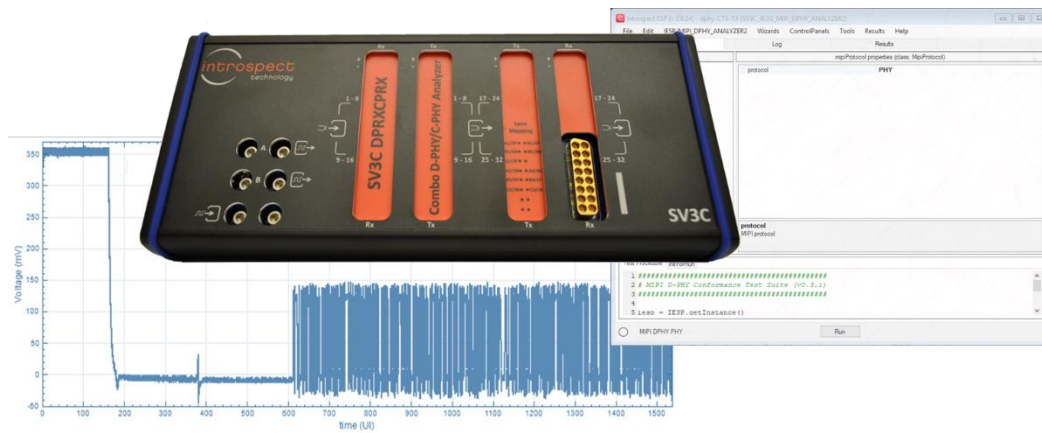




MIPI D-PHY Transmitter Conformance Test Suite



User Guide

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Introduction

The Introspect D-PHY Transmitter CTS Application is a Test Procedure that executes within the IntrospectESP software environment and that enables automated testing of D-PHY transmitters using the Introspect SV3C DPRX 4-Lane MIPI D-PHY Analyzer. The Test Procedure provides a fast and easy way to validate and debug D-PHY links as well as execute automated D-PHY electrical checklists based on the MIPI Alliance Conformance Test Suite.

The Introspect D-PHY Transmitter CTS Application enhances your productivity and saves valuable time by allowing you to focus on the device under test (DUT) specific steps of transmitter testing without worrying about test system programming. It provides an easy to use interface for selecting and sequencing tests and gives you visibility into the code structure and execution flows.

The Application also includes report generation features and custom code sections that allow you to achieve true test automation – through a true software handshake. Specifically, the custom code sections are compatible with executing external scripts for controlling a device or for accessing your proprietary .NET DLL for DUT control.

Features

The Introspect D-PHY Transmitter CTS Application offers

- MIPI specification coverage for D-PHY v1.0, v1.2, and beyond
- Configurable lane count and data rate
- Configurable test pattern / packet construction including arbitrary video frames
- User selection of tests based on the CTS test groups
- User-editable custom code for manipulating external components such as power supplies, device handlers, or thermal units
- Report generation
- Enhanced debug modes

Hardware Setup and Global Method of Implementation

Figure 1 shows the hardware setup for transmitter tests in general. All lanes of Introspect SV3C DPRX analyzer are connected directly to the Device under Test (DUT) board. The SV3C DPRX is connected to the control Computer through a USB cable and provided software drivers; and the DUT is connected to the control Computer using its own mechanism (e.g. I2C to USB converter). In the rest of this document, we assume that the DUT is connected to the same control Computer as the SV3C DPRX, but this is generally not a requirement for the Introspect CTS Application.

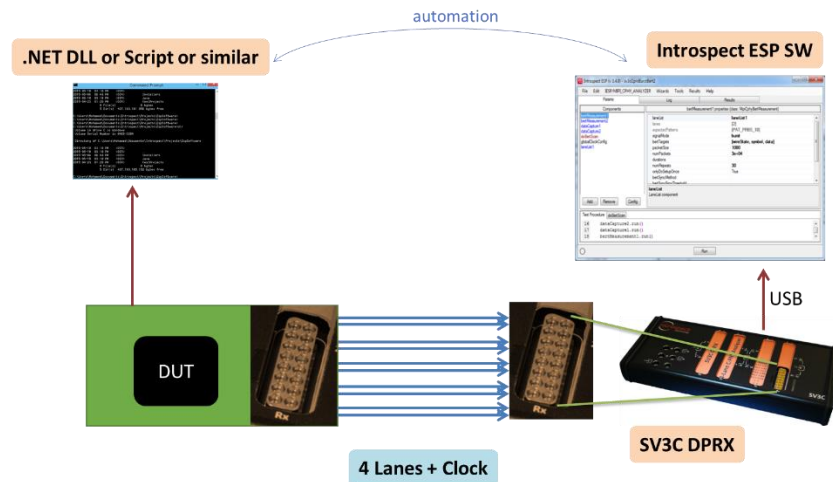
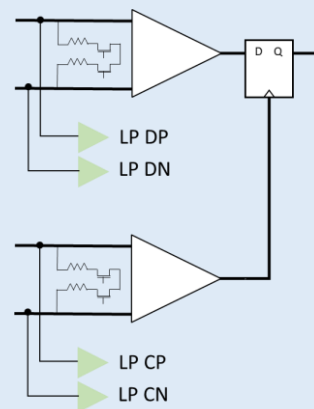


Figure 1 Overall hardware setup for D-PHY Transmitter CTS testing.

Noteworthy!

The SV3C MIPI D-PHY Analyzer contains built-in dynamic termination circuitry as shown in the figure on the right. Thus, unlike conventional oscilloscopes or analyzers, it can be used to directly connect to a MIPI device evaluation board using coaxial cables, without requiring an external Reference Termination Board (RTB) nor external high-impedance probes!

This architecture results in faster setup time, lower overall cost of test, and less potential for connection issues.



The Introspect ESP Software provides the main control for the SV3C DPRX, and the features of the CTS Application will be described thoroughly in later sections of this document. However, in this section, we describe the general scope of control within the CTS Application. Specifically, transmitter testing typically requires setting up the DUT to generate repeating signals and measuring such signals using the oscilloscope feature of the SV3C DPRX. Referring to Figure 2 which illustrates CTS Test #1.3.2, the DUT is configured to transmit a PRBS packet loop as defined in the MIPI D-PHY Specifications. Then, the SV3C DPRX is commanded to perform a triggered oscilloscope capture and to extract the time duration between the last LP transition and the first bit of the SOT byte. In general, most CTS tests are performed on PRBS packet loops, although this is customizable in the CTS Application to enable image patterns or color bar test patterns. Additionally, although an analog waveform is shown in Figure 2, the Application uses any/all measurement tools available at its disposal within the SV3C DPRX 4-Lane MIPI D-PHY Analyzer.

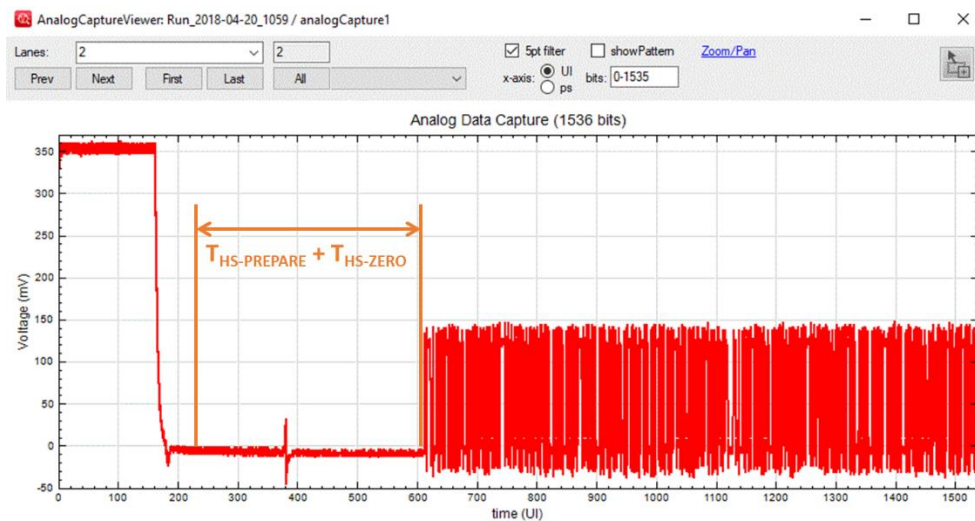


Figure 2 Overall Method of Implementation involves performing waveform captures and extracting measurements. Illustration is shown for CTS Test #1.3.2.

For some tests (e.g. Group 1) in the MIPI D-PHY CTS Specifications, the SV3C DPRX is expected to measure large-magnitude LP signals at 1.2V. Since this voltage level exceeds the linear range of the high-bandwidth input amplifiers on the Analyzer, these tests require the inclusion of a signal attenuator in the connection between the DUT and the Analyzer. An illustration of such connection is shown in Figure 3, and a list of recommended attenuator components is included in Table 1. During execution, each CTS Test instructs the user to insert the appropriate attenuator into the DUT signal path. Note that only the lane being measured needs to have the attenuator installed; alternatively, all lanes can be fitted with individual attenuators.

Table 1 Recommended co-axial fixed attenuators for performing voltage measurements in the CTS

Parameter Under Test	Required Attenuation	Recommended Part Number
HS Signal Voltage	6 dB	Mini-Circuits VAT-6+
LP Signal Voltage	15 dB	Mini-Circuits VAT-15+

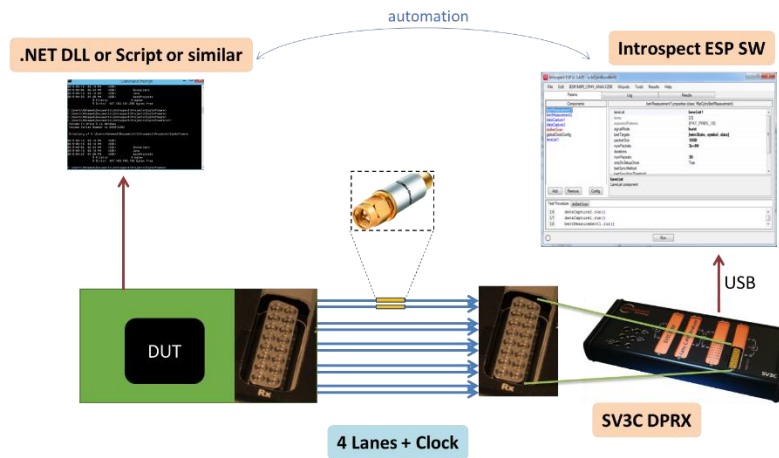


Figure 3 Hardware setup with attenuators in the signal path.

CTS Application User Interface

This section describes the components within the CTS Application. It then proceeds with instructions on how to configure tests, execute them, and customize their responses.

Component Classes Visible to the User

Figure 4 shows the Application window when it is first loaded into the IntrospectESP software. As can be seen, it is populated with a group of components that are highlighted, and these constitute the principal method for configuring tests and automating them. In the following sections, each component will be described briefly.

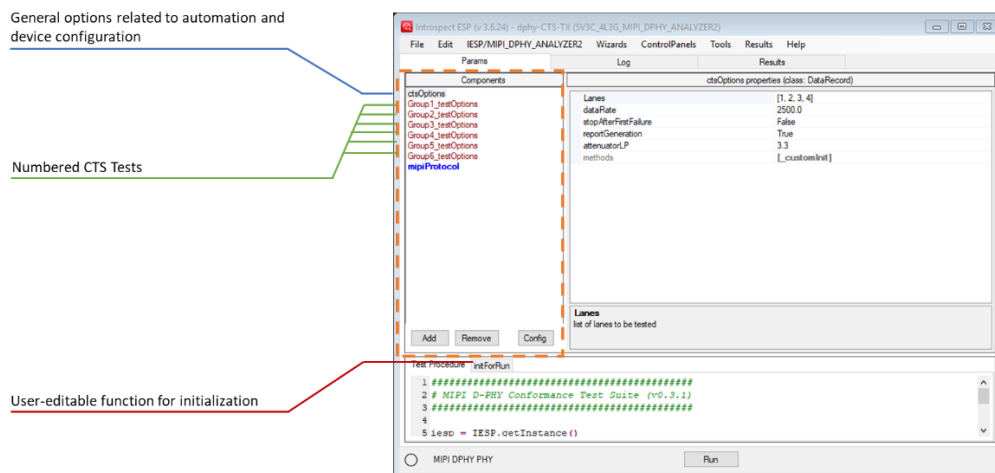


Figure 4 Illustration of the D-PHY Transmitter CTS Test Procedure when opened in IntrospectESP software.

CTS Options Component

This component defines general test options related to automation and report generation. For example, it defines the behavior of the Application in case one of the tests of the CTS fails. Based on the user requirement, the entire test sequence can be aborted, or the test can be skipped and subsequent tests executed. Similarly, this component is used to decide whether automated report generation is required or not. Finally, this component is where DUT parameters such as data rate and number of lanes are specified.

Numbered CTS Test Selection Components

This component lists the CTS test numbers exactly the way they are published by the MIPI Alliance. Each test can be enabled or disabled based on a Boolean (True/False) variable.

User-Editable Initialization Function

This is a function tab (visible in the Test Procedure section of the GUI) that allows you to enter custom code for initializing the test in general or for initializing signal transmission from the DUT. In general, the CTS requires the generation of repeating packet loops. But it is possible that some tests can be customized in the following manners:

- Replacing the PRBS packet loop with an image pattern loop
- Replacing the PRBS packet loop with repeating LPDT transmissions
- Configuring the DUT to generate static LP111 or LP000 values

Selecting the General Options for the Test

Figure 5 shows the ctsOptions data record component, which is used to select the options for the test. Typically, all defaults are valid. The parameter descriptions include items such as:

- runNominalTest: this commands the CTS Application to execute a quick pattern check on the device before any test is performed
- stopAfterFirstFailure: set this parameter to True if you want the CTS Application to abort after any of the tests fails
- reportGeneration: enables the creation of a CSV report of executed tests. Generated reports are accessible in the Results tab of the GUI
- Other options in this data record include features related to particular test configurations

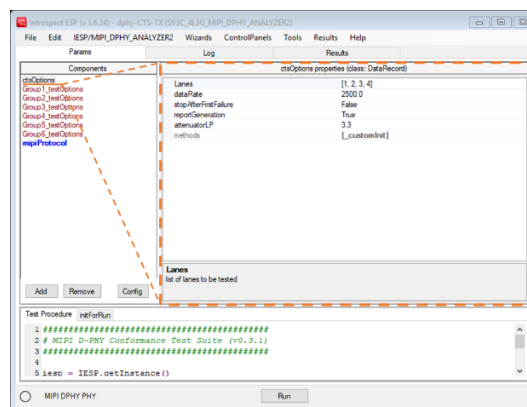


Figure 5 High-level automation options are configured using the ctsOptions data record.

Identifying Which Tests to Execute

Once the general options are established, the next step is to select which CTS tests to execute. This is done in groups as illustrated in Figure 6. In this figure, the data record for each of the groups is highlighted (by selecting it in the Components section of the GUI) in order to illustrate the list of tests for the group. Each test is enabled or disabled based on the corresponding Boolean variable.

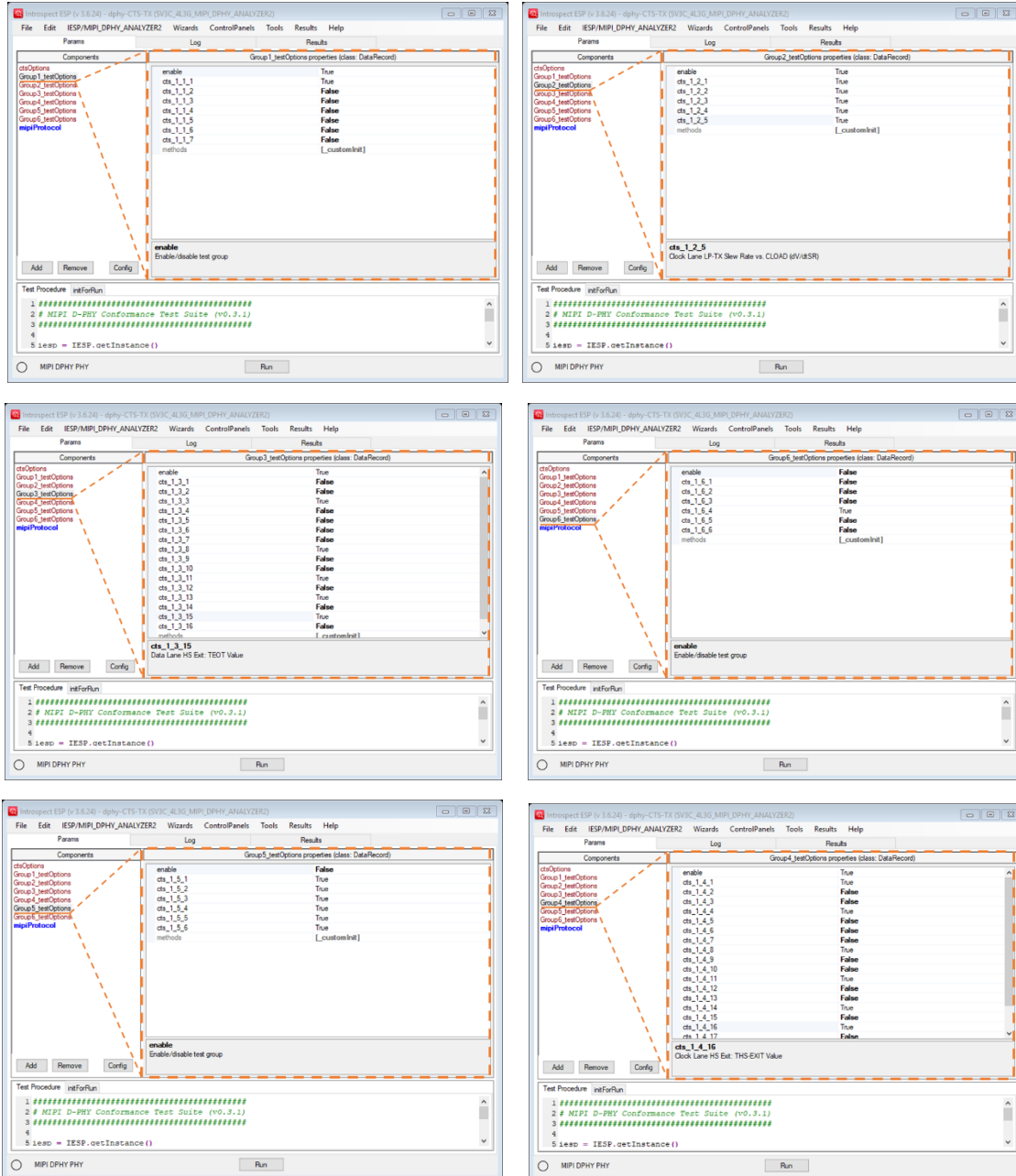


Figure 6 Illustration of the selection mechanism for each CTS test based on its corresponding group.

Confirming DUT Connections

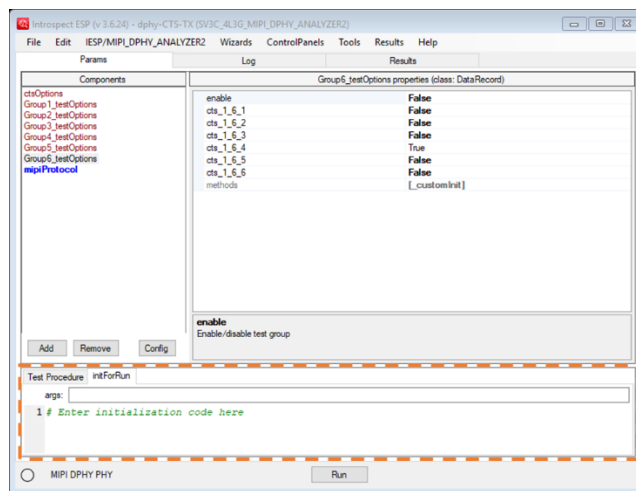
As was mentioned earlier, some tests require the insertion of attenuators in the signal path. Determining such connection requirements happens dynamically within the D-PHY CTS Application, and this is illustrated in Figure 7. When a test case is selected, a pop-up window describing the required connections appears, and the test is not executed until the connections have been made.



Figure 7 Illustration of the pop-up dialogs with connection instructions.

Entering Custom Code for Initializing the DUT

The D-PHY Transmitter CTS Application includes a function tab with user visible code in it. This function is executed at the beginning of the CTS, and it can be used to send initialization commands to the DUT. An illustration of the function tab with pre-populated code is shown in Figure 8.



User-editable code for initialization.

Compatible with custom device .NET DLL, external script, Labview interface, or Python interface (natively through the GUI)

Figure 8 User-editable code area for automatically initializing the test flow or the DUT.

Getting More Help

This document introduced the Introspect D-PHY Transmitter CTS Application at a high level, and it provided a detailed description of its user interface. Various other sources of information are available, and these include

- Online html help files from within the IntrospectESP software
- Context help provided with each of the components and each of the parameters
- Introspect SV3C DPRX Data Sheet (document number EN-D004E-E-17187)

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1.0	Initial document release	June 14, 2018

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