

## Application Note #09-0106

# Using the ScanTAP IsoPod to Prevent Hardware Damage in Harsh Electrical Environments

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### Summary

The Corelis ScanTAP IsoPod provides a 4k isolation barrier that completely isolates controllers from targets (UUTs). This robust protection provides an additional line of defense against harsh electrical environments and eliminates ground loop problems that are common on the production floor. It is designed with the same device pinout as Corelis JTAG controllers so that it can easily be dropped into a test setup without making any significant changes and continues to deliver reliable, high-speed boundary-scan results.

### Introduction

Test and measurement environments produce conditions that put measurement equipment and target boards at risk. Often units under test (UUTs) are pushed to their limits and operated beyond their typical boundaries, and are exposed to accidental contacts and electrostatic discharge (ESD). Manufacturing defects or other unexpected behavior can cause

overvoltage and excessive currents that can cause serious damage to electrical equipment. In such harsh environments, the ScanTAP IsoPod accessory becomes a useful tool to protect equipment without sacrificing performance. One particularly detrimental problem, ground loop, can be easily avoided by taking advantage of the isolation provided by the ScanTAP IsoPod.

### Ground Loop

Ground loop generally refers to the undesirable current in a conductor connecting two points that are thought to be at the same potential, but are actually at different potentials. In an ideal conductor, any segment of the conductor is considered to have the same potential because it is assumed there is no resistance in the conductor. In the ideal circuit shown in Figure 1 for example, the points of the conductor, labeled A and B, are considered to be at the same potential.

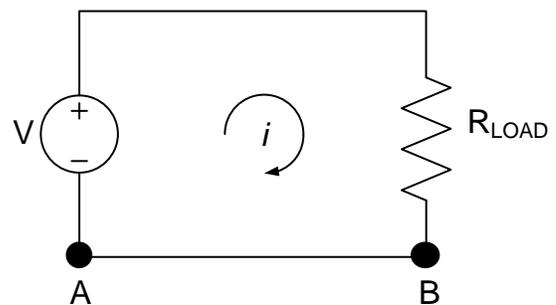


Figure 1: Ideal Circuit

In the real world, however, the finite resistance in conductors, though typically negligible, creates a minimal potential difference that generates a current flow in accordance with Ohm's law. The real world circuit, shown in Figure 2, illustrates the parasitic resistance between points A and B in the conductor which causes points A and B to have a potential difference when current is flowing in the circuit.

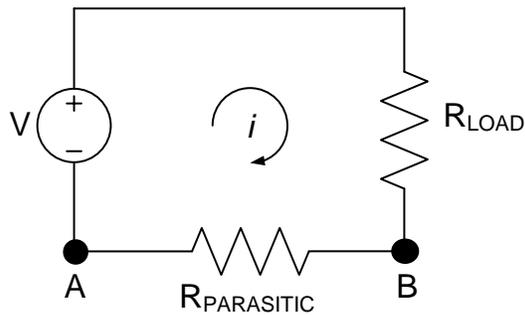


Figure 2: Real World Circuit

In general today with electronics increasingly shrinking most conductors are too short to have a large potential difference. The most common exception is in the instance of ground nodes, where power outlets share what is often considered a common potential even though they may be grounded to patches of the earth that are separated by relatively large distances. The path between the two grounds may introduce significant resistance if a current loop is created between them. This resistance, known as earth resistance, varies due to different environmental conditions including chemical makeup and moisture content and may constitute a large resistance and therefore a large potential difference between the two earth-grounded power outlets.

This scenario is not uncommon on many production floors where test equipment and UUT's are often powered from different outlets. Ideally all equipment used in a test setup should be powered from the same source, but sometimes various circumstances make it impossible or impractical to implement the test setup this way. When there is a connection established between the grounds of the two devices, via a cable, the loop created allows current to flow between the two earth grounds and in the event that environmental conditions produce a large resistance, this translates into a large potential difference between what each device considers to be ground.

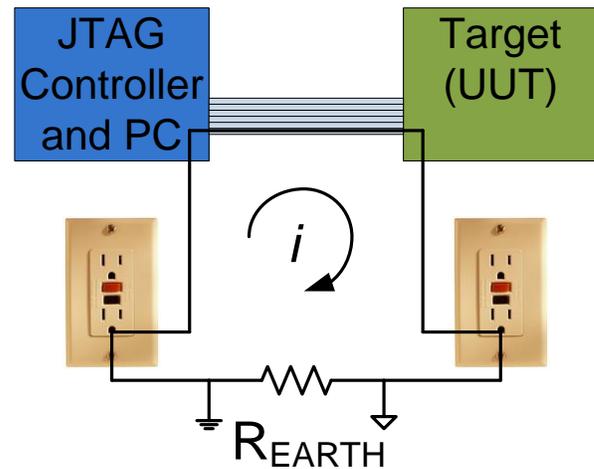


Figure 3: Ground Loop on the Production Floor

In one case, a customer reported a potential difference of 60V between the two ground terminals. Such large potential differences are sure to cause irreversible damage to hardware that operates in lower voltage ranges. Even if this severe damage is not an issue, smaller potential differences can produce signal integrity issues resulting in intermittent operational failures. Ground loop is sometimes thought of as an elusive phenomenon and is often the scapegoat for signal integrity issues, but there is a simple way to prevent and limit ground loop problems.

### Isolation

The solution to the ground loop problem is to isolate the two circuits, in this case the JTAG controller and the target (UUT), thereby electrically separating the connection between the two circuits. The isolation prevents current from directly flowing between the two devices and creating potential differences. The two devices still remain connected by exchanging energy through capacitive, inductive, optical, or other means. The ScanTAP IsoPod offers a 4kV galvanic isolation barrier that helps to eliminate

the damage from ground loops described above. The boundary scan controller and target (UUT) are each referenced to their own isolated ground while still allowing the information to be exchanged between the two circuits.

## Other Applications

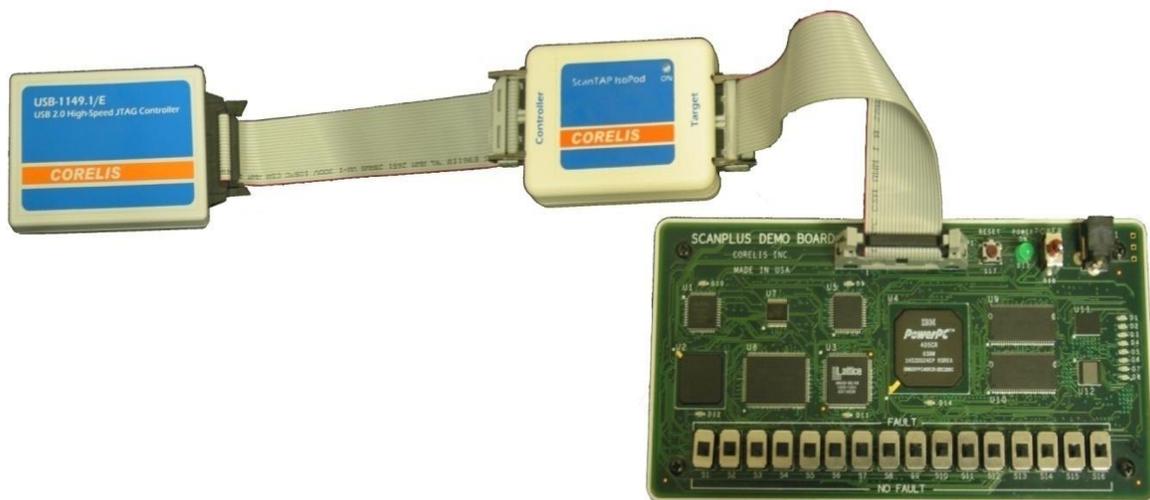
Aside from ground loop prevention, the ScanTAP IsoPod also provides additional advantages in the testing environment. The ScanTAP IsoPod's isolation circuitry adds additional tolerance against overvoltage and excessive current. This protection is useful to prevent damage to the controller from a user accidentally connecting the TAP cable backwards into the target. It will also help prevent damage from shorts caused by manufacturing defects or other operator errors. Development is also a common environment to

use extra protection where the operational results have not yet been verified on untested targets.

## Test Setup Integration

The procedure for integrating the ScanTAP IsoPod into an existing test setup or a new one is simple. There are three major components to the test setup: (1) a Corelis boundary-scan controller, (2) a ScanTAP IsoPod unit, and (3) a target UUT. Follow the instructions below to integrate the ScanTAP IsoPod into a test setup. Figure 4 below shows a typical test setup where the ScanTAP IsoPod is placed in series between the controller and the UUT.

**WARNING:** The ScanTAP IsoPod is not hot pluggable. Unplug power from all sources prior to connecting or disconnecting.



## Existing Test Setup

1. Disconnect the Corelis boundary-scan controller from the target by removing the cabling from the boundary-scan controller.
2. Connect the side of the ScanTAP IsoPod labeled 'Controller' to the Corelis boundary-scan controller using the supplied 20-pin cable.
3. Connect the side of the ScanTAP IsoPod labeled 'Target' to the target UUT using the cabling that was removed from the boundary-scan controller in step 1.
4. Supply power to the ScanTAP IsoPod by plugging the provided 5V power adapter into the side of the box.
5. Adjust the controller configuration as described in the *Test Execution* section.

## New Test Setup

1. Connect the side of the ScanTAP IsoPod labeled 'Controller' to the Corelis boundary-scan controller using the supplied 20-pin cable.
2. If the target connector uses the Corelis 20-pin pinout, connect the side of the ScanTAP IsoPod labeled 'Target' to the target using the second supplied 20-pin cable.
3. If the target uses a different pinout, a custom cable will need to be used. Verify the pinout matches the Corelis 20-pin pinout shown in the figure below.
4. Supply power to the ScanTAP IsoPod by plugging the provided 5V power adapter into the side of the box.

5. Adjust the controller configuration as described in the Test Execution section.

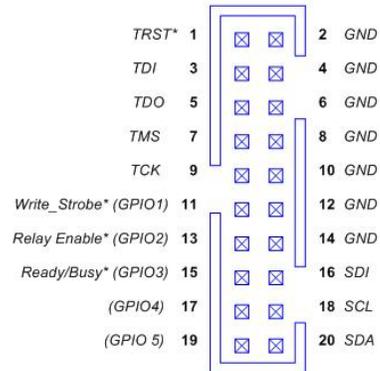


Figure 5: ScanTAP IsoPod Pinout

## Test Execution

When executing tests in ScanExpress Runner, Programmer, or Debugger, the delay compensation must be adjusted to account for the propagation delay introduced by the ScanTAP IsoPod and any additional cabling. Please adjust the delay compensation settings in the software by following the steps below.

1. Click the **Setup** menu item and then select the **Controller** entry to display the controller **Configuration** screen. Select the JTAG controller that will be used with the ScanTAP IsoPod from the *Controllers* section.
2. Using the table below as a reference, select the *TCK Frequency* for the test plan under *Controller Settings* and adjust the *Delay Compensation* based on the TCK frequency. The delay may need to be adjusted by  $\pm 0.5$  clocks depending on the cable lengths and the selected JTAG controller. Starting with the default setting of **1 MHz** and **No Delay** is recommended.

- Under *Controller Settings*, the controller voltage must be set to **3.30V**. Additionally, if applicable, set the **Input Threshold** and **Slew Rate** to **Automatic**, and set the **TAP Off State** to **Active**.
- After you have made your selections, click on the **Apply** button to save the

settings. Figure 6 shows the controller settings in ScanExpress Runner after the USB-1149.1/E is selected using a 10 MHz TCK frequency and 0.5 Clock delay compensation. The configuration screens for other controllers may appear slightly different.

TCK Frequency	Delay Compensation
1.0 MHz – 6.0 MHz	No Delay
7.5 MHz – 12.0 MHz	0.5 Clock
15.0 MHz – 19.0 MHz	1.0 Clock
20.0 MHz – 25.0 MHz	1.5 Clocks
28.0 MHz – 31.0 MHz	2.0 Clocks
34.0 MHz – 38.0 MHz	2.5 Clocks
41.0 MHz – 44.0 MHz	3.0 Clocks

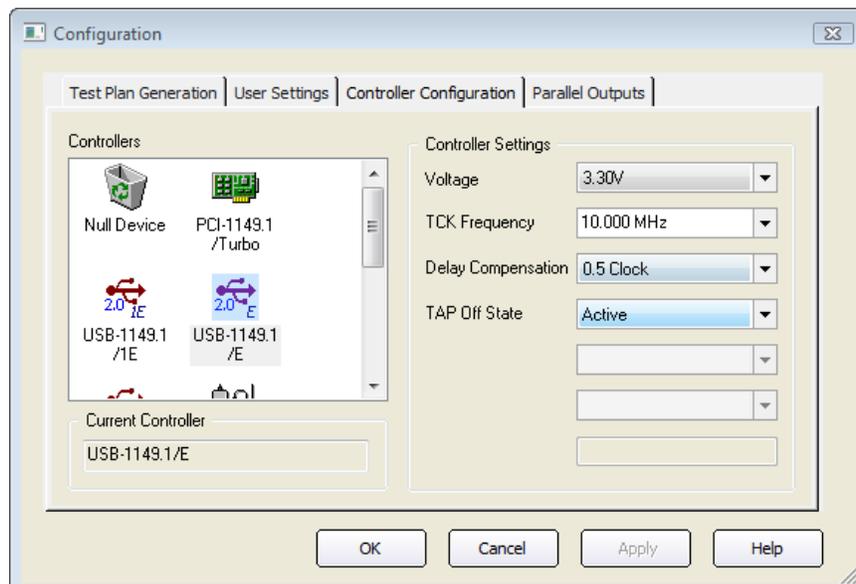


Figure 6: Controller Settings

## Revision History

<b>Version</b>	<b>Changes</b>	<b>Date</b>
Version 1.0	Initial Release	January 2009

Please send inquiries and comments to:

Technical Support: [support@corelis.com](mailto:support@corelis.com)

Sales Information: [sales@corelis.com](mailto:sales@corelis.com)

Web: [www.corelis.com](http://www.corelis.com)