TLK3131
Single Channel Multi-Rate Transceiver

Data Manual

Literature Number: SLLS957A
December 2008–Revised December 2009

Contents

List of Figures

List of Tables

Single Channel Multi-Rate Transceiver

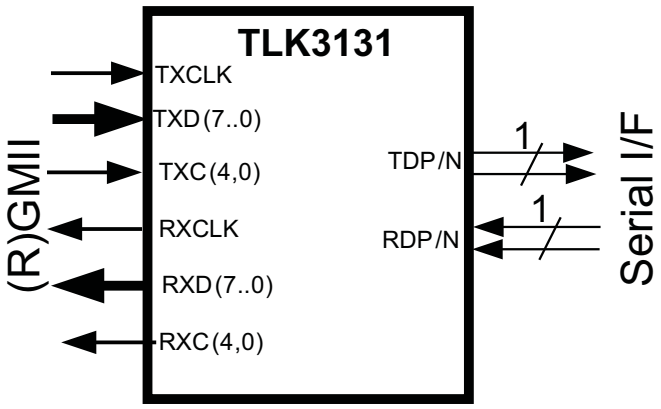
Check for Samples: TLK3131

1 Introduction

1.1 Features

- **Single Channel 600Mbps to 3.75Gbps Multi-Rate Transceiver**
- **Supports 1X/2X Fibre Channel (FC), CPRI (x1/x2/x4), OBSAI (x1/x2/x4), and 1GbE (1000Base-X) Data Rates**
- **IEEE Compliant 1000Base-X PCS Support**
- **Supports SERDES Operation Modes in 8/10 Bit Data Modes (TBI and 8 Bit + Control)**
- **Serial Side Transmit De-Emphasis and Receive Adaptive Equalization to Allow Extended Backplane Reach**
- **Low Jitter LC Oscillator Jitter-Cleaner Allows use of Poor Quality REFCLK**
- **Full Datapath Loopback Capability (Serial/Parallel Side)**
- **Support PRBS 2^7-1 and 2^{23} – 1 Gen/Verify. Support standard defined CRPAT, High and Low Frequency, and Mixed Freq Testing.**
- **GMII/RGMII: HSTL Class 1 I/O With On-Chip Termination: Programmable Input and 50Ω Output (1.5 and 1.8V Power Supply)**
- **GMII/RGMII: Source And Data Centered I/O Timing Modes**
- **Supports Jumbo Packet (9600 byte maximum) Operation.**
- **MDIO: IEEE 802.3 Clause 22 Compliant Management Data Input / Output Interface Modes (Either 1.2V or 2.5V MDIO I/O)**
- **1.2V Core, 1.5V/1.8V HSTL I/O Supply, and 2.5V LVCMOS I/O Supply**
- **JTAG: IEEE 1149.1/1149.6 Test Interface**
- **±200 ppm Clock Tolerance in 1000Base-X Receive Datapaths**
- **90 nm Advanced CMOS Technology**
- **Package: PBGA, 13×13mm, 144 Ball, 1mm Pitch**
- **700mW Maximum Power Dissipation at 1CH 3.75 Gbps (1.5V HSTL Mode, Input HSTL Termination Disabled)**
- **Asymmetric RX/TX Rates Supported**
- **Industrial Ambient Operating Temperature (–40°C to 85°C) at Full Rate**

1.2 Pin Out



Please be aware that an important notice concerning availability, standard warranty, and use in critical applications of Texas Instruments semiconductor products and disclaimers thereto appears at the end of this data sheet.

1.3 Description

The TLK3131 is a flexible single channel configurable serial transceiver. It can be configured to be compliant with the 1000Base-X 1Gbps Ethernet Specification (Auto-Negotiation not supported). The TLK3131 provides high-speed bi-directional point-to-point data transmissions with up to 7.5 Gbps of raw data transmission capacity. The primary application of this device is in backplanes and front panel connections requiring 3.75Gbps connections over controlled impedance media of approximately 50Ω. The transmission media can be printed circuit board (PCB) traces, copper cables or fiber-optical media. The ultimate rate and distance of data transfer is dependent upon the attenuation characteristics of the media and the noise coupling into the lines.

The TLK3131 performs the parallel-to-serial, serial-to-parallel conversion, and clock extraction functions for a physical layer interface. The TLK3131 also provides 1000Base-X (PCS) layer functionality described in Clause 36 of 802.3-2002. The serial transmitter is implemented using differential Current Mode Logic (CML) with integrated termination resistors.

Figure 1-1 shows an example system block diagram for TLK3131 used to provide the Physical Coding Sublayer to Coarse Wave-length Division Multiplexed optical transceiver or parallel optics.

Many common applications may be enabled by way of externally available control pins. Detailed control of the TLK3131 is available by way of accessing a register space of control bits available through a two-wire access port called the Management Data Input/Output (MDIO) interface.

The PCS (Physical Coding Sublayer) functions such as the CTC FIFO are designed to be compliant for an 1000Base-X PCS link. However, each of the PCS functions may be disabled or bypassed until the TLK3131 is operating at its most basic state, that of a simple single channel 10-bit SERDES suitable for a wide range of applications such as CPRI or OBSAI wireless infrastructure links.

The differential output swing for the TLK3131 is suitable for compliance with IEEE 802.3 Gigabit Ethernet links, which is also suitable for CPRI LV serial links. The TLK3131 provides for setting larger output signal swing suitable for CPRI HV links by setting an appropriate register bit available though MDIO.

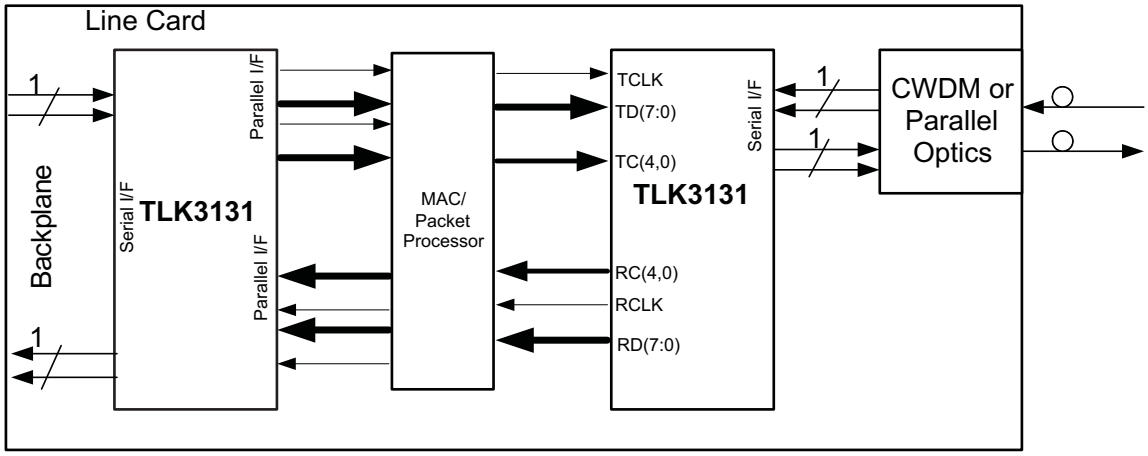


Figure 1-1. System Block Diagram – PCS

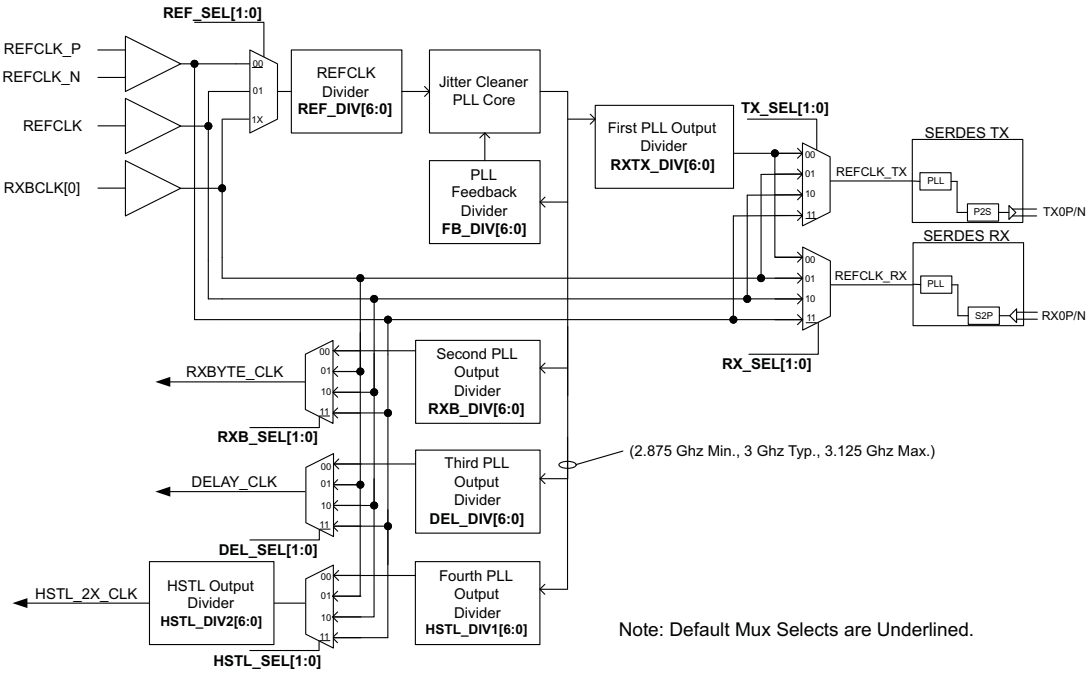


Figure 1-2. Block Diagram – TLK3131 Clocking Architecture

2 Detailed Description

2.1 Clocking Modes

The TLK3131 contains an internal low-bandwidth, low-jitter high quality LC oscillator that may be configured as a jitter cleaner. The jitter cleaner oscillator has a high frequency narrow band of operation that may be used to generate all common reference clock frequencies by way of programmable pre-scaler and post-scaler registers. In this manner a poor quality input reference clock can be input to the jitter cleaner which will lock to the reference clock and provide a clean reference to the internal SERDES PLLs. Appendix A defines in detail the clocking possibilities, and device settings.

Alternatively, the jitter cleaner may be used to lock to a recovered byte clock from the RX channel and remove jitter that may have transferred through the clock/data recovery circuit from the serial data stream to the recovered byte clock (including parallel output data timing). In this way the recovered byte clock may be extracted from the serial data stream yet be suitable for use in applications that require a clean clock source derived from the serial data stream. If the jitter cleaner is used to clean the recovered byte clock, it may not also be used to clean the input reference clock, and the PLL at the center of the deserializer core must have a clean low-jitter reference clock from an external clock source, preferably a low-jitter crystal based oscillator. Also note that the Transmit SERDES macro can run from the cleaned recovered RX byte clock which allows for the outgoing TX serial data rate to exactly match the incoming data rate of RX Channel.

The TLK3131 clocking architecture allows for bypass of the JC PLL in cases where power or application board area is critical.

See Figure 1-2 for a representation of the use of the jitter cleaner in the TLK3131.

2.2 Operating Frequency Range

The TLK3131 is optimized for operation at a serial data rate of 600 Mbit/s through 3.75 Gbit/s. The external differential (optionally single ended) reference clock has a large operating frequency range allowing support for many different applications. The reference clock frequency must be within ±200 PPM of the incoming serial data rate, and have less than 40ps of jitter. The following table shows a summary of frequency ranges supported. For more details, see Appendix A. The transmit parallel input clock must be frequency locked (0 ppm) to the supplied REFCLK frequency.

Table 2-1. Supported Protocol Rates and REFCLK Values

PROTOCOL	Refclk (MHz)	LINE RATE (Gbps)
1G Ethernet	62.5/125/250	1.25
1X/2X Fibre Channel	53.125/106.25/212.5	2.125 1.0625
OBSAI	76.8/153.6/307.2	3.072 1.536 0.768
CPRI	61.44/122.88/245.76	2.4576 1.2288 0.6144
Generic TBI	50 → 375 MHz	0.600 → 3.75
Generic RTBI	50 → 375 MHz	0.600 → 1.6
Generic NBID/TBID	50 → 375 MHz	0.600 → 3.2

2.3 CPRI Latency Support

The TLK3131 has a round trip latency measurement capability to support its use in CPRI applications. When enabled, the TLK3131 will measure the elapsed time from the transmission of a K28.5 code in a CPRI frame until the reception of a K28.5 code in the receive path. This measurement result may be read through an MDIO readable register. The measurement has an accuracy of ±4 ns with the Jitter Cleaner PLL enabled, and an accuracy of ± two parallel byte clock periods if the Jitter Cleaner PLL is disabled.

2.4 Powerdown Mode

The TLK3131 (through the ENABLE pin and through register control) is capable of going into a low power quiescent state. In this state, all analog and digital circuitry is disabled.

2.5 Application Examples

TLK3131 supports many different application modes. Detailed register settings per application mode are shown in Table 2-2. The following application diagrams do not show all possible applications, and are intended only to illustrate the flexibility of the device.

Figure 2-1 shows the TLK3131 in a single channel SERDES Application. The 1000Base-X PCS layer can be enabled or disabled. Note that the 8B/10B encoder/decoder functions can either be turned on or turned off. When turned off, either 5 or 10 bits (DDR/SDR) of data is accepted from and presented to the parallel side. When the 8B/10B encoder/decoder functions are enabled, 1 bit of control and 8 bits of data are accepted from and presented to the parallel side using the standardized (R)GMII control characters.

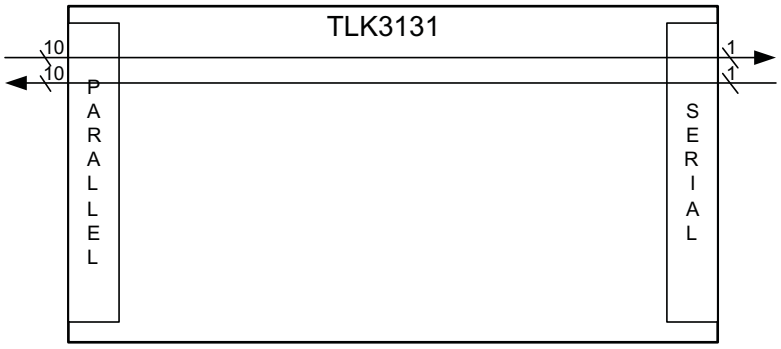


Figure 2-1. Single 10-Bit SERDES Application

Figure 2-2 shows the TLK3131 in a 1000Base-X Remote Loopback Application. It is possible to configure serial side loopback in SERDES mode.

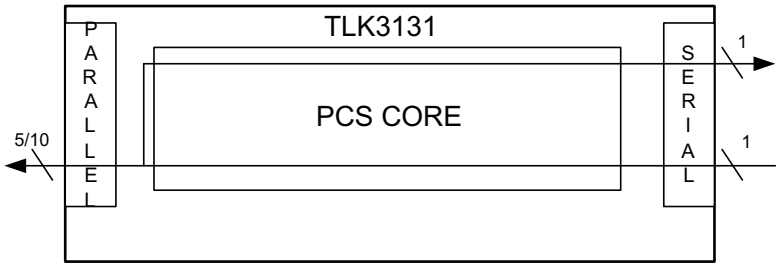


Figure 2-2. 1000Base-X – Remote (Serial) Loopback Application

Figure 2-3 shows the TLK3131 in a Local Loopback Application.

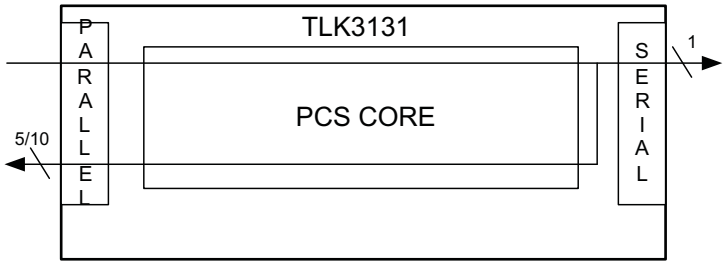


Figure 2-3. 1000Base-X – Local (Parallel) Loopback Application

The TLK3131 supports the IEEE 802.3 defined Management Data Input/Output (MDIO) Interface to allow ease in configuration and status monitoring of the link. The bi-directional data pin (MDIO) **must** be externally pulled up to 1.2V or 2.5V (VDDM) per the standard for MDIO.

The TLK3131 supports the IEEE 1149.1/1149.6 defined JTAG test port for ease in board manufacturing test. It also supports a comprehensive series of built-in tests for self-test purposes including PRBS generation and verification, CRPAT, Mixed/High/Low Frequency testing.

The TLK3131 operates with a 1.2V core voltage supply, a 1.5/1.8V HSTL I/O voltage supply and a 2.5V LVCMOS/bias supply.

The TLK3131 is packaged in a 13×13mm, 144-ball, 1mm ball pitch Plastic Ball Grid Array (PBGA) package and is characterized for operation from –40°C to 85°C Ambient, 105°C Junction, and 5% power supply variation at the balls of the device unless noted otherwise.

The following block diagram provides a high level description of the TLK3131.

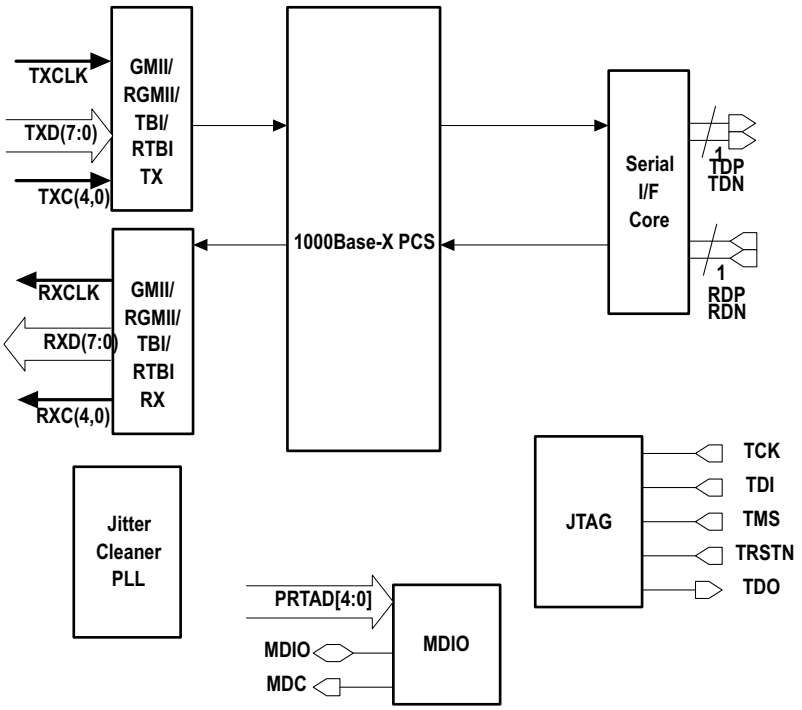


Figure 2-4. TLK3131 Block Diagram

Following is a more detailed block diagram description of the core.

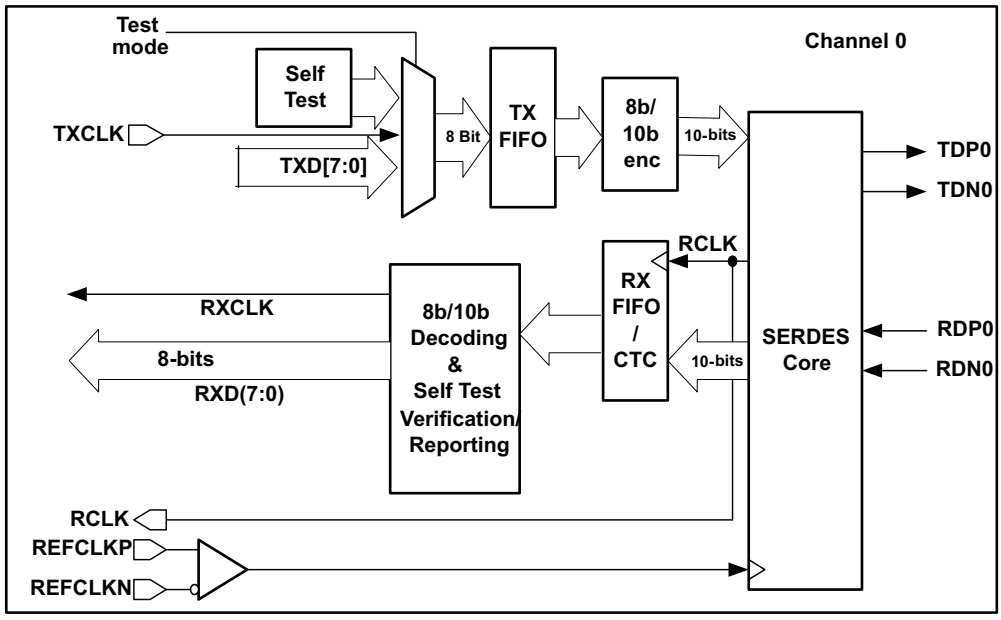


Figure 2-5. Detailed 1000Base-X Core Block Diagram

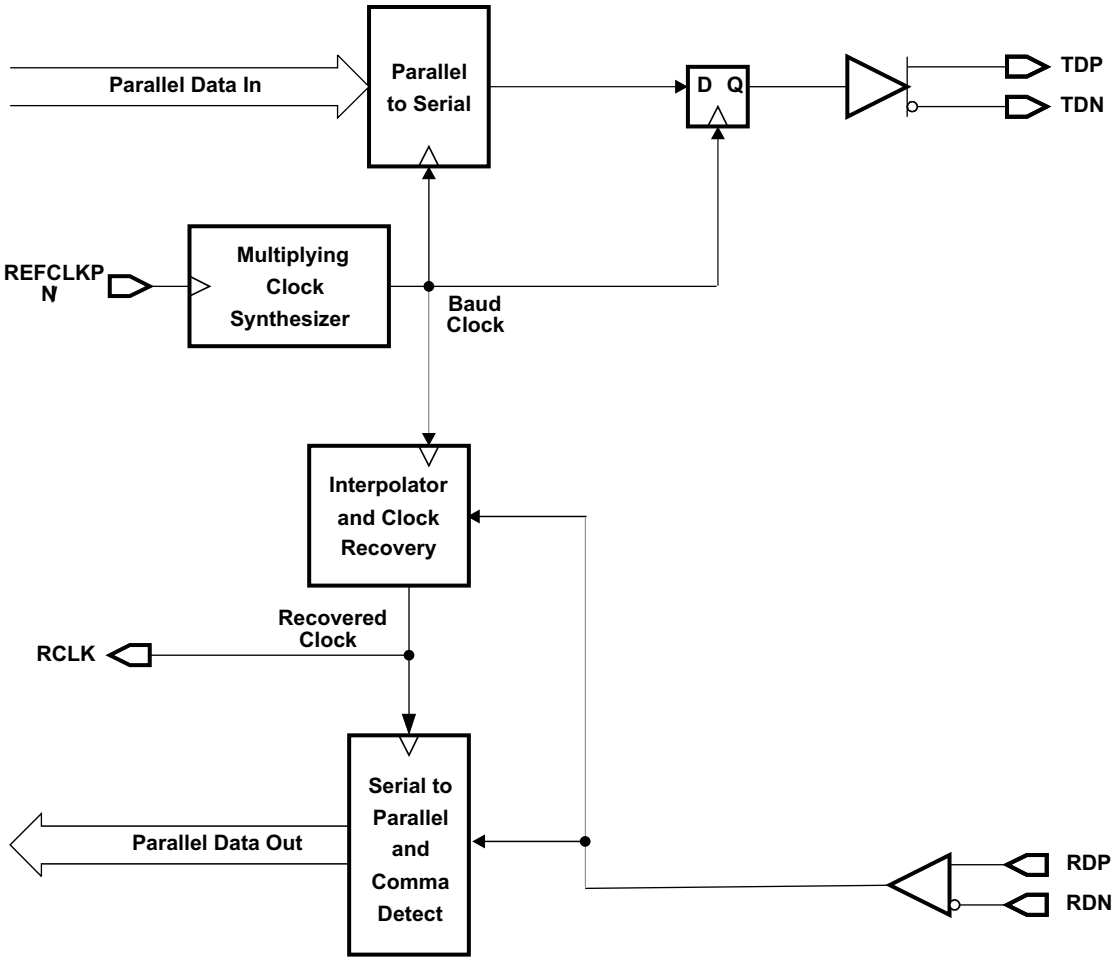


Figure 2-6. Block Diagram of SERDES Core

2.6 Device Operation Modes

Table 2-2. Device Operation Modes

DEVICE MODE	RGMII (DDR)	GMII (SDR)	RTBI (DDR)	TBI (SDR)	REBI (DDR)	EBI (SDR)	RNBI (DDR)	NBI (SDR)	TBID (DDR)	NBID (DDR)
MDIO Access Method	Clause 22 (1)									
DDR_SDR 17.5	1	0	1	0	1	0	1	0	X	
NIBBLE_ORDER 17.4	0/1	X	0/1	X	0/1	X	0/1	X		
TX_EDGE_MODE 17.1	0/1									
RX_EDGE_MODE 17.0										
FC_ENC_MODE 17.6	0						0/1		0	0/1
COMMA_DET_EN 17.7	1		0/1		0		1		0/1	1
PCS_EN 17.3 Logical OR w/CODE pin			0							
ENC_DEC_EN 17.2			0				1		0	1
BUSWIDTH 36864.7	0				1		0			
FULL_DDR 17.9	0								1	
Legend : (X = Don't Care) — (0 = Must Be Zero) — (1 = Must Be One) — (0/1 = Can Be Either Zero-or-One)										

(1) All Clause 22 Registers are per device channel.

2.7 Parallel Interface Modes - Detailed Description

The TLK3131 has several parallel interface modes. The major parallel interface modes of operation are presented below:

2.7.1 RGMII Mode (Reduced Gigabit Media Independent Interface)

Table 2-3. RGMII – Lane To Functional Pin Mapping

DATA CHANNEL NUMBER	TX_EN/TX_ER CONTROL BIT (INPUT)	TRANSMIT DATA NIBBLE (INPUT)	RX_DV/RX_ER CONTROL BIT (OUTPUT)	RECEIVE CONTROL NIBBLE (OUTPUT)	TRANSMIT CLOCK (INPUT)	RECEIVE CLOCK (OUTPUT)
Channel 0	TXC_[4]	TXD_[3:0]	RXD_[4]	RXD_[3:0]	TXCLK_[0]	RXCLK_[0]

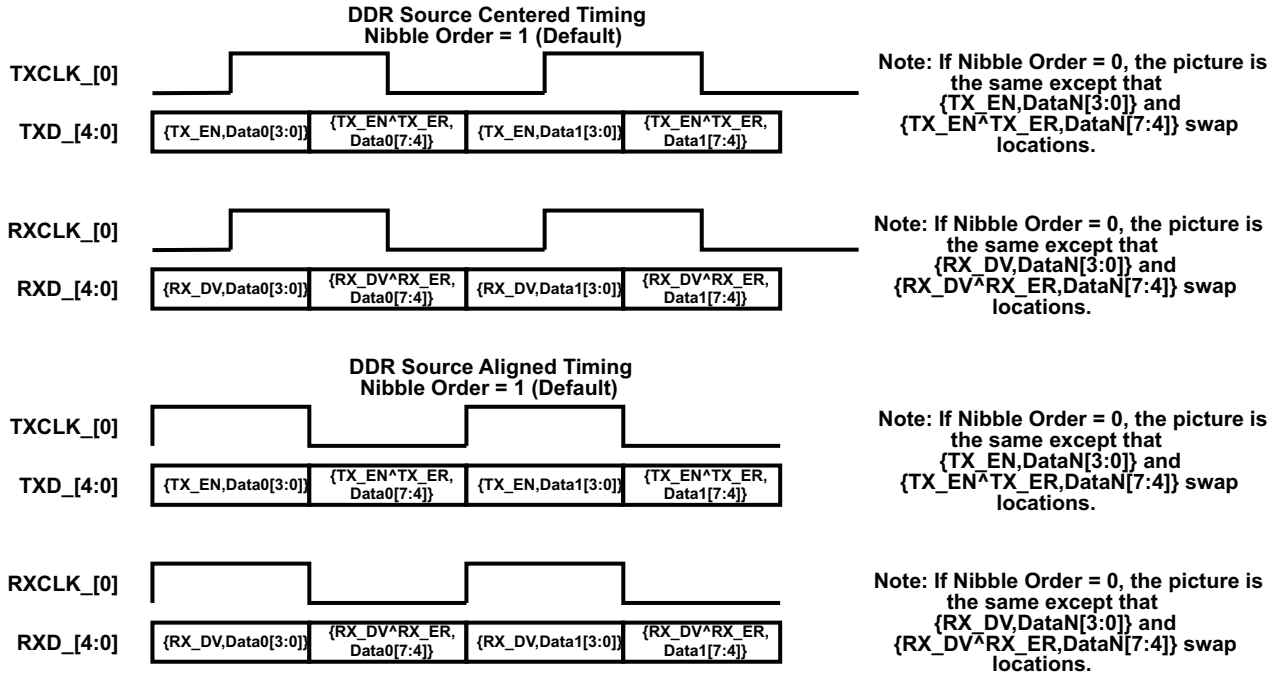


Figure 2-7. RGMII – Individual Channel Byte Ordering – Channel 0 Example

2.7.2 RTBI Mode (Reduced Ten Bit Interface)

Table 2-4. RTBI – Lane To Functional Pin Mapping

DATA CHANNEL NUMBER	TRANSMIT DATA 5 BITS (INPUT)	RECEIVE DATA 5 BITS (OUTPUT)	TRANSMIT CLOCK (INPUT)	RECEIVE CLOCK (OUTPUT)
Channel 0	TXC_[4:0]	RXD_[4:0]	TXCLK_[0]	RXCLK_[0]

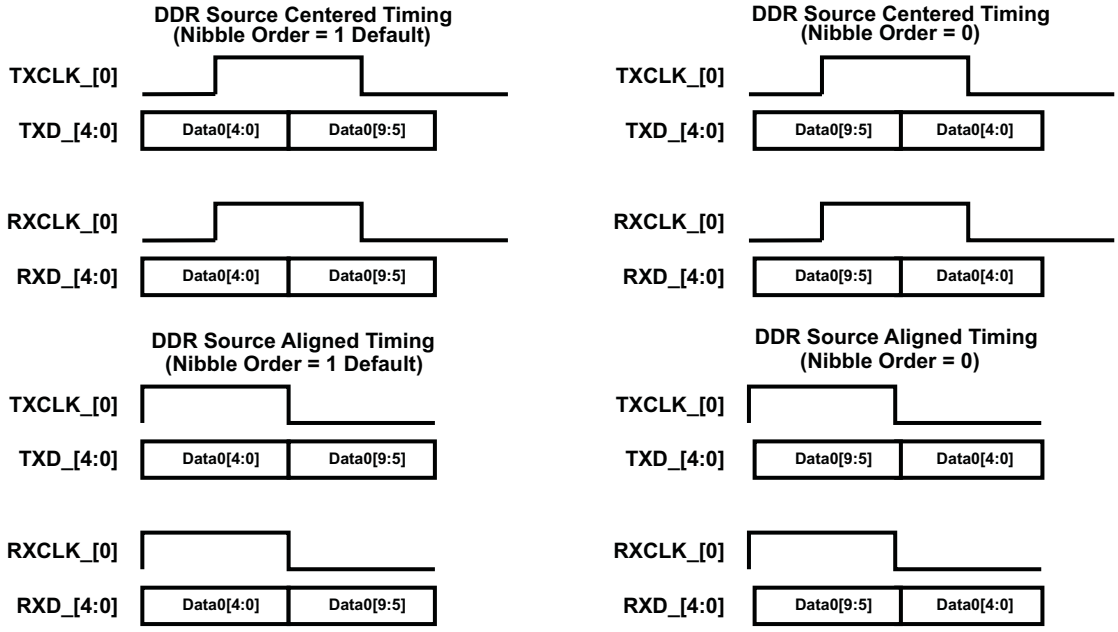


Figure 2-8. RTBI – Individual Channel Byte Ordering – Channel 0 Example

2.7.3 TBI Mode (Ten Bit Interface)

Table 2-5. TBI – Lane To Functional Pin Mapping

DATA CHANNEL NUMBER	TRANSMIT DATA 10 BITS (INPUT)	RECEIVE DATA 10 BITS (OUTPUT)	TRANSMIT CLOCK (INPUT)	RECEIVE CLOCK (OUTPUT)
Channel 0	{TXC_[4], TXC_[0],TXD_[7:0]}	{RXC_[4], RXC_[0],RXD_[7:0]}	TXCLK_[0]	RXCLK_ [0]

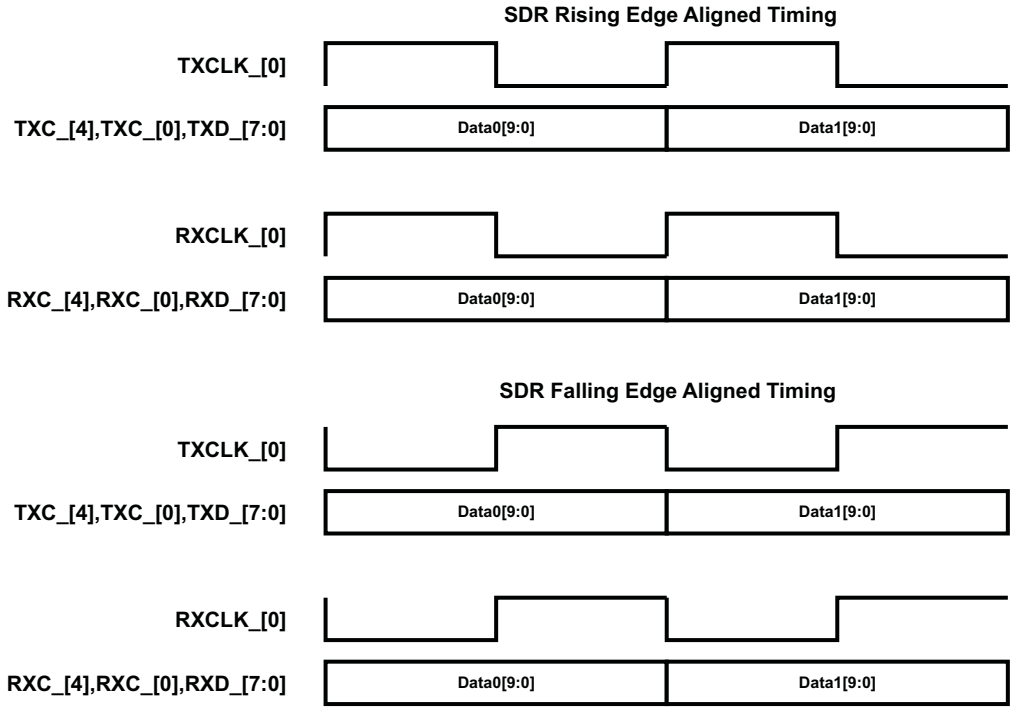


Figure 2-9. TBI – Individual Channel Byte Ordering – Channel 0 Example

2.7.4 GMII Mode (Gigabit Media Independent Interface)

Table 2-6. GMII – Lane To Functional Pin Mapping

DATA CHANNEL NUMBER	TX_EN CONTROL BIT (INPUT)	TX_ER CONTROL BIT (INPUT)	TRANSMIT DATA BYTE (INPUT)	RX_DV CONTROL BIT (OUTPUT)	RX_ER CONTROL BIT (OUTPUT)	RECEIVE DATA BYTE (OUTPUT)	TRANSMIT CLOCK (INPUT)	RECEIVE CLOCK (OUTPUT)
Channel 0	TXC_[0]	TXC_[4]	TXD_[7:0]	RXC_[0]	RXC_[4]	RXD_[7:0]	TXCLK_[0]	RXCLK_[0]

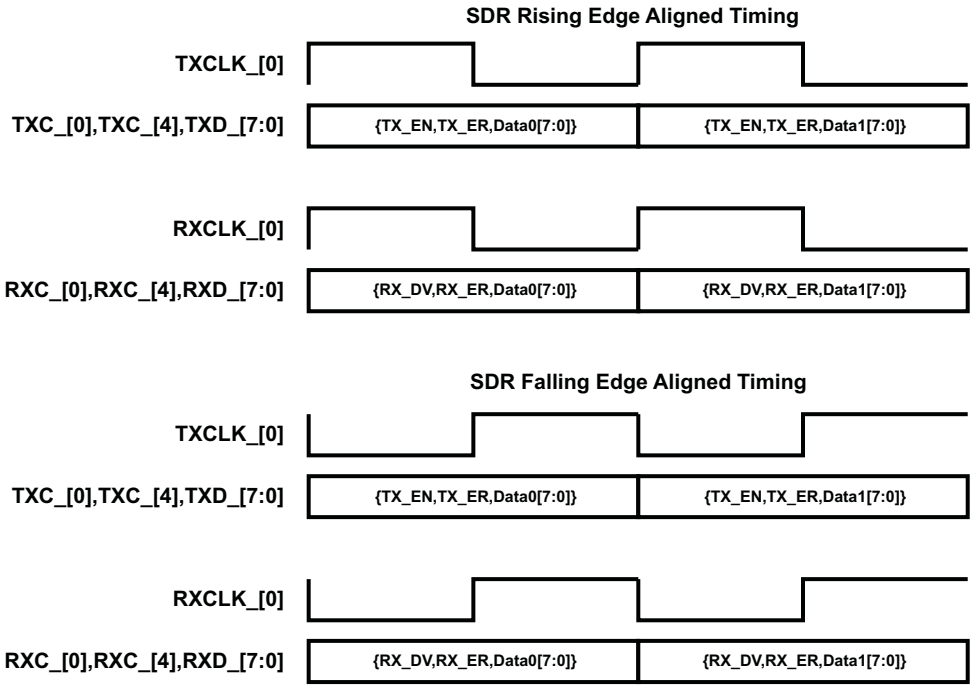


Figure 2-10. GMII – Individual Channel Byte Ordering – Channel 0 Example

2.7.5 EBI Mode (Eight Bit Interface)

Table 2-7. EBI – Lane To Functional Pin Mapping

DATA CHANNEL NUMBER	TRANSMIT DATA 8 BITS (INPUT)	RECEIVE DATA 8 BITS (OUTPUT)	TRANSMIT CLOCK (INPUT)	RECEIVE CLOCK (OUTPUT)
Channel 0	TXD_[7:0]	RXD_[7:0]	TXCLK_[0]	RXCLK_[0]

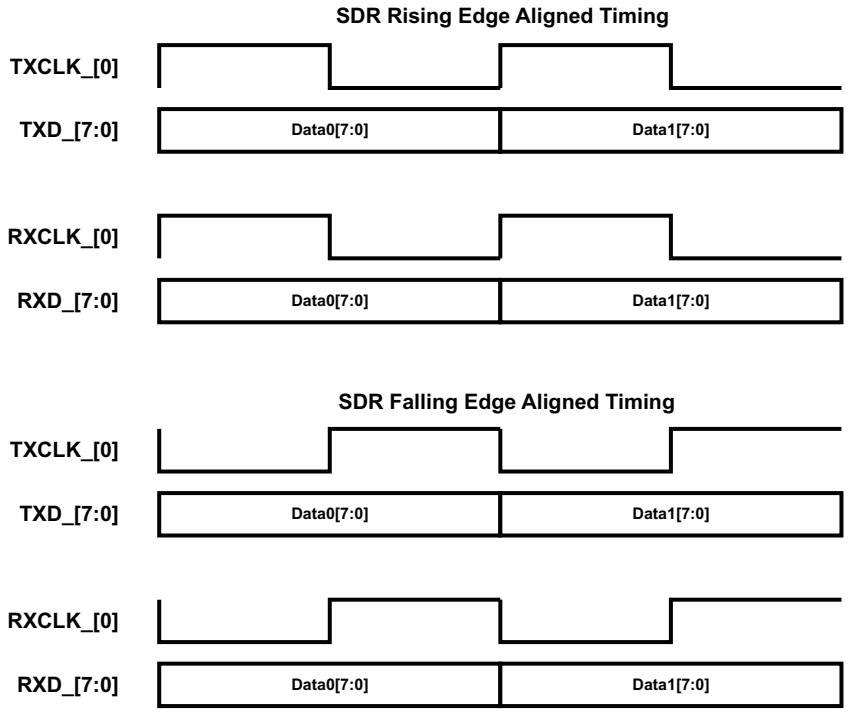


Figure 2-11. EBI – Individual Channel Byte Ordering – Channel 0 Example

2.7.6 REBI Mode (Reduced Eight Bit Interface)

Table 2-8. REBI – Lane To Functional Pin Mapping

DATA CHANNEL NUMBER	TRANSMIT DATA 4 BITS (INPUT)	RECEIVE DATA 4 BITS (OUTPUT)	TRANSMIT CLOCK (INPUT)	RECEIVE CLOCK (OUTPUT)
Channel 0	TXD_[3:0]	RXD_[3:0]	TXCLK_[0]	RXCLK_[0]

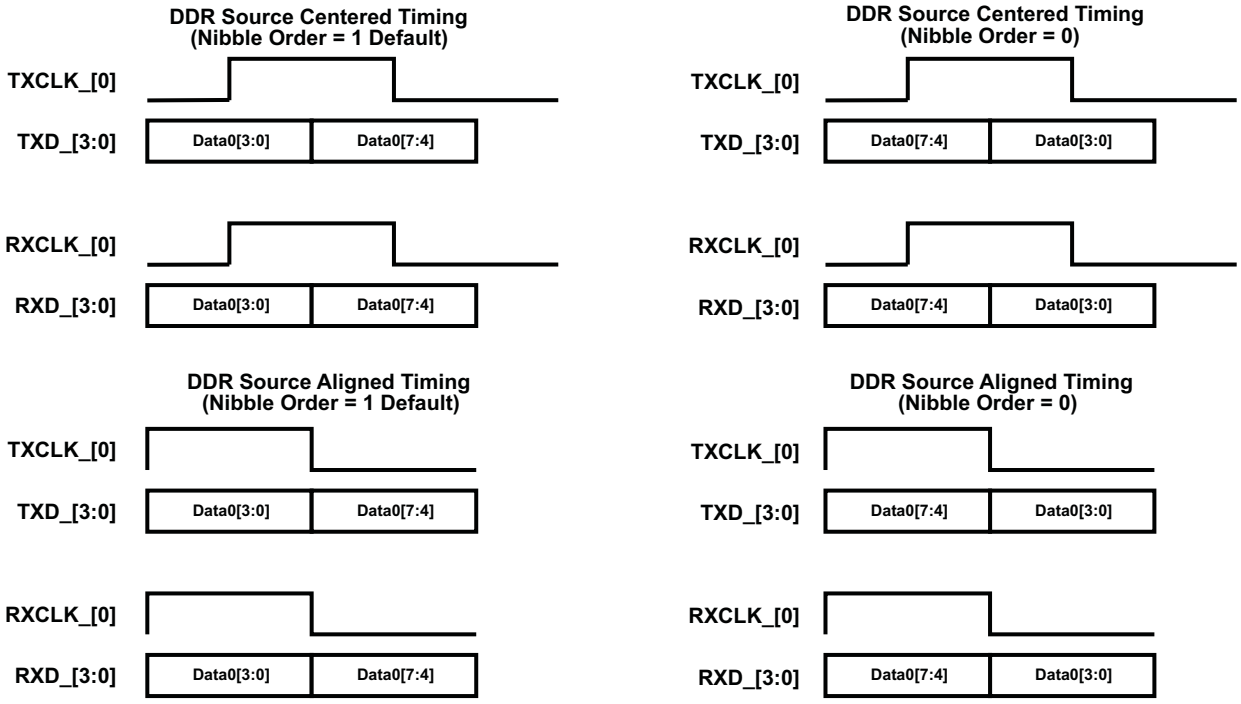


Figure 2-12. REBI – Individual Channel Byte Ordering – Channel 0 Example

2.7.7 NBI Mode (Nine Bit Interface Mode)

Table 2-9. NBI – Lane To Functional Pin Mapping

DATA CHANNEL NUMBER	TRANSMIT DATA 9 BITS (INPUT)	RECEIVE DATA 9 BITS (OUTPUT)	TRANSMIT CLOCK (INPUT)	RECEIVE CLOCK (OUTPUT)
Channel 0	{TXC_[0],TXD_[7:0]}	{RXC_[0],RXD_[7:0]}	TXCLK_[0]	RXCLK_[0]

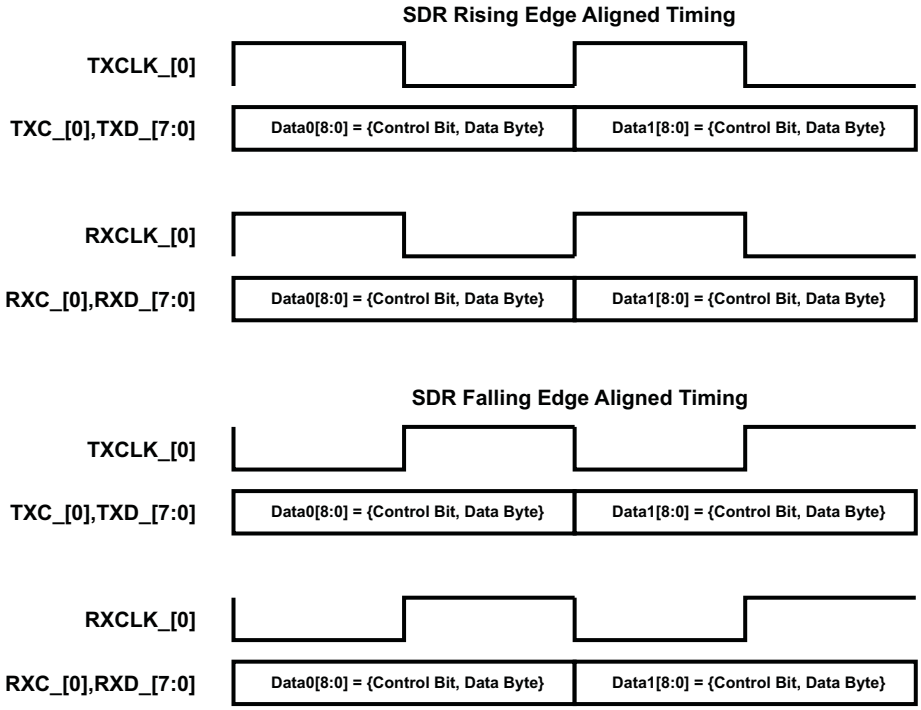


Figure 2-13. NBI – Individual Channel Byte Ordering – Channel 0 Example

2.7.8 RNBI Mode (Reduced Nine Bit Interface)

Table 2-10. RNBI – Lane To Functional Pin Mapping

DATA CHANNEL NUMBER	TRANSMIT DATA 5 BITS (INPUT)	RECEIVE DATA 5 BITS (OUTPUT)	TRANSMIT CLOCK (INPUT)	RECEIVE CLOCK (OUTPUT)
Channel 0	TXD_[4:0]	RXD_[4:0]	TXCLK_[0]	RXCLK_[0]

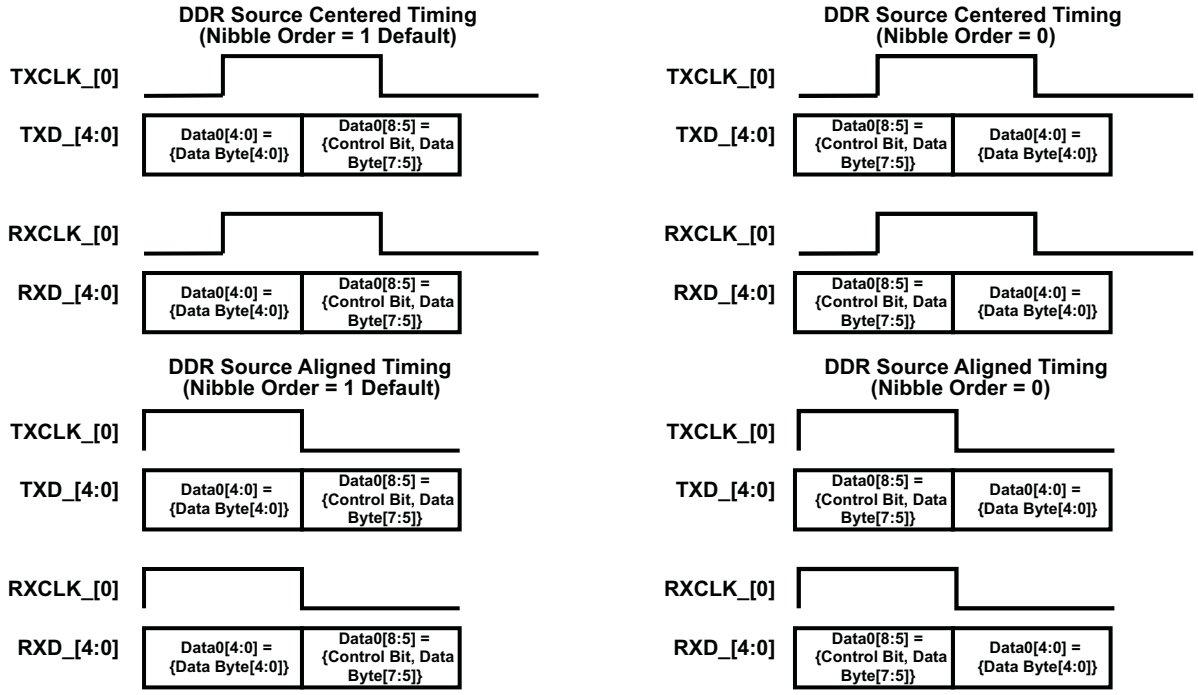


Figure 2-14. RNBI – Individual Channel Byte Ordering – Channel 0 Example

2.7.9 TBID Mode (Ten Bit Interface DDR)

Table 2-11. TBID – Lane To Functional Pin Mapping

DATA CHANNEL NUMBER	TRANSMIT DATA 10 BITS (INPUT)	RECEIVE DATA 10 BITS (OUTPUT)	TRANSMIT CLOCK (INPUT)	RECEIVE CLOCK (OUTPUT)
Channel 0	{TXC_[4], TXC_[0],TXD_[7:0]}	{RXC_[4], RXC_[0],RXD_[7:0]}	TXCLK_[0]	RXCLK_ [0]

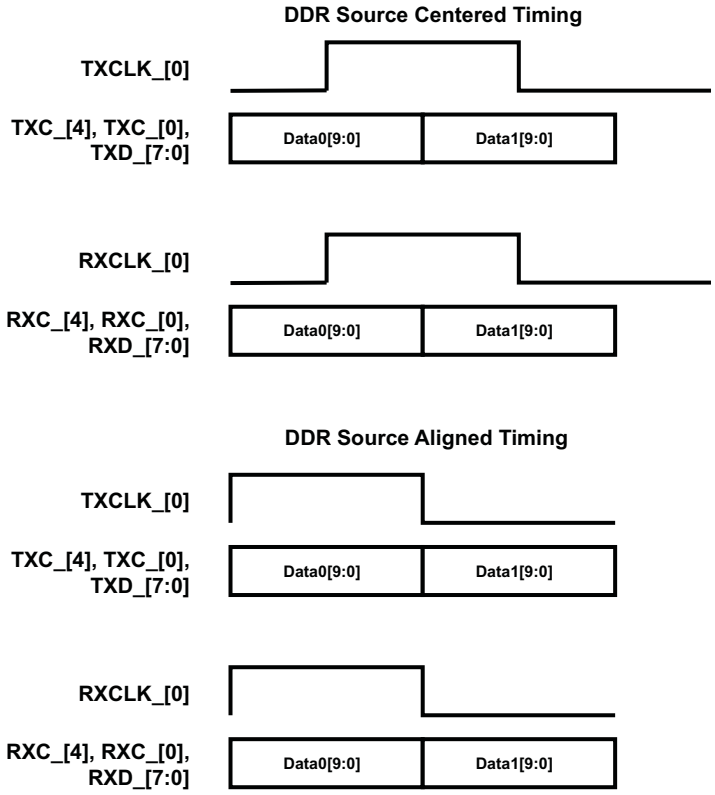


Figure 2-15. TBID – Individual Channel Byte Ordering – Channel 0 Example

2.7.10 NBID Mode (Nine Bit Interface DDR)

Table 2-12. NBID – Lane To Functional Pin Mapping

DATA CHANNEL NUMBER	TRANSMIT DATA 9 BITS (INPUT)	RECEIVE DATA 9 BITS (OUTPUT)	TRANSMIT CLOCK (INPUT)	RECEIVE CLOCK (OUTPUT)
Channel 0	{TXC_[0],TXD_[7:0]}	{RXC_[0],RXD_[7:0]}	TXCLK_[0]	RXCLK_ [0]

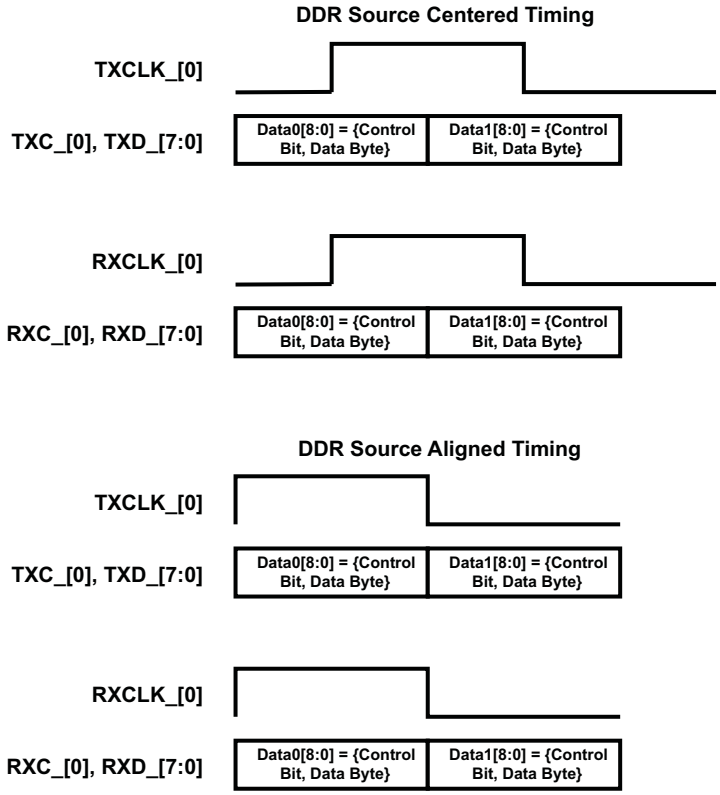


Figure 2-16. NBID – Individual Channel Byte Ordering – Channel 0 Example

2.7.11 Parallel Interface Clocking Modes

The TLK3131 supports source centered timing and source aligned DDR timing on the parallel receive output bus. TLK3131 also supports rising edge aligned and falling edge aligned SDR timing on the parallel receive output bus. See Figure 2-17 for more details.

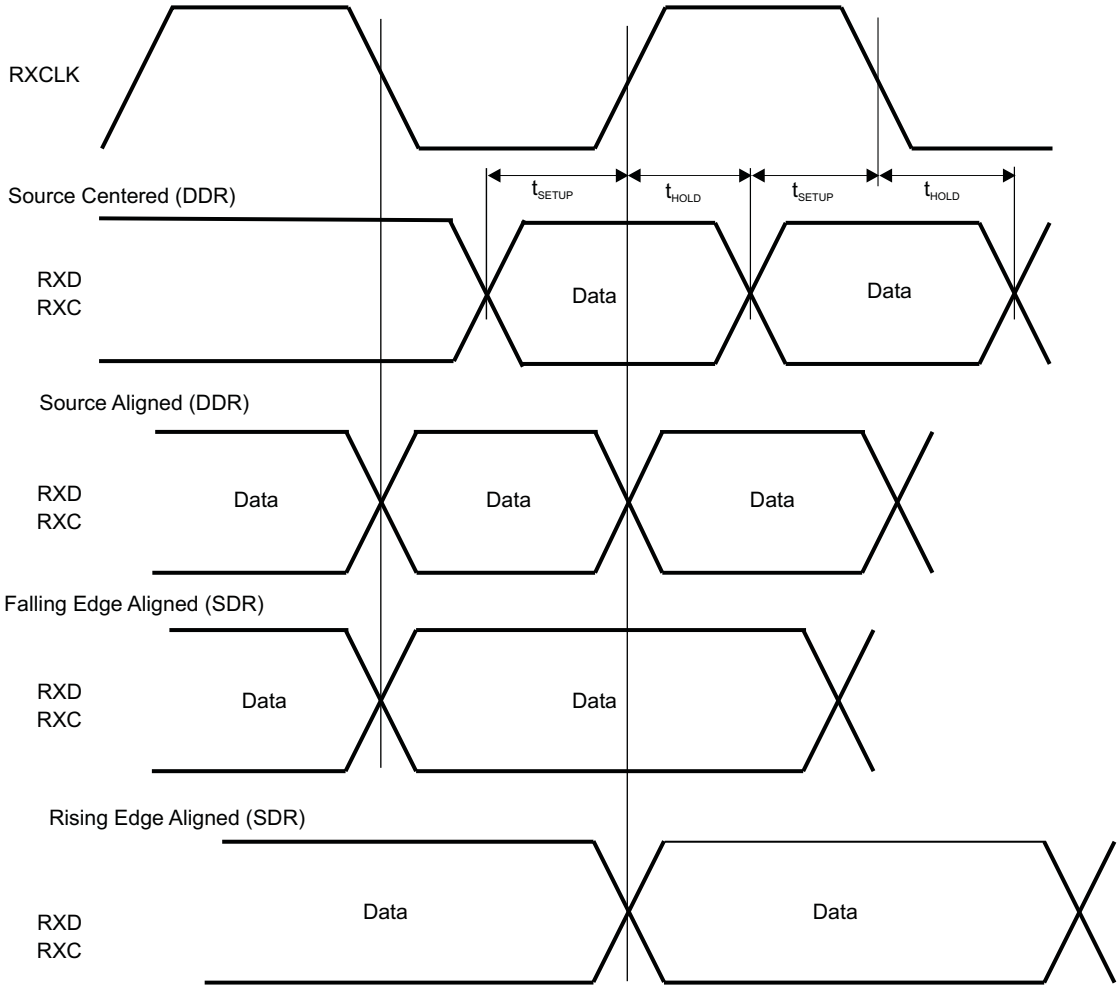


Figure 2-17. Receive Interface Timing – Source Centered/Aligned

The transmit input timing modes are shown in Figure 2-18. SDR/DDR input timing modes supported are similar to those supported in the receive direction.

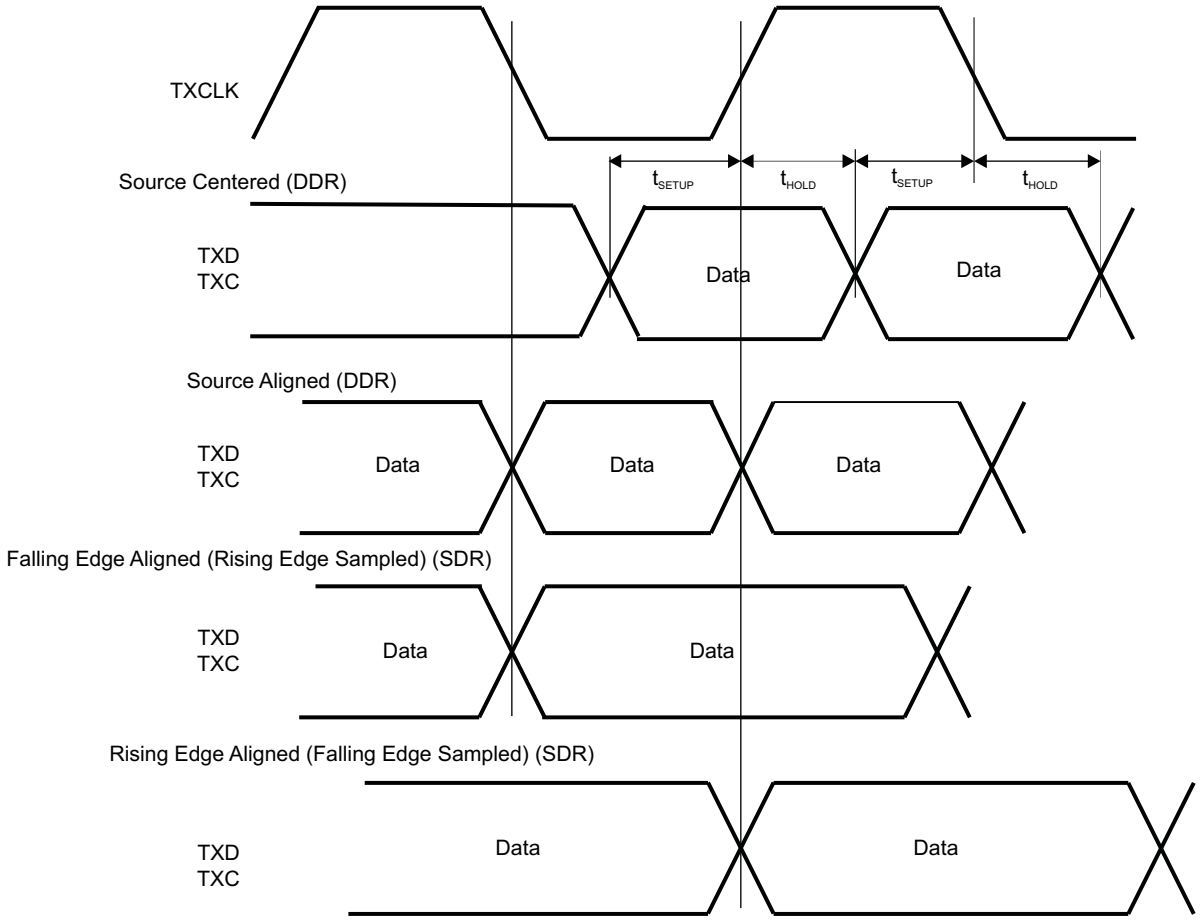


Figure 2-18. Transmit Interface Timing

2.7.12 Parallel to Serial

The parallel-to-serial shift register takes in data and converts it to a serial stream. The shift register is clocked by the internally generated bit clock, which is 10 times the reference clock (REFCLKP/REFCLKN) frequency. The least significant bit (LSB) is transmitted first.

2.7.13 Serial to Parallel

Serial data is received on the RDP/RDN pins. The interpolator and clock recovery circuit will lock to the data stream if the clock to be recovered is within ±200 PPM of the internally generated bit rate clock. The recovered clock is used to retime the input data stream. The serial data is then clocked into the serial-to-parallel shift registers. If enabled, the 10-bit wide parallel data is then fed into 8b/10b decoders.

2.7.14 High Speed CML Output

The high speed data output driver is implemented using Current Mode Logic (CML) with integrated pull up resistors, requiring no external components. The line can be directly coupled or AC coupled. Under many circumstances, AC coupling is desirable.

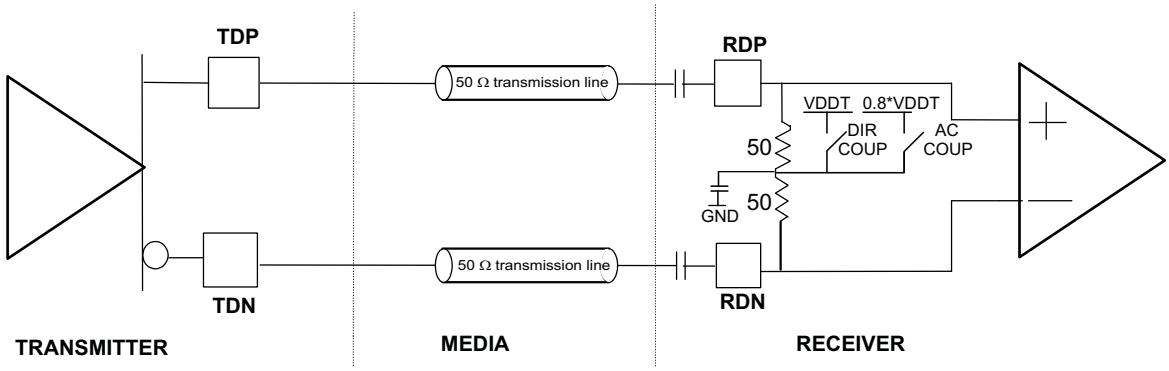


Figure 2-19. Example High Speed I/O AC Coupled Mode

Current Mode Logic (CML) drivers often require external components. The disadvantage of the external component is a limited edge rate due to package and line parasitic. The CML driver on TLK3131 has on-chip 50Ω termination resistors terminated to VDDT, providing optimum performance for increased speed requirements. The transmitter output driver is highly configurable allowing output amplitude and de-emphasis to be tuned to a channel's individual requirements. Software programmability allows for flexible output amplitude control. AC Coupled and Direct Coupled modes are supported. When AC coupling is selected, the receiver input is internally biased 0.8×VDDT which is the optimum voltage for input sensitivity. As the input and output references are derived from VDDT, the tolerance of this supply will dominate the accuracy of the internal reference.

When transmitting data across long lengths of PCB trace or cable, the high frequency content of the signal is attenuated due to the skin effect of the media. This causes a “smearing” of the data eye when viewed on an oscilloscope. The net result is reduced timing margins for the receiver and clock recovery circuits. In order to provide equalization for the high frequency loss, 1-tap finite impulse response (FIR) transmit de-emphasis is implemented. A highly configurable output driver maximizes flexibility in the end system by allowing de-emphasis and output amplitude to be tuned to a channel’s individual requirements. A total of 15 de-emphasis settings and 8 output amplitude settings can be independently selected.

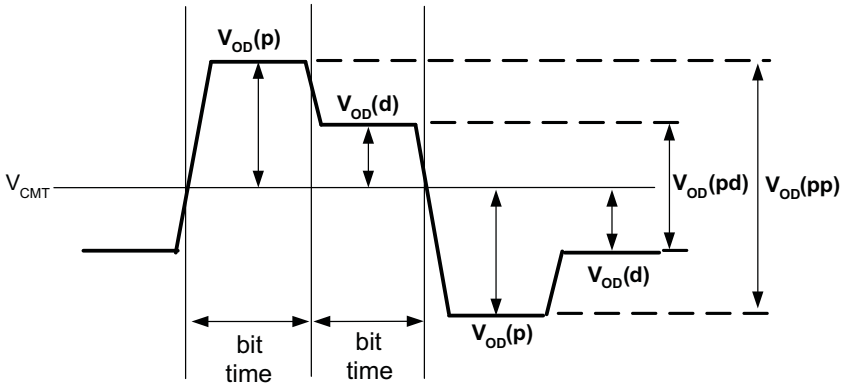


Figure 2-20. Output Differential Voltage With 1-Tap FIR De-emphasis

The level of de-emphasis is programmable via MDIO Register bits. Users can control the strength of the de-emphasis to optimize for a specific system requirement.

2.7.15 High Speed Receiver

The high speed receiver conforms to the physical layer requirements of IEEE 802.3ae Clause 47(XAUI),

Gigabit Ethernet, and FibreChannel 1 and 2. Register control gives selection between AC and DC coupling at the receiver. When the receiver is AC coupled, the termination impedances of the receivers are configured as 100 Ω with the center tap weakly tied to 0.8×VDDT with a capacitor to create an AC ground. When the receiver is DC coupled, the common mode will be determined by both receiver and transmitter characteristics.

The receive channel incorporates an adaptive equalizer. This circuit compensates for channel insertion loss by amplifying the high frequency components of the signal, reducing inter-symbol interference. Equalization can be enabled or disabled per register settings. Both the gain and bandwidth of the equalizer are controlled by the receiver equalization logic. There are ten available equalization settings.

2.7.16 Loopback

Configuration for parallel or serial side loopback is possible.

An external loopback (requiring external connection) is also supported, which can be used with the PRBS patterns, as well as the CRPAT, Mixed/High/Low Frequency tests.

2.7.17 Link Test Functions

The TLK3131 has an extensive suite of built in test functions to support system diagnostic requirements. There is a built-in link test generator and verification logic. Several patterns can be selected via the MDIO that offer extensive test coverage. The patterns are: 2^7-1 or 2^{23}-1 PRBS (Pseudo Random Bit Stream), CRPAT, high and low and mixed frequency patterns.

2.7.18 MDIO Management Interface

The TLK3131 supports the Management Data Input/Output (MDIO) Interface as defined in Clause 22 of the IEEE 802.3 Ethernet specification. The MDIO allows register-based management and control of the serial links. Normal operation of the TLK3131 is possible without use of this interface. However, some additional features are accessible only through the MDIO.

The MDIO Management Interface consists of a bi-directional data path (MDIO) and a clock reference (MDC). The device id and port address are determined by control pins (see Table 3-3).

TLK3131 will respond to MDIO accesses for two channels (channel 0 and channel 1), although there is no datapath for channel 1.

In Clause 22, the top 4 control pins PRTAD[4:1] determine the device port address. In this mode the 2 individual channels (channel one datapath unusable) in TLK3131 are classified as 2 different ports. So for any PRTAD[4:1] value there will be 2 ports per TLK3131.

TLK3131 will respond if the 4 MSB's of PHY address field on MDIO protocol (PA[4:1]) matches PRTAD[4:1]. The LSB of PHY address field (PA[0]) will determine which channel/port within TLK3131 to respond to.

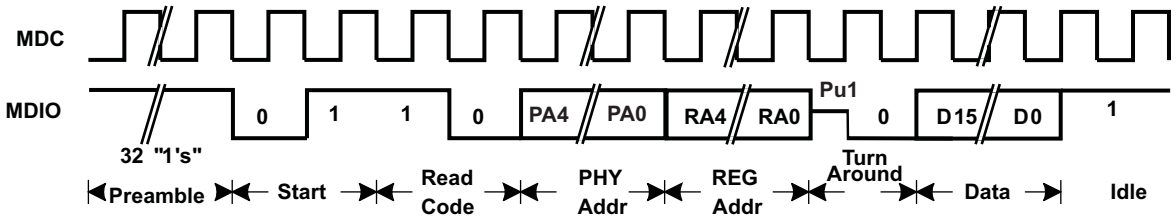
If PA[0] = 1b0, TLK3131 Channel 0 will respond.

If PA[0] = 1b1, TLK3131 Channel 1 will respond. (This channel does not have a datapath pinned out, and is not usable).

Write transactions which address an invalid register or device or a read only register will be ignored. Read transactions which address an invalid register will return a 0.

2.7.19 MDIO Protocol Timing

The Clause 22 timing required to read from the internal registers is shown in Figure 2-21. The Clause 22 timing required to write to the internal registers is shown in Figure 2-22.



(1) Note that the 1 in the Turn Around section is externally pulled up, and driven to Z by TLK3131

Figure 2-21. CL22 – Management Interface Read Timing

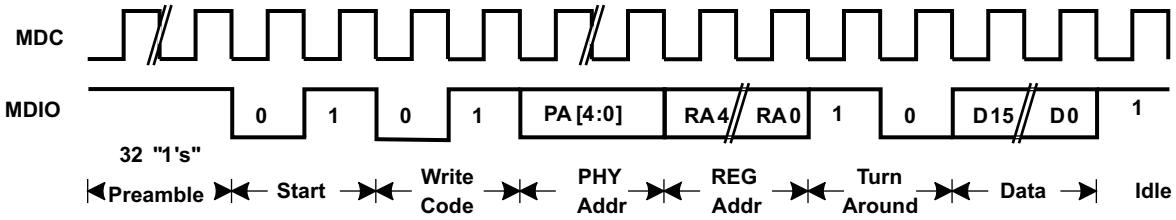


Figure 2-22. CL22 - Management Interface Write Timing

The IEEE 802.3 Clause 22 specification defines many of the registers, and additional registers have been implemented for expanded functionality.

2.7.20 Clause 22 Indirect Addressing

The TLK3131 Register space is divided into two register groups. One register group can be addressed directly through Clause 22, and one register group can be addressed indirectly through Clause 22. The register group which can be addressed through Clause 22 indirectly is implemented in vendor specific register space (16'h9000 onwards). Due to clause 22 register space limitations, an indirect addressing method is implemented so that this extended register space can be accessed through clause 22. To access this register space (16'h9000 onwards), an address control register (Reg 30, 5'h1E) should be written with the register address followed by a read/write transaction to address data register (Reg 31, 5'h1F) to access the contents of the address specified in address control register. Following timing diagrams illustrate an example write transaction to Register 16'h9000 using indirect addressing in Clause 22.

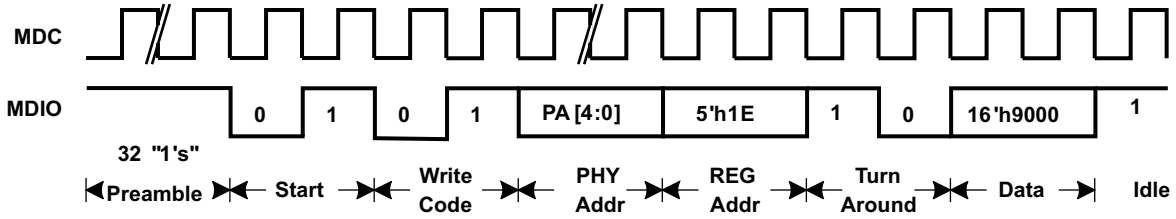


Figure 2-23. CL22 – Indirect Address Method – Address Write

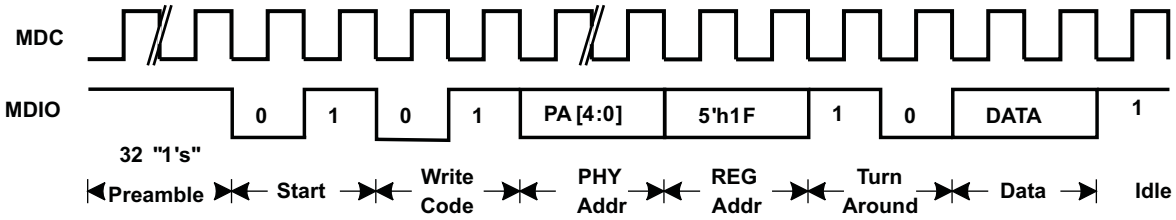


Figure 2-24. CL22 – Indirect Address Method – Data Write

Following timing diagrams illustrate an example read transaction to read contents of Register 16'h9000 using indirect addressing in Clause 22.

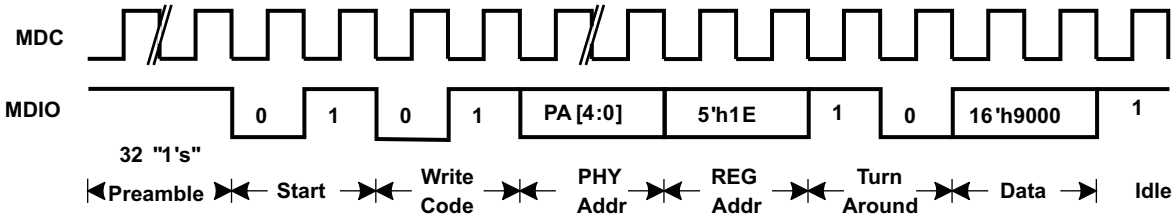
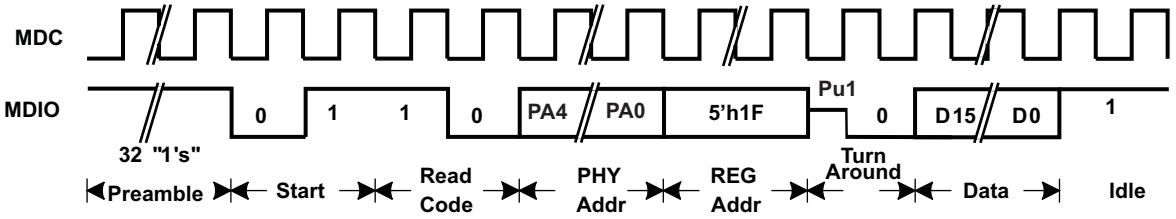


Figure 2-25. CL22 – Indirect Address Method – Address Write



(1) Note that the 1 in the Turn Around section is externally pulled up, and driven to Z by TLK3131.

Figure 2-26. CL22 – Indirect Address Method – Data Read

The IEEE 802.3 Clause 22/45 specification defines many of the registers, and additional registers have been implemented for expanded functionality.

2.8 PROGRAMMERS REFERENCE

Following registers can be addressed directly only through Clause 22. These bits are per channel basis.

Channel identification is based on PHY (Port) address field.

Channel 0 can be accessed by setting LSB of PHY address to 0.

Channel 1 can be accessed by setting LSB of PHY address to 1 (access is only required during device initialization per the software bring up procedure).

Table 2-13. PHY_CONTROL_1

ADDRESS: 0x00		DEFAULT: 0x0140	
BIT(s)	**NAME**	**DESCRIPTION**	**ACCESS**
0.15	Reset	1 = PHY reset (including all registers and Tx/Rx datapath) 0 = Normal operation (Default 1'b0) This is a global bit (not per channel). Asserting this bit is equivalent to asserting the device primary input RST_N.	RW SC(1)
0.14	Loopback	Logically OR'ed with PLOOP 1 = Enable loop back mode. In this mode, serial output of the channel is looped back onto serial input. 0 = Disable loop back mode (Default 1'b0)	RW
0.13	Speed Selection(LSB)	This is the least significant bit of the speed selection bits (MSB is 0.6). {0.6,0.13} = 2'b10 1000Base-X Rate This bit always reads 0.	RO
0.12	Auto-Negotiation Enable	Always reads 0. (Auto-Negotiation not supported)	RO
0.11	Power Down	Setting this bit high powers down the channel, with exception that MDIO interface stays active. Serdes PLL's can be shut down by de-asserting bits 36864.12 and 36864.4. Jitter cleaner PLL can be shut down by de-asserting 37127.15 1 = Power Down mode is enabled. 0 = Normal operation (Default 1'b0)	RW
0.10	Isolate	Setting this bit high isolates the channel from the parallel interface. Inputs are ignored; Outputs are set to high impedance. 1 = Isolate is enabled 0 = Normal operation (Default 1'b0)	RW
0.9	Restart Auto-Negotiation	Always reads 0. (Auto-Negotiation not supported)	RO
0.8	Duplex Mode	Always reads 1. (Only Full duplex supported)	RO
0.7	Collision Test	Not Applicable. Read will return a 0.	RO
0.6	Speed Selection (MSB)	This is the most significant bit of the speed selection bits (LSB is 0.13). {0.6,0.13} = 2'b10 1000Base-X Rate. This bit always reads 1	RO

(1) After reset bit is set to one, it automatically sets itself back to zero on the next MDC clock cycle.

Table 2-14. PHY_STATUS_1

ADDRESS: 0x01		DEFAULT: 0x0101	
BIT(s)	**NAME**	**DESCRIPTION**	**ACCESS**
1.15	1000Base-T4	Always reads 0	RO
1.14	100Base-X FD	Always reads 0	RO
1.13	100Base-X HD	Always reads 0	RO
1.12	10Mb/s FD	Always reads 0	RO
1.11	10Mb/s HD	Always reads 0	RO
1.10	100Base-T2 FD	Always reads 0	RO
1.9	100Base-T2 HD	Always reads 0	RO
1.8	Extended Status	Read will return 1 indicating extended status information is held in register 0x0F.	RO
1.6	MF Prea Supp	Read will return 0 indicating MDIO doesn't accept command without preceding preamble (minimum 32 1's). Writes will be ignored	RO
1.5	AN Complete	Always reads 0 (AN not supported)	RO
1.4	Remote Fault	Always reads 0	RO
1.3	AN Ability	Read will return 0, indicating that Auto negotiation is not supported	RO

Table 2-14. PHY_STATUS_1 (continued)

ADDRESS: 0x01		DEFAULT: 0x0101	
BIT(s)	**NAME**	**DESCRIPTION**	**ACCESS**
1.2	Link Status	Read will return the Link Status and is valid only when device is in GMII/RGMII mode or when bit 17.7 is set in Non-GMII/RGMII modes. Note: Link status will always indicate high when in loopback. In remote loopback mode, the bit represents the normal bit function. 1 = Link UP 0 = Link DOWN	RO/LL
1.1	Jabber Detect	Always reads 0	RO
1.0	Extended Capability	Read will return 1 indicating extended register capability	RO

Table 2-15. PHY_IDENTIFIER_1

ADDRESS: 0x02		DEFAULT: 0x4000	
BIT(s)	**NAME**	**DESCRIPTION**	**ACCESS**
2.15.0	OUI c:r	Organizationally unique identifier.	RO

Table 2-16. PHY_IDENTIFIER_2

ADDRESS: 0x03		DEFAULT: 0x50E0	
BIT(s)	**NAME**	**DESCRIPTION**	**ACCESS**
3.15:0	OUI c:r	Device identifier. Manufacturer model and revision number	RO

Table 2-17. PHY_EXT_STATUS

ADDRESS: 0x0F		DEFAULT: 0x8000	
BIT(s)	**NAME**	**DESCRIPTION**	**ACCESS**
15.15	1000Base-X FD	Always reads 1, indicating device supports Full Duplex mode.	RO
15.14	1000Base-X HD	Read will return 0, writes will be ignored.	RO
15.13	1000Base-T FD	Read will return 0, writes will be ignored.	RO
15.12	1000Base-T HD	Read will return 0, writes will be ignored.	RO

Table 2-18. PHY_CH_CONTROL_1

ADDRESS: 0x10		DEFAULT: 0x0000	
BIT(s)	**NAME**	**DESCRIPTION**	**ACCESS**
16.15	Reserved	Reserved, This value always reads zero.	RW/SC
16.11	Datapath reset control	1 = Resets channel logic excluding MDIO registers (Resets Tx and Rx datapath)	RW/SC
16.10:9	Receive Parallel Output clock select	00 = Selects SERDES TX clock (Default 2'b00) 01 = Selects Jitter cleaned clock(Selecting the jitter cleaned clock while the jitter cleaner PLL is disabled is not recommended) 10 = Selects SERDES RX clock 11 = Reserved	RW
16.8	Farend Loopback	Logically OR'ed with SLOOP When asserted high the data presented at the serial receive interface is looped back to the serial transmit interface of the channel via the deserializer, the serializer and if enabled the PCS function. If 1GX PCS is not enabled, the incoming datarate must be frequency locked (ppm 0) with REFCLK. Also referred to as remote loopback. 0 = Farend Loopback is disabled. (Default 1'b0) 1 = Farend loopback is enabled.	RW
16.7	PRBS Verifier Enable	A logic 1 enables the PRBS (2^7) verifier in the receive datapath. Logically OR'ed with the PRBSEN pin. (Default 1'b0)	RW
16.6	PRBS Generator Enable	A logic 1 enables the PRBS (2^7) generator in the transmit datapath. Logically OR'ed with the PRBSEN pin. (Default 1'b0)	RW
16.5	Channel sync freeze control	When set, freezes last acquired word alignment. (Default 1'b0)	RW

Table 2-18. PHY_CH_CONTROL_1 (continued)

ADDRESS: 0x10		DEFAULT: 0x0000	
BIT(s)	**NAME**	**DESCRIPTION**	**ACCESS**
16.4	Test Pattern Generator Enable	When high activates the generator selected by bits 16.2:0. (Default 1'b0)	RW
16.3	Test Pattern Verifier Enable	When high activates the verifier selected by bits 16.2:0. (Default 1'b0)	RW
16.2:0	Pattern Select	Test Pattern Selection 000 = High Frequency Test Pattern (Default 3'b000) 001 = Low Frequency Test Pattern 010 = Mixed Frequency Test Pattern 011 = CRPAT Long 100 = CRPAT Short Others = Reserved	RW

Table 2-19. PHY_CH_CONTROL_2

ADDRESS: 0x11		DEFAULT: 0x3590	
BIT(s)	**NAME**	**DESCRIPTION**	**ACCESS**
17.15	Reserved	Reserved, This value always reads zero.	RW/SC
17.14	Sync Status Override	1 = Causes an override of the sync state of 1000Base-X synchronization state machine to reflect a "1" in the sync_status (1.2) bit. 0 = Original (normal operation) sync_status value is represented in bit 1.2. (Default 1'b0)	RW
17.13	TX PMA Bit Order	When asserted, allows the ten bits of data given to the parallel side of the SERDES TX macro to be flipped. This is normally set since the SERDES transmits MSB first, and the 1000Base-X standard requires LSB to be transmitted first. For standard based operation, the customer may leave this bit alone. (Default 1'b1)	RW
17.12	RX PMA Bit Order	When asserted, allows the ten bits of data received from the parallel side of the SERDES RX macro to be flipped. This is normally set since the SERDES receives MSB first, and the 1000Base-X standard requires LSB to be received first. For standard based operation, the customer may leave this bit alone. (Default 1'b1)	RW
17.11	LOS Override	1 = Overrides Loss of signal (LOS) status coming from SERDES. Synchronization turned on irrespective of LOS status 0 = Synchronization depends on LOS status. (Default 1'b0)	RW
17.10	CTC enable	1 = Clock Tolerance Compensation on receive datapath is enabled (Default 1'b1) 0 = Clock Tolerance Compensation on receive datapath is disabled	RW
17.9	Full DDR mode	1 = Sets the device in full DDR mode (NBID/TBID modes) 0 = Disables full DDR mode (Default)	RW
17.8	RCLK out enable	1 = Enables RX_CLK out (Default 1'b1) 0 = Disables RX_CLK out. RX_CLK will be low when this bit is de-asserted	RW
17.7	Comma enable	1 = Enables comma detection (Default 1'b1) 0 = Disables comma detection	RW
17.6	FC enable	1 = Enables FC_PH overlay detection. This is needed in 1x/2x Fiber channel mode to allow proper detection of EOF 8B/10B disparity 0 = Disables FC_PH overlay detection (Default 1'b0)	RW
17.5	Data mode	Valid only when 17.9 (Full DDR mode) is LOW. 1 = Enables DDR data mode on parallel Transmit and Receive directions (data clocked on both rising and falling edge) 0 = Enables SDR data mode on parallel Transmit and Receive directions (data is clocked only on rising edge or only on falling edge) (Default 1'b0)	RW
17.4	Nibble order	Applicable only in non FULL DDR modes 1 = LSB on rising edge followed by MSB on falling edge (Default 1'b1) 0 = MSB on rising edge followed by LSB on falling edge	RW
17.3	PCS TX_RX Enable	1 = Enables 1000Base-X PCS Tx and PCS Rx functions 0 = Disables 1000Base-X PCS Tx Function (Default 1'b0)	RW
17.2	Encode Decode Enable	0 = 8B/10B encode decode functions are disabled (Default 1'b0) 1 = 8B/10B encode decode functions are enabled	RW
17.1	TX Edge Mode	When channel is in DDR mode 1 = Source aligned timing on transmit parallel interface. 0 = Source centered timing on transmit parallel interface. Data is latched on both rising and falling clock edges.	RW

Table 2-19. PHY_CH_CONTROL_2 (continued)

ADDRESS: 0x11		DEFAULT: 0x3590	
BIT(s)	**NAME**	**DESCRIPTION**	**ACCESS**
		When channel is in SDR mode 1 = Rising edge align mode. Incoming parallel data is aligned to rising edge of parallel input clock. Internally data is latched at the falling edge of the clock. 0 = Falling edge align mode. Incoming data is aligned to falling edge of parallel input clock. Internally data is latched at the rising edge of the clock	
17.0	RX Edge Mode	When channel is in DDR mode 1 = Source aligned timing on receive parallel interface. Data changes at clock edge. 0 = Source centered timing on receive parallel interface. When channel is in SDR mode 1 = Rising edge align mode. Outgoing parallel data is aligned to the rising edge of the parallel output clock 0 = Falling edge align mode. Outgoing parallel data is aligned to the falling edge of the parallel output clock	RW

Table 2-20. PHY_RX_CTC_FIFO_STATUS

ADDRESS: 0x12		DEFAULT: 0x0000	
BIT(s)	**NAME**	**DESCRIPTION**	**ACCESS**
18.15	RX_CTC_Reset	When high indicates overflow or underflow has occurred in CTC FIFO and FIFO has been reset.	RO/LH
18.14	RX_CTC_Insert	When high indicates RX CTC has inserted at least one ordered set.	
18.13	RX_CTC_Delete	When high indicates RX CTC has deleted at least one ordered set.	

Table 2-21. PHY_TX_CTC_FIFO_STATUS

ADDRESS: 0x13		DEFAULT: 0x0000	
BIT(s)	**NAME**	**DESCRIPTION**	**ACCESS**
19.15	TX_FIFO_Reset_1Gx	When high indicates collision has occurred in TX FIFO and the FIFO is reset in 1gx mode. Valid in Non-NBID, Non-TBID modes.	RO/LH

Table 2-22. PHY_TX_WIDE_FIFO _STATUS

ADDRESS: 0x14		DEFAULT: 0x0000	
BIT(s)	**NAME**	**DESCRIPTION**	**ACCESS**
20.15	TX_WIDE_FIFO_Overflow	When high indicates Overflow condition has occurred in TX WIDE FIFO. Valid only when device is in NBID/TBID modes.	RO/LH
20.14	TX_WIDE_FIFO_Underflow	When high indicates Underflow condition has occurred in TX WIDE FIFO. Valid only when device is in NBID/TBID modes.	

Table 2-23. PHY_TEST_PATTERN_SYNC_STATUS

ADDRESS: 0x15		DEFAULT: 0x0000	
BIT(s)	**NAME**	**DESCRIPTION**	**ACCESS**
21.1	Test Pattern Sync	When high indicates alignment has been determined and a correct pattern has been received for fixed test patterns.	RO
21.0	CRPAT Sync	When high indicates alignment has been determined and a correct pattern has been received for continuous test patterns.	

Table 2-24. PHY_TEST_PATTERN_COUNTER

ADDRESS: 0x16		DEFAULT: 0xFFFD	
BIT(s)	**NAME**	**DESCRIPTION**	**ACCESS**
22.15:0	Fixed Test Pattern Error Counter	This counter reflects error count for high, Mixed, and Low Frequency test patterns. Counter increments for each received character that has an error. Counter clears upon read.	COR

Table 2-25. PHY_CRPAT_PATTERN_COUNTER_1(1)

ADDRESS: 0x17		DEFAULT: 0xFFFF	
BIT(s)	**NAME**	**DESCRIPTION**	**ACCESS**
23.15:0	CRPAT Error counter[31:16]	This counter reflects MSW part of error count for CRPAT Frequency test pattern. Counter increments for each received character that has an error. Counter clears upon read.	COR

(1) User has to make sure that register 23 is read first and then register 24. If user reads register 24 before reading register 23, then the count value read through register 24 may not be correct.

Table 2-26. PHY_CRPAT_PATTERN_COUNTER_2(1)

ADDRESS: 0x18		DEFAULT: 0xFFFD	
BIT(s)	**NAME**	**DESCRIPTION**	**ACCESS**
24.15:0	CRPAT Error counter[15:0]	This counter reflects LSW part of error count for CRPAT Frequency test pattern. Counter increments for each received character that has an error. Counter clears upon read.	COR

(1) User has to make sure that register 23 is read first and then register 24. If user reads register 24 before reading register 23, then the count value read through register 24 may not be correct.

Table 2-27. PHY_TEST_MODE_CONTROL

ADDRESS: 0x1B		DEFAULT: 0x7000	
BIT(s)	**NAME**	**DESCRIPTION**	**ACCESS**
27.15	Reserved	Reserved, This value always reads zero.	RW/SC
27.14:12	Test Mux Select	Mux control to select debug signals onto test mux data pins. For TI test purposes only	RW

Table 2-28. PHY_CHANNEL_STATUS

ADDRESS: 0x1C		DEFAULT: 0x0000	
BIT(s)	**NAME**	**DESCRIPTION**	**ACCESS**
28.15	Signal Detect	When high, indicates that the SERDES detected valid signal.	RO/LL
28.13	Encoder Invalid Code Word	When high, indicates that the 1000Base-X encoder received an invalid control word.	RO/LH
28:12	Decoder Invalid Code Word	When high, indicates that the 1000Base-X decoder received an invalid code word.	

Table 2-29. PHY_PRBS_HIGH_SPEED_TEST_COUNTER

ADDRESS: 0x1D		DEFAULT: 0xFFFD	
BIT(s)	**NAME**	**DESCRIPTION**	**ACCESS**
29.15:0	PRBS High Speed Test Counter	This counter reflects errors for PRBS (2^7) test pattern verification . Counter increments by one for each received character that has error. This counter saturates at 16'hffff. When read, it resets to zero and continues to count.	COR

Table 2-30. PHY_EXT_ADDRESS_CONTROL

ADDRESS: 0x1E		DEFAULT: 0x0000	
BIT(s)	**NAME**	**DESCRIPTION**	**ACCESS**
30.15:0	Ext address control	This register should be written with the extended register address to be written/read. Contents of address written in this register can be accessed from Reg 31 (0x1F).	RW

Table 2-31. PHY_EXT_ADDRESS_DATA

ADDRESS: 0x1F		DEFAULT: 0x0000	
BIT(s)	**NAME**	**DESCRIPTION**	**ACCESS**
31.15:0	Ext address data register	This register contains the data associated with the register address written in Register 30 (0x1E)	RW

2.9 Top Level Programmers Reference

Following registers can be addressed indirectly through Clause 22.

Table 2-32. SERDES_PLL_CONFIG

ADDRESS: 0x9000		DEFAULT: 0x1515	
BIT(s)	**NAME**	**DESCRIPTION**	**ACCESS**
36864.14:13	Loop Bandwidth RX(LB_RX)	SERDES RX PLL Bandwidth settings 00 = Applicable when JC PLL is not engaged 01 = Reserved 10 = Reserved 11 = Applicable when JC PLL is engaged	RW
36864. 12	ENPLL_RX	0 = Disables PLL in SERDES RX 1 = Enable PLL in SERDES RX	RW
36864.11:8	PLL Multiplier factor RX (MPY_RX)	SERDES RX PLL multiplier setting See Table 2-33	RW
36864.7	BUSWIDTH	1 = 8 bit mode. Applicable for only EBI and REBI modes 0 = 10 Bit mode. Applicable for all other modes	RW
36864.6:5	Loop Bandwidth TX (LB_TX)	SERDES TX PLL Bandwidth settings 00 = Applicable when JC PLL is not engaged 01 = Reserved 10 = Reserved 11 = Applicable when JC PLL is engaged	RW
36864.4	ENPLL_TX	0 = Disables PLL in SERDES TX 1 = Enable PLL in SERDES TX	RW
36864. 3:0	PLL Multiplier factor TX (MPY_TX)	SERDES TX PLL multiplier setting See Table 2-33	RW

Table 2-33. PLL Multiplier Control

36864[11:8]/ 36864[3:0]		36864[11:8]/ 36864[3:0]	
VALUE	**PLL MULTIPLIER FACTOR**	**VALUE**	**PLL MULTIPLIER FACTOR**
0000	4x	1000	15x
0001	5x	1001	20x
0010	6x	1010	25x
0011	Reserved	1011	Reserved
0100	8x	1100	Reserved
0101	10x	1101	50x
0110	12x	1110	60x
0111	12.5x	1111	Reserved

Table 2-34. SERDES_RATE_CONFIG_TX_RX

ADDRESS: 0x9001		DEFAULT: 0x0000	
BIT(s)	**NAME**	**DESCRIPTION**	**ACCESS**
36865.15:14	RATE_0_TX	TX Ch 0 Operating rate 00 = Full rate (2 data samples/output per PLL output clock cycle) 01 = Half rate (1 data sample/output per PLL output clock cycle) 10 = Quarter rate (1 data sample/output per 2 PLL output clock cycle) 11 = Reserved	RW
36865.13:12	Reserved	Reserved	RW
36865.7:6	RATE_0_RX	RX Ch 0 Operating rate 00 = Full rate (2 data samples/output per PLL output clock cycle) 01 = Half rate (1 data sample/output per PLL output clock cycle) 10 = Quarter rate (1 data sample/output per 2 PLL output clock cycle) 11 = Reserved	RW
36865.5:4	Reserved	Reserved	RW

Table 2-35. SERDES_RX0_CONFIG(1)

ADDRESS: 0x9002		DEFAULT: 0x0001	
BIT(s)	**NAME**	**DESCRIPTION**	**ACCESS**
36866.15:12	EQUALIZER	Adaptive equalization control 0000 = Adaptive equalization disabled. Equalizer provides flat response at maximum gain. 0001 = Full adaptive equalization 0010 to 1111 = Reserved	RW
36866.11:9	CDR	Clock data recovery algorithm selection	RW
36866.8	INVPAIR	1 = Inverts polarity of RXP and RXN	RW
36866.7:6	LOS	00 = Loss of signal detection disabled 01 = Reserved 10 = Loss of signal detection enabled with threshold in the range of 85-175 mVdfpp. 11 = Reserved.	RW
36866.5:4	ALIGN	Receiver symbol alignment selection 00 = Alignment disabled. 01 = Comma alignment enabled 10 = Symbol alignment will be performed by one bit position when this mode is selected (i.e ALIGN changes from 00 to 10) 11= Reserved	RW
36866.3:2	TERM	Receive Termination selection 00 = Common point connected to VDDT (For DC Coupled Systems) 01 = Common point set to 0.8 VDDT (For AC Coupled Systems) 10 = Reserved 11 = Reserved	RW
36866.1	ENTEST	1= Enables test modes specified in TESTCFG (Register 0x9012)	RW
36866.0	ENRX	1 = Enables receiver 0 = Disables receiver	RW

(1) These are SERDES receiver control bits for channel 0.

Table 2-36. SERDES_RX1_CONFIG(1)

ADDRESS: 0x9004		DEFAULT: 0x0001	
BIT(s)	**NAME**	**DESCRIPTION**	**ACCESS**
36868.15:12	Reserved	Reserved	RW

(1) These are SERDES receiver control bits for channel 1.

Table 2-37. SERDES_TX0_CONFIG

ADDRESS: 0x900A		DEFAULT: 0x0001	
BIT(s)	**NAME**	**DESCRIPTION**	**ACCESS**
36874.11:9	SWING	Transmitter Output swing control for SERDES transmitter. Refer Table 2-40: Output Swing Control If swing is set to 750mV or more, CM bit (36874.8) needs to be set to 1. If swing is set to 625 mV or less, CM bit (36874.8) needs to be set to 0.	RW
36874.8	CM	1 = Applicable for SWING settings 750 mV or more. 0 = Applicable for SWING settings 625 mV or less.	RW
36874.7:4	DE-EMPHASIS	Transmitter Differential output De-emphasis control Refer Table 2-39: Transmit De-emphasis Control	RW
36874.3	INVPAIR	Transmitter Polarity 1 = Inverted polarity. TXP considered negative data and TXN considered positive data 0 = Normal polarity. TXP considered positive data and TXN considered negative data	RW
36874.1	ENTEST	1= Enables test modes specified in TESTCFG (Register 0x9011)	RW
36874.0	ENTX	1 = Enables transmitter 0 = Disables transmitter	RW

Table 2-38. SERDES_TX1_CONFIG

ADDRESS: 0x900C		DEFAULT: 0x0001	
BIT(s)	**NAME**	**DESCRIPTION**	**ACCESS**
36876.11:3, 1:0	Reserved	Reserved	RW

Table 2-39. Transmit De-emphasis Control

36874/36876[7:4]					
VALUE	**AMPLITUDE REDUCTION**		**VALUE**	**AMPLITUDE REDUCTION**	
	%	**dB**		**%**	**dB**
0000	0	0	1000	38.08	–4.16
0001	4.76	–0.42	1001	42.85	–4.86
0010	9.52	–0.87	1010	47.61	–5.61
0011	14.28	–1.34	1011	52.38	–6.44
0100	19.04	–1.83	1100	57.14	–7.35
0101	23.8	–2.36	1101	61.9	–8.38
0110	28.56	–2.92	1110	66.66	–9.54
0111	33.32	–3.52	1111	71.42	–10.87

Table 2-40. Output Swing Control

36874/36876[11:9]			
Value	**Amplitude (mVdfpp)**	**Value**	**Amplitude (mVdfpp)**
000	125	100	750
001	250	101	1000
010	500	110	1250
011	625	111	1375

Table 2-41. SERDES_TEST_CONFIG_TX(1)

ADDRESS: 0x9011		DEFAULT: 0x0000	
BIT(s)	**NAME**	**DESCRIPTION**	**ACCESS**
36881.10:8	Reserved	Reserved for TI test.	RW
36881.7:6	LOOPBACK_TX	00 = Disabled 01 = Pad loopback. For TI purposes only 10 = Inner loopback (CML driver disabled) 11 = Inner loopback (CML driver enabled)	RW
36881.5:4	CLKBYPASS_TX	PLL Bypass control in test mode 00 = No bypass 01 = Reserved 10 = Functional bypass. Macros run using TESCLKT 11 = Refclk observe (Reserved. For TI purposes only)	RW
36881.3	ENRXPATT_TX	0 – Disables test pattern verification in SERDES TX macro. 1 – Enables test pattern verification in SERDES TX macro.	RW
36881.2	ENTXPATT_TX	0 – Disables test pattern generation in SERDES TX macro. 1 – Enables test pattern generation in SERDES TX macro.	RW
36881.1:0	TESTPATT_TX	Valid when ENTXPATT_TX, ENRXPATT_TX, ENTEST_TX are set 00 = Reserved (Default) 01 = Clock pattern (Half baud clock pattern with period of 2UI) 10 = 2^7 – 1 PRBS pattern 11 = 2^{23} – 1 PRBS pattern	RW

(1) Above control bits are only for vendor testing only. Customer should leave them at their default values

Table 2-42. SERDES_TEST_CONFIG_RX(1)

ADDRESS: 0x9012		DEFAULT: 0x0000	
BIT(s)	**NAME**	**DESCRIPTION**	**ACCESS**
36882.10:8	Reserved	Reserved for TI test.	RW
36882.7:6	LOOPBACK_RX	00 = Disabled 01 = Pad loopback. For TI purposes only 10 = Inner loopback (CML driver disabled) 11 = Inner loopback (CML driver enabled)	RW
36882.5:4	CLKBYPASS_RX	PLL Bypass control in test mode 00 = No bypass 01 = Reserved 10 = Functional bypass. Macros run using TESCLKR 11 = Refclk observe (Reserved. For TI purposes only)	RW
36882.3	ENRXPATT_RX	0 – Disables test pattern verification in SERDES RX macro. 1 – Enables test pattern verification in SERDES RX macro.	RW
36882.2	ENTXPATT_RX	0 – Disables test pattern generation in SERDES RX macro. 1 – Enables test pattern generation in SERDES RX macro.	RW
36882.1:0	TESTPATT_RX	Valid when ENTXPATT_RX, ENRXPATT_RX, ENTEST_RX are set 00 = Reserved (Default) 01 = Clock pattern (Half baud clock pattern with period of 2UI) 10 = 2^7 – 1 PRBS pattern 11 = 2^{23} – 1 PRBS pattern	R

(1) Above control bits are only for vendor testing only. Customer should leave them at their default values

Table 2-43. SERDES_RX0_STATUS(1)

ADDRESS: 0x9013		DEFAULT: 0x0000	
BIT(s)	**NAME**	**DESCRIPTION**	**ACCESS**
36883.3	LOSDTCT	When HIGH indicates Loss of Signal condition is detected for RX CH 0	RO
36883.2	ODDCG	LOW when SYNC is HIGH. After that toggles every cycle.	RO
36883.1	SYNC	When comma detection is enabled, this bit is HIGH when an aligned comma is received.	RO
36883.0	RX CH 0 TESTFAIL	When HIGH, indicates an error occurred during test pattern verification for SERDES RX CH 0. This bit status is valid only when SERDES RX test pattern verification bits are set	RO

(1) Above status bits are only for Receive CH 0.

Table 2-44. SERDES_RX1_STATUS

ADDRESS: 0x9014		DEFAULT: 0x0000	
BIT(s)	**NAME**	**DESCRIPTION**	**ACCESS**
36884.3:0	Reserved	Reserved	RO

Table 2-45. SERDES_TX0_STATUS(1)

ADDRESS: 0x9017		DEFAULT: 0x0000	
BIT(s)	**NAME**	**DESCRIPTION**	**ACCESS**
36887.0	TX CH 0 TESTFAIL	When HIGH, indicates an error occurred during test pattern verification for SERDES TX CH 0.	RO

(1) Above status bits are only for Receive CH 1.

Table 2-46. SERDES_TX1_STATUS

ADDRESS: 0x9018		DEFAULT: 0x0000	
BIT(s)	**NAME**	**DESCRIPTION**	**ACCESS**
36888.0	Reserved	Reserved	RO

Table 2-47. SERDES_PLL_STATUS

ADDRESS: 0x901B		DEFAULT: 0x0000	
BIT(s)	**NAME**	**DESCRIPTION**	**ACCESS**
36891.4	PLL_LOCK_RX	1 = Indicates PLL is locked within 10ppm of REFCLKP/N in SERDES RX macro	RO/LL
36891.0	PLL_LOCK_TX	1 = Indicates PLL is locked within 10ppm of REFCLKP/N in SERDES TX macro	

Table 2-48. JC_CLOCK_MUX_CONTROL

ADDRESS: 0x9100		DEFAULT: 0x3FF0	
BIT(s)	**NAME**	**DESCRIPTION**	**ACCESS**
37120.15:14	REF_SEL[1:0]	Jitter Cleaner Reference clock select control 00 = Selects differential REFCLKP/N as jitter cleaner clock input 01 = Selects CMOS REFCLK as jitter cleaner clock input 10 = Selects recovered clock as jitter cleaner clock input 11 = Reserved	RW
37120.13:12	RXB_SEL[1:0]	Jitter Cleaner RXBYTECLK select control 00 = Selects RXB_DIV divider output clock as RXBYTECLK 01 = Selects recovered clock as RXBYTECLK 10 = Selects CMOS REFCLK as RXBYTECLK 11 = Selects differential REFCLKP/N as RXBYTECLK	RW
37120.11:10	TX_SEL[1:0]	Jitter Cleaner SERDES TX Reference clock input select control 00 = Selects jitter cleaner output clock as TX SERDES reference clock input 01 = Selects recovered clock as TX SERDES reference clock input 10 = Selects CMOS REFCLK as TX SERDES reference clock input 11 = Selects differential REFCLKP/N as TX SERDES reference clock input	RW
37120.9:8	RX_SEL[1:0]	Jitter Cleaner SERDES RX Reference clock input select control 00 = Selects jitter cleaner output clock as RX SERDES reference clock input 01 = Selects recovered clock as RX SERDES reference clock input (Not Recommended) 10 = Selects CMOS REFCLK as RX SERDES reference clock input 11 = Selects differential REFCLKP/N as RX SERDES reference clock input	RW
37120.7:6	DEL_SEL[1:0]	Delay stopwatch clock input select control 00 = Selects delay clock divider output clock as delay stopwatch clock input 01 = Selects recovered clock as delay stopwatch clock input 10 = Selects CMOS REFCLK as delay stopwatch clock input 11 = Selects differential REFCLKP/N as delay stopwatch clock input	RW
37120.5:4	HSTL_SEL[1:0]	HSTL VTP 2x clock divider input select control 00 = Selects HSTL DIV clock output as HSTL VTP 2x clock divider input 01 = Selects recovered clock as HSTL VTP 2x clock divider input 10 = Selects CMOS REFCLK as HSTL VTP 2x clock divider input 11 = Selects differential REFCLKP/N as HSTL VTP 2x clock divider input	RW

Table 2-49. JC_VTP_CLK_DIV_CONTROL

ADDRESS: 0x9101		DEFAULT: 0x0E06	
BIT(s)	**NAME**	**DESCRIPTION**	**ACCESS**
37121.14:8	HSTL_DIV[6:0]	HSTL Output Divider 1 Value. See Figure 1-2. This value is the divider value for the clock which runs the HSTL impedance compensation controller. The target output frequency for the impedance controller clock is 40 MHz. If the jitter cleaner is not enabled, this value is not used. Legal programmed values are greater than or equal to 6	RW
37121.6:0	HSTL_DIV2[6:0]	HSTL Output Divider 2 Value. See Figure 1-2. This value is the divider value for the HSTL impedance compensation controller. The target output frequency for this clock is 40 MHz. When the jitter cleaner (HSTL_DIV1) is used, this value should be provisioned to 6 decimal. When the jitter cleaner (HSTL_DIV1) is not used, this divider value should be provisioned according to the following equation: Value = (Parallel Output Byte Clock Frequency / 40 MHz) Legal programmed values are 1, and greater than or equal to 4	RW

Table 2-50. JC_DELAY_STOPWATCH_CLK_DIV_CONTROL

ADDRESS: 0x9102		DEFAULT: 0x0600	
BIT(s)	**NAME**	**DESCRIPTION**	**ACCESS**
37122.14:8	DEL_DIV[6:0]	Delay Measurement Clock Output Divider Value. See Figure 1-2. Controls the clock divider for the delay stop watch function. This value should be provisioned to decimal 6.This value is only used when the delay calculator circuit is enabled. Legal programmed values are greater than or equal to 6	RW
37122.2:1	Delay stop watch lane select[1:0]	Lane select to enable comma monitor. Valid only when 37122:0 is “1” 00 = Comma monitor enabled 01 = Reserved 10 = Reserved 11 = Reserved	RW
37122.0	Delay stop watch clock enable	When set, enables Delay stop watch clock	RW

Table 2-51. JC_DELAY_STOPWATCH_COUNTER

ADDRESS: 0x9103		DEFAULT: 0x0000	
BIT(s)	**NAME**	**DESCRIPTION**	**ACCESS**
37123.15:0	Delay stop watch counter[15:0]	Delay Counter. This value represents the latency in number of clock cycles. This counter resets on read and will return 16’h0000 if its read before rx comma is received. If latency is more than 16’hFFFF clock cycles then this counter returns 16’hFFFF.	RO

Table 2-52. JC_REFCLK_FB_DIV_CONTROL

ADDRESS: 0x9104		DEFAULT: 0x018E	
BIT(s)	**NAME**	**DESCRIPTION**	**ACCESS**
37124.15	REFDIV_EN	1 = Enables Reference clock divider 0 = Disables Reference clock divider	RW
37124.14:8	REF_DIV[0:6]	Controls the clock divider value for the reference clock. See Figure 1-2, and Appendix A for provisioning details Note: REF_DIV[6:0] = 37124.8:14. (Example: To program REF_DIV to decimal value 4, 14:8 needs to be set to 7’b0010000)	RW
37124.7	FBDIV_EN	1 = Enables Feedback divider 0 = Disables feedback divider	RW
37124.6:0	FB_DIV[6:0]	Controls the feedback divider value See Figure 1-2, and Appendix A for provisioning details. Note: JC_CHARGE_PUMP_ CONTROL (37126) needs to be set accordingly based on FB_DIV range. Refer Table 2-55: Charge Pump Control Setting (CP_CTRL)	RW

Table 2-53. JC_RXB_OUTPUT_CLK_DIV_CONTROL

ADDRESS: 0x9105		DEFAULT: 0x0E8E	
BIT(s)	**NAME**	**DESCRIPTION**	**ACCESS**
37125.14:8	RXB_DIV[6:0]	Receive Byte Clock Output Divider Value. This divider value is always provisioned with the same value as RXTX_DIV[6:0]. See Figure 1-2, and Appendix A for provisioning details. This value is only used when the jitter cleaner is used to source the receive parallel interface output clock. Legal programmed values are greater than or equal to 6	RW
37125.7	OUTDIV_EN	1 = Enables output divider (RXTX_DIV) 0 = Disables output divider	RW
37125.6:0	RXTX_DIV[6:0]	RX/TX SERDES Output Divider Value See Figure 1-2, and Appendix A for provisioning details Legal programmed values are greater than or equal to 6	RW

Table 2-54. JC_CHARGE_PUMP_CONTROL(1)

ADDRESS: 0x9106		DEFAULT: 0x00C0	
BIT(s)	**NAME**	**DESCRIPTION**	**ACCESS**
37126.15:14	CP_BUF_CTRL[1:0]	Charge pump buffer control	RW
37126.13:0	CP_CTRL[13:0]	Charge pump control. When JC PLL is used, CP_CTRL[13:0] values need to be set according to FB_DIV[6:0] range. Refer Table 2-55: Charge Pump Control Setting (CP_CTRL)	RW

(1) When JC PLL is used, this register value should be set according to the values specified in Charge Pump Control Setting Table

Table 2-55. Charge Pump Control Setting (CP_CTRL)

FB DIV VALUE RANGE (37124[6:0]) (IN DECIMAL)	JC_CHARGE_PUMP_ CONTROL SETTING (37126 [15:0])
1 - 15	0x00FF
16 - 18	0x00C1
19 - 30	0x0081
31 - 33	0x017F
34 - 45	0x017D
46 - 53	0x011F
54 - 59	0x0151
60 - 68	0x0121
69 - 77	0x01C3
78 - 85	0x0101
86 - 88	0x02FB
89 - 91	0x0183
92 - 99	0x0237
100 - 107	0x0181
108 - 113	0x0261
114 - 127	0x0215

Table 2-56. JC_PLL_CONTROL

ADDRESS: 0x9107		DEFAULT: 0x30C4	
BIT(s)	**NAME**	**DESCRIPTION**	**ACCESS**
37127.15	JC_EN_PLL	0 = Disables Jitter Cleaner 1 = Enables Jitter Cleaner	RW
37127.14:12	VCO_BIAS_CTRL[2:0]	Control bits for VCO tail current	RW
37127.11:8	VCO_CAPBANK_CTRL[3:0]	Control bits for VCO band select	RW
37127.7	DIFFTX_EN	Enable signal for TX differential path	RW
37127.6	DIFFRX_EN	Enable signal for RX differential path	RW
37127.5:4	PFD_CTRL[1:0]	Control bits for phase frequency detector	RW
37127.3	AD_SEL_TST	Control bit to select either digital or analog TST_OUT	RW
37127.2	REFCLK_CML_EN	Enable signal for CML buffer inside output divider	RW

Table 2-57. JC_TEST_CONTROL_1(1)

ADDRESS: 0x9108		DEFAULT: 0x0000	
BIT(s)	**NAME**	**DESCRIPTION**	**ACCESS**
37128.15:12	REFCK_DIV_TST[3:0]	Test bits for Reference divider	RW
37128.11:8	FB_DIV_TST[3:0]	Test bits for Feedback divider	RW
37128.7:4	TXRX_DIV_TST[3:0]	Test bits for TXRX output divider. Should be set to 4'b1010 when JC PLL is used	RW
37128.3:2	RXBCLK_DIV_TST[1:0]	Test bits for RXBYTECLK divider	RW

(1) This register value should be written 0x00A0 when JC PLL is used

Table 2-58. JC_TEST_CONTROL_2

ADDRESS: 0x9109		DEFAULT: 0x0000	
BIT(s)	**NAME**	**DESCRIPTION**	**ACCESS**
37129.15:14	DEL_DIV_TST[1:0]	Test bits for Delay clock divider	RW
37129.13:12	HSTL_DIV_TST[1:0]	Test bits for HSTL VTP divider	RW
37129.11:10	HSTL_DIV2_TST[1:0]	Test bits for HSTL VTP 2X divider	RW
37129.9:8	PFD_TST[1:0]	Test bits for Phase frequency detector	RW
37129.7:4	CP_TST[3:0]	Test bits for Charge pump	RW
37129.3:0	CP_BUF_TST[3:0]	Test bits for Charge pump Buffer	RW

Table 2-59. JC_TI_TEST_CONTROL_1

ADDRESS: 0x9150		DEFAULT:0x0000	
BIT(s)	**NAME**	**DESCRIPTION**	**ACCESS**
37200.15:8	CML_BIAS_TST[7:0]	Test bits for Bias generator for CML divider. For TI purposes only.	RW
37200.7:4	CML_BIAS_CTRL[3:0]	Control bits for Bias generator for CML divider. For TI purposes only.	RW
37200.3	DIFFTX_ENTST	Enable for TX clock out from SERDES REFCLK MUX. For TI purposes only.	RW
37200.2	DIFFRX_ENTST	Enable for RX clock out from SERDES REFCLK MUX. For TI purposes only.	RW

Table 2-60. JC_TI_TEST_CONTROL_2

ADDRESS: 0x9151		DEFAULT: 0x0000	
BIT(s)	**NAME**	**DESCRIPTION**	**ACCESS**
37201.15:13	VCO_FILCAP_CTRL[2:0]	Control bits for VCO tail current noise filter. For TI purposes only.	RW
37201.12:10	ANA_MUX_CTRL[2:0]	Control bits to select the tested signals. For TI purposes only.	RW

Table 2-61. JC_TRIM_STATUS

ADDRESS: 0x9152		DEFAULT: 0x0000	
BIT(s)	**NAME**	**DESCRIPTION**	**ACCESS**
37202.9:0	JC_TRIM[9:0]	Jitter Cleaner Resistor Trim value	RO

Table 2-62. DIE_ID_7

ADDRESS: 0x9200		DEFAULT: 0x0000	
BIT(s)	**NAME**	**DESCRIPTION**	**ACCESS**
37376.15:0	Die ID [127:112]	Bits [127:112] of the Die ID. Unique TI DIE identifier.	RO

Table 2-63. DIE_ID_6

ADDRESS: 0x9201		DEFAULT: 0x0000	
BIT(s)	**NAME**	**DESCRIPTION**	**ACCESS**
37377.15:0	Die ID [111:96]	Bits [111:96] of the Die ID. Unique TI DIE identifier.	RO

Table 2-64. DIE_ID_5

ADDRESS: 0x9202		DEFAULT: 0x0000	
BIT(s)	**NAME**	**DESCRIPTION**	**ACCESS**
37378.15:0	Die ID [95:80]	Bits [95:80] of the Die ID. Unique TI DIE identifier.	RO

Table 2-65. DIE_ID_4

ADDRESS: 0x9203		DEFAULT: 0x0000	
BIT(s)	**NAME**	**DESCRIPTION**	**ACCESS**
37379.15:0	Die ID [79:64]	Bits [79:64] of the Die ID. Unique TI DIE identifier.	RO

Table 2-66. DIE_ID_3

ADDRESS: 0x9204		DEFAULT: 0x0000	
BIT(s)	**NAME**	**DESCRIPTION**	**ACCESS**
37380.15:0	Die ID [63:48]	Bits [63:48] of the Die ID. Unique TI DIE identifier.	RO

Table 2-67. DIE_ID_2

ADDRESS: 0x9205		DEFAULT: 0x0000	
BIT(s)	**NAME**	**DESCRIPTION**	**ACCESS**
37381.15:0	Die ID [47:32]	Bits [47:32] of the Die ID. Unique TI DIE identifier.	RO

Table 2-68. DIE_ID_1

ADDRESS: 0x9206		DEFAULT: 0x0000	
BIT(s)	**NAME**	**DESCRIPTION**	**ACCESS**
37382.15:0	Die ID [31:16]	Bits [31:16] of the Die ID. Unique TI DIE identifier.	RO

Table 2-69. DIE_ID_0

ADDRESS: 0x9207		DEFAULT: 0x0000	
BIT(s)	**NAME**	**DESCRIPTION**	**ACCESS**
37383.15:0	Die ID [15:0]	Bits [15:0] of the Die ID. Unique TI DIE identifier.	RO

Table 2-70. EFUSE_STATUS

ADDRESS: 0x9208		DEFAULT: 0x0000	
BIT(s)	**NAME**	**DESCRIPTION**	**ACCESS**
37384.8	EFC ready	When high, indicates that EFUSE autoload operation has completed	RO
37384.4:0	EFC error[4:0]	Efuse error bus. Updated when EFC_ready goes high or when instruction is complete. Non-zero value indicates error condition.	

Table 2-71. EFUSE_CONTROL

ADDRESS: 0x9209		DEFAULT: 0x0000	
BIT(s)	**NAME**	**DESCRIPTION**	**ACCESS**
37385.15	EFUSE Auto Load Enable	When HIGH, Re-enables EFUSE Auto load function. Needs to set back to LOW to complete Auto load function.	RW

Table 2-72. HSTL_INPUT_TERMINATION_CONTROL

ADDRESS: 0x9300		DEFAULT: 0x0000	
BIT(s)	**NAME**	**DESCRIPTION**	**ACCESS**
37632.7:6	Reserved	Reserved	RW
37632.3:2	HSTL_TERM_0[1:0]	Termination setting for input HSTL cells (for CH 0) 00 = Termination disable (High Impedance) 01 = Half termination strength (300 Ω to VHSTL&GND) 10 = 3/4 termination strength (200 Ω to VHSTL&GND) 11 = Full termination strength (150 Ω to VHSTL&GND)	RW

Table 2-73. HSTL_OUTPUT_SLEWRATE_CONTROL

ADDRESS: 0x9301		DEFAULT: 0x0000	
BIT(s)	**NAME**	**DESCRIPTION**	**ACCESS**
37633.7:6	Reserved	Reserved	RW
37633.3:2	HSTL_SLEW_RATE_0 [1:0]	Slew Rate setting for output HSTL cells (for CH 0) 00 = No slew control (fastest edge) 01 = 33% slew control 10 = 66 % slew control termination strength 11 = Full slew control (slowest edge)	RW

Table 2-74. HSTL_INPUT_VTP_CONTROL

ADDRESS: 0x9302		DEFAULT: 0x0640	
BIT(s)	**NAME**	**DESCRIPTION**	**ACCESS**
37634.15	I_FORCE_UP_N	When set, increases NFET strength in all HSTL input cells. For TI purposes Only	RW
37634.14	I_FORCE_UP_P	When set, increases PFET strength in all HSTL input cells. For TI purposes Only	
37634.13	I_FORCE_DOWN_N	When set, decreases NFET strength in all HSTL input cells. For TI purposes Only	
37634.12	I_FORCE_DOWN_P	When set, decreases PFET strength in all HSTL input cells. For TI purposes Only	
37634.11:9	I_VTP_DRIVE[2:0]	Drive strength control for HSTL input cells 3'b000 = 30% drive strength increase 3'b001 = 20% drive strength increase 3'b010 = 10% drive strength increase 3'b011 = Normal drive strength (default) 3'b100 = 10% drive strength decrease 3'b101 = 20% drive strength decrease 3'b110 = 30% drive strength decrease 3'b111 = 40% drive strength decrease	RW
37634.7:5	I_FILTER_CONTROL[2:0]	Filter Control 3'b000 = Impedance change filtering off 3'b001 = Update on 2 consecutive update requests 3'b010 = Update on 3 consecutive update requests(default) 3'b011 = Update on 4 consecutive update requests 3'b100 = Update on 5 consecutive update requests 3'b101 = Update on 6 consecutive update requests 3'b110 = Update on 7 consecutive update requests 3'b111 = Update on 8 consecutive update requests	RW

Table 2-74. HSTL_INPUT_VTP_CONTROL (continued)

ADDRESS: 0x9302		DEFAULT: 0x0640	
BIT(s)	**NAME**	**DESCRIPTION**	**ACCESS**
37634.3	I_LOCK	Impedance Lock Control When set, disables dynamic impedance control updates for HSTL input cells	RW

Table 2-75. HSTL_OUTPUT_VTP_CONTROL

ADDRESS: 0x9303		DEFAULT: 0x0640	
BIT(s)	**NAME**	**DESCRIPTION**	**ACCESS**
37635.15	O_FORCE_UP_N	When set, increases NFET strength in all HSTL output cells . For TI purposes Only	RW
37635.14	O_FORCE_UP_P	When set, increases PFET strength in all HSTL output cells . For TI purposes Only	
37635.13	O_FORCE_DOWN_N	When set, decreases NFET strength in all HSTL output cells . For TI purposes Only	
37635.12	O_FORCE_DOWN_P	When set, decreases PFET strength in all HSTL output cells . For TI purposes Only	
37635.11:9	O_VTP_DRIVE[2:0]	Drive strength control for HSTL output cells 3'b000 = 30% drive strength increase 3'b001 = 20% drive strength increase 3'b010 = 10% drive strength increase 3'b011 = Normal drive strength(default) 3'b100 = 10% drive strength decrease 3'b101 = 20% drive strength decrease 3'b110 = 30% drive strength decrease 3'b111 = 40% drive strength decrease	RW
37635.7:5	O_FILTER_CONTROL[2:0]	Filter Control 3'b000 = Impedance change filtering off 3'b001 = Update on 2 consecutive update requests 3'b010 = Update on 3 consecutive update requests(default) 3'b011 = Update on 4 consecutive update requests 3'b100 = Update on 5 consecutive update requests 3'b101 = Update on 6 consecutive update requests 3'b110 = Update on 7 consecutive update requests 3'b111 = Update on 8 consecutive update requests	RW
37635.3	O_LOCK	Impedance Lock Control When set, disables dynamic impedance control updates for HSTL output cells	RW

Table 2-76. HSTL_GLOBAL_CONTROL

ADDRESS: 0x9304		DEFAULT: 0x0088	
BIT(s)	**NAME**	**DESCRIPTION**	**ACCESS**
37636.15	HSTL power down control	When set, triggers HSTL power down sequence and places all HSTL cells in power down state.	RW
37636.14	HSTL Retrain	When set, triggers retraining of all HSTL inputs and outputs to match the impedance. Retraining is triggered only when this bit value goes from 0 to 1. HSTL retraining should occur at the end of device provisioning.	RW
37636.11	HSTL_CLK_EN	HSTL impedance control clock (CLK2X) selection 1 = Uses MDC (MDIO clock) as CLK2X 0 = Uses clock generated from Jitter cleaner as CLK2X	RW
37636.7	Voltage reference selection	1 = Internal voltage reference used for HSTL input signals 0 = External voltage reference used for HSTL input signals	RW
37636.3	VTP POWERSAVE	When set, enables power save mode on HSTL VTP controllers	RW
37636.2	GP 3-state Control	When set, 3-states GP outputs	RW

Table 2-77. TX0_DLL_CONTROL

ADDRESS: 0x9400		DEFAULT: 0x0008	
BIT(s)	**NAME**	**DESCRIPTION**	**ACCESS**
37888.15	Lock_en	For TI use only	RW
37888.14	Write_en	For TI use only	
37888.13:8	Delay_sel[5:0]	DLL delay control. For TI use only	
37888.7:5	Offset[2:0]	Phase shift control. Adds or removes delay element. Each delay element is 0.15ns. Refer Table 2-81: DLL Offset Control	
37888.3	Filter_en	When asserted, the internal filter is used to reduce the cycle to cycle jitter of the output clock.	

Table 2-78. TX1_DLL_CONTROL

ADDRESS: 0x9401		DEFAULT: 0x0008	
BIT(s)	**NAME**	**DESCRIPTION**	**ACCESS**
37889.15:5, 3	Reserved	Reserved	RW

Table 2-79. RX0_DLL_CONTROL

ADDRESS: 0x9404		DEFAULT: 0x0008	
BIT(s)	**NAME**	**DESCRIPTION**	**ACCESS**
37892.15	Lock_en	For TI use only	RW
37892.14	Write_en	For TI use only	
37892.13:8	Delay_sel[5:0]	DLL delay control. For TI use only	
37892.7:5	Offset[2:0]	Phase shift control. Adds or removes delay element. Each delay element is 0.15 ns. Refer Table 2-81: DLL Offset Control	
37892.3	Filter_en	When asserted, the internal filter is used to reduce the cycle to cycle jitter of the output clock.	

Table 2-80. RX1_DLL_CONTROL

ADDRESS: 0x9405		DEFAULT: 0x0008	
BIT(s)	**NAME**	**DESCRIPTION**	**ACCESS**
37893.15:5, 3	Reserved	Reserved	RW

Table 2-81. DLL Offset Control

OFFSET[2:0]	
VALUE	**RESULT**
000	No delay elements are added
001	1 extra delay element is added
010	2 extra delay elements are added
011	3 extra delay elements are added
100	No delay elements are removed
101	1 extra delay element is removed
110	2 extra delay elements are removed
111	3 extra delay elements are removed

Table 2-82. TX0_DLL_STATUS

ADDRESS: 0x9408		DEFAULT: 0x0000	
BIT(s)	**NAME**	**DESCRIPTION**	**ACCESS**
37896.5:0	Delay_status[5:0]	For TI use only.	RO

Table 2-83. TX1_DLL_STATUS

ADDRESS: 0x9409		DEFAULT: 0x0000	
BIT(s)	**NAME**	**DESCRIPTION**	**ACCESS**
37897.5:0	Reserved	Reserved	RO

Table 2-84. RX0_DLL_STATUS

ADDRESS: 0x940C		DEFAULT: 0x0000	
BIT(s)	**NAME**	**DESCRIPTION**	**ACCESS**
37900.5:0	Delay_status[5:0]	For TI use only.	RO

Table 2-85. RX1_DLL_STATUS

ADDRESS: 0x940D		DEFAULT: 0x0000	
BIT(s)	**NAME**	**DESCRIPTION**	**ACCESS**
37901.5:0	Reserved	Reserved	RO

Table 2-86. CH0_TESTFAIL_ERR_COUNTER

ADDRESS: 0x9500		DEFAULT: 0x00FD	
BIT(s)	**NAME**	**DESCRIPTION**	**ACCESS**
38144.7:0	Ch0_Testfail error counter[7:0]	This counter reflects error count during PRBS test. Counter increments for each received character that has an error. Counter clears upon read. Counter value is valid only when SERDES RX test pattern verification bits are set.	COR

Table 2-87. CH1_TESTFAIL_ERR_COUNTER

ADDRESS: 0x9501		DEFAULT: 0x00FD	
BIT(s)	**NAME**	**DESCRIPTION**	**ACCESS**
38145.7:0	Reserved	Reserved	COR

Table 2-88. STCI_CONTROL_STATUS

ADDRESS: 0x9600		DEFAULT: 0x0000	
BIT(s)	**NAME**	**DESCRIPTION**	**ACCESS**
38400.15	STCI_CLK	Bit to generate STCI clock in functional mode.	RW
38400.11:10	STCI_CFG[1:0]	STCI CFG control	
38400.7	STCI_D	STCI data in	
38400.3	STCI_Q	STCI read data	RO

Table 2-89. TESTCLK_CONTROL

ADDRESS: 0x9601		DEFAULT: 0x0000	
BIT(s)	**NAME**	**DESCRIPTION**	**ACCESS**
38401.15	TESTCLKT	Bit to generate TESTCLKT clock in functional mode. For TI test purposes only	RW

Table 2-90. BIDI_CMOS_CONTROL

ADDRESS: 0x9700		DEFAULT: 0x0000	
BIT(s)	**NAME**	**DESCRIPTION**	**ACCESS**
38656.15	MDIO Disable Comp Test Control	0 = MDIO/MDC Bidi cells automatically detects operating voltage (Default) 1 = MDIO/MDC Bidi cells expects 2.5 V operating voltage	RW

Table 2-91. DEBUG_CONTROL

ADDRESS: 0x9800		DEFAULT: 0x001F	
BIT(s)	**NAME**	**DESCRIPTION**	**ACCESS**
38912:8	DEBUG_SEL_EN	1 = Sends debug status signals onto debug outputs (GPO) 0 = Debug outputs are tied to 0. For TI test purposes only	RW
38912.7	DIG_TST_OUT_EN	1 = Enables sending DIG TST debug signal onto GPO4 0 = Disables sending DIG TST debug signal onto GPO4. For TI test purposes only	
38912.4:0	DEBUG_SEL	Debug select bits. For TI test purposes only	

Table 2-92. DUTY_CYCLE_CONTROL

ADDRESS: 0x9900		DEFAULT: 0x0000	
BIT(s)	**NAME**	**DESCRIPTION**	**ACCESS**
39168.15	Duty Cycle Correction Bypass	1 = Bypasses duty cycle corrected RX/TXBCLK. (Duty cycle set to 40-60, same clocks as SERDES parallel launch and capture clocks) 0 = Uses duty cycle corrected RX/TXBCLK. (Duty cycle set to 50-50, no phase relationship to SERDES parallel launch and capture clock)(Default) For TI test purposes only	RW

3 Device Reset Requirements/Procedure

3.1 Gigabit Ethernet Mode (RGMII)

Power down sequence for channel 1

Note: Common for all modes after device reset(1)

- Write 1'b0 to 36868.0 to disable receiver for unused channel
- Write 1'b0 to 36876.0 to disable transmitter for unused channel
- Set LSB of PHY address to 1
- Write 1'b1 to 0.11 to power down unused channel
- Set LSB of PHY address to 0

REFCLK frequency = 125 MHz, Serdes Data Rate = Half Rate, Mode = Transceiver, Edge Mode = Source Centered Mode, RX_CLK[n] out = TXBCLK[n], Jitter Cleaner PLL Multiplier Ratio = 1X or Off

- Device Pin Setting(s) – Pin settings allow for maximum software configurability.
  - Ensure CODE input pin is Low.
  - Ensure PLOOP input pin is Low.
  - Ensure SLOOP input pin is Low.
  - Ensure SPEED [1:0] input pins are both High.
  - Ensure ENABLE input pin is High.
  - Ensure PRBS_EN input pin is Low.
- Reset Device
  - Issue a hard or soft reset (RST_N asserted for at least 10 µs -or- Write 1'b1 to 0.15)
- Power Down Sequence Note: This step is mandatory for proper functionality
  - Refer to Power down sequence above
- Clock Configuration
  - If using JCPLL (JCPLL 1X)
    - JCPLL Mux Settings (see Figure 1-2)
      - Select REFCLK input (Default = Differential)
        - If Single Ended REFCLK used – Write 2'b01 to 37120.15:14
        - If Differential REFCLK used – Write 2'b00 to 37120.15:14
    - Write 2'b11 to 37120.13:12 to select differential REFCLKP/N as RXBYTECLK
    - Write 4'b0000 to 37120.11:8 to select jitter cleaned clock for SERDES TX/RX.
    - Write 2'b11 to 37120.7:6 to select differential REFCLKP/N as delay stopwatch clock input
    - Write 2'b00 to 37120.5:4 to select jitter cleaned clock for HSTL VTP 2x
    - Write 2'b00 to 16.10:9 to select SERDES TX clock as RX_CLK output
    - Write 16'h0081 to 37126 to set Charge pump control
    - Write 16'h00A0 to 37128 to set TXRX output divider
    - Clock Divide Settings (see Figure A-1)
      - Write 7'b1000000 to 37124.14:8 to set REF_DIV to value of 1
      - Write 1'b1 to 37124.15 REFDIV_EN to enable reference clock divider
      - Write 7'h18 to 37124.6:0 to set FB_DIV to value of 24
      - Write 1'b1 to 37124.7 FBDIV_EN to enable feedback divider
      - Write 7'h18 to 37125.6:0 to set RXTX_DIV to value of 24
      - Write 1'b1 to 37125.7 OUTDIV_EN to enable RXTX_DIV output divider
      - Write 7'h0D to 37121.14:8 to set HSTL_DIV to value of 13
      - Write 7'h06 to 37121.6:0 to set HSTL_DIV2 to value of 6

(1) Note: All global registers must be accessed indirectly through Clause 22.

- Write 2’b11 to 36864.14:13 to set RX Loop Bandwidth
- Write 2’b11 to 36864.6:5 to set TX Loop Bandwidth
- Write 4’b0101 to 36864.11:8 to set MPY RX multiplier factor to 10
- Write 4’b0101 to 36864.3:0 to set MPY TX multiplier factor to 10
- Write 16’h4040 to 36865 SERDES_RATE_CONFIG_TX_RX to set Half Rate
- Write 3'b000 to 37127.14:12 to set control bits for VCO tail current to 0
- Write 1’b1 to 37127.15 to enable Jitter Cleaner
- Wait 50 ms in order for JCPLL to lock

- If using clock bypass mode (JCPLL Off)
  - JCPLL Mux Settings (see Figure 1-2)
    - Select REFCLK input (Default = Differential)
      - If Single Ended REFCLK used – Write 2’b01 to 37120.15:14
      - If Differential REFCLK used – Write 2’b00 to 37120.15:14
    - Select RXBYTE_CLK (Default = Differential)
      - If Single Ended REFCLK used – Write 2’b10 to 37120.13:12
      - If Differential REFCLK used – Write 2’b11 to 37120.13:12
    - Select SERDES TX Reference Clock Input (Default = Differential)
      - If Single Ended REFCLK used – Write 2’b10 to 37120.11:10
      - If Differential REFCLK used – Write 2’b11 to 37120.11:10
    - Select SERDES RX Reference Clock Input (Default = Differential)
      - If Single Ended REFCLK used – Write 2’b10 to 37120.9:8
      - If Differential REFCLK used – Write 2’b11 to 37120.9:8
    - Select DELAY_CLK (Default = Differential)
      - If Single Ended REFCLK used – Write 2’b10 to 37120.7:6
      - If Differential REFCLK used – Write 2’b11 to 37120.7:6
    - Select HSTL_2X_CLK (Default = Differential)
      - Write 2b'01 to 4/5.37120.5:4 to select RX SERDES recovered clock as HSTL_2X_CLK
    - Write 2’b00 to16.10:9 to select SERDES TX clock as RX_CLK output
    - Write 7’h04 to 37121.6:0 to set HSTL_DIV2 to value of 4.
    - Write 15’h1515 to 36864.14:0 SERDES_PLL_CONFIG to set MPY RX/TX multiplier factor to 10
    - Write 16’h4040 to 36865 SERDES_RATE_CONFIG_TX_RX to set Half Rate

- Mode Control (see Table 2-2)
  - Write 1’b0 to 17.0 for RX source centered mode
  - Write 1’b0 to 17.1 for TX source centered mode
  - Write 1’b1 to 17.2 to enable 8B/10B encode decode functions
  - Write 1’b1 to 17.3 to enable 1000Base-X PCS TX & PCS RX functions
  - Write 1’b1 to 17.4 to set nibble order, LSB on rising edge, MSB on falling edge
  - Write 1’b1 to 17.5 to enable DDR data on TX/RX direction
  - Write 1’b0 to 17.6 to disable FC_PH overlay detection
  - Write 1’b1 to 17.7 to enable comma detection
  - Write 1’b0 to 17.9 to disable full DDR mode
  - Write 1’b0 to 16.8 to disable Farend Loop back
  - Write 1’b0 to 0.14 to disable loop back mode
  - Write 3’b111 to 36874.11:9 to set TX swing setting amplitude to 1375 mVdfpp
  - Write 1’b1 to 36874.8 to set channel 0 TX CM bit

- RX equalization settings
  - Write 4'b0001 to 36866.15:12 to turn on adaptive equalization (4'b0000 is off)
  - Write 2'b01 to 36866.3:2 for AC coupled mode (2'b00 is DC coupled mode)
- TX DLL Offset
  - Write 16'h0028 to 37888 TX0_DLL_CONTROL
- Poll Serdes PLL Status for Locked State
  - Read 36891.4,0 SERDES_PLL_STATUS – PLL_LOCK_TX/RX
  - Keep polling until both bits are high.
- Issue Data path Reset
  - Write 1'b1 to 16.11
  - Write 1'b0, then 1'b1, followed by 1'b0 to 37636.14.
- Clear Latched Registers
  - Read 1 PHY_STATUS_1 to clear
  - Read 18 PHY_RX_CTC_FIFO_STATUS to clear
  - Read 19 PHY_TX_CTC_FIFO_STATUS to clear
  - Read 28 PHY_CHANNEL_STATUS to clear
  - Read 36891 SERDES_PLL_STATUS to clear
- Operational Mode Status
  - Read Verify 1.2 PHY_STATUS_1 – Link Status (1'b1)
  - Read Verify 18.15 PHY_RX_CTC_FIFO_STATUS – RX_CTC_Reset (1'b0)
  - Read Verify 19.15 PHY_TX_CTC_FIFO_STATUS – TX_FIFO_Reset_1Gx (1'b0)
  - Read Verify 28.13:12 PHY_CHANNEL_STATUS – Enc/Dec Invalid Code Word (2'b00)
  - Read Verify 36891.4 SERDES_PLL_STATUS – PLL_LOCK_RX (1'b1)
  - Read Verify 36891.0 SERDES_PLL_STATUS – PLL_LOCK_TX (1'b1)

3.2 JITTER TEST PATTERN GENERATION AND VERIFICATION PROCEDURES

Use one of the following procedures to generate and verify the respective test patterns. It is assumed that an appropriate external cable has been connected between serial outputs and serial inputs. No functional parallel side connections are necessary.

- **1000Base-X Based High/Mixed/Low Frequency Test Pattern:**
  - Device Pin Setting(s):
    - Ensure CODE primary input pin is low.
  - Reset Device
    - Issue a hard or soft reset (RST_N asserted for at least 10 us -or- Write 1'b1 to 0.15)
  - Power down channel 1 per procedure in previous device initialization section.
  - Select single ended or differential REFCLK input:
    - If Single Ended REFCLK used - Write 2'b01 to 37120.15:14
    - If Differential REFCLK used – Write 2'b00 to 37120.15:14
  - Select SERDES TX Reference Clock Input:
    - If Single Ended REFCLK used - Write 2'b10 to 37120.11:10
    - If Differential REFCLK used – Write 2'b11 to 37120.11:10
  - Select SERDES RX Reference Clock Input:
    - If Single Ended REFCLK used - Write 2'b10 to 37120.9:8
    - If Differential REFCLK used – Write 2'b11 to 37120.9:8
  - Disable Comma Detection:
    - Write 1'b0 to 17.7
  - Ensure a legal reference clock operation frequency is selected based on Appendix A, and provision control settings accordingly. It is also possible to use the Jitter Cleaner during these tests, and the user should consult Appendix A for further Jitter Cleaner provisioning details.
  - Issue Datapath Reset:
    - Write 1'b1 to 16.11
    - Write 1'b0, then 1'b1, followed by 1'b0 to 37636.14.
  - Select Test Pattern:
    - If High Frequency Pattern is desired:
      - Write 3'b000 to 16.2:0
    - If Low Frequency Pattern is desired:
      - Write 3'b001 to 16.2:0
    - If Mixed Frequency Pattern is desired:
      - Write 3'b010 to 16.2:0
  - Enable Test Pattern Generation:
    - Write 1'b1 to 16.4
  - Clear Counters:
    - Read 22.15:0 and discard the value.
  - Enable Test Pattern Verification:
    - Write 1'b1 to 16.3
  - Verify Test In Progress:
    - Poll 21.1 asserted.
  - The pattern verification is now in progress.
  - Verify Error Free Operation (as many times as desired during the duration of the test period):
    - Read 22.15:0, and verify 16'h0000 is read to confirm error free operation.

- **1000Base-X Based Continuous Random Pattern (CRPAT) Long/Short Test Pattern:**
  - Device Pin Setting(s):
    - Ensure CODE primary input pin is high.
  - Reset Device:
    - Issue a hard or soft reset (RST_N asserted –or- Write 1 to 0.15)
  - Power down channel 1 per procedure in previous device initialization section.
    - Select single ended or differential REFCLK input:
      - If Single Ended REFCLK used - Write 2'b01 to 37120.15:14
      - If Differential REFCLK used – Write 2'b00 to 37120.15:14
  - Select SERDES TX Reference Clock Input:
    - If Single Ended REFCLK used - Write 2'b10 to 37120.11:10
    - If Differential REFCLK used – Write 2'b11 to 37120.11:10
  - Select SERDES RX Reference Clock Input:
    - If Single Ended REFCLK used - Write 2'b10 to 37120.9:8
    - If Differential REFCLK used – Write 2'b11 to 37120.9:8
  - Ensure a legal reference clock operation frequency is selected based on Appendix A, and provision control settings accordingly. It is also possible to use the Jitter Cleaner during these tests, and the user should consult Appendix A for further Jitter Cleaner provisioning details.
  - Enable Encoder/Decoder
    - Write 1'b1 to 17.2
  - Issue Datapath Reset:
    - Write 1'b1 to 16.11
    - Write 1'b0, then 1'b1, followed by 1'b0 to 37636.14
  - Select Test Pattern:
    - If CRPAT Long Pattern is desired:
      - Write 3'b011 to 16.2:0
    - If CRPAT Short Pattern is desired:
      - Write 3'b100 to 16.2:0
  - Enable Test Pattern Generation:
    - Write 1'b1 to 16.4
  - Clear Counters:
    - Read 23.15:0 and 24.15:0 and discard the values.
  - Enable Test Pattern Verification:
    - Write 1'b1 to 16.3
  - Verify Test In Progress:
    - Poll 21.0 asserted.
  - The pattern verification is now in progress.
  - Verify Error Free Operation (as many times as desired during the duration of the test period):
    - Read 23.15:0, and verify 16'h0000 is read to confirm error free operation.
    - Read 24.15:0, and verify 16'h0000 is read to confirm error free operation.

If more than one test is specified results are unpredictable.

If another test type is desired, please begin at the first step of that procedure.

3.3 PRBS Test Generation and Verification Procedures

Use one of the following procedures to generate and verify the respective PRBS test patterns. It is assumed that an appropriate external cable has been connected between serial outputs and serial inputs. No functional parallel side connections are necessary.

- **1000Base-X 2^7-1 PRBS Register Based Testing**
  - Device Pin Setting(s):
    - Ensure CODE primary input pin is low.
  - Reset Device:
    - Issue a hard or soft reset (RST_N asserted –or– Write 1 to 0.15)
  - Power down channel 1 per procedure in previous device initialization section.
  - Select single ended or differential REFCLK input:
    - If Single Ended REFCLK used – Write 2'b01 to 37120.15:14
    - If Differential REFCLK used – Write 2'b00 to 37120.15:14
  - Select SERDES TX Reference Clock Input:
    - If Single Ended REFCLK used – Write 2'b10 to 37120.11:10
    - If Differential REFCLK used – Write 2'b11 to 37120.11:10
  - Select SERDES RX Reference Clock Input:
    - If Single Ended REFCLK used – Write 2'b10 to 37120.9:8
    - If Differential REFCLK used – Write 2'b11 to 37120.9:8
  - Ensure a legal reference clock operation frequency is selected based on Appendix A, and provision control settings accordingly. It is also possible to use the Jitter Cleaner during these tests, and the user should consult Appendix A for further Jitter Cleaner provisioning details.
  - Issue Datapath Reset:
    - Write 1'b1 to 16.11
    - Write 1'b0, then 1'b1, followed by 1'b0 to 37636.14.
  - Enable PRBS Generator:
    - Write 1'b1 to 16.6
  - Enable Test Pattern Verification:
    - Write 1'b1 to 16.7
  - Clear Counters:
    - Read 29.15:0 and discard the value.
  - The pattern verification is now in progress.
  - Verify Error Free Operation (as many times as desired during the duration of the test period):
    - Read 29.15:0, and verify 16'h0000 is read to confirm error free operation.
  - GPO0 contains a real time output that when high indicates if the input PRBS pattern on TDx0/RDx0 is errored.
- **2^7-1 PRBS Pin Based Testing**
  - Device Pin Setting(s):
    - Ensure PRBS_EN primary input pin is high.
    - PRBS Selection:
      - For PRBS 2^7-1 will be selected
  - Reset Device:
    - Issue a hard or soft reset (RST_N asserted -or– Write 1 to 0.15)
  - Power down channel 1 per procedure in previous device initialization section.
  - Select single ended or differential REFCLK input:
    - If Single Ended REFCLK used - Write 2'b01 to 37120.15:14
    - If Differential REFCLK used – Write 2'b00 to 37120.15:14
  - Select SERDES TX Reference Clock Input:

- If Single Ended REFCLK used – Write 2'b10 to 37120.11:10
- If Differential REFCLK used – Write 2'b11 to 37120.11:10

– Select SERDES RX Reference Clock Input:
- If Single Ended REFCLK used – Write 2'b10 to 37120.9:8
- If Differential REFCLK used – Write 2'b11 to 37120.9:8

– Ensure a legal reference clock operation frequency is selected based on Appendix A, and provision control settings accordingly. It is also possible to use the Jitter Cleaner during these tests, and the user should consult Appendix A for further Jitter Cleaner provisioning details.
– Issue Datapath Reset:
- Write 1'b1 to 16.11
- Write 1'b0, then 1'b1, followed by 1'b0 to 37636.14

– GPO0 contains a real time output that when high indicates if the input PRBS pattern on TD×0/RD×0 is errored.

• **SERDES Macro 2^7-1/2^{23}-1 PRBS Register Based Testing**
– Reset Device:
- Issue a hard or soft reset (RST_N asserted –or– Write 1 to 0.15)

– Power down channel 1 per procedure in previous device initialization section.
– Select single ended or differential REFCLK input:
- If Single Ended REFCLK used – Write 2'b01 to 37120.15:14
- If Differential REFCLK used – Write 2'b00 to 37120.15:14

– Select SERDES TX Reference Clock Input:
- If Single Ended REFCLK used – Write 2'b10 to 37120.11:10
- If Differential REFCLK used – Write 2'b11 to 37120.11:10

– Select SERDES RX Reference Clock Input:
- If Single Ended REFCLK used – Write 2'b10 to 37120.9:8
- If Differential REFCLK used – Write 2'b11 to 37120.9:8

– Ensure a legal reference clock operation frequency is selected based on Appendix A, and provision control settings accordingly. It is also possible to use the Jitter Cleaner during these tests, and the user should consult Appendix A for further Jitter Cleaner provisioning details.
– PRBS Selection:
- For PRBS 2^7-1-
  – Write 2'b10 36881.1:0.
  – Write 2'b10 36882.1:0.
- For PRBS 2^{23}-1-
  – Write 2'b11 36881.1:0.
  – Write 2'b11 36882.1:0.

– Enable PRBS Generation:
- Write 1'b1 to 36881.2
- Write 1'b1 to 36874.1

– Enable PRBS Verification:
- Write 1'b1 to 36882.3
- Write 1'b1 to 36866.1

– Clear Counters:
- Read 38144.7:0 and discard the value.

– The pattern verification is now in progress
– Verify Error Free Operation (as many times as desired during the duration of the test period):
- Read 38144.7:0, and verify 8'h00 is read to confirm error free operation on TDx0/RDx0.

– GPO0 contains a real time output that when high indicates if the input PRBS pattern on TDx0/RDx0

is errored.

3.4 Signal Pin Description

Table 3-1. Global Signals

SIGNAL	LOCATION	VOLTAGE	TYPE	DESCRIPTION
RST_N	M2	VDDO	2.5 V LVCMOS Input	**Chip Reset (Active Low)** When asserted (low logic level), this signal reinitializes the entire device. Must be held asserted (low logic level) for at least 10 µS after device power up.
ENABLE	J4	VDDO	2.5 V LVCMOS Input	**Device Enable.** When this pin is held low, the device is in a low power state. When high the device operates normally. A hard or soft reset must be applied after a change of state occurs on this input signal.
SPEED[1:0]	D2 H11	VDDO	2.5 V LVCMOS Input	**Speed Selection pins.** These pins put all four channels of TLK3131 into one of the three supported (full/half/quarter) operation speeds. 00 – Full Rate mode 01 – Half Rate mode 10 – Quarter rate mode 11 – Software Selectable Rate In the software selectable rate mode, the rate may be configured independently by the MDIO interface. The SPEED[1:0] inputs control both RX and TX directions. See Appendix A for further information on speed selection (full/half/quarter) for proper settings as a function of the application mode and reference clock frequency. Note that if these pins are not configured on the application board to select “Software Selectable Rate”, then the internal speed register bits cannot be used to control the rate settings, and the full/half/quarter rate selection is fixed.
PLOOP	K11	VDDO	2.5 V LVCMOS Input	**Parallel Loop Enable.** When high, the serial output is internally looped back to the serial input so that the transmit parallel interface input data is output onto the receive parallel interface.
SLOOP	H10	VDDO	2.5 V LVCMOS Input	**Serial Loop Enable.** When high, the serial input is internally looped back to the serial output, making a serial repeater. In device configurations where clock tolerance compensation is not performed in the transmit direction, there are two options for error-free serial loopback operation: 1. Frequency lock (0 ppm) the incoming serial data rate to the local reference clock device input. 2. Provision the TX SERDES REFCLK to run from a jitter cleaned version of the RX SERDES RXBCLK (Receive Byte Clock).
PRBS_EN	L1	VDDO	2.5 V LVCMOS Input	**PRBS Enable.** When this pin is asserted high, the internal PRBS generator and comparator circuits are enabled on the transmit and receive data paths. The PRBS results can be read through MDIO counters. Primary chip output signal GPO0 remains low during PRBS testing when the input serial stream PRBS pattern is correct, and pulses high when PRBS errors are detected on the input serial stream. GPO0 contains the Channel 0 PRBS currently passing (when low) indication. An external loopback connection (via external cables) is required during PRBS testing. PRBS 2^7-1 is transmitted on each transmit channel serial output, and compared on each receive channel serial input.
CODE	J2	VDDO	2.5 V LVCMOS Input	**Code Enable.** This signal is logically OR’d with the PCS_EN register bit (Register Bit 17.3). RGMII/GMII applications can either tie this input signal high (preferred) or tie this signal low (must program the PCS_EN 17.3 register bit after device reset to high if CODE is tied off low). Non RGMII/GMII applications **must** tie this input signal low.

Table 3-2. JTAG Signals

SIGNAL	LOCATION	VOLTAGE	TYPE	DESCRIPTION
TDI	J12	VDDO	2.5 V LVCMOS Input (Internal Pullup)	**JTAG Input Data.** TDI is used to serially shift test data and test instructions into the device during the operation of the test port.
TDO	F11	VDDO	2.5 V LVCMOS Output	**JTAG Output Data.** TDO is used to serially shift test data and test instructions out of the device during operation of the test port. When the JTAG port is not in use, TDO is in a high impedance state.
TMS	J11	VDDO	2.5 V LVCMOS Input (Internal Pullup)	**JTAG Mode Select.** TMS is used to control the state of the internal test-port controller.
TCK	H12	VDDO	2.5 V LVCMOS Input	**JTAG Clock.** TCK is used to clock state information and test data into and out of the device during the operation of the test port.
TRST_N	K12	VDDO	2.5 V LVCMOS Input (Internal Pullup)	**JTAG Test Reset.** TRST_N is used to reset the JTAG logic into system operational mode.

Table 3-3. MDIO Related Signals

SIGNAL	LOCATION	VOLTAGE	TYPE	DESCRIPTION
MDC	G12	VDDM	1.2 V OR 2.5 V LVCMOS Input	**Management Interface Clock** This clock is used to sample the MDIO signal.
MDIO	E12	VDDM	1.2 V OR 2.5 V LVCMOS Input/ Output	**Management Interface Data** This bidirectional data line for MDIO Port is sampled on the rising edge of MDC. THIS SIGNAL MUST BE EXTERNALLY PULLED UP TO VDDM. Consult IEEE802.3 Clause 22/45 for an appropriate resistance value.
PRTAD[4:0]	J10 L11 L2 M1 M12	VDDO	2.5 V LVCMOS Input	**Port Address** Used to select Port ID in Clause 22 MDIO modes. PRTAD[4:1] selects a block of two sequential Clause 22 port addresses. Each channel (second channel datapath is not pinned out) is implemented as a different port address, and can be accessed by setting the appropriate port address field within the Clause 22 MDIO transaction. PRTAD[0] is not used functionally, but is needed for device testability with other devices in the family of products. Channel 0 responds to port address 0 within the block of two port addresses. Channel 1 (datapath not usable) responds to port address 1 within the block of two port addresses.
REFCLK	H2	VDDO	2.5 V LVCMOS Input	**Single Ended Reference Clock** Single ended reference clock input. By default, the differential reference clock (REFCLKP/N) is selected. This default value may be changed by a mdio register (37120.15:14). The acceptable input frequency range on this input signal is 50 MHz → 150 MHz. Jitter performance is optimal when using the differential REFCLK input.

Table 3-4. Parallel Data Pins

SIGNAL	LOCATION	VOLTAGE	TYPE	DESCRIPTION
TXCLK_0	E11	VDDQ/ VREF1/2	1.5/1.8 V HSTL Input	**Transmit Data Clock (Parallel I/F)** This is the parallel side input clock.
TXD_[7:0]	A12 B10 C9 D10 B8 D11 C10 A10	VDDQ/ VREF1/2	1.5/1.8 V HSTL Input	**Transmit Data Pins** Parallel interface data pins. See the following tables for functionality per application mode: Table 2-3 RGMII - Lane To Functional Pin Mapping Table 2-4 RTBI - Lane To Functional Pin Mapping Table 2-5 TBI - Lane To Functional Pin Mapping Table 2-6 GMII - Lane To Functional Pin Mapping Table 2-7 EBI - Lane To Functional Pin Mapping Table 2-8 REBI - Lane To Functional Pin Mapping Table 2-9 NBI - Lane To Functional Pin Mapping Table 2-10 RNBI - Lane To Functional Pin Mapping Table 2-11 TBID - Lane To Functional Pin Mapping Table 2-12 NBID - Lane To Functional Pin Mapping
TXC_[4,0]	C8 B11	VDDQ/ VREF1/2	1.5/1.8 V HSTL Input	**Transmit Data Control** Parallel Control inputs. See the following tables for functionality per application mode: Table 2-3 RGMII - Lane To Functional Pin Mapping Table 2-4 RTBI - Lane To Functional Pin Mapping Table 2-5 TBI - Lane To Functional Pin Mapping Table 2-6 GMII - Lane To Functional Pin Mapping Table 2-7 EBI - Lane To Functional Pin Mapping Table 2-8 REBI - Lane To Functional Pin Mapping Table 2-9 NBI - Lane To Functional Pin Mapping Table 2-10 RNBI - Lane To Functional Pin Mapping Table 2-11 TBID - Lane To Functional Pin Mapping Table 2-12 NBID - Lane To Functional Pin Mapping
RXCLK_0	A4	VDDQ	1.5/1.8 V HSTL Output	**Receive Data Clock** This signal is the parallel side output clock.
RXD_[7:0]	C2 B2 B3 B1 A2 A5 A6 C5	VDDQ	1.5/1.8 V HSTL Output	**Receive Data Pins** Parallel interface data pins. See the following tables for functionality per application mode: Table 2-3 RGMII - Lane To Functional Pin Mapping Table 2-4 RTBI - Lane To Functional Pin Mapping Table 2-5 TBI - Lane To Functional Pin Mapping Table 2-6 GMII - Lane To Functional Pin Mapping Table 2-7 EBI - Lane To Functional Pin Mapping Table 2-8 REBI - Lane To Functional Pin Mapping Table 2-9 NBI - Lane To Functional Pin Mapping Table 2-10 RNBI - Lane To Functional Pin Mapping Table 2-11 TBID - Lane To Functional Pin Mapping Table 2-12 NBID - Lane To Functional Pin Mapping
RXC_[4,0]	C6 B6	VDDQ	1.5/1.8 V HSTL Output	**Receive Data Control** Control inputs. See the following tables for functionality per application mode: Table 2-3 RGMII - Lane To Functional Pin Mapping Table 2-4 RTBI - Lane To Functional Pin Mapping Table 2-5 TBI - Lane To Functional Pin Mapping Table 2-6 GMII - Lane To Functional Pin Mapping Table 2-7 EBI - Lane To Functional Pin Mapping Table 2-8 REBI - Lane To Functional Pin Mapping Table 2-9 NBI - Lane To Functional Pin Mapping Table 2-10 RNBI - Lane To Functional Pin Mapping Table 2-11 TBID - Lane To Functional Pin Mapping Table 2-12 NBID - Lane To Functional Pin Mapping

Table 3-5. Serial Side Data/Clock Pins

SIGNAL	LOCATION	VOLTAGE	TYPE	DESCRIPTION
TDP0/TDN0	L4 L3	AVDD	CML Output	**Transmit Differential Pairs** High speed serial outputs. The data rate of these signals is from 600 Mbps minimum to 3.75 Gbps maximum.
RDP0/RDN0	L8 L9	AVDD	CML Input	**Receive Differential Pairs**, High speed serial inputs with on-chip 100 Ω differential termination. Each input pair is terminated differentially across an on chip 100 Ω resistor. The data rate of these signals is from 600 Mbps minimum to 3.75 Gbps maximum.

Table 3-6. Miscellaneous Pins

SIGNAL	LOCATION	VOLTAGE	TYPE	DESCRIPTION
VPP	A7 B7	DVDD	P	Efuse Controller Voltage (1.2 V). Must be tied to 1.2 V (DVDD) in the system application.
TESTEN	J1	VDDO	LVCMOS 2.5 V Input	Test Mode Enable Input – Must Be Grounded in the System Application.
AMUX1	M10	N/A	Analog Output	SERDES Analog Mux 1 RX – Must be Unconnected/Open in the System Application
AMUX0	M6	N/A	Analog Output	SERDES Analog Mux 0 TX – Must be Unconnected/Open in the System Application
RES[4:3,1]	A9 C12 C3	N/A	Resistive Connection	HSTL Impedance Control Resistors – 0.5% Tolerance Resistor required of the following values: 150 Ohms between RES4 and GND 150 Ohms between RES3 and GND 50 Ohms between RES1 and GND **Note:** These resistors cannot be shared between output pins.
GPI1	L12	VDDO	LVCMOS 2.5 V Input	General Purpose Input – Must be Grounded in the System Application.
GPO[4:0]	K1 G10 F10 G9 K2	VDDO	LVCMOS 2.5 V Output	General Purpose Outputs – Must be Unconnected/Open in the System Application. It is recommended that these output ports go to headers or non-populated resistor pads to facilitate probing of internal device functions/settings during the initial system bring up process. Also, to monitor PRBS testing real time, these outputs must be available for probing on the application board.

Table 3-7. Voltage Supply and Reference Pins

SIGNAL	LOCATION	TYPE	DESCRIPTION
DVDD	D4, D6, D8, E9, H9, J3, K7	P	Digital Core Power Supply (1.2 V ±5%)
VDDO	D1, G11, H3	P	LVCMOS and Bias Power (2.5 V ±5%)
VDDM	F12	P	MDIO Power (2.5 V or 1.2 V ±5%)
VDDQ	A3, B12, B4, B9, C1, D5, D7, D9, E10	P	HSTL Power (1.5/1.8 V) 1.5 V Operation Range: 1.4 V → 1.6 V 1.8 V Operation Range: 1.7V → 1.9 V
VREF1, VREF2	D12, A8	P	HSTL Reference Voltage (0.75 V or 0.9 V) These signals should be equal to VDDQ divided by 2.
DGND	A1, A11, B5, C11, C4, C7, D3, E5, E6, E7, E8, F5, F6, F7, F8, F9, G5, G6, G7, G8, H5, H6, H7, H8	G	Digital Ground
AVDD	J5, J7, J8, K10, L5, L7, M3	P	Analog Power (1.2 V ±5%)
AGND	J6, J9, K4, K8, L10, L6, M4, M8	G	Analog Ground
VDDR	K5, M9	P	SERDES Voltage Regulator Input (1.5 V –or– 1.8 V)
VDDT	K3, K6, K9	P	SERDES Termination Voltage (1.2 V)
VDDD	M11, M5, M7	P	SERDES Digital Power (1.2 V)

Table 3-8. Jitter Cleaner Related Pins

SIGNAL	LOCATION	TYPE	DESCRIPTION
REFCLKP/ REFCLKN	G1 F1	I	**Differential Reference Clock Inputs** By default, the differential reference clock (REFCLKP/N) is selected. This default value may be changed by a mdio register (37120.15:14). Must Be Externally AC Coupled REFCLKP – DPECL REFCLK P Input REFCLKN – DPECL REFCLK N Input Acceptable input frequency range is 50 MHz → 375 MHz. Jitter performance is optimal when using the differential REFCLK input.
VDDA_VCO	F4	P	Jitter Cleaner – VCO Supply – 1.2 V
VSSA_VCO	E2	G	Jitter Cleaner Ground
VDDA_CP	G3	P	Jitter Cleaner – Charge Pump – 1.2 V
VSSA_CP	G4	G	Jitter Cleaner Ground
VDD_CML	H1	P	Jitter Cleaner – REFCLKP/N Input Supply – 1.2 V
VSS_CML	G2	G	Jitter Cleaner Ground
VDD_PLL	E4	P	Jitter Cleaner Digital Power (1.2 V)
VSS_PLL	E1	G	Jitter Cleaner Ground
VCO_TL_TST	H4	Analog Input	VCO Testability Input. This signal should be grounded in the application.
TST_OUT	E3	Analog Input/Output	Jitter Cleaner Testability Pin. This signal should be left open (unconnected) in the application.
CP_OUT	F3	Analog Output	Charge Pump Output. If the internal Jitter Cleaner PLL is used, this signal should be connected to the input of the external loop filter (See Figure B-1). If the internal Jitter Cleaner PLL is not used, this node should be left open (unconnected).
VTUNE	F2	Analog Input	LC VCO Bias Voltage. This signal should be connected to the output of the external loop filter if the Jitter Cleaner PLL is used (Figure B-1). If the internal Jitter Cleaner PLL is not used, this node should be grounded.

	1	2	3	4	5	6	7	8	9	10	11	12
A	DGND	RXD_3	VDDQ	RXCLK_0	RXD_2	RXD_1	VPP	VREF2	RES4	TXD_0	DGND	TXD_7
B	RXD_4	RXD_6	RXD_5	VDDQ	DGND	RXC_0	VPP	TXD_3	VDDQ	TXD_6	TXC_0	VDDQ
C	VDDQ	RXD_7	RES1	DGND	RXD_0	RXC_4	DGND	TXC_4	TXD_5	TXD_1	DGND	RES3
D	VDDO	SPEED1	DGND	DVDD	VDDQ	DVDD	VDDQ	DVDD	VDDQ	TXD_4	TXD_2	VREF1
E	VSS_PLL	VSSA_VCO	TST_OUT	VDD_PLL	DGND	DGND	DGND	DGND	DVDD	VDDQ	TXCLK_0	MDIO
F	REFCLKN	VTUNE	CP_OUT	VDDA_VCO	DGND	DGND	DGND	DGND	DGND	GPO2	TDO	VDDM
G	REFCLKP	VSS_CML	VDDA_CP	VSSA_CP	DGND	DGND	DGND	DGND	GPO1	GPO3	VDDO	MDC
H	VDD_CML	REFCLK	VDDO	VCO_TL_TST	DGND	DGND	DGND	DGND	DVDD	SLOOP	SPEED0	TCK
J	TESTEN	CODE	DVDD	ENABLE	AVDD	AGND	AVDD	AVDD	AGND	PRTAD4	TMS	TDI
K	GPO4	GPO0	VDDT	AGND	VDDR	VDDT	DVDD	AGND	VDDT	AVDD	PLOOP	TRST_N
L	PRBS_EN	PRTAD2	TDN0	TDP0	AVDD	AGND	AVDD	RDP0	RDN0	AGND	PRTAD3	GPI1
M	PRTAD1	RST_N	AVDD	AGND	VDDD	AMUX0	VDDD	AGND	VDDR	AMUX1	VDDD	PRTAD0

Figure 3-1. Device Pinout Diagram – (Top View)

4 Electrical Specifications

4.1 ABSOLUTE MAXIMUM RATINGS(1) (2)

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

		UNIT
Supply voltage(2)	AVDD, DVDD, VDDT, VDDD, VDDA_VCO, VDD_PLL, VDDA_CP, VDD_CML, VREF1/2	–0.3 to 1.5 V
	VDDQ, VDDR	–0.3 to 2.0 V
	VDDO, VDDM	–0.3 to 3.0 V
Input Voltage, V_I (LVCMOS)		–0.3 to Supply + 0.3 V
Input Voltage, V_I (HSTL CLASS 1)		–0.3 to 2.0 V
Storage temperature		–65°C to 150°C
Electrostatic Discharge		HBM: 2KV, CDM:500V
Characterized free-air operating temperature range		–40°C to 85°C

(1) Stresses beyond those listed under "absolute maximum ratings" may cause permanent damage to the device. These are stress ratings only, and functional operation of the device at these or any other conditions beyond those indicated under "recommended operating conditions" is not implied. Exposure to absolute-maximum-rated conditions for extended periods may affect device reliability.
(2) All voltage values, except differential I/O bus voltages, are with respect to network ground terminal.

4.2 RECOMMENDED OPERATING CONDITIONS

PARAMETER		CONDITION	MIN	NOM	MAX	UNIT
DVDD	Core supply voltage		1.14	1.2	1.26	V
AVDD	Analog supply voltage		1.14	1.2	1.26	V
VDDQ	Parallel HSTL I/O supply voltage	1.5 V Application	1.4	1.5	1.6	V
		1.8 V Application	1.7	1.8	1.9	
VDDO	LVCMOS I/O supply voltage		2.37	2.5	2.63	V
VDDM	MDIO CMOS I/O supply voltage	1.2 V Application	1.14	1.2	1.26	V
		2.5 V Application	2.37	2.5	2.63	
VREF1/2	HSTL reference voltage	1.5 V Application	0.65	0.75	0.85	V
		1.8 V Application	0.85	0.90	0.95	
I_{DD} Supply current	AVDD, VDDD, VDDT	3.75 Gbps			172	mA
	DVDD				122	mA
	VDDR				26	mA
	VDDQ (1.6 V)				170	mA
	VDDQ (1.9 V)				210	
	VDDO				22	mA
	VDDA_VCO, VDD_PLL, VDD_CML, VDDA_CP				98	mA
P_D	Total power consumption	See Table 4-3				W
I_{SD} (1) Shutdown current	AVDD, VDDD, VDDT (1.26V)	ENABLE low			25	mA
		ENABLE low, HSTL powerdown			25	
	DVDD (1.26V)	ENABLE low			61	mA
		ENABLE low, HSTL powerdown			21	
	VDDR (1.9V)	ENABLE low			1	mA
		ENABLE low, HSTL powerdown			1	
	VDDQ (1.9V)	ENABLE low			140	mA
		ENABLE low, HSTL powerdown			10	
	VDDO (2.63V)	ENABLE low			17	mA
		ENABLE low, HSTL powerdown			17	
	VDDA_VCO, VDD_PLL, VDD_CML, VDDA_CP (1.26V)	ENABLE low			1	mA
		ENABLE low, HSTL powerdown			1	

(1) Toggle RST_N before setting ENABLE low for proper shutdown.

4.3 REFERENCE CLOCK TIMING REQUIREMENTS (REFCLKP/N)(1) (2)

PARAMETER	CONDITION	MIN	NOM	MAX	UNIT
Frequency	Minimum data rate	60	–	375	MHz
Accuracy	1G PCS Mode	–100		100	ppm
Accuracy to TXCLK	All	0	0	0	ppm
Duty Cycle		45%	50%	55%	
Jitter	Random and deterministic			40	ps

(1) This clock should be crystal referenced to meet the requirements of the above table
(2) Contact TI for specific clocking recommendations

4.4 REFERENCE CLOCK ELECTRICAL CHARACTERISTICS (REFCLKP/N)

PARAMETER		CONDITION	MIN	NOM	MAX	UNIT
V_{id}	Differential Input Voltage		100		2000	mV_{PP}
C_{IN}	Input Capacitance				3	pF
R_{IN}	Input Differential Impedance		80	100	120	Ω
t_{rise}	Rise Time	20% to 80%	50		600	ps

4.5 SINGLE ENDED REFERENCE CLOCK ELECTRICAL CHARACTERISTICS (REFCLK)

PARAMETER		CONDITION	MIN	NOM	MAX	UNIT
V_{IH}	High-Level Input Voltage		1.7		VDDO + 0.3	V
V_{IL}	Low-Level Input Voltage		–0.3		0.7	V
I_{IH}/I_{IL}	High/Low Input Current				±10	µA
t_{rise}	Rise Time	20% → 80%			1	ns
Jitter	Peak to Peak Jitter	Jitter Cleaner not used on REFCLK			40	ps
Tcyc	Duty Cycle		40%	50%	60%	Period

4.6 JITTER CLEANER TIMING PARAMETERS

PARAMETER	CONDITION	MIN	NOM	MAX	UNIT
PLL Bandwidth	–3dB			1	MHz
Jitter Peaking				0.1	dB
VCO Output Jitter (rms)	2 MHz → 30 MHz			2	ps
VCO Output Jitter (rms)	1.2 MHz → 30 MHz			2.5	ps
VCO Output Jitter (rms)	600 kHz → 30 MHz			4	ps
VCO Output Jitter (rms)	300 kHz → 30 MHz			8	ps

4.7 LVCMOS ELECTRICAL CHARACTERISTICS

PARAMETER		CONDITION	MIN	NOM	MAX	UNIT
V_{OH}	High-level output voltage	I_{OH} = –100 µA, Driver Enabled	2.1		VDDO	V
V_{OL}	Low-level output voltage	I_{OL} = 100 µA, Driver Enabled	0		0.2	V
V_{IH}	High-level input voltage		1.7		VDDO + 0.3	V
V_{IL}	Low-level input voltage		–0.3		0.7	V
I_{IH}, I_{IL}	Receiver Only Low/High Input Current				±10	µA
I_{OZ}	Driver Only	Driver Disabled			±35	µA
	Driver/Receiver With Pullup/Pulldown	Driver Disabled With Pull Up/Down Enabled			±100	µA
C_{IN}	Input capacitance				5	pF

4.8 MDIO ELECTRICAL CHARACTERISTICS

PARAMETER		CONDITION	MIN	NOM	MAX	UNIT
V_{IH}	High-level input voltage	VDDM = 2.5 V	2.1		VDDM + 0.3	V
V_{IL}	Low-level input voltage	VDDM = 2.5 V	–0.3		0.7	V
V_{IH}	High-level input voltage	VDDM = 1.2 V	0.84		VDDM + 0.3	V
V_{IL}	Low-level input voltage	VDDM = 1.2 V	–0.3		0.36	V
V_{OL}	Low Level Output Voltage	VDDM = 2.5 V (I_{OL} = 100 µA)	0		0.2	V
		VDDM = 1.2 V (I_{OL} = 100 µA)	0		0.2	V
V_{OH}	High Level Output Voltage	VDDM = 1.2/2.5 V (Open Drain Driver) **Must be pulled up to VDDM on the customer board.**	–	–	–	V
I_{IH}, I_{IL}	Low/High Input Current	MDC Signal			±20	µA
I_Z	Low/High input current	MDIO – Driver disabled			±50	µA
C_{IN}	Input capacitance				5	pF

4.9 HSTL SIGNALS (VDDQ = 1.5/1.8 V)

PARAMETER		CONDITION	MIN	NOM	MAX	UNIT
$V_{OH(dc)}$	High-level output voltage		VDDQ– 0.4		VDDQ	V
$V_{OL(dc)}$	Low-level output voltage				0.40	V
$V_{OH(ac)}$	High-level output voltage		VDDQ– 0.5		VDDQ	V
$V_{OL(ac)}$	Low-level output voltage				0.50	V
$V_{IH(dc)}$	High-level DC input voltage	DC input, logic high	VREF1/2 + 0.10		VDDQ + 0.3	V
$V_{IL(dc)}$	Low-level DC input voltage	DC input, logic low	–0.30		VREF1/2 – 0.1	V
$V_{IH(ac)}$	High-level AC input voltage	AC input, logic high	VREF1/2 + 0.20		VDDQ+ 0.3	V
$V_{IL(ac)}$	Low-level AC input voltage	AC input, logic low	–0.30		VREF1/2 – 0.20	V
$I_{OH(dc)}$	High output current		–8			mA
$I_{OL(dc)}$	Low output current		8			mA
C_{IN}	Input Capacitance				4	pF
Tacr	AC Test Condition	Rise Time (20 → 80%)	1	1	1	ns
Tacs	AC Test Condition	Signal Swing	1	1	1	V

4.10 SERIAL TRANSMITTER/RECEIVER CHARACTERISTICS

PARAMETER		CONDITION	MIN	NOM	MAX	UNIT
$V_{OD(pp)}$	TX Output Differential Peak-to-Peak voltage swing. De-emphasis Amount = 0%. See Figure 4-1	SWING = 000 (See Table 2-40)	80	125	180	mV_{PP}
		SWING = 001 (See Table 2-40)	210	250	330	
		SWING = 010 (See Table 2-40)	425	500	630	
		SWING = 011 (See Table 2-40)	530	625	780	
		SWING = 100 (See Table 2-40)	635	750	900	
		SWING = 101 (See Table 2-40)	900	1000	1200	
		SWING = 110 (See Table 2-40)	1000	1250	1500	
		SWING = 111 (See Table 2-40)	1080	1375	1650	
V_{DE}	TX Output De-Emphasis ($V_{OD(dpp)}$ = V_{DE} × Percentage of nominal $V_{OD(pp)}$)	See Table 2-39 for details on de-emphasis settings.	4.7%		72%	
V_{CMT}	TX output common mode voltage	See Figure 4-1.		AVDD – (0.25 × $V_{OD(pp)}$)		mV

SERIAL TRANSMITTER/RECEIVER CHARACTERISTICS *(continued)*

PARAMETER		CONDITION	MIN	NOM	MAX	UNIT
V_{ID}	RX input differential voltage |RXP – RXN|	See Figure 4-3. Direct Coupled Mode Only	100		600	mV
		See Figure 4-3. AC Coupled Mode Only	100		1100	
$V_{ID(pp)}$	RX input differential peak-to-peak voltage swing 2 × |RXP – RXN|	See Figure 4-3. Direct Coupled Mode Only	200		1200	mV_{PP}
		See Figure 4-3. AC Coupled Mode Only	200		2200	
V_{CMR}	RX input common mode voltage range	See Figure 4-3. Direct Coupled Mode Only	800		0.9 × AVDD	mV
I_{lkg}	RX input leakage current		–10		10	µA
C_I	RX input capacitance				2	pF
t_r, t_f	Differential output signal rise, fall time (20% to 80%)	R_L = 50 Ω, C_L = 5 pF, See Figure 4-1	80		160	ps
J_{TOL}	Jitter Tolerance, Total Jitter at Serial Input	Zero crossing, See Figure 4-4.			0.65	UI(1)
J_{DR}	Serial Input Deterministic Jitter	Zero crossing, See Figure 4-4.			0.37	UI
J_T	Serial Output Total Jitter	3.125 GHz.		0.20	0.35	UI
J_D	Serial Output Deterministic Jitter	3.125 GHz.			0.17	UI
$R_{(LATENCY)}$	Total delay from RX input to RD output	1000Base-X Mode			190	Bit Times
$T_{(LATENCY)}$	Total delay from TD input to TX output	1000Base-X Mode			130	Bit Times
$R_{(LATENCY)}$	Total delay from RX input to RD output	NBID Mode	110		200	Bit Times
$T_{(LATENCY)}$	Total delay from TD input to TX output	NBID Mode	90		250	Bit Times
$R_{(LATENCY)}$	Total delay from RX input to RD output	TBID Mode	90		200	Bit Times
$T_{(LATENCY)}$	Total delay from TD input to TX output	TBID Mode	80		250	Bit Times

(1) Unit Interval = one serial bit time (min. 320 ps)

4.11 DRIVER TEMPLATE PARAMETERS

PARAMETER	NEAR END VALUE	FAR END VALUE	UNIT
X1 (See Figure 4-2)	0.175	0.275	UI
X2 (See Figure 4-2)	0.390	0.400	UI
A1 (See Figure 4-2)	400	100	mV
A2 (See Figure 4-2)	800	800	mV

4.12 TIMING DEFINITION

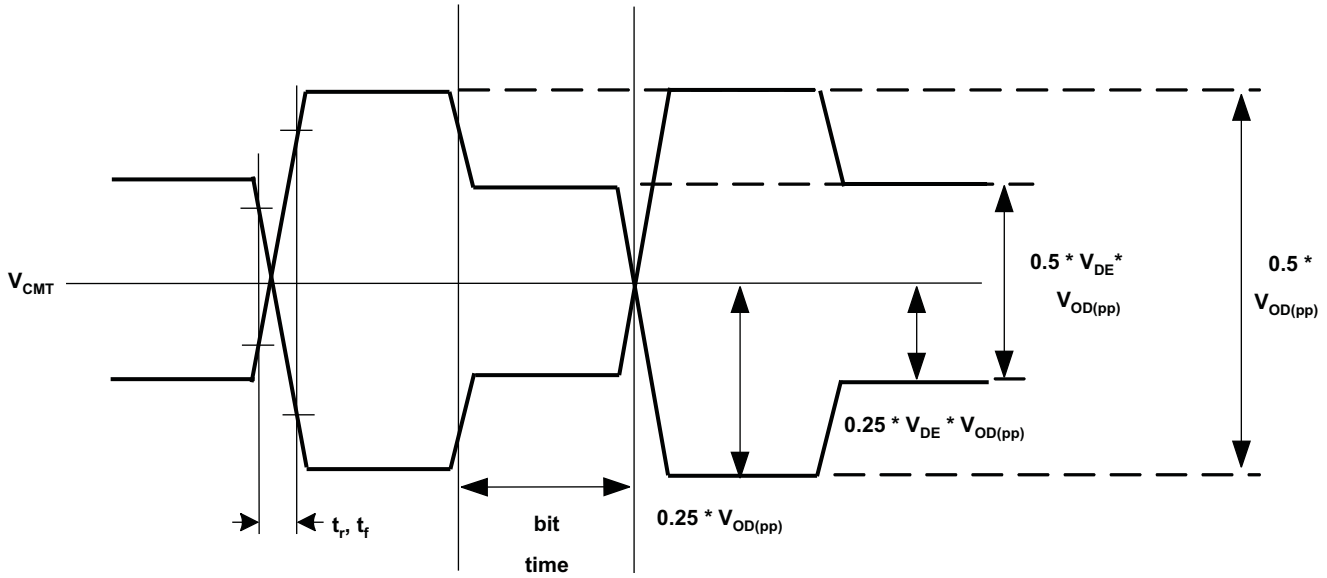


Figure 4-1. Transmit Output Waveform Parameter Definitions

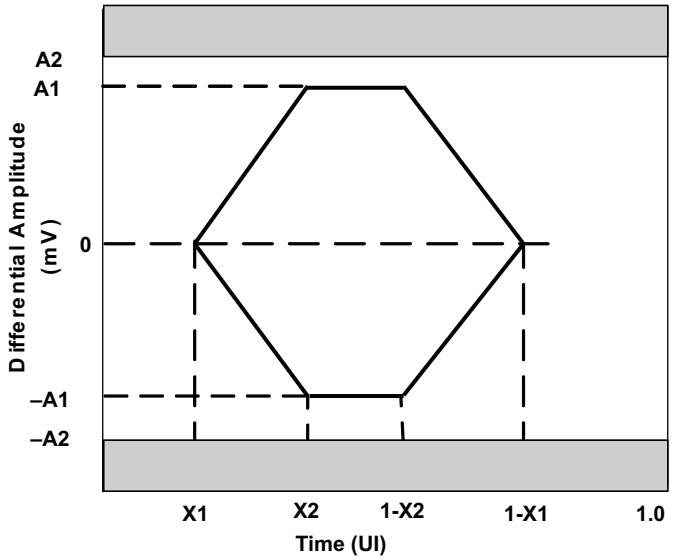


Figure 4-2. Transmit Template

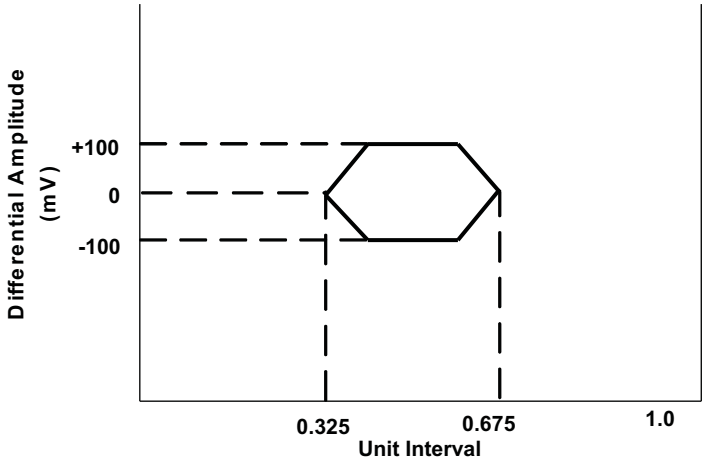
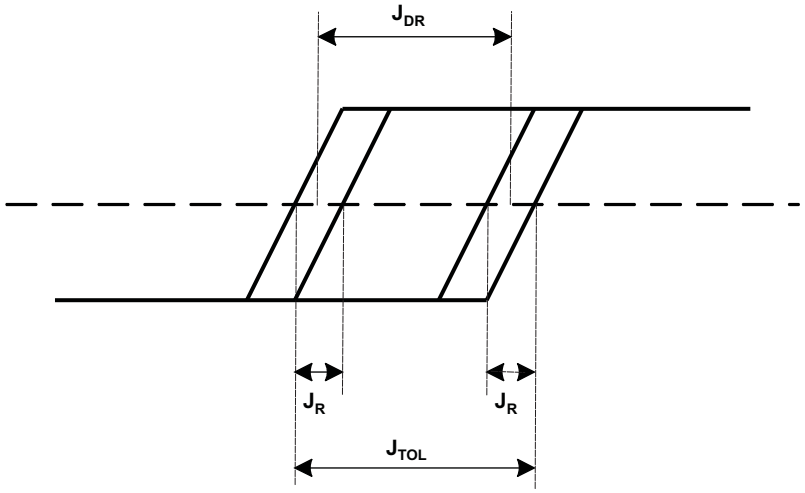


Figure 4-3. Receive Template



Note: $J_{TOL} = J_R + J_{DR}$, where J_{TOL} is the receive jitter tolerance, J_{DR} is the received deterministic jitter, and J_R is the Gaussian random edge jitter distribution at a maximum BER = 10^{-12}.

Figure 4-4. Input Jitter

4.13 APPLICATION MODES

The TLK3131 has several different application modes, which impact parallel interface I/O timing definitions. Each of the modes is defined below, and then subsequently referred to in the detailed timing parameter definitions. RXDATA and RXCLK, and TXDATA and TXCLK in the detailed timing specification will be defined by the exact following signal definitions.

Table 4-1. Parallel Interface – Valid Signal Operational Mode Definitions

TIMING MODE NAME	USAGE MODE	TX SIGNALS USED	RX SIGNALS USED
RGMII, RTBI	1000Base-X Applications, Reduced Ten Bit Applications (RTBI) Only DDR Timing Supported See Section 4.14: HSTL Output Switching Characteristics (DDR Timing Mode Only) and Section 4.16: HSTL (DDR Timing Mode Only) Input Timing Requirements for AC timing details. **Note: In RGMII Mode** CH0: TX_EN/TX_ER = TXD_[4] CH0: RX_DV/RX_ER = RXD_[4]	TXDATA = TXD_[4:0] TXCLK = TXCLK_[0]	RXDATA = RXD_[4:0] RXCLK = RXCLK_[0]
TBI, GMII	Ten Bit Interface Mode (TBI) Only SDR Timing Supported See Section 4.15: HSTL Output Switching Characteristics (SDR Timing Mode Only) and Section 4.17: HSTL (SDR Timing Mode Only) Input Timing Requirements for AC timing details. **Note: In GMII Mode** CH0: TX_EN = TXC_[0] CH0: TX_ER = TXC_[4] CH0: RX_DV = RXC_[0] CH0: RX_ER = RXC_[4] **Note: In TBI Mode** CH0: TX Data Bit 8 = TXC_[0] CH0: TX Data Bit 9 = TXC_[4] CH0: RX Data Bit 8 = RXC_[0] CH0: RX Data Bit 9 = RXC_[4]	TXDATA = TXC_ [4],TXC_ [0], TXD[7:0] TXCLK = TXCLK_ [0]	RXDATA = RXC_ [4],RXC_ [0], RXD[7:0] RXCLK = RXCLK_ [0]
EBI	Eight Bit Interface Mode (EBI) SDR Timing Support See Section 4.15: HSTL Output Switching Characteristics (SDR Timing Mode Only) and Section 4.17: HSTL (SDR Timing Mode Only) Input Timing Requirements for AC timing details.	TXDATA = TXD_ [7:0] TXCLK = TXCLK_ [0]	RXDATA = RXD_ [7:0] RXCLK = RXCLK_ [0]
REBI	Reduced Eight Bit Interface Mode (REBI) DDR Timing Support See Section 4.14: HSTL Output Switching Characteristics (DDR Timing Mode Only) and Section 4.16: HSTL (DDR Timing Mode Only) Input Timing Requirements for AC timing details.	TXDATA = TXD_ [3:0] TXCLK = TXCLK_ [0]	RXDATA = RXD_ [3:0] RXCLK = RXCLK_ [0]
NBI	Nine Bit Interface Mode (NBI) (Un-encoded Data Byte + 1 Control Bit) SDR Timing Support See Section 4.15: HSTL Output Switching Characteristics (SDR Timing Mode Only) and Section 4.17: HSTL (SDR Timing Mode Only) Input Timing Requirements for AC timing details. Note: In NBI Mode CH0: TX Control Bit = TXC_[0] CH0: RX Control Bit = RXC_[0]	TXDATA = TXC_ [0], TXD[7:0] TXCLK = TXCLK_ [0]	RXDATA = RXC_ [0], RXD[7:0] RXCLK = RXCLK_ [0]
RNBI	Reduced Nine Bit Interface Mode (RNBI) (Un-encoded Data Byte + 1 Control Bit) DDR Timing Support See Section 4.14: HSTL Output Switching Characteristics (DDR Timing Mode Only) and Section 4.16: HSTL (DDR Timing Mode Only) Input Timing Requirements for AC timing details. **Note: In RNBI Mode** CH0: TX Control Bit = TXD_[4] CH0: RX Control Bit = RXD_[4]	TXDATA = TXD_[4:0] TXCLK = TXCLK_[0]	RXDATA = RXD_[4:0] RXCLK = RXCLK_[0]
TBID	Ten Bit Interface DDR Mode (TBID) Only DDR Timing Supported See Section 4.14: HSTL Output Switching Characteristics (DDR Timing Mode Only) and Section 4.16: HSTL (DDR Timing Mode Only) Input Timing Requirements for AC timing details. **Note: In TBID Mode** CH0: TX Data Bit 8 = TXC_[0] CH0: TX Data Bit 9 = TXC_[4] CH0: RX Data Bit 8 = RXC_[0] CH0: RX Data Bit 9 = RXC_[4]	TXDATA = TXC_ [4],TXC_ [0], TXD[7:0] TXCLK = TXCLK_ [0]	RXDATA = RXC_ [4],RXC_ [0], RXD[7:0] RXCLK = RXCLK_ [0]
NBID	Nine Bit Interface DDR Mode (NBID) (Un-encoded Data Byte + 1 Control Bit) DDR Timing Support See Section 4.14: HSTL Output Switching Characteristics (DDR Timing Mode Only) and Section 4.16: HSTL (DDR Timing Mode Only) Input Timing Requirements for AC timing details. **Note: In NBID Mode** CH0: TX Control Bit = TXC_[0] CH0: RX Control Bit = RXC_[0]	TXDATA = TXC_ [0], TXD[7:0] TXCLK = TXCLK_ [0]	RXDATA = RXC_ [0], RXD[7:0] RXCLK = RXCLK_ [0]

4.14 HSTL Output Switching Characteristics (DDR Timing Mode Only)

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

PARAMETER		TEST CONDITIONS	MIN	NOM	MAX	UNIT
t_{setup}	RXDATA setup prior to RXCLK transition high or low	Source Centered, See Figure 4-5. Note: C_{load} = 10 pF, using timing reference of VDDQ/2	0.15 × t_{period}			ps
t_{hold}	RXDATA hold after RXCLK transition high or low	Source Centered, See Figure 4-5. Note: C_{load} = 10 pF, using timing reference of VDDQ/2	0.15 × t_{period}			ps
T_{duty}	RXCLK Duty Cycle	Source Centered and Source Aligned. Note: C_{load} = 10 pF, using timing reference of VDDQ/2.	45%		55%	
t_{period}	RXCLK Period	Source Centered and Source Aligned	6.25		16.67 (1)	ns
T_{freq}	RXCLK Frequency	Source Centered and Source Aligned	60 (2)		160	MHz
T_{pd}	RXCLK rising or falling to RXDATA valid.	Source Aligned, See Figure 4-6. Note: C_{load} = 10 pF, using timing reference of VDDQ/2	–0.10 × t_{period}		+0.10 × t_{period}	ps

(1) In TBID/NBID Modes Only, the maximum allowed RXCLK period is 33.33 ns.
(2) In TBID/NBID Modes Only, the minimum allowed RXCLK frequency is 30 MHz.

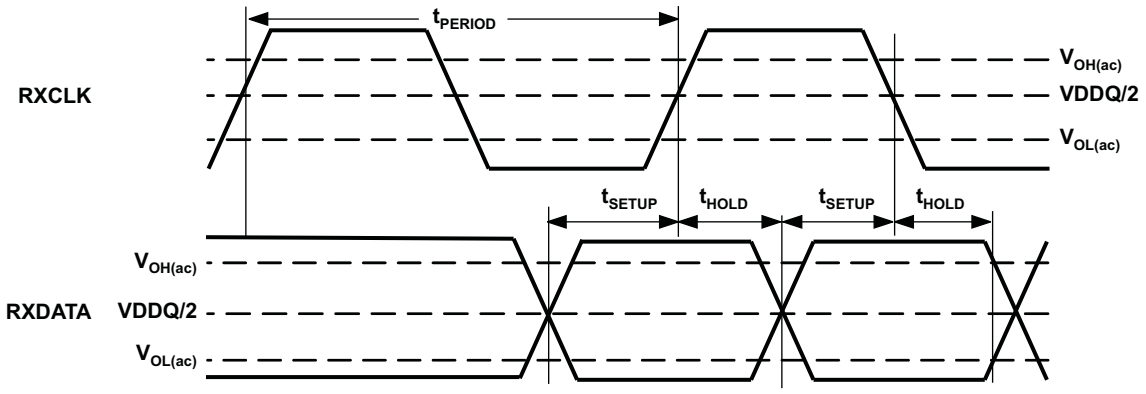


Figure 4-5. HSTL (DDR Timing Mode Only) Source Centered Output Timing Requirements

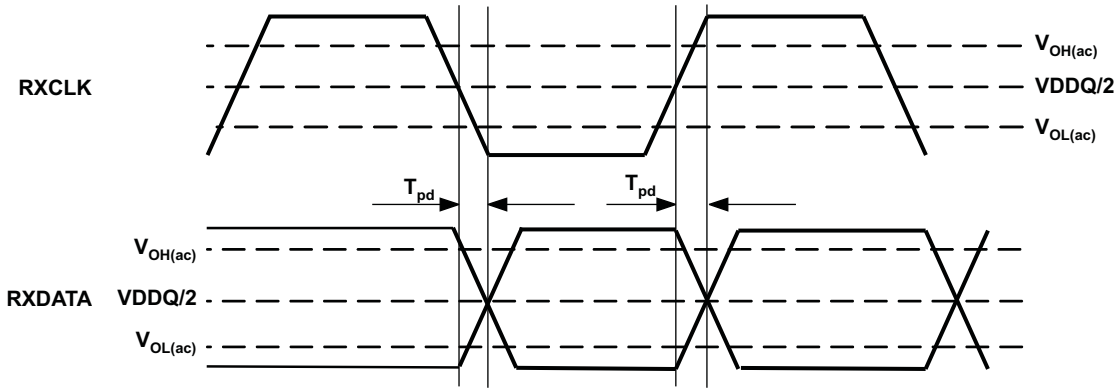


Figure 4-6. HSTL (DDR Timing Mode Only) Source Aligned Output Timing Requirements

4.15 HSTL Output Switching Characteristics (SDR Timing Mode Only)

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

PARAMETER		TEST CONDITIONS	MIN	MAX	UNIT
T_{duty}	RXCLK Duty Cycle	Rising and Falling Edge Aligned Data Note: C_{load} = 10pF, using timing reference of VDDQ/2.	40%	60%	
t_{period}	RXCLK Period	Rising and Falling Edge Aligned Data	2.67	16.67	ns
T_{freq}	RXCLK Frequency	Rising and Falling Edge Aligned Data	60	375	MHz
T_{pd}	RXCLK rising to RXDATA valid.	Rising Edge Aligned, See Figure 4-7 Note: C_{load} = 10pF, using timing reference of VDDQ/2.	–0.10 × t_{period}	+0.10 × t_{period}	ps
T_{pd}	RXCLK falling to RXDATA valid.	Falling Edge Aligned, See Figure 4-8 Note: C_{load} = 10pF, using timing reference of VDDQ/2.	–0.10 × t_{period}	+0.10 × t_{period}	ps

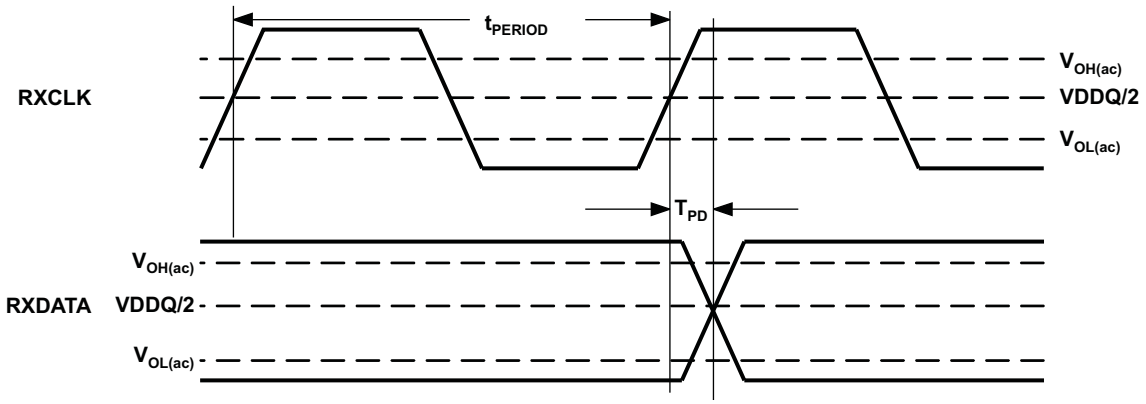


Figure 4-7. HSTL (SDR Timing Mode Only) Rising Edge Aligned Output Timing Requirements

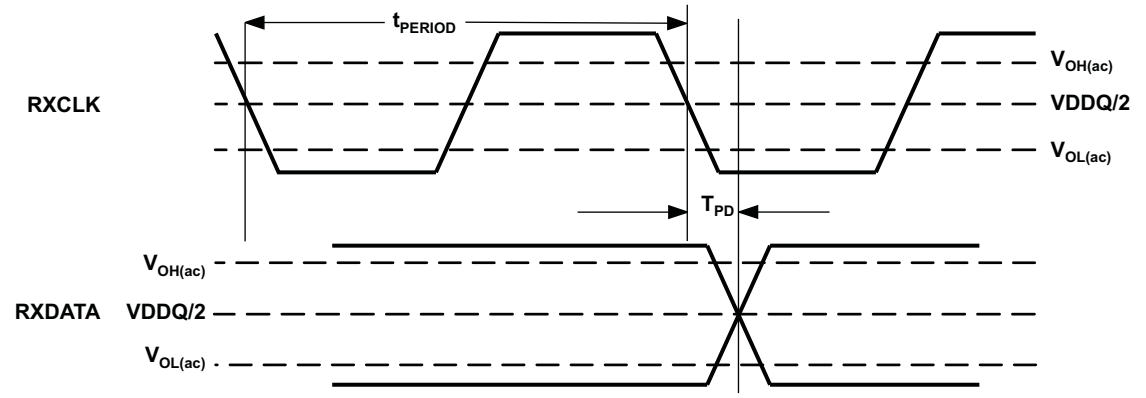


Figure 4-8. HSTL (SDR Timing Mode Only) Falling Edge Aligned Output Timing Requirements

4.16 HSTL (DDR Timing Mode Only) Input Timing Requirements

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

PARAMETER		TEST CONDITIONS	MIN	NOM(1)	MAX	UNIT
t_{setup}	TXDATA setup prior to TXCLK transition high or low	Source Centered. See Figure 4-9. Note: Input timing reference of VDDQ/2, with ±1 ns/V rise time on all input signals.	0.075 × t_{period}			ps
t_{hold}	TXDATA hold after TXCLK transition high or low	Source Centered. See Figure 4-9. Note: Input timing reference of VDDQ/2, with ±1 ns/V rise time on all input signals.	0.075 × t_{period}			ps
t_{duty}	TXCLK Duty Cycle	Source Centered Note: Input timing reference of VDDQ/2, with ±1 ns/V rise time on all input signals.	40%		60%	
t_{duty}	TXCLK Duty Cycle	Source Aligned Note: Input timing reference of VDDQ/2, with ±1 ns/V rise time on all input signals.	45%		55%	
t_{period}	TXCLK Period	Source Centered and Aligned.	6.25		16.67(2)	ns
Tfreq	TXCLK Frequency	Source Centered and Aligned.	60(3)		160	MHz
T_{skew}	TXCLK rising or falling to TXDATA valid.	Source Aligned. See Figure 4-10. Note: Input timing reference of VDDQ/2, with ±1 ns/V rise time on all input signals.	–0.175 × t_{period} (4)		+0.175 × t_{period} (5)	ps

(1) All typical values are at 25°C and with a nominal supply.
(2) In TBID/NBID Modes Only, the maximum allowed TXCLK period is 33.33 ns.
(3) In TBID/NBID Modes Only, the minimum allowed TXCLK frequency is 30 MHz.
(4) In TBID/NBID Modes, when the TXCLK is in the 30 → 60 MHz range, this parameter becomes -0.10 × t_{period}
(5) In TBID/NBID Modes, when the TXCLK is in the 30→ 60 MHz range, this parameter becomes +0.10 × t_{period}

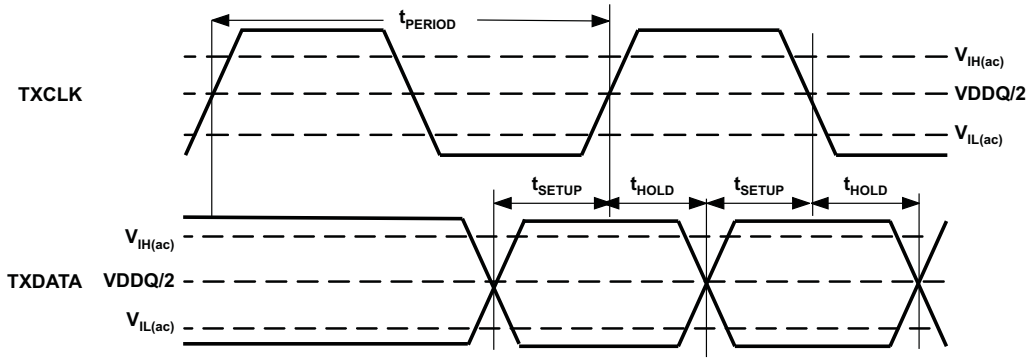


Figure 4-9. HSTL (DDR Timing Mode Only) Source Centered Data Input Timing Requirements

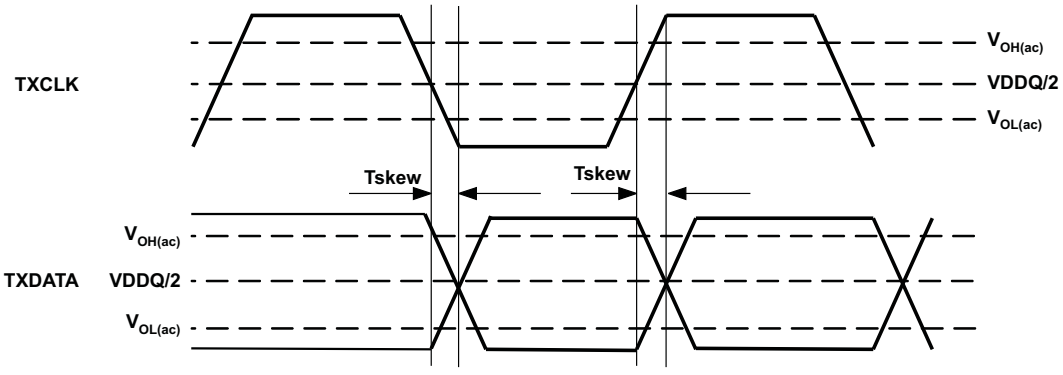


Figure 4-10. HSTL (DDR Timing Mode Only) Source Aligned Data Input Timing Requirements

4.17 HSTL (SDR Timing Mode Only) Input Timing Requirements

PARAMETER		TEST CONDITIONS	MIN	NOM(1)	MAX	UNIT
t_{setup}	TXDATA setup prior to TXCLK transition high	Falling Edge Aligned (Rising Edge Sampled) Data See Figure 4-11. Note: Input timing reference of VDDQ/2, with ±1 ns/V rise time on all input signals.	480			ps
t_{hold}	TXDATA hold after TXCLK transition high	Falling Edge Aligned (Rising Edge Sampled) Data See Figure 4-11. Note: Input timing reference of VDDQ/2, with ±1 ns/V rise time on all input signals.	480			ps
t_{setup}	TXDATA setup prior to TXCLK transition low	Rising Edge Aligned (Falling Edge Sampled) Data See Figure 4-12. Note: Input timing reference of VDDQ/2, with ±1 ns/V rise time on all input signals.	480			ps
t_{hold}	TXDATA hold after TXCLK transition low	Rising Edge Aligned (Falling Edge Sampled) Data See Figure 4-12. Note: Input timing reference of VDDQ/2, with ±1 ns/V rise time on all input signals.	480			ps
t_{duty}	TXCLK Duty Cycle	Rising and Falling Edge Sampled Data Note: Input timing reference of VDDQ/2, with ±1 ns/V rise time on all input signals.	40%		60%	
t_{period}	TXCLK Period	Rising and Falling Edge Aligned Data	2.67		16.67	ns
T_{freq}	TXCLK Frequency	Rising and Falling Edge Aligned Data	60		375	MHz

(1) All typical values are at 25°C and with a nominal supply.

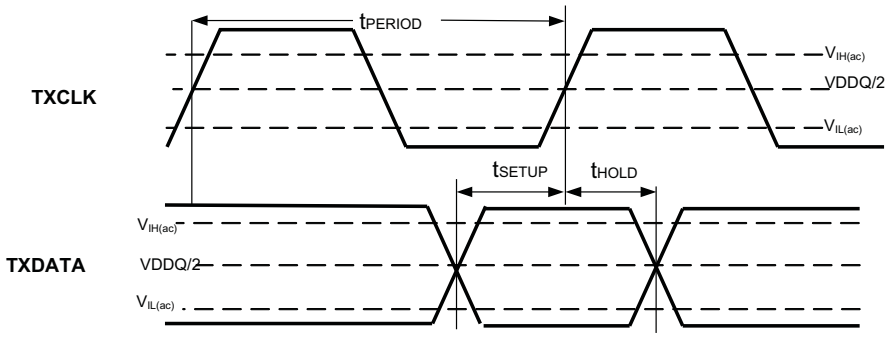


Figure 4-11. HSTL (SDR Timing Mode Only) Falling Edge Aligned (Rising Edge Sampled) Data Input Timing Requirements

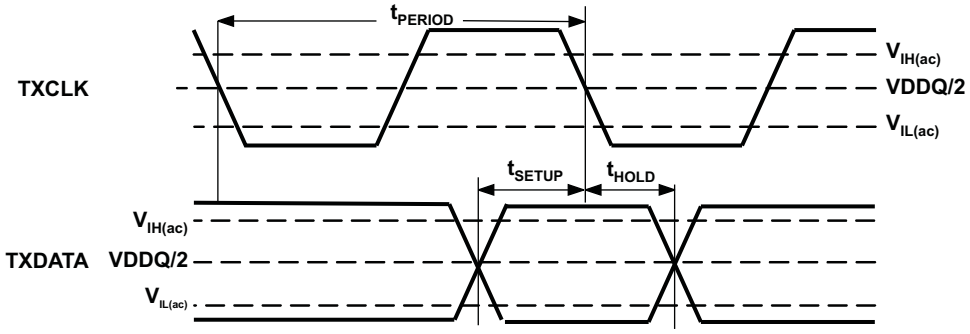


Figure 4-12. HSTL (SDR Timing Mode Only) Rising Edge Aligned (Falling Edge Sampled) Data Input Timing Requirements

4.18 MDIO Timing Requirements Over Recommended Operating Conditions

(Unless otherwise noted)

PARAMETER		TEST CONDITIONS	MIN	NOM	MAX	UNIT
t_{period}	MDC period	See Figure 4-13.	100			ns
t_{setup}	MDIO setup to ↑ MDC	See Figure 4-13.	10			ns
t_{hold}	MDIO hold to ↑ MDC	See Figure 4-13.	10			ns
T_{valid}	MDIO valid from MDC ↑		0		40	ns

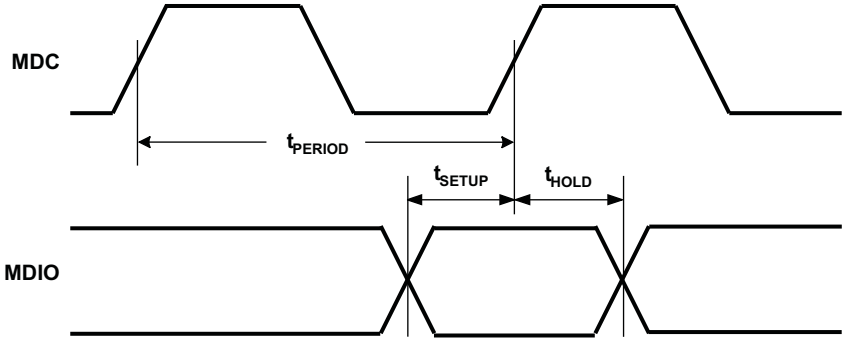


Figure 4-13. MDIO Read/Write Timing

4.19 JTAG Timing Requirements Over Recommended Operating Conditions

(unless otherwise noted)

PARAMETER		TEST CONDITIONS	MIN	NOM	MAX	UNIT
t_{period}	TCK period	See Figure 4-14.	66.67			ns
t_{setup}	TDI/TMS/TRST_N setup to ↑ TCK	See Figure 4-14.	3			ns
t_{hold}	TDI/TMS/TRST_N hold from ↑ TCK	See Figure 4-14.	5			ns
T_{valid}	TDO delay from TCK falling	See Figure 4-14.	0		5	ns

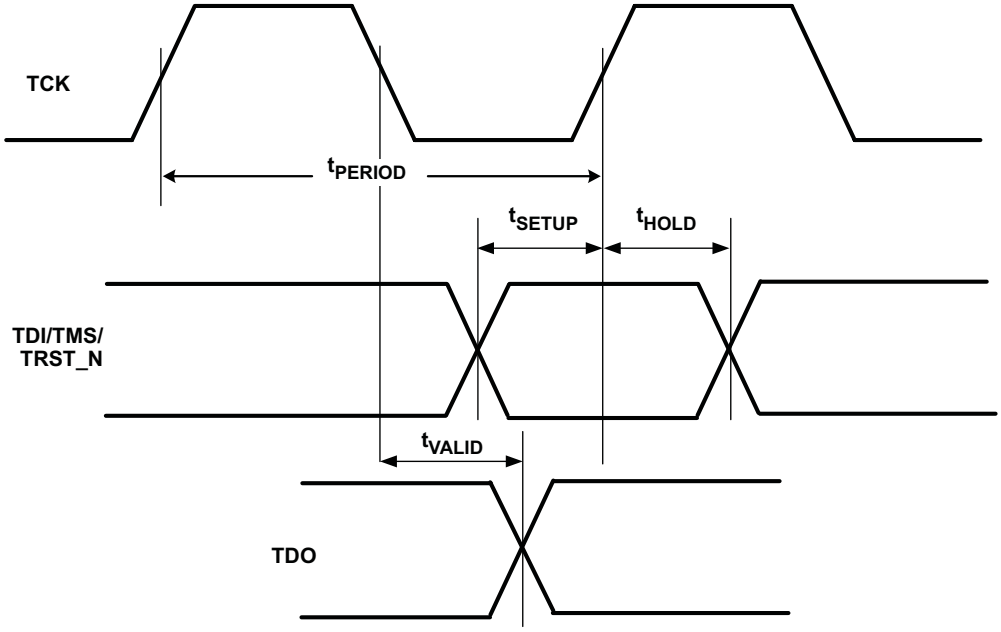


Figure 4-14. JTAG Timing

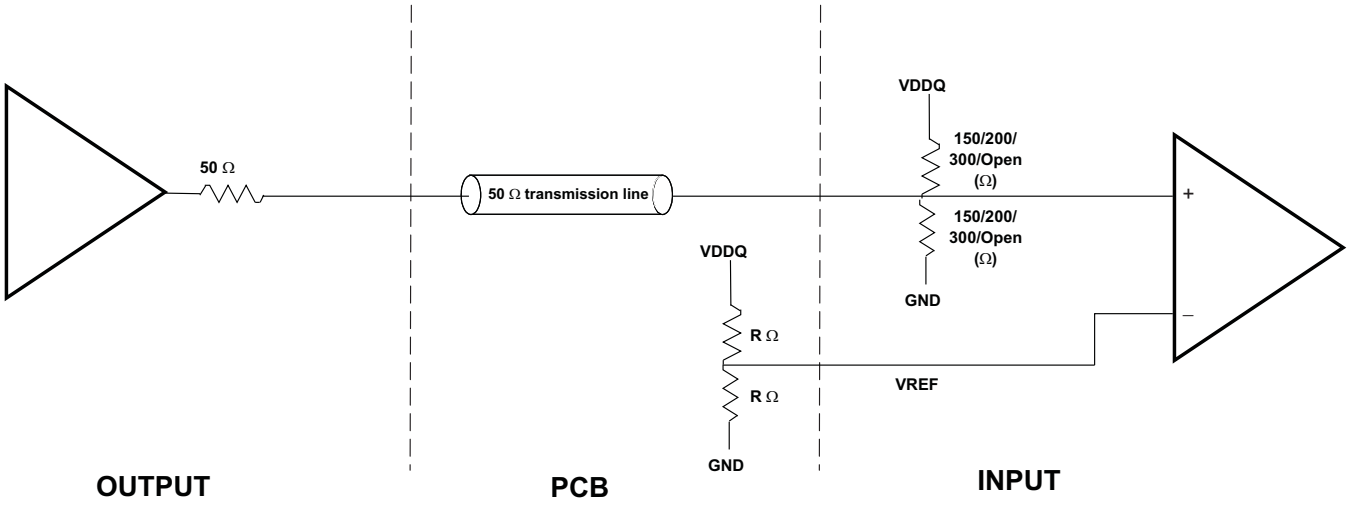


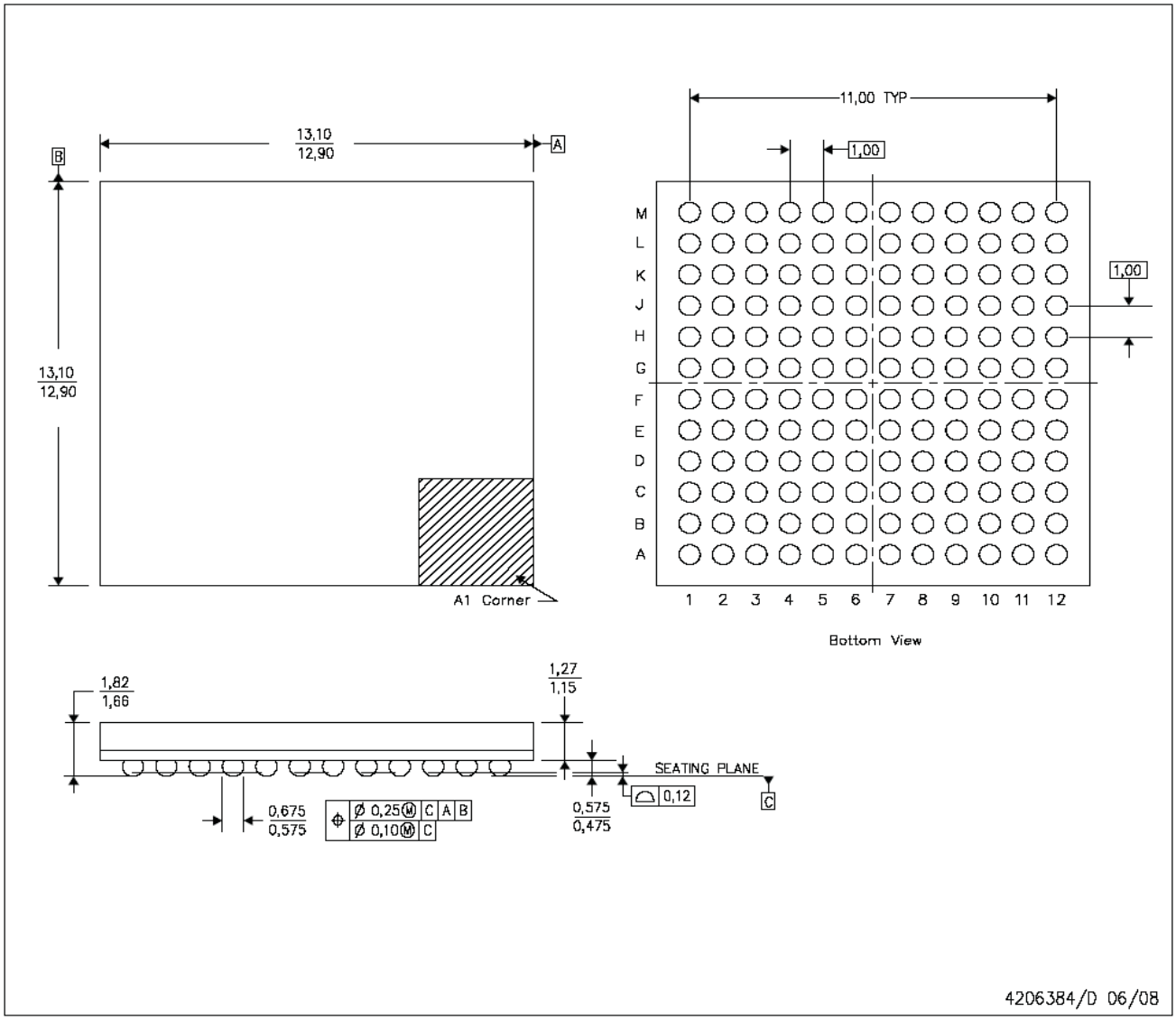
Figure 4-15. HSTL I/O Schematic

Table 4-2. TLK3131 Application Mode –vs– Interface Timing Mode Support(1)

Application Mode	RGMII	GMII	TBI	RTBI	NBI	RNBI	EBI	REBI	TBID	NBID
Gigabit Ethernet (1000Base-X) 1.25 Gbps	Y	Y	N	N	N	N	N	N	N	N
CPRI x1 0.6144 Gbps	N	N	Y	Y	Y	Y	N	N	Y	Y
CPRI x2 1.2288 Gbps	N	N	Y	Y	Y	Y	N	N	Y	Y
CPRI x4 2.4576 Gbps	N	N	Y	N	Y	N	N	N	Y	Y
OBSAI x1 0.768 Gbps	N	N	Y	Y	Y	Y	N	N	Y	Y
OBSAI x2 1.536 Gbps	N	N	Y	Y	Y	Y	N	N	Y	Y
OBSAI x4 3.072 Gbps	N	N	Y	N	Y	N	N	N	Y	Y
Fibre Channel 1X 1.0625 Gbps	N	N	Y	Y	Y	Y	N	N	Y	Y
Fibre Channel 2X 2.125 Gbps	N	N	Y	N	Y	N	N	N	Y	Y
8 Bit SERDES Mode 0.600 → 1.28 Gbps	N	N	N	N	N	N	Y	Y	N	N
8 Bit SERDES Mode 1.28 → 3.0 Gbps	N	N	N	N	N	N	Y	N	N	N
10 Bit SERDES Mode 0.600 → 1.6 Gbps	N	N	Y	Y	N	N	N	N	Y	N
10 Bit SERDES Mode 1.6 → 3.2 Gbps	N	N	Y	N	N	N	N	N	Y	N
10 Bit SERDES Mode 3.2 → 3.75 Gbps	N	N	Y	N	N	N	N	N	N	N
9 Bit SERDES Mode 0.600 → 1.6 Gbps	N	N	N	N	Y	Y	N	N	N	Y
9 Bit SERDES Mode 1.6 → 3.2 Gbps	N	N	N	N	Y	N	N	N	N	Y
9 Bit SERDES Mode 3.2 → 3.75 Gbps	N	N	N	N	Y	N	N	N	N	N

(1) Latency Measurement only operates in TBI, TBID, and RTBI Modes

ZWQ (S–PBGA–N144) PLASTIC BALL GRID ARRAY



NOTES:
A. All linear dimensions are in millimeters. Dimensioning and tolerancing per ASME Y14.5M–1994.
B. This drawing is subject to change without notice.
C. This is a lead–free solder ball design.

Figure 4-16. PACKAGE Information (Package Designator = ZWQ)

4.20 PACKAGE DISSIPATION RATING

PARAMETER		CONDITION	MIN	NOM	MAX	UNIT
θ_{JA}	Junction to free air thermal resistance	Airflow = 0 M/S		31.9		°C/W
θ_{JA}	Junction to free air thermal resistance	Airflow = 0.75 M/S		29.4		°C/W

Table 4-3. Worst Case Device Power Dissipation

Device Total Worst Case Power (All Channels Active, All Supplies +5%, T=85C)								
Serial Bit Rate = 3.75 Gbps								
VDDQ Voltage	1.6V				1.9V			
JC PLL Enabled	N		Y		N		Y	
HSTL Input Termination	None	Max.	None	Max.	None	Max.	None	Max.
Total Power (mW)	686	773	748	834	777	903	840	966
Serial Bit Rate = 3.125 Gbps								
VDDQ Voltage	1.6V				1.9V			
JC PLL Enabled	N		Y		N		Y	
HSTL Input Termination	None	Max.	None	Max.	None	Max.	None	Max.
Total Power (mW)	636	720	702	788	728	848	792	912
Serial Bit Rate =1.25 Gbps (Gigabit Ethernet)								
VDDQ Voltage	1.6V				1.9V			
JC PLL Enabled	N		Y		N		Y	
HSTL Input Termination	None	Max.	None	Max.	None	Max.	None	Max.
Total Power (mW)	520	648	565	693	579	765	629	810

A APPENDIX A – Frequency Ranges Supported

The following tables show the details of REFCLK input frequency versus Jitter Cleaner PLL multiplier value for each application TLK3131 supports.

If the desired serial bit rate is between 2.0 Gbps and 3.75 Gbps, full rate should be selected for the RATE[1:0] bits for that channel.

If the desired serial bit rate is between 1.0 Gbps and 2.125 Gbps, half rate should be selected for the RATE[1:0] bits for that channel.

If the desired serial bit rate is between 600 Mbps and 1.0625 Gbps, quarter rate should be selected for the RATE[1:0] bits for that channel.

If the desired serial bit rate falls in the overlap between the full and half rate ranges defined above, then either setting is appropriate.

If the desired serial bit rate falls in the overlap between the half and quarter rate ranges defined above, then either setting is appropriate.

In general, there are many different settings that will yield the same serial bit rate. It should be noted that selecting the setting with the highest SERDES REFCLK and the lowest SERDES PLL Multiplier will give the best serial performance.

Table A-1. Reference Clock Selection – Gigabit Ethernet Mode

Gigabit Ethernet Mode - Legal Clocking Mode Settings						
TLK3131 REFLK Input (MHz)	Jitter Cleaner Multiplier	SERDES REFCLK Input (MHz)	SERDES PLL Multiplier	Serial Data Rate = f(SPEED[1:0]) (Mbps)		
				Full (00)	Half (01)	Qrtr. (10)
62.50000	OFF	62.50000	20	2500.000	**1250.000**	625.000
62.50000	0.25	15.62500				
62.50000	0.5	31.25000				
62.50000	1	62.50000	20	2500.000	**1250.000**	625.000
62.50000	2	125.00000	10	2500.000	**1250.000**	625.000
125.00000	OFF	125.00000	10	2500.000	**1250.000**	625.000
125.00000	0.25	31.25000				
125.00000	0.5	62.50000	20	2500.000	**1250.000**	625.000
125.00000	1	125.00000	10	2500.000	**1250.000**	625.000
125.00000	2	250.00000	5	2500.000	**1250.000**	625.000
250.00000	OFF	250.00000	5	2500.000	**1250.000**	625.000
250.00000	0.25	62.50000	20	2500.000	**1250.000**	625.000
250.00000	0.5	125.00000	10	2500.000	**1250.000**	625.000
250.00000	1	250.00000	5	2500.000	**1250.000**	625.000
250.00000	2	500.00000				

Table A-2. Reference Clock Selection – 1X/2X Fibre Channel Mode

Fibre Channel Mode - Legal Clocking Mode Settings						
TLK3131 REFLK Input (MHz)	Jitter Cleaner Multiplier	SERDES REFCLK Input (MHz)	SERDES PLL Multiplier	Serial Data Rate = f(SPEED[1:0]) (Mbps)		
				Full (00)	Half (01)	Qrtr. (10)
53.12500	OFF	53.12500	20	**2125.000**	**1062.500**	
53.12500	0.25	13.28125				
53.12500	0.5	26.56250				
53.12500	1	53.12500	20	**2125.000**	**1062.500**	
53.12500	2	106.25000	10	**2125.000**	**1062.500**	
106.25000	OFF	106.25000	10	**2125.000**	**1062.500**	
106.25000	0.25	26.56250				
106.25000	0.5	53.12500	20	**2125.000**	**1062.500**	
106.25000	1	106.25000	10	**2125.000**	**1062.500**	
106.25000	2	212.50000	5	**2125.000**	**1062.500**	
212.50000	OFF	212.50000	5	**2125.000**	**1062.500**	
212.50000	0.25	53.12500	20	**2125.000**	**1062.500**	
212.50000	0.5	106.25000	10	**2125.000**	**1062.500**	
212.50000	1	212.50000	5	**2125.000**	**1062.500**	

Table A-3. Reference Clock Selection – OBSAI Mode

Gigabit Ethernet Mode - Legal Clocking Mode Settings						
TLK3131 REFLK Input (MHz)	Jitter Cleaner Multiplier	SERDES REFCLK Input (MHz)	SERDES PLL Multiplier	Serial Data Rate = f(SPEED[1:0]) (Mbps)		
				Full (00)	Half (01)	Qrtr. (10)
76.80000	OFF	76.80000	20	**3072.000**	**1536.000**	**768.000**
76.80000	0.25	19.20000				
76.80000	0.5	38.40000				
76.80000	1	76.80000	20	**3072.000**	**1536.000**	**768.000**
76.80000	2	153.60000	10	**3072.000**	**1536.000**	**768.000**
153.60000	OFF	153.60000	10	**3072.000**	**1536.000**	**768.000**
153.60000	0.25	38.40000				
153.60000	0.5	76.80000	20	**3072.000**	**1536.000**	**768.000**
153.60000	1	153.60000	10	**3072.000**	**1536.000**	**768.000**
153.60000	2	307.20000	5	**3072.000**	**1536.000**	**768.000**
307.20000	OFF	307.20000	5	**3072.000**	**1536.000**	**768.000**
307.20000	0.25	76.80000	20	**3072.000**	**1536.000**	**768.000**
307.20000	0.5	153.60000	10	**3072.000**	**1536.000**	**768.000**
307.20000	1	307.20000	5	**3072.000**	**1536.000**	**768.000**
307.20000	2	614.40000				

Table A-4. Reference Clock Selection – CPRI Mode

Reference Clock Selection – CPRI Mode						
TLK3131 REFLK Input (MHz)	Jitter Cleaner Multiplier	SERDES REFCLK Input (MHz)	SERDES PLL Multiplier	Serial Data Rate = f(SPEED[1:0]) (Mbps)		
				Full (00)	Half (01)	Qrtr. (10)
61.44000	OFF	61.44000	20	**2457.600**	**1228.800**	**614.400**
61.44000	0.25	15.36000				
61.44000	0.5	30.72000				
61.44000	1	61.44000	20	**2457.600**	**1228.800**	**614.400**
61.44000	2	122.88000	10	**2457.600**	**1228.800**	**614.400**
122.88000	OFF	122.88000	10	**2457.600**	**1228.800**	**614.400**
122.88000	0.25	30.72000				
122.88000	0.5	61.44000	20	**2457.600**	**1228.800**	**614.400**
122.88000	1	122.88000	10	**2457.600**	**1228.800**	**614.400**
122.88000	2	245.76000	5	**2457.600**	**1228.800**	**614.400**
245.76000	OFF	245.76000	5	**2457.600**	**1228.800**	**614.400**
245.76000	0.25	61.44000	20	**2457.600**	**1228.800**	**614.400**
245.76000	0.5	122.88000	10	**2457.600**	**1228.800**	**614.400**
245.76000	1	245.76000	5	**2457.600**	**1228.800**	**614.400**

Table A-5. Reference Clock Selection – 9/10 Bit SERDES Mode – Full Rate (SPEED[1:0] = 00)

Nine/Ten Bit SERDES Mode – Clock Range Support (RATE[1:0]=00) (Full)							
REFLK		Jitter Cleaner Multiplier	SERDES REFCLK		SERDES PLL Multiplier	Serial Data Rate (Mbps)	
Minimum (MHz)	Maximum (MHz)		Minimum (MHz)	Maximum (MHz)		FULL	
						Minimum	Maximum
200.0000	375.0000	OFF	200.0000	375.0000	5	2000.00	3750.00
100.0000	187.5000	OFF	100.0000	187.5000	10	2000.00	3750.00
50.0000	93.7500	OFF	50.0000	93.7500	20	2000.00	3750.00
		0.25			5		
		0.25			10		
200.0000	375.0000	0.25	50.0000	93.7500	20	2000.00	3750.00
		0.5			5		
200.0000	375.0000	0.5	100.0000	187.5000	10	2000.00	3750.00
100.0000	187.5000	0.5	50.0000	93.7500	20	2000.00	3750.00
		1			5		
100.0000	187.5000	1	100.0000	187.5000	10	2000.00	3750.00
50.0000	93.7500	1	50.0000	93.7500	20	2000.00	3750.00
		2			5		
50.0000	93.7500	2	100.0000	187.5000	10	2000.00	3750.00
		2			20		

Table A-6. Reference Clock Selection – 9/10 Bit SERDES Mode – Half Rate (SPEED[1:0] = 01)

Nine/Ten Bit SERDES Mode – Clock Range Support (RATE[1:0]=01) (Half)							
REFLK		Jitter Cleaner Multiplier	SERDES REFCLK		SERDES PLL Multiplier	Serial Data Rate (Mbps)	
Minimum (MHz)	Maximum (MHz)		Minimum (MHz)	Maximum (MHz)		Half	
						Minimum	Maximum
200.0000	375.0000	OFF	200.0000	375.0000	5	1000.00	1875.00
100.0000	212.5000	OFF	100.0000	212.5000	10	1000.00	2125.00
50.0000	106.2500	OFF	50.0000	106.2500	20	1000.00	2125.00
		0.25			5		
		0.25			10		
200.0000	375.0000	0.25	50.0000	93.7500	20	1000.00	1875.00
		0.5			5		
200.0000	375.0000	0.5	100.0000	187.5000	10	1000.00	1875.00
100.0000	212.5000	0.5	50.0000	106.2500	20	1000.00	2125.00
		1			5		
100.0000	200.0000	1	100.0000	200.0000	10	1000.00	20000.00
50.0000	106.2500	1	50.0000	106.2500	20	1000.00	2125.00
		2			5		
50.0000	100.0000	2	100.0000	200.0000	10	1000.00	2000.00
		2			20		

Table A-7. Reference Clock Selection – 9/10 Bit SERDES Mode – Quarter Rate (SPEED[1:0] = 10)

Nine/Ten Bit SERDES Mode – Clock Range Support (RATE[1:0]=10) (Quarter)							
REFLK		Jitter Cleaner Multiplier	SERDES REFCLK		SERDES PLL Multiplier	Serial Data Rate (Mbps)	
Minimum (MHz)	Maximum (MHz)		Minimum (MHz)	Maximum (MHz)		Quarter	
						Minimum	Maximum
240.0000	375.0000	OFF	240.0000	375.0000	5	600.00	937.50
120.0000	212.5000	OFF	120.0000	212.5000	10	600.00	1062.50
60.0000	106.2500	OFF	60.0000	106.2500	20	600.00	1062.50
		0.25			5		
		0.25			10		
240.0000	375.0000	0.25	60.0000	93.7500	20	600.00	937.50
		0.5			5		
240.0000	375.0000	0.5	120.0000	187.5000	10	600.00	937.50
120.0000	212.5000	0.5	60.0000	106.2500	20	600.00	1062.50
		1			5		
120.0000	200.0000	1	120.0000	200.0000	10	600.00	1000.00
60.0000	106.2500	1	60.0000	106.2500	20	600.00	1062.50
		2			5		
60.0000	100.0000	2	120.0000	200.0000	10	600.00	1000.00
		2			20		

Table A-8. Reference Clock Selection – 8 Bit SERDES Mode – Full Rate (SPEED[1:0] = 00)

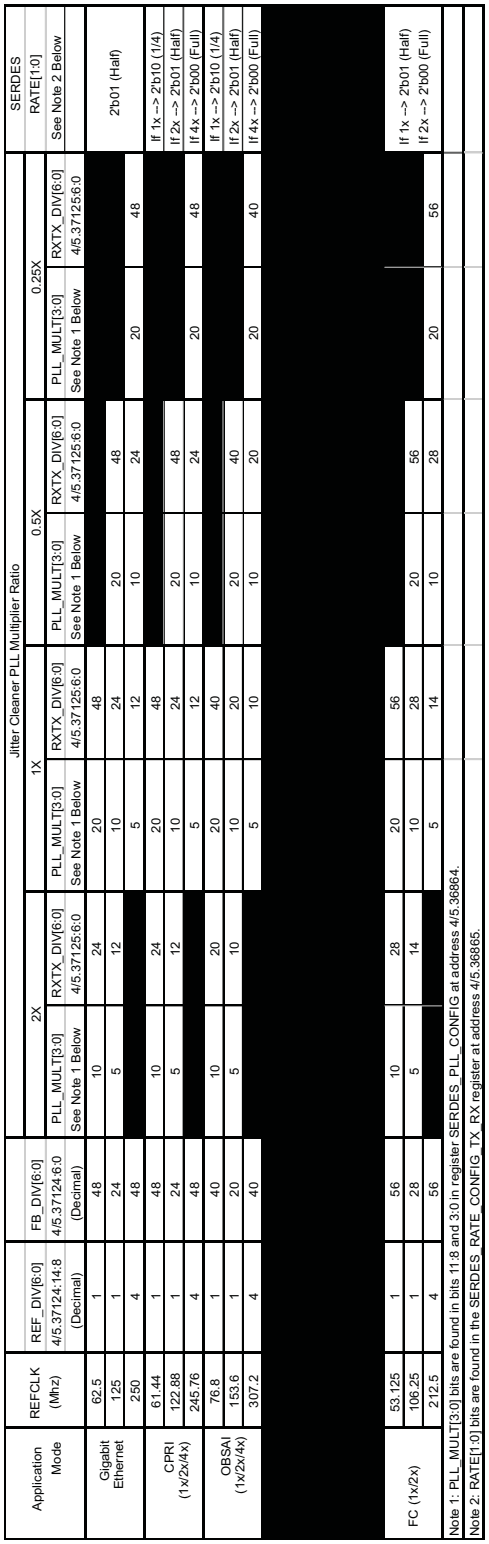
Eight Bit SERDES Mode – Clock Range Support (RATE[1:0]=00) (Full)							
REFLK		Jitter Cleaner Multiplier	SERDES REFCLK		SERDES PLL Multiplier	Serial Data Rate (Mbps)	
Minimum (MHz)	Maximum (MHz)		Minimum (MHz)	Maximum (MHz)		FULL	
						Minimum	Maximum
250.0000	375.0000	OFF	250.0000	375.0000	4	2000.00	3000.00
125.0000	187.5000	OFF	125.0000	187.5000	8	2000.00	3000.00
		0.25			4		
		0.25			8		
		0.5			4		
250.0000	375.0000	0.5	125.0000	187.5000	8	2000.00	3000.00
		1			4		
125.0000	187.5000	1	125.0000	187.5000	8	2000.00	3000.00
		2			4		
62.5000	93.7500	2	125.0000	187.5000	8	2000.00	3000.00

Table A-9. Reference Clock Selection – 8 Bit SERDES Mode – Half Rate (SPEED[1:0] = 01)

Eight Bit SERDES Mode – Clock Range Support (RATE[1:0]=01) (Half)							
REFLK		Jitter Cleaner Multiplier	SERDES REFCLK		SERDES PLL Multiplier	Serial Data Rate (Mbps)	
Minimum (MHz)	Maximum (MHz)		Minimum (MHz)	Maximum (MHz)		Half	
						Minimum	Maximum
250.0000	375.0000	OFF	250.0000	375.0000	4	1000.00	1500.00
125.0000	265.6250	OFF	125.0000	265.6250	8	1000.00	2125.00
		0.25			4		
		0.25			8		
		0.5			4		
250.0000	375.0000	0.5	125.0000	187.5000	8	1000.00	1500.00
		1			4		
125.0000	200.0000	1	125.0000	200.0000	8	1000.00	1600.00
		2			4		
62.5000	100.0000	2	125.0000	200.0000	8	1000.00	1600.00

Table A-10. Reference Clock Selection – 8 Bit SERDES Mode – Quarter Rate (SPEED[1:0] = 10)

Eight Bit SERDES Mode – Clock Range Support (RATE[1:0]=10) (Quarter)							
REFLK		Jitter Cleaner Multiplier	SERDES REFCLK		SERDES PLL Multiplier	Serial Data Rate (Mbps)	
Minimum (MHz)	Maximum (MHz)		Minimum (MHz)	Maximum (MHz)		Quarter	
						Minimum	Maximum
300.0000	375.0000	OFF	300.0000	375.0000	4	600.00	750.00
150.0000	265.6250	OFF	150.0000	265.6250	8	600.00	1062.50
		0.25			4		
		0.25			8		
		0.5			4		
300.0000	375.0000	0.5	150.0000	187.5000	8	600.00	750.00
		1			4		
150.0000	200.0000	1	150.0000	200.0000	8	600.00	800.00
		2			4		
75.0000	100.0000	2	150.0000	200.0000	8	600.00	800.00



Application Mode	REFCLK (Mhz)	Jitter Cleaner PLL Multiplier Ratio										SERDES RATE[1:0]
		2X			1X			0.5X		0.25X		
		REF_DIV[6:0] 4/5.37124:14:8 (Decimal)	FB_DIV[6:0] 4/5.37124:6:0 (Decimal)	PLL_MULT[3:0] See Note 1 Below	RXTX_DIV[6:0] 4/5.37125:6:0	PLL_MULT[3:0] See Note 1 Below	RXTX_DIV[6:0] 4/5.37125:6:0	PLL_MULT[3:0] See Note 1 Below	RXTX_DIV[6:0] 4/5.37125:6:0	PLL_MULT[3:0] See Note 1 Below	RXTX_DIV[6:0] 4/5.37125:6:0	See Note 2 Below
Gigabit Ethernet	62.5	1	48	10	24	20	48					2'b01 (Half)
	125	1	24	5	12	10	24	20	48	20	48	
	250	4	48			5	12	10	24			If 1x --> 2'b10 (1/4)
CPRI (1x/2x/4x)	61.44	1	48	10	24	20	48					If 2x --> 2'b01 (Half)
	122.88	1	24	5	12	10	24	20	48	20	48	If 4x --> 2'b00 (Full)
	245.76	4	48			5	12	10	24			If 1x --> 2'b10 (1/4)
OBSAI (1x/2x/4x)	76.8	1	40	10	20	20	40					If 2x --> 2'b01 (Half)
	153.6	1	20	5	10	10	20	20	40	20	40	If 4x --> 2'b00 (Full)
	307.2	4	40			5	10	10	20			
FC (1x/2x)	53.125	1	56	10	28	20	56					If 1x --> 2'b01 (Half)
	106.25	1	28	5	14	10	28	20	56	20	56	If 2x --> 2'b00 (Full)
	212.5	4	56			5	14	10	28			

Note 1: PLL_MULT[3:0] bits are found in bits 11:8 and 3:0 in register SERDES_PLL_CONFIG at address 4/5.36864.
Note 2: RATE[1:0] bits are found in the SERDES_RATE_CONFIG_TX_RX register at address 4/5.36865.

Figure A-1. Standard Based Jitter Cleaner/SERDES Provisioning

9/10 Bit SERDES Mode - Continuous Mode - Jitter Cleaner (2x) Mode																			
										SERDES RATE [1:0] (See Note 2 Below)									
REFCLK (Mhz)		REF_DIV[6:0]	FB_DIV[6:0]	PLL_MULT[3:0]	RXTX_DIV[6:0]	2'b00 (Full)		2'b01 (Half)		2'b10 (Quarter)									
		4/5.37124:14:8	4/5.37124:6:0	See Note 1 Below	4/5.37125:6:0														
Min	Max	(Decimal)	(Decimal)			Min	Max	Min	Max	Min	Max								
50.0000	52.0833	1	60	10	30	2000.000	2083.333	1000.000	1041.667										
50.4310	53.8793	1	58	10	29	2017.241	2155.172	1008.621	1077.586										
52.2321	55.8036	1	56	10	28	2089.286	2232.143	1044.643	1116.071										
54.1667	57.8704	1	54	10	27	2166.667	2314.815	1083.333	1157.407										
56.2500	60.0962	1	52	10	26	2250.000	2403.846	1125.000	1201.923										
58.5000	62.5000	1	50	10	25	2340.000	2500.000	1170.000	1250.000	600.000	625.000								
60.9375	65.1042	1	48	10	24	2437.500	2604.167	1218.750	1302.083	609.375	651.042								
63.5870	67.9348	1	46	10	23	2543.478	2717.391	1271.739	1358.696	635.870	679.348								
66.4773	71.0227	1	44	10	22	2659.091	2840.909	1329.545	1420.455	664.773	710.227								
69.6429	74.4048	1	42	10	21	2785.714	2976.190	1392.857	1488.095	696.429	744.048								
73.1250	78.1250	1	40	10	20	2925.000	3125.000	1462.500	1562.500	731.250	781.250								
76.9737	82.2368	1	38	10	19	3078.947	3289.474	1539.474	1644.737	769.737	822.368								
81.2500	86.8056	1	36	10	18	3250.000	3472.222	1625.000	1736.111	812.500	868.056								
86.0294	91.9118	1	34	10	17	3441.176	3676.471	1720.588	1838.235	860.294	919.118								
91.4063	97.6563	1	32	10	16	3656.250	3750.000	1828.125	1953.125	914.063	976.563								
97.5000	100.0000	1	30	10	15			1950.000	2000.000	975.000	1000.000								
Note 1: PLL_MULT[3:0] bits are found in bits 11:8 and 3:0 in register SERDES_PLL_CONFIG at address 4/5.36864.																			
Note 2: RATE[1:0] bits are found in the SERDES_RATE_CONFIG_TX_RX register at address 4/5.36865.																			

Note that REFCLK is limited to 93.75 Mhz when in full rate mode to achieve 3750 Mbps serial data rate.

Figure A-2. 9/10 BIT SERDES Mode – Jitter Cleaner/SERDES (2x) Provisioning

9/10 Bit SERDES Mode - Continuous Mode - Jitter Cleaner (1x) Mode											
REFCLK (Mhz)		REF_DIV[6:0] 4/5.37124:14:8	FB_DIV[6:0] 4/5.37124:6:0	PLL_MULT[3:0]	RXTX_DIV[6:0]	SERDES RATE [1:0] (See Note 2 Below)					
						RATE[1:0] =2'b00 Full		RATE[1:0] =2'b01 Half		RATE[1:0] =2'b10 Qrtr.	
Min	Max	(Decimal)	(Decimal)	See Note 1 Below	4/5.37125:6:0	Min	Max	Min	Max	Min	Max
50.0000	53.8793	1	58	20	58	2000.000	2155.172	1000.000	1077.586		
51.3158	54.8246	1	57	20	57	2052.632	2192.982	1026.316	1096.491		
52.2321	55.8036	1	56	20	56	2089.286	2232.143	1044.643	1116.071		
53.1818	56.8182	1	55	20	55	2127.273	2272.727	1063.636	1136.364		
54.1667	57.8704	1	54	20	54	2166.667	2314.815	1083.333	1157.407		
55.1887	58.9623	1	53	20	53	2207.547	2358.491	1103.774	1179.245		
56.2500	60.0962	1	52	20	52	2250.000	2403.846	1125.000	1201.923		
57.3529	61.2745	1	51	20	51	2294.118	2450.980	1147.059	1225.490	600.000	612.745
58.5000	62.5000	1	50	20	50	2340.000	2500.000	1170.000	1250.000	600.000	625.000
59.6939	63.7755	1	49	20	49	2387.755	2551.020	1193.878	1275.510	600.000	637.755
60.9375	65.1042	1	48	20	48	2437.500	2604.167	1218.750	1302.083	609.375	651.042
62.2340	66.4894	1	47	20	47	2489.362	2659.574	1244.681	1329.787	622.340	664.894
63.5870	67.9348	1	46	20	46	2543.478	2717.391	1271.739	1358.696	635.870	679.348
65.0000	69.4444	1	45	20	45	2600.000	2777.778	1300.000	1388.889	650.000	694.444
66.4773	71.0227	1	44	20	44	2659.091	2840.909	1329.545	1420.455	664.773	710.227
68.0233	72.6744	1	43	20	43	2720.930	2906.977	1360.465	1453.488	680.233	726.744
69.6429	74.4048	1	42	20	42	2785.714	2976.190	1392.857	1488.095	696.429	744.048
71.3415	76.2195	1	41	20	41	2853.659	3048.780	1426.829	1524.390	713.415	762.195
73.1250	78.1250	1	40	20	40	2925.000	3125.000	1462.500	1562.500	731.250	781.250
75.0000	80.1282	1	39	20	39	3000.000	3205.128	1500.000	1602.564	750.000	801.282
76.9737	82.2368	1	38	20	38	3078.947	3289.474	1539.474	1644.737	769.737	822.368
79.0541	84.4595	1	37	20	37	3162.162	3378.378	1581.081	1689.189	790.541	844.595
81.2500	86.8056	1	36	20	36	3250.000	3472.222	1625.000	1736.111	812.500	868.056
83.5714	89.2857	1	35	20	35	3342.857	3571.429	1671.429	1785.714	835.714	892.857
86.0294	91.9118	1	34	20	34	3441.176	3676.471	1720.588	1838.235	860.294	919.118
88.6364	94.6970	1	33	20	33	3545.455	3750.000	1772.727	1893.939	886.364	946.970
91.4063	97.6563	1	32	20	32	3656.250	3750.000	1828.125	1953.125	914.063	976.563
94.3548	100.8065	1	31	20	31			1887.097	2016.129	943.548	1008.065
97.5000	104.1667	1	30	20	30			1950.000	2083.333	975.000	1041.667
100.8621	106.2500	1	29	20	29			2017.241	2125.000	1008.621	1062.500
104.4643	106.2500	1	28	20	28			2089.286	2125.000	1044.643	1062.500
100.0000	104.1667	1	30	10	30	2000.000	2083.333	1000.000	1041.667		
100.0000	107.7586	1	29	10	29	2000.000	2155.172	1000.000	1077.586		
104.4643	111.6071	1	28	10	28	2089.286	2232.143	1044.643	1116.071		
108.3333	115.7407	1	27	10	27	2166.667	2314.815	1083.333	1157.407		
112.5000	120.1923	1	26	10	26	2250.000	2403.846	1125.000	1201.923		
117.0000	125.0000	1	25	10	25	2340.000	2500.000	1170.000	1250.000	600.000	625.000
121.8750	130.2083	1	24	10	24	2437.500	2604.167	1218.750	1302.083	600.000	651.042
127.1739	135.8696	1	23	10	23	2543.478	2717.391	1271.739	1358.696	635.870	679.348
132.9545	142.0455	1	22	10	22	2659.091	2840.909	1329.545	1420.455	664.773	710.227
139.2857	148.8095	1	21	10	21	2785.714	2976.190	1392.857	1488.095	696.429	744.048
146.2500	156.2500	1	20	10	20	2925.000	3125.000	1462.500	1562.500	731.250	781.250
153.9474	164.4737	1	19	10	19	3078.947	3289.474	1539.474	1644.737	769.737	822.368
162.5000	173.6111	1	18	10	18	3250.000	3472.222	1625.000	1736.111	812.500	868.056
172.0588	183.8235	1	17	10	17	3441.176	3676.471	1720.588	1838.235	860.294	919.118
182.8125	195.3125	1	16	10	16	3656.250	3750.000	1828.125	1953.125	914.063	976.563
195.0000	200.0000	1	15	10	15			1950.000	2000.000	975.000	1000.000
Note 1: PLL_MULT[3:0] bits are found in bits 11:8 and 3:0 in register SERDES_PLL_CONFIG at address 4/5.36864.											
Note 2: RATE[1:0] bits are found in the SERDES_RATE_CONFIG_TX_RX register at address 4/5.36865.											

Note that REFCLK is limited to 187.5 Mhz when in full rate mode to achieve 3750 Mbps serial data rate.

Figure A-3. 9/10 BIT SERDES Mode – Jitter Cleaner/SERDES (1x) Provisioning

9/10 Bit SERDES Mode - Continuous Mode - Jitter Cleaner (0.5X) Mode											
REFCLK (Mhz)		REF_DIV[6:0] 4/5.37124:14:8	FB_DIV[6:0] 4/5.37124:6:0	PLL_MULT[3:0]	RXTX_DIV[6:0]	SERDES RATE[1:0] (See Note 2 Below)					
						RATE[1:0] =2'b00 Full		RATE[1:0] =2'b01 Half		RATE[1:0] =2'b10 Qrtr.	
Min	Max	(Decimal)	(Decimal)	See Note 1 Below	4/5.37125:6:0	Min	Max	Min	Max	Min	Max
100.0000	105.9322	4	118	20	59	2000.000	2118.644	1000.000	1059.322		
100.8621	107.7586	4	116	20	58	2017.241	2155.172	1008.621	1077.586		
102.6316	109.6491	4	114	20	57	2052.632	2192.982	1026.316	1096.491		
104.4643	111.6071	4	112	20	56	2089.286	2232.143	1044.643	1116.071		
106.3636	113.6364	4	110	20	55	2127.273	2272.727	1063.636	1136.364		
108.3333	115.7407	4	108	20	54	2166.667	2314.815	1083.333	1157.407		
110.3774	117.9245	4	106	20	53	2207.547	2358.491	1103.774	1179.245		
112.5000	120.1923	4	104	20	52	2250.000	2403.846	1125.000	1201.923		
114.7059	122.5490	4	102	20	51	2294.118	2450.980	1147.059	1225.490	600.000	612.745
117.0000	125.0000	4	100	20	50	2340.000	2500.000	1170.000	1250.000	600.000	625.000
119.3878	127.5510	4	98	20	49	2387.755	2551.020	1193.878	1275.510	600.000	637.755
121.8750	130.2083	4	96	20	48	2437.500	2604.167	1218.750	1302.083	609.375	651.042
124.4681	132.9787	4	94	20	47	2489.362	2659.574	1244.681	1329.787	622.340	664.894
127.1739	135.8696	4	92	20	46	2543.478	2717.391	1271.739	1358.696	635.870	679.348
130.0000	138.8889	4	90	20	45	2600.000	2777.778	1300.000	1388.889	650.000	694.444
132.9545	142.0455	4	88	20	44	2659.091	2840.909	1329.545	1420.455	664.773	710.227
136.0465	145.3488	4	86	20	43	2720.930	2906.977	1360.465	1453.488	680.233	726.744
139.2857	148.8095	4	84	20	42	2785.714	2976.190	1392.857	1488.095	696.429	744.048
142.6829	152.4390	4	82	20	41	2853.659	3048.780	1426.829	1524.390	713.415	762.195
146.2500	156.2500	4	80	20	40	2925.000	3125.000	1462.500	1562.500	731.250	781.250
150.0000	160.2564	4	78	20	39	3000.000	3205.128	1500.000	1602.564	750.000	801.282
153.9474	164.4737	4	76	20	38	3078.947	3289.474	1539.474	1644.737	769.737	822.368
158.1081	168.9189	4	74	20	37	3162.162	3378.378	1581.081	1689.189	790.541	844.595
162.5000	173.6111	4	72	20	36	3250.000	3472.222	1625.000	1736.111	812.500	868.056
167.1429	178.5714	4	70	20	35	3342.857	3571.429	1671.429	1785.714	835.714	892.857
172.0588	183.8235	4	68	20	34	3441.176	3676.471	1720.588	1838.235	860.294	919.118
177.2727	189.3939	4	66	20	33	3545.455	3750.000	1772.727	1893.939	886.364	946.970
182.8125	195.3125	4	64	20	32	3656.250	3750.000	1828.125	1953.125	914.063	976.563
188.7097	201.6129	4	62	20	31			1887.097	2016.129	943.548	1008.065
195.0000	208.3333	4	60	20	30			1950.000	2083.333	975.000	1041.667
201.7241	212.5000	4	58	20	29			2017.241	2125.000	1008.621	1062.500
208.9286	212.5000	4	56	20	28			2089.286	2125.000	1044.643	1062.500
200.0000	208.3333	4	60	10	30	2000.000	2083.333	1000.000	1041.667		
201.7241	215.5172	4	58	10	29	2017.241	2155.172	1008.621	1077.586		
208.9286	223.2143	4	56	10	28	2089.286	2232.143	1044.643	1116.071		
216.6667	231.4815	4	54	10	27	2166.667	2314.815	1083.333	1157.407		
225.0000	240.3846	4	52	10	26	2250.000	2403.846	1125.000	1201.923		
234.0000	250.0000	4	50	10	25	2340.000	2500.000	1170.000	1250.000	600.000	625.000
243.7500	260.4167	4	48	10	24	2437.500	2604.167	1218.750	1302.083	609.375	651.042
254.3478	271.7391	4	46	10	23	2543.478	2717.391	1271.739	1358.696	635.870	679.348
265.9091	284.0909	4	44	10	22	2659.091	2840.909	1329.545	1420.455	664.773	710.227
278.5714	297.6190	4	42	10	21	2785.714	2976.190	1392.857	1488.095	696.429	744.048
292.5000	312.5000	4	40	10	20	2925.000	3125.000	1462.500	1562.500	731.250	781.250
307.8947	328.9474	4	38	10	19	3078.947	3289.474	1539.474	1644.737	769.737	822.368
325.0000	347.2222	4	36	10	18	3250.000	3472.222	1625.000	1736.111	812.500	868.056
344.1176	367.6471	4	34	10	17	3441.176	3676.471	1720.588	1838.235	860.294	919.118
365.6250	375.0000	4	32	10	16	3656.250	3750.000	1828.125	1875.000	914.063	937.500
Note 1: PLL_MULT[3:0] bits are found in bits 11:8 and 3:0 in register SERDES_PLL_CONFIG at address 4/5.36864.											
Note 2: RATE[1:0] bits are found in the SERDES_RATE_CONFIG_TX_RX register at address 4/5.36865.											

Figure A-4. 9/10 BIT SERDES Mode – Jitter Cleaner/SERDES (0.5x) Provisioning

9/10 Bit SERDES Mode - Continuous Mode - Jitter Cleaner (0.25X) Mode											
REFCLK (Mhz)		REF_DIV[6:0] 4/5.37124:14:8	FB_DIV[6:0] 4/5.37124:6:0	PLL_MULT[3:0]	RXTX_DIV[6:0]	SERDES RATE[1:0] (See Note 2 Below)					
						RATE[1:0] =2'b00 Full		RATE[1:0] =2'b01 Half		RATE[1:0] =2'b10 Qrtr.	
Min	Max	(Decimal)	(Decimal)	See Note 1 Below	4/5.37125:6:0	Min	Max	Min	Max	Min	Max
200.0000	211.8644	4	59	20	59	2000.000	2118.644	1000.000	1059.322		
201.7241	215.5172	4	58	20	58	2017.241	2155.172	1008.621	1077.586		
205.2632	219.2982	4	57	20	57	2052.632	2192.982	1026.316	1096.491		
208.9286	223.2143	4	56	20	56	2089.286	2232.143	1044.643	1116.071		
212.7273	227.2727	4	55	20	55	2127.273	2272.727	1063.636	1136.364		
216.6667	231.4815	4	54	20	54	2166.667	2314.815	1083.333	1157.407		
220.7547	235.8491	4	53	20	53	2207.547	2358.491	1103.774	1179.245		
225.0000	240.3846	4	52	20	52	2250.000	2403.846	1125.000	1201.923		
229.4118	245.0980	4	51	20	51	2294.118	2450.980	1147.059	1225.490		
234.0000	250.0000	4	50	20	50	2340.000	2500.000	1170.000	1250.000		
238.7755	255.1020	4	49	20	49	2387.755	2551.020	1193.878	1275.510	600.000	637.755
243.7500	260.4167	4	48	20	48	2437.500	2604.167	1218.750	1302.083	609.375	651.042
248.9362	265.9574	4	47	20	47	2489.362	2659.574	1244.681	1329.787	622.340	664.894
254.3478	271.7391	4	46	20	46	2543.478	2717.391	1271.739	1358.696	635.870	679.348
260.0000	277.7778	4	45	20	45	2600.000	2777.778	1300.000	1388.889	650.000	694.444
265.9091	284.0909	4	44	20	44	2659.091	2840.909	1329.545	1420.455	664.773	710.227
272.0930	290.6977	4	43	20	43	2720.930	2906.977	1360.465	1453.488	680.233	726.744
278.5714	297.6190	4	42	20	42	2785.714	2976.190	1392.857	1488.095	696.429	744.048
285.3659	304.8780	4	41	20	41	2853.659	3048.780	1426.829	1524.390	713.415	762.195
292.5000	312.5000	4	40	20	40	2925.000	3125.000	1462.500	1562.500	731.250	781.250
300.0000	320.5128	4	39	20	39	3000.000	3205.128	1500.000	1602.564	750.000	801.282
307.8947	328.9474	4	38	20	38	3078.947	3289.474	1539.474	1644.737	769.737	822.368
316.2162	337.8378	4	37	20	37	3162.162	3378.378	1581.081	1689.189	790.541	844.595
325.0000	347.2222	4	36	20	36	3250.000	3472.222	1625.000	1736.111	812.500	868.056
334.2857	357.1429	4	35	20	35	3342.857	3571.429	1671.429	1785.714	835.714	892.857
344.1176	367.6471	4	34	20	34	3441.176	3676.471	1720.588	1838.235	860.294	919.118
354.5455	375.0000	4	33	20	33	3545.455	3750.000	1772.727	1875.000	886.364	937.500
Note 1: PLL_MULT[3:0] bits are found in bits 11:8 and 3:0 in register SERDES_PLL_CONFIG at address 4/5.36864.											
Note 2: RATE[1:0] bits are found in the SERDES_RATE_CONFIG_TX_RX register at address 4/5.36865.											

Figure A-5. 9/10 BIT SERDES Mode – Jitter Cleaner/SERDES (0.25x) Provisioning

8 Bit SERDES Mode - Continuous Mode - Jitter Cleaner (2x) Mode																	
REFCLK (Mhz)		REF_DIV[6:0] 4/5.37124:14:8	FB_DIV[6:0] 4/5.37124:6:0	PLL_MULT[3:0]	RXTX_DIV[6:0]	SERDES RATE [1:0] (See Note 2 Below)											
						2'b00 (Full)		2'b01 (Half)		2'b10 (Quarter)							
Min	Max	(Decimal)	(Decimal)	See Note 1 Below	4/5.37125:6:0	Min	Max	Min	Max	Min	Max						
62.5000	65.1042	1	48	8	24	2000.000	2083.333	1000.000	1041.667								
63.5870	67.9348	1	46	8	23	2034.783	2173.913	1017.391	1086.957								
66.4773	71.0227	1	44	8	22	2127.273	2272.727	1063.636	1136.364								
69.6429	74.4048	1	42	8	21	2228.571	2380.952	1114.286	1190.476								
73.1250	78.1250	1	40	8	20	2340.000	2500.000	1170.000	1250.000	600.000	625.000						
76.9737	82.2368	1	38	8	19	2463.158	2631.579	1231.579	1315.789	615.789	657.895						
81.2500	86.8056	1	36	8	18	2600.000	2777.778	1300.000	1388.889	650.000	694.444						
86.0294	91.9118	1	34	8	17	2752.941	2941.176	1376.471	1470.588	688.235	735.294						
91.4063	97.6563	1	32	8	16	2925.000	3000.000	1462.500	1562.500	731.250	781.250						
97.5000	100.0000	1	30	8	15			1560.000	1600.000	780.000	800.000						
Note 1: PLL_MULT[3:0] bits are found in bits 11:8 and 3:0 in register SERDES_PLL_CONFIG at address 4/5.36864.																	
Note 2: RATE[1:0] bits are found in the SERDES_RATE_CONFIG_TX_RX register at address 4/5.36865.																	

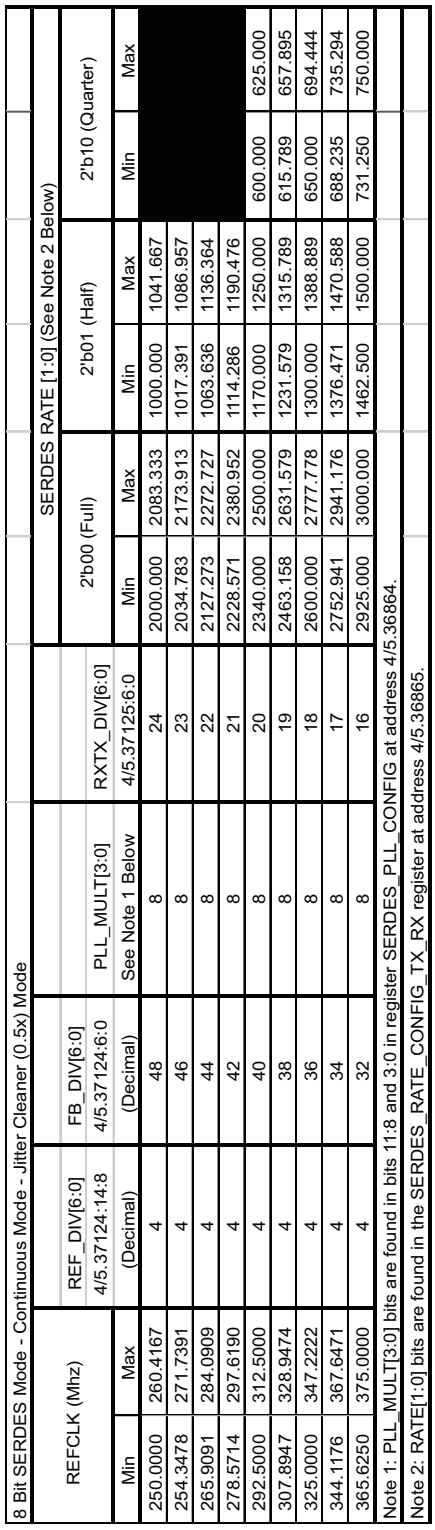
A. Note that REFCLK is limited to 93.75 Mhz when in Full rate mode to achieve 3000 Mbps serial data rate.

Figure A-6. 8 BIT SERDES Mode – Jitter Cleaner/SERDES (2x) Provisioning

8 Bit SERDES Mode - Continuous Mode - Jitter Cleaner (1x) Mode															
REFCLK (Mhz)		REF_DIV[6:0]	FB_DIV[6:0]	PLL_MULT[3:0]	RXTX_DIV[6:0]	SERDES RATE [1:0] (See Note 2 Below)									
		4/5.37124:14:8	4/5.37124:6:0		4/5.37125:6:0	2'b00 (Full)		2'b01 (Half)		2'b10 (Quarter)					
Min	Max	(Decimal)	(Decimal)	See Note 1 Below		Min	Max	Min	Max	Min	Max				
125.0000	130.2083	1	24	8	24	2000.000	2083.333	1000.000	1041.667						
127.1739	135.8696	1	23	8	23	2034.783	2173.913	1017.391	1086.957						
132.9545	142.0455	1	22	8	22	2127.273	2272.727	1063.636	1136.364						
139.2857	148.8095	1	21	8	21	2228.571	2380.952	1114.286	1190.476						
146.2500	156.2500	1	20	8	20	2340.000	2500.000	1170.000	1250.000	600.000	625.000				
153.9474	164.4737	1	19	8	19	2463.158	2631.579	1231.579	1315.789	615.789	657.895				
162.5000	173.6111	1	18	8	18	2600.000	2777.778	1300.000	1388.889	650.000	694.444				
172.0588	183.8235	1	17	8	17	2752.941	2941.176	1376.471	1470.588	688.235	735.294				
182.8125	195.3125	1	16	8	16	2925.000	3000.000	1462.500	1562.500	731.250	781.250				
195.0000	200.0000	1	15	8	15			1560.000	1600.000	780.000	800.000				
Note 1: PLL_MULT[3:0] bits are found in bits 11:8 and 3:0 in register SERDES_PLL_CONFIG at address 4/5.36864.															
Note 2: RATE[1:0] bits are found in the SERDES_RATE_CONFIG_TX_RX register at address 4/5.36865.															

Note that REFCLK is limited to 187.5 Mhz when in Full rate mode to achieve 3000 Mbps serial data rate.

Figure A-7. 8 BIT SERDES Mode – Jitter Cleaner/SERDES (1x) Provisioning



8 Bit SERDES Mode - Continuous Mode - Jitter Cleaner (0.5x) Mode							SERDES RATE [1:0] (See Note 2 Below)					
REFCLK (Mhz)		REF_DIV[6:0]	FB_DIV[6:0]	PLL_MULT[3:0]	RXTX_DIV[6:0]	2'b00 (Full)		2'b01 (Half)		2'b10 (Quarter)	
		4/5.37124:14:8	4/5.37124:6:0		4/5.37125:6:0						
Min	Max	(Decimal)	(Decimal)	See Note 1 Below		Min	Max	Min	Max	Min	Max
250.0000	260.4167	4	48	8	24	2000.000	2083.333	1000.000	1041.667		
254.3478	271.7391	4	46	8	23	2034.783	2173.913	1017.391	1086.957		
265.9091	284.0909	4	44	8	22	2127.273	2272.727	1063.636	1136.364		
278.5714	297.6190	4	42	8	21	2228.571	2380.952	1114.286	1190.476		
292.5000	312.5000	4	40	8	20	2340.000	2500.000	1170.000	1250.000	600.000	625.000
307.8947	328.9474	4	38	8	19	2463.158	2631.579	1231.579	1315.789	615.789	657.895
325.0000	347.2222	4	36	8	18	2600.000	2777.778	1300.000	1388.889	650.000	694.444
344.1176	367.6471	4	34	8	17	2752.941	2941.176	1376.471	1470.588	688.235	735.294
365.6250	375.0000	4	32	8	16	2925.000	3000.000	1462.500	1500.000	731.250	750.000

Note 1: PLL_MULT[3:0] bits are found in bits 11:8 and 3:0 in register SERDES_PLL_CONFIG at address 4/5.36864.

Note 2: RATE[1:0] bits are found in the SERDES_RATE_CONFIG_TX_RX register at address 4/5.36865.

Figure A-8. 8 BIT SERDES Mode – Jitter Cleaner/SERDES (0.5x) Provisioning

A.1 Recovered Byte Clock Jitter Cleaner Mode:

If it is desired to dedicate the Jitter Cleaner PLL to clean the RX SERDES recovered byte clock, then the following procedure must be followed:

1. Program REF_SEL[1:0] to 2'b10.
2. Program RXB_SEL[1:0] to 2'b00.
3. Program RX_SEL to 2'b10 -or- 2'b11.
4. Program TX_SEL as desired.
5. Program 16.10:9 as desired on a per channel basis.
6. Consult the rows in the appropriate Appendix A table to find the appropriate REFCLK and SERDES mode settings. Note that only rows indicating that the Jitter Cleaner PLL is OFF may be used. Provision the SERDES settings appropriately.
7. Divide the selected SERDES serial rate by 8 if in EBI/REBI modes, or 10 otherwise, and use that frequency as the input to Figure A-9 Recovered Byte Clock Jitter Cleaner Mode, to determine the appropriate Jitter Cleaner PLL settings. Note that only a 1:1 frequency ratio is supported between the SERDES output byte clock and the parallel interface output recovered byte clock. Depending upon the selection of TX_SEL, it may also be necessary to provision RXTX_DIV with the same value as RXB_DIV.

Recovered Byte Clock Cleaning Mode - Jitter Cleaner (1x) Mode				
Recovered Byte Clock (Mhz)		REF_DIV[6:0] 4/5.37124:14:8	FB_DIV[6:0] 4/5.37124:6:0	RXB_DIV[6:0] 4/5.37125:14:8
Min	Max	(Decimal)	(Decimal)	
50.0000	53.8793	1	58	58
51.3158	54.8246	1	57	57
52.2321	55.8036	1	56	56
53.1818	56.8182	1	55	55
54.1667	57.8704	1	54	54
55.1887	58.9623	1	53	53
56.2500	60.0962	1	52	52
57.3529	61.2745	1	51	51
58.5000	62.5000	1	50	50
59.6939	63.7755	1	49	49
60.9375	65.1042	1	48	48
62.2340	66.4894	1	47	47
63.5870	67.9348	1	46	46
65.0000	69.4444	1	45	45
66.4773	71.0227	1	44	44
68.0233	72.6744	1	43	43
69.6429	74.4048	1	42	42
71.3415	76.2195	1	41	41
73.1250	78.1250	1	40	40
75.0000	80.1282	1	39	39
76.9737	82.2368	1	38	38
79.0541	84.4595	1	37	37
81.2500	86.8056	1	36	36
83.5714	89.2857	1	35	35
86.0294	91.9118	1	34	34
88.6364	94.6970	1	33	33
91.4063	97.6563	1	32	32
94.3548	100.8065	1	31	31
97.5000	104.1667	1	30	30
100.8621	107.7586	1	29	29
104.4643	111.6071	1	28	28
108.3333	115.7407	1	27	27
112.5000	120.1923	1	26	26
117.0000	125.0000	1	25	25
121.8750	130.2083	1	24	24
127.1739	135.8696	1	23	23
132.9545	142.0455	1	22	22
139.2857	148.8095	1	21	21
146.2500	156.2500	1	20	20
153.9474	164.4737	1	19	19
162.5000	173.6111	1	18	18
172.0588	183.8235	1	17	17
182.8125	195.3125	1	16	16
195.0000	208.3333	1	15	15
208.9286	223.2143	1	14	14
225.0000	240.3846	1	13	13
243.7500	260.4167	1	12	12
265.9091	284.0909	1	11	11
292.5000	312.5000	1	10	10
325.0000	347.2222	1	9	9
365.6250	375.0000	1	8	8

Figure A-9. Recovered Byte Clock Jitter Cleaner Mode

B APPENDIX B – Jitter Cleaner PLL External Loop Filter

The following external loop filter is required anytime the Jitter Cleaner PLL is enabled.

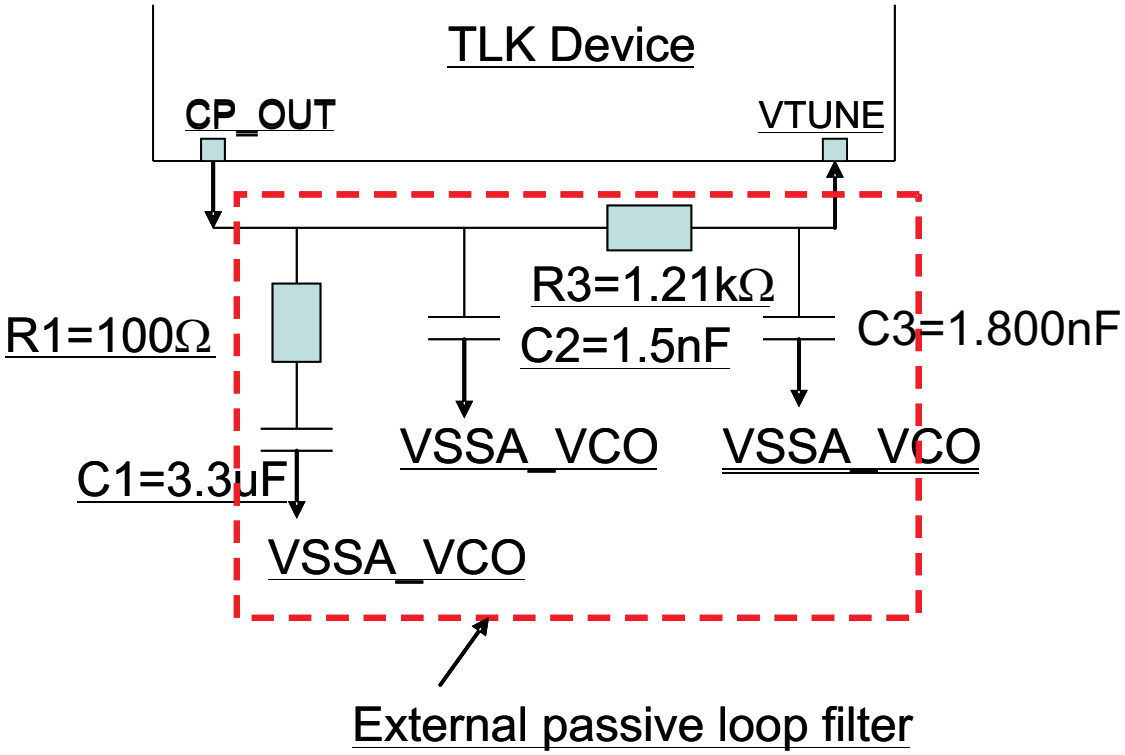


Figure B-1. Jitter Cleaner External Loop Filter

C APPENDIX C – Device Test Mode

This device can be placed into one of the three modes: functional mode including JTAG testing mode, scan testing mode, and Jadis/eFuse testing mode. The scan testing mode and Jadis/eFuse testing modes are for TI use only, and may be ignored by external users of this device.

Table C-1. Device Mode Configuration

FUNCTIONAL DEVICE PIN NAME	FUNCTIONAL MODE/JTAG TESTING	SCAN MODE	Jadis/eFuse MODE
TESTEN	0 or 1	0	1
GPI1	0	1	1

Table C-2. Device Test Mode Pin Configuration

FUNCTIONAL DEVICE PIN NAME	FUNCTIONAL MODE SIGNAL DIRECTION	TEST MODE SIGNAL DIRECTION	FUNCTIONAL MODE/JTAG TESTING	SCAN MODE	Jadis/eFuse MODE
SPEED1	I	I	SPEED1	Scan In 5	STCI_D
SPEED0	I	I	SPEED0	Scan In 4	EFUSE_TMS
PLOOP	I	I	PLOOP	Scan In 3	EFUSE_TDI
SLOOP	I	I	SLOOP	Scan In 2	STCICFG1
PRBS_EN	I	I	PRBS_EN	Scan In 1	EFUSE_INITZ
CODE	I	I	CODE	Scan Enable	TESTCLK_T
TDI	I	I	TDI	Adaptive Scan Enable (Test Mode)	JADIS_EFUSE_SEL
PRTAD4	I	I	PRTAD4	Scan HS Enable (Transition Fault)	TESTCLK_R
PRTAD3	I	I	PRTAD3	Scan Clock	STCICLK
PRTAD2	I	I: Jadis/eFuse O: Scan	PRTAD2	Scan Out 5	STCICFG0
PRTAD1	I	I	PRTAD1	Scan Clock Select (0: from device pin, 1: from Jadis), also EFUSE_SYS_CLK	EFUSE_SYS_CLK
PRTAD0	I	I	PRTAD0	HSTL Force Down	EFUSE_TCK
GPO0	O	O	TEST_DOUT0	Scan Out 4	Tied LOW
GPO1	O	O	TEST_DOUT1	Scan Out 3	Tied LOW
GPO2	O	O	TEST_DOUT2	Scan Out 2	STCI_Q
GPO3	O	O	TEST_DOUT3	Scan Out 1	EFUSE_TDO
GPO4	O	O	TEST_DOUT4 or JC PLL Digital Test Out	Burnin_Output	Burnin_Output

Revision History

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

Changes from Original (December 2008) to A Revision ..... **Page**

- Added text to (BIT 0:15) - This is a global bit (not per channel). Asserting this bit is equivalent to asserting the device primary input RST_N. 33
- Changed the Transmit Template figure - Y-axis values 70

PACKAGING INFORMATION

Orderable Device	Status (1)	Package Type	Package Drawing	Pins	Package Qty	Eco Plan (2)	Lead finish/ Ball material (6)	MSL Peak Temp (3)	Op Temp (°C)	Device Marking (4/5)	Samples
TLK3131ZWQ	ACTIVE	BGA	ZWQ	144	160	RoHS & Green	SNAGCU	Level-4-260C-72 HR	-40 to 85	TLK3131	Samples

(1) The marketing status values are defined as follows:
ACTIVE: Product device recommended for new designs.
LIFEBUY: TI has announced that the device will be discontinued, and a lifetime-buy period is in effect.
NRND: Not recommended for new designs. Device is in production to support existing customers, but TI does not recommend using this part in a new design.
PREVIEW: Device has been announced but is not in production. Samples may or may not be available.
OBSOLETE: TI has discontinued the production of the device.

(2) **RoHS:** TI defines "RoHS" to mean semiconductor products that are compliant with the current EU RoHS requirements for all 10 RoHS substances, including the requirement that RoHS substance do not exceed 0.1% by weight in homogeneous materials. Where designed to be soldered at high temperatures, "RoHS" products are suitable for use in specified lead-free processes. TI may reference these types of products as "Pb-Free".
RoHS Exempt: TI defines "RoHS Exempt" to mean products that contain lead but are compliant with EU RoHS pursuant to a specific EU RoHS exemption.
Green: TI defines "Green" to mean the content of Chlorine (Cl) and Bromine (Br) based flame retardants meet JS709B low halogen requirements of <=1000ppm threshold. Antimony trioxide based flame retardants must also meet the <=1000ppm threshold requirement.

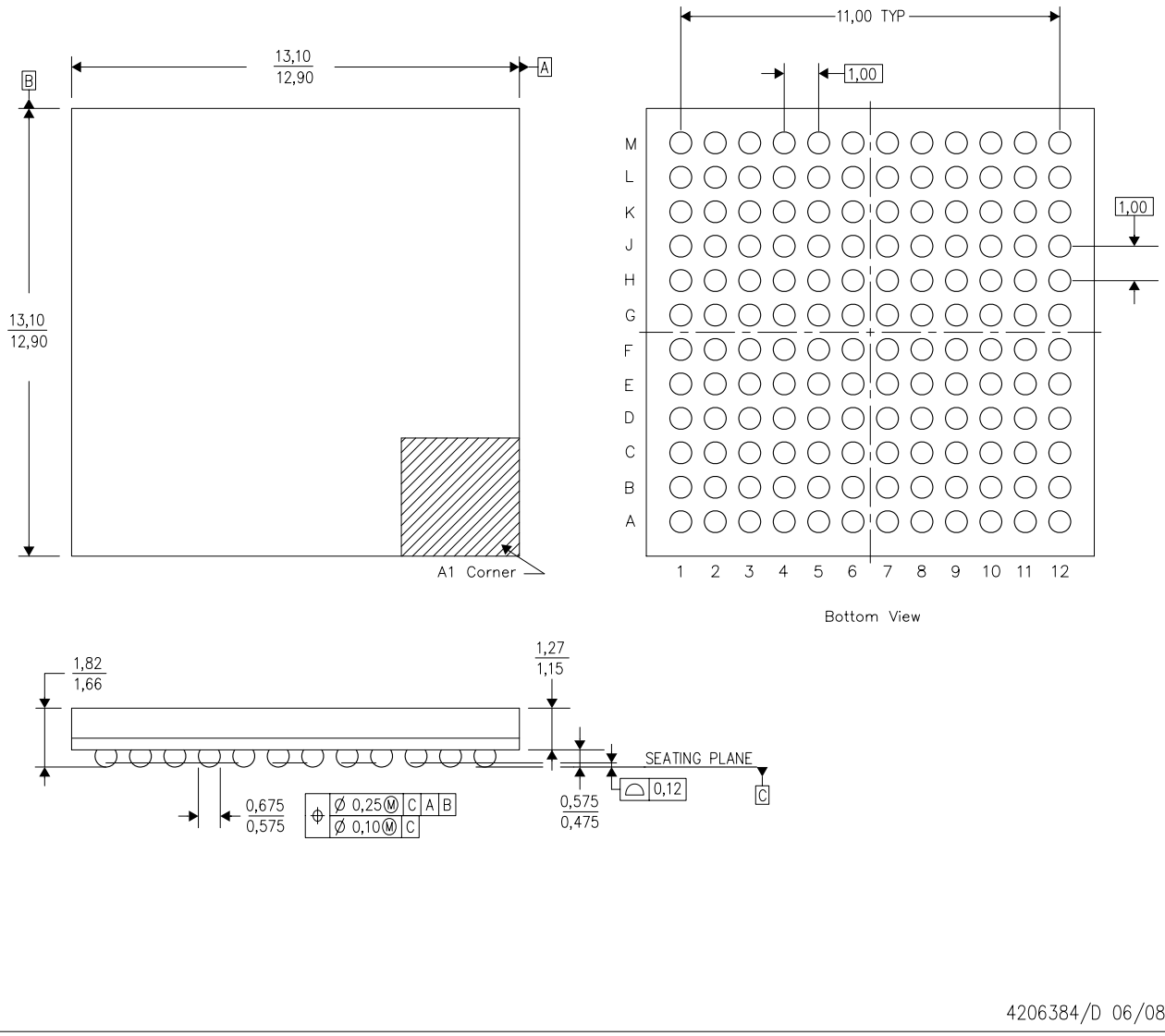
(3) MSL, Peak Temp. - The Moisture Sensitivity Level rating according to the JEDEC industry standard classifications, and peak solder temperature.

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

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

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

ZWQ (S–PBGA–N144) PLASTIC BALL GRID ARRAY



NOTES:
A. All linear dimensions are in millimeters. Dimensioning and tolerancing per ASME Y14.5M–1994.
B. This drawing is subject to change without notice.
C. This is a lead–free solder ball design.

IMPORTANT NOTICE AND DISCLAIMER

TI PROVIDES TECHNICAL AND RELIABILITY DATA (INCLUDING DATASHEETS), DESIGN RESOURCES (INCLUDING REFERENCE DESIGNS), APPLICATION OR OTHER DESIGN ADVICE, WEB TOOLS, SAFETY INFORMATION, AND OTHER RESOURCES “AS IS” AND WITH ALL FAULTS, AND DISCLAIMS ALL WARRANTIES, EXPRESS AND IMPLIED, INCLUDING WITHOUT LIMITATION ANY IMPLIED WARRANTIES OF MERCHANTABILITY, FITNESS FOR A PARTICULAR PURPOSE OR NON-INFRINGEMENT OF THIRD PARTY INTELLECTUAL PROPERTY RIGHTS.

These resources are intended for skilled developers designing with TI products. You are solely responsible for (1) selecting the appropriate TI products for your application, (2) designing, validating and testing your application, and (3) ensuring your application meets applicable standards, and any other safety, security, or other requirements. These resources are subject to change without notice. TI grants you permission to use these resources only for development of an application that uses the TI products described in the resource. Other reproduction and display of these resources is prohibited. No license is granted to any other TI intellectual property right or to any third party intellectual property right. TI disclaims responsibility for, and you will fully indemnify TI and its representatives against, any claims, damages, costs, losses, and liabilities arising out of your use of these resources.

TI’s products are provided subject to TI’s Terms of Sale (www.ti.com/legal/termsofsale.html) or other applicable terms available either on ti.com or provided in conjunction with such TI products. TI’s provision of these resources does not expand or otherwise alter TI’s applicable warranties or warranty disclaimers for TI products.

Mailing Address: Texas Instruments, Post Office Box 655303, Dallas, Texas 75265