

## Description

The 5P35023 is a VersaClock programmable clock generator and is designed for low-power, consumer, and high-performance PCI Express applications. The 5P35023 device is a three PLL architecture design, and each PLL is individually programmable and allowing for up to six unique frequency outputs.

The 5P35023 has built-in unique features such as Proactive Power Saving (PPS), Performance-Power Balancing (PPB), Overshot Reduction Technology (ORT) and Extreme Low Power DCO. An internal OTP memory allows the user to store the configuration in the device. After power up, the user can change the device register settings through the I2C interface when I2C mode is selected.

The device has programmable VCO and PLL source selection to allow the user to do power-performance optimization based on the application requirements. It also supports three single-ended outputs and two pair of differential outputs that support LVCMOS, LVPECL, LVDS and LP-HCSL. A Low Power 32.768kHz clock is supported with only less than 2 $\mu$ A current consumption for system RTC reference clock.

## Typical Applications

- PCIe Gen1–3 clock generator
- Consumer application crystal replacements
- SmartDevice, Handheld
- Computing and consumer applications
- Automotive applications (infotainment, dashboard, camera/vision, computing, networking)

## Key Specifications

- PCIe clocks phase jitter: PCIe Gen3
- Differential clocks < 1.5ps rms jitter integer range 12kHz–20MHz

## Features

- Configurable OE pin function as OE, PD#, PPS or DFC control function
- Configurable PLL bandwidth; minimizes jitter peaking
- PPS: Proactive Power Saving features save power during the end device power down mode
- PPB: Performance Power Balancing feature allows minimum power consumption based on required performance
- DFC: Dynamic Frequency Control feature allows user to dynamically switch between and up to 4 different frequencies smoothly
- Two PLLs support independent spread spectrum clocks to lower system EMI
- Store user configuration into OTP memory
- I<sup>2</sup>C interface
- Available in Automotive Grade 2 (-40°C to +105°C) or industrial (-40° to +85°) temperature ranges

## Output Features

- 2 DIFF outputs with configurable LP-HSCL, LVDS, LVPECL, LVCMOS output pairs. 1MHz–500MHz (160MHz with LVCMOS mode)
- 3 LVCMOS outputs: 1MHz–160MHz
- Maximum 8 LVCMOS outputs as REF + 3  $\times$  SE + 2  $\times$  DIFF\_T/C as LVCMOS
- Low power 32.768kHz clock supported for all SE1–SE3

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## Block Diagram



## Pin Assignments

Figure 1. Pin Assignments for 4 x 4 mm 24-VFQFPN Package – Top View



## Pin Descriptions

Table 1. Pin Descriptions

| Number | Name                 | Type   | Description   |
|--------|----------------------|--------|---|
| 1      | V <sub>DDA</sub>     | Power  | V <sub>DD</sub> 3.3V  |
| 2      | SDA_DFC0             | I/O    | I <sup>2</sup> C data pin. The pin can be DFC0 function by pin 3 SEL_DFC power-on latch status.   |
| 3      | SEL_DFC/<br>SCL_DFC1 | Input  | I <sup>2</sup> C CLK pin.<br>SEL_DFC is a latch input pin during the power-up.<br>High on power-on: I <sup>2</sup> C mode as SCLK function.<br>Low on power-on: SCL and SDA as DFC function control pins. |
| 4      | CLKIN/X2             | I/O    | Crystal oscillator interface output or differential clock input pin (CLKIN).  |
| 5      | CLKINB/X1            | Input  | Crystal oscillator interface input or differential clock input pin (CLKINB) or single-ended clock input.  |
| 6      | V <sub>BAT</sub>     | Power  | Power supply pin for 32.768kHz DCO; usually connect to coin cell battery, 3.0V–3.3V.  |
| 7      | NC                   | —      | No connect.   |
| 8      | REF                  | Output | 3.3V reference clock output.  |
| 9      | V <sub>DD33</sub>    | Power  | V <sub>DD</sub> 3.3V.   |
| 10     | OE2                  | Input  | Output enable control 2, multi-function pin. Refer to <a href="#">OE Pin Functions</a> table.   |
| 11     | V <sub>DDSE2</sub>   | Power  | Output power supply. Connect to 1.8–3.3V. Sets output voltage levels for SE2.   |
| 12     | SE2                  | Output | Output clock SE2.   |
| 13     | V <sub>DDSE1</sub>   | Power  | Output power supply. Connect to 1.8V–3.3V. Sets output voltage levels for SE1.  |
| 14     | SE1                  | Output | Output clock SE1.   |
| 15     | OE1                  | Input  | OE1's function selected from OTP pre-programmed register bits.<br>OE1 pull to 6.5V when burn OTP registers.<br>Refer to <a href="#">OE Pin Functions</a> table for details.                               |
| 16     | V <sub>DDDIFF1</sub> | Power  | Output power supply. Connect to 2.5V–3.3V. Sets output voltage levels for DIFF1.  |
| 17     | DIFF1B               | Output | Differential clock output 1_Complement; can be OTP pre-programmed to LVCMOS/LPHCSL/LVDS/LVPECL output type.   |
| 18     | DIFF1                | Output | Differential clock output 1_True; can be OTP pre-programmed to LVCMOS/LP-HCSL/LVDS/LVPECL output type.  |
| 19     | SE3                  | Output | Output clock SE3.   |
| 20     | V <sub>DDSE3</sub>   | Power  | Output power supply. Connect to 1.8V–3.3V. Sets output voltage levels for SE3.  |
| 21     | OE3                  | Input  | Output enable control 3, multi-function pin. Refer to <a href="#">OE Pin Functions</a> table.   |
| 22     | V <sub>DDDIFF2</sub> | Power  | Output power supply. Connect to 2.5V–3.3V. Sets output voltage levels for DIFF2.  |
| 23     | DIFF2B               | Output | Differential clock output 2_Complement; can be OTP pre-programmed to LVCMOS/LP-HCSL/LVDS/LVPECL output type.  |
| 24     | DIFF2                | Output | Differential clock output 2_True; can be OTP pre-programmed to LVCMOS/LP-HCSL/LVDS/LVPECL output type.  |
|        | EPAD                 | Power  | Connect to ground pad.  |

## Power Group

Table 2. Power Group

| Power Supply                  | SE               | DIFF  | DIV    | MUX     | PLL  | DCO | REF | Xtal |
|-------------------------------|------------------|-------|--------|---------|------|-----|-----|------|
| V <sub>DDSE1</sub>            | SE1 <sup>2</sup> |       |        |         |      |     |     |      |
| V <sub>DDSE2</sub>            | SE2 <sup>2</sup> |       |        |         |      |     |     |      |
| V <sub>DDSE3</sub>            | SE3 <sup>2</sup> |       |        |         |      |     |     |      |
| V <sub>DDDIFF1</sub>          |                  | DIFF1 | DIV3/4 | MUXPLL2 | PLL2 |     |     |      |
| V <sub>DDDIFF2</sub>          |                  | DIFF2 | DIV1   | MUXPLL1 |      |     |     |      |
| V <sub>DD33</sub>             |                  |       | DIV5   |         | PLL3 | DCO | REF | Xtal |
| V <sub>BAT</sub> <sup>1</sup> |                  |       |        |         |      | DCO |     | Xtal |
| V <sub>DDA</sub>              |                  |       | DIV2   |         | PLL1 |     |     |      |

<sup>1</sup> V<sub>BAT</sub> power ramp-up must be the same or earlier time or as other V<sub>DD</sub>s.

<sup>2</sup> V<sub>DDSEx</sub> for non-32kHz outputs should be OFF when V<sub>DDA</sub>/V<sub>DD33</sub> turns OFF; V<sub>BAT</sub> mode only supports 32.768kHz outputs from SE1–3.

## Output Sources

Table 3. Output Source

| Source    | Outputs  |           |           |           |       |       |
|-----------|----------|-----------|-----------|-----------|-------|-------|
|           | REF      | SE1       | SE2       | SE3       | DIFF1 | DIFF2 |
| Xtal REF  | Xtal REF | Xtal REF  | Xtal REF  | Xtal REF  |       |       |
| 32.768kHz |          | 32.768kHz | 32.768kHz | 32.768kHz |       |       |
| PLL1      |          |           |           | PLL1      | PLL1  | PLL1  |
| PLL2      |          | PLL2      | PLL2      | PLL2      | PLL2  | PLL2  |
| PLL3      |          | PLL3      | PLL3      |           | PLL3  | PLL3  |

Table 4. Output Source Selection Register Settings

| SE1                   | B36<4> | B36<3> | B31<1> | B29<3> |
|-----------------------|--------|--------|--------|--------|
| From 32kHz            | 0      | 1      | 0      | 0      |
| From PLL3 + Divider 5 | 1      | 0      | 0      | 0      |
| From PLL2 + Divider 4 | 1      | 1      | 1      | 0      |
| From REF + Divider 4  | 1      | 1      | 0      | 1      |

Table 5. Output Source Selection Register Settings

| SE2                   | B31<7> | B31<6> | B36<0> | B31<1> | B29<3> |
|-----------------------|--------|--------|--------|--------|--------|
| From 32kHz            | 0      | 0      | 0      | 0      | 0      |
| From PLL3 + Divider 5 | 1      | 0      | 0      | 0      | 0      |
| From PLL2 + Divider 4 | 1      | 1      | 1      | 1      | 0      |
| From REF + Divider 4  | 1      | 1      | 1      | 0      | 1      |

Table 6. Output Source Selection Register Settings

| SE3                   | B33<7> | B33<6> | B7<5> | B29<3> | B36<1> | B31<1> |
|-----------------------|--------|--------|-------|--------|--------|--------|
| From 32kHz            | 0      | 0      | 0     | 0      | 0      | 0      |
| From PLL3 + Divider 5 | 1      | 0      | 1     | 0      | 0      | 0      |
| From PLL2 + Divider 4 | 1      | 1      | 0     | 0      | 1      | 1      |
| From REF + Divider 4  | 1      | 1      | 0     | 1      | 1      | 0      |

Table 7. DIFF1 Output

| DIFF1                   | B34<7> | B0<3> |
|-------------------------|--------|-------|
| From PLL1 + Divider 1   | 0      | 0     |
| From PLL2/3 + Divider 3 | 1      | 0     |
| From REF + Divider 1    | 0      | 1     |

Table 8. DIFF2 Output

| DIFF2                   | B35<7> | B0<3> |
|-------------------------|--------|-------|
| From PLL1 + Divider 1   | 0      | 0     |
| From PLL2/3 + Divider 3 | 1      | 0     |
| From REF + Divider 1    | 0      | 1     |

## Device Features and Functions

### DFC – Dynamic Frequency Control

- OTP programmable – 4 different feedback fractional dividers (4 VCO frequencies) that apply to PLL2.
- ORT (overshoot reduction) function will be applied automatically during the VCO frequency change.
- Smooth frequency incremental or decremental from current VCO to targeted VCO based on DFC hardware pins selection.

Figure 2. DFC Function Block Diagram



Table 9. DFC Function Priority

| DFC_EN bit (W32[4]) | OE1_fun_sel (W30[6:5]) | OE3_fun_sel (W30[3:2]) | SCL_DFC1 | DFC[1:0]             | Notes   |
|---------------------|------------------------|------------------------|----------|----------------------|---|
| 0                   | x                      | x                      | x        | 0                    | DFC disable                                   |
| 1                   | 11 (DFC)               | 00–10 (DFC)            | x        | [0,OE1]              | One-pin DFC–OE1                               |
| 1                   | 11 (DFC)               | 11 (DFC)               | x        | [OE3,OE1]            | Two-pin DFC–OE3, OE1                          |
| 1                   | 00–10                  | 11                     | x        | Not permitted        | Not supported                                 |
| 1                   | 00–10                  | 00–10                  | 0        | [SCL_DFC1, SDA_DFC0] | I <sup>2</sup> C pin as DFC control pins mode |
| 1                   | 00–10                  | 00–10                  | 1        | W30[1:0]             | I <sup>2</sup> C control DFC mode             |

### DFC Function Programming

- Register B63b3:2 selects DFC00–DFC11 configuration.
- Byte16–19 are the registers for PLL2 VCO setting, based on B63b3:2 configuration selection, the data write to B16–19 will be stored in selected configuration OTP memory.
- Refer to [DFC Function Priority](#) table. Select proper control pin(s) to activate DFC function.
- Note the DFC function can also be controlled by I<sup>2</sup>C access.

## PPS – Proactive Power Saving Function

PPS (Proactive Power Saving) is an IDT patented unique design for the clock generator that proactively detects end device power down state and then switches output clocks between normal operation clock frequency and low power mode 32kHz clock that only consumes < 2µA current. The system could save power when the device goes into power down or sleep mode. The PPS function diagram is shown as below.

Figure 3. PPS Function Block Diagram



Figure 4. PPS Assertion/Deassertion Timing Chart



### PPS Function Programming

- Refer to the [OE Pin Functions](#) table to have the proper PPS function selected for OE pin(s). Note that the register default is set to Output enable (OE) function for OE pins.
- Have proper setup to Byte 30 and 32 for OE1–OE3 function selection; for PPS function, select 10 to control register bits.



## Timer Function Description

1. The timer function can be used together with the DFC -Dynamic Frequency Control function or with another PLL frequency programming.
2. The timer provides 4 different delay times by two bits selection: 0.5 sec – 1 sec – 2 sec – 4 sec.
3. The timeout flag will be set when timer times out and the flag can be cleared by writing 0 to timer enable bit.
4. When timer times out, RESET pin can generate a 250ms pulse signal if RESET control bit is enabled.
5. When timer times out, DFC stage will switch back to DFC00 setting if DFC function is enabled, and DFC function will be disabled after RESET.

Figure 5. Timer Functions



## OE Pin Function

The OE pins in the 5P35023 have multiple functions. The OE pins can be configured as output enable control (OE) or chip power-down control (PD#) or Proactive Power Saving function (PPS). Furthermore, the OE pins can be configured as a single or two-pin Dynamic Frequency Control (DFC), or the RESET out function that is associated with the Timer function.

Table 10. OE Pin Functions

| Function                     | Pin           |               |               |
|------------------------------|---------------|---------------|---------------|
|                              | OE1           | OE2           | OE3           |
| SE Output Enable/Disable     | SE1 (default) | SE2 (default) | SE3 (default) |
| DIFF Output Enable/Disable   | —             | DIFF1/DIFF2   | —             |
| Global Power Down (PD#)      | PD#           | —             | —             |
| Proactive Power Saving Input | SE1_PPS       | SE2_PPS       | SE3_PPS       |
| DOC Control (Only PLL2)      | DFC0          | —             | DFC1          |
| RESET OUT                    | —             | RESET OUT     | —             |

Table 11. OE Pin Function Summary

| OE Pin           | Description  |
|------------------|--|
| OE1: SE1         | OE1 only control SE1 enable/disable; other outputs are not affected by this pin status.  |
| OE2: SE2         | OE2 only control SE2 enable/disable; other outputs are not affected by this pin status.  |
| OE3: SE3         | OE3 only control SE3 enable/disable; other outputs are not affected by this pin status.  |
| OE2: DIFF1/DIFF2 | OE2 control differential outputs 1 and 2 only. Other SE outputs are not affected by this pin status.   |
| OE1: PD#         | OE1 control chip global power down (PD#) except 32.768kHz on OE1 (when 32kHz is enabled). When the PD# pin is active low, the chip goes to lowest power down mode and all outputs are disabled except 32kHz output and only keep 32k/Xtal calibration. |
| OE1: SE1_PPS     | Configure OE1 as SE1_PPS (Proactive Power Saving) function pin.  |
| OE2: SE2_PPS     | Configure OE2 as SE2_PPS (Proactive Power Saving) function pin.  |
| OE3: SE3_PPS     | Configure OE3 as SE3_PPS (Proactive Power Saving) function pin.  |
| OE1: DFC0        | Configure OE1 as DFC0 control pin 0.   |
| OE3: DFC1        | Configure OE3 as DFC1 control pin 1.   |

Table 12. PD# Priority

| PD# | I2C_OE_EN_bit | SE1/2/3, DIFF1/DIFF2, SE <sub>x</sub> _PPS | Output  | Notes          |
|-----|---------------|--|---------|----------------|
| 0   | x             | x  | Stop    | 32kHz free run |
| 1   | 0             | x  | Stop    |                |
| 1   | 1             | 0  | Stop    |                |
| 1   | 1             | 1  | Running |                |

## Reference Input and Selection

When programming, the 5P35023 accepts 8MHz–40MHz crystal input, 8MHz to 125MHz differential clocks input or 1MHz–125MHz LVCMOS (to X1) input. See below reference circuit for details.

### Crystal Input (X1/X2)

The crystal oscillators should be fundamental mode quartz crystals; overtone crystals are not suitable. Crystal frequency should be specified for parallel resonance with 40MHz maximum.

A crystal manufacturer will calibrate its crystals to the nominal frequency with a certain load capacitance value. When the oscillator load capacitance matches the crystal load capacitance, the oscillation frequency will be accurate as 0 PPM. When the oscillator load capacitance is lower than the crystal load capacitance, the oscillation frequency will be higher than nominal. In order to get an accurate oscillation frequency, the matching the oscillator load capacitance with the crystal load capacitance is required.

To set the oscillator load capacitance, 5P35023 has built-in two programmable tuning capacitors inside the chip, one at XIN and one at XOUT. They can be adjusted independently. The value of each capacitor is composed of a fixed capacitance amount plus a variable capacitance amount set with the XTAL[7:0] register. Adjustment of the crystal tuning capacitors allows for maximum flexibility to accommodate crystals from various manufacturers. The range of tuning capacitor values available are in accordance with the following table.

Table 13. Programmable Tuning Caps

| Parameter  | Bits  | Range               | Minimum (pF) | Maximum (pF) |
|------------|-------|---------------------|--------------|--------------|
| Xtal [7:0] | 4 × 2 | +1 / +2 / +4 / +8pF | 0            | 15pF         |



$$XTAL[4:0] = (XTAL C_L - 7pF) \times 2 \quad (Eq.1)$$

Equation 1 and the table of XTAL[7:0] tuning capacitor characteristics show that the parallel tuning capacitance can be set between 4.5pF to 12.5pF with a resolution of 0.25pF.

For a crystal  $C_L = 8pF$ , where  $C_L$  is the parallel capacity specified by the crystal vendor that sets the crystal frequency to the nominal value. Under the assumptions that the stray capacity between the crystal leads on the circuit board is zero and that no external tuning caps are placed on the crystal leads, then the internal parallel tuning capacity is equal to the load capacity presented to the crystal by the device.

The internal load capacitors are true parallel-plate capacitors for ultra-linear performance. Parallel-plate capacitors were chosen to reduce the frequency shift that occurs when non-linear load capacitance interacts with load, bias, supply, and temperature changes. External non-linear crystal load capacitors should not be used for applications that are sensitive to absolute frequency requirements.

## Spread Spectrum

The 5P35023 supports spread spectrum clocks from PLL1 and PLL2; the PLL1 built-in with analog spread spectrum and PLL2 has digital spread spectrum.

### Analog Spread Spectrum

Refer to programming guide.

## Digital Spread Spectrum

Figure 6. Digital Spread Spectrum

$$N = \frac{F_{vco}}{2 * F_{out}}$$

$$period = \frac{F_{pfd}}{2 * F_{ss}}$$

$$step = \frac{N * SS_{amount}}{period}$$



### Down spread or spread off

$$N = F_{vco}/F_{pfd}$$

Center Spread

$$N = N_{ssoff} + N * SS_{amount}/2$$

N: include integer and fraction

Fvco: VCOs frequency

Fpfd: PLLs pfd frequency

Fss: spread modulation rate

SSamount: spread percentage

The black line is for the down spread; N will decrease to make the center frequency is lower than spread off.

The blue line is for the center spread; there is an offset put on divider ratio to make the center frequency keep same as spread off.

Example: 0.5% down spread at 32kHz modulation rate.

### V<sub>BAT</sub>

The 5P35023 supports a low-power operation 32.768kHz RTC clock with only a coin cell battery supply. The coin cell battery power capacitance is usually 170mAh or higher, with less than 2µA\* low-power DCO operation mode will support application up to few years clock source for date/time keeping circuit (RTC).

When main power exists (for example, V<sub>DD33</sub> and V<sub>DDA</sub>), the 5P35023 will switch DCO power source to main power to save battery power. V<sub>BAT</sub> should be powered earlier or at the same time with other V<sub>DD</sub> power-up.

Table 14. V<sub>BAT</sub> Switching Threshold

| V <sub>DD33</sub> | V <sub>BAT</sub> | DCO Power Source  |
|-------------------|------------------|-------------------|
| > 2.5V            | —                | V <sub>DD33</sub> |
| < 2.3V            | —                | V <sub>BAT</sub>  |

V<sub>BAT</sub> needs to be 3.0V–3.3V.



## ORT-VCO Overshoot Reduction Technology

The 5P35023 supports the VCO overshoot reduction technology (ORT) to prevent an output clock frequency spike when the device is changing frequency on the fly or doing DFC (Dynamic Frequency Control) function. The VCO frequency changes are under control instead of free-run to targeted frequency.

## PLL Features and Descriptions

Table 15. Output 1 Divider

| Output Divider bits <1:0> | Output Divider bits <3:2> |    |    |    |
|---------------------------|---------------------------|----|----|----|
|                           | 00                        | 01 | 10 | 11 |
| 00                        | 1                         | 2  | 4  | 8  |
| 01                        | 4                         | 8  | 16 | 32 |
| 10                        | 5                         | 10 | 20 | 40 |
| 11                        | 6                         | 12 | 24 | 48 |

Table 16. Output 2, 4, and 5 Divider

| Output Divider bits <1:0> | Output Divider bits <3:2> |    |    |    |
|---------------------------|---------------------------|----|----|----|
|                           | 00                        | 01 | 10 | 11 |
| 00                        | 1                         | 2  | 4  | 5  |
| 01                        | 3                         | 6  | 12 | 15 |
| 10                        | 5                         | 10 | 20 | 25 |
| 11                        | 10                        | 20 | 40 | 50 |

Table 17. Output 3 Divider

| Output Divider bits <1:0> | Output Divider bits <3:2> |    |    |    |
|---------------------------|---------------------------|----|----|----|
|                           | 00                        | 01 | 10 | 11 |
| 00                        | 1                         | 2  | 4  | 8  |
| 01                        | 3                         | 6  | 12 | 24 |
| 10                        | 5                         | 10 | 20 | 40 |
| 11                        | 10                        | 20 | 40 | 80 |

# Output Clock Test Conditions

Figure 7. LVCMOS Output Test Conditions

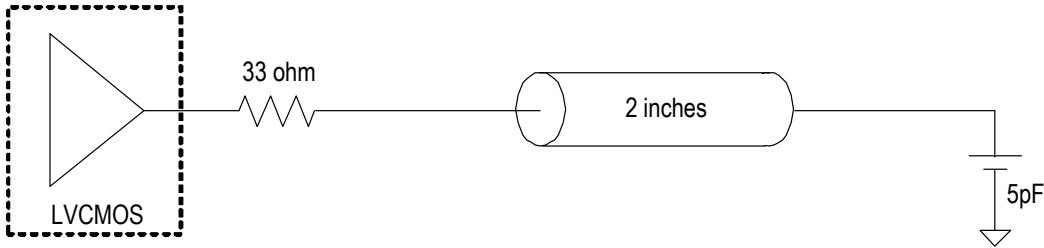
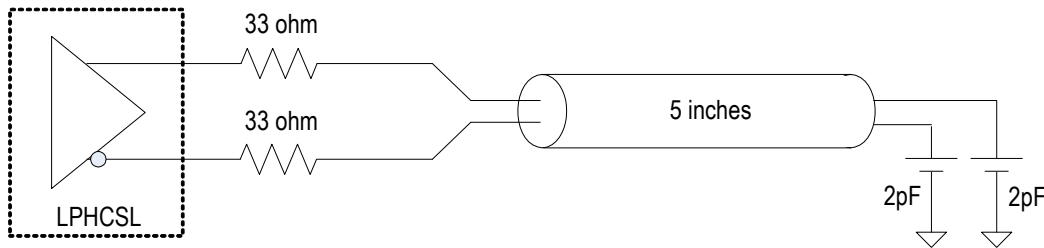


Figure 8. LP-HCSL Output Test Conditions



## Absolute Maximum Ratings

The absolute maximum ratings are stress ratings only. Stresses greater than those listed below can cause permanent damage to the device. Functional operation of the 5P35023 at absolute maximum ratings is not implied. Exposure to absolute maximum rating conditions may affect device reliability.

Table 18. Absolute Maximum Ratings

| Item   | Rating   |
|--|--|
| Supply Voltage, $V_{DDA}$ , $V_{DD33}$ , $V_{DDSE}$ , $V_{DDDIFF}$ | 3.465V   |
| Supply Voltage, $V_{BAT}$  | 3.465V   |
| <b>Inputs</b>  |  |
| XIN/CLKIN  | 0V to 3.3V voltage swing for both LVCMOS or DIFF CLK |
| Other Inputs   | -0.5V to $V_{DD33}$ or $V_{DDSE}$                    |
| Outputs, $V_{DDSE}$ (LVCMOS)                                       | -0.5V to $V_{DDSE}$ or $V_{DDDIFF} + 0.5V$           |
| Outputs, IO (SDA)  | 10mA   |
| Package Thermal Impedance, $\theta_{JA}$                           | 50.1°C/W (0mps)                                      |
| Package Thermal Impedance, $\theta_{JC}$                           | 61.68°C/W (0mps)                                     |
| Storage Temperature, $T_{STG}$                                     | -65°C to 150°C                                       |
| ESD Human Body Model   | 2000V  |
| ESD Charge Device Model  | 1000V  |
| Junction Temperature   | 125°C  |

## Recommended Operating Conditions

Table 19. Recommended Operating Conditions

| Symbol          | Parameter   | Minimum | Typical | Maximum | Units | Notes   |
|-----------------|---|---------|---------|---------|-------|---------|
| $V_{DDSE}$      | Power supply voltage for supporting 1.8V outputs.                           | 1.71    | 1.8     | 1.89    | V     |         |
|                 | Power supply voltage for supporting 2.5V outputs.                           | 2.375   | 2.5     | 2.625   |       |         |
|                 | Power supply voltage for supporting 3.3V outputs.                           | 3.135   | 3.3     | 3.465   |       |         |
| $V_{DD33}$      | Power supply voltage for core logic functions.                              | 3.135   | 3.3     | 3.465   | V     | 1,2,3,4 |
| $V_{DDA}$       | Analog power supply voltage. Use filtered analog power supply if available. | 2.375   |         | 3.465   | V     |         |
| $V_{BAT}$       | Battery power supply voltage.   | 2.8     | 3       | 3.465   | V     | 1,2,3,4 |
| $T_A$           | Operating temperature, ambient (industrial).                                | -40     |         | 85      | °C    |         |
|                 | Operating temperature, ambient (automotive).                                | -40     |         | 105     | °C    |         |
| $C_{LOAD\_OUT}$ | Maximum load capacitance (LVCMOS only).                                     |         | 5       |         | pF    |         |

Table 19. Recommended Operating Conditions

| Symbol   | Parameter  | Minimum | Typical | Maximum | Units | Notes |
|----------|--|---------|---------|---------|-------|-------|
| $F_{IN}$ | External reference crystal.  | 8       |         | 40      | MHz   |       |
|          | External reference crystal with DCO used.  | 12      |         | 38      |       |       |
|          | External single-ended reference clock CLKINB.  | 1       |         | 125     |       |       |
|          | External differential reference clock CLKIN, CLKINB.   | 8       |         | 125     |       |       |
| $t_{PU}$ | Power up time for all $V_{DD}$ s to reach minimum specified voltage (power ramps must be monotonic). | 0.05    |         | 3       | ms    |       |

<sup>1</sup> Power-up sequence conditions.

<sup>2</sup>  $V_{DDSEx}$  for non-32kHz outputs should be OFF when  $V_{DDA}/V_{DD33}$  turn off,  $V_{BAT}$  mode only supports 32.768kHz outputs from SE1–3.

<sup>3</sup>  $V_{BAT}$  power ramp-up should be same or earlier time than other  $V_{DD}$  power rail.

<sup>4</sup> When using a single-ended clock to CLKINB pin within differential clocking mode, CLKIN pin needs to be grounded and minimum input frequency should be higher than 8MHz.

## Electrical Characteristics

Supply voltage: all  $V_{DD} \pm 5\%$ , unless otherwise stated.

 Table 20. Input Capacitance, LVCMOS Output Impedance, and Internal Pull-down Resistance ( $T_A = +25^\circ\text{C}$ )

| Symbol             | Parameter   | Minimum | Typical | Maximum | Units      |
|--------------------|---|---------|---------|---------|------------|
| $C_{IN}$           | Input Capacitance (CLKIN, CLKINB, OE, SDA, SCL, DFC1:0)     |         | 3       | 7       | pF         |
| Pull-down Resistor | OE  |         | 200     |         | k $\Omega$ |
| $R_{OUT}$          | LVCMOS Output Driver Impedance ( $V_{DDSE} = 1.8\text{V}$ ) |         | 22      |         | $\Omega$   |
|                    | LVCMOS Output Driver Impedance ( $V_{DDSE} = 2.5\text{V}$ ) |         | 22      |         | $\Omega$   |
|                    | LVCMOS Output Driver Impedance ( $V_{DDSE} = 3.3\text{V}$ ) |         | 22      |         | $\Omega$   |
| X1, X2             | Programmable Input Capacitance at X1 or X2                  | 0       |         | 15      | pF         |

Table 21. Crystal Characteristics

| Parameter  | Conditions | Minimum     | Typical | Maximum | Units         |
|--|------------|-------------|---------|---------|---------------|
| Mode of Oscillation                                | —          | Fundamental |         |         |               |
| Frequency  | —          | 8           |         | 40      | MHz           |
| Frequency when 32.768kHz DCO is used               | —          | 12          |         | 38      | MHz           |
| Equivalent Series Resistance (ESR)                 | —          |             | 10      | 100     | $\Omega$      |
| Shunt Capacitance                                  | —          |             | 2       | 7       | pF            |
| Load Capacitance ( $C_L$ )                         | —          | 6           | 8       | 10      | pF            |
| Maximum Crystal Drive Level ( $C_L = 8\text{pF}$ ) | —          |             |         | 100     | $\mu\text{W}$ |



Table 22. DC Electrical Characteristics (Industrial)<sup>1,2</sup>

| Symbol   | Parameter                        | Conditions  | Minimum | Typical | Maximum | Units |
|--|----------------------------------|---|---------|---------|---------|-------|
| $I_{DDCORE}$                                   | Core Supply Current              | $V_{DD} = V_{DDSE} = V_{DD33} = 3.3$ ; XTAL = 25MHz, PLL2/3 off, no output, PLLs disabled.              |         | 5       |         | mA    |
| $I_{DD\_PLL1}^3$                               | PLL1 Supply Current              | $V_{DD} = V_{DDSE} = V_{DD33} = 3.3$ V; XTAL = 25MHz, PLL2/3 off, no output, PLL1 = 600MHz.             |         | 13      |         | mA    |
|  |                                  | $V_{DD} = V_{DDSE} = V_{DD33} = 2.5$ V; XTAL = 25MHz, PLL2/3 off, no output, PLL1 = 600MHz.             |         | 13      |         | mA    |
| $I_{DD\_PLL2}^3$                               | PLL2 Supply Current              | $V_{DD} = V_{DDSE} = V_{DD33} = 3.3$ V; XTAL = 25MHz, PLL1/3 off, no output, PLL2 = 1GHz.               |         | 11      |         | mA    |
|  |                                  | $V_{DD} = V_{DDSE} = V_{DD33} = 2.5$ V; XTAL = 25MHz, PLL1/3 off, no output, PLL2 = 1GHz.               |         | 11      |         | mA    |
| $I_{DD\_PLL3}^3$                               | PLL3 Supply Current              | $V_{DD} = V_{DDSE} = V_{DD33} = 3.3$ V; XTAL = 25MHz, PLL1/2 off, no output, PLL3 = 480MHz.             |         | 4       |         | mA    |
| $I_{DDOx}$                                     | Output Buffer Supply Current     | LVPECL, 500MHz, 3.3V $V_{DDDIFF}$ (DIFF1,2).  |         | 39      |         | mA    |
|  |                                  | LVPECL, 156.25MHz, 2.5V $V_{DDDIFF}$ (DIFF1,2).   |         | 33      |         | mA    |
|  |                                  | LVDS, 500MHz, 3.3V $V_{DDDIFF}$ (DIFF1,2).  |         | 13      |         | mA    |
|  |                                  | LVDS, 250MHz, 2.5V $V_{DDDIFF}$ (DIFF1,2).  |         | 8       |         | mA    |
|  |                                  | LPHCSL, 125MHz, 3.3V $V_{DDDIFF}$ , 2pF load (DIFF1,2).   |         | 7       |         | mA    |
|  |                                  | LPHCSL, 100MHz, 2.5V $V_{DDDIFF}$ , 2pF load (DIFF1,2).   |         | 8       |         | mA    |
|  |                                  | LVC MOS, 8MHz, 3.3V, $V_{DDSE}^{1,2}$ (SE1).  |         | 1       |         | mA    |
|  |                                  | LVC MOS, 8MHz, 2.5V $V_{DDSEx}^{1,2}$ (SE1).  |         | 1       |         | mA    |
|  |                                  | LVC MOS, 8MHz, 1.8V $V_{DDSEx}^{1,2}$ (SE1).  |         | 1       |         | mA    |
|  |                                  | LVC MOS, 160MHz, 3.3V $V_{DDSEx}^1$ (SE1).  |         | 9.5     |         | mA    |
|  |                                  | LVC MOS, 160MHz, 2.5V $V_{DDSEx}^{1,2}$ (SE1).  |         | 5.0     |         | mA    |
| LVC MOS, 160MHz, 1.8V $V_{DDSEx}^{1,2}$ (SE1). |                                  | 6.0   |         | mA      |         |       |
| $I_{DDPD}$                                     | Power Down Current               | PD asserted with $V_{DDA}$ , $V_{DD33}$ and $V_{DDSE}$ on, I <sup>2</sup> C programming, 32kHz running. |         | 3.5     |         | mA    |
| $I_{DDSUSPEND} - V_{DD33}$                     | $I_{DDSUSPEND} - V_{BAT}$        | Only $V_{BAT} = 3.3$ V and $V_{DDSEn}$ is powered.  |         | 1.1     |         | μA    |
| $I_{DDSUSPEND} - SE_n 3.3V$                    | $I_{DDSUSPEND} - V_{DDSEn} 3.3V$ | Only $V_{BAT} = 3.3$ V and $V_{DDSEn}$ is powered with 3.3V.  |         | 3.4     |         | μA    |
| $I_{DDSUSPEND} - SE_n 2.5V$                    | $I_{DDSUSPEND} - V_{DDSEn} 2.5V$ | Only $V_{BAT} = 3.3$ V and $V_{DDSEn}$ is powered with 2.5V.  |         | 2.5     |         | μA    |
| $I_{DDSUSPEND} - SE_n 1.8V$                    | $I_{DDSUSPEND} - V_{DDSEn} 1.8V$ | Only $V_{BAT} = 3.3$ V and $V_{DDSEn}$ is powered with 1.8V.  |         | 1.8     |         | μA    |

<sup>1</sup> Single CMOS driver active.

<sup>2</sup> SE1–3 current measured with 2 inches transmission line and 5pF load, DIFF clock current measured with 5 inches transmission line with 2pF loads.

<sup>3</sup>  $I_{DDCORE} = I_{DDA} + I_{DDD}$ , no loads.

Table 23. DC Electrical Characteristics (Automotive)<sup>1,2</sup>

| Symbol   | Parameter                        | Conditions  | Minimum | Typical | Maximum | Units   |
|--|----------------------------------|---|---------|---------|---------|---------|
| $I_{DDCORE}$                                   | Core Supply Current              | $V_{DD} = V_{DDSE} = V_{DD33} = 3.3$ ; XTAL = 25MHz, PLL2/3 off, no output, PLLs disabled.              |         | 5       |         | mA      |
| $I_{DD\_PLL1}^3$                               | PLL1 Supply Current              | $V_{DD} = V_{DDSE} = V_{DD33} = 3.3$ V; XTAL = 25MHz, PLL2/3 off, no output, PLL1 = 600MHz.             |         | 13      |         | mA      |
|  |                                  | $V_{DD} = V_{DDSE} = V_{DD33} = 2.5$ V; XTAL = 25MHz, PLL2/3 off, no output, PLL1 = 600MHz.             |         | 13      |         | mA      |
| $I_{DD\_PLL2}^3$                               | PLL2 Supply Current              | $V_{DD} = V_{DDSE} = V_{DD33} = 3.3$ V; XTAL = 25MHz, PLL1/3 off, no output, PLL2 = 1GHz.               |         | 11      |         | mA      |
|  |                                  | $V_{DD} = V_{DDSE} = V_{DD33} = 2.5$ V; XTAL = 25MHz, PLL1/3 off, no output, PLL2 = 1GHz.               |         | 11      |         | mA      |
| $I_{DD\_PLL3}^3$                               | PLL3 Supply Current              | $V_{DD} = V_{DDSE} = V_{DD33} = 3.3$ V; XTAL = 25MHz, PLL1/2 off, no output, PLL3 = 480MHz.             |         | 4.7     |         | mA      |
| $I_{DDOx}$                                     | Output Buffer Supply Current     | LVPECL, 500MHz, 3.3V $V_{DDDIFF}$ (DIFF1,2).  |         | 39      |         | mA      |
|  |                                  | LVPECL, 156.25MHz, 2.5V $V_{DDDIFF}$ (DIFF1,2).   |         | 33      |         | mA      |
|  |                                  | LVDS, 500MHz, 3.3V $V_{DDDIFF}$ (DIFF1,2).  |         | 15      |         | mA      |
|  |                                  | LVDS, 250MHz, 2.5V $V_{DDDIFF}$ (DIFF1,2).  |         | 9       |         | mA      |
|  |                                  | LPHCSL, 125MHz, 3.3V $V_{DDDIFF}$ , 2pF load (DIFF1,2).   |         | 9       |         | mA      |
|  |                                  | LPHCSL, 100MHz, 2.5V $V_{DDDIFF}$ , 2pF load (DIFF1,2).   |         | 7       |         | mA      |
|  |                                  | LVC MOS, 8MHz, 3.3V, $V_{DDSE}^{1,2}$ (SE1).  |         | 1       |         | mA      |
|  |                                  | LVC MOS, 8MHz, 2.5V $V_{DDSEx}^{1,2}$ (SE1).  |         | 1       |         | mA      |
|  |                                  | LVC MOS, 8MHz, 1.8V $V_{DDSEx}^{1,2}$ (SE1).  |         | 1       |         | mA      |
|  |                                  | LVC MOS, 160MHz, 3.3V $V_{DDSEx}^1$ (SE1).  |         | 9.5     |         | mA      |
|  |                                  | LVC MOS, 160MHz, 2.5V $V_{DDSEx}^{1,2}$ (SE1).  |         | 9       |         | mA      |
| LVC MOS, 160MHz, 1.8V $V_{DDSEx}^{1,2}$ (SE1). |                                  | 6   |         | mA      |         |         |
| $I_{DDPD}$                                     | Power Down Current               | PD asserted with $V_{DDA}$ , $V_{DD33}$ and $V_{DDSE}$ on, I <sup>2</sup> C programming, 32kHz running. |         | 3.5     |         | mA      |
| $I_{DDSUSPEND} - V_{DD33}$                     | $I_{DDSUSPEND} - V_{BAT}$        | Only $V_{BAT} = 3.3$ V and $V_{DDSEn}$ is powered.  |         | 1.1     |         | $\mu$ A |
| $I_{DDSUSPEND} - SE_n 3.3V$                    | $I_{DDSUSPEND} - V_{DDSEn} 3.3V$ | Only $V_{BAT} = 3.3$ V and $V_{DDSEn}$ is powered with 3.3V.  |         | 3.4     |         | $\mu$ A |
| $I_{DDSUSPEND} - SE_n 2.5V$                    | $I_{DDSUSPEND} - V_{DDSEn} 2.5V$ | Only $V_{BAT} = 3.3$ V and $V_{DDSEn}$ is powered with 2.5V.  |         | 2.5     |         | $\mu$ A |
| $I_{DDSUSPEND} - SE_n 1.8V$                    | $I_{DDSUSPEND} - V_{DDSEn} 1.8V$ | Only $V_{BAT} = 3.3$ V and $V_{DDSEn}$ is powered with 1.8V.  |         | 1.8     |         | $\mu$ A |

<sup>1</sup> Single CMOS driver active.

<sup>2</sup> SE1–3 current measured with 2 inches transmission line and 5pF load, DIFF clock current measured with 5 inches transmission line with 2pF loads.

<sup>3</sup>  $I_{DDCORE} = I_{DDA} + I_{DDD}$ , no loads.

Table 24. Input Parameters<sup>1,2</sup>

| Symbol             | Parameter                              | Conditions                              | Minimum   | Typical | Maximum | Units |
|--------------------|--|---|-----------|---------|---------|-------|
| V <sub>IH</sub>    | Input High Voltage – CLKIN             | Single-ended inputs.                    | 2.4       |         | 3.465   | V     |
| V <sub>IL</sub>    | Input Low Voltage – CLKIN              | Single-ended inputs.                    | GND - 0.3 |         | 0.8     | V     |
| V <sub>SWING</sub> | Input Amplitude – CLKIN                | Differential input.                     | 325       |         | 3300    | mV    |
| dV/dt              | Input Slew Rate – CLKIN                | Differential input.                     | 0.4       |         | 8       | V/ns  |
| V <sub>CM</sub>    | Input Common Mode Voltage              | Differential input.                     | 200       |         | 2500    | mV    |
| I <sub>IL</sub>    | Input Leakage Low Current for OE1      | V <sub>IN</sub> = GND                   | -150      |         | 5       | μA    |
|                    | Input Leakage Low Current for OE2/3    | V <sub>IN</sub> = GND.                  |           |         | 5       | μA    |
| I <sub>IH</sub>    | Input Leakage High Current for OE1/2/3 | V <sub>IN</sub> = 3.465V (industrial).  |           |         | 20      | μA    |
| I <sub>IH</sub>    | Input Leakage High Current for OE1/2/3 | V <sub>IN</sub> = 3.465V (automotive).  |           |         | 35      | μA    |
| d <sub>TIN</sub>   | Input Duty Cycle                       | Measurement from differential waveform. | 45        |         | 55      | %     |

<sup>1</sup> Guaranteed by design and characterization, not 100% tested in production.

<sup>2</sup> Slew rate measured through ±75mV window centered around differential zero.

Table 25. Power Consumption of 32.768kHz Output Only Operation

Supply voltage V<sub>DDSE</sub> = 1.8V–3.3V ±5%, T<sub>A</sub> = -40°C to +85°C.

| Symbol                         | Parameter                                   | Conditions                     | Minimum | Typical | Maximum | Units |
|--------------------------------|---|--------------------------------|---------|---------|---------|-------|
| I <sub>V<sub>BAT</sub></sub>   | V <sub>BAT</sub> = 3.3V Power Input Current |                                |         | 1.1     |         | μA    |
| I <sub>V<sub>DDSEx</sub></sub> | V <sub>DDSEx</sub> = 1.8V Current           | 0.5 inch, no load, one output. |         | 0.4     |         | μA    |
|                                | V <sub>DDSEx</sub> = 1.8V Current           | 2.0 inch, no load, one output. |         | 1.0     |         | μA    |
|                                | V <sub>DDSEx</sub> = 1.8V Current           | 5.0 inch, no load, one output. |         | 2.3     |         | μA    |
|                                | V <sub>DDSEx</sub> = 2.5V Current           | 0.5 inch, no load, one output. |         | 0.6     |         | μA    |
|                                | V <sub>DDSEx</sub> = 2.5V Current           | 2.0 inch, no load, one output. |         | 1.5     |         | μA    |
|                                | V <sub>DDSEx</sub> = 2.5V Current           | 5.0 inch, no load, one output. |         | 3.1     |         | μA    |
|                                | V <sub>DDSEx</sub> = 3.3V Current           | 0.5 inch, no load, one output. |         | 0.8     |         | μA    |
|                                | V <sub>DDSEx</sub> = 3.3V Current           | 2.0 inch, no load, one output. |         | 1.9     |         | μA    |
|                                | V <sub>DDSEx</sub> = 3.3V Current           | 5.0 inch, no load, one output. |         | 4.2     |         | μA    |

Table 26. DC Electrical Characteristics – 3.3V LVCMOS

 $V_{DDSE} = 3.3V \pm 5\%$ ,  $T_A = -40^\circ C$  to  $+105^\circ C$ , unless stated otherwise.

| Symbol     | Parameter              | Conditions                               | Minimum   | Typical | Maximum                               | Units   |
|------------|------------------------|--|-----------|---------|---------------------------------------|---------|
| $V_{OH}$   | Output High Voltage    | $I_{OH} = -15mA$ .                       | 2.4       |         | $V_{DDSE}$                            | V       |
| $V_{OL}$   | Output Low Voltage     | $I_{OL} = 15mA$ .                        |           |         | 0.4 (industrial)<br>0.45 (automotive) | V       |
| $I_{OZDD}$ | Output Leakage Current | Tri-state outputs, $V_{DDSE} = 3.465V$ . |           |         | 3                                     | $\mu A$ |
|            |                        | Tri-state outputs, $V_{DDSE} = 0V$ .     | -3        |         |                                       | $\mu A$ |
| $V_{IH}$   | Input High Voltage     | Single-ended inputs – OE, SDA, SCL.      | 2         |         | $V_{DDSE} + 0.3$                      | V       |
| $V_{IL}$   | Input Low Voltage      | Single-ended inputs – OE, SDA, SCL.      | GND - 0.3 |         | 0.8                                   | V       |
| $V_{IH}$   | Input High Voltage     | Single-ended input – XIN/CLKIN           | 2.4       |         | $V_{DD33}$                            | V       |
| $V_{IL}$   | Input Low Voltage      | Single-ended input – XIN/CLKIN           | GND - 0.3 |         | 0.8                                   | V       |

Table 27. DC Electrical Characteristics – 2.5V LVCMOS

 $V_{DDSE} = 2.5V \pm 5\%$ ,  $T_A = -40^\circ C$  to  $+105^\circ C$ , unless stated otherwise.

| Symbol     | Parameter              | Conditions                               | Minimum               | Typical | Maximum                               | Units   |
|------------|------------------------|--|-----------------------|---------|---------------------------------------|---------|
| $V_{OH}$   | Output High Voltage    | $I_{OH} = -12mA$ .                       | $0.7 \times V_{DDSE}$ |         | $V_{DDSE}$                            | V       |
| $V_{OL}$   | Output Low Voltage     | $I_{OL} = 12mA$ .                        |                       |         | 0.4 (industrial)<br>0.45 (automotive) | V       |
| $I_{OZDD}$ | Output Leakage Current | Tri-state outputs, $V_{DDSE} = 2.625V$ . |                       |         | 3                                     | $\mu A$ |
|            |                        | Tri-state outputs, $V_{DDSE} = 0V$ .     | -3                    |         |                                       | $\mu A$ |
| $V_{IH}$   | Input High Voltage     | Single-ended inputs – OE, SDA, SCL.      | 1.7                   |         | $V_{DDSE} + 0.3$                      | V       |
| $V_{IL}$   | Input Low Voltage      | Single-ended inputs – OE, SDA, SCL.      | GND - 0.3             |         | 0.8                                   | V       |

Table 28. DC Electrical Characteristics – 1.8V LVCMOS

 $V_{DDSE} = 1.8V \pm 5\%$ ,  $T_A = -40^\circ C$  to  $+105^\circ C$ , unless stated otherwise.

| Symbol     | Parameter              | Conditions                              | Minimum                | Typical | Maximum   | Units   |
|------------|------------------------|---|------------------------|---------|---|---------|
| $V_{OH}$   | Output High Voltage    | $I_{OH} = -8mA$ .                       | $0.7 \times V_{DDSE}$  |         | $V_{DDSE}$  | V       |
| $V_{OL}$   | Output Low Voltage     | $I_{OL} = 8mA$ .                        |                        |         | $0.25 \times V_{DDSE}$  | V       |
| $I_{OZDD}$ | Output Leakage Current | Tri-state outputs, $V_{DDSE} = 1.89V$ . |                        |         | 3   | $\mu A$ |
|            |                        | Tri-state outputs, $V_{DDSE} = 0V$ .    | -3                     |         |   | $\mu A$ |
| $V_{IH}$   | Input High Voltage     | Single-ended inputs.                    | $0.65 \times V_{DDSE}$ |         | $V_{DDSE} + 0.3$  | V       |
| $V_{IL}$   | Input Low Voltage      | Single-ended inputs.                    | GND - 0.3              |         | $0.35 \times V_{DDSE}$ (industrial)<br>$0.2 \times V_{DDSE}$ (automotive) | V       |

Table 29. Electrical Characteristics – DIF 0.7V LPHCSL Differential Outputs

 $V_{DDDIFF} = 3.3\text{ V} \pm 5\%$  or  $2.5\text{ V} \pm 5\%$ ,  $T_A = -40^\circ$  to  $+105^\circ\text{C}$ .

| Symbol               | Parameter                     | Minimum | Typical | Maximum | Units | Notes                              |
|----------------------|-------------------------------|---------|---------|---------|-------|------------------------------------|
| dV/dt                | Slew Rate                     | 1       | 2.5     | 4       | V/ns  | 1,2,3,8                            |
| $\Delta\text{dV/dt}$ | Slew Rate Mismatch            |         |         | 20      | %     | 1,2,3,8<br>at $\leq 200\text{MHz}$ |
| $V_{HIGH}$           | Voltage High                  | 660     | 800     | 1150    | mV    | 1,6,7,8                            |
| $V_{LOW}$            | Voltage Low                   | -150    | 0       | 150     | mV    | 1,6                                |
| $V_{MAX}$            | Maximum Voltage               |         |         | 1150    | mV    | 1                                  |
| $V_{MIN}$            | Minimum Voltage               | -300    |         |         | mV    | 1                                  |
| $V_{SWING}$          | Voltage Swing                 | 300     |         |         | mV    | 1,2                                |
| $V_{CROSS}$          | Crossing Voltage Value        | 250     | 360     | 550     | mV    | 1,4,6                              |
| $\Delta V_{CROSS}$   | Crossing Voltage Variation    |         |         | 140     | mV    | 1,5                                |
| Jitter-Cy/Cy         | Cycle to Cycle Jitter         |         | 10      |         | ps    | 1,2                                |
| Jitter-STJ           | Short Term Period Jitter      |         | 70      |         | ps    | 1,2                                |
| $T_{DC}$             | Duty Cycle                    | 45      |         | 55      | %     | 1,2                                |
| Measured Frequency   | LPHCSL at Differential Output |         |         | 500     | MHz   | 1,2                                |

<sup>1</sup> Guaranteed by design and characterization, not 100% tested in production.

<sup>2</sup> Measured from differential waveform.

<sup>3</sup> Slew rate is measured through the  $V_{SWING}$  voltage range centered around differential 0V. This results in a  $\pm 150\text{mV}$  window around differential 0V.

<sup>4</sup>  $V_{CROSS}$  is defined as voltage where Clock = Clock# measured on a component test board and only applies to the differential rising edge (i.e. Clock rising and Clock# falling).

<sup>5</sup> The total variation of all  $V_{CROSS}$  measurements in any particular system. Note that this is a subset of  $V_{CROSS}$  min/max ( $V_{CROSS}$  absolute) allowed. The intent is to limit  $V_{CROSS}$  induced modulation by setting  $\Delta V_{CROSS}$  to be smaller than  $V_{CROSS}$  absolute.

<sup>6</sup> Measured from single-ended waveform.

<sup>7</sup> Measured with scope averaging off, using statistics function. Variation is the difference between minimum and maximum.

<sup>8</sup> Scope average on.

<sup>9</sup> Differential clock amplitude setting = 00.

Table 30. Electrical Characteristics – LVDS

 $V_{DDDIFF} = 3.3\text{ V} \pm 5\%$  or  $2.5\text{ V} \pm 5\%$ ,  $T_A = -40^\circ$  to  $+105^\circ\text{C}$ .

| Symbol             | Parameter   | Minimum | Typical | Maximum | Units | Notes |
|--------------------|---|---------|---------|---------|-------|-------|
| VOT (+)            | Differential Output Voltage for the TRUE Binary State                               | 247     |         | 454     | mV    |       |
| VOT (-)            | Differential Output Voltage for the FALSE Binary State                              | -454    |         | -247    | mV    |       |
| $\Delta$ VOT       | Change in VOT between Complimentary Output States                                   |         |         | 50      | mV    |       |
| VOS                | Output Common Mode Voltage (Offset Voltage)   | 1.125   | 1.25    | 1.375   | V     |       |
| $\Delta$ VOS       | Change in VOS between Complimentary Output States                                   |         |         | 50      | mV    |       |
| IOS                | Outputs Short Circuit Current, $V_{OUT+}$ or $V_{OUT-} = 0\text{V}$ or $V_{DDDIFF}$ |         | 9       | 24      | mA    |       |
| IOSD               | Differential Outputs Short Circuit Current, $V_{OUT+} = V_{OUT-}$                   |         | 6       | 12      | mA    |       |
| Jitter-Cy/Cy       | Cycle to Cycle Jitter   |         | 20      |         | ps    | 1,2   |
| Jitter-STJ         | Short Term Period Jitter  |         | 100     |         | ps    | 1,2   |
| $T_{DC}$           | Duty Cycle  | 45      |         | 55      | %     | 1,2   |
| Measured Frequency | LVDS at Differential Output   |         |         | 500     | MHz   | 1,2   |

<sup>1</sup> Guaranteed by design and characterization, not 100% tested in production.

<sup>2</sup> Measured from differential waveform.

<sup>3</sup> Differential clock amplitude setting = 01.

Table 31. Electrical Characteristics – LVPECL

 $V_{DDDIFF} = 3.3\text{ V} \pm 5\%$  or  $2.5\text{ V} \pm 5\%$ ,  $T_A = -40^\circ$  to  $+105^\circ\text{C}$ .

| Symbol             | Parameter  | Minimum             | Typical | Maximum             | Units | Notes |
|--------------------|--|---------------------|---------|---------------------|-------|-------|
| $V_{OH}$           | Output Voltage HIGH, terminated through 50 $\Omega$ tied to $V_{DDDIFF} - 2\text{V}$ | $V_{DDDIFF} - 1.19$ |         | $V_{DDDIFF} - 0.69$ | V     |       |
| $V_{OL}$           | Output Voltage LOW, terminated through 50 $\Omega$ tied to $V_{DDDIFF} - 2\text{V}$  | $V_{DDDIFF} - 1.94$ |         | $V_{DDDIFF} - 1.4$  | V     |       |
| $V_{SWING}$        | Output Differential Voltage Swing (see <a href="#">Figure 9</a> )                    | 1.1                 |         | 2                   | V     | 2,3   |
| Jitter-Cy/Cy       | Cycle to Cycle Jitter  |                     | 20      |                     | ps    | 1,2   |
| Jitter-STJ         | Short Term Period Jitter   |                     | 100     |                     | ps    | 1,2   |
| $T_{DC}$           | Duty Cycle   | 45                  |         | 55                  | %     | 1,2   |
| Measured Frequency | LVPECL at Differential Output  |                     |         | 500                 | MHz   | 1,2   |

<sup>1</sup> Guaranteed by design and characterization, not 100% tested in production.

<sup>2</sup> Measured from differential waveform.

<sup>3</sup> Differential clock amplitude setting = 01.

Figure 9. Output Differential Voltage Swing



## AC Electrical Characteristics

$V_{DDSE} = 3.3V \pm 5\%$  or  $2.5V \pm 5\%$  or  $1.8V \pm 5\%$ ,  $T_A = -40^\circ C$  to  $+105^\circ C$  (spread spectrum off), unless stated otherwise.

Table 32. AC Electrical Characteristics

| Symbol     | Parameter                   | Conditions   | Minimum | Typical | Maximum | Units |
|------------|-----------------------------|--|---------|---------|---------|-------|
| $f_{IN}^1$ | Input Frequency             | Input frequency limit (XIN).   | 8       |         | 40      | MHz   |
|            |                             | Input frequency limit (XIN) when enable DCO.   | 12      |         | 38      | MHz   |
|            |                             | Input frequency limit (differential CLKIN).  | 8       |         | 125     | MHz   |
|            |                             | Input frequency limit (LVCMOS to X1).  | 1       |         | 125     | MHz   |
| $f_{OUT}$  | Output Frequency            | Single-ended clock output limit (LVCMOS).  | 1       | < 125   | 160     | MHz   |
|            |                             | Differential clock output limit (LPHCSL).  | 1       | < 333   | 500     | MHz   |
|            |                             | Differential clock output limit (LVDS).  | 1       | < 333   | 500     | MHz   |
|            |                             | Differential clock output limit (LVPECL).  | 1       |         | 500     | MHz   |
| $f_{VCO1}$ | VCO Frequency Range of PLL1 | VCO operating frequency range.   | 300     |         | 600     | MHz   |
| $f_{VCO2}$ | VCO Frequency Range of PLL2 | VCO operating frequency range.   | 400     |         | 1200    | MHz   |
| $f_{VCO3}$ | VCO Frequency Range of PLL3 | VCO operating frequency range.   | 300     |         | 800     | MHz   |
| $t_2$      | Input Duty Cycle            | Duty cycle.  | 45      |         | 55      | %     |
| $t_3$      | Output Duty Cycle           | LVCMOS, Single-ended.  | 45      |         | 55      | %     |
|            |                             | DIFF1 / DIFF2 configured as a pair of LVCMOS outputs, 180° out of phase (crossing point measurements). | 40      |         | 60      | %     |
|            | Output Duty Cycle – REF     | Reference clock output or SE1–3 fan out clock.   | 40      |         | 60      | %     |
| $t_4^4$    | Rise/Fall, SLEW[0] = 1      | Single-ended LVCMOS output clock rise and fall time, 20% to 80% of $V_{DDSE}$ 1.8V–3.3V.               |         | 1.0     |         | ns    |
|            | Rise/Fall, SLEW[0] = 0      | Single-ended LVCMOS output clock rise and fall time, 20% to 80% of $V_{DDSE}$ 1.8V–3.3V.               |         | 1.1     |         |       |
| $t_5^5$    | Rise Time                   | LVDS, 20% to 80%.  |         | 300     |         | ps    |
|            | Fall Time                   | LVDS, 80% to 20%.  |         | 300     |         |       |
|            | Rise Time                   | LVPECL, 20% to 80%.  |         | 300     |         |       |
|            | Fall Time                   | LVPECL, 80% to 20%.  |         | 300     |         |       |



Table 32. AC Electrical Characteristics (Cont.)

| Symbol          | Parameter    | Conditions  | Minimum | Typical                                    | Maximum | Units |
|-----------------|--------------|---|---------|--|---------|-------|
| t6              | Clock Jitter | Cycle-to-cycle jitter (peak-to-peak), multiple output frequencies switching, differential outputs (1.8V to 3.3V nominal output voltage).<br>SE1 = 25MHz<br>SE2 = 100MHz<br>SE3 = 100MHz<br>DIFF1/2 = 100MHz |         | 50   |         | ps    |
|                 |              | RMS phase jitter (12kHz to 20MHz integration range) differential output, $V_{DDSE} = 3.465V$ , 25MHz crystal.<br>SE1 = 25MHz<br>SE2 = 100MHz<br>SE3 = 100MHz<br>DIFF1/2 = 100MHz                            |         | 1.1<br>(industrial)<br>1.5<br>(automotive) |         | ps    |
|                 |              | RMS phase jitter (12kHz to 20 MHz integration range) REF output.  |         | 0.3  |         | ps    |
| t7              | Output Skew  | Skew between the same frequencies, with outputs using the same driver format.   |         | 75   |         | ps    |
| t8 <sup>2</sup> | Lock Time    | PLL lock time from power-up.  |         |  | 20      | ms    |
| t9              | Lock Time    | 32.768kHz clock low power power-up time.  |         | 10   | 100     | ms    |
| t9 <sup>3</sup> | Lock Time    | PLL lock time from shutdown mode.   |         | 0.1  | 2       | ms    |

<sup>1</sup> Practical lower frequency is determined by loop filter settings.

<sup>2</sup> Includes loading the configuration bits from EPROM to PLL registers. It does not include EPROM programming/write time.

<sup>3</sup> Actual PLL lock time depends on the loop configuration.

<sup>4</sup> t4 Rise/Fall time measurements are based on 5pF load.

<sup>5</sup> t5 Rise/Fall time measurements are based on 2pF load.

## PCI Express Jitter Specifications

$V_{DDIFF} = 3.3V \pm 5\%$  or  $2.5V \pm 5\%$ ,  $T_A = -40^\circ C$  to  $+105^\circ C$ .

Table 33. PCI Express Jitter Specifications

| Symbol                            | Parameter                 | Conditions   | Minimum | Typical | Maximum | Industry Specification | Units | Notes |
|-----------------------------------|---------------------------|--|---------|---------|---------|------------------------|-------|-------|
| $t_j$ (PCIe Gen1)                 | Phase Jitter Peak-to-Peak | $f = 100MHz/125MHz, 25MHz$ crystal input.<br>Evaluation band: 0Hz – Nyquist (clock frequency/2). |         | 30      |         | 86                     | ps    | 1,4   |
| $t_{REFCLK\_HF\_RMS}$ (PCIe Gen2) | Phase Jitter RMS          | $f = 100MHz/125MHz, 25MHz$ crystal input.<br>High band: 1.5MHz – Nyquist (clock frequency/2).    |         | 2.56    |         | 3.10                   | ps    | 2,4   |
| $t_{REFCLK\_LF\_RMS}$ (PCIe Gen2) | Phase Jitter RMS          | $f = 100MHz/125MHz, 25MHz$ crystal input.<br>Low band: 10kHz – 1.5MHz.                           |         | 0.7     |         | 3.0                    | ps    | 2,4   |
| $t_{REFCLK\_RMS}$ (PCIe Gen3)     | Phase Jitter RMS          | $f = 100MHz/125MHz, 25MHz$ crystal input.<br>Evaluation band: 0Hz – Nyquist (clock frequency/2). |         | 0.8     |         | 1.0                    | ps    | 3,4   |

Note: Electrical parameters are guaranteed over the specified ambient operating temperature range, which is established when the device is mounted in a test socket with maintained transverse airflow greater than 500 lpm. The device will meet specifications after thermal equilibrium has been reached under these conditions.

<sup>1</sup> Peak-to-peak jitter after applying system transfer function for the common clock architecture. Maximum limit for PCI Express Gen1.

<sup>2</sup> RMS jitter after applying the two evaluation bands to the two transfer functions defined in the common clock architecture and reporting the worst case results for each evaluation band. Maximum limit for PCI Express Gen2 is 3.1ps RMS for  $t_{REFCLK\_HF\_RMS}$  (high band) and 3.0ps RMS for  $t_{REFCLK\_LF\_RMS}$  (low band).

<sup>3</sup> RMS jitter after applying system transfer function for the common clock architecture. This specification is based on the PCI\_Express\_Base\_r3.0 10 Nov. 2010 specification, and is subject to change pending the final release version of the specification.

<sup>4</sup> This parameter is guaranteed by characterization. Not tested in production.

## Spread Spectrum Generation Specifications

Table 34. Spread Spectrum Generation Specifications

| Symbol                  | Parameter            | Conditions   | Minimum | Typical      | Maximum | Units       |
|-------------------------|----------------------|--|---------|--------------|---------|-------------|
| $f_{OUT}$               | Output Frequency     | Output frequency range.                              | 1       |              | 350     | MHz         |
| $f_{MOD}$ <sup>1</sup>  | Modulation Frequency | Modulation frequency.                                |         | 30 to 63     |         | kHz         |
| $f_{SPREAD}$            | Spread Value         | Amount of spread value (programmable) – down spread. |         | -0.5% to -2% |         | % $f_{OUT}$ |
| %tolerance <sup>2</sup> | Spread% Value        | Variation of spread range.                           |         | ±15          |         | %           |

<sup>1</sup> Input frequency dependent (see programming guide).

<sup>2</sup> Design target.

## I<sup>2</sup>C Bus Characteristics

Table 35. I<sup>2</sup>C Bus DC Characteristics

| Symbol           | Parameter             | Conditions             | Minimum                  | Typical | Maximum                 | Units |
|------------------|-----------------------|------------------------|--------------------------|---------|-------------------------|-------|
| V <sub>IH</sub>  | Input High Level      |                        | 0.7 × V <sub>DD33</sub>  |         |                         | V     |
| V <sub>IL</sub>  | Input Low Level       |                        |                          |         | 0.3 × V <sub>DD33</sub> | V     |
| V <sub>HYS</sub> | Hysteresis of Inputs  |                        | 0.05 × V <sub>DD33</sub> |         |                         | V     |
| I <sub>IN</sub>  | Input Leakage Current |                        |                          |         | ±1                      | μA    |
| V <sub>OL</sub>  | Output Low Voltage    | I <sub>OL</sub> = 3mA. |                          |         | 0.4                     | V     |

Table 36. I<sup>2</sup>C Bus AC Characteristics

| Symbol                | Parameter                                | Conditions | Minimum                   | Typical | Maximum | Units |
|-----------------------|--|------------|---------------------------|---------|---------|-------|
| F <sub>SCLK</sub>     | Serial Clock Frequency (SCL)             |            |                           | 100     | 400     | kHz   |
| t <sub>BUF</sub>      | Bus Free Time between STOP and START     |            | 1.3                       |         |         | μs    |
| t <sub>SU:START</sub> | Setup Time, START                        |            | 0.6                       |         |         | μs    |
| t <sub>HD:START</sub> | Hold Time, START                         |            | 0.6                       |         |         | μs    |
| t <sub>SU:DATA</sub>  | Setup Time, Data Input (SDA)             |            | 100                       |         |         | ns    |
| t <sub>HD:DATA</sub>  | Hold Time, Data Input (SDA) <sup>1</sup> |            | 0                         |         |         | μs    |
| t <sub>OVD</sub>      | Output Data Valid from Clock             |            |                           |         | 0.9     | μs    |
| C <sub>B</sub>        | Capacitive Load for Each Bus Line        |            |                           |         | 400     | pF    |
| t <sub>R</sub>        | Rise Time, Data and Clock (SDA, SCL)     |            | 20 + 0.1 × C <sub>B</sub> |         | 300     | ns    |
| t <sub>F</sub>        | Fall Time, Data and Clock (SDA, SCL)     |            | 20 + 0.1 × C <sub>B</sub> |         | 300     | ns    |
| t <sub>HIGH</sub>     | High Time, Clock (SCL)                   |            | 0.6                       |         |         | μs    |
| t <sub>LOW</sub>      | Low Time, Clock (SCL)                    |            | 1.3                       |         |         | μs    |
| t <sub>SU:STOP</sub>  | Setup Time, STOP                         |            | 0.6                       |         |         | μs    |

<sup>1</sup> A device must internally provide a hold time of at least 300ns for the SDA signal (referred to the V<sub>IH(MIN)</sub> of the SCL signal) to bridge the undefined region of the falling edge of SCL.

## I<sup>2</sup>C Mode Operations

The device acts as a slave device on the I<sup>2</sup>C bus using one of the four I<sup>2</sup>C addresses (0xD0, 0xD2, 0xD4, or 0xD6) to allow multiple devices to be used in the system. The interface accepts byte-oriented block write and block read operations. Two address bytes specify the register address of the byte position of the first register to write or read. Data bytes (registers) are accessed in sequential order from the lowest to the highest byte (most significant bit first). Read and write block transfers can be stopped after any complete byte transfer. During a write operation, data will not be moved into the registers until the STOP bit is received, at which point, all data received in the block write will be written simultaneously.

For full electrical I<sup>2</sup>C compliance, it is recommended to use external pull-up resistors for SDA and SCL. The internal pull-down resistors have a size of 100kΩ typical.

Figure 10. I<sup>2</sup>C Slave Read and Write Cycle Sequencing

**Byte 0: General Control**

| Byte 00h | Name                     | Control Function                      | Type | 0                                  | 1                     | PWD |
|----------|--------------------------|---------------------------------------|------|------------------------------------|-----------------------|-----|
| Bit 7    | OTP_Burned               | OTP memory programming indication     | R/W  | OTP memory non-programmed          | OTP memory programmed | 0   |
| Bit 6    | I <sup>2</sup> C_addr[1] | I <sup>2</sup> C address select bit 1 | R/W  | 00: D0 / 01: D2<br>10: D4 / 11: D6 |                       | 0   |
| Bit 5    | I <sup>2</sup> C_addr[0] | I <sup>2</sup> C address select bit 0 | R/W  |                                    |                       | 0   |
| Bit 4    | PLL1_SSEN                | PLL1 Spread Spectrum enable           | R/W  | disable                            | enable                | 0   |
| Bit 3    | DIV1_src_sel             | Divider 1 source clock select         | R/W  | PLL1                               | Xtal                  | 0   |
| Bit 2    | PLL3_refin_sel           | PLL3 source selection                 | R/W  | Xtal                               | Seed (DIV2)           | 0   |
| Bit 1    | EN_CLKIN                 | Enable CLKIN                          | R/W  | disable                            | enable                | 0   |
| Bit 0    | OTP_protect              | OTP memory protection                 | R/W  | read/write                         | write locked          | 0   |

**Byte 1: Dash Code ID (optional)**

| Byte 01h | Name           | Control Function | Type | 0 | 1 | PWD |
|----------|----------------|------------------|------|---|---|-----|
| Bit 7    | DashCode ID[7] | Dash code ID     | R/W  | — | — | 0   |
| Bit 6    | DashCode ID[6] | Dash code ID     | R/W  | — | — | 0   |
| Bit 5    | DashCode ID[5] | Dash code ID     | R/W  | — | — | 0   |
| Bit 4    | DashCode ID[4] | Dash code ID     | R/W  | — | — | 0   |
| Bit 3    | DashCode ID[3] | Dash code ID     | R/W  | — | — | 0   |
| Bit 2    | DashCode ID[2] | Dash code ID     | R/W  | — | — | 0   |
| Bit 1    | DashCode ID[1] | Dash code ID     | R/W  | — | — | 0   |
| Bit 0    | DashCode ID[0] | Dash code ID     | R/W  | — | — | 0   |

**Byte 2: Crystal Cap Setting**

| Byte 02h | Name        | Control Function            | Type | 0                            | 1 | PWD |
|----------|-------------|-----------------------------|------|------------------------------|---|-----|
| Bit 7    | Xtal_Cap[7] | Xtal cap load trimming bits | R/W  | x1 x2<br>x4 x8<br>total 15pf |   | 0   |
| Bit 6    | Xtal_Cap[6] | Xtal cap load trimming bits | R/W  |                              |   | 0   |
| Bit 5    | Xtal_Cap[5] | Xtal cap load trimming bits | R/W  |                              |   | 0   |
| Bit 4    | Xtal_Cap[4] | Xtal cap load trimming bits | R/W  |                              |   | 1   |
| Bit 3    | Xtal_Cap[3] | Xtal cap load trimming bits | R/W  |                              |   | 0   |
| Bit 2    | Xtal_Cap[2] | Xtal cap load trimming bits | R/W  |                              |   | 0   |
| Bit 1    | Xtal_Cap[1] | Xtal cap load trimming bits | R/W  |                              |   | 0   |
| Bit 0    | Xtal_Cap[0] | Xtal cap load trimming bits | R/W  |                              |   | 1   |

**Byte 3: PLL3 M Divider**

| Byte 03h | Name          | Control Function               | Type | 0              | 1                   | PWD |
|----------|---------------|--------------------------------|------|----------------|---------------------|-----|
| Bit 7    | PLL3_MDIV1    | PLL3 source clock divider      | R/W  | disable M DIV1 | bypadd divider (/1) | 0   |
| Bit 6    | PLL3_MDIV2    | PLL3 source clock divider      | R/W  | disable M DIV2 | bypadd divider (/2) | 0   |
| Bit 5    | PLL3 M_DIV[5] | PLL3 reference integer divider | R/W  | 3–64           | default 25          | 0   |
| Bit 4    | PLL3 M_DIV[4] | PLL3 reference integer divider | R/W  | —              | —                   | 1   |
| Bit 3    | PLL3 M_DIV[3] | PLL3 reference integer divider | R/W  | —              | —                   | 1   |
| Bit 2    | PLL3 M_DIV[2] | PLL3 reference integer divider | R/W  | —              | —                   | 0   |
| Bit 1    | PLL3 M_DIV[1] | PLL3 reference integer divider | R/W  | —              | —                   | 0   |
| Bit 0    | PLL3 M_DIV[0] | PLL3 reference integer divider | R/W  | —              | —                   | 1   |

**Byte 4: PLL3 N Divider**

| Byte 04h | Name          | Control Function                       | Type | 0   | 1 | PWD |
|----------|---------------|--|------|---|---|-----|
| Bit 7    | PLL3 N_DIV[7] | PLL3 VCO feedback integer divider bit7 | R/W  | 12–2048, default VCO setting is<br>480MHz |   | 1   |
| Bit 6    | PLL3 N_DIV[6] | PLL3 VCO feedback integer divider bit6 | R/W  |   |   | 1   |
| Bit 5    | PLL3 N_DIV[5] | PLL3 VCO feedback integer divider bit5 | R/W  |   |   | 1   |
| Bit 4    | PLL3 N_DIV[4] | PLL3 VCO feedback integer divider bit4 | R/W  |   |   | 0   |
| Bit 3    | PLL3 N_DIV[3] | PLL3 VCO feedback integer divider bit3 | R/W  |   |   | 0   |
| Bit 2    | PLL3 N_DIV[2] | PLL3 VCO feedback integer divider bit2 | R/W  |   |   | 0   |
| Bit 1    | PLL3 N_DIV[1] | PLL3 VCO feedback integer divider bit1 | R/W  |   |   | 0   |
| Bit 0    | PLL3 N_DIV[0] | PLL3 VCO feedback integer divider bit0 | R/W  |   |   | 0   |

**Byte 5: PLL3 Loop Filter Setting and N Divider 10:8**

| Byte 05h | Name           | Control Function                        | Type | 0                                      | 1                  | PWD |
|----------|----------------|---|------|--|--------------------|-----|
| Bit 7    | PLL3_R100K     | PLL3 Loop filter resister 100kohm       | R/W  | bypass                                 | plus 100kohm       | 0   |
| Bit 6    | PLL3_R50K      | PLL3 Loop filter resister 50kohm        | R/W  | bypass                                 | plus 50kohm        | 0   |
| Bit 5    | PLL3_R25K      | PLL3 Loop filter resister 25kohm        | R/W  | bypass                                 | plus 25kohm        | 0   |
| Bit 4    | PLL3_R12.5K    | PLL3 Loop filter resister 12.5kohm      | R/W  | bypass                                 | plus 12.5kohm      | 1   |
| Bit 3    | PLL3_R6K       | PLL3 Loop filter resister 6kohm         | R/W  | bypass                                 | only 6kohm applied | 0   |
| Bit 2    | PLL3 N_DIV[10] | PLL3 VCO feedback integer divider bit10 | R/W  | 12–2048, default VCO setting is 480MHz |                    | 0   |
| Bit 1    | PLL3 N_DIV[9]  | PLL3 VCO feedback integer divider bit9  | R/W  |  |                    | 0   |
| Bit 0    | PLL3 N_DIV[8]  | PLL3 VCO feedback integer divider bit8  | R/W  |  |                    | 1   |

**Byte 6: PLL3 Charge Pump Control**

| Byte 06h | Name            | Control Function                        | Type | 0    | 1    | PWD |
|----------|-----------------|---|------|------|------|-----|
| Bit 7    | OUTDIV 3 Source | Output divider 3 source clock selection | R/W  | PLL2 | PLL3 | 0   |
| Bit 6    | PLL3_CP_8X      | PLL3 charge pump control                | R/W  | —    | x8   | 1   |
| Bit 5    | PLL3_CP_4X      | PLL3 charge pump control                | R/W  | —    | x4   | 1   |
| Bit 4    | PLL3_CP_2X      | PLL3 charge pump control                | R/W  | —    | x2   | 0   |
| Bit 3    | PLL3_CP_1X      | PLL3 charge pump control                | R/W  | —    | x1   | 1   |
| Bit 2    | PLL3_CP_/24     | PLL3 charge pump control                | R/W  | —    | /24  | 1   |
| Bit 1    | PLL3_CP_/3      | PLL3 charge pump control                | R/W  | —    | /3   | 0   |
| Bit 0    | PLL3_SIREF      | PLL3 SiRef current selection            | R/W  | 10µA | 20µA | 0   |

Formula:  $(iRef (10\mu A) \times (1 + SIREF) \times (1 \times 1X + 2 \times 2X + 4 \times 4X + 8 \times 8X + 16 \times 16X)) / ((24 \times /24) + (3 \times /3))$

**Byte 7: PLL1 Control and OUTDIV5 Divider**

| Byte 07h | Name              | Control Function              | Type | 0       | 1      | PWD |
|----------|-------------------|-------------------------------|------|---------|--------|-----|
| Bit 7    | PLL1_MDIV_Doubler | PLL1 reference clock doubler  | R/W  | disable | enable | 0   |
| Bit 6    | PLL1_SIREF        | PLL1 SiRef current selection  | R/W  | 10.8µA  | 21.6µA | 0   |
| Bit 5    | PLL1_EN_CH2       | PLL1 output Channel 2 control | R/W  | disable | enable | 1   |
| Bit 4    | PLL1_EN_3rdpole   | PLL1 3rd Pole control         | R/W  | disable | enable | 0   |
| Bit 3    | OUTDIV5[3]        | Output divider5 control bit 3 | R/W  | —       | —      | 0   |
| Bit 2    | OUTDIV5[2]        | Output divider5 control bit 2 | R/W  | —       | —      | 0   |
| Bit 1    | OUTDIV5[1]        | Output divider5 control bit 1 | R/W  | —       | —      | 1   |
| Bit 0    | OUTDIV5[0]        | Output divider5 control bit 0 | R/W  | —       | —      | 1   |

**Byte 8: PLL1 M Divider**

| Byte 08h | Name          | Control Function                           | Type | 0                   | 1                   | PWD |
|----------|---------------|--|------|---------------------|---------------------|-----|
| Bit 7    | PLL1_MDIV1    | PLL3 VCO reference clock divider 1         | R/W  | disable M DIV1      | bypass divider (/1) | 0   |
| Bit 6    | PLL1_MDIV2    | PLL3 VCO reference clock divider 2         | R/W  | disable M DIV2      | bypass divider (/2) | 0   |
| Bit 5    | PLL1 M_DIV[5] | PLL1 reference clock divider control bit 5 | R/W  | 3–64, default is 25 |                     | 0   |
| Bit 4    | PLL1 M_DIV[4] | PLL1 reference clock divider control bit 4 | R/W  |                     |                     | 1   |
| Bit 3    | PLL1 M_DIV[3] | PLL1 reference clock divider control bit 3 | R/W  |                     |                     | 1   |
| Bit 2    | PLL1 M_DIV[2] | PLL1 reference clock divider control bit 2 | R/W  |                     |                     | 0   |
| Bit 1    | PLL1 M_DIV[1] | PLL1 reference clock divider control bit 1 | R/W  |                     |                     | 0   |
| Bit 0    | PLL1 M_DIV[0] | PLL1 reference clock divider control bit 0 | R/W  |                     |                     | 1   |

**Byte 9: PLL1 VCO N Divider**

| Byte 09h | Name          | Control Function                        | Type | 0                       | 1 | PWD |
|----------|---------------|---|------|-------------------------|---|-----|
| Bit 7    | PLL1 N_DIV[7] | PLL1 VCO feedback divider control bit 7 | R/W  | 12–2048, default is 600 |   | 0   |
| Bit 6    | PLL1 N_DIV[6] | PLL1 VCO feedback divider control bit 6 | R/W  |                         |   | 1   |
| Bit 5    | PLL1 N_DIV[5] | PLL1 VCO feedback divider control bit 5 | R/W  |                         |   | 0   |
| Bit 4    | PLL1 N_DIV[4] | PLL1 VCO feedback divider control bit 4 | R/W  |                         |   | 1   |
| Bit 3    | PLL1 N_DIV[3] | PLL1 VCO feedback divider control bit 3 | R/W  |                         |   | 1   |
| Bit 2    | PLL1 N_DIV[2] | PLL1 VCO feedback divider control bit 2 | R/W  |                         |   | 0   |
| Bit 1    | PLL1 N_DIV[1] | PLL1 VCO feedback divider control bit 1 | R/W  |                         |   | 0   |
| Bit 0    | PLL1 N_DIV[0] | PLL1 VCO feedback divider control bit 0 | R/W  |                         |   | 0   |

**Byte 10: PLL Loop Filter and N Divider**

| Byte 0Ah | Name           | Control Function                        | Type | 0                       | 1                    | PWD |
|----------|----------------|---|------|-------------------------|----------------------|-----|
| Bit 7    | PLL1_R100K     | PLL1 Loop filter resister 100kohm       | R/W  | bypass                  | plus 100kohm         | 1   |
| Bit 6    | PLL1_R50K      | PLL1 Loop filter resister 50kohm        | R/W  | bypass                  | plus 50kohm          | 0   |
| Bit 5    | PLL1_R25K      | PLL1 Loop filter resister 25kohm        | R/W  | bypass                  | plus 25kohm          | 1   |
| Bit 4    | PLL1_R12.5K    | PLL1 Loop filter resister 12.5kohm      | R/W  | bypass                  | plus 12.5kohm        | 1   |
| Bit 3    | PLL1_R1.0K     | PLL1 Loop filter resister 1kohm         | R/W  | bypass                  | only 1.0kohm applied | 0   |
| Bit 2    | PLL1 N_DIV[10] | PLL1 VCO feedback integer divider bit10 | R/W  | 12–2048, default is 600 |                      | 0   |
| Bit 1    | PLL1 N_DIV[9]  | PLL1 VCO feedback integer divider bit9  | R/W  |                         |                      | 1   |
| Bit 0    | PLL1 N_DIV[8]  | PLL1 VCO feedback integer divider bit8  | R/W  |                         |                      | 0   |

**Byte 11: PLL1 Charge Pump**

| Byte 0Bh | Name        | Control Function         | Type | 0 | 1   | PWD |
|----------|-------------|--------------------------|------|---|-----|-----|
| Bit 7    | PLL1_CP_32X | PLL1 charge pump control | R/W  | — | x32 | 0   |
| Bit 6    | PLL1_CP_16X | PLL1 charge pump control | R/W  | — | x16 | 0   |
| Bit 5    | PLL1_CP_8X  | PLL1 charge pump control | R/W  | — | x8  | 0   |
| Bit 4    | PLL1_CP_4X  | PLL1 charge pump control | R/W  | — | x4  | 0   |
| Bit 3    | PLL1_CP_2X  | PLL1 charge pump control | R/W  | — | x2  | 0   |
| Bit 2    | PLL1_CP_1X  | PLL1 charge pump control | R/W  | — | x1  | 1   |
| Bit 1    | PLL1_CP_/24 | PLL1 charge pump control | R/W  | — | /24 | 1   |
| Bit 0    | PLL1_CP_/3  | PLL1 charge pump control | R/W  | — | /3  | 0   |

**Byte 12: PLL1 Spread Spectrum Control**

| Byte 0Ch | Name               | Control Function                              | Type | 0 | 1 | PWD |
|----------|--------------------|---|------|---|---|-----|
| Bit 7    | PLL1_SS_REFDIV[23] | PLL1 Spread Spectrum control - Ref divider 23 | R/W  | — | — | 0   |
| Bit 6    | PLL1_SS_REFDIV[6]  | PLL1 Spread Spectrum control - Ref divider 6  | R/W  | — | — | 0   |
| Bit 5    | PLL1_SS_REFDIV[5]  | PLL1 Spread Spectrum control - Ref divider 5  | R/W  | — | — | 0   |
| Bit 4    | PLL1_SS_REFDIV[4]  | PLL1 Spread Spectrum control - Ref divider 4  | R/W  | — | — | 0   |
| Bit 3    | PLL1_SS_REFDIV[3]  | PLL1 Spread Spectrum control - Ref divider 3  | R/W  | — | — | 0   |
| Bit 2    | PLL1_SS_REFDIV[2]  | PLL1 Spread Spectrum control - Ref divider 2  | R/W  | — | — | 0   |
| Bit 1    | PLL1_SS_REFDIV[1]  | PLL1 Spread Spectrum control - Ref divider 1  | R/W  | — | — | 0   |
| Bit 0    | PLL1_SS_REFDIV[0]  | PLL1 Spread Spectrum control - Ref divider 0  | R/W  | — | — | 0   |

**Byte 13: PLL1 Spread Spectrum Control**

| Byte 0Dh | Name             | Control Function                          | Type | 0 | 1 | PWD |
|----------|------------------|---|------|---|---|-----|
| Bit 7    | PLL1_SS_FBDIV[7] | PLL1 Spread Spectrum - feedback divider 7 | R/W  | — | — | 0   |
| Bit 6    | PLL1_SS_FBDIV[6] | PLL1 Spread Spectrum - feedback divider 6 | R/W  | — | — | 0   |
| Bit 5    | PLL1_SS_FBDIV[5] | PLL1 Spread Spectrum - feedback divider 5 | R/W  | — | — | 0   |
| Bit 4    | PLL1_SS_FBDIV[4] | PLL1 Spread Spectrum - feedback divider 4 | R/W  | — | — | 0   |
| Bit 3    | PLL1_SS_FBDIV[3] | PLL1 Spread Spectrum - feedback divider 3 | R/W  | — | — | 0   |
| Bit 2    | PLL1_SS_FBDIV[2] | PLL1 Spread Spectrum - feedback divider 2 | R/W  | — | — | 0   |
| Bit 1    | PLL1_SS_FBDIV[1] | PLL1 Spread Spectrum - feedback divider 1 | R/W  | — | — | 0   |
| Bit 0    | PLL1_SS_FBDIV[0] | PLL1 Spread Spectrum - feedback divider 0 | R/W  | — | — | 0   |



**Byte 14: PLL1 Spread Spectrum Control**

| Byte 0Eh | Name              | Control Function                           | Type | 0 | 1 | PWD |
|----------|-------------------|--|------|---|---|-----|
| Bit 7    | PLL1_SS_FBDIV[15] | PLL1 Spread Spectrum - feedback divider 15 | R/W  | — | — | 0   |
| Bit 6    | PLL1_SS_FBDIV[14] | PLL1 Spread Spectrum - feedback divider 14 | R/W  | — | — | 0   |
| Bit 5    | PLL1_SS_FBDIV[13] | PLL1 Spread Spectrum - feedback divider 13 | R/W  | — | — | 0   |
| Bit 4    | PLL1_SS_FBDIV[12] | PLL1 Spread Spectrum - feedback divider 12 | R/W  | — | — | 0   |
| Bit 3    | PLL1_SS_FBDIV[11] | PLL1 Spread Spectrum - feedback divider 11 | R/W  | — | — | 0   |
| Bit 2    | PLL1_SS_FBDIV[10] | PLL1 Spread Spectrum - feedback divider 10 | R/W  | — | — | 0   |
| Bit 1    | PLL1_SS_FBDIV[09] | PLL1 Spread Spectrum - feedback divider 9  | R/W  | — | — | 0   |
| Bit 0    | PLL1_SS_FBDIV[08] | PLL1 Spread Spectrum - feedback divider 8  | R/W  | — | — | 0   |

**Byte 15: Output Divider1 Control**

| Byte 0Fh | Name       | Control Function              | Type | 0 | 1 | PWD |
|----------|------------|-------------------------------|------|---|---|-----|
| Bit 7    | OUTDIV1[3] | Output divider1 control bit 3 | R/W  | — | — | 0   |
| Bit 6    | OUTDIV1[2] | Output divider1 control bit 2 | R/W  | — | — | 0   |
| Bit 5    | OUTDIV1[1] | Output divider1 control bit 1 | R/W  | — | — | 1   |
| Bit 4    | OUTDIV1[0] | Output divider1 control bit 0 | R/W  | — | — | 1   |
| Bit 3    | OUTDIV2[3] | Output divider2 control bit 3 | R/W  | — | — | 0   |
| Bit 2    | OUTDIV2[2] | Output divider2 control bit 2 | R/W  | — | — | 0   |
| Bit 1    | OUTDIV2[1] | Output divider2 control bit 1 | R/W  | — | — | 1   |
| Bit 0    | OUTDIV2[0] | Output divider2 control bit 0 | R/W  | — | — | 1   |

**Byte 16: PLL2 Integer Feedback Divide**

| Byte 10h | Name            | Control Function                 | Type | 0 | 1 | PWD |
|----------|-----------------|----------------------------------|------|---|---|-----|
| Bit 7    | Reserved        |                                  |      |   |   | 0   |
| Bit 6    | Reserved        |                                  |      |   |   | 0   |
| Bit 5    | Reserved        |                                  |      |   |   | 0   |
| Bit 4    | Reserved        |                                  |      |   |   | 0   |
| Bit 3    | Reserved        |                                  |      |   |   | 0   |
| Bit 2    | PLL2_FB_INT[10] | PLL2 feedback integer divider 10 | R/W  | — | — | 0   |
| Bit 1    | PLL2_FB_INT[9]  | PLL2 feedback integer divider 9  | R/W  | — | — | 0   |
| Bit 0    | PLL2_FB_INT[8]  | PLL2 feedback integer divider 8  | R/W  | — | — | 0   |

**Byte 17: PLL2 Integer Feedback Divider**

| Byte 11h | Name               | Control Function                | Type | 0 | 1 | PWD |
|----------|--------------------|---------------------------------|------|---|---|-----|
| Bit 7    | PLL2_FB_INT_DIV[7] | PLL2 feedback integer divider 7 | R/W  | — | — | 0   |
| Bit 6    | PLL2_FB_INT_DIV[6] | PLL2 feedback integer divider 6 | R/W  | — | — | 0   |
| Bit 5    | PLL2_FB_INT_DIV[5] | PLL2 feedback integer divider 5 | R/W  | — | — | 1   |
| Bit 4    | PLL2_FB_INT_DIV[4] | PLL2 feedback integer divider 4 | R/W  | — | — | 0   |
| Bit 3    | PLL2_FB_INT_DIV[3] | PLL2 feedback integer divider 3 | R/W  | — | — | 1   |
| Bit 2    | PLL2_FB_INT_DIV[2] | PLL2 feedback integer divider 2 | R/W  | — | — | 0   |
| Bit 1    | PLL2_FB_INT_DIV[1] | PLL2 feedback integer divider 1 | R/W  | — | — | 0   |
| Bit 0    | PLL2_FB_INT_DIV[0] | PLL2 feedback integer divider 0 | R/W  | — | — | 0   |

**Byte 18: PLL2 Fractional Feedback Divider**

| Byte 12h | Name               | Control Function                   | Type | 0 | 1 | PWD |
|----------|--------------------|------------------------------------|------|---|---|-----|
| Bit 7    | PLL2_FB_FRC_DIV[7] | PLL2 feedback fractional divider 7 | R/W  | — | — | 0   |
| Bit 6    | PLL2_FB_FRC_DIV[6] | PLL2 feedback fractional divider 6 | R/W  | — | — | 0   |
| Bit 5    | PLL2_FB_FRC_DIV[5] | PLL2 feedback fractional divider 5 | R/W  | — | — | 0   |
| Bit 4    | PLL2_FB_FRC_DIV[4] | PLL2 feedback fractional divider 4 | R/W  | — | — | 0   |
| Bit 3    | PLL2_FB_FRC_DIV[3] | PLL2 feedback fractional divider 3 | R/W  | — | — | 0   |
| Bit 2    | PLL2_FB_FRC_DIV[2] | PLL2 feedback fractional divider 2 | R/W  | — | — | 0   |
| Bit 1    | PLL2_FB_FRC_DIV[1] | PLL2 feedback fractional divider 1 | R/W  | — | — | 0   |
| Bit 0    | PLL2_FB_FRC_DIV[0] | PLL2 feedback fractional divider 0 | R/W  | — | — | 0   |

**Byte 19: PLL2 Fractional Feedback Divider**

| Byte 13h | Name                | Control Function                    | Type | 0 | 1 | PWD |
|----------|---------------------|-------------------------------------|------|---|---|-----|
| Bit 7    | PLL2_FB_FRC_DIV[15] | PLL2 feedback fractional divider 15 | R/W  | — | — | 0   |
| Bit 6    | PLL2_FB_FRC_DIV[14] | PLL2 feedback fractional divider 14 | R/W  | — | — | 0   |
| Bit 5    | PLL2_FB_FRC_DIV[13] | PLL2 feedback fractional divider 13 | R/W  | — | — | 0   |
| Bit 4    | PLL2_FB_FRC_DIV[12] | PLL2 feedback fractional divider 12 | R/W  | — | — | 0   |
| Bit 3    | PLL2_FB_FRC_DIV[11] | PLL2 feedback fractional divider 11 | R/W  | — | — | 0   |
| Bit 2    | PLL2_FB_FRC_DIV[10] | PLL2 feedback fractional divider 10 | R/W  | — | — | 0   |
| Bit 1    | PLL2_FB_FRC_DIV[9]  | PLL2 feedback fractional divider 9  | R/W  | — | — | 0   |
| Bit 0    | PLL2_FB_FRC_DIV[8]  | PLL2 feedback fractional divider 8  | R/W  | — | — | 0   |

**Byte 20: PLL2 Spread Spectrum Control**

| Byte 14h | Name         | Control Function                    | Type | 0 | 1 | PWD |
|----------|--------------|-------------------------------------|------|---|---|-----|
| Bit 7    | PLL2_STEP[7] | PLL2 spread step size control bit 7 | R/W  | — | — | 0   |
| Bit 6    | PLL2_STEP[6] | PLL2 spread step size control bit 6 | R/W  | — | — | 0   |
| Bit 5    | PLL2_STEP[5] | PLL2 spread step size control bit 5 | R/W  | — | — | 0   |
| Bit 4    | PLL2_STEP[4] | PLL2 spread step size control bit 4 | R/W  | — | — | 0   |
| Bit 3    | PLL2_STEP[3] | PLL2 spread step size control bit 3 | R/W  | — | — | 0   |
| Bit 2    | PLL2_STEP[2] | PLL2 spread step size control bit 2 | R/W  | — | — | 0   |
| Bit 1    | PLL2_STEP[1] | PLL2 spread step size control bit 1 | R/W  | — | — | 0   |
| Bit 0    | PLL2_STEP[0] | PLL2 spread step size control bit 0 | R/W  | — | — | 0   |

**Byte 21: PLL2 Spread Spectrum Control**

| Byte 15h | Name          | Control Function                     | Type | 0 | 1 | PWD |
|----------|---------------|--------------------------------------|------|---|---|-----|
| Bit 7    | PLL2_STEP[15] | PLL2 spread step size control bit 15 | R/W  | — | — | 0   |
| Bit 6    | PLL2_STEP[14] | PLL2 spread step size control bit 14 | R/W  | — | — | 0   |
| Bit 5    | PLL2_STEP[13] | PLL2 spread step size control bit 13 | R/W  | — | — | 0   |
| Bit 4    | PLL2_STEP[12] | PLL2 spread step size control bit 12 | R/W  | — | — | 0   |
| Bit 3    | PLL2_STEP[11] | PLL2 spread step size control bit 11 | R/W  | — | — | 0   |
| Bit 2    | PLL2_STEP[10] | PLL2 spread step size control bit 10 | R/W  | — | — | 0   |
| Bit 1    | PLL2_STEP[9]  | PLL2 spread step size control bit 9  | R/W  | — | — | 0   |
| Bit 0    | PLL2_STEP[8]  | PLL2 spread step size control bit 8  | R/W  | — | — | 0   |

**Byte 22: PLL2 Spread Spectrum Control**

| Byte 16h | Name               | Control Function                          | Type | 0 | 1 | PWD |
|----------|--------------------|---|------|---|---|-----|
| Bit 7    | PLL2_STEP_DELTA[7] | PLL2 spread step size control delta bit 7 | R/W  | — | — | 0   |
| Bit 6    | PLL2_STEP_DELTA[6] | PLL2 spread step size control delta bit 6 | R/W  | — | — | 0   |
| Bit 5    | PLL2_STEP_DELTA[5] | PLL2 spread step size control delta bit 5 | R/W  | — | — | 0   |
| Bit 4    | PLL2_STEP_DELTA[4] | PLL2 spread step size control delta bit 4 | R/W  | — | — | 0   |
| Bit 3    | PLL2_STEP_DELTA[3] | PLL2 spread step size control delta bit 3 | R/W  | — | — | 0   |
| Bit 2    | PLL2_STEP_DELTA[2] | PLL2 spread step size control delta bit 2 | R/W  | — | — | 0   |
| Bit 1    | PLL2_STEP_DELTA[1] | PLL2 spread step size control delta bit 1 | R/W  | — | — | 0   |
| Bit 0    | PLL2_STEP_DELTA[0] | PLL2 spread step size control delta bit 0 | R/W  | — | — | 0   |

**Byte 23: PLL2 Period Control**

| Byte 17h | Name           | Control Function          | Type | 0 | 1 | PWD |
|----------|----------------|---------------------------|------|---|---|-----|
| Bit 7    | PLL2_PERIOD[7] | PLL2 period control bit 7 | R/W  | — | — | 0   |
| Bit 6    | PLL2_PERIOD[6] | PLL2 period control bit 6 | R/W  | — | — | 0   |
| Bit 5    | PLL2_PERIOD[5] | PLL2 period control bit 5 | R/W  | — | — | 0   |
| Bit 4    | PLL2_PERIOD[4] | PLL2 period control bit 4 | R/W  | — | — | 0   |
| Bit 3    | PLL2_PERIOD[3] | PLL2 period control bit 3 | R/W  | — | — | 0   |
| Bit 2    | PLL2_PERIOD[2] | PLL2 period control bit 2 | R/W  | — | — | 0   |
| Bit 1    | PLL2_PERIOD[1] | PLL2 period control bit 1 | R/W  | — | — | 0   |
| Bit 0    | PLL2_PERIOD[0] | PLL2 period control bit 0 | R/W  | — | — | 0   |

**Byte 24: PLL2 Control Register**

| Byte 18h | Name           | Control Function                   | Type | 0       | 1                  | PWD |
|----------|----------------|------------------------------------|------|---------|--------------------|-----|
| Bit 7    | PLL2_PERIOD[9] | PLL2 period control bit 9          | R/W  | —       | —                  | 0   |
| Bit 6    | PLL2_PERIOD[8] | PLL2 period control bit 8          | R/W  | —       | —                  | 0   |
| Bit 5    | PLL2_SSEN      | PLL2 spread spectrum enable        | R/W  | disable | enable             | 0   |
| Bit 4    | PLL2_R100K     | PLL2 Loop filter resister 100kohm  | —    | bypass  | plus 100kohm       | 0   |
| Bit 3    | PLL2_R50K      | PLL2 Loop filter resister 50kohm   | —    | bypass  | plus 50kohm        | 0   |
| Bit 2    | PLL2_R25K      | PLL2 Loop filter resister 25kohm   | —    | bypass  | plus 25kohm        | 0   |
| Bit 1    | PLL2_R12.5K    | PLL2 Loop filter resister 12.5kohm | —    | bypass  | plus 12.5kohm      | 0   |
| Bit 0    | PLL2_R6K       | PLL2 Loop filter resister 6kohm    | —    | bypass  | only 6kohm applied | 0   |

**Byte 25: PLL2 Charge Pump Control**

| Byte 19h | Name        | Control Function             | Type | 0          | 1          | PWD |
|----------|-------------|------------------------------|------|------------|------------|-----|
| Bit 7    | PLL2_CP_16X | PLL2 charge pump control     | R/W  | —          | x16        | 0   |
| Bit 6    | PLL2_CP_8X  | PLL2 charge pump control     | R/W  | —          | x8         | 0   |
| Bit 5    | PLL2_CP_4X  | PLL2 charge pump control     | R/W  | —          | x4         | 1   |
| Bit 4    | PLL2_CP_2X  | PLL2 charge pump control     | R/W  | —          | x2         | 0   |
| Bit 3    | PLL2_CP_1X  | PLL2 charge pump control     | R/W  | —          | x1         | 0   |
| Bit 2    | PLL2_CP_/24 | PLL2 charge pump control     | R/W  | —          | /24        | 1   |
| Bit 1    | PLL2_CP_/3  | PLL2 charge pump control     | R/W  | —          | /3         | 0   |
| Bit 0    | PLL2_SIREF  | PLL2 SiRef current selection | R/W  | 10 $\mu$ A | 20 $\mu$ A | 0   |

**Byte 26: PLL2 M Divider Setting**

| Byte 1Ah | Name              | Control Function                     | Type | 0                   | 1                   | PWD |
|----------|-------------------|--------------------------------------|------|---------------------|---------------------|-----|
| Bit 7    | PLL2_MDIV_Doubler | PLL2 reference divider - doubler     | R/W  | disable             | enable              | 0   |
| Bit 6    | PLL2_MDIV1        | PLL2 reference divider 1             | R/W  | disable M DIV1      | bypadd divider (/1) | 1   |
| Bit 5    | PLL2_MDIV2        | PLL2 reference divider 2             | R/W  | disable M DIV2      | bypadd divider (/2) | 0   |
| Bit 4    | PLL2_MDIV[4]      | PLL2 reference divider control bit 4 | R/W  | 3–64, default is 25 |                     | 0   |
| Bit 3    | PLL2_MDIV[3]      | PLL2 reference divider control bit 3 | R/W  |                     |                     | 0   |
| Bit 2    | PLL2_MDIV[2]      | PLL2 reference divider control bit 2 | R/W  |                     |                     | 0   |
| Bit 1    | PLL2_MDIV[1]      | PLL2 reference divider control bit 1 | R/W  |                     |                     | 0   |
| Bit 0    | PLL2_MDIV[0]      | PLL2 reference divider control bit 0 | R/W  |                     |                     | 0   |

**Byte 27: Output Divider 4**

| Byte 1Bh | Name       | Control Function            | Type | 0 | 1 | PWD |
|----------|------------|-----------------------------|------|---|---|-----|
| Bit 7    | OUTDIV3[3] | Out divider 3 control bit 3 | R/W  | — | — | 0   |
| Bit 6    | OUTDIV3[2] | Out divider 3 control bit 2 | R/W  | — | — | 0   |
| Bit 5    | OUTDIV3[1] | Out divider 3 control bit 1 | R/W  | — | — | 1   |
| Bit 4    | OUTDIV3[0] | Out divider 3 control bit 0 | R/W  | — | — | 1   |
| Bit 3    | OUTDIV4[3] | Out divider 4 control bit 3 | R/W  | — | — | 0   |
| Bit 2    | OUTDIV4[2] | Out divider 4 control bit 2 | R/W  | — | — | 0   |
| Bit 1    | OUTDIV4[1] | Out divider 4 control bit 1 | R/W  | — | — | 1   |
| Bit 0    | OUTDIV4[0] | Out divider 4 control bit 0 | R/W  | — | — | 1   |

**Byte 28: PLL Operation Control Register**

| Byte 1Ch | Name           | Control Function                             | Type | 0           | 1                     | PWD |
|----------|----------------|--|------|-------------|-----------------------|-----|
| Bit 7    | PLL2_HRS_EN    | PLL2 spread high resolution selection enable | R/W  | normal      | enable (shift 4 bits) | 0   |
| Bit 6    | PLL2_refin_sel | PLL2 reference clock source select           | R/W  | Xtal        | DIV2                  | 0   |
| Bit 5    | PLL3_PDB       | PLL3 Power Down                              | R/W  | Power Down  | running               | 1   |
| Bit 4    | PLL3_LCKBYPSSB | PLL3 lock bypass                             | R/W  | bypass lock | lock                  | 1   |
| Bit 3    | PLL2_PDB       | PLL2 Power Down                              | R/W  | Power Down  | running               | 1   |
| Bit 2    | PLL2_LCKBYPSSB | PLL2 lock bypass                             | R/W  | bypass lock | lock                  | 1   |
| Bit 1    | PLL1_PDB       | PLL1 Power Down                              | R/W  | Power Down  | running               | 1   |
| Bit 0    | PLL1_LCKBYPSSB | PLL1 lock bypass                             | R/W  | bypass lock | lock                  | 1   |

**Byte 29: Output Control**

| Byte 1Dh | Name           | Control Function                        | Type | 0                            | 1          | PWD |
|----------|----------------|---|------|------------------------------|------------|-----|
| Bit 7    | DIFF1_SEL      | Differential clock 1 output OE2 control |      | not controlled               | controlled | 0   |
| Bit 6    | DIFF2_SEL      | Differential clock 2 output OE2 control |      | not controlled               | controlled | 0   |
| Bit 5    | DIFF1_EN       | Differential clock 1 output enable      | R/W  | disable                      | enable     | 1   |
| Bit 4    | DIFF2_EN       | Differential clock 2 output enable      | R/W  | disable                      | enable     | 1   |
| Bit 3    | OUTDIV4_Source | Output divider 4 source clock selection | R/W  | PLL2                         | Xtal       | 0   |
| Bit 2    | SE1_SLEW       | SE 1 slew rate control                  | R/W  | normal                       | strong     | 0   |
| Bit 1    | VDD1_SEL[1]    | VDD1 level control bit 1                | R/W  | 00/01: 3.3V 10: 2.5V 11: 1.8 |            | 0   |
| Bit 0    | VDD1_SEL[0]    | VDD1 level control bit 0                | R/W  |                              |            | 0   |

**Byte 30: OE and DFC Control**

| Byte 1Eh | Name           | Control Function                 | Type | 0                         | 1                         | PWD |
|----------|----------------|----------------------------------|------|---------------------------|---------------------------|-----|
| Bit 7    | SE1_EN         | SE1 output enable control        | R/W  | disable                   | enable                    | 1   |
| Bit 6    | OE1_fun_sel[1] | OE1 pin function selection bit 1 | R/W  | 11:DFC0<br>01: PD#        | 10: SE1_PPS<br>00: SE1 OE | 0   |
| Bit 5    | OE1_fun_sel[0] | OE1 pin function selection bit 0 | R/W  |                           |                           | 0   |
| Bit 4    | SE3_EN         | SE3 output enable control        | R/W  | disable                   | enable                    | 1   |
| Bit 3    | OE3_fun_sel[1] | OE3 pin function selection bit 1 | R/W  | 11:DFC1<br>01: xx         | 10: SE3_PPS<br>00: SE3 OE | 0   |
| Bit 2    | OE3_fun_sel[0] | OE3 pin function selection bit 0 | R/W  |                           |                           | 0   |
| Bit 1    | DFC_SW_Sel[1]  | DFC frequency select bit 1       | R/W  | 00: N0 01: N1 10:N2 11:N3 |                           | 0   |
| Bit 0    | DFC_SW_Sel[0]  | DFC frequency select bit 0       | R/W  |                           |                           | 0   |

**Byte 31: Control Register**

| Byte 1Fh | Name            | Control Function              | Type | 0                             | 1                       | PWD |
|----------|-----------------|-------------------------------|------|-------------------------------|-------------------------|-----|
| Bit 7    | SE2_Freerun_32K | SE2 32K free run              |      | freerun 32K                   | B31 bit6 control source | 1   |
| Bit 6    | SE2_CLKSEL1     | SE2 source clock selection    |      | DIV5                          | DIV4                    | 0   |
| Bit 5    | VDD2_SEL[1]     | VDD2 level control bit 1      | R/W  | 00/01: 3.3V 10: 2.5V 11: 1.8V |                         | 0   |
| Bit 4    | VDD2_SEL[0]     | VDD2 level control bit 0      | R/W  |                               |                         | 0   |
| Bit 3    | SE2_SLEW        | SE2 slew rate control         | R/W  | normal                        | strong                  | 0   |
| Bit 2    | PLL2_3rd_EN_CFG | PLL2 3rd order control        |      | 1st order                     | 3rd order               | 1   |
| Bit 1    | PLL2_EN_CH2     | PLL2 channel 2 enable control | R/W  | disable                       | enable                  | 0   |
| Bit 0    | PLL2_EN_3rdpole | PLL2 3rd Pole control         | R/W  | disable                       | enable                  | 1   |

**Byte 32: Control Register**

| Byte 20h | Name           | Control Function                 | Type | 0  | 1       | PWD |
|----------|----------------|----------------------------------|------|--|---------|-----|
| Bit 7    | SE2_EN         | SE2 output enable control        | R/W  | disable  | enable  | 1   |
| Bit 6    | OE2_fun_sel[1] | OE2 pin function selection bit 1 | R/W  | 11: RESET 10: SE2_PPS<br>01: DIFF1/2 OE 00: SE2 OE |         | 0   |
| Bit 5    | OE2_fun_sel[0] | OE2 pin function selection bit 0 | R/W  |  |         | 0   |
| Bit 4    | DFC_EN         | DFC function control             | R/W  | disable  | enable  | 0   |
| Bit 3    | WD_EN          | Watchdog timer control           | R/W  | disable  | enable  | 0   |
| Bit 2    | Timer_sel<1>   | Watchdog timer select bit 1      | R/W  | 00: 250ms 01: 500ms<br>10: 2s 11: 4s               |         | 0   |
| Bit 1    | Timer_sel<0>   | Watchdog timer select bit 0      | R/W  |  |         | 0   |
| Bit 0    | Alarm_Flag     | Alarm Status (Read Only)         | R    | No alarm   | Alarmed | 0   |

**Byte 33: SE3 and DIFF1 Control Register**

| Byte 21h | Name             | Control Function                         | Type | 0                          | 1                                 | PWD |
|----------|------------------|--|------|----------------------------|-----------------------------------|-----|
| Bit 7    | SE3_Freerun_32K  | SE3 32K free run                         |      | freerun 32K                | DIC2 or DIV4 selected by B33 bit6 | 1   |
| Bit 6    | SE3_CLKSEL1      | SE3 source clock selection               |      | DIV2                       | DIV4                              | 0   |
| Bit 5    | VDD3_SEL[1]      | VDD3 level control bit 1                 | R/W  | 11: 1.8V 10: 2.5V 0x: 3.3V |                                   | 0   |
| Bit 4    | VDD3_SEL[0]      | VDD3 level control bit 0                 | R/W  |                            |                                   | 0   |
| Bit 3    | SE3_SLEW         | SE3 slew rate control                    | R/W  | normal                     | strong                            | 0   |
| Bit 2    | DIFF_PDBHIZEN    | Differential output high-Z at power down | R/W  | TBD                        | output tri-state, bias off        | 0   |
| Bit 1    | DIFF1_CMOS2_FLIP | Differential 1/2 LVCMOS output control   | R/W  | DIFF1_B inverted           | DIFF1_B non-inverted              | 0   |
| Bit 0    | DIFF2_CMOS2_FLIP | Differential 1/2 LVCMOS output control   | R/W  | DIFF2_B inverted           | DIFF2_B non-inverted              | 0   |

**Byte 34: DIFF1 Control Register**

| Byte 22h | Name                 | Control Function                             | Type | 0   | 1    | PWD |
|----------|----------------------|--|------|---|------|-----|
| Bit 7    | DIFF1_CLK_SEL        | Differential clock 1 source selection        | R/W  | DIV1  | DIV3 | 1   |
| Bit 6    | DIFF1_io_pwr_sel     | Differential clock 1 output power            | R/W  | 2.5V  | 3.3V | 1   |
| Bit 5    | DIFF1_OUTPUT_TYPE[1] | Differential clock 1 type select bit 1       | R/W  | 00: LVCMOS 01: LVDS<br>10: LVPECL 11: LPHCSL  |      | 1   |
| Bit 4    | DIFF1_OUTPUT_TYPE[0] | Differential clock 1 type select bit 0       | R/W  |   |      | 1   |
| Bit 3    | DIFF1_AMP[1]         | Differential clock 1 amplitude control bit 1 | R/W  | LPHCSL: 00 = 740mV, 01 = 800mV,<br>10 = 855mV, 11 = 910mV<br>LVPECL: 00 = 710mV, 01 = 810mV,<br>10 = 875mV, 11 = 920mV<br>LVDS: 00 = 311mV, 01 = 344mV,<br>10 = 376mV, 11 = 408mV |      | 0   |
| Bit 2    | DIFF1_AMP[0]         | Differential clock 1 amplitude control bit 0 | R/W  |   |      | 1   |

| Byte 22h | Name            | Control Function                              | Type | 0       | 1      | PWD |
|----------|-----------------|---|------|---------|--------|-----|
| Bit 1    | DIFF1_CMOS_SLEW | Differential clock 1 LVCMOS slew rate control | R/W  | normal  | strong | 0   |
| Bit 0    | D1FF1_CMOS2_EN  | Differential clock 1 LVCMOS output_B control  | R/W  | disable | enable | 0   |

**Byte 35: DIFF2 Control Register**

| Byte 23h | Name                 | Control Function                              | Type | 0   | 1      | PWD |
|----------|----------------------|---|------|---|--------|-----|
| Bit 7    | DIFF2_CLK_SEL        | Differential clock 2 source selection         | R/W  | DIV1  | DIV3   | 0   |
| Bit 6    | DIFF2_IO_PWR_SEL     | Differential clock 2 output power             | R/W  | 2.5V  | 3.3V   | 1   |
| Bit 5    | DIFF2_OUTPUT_TYPE[1] | Differential clock 2 type select bit 1        | R/W  | 00: LVCMOS 01: LVDS<br>10: LVPECL 11: LPHCSL  |        | 1   |
| Bit 4    | DIFF2_OUTPUT_TYPE[0] | Differential clock 2 type select bit 0        | R/W  |   |        | 1   |
| Bit 3    | DIFF2_AMP[1]         | Differential clock 2 amplitude control bit 1  | R/W  | LPHCSL: 00 = 740mV, 01 = 800mV,<br>10 = 855mV, 11 = 910mV<br>LVPECL: 00 = 710mV, 01 = 810mV,<br>10 = 875mV, 11 = 920mV<br>LVDS: 00 = 311mV, 01 = 344mV,<br>10 = 376mV, 11 = 408mV |        | 0   |
| Bit 2    | DIFF2_AMP[0]         | Differential clock 2 amplitude control bit 0  | R/W  |   |        | 1   |
| Bit 1    | DIFF2_CMOS_SLEW      | Differential clock 2 LVCMOS slew rate control | R/W  | normal  | strong | 0   |
| Bit 0    | DIFF2_CMOS2_EN       | Differential clock 2 LVCMOS output_B control  | R/W  | disable   | enable | 0   |

**Byte 36: SE1 and DIV4 control**

| Byte 24h | Name                   | Control Function                 | Type | 0            | 1               | PWD |
|----------|------------------------|----------------------------------|------|--------------|-----------------|-----|
| Bit 7    | I2C_PDB                | chip power down control bit      | R/W  | power down   | normal          | 1   |
| Bit 6    | Ref_free_run           | Reference clock output (SE2/SE3) | R/W  | stop         | free run        | 0   |
| Bit 5    | free_run_output_config | SE clocks free run control       | R/W  | SE2 free run | SE2/3 free run  | 0   |
| Bit 4    | SE1_Freerun_32K        | SE1 clock output default         | R/W  | 32k free run | B36bit3 control | 0   |
| Bit 3    | SE1_CLKSEL1            | SEL1 output select               | R/W  | DIV5         | DIV4            | 1   |
| Bit 2    | REF_EN                 | REF output enable                | R/W  | disable      | enable          | 1   |
| Bit 1    | DIV4_CH3_EN            | DIV4 channel 3 output control    | R/W  | disable      | enable          | 0   |
| Bit 0    | DIV4_CH2_EN            | DIV4 channel 2 output control    | R/W  | disable      | enable          | 0   |



## Glossary of Features

Table 37. Glossary of Features

| Term      | Function Description  | Apply to  |
|-----------|---|-----------|
| DFC       | Dynamic Frequency Control; from selected PLL to support four VCO frequencies; means two different output frequencies by assigned H/W pin state changes (H-L or L-H) needs to have frequency change Glitch-Free function in order to not crash application system. | PLL2      |
| ORT       | Overshoot Reduction; when the DFC dynamic frequency change is functional, the VCO changes frequencies smoothly to target frequency without overshoot or undershoot.   | PLL2      |
| OE        | Output enable function; each output can be controlled by assigned OE pin and the dedicated OE pin can be OTP programmable as global Power Down function (PD#) or Output Enable (OE) or Proactive Power Saving function (PPS) or RESET pin function.               | OE1-3     |
| SS        | Spread spectrum clock.  | PLL1/PLL2 |
| Slew Rate | LVC MOS outputs with slew rate control – slow and fast.   | LVC MOS   |
| PPS       | Proactive Power Saving; utilize OE pin as monitor pin for end device X2 clock status. See <a href="#">PPS – Proactive Power Saving Function</a> description for details.  | SE1-3     |

## Package Outline Drawings

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

[www.idt.com/document/psc/24-vfqfjn-package-outline-drawing-40-x-40-x-09-mm-body-05-mm-pitch-epad-26-x-26-mm-nlg24s3-wettable](http://www.idt.com/document/psc/24-vfqfjn-package-outline-drawing-40-x-40-x-09-mm-body-05-mm-pitch-epad-26-x-26-mm-nlg24s3-wettable)

[www.idt.com/document/psc/24-vfqfjn-package-outline-drawing-40-x-40-x-090-mm-body050mm-pitchepad-260-x-260-mm-nlg24p3](http://www.idt.com/document/psc/24-vfqfjn-package-outline-drawing-40-x-40-x-090-mm-body050mm-pitchepad-260-x-260-mm-nlg24p3)

## Marking Diagrams (industrial)



- Line 1 and 2 is the truncated part number.
  - “-000” denotes the blank part.
  - “-ddd” denotes the dash code.
- “YWW” is the last digit of the year and work week that the part was assembled.
- “\*\*\*” denotes lot sequence number.
- “\$” denotes mark code.

## Marking Diagrams (automotive)



- Line 1 and 2 is the truncated part number.
  - “-000” denotes the blank part.
  - “-ddd” denotes the dash code.
- “YWW” is the last digit of the year and work week that the part was assembled.
- “\*\*\*” denotes lot sequence number.
- “\$” denotes mark code.

## Ordering Information

| Orderable Part Number | Package   | Carrier Type  | Temperature                       |
|-----------------------|---|---------------|-----------------------------------|
| 5P35023-000NLGI       | 4 × 4 mm, 0.5mm pitch 24-VFQFPN                 | Trays         | -40 to +85°C, Industrial          |
| 5P35023-000NLGI8      | 4 × 4 mm, 0.5mm pitch 24-VFQFPN                 | Tape and Reel | -40 to +85°C, Industrial          |
| 5P35023-dddNLGI       | 4 × 4 mm, 0.5mm pitch 24-VFQFPN                 | Trays         | -40 to +85°C, Industrial          |
| 5P35023-dddNLGI8      | 4 × 4 mm, 0.5mm pitch 24-VFQFPN                 | Tape and Reel | -40 to +85°C, Industrial          |
| 5P35023-000NLG2       | 4 × 4 mm, 0.5mm pitch 24-VFQFPN, Wettable Flank | Trays         | -40 to +105°C, Automotive Grade 2 |
| 5P35023-000NLG28      | 4 × 4 mm, 0.5mm pitch 24-VFQFPN, Wettable Flank | Tape and Reel | -40 to +105°C, Automotive Grade 2 |
| 5P35023-dddNLG2       | 4 × 4 mm, 0.5mm pitch 24-VFQFPN, Wettable Flank | Trays         | -40 to +105°C, Automotive Grade 2 |
| 5P35023-dddNLG28      | 4 × 4 mm, 0.5mm pitch 24-VFQFPN, Wettable Flank | Tape and Reel | -40 to +105°C, Automotive Grade 2 |

## Revision History

| Revision Date     | Description of Change   |
|-------------------|---|
| May 15, 2019      | <ul style="list-style-type: none"> <li>▪ Added information for automotive parts.</li> <li>▪ Corrected error in thermal impedance values.</li> <li>▪ Corrected error in LVCMOS test load.</li> </ul> |
| November 30, 2017 | Updated I2C section.  |
| January 25, 2017  | <ul style="list-style-type: none"> <li>▪ Updates/corrected typos in Byte 27.</li> <li>▪ Updated package outline drawings.</li> </ul>  |
| May 26, 2016      | Initial release.  |



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