STLC1510

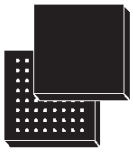
NorthenLite™ G.lite DMT Transceiver

PRODUCT PREVIEW

- ATM transport
- Forward Error correction & interleaving
- Framing & de-framing
- DMT modulation and demodulation
- Start-up & showtime control processing

In addition, the STLC1510 provides the following features:

- Serial and Parallel network interface at back-end to CO equipment
- Serial interface to the AFE chip STLC1511
- Access to off chip memory
- Power-up boot program stored in ROM
- 132 balls 12x12x1.7 mm LBGA package
- Power Consumption: 0.75 Watt
- Power Supp.: 2.5 V (core) and 3.3 V (I/O ring)
-



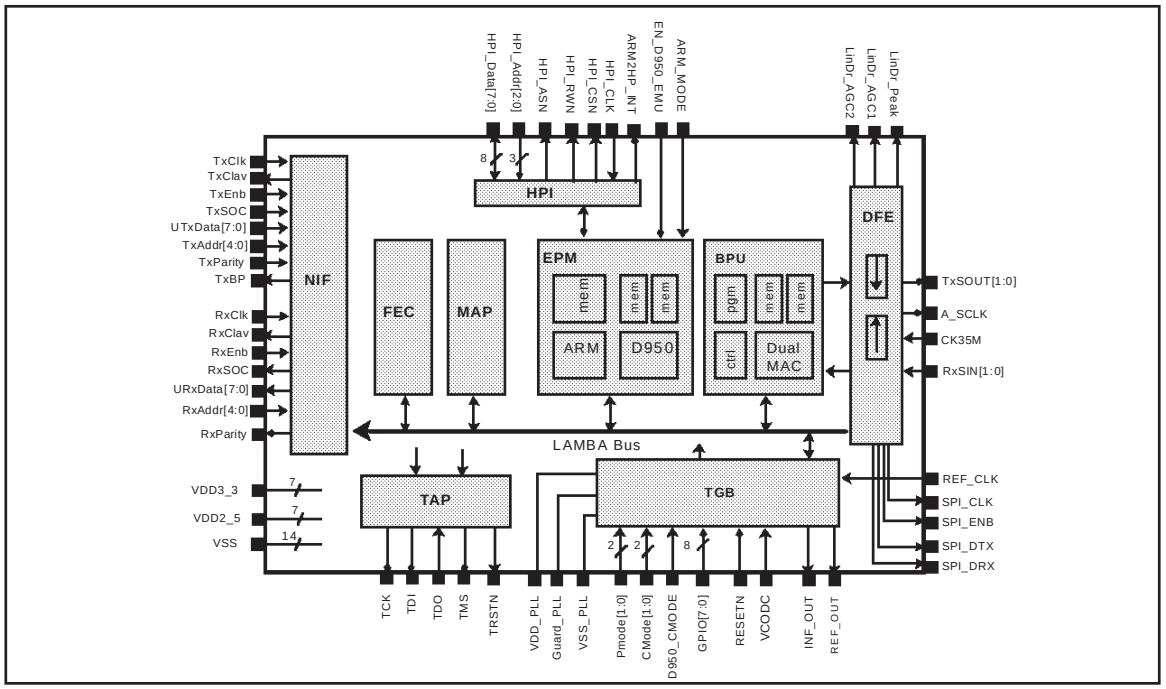
LBGA132
ORDERING NUMBER: STLC1510

1.0 GENERAL DESCRIPTION

The STLC1510 is a high-speed modem chip that provides the digital portion of a G.992.2 DSL access at a Central Office (CO) site. It provides downstream and upstream data transport between an ATM byte stream and an analog front-end chip using Discrete Multi-Tone (DMT) Modulation.

The STLC1510 is compliant with ITU-T G.992.2 (G.Lite), G.996.1 (G.Test), G.994.1 (G.Handshake), G.997.1 (G.Ploam).

Figure 1. Block Diagram



2.0 LIST OF MAIN BLOCKS

The STLC1510 G.lite DMT Transceiver is formed by the following blocks (refer to Figure 1.):

Embedded Processor Module (EPM)

The EPM includes two embedded processor cores: the ARM7TDMI, a RISC microprocessor, and the D950, a 16-bit DSP processor. The RISC microprocessor handles the chip control, G.Lite start-up and showtime control and DSP initialization. It also implements the Framing and Interleaving/Deinterleaving function required by G.992.2 standard.

Block Processing Unit (BPU)

Computationally intensive digital signal processing functions are performed in this engine. This engine utilizes customized DSP architecture that includes two multiplier/accumulator (MAC).

Digital Front-End (DFE)

This block provides the interface to an external analog front-end (AFE) device. This block provides decimation, interpolation for the signal sample for the ADC and DAC on the AFE and signal level monitoring for the analog AGC.

Network Interface (NIF)

The NIF is a selectable interface that carries the ATM signals to and from the STLC1510. This interface supports one parallel interface (Utopia Level 2) or a serial data interface. The NIF includes a FIFO to buffer the data between the clock domains of the back-end interface and the internal clock.

Forward Error-Correction (FEC)

The Forward Error Correction is done using Reed-Solomon Coding. The R-S FEC encoding is performed byte-wise in the transceiver on the transmitted bytes. The two basic parameters that determine the performance of the code are the code word size, which consists of one or more DMT symbols (S), and the number of redundant check bytes R.

Mapper/De-mapper Block (MAP)

The Mapper/De-mapper Block (MAP) performs the bit packing and un-packing and constellation encoder/decoder for a G.992.2 DSL modem. This block also supports generation of Reverb and medley.

Timing Generation Block (TGB)

The timing generation block generates global clock and synchronization signals for the STLC1510. It uses the input clock signals to derive the main internal and output clock signals, as well as all synchronization pulses required to coordinate timing between the sub-blocks.

Test Access Port (TAP)

This block provides the test access to the STLC1510 using JTAG and BIST techniques.

HPI Interface

A host processor interface is provided to allow the STLC1510 to be optionally controlled by an external microcontroller.

3.0 TRANSIENT ENERGY CAPABILITIES

3.1 ESD

ESD (Electronic Discharged) tests have been performed for the Human Body Model (HBM).

The pins of the device are to be able to withstand minimum 2000V for the HBM.

3.2 Latch-up

The maximum sink or source current from any pin is limited to 200mA to prevent latch-up.

4.0 ABSOLUTE MAXIMUM RATINGS

The absolute maximum ratings, as specified below, are those ratings beyond which the device's lifetime may be impaired. The meeting of electrical specifications is not implied when the device is subjected to the absolute limits.

The following table identifies the device's minimum and maximum ratings and along with the operating-conditions they define the limits for testing the device

Table 1. ABSOLUTE MAXIMUM RATINGS

SYMBOL	PARAMETER	MINIMUM	MAXIMUM	UNITS
VDD3_3	3.3V Supply voltage w.r.t. VSS (0V)	-0.5	4	V
VDD2_5	2.5V Supply voltage w.r.t. VSS (0V)	-0.5	3.3	V
T_{amb}	Ambient temperature	-40	85	°C
V_{IN}, V_{OUT}	Voltage at any 3.3V standard input or output	-0.5	VDD3_3 + 0.5	V
V_{IN5}, V_{OUT5}	Voltage at any 5V compatible input or output[1]	-0.8	6.3	V
I_{IN}, I_{OUT}	Current at any input or outputs	-20	20	mA
P_D	Power dissipation	0	0.75	W
Vesd	Electrostatic Protection	2000		V
I latchup	I/O Latch-up Current V < 0V, V > Vdd	200		mA

<1> -0.8V undershoots and 6.3V overshoots do not last longer than 4nS.

Figure 2. Ball Map.

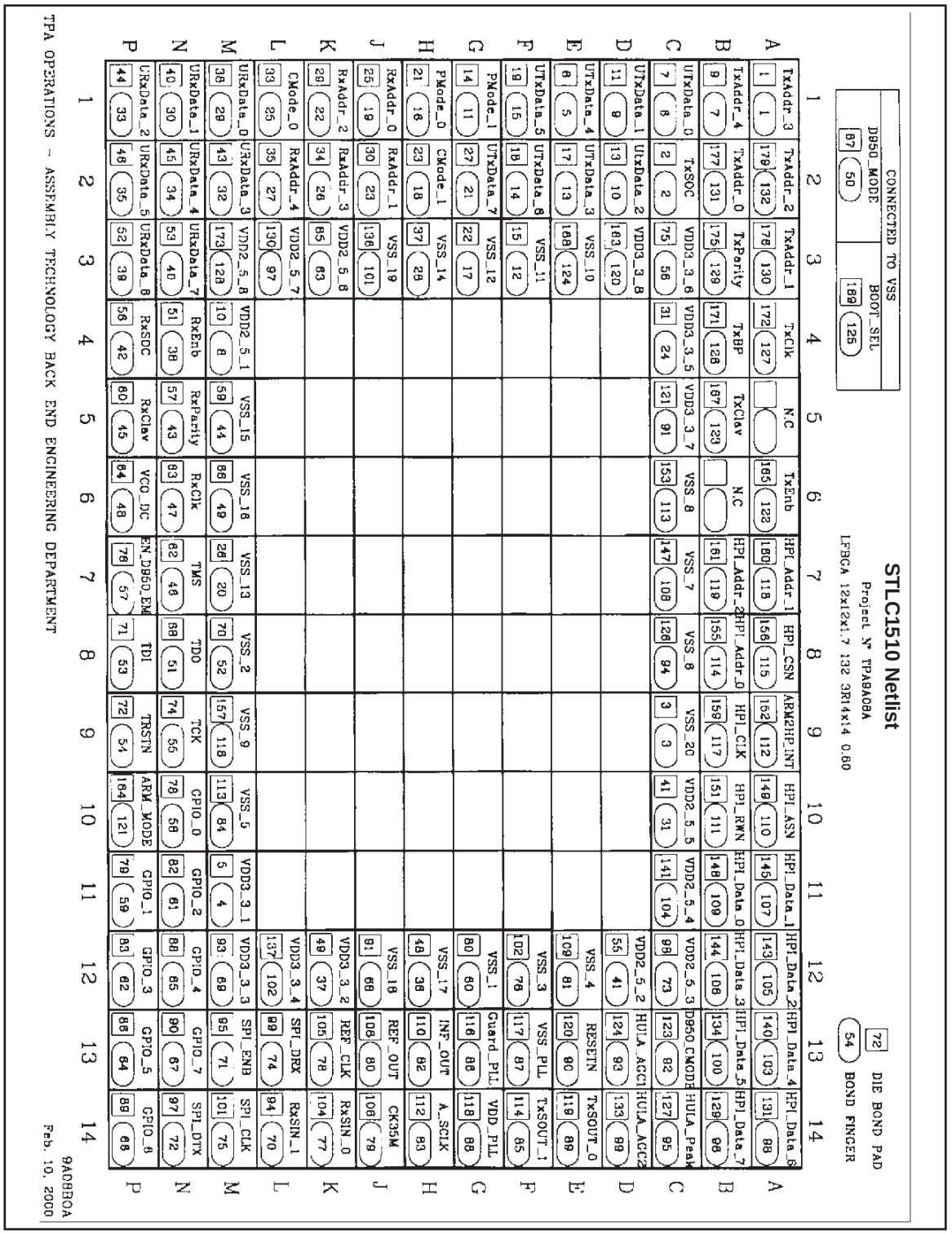


Table 2. Pad Description

Signal	I/O	Pad Type	Description	BGA
Clock Interface				
REF_CLK	I	5V Tol CMOS input	17.168 MHz or 35.328 MHz reference clock input.[1]	K13
RESETN	I	5V Tol CMOS input	Hardware reset (active low)	E13
D950_CMODE	I	5V Tol CMOS input	'1' - Normal operation '0' - Reduced REF_CLK frequency in bypass mode for chip test	C13
PMode_1	I	5V Tol CMOS input	Power Mode Select	G1
PMode_0	I	5V Tol CMOS input	Power Mode Select	H1
CMode_1	I	5V Tol CMOS input	Clock Mode Select	H2
CMode_0	I	5V Tol CMOS input	Clock Mode Select	L1
STLC1511 AFE Interface				
A_SCLK	I	5V Tol CMOS input	ADC/DAC sample frame clock	H14
CK35M	O	5V Tol 3.3V TTL 2mA slew ltd output	35.328 MHz reference clock output.	J14
RxSIN_1	I	5V Tol CMOS input	ADC serial input data	L14
RxSIN_0	I	5V Tol CMOS input	ADC serial input data	K14
TxSOUT_1	O	5V Tol 3.3V TTL 2mA slew ltd output	DAC serial output data	F14
TxSOUT_0	O	5V Tol 3.3V TTL 2mA slew ltd output	DAC serial output data	E14
SPI_CLK	O	5V Tol 3.3V TTL 2mA slew ltd output	STLC1511 control interface clock	M14
SPI_ENB	O	5V Tol 3.3V TTL 2mA slew ltd output	TX/RX STLC1511 Enable Control signal	M13
SPI_DTX	O	5V Tol 3.3V TTL 2mA slew ltd output	TX STLC1511 Control Data	N14
SPI_DRX	I	5V Tol CMOS input	RX STLC1511 input Control Data	L13
XTAL_CTRL	O	5V Tol 3.3V TTL 2mA slew ltd output	XTAL output control pin	Not on BGA
STLC1512 Line Driver Interface				
LinDr_AGC1	O	5V Tol 3.3V TTL 2mA slew ltd output	STLC1511 AGC Gain control 1	D13
LinDr_AGC2	O	5V Tol 3.3V TTL 2mA slew ltd output	STLC1511 AGC Gain control 2	D14
LinDr_Peak	O	5V Tol 3.3V TTL 2mA slew ltd output	STLC1511 Peak control[2]	C14

Table 2. Pad Description

Signal	I/O	Pad Type	Description	BGA
Test Interface				
TCK	I	5V Tol CMOS input	JTAG Test Clock	N9
TMS	I	5V Tol CMOS input	JTAG Test Mode Select	N7
TDI	I	5V Tol CMOS input	JTAG Test Data Input	P8
TDO	O	5V Tol 3.3V TTL 2mA slew ltd output	JTAG Test Data Output	N8
TRSTN	I	5V Tol CMOS input	dedicated TAP reset (active low)	P9
Network Interface (UTOPIA / Serial Clock & Data)				
TxClk	I/O	5V Tol CMOS input/ 5V Tol 3.3V TTL 2mA slew ltd output	Input Utopia2 Tx clock or output PSIF Tx clock.	A4
TxClav	O	5V Tol 3.3V TTL 2mA slew ltd output	Tx cell available signal.	B5
TxBP	O	5V Tol 3.3V TTL 2mA slew ltd output	Tx back pressure signal.	B4
TxEnb	I	5V Tol. CMOS input	Tx Enable.	A6
TxSOC	I	5V Tol CMOS input	Tx start of Cell	C2
UTxData_7	I	5V Tol CMOS input	Utopia2 Transmit data bit 7	G2
UTxData_6	I	5V Tol CMOS input	Utopia2 Transmit data bit 6	F2
UTxData_5	I	5V Tol CMOS input	Utopia2 Transmit data bit 5	F1
UTxData_4	I	5V Tol CMOS input	Utopia2 Transmit data bit 4	E1
UTxData_3	I	5V Tol CMOS input	Utopia2 Transmit data bit 3	E2
UTxData_2	I	5V Tol CMOS input	Utopia2 Transmit data bit 2	D2
UTxData_1	I	5V Tol CMOS input	Utopia2 Transmit data bit 1	D1
UTxData_0	I	5V Tol CMOS input	Utopia2 Transmit data bit 0; also CDIF input data	C1
TxAddr_4	I	5V Tol CMOS input	Utopia2 Transmit Address	B1
TxAddr_3	I	5V Tol CMOS input	Utopia2 Transmit Address	A1
TxAddr_2	I	5V Tol CMOS input	Utopia2 Transmit Address	A2
TxAddr_1	I	5V Tol CMOS input	Utopia2 Transmit Address	A3
TxAddr_0	I	5V Tol CMOS input	Utopia2 Transmit Address	B2
TxParity	I	5V Tol. CMOS input	Odd parity bit of the data on UTxData[7:0].	B3
RxClk	I/O	5V Tol CMOS input/ 5V Tol 3.3V TTL 2mA slew ltd output	Input Utopia2 Rx clock or output PSIF Rx clock.	N6

Table 2. Pad Description

Signal	I/O	Pad Type	Description	BGA
RxClav	O	5V Tol 3.3V TTL 2mA slew ltd output	Rx cell available signal.	P5
RxEnb	I	5V Tol. CMOS input	Rx Enable.	N4
RxSOC	O	5V Tol 3.3V TTL 2mA slew ltd output	Rx start of Cell	P4
URxData_7	O	5V Tol 3.3V TTL 2mA slew ltd output	Utopia2 Receive data bit 7	N3
URxData_6	O	5V Tol 3.3V TTL 2mA slew ltd output	Utopia2 Receive data bit 6	P3
URxData_5	O	5V Tol 3.3V TTL 2mA slew ltd output	Utopia2 Receive data bit 5	P2
URxData_4	O	5V Tol 3.3V TTL 2mA slew ltd output	Utopia2 Receive data bit 4	N2
URxData_3	O	5V Tol 3.3V TTL 2mA slew ltd output	Utopia2 Receive data bit 3	M2
URxData_2	O	5V Tol 3.3V TTL 2mA slew ltd output	Utopia2 Receive data bit 2	P1
URxData_1	O	5V Tol 3.3V TTL 2mA slew ltd output	Utopia2 Receive data bit 1	N1
URxData_0	O	5V Tol 3.3V TTL 2mA slew ltd output	Utopia2 Receive data bit 0; also CDIF output data	M1
RxAddr_4	I	5V Tol. CMOS input	Utopia2 Receive Address	L2
RxAddr_3	I	5V Tol. CMOS input	Utopia2 Receive Address	K2
RxAddr_2	I	5V Tol. CMOS input	Utopia2 Receive Address	K1
RxAddr_1	I	5V Tol. CMOS input	Utopia2 Receive Address	J2
RxAddr_0	I	5V Tol. CMOS input	Utopia2 Receive Address	J1
RxParity	O	5V Tol 3.3V TTL 2mA slew ltd output	Odd parity bit of the data on URxData[7:0].	N5
HPI				
HPI_Data_7	I/O	5V Tol CMOS input/ 5V Tol 3.3V TTL 2mA slew ltd output	HPI Port Data	B14
HPI_Data_6	I/O	5V Tol CMOS input/ 5V Tol 3.3V TTL 2mA slew ltd output	HPI Port Data	A14
HPI_Data_5	I/O	5V Tol CMOS input/ 5V Tol 3.3V TTL 2mA slew ltd output	HPI Port Data	B13
HPI_Data_4	I/O	5V Tol CMOS input/ 5V Tol 3.3V TTL 2mA slew ltd output	HPI Port Data	A13
HPI_Data_3	I/O	5V Tol CMOS input/ 5V Tol 3.3V TTL 2mA slew ltd output	HPI Port Data	B12

Table 2. Pad Description

Signal	I/O	Pad Type	Description	BGA
HPI_Data_2	I/O	5V Tol CMOS input/ 5V Tol 3.3V TTL 2mA slew ltd output	HPI Port Data	A12
HPI_Data_1	I/O	5V Tol CMOS input/ 5V Tol 3.3V TTL 2mA slew ltd output	HPI Port Data	A11
HPI_Data_0	I/O	5V Tol CMOS input/ 5V Tol 3.3V TTL 2mA slew ltd output	HPI Port Data	B11
HPI_Addr_2	I	5V Tol. CMOS input	HPI Port Address	B7
HPI_Addr_1	I	5V Tol. CMOS input	HPI Port Address	A7
HPI_Addr_0	I	5V Tol. CMOS input	HPI Port Address	B8
HPI_CLK	I	5V Tol. CMOS input	HPI Clock Input	B9
HPI_RWN	I	5V Tol. CMOS input	HPI Port Read/WriteN	B10
HPI_CSN	I	5V Tol. CMOS input	HPI Port Chip Select	A8
HPI_ASN	I	5V Tol. CMOS input	HPI Port Address Strobe Input	A10
ARM2HP_INT	O	5V Tol 3.3V TTL 2mA slew ltd output	Active-low ARM7 To Host Processor Interrupt[3]	A9
Misc				
VCODC	I	Analog Input	VCO control voltage for stand alone PLL testing	P6
REF_OUT	O	5V Tol 3.3V TTL 2mA slew ltd output	PLL REF signal at input to phase detector	J13
INF_OUT	O	5V Tol 3.3V TTL 2mA slew ltd output	PLL INF signal at input to phase detector	H13
EN_D950_EMU	I	5V Tol CMOS input	EN_D950_EMU=0; D950 core held in reset by ARM7, GPIO pin #1,2,3 and 4 are normal mode EN_D950_EMU=1; D950 core is not held in reset by ARM7, GPIO pins #1,2,3 and 4 are dedicated to the D950 emulator	P7
ARM_MODE	I	5V Tol CMOS input	ARM_MODE=0; Connects external TAP pins directly to ARM_TAP ARM_MODE=1; ARM_TAP in daisy chain configuration after MTAP (i.e. same as ALPHA configuration)	P10
GPIO_7	I/O	5V Tol CMOS input /5V Tol 3.3V TTL 2mA slew ltd output	General Purpose I/O Ports	N13
GPIO_6	I/O	5V Tol CMOS input / 5V Tol 3.3V TTL 2mA slew ltd output	General Purpose I/O Ports	P14
GPIO_5	I/O	5V Tol CMOS input / 5V Tol 3.3V TTL 2mA slew ltd output	General Purpose I/O Ports	P13

Table 2. Pad Description

Signal	I/O	Pad Type	Description	BGA
GPIO_4	I/O	5V Tol CMOS input / 5V Tol 3.3V TTL 2mA slew ltd output	General Purpose I/O Ports/ D950_IDLE	N12
GPIO_3	I/O	5V Tol CMOS input / 5V Tol 3.3V TTL 2mA slew ltd output	General Purpose I/O Ports/ D950_SNAP	P12
GPIO_2	I/O	5V Tol CMOS input /5V Tol 3.3V TTL 2mA slew ltd output	General Purpose I/O Ports/ D950_INCYCLE	N11
GPIO_1	I/O	5V Tol CMOS input / 5V Tol 3.3V TTL 2mA slew ltd output	General Purpose I/O Ports/ D950_NERQ	P11
GPIO_0	I/O	5V Tol CMOS input / 5V Tol 3.3V TTL 2mA slew ltd output	General Purpose I/O Ports/LCLK	N10
Power Supply				
VDD3_3_8	P	3.3 volt supply pad	3.3V I/O power supply	D3
VDD3_3_7	P	3.3 volt supply pad	3.3V I/O power supply	C5
VDD3_3_6	P	3.3 volt supply pad	3.3V I/O power supply	C3
VDD3_3_5	P	3.3 volt supply pad	3.3V I/O power supply	C4
VDD3_3_4	P	3.3 volt supply pad	3.3V I/O power supply	L12
VDD3_3_3	P	3.3 volt supply pad	3.3V I/O power supply	M12
VDD3_3_2	P	3.3 volt supply pad	3.3V I/O power supply	K12
VDD3_3_1	P	3.3 volt supply pad	3.3V I/O power supply	M11
VDD2_5_8	P	2.5 volt supply pad	2.5V ASIC core power supply	M3
VDD2_5_7	P	2.5 volt supply pad	2.5V ASIC core power supply	L3
VDD2_5_6	P	2.5 volt supply pad	2.5V ASIC core power supply	K3
VDD2_5_5	P	2.5 volt supply pad	2.5V ASIC core power supply	C10
VDD2_5_4	P	2.5 volt supply pad	2.5V ASIC core power supply	C11
VDD2_5_3	P	2.5 volt supply pad	2.5V ASIC core power supply	C12
VDD2_5_2	P	2.5 volt supply pad	2.5V ASIC core power supply	D12
VDD2_5_1	P	2.5 volt supply pad	2.5V ASIC core power supply	M4
VSS_20	P	common ground supply pad	Ground return for VDD3_3 and VDD2_5	C9
VSS_19	P	common ground supply pad	Ground return for VDD3_3 and VDD2_5	J3
VSS_18	P	common ground supply pad	Ground return for VDD3_3 and VDD2_5	J12
VSS_17	P	common ground supply pad	Ground return for VDD3_3 and VDD2_5	H12

Table 2. Pad Description

Signal	I/O	Pad Type	Description	BGA
VSS_16	P	common ground supply pad	Ground return for VDD3_3 and VDD2_5	M6
VSS_15	P	common ground supply pad	Ground return for VDD3_3 and VDD2_5	M5
VSS_14	P	common ground supply pad	Ground return for VDD3_3 and VDD2_5	H3
VSS_13	P	common ground supply pad	Ground return for VDD3_3 and VDD2_5	M7
VSS_12	P	common ground supply pad	Ground return for VDD3_3 and VDD2_5	G3
VSS_11	P	common ground supply pad	Ground return for VDD3_3 and VDD2_5	F3
VSS_10	P	common ground supply pad	Ground return for VDD3_3 and VDD2_5	E3
VSS_9	P	common ground supply pad	Ground return for VDD3_3 and VDD2_5	M9
VSS_8	P	common ground supply pad	Ground return for VDD3_3 and VDD2_5	C6
VSS_7	P	common ground supply pad	Ground return for VDD3_3 and VDD2_5	C7
VSS_6	P	common ground supply pad	Ground return for VDD3_3 and VDD2_5	C8
VSS_5	P	common ground supply pad	Ground return for VDD3_3 and VDD2_5	M10
VSS_4	P	common ground supply pad	Ground return for VDD3_3 and VDD2_5	E12
VSS_3	P	common ground supply pad	Ground return for VDD3_3 and VDD2_5	F12
VSS_2	P	common ground supply pad	Ground return for VDD3_3 and VDD2_5	M8
VSS_1	P	common ground supply pad	Ground return for VDD3_3 and VDD2_5	G12
VDD_PLL	P	2.5 volt supply pad	2.5V supply for PLL	G14
VSS_PLL	P	ground pad	Ground return for PLL	F13
Guard_PLL	P	ground pad	Ground Voltage reference for PLL	G13

<1> 212 MHz in PLL bypass mode
<2> This pad is configured as a pseudo open drain connection and can only pull the output low, or go high impedance
<3> Add pullup to this pin on board. This pad is configured as a pseudo open drain connection and can only pull the output low, or go high impedance

5.0 MAIN BLOCK DESCRIPTION

The following sections describe the sequence of functions performed by the chip

5.1 Network Interface and Controller (NIF)

The Network Interface and Controller block (NIF) is responsible for transferring data between the STLC1510 and the ATM network. The NIF has two interfaces to the backplane: an 8-bit Utopia Level 2 Physical Interface (U2PHY) and a clock and data serial interface (CDIF). It communicates with the rest of the STLC1510 via the Lamba Bus. Figure 3. shows a functional/data path block diagram of the NIF (this diagram does not include all glue logic between the major functional blocks). 37 external pins are required for the U2PHY and CDIF interfaces (19 for the Tx direction, 18 for Rx). Pins are shared between the two interfaces, as they will not both be active at the same time.

5.1.1 Features

- Utopia Level 2 8-bit parallel interface.
- Up to 9 ATM cells (477 bytes) of rate adaptation buffering for the Utopia Level 2 TX interface. The amount of buffering is programmable via a memory-mapped register.
- Up to 2 ATM cells (106 bytes) of rate adaptation buffering for the Utopia Level 2 RX interface. The amount of buffering is programmable via a memory-mapped register.
- ATM Transconvergance (TC) layer cell processor with 16-bit data path: performs scrambling/descrambling, HEC calculation, cell delineation with error detection (no error correction) and cell rate decoupling by idle cell insertion/detection.
- Clock and Data serial interface.
- Implemented as a hardware module on the Lamba bus with an 8-bit data interface and 16-bit control interface.
- 4 ATM cells (212 bytes) of rate adaptation buffering in each direction (TX and RX) for interfacing to the Lamba bus.
- Pads partial or runt cells (ATM cells of length less than 53 bytes) to 53 bytes in the TX direction to prevent loss of synchronization at the CPE.

5.1.2 External Interface (Pins)

The STLC1510 connects to the ATM network via 37 external pins. These are illustrated in Figure 3. Note that the pins TxClk and RxClk are bidirectional and, along with UTxData[0] and URxData[0], are shared between the CDIF and U2PHY

5.1.3 Clock and data serial Interface (CDIF)

The STLC1510 can communicate serially to an ATM network through the CDIF. Two serial data lines, one for the Tx path (CO to CPE), the other for the Rx path (CPE to CO), and two respective clocks realize the exchange of information and control signals between the STLC1510 and the network.

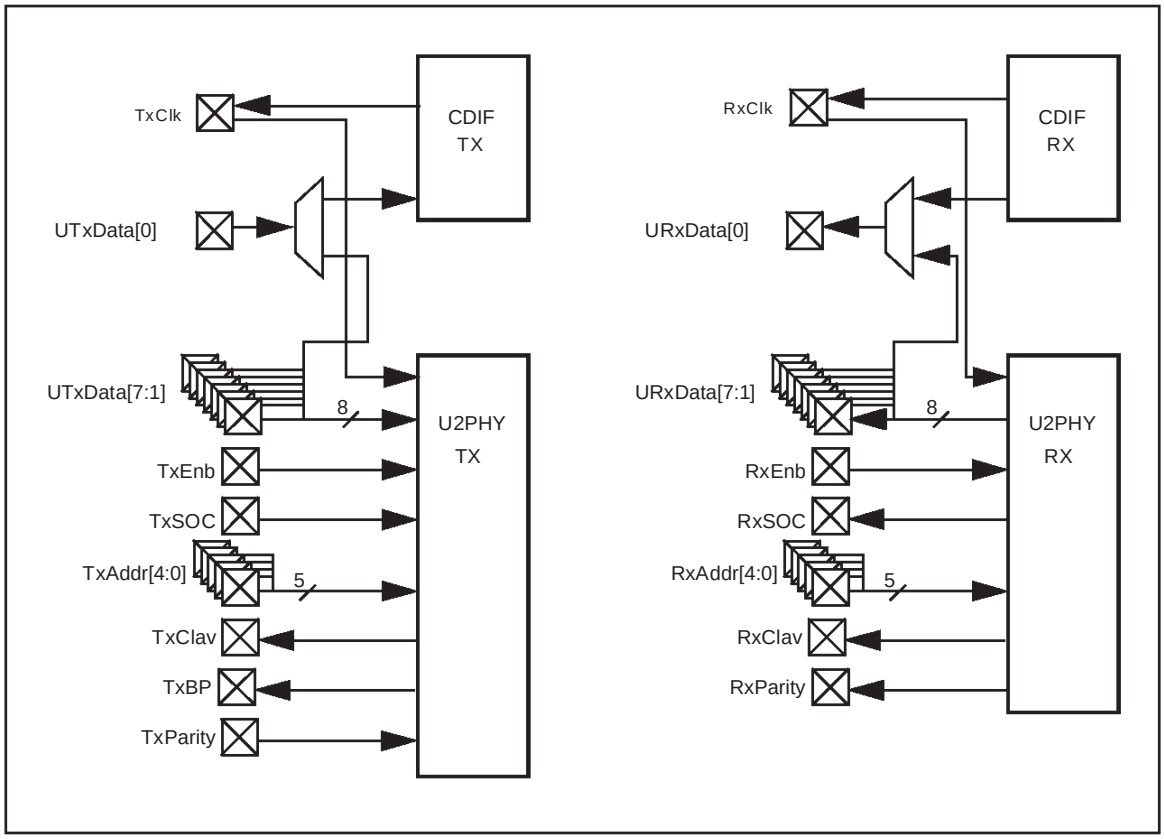
The CDIF of the STLC1510 has the following attributes:

- Synchronizes to the ATM network.
- Provides Tx and Rx clocks to the ATM network.

Transfers data between the ATM network and the STLC1510's Lamba Bus

- Accepts idle ATM cells inserted by the ATM network in the Tx direction. These idle cells are used by the ATM network to adapt to the clock provided to it by the STLC1510.
- Generates clock gapping in the Tx direction. This serves two purposes: it is a flow control mechanism to the ATM network chip, and it can be used for the byte alignment. In the byte-alignment role, a clock gap longer than a pre-set threshold indicates that the most significant bit of a byte should be transmitted on the next rising clock edge. This is useful for aligning data bytes to the overhead bits inserted by the STLC1510. In the flow control role, incoming data is not sampled when the clock is off. The threshold used to distinguish between byte alignment and flow control clock gapping is software programmable and has a range of from 0 to 65535 clock cycles (a 16 bit register stores the value).
- Generates clock gapping in the Rx direction. This serves as a flow-control mechanism; when there is no data available for transmission to the backplane, the clock is shut off, ensuring that no invalid data bits are sampled by the backplane.

Figure 3. NIF Off-Chip Signals



The following tasks are performed by the ATM network (in accordance with ITU-T Recommendation I.432.1), and therefore do not have to be implemented in the STLC1510 when using the CDIF:

- HCS generation (Tx).
- Payload scrambling (Tx).
- Optionally, enables clear channel mode, in which HCS generation and payload scrambling are disabled (Tx).
- HCS cell delineation (Rx).
- Payload descrambling (Rx).
- Idle cell filtering (Rx).
- Header error detection to recover valid ATM cells (header correction is not implemented) (Rx).
- Optionally, enables clear channel mode, in which every 53 x 8 = 424 bits are collected by the receiver and sent to the backplane (Rx).

5.1.4 UTOPIA Level 2 Interface and Controller

The Universal Test and Operations Physical Interface for ATM (UTOPIA) provides a standard that links ATM layer or various management entities with a variety of physical (PHY) layers.

The UTOPIA IF has the following features:

- provides clock decoupling mechanism.
- throttles data flow from the ATM layer.
- indicates to the ATM layer when the modem is ready to receive data.
- signals to the ATM layer the presence of valid data for transmission.
- Recognizes the address when the modem is selected for communication.
- Supports octet-level and/or cell-level handshaking.
- UTOPIA Level 2 supports a multi-PHY operation for up to n PHY devices where,
- n=< 8 at ATM layers intended for 155 Mbps;

- n=< 4 at ATM layers intended for 622 Mbps.
- This interface is subdivided into two parts: the Transmit Interface (TxIF) and the Receive Interface (RxIF).
- Both the TxIF and RxIF are controlled by the ATM layer.
- The ATM layer provides an interface clock to the PHY layer for synchronizing all interface transfers.
- The PHY layer will incorporate rate-matching buffers.
- Transmit data is transferred from the ATM layer to the PHY layer as follows: first, the PHY layer indicates it can accept data, then the ATM layer drives data onto the data bus and asserts the TxEnb.
- The data flow is controlled by the PHY layer.

For a complete definition of TxIF signals and RxIF signals please consult the UTOPIA Level 1 and UTOPIA Level 2 documents released by The ATM Forum Technical Committee.

There is an additional signal added to the Utopia Interface in the TX direction: Back Pressure (TxBP). This signal alerts the backplane when a software programmable depth has been reached in the TX Utopia FIFO, while still allowing more data (up to the 10 cells maximum) to be accepted by the FIFO.

5.1.5 ATM Transport Convergence (TC) Layer Processor

The Cell TC block has the following attributes:

- Idle cells inserted in the Tx direction for cell rate de-coupling are discarded.
- HEC bytes are generated in the Tx direction as described in ITU-T Recommendation I.432, including the recommended modulo-2 addition (XOR) of the pattern binary 01010101 to the HEC bits.
- Scrambling of the cell payload is used in the transmit direction to improve the security and robustness of the HEC cell delineation mechanism. The cell payload is descrambled by the Cell TC block of an ATU receiver.
- When interfacing ATM bytes to the bearer channel, the most significant bit (msb) is sent first.
- Cell delineation is performed using a coding law checking the HEC field in the cell header according to the algorithm described in ITU-T Recommendation I.432.
- Error detection is performed as defined in ITU-T Recommendation I.432 with the exception that any HEC error is considered a multiple-bit error. Therefore, HEC error correction is not performed.
- The ATU-C transmitter preserves V-C and T-R interface byte boundaries (explicitly present or implied by ATM cell boundaries) at the U-C interface.
- Interfaces to the Lamba bus.

5.2 FIFO

The STLC1510 incorporates 4 FIFO buffers for rate decoupling:

- Utopia TX FIFO (8 bit input from the Utopia TX interface, 16 bit output to the ATM-TC cell processor): 243 words X 16 bits/word = 486 bytes >= 9 ATM cells @ 53 bytes/cell
- Utopia RX FIFO (16 bit input from the ATM-TC cell processor, 8 bit output to the Utopia RX interface): 54 words X 16 bits/word = 108 bytes >= 2 ATM cells @ 53 bytes/cell
- Lamba TX FIFO (16 bit input from the ATM-TC cell processor, 8 bit output to the Lamba Bus): 106 words X 16 bits/word = 212 bytes >= 4 ATM cells @ 53 bytes/cell
- Lamba RX FIFO (8 bit input from the Lamba Bus, 16 bit output to the ATM-TC cell processor): 106 words X 16 bits/word = 212 bytes >= 4 ATM cells @ 53 bytes/cell
- All the FIFO's share the following features:
- Perform 8-bit to 16-bit word conversion or 16-bit to 8-bit word conversion, with storage implemented as 16-bit wide dual port RAMs.
- Flags indicating when the FIFO is full, almost full, empty, almost empty and half empty. (The FIFO depths for the almost full and almost empty flags are hard-wired).
- Diagnostic input and an error flag.
- The Utopia Tx FIFO has the following additional attributes:

- Software programmable generation of the flag TX_CLAV (CeLl AVailable, TX direction) via registers. This translates to the FIFO having a software programmable depth.
- Software programmable generation of the flag TX_BP (Back Pressure, TX direction) via registers. This allows the FIFO to throttle incoming data flow, while still accepting data that was already en route when the flag was asserted.

The Utopia Rx FIFO has the following additional attributes:

- Software programmable generation of the flag RX_CLAV (CeLl AVailable, RX direction) via registers. This translates to the FIFO having a software programmable depth.

5.3 Reed Solomon Forward Error Correction (RS-FEC)

Forward error correction is provided with byte-wise Reed Solomon (RS) Encoding and Decoding in a 256 element Galois Field.

5.3.1 Parameters

The following parameter values for S and R are supported:

- $R = 0, 4, 8, 16$
- $S = 1, 2, 4, 8, 16$

Furthermore

- R/S is integer,
- the combination $S > 1$ and $D = 1$ is allowed, while not required.
- byte wise coding over $GF(256)$,
- and hence $N_{FEC} \leq 255$.

The Reed-Solomon Code Word length is N_{FEC}, and its value results from the selection of S and R, and the number of data bytes B per Data Frame, whereby $B = 2 \ldots 48 \ldots 144$ for downstream, or $B = 1 \ldots 16 \ldots 60$ for upstream. The RS Data Word length is

$$K_{FEC} = S \cdot (B + 1)$$

and the RS Code Word length is

$$N_{FEC} = K + R$$

The code word is transmitted over S DMT symbols, and hence the number of bytes per Data Frame is

$$B' = \frac{N_{FEC}}{S} = B + 1 + \frac{R}{S}$$

The Galois Field primitive element α is defined by the zero of the primitive polynomial

$$p(x) = x^8 + x^4 + x^3 + x^2 + 1$$

The Reed-Solomon generator polynomial is

$$G(x) = \prod_{k=0}^{R-1} (x + \alpha^k)$$

The RS encoder does not introduce latency. RS decoding has a latency of at least N, whereby the upper bound of the latency is given by the actual decoder implementation.

The transmitter and receiver provide synchronization of the RS Code Words.

5.4 Bit Mapper/Demapper Module (MAP)

5.4.1 Features

- G.992.2 Compliant constellation encoder, up to 15 bits per sub-carrier capability.
- Support for 1-bit per sub-carrier modulation (BAM) and idle sub-carriers.
- Constellation encoder, Q1.15 complex fixed point output.
- Bit unpacking and packing from/to 256-byte data frame.
- Support for pilot tone insertion.
- Support for REVERB, SEGUE and MEDLEY generation.
- Support for random 4-QAM generation.
- No trellis coding.
- Implemented as a peripheral device.

5.4.2 Mapper Description

The mapper realizes the bit extraction and constellation encoding functions specified in G.922.2 (§ 7.8.1 and § 7.8.2 respectively); it is mainly intended to accelerate the main CPU in these bit manipulation operations.

The mapper consists of:

- A Bit Unpack unit, extracting a variable length bit string from the frame RAM
- A Constellation Encoder, converting the bits to a constellation point
- Pseudo -random sequence generators PRBS, & MAPPRG.

5.4.3 Demapper Description

The demapper consists of:

- A Constellation Decoder, converting the input constellation point to bits.
- A Bit Pack unit, inserting the variable length bit string into the frame RAM.

5.5 Embedded Processor Core - Functional Description

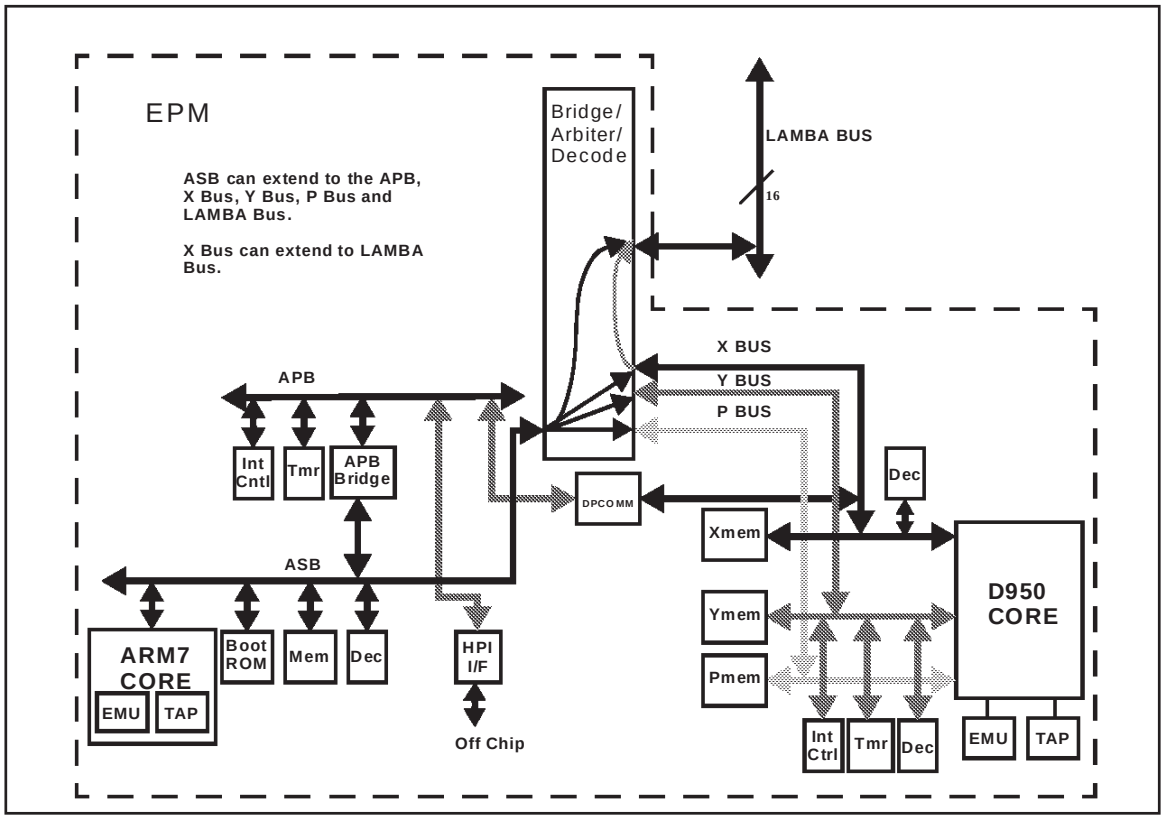
The Embedded Processor Core consists of two programmable cores; the ARM7TDMI 32-bit microprocessor and the D950 16-bit DSP, their associated peripherals/memory, a DPCOMM (Dual-Port Communications) for messaging, and a Bridge/Arbiter/ Decode (BAD) block. A block diagram of the EPM is shown below.

There are two buses locally used by the ARM7 core which are collectively known as the Advanced Microcontroller Bus Architecture (AMBA):

- Advanced System Bus (ASB)
- Advanced Peripheral Bus (APB) connected to the ASB via an APB Bridge

The LAMBA Bus, a subset of the AMBA bus specification, connects all the blocks in the data pump portion of the STLC1510.

Figure 4. EPM and LAMBA Bus Block Diagram



5.5.1 EPM Attributes

- It provides access to internal registers for control and monitoring of the various hardware blocks.
- Provides control to perform Software (SW) download into the EPM and BPU memories as part of the power up sequence.
- Provides interrupt and exception handling for various macro blocks.
- Software on the EPM preforms several DSP functions that are not implemented in the BPU during Start-up, fast re-train or Show Time.
- Address space is large enough to address the internal registers, on-chip and some off-chip memories
- Provides debugging access through a JTAG interface, for SW running on the processor.
- Provides a dual port RAM to pass messages between the D950 and ARM7 cores.
- Supports an external Host Processor Interface to pass messages to/from the ARM7
- Both cores have embedded emulator blocks for debug

5.5.2 ARM7TDMI MCU Core

The ARM7TDMI is a member of the Advanced RISC Machines (ARM) family of general purpose 32-bit microprocessors. The architecture is based on the Reduced Instruction Set Computer (RISC) principle which results in high instruction throughput and fast real-time interrupt response.

Pipelining is employed so that all parts of the processing and memory systems can operate continuously. While one instruction is being executed, the next is being decoded while the next is being fetched from memory.

Attributes:

- 32-bit register bank
- 32-bit ALU
- 32-bit shifter
- 32-bit addressing
- 32x8 DSP multiplier
- ”Thumb” architectural extension which allows generation of more memory efficient code
- Peripherals include decoders, timer and interrupt controller

5.6 D950 DSP Core

The D950 core is a 16-bit DSP based on the Harvard architecture with three bidirectional 16-bit buses, two for data and one for instruction. Each of these buses is dedicated to a unidirectional 16-bit address bus (XA/YA/IA).

The core is composed of three main units, a Data Calculation Unit (DCU), an Address Calculation Unit (ACU) and a Program Control Unit (PCU).

Attributes

- Data Calculation Unit
- Address Calculation Unit
- Program Control Unit
- 16x16 single cycle MAC
- fast and flexible buses

The D950 top level consists of a D950 core, I mem, X mem1 (8 bit), X mem2 (16 bit), Y mem, Timer, Emulator, Interrupt Controller and TAP peripherals.

5.6.1 BAD - Bridge, Arbiter, Decoder

The Bridge/Arbiter/Decoder (BAD) block controls the data traffic among the ARM7, the D950 and the data pump. It provides decoding circuitry, LAMBA bus arbitration and isolation buffers.

5.6.2 DPCOMM - Dual Port RAM Messaging between ARM and D950

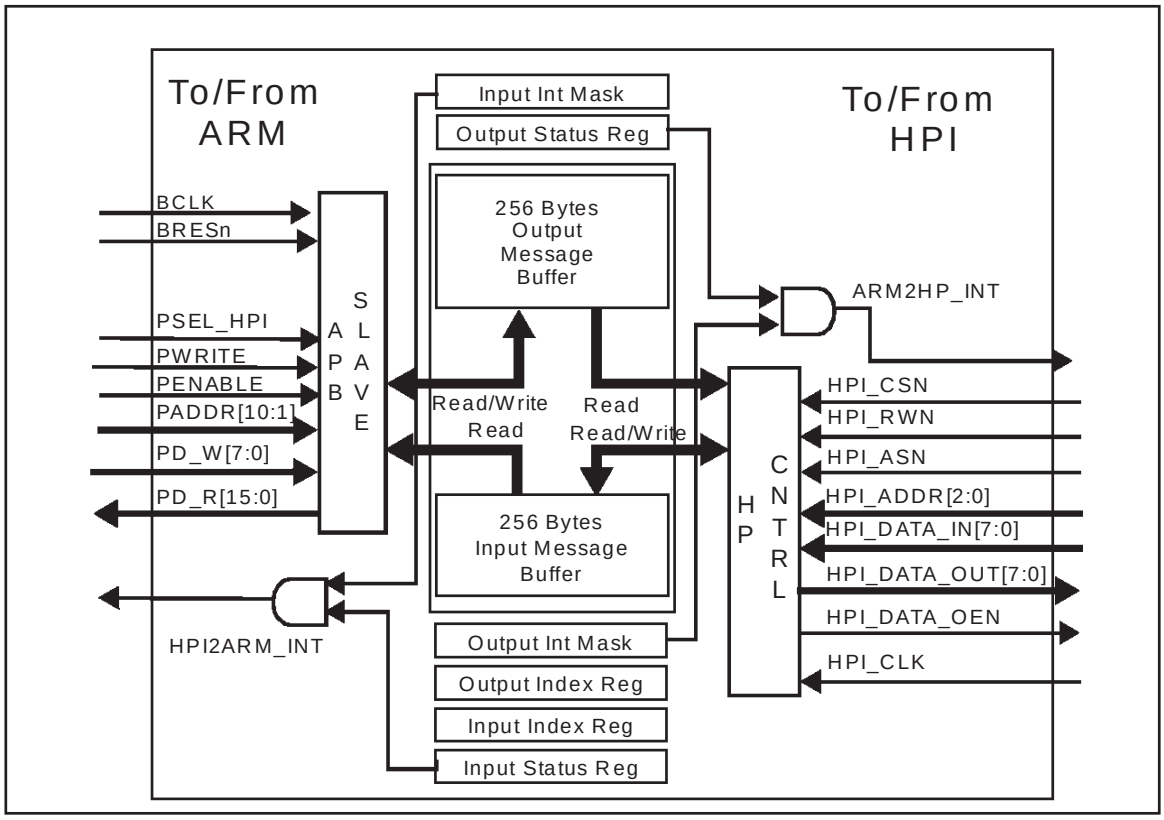
A Dual Port SRAM (1024x16) plus control registers, is connected between the APB bus of the ARM7 and the X bus of the D950. It is used as a mailbox to pass data between the ARM and the D950 DSP.

5.7 Host Processor Interface (HPI)

- The HPI resides on the APB bus of the ARM7. The chip select for the HPI is generated by the APB Bridge. Since the HPI resides on the APB, it is treated as a 16 bit entity. This means that APB Address 0 is ignored and all HPI addresses are on 16 bit boundaries. i.e. incremental address location are h0000 h0002 h0004 etc...
- The HPI is dual port SRAM based with control that generates an interrupt when a message wants to be passed. The DPSRAM is implemented on-chip.
- External to the ASIC, the pins of this interface are 8 bidirectional data pins, 3 input address pins, 1 input Read/Writen pin, 1 Address Strobe, 1 clock, 1 input chip select pin and 1 output interrupt pin.

- A status register, an index register (for the Host Processor), an interrupt mask register, and a message buffer are required for both input and output transactions.
- The Input Status Register (ISR) is set by the Host Processor by writing h01 and cleared by writing h00 to the location. It is cleared by ARM by writing anything to it.
- The Output Status Registers (OSR) is set by the ARM by writing h01 and cleared by writing h00. It is cleared by the Host Processor by writing anything to it.
- The Input and Output Index Registers (IIR & OIR respectively) are reset to their starting value by writing h00 to their respective addresses. They can also be cleared by the Host Processor by writing anything to them.
- The Input Interrupt Mask Register (IIM) resets to h00, causing the Mask to be set (active low). This means that before the ARM can receive message ready interrupts from the Host Processor, this register must be written with h0001 (by ARM) to unmask the interrupt.
- The Output Interrupt Mask Register (OIM) resets to h00, causing the Mask to be set (active low). This means that before the Host Processor can receive message ready interrupts from the ARM, this register must be written with h01 (by the Host Processor) to unmask the interrupt.
- The Input and Output Message buffers are each 256 bytes long and 1 byte wide (an overflow in the index register will not write to the other message buffer, but will start to overwrite the current message buffer).
- Addressing of the Input and Output Message Buffers by the Host Processor is implemented indirectly via the Input and Output Index Registers.
- An external interrupt signal is generated when the output status register is set by the ARM7. An ARM7 interrupt signal is generated when the input status register is set by the Host Processor.

Figure 5. HPI Block Diagram



5.7.1 Send Message from Host Processor to ARM

- Read Input Status Register. If h01, the ARM has not read out the last message. If h00, the ARM has read the last message and the Input Message Buffer is available for use.
- Clear Input Index Reg by writing any value to its address (b'100).
- Write message into Input Message Buffer by consecutively writing to its address (b'111). Each write will cause the Input Index Register to increment by 1 and access another byte location.
- Write h01 to Input Status Register (address b'011) to interrupt the ARM

5.7.2 Receive Message from ARM by Host Processor

After receiving interrupt from ARM:

- Clear Output Index Register (address b'001) by writing any value.
- Read message from Output Message Buffer by consecutively reading from its address (b'110). Each read will cause the Output Index Register to increment by 1 and access another byte location.
- Clear the Output Status Reg (address b'000) by writing any value (the ARM can clear the OSR by writing 0 to it).
- Send Message from ARM to Host Processor
- Read Output Status Register. If h0001, the HP has not read out the last message. If h0000, the HP has read the last message and the Output Message Buffer is available for use.
- Write message into Output Message Buffer. This buffer is directly addressable by the ARM.
- Write h0001 to Output Status Register to interrupt the HP

5.7.3 Receive Message from Host Processor by ARM

After receiving interrupt from HP:

- Read message from Input Message Buffer. This buffer is directly addressable by the ARM.
- Clear the Input Status Reg by writing h0001 to its address (the HP can clear the ISR by writing 0 to it).

Table 3. Signal List

Name	I/O	Internal/ External	I/F	Description
BRESn	I	Internal	APB	Active low master RESET
BCLK	I	Internal	APB	ASB clock
PSEL_HPI	I	Internal	APB	Active high block select from APB
PADDR[10:1]	I	Internal	APB	APB address [11:1]
PD_W[7:0]	I	Internal	APB	APB write data
PD_R[15:0]	O	Internal	APB	APB read data
PWRITE	I	Internal	APB	APB Write - Active high, Read - Active low
PENABLE	I	Internal	APB	APB enable signal for timing
HP2ARM_INT	O	Internal	APB	Interrupt from Host Processor to ARM
HPI_CLK	I	External	HP	Host Processor bus clock
HPI_CSN	I	External	HP	Active low select from Host Processor
HPI_ASN	I	External	HP	Address Strobe from Host Processor
HPI_RWN	I	External	HP	HP Read - Active high, Write - Active low
HPI_ADDR[2:0]	I	External	HP	Host Processor address
HPI_DATA_IN [7:0]	I	External	HP	Host Processor data in
HPI_DATA_OUT [7:0]	O	External	HP	Host Processor data out
HPI_DATA_OEN	O	External	HP	Host Processor data output enable
ARM2HP_INT	O	External	HP	Interrupt from ARM to Host Processor

Table 4. HPI Memory Map

HPI Reg	Host Processor Addr
	BIN
Output Status Reg	000
Output Index Reg	001
Output Mask Reg	010
Input Status Reg	011
Input Index Reg	100
Input Mask Reg	101
Output Message Buffer	110
Input Message Buffer	111

5.8 Block Processing Unit (BPU) Functional Description

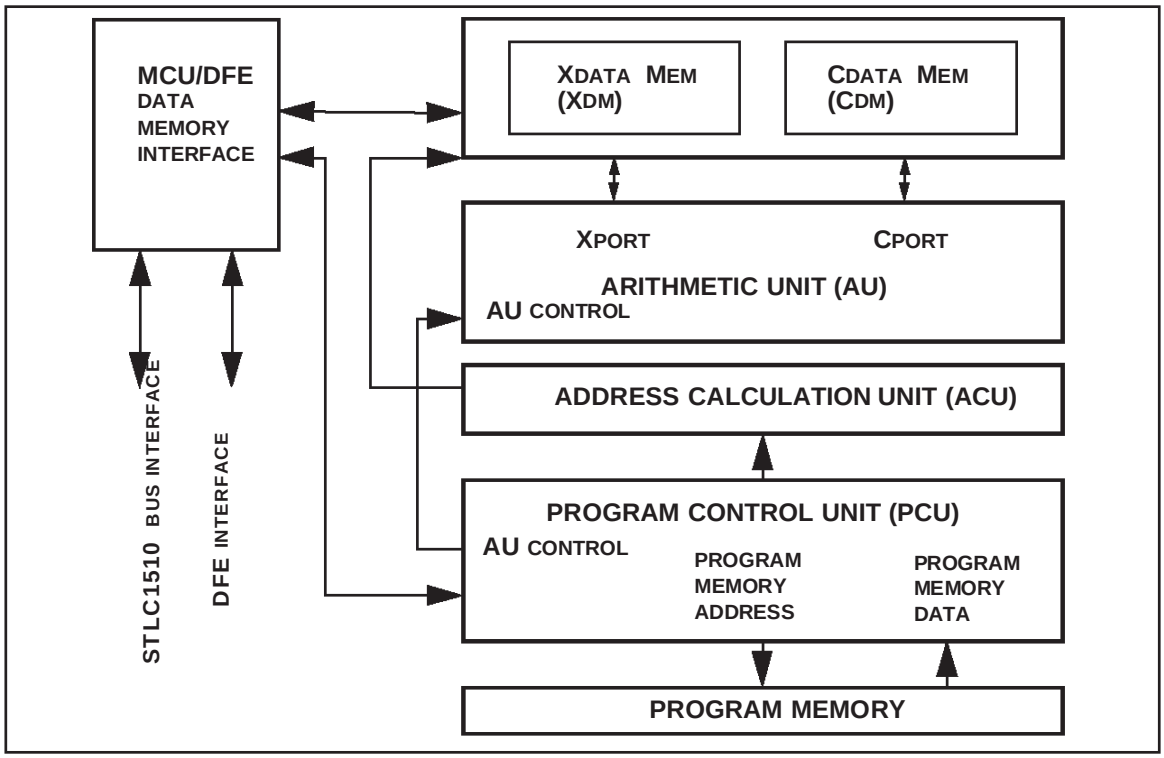
5.8.1 Block Processing Unit - Core

The BPU is a programmable Digital Signal Processor responsible for the bulk of the high rate signal processing required in the modem. This processor utilizes a dual multiply accumulate Arithmetic Unit (AU) and Very Long Instruction Word (VLIW) format to achieve high processing efficiencies.

The BPU is designed to perform the following functions:

- Finite Impulse Filters (FIR)
- (Infinite Impulse Response) IIR
- FFT/IFFT
- Compression/decompression for FFT/IFFT
- FDEQ
- Tx Gain
- SNR calculation - recursive average
- add/remove cyclic prefix
- Slicer
- Auto Correlation
- FDEQ update
- Digital AGC

Figure 6. BPU Core Block Diagram



5.9 Digital Front End (DFE)

The Digital Front End (DFE) block contains dedicated hardware to map signals between the analog interface (AFE) and the BPU.

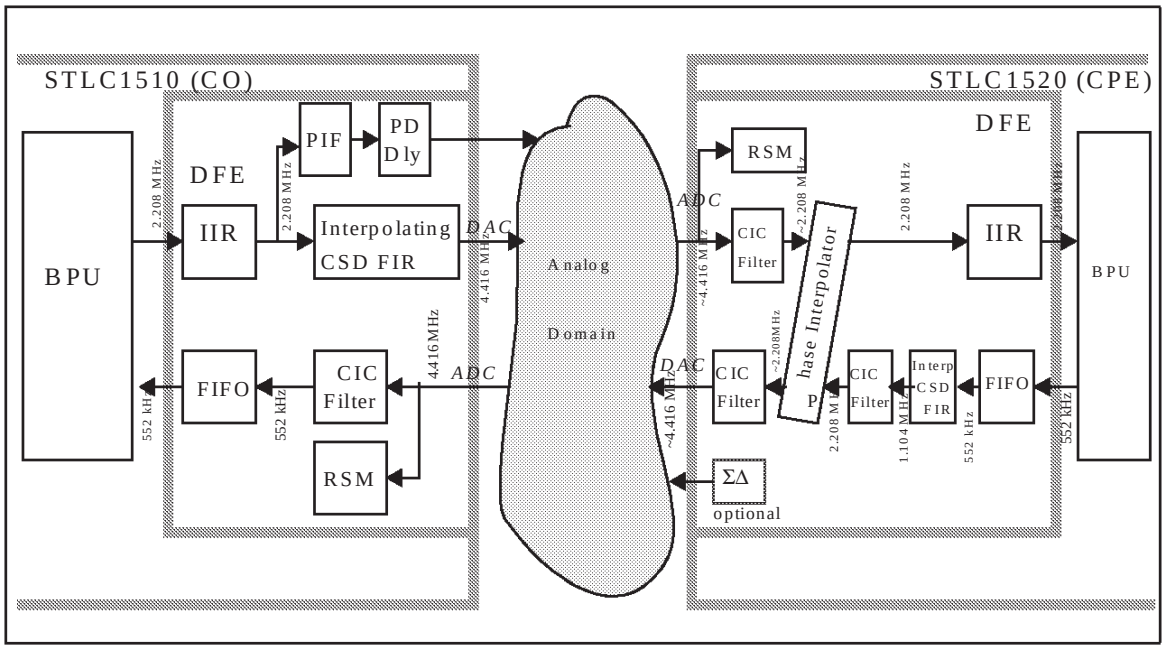
The DFE block has the following features:

- It performs part of the sampling rate conversion between the AFE sampling rate and the 2x symbol rate of the BPU.
- It provides the necessary digital hardware to implement an analog-based AGC.
- It provides the necessary buffering to provide DMT symbol alignment within the BPU.
- It provides the facilities to allow timing recovery in CPE mode. This consists of a digital phase interpolator and a digital ΣΔ D/A convertor
- Two loopback modes are provided in this block.
- Various bypass modes are provided to allow observation and isolation of any block in the DFE for test purposes.
- Interface to the LAMBA Bus.

5.9.1 Application Description

Figure 7. shows the application of the various DFE components when used in a CO (network) and CPE (remote) applications.

Figure 7. DFE Application Diagram



5.9.2 Interface Description

The registers accessible by the EPM are:

- Decimator oversampling ratio
- Decimator order.
- Various loopback and bypass modes.
- Number of bits transferred to the Aloha ASIC DAC.
- AFE control registers.
- ADC clip counter.
- RSM parameters such as time constant, peak detector thresholds, peak detector modes, integrator initialization, and detector outputs.
- IIR coefficients.
- Predictor IIR filter coefficients.
- Frame synchronization buffer length
- Timing recovery (crystal) control word.
- Timing recovery ΣΔ dither level selection.
- CO/CPE mode selection.
- Phase interpolator parameters such as alpha, frequency error and frequency error gain.
- CO peak detector parameters such as set-up and hold delays, threshold, and slew rate.

5.10 Timing Generation Block (TGB)

The timing and reset generation block generates the device's global clock and synchronization signals. It uses the input clock signal (35.328 or 17.664 MHz) to derive the main internal clock signals, as well as all synchronization pulses required to coordinate timing between the sub-blocks. It also synchronizes the external RESETN with the internal ASIC clock.

The PLL input source, and PLL bypass signals are decoded from the PMode[1:0] pins. The CMode[1:0] pins are configured to always provide an 8.8 MHz input to the PLL when the PLL is not in bypass mode. Thus a divide by 2 or 4 will be selected to divide down the 17 or 35 MHz input clock references to 8.8 MHz. When the PLL is to be bypassed, it is powered down, and the input reference is used to bypass the PLL output.

The CK35M signals are generated by dividing down the internal ASIC clock. A 3 bit memory mapped register is used to adjust the reset phase of the divide by 6 generator. This gives software control of the phase of the CK35M signal which interfaces to the AFE device. There is also a programmable "one shot" mode which is used to reset the phase of the CK35M in the event the interface cannot synchronously meet the timing requirements.

The NIFTX_CLK and NIFRX_CLK are generated when the NIF is in clock and data mode, i.e. not utopia mode.

5.10.1 RESET Structure

The RESET structure for the STLC1510 has the following requirements/attributes:

- Requires off-chip power supervisor to supply 10ms power-on reset (may also require push button reset for test) and 5ms TRSTN (TAP reset).
- Reset initialization will begin when RESETN is de-asserted by the off-chip power supervisor. After 2 rising edges of 4.4MHz clock, ASIC_RESETn is de-asserted and the STLC1510 (minus the BPU and D950 cores) will come out of reset. The ARM7 will follow its boot procedure which at some point, will download program code to the BPU and D950 cores then release them individually from reset.

5.11 Test Access Port Functional Description

The IEEE 1149.1 compliant Test Access Port (TAP) serves three purposes:

- TAP interface for both ASIC and board level testing
- RAMBIST interface for testing the embedded memories during ASIC level test.
- General Purpose I/O port for general and miscellaneous control and monitoring.

In addition to these functions, there are two sets of mode pins, **PMODE[1:0**], and **CMODE[1:0]** which are used to put the STLC1510 into various modes. The definition of these modes are given below, where the shaded rows indicate special modes not to be used in normal operations.

Table 5. Power Mode Pin Definition

PMODE[1:0]	Mode State	Description
00	Power Down Mode 0	Nothing is powered down.
01	Power Down Mode 1	ARM7 is powered down.
10	Power Down Mode 2	D950 is powered down.
11	Power Down Mode 3	BPU processor is powered down

Table 6. Clock Mode Pin Definition

CMODE[1:0]	Mode State	Description
00	Div2	Master clock is REFCLK divided by 2 and then multiplied by 24. The input REFCLK should be 17.664 MHz
01	Normal	Master clock is REFCLK divided by 4 and then multiplied by 24. The input REFCLK should be 35.328 MHz
1X	Bypass	Master clock is REFCLK

5.11.1DFT Interfaces

The STLC1510 incorporates certain features (Design for Testability, DFT) to improve the coverage of the final production test. Certain pins are dedicated to this features, and should not be used during normal operation. The Test Interface pins need to be connected as follows:

Signal	BGA	Connected to
TCK	N9	Pull-Up
TMS	N7	Pull-Up
TDI	P8	Pull-Up
TDO	N8	open
TRSTN	P9	See “RESET Structure” on page 21.

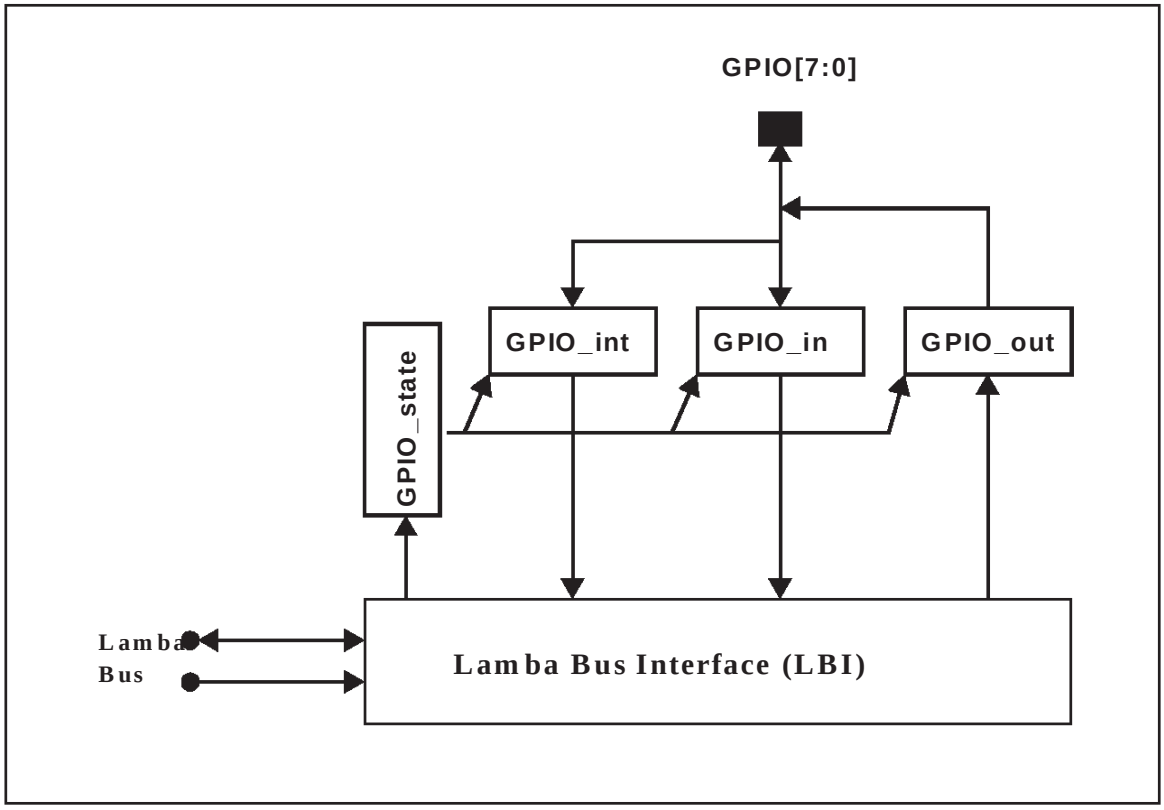
5.11.2General Purpose I/O (GPIO) Interface

The STLC1510 has a 8-bit General Purpose I/O port to allow low speed control and monitoring of external signals via the LAMBA bus. The block diagram for this interface is shown in Figure 8.

The GPIO has the following attributes:

- There are 8 GPIO pins.
- Each pin can be individually set to one of 4 modes:
  - Input mode: Input signals will be sampled with LAMBA bus clock and stored in **GPIO_in** register.
  - Output mode: The GPIO pin is driven with the state in the **GPIO_out** register.
  - Interrupt mode: The **GPIO_int** register is set when there is a negative transition detected on its corresponding GPIO pin. The logic level of each interrupt pin will as well be stored in the **GPIO_in** register. An interrupt condition on any of the GPIO pins will result in an interrupt to the D950.
  - Dedicated mode. The GPIO pin is configured to be its second function according to the Table below If the pin does not have a second function, it will be configured as an input pin.
- There is no external clock for the GPIO interface and as such no timing defined.

Figure 8. GPIO Interface Block Diagram



5.12 Processor Emulation

There are three programmable processors on the LAVA ASIC: an ARM microprocessor, a D950 Digital Signal Processor, and a custom DSP engine (BPU). All these are capable of JTAG based emulation with the following attributes:

- Stop on breakpoint.
- Single step
- Full register R/W.
- Program modification and resume.

6.0 ELECTRICAL CHARACTERISTICS

This device shall meet the functional requirements detailed herein when operated over the specified timing, electrical, and temperature range.

7.0 OPERATING RANGES

The operating ranges shall be in accordance with the following table.

Table 7. Operating Ranges

SYMBOL	PARAMETER	MIN.	NOM.	MAX.	UNITS
VDD3_3	CMOS 3.3v I/O Supply voltage	3.0	3.3	3.6	V
VDD2_5	CMOS 2.5v Core Supply voltage	2.25	2.5	2.75	V
I_{DD3}	CMOS 3.3v I/O Supply current		11		mA
I_{DDS3}	CMOS 3.3v I/O Static supply current		TBD		mA
I_{DD2}	CMOS 2.5v Core Supply current		240		mA
I_{DDS2}	CMOS 2.5v Core Static supply current		TBD		mA
T_A	Ambient temperature under bias[1]	-40	25	85	×C
T_J	Operating junction temperature	-40	25	105	×C

<1> Assuming no air flow and a package thermal resistance of 30×C/watt

7.1 DC Characteristics

The following table identifies the general DC characteristics for input and output pins.

Table 8. General Interface Electrical Characteristics

SYMBOL	PARAMETER	Conditions	Min	Typ	Max	Unit
V_{il}	Low level i/p voltage				0.8	V
V_{ih}	High level i/p voltage		2.0			V
V_{ol}	Low level o/p voltage[1]	I_{ol} = 2mA			0.4	V
V_{oh}	High level o/p voltage[a]	I_{oh} = 2mA	2.4			V
I_{il}	Low Level Input Current without pull-up device[2]	V_i=0V			1.0	µA
I_{ih}	High Level Input Current without pull-down device[b]	V_i=VD3_3 Vi=VDD5			2.0 4.0	µA µA
I_{oz}	Tri-state Output leakage without pull up/down device[b]	V_o=0V or VDD3_3			1.0	µA
I_{pu}	Pullup current	V_i = 0V		-50		µA
I_{pd}	Pulldown current	V_i = VDD5		100		µA
R_{up}	Equivalent pull-up resistance	V_i = 0V		50		kΩ
Rpd	Equivalent pull-down resistance	Vi = VDD2_5		50		kΩ

<1> Takes into account 0.075*Vdd voltage drop in both supply lines.
<2> The leakage currents are generally very small, < 1nA. The value given here, i µA, is a maximum that can occur after an Electrostatic Stress on the pin.

7.2 AC Characteristics

7.2.1 AFE Interface Timing

Figure 9. AFE Data Interface Timing (TTL)

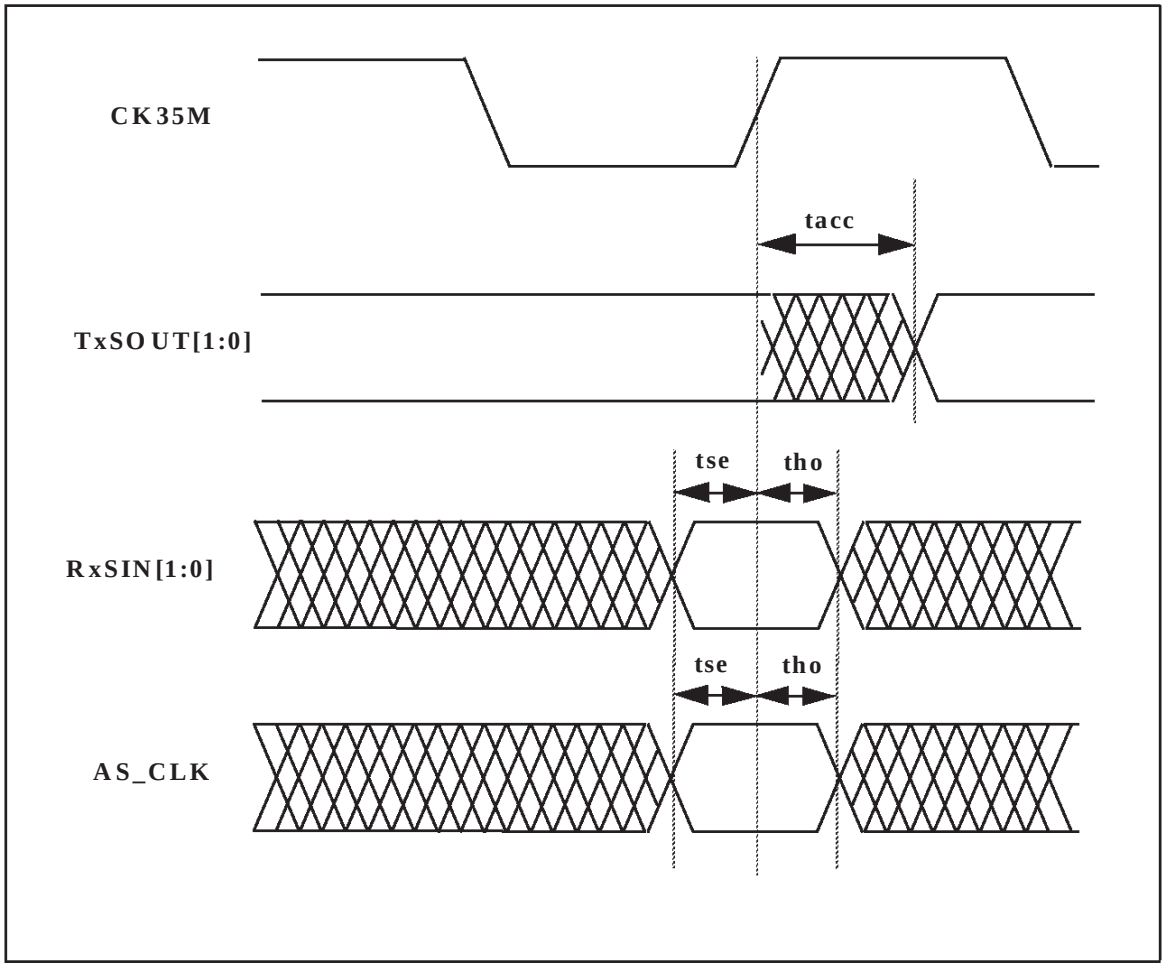


Table 9. AFE Data Interface Timing

Pin Name	Parameter	Min.	Max.	Reference Pin
TxSOUT[1:0]	tacc	0	10ns	w.r.t. rising CK35M
TxSIN[1:0]	tse	5ns		w.r.t. rising CK35M
TxSIN[1:0]	tho	5ns		w.r.t rising CK35M
AS_CLK	tse	5ns		w.r.t. rising CK35M
AS_CLK	tho	5ns		w.r.t rising CK35M

Figure 10. AFE Control Interface Timing (TTL)

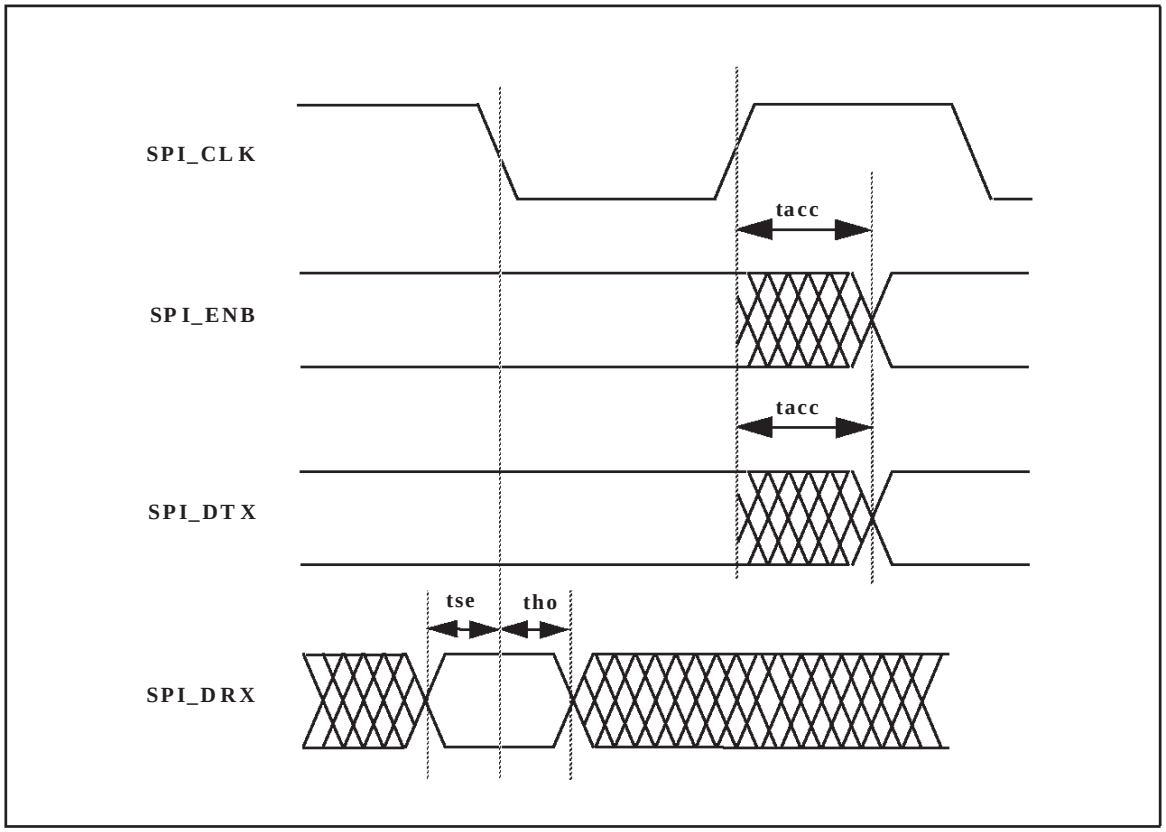


Table 10. AFE Control Interface Timing

Pin Name	Parameter	Min.	Max.	Reference Pin
SPI_ENB	tacc	0	5ns	w.r.t. rising SPI_CLK
SPI_DTX	tacc	0	5ns	w.r.t. rising SPI_CLK
SPI_DRX	tse	5ns		w.r.t. falling SPI_CLK
SPI_DRX	tho	5ns		w.r.t falling SPI_CLK

Figure 11. Line Driver Control Interface Timing (TTL)

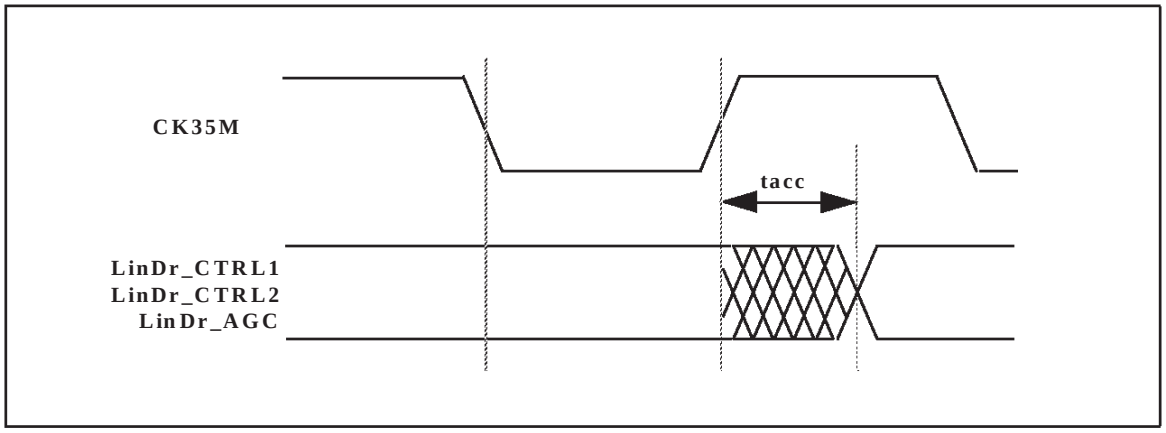


Table 11. Line Driver Control Interface Timing

Pin Name	Parameter	Min.	Max.	Reference Pin
LinDr_CTRL1	tacc	0	7ns	w.r.t. rising CK35M
LinDr_CTRL2	tacc	0	7ns	w.r.t. rising CK35M
LinDr_AGC	tacc	0	7ns	w.r.t. rising CK35M

Figure 12. Test Interface Timing (TTL)

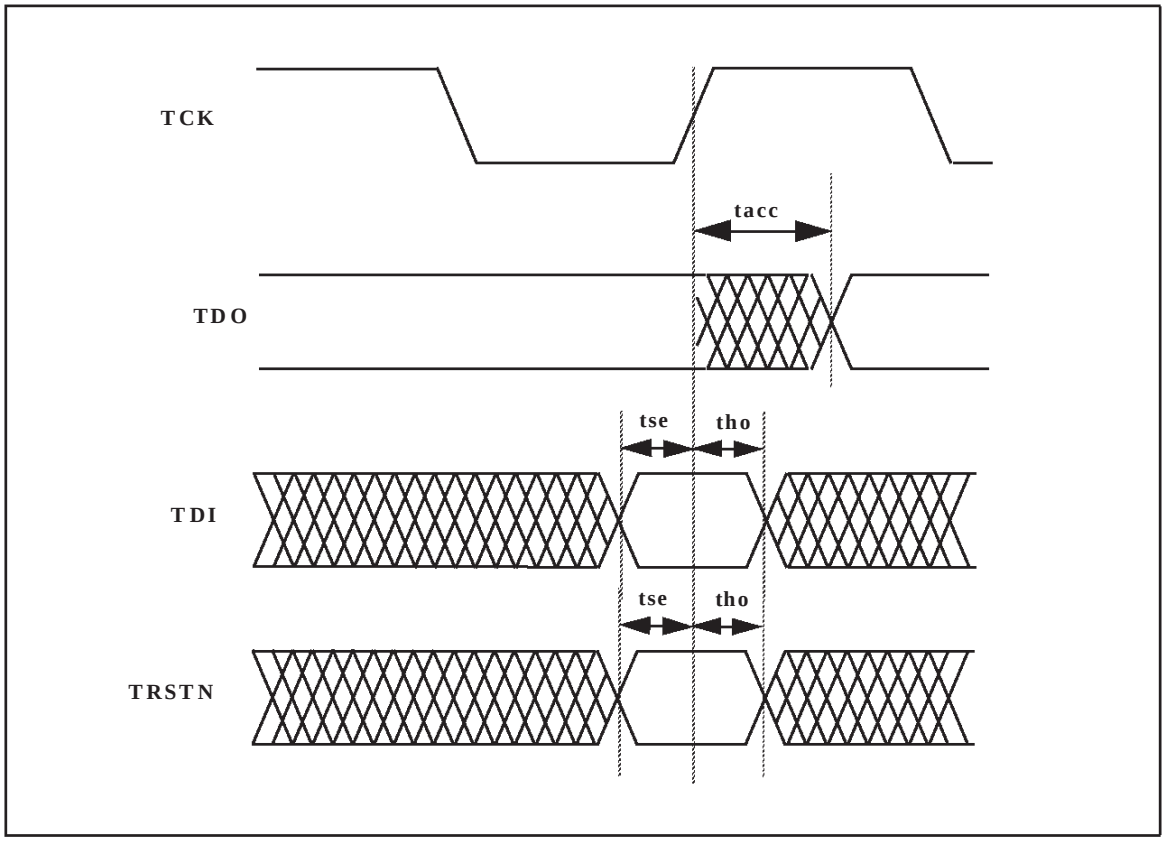


Table 12. Test Interface Timing

Pin Name	Parameter	Min.	Max.	Reference Pin
TDO	tacc	0	10ns	w.r.t. rising TCK
TDI	tse	5ns		w.r.t. rising TCK
TDI	tho	5ns		w.r.t rising TCK
TRSTN	tse	5ns		w.r.t. rising TCK
TRSTN	tho	5ns		w.r.t rising TCK

Network Interface Timing

Figure 13. UTOPIA Transmit Interface Timing

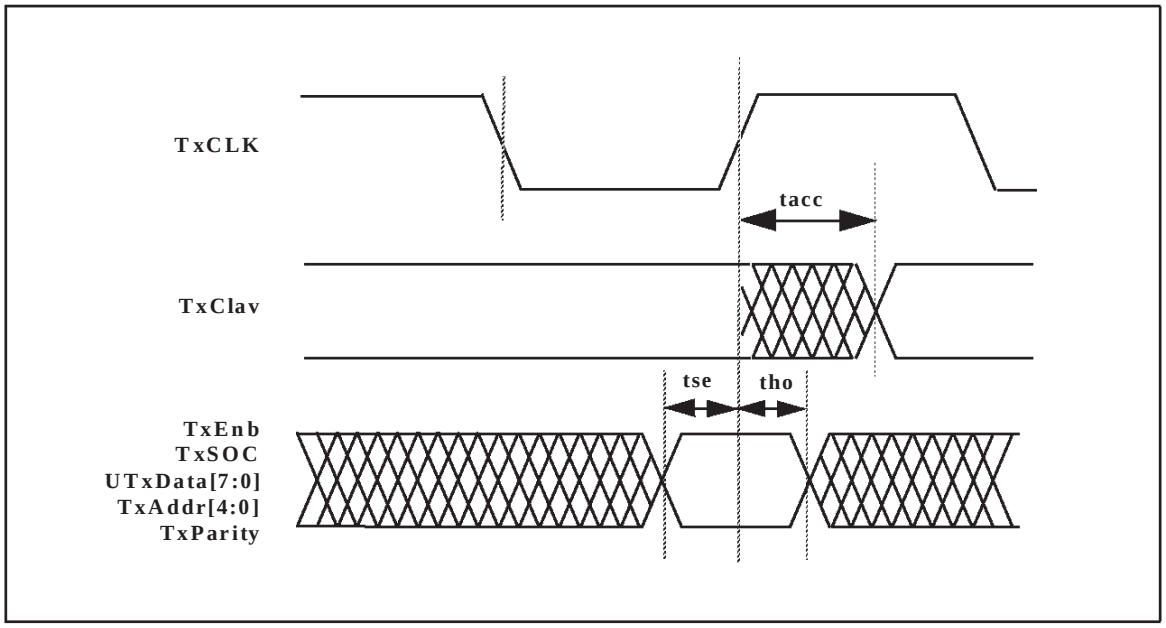


Table 13. Transmit Utopia Interface Timing

Pin Name	Parameter	Min.	Max.	Reference Pin
TxClav	tacc	0	10ns	w.r.t. rising TxClk
TxSOC	tse	5ns		w.r.t. rising TxClk
TxSOC	tho	2ns		w.r.t rising TxClk
TxEnb	tse	5ns		w.r.t. rising TxClk
TxEnb	tho	2ns		w.r.t rising TxClk
UTxData[7:0]	tse	5ns		w.r.t. rising TxClk
UTxData[7:0]	tho	2ns		w.r.t. rising TxClk
TxAddr[4:0]	tse	5ns		w.r.t. rising TxClk
TxAddr[4:0]	tho	2ns		w.r.t rising TxClk
TxParity	tse	5ns		w.r.t. rising TxClk
TxParity	tho	2ns		w.r.t rising TxClk

Figure 14. UTOPIA Receive Interface Timing

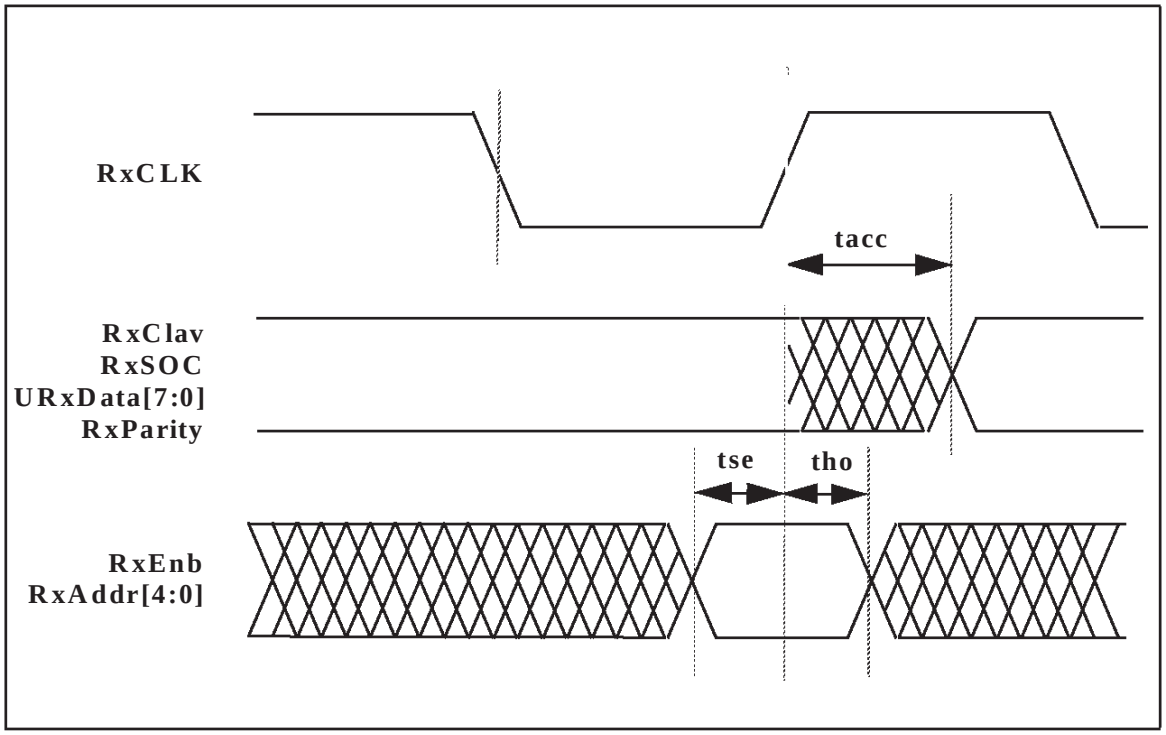


Table 14. Receive Utopia Interface Timing

Pin Name	Parameter	Min.	Max.	Reference Pin
RxClav	tacc	0	10ns	w.r.t. rising RxClk
RxEnb	tse	5ns		w.r.t. rising RxClk
RxEnb	tho	2ns		w.r.t rising RxClk
RxSOC	tacc	0	10ns	w.r.t. rising RxClk
URxData[7:0]	tacc	0	10ns	w.r.t rising RxClk
RxAddr[4:0]	tse	5ns		w.r.t. rising RxClk
RxAddr[4:0]	tho	2ns		w.r.t. rising RxClk
RxParity	tacc	5ns		w.r.t. rising RxClk

Figure 15. Serial Transmit Interface Timing

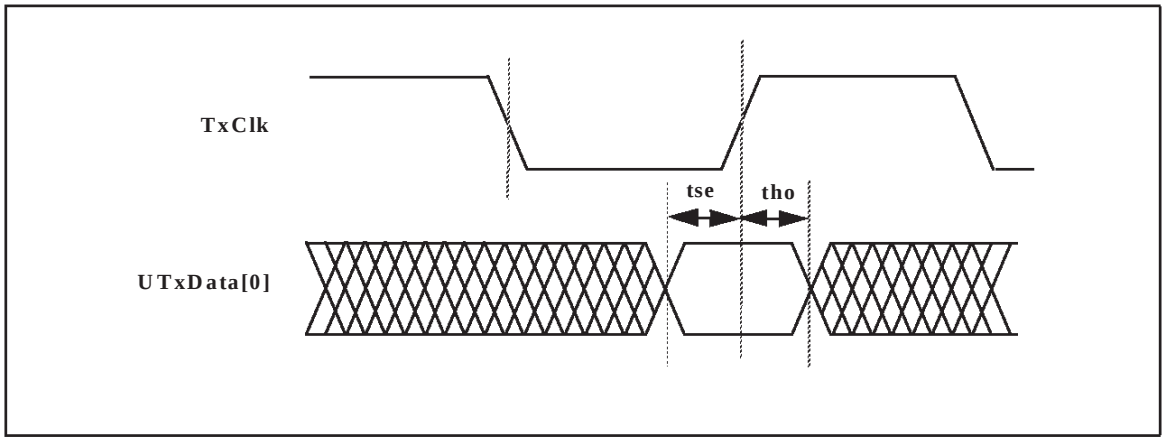


Table 15. Transmit Serial Interface Timing

Pin Name	Parameter	Min.	Max.	Reference Pin
TxClk	frequency			
UTxData[0]	tse	0ns		w.r.t. rising TxClk
UTxData[0]	tho	0ns		w.r.t. rising TxClk

Figure 16. Serial Receive Interface Timing

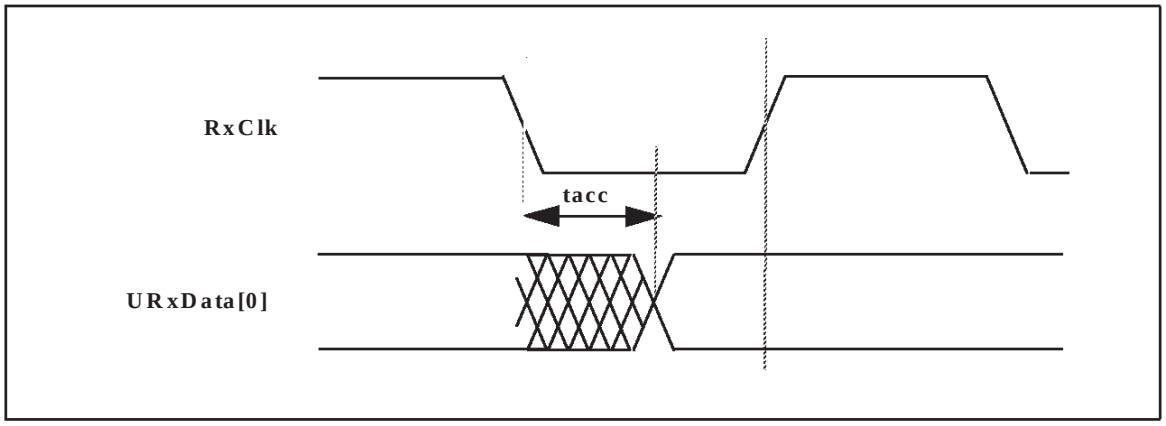


Table 16. Receive Serial Interface Timing

Pin Name	Parameter	Min.	Max.	Reference Pin
RxClk	frequency			
URxData[0]	tacc	0	3ns	w.r.t. falling RxClk

Host Processor Interface Timing

Figure 17. Host Processor Interface Timing (TTL)

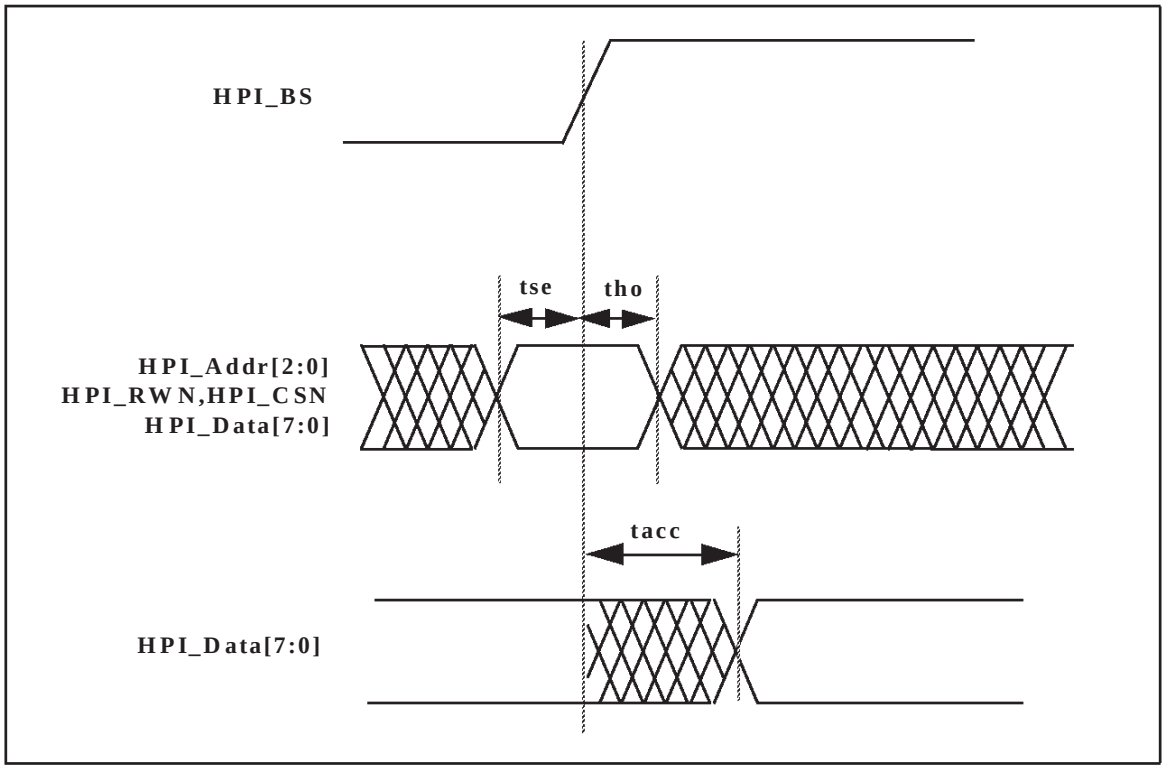


Table 17. Host Processor Interface Timing

Pin Name	Parameter	Min.	Max.	Reference Pin
HPI_Addr[2:0]	tse	2.45ns		w.r.t. rising HPI_BS
HPI_Addr[2:0]	tho	0.01ns		w.r.t. rising HPI_BS
HPI_CSN	tse	3.1ns		w.r.t. rising HPI_BS
HPI_CSN	tho	0.01ns		w.r.t. rising HPI_BS
HPI_RWN	tse	0.84ns		w.r.t. rising HPI_BS
HPI_RWN	tho	0.01ns		w.r.t. rising HPI_BS
HPI_Data[7:0]	tse	2.15ns		w.r.t. rising HPI_BS
HPI_Data[7:0]	tho	0.01ns		w.r.t. falling HPI_CSN
HPI_Data[7:0]	tacc		10ns	w.r.t. falling HPI_CSN

7.2.2 GPIO Interface Timing

The GPIO[7:0] pins are memory mapped programmable pins. These pins can be programmed as input or output providing visibility to internal chip access points, as well as an ability to latch external control signals. A special mode can be configured where the LAMBA Bus Clock is made available on a configured output pin GPIO[0]. For timing characterization, this mode should be used to exercise the GPIO[7:1] pins as both inputs and outputs. The diagram below refers to this special mode.

Figure 18. GPIO Interface Timing

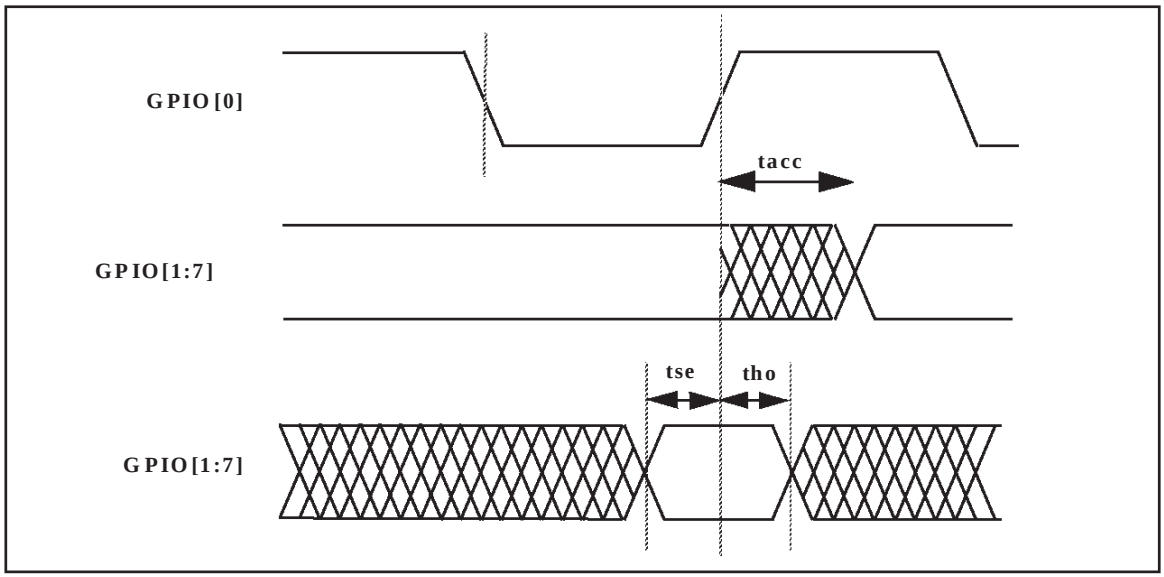


Table 18. GPIO Interface Timing

Pin Name	Parameter	Min.	Max.	Reference Pin
GPIO[1:7]	tacc	0	10ns	w.r.t. rising GPIO[0]
GPIO[1:7]	tse	5ns		w.r.t. rising GPIO[0]
GPIO[1:7]	tho	2ns		w.r.t. rising GPIO[0]

7.3 Power-up supply sequencing

There are two power supply voltages that must be applied to this chip to ensure correct functionality, (3.3V and 2.5V). The chip itself will function correctly regardless of the sequence in which the supplies are applied on power-up.

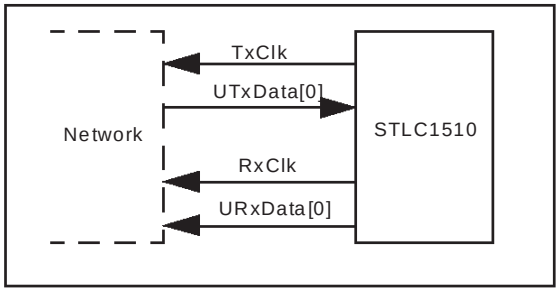
However if the 3.3V supply is off and there is external 5V activity at the IOs, the internal ESD protection circuitry will clamp the external signals at 2.8 Volts maximum (by sinking as much current as provided by the interface).

8.0 EXTERNAL INTERFACE TIMING

8.1 NIF (Network Interface) Serial Interface

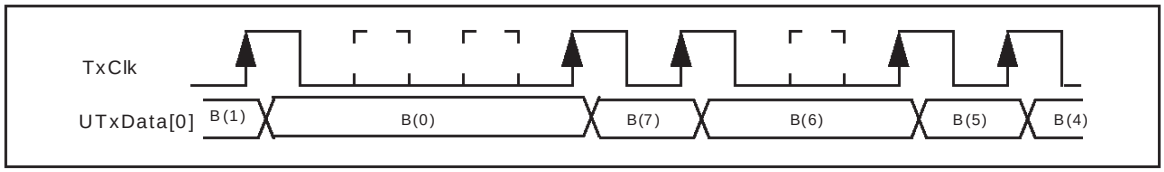
The NIF serial interface consists of separate clock and data lines in the RX and TX directions. This interface is illustrated briefly in Figure 19.

Figure 19. The NIF Serial Interface



In the Tx direction, the reception of a data byte from the network starts with the most significant bit. Bits are sampled by STLC1510 on the rising edge of TxClk. In the presence of clock gapping (which is generated by the STLC1510, as it supplies the clocks in both directions), a previous bit persists until the next rising edge of the clock. Figure 21. shows the relationship between TxClk and UTxData[0].

Figure 20. Network Serial Interface Tx Timing



In the Rx direction, the most significant bit of a data byte is transmitted to the network first, with the least significant bit transmitted last. The serial data stream is sampled by the network on the rising edge of RxClk. Samples at the gapped positions are ignored. Figure 21. illustrates the Rx timing diagram of the serial interface. Ignored samples are indicated by 'X' in the timing diagram.

Figure 21. Network Serial Interface Rx Timing

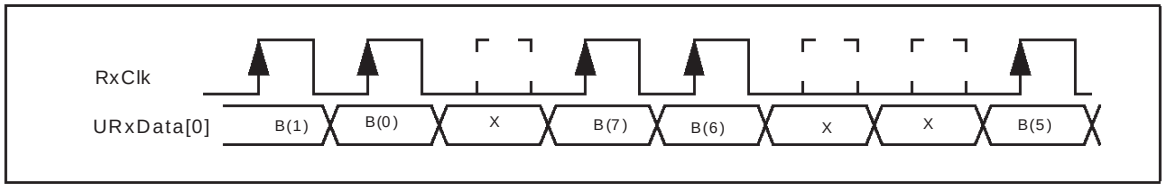
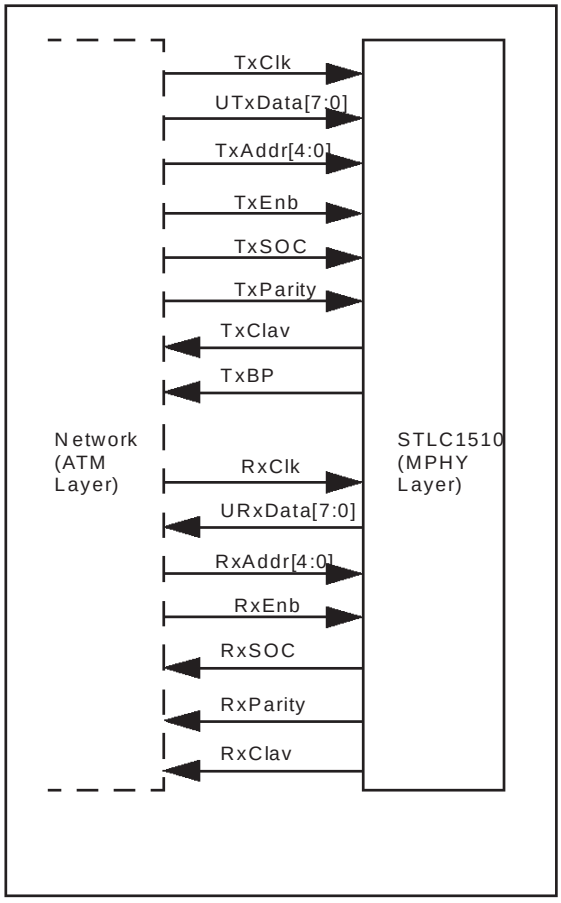


Figure 22. The NIF Utopia Level 2 Interface



8.2 UTOPIA Level 2 Interface

The Utopia Level 2 Interface is an 8-bit interface, operating independently in the TX and RX directions. The Utopia Level 2 Interface is briefly illustrated in Figure 22.

General features:

- Implemented according to The ATM Forum Technical Committee's Utopia Level 2 specification. Utopia Level 2 is an extension of Utopia Level 1 which provides for connecting multiple MPHY layer devices to a single ATM layer. Once a given MPHY layer device has been selected for data transfer according to the mechanisms specified in Utopia Level 2, the transfer itself is performed according to the mechanisms specified in Utopia Level 1.
- 8-bit data transfer in each direction (TX and RX), with a maximum clock speed of approximately 21 MHz.
- Clocks are provided by the ATM layer through the TxClk and RxClk ports. (ATM layer is the master, PHY layer is the slave)
- There are 5 address lines for each of the TX and RX interfaces. Up to 31 addresses are supported, with the 32nd address (11111) being a reserved, idle address. Single PHY operation is supported by leaving the address lines set to the address of the PHY device.
- For more information, please see the ATM

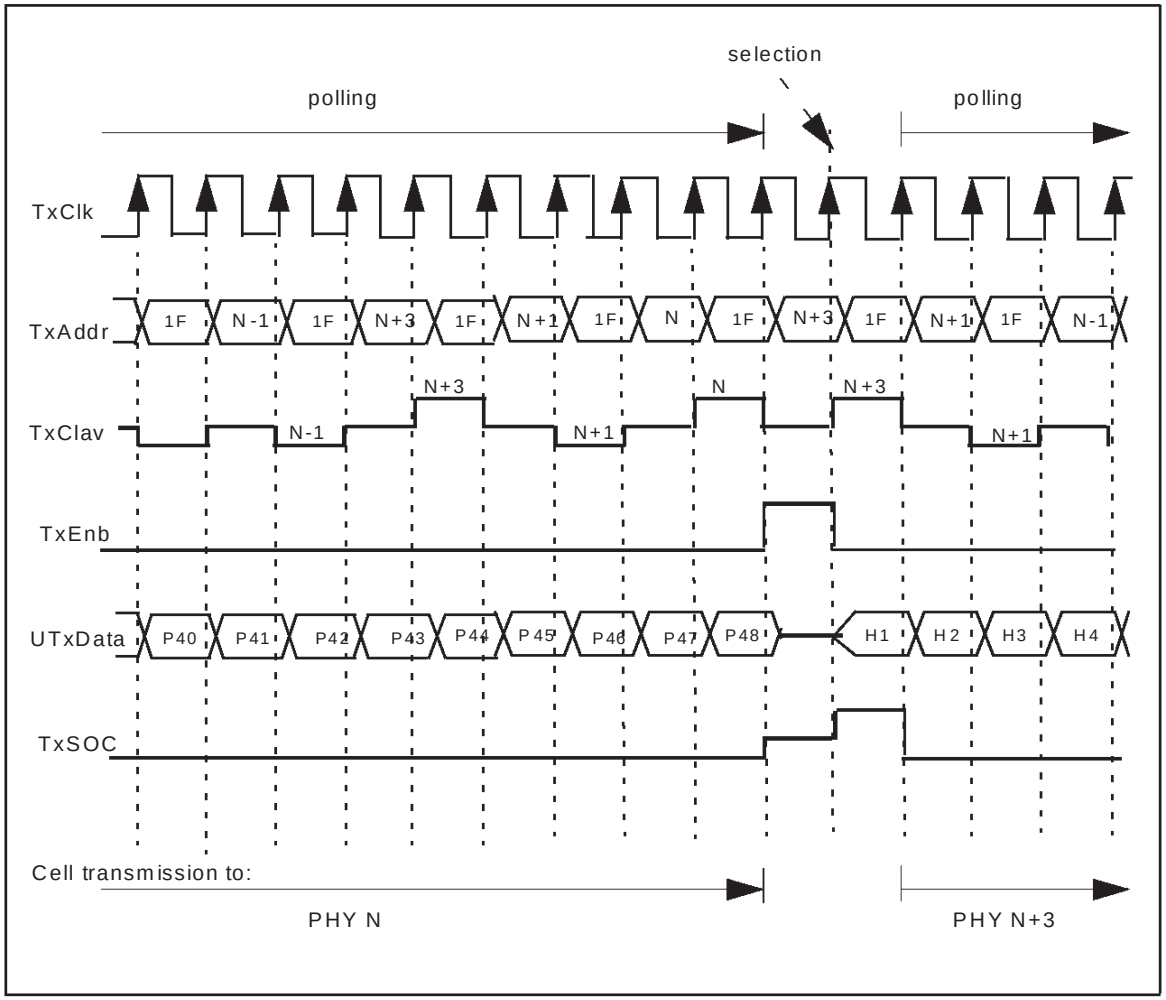
Forum Technical Committee's Utopia Level 1 and Utopia Level 2 specifications, and Chapter 7 of this document, Network Interface and Controller (NIF).

Features of MPHY Layer Cell-Level Handshake (Tx Direction):

- A single MPHY port at a time is selected for a cell transmission. However, another MPHY port may be polled for its TxClav status while the selected MPHY port transfers data. The ATM layer polls the TxClav status of a MPHY port by placing its address on TxAddr. The MPHY port (STLC1510 device) drives TxClav during each cycle following one with its address on the TxAddr lines.
- The ATM layer selects a MPHY port for transfer by placing the desired MPHY address onto TxAddr, when TxEnb is deasserted (high) during the current clock cycle, and asserted (low) during the next clock cycle. All MPHY devices only examine the value on TxAddr for selection purposes when TxEnb is deasserted (high). The MPHY port is selected starting from the cycle after its address is on the TxAddr lines, and TxEnb is deasserted (high); and ending in the cycle a new MPHY port is addressed for selection, and TxEnb is deasserted (high).

Figure 23. depicts the polling phase and the selection phase of the UTOPIA2 transmit interface. After the selection of the MPHY port, the cell transfer is executed the same way as in UTOPIA Level 1.

Figure 23. UTOPIA Level 2 transmit timing, polling phase and selection phase.



The TxBP pin is not part of the Utopia Level 2 specification, but its functionality does not interfere with the operation of the Utopia Level 2 Interface. It can be left unconnected if necessary for a given application. This signal is described in more detail in the NIF chapter of this document.

Features of MPHY Layer Cell-Level Handshake (Rx Direction):

- A single MPHY port at a time is selected for a cell transmission. However, another MPHY port may be polled for its RxClav status while the selected MPHY port transfers data. The ATM layer polls the RxClav status of a MPHY port by placing its address on RxAddr. The MPHY port (STLC1510 device) drives RxClav during each cycle following one with its address on the RxAddr lines.
- The ATM selects an MPHY port for transfer by placing the desired MPHY port address onto RxAddr, when RxEnb is deasserted (high) during the current clock cycle and asserted (low) during the following clock cycle. All MPHY devices examine the value on RxAddr for selection purposes when RxEnb is deasserted (high). The MPHY port is selected starting from the cycle after its address is on the RxAddr lines, and RxEnb is deasserted (low); and ending in the cycle a new MPHY port is addressed for selection, and RxEnb is deasserted (high).

Figure 24. illustrates the timing diagram of the receive interface when a cell is received from PHY N and the other PHYs are polled.

Figure 24. UTOPIA Level 2 receive timing, polling phase and selection phase.

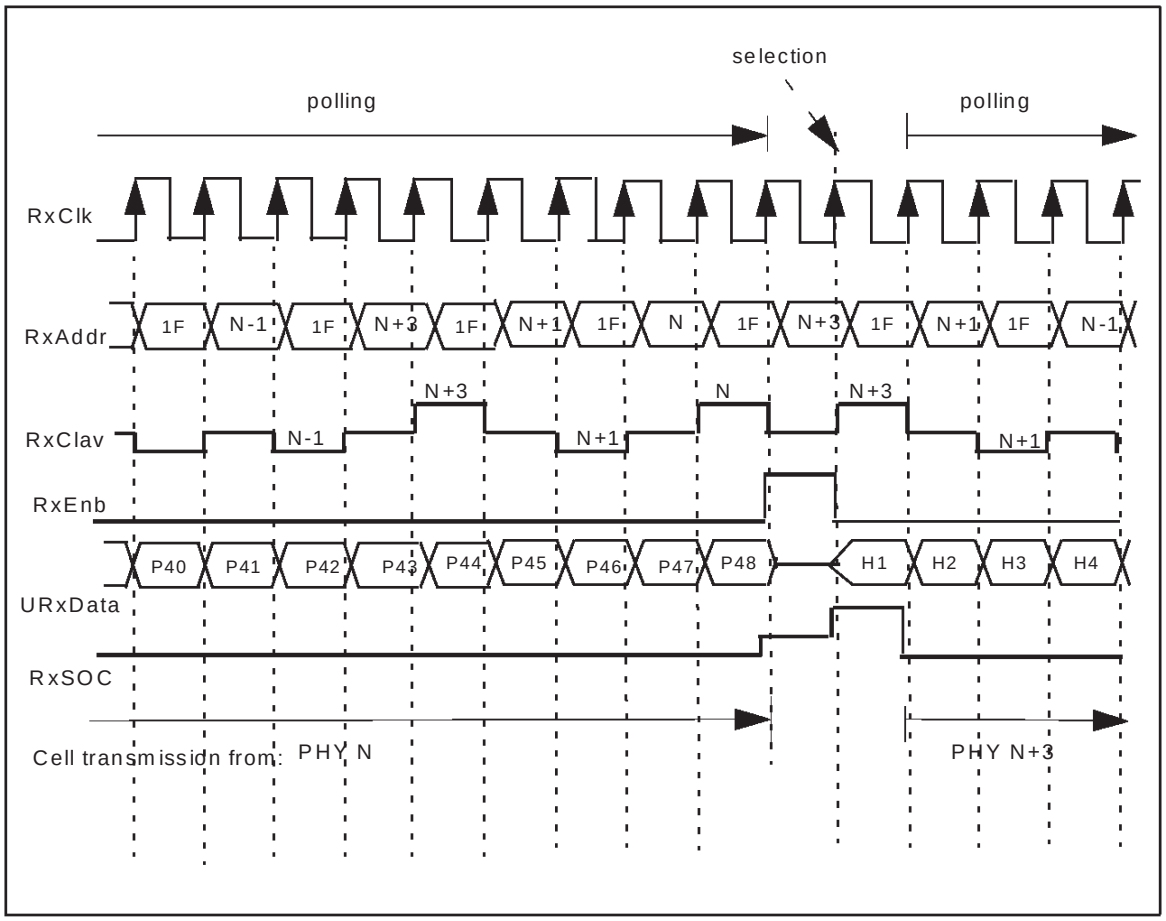
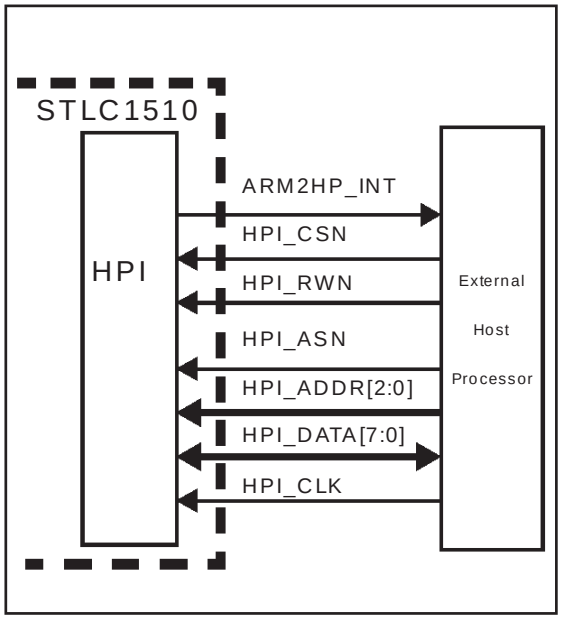


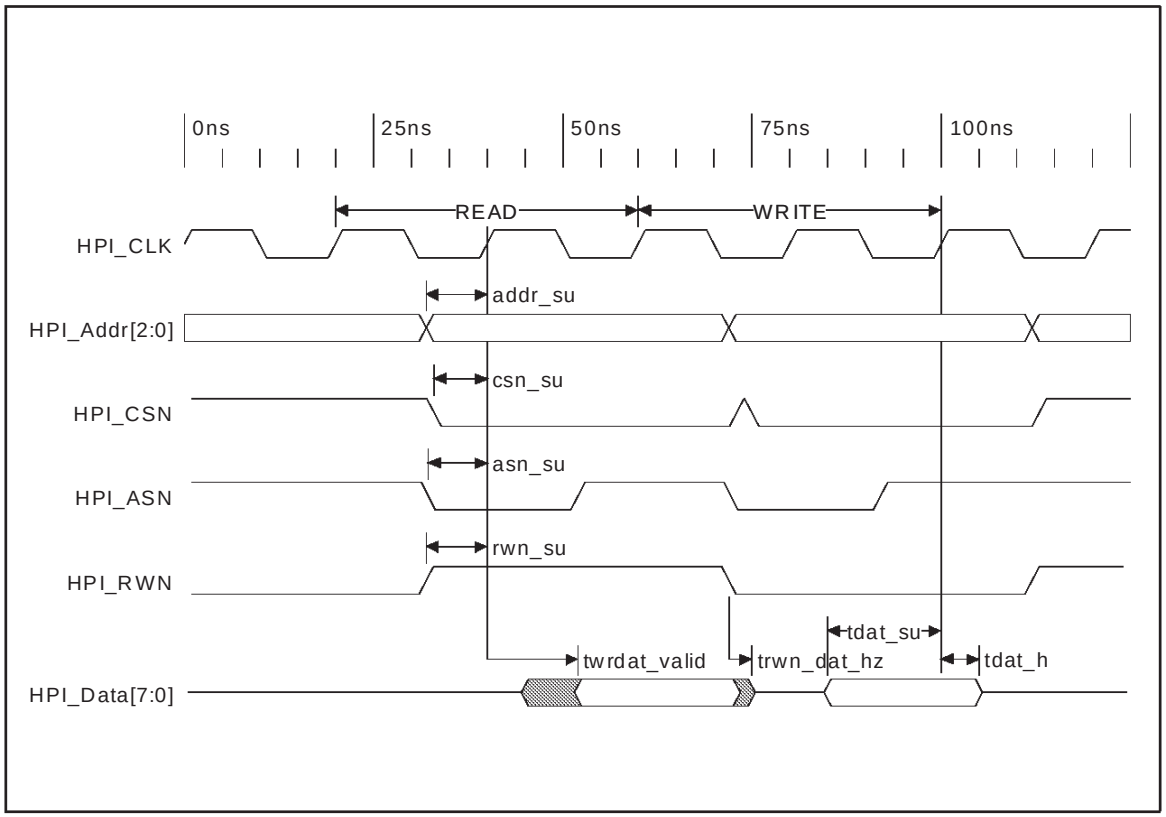
Figure 25. HPI Block Diagram



8.3 Host Processor Interface (HPI)

A host processor interface is provided to allow the STLC1510 to be controlled by an external microcontroller. The design has been optimized for the Motorola MPC850. More details are provided in the EPM section of this document.

Figure 26. Host Processor Interface Timing Diagram



8.4 AFE Interface

The interface to the companion Analog Front-end device (STLC1511) operates at a rate of 35.328MHz. It consists of two types:

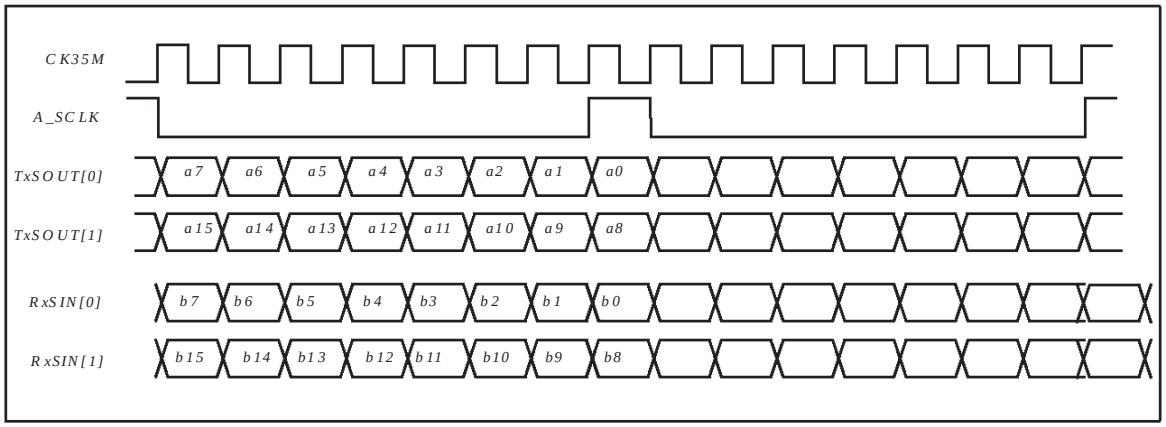
- A serial signal interface for transferring DAC and ADC samples to and from the Aloha ASIC ASIC.
- A serial control interface for Aloha ASIC.

The serial signal interface to the Aloha ASIC provides for transport of transmit and receive data between the LAVA ASIC and Aloha ASIC. This is accomplished with a two bit wide data stream in each direction plus the appropriate clocks. Refer to Figure 27. for the timing diagram of this interface.

The serial signal interface consists of six pins:

- A 35.328MHz continuous clock output (**CK35M**);
- A dual serial pin input pin for ADC samples (**RxSIN**);
    - It can carry up to 16 bits. The exact number of bits carried is programmable between 12 and 16. Refer to the AFE interface definition for details.
- A dual serial pin output pin for DAC samples (**TxSOUT**);
- It can carry up to 16 bits. The exact number of bits carried is programmable between 14 and 16. Refer to the AFE interface definition for details
- An ADC and DAC sample clock input (**A_SCLK**).
- For TX and RX interface, data is sent on positive edge of clock and sampled by the receiver on the negative edge of the clock.

Figure 27. AFE ADC/DAC Sample Serial Interface Timing Diagram



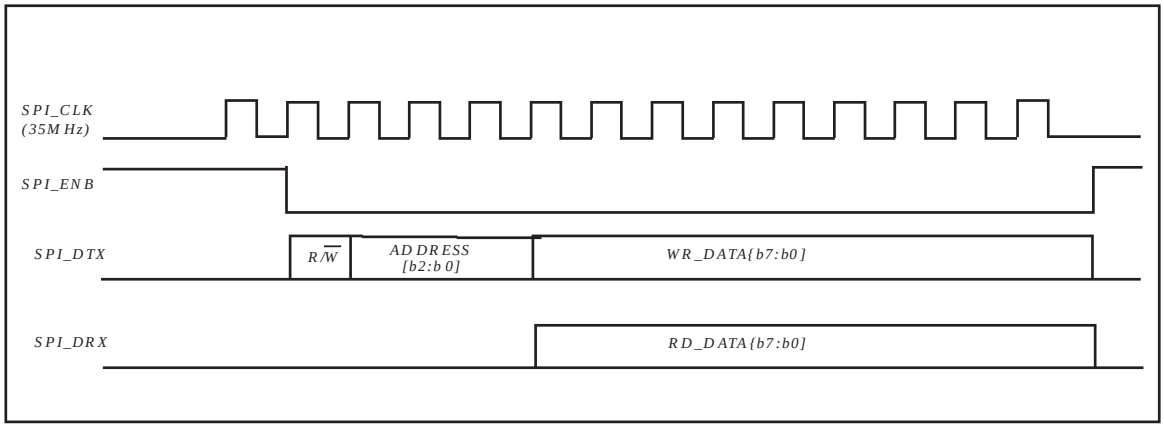
The serial control I/F consists of 4 pins:

- SPI_CLK: a gated 35.328MHz clock. *It is only present during digital I/F read/write cycles and is inactive otherwise.*
- SPI_ENB: an active low enable pin which allows selection between different AFEs if required.
- SPI_DTX: an output data pin which is used to send control information to the AFE ASIC.
- SPI_DRX: an input data pin which is used receive control information from the AFE ASIC. It is enabled only when $R/\overline{W}$ is low.

The format for the serial interface is given below:

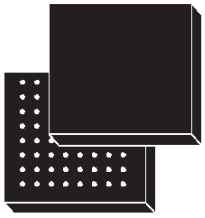
- $R/\overline{W}$ - determines the access mode for the register *address[b1:b0]*.
- *ADDR[b2:b0]* - identifies the control register accessed. These registers will correspond to the mapping in the LAVA ASIC.
- *WR_DATA[b7:b0]* - the control data written to the AFE ASIC.

Figure 28. AFE Control Interface Timing Diagram



DIM.	mm			inch		
	MIN.	TYP.	MAX.	MIN.	TYP.	MAX.
A	1.210		1.700	0.047		0.067
A1	0.270			0.010		
A2		1.120			0.044	
b	0.450	0.500	0.550	0.018	0.02	0.021
D	11.75	12.00	12.15	0.462	0.472	0.478
D1		10.40			0.409	
E	11.75	12.00	12.15	0.462	0.472	0.478
E1		10.40			0.409	
e	0.720	0.800	0.880	0.028	0.031	0.034
f	0.650	0.800	0.950	0.025	0.031	0.037
ddd			0.120			0.004

OUTLINE AND MECHANICAL DATA



Body: 12 x 12 x 1.7mm

LFBGA132