QLUS3316-PQ208C Device Data Sheet

Utopia Level 3 Slave Bridges

1.0 Utopia Level 3 (L3) Bridge Core Features

- Implements two Utopia L3 Slaves providing a solution to bridge Utopia Master devices
- Compliant with ATM-Forum af-phy-0136.000 (Utopia L3)
- Meets 90MHz performance offering more than 1.4Gbps cell rate transfers
- Single chip solution for improved system integration
- Support cell level transfer mode, single PHY
- Cell and clock rate decoupling with on chip FIFOs
- Up to 1.5 KByte of on chip FIFO per data direction
- Integrated management interface and built-in errored cell discard
- ATM Cell size programmable via external pins from 16 to 128 bytes
- Optional Utopia parity generation/checking enable/disable via external pin
- Built in JTAG port (IEEE1149 compliant)
- Simulation model available for system level verification (Contact Quicklogic for details)
- Solution also available as flexible Soft-IP core, delivered with a full device modelization and verification testbenches

QUICKLOGIC

2.0 Utopia Overview

The Utopia (Universal Test & Operations PHY Interface for ATM) interface is defined by the ATM Forum to provide a standard interface between ATM devices and ATM PHY or SAR (Segmentation And Re-assembly) devices.

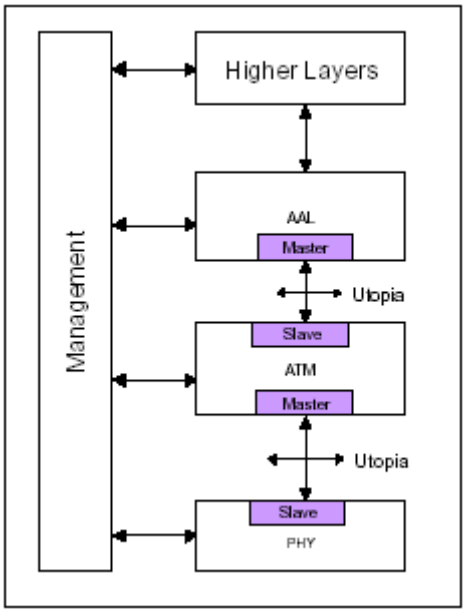

Figure 1: Utopia Reference Model

The Utopia Standard defines a full duplex bus interface with a Master/Slave paradigm. The Slave interface responds to the requests from the Master. The Master performs PHY arbitration and initiates data transfers to and from the Slave device.

The ATM forum has standardized the Utopia Levels 1 (L1) to 3 (L3). Each level extends the maximum supported interface speed from OC3, 155Mbps (L1) over OC12, 622Mbps (L2) to 3.2Gbit/s (L3).

The following Table 1 gives an overview of the main differences in these three levels.

Table 1: Utopia Level Differences

Utopia Level	Interface Width	Max. Interface Speed	Maximum Throughput
1	8-bit	25 MHz	200 Mbps (typ. OC3 155 Mbps)
2	8-bit, 16-bit	50 MHz	800 Mbps (typ. OC12 622 Mbps)
3	8-bit, 32-bit	104 MHz	3.2 Gbps (typ. OC48 2.5 Gbps)

Utopia Level 1 implements an 8-bit interface running at up to 25MHz. Level 2 adds a 16 Bit interface and increases the speed to 50MHz. Level 3 extends the interface further by a 32 Bit word-size and speeds up to 104MHz providing rates up to 3.2 Gbit/s over the interface.

In addition to the differences in throughput, Utopia Level 2 uses a shared bus offering to physically share a single interface bus between one master and up to 31 slave devices (Multi-PHY or MPHY operation). This allows the implementation of aggregation units that multiplex several slave devices to a single Master device. The Level 1 and Level 3 are point-to-point only, whereas Level 1 has no notion of multiple slaves. Level 3 still has the notion of multiple slaves, but they must be implemented in a single physical device connected to the Utopia Interface.

3.0 Utopia Slave/Slave Bridge Application

As it is not possible to connect two Master devices together, the Slave/Slave Bridge provides the necessary interfaces to convey between two Master devices as shown in Figure 2.

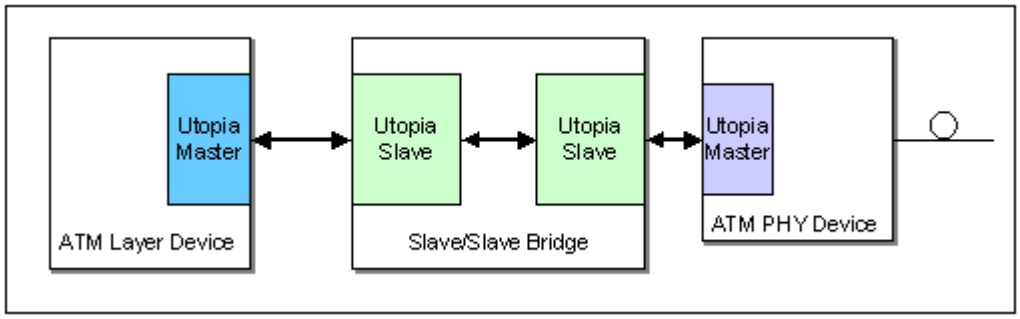

Figure 2: Utopia Slave Bridge

The Bridge automatically transfers data as soon as it becomes available from one side to the other. Internal asynchronous FIFOs enable independent clock domains for each interface.

4.0 Application

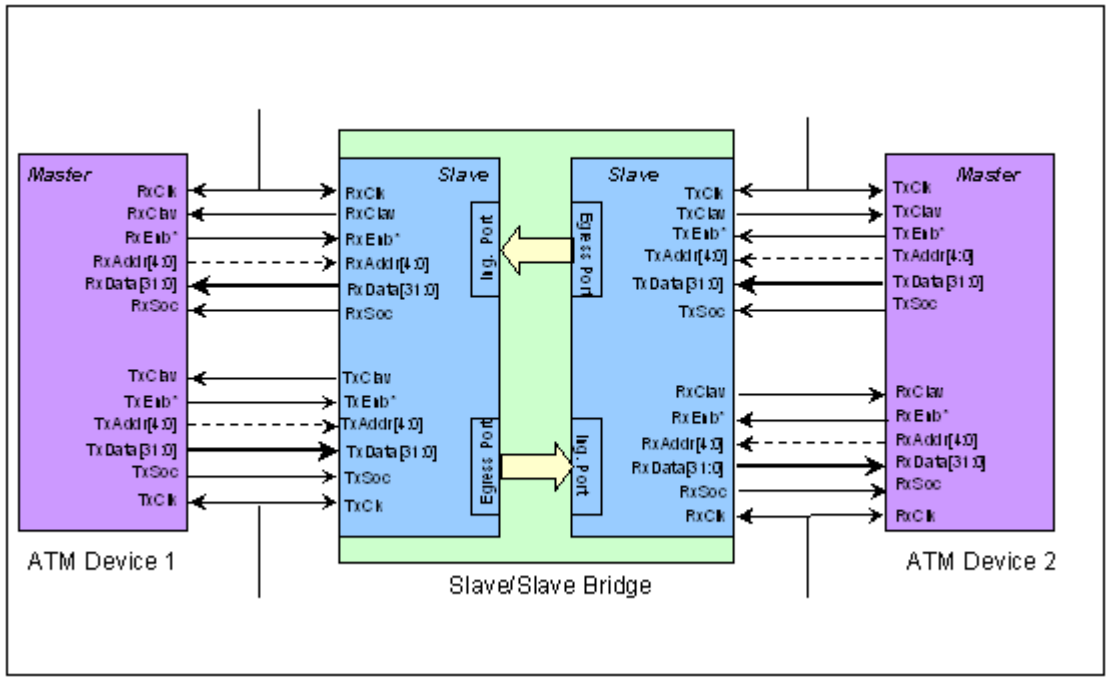

Figure 3: Slave/Slave Bridge connecting two Master Devices

Data flows from the Bridge's TX Ports to the corresponding RX Ports on the other side of the bridge.

5.0 Core Pinout

On the Utopia interfaces, the Core implements all the required Utopia signals and provides all the Utopia optional signals (Indicated by an 'O' in the following tables). The optional Utopia signals are activated during the Core configuration and inactive Utopia signals should be left unconnected (Outputs) or tied to a zero logic level (inputs) as specified in the following Tables.

In addition to the Utopia Interface signals, error indication signals are available for error monitoring or statistics. An error indication always shows that a cell has been discarded by the bridge. Possible errors are parity or cell-length errors on the receive interface of the corresponding Utopia Interfaces.

All Utopia interfaces work in the same transfer mode (cell level). A mix is not possible.

To identify the sides of the core the notion "WEST" and "EAST" for the corresponding interfaces will be used.

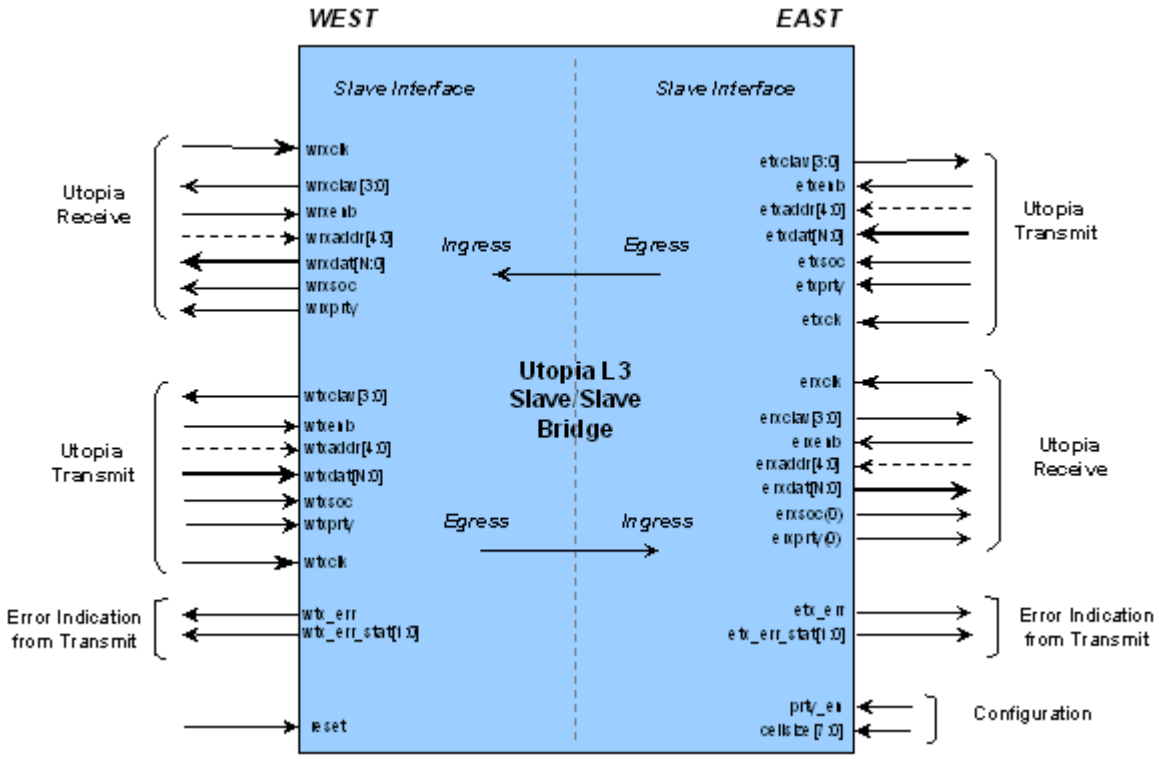

Figure 4: Utopia Level 3 Slave/Slave Bridge Top Entity

5.1 Signal Descriptions

Table 2: Global Signal

Pin	Mode	Description
reset	In	Active high chip reset

Table 3: Device Management Interface

Pin	Mode	Description
wtx_err	Out	Transmit error indication on west interface. When driven high, indicates that an errored cell (Wrong parity or wrong length) was received from the device connected to the west interface and is discarded.
wtx_err_stat(1:0)	Out	Transmit error status information for west interface. When wtx_err is driven, indicates the error status of the discarded cell: • wtx_err_stat(0) : When set to '1' indicates that a cell is discarded because of a parity error. • wtx_err_stat(1) : When set to '1' indicates that a cell is discarded because it has a wrong length (Consecutive assertion of ut_tx_soc on the Utopia interface within less than a complete cell time).
etx_err	Out	Transmit error indication on east interface. When driven high, indicates that an errored cell (Wrong parity or wrong length) was received from the device connected to the east interface side.
etx_err_stat(1:0)	Out	Transmit error status information for east receive interface. When etx_err is driven, indicates the error status of the discarded cell: • ex_err_stat(0) : When set to '1' indicates that a cell is discarded because of a parity error. • etx_err_stat(1) : When set to '1' indicates that a cell is discarded because it has a wrong length (Consecutive assertion of ut_tx_soc on the Utopia interface within less than a complete cell time).

NOTE: *wtx_.. signals are sampled with west transmit clock (wtxclk). etx_.. signals are sampled with west receive clock (wrxclk).*

Table 4: West Utopia Slave Transmit Interface

Pin	Mode	Description
wtxclk	In	90MHz transmit byte clock. The Core samples all Utopia Transmit signals on txclk rising edge.
wtxdata[15:0]	In	Transmit data bus.
wtxprty	In	Transmit data bus parity. Standard odd or non-standard even parity can be optionally checked by the connected Slave. When the parity check is disabled during the Core configuration, or not used in the design, the pin txprty should be tied to '0'.
wtxsoc	In	Transmit start of cell. Asserted by the Master to indicate that the current word is the first word of a cell.
wtxenb	In	Active low transmit data transfer enable.
wtxclav[0]	Out	Cell buffer available. Asserted in octet level transfers to indicate to the Master that the FIFO is almost full (Active low) or, in cell level transfers, to indicate to the Master that the PHY port FIFO has space to accept one cell.
wtxclav[3:1] (O)	Out	Extra FIFO Full / Cell buffer available. In MPHY mode and when direct status indication is selected during the Core configuration, one txclav signal is implemented per PHY port. The maximum number of clav signals is limited to four.
wtxaddr[4:0]	In	Utopia transmit address. When the Core operates in MPHY mode, address bus used during polling and slave port selection. Bit 4 is the MSB. txaddr(4:0) becomes optional (And should be left open) when the Core does not operate in MPHY mode.

NOTE: *(O) indicates optional signals.*

Table 5: West Utopia Slave Receive Interface

Pin	Mode	Description
wrxclk	In	90MHz receive byte clock. The Core samples all Utopia Receive signals on rxclk rising edge.
wrxdata[15:0]	Out	Receive data bus.
wrxprty (O)	Out	Receive data bus parity. Standard odd or non standard even parity can be optionally generated by the Utopia Slave Core. When the parity generation is disabled during the Core configuration, the pin rxprty can be let unconnected.
wrxsoc	Out	Receive start of cell. Asserted to indicate that the current word is the first word of a cell.
wrxenb	In	Active low transmit data transfer enable.
wrxclav[0]	Out	Cell buffer available. Asserted in octet level transfers to indicate to the Master that the FIFO is almost empty (Active low) or, in cell level transfers, to indicate to the Master that the PHY port FIFO has space one cell available in the FIFO.
wrxclav[3:1] (O)	Out	Extra FIFO Full / Cell buffer available. In MPHY mode and when direct status indication is selected, one rxclav signal is implemented per PHY port. The maximum number of clav signals is limited to four.
wrxaddr(4:0)	In	Utopia receive address. When the Core operates in MPHY mode, address bus used during polling and slave port selection. Bit 4 is the MSB. txaddr(4:0) becomes optional (And should be left open) when the Core does not operate in MPHY mode.

Table 6: East Utopia Slave Transmit Interface

Pin	Mode	Description
etxclk	In	90MHz transmit byte clock. The Core samples all Utopia Transmit signals on txclk rising edge.
etxdata[15:0]	In	Transmit data bus.
etxprty	In	Transmit data bus parity. Standard odd or non-standard even parity can be optionally checked by the connected Slave. When the parity check is disabled during the Core configuration, or not used in the design, the pin txprty should be left open.
etxsoc	In	Transmit start of cell. Asserted by the Master to indicate that the current word is the first word of a cell.
etxenb	In	Active low transmit data transfer enable.
etxclav[0]	Out	Cell buffer available. Asserted in octet level transfers to indicate to the Master that the FIFO is almost full (Active low) or, in cell level transfers, to indicate to the Master that the PHY port FIFO has space to accept one cell.
etxclav[3:1] (O)	Out	Extra FIFO Full / Cell buffer available. In MPHY mode and when direct status indication is selected during the Core configuration, one txclav signal is implemented per PHY port. The maximum number of clav signals is limited to four.
etxaddr[4:0]	In	Utopia transmit address. When the Core operates in MPHY mode, address bus used during polling and slave port selection. Bit 4 is the MSB. txaddr(4:0) becomes optional (And should be left open) when the Core does not operate in MPHY mode.

NOTE: *(O) indicates optional signals.*

Table 7: East Utopia Slave Receive Interface

Pin	Mode	Description
erxclk	In	90MHz receive byte clock. The Core samples all Utopia Receive signals on rxclk rising edge.
erxdata[15:0]	Out	Receive data bus.
erxprty (O)	Out	Receive data bus parity. Standard odd or non standard even parity can be optionally generated by the Utopia Slave Core. When the parity generation is disabled during the Core configuration, the pin rxprty can be let unconnected.
erxsoc	Out	Receive start of cell. Asserted to indicate that the current word is the first word of a cell.
erxenb	In	Active low transmit data transfer enable.
erxclav[0]	Out	Cell buffer available. Asserted in octet level transfers to indicate to the Master that the FIFO is almost empty (Active low) or, in cell level transfers, to indicate to the Master that the PHY port FIFO has space one cell available in the FIFO.
rxclav[3:1] (O)	Out	Extra FIFO Full / Cell buffer available. In MPHY mode and when direct status indication is selected, one rxclav signal is implemented per PHY port. The maximum number of clav signals is limited to four.
erxaddr(4:0)	In	Utopia receive address. When the Core operates in MPHY mode, address bus used during polling and slave port selection. Bit 4 is the MSB. taddr(4:0) becomes optional (And should be left open) when the Core does not operate in MPHY mode.

Table 8: Device Configuration Pins

Pin	Mode	Description
prty_en	In	Enable parity checking on the Utopia interface. If disabled (tied to 0), the wrx_err_stat(0) signal can be ignored and left open and the rx parity input should be tied to 0. Also the tx parity pins can be left open.
cellsize[7:0]	In	Define cellsize: sets the size in bytes of a cell. Binary value to be set usually by board wiring. The size must be a multiple of 2.

The configuration pins are not intended for change during operation. They are usually board wired to configure the device for operation.

6.0 Global Signal Distribution

The externally provided Utopia Transmit and Receive clocks are connected to global resources to provide low skew and fast chip level distribution. In both data directions, the two corresponding Utopia Interfaces are decoupled by asynchronous FIFOs.

Therefore each interface runs completely independently each at its own tx and rx clocks which typically are up to 104 MHz on the Level 3 interface (west) and up to 50 MHz on the Level 2 interface (east).

The Error indications of the two receive interfaces are always sampled within the west clock domains. The errors of the east tx (receiving) interface is available on the etx_err signal, which is handled using the west clock domain (wrxclk). The west tx (receiving) error is directly derived from the west tx block (wtxclk).

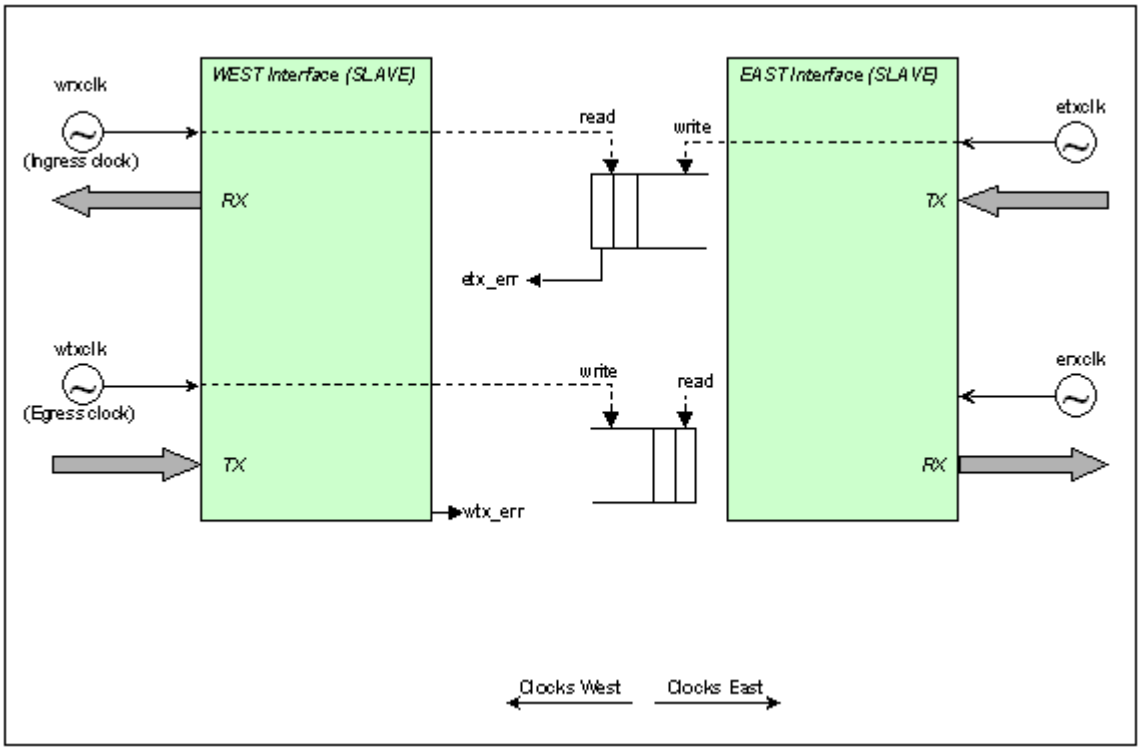

Figure 5: Slave/Slave Bridge Clock Distribution

7.0 Functional Description – Utopia Interface

The Utopia Bridge operates in single PHY mode. Therefore no address bus and only a single status pin (clav[0]) per direction is used on the interfaces.

7.1 Utopia Interface Single PHY Transmit Interface

The Transmit interface is controlled by the Master.

The transmit interface has data flowing in the same direction as the ATM enable `ut_txenb`. The ATM transmit block generates all output signals on the rising edge of the `ut_txclk`.

Transmit data is transferred from the Master to PHY layer via the following procedure. The Core indicates it can accept data using the `ut_txclav` signal, then the Master drives data onto `ut_txdat` and asserts `ut_txenb`.

Once a cell transfer has started, the Master or the Slave device cannot pause the transfer by any mean.

7.1.1 Cell Level Transfer

The Slave asserts `ut_txclav` **1** when it is capable of accepting the transfer of a whole cell. The Master asserts `ut_txenb` (Low) to indicate that it drives valid data to the Slave **2**. Together with the first octet of a cell, the Master asserts `ut_txsoc` for one clock cycle **3**.

To ensure that the Master does not cause transmit overrun, the Slave de-asserts `ut_txclav` when `ut_txsoc` is de-asserted by the Master **4**.

When a cell transfer is initiated, the Master or the Slave cannot pause the transfer by any means.

To complete the cell transfer, the Master de-asserts the Utopia enable signal `ut_txenb` **5**.

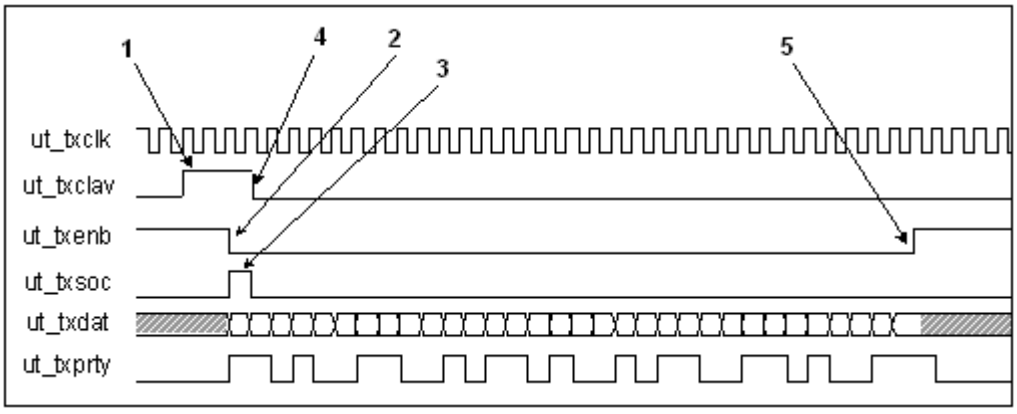

Figure 6: Single Cell Transfer

7.1.2 Back to Back Cells Transfer

When, during a cell transfer, the Slave is able to receive a subsequent cell, the Master can keep `ut_txenb` asserted between two cells **1** and asserts `ut_txsoc`, to start a new cell transfer, immediately after the last octet of the previous cell **2**.

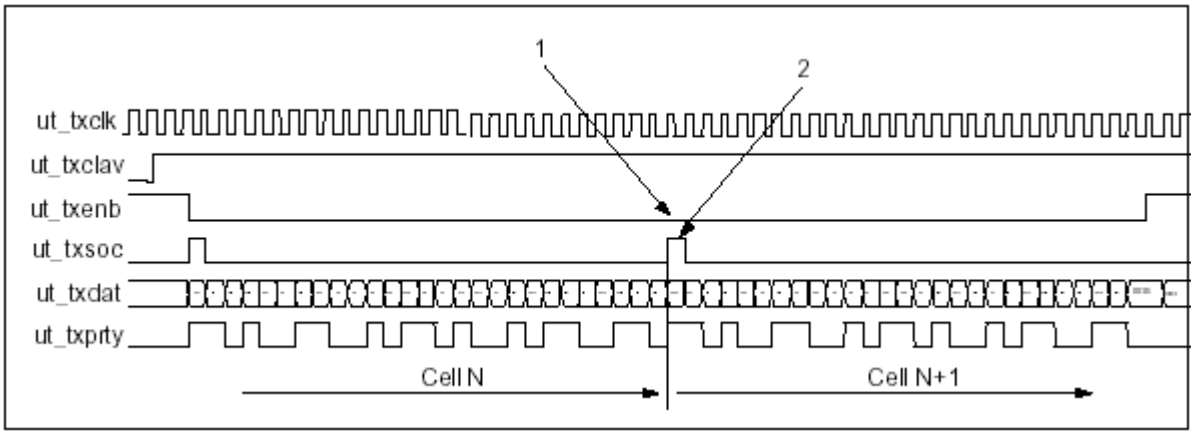

Figure 7: Back to Back Cell Transfer

7.2 Utopia Interface Single PHY Receive Interface

The Receive interface is controlled by the Master. The receive interface has data flowing in the opposite direction to the Master enable `ut_rxenb`.

Receive data is transferred from the Slave to Master via the following procedure. The Slave indicates it has valid data, then the Master asserts `ut_rxenb` to read this data from the Slave. The Slave indicates valid data (thereby controlling the data flow) via the `ut_rxclav` signal.

7.2.1 Single Cell Transfer

The Slave asserts `ut_rxclav` when it is ready to send a complete cell to the Master device **1**. The Master interface asserts `ut_rxenb` to start the cell transfer **2**. The Slave samples `ut_rxenb` and starts driving data on the following clock edge **3**. The Slave asserts `ut_rxsoc` together with the cell first word to indicate the start of a cell **4**.

The Master drives `ut_txenb` high two clock cycles before the expected end of the current cell if the Slave has no more cell to transfer **5**. The Slave de-asserts `ut_rxclav` to indicate that no new cell is available **6** together with the start of cell indication.

When a cell transfer is initiated, the transfer cannot be paused by the Master or the Slave.

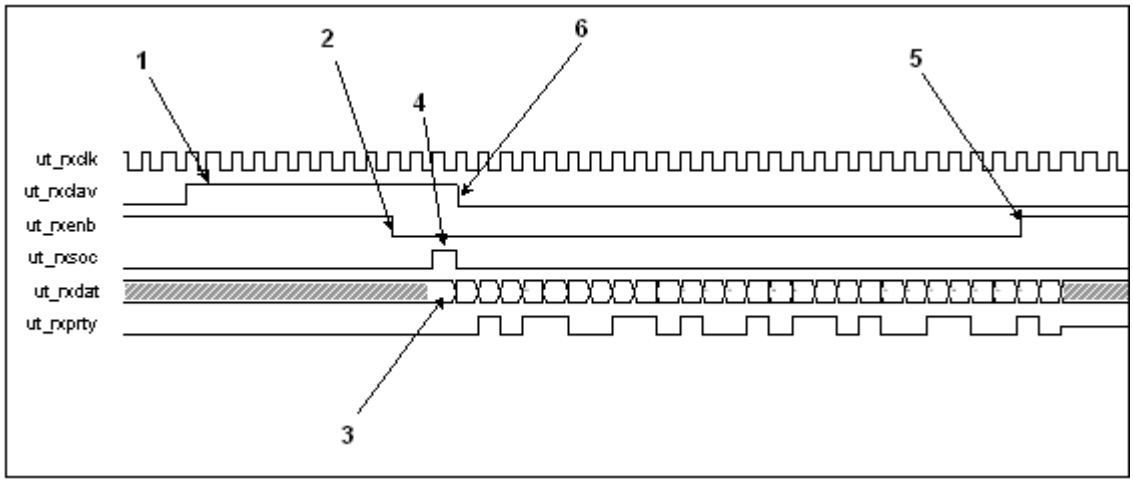

Figure 8: Single Cell Transfer

7.2.2 Back to Back Cell Transfer

If the Master keeps `ut_rxenb` asserted at the end of a cell transfer **1** and if the Slave has a new cell to send, the Slave keeps `ut_rxclav` drives the new cell asserting `ut_rxsoc` to indicate the start of a new cell **2**.

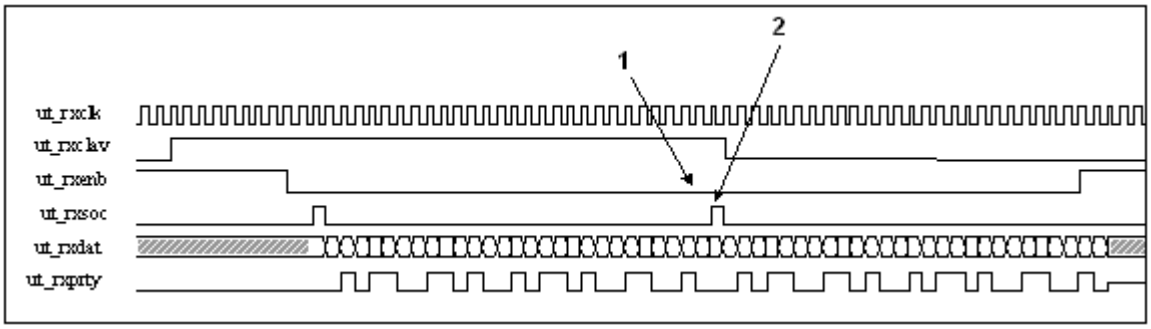

Figure 9: Back to Back Cells Transfer

8.0 Core Management and Error Handling

On Egress, the Core is designed to handle and report Utopia errors such as Parity error or wrong cell length. Errored cells are discarded with an error status indication provided to the user PHY application.

When an errored cell is received on the Utopia interface, the Core discards the complete cell and provides a cell discard indication to the User PHY application (Signal `eg_err(n)` asserted) **1** together with a cell discard status (Signal `eg_err_stat(1:0)`) **2**.

NOTE: *eg_err is routed to the corresponding `wtx_err` and `etx_err` respectively (see Figure 4).*

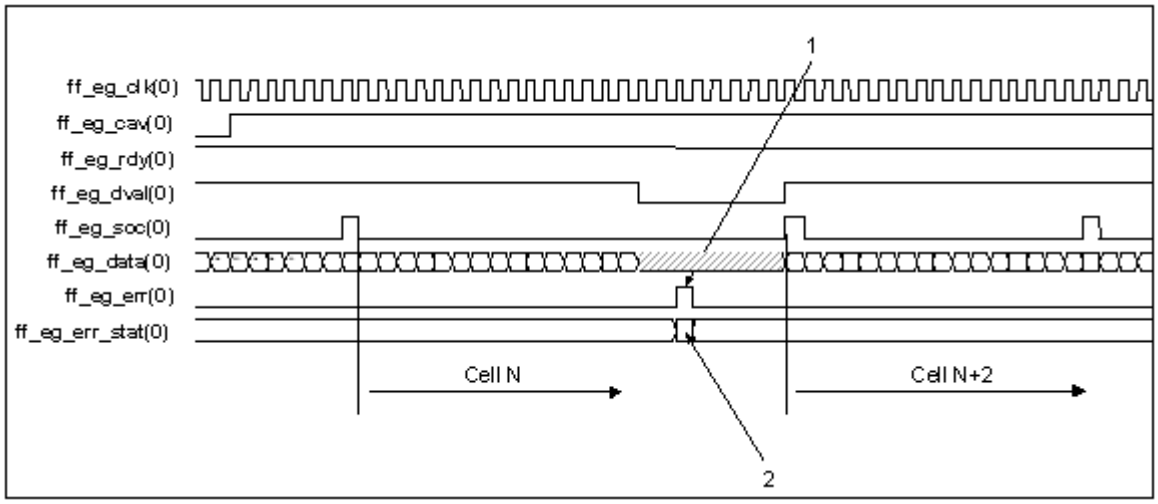

Figure 10: Cell Discard Indication

Table 9: Error Status Word Bit Coding

Error Status Bit	Name	Description
0	PARITY_ERR	Valid when wtx/etx_err is asserted. If set to one indicates that a cell is discarded with a parity error decoded by the Core.
1	LENGTH_ERR	Valid when wtx/etx_err is asserted. If set to one indicates that a cell is discarded with a cell length error detected on the Utopia interface.

The signals are sampled on the corresponding clocks from the west interface:

- etx_... sampled with wrxclk (west receive clock)
- wtx_... sampled with wtxclk (west transmit clock)

9.0 Complexity and Performance Summary

9.1 Timing Parameters Definition

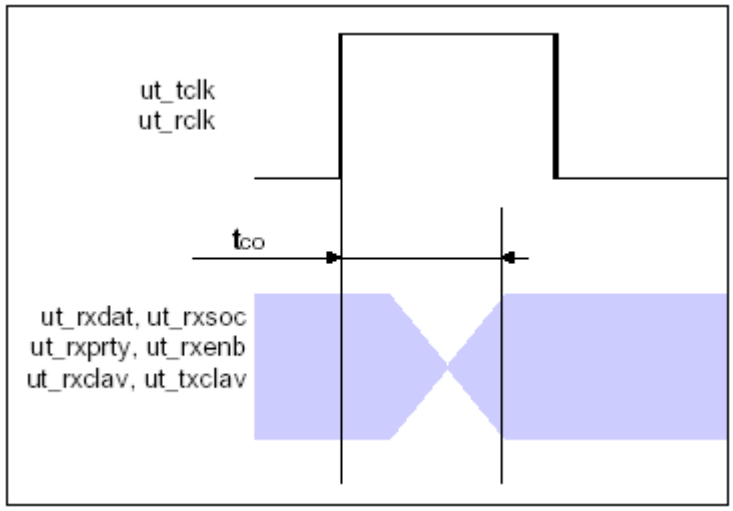

Figure 11: Tco Timing Parameter Definition

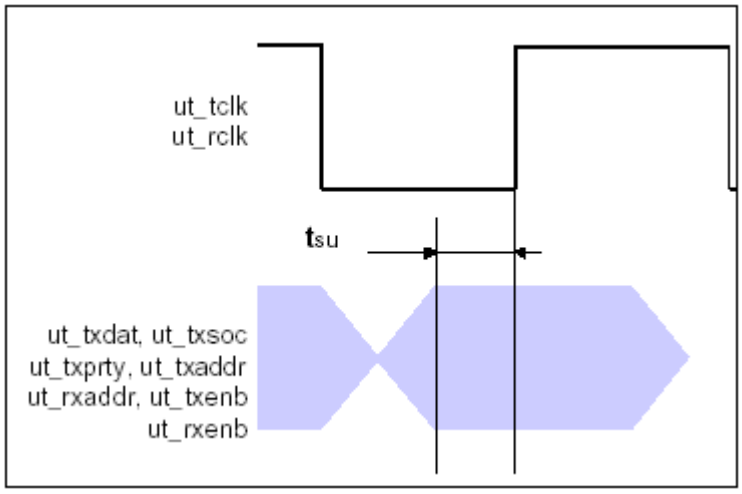

Figure 12: Tsu Timing Parameter Definition

Table 10: 16-Bit Utopia Interface Timing Characteristics

Parameter	typ	Max	Unit
tco	7.0	6.0	ns
tsu	2.5	1.8	ns
wrxclk		90	MHz
wtxclk		90	MHz
erxclk		90	MHz
etxclk		90	MHz
minimum reset time	50		ns

NOTE: *Timing model "worst" case is used.*

10.0 Device Pinout

10.1 Signals Overview

Table 11: Signals Overview Table

Signals	Description
wrxclk, wrxclav, wrxenb*,wrxdat, wrxsoc	West Utopia Receive Interface
wtxclk, wtxclav, wtxenb*, wtxdata, wtxsoc	West Utopia Transmit Interface
wtx_err, wtx_err_stat	West Interface error indication (sampled with wtxclk)
	.
erxclk, erxclav, erxenb*, erxdata, erxsoc	East Utopia Receive Interface
etxclk, etxclav, etxenb*, etxdata, etxsoc	East Utopia Transmit Interface
etx_err, etx_err_stat	East Interface error indication (sampled with wrxclk)
prty_en, cellsize	Configuration Pins to be board wired. Cellsize [0] Should be tied to GND.
reset	Active high device reset
GND	Ground
VCC	Device Power 2.5 V
clk(x)	unused clock inputs should be tied to GND
IOCTRL(x)	
VCCIO(x)	IO Power 3.3 V
INREF(x)	connect to GND
PLLRST(x)	connect to GND or VCC
PLLOUT(x)	connect to GND or VCC
VCCPLL(x)	
GNDPLL(x)	
TCK, TRSTB	JTAG signals. connect to GND
TMS, TDI	JTAG signals. connect to VCC
TDO	JTAG signal. leave open
iov	
nc	not connected. should be left open

*: active low signal

10.2 208 Pin PQFP (PQ208) Device Diagram

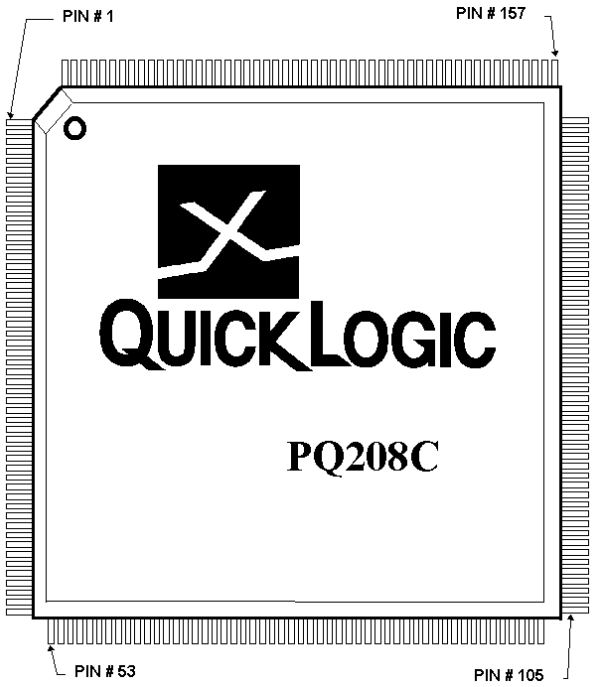

Figure 13: PQ208 top view

10.3 208 Pin PQFP (PQ208) Pinout Table

Table 12: 208 Pin PQFP (PQ208) Pinout Table

PIN	SIGNAL	PIN	Signal	PIN	Signal	PIN	Signal
1	nc	53	nc	105	nc	157	tck
2	wtxclav[0]	54	tdi	106	etxclav[0]	158	stm gnd
3	wtxprty	55	nc	107	etxprty	159	reset
4	wtxenb	56	nc	108	etxenb	160	nc
5	wtxsoc	57	nc	109	etxsoc	161	nc
6	wtxdat[0]	58	nc	110	etxdat[15]	162	nc
7	wtxdat[1]	59	gnd	111	etxdat[14]	163	gnd
8	wtxdat[2]	60	nc	112	etxdat[13]	164	nc
9	wtxdat[3]	61	vcc	113	etxdat[12]	165	vcc
10	vcc	62	nc	114	vcc	166	nc
11	wtxdat[4]	63	nc	115	etxdat[11]	167	nc
12	gnd	64	nc	116	gnd	168	nc
13	wtxdat[5]	65	nc	117	etxdat[10]	169	nc
14	wtxdat[6]	66	nc	118	etxdat[9]	170	nc
15	wtxdat[7]	67	nc	119	etxdat[8]	171	nc
16	wtxdat[8]	68	wrx_err_stat[1]	120	etxdat[7]	172	nc
17	wtxdat[9]	69	wrx_err_stat[0]	121	etxdat[6]	173	nc
18	wtxdat[10]	70	wrx_err	122	etxdat[5]	174	erx_err_stat[1]
19	wtxdat[11]	71	nc	123	etxdat[4]	175	erx_err_stat[0]
20	wtxdat[12]	72	nc	124	etxdat[3]	176	erx_err
21	wtxdat[13]	73	gnd	125	etxdat[2]	177	gnd
22	wtxdat[14]	74	nc	126	etxdat[1]	178	nc
23	gnd	75	nc	127	gnd	179	nc
24	wtxdat[15]	76	nc	128	etxdat[0]	180	nc
25	wtxclk	77	nc	129	nc	181	nc
26	nc	78	gnd	130	nc	182	gnd
27	vcc	79	nc	131	vcc	183	nc
28	wrxclk	80	nc	132	etxclk	184	nc
29	nc	81	nc	133	erxclk	185	nc
30	vcc	82	nc	134	vcc	186	nc
31	wrxdat[0]	83	vccio	135	erxdat[15]	187	vccio
32	wrxdat[1]	84	nc	136	erxdat[14]	188	nc
33	wrxdat[2]	85	nc	137	erxdat[13]	189	nc
34	wrxdat[3]	86	nc	138	erxdat[12]	190	nc
35	wrxdat[4]	87	nc	139	erxdat[11]	191	cellsize[0]
36	wrxdat[5]	88	nc	140	erxdat[10]	192	cellsize[1]
37	wrxdat[6]	89	nc	141	erxdat[9]	193	cellsize[2]
38	wrxdat[7]	90	nc	142	erxdat[8]	194	cellsize[3]
39	wrxdat[8]	91	nc	143	erxdat[7]	195	cellsize[4]
40	wrxdat[9]	92	nc	144	erxdat[6]	196	cellsize[5]
41	vcc	93	nc	145	vcc	197	cellsize[6]
42	wrxdat[10]	94	nc	146	erxdat[5]	198	cellsize[7]
43	gnd	95	gnd	147	gnd	199	gnd
44	wrxdat[11]	96	nc	148	erxdat[4]	200	nc
45	wrxdat[12]	97	vcc	149	erxdat[3]	201	vcc
46	wrxdat[13]	98	nc	150	erxdat[2]	202	vcc
47	wrxdat[14]	99	nc	151	erxdat[1]	203	prty_en
48	wrxdat[15]	100	nc	152	erxdat[0]	204	nc
49	wrxsoc	101	nc	153	erxsoc	205	nc
50	wrxenb	102	nc	154	erxenb	206	nc
51	wrxprty	103	trstb	155	erxprty	207	nc
52	wrxclav[0]	104	tms	156	erxclav[0]	208	nc

11.0 References

- ATM Forum, Utopia Level 3, af-phy-0136.000, 1999

12.0 Contact

QuickLogic Corp.

Tel : 408 990 4000 (US)

: + 44 1932 57 9011 (Europe)

: + 49 89 930 86 170 (Germany)

: + 852 8106 9091 (Asia)

: + 81 45 470 5525 (Japan)

E-mail : info@quicklogic.com

Internet : www.quicklogic.com