle to Cycle Jitter             | Measurement at 1.5V                        | –        | 350      | ps   |
| L <sub>ACC</sub>                 | 48M Long Term Accuracy            | Measured at crossing point V <sub>OX</sub> | –        | 100      | ppm  |
| <b>27_M at 3.3V</b>              |                                   |  |          |          |      |
| T <sub>DC</sub>                  | Duty Cycle                        | Measurement at 1.5V                        | 45       | 55       | %    |
| T <sub>PERIOD</sub>              | Spread Disabled 27M Period        | Measurement at 1.5V                        | 27.000   | 27.0547  | ns   |
|                                  | Spread Enabled 27M Period         | Measurement at 1.5V                        | 27.000   | 27.0547  |      |
| T <sub>HIGH</sub>                | 27_M High time                    | Measurement at 2.0V                        | 10.5     | –        | ns   |
| T <sub>LOW</sub>                 | 27_M Low time                     | Measurement at 0.8V                        | 10.5     | –        | ns   |
| T <sub>R</sub> / T <sub>F</sub>  | Rising and Falling Edge Rate      | Measured between 0.8V and 2.0V             | 1.0      | 4.0      | V/ns |
| T <sub>CCJ</sub>                 | Cycle to Cycle Jitter             | Measurement at 1.5V                        | –        | 500      | ps   |
| L <sub>ACC</sub>                 | 27_M Long Term Accuracy           | Measured at crossing point V <sub>OX</sub> | –        | 0        | ppm  |
| <b>REF at 3.3V</b>               |                                   |  |          |          |      |
| T <sub>DC</sub>                  | REF Duty Cycle                    | Measurement at 1.5V                        | 45       | 55       | %    |
| T <sub>PERIOD</sub>              | REF Period                        | Measurement at 1.5V                        | 69.8203  | 69.8622  | ns   |
| T <sub>PERIODAbs</sub>           | REF Absolute Period               | Measurement at 1.5V                        | 68.82033 | 70.86224 | ns   |
| T <sub>R</sub> / T <sub>F</sub>  | REF Rising and Falling Edge Rate  | Measured between 0.8V and 2.0V             | 1.0      | 4.0      | V/ns |
| T <sub>SKEW</sub>                | REF Clock to REF Clock            | Measurement at 1.5V                        | –        | 500      | ps   |
| T <sub>CCJ</sub>                 | REF Cycle to Cycle Jitter         | Measurement at 1.5V                        | –        | 1000     | ps   |
| L <sub>ACC</sub>                 | Long Term Accuracy                | Measurement at 1.5V                        | –        | 300      | ppm  |
| <b>ENABLE/DISABLE and SET-UP</b> |                                   |  |          |          |      |
| T <sub>STABLE</sub>              | Clock Stabilization from Power-up |  | –        | 1.8      | ms   |
| T <sub>SS</sub>                  | Stopclock Set-up Time             |  | 10.0     | –        | ns   |
| T <sub>SH</sub>                  | Stopclock Hold Time               |  | 0        | –        | ns   |

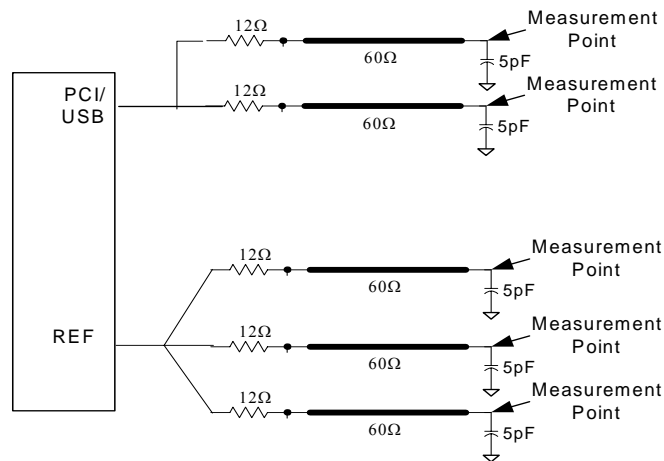
## Test and Measurement Set-up

### For Single-ended Signals and Reference

The following diagram shows test load configurations for the single-ended PCI, USB, and REF output signals.

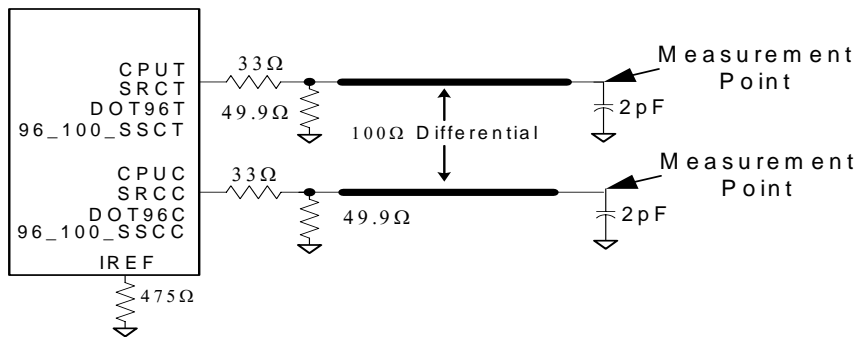


**Figure 15. Single-ended Load Configuration Low Drive Option**



**Figure 16. Single-ended Load Configuration High Drive Option**

The following diagram shows the test load configuration for the differential CPU and SRC outputs.



**Figure 17. 0.7V Differential Load Configuration**

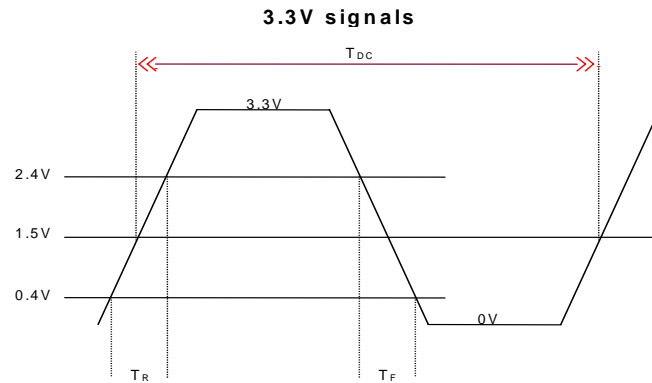
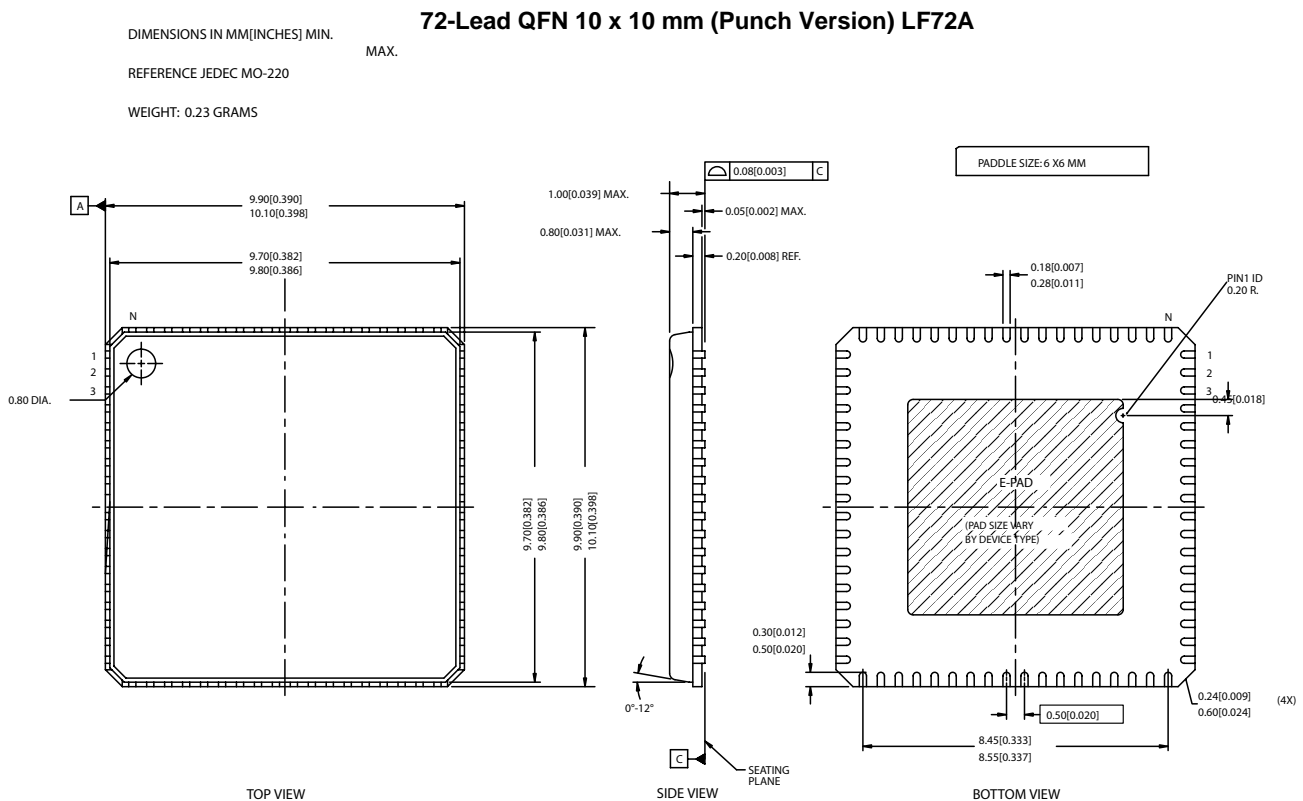


Figure 18. Single-ended Output Signals (for AC Parameters Measurement)

Ordering Information

| Part Number      | Package Type               | Product Flow           |
|------------------|----------------------------|------------------------|
| <b>Lead-free</b> |                            |                        |
| CY28447LFXC      | 72-pin QFN                 | Commercial, 0° to 85°C |
| CY28447LFXCT     | 72-pin QFN – Tape and Reel | Commercial, 0° to 85°C |

Package Diagram



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