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Independent Clock Quad HOTLink II™ Deserializing Reclocker

Features

- Second-generation HOTLink® technology
- Compliant to SMPTE 292M and SMPTE 259M video standards
- Quad channel video reclocking deserializer
 - 195 to 1500 Mbps serial data signaling rate
 - Simultaneous operation at different signaling rates
- Supports reception of either 1.485 or 1.485/1.001 Gbps data rate with the same training clock
- Supports half-rate and full-rate clocking
- Internal phase-locked loops (PLLs) with no external PLL components
- Selectable differential PECL-compatible serial inputs
 - Internal DC restoration
- Synchronous LVTTTL parallel interface
- JTAG boundary scan
- Built-In Self-Test (BIST) for at-speed link testing
- Link Quality Indicator
 - Analog signal detect
 - Digital signal detect
- Low-power: 3W @ 3.3V typical
- Single 3.3V supply
- Thermally enhanced BGA
- Pb-Free package option available
- 0.25μ BiCMOS technology

Functional Description

The CYV15G0404RB Independent Clock Quad HOTLink II™ Deserializing Reclocker is a point-to-point or point-to-multi-point communications building block enabling data transfer over a variety of high speed serial links including SMPTE 292

and SMPTE 259 video applications. It supports signaling rates in the range of 195 to 1500 Mbps for each serial link. The four channels are independent and can simultaneously operate at different rates. Each receive channel accepts serial data and converts it to 10-bit parallel characters and presents these characters to an Output Register. The received serial data can also be reclocked and retransmitted through the reclocker serial outputs. [Figure 1, "HOTLink II™ System Connections," on page 2](#) illustrates typical connections between independent video coprocessors and corresponding CYV15G0404RB Reclocking Deserializer and CYV15G0403TB Serializer chips.

The CYV15G0404RB is SMPTE-259M and SMPTE-292M compliant according to SMPTE EG34-1999 Pathological Test Requirements.

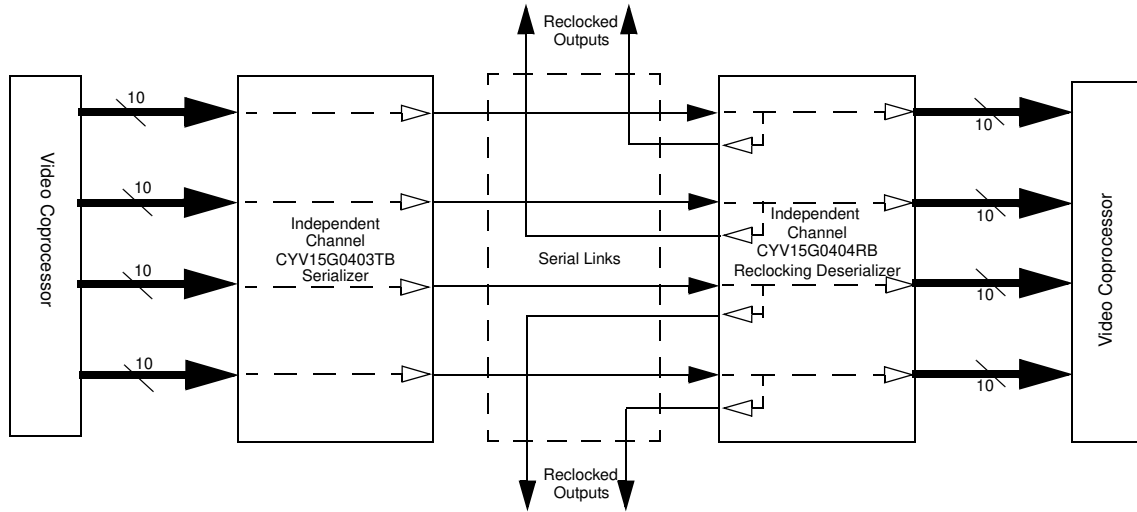
As a second generation HOTLink device, the CYV15G0404RB extends the HOTLink family with enhanced levels of integration and faster data rates, while maintaining serial-link compatibility (data and BIST) with other HOTLink devices.

Each channel of the CYV15G0404RB Quad HOTLink II device accepts a serial bit-stream from one of two selectable PECL-compatible differential line receivers, and using a completely integrated Clock and Data Recovery PLL, recovers the timing information necessary for data reconstruction. The device reclocks and retransmits recovered bit-stream through the reclocker serial outputs. It also deserializes the recovered serial data and presents it to the destination host system.

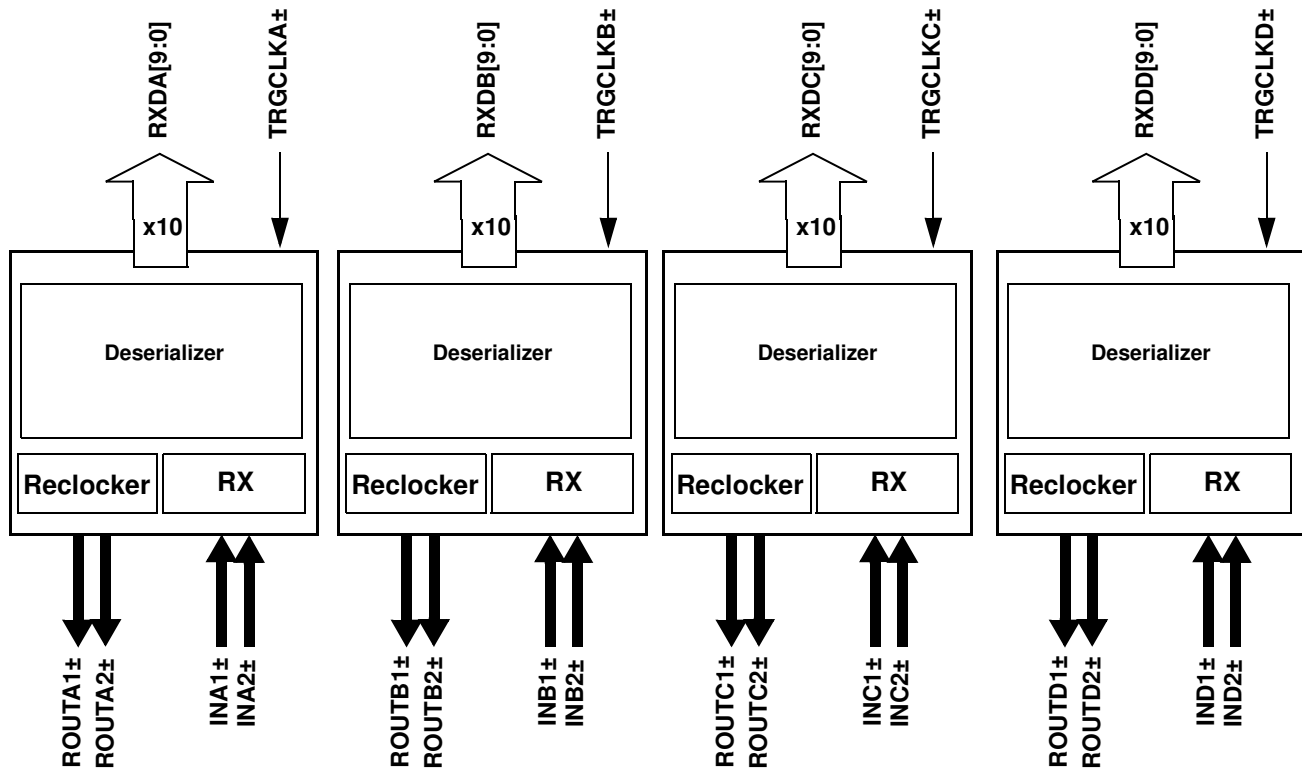
Each channel contains an independent BIST pattern checker. This BIST hardware enables at speed testing of the high-speed serial data paths in each receive section of this device, each transmit section of a connected HOTLink II device, and across the interconnecting links.

The CYV15G0404RB is ideal for SMPTE applications where different data rates and serial interface standards are necessary for each channel. Some applications include multi-format routers, switches, format converters, SDI monitors, and camera control units.

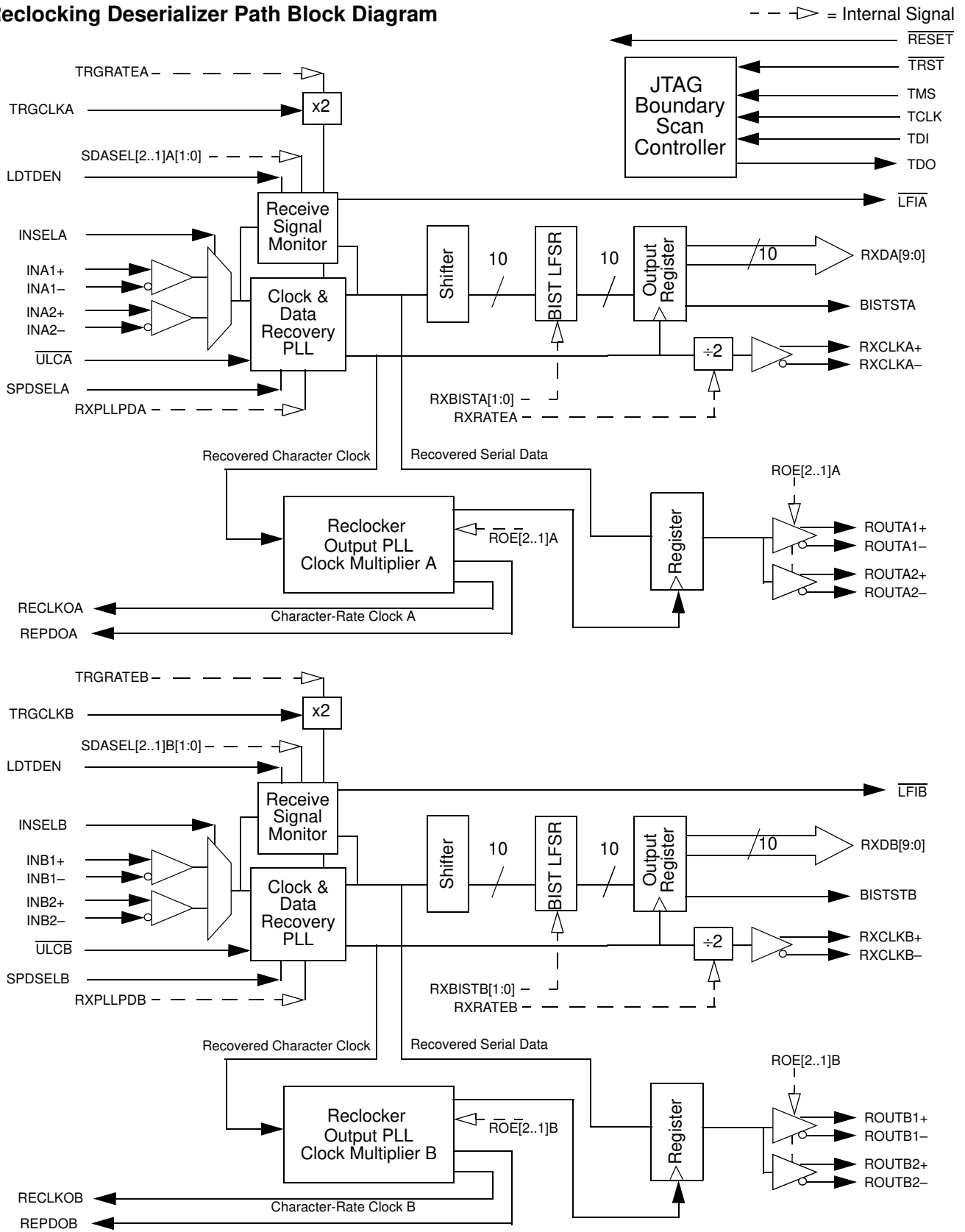
Figure 1. HOTLink II™ System Connections



CYV15G0404RB Deserializing Reclocker Logic Block Diagram

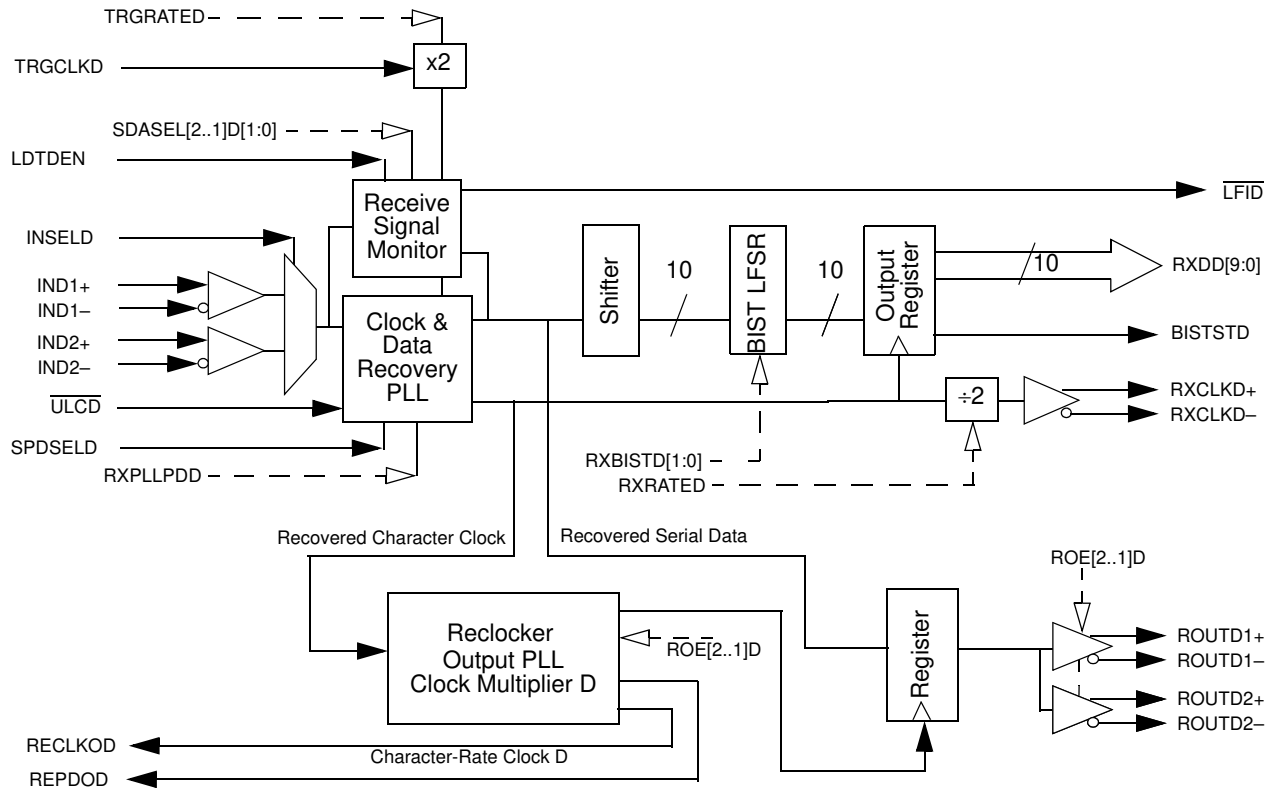
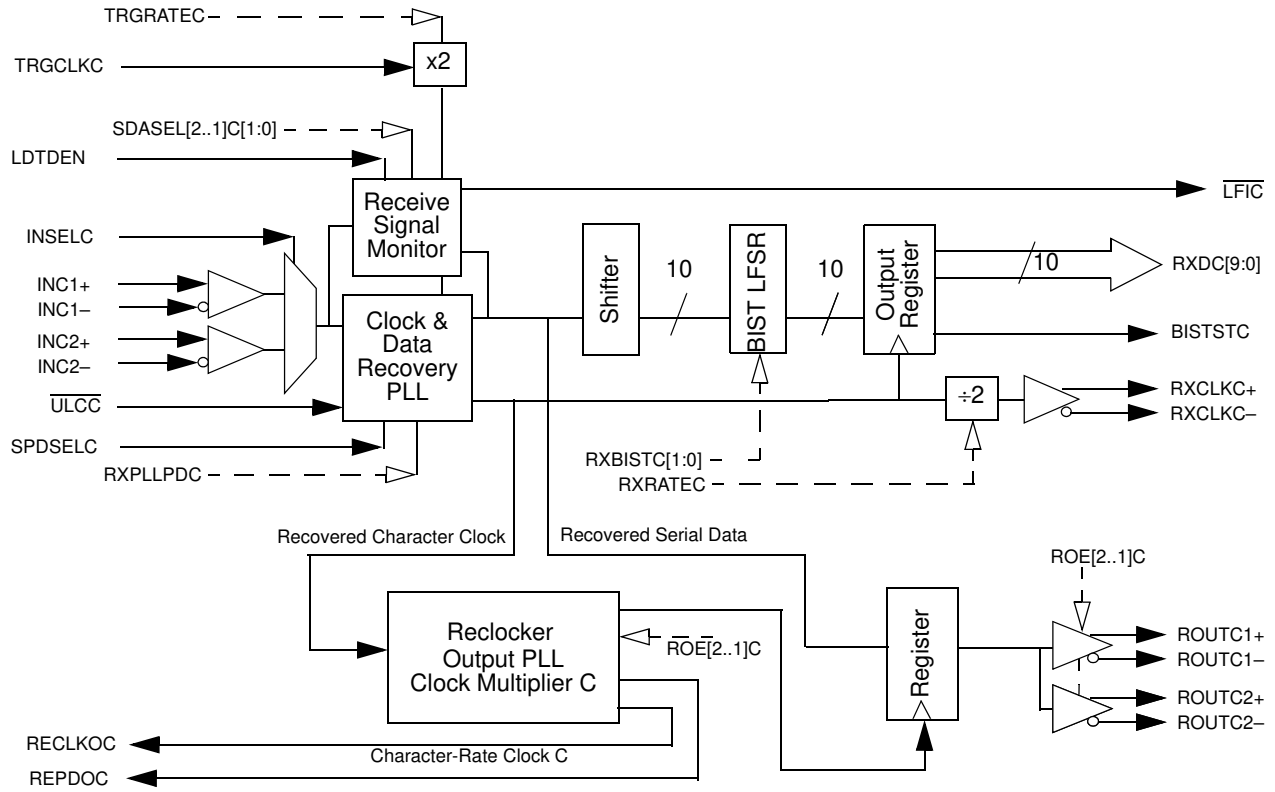


Reclocking Deserializer Path Block Diagram



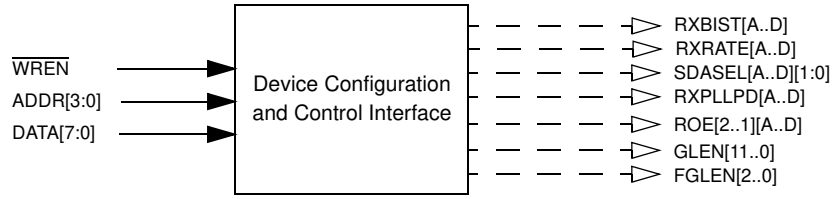
Reclocking Deserializer Path Block Diagram (continued)

-- ▷ = Internal Signal



Device Configuration and Control Block Diagram

-- ▷ = Internal Signal



Pin Configuration (Top View)^[1]

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
A	IN C1-	ROUT C1-	IN C2-	ROUT C2-	V _{CC}	IN D1-	ROUT D1-	GND	IN D2-	ROUT D2-	IN A1-	ROUT A1-	GND	IN A2-	ROUT A2-	V _{CC}	IN B1-	ROUT B1-	IN B2-	ROUT B2-
B	IN C1+	ROUT C1+	IN C2+	ROUT C2+	V _{CC}	IN D1+	ROUT D1+	GND	IN D2+	ROUT D2+	IN A1+	ROUT A1+	GND	IN A2+	ROUT A2+	V _{CC}	IN B1+	ROUT B1+	IN B2+	ROUT B2+
C	TDI	TMS	INSEL C	INSEL B	V _{CC}	ULCD	ULCC	GND	DATA [7]	DATA [5]	DATA [3]	DATA [1]	GND	V _{CC}	SPD SELD	V _{CC}	LDTD EN	TRST	GND	TDO
D	TCLK	RESET	INSEL D	INSEL A	V _{CC}	ULCA	SPD SELC	GND	DATA [6]	DATA [4]	DATA [2]	DATA [0]	GND	GND	ULCB	V _{CC}	NC	V _{CC}	SCAN EN2	TMEN3
E	V _{CC}	V _{CC}	V _{CC}	V _{CC}													V _{CC}	V _{CC}	V _{CC}	V _{CC}
F	RX DC[8]	RX DC[9]	V _{CC}	V _{CC}													V _{CC}	RX DB[0]	RE CLKOB	RX DB[1]
G	GND	WREN	GND	GND													SPD SELB	NC	SPD SELA	RX DB[3]
H	GND	GND	GND	GND													GND	GND	GND	GND
J	GND	GND	GND	GND													BIST STB	RX DB[2]	RX DB[7]	RX DB[4]
K	RX DC[4]	TRG CLKC-	GND	GND													RX DB[5]	RX DB[6]	RX DB[9]	LFIB
L	RX DC[5]	TRG CLKC+	LFIC	GND													RX DB[8]	RX CLKB+	RX CLKB-	GND
M	RX DC[6]	RX DC[7]	V _{CC}	RE PDOC													TRG CLKB+	TRG CLKB-	RE PDOB	GND
N	GND	GND	GND	GND													GND	GND	GND	GND
P	RX DC[3]	RX DC[2]	RX DC[1]	RX DC[0]													GND	GND	GND	GND
R	BIST STC	RE CLKOC	RX CLKC+	RX CLKC-													V _{CC}	V _{CC}	V _{CC}	V _{CC}
T	V _{CC}	V _{CC}	V _{CC}	V _{CC}													V _{CC}	V _{CC}	V _{CC}	V _{CC}
U	V _{CC}	V _{CC}	V _{CC}	V _{CC}	V _{CC}	RX DD[4]	RX DD[3]	GND	GND	ADDR [0]	TRG CLKD-	GND	GND	GND	V _{CC}	V _{CC}	RX DA[4]	V _{CC}	BIST STA	RX DA[0]
V	V _{CC}	V _{CC}	V _{CC}	RX DD[8]	V _{CC}	RX DD[5]	RX DD[1]	GND	BIST STD	ADDR [2]	TRG CLKD+	RE CLKOA	GND	GND	V _{CC}	V _{CC}	RX DA[9]	RX DA[5]	RX DA[2]	RX DA[1]
W	V _{CC}	V _{CC}	LFID	RX CLKD-	V _{CC}	RX DD[6]	RX DD[0]	GND	ADDR [3]	ADDR [1]	RX CLKA+	RE PDOA	GND	GND	V _{CC}	V _{CC}	LFIA	TRG CLKA+	RX DA[6]	RX DA[3]
Y	V _{CC}	V _{CC}	RX DD[9]	RX CLKD+	V _{CC}	RX DD[7]	RX DD[2]	GND	RE CLKOD	NC	GND	RX CLKA-	GND	GND	V _{CC}	V _{CC}	RE PPOD	TRG CLKA-	RX DA[8]	RX DA[7]

Note
1. NC = Do not connect.

Pin Configuration (Bottom View)^[1]

	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1
A	ROUT B2-	IN B2-	ROUT B1-	IN B1-	V _{CC}	ROUT A2-	IN A2-	GND	ROUT A1-	IN A1-	ROUT D2-	IN D2-	GND	ROUT D1-	IN D1-	V _{CC}	ROUT C2-	IN C2-	ROUT C1-	IN C1-
B	ROUT B2+	IN B2+	ROUT B1+	IN B1+	V _{CC}	ROUT A2+	IN A2+	GND	ROUT A1+	IN A1+	ROUT D2+	IN D2+	GND	ROUT D1+	IN D1+	V _{CC}	ROUT C2+	IN C2+	ROUT C1+	IN C1+
C	TDO	GND	$\overline{\text{TRST}}$	LDTDEN	V _{CC}	SPD SELD	V _{CC}	GND	DATA [1]	DATA [3]	DATA [5]	DATA [7]	GND	$\overline{\text{ULCC}}$	$\overline{\text{ULCD}}$	V _{CC}	INSELB	INSEL C	TMS	TDI
D	TMEN3	SCAN EN2	V _{CC}	NC	V _{CC}	$\overline{\text{ULCB}}$	GND	GND	DATA [0]	DATA [2]	DATA [4]	DATA [6]	GND	SPD SELC	$\overline{\text{ULCA}}$	V _{CC}	INSELA	INSEL D	$\overline{\text{RESET}}$	TCLK
E	V _{CC}	V _{CC}	V _{CC}	V _{CC}													V _{CC}	V _{CC}	V _{CC}	V _{CC}
F	RX DB[1]	RE CLKOB	RX DB[0]	V _{CC}													V _{CC}	V _{CC}	RX DC[9]	RX DC[8]
G	RX DB[3]	SPD SELA	NC	SPD SELB													GND	GND	$\overline{\text{WREN}}$	GND
H	GND	GND	GND	GND													GND	GND	GND	GND
J	RX DB[4]	RX DB[7]	RX DB[2]	BIST STB													GND	GND	GND	GND
K	$\overline{\text{LFIB}}$	RX DB[9]	RX DB[6]	RX DB[5]													GND	GND	TRG CLKC-	RX DC[4]
L	GND	RX CLKB-	RX CLKB+	RX DB[8]													GND	$\overline{\text{LFIC}}$	TRG CLKC+	RX DC[5]
M	GND	RE PDOB	TRG CLKB-	TRG CLKB+													RE PDOC	V _{CC}	RX DC[7]	RX DC[6]
N	GND	GND	GND	GND													GND	GND	GND	GND
P	GND	GND	GND	GND													RX DC[0]	RX DC[1]	RX DC[2]	RX DC[3]
R	V _{CC}	V _{CC}	V _{CC}	V _{CC}													RX CLKC-	RX CLKC+	RE CLKOC	BIST STC
T	V _{CC}	V _{CC}	V _{CC}	V _{CC}													V _{CC}	V _{CC}	V _{CC}	V _{CC}
U	RX DA[0]	BIST STA	V _{CC}	RX DA[4]	V _{CC}	V _{CC}	GND	GND	GND	TRG CLKD-	ADDR [0]	GND	GND	RX DD[3]	RX DD[4]	V _{CC}	V _{CC}	V _{CC}	V _{CC}	V _{CC}
V	RX DA[1]	RX DA[2]	RX DA[5]	RX DA[9]	V _{CC}	V _{CC}	GND	GND	RE CLKOA	TRG CLKD+	ADDR [2]	BIST STD	GND	RX DD[1]	RX DD[5]	V _{CC}	RX DD[8]	V _{CC}	V _{CC}	V _{CC}
W	RX DA[3]	RX DA[6]	TRG CLKA+	$\overline{\text{LFIA}}$	V _{CC}	V _{CC}	GND	GND	RE PDOA	RX CLKA+	ADDR [1]	ADDR [3]	GND	RX DD[0]	RX DD[6]	V _{CC}	RX CLKD-	$\overline{\text{LFID}}$	V _{CC}	V _{CC}
Y	RX DA[7]	RX DA[8]	TRG CLKA-	RE PDOD	V _{CC}	V _{CC}	GND	GND	RX CLKA-	GND	NC	RE CLKOD	GND	RX DD[2]	RX DD[7]	V _{CC}	RX CLKD+	RX DD[9]	V _{CC}	V _{CC}

Pin Definitions
CYV15G0404RB Quad HOTLink II Deserializing Reclocker

Name	IO Characteristics	Signal Description
Receive Path Data and Status Signals		
RXDA[9:0] RXDB[9:0] RXDC[9:0] RXDD[9:0]	LVTTL Output, synchronous to the RXCLK± output	Parallel Data Output. RXDx[9:0] parallel data outputs change relative to the receive interface clock. If RXCLKx± is a full-rate clock, the RXCLKx± clock outputs are complementary clocks operating at the character rate. The RXDx[9:0] outputs for the associated receive channels follow the rising edge of RXCLKx+ or the falling edge of RXCLKx-. If RXCLKx± is a half-rate clock, the RXCLKx± clock outputs are complementary clocks operating at half the character rate. The RXDx[9:0] outputs for the associated receive channels follow both the falling and rising edges of the associated RXCLKx± clock outputs. When BIST is enabled on the receive channel, the RXDx[1:0] and BISTSTx outputs present the BIST status. See Table 5, "Receive BIST Status Bits," on page 17 for each status that the BIST state machine reports. Also, while BIST is enabled, ignore the RXDx[9:2] outputs.
BISTSTA BISTSTB BISTSTC BISTSTD	LVTTL Output, synchronous to the RXCLKx± output	BIST Status Output. When RXBISTx[1:0] = 10, BISTSTx (along with RXDx[1:0]) displays the status of the BIST reception. See Table 5, "Receive BIST Status Bits," on page 17 for the BIST status for each combination of BISTSTx and RXDx[1:0]. When RXBISTx[1:0] ≠ 10, ignore BISTSTx.
REPDOA REPDOB REPDOC REPDOD	Asynchronous to reclocker output channel enable / disable	Reclocker Powered Down Status Output. REPDOx asserts HIGH when the associated channel's reclocker output logic powers down. This occurs when disabling ROE2x and ROE1x by setting ROE2x = 0 and ROE1x = 0.
Receive Path Clock Signals		
TRGCLKA± TRGCLKB± TRGCLKC± TRGCLKD±	Differential LVPECL or single-ended LVTTL input clock	CDR PLL Training Clock. The frequency detector (Range Controller) of the associated receive PLL uses the TRGCLKx± clock inputs as the reference source to reduce PLL acquisition time. In the presence of valid serial data, the recovered clock output of the receive CDR PLL (RXCLKx±) has no frequency or phase relationship with TRGCLKx±. When a single-ended LVCMOS or LVTTL clock source drives the clock, connect the clock source to either the true or complement TRGCLKx input, and leave the alternate TRGCLKx input open (floating). When an LVPECL clock source drives it, the clock must be a differential clock, using both inputs.
RXCLKA± RXCLKB± RXCLKC± RXCLKD±	LVTTL Output Clock	Receive Clock Output. RXCLKx± is the receive interface clock that controls timing of the RXDx[9:0] parallel outputs. These true and complement clocks control timing of data output transfers. These clocks output continuously at either the half-character rate (1/20 the serial bit-rate) or character rate (1/10 the serial bit-rate) of the data being received, as selected by RXRATEx.
RECLKOA RECLKOB RECLKOC RECLKOD	LVTTL Output	Reclocker Clock Output. The associated reclocker output PLL synthesizes the RECLKOx output clock, which operates synchronous to the internal recovered character clock. RECLKOx operates at either the same frequency as RXCLKx± (RXRATEx = 0), or at twice the frequency of RXCLKx± (RXRATEx = 1). The reclocker clock outputs have no fixed phase relationship to RXCLKx±.
Device Control Signals		
RESET	LVTTL Input, asynchronous, internal pull up	Asynchronous Device Reset. RESET initializes all state machines, counters, and configuration latches in the device to a known state. RESET must assert LOW for a minimum pulse width. When the reset is removed, all state machines, counters and configuration latches are at an initial state. According to the JTAG specifications, the device RESET cannot reset the JTAG controller. Therefore, the JTAG controller has to be reset separately. Refer to "JTAG Support" on page 17 for the methods to reset the JTAG state machine. See Table 3, "Device Configuration and Control Latch Descriptions," on page 14 for the initialize values of the device configuration latches.

Pin Definitions (continued)
CYV15G0404RB Quad HOTLink II Deserializing Reclocker

Name	IO Characteristics	Signal Description
LDTDEN	LVTTL Input, internal pull up	Level Detect Transition Density Enable. When LDTDEN is HIGH, the Signal Level Detector, Range Controller, and Transition Density Detector are all enabled to determine if the RXPLL tracks TRGCLKx± or the selected input serial data stream. If the Signal Level Detector, Range Controller, or Transition Density Detector are out of their respective limits while LDTDEN is HIGH, the RXPLL locks to TRGCLKx± until they become valid. The SDASEL[A..D][1:0] inputs configure the trip level of the Signal Level Detector. The Transition Density Detector limit is one transition in every 60 consecutive bits. When LDTDEN is LOW, only the Range Controller determines if the RXPLL tracks TRGCLKx± or the selected input serial data stream. Set LDTDEN = HIGH.
ULCA ULCB ULCC ULCD	LVTTL Input, internal pull up	Use Local Clock. When ULCx is LOW, the RXPLL locks to TRGCLKx± instead of the received serial data stream. While ULCx is LOW, the LFIx for the associated channel is LOW, indicating a link fault. When ULCx is HIGH, the RXPLL performs Clock and Data Recovery functions on the input data streams. This function is used in applications that need a stable RXCLKx±. When valid data transitions are absent for a long time, or the high-gain differential serial inputs (INx±) are left floating, the RXCLKx± outputs may briefly be different from TRGCLKx±.
SPDSELA SPDSELB SPDSELC SPDSELD	3-Level Select ^[2] static control input	Serial Rate Select. The SPDSELx inputs specify the operating signaling-rate range of each channel's receive PLL. LOW = 195–400 MBd MID = 400–800 MBd HIGH = 800–1500 MBd.
INSELA INSELB INSELC INSELD	LVTTL Input, asynchronous	Receive Input Selector. The INSELx input determines which external serial bit stream passes to the receiver's Clock and Data Recovery circuit. When INSELx is HIGH, the Primary Differential Serial Data Input, INx1±, is the associated receive channel. When INSELx is LOW, the Secondary Differential Serial Data Input, INx2±, is the associated receive channel.
LFI LFIB LFIC LFID	LVTTL Output, asynchronous	Link Fault Indication Output. LFIx is an output status indicator signal. LFIx is the logical OR of six internal conditions. LFIx asserts LOW when any of the following conditions is true: <ul style="list-style-type: none"> Received serial data rate is outside expected range Analog amplitude is below expected levels Transition density is lower than expected Receive is channel disabled ULCx is LOW TRGCLKx± is absent.
Device Configuration and Control Bus Signals		
WREN	LVTTL input, asynchronous, internal pull up	Control Write Enable. The WREN input writes the values of the DATA[7:0] bus into the latch specified by the address location on the ADDR[3:0] bus. ^[3]
ADDR[3:0]	LVTTL input asynchronous, internal pull up	Control Addressing Bus. The ADDR[3:0] bus is the input address bus that configures the device. The WREN input writes the values of the DATA[7:0] bus into the latch specified by the address location on the ADDR[3:0] bus. ^[3] Table 3, "Device Configuration and Control Latch Descriptions," on page 14 lists the configuration latches within the device, and the initialization value of the latches when RESET is asserted. Table 4, "Device Control Latch Configuration Table," on page 16 shows how the latches are mapped in the device.

Notes

- Use 3-Level Select inputs for static configuration. These are ternary inputs that use logic levels of LOW, MID, and HIGH. To implement the LOW level, connect directly to V_{SS} (ground). To implement the HIGH level, connect directly to V_{CC} (power). To implement the MID level, do not connect the input (leave floating), which allows it to self bias to the proper level.
- See "Device Configuration and Control Interface" on page 13 for detailed information about the operation of the Configuration Interface.

Pin Definitions (continued)
CYV15G0404RB Quad HOTLink II Deserializing Reclocker

Name	IO Characteristics	Signal Description
DATA[7:0]	LVTTTL input asynchronous, internal pull-up	Control Data Bus. The DATA[7:0] bus is the input data bus that configures the device. The WREN input writes the values of the DATA[7:0] bus into the latch specified by address location on the ADDR[3:0] bus. ^[3] Table 3, "Device Configuration and Control Latch Descriptions," on page 14 lists the configuration latches within the device, and the initialization value of the latches when RESET is asserted. Table 4, "Device Control Latch Configuration Table," on page 16 shows the way the latches are mapped in the device.
Internal Device Configuration Latches		
RXRATE[A..D]	Internal Latch ^[4]	Receive Clock Rate Select.
SDASEL[2..1][A..D][1:0]	Internal Latch ^[4]	Signal Detect Amplitude Select.
RXPLLPD[A..D]	Internal Latch ^[4]	Receive Channel Power Control.
RXBIST[A..D][1:0]	Internal Latch ^[4]	Receive BIST Disabled.
ROE2[A..D]	Internal Latch ^[4]	Reclocker Differential Serial Output Driver 2 Enable.
ROE1[A..D]	Internal Latch ^[4]	Reclocker Differential Serial Output Driver 1 Enable.
GLEN[11..0]	Internal Latch ^[4]	Global Latch Enable.
FGLEN[2..0]	Internal Latch ^[4]	Force Global Latch Enable.
Factory Test Modes		
SCANEN2	LVTTTL input, internal pull down	Factory Test 2. The SCANEN2 input is for factory testing only. Leave this input as a NO CONNECT, or GND only.
TMEN3	LVTTTL input, internal pull down	Factory Test 3. The TMEN3 input is for factory testing only. Leave this input as a NO CONNECT, or GND only.
Analog I/O		
ROUTA1± ROUTB1± ROUTC1± ROUTD1±	CML Differential Output	Primary Differential Serial Data Output. The ROUTx1± PECL-compatible CML outputs (+3.3V referenced) can drive terminated transmission lines or standard fiber-optic transmitter modules, and must be AC-coupled for PECL-compatible connections.
ROUTA2± ROUTB2± ROUTC2± ROUTD2±	CML Differential Output	Secondary Differential Serial Data Output. The ROUTx2± PECL-compatible CML outputs (+3.3V referenced) are capable of driving terminated transmission lines or standard fiber-optic transmitter modules, and must be AC coupled for PECL-compatible connections.
INA1± INB1± INC1± IND1±	Differential Input	Primary Differential Serial Data Input. The INx1± input accepts the serial data stream for deserialization. The INx1± serial stream passes to the receive CDR circuit to extract the data content when INSELx = HIGH.
INA2± INB2± INC2± IND2±	Differential Input	Secondary Differential Serial Data Input. The INx2± input accepts the serial data stream for deserialization. The INx2± serial stream passes to the receiver CDR circuit to extract the data content when INSELx = LOW.
JTAG Interface		
TMS	LVTTTL Input, internal pull up	Test Mode Select. Controls access to the JTAG Test Modes. If TMS is HIGH for ≥5 TCLK cycles, the JTAG test controller resets.
TCLK	LVTTTL Input, internal pull down	JTAG Test Clock.

Note

4. See *Device Configuration and Control Interface* for detailed information on the internal latches.

Pin Definitions (continued)
CYV15G0404RB Quad HOTLink II Deserializing Reclocker

Name	IO Characteristics	Signal Description
TDO	3-State LVTTTL Output	Test Data Out. JTAG data output buffer. High-Z while JTAG test mode is not selected.
TDI	LVTTTL Input, internal pull up	Test Data In. JTAG data input port.
TRST	LVTTTL Input, internal pull up	JTAG reset signal. When asserted (LOW), this input asynchronously resets the JTAG test access port controller.
Power		
V _{CC}		+3.3V Power.
GND		Signal and Power Ground for all internal circuits.

CYV15G0404RB HOTLink II Operation

The CYV15G0404RB is a highly configurable, independent clocking, quad-channel reclocking deserializer that supports reliable transfer of large quantities of digital video data, using high-speed serial links from multiple sources to multiple destinations. This device supports four 10-bit channels.

CYV15G0404RB Receive Data Path
Serial Line Receivers

Two differential Line Receivers, IN_{x1±} and IN_{x2±}, are available on each channel to accept serial data streams. The associated INSEL_x input selects the active Serial Line Receiver on a channel. The Serial Line Receiver inputs are differential, and can accommodate wire interconnect and filtering losses or transmission line attenuation greater than 16 dB. For normal operation, these inputs must receive a signal of at least V_{I_{DIFF}} > 100 mV, or 200 mV peak-to-peak differential. Each Line Receiver can be DC or AC coupled to +3.3V powered fiber-optic interface modules (any ECL/PECL family, not limited to 100K PECL) or AC coupled to +5V powered optical modules. The common mode tolerance of these line receivers accommodates a wide range of signal termination voltages. Each receiver provides internal DC restoration, to the center of the receiver's common mode range, for AC coupled signals.

Signal Detect/Link Fault

Each selected Line Receiver (that is, that routed to the clock and data recovery PLL) is simultaneously monitored for

- Analog amplitude above amplitude level selected by SDASEL_x
- Transition density above the specified limit
- Range controls reporting the received data stream inside normal frequency range (± 1500 ppm^[21])
- Receive channel enabled
- Reference clock present
- $\overline{\text{ULC}}$ not asserted.

Note

5. The peak amplitudes listed in this table are for typical waveforms that generally have 3–4 transitions for every ten bits. In a worst case environment the signals may have a sine-wave appearance (highest transition density with repeating 0101...). Signal peak amplitudes levels within this environment type could increase the values in the table above by approximately 100 mV.

All of these conditions must be valid for the Signal Detect block to indicate a valid signal is present. This status is presented on the LFI_x (Link Fault Indicator) output associated with each receive channel, which changes synchronous to the receive interface clock.

Analog Amplitude

While most signal monitors are based on fixed constants, the analog amplitude level detection is adjustable to allow operation with highly attenuated signals, or in high noise environments. The SDASEL_x latch sets the analog amplitude level detection via the device configuration interface. The SDASEL_x latch sets the trip point for the detection of a valid signal at one of three levels, as listed in Table 1. This control input affects the analog monitors for all receive channels. The Analog Signal Detect monitors are active for the Line Receiver, as selected by the associated INSEL_x input.

Table 1. Analog Amplitude Detect Valid Signal Levels^[5]

SDASEL	Typical Signal with Peak Amplitudes Above
00	Analog Signal Detector is disabled
01	140 mV p-p differential
10	280 mV p-p differential
11	420 mV p-p differential

Transition Density

The Transition Detection logic checks for the absence of transitions spanning greater than six transmission characters (60 bits). If there are no transitions in the data received, the Detection logic for that channel asserts LFI_x.

Range Controls

The CDR circuit includes logic to monitor the frequency of the PLL Voltage Controlled Oscillator (VCO) samples the incoming data stream. This logic ensures that the VCO

operates at, or near the rate of the incoming data stream for two primary cases:

- When the incoming data stream resumes after a time in which it was “missing.”
- When the incoming data stream is outside the acceptable signaling rate range.

To perform this function, periodically compare the frequency of the RXPLL VCO to the frequency of the TRGCLKx± input. If the VCO is running at a frequency beyond ±1500 ppm^[21] as defined by the TRGCLKx± frequency, it is periodically forced to the correct frequency (as defined by TRGCLKx±, SPDSELx, and TRGRATEx) and then released in an attempt to lock to the input data stream.

Calculate the sampling and relock period of the Range Control as follows: RANGE_CONTROL_SAMPLING_PERIOD = (RECOVERED BYTE CLOCK PERIOD) * (4096).

During the time that the Range Control forces the RXPLL VCO to track TRGCLKx±, the LFIx output is asserted LOW. After a valid serial data stream is applied, it may take up to one RANGE CONTROL SAMPLING PERIOD before the PLL locks to the input data stream, after which LFIx is HIGH.

Table 2 lists the operating serial signaling rate and allowable range of TRGCLK± frequencies.

Table 2. Operating Speed Settings

SPDSELx	TRGRATEx	TRGCLKx± Frequency (MHz)	Signaling Rate (Mbps)
LOW	1	Reserved	195–400
	0	19.5–40	
MID (Open)	1	20–40	400–800
	0	40–80	
HIGH	1	40–75	800–1500
	0	80–150	

Receive Channel Enabled

The CYV15G0404RB contains four receive channels that it can independently enable and disable. Each channel are enabled or disabled separately through the RXPLLPDx input latch as controlled by the device configuration interface. RXPLLPDx latch = 0 disables the associated PLL and analog circuitry of the channel. Any disabled channel indicates a constant link fault condition on the LFIx output. RXPLLPDx = 1 enables the associated PLL and receive channel to receive a serial stream.

Note When a disabled receive channel is reenabled, the status of the associated LFIx output and data on the parallel outputs for the associated channel may be indeterminate for up to 2 ms.

Clock/Data Recovery

A separate CDR block within each receive channel performs the extraction of a bit rate clock and recovery of bits from each received serial stream. An integrated PLL that tracks the frequency of the transitions in the incoming bit stream and aligns the phase of the internal bit rate clock to the transitions

in the selected serial data stream performs the clock extraction function.

Each CDR accepts a character-rate (bit-rate ÷ 10) or half-character-rate (bit-rate ÷ 20) training clock from the associated TRGCLKx± input. This TRGCLKx± input is used to

- Ensure that the VCO (within the CDR) is operating at the correct frequency (rather than a harmonic of the bit rate)
- Reduce PLL acquisition time
- Limit unlocked frequency excursions of the CDR VCO when there is no input data present at the selected Serial Line Receiver.

Regardless of the type of signal present, the CDR attempts to recover a data stream from it. If the signaling rate of the recovered data stream is outside the limits set by the range control monitors, the CDR tracks TRGCLKx± instead of the data stream. Once the CDR output (RXCLK±) frequency returns close to TRGCLKx± frequency, the CDR input switches back to the input data stream. If no data is present at the selected line receiver, this switching behavior may cause brief RXCLK± frequency excursions from TRGCLKx±. However, the LFIx output indicates the validity of the input data stream. The frequency of TRGCLKx± must be within ±1500 ppm^[21] of the frequency of the clock that drives the reference clock input of the remote transmitter, to ensure a lock to the incoming data stream. This large ppm tolerance allows the CDR PLL to reliably receive a 1.485 or 1.485/1.001 Gbps SMPTE HD-SDI data stream with a constant TRGCLK frequency.

For systems using multiple or redundant connections, use the LFIx output to select an alternate data stream. When the device detects an LFIx indication, external logic toggles selection of the associated INx1± and INx2± input through the associated INSELx input. When a port switch takes place, the receive PLL for that channel reacquires the new serial stream.

Reclocker

Each receive channel performs a reclocker function on the incoming serial data. To do this, the Clock and Data Recovery PLL first recovers the clock from the data. The recovered clock retimes the data and then passes it to an output register. It also passes the recovered character clock from the receive PLL to the reclocker output PLL, which generates the bit clock that clocks the retimed data into the output register. This data stream is then transmitted through the differential serial outputs.

Reclocker Serial Output Drivers

The serial output interface drivers use differential Current Mode Logic (CML) drivers to provide source-matched drivers for 50Ω transmission lines. These drivers accept data from the reclocker output register in the reclocker channel. These drivers have signal swings equivalent to that of standard PECL drivers, and can drive AC coupled optical modules or transmission lines.

Reclocker Output Channels Enabled

Each driver can be enabled or disabled separately via the device configuration interface.

When a driver is disabled using the configuration interface, it internally powers down to reduce device power. If both

reclocker serial drivers for a channel are in this disabled state, the associated internal reclocker logic also powers down. The deserialization logic and parallel outputs remain enabled. A device reset ($\overline{\text{RESET}}$ sampled LOW) disables all output drivers.

Note When the disabled reclocker function (that is, both outputs disabled) is reenabled, the data on the reclocker serial outputs may not meet all timing specifications for up to 250 μs .

Output Bus

Each receive channel presents a 10-bit data signal (and a BIST status signal when $\text{RXBISTx}[1:0] = 10$).

Receive BIST Operation

Each receiver channel contains an internal pattern checker that is used to validate both device and link operation. These pattern checkers are enabled by the associated $\text{RXBISTx}[1:0]$ latch through the device configuration interface. When enabled, a register in the associated receive channel becomes a signature pattern generator and checker by logically converting to a Linear Feedback Shift Register (LFSR). This LFSR generates a 511-character sequence. This provides a predictable, yet pseudorandom, sequence that can be matched to an identical LFSR in the attached Transmitter(s). When synchronized with the received data stream, the associated Receiver checks each character from the deserializer with each character generated by the LFSR and indicates compare errors and BIST status at the $\text{RXDx}[1:0]$ and BISTSTx bits of the Output Register.

The BIST status bus $\{\text{BISTSTx}, \text{RXDx}[0], \text{RXDx}[1]\}$ indicates 010b or 100b for one character period per BIST loop to indicate loop completion. Use this status to check test pattern progress.

Table 5, “Receive BIST Status Bits,” on page 17 lists the specific status reported by the BIST state machine. The receive status outputs report these same codes.

If the number of invalid characters received exceeds the number of valid characters by 16, the receive BIST state machine aborts the compare operations and resets the LFSR to look for the start of the BIST sequence again.

A device reset ($\overline{\text{RESET}}$ sampled LOW) presets the BIST Enable Latches to disable BIST on all channels.

BIST Status State Machine

When a receive path is enabled to look for and compare the received data stream with the BIST pattern, the $\{\text{BISTSTx}, \text{RXDx}[0], \text{RXDx}[1]\}$ bits identify the present state of the BIST compare operation.

The BIST state machine has multiple states, as shown in Figure 2, “Receive BIST State Machine,” on page 18 and Table 5, “Receive BIST Status Bits,” on page 17. When the receive PLL detects an out-of-lock condition, it forces the BIST state to the Start-of-BIST state, regardless of the present state of the BIST state machine. If the number of detected errors ever exceeds the number of valid matches by greater than 16, the state machine is forced to the WAIT_FOR_BIST state, where it monitors the receive path for the first character of the next BIST sequence.

Power Control

The CYV15G0404RB supports user control of the powered up or down state of each transmit and receive channel. The RXPLLDPx latch controls the receive channels through the device configuration interface. $\text{RXPLLDPx} = 0$ disables the associated PLL and analog circuitry of the channel. The OE1x and the OE2x latches control the transmit channels via the device configuration interface. The ROE1x and the ROE2x latches control the reclocker function through the device configuration interface. When the configuration interface disables a driver, the driver internally powers down to reduce device power. If both serial drivers for a channel are in this disabled state, the associated internal logic for that channel also powers down. The reclocker serial drivers being disabled in turn disables the reclocker function, but the deserialization logic and parallel outputs remain enabled.

Device Reset State

Assertion of $\overline{\text{RESET}}$ resets all state machines, counters, and configuration latches in the device to a reset state. Additionally, the JTAG controller must be reset for valid operation (even if not performing JTAG testing). See “JTAG Support” on page 17 for JTAG state machine initialization. See Table 3, “Device Configuration and Control Latch Descriptions,” on page 14 for the initialize values of the configuration latches.

Following a device reset, enable the receive channels used for normal operation. Do this by sequencing the appropriate values on the device configuration interface.^[3]

Device Configuration and Control Interface

Configure the CYV15G0404RB through the configuration interface. The configuration interface enables the device to be configured globally or enables each channel to be configured independently. Table 3, “Device Configuration and Control Latch Descriptions,” on page 14 lists the configuration latches within the device, including the initialization value of the latches on the assertion of $\overline{\text{RESET}}$. Table 4, “Device Control Latch Configuration Table,” on page 16 shows how the latches are mapped in the device. Each row in Table 4 maps to an 8-bit latch bank. There are 16 such write only latch banks. When $\text{WREN} = 0$, the logic value in the $\text{DATA}[7:0]$ latches to the latch bank specified by the values in $\text{ADDR}[3:0]$. The second column of Table 4 specifies the channels associated with the corresponding latch bank. For example, the first three latch banks (0, 1, and 2) consist of configuration bits for channel A. Latch banks 12, 13, and 14 consist of Global configuration bits, and the last latch bank (15) is the Mask latch bank, which can be configured to perform bit-by-bit configuration.

Global Enable Function

The global enable function, controlled by the GLENx bits, is a feature that can reduce the number of write operations needed to set up the latch banks. This function is beneficial in systems that use a common configuration in multiple channels. The GLENx bit is present in bit 0 of latch banks 0 through 11 only. Its default value (1) enables the global update of the latch bank’s contents. Setting the GLENx bit to 0 disables this functionality.

Latch Banks 12, 13, and 14 load values in the related latch banks in globally. A write operation to latch bank 12 performs a global write to latch banks 0, 3, 6, and 9, depending on the value of GLENx in these latch banks; latch bank 13 performs a global write to latch banks 1, 4, 7, and 10; and latch bank 14 performs a global write to latch banks 2, 5, 8, and 11. The GLENx bit cannot be modified by a global write operation.

Force Global Enable Function

FGLENx forces the global update of the target latch banks, but does not change the contents of the GLENx bits. If FGLENx = 1 for the associated global channel, FGLENx forces the global update of the target latch banks.

Mask Function

An additional latch bank (15) is a global mask vector that controls the update of the configuration latch banks on a bit-by-bit basis. A logic 1 in a bit location enables the update of that same location of the target latch bank(s), whereas a logic 0 disables it. The reset value of this latch bank is FFh, thereby making its use optional by default. The mask latch bank is not maskable. The bit 0 value of the mask latch bank does not affect the FGLEN functionality.

Latch Types

There are two types of latch banks: static (S) and dynamic (D). Each channel is configured by two static and one dynamic

latch banks. The S type contains those settings that normally do not change for a given application, whereas the D type controls the settings that might change during the application's lifetime. The first and second rows of each channel (address numbers 0, 1, 3, 4, 6, 7, 9, and 10) are the static control latches. The third row of latches for each channel (address numbers 2, 5, 8, and 11) are the dynamic control latches that are associated with enabling dynamic functions within the device.

Latch Bank 14 is also useful for those users that do not need the latch based programmable feature of the device. This latch bank is used in those applications that do not need to modify the default value of the static latch banks, and that can afford global (that is, not independent) control of the dynamic signals. In this case, this feature becomes available when ADDR[3:0] is unchanged with a value of "1110" and WREN is asserted. The signals present in DATA[7:0] effectively become global control pins, and for the latch banks 2, 5, 8, and 11.

Static Latch Values

There are some latches in the table that have a static value (that is, 1, 0, or X). The latches that have a '1' or '0' must be configured with their corresponding value each time that their associated latch bank is configured. The latches that have an 'X' are don't cares and can be configured with any value

Table 3. Device Configuration and Control Latch Descriptions

Name	Signal Description
RXRATEA RXRATEB RXRATEC RXRATED	Receive Clock Rate Select. The initialization value of the RXRATEx latch = 1. RXRATEx selects the rate of the RXCLKx± clock output. When RXRATEx = 1, the RXCLKx± clock outputs are complementary clocks that follow the recovered clock operating at half the character rate. Data for the associated receive channels must latch alternately on the rising edge of RXCLKx+ and RXCLKx-. When RXRATEx = 0, the RXCLKx± clock outputs are complementary clocks that follow the recovered clock operating at the character rate. Data for the associated receive channels must latch on the rising edge of RXCLKx+ or falling edge of RXCLKx-.
SDASEL1A[1:0] SDASEL1B[1:0] SDASEL1C[1:0] SDASEL1D[1:0]	Primary Serial Data Input Signal Detector Amplitude Select. The initialization value of the SDASEL1x[1:0] latch = 10. SDASEL1x[1:0] selects the trip point for the detection of a valid signal for the INx1± Primary Differential Serial Data Inputs. When SDASEL1x[1:0] = 00, the Analog Signal Detector is disabled. When SDASEL1x[1:0] = 01, the typical p-p differential voltage threshold level is 140 mV. When SDASEL1x[1:0] = 10, the typical p-p differential voltage threshold level is 280 mV. When SDASEL1x[1:0] = 11, the typical p-p differential voltage threshold level is 420 mV.
SDASEL2A[1:0] SDASEL2B[1:0] SDASEL2C[1:0] SDASEL2D[1:0]	Secondary Serial Data Input Signal Detector Amplitude Select. The initialization value of the SDASEL2x[1:0] latch = 10. SDASEL2x[1:0] selects the trip point for the detection of a valid signal for the INx2± Secondary Differential Serial Data Inputs. When SDASEL2x[1:0] = 00, the Analog Signal Detector is disabled When SDASEL2x[1:0] = 01, the typical p-p differential voltage threshold level is 140 mV. When SDASEL2x[1:0] = 10, the typical p-p differential voltage threshold level is 280 mV. When SDASEL2x[1:0] = 11, the typical p-p differential voltage threshold level is 420 mV.
TRGRATEA TRGRATEB TRGRATEC TRGRATED	Training Clock Rate Select. The initialization value of the TRGRATEx latch = 0. TRGRATEx selects the clock multiplier for the training clock input to the associated CDR PLL. When TRGRATEx = 0, the associated TRGCLKx± input is not multiplied before it is passed to the CDR PLL. When TRGRATEx = 1, the TRGCLKx± input is multiplied by 2 before it is passed to the CDR PLL. TRGRATEx = 1 and SPDSELx = LOW is an invalid state and this combination is reserved.

Table 3. Device Configuration and Control Latch Descriptions (continued)

Name	Signal Description
RXPLLPDA RXPLLPDB RXPLLPDC RXPLLPDD	Receive Channel Enable. The initialization value of the RXPLLPDx latch = 0. RXPLLPDx selects whether the associated receive channel is enabled or powered down. RXPLLPDx = 0 powers down the associated receive PLL and analog circuitry. RXPLLPDx = 1 enables the associated receive PLL and analog circuitry.
RXBISTA[1:0] RXBISTB[1:0] RXBISTC[1:0] RXBISTD[1:0]	Receive Bist Disable / SMPTE Receive Enable. The initialization value of the RXBISTx[1:0] latch = 11. For SMPTE data reception, RXBISTx[1:0] should not remain in this initialization state (11). RXBISTx[1:0] selects whether receive BIST is disabled or enabled and sets the associated channel for SMPTE data reception. RXBISTx[1:0] = 01 disables the receiver BIST function and sets the associated channel to receive SMPTE data. RXBISTx[1:0] = 10 enables the receive BIST function and sets the associated channel to receive BIST data. RXBISTx[1:0] = 00 and RXBISTx[1:0] = 11 are invalid states.
ROE2A ROE2B ROE2C ROE2D	Reclocker Secondary Differential Serial Data Output Driver Enable. The initialization value of the ROE2x latch = 0. ROE2x selects whether the ROUT2± secondary differential output drivers are enabled or disabled. ROE2x = 1 enables the associated serial data output driver, allowing data to be transmitted from the transmit shifter. ROE2x = 0 disables the associated serial data output driver. When the configuration interface disables a driver, the driver internally powers down to reduce device power. If both serial drivers for a channel are in this disabled state, the associated internal logic for that channel also powers down. A device reset (RESET sampled LOW) disables all output drivers.
ROE1A ROE1B ROE1C ROE1D	Reclocker Primary Differential Serial Data Output Driver Enable. The initialization value of the ROE1x latch = 0. ROE1x selects whether the ROUT1± primary differential output drivers are enabled or disabled. ROE1x = 1 enables the associated serial data output driver, allowing data to be transmitted from the transmit shifter. ROE1x = 0 disables the associated serial data output driver. When the configuration interface disables a driver, the driver internally powers down to reduce device power. If both serial drivers for a channel are in this disabled state, the associated internal logic for that channel also powers down. A device reset (RESET sampled LOW) disables all output drivers.
GLEN[11..0]	Global Enable. The initialization value of the GLENx latch = 1. The GLENx reconfigures several channels simultaneously in applications where several channels may have the same configuration. When GLENx = 1 for a given address, that address can participate in a global configuration. When GLENx = 0 for a given address, that address cannot participate in a global configuration.
FGLEN[2..0]	Force Global Enable. The initialization value of the FGLENx latch is NA. The FGLENx latch forces a GLobal ENable no matter what the setting is on the GLENx latch. If FGLENx = 1 for the associated Global channel, FGLEN forces the global update of the target latch banks.

Device Configuration Strategy

Follow these steps to load the configuration latches on each channel:

1. Pulse $\overline{\text{RESET}}$ Low after device power up. This operation resets all four channels. Initialize the JTAG state machine to its reset state, as detailed in “JTAG Support” on page 17.
2. Set the static latch banks for the target channel. You can perform this step using a global operation, if the application

permits it. [This is an optional step if the default settings match the desired configuration.]

3. Set the dynamic bank of latches for the target channel. Enable the Receive PLLs and set each channel for SMPTE data reception (RXBISTx[1:0] = 01) or BIST data reception (RXBISTx[1:0] = 10). You can perform this step using a global operation, if the application permits it. [Required step.]

Table 4. Device Control Latch Configuration Table

ADDR	Channel	Type	DATA7	DATA6	DATA5	DATA4	DATA3	DATA2	DATA1	DATA0	Reset Value
0 (0000b)	A	S	1	0	X	X	0	0	RXRATEA	GLEN0	10111111
1 (0001b)	A	S	SDASEL2A[1]	SDASEL2A[0]	SDASEL1A[1]	SDASEL1A[0]	X	X	TRGRATEA	GLEN1	10101101
2 (0010b)	A	D	RXBISTA[1]	RXPLLPDA	RXBISTA[0]	X	ROE2A	ROE1A	X	GLEN2	10110011
3 (0011b)	B	S	1	0	X	X	0	0	RXRATEB	GLEN3	10111111
4 (0100b)	B	S	SDASEL2B[1]	SDASEL2B[0]	SDASEL1B[1]	SDASEL1B[0]	X	X	TRGRATEB	GLEN4	10101101
5 (0101b)	B	D	RXBISTB[1]	RXPLLPDB	RXBISTB[0]	X	ROE2B	ROE1B	X	GLEN5	10110011
6 (0110b)	C	S	1	0	X	X	0	0	RXRATEC	GLEN6	10111111
7 (0111b)	C	S	SDASEL2C[1]	SDASEL2C[0]	SDASEL1C[1]	SDASEL1C[0]	X	X	TRGRATEC	GLEN7	10101101
8 (1000b)	C	D	RXBISTC[1]	RXPLLPDC	RXBISTC[0]	X	ROE2C	ROE1C	X	GLEN8	10110011
9 (1001b)	D	S	1	0	X	X	0	0	RXRATED	GLEN9	10111111
10 (1010b)	D	S	SDASEL2D[1]	SDASEL2D[0]	SDASEL1D[1]	SDASEL1D[0]	X	X	TRGRATED	GLEN10	10101101
11 (1011b)	D	D	RXBISTD[1]	RXPLLPDD	RXBISTD[0]	X	ROE2D	ROE1D	X	GLEN11	10110011
12 (1100b)	GLOBAL	S	1	0	X	X	0	0	RXRATEGL	FGLEN0	N/A
13 (1101b)	GLOBAL	S	SDASEL2GL[1]	SDASEL2GL[0]	SDASEL1GL[1]	SDASEL1GL[0]	X	X	TRGRATEGL	FGLEN1	N/A
14 (1110b)	GLOBAL	D	RXBISTGL[1]	RXPLLPDGL	RXBISTGL[0]	X	ROE2GL	ROE1GL	X	FGLEN2	N/A
15 (1111b)	MASK	D	D7	D6	D5	D4	D3	D2	D1	D0	11111111

JTAG Support

The CYV15G0404RB contains a JTAG port to allow system level diagnosis of device interconnect. Of the available JTAG modes, boundary scan and bypass are supported. This capability is present only on the LVTTTL inputs and outputs and the TRGCLKx± clock input. The high-speed serial inputs and outputs are not part of the JTAG test chain.

To ensure valid device operation after power-up (including non-JTAG operation), the JTAG state machine must also be initialized to a reset state. This must be done in addition to the device reset (using RESET). Initialize the JTAG state machine using TRST (assert it LOW and deassert it or leave it asserted), or by asserting TMS HIGH for at least 5 consecutive TCLK cycles. This is necessary in order to ensure that the

JTAG controller does not enter any of the test modes after device power-up. In this JTAG reset state, the rest of the device will operate normally.

Note The order of device reset (using $\overline{\text{RESET}}$) and JTAG initialization does not matter.

3-Level Select Inputs

Each 3-Level select input reports as two bits in the scan register. These bits report the LOW, MID, and HIGH state of the associated input as 00, 10, and 11 respectively

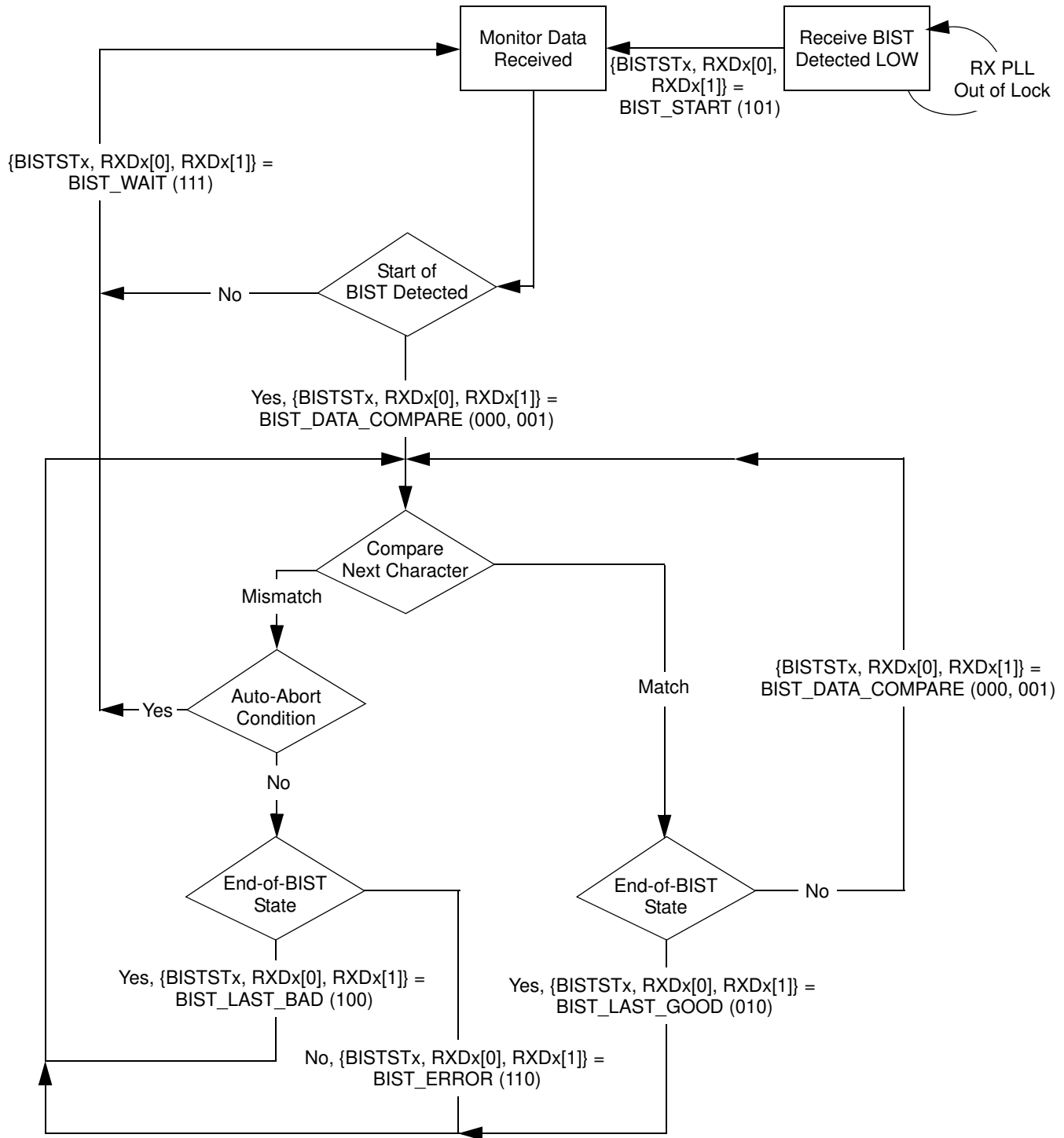
JTAG ID

The JTAG device ID for the CYV15G0404RB is '0C811069'x.

Table 5. Receive BIST Status Bits

{BISTSTx, RXDx[0], RXDx[1]}	Description
	Receive BIST Status (Receive BIST = Enabled)
000, 001	BIST Data Compare. Character compared correctly.
010	BIST Last Good. Last Character of BIST sequence detected and valid.
011	Reserved.
100	BIST Last Bad. Last Character of BIST sequence detected invalid.
101	BIST Start. Receive BIST is enabled on this channel, but character compares have not yet commenced. This also indicates a PLL Out of Lock condition.
110	BIST Error. While comparing characters, a mismatch was found in one or more of the character bits.
111	BIST Wait. The receiver is comparing characters, but has not yet found the start of BIST character to enable the LFSR.

Figure 2. Receive BIST State Machine



Maximum Ratings

Exceeding maximum ratings may shorten the device life. User guidelines are not tested

Storage Temperature	-65°C to +150°C
Ambient Temperature with Power Applied.....	-55°C to +125°C
Supply Voltage to Ground Potential	-0.5V to +3.8V
DC Voltage Applied to LVTTTL Outputs in High-Z State	-0.5V to $V_{CC} + 0.5V$
Output Current into LVTTTL Outputs (LOW).....	60 mA
DC Input Voltage.....	-0.5V to $V_{CC} + 0.5V$

Static Discharge Voltage..... > 2000 V (MIL-STD-883, Method 3015)

Latch Up Current

Power Up Requirements

The CYV15G0404RB requires one power supply. The voltage on any input or I/O pin cannot exceed the power pin during power up.

Operating Range

Range	Ambient Temperature	V_{CC}
Commercial	0°C to +70°C	+3.3V ±5%

CYV15G0404RB DC Electrical Characteristics

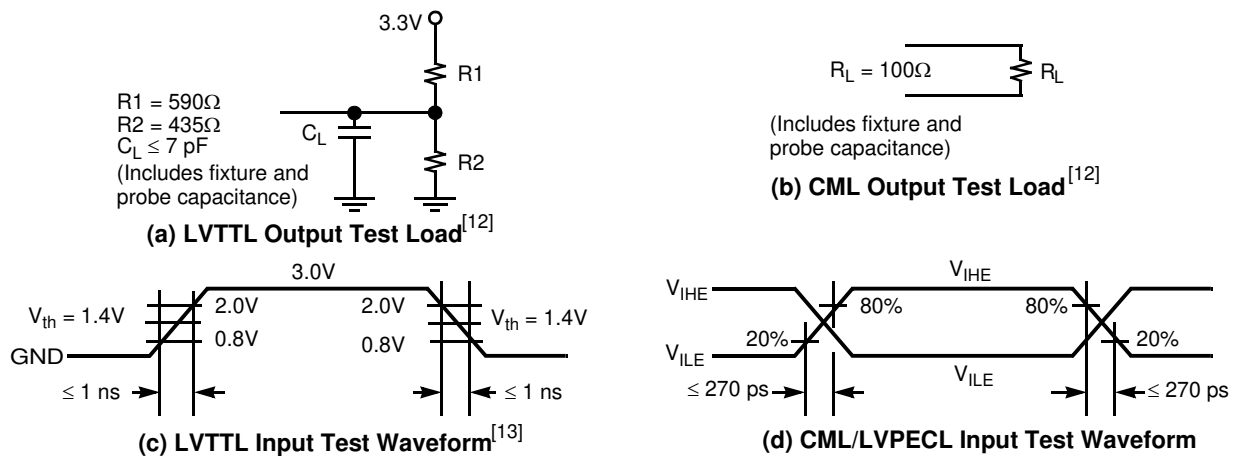
Parameter	Description	Test Conditions	Min	Max	Unit
LVTTTL-compatible Outputs					
V_{OHT}	Output HIGH Voltage	$I_{OH} = -4 \text{ mA}$, $V_{CC} = \text{Min.}$	2.4		V
V_{OLT}	Output LOW Voltage	$I_{OL} = 4 \text{ mA}$, $V_{CC} = \text{Min.}$		0.4	V
I_{OST}	Output Short Circuit Current	$V_{OUT} = 0V^{[6]}$, $V_{CC} = 3.3V$	-20	-100	mA
I_{OZL}	High-Z Output Leakage Current	$V_{OUT} = 0V$, V_{CC}	-20	20	μA
LVTTTL-compatible Inputs					
V_{IHT}	Input HIGH Voltage		2.0	$V_{CC} + 0.3$	V
V_{ILT}	Input LOW Voltage		-0.5	0.8	V
I_{IHT}	Input HIGH Current	TRGCLKx Input, $V_{IN} = V_{CC}$		1.5	mA
		Other Inputs, $V_{IN} = V_{CC}$		+40	μA
I_{ILT}	Input LOW Current	TRGCLKx Input, $V_{IN} = 0.0V$		-1.5	mA
		Other Inputs, $V_{IN} = 0.0V$		-40	μA
I_{IHPDT}	Input HIGH Current with Internal Pull Down	$V_{IN} = V_{CC}$		+200	μA
I_{ILPUT}	Input LOW Current with Internal Pull Up	$V_{IN} = 0.0V$		-200	μA
LVDIFF Inputs: TRGCLKx±					
$V_{DIFF}^{[7]}$	Input Differential Voltage		400	V_{CC}	mV
V_{IHHP}	Highest Input HIGH Voltage		1.2	V_{CC}	V
V_{ILLP}	Lowest Input LOW voltage		0.0	$V_{CC}/2$	V
$V_{COMREF}^{[8]}$	Common Mode Range		1.0	$V_{CC} - 1.2V$	V
3-Level Inputs					
V_{IHH}	Three-Level Input HIGH Voltage	Min. $\leq V_{CC} \leq$ Max.	$0.87 * V_{CC}$	V_{CC}	V
V_{IMM}	Three-Level Input MID Voltage	Min. $\leq V_{CC} \leq$ Max.	$0.47 * V_{CC}$	$0.53 * V_{CC}$	V
V_{ILL}	Three-Level Input LOW Voltage	Min. $\leq V_{CC} \leq$ Max.	0.0	$0.13 * V_{CC}$	V
I_{IHH}	Input HIGH Current	$V_{IN} = V_{CC}$		200	μA
I_{IMM}	Input MID current	$V_{IN} = V_{CC}/2$	-50	50	μA
I_{ILL}	Input LOW current	$V_{IN} = \text{GND}$		-200	μA

Notes

6. Tested one output at a time, output shorted for less than one second, less than 10% duty cycle.
7. This is the minimum difference in voltage between the true and complement inputs required to ensure detection of a logic-1 or logic-0. A logic-1 exists when the true (+) input is more positive than the complement (-) input. A logic-0 exists when the complement (-) input is more positive than true (+) input.
8. The common mode range defines the allowable range of TRGCLKx+ and TRGCLKx- when TRGCLKx+ = TRGCLKx-. This marks the zero-crossing between the true and complement inputs as the signal switches between a logic-1 and a logic-0.

CYV15G0404RB DC Electrical Characteristics (continued)

Parameter	Description	Test Conditions	Min	Max	Unit	
Differential CML Serial Outputs: ROUTA1±, ROUTA2±, ROUB1±, ROUB2±, ROUC1±, ROUC2±, ROUD1±, ROUD2±						
V _{OHC}	Output HIGH Voltage (V _{CC} Referenced)	100Ω differential load	V _{CC} - 0.5	V _{CC} - 0.2	V	
		150Ω differential load	V _{CC} - 0.5	V _{CC} - 0.2	V	
V _{OLC}	Output LOW Voltage (V _{CC} Referenced)	100Ω differential load	V _{CC} - 1.4	V _{CC} - 0.7	V	
		150Ω differential load	V _{CC} - 1.4	V _{CC} - 0.7	V	
V _{ODIF}	Output Differential Voltage (OUT+) - (OUT-)	100Ω differential load	450	900	mV	
		150Ω differential load	560	1000	mV	
Differential Serial Line Receiver Inputs: INA1±, INA2±, INB1±, INB2±, INC1±, INC2±, IND1±, IND2±						
V _{DIFFs} ^[7]	Input Differential Voltage (IN+) - (IN-)		100	1200	mV	
V _{IHE}	Highest Input HIGH Voltage			V _{CC}	V	
V _{ILE}	Lowest Input LOW Voltage		V _{CC} - 2.0		V	
I _{IHE}	Input HIGH Current	V _{IN} = V _{IHE} Max.		1350	μA	
I _{ILE}	Input LOW Current	V _{IN} = V _{ILE} Min.	-700		μA	
V _{COM} ^[9]	Common Mode input range	((V _{CC} - 2.0V) + 0.5) min, (V _{CC} - 0.5V) max.	+1.25	+3.1	V	
Power Supply			Typ	Max		
I _{CC} ^[10,11]	Max Power Supply Current	TRGCLKx = MAX	Commercial	910	1270	mA
			Industrial			1320
I _{CC} ^[10,11]	Typical Power Supply Current	TRGCLKx = 125 MHz	Commercial	900	1270	mA
			Industrial			1320

AC Test Loads and Waveforms

Notes

- The common mode range defines the allowable range of INPUT+ and INPUT- when INPUT+ = INPUT-. This marks the zero crossing between the true and complement inputs as the signal switches between a logic-1 and a logic-0.
- Maximum I_{CC} is measured with V_{CC} = MAX, T_A = 25°C, with all channels and Serial Line Drivers enabled, sending a continuous alternating 01 pattern, and outputs unloaded.
- Typical I_{CC} is measured under similar conditions except with V_{CC} = 3.3V, T_A = 25°C, with all channels enabled and one Serial Line Driver for each transmit channel sending a continuous alternating 01 pattern. The redundant outputs on each channel are powered down and the parallel outputs are unloaded.
- Cypress uses constant current (ATE) load configurations and forcing functions. This figure is for reference only.
- The LVTTTL switching threshold is 1.4V. All timing references are made relative to where the signal edges cross the threshold voltage.

CYV15G0404RB AC Electrical Characteristics

Parameter	Description	Min	Max	Unit
CYV15G0404RB Receiver LVTTTL Switching Characteristics Over the Operating Range				
f_{RS}	RXCLKx± Clock Output Frequency	9.75	150	MHz
t_{RXCLKP}	RXCLKx± Period = $1/f_{RS}$	6.66	102.56	ns
t_{RXCLKD}	RXCLKx± Duty Cycle Centered at 50% (Full Rate and Half Rate)	-1.0	+1.0	ns
$t_{RXCLKR}^{[14]}$	RXCLKx± Rise Time	0.3	1.2	ns
$t_{RXCLKF}^{[14]}$	RXCLKx± Fall Time	0.3	1.2	ns
$t_{RXDV-}^{[18]}$	Status and Data Valid Time to RXCLKx± (RXRATE _x = 0) (Full Rate)	5UI-2.0 ^[19]		ns
	Status and Data Valid Time to RXCLKx± (RXRATE _x = 1) (Half Rate)	5UI-1.3 ^[19]		ns
$t_{RXDV+}^{[18]}$	Status and Data Valid Time to RXCLKx± (RXRATE _x = 0)	5UI-1.8 ^[19]		ns
	Status and Data Valid Time to RXCLKx± (RXRATE _x = 1)	5UI-2.6 ^[19]		ns
f_{ROS}	RECLKOx Clock Frequency	19.5	150	MHz
t_{RECLKO}	RECLKOx Period = $1/f_{ROS}$	6.66	51.28	ns
$t_{RECLKOD}$	RECLKOx Duty Cycle centered at 60% HIGH time	-1.9	0	ns
CYV15G0404RB TRGCLKx Switching Characteristics Over the Operating Range				
f_{TRG}	TRGCLKx Clock Frequency	19.5	150	MHz
TRGCLK	TRGCLKx Period = $1/f_{REF}$	6.6	51.28	ns
t_{TRGH}	TRGCLKx HIGH Time (TRGRATE _x = 1)(Half Rate)	5.9		ns
	TRGCLKx HIGH Time (TRGRATE _x = 0)(Full Rate)	2.9 ^[14]		ns
t_{TRGL}	TRGCLKx LOW Time (TRGRATE _x = 1)(Half Rate)	5.9		ns
	TRGCLKx LOW Time (TRGRATE _x = 0)(Full Rate)	2.9 ^[14]		ns
$t_{TRGD}^{[20]}$	TRGCLKx Duty Cycle	30	70	%
$t_{TRGR}^{[14, 15, 16, 17]}$	TRGCLKx Rise Time (20%–80%)		2	ns
$t_{TRGF}^{[14, 15, 16, 17]}$	TRGCLKx Fall Time (20%–80%)		2	ns
$t_{TRGRX}^{[21]}$	TRGCLKx Frequency Referenced to Received Clock Frequency	-0.15	+0.15	%
CYV15G0404RB Bus Configuration Write Timing Characteristics Over the Operating Range				
t_{DATAH}	Bus Configuration Data Hold	0		ns
t_{DATAS}	Bus Configuration Data Setup	10		ns
t_{WRENp}	Bus Configuration WREN Pulse Width	10		ns
CYV15G0404RB JTAG Test Clock Characteristics Over the Operating Range				
f_{TCLK}	JTAG Test Clock Frequency		20	MHz
t_{TCLK}	JTAG Test Clock Period	50		ns

Notes

14. Tested initially and after any design or process changes that may affect these parameters, but not 100% tested.
15. The ratio of rise time to falling time must not vary by greater than 2:1.
16. For a given operating frequency, neither rise nor fall specification can be greater than 20% of the clock cycle period or the data sheet maximum time.
17. All transmit AC timing parameters measured with 1ns typical rise time and fall time.
18. Parallel data output specifications are only valid if all outputs are loaded with similar DC and AC loads.
19. Receiver UI (Unit Interval) is calculated as $1/(f_{TRG} * 20)$ (when TRGRATE_x = 1) or $1/(f_{TRG} * 10)$ (when TRGRATE_x = 0). In an operating link this is equivalent to t_b .
20. The duty cycle specification is a simultaneous condition with the t_{REFH} and t_{REFL} parameters. This means that at faster character rates the TRGCLKx± duty cycle cannot be as large as 30%–70%.
21. TRGCLKx± has no phase or frequency relationship with the recovered clock(s) and only acts as a centering reference to reduce clock synchronization time. TRGCLKx± must be within ±1500 PPM (±0.15%) of the transmitter PLL reference (REFCLKx±) frequency. Although transmitting to a HOTLink II receiver channel necessitates the frequency difference between the transmitter and receiver reference clocks to be within ±1500-PPM, the stability of the crystal needs to be within the limits specified by the appropriate standard when transmitting to a remote receiver that is compliant to that standard.

CYV15G0404RB AC Electrical Characteristics (continued)

Parameter	Description	Min	Max	Unit	
CYV15G0404RB Device RESET Characteristics Over the Operating Range					
t_{RST}	Device RESET Pulse Width	30		ns	
CYV15G0404RB Reclocker Serial Output Characteristics Over the Operating Range					
Parameter	Description	Condition	Min.	Max.	Unit
t_B	Bit Time		5128	660	ps
$t_{RISE}^{[14]}$	CML Output Rise Time 20–80% (CML Test Load)	SPDSELx = HIGH	50	270	ps
		SPDSELx = MID	100	500	ps
		SPDSELx =LOW	180	1000	ps
$t_{FALL}^{[14]}$	CML Output Fall Time 80–20% (CML Test Load)	SPDSELx = HIGH	50	270	ps
		SPDSELx = MID	100	500	ps
		SPDSELx =LOW	180	1000	ps

PLL Characteristics

Parameter	Description	Condition	Min	Typ	Max	Unit
CYV15G0404RB Reclocker Output PLL Characteristics						
$t_{JRGENSED}^{[14, 22]}$	Reclocker Jitter Generation - SD Data Rate	TRGCLKx = 27 MHz		133		ps
$t_{JRGENHD}^{[14, 22]}$	Reclocker Jitter Generation - HD Data Rate	TRGCLKx = 148.5 MHz		107		ps
CYV15G0404RB Receive PLL Characteristics Over the Operating Range						
t_{RXLOCK}	Receive PLL Lock to Input Data Stream (cold start)				376k	UI
	Receive PLL Lock to Input Data Stream				376k	UI
$t_{RXUNLOCK}$	Receive PLL Unlock Rate				46	UI

Capacitance^[14]

Parameter	Description	Test Conditions	Max	Unit
C_{INTTL}	TTL Input Capacitance	$T_A = 25^\circ\text{C}$, $f_0 = 1\text{ MHz}$, $V_{CC} = 3.3\text{V}$	7	pF
C_{INPECL}	PECL input Capacitance	$T_A = 25^\circ\text{C}$, $f_0 = 1\text{ MHz}$, $V_{CC} = 3.3\text{V}$	4	pF

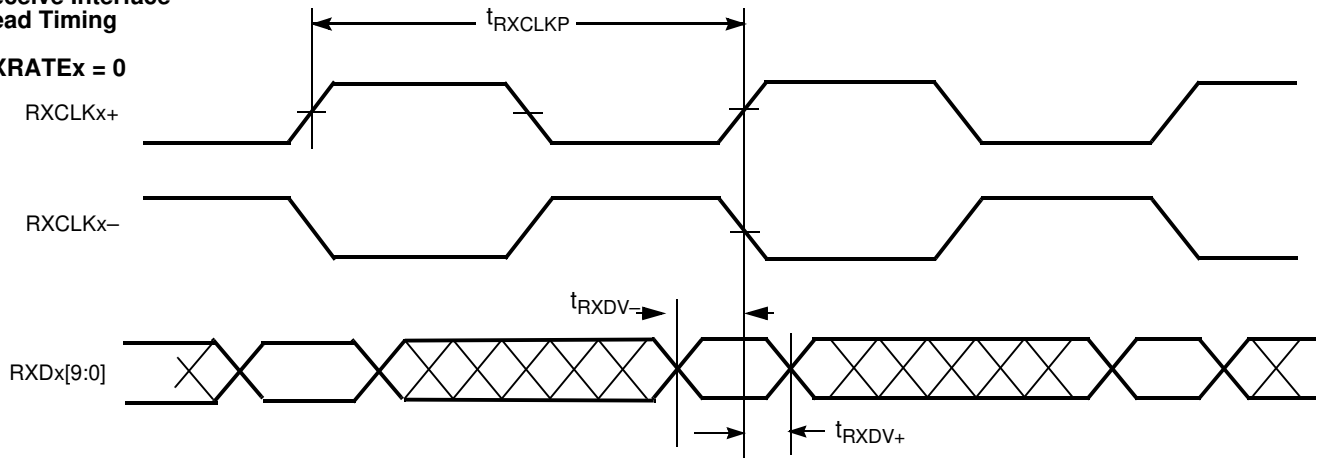
Note

22. Receiver input stream is BIST data from the transmit channel. This data is reclocked and output to a wide bandwidth digital sampling oscilloscope. The measurement was recorded after 10,000 histogram hits, time referenced to REFCLKx± of the transmit channel.

Switching Waveforms for the CYV15G0404RB HOTLink II Receiver

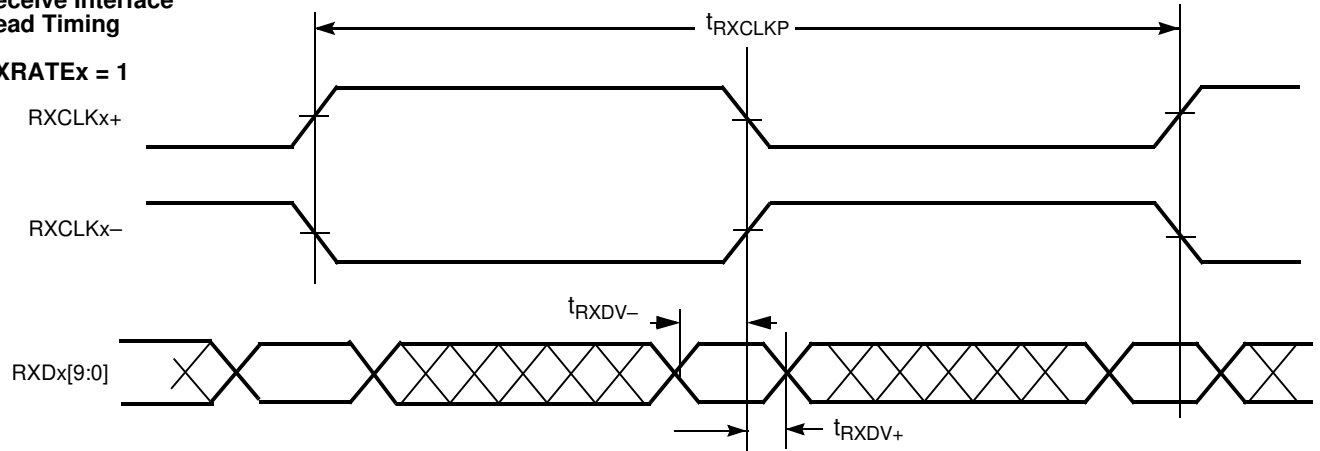
Receive Interface
Read Timing

RXRATE_x = 0



Receive Interface
Read Timing

RXRATE_x = 1



CYV15G0404RB HOTLink II Bus Configuration Switching Waveforms

Bus Configuration
Write Timing

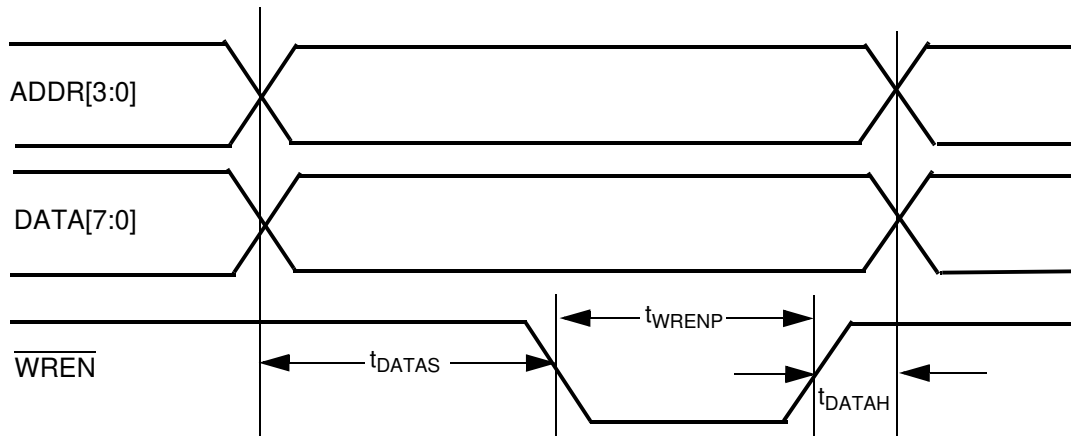


Table 6. Package Coordinate Signal Allocation

Ball ID	Signal Name	Signal Type	Ball ID	Signal Name	Signal Type	Ball ID	Signal Name	Signal Type
A01	INC1-	CML IN	C07	ULCC	LVTTTL IN PU	F17	VCC	POWER
A02	ROUTC1-	CML OUT	C08	GND	GROUND	F18	RXDB[0]	LVTTTL OUT
A03	INC2-	CML IN	C09	DATA[7]	LVTTTL IN PU	F19	RECLKOB	LVTTTL OUT
A04	ROUTC2-	CML OUT	C10	DATA[5]	LVTTTL IN PU	F20	RXDB[1]	LVTTTL OUT
A05	VCC	POWER	C11	DATA[3]	LVTTTL IN PU	G01	GND	GROUND
A06	IND1-	CML IN	C12	DATA[1]	LVTTTL IN PU	G02	WREN	LVTTTL IN PU
A07	ROU1D1-	CML OUT	C13	GND	GROUND	G03	GND	GROUND
A08	GND	GROUND	C14	VCC	POWER	G04	GND	GROUND
A09	IND2-	CML IN	C15	SPDSELD	3-LEVEL SEL	G17	SPDSELB	3-LEVEL SEL
A10	ROU2D2-	CML OUT	C16	VCC	POWER	G18	NC	NO CONNECT
A11	INA1-	CML IN	C17	LDTDEN	LVTTTL IN PU	G19	SPDSELA	3-LEVEL SEL
A12	ROU1A1-	CML OUT	C18	TRST	LVTTTL IN PU	G20	RXDB[3]	LVTTTL OUT
A13	GND	GROUND	C19	GND	GROUND	H01	GND	GROUND
A14	INA2-	CML IN	C20	TDO	LVTTTL 3-S OUT	H02	GND	GROUND
A15	ROU2A2-	CML OUT	D01	TCLK	LVTTTL IN PD	H03	GND	GROUND
A16	VCC	POWER	D02	RESET	LVTTTL IN PU	H04	GND	GROUND
A17	INB1-	CML IN	D03	INSELD	LVTTTL IN	H17	GND	GROUND
A18	ROU1B1-	CML OUT	D04	INSELA	LVTTTL IN	H18	GND	GROUND
A19	INB2-	CML IN	D05	VCC	POWER	H19	GND	GROUND
A20	ROU2B2-	CML OUT	D06	ULCA	LVTTTL IN PU	H20	GND	GROUND
B01	INC1+	CML IN	D07	SPDSELC	3-LEVEL SEL	J01	GND	GROUND
B02	ROUTC1+	CML OUT	D08	GND	GROUND	J02	GND	GROUND
B03	INC2+	CML IN	D09	DATA[6]	LVTTTL IN PU	J03	GND	GROUND
B04	ROUTC2+	CML OUT	D10	DATA[4]	LVTTTL IN PU	J04	GND	GROUND
B05	VCC	POWER	D11	DATA[2]	LVTTTL IN PU	J17	BISTSTB	LVTTTL OUT
B06	IND1+	CML IN	D12	DATA[0]	LVTTTL IN PU	J18	RXDB[2]	LVTTTL OUT
B07	ROU1D1+	CML OUT	D13	GND	GROUND	J19	RXDB[7]	LVTTTL OUT
B08	GND	GROUND	D14	GND	GROUND	J20	RXDB[4]	LVTTTL OUT
B09	IND2+	CML IN	D15	ULCB	LVTTTL IN PU	K01	RXDC[4]	LVTTTL OUT
B10	ROU2D2+	CML OUT	D16	VCC	POWER	K02	TRGCLKC-	PECL IN
B11	INA1+	CML IN	D17	NC	NO CONNECT	K03	GND	GROUND
B12	ROU1A1+	CML OUT	D18	VCC	POWER	K04	GND	GROUND
B13	GND	GROUND	D19	SCANEN2	LVTTTL IN PD	K17	RXDB[5]	LVTTTL OUT
B14	INA2+	CML IN	D20	TMEN3	LVTTTL IN PD	K18	RXDB[6]	LVTTTL OUT
B15	ROU2A2+	CML OUT	E01	VCC	POWER	K19	RXDB[9]	LVTTTL OUT
B16	VCC	POWER	E02	VCC	POWER	K20	LFIB	LVTTTL OUT
B17	INB1+	CML IN	E03	VCC	POWER	L01	RXDC[5]	LVTTTL OUT
B18	ROU1B1+	CML OUT	E04	VCC	POWER	L02	TRGCLKC+	PECL IN
B19	INB2+	CML IN	E17	VCC	POWER	L03	LFIC	LVTTTL OUT

Table 6. Package Coordinate Signal Allocation (continued)

Ball ID	Signal Name	Signal Type	Ball ID	Signal Name	Signal Type	Ball ID	Signal Name	Signal Type
B20	ROUTB2+	CML OUT	E18	VCC	POWER	L04	GND	GROUND
C01	TDI	LVTTTL IN PU	E19	VCC	POWER	L17	RXDB[8]	LVTTTL OUT
C02	TMS	LVTTTL IN PU	E20	VCC	POWER	L18	RXCLKB+	LVTTTL OUT
C03	INSEL C	LVTTTL IN	F01	RXDC[8]	LVTTTL OUT	L19	RXCLKB-	LVTTTL OUT
C04	INSEL B	LVTTTL IN	F02	RXDC[9]	LVTTTL OUT	L20	GND	GROUND
C05	VCC	POWER	F03	VCC	POWER	M01	RXDC[6]	LVTTTL OUT
C06	ULCD	LVTTTL IN PU	F04	VCC	POWER	M02	RXDC[7]	LVTTTL OUT
M03	VCC	POWER	U03	VCC	POWER	W03	LFID	LVTTTL OUT
M04	REPDOC	LVTTTL OUT	U04	VCC	POWER	W04	RXCLKD-	LVTTTL OUT
M17	TRGCLKB+	PECL IN	U05	VCC	POWER	W05	VCC	POWER
M18	TRGCLKB-	PECL IN	U06	RXDD[4]	LVTTTL OUT	W06	RXDD[6]	LVTTTL OUT
M19	REPDOB	LVTTTL OUT	U07	RXDD[3]	LVTTTL OUT	W07	RXDD[0]	LVTTTL OUT
M20	GND	GROUND	U08	GND	GROUND	W08	GND	GROUND
N01	GND	GROUND	U09	GND	GROUND	W09	ADDR [3]	LVTTTL IN PU
N02	GND	GROUND	U10	ADDR [0]	LVTTTL IN PU	W10	ADDR [1]	LVTTTL IN PU
N03	GND	GROUND	U11	TRGCLKD-	PECL IN	W11	RXCLKA+	LVTTTL OUT
N04	GND	GROUND	U12	GND	GROUND	W12	REPDOA	LVTTTL OUT
N17	GND	GROUND	U13	GND	GROUND	W13	GND	GROUND
N18	GND	GROUND	U14	GND	GROUND	W14	GND	GROUND
N19	GND	GROUND	U15	VCC	POWER	W15	VCC	POWER
N20	GND	GROUND	U16	VCC	POWER	W16	VCC	POWER
P01	RXDC[3]	LVTTTL OUT	U17	RXDA[4]	LVTTTL OUT	W17	LFIA	LVTTTL OUT
P02	RXDC[2]	LVTTTL OUT	U18	VCC	POWER	W18	TRGCLKA+	PECL IN
P03	RXDC[1]	LVTTTL OUT	U19	BISTSTA	LVTTTL OUT	W19	RXDA[6]	LVTTTL OUT
P04	RXDC[0]	LVTTTL OUT	U20	RXDA[0]	LVTTTL OUT	W20	RXDA[3]	LVTTTL OUT
P17	GND	GROUND	V01	VCC	POWER	Y01	VCC	POWER
P18	GND	GROUND	V02	VCC	POWER	Y02	VCC	POWER
P19	GND	GROUND	V03	VCC	POWER	Y03	RXDD[9]	LVTTTL OUT
P20	GND	GROUND	V04	RXDD[8]	LVTTTL OUT	Y04	RXCLKD+	LVTTTL OUT
R01	BISTSTC	LVTTTL OUT	V05	VCC	POWER	Y05	VCC	POWER
R02	RECLKOC	LVTTTL OUT	V06	RXDD[5]	LVTTTL OUT	Y06	RXDD[7]	LVTTTL OUT
R03	RXCLKC+	LVTTTL OUT	V07	RXDD[1]	LVTTTL OUT	Y07	RXDD[2]	LVTTTL OUT
R04	RXCLKC-	LVTTTL OUT	V08	GND	GROUND	Y08	GND	GROUND
R17	VCC	POWER	V09	BISTSTD	LVTTTL OUT	Y09	RECLKOD	LVTTTL OUT
R18	VCC	POWER	V10	ADDR [2]	LVTTTL IN PU	Y10	NC	NO CONNECT
R19	VCC	POWER	V11	TRGCLKD+	PECL IN	Y11	GND	GROUND
R20	VCC	POWER	V12	RECLKOA	LVTTTL OUT	Y12	RXCLKA-	LVTTTL OUT
T01	VCC	POWER	V13	GND	GROUND	Y13	GND	GROUND
T02	VCC	POWER	V14	GND	GROUND	Y14	GND	GROUND