

# DS26324

## 3.3V, 16-Channel, E1/T1/J1 Short-Haul Line Interface Unit

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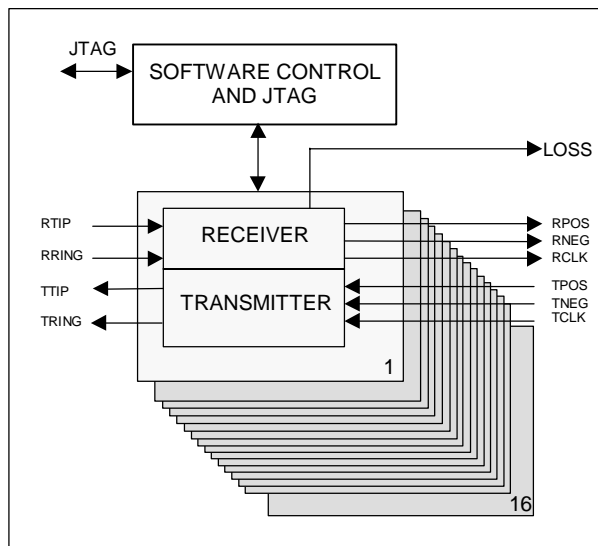
### GENERAL DESCRIPTION

The DS26324 is a 16-channel short-haul line interface unit (LIU) that supports E1/T1/J1 from a single 3.3V power supply. A wide variety of applications are supported through internal impedance matching. A single bill of material can support E1/T1/J1 that requires no external termination. Redundancy is supported through nonintrusive monitoring, optimal high-impedance modes and configurable 1:1 or 1+1 backup enhancements. An on-chip synthesizer generates the E1/T1/J1 clock rates by a single master clock input of various frequencies. Two clock output references are also offered. The device is offered in a 256-pin TE-CSBGA, the smallest package available for a 16-channel LIU.

### APPLICATIONS

T1 Digital Cross-Connects  
ATM and Frame Relay Equipment  
Wireless Base Stations  
ISDN Primary Rate Interface  
E1/T1/J1 Multiplexer and Channel Banks  
E1/T1/J1 LAN/WAN Routers

### FUNCTIONAL DIAGRAM



### FEATURES

- 16 E1, T1, or J1 Short-Haul Line Interface Units
- Independent E1, T1 or J1 Selections
- Fully Internal Impedance Match Requires No External Resistors
- Software-Selectable Transmit and Receive-Side Impedance Match
- Crystal-Less Jitter Attenuator
- Selectable Single-Rail and Dual-Rail Mode and AMI or HDB3/B8ZS Line Encoding and Decoding
- Detection and Generation of AIS
- Digital/Analog Loss of Signal Detection as per T1.231, G.775 and ETS 300 233
- External Master Clock Can Be Multiple of 2.048MHz or 1.544MHz for T1/J1 or E1 Operation; This Clock Will Be Internally Adapted for T1 or E1 Usage
- Receiver Signal Level Indicator from -2.5dB to -20dB in 2.5dB Increments
- Two Built-In BERT Testers for Diagnostics
- 8-Bit Parallel Interface Support for Intel or Motorola Mode or a 4-Wire Serial Interface
- Transmit Short-Circuit Protection
- G.772 Nonintrusive Monitoring
- Receive Monitor Mode Handles Combinations of 14dB to 20dB of Resistive Attenuation Along with 12dB to 30dB of Cable Attenuation
- Specification Compliance to the Latest T1 and E1 Standards—ANSI T1.102, AT&T Pub 62411, T1.231, T1.403, ITU-T G.703, G.742, G.775, G.823, ETS 300 166, and ETS 300 233
- Single 3.3V Supply with 5V Tolerant I/O
- JTAG Boundary Scan as Per IEEE 1149.1

### ORDERING INFORMATION

| PART      | TEMP RANGE     | PIN-PACKAGE  |
|-----------|----------------|--------------|
| DS26324G  | 0°C to +70°C   | 256 TE-CSBGA |
| DS26324GN | -40°C to +85°C | 256 TE-CSBGA |

**Note:** Some revisions of this device may incorporate deviations from published specifications known as errata. Multiple revisions of any device may be simultaneously available through various sales channels. For information about device errata, click here: [www.maxim-ic.com/errata](http://www.maxim-ic.com/errata).

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# 1 STANDARDS COMPLIANCE

## 1.1 Telecom Specifications compliance

The DS26324 LIU meets all the relevant latest Telecommunications Specifications. The following provides the T1 and E1 Specifications and relevant sections that are applicable to the DS26324.

- **T1-Related Telecommunications Specifications**
  - ANSI T1.102: Digital Hierarchy Electrical Interface
  - ANSI T1.231: Digital Hierarchy- Layer 1 in Service Performance Monitoring
  - ANSI T1.403: Network and Customer Installation Interface- DS1 Electrical Interface
  - G.736: Characteristics of a synchronous digital multiplex equipment operating at 2048kbps
  - G.823: The control of jitter and wander within digital networks which are based on the 2048kbps hierarchy
  - Pub 62411: High Capacity Terrestrial Digital Service
  - ITU-T G.772: Protected monitoring points provided on digital transmission systems
  
- **E1-Related Telecommunications Specifications**
  - ITU-T G.703: Physical/Electrical Characteristics of G.703 Hierarchical Digital Interfaces
  - ITU-T G.736: Characteristics of Synchronous Digital Multiplex Equipment operating at 2048kbps
  - ITU-T G.742: Second Order Digital Multiplex Equipment Operating at 8448kbps
  - ITU-T G.772: Protected monitoring points provided on digital transmission systems
  - ITU-T G.775: Loss of signal (LOS) and alarm indication signal (AIS) defect detection and clearance criteria
  - ETS 300 166: Physical and electrical characteristics of hierarchical digital interfaces for equipment using the 2048kbps-based plesiosynchronous or synchronous digital hierarchies
  - ETS 300 233: Integrated Services Digital Network (ISDN)
  - G.736: Characteristics of a synchronous digital multiplex equipment operating at 2048kbps
  - G.823: The control of jitter and wander within digital networks which are based on the 2048kbps hierarchy
  - Pub 62411: High Capacity Terrestrial Digital Service

## 2 DETAILED DESCRIPTION

The DS26324 is a single-chip, 16-channel, short-haul line interface unit for T1 (1.544Mbps) and E1 (2.048Mbps) applications. Sixteen independent receivers and transmitters are provided in a single TE-CSBGA package. The LIUs can be individually selected for T1, J1, or E1 operation. The LIU requires a single master reference clock. This clock can be either 1.544MHz or 2.048MHz or multiples thereof, and either frequency can be internally adapted for T1, J1, or E1 mode. Internal impedance matching provided for both transmit and receive paths reduces external component count. The transmit waveforms are compliant to G.703 and T1.102 specification. The DS26324 provides software-selectable internal transmit termination for 100 $\Omega$  T1 twisted pair, 110 $\Omega$  J1 twisted pair, 120 $\Omega$  E1 twisted pair, and 75 $\Omega$  E1 coaxial applications. The transmitters have fast high-impedance capability and can be individually powered down.

The receivers can function with up to an 18dB receive signal attenuation. A monitor gain setting also can be enabled to provide 14dB and 20dB. The DS26324 can be configured as a 14-channel LIU with Channel 1 and 9 used for nonintrusive monitoring in accordance with G.772. The receivers and transmitters can be programmed into single or dual-rail mode. AMI or HDB3/B8ZS encoding and decoding is selectable in single-rail mode. A 128-bit crystal-less on-board jitter attenuator for each LIU can be placed in receive or transmit directions. The jitter attenuator meets the ETS CTR12/13 ITU-T G.736, G.742, G.823, and AT&T Pub 62411 specifications.

The DS26324 detects and generates AIS in accordance with T1.231, G.775, and ETS 300 233. Loss of signal is detected in accordance with T1.231, G.775, and ETS 300 233. The DS26324 can perform digital, analog, remote, and dual loopbacks on individual LIUs. JTAG boundary scan is provided for the digital pins.

The DS26324 can be configured using 8-bit multiplexed or nonmultiplexed Intel or Motorola ports. A 4-pin serial port selection is also available for configuration and monitoring of the device.

The analog AMI/HDB3 waveform of the E1 line or the AMI/B8ZS waveform of the T1 line is transformer coupled into the RTIP and RRING pins of the DS26324. The user can terminate the receive line using only internal termination that requires no external resistors. Or, the user has the option to use partially internal impedance matching using a common 120 $\Omega$  external resistor for E1, T1, and J1, and matching the line impedance internally to obtain 75 $\Omega$ , 100 $\Omega$ , 110 $\Omega$ , or 120 $\Omega$  termination values. Note that fully internal impedance match requires a 1:1 transformer on the receive line. Partially internal impedance matching supports either a 1:1 or a 1:2 transformer on the receive line. If a 1:2 transformer is used, the external termination resistor should be 30 $\Omega$ . The DS26324 drives the E1 or T1 line from the TTIP and TRING pins by a 1:2 coupling transformer.

The device recovers clock and data from the analog signal and passes it through a selectable jitter attenuator outputting the received line clock at RCLK and data at RPOS and RNEG.

The DS26324 receivers can recover data and clock for up to 18dB of attenuation of the transmitted signals in T1 mode and 43dB for E1 mode. Receiver 1 can monitor the performance of receivers 2 to 8 or transmitters 2 to 8. Receiver 9 can monitor the performance of receivers 10 to 16 or transmitters 10 to 16.

The DS26324 contains 16 identical transmitters. Digital transmit data is input at TPOS/TNEG with reference to TCLK. The data at these pins can be single-rail or dual-rail. This data is processed by waveshaping circuitry and the line driver to output at TTIP and TRING in accordance with ANSI T1.102 for T1/J1 or G.703 for E1 mask.

### 3 BLOCK DIAGRAMS

Figure 3-1. Block Diagram

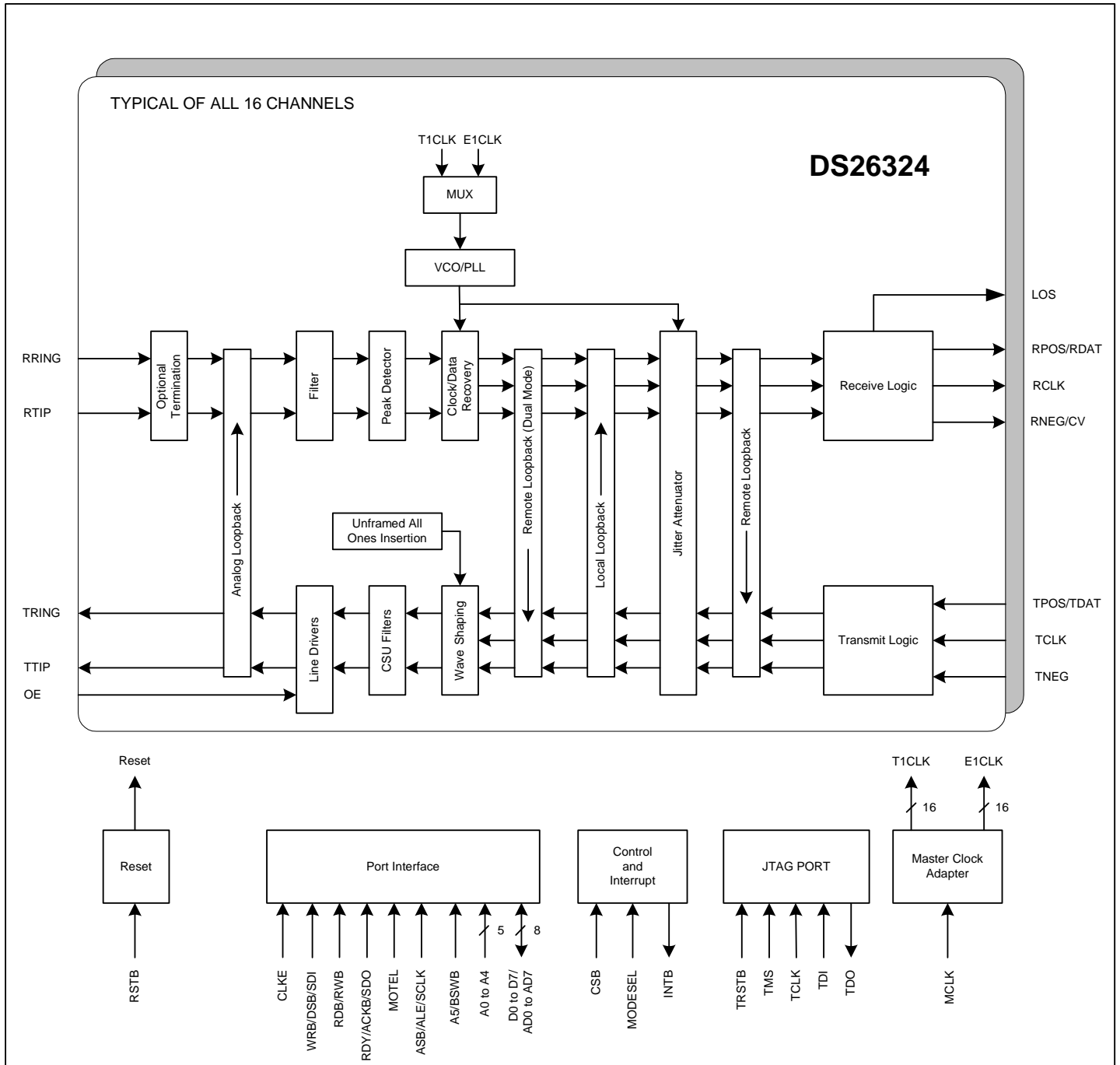




Figure 3-2. Receive Logic Detail

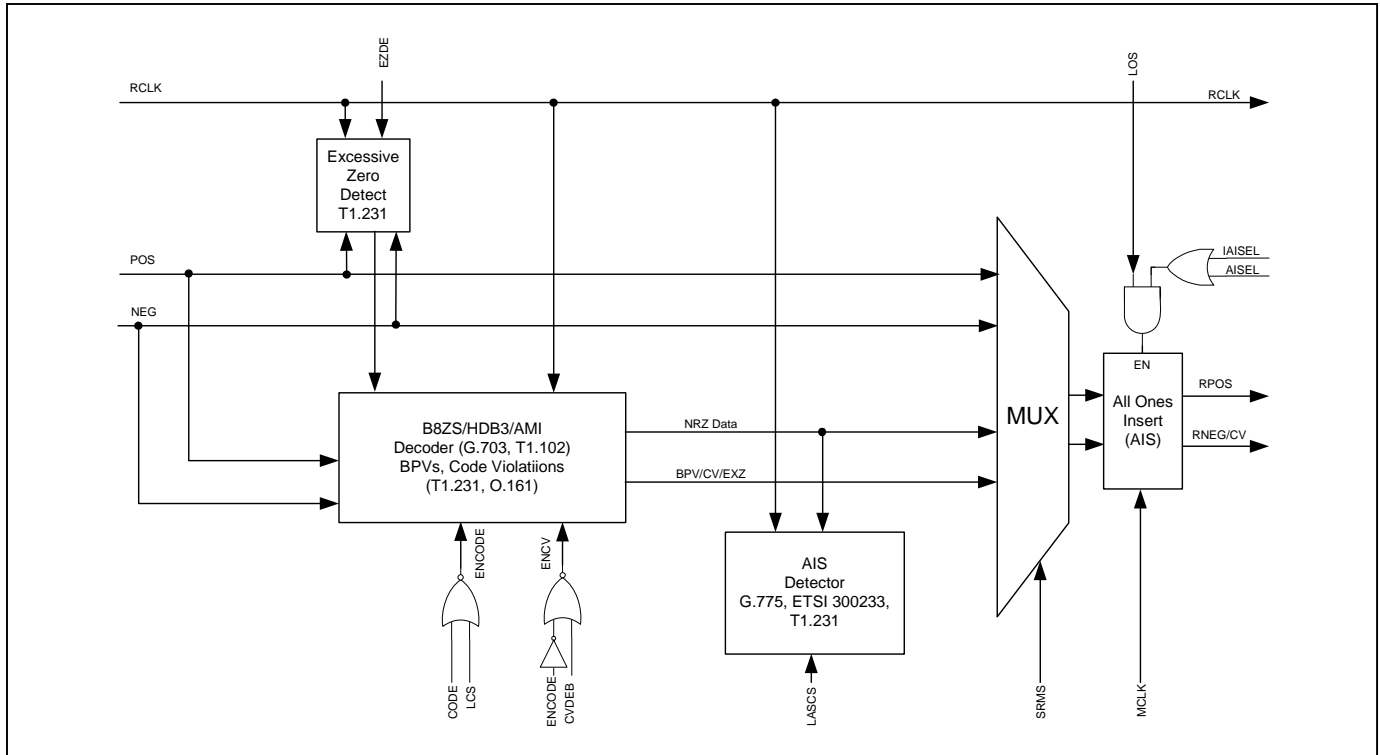
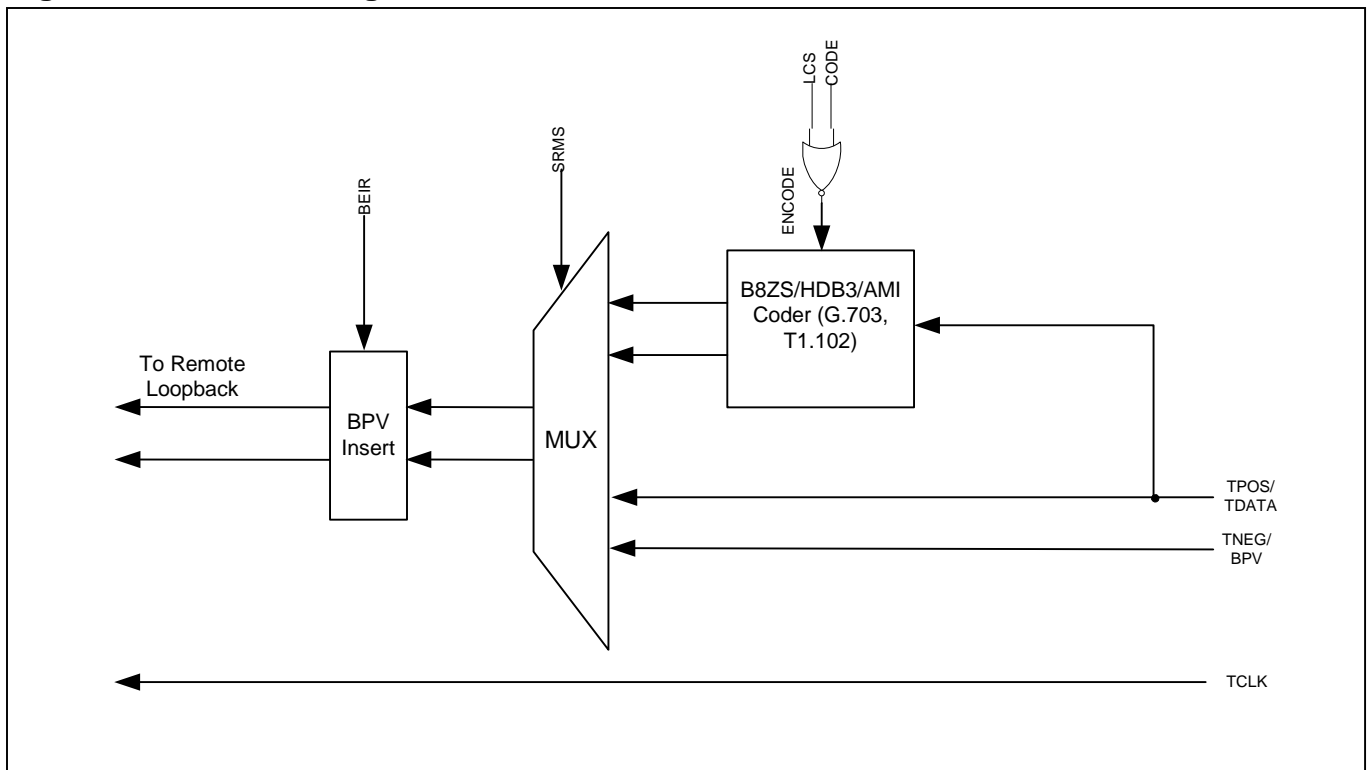


Figure 3-3. Transmit Logic Detail



## 4 PIN DESCRIPTION

Table 4-1. Pin Descriptions

| NAME                               | PIN | TYPE          | FUNCTION  |
|------------------------------------|-----|---------------|---|
| <b>ANALOG TRANSMIT AND RECEIVE</b> |     |               |   |
| TTIP1                              | E1  | Analog output | <p><b>Transmit Bipolar Tip for Channels 1–16.</b> These pins are differential line driver tip outputs. These pins can be high impedance if pin OE is low. When “1” is set in the Output Enable Register <a href="#">OE</a> bit, the associated TTIPn pin will be enabled when the OE pin is high. The differential outputs of TTIPn and TRINGn can provide internal matched impedance for E1 75Ω, E1 120Ω, T1 100Ω, or J1 110Ω.</p> <p>If the TCLK input for a given LIU is held low for 64 MCLKs, that LIU’s transmitter is powered down and the TTIP/TRING outputs are high impedance.</p>    |
| TTIP2                              | F1  |               |   |
| TTIP3                              | K1  |               |   |
| TTIP4                              | L1  |               |   |
| TTIP5                              | T5  |               |   |
| TTIP6                              | T6  |               |   |
| TTIP7                              | T10 |               |   |
| TTIP8                              | T11 |               |   |
| TTIP9                              | M16 |               |   |
| TTIP10                             | L16 |               |   |
| TTIP11                             | G16 |               |   |
| TTIP12                             | F16 |               |   |
| TTIP13                             | A12 |               |   |
| TTIP14                             | A11 |               |   |
| TTIP15                             | A7  |               |   |
| TTIP16                             | A6  |               |   |
| TRING1                             | E2  | Analog output | <p><b>Transmit Bipolar Ring for Channels 1–16.</b> These pins are differential line driver ring outputs. These pins can be high impedance if pin OE is low. When “1” is set in the Output Enable Register <a href="#">OE</a> bit, the associated TRINGn pin will be enabled when the OE pin is high. The differential outputs of TTIPn and TRINGn can provide internal matched impedance for E1 75Ω, E1 120Ω, T1 100Ω, or J1 110Ω.</p> <p>If the TCLK input for a given LIU is held low for 64 MCLKs, that LIU’s transmitter is powered down and the TTIP/TRING outputs are high impedance.</p> |
| TRING2                             | F2  |               |   |
| TRING3                             | K2  |               |   |
| TRING4                             | L2  |               |   |
| TRING5                             | R5  |               |   |
| TRING6                             | R6  |               |   |
| TRING7                             | R10 |               |   |
| TRING8                             | R11 |               |   |
| TRING9                             | M15 |               |   |
| TRING10                            | L15 |               |   |
| TRING11                            | G15 |               |   |
| TRING12                            | F15 |               |   |
| TRING13                            | B12 |               |   |
| TRING14                            | B11 |               |   |
| TRING15                            | B7  |               |   |
| TRING16                            | B6  |               |   |
| RTIP1                              | A1  | Analog input  | <p><b>Receive Bipolar Tip for Channels 1–16.</b> Receive analog input for differential receiver. Data and clock are recovered and output at RPOS/RNEG and RCLK pins, respectively. The differential inputs of RTIPn and RRINGn can provide internal impedance matching with external resistance for E1 75Ω, E1 120Ω, T1 100Ω, or J1 110Ω.</p>   |
| RTIP2                              | C1  |               |   |
| RTIP3                              | H1  |               |   |
| RTIP4                              | N1  |               |   |
| RTIP5                              | T1  |               |   |
| RTIP6                              | T3  |               |   |
| RTIP7                              | T8  |               |   |
| RTIP8                              | T13 |               |   |
| RTIP9                              | T16 |               |   |
| RTIP10                             | P16 |               |   |
| RTIP11                             | J16 |               |   |
| RTIP12                             | D16 |               |   |
| RTIP13                             | A16 |               |   |
| RTIP14                             | A14 |               |   |
| RTIP15                             | A9  |               |   |
| RTIP16                             | A4  |               |   |

| NAME                 | PIN   | TYPE         | FUNCTION  |  |               |       |              |   |   |       |   |   |               |   |   |               |   |   |       |
|----------------------|-------|--------------|---|--|---------------|-------|--------------|---|---|-------|---|---|---------------|---|---|---------------|---|---|-------|
| RESREF               | R9    | Analog input | <b>Resistor Reference.</b> If fully internal receive impedance match is selected, a 16kΩ ±1% resistor to GND is needed. If not used, tie pin low.   |  |               |       |              |   |   |       |   |   |               |   |   |               |   |   |       |
| RRING1               | A2    | Analog input | <b>Receive Bipolar Ring for Channels 1–16.</b> Receive analog input for differential receiver. Data and clock are recovered and output at RPOS/RNEG and RCLK pins, respectively. The differential inputs of RTIPn and RRINGn can provide internal impedance matching with external resistance for E1 75Ω, E1 120Ω, T1 100Ω, or J1 110Ω.   |  |               |       |              |   |   |       |   |   |               |   |   |               |   |   |       |
| RRING2               | C2    |              |   |  |               |       |              |   |   |       |   |   |               |   |   |               |   |   |       |
| RRING3               | H2    |              |   |  |               |       |              |   |   |       |   |   |               |   |   |               |   |   |       |
| RRING4               | N2    |              |   |  |               |       |              |   |   |       |   |   |               |   |   |               |   |   |       |
| RRING5               | R1    |              |   |  |               |       |              |   |   |       |   |   |               |   |   |               |   |   |       |
| RRING6               | R3    |              |   |  |               |       |              |   |   |       |   |   |               |   |   |               |   |   |       |
| RRING7               | R8    |              |   |  |               |       |              |   |   |       |   |   |               |   |   |               |   |   |       |
| RRING8               | R13   |              |   |  |               |       |              |   |   |       |   |   |               |   |   |               |   |   |       |
| RRING9               | T15   |              |   |  |               |       |              |   |   |       |   |   |               |   |   |               |   |   |       |
| RRING10              | P15   |              |   |  |               |       |              |   |   |       |   |   |               |   |   |               |   |   |       |
| RRING11              | J15   |              |   |  |               |       |              |   |   |       |   |   |               |   |   |               |   |   |       |
| RRING12              | D15   |              |   |  |               |       |              |   |   |       |   |   |               |   |   |               |   |   |       |
| RRING13              | B16   |              |   |  |               |       |              |   |   |       |   |   |               |   |   |               |   |   |       |
| RRING14              | B14   |              |   |  |               |       |              |   |   |       |   |   |               |   |   |               |   |   |       |
| RRING15              | B9    |              |   |  |               |       |              |   |   |       |   |   |               |   |   |               |   |   |       |
| RRING16              | B4    |              |   |  |               |       |              |   |   |       |   |   |               |   |   |               |   |   |       |
| <b>DIGITAL Tx/Rx</b> |       |              |   |  |               |       |              |   |   |       |   |   |               |   |   |               |   |   |       |
| TPOS1/TDATA1         | F6    | I            | <b>Transmit Positive Data Input for Channels 1–6.</b> When DS26324 is configured in dual-rail mode, the data input to TPOSn is output as a positive pulse on the line (tip and ring).<br><br><b>Transmit Data Input for Channels 1–16.</b> When the device is configured in single-rail mode NRZ data is input to TDATA n. The data is sampled on the falling edge of TCLKn and encoded HDB3/B8ZS or AMI before being output to the line. |  |               |       |              |   |   |       |   |   |               |   |   |               |   |   |       |
| TPOS2/TDATA2         | G7    |              |   |  |               |       |              |   |   |       |   |   |               |   |   |               |   |   |       |
| TPOS3/TDATA3         | J6    |              |   |  |               |       |              |   |   |       |   |   |               |   |   |               |   |   |       |
| TPOS4/TDATA4         | K6    |              |   |  |               |       |              |   |   |       |   |   |               |   |   |               |   |   |       |
| TPOS5/TDATA5         | L9    |              |   |  |               |       |              |   |   |       |   |   |               |   |   |               |   |   |       |
| TPOS6/TDATA6         | N5    |              |   |  |               |       |              |   |   |       |   |   |               |   |   |               |   |   |       |
| TPOS7/TDATA7         | P12   |              |   |  |               |       |              |   |   |       |   |   |               |   |   |               |   |   |       |
| TPOS8/TDATA8         | M11   |              |   |  |               |       |              |   |   |       |   |   |               |   |   |               |   |   |       |
| TPOS9/TDATA9         | L11   |              |   |  |               |       |              |   |   |       |   |   |               |   |   |               |   |   |       |
| TPOS10/TDATA10       | J11   |              |   |  |               |       |              |   |   |       |   |   |               |   |   |               |   |   |       |
| TPOS11/TDATA11       | G11   |              |   |  |               |       |              |   |   |       |   |   |               |   |   |               |   |   |       |
| TPOS12/TDATA12       | C14   |              |   |  |               |       |              |   |   |       |   |   |               |   |   |               |   |   |       |
| TPOS13/TDATA13       | F9    |              |   |  |               |       |              |   |   |       |   |   |               |   |   |               |   |   |       |
| TPOS14/TDATA14       | E7    |              |   |  |               |       |              |   |   |       |   |   |               |   |   |               |   |   |       |
| TPOS15/TDATA15       | N12   |              |   |  |               |       |              |   |   |       |   |   |               |   |   |               |   |   |       |
| TPOS16/TDATA16       | D5    |              |   |  |               |       |              |   |   |       |   |   |               |   |   |               |   |   |       |
| TNEG1                | C3    | I            | <b>Transmit Negative Data for Channels 1–16.</b> When DS26324 is configured in dual-rail mode. The data input to TNEGn is output as a negative mark on the line. TPOS and TNEG in dual-rail mode result in positive and negative pulses sent on the line:   |  |               |       |              |   |   |       |   |   |               |   |   |               |   |   |       |
| TNEG2                | J14   |              |   | <table border="1"> <thead> <tr> <th>TPOSn</th> <th>TNEGn</th> <th>OUTPUT PULSE</th> </tr> </thead> <tbody> <tr> <td>0</td> <td>0</td> <td>Space</td> </tr> <tr> <td>0</td> <td>1</td> <td>Negative mark</td> </tr> <tr> <td>1</td> <td>0</td> <td>Positive mark</td> </tr> <tr> <td>1</td> <td>1</td> <td>Space</td> </tr> </tbody> </table> | TPOSn         | TNEGn | OUTPUT PULSE | 0 | 0 | Space | 0 | 1 | Negative mark | 1 | 0 | Positive mark | 1 | 1 | Space |
| TPOSn                | TNEGn |              |   |  | OUTPUT PULSE  |       |              |   |   |       |   |   |               |   |   |               |   |   |       |
| 0                    | 0     |              |   |  | Space         |       |              |   |   |       |   |   |               |   |   |               |   |   |       |
| 0                    | 1     |              |   |  | Negative mark |       |              |   |   |       |   |   |               |   |   |               |   |   |       |
| 1                    | 0     |              |   |  | Positive mark |       |              |   |   |       |   |   |               |   |   |               |   |   |       |
| 1                    | 1     |              |   | Space  |               |       |              |   |   |       |   |   |               |   |   |               |   |   |       |
| TNEG3                | J5    |              |   |  |               |       |              |   |   |       |   |   |               |   |   |               |   |   |       |
| TNEG4                | G10   |              |   |  |               |       |              |   |   |       |   |   |               |   |   |               |   |   |       |
| TNEG5                | M6    |              |   |  |               |       |              |   |   |       |   |   |               |   |   |               |   |   |       |
| TNEG6                | P6    |              |   |  |               |       |              |   |   |       |   |   |               |   |   |               |   |   |       |
| TNEG7                | P7    |              |   |  |               |       |              |   |   |       |   |   |               |   |   |               |   |   |       |
| TNEG8                | K9    |              |   |  |               |       |              |   |   |       |   |   |               |   |   |               |   |   |       |
| TNEG9                | L12   |              |   |  |               |       |              |   |   |       |   |   |               |   |   |               |   |   |       |
| TNEG10               | J12   |              |   |  |               |       |              |   |   |       |   |   |               |   |   |               |   |   |       |
| TNEG11               | H11   |              |   |  |               |       |              |   |   |       |   |   |               |   |   |               |   |   |       |
| TNEG12               | E13   |              |   |  |               |       |              |   |   |       |   |   |               |   |   |               |   |   |       |
| TNEG13               | G8    |              |   |  |               |       |              |   |   |       |   |   |               |   |   |               |   |   |       |
| TNEG14               | F7    |              |   |  |               |       |              |   |   |       |   |   |               |   |   |               |   |   |       |
| TNEG15               | C6    |              |   |  |               |       |              |   |   |       |   |   |               |   |   |               |   |   |       |
| TNEG16               | C5    |              |   |  |               |       |              |   |   |       |   |   |               |   |   |               |   |   |       |

| NAME           | PIN | TYPE            | FUNCTION   |
|----------------|-----|-----------------|--|
| TCLK1          | F5  | I               | <p><b>Transmit Clock for Channels 1–16.</b> The transmit clock has to be 1.544MHz for T1 or 2.048MHz for E1 mode. TCLKn is the clock used to sample the data TPOS/TNEG or TDAT on the falling edge. The expected TCLK can be inverted.</p> <p>If TCLKn is 'high' for 16 or more MCLKs, then transmit all ones (TAOs) is sent to the line side of the corresponding transmit channel. When TCLKn starts clocking again, normal operation will begin again for the corresponding transmit channel.</p> <p>If TCLKn is 'low' for 64 or more MCLKs, then the corresponding transmit channel on the line side will power-down and be put into high impedance. When TCLKn starts clocking again the corresponding transmit channel will power-up and come out of high impedance.</p>         |
| TCLK2          | G4  |                 |  |
| TCLK3          | G9  |                 |  |
| TCLK4          | H6  |                 |  |
| TCLK5          | M7  |                 |  |
| TCLK6          | L8  |                 |  |
| TCLK7          | L10 |                 |  |
| TCLK8          | P9  |                 |  |
| TCLK9          | K11 |                 |  |
| TCLK10         | K12 |                 |  |
| TCLK11         | F14 |                 |  |
| TCLK12         | E12 |                 |  |
| TCLK13         | C11 |                 |  |
| TCLK14         | D12 |                 |  |
| TCLK15         | N7  |                 |  |
| TCLK16         | D11 |                 |  |
| RPOS1/RDATA1   | F4  | O,<br>tri-state | <p><b>Receive Positive Data Output for Channels 1–16.</b> In dual-rail mode the NRZ data output indicates a positive pulse on RTIP/RRING. Upon detecting an LOS, AIS can be inserted if the AISEL bit in the <a href="#">GC</a> (0Fh) register is set; otherwise, the pins will be active. AIS insertion can also be controlled on an individual LIU basis by the <a href="#">AISEL</a> (05h) register. If a given receiver is in power-down mode, the associated RPOS pin is high impedance.</p> <p><b>Receive Data Output for Channels 1–16.</b> In single-rail mode, NRZ data is sent out on this pin. If a given receiver is in power-down mode, the associated RPOS pin is high impedance.</p> <p><b>Note:</b> During an LOS condition, the RPOS/RDATA outputs remain active.</p> |
| RPOS2/RDATA2   | F3  |                 |  |
| RPOS3/RDATA3   | L3  |                 |  |
| RPOS4/RDATA4   | L4  |                 |  |
| RPOS5/RDATA5   | K8  |                 |  |
| RPOS6/RDATA6   | M9  |                 |  |
| RPOS7/RDATA7   | P8  |                 |  |
| RPOS8/RDATA8   | M12 |                 |  |
| RPOS9/RDATA9   | M14 |                 |  |
| RPOS10/RDATA10 | K13 |                 |  |
| RPOS11/RDATA11 | G12 |                 |  |
| RPOS12/RDATA12 | E14 |                 |  |
| RPOS13/RDATA13 | C12 |                 |  |
| RPOS14/RDATA14 | C10 |                 |  |
| RPOS15/RDATA15 | C8  |                 |  |
| RPOS16/RDATA16 | E5  |                 |  |
| RNEG1/CV1      | E3  | O,<br>tri-state | <p><b>Receive Negative Data Output for Channels 1–16.</b> In dual-rail mode the NRZ data output indicates a negative pulse on RTIP/RRING. Upon detecting a LOS, AIS can be inserted if AISEL bit in the <a href="#">GC</a> register is set; otherwise, the pins will be active. AIS insertion can also be controlled on an individual LIU basis by <a href="#">AISEL</a> register. If a given receiver is in power-down mode, the associated RNEG pin is high impedance.</p> <p><b>Code Violation for Channels 1–16.</b> In single-rail mode, bipolar violation, code violation, and excessive zeros are reported on CVn. If HDB3 or B8ZS is not selected, this pin indicates only BPVs. If a given receiver is in power-down mode, the associated CV pin is high impedance.</p>       |
| RNEG2/CV2      | G5  |                 |  |
| RNEG3/CV3      | K4  |                 |  |
| RNEG4/CV4      | M3  |                 |  |
| RNEG5/CV5      | L7  |                 |  |
| RNEG6/CV6      | M10 |                 |  |
| RNEG7/CV7      | P11 |                 |  |
| RNEG8/CV8      | K10 |                 |  |
| RNEG9/CV9      | M13 |                 |  |
| RNEG10/CV10    | L14 |                 |  |
| RNEG11/CV11    | F13 |                 |  |
| RNEG12/CV12    | F11 |                 |  |
| RNEG13/CV13    | E10 |                 |  |
| RNEG14/CV14    | C9  |                 |  |
| RNEG15/CV15    | C7  |                 |  |
| RNEG16/CV16    | J3  |                 |  |

| NAME           | PIN | TYPE            | FUNCTION   |
|----------------|-----|-----------------|--|
| RCLK1          | D3  | O,<br>tri-state | <b>Receive Clock for Channels 1–16.</b> The receive data (RPOS/RNEG) is clocked out on the rising edge of RCLK. If a given receiver is in power-down mode the RCLK is high impedance. Upon an LOS being detected, the RCLK is switched from the recovered clock to MCLK. RCLK can be inverted by the RCLKI register.   |
| RCLK2          | G6  |                 |  |
| RCLK3          | K3  |                 |  |
| RCLK4          | K5  |                 |  |
| RCLK5          | P5  |                 |  |
| RCLK6          | M8  |                 |  |
| RCLK7          | P10 |                 |  |
| RCLK8          | P13 |                 |  |
| RCLK9          | L13 |                 |  |
| RCLK10         | K14 |                 |  |
| RCLK11         | G13 |                 |  |
| RCLK12         | F12 |                 |  |
| RCLK13         | E8  |                 |  |
| RCLK14         | E9  |                 |  |
| RCLK15         | F8  |                 |  |
| RCLK16         | E6  |                 |  |
| MCLK           | H12 | I               | <b>Master Clock.</b> This is an independent free-running clock that can be a multiple of 2.048MHz $\pm$ 50ppm for E1 mode or 1.544MHz $\pm$ 50ppm for T1 mode. The clock selection is available by <a href="#">MC</a> bits MPS0, MPS1, FREQS, and PLLE. A multiple of 2.048MHz can be internal adapted to 1.544MHz and a multiple of 1.544MHz can be internal adapted to 2.048MHz.   |
| LOS1           | D2  | O               | <b>Loss-of-Signal Output.</b> This output goes high when there is no transition on the received signal over a specified interval. The output will go low when there is sufficient ones density in the received signal. The LOS criteria for assertion and desertion criteria are described in Section <a href="#">5.5.6</a> . The LOS outputs can be configured to comply with T1.231, ITU-T G.775, or ETS 300 233.<br><br><b>T1/E1 Clock (TECLK) (Ball E11 only).</b> This output becomes a T1 or E1 programmable clock output when enabled by register <a href="#">MC</a> . For T1 or E1 frequency selection, see the <a href="#">CCR</a> register.<br><br><b>Clock A (CLKA) (Ball F10 only).</b> This output becomes a programmable clock output when enabled by register <a href="#">MC</a> . For frequency options, see <a href="#">CCR</a> register. |
| LOS2           | G2  |                 |  |
| LOS3           | J2  |                 |  |
| LOS4           | M2  |                 |  |
| LOS5           | R2  |                 |  |
| LOS6           | T2  |                 |  |
| LOS7           | R4  |                 |  |
| LOS8           | R7  |                 |  |
| LOS9           | R14 |                 |  |
| LOS10          | N15 |                 |  |
| LOS11          | K15 |                 |  |
| LOS12          | H15 |                 |  |
| LOS13          | B10 |                 |  |
| LOS14          | B8  |                 |  |
| LOS15/TECLK    | E11 |                 |  |
| LOS16/CLKA     | F10 |                 |  |
| HOST SELECTION |     |                 |  |
| MODESEL        | A3  | I               | <b>Mode Selection.</b> This pin is used to select the control mode of the DS26324:<br>Low $\rightarrow$ Serial Host Mode<br>High $\rightarrow$ Parallel Host Mode  |
| MOTEL          | B3  | I               | <b>Motorola Intel Select.</b> When this pin is low, Motorola mode is selected. When this pin is high Intel mode is selected.   |
| CSB            | P14 | I               | <b>Chip Select Bar.</b> This signal must be low during all accesses to the registers.  |

| NAME          | PIN | TYPE                | FUNCTION  |
|---------------|-----|---------------------|---|
| SCLK/ALE/ASB  | N14 | I                   | <p><b>Shift Clock.</b> In the serial host mode, this pin is the serial clock. Data on SDI is clocked on the rising edge of SCLK. The data is clocked on SDO on the rising edge of SCLK if CLKE is high. If CLKE is low the data on SDO is clocked on the falling edge of SCLK.</p> <p><b>Address Latch Enable.</b> In parallel Intel multiplexed mode, the address lines are latched on the falling edge of ALE.</p> <p><b>Address Strobe Bar.</b> In parallel Motorola multiplexed mode, the address is sampled on the falling edge of ASB.</p> <p><b>Note:</b> Tie ALE/ASB pin high if using nonmuxed mode.</p>   |
| RDB/RWB       | H14 | I                   | <p><b>Read Bar.</b> In Intel host mode, this pin must be low for read operation.</p> <p><b>Read Write Bar.</b> In Motorola mode, this pin is low for write operation and high for read operation.</p>   |
| SDI/WRB/DSB   | G14 | I                   | <p><b>Serial Data Input.</b> In the serial host mode, this pin is the serial input SDI; it is sampled on the rising edge of SCLK.</p> <p><b>Write Bar.</b> In Intel host mode, this pin is active low during write operation. The data or address (multiplexed mode) is sampled on the rising edge of WRB.</p> <p><b>Data Strobe Bar.</b> In the parallel Motorola mode, this pin is active low. During a write operation the data or address is sampled on the rising edge of DSB. During a read operation the data or address is driven on the rising edge of DSB. In the nonmultiplexed Motorola mode the address bus (A[5:0]) is latched on the falling edge of DSB.</p>              |
| SDO/RDYB/ACKB | C13 | O                   | <p><b>Serial Data Out.</b> In serial host mode, the SDO data is output on this pin. If a serial write is in progress this pin is high impedance. During a read SDO is high impedance when the SDI is in command/address mode. If CLKE is low SDO is output on the rising edge of SCLK, if CLKE is high on the falling edge.</p> <p><b>Ready Bar Output.</b> A high on this pin reports to the host that the cycle is not complete and wait states must be inserted. A low means the cycle is complete.</p> <p><b>Acknowledge Bar.</b> In Motorola parallel mode, a low on this pin indicates that the read data is available for the Host or that the written data cycle is complete.</p> |
| INTB          | D7  | O,<br>open<br>drain | <p><b>Interrupt Bar (Active Low).</b> This signal is tri-state when RSTB pin is low. This interrupt signal is driven low when an event is detected on any of the enabled interrupt sources in any of the register banks. When there are no active and enabled interrupt sources, the pin can be programmed to either drive high or as open drain. The reset default is open drain when there are no active enabled interrupt sources. All interrupt sources are disabled when RSTB = 0 and they must be programmed to be enabled.</p>   |

| NAME        | PIN | TYPE              | FUNCTION  |
|-------------|-----|-------------------|---|
| D7/AD7      | N3  | I/O,<br>tri-state | <p><b>Data Bus 7–0.</b> In nonmultiplexed host mode, these pins are the bidirectional data bus.</p> <p><b>Address/Data Bus 7–0.</b> In multiplexed host mode, these pins are the bidirectional address/data bus. <b>Note:</b> AD7 and AD6 do not carry address information.</p> <p>In serial host mode, these pins should be grounded.</p>  |
| D6/AD6      | P3  |                   |   |
| D5/AD5      | M4  |                   |   |
| D4/AD4      | L5  |                   |   |
| D3/AD3      | K7  |                   |   |
| D2/AD2      | P4  |                   |   |
| D1/AD1      | M5  |                   |   |
| D0/AD0      | L6  |                   |   |
| A5/BSWP     | E4  | I                 | <p><b>Address 5.</b> In the host nonmultiplexed mode, this is the most significant bit of the address bus.</p> <p><b>Bit Swap.</b> In serial host mode, this bit defines the serial data position to be MSB first when low and LSB first when high.</p> <p>In multiplexed host mode, this pin should be grounded.</p>   |
| A4          | C4  | I                 | <p><b>Address Bus 4–0.</b> These five pins are address pins in the parallel host mode.</p> <p>In serial host mode and multiplexed host mode, these pins should be grounded.</p>   |
| A3          | H5  |                   |   |
| A2          | G3  |                   |   |
| A1          | H3  |                   |   |
| A0          | N10 |                   |   |
| OE          | R12 | I                 | <p><b>Output Enable.</b> If this pin is pulled low all the transmitters outputs (TTIP and TRING) are high impedance. If pulled high all the transmitters are enabled when the associated output enable <a href="#">OE</a> bit is set. If <a href="#">TST.RHPMC</a> is set, the OE pin is granted control of the receiver internal termination. When OE is low, receiver internal termination will be high impedance. When OE is high, receiver termination will be enabled. The receiver can still monitor incoming signals even when termination is in high impedance.</p> |
| CLKE/MUX    | T14 | I                 | <p><b>Clock Edge.</b> If CLKE is high, SDO is clocked out on falling edge of SCLK and if low SDO is on rising edge of SCLK.</p> <p><b>Multiplexed/Nonmultiplexed Select Pin.</b> When in parallel port mode, this pin is used to select multiplexed address and data operation or separate address and data. When mux is a high multiplexed address and data is used and when mux is low nonmultiplexed is used.</p>  |
| <b>JTAG</b> |     |                   |   |
| TRSTB       | E15 | I,<br>pullup      | <p><b>JTAG Test Port Reset.</b> This pin if low will reset the JTAG port. If not used it can be left floating.</p>  |
| TMS         | B13 | I,<br>pullup      | <p><b>JTAG Test Mode Select.</b> This pin is clocked on the rising edge of TCK and is used to control the JTAG selection between scan and Test Machine control.</p>   |
| TCK         | D14 | I                 | <p><b>JTAG Test Clock.</b> The data TDI and TMS are clocked on rising edge of TCK and TDO is clocked out on the falling edge of TCK.</p>  |
| TDO         | A15 | O,<br>high-Z      | <p><b>JTAG Test Data Out.</b> This is the serial output of the JTAG port. The data is clocked out on the falling edge of TCK.</p>   |
| TDI         | B15 | I,<br>pullup      | <p><b>Test Data Input.</b> This pin input is the serial data of the JTAG Test. The data on TDI is clocked on the rising edge of TCK. This pin can be left unconnected.</p>  |

| NAME                  | PIN                                      | TYPE         | FUNCTION   |
|-----------------------|--|--------------|--|
| <b>RESET</b>          |  |              |  |
| RSTB                  | B5                                       | I,<br>pullup | <b>Reset Bar.</b> This is the asynchronous reset input bar. It is internally pulled high. A 1 $\mu$ s low on this pin will reset the DS26324 registers to default value. |
| <b>POWER SUPPLIES</b> |  |              |  |
| DVDD                  | H8,<br>J9                                | I            | <b>3.3V Digital Power Supply</b>   |
| DVSS                  | H9,<br>J8                                | I            | <b>Digital Ground</b>  |
| VDDT1                 | D1                                       | I,<br>high-Z | <b>3.3V Power Supply for the Transmitter.</b> All VDDT pins must be connected to VDDT, which has to be 3.3V.   |
| VDDT2                 | G1                                       |              |  |
| VDDT3                 | J1                                       |              |  |
| VDDT4                 | M1                                       |              |  |
| VDDT5                 | T4                                       |              |  |
| VDDT6                 | T7                                       |              |  |
| VDDT7                 | T9                                       |              |  |
| VDDT8                 | T12                                      |              |  |
| VDDT9                 | N16                                      |              |  |
| VDDT10                | K16                                      |              |  |
| VDDT11                | H16                                      |              |  |
| VDDT12                | E16                                      |              |  |
| VDDT13                | A13                                      |              |  |
| VDDT14                | A10                                      |              |  |
| VDDT15                | A8                                       |              |  |
| VDDT16                | A5                                       |              |  |
| GNDT1                 | D4                                       | I            | <b>Analog Ground for Transmitters</b>  |
| GNDT2                 | H4                                       |              |  |
| GNDT3                 | J4                                       |              |  |
| GNDT4                 | N4                                       |              |  |
| GNDT5                 | N6                                       |              |  |
| GNDT6                 | N8                                       |              |  |
| GNDT7                 | N9                                       |              |  |
| GNDT8                 | N11                                      |              |  |
| GNDT9                 | N13                                      |              |  |
| GNDT10                | J13                                      |              |  |
| GNDT11                | H13                                      |              |  |
| GNDT12                | D13                                      |              |  |
| GNDT13                | D10                                      |              |  |
| GNDT14                | D9                                       |              |  |
| GNDT15                | D8                                       |              |  |
| GNDT16                | D6                                       |              |  |
| AVDD                  | B1,<br>C16,<br>P1,<br>R16,<br>H7,<br>J10 | I            | <b>3.3V Analog Core Power Supply.</b> Decouple each pin separately.  |
| AVSS                  | B2,<br>C15,<br>P2,<br>R15,<br>H10,<br>J7 | I            | <b>Analog Core Ground</b>  |



## 5 FUNCTIONAL DESCRIPTION

### 5.1 Port Operation

#### 5.1.1 Serial Port Operation

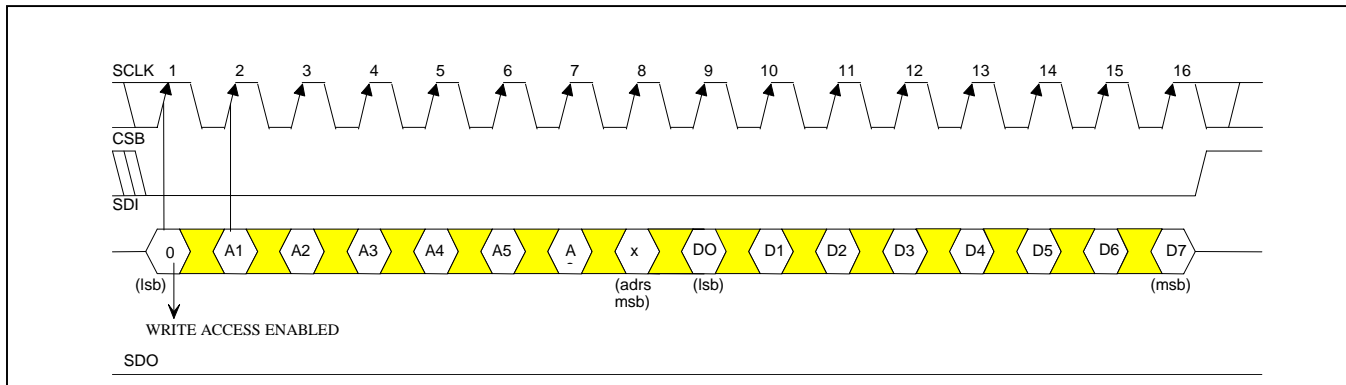
Setting MODESEL = 'low' enables the serial bus interface on the DS26324. Port read/write timing is unrelated to the system transmit and receive timing, allowing asynchronous reads or writes by the host. See Section 9.3 for the AC timing of the serial port. All serial port accesses are LSB first when BSWP pin is high and MSB first when BSWP is low. Figure 5-1 to Figure 5-3 show operation with LSB first.

This port is compatible with the SPI interface defined for Motorola Processors. An example of this is the MMC2107 from Motorola.

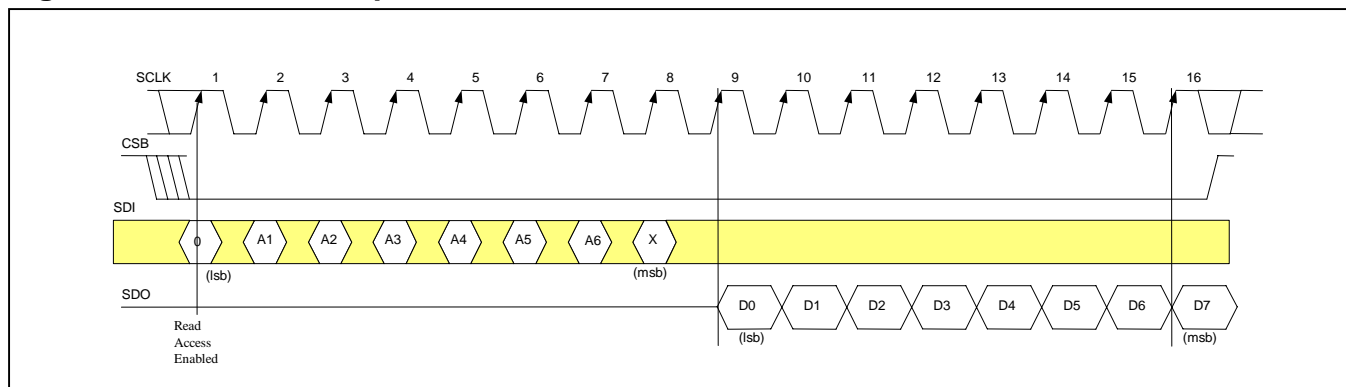
Reading or writing to the internal registers requires writing one address/command byte prior to transferring register data. The first bit written (LSB) of the address/command byte specifies whether the access is a read (1) or a write (0). The next 6 bits identify the register address (A1 to A6) (A7 is ignored).

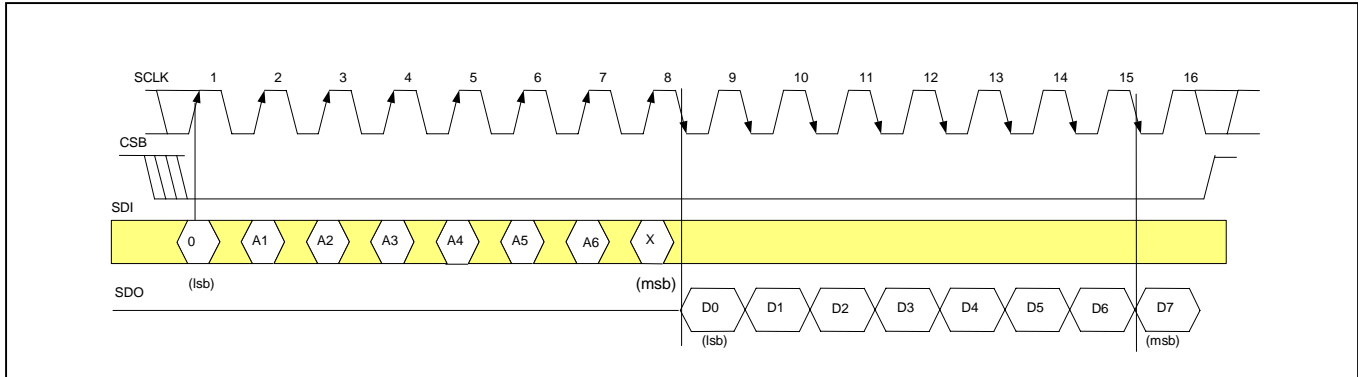
All data transfers are initiated by driving the CSB input low. When CLKE is low, SDO data is output on the rising edge of SCLK and when CLKE is high, data is output on the falling edge of SCLK. Data is held until the next falling or rising edge. All data transfers are terminated if CSB input transitions high. Port control logic is disabled and SDO is tri-stated when CSB is high. SDI is always sampled on the rising edge of SCLK.

**Figure 5-1. Serial Port Operation for Write Access**



**Figure 5-2. Serial Port Operation for Read Access with CLKE = 0**



**Figure 5-3. Serial Port Operation for Read Access with CLKE = 1**

### 5.1.2 Parallel Port Operation

When using the parallel interface on the DS26324 the user has the option for either multiplexed bus operation or nonmultiplexed bus operation. The ALE pin is pulled high in nonmultiplexed bus operation. The DS26324 can operate with either Intel or Motorola bus-timing configurations selected by MOTEL pin. This pin being high selects the Intel mode. The parallel port is only operational if MODESEL pin is pulled high. The following Table lists all the pins and their functions in the parallel port mode. See the timing diagrams in Section 9 for more details.

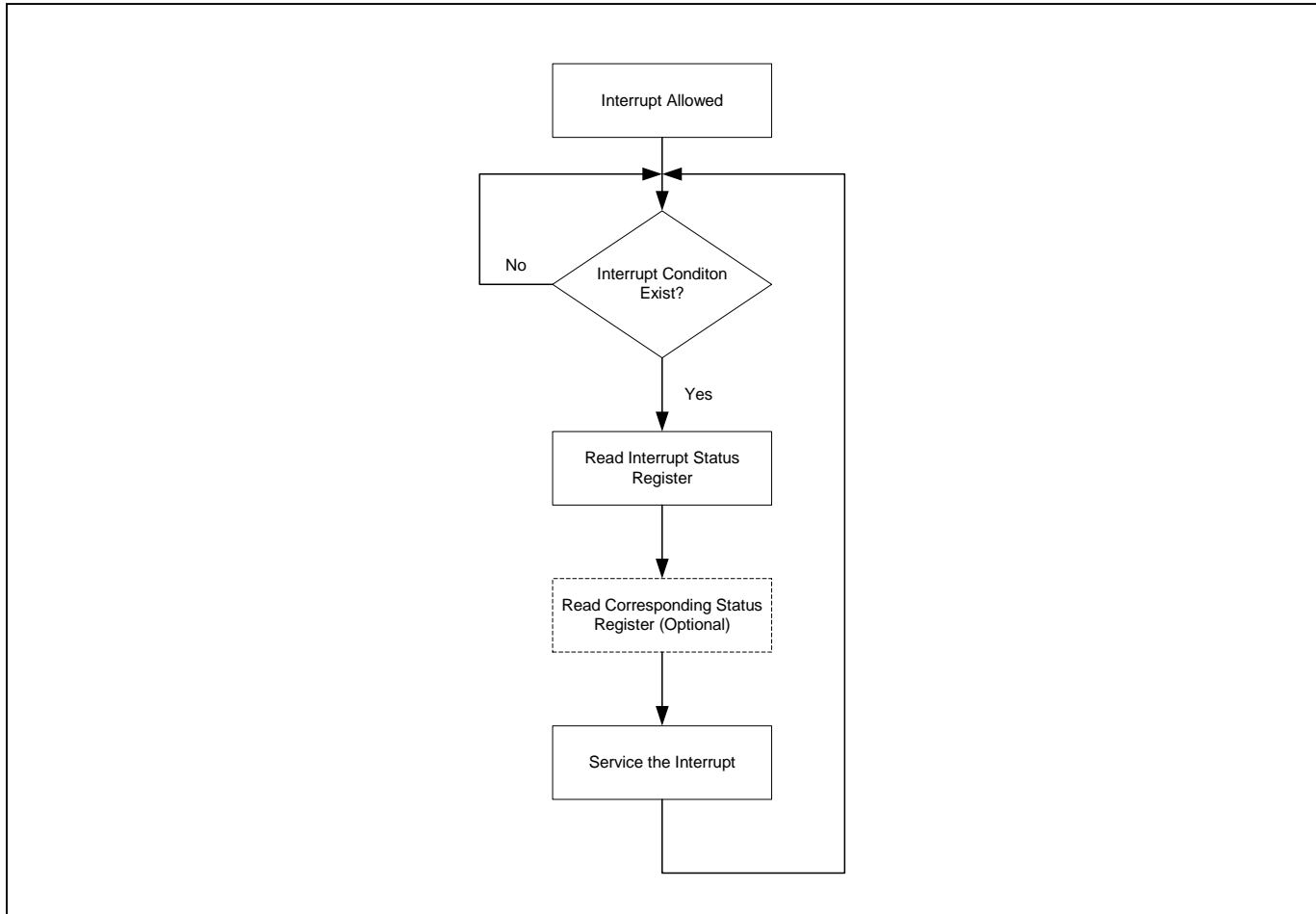
**Table 5-1. Parallel Port Mode Selection and Pin Functions**

| MODESEL, MOTEL, MUX | PARALLEL HOST INTERFACE | ADDRESS, DATA, AND CONTROL                     |
|---------------------|-------------------------|--|
| 100                 | Nonmultiplexed Motorola | CSB, ACKB, DSB, RWB, ASB, A[5:0], D[7:0], INTB |
| 110                 | Nonmultiplexed Intel    | CSB, RDYB, WRB, RDB, ALE, A[5:0], D[7:0], INTB |
| 101                 | Multiplexed Motorola    | CSB, ACKB, DSB, RWB, ASB, AD[7:0], INTB        |
| 111                 | Multiplexed Intel       | CSB, RDYB, WRB, RDB, ALE, AD[7:0], INTB        |

### 5.1.3 Interrupt Handling

There are four sets of events that can potentially trigger an Interrupt. The interrupt functions as follows:

- When status changes on an interruptible event, INTB pin will go low if the event is enabled through the corresponding Interrupt Enable Register. The INTB has to be pulled high externally with a 10kΩ resistor for wired-OR operation. If a wired-OR operation is not required, the INTB pin can be configured to be high when not active by setting register [GISC.INTM](#).
- When an Interrupt occurs the Host Processor has to read the Interrupt Status register to determine the source of the Interrupt. The read will also clear the Interrupt Status register and this will clear the output INTB pin. The Interrupt Status register can also be configured as clear on write as per register [GISC.CWE](#). When set to clear on write, and interrupt status register bit (and the interrupt it generates) will only be cleared on writing a '1' to it's bit location in the interrupt status register. This makes it possible to clear interrupts on some bits in a register without clearing them on all bits.
- Subsequently the host processor can read the corresponding Status Register to check the real-time status of the event.

**Figure 5-4. Interrupt Handling Flow Diagram**

## 5.2 Power-Up and Reset

Internal Power\_On\_Reset circuitry generates a reset during power-up. All registers are reset to the default values. Writing to the Software Reset Register generates at least 1 $\mu$ s reset cycle, which has the same effect as the power-up reset.

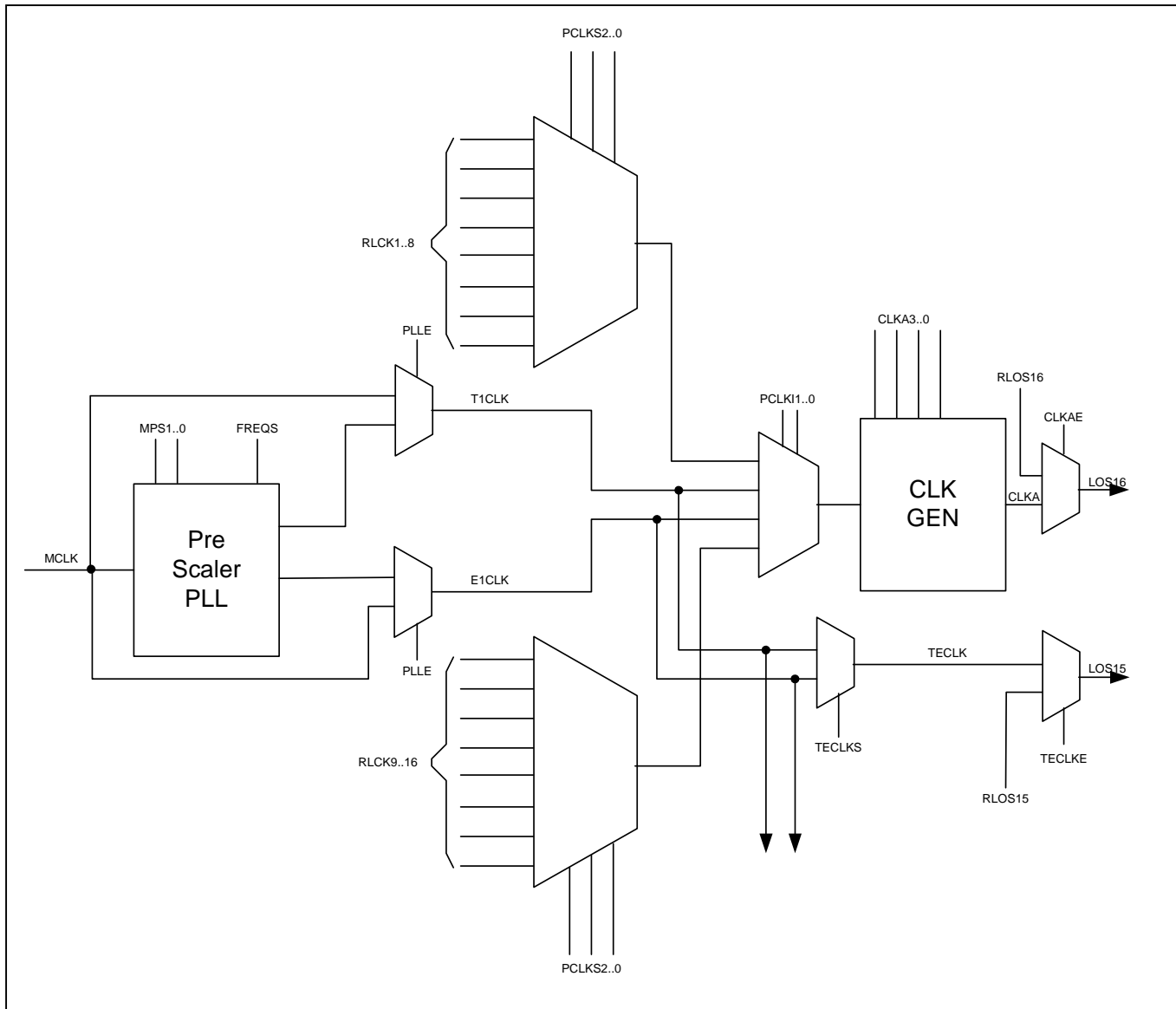
The DS26324 can be reset by a low going pulse on the RSTB pin (see [Table 4-1](#)). A reset can also be performed in software by writing any value to the [SWR](#) register.

## 5.3 Master Clock

The DS26324 requires 2.048MHz  $\pm$ 50ppm or 1.544MHz  $\pm$ 50ppm or multiple thereof. The receiver uses the MCLK as a reference for clock recovery, jitter attenuation and generating RCLK during LOS. The AIS tTransmission uses MCLK for transmit all ones condition. See register [MC](#) to set desired incoming frequency. When the PLLE bit is set, the master clock adapter will generate both 2.048MHz (E1) and 1.544MHz (T1) clocks. If the PLLE bit is clear, both internal reference clocks will track MCLK.

MCLK or RCLK can also be used to output CLKA on the LOS16 pin. Register [CCR](#) is used to select the clock generated for CLKA and the TECLK. Any RCLK can also be selected as an input to the clock generator using this same register. For a detailed description of selections available see [Figure 5-5](#).

Figure 5-5. Prescaler PLL and Clock Generator



## 5.4 Transmitter

NRZ data arrives on TPOS and TNEG on the transmit system side. The TPOS and TNEG data is sampled on the falling edge of TCLK.

The data is encoded with HDB3 or B8ZS or AMI encoding when single-rail mode is selected (only TPOS as the data source). When in single-rail mode only, BPV errors can be inserted for test purposes by register [BEIR](#). Pre-encoded data is expected when dual-rail mode is selected. The encoded data passes through a jitter attenuator if it is enabled for the transmit path. A digital sequencer and DAC are used to generate transmit waveforms compliant with T1.102 and G.703 pulse masks.

The line driver supports internal impedance matching for 75Ω, 100Ω, 110Ω, and 120Ω modes.

The DS26324 drivers have short and open circuit driver fail monitor detection. There is an OE pin that can high impedance the transmitter outputs for protection switching when low. The individual transmitters are by default in high impedance. The [OE](#) register is used to enable the transmitters individually when the OE pin is high. The DS26324 has to have the transmitter's enabled by setting the register and then pulling the OE pin high. The registers that control the transmitter operation are shown in [Table 5-2](#).

**Table 5-2. Telecommunications Specification Compliance for DS26324 Transmitters**

| TRANSMITTER FUNCTION   | TELECOMMUNICATIONS COMPLIANCE |
|--|-------------------------------|
| AMI Coding, B8ZS Substitution, DS1 Electrical Interface                            | ANSI T1.102                   |
| T1 Telecom Pulse Mask compliance   | ANSI T1.403                   |
| T1 Telecom Pulse Mask compliance   | ANSI T1.102                   |
| Transmit Electrical Characteristics for E1 Transmission and Return Loss Compliance | ITU-T G.703                   |

**Table 5-3. Registers Related to Control of DS26324 Transmitters**

| REGISTER                                       | NAME                   | FUNCTION   |
|--|------------------------|--|
| Transmit All Ones Enable                       | <a href="#">TAOE</a>   | Transmit all ones enable.  |
| Driver Fault Monitor Status                    | <a href="#">DFMS</a>   | Driver fault status.   |
| Driver Fault Monitor Interrupt Enable          | <a href="#">DFMIE</a>  | Driver fault status interrupt mask.  |
| Driver Fault Monitor Interrupt Status          | <a href="#">DFMIS</a>  | Driver fault status interrupt mask.  |
| Automatic Transmit All Ones Select             | <a href="#">ATAOS</a>  | Transmit all ones enabled automatically on LOS.  |
| Global Configuration                           | <a href="#">GC</a>     | Global control of jitter attenuator, line coding and short circuit protection.   |
| Template Select Transmitter                    | <a href="#">TST</a>    | The transmitter that the Template Select Transmitter Register applies to.  |
| Template Select                                | <a href="#">TS</a>     | The TS2 to TS0 bits for selection of the templates for transmitter and TIMPOFF and TIMPRIM bits to control transmit impedance match. |
| Output Enable Configuration                    | <a href="#">OE</a>     | These register bits can be used to enable the transmitter outputs.   |
| Master Clock Selection                         | <a href="#">MC</a>     | Selects the MCLK frequency used for transmit and receive.  |
| Single-Rail Mode Select                        | <a href="#">SRMS</a>   | This register can be used to select between single-rail and dual-rail mode.  |
| Line Code Selection                            | <a href="#">LCS</a>    | The individual transceiver line codes can be selected to overwrite the global setting.   |
| Transmit Power-Down Enable                     | <a href="#">TPDE</a>   | Individual transmitters can be powered down.   |
| Individual Jitter Attenuator Enable            | <a href="#">IJAЕ</a>   | Enables the jitter attenuator.   |
| Individual Jitter Attenuator Position Select   | <a href="#">IJAPS</a>  | Selects whether jitter attenuator is in transmit or receive path   |
| Individual Jitter Attenuator FIFO Depth Select | <a href="#">IJAFDS</a> | Selects depth of jitter attenuator FIFO.   |
| Individual Jitter Attenuator FIFO Limit Trip   | <a href="#">IJAFLT</a> | Indicates jitter attenuator FIFO within 4 bits of its useful limit.  |
| Individual Short-Circuit Protection Disable    | <a href="#">ISCPD</a>  | This register allows the individual transmitters to have short-circuit protection disable.   |
| Bit Error Rate Tester Control                  | <a href="#">BTCR</a>   | This register allows mapping of the internal BERTs into an individual transmit path.   |
| Transmit Clock Invert                          | <a href="#">TCLKI</a>  | Inverts TCLK input.  |
| BPV Error Insertion                            | <a href="#">BEIR</a>   | Inserts a bipolar error in the transmit path when in single-rail mode.   |

### 5.4.1 Transmit Line Templates

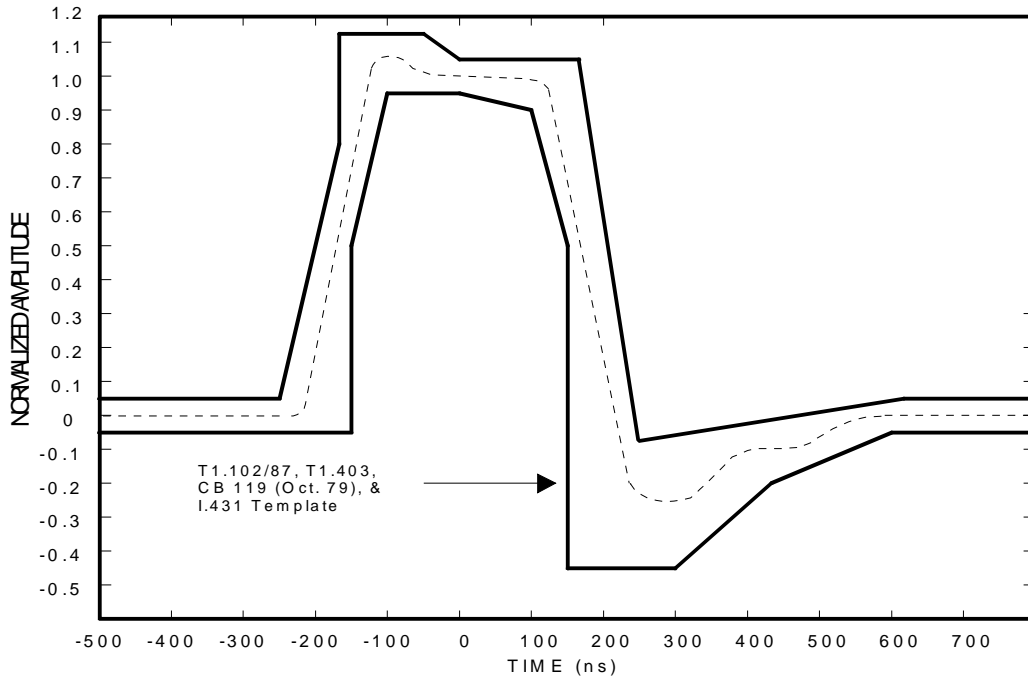
The DS26324 transmitters can be selected individually to meet the pulse masks for E1 and T1/J1 mode. The T1/J1 pulse mask is shown in the Transmit Pulse Template and can be configured on an individual LIU basis. The transmit template is selected via the TS2-TS0 bits in the [TS](#) register. Transmit impedance matching is selected using the TIMPOFF and the TIMPRM bits of the same register. When transmit impedance matching is enabled TIMPRM will select between 75Ω and 120Ω impedance if an E1 template is selected, and between 100Ω and 110Ω impedance if a T1/J1 template is selected. In E1 mode, if 75Ω is selected via the TIMPRM bit, the output pulse amplitude will be 2.37V, if 120Ω is selected via the TIMPRM bit, the output pulse amplitude will be 3.0V.

The E1 pulse template is shown in [Figure 5-7](#) and the T1 pulse template is shown in [Figure 5-6](#).

**Table 5-4. Template Selections for Short-Haul Mode**

| TS2, TS1, TS0 | APPLICATION       |
|---------------|-------------------|
| 000           | E1                |
| 001           | Reserved          |
| 010           |                   |
| 011           | DSX-1 (0–133ft)   |
| 100           | DSX-1 (133–266ft) |
| 101           | DSX-1 (266–399ft) |
| 110           | DSX-1 (399–533ft) |
| 111           | DSX-1 (533–655ft) |

Figure 5-6. T1 Transmit Pulse Templates



DSX-1 Template (per ANSIT1.102 -1993)

| MAXIMUM CURVE |      |       |
|---------------|------|-------|
| UI            | Time | Amp.  |
| -0.77         | -500 | 0.05  |
| -0.39         | -255 | 0.05  |
| -0.27         | -175 | 0.80  |
| -0.27         | -175 | 1.15  |
| -0.12         | -75  | 1.15  |
| 0.00          | 0    | 1.05  |
| 0.27          | 175  | 1.05  |
| 0.35          | 225  | -0.07 |
| 0.93          | 600  | 0.05  |
| 1.16          | 750  | 0.05  |

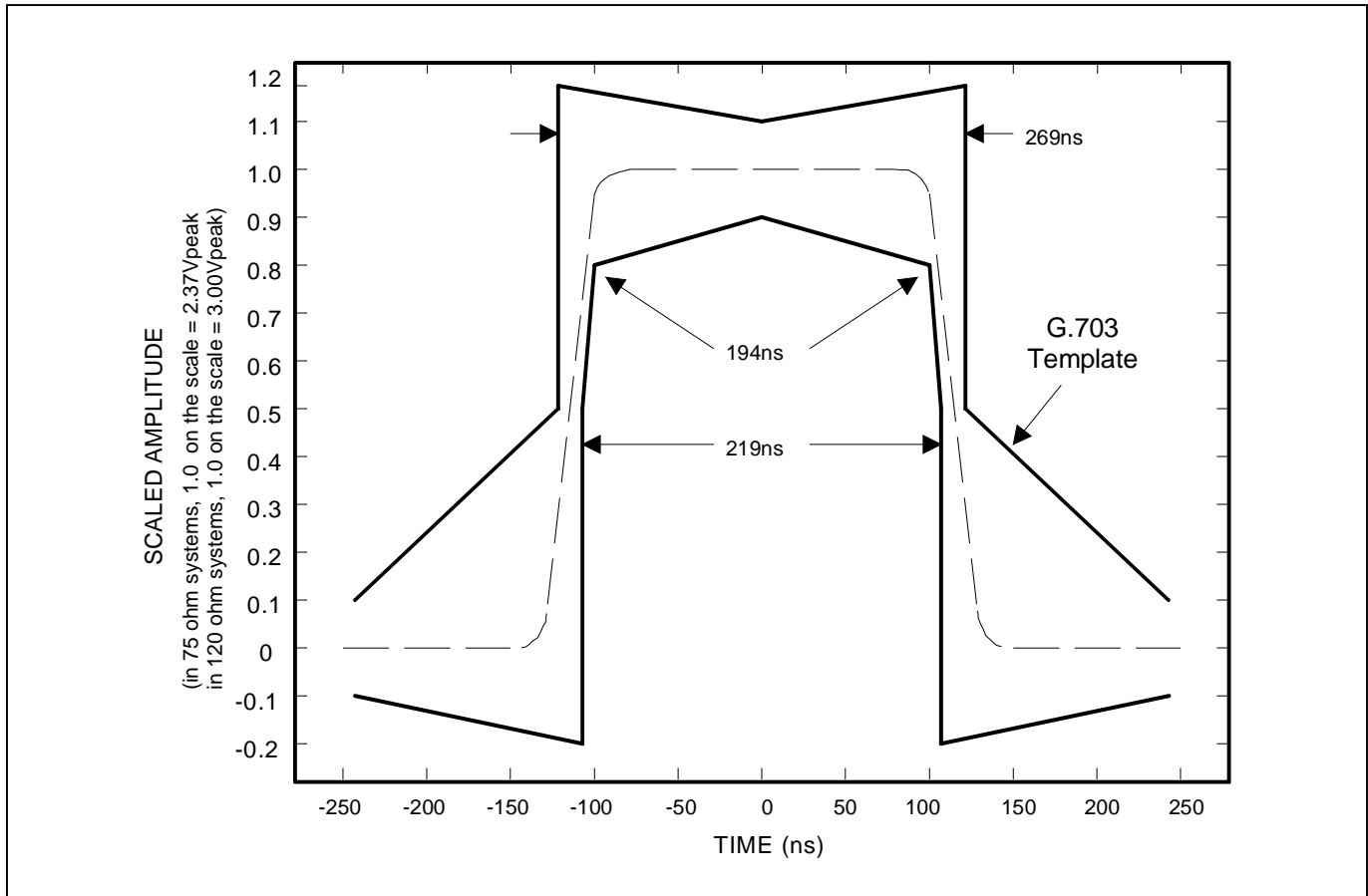
| MINIMUM CURVE |      |       |
|---------------|------|-------|
| UI            | Time | Amp.  |
| -0.77         | -500 | -0.05 |
| -0.23         | -150 | -0.05 |
| -0.23         | -150 | 0.50  |
| -0.15         | -100 | 0.95  |
| 0.00          | 0    | 0.95  |
| 0.15          | 100  | 0.90  |
| 0.23          | 150  | 0.50  |
| 0.23          | 150  | -0.45 |
| 0.46          | 300  | -0.45 |
| 0.66          | 430  | -0.20 |
| 0.93          | 600  | -0.05 |
| 1.16          | 750  | -0.05 |

DS1 Template (per ANSIT1.403 -1995)

| MAXIMUM CURVE |      |       |
|---------------|------|-------|
| UI            | Time | Amp.  |
| -0.77         | -500 | 0.05  |
| -0.39         | -255 | 0.05  |
| -0.27         | -175 | 0.80  |
| -0.27         | -175 | 1.20  |
| -0.12         | -75  | 1.20  |
| 0.00          | 0    | 1.05  |
| 0.27          | 175  | 1.05  |
| 0.34          | 225  | -0.05 |
| 0.77          | 600  | 0.05  |
| 1.16          | 750  | 0.05  |

| MINIMUM CURVE |      |       |
|---------------|------|-------|
| UI            | Time | Amp.  |
| -0.77         | -500 | -0.05 |
| -0.23         | -150 | -0.05 |
| -0.23         | -150 | 0.50  |
| -0.15         | -100 | 0.95  |
| 0.00          | 0    | 0.95  |
| 0.15          | 100  | 0.90  |
| 0.23          | 150  | 0.50  |
| 0.23          | 150  | -0.45 |
| 0.46          | 300  | -0.45 |
| 0.61          | 430  | -0.26 |
| 0.93          | 600  | -0.05 |
| 1.16          | 750  | -0.05 |

Figure 5-7. E1 Transmit Pulse Templates

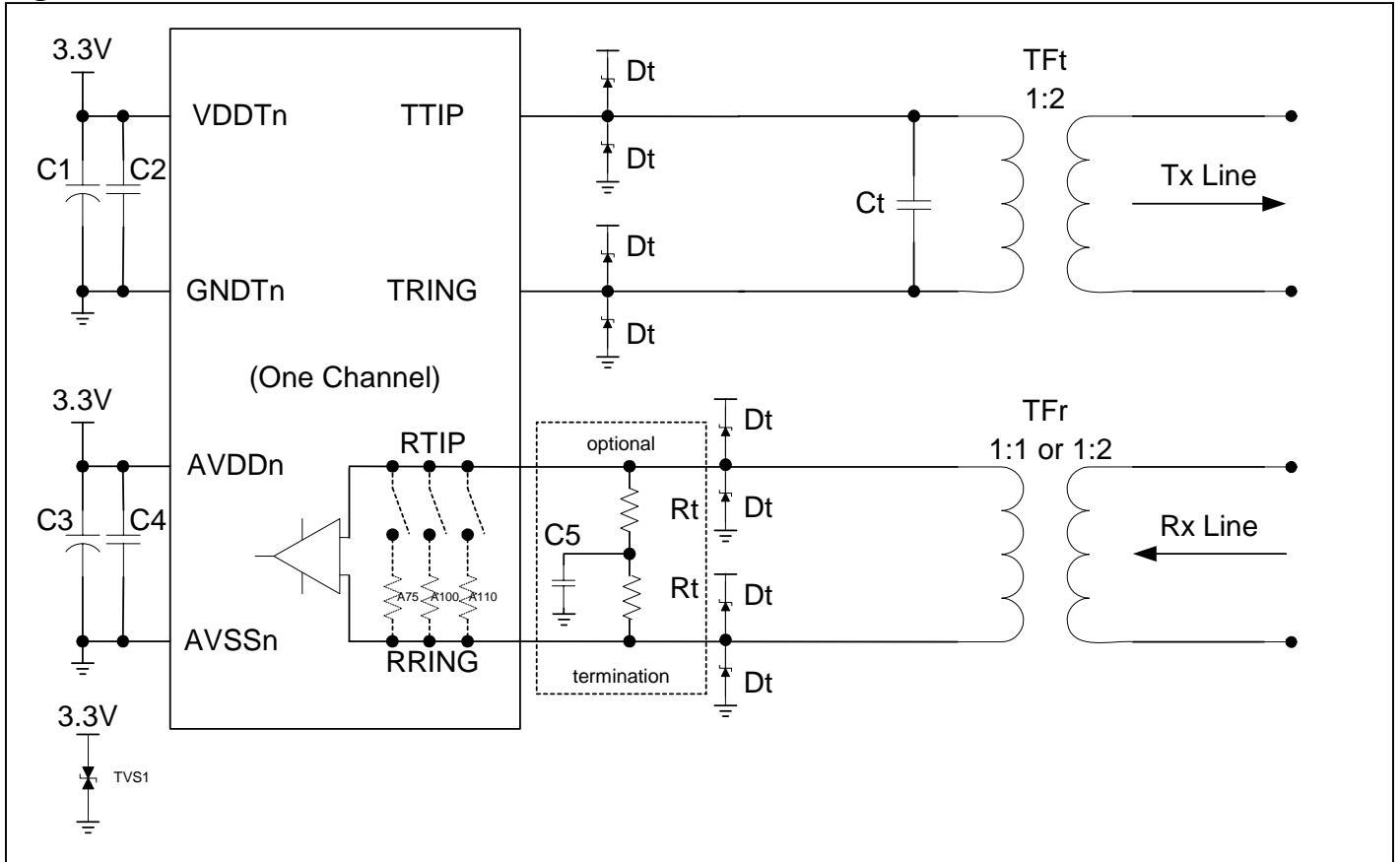




### 5.4.2 LIU Transmit Front-End

It is recommended that the LIU for the transmitter be configured as described in [Figure 5-8](#) and in [Table 5-6](#).

**Figure 5-8. LIU Front-End**



**Table 5-6. LIU Front-End Values**

| MODE                   | COMPONENT       | 75Ω COAX, 120Ω TWISTED PAIR,<br>100/110Ω TWISTED PAIR               |
|------------------------|-----------------|---|
| Tx Capacitance         | Ct              | 560pF typical. Adjust for board parasitics for optimal return loss. |
| Tx Protection          | Dt <sup>1</sup> | International Rectifier 11DQ04 or 10BQ060,<br>Motorola MBR0540T1    |
| Rx Transformer RTR 1:1 | TFr             | Pulse TX1475  |
| Tx Transformer 1:2     | TFt             | Halo TG83-S005NU  |
| Rx Transformer RTR 1:2 | TFr             | Pulse T1124 (0°C to +70°C),<br>Pulse T1114 (-40°C to 85°C)          |
| Tx Transformer 1:2     | TFt             |   |
| Tx Decoupling (TVDDn)  | C1              | Common decoupling for all 16 channels = 68μF.                       |
| Tx Decoupling (TVDDn)  | C2              | Recommended decoupling per channel = 0.1μF.                         |
| Rx Decoupling (AVDD)   | C3              | Common decoupling for all 16 channels = 68μF.                       |
| Rx Decoupling (AVDD)   | C4              | Decouple all six pins separately with a 0.1μF capacitor.            |
| Rx Termination         | C5 <sup>1</sup> | Rx capacitance for all 16 channels = 0.1μF.                         |
| Rx Termination RTR 1:1 | Rt <sup>1</sup> | Need two resistors = 60.4Ω ±1%.                                     |
| Rx Termination RTR 1:2 | Rt <sup>1</sup> | Need two resistors = 15.0Ω ±1%.                                     |
| Voltage Protection     | TVS1            | SGS-Thomson SMLVT 3V3 (3.3V Transient Suppressor)                   |

<sup>1</sup>Only use if necessary for application.

### 5.4.3 Transmit Dual-Rail Mode

Transmit dual-rail mode consists of the TPOS, TNEG, and TCLK pins on the system side. NRZ data is sampled on the falling edge of TCLK as shown in [Figure 9-12](#).

B8ZS or HDB3 encoding is not available in transmit dual-rail mode. The data that appears on the TPOS and TNEG pins is output on TTIP and TRING without any modification. The Single-Rail Mode Select Register ([SRMS](#)) is used for selection of dual-rail or single-rail mode. The data that arrives at the TPOS and TNEG can be overwritten in the maintenance mode by setting the BERT Control Register ([BTCR](#)).

### 5.4.4 Transmit Single-Rail Mode

Transmit single-rail mode consists of the TPOS and TCLK pins on the system side (TNEG is not used.). NRZ data is sampled on the falling edge of TCLK as shown in [Figure 9-12](#). The zero substitution B8ZS or HDB3 encoding is allowed. The TPOS data is encoded in AMI or B8ZS/HDB3 format on the TTIP and TRING pins after pulse shaping. The Single-Rail Mode Select Register ([SRMS](#)) is used for selection of dual-rail or single-rail mode. The data that arrives at the TPOS can be overwritten in the maintenance mode by setting in Bit Error Rate Tester Control Register ([BTCR](#)).

### 5.4.5 Zero Suppression—B8ZS or HDB3

B8ZS coding is available when the device is in T1 mode (selected by TS2, TS1 and TS0 bits in the [TS](#) register). B8ZS/HDB3 coding are enabled by default in single-rail mode. Setting the LCS bit in the [LCS](#) Register disables B8ZS/HDB3. Note that if the individual LIU is configured in E1 mode then HDB3 code substitution will be selected. Bipolar violations can be inserted via the [BEIR](#) register only if B8ZS or HDB3 coding is turned off.

B8ZS substitution is defined in ANSI T1.102 and HDB3 in ITU-T G.703 standards.

### 5.4.6 Transmit Power-Down

The transmitter will be powered down if the relevant bits in the [TPDE](#) are set. The TTIP/TRING outputs will be high impedance when TPDE is set.

### 5.4.7 Transmit All Ones

When Transmit All Ones is invoked, continuous ones are transmitted using MCLK as the timing reference. Data input at TPOS and TNEG is ignored.

Transmit All Ones can be sent by setting bits in the [TAOE](#) Register. Also, Transmit All Ones will be enabled if bits in [ATAOS](#) are set and the corresponding receiver goes into LOS state in status register [LOSS](#).

### 5.4.8 Driver Fail Monitor

The Driver Fail Monitor is connected to the TTIP and TRING pins. It will detect a short or open circuit on the secondary side of the transmit transformer. The drive current will be limited to 50mA if a short circuit is detected. The [DFMS](#) status registers and the corresponding interrupt and enable registers can be used to monitor the driver failure.

## 5.5 Receiver

The DS26324's 16 receivers are all identical. A 1:2 or 1:1 transformer can be used on the receive side (selected by the RTR bit), but only a 1:1 transformer can be used if fully internal impedance match is enabled. Fully internal receive impedance match does not require the use of any external resistor on the receive line. If partially internal impedance matching is selected, the DS26324 will need only an external 120Ω resistor (30Ω for a 1:2 transformer) for E1, T1, and J1. The receive impedance match settings are controlled by the transmit template/impedance selection. See [Figure 5-8](#) and [Table 5-6](#) for external component values. Partially internal impedance matching is enabled via the [TS.RIMPON](#) bit. Fully internal impedance matching is enabled by setting [GC.RIMPMS](#) and [TS.RIMPON](#).

The peak detector and data slicer process the received signal. The output of the data slicer goes to clock and data recovery. A 2.048/1.544 PLL is internally multiplied by 16 via another internal PLL and fed to the clock recovery system derives E1 or T1 clock. The clock recovery system uses the clock from the PLL circuit to form a 16 times oversampler, which is used to recover the clock and data. This oversampling technique offers outstanding performance to meet jitter tolerance specifications.

B8ZS/HDB3/AMI decoding is available when single-rail mode is selected. The selection of single-rail or dual rail is done by settings in the [SRMS](#) register.

The receiver is capable of recovering signals up to 18dB worth of attenuation. The receiver contains functionality to provide resistive gain up to 20dB for monitor mode.

Three receive termination modes are available:

- 1) **External Impedance Matching.** Internal impedance matching is disabled, external resistor should match line impedance.
- 2) **Partially Internal Impedance Matching.** Internal impedance matching is enabled, in parallel with an external termination resistor (one value for all terminations).
- 3) **Fully Internal Impedance Matching.** Internal impedance matching is enabled, no external termination necessary. This mode requires a 1:1 receive-side transformer.

### 5.5.1 Receiver Impedance Matching Calibration

In fully internal impedance matching mode, calibration of the internal resistors is necessary to match the line impedance accurately. Calibration must be done upon power-up of the device. The resistance of the internal resistors does vary across temperature. Therefore, it may be necessary to recalibrate if the ambient temperature changes more than 30°C. The user may conclude that it is necessary to recalibrate on a periodic basis if he expects such temperature swings. Calibration is not necessary for partially internal impedance match mode.

### 5.5.2 Receiver Monitor Mode

The receive equalizer is equipped with monitor mode function that allows for resistive gain up to 20dB, along with cable attenuation of 6dB to 24dB as shown in the [RSMM1–4](#) registers.

### 5.5.3 Peak Detector and Slicer

The slicer determines the polarity and presence of the received data. The output of the slicer is sent to the clock and data recovery circuitry for extraction of data and clock. The slicer has a built-in peak detector for determination of the slicing threshold.

### 5.5.4 Receive Level Indicator

The DS26324 will report the signal strength at RTIP and RRING in increments described in [Table 6-17](#), via register bits CnRL3–CnRL0 located in the [RSL1–4](#) registers.

### 5.5.5 Clock and Data Recovery

The resultant E1 or T1 clock derived from the 2.048/1.544 PLL is internally multiplied by 16 via another internal PLL and fed to the clock recovery system. The clock recovery system uses the clock from the PLL circuit to form a 16 times oversampler, which is used to recover the clock and data. This oversampling technique offers outstanding performance to meet jitter tolerance specifications.

### 5.5.6 Loss of Signal

The DS26324 uses both the digital and analog loss-detection method in compliance with the latest ANSI T1.231 for T1/J1 and ITU-T G.775 or ETS 300 233 for E1 mode of operation.

LOS is detected if the receiver level falls below a threshold analog voltage for certain duration. Alternatively, this can be termed as having received “zeros” for certain duration. The signal level and timing duration are defined in accordance with the ANSI T1.231, ITU-T G.775, or ETS 300 233 specifications.

The loss detection thresholds are based on cable loss of 18dB for both T1 and E1 modes.

RCLK is replaced by MCLK when the receiver detects a loss of signal. If the AISEL bit is set in the [GC](#) register or the [AISEL](#) bit is set, the RPOS/RNEG data is replaced by AIS. The loss state is exited when the receiver detects a certain number of ones density at a higher signal level than the loss detection level. The loss detection signal level and loss reset signal level are defined with a hysteresis to prevent the receiver from bouncing between “LOS” and “no LOS” states.

[Table 5-7](#) outlines the specifications governing the loss function.

**Table 5-7. Loss Criteria ANSI T1.231, ITU-T G.775, and ETS 300 233 Specifications**

| CRITERIA                | STANDARD  |  |   |
|-------------------------|---|--|---|
|                         | T1.231  | ITU-T G.775  | ETS 300 233   |
| Loss Detection Criteria | No pulses are detected for 175 $\pm$ 75 bits.   | No pulses are detected for duration of 10 to 255 bit periods.              | No pulses are detected for a duration of 2048 bit periods or 1ms. |
| Loss Reset Criteria     | Loss is terminated if a duration of 12.5% ones are detected over duration of 175 $\pm$ 75 bits.<br>Loss is not terminated if 8 consecutive zeros are found if B8ZS encoding is used. If B8ZS is not used loss is not terminated if 100 consecutive pulses are zero. | The incoming signal has transitions for duration of 10 to 255 bit periods. | Loss reset criteria is not defined.                               |

### 5.5.6.1 ANSI T1.231 for T1 and J1 Modes

Loss is detected if the received signal level is less than 200mV for duration of 192 bit periods. LOS is reset if the all of the following criteria are met:

- 24 or more ones are detected in 192-bit period with a detection threshold of 300mV measured at RTIP and RRING.
- During the 192 bits less than 100 consecutive zeros are detected.
- 8 consecutive zeros are not detected if B8ZS is set.

### 5.5.6.2 ITU-T G.775 for E1 Modes

LOS is detected if the received signal level is less than 200mV for a continuous duration of 192 bit periods. LOS is reset if the receive signal level is greater than 300mV for a duration of 192 bit periods.

### 5.5.6.3 ETS 300 233 for E1 Modes

LOS is detected if the received signal level is less than 200mV for a continuous duration of 2048 (1ms) bit periods. LOS is reset if the receive signal level is greater than 300mV for a duration of 192 bit periods.

## 5.5.7 AIS

[Table 5-8](#) outlines the DS26324 AIS related specifications. [Table 5-9](#) states the AIS functionality in the DS26324. The registers related to the AIS detection are shown in [Table 5-10](#).

**Table 5-8. AIS Criteria ANSI T1.231, ITU-T G.775, and ETS 300 233 Specifications**

| CRITERIA               | STANDARD   |  |   |
|------------------------|--|--|---|
|                        | ITU-T G.775 for E1   | ETS 300 233 for E1                             | ANSI T1.231 for T1  |
| AIS Detection Criteria | 2 or fewer zeros in each of 2 consecutive 512-bit stream received. | Fewer than 3 zeros detected in 512 bit period. | Fewer than 9 zeros detected in a 8192-bit period (a ones density of 99.9% over a period of 5.3ms) are received. |
| AIS Clearance Criteria | 3 or more zeros in each of 2 consecutive 512-bit streams received. | 3 or more zeros in 512 bits received.          | 9 or more zeros detected in a 8192-bit period are received.   |

**Table 5-9. AIS Detection and Reset Criteria for DS26324**

| CRITERIA               | STANDARD  |  |   |
|------------------------|---|--|---|
|                        | ITU-T G.775 for E1  | ETS 300 233 for E1                             | ANSI T1.231 for T1                            |
| AIS Detection Criteria | 2 or fewer zeros in each of 2 consecutive 512-bit streams received. | Fewer than 3 zeros detected in 512-bit period. | Fewer than 9 zeros contained in 8192 bits.    |
| AIS Clearance Criteria | 3 or more zeros in each of 2 consecutive 512-bit streams received.  | 3 or more zeros in 512 bits received.          | 9 or more bits received in a 8192-bit stream. |

**Table 5-10. Registers Related to AIS Detection**

| REGISTER                       | NAME                  | FUNCTIONALITY   |
|--------------------------------|-----------------------|---|
| LOS/AIS Criteria Selection     | <a href="#">LASCS</a> | Section criteria for AIS (T1.231, G.775, ETS 300 233 for E1).     |
| Alarm Indication Signal Status | <a href="#">AIS</a>   | Set when AIS is detected.   |
| AIS Interrupt Enable           | <a href="#">AISIE</a> | If reset, interrupt due to AIS is not generated.                  |
| AIS Interrupt Status           | <a href="#">AISIS</a> | Latched if there is a change in AIS and the interrupt is enabled. |

### 5.5.8 Receive Dual-Rail Mode

Receive dual-rail mode consists of the RPOS, RNEG, and RCLK pins on the system side. In receive dual-rail mode, B8ZS and HDB3 decoding is not available. The data that appears on the RTIP and RRING pins is output on

RPOS and RNEG without any modification. The Single-Rail Mode Select Register ([SRMS](#)) is used for selection of dual-rail or single-rail mode. The bipolar violation (and B8ZS/HDB3) detectors detect violations in dual-rail and single-rail modes, but in dual-rail mode the violations will only be reported to the Line Violation Detect Status ([LVDS](#)) registers.

### 5.5.9 Receive Single-Rail Mode

Receive single-rail mode consists of the RPOS, RCLK, and CV pins on the system side. B8ZS or HDB3 decoding is available. The Single-Rail Mode Select Register ([SRMS](#)) is used for selection of dual-rail or single-rail mode.

#### 5.5.10 Bipolar Violation and Excessive Zero Detector

The DS26324 detects HDB3 code violations, BPVs, and excessive zero errors. The reporting of the errors is done through the RNEGn/CVn pin in single-rail mode and the [LVDS](#) registers in both single- and dual-rail modes. Code violations are only detected in E1 mode with HDB3 encoding. The code violation detection declares an error when a bipolar violation of the same polarity as the last bipolar violation is received.

Excessive zeros are detected if eight consecutive zeros are detected with B8ZS enabled and four consecutive zeros are detected with HDB3 enabled. Excessive zero detection is enabled via the Excessive Zero Detect Enable Register ([EZDE](#)) and when HDB3/B8ZS encoding/decoding is selected via the Line Code Selection Register ([LCS](#)).

The bits in the [LCS](#), [EZDE](#), and [CVDEB](#) registers determine the combinations that are reported. [Table 5-11](#) outlines the functionality.

**Table 5-11. BPV, Code Violation, and Excessive Zero Error Reporting**

| CONDITIONS          |                      |                       | ERRORS DETECTED                                  |
|---------------------|----------------------|-----------------------|--|
| <a href="#">LCS</a> | <a href="#">EZDE</a> | <a href="#">CVDEB</a> |  |
| 0                   | 0                    | 0                     | BPV (T1)/Code Violation (E1)                     |
| 0                   | 0                    | 1                     | BPV  |
| 0                   | 1                    | 0                     | Excessive Zeros and BPV (T1)/Code Violation (E1) |
| 0                   | 1                    | 1                     | Excessive Zeros and BPV                          |
| 1                   | X                    | X                     | BPV  |

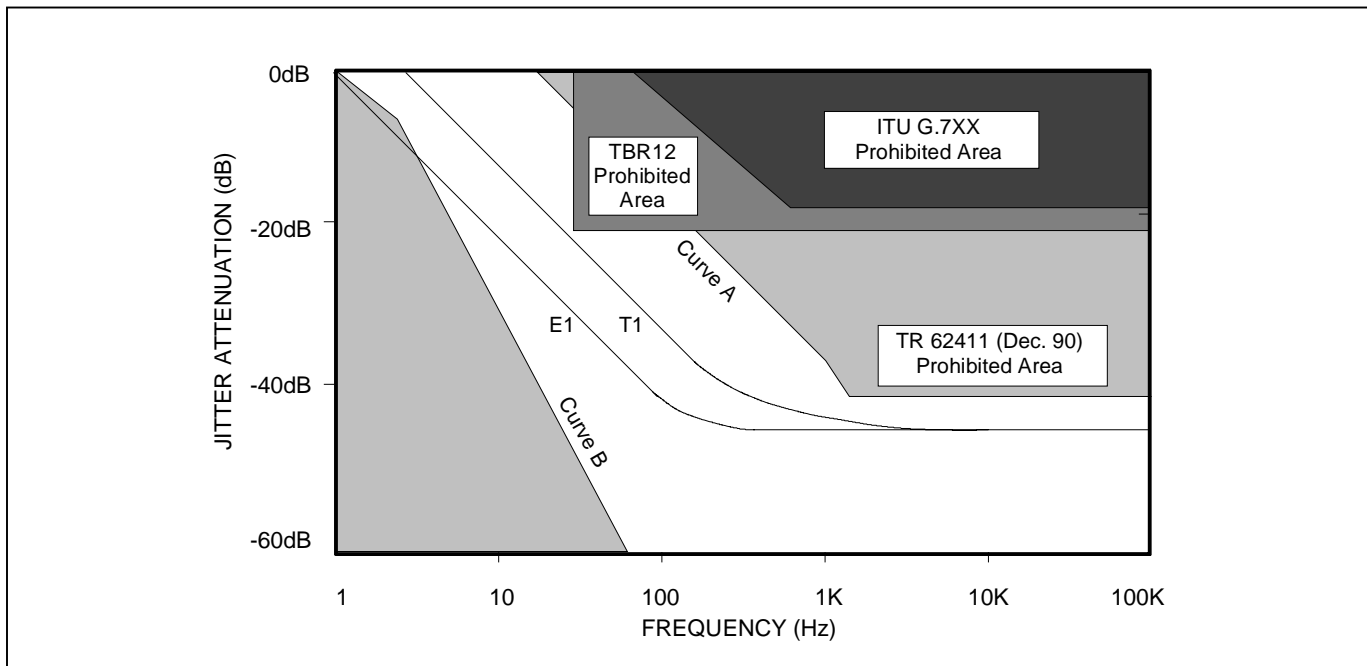
## 5.6 Jitter Attenuator

The DS26324 contains an on-board jitter attenuator that can be set to a depth of either 32 or 128 bits via the JADS bit in register [GC](#). It can also be controlled on an individual LIU basis by settings in the [IJAFDS](#) register.

The 128-bit mode is used in applications where large excursions of wander are expected. The 32-bit mode is used in delay sensitive applications. The characteristics of the attenuation are shown in [Figure 5-9](#). The jitter attenuator can be placed in either the receive path or the transmit path or none by appropriately setting the JAPS and the JAE bits in register [GC](#). These selections can be changed on an individual LIU basis by settings in the [IJAPS](#) and [IJAE](#).

In order for the jitter attenuator to operate properly, a 2.048MHz clock or multiple thereof, or 1.544MHz clock or multiple thereof, must be applied at MCLK. ITU-T specification G.703 requires an accuracy of  $\pm 50\text{ppm}$  for both T1 and E1 applications. AT&T Pub 62411 and ANSI specs require an accuracy of  $\pm 32\text{ppm}$  for T1 interfaces. On-board circuitry adjusts either the recovered clock from the clock/data recovery block or the clock applied at the TCLK pin to create a smooth jitter-free clock, which is used to clock data out of the jitter attenuator FIFO. It is acceptable to provide a jittery clock at the TCLK pin if the jitter attenuator is placed on the transmit side. If the incoming jitter exceeds either  $120\text{UI}_{\text{P-P}}$  (buffer depth is 128 bits) or  $28\text{UI}_{\text{P-P}}$  (buffer depth is 32 bits), the DS26324 will divide the internal nominal 32.768MHz (E1) or 24.704MHz (T1) clock by either 15 or 17 instead of the normal 16 to keep the buffer from overflowing. When the device divides by either 15 or 17, it also sets the jitter attenuator limit trip (IJAFLT) bits in the [IJAFLT](#) register described.

**Figure 5-9. Jitter Attenuation**



## 5.7 G.772 Monitor

In this application, only 14 transceivers are functional and two transceivers are used for nonintrusive monitoring of input and output of the other 14 channels. Channel 9 is used for 10 to 16 channels and Channel 1 is used for 2 to 8 channels. G.772 monitoring is configured by the BERT and G.772 Monitoring Control Register (BGMC) (see [Table 6-9](#)). While monitoring, Channel 1 can be configured in remote loopback and the monitored signal can be output on TTIP1 and TRING1. While monitoring, Channel 9 can be configured in remote loopback and the monitored signal can be output on TTIP9 and TRING9.

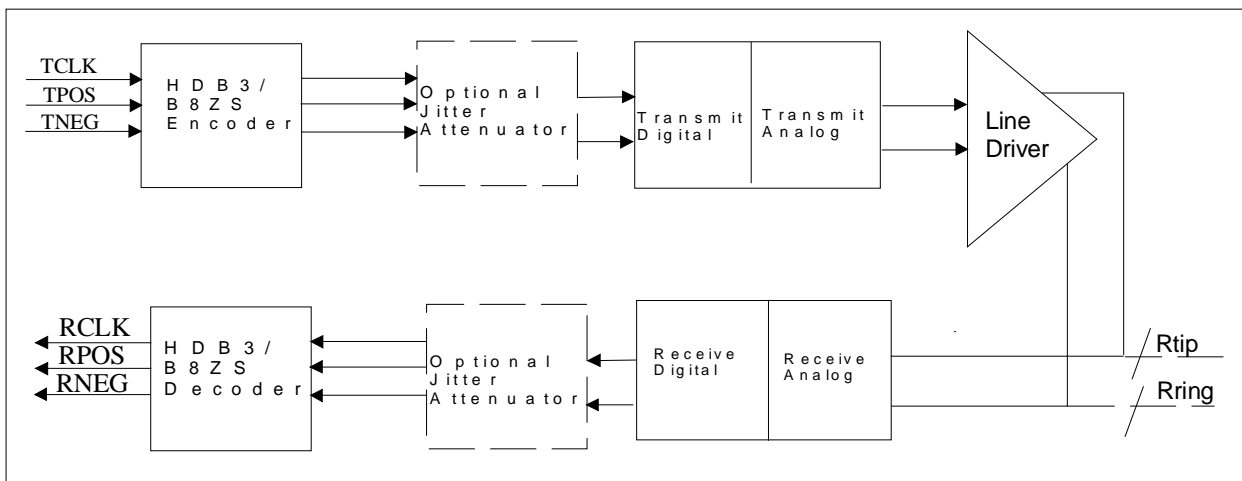
## 5.8 Loopbacks

The DS26324 provides four loopbacks for diagnostic purposes: analog loopback, digital loopback, remote loopback, and dual loopback. Dual loopback is accomplished by turning on digital loopback and remote loopback at the same time.

### 5.8.1 Analog Loopback

The analog output of the transmitter TTIP and TRING is looped back to RTIP and RRING of the receiver. Data at RTIP and RRING is ignored in analog loopback. This is shown in [Figure 5-10](#).

**Figure 5-10. Analog Loopback**

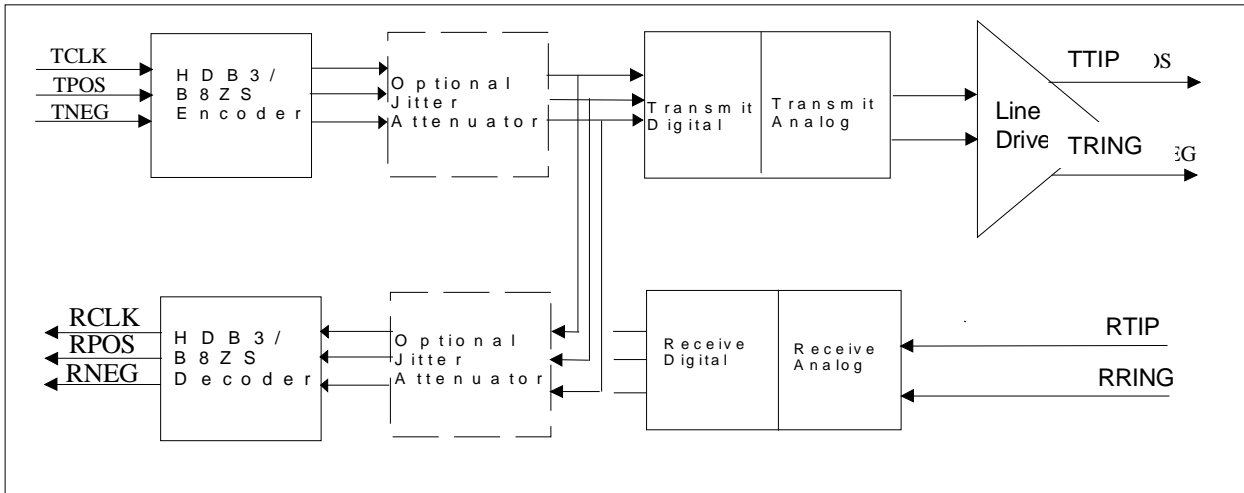




### 5.8.2 Digital Loopback

The transmit system data TPOS, TNEG, and TCLK will be looped back to output on RCLK, RPOS, and RNEG. The data input at TPOS and TNEG is output on TTIP and TRING. All ones can also be output when selected by the Transmit All Ones Enable Register (TAOE). Signals at RTIP and RRING will be ignored. This loopback is conceptually shown in [Figure 5-11](#).

**Figure 5-11. Digital Loopback**

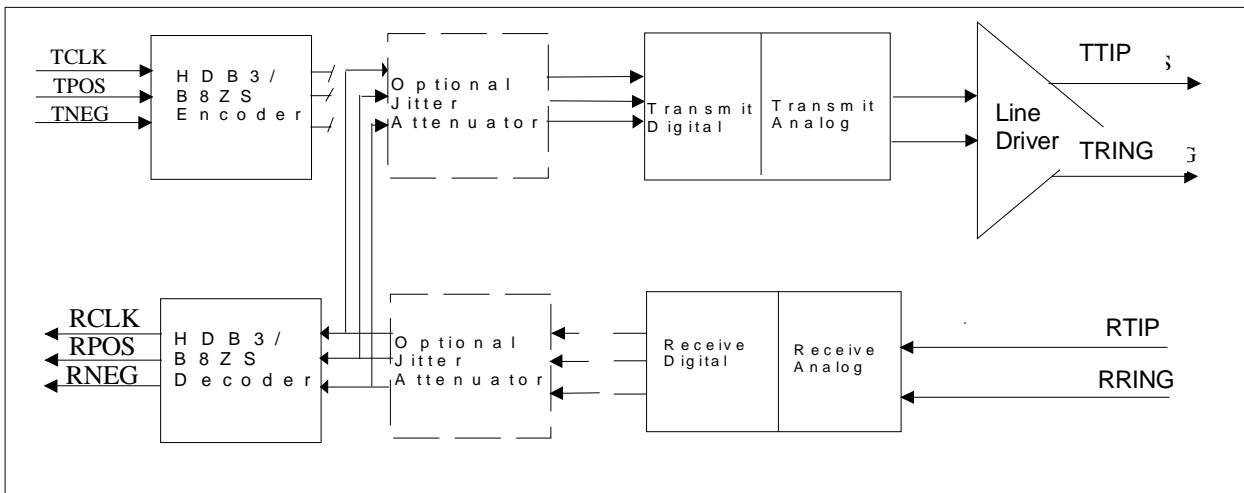


### 5.8.3 Remote Loopback

The inputs at RTIP and RRING are looped back to TTIP and TRING. The inputs at TCLK, TPOS, and TNEG are ignored during a remote loopback. This loopback is conceptually shown in [Figure 5-12](#).

**Note:** Remote loopback does not take precedence over transmit power-down and requires TCLK to operate. The transmitters will use the recovered RCLK in remote loopback. TCLK is still required because if it is removed the transmitters will power-down (TCLK held low) or transmit all ones (TCLK held high).

**Figure 5-12. Remote Loopback**



## 5.9 BERT

There are two bit error-rate testers available on the DS26324. One BERT can be mapped into LIUs 1–8 and the other into LIUs 9–16 via the [BTCR](#) registers. The two BERTs operate independently of each other.

Each BERT transmitter, by default, replaces data from TPOS and TNEG; each BERT receiver, by default, samples recovered data from RTIP and RRING.

The BERT can be enabled to replace data received on RTIP and RRING via the BERTDIR bit in the BERT and G.772 Monitoring Control Register ([BGMC](#)). In this mode, the SRMS bit determines whether data comes out single-rail or dual-rail. BERT data can be sourced using the recovered clock, MCLK, or TCLK. In this mode of operation, the BERT receiver samples data on TPOS and TNEG on the falling edge of TCLK. This function is useful for testing the digital side of the LIU. If TCLK is selected as a source for this mode, the input TCLK will control the BERT transmitter and receiver. If the recovered clock or MCLK is selected, the RCLK output needs to drive the TCLK input in order for the BERT receiver to sync to the data.

### 5.9.1 General Description

The BERT is a software-programmable test pattern generator and monitor capable of meeting most error performance requirements for digital transmission equipment. It will generate and synchronize to pseudorandom patterns with a generation polynomial of the form  $x^n + x^y + 1$ , where  $n$  and  $y$  can take on values from 1 to 32 and repetitive patterns of any length up to 32 bits.

The transmit direction generates the programmable test pattern, and inserts the test pattern payload into the data stream.

The receive direction extracts the test pattern payload from the receive data stream, and monitors the test pattern payload for the programmable test pattern.

#### 5.9.1.1 BERT Features

- **Programmable PRBS Pattern.** The pseudorandom bit sequence (PRBS) polynomial ( $x^n + x^y + 1$ ) and seed are programmable (length  $n = 1$  to 32, tap  $y = 1$  to  $n - 1$ , and seed = 0 to  $2^n - 1$ ).
- **Programmable Repetitive Pattern.** The repetitive pattern length and pattern are programmable (the length  $n = 1$  to 32 and pattern = 0 to  $2^n - 1$ ).
- **24-Bit Error Count and 32-Bit Bit Count Registers**
- **Programmable Bit-Error Insertion.** Errors can be inserted individually, on a pin transition, or at a specific rate. The rate  $1/10^n$  is programmable ( $n = 1$  to 7).
- **Pattern Synchronization at a  $10^{-3}$  BER.** Pattern synchronization is achieved even in the presence of a random bit error rate (BER) of  $10^{-3}$ .

## 5.9.2 Configuration and Monitoring

Set [BTCR.BERTE](#) = 1 to enable the BERT. The following tables show how to configure the on-board BERT to send and receive common patterns.

**Table 5-12. Pseudorandom Pattern Generation**

| PATTERN TYPE                                   | BPCR REGISTER     |                   |     |      | BERT.PCR | BERT.SPR2 | BERT.SPR1 | BERT.CR       |
|--|-------------------|-------------------|-----|------|----------|-----------|-----------|---------------|
|  | PTF[4:0]<br>(hex) | PLF[4:0]<br>(hex) | PTS | QRSS |          |           |           | TPIC,<br>RPIC |
| 2 <sup>9</sup> -1 O.153 (511 type)             | 04                | 08                | 0   | 0    | 0x0408   | 0xFFFF    | 0xFFFF    | 0             |
| 2 <sup>11</sup> -1 O.152 and O.153 (2047 type) | 08                | 0A                | 0   | 0    | 0x080A   | 0xFFFF    | 0xFFFF    | 0             |
| 2 <sup>15</sup> -1 O.151                       | 0D                | 0E                | 0   | 0    | 0x0D0E   | 0xFFFF    | 0xFFFF    | 1             |
| 2 <sup>20</sup> -1 O.153                       | 10                | 13                | 0   | 0    | 0x1013   | 0xFFFF    | 0xFFFF    | 0             |
| 2 <sup>20</sup> -1 O.151 QRSS                  | 02                | 13                | 0   | 1    | 0x0253   | 0xFFFF    | 0xFFFF    | 0             |
| 2 <sup>23</sup> -1 O.151                       | 11                | 16                | 0   | 0    | 0x1116   | 0xFFFF    | 0xFFFF    | 1             |

**Table 5-13. Repetitive Pattern Generation**

| PATTERN TYPE                 | BPCR REGISTER     |                   |     |      | BERT.PCR | BERT.SPR2 | BERT.SPR1 |
|------------------------------|-------------------|-------------------|-----|------|----------|-----------|-----------|
|                              | PTF[4:0]<br>(hex) | PLF[4:0]<br>(hex) | PTS | QRSS |          |           |           |
| All Ones                     | NA                | 00                | 1   | 0    | 0x0020   | 0xFFFF    | 0xFFFF    |
| All Zeros                    | NA                | 00                | 1   | 0    | 0x0020   | 0xFFFF    | 0xFFFE    |
| Alternating Ones and Zeros   | NA                | 01                | 1   | 0    | 0x0021   | 0xFFFF    | 0xFFFE    |
| Double Alternating and Zeros | NA                | 03                | 1   | 0    | 0x0023   | 0xFFFF    | 0xFFFC    |
| 3 in 24                      | NA                | 17                | 1   | 0    | 0x0037   | 0xFF20    | 0x0022    |
| 1 in 16                      | NA                | 0F                | 1   | 0    | 0x002F   | 0xFFFF    | 0x0001    |
| 1 in 8                       | NA                | 07                | 1   | 0    | 0x0027   | 0xFFFF    | 0xFF01    |
| 1 in 4                       | NA                | 03                | 1   | 0    | 0x0023   | 0xFFFF    | 0xFFF1    |

After configuring these bits, the pattern must be loaded into the BERT. This is accomplished via a zero-to-one transition on [BCR.TNPL](#) and [BCR.RNPL](#).

Monitoring the BERT requires reading the [BSR](#) register, which contains the Bit Error Count (BEC) bit and the Out of Synchronization (OOS) bit. The BEC bit will be one when the bit error counter is one or more. The OOS will be one when the receive pattern generator is not synchronized to the incoming pattern, which will occur when it receives a minimum 6 bit errors within a 64-bit window. The Receive BERT Bit Count Register ([RBCR](#)) and the Receive BERT Bit Error Count Register ([RBECCR](#)) will be updated upon the reception of a Performance Monitor Update signal (e.g., [BCR.LPMU](#)). This signal will update the registers with the values of the counters since the last update and will reset the counters.

### 5.9.3 Receive Pattern Detection

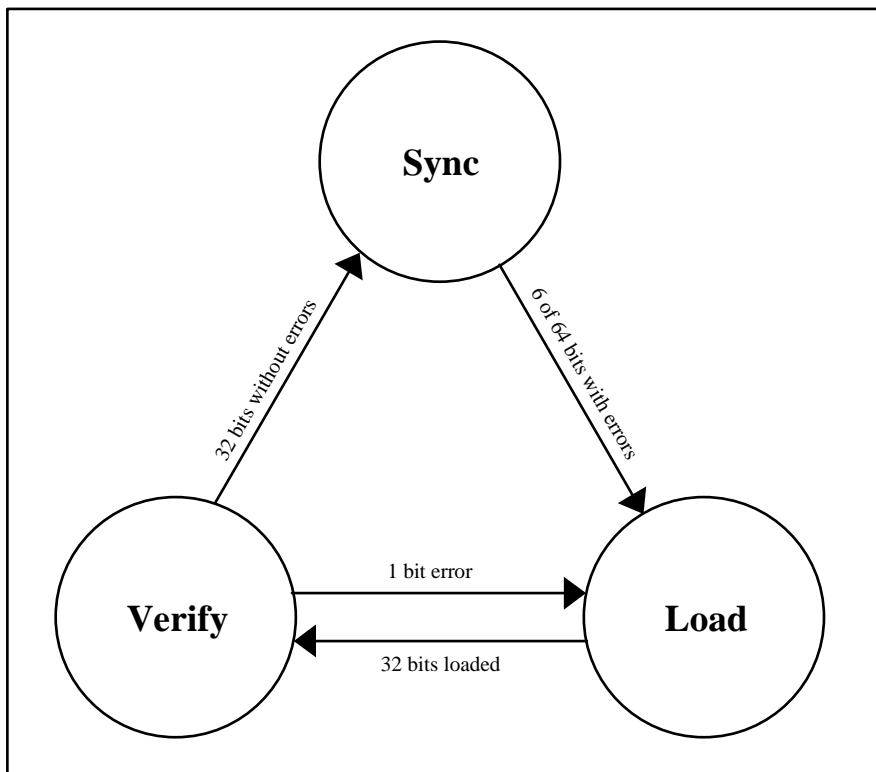
The Receive BERT receives only the payload data and synchronizes the receive pattern generator to the incoming pattern. The receive pattern generator is a 32-bit shift register that shifts data from the least significant bit (LSB) or bit 1 to the most significant bit (MSB) or bit 32. The input to bit 1 is the feedback. For a PRBS pattern (generating polynomial  $x^n + x^y + 1$ ), the feedback is an XOR of bit  $n$  and bit  $y$ . For a repetitive pattern (length  $n$ ), the feedback is bit  $n$ . The values for  $n$  and  $y$  are individually programmable (1 to 32). The output of the receive pattern generator is the feedback. If QRSS is enabled, the feedback is an XOR of bits 17 and 20, and the output will be forced to one if the next 14 bits are all zeros. QRSS is programmable (on or off). For PRBS and QRSS patterns, the feedback will be forced to one if bits 1 through 31 are all zeros. Depending on the type of pattern programmed, pattern detection performs either PRBS synchronization or repetitive pattern synchronization.

#### 5.9.3.1 Receive PRBS Synchronization

PRBS synchronization synchronizes the receive pattern generator to the incoming PRBS or QRSS pattern. The receive pattern generator is synchronized by loading 32 data stream bits into the receive pattern generator, and then checking the next 32 data stream bits. Synchronization is achieved if all 32 bits match the incoming pattern. If at least six incoming bits in the current 64-bit window do not match the receive pattern generator, automatic pattern re-synchronization is initiated. Automatic pattern re-synchronization can be disabled.

See [Figure 5-13](#) for the PRBS synchronization diagram.

**Figure 5-13. PRBS Synchronization State Diagram**

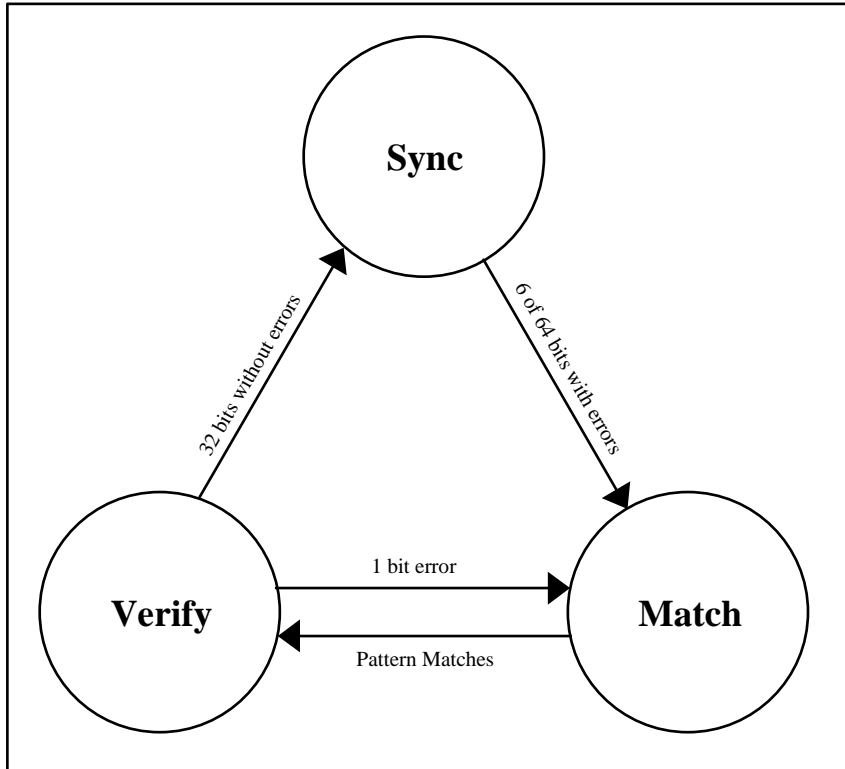


### 5.9.3.2 Receive Repetitive Pattern Synchronization

Repetitive pattern synchronization synchronizes the receive pattern generator to the incoming repetitive pattern. The receive pattern generator is synchronized by searching each incoming data stream bit position for the repetitive pattern, and then checking the next 32 data stream bits. Synchronization is achieved if all 32 bits match the incoming pattern. If at least six incoming bits in the current 64-bit window do not match the receive PRBS pattern generator, automatic pattern re-synchronization is initiated. Automatic pattern re-synchronization can be disabled.

See [Figure 5-14](#) for the repetitive pattern synchronization state diagram.

**Figure 5-14. Repetitive Pattern Synchronization State Diagram**



### 5.9.3.3 Receive Pattern Monitoring

Receive pattern monitoring monitors the incoming data stream for both an OOS condition and bit errors and counts the incoming bits. An Out Of Synchronization (OOS) condition is declared when the synchronization state machine is not in the "Sync" state. An OOS condition is terminated when the synchronization state machine is in the "Sync" state.

Bit errors are determined by comparing the incoming data stream bit to the receive pattern generator output. If they do not match, a bit error is declared, and the bit error and bit counts are incremented. If they match, only the bit count is incremented. The bit count and bit error count are not incremented when an OOS condition exists.

## 5.9.4 Transmit Pattern Generation

Pattern generation generates the outgoing test pattern, and passes it onto error insertion. The transmit pattern generator is a 32-bit shift register that shifts data from the least significant bit (LSB) or bit 1 to the most significant bit (MSB) or bit 32. The input to bit 1 is the feedback. For a PRBS pattern (generating polynomial  $x^n + x^y + 1$ ), the feedback is an XOR of bit  $n$  and bit  $y$ . For a repetitive pattern (length  $n$ ), the feedback is bit  $n$ . The values for  $n$  and  $y$  are individually programmable (1 to 32). The output of the receive pattern generator is the feedback. If QRSS is enabled, the feedback is an XOR of bits 17 and 20, and the output will be forced to one if the next 14 bits are all zeros. QRSS is programmable (on or off). For PRBS and QRSS patterns, the feedback will be forced to one if bits 1 through 31 are all zeros. When a new pattern is loaded, the pattern generator is loaded with a seed/pattern value before pattern generation starts. The seed/pattern value is programmable ( $0 - 2^n - 1$ ).

### 5.9.4.1 Transmit Error Insertion

Error insertion inserts errors into the outgoing pattern data stream. Errors are inserted one at a time or at a rate of one out of every  $10^n$  bits. The value of  $n$  is programmable (1 to 7 or off). Single bit error insertion can be initiated from the microprocessor interface, or by the manual error insertion input (TMEI). The method of single error insertion is programmable (register or input). If pattern inversion is enabled, the data stream is inverted before the overhead/stuff bits are inserted. Pattern inversion is programmable (on or off).

## 6 REGISTER MAPS AND DEFINITION

Six address bits are used to control the settings of the registers. In the parallel nonmultiplexed mode address [5:0] is used. In multiplexed mode AD[5:0] is used and A[6:1] is used in the serial mode. The register space contains two independent sets of registers. The lower set of registers (LIUs 1–8) is located from address 00 hex to 1F hex and contains controls for LIUs 1–8. The upper set of registers (LIUs 9–16) is a duplicate of the lower set, located from address 20 hex to 3F hex that controls LIUs 9–16. Each of these sets of registers consists of four banks: Primary, Secondary, Individual LIU, and BERT.

The [ADDP](#) register for the lower set of registers (LIUs 1–8) is located at address 1F hex. This register is used as a pointer to access the 4 banks of registers in the lower (LIUs 1–8) register set. Similarly, the [ADDP](#) register for the upper set of registers (LIUs 9–16) is located at address 3F hex. This register is used as a pointer to access the four banks of registers in the upper (LIUs 9–16) register set. Setting an [ADDP](#) register to AA hex will access the secondary bank of registers, 01 hex will access the Individual LIU bank of registers, 02 hex will access the BERT bank of registers, and 00 hex (default on power-up) will access the Primary bank of registers. Note that bank selection for the lower set of registers (LIUs 1–8) is controlled only by the ADDP at 1F hex and that bank selection for the upper set of registers (LIUs 9–16) is controlled only by the ADDP at 3F hex.

Table 6-1. Primary Register Set

| REGISTER                              | NAME                  | HEX FOR CH 1–8 | ADDRESS FOR CH 1–8              |                               | HEX FOR CH 9–16 | ADDRESS FOR CH 9–16             |                               | RW |
|---------------------------------------|-----------------------|----------------|---------------------------------|-------------------------------|-----------------|---------------------------------|-------------------------------|----|
|                                       |                       |                | PARALLEL INTERFACE A[7:0] (HEX) | SERIAL INTERFACE A[7:1] (HEX) |                 | PARALLEL INTERFACE A[7:0] (HEX) | SERIAL INTERFACE A[7:1] (HEX) |    |
| Identification                        | <a href="#">ID</a>    | 00             | xx000000                        | x000000                       | 20              | Not used                        | Not used                      | R  |
| Analog Loopback Control               | <a href="#">ALBC</a>  | 01             | xx000001                        | x000001                       | 21              | xx100001                        | x100001                       | RW |
| Remote Loopback Control               | <a href="#">RLBC</a>  | 02             | xx000010                        | x000010                       | 22              | xx100010                        | x100010                       | RW |
| Transmit All Ones Enable              | <a href="#">TAOE</a>  | 03             | xx000011                        | x000011                       | 23              | xx100011                        | x100011                       | RW |
| Loss of Signal Status                 | <a href="#">LOSS</a>  | 04             | xx000100                        | x000100                       | 24              | xx100100                        | x100100                       | R  |
| Driver Fault Monitor Status           | <a href="#">DFMS</a>  | 05             | xx000101                        | x000101                       | 25              | xx100101                        | x100101                       | R  |
| Loss of Signal Interrupt Enable       | <a href="#">LOSIE</a> | 06             | xx000110                        | x000110                       | 26              | xx100110                        | x100110                       | RW |
| Driver Fault Monitor Interrupt Enable | <a href="#">DFMIE</a> | 07             | xx000111                        | x000111                       | 27              | xx100111                        | x100111                       | RW |
| Loss of Signal Interrupt Status       | <a href="#">LOSIS</a> | 08             | xx001000                        | x001000                       | 28              | xx101000                        | x101000                       | R  |
| Driver Fault Monitor Interrupt Status | <a href="#">DFMIS</a> | 09             | xx001001                        | x001001                       | 29              | xx101001                        | x101001                       | R  |
| Software Reset                        | <a href="#">SWR</a>   | 0A             | xx001010                        | x001010                       | 2A              | xx101010                        | x101010                       | W  |
| BERT and G.772 Monitoring Control     | <a href="#">BGMC</a>  | 0B             | xx001011                        | x001011                       | 2B              | xx101011                        | x101011                       | RW |
| Digital Loopback Control              | <a href="#">DLBC</a>  | 0C             | xx001100                        | x001100                       | 2C              | xx101100                        | x101100                       | RW |
| LOS/AIS Criteria Selection            | <a href="#">LASCS</a> | 0D             | xx001101                        | x001101                       | 2D              | xx101101                        | x101101                       | RW |
| Automatic Transmit All Ones Select    | <a href="#">ATAOS</a> | 0E             | xx001110                        | x001110                       | 2E              | xx101110                        | x101110                       | RW |
| Global Configuration                  | <a href="#">GC</a>    | 0F             | xx001111                        | x001111                       | 2F              | xx101111                        | x101111                       | RW |
| Template Select Transmitter           | <a href="#">TST</a>   | 10             | xx010000                        | x010000                       | 30              | xx110000                        | x110000                       | RW |
| Template Select                       | <a href="#">TS</a>    | 11             | xx010001                        | x010001                       | 31              | xx110001                        | x110001                       | RW |
| Output Enable Configuration           | <a href="#">OE</a>    | 12             | xx010010                        | x010010                       | 32              | xx110010                        | x110010                       | RW |
| Alarm Indication Signal Status        | <a href="#">AIS</a>   | 13             | xx010011                        | x010011                       | 33              | xx110011                        | x110011                       | R  |
| AIS Interrupt Enable                  | <a href="#">AISIE</a> | 14             | xx010100                        | x010100                       | 34              | xx110100                        | x110100                       | RW |
| AIS Interrupt Status                  | <a href="#">AISIS</a> | 15             | xx010101                        | x010101                       | 35              | xx110101                        | x110101                       | R  |
| Reserved                              | —                     | 16–1E          | xx010110–<br>xx011110           | x010110–<br>x011110           | 36–3E           | xx110110–<br>x111110            | x110110–<br>x111110           | —  |
| Address Pointer for Bank Selection    | <a href="#">ADDP</a>  | 1F             | xx011111                        | x011111                       | 3F              | xx111111                        | x111111                       | RW |



**Table 6-2. Secondary Register Set**

| REGISTER                           | NAME                  | HEX FOR CH 1–8 | ADDRESS FOR CHANNELS 1–8        |                               | HEX FOR CH 9–16 | ADDRESS FOR CHANNELS 9–16       |                               | RW |
|------------------------------------|-----------------------|----------------|---------------------------------|-------------------------------|-----------------|---------------------------------|-------------------------------|----|
|                                    |                       |                | PARALLEL INTERFACE A[7:0] (HEX) | SERIAL INTERFACE A[7:1] (HEX) |                 | PARALLEL INTERFACE A[7:0] (HEX) | SERIAL INTERFACE A[7:1] (HEX) |    |
| Single-Rail Mode Select            | <a href="#">SRMS</a>  | 00             | xx000000                        | x000000                       | 20              | xx100000                        | x100000                       | RW |
| Line Code Selection                | <a href="#">LCS</a>   | 01             | xx000001                        | x000001                       | 21              | xx100001                        | x100001                       | R  |
| Not Used                           | —                     | 02             | xx000010                        | x000010                       | 22              | xx100010                        | x100010                       | R  |
| Receive Power-Down Enable          | <a href="#">RPDE</a>  | 03             | xx000011                        | x000011                       | 23              | xx100011                        | x100011                       | RW |
| Transmit Power-Down Enable         | <a href="#">TPDE</a>  | 04             | xx000100                        | x000100                       | 24              | xx100100                        | x100100                       | RW |
| Excessive Zero Detect Enable       | <a href="#">EZDE</a>  | 05             | xx000101                        | x000101                       | 25              | xx100101                        | x100101                       | R  |
| Code Violation Detect Enable Bar   | <a href="#">CVDEB</a> | 06             | xx000110                        | x000110                       | 26              | xx100110                        | x100110                       | R  |
| Not Used                           | —                     | 07–1E          | xx000111–<br>xx011110           | x000111–<br>x011110           | 27–3E           | xx100111–<br>xx111110           | x100111–<br>x111110           | W  |
| Address Pointer for Bank Selection | <a href="#">ADDP</a>  | 1F             | xx011111                        | x011111                       | 3F              | xx111111                        | x111111                       | RW |

**Table 6-3. Individual LIU Register Set**

| REGISTER                                       | NAME   | HEX FOR CH 1–8 | ADDRESS FOR CHANNELS 1–8        |                               | HEX FOR CH 9–16 | ADDRESS FOR CHANNELS 9–16       |                               | RW |
|--|--|----------------|---------------------------------|-------------------------------|-----------------|---------------------------------|-------------------------------|----|
|  |  |                | PARALLEL INTERFACE A[7:0] (HEX) | SERIAL INTERFACE A[7:1] (HEX) |                 | PARALLEL INTERFACE A[7:0] (HEX) | SERIAL INTERFACE A[7:1] (HEX) |    |
| Individual Jitter Attenuator Enable            | <a href="#">IJAЕ</a>   | 00             | xx000000                        | x000000                       | 20              | xx100000                        | x100000                       | RW |
| Individual Jitter Attenuator Position Select   | <a href="#">IJAPS</a>  | 01             | xx000001                        | x000001                       | 21              | xx100001                        | x100001                       | RW |
| Individual Jitter Attenuator FIFO Depth Select | <a href="#">IJAFDS</a>   | 02             | xx000010                        | x000010                       | 22              | xx100010                        | x100010                       | RW |
| Individual Jitter Attenuator FIFO Limit Trip   | <a href="#">IJAFLT</a>   | 03             | xx000011                        | x000011                       | 23              | xx100011                        | x100011                       | R  |
| Individual Short-Circuit Protection Disable    | <a href="#">ISCPD</a>  | 04             | xx000100                        | x000100                       | 24              | xx100100                        | x100100                       | RW |
| Individual AIS Select                          | <a href="#">IAISEL</a>   | 05             | xx000101                        | x000101                       | 25              | xx100101                        | x100101                       | RW |
| Master Clock Select                            | <a href="#">MC</a>   | 06             | xx000110                        | x000110                       | 26              | Not used                        | Not used                      | RW |
| Receive Sensitivity Monitor Mode 1–4           | <a href="#">RSMM1</a> ,<br><a href="#">RSMM2</a> ,<br><a href="#">RSMM3</a> ,<br><a href="#">RSMM4</a> | 08–0B          | xx001000–<br>xx001011           | x001000–<br>x001011           | 28–2B           | xx101000–<br>xx101011           | x101000–<br>x101011           | RW |
| Receive Signal Level Indicator 1–4             | <a href="#">RSL</a> 1–4  | 0C–0F          | xx001100–<br>xx001111           | x001100–<br>x001111           | 2C–2F           | xx101100–<br>xx101111           | x101100–<br>x101111           | R  |
| Bit Error Rate Tester Control                  | <a href="#">BTCR</a>   | 10             | xx010000                        | x010000                       | 30              | xx110000                        | x110000                       | RW |
| Line Violation Detect Status                   | <a href="#">LVDS</a>   | 12             | xx010010                        | x010010                       | 32              | xx110010                        | x110010                       | R  |
| Receive Clock Invert                           | <a href="#">RCLKI</a>  | 13             | xx010011                        | x010011                       | 33              | xx110011                        | x110011                       | RW |
| Transmit Clock Invert                          | <a href="#">TCLKI</a>  | 14             | xx010100                        | x010100                       | 34              | xx110100                        | x110100                       | RW |
| Clock Control Register                         | <a href="#">CCR</a>  | 15             | xx010101                        | x010101                       | 35              | Not used                        | Not used                      | RW |
| RCLK Disable Upon LOS                          | <a href="#">RDULR</a>  | 16             | xx010110                        | x010110                       | 36              | xx110110                        | x110110                       | RW |
| Global Interrupt Status Control                | <a href="#">GISC</a>   | 1E             | xx011110                        | x011110                       | 3E              | Not used                        | Not used                      | RW |
| Address Pointer for Bank Selection             | <a href="#">ADDP</a>   | 1F             | xx011111                        | x011111                       | 3F              | xx111111                        | x111111                       | RW |

Table 6-4. BERT Register Set

| REGISTER                              | NAME                   | HEX FOR CH 1-8 | ADDRESS FOR CHANNELS 1-8        |                               | HEX FOR CH 9-16 | ADDRESS FOR CHANNELS 9-16       |                               | RW |
|---------------------------------------|------------------------|----------------|---------------------------------|-------------------------------|-----------------|---------------------------------|-------------------------------|----|
|                                       |                        |                | PARALLEL INTERFACE A[7:0] (HEX) | SERIAL INTERFACE A[7:1] (HEX) |                 | PARALLEL INTERFACE A[7:0] (HEX) | SERIAL INTERFACE A[7:1] (HEX) |    |
| BERT Control                          | <a href="#">BCR</a>    | 00             | xx000000                        | x000000                       | 20              | xx100000                        | x100000                       | RW |
| Reserved                              | —                      | 01             | xx000001                        | x000001                       | 21              | xx100001                        | x100001                       | —  |
| BERT Pattern Configuration 1          | <a href="#">BPCR1</a>  | 02             | xx000010                        | x000010                       | 22              | xx100010                        | x100010                       | RW |
| BERT Pattern Configuration 2          | <a href="#">BPCR2</a>  | 03             | xx000011                        | x000011                       | 23              | xx100011                        | x100011                       | RW |
| BERT Seed/Pattern 1                   | <a href="#">BSPR1</a>  | 04             | xx000100                        | x000100                       | 24              | xx100100                        | x100100                       | RW |
| BERT Seed/Pattern 2                   | <a href="#">BSPR2</a>  | 05             | xx000101                        | x000101                       | 25              | xx100101                        | x100101                       | RW |
| BERT Seed/Pattern 3                   | <a href="#">BSPR3</a>  | 06             | xx000110                        | x000110                       | 26              | xx100110                        | x100110                       | RW |
| BERT Seed/Pattern 4                   | <a href="#">BSPR4</a>  | 07             | xx000111                        | x000111                       | 27              | xx100111                        | x100111                       | RW |
| Transmit Error Insertion Control      | <a href="#">TEICR</a>  | 08             | xx001000                        | x001000                       | 28              | xx101000                        | x101000                       | RW |
| Reserved                              | —                      | 09-0A          | xx001001-<br>x001010            | —                             | 29-2A           | xx101001-<br>x101010            | —                             | —  |
| BERT Status                           | <a href="#">BSR</a>    | 0C             | xx001100                        | x001100                       | 2C              | xx101100                        | x101100                       | R  |
| Reserved                              | —                      | 0D             | xx001101                        | x001101                       | 2D              | xx101101                        | x101101                       | —  |
| BERT Status Register Latched          | <a href="#">BSRL</a>   | 0E             | xx010011                        | x010011                       | 2E              | xx110011                        | x110011                       | RW |
| BERT Status Register Interrupt Enable | <a href="#">BSRIE</a>  | 10             | xx010000                        | x010000                       | 30              | xx110000                        | x110000                       | RW |
| Reserved                              | —                      | 11-13          | xx010001-<br>xx010011           | X010001-<br>x010011           | 31-33           | xx110001-<br>xx110011           | x110001-<br>x110011           | —  |
| Receive Bit Error Count Register 1    | <a href="#">RBECR1</a> | 14             | xx010100                        | x010100                       | 34              | xx110100                        | x110100                       | R  |
| Receive Bit Error Count Register 2    | <a href="#">RBECR2</a> | 15             | xx010101                        | x010101                       | 35              | xx110101                        | x110101                       | R  |
| Receive Bit Error Count Register 3    | <a href="#">RBECR3</a> | 16             | xx010110                        | x010110                       | 36              | xx110110                        | x110110                       | R  |
| Receive Bit Count Register 1          | <a href="#">RBCR1</a>  | 18             | xx011000                        | x011000                       | 38              | xx111000                        | x111000                       | R  |
| Receive Bit Count Register 2          | <a href="#">RBCR2</a>  | 19             | xx011001                        | x011001                       | 39              | xx111001                        | x111001                       | R  |
| Receive Bit Count Register 3          | <a href="#">RBCR3</a>  | 1A             | xx011010                        | x011010                       | 3A              | xx111010                        | x111010                       | R  |
| Receive Bit Count Register 4          | <a href="#">RBCR4</a>  | 1B             | xx011011                        | x011011                       | 3B              | xx111011                        | x111011                       | R  |
| Reserved                              | —                      | 1C-1E          | xx011100-<br>xx011110           | x011100-<br>x011110           | 3C-3E           | xx111100-<br>xx111110           | x111100-<br>x111110           | —  |
| Address Pointer for Bank Selection    | <a href="#">ADDP</a>   | 1F             | xx011111                        | x011111                       | 3F              | xx111111                        | x111111                       | RW |

Table 6-5. Primary Register Set Bit Map

| REGISTER     | ADDRESS FOR LIUs 1-8 | R/W | BIT 7   | BIT 6   | BIT 5  | BIT 4  | BIT 3  | BIT 2  | BIT 1  | BIT 0  |
|--------------|----------------------|-----|---------|---------|--------|--------|--------|--------|--------|--------|
| <u>ID</u>    | 00                   | R   | ID7     | ID6     | ID5    | ID4    | ID3    | ID2    | ID1    | ID0    |
| <u>ALBC</u>  | 01                   | RW  | ALBC8   | ALBC7   | ALBC6  | ALBC5  | ALBC4  | ALBC3  | ALBC2  | ALBC1  |
| <u>RLBC</u>  | 02                   | RW  | RLBC8   | RLBC7   | RLBC6  | RLBC5  | RLBC4  | RLBC3  | RLBC2  | RLBC1  |
| <u>TAOE</u>  | 03                   | RW  | TAOE8   | TAOE7   | TAOE6  | TAOE5  | TAOE4  | TAOE3  | TAOE2  | TAOE1  |
| <u>LOSS</u>  | 04                   | RW  | LOSS8   | LOSS7   | LOSS6  | LOSS5  | LOSS4  | LOSS3  | LOSS2  | LOSS1  |
| <u>DFMS</u>  | 05                   | RW  | DFMS8   | DFMS7   | DFMS6  | DFMS5  | DFMS4  | DFMS3  | DFMS2  | DFMS1  |
| <u>LOSIE</u> | 06                   | RW  | LOSIE8  | LOSIE7  | LOSIE6 | LOSIE5 | LOSIE4 | LOSIE3 | LOSIE2 | LOSIE1 |
| <u>DFMIE</u> | 07                   | RW  | DFMIE8  | DFMIE7  | DFMIE6 | DFMIE5 | DFMIE4 | DFMIE3 | DFMIE2 | DFMIE1 |
| <u>LOSI8</u> | 08                   | R   | LOSI8   | LOSI7   | LOSI6  | LOSI5  | LOSI4  | LOSI3  | LOSI2  | LOSI1  |
| <u>DFMIS</u> | 09                   | R   | DFMIS8  | DFMIS7  | DFMIS6 | DFMIS5 | DFMIS4 | DFMIS3 | DFMIS2 | DFMIS1 |
| <u>SWR</u>   | 0A                   | W   | SWRL    | SWRL    | SWRL   | SWRL   | SWRL   | SWRL   | SWRL   | SWRL   |
| <u>BGMC</u>  | 0B                   | RW  | BERTDIR | BMCK5   | BTCK5  | —      | GMC4   | GMC3   | GMC2   | GMC1   |
| <u>DLBC</u>  | 0C                   | RW  | DLBC8   | DLBC7   | DLBC6  | DLBC5  | DLBC4  | DLBC3  | DLBC2  | DLBC1  |
| <u>LASCS</u> | 0D                   | RW  | LASCS8  | LASCS7  | LASCS6 | LASCS5 | LASCS4 | LASCS3 | LASCS2 | LASCS1 |
| <u>ATAOS</u> | 0E                   | RW  | ATAOS8  | ATAOS7  | ATAOS6 | ATAOS5 | ATAOS4 | ATAOS3 | ATAOS2 | ATAOS1 |
| <u>GC</u>    | 0F                   | RW  | RIMPMS  | AISEL   | SCPD   | CODE   | JADS   | CRIMP  | JAPS   | JAE    |
| <u>TST</u>   | 10                   | RW  | JABWS1  | JABWS0  | RHPMC  | —      | —      | TST2   | TST1   | TST0   |
| <u>TS</u>    | 11                   | RW  | RIMPON  | TIMPOFF | —      | —      | TIMPRM | TS2    | TS1    | TS0    |
| <u>OE</u>    | 12                   | RW  | OE8     | OE7     | OE6    | OE5    | OE4    | OE3    | OE2    | OE1    |
| <u>AIS</u>   | 13                   | R   | AIS8    | AIS7    | AIS6   | AIS5   | AIS4   | AIS3   | AIS2   | AIS1   |
| <u>AISIE</u> | 14                   | RW  | AISIE8  | AISIE7  | AISIE6 | AISIE5 | AISIE4 | AISIE3 | AISIE2 | AISIE1 |
| <u>AISIS</u> | 15                   | R   | AISIS8  | AISIS7  | AISIS6 | AISIS5 | AISIS4 | AISIS3 | AISIS2 | AISIS1 |
| Not Used     | 16-1E                | —   | —       | —       | —      | —      | —      | —      | —      | —      |
| <u>ADDP</u>  | 1F                   | RW  | ADDP7   | ADDP6   | ADDP5  | ADDP4  | ADDP3  | ADDP2  | ADDP1  | ADDP0  |

| REGISTER     | ADDRESS FOR LIUs 9-16 | R/W | BIT 7   | BIT 6   | BIT 5   | BIT 4   | BIT 3   | BIT 2   | BIT 1   | BIT 0  |
|--------------|-----------------------|-----|---------|---------|---------|---------|---------|---------|---------|--------|
| Not Used     | 20                    | R   | —       | —       | —       | —       | —       | —       | —       | —      |
| <u>ALBC</u>  | 21                    | RW  | ALC16   | ALBC15  | ALBC14  | ALBC13  | ALBC12  | ALBC11  | ALBC10  | ALBC9  |
| <u>RLBC</u>  | 22                    | RW  | RLBC16  | RLBC15  | RLBC14  | RLBC13  | RLBC12  | RLBC11  | RLBC10  | RLBC9  |
| <u>TAOE</u>  | 23                    | RW  | TAOE16  | TAOE15  | TAOE14  | TAOE13  | TAOE12  | TAOE11  | TAOE10  | TAOE9  |
| <u>LOSS</u>  | 24                    | RW  | LOSS16  | LOSS15  | LOSS14  | LOSS13  | LOSS12  | LOSS11  | LOSS10  | LOSS9  |
| <u>DFMS</u>  | 25                    | RW  | DFMS16  | DFMS15  | DFMS14  | DFMS13  | DFMS12  | DFMS11  | DFMS10  | DFMS9  |
| <u>LOSIE</u> | 26                    | RW  | LOSIE16 | LOSIE15 | LOSIE14 | LOSIE13 | LOSIE12 | LOSIE11 | LOSIE10 | LOSIE9 |
| <u>DFMIE</u> | 27                    | RW  | DFMIE16 | DFMIE15 | DFMIE14 | DFMIE13 | DFMIE12 | DFMIE11 | DFMIE10 | DFMIE9 |
| <u>LOSI8</u> | 28                    | R   | LOSI16  | LOSI15  | LOSI14  | LOSI13  | LOSI12  | LOSI11  | LOSI10  | LOSI9  |
| <u>DFMIS</u> | 29                    | R   | DFMIS16 | DFMIS15 | DFMIS14 | DFMIS13 | DFMIS12 | DFMIS11 | DFMIS10 | DFMIS9 |
| <u>SWR</u>   | 2A                    | W   | SWRU    | SWRU    | SWRU    | SWRU    | SWRU    | SWRU    | SWRU    | SWRU   |
| <u>BGMC</u>  | 2B                    | RW  | BERTDIR | BMCK5   | BTCK5   | —       | GMC4    | GMC3    | GMC2    | GMC1   |
| <u>DLBC</u>  | 2C                    | RW  | DLBC16  | DLBC15  | DLBC14  | DLBC13  | DLBC12  | DLBC11  | DLBC10  | DLBC9  |
| <u>LASCS</u> | 2D                    | RW  | LASCS16 | LASCS15 | LASCS14 | LASCS13 | LASCS12 | LASCS11 | LASCS10 | LASCS9 |
| <u>ATAOS</u> | 2E                    | RW  | ATAOS16 | ATAOS15 | ATAOS14 | ATAOS13 | ATAOS12 | ATAOS11 | ATAOS10 | ATAOS9 |
| <u>GC</u>    | 2F                    | RW  | RIMPMS  | AISEL   | SCPD    | CODE    | JADS    | CALEN   | JAPS    | JAE    |
| <u>TST</u>   | 30                    | RW  | —       | —       | —       | —       | —       | TST2    | TST1    | TST0   |
| <u>TS</u>    | 31                    | RW  | RIMPON  | TIMPOFF | —       | —       | TIMPRM  | TS2     | TS1     | TS0    |
| <u>OE</u>    | 32                    | RW  | OE16    | OE15    | OE14    | OE13    | OE12    | OE11    | OE10    | OE9    |
| <u>AIS</u>   | 33                    | R   | AIS16   | AIS15   | AIS14   | AIS13   | AIS12   | AIS11   | AIS10   | AIS9   |
| <u>AISIE</u> | 34                    | RW  | AISIE16 | AISIE15 | AISIE14 | AISIE13 | AISIE12 | AISIE11 | AISIE10 | AISIE9 |
| <u>AISIS</u> | 35                    | R   | AISIS16 | AISIS15 | AISIS14 | AISIS13 | AISIS12 | AISIS11 | AISIS10 | AISIS9 |
| Not Used     | 36-3E                 | —   | —       | —       | —       | —       | —       | —       | —       | —      |
| <u>ADDP</u>  | 3F                    | RW  | ADDP7   | ADDP6   | ADDP5   | ADDP4   | ADDP3   | ADDP2   | ADDP1   | ADDP0  |

Note: Underlined bits are read only.

**Table 6-6. Secondary Register Set Bit Map**

| REGISTER              | ADDRESS FOR LIUs 1-8 | RW | BIT 7  | BIT 6  | BIT 5  | BIT 4  | BIT 3  | BIT 2  | BIT 1  | BIT 0  |
|-----------------------|----------------------|----|--------|--------|--------|--------|--------|--------|--------|--------|
| <a href="#">SRMS</a>  | 00                   | RW | SRMS8  | SRMS7  | SRMS6  | SRMS5  | SRMS4  | SRMS3  | SRMS2  | SRMS1  |
| <a href="#">LCS</a>   | 01                   | RW | LCS8   | LCS7   | LCS6   | LCS5   | LSC4   | LCS3   | LSC2   | LSC1   |
| Not Used              | 02                   | RW | —      | —      | —      | —      | —      | —      | —      | —      |
| <a href="#">RPDE</a>  | 03                   | RW | RPDE8  | RPDE7  | RPDE6  | RPDE5  | RPDE4  | RPDE3  | RPDE2  | RPDE1  |
| <a href="#">TPDE</a>  | 04                   | RW | TPDE8  | TDPE7  | TPDE6  | TPDE5  | TPDE4  | TPDE3  | TPDE2  | TPDE1  |
| <a href="#">EZDE</a>  | 05                   | RW | EZDE8  | EZDE7  | EZDE6  | EZDE5  | EZDE4  | EZDE3  | EZDE2  | EZDE1  |
| <a href="#">CVDEB</a> | 06                   | RW | CVDEB8 | CVDEB7 | CVDEB6 | CVDEB5 | CVDEB4 | CVDEB3 | CVDEB2 | CVDEB1 |
| Not Used              | 07-1E                | —  | —      | —      | —      | —      | —      | —      | —      | —      |
| <a href="#">ADDP</a>  | 1F                   | RW | ADDP7  | ADDP6  | ADDP5  | ADDP4  | ADDP3  | ADDP2  | ADDP1  | ADDP0  |

| REGISTER              | ADDRESS FOR LIUs 9-16 | RW | BIT 7   | BIT 6   | BIT 5   | BIT 4   | BIT 3   | BIT 2   | BIT 1   | BIT 0  |
|-----------------------|-----------------------|----|---------|---------|---------|---------|---------|---------|---------|--------|
| <a href="#">SRMS</a>  | 20                    | RW | SRMS16  | SRMS15  | SRMS14  | SRMS13  | SRMS12  | SRMS11  | SRMS10  | SRMS9  |
| <a href="#">LCS</a>   | 21                    | RW | LCS16   | LCS15   | LCS14   | LCS13   | LSC12   | LCS11   | LSC10   | LSC9   |
| Not Used              | 22                    | RW | —       | —       | —       | —       | —       | —       | —       | —      |
| <a href="#">RPDE</a>  | 23                    | RW | RPDE16  | RPDE15  | RPDE14  | RPDE13  | RPDE12  | RPDE11  | RPDE10  | RPDE9  |
| <a href="#">TPDE</a>  | 24                    | RW | TPDE16  | TDPE15  | TPDE14  | TPDE13  | TPDE12  | TPDE11  | TPDE10  | TPDE9  |
| <a href="#">EZDE</a>  | 25                    | RW | EZDE16  | EZDE15  | EZDE14  | EZDE13  | EZDE12  | EZDE11  | EZDE10  | EZDE9  |
| <a href="#">CVDEB</a> | 26                    | RW | CVDEB16 | CVDEB15 | CVDEB14 | CVDEB13 | CVDEB12 | CVDEB11 | CVDEB10 | CVDEB9 |
| Not Used              | 27-3E                 | —  | —       | —       | —       | —       | —       | —       | —       | —      |
| <a href="#">ADDP</a>  | 3F                    | RW | ADDP7   | ADDP6   | ADDP5   | ADDP4   | ADDP3   | ADDP2   | ADDP1   | ADDP0  |

Table 6-7. Individual LIU Register Set Bit Map

| REGISTER               | ADDRESS FOR LIUs 1-8 | RW | BIT 7         | BIT 6         | BIT 5         | BIT 4                            | BIT 3         | BIT 2         | BIT 1         | BIT 0         |
|------------------------|----------------------|----|---------------|---------------|---------------|----------------------------------|---------------|---------------|---------------|---------------|
| <a href="#">IJAЕ</a>   | 00                   | RW | IJAЕ8         | IJAЕ7         | IJAЕ6         | IJAЕ5                            | IJAЕ4         | IJAЕ3         | IJAЕ2         | IJAЕ1         |
| <a href="#">IJAPS</a>  | 01                   | RW | IJAPS8        | IJAPS7        | IJAPS6        | IJAPS5                           | IJAPS4        | IJAPS3        | IJAPS2        | IJAPS1        |
| <a href="#">IJAFDS</a> | 02                   | RW | IJAFDS8       | IJAFDS7       | IJAFDS6       | IJAFDS5                          | IJAFDS4       | IJAFDS3       | IJAFDS2       | IJAFDS1       |
| <a href="#">IJAFLT</a> | 03                   | R  | IJAFLT8       | IJAFLT7       | IJAFLT6       | IJAFLT5                          | IJAFLT4       | IJAFLT3       | IJAFLT2       | IJAFLT1       |
| <a href="#">ISCPD</a>  | 04                   | RW | ISCPD8        | ISCPD7        | ISCPD6        | ISCPD5                           | ISCPD4        | ISCPD3        | ISCPD2        | ISCPD1        |
| <a href="#">IAISEL</a> | 05                   | RW | IAISEL8       | IAISEL7       | IAISEL6       | IAISEL5                          | IAISEL4       | IAISEL3       | IAISEL2       | IAISEL1       |
| <a href="#">MC</a>     | 06                   | RW | PCLKI1        | PCLKI0        | TECLKE        | CLKAE                            | MPS1          | MPS0          | FREQS         | PLLE          |
| <a href="#">RSMM1</a>  | 08                   | RW | RTR2          | C2RSM2        | C2RSM1        | C2RSM0                           | RTR1          | C1RSM2        | C1RSM1        | C1RSM0        |
| <a href="#">RSMM2</a>  | 09                   | RW | RTR4          | C4RSM2        | C4RSM1        | C4RSM0                           | RTR3          | C3RSM2        | C3RSM1        | C3RSM0        |
| <a href="#">RSMM3</a>  | 0A                   | RW | RTR6          | C6RSM2        | C6RSM1        | C6RSM0                           | RTR5          | C5RSM2        | C5RSM1        | C5RSM0        |
| <a href="#">RSMM4</a>  | 0B                   | RW | RTR8          | C8RSM2        | C8RSM1        | C8RSM0                           | RTR7          | C7RSM2        | C7RSM1        | C7RSM0        |
| <a href="#">RSL1</a>   | 0C                   | R  | <u>C2RSL3</u> | <u>C2RSL2</u> | <u>C2RSL1</u> | <u>C2RSL0</u>                    | <u>C1RSL3</u> | <u>C1RSL2</u> | <u>C1RSL1</u> | <u>C1RSL0</u> |
| <a href="#">RSL2</a>   | 0D                   | R  | <u>C4RSL3</u> | <u>C4RSL2</u> | <u>C4RSL1</u> | <u>C4RSL0</u>                    | <u>C3RSL3</u> | <u>C3RSL2</u> | <u>C3RSL1</u> | <u>C3RSL0</u> |
| <a href="#">RSL3</a>   | 0E                   | R  | <u>C6RSL3</u> | <u>C6RSL2</u> | <u>C6RSL1</u> | <u>C6RSL0</u>                    | <u>C5RSL3</u> | <u>C5RSL2</u> | <u>C5RSL1</u> | <u>C5RSL0</u> |
| <a href="#">RSL4</a>   | 0F                   | R  | <u>C8RSL3</u> | <u>C8RSL2</u> | <u>C8RSL1</u> | <u>C8RSL0/</u><br><u>CALSTAT</u> | <u>C7RSL3</u> | <u>C7RSL2</u> | <u>C7RSL1</u> | <u>C7RSL0</u> |
| <a href="#">BTCR</a>   | 10                   | RW | BTS2          | BTS1          | BTS0          | —                                | —             | —             | —             | BERTE         |
| <a href="#">BEIR</a>   | 11                   | RW | BEIR8         | BEIR7         | BEIR6         | BEIR5                            | BEIR4         | BEIR3         | BEIR2         | BEIR1         |
| <a href="#">LVDS</a>   | 12                   | R  | LVDS8         | LVDS7         | LVDS6         | LVDS5                            | LVDS4         | LVDS3         | LVDS2         | LVDS1         |
| <a href="#">RCLKI</a>  | 13                   | RW | RCLKI8        | RCLKI7        | RCLKI6        | RCLKI5                           | RCLKI4        | RCLKI3        | RCLKI2        | RCLKI1        |
| <a href="#">TCLKI</a>  | 14                   | RW | TCLKI8        | TCLKI7        | TCLKI6        | TCLKI5                           | TCLKI4        | TCLKI3        | TCLKI2        | TCLKI1        |
| <a href="#">CCR</a>    | 15                   | RW | PCLKS2        | PCLKS1        | PCLKS0        | TECLKS                           | CLKA3         | CLKA2         | CLKA1         | CLKA0         |
| <a href="#">RDULR</a>  | 16                   | RW | RDULR8        | RDULR7        | RDULR6        | RDULR5                           | RDULR4        | RDULR3        | RDULR2        | RDULR1        |
| <a href="#">GISC</a>   | 1E                   | RW | —             | —             | —             | —                                | —             | —             | INTM          | CWE           |
| <a href="#">ADDP</a>   | 1F                   | RW | ADDP7         | ADDP6         | ADDP5         | ADDP4                            | ADDP3         | ADDP2         | ADDP1         | ADDP0         |

| REGISTER               | ADDRESS FOR LIUs 9-16 | RW | BIT 7          | BIT 6          | BIT 5          | BIT 4          | BIT 3          | BIT 2          | BIT 1          | BIT 0          |
|------------------------|-----------------------|----|----------------|----------------|----------------|----------------|----------------|----------------|----------------|----------------|
| <a href="#">IJAЕ</a>   | 20                    | RW | IJAЕ16         | IJAЕ15         | IJAЕ14         | IJAЕ13         | IJAЕ12         | IJAЕ11         | IJAЕ10         | IJAЕ9          |
| <a href="#">IJAPS</a>  | 21                    | RW | IJAPS16        | IJAPS15        | IJAPS14        | IJAPS13        | IJAPS12        | IJAPS11        | IJAPS10        | IJAPS9         |
| <a href="#">IJAFDS</a> | 22                    | RW | IJAFDS16       | IJAFDS15       | IJAFDS14       | IJAFDS13       | IJAFDS12       | IJAFDS11       | IJAFDS10       | IJAFDS9        |
| <a href="#">IJAFLT</a> | 23                    | R  | IJAFLT16       | IJAFLT15       | IJAFLT14       | IJAFLT13       | IJAFLT12       | IJAFLT11       | IJAFLT10       | IJAFLT9        |
| <a href="#">ISCPD</a>  | 24                    | RW | ISCPD16        | ISCPD15        | ISCPD14        | ISCPD13        | ISCPD12        | ISCPD11        | ISCPD10        | ISCPD9         |
| <a href="#">IAISEL</a> | 25                    | RW | IAISEL16       | IAISEL15       | IAISEL14       | IAISEL13       | IAISEL12       | IAISEL11       | IAISEL10       | IAISEL9        |
| Not Used               | 26                    | RW | —              | —              | —              | —              | —              | —              | —              | —              |
| <a href="#">RSMM1</a>  | 28                    | RW | RTR10          | C10RSM2        | C10RSM1        | C10RSM0        | RTR9           | C9RSM2         | C9RSM1         | C9RSM0         |
| <a href="#">RSMM2</a>  | 29                    | RW | RTR12          | C12RSM2        | C12RSM1        | C12RSM0        | RTR11          | C11RSM2        | C11RSM1        | C11RSM0        |
| <a href="#">RSMM3</a>  | 2A                    | RW | RTR14          | C14RSM2        | C14RSM1        | C14RSM0        | RTR13          | C13RSM2        | C13RSM1        | C13RSM0        |
| <a href="#">RSMM4</a>  | 2B                    | RW | RTR16          | C16RSM2        | C16RSM1        | C16RSM0        | RTR15          | C15RSM2        | C15RSM1        | C15RSM0        |
| <a href="#">RSL1</a>   | 2C                    | R  | <u>C10RSL3</u> | <u>C10RSL2</u> | <u>C10RSL1</u> | <u>C10RSL0</u> | <u>C9RSL3</u>  | <u>C9RSL2</u>  | <u>C9RSL1</u>  | <u>C9RSL0</u>  |
| <a href="#">RSL2</a>   | 2D                    | R  | <u>C12RSL3</u> | <u>C12RSL2</u> | <u>C12RSL1</u> | <u>C12RSL0</u> | <u>C11RSL3</u> | <u>C11RSL2</u> | <u>C11RSL1</u> | <u>C11RSL0</u> |
| <a href="#">RSL3</a>   | 2E                    | R  | <u>C14RSL3</u> | <u>C14RSL2</u> | <u>C14RSL1</u> | <u>C14RSL0</u> | <u>C13RSL3</u> | <u>C13RSL2</u> | <u>C13RSL1</u> | <u>C13RSL0</u> |
| <a href="#">RSL4</a>   | 2F                    | R  | <u>C16RSL3</u> | <u>C16RSL2</u> | <u>C16RSL1</u> | <u>C16RSL0</u> | <u>C15RSL3</u> | <u>C15RSL2</u> | <u>C15RSL1</u> | <u>C15RSL0</u> |
| <a href="#">BTCR</a>   | 30                    | RW | BTS2           | BTS1           | BTS0           | —              | —              | —              | —              | BERTE          |
| <a href="#">BEIR</a>   | 31                    | RW | BEIR16         | BEIR15         | BEIR14         | BEIR13         | BEIR12         | BEIR11         | BEIR10         | BEIR9          |
| <a href="#">LVDS</a>   | 32                    | R  | LVDS16         | LVDS15         | LVDS14         | LVDS13         | LVDS12         | LVDS11         | LVDS10         | LVDS9          |
| <a href="#">RCLKI</a>  | 33                    | RW | RCLKI16        | RCLKI15        | RCLKI14        | RCLKI13        | RCLKI12        | RCLKI11        | RCLKI10        | RCLKI9         |
| <a href="#">TCLKI</a>  | 34                    | RW | TCLKI16        | TCLKI15        | TCLKI14        | TCLKI13        | TCLKI12        | TCLKI11        | TCLKI10        | TCLKI9         |
| Not Used               | 35                    | RW | —              | —              | —              | —              | —              | —              | —              | —              |
| <a href="#">RDULR</a>  | 36                    | RW | RDULR16        | RDULR15        | RDULR14        | RDULR13        | RDULR12        | RDULR11        | RDULR10        | RDULR9         |
| Not Used               | 3E                    | RW | —              | —              | —              | —              | —              | —              | INTM           | CWE            |
| <a href="#">ADDP</a>   | 3F                    | RW | ADDP7          | ADDP6          | ADDP5          | ADDP4          | ADDP3          | ADDP2          | ADDP1          | ADDP0          |

Note: Underlined bits are read only.

**Table 6-8. BERT Register Bit Map**

| REGISTER               | ADDRESS FOR LIUs |              | RW | BIT 7        | BIT 6        | BIT 5        | BIT 4        | BIT 3        | BIT 2        | BIT 1        | BIT 0        |
|------------------------|------------------|--------------|----|--------------|--------------|--------------|--------------|--------------|--------------|--------------|--------------|
|                        | 1-8              | 9-16         |    |              |              |              |              |              |              |              |              |
| <a href="#">BCR</a>    | 00               | 20           | RW | PMUM         | LPMU         | RNPL         | RPIC         | MPR          | APRD         | TNPL         | TPIC         |
| Not Used               | 01               | <u>21</u>    | —  | —            | —            | —            | —            | —            | —            | —            | —            |
| <a href="#">BPCR1</a>  | 02               | 22           | RW | —            | QRSS         | PTS          | PLF4         | PLF3         | PLF2         | PLF1         | PLF0         |
| <a href="#">BPCR2</a>  | 03               | <u>23</u>    | —  | —            | —            | —            | PTF4         | PTF3         | PTF2         | PTF1         | PTF0         |
| <a href="#">BSPR1</a>  | 04               | 24           | RW | BSP7         | BSP6         | BSP5         | BSP4         | BSP3         | BSP2         | BSP1         | BSP0         |
| <a href="#">BSPR2</a>  | 05               | <u>25</u>    | —  | BSP15        | BSP14        | BSP13        | BSP12        | BSP11        | BSP10        | BSP9         | BSP8         |
| <a href="#">BSPR3</a>  | 06               | 26           | RW | BSP23        | BSP22        | BSP21        | BSP20        | BSP19        | BSP18        | BSP17        | BSP16        |
| <a href="#">BSPR4</a>  | 07               | <u>27</u>    | —  | BSP31        | BSP30        | BSP29        | BSP28        | BSP27        | BSP26        | BSP25        | BSP24        |
| <a href="#">TEICR</a>  | 08               | 28           | RW | —            | —            | TEIR2        | TEIR1        | TEIR0        | BEI          | TSEI         | MEIMS        |
| Not Used               | 09-0B            | <u>29-2B</u> | —  | —            | —            | —            | —            | —            | —            | —            | —            |
| <a href="#">BSR</a>    | 0C               | 2C           | R  | —            | —            | —            | —            | <u>PMS</u>   | —            | <u>BEC</u>   | <u>OOS</u>   |
| Not Used               | 0D               | <u>2D</u>    | —  | —            | —            | —            | —            | —            | —            | —            | —            |
| <a href="#">BSRL</a>   | 0E               | 2E           | R  | —            | —            | —            | —            | <u>PMSL</u>  | <u>BEL</u>   | <u>BECL</u>  | <u>OOSL</u>  |
| Not Used               | 0F               | <u>2F</u>    | —  | —            | —            | —            | —            | —            | —            | —            | —            |
| <a href="#">BSRIE</a>  | 10               | 30           | RW | —            | —            | —            | —            | PMSIE        | BEIE         | BECIE        | OOSIE        |
| Not Used               | 11-13            | <u>31-33</u> | —  | —            | —            | —            | —            | —            | —            | —            | —            |
| <a href="#">RBECR1</a> | 14               | 34           | R  | <u>BEC7</u>  | <u>BEC6</u>  | <u>BEC5</u>  | <u>BEC4</u>  | <u>BEC3</u>  | <u>BEC2</u>  | <u>BEC1</u>  | <u>BEC0</u>  |
| <a href="#">RBECR2</a> | 15               | 35           | R  | <u>BEC15</u> | <u>BEC14</u> | <u>BEC13</u> | <u>BEC12</u> | <u>BEC11</u> | <u>BEC10</u> | <u>BEC9</u>  | <u>BEC8</u>  |
| <a href="#">RBECR3</a> | 16               | 36           | R  | <u>BEC23</u> | <u>BEC22</u> | <u>BEC21</u> | <u>BEC20</u> | <u>BEC19</u> | <u>BEC18</u> | <u>BEC17</u> | <u>BEC16</u> |
| Not Used               | 17               | <u>37</u>    | —  | —            | —            | —            | —            | —            | —            | —            | —            |
| <a href="#">RBCR1</a>  | 18               | 38           | R  | <u>BC7</u>   | <u>BC6</u>   | <u>BC5</u>   | <u>BC4</u>   | <u>BC3</u>   | <u>BC2</u>   | <u>BC1</u>   | <u>BC0</u>   |
| <a href="#">RBCR2</a>  | 19               | 39           | R  | <u>BC15</u>  | <u>BC14</u>  | <u>BC13</u>  | <u>BC12</u>  | <u>BC11</u>  | <u>BC10</u>  | <u>BC9</u>   | <u>BC8</u>   |
| <a href="#">RBCR3</a>  | 1A               | 3A           | R  | <u>BC23</u>  | <u>BC22</u>  | <u>BC21</u>  | <u>BC20</u>  | <u>BC19</u>  | <u>BC18</u>  | <u>BC17</u>  | <u>BC16</u>  |
| <a href="#">RBCR4</a>  | 1B               | 3B           | R  | <u>BC31</u>  | <u>BC30</u>  | <u>BC29</u>  | <u>BC28</u>  | <u>BC27</u>  | <u>BC26</u>  | <u>BC25</u>  | <u>BC24</u>  |
| Not Used               | 1C-1E            | 3C-3E        | —  | —            | —            | —            | —            | —            | —            | —            | —            |
| <a href="#">ADDP</a>   | 1F               | 3F           | RW | ADDP7        | ADDP6        | ADDP5        | ADDP4        | ADDP3        | ADDP2        | ADDP1        | ADDP0        |

**Note:** Underlined bits are read only.

## 6.1 Register Description

This section contains the detailed register descriptions of each bit. Whenever the variable “*n*” in italics is used in any of the register descriptions, it represents 1–16. Note that in the register descriptions, there are duplicate registers for LIUs 1–8 and LIUs 9–16. There are registers in LIUs 1–8 that do not have a duplicate in the register set for LIUs 9–16. For these registers, only one address is listed. All other registers list two addresses, one for LIUs 1–8 and one for LIUs 9–16.

### 6.1.1 Primary Register Bank

The ADDP register must be set to 00h to access this bank.

Register Name: **ID**  
 Register Description: **ID Register**  
 Register Address: **00h**

| Bit # | 7   | 6   | 5   | 4   | 3   | 2   | 1   | 0   |
|-------|-----|-----|-----|-----|-----|-----|-----|-----|
| Name  | ID7 | ID6 | ID5 | ID4 | ID3 | ID2 | ID1 | ID0 |

**Bit 7: Device CODE ID Bit 7 (ID7).** This bit is “zero” for short-haul operation.

**Bits 6 to 3: Device CODE ID Bits 6 to 3 (ID6 to ID3).** These bits tell the user the number of ports the device contains.

**Bits 2 to 0: Device CODE ID Bits 2 to 0 (ID2 to ID0).** These bits tell the user the revision of the part. Contact the factory for details.

Register Name: **ALBC**  
 Register Description: **Analog Loopback Control**  
 Register Address (LIUs 1–8): **01h**

| Bit #   | 7     | 6     | 5     | 4     | 3     | 2     | 1     | 0     |
|---------|-------|-------|-------|-------|-------|-------|-------|-------|
| Name    | ALBC8 | ALBC7 | ALBC6 | ALBC5 | ALBC4 | ALBC3 | ALBC2 | ALBC1 |
| Default | 0     | 0     | 0     | 0     | 0     | 0     | 0     | 0     |

Register Address (LIUs 9–16): **21h**

| Bit #   | 7      | 6      | 5      | 4      | 3      | 2      | 1      | 0     |
|---------|--------|--------|--------|--------|--------|--------|--------|-------|
| Name    | ALBC16 | ALBC15 | ALBC14 | ALBC13 | ALBC12 | ALBC11 | ALBC10 | ALBC9 |
| Default | 0      | 0      | 0      | 0      | 0      | 0      | 0      | 0     |

**Bits 7 to 0: Analog Loopback Control Bits Channel *n* (ALBC<sub>*n*</sub>).** When this bit is set, LIU<sub>*n*</sub> is placed in Analog Loopback. TTIP and TRING are looped back to RTIP and RRING. The data at RTIP and RRING is ignored. LOS Detector is still in operation. The jitter attenuator is in use if enabled for the transmitter or receiver.



Register Name: **RLBC**  
 Register Description: **Remote Loopback Control**  
 Register Address (LIUs 1–8): **02h**

| Bit #   | 7     | 6     | 5     | 4     | 3     | 2     | 1     | 0     |
|---------|-------|-------|-------|-------|-------|-------|-------|-------|
| Name    | RLBC8 | RLBC7 | RLBC6 | RLBC5 | RLBC4 | RLBC3 | RLBC2 | RLBC1 |
| Default | 0     | 0     | 0     | 0     | 0     | 0     | 0     | 0     |

Register Address (LIUs 9–16): **22h**

| Bit #   | 7      | 6      | 5      | 4      | 3      | 2      | 1      | 0     |
|---------|--------|--------|--------|--------|--------|--------|--------|-------|
| Name    | RLBC16 | RLBC15 | RLBC14 | RLBC13 | RLBC12 | RLBC11 | RLBC10 | RLBC9 |
| Default | 0      | 0      | 0      | 0      | 0      | 0      | 0      | 0     |

**Bits 7 to 0: Remote Loopback Control Bits Channel  $n$  (RLBC $n$ ).** When this bit is set, remote loopback is enabled on LIU $n$ . The analog received signal goes through the receive digital and is looped back to the transmitter. The data at TPOS and TNEG is ignored. The jitter attenuator is in use if enabled.

Register Name: **TAOE**  
 Register Description: **Transmit All Ones Enable**  
 Register Address (LIUs 1–8): **03h**

| Bit #   | 7     | 6     | 5     | 4     | 3     | 2     | 1     | 0     |
|---------|-------|-------|-------|-------|-------|-------|-------|-------|
| Name    | TAOE8 | TAOE7 | TAOE6 | TAOE5 | TAOE4 | TAOE3 | TAOE2 | TAOE1 |
| Default | 0     | 0     | 0     | 0     | 0     | 0     | 0     | 0     |

Register Address (LIUs 9–16): **23h**

| Bit #   | 7      | 6      | 5      | 4      | 3      | 2      | 1      | 0     |
|---------|--------|--------|--------|--------|--------|--------|--------|-------|
| Name    | TAOE16 | TAOE15 | TAOE14 | TAOE13 | TAOE12 | TAOE11 | TAOE10 | TAOE9 |
| Default | 0      | 0      | 0      | 0      | 0      | 0      | 0      | 0     |

**Bits 7 to 0: Transmit All Ones Enable Channel  $n$  (TAOE $n$ ).** When this bit is set, continuous stream of All ones on TTIP and TRING are sent on Channel  $n$ . MCLK is used as a reference clock for Transmit All Ones Signal. The data arriving at TPOS and TNEG is ignored.

Register Name: **LOSS**  
 Register Description: **Loss of Signal Status**  
 Register Address (LIUs 1–8): **04h**

| Bit #   | 7            | 6            | 5            | 4            | 3            | 2            | 1            | 0            |
|---------|--------------|--------------|--------------|--------------|--------------|--------------|--------------|--------------|
| Name    | <u>LOSS8</u> | <u>LOSS7</u> | <u>LOSS6</u> | <u>LOSS5</u> | <u>LOSS4</u> | <u>LOSS3</u> | <u>LOSS2</u> | <u>LOSS1</u> |
| Default | 0            | 0            | 0            | 0            | 0            | 0            | 0            | 0            |

Register Address (LIUs 9–16): **24h**

| Bit #   | 7             | 6             | 5             | 4             | 3             | 2             | 1             | 0            |
|---------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|--------------|
| Name    | <u>LOSS16</u> | <u>LOSS15</u> | <u>LOSS14</u> | <u>LOSS13</u> | <u>LOSS12</u> | <u>LOSS11</u> | <u>LOSS10</u> | <u>LOSS9</u> |
| Default | 0             | 0             | 0             | 0             | 0             | 0             | 0             | 0            |

**Bits 7 to 0: Loss of Signal Status Channel  $n$  (LOSS $n$ ).** When this bit is set, a LOS condition has been detected on LIU $n$ . The criteria and conditions of LOS are described in Section [5.5.6](#).

Register Name: **DFMS**  
 Register Description: **Driver Fault Monitor Status**  
 Register Address (LIUs 1–8): **05h**

| Bit #   | 7            | 6            | 5            | 4            | 3            | 2            | 1            | 0            |
|---------|--------------|--------------|--------------|--------------|--------------|--------------|--------------|--------------|
| Name    | <u>DFMS8</u> | <u>DFMS7</u> | <u>DFMS6</u> | <u>DFMS5</u> | <u>DFMS4</u> | <u>DFMS3</u> | <u>DFMS2</u> | <u>DFMS1</u> |
| Default | 0            | 0            | 0            | 0            | 0            | 0            | 0            | 0            |

Register Address (LIUs 9–16): **25h**

| Bit #   | 7             | 6             | 5             | 4             | 3             | 2             | 1             | 0            |
|---------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|--------------|
| Name    | <u>DFMS16</u> | <u>DFMS15</u> | <u>DFMS14</u> | <u>DFMS13</u> | <u>DFMS12</u> | <u>DFMS11</u> | <u>DFMS10</u> | <u>DFMS9</u> |
| Default | 0             | 0             | 0             | 0             | 0             | 0             | 0             | 0            |

**Bits 7 to 0: Driver Fault Monitor Status Channel  $n$  (DFMS $n$ ).** When this bit is set, it indicates that there is a short or open circuit at the transmit driver for LIU $n$ .

Register Name: **LOSIE**  
 Register Description: **Loss of Signal Interrupt Enable**  
 Register Address (LIUs 1–8): **06h**

| Bit #   | 7             | 6             | 5             | 4             | 3             | 2             | 1             | 0             |
|---------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|
| Name    | <u>LOSIE8</u> | <u>LOSIE7</u> | <u>LOSIE6</u> | <u>LOSIE5</u> | <u>LOSIE4</u> | <u>LOSIE3</u> | <u>LOSIE2</u> | <u>LOSIE1</u> |
| Default | 0             | 0             | 0             | 0             | 0             | 0             | 0             | 0             |

Register Address (LIUs 9–16): **26h**

| Bit #   | 7              | 6              | 5              | 4              | 3              | 2              | 1              | 0             |
|---------|----------------|----------------|----------------|----------------|----------------|----------------|----------------|---------------|
| Name    | <u>LOSIE16</u> | <u>LOSIE15</u> | <u>LOSIE14</u> | <u>LOSIE13</u> | <u>LOSIE12</u> | <u>LOSIE11</u> | <u>LOSIE10</u> | <u>LOSIE9</u> |
| Default | 0              | 0              | 0              | 0              | 0              | 0              | 0              | 0             |

**Bits 7 to 0: Loss of Signal Interrupt Enable Channel  $n$  (LOSIE $n$ ).** When this bit is set, a change in LOS status for LIU $n$  can generate an Interrupt.

Register Name: **DFMIE**  
 Register Description: **Driver Fault Monitor Interrupt Enable**  
 Register Address (LIUs 1–8): **07h**

| Bit #   | 7             | 6             | 5             | 4             | 3             | 2             | 1             | 0             |
|---------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|
| Name    | <u>DFMIE8</u> | <u>DFMIE7</u> | <u>DFMIE6</u> | <u>DFMIE5</u> | <u>DFMIE4</u> | <u>DFMIE3</u> | <u>DFMIE2</u> | <u>DFMIE1</u> |
| Default | 0             | 0             | 0             | 0             | 0             | 0             | 0             | 0             |

Register Address (LIUs 9–16): **27h**

| Bit #   | 7              | 6              | 5              | 4              | 3              | 2              | 1              | 0             |
|---------|----------------|----------------|----------------|----------------|----------------|----------------|----------------|---------------|
| Name    | <u>DFMIE16</u> | <u>DFMIE15</u> | <u>DFMIE14</u> | <u>DFMIE13</u> | <u>DFMIE12</u> | <u>DFMIE11</u> | <u>DFMIE10</u> | <u>DFMIE9</u> |
| Default | 0              | 0              | 0              | 0              | 0              | 0              | 0              | 0             |

**Bits 7 to 0: Driver Fault Monitor Interrupt Enable Channel  $n$  (DFMIE $n$ ).** When this bit is set, a change in DFM Status can generate an interrupt in monitor  $n$ .

Register Name: **LOSIS**  
 Register Description: **Loss of Signal Interrupt Status**  
 Register Address (LIUs 1–8): **08h**

| Bit #   | 7             | 6             | 5             | 4             | 3             | 2             | 1             | 0             |
|---------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|
| Name    | <u>LOSIS8</u> | <u>LOSIS7</u> | <u>LOSIS6</u> | <u>LOSIS5</u> | <u>LOSIS4</u> | <u>LOSIS3</u> | <u>LOSIS2</u> | <u>LOSIS1</u> |
| Default | 0             | 0             | 0             | 0             | 0             | 0             | 0             | 0             |

Register Address (LIUs 9–16): **28h**

| Bit #   | 7              | 6              | 5              | 4              | 3              | 2              | 1              | 0             |
|---------|----------------|----------------|----------------|----------------|----------------|----------------|----------------|---------------|
| Name    | <u>LOSIS16</u> | <u>LOSIS15</u> | <u>LOSIS14</u> | <u>LOSIS13</u> | <u>LOSIS12</u> | <u>LOSIS11</u> | <u>LOSIS10</u> | <u>LOSIS9</u> |
| Default | 0              | 0              | 0              | 0              | 0              | 0              | 0              | 0             |

**Bits 7 to 0: Loss of Signal Interrupt Status Channel  $n$  (LOSIS $n$ ).** When this bit is set, it indicates a LOS status has transition from a “0 to 1” or “1 to 0” and was detected for LIU $n$ . The bit for LIU $n$  is enabled by register LOSIE (06h). This bit when latched is cleared on a read operation.

Register Name: **DFMIS**  
 Register Description: **Driver Fault Monitor Interrupt Status**  
 Register Address (LIUs 1–8): **09h**

| Bit #   | 7             | 6             | 5             | 4             | 3             | 2             | 1             | 0             |
|---------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|
| Name    | <u>DFMIS8</u> | <u>DFMIS7</u> | <u>DFMIS6</u> | <u>DFMIS5</u> | <u>DFMIS4</u> | <u>DFMIS3</u> | <u>DFMIS2</u> | <u>DFMIS1</u> |
| Default | 0             | 0             | 0             | 0             | 0             | 0             | 0             | 0             |

Register Address (LIUs 9–16): **29h**

| Bit #   | 7              | 6              | 5              | 4              | 3              | 2              | 1              | 0             |
|---------|----------------|----------------|----------------|----------------|----------------|----------------|----------------|---------------|
| Name    | <u>DFMIS16</u> | <u>DFMIS15</u> | <u>DFMIS14</u> | <u>DFMIS13</u> | <u>DFMIS12</u> | <u>DFMIS11</u> | <u>DFMIS10</u> | <u>DFMIS9</u> |
| Default | 0              | 0              | 0              | 0              | 0              | 0              | 0              | 0             |

**Bits 7 to 0: Driver Fault Status Register Channel  $n$  (DFMIS $n$ ).** When this bit is set, it indicates a DFM status has transitioned from “0 to 1” or “1 to 0” and was detected for LIU $n$ . The bit for LIU $n$  is enabled by register DFMIE (07h). This bit when latched is cleared on a read operation.

Register Name: **SWR**  
 Register Description: **Software Reset**  
 Register Address (LIUs 1–8): **0Ah**

|         |      |      |      |      |      |      |      |      |
|---------|------|------|------|------|------|------|------|------|
| Bit #   | 7    | 6    | 5    | 4    | 3    | 2    | 1    | 0    |
| Name    | SWRL | SWRL | SWRL | SWRL | SWRL | SWRL | SWRL | SWRL |
| Default | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    |

**Bits 7 to 0: Software Reset (SWRL).** Whenever any write is performed to this register, at least 1 $\mu$ s reset will be generated that resets the lower set of registers (LIUs 1–8). All the registers will be restored to their default values. A read operation will always read back all zeros.

Register Address (LIUs 9–16): **2Ah**

|         |      |      |      |      |      |      |      |      |
|---------|------|------|------|------|------|------|------|------|
| Bit #   | 7    | 6    | 5    | 4    | 3    | 2    | 1    | 0    |
| Name    | SWRU | SWRU | SWRU | SWRU | SWRU | SWRU | SWRU | SWRU |
| Default | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    |

**Bits 7 to 0: Software Reset (SWRU).** Whenever any write is performed to this register, at least 1 $\mu$ s reset will be generated that resets the upper set of registers (LIUs 9–16). All the registers will be restored to their default values. A read operation will always read back all zeros.

Register Name: **BGMC**  
 Register Description: **BERT and G.772 Monitoring Control**  
 Register Address (LIUs 1–8): **0Bh**

| Bit #   | 7       | 6     | 5     | 4 | 3    | 2    | 1    | 0    |
|---------|---------|-------|-------|---|------|------|------|------|
| Name    | BERTDIR | BMCKS | BTCKS | — | GMC3 | GMC2 | GMC1 | GMC0 |
| Default | 0       | 0     | 0     | 0 | 0    | 0    | 0    | 0    |

**Bit 7: BERT Direction Control Bit (BERTDIR).** When this bit is set, the BERT for LIUs 1–8 will be enabled on the system side of the part (BERT data will come out on RPOS/RNEG and be expected on TPOS/TNEG) for whichever LIU the BERT is enabled.

**Bit 6: BERT MCLK Selection (BMCKS).** When the BERT is enabled on the system side (BERTDIR = 1), setting this bit will select MCLK as the BERT clock unless BTCKS is set. If neither BMCKS nor BTCKS is set, the BERT will use the recovered clock.

**Bit 5: BERT TCLK Selection (BTCKS).** When the BERT is enabled on the system side (BERTDIR = 1), setting this bit selects TCLK as the BERT clock, regardless of the state of the BMCKS bit. If neither BMCKS nor BTCKS is set, the BERT will use the recovered clock.

**Bits 3 to 0: G.772 Monitoring Control (GMC[3:0]).** These bits are used to select transmitter or receiver for nonintrusive monitoring. Receiver 1 is used to monitor Channels 2 to 8 of one receiver from RTIP2–RTIP8/RRING2–RRING8 or of one transmitter from TTIP2–TTIP8/TRING2–TRING8. See [Table 6-9](#).

Register Address (LIUs 9–16): **2Bh**

| Bit #   | 7       | 6     | 5     | 4 | 3    | 2    | 1    | 0    |
|---------|---------|-------|-------|---|------|------|------|------|
| Name    | BERTDIR | BMCKS | BTCKS | — | GMC3 | GMC2 | GMC1 | GMC0 |
| Default | 0       | 0     | 0     | 0 | 0    | 0    | 0    | 0    |

**Bit 7: BERT Direction Control Bit (BERTDIR).** When this bit is set, the BERT for LIUs 9–16 will be enabled on the system side of the part (BERT data will come out on RPOS/RNEG and be expected on TPOS/TNEG) for whichever LIU the BERT is enabled.

**Bit 6: BERT MCLK Selection (BMCKS).** When the BERT is enabled on the system side (BERTDIR = 1), setting this bit will select MCLK as the BERT clock unless BTCKS is set. If neither BMCKS nor BTCKS is set, the BERT will use the recovered clock. If the clock used as the BERT clock is MCLK or the recovered clock, TCLK must be frequency locked to the BERT clock in order for the BERT to sync.

**Bit 5: BERT TCLK Selection (BTCKS).** When the BERT is enabled on the system side (BERTDIR = 1), setting this bit selects TCLK as the BERT clock, regardless of the state of the BMCKS bit. If neither BMCKS nor BTCKS is set, the BERT will use the recovered clock.

**Bits 3 to 0: G.772 Monitoring Control (GMC).** These bits are used to select transmitter or receiver for nonintrusive monitoring. Receiver 9 is used to monitor Channels 10 to 16 of one receiver from RTIP10–RTIP16/RRING10–RRING16 or of one transmitter from TTIP10–TTIP16/TRING10–TRING16. See [Table 6-10](#).

**Table 6-9. G.772 Monitoring Control (LIU 1)**

| GMC3 | GMC2 | GMC1 | GMC0 | SELECTION     |
|------|------|------|------|---------------|
| 0    | 0    | 0    | 0    | No Monitoring |
| 0    | 0    | 0    | 1    | Receiver 2    |
| 0    | 0    | 1    | 0    | Receiver 3    |
| 0    | 0    | 1    | 1    | Receiver 4    |
| 0    | 1    | 0    | 0    | Receiver 5    |
| 0    | 1    | 0    | 1    | Receiver 6    |
| 0    | 1    | 1    | 0    | Receiver 7    |
| 0    | 1    | 1    | 1    | Receiver 8    |
| 1    | 0    | 0    | 0    | No Monitoring |
| 1    | 0    | 0    | 1    | Transmitter 2 |
| 1    | 0    | 1    | 0    | Transmitter 3 |
| 1    | 0    | 1    | 1    | Transmitter 4 |
| 1    | 1    | 0    | 0    | Transmitter 5 |
| 1    | 1    | 0    | 1    | Transmitter 6 |
| 1    | 1    | 1    | 0    | Transmitter 7 |
| 1    | 1    | 1    | 1    | Transmitter 8 |

**Table 6-10. G.772 Monitoring Control (LIU 9)**

| GMC3 | GMC2 | GMC1 | GMC0 | SELECTION      |
|------|------|------|------|----------------|
| 0    | 0    | 0    | 0    | No Monitoring  |
| 0    | 0    | 0    | 1    | Receiver 10    |
| 0    | 0    | 1    | 0    | Receiver 11    |
| 0    | 0    | 1    | 1    | Receiver 12    |
| 0    | 1    | 0    | 0    | Receiver 13    |
| 0    | 1    | 0    | 1    | Receiver 14    |
| 0    | 1    | 1    | 0    | Receiver 15    |
| 0    | 1    | 1    | 1    | Receiver 16    |
| 1    | 0    | 0    | 0    | No Monitoring  |
| 1    | 0    | 0    | 1    | Transmitter 10 |
| 1    | 0    | 1    | 0    | Transmitter 11 |
| 1    | 0    | 1    | 1    | Transmitter 12 |
| 1    | 1    | 0    | 0    | Transmitter 13 |
| 1    | 1    | 0    | 1    | Transmitter 14 |
| 1    | 1    | 1    | 0    | Transmitter 15 |
| 1    | 1    | 1    | 1    | Transmitter 16 |

Register Name: **DLBC**  
 Register Description: **Digital Loopback Control**  
 Register Address (LIUs 1–8): **0Ch**

| Bit #   | 7     | 6     | 5     | 4     | 3     | 2     | 1     | 0     |
|---------|-------|-------|-------|-------|-------|-------|-------|-------|
| Name    | DLBC8 | DLBC7 | DLBC6 | DLBC5 | DLBC4 | DLBC3 | DLBC2 | DLBC1 |
| Default | 0     | 0     | 0     | 0     | 0     | 0     | 0     | 0     |

Register Address (LIUs 9–16): **2Ch**

| Bit #   | 7      | 6      | 5      | 4      | 3      | 2      | 1      | 0     |
|---------|--------|--------|--------|--------|--------|--------|--------|-------|
| Name    | DLBC16 | DLBC15 | DLBC14 | DLBC13 | DLBC12 | DLBC11 | DLBC10 | DLBC9 |
| Default | 0      | 0      | 0      | 0      | 0      | 0      | 0      | 0     |

**Bits 7 to 0: Digital Loopback Control Channel  $n$  (DLBC $n$ ).** When this bit is set the LIU $n$  is placed in digital loopback. The data at TPOS/TNEG is encoded and looped back to the decoder and output on RPOS/RNEG. The Jitter Attenuator can optionally be included in the transmit or receive paths.

Register Name: **LASCS**  
 Register Description: **LOS/AIS Criteria Selection**  
 Register Address (LIUs 1–8): **0Dh**

| Bit #   | 7      | 6      | 5      | 4      | 3      | 2      | 1      | 0      |
|---------|--------|--------|--------|--------|--------|--------|--------|--------|
| Name    | LASCS8 | LASCS7 | LASCS6 | LASCS5 | LASCS4 | LASCS3 | LASCS2 | LASCS1 |
| Default | 0      | 0      | 0      | 0      | 0      | 0      | 0      | 0      |

Register Address (LIUs 9–16): **2Dh**

| Bit #   | 7       | 6       | 5       | 4       | 3       | 2       | 1       | 0      |
|---------|---------|---------|---------|---------|---------|---------|---------|--------|
| Name    | LASCS16 | LASCS15 | LASCS14 | LASCS13 | LASCS12 | LASCS11 | LASCS10 | LASCS9 |
| Default | 0       | 0       | 0       | 0       | 0       | 0       | 0       | 0      |

**Bits 7 to 0: LOS/AIS Criteria Selection Channel  $n$  (LASCS $n$ ).** This bit is used for LOS/AIS selection criteria for LIU $n$ . In E1 mode, if set it uses ETS 300 233 mode selections. If reset it uses G.775 criteria. In T1/J1 mode T1.231 criteria is selected.

Register Name: **ATAOS**  
 Register Description: **Automatic Transmit All Ones Select**  
 Register Address (LIUs 1–8): **0Eh**

| Bit #   | 7      | 6      | 5      | 4      | 3      | 2      | 1      | 0      |
|---------|--------|--------|--------|--------|--------|--------|--------|--------|
| Name    | ATAOS8 | ATAOS7 | ATAOS6 | ATAOS5 | ATAOS4 | ATAOS3 | ATAOS2 | ATAOS1 |
| Default | 0      | 0      | 0      | 0      | 0      | 0      | 0      | 0      |

Register Address (LIUs 9–16): **2Eh**

| Bit #   | 7       | 6       | 5       | 4       | 3       | 2       | 1       | 0      |
|---------|---------|---------|---------|---------|---------|---------|---------|--------|
| Name    | ATAOS16 | ATAOS15 | ATAOS14 | ATAOS13 | ATAOS12 | ATAOS11 | ATAOS10 | ATAOS9 |
| Default | 0       | 0       | 0       | 0       | 0       | 0       | 0       | 0      |

**Bits 7 to 0: Automatic Transmit All Ones Select Channel  $n$  (ATAOS $n$ ).** When this bit is set all ones signal is sent if an LOS is detected for LIU $n$ . “All Ones Signal” uses MCLK as the reference clock.

Register Name: **GC**  
 Register Description: **Global Configuration**  
 Register Address (LIUs 1–8): **0Fh**

| Bit #   | 7      | 6     | 5    | 4    | 3    | 2     | 1    | 0   |
|---------|--------|-------|------|------|------|-------|------|-----|
| Name    | RIMPMS | AISEL | SCPD | CODE | JADS | CRIMP | JAPS | JAE |
| Default | 0      | 0     | 0    | 0    | 0    | 0     | 0    | 0   |

**Note:** CRIMP controls all 16 LIUs. All other bits are for LIUs 1–8 only.

**Bit 7: Receive Impedance Mode Select (RIMPMS).** When this bit is set, fully internal impedance match mode is selected, so RTIP and RRING require no external resistor. If this bit is set, the receiver line transformer must be a 1:1 turns ratio and the RTR bit set. When reset, external termination mode is selected and an external resistor is required to terminate the receive line. This external resistor will be adjusted internally to the correct termination value if partially internal impedance matching is turned on ([TS.RIMPON](#) = 1).

**Bit 6: AIS Enable During Loss (AISEL).** When this bit is set, an AIS is sent to the system side upon detecting LOS for each channel. The individual LIU register [AISEL](#) settings will be ignored when this bit is set. When reset, the [AISEL](#) register will have control.

**Bit 5: Short Circuit Protection Disable (SCPD).** If this bit is set the short-circuit protection is disabled for all the transmitters. The individual LIU register [ISCPD](#) settings will be ignored when this bit is set. When reset, the [ISCPD](#) register will have control.

**Bit 4: Code (CODE).** If this bit is set AMI encoder/decoder is selected. The [LCS](#) register settings will be ignored when this bit is set. If reset, the [LCS](#) register will have control.

**Bit 3: Jitter Attenuator Depth Select (JADS).** If this bit is set the jitter attenuator FIFO depth is 128 bits. The settings in the [IJAFDS](#) register will be ignored if this register is set. If reset the [IJAFDS](#) register will have control.

**Bit 2: Calibrate Receive Internal Termination (CRIMP).** A low-to-high transition on this bit initiates a calibration cycle for the receive internal termination. This requires a 16kΩ ±1% resistor on the RESREF pin. Bit 2 of the GC register at address 0x2F must also be set to enable calibration. While this bit is set, [RSL4.4](#) (0x0F in individual bank) will indicate the status of the calibration cycle.

**Bit 1: Jitter Attenuator Position Select (JAPS).** When the JAPS bit is set high, the jitter attenuator will be in the receive path and when default or set low in the Transmit path. These settings can be changed for an individual LIU by settings in the [IJAPS](#) register. Note that when bit JAE is set, the settings in the [IJAPS](#) register will be ignored.

**Bit 0: Jitter Attenuator Enable (JAE).** When this bit is set the jitter attenuator is enabled. The settings in the [IJAE](#) register will be ignored if this register is set. If reset, the IJAE register will have control.



Register Address (LIUs 9–16): **2Fh**

| Bit #   | 7      | 6     | 5    | 4    | 3    | 2     | 1    | 0   |
|---------|--------|-------|------|------|------|-------|------|-----|
| Name    | RIMPMS | AISEL | SCPD | CODE | JADS | CALEN | JAPS | JAE |
| Default | 0      | 0     | 0    | 0    | 0    | 0     | 0    | 0   |

**Bit 7: Receive Impedance Mode Select (RIMPMS).** When this bit is set, the fully internal receive impedance matching mode is selected, so RTIP and RRING require no external resistor. If this bit is set, the receiver line transformer must be a 1:1 turns ratio and the RTR bit set. When reset and [TS.RIMPON](#) = 1, partially internal receive impedance matching mode is selected and an external resistor is required to terminate the receive line. This external resistor will be adjusted internally to the correct termination value.

**Bit 6: AIS Enable During Loss (AISEL).** When this bit is set, an AIS is sent to the system side upon detecting LOS for each channel. The individual LIU register [AISEL](#) settings will be ignored when this bit is set. When reset, the [AISEL](#) register will have control.

**Bit 5: Short Circuit Protection Disable (SCPD).** If this bit is set the short-circuit protection is disabled for all the transmitters. The individual LIU register [ISCPD](#) settings will be ignored when this bit is set. When reset, the [ISCPD](#) register will have control.

**Bit 4: Code (CODE).** If this bit is set AMI encoder/decoder is selected. The [LCS](#) register settings will be ignored when this bit is set. If reset, the [LCS](#) register will have control.

**Bit 3: Jitter Attenuator Depth Select (JADS).** If this bit is set the jitter attenuator FIFO depth is 128 bits. The settings in the [JAFDS](#) register will be ignored if this register is set. If reset the [JAFDS](#) register will have control.

**Bit 2: Calibrate Receive Impedance Match (CALEN).** This bit must be set to enable calibration of the receive termination. If this bit is set and a 16k $\Omega$  resistor is on the RESREF pin, then a low-to-high transition on the CRIMP bit will initiate a calibration cycle for the receive internal termination. The user should wait at least 5 $\mu$ s before setting the CRIMP bit.

**Bit 1: Jitter Attenuator Position Select (JAPS).** When the JAPS bit is set, the jitter attenuator will be in the receive path for each channel. The individual LIU register [IJAPS](#) settings will be ignored when this bit is set. When reset, the [IJAPS](#) register will have control.

**Bit 0: Jitter Attenuator Enable (JAE).** When this bit is set the jitter attenuator is enabled. The settings in the [IJAE](#) register will be ignored if this register is set. If reset, the IJAE register will have control.

Register Name: **TST**  
 Register Description: **Template Select Transmitter**  
 Register Address (LIUs 1–8): **10h**

|         |        |        |       |   |   |      |      |      |
|---------|--------|--------|-------|---|---|------|------|------|
| Bit #   | 7      | 6      | 5     | 4 | 3 | 2    | 1    | 0    |
| Name    | JABWS1 | JABWS0 | RHPMC | — | — | TST2 | TST1 | TST0 |
| Default | 0      | 0      | 0     | 0 | 0 | 0    | 0    | 0    |

**Bits 7 and 6: Jitter Attenuator Bandwidth Selection [1:0] (JABWS[1:0]).** In E1 mode, JABWS[1:0] is used to control the bandwidth of the jitter attenuator according to the following table:

| JABWS | BANDWIDTH (Hz) |
|-------|----------------|
| 00    | 0.625          |
| 01    | 1.25           |
| 10    | 2.5            |
| 11    | 5              |

**Bit 5: Receive Hitless Protection Mode Control (RHPMC).** When this bit is set, the receive impedance match on/off selection will be controlled by the OE pin. If OE is high, receive impedance match is on. If OE is low, receive impedance match is off (Internal impedance to RTIP and RRING is high impedance). When this bit is reset, the RIMPON register bit will control receive impedance match.

**Bits 2 to 0: TST Template Select Transceiver [2:0] (TST[2:0]).** TST[2:0] is used to select the transceiver that the Transmit Template Select Register (0x11) will configure for LIUs 1–8. See [Table 6-11](#).

Register Address (LIUs 9–16): **30h**

|         |        |        |       |   |   |      |      |      |
|---------|--------|--------|-------|---|---|------|------|------|
| Bit #   | 7      | 6      | 5     | 4 | 3 | 2    | 1    | 0    |
| Name    | JABWS1 | JABWS0 | RHPMC | — | — | TST2 | TST1 | TST0 |
| Default | 0      | 0      | 0     | 0 | 0 | 0    | 0    | 0    |

**Bits 7 and 6: Jitter Attenuator Bandwidth Selection [1:0] (JABWS[1:0]).** In E1 mode, JABWS[1:0] is used to control the bandwidth of the jitter attenuator according to the following table:

| JABWS | BANDWIDTH (Hz) |
|-------|----------------|
| 00    | 0.625          |
| 01    | 1.25           |
| 10    | 2.5            |
| 11    | 5              |

**Bit 5: Receive Hitless Protection Mode Control (RHPMC).** When this bit is set, the receive impedance match on/off selection will be controlled by the OE pin. If OE is high, receive impedance match is on. If OE is low, receive impedance match is off (internal impedance to RTIP and RRING is high impedance). When this bit is reset, the RIMPON register bit will control receive impedance match.

**Bits 2 to 0: TST Template Select Transceiver [2:0] (TST[2:0]).** TST[2:0] is used to select the transceiver that the Transmit Template Select Register (0x11) will configure for LIUs 9–16. See [Table 6-12](#).

**Table 6-11. TST Template Select Transmitter Register (LIUs 1–8)**

| <b>TST[2:0]</b> | <b>CHANNEL</b> | <b>TST[2:0]</b> | <b>CHANNEL</b> |
|-----------------|----------------|-----------------|----------------|
| 000             | 1              | 100             | 5              |
| 001             | 2              | 101             | 6              |
| 010             | 3              | 110             | 7              |
| 011             | 4              | 111             | 8              |

**Table 6-12. TST Template Select Transmitter Register (LIUs 9–16)**

| <b>TST[2:0]</b> | <b>CHANNEL</b> | <b>TST[2:0]</b> | <b>CHANNEL</b> |
|-----------------|----------------|-----------------|----------------|
| 000             | 9              | 100             | 13             |
| 001             | 10             | 101             | 14             |
| 010             | 11             | 110             | 15             |
| 011             | 12             | 111             | 16             |

Register Name: **TS**  
 Register Description: **Template Select**  
 Register Address (LIUs 1–8): **11h**  
 Register Address (LIUs 9–16): **31h**

| Bit #   | 7      | 6       | 5 | 4 | 3      | 2   | 1   | 0   |
|---------|--------|---------|---|---|--------|-----|-----|-----|
| Name    | RIMPON | TIMPOFF | — | — | TIMPRM | TS2 | TS1 | TS0 |
| Default | 0      | 0       | 0 | 0 | 0      | 0   | 0   | 0   |

**Note:** This register configures each LIU individually. This register configures the LIU selected by [TST.TST\[2:0\]](#).

**Bit 7: Receive Impedance Match On (RIMPON).** If this bit is set, internal receive impedance matching is turned on. Otherwise, the receiver is in high impedance. Note that the OE pin can have control instead of this bit when the [TST.RHPMC](#) bit is set.

**Bit 6: Transmit Impedance Termination Off (TIMPOFF).** If this bit is set all the internal transmit terminating impedance is turned off.

**Bit 3: Transmit Impedance Receive Match (TIMPRM).** This bit selects the internal transmit termination impedance and receive impedance match for E1 mode and T1/J1 mode.

0 = 75Ω for E1 mode or 100Ω for T1 mode.

1 = 120Ω for E1 mode or 110Ω for J1 mode.

**Bits 2 to 0: Template Selection [2:0] (TS[2:0]).** Bits TS[2:0] are used to select E1 or T1/J1 mode, the template, and the settings for various cable lengths. The impedance termination for the transmitter and impedance match for the receiver are specified by bit TIMPRM. See [Table 6-13](#) for bit selection of TS[2:0].

**Table 6-13. Template Selection**

| TEMPLATE SELECTION |                                      |                 |               |
|--------------------|--------------------------------------|-----------------|---------------|
| TS[2:0]            | LINE LENGTH (ft)                     | CABLE LOSS (dB) | IMPEDANCE (Ω) |
| 011                | 0–133 ABAM                           | 0.6             | 100/110       |
| 100                | 133–266 ABAM                         | 1.2             | 100/110       |
| 101                | 266–399 ABAM                         | 1.8             | 100/110       |
| 110                | 399–533 ABAM                         | 2.4             | 100/110       |
| 111                | 533–655 ABAM                         | 3.0             | 100/110       |
| 000                | G.703 coaxial and twisted pair cable |                 | 75/120        |
| 001 and 010        | Reserved                             | —               | —             |

Register Name: **OE**  
 Register Description: **Output Enable Configuration**  
 Register Address (LIUs 1–8): **12h**

| Bit #   | 7   | 6   | 5   | 4   | 3   | 2   | 1   | 0   |
|---------|-----|-----|-----|-----|-----|-----|-----|-----|
| Name    | OE8 | OE7 | OE6 | OE5 | OE4 | OE3 | OE2 | OE1 |
| Default | 0   | 0   | 0   | 0   | 0   | 0   | 0   | 0   |

Register Address (LIUs 9–16): **32h**

| Bit #   | 7    | 6    | 5    | 4    | 3    | 2    | 1    | 0   |
|---------|------|------|------|------|------|------|------|-----|
| Name    | OE16 | OE15 | OE14 | OE13 | OE12 | OE11 | OE10 | OE9 |
| Default | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0   |

**Bits 7 to 0: Output Enable Channel  $n$  (OEn).** When this bit is reset, the transmitter output for LIUn is high impedance. When this bit is set, the transmitter output for LIUn is enabled. Note that the OE pin will override this setting when low.

Register Name: **AIS**  
 Register Description: **Alarm Indication Signal Status**  
 Register Address (LIUs 1–8): **13h**

| Bit #   | 7           | 6           | 5           | 4           | 3           | 2           | 1           | 0           |
|---------|-------------|-------------|-------------|-------------|-------------|-------------|-------------|-------------|
| Name    | <u>AIS8</u> | <u>AIS7</u> | <u>AIS6</u> | <u>AIS5</u> | <u>AIS4</u> | <u>AIS3</u> | <u>AIS2</u> | <u>AIS1</u> |
| Default | 0           | 0           | 0           | 0           | 0           | 0           | 0           | 0           |

Register Address (LIUs 9–16): **33h**

| Bit #   | 7            | 6            | 5            | 4            | 3            | 2            | 1            | 0           |
|---------|--------------|--------------|--------------|--------------|--------------|--------------|--------------|-------------|
| Name    | <u>AIS16</u> | <u>AIS15</u> | <u>AIS14</u> | <u>AIS13</u> | <u>AIS12</u> | <u>AIS11</u> | <u>AIS10</u> | <u>AIS9</u> |
| Default | 0            | 0            | 0            | 0            | 0            | 0            | 0            | 0           |

**Bits 7 to 0: Alarm Indication Signal Channel  $n$  (AISn).** This bit will be set when AIS is detected for LIUn. The criteria for AIS selection is detailed in Section [5.5.7](#). The selection of the AIS criteria is done by settings in the [LASCS](#) (OD) register.

Register Name: **AISIE**  
 Register Description: **AIS Interrupt Enable**  
 Register Address (LIUs 1–8): **14h**

|         |        |        |        |        |        |        |        |        |
|---------|--------|--------|--------|--------|--------|--------|--------|--------|
| Bit #   | 7      | 6      | 5      | 4      | 3      | 2      | 1      | 0      |
| Name    | AISIE8 | AISIE7 | AISIE6 | AISIE5 | AISIE4 | AISIE3 | AISIE2 | AISIE1 |
| Default | 0      | 0      | 0      | 0      | 0      | 0      | 0      | 0      |

Register Address (LIUs 9–16): **34h**

|         |         |         |         |         |         |         |         |        |
|---------|---------|---------|---------|---------|---------|---------|---------|--------|
| Bit #   | 7       | 6       | 5       | 4       | 3       | 2       | 1       | 0      |
| Name    | AISIE16 | AISIE15 | AISIE14 | AISIE13 | AISIE12 | AISIE11 | AISIE10 | AISIE9 |
| Default | 0       | 0       | 0       | 0       | 0       | 0       | 0       | 0      |

**Bits 7 to 0: AIS Interrupt Mask Channel  $n$  (AISIE $n$ ).** When this bit is set, interrupts can be generated for LIU $n$  if AIS status transitions.

Register Name: **AISIS**  
 Register Description: **AIS Interrupt Status**  
 Register Address (LIUs 1–8): **15h**

|         |        |        |        |        |        |        |        |        |
|---------|--------|--------|--------|--------|--------|--------|--------|--------|
| Bit #   | 7      | 6      | 5      | 4      | 3      | 2      | 1      | 0      |
| Name    | AISIS8 | AISIS7 | AISIS6 | AISIS5 | AISIS4 | AISIS3 | AISIS2 | AISIS1 |
| Default | 0      | 0      | 0      | 0      | 0      | 0      | 0      | 0      |

Register Address (LIUs 9–16): **35h**

|         |         |         |         |         |         |         |         |        |
|---------|---------|---------|---------|---------|---------|---------|---------|--------|
| Bit #   | 7       | 6       | 5       | 4       | 3       | 2       | 1       | 0      |
| Name    | AISIS16 | AISIS15 | AISIS14 | AISIS13 | AISIS12 | AISIS11 | AISIS10 | AISIS9 |
| Default | 0       | 0       | 0       | 0       | 0       | 0       | 0       | 0      |

**Bits 7 to 0: AIS Interrupt Status Channel  $n$  (AISIS $n$ ).** This bit is set when AIS ransitions from a “0 to 1” or “1 to 0” and interrupts are enabled by the [AISIE](#)(14) register for LIU $n$ . If set, this bit is cleared on a read operation or when the interrupt enable register is disabled.

Register Name: **ADDP**  
 Register Description: **Address Pointer for Bank Selection**  
 Register Address (LIUs 1–8): **1Fh**  
 Register Address (LIUs 9–16): **3Fh**

|         |       |       |       |       |       |       |       |       |
|---------|-------|-------|-------|-------|-------|-------|-------|-------|
| Bit #   | 7     | 6     | 5     | 4     | 3     | 2     | 1     | 0     |
| Name    | ADDP7 | ADDP6 | ADDP5 | ADDP4 | ADDP3 | ADDP2 | ADDP1 | ADDP0 |
| Default | 0     | 0     | 0     | 0     | 0     | 0     | 0     | 0     |

**Bits 7 to 0: Address Pointer (ADDP).** This pointer is used to switch between pointing to the primary registers, the secondary registers, individual registers, and BERT registers. See [Table 6-14](#) for bank selection. The register space contains control for Channels 1 to 8 from address 00 hex to 1F hex and a duplicate set of registers for control of Channels 9 to 16 from address 20 hex to 3F hex. The ADDP at address 1F hex select the banks for the set of registers for LIUs 1–8. The ADDP register at address 3F select the banks for the set of registers for LIUs 9–16.

**Table 6-14. Address Pointer Bank Selection**

| ADDP[7:0] (HEX) | BANK NAME           |
|-----------------|---------------------|
| 00              | Primary Bank        |
| AA              | Secondary Bank      |
| 01              | Individual LIU Bank |
| 02              | BERT Bank           |

### 6.1.2 Secondary Register Bank

The ADDP register must be set to AAh in order to access this bank.

Register Name: **SRMS**  
 Register Description: **Single-Rail Mode Select**  
 Register Address (LIUs 1–8): **00h**

|         |       |       |       |       |       |       |       |       |
|---------|-------|-------|-------|-------|-------|-------|-------|-------|
| Bit #   | 7     | 6     | 5     | 4     | 3     | 2     | 1     | 0     |
| Name    | SRMS8 | SRMS7 | SRMS6 | SRMS5 | SRMS4 | SRMS3 | SRMS2 | SRMS1 |
| Default | 0     | 0     | 0     | 0     | 0     | 0     | 0     | 0     |

Register Address (LIUs 9–16): **20h**

|         |        |        |        |        |        |        |        |       |
|---------|--------|--------|--------|--------|--------|--------|--------|-------|
| Bit #   | 7      | 6      | 5      | 4      | 3      | 2      | 1      | 0     |
| Name    | SRMS16 | SRMS15 | SRMS14 | SRMS13 | SRMS12 | SRMS11 | SRMS10 | SRMS9 |
| Default | 0      | 0      | 0      | 0      | 0      | 0      | 0      | 0     |

**Bits 7 to 0: Single-Rail Mode Select Channel  $n$  (SRMS $n$ ).** When this bit is set single-rail mode is selected for the system transmit and receive  $n$ . If this bit is reset, dual-rail is selected.

Register Name: **LCS**  
 Register Description: **Line Code Selection**  
 Register Address (LIUs 1–8): **01h**

| Bit #   | 7    | 6    | 5    | 4    | 3    | 2    | 1    | 0    |
|---------|------|------|------|------|------|------|------|------|
| Name    | LCS8 | LCS7 | LCS6 | LCS5 | LCS4 | LCS3 | LCS2 | LCS1 |
| Default | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    |

Register Address (LIUs 9–16): **21h**

| Bit #   | 7     | 6     | 5     | 4     | 3     | 2     | 1     | 0    |
|---------|-------|-------|-------|-------|-------|-------|-------|------|
| Name    | LCS16 | LCS15 | LCS14 | LCS13 | LCS12 | LCS11 | LCS10 | LCS9 |
| Default | 0     | 0     | 0     | 0     | 0     | 0     | 0     | 0    |

**Bits 7 to 0: Line Code Select Channel  $n$  (LCS $n$ ).** When this bit is set AMI encoding/decoding is selected for LIU $n$ . If reset, B8ZS or HDB3 encoding/decoding is selected for LIU $n$ . Note that if the [GC.CODE](#) register bit is set it will ignore this register.

Register Name: **RPDE**  
 Register Description: **Receive Power-Down Enable**  
 Register Address (LIUs 1–8): **03h**

| Bit #   | 7     | 6     | 5     | 4     | 3     | 2     | 1     | 0     |
|---------|-------|-------|-------|-------|-------|-------|-------|-------|
| Name    | RPDE8 | RPDE7 | RPDE6 | RPDE5 | RPDE4 | RPDE3 | RPDE2 | RPDE1 |
| Default | 0     | 0     | 0     | 0     | 0     | 0     | 0     | 0     |

Register Address (LIUs 9–16): **23h**

| Bit #   | 7      | 6      | 5      | 4      | 3      | 2      | 1      | 0     |
|---------|--------|--------|--------|--------|--------|--------|--------|-------|
| Name    | RPDE16 | RPDE15 | RPDE14 | RPDE13 | RPDE12 | RPDE11 | RPDE10 | RPDE9 |
| Default | 0      | 0      | 0      | 0      | 0      | 0      | 0      | 0     |

**Bits 7 to 0: Receive Power-Down Enable Channel  $n$  (RPDE $n$ ).** When this bit is set the receiver for LIU $n$  is powered down.

Register Name: **TPDE**  
 Register Description: **Transmit Power-Down Enable**  
 Register Address (LIUs 1–8): **04h**

| Bit #   | 7     | 6     | 5     | 4     | 3     | 2     | 1     | 0     |
|---------|-------|-------|-------|-------|-------|-------|-------|-------|
| Name    | TPDE8 | TPDE7 | TPDE6 | TPDE5 | TPDE4 | TPDE3 | TPDE2 | TPDE1 |
| Default | 0     | 0     | 0     | 0     | 0     | 0     | 0     | 0     |

Register Address (LIUs 9–16): **24h**

| Bit #   | 7      | 6      | 5      | 4      | 3      | 2      | 1      | 0     |
|---------|--------|--------|--------|--------|--------|--------|--------|-------|
| Name    | TPDE16 | TPDE15 | TPDE14 | TPDE13 | TPDE12 | TPDE11 | TPDE10 | TPDE9 |
| Default | 0      | 0      | 0      | 0      | 0      | 0      | 0      | 0     |

**Bits 7 to 0: Transmit Power-Down Enable Channel  $n$  (TPDE $n$ ).** When this bit is set the transmitter for LIU $n$  is powered down.



Register Name: **EZDE**  
 Register Description: **Excessive Zero Detect Enable**  
 Register Address (LIUs 1–8): **05h**

| Bit #   | 7     | 6     | 5     | 4     | 3     | 2     | 1     | 0     |
|---------|-------|-------|-------|-------|-------|-------|-------|-------|
| Name    | EZDE8 | EZDE7 | EZDE6 | EZDE5 | EZDE4 | EZDE3 | EZDE2 | EZDE1 |
| Default | 0     | 0     | 0     | 0     | 0     | 0     | 0     | 0     |

Register Address (LIUs 9–16): **25h**

| Bit #   | 7      | 6      | 5      | 4      | 3      | 2      | 1      | 0     |
|---------|--------|--------|--------|--------|--------|--------|--------|-------|
| Name    | EZDE16 | EZDE15 | EZDE14 | EZDE13 | EZDE12 | EZDE11 | EZDE10 | EZDE9 |
| Default | 0      | 0      | 0      | 0      | 0      | 0      | 0      | 0     |

**Bits 7 to 0: Excessive Zero Detect Enable Channel  $n$  (EZDE $n$ ).** When this bit is reset excessive zero detection is disabled for LIU $n$ . When this bit is set excessive zero detect enable is enabled. Excessive zero detection is only relevant when HDB3 or B8ZS decoding is enabled ([LCS](#) register).

Register Name: **CVDEB**  
 Register Description: **Code Violation Detect Enable Bar**  
 Register Address (LIUs 1–8): **06h**

| Bit #   | 7      | 6      | 5      | 4      | 3      | 2      | 1      | 0      |
|---------|--------|--------|--------|--------|--------|--------|--------|--------|
| Name    | CVDEB8 | CVDEB7 | CVDEB6 | CVDEB5 | CVDEB4 | CVDEB3 | CVDEB2 | CVDEB1 |
| Default | 0      | 0      | 0      | 0      | 0      | 0      | 0      | 0      |

Register Address (LIUs 9–16): **26h**

| Bit #   | 7       | 6       | 5       | 4       | 3       | 2       | 1       | 0      |
|---------|---------|---------|---------|---------|---------|---------|---------|--------|
| Name    | CVDEB16 | CVDEB15 | CVDEB14 | CVDEB13 | CVDEB12 | CVDEB11 | CVDEB10 | CVDEB9 |
| Default | 0       | 0       | 0       | 0       | 0       | 0       | 0       | 0      |

**Bits 7 to 0: Code Violation Detect Enable Bar Channel  $n$  (CVDEB $n$ ).** If this bit is set, code violation detection is disabled for the LIU $n$ . If this bit is reset, code violation detection is enabled. Code violation detection is only relevant when HDB3 decoding is enabled ([LCS](#) register).

### 6.1.3 Individual LIU Register Bank

The ADDP register must be set to 01h to access this bank.

Register Name: **IJAE**  
 Register Description: **Individual Jitter Attenuator Enable**  
 Register Address (LIUs 1–8): **00h**

| Bit #   | 7     | 6     | 5     | 4     | 3     | 2     | 1     | 0     |
|---------|-------|-------|-------|-------|-------|-------|-------|-------|
| Name    | IJAE8 | IJAE7 | IJAE6 | IJAE5 | IJAE4 | IJAE3 | IJAE2 | IJAE1 |
| Default | 0     | 0     | 0     | 0     | 0     | 0     | 0     | 0     |

Register Address (LIUs 9–16): **20h**

| Bit #   | 7      | 6      | 5      | 4      | 3      | 2      | 1      | 0     |
|---------|--------|--------|--------|--------|--------|--------|--------|-------|
| Name    | IJAE16 | IJAE15 | IJAE14 | IJAE13 | IJAE12 | IJAE11 | IJAE10 | IJAE9 |
| Default | 0      | 0      | 0      | 0      | 0      | 0      | 0      | 0     |

**Bits 7 to 0: Individual Jitter Attenuator Enable Channel  $n$  (IJAE $n$ ).** When this bit is set, the LIU jitter attenuator  $n$  is enabled. Note that if the [GC.JAE](#) register bit is set, this register will be ignored.

Register Name: **IJAPS**  
 Register Description: **Individual Jitter Attenuator Position Select**  
 Register Address (LIUs 1–8): **01h**

| Bit #   | 7      | 6      | 5      | 4      | 3      | 2      | 1      | 0      |
|---------|--------|--------|--------|--------|--------|--------|--------|--------|
| Name    | IJAPS8 | IJAPS7 | IJAPS6 | IJAPS5 | IJAPS4 | IJAPS3 | IJAPS2 | IJAPS1 |
| Default | 0      | 0      | 0      | 0      | 0      | 0      | 0      | 0      |

Register Address (LIUs 9–16): **21h**

| Bit #   | 7       | 6       | 5       | 4       | 3       | 2       | 1       | 0      |
|---------|---------|---------|---------|---------|---------|---------|---------|--------|
| Name    | IJAPS16 | IJAPS15 | IJAPS14 | IJAPS13 | IJAPS12 | IJAPS11 | IJAPS10 | IJAPS9 |
| Default | 0       | 0       | 0       | 0       | 0       | 0       | 0       | 0      |

**Bits 7 to 0: Individual Jitter Attenuator Position Select Channel  $n$  (IJAPS $n$ ).** When this bit is set high, the jitter attenuator is in the receive path  $n$ ; when this bit is default or set low the jitter attenuator is in the transmit path  $n$ . Note that if the [GC.JAE](#) register bit is set, this register will be ignored.

Register Name: **IJAFDS**  
 Register Description: **Individual Jitter Attenuator FIFO Depth Select**  
 Register Address (LIUs 1–8): **02h**

| Bit #   | 7       | 6       | 5       | 4       | 3       | 2       | 1       | 0       |
|---------|---------|---------|---------|---------|---------|---------|---------|---------|
| Name    | IJAFDS8 | IJAFDS7 | IJAFDS6 | IJAFDS5 | IJAFDS4 | IJAFDS3 | IJAFDS2 | IJAFDS1 |
| Default | 0       | 0       | 0       | 0       | 0       | 0       | 0       | 0       |

Register Address (LIUs 9–16): **22h**

| Bit #   | 7        | 6        | 5        | 4        | 3        | 2        | 1        | 0       |
|---------|----------|----------|----------|----------|----------|----------|----------|---------|
| Name    | IJAFDS16 | IJAFDS15 | IJAFDS14 | IJAFDS13 | IJAFDS12 | IJAFDS11 | IJAFDS10 | IJAFDS9 |
| Default | 0        | 0        | 0        | 0        | 0        | 0        | 0        | 0       |

**Bits 7 to 0: Individual Jitter Attenuator FIFO Depth Select  $n$  (IJAFDS $n$ ).** When this bit is set for LIU $n$  the jitter attenuator FIFO depth will be 128 bits. When reset the jitter attenuator FIFO depth will be 32 bits. Note that if the [GC.IJAFDS](#) register bit is set, this register will be ignored.

Register Name: **IJAFLT**  
 Register Description: **Individual Jitter Attenuator FIFO Limit Trip**  
 Register Address (LIUs 1–8): **03h**

| Bit #   | 7       | 6       | 5       | 4       | 3       | 2       | 1       | 0       |
|---------|---------|---------|---------|---------|---------|---------|---------|---------|
| Name    | IJAFLT8 | IJAFLT7 | IJAFLT6 | IJAFLT5 | IJAFLT4 | IJAFLT3 | IJAFLT2 | IJAFLT1 |
| Default | 0       | 0       | 0       | 0       | 0       | 0       | 0       | 0       |

Register Address (LIUs 9–16): **23h**

| Bit #   | 7        | 6        | 5        | 4        | 3        | 2        | 1        | 0       |
|---------|----------|----------|----------|----------|----------|----------|----------|---------|
| Name    | IJAFLT16 | IJAFLT15 | IJAFLT14 | IJAFLT13 | IJAFLT12 | IJAFLT11 | IJAFLT10 | IJAFLT9 |
| Default | 0        | 0        | 0        | 0        | 0        | 0        | 0        | 0       |

**Bits 7 to 0: Individual Jitter Attenuator FIFO Limit Trip  $n$  (IJAFLT $n$ ).** Set when the jitter attenuator FIFO reaches to within 4 bits of its useful limit for transmitter  $n$ . This bit will be cleared when read.

Register Name: **ISCPD**  
 Register Description: **Individual Short-Circuit Protection Disable**  
 Register Address (LIUs 1–8): **04h**

| Bit #   | 7      | 6      | 5      | 4      | 3      | 2      | 1      | 0      |
|---------|--------|--------|--------|--------|--------|--------|--------|--------|
| Name    | ISCPD8 | ISCPD7 | ISCPD6 | ISCPD5 | ISCPD4 | ISCPD3 | ISCPD2 | ISCPD1 |
| Default | 0      | 0      | 0      | 0      | 0      | 0      | 0      | 0      |

Register Address (LIUs 9–16): **24h**

| Bit #   | 7       | 6       | 5       | 4       | 3       | 2       | 1       | 0      |
|---------|---------|---------|---------|---------|---------|---------|---------|--------|
| Name    | ISCPD16 | ISCPD15 | ISCPD14 | ISCPD13 | ISCPD12 | ISCPD11 | ISCPD10 | ISCPD9 |
| Default | 0       | 0       | 0       | 0       | 0       | 0       | 0       | 0      |

**Bits 7 to 0: Individual Short-Circuit Protection Disable  $n$  (ISCPD $n$ ).** When this bit is set the short-circuit protection is disabled for the individual transmitter  $n$ . Note that if the [GC.SCPD](#) register bit is set, the settings in this register will be ignored.

Register Name: **IAISEL**  
 Register Description: **Individual AIS Select**  
 Register Address (LIUs 1–8): **05h**

| Bit #   | 7       | 6       | 5       | 4       | 3       | 2       | 1       | 0       |
|---------|---------|---------|---------|---------|---------|---------|---------|---------|
| Name    | IAISEL8 | IAISEL7 | IAISEL6 | IAISEL5 | IAISEL4 | IAISEL3 | IAISEL2 | IAISEL1 |
| Default | 0       | 0       | 0       | 0       | 0       | 0       | 0       | 0       |

Register Address (LIUs 9–16): **25h**

| Bit #   | 7        | 6        | 5        | 4        | 3        | 2        | 1        | 0       |
|---------|----------|----------|----------|----------|----------|----------|----------|---------|
| Name    | IAISEL16 | IAISEL15 | IAISEL14 | IAISEL13 | IAISEL12 | IAISEL11 | IAISEL10 | IAISEL9 |
| Default | 0        | 0        | 0        | 0        | 0        | 0        | 0        | 0       |

**Bits 7 to 0: Individual AIS Enable During Loss  $n$  (IAISEL $n$ ).** When this bit is set, individual AIS enable during loss is enabled for the individual receiver  $n$ , and AIS is sent to the system side upon detection of an LOS. Note that if the [GC.AISEL](#) register bit is set, the settings in this register will be ignored.

Register Name: **MC**  
 Register Description: **Master Clock Select**  
 Register Address: **06h**

| Bit #   | 7      | 6      | 5      | 4     | 3    | 2    | 1     | 0    |
|---------|--------|--------|--------|-------|------|------|-------|------|
| Name    | PCLKI1 | PCLKI0 | TECLKE | CLKAE | MPS1 | MPS0 | FREQS | PLLE |
| Default | 0      | 0      | 0      | 0     | 0    | 0    | 0     | 0    |

**Bits 7 and 6: PLL Clock Input [1:0] (PCLKI[1:0]).** These bits select the input into to the PLL.

00: MCLK is used.

01: RCLK1 to 8 is used based on the selection in register [CCR](#).

10: RCLK9 to 16 is used based on the selection in register CCR.

11: Reserved.

**Bit 5: T1/E1 Clock Enable (TECLKE).** When this bit is set the TECLK output is enabled. If not set TECLK will be disabled and the TECLK output is a LOS output. TECLK requires PLLE to be set for correct functionality.

**Bit 4: Clock A Enable (CLKAE).** When this bit is set the CLKA output is enabled. If not set CLKA will be disabled and the CLKA output is a LOS output. CLKA requires PLLE to be set for correct functionality.

**Bits 3 and 2: Master Period Select [1:0] (MPS[1:0]).** These bits MPS[1:0] selects the external MCLK frequency for the DS26324. See [Table 6-15](#) for details. This register when written to will also controller functionality of Channels 9 to 16.

**Bit 1: Frequency Select (FREQS).** In conjunction with MPS[1:0] selects the external MCLK frequency for the DS26324. If this bit is set the external Master clock can be 1.544MHz or multiple thereof. If not set the external master clock can be 2.048MHz or multiple thereof. See [Table 6-15](#) for details. This register when written to will also controller functionality of Channels 9 to 16.

**Bit 0: Phase Lock Loop Enable (PLLE).** When this bit is set the phase lock loop is enabled. If not set MCLK will be the applied input clock.

**Table 6-15. DS26324 MCLK Selections**

| PLLE | MPS1, MPS0 | MCLK,<br>MHz $\pm$ 50ppm | FREQS | MODE        |
|------|------------|--------------------------|-------|-------------|
| 0    | xx         | 1.544                    | x     | T1          |
| 0    | xx         | 2.048                    | x     | E1          |
| 1    | 00         | 1.544                    | 1     | T1/J1 or E1 |
| 1    | 01         | 3.088                    | 1     | T1/J1 or E1 |
| 1    | 10         | 6.176                    | 1     | T1/J1 or E1 |
| 1    | 11         | 12.352                   | 1     | T1/J1 or E1 |
| 1    | 00         | 2.048                    | 0     | T1/J1 or E1 |
| 1    | 01         | 4.096                    | 0     | T1/J1 or E1 |
| 1    | 10         | 8.192                    | 0     | T1/J1 or E1 |
| 1    | 11         | 16.384                   | 0     | T1/J1 or E1 |

Register Name: **RSMM1**  
 Register Description: **Receive Sensitivity Monitor Mode 1**  
 Register Address (LIUs 1–8): **08h**

| Bit #   | 7    | 6      | 5      | 4      | 3    | 2      | 1      | 0      |
|---------|------|--------|--------|--------|------|--------|--------|--------|
| Name    | RTR2 | C2RSM2 | C2RSM1 | C2RSM0 | RTR1 | C1RSM2 | C1RSM1 | C1RSM0 |
| Default | 0    | 0      | 0      | 0      | 0    | 0      | 0      | 0      |

**Bit 7: Receiver Transformer Turns Ratio Channel 2 (RTR2).** If this bit is set the turns ratio is 1:1 on the receiver side. This bit should be set when a 1:1 receiver transformer is used. Note that in order to use fully internal receive impedance termination, a 1:1 transformer must be used and this bit must be set to 1.

**Bits 6 to 4: Channel 2 Receive Sensitivity/Monitor Select [2:0] (C2RSM[2:0]).** Bits C2RSM[2:0] are used to select the receiver sensitivity level and the monitor mode resistive gain. See [Table 6-16](#).

**Bit 3: Receiver Transformer Turns Ratio Channel 1 (RTR1).** If this bit is set the turns ratio is 1:1 on the receiver side. This bit should be set when a 1:1 receiver transformer is used. Note that in order to use the fully internal receive impedance termination, a 1:1 transformer must be used and this bit must be set to 1.

**Bits 2 to 0: Channel 1 Receive Sensitivity/Monitor Select [2:0] (C1RSM[2:0]).** Bits C1RSM[2:0] are used to select the receiver sensitivity level and the monitor mode resistive gain. See [Table 6-16](#).

Register Address (LIUs 9–16): **28h**

| Bit #   | 7     | 6       | 5       | 4       | 3    | 2      | 1      | 0      |
|---------|-------|---------|---------|---------|------|--------|--------|--------|
| Name    | RTR10 | C10RSM2 | C10RSM1 | C10RSM0 | RTR9 | C9RSM2 | C9RSM1 | C9RSM0 |
| Default | 0     | 0       | 0       | 0       | 0    | 0      | 0      | 0      |

**Bit 7: Receiver Transformer Turns Ratio Channel 10 (RTR10).** If this bit is set the turns ratio is 1:1 on the receiver side. This bit should be set when a 1:1 receiver transformer is used. Note that in order to use fully internal receive impedance termination, a 1:1 transformer must be used and this bit must be set to 1.

**Bits 6 to 4: Channel 10 Receive Sensitivity/Monitor Select [2:0] (C10RSM[2:0]).** Bits C10RSM[2:0] are used to select the receiver sensitivity level and the monitor mode resistive gain. See [Table 6-16](#).

**Bit 3: Receiver Transformer Turns Ratio Channel 9 (RTR9).** If this bit is set the Turns Ratio is 1:1 on the receiver side. This bit should be set when a 1:1 receiver transformer is used. Note that in order to use the fully internal receive impedance termination, a 1:1 transformer must be used and this bit must be set to 1.

**Bits 2 to 0: Channel 9 Receive Sensitivity/Monitor Select [2:0] (C9RSM[2:0]).** Bits C9RSM[2:0] are used to select the receiver sensitivity level and the monitor mode resistive gain. See [Table 6-16](#).

Register Name: **RSMM2**  
 Register Description: **Receive Sensitivity Monitor Mode 2**  
 Register Address (LIUs 1–8): **09h**

| Bit #   | 7    | 6      | 5      | 4      | 3    | 2      | 1      | 0      |
|---------|------|--------|--------|--------|------|--------|--------|--------|
| Name    | RTR4 | C4RSM2 | C4RSM1 | C4RSM0 | RTR3 | C3RSM2 | C3RSM1 | C3RSM0 |
| Default | 0    | 0      | 0      | 0      | 0    | 0      | 0      | 0      |

**Bit 7: Receiver Transformer Turns Ratio Channel 4 (RTR4).** If this bit is set the turns ratio is 1:1 on the receiver side. This bit should be set when a 1:1 receiver transformer is used. Note that in order to use fully internal receive impedance termination, a 1:1 transformer must be used and this bit must be set to 1.

**Bit 6 to 4: Channel 4 Receive Sensitivity/Monitor Select [2:0] (C4RSM[2:0]).** Bits C4RSM[2:0] are used to select the receiver sensitivity level and the monitor mode resistive gain. See [Table 6-16](#).

**Bit 3: Receiver Transformer Turns Ratio Channel 3 (RTR3).** If this bit is set the turns ratio is 1:1 on the receiver side. This bit should be set when a 1:1 receiver transformer is used. Note that in order to use the fully internal receive impedance termination, a 1:1 transformer must be used and this bit must be set to 1.

**Bit 2 to 0: Channel 3 Receive Sensitivity/Monitor Select [2:0] (C3RSM[2:0]).** Bits C3RSM[2:0] are used to select the receiver sensitivity level and the monitor mode resistive gain. See [Table 6-16](#).

Register Address (LIUs 9–16): **29h**

| Bit #   | 7     | 6       | 5       | 4       | 3     | 2       | 1       | 0       |
|---------|-------|---------|---------|---------|-------|---------|---------|---------|
| Name    | RTR12 | C12RSM2 | C12RSM1 | C12RSM0 | RTR11 | C11RSM2 | C11RSM1 | C11RSM0 |
| Default | 0     | 0       | 0       | 0       | 0     | 0       | 0       | 0       |

**Bit 7: Receiver Transformer Turns Ratio Channel 12 (RTR12).** If this bit is set the turns ratio is 1:1 on the receiver side. This bit should be set when a 1:1 receiver transformer is used. Note that in order to use fully internal receive impedance termination, a 1:1 transformer must be used and this bit must be set to 1.

**Bits 6 to 4: Channel 12 Receive Sensitivity/Monitor Select [2:0] (C12RSM[2:0]).** Bits C12RSM[2:0] are used to select the receiver sensitivity level and the monitor mode resistive gain. See [Table 6-16](#).

**Bit 3: Receiver Transformer Turns Ratio Channel 11 (RTR11).** If this bit is set the turns ratio is 1:1 on the receiver side. This bit should be set when a 1:1 receiver transformer is used. Note that in order to use the fully internal receive impedance termination, a 1:1 transformer must be used and this bit must be set to 1.

**Bits 2 to 0: Channel 11 Receive Sensitivity/Monitor Select [2:0] (C11RSM[2:0]).** Bits C11RSM[2:0] are used to select the receiver sensitivity level and the monitor mode resistive gain. See [Table 6-16](#).

Register Name: **RSMM3**  
 Register Description: **Receive Sensitivity Monitor Mode 3**  
 Register Address (LIUs 1–8): **0Ah**

| Bit #   | 7    | 6      | 5      | 4      | 3    | 2      | 1      | 0      |
|---------|------|--------|--------|--------|------|--------|--------|--------|
| Name    | RTR6 | C6RSM2 | C6RSM1 | C6RSM0 | RTR5 | C5RSM2 | C5RSM1 | C5RSM0 |
| Default | 0    | 0      | 0      | 0      | 0    | 0      | 0      | 0      |

**Bit 7: Receiver Transformer Turns Ratio Channel 6 (RTR6).** If this bit is set the turns ratio is 1:1 on the receiver side. This bit should be set when a 1:1 receiver transformer is used. Note that in order to use fully internal receive impedance termination, a 1:1 transformer must be used and this bit must be set to 1.

**Bits 6 to 4: Channel 6 Receive Sensitivity/Monitor Select [2:0] (C6RSM[2:0]).** Bits C6RSM[2:0] are used to select the receiver sensitivity level and the monitor mode resistive gain. See [Table 6-16](#).

**Bit 3: Receiver Transformer Turns Ratio Channel 5 (RTR5).** If this bit is set the turns ratio is 1:1 on the receiver side. This bit should be set when a 1:1 receiver transformer is used. Note that in order to use the fully internal receive impedance termination, a 1:1 transformer must be used and this bit must be set to 1.

**Bits 2 to 0: Channel 5 Receive Sensitivity/Monitor Select [2:0] (C5RSM[2:0]).** Bits C5RSM[2:0] are used to select the receiver sensitivity level and the monitor mode resistive gain. See [Table 6-16](#).

Register Address (LIUs 9–16): **2Ah**

| Bit #   | 7     | 6       | 5       | 4       | 3     | 2       | 1       | 0       |
|---------|-------|---------|---------|---------|-------|---------|---------|---------|
| Name    | RTR14 | C14RSM2 | C14RSM1 | C14RSM0 | RTR13 | C13RSM2 | C13RSM1 | C13RSM0 |
| Default | 0     | 0       | 0       | 0       | 0     | 0       | 0       | 0       |

**Bit 7: Receiver Transformer Turns Ratio Channel 14 (RTR14).** If this bit is set the turns ratio is 1:1 on the receiver side. This bit should be set when a 1:1 receiver transformer is used. Note that in order to use fully internal receive impedance termination, a 1:1 transformer must be used and this bit must be set to 1.

**Bits 6 to 4: Channel 14 Receive Sensitivity/Monitor Select [2:0] (C14RSM[2:0]).** Bits C14RSM[2:0] are used to select the receiver sensitivity level and the monitor mode resistive gain. See [Table 6-16](#).

**Bit 3: Receiver Transformer Turns Ratio Channel 13 (RTR13).** If this bit is set the turns ratio is 1:1 on the receiver side. This bit should be set when a 1:1 receiver transformer is used. Note that in order to use the fully internal receive impedance termination, a 1:1 transformer must be used and this bit must be set to 1.

**Bits 2 to 0: Channel 13 Receive Sensitivity/Monitor Select [2:0] (C13RSM[2:0]).** Bits C13RSM[2:0] are used to select the receiver sensitivity level and the monitor mode resistive gain. See [Table 6-16](#).



Register Name: **RSMM4**  
 Register Description: **Receive Sensitivity Monitor Mode 4**  
 Register Address (LIUs 1–8): **0Bh**

|         |      |        |        |        |      |        |        |        |
|---------|------|--------|--------|--------|------|--------|--------|--------|
| Bit #   | 7    | 6      | 5      | 4      | 3    | 2      | 1      | 0      |
| Name    | RTR8 | C8RSM2 | C8RSM1 | C8RSM0 | RTR7 | C7RSM2 | C7RSM1 | C7RSM0 |
| Default | 0    | 0      | 0      | 0      | 0    | 0      | 0      | 0      |

**Bit 7: Receiver Transformer Turns Ratio Channel 8 (RTR8).** If this bit is set the turns ratio is 1:1 on the receiver side. This bit should be set when a 1:1 receiver transformer is used. Note that in order to use fully internal receive impedance termination, a 1:1 transformer must be used and this bit must be set to 1.

**Bits 6 to 4: Channel 8 Receive Sensitivity/Monitor Select [2:0] (C8RSM[2:0]).** Bits C8RSM[2:0] are used to select the receiver sensitivity level and the monitor mode resistive gain. See [Table 6-16](#).

**Bit 3: Receiver Transformer Turns Ratio Channel 7 (RTR7).** If this bit is set the turns ratio is 1:1 on the receiver side. This bit should be set when a 1:1 receiver transformer is used. Note that in order to use the fully internal receive impedance termination, a 1:1 transformer must be used and this bit must be set to 1.

**Bits 2 to 0: Channel 7 Receive Sensitivity/Monitor Select [2:0] (C7RSM[2:0]).** Bits C7RSM[2:0] are used to select the receiver sensitivity level and the monitor mode resistive gain. See [Table 6-16](#).

Register Address (LIUs 9–16): **2Bh**

|         |       |         |         |         |       |         |         |         |
|---------|-------|---------|---------|---------|-------|---------|---------|---------|
| Bit #   | 7     | 6       | 5       | 4       | 3     | 2       | 1       | 0       |
| Name    | RTR16 | C16RSM2 | C16RSM1 | C16RSM0 | RTR15 | C15RSM2 | C15RSM1 | C15RSM0 |
| Default | 0     | 0       | 0       | 0       | 0     | 0       | 0       | 0       |

**Bit 7: Receiver Transformer Turns Ratio Channel 16 (RTR16).** If this bit is set the turns ratio is 1:1 on the receiver side. This bit should be set when a 1:1 receiver transformer is used. Note that in order to use fully internal receive impedance termination, a 1:1 transformer must be used and this bit must be set to 1.

**Bit 6 to 4: Channel 16 Receive Sensitivity/Monitor Select [2:0] (C16RSM[2:0]).** Bits C16RSM[2:0] are used to select the receiver sensitivity level and the monitor mode resistive gain. See [Table 6-16](#).

**Bit 3: Receiver Transformer Turns Ratio Channel 15 (RTR15).** If this bit is set the turns ratio is 1:1 on the receiver side. This bit should be set when a 1:1 receiver transformer is used. Note that in order to use the fully internal receive impedance termination, a 1:1 transformer must be used and this bit must be set to 1.

**Bits 2 to 0: Channel 15 Receive Sensitivity/Monitor Select [2:0] (C15RSM[2:0]).** Bits C15RSM[2:0] are used to select the receiver sensitivity level and the monitor mode resistive gain. See [Table 6-16](#).

**Table 6-16. Receiver Sensitivity/Monitor Mode Gain Selection**

| RECEIVER MONITOR MODE DISABLED | C <sub>n</sub> RSM[2:0], T1/ E1 MODE | RECEIVER SENSITIVITY (MAXIMUM LOSS) (dB) | RECEIVER MONITOR MODE GAIN SETTINGS (dB) | LOSS DECLARATION LEVEL (dB) |
|--------------------------------|--------------------------------------|--|--|-----------------------------|
| No flat gain                   | 000                                  | 12                                       | 0  | 15                          |
| No flat gain                   | 001                                  | 18                                       | 0  | 21                          |
| Receiver monitor mode enabled  | C <sub>n</sub> RSM[2:0]              | Max cable loss                           | Receiver monitor mode gain settings      | —                           |
| Flat gain                      | 100                                  | 30                                       | 14                                       | 37                          |
| Flat gain                      | 101                                  | 22.5                                     | 20                                       | 45.5                        |

Register Name: **RSL1**  
 Register Description: **Receive Signal Level Indicator 1**  
 Register Address (LIUs 1–8): **0Ch**

|         |               |               |               |               |               |               |               |               |
|---------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|
| Bit #   | 7             | 6             | 5             | 4             | 3             | 2             | 1             | 0             |
| Name    | <u>C2RSL3</u> | <u>C2RSL2</u> | <u>C2RSL1</u> | <u>C2RSL0</u> | <u>C1RSL3</u> | <u>C1RSL2</u> | <u>C1RSL1</u> | <u>C1RSL0</u> |
| Default | 0             | 0             | 0             | 0             | 0             | 0             | 0             | 0             |

**Bits 7 to 4: Channel 2 Receive Signal Level [3:0] (C2RSL[3:0]).** C2RSL[3:0] bits provide the receive signal level as shown in [Table 6-17](#).

**Bits 3 to 0: Channel 1 Receive Signal Level [3:0] (C1RSL[3:0]).** C1RSL[3:0] bits provide the receive signal level as shown in [Table 6-17](#).

Register Address (LIUs 9–16): **2Ch**

|         |                |                |                |                |               |               |               |               |
|---------|----------------|----------------|----------------|----------------|---------------|---------------|---------------|---------------|
| Bit #   | 7              | 6              | 5              | 4              | 3             | 2             | 1             | 0             |
| Name    | <u>C10RSL3</u> | <u>C10RSL2</u> | <u>C10RSL1</u> | <u>C10RSL0</u> | <u>C9RSL3</u> | <u>C9RSL2</u> | <u>C9RSL1</u> | <u>C9RSL0</u> |
| Default | 0              | 0              | 0              | 0              | 0             | 0             | 0             | 0             |

**Bits 7 to 4: Channel 10 Receive Signal Level [3:0] (C10RSL[3:0]).** C10RSL[3:0] bits provide the receive signal level as shown in [Table 6-17](#).

**Bits 3 to 0: Channel 9 Receive Signal Level [3:0] (C9RSL[3:0]).** C9RSL[3:0] bits provide the receive signal level as shown in [Table 6-17](#).

**Table 6-17. Receiver Signal Level**

| CnRSL3 to<br>CnRSL0 | RECEIVE LEVEL (dB) |              |
|---------------------|--------------------|--------------|
|                     | T1                 | E1           |
| 0000                | >-2.5              | >-2.5        |
| 0001                | -2.5 to -5         | -2.5 to -5   |
| 0010                | -5 to -7.5         | -5 to -7.5   |
| 0011                | -7.5 to -10        | -7.5 to -10  |
| 0100                | -10 to -12.5       | -10 to -12.5 |
| 0101                | -12.5 to -15       | -12.5 to -15 |
| 0110                | -15 to -17.5       | -15 to -17.5 |
| 0111                | -17.5 to -20       | -17.5 to -20 |

Register Name: **RSL2**  
Register Description: **Receive Signal Level Indicator 2**  
Register Address (LIUs 1–8): **0Dh**

| Bit #   | 7             | 6             | 5             | 4             | 3             | 2             | 1             | 0             |
|---------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|
| Name    | <u>C4RSL3</u> | <u>C4RSL2</u> | <u>C4RSL1</u> | <u>C4RSL0</u> | <u>C3RSL3</u> | <u>C3RSL2</u> | <u>C3RSL1</u> | <u>C3RSL0</u> |
| Default | 0             | 0             | 0             | 0             | 0             | 0             | 0             | 0             |

**Bits 7 to 4: Channel 4 Receive Signal Level [3:0] (C4RSL[3:0]).** C4RSL[3:0] bits provide the receive signal level as shown in [Table 6-17](#).

**Bits 3 to 0: Channel 3 Receive Signal Level [3:0] (C3RSL[3:0]).** C3RSL[3:0] bits provide the receive signal level as shown in [Table 6-17](#).

Register Address (LIUs 9–16): **2Dh**

| Bit #   | 7              | 6              | 5              | 4              | 3              | 2              | 1              | 0              |
|---------|----------------|----------------|----------------|----------------|----------------|----------------|----------------|----------------|
| Name    | <u>C12RSL3</u> | <u>C12RSL2</u> | <u>C12RSL1</u> | <u>C12RSL0</u> | <u>C11RSL3</u> | <u>C11RSL2</u> | <u>C11RSL1</u> | <u>C11RSL0</u> |
| Default | 0              | 0              | 0              | 0              | 0              | 0              | 0              | 0              |

**Bits 7 to 4: Channel 12 Receive Signal Level [3:0] (C12RSL[3:0]).** C12RSL[3:0] bits provide the receive signal level as shown in [Table 6-17](#).

**Bits 3 to 0: Channel 11 Receive Signal Level [3:0] (C11RSL[3:0]).** C11RSL[3:0] bits provide the receive signal level as shown in [Table 6-17](#).

Register Name: **RSL3**  
 Register Description: **Receive Signal Level Indicator 3**  
 Register Address (LIUs 1–8): **0Eh**

| Bit #   | 7             | 6             | 5             | 4             | 3             | 2             | 1             | 0             |
|---------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|
| Name    | <u>C6RSL3</u> | <u>C6RSL2</u> | <u>C6RSL1</u> | <u>C6RSL0</u> | <u>C5RSL3</u> | <u>C5RSL2</u> | <u>C5RSL1</u> | <u>C5RSL0</u> |
| Default | 0             | 0             | 0             | 0             | 0             | 0             | 0             | 0             |

**Bits 7 to 4: Channel 6 Receive Signal Level [3:0] (C6RSL[3:0]).** C6RSL[3:0] bits provide the receive signal level as shown in [Table 6-17](#).

**Bits 3 to 0: Channel 5 Receive Signal Level [3:0] (C5RSL[3:0]).** C5RSL[3:0] bits provide the receive signal level as shown in [Table 6-17](#).

Register Address (LIUs 9–16): **2Eh**

| Bit #   | 7              | 6              | 5              | 4              | 3              | 2              | 1              | 0              |
|---------|----------------|----------------|----------------|----------------|----------------|----------------|----------------|----------------|
| Name    | <u>C14RSL3</u> | <u>C14RSL2</u> | <u>C14RSL1</u> | <u>C14RSL0</u> | <u>C13RSL3</u> | <u>C13RSL2</u> | <u>C13RSL1</u> | <u>C13RSL0</u> |
| Default | 0              | 0              | 0              | 0              | 0              | 0              | 0              | 0              |

**Bits 7 to 4: Channel 14 Receive Signal Level [3:0] (C14RSL[3:0]).** C14RSL[3:0] bits provide the receive signal level as shown in [Table 6-17](#).

**Bits 3 to 0: Channel 13 Receive Signal Level [3:0] (C13RSL[3:0]).** C13RSL[3:0] bits provide the receive signal level as shown in [Table 6-17](#).

Register Name: **RSL4**  
 Register Description: **Receive Signal Level Indicator 4**  
 Register Address (LIUs 1–8): **0Fh**

| Bit #   | 7             | 6             | 5             | 4                          | 3             | 2             | 1             | 0             |
|---------|---------------|---------------|---------------|----------------------------|---------------|---------------|---------------|---------------|
| Name    | <u>C8RSL3</u> | <u>C8RSL2</u> | <u>C8RSL1</u> | <u>C8RSL0/<br/>CALSTAT</u> | <u>C7RSL3</u> | <u>C7RSL2</u> | <u>C7RSL1</u> | <u>C7RSL0</u> |
| Default | 0             | 0             | 0             | 0                          | 0             | 0             | 0             | 0             |

**Bits 7 to 4: Channel 8 Receive Signal Level [3:0] (C8RSL[3:0]).** C8RSL[3:0] bits provide the receive signal level as shown in [Table 6-17](#).

**Bit 4: Channel 8 Receive Signal Level 0/Calibration Status (C8RSL0/CALSTAT).** When CRIMP is high, C8RSL0 will be replaced by a real-time status bit for the receive internal termination calibration circuit. If the bit is low, this indicates that the calibration has not completed. If the bit is high, this indicates the calibration completed successfully. Normally this bit should go high within 7 $\mu$ s of the low-to-high transition of the CRIMP bit. Receive termination values will be updated subsequently.

**Bits 3 to 0: Channel 7 Receive Signal Level [3:0] (C7RSL[3:0]).** C7RSL[3:0] bits provide the receive signal level as shown in [Table 6-17](#).

Register Address (LIUs 9–16): **2Fh**

| Bit #   | 7              | 6              | 5              | 4              | 3              | 2              | 1              | 0              |
|---------|----------------|----------------|----------------|----------------|----------------|----------------|----------------|----------------|
| Name    | <u>C16RSL3</u> | <u>C16RSL2</u> | <u>C16RSL1</u> | <u>C16RSL0</u> | <u>C15RSL3</u> | <u>C15RSL2</u> | <u>C15RSL1</u> | <u>C15RSL0</u> |
| Default | 0              | 0              | 0              | 0              | 0              | 0              | 0              | 0              |

**Bits 7 to 4: Channel 16 Receive Signal Level [3:0] (C16RSL[3:0]).** C16RSL[3:0] bits provide the receive signal level as shown in [Table 6-17](#).

**Bits 3 to 0: Channel 15 Receive Signal Level [3:0] (C15RSL[3:0]).** C15RSL[3:0] bits provide the receive signal level as shown in [Table 6-17](#).

Register Name: **BTCR**  
 Register Description: **Bit Error Rate Tester Control**  
 Register Address (LIUs 1–8): **10h**

| Bit #   | 7    | 6    | 5    | 4 | 3 | 2 | 1 | 0     |
|---------|------|------|------|---|---|---|---|-------|
| Name    | BTS2 | BTS1 | BTS0 | — | — | — | — | BERTE |
| Default | 0    | 0    | 0    | 0 | 0 | 0 | 0 | 0     |

**Note:** This register enables the LIU1-LIU8 BERT. The BERT can only connect to one LIU at a time. The LIU1-LIU8 BERT operates independently of the LIU9-LIU16 BERT.

**Bits 7 to 5: Bit Error Rate Transceiver Select [2:0] (BTS[2:0]).** These bits BTS[2:0] select the LIU that the BERT applies to (see [Table 6-18](#)). This is only applicable if the BERTE bit is set.

**Bit 0: Bit Error Rate Tester Enable (BERTE).** When this bit is set and 2 $\mu$ s have past, the BERT will be enabled. The BERT register set should be written and read to only after being enabled. The BERT is only active for one LIU at a time selected by BTS[2:0]. This bit also forces the part into single-rail mode with HDB3/B8ZS encoding enabled.

Register Address (LIUs 9–16): **30h**

| Bit #   | 7    | 6    | 5    | 4 | 3 | 2 | 1 | 0     |
|---------|------|------|------|---|---|---|---|-------|
| Name    | BTS2 | BTS1 | BTS0 | — | — | — | — | BERTE |
| Default | 0    | 0    | 0    | 0 | 0 | 0 | 0 | 0     |

**Note:** This register enables the LIU9-LIU16 BERT. The BERT can only connect to one LIU at a time. The LIU9-LIU16 BERT operates independently of the LIU1–LIU8 BERT.

**Bits 7 to 5: Bit Error Rate Transceiver Select [2:0] (BTS[2:0])** These bits BTS[2:0] select the LIU that the BERT applies too (see [Table 6-19](#)). This is only applicable if the BERTE bit is set.

**Bit 0: Bit Error Rate Tester Enable (BERTE).** When this bit is set and 2 $\mu$ s have past, the BERT will be enabled. The BERT register set should be written and read to only after being enabled. The BERT is only active for one LIU at a time selected by BTS[2:0]. This bit also forces the part into single-rail mode with HDB3/B8ZS encoding enabled.

**Table 6-18. Bit Error Rate Transceiver Select for Channels 1–8**

| REGISTER ADDRESS | BTS2 | BTS1 | BTS0 | CHANNEL BERT APPLIES TO |
|------------------|------|------|------|-------------------------|
| 10h              | 0    | 0    | 0    | Channel 1               |
| 10h              | 0    | 0    | 0    | Channel 2               |
| 10h              | 0    | 1    | 0    | Channel 3               |
| 10h              | 0    | 1    | 1    | Channel 4               |
| 10h              | 1    | 0    | 0    | Channel 5               |
| 10h              | 1    | 0    | 1    | Channel 6               |
| 10h              | 1    | 1    | 0    | Channel 7               |
| 10h              | 1    | 1    | 1    | Channel 8               |

**Table 6-19. Bit Error Rate Transceiver Select for Channels 9–16**

| REGISTER ADDRESS | BTS2 | BTS1 | BTS0 | CHANNEL BERT APPLIES TO |
|------------------|------|------|------|-------------------------|
| 30h              | 0    | 0    | 0    | Channel 9               |
| 30h              | 0    | 0    | 0    | Channel 10              |
| 30h              | 0    | 1    | 0    | Channel 11              |
| 30h              | 0    | 1    | 1    | Channel 12              |
| 30h              | 1    | 0    | 0    | Channel 13              |
| 30h              | 1    | 0    | 1    | Channel 14              |
| 30h              | 1    | 1    | 0    | Channel 15              |
| 30h              | 1    | 1    | 1    | Channel 16              |

Register Name: **BEIR**  
Register Description: **BPV Error Insertion**  
Register Address (LIUs 1–8): **11h**

| Bit #   | 7     | 6     | 5     | 4     | 3     | 2     | 1     | 0     |
|---------|-------|-------|-------|-------|-------|-------|-------|-------|
| Name    | BEIR8 | BEIR7 | BEIR6 | BEIR5 | BEIR4 | BEIR3 | BEIR2 | BEIR1 |
| Default | 0     | 0     | 0     | 0     | 0     | 0     | 0     | 0     |

Register Address (LIUs 9–16): **31h**

| Bit #   | 7      | 6      | 5      | 4      | 3      | 2      | 1      | 0     |
|---------|--------|--------|--------|--------|--------|--------|--------|-------|
| Name    | BEIR16 | BEIR15 | BEIR14 | BEIR13 | BEIR12 | BEIR11 | BEIR10 | BEIR9 |
| Default | 0      | 0      | 0      | 0      | 0      | 0      | 0      | 0     |

**Bits 7 to 0: BPV Error Insertion Register  $n$  (BEIR $n$ ).** A 0-to-1 transition on this bit will cause a single bipolar violation (BPV) to be inserted into the transmit data stream Channel  $n$ . This bit must be cleared and set again for a subsequent error to be inserted. This is only applicable in single-rail mode.

Register Name: **LVDS**  
 Register Description: **Line Violation Detect Status**  
 Register Address (LIUs 1–8): **12h**

| Bit #   | 7            | 6            | 5            | 4            | 3            | 2            | 1            | 0            |
|---------|--------------|--------------|--------------|--------------|--------------|--------------|--------------|--------------|
| Name    | <u>LVDS8</u> | <u>LVDS7</u> | <u>LVDS6</u> | <u>LVDS5</u> | <u>LVDS4</u> | <u>LVDS3</u> | <u>LVDS2</u> | <u>LVDS1</u> |
| Default | 0            | 0            | 0            | 0            | 0            | 0            | 0            | 0            |

Register Address (LIUs 9–16): **32h**

| Bit #   | 7             | 6             | 5             | 4             | 3             | 2             | 1             | 0            |
|---------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|--------------|
| Name    | <u>LVDS16</u> | <u>LVDS15</u> | <u>LVDS14</u> | <u>LVDS13</u> | <u>LVDS12</u> | <u>LVDS11</u> | <u>LVDS10</u> | <u>LVDS9</u> |
| Default | 0             | 0             | 0             | 0             | 0             | 0             | 0             | 0            |

**Bits 7 to 0: Line Violation Detect Status  $n$  (LVDS $n$ ).** A bipolar violation, a code violation, or excessive zeros will cause the associated LVDS $n$  bit to latch. This bit will be cleared on a read operation. The LVDS register captures the first violation within a three clock period window. If a second violation occurs after the first violation within the three clock period window, then the second violation will not be latched even if a read to the LVDS register was performed. Excessive zeros need to be enabled by the [EZDE](#) register for detection by this register. Code violations are only relevant when in HDB3 mode and can be disabled for detection by this register by setting the [CVDEB](#) register.

Register Name: **RCLKI**  
 Register Description: **Receive Clock Invert**  
 Register Address (LIUs 1–8): **13h**

| Bit #   | 7      | 6      | 5      | 4      | 3      | 2      | 1      | 0      |
|---------|--------|--------|--------|--------|--------|--------|--------|--------|
| Name    | RCLKI8 | RCLKI7 | RCLKI6 | RCLKI5 | RCLKI4 | RCLKI3 | RCLKI2 | RCLKI1 |
| Default | 0      | 0      | 0      | 0      | 0      | 0      | 0      | 0      |

Register Address (LIUs 9–16): **33h**

| Bit #   | 7       | 6       | 5       | 4       | 3       | 2       | 1       | 0      |
|---------|---------|---------|---------|---------|---------|---------|---------|--------|
| Name    | RCLKI16 | RCLKI15 | RCLKI14 | RCLKI13 | RCLKI12 | RCLKI11 | RCLKI10 | RCLKI9 |
| Default | 0       | 0       | 0       | 0       | 0       | 0       | 0       | 0      |

**Bit 7 to 0: Receive Clock Invert  $n$  (RCLKI $n$ ).** When this bit is set the RCLK for Channel  $n$  is inverted. This aligns RPOS/RNEG on the falling edge of RCLK. When reset or default RPOS/RNEG is aligned on the rising edge of RCLK.



Register Name: **TCLKI**  
 Register Description: **Transmit Clock Invert**  
 Register Address (LIUs 1–8): **14h**

|         |        |        |        |        |        |        |        |        |
|---------|--------|--------|--------|--------|--------|--------|--------|--------|
| Bit #   | 7      | 6      | 5      | 4      | 3      | 2      | 1      | 0      |
| Name    | TCLKI8 | TCLKI7 | TCLKI6 | TCLKI5 | TCLKI4 | TCLKI3 | TCLKI2 | TCLKI1 |
| Default | 0      | 0      | 0      | 0      | 0      | 0      | 0      | 0      |

Register Address (LIUs 9–16): **34h**

|         |         |         |         |         |         |         |         |        |
|---------|---------|---------|---------|---------|---------|---------|---------|--------|
| Bit #   | 7       | 6       | 5       | 4       | 3       | 2       | 1       | 0      |
| Name    | TCLKI16 | TCLKI15 | TCLKI14 | TCLKI13 | TCLKI12 | TCLKI11 | TCLKI10 | TCLKI9 |
| Default | 0       | 0       | 0       | 0       | 0       | 0       | 0       | 0      |

**Bits 7 to 0: Transmit Clock Invert  $n$  (TCLKIn).** When this bit is set the expected TCLK for Channel  $n$  is inverted. TPOS/TNEG should be aligned on the falling edge of TCLK. When reset or default TPOS/TNEG should be aligned on the rising edge of TCLK.

Register Name: **CCR**  
 Register Description: **Clock Control**  
 Register Address: **15h**

|         |        |        |        |        |       |       |       |       |
|---------|--------|--------|--------|--------|-------|-------|-------|-------|
| Bit #   | 7      | 6      | 5      | 4      | 3     | 2     | 1     | 0     |
| Name    | PCLKS2 | PCLKS1 | PCLKS0 | TECLKS | CLKA3 | CLKA2 | CLKA1 | CLKA0 |
| Default | 0      | 0      | 0      | 0      | 0     | 0     | 0     | 0     |

**Bits 7 to 5: PLL Clock Select (PCLKS[2:0]).** These bits determine the RCLK that is to be used as the input to the PLL. If an LOS is detect for the channel that RCLK is recovered from, the PLL will switch to MCLK until the LOS is cleared. When the LOS is cleared RCLK will be used again. See [Table 6-20](#) for RCLK selection. [MC.PCLKI\[1:0\]](#) must be set to '01' or '10' in order for these settings to take effect.

**Table 6-20. PLL Clock Select**

| PCLKS[2:0] | PLL CLOCK<br>SELECTED<br><a href="#">MC.PCLKI[1:0]=01</a> | PLL CLOCK<br>SELECTED<br><a href="#">MC.PCLKI[1:0]=10</a> |
|------------|---|---|
| 000        | RCLK1   | RCLK9   |
| 001        | RCLK2   | RCLK10  |
| 010        | RCLK3   | RCLK11  |
| 011        | RCLK4   | RCLK12  |
| 100        | RCLK5   | RCLK13  |
| 101        | RCLK6   | RCLK14  |
| 110        | RCLK7   | RCLK15  |
| 111        | RCLK8   | RCLK16  |

**Bit 4: T1/E1 Clock Select (TECLKS).** When this bit is set the T1/E1 clock output is 2.048MHz. When this bit is reset the T1/E1 clock rate is 1.544MHz

**Bits 3 to 0: Clock A Select (CLKA[3:0]).** These bits select the output frequency for CLKA pin. See [Table 6-21](#) for available frequencies. For best jitter performance, select MCLK as the source for CLKA and input a 2.048MHz MCLK.

**Table 6-21. Clock A Select**

| CLKA[3:0] | CLKA (Hz) |
|-----------|-----------|
| 0000      | 2.048M    |
| 0001      | 4.096M    |
| 0010      | 8.192M    |
| 0011      | 16.384M   |
| 0100      | 1.544M    |
| 0101      | 3.088M    |
| 0110      | 6.176M    |
| 0111      | 12.352M   |
| 1000      | 1.536M    |
| 1001      | 3.072M    |
| 1010      | 6.144M    |
| 1011      | 12.288M   |
| 1100      | 32k       |
| 1101      | 64k       |
| 1110      | 128k      |
| 1111      | 256k      |

Register Name: **RDULR**  
 Register Description: **RCLK Disable Upon LOS**  
 Register Address (LIUs 1–8): **16h**

|         |        |        |        |        |        |        |        |        |
|---------|--------|--------|--------|--------|--------|--------|--------|--------|
| Bit #   | 7      | 6      | 5      | 4      | 3      | 2      | 1      | 0      |
| Name    | RDULR8 | RDULR7 | RDULR6 | RDULR5 | RDULR4 | RDULR3 | RDULR2 | RDULR1 |
| Default | 0      | 0      | 0      | 0      | 0      | 0      | 0      | 0      |

Register Address (LIUs 9–16): **36h**

|         |         |         |         |         |         |         |         |        |
|---------|---------|---------|---------|---------|---------|---------|---------|--------|
| Bit #   | 7       | 6       | 5       | 4       | 3       | 2       | 1       | 0      |
| Name    | RDULR16 | RDULR15 | RDULR14 | RDULR13 | RDULR12 | RDULR11 | RDULR10 | RDULR9 |
| Default | 0       | 0       | 0       | 0       | 0       | 0       | 0       | 0      |

**Bits 7 to 0: RCLK Disable Upon LOS Register  $n$  (RDULR $n$ ).** When this bit is set the RCLK for Channel  $n$  is disabled upon a loss of signal and set as a low output. When reset or default RCLK will switch to MCLK upon a loss of signal within 10ms.

Register Name: **GISC**  
 Register Description: **Global Interrupt Status Control**  
 Register Address: **1Eh**

|         |   |   |   |   |   |   |      |     |
|---------|---|---|---|---|---|---|------|-----|
| Bit #   | 7 | 6 | 5 | 4 | 3 | 2 | 1    | 0   |
| Name    | — | — | — | — | — | — | INTM | CWE |
| Default | 0 | 0 | 0 | 0 | 0 | 0 | 0    | 0   |

**Bit 1: INT Pin Mode (INTM).** This bit determines the inactive mode of the  $\overline{\text{INT}}$  pin. The  $\overline{\text{INT}}$  pin always drives low when active.

0 = Pin is high impedance when not active.

1 = Pin drives high when not active.

**Bit 0: Clear On Write Enable (CWE).** When this bit is set the clear on write is enabled for all the latched interrupt status registers. The host processor must write a 1 to the latched interrupt status register bit position before the particular bit will be cleared. Default for all the latched interrupt status registers is to clear on a read.

## 6.1.4 BERT Registers

Register Name: **BCR**  
 Register Description: **BERT Control**  
 Register Address (LIUs 1–8): **00h**  
 Register Address (LIUs 9–16): **20h**

| Bit #   | 7    | 6    | 5    | 4    | 3   | 2    | 1    | 0    |
|---------|------|------|------|------|-----|------|------|------|
| Name    | PMUM | LPMU | RNPL | RPIC | MPR | APRD | TNPL | TPIC |
| Default | 0    | 0    | 0    | 0    | 0   | 0    | 0    | 0    |

**Bit 7: Performance Monitoring Update Mode (PMUM).** When 0, a performance monitoring update is initiated by the LPMU register bit. When 1, a performance monitoring update is initiated by the receive performance monitoring update signal (RPMU). Note: If RPMU or LPMU is one, changing the state of this bit may cause a performance monitoring update to occur.

**Bit 6: Local Performance Monitoring Update (LPMU).** This bit causes a performance monitoring update to be initiated if local performance monitoring update is enabled (PMUM = 0). A 0-to-1 transition causes the performance monitoring registers to be updated with the latest data, and the counters reset (0 or 1). For a second performance monitoring update to be initiated, this bit must be set to 0, and back to 1. If LPMU goes low before the PMS bit goes high, an update might not be performed. This bit has no affect when PMUM = 1.

**Bit 5: Receive New Pattern Load (RNPL).** A 0-to-1 transition of this bit will cause the programmed test pattern (QRSS, PTS, PLF[4:0], PTF[4:0], and BSP[31:0]) to be loaded in to the receive pattern generator. This bit must be changed to zero and back to one for another pattern to be loaded. Loading a new pattern will forces the receive pattern generator out of the “Sync” state which causes a resynchronization to be initiated. Note: QRSS, PTS, PLF[4:0], PTF[4:0], and BSP[31:0] must not change from the time this bit transitions from 0 to 1 until four RXCK clock cycles after this bit transitions from 0 to 1.

**Bit 4: Receive Pattern Inversion Control (RPIC).** When 0, the receive incoming data stream is not altered. When 1, the receive incoming data stream is inverted.

**Bit 3: Manual Pattern Resynchronization (MPR).** A zero to one transition of this bit will cause the receive pattern generator to resynchronize to the incoming pattern. This bit must be changed to zero and back to one for another resynchronization to be initiated. Note: A manual resynchronization forces the receive pattern generator out of the “Sync” state.

**Bit 2: Automatic Pattern Resynchronization Disable (APRD).** When 0, the receive pattern generator will automatically resynchronize to the incoming pattern if six or more times during the current 64-bit window the incoming data stream bit and the receive pattern generator output bit did not match. When 1, the receive pattern generator will not automatically resynchronize to the incoming pattern. Note: Automatic synchronization is prevented by not allowing the receive pattern generator to automatically exit the “Sync” state.

**Bit 1: Transmit New Pattern Load (TNPL).** A 0-to-1 transition of this bit will cause the programmed test pattern (QRSS, PTS, PLF[4:0], PTF[4:0], and BSP[31:0]) to be loaded in to the transmit pattern generator. This bit must be changed to zero and back to one for another pattern to be loaded. Note: QRSS, PTS, PLF[4:0], PTF[4:0], and BSP[31:0] must not change from the time this bit transitions from 0 to 1 until four TXCK clock cycles after this bit transitions from 0 to 1.

**Bit 0: Transmit Pattern Inversion Control (TPIC).** When 0, the transmit outgoing data stream is not altered. When 1, the transmit outgoing data stream is inverted.

Register Name: **BPCR1**  
 Register Description: **BERT Pattern Configuration Register 1**  
 Register Address (LIUs 1–8): **02h**  
 Register Address (LIUs 9–16): **22h**

| Bit #   | 7 | 6    | 5   | 4    | 3    | 2    | 1    | 0    |
|---------|---|------|-----|------|------|------|------|------|
| Name    | — | QRSS | PTS | PLF4 | PLF3 | PLF2 | PLF1 | PLF0 |
| Default | 0 | 0    | 0   | 0    | 0    | 0    | 0    | 0    |

**Bit 6: QRSS Enable (QRSS).** When 0, the pattern generator configuration is controlled by PTS, PLF[4:0], and PTF[4:0], and BSP[31:0]. When 1, the pattern generator configuration is forced to a PRBS pattern with a generating polynomial of  $x^{20} + x^{17} + 1$ . The output of the pattern generator will be forced to one if the next fourteen output bits are all zero.

**Bit 5: Pattern Type Select (PTS).** When 0, the pattern is a PRBS pattern. When 1, the pattern is a repetitive pattern.

**Bits 4 to 0: Pattern Length Feedback (PLF[4:0]).** These five bits control the “length” feedback of the pattern generator. The “length” feedback will be from bit  $n$  of the pattern generator ( $n = \text{PLF}[4:0] + 1$ ). For a PRBS signal, the feedback is an XOR of bit  $n$  and bit  $y$ . For a repetitive pattern the feedback is bit  $n$ .

Register Name: **BPCR2**  
 Register Description: **BERT Pattern Configuration Register 2**  
 Register Address (LIUs 1–8): **03h**  
 Register Address (LIUs 9–16): **23h**

| Bit #   | 7 | 6 | 5 | 4    | 3    | 2    | 1    | 0    |
|---------|---|---|---|------|------|------|------|------|
| Name    | — | — | — | PTF4 | PTF3 | PTF2 | PTF1 | PTF0 |
| Default | 0 | 0 | 0 | 0    | 0    | 0    | 0    | 0    |

**Bits 4 to 0: Pattern Tap Feedback (PTF[4:0]).** These five bits control the PRBS “tap” feedback of the pattern generator. The “tap” feedback will be from bit  $y$  of the pattern generator ( $y = \text{PTF}[4:0] + 1$ ). These bits are ignored when programmed for a repetitive pattern. For a PRBS signal, the feedback is an XOR of bit  $n$  and bit  $y$ .

Register Name: **BSPR1**  
 Register Description: **BERT Seed/Pattern Register 1**  
 Register Address (LIUs 1–8): **04h**  
 Register Address (LIUs 9–16): **24h**

| Bit #   | 7    | 6    | 5    | 4    | 3    | 2    | 1    | 0    |
|---------|------|------|------|------|------|------|------|------|
| Name    | BSP7 | BSP6 | BSP5 | BSP4 | BSP3 | BSP2 | BSP1 | BSP0 |
| Default | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    |

Register Name: **BSPR2**  
 Register Description: **BERT Seed/Pattern Register 2**  
 Register Address (LIUs 1–8): **05h**  
 Register Address (LIUs 9–16): **25h**

| Bit #   | 7     | 6     | 5     | 4     | 3     | 2     | 1    | 0    |
|---------|-------|-------|-------|-------|-------|-------|------|------|
| Name    | BSP15 | BSP14 | BSP13 | BSP12 | BSP11 | BSP10 | BSP9 | BSP8 |
| Default | 0     | 0     | 0     | 0     | 0     | 0     | 0    | 0    |

Register Name: **BSPR3**  
 Register Description: **BERT Seed/Pattern Register 3**  
 Register Address (LIUs 1–8): **06h**  
 Register Address (LIUs 9–16): **26h**

| Bit #   | 7     | 6     | 5     | 4     | 3     | 2     | 1     | 0     |
|---------|-------|-------|-------|-------|-------|-------|-------|-------|
| Name    | BSP23 | BSP22 | BSP21 | BSP20 | BSP19 | BSP18 | BSP17 | BSP16 |
| Default | 0     | 0     | 0     | 0     | 0     | 0     | 0     | 0     |

Register Name: **BSPR4**  
 Register Description: **BERT Seed/Pattern Register 4**  
 Register Address (LIUs 1–8): **07h**  
 Register Address (LIUs 9–16): **27h**

| Bit #   | 7     | 6     | 5     | 4     | 3     | 2     | 1     | 0     |
|---------|-------|-------|-------|-------|-------|-------|-------|-------|
| Name    | BSP31 | BSP30 | BSP29 | BSP28 | BSP27 | BSP26 | BSP25 | BSP24 |
| Default | 0     | 0     | 0     | 0     | 0     | 0     | 0     | 0     |

**Bits 31 to 0: BERT Seed/Pattern (BSP[31:0]).** These 32 bits are the programmable seed for a transmit PRBS pattern, or the programmable pattern for a transmit or receive repetitive pattern. BSP(31) will be the first bit output on the transmit side for a 32-bit repetitive pattern or 32-bit length PRBS. BSP(31) will be the first bit input on the receive side for a 32-bit repetitive pattern.

Register Name: **TEICR**  
 Register Description: **Transmit Error Insertion Control Register**  
 Register Address (LIUs 1–8): **08h**  
 Register Address (LIUs 9–16): **28h**

| Bit #   | 7 | 6 | 5     | 4     | 3     | 2   | 1    | 0     |
|---------|---|---|-------|-------|-------|-----|------|-------|
| Name    | — | — | TEIR2 | TEIR1 | TEIR0 | BEI | TSEI | MEIMS |
| Default | 0 | 0 | 0     | 0     | 0     | 0   | 0    | 0     |

**Bits 5 to 3: Transmit Error Insertion Rate (TEIR[2:0]).** These three bits indicate the rate at which errors are inserted in the output data stream. One out of every  $10^n$  bits is inverted. TEIR[2:0] is the value  $n$ . A TEIR[2:0] value of 0 disables error insertion at a specific rate. A TEIR[2:0] value of 1 result in every 10th bit being inverted. A TEIR[2:0] value of 2 result in every 100th bit being inverted. Error insertion starts when this register is written to with a TEIR[2:0] value that is nonzero. If this register is written to during the middle of an error insertion process, the new error rate will be started after the next error is inserted.

**Bit 2: Bit Error Insertion Enable (BEI).** When 0, single bit error insertion is disabled. When 1, single bit error insertion is enabled.

**Bit 1: Transmit Single Error Insert (TSEI).** This bit causes a bit error to be inserted in the transmit data stream if manual error insertion is disabled (MEIMS = 0) and single bit error insertion is enabled. A 0 to 1 transition causes a single bit error to be inserted. For a second bit error to be inserted, this bit must be set to 0, and back to 1. Note: If MEIMS is low, and this bit transitions more than once between error insertion opportunities, only one error will be inserted.

**Bit 0: Manual Error Insert Mode Select (MEIMS).** When 0, error insertion is initiated by the TSEI register bit. When 1, error insertion is initiated by the transmit manual error insertion signal (TMEI). Note: If TMEI or TSEI is one, changing the state of this bit may cause a bit error to be inserted.

Register Name: **BSR**  
 Register Description: **BERT Status**  
 Register Address (LIUs 1–8): **0Ch**  
 Register Address (LIUs 9–16): **2Ch**

| Bit #   | 7 | 6 | 5 | 4 | 3   | 2 | 1   | 0   |
|---------|---|---|---|---|-----|---|-----|-----|
| Name    | — | — | — | — | PMS | — | BEC | OOS |
| Default | 0 | 0 | 0 | 0 | 0   | 0 | 0   | 0   |

**Bit 3: Performance Monitoring Update Status (PMS).** This bit indicates the status of the receive performance monitoring register (counters) update. This bit will transition from low to high when the update is completed. PMS is asynchronously forced low when the LPMU bit (PMUM = 0) or RPMU signal (PMUM=1) goes low.

**Bit 1: Bit Error Count (BEC).** When 0, the bit error count is zero. When 1, the bit error count is one or more.

**Bit 0: Out Of Synchronization (OOS).** When 0, the receive pattern generator is synchronized to the incoming pattern. When 1, the receive pattern generator is not synchronized to the incoming pattern.

Register Name: **BSRL**  
 Register Description: **BERT Status Register Latched**  
 Register Address (LIUs 1–8): **0Eh**  
 Register Address (LIUs 9–16): **2Eh**

| Bit #   | 7 | 6 | 5 | 4 | 3           | 2          | 1           | 0           |
|---------|---|---|---|---|-------------|------------|-------------|-------------|
| Name    | — | — | — | — | <u>PMSL</u> | <u>BEL</u> | <u>BECL</u> | <u>OOSL</u> |
| Default | 0 | 0 | 0 | 0 | 0           | 0          | 0           | 0           |

**Bit 3: Performance Monitoring Update Status Latched (PMSL).** This bit is set when the PMS bit transitions from 0 to 1. A read operation clears this bit.

**Bit 2: Bit Error Latched (BEL).** This bit is set when a bit error is detected. A read operation clears this bit.

**Bit 1: Bit Error Count Latched (BECL).** This bit is set when the BEC bit transitions from 0 to 1. A read operation clears this bit.

**Bit 0: Out Of Synchronization Latched (OOSL).** This bit is set when the OOS bit changes state. A read operation clears this bit.

Register Name: **BSRIE**  
 Register Description: **BERT Status Register Interrupt Enable**  
 Register Address (LIUs 1–8): **10h**  
 Register Address (LIUs 9–16): **30h**

| Bit #   | 7 | 6 | 5 | 4 | 3     | 2    | 1     | 0     |
|---------|---|---|---|---|-------|------|-------|-------|
| Name    | — | — | — | — | PMSIE | BEIE | BECIE | OOSIE |
| Default | 0 | 0 | 0 | 0 | 0     | 0    | 0     | 0     |

**Bit 3: Performance Monitoring Update Status Interrupt Enable (PMSIE).** This bit enables an interrupt if the PMSL bit is set.

0 = interrupt disabled  
 1 = interrupt enabled

**Bit 2: Bit Error Interrupt Enable (BEIE).** This bit enables an interrupt if the BEL bit is set.

0 = interrupt disabled  
 1 = interrupt enabled

**Bit 1: Bit Error Count Interrupt Enable (BECIE).** This bit enables an interrupt if the BECL bit is set.

0 = interrupt disabled  
 1 = interrupt enabled

**Bit 0: Out Of Synchronization Interrupt Enable (OOSIE).** This bit enables an interrupt if the OOSL bit is set.

0 = interrupt disabled  
 1 = interrupt enabled



Register Name: **RBECR1**  
 Register Description: **Receive BERT Bit Error Count Register 1**  
 Register Address (LIUs 1–8): **14h**  
 Register Address (LIUs 9–16): **34h**

|         |             |             |             |             |             |             |             |             |
|---------|-------------|-------------|-------------|-------------|-------------|-------------|-------------|-------------|
| Bit #   | 7           | 6           | 5           | 4           | 3           | 2           | 1           | 0           |
| Name    | <u>BEC7</u> | <u>BEC6</u> | <u>BEC5</u> | <u>BEC4</u> | <u>BEC3</u> | <u>BEC2</u> | <u>BEC1</u> | <u>BEC0</u> |
| Default | 0           | 0           | 0           | 0           | 0           | 0           | 0           | 0           |

Register Name: **RBECR2**  
 Register Description: **Receive BERT Bit Error Count Register 2**  
 Register Address (LIUs 1–8): **15h**  
 Register Address (LIUs 9–16): **35h**

|         |              |              |              |              |              |              |             |             |
|---------|--------------|--------------|--------------|--------------|--------------|--------------|-------------|-------------|
| Bit #   | 7            | 6            | 5            | 4            | 3            | 2            | 1           | 0           |
| Name    | <u>BEC15</u> | <u>BEC14</u> | <u>BEC13</u> | <u>BEC12</u> | <u>BEC11</u> | <u>BEC10</u> | <u>BEC9</u> | <u>BEC8</u> |
| Default | 0            | 0            | 0            | 0            | 0            | 0            | 0           | 0           |

Register Name: **RBECR3**  
 Register Description: **Receive BERT Bit Error Count Register 3**  
 Register Address (LIUs 1–8): **16h**  
 Register Address (LIUs 9–16): **36h**

|         |              |              |              |              |              |              |              |              |
|---------|--------------|--------------|--------------|--------------|--------------|--------------|--------------|--------------|
| Bit #   | 7            | 6            | 5            | 4            | 3            | 2            | 1            | 0            |
| Name    | <u>BEC23</u> | <u>BEC22</u> | <u>BEC21</u> | <u>BEC20</u> | <u>BEC19</u> | <u>BEC18</u> | <u>BEC17</u> | <u>BEC16</u> |
| Default | 0            | 0            | 0            | 0            | 0            | 0            | 0            | 0            |

**Bits 23 to 0: BERT Bit Error Count (BEC[23:0]).** These 24 bits indicate the number of bit errors detected in the incoming data stream. This count stops incrementing when it reaches a count of FF FFFFh. The associated bit error counter will not be incremented when an OOS condition exists.

Register Name: **RBCR1**  
 Register Description: **Receive BERT Bit Count Register 1**  
 Register Address (LIUs 1–8): **18h**  
 Register Address (LIUs 9–16): **38h**

|         |            |            |            |            |            |            |            |            |
|---------|------------|------------|------------|------------|------------|------------|------------|------------|
| Bit #   | 7          | 6          | 5          | 4          | 3          | 2          | 1          | 0          |
| Name    | <u>BC7</u> | <u>BC6</u> | <u>BC5</u> | <u>BC4</u> | <u>BC3</u> | <u>BC2</u> | <u>BC1</u> | <u>BC0</u> |
| Default | 0          | 0          | 0          | 0          | 0          | 0          | 0          | 0          |

Register Name: **RBCR2**  
 Register Description: **Receive BERT Bit Count Register 2**  
 Register Address (LIUs 1–8): **19h**  
 Register Address (LIUs 9–16): **39h**

|         |             |             |             |             |             |             |            |            |
|---------|-------------|-------------|-------------|-------------|-------------|-------------|------------|------------|
| Bit #   | 15          | 14          | 13          | 12          | 11          | 10          | 9          | 8          |
| Name    | <u>BC15</u> | <u>BC14</u> | <u>BC13</u> | <u>BC12</u> | <u>BC11</u> | <u>BC10</u> | <u>BC9</u> | <u>BC8</u> |
| Default | 0           | 0           | 0           | 0           | 0           | 0           | 0          | 0          |

Register Name: **RBCR3**  
 Register Description: **Receive BERT Bit Count Register 3**  
 Register Address (LIUs 1–8): **1Ah**  
 Register Address (LIUs 9–16): **3Ah**

|         |             |             |             |             |             |             |             |             |
|---------|-------------|-------------|-------------|-------------|-------------|-------------|-------------|-------------|
| Bit #   | 7           | 6           | 5           | 4           | 3           | 2           | 1           | 0           |
| Name    | <u>BC23</u> | <u>BC22</u> | <u>BC21</u> | <u>BC20</u> | <u>BC19</u> | <u>BC18</u> | <u>BC17</u> | <u>BC16</u> |
| Default | 0           | 0           | 0           | 0           | 0           | 0           | 0           | 0           |

Register Name: **RBCR4**  
 Register Description: **Receive BERT Bit Count Register 4**  
 Register Address (LIUs 1–8): **1Bh**  
 Register Address (LIUs 9–16): **3Bh**

|         |             |             |             |             |             |             |             |             |
|---------|-------------|-------------|-------------|-------------|-------------|-------------|-------------|-------------|
| Bit #   | 15          | 14          | 13          | 12          | 11          | 10          | 9           | 8           |
| Name    | <u>BC31</u> | <u>BC30</u> | <u>BC29</u> | <u>BC28</u> | <u>BC27</u> | <u>BC26</u> | <u>BC25</u> | <u>BC24</u> |
| Default | 0           | 0           | 0           | 0           | 0           | 0           | 0           | 0           |

**Bits 31 to 0: BERT Bit Count (BC[31:0]).** These 32 bits indicate the number of bits in the incoming data stream. This count stops incrementing when it reaches a count of FFFF FFFFh. The associated bit counter will not be incremented when an OOS condition exists.

## 7 JTAG BOUNDARY SCAN ARCHITECTURE AND TEST ACCESS PORT

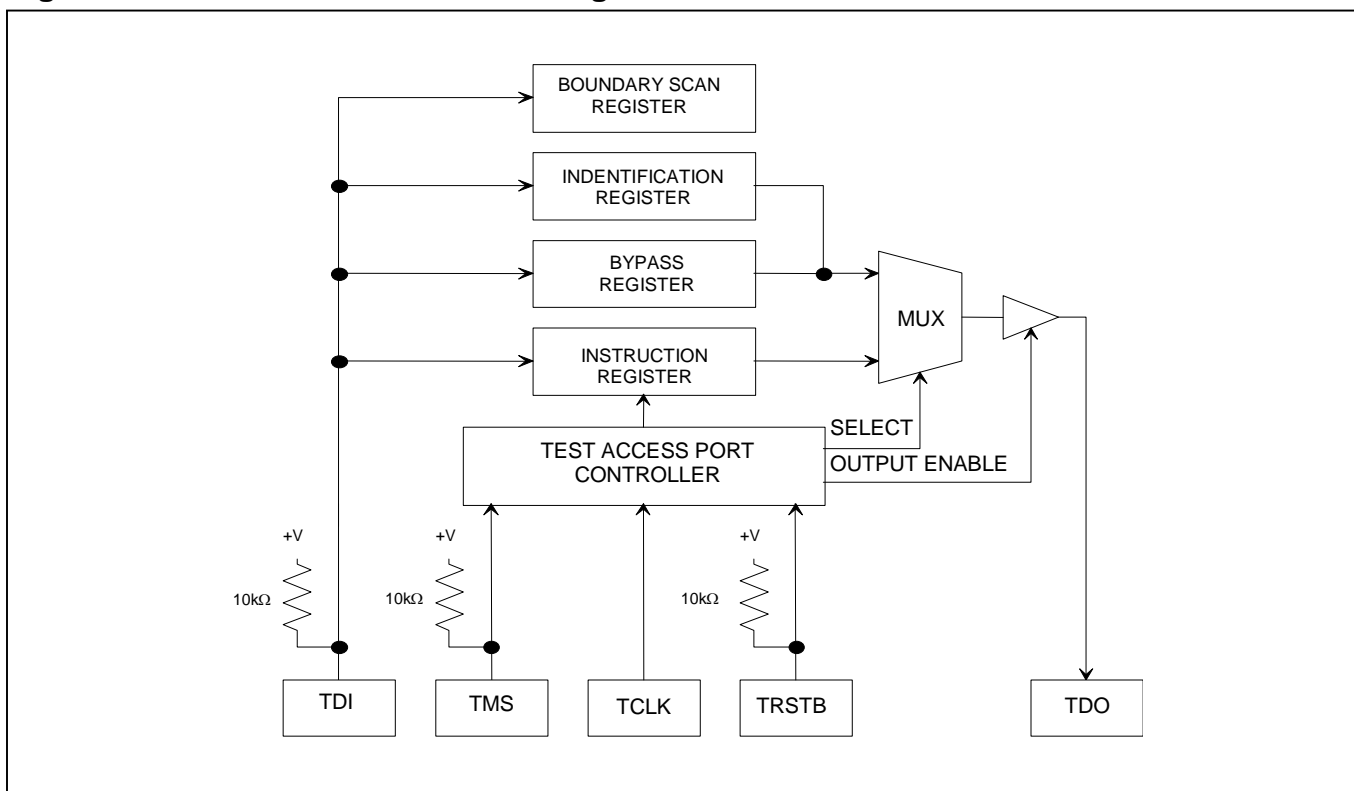
The DS26324 IEEE 1149.1 design supports the standard instruction codes SAMPLE/PRELOAD, BYPASS, and EXTEST. Optional public instructions included are HIGHZ, CLAMP, and IDCODE. The DS26324 contains the following as required by IEEE 1149.1 Standard Test-Access Port and Boundary-Scan Architecture:

Test Access Port (TAP)  
TAP Controller  
Instruction Register

Bypass Register  
Boundary Scan Register  
Device Identification Register

Details on Boundary Scan Architecture and the Test Access Port can be found in IEEE 1149.1-1990, IEEE 1149.1a-1993, and IEEE 1149.1b-1994. The Test Access Port has the necessary interface pins: TRSTB, TCLK, TMS, TDI, and TDO. See the pin descriptions for details. For the latest BSDL files go to [www.maxim-ic.com/tools/bsdl/](http://www.maxim-ic.com/tools/bsdl/) and search for DS26324.

**Figure 7-1. JTAG Functional Block Diagram**



## 7.1 TAP Controller State Machine

The TAP controller is a finite state machine that responds to the logic level at TMS on the rising edge of TCLK. The state diagram is shown in [Figure 7-2](#).

### 7.1.1 Test-Logic-Reset

Upon power-up, the TAP controller will be in the Test-Logic-Reset state. The instruction register will contain the IDCODE instruction. All system logic of the device will operate normally. This state is automatically entered during power-up. This state is entered from any state if the TMS is held high for at least 5 clocks.

### 7.1.2 Run-Test-Idle

The Run-Test-Idle is used between scan operations or during specific tests. The instruction register and test registers will remain idle. The controller remains in this state when TMS is held low. When the TMS is high and rising edge of TCLK is applied the controller moves to the Select-DR-Scan state.

### 7.1.3 Select-DR-Scan

All test registers retain their previous state. With TMS LOW, a rising edge of TCLK moves the controller into the Capture-DR state and will initiate a scan sequence. TMS HIGH during a rising edge on TCLK moves the controller to the Select-IR-Scan state.

### 7.1.4 Capture-DR

Data can be parallel-loaded into the test-data registers if the current instruction is EXTEST or SAMPLE/PRELOAD. If the instruction does not call for a parallel load or the selected register does not allow parallel loads, the test register will remain at its current value. On the rising edge of TCLK, the controller will go to the shift-DR state if TMS is LOW or it will go to the exit1-DR state if TMS is HIGH.

### 7.1.5 Shift-DR

The test-data register selected by the current instruction will be connected between TDI and TDO and will shift data one stage towards its serial output on each rising edge of TCLK. If a test register selected by the current instruction is not placed in the serial path, it will maintain its previous state. When the TAP controller is in this state and a rising edge of TCLK is applied, the controller enters the Exit1-DR state if TMS is high or remains in Shift-DR state if TMS is low.

### 7.1.6 Exit1-DR

While in this state, a rising edge on TCLK will put the controller in the Update-DR state, which terminates the scanning process, if TMS is HIGH. A rising edge on TCLK with TMS LOW will put the controller in the Pause-DR state.

### 7.1.7 Pause-DR

Shifting of the test registers is halted while in this state. All test registers selected by the current instruction will retain their previous state. The controller will remain in this state while TMS is LOW. A rising edge on TCLK with TMS HIGH will put the controller in the Exit2-DR state.

### 7.1.8 Exit2-DR

A rising edge on TCLK with TMS HIGH while in this state will put the controller in the Update-DR state and terminate the scanning process. A rising edge on TCLK with TMS LOW will enter the Shift-DR state.

### 7.1.9 Update-DR

A falling edge on TCLK while in the Update-DR state will latch the data from the shift register path of the test registers into the data output latches. This prevents changes at the parallel output due to changes in the shift register.

### 7.1.10 Select-IR-Scan

All test registers retain their previous state. The instruction register will remain unchanged during this state. With TMS LOW, a rising edge on TCLK moves the controller into the Capture-IR state and will initiate a scan sequence for the instruction register. TMS HIGH during a rising edge on TCLK puts the controller back into the Test-Logic-Reset state.

### 7.1.11 Capture-IR

The Capture-IR state is used to load the shift register in the instruction register with a fixed value. This value is loaded on the rising edge of TCLK. If TMS is HIGH on the rising edge of TCLK, the controller will enter the Exit1-IR state. If TMS is LOW on the rising edge of TCLK, the controller will enter the Shift-IR state.

### 7.1.12 Shift-IR

In this state, the shift register in the instruction register is connected between TDI and TDO and shifts data one stage for every rising edge of TCLK towards the serial output. The parallel registers as well as all test registers remain at their previous states. A rising edge on TCLK with TMS HIGH will move the controller to the Exit1-IR state. A rising edge on TCLK with TMS LOW will keep the controller in the Shift-IR state while moving data one stage through the instruction shift register.

### 7.1.13 Exit1-IR

A rising edge on TCLK with TMS LOW will put the controller in the pause-IR state. If TMS is HIGH on the rising edge of TCLK, the controller will enter the update-IR state and terminate the scanning process.

### 7.1.14 Pause-IR

Shifting of the instruction shift register is halted temporarily. With TMS HIGH, a rising edge on TCLK will put the controller in the Exit2-IR state. The controller will remain in the Pause-IR state if TMS is LOW during a rising edge on TCLK.

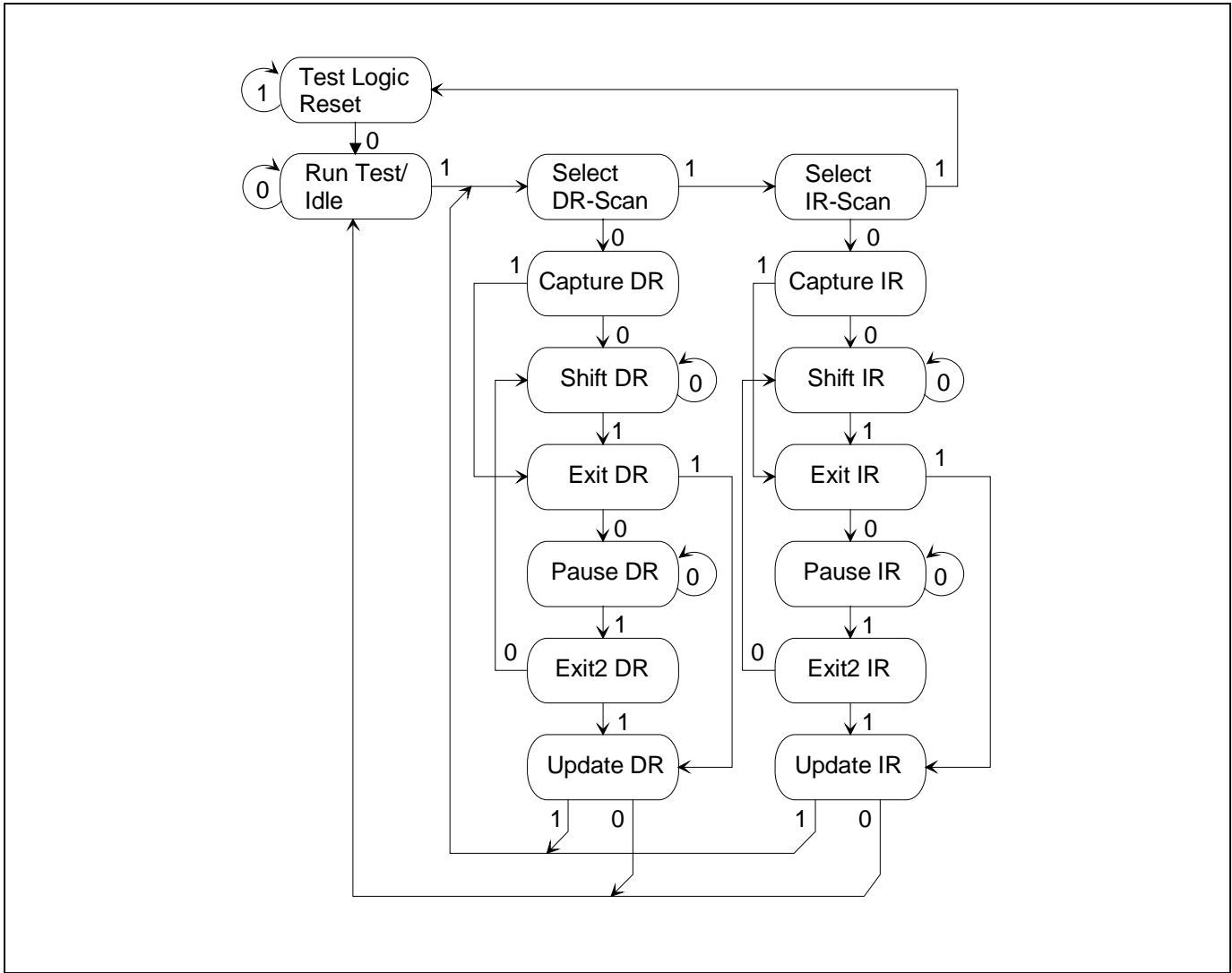
### 7.1.15 Exit2-IR

A rising edge on TCLK with TMS HIGH will put the controller in the Update-IR state. The controller will loop back to Shift-IR if TMS is LOW during a rising edge of TCLK in this state.

### 7.1.16 Update-IR

The instruction code shifted into the instruction shift register is latched into the parallel output on the falling edge of TCLK as the controller enters this state. Once latched, this instruction becomes the current instruction. A rising edge on TCLK with TMS LOW will put the controller in the Run-Test-Idle state. With TMS HIGH, the controller will enter the Select-DR-Scan state.

Figure 7-2. TAP Controller State Diagram



## 7.2 Instruction Register

The instruction register contains a shift register as well as a latched parallel output and is 3 bits in length. When the TAP controller enters the Shift-IR state, the instruction shift register will be connected between TDI and TDO. While in the Shift-IR state, a rising edge on TCLK with TMS LOW will shift the data one stage towards the serial output at TDO. A rising edge on TCLK in the Exit1-IR state or the Exit2-IR state with TMS HIGH will move the controller to the update-IR state. The falling edge of that same TCLK will latch the data in the instruction shift register to the instruction parallel output. Instructions supported by the DS26324 and its respective operational binary codes are shown in [Table 7-1](#).

**Table 7-1. Instruction Codes for IEEE 1149.1 Architecture**

| INSTRUCTION    | SELECTED REGISTER     | INSTRUCTION CODES |
|----------------|-----------------------|-------------------|
| EXTEST         | Boundary Scan         | 000               |
| HIGHZ          | Bypass                | 010               |
| CLAMP          | Bypass                | 011               |
| SAMPLE/PRELOAD | Boundary Scan         | 100               |
| IDCODE         | Device Identification | 110               |
| BYPASS         | Bypass                | 111               |

### 7.2.1 EXTEST

This allows testing of all interconnections to the device. When the EXTEST instruction is latched in the instruction register, the following actions occur. Once enabled via the Update-IR state, the parallel outputs of all digital output pins will be driven. The Boundary Scan Register will be connected between TDI and TDO. The Capture-DR will sample all digital inputs into the Boundary Scan Register.

### 7.2.2 HIGHZ

All digital outputs of the device will be placed in a high-impedance state. The Bypass Register will be connected between TDI and TDO.

### 7.2.3 CLAMP

All digital outputs of the device will output data from the boundary scan parallel output while connecting the Bypass Register between TDI and TDO. The outputs will not change during the CLAMP instruction.

### 7.2.4 SAMPLE/PRELOAD

This is a mandatory instruction for the IEEE 1149.1 specification that supports two functions. The digital I/Os of the device can be sampled at the Boundary Scan Register without interfering with the normal operation of the device by using the Capture-DR state. SAMPLE/PRELOAD also allows the device to shift data into the Boundary Scan Register via TDI using the Shift-DR state.

### 7.2.5 IDCODE

When the IDCODE instruction is latched into the Parallel Instruction Register, the Identification Test Register is selected. The device identification code will be loaded into the Identification Register on the rising edge of TCLK following entry into the Capture-DR state. Shift-DR can be used to shift the identification code out serially via TDO. During Test-Logic-Reset, the identification code is forced into the Instruction Register's parallel output. The ID code will always have a 1 in the LSB position. The next 11 bits identify the manufacturer's JEDEC number and number of continuation bytes followed by 16 bits for the device and 4 bits for the version [Table 7-2](#). [Table 7-3](#) lists the device ID code for the DS26324.

### 7.2.6 BYPASS

When the BYPASS instruction is latched into the Parallel Instruction Register, TDI connects to TDO through the one-bit test Bypass Register. This allows data to pass from TDI to TDO not affecting the device's normal operation.

**Table 7-2. ID Code Structure**

| MSB             |           | LSB         |   |
|-----------------|-----------|-------------|---|
| Version         | Device ID | JEDEC       | 1 |
| Contact Factory |           |             |   |
| 4 bits          | 16 bits   | 00010100001 | 1 |

**Table 7-3. Device ID Codes**

| DEVICE  | 16-BIT ID |
|---------|-----------|
| DS26324 | 003Ch     |

### 7.3 Test Registers

IEEE 1149.1 requires a minimum of two test registers: the Bypass Register and the Boundary Scan Register. An optional test register has been included with the DS26324 design. This test register is the Identification Register and is used with the IDCODE instruction and the Test-Logic-Reset state of the TAP controller.

#### 7.3.1 Boundary Scan Register

This register contains both a shift register path and a latched parallel output for all control cells and digital I/O cells and is n bits in length.

#### 7.3.2 Bypass Register

This register is a single 1-bit shift register used with the BYPASS, CLAMP, and HIGHZ instructions that provide a short path between TDI and TDO.

#### 7.3.3 Identification Register

The Identification Register contains a 32-bit shift register and a 32-bit latched parallel output. This register is selected during the IDCODE instruction and when the TAP controller is in the Test-Logic-Reset state. See [Table 7-2](#) and [Table 7-3](#) for more information about bit usage.



## 8 DC ELECTRICAL CHARACTERIZATION

### ABSOLUTE MAXIMUM RATINGS

|   |                                       |
|---|---------------------------------------|
| Voltage Range on Any Lead with Respect to $V_{SS}$ (except $V_{DD}$ ) | -0.3V to +5.5V                        |
| Supply Voltage ( $V_{DD}$ ) Range with Respect to $V_{SS}$            | -0.3V to +3.63V                       |
| Operating Temperature Range for DS26324G                              | 0°C to +70°C                          |
| Operating Temperature Range for DS26324GN                             | -40°C to +85°C                        |
| Storage Temperature   | -55°C to +125°C                       |
| Soldering Temperature   | See IPC/JEDEC J-STD-020 Specification |

*This is a stress rating only and functional operation of the device at these or any other conditions above those indicated in the operation sections of this specification is not implied. Exposure to absolute maximum rating conditions for extended periods of time may affect reliability.*

### 8.1 DC Pin Logic Levels

**Table 8-1. Recommended DC Operating Conditions**

( $T_A = -40^\circ\text{C}$  to  $+85^\circ\text{C}$  for DS26324GN.)

| PARAMETER | SYMBOL   | MIN   | TYP | MAX   | UNITS | NOTES |
|-----------|----------|-------|-----|-------|-------|-------|
| Logic 1   | $V_{IH}$ | 2.0   |     | 5.5   | V     |       |
| Logic 0   | $V_{IL}$ | -0.3  |     | +0.8  | V     |       |
| Supply    | $V_{DD}$ | 3.135 | 3.3 | 3.465 | V     |       |

**Table 8-2. Pin Capacitance**

( $T_A = +25^\circ\text{C}$ )

| PARAMETER          | SYMBOL    | MIN | TYP | MAX | UNITS | NOTES |
|--------------------|-----------|-----|-----|-----|-------|-------|
| Input Capacitance  | $C_{IN}$  |     | 7   |     | pF    |       |
| Output Capacitance | $C_{OUT}$ |     | 7   |     | pF    |       |

### 8.2 Supply Current and Output Voltage

**Table 8-3. DC Characteristics**

( $V_{DD} = 3.135$  to  $3.465\text{V}$ ,  $T_A = -40^\circ\text{C}$  to  $+85^\circ\text{C}$ .) (Note 1)

| PARAMETER                                | SYMBOL   | MIN   | TYP | MAX   | UNITS         | NOTES |
|--|----------|-------|-----|-------|---------------|-------|
| Supply Current at 3.465V                 | $I_{DD}$ |       |     | 1100  | mA            | 2, 3  |
| Supply Current at 3.3V                   |          |       | 500 |       |               |       |
| Input Leakage                            | $I_{IL}$ | -10.0 |     | +10.0 | $\mu\text{A}$ |       |
| Tri-State Output Leakage                 | $I_{OL}$ | -10.0 |     | +10.0 | $\mu\text{A}$ |       |
| Output Voltage ( $I_o = -4.0\text{mA}$ ) | $V_{OH}$ | 2.4   |     |       | V             |       |
| Output Voltage ( $I_o = +4.0\text{mA}$ ) | $V_{OL}$ |       |     | 0.4   | V             |       |

**Note 1:** Specifications to  $-40^\circ\text{C}$  are guaranteed by design (GBD) and not production tested.

**Note 2:**  $RCLK1-n = TCLK1-n = 1.544\text{MHz}$ .

**Note 3:** Power dissipation with all ports active, TTIP and TRING driving a  $25\Omega$  load, for an all-ones data density.

## 9 AC TIMING CHARACTERISTICS

### 9.1 Line Interface Characteristics

**Table 9-1. Transmitter Characteristics**

| PARAMETER                                |             | SYMBOL | MIN  | TYP  | MAX  | UNITS | NOTES |
|--|-------------|--------|------|------|------|-------|-------|
| Output Mark Amplitude                    | E1 75Ω      | $V_M$  | 2.14 | 2.37 | 2.6  | V     |       |
|  | E1 120Ω     |        | 2.7  | 3.0  | 3.3  |       |       |
|  | T1 100Ω     |        | 2.4  | 3.0  | 3.6  |       |       |
|  | T1 110Ω     |        | 2.4  | 3.0  | 3.6  |       |       |
| Output Zero Amplitude                    |             | $V_S$  | -0.3 |      | +0.3 | V     | 1     |
| Transmit Amplitude Variation with Supply |             |        | -1   |      | +1   | %     |       |
| Transmit Path Delay                      | Single-Rail |        |      | 8    |      | UI    |       |
|  | Dual-Rail   |        |      | 3    |      |       |       |

**Table 9-2. Receiver Characteristics**

| PARAMETER                       |             | SYMBOL | MIN | TYP  | MAX | UNITS | NOTES |
|---------------------------------|-------------|--------|-----|------|-----|-------|-------|
| Cable Attenuation               |             | Attn   |     |      | 12  | dB    |       |
| Analog Loss-of-Signal Threshold |             |        |     | 200  |     | mV    | 1     |
| Hysteresis Short-Haul Mode      |             |        |     | 100  |     | mV    |       |
| Allowable Zeros Before Loss     |             |        |     | 192  |     |       | 2     |
|                                 |             |        |     | 192  |     |       |       |
|                                 |             |        |     | 2048 |     |       |       |
| Allowable Ones Before Loss      |             |        |     | 24   |     |       | 3     |
|                                 |             |        |     | 192  |     |       |       |
|                                 |             |        |     | 192  |     |       |       |
| Receive Path Delay              | Single-Rail |        |     | 8    |     | UI    |       |
|                                 | Dual-Rail   |        |     | 3    |     |       |       |

**Note 1:** Measured at the RRING and RTIP pins.

**Note 2:** 192 zeros for T1 and T1.231 Specification Compliance; 192 zeros for E1 and G.775 Specification Compliance; 2048 zeros for ETS 300 233 compliance.

**Note 3:** 24 ones in 192-bit period for T1.231; 192 ones for G.775; 192 ones for ETS 300 233.

## 9.2 Parallel Host Interface Timing Characteristics

The following tables show the AC characteristics for the external bus interface.

**Table 9-3. Intel Read Mode Characteristics**

( $V_{DD} = 3.3V \pm 5\%$ ,  $T_J = -40^{\circ}C$  to  $+125^{\circ}C$ .) (Note 1) (See [Figure 9-1](#) and [Figure 9-2](#).)

| SIGNAL NAME(S)  | SYMBOL | DESCRIPTION                              | MIN | TYP | MAX | UNITS | NOTES |
|-----------------|--------|--|-----|-----|-----|-------|-------|
| RDB             | t1     | Pulse width if not using RDYB            | 40  |     |     | ns    | 2     |
| CSB             | t2     | Setup time to RDB                        | 0   |     |     | ns    | 2     |
| CSB             | t3     | Hold time from RDB                       | 0   |     |     | ns    | 2     |
| AD[7:0]         | t4     | Setup time to ALE                        | 2   |     |     | ns    | 2     |
| A[5:0]          | t5     | Hold time from RDB                       | 0   |     |     | ns    | 2     |
| D[7:0], AD[7:0] | t6     | Delay time RDB, CSB active               |     |     | 40  | ns    | 2     |
| D[7:0], AD[7:0] | t7     | Deassert delay from RDB, CSB inactive    | 2   |     | 20  | ns    | 2     |
| RDYB            | t8     | Enable delay time from CSB active        |     |     | 20  | ns    | 2     |
| RDYB            | t9     | Disable delay time from the CSB inactive |     |     | 15  | ns    | 2     |
| AD[7:0]         | t10    | Hold time from ALE                       | 3   |     |     | ns    | 2     |
| ALE             | t11    | Pulse width                              | 5   |     |     | ns    | 2     |
| D[7:0]          | t12    | Output delay from ALE Latched            |     |     | 40  | ns    | 2     |
| A[5:0]          | t13    | Setup time to RDB                        | 10  |     |     | ns    | 2     |
| RDYB            | t14    | Delay time from RDB                      | 0   |     |     | ns    | 2     |
| RDYB            | t15    | Active output delay time from RDB        | 10  |     | 35  | ns    | 2     |

**Note 1:** The timing parameters in this table are guaranteed by design (GBD).

**Note 2:** The input/output timing reference level for all signals is  $V_{DD}/2$ .

Figure 9-1. Intel Nonmuxed Read Cycle

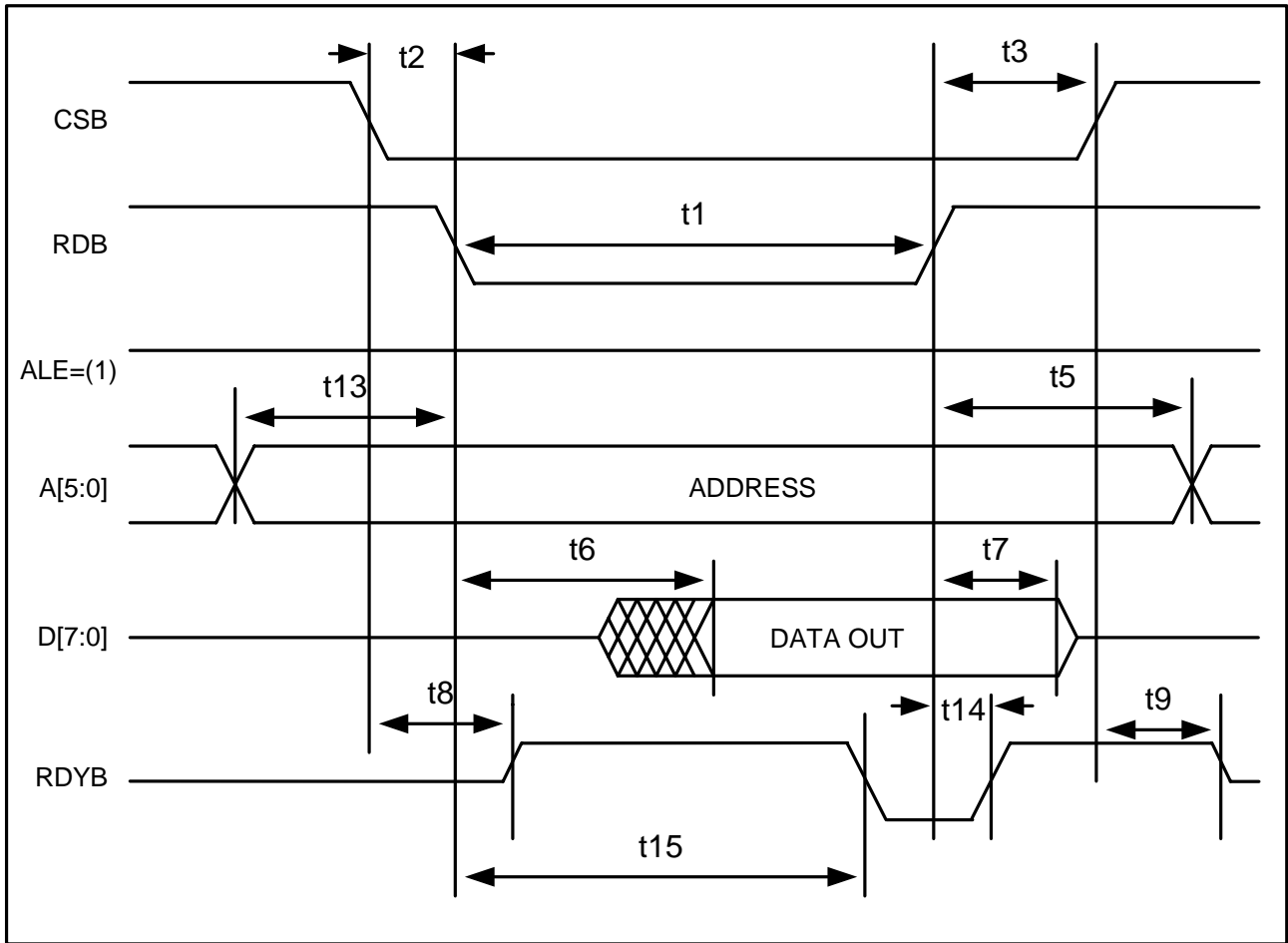
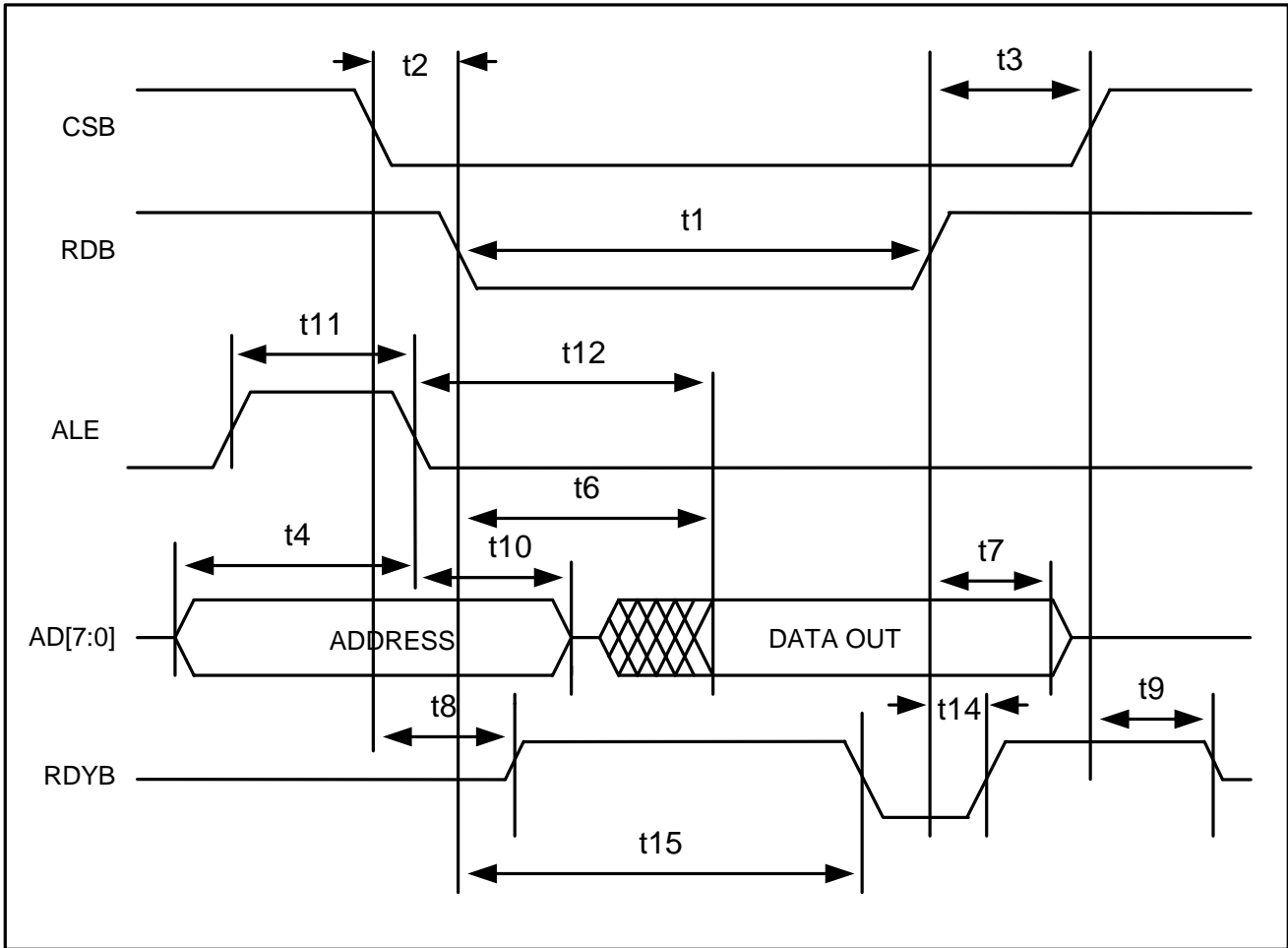


Figure 9-2. Intel Mux Read Cycle



**Table 9-4. Intel Write Cycle Characteristics**(V<sub>DD</sub> = 3.3V ±5%, T<sub>J</sub> = -40°C to +125°C.) (Note 1) (See [Figure 9-3](#) and [Figure 9-4](#).)

| SIGNAL NAME(S)  | SYMBOL | DESCRIPTION                          | MIN | TYP | MAX | UNITS | NOTES |
|-----------------|--------|--------------------------------------|-----|-----|-----|-------|-------|
| WRB             | t1     | Pulse width                          | 40  |     |     | ns    | 2     |
| CSB             | t2     | Setup time to WRB                    | 0   |     |     | ns    | 2     |
| CSB             | t3     | Hold time to WRB                     | 0   |     |     | ns    | 2     |
| AD[7:0]         | t4     | Setup time to ALE                    | 2   |     |     | ns    | 2     |
| A[5:0]          | t5     | Hold time from WRB                   | 0   |     |     | ns    | 2     |
| D[7:0], AD[7:0] | t6     | Input setup time to WRB              | 10  |     |     | ns    | 2     |
| D[7:0], AD[7:0] | t7     | Input hold time to WRB               | 5   |     |     | ns    | 2     |
| RDYB            | t8     | Enable delay from CSB active         |     |     | 20  | ns    | 2     |
| RDYB            | t9     | Delay time from WRB active           | 10  |     |     | ns    | 2     |
| RDYB            | t10    | Delay time from WRB inactive         | 0   |     |     | ns    | 2     |
| RDYB            | t11    | Disable delay time from CSB inactive |     |     | 15  | ns    | 2     |
| ALE             | t12    | Pulse width                          | 5   |     |     | ns    | 2     |
| AD[7:0]         | t13    | Hold time from ALE inactive          | 3   |     |     | ns    | 2     |
| A[5:0]          | t14    | Valid address to WRB inactive        | 35  |     |     | ns    | 2     |

**Note 1:** The timing parameters in this table are guaranteed by design (GBD).**Note 2:** The input/output timing reference level for all signals is V<sub>DD</sub>/2.

Figure 9-3. Intel Nonmux Write Cycle

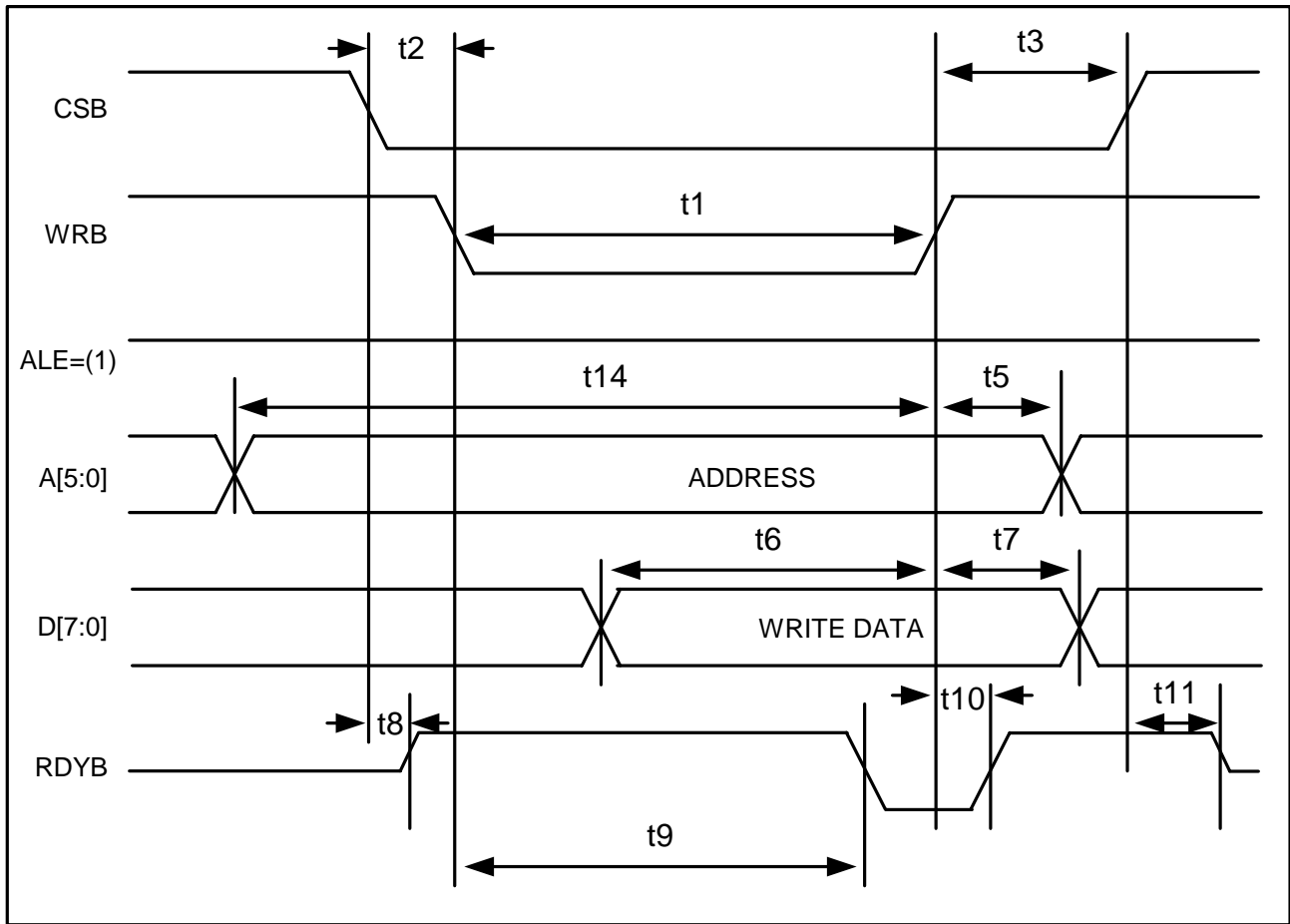
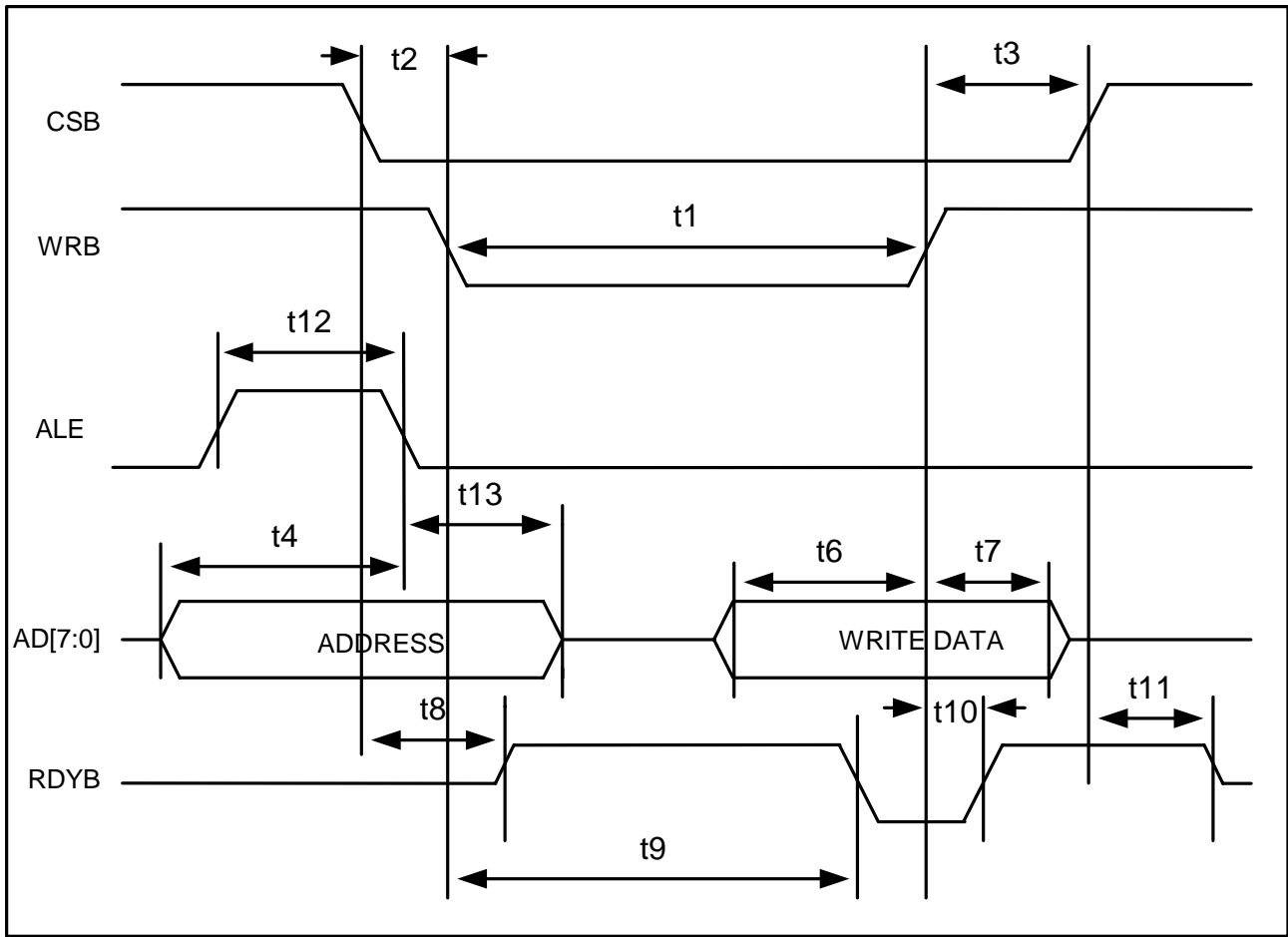


Figure 9-4. Intel Mux Write Cycle





**Table 9-5. Motorola Read Cycle Characteristics**(V<sub>DD</sub> = 3.3V ±5%, T<sub>J</sub> = -40°C to +125°C.) (Note 1) (See [Figure 9-5](#) and [Figure 9-6](#).)

| SIGNAL NAME(S)  | SYMBOL | DESCRIPTION                               | MIN | TYP | MAX | UNITS | NOTES |
|-----------------|--------|---|-----|-----|-----|-------|-------|
| DSB             | t1     | Pulse width                               | 40  |     |     | ns    | 2     |
| CSB             | t2     | Setup time to DSB active                  | 0   |     |     | ns    | 2     |
| CSB             | t3     | Hold time from DSB inactive               | 0   |     |     | ns    | 2     |
| RWB             | t4     | Setup time to DSB active                  | 0   |     |     | ns    | 2     |
| RWB             | t5     | Hold time from DSB inactive               | 0   |     |     | ns    | 2     |
| AD[7:0]         | t6     | Setup time to ASB active                  | 2   |     |     | ns    | 2     |
| AD[7:0]         | t7     | Hold time to ASB inactive                 | 3   |     |     | ns    | 2     |
| AD[7:0], D[7:0] | t8     | Output delay time from DSB active         |     |     | 40  | ns    | 2     |
| AD[7:0], D[7:0] | t10    | Output valid delay time from DSB inactive | 2   |     | 20  | ns    | 2     |
| ACKB            | t11    | Output delay time from CSB inactive       |     |     | 15  | ns    | 2     |
| ACKB            | t12    | Output delay time from DSB inactive       | 0   |     |     | ns    | 2     |
| ACKB            | t13    | Enable output delay time from DSB active  |     |     | 20  | ns    | 2     |
| ACKB            | t14    | Output delay time from DSB active         | 10  |     | 35  | ns    | 2     |
| A[5:0]          | t15    | Hold time from DSB inactive               | 0   |     |     | ns    | 2     |
| A[5:0]          | t16    | Setup time to DSB active                  | 10  |     |     | ns    | 2     |

**Note 1:** The timing parameters in this table are guaranteed by design (GBD).**Note 2:** The input/output timing reference level for all signals is V<sub>DD</sub>/2.

Figure 9-5. Motorola Nonmux Read Cycle

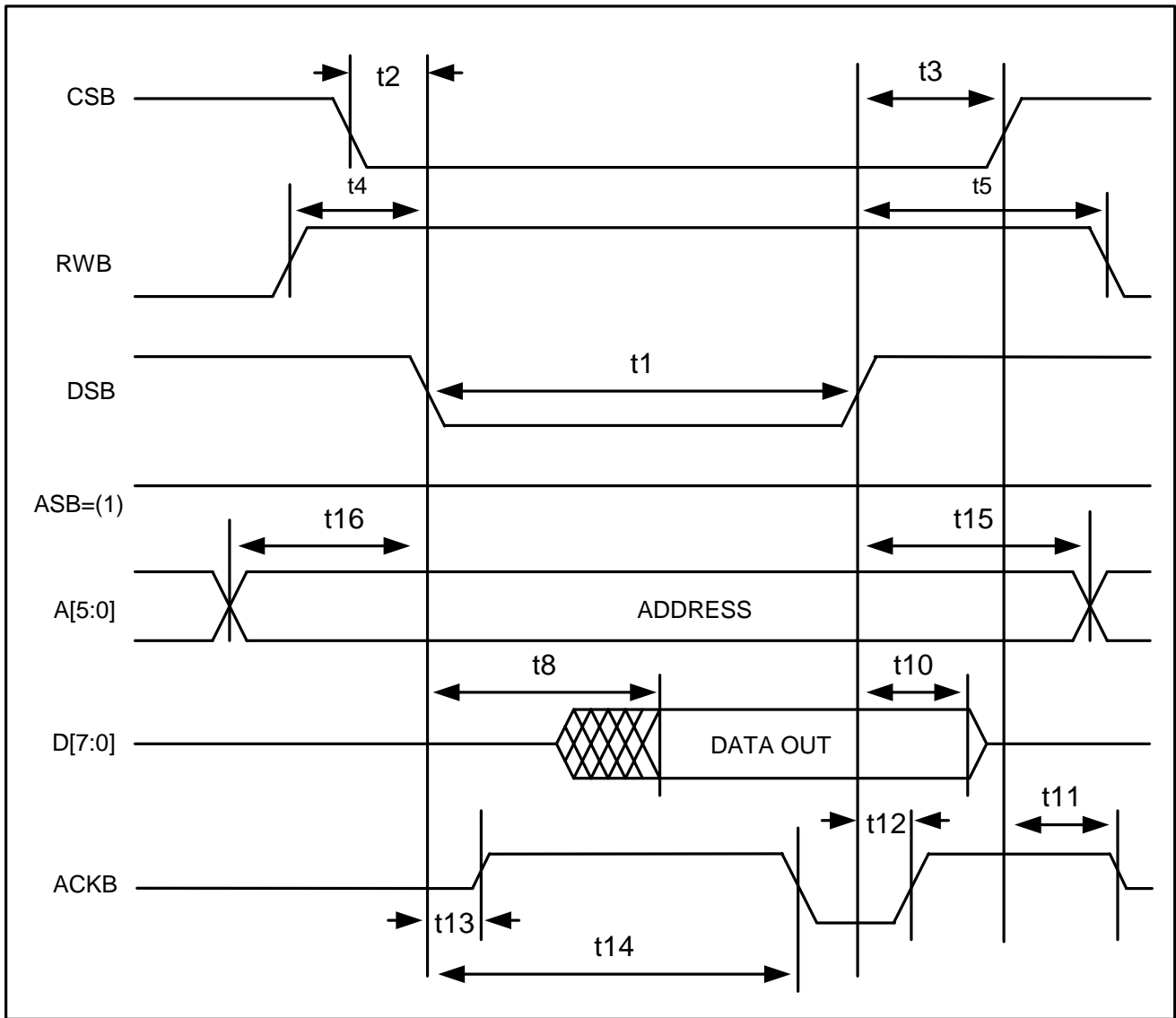
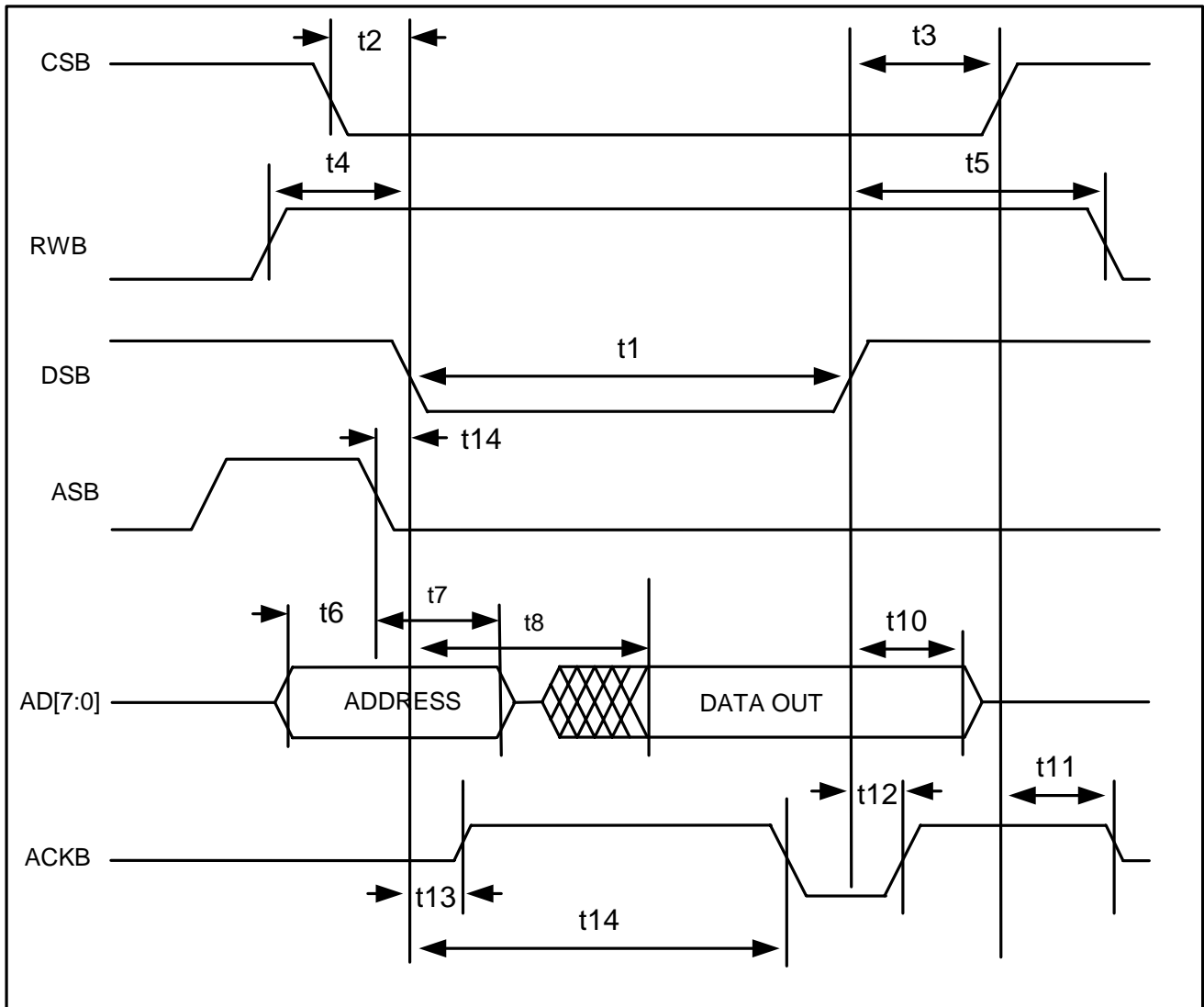


Figure 9-6. Motorola Mux Read Cycle

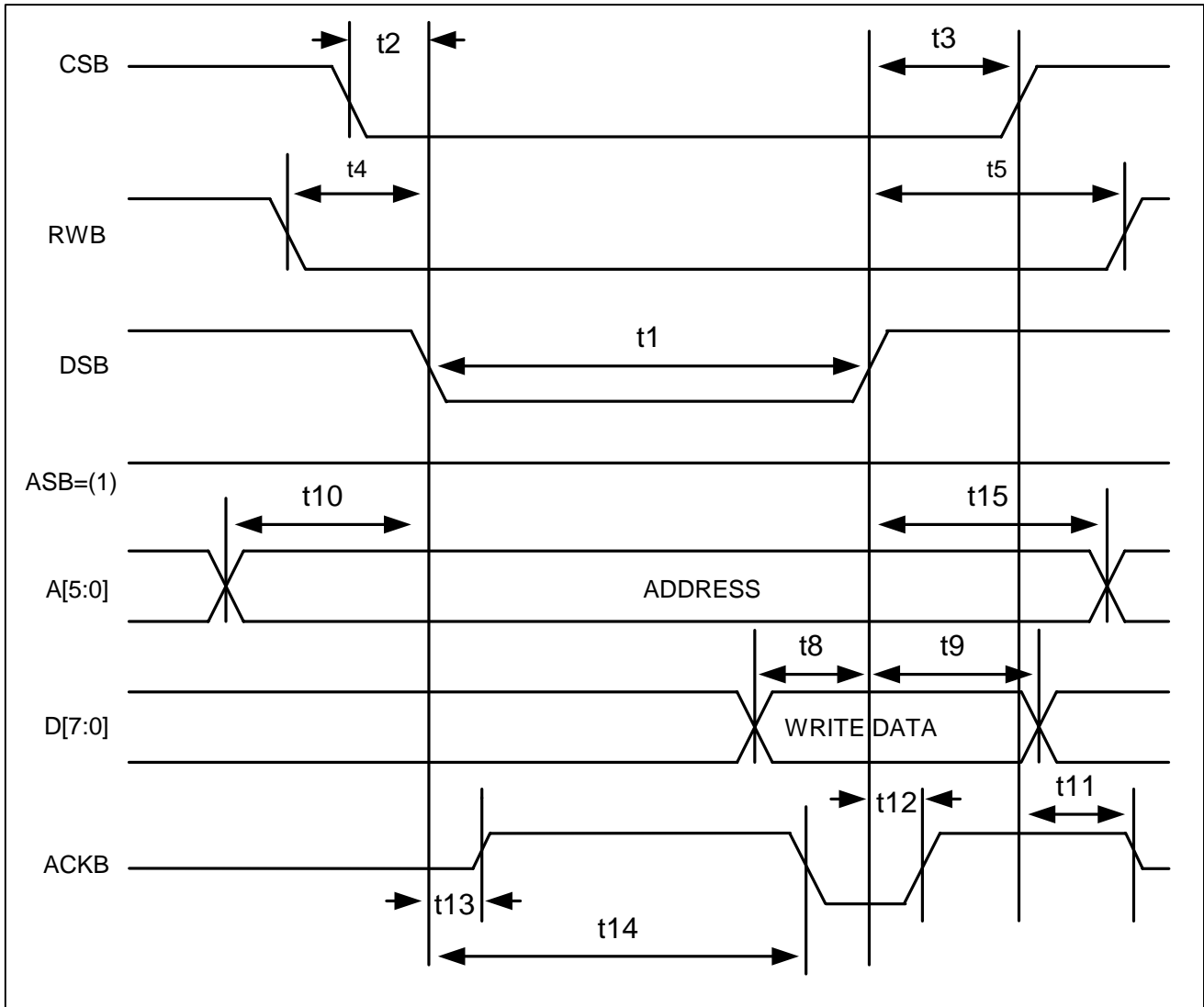


**Table 9-6. Motorola Write Cycle Characteristics**(V<sub>DD</sub> = 3.3V ±5%, T<sub>J</sub> = -40°C to +125°C.) (Note 1) (See [Figure 9-7](#) and [Figure 9-8](#).)

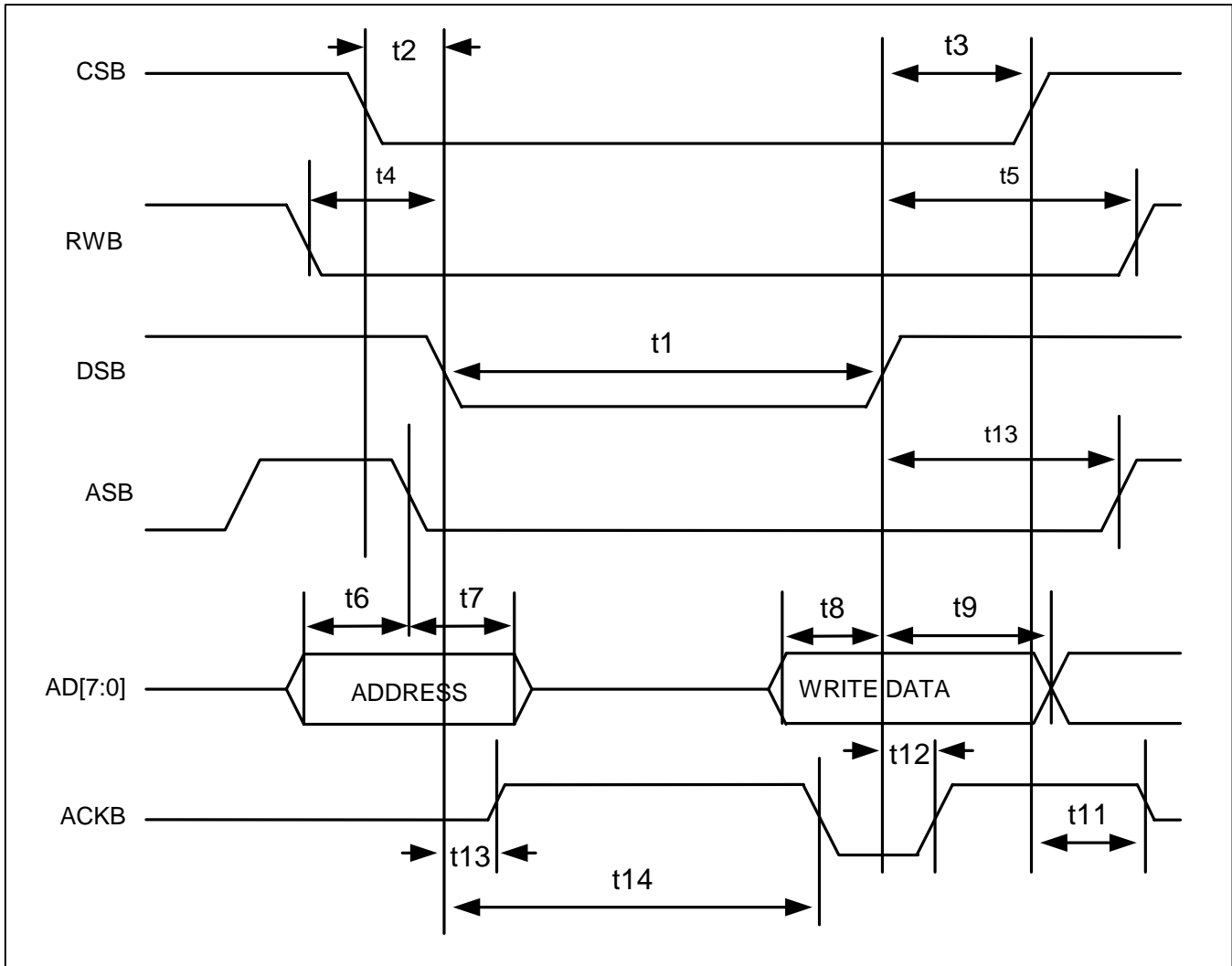
| SIGNAL NAME(S)  | SYMBOL | DESCRIPTION                              | MIN | TYP | MAX | UNITS | NOTES |
|-----------------|--------|--|-----|-----|-----|-------|-------|
| DSB             | t1     | Pulse width                              | 35  |     |     | ns    | 2     |
| CSB             | t2     | Setup time to DSB active                 | 0   |     |     | ns    | 2     |
| CSB             | t3     | Hold time from DSB inactive              | 0   |     |     | ns    | 2     |
| RWB             | t4     | Setup time to DSB active                 | 0   |     |     | ns    | 2     |
| RWB             | t5     | Hold time to DSB inactive                | 0   |     |     | ns    | 2     |
| AD[7:0]         | t6     | Setup time to ASB active                 | 2   |     |     | ns    | 2     |
| AD[7:0]         | t7     | Hold time from ASB active                | 3   |     |     | ns    | 2     |
| AD[7:0], D[7:0] | t8     | Setup time to DSB inactive               | 10  |     |     | ns    | 2     |
| AD[7:0], D[7:0] | t9     | Hold time from DSB inactive              | 5   |     |     | ns    | 2     |
| A[5:0]          | t10    | Setup time to DSB active                 | 10  |     |     | ns    | 2     |
| ACKB            | t11    | Output delay from CSB inactive           |     |     | 15  | ns    | 2     |
| ACKB            | t12    | Output delay from DSB inactive           | 0   |     |     | ns    | 2     |
| ACKB            | t13    | Output enable delay time from DSB active |     |     | 20  | ns    | 2     |
| ACKB            | t14    | Output delay time from DSB active        | 10  |     |     | ns    | 2     |
| A[5:0]          | t15    | Hold time from DSB                       | 0   |     |     | ns    | 2     |

**Note 1:** The timing parameters in this table are guaranteed by design (GBD).**Note 2:** The input/output timing reference level for all signals is V<sub>DD</sub>/2.

Figure 9-7. Motorola Nonmux Write Cycle



**Figure 9-8. Motorola Mux Write Cycle**



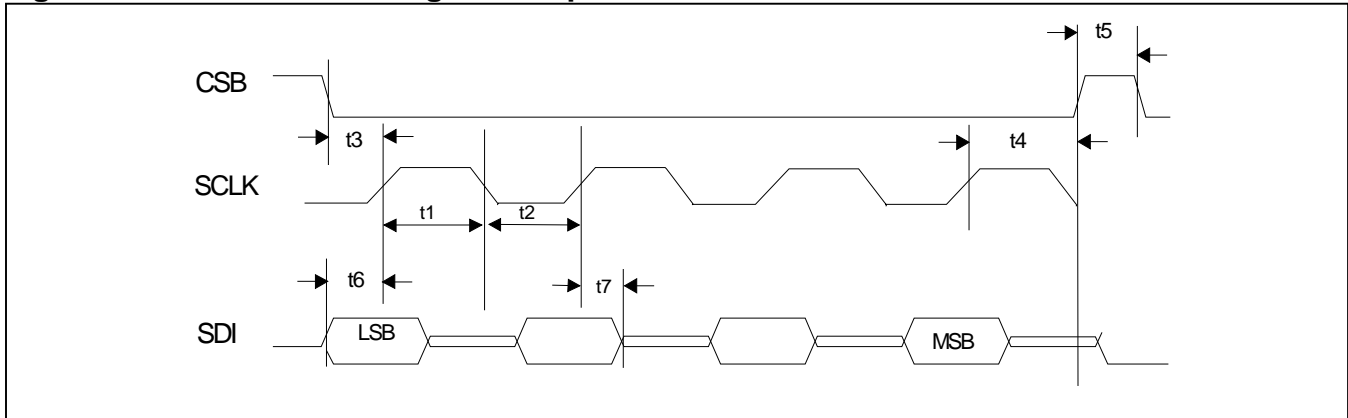
### 9.3 Serial Port

**Table 9-7. Serial Port Timing Characteristics**

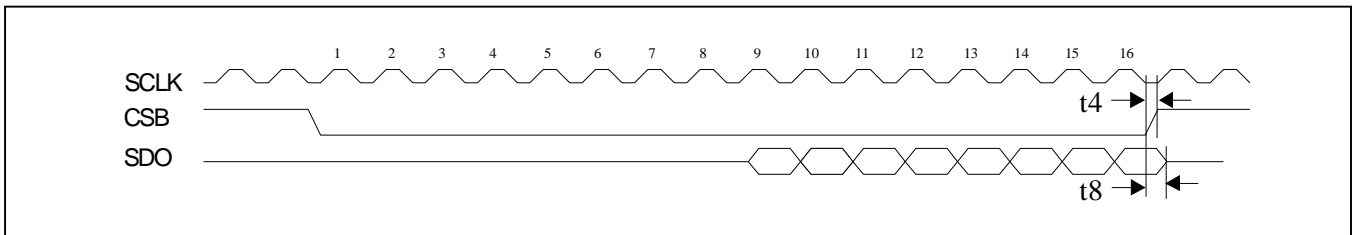
(See [Figure 9-9](#), [Figure 9-10](#), and [Figure 9-11](#).)

| PARAMETER   | SYMBOL | MIN | TYP | MAX | UNITS | NOTES |
|---|--------|-----|-----|-----|-------|-------|
| SCLK High Time  | t1     | 25  |     |     | ns    |       |
| SCLK Low Time   | t2     | 25  |     |     | ns    |       |
| Active CSB to SCLK Setup Time   | t3     | 50  |     |     | ns    |       |
| Last SCLK to CSB Inactive Time  | t4     | 50  |     |     | ns    |       |
| CSB Idle Time   | t5     | 50  |     |     | ns    |       |
| SDI to SCLK Setup Time  | t6     | 5   |     |     | ns    |       |
| SCLK to SDI Hold Time   | t7     | 5   |     |     | ns    |       |
| SCLK Falling Edge to SDO<br>High Impedance (CLKE = 0); CSB Rising to SDO<br>High Impedance (CLKE = 1) | t8     |     | 100 |     | ns    |       |

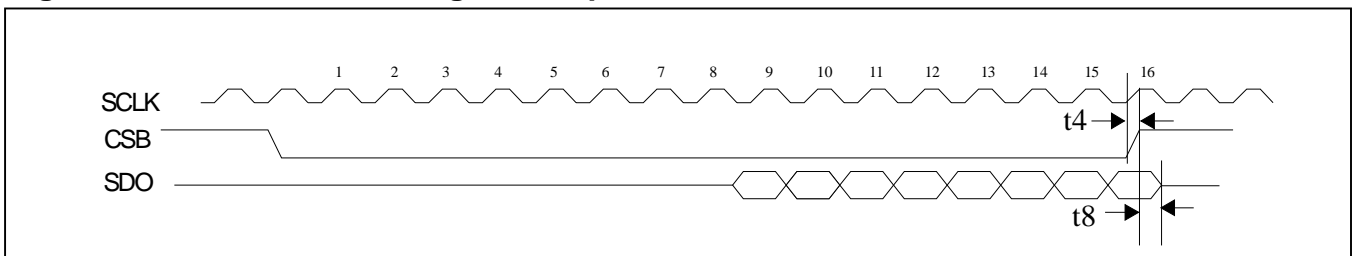
**Figure 9-9. Serial Bus Timing Write Operation**



**Figure 9-10. Serial Bus Timing Read Operation with CLKE = 0**



**Figure 9-11. Serial Bus Timing Read Operation with CLKE = 1**



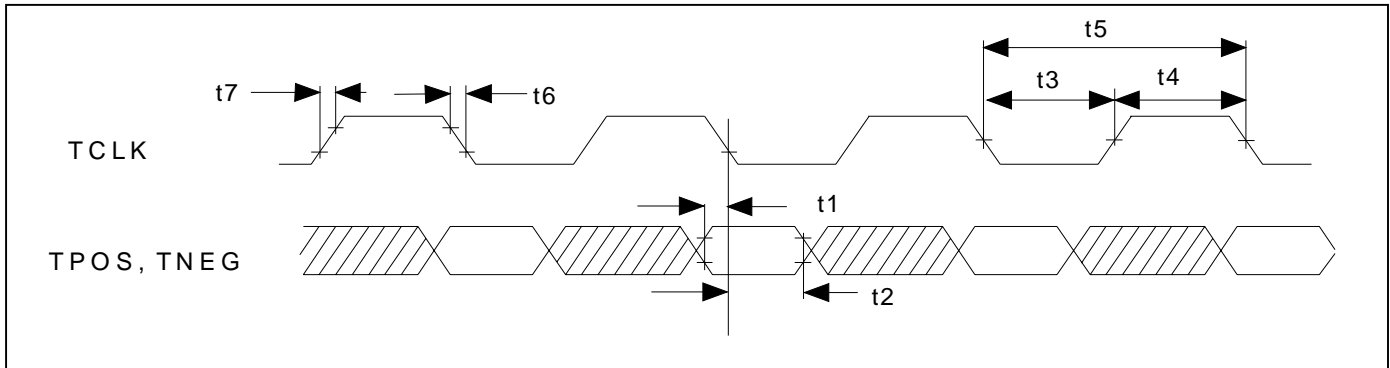
### 9.4 System Timing

**Table 9-8. Transmitter System Timing**

(See [Figure 9-12.](#))

| PARAMETER   | SYMBOL | MIN | TYP | MAX | UNITS | NOTES |
|---|--------|-----|-----|-----|-------|-------|
| TPOS, TNEG Setup Time with Respect to TCLK Falling Edge | t1     | 40  |     |     | ns    |       |
| TPOS, TNEG Hold Time with Respect to TCLK Falling Edge  | t2     | 40  |     |     | ns    |       |
| TCLK Pulse-Width High                                   | t3     | 75  |     |     | ns    |       |
| TCLK Pulse-Width Low                                    | t4     | 75  |     |     | ns    |       |
| TCLK Period   | t5     |     | 488 |     | ns    |       |
|   |        |     | 648 |     |       |       |
| TCLK Rise Time  | t6     |     |     | 25  | ns    |       |
| TCLK Fall Time  | t7     |     |     | 25  | ns    |       |

**Figure 9-12. Transmitter Systems Timing**



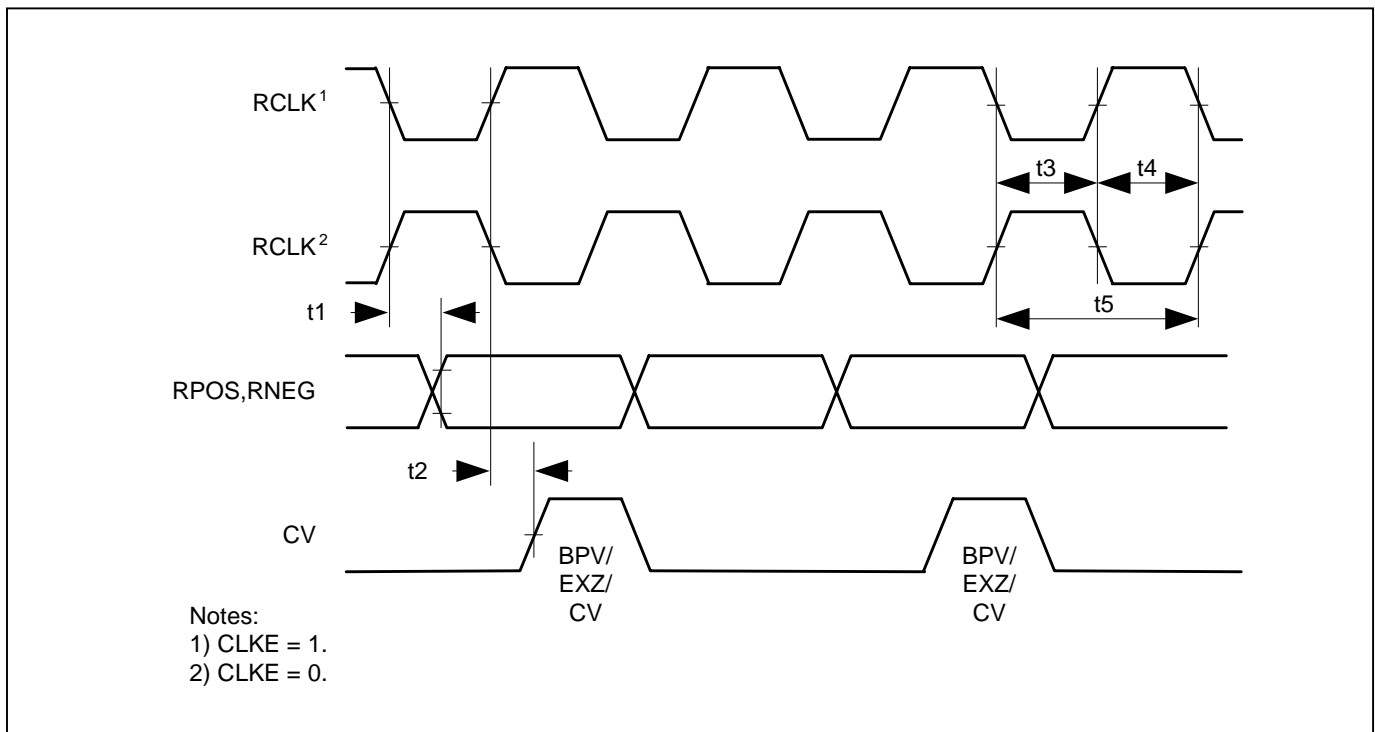


**Table 9-9. Receiver System Timing**

(See [Figure 9-13.](#))

| PARAMETER                                  | SYMBOL | MIN | TYP | MAX | UNITS | NOTES |
|--|--------|-----|-----|-----|-------|-------|
| Delay RCLK to RPOS, RNEG Valid             | t1     |     |     | 50  | ns    |       |
| Delay RCLK to CV Valid in Single-Rail Mode | t2     |     |     | 50  | ns    |       |
| RCLK Pulse-Width High                      | t3     | 200 |     |     | ns    |       |
| RCLK Pulse-Width Low                       | t4     | 200 |     |     | ns    |       |
| RCLK Period                                | t5     |     | 488 |     | ns    |       |
|  |        |     |     | 648 |       |       |

**Figure 9-13. Receiver Systems Timing**



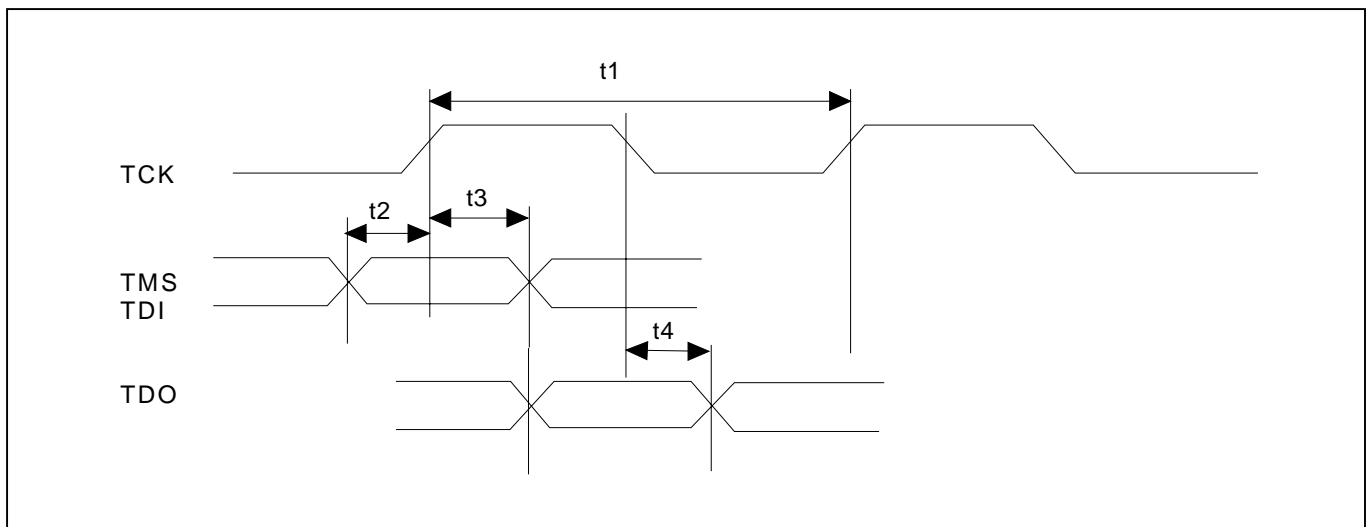
## 9.5 JTAG Timing

**Table 9-10. JTAG Timing Characteristics**

(See [Figure 9-14.](#))

| PARAMETER                | SYMBOL | MIN | TYP | MAX | UNITS | NOTES |
|--------------------------|--------|-----|-----|-----|-------|-------|
| TCK Period               | t1     | 100 |     |     | ns    |       |
| TMS and TDI Setup to TCK | t2     | 25  |     |     | ns    |       |
| TMS and TDI Hold to TCK  | t3     | 25  |     |     | ns    |       |
| TCK to TDO Hold          | t4     |     |     | 50  | ns    |       |

**Figure 9-14. JTAG Timing**



## 10 PIN CONFIGURATION

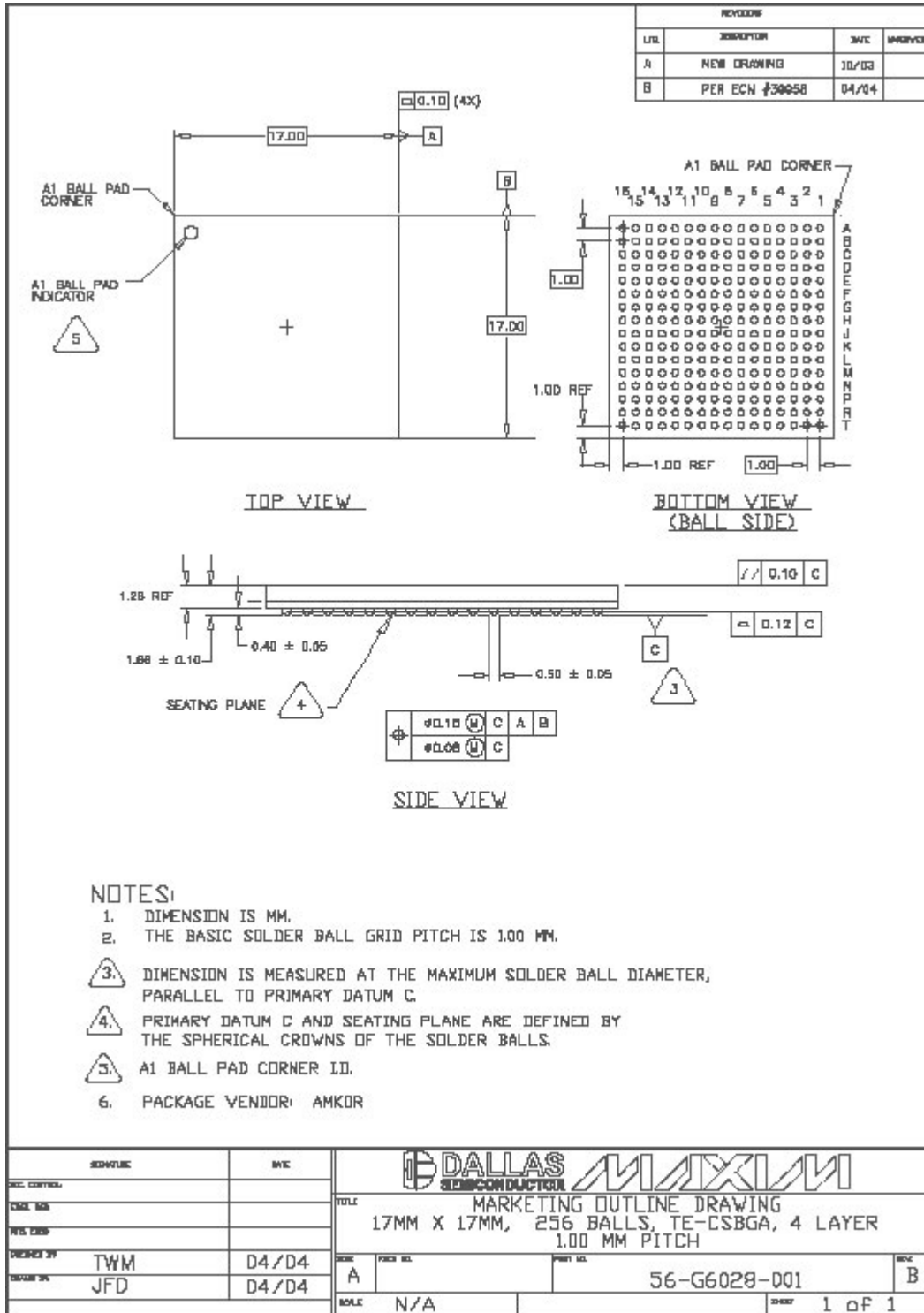
Figure 10-1. 256-Ball TE-CSBGA

|          | 1      | 2      | 3       | 4       | 5      | 6       | 7       | 8      | 9       | 10     | 11      | 12      | 13           | 14           | 15      | 16      |
|----------|--------|--------|---------|---------|--------|---------|---------|--------|---------|--------|---------|---------|--------------|--------------|---------|---------|
| <b>A</b> | RTIP1  | RRING1 | MODESEL | RTIP16  | VDDT16 | TTIP16  | TTIP15  | VDDT15 | RTIP15  | VDDT14 | TTIP14  | TTIP13  | VDDT13       | RTIP14       | TDO     | RTIP13  |
| <b>B</b> | AVDD   | AVSS   | MOTEL   | RRING16 | RSTB   | TRING16 | TRING15 | LOS14  | RRING15 | LOS13  | TRING14 | TRING13 | TMS          | RRING14      | TDI     | RRING13 |
| <b>C</b> | RTIP2  | RRING2 | TNEG1   | A4      | TNEG16 | TNEG15  | RNEG15  | RPOS15 | RNEG14  | RPOS14 | TCLK13  | RPOS13  | SDO/RDY/ACKB | TPOS12       | AVSS    | AVDD    |
| <b>D</b> | VDDT1  | LOS1   | RCLK1   | GNDT1   | TPOS16 | GNDT16  | INTB    | GNDT15 | GNDT14  | GNDT13 | TCLK16  | TCLK14  | GNDT12       | TCK          | RRING12 | RTIP12  |
| <b>E</b> | TTIP1  | TRING1 | RNEG1   | A5      | RPOS16 | RCLK16  | TPOS14  | RCLK13 | RCLK14  | RNEG13 | LOS15   | TCLK12  | TNEG12       | RPOS12       | TRSTB   | VDDT12  |
| <b>F</b> | TTIP2  | TRING2 | RPOS2   | RPOS1   | TCLK1  | TPOS1   | TNEG14  | RCLK15 | TPOS13  | LOS16  | RNEG12  | RCLK12  | RNEG11       | TCLK11       | TRING12 | TTIP12  |
| <b>G</b> | VDDT2  | LOS2   | A2      | TCLK2   | RNEG2  | RCLK2   | TPOS2   | TNEG13 | TCLK3   | TNEG4  | TPOS11  | RPOS11  | RCLK11       | SDI/WRB/DSB  | TRING11 | TTIP11  |
| <b>H</b> | RTIP3  | RRING3 | A1      | GNDT2   | A3     | TCLK4   | AVDD    | DVDD   | DVSS    | AVSS   | TNEG11  | MCLK    | GNDT11       | RDB/RWB      | LOS12   | VDDT11  |
| <b>J</b> | VDDT3  | LOS3   | RNEG16  | GNDT3   | TNEG3  | TPOS3   | AVSS    | DVSS   | DVDD    | AVDD   | TPOS10  | TNEG10  | GNDT10       | TNEG2        | RRING11 | RTIP11  |
| <b>K</b> | TTIP3  | TRING3 | RCLK3   | RNEG3   | RCLK4  | TPOS4   | D3      | RPOS5  | TNEG8   | RNEG8  | TCLK9   | TCLK10  | RPOS10       | RCLK10       | LOS11   | VDDT10  |
| <b>L</b> | TTIP4  | TRING4 | RPOS3   | RPOS4   | D4     | D0      | RNEG5   | TCLK6  | TPOS5   | TCLK7  | TPOS9   | TNEG9   | RCLK9        | RNEG10       | TRING10 | TTIP10  |
| <b>M</b> | VDDT4  | LOS4   | RNEG4   | D5      | D1     | TNEG5   | TCLK5   | RCLK6  | RPOS6   | RNEG6  | TPOS8   | RPOS8   | RNEG9        | RPOS9        | TRING9  | TTIP9   |
| <b>N</b> | RTIP4  | RRING4 | D7      | GNDT4   | TPOS6  | GNDT5   | TCLK15  | GNDT6  | GNDT7   | A0     | GNDT8   | TPOS15  | GNDT9        | SCLK/ALE/ASB | LOS10   | VDDT9   |
| <b>P</b> | AVDD   | AVSS   | D6      | D2      | RCLK5  | TNEG6   | TNEG7   | RPOS7  | TCLK8   | RCLK7  | RNEG7   | TPOS7   | RCLK8        | CSB          | RRING10 | RTIP10  |
| <b>R</b> | RRING5 | LOS5   | RRING6  | LOS7    | TRING5 | TRING6  | LOS8    | RRING7 | DVSS    | TRING7 | TRING8  | OE      | RRING8       | LOS9         | AVSS    | AVDD    |
| <b>T</b> | RTIP5  | LOS6   | RTIP6   | VDDT5   | TTIP5  | TTIP6   | VDDT6   | RTIP7  | VDDT7   | TTIP7  | TTIP8   | VDDT8   | RTIP8        | CLKE/MUX     | RRING9  | RTIP9   |

## 11 PACKAGE INFORMATION

(The package drawing(s) in this data sheet may not reflect the most current specifications. The package number provided for each package is a link to the latest package outline information.)

### 11.1 256-Ball TE-CSBGA (17mm x 17mm) ([56-G6028-001](#))



## 12 THERMAL INFORMATION

**Table 12-1. Thermal Characteristics**

| PARAMETER  | MIN   | TYP       | MAX    | V (m/s) | NOTES |
|--|-------|-----------|--------|---------|-------|
| Ambient Temperature                                | -40°C |           | +85°C  |         | 1     |
| Junction Temperature                               |       |           | +125°C |         |       |
| Theta-JA ( $\theta_{JA}$ ) in Still Air Conduction |       | +16.6°C/W |        | 0       | 2     |
| Theta-JC ( $\theta_{JC}$ ) Conduction              |       | +3.0°C/W  |        |         |       |
| Theta-JB ( $\theta_{JB}$ ) Conduction              |       | +7.5°C/W  |        |         |       |
| Theta-JA ( $\theta_{JA}$ ) in Forced Air           |       | +15.0°C/W |        | 0.75    |       |
| Theta-JA ( $\theta_{JA}$ ) in Forced Air           |       | +14.6°C/W |        | 1.25    |       |
| Theta-JA ( $\theta_{JA}$ ) in Forced Air           |       | +14.0°C/W |        | 2.5     |       |

**Note 1:** The package is mounted on a four-layer JEDEC standard test board.

**Note 2:** Theta-JA ( $\theta_{JA}$ ) is the junction-to-ambient thermal resistance, when the package is mounted on a four-layer JEDEC standard test board.

**Table 12-2. Package Power Dissipation (for Thermal Considerations)**

| MODE    | TYPICAL 50% 1s (Note 1) |                    |          | TYPICAL 100% 1s (Note 2) |                    |          | MAXIMUM 100% 1s (Note 3) |                    |          |
|---------|-------------------------|--------------------|----------|--------------------------|--------------------|----------|--------------------------|--------------------|----------|
|         | FULLY INTERNAL          | PARTIALLY INTERNAL | EXTERNAL | FULLY INTERNAL           | PARTIALLY INTERNAL | EXTERNAL | FULLY INTERNAL           | PARTIALLY INTERNAL | EXTERNAL |
| E1-75Ω  | 1.64                    | 1.43               | 1.31     | 2.56                     | 2.15               | 1.90     | 2.82                     | 2.36               | 1.98     |
| E1-120Ω | 1.49                    | 1.19               | 1.19     | 2.23                     | 1.62               | 1.62     | 2.54                     | 1.69               | 1.69     |
| T1-LBO0 | 1.87                    | 1.52               | 1.47     | 2.96                     | 2.26               | 2.14     | 3.56                     | 2.51               | 2.23     |
| T1-LBO1 | 1.92                    | 1.57               | 1.51     | 3.03                     | 2.32               | 2.20     | 3.63                     | 2.57               | 2.30     |
| T1-LBO2 | 1.95                    | 1.60               | 1.55     | 3.06                     | 2.35               | 2.29     | 3.66                     | 2.60               | 2.39     |
| T1-LBO3 | 1.99                    | 1.63               | 1.58     | 3.12                     | 2.41               | 2.29     | 3.72                     | 2.67               | 2.39     |
| T1-LBO4 | 2.02                    | 1.67               | 1.61     | 3.16                     | 2.46               | 2.34     | 3.77                     | 2.72               | 2.44     |
| J1-LBO0 | 1.84                    | 1.49               | 1.47     | 2.90                     | 2.20               | 2.14     | 3.44                     | 2.36               | 2.23     |
| J1-LBO1 | 1.89                    | 1.54               | 1.51     | 2.96                     | 2.26               | 2.20     | 3.51                     | 2.42               | 2.30     |
| J1-LBO2 | 1.92                    | 1.57               | 1.55     | 2.99                     | 2.29               | 2.29     | 3.54                     | 2.45               | 2.39     |
| J1-LBO3 | 1.95                    | 1.60               | 1.58     | 3.05                     | 2.35               | 2.29     | 3.60                     | 2.52               | 2.39     |
| J1-LBO4 | 1.99                    | 1.63               | 1.61     | 3.10                     | 2.39               | 2.34     | 3.65                     | 2.57               | 2.44     |

**Note 1:** Typical voltage, transmitting/receiving 50% 1s in Watts.

**Note 2:** Typical voltage, transmitting/receiving 100% 1s in Watts.

**Note 3:** Maximum voltage, transmitting/receiving 100% 1s in Watts.

[Table 12-3](#) describes how much power to deduct per-channel from the total power dissipation values listed in [Table 12-2](#).

**Table 12-3. Per-Channel Power-Down Savings (for Thermal Considerations)**

| MODE    | TYPICAL 50% 1s (Note 1) |                    |          | TYPICAL 100% 1s (Note 2) |                    |          | MAXIMUM 100% 1s (Note 3) |                    |          |
|---------|-------------------------|--------------------|----------|--------------------------|--------------------|----------|--------------------------|--------------------|----------|
|         | FULLY INTERNAL          | PARTIALLY INTERNAL | EXTERNAL | FULLY INTERNAL           | PARTIALLY INTERNAL | EXTERNAL | FULLY INTERNAL           | PARTIALLY INTERNAL | EXTERNAL |
| E1-75Ω  | 0.093                   | 0.080              | 0.072    | 0.151                    | 0.125              | 0.109    | 0.166                    | 0.137              | 0.113    |
| E1-120Ω | 0.084                   | 0.065              | 0.065    | 0.130                    | 0.092              | 0.092    | 0.148                    | 0.095              | 0.095    |
| T1-LBO0 | 0.108                   | 0.086              | 0.083    | 0.176                    | 0.132              | 0.125    | 0.213                    | 0.147              | 0.130    |
| T1-LBO1 | 0.111                   | 0.089              | 0.086    | 0.180                    | 0.136              | 0.129    | 0.217                    | 0.151              | 0.134    |
| T1-LBO2 | 0.113                   | 0.091              | 0.088    | 0.182                    | 0.138              | 0.134    | 0.219                    | 0.153              | 0.140    |
| T1-LBO3 | 0.115                   | 0.093              | 0.090    | 0.186                    | 0.142              | 0.134    | 0.223                    | 0.157              | 0.140    |
| T1-LBO4 | 0.117                   | 0.095              | 0.092    | 0.189                    | 0.145              | 0.137    | 0.226                    | 0.160              | 0.143    |
| J1-LBO0 | 0.106                   | 0.084              | 0.083    | 0.172                    | 0.128              | 0.125    | 0.205                    | 0.137              | 0.130    |
| J1-LBO1 | 0.109                   | 0.087              | 0.086    | 0.176                    | 0.132              | 0.129    | 0.209                    | 0.141              | 0.134    |
| J1-LBO2 | 0.111                   | 0.089              | 0.088    | 0.178                    | 0.134              | 0.134    | 0.211                    | 0.143              | 0.140    |
| J1-LBO3 | 0.113                   | 0.091              | 0.090    | 0.182                    | 0.138              | 0.134    | 0.215                    | 0.147              | 0.140    |
| J1-LBO4 | 0.115                   | 0.093              | 0.092    | 0.185                    | 0.141              | 0.137    | 0.218                    | 0.150              | 0.143    |

**Note 1:** Typical voltage, transmitting/receiving 50% 1s in Watts.

**Note 2:** Typical voltage, transmitting/receiving 100% 1s in Watts.

**Note 3:** Maximum voltage, transmitting/receiving 100% 1s in Watts.

$$T_A^{\circ}\text{C} + \theta_{JA} \times \text{Power Dissipation} \leq \text{Maximum Junction Temperature}$$

Where:  $T_A$  = Maximum Ambient Temperature

**Example:**

$$T_A = +70^{\circ}\text{C}$$

Mode = Typical 100% 1s E1-75Ω, Fully Internal Impedance Matching

Air Flow = 1.25m/s

$$70^{\circ}\text{C} + 14.6^{\circ}\text{C/W} \times 2.56\text{W} = 107^{\circ}\text{C}$$

This is below the maximum junction temperature and, therefore, this solution will support the thermal requirements.

## 13 DATA SHEET REVISION HISTORY

| REVISION DATE   | DESCRIPTION   | PAGES CHANGED |
|---|---|---------------|
| 070105  | Initial release.  | —             |
| 042007  | Added descriptions of feature enhancements implemented in revision A2: <ul style="list-style-type: none"> <li>1) Programmable corner frequency for the jitter attenuator in E1 mode.</li> <li>2) Fully internal impedance matching option for RTIP/RRING.</li> <li>3) Option for system-side deployment of BERT.</li> <li>4) Revised B8ZS/HDB3 sections for clarification of functions.</li> <li>5) Added RESREF pin for receive termination calibration.</li> </ul> See below for the detailed list of changes made to this data sheet revision. |               |
|   | See <i>Features</i> bullets, <i>Detailed Description</i> , and <i>Section 5.5.1</i> for mention of fully internal receive impedance matching.   | 1, 7, 27      |
|   | Added RESREF pin (R9).  | 11            |
|   | In OE pin description, changed GC.RTCTL to TST.RHPMC.   | 15            |
|   | Deleted R9 from DVSS.   | 16            |
|   | In <i>Section 5.4: Transmitter</i> , second paragraph, changed NRZ encoding to AMI encoding.  | 20            |
|   | Replaced <i>Figure 5-8</i> .  | 25            |
|   | In <i>Table 5-6</i> , updated Rt; updated <i>Section 5.4.3</i> and <i>Section 5.4.4</i> ; in <i>Section 5.4.5: Zero Suppression—B8ZS or HDB3</i> , removed “or Transmit Maintenance Register settings” from last sentence of first paragraph (no such register for this part).  | 26            |
|   | Changed <i>Section 5.4.8</i> name from <i>Drive Failure Monitor</i> to <i>Driver Fail Monitor</i> ; updated <i>Section 5.5</i> ; added new <i>Section 5.5.1: Receive Impedance Matching Calibration</i> .   | 27            |
|   | Added <i>Section 5.5.8: Receive Dual-Rail Mode</i> ; added new <i>Section 5.5.9: Receive Single-Rail Mode</i> ; updated <i>Table 5-11</i> .   | 30            |
|   | Updated <i>Section 5.8.2: Digital Loopback</i> .  | 33            |
|   | Added new paragraph to <i>Section 5.9: BERT</i> .   | 34            |
|   | Changed GMC to BGMC ( <i>Table 6-1</i> ) (see also page 53).  | 40            |
|   | In <i>Table 6-4</i> , deleted <i>Receive Bit Error Count Register 4</i> (does not exist for this part).   | 43            |
|   | In <i>Table 6-5</i> , changed bit names for LOSS (LIUs 1–16) to correctly match bit description on page 49; for TST, changed bits 7–5 from Reserved to JABWS1, JABWS0, and RHPMC (see also page 58).  | 44            |
| In <i>Table 6-6</i> , changed SRS bit to correctly say SRMS.  | 45  |               |
| In <i>Table 6-7</i> , added missing address (27) to SHLHS for LIUs 9–16; changed bit 7 and bits 3–0 names for RSMM4 (LIUs 9–16) to correctly match bit description on page 74; changed “GISC” (3E) to “Not Used” for LIUs 9–16.   | 46  |               |
| In <i>Table 6-8</i> , changed BSR register bit 3 (PMS) to show it is read only (added underline), matching the bit description on page 88, as well as changed “RW” to “R” to correctly show all bits are read only; changed BSRL register bit 3 (PMSL) to show it is read only (added underline), matching the bit description on page 89, as well as changed “RL/W” to “R” to correctly show all bits are read only. | 47  |               |

| REVISION DATE | DESCRIPTION   | PAGES CHANGED     |
|---------------|---|-------------------|
|               | Changed GMC to BGMC; changed bits 7, 6, and 5 from Reserved to BERTDIR, BMCKS, and BTCKS.   | 53                |
|               | In the GC register (LIUs 1–8), changed bit 7 from Reserved to RIMPMS and bit 2 from RTCTL to CRIMP (see also page 44, <i>Table 6-5</i> ).   | 56                |
|               | In the GC register (LIUs 9–16), changed bit 7 from Reserved to RIMPMS and changed bit 2 from Reserved to CALEN (see also page 44, <i>Table 6-5</i> ).   | 57                |
|               | For TST, changed bits 7, 6, and 5 from Reserved to JABWS1, JABWS0, and RHPMC.   | 58                |
|               | In the bit 7 (RIMPON) description, changed GC.RTCTL to TST.RHPMC; added note to bit description.  | 60                |
|               | Changed bit description for OE bits 7 to 0.   | 61                |
|               | For EZDE, corrected bit names for LIUs 1–16 from EXZDE[1:16] to EZDE[1:16]; changed bit description to say “Excessive zero detection is only relevant when HDB3 or B8ZS decoding is enabled.” For CVDEB, changed bit description to say “Code violation detection is only relevant when HDB3 decoding is enabled (LCS register).” | 65                |
|               | Added note to bit 3 (RSMM1:RSSM4) description and updated descriptions for bits 6–4 and 2–0 (deleted “When” from each sentence for clarity).  | 71, 72, 73, 74    |
|               | Updated package drawing information.  | 117               |
|               | In <i>Table 12-1</i> , deleted “Power Dissipation in Package”; added new <i>Table 12-2. Package Power Dissipation (for Thermal Considerations)</i> and <i>Table 12-3. Per-Channel Power-Down Saving (for Thermal Considerations)</i> .  | 118               |
| 053107        | Table 8-3: added “Note 1: Specifications to -40°C are guaranteed by design (GBD) and not production tested.”  | 97                |
|               | Table 9-3, 9-4, 9-5, and 9-6: added “Note 1: The timing parameters in this table are guaranteed by design (GBD).”   | 99, 102, 105, 108 |
| 012108        | Changed the GC (2Fh) register bit 1 (JAPS) description.   | 57                |

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