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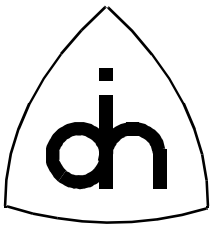

Technical Description for Arni-PCI

Doc. No. 1111-1-HAA-1008-1

Rev. 1.0-P2

March 28, 2001

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1. Abstract

This document provides a technical description of Odin TeleSystems' Arni-16-PCI and Arni-32-PCI adapter cards (referred to as Arni-PCI cards). This presentation is targeted to systems integrators and application developers who are developing telecommunications systems and/or software applications using the Arni-PCI platform. The purpose of this document is to provide the needed information about the hardware to allow software developers to efficiently integrate Arni-PCI into their overall system under design.

For information on how to develop host applications utilizing the OTX Hardware Device Driver Application Programming Interface (API), please refer to the "*Programmer's Guide for OTX Hardware API"* document (Odin TeleSystems Inc. document number 1411-1-SAA-1006-1). For help on how to install the Arni-PCI card and the OTX Device Driver Software, please refer to the "*Installation Guide for OTX PCI Adapters"* (Odin document number 1512-1-HCA-1001-1).

2. Table of Content

3. Introduction to Arni-PCI

Arni-PCI is a high-density analog phone/fax/modem interface card. The Arni-PCI card allows Personal Computers (PCs) and other systems with a PCI bus to be interfaced with a high number of analog POTS (Plain Old Telephone Service) lines. The Arni card is a station card, i.e. it can simulate phone terminals. For a line card, i.e. a card that can a simulate a telephone exchange and drive phones, please refer to Odin's Sif adapter (HAA-1030-1).

The base of Arni-PCI is 16-access network interface card, Arni-16-PCI (Odin Product Number HAA-1031-1). The 16-access base board can be extended with a daughter module (Arni-16-EXT, Odin module number HMA-1046-1) to support 32 line interfaces. The 16-access NIC board together with the 16-access module comprise the full Arni-32-PCI (Odin Product Number HAA-1008-1).

Arni-PCI is a member of the Odin Telecom frameworX (OTX) product family. Arni-PCI is supported by the OTX device driver and by the OTX Hardware Application Programming Interface (API). Equipped with the OTX DSP Modules, Arni-PCI can be utilized in a variety of phone, modem, and fax applications.

Arni-PCI supports 32 full duplex analog phone interfaces for the Plain Old Telephones Service (POTS). Throughout the document the POTS interfaces are referred to as Line Interfaces (LIs). The electrical interface parameters, such as DC characteristics, receive/transmit levels, transhybrid balancing, and terminating impedance, are software controllable. Thus Arni-PCI supports all the major PTT standards worldwide.

The Arni-PCI provides H.100 Computer Telephony Bus. The H.100 bus comprises of thirty-two (32) 2, 4, or 8 Mbit/s Time-Division Multiplexed (TDM) highways for board-to-board communication. On the Arni-PCI board the H.100 highways are connected to a non-blocking time-space switch. The time-space switch allows 256 time-slots to be switched between H.100 highways and the local highways. 1024 time-slots can be switched locally between on-board devices. The H.100 bus is backwards compatible with the MVIP bus.

The Arni-PCI board also contains an OTX Application Specific Module (ASM) socket. The ASM interface can be used to add daughter boards providing additional resources. For example, Arni-PCI can be augmented with Vidar-5x4-ASM providing 4 TI TMS320C548 Digital Signal Processors (DSPs). By loading and running different programs in these DSPs, the Arni-PCI adapter can support a variety of different telecom functions, such as tone detection and generation, voice encoding and decoding, fax and modem emulation, etc.

Finally, Arni-PCI contains four (4) codecs. The codecs perform Analog-to-Digital (A/D) and Digital-to-Analog (D/A) conversions. Both the A-law and the u-law are supported. The codecs can be switched to any time-slots on the board. Standard handsets can be connected to the codecs to provide phone functionality.

4. Specifications

Arni-PCI is a full-length PCI board. The physical dimensions of Arni-PCI are shown in Figure 1.

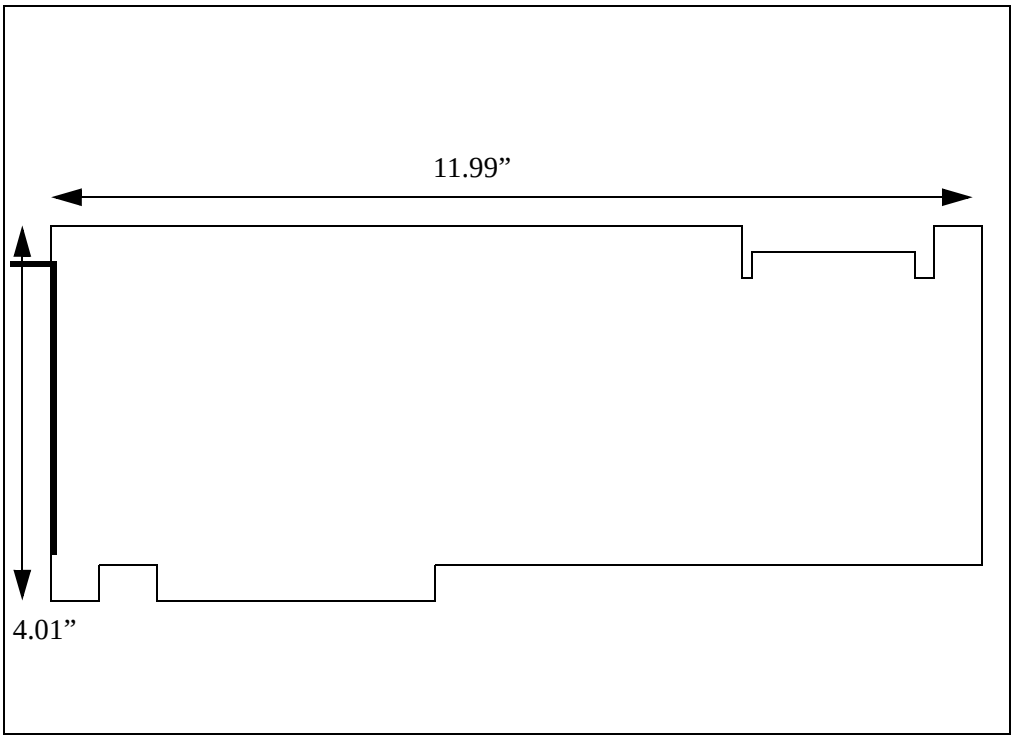

Figure 1. Arni-PCI Physical Dimensions (inches).

The Arni-PCI operates with +5.0 V supply voltage.

5. Supported Driver Devices

5.1 Physical Devices

The Arni-PCI supports the following physical API driver devices:

TABLE 1. OTX Physical Driver Devices supported by Arni-PCI

Host Device	Device Type	Max #	Description
0	*OTX_DEVICE_ARNI_PCI*	1	Board Device
OTX_DEVICE_ARNI_PCI	*OTX_DEVICE_LI_CONTROLLER*	2 or 4	POTS Line Interface Controller for 8 LIs
OTX_DEVICE_LI_CONTROLLER	*OTX_DEVICE_LI_POTS*	8	POTS Line Interface Devices
OTX_DEVICE_ARNI_PCI	*OTX_DEVICE_TSS*	1	Time-Space Switch
OTX_DEVICE_ARNI_PCI	*OTX_DEVICE_CODEC*	4	Codec performing A/D and D/A conversions for analog front ends.
OTX_DEVICE_ARNI_PCI	*OTX_DEVICE_VIDAR_5x_ASM*	1	Vidar-5x4-ASM Daughter Board (OPTIONAL)

5.2 Logical Devices

The Arni-PCI supports the following logical API driver devices:

TABLE 2. OTX Logical Driver Devices supported by Arni-PCI

Host Device	Device Type	Max #	Description
OTX_DEVICE_LI_POTS	*OTX_LDEVICE_TONE_DTMF_DIALER*	1	Logical Device for dialing DTMF Digits

In addition, DSPs on an ASM board can be loaded with various program packages to provide support for a variety of Logical Devices types. For example, the Signal Processing Package One (OtxSpm1) for Vidar-5x4-ASM provides support for the following API logical devices:

- *OTX_LDEVICE_TONE_EFFECTS_GENERATOR*
- *OTX_LDEVICE_TONE_SINEWAVE_GENERATOR*
- *OTX_LDEVICE_TONE_DTMF_GENERATOR*
- *OTX_LDEVICE_TONE_DTMF_DIALER*
- *OTX_LDEVICE_TONE_SILENCE_DETECTOR*
- *OTX_LDEVICE_TONE_DTMF_DETECTOR*
- *OTX_LDEVICE_TONE_DIAL_DETECTOR*
- *OTX_LDEVICE_TONE_FSK_DETECTOR*
- *OTX_LDEVICE_DATA_CONVERTER*

Additional OTX DSP packages will be offered for:

- *OTX_LDEVICE_MODEM_V34_SENDER*
- *OTX_LDEVICE_MODEM_V34_RECEIVER*
- *OTX_LDEVICE_MODEM_V90_SENDER*
- *OTX_LDEVICE_MODEM_V90_RECEIVER*
- *OTX_LDEVICE_FAX_V17_SENDER*
- *OTX_LDEVICE_FAX_V17_RECEIVER*
- *OTX_LDEVICE_VOICE_ECHO_CANCELLER*
- *OTX_LDEVICE_VOICE_SILENCE_SUPRESSOR*
- *OTX_LDEVICE_VOICE_CODEC_G723_ENCODER*
- *OTX_LDEVICE_VOICE_CODEC_G723_DECODER*
- *OTX_LDEVICE_VOICE_CODEC_G729_ENCODER*
- *OTX_LDEVICE_VOICE_CODEC_G729_DECODER*

For mode information on the physical and logical driver devices, please refer to *Programmer's Guide for OTX Hardware Driver* (Odin document # 1412-1-SAA-1006-1).

6. System Architecture

The overall system architecture can be best described and understood through different architectural views or aspects. This document explores the systems architecture from the following angles:

1. **External Interface View:** The external interface view describes the external interfaces of the adapter board, and how they are connected to the various internal devices and modules.

2. **Data Architecture View:** The data architecture view illustrates how the Time - Division Multiplexed (TDM) serial data is connected and transferred through the board.

3. **Control Architecture View:** The control architecture view describes how the internal devices and modules can be controlled by the host processor.

4. **Clock Architecture View:** The clock architecture view specifies what clocking and synchronization options are available, how clocking is derived, and how it distributed to the various devices.

5. **Logical Subsystem View:** The logical subsystem view describes the logical design subsystems in the system. Each subsystem can comprise hardware, firmware and driver or on-board processor software.

It is important to note that one device within the board can be involved in several of these views, each view describing how one aspect of the device interfaces with other devices.

6.1 External Interfaces

The Arni-PCI contains the following external interfaces:

- PCI Host Bus
- H.100 Computer Telephony Bus
- Centronics Network Interface with
  - 32 Tip and Ring POTS Line Interfaces
  - 4 Interfaces for Handsets
- Socket for Arni-16-Ext Extension board, which will convert Arni-16-PCI into Arni-32-PCI
- OTX ASM Socket
- JTAG Port for DSP Control

The external interfaces of the Arni-PCI card are illustrated in Figure 2.

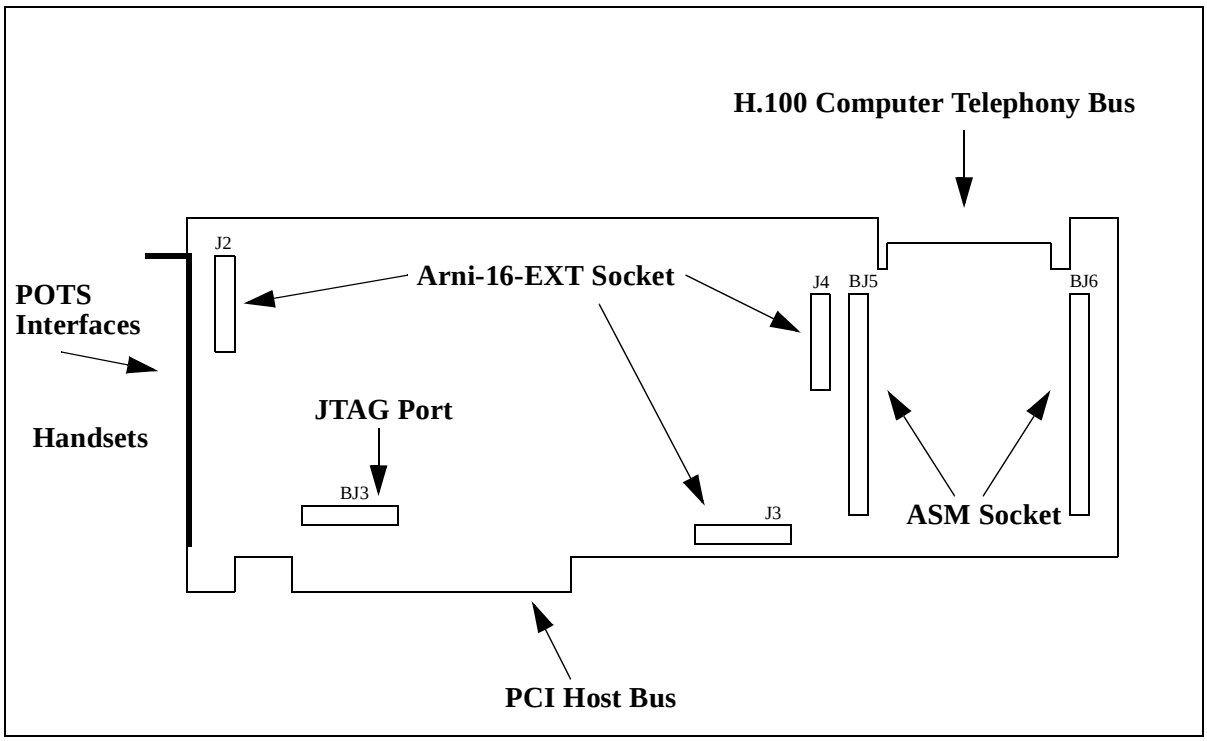

Figure 2. Arni-PCI External Interfaces.

6.1.1 PCI Host Bus Interface

The interface between the Arni-PCI board and the Host Computer is the PCI (Peripheral Connection Interconnect) bus. The electrical characteristics comply to the PCI Standard, Revision 2.1. For more information on the PCI bus, please contact the PCI special interest group, PCI SIG, ***http://www.pcisig.com*** .

6.1.2 H.100 Computer Telephony Bus Interface

Arni-PCI supports the H.100 Computer Telephony Bus standard. The H.100 bus is a collection of time-division multiplexed (TDM) digital telephony highways designed to carry telephony traffic between extensions boards within one PC chassis. The H.100 bus supports 32 TDM highways. The highways can be operated at 2.048, 4.096, or 8.192 MBit/s carrying 32, 64, or 128 64 kbit/s time-slots, respectively. Up to 20 boards can be connected to one H.100 bus. The maximum distance between boards is 7 inches.

Within the PC chassis the data streams are passed from card to card using a 60 pin ribbon cable and AMP 1-557089-2 connectors. The H.100 connector is a 60-finger edge connector on the upper right-hand side (Figure 2) of the board. The pin-out of the H.100 connector is listed in Table 3.

TABLE 3. Arni-PCI H.100 Pin Assignments

Pin	Signal	Pin	Signal
1	Reserved	2	Power to active devices (CT_+5Vdc)
3	TDM Highway 31 (CT_D31)	4	TDM Highway 30 (CT_D30)
5	TDM Highway 29 (CT_D29)	6	TDM Highway 28 (CT_D28)
7	GND	8	TDM Highway 27 (CT_D27)
9	TDM Highway 26 (CT_D26)	10	TDM Highway 25 (CT_D25)
11	TDM Highway 24 (CT_D24)	12	GND
13	TDM Highway 23 (CT_D23)	14	TDM Highway 22 (CT_D22)
15	TDM Highway 21 (CT_D21)	16	TDM Highway 20 (CT_D20)
17	GND	18	TDM Highway 19 (CT_D19)
19	TDM Highway 18 (CT_D18)	20	TDM Highway 17 (CT_D17)
21	TDM Highway 16 (CT_D16)	22	GND
23	TDM Highway 15 (CT_D15)	24	TDM Highway 14 (CT_D14)
25	TDM Highway 13 (CT_D13)	26	TDM Highway 12 (CT_D12)
27	GND	28	TDM Highway 11 (CT_D11)
29	TDM Highway 10 (CT_D10)	30	TDM Highway 9 (CT_D9)
31	TDM Highway 8 (CT_D8)	32	GND
33	TDM Highway 7 (CT_D7)	34	TDM Highway 6 (CT_D6)

TABLE 3. Arni-PCI H.100 Pin Assignments

Pin	Signal	Pin	Signal
35	TDM Highway 5 (CT_D5)	36	TDM Highway 4 (CT_D4)
37	GND	38	TDM Highway 3 (CT_D3)
39	TDM Highway 2 (CT_D2)	40	TDM Highway 1 (CT_D1)
41	TDM Highway 0 (CT_D0)	42	GND
43	Frame Sync from “A” Clock Master (/CT_FRAME_A)	44	GND
45	Bit Clock from “A” Clock Master (CT_C8_A)	46	GND
47	Secondary Network Timing Reference (CT_NETREF)	48	GND
49	Redundant Frame Sync from “B” Clock Master (/CT_FRAME_B)	50	GND
51	Redundant Bit Clock from “B” Clock Master (CT_C8_B)	52	GND
53	Message Channel (CT_MC)	54	GND
55	Compatibility Frame Pulse (/FR_COMP)	56	GND
57	SCbus System Clock (SCLK)	58	GND
59	SCbus System Clock time two (SCLKx2)	60	GND
61	MVIP-90 bit clock (C2)	62	GND
63	MVIP-90 bit clock time two (/C4)	64	GND
65	H-MVIP 16 Mhz Clock (/C16+)	66	H-MVIP 16 Mhz Clock /C16-
67	GND	68	RESERVED

For more information on the H.100 bus, please contact the Enterprise Computer Telephony Forum, ECTF, ***http://www.ectf.org*** .

6.1.3 Network Interfaces

The back panel of Arni-PCI contains a Centronics type connector with 100 contacts. The connector provides the following interfaces:

- 32 POTS Tip and Ring Line Interfaces
- 4 Analog Interfaces for Handsets

Arni-PCI is delivered with a telco-type connector cable and two Harmonica modules which converts from Centronics connector to RJ-11 connectors. The Harmonica module allows the connection of phone lines and handsets to the Arni-PCI board using RJ-11 connectors (See Figure 3).

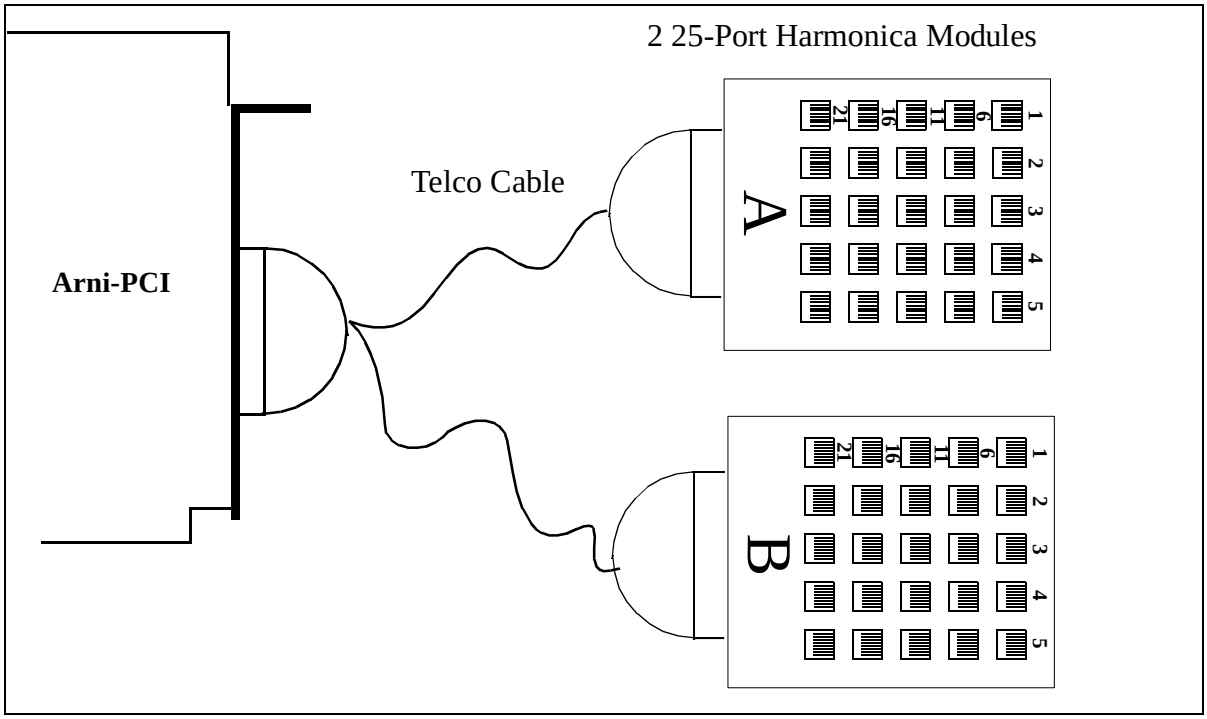

Figure 3. Arni-PCI Harmonica Modules

TABLE 4.

RJ-11 #	Harmonica Module	Connect To	Harmonica Module	Connect To
1	A	POTS Line #0	B	POTS Line #16
2	A	POTS Line #1	B	POTS Line #17
3	A	POTS Line #2	B	POTS Line #18
4	A	POTS Line #3	B	POTS Line #19
5	A	Handset #0	B	Reserved
6	A	POTS Line #4	B	POTS Line #20
7	A	POTS Line #5	B	POTS Line #21
8	A	POTS Line #6	B	POTS Line #22
9	A	POTS Line #7	B	POTS Line #23
10	A	Handset #1	B	Reserved
11	A	POTS Line #8	B	POTS Line #24
12	A	POTS Line #9	B	POTS Line #25
13	A	POTS Line #10	B	POTS Line #26
14	A	POTS Line #11	B	POTS Line #27

TABLE 4.

RJ-11 #	Harmonica Module	Connect To	Harmonica Module	Connect To
15	A	Handset #2	B	Reserved
16	A	POTS Line #12	B	POTS Line #28
17	A	POTS Line #13	B	POTS Line #29
18	A	POTS Line #14	B	POTS Line #30
19	A	POTS Line #15	B	POTS Line #31
20	A	Handset #3	B	Reserved
21-25	A	Reserved	B	Reserved

Although Arni-PCI is delivered with the RJ-11 Harmonica module, the modular structure of Arni-PCI allows it to be adapted for other types of connectors as well. For example, if the application requires BNC or Bantam type connectors, the Harmonica module can be replaced with another type of adapter which converts from Centronics to BNC or Bantam type connectors. The pin-outs of the Centronics and the RJ-11 connectors are documented in Figure 4 and in Table 5.

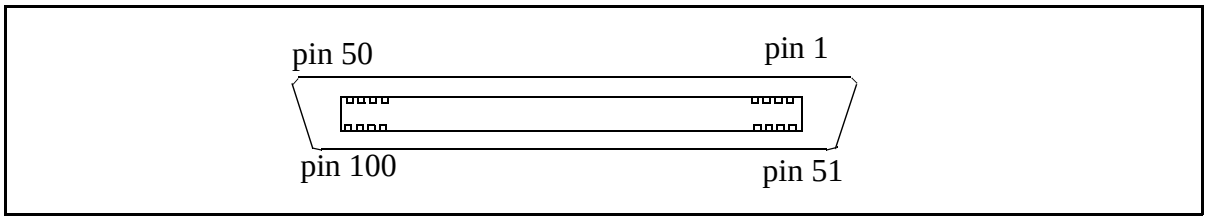

Figure 4. Arni-PCI Centronics Connector.

TABLE 5. Arni-PCI Centronics Connector Pin Assignments

Pin	Signal	Pin	Signal
1	Codec-0, Speaker (+)	100	Codec-0, Speaker (-)
2	Codec-0, Handset Microphone (+)	99	Codec-0, Handset Microphone Ground
3	Codec-1, Speaker (+)	98	Codec-1, Speaker (-)
4	Codec-1, Handset Microphone (+)	97	Codec-1, Handset Microphone Ground
5	Codec-2, Speaker (+)	96	Codec-2, Speaker (-)
6	Codec-2, Handset Microphone (+)	95	Codec-2, Handset Microphone Ground
7	Codec-3, Speaker (+)	94	Codec-3, Speaker (+)
8	Codec-3, Handset Microphone (+)	93	Codec-3, Handset Microphone Ground
9	Reserved	92	Reserved
10	Reserved	91	Reserved

TABLE 5. Arni-PCI Centronics Connector Pin Assignments

Pin	Signal	Pin	Signal
11	Reserved	90	Reserved
12	Reserved	89	Reserved
13	Reserved	88	Reserved
14	Reserved	87	Reserved
15	Reserved	86	Reserved
16	Reserved	85	Reserved
17	Reserved	84	Reserved
18	Reserved	83	Reserved
19	Line Interface 0 (Tip)	82	Line Interface 0 (Ring)
20	Line Interface 1 (Tip)	81	Line Interface 1 (Ring)
21	Line Interface 2 (Tip)	80	Line Interface 2 (Ring)
22	Line Interface 3 (Tip)	79	Line Interface 3 (Ring)
23	Line Interface 4 (Tip)	78	Line Interface 4 (Ring)
24	Line Interface 5 (Tip)	77	Line Interface 5 (Ring)
25	Line Interface 6 (Tip)	76	Line Interface 6 (Ring)
26	Line Interface 7 (Tip)	75	Line Interface 7 (Ring)
27	Line Interface 8 (Tip)	74	Line Interface 8 (Ring)
28	Line Interface 9 (Tip)	73	Line Interface 9 (Ring)
29	Line Interface 10 (Tip)	72	Line Interface 10 (Ring)
30	Line Interface 11 (Tip)	71	Line Interface 11 (Ring)
31	Line Interface 12 (Tip)	70	Line Interface 12 (Ring)
32	Line Interface 13 (Tip)	69	Line Interface 13 (Ring)
33	Line Interface 14 (Tip)	68	Line Interface 14 (Ring)
34	Line Interface 15 (Tip)	67	Line Interface 15 (Ring)
35	Line Interface 16 (Tip)	66	Line Interface 16 (Ring)
36	Line Interface 17 (Tip)	65	Line Interface 17 (Ring)
37	Line Interface 18 (Tip)	64	Line Interface 18 (Ring)
38	Line Interface 19 (Tip)	63	Line Interface 19 (Ring)
39	Line Interface 20 (Tip)	62	Line Interface 20 (Ring)
40	Line Interface 21 (Tip)	61	Line Interface 21 (Ring)
41	Line Interface 22 (Tip)	60	Line Interface 22 (Ring)
42	Line Interface 23 (Tip)	59	Line Interface 23 (Ring)
43	Line Interface 24 (Tip)	58	Line Interface 24 (Ring)
44	Line Interface 25 (Tip)	57	Line Interface 25 (Ring)
45	Line Interface 26 (Tip)	56	Line Interface 26 (Ring)
46	Line Interface 27 (Tip)	55	Line Interface 27 (Ring)

TABLE 5. Arni-PCI Centronics Connector Pin Assignments

Pin	Signal	Pin	Signal
47	Line Interface 28 (Tip)	54	Line Interface 28 (Ring)
48	Line Interface 29 (Tip)	53	Line Interface 29 (Ring)
49	Line Interface 30 (Tip)	52	Line Interface 30 (Ring)
50	Line Interface 31 (Tip)	51	Line Interface 31 (Ring)

The RJ-11 pin-outs in the Harmonica module for the 2-wire Tip and Ring Line Interfaces are shown in Figure 5.

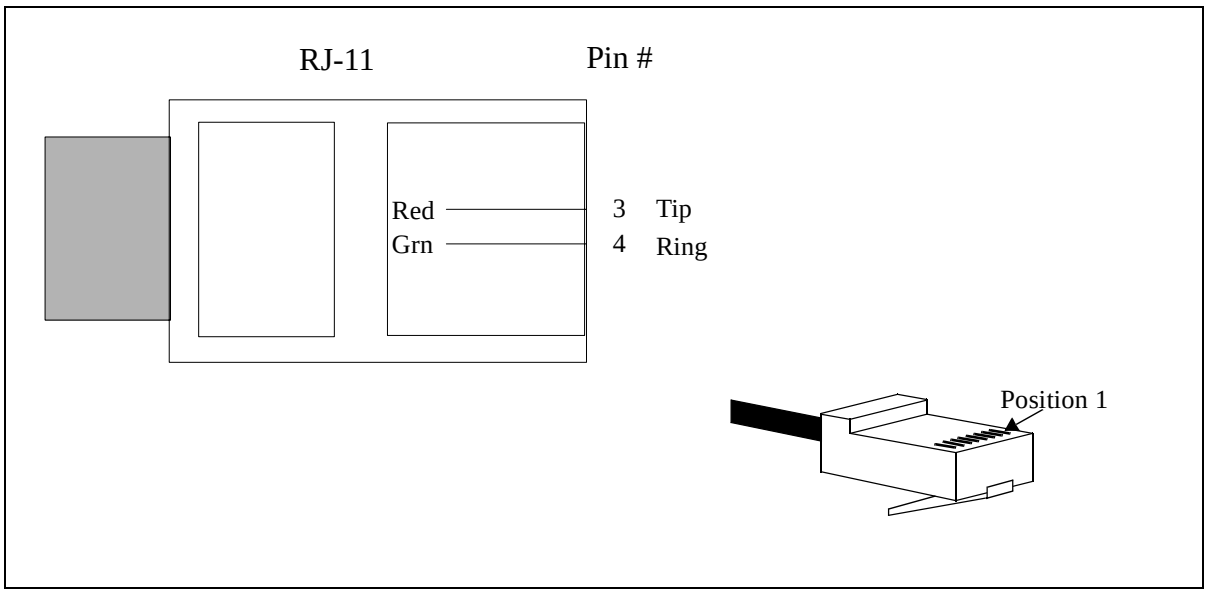

Figure 5. RJ-11 Connector for the POTS Interface.

The RJ-11 pin-outs for the Handsets are shown in Figure 6.

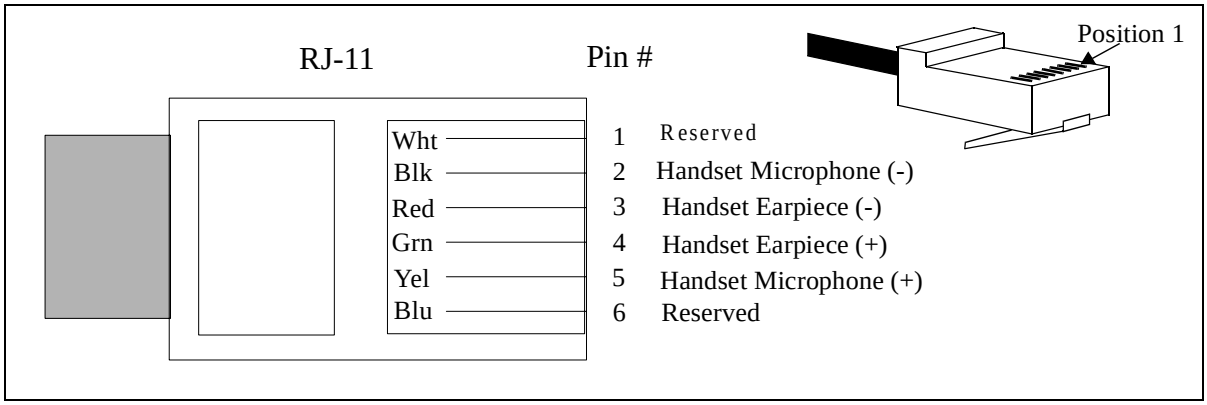

Figure 6. RJ-11 Connector for the Handsets.

6.1.4 OTX ASM Interface

The Arni-PCI board contains an OTX ASM (Application Specific Module) Interface (Reference Designators BJ5 and BJ6). The ASM Interface can be used to attach a daughter board modules to the Arni-PCI board. The ASM daughter boards can add functionality, such as DSP or HDLC resources.

6.1.5 JTAG Interface

The JTAG port (reference designator BJ3) are used for:

- Board Testing
- Programming of Complex Programmable Logical Devices (CPLDs)
- Connecting the DSP emulator board for DSP Software Development.

For more information on how to use the JTAG port and the DSP emulator, please refer to *"Programmer's Guide for OTX DSP Application Development,"* Odin Document # 1412-1-SAA-1004-1.

6.2 Data Architecture

Internally, Arni-PCI utilizes serial TDM (Time-Division Multiplexed) data streams for transfer of data or voice. The internal serial TDM data streams are called "Highways." External interfaces are called spans.

The serial highways provide data paths between physical devices as shown in Figure 7. If the physical device connects to more than one highway, the device specific highway port number is also shown in Figure 7.

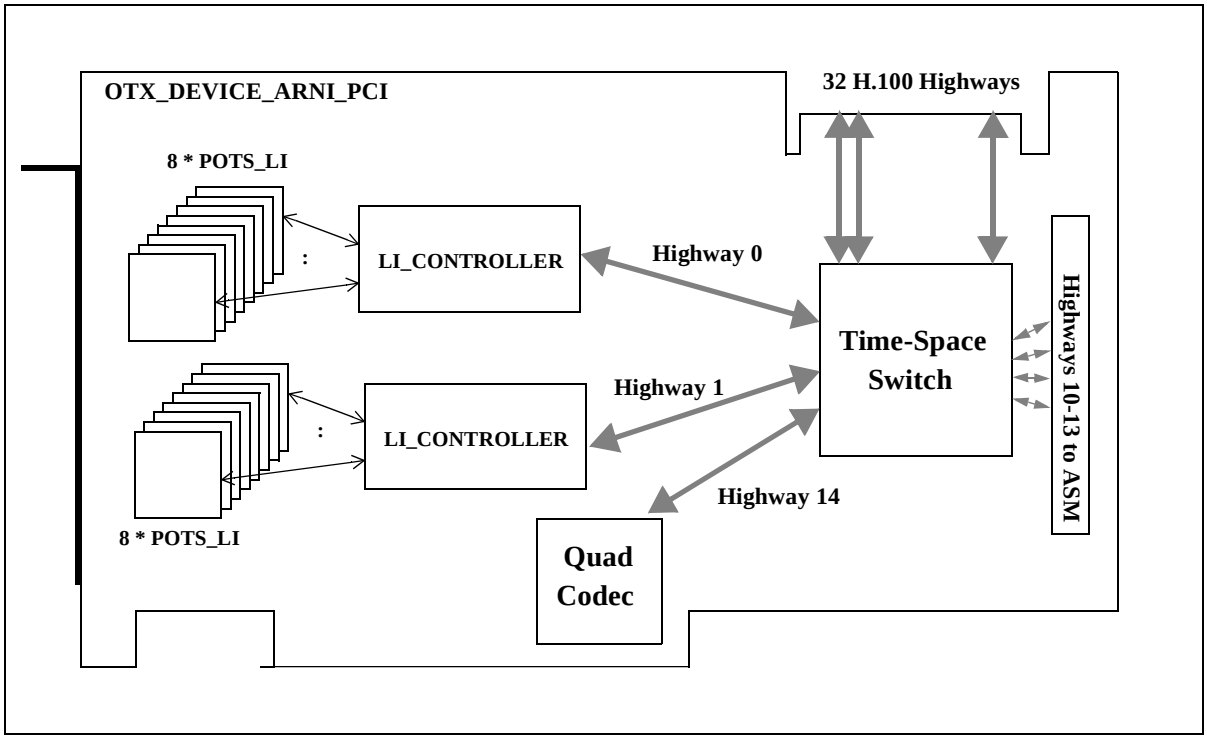

Figure 7. Arni-PCI Highway Connections.

The Arni-PCI internal highways are configured to operate at 2.048 Mbit/s, each containing 32 8-bit time-slots. The data rate of one time-slot is 64 kbit/s. Table 7 lists the internal highways used on Arni-PCI boards.

TABLE 6. Arni-PCI Highway Connections

Highway #	Connecting Time-Space Switch to
0	LI Controller #0 on Arni-PCI NIC
1	LI Controller #1 on Arni-PCI NIC
2	LI Controller #2 on Arni-16-EXT
3	LI Controller #3 on Arni-16-EXT
4-9	Reserved
10-13	ASM Daughter Board
14	Quad Codec
15	Reserved

The time-space switch in non-blocking and allows any internal time-slot on any internal highway to be switched to any other highway/time-slot. The cross-connections are software programmable and automatically taken care of by the OTX driver.

In addition to the internal highways, Arni-PCI supports 32 external H.100 highways.

The Arni-PCI time-space also provides support for multicasting and messaging. In multicasting any input channel can be cross-connected to multiple output channels. For example, an incoming Li time slot can be both switched to an outgoing H.100 Highway and it can also be switched to the Codec or ASM board.

In the messaging mode, the time-space switch can be instructed to send a constant byte on any time slot. Once activated, every byte on the specified time slot will contain the same value. The generation of constant byte does not consume any processing capacity.

6.3 Control Architecture

The host PC can control the physical devices on the Arni-PCI board through the PCI bus. The Arni-PCI control architecture is illustrated in Figure 8.

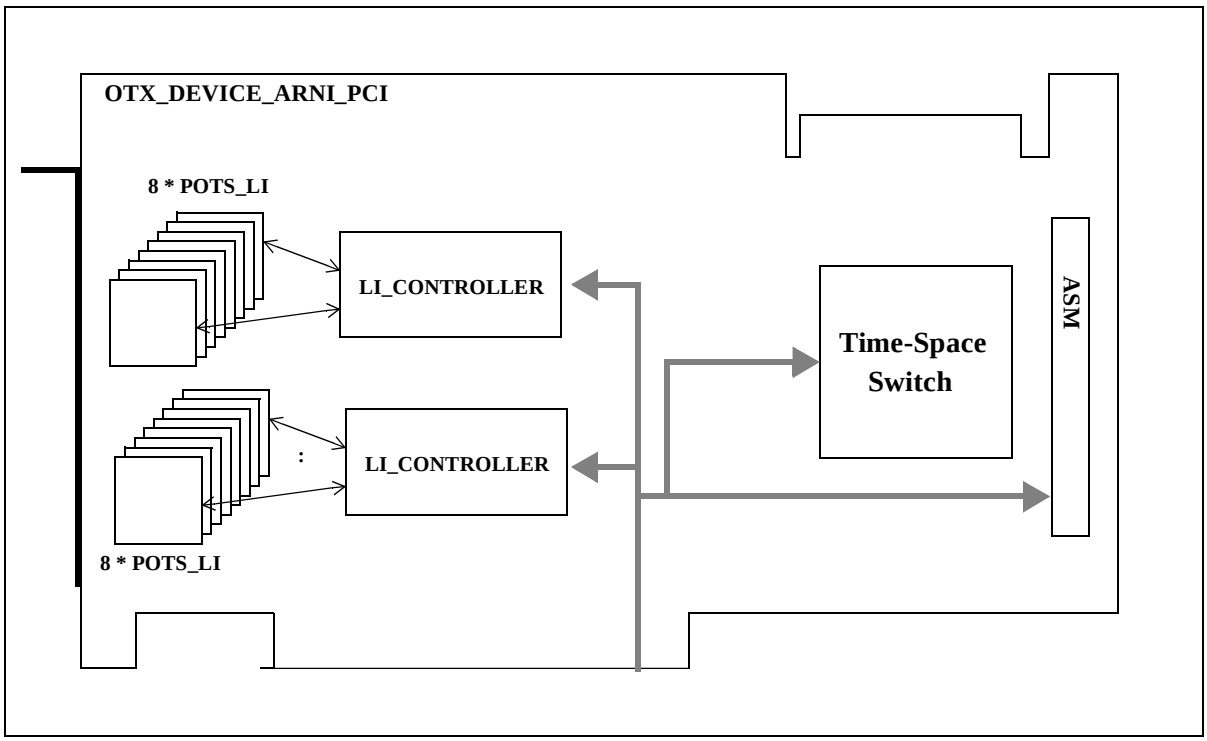

Figure 8. Arni-PCI Control Architecture.

6.4 Clock Architecture

On the Arni-PCI board all the internal TDM data highways and the all the devices processing TDM data are synchronized to one clock reference. The clock reference can be derived from multiple sources and then switched to all the devices. The clocking sources supported by Arni-PCI are illustrated in Figure 9 and listed in Table 7.

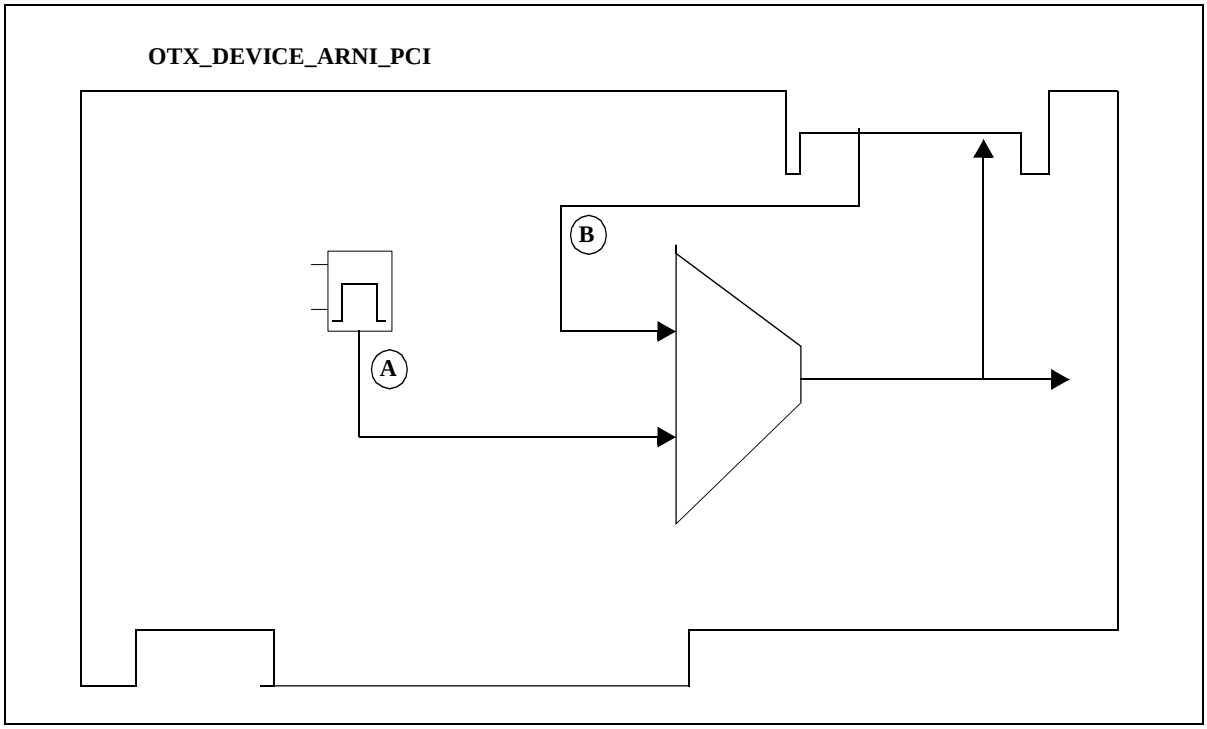

Figure 9. Arni-PCI Clock Architecture Overview.

TABLE 7. Arni-PCI Clocking Sources.

Clock Source	Description
A	On-board free running oscillator.
B	H.100 Reference Clock

6.5 Logical Subsystems

The logical subsystem view describes the logical design subsystems within the Arni-PCI adapter. Each subsystem can comprise hardware, firmware, and driver or on-board processor software. The Arni-PCI consists of two subsystems:

1. Line Interface Subsystem
2. Switching Subsystem
3. Codec Subsystem

6.5.1 Line Interface Subsystem

The Line Interface subsystem is responsible for interfacing the Arni-PCI card with the external POTS lines. The subsystem provides the connectors and overvoltage protection. The Line Interface Subsystem controls electrical characteristics of the external interfaces:

- DC characteristics
- Receive and Transmit levels
- Transhybrid balancing
- Terminating impedance

The subsystem also provides the following functions:

- DTMF Dialing
- Pulse Dialing
- 16-bit linear codec
- Caller ID Detection and Storage (future functionality)

6.5.2 Switching Subsystem

The switching subsystem provides a time-space switch for the switching of any incoming time/slot to any outgoing time slot. This subsystem is also responsible for delivering and switching of the on-board clock signals. The switching subsystem has already been covered in Chapter 6.2: "Data Architecture" and Chapter 6.4: "Clock Architecture".

6.5.3 Codec Subsystem

The Arni-PCI board contains four codecs allowing the user to listen in on any 4 internal time-slots. The codecs convert four digital Pulse Code Modulated (PCM) time-slots into analog electrical signals. The analog signals from the codecs can then be connected to standard telephone handsets through connectors 5 - 8 in the Harmonica.

The Arni-PCI codecs support both A-law and u-law for the Analog-to-Digital and Digital-to-Analog conversions. The conversion law to be used can be selected by software.

Codec #0 is permanently connected to time-slot 1 (0 count) on the Internal Highway #14. Codecs 1 - 3 are connected to time-slots 2 - 4, respectively. The time-space switch can be used to cross-connect the codecs into any incoming or outgoing time-slot in the Line Interface, ASM, or H.100 Highways.

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