

# DS250DF410 25Gbps マルチレート 4 チャンネル・リタイマ

## 1 特長

- 信号コンディショニング機能を備えた 4 チャンネル・マルチレート・リタイマ
- すべてのチャンネルは独立に 20.2752~ 25.8Gbps でロック (10.3125Gbps、12.5Gbps などのサブレートを含む)
- 非常に短いレイテンシ : 25.78125Gbps のデータ・レートで 500ps 未満 (標準値)
- 単一電源で、低ジッタの基準クロックを必要とせず、電源デカップリングが最小限であるため、基板配線が簡単、BOM コストも削減可能
- 2x2 のクロス・ポイントを内蔵
- アダプティブ連続時間リニア・イコライザ (CTLE)
- アダプティブ・デジジョン・フィードバック・イコライザ (DFE)
- 3 タップ FIR フィルタ付きの低ジッタ・トランスミッタ
- 結合イコライゼーションにより、12.9GHz で 35dB を超えるチャンネル損失に対応
- 伝送振幅を変更可能 : 205mVppd~1225mVppd (標準値)
- オンチップのアイ・オープニング・モニタ (EOM)、PRBS パターン・チェッカ/ジェネレータ
- JTAG/AC-JTAG バウンダリ・スキャンをサポート
- フロースルーで簡単に配線できる小型 6mm x 6mm BGA パッケージ

## 2 アプリケーション

- フロント・ポート光学系のジッタ・クリーニング
- アクティブ・ケーブル・アセンブリ
- バックプレーン/ミッドプレーンの範囲拡張
- IEEE802.3bj 100GbE、Infiniband EDR、OIF-CEI-25G-LR/MR/SR/VSR の電氣的インターフェイス
- SFP28、QSFP28、CFP2/CFP4、CDFP

## 3 概要

DS250DF410 デバイスは、信号コンディショニング機能を備えた 4 チャンネル、マルチレート・リタイマです。10<sup>-15</sup> 以下のビット・エラー・レート (BER) を達成しながら、長距離で、損失が大きく、クロストークの影響を受ける高速シリアル・リンクの到達距離と堅牢性を拡張するために使用します。

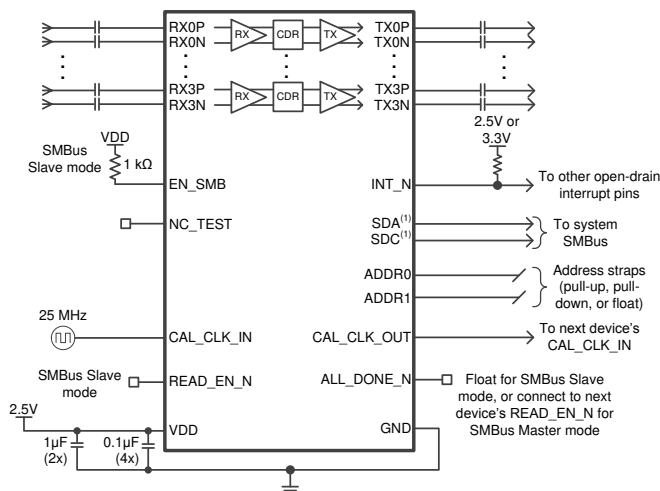
DS250DF410の各チャンネルは、20.2752Gbps~25.8Gbpsの連続した範囲のシリアル・データ・レート、またはサポートされている任意のサブレート(÷2および÷4) (10.3125Gbpsや12.5Gbpsなどの主要データ・レートを含む)へ独立にロックされるため、DS250DF410は個別レートの前方誤り訂正(FEC)パススルーをサポートできます。

### 製品情報<sup>(1)</sup>

| 型番         | パッケージ     | 本体サイズ(公称)     |
|------------|-----------|---------------|
| DS250DF410 | ABM (101) | 6.00mmx6.00mm |

(1) 利用可能なすべてのパッケージについては、このデータシートの末尾にある注文情報を参照してください。

### 概略回路図



(1) SMBus signals need to be pulled up elsewhere in the system.



## 目次

|          |  |          |           |   |           |
|----------|--|----------|-----------|---|-----------|
| <b>1</b> | <b>特長</b> .....  | <b>1</b> | <b>8</b>  | <b>Detailed Description</b> .....           | <b>17</b> |
| <b>2</b> | <b>アプリケーション</b> .....  | <b>1</b> | 8.1       | Overview .....                              | 17        |
| <b>3</b> | <b>概要</b> .....  | <b>1</b> | 8.2       | Functional Block Diagram .....              | 17        |
| <b>4</b> | <b>改訂履歴</b> .....  | <b>2</b> | 8.3       | Feature Description .....                   | 18        |
| <b>5</b> | <b>概要 (続き)</b> .....   | <b>3</b> | 8.4       | Device Functional Modes .....               | 29        |
| <b>6</b> | <b>Pin Configuration and Functions</b> .....                               | <b>4</b> | 8.5       | Programming .....                           | 30        |
| <b>7</b> | <b>Specifications</b> .....  | <b>8</b> | 8.6       | Register Maps .....                         | 32        |
| 7.1      | Absolute Maximum Ratings .....   | 8        | <b>9</b>  | <b>Application and Implementation</b> ..... | <b>76</b> |
| 7.2      | ESD Ratings .....  | 8        | 9.1       | Application Information .....               | 76        |
| 7.3      | Recommended Operating Conditions .....                                     | 8        | 9.2       | Typical Applications .....                  | 76        |
| 7.4      | Thermal Information .....  | 9        | <b>10</b> | <b>Power Supply Recommendations</b> .....   | <b>90</b> |
| 7.5      | Electrical Characteristics .....   | 9        | <b>11</b> | <b>Layout</b> .....                         | <b>90</b> |
| 7.6      | Timing Requirements, Retimer Jitter<br>Specifications .....                | 13       | 11.1      | Layout Guidelines .....                     | 90        |
| 7.7      | Timing Requirements, Retimer Specifications .....                          | 14       | 11.2      | Layout Example .....                        | 90        |
| 7.8      | Timing Requirements, Recommended Calibration<br>Clock Specifications ..... | 14       | <b>12</b> | <b>デバイスおよびドキュメントのサポート</b> .....             | <b>92</b> |
| 7.9      | Recommended SMBus Switching Characteristics<br>(Slave Mode) .....          | 14       | 12.1      | ドキュメントのサポート .....                           | 92        |
| 7.10     | Recommended SMBus Switching Characteristics<br>(Master Mode) .....         | 15       | 12.2      | ドキュメントのサポート .....                           | 92        |
| 7.11     | Recommended JTAG Switching Characteristics ..                              | 15       | 12.3      | ドキュメントの更新通知を受け取る方法 .....                    | 92        |
| 7.12     | Typical Characteristics .....  | 16       | 12.4      | サポート・リソース .....                             | 92        |
|          |  |          | 12.5      | 商標 .....                                    | 92        |
|          |  |          | 12.6      | 静電気放電に関する注意事項 .....                         | 92        |
|          |  |          | 12.7      | Glossary .....                              | 92        |
|          |  |          | <b>13</b> | <b>メカニカル、パッケージ、および注文情報</b> .....            | <b>92</b> |

## 4 改訂履歴

資料番号末尾の英字は改訂を表しています。その改訂履歴は英語版に準じています。

### Revision C (February 2019) から Revision D に変更

Page

|   |                 |   |
|---|-----------------|---|
| • | 最初の公開リリース ..... | 1 |
|---|-----------------|---|

## 5 概要 (続き)

DS250DF410は単一電源で、必要な外部部品も最小限です。これらの特長により、PCB配線の複雑性とBOMコストが低減されます。

DS250DF410の高度なイコライゼーション機能には、低ジッタの3タップ送信有限インパルス応答(FIR)フィルタ、アダプティブ連続時間リニア・イコライザ(CTLE)、アダプティブ・デシジョン・フィードバック・イコライザ(DFE)が含まれています。これにより、複数のコネクタやクロストークが存在する、損失の多い相互接続およびバックプレーンにおいて、到達距離を拡張できます。内蔵のCDR機能は、フロントポート光学モジュール・アプリケーションで、ジッタ・バジェットをリセットし、高速シリアル・データをリタイムするために最適です。DS250DF410は、各チャネル・ペアに2x2のクロスポイントを実装しているため、ホストはレーンクロス、ファンアウト、多重化のいずれの方法でも使用できます。

DS250DF410はSMBus経由、または外付けのEEPROMにより構成可能です。最大16個のデバイスが、共通のチャネル・フォーマットを使用して単一のEEPROMを共有できます。非破壊的なオンチップ・アイ・モニタとPRBSジェネレータ/チェッカにより、インシステム診断が可能です。

## 6 Pin Configuration and Functions

ABM Package  
101-Pin FC/CSP  
Top View



Pin Functions

| PIN                                 |     | TYPE  | INTERNAL PULL-UP/<br>PULL-DOWN | DESCRIPTION   |
|-------------------------------------|-----|-------|--------------------------------|---|
| NAME                                | NO. |       |                                |   |
| <b>HIGH SPEED DIFFERENTIAL I/Os</b> |     |       |                                |   |
| RX0N                                | A10 | Input | None                           | Inverting and non-inverting differential inputs to the equalizer. An on-chip 100-Ω termination resistor connects RXP to RXN. These inputs need to be AC coupled. <sup>(1)</sup> |
| RX0P                                | A11 | Input | None                           |   |
| RX1N                                | A7  | Input | None                           | Inverting and non-inverting differential inputs to the equalizer. An on-chip 100-Ω termination resistor connects RXP to RXN. These inputs need to be AC coupled. <sup>(1)</sup> |
| RX1P                                | A8  | Input | None                           |   |

(1) High-speed pins do not have short-circuit protection. High-speed pins should be AC-coupled.

**Pin Functions (continued)**

| PIN                                       |     | TYPE                 | INTERNAL<br>PULL-UP/<br>PULL-DOWN                                     | DESCRIPTION  |
|---|-----|----------------------|---|--|
| NAME                                      | NO. |                      |   |  |
| RX2N                                      | A4  | Input                | None  | Inverting and non-inverting differential inputs to the equalizer. An on-chip 100-Ω termination resistor connects RXP to RXN. These inputs need to be AC coupled. <sup>(1)</sup>  |
| RX2P                                      | A5  | Input                | None  |  |
| RX3N                                      | A1  | Input                | None  | Inverting and non-inverting differential inputs to the equalizer. An on-chip 100-Ω termination resistor connects RXP to RXN. These inputs need to be AC coupled. <sup>(1)</sup>  |
| RX3P                                      | A2  | Input                | None  |  |
| TX0N                                      | L10 | Output               | None  | Inverting and non-inverting 50-Ω driver outputs. Compatible with AC-coupled differential inputs. These outputs need to be AC coupled. <sup>(1)</sup>   |
| TX0P                                      | L11 | Output               | None  |  |
| TX1N                                      | L7  | Output               | None  | Inverting and non-inverting 50-Ω driver outputs. Compatible with AC-coupled differential inputs. These outputs need to be AC coupled. <sup>(1)</sup>   |
| TX1P                                      | L8  | Output               | None  |  |
| TX2N                                      | L4  | Output               | None  | Inverting and non-inverting 50-Ω driver outputs. Compatible with AC-coupled differential inputs. These outputs need to be AC coupled. <sup>(1)</sup>   |
| TX2P                                      | L5  | Output               | None  |  |
| TX3N                                      | L1  | Output               | None  | Inverting and non-inverting 50-Ω driver outputs. Compatible with AC-coupled differential inputs. These outputs need to be AC coupled. <sup>(1)</sup>   |
| TX3P                                      | L2  | Output               | None  |  |
| <b>CALIBRATION CLOCK PINS</b>             |     |                      |   |  |
| CAL_CLK_IN/<br>JTAG_TDI                   | F1  | Input, 2.5V<br>CMOS  | Weak pull-up in<br>JTAG mode. Weak<br>pull-down in<br>functional mode | 25 MHz (±100 PPM) 2.5-V single-ended clock from external oscillator. No stringent phase noise or jitter requirements on this clock. Used to calibrate VCO frequency range.<br>In JTAG mode (EN_SMB = 1 kΩ to GND), this is JTAG Test Data In (TDI).  |
| CAL_CLK_OUT/<br>JTAG_TDO                  | F11 | Output, 2.5V<br>CMOS | None  | 2.5-V buffered replica of calibration clock input (pin E1) for connecting multiple devices in a daisy-chained fashion.<br>In JTAG mode (EN_SMB = 1 kΩ to GND), this is JTAG Test Data Out (TDO).   |
| <b>SYSTEM MANAGEMENT BUS (SMBus) PINS</b> |     |                      |   |  |
| ADDR0                                     | D11 | Input, 4-level       | None  | 4-level strap pins used to set the SMBus address of the device. The pin state is read on power-up. The multi-level nature of these pins allows for 16 unique device addresses. The four strap options include:<br>0: 1 kΩ to GND<br>R: 20 kΩ to GND<br>F: Float<br>1: 1 kΩ to VDD<br>Refer to <a href="#">Device SMBus Address</a> for more information.<br>In JTAG mode (EN_SMB = 1 kΩ to GND), ADDR1 is JTAG Test Reset (TRS). |
| ADDR1/JTAG_TRS                            | D1  | Input, 4-level       | Weak pull-up in<br>JTAG mode  |  |

**Pin Functions (continued)**

| PIN                           |     | TYPE                         | INTERNAL PULL-UP/<br>PULL-DOWN | DESCRIPTION   |
|-------------------------------|-----|------------------------------|--------------------------------|---|
| NAME                          | NO. |                              |                                |   |
| EN_SMB                        | G1  | Input, 4-level               | None                           | Four-level 2.5-V input used to select between SMBus master mode (float) and SMBus slave mode (high). The four defined levels are:<br>0: 1 kΩ to GND - JTAG mode; certain pins take on JTAG functionality<br>R: 20 kΩ to GND - RESERVED, T1 test mode<br>F: Float - SMBus Master Mode<br>1: 1 kΩ to VDD - SMBus Slave Mode   |
| SDA                           | G11 | I/O, 3.3V LVCMOS, Open Drain | None                           | SMBus data input / open drain output. External 2-kΩ to 5-kΩ pull-up resistor is required as per SMBus interface standard. This pin is 3.3V-tolerant.  |
| SDC                           | H11 | I/O, 3.3V LVCMOS, Open Drain | None                           | SMBus clock input / open drain clock output. External 2-kΩ to 5-kΩ pull-up resistor is required as per SMBus interface standard. This pin is 3.3V-tolerant.   |
| <b>SMBus MASTER MODE PINS</b> |     |                              |                                |   |
| ALL_DONE_N                    | E1  | Output, LVCMOS               | None                           | Indicates the completion of a valid EEPROM register load operation when in SMBus Master Mode (EN_SMB=Float):<br>High = External EEPROM load failed or incomplete<br>Low = External EEPROM load successful and complete<br>When in SMBus slave mode (EN_SMB=1), this output reflects the status of the READ_EN_N input.  |
| READ_EN_N                     | E11 | Input, 3.3V LVCMOS           | Weak pull-up                   | SMBus Master Mode (EN_SMB=Float):<br>When asserted low, initiates the SMBus master mode EEPROM read function. Once EEPROM read is complete (indicated by assertion of ALL_DONE_N low), this pin can be held low for normal device operation.<br>SMBus Slave Mode (EN_SMB=1): When asserted low, this causes the device to be held in reset (SMBus state machine reset and register reset). This pin should be pulled high or left floating for normal operation in SMBus Slave Mode. This pin is 3.3V-tolerant. |
| <b>MISCELLANEOUS PINS</b>     |     |                              |                                |   |
| INT_N                         | H1  | Output, LVCMOS, Open Drain   | None                           | Open-drain 3.3-V tolerant active-low interrupt output. This pin is pulled low when an interrupt occurs. The events which trigger an interrupt are programmable through SMBus registers. INT_N can be connected in a wired-OR fashion with other device's interrupt pin. A single pull-up resistor in the 2-kΩ to 5-kΩ range is adequate for the entire INT_N net.   |

**Pin Functions (continued)**

| PIN            |   | TYPE          | INTERNAL PULL-UP/<br>PULL-DOWN                            | DESCRIPTION  |
|----------------|---|---------------|---|--|
| NAME           | NO.   |               |   |  |
| TEST0/JTAG_TCK | D10   | Input, LVCMOS | No pull-up in JTAG mode. Weak pull-up in functional mode. | Reserved TI test pins. During normal (non-test-mode) operation, these pins are configured as inputs and therefore they are not affected by the presence of a signal. These pins may be left floating, tied to GND, or connected to a 2.5-V (max) output.<br>In JTAG mode (EN_SMB = 1 kΩ to GND), TEST0 is JTAG Test Clock (TCK) and TEST1 is JTAG Test Mode Select (TMS).  |
| TEST1/JTAG_TMS | D2  | Input, LVCMOS | Weak pull-up  |  |
| TEST2          | E10   | Input, LVCMOS | Weak pull-up  | Reserved TI test pins. During normal (non-test-mode) operation, these pins are configured as inputs and therefore they are not affected by the presence of a signal. These pins may be left floating, tied to GND, or connected to a 2.5-V (max) output.   |
| TEST3          | E2  | Input, LVCMOS | Weak pull-up  |  |
| TEST4          | H10   | Input, LVCMOS | Weak pull-up  |  |
| TEST5          | H2  | Input, LVCMOS | Weak pull-up  |  |
| <b>POWER</b>   |   |               |   |  |
| GND            | A3, A6, A9, B1, B2, B3, B4, B5, B6, B7, B8, B9, B10, B11, C1, C6, C11, D6, E3, E5, E7, E9, F3, F4, F5, F6, F7, F8, F9, G2, G3, G5, G7, G9, G10, H6, J1, J6, J11, K1, K2, K3, K4, K5, K6, K7, K8, K9, K10, K11, L3, L6, L9 | Power         | None  | Ground reference. The GND pins on this device should be connected through a low-resistance path to the board GND plane.  |
| VDD            | C3, C9, D3, D4, D5, D7, D8, D9, H3, H4, H5, H7, H8, H9, J3, J9  | Power         | None  | Power supply, VDD = 2.5 V ±5%. TI recommends connecting at least six decoupling capacitors between the DS250DF410's VDD plane and GND as close to the DS250DF410 as possible. For example, four 0.1-μF capacitors and two 1-μF capacitors directly beneath the device or as close to the VDD pins as possible. The VDD pins on this device should be connected through a low-resistance path to the board VDD plane. |

## 7 Specifications

### 7.1 Absolute Maximum Ratings

over operating free-air temperature range (unless otherwise noted) <sup>(1)</sup>

|                             |   | MIN  | MAX  | UNIT |
|-----------------------------|---|------|------|------|
| VDD_ABSMAX                  | Supply voltage (VDD)  | -0.5 | 2.75 | V    |
| VIO <sub>2.5V,ABS</sub> MAX | 2.5 V I/O voltage (LVCMOS, CMOS and Analog)                               | -0.5 | 2.75 | V    |
| VIO <sub>3.3V,ABS</sub> MAX | Open Drain Voltage (SDA, SDC, INT_N) and LVCMOS Input Voltage (READ_EN_N) | -0.5 | 4.0  | V    |
| VIN_ABSMAX                  | Signal input voltage (RXnP, RXnN)   | -0.5 | 2.75 | V    |
| VOU <sub>T,ABS</sub> MAX    | Signal output voltage (TXnP, TXnN)  | -0.5 | 2.75 | V    |
| T <sub>J,ABS</sub> MAX      | Junction temperature  |      | 150  | °C   |
| T <sub>stg</sub>            | Storage temperature   | -40  | 150  | °C   |

- (1) Stresses beyond those listed under *Absolute Maximum Ratings* may cause permanent damage to the device. These are stress ratings only, which do not imply functional operation of the device at these or any other conditions beyond those indicated under *Recommended Operating Conditions*. Exposure to absolute-maximum-rated conditions for extended periods may affect device reliability.

### 7.2 ESD Ratings

|                    |                         | VALUE  | UNIT  |
|--------------------|-------------------------|--|-------|
| V <sub>(ESD)</sub> | Electrostatic discharge | Human-body model (HBM), per ANSI/ESDA/JEDEC JS-001 <sup>(1)</sup>              | ±2000 |
|                    |                         | Charged-device model (CDM), per JEDEC specification JESD22-C101 <sup>(2)</sup> | ±1000 |

- (1) JEDEC document JEP155 states that 500-V HBM allows safe manufacturing with a standard ESD control process. Pins listed as ±2 kV may actually have higher performance.
- (2) JEDEC document JEP157 states that 250-V CDM allows safe manufacturing with a standard ESD control process.

### 7.3 Recommended Operating Conditions

over operating free-air temperature range (unless otherwise noted)

|                           |  | MIN   | MAX               | UNIT |
|---------------------------|--|-------|-------------------|------|
| VDD                       | Supply voltage, VDD to GND. DC plus AC power should not exceed these limits. | 2.375 | 2.625             | V    |
| NVDD                      | Supply noise, DC to < 50 Hz, sinusoidal <sup>(1)</sup>                       |       | 250               | mVpp |
| NVDD                      | Supply noise, 50 Hz to 10 MHz, sinusoidal <sup>(1)</sup>                     |       | 20                | mVpp |
| NVDD                      | Supply noise, >10 MHz, sinusoidal <sup>(1)</sup>                             |       | 10                | mVpp |
| T <sub>rampVDD</sub>      | VDD supply ramp time, from 0V to 2.375V                                      | 150   |                   | µs   |
| T <sub>J</sub>            | Operating junction temperature   | -40   | 110               | °C   |
| T <sub>A</sub>            | Operating ambient temperature  | -40   | 85 <sup>(2)</sup> | °C   |
| VIO <sub>2.5V</sub>       | 2.5 V I/O voltage (LVCMOS, CMOS and Analog)                                  | 2.375 | 2.625             | V    |
| VIO <sub>3.3V,INT_N</sub> | Open Drain LVCMOS I/O voltage (INT_N)  |       | 3.6               | V    |
| VIO <sub>3.3V</sub>       | Open Drain LVCMOS I/O voltage (SDA, SDC)                                     | 2.375 | 3.6               | V    |

- (1) Steps must be taken to ensure the combined AC plus DC supply noise meets the specified VDD supply voltage limits.
- (2) Steps must be taken to ensure the operating junction temperature range and ambient temperature stay-in-lock range (TEMP<sub>LOCK+</sub>, TEMP<sub>LOCK-</sub>) are met. Refer to [Electrical Characteristics](#) for more details concerning TEMP<sub>LOCK+</sub> and TEMP<sub>LOCK-</sub>.



## 7.4 Thermal Information

| THERMAL METRIC <sup>(1)</sup>                                   | CONDITIONS/ASSUMPTIONS <sup>(2)</sup> | DS250DF410   | UNIT |
|---|---------------------------------------|--------------|------|
|   |                                       | FC/CSP (ABM) |      |
|   |                                       | 101 PINS     |      |
| R <sub>θJA</sub> Junction-to-ambient thermal resistance         | 4-Layer JEDEC Board                   | 34.2         | °C/W |
|   | 10-Layer 8-in x 6-in Board            | 16.7         |      |
|   | 20-Layer 8-in x 6-in Board            | 15.6         |      |
|   | 30-Layer 8-in x 6-in Board            | 14.6         |      |
| R <sub>θJC(top)</sub> Junction-to-case (top) thermal resistance | 4-Layer JEDEC Board                   | 7.8          | °C/W |
| R <sub>θJB</sub> Junction-to-board thermal resistance           | 4-Layer JEDEC Board                   | 13.7         | °C/W |
| Ψ <sub>JT</sub> Junction-to-top characterization parameter      | 4-Layer JEDEC Board                   | 0.004        | °C/W |
|   | 10-Layer 8-in x 6-in Board            | 0.004        |      |
|   | 20-Layer 8-in x 6-in Board            | 0.004        |      |
|   | 30-Layer 8-in x 6-in Board            | 0.004        |      |
| Ψ <sub>JB</sub> Junction-to-board characterization parameter    | 4-Layer JEDEC Board                   | 13.0         | °C/W |
|   | 10-Layer 8-in x 6-in Board            | 11.7         |      |
|   | 20-Layer 8-in x 6-in Board            | 11.5         |      |
|   | 30-Layer 8-in x 6-in Board            | 11.3         |      |

- (1) For more information about traditional and new thermal metrics, see the *Semiconductor and IC Package Thermal Metrics* application report, [SPRA953](#).
- (2) No heat sink or airflow was assumed for these estimations. Depending on the application, a heat sink, faster airflow, and/or reduced ambient temperature (<85 C) may be required in order to meet the maximum junction temperature specification per the [Recommended Operating Conditions](#).

## 7.5 Electrical Characteristics

over operating free-air temperature range (unless otherwise noted)

| PARAMETER  | TEST CONDITIONS  | MIN     | TYP | MAX               | UNIT |
|--|--|---------|-----|-------------------|------|
| R <sub>baud</sub> Input data rate                  | Full-rate  | 20.2752 |     | 25.8              | Gbps |
|  | Half-rate  | 10.1376 |     | 12.9              | Gbps |
|  | Quarter-rate   | 5.0688  |     | 6.45              | Gbps |
| t <sub>EEPROM</sub> EEPROM configuration load time | Single device reading its configuration from an EEPROM. Common channel configuration. This time scales with the number of devices reading from the same EEPROM.  |         |     | 15 <sup>(1)</sup> | ms   |
| t <sub>EEPROM</sub> EEPROM configuration load time | Single device reading its configuration from an EEPROM. Unique channel configuration. This time scales with the number of devices reading from the same EEPROM.  |         |     | 40 <sup>(1)</sup> | ms   |
| t <sub>POR</sub> Power-on reset assertion time     | Internal power-on reset (PoR) stretch between stable power supply and de-assertion of internal PoR. The SMBus address is latched on the completion of the PoR stretch, and SMBus accesses are permitted. |         |     | 50                | ms   |

- (1) From low assertion of READ\_EN\_N to low assertion of ALL\_DONE\_N. Does not include Power-On Reset time.

**Electrical Characteristics (continued)**

over operating free-air temperature range (unless otherwise noted)

| PARAMETER                        |   | TEST CONDITIONS  | MIN | TYP  | MAX | UNIT |
|----------------------------------|---|--|-----|------|-----|------|
| <b>POWER SUPPLY</b>              |   |  |     |      |     |      |
| $W_{\text{channel}}$             | Power consumption per active channel                | With CTLE, full DFE, Tx FIR, Driver, and Crosspoint enabled. Idle power consumption not included.  |     | 241  | 305 | mW   |
|                                  |   | With CTLE, full DFE, Tx FIR, and Driver enabled; Crosspoint disabled. Idle power consumption not included.                                     |     | 233  |     | mW   |
|                                  |   | With CTLE, partial DFE (taps 1-2 only), Tx FIR, and Driver enabled; Crosspoint and DFE taps 3-5 disabled. Idle power consumption not included. |     | 220  |     | mW   |
|                                  |   | With CTLE, Tx FIR, Driver, and Crosspoint enabled; DFE disabled. Idle power consumption not included.  |     | 211  | 290 | mW   |
|                                  |   | Assuming CDR acquiring lock with CTLE, full DFE, Tx FIR, Driver, and Crosspoint enabled. Idle power consumption not included.                  |     | 365  | 430 | mW   |
|                                  |   | Assuming CDR acquiring lock with CTLE, Tx FIR, Driver, and Crosspoint enabled; DFE disabled. Idle power consumption not included.              |     | 318  | 393 | mW   |
|                                  |   | PRBS checker power consumption only <sup>(2)</sup>   |     | 220  | 302 | mW   |
|                                  |   | PRBS generator power consumption only <sup>(2)</sup>   |     | 230  | 315 | mW   |
| $W_{\text{static\_total}}$       | Total idle power consumption                        | Idle/static mode, power supplied, no high-speed data present at inputs, all channels automatically powered down.                               |     | 329  | 525 | mW   |
| $I_{\text{total}}$               | Active mode total device supply current consumption | With CTLE, full DFE, Tx FIR, Driver, and Crosspoint enabled.   |     | 518  | 665 | mA   |
|                                  |   | With CTLE, full DFE, Tx FIR, and Driver enabled; Crosspoint disabled.  |     | 505  |     | mA   |
|                                  |   | With CTLE, partial DFE (taps 1-2 only), Tx FIR, and Driver enabled; Crosspoint and DFE taps 3-5 disabled.                                      |     | 485  |     | mA   |
|                                  |   | With CTLE, Tx FIR, Driver, and Crosspoint enabled. DFE disabled.   |     | 470  | 639 | mA   |
| $I_{\text{static\_total}}$       | Idle mode total device supply current consumption   | Idle/static mode. Power supplied, no high-speed data present at inputs, all channels automatically powered down.                               |     | 132  | 200 | mA   |
| <b>LVC MOS DC SPECIFICATIONS</b> |   |  |     |      |     |      |
| $V_{\text{IH}}$                  | Input high-level voltage                            | 2.5-V LVC MOS pins   |     | 1.75 | VDD | V    |
|                                  |   | 3.3-V LVC MOS pin (READ_EN_N)  |     | 1.75 | 3.6 | V    |
| $V_{\text{IL}}$                  | Input low-level voltage                             | 2.5-V LVC MOS pins   |     | GND  | 0.7 | V    |
|                                  |   | 3.3-V LVC MOS pin (READ_EN_N)  |     | GND  | 0.8 | V    |

(2) To ensure optimal performance, it is recommended to not enable more than two PRBS blocks (checker and/or generator) per device.

## Electrical Characteristics (continued)

over operating free-air temperature range (unless otherwise noted)

| PARAMETER                               |   | TEST CONDITIONS   | MIN  | TYP        | MAX | UNIT  |
|---|---|---|------|------------|-----|-------|
| V <sub>TH</sub>                         | High level (1) input voltage  | 4-level pins ADDR0, ADDR1, and EN_SMB   |      | 0.95 × VDD |     | V     |
|   | Float level input voltage   | 4-level pins ADDR0, ADDR1, and EN_SMB   |      | 0.67 × VDD |     | V     |
|   | 10K to GND input voltage  | 4-level pins ADDR0, ADDR1, and EN_SMB   |      | 0.33 × VDD |     | V     |
|   | Low-level (0) input voltage   | 4-level pins ADDR0, ADDR1, and EN_SMB   |      | 0.1        |     | V     |
| V <sub>OH</sub>                         | High-level output voltage   | I <sub>OH</sub> = 4 mA  | 2    |            |     | V     |
| V <sub>OL</sub>                         | Low-level output voltage  | I <sub>OL</sub> = -4 mA   |      |            | 0.4 | V     |
| I <sub>IH</sub>                         | Input high leakage current  | V <sub>input</sub> = VDD, Open drain pins   |      |            | 70  | μA    |
| I <sub>IH</sub>                         | Input high leakage current  | V <sub>input</sub> = VDD and CAL_CLK_IN pin   |      |            | 65  | μA    |
| I <sub>IH</sub>                         | Input high leakage current  | V <sub>input</sub> = VDD, ADDR[1:0] and EN_SMB pins   |      |            | 65  | μA    |
| I <sub>IH</sub>                         | Input high leakage current  | V <sub>input</sub> = VDD, READ_EN_N   |      |            | 15  | μA    |
| I <sub>IL</sub>                         | Input low leakage current   | V <sub>input</sub> = 0 V, Open drain pins   | -15  |            |     | μA    |
| I <sub>IL</sub>                         | Input low leakage current   | V <sub>input</sub> = 0 V, CAL_CLK_IN pins   | -15  |            |     | μA    |
| I <sub>IL</sub>                         | Input low leakage current   | V <sub>input</sub> = 0 V, ADDR[1:0], READ_EN_N, and EN_SMB pins   | -115 |            |     | μA    |
| <b>RECEIVER INPUTS (RXnP, RXnN)</b>     |   |   |      |            |     |       |
| V <sub>IDMax</sub>                      | Maximum input differential voltage                                  | For normal operation  |      | 1225       |     | mVppd |
| RL <sub>SDD11</sub>                     | Differential input return loss, SDD11 <sup>(3)</sup>                | Between 50 MHz and 3.69 GHz   |      | <-18       |     | dB    |
|   |   | Between 3.69 GHz and 12.9 GHz   |      | <-14       |     | dB    |
| RL <sub>SDC11</sub>                     | Differential to common-mode input return loss, SDC11 <sup>(3)</sup> | Between 50 MHz and 12.9 GHz   |      | <-23       |     | dB    |
| RL <sub>SCD11</sub>                     | Differential to common-mode input return loss, SCD11 <sup>(3)</sup> | Between 50 MHz and 12.9 GHz   |      | <-22       |     | dB    |
| RL <sub>SCC11</sub>                     | Common-mode input return loss, SCC11 <sup>(3)</sup>                 | Between 150 MHz and 10 GHz  |      | <-11       |     | dB    |
|   |   | Between 10 GHz and 12.9 GHz   |      | <-10       |     | dB    |
| V <sub>SDAT</sub>                       | AC signal detect assert (ON) threshold level                        | Minimum input peak-to-peak amplitude level at device pins required to assert signal detect. 25.78125Gbps with PRBS7 pattern and 20dB loss channel   |      | 196        |     | mVppd |
| V <sub>SDDT</sub>                       | AC signal detect de-assert (OFF) threshold level                    | Maximum input peak-to-peak amplitude level at device pins which causes signal detect to de-assert. 25.78125Gbps with PRBS7 pattern and 20dB loss channel  |      | 147        |     | mVppd |
| <b>TRANSMITTER OUTPUTS (TXnP, TXnN)</b> |   |   |      |            |     |       |
| VOD                                     | Output differential voltage amplitude                               | Measured with c(0)=7 setting (Reg_0x3D[6:0]=0x07, Reg_0x3E[6:0]=0x40, REG_0x3F[6:0]=0x40). Differential measurement using an 8T pattern (eight 1s followed by eight 0s) at 25.78125 Gbps with TXPn and TXNn terminated by 50 Ohms to GND. |      | 525        |     | mVppd |

(3) Measured with an evaluation board which uses microstrip traces and low-loss dielectric with approximately 3 dB insertion loss at 12.9 GHz between the DS250DF410 and the measurement instrument.

**Electrical Characteristics (continued)**

over operating free-air temperature range (unless otherwise noted)

| PARAMETER  |  | TEST CONDITIONS  | MIN  | TYP  | MAX | UNIT    |
|--|--|--|------|------|-----|---------|
| VOD  | Output differential voltage amplitude                                | Measured with c(0)=31 setting (Reg_0x3D[6:0]=0x1F, Reg_0x3E[6:0]=0x40, REG_0x3F[6:0]=0x40). Differential measurement using an 8T pattern (eight 1s followed by eight 0s) at 25.78125 Gbps with TXPn and TXNn terminated by 50 Ohms to GND. |      | 1225 |     | mVppd   |
| VOD <sub>idle</sub>                                  | Differential output amplitude with TX disabled                       |  |      | < 11 |     | mVppd   |
| VOD <sub>res</sub>                                   | Output VOD resolution  | Difference in VOD between two adjacent c(0) settings. Applies to VOD in the 525mVppd to 1225mVppd range [c(0)>4].  |      | < 50 |     | mVppd   |
| V <sub>cm-TX-AC</sub>                                | Common-mode AC output noise  | With respect to signal ground. Measured with PRBS9 data pattern. Measured with a 33GHz (-3dB) low-pass filter.   |      | 6.5  |     | mV, RMS |
| t <sub>r</sub> , t <sub>f</sub>                      | Output transition time   | 20%-to-80% rise time and 80%-to-20% fall time on a clock-like {11111 00000} data pattern at 25.78125 Gbps. Measured for ~800 mVppd output amplitude and no equalization: Reg_0x3D=+13, Reg_0x3E=0, REG_0x3F=0                              |      | 17   |     | ps      |
| RL <sub>SDD22</sub>                                  | Differential output return loss, SDD22 <sup>(4)</sup>                | Between 50 MHz and 5 GHz   |      | <-14 |     | dB      |
|  |  | Between 5 GHz and 12.9 GHz   |      | <-13 |     | dB      |
| RL <sub>SCD22</sub>                                  | Common-mode to differential output return loss, SCD22 <sup>(4)</sup> | Between 50 MHz and 12.9 GHz  |      | <-22 |     | dB      |
| RL <sub>SDC22</sub>                                  | Differential-to-common-mode output return loss, SDC22 <sup>(4)</sup> | Between 50 MHz and 12.9 GHz  |      | <-22 |     | dB      |
| RL <sub>SCC22</sub>                                  | Common-mode output return loss, SCC22 <sup>(4)</sup>                 | Between 50 MHz and 10 GHz  |      | <-9  |     | dB      |
|  |  | Between 10 GHz and 12.9 GHz  |      | <-12 |     | dB      |
| <b>SMBus ELECTRICAL CHARACTERISTICS (SLAVE MODE)</b> |  |  |      |      |     |         |
| V <sub>IH</sub>                                      | Input high-level voltage   | SDA and SDC  | 1.75 |      | 3.6 | V       |
| V <sub>IL</sub>                                      | Input low-level voltage  | SDA and SDC  | GND  |      | 0.8 | V       |
| C <sub>IN</sub>                                      | Input pin capacitance  |  |      | 15   |     | pF      |
| V <sub>OL</sub>                                      | Low-level output voltage   | SDA or SDC, IOL = 1.25 mA  |      |      | 0.4 | V       |
| I <sub>IN</sub>                                      | Input current  | SDA or SDC, VINPOT = VIN, VDD, GND   | -15  |      | 15  | μA      |
| T <sub>R</sub>                                       | SDA rise time, read operation  | Pull-up resistor = 1 kΩ, C <sub>b</sub> = 50pF   |      | 150  |     | ns      |
| T <sub>F</sub>                                       | SDA fall time, read operation  | Pull-up resistor = 1 kΩ, C <sub>b</sub> = 50pF   |      | 4.5  |     | ns      |

(4) Measured with an evaluation board which uses microstrip traces and low-loss dielectric with approximately 3 dB insertion loss at 12.9 GHz between the DS250DF410 and the measurement instrument.

## 7.6 Timing Requirements, Retimer Jitter Specifications

over operating free-air temperature range (unless otherwise noted)

| PARAMETER             |   | TEST CONDITIONS  | MIN | TYP  | MAX | UNIT                     |
|-----------------------|---|--|-----|------|-----|--------------------------|
| J <sub>TJ</sub>       | Output total jitter (TJ)  | Measured at 25.78125 Gbps to a probability level of 1E-12 with PRBS11 data pattern an evaluation board traces de-embedded.   |     | 0.17 |     | U <sub>Ipp</sub> @ 1E-12 |
| J <sub>RJ</sub>       | Output random Jitter (RJ)   | Measured at 25.78125 Gbps to a probability level of 1E-12 with PRBS11 data pattern an evaluation board traces de-embedded  |     | 6    |     | mUI RMS                  |
| J <sub>DCD</sub>      | Output duty cycle distortion (DCD)  | Measured at 25.78125 Gbps to a probability level of 1E-12 with PRBS11 data pattern an evaluation board traces de-embedded  |     | 4    |     | mUI <sub>pp</sub>        |
| J <sub>PEAK</sub>     | Jitter peaking  | Measured at 10.3125 Gbps with PRBS7 data pattern. Peaking frequency in the range of 1 to 6 MHz.  |     | 0.8  |     | dB                       |
| J <sub>PEAK</sub>     | Jitter peaking  | Measured at 25.78125 Gbps with PRBS7 data pattern. Peaking frequency in the range of 1 to 17 MHz.  |     | 0.4  |     | dB                       |
| BW <sub>PLL</sub>     | PLL bandwidth   | Data rate of 10.3125Gbps with PRBS7 pattern  |     | 5.3  |     | MHz                      |
| BW <sub>PLL</sub>     | PLL bandwidth   | Data rate of 25.78125Gbps with PRBS7 pattern   |     | 5.5  |     | MHz                      |
| J <sub>TOL</sub>      | Input jitter tolerance  | Measured at 25.78125 Gbps with SJ frequency = 190 KHz, 30dB input channel loss, PRBS31 data pattern, 800 mVppd launch amplitude, and 0.078 U <sub>Ipp</sub> total uncorrelated output jitter in addition to the applied SJ. BER < 1E-12. |     | 9    |     | U <sub>Ipp</sub>         |
| J <sub>TOL</sub>      | Input jitter tolerance  | Measured at 25.78125 Gbps with SJ frequency = 940 KHz, 30dB input channel loss, PRBS31 data pattern, 800 mVppd launch amplitude, and 0.078 U <sub>Ipp</sub> total uncorrelated output jitter in addition to the applied SJ. BER < 1E-12. |     | 1    |     | U <sub>Ipp</sub>         |
| J <sub>TOL</sub>      | Input jitter tolerance  | Measured at 25.78125 Gbps with SJ frequency > 15MHz, 30dB input channel loss, PRBS31 data pattern, 800 mVppd launch amplitude, and 0.078 U <sub>Ipp</sub> total uncorrelated output jitter in addition to the applied SJ. BER < 1E-12.   |     | 0.3  |     | U <sub>Ipp</sub>         |
| TEMP <sub>LOCK-</sub> | CDR stay-in-lock ambient temperature range, negative ramp. Maximum temperature change below initial CDR lock acquisition temperature. | 85 °C starting ambient temperature, ramp rate -3 °C/minute, 1.7 liters/sec airflow, 12 layer PCB.  |     | 115  |     | °C                       |
| TEMP <sub>LOCK+</sub> | CDR stay-in-lock ambient temperature range, positive ramp. Maximum temperature change above initial CDR lock acquisition temperature. | -40 °C starting ambient temperature, ramp rate +3 °C/minute, 1.7 liters/sec airflow, 12 layer PCB.   |     | 125  |     | °C                       |

### 7.7 Timing Requirements, Retimer Specifications

over operating free-air temperature range (unless otherwise noted)

| PARAMETER         |   | TEST CONDITIONS   | MIN | TYP           | MAX | UNIT |
|-------------------|---|---|-----|---------------|-----|------|
| t <sub>D</sub>    | Input-to-output latency (propagation delay) through a channel | No crosspoint; CDR enabled and locked.  |     | 3.5UI + 125ps |     | ps   |
|                   |   | Crosspoint enabled; CDR enabled and locked.   |     | 3.5UI + 145ps |     | ps   |
|                   |   | No crosspoint; CDR in raw (bypass) mode.  |     | < 145         |     | ps   |
| t <sub>SK</sub>   | Channel-to-channel interpair skew                             | Latency difference between channels at full-rate. 25.78125 Gbps data rate.                          |     | < 30          |     | ps   |
| t <sub>lock</sub> | CDR lock acquisition time                                     | Measured at 25.78125 Gbps, Adapt Mode = 1 (Reg_0x31[6:5]=0x1), EOM timer = 0x5 (Reg_0x2A[7:4]=0x5). |     | < 100         |     | ms   |
| t <sub>lock</sub> | CDR lock acquisition time                                     | Measured at 10.3125 Gbps, Adapt Mode = 1 (Reg_0x31[6:5]=0x1), EOM timer = 0x5 (Reg_0x2A[7:4]=0x5).  |     | < 100         |     | ms   |

### 7.8 Timing Requirements, Recommended Calibration Clock Specifications

over operating free-air temperature range (unless otherwise noted)

| PARAMETER          |  | TEST CONDITIONS  | MIN  | TYP | MAX | UNIT |
|--------------------|--|--|------|-----|-----|------|
| CLK <sub>f</sub>   | Calibration clock frequency  |  |      | 25  |     | MHz  |
| CLK <sub>PPM</sub> | Calibration clock PPM tolerance  |  | -100 |     | 100 | PPM  |
| CLK <sub>IDC</sub> | Recommended/tolerable input duty cycle                                 |  | 40%  | 50% | 60% |      |
| CLK <sub>ODC</sub> | Intrinsic calibration clock duty cycle distortion                      | Intrinsic duty cycle distortion of chip calibration clock output at the CAL_CLK_OUT pin, assuming 50% duty cycle on CAL_CLK_IN pin.                                      | 45%  |     | 55% |      |
| CLK <sub>num</sub> | Number of devices which can be cascaded from CAL_CLK_OUT to CAL_CLK_IN | Assumes worst-case 60%/40% input duty cycle on the first device. CAL_CLK_OUT from first device connects to CAL_CLK_IN of second device, and so on until the last device. |      | 20  |     | N/A  |

### 7.9 Recommended SMBus Switching Characteristics (Slave Mode)

over operating free-air temperature range (unless otherwise noted)

| PARAMETER           |                     | TEST CONDITIONS | MIN | TYP  | MAX | UNIT |
|---------------------|---------------------|-----------------|-----|------|-----|------|
| f <sub>SDC</sub>    | SDC clock frequency |                 | 10  | 100  | 400 | kHz  |
| t <sub>HD-DAT</sub> | Data hold time      |                 |     | 0.75 |     | ns   |
| t <sub>SU-DAT</sub> | Data setup time     |                 |     | 100  |     | ns   |

## 7.10 Recommended SMBus Switching Characteristics (Master Mode)

over operating free-air temperature range (unless otherwise noted)

| PARAMETER    |                                  | TEST CONDITIONS                 | MIN  | TYP  | MAX  | UNIT    |
|--------------|----------------------------------|---------------------------------|------|------|------|---------|
| $f_{SDC}$    | SDC clock frequency              |                                 | 260  | 303  | 346  | kHz     |
| $T_{LOW}$    | SDC low period                   |                                 | 1.66 | 1.90 | 2.21 | $\mu$ s |
| $T_{HIGH}$   | SDC high period                  |                                 | 1.22 | 1.40 | 1.63 | $\mu$ s |
| $T_{HD-STA}$ | Hold time start operation        |                                 |      | 0.6  |      | $\mu$ s |
| $T_{SU-STA}$ | Setup time start operation       |                                 |      | 0.6  |      | $\mu$ s |
| $T_{HD-DAT}$ | Data hold time                   |                                 |      | 0.6  |      | $\mu$ s |
| $T_{SD-DAT}$ | Data setup time                  |                                 |      | 0.1  |      | $\mu$ s |
| $T_{SU-STO}$ | Stop condition setup time        |                                 |      | 0.6  |      | $\mu$ s |
| $T_{BUF}$    | Bus free time between Stop-Start |                                 |      | 1.3  |      | $\mu$ s |
| $T_R$        | SDC rise time                    | Pull-up resistor = 1 k $\Omega$ |      | 300  |      | ns      |
| $T_F$        | SDC fall time                    | Pull-up resistor = 1 k $\Omega$ |      | 300  |      | ns      |

## 7.11 Recommended JTAG Switching Characteristics

over operating free-air temperature range (unless otherwise noted)

| PARAMETER |                            | TEST CONDITIONS | MIN | TYP | MAX | UNIT |
|-----------|----------------------------|-----------------|-----|-----|-----|------|
| $t_{TCK}$ | TCK clock period           |                 | 100 |     |     | ns   |
| $t_{SU}$  | TDI, TMS setup time to TCK |                 |     | 50  |     | ns   |
| $t_{HD}$  | TDI, TMS hold time to TCK  |                 |     | 50  |     | ns   |
| $t_{DLY}$ | TCK falling edge to TDO    |                 |     | 50  |     | ns   |

## 7.12 Typical Characteristics

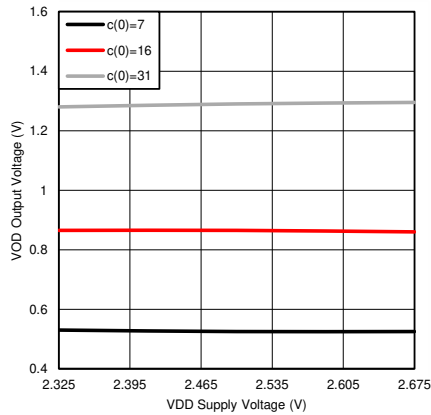


Figure 1. Typical VOD vs Supply Voltage

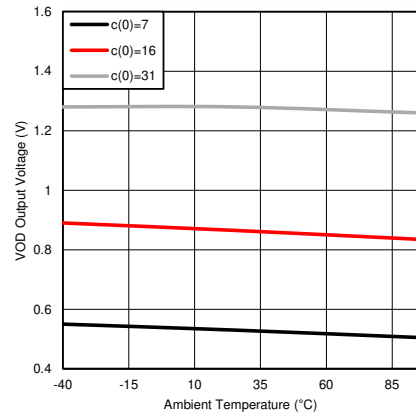


Figure 2. Typical VOD vs Temperature

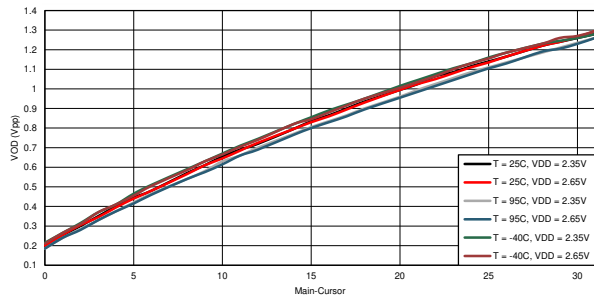


Figure 3. Typical VOD vs FIR Main-Cursor

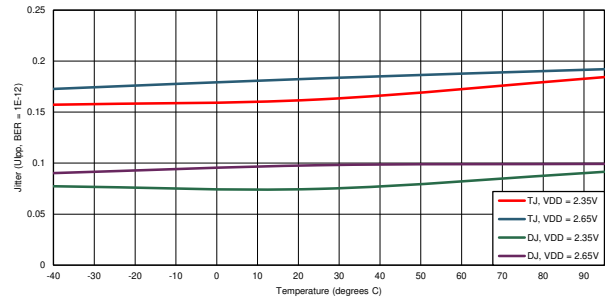
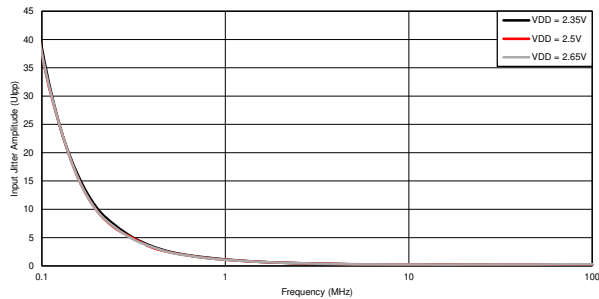
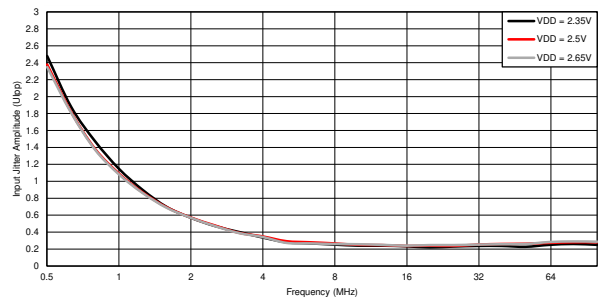


Figure 4. Typical Output Jitter vs Temperature at 25.78125 Gbps



0.1 MHz to 100 MHz  
T = 25°C  
Input Random Jitter = 0.078 UIpp

Figure 5. Typical Sinusoidal Input Jitter Tolerance for 30-dB Channel at 25.78125 Gbps



0.5 MHz to 100 MHz  
T = 25°C  
Input Random Jitter = 0.078 UIpp

Figure 6. Typical Input Jitter Tolerance for 30-dB Channel at 25.78125 Gbps



## 8 Detailed Description

### 8.1 Overview

The DS250DF410 is a four-channel multi-rate retimer with integrated signal conditioning. Each of the four channels operates independently. Each channel includes a continuous-time linear equalizer (CTLE) and a Decision Feedback Equalizer (DFE), which together compensate for the presence of a dispersive transmission channel between the source transmitter and the DS250DF410 receiver. The CTLE and DFE are self-adaptive.

Each channel includes an independent voltage-controlled oscillator (VCO) and phase-locked loop (PLL) which produce a clean clock that is frequency-locked to the clock embedded in the input data stream. The high-frequency jitter on the incoming data is attenuated by the PLL, producing a clean clock with substantially-reduced jitter. This clean clock is used to re-time the incoming data, removing high-frequency jitter from the data stream and reproducing the data on the output with significantly-reduced jitter.

Each channel of the DS250DF410 features an output driver with adjustable differential output voltage and output equalization in the form of a three-tap finite impulse response (FIR) filter. The output FIR compensates for dispersion in the transmission channel at the output of the DS250DF410.

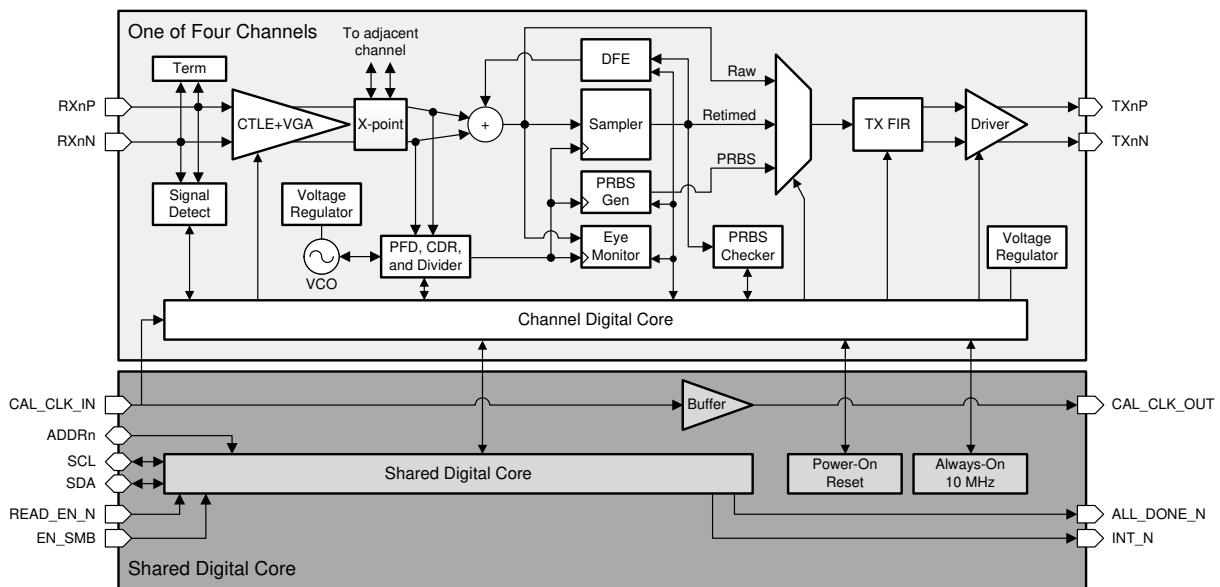
Between each group of two adjacent channels (e.g. between channels 0 and 1, 2 and 3) is a full 2x2 cross-point switch. This allows multiplexing and de-multiplexing/fanout applications for fail-over redundancy, as well as cross-over applications to aid PCB routing.

Each channel also includes diagnostic features such as a Pseudo Random Bit Sequence (PRBS) pattern generator and checker, as well as a non-destructive eye opening monitor (EOM). The EOM can be used to plot the post-equalized eye at the input to the decision slicer or simply to read the horizontal eye opening (HEO) and vertical eye opening (VEO).

The DS250DF410 is configurable through a single SMBus port. The DS250DF410 can also act as an SMBus master to configure itself from an EEPROM. Up to sixteen DS250DF410 devices can share a single SMBus.

The sections which follow describe the functionality of various circuits and features within the DS250DF410. For more information about how to program or operate these features, consult the DS250DF410 Programming Guide.

### 8.2 Functional Block Diagram



## 8.3 Feature Description

### 8.3.1 Device Data Path Operation

The DS250DF410 data path consists of several key blocks as shown in the functional block diagram. These key circuits are:

- *Signal Detect*
- *Continuous Time Linear Equalizer (CTLE)*
- *Variable Gain Amplifier (VGA)*
- *Cross-Point Switch*
- *Decision Feedback Equalizer (DFE)*
- *Clock and Data Recovery (CDR)*
- *Calibration Clock*
- *Differential Driver with FIR Filter*

### 8.3.2 Signal Detect

The DS250DF410 receiver contains a signal detect circuit. The signal detect circuit monitors the energy level on the receiver inputs and powers on or off the rest of the high-speed data path if a signal is detected or not. By default, each channel allows the signal detect circuit to automatically power on or off the rest of the high speed data path depending on the presence of an input signal. The signal detect block can be manually controlled in the SMBus channel registers. This can be useful if it is desired to manually force channels to be disabled. For information on how to manually operate the signal detect circuit refer to the DS250DF410 Programming Guide.

### 8.3.3 Continuous Time Linear Equalizer (CTLE)

The CTLE in the DS250DF410 is a fully-adaptive equalizer. The CTLE adapts according to a Figure of Merit (FOM) calculation during the lock acquisition process. The FOM calculation is based upon the horizontal eye opening (HEO) and vertical eye opening (VEO). Once the CDR locks and the CTLE adapts, the CTLE boost level is frozen until a manual re-adapt command is issued or until the CDR re-enters the lock acquisition state. The CTLE can be re-adapted by resetting the CDR.

The CTLE consists of 4 stages, with each stage having 2-bit boost control. This allows for 256 different boost combinations. The CTLE adaption algorithm allows the CTLE to adapt through 16 of these boost combinations. These 16 boost combinations comprise the EQ Table in the channel registers. See channel registers 0x40 through 0x4F. This EQ Table can be reprogrammed to support up to 16 of the 256 boost settings.

The boost levels can be set between 8 dB and 25 dB (at 12.89 GHz.)

### 8.3.4 Variable Gain Amplifier (VGA)

The DS250DF410 receiver implements a VGA. The VGA assists in the recovery of extremely small signals, working in conjunction with the CTLE to equalize and scale amplitude. The VGA has 1-bit control via Reg\_0x8E[0], and the VGA is in the low-gain state (Reg\_0x8E[0]=0) by default. In addition to the VGA, the CTLE implements its own gain control via Reg\_0x13[5] to adjust the DC amplitude similar to the VGA. For more information on how to configure the VGA and EQ gain, refer to the DS250DF410 Programming Guide.

### 8.3.5 Cross-Point Switch

Each group of two adjacent channels in the DS250DF410 has a 2x2 cross-point that may be enabled to implement a 2-to-1 mux, a 1-to-2 fanout, or an A-to-B/B-to-A lane cross. A cross-point exists between the following channel pairs:

- Channel 0 and Channel 1
- Channel 2 and Channel 3

## Feature Description (continued)

### 8.3.6 Decision Feedback Equalizer (DFE)

A 5-tap DFE can be enabled within the data path of each channel to assist with reducing the effects of crosstalk, reflections, or post cursor inter-symbol interference (ISI). The DFE must be manually enabled, regardless of the selected adapt mode. Once the DFE has been enabled it can be configured to adapt only during lock acquisition or to adapt continuously. The DFE can also be manually configured to specified tap polarities and tap weights. However, when the DFE is configured manually the DFE auto-adaptation should be disabled. For many applications with lower insertion loss (i.e. < 30 dB) lower crosstalk, and/or lower reflections, part or all of the DFE can be disabled to reduce power consumption. The DFE can either be fully enabled (taps 1-5), partially enabled (taps 1-2 only), or fully disabled (no taps).

The DFE taps are all feedback taps with 1UI spacing. Each tap has a specified boost weight range and polarity bit.

**表 1. DFE Tap Weights**

| DFE PARAMETER        | DECIMAL (REGISTER VALUE)   | VALUE (mV) (TYP) |
|----------------------|--|------------------|
| Tap 1 Weight Range   | 0 - 31   | 0 – 217          |
| Tap 2-5 Weight Range | 0 - 15   | 0 – 105          |
| Tap Weight Step Size | NA   | 7                |
| Polarity             | 0: (+) positive; feedback value creates a low-pass filter response, thus providing attenuation to correct for negative-sign post-cursor ISI<br>1: (-) negative; Feedback value creates a high-pass filter response, thus providing boost to correct for positive-sign post-cursor ISI. |                  |

### 8.3.7 Clock and Data Recovery (CDR)

The CDR consists of a Phase Locked Loop (PLL), PPM counter, and Input and Output Data Multiplexers (mux) allowing for retimed data, un-retimed data, PRBS generator and output muted modes.

By default, the equalized data is fed into the CDR for clock and data recovery. The recovered data is then output to the FIR filter and differential driver together with the recovered clock which has been cleaned of any high-frequency jitter outside the bandwidth of the CDR clock recovery loop. The bandwidth of the CDR defaults to 5.5 MHz (typ) in full-rate (divide-by-1) mode and 5.3 MHz (typ) in sub-rate mode. The CDR bandwidth is adjustable. Refer to the DS250DF410 Programming Guide for more information on adjusting the CDR bandwidth. Users can configure the CDR data to route the recovered clock and data to the PRBS checker. Users also have the option of configuring the output of the CDR to send raw non-retimed data, or data from the pattern generator.

The CDR requires the following to be properly configured:

- 25 MHz calibration clock to run the PPM counter (CAL\_CLK\_IN).
- Expected data rates must be programmed into the CDR either through the rate table or entered manually with the corrected divider settings. Refer to the Programming Guide for more information on configuring the CDR for different data rates.

### 8.3.8 Calibration Clock

The calibration clock is not part of the CDR's PLL and thus is not used for clock and data recovery. The calibration clock is connected only to the PPM counter for each CDR. The PPM counter constrains the allowable lock ranges of the CDR according to the programmed values in the rate table or the manually entered data rates. The host should provide an input calibration clock signal of 25 MHz frequency. Because this clock is not used for clock and data recovery, there are no stringent jitter requirements placed on this 25 MHz calibration clock.

### 8.3.9 Differential Driver with FIR Filter

The DS250DF410 output driver has a three-tap finite impulse response (FIR) filter which allows for pre- and post-cursor equalization to compensate for a wide variety of output channel media. The filter consists of a weighted sum of three consecutive retimed bits as shown in the following diagram. C[0] can take on values in the range [-31, +31]. C[-1] and C[+1] can take on values in the range [-15, 15].

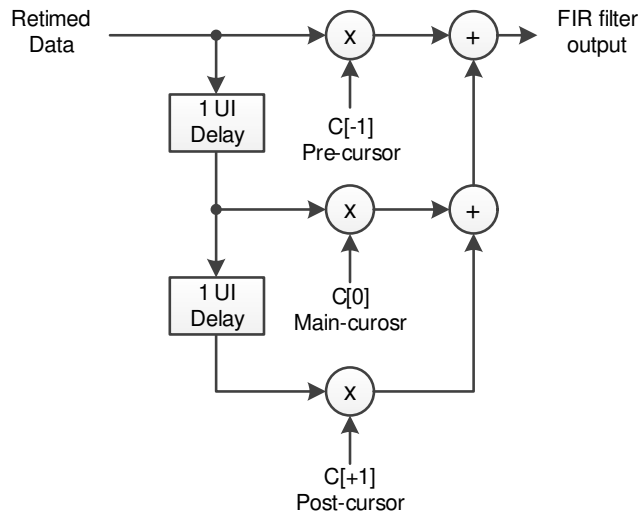


Fig 7. FIR Filter Functional model

When utilizing the FIR filter, it is important to abide by the following general rules:

- $|C[-1]| + |C[0]| + |C[+1]| \leq 31$ ; the FIR tap coefficients absolute sum must be less or equal to 31
- $\text{sgn}(C[-1]) = \text{sgn}(C[+1]) \neq \text{sgn}(C[0])$ , for high-pass filter effect; the sign for the pre-cursor and/or post-cursor tap must be different from main-cursor tap to realize boost effect
- $\text{sgn}(C[-1]) = \text{sgn}(C[+1]) = \text{sgn}(C[0])$ , for low-pass filter effect; the sign for the pre-cursor and/or post-cursor tap must be equal to the main-cursor tap to realize attenuation effect

The FIR filter is used to pre-distort the transmitted waveform to compensate for frequency-dependant loss in the output channel. The most common way of pre-distorting the signal is to accentuate the transitions and de-emphasize the non-transitions. The bit before a transition is accentuated via the pre-cursor tap, and the bit after the transition is accentuated via the post-cursor tap. The figures below give a conceptual illustration of how the FIR filter affects the output waveform. The following characteristics can be derived from the example waveforms.

- $VOD_{pk-pk} = V_7 - V_8$
- $VOD_{low-frequency} = V_2 - V_5$
- $Rpre_{dB} = 20 * \log_{10} (v_3/v_2)$
- $Rpst_{dB} = 20 * \log_{10} (v_1/v_2)$

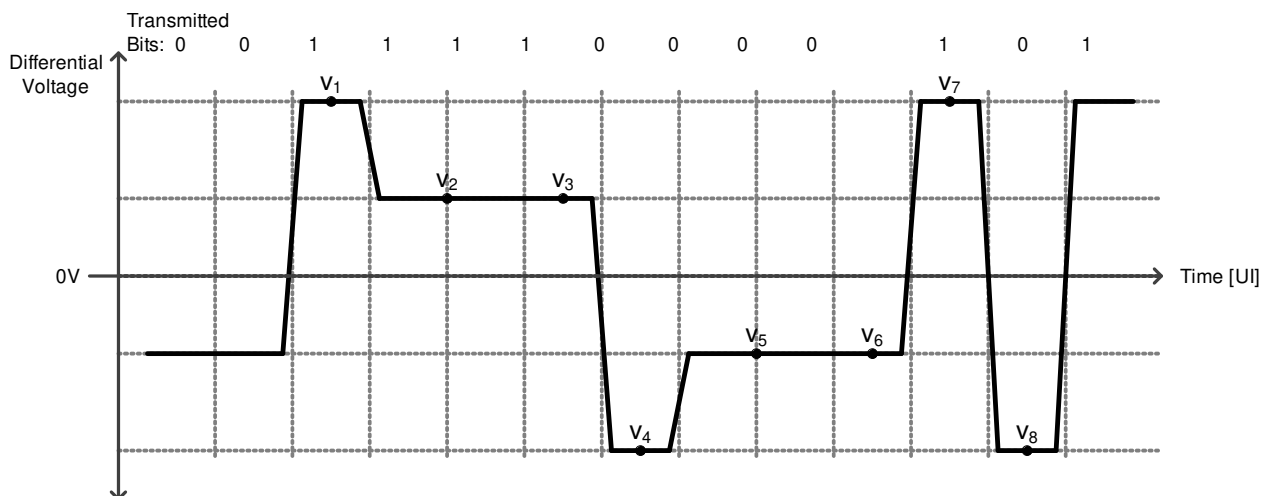


Fig 8. Conceptual FIR Waveform With Post-Cursor Only

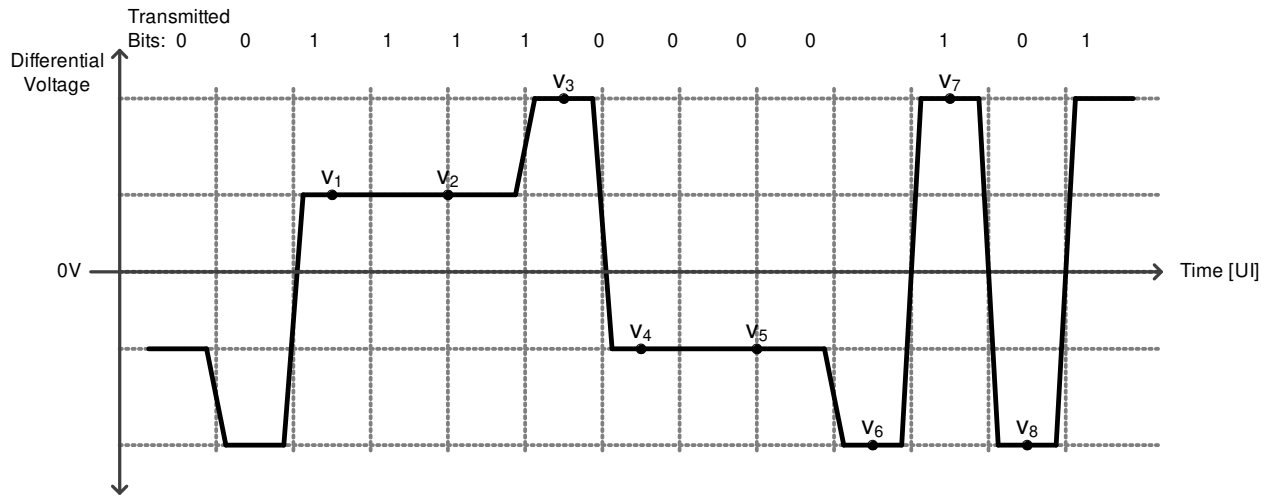


Figure 9. Conceptual FIR Waveform With Pre-Cursor Only

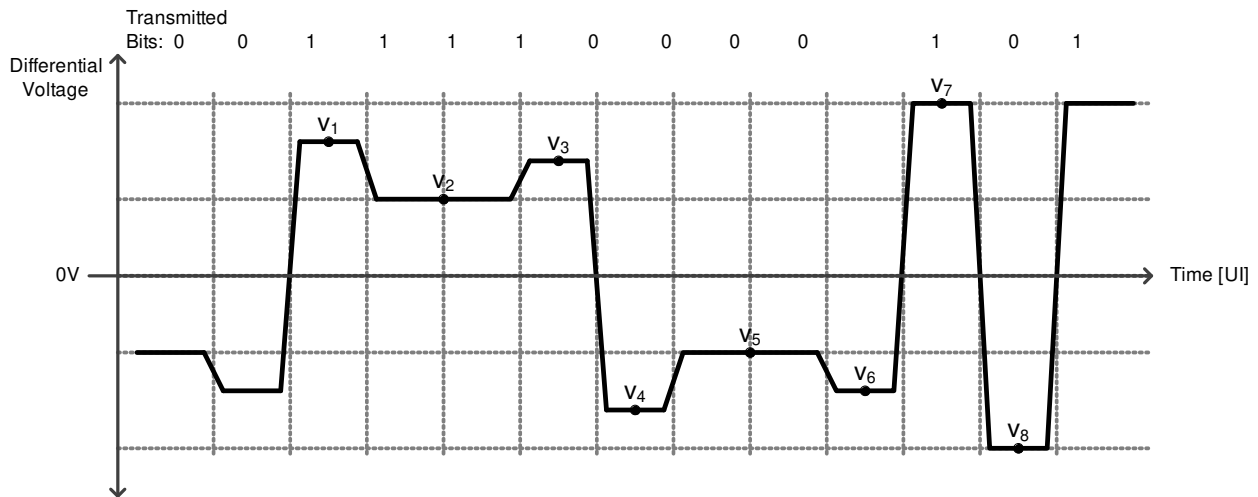


Figure 10. Conceptual FIR Waveform With Both Pre- and Post-Cursor

### 8.3.9.1 Setting the Output $V_{OD}$ , Pre-Cursor, and Post-Cursor Equalization

The output differential voltage ( $V_{OD}$ ), pre-cursor, and post-cursor equalization of the driver is controlled by manipulating the FIR tap settings. The main cursor tap is the primary knob for amplitude adjustment. The pre- and post-cursor FIR tap settings can then be adjusted to provide equalization. To maintain a constant peak-to-peak  $V_{OD}$ , the user should adjust the main cursor tap value relative to the pre- and post-cursor tap changes so as to maintain a constant absolute sum of the FIR tap values. The table below shows various settings for  $V_{OD}$  settings ranging from 205 mVpp to 1225 mVpp (typical). Note that the output peak-to-peak amplitude is a function of the sum of the absolute values of the taps, whereas the low-frequency amplitude is purely a function of the main-cursor value.

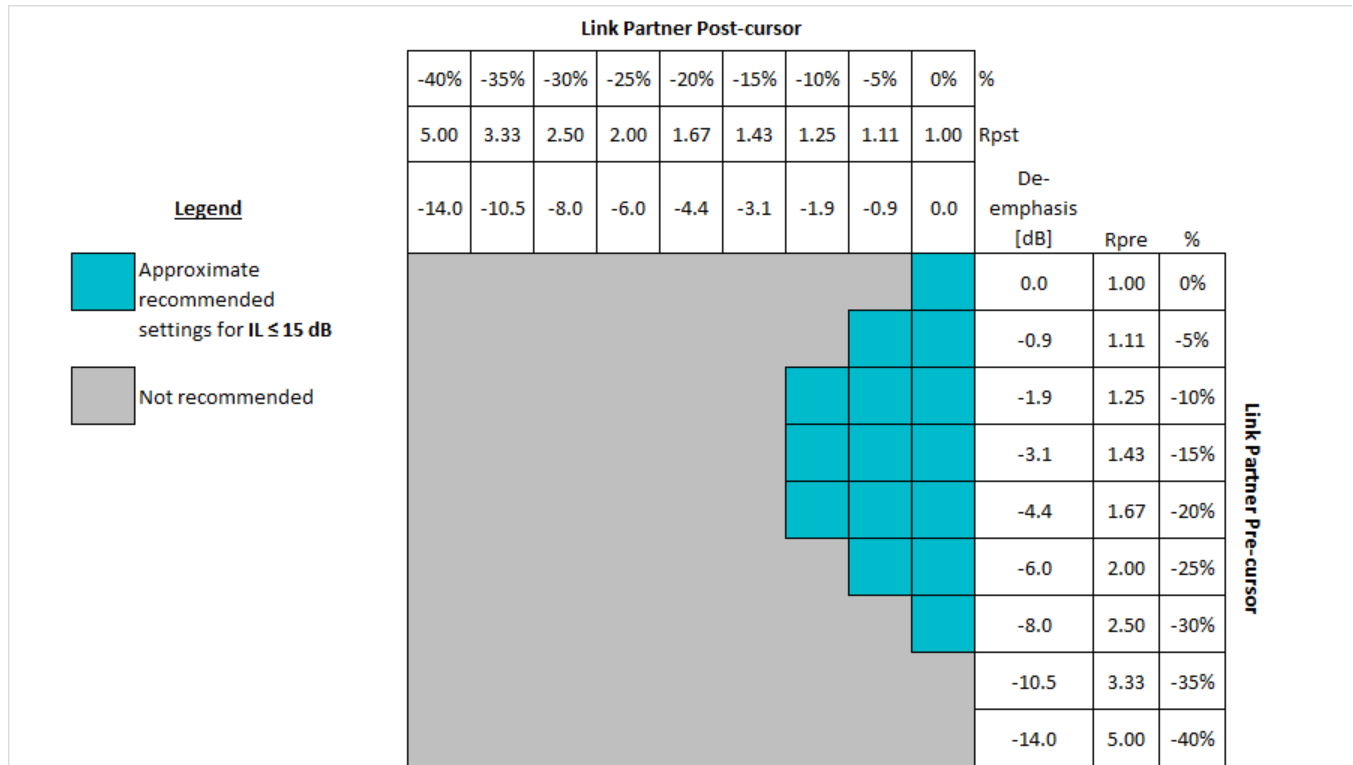
**表 2. Typical VOD and FIR Values**

| FIR SETTINGS                 |                               |                               | Peak-to Peak<br>VOD(V) | RPRE(dB) | RPST(dB) |
|------------------------------|-------------------------------|-------------------------------|------------------------|----------|----------|
| PRE-CURSOR:<br>REG_0x3E[6:0] | MAIN-CURSOR:<br>REG_0x3D[6:0] | POST-CURSOR:<br>REG_0x3F[6:0] |                        |          |          |
| 0                            | 0                             | 0                             | 0.205                  | NA       | NA       |
| 0                            | +1                            | 0                             | 0.260                  | NA       | NA       |
| 0                            | +2                            | 0                             | 0.305                  | NA       | NA       |
| 0                            | +3                            | 0                             | 0.355                  | NA       | NA       |
| 0                            | +4                            | 0                             | 0.395                  | NA       | NA       |
| 0                            | +5                            | 0                             | 0.440                  | NA       | NA       |
| 0                            | +6                            | 0                             | 0.490                  | NA       | NA       |
| 0                            | +7                            | 0                             | 0.525                  | NA       | NA       |
| 0                            | +8                            | 0                             | 0.565                  | NA       | NA       |
| 0                            | +9                            | 0                             | 0.610                  | NA       | NA       |
| 0                            | +10                           | 0                             | 0.650                  | NA       | NA       |
| 0                            | +11                           | 0                             | 0.685                  | NA       | NA       |
| 0                            | +12                           | 0                             | 0.720                  | NA       | NA       |
| 0                            | +13                           | 0                             | 0.760                  | NA       | NA       |
| 0                            | +14                           | 0                             | 0.790                  | NA       | NA       |
| 0                            | +15                           | 0                             | 0.825                  | NA       | NA       |
| 0                            | +16                           | 0                             | 0.860                  | NA       | NA       |
| 0                            | +17                           | 0                             | 0.890                  | NA       | NA       |
| 0                            | +18                           | 0                             | 0.925                  | NA       | NA       |
| 0                            | +19                           | 0                             | 0.960                  | NA       | NA       |
| 0                            | +20                           | 0                             | 0.985                  | NA       | NA       |
| 0                            | +21                           | 0                             | 1.010                  | NA       | NA       |
| 0                            | +22                           | 0                             | 1.040                  | NA       | NA       |
| 0                            | +23                           | 0                             | 1.075                  | NA       | NA       |
| 0                            | +24                           | 0                             | 1.095                  | NA       | NA       |
| 0                            | +25                           | 0                             | 1.125                  | NA       | NA       |
| 0                            | +26                           | 0                             | 1.150                  | NA       | NA       |
| 0                            | +27                           | 0                             | 1.165                  | NA       | NA       |
| 0                            | +28                           | 0                             | 1.190                  | NA       | NA       |
| 0                            | +29                           | 0                             | 1.205                  | NA       | NA       |
| 0                            | +30                           | 0                             | 1.220                  | NA       | NA       |
| 0                            | +31                           | 0                             | 1.225                  | NA       | NA       |
| 0                            | +18                           | -1                            | 0.960                  | NA       | 2.1      |
| 0                            | +17                           | -2                            | 0.960                  | NA       | 2.5      |
| 0                            | +16                           | -3                            | 0.960                  | NA       | 3.1      |
| 0                            | +15                           | -4                            | 0.960                  | NA       | 3.8      |
| 0                            | +14                           | -5                            | 0.960                  | NA       | 4.7      |
| 0                            | +13                           | -6                            | 0.960                  | NA       | 5.8      |
| 0                            | +12                           | -7                            | 0.960                  | NA       | 7.2      |
| 0                            | +11                           | -8                            | 0.960                  | NA       | 9.0      |
| 0                            | +10                           | -9                            | 0.960                  | NA       | 11.6     |
| -1                           | 18                            | 0                             | 0.960                  | 1.0      | NA       |
| -2                           | 17                            | 0                             | 0.960                  | 1.6      | NA       |
| -3                           | 16                            | 0                             | 0.960                  | 2.4      | NA       |
| -4                           | 15                            | 0                             | 0.960                  | 3.3      | NA       |
| 0                            | 26                            | -1                            | 1.165                  | NA       | 1.1      |

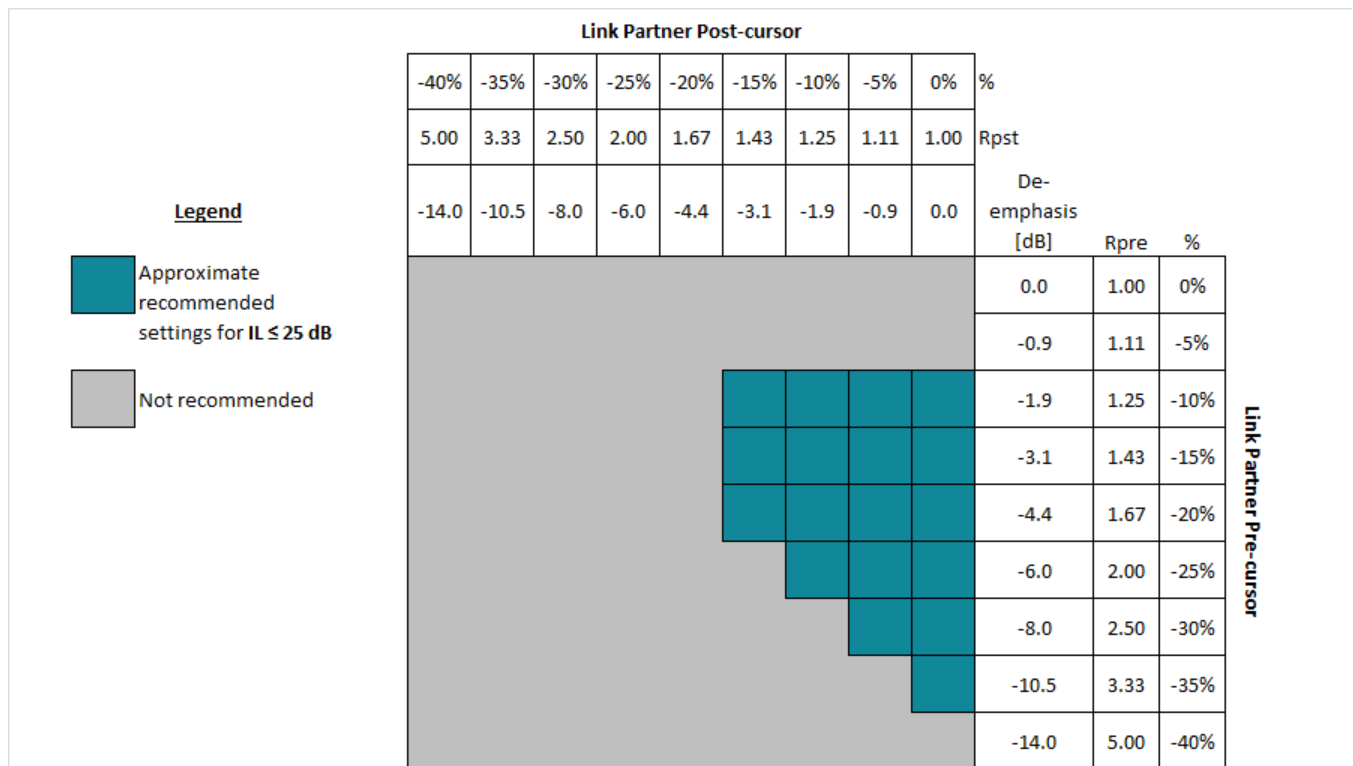
**表 2. Typical VOD and FIR Values (continued)**

| FIR SETTINGS                 |                               |                               | Peak-to Peak<br>VOD(V) | RPRE(dB) | RPST(dB) |
|------------------------------|-------------------------------|-------------------------------|------------------------|----------|----------|
| PRE-CURSOR:<br>REG_0x3E[6:0] | MAIN-CURSOR:<br>REG_0x3D[6:0] | POST-CURSOR:<br>REG_0x3F[6:0] |                        |          |          |
| 0                            | 25                            | -2                            | 1.165                  | NA       | 1.3      |
| 0                            | 24                            | -3                            | 1.165                  | NA       | 1.8      |
| 0                            | 23                            | -4                            | 1.165                  | NA       | 2.2      |
| 0                            | 22                            | -5                            | 1.165                  | NA       | 2.7      |
| 0                            | 21                            | -6                            | 1.165                  | NA       | 3.3      |
| 0                            | 20                            | -7                            | 1.165                  | NA       | 3.9      |
| 0                            | 19                            | -8                            | 1.165                  | NA       | 4.7      |
| 0                            | 18                            | -9                            | 1.165                  | NA       | 5.7      |
| 0                            | 17                            | -10                           | 1.165                  | NA       | 6.9      |
| 0                            | 16                            | -11                           | 1.165                  | NA       | 8.4      |
| 0                            | 15                            | -12                           | 1.165                  | NA       | 10.1     |
| -1                           | 26                            | 0                             | 1.165                  | 0.7      | NA       |
| -2                           | 25                            | 0                             | 1.165                  | 1.2      | NA       |
| -3                           | 24                            | 0                             | 1.165                  | 1.5      | NA       |
| -4                           | 23                            | 0                             | 1.165                  | 2.0      | NA       |
| -5                           | 22                            | 0                             | 1.165                  | 2.6      | NA       |
| -6                           | 21                            | 0                             | 1.165                  | 3.2      | NA       |
| -7                           | 20                            | 0                             | 1.165                  | 4.0      | NA       |

The recommended pre-cursor and post-cursor settings for a given channel will depend on the channel characteristics (mainly insertion loss) as well as the equalization capabilities of the downstream receiver. The DS250DF410 receiver, with its highly-capable CTLE and DFE, does not require a significant amount of pre- or post-cursor. The figures below give general recommendations for pre- and post-cursor for different channel loss conditions. The insertion loss (IL) in these plots refers to the total loss between the link partner transmitter and the DS250DF410 receiver.

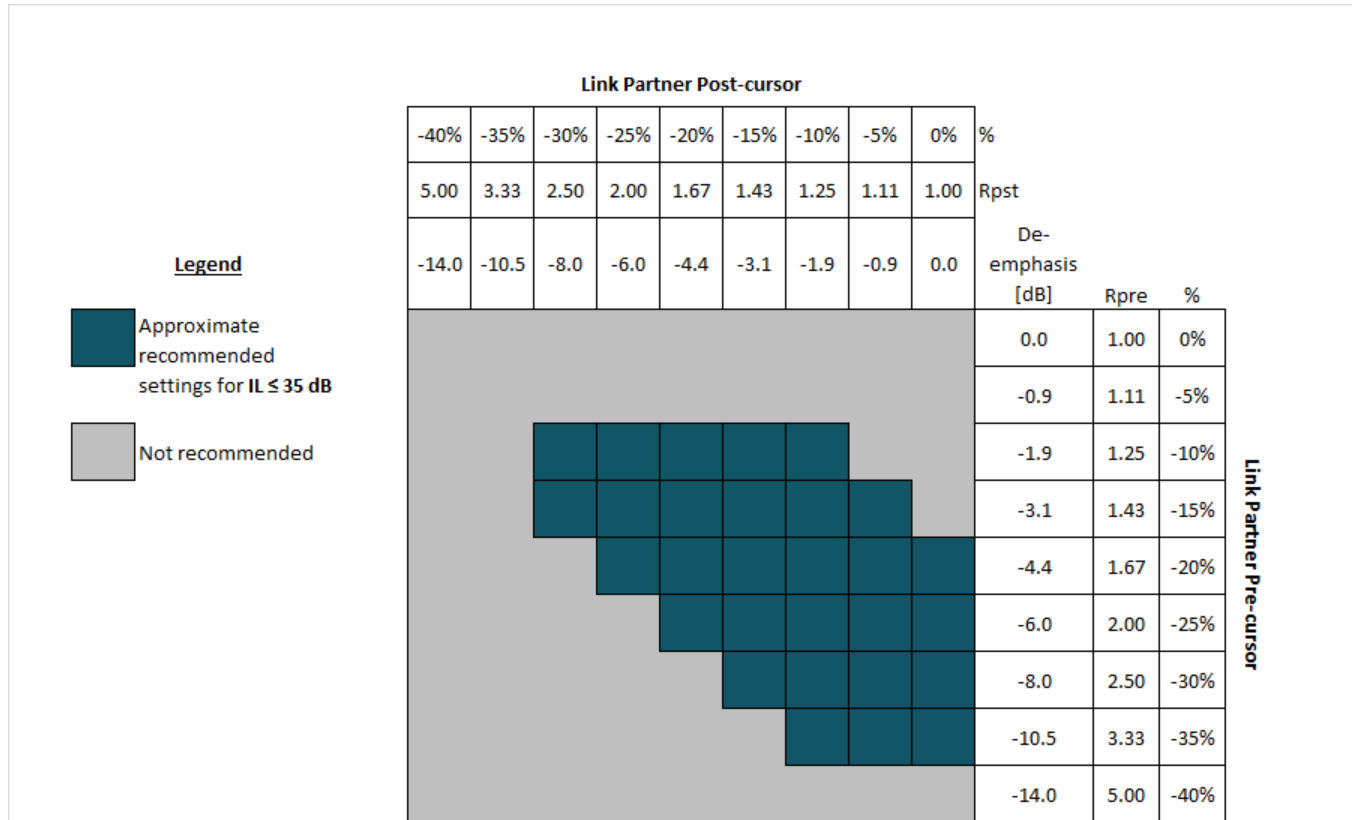


**Figure 11. Guideline for Link Partner FIR Settings When IL ≤ 15 dB**



**Figure 12. Guideline for Link Partner FIR Settings When IL ≤ 25 dB**





13. Guideline for Link Partner FIR Settings When IL ≤ 35 dB

### 8.3.9.2 Output Driver Polarity Inversion

In some applications, it may be necessary to invert the polarity of the data transmitted from the retimer. To invert the polarity of the data, read back the FIR polarity settings for the pre, main and post cursor taps and then invert these bits.

### 8.3.10 Debug Features

#### 8.3.10.1 Pattern Generator

Each channel in the DS250DF410 can be configured to generate a 16-bit user-defined data pattern or a pseudo random bit sequence (PRBS). The user defined pattern can also be set to automatically invert every other 16-bit symbol for DC balancing purposes. The DS250DF410 pattern generator supports the following PRBS sequences:

- PRBS –  $2^7 - 1$
- PRBS –  $2^9 - 1$
- PRBS –  $2^{11} - 1$
- PRBS –  $2^{15} - 1$
- PRBS –  $2^{23} - 1$
- PRBS –  $2^{31} - 1$
- PRBS –  $2^{58} - 1$
- PRBS –  $2^{63} - 1$

### 8.3.10.2 Pattern Checker

The pattern checker can be manually set to look for specific PRBS sequences and polarities or it can be set to automatically detect the incoming pattern and polarity. The PRBS checker supports the same set of PRBS patterns as the PRBS generator.

The pattern checker consists of an 11-bit error counter. The pattern checker uses 32-bit words, but every bit in the word is checked for error, so the error count represents the count of single bit errors.

To read out the bit and error counters, the pattern checker must first be frozen. Continuous operation with simultaneous read out of the bit and error counters is not supported in this implementation. Once the bit and error counter is read, they can be un-frozen to continue counting.

### 8.3.10.3 Eye Opening Monitor

The DS250DF410's Eye Opening Monitor (EOM) measures the internal data eye at the input of the decision slicer and can be used for 2 functions:

1. Horizontal Eye Opening (HEO) and Vertical Eye Opening (VEO) measurement
2. Full Eye Diagram Capture

The HEO measurement is made at the 0V crossing and is read in channel register 0x27. The VEO measurement is made at the 0.5 UI mark and is read in channel register 0x28. The HEO and VEO registers can be read from channel registers 0x27 and 0x28 at any time while the CDR is locked. The following equations are used to convert the contents of channel registers 0x27 and 0x28 into their appropriate units:

- $\text{HEO [UI]} = \text{Reg\_0x27} \div 32$
- $\text{VEO [mV]} = \text{Reg\_0x28} \times 3.125$

A full eye diagram capture can be performed when the CDR is locked. The eye diagram is constructed within a 64 x 64 array, where each cell in the matrix consists of an 16-bit word representing the total number of hits recorded at that particular phase and voltage offset. Users can manually adjust the vertical scaling of the EOM or allow the state machine to control the scaling which is the default option. The horizontal scaling controlled by the state machine and is always directly proportional to the data rate.

When a full eye diagram plot is captured, the retimer will shift out four 16-bit words of residual data that should be discarded followed by 4096 16-bit words that make up the 64 x 64 eye plot. The first actual word of the eye plot from the retimer is for (X, Y) position (0,0), which is the earliest position in time and the most negative position in voltage. Each time the eye plot data is read out the voltage position is incremented. Once the voltage position has incremented to position 63 (the most positive voltage), the next read will cause the voltage position to reset to 0 (the most negative voltage) and the phase position to increment. This process will continue until the entire 64 x 64 matrix is read out. [Figure 14](#) below shows the EOM read out sequence overlaid on top of a simple eye opening plot. In this plot any hits are shown in green. This type of plot is helpful for quickly visualizing the HEO and VEO. Users can apply different algorithms to the output data to plot density or color gradients to the output data.

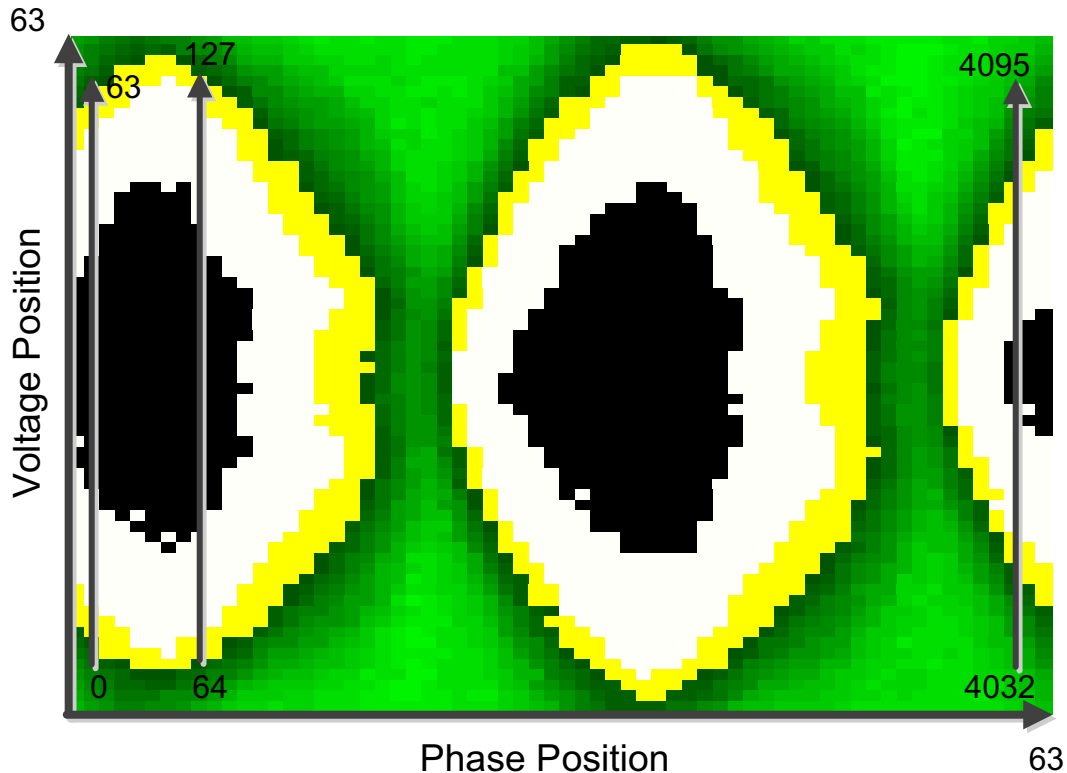


图 14. EOM Full Eye Capture Readout

To manually control the EOM vertical range, remove scaling control from the state machine then select the desired range:

Channel Reg 0x2C[6] → 0 (see 表 3).

表 3. Eye Opening Monitor Vertical Range Settings

| CH REG 0x11[7:6] VALUE | EOM VERTICAL RANGE [mV] |
|------------------------|-------------------------|
| 2'b00                  | ±100                    |
| 2'b01                  | ±200                    |
| 2'b10                  | ±300                    |
| 2'b11                  | ±400                    |

The EOM operates as an under-sampled circuit. This allows the EOM to be useful in identifying over equalization, ringing and other gross signal conditioning issues. However, the EOM cannot be correlated to a bit error rate.

The EOM can be accessed in two ways to read out the entire eye plot:

- Multi-byte reads can be used such that data is repeatedly latched out from channel register 0x25.
- With single byte reads, the MSB are located in register 0x25 and the LSB are located in register 0x26. In this mode, the device must be addressed each time a new byte is read.

To perform a full eye capture with the EOM, follow these steps below within the desired channel register set:

表 4. Eye Opening Monitor Full Eye Capture Instructions

| STEP | REGISTER [bits] | Operation | VALUE | DESCRIPTION                        |
|------|-----------------|-----------|-------|------------------------------------|
| 1    | 0x67[5]         | Write     | 0     | Disable lock EOM lock monitoring   |
| 2    | 0x2C[6]         | Write     | 0     | Set the desired EOM vertical range |
|      | 0x11[7:6]       | Write     | 2'b-- |                                    |

**表 4. Eye Opening Monitor Full Eye Capture Instructions (continued)**

| STEP | REGISTER [bits] | Operation | VALUE | DESCRIPTION  |
|------|-----------------|-----------|-------|--|
| 3    | 0x11[5]         | Write     | 0     | Power on the EOM   |
| 4    | 0x24[7]         | Write     | 1     | Enable fast EOM  |
| 5    | 0x24[0]         | Read      | 1     | Begin read out of the 64 x 64 array, discard first 4 words<br>Ch reg 0x24[0] is self-clearing. |
|      | 0x25            |           |       | 0x25 is the MSB of the 16-bit word   |
|      | 0x26            |           |       | 0x26 is the LSB of the 16-bit word   |
| 6    | 0x25            | Read      |       | Continue reading information until the 64 x 64 array is complete.                              |
|      | 0x26            |           |       |  |
| 7    | 0x67[5]         | Write     | 1     | Return the EOM to its original state. Undo steps 1-4   |
|      | 0x2C[6]         | Write     | 1     |  |
|      | 0x11[5]         | Write     | 1     |  |
|      | 0x24[7]         | Write     | 0     |  |

### 8.3.11 Interrupt Signals

The DS250DF410 can be configured to report different events as interrupt signals. These interrupt signals do not impact the operation of the device, but merely report that the selected event has occurred. The interrupt bits in the register sets are all sticky bits. This means that when an event triggers an interrupt the status bit for that interrupt is set to logic HIGH. This interrupt status bit will remain at logic HIGH until the bit has been read. Once the bit has been read it will be automatically cleared, which allows for new interrupts to be detected. The DS250DF410 will report the occurrence of an interrupt through the INT\_N pin. The INT\_N pin is an open drain output that will pull the line low when an interrupt signal is triggered.

Note that all available interrupts are disabled by default. Users must activate the various interrupts before they can be used.

The interrupts available in the DS250DF410 are:

- CDR loss of lock
- CDR locked
- Signal detect loss
- Signal detected
- PRBS pattern checker bit error detected
- HEO/VEO threshold violation

When an interrupt occurs, share register 0x08 reports which channel generated the interrupt request. Users can then select the channel(s) that generated the interrupt request and service the interrupt by reading the appropriate interrupt status bits in the corresponding channel registers. For more information on reading interrupt status, refer to the DS250DF410 Programming Guide.

### 8.3.12 JTAG Boundary Scan

The DS250DF410 supports JTAG and AC-JTAG boundary scan to facilitate in-system manufacturing tests. JTAG mode is enabled with the EN\_SMB as shown in 表 5. Refer to the DS250DF410 Product Folder for the boundary scan description language (BSDL) file for the DS250DF410.

**表 5. JTAG Mode pins**

| PIN                  |     | INTERNAL PULL-UP / PULL-DOWN | JTAG MODE FUNCTIONALITY (EN_SMB = 1 kΩ to GND) |
|----------------------|-----|------------------------------|--|
| NAME                 | NO. |                              |  |
| CAL_CLK_IN/JTAG_TDI  | F1  | Weak pull-up                 | JTAG Test Data In (TDI)                        |
| CAL_CLK_OUT/JTAG_TDO | F11 | None                         | JTAG Test Data Out (TDO)                       |
| ADDR1/JTAG_TRS       | D1  | Weak pull-up                 | JTAG Test Rset (TRS)                           |
| TEST0/JTAG_TCK       | D10 | None                         | JTAG Test Clock (TCK)                          |
| TES1/JTAG_TMS        | D2  | Weak pull-up                 | JTAG Test Mode Select (TMS)                    |

## 8.4 Device Functional Modes

### 8.4.1 Supported Data Rates

The DS250DF410 supports a wide range of input data rates, including divide-by-2 and divide-by-4 sub-rates. The supported data rates are listed in 表 6. Refer to the DS250DF410 Programming Guide for information on configuring the DS250DF410 for different data rates.

表 6. Supported Data Rates

| DATA RATE RANGE |             | DIVIDER | CDR MODE | COMMENT   |
|-----------------|-------------|---------|----------|---|
| MIN             | MAX         |         |          |   |
| ≥ 20.6 Gbps     | ≤ 25.8 Gbps | 1       | Enabled  |   |
| ≥ 10.3 Gbps     | ≤ 12.9 Gbps | 2       | Enabled  |   |
| > 6.45 Gbps     | < 10.3 Gbps | N/A     | Disabled | Output jitter will be higher with CDR disabled. |
| ≥ 5.15 Gbps     | ≤ 6.45 Gbps | 4       | Enabled  |   |
| ≥ 1.25 Gbps     | < 5.15 Gbps | N/A     | Disabled | Output jitter will be higher with CDR disabled. |

### 8.4.2 SMBus Master Mode

SMBus master mode allows the DS250DF410 to program itself by reading directly from an external EEPROM. When using the SMBus master mode, the DS250DF410 will read directly from specific location in the external EEPROM. When designing a system for using the external EEPROM, the user needs to follow these specific guidelines:

- Maximum EEPROM size is 2048 Bytes
- Minimum EEPROM size for a single DS250DF410 with individual channel configuration is 305 Bytes (3 base header bytes + 12 address map bytes + 4 × 72 channel register bytes + 2 share register bytes; bytes are defined to be 8-bits)
- Set ENSMB = Float, for SMBus master mode
- The external EEPROM device address byte must be 0xA0
- The external EEPROM device must support 400kHz operation at 2.5-V or 3.3-V supply
- Set the SMBus address of the DS250DF410 by configuring the ADDR0 and ADDR1 pins

When loading multiple DS250DF410 devices from the same EEPROM, use these guidelines to configure the devices:

- Configure the SMBus addresses for each DS250DF410 to be sequential. The first device in the sequence must have an address of 0x30
- Daisy chain READ\_EN\_N and ALL\_DONE\_N from one device to the next device in the sequence so that they do not compete for the EEPROM at the same time.
- If all of the DS250DF410 devices share the same EEPROM channel and share register settings, configure the common channel bit in the base header to 1. With common channel configuration enabled, each DS250DF410 device will configure all 4 channels with the same settings.

When loading a single DS250DF410 from an EEPROM, use these guidelines to configure the device:

- Set the common channel bit to 0 to allow for individual channel configuration, or set the common channel bit to 1 to load the same configuration settings to all channels.
- When configuring individual channels, a 512, 1024 or 2048 Byte EEPROM must be used.
- If there are more than three DS250DF410 devices on a PCB that require individual channel configuration, then each device must have its own EEPROM.

### 8.4.3 Device SMBus Address

The DS250DF410's SMBus slave address is strapped at power up using the ADDR[1:0] pins. The pin state is read on power up, after the internal power-on reset signal is de-asserted. The ADDR[1:0] pins are four-level LVCMOS IOs, which provides for 16 unique SMBus addresses. The four levels are achieved by pin strap options as follows:

- 0: 1 kΩ to GND
- R: 10 kΩ to GND (20 kΩ also acceptable)
- F: Float
- 1: 1 kΩ to VDD

**表 7. SMBus Address Map**

| 8-BIT WRITE ADDRESS [HEX] | REQUIRED ADDRESS PIN STRAP VALUE |       |
|---------------------------|----------------------------------|-------|
|                           | ADDR1                            | ADDR0 |
| 0x30                      | 0                                | 0     |
| 0x32                      | 0                                | R     |
| 0x34                      | 0                                | F     |
| 0x36                      | 0                                | 1     |
| 0x38                      | R                                | 0     |
| 0x3A                      | R                                | R     |
| 0x3C                      | R                                | F     |
| 0x3E                      | R                                | 1     |
| 0x40                      | F                                | 0     |
| 0x42                      | F                                | R     |
| 0x44                      | F                                | F     |
| 0x46                      | F                                | 1     |
| 0x48                      | 1                                | 0     |
| 0x4A                      | 1                                | R     |
| 0x4C                      | 1                                | F     |
| 0x4E                      | 1                                | 1     |

## 8.5 Programming

### 8.5.1 Bit Fields in the Register Set

Many of the registers in the DS250DF410 are divided into bit fields. This allows a single register to serve multiple purposes which may be unrelated. Often, configuring the DS250DF410 requires writing a bit field that makes up only part of a register value while leaving the remainder of the register value unchanged. The procedure for accomplishing this task is to read in the current value of the register to be written, modify only the desired bits in this value, and write the modified value back to the register. Of course, if the entire register is to be changed, rather than just a bit field within the register, it is not necessary to read in the current value of the register first. In all register configuration procedures described in the following sections, this procedure should be kept in mind. In some cases, the entire register is to be modified. When only a part of the register is to be changed, however, the procedure described above should be used.

Most register bits can be read or written to. However, some register bits are constrained to specific interface instructions.

Register bits can have the following interface constraints:

- R - Read only
- RW - Read/Write
- RWSC - Read/Write, self-clearing

## Programming (continued)

### 8.5.2 Writing to and Reading from the Global/Shared/Channel Registers

The DS250DF410 has 3 types of registers:

- 1) Global Registers – These registers can be accessed at any time and are used to select individual channel registers, the shared registers or to read back the TI ID and version information.
- 2) Shared Registers – These registers are used for device-level configuration, status read back or control.
- 3) Channel Registers – These registers are used to control and configure specific features for each individual channel. All channels have the same channel register set and can be configured independent of each other.

The global registers can be accessed at any time, regardless of whether the shared or channel register set is selected. The DS250DF410 global registers are located on addresses 0xEF-0xFF. The function of the global registers falls into the following categories:

- Channel selection and share enabling – Registers 0xFC and 0xFF
- Device and version information – Registers 0xEF-0xF3
- Reserved/unused registers – all other addresses

Register 0xFC is used to select the channel registers to be written to. To select a channel, write a 1 to its corresponding bit in register 0xFC. Note that more than one channel may be written to by setting multiple bits in register 0xFC. However, when performing an SMBus read transaction only one channel can be selected at a time. If multiple channels are selected in register 0xFC when attempting to perform an SMBus read, the device will return 0xFF.

Register 0xFF bit 1 can be used to perform broadcast register writes to all channels. A single channel read-modify broadcast write type commands can be accomplished by setting register 0xFF to 0x03 and selecting a single channel in register 0xFC. This type of configuration allows for the reading of a single channel's register information and then writing to all channels with the modified value. Register 0xFF bit 0 is used to select the shared register page or the channel register page for the channels selected in register 0xFC.

TI repeaters/retimers have a vendor ID register (0xFE) which will always read back 0x03. In addition, there are three device ID registers (0xF0, 0xF1, and 0xF3). These are useful to verify that there is a good SMBus connection between the SMBus master and the DS250DF410.

## 8.6 Register Maps

**Table 8. Global Registers**

| ADDRESS (HEX) | BITS | DEFAULT VALUE (HEX) | MODE | EEPROM | FIELD NAME        | DESCRIPTION  |
|---------------|------|---------------------|------|--------|-------------------|--|
| EF            | 7    | 0                   | R    | N      | SPARE             |  |
|               | 6    | 0                   | R    | N      | SPARE             |  |
|               | 5    | 0                   | R    | N      | SPARE             |  |
|               | 4    | 0                   | R    | N      | SPARE             |  |
|               | 3    | 1                   | R    | N      | CHAN_CONFIG_ID[3] | TI device ID (Quad count).<br>DS250DF810: 0x0C<br>DS250DF410: 0x0E |
|               | 2    | 1                   | R    | N      | CHAN_CONFIG_ID[2] |  |
|               | 1    | 1                   | R    | N      | CHAN_CONFIG_ID[1] |  |
|               | 0    | 0                   | R    | N      | CHAN_CONFIG_ID[0] |  |
| F0            | 7    | 0                   | R    | N      | VERSION[7]        | Version ID   |
|               | 6    | 0                   | R    | N      | VERSION[6]        |  |
|               | 5    | 1                   | R    | N      | VERSION[5]        |  |
|               | 4    | 1                   | R    | N      | VERSION[4]        |  |
|               | 3    | 0                   | R    | N      | VERSION[3]        |  |
|               | 2    | 0                   | R    | N      | VERSION[2]        |  |
|               | 1    | 1                   | R    | N      | VERSION[1]        |  |
|               | 0    | 0                   | R    | N      | VERSION[0]        |  |
| F1            | 7    | 0                   | R    | N      | DEVICE_ID[7]      | Full device ID   |
|               | 6    | 0                   | R    | N      | DEVICE_ID[6]      |  |
|               | 5    | 0                   | R    | N      | DEVICE_ID[5]      |  |
|               | 4    | 1                   | R    | N      | DEVICE_ID[4]      |  |
|               | 3    | 0                   | R    | N      | DEVICE_ID[3]      |  |
|               | 2    | 0                   | R    | N      | DEVICE_ID[2]      |  |
|               | 1    | 0                   | R    | N      | DEVICE_ID[1]      |  |
|               | 0    | 0                   | R    | N      | DEVICE_ID[0]      |  |
| F3            | 7    | 0                   | R    | N      | CHAN_VERSION[3]   | Digital Channel Version  |
|               | 6    | 0                   | R    | N      | CHAN_VERSION[2]   |  |
|               | 5    | 0                   | R    | N      | CHAN_VERSION[1]   |  |
|               | 4    | 0                   | R    | N      | CHAN_VERSION[0]   |  |
|               | 3    | 0                   | R    | N      | SHARE_VERSION[3]  | Digital Share Version  |
|               | 2    | 0                   | R    | N      | SHARE_VERSION[2]  |  |
|               | 1    | 0                   | R    | N      | SHARE_VERSION[1]  |  |
|               | 0    | 0                   | R    | N      | SHARE_VERSION[0]  |  |
| FB            | 7    | 0                   | RW   | N      | RESERVED          | RESERVED   |
|               | 6    | 0                   | RW   | N      | RESERVED          | RESERVED   |
|               | 5    | 0                   | RW   | N      | RESERVED          | RESERVED   |
|               | 4    | 0                   | RW   | N      | RESERVED          | RESERVED   |
|               | 3    | 0                   | RW   | N      | RESERVED          | RESERVED   |
|               | 2    | 1                   | RW   | N      | RESERVED          | RESERVED   |
|               | 1    | 0                   | RW   | N      | RESERVED          | RESERVED   |
|               | 0    | 0                   | RW   | N      | RESERVED          | RESERVED   |
| FC            | 7    | 0                   | RW   | N      | EN_CH7            | Select channel 7 (DS250DF810 only)                                 |
|               | 6    | 0                   | RW   | N      | EN_CH6            | Select channel 6 (DS250DF810 only)                                 |
|               | 5    | 0                   | RW   | N      | EN_CH5            | Select channel 5 (DS250DF810 only)                                 |
|               | 4    | 0                   | RW   | N      | EN_CH4            | Select channel 4 (DS250DF810 only)                                 |



**Register Maps (continued)**
**Table 8. Global Registers (continued)**

| ADDRESS (HEX) | BITS | DEFAULT VALUE (HEX) | MODE | EEPROM | FIELD NAME   | DESCRIPTION  |
|---------------|------|---------------------|------|--------|--------------|--|
|               | 3    | 0                   | RW   | N      | EN_CH3       | Select channel 3   |
|               | 2    | 0                   | RW   | N      | EN_CH2       | Select channel 2   |
|               | 1    | 0                   | RW   | N      | EN_CH1       | Select channel 1   |
|               | 0    | 0                   | RW   | N      | EN_CH0       | Select channel 0   |
| FD            | 7    | 0                   | RW   | N      | RESERVED     | RESERVED   |
|               | 6    | 0                   | RW   | N      | RESERVED     | RESERVED   |
|               | 5    | 0                   | RW   | N      | RESERVED     | RESERVED   |
|               | 4    | 0                   | RW   | N      | RESERVED     | RESERVED   |
|               | 3    | 0                   | RW   | N      | RESERVED     | RESERVED   |
|               | 2    | 0                   | RW   | N      | RESERVED     | RESERVED   |
|               | 1    | 0                   | RW   | N      | RESERVED     | RESERVED   |
|               | 0    | 0                   | RW   | N      | RESERVED     | RESERVED   |
| FE            | 7    | 0                   | R    | N      | VENDOR_ID[7] | TI vendor ID   |
|               | 6    | 0                   | R    | N      | VENDOR_ID[6] |  |
|               | 5    | 0                   | R    | N      | VENDOR_ID[5] |  |
|               | 4    | 0                   | R    | N      | VENDOR_ID[4] |  |
|               | 3    | 0                   | R    | N      | VENDOR_ID[3] |  |
|               | 2    | 0                   | R    | N      | VENDOR_ID[2] |  |
|               | 1    | 1                   | R    | N      | VENDOR_ID[1] |  |
|               | 0    | 1                   | R    | N      | VENDOR_ID[0] |  |
| FF            | 7    | 0                   | RW   | N      | RESERVED     | RESERVED   |
|               | 6    | 0                   | RW   | N      | RESERVED     | RESERVED   |
|               | 5    | 1                   | RW   | N      | EN_SHARE_Q1  | Select shared registers for quad 1 (DS250DF810 only)   |
|               | 4    | 0                   | RW   | N      | EN_SHARE_Q0  | Select shared registers for quad 0   |
|               | 3    | 0                   | RW   | N      | RESERVED     | RESERVED   |
|               | 2    | 0                   | RW   | N      | RESERVED     | RESERVED   |
|               | 1    | 0                   | RW   | N      | WRITE_ALL_CH | Allows user to write to all channels as if they are the same, but only allows read back from the channel specified in 0xFC.<br>Note: EN_CH_SMB must be = 1 or else this function is invalid. |
|               | 0    | 0                   | RW   | N      | EN_CH_SMB    | 1: Enables SMBUS access to the channels specified in Reg_0xFC<br>0: The shared registers are selected  |

**Table 9. Shared Registers**

| ADDRESS (HEX) | BITS | DEFAULT VALUE (HEX) | MODE | EEPROM   | FIELD NAME          | DESCRIPTION   |
|---------------|------|---------------------|------|----------|---------------------|---|
| 00            | 7    | 1                   | R    | N        | SMBUS_ADDR[3]       | SMBus Address<br>Strapped 7-bit address is 0x18 + SMBus_Addr[3:0]   |
|               | 6    | 1                   | R    | N        | SMBUS_ADDR[2]       |   |
|               | 5    | 0                   | R    | N        | SMBUS_ADDR[1]       |   |
|               | 4    | 0                   | R    | N        | SMBUS_ADDR[0]       |   |
|               | 3:0  | 0                   | R    | N        | RESERVED            | RESERVED  |
| 01            | 7    | 1                   | R    | N        | RESERVED            | RESERVED  |
|               | 6    | 0                   | R    | N        | RESERVED            | RESERVED  |
|               | 5    | 1                   | R    | N        | RESERVED            | RESERVED  |
|               | 4    | 1                   | R    | N        | RESERVED            | RESERVED  |
|               | 3    | 0                   | R    | N        | RESERVED            | RESERVED  |
|               | 2    | 0                   | R    | N        | RESERVED            | RESERVED  |
|               | 1    | 0                   | R    | N        | RESERVED            | RESERVED  |
| 0             | 1    | R                   | N    | RESERVED | RESERVED            |   |
| 02            | 7:0  | 0                   | RW   | N        | RESERVED            | RESERVED  |
| 03            | 7:0  | 0                   | RW   | N        | RESERVED            | RESERVED  |
| 04            | 7    | 0                   | RW   | N        | RESERVED            | RESERVED  |
|               | 6    | 0                   | RWSC | N        | RST_I2C_REGS        | 1: Reset shared registers. This bit is self-clearing.<br>0: Normal operation  |
|               | 5    | 0                   | RWSC | N        | RST_I2C_MAS         | 1: Reset for SMBus/I2C Master. This bit is self-clearing.<br>0: Normal operation  |
|               | 4    | 0                   | RW   | N        | FRC_EEPRM_RD        | 1: Force EEPROM Configuration<br>0: Normal operation  |
|               | 3    | 1                   | RW   | Y        | RESERVED            | RESERVED  |
|               | 2    | 0                   | RW   | N        | RESERVED            | RESERVED  |
|               | 1    | 0                   | RW   | N        | RESERVED            | RESERVED  |
|               | 0    | 1                   | RW   | N        | RESERVED            | RESERVED  |
| 05            | 7    | 0                   | RW   | N        | DISAB_EEPRM_CFG     | 1: Disable Master Mode EEPROM configuration (if not started; this bit is not effective if EEPROM configuration is already started)<br>0: Normal operation                                 |
|               | 6:5  | 0                   | RW   | N        | RESERVED            | RESERVED  |
|               | 4    | 1                   | R    | N        | EEPROM_READ_DONE    | 1: SMBus Master mode EEPROM read complete<br>0: SMBus Master mode EEPROM read not started or not complete   |
|               | 3    | 0                   | RW   | N        | TEST0_AS_CAL_CLK_IN | 1: Use TEST0 as the input for the 25MHz CAL_CLK instead of CAL_CLK_IN. This must be configured for quad0 only.<br>0: Normal operation. Use CAL_CLK_IN as the input for the 25MHz CAL_CLK. |
|               | 2    | 0                   | RW   | Y        | CAL_CLK_INV_DIS     | 1: Disable the inversion of CAL_CLK_OUT<br>0: Normal operation. CAL_CLK_OUT is inverted with respect to CAL_CLK_IN.   |
|               | 1    | 0                   | RW   | Y        | RESERVED            | RESERVED  |
| 0             | 1    | RW                  | Y    | RESERVED | RESERVED            |   |

**Table 9. Shared Registers (continued)**

| ADDRESS (HEX) | BITS | DEFAULT VALUE (HEX) | MODE | EEPROM | FIELD NAME        | DESCRIPTION  |
|---------------|------|---------------------|------|--------|-------------------|--|
| 06            | 7:0  | 0                   | RW   | N      | RESERVED          | RESERVED   |
| 08            | 7    | 0                   | R    | N      | RESERVED          | RESERVED   |
|               | 6    | 0                   | R    | N      | RESERVED          | RESERVED   |
|               | 5    | 0                   | R    | N      | RESERVED          | RESERVED   |
|               | 4    | 0                   | R    | N      | RESERVED          | RESERVED   |
|               | 3    | 0                   | R    | N      | INT_Q0C3          | Interrupt from channel 3. For DS250DF810, this applies to the quad selected by Reg_0xFF[5:4].                                      |
|               | 2    | 0                   | R    | N      | INT_Q0C2          | Interrupt from channel 2. For DS250DF810, this applies to the quad selected by Reg_0xFF[5:4].                                      |
|               | 1    | 0                   | R    | N      | INT_Q0C1          | Interrupt from channel 1. For DS250DF810, this applies to the quad selected by Reg_0xFF[5:4].                                      |
|               | 0    | 0                   | R    | N      | INT_Q0C0          | Interrupt from channel 0. For DS250DF810, this applies to the quad selected by Reg_0xFF[5:4].                                      |
| 0A            | 7:1  | 0                   | R    | Y      | RESERVED          | RESERVED   |
|               | 0    | 0                   | RW   | Y      | DIS_REFCLK_OUT    | 1: Disable CAL_CLK_OUT (high-Z)<br>0: Normal operation. Enable CAL_CLK_OUT   |
| 0B            | 7    | 0                   | RW   | N      | RESERVED          | RESERVED   |
|               | 6    | 0                   | R    | N      | REFCLK_DET        | 1: 25MHz clock detected on CAL_CLK_IN<br>0: No clock detected on CAL_CLK_IN  |
|               | 5    | 0                   | RW   | N      | RESERVED          | RESERVED   |
|               | 4    | 0                   | RW   | N      | RESERVED          | RESERVED   |
|               | 3    | 0                   | RW   | N      | MR_REFCLK_DET_DIS | 0: CAL_CLK_IN detection and status reporting enabled (default)<br>1: CAL_CLK_IN detection disabled                                 |
|               | 2    | 0                   | RW   | N      | RESERVED          | RESERVED   |
|               | 1    | 0                   | RW   | N      | RESERVED          | RESERVED   |
|               | 0    | 0                   | RW   | N      | RESERVED          | RESERVED   |
| 0C            | 7:0  | 0                   | RW   | N      | RESERVED          | RESERVED   |
| 0D            | 7:0  | 0                   | R    | N      | RESERVED          | RESERVED   |
| 0E            | 7:2  | 0                   | RW   | N      | RESERVED          | RESERVED   |
|               | 1:0  | 0                   | R    | N      | RESERVED          | RESERVED   |
| 0F            | 7:0  | 0                   | RW   | N      | RESERVED          | RESERVED   |
| 10            | 7    | 1                   | RW   | N      | RESERVED          | RESERVED   |
|               | 6    | 1                   | RW   | N      | RESERVED          | RESERVED   |
|               | 5    | 1                   | RW   | N      | RESERVED          | RESERVED   |
|               | 4    | 1                   | RW   | N      | RESERVED          | RESERVED   |
|               | 3    | 1                   | RW   | Y      | RESERVED          | RESERVED   |
|               | 2    | 1                   | RW   | Y      | RESERVED          | RESERVED   |
|               | 1    | 1                   | RW   | Y      | RESERVED          | RESERVED   |
|               | 0    | 1                   | RW   | Y      | RESERVED          | RESERVED   |
| 11            | 7    | 0                   | R    | N      | EECFG_CMPLT       | 11: Not valid<br>10: EEPROM load completed successfully<br>01: EEPROM load failed after 64 attempts<br>00: EEPROM load in progress |
|               | 6    | 0                   | R    | N      | EECFG_FAIL        |  |

**Table 9. Shared Registers (continued)**

| ADDRESS (HEX) | BITS | DEFAULT VALUE (HEX) | MODE | EEPROM | FIELD NAME     | DESCRIPTION  |
|---------------|------|---------------------|------|--------|----------------|--|
|               | 5    | 0                   | R    | N      | EECFG_ATMPT[5] | Number of attempts made to load EEPROM image   |
|               | 4    | 0                   | R    | N      | EECFG_ATMPT[4] |  |
|               | 3    | 0                   | R    | N      | EECFG_ATMPT[3] |  |
|               | 2    | 0                   | R    | N      | EECFG_ATMPT[2] |  |
|               | 1    | 0                   | R    | N      | EECFG_ATMPT[1] |  |
|               | 0    | 0                   | R    | N      | EECFG_ATMPT[0] |  |
| 12            | 7    | 1                   | RW   | N      | REG_I2C_FAST   | 1: EEPROM load uses Fast I2C Mode (400 kHz)<br>0: EEPROM load uses Standard I2C Mode (100 kHz) |
|               | 6    | 0                   | RW   | N      | RESERVED       | RESERVED   |
|               | 5    | 0                   | RW   | N      | RESERVED       | RESERVED   |
|               | 4    | 1                   | RW   | N      | RESERVED       | RESERVED   |
|               | 3    | 0                   | RW   | N      | RESERVED       | RESERVED   |
|               | 2    | 0                   | RW   | N      | RESERVED       | RESERVED   |
|               | 1    | 0                   | RW   | N      | RESERVED       | RESERVED   |
|               | 0    | 1                   | RW   | N      | RESERVED       | RESERVED   |

**Table 10. Channel Registers, 0 to 39**

| ADDRESS (HEX) | BITS | DEFAULT VALUE (HEX) | MODE | EEPROM | FIELD NAME        | DESCRIPTION   |
|---------------|------|---------------------|------|--------|-------------------|---|
| 00            | 7    | 0                   | RW   | N      | RESERVED          | RESERVED  |
|               | 6    | 0                   | RW   | N      | RESERVED          | RESERVED  |
|               | 5    | 0                   | RW   | N      | RESERVED          | RESERVED  |
|               | 4    | 0                   | RW   | N      | RESERVED          | RESERVED  |
|               | 3    | 0                   | RW   | N      | RST_CORE          | 1: Reset the 10M core clock domain. This is the main clock domain for all the state machines<br>0: Normal operation   |
|               | 2    | 0                   | RW   | N      | RST_REGS          | 1: Reset channel registers to power-up defaults.<br>0: Normal operation   |
|               | 1    | 0                   | RW   | N      | RST_VCO           | 1: Resets the CDR S2P clock domain, includes PPM counter, EOM counter.<br>0: Normal operation   |
|               | 0    | 0                   | RW   | N      | RST_REFCLK        | 1: Resets the 25MHz reference clock domain, includes PPM counter. Does not work if 25MHz clock is not present.<br>0: Normal operation   |
| 01            | 7    | 0                   | R    | N      | SIGDET            | Raw Signal Detect observation   |
|               | 6    | 0                   | R    | N      | POL_INV_DET       | Indicates PRBS checker detected polarity inversion in the locked data sequence.   |
|               | 5    | 0                   | R    | N      | CDR_LOCK_LOSS_INT | 1: Indicates loss of CDR lock after having acquired it. Bit clears on read. Feature must be enabled with Reg_0x31[1]  |
|               | 4    | 0                   | R    | N      | PRBS_SEQ_DET[3]   | Indicates the pattern detected on the input serial stream   |
|               | 3    | 0                   | R    | N      | PRBS_SEQ_DET[2]   | 0xxx: No detect<br>1000: 7 bits PRBS sequence<br>1001: 9 bits PRBS sequence<br>1010: 11 bits PRBS sequence<br>1011: 15 bits PRBS sequence<br>1100: 23 bits PRBS sequence<br>1101: 31 bits PRBS sequence<br>1110: 58 bits PRBS sequence<br>1111: 63 bits PRBS sequence |
|               | 2    | 0                   | R    | N      | PRBS_SEQ_DET[1]   |   |
|               | 1    | 0                   | R    | N      | PRBS_SEQ_DET[0]   |   |
|               | 0    | 0                   | R    | N      | SIG_DET_LOSS_INT  |   |
| 02            | 7    | 0                   | R    | N      | CDR_STATUS[7]     | This register is used to read the status of internal signal. Select what is observable on this bus using Reg_0x0C[7:4]  |
|               | 6    | 0                   | R    | N      | CDR_STATUS[6]     |   |
|               | 5    | 0                   | R    | N      | CDR_STATUS[5]     |   |
|               | 4    | 0                   | R    | N      | CDR_STATUS[4]     |   |
|               | 3    | 0                   | R    | N      | CDR_STATUS[3]     |   |
|               | 2    | 0                   | R    | N      | CDR_STATUS[2]     |   |
|               | 1    | 0                   | R    | N      | CDR_STATUS[1]     |   |
|               | 0    | 0                   | R    | N      | CDR_STATUS[0]     |   |

**Table 10. Channel Registers, 0 to 39 (continued)**

| ADDRESS (HEX) | BITS | DEFAULT VALUE (HEX) | MODE | EEPROM | FIELD NAME | DESCRIPTION   |
|---------------|------|---------------------|------|--------|------------|---|
| 03            | 7    | 0                   | RW   | Y      | EQ_BST0[1] | This register can be used to force an EQ boost setting if used in conjunction with channel Reg_0x2D[3]. |
|               | 6    | 0                   | RW   | Y      | EQ_BST0[0] |   |
|               | 5    | 0                   | RW   | Y      | EQ_BST1[1] |   |
|               | 4    | 0                   | RW   | Y      | EQ_BST1[0] |   |
|               | 3    | 0                   | RW   | Y      | EQ_BST2[1] |   |
|               | 2    | 0                   | RW   | Y      | EQ_BST2[0] |   |
|               | 1    | 0                   | RW   | Y      | EQ_BST3[1] |   |
|               | 0    | 0                   | RW   | Y      | EQ_BST3[0] |   |
| 04            | 7    | 0                   | RW   | N      | RESERVED   | RESERVED  |
|               | 6    | 0                   | RW   | N      | RESERVED   | RESERVED  |
|               | 5    | 0                   | RW   | N      | RESERVED   | RESERVED  |
|               | 4    | 0                   | RW   | N      | RESERVED   | RESERVED  |
|               | 3    | 0                   | RW   | N      | RESERVED   | RESERVED  |
|               | 2    | 0                   | RW   | N      | RESERVED   | RESERVED  |
|               | 1    | 0                   | RW   | N      | RESERVED   | RESERVED  |
|               | 0    | 1                   | RW   | N      | RESERVED   | RESERVED  |
| 05            | 7    | 0                   | RW   | N      | RESERVED   | RESERVED  |
|               | 6    | 0                   | RW   | N      | RESERVED   | RESERVED  |
|               | 5    | 0                   | RW   | N      | RESERVED   | RESERVED  |
|               | 4    | 0                   | RW   | N      | RESERVED   | RESERVED  |
|               | 3    | 0                   | RW   | N      | RESERVED   | RESERVED  |
|               | 2    | 0                   | RW   | N      | RESERVED   | RESERVED  |
|               | 1    | 0                   | RW   | N      | RESERVED   | RESERVED  |
|               | 0    | 1                   | RW   | N      | RESERVED   | RESERVED  |
| 06            | 7    | 0                   | RW   | N      | RESERVED   | RESERVED  |
|               | 6    | 0                   | RW   | N      | RESERVED   | RESERVED  |
|               | 5    | 0                   | RW   | N      | RESERVED   | RESERVED  |
|               | 4    | 0                   | RW   | N      | RESERVED   | RESERVED  |
|               | 3    | 0                   | RW   | N      | RESERVED   | RESERVED  |
|               | 2    | 0                   | RW   | N      | RESERVED   | RESERVED  |
|               | 1    | 0                   | RW   | N      | RESERVED   | RESERVED  |
|               | 0    | 1                   | RW   | N      | RESERVED   | RESERVED  |
| 07            | 7    | 0                   | RW   | N      | RESERVED   | RESERVED  |
|               | 6    | 0                   | RW   | N      | RESERVED   | RESERVED  |
|               | 5    | 0                   | RW   | N      | RESERVED   | RESERVED  |
|               | 4    | 0                   | RW   | N      | RESERVED   | RESERVED  |
|               | 3    | 0                   | RW   | N      | RESERVED   | RESERVED  |
|               | 2    | 0                   | RW   | N      | RESERVED   | RESERVED  |
|               | 1    | 0                   | RW   | N      | RESERVED   | RESERVED  |
|               | 0    | 1                   | RW   | N      | RESERVED   | RESERVED  |

**Table 10. Channel Registers, 0 to 39 (continued)**

| ADDRESS (HEX) | BITS | DEFAULT VALUE (HEX) | MODE | EEPROM | FIELD NAME   | DESCRIPTION  |
|---------------|------|---------------------|------|--------|--|--|
| 08            | 7    | 0                   | RW   | Y      | RESERVED   | RESERVED   |
|               | 6    | 1                   | RW   | Y      | RESERVED   | RESERVED   |
|               | 5    | 1                   | RW   | Y      | RESERVED   | RESERVED   |
|               | 4    | 1                   | RW   | Y      | RESERVED   | RESERVED   |
|               | 3    | 0                   | RW   | Y      | RESERVED   | RESERVED   |
|               | 2    | 0                   | RW   | Y      | RESERVED   | RESERVED   |
|               | 1    | 1                   | RW   | Y      | RESERVED   | RESERVED   |
|               | 0    | 1                   | RW   | Y      | RESERVED   | RESERVED   |
| 09            | 7    | 0                   | RW   | Y      | REG_VCO_CAP_OV   | Enable bit to override cap_cnt with value in Reg_0x0B[4:0]   |
|               | 6    | 0                   | RW   | Y      | REG_SET_CP_LVL_LPF_OV                                  | Enable bit to override lpf_dac_val with value in Reg_0x1F[4:0]   |
|               | 5    | 0                   | RW   | Y      | REG_BYPASS_PFD_OV                                      | 0: Normal operation.   |
|               | 4    | 0                   | RW   | Y      | REG_EN_FD_PD_VCO_PDIQ_OV                               | Enable bit to override en_fd, pd_pd, pd_vco, pd_pdiq with Reg_0x1E[0], Reg_0x1E[2], Reg_0x1C[0], Reg_0x1C[1]   |
|               | 3    | 0                   | RW   | Y      | REG_EN_PD_CP_OV  | Enable bit to override pd_fd_cp and pd_pd_cp with value in Reg_0x1B[1:0]   |
|               | 2    | 0                   | RW   | Y      | REG_DIVSEL_OV  | Enable bit to override divsel with value in Reg_0x18[6:4]  |
|               | 1    | 0                   | RW   | Y      | RESERVED   | RESERVED   |
|               | 0    | 0                   | RW   | Y      | RESERVED   | RESERVED   |
| 0A            | 7    | 0                   | RW   | Y      | RESERVED   | RESERVED   |
|               | 6    | 0                   | RW   | Y      | REG_EN_IDAC_PD_CP_OV_AND_REG_EN_IDAC_FD_CP_OV          | Enable bit to override phase detector charge pump settings with Reg_0x1C[7:5]<br>Enable bit to override frequency detector charge pump settings with Reg_0x1C[4:2] |
|               | 5    | 0                   | RW   | Y      | REG_DAC_LPF_HIGH_PHASE_OV_AND_REG_DAC_LPF_LOW_PHASE_OV | Enable bit to loop filter comparator trip voltages with Reg_0x16[7:0]  |
|               | 4    | 0                   | RW   | Y      | RESERVED   | RESERVED   |
|               | 3    | 0                   | RW   | N      | REG_CDR_RESET_OV                                       | Enable CDR Reset override with Reg_0x0A[2]   |
|               | 2    | 0                   | RW   | N      | REG_CDR_RESET_SM                                       | CDR Reset override bit   |
|               | 1    | 0                   | RW   | N      | REG_CDR_LOCK_OV  | Enable CDR lock signal override with Reg_0x0A[0]   |
|               | 0    | 0                   | RW   | N      | REG_CDR_LOCK   | CDR lock signal override bit   |
| 0B            | 7    | 0                   | RW   | Y      | RESERVED   | RESERVED   |
|               | 6    | 1                   | RW   | Y      | RESERVED   | RESERVED   |
|               | 5    | 1                   | RW   | Y      | RESERVED   | RESERVED   |
|               | 4    | 0                   | RW   | Y      | RESERVED   | RESERVED   |
|               | 3    | 0                   | RW   | Y      | RESERVED   | RESERVED   |
|               | 2    | 0                   | RW   | Y      | RESERVED   | RESERVED   |
|               | 1    | 1                   | RW   | Y      | RESERVED   | RESERVED   |
|               | 0    | 1                   | RW   | Y      | RESERVED   | RESERVED   |

**Table 10. Channel Registers, 0 to 39 (continued)**

| ADDRESS (HEX) | BITS | DEFAULT VALUE (HEX) | MODE | EEPROM | FIELD NAME | DESCRIPTION   |
|---------------|------|---------------------|------|--------|------------|---|
| 0C            | 7    | 0                   | RW   | N      | RESERVED   | RESERVED  |
|               | 6    | 0                   | RW   | N      | RESERVED   | RESERVED  |
|               | 5    | 0                   | RW   | N      | RESERVED   | RESERVED  |
|               | 4    | 0                   | RW   | N      | RESERVED   | RESERVED  |
|               | 3    | 0                   | RW   | N      | RESERVED   | RESERVED  |
|               | 2    | 0                   | RW   | N      | RESERVED   | RESERVED  |
|               | 1    | 0                   | RW   | N      | RESERVED   | RESERVED  |
|               | 0    | 0                   | RW   | N      | RESERVED   | RESERVED  |
| 0D            | 7    | 1                   | RW   | N      | DES_PD     | 1: De-serializer (for PRBS checker) is powered down<br>0: De-serializer (for PRBS checker) is enabled |
|               | 6    | 0                   | RW   | N      | RESERVED   | RESERVED  |
|               | 5    | 0                   | RW   | Y      | RESERVED   | RESERVED  |
|               | 4    | 0                   | RW   | Y      | RESERVED   | RESERVED  |
|               | 3    | 0                   | RW   | Y      | RESERVED   | RESERVED  |
|               | 2    | 0                   | RW   | Y      | RESERVED   | RESERVED  |
|               | 1    | 0                   | RW   | N      | RESERVED   | RESERVED  |
|               | 0    | 0                   | RW   | N      | RESERVED   | RESERVED  |
| 0E            | 7    | 1                   | RW   | N      | RESERVED   | RESERVED  |
|               | 6    | 0                   | RW   | N      | RESERVED   | RESERVED  |
|               | 5    | 0                   | RW   | N      | RESERVED   | RESERVED  |
|               | 4    | 1                   | RW   | N      | RESERVED   | RESERVED  |
|               | 3    | 0                   | RW   | N      | RESERVED   | RESERVED  |
|               | 2    | 0                   | RW   | N      | RESERVED   | RESERVED  |
|               | 1    | 1                   | RW   | N      | RESERVED   | RESERVED  |
|               | 0    | 1                   | RW   | N      | RESERVED   | RESERVED  |
| 0F            | 7    | 0                   | RW   | N      | RESERVED   | RESERVED  |
|               | 6    | 1                   | RW   | N      | RESERVED   | RESERVED  |
|               | 5    | 1                   | RW   | N      | RESERVED   | RESERVED  |
|               | 4    | 0                   | RW   | N      | RESERVED   | RESERVED  |
|               | 3    | 1                   | RW   | N      | RESERVED   | RESERVED  |
|               | 2    | 0                   | RW   | N      | RESERVED   | RESERVED  |
|               | 1    | 0                   | RW   | N      | RESERVED   | RESERVED  |
|               | 0    | 1                   | RW   | N      | RESERVED   | RESERVED  |
| 10            | 7    | 0                   | RW   | N      | RESERVED   | RESERVED  |
|               | 6    | 0                   | RW   | N      | RESERVED   | RESERVED  |
|               | 5    | 0                   | RW   | N      | RESERVED   | RESERVED  |
|               | 4    | 0                   | RW   | N      | RESERVED   | RESERVED  |
|               | 3    | 0                   | RW   | N      | RESERVED   | RESERVED  |
|               | 2    | 0                   | RW   | N      | RESERVED   | RESERVED  |
|               | 1    | 0                   | RW   | N      | RESERVED   | RESERVED  |
|               | 0    | 0                   | RW   | N      | RESERVED   | RESERVED  |



**Table 10. Channel Registers, 0 to 39 (continued)**

| ADDRESS (HEX) | BITS | DEFAULT VALUE (HEX) | MODE | EEPROM | FIELD NAME        | DESCRIPTION  |
|---------------|------|---------------------|------|--------|-------------------|--|
| 11            | 7    | 0                   | RW   | Y      | EOM_SEL_VRANGE[1] | Manually set the EOM vertical range, used with channel Reg_0x2C[6]:<br>00: ±100 mV<br>01: ±200 mV<br>10: ±300 mV<br>11: ±400 mV  |
|               | 6    | 0                   | RW   | Y      | EOM_SEL_VRANGE[0] |  |
|               | 5    | 1                   | RW   | Y      | EOM_PD            | 1: Normal operation. Eye opening monitor (EOM) is automatically duty-cycled.<br>0: EOM is force-enabled  |
|               | 4    | 0                   | RW   | N      | RESERVED          | RESERVED   |
|               | 3    | 0                   | RW   | Y      | DFE_TAP2_POL      | Bit forces DFE tap 2 polarity<br>1: Negative, boosts by the specified tap weight<br>0: Positive, attenuates by the specified tap weight  |
|               | 2    | 0                   | RW   | Y      | DFE_TAP3_POL      | Bit forces DFE tap 3 polarity<br>1: Negative, boosts by the specified tap weight<br>0: Positive, attenuates by the specified tap weight  |
|               | 1    | 0                   | RW   | Y      | DFE_TAP4_POL      | Bit forces DFE tap 4 polarity<br>1: Negative, boosts by the specified tap weight<br>0: Positive, attenuates by the specified tap weight  |
|               | 0    | 0                   | RW   | Y      | DFE_TAP5_POL      | Bit forces DFE tap 5 polarity<br>1: Negative, boosts by the specified tap weight<br>0: Positive, attenuates by the specified tap weight  |
| 12            | 7    | 1                   | RW   | Y      | DFE_TAP1_POL      | Bit forces DFE tap 1 polarity<br>1: Negative, boosts by the specified tap weight<br>0: Positive, attenuates by the specified tap weight  |
|               | 6    | 0                   | RW   | N      | RESERVED          | RESERVED   |
|               | 5    | 0                   | RW   | Y      | RESERVED          | RESERVED   |
|               | 4    | 0                   | RW   | Y      | DFE_WT1[4]        | These bits force DFE tap 1 weight. Manual DFE operation is required for this to take effect by setting Reg_0x15[7]=1.<br>If Reg_0x15[7]=0, the value defined here is used as the initial DFE tap 1 weight during adaptation. |
|               | 3    | 0                   | RW   | Y      | DFE_WT1[3]        |  |
|               | 2    | 0                   | RW   | Y      | DFE_WT1[2]        |  |
|               | 1    | 1                   | RW   | Y      | DFE_WT1[1]        |  |
|               | 0    | 1                   | RW   | Y      | DFE_WT1[0]        |  |

**Table 10. Channel Registers, 0 to 39 (continued)**

| ADDRESS (HEX) | BITS | DEFAULT VALUE (HEX) | MODE | EEPROM | FIELD NAME       | DESCRIPTION   |
|---------------|------|---------------------|------|--------|------------------|---|
| 13            | 7    | 1                   | RW   | N      | EQ_PD_PEAKDETECT | 1: Normal operation. Power down test mode.<br>0: Test mode.   |
|               | 6    | 0                   | RW   | Y      | EQ_PD_SD         | 1: Power down signal detect.<br>0: Normal operation. Enable signal detect.  |
|               | 5    | 1                   | RW   | Y      | EQ_HI_GAIN       | 1: Enable high DC gain mode in the equalizer<br>0: Enable low DC gain mode in the equalizer<br>(Refer to the Programming Guide for more details)                      |
|               | 4    | 1                   | RW   | Y      | EQ_EN_DC_OFF     | 1: Normal operation.<br>0: Disable DC offset compensation.  |
|               | 3    | 0                   | RW   | Y      | RESERVED         | RESERVED  |
|               | 2    | 0                   | RW   | Y      | EQ_LIMIT_EN      | 1: Configures the final stage of the equalizer to be a limiting stage.<br>0: Normal operation, final stage of the equalizer is configured to be a non-limiting stage. |
|               | 1    | 0                   | RW   | Y      | RESERVED         | RESERVED  |
|               | 0    | 0                   | RW   | Y      | RESERVED         | RESERVED  |
| 14            | 7    | 0                   | RW   | Y      | EQ_SD_PRESET     | 1: Forces signal detect HIGH, and force enables the channel. Should not be set if bit 6 is set.<br>0: Normal Operation.   |
|               | 6    | 0                   | RW   | Y      | EQ_SD_RESET      | 1: Forces signal detect LOW and force disables the channel. Should not be set if bit 7 is set.<br>0: Normal Operation.  |
|               | 5    | 0                   | RW   | Y      | EQ_REFA_SEL1     | Controls the signal detect assert levels.<br>(Refer to the Programming Guide for more details)  |
|               | 4    | 0                   | RW   | Y      | EQ_REFA_SEL0     |   |
|               | 3    | 0                   | RW   | Y      | EQ_REFD_SEL1     | Controls the signal detect de-assert levels.<br>(Refer to the Programming Guide for more details)   |
|               | 2    | 1                   | RW   | Y      | EQ_REFD_SEL0     |   |
|               | 1    | 0                   | RW   | N      | RESERVED         | RESERVED  |
|               | 0    | 0                   | RW   | N      | RESERVED         | RESERVED  |
| 15            | 7    | 0                   | RW   | Y      | DFE_FORCE_EN     | 1: Enables manual DFE tap settings<br>0: Normal operation   |
|               | 6    | 0                   | RW   | N      | RESERVED         | RESERVED  |
|               | 5    | 0                   | RW   | N      | RESERVED         | RESERVED  |
|               | 4    | 1                   | RW   | Y      | RESERVED         | RESERVED  |
|               | 3    | 0                   | RW   | Y      | DRV_PD           | 1: Powers down the high speed driver<br>0: Normal operation   |
|               | 2    | 0                   | RW   | Y      | RESERVED         | RESERVED  |
|               | 1    | 0                   | RW   | Y      | RESERVED         | RESERVED  |
|               | 0    | 0                   | RW   | Y      | RESERVED         | RESERVED  |

**Table 10. Channel Registers, 0 to 39 (continued)**

| ADDRESS (HEX) | BITS | DEFAULT VALUE (HEX) | MODE | EEPROM | FIELD NAME      | DESCRIPTION   |
|---------------|------|---------------------|------|--------|-----------------|---|
| 16            | 7    | 0                   | RW   | Y      | RESERVED        | RESERVED  |
|               | 6    | 1                   | RW   | Y      | RESERVED        | RESERVED  |
|               | 5    | 1                   | RW   | Y      | RESERVED        | RESERVED  |
|               | 4    | 1                   | RW   | Y      | RESERVED        | RESERVED  |
|               | 3    | 1                   | RW   | Y      | RESERVED        | RESERVED  |
|               | 2    | 0                   | RW   | Y      | RESERVED        | RESERVED  |
|               | 1    | 1                   | RW   | Y      | RESERVED        | RESERVED  |
|               | 0    | 0                   | RW   | Y      | RESERVED        | RESERVED  |
| 17            | 7    | 0                   | RW   | Y      | RESERVED        | RESERVED  |
|               | 6    | 0                   | RW   | Y      | RESERVED        | RESERVED  |
|               | 5    | 1                   | RW   | Y      | RESERVED        | RESERVED  |
|               | 4    | 1                   | RW   | Y      | RESERVED        | RESERVED  |
|               | 3    | 0                   | RW   | Y      | RESERVED        | RESERVED  |
|               | 2    | 1                   | RW   | Y      | RESERVED        | RESERVED  |
|               | 1    | 1                   | RW   | Y      | RESERVED        | RESERVED  |
|               | 0    | 0                   | RW   | Y      | RESERVED        | RESERVED  |
| 18            | 7    | 0                   | RW   | N      | RESERVED        | RESERVED  |
|               | 6    | 1                   | RW   | Y      | PDIQ_SEL_DIV[2] | These bits will force the divider setting if 0x09[2] is set.<br>000: Divide by 1<br>001: Divide by 2<br>010: Divide by 4<br>011: Divide by 8<br>100: Divide by 16<br>All other values are reserved. |
|               | 5    | 0                   | RW   | Y      | PDIQ_SEL_DIV[1] |   |
|               | 4    | 0                   | RW   | Y      | PDIQ_SEL_DIV[0] |   |
|               | 3    | 0                   | RW   | N      | RESERVED        | RESERVED  |
|               | 2    | 0                   | RW   | Y      | RESERVED        | RESERVED  |
|               | 1    | 0                   | RW   | N      | RESERVED        | RESERVED  |
|               | 0    | 0                   | RW   | N      | RESERVED        | RESERVED  |
| 19            | 7    | 0                   | RW   | N      | RESERVED        | RESERVED  |
|               | 6    | 0                   | RW   | N      | RESERVED        | RESERVED  |
|               | 5    | 1                   | RW   | Y      | RESERVED        | RESERVED  |
|               | 4    | 0                   | RW   | Y      | RESERVED        | RESERVED  |
|               | 3    | 0                   | RW   | Y      | RESERVED        | RESERVED  |
|               | 2    | 0                   | RW   | Y      | RESERVED        | RESERVED  |
|               | 1    | 0                   | RW   | Y      | RESERVED        | RESERVED  |
|               | 0    | 0                   | RW   | Y      | RESERVED        | RESERVED  |
| 1A            | 7    | 0                   | RW   | Y      | RESERVED        | RESERVED  |
|               | 6    | 1                   | RW   | Y      | RESERVED        | RESERVED  |
|               | 5    | 0                   | RW   | Y      | RESERVED        | RESERVED  |
|               | 4    | 1                   | RW   | Y      | RESERVED        | RESERVED  |
|               | 3    | 1                   | RW   | Y      | RESERVED        | RESERVED  |
|               | 2    | 0                   | RW   | Y      | RESERVED        | RESERVED  |
|               | 1    | 0                   | RW   | N      | RESERVED        | RESERVED  |
|               | 0    | 0                   | RW   | N      | RESERVED        | RESERVED  |

**Table 10. Channel Registers, 0 to 39 (continued)**

| ADDRESS (HEX) | BITS | DEFAULT VALUE (HEX) | MODE | EEPROM | FIELD NAME             | DESCRIPTION  |
|---------------|------|---------------------|------|--------|------------------------|--|
| 1B            | 7    | 0                   | RW   | N      | RESERVED               | RESERVED   |
|               | 6    | 0                   | RW   | N      | RESERVED               | RESERVED   |
|               | 5    | 0                   | RW   | N      | RESERVED               | RESERVED   |
|               | 4    | 0                   | RW   | N      | RESERVED               | RESERVED   |
|               | 3    | 0                   | RW   | N      | RESERVED               | RESERVED   |
|               | 2    | 0                   | RW   | N      | RESERVED               | RESERVED   |
|               | 1    | 1                   | RW   | Y      | CP_EN_CP_PD            | 1: Normal operation, phase detector charge pump enabled  |
|               | 0    | 1                   | RW   | Y      | CP_EN_CP_FD            | 1: Normal operation, frequency detector charge pump enabled  |
| 1C            | 7    | 1                   | RW   | Y      | EN_IDAC_PD_CP2         | Phase detector charge pump setting. Override bit required for these bits to take effect  |
|               | 6    | 0                   | RW   | Y      | EN_IDAC_PD_CP1         |  |
|               | 5    | 0                   | RW   | Y      | EN_IDAC_PD_CP0         |  |
|               | 4    | 1                   | RW   | Y      | EN_IDAC_FD_CP2         | Frequency detector charge pump setting. Override bit required for these bits to take effect  |
|               | 3    | 0                   | RW   | Y      | EN_IDAC_FD_CP1         |  |
|               | 2    | 0                   | RW   | Y      | EN_IDAC_FD_CP0         |  |
|               | 1    | 0                   | RW   | Y      | RESERVED               | RESERVED   |
|               | 0    | 0                   | RW   | Y      | RESERVED               | RESERVED   |
| 1D            | 7    | 0                   | RW   | N      | RESERVED               | RESERVED   |
|               | 6    | 0                   | RW   | N      | RESERVED               | RESERVED   |
|               | 5    | 0                   | RW   | N      | RESERVED               | RESERVED   |
|               | 4    | 0                   | RW   | N      | RESERVED               | RESERVED   |
|               | 3    | 0                   | RW   | N      | RESERVED               | RESERVED   |
|               | 2    | 0                   | RW   | N      | RESERVED               | RESERVED   |
|               | 1    | 0                   | RW   | N      | RESERVED               | RESERVED   |
|               | 0    | 0                   | RW   | N      | RESERVED               | RESERVED   |
| 1E            | 7    | 1                   | RW   | Y      | PFD_SEL_DATA_PRELCK[2] | Output mode for when the CDR is not locked. For these values to take effect, Reg_0x09[5] must be set to 0, which is the default.<br>000: Raw Data<br>111: Mute (Default)<br>All other values are reserved. (Refer to the Programming Guide for more details) |
|               | 6    | 1                   | RW   | Y      | PFD_SEL_DATA_PRELCK[1] |  |
|               | 5    | 1                   | RW   | Y      | PFD_SEL_DATA_PRELCK[0] |  |
|               | 4    | 0                   | RW   | N      | SER_EN                 | 1: Enable serializer (used for PRBS Generator)<br>0: Normal operation. Disable serializer.   |
|               | 3    | 1                   | RW   | Y      | DFE_PD                 | This bit must be cleared for the DFE to be functional in any adapt mode.<br>1: (Default) DFE disabled.<br>0: DFE enabled   |
|               | 2    | 0                   | RW   | Y      | PFD_PD_PD              | 1: Power down PFD phase detector.<br>0: Normal operation. Enable PFD phase detector.   |
|               | 1    | 0                   | RW   | Y      | EN_PARTIAL_DFE         | 1: Enable DFE taps 3-5. DFE_PD must also be set to 0.<br>0: (Default) Disable DFE taps 3-5.  |
|               | 0    | 1                   | RW   | Y      | PFD_EN_FD              | 1: Normal operation. Enable PFD frequency detector.<br>0: Disable PFD frequency detector.  |

**Table 10. Channel Registers, 0 to 39 (continued)**

| ADDRESS (HEX) | BITS | DEFAULT VALUE (HEX) | MODE | EEPROM | FIELD NAME            | DESCRIPTION  |
|---------------|------|---------------------|------|--------|-----------------------|--|
| 1F            | 7    | 0                   | RW   | N      | RESERVED              | RESERVED   |
|               | 6    | 0                   | RW   | N      | RESERVED              | RESERVED   |
|               | 5    | 0                   | RW   | N      | RESERVED              | RESERVED   |
|               | 4    | 0                   | RW   | Y      | RESERVED              | RESERVED   |
|               | 3    | 1                   | RW   | Y      | MR_LPF_AUTO_ADJUST_EN | 1: Normal operation. Allow LPF to tune to optimum value during fast-cap search routine.<br>0: Otherwise LPF value is determined by the Reg_0x9D. |
|               | 2    | 0                   | RW   | Y      | RESERVED              | RESERVED   |
|               | 1    | 1                   | RW   | Y      | RESERVED              | RESERVED   |
|               | 0    | 1                   | RW   | Y      | RESERVED              | RESERVED   |
| 20            | 7    | 0                   | RW   | Y      | DFE_WT5[3]            | Bits force DFE tap 5 weight, manual DFE operation required to take effect by setting 0x15[7]=1.  |
|               | 6    | 0                   | RW   | Y      | DFE_WT5[2]            |  |
|               | 5    | 0                   | RW   | Y      | DFE_WT5[1]            |  |
|               | 4    | 0                   | RW   | Y      | DFE_WT5[0]            |  |
|               | 3    | 0                   | RW   | Y      | DFE_WT4[3]            | Bits force DFE tap 4 weight, manual DFE operation required to take effect by setting 0x15[7]=1.  |
|               | 2    | 0                   | RW   | Y      | DFE_WT4[2]            |  |
|               | 1    | 0                   | RW   | Y      | DFE_WT4[1]            |  |
|               | 0    | 0                   | RW   | Y      | DFE_WT4[0]            |  |
| 21            | 7    | 0                   | RW   | Y      | DFE_WT3[3]            | Bits force DFE tap 3 weight, manual DFE operation required to take effect by setting 0x15[7]=1.  |
|               | 6    | 0                   | RW   | Y      | DFE_WT3[2]            |  |
|               | 5    | 0                   | RW   | Y      | DFE_WT3[1]            |  |
|               | 4    | 0                   | RW   | Y      | DFE_WT3[0]            |  |
|               | 3    | 0                   | RW   | Y      | DFE_WT2[3]            | Bits force DFE tap 2 weight, manual DFE operation required to take effect by setting 0x15[7]=1.  |
|               | 2    | 0                   | RW   | Y      | DFE_WT2[2]            |  |
|               | 1    | 0                   | RW   | Y      | DFE_WT2[1]            |  |
|               | 0    | 0                   | RW   | Y      | DFE_WT2[0]            |  |
| 22            | 7    | 0                   | RW   | N      | EOM_OV                | 1: Override enable for EOM manual control<br>0: Normal operation   |
|               | 6    | 0                   | RW   | N      | EOM_SEL_RATE_OV       | 1: Override enable for EOM rate selection<br>0: Normal operation   |
|               | 5    | 0                   | RW   | N      | RESERVED              | RESERVED   |
|               | 4    | 0                   | RW   | N      | RESERVED              | RESERVED   |
|               | 3    | 0                   | RW   | N      | RESERVED              | RESERVED   |
|               | 2    | 0                   | RW   | N      | RESERVED              | RESERVED   |
|               | 1    | 0                   | RW   | N      | RESERVED              | RESERVED   |
|               | 0    | 0                   | RW   | N      | RESERVED              | RESERVED   |

**Table 10. Channel Registers, 0 to 39 (continued)**

| ADDRESS (HEX) | BITS | DEFAULT VALUE (HEX) | MODE | EEPROM | FIELD NAME                   | DESCRIPTION  |
|---------------|------|---------------------|------|--------|------------------------------|--|
| 23            | 7    | 0                   | RW   | N      | EOM_GET_HEO_VEO_OV           | 1: Override enable for manual control of the HEO/VEO trigger<br>0: Normal operation  |
|               | 6    | 1                   | RW   | Y      | DFE_OV                       | 1: Normal operation; DFE must be enabled in Reg_0x1E[3].   |
|               | 5    | 0                   | RW   | N      | RESERVED                     | RESERVED   |
|               | 4    | 0                   | RW   | N      | RESERVED                     | RESERVED   |
|               | 3    | 0                   | RW   | N      | RESERVED                     | RESERVED   |
|               | 2    | 0                   | RW   | N      | RESERVED                     | RESERVED   |
|               | 1    | 0                   | RW   | N      | RESERVED                     | RESERVED   |
| 24            | 7    | 0                   | RW   | N      | FAST_EOM                     | 1: Enables fast EOM for full eye capture. In this mode the phase DAC and voltage DAC or the EOM are automatically incremented through a 64 x 64 matrix. Values for each point are stored in Reg_0x25 and Reg_0x26.<br>0: Normal operation. |
|               | 6    | 0                   | R    | N      | DFE_EQ_ERROR_NO_LOCK         | DFE/CTLE SM quit due to loss of lock   |
|               | 5    | 0                   | R    | N      | GET_HEO_VEO_ERROR_NO_HITS    | get_heo_veo sees no hits at zero crossing  |
|               | 4    | 0                   | R    | N      | GET_HEO_VEO_ERROR_NO_OPENING | get_heo_veo cannot see a vertical eye opening  |
|               | 3    | 0                   | RW   | N      | RESERVED                     | RESERVED   |
|               | 2    | 0                   | RWSC | N      | DFE_ADAPT                    | 1: Manually start DFE adaption (self-clearing).<br>0: Normal operation.  |
|               | 1    | 0                   | R    | N      | EOM_GET_HEO_VEO              | 1: Manually triggers HEO/VEO measurement; feature must be enabled with Reg_0x23[7]; the HEO/VEO values are read from Reg_0x27, Reg_0x28  |
| 25            | 7    | 0                   | R    | N      | EOM_COUNT15                  | MSBs of EOM counter  |
|               | 6    | 0                   | R    | N      | EOM_COUNT14                  |  |
|               | 5    | 0                   | R    | N      | EOM_COUNT13                  |  |
|               | 4    | 0                   | R    | N      | EOM_COUNT12                  |  |
|               | 3    | 0                   | R    | N      | EOM_COUNT11                  |  |
|               | 2    | 0                   | R    | N      | EOM_COUNT10                  |  |
|               | 1    | 0                   | R    | N      | EOM_COUNT9                   |  |
| 26            | 7    | 0                   | R    | N      | EOM_COUNT7                   | LSBs of EOM counter  |
|               | 6    | 0                   | R    | N      | EOM_COUNT6                   |  |
|               | 5    | 0                   | R    | N      | EOM_COUNT5                   |  |
|               | 4    | 0                   | R    | N      | EOM_COUNT4                   |  |
|               | 3    | 0                   | R    | N      | EOM_COUNT3                   |  |
|               | 2    | 0                   | R    | N      | EOM_COUNT2                   |  |
|               | 1    | 0                   | R    | N      | EOM_COUNT1                   |  |
| 26            | 0    | 0                   | R    | N      | EOM_COUNT0                   |  |

**Table 10. Channel Registers, 0 to 39 (continued)**

| ADDRESS (HEX) | BITS | DEFAULT VALUE (HEX) | MODE | EEPROM | FIELD NAME            | DESCRIPTION  |
|---------------|------|---------------------|------|--------|-----------------------|--|
| 27            | 7    | 0                   | R    | N      | HEO7                  | HEO value, requires CDR to be locked for valid measurement   |
|               | 6    | 0                   | R    | N      | HEO6                  |  |
|               | 5    | 0                   | R    | N      | HEO5                  |  |
|               | 4    | 0                   | R    | N      | HEO4                  |  |
|               | 3    | 0                   | R    | N      | HEO3                  |  |
|               | 2    | 0                   | R    | N      | HEO2                  |  |
|               | 1    | 0                   | R    | N      | HEO1                  |  |
|               | 0    | 0                   | R    | N      | HEO0                  |  |
| 28            | 7    | 0                   | R    | N      | VEO7                  | VEO value, requires CDR to be locked for valid measurement   |
|               | 6    | 0                   | R    | N      | VEO6                  |  |
|               | 5    | 0                   | R    | N      | VEO5                  |  |
|               | 4    | 0                   | R    | N      | VEO4                  |  |
|               | 3    | 0                   | R    | N      | VEO3                  |  |
|               | 2    | 0                   | R    | N      | VEO2                  |  |
|               | 1    | 0                   | R    | N      | VEO1                  |  |
|               | 0    | 0                   | R    | N      | VEO0                  |  |
| 29            | 7    | 0                   | RW   | N      | RESERVED              | RESERVED   |
|               | 6    | 0                   | R    | N      | EOM_VRANGE_SETTING[1] | Read the currently set Eye Monitor Voltage Range:<br>11 - +/-400mV<br>10 - +/- 300mV<br>01 - +/- 200mV<br>00 - +/- 100mV"  |
|               | 5    | 0                   | R    | N      | EOM_VRANGE_SETTING[0] |  |
|               | 4    | 0                   | RW   | N      | RESERVED              | RESERVED   |
|               | 3    | 0                   | RW   | N      | RESERVED              | RESERVED   |
|               | 2    | 0                   | RW   | N      | RESERVED              | RESERVED   |
|               | 1    | 0                   | R    | N      | VEO[8]                | VEO MSB value  |
|               | 0    | 0                   | R    | N      | HEO[8]                | HEO MSB value  |
| 2A            | 7    | 0                   | RW   | Y      | EOM_TIMER_THR[3]      | The value of EOM_TIMER_THR[7:4] controls the amount of time the Eye Monitor samples each point in the eye. (Refer to the Programming Guide for more details)   |
|               | 6    | 1                   | RW   | Y      | EOM_TIMER_THR[2]      |  |
|               | 5    | 0                   | RW   | Y      | EOM_TIMER_THR[1]      |  |
|               | 4    | 1                   | RW   | Y      | EOM_TIMER_THR[0]      |  |
|               | 3    | 1                   | RW   | Y      | VEO_MIN_REQ_HITS[3]   | Whenever the Eye Monitor is used to measure HEO and VEO, the data is sampled for some number of bits, set by Reg_0x2A[7:4]. This register sets the number of hits within that sample size that is required before the EOM will indicate a hit has occurred. This filtering only affects the VEO measurement. |
|               | 2    | 0                   | RW   | Y      | VEO_MIN_REQ_HITS[2]   |  |
|               | 1    | 1                   | RW   | Y      | VEO_MIN_REQ_HITS[1]   |  |
|               | 0    | 0                   | RW   | Y      | VEO_MIN_REQ_HITS[0]   |  |

**Table 10. Channel Registers, 0 to 39 (continued)**

| ADDRESS (HEX) | BITS | DEFAULT VALUE (HEX) | MODE | EEPROM              | FIELD NAME           | DESCRIPTION  |                        |
|---------------|------|---------------------|------|---------------------|----------------------|--|------------------------|
| 2B            | 7    | 0                   | RW   | N                   | RESERVED             | RESERVED   |                        |
|               | 6    | 0                   | RW   | N                   | RESERVED             | RESERVED   |                        |
|               | 5    | 0                   | RW   | Y                   | RESERVED             | RESERVED   |                        |
|               | 4    | 0                   | RW   | Y                   | RESERVED             | RESERVED   |                        |
|               | 3    | 1                   | RW   | Y                   | EOM_MIN_REQ_HITS[3]  | Whenever the Eye Monitor is used to measure HEO and VEO, the data is sampled for some number of bits, set by Reg_0x2A[7:4]. This register sets the number of hits within that sample size that is required before the EOM will indicate a hit has occurred. This filtering only affects the HEO measurement. |                        |
|               | 2    | 0                   | RW   | Y                   | EOM_MIN_REQ_HITS[2]  |  |                        |
|               | 1    | 1                   | RW   | Y                   | EOM_MIN_REQ_HITS[1]  |  |                        |
| 0             | 0    | RW                  | Y    | EOM_MIN_REQ_HITS[0] |                      |  |                        |
| 2C            | 7    | 1                   | RW   | N                   | RELOAD_DFE_TAPS      | Causes DFE taps to load from last adapted values   |                        |
|               | 6    | 1                   | RW   | Y                   | VEO_SCALE            | 1: Normal operation. Scale VEO based on EOM vrange.  |                        |
|               | 5    | 1                   | RW   | Y                   | DFE_SM_FOM1          | This register defines the Figure of Merit used when adapting the DFE:<br>00: not valid<br>01: SM uses only HEO<br>10: SM uses only VEO<br>11: SM uses both HEO and VEO<br>Additionally, if Reg_0x6E[6] is set to '1', the Alternate FOM is used. This bit takes precedence over DFE_SM_FOM                   |                        |
|               | 4    | 1                   | RW   | Y                   | DFE_SM_FOM0          |  |                        |
|               | 3    | 0                   | RW   | Y                   | DFE_ADAPT_COUNTER[3] |  | DFE look-beyond count. |
|               | 2    | 1                   | RW   | Y                   | DFE_ADAPT_COUNTER[2] |  |                        |
|               | 1    | 1                   | RW   | Y                   | DFE_ADAPT_COUNTER[1] |  |                        |
|               | 0    | 0                   | RW   | Y                   | DFE_ADAPT_COUNTER[0] |  |                        |
| 2D            | 7    | 0                   | RW   | Y                   | RESERVED             | RESERVED   |                        |
|               | 6    | 0                   | RW   | Y                   | RESERVED             | RESERVED   |                        |
|               | 5    | 1                   | RW   | Y                   | RESERVED             | RESERVED   |                        |
|               | 4    | 1                   | RW   | Y                   | RESERVED             | RESERVED   |                        |
|               | 3    | 0                   | RW   | Y                   | REG_EQ_BST_OV        | 1: Allow override control of the EQ setting by writing to Reg_0x03<br>0: Normal operation.   |                        |
|               | 2    | 0                   | RW   | Y                   | RESERVED             | RESERVED   |                        |
|               | 1    | 0                   | RW   | Y                   | RESERVED             | RESERVED   |                        |
|               | 0    | 0                   | RW   | Y                   | RESERVED             | RESERVED   |                        |
| 2E            | 7    | 0                   | RW   | N                   | RESERVED             | RESERVED   |                        |
|               | 6    | 0                   | RW   | N                   | RESERVED             | RESERVED   |                        |
|               | 5    | 0                   | R    | N                   | EQ_BST3_BIT2_TO_EQ   | Read-back of eq_BST3[2] driving the EQ   |                        |
|               | 4    | 0                   | RW   | N                   | RESERVED             | RESERVED   |                        |
|               | 3    | 0                   | RW   | N                   | RESERVED             | RESERVED   |                        |
|               | 2    | 0                   | RW   | N                   | PRBS_PATTERN_SEL[2]  | MSB for the PRBS_PATTERN_SEL field. Lower bits are found on Reg_0x30[1:0]. Refer to the Reg_0x30 description on this table.  |                        |
|               | 1    | 0                   | RW   | N                   | RESERVED             | RESERVED   |                        |
|               | 0    | 0                   | RW   | N                   | RESERVED             | RESERVED   |                        |



**Table 10. Channel Registers, 0 to 39 (continued)**

| ADDRESS (HEX) | BITS | DEFAULT VALUE (HEX) | MODE | EEPROM | FIELD NAME          | DESCRIPTION  |
|---------------|------|---------------------|------|--------|---------------------|--|
| 2F            | 7    | 0                   | RW   | Y      | RESERVED            | RESERVED   |
|               | 6    | 1                   | RW   | Y      | RATE[2]             | Configure PPM register and divider for a standard data rate.<br>(Refer to the Programming Guide for more details)  |
|               | 5    | 0                   | RW   | Y      | RATE[1]             |  |
|               | 4    | 1                   | RW   | Y      | RATE[0]             |  |
|               | 3    | 0                   | RW   | Y      | INDEX_OV            | If this bit is 1, then Reg_0x39 is to be used as 4-bit index to the [15:0] array of EQ settings. The EQ setting at that index is loaded to the EQ boost registers going to the analog and is used as the starting point for adaption.  |
|               | 2    | 1                   | RW   | Y      | EN_PPM_CHECK        | 1: (Default) Enable the PPM to be used as a qualifier when performing Lock Detect<br>0: Remove the PPM check as a lock qualifier.  |
|               | 1    | 0                   | RW   | Y      | RESERVED            | RESERVED   |
|               | 0    | 0                   | RWSC | N      | CTLE_ADAPT          | 1: Re-starts CTLE adaptation, self-clearing  |
| 30            | 7    | 0                   | RW   | N      | FREEZE_PPM_CNT      | 1: Freeze the PPM counter to allow safe read asynchronously  |
|               | 6    | 0                   | RW   | Y      | EQ_SEARCH_OV_EN     | 1: Enables the EQ "search" bit to be forced by Reg_0x13[2]   |
|               | 5    | 0                   | RW   | N      | EN_PATT_INV         | 1: Enable automatic pattern inversion of successive 16 bit words when using the "Fixed Pattern" generator option.  |
|               | 4    | 0                   | RW   | N      | RELOAD_PRBS_CHKR    | 1: Force reload of seed into PRBS checker LFSR without holding the checker in reset.   |
|               | 3    | 0                   | RW   | N      | PRBS_EN_DIG_CLK     | This bit enables the clock to operate the PRBS generator and/or the PRBS checker. Toggling this bit is the primary method to reset the PRBS pattern generator and PRBS checker.  |
|               | 2    | 0                   | RW   | N      | PRBS_PROGPATT_EN    | Enable a fixed data pattern output. Requires that serializer is enabled with Reg_0x1E[4]. PRBS generator and checker should be disabled, Reg_0x30[3]. The fixed data pattern is set by Reg_0x7C and Reg_0x97. Enable inversion of the pattern every 16 bits with Reg_0x30[5].  |
|               | 1    | 0                   | RW   | N      | PRBS_PATTERN_SEL[1] | Selects the pattern output when using the PRBS generator. Requires the pattern generator to be configured properly. The MSB for the PRBS_PATTERN_SEL field is in Reg_0x2E[2].<br>Use Reg_0x30[3] to enable the PRBS generator.<br>000: 2 <sup>7</sup> -1 bits PRBS sequence<br>001: 2 <sup>9</sup> -1 bits PRBS sequence<br>010: 2 <sup>11</sup> -1 bits PRBS sequence<br>011: 2 <sup>15</sup> -1 bits PRBS sequence<br>100: 2 <sup>23</sup> -1 bits PRBS sequence<br>101: 2 <sup>31</sup> -1 bits PRBS sequence<br>110: 2 <sup>58</sup> -1 bits PRBS sequence<br>111: 2 <sup>63</sup> -1 bits PRBS sequence |
|               | 0    | 0                   | RW   | N      | PRBS_PATTERN_SEL[0] |  |

**Table 10. Channel Registers, 0 to 39 (continued)**

| ADDRESS (HEX) | BITS | DEFAULT VALUE (HEX) | MODE | EEPROM | FIELD NAME             | DESCRIPTION   |
|---------------|------|---------------------|------|--------|------------------------|---|
| 31            | 7    | 0                   | RW   | N      | PRBS_INT_EN            | 1: Enables interrupt for detection of PRBS errors. The PRBS checker must be properly configured for this feature to work.   |
|               | 6    | 0                   | RW   | Y      | ADAPT_MODE[1]          | 00: no adaption<br>01: adapt CTLE only<br>10: adapt CTLE until optimal, then DFE, then CTLE again<br>11: adapt CTLE until lock, then DFE, then EQ until optimal<br>Note: for ADAPT_MODE=2 or 3, the DFE must be enabled by setting Reg_0x1E[3]=0 and Reg_0x1E[1]=1. (Refer to the Programming Guide for more details) |
|               | 5    | 1                   | RW   | Y      | ADAPT_MODE[0]          |   |
|               | 4    | 0                   | RW   | Y      | EQ_SM_FOM[1]           | CTLE (EQ) adaption state machine figure of merit.<br>00: (Default) SM uses both HEO and VEO<br>01: SM uses HEO only<br>10: SM uses VEO only<br>11: SM uses both HEO and VEO<br>Additionally, if Reg_0x6E[7]=1, the Alternate FOM is used. Reg_0x6E[7] takes precedence over EQ_SM_FOM.                                |
|               | 3    | 0                   | RW   | Y      | EQ_SM_FOM[0]           |   |
|               | 2    | 0                   | RW   | N      | RESERVED               | RESERVED  |
|               | 1    | 0                   | RW   | Y      | CDR_LOCK_LOSS_INT_EN   | Enable for CDR Lock Loss Interrupt. Observable in Reg_0x01[5]   |
|               | 0    | 0                   | RW   | Y      | SIGNAL_DET_LOSS_INT_EN | Enable for Signal Detect Loss Interrupt. Observable in Reg_0x01[0]  |
| 32            | 7    | 0                   | RW   | Y      | HEO_INT_THRESH[3]      | These bits set the threshold for the HEO and VEO interrupt. Each threshold bit represents 8 counts of HEO or VEO.   |
|               | 6    | 0                   | RW   | Y      | HEO_INT_THRESH[2]      |   |
|               | 5    | 0                   | RW   | Y      | HEO_INT_THRESH[1]      |   |
|               | 4    | 1                   | RW   | Y      | HEO_INT_THRESH[0]      |   |
|               | 3    | 0                   | RW   | Y      | VEO_INT_THRESH[3]      |   |
|               | 2    | 0                   | RW   | Y      | VEO_INT_THRESH[2]      |   |
|               | 1    | 0                   | RW   | Y      | VEO_INT_THRESH[1]      |   |
|               | 0    | 1                   | RW   | Y      | VEO_INT_THRESH[0]      |   |
| 33            | 7    | 1                   | RW   | Y      | HEO_THRESH[3]          | In adapt mode 3, the register sets the minimum HEO and VEO required for CTLE adaption, before starting DFE adaption. This can be a max of 15.   |
|               | 6    | 0                   | RW   | Y      | HEO_THRESH[2]          |   |
|               | 5    | 0                   | RW   | Y      | HEO_THRESH[1]          |   |
|               | 4    | 0                   | RW   | Y      | HEO_THRESH[0]          |   |
|               | 3    | 1                   | RW   | Y      | VEO_THRESH[3]          |   |
|               | 2    | 0                   | RW   | Y      | VEO_THRESH[2]          |   |
|               | 1    | 0                   | RW   | Y      | VEO_THRESH[1]          |   |
|               | 0    | 0                   | RW   | Y      | VEO_THRESH[0]          |   |

**Table 10. Channel Registers, 0 to 39 (continued)**

| ADDRESS (HEX) | BITS | DEFAULT VALUE (HEX) | MODE | EEPROM | FIELD NAME             | DESCRIPTION   |
|---------------|------|---------------------|------|--------|------------------------|---|
| 34            | 7    | 0                   | R    | N      | PPM_ERR_RDY            | 1: Indicates that a PPM error count is read to be read from channel Reg_0x3B and Reg_0x3C   |
|               | 6    | 0                   | RW   | Y      | LOW_POWER_MODE_DISABLE | By default, all blocks (except signal detect) power down after 100 ms after signal detect goes low. If set high, all blocks get powered on after the signal detect initially goes high.   |
|               | 5    | 1                   | RW   | Y      | LOCK_COUNTER[1]        | After achieving lock, the CDR continues to monitor the lock criteria. If the lock criteria fail, the lock is checked for a total of N number of times before declaring an out of lock condition, where N is set by this the value in these registers, with a max value of +3, for a total of 4. If during the N lock checks, lock is regained, then the lock condition is left HI, and the counter is reset back to zero. |
|               | 4    | 1                   | RW   | Y      | LOCK_COUNTER[0]        |   |
|               | 3    | 1                   | RW   | Y      | DFE_MAX_TAP2_5[3]      | These four bits are used to set the maximum value by which DFE taps 2-5 are able to adapt with each subsequent adaptation. Same used for both polarities.   |
|               | 2    | 1                   | RW   | Y      | DFE_MAX_TAP2_5[2]      |   |
|               | 1    | 1                   | RW   | Y      | DFE_MAX_TAP2_5[1]      |   |
|               | 0    | 1                   | RW   | Y      | DFE_MAX_TAP2_5[0]      |   |
| 35            | 7    | 0                   | RW   | Y      | DATA_LOCK_PPM[1]       | Modifies the value of the PPM delta tolerance from channel Reg_0x64:<br>00 - ppm_delta[7:0] = 1 x ppm_delta[7:0]<br>01 - ppm_delta[7:0] = 1 x ppm_delta[7:0] + ppm_delta[3:1]<br>10 - ppm_delta[7:0] = 2 x ppm_delta[7:0]<br>11 - ppm_delta[7:0] = 2 x ppm_delta[7:0] + ppm_delta[3:1]  |
|               | 6    | 0                   | RW   | Y      | DATA_LOCK_PPM[0]       |   |
|               | 5    | 0                   | RW   | N      | GET_PPM_ERROR          | Get PPM error from PPM_COUNT - clears when done. Normally updates continuously, but can be manually triggered with read value from Reg_0x3B and Reg_0x3C  |
|               | 4    | 0                   | RW   | Y      | DFE_MAX_TAP1[4]        | Limits DFE tap 1 maximum magnitude.   |
|               | 3    | 1                   | RW   | Y      | DFE_MAX_TAP1[3]        |   |
|               | 2    | 1                   | RW   | Y      | DFE_MAX_TAP1[2]        |   |
|               | 1    | 1                   | RW   | Y      | DFE_MAX_TAP1[1]        |   |
|               | 0    | 1                   | RW   | Y      | DFE_MAX_TAP1[0]        |   |
| 36            | 7    | 0                   | RW   | N      | RESERVED               | RESERVED  |
|               | 6    | 0                   | RW   | Y      | HEO_VEO_INT_EN         | 1: Enable HEO/VEO interrupt capability  |
|               | 5    | 1                   | RW   | Y      | REF_MODE[1]            | 11: Normal Operation. Reference mode 3.   |
|               | 4    | 1                   | RW   | Y      | REF_MODE[0]            |   |
|               | 3    | 0                   | RW   | N      | RESERVED               | RESERVED  |
|               | 2    | 0                   | RW   | Y      | RESERVED               | RESERVED  |
|               | 1    | 0                   | RW   | N      | RESERVED               | RESERVED  |
|               | 0    | 0                   | RW   | N      | RESERVED               | RESERVED  |

**Table 10. Channel Registers, 0 to 39 (continued)**

| ADDRESS (HEX) | BITS | DEFAULT VALUE (HEX) | MODE | EEPROM | FIELD NAME     | DESCRIPTION  |
|---------------|------|---------------------|------|--------|----------------|--|
| 37            | 7    | 0                   | R    | N      | CTLE_STATUS[7] | Feature is reserved for future use   |
|               | 6    | 0                   | R    | N      | CTLE_STATUS[6] |  |
|               | 5    | 0                   | R    | N      | CTLE_STATUS[5] |  |
|               | 4    | 0                   | R    | N      | CTLE_STATUS[4] |  |
|               | 3    | 0                   | R    | N      | CTLE_STATUS[3] |  |
|               | 2    | 0                   | R    | N      | CTLE_STATUS[2] |  |
|               | 1    | 0                   | R    | N      | CTLE_STATUS[1] |  |
|               | 0    | 0                   | R    | N      | CTLE_STATUS[0] |  |
| 38            | 7    | 0                   | R    | N      | DFE_STATUS[7]  | Feature is reserved for future use   |
|               | 6    | 0                   | R    | N      | DFE_STATUS[6]  |  |
|               | 5    | 0                   | R    | N      | DFE_STATUS[5]  |  |
|               | 4    | 0                   | R    | N      | DFE_STATUS[4]  |  |
|               | 3    | 0                   | R    | N      | DFE_STATUS[3]  |  |
|               | 2    | 0                   | R    | N      | DFE_STATUS[2]  |  |
|               | 1    | 0                   | R    | N      | DFE_STATUS[1]  |  |
|               | 0    | 0                   | R    | N      | DFE_STATUS[0]  |  |
| 39            | 7    | 0                   | RW   | N      | RESERVED       | RESERVED   |
|               | 6    | 1                   | RW   | Y      | MR_EOM_RATE[1] | With eom_ov = 1, these bits control the Eye Monitor Rate:<br>11: Use for full rate, fastest<br>10: Use for 1/2 Rate<br>All other values are reserved |
|               | 5    | 1                   | RW   | Y      | MR_EOM_RATE[0] |  |
|               | 4    | 0                   | RW   | Y      | RESERVED       | RESERVED   |
|               | 3    | 0                   | RW   | Y      | START_INDEX[3] | Start index for EQ adaptation  |
|               | 2    | 0                   | RW   | Y      | START_INDEX[2] |  |
|               | 1    | 0                   | RW   | Y      | START_INDEX[1] |  |
|               | 0    | 0                   | RW   | Y      | START_INDEX[0] |  |

**Table 11. Channel Registers, 3A to A9**

| ADDRESS (Hex) | BITS | DEFAULT VALUE (Hex) | MODE | EEPROM | FIELD NAME       | DESCRIPTION   |
|---------------|------|---------------------|------|--------|------------------|---|
| 3A            | 7    | 0                   | RW   | Y      | FIXED_EQ_BST0[1] | During adaptation, if the divider setting is >2, then a fixed EQ setting from this register will be used. However, if channel Reg_0x6F[7] is enabled, then an EQ adaptation will be performed instead |
|               | 6    | 0                   | RW   | Y      | FIXED_EQ_BST0[0] |   |
|               | 5    | 0                   | RW   | Y      | FIXED_EQ_BST1[1] |   |
|               | 4    | 0                   | RW   | Y      | FIXED_EQ_BST1[0] |   |
|               | 3    | 0                   | RW   | Y      | FIXED_EQ_BST2[1] |   |
|               | 2    | 0                   | RW   | Y      | FIXED_EQ_BST2[0] |   |
|               | 1    | 0                   | RW   | Y      | FIXED_EQ_BST3[1] |   |
|               | 0    | 0                   | RW   | Y      | FIXED_EQ_BST3[0] |   |
| 3B            | 7    | 0                   | R    | N      | PPM_COUNT[15]    | PPM count MSB   |
|               | 6    | 0                   | R    | N      | PPM_COUNT[14]    |   |
|               | 5    | 0                   | R    | N      | PPM_COUNT[13]    |   |
|               | 4    | 0                   | R    | N      | PPM_COUNT[12]    |   |
|               | 3    | 0                   | R    | N      | PPM_COUNT[11]    |   |
|               | 2    | 0                   | R    | N      | PPM_COUNT[10]    |   |
|               | 1    | 0                   | R    | N      | PPM_COUNT[9]     |   |
|               | 0    | 0                   | R    | N      | PPM_COUNT[8]     |   |
| 3C            | 7    | 0                   | R    | N      | PPM_COUNT[7]     | PPM count LSB   |
|               | 6    | 0                   | R    | N      | PPM_COUNT[6]     |   |
|               | 5    | 0                   | R    | N      | PPM_COUNT[5]     |   |
|               | 4    | 0                   | R    | N      | PPM_COUNT[4]     |   |
|               | 3    | 0                   | R    | N      | PPM_COUNT[3]     |   |
|               | 2    | 0                   | R    | N      | PPM_COUNT[2]     |   |
|               | 1    | 0                   | R    | N      | PPM_COUNT[1]     |   |
|               | 0    | 0                   | R    | N      | PPM_COUNT[0]     |   |
| 3D            | 7    | 0                   | RW   | Y      | EN_FIR_CURSOR    | 1: Enable Pre- and Post-cursor FIR<br>0: Disable Pre- and Post-cursor FIR (lower power)   |
|               | 6    | 0                   | RW   | Y      | FIR_C0_SGN       | Main-cursor sign bit<br>0: positive<br>1: negative  |
|               | 5    | 0                   | RW   | Y      | RESERVED         | RESERVED  |
|               | 4    | 1                   | RW   | Y      | FIR_C0[4]        | Main-cursor magnitude<br>(Refer to the Programming Guide for more details)  |
|               | 3    | 1                   | RW   | Y      | FIR_C0[3]        |   |
|               | 2    | 0                   | RW   | Y      | FIR_C0[2]        |   |
|               | 1    | 1                   | RW   | Y      | FIR_C0[1]        |   |
|               | 0    | 0                   | RW   | Y      | FIR_C0[0]        |   |
| 3E            | 7    | 0                   | RW   | Y      | FIR_PD_TX        |   |
|               | 6    | 1                   | RW   | Y      | FIR_CN1_SGN      | Pre-cursor sign bit<br>1: negative<br>0: positive   |
|               | 5    | 0                   | RW   | Y      | RESERVED         | RESERVED  |
|               | 4    | 0                   | RW   | Y      | RESERVED         | RESERVED  |
|               | 3    | 0                   | RW   | Y      | FIR_CN1[3]       | Pre-cursor magnitude<br>(Refer to the Programming Guide for more details)   |
|               | 2    | 0                   | RW   | Y      | FIR_CN1[2]       |   |
|               | 1    | 0                   | RW   | Y      | FIR_CN1[1]       |   |
|               | 0    | 0                   | RW   | Y      | FIR_CN1[0]       |   |

**Table 11. Channel Registers, 3A to A9 (continued)**

| ADDRESS (Hex) | BITS | DEFAULT VALUE (Hex) | MODE | EEPROM | FIELD NAME               | DESCRIPTION  |
|---------------|------|---------------------|------|--------|--------------------------|--|
| 3F            | 7    | 0                   | RW   | Y      | RESERVED                 | RESERVED   |
|               | 6    | 1                   | RW   | Y      | FIR_CP1_SGN              | Post-cursor sign bit<br>1: negative<br>0: positive                         |
|               | 5    | 0                   | RW   | Y      | RESERVED                 | RESERVED   |
|               | 4    | 0                   | RW   | Y      | RESERVED                 | RESERVED   |
|               | 3    | 0                   | RW   | Y      | FIR_CP1[3]               | Post-cursor magnitude<br>(Refer to the Programming Guide for more details) |
|               | 2    | 0                   | RW   | Y      | FIR_CP1[2]               |  |
|               | 1    | 0                   | RW   | Y      | FIR_CP1[1]               |  |
|               | 0    | 0                   | RW   | Y      | FIR_CP1[0]               |  |
| 40            | 7    | 0                   | RW   | Y      | EQ_ARRAY_INDEX_0_BST0[1] |  |
|               | 6    | 0                   | RW   | Y      | EQ_ARRAY_INDEX_0_BST0[0] |  |
|               | 5    | 0                   | RW   | Y      | EQ_ARRAY_INDEX_0_BST1[1] |  |
|               | 4    | 0                   | RW   | Y      | EQ_ARRAY_INDEX_0_BST1[0] |  |
|               | 3    | 0                   | RW   | Y      | EQ_ARRAY_INDEX_0_BST2[1] |  |
|               | 2    | 0                   | RW   | Y      | EQ_ARRAY_INDEX_0_BST2[0] |  |
|               | 1    | 0                   | RW   | Y      | EQ_ARRAY_INDEX_0_BST3[1] |  |
|               | 0    | 0                   | RW   | Y      | EQ_ARRAY_INDEX_0_BST3[0] |  |
| 41            | 7    | 0                   | RW   | Y      | EQ_ARRAY_INDEX_1_BST0[1] |  |
|               | 6    | 1                   | RW   | Y      | EQ_ARRAY_INDEX_1_BST0[0] |  |
|               | 5    | 0                   | RW   | Y      | EQ_ARRAY_INDEX_1_BST1[1] |  |
|               | 4    | 0                   | RW   | Y      | EQ_ARRAY_INDEX_1_BST1[0] |  |
|               | 3    | 0                   | RW   | Y      | EQ_ARRAY_INDEX_1_BST2[1] |  |
|               | 2    | 0                   | RW   | Y      | EQ_ARRAY_INDEX_1_BST2[0] |  |
|               | 1    | 0                   | RW   | Y      | EQ_ARRAY_INDEX_1_BST3[1] |  |
|               | 0    | 0                   | RW   | Y      | EQ_ARRAY_INDEX_1_BST3[0] |  |
| 42            | 7    | 0                   | RW   | Y      | EQ_ARRAY_INDEX_2_BST0[1] |  |
|               | 6    | 1                   | RW   | Y      | EQ_ARRAY_INDEX_2_BST0[0] |  |
|               | 5    | 0                   | RW   | Y      | EQ_ARRAY_INDEX_2_BST1[1] |  |
|               | 4    | 1                   | RW   | Y      | EQ_ARRAY_INDEX_2_BST1[0] |  |
|               | 3    | 0                   | RW   | Y      | EQ_ARRAY_INDEX_2_BST2[1] |  |
|               | 2    | 0                   | RW   | Y      | EQ_ARRAY_INDEX_2_BST2[0] |  |
|               | 1    | 0                   | RW   | Y      | EQ_ARRAY_INDEX_2_BST3[1] |  |
|               | 0    | 0                   | RW   | Y      | EQ_ARRAY_INDEX_2_BST3[0] |  |
| 43            | 7    | 1                   | RW   | Y      | EQ_ARRAY_INDEX_3_BST0[1] |  |
|               | 6    | 0                   | RW   | Y      | EQ_ARRAY_INDEX_3_BST0[0] |  |
|               | 5    | 0                   | RW   | Y      | EQ_ARRAY_INDEX_3_BST1[1] |  |
|               | 4    | 0                   | RW   | Y      | EQ_ARRAY_INDEX_3_BST1[0] |  |
|               | 3    | 0                   | RW   | Y      | EQ_ARRAY_INDEX_3_BST2[1] |  |
|               | 2    | 0                   | RW   | Y      | EQ_ARRAY_INDEX_3_BST2[0] |  |
|               | 1    | 0                   | RW   | Y      | EQ_ARRAY_INDEX_3_BST3[1] |  |
|               | 0    | 0                   | RW   | Y      | EQ_ARRAY_INDEX_3_BST3[0] |  |

**Table 11. Channel Registers, 3A to A9 (continued)**

| ADDRESS (Hex) | BITS | DEFAULT VALUE (Hex) | MODE | EEPROM | FIELD NAME               | DESCRIPTION |
|---------------|------|---------------------|------|--------|--------------------------|-------------|
| 44            | 7    | 1                   | RW   | Y      | EQ_ARRAY_INDEX_4_BST0[1] |             |
|               | 6    | 0                   | RW   | Y      | EQ_ARRAY_INDEX_4_BST0[0] |             |
|               | 5    | 0                   | RW   | Y      | EQ_ARRAY_INDEX_4_BST1[1] |             |
|               | 4    | 1                   | RW   | Y      | EQ_ARRAY_INDEX_4_BST1[0] |             |
|               | 3    | 0                   | RW   | Y      | EQ_ARRAY_INDEX_4_BST2[1] |             |
|               | 2    | 0                   | RW   | Y      | EQ_ARRAY_INDEX_4_BST2[0] |             |
|               | 1    | 0                   | RW   | Y      | EQ_ARRAY_INDEX_4_BST3[1] |             |
|               | 0    | 0                   | RW   | Y      | EQ_ARRAY_INDEX_4_BST3[0] |             |
| 45            | 7    | 1                   | RW   | Y      | EQ_ARRAY_INDEX_5_BST0[1] |             |
|               | 6    | 1                   | RW   | Y      | EQ_ARRAY_INDEX_5_BST0[0] |             |
|               | 5    | 0                   | RW   | Y      | EQ_ARRAY_INDEX_5_BST1[1] |             |
|               | 4    | 0                   | RW   | Y      | EQ_ARRAY_INDEX_5_BST1[0] |             |
|               | 3    | 0                   | RW   | Y      | EQ_ARRAY_INDEX_5_BST2[1] |             |
|               | 2    | 0                   | RW   | Y      | EQ_ARRAY_INDEX_5_BST2[0] |             |
|               | 1    | 0                   | RW   | Y      | EQ_ARRAY_INDEX_5_BST3[1] |             |
|               | 0    | 0                   | RW   | Y      | EQ_ARRAY_INDEX_5_BST3[0] |             |
| 46            | 7    | 1                   | RW   | Y      | EQ_ARRAY_INDEX_6_BST0[1] |             |
|               | 6    | 1                   | RW   | Y      | EQ_ARRAY_INDEX_6_BST0[0] |             |
|               | 5    | 0                   | RW   | Y      | EQ_ARRAY_INDEX_6_BST1[1] |             |
|               | 4    | 1                   | RW   | Y      | EQ_ARRAY_INDEX_6_BST1[0] |             |
|               | 3    | 0                   | RW   | Y      | EQ_ARRAY_INDEX_6_BST2[1] |             |
|               | 2    | 0                   | RW   | Y      | EQ_ARRAY_INDEX_6_BST2[0] |             |
|               | 1    | 0                   | RW   | Y      | EQ_ARRAY_INDEX_6_BST3[1] |             |
|               | 0    | 0                   | RW   | Y      | EQ_ARRAY_INDEX_6_BST3[0] |             |
| 47            | 7    | 1                   | RW   | Y      | EQ_ARRAY_INDEX_7_BST0[1] |             |
|               | 6    | 1                   | RW   | Y      | EQ_ARRAY_INDEX_7_BST0[0] |             |
|               | 5    | 0                   | RW   | Y      | EQ_ARRAY_INDEX_7_BST1[1] |             |
|               | 4    | 1                   | RW   | Y      | EQ_ARRAY_INDEX_7_BST1[0] |             |
|               | 3    | 0                   | RW   | Y      | EQ_ARRAY_INDEX_7_BST2[1] |             |
|               | 2    | 0                   | RW   | Y      | EQ_ARRAY_INDEX_7_BST2[0] |             |
|               | 1    | 0                   | RW   | Y      | EQ_ARRAY_INDEX_7_BST3[1] |             |
|               | 0    | 1                   | RW   | Y      | EQ_ARRAY_INDEX_7_BST3[0] |             |
| 48            | 7    | 1                   | RW   | Y      | EQ_ARRAY_INDEX_8_BST0[1] |             |
|               | 6    | 1                   | RW   | Y      | EQ_ARRAY_INDEX_8_BST0[0] |             |
|               | 5    | 0                   | RW   | Y      | EQ_ARRAY_INDEX_8_BST1[1] |             |
|               | 4    | 1                   | RW   | Y      | EQ_ARRAY_INDEX_8_BST1[0] |             |
|               | 3    | 0                   | RW   | Y      | EQ_ARRAY_INDEX_8_BST2[1] |             |
|               | 2    | 1                   | RW   | Y      | EQ_ARRAY_INDEX_8_BST2[0] |             |
|               | 1    | 0                   | RW   | Y      | EQ_ARRAY_INDEX_8_BST3[1] |             |
|               | 0    | 1                   | RW   | Y      | EQ_ARRAY_INDEX_8_BST3[0] |             |

**Table 11. Channel Registers, 3A to A9 (continued)**

| ADDRESS (Hex) | BITS | DEFAULT VALUE (Hex) | MODE | EEPROM | FIELD NAME                | DESCRIPTION |
|---------------|------|---------------------|------|--------|---------------------------|-------------|
| 49            | 7    | 1                   | RW   | Y      | EQ_ARRAY_INDEX_9_BST0[1]  |             |
|               | 6    | 1                   | RW   | Y      | EQ_ARRAY_INDEX_9_BST0[0]  |             |
|               | 5    | 0                   | RW   | Y      | EQ_ARRAY_INDEX_9_BST1[1]  |             |
|               | 4    | 1                   | RW   | Y      | EQ_ARRAY_INDEX_9_BST1[0]  |             |
|               | 3    | 1                   | RW   | Y      | EQ_ARRAY_INDEX_9_BST2[1]  |             |
|               | 2    | 0                   | RW   | Y      | EQ_ARRAY_INDEX_9_BST2[0]  |             |
|               | 1    | 0                   | RW   | Y      | EQ_ARRAY_INDEX_9_BST3[1]  |             |
|               | 0    | 0                   | RW   | Y      | EQ_ARRAY_INDEX_9_BST3[0]  |             |
| 4A            | 7    | 1                   | RW   | Y      | EQ_ARRAY_INDEX_10_BST0[1] |             |
|               | 6    | 1                   | RW   | Y      | EQ_ARRAY_INDEX_10_BST0[0] |             |
|               | 5    | 1                   | RW   | Y      | EQ_ARRAY_INDEX_10_BST1[1] |             |
|               | 4    | 0                   | RW   | Y      | EQ_ARRAY_INDEX_10_BST1[0] |             |
|               | 3    | 1                   | RW   | Y      | EQ_ARRAY_INDEX_10_BST2[1] |             |
|               | 2    | 0                   | RW   | Y      | EQ_ARRAY_INDEX_10_BST2[0] |             |
|               | 1    | 1                   | RW   | Y      | EQ_ARRAY_INDEX_10_BST3[1] |             |
|               | 0    | 0                   | RW   | Y      | EQ_ARRAY_INDEX_10_BST3[0] |             |
| 4B            | 7    | 1                   | RW   | Y      | EQ_ARRAY_INDEX_11_BST0[1] |             |
|               | 6    | 1                   | RW   | Y      | EQ_ARRAY_INDEX_11_BST0[0] |             |
|               | 5    | 1                   | RW   | Y      | EQ_ARRAY_INDEX_11_BST1[1] |             |
|               | 4    | 1                   | RW   | Y      | EQ_ARRAY_INDEX_11_BST1[0] |             |
|               | 3    | 0                   | RW   | Y      | EQ_ARRAY_INDEX_11_BST2[1] |             |
|               | 2    | 1                   | RW   | Y      | EQ_ARRAY_INDEX_11_BST2[0] |             |
|               | 1    | 1                   | RW   | Y      | EQ_ARRAY_INDEX_11_BST3[1] |             |
|               | 0    | 1                   | RW   | Y      | EQ_ARRAY_INDEX_11_BST3[0] |             |
| 4C            | 7    | 1                   | RW   | Y      | EQ_ARRAY_INDEX_12_BST0[1] |             |
|               | 6    | 1                   | RW   | Y      | EQ_ARRAY_INDEX_12_BST0[0] |             |
|               | 5    | 1                   | RW   | Y      | EQ_ARRAY_INDEX_12_BST1[1] |             |
|               | 4    | 1                   | RW   | Y      | EQ_ARRAY_INDEX_12_BST1[0] |             |
|               | 3    | 1                   | RW   | Y      | EQ_ARRAY_INDEX_12_BST2[1] |             |
|               | 2    | 1                   | RW   | Y      | EQ_ARRAY_INDEX_12_BST2[0] |             |
|               | 1    | 0                   | RW   | Y      | EQ_ARRAY_INDEX_12_BST3[1] |             |
|               | 0    | 1                   | RW   | Y      | EQ_ARRAY_INDEX_12_BST3[0] |             |
| 4D            | 7    | 1                   | RW   | Y      | EQ_ARRAY_INDEX_13_BST0[1] |             |
|               | 6    | 1                   | RW   | Y      | EQ_ARRAY_INDEX_13_BST0[0] |             |
|               | 5    | 1                   | RW   | Y      | EQ_ARRAY_INDEX_13_BST1[1] |             |
|               | 4    | 0                   | RW   | Y      | EQ_ARRAY_INDEX_13_BST1[0] |             |
|               | 3    | 1                   | RW   | Y      | EQ_ARRAY_INDEX_13_BST2[1] |             |
|               | 2    | 1                   | RW   | Y      | EQ_ARRAY_INDEX_13_BST2[0] |             |
|               | 1    | 1                   | RW   | Y      | EQ_ARRAY_INDEX_13_BST3[1] |             |
|               | 0    | 0                   | RW   | Y      | EQ_ARRAY_INDEX_13_BST3[0] |             |



**Table 11. Channel Registers, 3A to A9 (continued)**

| ADDRESS (Hex) | BITS | DEFAULT VALUE (Hex) | MODE | EEPROM | FIELD NAME                | DESCRIPTION |
|---------------|------|---------------------|------|--------|---------------------------|-------------|
| 4E            | 7    | 1                   | RW   | Y      | EQ_ARRAY_INDEX_14_BST0[1] |             |
|               | 6    | 1                   | RW   | Y      | EQ_ARRAY_INDEX_14_BST0[0] |             |
|               | 5    | 1                   | RW   | Y      | EQ_ARRAY_INDEX_14_BST1[1] |             |
|               | 4    | 0                   | RW   | Y      | EQ_ARRAY_INDEX_14_BST1[0] |             |
|               | 3    | 1                   | RW   | Y      | EQ_ARRAY_INDEX_14_BST2[1] |             |
|               | 2    | 1                   | RW   | Y      | EQ_ARRAY_INDEX_14_BST2[0] |             |
|               | 1    | 1                   | RW   | Y      | EQ_ARRAY_INDEX_14_BST3[1] |             |
|               | 0    | 1                   | RW   | Y      | EQ_ARRAY_INDEX_14_BST3[0] |             |
| 4F            | 7    | 1                   | RW   | Y      | EQ_ARRAY_INDEX_15_BST0[1] |             |
|               | 6    | 1                   | RW   | Y      | EQ_ARRAY_INDEX_15_BST0[0] |             |
|               | 5    | 1                   | RW   | Y      | EQ_ARRAY_INDEX_15_BST1[1] |             |
|               | 4    | 1                   | RW   | Y      | EQ_ARRAY_INDEX_15_BST1[0] |             |
|               | 3    | 1                   | RW   | Y      | EQ_ARRAY_INDEX_15_BST2[1] |             |
|               | 2    | 1                   | RW   | Y      | EQ_ARRAY_INDEX_15_BST2[0] |             |
|               | 1    | 1                   | RW   | Y      | EQ_ARRAY_INDEX_15_BST3[1] |             |
|               | 0    | 1                   | RW   | Y      | EQ_ARRAY_INDEX_15_BST3[0] |             |
| 50            | 7    | 1                   | RW   | N      | RESERVED                  | RESERVED    |
|               | 6    | 0                   | RW   | N      | RESERVED                  | RESERVED    |
|               | 5    | 0                   | RW   | N      | RESERVED                  | RESERVED    |
|               | 4    | 0                   | RW   | N      | RESERVED                  | RESERVED    |
|               | 3    | 1                   | RW   | N      | RESERVED                  | RESERVED    |
|               | 2    | 0                   | RW   | N      | RESERVED                  | RESERVED    |
|               | 1    | 0                   | RW   | N      | RESERVED                  | RESERVED    |
|               | 0    | 0                   | RW   | N      | RESERVED                  | RESERVED    |
| 51            | 7    | 1                   | RW   | N      | RESERVED                  | RESERVED    |
|               | 6    | 0                   | RW   | N      | RESERVED                  | RESERVED    |
|               | 5    | 0                   | RW   | N      | RESERVED                  | RESERVED    |
|               | 4    | 0                   | RW   | N      | RESERVED                  | RESERVED    |
|               | 3    | 0                   | RW   | N      | RESERVED                  | RESERVED    |
|               | 2    | 0                   | RW   | N      | RESERVED                  | RESERVED    |
|               | 1    | 1                   | RW   | N      | RESERVED                  | RESERVED    |
|               | 0    | 0                   | RW   | N      | RESERVED                  | RESERVED    |
| 52            | 7    | 1                   | RW   | N      | RESERVED                  | RESERVED    |
|               | 6    | 0                   | RW   | N      | RESERVED                  | RESERVED    |
|               | 5    | 1                   | RW   | N      | RESERVED                  | RESERVED    |
|               | 4    | 0                   | RW   | N      | RESERVED                  | RESERVED    |
|               | 3    | 0                   | RW   | N      | RESERVED                  | RESERVED    |
|               | 2    | 0                   | RW   | N      | RESERVED                  | RESERVED    |
|               | 1    | 0                   | RW   | N      | RESERVED                  | RESERVED    |
|               | 0    | 0                   | RW   | N      | RESERVED                  | RESERVED    |

**Table 11. Channel Registers, 3A to A9 (continued)**

| ADDRESS (Hex) | BITS | DEFAULT VALUE (Hex) | MODE | EEPROM | FIELD NAME | DESCRIPTION |
|---------------|------|---------------------|------|--------|------------|-------------|
| 53            | 7    | 0                   | RW   | N      | RESERVED   | RESERVED    |
|               | 6    | 1                   | RW   | N      | RESERVED   | RESERVED    |
|               | 5    | 0                   | RW   | N      | RESERVED   | RESERVED    |
|               | 4    | 0                   | RW   | N      | RESERVED   | RESERVED    |
|               | 3    | 0                   | RW   | N      | RESERVED   | RESERVED    |
|               | 2    | 1                   | RW   | N      | RESERVED   | RESERVED    |
|               | 1    | 1                   | RW   | N      | RESERVED   | RESERVED    |
|               | 0    | 0                   | RW   | N      | RESERVED   | RESERVED    |
| 54            | 7    | 0                   | RW   | N      | RESERVED   | RESERVED    |
|               | 6    | 1                   | RW   | N      | RESERVED   | RESERVED    |
|               | 5    | 0                   | RW   | N      | RESERVED   | RESERVED    |
|               | 4    | 1                   | RW   | N      | RESERVED   | RESERVED    |
|               | 3    | 0                   | RW   | N      | RESERVED   | RESERVED    |
|               | 2    | 0                   | RW   | N      | RESERVED   | RESERVED    |
|               | 1    | 1                   | RW   | N      | RESERVED   | RESERVED    |
|               | 0    | 0                   | RW   | N      | RESERVED   | RESERVED    |
| 55            | 7    | 1                   | RW   | N      | RESERVED   | RESERVED    |
|               | 6    | 0                   | RW   | N      | RESERVED   | RESERVED    |
|               | 5    | 0                   | RW   | N      | RESERVED   | RESERVED    |
|               | 4    | 0                   | RW   | N      | RESERVED   | RESERVED    |
|               | 3    | 1                   | RW   | N      | RESERVED   | RESERVED    |
|               | 2    | 1                   | RW   | N      | RESERVED   | RESERVED    |
|               | 1    | 0                   | RW   | N      | RESERVED   | RESERVED    |
|               | 0    | 0                   | RW   | N      | RESERVED   | RESERVED    |
| 56            | 7    | 1                   | RW   | N      | RESERVED   | RESERVED    |
|               | 6    | 0                   | RW   | N      | RESERVED   | RESERVED    |
|               | 5    | 1                   | RW   | N      | RESERVED   | RESERVED    |
|               | 4    | 1                   | RW   | N      | RESERVED   | RESERVED    |
|               | 3    | 0                   | RW   | N      | RESERVED   | RESERVED    |
|               | 2    | 0                   | RW   | N      | RESERVED   | RESERVED    |
|               | 1    | 0                   | RW   | N      | RESERVED   | RESERVED    |
|               | 0    | 0                   | RW   | N      | RESERVED   | RESERVED    |
| 57            | 7    | 1                   | RW   | N      | RESERVED   | RESERVED    |
|               | 6    | 1                   | RW   | N      | RESERVED   | RESERVED    |
|               | 5    | 0                   | RW   | N      | RESERVED   | RESERVED    |
|               | 4    | 0                   | RW   | N      | RESERVED   | RESERVED    |
|               | 3    | 1                   | RW   | N      | RESERVED   | RESERVED    |
|               | 2    | 0                   | RW   | N      | RESERVED   | RESERVED    |
|               | 1    | 0                   | RW   | N      | RESERVED   | RESERVED    |
|               | 0    | 0                   | RW   | N      | RESERVED   | RESERVED    |

**Table 11. Channel Registers, 3A to A9 (continued)**

| ADDRESS (Hex) | BITS | DEFAULT VALUE (Hex) | MODE | EEPROM | FIELD NAME | DESCRIPTION |
|---------------|------|---------------------|------|--------|------------|-------------|
| 58            | 7    | 0                   | RW   | N      | RESERVED   | RESERVED    |
|               | 6    | 1                   | RW   | N      | RESERVED   | RESERVED    |
|               | 5    | 0                   | RW   | N      | RESERVED   | RESERVED    |
|               | 4    | 1                   | RW   | N      | RESERVED   | RESERVED    |
|               | 3    | 0                   | RW   | N      | RESERVED   | RESERVED    |
|               | 2    | 1                   | RW   | N      | RESERVED   | RESERVED    |
|               | 1    | 1                   | RW   | N      | RESERVED   | RESERVED    |
|               | 0    | 1                   | RW   | N      | RESERVED   | RESERVED    |
| 59            | 7    | 0                   | RW   | N      | RESERVED   | RESERVED    |
|               | 6    | 1                   | RW   | N      | RESERVED   | RESERVED    |
|               | 5    | 0                   | RW   | N      | RESERVED   | RESERVED    |
|               | 4    | 1                   | RW   | N      | RESERVED   | RESERVED    |
|               | 3    | 1                   | RW   | N      | RESERVED   | RESERVED    |
|               | 2    | 1                   | RW   | N      | RESERVED   | RESERVED    |
|               | 1    | 0                   | RW   | N      | RESERVED   | RESERVED    |
|               | 0    | 1                   | RW   | N      | RESERVED   | RESERVED    |
| 5A            | 7    | 0                   | RW   | N      | RESERVED   | RESERVED    |
|               | 6    | 1                   | RW   | N      | RESERVED   | RESERVED    |
|               | 5    | 1                   | RW   | N      | RESERVED   | RESERVED    |
|               | 4    | 0                   | RW   | N      | RESERVED   | RESERVED    |
|               | 3    | 1                   | RW   | N      | RESERVED   | RESERVED    |
|               | 2    | 0                   | RW   | N      | RESERVED   | RESERVED    |
|               | 1    | 0                   | RW   | N      | RESERVED   | RESERVED    |
|               | 0    | 1                   | RW   | N      | RESERVED   | RESERVED    |
| 5B            | 7    | 0                   | RW   | N      | RESERVED   | RESERVED    |
|               | 6    | 1                   | RW   | N      | RESERVED   | RESERVED    |
|               | 5    | 1                   | RW   | N      | RESERVED   | RESERVED    |
|               | 4    | 1                   | RW   | N      | RESERVED   | RESERVED    |
|               | 3    | 0                   | RW   | N      | RESERVED   | RESERVED    |
|               | 2    | 1                   | RW   | N      | RESERVED   | RESERVED    |
|               | 1    | 0                   | RW   | N      | RESERVED   | RESERVED    |
|               | 0    | 1                   | RW   | N      | RESERVED   | RESERVED    |
| 5C            | 7    | 1                   | RW   | N      | RESERVED   | RESERVED    |
|               | 6    | 1                   | RW   | N      | RESERVED   | RESERVED    |
|               | 5    | 0                   | RW   | N      | RESERVED   | RESERVED    |
|               | 4    | 1                   | RW   | N      | RESERVED   | RESERVED    |
|               | 3    | 0                   | RW   | N      | RESERVED   | RESERVED    |
|               | 2    | 1                   | RW   | N      | RESERVED   | RESERVED    |
|               | 1    | 0                   | RW   | N      | RESERVED   | RESERVED    |
|               | 0    | 1                   | RW   | N      | RESERVED   | RESERVED    |

**Table 11. Channel Registers, 3A to A9 (continued)**

| ADDRESS (Hex) | BITS | DEFAULT VALUE (Hex) | MODE | EEPROM | FIELD NAME      | DESCRIPTION  |
|---------------|------|---------------------|------|--------|-----------------|--|
| 5D            | 7    | 1                   | RW   | N      | RESERVED        | RESERVED   |
|               | 6    | 0                   | RW   | N      | RESERVED        | RESERVED   |
|               | 5    | 0                   | RW   | N      | RESERVED        | RESERVED   |
|               | 4    | 1                   | RW   | N      | RESERVED        | RESERVED   |
|               | 3    | 1                   | RW   | N      | RESERVED        | RESERVED   |
|               | 2    | 0                   | RW   | N      | RESERVED        | RESERVED   |
|               | 1    | 0                   | RW   | N      | RESERVED        | RESERVED   |
|               | 0    | 1                   | RW   | N      | RESERVED        | RESERVED   |
| 5E            | 7    | 1                   | RW   | N      | RESERVED        | RESERVED   |
|               | 6    | 0                   | RW   | N      | RESERVED        | RESERVED   |
|               | 5    | 0                   | RW   | N      | RESERVED        | RESERVED   |
|               | 4    | 1                   | RW   | N      | RESERVED        | RESERVED   |
|               | 3    | 0                   | RW   | N      | RESERVED        | RESERVED   |
|               | 2    | 1                   | RW   | N      | RESERVED        | RESERVED   |
|               | 1    | 1                   | RW   | N      | RESERVED        | RESERVED   |
|               | 0    | 0                   | RW   | N      | RESERVED        | RESERVED   |
| 5F            | 7    | 1                   | RW   | N      | RESERVED        | RESERVED   |
|               | 6    | 0                   | RW   | N      | RESERVED        | RESERVED   |
|               | 5    | 1                   | RW   | N      | RESERVED        | RESERVED   |
|               | 4    | 0                   | RW   | N      | RESERVED        | RESERVED   |
|               | 3    | 0                   | RW   | N      | RESERVED        | RESERVED   |
|               | 2    | 1                   | RW   | N      | RESERVED        | RESERVED   |
|               | 1    | 0                   | RW   | N      | RESERVED        | RESERVED   |
|               | 0    | 1                   | RW   | N      | RESERVED        | RESERVED   |
| 60            | 7    | 0                   | RW   | Y      | GRP0_OV_CNT[7]  | Group 0 count LSB                                      |
|               | 6    | 0                   | RW   | Y      | GRP0_OV_CNT[6]  |  |
|               | 5    | 0                   | RW   | Y      | GRP0_OV_CNT[5]  |  |
|               | 4    | 0                   | RW   | Y      | GRP0_OV_CNT[4]  |  |
|               | 3    | 0                   | RW   | Y      | GRP0_OV_CNT[3]  |  |
|               | 2    | 0                   | RW   | Y      | GRP0_OV_CNT[2]  |  |
|               | 1    | 0                   | RW   | Y      | GRP0_OV_CNT[1]  |  |
|               | 0    | 0                   | RW   | Y      | GRP0_OV_CNT[0]  |  |
| 61            | 7    | 0                   | RW   | Y      | CNT_DLTA_OV_0   | Override enable for group 0 manual data rate selection |
|               | 6    | 0                   | RW   | Y      | GRP0_OV_CNT[14] | Group 0 count MSB                                      |
|               | 5    | 0                   | RW   | Y      | GRP0_OV_CNT[13] |  |
|               | 4    | 0                   | RW   | Y      | GRP0_OV_CNT[12] |  |
|               | 3    | 0                   | RW   | Y      | GRP0_OV_CNT[11] |  |
|               | 2    | 0                   | RW   | Y      | GRP0_OV_CNT[10] |  |
|               | 1    | 0                   | RW   | Y      | GRP0_OV_CNT[9]  |  |
|               | 0    | 0                   | RW   | Y      | GRP0_OV_CNT[8]  |  |

**Table 11. Channel Registers, 3A to A9 (continued)**

| ADDRESS (Hex) | BITS | DEFAULT VALUE (Hex) | MODE | EEPROM | FIELD NAME      | DESCRIPTION   |
|---------------|------|---------------------|------|--------|-----------------|---|
| 62            | 7    | 0                   | RW   | Y      | GRP1_OV_CNT[7]  | Group 1 count LSB   |
|               | 6    | 0                   | RW   | Y      | GRP1_OV_CNT[6]  |   |
|               | 5    | 0                   | RW   | Y      | GRP1_OV_CNT[5]  |   |
|               | 4    | 0                   | RW   | Y      | GRP1_OV_CNT[4]  |   |
|               | 3    | 0                   | RW   | Y      | GRP1_OV_CNT[3]  |   |
|               | 2    | 0                   | RW   | Y      | GRP1_OV_CNT[2]  |   |
|               | 1    | 0                   | RW   | Y      | GRP1_OV_CNT[1]  |   |
|               | 0    | 0                   | RW   | Y      | GRP1_OV_CNT[0]  |   |
| 63            | 7    | 0                   | RW   | Y      | CNT_DLTA_OV_1   | Override enable for group 1 manual data rate selection  |
|               | 6    | 0                   | RW   | Y      | GRP1_OV_CNT[14] | Group 1 count MSB   |
|               | 5    | 0                   | RW   | Y      | GRP1_OV_CNT[13] |   |
|               | 4    | 0                   | RW   | Y      | GRP1_OV_CNT[12] |   |
|               | 3    | 0                   | RW   | Y      | GRP1_OV_CNT[11] |   |
|               | 2    | 0                   | RW   | Y      | GRP1_OV_CNT[10] |   |
|               | 1    | 0                   | RW   | Y      | GRP1_OV_CNT[9]  |   |
|               | 0    | 0                   | RW   | Y      | GRP1_OV_CNT[8]  |   |
| 64            | 7    | 0                   | RW   | Y      | GRP0_OV_DLTA[3] | Sets the PPM delta tolerance for the PPM counter lock check for group 0. Must also program channel Reg_0x67[7]. |
|               | 6    | 0                   | RW   | Y      | GRP0_OV_DLTA[2] |   |
|               | 5    | 0                   | RW   | Y      | GRP0_OV_DLTA[1] |   |
|               | 4    | 0                   | RW   | Y      | GRP0_OV_DLTA[0] |   |
|               | 3    | 0                   | RW   | Y      | GRP1_OV_DLTA[3] | Sets the PPM delta tolerance for the PPM counter lock check for group 1. Must also program channel Reg_0x67[6]. |
|               | 2    | 0                   | RW   | Y      | GRP1_OV_DLTA[2] |   |
|               | 1    | 0                   | RW   | Y      | GRP1_OV_DLTA[1] |   |
|               | 0    | 0                   | RW   | Y      | GRP1_OV_DLTA[0] |   |
| 65            | 7    | 0                   | RW   | N      | RESERVED        | RESERVED  |
|               | 6    | 0                   | RW   | N      | RESERVED        | RESERVED  |
|               | 5    | 0                   | RW   | N      | RESERVED        | RESERVED  |
|               | 4    | 0                   | RW   | N      | RESERVED        | RESERVED  |
|               | 3    | 0                   | RW   | N      | RESERVED        | RESERVED  |
|               | 2    | 0                   | RW   | N      | RESERVED        | RESERVED  |
|               | 1    | 0                   | RW   | N      | RESERVED        | RESERVED  |
|               | 0    | 0                   | RW   | N      | RESERVED        | RESERVED  |
| 66            | 7    | 0                   | RW   | N      | RESERVED        | RESERVED  |
|               | 6    | 0                   | RW   | N      | RESERVED        | RESERVED  |
|               | 5    | 0                   | RW   | N      | RESERVED        | RESERVED  |
|               | 4    | 0                   | RW   | N      | RESERVED        | RESERVED  |
|               | 3    | 0                   | RW   | N      | RESERVED        | RESERVED  |
|               | 2    | 0                   | RW   | N      | RESERVED        | RESERVED  |
|               | 1    | 0                   | RW   | N      | RESERVED        | RESERVED  |
|               | 0    | 0                   | RW   | N      | RESERVED        | RESERVED  |

**Table 11. Channel Registers, 3A to A9 (continued)**

| ADDRESS (Hex) | BITS | DEFAULT VALUE (Hex) | MODE | EEPROM | FIELD NAME       | DESCRIPTION  |
|---------------|------|---------------------|------|--------|------------------|--|
| 67            | 7    | 0                   | RW   | Y      | GRP0_OV_DLTA[4]  |  |
|               | 6    | 0                   | RW   | Y      | GRP1_OV_DLTA[4]  |  |
|               | 5    | 1                   | RW   | Y      | HV_LOCKMON_EN    | 1: Enable periodic monitoring of HEO/VEO for lock qualification.<br>0: Disable periodic HEO/VEO monitoring for lock qualification. |
|               | 4    | 0                   | RW   | N      | RESERVED         | RESERVED   |
|               | 3    | 0                   | RW   | N      | RESERVED         | RESERVED   |
|               | 2    | 0                   | RW   | N      | RESERVED         | RESERVED   |
|               | 1    | 0                   | RW   | N      | RESERVED         | RESERVED   |
|               | 0    | 0                   | RW   | N      | RESERVED         | RESERVED   |
| 68            | 7    | 0                   | RW   | N      | RESERVED         | RESERVED   |
|               | 6    | 0                   | RW   | N      | RESERVED         | RESERVED   |
|               | 5    | 0                   | RW   | N      | RESERVED         | RESERVED   |
|               | 4    | 0                   | RW   | N      | RESERVED         | RESERVED   |
|               | 3    | 0                   | RW   | N      | RESERVED         | RESERVED   |
|               | 2    | 0                   | RW   | N      | RESERVED         | RESERVED   |
|               | 1    | 0                   | RW   | N      | RESERVED         | RESERVED   |
|               | 0    | 0                   | RW   | N      | RESERVED         | RESERVED   |
| 69            | 7    | 0                   | RW   | N      | RESERVED         | RESERVED   |
|               | 6    | 0                   | RW   | N      | RESERVED         | RESERVED   |
|               | 5    | 0                   | RW   | N      | RESERVED         | RESERVED   |
|               | 4    | 0                   | RW   | N      | RESERVED         | RESERVED   |
|               | 3    | 1                   | RW   | Y      | RESERVED         | RESERVED   |
|               | 2    | 0                   | RW   | Y      | RESERVED         | RESERVED   |
|               | 1    | 1                   | RW   | Y      | RESERVED         | RESERVED   |
|               | 0    | 0                   | RW   | Y      | RESERVED         | RESERVED   |
| 6A            | 7    | 0                   | RW   | Y      | VEO_LCK_THRSH[3] | VEO threshold to meet before lock is established. The LSB step size is 4 counts of VEO.  |
|               | 6    | 0                   | RW   | Y      | VEO_LCK_THRSH[2] |  |
|               | 5    | 1                   | RW   | Y      | VEO_LCK_THRSH[1] |  |
|               | 4    | 0                   | RW   | Y      | VEO_LCK_THRSH[0] |  |
|               | 3    | 0                   | RW   | Y      | HEO_LCK_THRSH[3] | HEO threshold to meet before lock is established. The LSB step size is 4 counts of HEO.  |
|               | 2    | 0                   | RW   | Y      | HEO_LCK_THRSH[2] |  |
|               | 1    | 0                   | RW   | Y      | HEO_LCK_THRSH[1] |  |
|               | 0    | 1                   | RW   | Y      | HEO_LCK_THRSH[0] |  |
| 6B            | 7    | 0                   | RW   | Y      | RESERVED         | RESERVED   |
|               | 6    | 1                   | RW   | Y      | FOM_A[6]         | Alternate Figure of Merit variable A. Max value for this register is 128.  |
|               | 5    | 0                   | RW   | Y      | FOM_A[5]         |  |
|               | 4    | 0                   | RW   | Y      | FOM_A[4]         |  |
|               | 3    | 0                   | RW   | Y      | FOM_A[3]         |  |
|               | 2    | 0                   | RW   | Y      | FOM_A[2]         |  |
|               | 1    | 0                   | RW   | Y      | FOM_A[1]         |  |
|               | 0    | 0                   | RW   | Y      | FOM_A[0]         |  |

**Table 11. Channel Registers, 3A to A9 (continued)**

| ADDRESS (Hex) | BITS | DEFAULT VALUE (Hex) | MODE | EEPROM | FIELD NAME      | DESCRIPTION  |
|---------------|------|---------------------|------|--------|-----------------|--|
| 6C            | 7    | 0                   | RW   | Y      | FOM_B[7]        | HEO adjustment for Alternate FoM, variable B   |
|               | 6    | 0                   | RW   | Y      | FOM_B[6]        |  |
|               | 5    | 0                   | RW   | Y      | FOM_B[5]        |  |
|               | 4    | 0                   | RW   | Y      | FOM_B[4]        |  |
|               | 3    | 0                   | RW   | Y      | FOM_B[3]        |  |
|               | 2    | 0                   | RW   | Y      | FOM_B[2]        |  |
|               | 1    | 0                   | RW   | Y      | FOM_B[1]        |  |
|               | 0    | 0                   | RW   | Y      | FOM_B[0]        |  |
| 6D            | 7    | 0                   | RW   | Y      | FOM_C[7]        | VEO adjustment for Alternate FoM, variable C   |
|               | 6    | 0                   | RW   | Y      | FOM_C[6]        |  |
|               | 5    | 0                   | RW   | Y      | FOM_C[5]        |  |
|               | 4    | 0                   | RW   | Y      | FOM_C[4]        |  |
|               | 3    | 0                   | RW   | Y      | FOM_C[3]        |  |
|               | 2    | 0                   | RW   | Y      | FOM_C[2]        |  |
|               | 1    | 0                   | RW   | Y      | FOM_C[1]        |  |
|               | 0    | 0                   | RW   | Y      | FOM_C[0]        |  |
| 6E            | 7    | 0                   | RW   | Y      | EN_NEW_FOM_CTLE | 1: CTLE adaption state machine will use the alternate FoM<br>$HEO\_ALT = (HEO-B)*A*2VEO\_ALT = (VEO-C)*(1-A)*2$<br>The values of A,B,C are set in channel Reg_0x6B, 0x6C, and 0x6D. The value of A is equal to the register value divided by 128. The Alternate FoM = $(HEOB)*A*2 + (VEO-C)*(1-A)*2$ |
|               | 6    | 0                   | RW   | Y      | EN_NEW_FOM_DFE  | 1: DFE adaption state machine will use the alternate FoM.<br>$HEO\_ALT = (HEO-B)*A*2VEO\_ALT = (VEO-C)*(1-A)*2$<br>The values of A,B,C are set in channel Reg_0x6B, 0x6C, and 0x6D. The value of A is equal to the register value divided by 128. The Alternate FoM = $(HEOB)*A*2 + (VEO-C)*(1-A)*2$ |
|               | 5    | 0                   | RW   | N      | RESERVED        | RESERVED   |
|               | 4    | 0                   | RW   | N      | RESERVED        | RESERVED   |
|               | 3    | 0                   | RW   | N      | RESERVED        | RESERVED   |
|               | 2    | 0                   | RW   | N      | RESERVED        | RESERVED   |
|               | 1    | 0                   | RW   | N      | RESERVED        | RESERVED   |
|               | 0    | 0                   | RW   | N      | RESERVED        | RESERVED   |

**Table 11. Channel Registers, 3A to A9 (continued)**

| ADDRESS (Hex) | BITS | DEFAULT VALUE (Hex) | MODE | EEPROM         | FIELD NAME          | DESCRIPTION  |
|---------------|------|---------------------|------|----------------|---------------------|--|
| 6F            | 7    | 0                   | RW   | Y              | MR_EN_LOW_DIVSEL_EQ | Normally, during adaptation, if the divider setting is >2, then a fixed EQ setting, from Reg_0x3A will be used. However, if Reg_0x6F[7]=1, then an EQ adaptation will be performed instead.  |
|               | 6    | 0                   | RW   | Y              | RESERVED            | RESERVED   |
|               | 5    | 0                   | RW   | Y              | RESERVED            | RESERVED   |
|               | 4    | 0                   | RW   | N              | RESERVED            | RESERVED   |
|               | 3    | 0                   | RW   | N              | RESERVED            | RESERVED   |
|               | 2    | 0                   | RW   | N              | RESERVED            | RESERVED   |
|               | 1    | 0                   | RW   | N              | RESERVED            | RESERVED   |
|               | 0    | 0                   | RW   | N              | RESERVED            | RESERVED   |
| 70            | 7    | 0                   | RW   | N              | RESERVED            | RESERVED   |
|               | 6    | 0                   | RW   | N              | RESERVED            | RESERVED   |
|               | 5    | 0                   | RW   | N              | RESERVED            | RESERVED   |
|               | 4    | 0                   | RW   | N              | RESERVED            | RESERVED   |
|               | 3    | 0                   | RW   | Y              | EQ_LB_CNT[3]        | CTLE look-beyond count for adaptation  |
|               | 2    | 1                   | RW   | Y              | EQ_LB_CNT[2]        |  |
|               | 1    | 0                   | RW   | Y              | EQ_LB_CNT[1]        |  |
| 0             | 1    | RW                  | Y    | EQ_LB_CNT[0]   |                     |  |
| 71            | 7    | 0                   | R    | N              | PRBS_INT            | When enabled by Reg_0x31[7], goes HI if a PRBS stream is detected. Clears on reading. PRBS checker must be enabled with Reg_0x30[3]. Once cleared, if a PRBS error occurs, then the interrupt will again go HI. Clears on reading. If signal detect is lost, this is considered a PRBS error, and the interrupt will go HI. Clears on reading. |
|               | 6    | 0                   | R    | N              | RESERVED            | RESERVED   |
|               | 5    | 0                   | R    | N              | DFE_POL_1_OBS       | DFE tap 1 polarity observation   |
|               | 4    | 0                   | R    | N              | DFE_WT1_OBS[4]      | DFE tap 1 weight observation   |
|               | 3    | 0                   | R    | N              | DFE_WT1_OBS[3]      |  |
|               | 2    | 0                   | R    | N              | DFE_WT1_OBS[2]      |  |
|               | 1    | 0                   | R    | N              | DFE_WT1_OBS[1]      |  |
|               | 0    | 0                   | R    | N              | DFE_WT1_OBS[0]      |  |
| 72            | 7    | 0                   | R    | N              | RESERVED            | RESERVED   |
|               | 6    | 0                   | R    | N              | RESERVED            | RESERVED   |
|               | 5    | 0                   | R    | N              | RESERVED            | RESERVED   |
|               | 4    | 0                   | R    | N              | DFE_POL_2_OBS       | Primary observation point for DFE tap 2 polarity   |
|               | 3    | 0                   | R    | N              | DFE_WT2_OBS[3]      | Primary observation point for DFE tap 2 weight   |
|               | 2    | 0                   | R    | N              | DFE_WT2_OBS[2]      |  |
|               | 1    | 0                   | R    | N              | DFE_WT2_OBS[1]      |  |
| 0             | 0    | R                   | N    | DFE_WT2_OBS[0] |                     |  |



**Table 11. Channel Registers, 3A to A9 (continued)**

| ADDRESS (Hex) | BITS | DEFAULT VALUE (Hex) | MODE | EEPROM | FIELD NAME           | DESCRIPTION  |
|---------------|------|---------------------|------|--------|----------------------|--|
| 73            | 7    | 0                   | R    | N      | RESERVED             | RESERVED   |
|               | 6    | 0                   | R    | N      | RESERVED             | RESERVED   |
|               | 5    | 0                   | R    | N      | RESERVED             | RESERVED   |
|               | 4    | 0                   | R    | N      | DFE_POL_3_OBS        | Primary observation point for DFE tap 3 polarity   |
|               | 3    | 0                   | R    | N      | DFE_WT3_OBS[3]       | Primary observation point for DFE tap 3 weight     |
|               | 2    | 0                   | R    | N      | DFE_WT3_OBS[2]       |  |
|               | 1    | 0                   | R    | N      | DFE_WT3_OBS[1]       |  |
|               | 0    | 0                   | R    | N      | DFE_WT3_OBS[0]       |  |
| 74            | 7    | 0                   | R    | N      | RESERVED             | RESERVED   |
|               | 6    | 0                   | R    | N      | RESERVED             | RESERVED   |
|               | 5    | 0                   | R    | N      | RESERVED             | RESERVED   |
|               | 4    | 0                   | R    | N      | DFE_POL_4_OBS        | Primary observation point for DFE tap 4 polarity   |
|               | 3    | 0                   | R    | N      | DFE_WT4_OBS[3]       | Primary observation point for DFE tap 4 weight     |
|               | 2    | 0                   | R    | N      | DFE_WT4_OBS[2]       |  |
|               | 1    | 0                   | R    | N      | DFE_WT4_OBS[1]       |  |
|               | 0    | 0                   | R    | N      | DFE_WT4_OBS[0]       |  |
| 75            | 7    | 0                   | R    | N      | RESERVED             | RESERVED   |
|               | 6    | 0                   | R    | N      | RESERVED             | RESERVED   |
|               | 5    | 0                   | R    | N      | RESERVED             | RESERVED   |
|               | 4    | 0                   | R    | N      | DFE_POL_5_OBS        | Primary observation point for DFE tap 5 polarity   |
|               | 3    | 0                   | R    | N      | DFE_WT5_OBS[3]       | Primary observation point for DFE tap 5 weight     |
|               | 2    | 0                   | R    | N      | DFE_WT5_OBS[2]       |  |
|               | 1    | 0                   | R    | N      | DFE_WT5_OBS[1]       |  |
|               | 0    | 0                   | R    | N      | DFE_WT5_OBS[0]       |  |
| 76            | 7    | 0                   | RW   | Y      | POST_LOCK_VEO_THR[3] | VEO threshold after LOCK is established            |
|               | 6    | 0                   | RW   | Y      | POST_LOCK_VEO_THR[2] |  |
|               | 5    | 1                   | RW   | Y      | POST_LOCK_VEO_THR[1] |  |
|               | 4    | 0                   | RW   | Y      | POST_LOCK_VEO_THR[0] |  |
|               | 3    | 0                   | RW   | Y      | POST_LOCK_HEO_THR[3] | HEO threshold after LOCK is established            |
|               | 2    | 0                   | RW   | Y      | POST_LOCK_HEO_THR[2] |  |
|               | 1    | 0                   | RW   | Y      | POST_LOCK_HEO_THR[1] |  |
|               | 0    | 1                   | RW   | Y      | POST_LOCK_HEO_THR[0] |  |
| 77            | 7    | 0                   | RW   | N      | PRBS_GEN_POL_EN      | 1: Force polarity inversion on generated PRBS data |
|               | 6    | 0                   | RW   | Y      | RESERVED             | RESERVED   |
|               | 5    | 0                   | RW   | Y      | RESERVED             | RESERVED   |
|               | 4    | 1                   | RW   | Y      | RESERVED             | RESERVED   |
|               | 3    | 1                   | RW   | Y      | RESERVED             | RESERVED   |
|               | 2    | 0                   | RW   | Y      | RESERVED             | RESERVED   |
|               | 1    | 1                   | RW   | Y      | RESERVED             | RESERVED   |
|               | 0    | 0                   | RW   | N      | RESERVED             | RESERVED   |

**Table 11. Channel Registers, 3A to A9 (continued)**

| ADDRESS (Hex) | BITS | DEFAULT VALUE (Hex) | MODE | EEPROM | FIELD NAME             | DESCRIPTION  |
|---------------|------|---------------------|------|--------|------------------------|--|
| 78            | 7    | 0                   | R    | N      | RESERVED               | RESERVED   |
|               | 6    | 0                   | R    | N      | RESERVED               | RESERVED   |
|               | 5    | 0                   | R    | N      | SD_STATUS              | Primary observation point for signal detect status   |
|               | 4    | 0                   | R    | N      | CDR_LOCK_STATUS        | Primary observation point for CDR lock status  |
|               | 3    | 0                   | R    | N      | CDR_LOCK_INT           | Requires that channel Reg_0x79[1] be set.<br>1: Indicates CDR has achieved lock, lock goes from LOW to HIGH. This bit is cleared after reading. This bit will stay set until it has been cleared by reading.   |
|               | 2    | 0                   | R    | N      | SD_INT                 | Requires that channel Reg_0x79[0] be set.<br>1: Indicates signal detect status has changed. This will trigger when signal detect goes from LOW to HIGH or HIGH to LOW. This bit is cleared after reading. This bit will stay set until it has been cleared by reading. |
|               | 1    | 0                   | R    | N      | EOM_VRANGE_LIMIT_ERROR | Goes high if GET_HEO_VEO indicates high during adaptation  |
|               | 0    | 0                   | R    | N      | HEO_VEO_INT            | Requires that channel Reg_0x36[6] be set.<br>1: Indicates that HEO/VEO dropped below the limits set in channel Reg_0x76 This bit is cleared after reading. This bit will stay set until it has been cleared by reading.  |
| 79            | 7    | 0                   | RW   | N      | RESERVED               | RESERVED   |
|               | 6    | 0                   | RW   | N      | PRBS_CHK_EN            | 1: Enable the PRBS checker.<br>0: Disable the PRBS checker   |
|               | 5    | 0                   | RW   | N      | PRBS_GEN_EN            | 1: Enable the pattern generator<br>0: Disable the pattern generator  |
|               | 4    | 1                   | RW   | N      | RESERVED               | RESERVED   |
|               | 3    | 0                   | RW   | N      | RESERVED               | RESERVED   |
|               | 2    | 0                   | RW   | N      | RESERVED               | RESERVED   |
|               | 1    | 0                   | RW   | Y      | CDR_LOCK_INT_EN        | 1: Enable CDR lock interrupt, observable in channel Reg_0x78[3]<br>0: Disable CDR lock interrupt   |
|               | 0    | 0                   | RW   | Y      | SD_INT_EN              | 1: Enable signal detect interrupt, observable in channel Reg_0x78[3]<br>0: Disable signal detect interrupt   |
| 7A            | 7    | 0                   | RW   | N      | RESERVED               | RESERVED   |
|               | 6    | 0                   | RW   | N      | RESERVED               | RESERVED   |
|               | 5    | 0                   | RW   | N      | RESERVED               | RESERVED   |
|               | 4    | 0                   | RW   | N      | RESERVED               | RESERVED   |
|               | 3    | 0                   | RW   | N      | RESERVED               | RESERVED   |
|               | 2    | 0                   | RW   | N      | RESERVED               | RESERVED   |
|               | 1    | 0                   | RW   | N      | RESERVED               | RESERVED   |
|               | 0    | 0                   | RW   | N      | RESERVED               | RESERVED   |

**Table 11. Channel Registers, 3A to A9 (continued)**

| ADDRESS (Hex) | BITS | DEFAULT VALUE (Hex) | MODE | EEPROM | FIELD NAME                  | DESCRIPTION   |
|---------------|------|---------------------|------|--------|-----------------------------|---|
| 7B            | 7    | 0                   | RW   | N      | RESERVED                    | RESERVED  |
|               | 6    | 0                   | RW   | N      | RESERVED                    | RESERVED  |
|               | 5    | 0                   | RW   | N      | RESERVED                    | RESERVED  |
|               | 4    | 0                   | RW   | N      | RESERVED                    | RESERVED  |
|               | 3    | 0                   | RW   | N      | RESERVED                    | RESERVED  |
|               | 2    | 0                   | RW   | N      | RESERVED                    | RESERVED  |
|               | 1    | 0                   | RW   | N      | RESERVED                    | RESERVED  |
|               | 0    | 0                   | RW   | N      | RESERVED                    | RESERVED  |
| 7C            | 7    | 0                   | R    | N      | PRBS_FIXED[7]               | Pattern generator user defined pattern LSB. MSB located at channel Reg_0x97.  |
|               | 6    | 0                   | R    | N      | PRBS_FIXED[6]               |   |
|               | 5    | 0                   | R    | N      | PRBS_FIXED[5]               |   |
|               | 4    | 0                   | R    | N      | PRBS_FIXED[4]               |   |
|               | 3    | 0                   | R    | N      | PRBS_FIXED[3]               |   |
|               | 2    | 0                   | R    | N      | PRBS_FIXED[2]               |   |
|               | 1    | 0                   | R    | N      | PRBS_FIXED[1]               |   |
|               | 0    | 0                   | R    | N      | PRBS_FIXED[0]               |   |
| 7D            | 7    | 0                   | RW   | Y      | CONT_ADAPT_HEO_CHNG_THRS[3] | Limit for HEO change before triggering a DFE adaption while continuous DFE adaption is enabled.   |
|               | 6    | 1                   | RW   | Y      | CONT_ADAPT_HEO_CHNG_THRS[2] |   |
|               | 5    | 0                   | RW   | Y      | CONT_ADAPT_HEO_CHNG_THRS[1] |   |
|               | 4    | 0                   | RW   | Y      | CONT_ADAPT_HEO_CHNG_THRS[0] |   |
|               | 3    | 1                   | RW   | Y      | CONT_ADAPT_VEO_CHNG_THRS[3] | Limit for VEO change before triggering a DFE adaption while continuous DFE adaption is enabled. (Refer to the Programming Guide for more details) |
|               | 2    | 0                   | RW   | Y      | CONT_ADAPT_VEO_CHNG_THRS[2] |   |
|               | 1    | 0                   | RW   | Y      | CONT_ADAPT_VEO_CHNG_THRS[1] |   |
|               | 0    | 0                   | RW   | Y      | CONT_ADAPT_VEO_CHNG_THRS[0] |   |
| 7E            | 7    | 0                   | RW   | Y      | CONT_ADPT_TAP_INCR[3]       | Limit for allowable tap increase from the previous base point   |
|               | 6    | 0                   | RW   | Y      | CONT_ADPT_TAP_INCR[2]       |   |
|               | 5    | 0                   | RW   | Y      | CONT_ADPT_TAP_INCR[1]       |   |
|               | 4    | 1                   | RW   | Y      | CONT_ADPT_TAP_INCR[0]       |   |
|               | 3    | 0                   | RW   | Y      | RESERVED                    | RESERVED  |
|               | 2    | 0                   | RW   | Y      | RESERVED                    | RESERVED  |
|               | 1    | 1                   | RW   | Y      | RESERVED                    | RESERVED  |
|               | 0    | 1                   | RW   | Y      | RESERVED                    | RESERVED  |

**Table 11. Channel Registers, 3A to A9 (continued)**

| ADDRESS (Hex) | BITS | DEFAULT VALUE (Hex) | MODE | EEPROM | FIELD NAME         | DESCRIPTION   |
|---------------|------|---------------------|------|--------|--------------------|---|
| 7F            | 7    | 0                   | RW   | N      | EN_OBS_ALT_FOM     | 1: Allows for alternate FoM calculation to be shown in channel registers Reg_0x27, Reg_0x28 and Reg_0x29 instead of HEO and VEO               |
|               | 6    | 0                   | RW   | N      | RESERVED           | RESERVED  |
|               | 5    | 1                   | RW   | Y      | RESERVED           | RESERVED  |
|               | 4    | 0                   | RW   | Y      | EN_DFE_CONT_ADAPT  | 1: Continuous DFE adaption is enabled<br>0: DFE adapts only during lock and then freezes<br>(Refer to the Programming Guide for more details) |
|               | 3    | 1                   | RW   | Y      | CONT_ADPT_CMP_BOTH | 1: If continuous DFE adaption is enabled, a DFE adaption will trigger if either HEO or VEO degrades   |
|               | 2    | 0                   | RW   | Y      | CONT_ADPT_COUNT[2] | Limit for number of weights the DFE can look ahead in continuous adaption.<br>(Refer to the Programming Guide for more details)               |
|               | 1    | 1                   | RW   | Y      | CONT_ADPT_COUNT[1] |   |
|               | 0    | 0                   | RW   | Y      | CONT_ADPT_COUNT[0] |   |
| 80            | 7    | 0                   | R    | N      | RESERVED           | RESERVED  |
|               | 6    | 0                   | R    | N      | RESERVED           | RESERVED  |
|               | 5    | 0                   | R    | N      | RESERVED           | RESERVED  |
|               | 4    | 0                   | R    | N      | RESERVED           | RESERVED  |
|               | 3    | 0                   | R    | N      | RESERVED           | RESERVED  |
|               | 2    | 0                   | R    | N      | RESERVED           | RESERVED  |
|               | 1    | 0                   | R    | N      | RESERVED           | RESERVED  |
|               | 0    | 0                   | R    | N      | RESERVED           | RESERVED  |
| 81            | 7    | 1                   | R    | N      | RESERVED           | RESERVED  |
|               | 6    | 1                   | R    | N      | RESERVED           | RESERVED  |
|               | 5    | 1                   | R    | N      | RESERVED           | RESERVED  |
|               | 4    | 0                   | R    | N      | RESERVED           | RESERVED  |
|               | 3    | 0                   | R    | N      | RESERVED           | RESERVED  |
|               | 2    | 1                   | R    | N      | RESERVED           | RESERVED  |
|               | 1    | 0                   | R    | N      | RESERVED           | RESERVED  |
|               | 0    | 0                   | R    | N      | RESERVED           | RESERVED  |

**Table 11. Channel Registers, 3A to A9 (continued)**

| ADDRESS (Hex) | BITS | DEFAULT VALUE (Hex) | MODE | EEPROM | FIELD NAME       | DESCRIPTION  |
|---------------|------|---------------------|------|--------|------------------|--|
| 82            | 7    | 0                   | RW   | N      | FREEZE_PRBS_CNTR | 1: Freeze the PRBS error count to allow for readback.<br>0: Normal operation. Error counters is allowed to increment if the PRBS checker is properly configured  |
|               | 6    | 0                   | RW   | N      | RST_PRBS_CNTR    | 1: Reset the PRBS error counter.<br>0: Normal operation. Error counter is released from reset.   |
|               | 5    | 0                   | RW   | N      | PRBS_PATT_OV     | 1: Override PRBS pattern auto-detection. Forces the pattern checker to only lock onto the pattern defined in Reg_0x82[4:2].<br>0: Normal operation. Pattern checker will automatically detect the PRBS pattern                             |
|               | 4    | 0                   | RW   | N      | PRBS_PATT[2]     | Used with the PRBS checker. Usage is enabled with Reg_0x82[5]. Select PRBS pattern to be checked:<br>000 - PRBS7<br>001 - PRBS9<br>010 - PRBS11<br>011 - PRBS15<br>100 - PRBS23<br>101 - PRBS31<br>110 - PRBS58<br>111 - PRBS63            |
|               | 3    | 0                   | RW   | N      | PRBS_PATT[1]     |  |
|               | 2    | 0                   | RW   | N      | PRBS_PATT[0]     |  |
|               | 1    | 0                   | RW   | N      | PRBS_POL_OV      | 1: Override PRBS pattern auto polarity detection. Forces the pattern checker to only lock onto the polarity defined in bit 0 of this register.<br>0: Normal operation, pattern checker will automatically detect the PRBS pattern polarity |
|               | 0    | 0                   | RW   | N      | PRBS_POL         | Usage is enabled with Reg_0x82[1]=1<br>0: Forced polarity = true<br>1: Forced polarity = inverted  |
| 83            | 7    | 0                   | R    | N      | RESERVED         | RESERVED   |
|               | 6    | 0                   | R    | N      | RESERVED         | RESERVED   |
|               | 5    | 0                   | R    | N      | RESERVED         | RESERVED   |
|               | 4    | 0                   | R    | N      | RESERVED         | RESERVED   |
|               | 3    | 0                   | R    | N      | RESERVED         | RESERVED   |
|               | 2    | 0                   | R    | N      | PRBS_ERR_CNT[10] | PRBS checker error count   |
|               | 1    | 0                   | R    | N      | PRBS_ERR_CNT[9]  |  |
|               | 0    | 0                   | R    | N      | PRBS_ERR_CNT[8]  |  |
| 84            | 7    | 0                   | R    | N      | PRBS_ERR_CNT[7]  | PRBS checker error count   |
|               | 6    | 0                   | R    | N      | PRBS_ERR_CNT[6]  |  |
|               | 5    | 0                   | R    | N      | PRBS_ERR_CNT[5]  |  |
|               | 4    | 0                   | R    | N      | PRBS_ERR_CNT[4]  |  |
|               | 3    | 0                   | R    | N      | PRBS_ERR_CNT[3]  |  |
|               | 2    | 0                   | R    | N      | PRBS_ERR_CNT[2]  |  |
|               | 1    | 0                   | R    | N      | PRBS_ERR_CNT[1]  |  |
|               | 0    | 0                   | R    | N      | PRBS_ERR_CNT[0]  |  |

**Table 11. Channel Registers, 3A to A9 (continued)**

| ADDRESS (Hex) | BITS | DEFAULT VALUE (Hex) | MODE | EEPROM | FIELD NAME | DESCRIPTION |
|---------------|------|---------------------|------|--------|------------|-------------|
| 85            | 7    | 0                   | R    | N      | RESERVED   | RESERVED    |
|               | 6    | 0                   | R    | N      | RESERVED   | RESERVED    |
|               | 5    | 0                   | R    | N      | RESERVED   | RESERVED    |
|               | 4    | 0                   | R    | N      | RESERVED   | RESERVED    |
|               | 3    | 0                   | R    | N      | RESERVED   | RESERVED    |
|               | 2    | 0                   | R    | N      | RESERVED   | RESERVED    |
|               | 1    | 0                   | R    | N      | RESERVED   | RESERVED    |
|               | 0    | 0                   | R    | N      | RESERVED   | RESERVED    |
| 86            | 7    | 0                   | R    | N      | RESERVED   | RESERVED    |
|               | 6    | 0                   | R    | N      | RESERVED   | RESERVED    |
|               | 5    | 0                   | R    | N      | RESERVED   | RESERVED    |
|               | 4    | 0                   | R    | N      | RESERVED   | RESERVED    |
|               | 3    | 0                   | R    | N      | RESERVED   | RESERVED    |
|               | 2    | 0                   | R    | N      | RESERVED   | RESERVED    |
|               | 1    | 0                   | R    | N      | RESERVED   | RESERVED    |
|               | 0    | 0                   | R    | N      | RESERVED   | RESERVED    |
| 87            | 7    | 0                   | R    | N      | RESERVED   | RESERVED    |
|               | 6    | 0                   | R    | N      | RESERVED   | RESERVED    |
|               | 5    | 0                   | R    | N      | RESERVED   | RESERVED    |
|               | 4    | 0                   | R    | N      | RESERVED   | RESERVED    |
|               | 3    | 0                   | R    | N      | RESERVED   | RESERVED    |
|               | 2    | 0                   | R    | N      | RESERVED   | RESERVED    |
|               | 1    | 0                   | R    | N      | RESERVED   | RESERVED    |
|               | 0    | 0                   | R    | N      | RESERVED   | RESERVED    |
| 88            | 7    | 0                   | R    | N      | RESERVED   | RESERVED    |
|               | 6    | 0                   | R    | N      | RESERVED   | RESERVED    |
|               | 5    | 0                   | R    | N      | RESERVED   | RESERVED    |
|               | 4    | 0                   | R    | N      | RESERVED   | RESERVED    |
|               | 3    | 0                   | R    | N      | RESERVED   | RESERVED    |
|               | 2    | 0                   | R    | N      | RESERVED   | RESERVED    |
|               | 1    | 0                   | R    | N      | RESERVED   | RESERVED    |
|               | 0    | 0                   | R    | N      | RESERVED   | RESERVED    |
| 89            | 7    | 0                   | R    | N      | RESERVED   | RESERVED    |
|               | 6    | 0                   | R    | N      | RESERVED   | RESERVED    |
|               | 5    | 0                   | R    | N      | RESERVED   | RESERVED    |
|               | 4    | 0                   | R    | N      | RESERVED   | RESERVED    |
|               | 3    | 0                   | R    | N      | RESERVED   | RESERVED    |
|               | 2    | 0                   | R    | N      | RESERVED   | RESERVED    |
|               | 1    | 0                   | R    | N      | RESERVED   | RESERVED    |
|               | 0    | 0                   | R    | N      | RESERVED   | RESERVED    |

**Table 11. Channel Registers, 3A to A9 (continued)**

| ADDRESS (Hex) | BITS | DEFAULT VALUE (Hex) | MODE | EEPROM | FIELD NAME   | DESCRIPTION   |
|---------------|------|---------------------|------|--------|--------------|---|
| 8A            | 7    | 0                   | R    | N      | RESERVED     | RESERVED  |
|               | 6    | 0                   | R    | N      | RESERVED     | RESERVED  |
|               | 5    | 0                   | R    | N      | RESERVED     | RESERVED  |
|               | 4    | 0                   | R    | N      | RESERVED     | RESERVED  |
|               | 3    | 0                   | R    | N      | RESERVED     | RESERVED  |
|               | 2    | 0                   | R    | N      | RESERVED     | RESERVED  |
|               | 1    | 0                   | R    | N      | RESERVED     | RESERVED  |
|               | 0    | 0                   | R    | N      | RESERVED     | RESERVED  |
| 8B            | 7    | 0                   | RW   | N      | RESERVED     | RESERVED  |
|               | 6    | 0                   | RW   | N      | RESERVED     | RESERVED  |
|               | 5    | 0                   | RW   | N      | RESERVED     | RESERVED  |
|               | 4    | 0                   | RW   | N      | RESERVED     | RESERVED  |
|               | 3    | 0                   | RW   | N      | RESERVED     | RESERVED  |
|               | 2    | 0                   | RW   | N      | RESERVED     | RESERVED  |
|               | 1    | 0                   | RW   | N      | RESERVED     | RESERVED  |
|               | 0    | 0                   | RW   | N      | RESERVED     | RESERVED  |
| 8C            | 7    | 0                   | RW   | N      | RESERVED     | RESERVED  |
|               | 6    | 0                   | RW   | N      | RESERVED     | RESERVED  |
|               | 5    | 0                   | RW   | N      | RESERVED     | RESERVED  |
|               | 4    | 0                   | RW   | N      | RESERVED     | RESERVED  |
|               | 3    | 0                   | RW   | N      | RESERVED     | RESERVED  |
|               | 2    | 0                   | RW   | N      | RESERVED     | RESERVED  |
|               | 1    | 0                   | RW   | N      | RESERVED     | RESERVED  |
|               | 0    | 0                   | RW   | N      | RESERVED     | RESERVED  |
| 8D            | 7    | 0                   | RW   | N      | RESERVED     | RESERVED  |
|               | 6    | 0                   | RW   | N      | RESERVED     | RESERVED  |
|               | 5    | 0                   | RW   | N      | RESERVED     | RESERVED  |
|               | 4    | 0                   | RW   | N      | RESERVED     | RESERVED  |
|               | 3    | 0                   | RW   | N      | RESERVED     | RESERVED  |
|               | 2    | 1                   | RW   | N      | RESERVED     | RESERVED  |
|               | 1    | 1                   | RW   | N      | RESERVED     | RESERVED  |
|               | 0    | 0                   | RW   | N      | RESERVED     | RESERVED  |
| 8E            | 7    | 0                   | RW   | N      | RESERVED     | RESERVED  |
|               | 6    | 0                   | RW   | N      | RESERVED     | RESERVED  |
|               | 5    | 0                   | RW   | N      | RESERVED     | RESERVED  |
|               | 4    | 0                   | RW   | N      | RESERVED     | RESERVED  |
|               | 3    | 0                   | RW   | N      | RESERVED     | RESERVED  |
|               | 2    | 0                   | RW   | N      | RESERVED     | RESERVED  |
|               | 1    | 0                   | RW   | N      | RESERVED     | RESERVED  |
|               | 0    | 0                   | RW   | Y      | VGA_SEL_GAIN | VGA selection bit :<br>1: VGA high-gain mode<br>0: VGA low-gain mode<br>(Refer to the Programming Guide for more details) |

**Table 11. Channel Registers, 3A to A9 (continued)**

| ADDRESS (Hex) | BITS | DEFAULT VALUE (Hex) | MODE | EEPROM | FIELD NAME      | DESCRIPTION  |
|---------------|------|---------------------|------|--------|-----------------|--|
| 8F            | 7    | 0                   | R    | N      | EQ_BST_TO_EQ[7] | Primary observation point for the EQ boost setting.            |
|               | 6    | 0                   | R    | N      | EQ_BST_TO_EQ[6] |  |
|               | 5    | 0                   | R    | N      | EQ_BST_TO_EQ[5] |  |
|               | 4    | 0                   | R    | N      | EQ_BST_TO_EQ[4] |  |
|               | 3    | 0                   | R    | N      | EQ_BST_TO_EQ[3] |  |
|               | 2    | 0                   | R    | N      | EQ_BST_TO_EQ[2] |  |
|               | 1    | 0                   | R    | N      | EQ_BST_TO_EQ[1] |  |
|               | 0    | 0                   | R    | N      | EQ_BST_TO_EQ[0] |  |
| 90            | 7    | 0                   | RW   | N      | RESERVED        | RESERVED   |
|               | 6    | 0                   | RW   | N      | RESERVED        | RESERVED   |
|               | 5    | 0                   | RW   | N      | RESERVED        | RESERVED   |
|               | 4    | 0                   | RW   | N      | RESERVED        | RESERVED   |
|               | 3    | 0                   | RW   | N      | RESERVED        | RESERVED   |
|               | 2    | 0                   | RW   | N      | RESERVED        | RESERVED   |
|               | 1    | 0                   | RW   | N      | RESERVED        | RESERVED   |
|               | 0    | 0                   | RW   | N      | RESERVED        | RESERVED   |
| 91            | 7    | 0                   | RW   | N      | RESERVED        | RESERVED   |
|               | 6    | 0                   | RW   | N      | RESERVED        | RESERVED   |
|               | 5    | 0                   | RW   | N      | RESERVED        | RESERVED   |
|               | 4    | 0                   | RW   | N      | RESERVED        | RESERVED   |
|               | 3    | 0                   | RW   | N      | RESERVED        | RESERVED   |
|               | 2    | 0                   | RW   | N      | RESERVED        | RESERVED   |
|               | 1    | 0                   | RW   | N      | RESERVED        | RESERVED   |
|               | 0    | 0                   | RW   | N      | RESERVED        | RESERVED   |
| 92            | 7:0  | 0                   | RW   | N      | RESERVED        | RESERVED   |
| 93            | 7:0  | 0                   | RW   | N      | RESERVED        | RESERVED   |
| 94            | 7:0  | 0                   | RW   | N      | RESERVED        | RESERVED   |
| 95            | 7    | 0                   | RW   | N      | SD_ENABLE       | 1: Force enable signal detect<br>0: Normal operation           |
|               | 6    | 0                   | RW   | N      | SD_DISABLE      | 1: Force disable signal detect<br>0: Normal operation          |
|               | 5    | 0                   | RW   | N      | DC_OFF_ENABLE   | 1: Force enable DC offset compensation<br>0: Normal operation  |
|               | 4    | 0                   | RW   | N      | DC_OFF_DISABLE  | 1: Force disable DC offset compensation<br>0: Normal operation |
|               | 3    | 1                   | RW   | N      | EQ_ENABLE       | 1: Force enable the CTLE<br>0: Normal operation                |
|               | 2    | 0                   | RW   | N      | EQ_DISABLE      | 1: Force disable the CTLE<br>0: Normal operation               |
|               | 1    | 0                   | RW   | N      | RESERVED        | RESERVED   |
|               | 0    | 0                   | RW   | N      | RESERVED        | RESERVED   |



**Table 11. Channel Registers, 3A to A9 (continued)**

| ADDRESS (Hex) | BITS | DEFAULT VALUE (Hex) | MODE | EEPROM | FIELD NAME     | DESCRIPTION  |
|---------------|------|---------------------|------|--------|----------------|--|
| 96            | 7    | 0                   | RW   | N      | RESERVED       | RESERVED   |
|               | 6    | 0                   | RW   | N      | RESERVED       | RESERVED   |
|               | 5    | 0                   | RW   | N      | RESERVED       | RESERVED   |
|               | 4    | 0                   | RW   | N      | RESERVED       | RESERVED   |
|               | 3    | 1                   | RW   | Y      | EQ_EN_LOCAL    | 1: Enable the ebuf for the local output. Can be set independently of other controls. (Refer to the Programming Guide for more details)   |
|               | 2    | 0                   | RW   | Y      | EQ_EN_FANOUT   | 1: Enable the ebuf for the fanout. Can be set independently of other controls. (Refer to the Programming Guide for more details)   |
|               | 1    | 0                   | RW   | Y      | EQ_SEL_XPNT    | 1: Indicates to a channel where it is getting its data from. 0 indicates local. 1-indicates from the cross. (Refer to the Programming Guide for more details)  |
|               | 0    | 0                   | RW   | Y      | XPNT_SLAVE     | 1: Indicates to a channel if it needs to wait for the other channel to complete its lock/adaptation. The need for this condition comes up when input of one channel is routed to the other channel or multiple channels. (Refer to the Programming Guide for more details) |
| 97            | 7    | 0                   | R    | N      | PRBS_FIXED[15] | Pattern generator user defined pattern MSB. LSB located at channel Reg_0x7C.   |
|               | 6    | 0                   | R    | N      | PRBS_FIXED[14] |  |
|               | 5    | 0                   | R    | N      | PRBS_FIXED[13] |  |
|               | 4    | 0                   | R    | N      | PRBS_FIXED[12] |  |
|               | 3    | 0                   | R    | N      | PRBS_FIXED[11] |  |
|               | 2    | 0                   | R    | N      | PRBS_FIXED[10] |  |
|               | 1    | 0                   | R    | N      | PRBS_FIXED[9]  |  |
|               | 0    | 0                   | R    | N      | PRBS_FIXED[8]  |  |
| 98            | 7:6  | 0                   | RW   | N      | RESERVED       | RESERVED   |
|               | 5:0  | 0                   | RW   | Y      | RESERVED       | RESERVED   |
| 99            | 7    | 0                   | RW   | Y      | RESERVED       | RESERVED   |
|               | 6    | 0                   | RW   | Y      | RESERVED       | RESERVED   |
|               | 5    | 1                   | RW   | Y      | RESERVED       | RESERVED   |
|               | 4    | 1                   | RW   | Y      | RESERVED       | RESERVED   |
|               | 3    | 1                   | RW   | Y      | RESERVED       | RESERVED   |
|               | 2    | 1                   | RW   | Y      | RESERVED       | RESERVED   |
|               | 1    | 1                   | RW   | Y      | RESERVED       | RESERVED   |
|               | 0    | 1                   | RW   | Y      | RESERVED       | RESERVED   |

**Table 11. Channel Registers, 3A to A9 (continued)**

| ADDRESS (Hex) | BITS | DEFAULT VALUE (Hex) | MODE | EEPROM | FIELD NAME       | DESCRIPTION  |
|---------------|------|---------------------|------|--------|------------------|--|
| 9A            | 7    | 0                   | RW   | Y      | RESERVED         | RESERVED   |
|               | 6    | 0                   | RW   | Y      | RESERVED         | RESERVED   |
|               | 5    | 1                   | RW   | Y      | RESERVED         | RESERVED   |
|               | 4    | 1                   | RW   | Y      | RESERVED         | RESERVED   |
|               | 3    | 1                   | RW   | Y      | RESERVED         | RESERVED   |
|               | 2    | 1                   | RW   | Y      | RESERVED         | RESERVED   |
|               | 1    | 1                   | RW   | Y      | RESERVED         | RESERVED   |
|               | 0    | 1                   | RW   | Y      | RESERVED         | RESERVED   |
| 9B            | 7    | 1                   | RW   | Y      | RESERVED         | RESERVED   |
|               | 6    | 1                   | RW   | Y      | RESERVED         | RESERVED   |
|               | 5    | 1                   | RW   | Y      | RESERVED         | RESERVED   |
|               | 4    | 0                   | RW   | Y      | RESERVED         | RESERVED   |
|               | 3    | 0                   | RW   | Y      | RESERVED         | RESERVED   |
|               | 2    | 0                   | RW   | Y      | RESERVED         | RESERVED   |
|               | 1    | 0                   | RW   | N      | RESERVED         | RESERVED   |
|               | 0    | 0                   | RW   | N      | RESERVED         | RESERVED   |
| 9C            | 7    | 0                   | RW   | N      | RESERVED         | RESERVED   |
|               | 6    | 0                   | RW   | N      | RESERVED         | RESERVED   |
|               | 5    | 1                   | RW   | Y      | RESERVED         | RESERVED   |
|               | 4    | 0                   | RW   | Y      | RESERVED         | RESERVED   |
|               | 3    | 0                   | RW   | Y      | RESERVED         | RESERVED   |
|               | 2    | 1                   | RW   | Y      | RESERVED         | RESERVED   |
|               | 1    | 0                   | RW   | Y      | RESERVED         | RESERVED   |
|               | 0    | 0                   | RW   | Y      | RESERVED         | RESERVED   |
| 9D            | 7    | 1                   | RW   | N      | RESERVED         | RESERVED   |
|               | 6    | 0                   | RW   | N      | RESERVED         | RESERVED   |
|               | 5    | 1                   | RW   | N      | RESERVED         | RESERVED   |
|               | 4    | 0                   | RW   | N      | RESERVED         | RESERVED   |
|               | 3    | 0                   | RW   | Y      | RESERVED         | RESERVED   |
|               | 2    | 1                   | RW   | Y      | RESERVED         | RESERVED   |
|               | 1    | 0                   | RW   | Y      | RESERVED         | RESERVED   |
|               | 0    | 1                   | RW   | N      | RESERVED         | RESERVED   |
| 9E            | 7    | 0                   | RW   | Y      | CP_EN_IDAC_PD[2] | Phase detector charge pump setting, when override is enabled. See reg_0C for other bits.     |
|               | 6    | 1                   | RW   | Y      | CP_EN_IDAC_PD[1] |  |
|               | 5    | 0                   | RW   | Y      | CP_EN_IDAC_PD[0] |  |
|               | 4    | 0                   | RW   | Y      | CP_EN_IDAC_FD[2] | Frequency detector charge pump setting, when override is enabled. See reg_0C for other bits. |
|               | 3    | 1                   | RW   | Y      | CP_EN_IDAC_FD[1] |  |
|               | 2    | 0                   | RW   | Y      | CP_EN_IDAC_FD[0] |  |
|               | 1    | 0                   | RW   | N      | RESERVED         | RESERVED   |
|               | 0    | 0                   | RW   | N      | RESERVED         | RESERVED   |
| 9F            | 7:0  | 0                   | R    | N      | NOT USED         |  |
| A0            | 7:0  | 0                   | R    | N      | NOT USED         |  |
| A1            | 7:0  | 0                   | R    | N      | NOT USED         |  |
| A2            | 7:0  | 0                   | R    | N      | NOT USED         |  |
| A3            | 7:0  | 0                   | R    | N      | NOT USED         |  |
| A4            | 7:0  | 0                   | R    | N      | NOT USED         |  |

**Table 11. Channel Registers, 3A to A9 (continued)**

| ADDRESS (Hex) | BITS | DEFAULT VALUE (Hex) | MODE | EEPROM | FIELD NAME             | DESCRIPTION   |               |
|---------------|------|---------------------|------|--------|------------------------|---|---------------|
| A5            | 7    | 0                   | RW   | Y      | PFD_SEL_DATA_PSTLCK[2] | Output mode for when the CDR is in lock. For these values to take effect, Reg_0x09[5] must be set to 0, which is the default.<br>000: Raw Data<br>001: Retimed data (default)<br>100: PRBS Generator or Fixed Pattern Generator Data<br>101: 10M clock<br>111: Mute<br>All other values are reserved. (Refer to the Programming Guide for more details) |               |
|               | 6    | 0                   | RW   | Y      | PFD_SEL_DATA_PSTLCK[1] |   |               |
|               | 5    | 1                   | RW   | Y      | PFD_SEL_DATA_PSTLCK[0] |   |               |
|               | 4    | 0                   | RW   | N      | RESERVED               |   | RESERVED      |
|               | 3    | 0                   | RW   | N      | RESERVED               |   | RESERVED      |
|               | 2    | 0                   | RW   | N      | RESERVED               |   | RESERVED      |
|               | 1    | 0                   | RW   | N      | RESERVED               |   | RESERVED      |
|               | 0    | 0                   | RW   | N      | RESERVED               |   | RESERVED      |
|               | A6   | 7                   | 0    | RW     | N                      |   | INCR_HIST_TMR |
| 6             |      | 1                   | RW   | Y      | EOM_TMR_ABRT_ON_HIT    | Enables faster scan through the eye-matrix by moving on to the next matrix point as soon as hit is observed<br>Note: This bit does not affect when slope measurement are in progress  |               |
| 5             |      | 0                   | RW   | Y      | SLP_MIN_REQ_HITS[1]    | Minimum required hit count for registering a hit during slope measurements.   |               |
| 4             |      | 0                   | RW   | Y      | SLP_MIN_REQ_HITS[0]    |   |               |
| 3             |      | 0                   | RW   | Y      | LFT_SLP                | 0: allows slope measurement for the right side of the eye<br>1: allows slope measurement for the left side of the eye   |               |
| 2             |      | 0                   | RW   | Y      | TOP_SLP                | 0: allows slope measurement for the bottom side of the eye<br>1: allows slope measurement for the top side of the eye   |               |
| 1             |      | 1                   | RW   | Y      | DFE_BATHTUB_FOM        | Enables slope-based bathtub FoM for DFE adaptation  |               |
| 0             |      | 1                   | RW   | Y      | CTLE_BATHTUB_FOM       | Enables slope-based bathtub FoM for CTLE adaptation   |               |
| A7            | 7:0  | 0                   | R    | N      | RESERVED               | RESERVED  |               |
| A8            | 7:0  | 0                   | RW   | N      | RESERVED               | RESERVED  |               |
| A9            | 7:0  | 0                   | RW   | Y      | RESERVED               | RESERVED  |               |

## 9 Application and Implementation

注

Information in the following applications sections is not part of the TI component specification, and TI does not warrant its accuracy or completeness. TI's customers are responsible for determining suitability of components for their purposes. Customers should validate and test their design implementation to confirm system functionality.

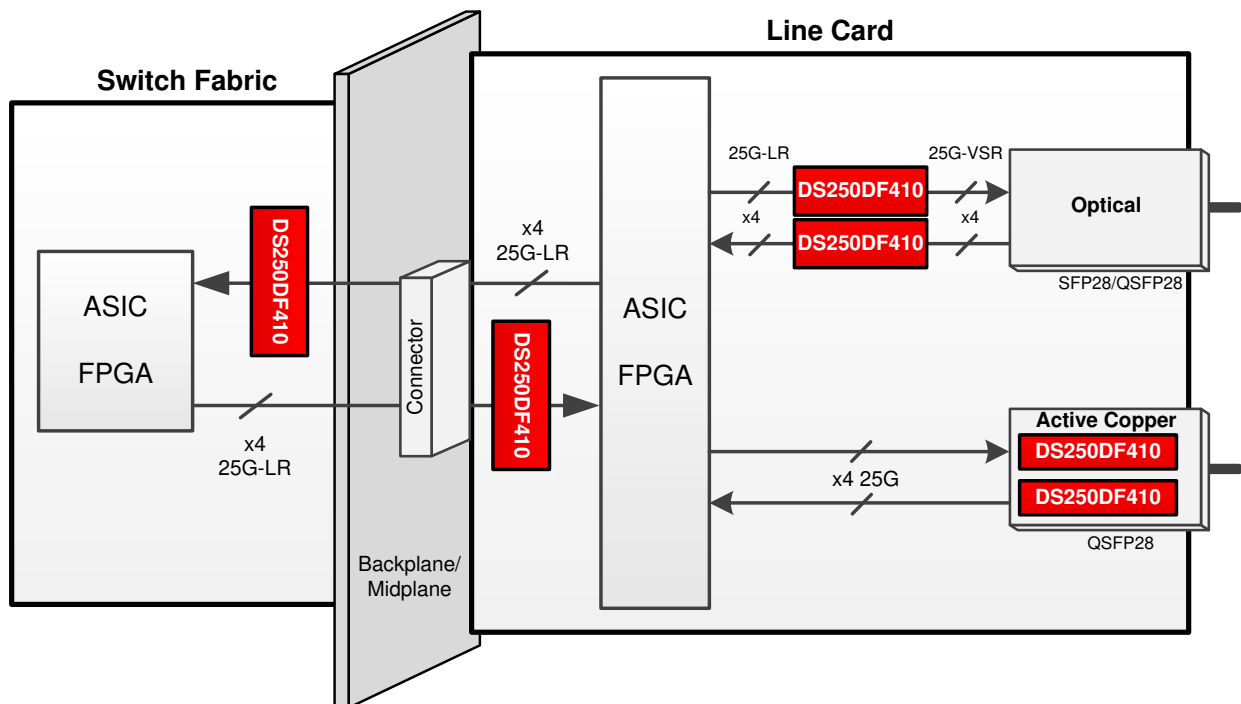
### 9.1 Application Information

The DS250DF410 is a high-speed retimer which extends the reach of differential channels and cleans jitter and other signal impairments in the process. It can be deployed in a variety of different systems from backplanes to front ports to active cable assemblies. The following sections outline typical applications and their associated design considerations.

### 9.2 Typical Applications

The DS250DF410 is typically used in the following application scenarios:

1. [Front-Port Jitter Cleaning Applications](#)
2. [Active Cable Applications](#)
3. [Backplane and Mid-plane Applications](#)



☒ 15. Typical Uses for the DS250DF410 in a System

## Typical Applications (continued)

### 9.2.1 Front-Port Jitter Cleaning Applications

The DS250DF410 has strong equalization capabilities that allow it to equalize insertion loss, reduce jitter, and extend the reach of front-port interfaces. A single DS250DF410 can be used to support all four egress channels for a 100GbE port. Another DS250DF410 can be used to support all four ingress channels for the same 100GbE ports. Alternatively, a single DS250DF410 can be used to support all egress channels for four 25GbE ports, and another DS250DF410 can be used to support all four ingress channels for the same four 25GbE ports.

For applications which require IEEE802.3 100GBASE-CR4 or 25GBASE-CR auto-negotiation and link training, a linear repeater device such as the [DS280BR810](#) (or similar) is recommended.

Figure 16 illustrates this configuration, and Figure 17 shows an example simplified schematic for a typical front-port application.

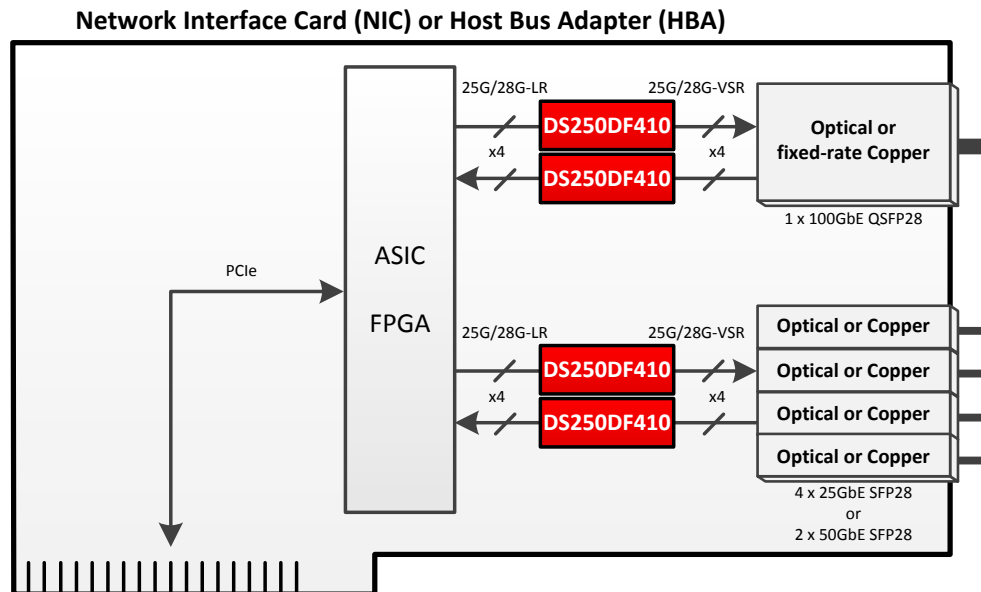
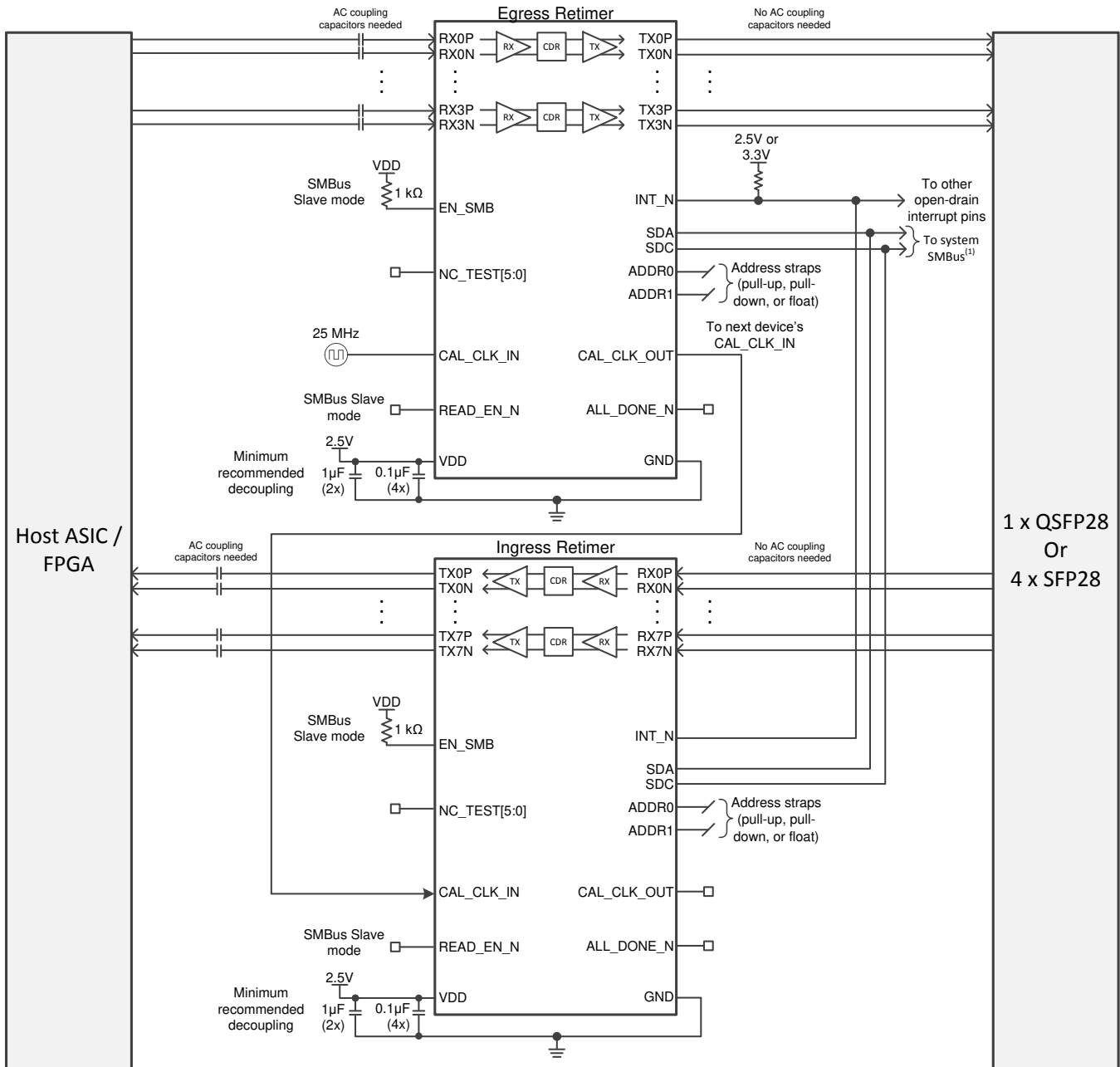


Figure 16. Front-Port Application Block Diagram

Typical Applications (continued)



(1) SMBus signals need to be pulled up elsewhere in the system.

17. Front-Port Application Schematic

9.2.1.1 Design Requirements

For this design example, the following guidelines outlined in 表 12 apply.

**Typical Applications (continued)**
**表 12. Front-Port Application Design Guidelines**

| DESIGN PARAMETER              | REQUIREMENT  |
|-------------------------------|--|
| AC coupling capacitors        | <i>Egress (ASIC-to-module) direction:</i> AC coupling capacitors in the range of 100 to 220 nF are required for the RX inputs and are NOT required for the TX outputs.<br><i>Ingress (module-to-ASIC) direction:</i> AC coupling capacitors in the range of 100 to 220 nF are required for the TX outputs and are NOT required for the RX inputs.  |
| Input channel insertion loss  | ≤ 35 dB at 25.78125 Gbps Nyquist frequency (12.9 GHz)  |
| Output channel insertion loss | <i>Egress (ASIC-to-module) direction:</i> Follow CAUI-4 / CEI-25G-VSR host channel requirements (approximately 7dB at 12.9 GHz).<br><i>Ingress (module-to-ASIC) direction:</i> Depends on downstream ASIC / FPGA capabilities. The DS250DF410 has a low-jitter output driver with 3-tap FIR filter for equalizing a portion of the output channel. |
| Host ASIC TX launch amplitude | 800 mVppd to 1200 mVppd.   |
| Host ASIC TX FIR filter       | Depends on channel loss. Refer to <a href="#">Setting the Output V<sub>OD</sub>, Pre-Cursor, and Post-Cursor Equalization</a> .  |

**9.2.1.2 Detailed Design Procedure**

The design procedure for front-port applications is as follows:

- Determine the total number of channels on the board which require a DS250DF410 for signal conditioning. This will dictate the total number of DS250DF410 devices required for the board. It is generally recommended that channels connected to the same front-port cage be grouped together in the same DS250DF410 device. This will simplify the device settings, as similar loss channels generally utilize similar settings.
- Determine the maximum current draw required for all DS250DF410 retimers. This may impact the selection of the regulator for the 2.5-V supply rail. To calculate the maximum current draw, multiply the maximum transient power supply current by the total number of DS250DF410 devices.
- Determine the maximum operational power consumption for the purpose of thermal analysis. There are two ways to approach this calculation:
  - Maximum mission-mode operational power consumption is when all channels are locked and re-transmitting the data which is received. PRBS pattern checkers/generators are not used in this mode because normal traffic cannot be checked with a PRBS checker. For this calculation, multiply the worst-case power consumption in mission mode by the total number of DS250DF410 devices.
  - Maximum debug-mode operational power consumption is when all channels are locked and re-transmitting the data which is received. At the same time, some channels' PRBS checkers or generators may be enabled. For this calculation, multiply the worst-case power consumption in debug mode by the total number of DS250DF410 devices.
- Determine the SMBus address scheme needed to uniquely address each DS250DF410 device on the board, depending on the total number of devices identified in step 2. Each DS250DF410 can be strapped with one of 16 unique SMBus addresses. If there are more DS250DF410 devices on the board than the number of unique SMBus addresses which can be assigned, then use an I2C expander like the **TCA/PCA family of I2C/SMBus switches and multiplexers** to split up the SMBus into multiple busses.
- Determine if the device will be configured from EEPROM (SMBus Master Mode) or from the system I2C bus (SMBus Slave Mode).
  - If SMBus Master Mode will be used, provisions should be made for an EEPROM on the board with 8-bit SMBus address 0xA0. Refer to [SMBus Master Mode](#) for more details on SMBus Master Mode including EEPROM size requirements.
  - If SMBus Slave Mode will be used for all device configurations, an EEPROM is not needed.
- Make provisions in the schematic and layout for standard decoupling capacitors between the device VDD supply and GND. Refer to the pin function description in [Pin Configuration and Functions](#) for more details.
- Make provisions in the schematic and layout for a 25 MHz (±100 ppm) single-ended CMOS clock. Each DS250DF410 retimer buffers the clock on the CAL\_CLK\_IN pin and presents the buffered clock on the CAL\_CLK\_OUT pin. This allows multiple (up to 20) retimers' calibration clocks to be daisy chained to avoid

the need for multiple oscillators on the board. If the oscillator used on the board has a 2.5-V CMOS output, then no AC coupling capacitor or resistor ladder is required at the input to CAL\_CLK\_IN. No AC coupling or resistor ladder is needed between one retimer's CAL\_CLK\_OUT output and the next retimer's CAL\_CLK\_IN input. The final retimer's CAL\_CLK\_OUT output can be left floating.

8. Connect the INT\_N open-drain output to an FPGA or CPU if interrupt monitoring is desired. Note that multiple retimers' INT\_N outputs can be connected together because this is an open-drain output. The common INT\_N net should be pulled high.
9. If the application requires initial CDR lock acquisition at the ambient temperature extremes defined in *Recommended Operating Conditions*, care should be taken to ensure the operating junction temperature is met as well as the CDR stay-in-lock ambient temperature range defined in *Timing Requirements, Retimer Jitter Specifications*. For example, if initial CDR lock acquisition occurs at an ambient temperature of 85 °C, then maintaining CDR lock would require the ambient temperature surrounding the DS250DF410 to be kept above (85 °C - TEMP<sub>LOCK</sub>).

**9.2.1.3 Application Curves**

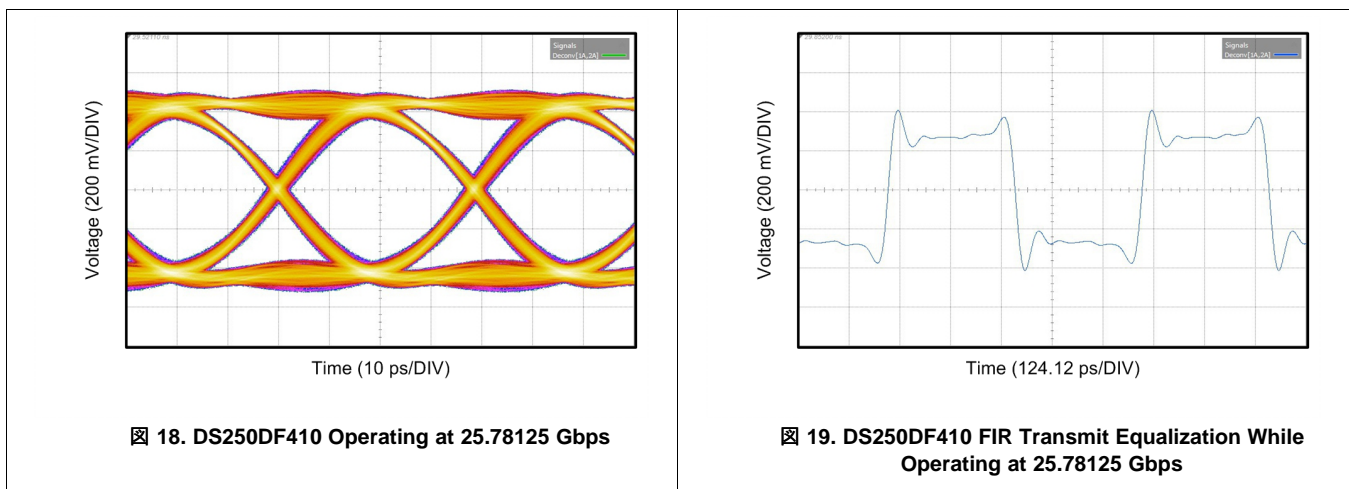


Figure 18 shows a typical output eye diagram for the DS250DF410 operating at 25.78125 Gbps with PRBS9 pattern using FIR main-cursor of +18, pre-cursor of -1 and post-cursor of +2. All other device settings are left at default.

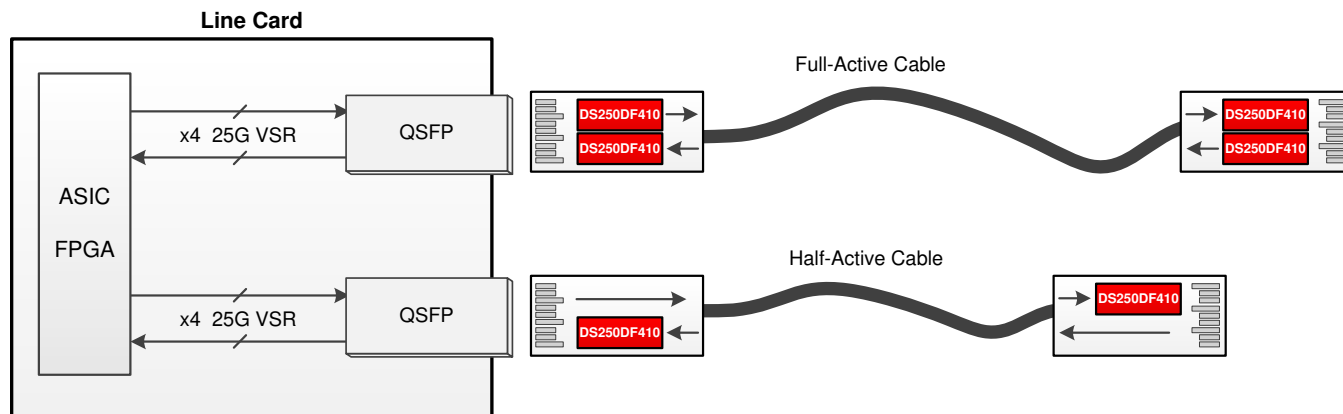
Figure 19 shows an example of DS250DF410 FIR transmit equalization while operating at 25.78125 Gbps. In this example, the Tx FIR filter main-cursor is set to +15, post-cursor to -3 and pre-cursor to -3. An 8T pattern is used to evaluate the FIR filter, which consists of 0xFF00. All other device settings are left at default.



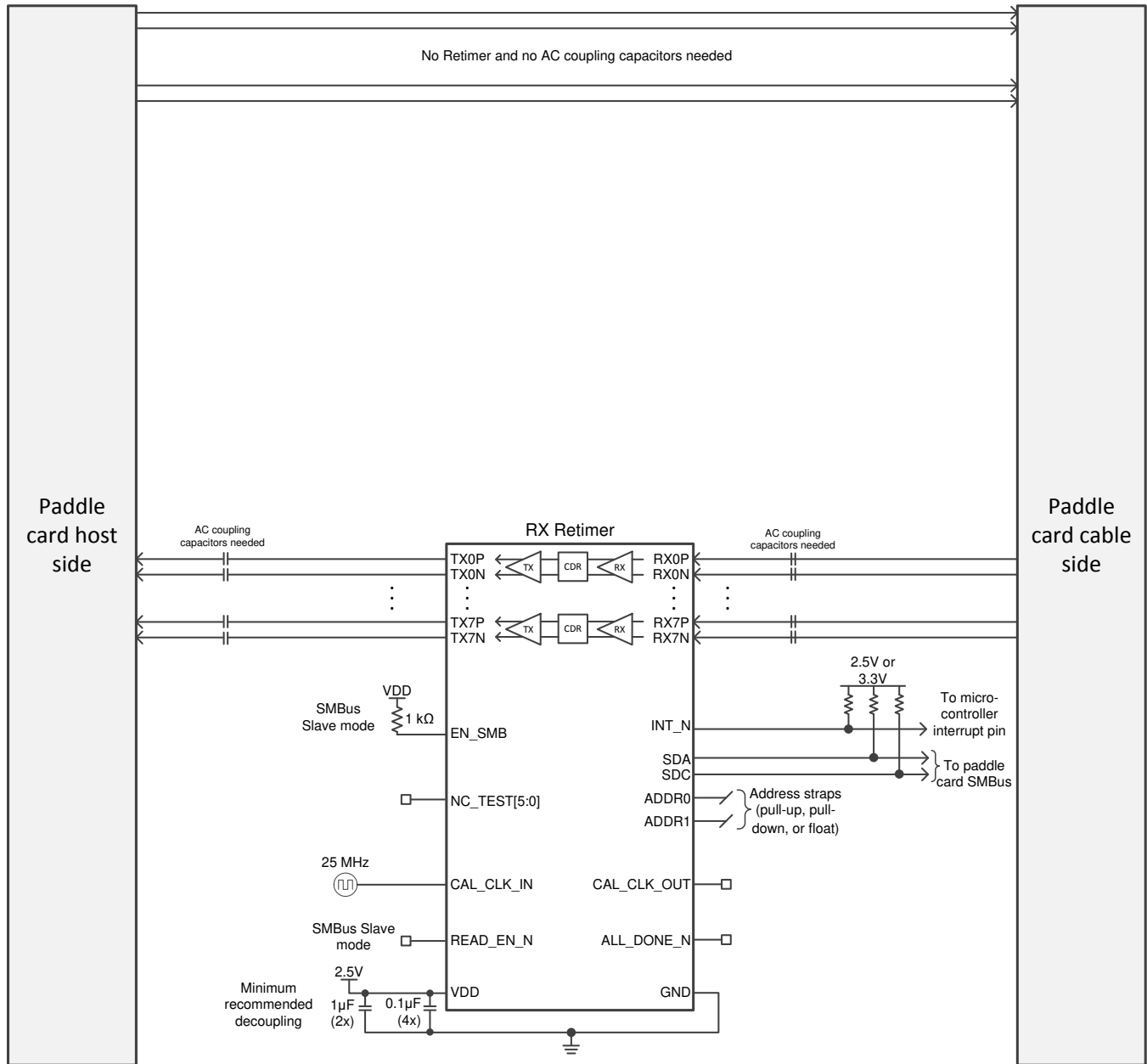
### 9.2.2 Active Cable Applications

The DS250DF410 has strong equalization capabilities that allow it to recover data over long and/or thin-gauge copper cables. A single DS250DF410 can be used on a QSFP28 paddle card to create a half-active cable assembly which is longer and/or thinner than passive cables. Alternatively, two DS250DF410 devices can be used on a QSFP28 paddle card to create a full-active cable assembly and achieve even longer reach and/or thinner cables.

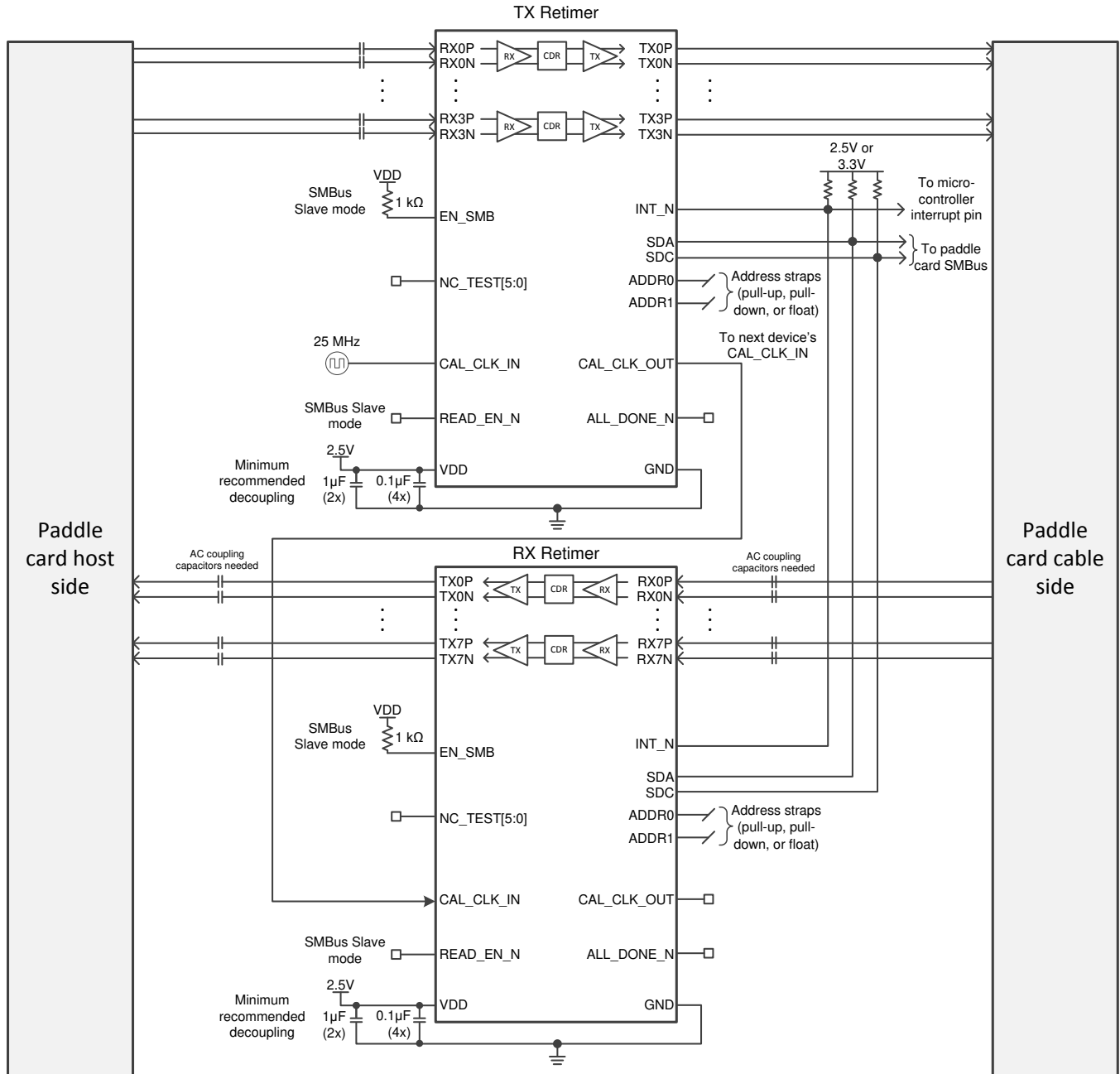
Figure 20 illustrates these configurations, Figure 21 shows an example simplified schematic for a half-active cable application, and Figure 22 shows an example simplified schematic for a full-active cable application.



**Figure 20. Active Cable Application Block Diagram**



**21. Half-Active Cable Application Schematic**



22. Full-Active Cable Application Schematic

### 9.2.2.1 Design Requirements

For this design example, the following guidelines outlined in 表 13 and 表 14 apply.

**表 13. Half-Active Cable Application Design Guidelines**

| DESIGN PARAMETER       | REQUIREMENT   |
|------------------------|---|
| Device placement       | Place the DS250DF410 on the receive side of the paddle card such that it is receiving data from the cable, and transmitting towards the host.   |
| AC coupling capacitors | 100 nF AC coupling capacitors are required for the RX inputs and the TX outputs.  |
| Cable insertion loss   | The raw cable insertion loss including the insertion loss of the paddle card should be $\leq 27$ dB at 25.78125 Gbps Nyquist frequency (12.9 GHz). This is to ensure that the total loss at the input to the DS250DF410 is $\leq 35$ dB at 12.9 GHz. Assuming a worst-case host-side PCB loss of 7 dB, plus a connector loss of 1 dB, the remaining loss allocated for the raw cable and paddle cards is 27 dB. |

**表 14. Full-Active Cable Application Design Guidelines**

| DESIGN PARAMETER       | REQUIREMENT  |
|------------------------|--|
| Device placement       | A full-active QSFP cable will utilize two pieces of DS250DF410 per paddle card. Typically, one device will be placed on each side of the paddle card.  |
| AC coupling capacitors | <i>Transmit-side Retimer:</i> 100 nF AC coupling capacitors are required for the RX inputs and are not required for the TX outputs. This link segment will be AC coupled on the paddle card at the opposite end of the cable.<br><i>Receive-side Retimer:</i> 100 nF AC coupling capacitors are required for the RX inputs and the TX outputs. |
| Cable insertion loss   | The raw cable insertion loss including the insertion loss of the paddle card should be $\leq 35$ dB at 25.78125 Gbps Nyquist frequency (12.9 GHz).   |

### 9.2.2.2 Detailed Design Procedure

The design procedure for active cable applications is as follows:

1. Determine the maximum current draw required for the DS250DF410 retimer(s) on the paddle card. This may impact the selection of the regulator for the 2.5-V supply rail. To calculate the maximum current draw, multiply the maximum transient power supply current by the total number of DS250DF410 devices.
2. Determine the maximum operational power consumption for the purpose of thermal analysis. There are two ways to approach this calculation:
  - a. Maximum mission-mode operational power consumption is when all channels are locked and re-transmitting the data which is received. PRBS pattern checkers/generators are not used in this mode because normal traffic cannot be checked with a PRBS checker. For this calculation, multiply the worst-case power consumption in mission mode by the total number of DS250DF410 devices.
  - b. Maximum debug-mode operational power consumption is when all channels are locked and re-transmitting the data which is received. At the same time, some channels' PRBS checkers or generators may be enabled. For this calculation, multiply the worst-case power consumption in debug mode by the total number of DS250DF410 devices.
3. Determine the SMBus address for the DS250DF410 Retimer(s). If using just one Retimer for a half-active cable, the ADDR[1:0] pins can be left floating for an 8-bit SMBus slave address of 0x44. If using a second DS250DF410, as in the case of a full-active cable assembly, a single pull-up or pull-down resistor can be used on one address pin. For example, with ADDR0 = Float and ADDR1 = 1 k $\Omega$  the 8-bit SMBus slave address will be 0x34.
4. Determine if the device will be configured from EEPROM (SMBus Master Mode) or from the system I2C bus (SMBus Slave Mode).
  - a. If SMBus Master Mode will be used, provisions should be made for an EEPROM on the board with 8-bit SMBus address 0xA0. Refer to [SMBus Master Mode](#) for more details on SMBus Master Mode including EEPROM size requirements.

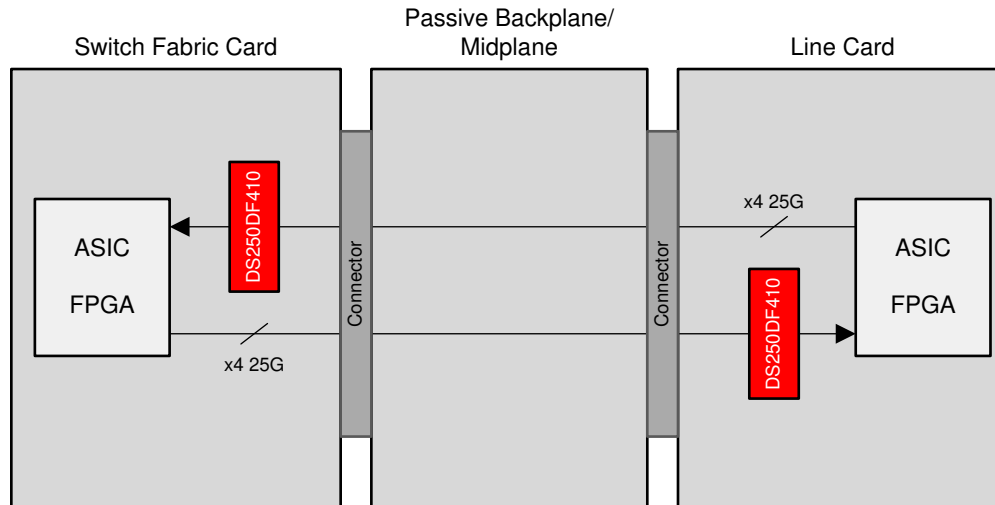
- b. If SMBus Slave Mode will be used for all device configurations, for example when the Retimer(s) is configured with a microcontroller, an EEPROM is not needed.
5. Make provisions in the schematic and layout for standard decoupling capacitors between the device VDD supply and GND. Refer to the pin function description in [Pin Configuration and Functions](#) for more details.
6. Make provisions in the schematic and layout for a 25 MHz ( $\pm 100$  ppm) single-ended CMOS clock. The DS250DF410 retimer buffers the clock on the CAL\_CLK\_IN pin and presents the buffered clock on the CAL\_CLK\_OUT pin. When using two Retimers on a paddle card, only one 25 MHz clock is required. The CAL\_CLK\_OUT pin of one retimer can be connected to the CAL\_CLK\_IN pin of the other retimer.
7. Connect the INT\_N open-drain output to the paddle card MCU if interrupt monitoring is desired, otherwise leave it floating. Note that multiple retimers' INT\_N outputs can be connected together because this is an open-drain output. The common INT\_N net should be pulled high.
8. If the application requires initial CDR lock acquisition at the ambient temperature extremes defined in [Recommended Operating Conditions](#), care should be taken to ensure the operating junction temperature is met as well as the CDR stay-in-lock ambient temperature range defined in [Timing Requirements, Retimer Jitter Specifications](#). For example, if initial CDR lock acquisition occurs at an ambient temperature of 85 °C, then maintaining CDR lock would require the ambient temperature surrounding the DS250DF410 to be kept above (85 °C - TEMP<sub>LOCK</sub>).

### 9.2.2.3 Application Curves

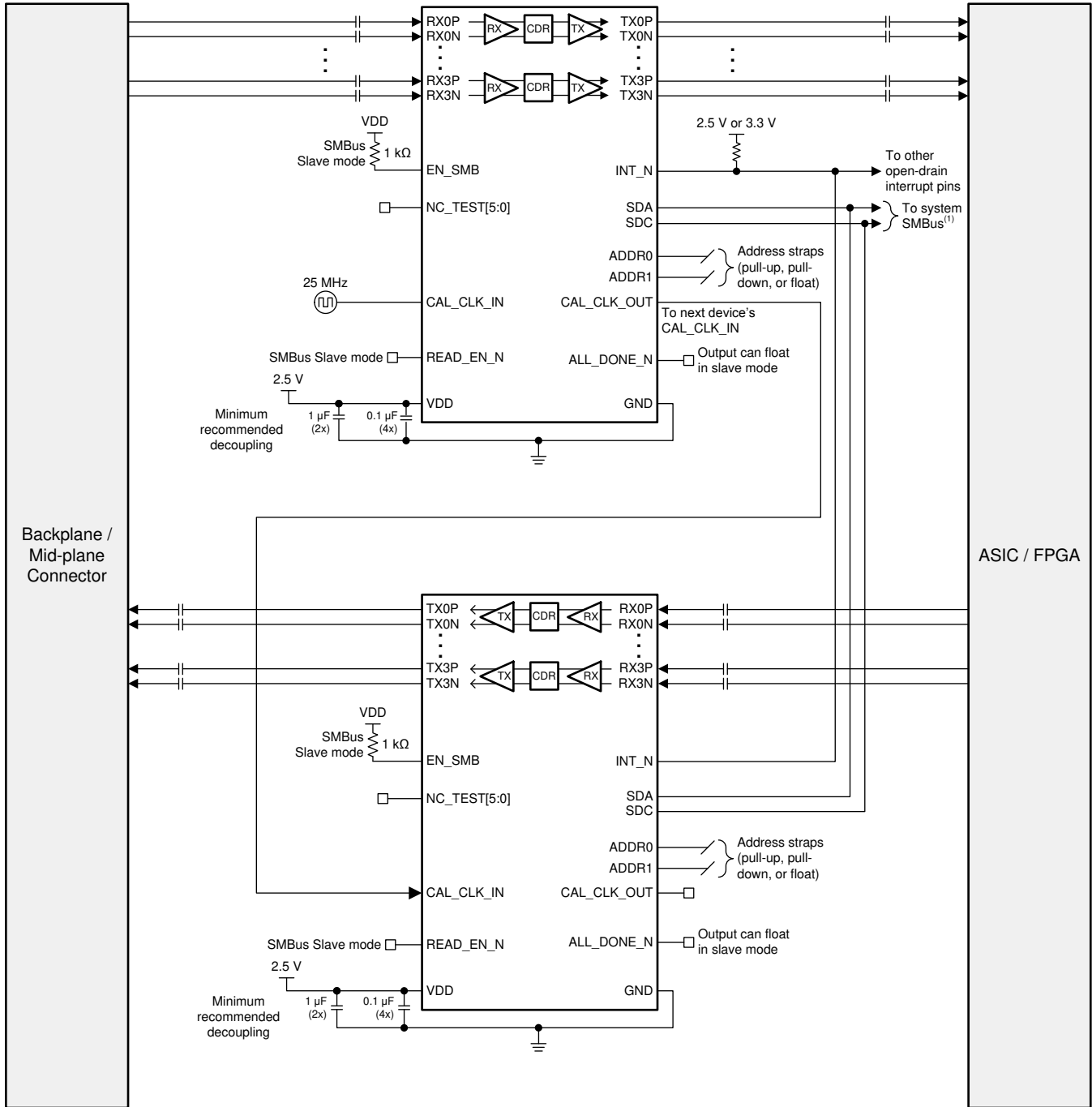
See [Application Curves](#) in section [Front-Port Jitter Cleaning Applications](#).

### 9.2.3 Backplane and Mid-plane Applications

The DS250DF410 has strong equalization capabilities that allow it to recover data over channels up to 35 dB insertion loss. As a result, the optimum placement for the DS250DF410 in a backplane/mid-plane application is with the higher-loss channel segment at the input and the lower-loss channel segment at the output. This reduces the equalization burden on the downstream ASIC/FPGA, as the DS250DF410 is equalizing a majority of the overall channel. This type of asymmetric placement is not a requirement, but when an asymmetric placement is required due to the presence of a passive backplane or mid-plane, then this becomes the recommended placement.



⊠ 23. Backplane/Mid-Plane Application Block Diagram



24. Backplane/Mid-Plane Application Schematic

### 9.2.3.1 Design Requirements

For this design example, the following guidelines outlined in 表 15 apply.

**表 15. Backplane/Mid-Plane Application Design Guidelines**

| DESIGN PARAMETER                 | REQUIREMENT   |
|----------------------------------|---|
| AC coupling capacitors           | AC coupling capacitors in the range of 100 to 220 nF are required for the RX inputs and TX outputs.   |
| Input channel insertion loss     | ≤ 35 dB at 25.78125 Gbps Nyquist frequency (12.9 GHz)   |
| Output channel insertion loss    | Depends on downstream ASIC / FPGA capabilities. The DS250DF410 has a low-jitter output driver with 3-tap FIR filter for equalizing a portion of the output channel. |
| Link partner TX launch amplitude | 800 mVppd to 1200 mVppd   |
| Link partner TX FIR filter       | Depends on channel loss. Refer to <a href="#">Setting the Output V<sub>OD</sub>, Pre-Cursor, and Post-Cursor Equalization</a> .                                     |

### 9.2.3.2 Detailed Design Procedure

The design procedure for backplane/mid-plane applications is as follows:

- Determine the total number of channels on the board which require a DS250DF410 for signal conditioning. This will dictate the total number of DS250DF410 devices required for the board. It is generally recommended that channels with similar total insertion loss on the board be grouped together in the same DS250DF410 device. This will simplify the device settings, as similar loss channels generally utilize similar settings.
- Determine the maximum current draw required for all DS250DF410 retimers. This may impact the selection of the regulator for the 2.5-V supply rail. To calculate the maximum current draw, multiply the maximum transient power supply current by the total number of DS250DF410 devices.
- Determine the maximum operational power consumption for the purpose of thermal analysis. There are two ways to approach this calculation:
  - Maximum mission-mode operational power consumption is when all channels are locked and re-transmitting the data which is received. PRBS pattern checkers/generators are not used in this mode because normal traffic cannot be checked with a PRBS checker. For this calculation, multiply the worst-case power consumption in mission mode by the total number of DS250DF410 devices.
  - Maximum debug-mode operational power consumption is when all channels are locked and re-transmitting the data which is received. At the same time, some channels' PRBS checkers or generators may be enabled. For this calculation, multiply the worst-case power consumption in debug mode by the total number of DS250DF410 devices.
- Determine the SMBus address scheme needed to uniquely address each DS250DF410 device on the board, depending on the total number of devices identified in step 2. Each DS250DF410 can be strapped with one of 16 unique SMBus addresses. If there are more DS250DF410 devices on the board than the number of unique SMBus addresses which can be assigned, then use an I2C expander like the **TCA/PCA family of I2C/SMBus switches and multiplexers** to split up the SMBus into multiple busses.
- Determine if the device will be configured from EEPROM (SMBus Master Mode) or from the system I2C bus (SMBus Slave Mode).
  - If SMBus Master Mode will be used, provisions should be made for an EEPROM on the board with 8-bit SMBus address 0xA0. Refer to [SMBus Master Mode](#) for more details on SMBus Master Mode including EEPROM size requirements.
  - If SMBus Slave Mode will be used for all device configurations, an EEPROM is not needed.
- Make provisions in the schematic and layout for standard decoupling capacitors between the device VDD supply and GND. Refer to the pin function description in [Pin Configuration and Functions](#) for more details.
- Make provisions in the schematic and layout for a 25MHz (±100 ppm) single-ended CMOS clock. Each DS250DF410 retimer buffers the clock on the CAL\_CLK\_IN pin and presents the buffered clock on the CAL\_CLK\_OUT pin. This allows multiple (up to 20) retimers' calibration clocks to be daisy chained to avoid the need for multiple oscillators on the board. If the oscillator used on the board has a 2.5-V CMOS output, then no AC coupling capacitor or resistor ladder is required at the input to CAL\_CLK\_IN. No AC coupling or resistor ladder is needed between one retimer's CAL\_CLK\_OUT output and the next retimer's CAL\_CLK\_IN input. The final retimer's CAL\_CLK\_OUT output can be left floating.



8. Connect the INT\_N open-drain output to an FPGA or CPU if interrupt monitoring is desired. Note that multiple retimers' INT\_N outputs can be connected together because this is an open-drain output. The common INT\_N net should be pulled high.
9. If the application requires initial CDR lock acquisition at the ambient temperature extremes defined in [Recommended Operating Conditions](#), care should be taken to ensure the operating junction temperature is met as well as the CDR stay-in-lock ambient temperature range defined in [Timing Requirements, Retimer Jitter Specifications](#). For example, if initial CDR lock acquisition occurs at an ambient temperature of 85 °C, then maintaining CDR lock would require the ambient temperature surrounding the DS250DF410 to be kept above (85 °C - TEMP<sub>LOCK</sub>).

### 9.2.3.3 Application Curves

See [Application Curves](#) in section [Front-Port Jitter Cleaning Applications](#).

## 10 Power Supply Recommendations

Follow these general guidelines when designing the power supply:

1. The power supply should be designed to provide the recommended operating conditions outlined in [Specifications](#) in terms of DC voltage, AC noise, and start-up ramp time.
2. The maximum current draw for the DS250DF410 is provided in [Specifications](#). This figure can be used to calculate the maximum current the power supply must provide. Typical mission-mode current draw can be inferred from the typical power consumption in [Specifications](#).
3. The DS250DF410 does not require any special power supply filtering (that is, ferrite bead), provided the recommended operating conditions are met. Only standard supply decoupling is required. Refer to [Pin Configuration and Functions](#) for details concerning the recommended supply decoupling.

## 11 Layout

### 11.1 Layout Guidelines

The following guidelines should be followed when designing the layout:

1. Decoupling capacitors should be placed as close to the VDD pins as possible. Placing them directly underneath the device is one option if the board design permits.
2. High-speed differential signals TXnP/TXnN and RXnP/RXnN should be tightly coupled, skew matched, and impedance controlled.
3. Vias should be avoided when possible on the high-speed differential signals. When vias must be used, care should be taken to minimize the via stub, either by transitioning through most/all layers, or by back drilling.
4. GND relief can be used beneath the high-speed differential signal pads to improve signal integrity by counteracting the pad capacitance.
5. GND relief can be used beneath the AC coupling capacitor pads to improve signal integrity by counteracting the pad capacitance.
6. GND vias should be placed directly beneath the device connecting the GND plane attached to the device to the GND planes on other layers. This has the added benefit of improving thermal conductivity from the device to the board.
7. BGA landing pads for a 0.5-mm pitch flip-chip BGA are typically 0.3 mm in diameter (exposed). The actual size of the copper pad will depend on whether solder-mask-defined (SMD) or non-solder-mask-defined solder land pads are used. For more information, refer to TI's Surface Mount Technology (SMT) and Packaging application notes on the TI website.
8. If vias are used for the high-speed signals, ground via should be implemented adjacent to the signal via to provide return path and isolation. For differential pair, the typical via configuration is *ground-signal-signal-ground*.
9. Note that some BGA balls in the DS250DF410 pinout have been de-populated to allow for GND and VDD vias to be placed with  $\geq 1.0$  mm via-to-via spacing.

### 11.2 Layout Example

The following example layout demonstrates how all signals can be escaped from the BGA array using microstrip routing on a generic multi-layer stackup. This example layout assumes the following:

- Trace width: 0.159 mm (6.25 mil)
- Trace edge-to-edge spacing: 0.197 mm (7.75 mil)
- VIA-to-VIA spacing: 0.7 mm (27.9 mil) minimum; Note: 1.0 mm VIA-to-VIA spacing is also achievable if PCB manufacturing rules stipulate
- No VIA-in-pad used
- Note: Some TI test pins (i.e. NC\_TEST[5:0]) are routed in this example layout, but in most applications these pins can be left floating.

Note that many other escape routing options exist using different trace width and spacing combinations. The optimum trace width and spacing will depend on the PCB material, PCB routing density, and other factors.

Layout Example (continued)

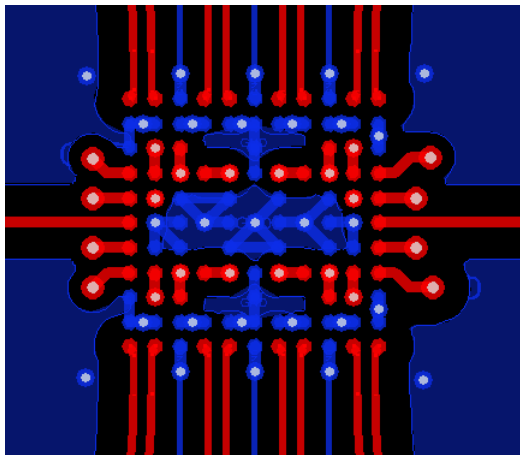


图 25. Top Layer

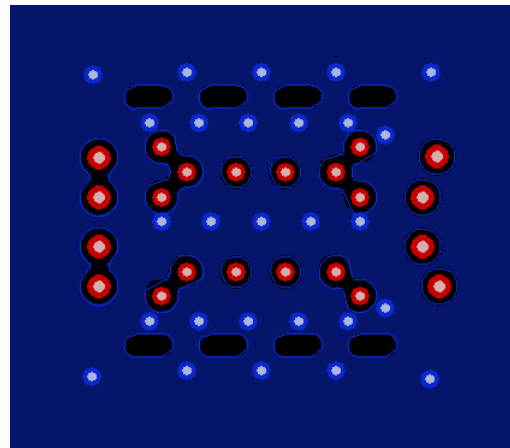


图 26. Layer 1 GND

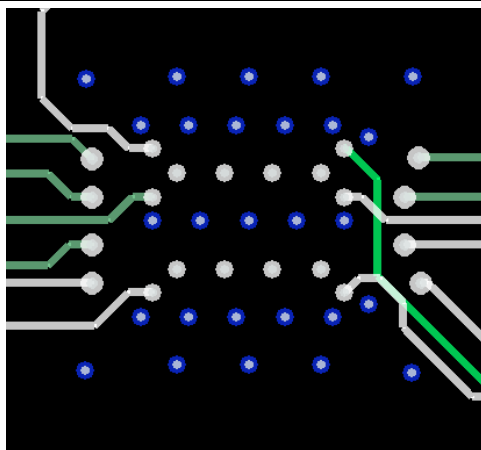


图 27. Internal Low-Speed Signal Layers

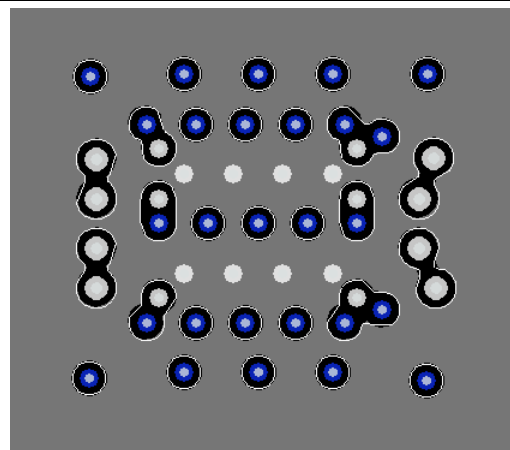


图 28. VDD Layer

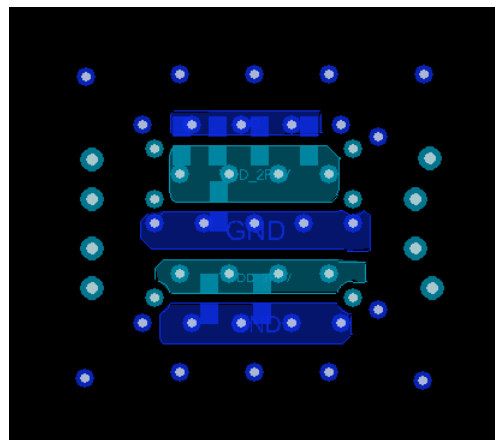


图 29. Bottom Layer

## 12 デバイスおよびドキュメントのサポート

### 12.1 ドキュメントのサポート

#### 12.1.1 開発サポート

詳細情報については、TIの表面実装テクノロジー(SMT)リファレンスを参照してください。

<http://focus.ti.com/quality/docs>(「品質および鉛(Pb)フリーのデータ」メニューの下)

### 12.2 ドキュメントのサポート

#### 12.2.1 関連資料

関連資料については、以下を参照してください。

- 『DS2x0DF810、DS250DFx10、DS250DF230プログラマ・ガイド』(SNLU182)

DS250DF410 MySecure フォルダの『DS2X0DFX10 IBIS-AMI Model and Programming Guide』(英語) へのアクセスを請求するには、[ここ](#)をクリックしてください。

### 12.3 ドキュメントの更新通知を受け取る方法

ドキュメントの更新についての通知を受け取るには、[ti.com](http://ti.com)のデバイス製品フォルダを開いてください。右上の「アラートを受け取る」をクリックして登録すると、変更されたすべての製品情報に関するダイジェストを毎週受け取れます。変更の詳細については、修正されたドキュメントに含まれている改訂履歴をご覧ください。

### 12.4 サポート・リソース

TI E2E™ [support forums](#) are an engineer's go-to source for fast, verified answers and design help — straight from the experts. Search existing answers or ask your own question to get the quick design help you need.

Linked content is provided "AS IS" by the respective contributors. They do not constitute TI specifications and do not necessarily reflect TI's views; see TI's [Terms of Use](#).

### 12.5 商標

E2E is a trademark of Texas Instruments.

### 12.6 静電気放電に関する注意事項



すべての集積回路は、適切なESD保護方法を用いて、取扱いと保存を行うようにして下さい。

静電気放電はわずかな性能の低下から完全なデバイスの故障に至るまで、様々な損傷を与えます。高精度の集積回路は、損傷に対して敏感であり、極めてわずかなパラメータの変化により、デバイスに規定された仕様に適合しなくなる場合があります。

### 12.7 Glossary

[SLYZ022](#) — *TI Glossary*.

This glossary lists and explains terms, acronyms, and definitions.

## 13 メカニカル、パッケージ、および注文情報

以降のページには、メカニカル、パッケージ、および注文に関する情報が記載されています。この情報は、そのデバイスについて利用可能な最新のデータです。このデータは予告なく変更されることがあり、ドキュメントが改訂される場合もあります。本データシートのブラウザ版を使用されている場合は、画面左側の説明をご覧ください。

**PACKAGING INFORMATION**

| Orderable Device | Status<br>(1) | Package Type | Package Drawing | Pins | Package Qty | Eco Plan<br>(2) | Lead finish/<br>Ball material<br>(6) | MSL Peak Temp<br>(3) | Op Temp (°C) | Device Marking<br>(4/5) | Samples                 |
|------------------|---------------|--------------|-----------------|------|-------------|-----------------|--------------------------------------|----------------------|--------------|-------------------------|-------------------------|
| DS250DF410ABMR   | ACTIVE        | FCCSP        | ABM             | 101  | 1000        | RoHS & Green    | SNAGCU                               | Level-3-260C-168 HR  | -40 to 85    | DS250DF4                | <a href="#">Samples</a> |
| DS250DF410ABMT   | ACTIVE        | FCCSP        | ABM             | 101  | 250         | RoHS & Green    | SNAGCU                               | Level-3-260C-168 HR  | -40 to 85    | DS250DF4                | <a href="#">Samples</a> |

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

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

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

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

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

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

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

**RoHS Exempt:** TI defines "RoHS Exempt" to mean products that contain lead but are compliant with EU RoHS pursuant to a specific EU RoHS exemption.

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

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

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

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

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

**Important Information and Disclaimer:**The information provided on this page represents TI's knowledge and belief as of the date that it is provided. TI bases its knowledge and belief on information provided by third parties, and makes no representation or warranty as to the accuracy of such information. Efforts are underway to better integrate information from third parties. TI has taken and continues to take reasonable steps to provide representative and accurate information but may not have conducted destructive testing or chemical analysis on incoming materials and chemicals. TI and TI suppliers consider certain information to be proprietary, and thus CAS numbers and other limited information may not be available for release.

In no event shall TI's liability arising out of such information exceed the total purchase price of the TI part(s) at issue in this document sold by TI to Customer on an annual basis.



**TAPE AND REEL INFORMATION**

**QUADRANT ASSIGNMENTS FOR PIN 1 ORIENTATION IN TAPE**


\*All dimensions are nominal

| Device         | Package Type | Package Drawing | Pins | SPQ  | Reel Diameter (mm) | Reel Width W1 (mm) | A0 (mm) | B0 (mm) | K0 (mm) | P1 (mm) | W (mm) | Pin1 Quadrant |
|----------------|--------------|-----------------|------|------|--------------------|--------------------|---------|---------|---------|---------|--------|---------------|
| DS250DF410ABMR | FCCSP        | ABM             | 101  | 1000 | 330.0              | 16.4               | 6.3     | 6.3     | 1.5     | 12.0    | 16.0   | Q1            |
| DS250DF410ABMT | FCCSP        | ABM             | 101  | 250  | 178.0              | 16.4               | 6.3     | 6.3     | 1.5     | 12.0    | 16.0   | Q1            |

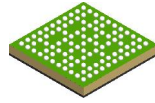
**TAPE AND REEL BOX DIMENSIONS**


\*All dimensions are nominal

| Device         | Package Type | Package Drawing | Pins | SPQ  | Length (mm) | Width (mm) | Height (mm) |
|----------------|--------------|-----------------|------|------|-------------|------------|-------------|
| DS250DF410ABMR | FCCSP        | ABM             | 101  | 1000 | 356.0       | 356.0      | 36.0        |
| DS250DF410ABMT | FCCSP        | ABM             | 101  | 250  | 208.0       | 191.0      | 35.0        |



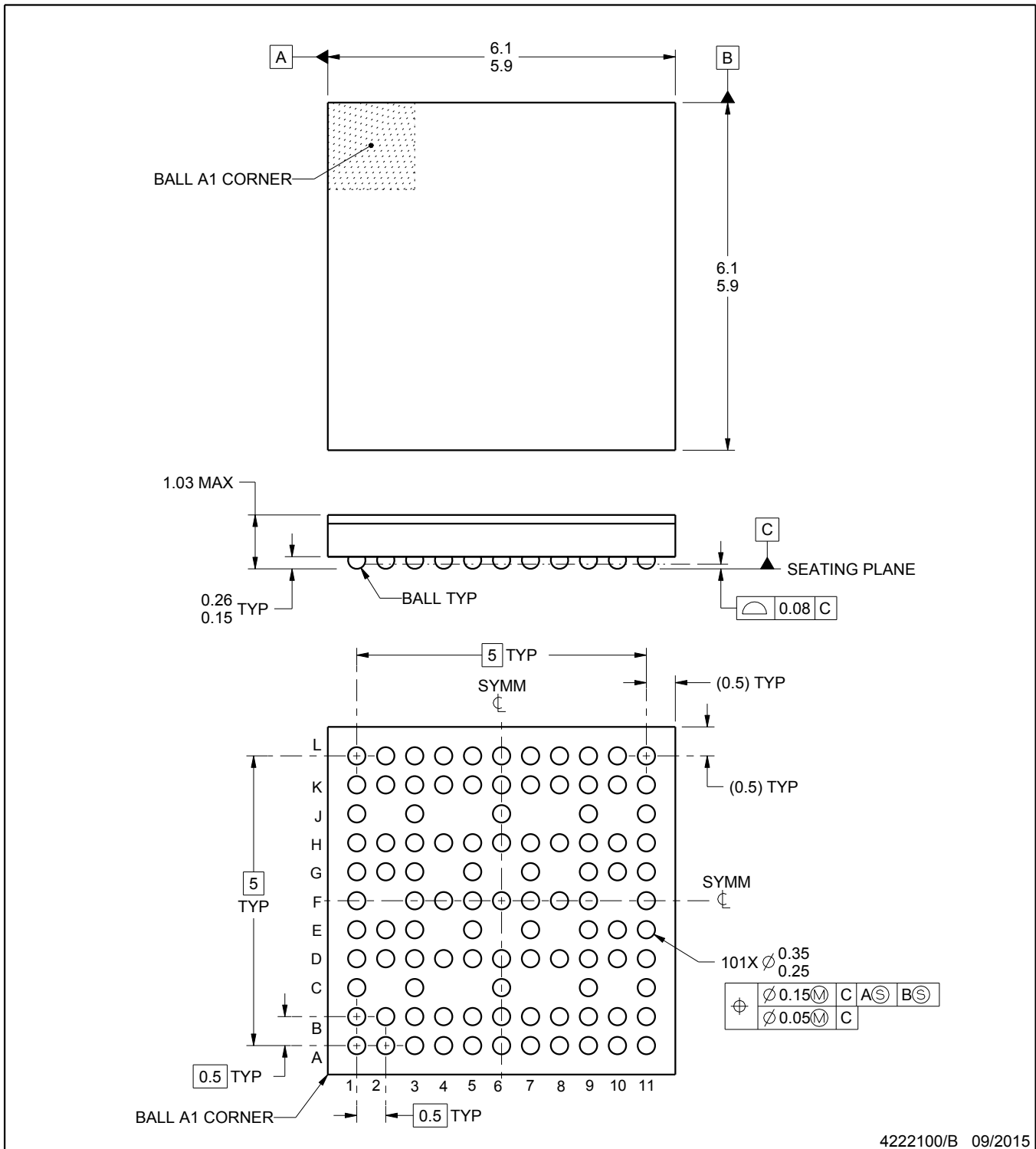
# ABM0101A



# PACKAGE OUTLINE

FCBGA - 1.03 mm max height

PLASTIC BALL GRID ARRAY



**NOTES:**

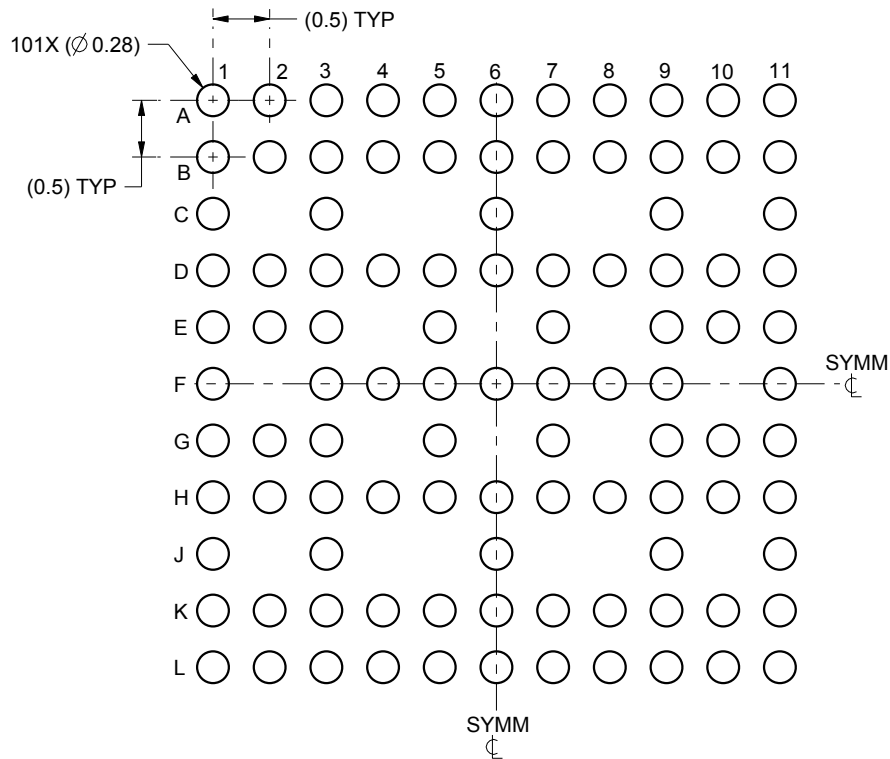
1. All linear dimensions are in millimeters. Any dimensions in parenthesis are for reference only. Dimensioning and tolerancing per ASME Y14.5M.
2. This drawing is subject to change without notice.

# EXAMPLE BOARD LAYOUT

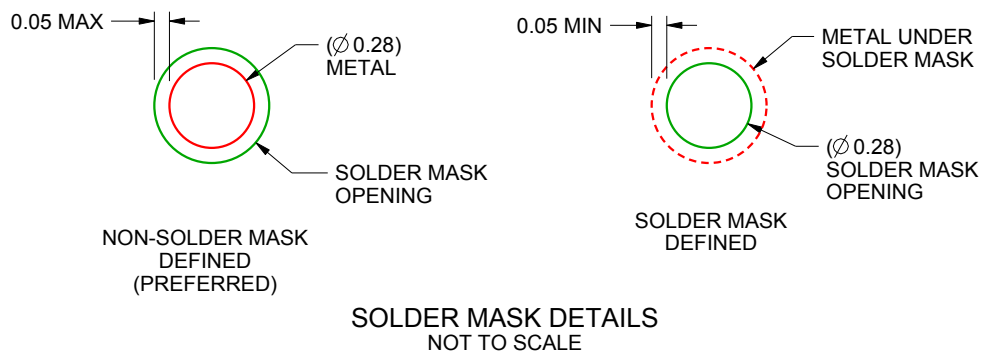
ABM0101A

FCBGA - 1.03 mm max height

PLASTIC BALL GRID ARRAY



LAND PATTERN EXAMPLE  
SCALE: 15X



SOLDER MASK DETAILS  
NOT TO SCALE

4222100/B 09/2015

NOTES: (continued)

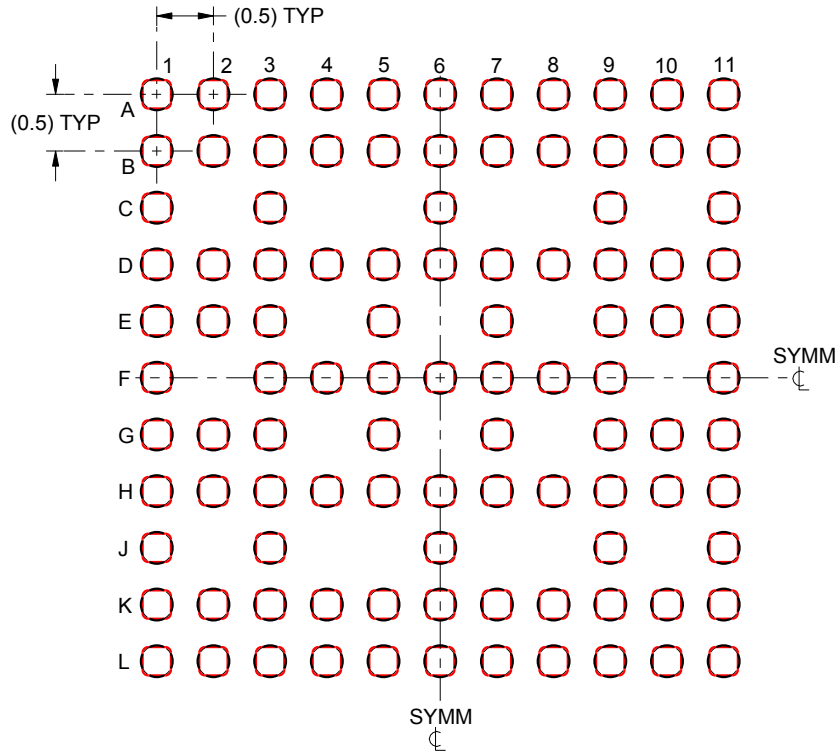
- Final dimensions may vary due to manufacturing tolerance considerations and also routing constraints. For information, see Texas Instruments literature number SPRAA99 ([www.ti.com/lit/spraa99](http://www.ti.com/lit/spraa99)).

# EXAMPLE STENCIL DESIGN

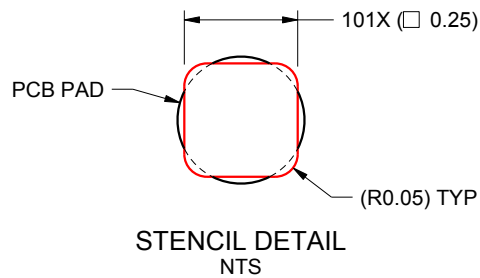
ABM0101A

FCBGA - 1.03 mm max height

PLASTIC BALL GRID ARRAY



SOLDER PASTE EXAMPLE  
BASED ON 0.1 mm THICK STENCIL  
SCALE: 15X



4222100/B 09/2015

NOTES: (continued)

4. Laser cutting apertures with trapezoidal walls and rounded corners may offer better paste release.

## 重要なお知らせと免責事項

TI は、技術データと信頼性データ(データシートを含みます)、設計リソース(リファレンス・デザインを含みます)、アプリケーションや設計に関する各種アドバイス、Web ツール、安全性情報、その他のリソースを、欠陥が存在する可能性のある「現状のまま」提供しており、商品性および特定目的に対する適合性の黙示保証、第三者の知的財産権の非侵害保証を含むいかなる保証も、明示的または黙示的にかかわらず拒否します。

これらのリソースは、TI 製品を使用する設計の経験を積んだ開発者への提供を意図したものです。(1) お客様のアプリケーションに適した TI 製品の選定、(2) お客様のアプリケーションの設計、検証、試験、(3) お客様のアプリケーションに該当する各種規格や、その他のあらゆる安全性、セキュリティ、規制、または他の要件への確実な適合に関する責任を、お客様のみが単独で負うものとし、

上記の各種リソースは、予告なく変更される可能性があります。これらのリソースは、リソースで説明されている TI 製品を使用するアプリケーションの開発の目的でのみ、TI はその使用をお客様に許諾します。これらのリソースに関して、他の目的で複製することや掲載することは禁止されています。TI や第三者の知的財産権のライセンスが付与されている訳ではありません。お客様は、これらのリソースを自身で使用した結果発生するあらゆる申し立て、損害、費用、損失、責任について、TI およびその代理人を完全に補償するものとし、TI は一切の責任を拒否します。

TI の製品は、[TI の販売条件](#)、または [ti.com](#) やかかる TI 製品の関連資料などのいずれかを通じて提供する適用可能な条項の下で提供されています。TI がこれらのリソースを提供することは、適用される TI の保証または他の保証の放棄の拡大や変更を意味するものではありません。

お客様がいかなる追加条項または代替条項を提案した場合でも、TI はそれらに異議を唱え、拒否します。

郵送先住所 : Texas Instruments, Post Office Box 655303, Dallas, Texas 75265  
Copyright © 2024, Texas Instruments Incorporated