SV4D Direct Attach MIPI Test Module

Quick Start Manual

VERSION 1.0

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TABLE OF CONTENTS

INTRODUCTION

The SV4D Direct Attach MIPI Test Module is the latest member of the Introspect Technology D-Series, targeting the mass production test of semiconductor devices based on MIPI® Alliances interfaces. This ultra-compact test module enables at-speed production testing from wafer sort all the way through to production final test. The module has been designed to be readily integrated on any ATE load board or DIB with minimal external components, and supports multi-port, multi-site testing with configurable protocol support for MIPI CSI-2SM, DSI SM, and DSI-2 SM. The SV4D is ideal for high-end applications such as camera and image sensors, apps processors, SOC, and DDIC. Coupled with an exceptionally powerful software development environment, the SV4D provides the fastest path for MIPI mass production test.

A high-level block diagram of the SV4D MIPI Test Module is shown in Figure 1 below. Please see the SV4D datasheet for further details.

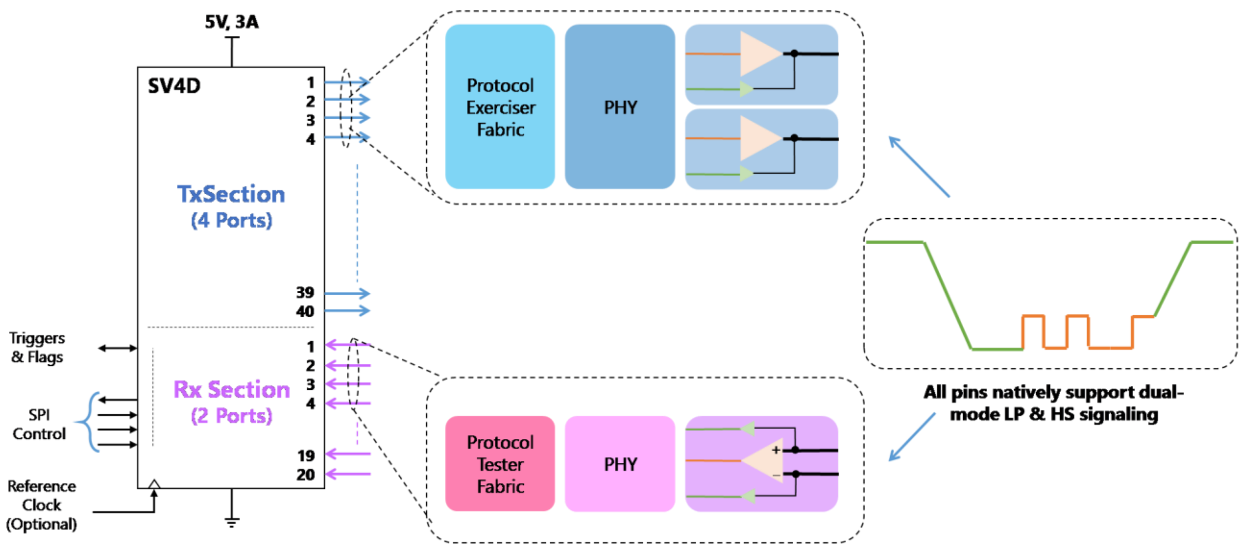


Figure 1 High-level block diagram of the SV4D MIPI Test Module

This Quick Start Manual will provide the information required for a user to get up and running with the SV4D DPTX without being mounted on an ATE. Basic hardware and software installation instructions are included. A step-by-step procedure to generate MIPI D-PHY signals, to create SPI/ATE vector files, and to perform firmware updates are all provided in this manual.

QUICK START HARDWARE DESCRIPTION

Requirements

The full list of hardware required for this Quick Start Manual is provided below:

- **1 x SV4D MIPI Test Module**. See Figure 2 on page 6
- **1 x SV4MCarrier Board**. The SV4D is mounted on the SV4M via the connector **J43 (SV4D)** /**J1 (SV4M)**. See Figure 2 and Figure 3
- **Minimum 1 x Samtec Firefly cables**, (part numbers ECUE-12-017-T1-FF-01-1) or similar
- **1 x MXP to SMA Cable Assembly** (Mfg Huber/Suhner, Part # MF53/2x8A_21MXP)
- **1 x 12-volt AC / DC power supply** (Mfg: CUI, Part # ETSA120500U)
- 1 x Personal Computer connected to the SV4D through a USB cable, with the **Introspect ESP software** installation, **version 3.6.55** or later
- Optional: MIPI D-PHY Receiving DUT, for demonstrating the provided test procedures

Related Documents

- EN-G029E-E-19099 - SV4D Reference Design Guide.pdf
- EN-G031E-E-19081 - SV4D Quick Start Manual
- EN-G032E-E-19081 - SPI Communications Overview
- SV4D Design Files.zip (includes reference schematic, layout, and CAD file for ATE load board design)

SV4D and SV4M Hardware Description

The SV4D module is shown in Figure 2, and the locations of TX Ports A, B, C, and D are labelled.

Each of the high-speed DPHY port (TX ports A, B, C, and D) consist of ten signal wires: four data lanes and one clock lane. Please see the Datasheet or Reference Design Guide for full part number and pinout information.

The low speed connector (J43 in Figure 2) provides all additional communication between the SV4D and SV4M.

Three views of the SV4M carrier board are shown in Figure 3: (a) the top side of the SV4M, with MXP connectors for high-speed signals, (b) the bottom side of the SV4M, for connection to the SV4D, and (c) the bottom side of the SV4M with the SV4D and heat sink / cooling fan installed.

The SV4M carrier board serves multiple purposes when connected to the SV4D module:

- The SV4M provides an FTDI SPI-to-USB converter which allows for the standard USB connection of the SV4D with a PC and seamless integration with Introspect ESP software for test program development without requiring an ATE.

- The SV4M provides a break-out of the high-speed signals on the firefly cables to the MXP connector, which is compatible with the Introspect bench tools or with any oscilloscope. Connecting J35/J36 or J39/40 of the SV4D to J4/5 of the SV4M allows either Port A or Port C to be accessible through J14. See Figure 5(c) in the following section for an example of the Firefly cable connection for passing TX Port A to the MXP connector.

- The SV4M provides a simple platform for firmware updates for the SV4D, using the Introspect ESP software package.

- The SV4M provides a reference design for load board implementation, and it is provided with the complete design and CAD data files.

The center MXP connector, as labelled in Figure 3, is designated for the DPHY TX signals (either Port A or C depending on the Firefly cable connection). The pin mapping for this MXP cable is provided in Table 1 below.

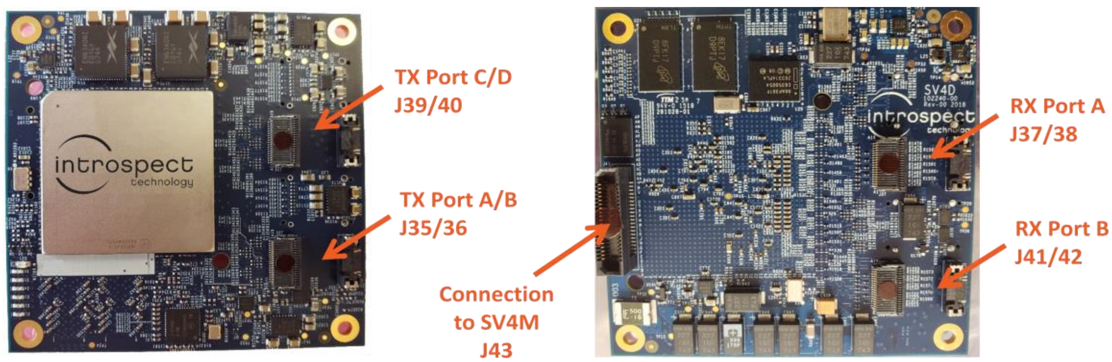


Figure 2 SV4D module, including TX and RX connector locations

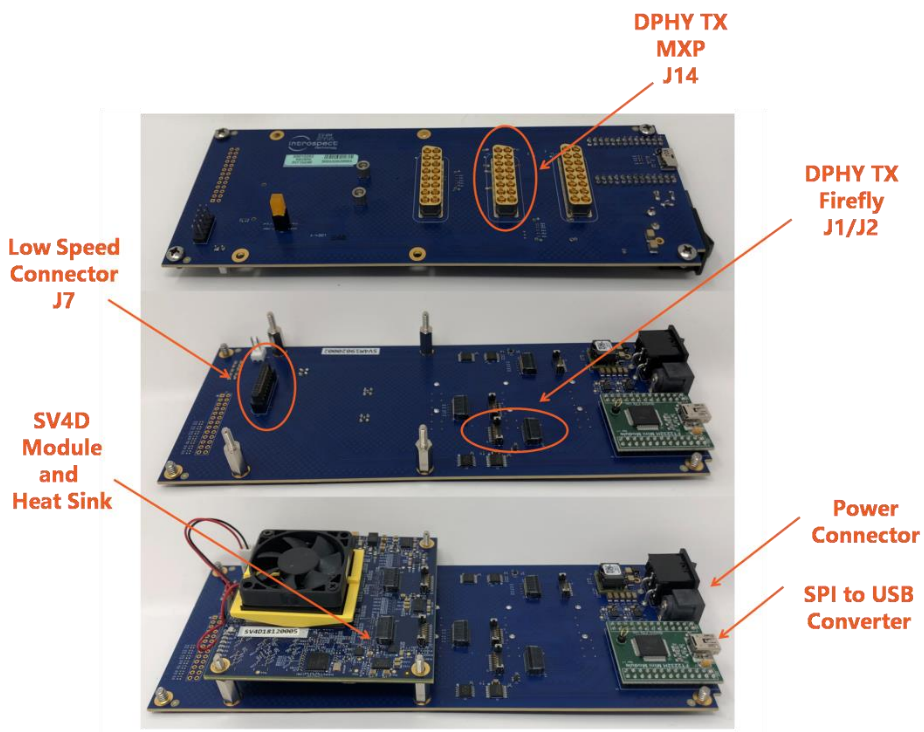
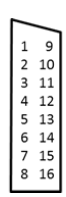


Figure 3 SV4M Test Board, including connector locations

Table 1 DPHY signal mapping of the SV4M MXP connector



Connector Pin Number	Corresponding TX Lane
1,2	Lane 1 (P,N)
3,4	Lane 2 (P,N)
5,6	Lane 3 (P,N)
9,10	Lane 4 (P,N)
13, 14	CLK (P,N)

INTROSPECT ESP SOFTWARE INSTALLATION

Software System Requirements

The Introspect ESP GUI software provides an easy-to-use environment for device characterization and test-plan development. To run the software, the following components are required:

- A PC installed with Windows XP or Windows 7, 8 or 10
- The Introspect ESP install executable
- USB device drivers (refer to the driver installation instructions)

Introspect ESP Installation

1. **Prepare for Installation**

   Links to the latest versions of the Introspect software are provided on the Introspect ShareFile. Please contact support@introspect.ca to gain access to the zipped installation files required for the following steps.

   Quit any Introspect ESP sessions before starting any new installation.

2. **Install Software**

   a. From the directory containing the installation files double-click on the icon for "IntrospectESP_Installer.exe" and follow the instructions on screen.

   b. The installer will install Python (if not already installed) and several 3rd-party Python modules.

   c. When prompted, specify the location where you want to install the Introspect ESP application. (Note that this must be a new location, not a location of a previous installation.) The default location is the "Introspect" folder under the Windows "Program Files" folder. The application will be installed into a sub-folder with a name that includes the software version number.

3. **Install License File**

   Towards the end of the installation, you will be asked if you have an existing license for the software. Note that the license consists of two files:

   IntrospectESP_GUI_license.lic

   IntrospectESP_GUI_licenseOptions.txt

a. If you already have these files, and if the license has a valid date and version, the installer will help you copy your existing license file into the new installation folder when you point to the file in the provided browser window. Once this is done, continue to step 4.

b. If you have been provided an activation code, you may select "Skip licensing" and continue to step 4 below. You will be able to enter the activation code once you start the GUI, and the required license file will be created.

c. If you do not have a valid license file or an activation code, the installer will provide you with information that needs to be sent to Introspect Technology in order to obtain one. Cut and paste that information to request a license via: license_support@introspect.ca.

Upon receipt of the valid license files from license_support@introspect.ca, place the two files in the following license directory:

<new_install_dir>\Licenses\

4. Run the Software

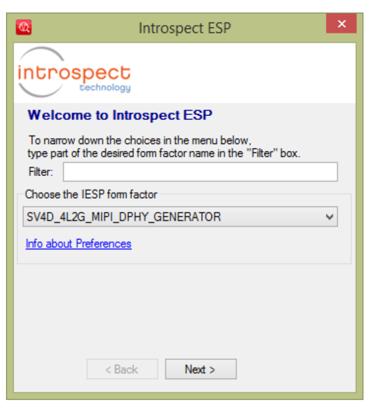
a. Double-click on the "IntrospectESP_GUI.exe" icon in the GUI folder and you should see the first "welcome" window of the GUI.

If you have been given an activation code, you will be asked to enter it at this time.

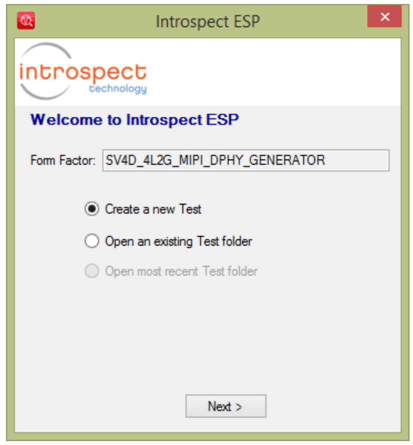
b. From the welcome window, please specify the hardware as "SV4D_4L2G_MIPI_DPHY_GENERATOR" as shown in the figure below.

(Note that other form factors, such as those for the SV1C and SV3C families of product, may be selected through this menu as well.)

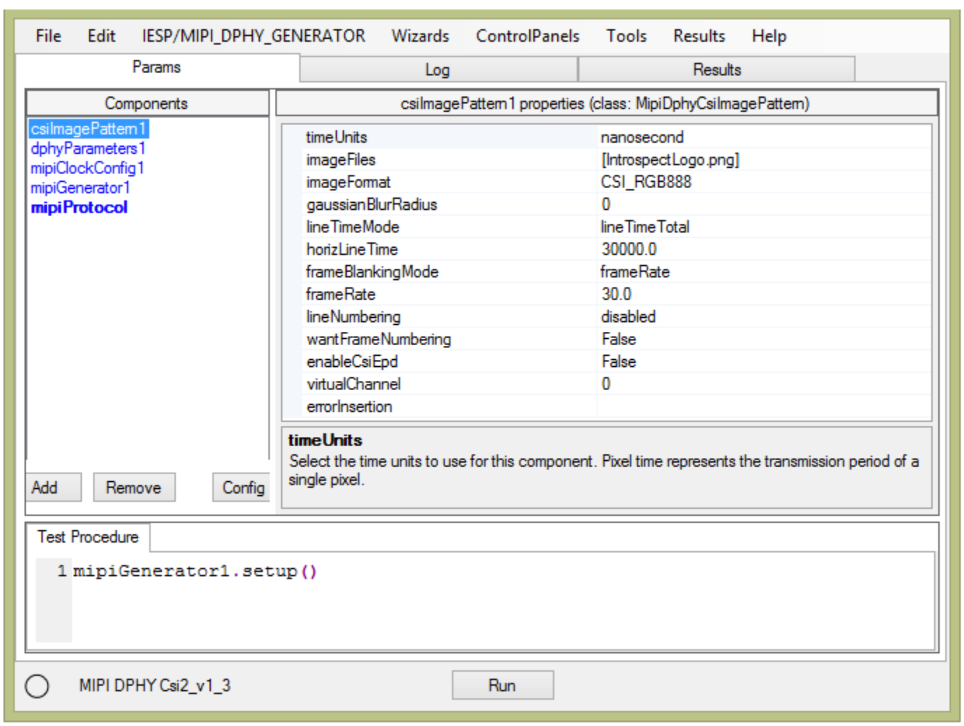
Press "Next" to continue.



b. A second "welcome" pop-up will appear. Select the option "Create a new Test manually", as shown below, and click the "Next" button:



c. With a valid license in the Licenses directory, the following GUI screen should come up, which indicates that the Introspect ESP software has been successfully installed.



5. Further documentation

The following additional information may be found in the "\Doc" directory of the software installation:

a. "IntrospectESP_UserManual.pdf" is the user manual for the Introspect ESP software and is recommended reading for all users.

b. "svt.html" and "iesp.html" provide documentation on the Python component classes and lower-level functions. These are intended for intermediate and advanced users.

• Note that both the user manual and the above html files are also conveniently available from the "Help" pull down menu located on the top right of the Introspect ESP window.

c. "Application Notes" can be found in the \ApplicationNotes sub-folder and have more advanced features, often in the form of tutorials.

USB Driver Installation

The following brief procedure will allow for automated driver installation.

1. Hardware setup

For this procedure, connect the PC to the SV4D DPTX as shown in Figure 4 below, and power on the module. To allow for driver installation, the PC should be connected to the internet as well.

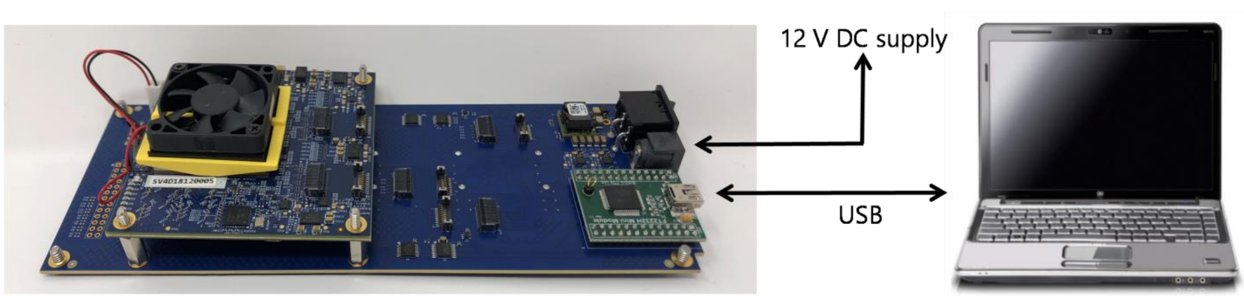


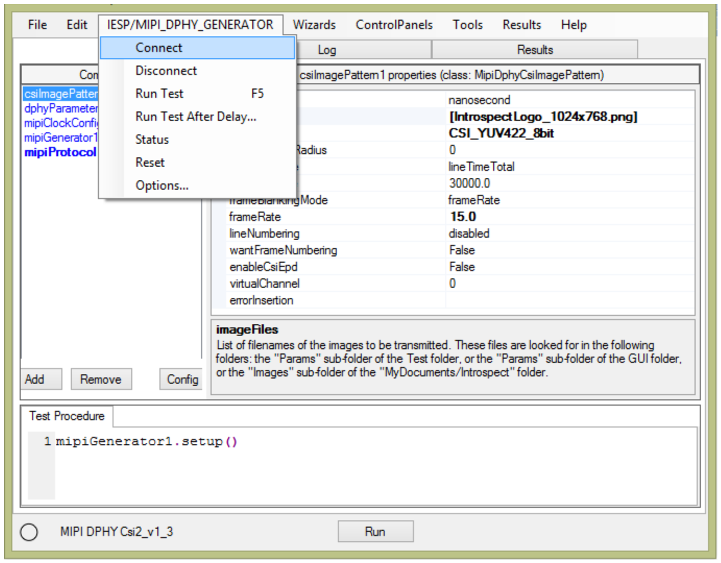
Figure 4   Connection for the automated FTDI driver installation.

2. Wait for the PC to detect the new hardware

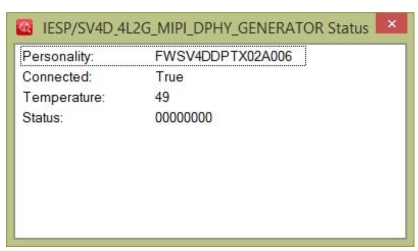
The PC should display the message "New drivers successfully installed" once the installation process is complete. If this does not occur, see the troubleshooting notes at the end of this section.

3. Verify that drivers have been successfully installed

a. Select the pull-down menu "IESP/MIPI_DPHY_GENERATOR -> Connect" as shown below. Establishing the connection should require a couple of seconds.



b. To verify the connection, select the pull-down menu "IESP/MIPI_DPHY_GENERATOR ->Status" three lines below the "Connect" entry, as shown above. A dialog window, as below, should confirm that the SV4D module is connected. The personality / firmware version may be more recent than the version shown below.



4. Troubleshooting

a. If the connection cannot be made, or if the drivers cannot be found or automatically installed, please refer to the Appendix, "FTDI Driver Manual Installation" to install the required drivers.

SV4D DPTX DEMONSTRATION 1

Transmitting CSI-2 Images

The following step by step guide will allow the user to send CSI-2 data packets from the SV4D DPTX to a DUT or display. The following procedure is intended to provide an overview of how to use the GUI and highlight several of the GUI's features.

1. Connect the hardware components

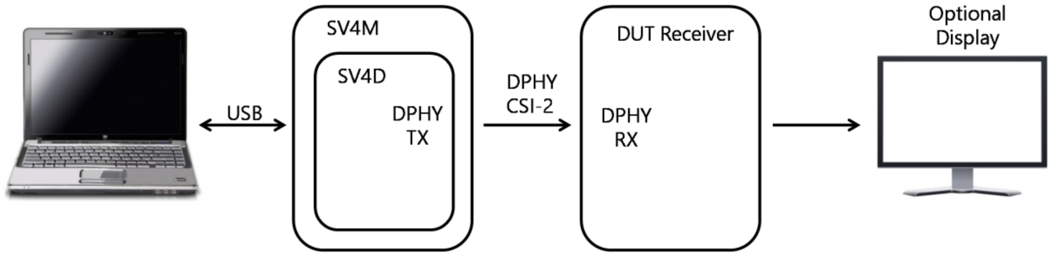
A high-level block diagram for this test setup is shown in Figure 5(a). In this case, the SV4D generates CSI-2 compliant data and transmits them to a device under test. Optionally, the DUT receiver can send the received video frames to a display for visual inspection.

For this Quick Start Manual, a specific implementation of the block diagram is provided in Figure 5(b). In this case, the DUT is an iMX6 applications processor from NXP, implemented on a module and development kit available from e-con Systems:

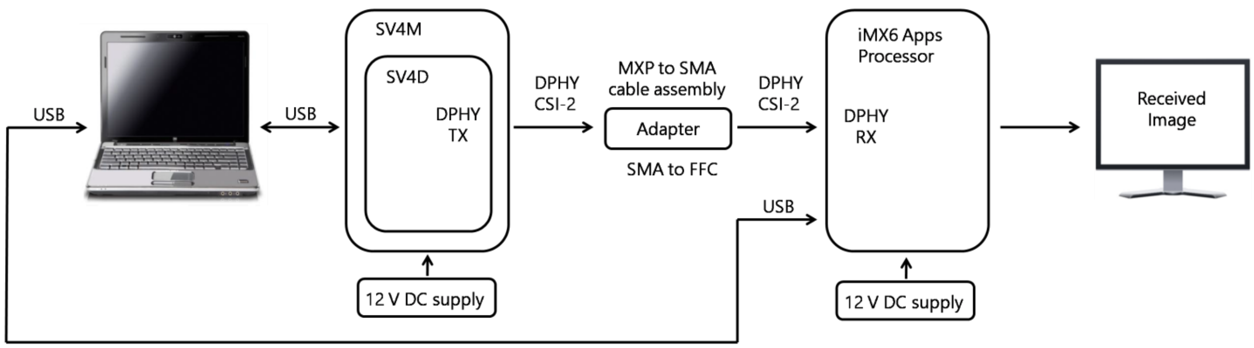
https://www.e-consystems.com/iMX6-som-system-on-module.asp

The interface to this applications processor is a 2 lane, CSI-2 link operating at 800 Mbps. The specific connection details are shown in the figure, and a photograph of the setup used is shown in Figure 5(c). Note that the adapter board indicated in the figures is used to convert from SMA cable connections from the SV4D to the 24 pin FFC connector of the iMX6 development kit.

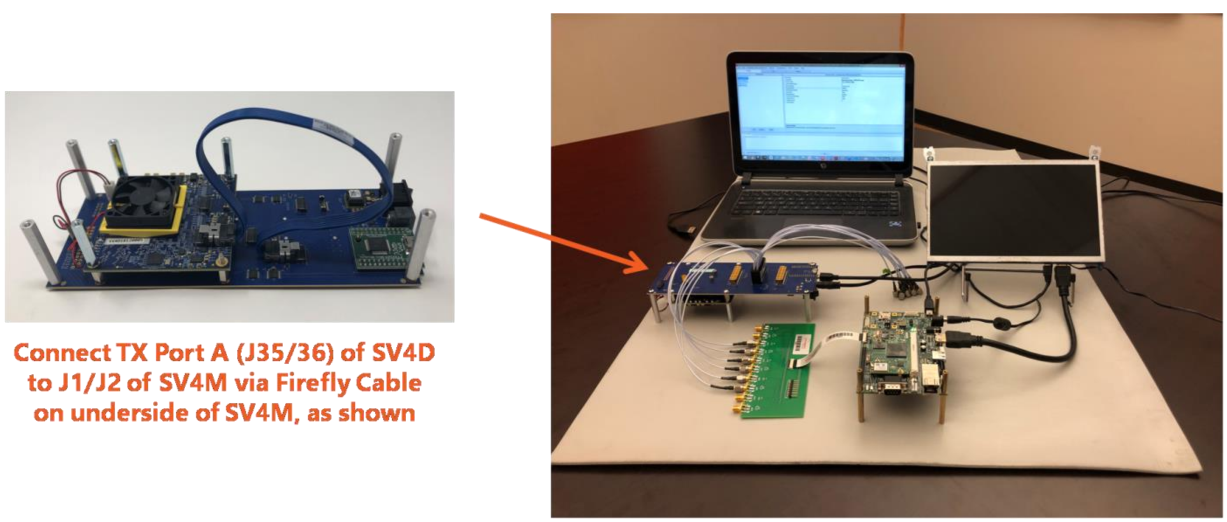
While this Quick Start Manual uses this specific DUT implementation, the step-by-step instructions for building a test procedure, as follows, can be readily adapted as required for other DUT implementations.



(a)



(b)



(c)

Figure 5(a) Block diagram for Demonstration 1 (b) Detailed block diagram using the iMX6 Applications Processor (c) Photograph of the full demonstration setup

2. Familiarize yourself with the Introspect ESP GUI

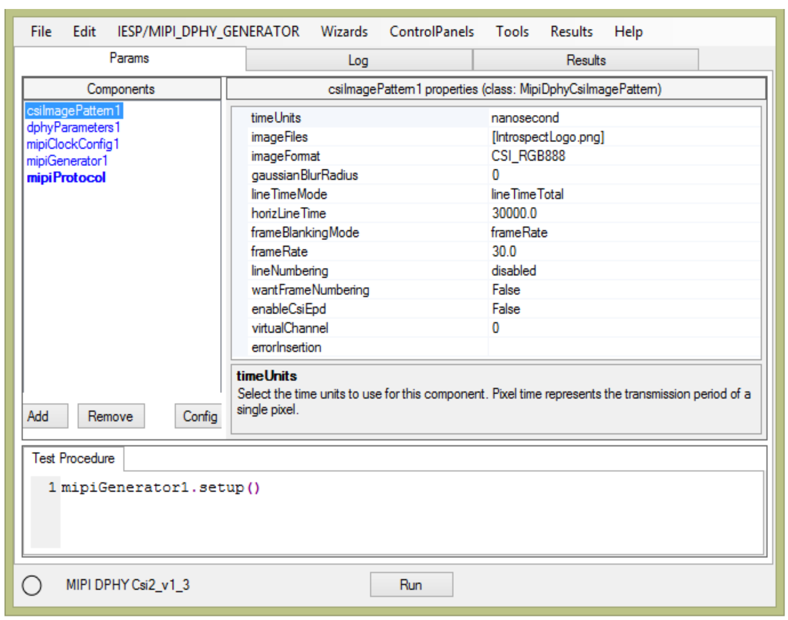
a. Open up one instance of the Introspect GUI (double click on "IntrospectESP_GUI.exe") and select form factor "**SV4D_4L2G_MIPI_DPHY_GENERATOR**" if you have not already done so in the previous software and USB driver installation steps.

b. The typical start-up screen for the Introspect GUI is as shown in the Figure below.

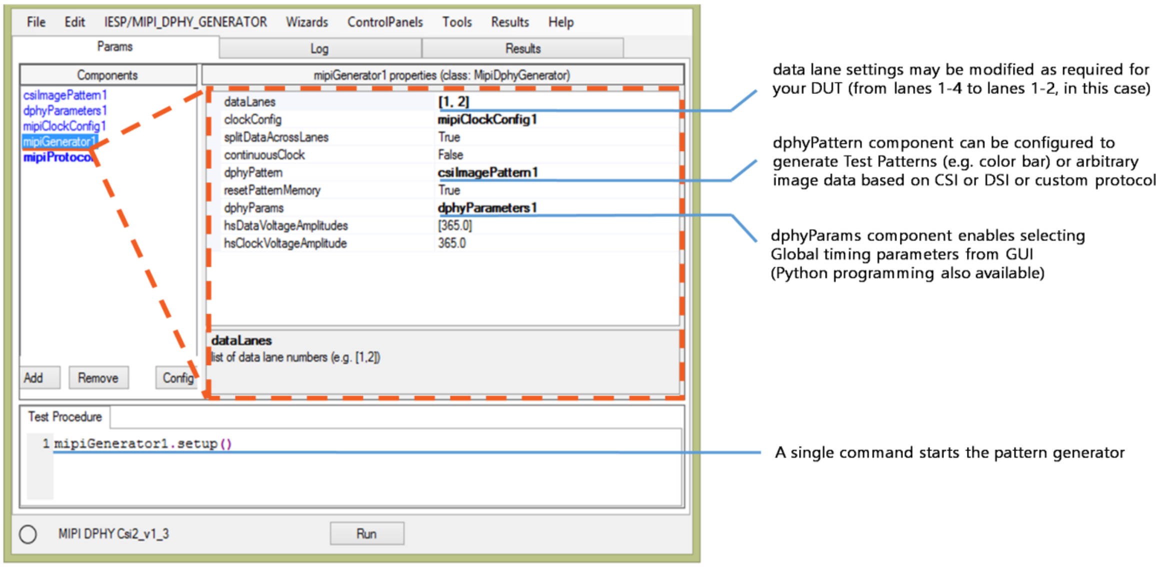
The window pane shown on the top left side of the figure is the "**Components**" window, which shows several pre-populated Python components associated with the DPHY generator.

The window pane on the top right is the "**Properties**" window, which shows specific properties of the selected python component, which can be easily modified by the user.

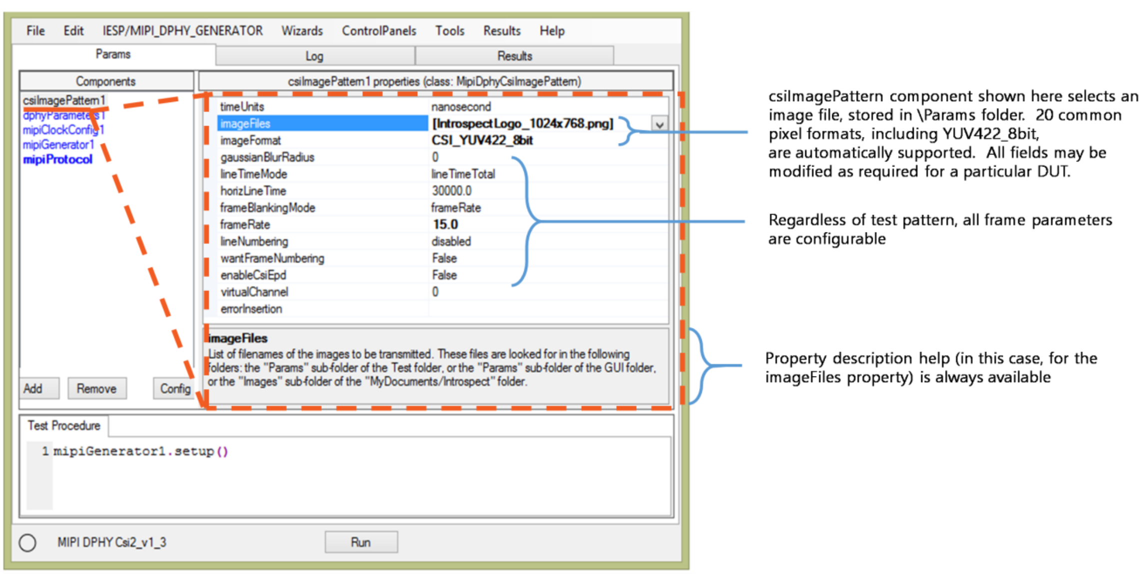
The window pane on the bottom is the "**Test Procedure**" window. By default, when started in the MIPI_DPHY_GENERATOR form factor, the GUI contains a single command in the Test Procedure window: mipiGenerator.setup(), as shown in the bottom GUI window pane in the Figure below. When the "Run" button is pressed, this line in the test procedure is currently the only command executed.



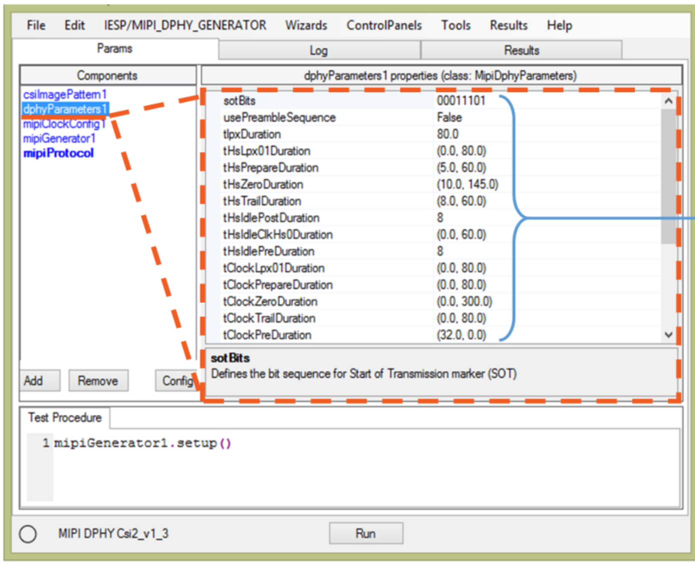
e. The "**mipiGenerator**" python component is one of several pre-populated components shown in the left side window pane. The mipiGenerator is the highest component in the hierarchy, which in turn calls three lower level components, as listed in the "Properties" window: "mipiClockConfig1", "csiImagePattern1", and "dphyParameters1". Refer to the callout boxes in the figure below for further details.



f. One of the parameters for the mipiGenerator1 component is the dphyPattern, and it is used to define the kind of payload that is transmitted by the SV4D DPTX. Various custom and standard patterns can be generated, and the default setup is an image file (i.e. a png file with the Introspect logo) sent as a CSI-2 pattern.

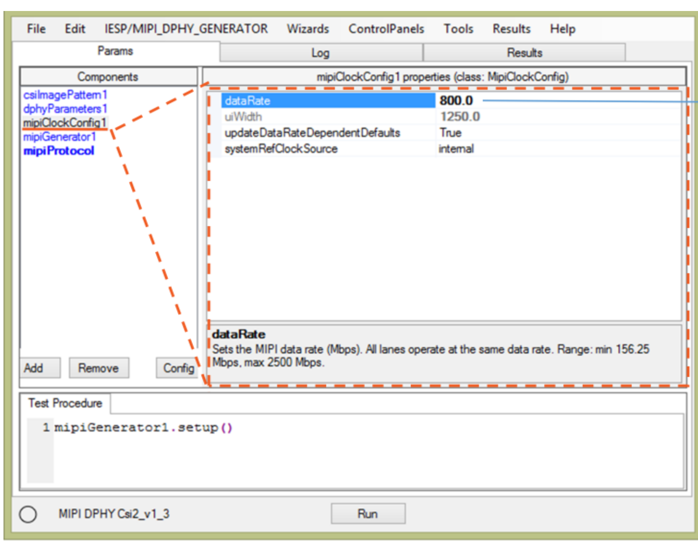


g. Another of the parameters for the mipiGenerator1 component is the dphyParameters, which allows for defining global timing parameters for the physical layer, as shown in the screen capture below.



Global timing parameters are included in units of UI and nanoseconds exactly like the MIPI specification. SOT bits configurable on the fly for the purpose of testing.

h. Another of the parameters for the mipiGenerator1 component is the mipiClockConfig, which sets the data rate, as shown in the screen capture below. In this example, the data rate has been modified from the default setting.

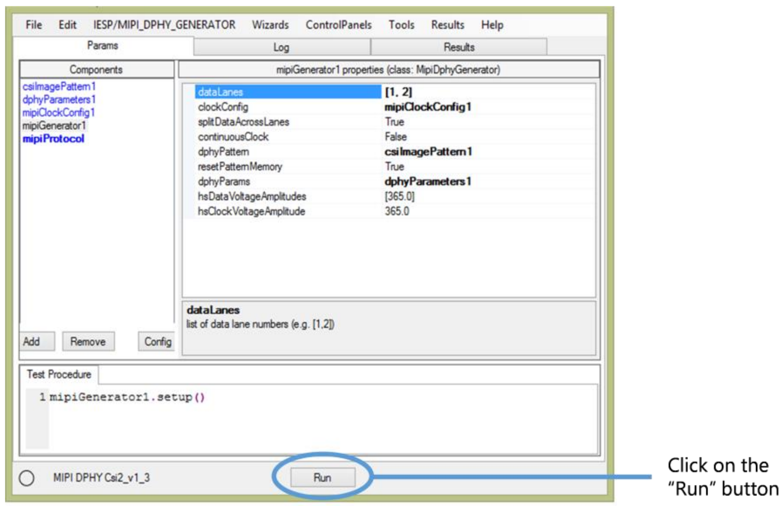


data rate may be modified as required

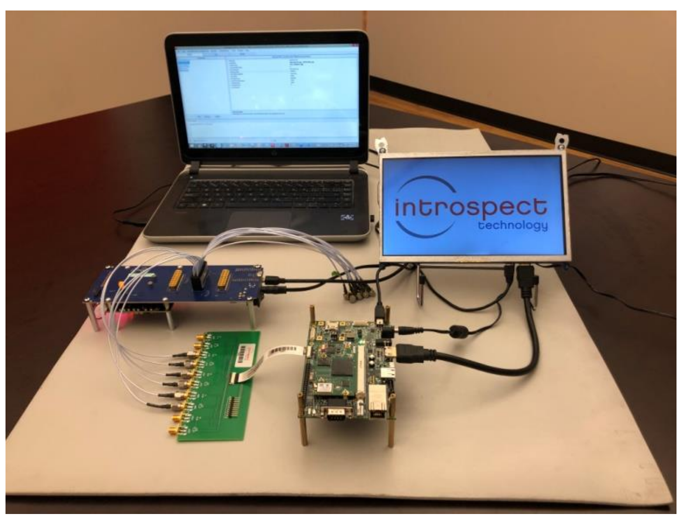
Note: please save your work using the pull-down menu "File -> Save..."

3. Execute the test

a. Up until this point, you have connected the hardware and familiarized yourself with the software interface. However, no pattern is being produced by the generator yet. In the main window of the Introspect ESP software, click Run at the bottom of the GUI window (alternatively use the shortcut key F5) as shown in the image below.



b. The software will take several seconds to upload the image file to the SV4D over the USB connection. The successfully transmitted image (Introspect Logo) will be visible on the display, if connected, as in the image below. The image is continuously transmitted, even after the test completes, with the frame rate specified in the csiImagePattern component.



Once executed, the received Introspect logo will appear on the display.

SV4D DPTX DEMONSTRATION 2

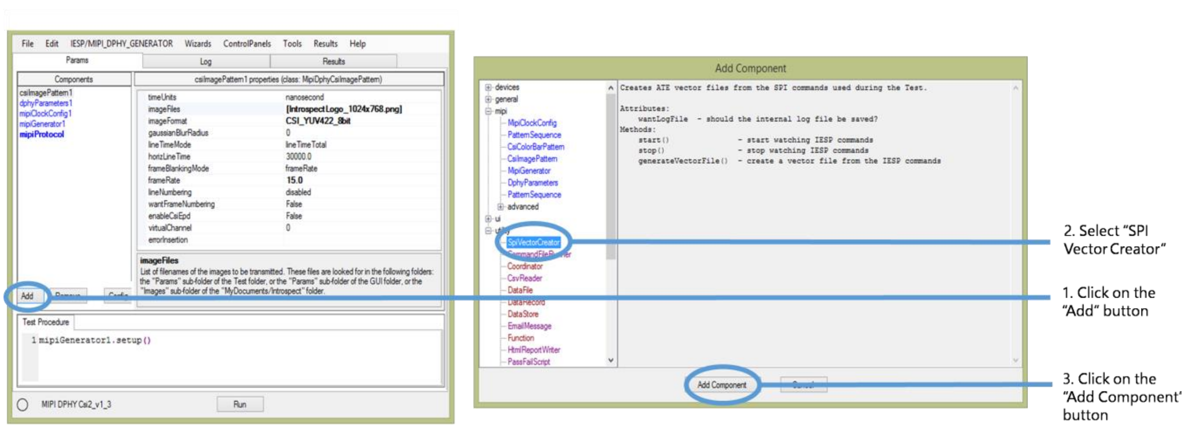
Generating SPI Vectors for ATE

The following step-by-step guide will allow the user to generate SPI vectors for a test program developed in the Introspect ESP GUI. These vectors provide a record all the transitions on the SPI bus related to register reads and writes in the test being executed in the Introspect GUI, which can then be conveniently imported into an ATE environment. For a detailed description of all syntax and address maps for low-level register reads and writes, please see the "SV4D Command Interface Document".

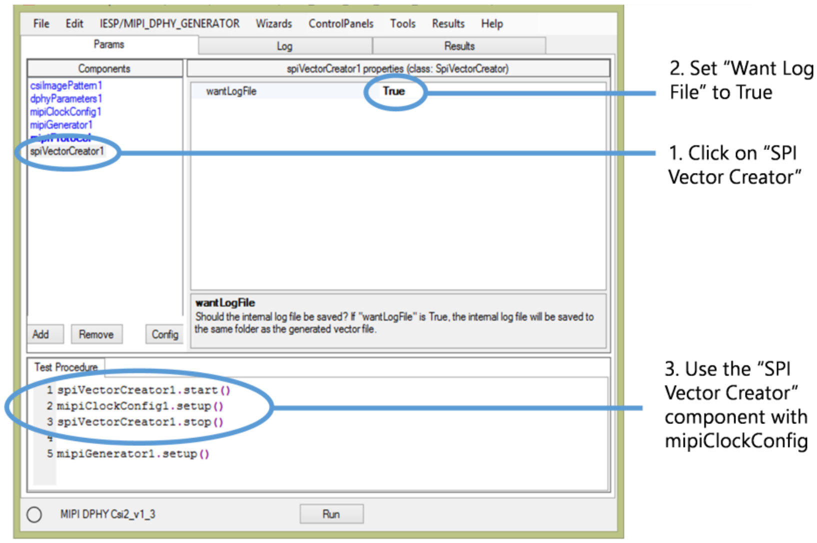
1.Test Setup

No particular hardware test setup with a DUT is required to demonstrate this feature. You may use either the test folder saved from Demonstration 1 or create a new test folder.

a. In this chosen test folder, the user will need to add a component to the existing test program. Please select "Add" in the component window, and in the pop-up window which follows, select "SpiVectorCreator", and then select "Add Component", all as shown in the Figure below.



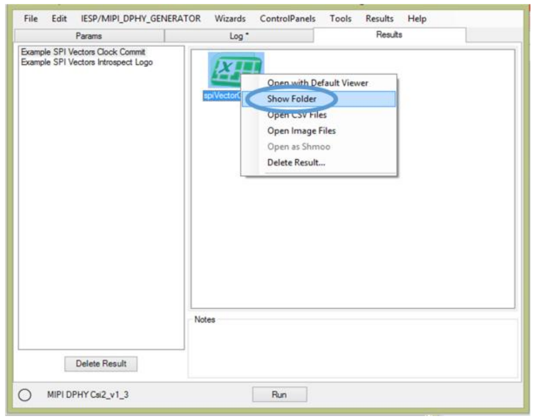
This creates a new component, "spiVectorCreator" in the component window, as shown on the following page.



b. Select the "spiVectorCreator" component in the Component window, and then modify the property "wantLogFile" in the Properties window to be "True".

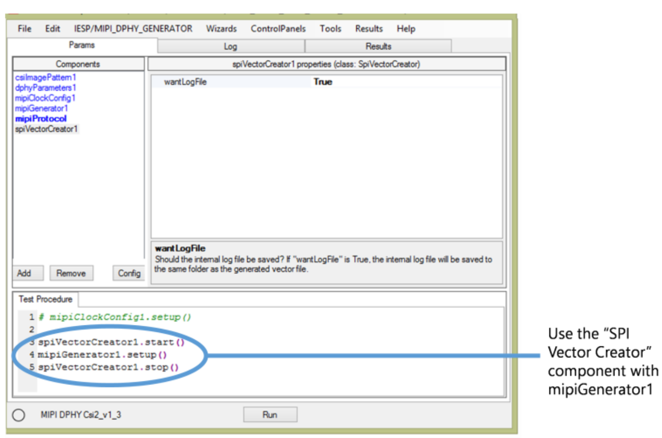
You will notice that a new line has been added to the test procedure: "spiVectorCreator1.start(). When this command appears in the test procedure, all subsequent commands are logged in the "spiVectorCreator" output. To begin with a simple example, see lines 1-3 in test procedure in the figure above. In this case, the spiVectorCreator is used only to generate a log of commands associated with the component "mipiClockConfig1.setup(), rather than the much more involved "mipiGenerator1.setup".

c. When this test procedure is executed, an entry is created under the "Results" tab, as shown in the figure on the following page (note that the test results created during live execution have the timestamp in their file name, unlike the results shown in this figure). You may right-click your mouse on SPI vector creator icon, and select "Show Folder", as outlined in the figure below.



Within the folder which opens up in a Windows Explorer window, there will be two files. The first, **"spiVectorLog.txt"** contains a short list of all SPI commands sent during the execution of mipiClockConfig1.setup(). This .txt file is human-readable; it contains time stamps and a record of all register reads and writes made. The second file, **"spiVector.csv"**, contains the same commands listed in the spiVectorLog.txt, but breaks down all register reads and writes as vectors which can be written to / read from on the SPI lines. These vectors may be imported into an ATE environment.

d. For a more detailed SPI logging example, you may rearrange the test program as shown in the figure below. In this case, the mipiClockConfig1.setup command has been commented out (using the # sign) and the spiVectorCreator is being used to log all commands associated with the mipiGenerator1.setup() itself. When executed, the resulting test folder contains the same two files, "spiVectorLog.txt" and "spiVector.csv". In this case, the spiVector.csv file is much larger (approximately 160 MBytes) because the SPI vector contains all of image data sent to the SV4D. In a similar manner, the generation of SPI test vectors may be generated for any section of a test procedure, in order to facilitate a smooth transition between developing test programs with the SV4D and the GUI and using the test programs within an ATE environment.



APPENDIX

FTDI Driver Manual Installation

The Introspect ESP software communicates with the SPI Controller via an FTDI device (connected via USB). If you don't already have required FTDI drivers installed on your Windows computer, or if the automated driver detection presented earlier in this document was unsuccessful, you will need to download them from the FTDI web site. To do this, follow the instructions found at

http://www.ftdichip.com/Documents/InstallGuides.htm

The latest drivers can be found at

http://www.ftdichip.com/Drivers/D2XX.htm

Note that the driver version used in our product development is 2.12.

You may wish to use the "usbview" utility program linked to on the following FTDI page:

http://www.ftdichip.com/Resources/Utilities.htm

This program will allow you to check that your computer can "see" the FTDI device over USB.

Revision Number	History	Date
1.0	Document release	March 22, 2019

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