DLP Technology Hardware Diagnostic Tool Guide v1.1

Sept. 26, 2023

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Introduction

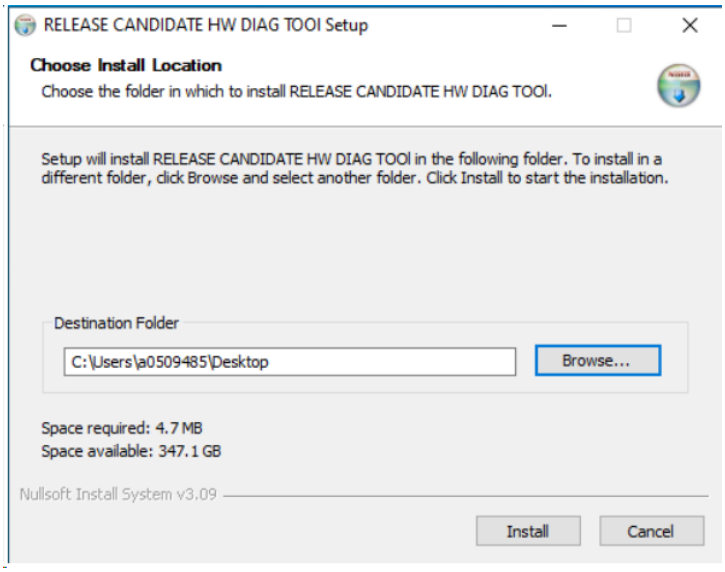
This program is designed to allow a user to self-diagnose issues that they may run into while using DLP technology controllers. Version 1.1 of this program includes methods to diagnose issues related to image quality and issues encountered using DSI.

Diagnostic Tool Specifications

Supported Products	DLP technology controller (DLPC) - DLPC3430, DLPC3432, DLPC3433, DLPC3420, DLPC3421, DLPC3470, DLPC3478, DLPC3439, DLPC3479, DLPC3426, DLPC3434, DLPC3436, DLPC3437
Supported I2C Devices	DeVaSys, Cypress, USB2ANY
Supported OS	Windows 10 or newer

Installation

Begin the install process by downloading the DLP_Hardware_Diagnostic_Program.exe installer. Run the installer, choose a location you would like to save the program and click install. Once the installer has completed a folder named DLP_Hardware_Diagnostic_Program_v1.1 will appear in your previously chosen file path with the diagnostic tool program. Simply locate the program and run it.



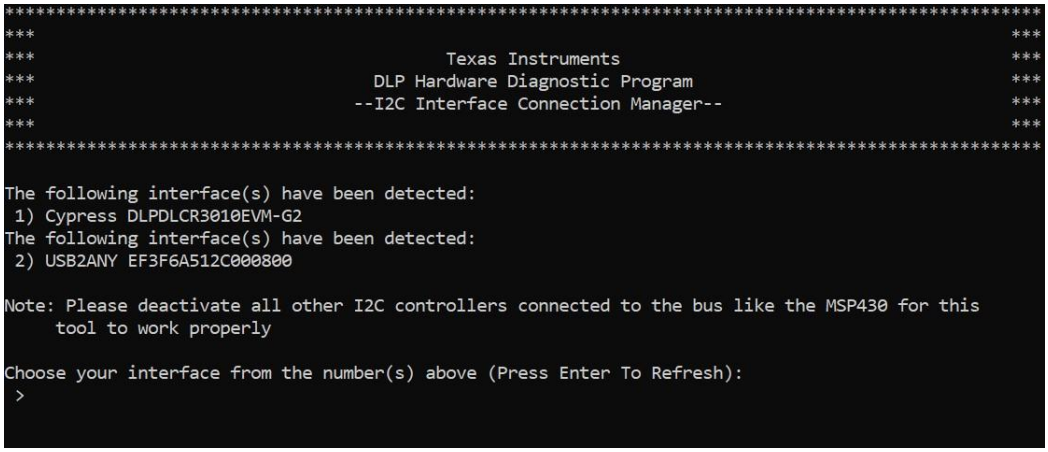
If you receive any errors regarding missing .dll files, you will need to download and install the Microsoft redistributables. The link can be found here, download and install the latest package for your device, then relaunch the diagnostic tool program.

Connecting the diagnostic tool to your device

Before starting a diagnostic session, the host processor connected to the DLPC chip must stop sending transactions on the I2C bus. If transactions are still being sent on the bus during a diagnostic session, the diagnostic program WILL NOT work correctly.

To connect to the diagnostic program, use one of the three supported I2C interfaces and connect the SCL, SDA, 3.3V and GND pins to the supported DLP technology controller. Ensure that there are not any active connections to the system.

After properly connecting your device and powering it on, launch the diagnostic tool executable. The following menu will appear after a few seconds.



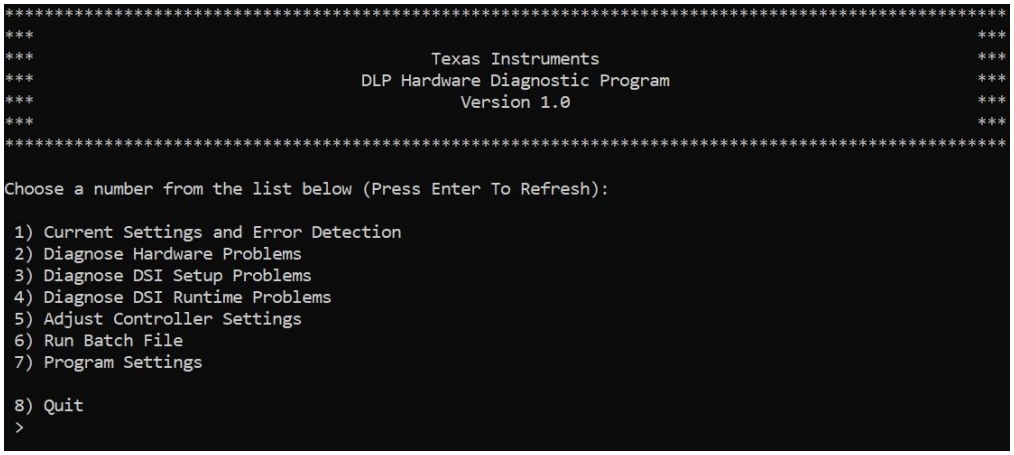
Select your desired interface by typing the number to the left of its name and pressing enter. In this example, a user would type “2” and press enter to select the USB2ANY interface.

After selecting the desired interface, the program will take control of the I2C bus and launch the main menu. If the tool creates an unwanted image output at any time, power cycle the system. The tool does not have to be relaunched.

NOTE: If the DLPC is configured to use the alternate I2C address 0x3A, go to the ‘Adjust Controller Settings’ menu and change the I2C Target Address. Otherwise, commands will be ignored by the DLPC and this program will not work.

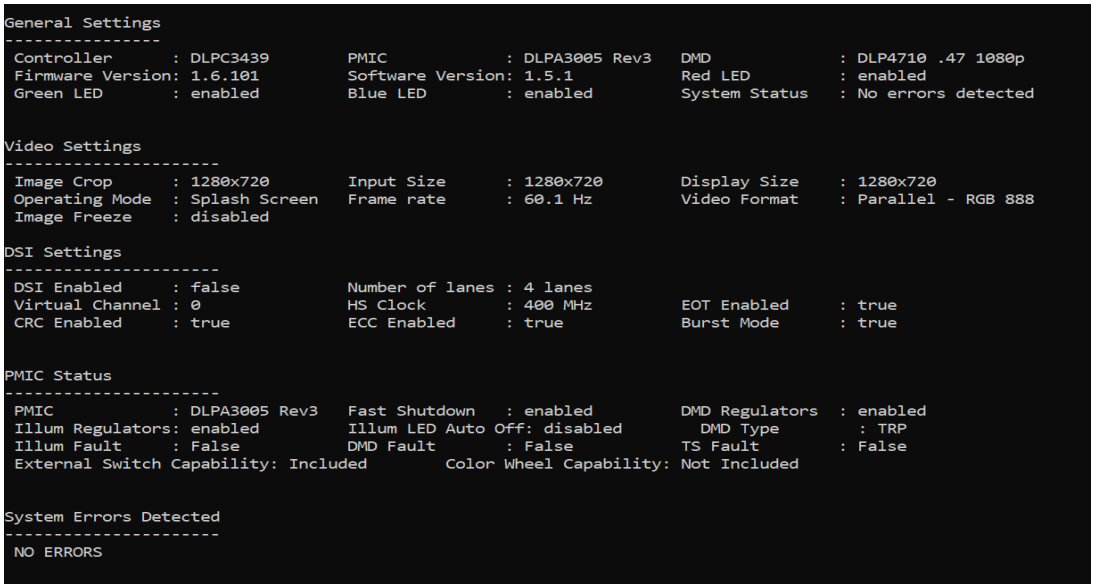
The main menu

The main menu allows access to all portions of the controller. Type the number corresponding to the desired tool. If an LC or XPR controller is being used, an ‘LC Debugger’ or ‘XPR Debugger’ option will show. Selecting ‘Quit’ will end the program and close the window.



Current settings, error detection, and PMIC status

The Settings tool provides a location to see the configuration and the relevant settings of the connected DLP technology controller and PMIC in one place. At any point in the debugging process, this tool can be called to display the most current settings.



System errors that can appear include:

- Individual LED errors
- DMD interface errors
- DMD training errors
- Sequence errors
- DC power supply errors
- Product configuration errors

NOTE: Display Size will read N/A on the 342X series of controllers as this command is not supported. Also, on XPR Controllers, only the FPGA Input Image Size will show instead of Image Crop, Display Size, and Input Size, as these commands are not supported.

Hardware diagnostic tool

Version 1.0 of the ‘Diagnose Hardware Problems’ tool is intended to diagnose hardware issues on the basis of poor image quality. Six distinct actions can be performed to test for the root cause of the issue.

```
*****************************************************************************************************
***                                                                                               ***
***                                    Texas Instruments                                          ***
***                                DLP Hardware Diagnostic Program                                ***
***                                     --Hardware Debugger--                                     ***
***                                                                                               ***
*****************************************************************************************************

*****************************************************************************************************
What issue are you experiencing? Please choose a number from the list below:

 1) Image Quality

 2) Return to Main Menu
 3) Quit Program
 > 1

*****************************************************************************************************
Actions that can be performed to test image quality:

 1) Cycle between Looks (Test Patterns only)
 2) Cycle through pre-set Test Patterns with a custom LED configuration
 3) Toggle between display modes (Test Pattern, Splash Image, and External Video)
 4) Increment though Splash Images
 5) Generate a custom Test Pattern
 6) Test for Linearity Issues
 7) Return to Previous Menu
```

A brief overview of the options:

1) **Cycling between Looks** – A Look displays a particular white point balance. By cycling through the Looks, each can be examined for intended white point and correct color sequences.

```
A Look typically specifies a target white point. Looks are specified by an enumerated value (such as 0, 1, 2, 3).
The number of Looks available may be limited by the available space in flash memory.

Current Look Number: 0 (Press Enter to cycle to the next Look)
Current Look Number: 1 (Press Enter to cycle to the next Look)
Current Look Number: 2 (Press Enter to cycle to the next Look)
Current Look Number: 3 (Press Enter to cycle to the next Look)
Current Look Number: 4 (Press Enter to cycle to the next Look)
Resetting to Inital Look: 0

Press enter to return to the previous menu:
```

2) **Cycling between Test Patterns based on LED configuration** – A variety of pre-set test patterns can be tested against a custom configuration of the Red, Green and Blue LEDs. Some patterns may display a worse image quality than others, potentially indicating a signal integrity issue. Changing the LED configuration ensures that the colors are balanced correctly.

```
Red LED: Enabled
Green LED: Enabled
Blue LED: Enabled

The R, G, and B LEDs can be enabled and disabled independently. Choose a configuation to test:

 1) RGB Enabled
 2) R Only Enabled
 3) G Only Enabled
 4) B Only Enabled
 5) RG Enabled
 6) GB Enabled
 7) RB Enabled

 > 5

Red LED: Enabled
Green LED: Enabled
Blue LED: Disabled

Press enter to cycle through the test patterns.
```

```
Pattern: Colorbars
Pattern: Solid Field, Black (0x0)
Pattern: Solid Field, Red (0x1)
Pattern: Solid Field, Green (0x2)
Pattern: Solid Field, Blue (0x3)
Pattern: Solid Field, White (0x7)
Pattern: Checkerboard, White (0x7)
Pattern: Horizontal Lines, White (0x7)
Pattern: Vertical Lines, White (0x7)
Pattern: Horizontal Lines, White (0x7)
Pattern: Vertical Lines, White (0x7)
Pattern: Diagonal Lines, White (0x7)
Pattern: Horizontal Ramp, White (0x7)
Pattern: Vertical Ramp, White (0x7)

Resetting to RGB Enabled Colorbars Test Pattern.
Red LED: Enabled
Green LED: Enabled
Blue LED: Enabled

Press enter to return to the previous menu:
```

3) **Toggling between the three display modes** – The display output can be switched between a Test Pattern(an internally generated image), and a Splash Image(an externally loaded image) to determine if an issue is with the front-end or back-end processing. The display can also be toggled to External Video mode for DSI. If an external video source is not connected, toggling will not visually change the output.

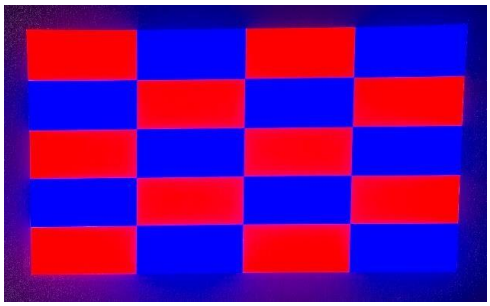
```
Inital Operating Mode: Test Pattern Generator

For each switching iteration, choose a letter from the choices below and then press enter:
--Type 'T' to toggle between Splash Pattern and Test Pattern Generator.
--Type 'E' to switch to external video.
--Type 'X' to exit
User Input: T

Current Operating Mode: Splash Screen
Splash Screen Index: 0
Display Size: 1280x720
Splash Image Size: 640x480
User Input: t

Current Operating Mode: Test Pattern Generator
Display Size: 1280x720
User Input: e

Current Operating Mode: External Video Port
Video Format: Parallel - RGB 888
User Input: T

Current Operating Mode: Splash Screen
Splash Screen Index: 0
Display Size: 1280x720
Splash Image Size: 640x480
User Input: X

Press enter to return to the previous menu:
```

4) **Increment through Splash Images** – Each Splash Image currently loaded in the firmware can be viewed sequentially, ensuring that the display output is as intended for each image, testing qualities such as colors and resolution.

```
Starting Splash Image Size: 640x480
Current Splash Image Number: 0 (Press Enter to cycle to the next Splash Image)

Current Splash Image Size: 640x480
Current Splash Image Number: 0 (Press Enter to cycle to the next Splash Image)

Current Splash Image Size: 854x480
Current Splash Image Number: 1 (Press Enter to cycle to the next Splash Image)

Current Splash Image Size: 427x240
Current Splash Image Number: 2 (Press Enter to cycle to the next Splash Image)

Current Splash Image Size: 427x240
Resetting to Splash Image Number 0.
Current Splash Image Size: 640x480

Press enter to return to the previous menu:
```

5) **Generate custom Test Pattern** – Highly customizable test patterns can be generated to test a particular aspect of an image, such as pattern, colors, or brightness. This test pattern can be used to view the Looks in Option 1 and will be the pattern seen when toggling in Option 3 of the main menu.

```
Current test pattern
--------------------
Pattern: Colorbars (0x8)
Border: Disabled (0x0)
Foreground Color:  Black (0x0)
Background Color:  Black (0x0)

Test patterns are generated internally. Choose a pattern type to generate a custom pattern:

 1) Solid Color Field
 2) Ramp - Horizontal or Vertical
 3) Lines - Horizontal, Vertical, Diagonal, or Grid
 4) Checkerboard
 5) Color Bars
 > 4

Choose a foreground color:
 1) Black
 2) Red
 3) Blue
 4) Green
 5) Cyan
 6) Magenta
 7) Yellow
 8) White
 > 2

Choose a background color:
 1) Black
 2) Red
 3) Blue
 4) Green
 5) Cyan
 6) Magenta
 7) Yellow
 8) White
 > 3

Choose a number of horizontal checkers: 4
Choose a number of veritcal checkers: 5
Build another test pattern? (Y/N):
```

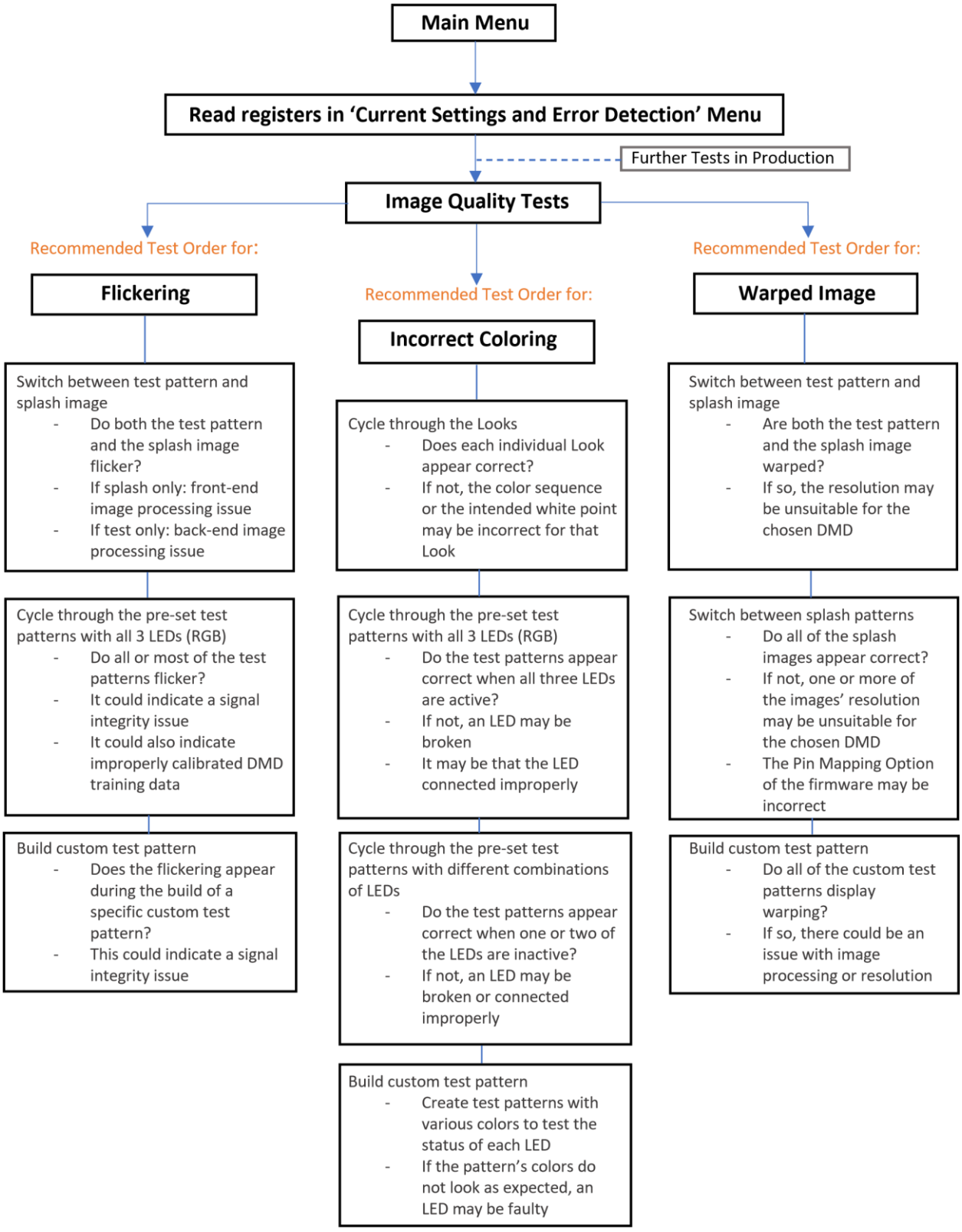


6) **Linearity Test** – This option tests the linearity of the sequence, verifying if there's a problem with the firmware of the system. This function displays a white ramp, red ramp, green ramp, then a blue ramp, and cycles through all the Looks for each ramp. If there is a problem with the firmware, an image artifact will be seen. Ideally video output should be clear and linear for example if the ramp test patterns seem to jump from dark to light suddenly this could indicate a non-linearity issue. These tests should expose any non-optimal sequences as image quality issues.

```
You have selected the Linearity Test tool.
The program will cycle through white, red, green, and blue ramps and through all the Looks for each.
You are currently viewing the white ramp. Press enter to cycle through each Look.
Current Look Number: 1 (Press Enter to cycle to the next Look)
Current Look Number: 1 (Press Enter to cycle to the next Look)
Current Look Number: 2 (Press Enter to cycle to the next Look)
Current Look Number: 3 (Press Enter to cycle to the next Look)
Resetting to Inital Look: 0

Press enter to cycle to the red ramp

Current Look Number: 0 (Press Enter to cycle to the next Look)
Current Look Number: 1 (Press Enter to cycle to the next Look)
Current Look Number: 2 (Press Enter to cycle to the next Look)
Current Look Number: 3 (Press Enter to cycle to the next Look)
Resetting to Inital Look: 0

Press enter to cycle to the green ramp

Current Look Number: 0 (Press Enter to cycle to the next Look)
Current Look Number: 1 (Press Enter to cycle to the next Look)
Current Look Number: 2 (Press Enter to cycle to the next Look)
Current Look Number: 3 (Press Enter to cycle to the next Look)
Resetting to Inital Look: 0

Press enter to cycle to the blue ramp

Current Look Number: 0 (Press Enter to cycle to the next Look)
Current Look Number: 1 (Press Enter to cycle to the next Look)
Current Look Number: 2 (Press Enter to cycle to the next Look)
Current Look Number: 3 (Press Enter to cycle to the next Look)
Resetting to Inital Look: 0

You have cycled through all the ramps. Press enter to revert to the Color Bars test pattern.

Press enter to return to the previous menu.
```

NOTE: For XPR systems, test patterns will be displayed using the XPR FPGA Test Pattern operating mode. Also, the default test pattern displayed for all the controllers is the Colorbars pattern, except for the DLPC3437, which is the Checkerboard pattern.

Recommended Hardware Diagnostic Flow



DSI diagnostic tools

Introduction to DSI

DSI or “Display Serial Interface” is a synchronous, high speed, differential video interface. The interface supports up to 4 lanes reducing the required PCB traces and overall hardware design complexity. More information can be found on DSI in the DSI Setup and Debugging Guide.

DSI diagnostic flow

1) When beginning to diagnose a DSI issue, first choose the ‘Current DSI Settings’ tool from the main menu and check if the current controller values match the values expected.
2) Ensure correct order of operations: Configure the controller, run the ‘Diagnose DSI Setup Problems’ tool, start the DSI video source. This will make sure that all required settings have been configured.
3) Finally, start the DSI video source. Allowing a working state to be reached. If the DLP technology system does not project as expected, launch the ‘Diagnose DSI Runtime Problems’ tool and run through the diagnostic session following the provided instructions.

DSI runtime diagnostic tool

This tool uses error data from the controller to determine if there are any current DSI issues and recommends a resolution.

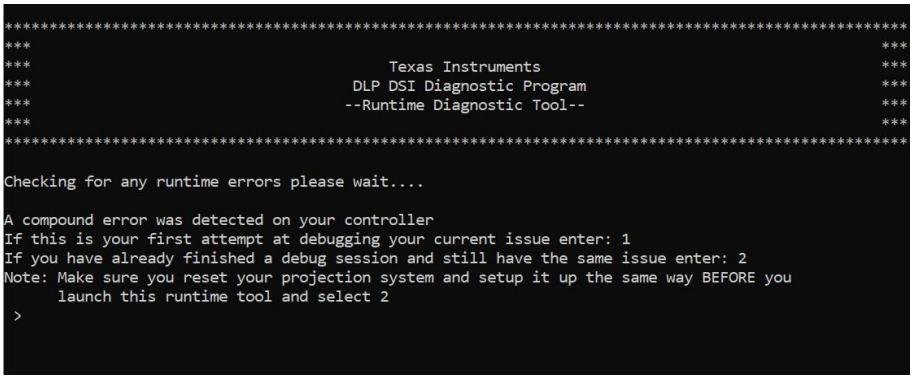
When this tool launches, it will begin the diagnostic process if it detects an error. The runtime diagnostic tool will display what error it thinks might be present and the recommended solution. Many times, this solution is either tied to hardware or the DSI source’s configuration in which case a text solution will be provided for a user to follow. After recommended corrections are made, the user should restart their DSI video transmission to see if they encounter further errors. It is also recommended that the controller is restarted and reconfigured after each correction as certain error states may be nonrecoverable.

Some errors can be corrected on the controller side. If this is the case, one of the resolution tools will launch and allow corrections to be made to the current configuration based upon the error. These corrections are only temporary and correction will need to be made to the default setup. For example, the hardware configuration would need to be altered to include pull ups and pull downs in the case of an incorrect lane count.

Sometimes multiple issues can be present. Users should continue to run the runtime diagnostic tool fixing the issues presented until the same recommendations or error codes clear/resolve or a satisfactory video output is received.

Compound Errors

Occasionally, the diagnostic program may detect a ‘compound error’.



Compound errors are errors that can be partially cleared. Generally, clearing is ideal as it removes old errors or junk data. In the first debug attempt, this junk is cleared to create a simplified error code. However, on occasion, this can result in useful data being cleared, so this data is kept during the debug if necessary.

Adjust controller settings

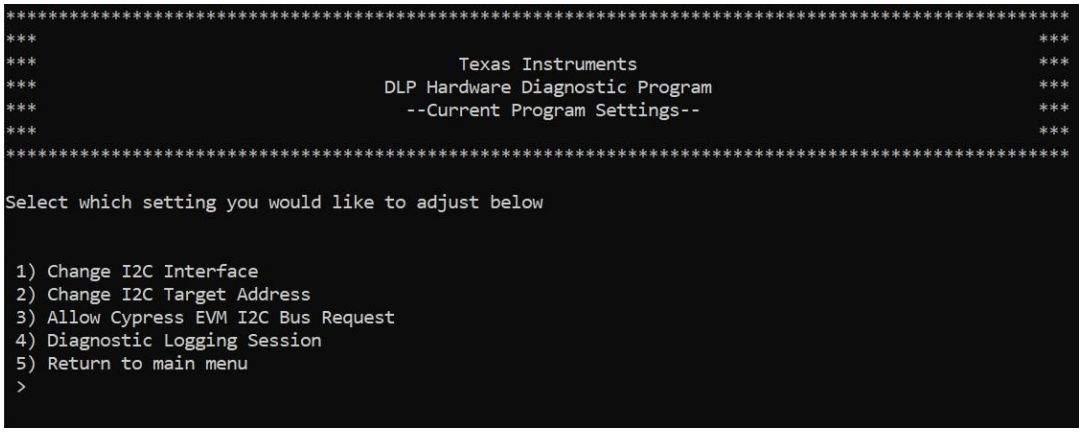
While setting adjustments can be made with the help of Control Program, the DSI Diagnostic Tool has some setting adjusters built-in to reduce the need to switch between multiple tools.

Current adjusters include

- DSI HS Clock
- DSI Lane Count
- Virtual Video Channel
- Display Size – Not available on 3420 or 3421
- Crop Size
- External Input Image Size – Not available on 3420

Program Settings

This menu allows you to change certain settings in the program.

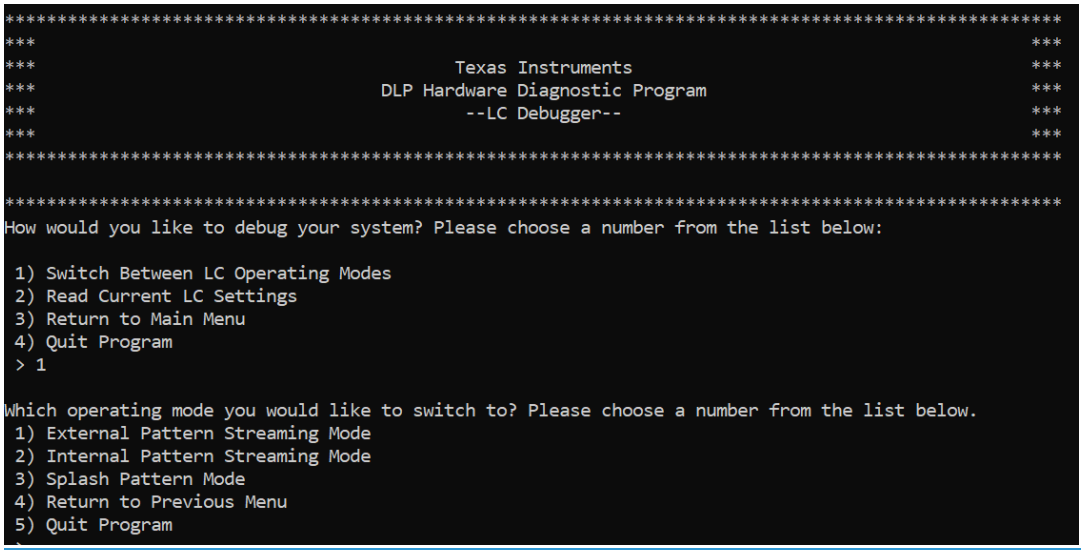


A brief overview of the options:

1) **Change I2C Interface** - This disconnects from the current I2C interface and returns to the connection manager screen allowing users to change their currently used interface.
2) **Change I2C Target Address** - Changes the I2C address being used when commands are being sent (Options are 0x36 and 0x3A)
3) **Allow Cypress EVM I2C Bus Request** - EVMs like the DLPLCR3010-G2 have a function where the Cypress chip can request the MSP430 to give up the bus by using its GPIO pins. If a user changes the MSP430 code or this gets enabled on a non-EVM board, this setting allows the user to disable that GPIO request.
4) **Diagnostic Logging Session** - This setting allows the user to start and end diagnostic sessions which log the current state of the DLPC chip as the user goes through their debug.
    - ✦ Diagnostic files are saved at: C:\Users\{USER-ID}\AppData\Roaming\Texas Instruments\DLP PICO DSI Diagnostic

LC debugger

The LC Debugger option, which is only available to LC controllers, allows the user to test the LC Operating Modes of their system and read the LC settings of the controller. These are External Pattern Streaming, Internal Pattern Streaming and Splash Patterns. The program will take the user through setting up these modes, and display what the user has specified. This can be used to debug applications for 3D Optical Inspection, 3D Measurement, 3D Facial and Fingerprint Recognition, 3D Printing, Robotic Vision and Machine Vision. The processes for setting up these operating modes (in order) are shown below:



External pattern streaming

1. Write Trigger Out Configuration
2. Write Pattern Configuration
3. Write Operating Mode Select

External Pattern Streaming mode displays pattern data received via an external video port.

Internal pattern streaming

1. Write Trigger Out Configuration
2. Write Trigger In Configuration
3. Write Pattern Ready Configuration
4. Write Operating Mode Select
5. Write Internal Pattern Control

Internal Pattern Streaming mode displays 1D pattern data stored in flash.

Splash patterns

1. Write Trigger Out Configuration
2. Write Pattern Configuration
3. Write Operating Mode Select
4. Write Splash Screen Select
5. Write Display Size
6. Write Input Image Size
7. Write Image Crop
8. Write Splash Screen Execute

Splash Pattern mode displays 2D patterns stored as images in flash.

Read LC settings

Reads the LC settings specified on the user's system.

```
LC Settings
----------------------
 Image Crop      : 1280x720
 Input Size      : 1280x720        Operating Mode  : Splash Screen   Display Size    : 1280x720
 Red LED         : enabled         Green LED       : enabled        Blue LED        : enabled


Pattern Configuration
----------------------
1 Bit Mono External
Red Illumination Disabled
Green Illumination Disabled
Blue Illumination Disabled
Illumination Time: 0 us
Pre Illumination Dark Time: 0 us
Post Illumination Dark Time: 0 us
```

XPR Debugger

As of right now, the only function is to read the XPR settings of the controller. **NOTE: The DLPC3437 does not support the Read Actuator DAC command.

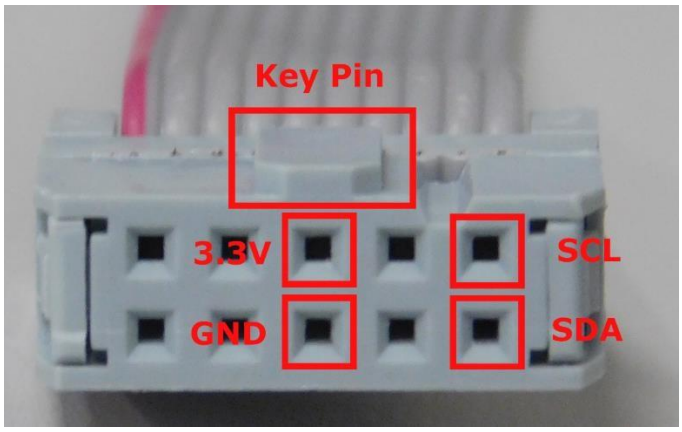
```
*********************************************************************************************************
***                                                                                                   ***
***                                      Texas Instruments                                            ***
***                                  DLP Hardware Diagnostic Program                                  ***
***                                          --XPR Debugger--                                         ***
***                                                                                                   ***
*********************************************************************************************************

*********************************************************************************************************
How would you like to debug your system? Please choose a number from the list below:

 1) Read Current XPR Settings
 2) Return to Main Menu
 3) Quit Program
 > 1

 Controller      : DLPC3437        FPGA Input Image Size: 1920x1080      Actuator Gain    : 0.547 V/V
 FPGA Keying Status: Passed          Display Mode    : XPR Mode        Video Format     : RGB 888
```

USB2ANY connection instructions

For an introduction to the USB2ANY Interface Adapter, the User's Guide can be found here. The USB2ANY interface is the preferred interface for connecting to end user devices which do not contain a Cypress chip or DeVaSys board.

The following diagram shows the necessary wiring for the USB2ANY Interface:

- Users MUST connect 3.3V, GND, SCL, and SDA



Further help

If issues are still present, contact a DLP technology engineer using E2E:

1) Please provide the following information in your post/support request.
    a. A detailed description of the issue you are encountering: No video, intermittent video, flickering image, etc.
        i. A description of the results of the image quality tests
        ii. If possible, provide an image or video of your issue
    b. Which firmware the system is using and where it was originally downloaded from
    c. c. If the issue is DSI related:
        i. Your diagnostic session log file
        C:\Users\{USER-ID}\AppData\Roaming\Texas Instruments\DLP PICO DSI Diagnostic
        ii. Information regarding the video format being sent
            1. Frame rate
            2. Color format (eg. RGB565)
            3. Video size (eg 1280x720)
            4. Blanking time and Blanking Type (HS Blanking or LP11 Blanking)
            5. Burst or NonBurst iii. The DPHY timing parameters your DSI Source is using (Different systems may refer to these by different names please try your best to fill out as many of these parameters as you can).
                1 HS Prepare, HS Zero, HS Exit, HS Trail
                2 Clk Prepare, Clk Zero, Clk Trail, Clk Pre, Clk Post
                3 Wakeup, TA Go, Pixel Clk, Lane Clk