CORELIS

USB-1149.1/E

USB-1149.1/E
High-Speed USB Port Boundary-Scan Controller

User's Manual

USB-1149.1/E User's Manual, P/N 70345 REV I

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PRINTING HISTORY

New editions are complete revisions of the manual. Update packages, which are issued between editions, contain additional and replacement pages to be merged into the manual by the customer. The dates on the title page change only when a new edition is published.

A software code may be printed before the date; this indicates the version of the software product at the time the manual or update was issued. Many product updates and fixes do not require manual changes and, conversely, manual corrections may be done without accompanying product changes. Therefore, do not expect a one to one correspondence between product updates and manual updates.

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Chapter 1
Product Overview

Introduction

The USB-1149.1/E High-Speed Boundary-Scan (JTAG) Controller is a member of the Corelis ScanExpress™ family of scan-based test, analysis, and diagnostic tools. The USB-1149.1/E interfaces between a PC equipped with a USB2.0 (or USB1.1) port and any IEEE Standard 1149.1 compatible target. The USB-1149.1/E is designed to control the operation of an IEEE Standard 1149.1 boundary-scan (JTAG) test access port (TAP) by generating the proper signals under software control to interface with the target device. It contains memory-behind-the-pin architecture and supports scan operations at continuous JTAG clock (TCK) speeds of up to 100 MHz.

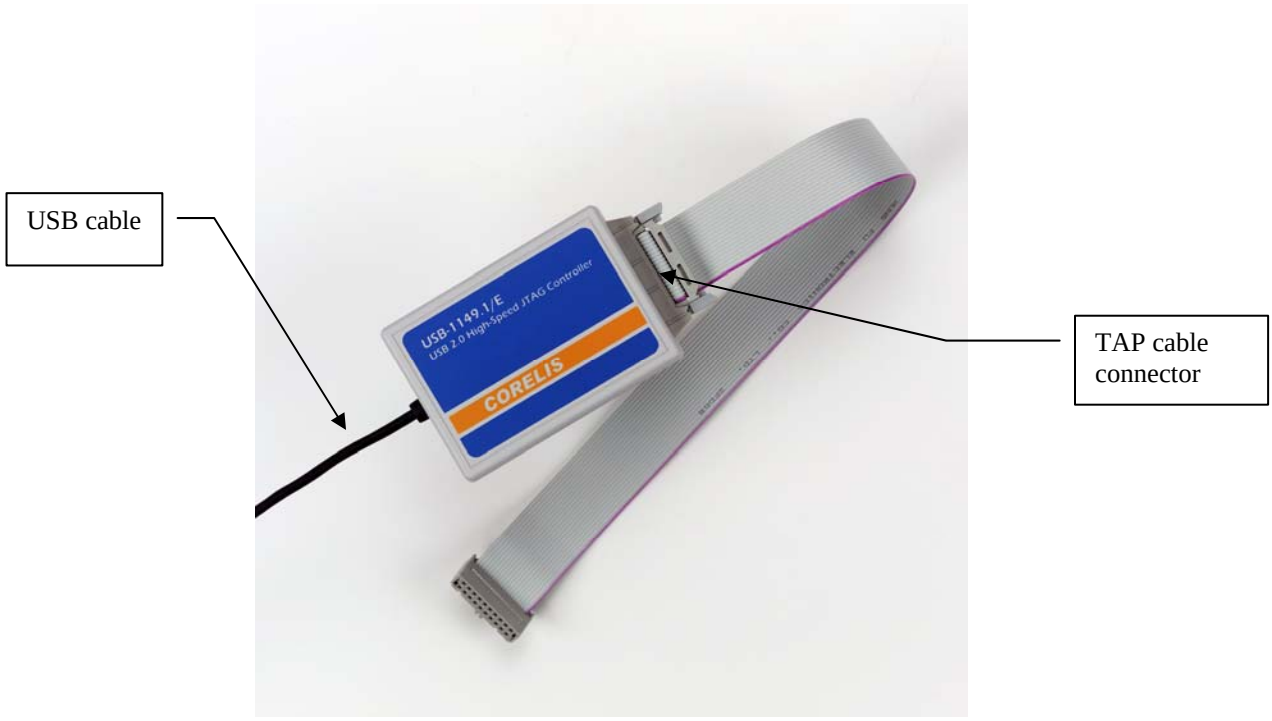

Figure 1-1. The Corelis USB-1149.1/E Boundary-Scan Controller

The USB-1149.1/E facilitates software-controlled boundary-scan operations per IEEE Standard 1149.1. It provides command access to the target's Test Access Port (TAP), accessing device internal registers and on-chip debugger, verifying PCB interconnects, performing functional testing, and debug without manual probing. The JTAG interface also provides access to internal device functions that are not accessible via external probing, enabling fault isolation within the device itself. The JTAG interface also enables programming target FLASH and CPLD devices, as well as data download and uploading to and from the target memory devices.

The USB-1149.1/E is often used to perform microprocessor emulation via the device JTAG port. It is used for firmware development providing single-step, break, and content update/visibility access.

There are several versions of this product, which are optimized for various families of targets, providing enhanced large data block download and upload mechanisms for these respective devices. These differ only by the size and pin assignment of target cable TAP connector. Depending on pins available, these connectors attach zero to three general-purpose discrete i/o signals whose usage is under software control. This enables the non-scanned external write strobe signaling to FLASH's, and/or sensing of the write-cycle device completion, for example. The versions offered as of this publication time are shown in Table 1-1 below.

Model	Model Description	Connector
10342R	Universal model with 20-wire general scan signals header, including ejectors, which mates with an external TAP cable	20 pins
10340	ARC model, similar to 10342, with 20-wire general scan signals header, including ejectors, which mates with an external ARC cable	20 pins

Table 1-1. Model Descriptions

What Is IEEE Standard 1149.1?

The IEEE Standard 1149.1 Test Access Port (TAP) and boundary-scan architecture enable control of an IC, board, or system, via a standard four-signal interface. Each IEEE-1149.1 compliant IC incorporates a feature known as boundary-scan, which ensures that a JTAG controller can control and observe each functional pin of the IC via the JTAG interface. A controller can load test, debug, or initialization patterns serially into the appropriate IC(s) via the IEEE-1149.1 TAP. Thus, even with limited physical access, a user can observe or control IC, board, or system functions.

Two main elements comprise the IEEE Standard 1149.1 test Port: a Test Access Port (TAP), which interfaces internal IC logic with the external world via a four-signal (optionally five-signal) Port as shown in Figure 1-2**,** and a boundary-scan architecture, which defines standard boundary cells that drive and receive data at the IC pins. IEEE Standard 1149.1 also defines both mandatory and optional OPCODES and test features. The test Port signals are: Test Clock (TCK), Test Mode Select (TMS), Test Data In (TDI), Test Data Out (TDO), and the optional Test Logic Reset (TRST).

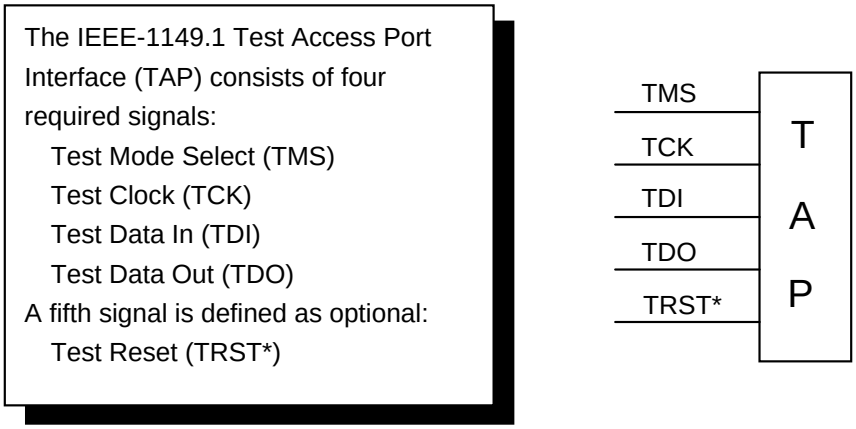

Figure 1-2. Minimal Test Access Port (TAP)

Features of the USB-1149.1/E

The Corelis USB-1149.1/E is a sophisticated test controller that can access devices, boards or systems compliant with IEEE Standard 1149.1. The USB version 2.0 port compatible module supports one JTAG boundary-scan chain (TAP). In addition, three general purpose, bi-directional discrete I/O signals can test or control non-boundary-scan areas of the unit under test (UUT). The discretes can also assist in greatly expediting certain long scan activities, such as FLASH programming. With its software-controlled voltage translating logic for all the above signals, the USB-1149.1/E can test low voltage systems.

The USB-1149.1/E contains several performance enhancing functional sections aimed at streamlining test vector throughput and emulator target download/upload transfers. Key functional elements include the TAP controller, and the memory resources that support it. The on-board memory provides scan data buffering and can at times store the entire scan data for maximum performance, real-time scan operations.

A test system operates the TAP controller and its associated memory through the host USB (2.0, with 1.1 backward compatibility) Port. The high data rate of the USB 2.0 Port is fully supported (up to 480 Mbit/sec.), regardless of actual test clock speeds. This latter TCK rate can operate up to 100 MHz depending on selected signal voltages and target conditions. The on-board memory elements further decouple the scan operations from the host software. A hardware state machine that contains status and control registers accessible through the USB Port directly controls all functions of the USB-1149.1/E.

Hardware mechanisms enable optimal data flow between the USB port and the memory resources paced by the port and/or scanning rates underway, in both directions.

A programmable, time delay skew compensation mechanism supports the USB-1149.1/E's high TCK clock rates. It accommodates the returned target scan stream delays due to signal travel time down and up the cable. It can also adjust for a target's internal TCK-to-TDO response delay.

Adjustable Voltage Interface

The software-programmable voltage level of the discrete I/O and TAP interface can be set to any voltage between 1.25 V and 3.30 V in increments of about 0.05V.

Discrete Input/Output Signals

The USB-1149.1/E operates three discrete input/output signals under software control. These attach to the target TAP connector, depending on the available pins of each product version. They are driven or sensed as directed by software, in coordination with the scanning operation. Each such signal can be configured independently as TTL output, open-collector (open-drain) output, or as input at the programmable voltage level. As open-collector drivers, they can readily tie to similar target signals without the need to alter its circuitry, yet still gain control of related functions, such as a FLASH write signal.

As outputs, these discretes are useful for providing control functions on the user target system such as general reset, power control, device write pulse, disable/enable and/or similar signals for non-boundary-scan target stimulus.

Conversely, as inputs, they enable host sensing of the target to pace scanning activity or related conditions (such as a FLASH ready signal).

By means of these discretes, significant scan cycles can be eliminated in long scan sequences (such as programming a large FLASH).

USB Port Interface

The USB-1149.1/E operates under USB version 2.0 with backward compatibility to version 1.1 (excluding low speed). Speed adjustment is automatic per the standard. This host port also supplies the power to operate the USB-1149.1/E. The hot plug-in/out feature of this standard is fully supported. The user simply plugs it into a PC USB socket, and it is auto-sensed as ready-to-scan.

For optimal performance, the user is recommended to utilize a host PC with a USB 2.0 port, given the considerably higher transfer rate.

Do not connect the USB-1149.1/E to the host PC through a passive (un-powered) USB hub, as it may not provide the USB-1149.1/E with adequate operating power from the host PC.

Programmable Clocks

The USB-1149.1/E's programmable TCK output to the IEEE Standard 1149.1 compatible target system can be configured over a wide range of frequencies, using on-board clock generation circuitry. A programmable Phase Locked Loop (PLL) enables both a wide range and fine selection resolution. See Table 1-2 for the set of programmable values.

TCK range (MHz)	Rate Resolution (MHz)
15 to 100	1
1 to 15	0.5
.05 to 1	0.05

Table 1-2. Programmable TCK Frequencies

USB-1149.1/E Specifications

Host Computer

CPU	Pentium III @ 1GHz or better, with USB 1.1, or 2.0 (preferred for top performance) Port. Do not connect the USB-1149.1/E to the host through a passive (un-powered) USB hub as it may not provide the USB-1149.1/E with adequate operating power from the host PC.
Operating System	Windows 2000, XP

USB Interface

Version	2.0 (backward compatible to 1.1, excluding low speed)
Memory Space Size	128 Kbits

TAP Interface

Maximum TCK frequency	100 MHz
TCK frequency steps	1.00 MHz increments between 15 and 100 MHz
TCK frequency steps (cont'd)	0.50 MHz increments between 1 and 15 MHz
TCK frequency steps (cont'd)	0.05 MHz increments between 0.05 and 1 MHz
Maximum scanning data length	unlimited

Target Interface Signal DC Characteristics

Symbol	Test Conditions	Limit Min	Limit Max	Units
V_{IH}	Vdd Adjust >= 2.7 V	2	Vdd + 0.5	V
	Vdd Adjust < 2.7 V	0.65 × Vdd	Vdd + 0.5	V
V_{IL}	Vdd Adjust >= 2.7		0.8	V
	Vdd Adjust <= 2.0		0.35 × Vdd	V
V_{OH}	I_{OH}= -12 mA	Vdd – 0.5		V
V_{OL}	I_{OL} = 12 mA		0.4	V

Table 1-3. Target Interface Signal DC Characteristics

Physical

Module Outline Dimensions (box)	2.286 in. × 3.236 in. x 0.86 in.
Built-in USB Cable	6 feet
Target Cable	12 inches

I/O Connectors

USB Connector	Standard USB connector, type A plug at the host end of the built-in cable.
JTAG connector	20 pin (2x10) header with long ejectors, 3M part number 3428-5602 or equivalent, mating to external cable.

Power Requirements

5 V	provided via the USB cable in compliance with specification

Operating Environment

Temperature	0°C to 55°C
Relative Humidity	10% to 90%, non condensing

Storage Environment

Temperature	-40°C to 85°C

Chapter 2
USB-1149.1/E Installation

The USB-1149.1/E product model 10342R consists of the following components:

- USB-1149.1/E USB2.0 based boundary-scan controller module
- USB-1149.1/E User's Manual
- 15310-2 Cable, 20 pin header to 10 pin TAP, 12"
- 15311-2 Cable, 20 pin header to 16 pin TAP, 12"
- 15312-2 Cable, 20 pin header to 20 pin TAP, 12"

USB cabling is built into the unit and receives power from the host PC. No external power supply is required.

Ensure all materials listed are present and free from visible damage or defects before proceeding. If anything appears to be missing or damaged, contact Corelis at the number listed on the front cover immediately.

The following optional target interface cables are also available from Corelis:

- 20-pin to 14-pin EJTAG TAP Adapter Cable, Corelis P/N 15425
- 20-pin to 20-pin ARM TAP Adapter Cable, Corelis P/N 15432
- 20-pin to 16-pin PowerPC TAP Adapter Cable, Corelis P/N 15433
- 20-pin to 15-pin ARC TAP Adapter Cable, Corelis P/N 15436

Software Installation First!

The installation procedure requires the use of software that contains the driver for the USB-1149.1/E module. Obtain the ScanExpress CD-ROM (or any other Corelis application that supports the USB-1149.1/E module) in order to proceed with installation. **Install the ScanExpress Application Software before installing the USB-1149.1/E controller.** The USB-1149.1/E controller is a hot-pluggable USB device, and its drivers are installed with the ScanExpress Application Software. Windows will automatically recognize and configure the USB-1149.1/E the first time it is detected in your system.

WARNING !

You MUST install the software first – before installing the unit. **Do not install the USB-1149.1/E unit until you have successfully installed the application software** (ScanPlus, CodeRunner, etc.). Installing the software provides the hot-plug USB driver for the unit so that the operating system is able to properly detect and configure the unit. Installing the unit before the software may result in improper unit configuration and operation.

In the event that you installed the USB-1149.1/E controller before installing the software, unplug the module, **cancel** the **Add/Remove Hardware Wizard** (that will automatically show up when you use Windows 2000 or Windows XP operating system) and install the ScanExpress Applications from the CD. The next time you start the PC and plug in the USB-1149.1/E, Windows will automatically recognize and configure the USB-1149.1/E.

Hardware Installation

To install the USB-1149.1/E on a host PC, follow the installation steps below. Note that you must install the application CD first and only then plug in the USB-1149.1/E controller into an available USB port on the host PC. When Windows detects the controller, it will automatically start the **Found New Hardware Wizard** to guide the user through the driver installation process. The following section describes this process in detail under Windows XP with Service Pack 2. Note that depending on the version of windows, the procedure may differ slightly.

Installation Steps:

1. Install the application software, such as ScanExpress Runner, from the CD on your computer.

2. Plug the USB cable of the USB-1149.1/E module into the any available USB mating connector on your PC.

3. The **Found New Hardware Wizard** dialog box will automatically start as shown below in Figure 2-1.

4. Select "No, not this time" as shown below and click on the **Next** button.

Figure 2-1. Found New Hardware Wizard (WinXP)

5. The following dialog box as shown in Figure 2-2 will pop up. Select "Install the software automatically (Recommended)" and click on the **Next** button.

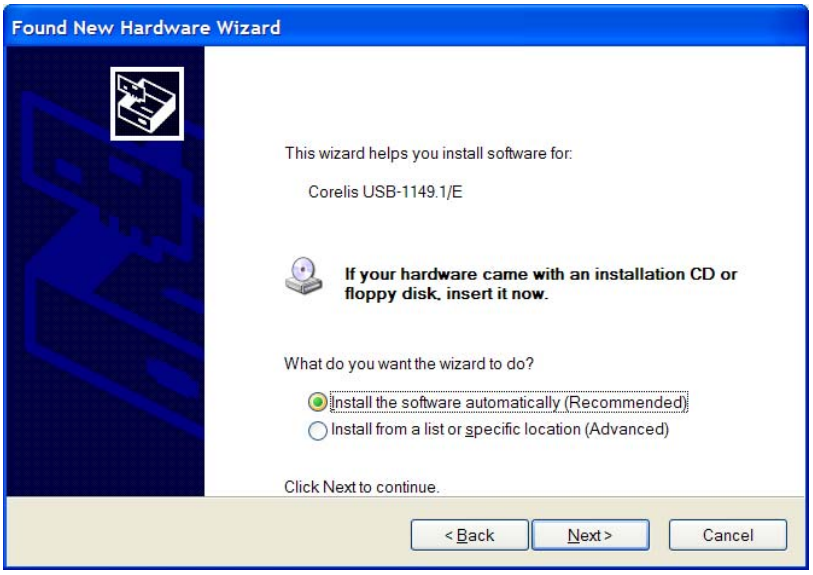

Figure 2-2. Found New Hardware Wizard (WinXP)

6. Under Windows XP, a warning dialog box will pop up indicating that the device driver has not passed Windows logo testing as shown in Figure 2-3. You can safely ignore the warning and continue installation process by pressing the **Continue Anyway** button.

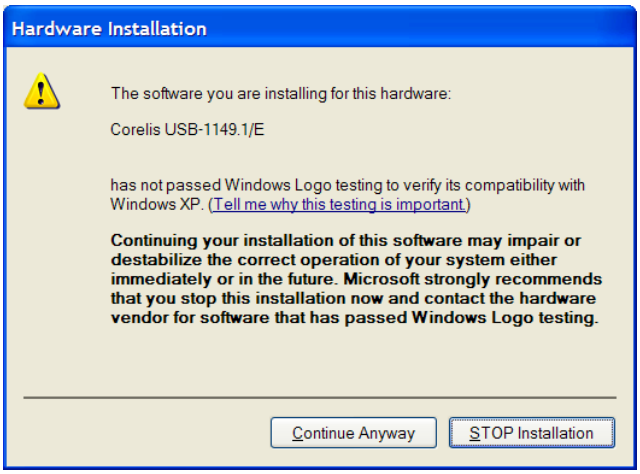

Figure 2-3. Windows Logo Warning Dialog (WinXP)

7. After the necessary files are copied to the system, the following dialog box, Figure 2-4, will pop up indicating that the device driver is successfully installed.

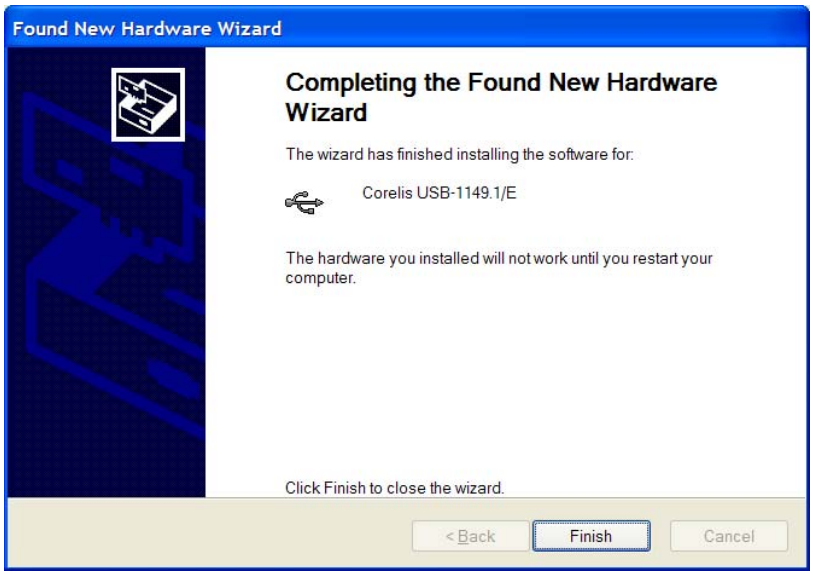

Figure 2-4. Installation Successfully Completed (WinXP)

8. Click on the **Finish** button to close the dialog box. After closing the dialog box, Windows will install another device driver for the controller. The **Found New Hardware Wizard** dialog box will automatically start as shown below in Figure 2-5.

9. Select "No, not this time" as shown below and click on the **Next** button.

Figure 2-5. Found New Hardware Wizard (WinXP)

10. The following dialog box as shown in Figure 2-6 will pop up. Select "Install the software automatically (Recommended)" and click on the **Next** button.

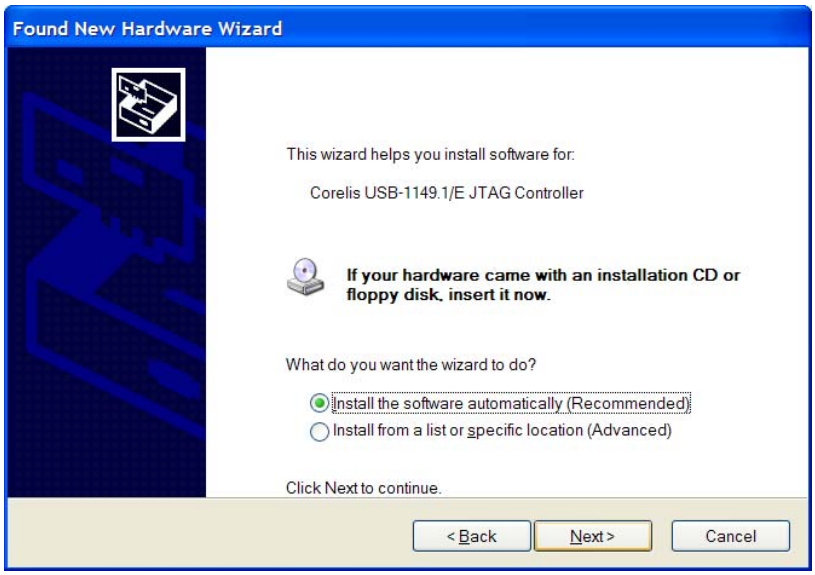

Figure 2-6. Found New Hardware Wizard (WinXP)

11. Under Windows XP, a warning dialog box will pop up indicating that the device driver has not passed Windows logo testing as shown in Figure 2-7. You can safely ignore the warning and continue installation process by pressing the **Continue Anyway** button.

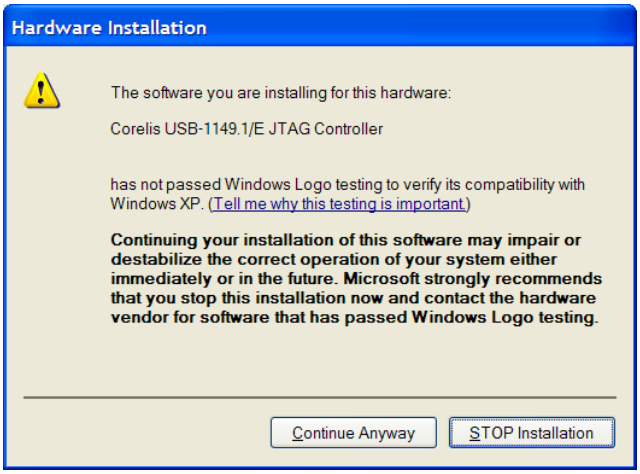

Figure 2-7. Windows Logo Warning Dialog (WinXP)

12. After the necessary files are copied to the system, the following dialog box, Figure 2-8, will pop up indicating that the device driver is successfully installed. Click on the **Finish** button to complete the driver installation.

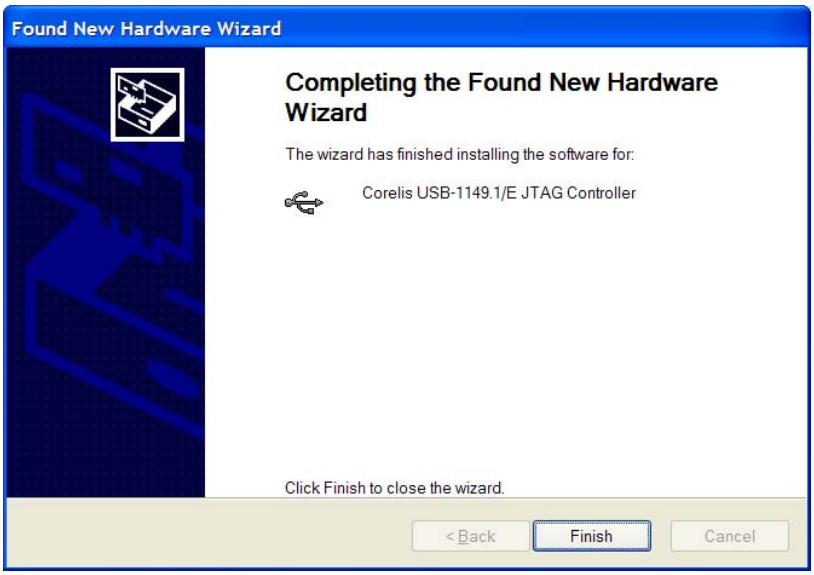

Figure 2-8. Installation Successfully Completed (WinXP)

13. The installation of the device drivers is now completed. Verify that the USB-1149.1/E was correctly installed by checking for its entry in the **Windows Device Manager**. To run the **Device Manager**, right mouse click on the **My Computer** icon and then select **Properties**. Choose the **Hardware** tab and click on the **Device Manager** button. **Corelis USB-1149.1/E JTAG Controller** should be listed in the **Universal Serial Bus controller** section as shown in Figure 2-9.

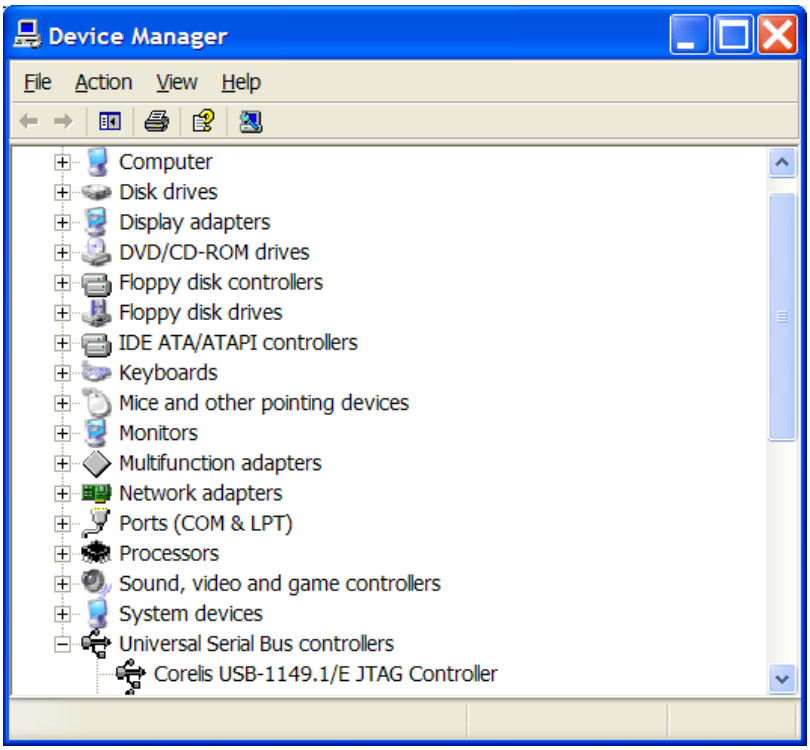

Figure 2-9. Windows Device Manager (WinXP)

Congratulations! You now successfully installed the USB-1149.1/E drivers on your computer and it is ready to be used. We suggest that you preserve the original packing material for the future shipment or storage of the USB-1149.1/E.

Chapter 3
Connecting to the Target

Connecting to the Target

The connection to the user target (UUT) board/system is done using the TAP cable that connects to the 20 pin connector on the USB-1149.1/E box on the opposite side of the USB cable.

To connect the TAP cable connector to the target (UUT) follow these steps in the order listed:

1. Verify that the target power is OFF.
2. Plug the TAP cable connector to the mating target header.
3. Now you can turn the target power ON.

ALERT !

Make sure your target board is connected to GROUND prior to powering up the target board. This assures that the target power return flows through its power supply return (GND) signal and not through the ground wire of the USB cable. Otherwise, with a 'floating' target if the user hot-plugs the target power cable from its external supply (such as a 'brick' type power supply) there is no guarantee that the ground will make contact with the target first, before the power does. In such case, it is possible to momentarily engage the voltage pin of the target power supply connector prior to engaging the ground (return) pin. During such action all target current will momentarily flow through the USB cable to ground with the resulting transients possibly resetting the USB-1149.1/E unit.

Appendix A contains general recommendation for implementing compatible target TAP connector(s). Following these recommendations makes the connection to the target easy and straightforward.

To accommodate target boards with TAP connectors other than this standard, Corelis offers short, custom adapter cables for connectors such as the Altera ByteBlaster connector, the Xilinx 9 pin header, the Lattice TAP connector or the TI 14 pin DSP connector)

Target Connector Pin Assignments

The following tables enumerate the pinout of the TAP connector for each of the USB-1149.1/E target cables.

Pin	Signal	Direction	USB-1149.1/E side termination
1	TRST*	Input to the UUT	33 ohm series
2	GND		
3	TDI	Input to the UUT	33 ohm series
4	GND		
5	TDO	Output from the UUT	4.7K pull-up
6	GND		
7	TMS	Input to the UUT	33 ohm series
8	GND		
9	TCK	Input to the UUT	33 ohm series
10	GND		
11	DISCR0 (external write*)	Input to the UUT (also general I/O)	4.7K pull-up
12	GND		
13	DISCR1	Discrete Input/output to UUT	4.7K pull-up
14	GND		
15	DISCR2 (ready/busy)	Output from the UUT (also general I/O)	4.7K pull-up
16	GND		
17	Reserved		
18	GND		
19	Reserved		
20	Reserved		

Table 3-1. Cable 15312-2 TAP Connector Pin Assignments

Pin	Signal	Direction	USB-1149.1/E side termination
1	TRST*	Input to the UUT	33 ohm series
2	GND		
3	TDI	Input to the UUT	33 ohm series
4	GND		
5	TDO	Output from the UUT	4.7 pull-up
6	GND		
7	TMS	Input to the UUT	33 ohm series
8	GND		
9	TCK	Input to the UUT	33 ohm series
10	GND		
11	DISCR0 (external write*)	Input to the UUT (also general I/O)	4.7K pull-up
12	GND		
13	DISCR1	Discrete Input/output to UUT	4.7K pull-up
14	GND		
15	DISCR2 (ready/busy)	Output from the UUT (also general I/O)	4.7K pull-up
16	GND		

Table 3-2. Cable 15311-2 TAP Connector Pin Assignments

Pin	Signal	Direction	USB-1149.1/E side termination
1	TRST*	Input to the UUT	33 ohm series
2	GND		
3	TDI	Input to the UUT	33 ohm series
4	GND		
5	TDO	Output from the UUT	4.7k ohm pull-up
6	GND		
7	TMS	Input to the UUT	33 ohm series
8	GND		
9	TCK	Input to the UUT	33 ohm series
10	GND		

Table 3-3. Cable 15310-2 TAP Connector Pin Assignments

Pin	Signal	Direction	USB-1149.1/E side termination
1	TRST*	Input to the UUT	33 ohm series
2	GND		
3	TDI	Input to the UUT	33 ohm series
4	GND		
5	TDO	Output from the UUT	4.7k ohm pull-up
6	GND		
7	TMS	Input to the UUT	33 ohm series
8	GND		
9	TCK	Input to the UUT	33 ohm series
10	GND		
11	DISCR0 (external write*)	Input to the UUT (also general i/o)	4.7k ohm pull-up
12	Not connected		
13	DISCR1	Discrete Input/output to UUT	4.7k ohm pull-up
14	Not connected		

Table 3-4. EJTAG Compatible Cable 15425 TAP Connector Pin Assignments

Pin	Signal	Direction	USB-1149.1/E side termination
1	Not connected		
2	Not connected		
3	TRST*	Input to the UUT	33 ohm series
4	GND		
5	TDI	Input to the UUT	33 ohm series
6	GND		
7	TMS	Input to the UUT	33 ohm series
8	GND		
9	TCK	Input to the UUT	33 ohm series
10	GND		
11	Not connected		
12	GND		
13	TDO	Output from the UUT	4.7k ohm pull-up
14	GND		
15	DISCR1	Discrete Input/output to UUT	4.7k ohm pull-up
16	GND		
17	DISCR2 (ready/busy)	Output from the UUT (also general I/O)	4.7k ohm pull-up
18	GND		
19	DISCR0 (external write*)	Input to the UUT (also general i/o)	4.7k ohm pull-up
20	GND		

Table 3-5. ARM Compatible Cable 15428 TAP Connector Pin Assignments

Pin	Signal	Direction	USB-1149.1/E side termination
1	TDO	Output from the UUT	4.7k ohm pull-up
2	GND		
3	TDI	Input to the UUT	33 ohm series
4	TRST*	Input to the UUT	33 ohm series
5	Not connected		
6	Not connected		
7	TCK	Input to the UUT	33 ohm series
8	Not connected		
9	TMS	Input to the UUT	33 ohm series
10	Not connected		
11	DISCR2	Discrete Input/output to UUT	4.7k ohm pull-up
12	DISCR0	Discrete Input/output to UUT	4.7k ohm pull-up
13	DISCR1	Discrete Input/output to UUT	4.7k ohm pull-up
14	Not connected		
15	Not connected		
16	GND		

Table 3-6. PorwerPC Compatible Cable 15433 TAP Connector Pin Assignments

Chapter 4
Using USB-1149.1/E with ScanExpress

Hardware Setup

You must configure the USB-1149.1/E controller in a ScanExpress application before the application can use it. This chapter uses ScanExpress Runner as an example to illustrate the configuration process.

Using USB-1149.1/E with ScanExpress Tools

The USB-1149.1/E unit is compatible with ScanExpress Runner, ScanExpress Debugger and ScanExpress Programmer. The following steps are provided for ScanExpress Runner. Selecting the module in ScanExpress Debugger or ScanExpress Programmer is done in a similar fashion.

1. Make sure that USB-1149.1/E controller is plugged in to your PC. Wait 3 to 5 seconds before starting ScanExpress Applications if you just plugged in the controller.
2. Invoke the ScanExpress Runner application.
3. Click the **Setup** menu item and then select the **Controller** entry to display the Controller Configuration screen shown in Figure 4-1.

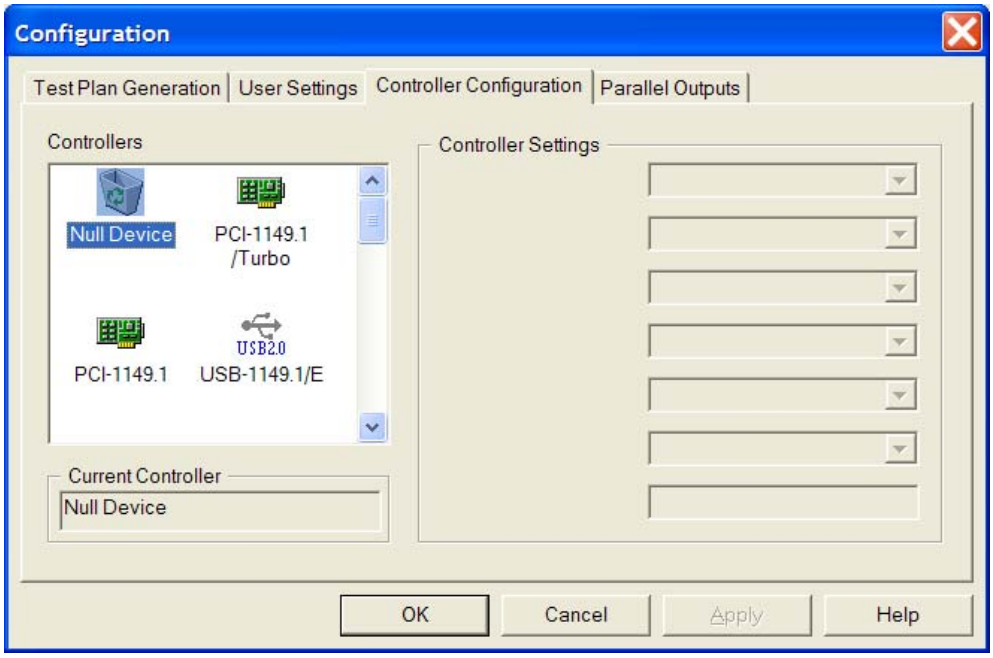

Figure 4-1. Controller Configuration Screen

4. Select the **USB-1149.1/E** controller from the icons on the left. Adjust the settings to the desired values.

5. After you have made your selections, click on the **Apply** button to test and save the settings. When the program saves the settings successfully, it displays the controller in the **Current Controller** box. If ScanExpress Runner cannot find the controller, it displays an error dialog.

6. Once ScanExpress Runner finds the USB-1149.1/E controller, it displays a screen similar to Figure 4-2.

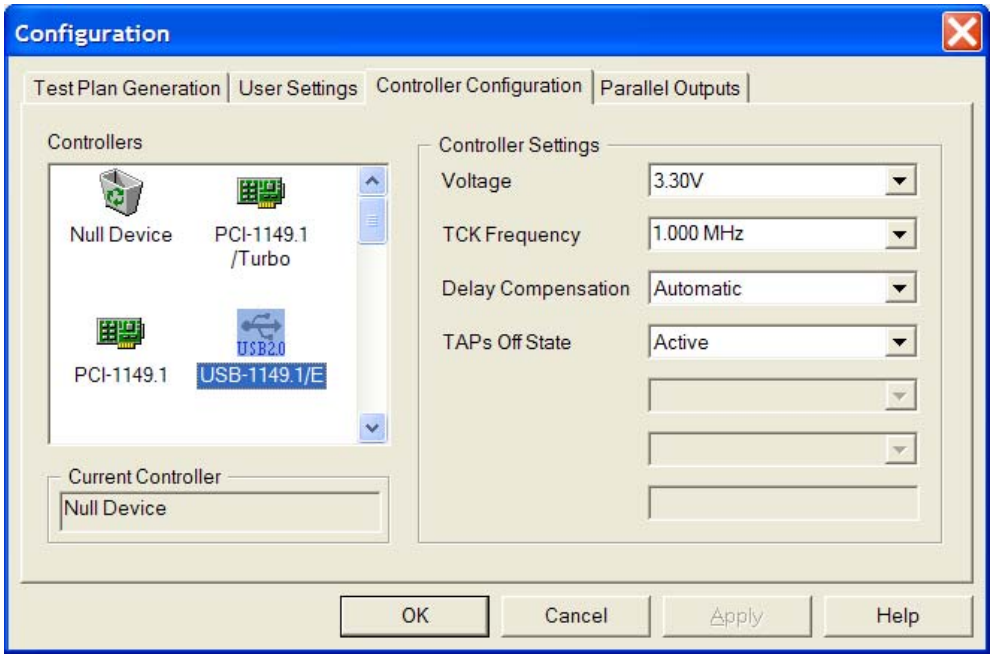

Figure 4-2. USB-1149.1/E Setup Screen

Chapter 5
Third Party Application Interface

ScanExpress Runner provides a general purpose, third-party application interface that includes specifying the correct controller and settings. This section clarifies the requirements related to the USB-1149.1/E unit. Refer to the ScanExpress Runner manual for further information.

Using USB-1149.1/E with ScanExpress Runner Command-line

You can invoke ScanExpress Runner with special command line parameters to execute a Test Step file, provide test results and diagnostic messages in a log file (if you have the ScanExpress Runner ADO), and then terminate. The following table shows the controller identifiers and associated parameters. Consult the ScanExpress Runner User's Manual for more detail.

The USB-1149.1/E controller uses 3 parameters. The parameters are described in the table below.

Controller keyword: **USB-1149.1/E**

Position	Parameter	Value	Setting
1	TAP Voltage	1 2 … 41 42	1.25 V 1.30 V … (0.05 volts per step) 3.25 V 3.30 V
2	Clock Frequency	1 … 86 87 … 114	100 MHz … (1 MHz increment) 15 MHz 14.5 MHz … (0.5 MHz increment) 1 MHz

Table 5-1. USB-1149.1/E Controller Parameters

Position	Parameter	Value	Setting
3	Delay Compensation	1	Automatic
		2	No Delay
		3	0.5 Clock Delay
		4	1.0 Clock Delay
		5	1.5 Clock Delay
		6	2.0 Clock Delay
		7	2.5 Clock Delay
		8	3.0 Clock Delay

Table 5-1. USB-1149.1/E Controller Parameters (continued)

Example:

To select a USB-1149.1/E controller with a TAP voltage of 3.30 V, TCK frequency of 1 MHz, and automatic delay compensation, use this "controller specification" string:

```
-controller "USB-1149.1/E,42,113,1,,,,"
```

Appendix A
Recommended Target Connectors

10-pin TAP Connector

The Boundary-Scan TAP is a well-defined IEEE-1149.1-compatible electrical interface between boundary-scan test equipment and the boundary-scan compatible devices in the user's target board. Boundary-scan based test equipment, such as the Corelis ScanExpress family of products, utilize a single TAP to interface to the UUT. This section explains how to implement a simple TAP connector that is compatible with most standard test equipment.

The TAP contains 5 signals: TCK, TMS, TDO, TDI and optionally TRST*. It also contains ground signal(s). Corelis recommends the standard TAP connector shown in Figure A-1, which is widely regarded as the industry standard. Note that each signal is terminated with a resistor (discussed below) in order to improve noise immunity.

The connector on the user's target should have a standard flat cable compatible pinout to match the TAP connector described in Table A-1. Figure A-1 shows the top view of the basic target 10-pin connector header (0.100 × 0.100 in. spacing):

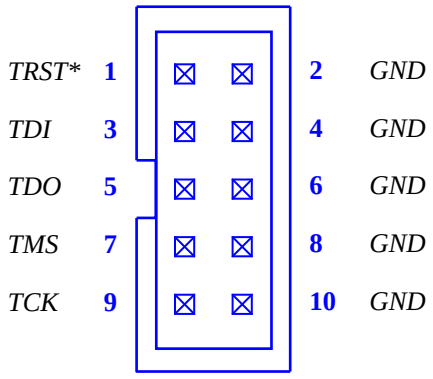

Figure A-1. Standard 10-pin TAP connector (top view)

Table A-1 describes the 10 pin TAP connector signals and Corelis recommended values of terminating resistors:

Pin	Signal	Direction	Termination
1	TRST*	Input to the UUT	1K pull-up (or 1.5K pull-down)
2	GND		
3	TDI	Input to the UUT	1K pull-up
4	GND		
5	TDO	Output of the UUT	33 ohm series
6	GND		
7	TMS	Input to the UUT	1K pull-up
8	GND		
9	TCK	Input to the UUT	1K pull-up
10	GND		

Note: Some target boards may require a pull-down resistor on the TRST* signal to assure normal device operations when not in boundary-scan test mode.

Table A-1. Signal Description and Termination

Table A-2 summarizes the specifications for the 10-pin TAP connector. Equivalent connectors are available from other manufacturers.

Reference	Description	Manufacturer	Part Number
10-Pin Target TAP	Straight header, 10-pin, 4 wall, with center notch	3M	3473-6610

Table A-2. Standard 10-Pin TAP Connector

Figure A-2 shows a typical schematic of the target TAP connector with the recommended termination resistors. The 1K pull-up resistors should connect to the target Vcc supply corresponding to the interface voltage (programmable on the USB-1149.1/E from 1.25 to 3.3 V). Recommended resistor values are +/- 5%.

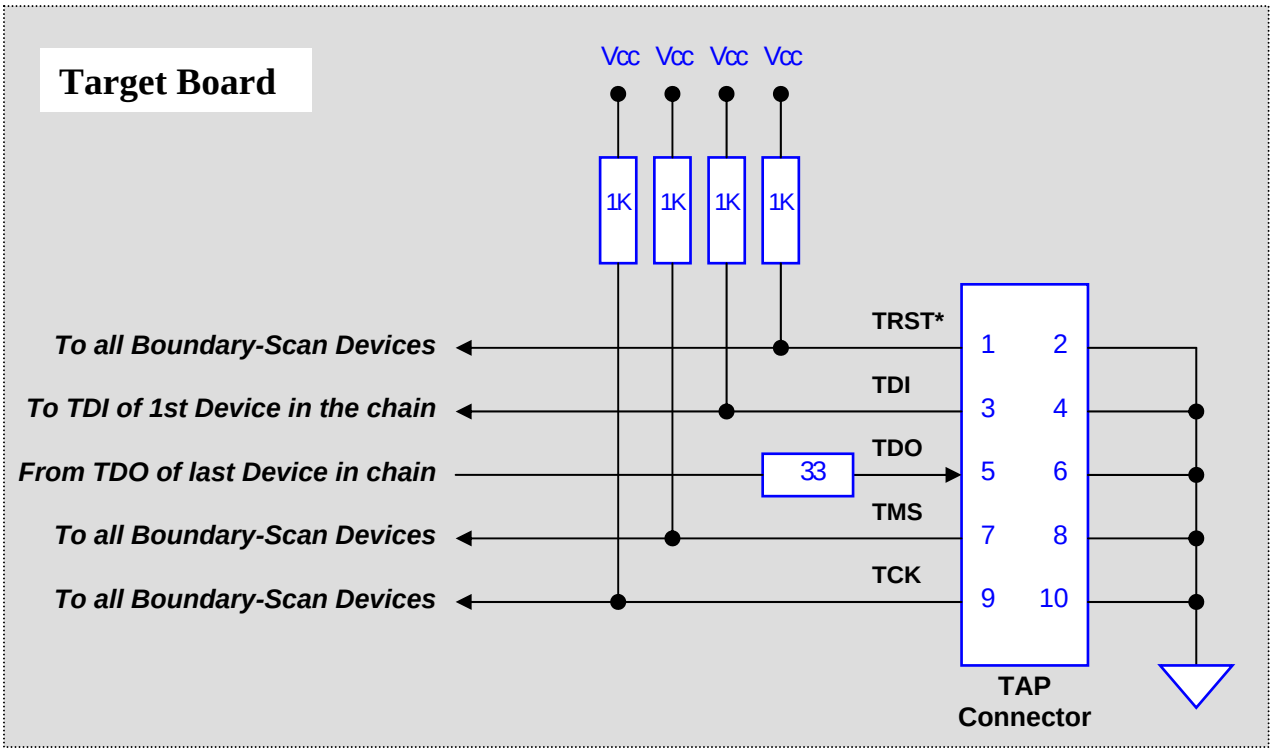

Figure A-2. TAP Connector Schematic

16-pin Flash Programming TAP Connector

To build in support for in-circuit programming of flash or microprocessor devices, Corelis recommends including supplemental control signals in the TAP interface. The ScanExpress Programmer can use a 16-pin TAP, similar to Figure A-3, to improve programming time. This interface adds Write_Strobe*, Ready/Busy*, and ground signals to the standard 5-signal interface. Terminating resistors (see Table) can improve signal quality.

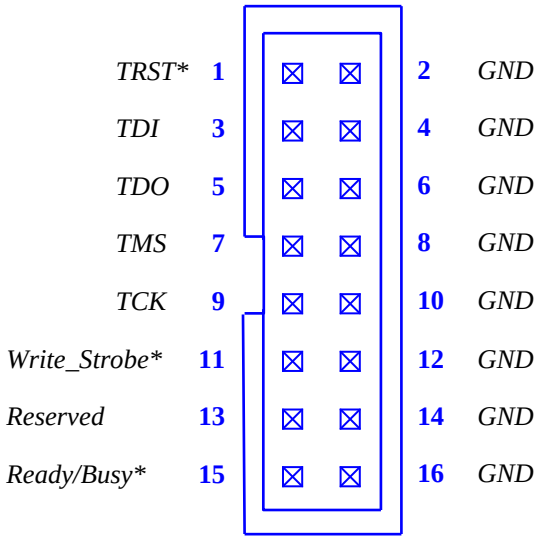

Figure A-3. Boundary-scan Flash Programming 16-pin TAP Connector (top view)

Corelis' Flash Programming software supports the external signals Write_Strobe* and Ready/Busy*, in addition to the standard but slower scanned out/in signals approach.

The Write_Strobe* signal is active low and should be pulled up with a 1K resistor on the target board. It needs to be logically OR-ed with the flash Write-Enable (WE*) signal so that either the flash Write-Enable (WE*) signal or the external Write_Strobe* going low will assert the flash WE* input.

The active low Ready/Busy* signal is typically an open-collector/open-drain signal that ties directly to the same signal(s) on the Flash device(s). This enables multiple devices to drive it toward the USB-1149.1/E.

Table A-3 summarizes the specifications for a 16-pin TAP connector without latch ejector. Equivalent connectors are available from other manufacturers.

Reference	Description	Manufacturer	Part Number
Flash TAP	Straight header, 16-pin, 4 wall, with center notch	3M	2516-6002UG

Table A-3. Flash Programming TAP 16 Pin Connector

Table A-4 describes the signals and Corelis recommended values of terminating resistors:

Pin	Signal	Direction	Termination
1	TRST*	Input to the UUT	1K pull-up (or 1.5K pull-down)
2	GND		
3	TDI	Input to the UUT	1K pull-up
4	GND		
5	TDO	Output from UUT	33 ohm series
6	GND		
7	TMS	Input to the UUT	1K pull-up
8	GND		
9	TCK	Input to the UUT	1K pull-up
10	GND		
11	Write_Strobe*	Input to the UUT	1K pull-up
12	GND		
13	Reserved		
14	GND		
15	Ready/Busy*	Output from UUT	1K pull-up
16	GND		

Note: Some target boards may require a pull-down resistor on the TRST* signal to assure normal device operations when not in boundary-scan test mode

Note: The target TDI signal is driven by the TDO signal of the boundary-scan controller

Note: The target TDO signal drives the boundary scan controller's TDI signal

Table A-4. Signal Description and Termination

Figure A-4 shows a typical schematic of the target TAP connector with termination resistors. The 1K pull-up resistors should connect to the target Vcc supply corresponding to the interface voltage (programmable on the USB-1149.1/E from 1.25 to 3.3 V). Recommended resistor values are +/- 5%.

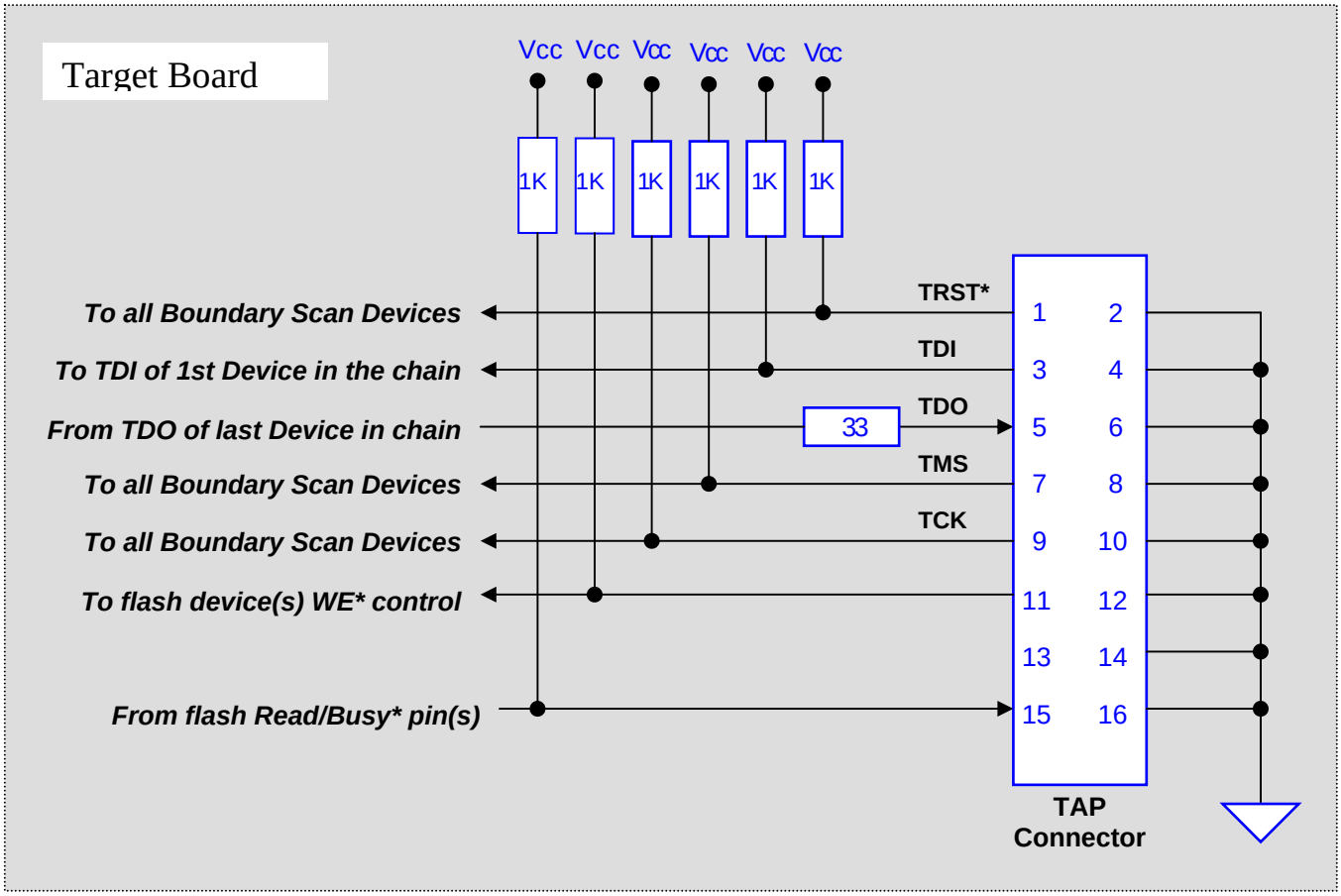

Figure A-4. Flash Programming TAP Connector Schematics

20-pin TAP Connector

The 20-pin TAP connector is an enhanced 16-pin connector, with all seven 16-pin TAP signals, plus two additional signals and grounds for Corelis ScanTAP intelligent pod products. These two signals serve additional functions such as power monitoring / power short testing. However, USB-1149.1/E controller does **not** support power monitoring / power short testing. This information is provided here for your information only.

The connector on the user's target should have the standard flat cable compatible pin out. Connect ***all*** grounds directly to the target's ground plane. Below is the top view of the target 20-pin connector header (0.100" x 0.100" spacing):

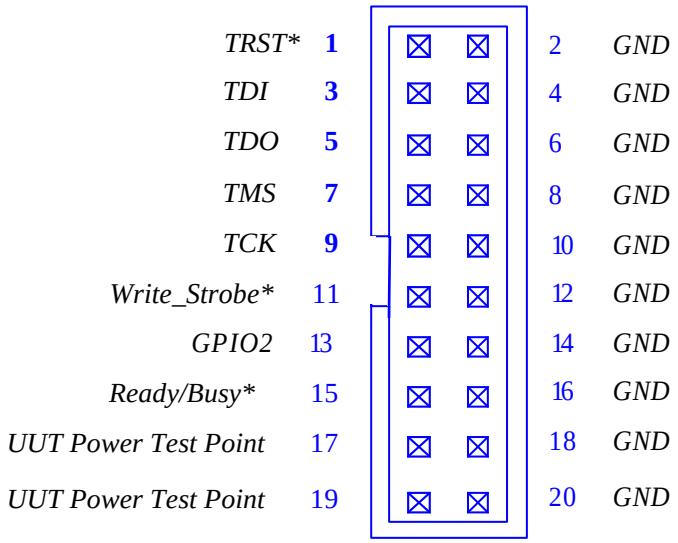

Figure A-5. Boundary-scan 20-pin TAP Connector (top view)

Pin	Signal	Direction	Termination
1	TRST*	Input to the UUT	1K pull-up
2	GND		
3	TDI	Input to the UUT	1K pull-up
4	GND		
5	TDO	Output of the UUT	33 ohm series
6	GND		
7	TMS	Input to the UUT	1K pull-up
8	GND		
9	TCK	Input to the UUT	1K pull-up
10	GND		
11	Write Strobe* (GPIO1)	Input to the UUT	1K pull-up
12	GND		
13	GPIO2	Discrete Input to UUT	1K pull-up
14	GND		
15	Ready/Busy* (GPIO3)	Output of the UUT	1K pull-up
16	GND		
17	VCC1	UUT Power Test Point	None
18	GND		
19	VCC2	UUT Power Test Point	None
20	GND		

Note: Some target boards may require a pull-down resistor on the TRST* signal to assure normal device operations when not in boundary-scan test mode

Note: The target TDI signal driven by the TDO signal of the boundary scan controller

Note: The target TDO signal drives the boundary scan controller's TDI

Table A-5. Signal Description and Termination

Below is the 3M part number for the above connector. It is a 0.100" x 0.100" header without latch/ejector. Note that there are many other manufacturers who have similar parts.

Reference	Description	Manufacturer	Part Number
20-Pin Target TAP	Straight header, 20-pin, 4 wall, with center notch	3M	2520-6002UG

Table A-6. Boundary Scan TAP 20 Pin Connector

Figure A-6 shows a typical schematic of the target TAP connector with termination resistors. The 1K pull-up resistors should connect to the target Vcc supply corresponding to the interface voltage (programmable on the USB-1149.1/E from 1.25 to 3.3 V). Recommended resistor values are +/- 5%.

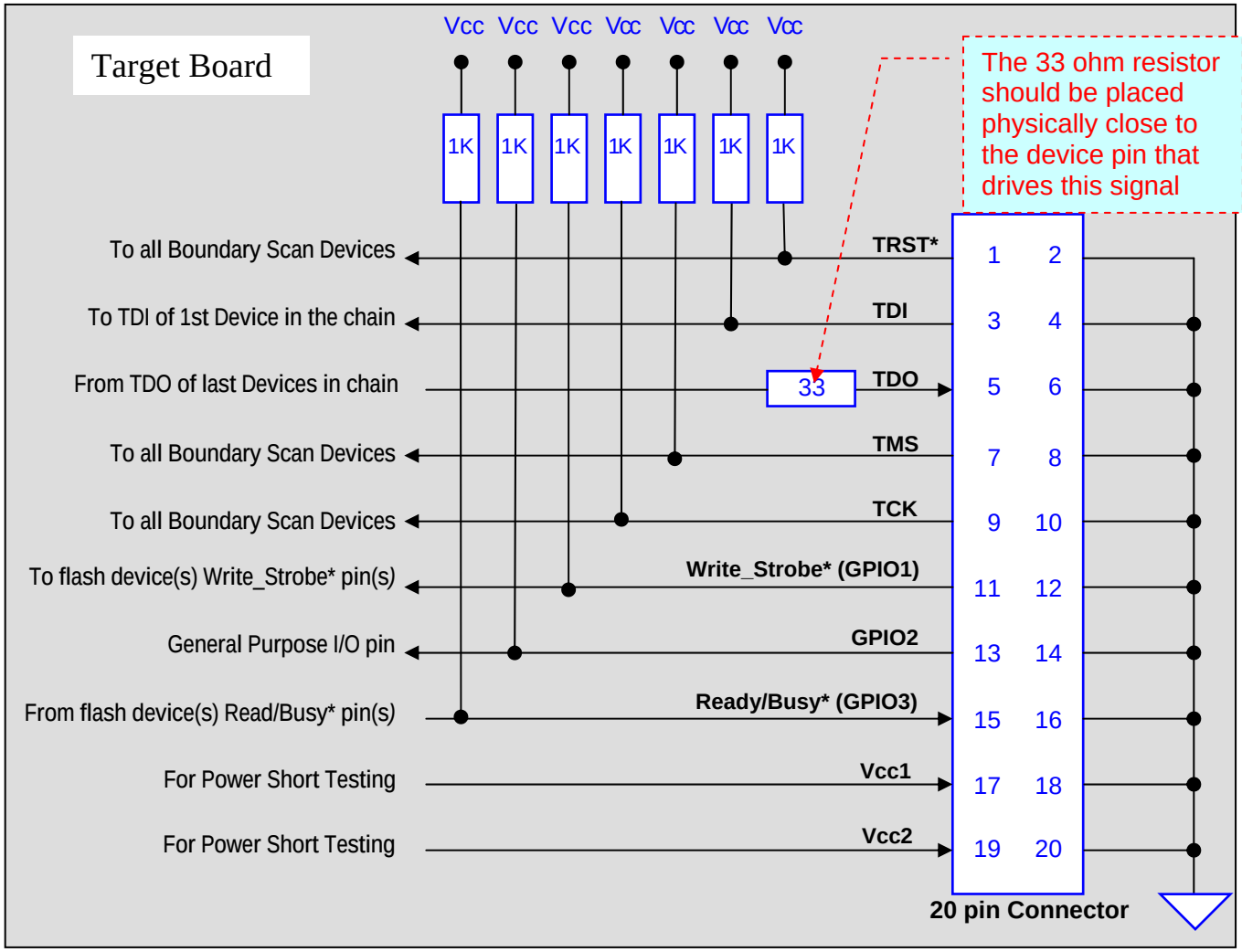

Figure A-6. Boundary Scan 20 Pin TAP Connector Schematics

Appendix B
Self Test Utility Software

The USB-1149.1/E has a self test utility that can be used to test the unit and make sure that it is fully functional. Logic at the TAP connectors can read back data shifted out on TMS and TDO synchronously with the TCK. Using these signal paths, a host can test the TAP signals all the way to the connectors, verifying the overall functionality of the system.

Self-Test

The self-test utility is provided as an off-line confidence test only and **under normal circumstances there is no need to run the self-test utility software**. However, if you suspect that the product is damaged, you can run the self-test on the USB-1149.1/E module. The self-test utility is installed on your computer in the same folder where ScanExpress Applications (ScanExpress Runner, ScanExpress Debugger and ScanExpress Programmer) are installed. Make sure to disconnect the target TAP cables before running the test.

Using the Windows Explorer, select and run the ***usb1149e_test.exe*** file. A small pop-up should appear. Click on **Test** to run the self-test.

The program should respond with results similar to the screens shown in Figure B-1.

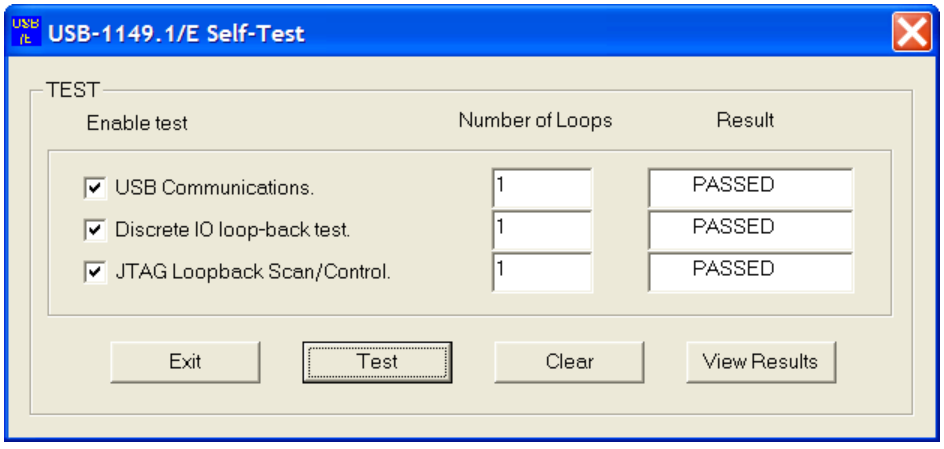

Figure B-1. Self-Test Result for the USB-1149.1/E