



Sun™ PCI High Speed Quad Port Serial Interface Adapter User's Guide

Sun Microsystems, Inc.
www.sun.com

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Regulatory Compliance Statements

Your Sun product is marked to indicate its compliance class:

- Federal Communications Commission (FCC) — USA
- Industry Canada Equipment Standard for Digital Equipment (ICES-003) — Canada
- Voluntary Control Council for Interference (VCCI) — Japan
- Bureau of Standards Metrology and Inspection (BSMI) — Taiwan

Please read the appropriate section that corresponds to the marking on your Sun product before attempting to install the product.

FCC Class A Notice

This device complies with Part 15 of the FCC Rules. Operation is subject to the following two conditions:

1. This device may not cause harmful interference.
2. This device must accept any interference received, including interference that may cause undesired operation.

Note: This equipment has been tested and found to comply with the limits for a Class A digital device, pursuant to Part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference when the equipment is operated in a commercial environment. This equipment generates, uses, and can radiate radio frequency energy, and if it is not installed and used in accordance with the instruction manual, it may cause harmful interference to radio communications. Operation of this equipment in a residential area is likely to cause harmful interference, in which case the user will be required to correct the interference at his own expense.

Modifications: Any modifications made to this device that are not approved by Sun Microsystems, Inc. may void the authority granted to the user by the FCC to operate this equipment.

FCC Class B Notice

This device complies with Part 15 of the FCC Rules. Operation is subject to the following two conditions:

1. This device may not cause harmful interference.
2. This device must accept any interference received, including interference that may cause undesired operation.

Note: This equipment has been tested and found to comply with the limits for a Class B digital device, pursuant to Part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference in a residential installation. This equipment generates, uses and can radiate radio frequency energy and, if not installed and used in accordance with the instructions, may cause harmful interference to radio communications. However, there is no guarantee that interference will not occur in a particular installation. If this equipment does cause harmful interference to radio or television reception, which can be determined by turning the equipment off and on, the user is encouraged to try to correct the interference by one or more of the following measures:

- Reorient or relocate the receiving antenna.
- Increase the separation between the equipment and receiver.
- Connect the equipment into an outlet on a circuit different from that to which the receiver is connected.
- Consult the dealer or an experienced radio/television technician for help.

Modifications: Any modifications made to this device that are not approved by Sun Microsystems, Inc. may void the authority granted to the user by the FCC to operate this equipment.

ICES-003 Class A Notice - Avis NMB-003, Classe A

This Class A digital apparatus complies with Canadian ICES-003.

Cet appareil numérique de la classe A est conforme à la norme NMB-003 du Canada.

ICES-003 Class B Notice - Avis NMB-003, Classe B

This Class B digital apparatus complies with Canadian ICES-003.

Cet appareil numérique de la classe B est conforme à la norme NMB-003 du Canada.


VCCI 基準について

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警告使用者：

這是甲類的資訊產品，在居住的環境中使用時，可能會造成射頻干擾，在這種情況下，使用者會被要求採取某些適當的對策。

CCC Class A Notice

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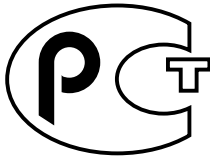
以下声明适用于运往中国且其认证标志上注有 "Class A" 字样的产品。

声明

此为A级产品，在生活环境中，该产品可能会造成无线电干扰。
在这种情况下，可能需要用户对其干扰采取切实可行的措施。



GOST-R Certification Mark



Declaration of Conformity

Compliance Model Number: **HSI-U**
Product Family Name: **Sun PCI High Speed Serial Interface Adapter (X1355a)**

EMC

USA—FCC Class A

This equipment complies with Part 15 of the FCC Rules. Operation is subject to the following two conditions:

1. This equipment may not cause harmful interference.
2. This equipment must accept any interference that may cause undesired operation.

European Union

This equipment complies with the following requirements of the EMC Directive 89/336/EEC:

As Telecommunication Network Equipment (TNE) in Both Telecom Centers and Other Than Telecom Centers per (as applicable):

EN 300 386 V.1.3.2 (2003-05) Required Limits:

EN 55022:1994 +A1:1995 +A2:1997 Class A

EN 61000-3-2:2000 Pass

EN 61000-3-3:1995 +A1:2000 Pass

IEC 61000-4-2 6 kV (Direct), 8 kV (Air)

IEC 61000-4-3 3 V/m 80-1000MHz, 10 V/m 800-960 MHz, and 1400-2000 MHz

IEC 61000-4-4 1 kV AC and DC Power Lines, 0.5 kV Signal Lines

IEC 61000-4-5 2 kV AC Line-Gnd, 1 kV AC Line-Line and Outdoor Signal Lines, 0.5 kV Indoor signal Lines > 10m.

IEC 61000-4-6 3 V

IEC 61000-4-11 Pass

As Information Technology Equipment (ITE) Class A per (as applicable):

EN 55022:1994 +A1:1995 +A2:1997 Class A

EN 61000-3-2:2000 Pass

EN 61000-3-3:1995 +A1:2000 Pass

EN 55024:1998 +A1:2001 +A2:2003 Required Limits:

IEC 61000-4-2 4 kV (Direct), 8 kV (Air)

IEC 61000-4-3 3 V/m

IEC 61000-4-4 1 kV AC Power Lines, 0.5 kV Signal and DC Power Lines

IEC 61000-4-5 1 kV AC Line-Line and Outdoor Signal Lines, 2 kV AC Line-Gnd, 0.5 kV DC Power Lines

IEC 61000-4-6 3 V

IEC 61000-4-8 1 A/m

IEC 61000-4-11 Pass

Safety: This equipment complies with the following requirements of the Low Voltage Directive 73/23/EEC:

EC Type Examination Certificates:

EN 60950-1:2001, 1st Edition

Chomerics Report No. SAFR0126B.03

IEC 60950-1:2001, 1st Edition

CB Scheme Certificate No.

Evaluated to all CB Countries

UL 60950-1:2003, 1st Edition, CSA C22.2 No. 60950-1-03

File:

Supplementary Information: This product was tested and complies with all the requirements for the CE Mark. This equipment complies with the Restriction of Hazardous Substances (RoHS) directive 2002/95/EC.

/S/

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Preface

This document provides information for users of the Sun™ PCI High Speed Quad Port Serial Interface adapter. Information provided includes adapter installation, software installation and configuration, utilities, cable pin-outs and signals, and null modem cable requirements. This document is intended for use by either first-time or experienced users.

If you have just acquired this product, review the introductory sections and follow the guidelines for installing and using the adapter.

Note – The Sun PCI High Speed Quad Port Serial Interface adapter is high-speed serial-interface (HSI) adapter for PCI applications. The adapter is referred to as SunHSI/U™ in this manual.

How This Book Is Organized

This document is organized as follows:

Chapter 1 describes the products and lists system requirements.

Chapter 2 provides instructions for installing the adapter.

Chapter 3 contains the SunHSI™ software installation instructions.

Chapter 4 describes the utilities supplied with the SunHSI software.

Appendix A lists the cable pin assignments and signals.

Appendix B provides information on external clocking and the null modem cable.

Appendix C explains the inverted data and clock signals for T1.

Appendix D gives an overview of the SunVTS™ diagnostic software.
Appendix E provides instructions for viewing the man pages.

Using UNIX Commands

This document might not contain information about basic UNIX® commands and procedures such as shutting down the system, booting the system, and configuring devices. Refer to the following for this information:

- Software documentation that you received with your system
- Solaris™ Operating System documentation, which is at:

<http://docs.sun.com>

Shell Prompts

Shell	Prompt
C shell	<i>machine-name%</i>
C shell superuser	<i>machine-name#</i>
Bourne shell and Korn shell	\$
Bourne shell and Korn shell superuser	#

Typographic Conventions

Typeface ¹	Meaning	Examples
AaBbCc123	The names of commands, files, and directories; on-screen computer output	Edit your <code>.login</code> file. Use <code>ls -a</code> to list all files. % You have mail.
AaBbCc123	What you type, when contrasted with on-screen computer output	% su password:
<i>AaBbCc123</i>	Book titles, new words or terms, words to be emphasized. Replace command-line variables with real names or values.	Read Chapter 6 in the <i>User's Guide</i> . These are called <i>class</i> options. You <i>must</i> be superuser to do this. To delete a file, type <code>rm filename</code> .

¹ The settings on your browser might differ from these settings.

Related Documentation

The documents listed as online are available at:

<http://www.sun.com/documentation>

Application	Title	Part Number	Format	Location
Installation	<i>Sun PCI High Speed Quad Port Serial Interface Adapter Release Notes</i>	819-1208	PDF	Online
			HTML	Online
Installation and User Information	<i>Sun PCI High Speed Quad Port Serial Interface Adapter User's Guide</i>	819-1207-10	PDF	Online
			HTML	Online

Documentation, Support, and Training

Sun Function	URL
Documentation	http://www.sun.com/documentation/
Support	http://www.sun.com/support/
Training	http://www.sun.com/training/

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Please include the title and part number of your document with your feedback:

Sun PCI High Speed Quad Port Serial Interface Adapter User's Guide, part number 819-1207-10

Product Overview

This chapter includes the following topics:

- [“Product Description” on page 1](#)
- [“Features” on page 2](#)
- [“Hardware and Software Requirements” on page 3](#)

Product Description

The Sun PCI High Speed Quad Port Serial Interface adapter is high-speed serial interface (HSI) adapter for PCI applications and is referred to as the SunHSI/U™ adapter in this manual. The adapter offers comprehensive hot-plug compatibility with Solstice™ WAN software packages available through Sun. The SunHSI™ software is a transparent interface on the SunHSI/U adapter, providing a compliant environment for SunLink™ WAN packages operating on similar Sun communication modules.

The SunHSI/U adapter (see [FIGURE 1-1](#)) is an intelligent, four-port communication controller with onboard CPU and memory dedicated to WAN communication functions. This architecture operates much more efficiently at high data rates than unintelligent WAN modules. Onboard intelligence allows the workstation or server to be off-loaded from many of the low-level communication tasks that it must perform when there is no native intelligence on the controller.

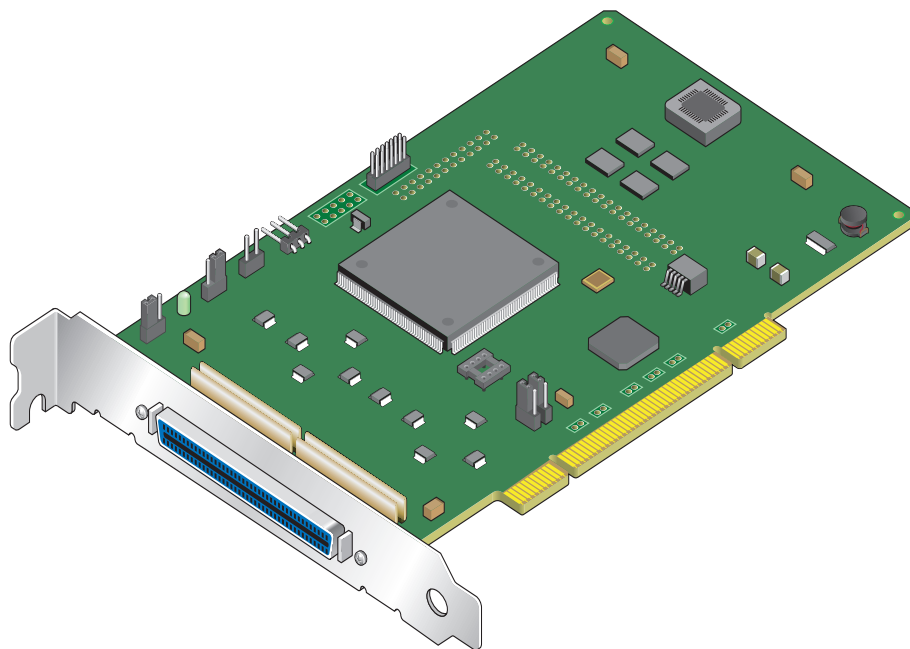


FIGURE 1-1 SunHSI/U Adapter

The adapter comes with the RS-449 industry standard connectors (for example, DB-37).

The protocols that operate with the SunHSI/U adapter include the Solstice X.25 and Solstice Point-to-Point Protocol (PPP). The SunHSI/U adapter conforms to the Sun Synchronous Serial Driver Interface Specification.

Features

- Four synchronous RS-449 serial ports
- Each port can be independently configured
- T1/E1 transfer speed simultaneously on all four ports
- Works in 3.3 Volt 66 MHz and 5 Volt 33 MHz PCI slots
- Increased RS-232 support for data transmission range, up to 100 Kbps
- Meets PCI local bus specification, rev. 2.2
- Solaris 64-bit and 32-bit Operating System compatibility
- Hot-plug capability

Hardware and Software Requirements

The hardware and software requirements for the SunHSI/U adapter are listed in [TABLE 1-1](#).

TABLE 1-1 Hardware and Software Requirements

Sun Systems	
Workstations	Sun Blade™ 100, 150, 1500, 1000, 2000, 2500
Servers	Sun Fire™ V210, V240, 280R, V440, V480, V490, V880, V890, V1280, E2900, E6900/E4900, 15K/12K, E25K/E20K
NEBS-certified servers	Netra™ 240, 440, 1280
Operating Systems	
	Solaris 10, Solaris 9, and Solaris 8
SunHSI Software (PCI device drivers, man pages, and utilities)	
	SunHSI/P™ 3.1 or newer [†]
Diagnostics Version	
Solaris 10	SunVTS™ 6.0 and subsequent compatible releases
Solaris 9	SunVTS 5.0 and subsequent compatible releases
Solaris 8	SunVTS 4.0 and subsequent compatible releases

[†] The Sun HSI/P software is downloadable from the Sun Download Center at: <http://www.sun.com/download>

SunHSI/U Adapter Installation

This chapter describes how to install the adapter in your system and includes the following topics:

- [“Installation Process” on page 5](#)
- [“To Install the Adapter” on page 5](#)
- [“External Cabling” on page 6](#)

Installation Process

A simplified version of the installation process follows:

1. Install the adapter (see [“To Install the Adapter” on page 5](#)).
2. Install the SunHSI PCI software (see [“SunHSI PCI Software Installation” on page 9](#)).
3. Test the installation (see [“To Test the Installation” on page 14](#)).

▼ To Install the Adapter



Caution – Electronic components on printed circuit boards are extremely sensitive to static electricity. Ordinary amounts of static electricity generated by your clothing or work environment can damage the electronic equipment. When installing the SunHSI/U adapter in a system, use anti-static grounding straps and antistatic mats to help prevent damage due to electrostatic discharge.

Note – Refer to your system installation guide or service manual for detailed instructions for the following steps.

1. **Power off your system, using the standard shutdown procedures described in the *Solaris Handbook for Sun Peripherals* or your system service manual.**

The *Solaris Handbook for Sun Peripherals* is shipped with the Solaris OS software and is available on the <http://docs.sun.com> web site.

2. **Remove the cover from the unit to access the card slots and connectors.**
3. **Select an available 3.3 Volt or 5 Volt PCI slot and remove the slot filler panel.**
4. **Insert the adapter into the PCI connector of the system unit.**

Ensure that the front plate on the adapter mounts flush with the chassis panel opening.

5. **Install the front plate screw to secure the adapter into the chassis.**

This also provides a chassis ground connection to the adapter.

6. **Reinstall the cover on the unit.**
7. **Attach the serial port cable assembly to the I/O connector on the adapter.**
8. **Connect any cables from the peripheral devices to the RS-449 connectors on the adapter's cable.**
9. **Turn power back on and allow the system to reboot.**

This completes the hardware installation. Proceed to "[SunHSI PCI Software Installation](#)" on page 9.

External Cabling

The SunHSI/U adapter provides external connectivity through a passive cabling system. A hydra-style connector provides connectivity to four RS-449 devices by means of four DB-37 female connectors in a DTE configuration.

Note – Always use shielded twisted pair RS-449 cables with your SunHSI/U adapter.

RS-232 to RS-449 Connections

In order to connect RS-232 devices to the adapter, you need to install an externally powered RS-449 to RS-232 interface converter to each DB-37 connector on which you intend to connect an RS-232 device. A converter is necessary because of incompatibilities between RS-232 and RS-449 signal levels.

To obtain an externally powered RS-232 to RS-449 interface converter, contact:

Black Box Corporation at:

<http://www.blackbox.com>

Note – Use only externally powered RS-449 devices with the SunHSI/U adapter.

SunHSI PCI Software Installation

This chapter describes how to install the SunHSI PCI software and includes the following sections:

- “Installation Overview” on page 9
- “Before Installing the Software” on page 11
- “Installing the Software” on page 12
- “Configuring the Software” on page 14

Installation Overview

Software for unbundled products is distributed in the form of software packages. The SunHSI PCI software package can be downloaded from the Sun Download Center at:

<http://www.sun.com/download>

You can use the `pkgadd` command to install software packages, to spool software packages for installation at a later date, or to remove software packages from your system. For more information see the *Solaris System Administration Guide*. When you have completed the software installation and run the postinstallation script, you will have created the software directories and files illustrated in [FIGURE 3-1](#) and [FIGURE 3-2](#).

Note – If you are upgrading to the SunHSI/U adapter from the SunHSI/P adapter or if you are running a SunHSI/P adapter along with the SunHSI/U adapter, you must upgrade the SunHSI software to the latest version.

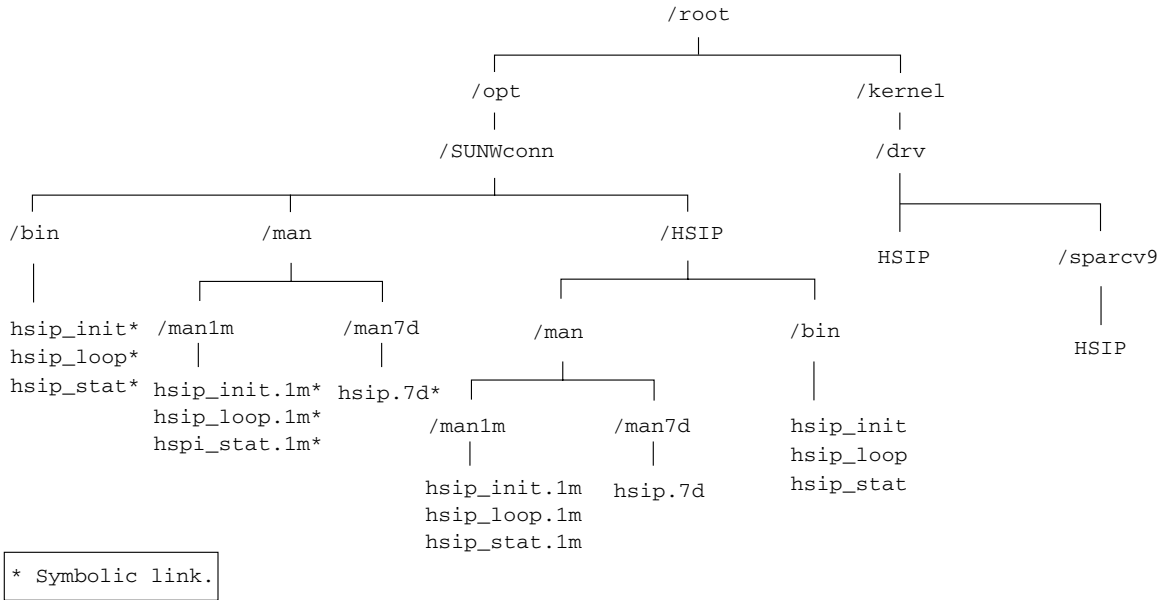


FIGURE 3-1 SunHSI PCI Software Directories and Files

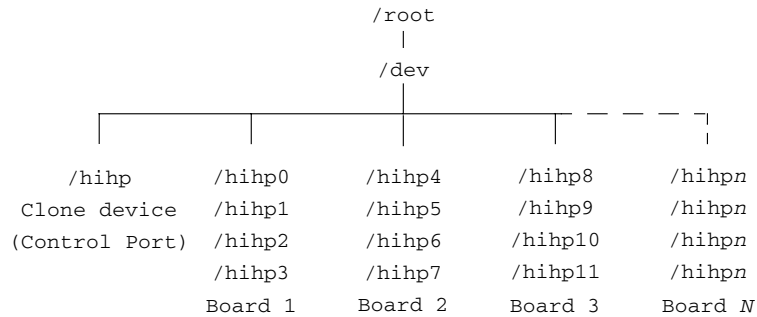


FIGURE 3-2 SunHSI Devices Created by the Postinstallation Script

Before Installing the Software

Verifying the Software and Hardware Requirements

Before installing the software, answer the following questions:

- Does your system have any available 3.3V or 5V PCI slots?
- Have you downloaded the SunHSI software from the Sun Download Center at:
<http://www.sun.com/download>
- What is the installation directory (default directory is /opt)?
- Do you have the superuser password for both the system where the software is to be installed and the system with download software, if different?
- Does your system have enough disk space?

Use both the following commands to check for disk space:

```
# df -k /opt
# df -k /
```

TABLE 3-1 Required Disk Space

SunHSI Package Name	Default Installation Directory	Approximate Space Required
SUNWhsip	/	1 Mbyte
SUNWhsipm and SUNWhsipu	/opt	1 Mbyte total

▼ To Remove Older Versions of the Software



Caution – Do not overwrite any existing SunHSI software packages. If you install the SunHSI software packages over existing SunHSI software packages, you will have two instances of the software packages. This might cause problems when installing or backing out of software patches.

Before installing the SunHSI PCI software on your system, check your system to see if previous versions of the SunHSI software are installed. If older SunHSI software exists, you must remove this software before installing the new SunHSI software.

- Using the `pkginfo` command, check the system for installed SunHSI software packages:

```
# /usr/bin/pkginfo | grep SUNWhsip
system  SUNWhsip    SunHSI/P Driver for PCI
system  SUNWhsipm   SunHSI/P Man Pages for PC
system  SUNWhsipu   SunHSI/P Utilities for PCI
```

- If no SunHSI packages are installed, skip to the next section, [“Installing the Software” on page 12](#), to continue with the software installation.
- If there are SunHSI packages installed, remove them by logging on as superuser (root) and typing the following command:

```
# /usr/sbin/pkgrm SUNWhsip SUNWhsipu SUNWhsipm
```

Installing the Software

The SunHSI PCI driver, utilities, and man pages are distributed in the standard Solaris `pkgadd` distribution format. The `pkgadd` utility loads the `SUNWhsip`, `SUNWhsipm`, and `SUNWhsipu` packages onto the system from the distribution media.

▼ To Install the SunHSI Software

1. Access the directory where the SunHSI software has been downloaded.

```
# cd download-directory
```

where *download-directory* is the name of the directory where the SunHSI software was downloaded.

2. Log in as superuser or change to superuser.

You must possess superuser privileges to invoke the following commands. This ensures that all preinstallation scripts in the software package will be executed with superuser privileges.

```
# /usr/bin/su
Password: superuser-password
```

3. Using the pkgadd command, install the software packages as follows:.

```
# pkgadd -d /download-directory/sunhsip_3_1/Product

The following packages are available:
 1 SUNWhsip      SunHSI/P Driver for PCI 3.1,REV=2005.xx.xx
 2 SUNWhsipm    SunHSI/P Man pages for PCI 3.1,REV=2005.xx.xx
 3 SUNWhsipu    SunHSI/P Utilities for PCI 3.1,REV=2005.xx.xx

Select package(s) you wish to process (or 'all' to process
all packages). (default: all) [?,??,q]: all
```

where *download-directory* is the name of the directory where the SunHSI software was downloaded.

a. Type **all** or leave blank then press the Return key to continue the installation of the driver software.

If the pkgadd utility warns you that some scripts must be executed with superuser permissions, type *y*.

4. After successful completion of the package installation, reboot the system using the reconfigure option.

a. Synchronize the hard disks and halt the system, using the following commands.

```
# /usr/sbin/sync
# /usr/sbin/halt
```

b. At the **ok** prompt, type the **boot** command with the **-r** option:

```
ok boot -r
```

5. After the system reboots, verify the installation by typing the following commands:

```
# /usr/bin/pkginfo | grep SUNWhsip
system  SUNWhsip      SunHSI/P Driver for PCI
system  SUNWhsipm       SunHSI/P Man Pages for PC
system  SUNWhsipu       SunHSI/P Utilities for PCI

# modinfo | grep HSIP
126 7bb24000 17708 150 1 HSIP (PT-PCI334 Driver)

# grep HSIP /etc/path_to_inst
"/ssm@0,0/pci@18,700000/pci1214,334a@2" 0 "HSIP"
```

The output shows that the packages are installed, the driver is loaded, and that the software is mapped to the adapter.

▼ To Test the Installation

- Type the following command (replace *n* with the adapter port you are testing):

```
# hsip_loop -c 100 -l 2048 -s 2048000 -t 1 hihpn
```

This command runs an internal loopback test. For more information, see the `hsip_loop(1M)` man page.

Configuring the Software

To configure the adapter for the Point-to-Point Protocol (PPP), see [“To Configure for Point-to-Point Protocol” on page 15](#). Also refer to the *Solaris System Administration Guide: Network Services* documentation for the version of Solaris that you are running. These documents are available from the following web site:

<http://docs.sun.com/>

To configure the adapter for the X.25 9.2 protocol, refer to the *Solstice X.25 9.2 Administration Guide* (806-1234). The X.25 9.2 documents are available from the following web site:

<http://docs.sun.com/>

▼ To Configure for Point-to-Point Protocol

1. Change to the `/etc/ppp` directory and create an executable file called `conf_hsip`, containing the following information:

```
#!/bin/ksh -x

DEVICE=`echo $DEVICE | sed 's//dev//'\`
/opt/SUNWconn/bin/hsip_init $DEVICE speed=2048000 mode=fdx loopback=no \
nrzi=no txc=baud rxc=rxr txd=txd rxd=rxr signal=no 2>&1 > /dev/null
```

2. Create another executable file called `demand`, containing the following information:

```
if [ -f /var/run/ppp-demand.pid ] &&
  /usr/bin/kill -s 0 `bin/cat /var/run/ppp-demand.pid`
then
  :
else
env DEVICE=hihp0 /usr/bin/pppd hihp0 :qa1b-hihp0 call far-hsip
env DEVICE=hihp1 /usr/bin/pppd hihp1 :qa1b-hihp1 call far-hsip
env DEVICE=hihp2 /usr/bin/pppd hihp2 :qa1b-hihp2 call far-hsip
env DEVICE=hihp3 /usr/bin/pppd hihp3 :qa1b-hihp3 call far-hsip
fi
```

3. Change to the `/etc/ppp/peers` directory and create an executable file called `far-hsip`, containing the following information:

```
connect '/etc/ppp/conf-hsip'
local
sync
noauth
0:
ipcp-accept-local
nodefaultroute
passive
persist
noccp
nopcomp
novj
noaccomp
```

4. Add the client site hosts on the server machine and add the server site hosts on the client machine.

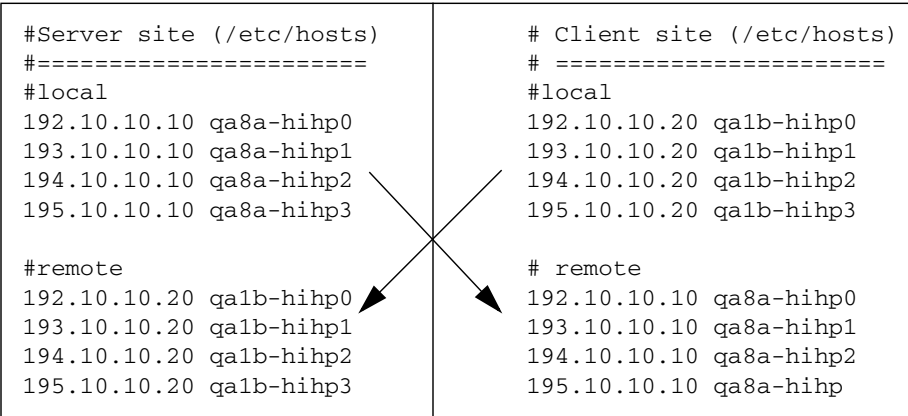
a. Edit the server's `/etc/hosts` file and add the client site local hosts.

b. Edit the client's `/etc/hosts` file and add the server site local hosts.

Note – Both IP addresses have to be on the same subnet.

Refer to the `hosts(4)` man page and the sample `/etc/hosts` files:

<pre>#Server site (/etc/hosts) #===== #local 192.10.10.10 qa8a-hihp0 193.10.10.10 qa8a-hihp1 194.10.10.10 qa8a-hihp2 195.10.10.10 qa8a-hihp3 #remote 192.10.10.20 qa1b-hihp0 193.10.10.20 qa1b-hihp1 194.10.10.20 qa1b-hihp2 195.10.10.20 qa1b-hihp3</pre>	<pre># Client site (/etc/hosts) # ===== #local 192.10.10.20 qa1b-hihp0 193.10.10.20 qa1b-hihp1 194.10.10.20 qa1b-hihp2 195.10.10.20 qa1b-hihp3 # remote 192.10.10.10 qa8a-hihp0 193.10.10.10 qa8a-hihp1 194.10.10.10 qa8a-hihp2 195.10.10.10 qa8a-hihp</pre>
---	---



5. Edit the `/etc/netmasks` file as follows:

```
192.10.10.0 255.255.255.0
193.10.10.0 255.255.255.0
194.10.10.0 255.255.255.0
195.10.10.0 255.255.255.0
```

6. Start the PPP connection by typing the following commands:

```
/etc/rc2.d/S47pppd stop
/etc/rc2.d/S47pppd start
```

```
boot -r
```

SunHSI Utilities

The SunHSI software includes the `hsip_init`, `hsip_loop`, and `hsip_stat` utilities. This chapter contains a short description of each utility. Refer to each man page to get more information on the commands. Also see [“Viewing the Man Pages” on page 41](#).

This chapter includes the following topics:

- [“hsip_init Utility” on page 17](#)
- [“hsip_loop Utility” on page 20](#)
- [“hsip_stat Utility” on page 21](#)

Note – You need to be superuser (root) in order to run the `hsip_init`, `hsip_loop`, or `hsip_stat` utilities.

`hsip_init` Utility

The `hsip_init` utility enables you to modify some of the hardware operating modes common to synchronous serial lines. This modification is needed for the operation of some communications packages and is useful in troubleshooting a link. See the `hsip_init(1M)` man page for details.

The `hsip_init` utility includes options for T1 compatibility and operating modes. See [“T1 Compatibility Options” on page 18](#) and [“Operating Modes Options” on page 18](#) for information on these options.

T1 Compatibility Options

The version of the `hsip_init` utility shipped with the SunHSI software has options that enable you to invert data and clock signals to accommodate the requirements of T1 or CEPT transmission equipment. The `hsip_init` parameters that allow for inversion are:

- `txd` – transmit data signal
- `rxd` – receive data signal
- `txc` – transmit clock signal
- `rxc` – receive clock signal

The effect of the default settings for all of these parameters is that SunHSI software does *not* invert the data or clock signal controlled by the parameter. To invert a signal, you specify a setting of the form *param-name=-paramname*, for example, `txc=-txc`.

As an example, suppose you want to invert the transmit and receive data signals on the first SunHSI/U port (port 0) on the second SunHSI/U adapter in your system. To do so, enter the following command:

```
# hsip_init hihp4 txd=-txd rxd=-rxd
```

To invert both clock and data signals, enter:

```
# hsip_init hihp4 txd=-txd rxd=-rxd txc=-txc rxc=-rxc
```

[Appendix C](#) discusses the background and requirements for these inverted settings.

Operating Modes Options

This section describes the operating modes that you can set with the `hsip_init` utility.

The SunHSI software operates in two main operating modes, the high-level data link control (HDLC) mode and the IBM (SDLC) mode. The HDLC mode always operates in a full-duplex, point-to-point fashion. While the IBM mode defaults to a full-duplex, point-to-point, operation, you can also set this mode to be either a half-duplex or a multipoint operation.

HDLC Mode

The default operating mode used by the SunHSI software is the HDLC full-duplex protocol (`mode=fdx`). In this mode the transmitter is always enabled. The transmitter sends flag bytes continuously when it is not sending a data frame.

If no message is currently being transmitted, the driver will attempt to start sending its next message. At this point the driver indicates that it is busy transmitting, to prevent the transmission of another message concurrently. The driver also activates a mechanism that ensures that the transmit operation will not hang if the hardware is not responding.

When the transmission is completed, the busy mechanism previously set is cleared and the next message can be transmitted. If the transmission is hung an abort sequence is sent instead of the cyclic redundancy check (CRC), so that the receiver will not interpret the frame as valid data. The message is discarded, and the output error statistic is incremented, which allows for a proper recovery by higher level protocols.

The received data is buffered until a complete frame has been received. If any error occurs during the reception of a frame, the appropriate statistic is incremented and the frame is discarded.

IBM (SDLC) Mode

SDLC mode is designed to support IBM system network architecture (SNA) communications. It uses most of the same protocols used in HDLC mode, with two major exceptions:

- When the line is idle, instead of sending flag bytes the transmitter is disabled.
- The request-to-send (RTS) and clear-to-send (CTS) signals are used to gate transmission.

IBM Full-Duplex Mode

When the SunHSI software is set to this mode (`mode=ibm-fdx`), the software uses a full-duplex point-to-point communication protocol. Both ends of the link are expected to have RTS and CTS signals asserted at all times when data is being exchanged. When starting a message transmission, the interface raises the RTS signal and expects the CTS signal to be asserted immediately. If this is not done, all messages currently queued for transmission are discarded, and the write operation returns an error.

If the CTS signal drops before the frame transmission is complete, the frame is discarded and the abort error statistic is incremented. If the transmission underruns, an abort sequence is *not* sent and the frame is silently discarded. The RTS signal remains asserted until the data transmission is complete.

IBM Half-Duplex Mode

Half-duplex is a submode of the IBM mode (`mode=ibm-hdx`). Half-duplex mode operates in the same manner as full-duplex mode except that transmission cannot occur while receiving, and vice-versa. When a transmission is completed, the RTS signal is dropped. Dropping the RTS signal tells the remote station to begin transmitting if it is ready to.

IBM MultiPoint Mode

In a multipoint configuration (`mode=ibm-mpt`), more than two stations *share* a link. This configuration is accomplished by designating one station as a primary station and the rest as secondary stations. In this mode, the port acts as a secondary station. The primary station arbitrates traffic on the link by polling the secondary stations, to see if they are ready to transmit.

If a secondary station has data to transmit, it will raise its RTS signal and check for CTS signals. When a CTS signal comes up the station may begin transmitting, following the same rules for RTS and CTS signals used in half-duplex mode. When the transmission is complete the secondary drops the RTS signal, which enables another station to respond to a poll and begin transmitting. The RTS signal cannot be dropped until the transmission is complete.

hsip_loop Utility

The `hsip_loop` utility is high-speed, synchronous, serial loopback test program for high-speed serial interface. The utility performs several loopback tests that exercise the components of a serial communications link. See the `hsip_loop(1M)` man page for more information.

hsip_stat Utility

The `hsip_stat` utility reports the event statistics maintained by the SunHSI device driver. The report might be a single snapshot of the accumulated totals, or a series of samples showing incremental changes. At the beginning of the report, the device name being used to query a particular device appears. See the `hsip_stat(1M)` man page for more information.

Cable Pin Assignments & Signals

This appendix includes the following information:

- [“Pin Assignments” on page 23](#)
- [“Interface Signals” on page 27](#)

Pin Assignments

A shielded, hydra-style breakout cable providing four 37-pin, D-shell (DB-37) DTE connectors is available for the SunHSI/U adapter. Since there are not enough wires to create the signal ground (pin 19) connections, use the shield ground (pin 1) of the DB-37 connector for this signal. The pin assignments for the cabling and connectors are shown in [TABLE A-1](#).

TABLE A-1 RS-449 Connector Pin Assignments

80-Pin Amp. Pin No.	RS-449 Signal Name	RS-449 DB-37 Pin No.	Description
1	RxD1(A)	6	Port 1 Receive Data
2	RxD1(B)	24	Port 1 Receive Data
3	DTR1(A)	12	Port 1 Data Terminal Ready
4	DTR1(B)	30	Port 1 Data Terminal Ready
5	TxD1(A)	4	Port 1 Transmit Data
6	TxD1(B)	22	Port 1 Transmit Data
7	RTS1(A)	7	Port 1 Request To Send
8	RTS1(B)	25	Port 1 Request To Send
9	TxC1(A)	17	Port 1 Transmit Clock

TABLE A-1 RS-449 Connector Pin Assignments (*Continued*)

80-Pin Amp. Pin No.	RS-449 Signal Name	RS-449 DB-37 Pin No.	Description
10	TxC1(B)	35	Port 1 Transmit Clock
11	TxCI1(A)	5	Port 1 Transmit Clock In
12	TxCI1(B)	23	Port 1 Transmit Clock In
13	DCD1(A)	13	Port 1 Data Carrier Detect
14	DCD1(B)	31	Port 1 Data Carrier Detect
15	DSR1(A)	11	Port 1 Data Set Ready
16	DSR1(B)	29	Port 1 Data Set Ready
17	CTS1(A)	9	Port 1 Clear To Send
18	CTS1(B)	27	Port 1 Clear To Send
19	RxC1(A)	8	Port 1 Receive Clock
20	RxC1(B)	26	Port 1 Receive Clock
Shield Ground	SG	1	Port 1 Shield Ground and Signal Ground
21	RxD2(A)	6	Port 2 Receive Data
22	RxD2(B)	24	Port 2 Receive Data
23	DTR2(A)	12	Port 2 Data Terminal Ready
24	DTR2(B)	30	Port 2 Data Terminal Ready
25	TxD2(A)	4	Port 2 Transmit Data
26	TxD2(B)	22	Port 2 Transmit Data
27	RTS2(A)	7	Port 2 Request To Send
28	RTS2(B)	25	Port 2 Request To Send
29	TxC2(A)	17	Port 2 Transmit Clock
30	TxC2(B)	35	Port 2 Transmit Clock
31	TxCI2(A)	5	Port 2 Transmit Clock In
32	TxCI2(B)	23	Port 2 Transmit Clock In
33	DCD2(A)	13	Port 2 Data Carrier Detect
34	DCD2(B)	31	Port 2 Data Carrier Detect
35	DSR2(A)	11	Port 2 Data Set Ready
36	DSR2(B)	29	Port 2 Data Set Ready
37	CTS2(A)	9	Port 2 Clear To Send

TABLE A-1 RS-449 Connector Pin Assignments (*Continued*)

80-Pin Amp. Pin No.	RS-449 Signal Name	RS-449 DB-37 Pin No.	Description
38	CTS2(B)	27	Port 2 Clear To Send
39	RxC2(A)	8	Port 2 Receive Clock
40	RxC2(B)	26	Port 2 Receive Clock
Shield Ground	SG	1	Port 2 Shield Ground and Signal ground
41	RxD3(A)	6	Port 3 Receive Data
42	RxD3(B)	24	Port 3 Receive Data
43	DTR3(A)	12	Port 3 Data Terminal Ready
44	DTR3(B)	30	Port 3 Data Terminal Ready
45	TxD3(A)	4	Port 3 Transmit Data
46	TxD3(B)	22	Port 3 Transmit Data
47	RTS3(A)	7	Port 3 Request To Send
48	RTS3(B)	25	Port 3 Request To Send
49	TxC3(A)	17	Port 3 Transmit Clock
50	TxC3(B)	35	Port 3 Transmit Clock
51	TxCI3(A)	5	Port 3 Transmit Clock In
52	TxCI3(B)	23	Port 3 Transmit Clock In
53	DCD3(A)	13	Port 3 Data Carrier Detect
54	DCD3(B)	31	Port 3 Data Carrier Detect
55	DSR3(A)	11	Port 3 Data Set Ready
56	DSR3(B)	29	Port 3 Data Set Ready
57	CTS3(A)	9	Port 3 Clear To Send
58	CTS3(B)	27	Port 3 Clear To Send
59	RxC3(A)	8	Port 3 Receive Clock
60	RxC3(B)	26	Port 3 Receive Clock
Shield Ground	SG	1	Port 3 Shield Ground and Signal Ground
61	RxD4(A)	6	Port 4 Receive Data
62	RxD4(B)	24	Port 4 Receive Data
63	DTR4(A)	12	Port 4 Data Terminal Ready
64	DTR4(B)	30	Port 4 Data Terminal Ready

TABLE A-1 RS-449 Connector Pin Assignments (*Continued*)

80-Pin Amp. Pin No.	RS-449 Signal Name	RS-449 DB-37 Pin No.	Description
65	TxD4(A)	4	Port 4 Transmit Data
66	TxD4(B)	22	Port 4 Transmit Data
67	RTS4(A)	7	Port 4 Request To Send
68	RTS4(B)	25	Port 4 Request To Send
69	TxC4(A)	17	Port 4 Transmit Clock
70	TxC4(B)	35	Port 4 Transmit Clock
71	TxCI4(A)	5	Port 4 Transmit Clock In
72	TxCI4(B)	23	Port 4 Transmit Clock In
73	DCD4(A)	13	Port 4 Data Carrier Detect
74	DCD4(B)	31	Port 4 Data Carrier Detect
75	DSR4(A)	11	Port 4 Data Set Ready
76	DSR4(B)	29	Port 4 Data Set Ready
77	CTS4(A)	9	Port 4 Clear To Send
78	CTS4(B)	27	Port 4 Clear To Send
79	RxC4(A)	8	Port 4 Receive Clock
80	RxC4(B)	26	Port 4 Receive Clock
Shield Ground	SG	1	Port 4 Shield Ground and Signal ground

Interface Signals

Functional descriptions of the RS-449 interface signals are provided in [TABLE A-2](#).

TABLE A-2 RS-449 Interface Signals

RS-449 Pin Number	Signal Name	Function
1	Shield Ground	Enables tandem sections of shielded cable to retain continuity through the connector.
19	Signal Ground (SG)	Directly connects the DTE circuit ground to the DCE circuit ground, providing a path for DTE and DCE signal commons.
4/22	Transmit Data (TxD)	Used by the DTE to pass binary data to the DCE for transmission over the communications channel.
6/24	Receive Data (RxD)	Used by the DCE to pass binary data received from the communications channel to the DTE.
5/23	Transmit Clock in (TxCI)	Enables the DCE to transmit signal element timing to the DTE. This enables the DTE Transmit Data signal on circuit TxD to be in synchronization with On/Off transitions on this lead.
8/26	Receive Clock (RxC)	Transitions on this lead enables the DTE to time data received over circuit RxD.
17/35	Transmit Clock (TxC)	Enables the DTE to provide transmit timing information to the DCE so that the DTE can synchronize with data arriving over the TxD lead.
7/25	Request to Send (RTS)	Used by the DTE to advise the DCE it is ready to transmit data.
9/27	Clear to Send (CTS)	Used by the DCE to advise the DTE that the DCE is ready to send data over the communications channel.
11/29	Data Set Ready (DSR)	Used to advise the DTE of the Ready status on the DCE. In most cases, this signal simply implies the unit is powered on.
12/30	Data Terminal Ready (DTR)	Used by the DTE to advise the DCE it is ready to transmit or receive.
13/31	Data Carrier Detect (DCD)	The DCE uses this lead to advise the DTE that an incoming signal on the communications channel is present. When first initialized this signal is an indication to the DTE to expect data momentarily.

Null Modem Cable Requirements

A synchronous null modem cable is a specially configured cable that simulates modems that are connected back-to-back. When the distance between the two host systems is not great, you may be able to use a null modem cable instead of a synchronous modem or a synchronous modem eliminator.

The maximum distance a null modem cable can work is determined by the specification for your serial port interface.

There are two steps you must perform to use a null modem cable for machine supplied clocking:

- Run `hsip_init` (see [“Configuring Internal or External Clocking” on page 30](#)) so that the Sun system, in the absence of a synchronous modem, supplies clocking on the serial line.
- Build or configure the cable for the null modem.

Note – You must run `hsip_init` each time you reboot your system.

The following topics are included in this appendix:

- [“Configuring Internal or External Clocking” on page 30](#)
- [“Building the Null Modem Cable” on page 30](#)

Configuring Internal or External Clocking

To configure an RS-449 port to provide transmit clocking for itself as well as receive clocking for the other end of the link, set the `txc` (transmit clock) and `rxc` (receive clock) parameters in `hsip_init` to `baud` and `rxc`, respectively. For example, the following `hsip_init` command sets the data rate of the first SunHSI/U serial port to 9600 bps and sets the clocking as described:

```
# hsip_init hihp0 9600 txc=baud rxc=rx
```

You enter such a command at both ends of a link if both sides are supplying clocking.

If a Sun system is at each end of a link and one system supplies clocking for both sides, enter the following command on the system that is not supplying the clocking:

```
# hsip_init hihp0 9600 txc=txc rxc=rx
```

Building the Null Modem Cable

To build a null modem cable, you can configure your own cable or use a standard cable with an adapter box.

Note – Be sure to use shielded, twisted-pair wire when building a null modem cable.

If you decide to use an adapter box, be sure to obtain an adapter that allows you to change the pin configurations. Preconfigured adapters generally do not work with synchronous protocols because they do not handle clock signals correctly.

RS-449 Null Modem Cable

TABLE B-1 and TABLE B-2 list the signals and names for RS-499 and X.21 circuits.

TABLE B-1 RS-449 Signals

Circuit	Name	Direction
TxD	Transmit Data	To DCE
RxD	Receive Data	From DCE
TxC	Transmit Clock	To DCE
TxCI	Transmit Clock In	From DCE
RxC	Receive Clock	From DCE
RTS	Request to Send	To DCE
CTS	Clear to Send	From DCE
DCD	Data Carrier Detect	From DCE
DTR	Data Terminal Ready	To DCE
DSR	Data Set Ready	From DCE
SG	Signal Ground	

TABLE B-2 X.21 Signals

Circuit	Name	Direction
G	Signal Ground	
T	Transmit	To DCE
R	Receive	From DCE
C	Control	To DCE
I	Indication	From DCE
S	Signal Element Timing	From DCE
B	Byte Timing	From DCE

FIGURE B-1 illustrates a synchronous null modem cable that enables you to connect two Sun systems that each supply clocking, using the RS-449 interface. Each Sun system supplies clocking on pins 17 and 35. The null modem cable routes this clocking to pins 8 and 26 on the opposite side to provide receive clocking.

Because the RS-449 interface is balanced, there are two pins for each signal. For example, Transmit Data (TxD), pins 4 and 22, is connected to Received Data (RxD), pins 6 and 24. This means that pin 4 is connected to pin 6 and pin 22 is connected to pin 24.

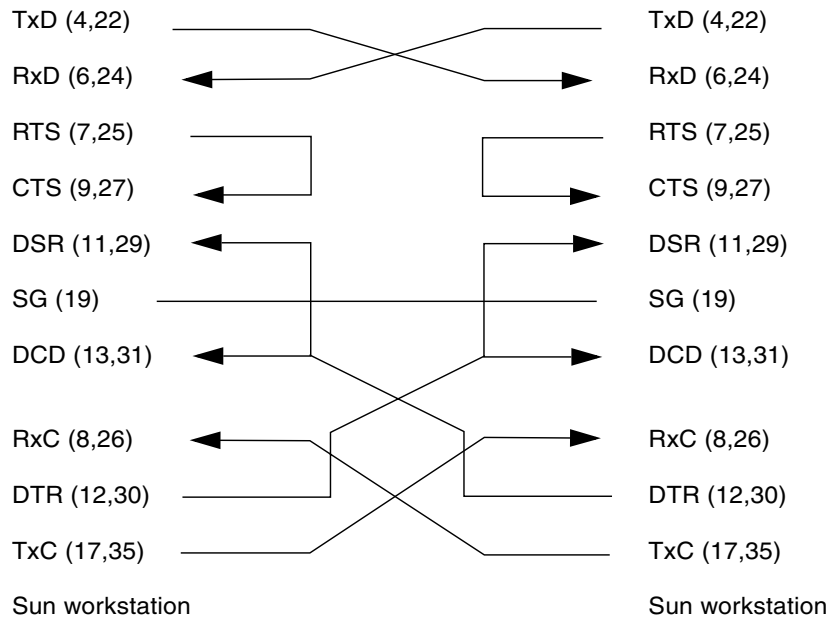


FIGURE B-1 Null Modem Cable –Both Sun Systems Supplies Clocking

FIGURE B-2 illustrates a synchronous null modem cable that enables you to connect to another system, Sun or nonSun, using the RS-449 interface. The Sun system supplies both the transmit and receive clocks for the other system. Note that this null modem cable is not symmetrical.

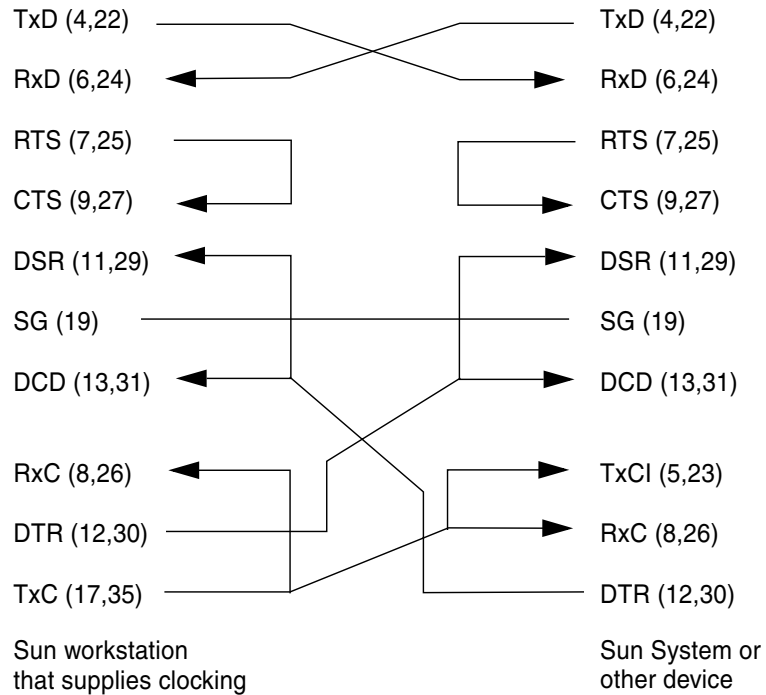


FIGURE B-2 Null Modem Cable -Sun System Supplies Clocking for Both Sides

X.21 to RS-449 Converter

FIGURE B-3 illustrates the pin connections required for an X.21 to RS-449 converter.

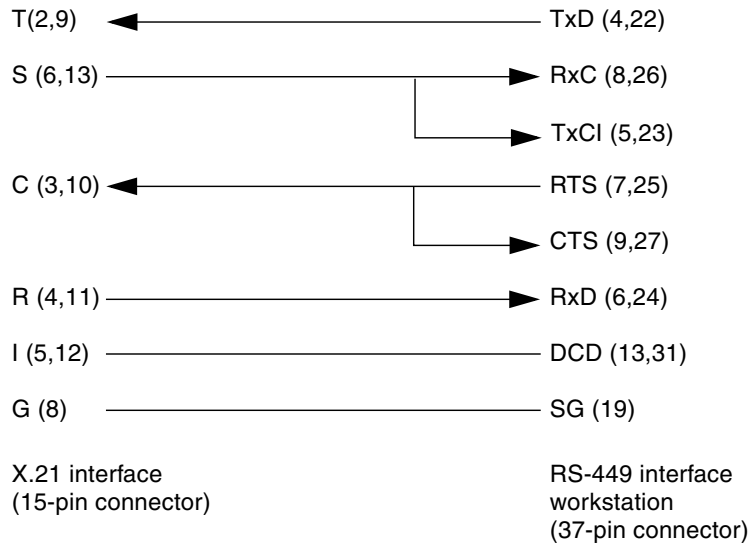


FIGURE B-3 X.21 to RS-449 Converter

When using an X.21 conversion you must perform the following `hsip_init` operation:

```
# hsip_init hihp0 9600 txc=txc rxc=rxc
```

Note – Both receive and transmit clock inputs (RxC and TxCI) need a clock signal if `txc` is set to `txc` and `rxc` is set to `rxc`.

T1 Inverted Data and Clock Signals

This appendix includes the following topics:

- [“Data Signal Inversion” on page 35](#)
- [“Clock Signal Inversion” on page 37](#)

Data Signal Inversion

The requirement for inverting data signals arises from the *ones density* problem you encounter with most T1 transmission lines in North America. The T1 transmission scheme uses a signaling mechanism known as Alternate Mark Inversion (AMI), in which one bits are represented by a positive or negative pulse, while zero bits are represented by the absence of a pulse. In this scheme, the polarity of each pulse must be the opposite of the polarity of the pulse which immediately preceded it. This signaling scheme makes it possible to embed a reference clock for the data into the data stream itself.

Various types of T1 transmission equipment, such as Data Service Units (DSU), Channel Service Units (CSU), repeaters, and various telephone central office equipment, must be able to keep a phase locked loop (PLL) circuit locked on to this reference clock. This PLL circuit uses the pulses generated when one bits are transmitted to lock the embedded clock to a local reference oscillator. To keep the PLL circuit locked on the extracted clock, a certain density of pulses (one bits) must be guaranteed. For North American T1 lines, the density requirement dictates that at least one out of every 16 bits must be a one (see *AT&T Technical Publication 62411*). Another way of stating this is that no more than 15 consecutive zero bits can occur anywhere in the data stream.

T1 lines were originally intended to carry voice traffic, wherein the digitized voice signals could be altered to meet the ones-density requirement by forcing every eighth bit of a voice channel to be a one. This practice introduces a small, but virtually inaudible, amount of distortion in the voice signal. Digital data streams

between two computers are another matter, since the corruption of even one data bit causes a packet to be rejected. Note that in a typical data packet it is quite easy to produce bit patterns that violate the ones-density requirement. A random file could easily contain a sequence of bytes that would produce 16 or more consecutive zero bits if transmitted serially.

There are many different schemes for circumventing the ones-density requirement. The most common technique simply reserves every eighth bit of the signal for a *density bit* and forces this bit to be a one. These bits are not available for data transmission, which means that 12.5 percent of the bandwidth of the T1 line is wasted. When you consider that the lease cost for a coast-to-coast T1 line can be expensive, this waste of bandwidth can be unacceptable. There are alternatives.

Bipolar with 8-Zero Substitution

One alternative of them uses a special code that transmission equipment can generate when using the AMI signalling scheme. This special code depends on the fact that two successive one bits that are represented by pulses of the same polarity result in a signal known as a *Bipolar Violation*. A CSU can be designed so that it will automatically replace any string of eight consecutive zeros with a special code pattern that contains two of Bipolar Violations. A compatible, receiving CSU recognizes this special code and converts it back to a pattern of eight zeros. This technique is known as B8ZS (Bipolar with 8-Zero Substitution).

All CEPT lines (the European equivalent of T1) mandate the use of a variant of B8ZS that reduces the density requirement to no more than three consecutive zeros. However, telephone companies in North America have been slow to adopt B8ZS, because it would entail a significant capital investment. Therefore, the B8ZS solution cannot solve the ones-density problem in the short term.

HDLC Zero Insertion Algorithm

An alternative to B8ZS, an alternative used by the SunHSI product, makes use of the fact that the HDLC framing rules specify that any data stream that contains five or more consecutive one bits requires that the transmitting end insert a zero bit after the fifth one bit. This guarantees that the HDLC flag pattern 01111110 (hex 7E) does not occur randomly inside a frame. The receiving end must automatically discard the zero bit that follows a pattern of five consecutive ones. So, HDLC framing, which is used by SunHSI/U, guarantees that, except for the flag pattern, in any set of six bits at least one bit will be a zero. If you include the flag pattern in any set of seven bits, at least one bit will be a zero.

By inverting the data signal with HDLC framing on both ends of a link, the HDLC zero insertion algorithm becomes a ones insertion algorithm. This guarantees that in any set of seven bits, at least one bit will be a one. Thus, the HDLC data stream meets the density requirements of North American T1 lines without sacrificing any bandwidth.

Clock Signal Inversion

The need to invert clock lines is separate from the need to invert data lines. Most computer, modem, and terminal vendors adhere to an industry standard specification known as RS-334. This specification defines the relationship between a data bit and a reference clock on a synchronous serial link. The specification also dictates that a device should transmit data with reference to the rising edge of the clock signal, and that data should be received with reference to the falling edge of the clock signal.

When using long cables or cables not carrying a clock signal, a phase shift might occur causing a high number of errors. In such cases, inverting the clock signal may correct the phase shift. You may also need to invert the clock signal when connecting a SunHSI/U port to equipment not adhering to the RS-334 standard.

SunVTS Diagnostic Testing

The SunVTS software executes multiple diagnostic hardware tests from a single user interface, and is used to verify the configuration and functionality of most hardware controllers and devices. The SunVTS software operates primarily from a graphical user interface, enabling test parameters to be set quickly and easily while a diagnostic test operation is being performed.

Refer to the SunVTS documents (see [TABLE D-1](#)) for instructions on how to run and monitor the `sunlink` diagnostic. These SunVTS documents are available online at the following URL:

<http://www.sun.com/documentation>

Select the document for the Solaris release on your system.

TABLE D-1 Sun VTS Documentation

Title	Descriptions
<i>SunVTS User's Guide</i>	Describes the SunVTS diagnostic environment.
<i>SunVTS Test Reference Manual</i>	Describes each SunVTS test (including <code>sunlink</code>) and describes the various test options and command-line arguments.
<i>SunVTS Quick Reference Card</i>	Provides an overview of the user interface.

Using the SunVTS `sunlink` Test

The `sunlink` diagnostic test, which is shipped with the SunVTS software, verifies the functionality of SunHSI adapters. This test can be run from the SunVTS user interface, or it can be run from the command line. Refer to the *SunVTS Test Reference Manual* for more information about the `sunlink` test.

Note – Some of the sunlink tests require a RS-449 loopback plug, which can be ordered through Sun (part number 540-1430).

Viewing the Man Pages

The following man pages are included with the SunHSI software:

- `hsip(7d)`
- `hsip_init(1m)`
- `hsip_loop(1m)`
- `hsip_stat(1m)`

If you cannot view these man pages, you need to add the `/opt/SUNWconn/man/` directory to your `MANPATH` environment variable. Depending on the UNIX shell you are using, this variable might be defined in one of a number of startup files.

Man Pages

▼ To View Man Pages in the C Shell Environment

1. **Examine your `$HOME/.login` and `$HOME/.cshrc` files to locate the `MANPATH` variable.**
2. **Using a text editor, add the following line to the end of the file containing the `MANPATH` variable.**

```
setenv MANPATH "/opt/SUNWconn/man/:$MANPATH"
```

If neither of the files in [Step 1](#) contains the `MANPATH` variable, add the following line to the end of one of the files, or contact your system administrator for assistance.

```
setenv MANPATH "/opt/SUNWconn/man/"
```

3. Use the `source` command on the file you edited to make the changes effective in your current window.

For example, if you added the `MANPATH` line to the `.login` file, you would type:

```
hostname% source $HOME/.login
```

Note – If you log out and then back into your system, you update the `MANPATH` variable in all command windows and shells.

▼ To View Man Pages in Bourne or Korn Shell Environments

1. Using a text editor, add these two lines to the end of the `$HOME/.profile` file.

```
MANPATH=/opt/SUNWconn/man:$MANPATH
export MANPATH
```

If this file did not already contain this variable, add the following two lines to the end of the file, or contact your system administrator for assistance.

```
MANPATH=/opt/SUNWconn/man
export MANPATH
```

2. Make the changes effective in your current window.

```
$ . $HOME/.profile
```

Note – If you log out and then back into to your system, you update the `MANPATH` variable in all command windows and shells.

Glossary

AMI	Alternate mark inversion.
bps	Bits per second.
CEPT	European Conference of Postal and Telecommunications Administrations.
CSU	channel service unit.
CPU	central processing unit.
DSU	Data Service Unit.
E1	European equivalent of T1.
HDLC	High-Level Data Link Control.
MHz	MegaHertz.
PLL	Phase-locked loop.
PPP	Point-to-Point Protocol.
SDLC	Synchronous Data Link Control.
SNA	System Network Architecture.
T1	A communications service providing leased-line support for 1,554,000 bps on twisted copper wire.
WAN	Wide area network.

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