DLP® LightCrafter™ Dual DLPC900 Evaluation Module (EVM) User's Guide

User's Guide

![Texas Instruments]

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The DLP® LightCrafter™Dual DLPC900 evaluation module (EVM) offers a reference design to enable faster development cycles for users of dual DLPC900 Controller architecture in support of dual controller DMDs. This platform targets applications needing intelligent pattern management along with high resolution display.

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About This Guide

This guide explains the hardware and software features of the DLP LightCrafter Dual DLPC900 EVM systems. The EVM architecture and connectors are described along with a quick start guide on how to operate the DLP LightCrafter Dual DLPC900 EVM using a Graphical User Interface (GUI). Specific details for each DLP component can be found in related component documentation.

Note

Power supply, optics, illumination source, and cables are sold separately.
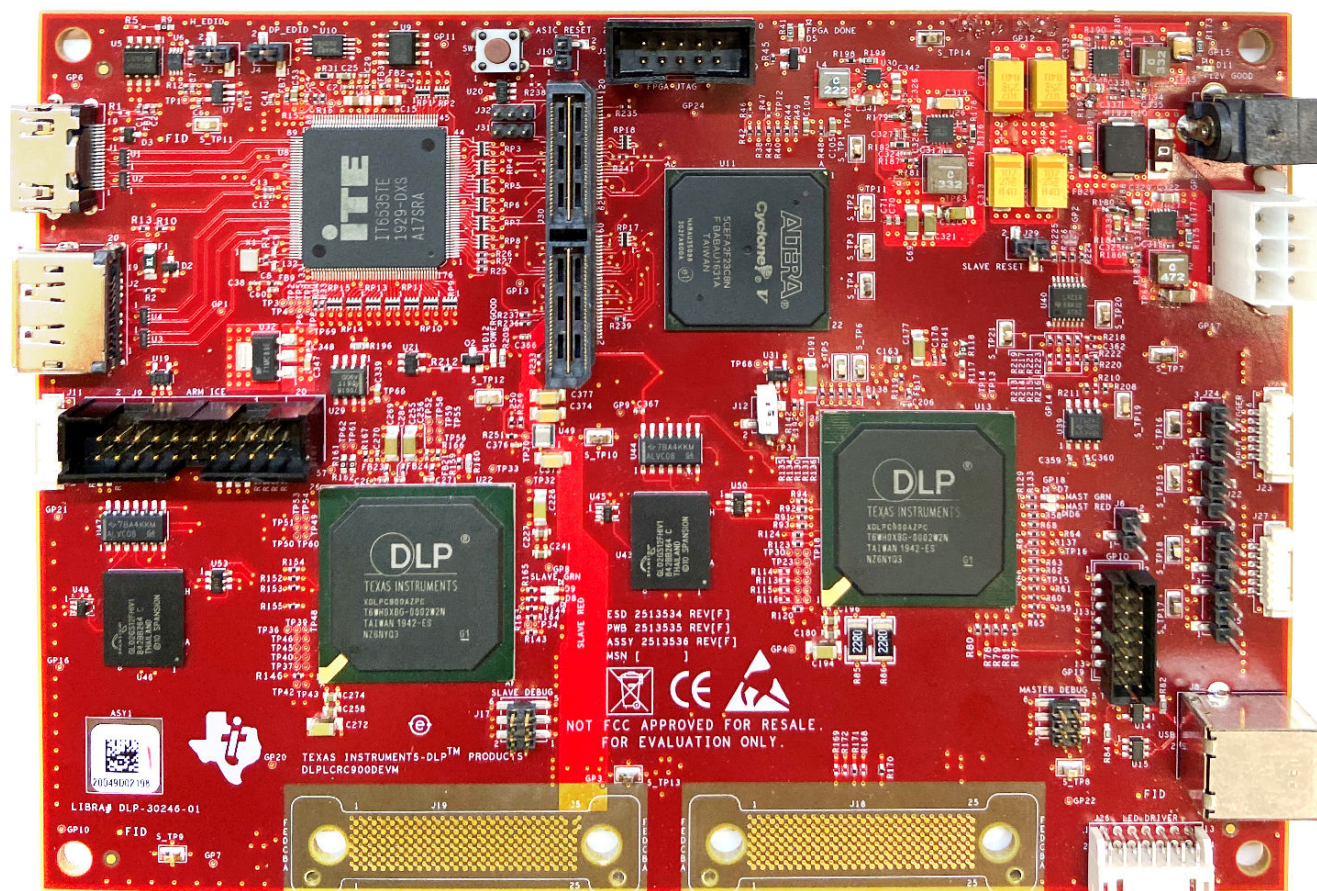
Figure 1-1. DLP LightCrafter Dual DLPC900 Evaluation Module

Related Documentation from Texas Instruments

Component datasheets, technical documents, design documents, and ordering information can be found at the following links:

DLPC900 Digital Controller Product Folder

DLPC900 Programmer's Guide

DLP LightCrafter Dual DLPC900 EVM Product Folder

DLP500YX DMD Product Folder

DLP LightCrafter DLP500YX DMD EVM Product Folder

DLP670S DMD Product Folder

DLP LightCrafter DLP670S DMD EVM Product Folder

DLP9000 DMD Product Folder

DLP LightCrafter DLP9000 DMD EVM Product Folder

If You Need Assistance

Refer to the TI E2E DLP products forum.

DLP LightCrafter Dual DLPC900 EVM Overview

1.1 Welcome

The DLP LightCrafter Dual DLPC900 EVM, coupled to one of a number of DLP LightCrafter Dual DLPC900 DMD EVMs, allows for easy evaluation of the DLP LightCrafter subsystem in bringing together high resolution display and advanced pattern control which is well suited for:

- Structured light applications
  - Factory automation and 3D machine vision
  - In-line automated optical 3D inspection
  - Robotic 3D vision
  - Offline 3D metrology
  - 3D scanners
  - 3D identification and biometrics
- 3D printing and additive manufacturing
- Medical and life sciences
- High speed imaging and display

1.2 DLP LightCrafter Dual DLPC900 Evaluation Module (EVM) Hardware

The DLP LightCrafter Dual DLPC900 EVM is one half of a complete DMD imaging electronics subsystem. It consists of the Dual DLPC900 Board which includes two DLPC900 Digital Controllers, a digital video receiver, flash memory, power management circuits, and supporting digital logic.

Also needed to complete the imaging subsystem is a DLP LightCrafter DMD EVM of which three are compatible with the LightCrafter Dual DLPC900 EVM. Each of these DMD EVMs consists of a DMD, a DMD board (pcb) containing on-board DMD power circuits, DMD mounting hardware when necessary, and two flexible (pcb) cables for connections to the Dual DLPC900 board. Supported DMD devices and their corresponding DMD EVM modules are:

- DLP500YX DMD is the DMD within the DLPLCR50XEVM
- DLP670S DMD is the DMD within the DLPLCR67EVM
- DLP9000 DMD is the DMD within the DLPLCR90EVM

Figure 1-1 is a block diagram outlining the major hardware components within the DLP subsystem using the DLPLCR90EVM as one of the three DMD examples.
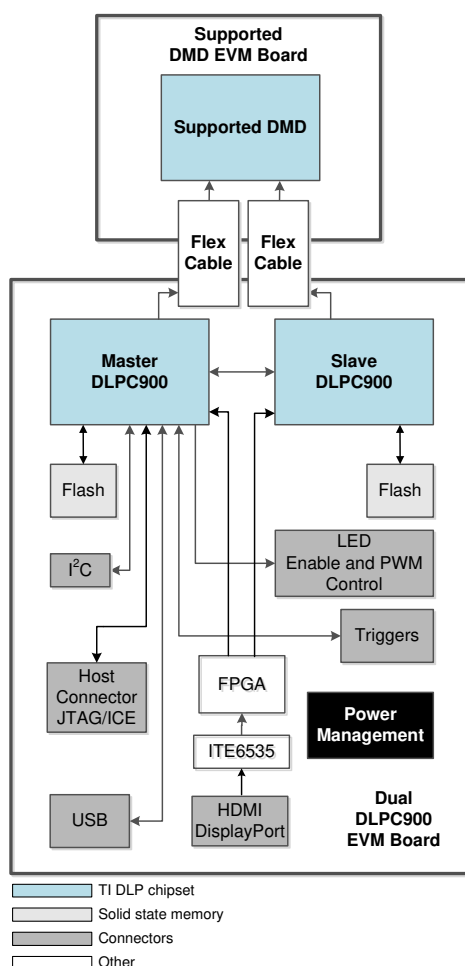
Figure 1-1. DLP LightCrafter Dual DLPC900 Hardware Components

1.3 EVM Boards

The DLP LightCrafter Dual DLPC900 EVM contains the electronics capable of controlling supported Dual controller DMDs. The EVMs offer several interface options, USB, I^{2}C, trigger inputs and outputs, with video inputs through HDMI or Display Port connectors. Figure 1-2 shows the EVM block diagram of the DLP LightCrafter Dual DLPC900 EVM.
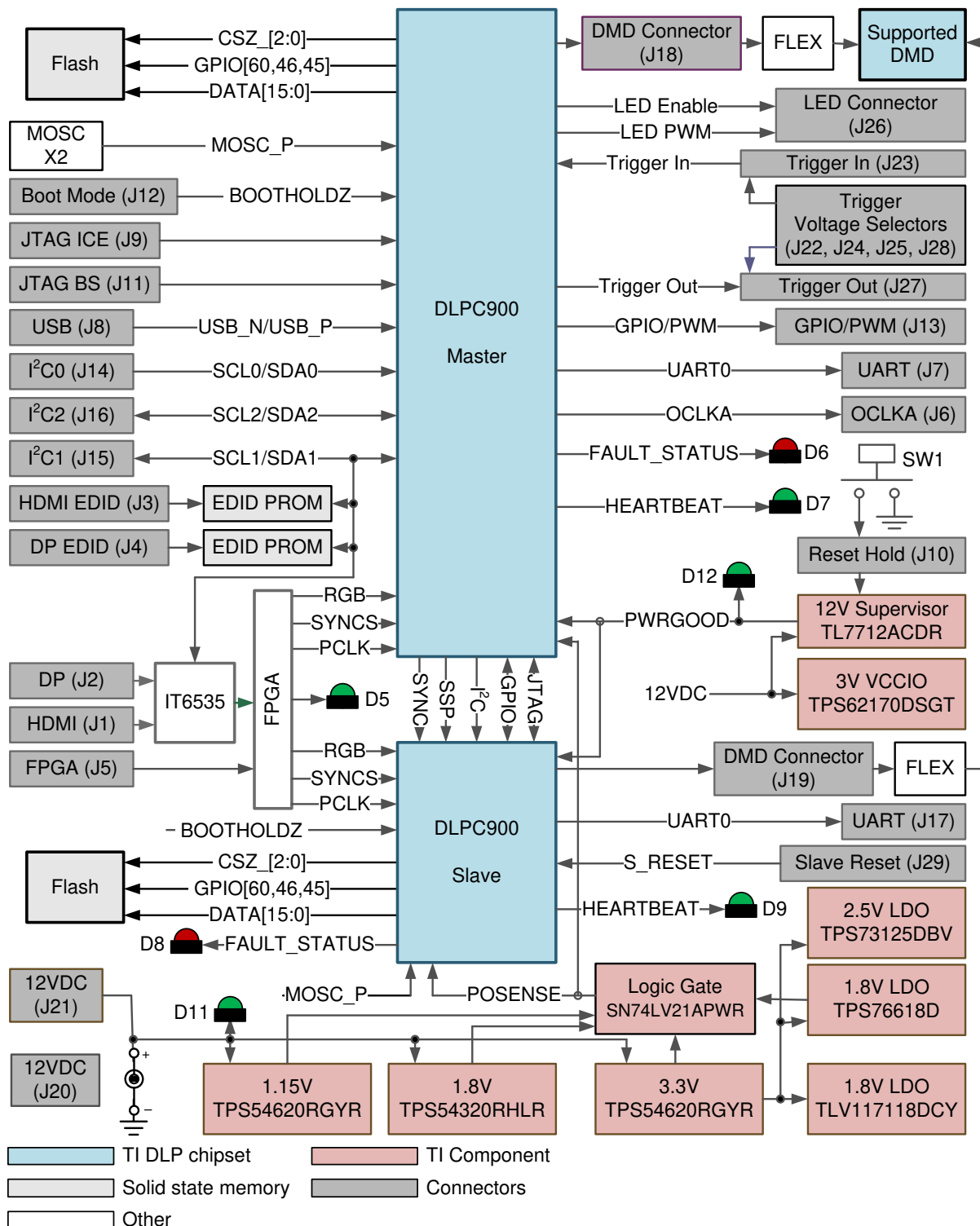
Figure 1-2. DLP LightCrafter Dual DLPC900 EVM Block Diagram

The DLP LightCrafter Dual DLPC900 EVM major components are:

- A Video Splitter FPGA
- Two DLPC900 Digital DMD Controllers
- Parallel FLASH memory for storing programming and pattern images for each DLPC900
- All necessary power supplies to support the DLP subsystem
- One IT6535 digital receiver for HDMI and Display Port Video Input

1.4 Other Items Needed for Operation

The DLP LightCrafter Dual DLPC900 EVM is a flexible, ready-to-use evaluation module which, when coupled to one of the supported DLP LightCrafter Dual Controller DMD EVMs, enables the sending of customer created patterns from the DLPC900 Controllers to the attached DMD for display at the customer determined pattern rates. The DLP LightCrafter Dual DLPC900 EVM and supported DMD EVMs are offered for purchase separately so that customers can determine which elements they wish to piece together for their own application evaluation system.

The following items are not included with the EVM and need to be purchased separately if needed for customer evaluation:

- Power supply - see Section 5.1 *External Power Supply Requirements* for details
- USB cable: A to B USB cable
- HDMI® or DisplayPort™ cable connected to a graphics or video source (if using video input)
- Illumination module or source
- Illumination and projection optics

1.5 DLP LightCrafter Dual DLPC900 Connections

Figure 1-3 depicts the switches and connectors with their respective locations. Note: Power supply (and cable), USB cable, and display cable are NOT included with the module.
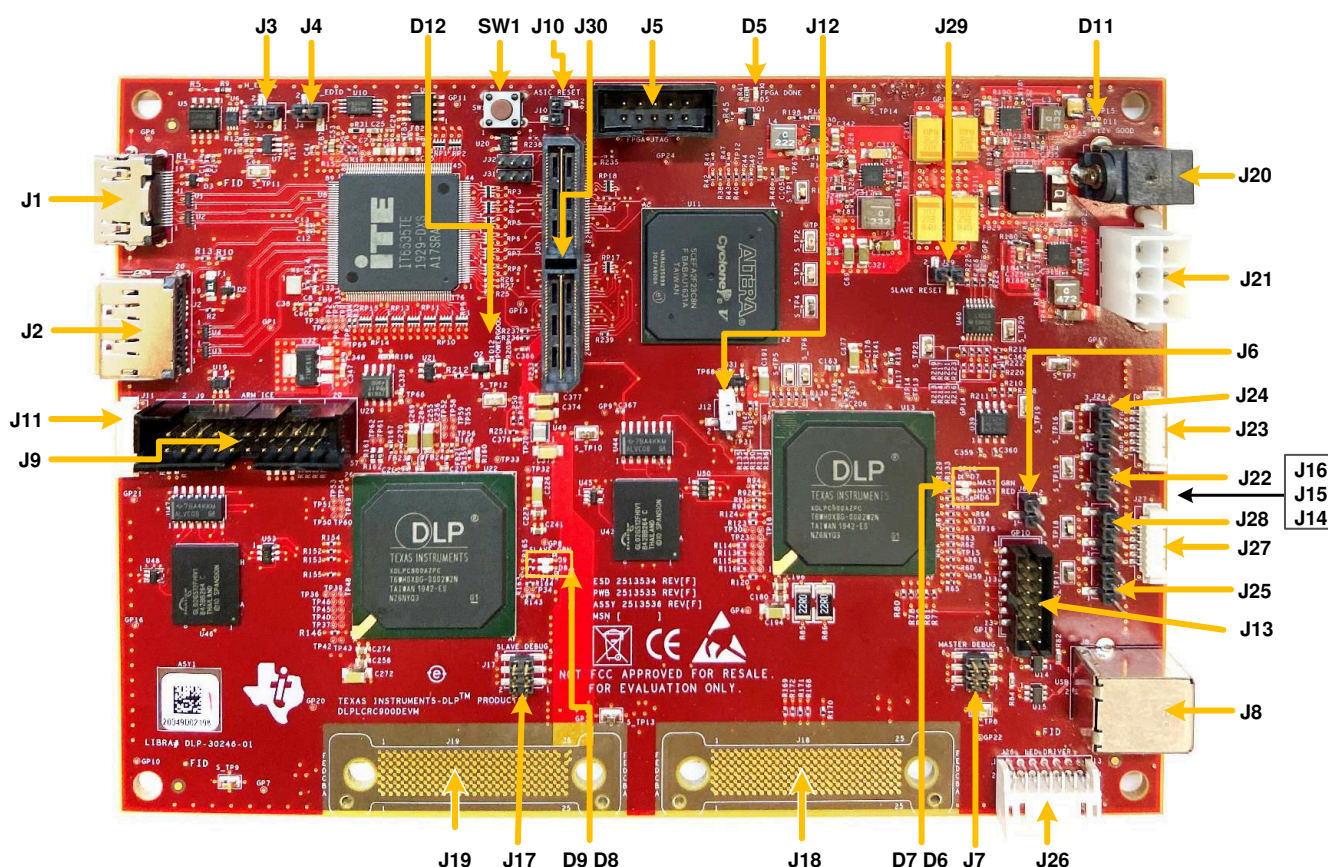
Figure 1-3. DLP LightCrafter Dual DLPC900 EVM Connectors (Top View)

Connector Reference	EVM Function	Description or Use
SW1	Board Level Reset Switch	When pressed resets both DLPC900 controllers. When released, both controllers boots from reset.
J1	HDMI Input	Video input to Video Splitter FPGA and DLPC900 controllers. For Video or Video Pattern inputs (primary).
J2	DisplayPort Input	Video input to Video Splitter FPGA and DLPC900 controllers. For Video or Video Pattern inputs (secondary).
J3	EDID jumper (HDMI)	When jumper is installed, the EDID prom for the HDMI interface can be updated.
J4	EDID jumper (DisplayPort)	When jumper is installed, the EDID prom for the DisplayPort interface can be updated.
J5	FPGA programming connector (Intel video splitter)	Connect Intel (Altera) FPGA programming tools to program the Video Splitter FPGA.
J6	OCLKA output	User configurable DLPC900 output clock for additional user on board logic. Pin 1 = OCLKA; Pin 2 = GND

Connector Reference	EVM Function	Description or Use
J7	DLPC900 debug UART (Master DLPC900)	Master DLPC900 UART interface for debug messages to a terminal • Bits per second: 115200 • Data bits: 8 • Parity: None • Flow Control: None • Pin 1 = 3.3 V • Pin 2 = TX out • Pin 6 = Ground LVTTL compatible only
J8	Host USB interface	DLPC900 USB interface for Host communications with DLPC900
J9	ARM RVI ICE debugger	TI use only; Used for debugging DLPC900 ARM software code, requires the ARM RVI ICE debugger.
J10	DLPC900 Reset jumper	When jumper is installed, the controller is held in RESET.
J11	JTAG Boundary Scan	Used for programming the boot image into the flash memory when flash memory is blank or corrupted.
J12	HOLDBoot jumper	When jumper is installed, forces the controllers to remain in boot mode when power is applied.
J13	GPIO inputs/outputs	User configurable general purpose Inputs and/or outputs for customer use.
J14	Host I^{2}C Port 0	Host dedicated I^{2}C interface port for communications to DLPC900. [Pin 1 = SCL, Pin 2 = SDA, Pin 3 = 3.3V, Pin 4 = GND]
J15	Host I^{2}C Port 1	I^{2}C interface port for programming EDID UARTs via I^{2}C [Pin 1 = SCL, Pin 2 = SDA, Pin 3 = 3.3V, Pin 4 = GND]
J16	Host I^{2}C Port 2	I^{2}C interface port 2. For TI internal use. [Pin 1 = SCL, Pin 2 = SDA, Pin 3 = 3.3V, Pin 4 = GND]
J17	DLPC900 debug UART (Slave DLPC900)	Slave DLPC900 UART interface for debug messages to a terminal • Bits per second: 115200 • Data bits: 8 • Parity: None • Flow Control: None • Pin 1 = 3.3 V • Pin 2 = TX out • Pin 6 = Ground LVTTL compatible only
J18	DMD flex connector (Master DLPC900)	Flex cable connection for data interface to DMD board and DMD.
J19	DMD flex connector (Slave DLPC900)	Flex cable connection for data interface to DMD board and DMD.
J20	+12 VDC Power input	EVM power input. [Pin 1 = +12 VDC, Pin 2,3 = GND] see Section 5.1
J21	+12 VDC Power input (Alternate)	EVM power alternate input. [Pin 1,2,3 = GND, Pin 4,5,6 = +12 VDC] see Section 5.1
J22	Trigger Input 1 voltage level selectors.	Set the voltage levels of the Trigger Input 1 signals. • Jump across pins 1 to 2 for 3.3 V • Jump across pins 2 to 3 for 1.8 V
J23	External Trigger Inputs connector	Trigger Input 1 and 2 for triggering the DLPC900 with external input signals (from Cameras, processors, etc.) See Section 4.1.
J24	Trigger Input 2 voltage level selectors.	Set the voltage levels of the Trigger Input 2 signals. • Jump across pins 1 to 2 for 3.3 V • Jump across pins 2 to 3 for 1.8 V
J25	Trigger Output 1 voltage level selectors	Set the voltage levels of the Trigger Output 1 signals. • Jump across pins 1 to 2 for 3.3 V • Jump across pins 2 to 3 for 1.8 V

Connector Reference	EVM Function	Description or Use
J26	LED illuminator enables and PWM drive signals	• Pins 1, 2, and 3 are 12 V. • Pin 5 is Red LED Enable output. • Pin 6 is Green LED Enable output. • Pin 7 is Blue LED Enable output. • Pin 8 is RED PWM output. • Pin 9 is Green PWM output. • Pin 10 is Blue PWM output. • Pins 11, 12, 13, and 14 are ground.
J27	Trigger output connector	Trigger Outputs 1 and 2 for triggering the DLPC900 with external input signals (from Cameras, processors, etc.) See Section 4.2.
J28	Trigger Output 2 voltage level selectors	Set the voltage levels of the Trigger Output 2 signals. • Jump across pins 1 to 2 for 3.3 V • Jump across pins 2 to 3 for 1.8 V
J29	Slave DLPC900 hold reset	When jumper is installed, the controller is held in RESET.
J30	External Parallel RGB Video Input	Connect a video receiver with RGB outputs
D5	FPGA Init-Done	When lit indicates the FPGA configured without errors after power is applied.
D6	Master DLPC900 Red fault status LED	When lit indicates a fault has occurred in the Master DLPC900 controller.
D7	Master DLPC900 Green Heartbeat LED	When toggling indicates Master DLPC900 controller is operating.
D8	Slave DLPC900 Red fault status LED	When lit indicates a fault has occurred in the Slave DLPC900 controller.
D9	Slave DLPC900 Green Heartbeat LED	When toggling indicates Slave DLPC900 controller is operating.
D11	12-V Power LED	When lit indicates external 12-V supply is on.
D12	PWRGOOD LED	When lit indicates power is normal.

1.5.1 DLP LightCrafter Dual DLPC900 LED Enable and PWM Outputs

The LED enables on J26 are low-current 3.3-V outputs and are not to be used to drive LEDs directly. The enables are to be used as a control to enable a regulator that provides the necessary current to the LEDs. The PWM outputs are also 3.3-V outputs and used for controlling the current to the LEDs, which controls the brightness.

Note

The 12-V DC output on J26 are not to be used to power the LED drive circuitry since it does not provide the necessary current when all three LED enables are simultaneous turned on. Doing so can cause a drop in the 12-V supply to the EVM regulator circuitry and reset the controller.

1.5.2 DLP LightCrafter Dual DLPC900 Trigger Input and Output Voltage Selectors

The trigger inputs on J23 are inputs from external devices to control the pattern sequence. While trigger input 2 is high, trigger input 1 advances the pattern sequence to the next pattern in the sequence on every pulse.

The trigger outputs on J27 are outputs to control external devices. While trigger output 1 frames the exposure time of the pattern, trigger output 2 pulses to mark the beginning of each pattern.

Both input and output triggers have voltage level selectors. Use J22, J24, J25, and J28 to select the voltage as shown in Figure 1-4. If no voltage is selected, then the onboard logic is not functional and any outgoing or incoming signals are not available.
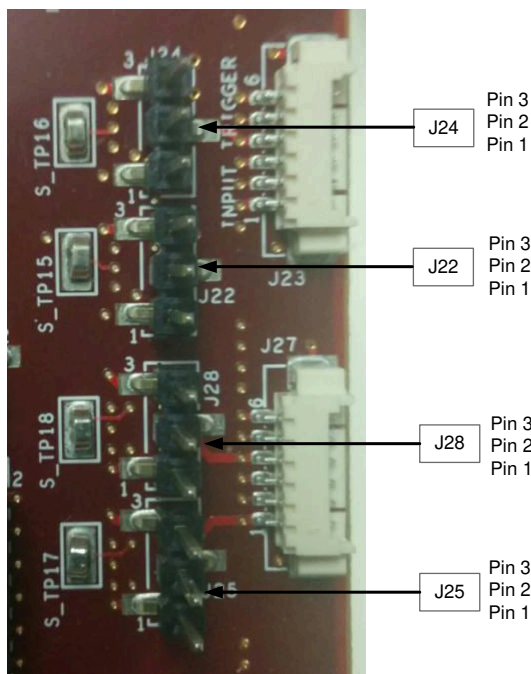
Figure 1-4. DLP LightCrafter Dual DLPC900 EVM Trigger Voltage Level Selectors

1.6 DLP LightCrafter Dual DLPC900 EVM Flex Cable

Electrical malfunctions can occur by stressing the flex cable(s) connecting the DMD circuit board to the DLPC900 controller circuit board. Stressing the flex cable can be caused by:

- Bending the cable outside the area identified in Figure 1-5 (within 20.3 mm of connector plate centers).
- Repeatedly bending the flex cable(s) where the bend radius is less than 25.4 mm.
- A single bending of the flex cable(s) where the bend radius is less than 6.35 mm.

Figure 1-5. Flex Cable Diagram

Note

The minimum bend radius for forming flex cable (flexible) circuit is 6.35 mm

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Use caution when bending the flex cable to not exceed bending guidelines explained above.

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![Texas Instruments logo]

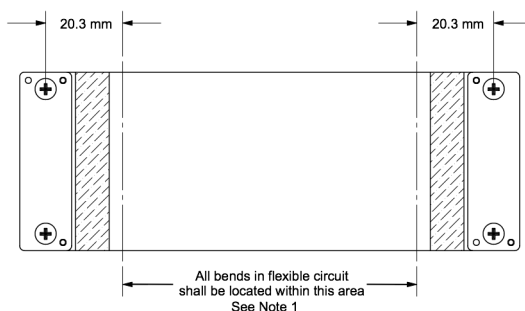This chapter offers a quick start guide to power-up the EVM, run the GUI control software, and create a simple three pattern sequence.

Note

If the text in the GUI does not display correctly please see DPI Settings

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2.1 Power-up the DLP LightCrafter Dual DLPC900 EVM

The DLP LightCrafter Dual DLPC900 EVM is ready to use, out of the box, after assembling with one of the supported DMD EVMs. Steps 1 through 6 show how to power, display an image, and connect the EVM to a PC.

1. Connect a 12-V DC power supply to the power supply connector J20 in Figure 1-3.
2. LEDs — D5, D11, and D12 light up green to indicate configuration and power is normal.
3. LEDs — D7 and D9 toggle on and off, indicating the DLPC900 controllers are operating normally.
4. After 5 seconds, the two DLPC900 devices start sending a built-in rotating pattern sequence of images to the DMD for display on the DMD.
5. Connect a USB cable from a PC to connector J8 on the DLP LightCrafter Dual DLPC900 EVM, as seen in Figure 1-3. The first time the cable is connected on a PC, the DLP LightCrafter Dual DLPC900 EVM enumerates as a USB composite device with human-interface device (HID) class. No drivers are required since these are natively handled by all operating systems.
6. The DLP LightCrafter Dual DLPC900 EVM can be controlled with the free GUI software version available for download from DLPLCRC900DEVM.

Note

Be sure to install DLP LightCrafter GUI software version 6.0 or newer. Operating the DLP LightCrafter Dual DLPC900 EVM with prior revisions of GUI renders the EVM inoperable.

Note

The DLPC900 does not have a dedicated INIT_DONE signal output to indicate that it has completed its power-up initialization and is ready to accept commands. The user may configure one of the nine GPIOs available as an INIT_DONE signal output simply by adding the GPIO configuration into a default batch file that is executed at power-up. A 10-kΩ pull-down resistor must be connected to the GPIO to be used.

The following is an example of adding the configuration for GPIO_08 to a batch file, where GPIO_08 is configured as an output and the signal is set high. When this command is added to the top of the batch file, the GPIO output goes high in approximately 800 ms from the time POSENSE goes high.

GPIO_CONFIG: 0x8 0x3

2.2 Creating A Simple Pattern Sequence

Before creating a pattern sequence, make sure to follow the steps in Section 2.1. Download and execute the latest DLPC900REF-SW Windows-Installer, and then start the DLP LightCrafter DLPC900 GUI application. The GUI detects the attached EVM, and the *Connected* radio-button lights up **Green** indicating the connection was successful. The GUI software includes sample images for the DLP LightCrafter Dual DLPC900 EVM that are used in the examples in this guide. If the sample image files have not been unzipped during the installation process, then within the GUI install directory, unzip the image files to gain access to all the sample images. All images are 1-bit binary patterns and have the native resolutions of 2048x1200, 2560x1600, and 2716x1600 to accommodate the different resolutions of the Dual DLPC900 EVM compatible DMD EVMs.

Follow these steps to create a pattern sequence. See Figure 3-7 to identify the buttons on the Menu bar.

1. Select *Pattern On-The-Fly Mode* from the *Operating Mode* group box, and click the *Pattern Design* button so that the panel is displayed as shown in Figure 2-1.
2. Click the *Add Pattern* button (with the plus sign) in the *Menu* bar and browse for any three bitmap images from the sample of images. The default directory is C:\Texas Instruments-DLP\DLPC900REF-SW-5.*x* \DLPC900REF-GUI\[DMD]_Images. Be sure to select them from the correct image sub-folder for the EVM that is being used. All three images can be selected at the same time within the open file dialog window, but may not appear in the same order in the GUI as in the dialog window.
3. Select the first pattern within the *Pattern Design* panel and choose a bit depth of 1. Set exposure to 100000 µs, dark time to 50000 µs, and select **Red** for the color.
4. Select the second pattern and choose a bit depth of 1. Set exposure to 150000 µs, dark time to 75000 µs, and select **Green** for the color.
5. Select the third pattern and choose a bit depth of 1. Set exposure to 200000 µs, dark time to 100000 µs, and select **Blue** for the color. Figure 2-2 shows the pattern sequence.
6. Select the *Repeat* radio-button to continuously repeat the pattern sequence.
7. Click the *Update LUT* button to upload the pattern sequence definition including the three pattern images to the EVM.
8. Click the *Start* button to run the pattern sequence. The three selected patterns show for the timings entered in steps 3, 4, & 5 and repeat until Step 9 is completed.
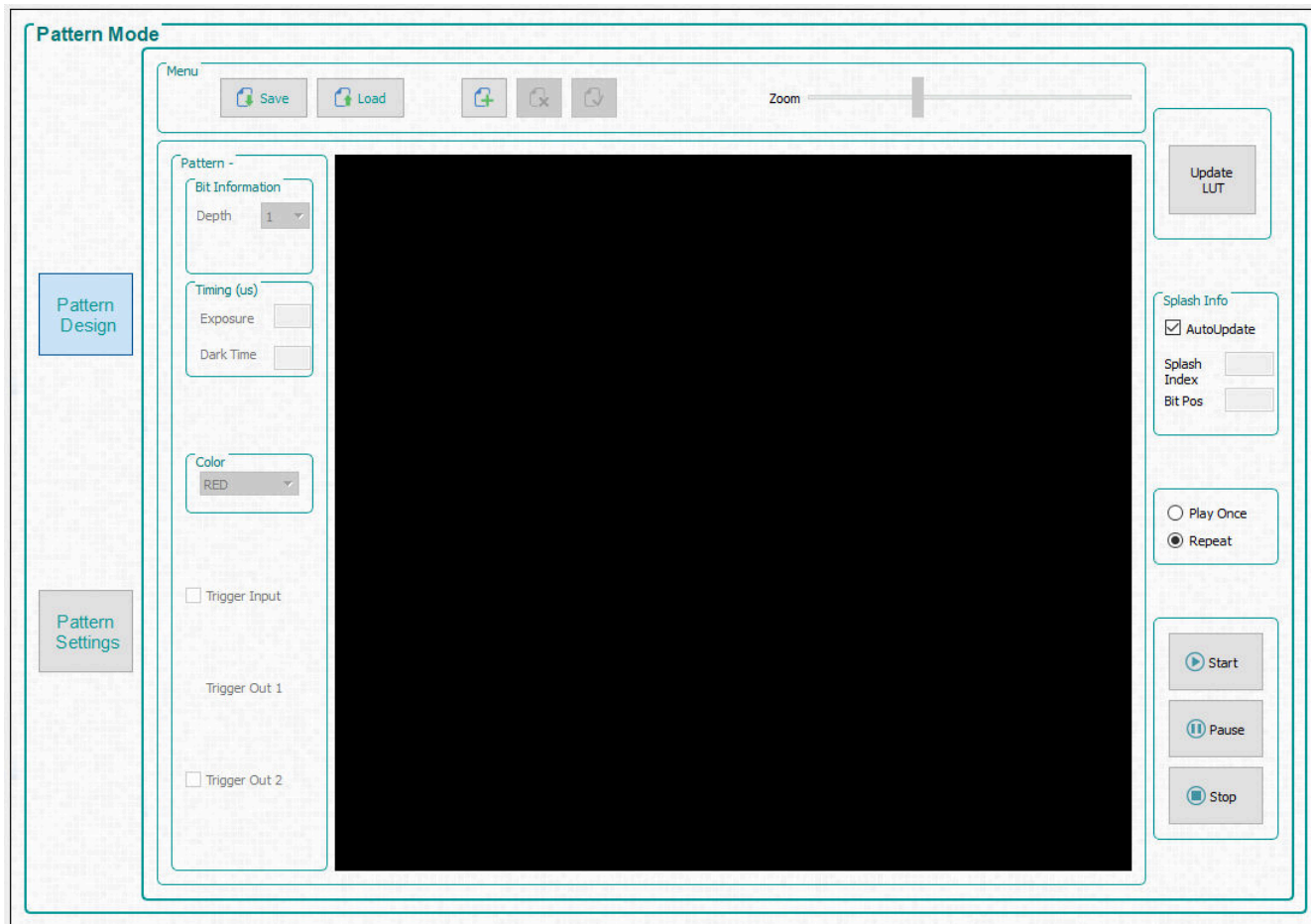9. Click the *Stop* button to stop the pattern sequence.
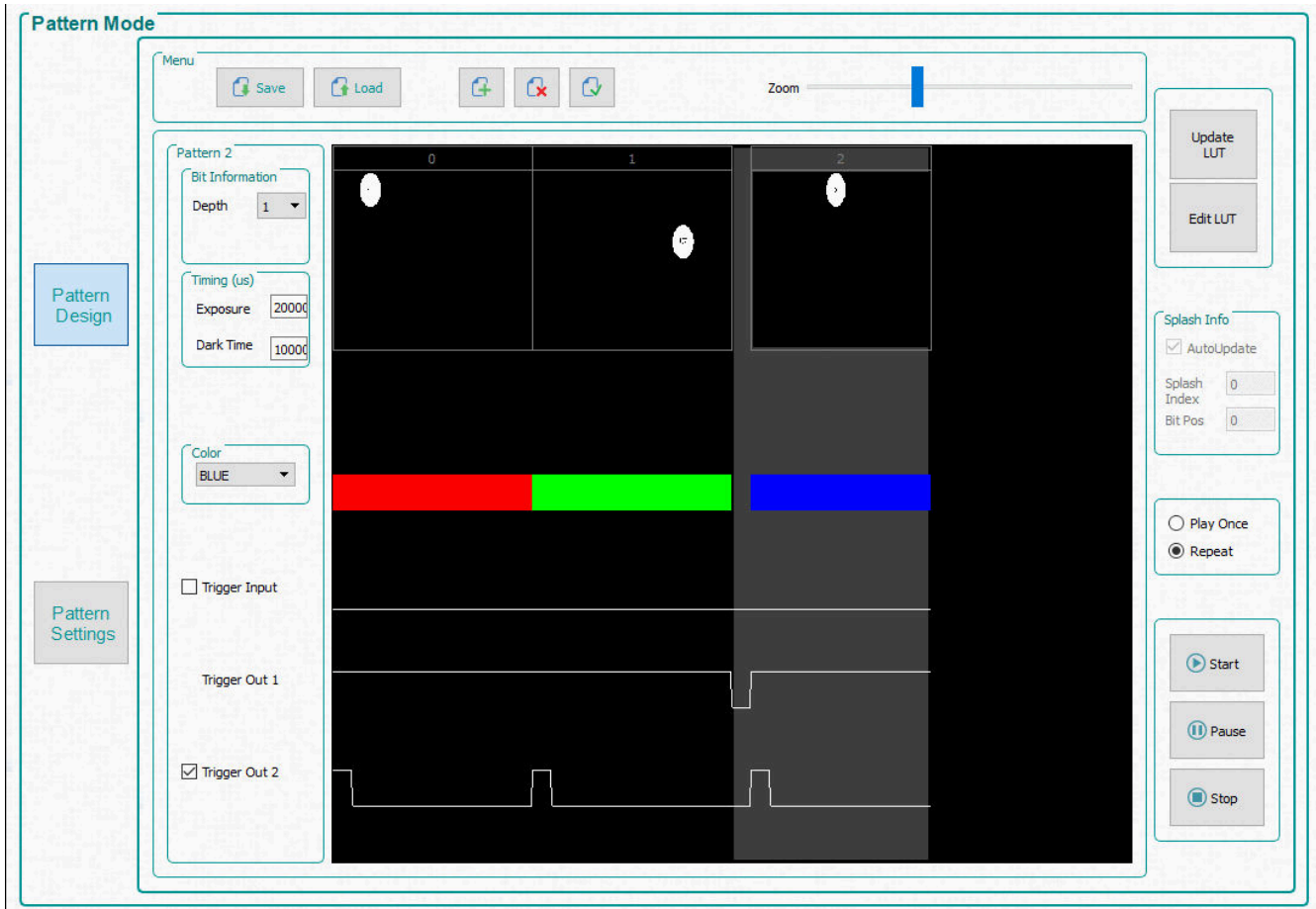
Figure 2-1. Pattern Mode Panel

Figure 2-2. Simple Three Pattern Sequence

Operating the DLP LightCrafter Dual DLPC900 EVM

This chapter introduces the Windows software provided with the DLP LightCrafter Dual DLPC900 EVM.

3.1 DLP LightCrafter Dual DLPC900 Control Software

The DLPC900REF-SW bundle includes a QT-based GUI application to control the modules through the USB interface. QT is a cross-platform application and user-interface framework with open source and commercial licenses available. Install the QT based GUI download and execute the latest DLPC900REF-SW Windows-Installer, and then start the DLP LightCrafter DLPC900 GUI application.

The DLP LightCrafter Single DLPC900 EVM supports two basic types of operation:

- Video Mode displays images from:
    - HDMI and DisplayPort inputs.
    - 24-bit RGB customer provided bitmaps stored in flash memory.
    - Internal test pattern generator with ten user-selectable patterns.
    - Solid Full-screen Curtain with user-selectable colors.
- Pattern Sequence displays images from:
    - Pre-stored Pattern Mode: 1-, 2-, 3-, 4-, 5-, 6-, 7-, and 8-bit user-defined bitmap images pre-stored in Flash memory.
    - Video Pattern Mode: 1-, 2-, 3-, 4-, 5-, 6-, 7-, and 8-bit user-define bitmap images streamed through the DLPC900 24-bit RGB interface.
    - Pattern On-the-Fly Mode: 1-, 2-, 3-, 4-, 5-, 6-, 7-, and 8-bit user-define bitmap images dynamically loaded into internal memory via USB or I^2C interfaces. The DLP500YX EVM also supports 10-, 12-, 14-, and 16-bit bitmap images in this mode.

3.2 PC Software

Upon execution of the DLP LightCrafter DLPC900 GUI application, the panel shown in Figure 3-1 is displayed. The GUI panel contains the following three sections:

- System common controls and status on the left.
- System feature controls buttons on the top.
- Feature control panels in the center.

In any of the GUI sections, clicking a Get button reads the current settings of that particular subsection. Clicking the Set button programs the settings into the respective subsection. Please note that some commands may require additional steps before the GUI display is updated.
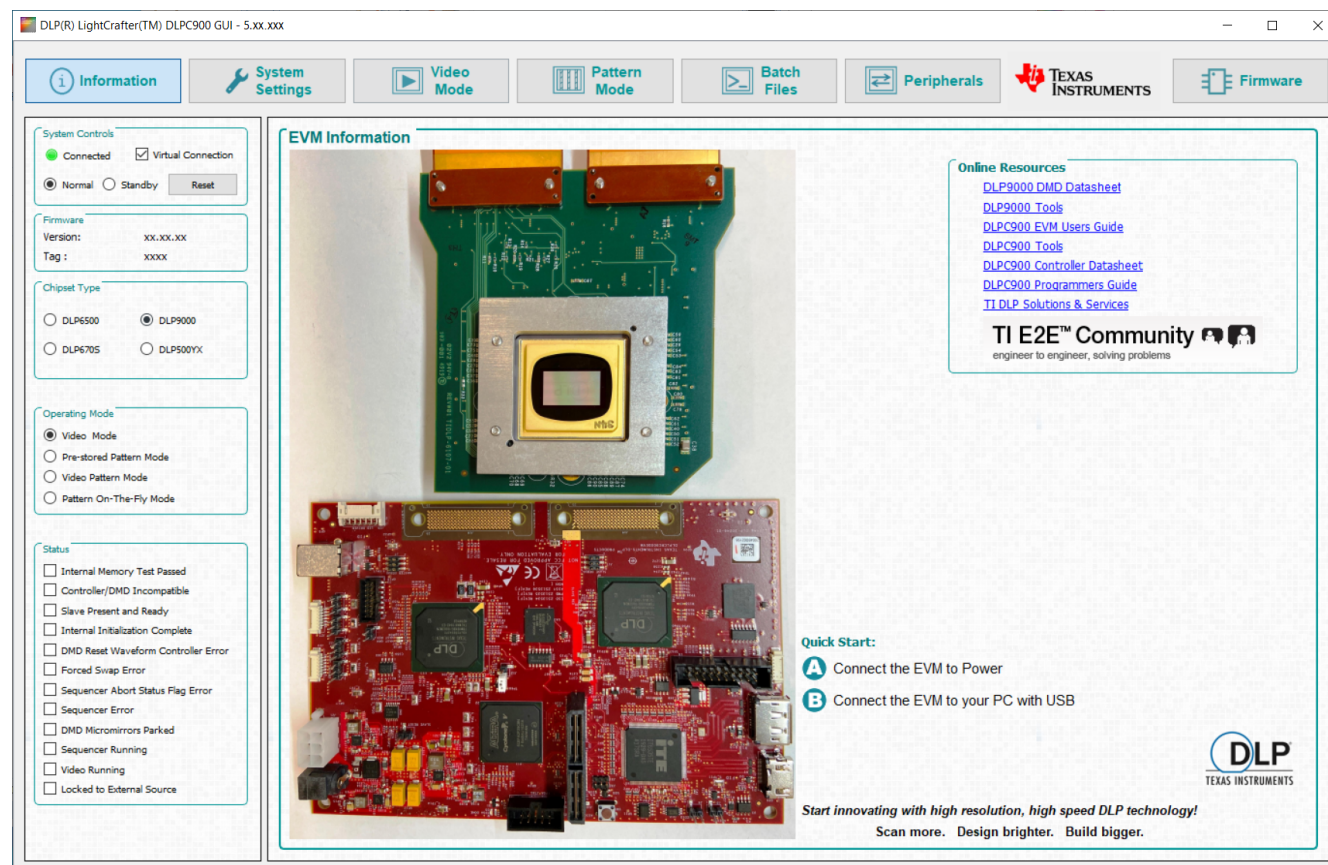

Figure 3-1. DLP LightCrafter DLPC900 GUI

Note

If the text in the GUI does not display correctly please change the DPI settings. Right click on the executable and select *Properties*. On the *Compatibility* tab select the "Change high DPI settings" button. Change your settings as shown in High DPI Settings.
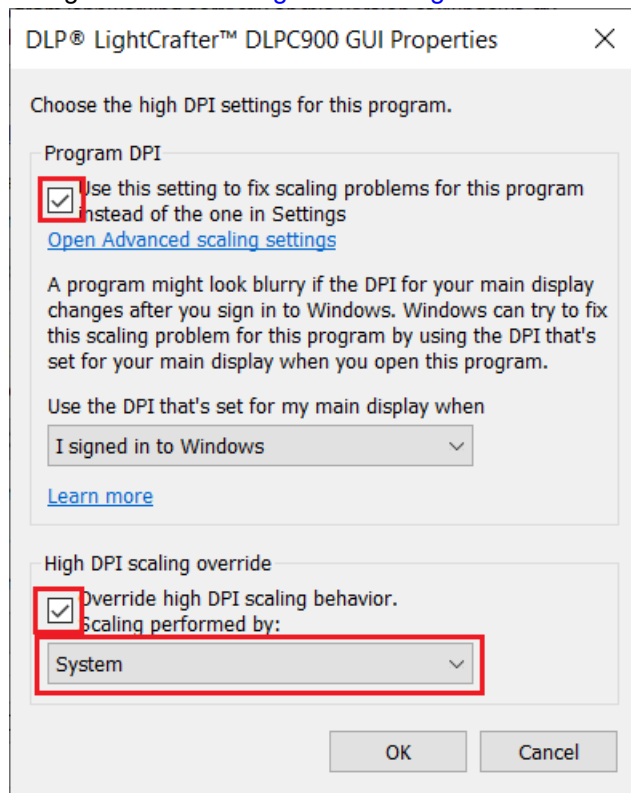

Figure 3-2. High DPI Settings

3.3 System Common Controls

The DLP LightCrafter DLPC900 GUI communicates with the DLPC900 using USB 1.1. The DLPC900 enumerates as a USB device with HID Support. The PC polls all the HID peripherals and once the PC detects the DLPC900, the *Connected* radio-button changes to **green**. If the USB cable is disconnected, the *Connected* radio-button changes to **red**. Once the *Connected* radio-button shows **green**, the firmware *Version* and the *Tag* name are displayed.

The *Virtual Connection* option is useful when there is no connection to the EVM. When the *Virtual Connection* is checked, all commands continue to operate as if there was a connection to the EVM except for firmware uploads and updating the Look Up Table (LUT).

3.3.1 Operating Mode

Within the *System Controls* group box, the GUI updates the state of the EVM to indicate it is in *Normal Operation* or *Standby Mode*. The user may command the EVM into *Standby Mode* if the EVM is not being used or the *Normal Operation* can be selected to command the EVM to wake up. The user may click the *Reset* button to command the EVM to perform a software reset.

Note

When in Standby Mode the GUI suspends status updates until a return to operation or SW reset is issued. If a HW reset is asserted the GUI must be restarted to recognize return to operation.

The EVM can be commanded to enter one of the four operating modes. Within the *Operating Mode* group box there are four choices:

1. *Video Mode* – This mode is primarily used for display applications, and is not recommended for applications which require pixel and timing accuracy. In this mode, the user can choose from the four following video modes:
   - Parallel RGB interface
   - Internal test pattern generator with ten test pattern options
   - Pattern image display from flash memory
   - Solid Curtain with choice of color
2. *Pre-stored Pattern Mode* – In this mode, the user can create a pattern sequence using images stored in flash.
3. *Video Pattern Mode* – In this mode, the user can define a pattern sequence using pattern data or video which is streamed using a parallel RGB interface.
4. *Pattern On-The-Fly Mode* – In this mode, the user can create a pattern sequence using bitmap images which are loaded into the internal memory of the DLPC900 via the USB or I^{2}C interfaces. This mode can be helpful to view a pattern sequence before storing the images in flash memory, as updating the flash to use *Pattern Mode* can be a timely process.

3.3.2 Connected DMD Type

The GUI queries the DMD EVM to determine the DMD type connected to the DLP LightCrafter Dual DLPC900 EVM. The indicators in the *Chipset Type* group box are updated to show which DLPC900 compatible DMDs is connected.

3.3.3 EVM Information

The *Introduction Main Page* shows an image of the EVM currently connected and helpful links to online resources.

3.3.4 Status

The *Status* panel indicators show the current state of the DLPC900. When any of the boxes are checked, this indicates the stated text has occurred. Any boxes that state an error and remain checked must be corrected before continuing to operate the EVM.
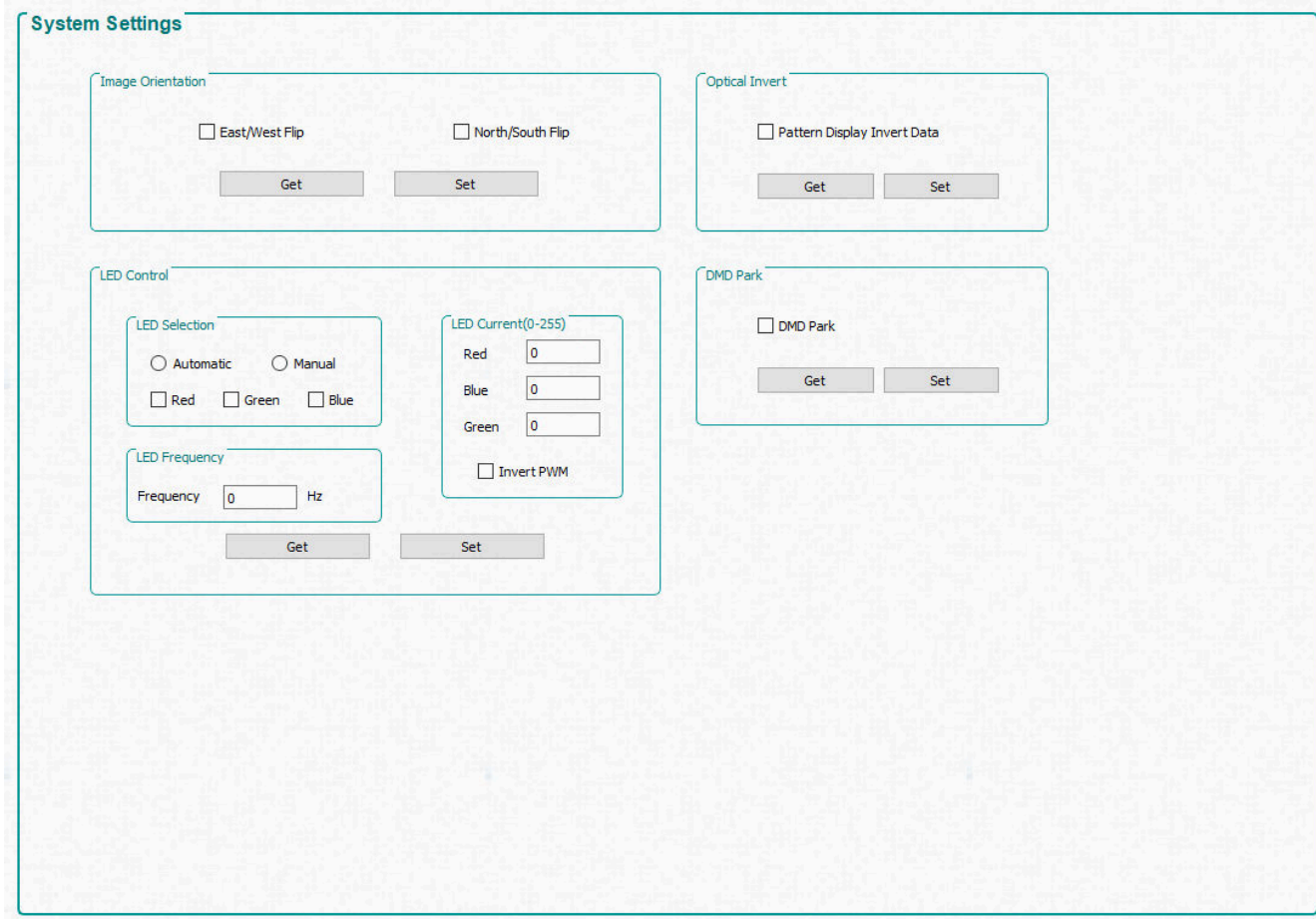
The following is a description of each status indicator:

- *System Memory Test* – The DLPC900 performs an internal memory test at power-up. The box is checked if the test passed.
- *Controller/DMD Incompatible* – The box can be checked if either the controller or DMD are incompatible with the firmware including loading incorrect firmware. There also may be an issue with communication between the controller and DMD, especially in the SCP lines. If this is the case, it could be caused by damage to the flex cable, the DMD not sitting properly in the socket, or a missing or damaged DMD.
- *Slave Present and Ready* – The box is checked when the GUI is connected to a DLP LightCrafter Dual DLPC900 EVM. If the GUI is connected to a DLP LightCrafter Dual DLPC900 EVM and the box is not checked, it could indicate that one or both of the DLPC900s are malfunctioning or that the EVM was incorrectly programmed with a Single DLPC900 firmware file.
- *Internal Initialization Complete* – The box is checked when all power-up initialization routines have completed and passed.
- *DMD Reset Waveform Controller Error* – The box is checked whenever the DMD Reset Controller has found multiple overlapping Vbias or reset operations accessing the same DMD block of micromirrors.
- *Forced Buffer Swap* – The box is checked whenever a forced buffer swap occurs. This error can occur if the DLP LightCrafter Dual DLPC900 EVM is set to Video Mode and the vertical back-porch timing is too small. The error can also occur if the DLP LightCrafter Dual DLPC900 EVM is set to Video Pattern Mode where the patterns are from the video port and the pattern sequence timings do not match the video port VSYNC - specifically the cumulative exposure times are greater than the frame time. Forced buffer swaps may also occur during any of the pattern modes in preparing a pattern sequence and the timing of a status read. The user may need to perform additional reads of the status to get a correct state of this indicator. If the box continues to be checked, this could indicate an error condition in the pattern sequence.

- *Sequence Abort Status Flag* – The box is checked whenever a sequence abort has occurred. Sequence abort may occur during any pattern mode in preparing a pattern sequence and the timing of reading the status. Additional status reads may be needed to get a correct state of this indicator. If the box continues to be checked, it could indicate an error condition in the pattern sequence. This can also indicate that the cumulative exposure time is greater that the frame time.
- *Sequence Error* – The box is checked whenever a sequence error has occurred. Sequence errors may occur during any of the pattern modes in preparing a pattern sequence and the timing of reading the status. The user may need to perform additional reads of the status to get a correct state of this indicator. If the box continues to be checked, this could indicate an error condition in the pattern sequence.
- *DMD Micromirrors Parked* – The box is checked whenever the DMD micromirrors are parked.
- *Sequencer Running* – The box is checked whenever the sequencer is running.
- *Video Running* – The box is checked whenever video is running normally.
- *Locked to External Source* – The box is checked to indicate that the EVM has *locked* to an external parallel RGB video source. If the EVM loses the locked signal at any time, the box becomew unchecked. A locked source must be present to switch to Video Pattern Mode.

3.4 System Settings

Click the *System Settings* button at the top of the GUI to display the *System Settings* panel shown in Figure 3-3.

Figure 3-3. System Settings Panel

Within the *System Settings* panel, the user can control the orientation of the image, the LEDs, and the optical inversion.

- *Image Orientation* – Depending on the orientation of the projected image, the image may require to be flipped on its short or long axis. The East/West setting causes the image to be flipped on its long axis. The North/ South setting causes the image to be flipped on its short axis. This setting must be set before any Pattern LUT updates are sent to the DLPC900 and the pattern sequence must be in the stopped state.
- *LED Controls* – The LED controls allow the user to manually control the state of the LEDs or allow the internal DLPC900 sequencer to control them.

Note

If the LEDs are disabled in manual control, they must be enabled before switching to automatic control (internal DLPC900 sequencer).

The LED current regulates the brightness of the LEDs. Setting the Invert PWM causes the LED currents to have an opposite effect on the LEDs as the current is changed. When manipulating the LED frequency and current, it is best to think of the led current value from 0-255 (0.39% per step) as the duty cycle where 255 equals ~100% (99.61%) Internally the software then calculates the PWM value depending on the set frequency and duty cycle. Setting the Invert PWM changes the polarity of the PWM signal which causes the LED currents to have an opposite effect on the LEDs as the current is changed.

Note

DLP LightCrafter Dual DLPC900 EVMs do not come with LEDs or optical engines of any kind.
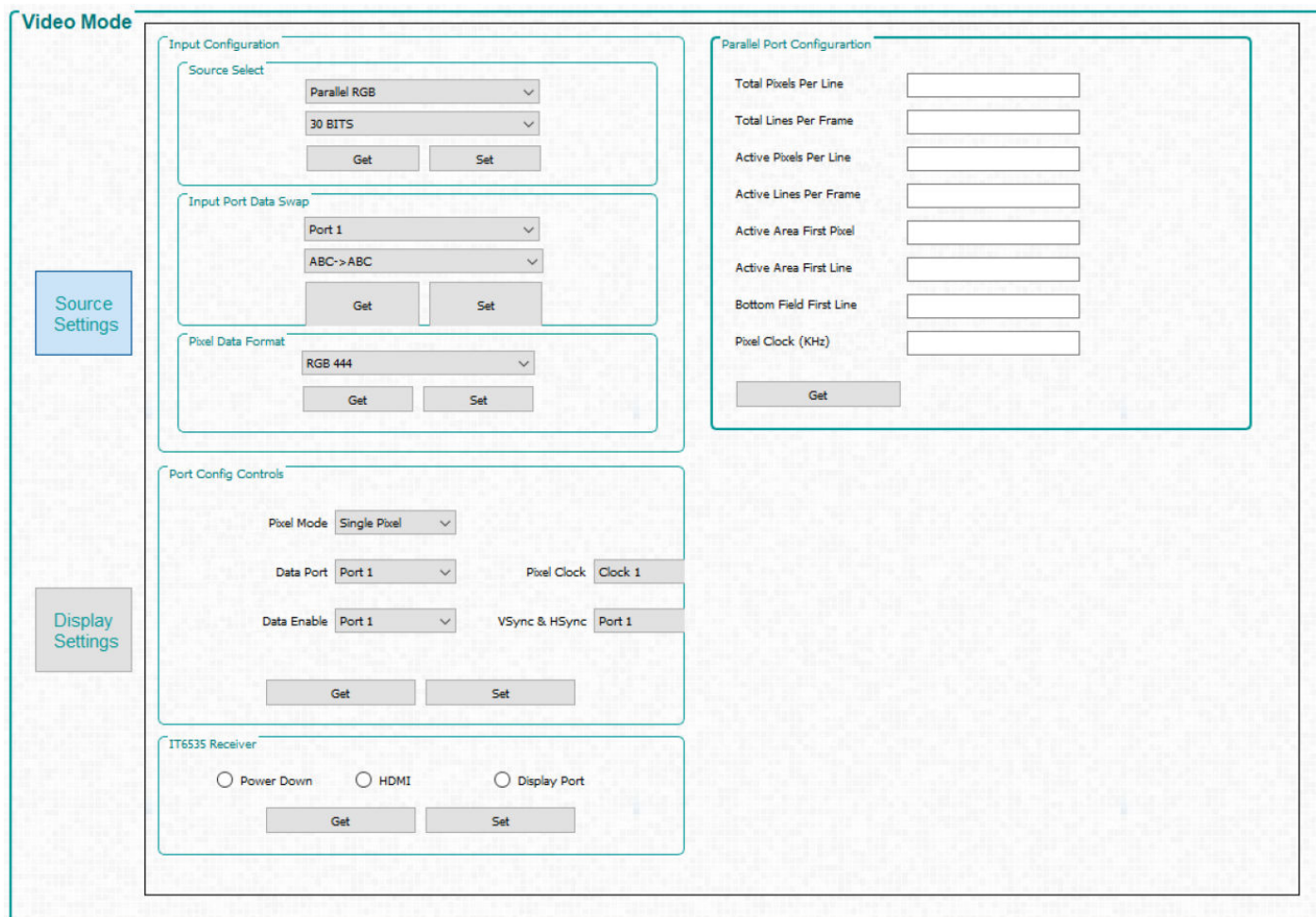

- *Pattern Display Invert Data* – This setting allows the user to invert the data to the DMD. The setting must be set before any Pattern LUT updates are sent to the DLPC900 and the pattern sequence must be in the stopped state. This setting is not applicable to *Video Mode*.
- *DMD Park* – This setting allows the user to park and un-park the DMD. Using the isolated Park/Unpark command is no longer recommended except for debugging purposes. If the Display Mode is set to Pre-stored pattern mode, Video pattern mode or Pattern On-The-Fly mode, the pattern sequence must be stopped prior to execution of this command.

3.5 Video Mode

Click the *Video Mode* button at the top of the GUI to display the *Video Mode* panel. Within this panel, there are two tabs:

The Source Settings Tab is shown in Video Mode Panel - Source Settings Tab.

The Display Settings Tab is shown in Video Mode Panel - Display Settings Tab.

Figure 3-4. Video Mode Panel - Source Settings Tab

1. Input Configuration.
   - *Source Select* – Allows the user to select:
     a. Parallel RGB interface
     b. Internal test pattern generator
     c. Pattern images from flash memory
     d. Solid Curtain– which displays a constant, solid color image (including black or white)
   - *Input Port Data Swap* – Depending on the routing of the parallel RGB data lines, it may be necessary to swap the order of the color channels. The DLP LightCrafter Single DLPC900 EVM require ABC->BAC setting. ABC corresponded to RGB; therefore, the settings mentioned previously means that channels RG are swapped. The user can also select which port to apply the settings to.
   - *Pixel Data Format* – Allows the user to select the video format of the input source.
2. *Port Config Controls* – Depending on which input signals were chosen during board design, it may be necessary to select the appropriate signals so that the DLPC900 can properly detect the incoming video

source. If incorrect settings are chosen, the curtain may be displayed or the image may be incorrect. *Pixel Mode* can also be set to Single Pixel or Dual Pixel. Dual Pixel allows for higher data rates by loading two pixels per clock instead of one pixel per clock.

3. *IT6535 Receiver* – This control allows selection between the HDMI or the DisplayPort input connectors of the IT6535 digital receiver. The digital receiver can also be powered-down, which tri-states all the output signals of the IT6535 to allow another device to share the input ports and syncs of the DLPC900.

4. *Pixel Port Configuration* - Allows readback of the current parallel port configuration parameters determined by the EDID or user Display Dimensions
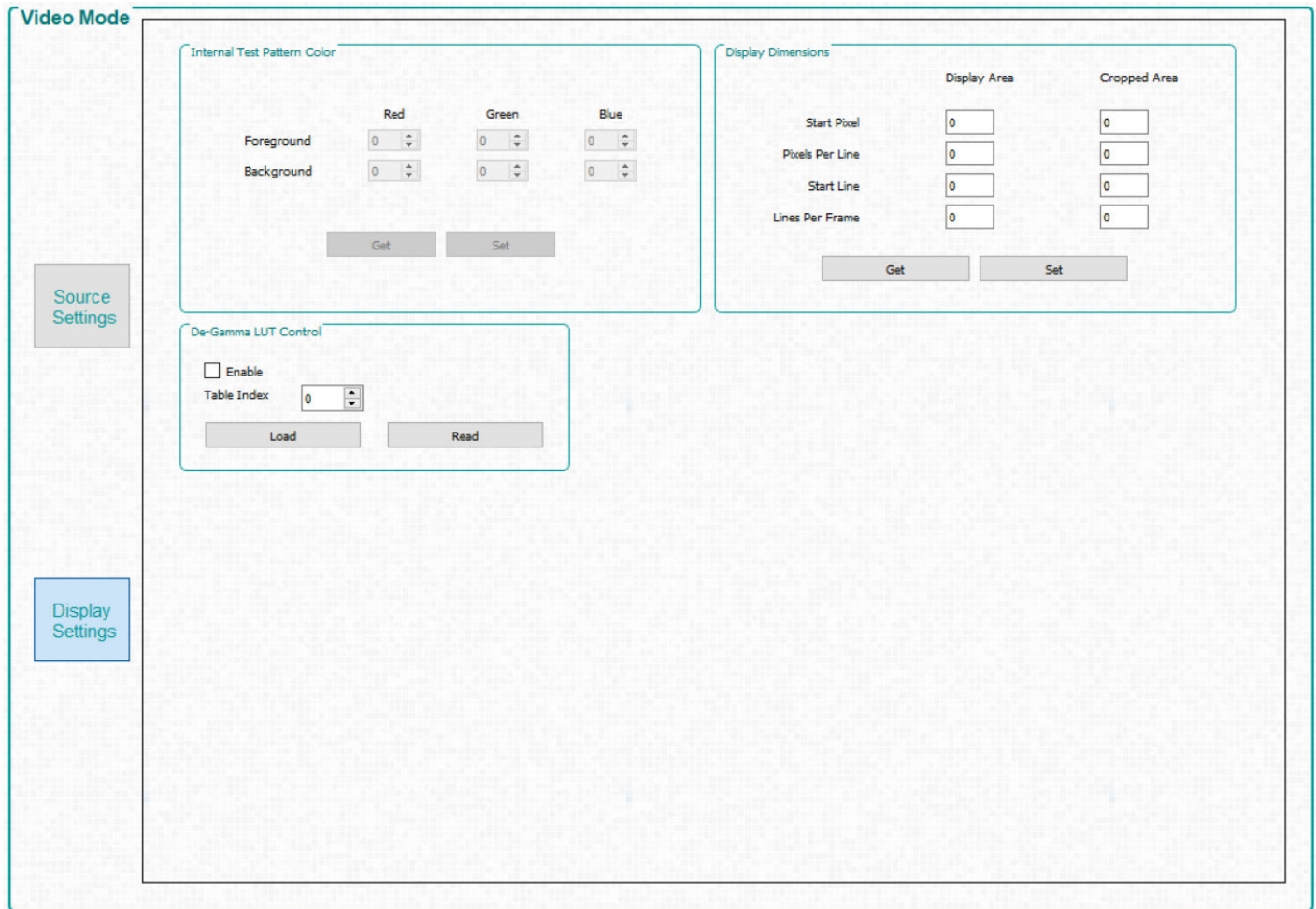
Figure 3-5. Video Mode Panel - Display Settings Tab

1. *Internal Test Pattern Color* – When the internal test pattern is selected as the input source, the foreground and background colors can be changed.

2. *Display Dimensions* – Allows the user to scale or crop the image of the incoming video source.

3. *De-Gamma LUT Control* – De-Gamma controls:

4. *De-Gamma LUT Control* – De-Gamma controls:
   • Enable/Disable - Command enables or disables De-Gamma
   • Sets the level of De-gamma - See the *Gamma Configuration and Enable* section of the DLPC900 Programmer's Guide for further information.

3.5.1 Video Support

Please refer to the DMD data sheet of the DMD connected to the DLP LightCrafter Dual DLPC900 EVM for supported video frame rates.

3.6 Pattern Modes

Click the *Pattern Mode* button at the top of the GUI to display the *Pattern Mode* panel as shown in Figure 3-6.

The *Pattern Mode* panel allows the user to create a pattern sequence. First the user must choose the operating mode by selecting which of the three pattern modes to use. The three pattern modes are:

1. *Pre-Stored Pattern Mode*. In this mode the patterns are pre-stored in flash memory and loaded into the internal memory of the DLPC900 by the firmware. The pattern sequences and images must first be defined before starting the pattern sequence.
2. *Video Pattern Mode*. In this mode, the images are streamed from the incoming video source. The pattern sequences must be defined first before starting the pattern sequence.
3. *Pattern On-The-Fly Mode*. In this mode the patterns are uploaded to the internal memory of the DLPC900 via the USB or the I^{2}C interface. The pattern sequences must be defined first before starting the pattern sequence. Using USB is preferred for its higher upload speed.

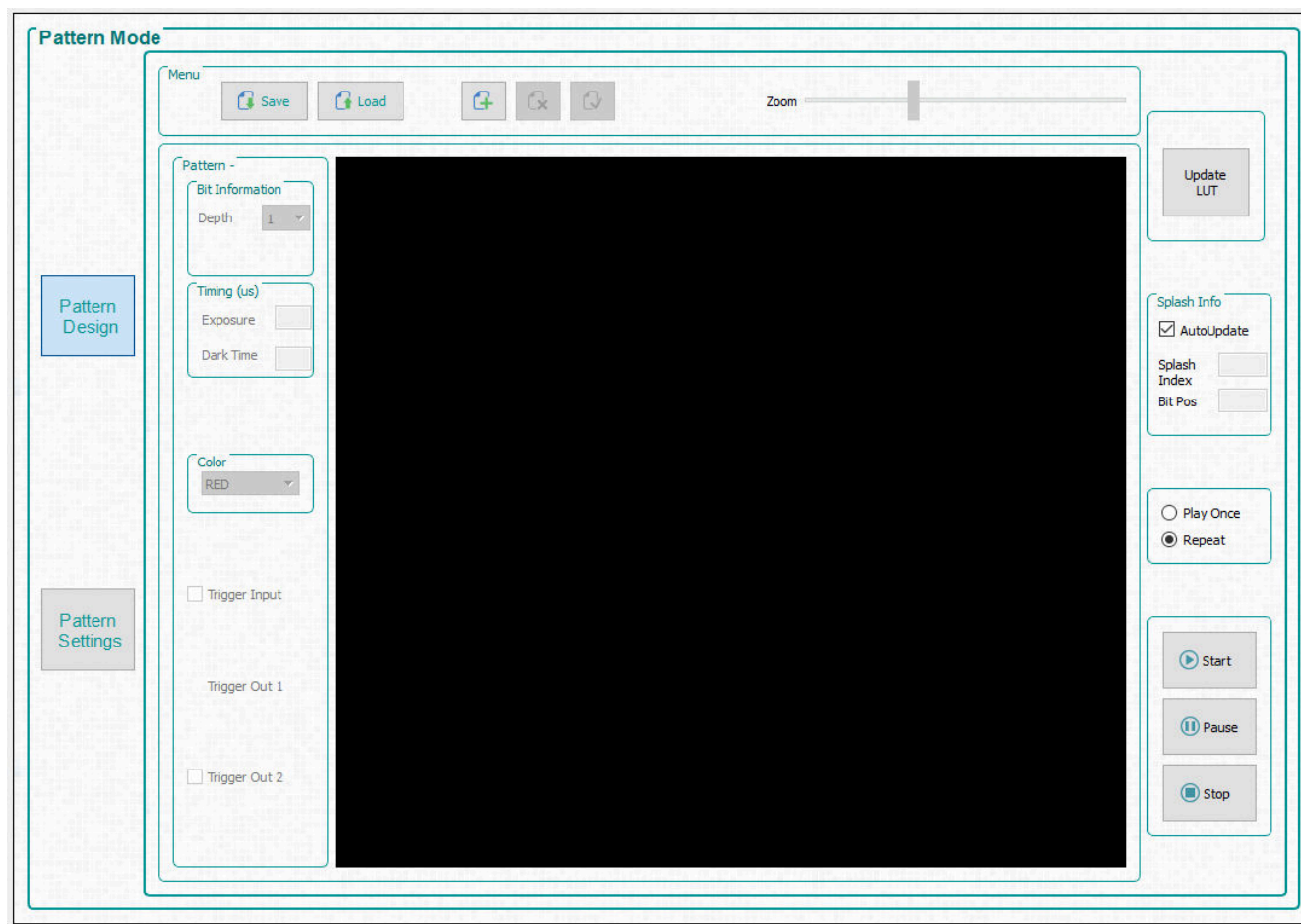**Figure 3-6. Pattern Mode Design Panel**

3.6.1 Menu Bar

The *Menu* bar has six controls as shown in Figure 3-7.

- The *Save* button allows the current pattern design to be saved to a file.
- The *Load* button allows a saved design to be loaded into the Design Panel. This control also allows images to be loaded from a text file that contains a list of the bitmaps in a desired order.
- The *Add* pattern button adds a single or multiple patterns to be loaded into the Design Panel.
- The *Zoom* bar allows the Design Panel to show more of the patterns within the panel.
- The *Delete* pattern button deletes a selection of patterns (a single pattern or multiple patterns) from the Design Panel.
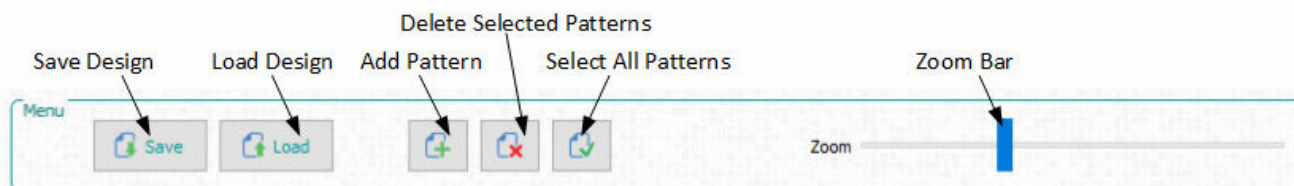- The *Select* button selects all the patterns from within the Design Panel.

Figure 3-7. Pattern Mode Menu Bar

3.6.2 Creating a Pattern Sequence in Pattern On-The-Fly Mode

Pattern On-The-Fly Mode is the easiest and quickest way to create a pattern sequence. Follow these steps to create a simple pattern sequence using three images

1. Make sure the EVM is powered up and operating correctly, and the *Connected* radio-button is lit **green**.
2. Select *Pattern On-The-Fly Mode* from the *Operating Mode* group box, and then click the *Pattern Design* button so that the large black panel is displayed as shown in Figure 3-6.
3. Click the *Add Pattern* button in the *Menu* bar and browse for any three bitmap images from the sample of images directory. Be sure to select them from the correct image folder for the EVM that is being used. All three images can be selected at the same time within the open file dialog window. When selecting multiple files at once, the operating system may not load the images in the same order as they were selected. To add images in a predefined order, use the *Load* button. This option loads the images from a text file that contains the file names of each bitmap in the desired order. Alternatively, you can add the images one at a time using the *Add Pattern* button to ensure order. Figure 3-8 shows an example of loading images from a file. The bitmap images must be located in the same directory as the text file. See Figure 3-9 after the images have been added.
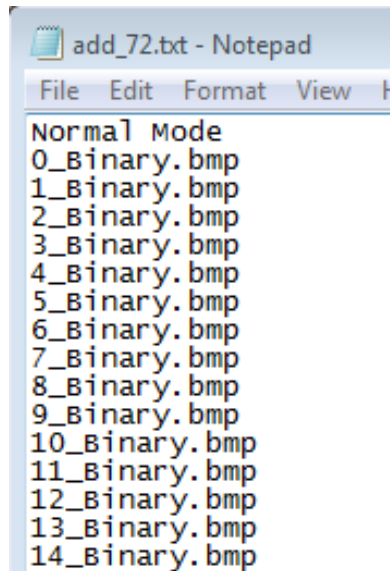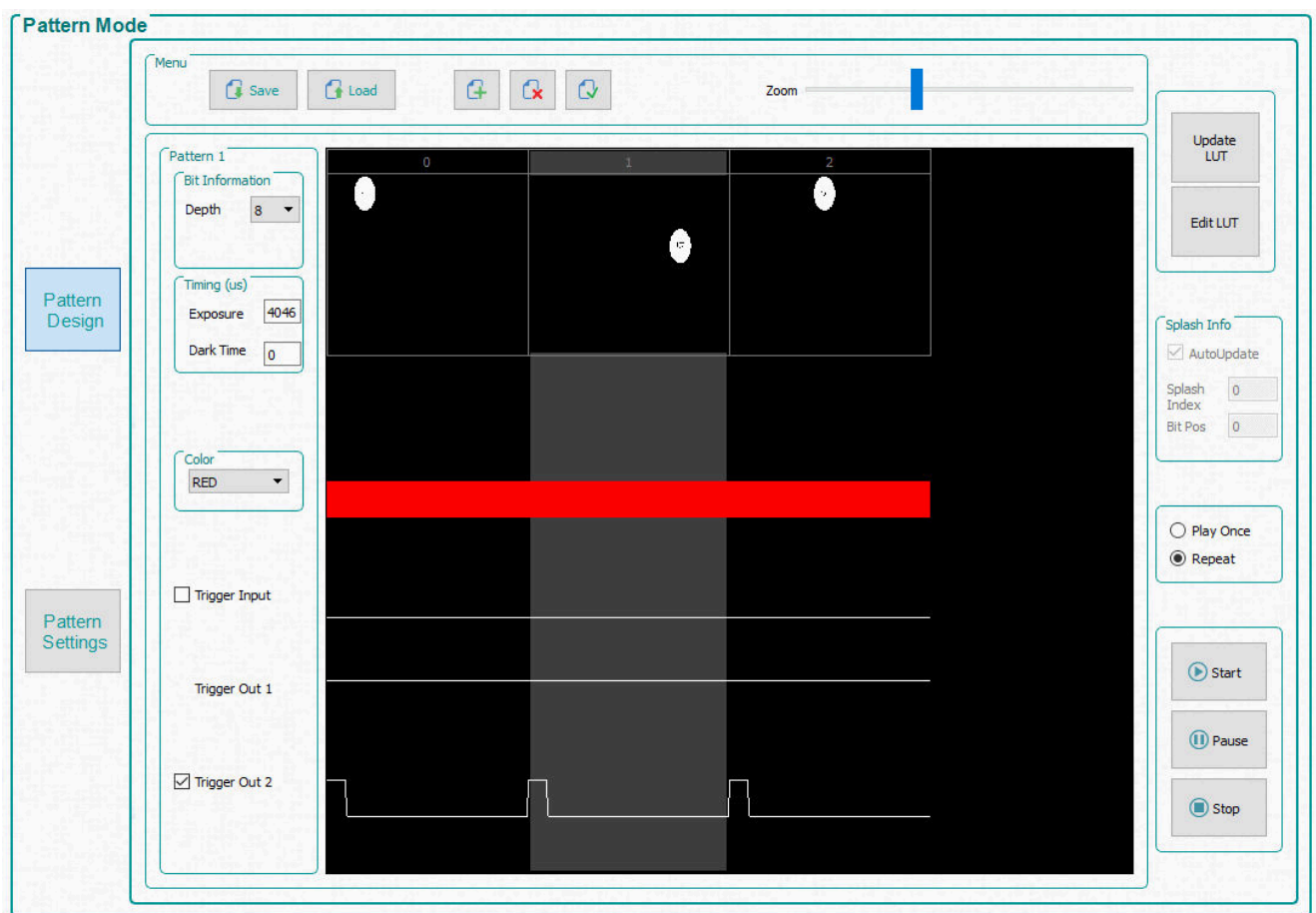
Figure 3-8. Add From List

Figure 3-9. Pattern Sequence

4. Each pattern in the display can now be selected individually or a multiple selection can be done. To select multiple patterns in a series, use *Shift+Click*. To select multiple patterns that are not in a series, use *Ctrl +Click*. An alternate method for selecting all images is to use the *Select All Patterns* button on the *Menu* bar.

5. Select the first pattern and choose a bit depth of 1. Set exposure to 100000 μs and set dark time to 50000 μs. The dark time is the time from the end of one pattern to the start of the next pattern. Select **Red** for the color.

6. Select the second pattern and choose a bit depth of 1. Set exposure to 150000 μs and set dark time to 75000 μs, and select **Green** as the color.

7. Select the third pattern and choose a bit depth of 1. Set exposure to 200000 μs and set dark time to 100000 μs, and select **Blue** as the color. Figure 3-10 shows the pattern sequence. The *Zoom* bar can be used to zoom in and out. This is useful when many patterns are loaded into the panel.
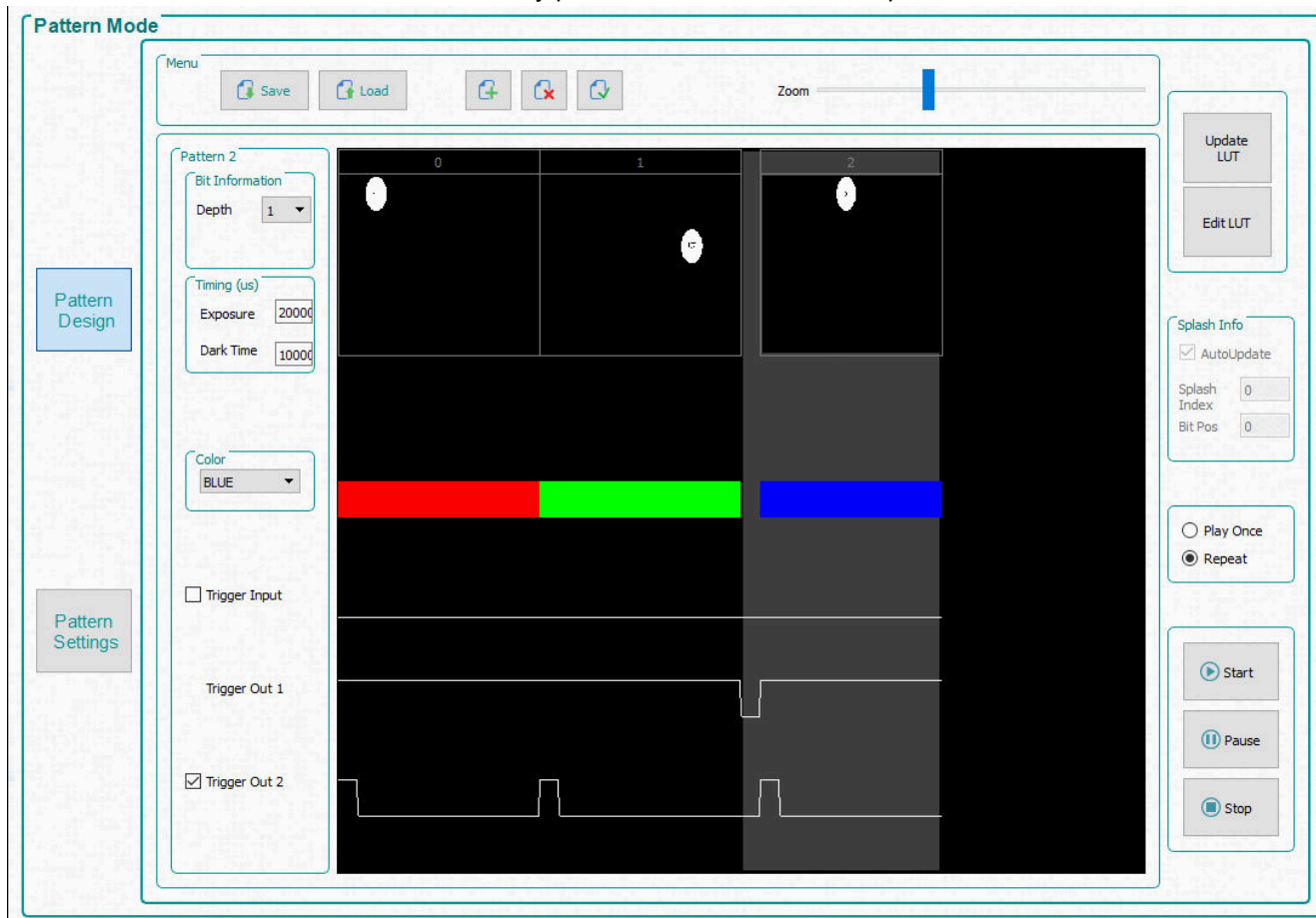
Figure 3-10. Three Pattern Sequence

8. Select the *Repeat* radio-button to continuously repeat the pattern sequence, or, if only one time is desired, then select the *Play Once* radio-button.

9. Click the *Update LUT* button to upload the pattern sequence definition, including the three pattern images, to the DLPC900. Notice the green status bar indicating that the updated LUT is uploading to the EVM. This animation does not occur if the user only edits pattern settings rather than uploading actual new patterns. If there are any errors in the pattern sequence, the GUI displays an error message.

10. Once the upload is complete, click the *Start* button. The display repeatedly displays the Red, Green, and Blue dots.

11. To pause the pattern sequence, click the *Pause* button. To continue from where the pattern sequence paused, click the *Start* button.

12. To stop the pattern sequence, click the *Stop* button. To restart the pattern sequence click the *Start* button. The pattern sequence starts from the beginning whenever the pattern sequence is stopped using the *Stop* button.

Another method of creating a pattern sequence in *Patten On-The-Fly Mode* is using a batch file that contains all the necessary commands and the compressed images.

Follow these steps to execute a pattern sequence using a batch file.

1. Stop the pattern sequence if it is currently running.
2. Click the *Batch Files* button at the top of the GUI.
3. Check the box to *Enable Command Logging*.
4. Click the *Clear All button* to clear any content in the panel.
5. Click the *Load Batch File* button and select the **onthefly.txt** file located in the sample images directory. Be sure to select the correct file for the EVM being used.
6. Click the *Execute All* button. Wait for the batch file to execute.
7. Click the *Pattern Mode* button at the top of the GUI.
8. Click the *Start* button.
9. Click the *Stop* button to end this example.

3.6.3 Creating a Pattern Sequence in Pre-Stored Pattern Mode

Creating a Pre-Stored Pattern sequence is very similar to *Pattern On-The-Fly Mode*. The difference is that the patterns are pre-stored in flash memory.

If images are not present in the flash memory, proceed to Section 3.9.1 section to add the images to the firmware and upload them to the EVM, then return here for steps on creating the pattern sequence.

To start creating a Pre-Stored Pattern sequence, follow the steps in Section 3.6.2 with the only change in step 2. In step 2, select the *Pre-Stored Patten* radio-button and then proceed with step 3.

3.6.4 Reordering a Pattern Sequence using the Edit LUT Feature

The *Edit LUT* feature is only available in *Pre-Stored Pattern Mode* and *Pattern On-The-Fly Mode* when using GUI 4.0 or later in conjunction with Firmware 5.0 or later. This feature allows the user to manipulate the pattern display sequence without having to reload or change any data in the DLPC900 memory. The *Edit LUT* button appears on the right hand side of the *Pattern Mode* tab after adding patterns as described in Section 3.6.2.

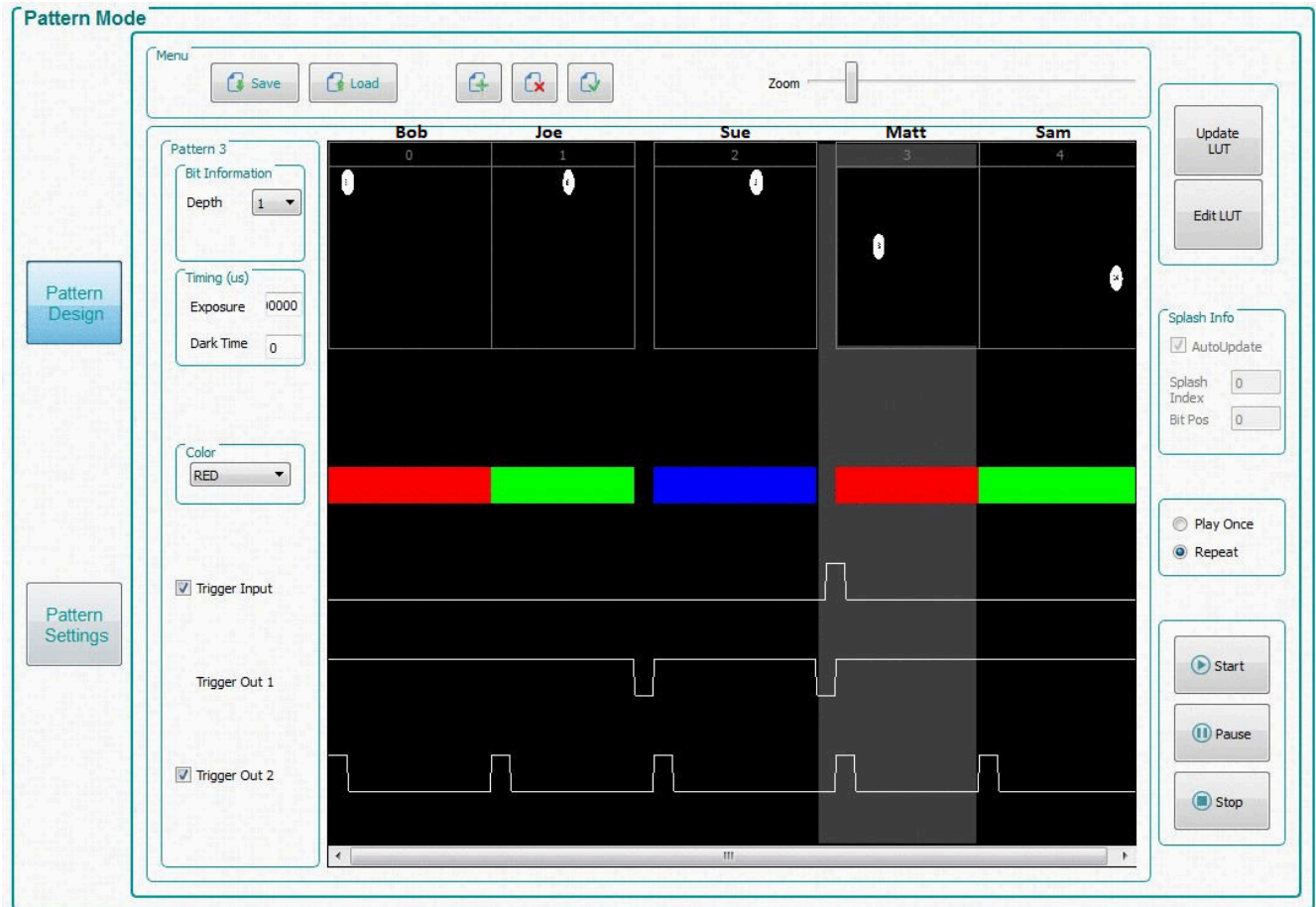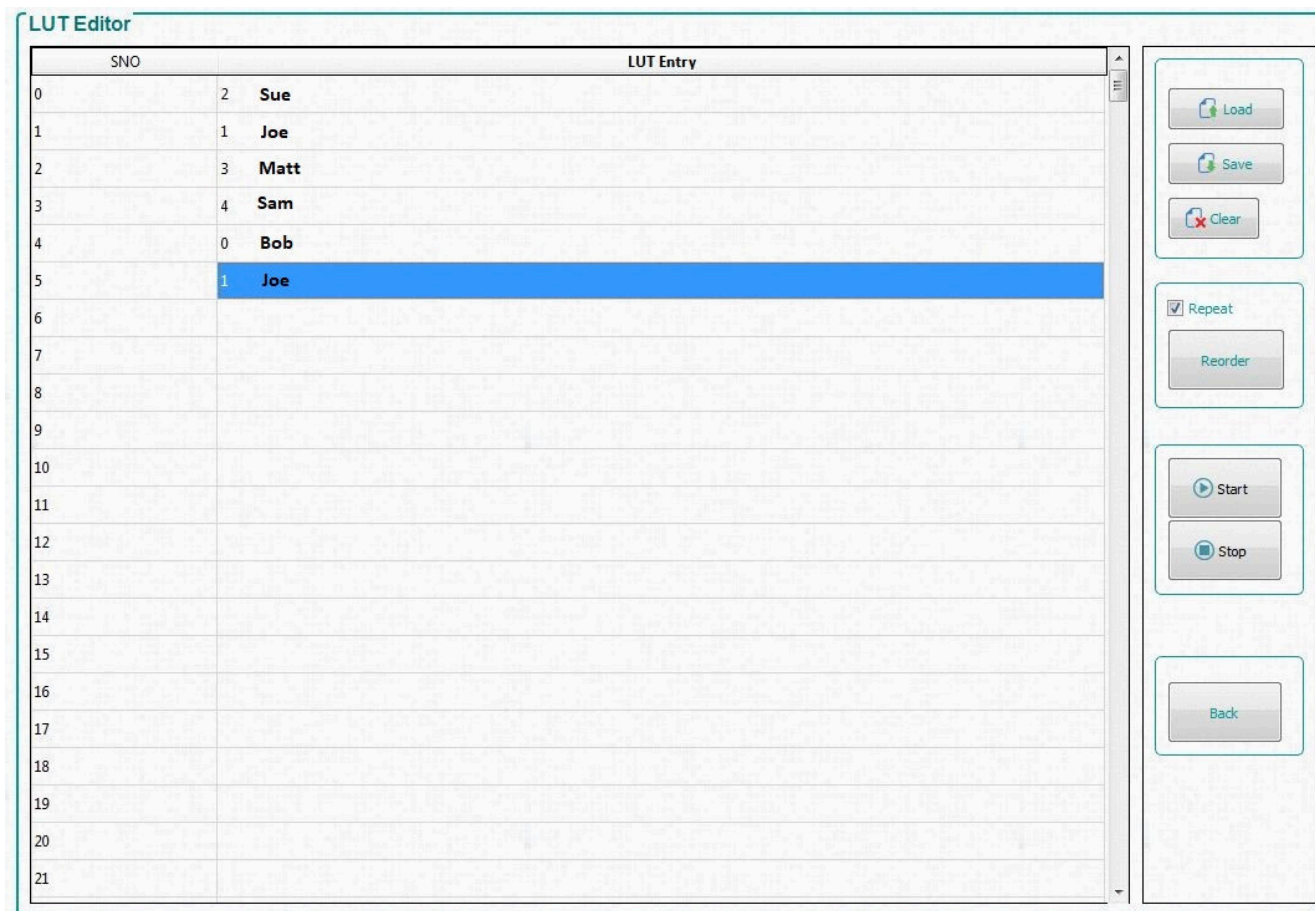**Figure 3-11. Pattern Design Example**

The *LUT Editor* panel is shown in Figure 3-12 where the column labeled "SNO" (i.e. Sequence Number) represents the pattern display slot numbers according to the order set (after clicking *Update LUT*) in the *Pattern Design* tab as shown in Figure 3-11. The user can then reorder those patterns by either manually entering the pattern number of their choice into a row in the "LUT entry" column or loading a text file beginning with the word "Reorder" followed by the desired numerical pattern slots as shown in Figure 3-13.

Figure 3-12. LUT Editor Panel

The following steps detail an example using the *Edit LUT* feature with five patterns in *Pattern On-The-Fly-Mode*:

1. By following the steps similar to Section 3.6.2, load five patterns in *Pattern On-The-Fly-Mode* as shown in Figure 3-11.
2. Set the exposure time to 1000000 us for ease of viewing.
3. Set an input trigger on Pattern 3 by checking the *Trigger Input* box.
4. Set all other user desired pattern property settings.
5. Click the *Update LUT* button and wait for all patterns to be uploaded to the EVM.
6. Click the *Start* button to view the pattern display order.
7. Click the *Edit LUT* button to open the *LUT Editor* panel as shown in Figure 3-12. This panel initially opens with an empty "LUT Entry" column.
8. To reorder the patterns, enter a "2" in "LUT Entry" row 1, and subsequently a "1", "3", "4", "0", and "1" as shown in Figure 3-12 .
9. Click the *Stop* button to stop the pattern sequence even if it is not currently running.
10. Check the *Repeat* box for display repetition of the new pattern sequence and then click the *Reorder* button.
11. Click the *Start* button to view the new pattern display order.

12. Click the *Save* button to save the new pattern sequence as a text file for later use. Name the file **Reorderexample.txt** and save it in a directory of choice.
13. Browse to wherever the text file was saved, and open the file in a text editor program as shown in Figure 3-13.
14. Notice at the top of the text file is the word "Reorder" which is required to successfully load a reorder file in the GUI. If desired, swap any of the pattern numbers to create a new pattern sequence and save the file.
15. Click the *Load* button and browse for **Reorderexample.txt**.
16. Click the *Start* button to view the new pattern display order.
17. Click the *Stop* button to stop the pattern sequence.
18. Click the *Back* button to return to the *Pattern Mode* tab.

Note

When using the GUI interface, each pattern carries several items of information corresponding to the slot that it was inserted in the original LUT order. Therefore, when reordering a pattern to a different slot in the LUT, it retains its original assigned bit information, timing (exposure and dark time), LED color, and trigger information and NOT the information that is located in its reassigned slot in the LUT. For example, if pattern 3 contains a trigger input to begin the user's execution in Figure 3-11 and is reordered to slot 2 as shown in Figure 3-12, the trigger input is now located at slot 3 in the LUT rather than slot 0.

In *Pre-Stored Pattern Mode*, reordering the LUT does not change the pattern locations as it does in *Pattern On-The-Fly Mode*. Only the requested bit information, timing, color, and trigger information are reordered based on the user's updated LUT. However, it is possible to manipulate the pattern information after reordering the sequence by manually editing the batch file commands uploaded to the EVM rather than using the GUI.
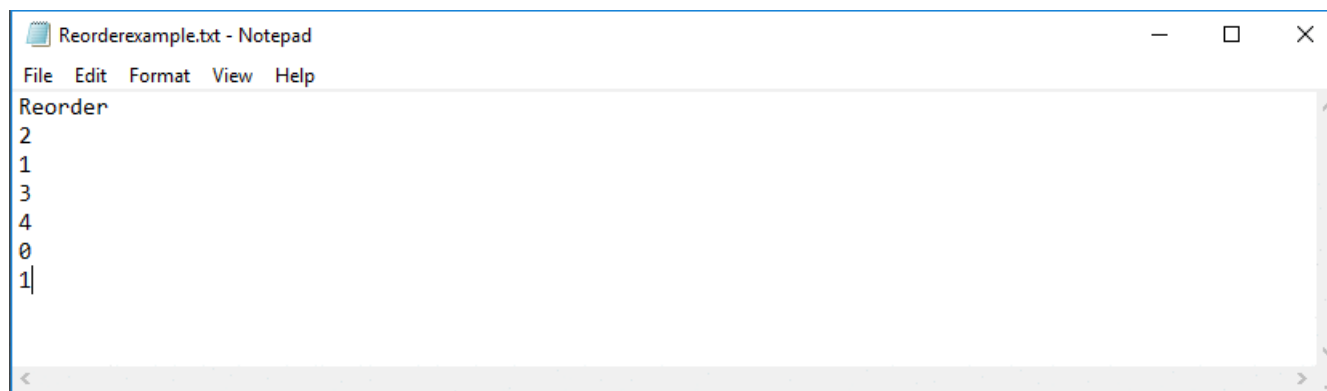

Figure 3-13. Reorder Example

It may be helpful to understand the *Edit LUT* feature by giving names to the patterns, as shown above the patterns in Figure 3-11, and treating them as the batting order in a baseball game. This way, it is easier to picture the distinction between the slot order numbers in the "SNO" column (the new batting order) and the patterns that are inserted into the "LUT Entry" column (the batters). For example, Bob retains his batting statistics independent of his batting position (i.e. bit information, timing, color, trigger), so if he originally bats first (slot 0 in Figure 3-11) but is moved to fifth in the new batting order (reorder LUT entry 4 in Figure 3-12) he retains all of his properties. The only difference is that now he does not bat (i.e. is not displayed) until after the four batters (patterns) preceding him (Sue, Joe, Matt, and Sam). Notice also that in our example Joe bats twice in the new batting order (SNO 2 and 5). There is only one Joe, who bats twice in the new batting order. In the same way, a pattern in the original pattern list can be displayed in many positions in the reordered display LUT, without adding or removing any patterns in DLPC900 memory. Therefore in terms of the system memory, it is only changed when using the *Update LUT* feature but never when using the *Edit LUT* (Reorder) feature in the Figure 3-11.

3.6.4.1 Special Considerations for Input Triggers when using the Edit LUT Feature

Input triggers have some special considerations when using the new *Edit LUT* Feature. As previously noted, Pattern 3 ("Matt") has an input trigger associated with it. When a trigger is added to a pattern, the pattern preceding it, Pattern 2 ("Sue") in this case, has an all-black pattern loaded at the very end of it so that while the sequence is waiting for the trigger it does not have a pattern displaying during the wait. This attribute follows Pattern 2 during a reorder. In our example the first entry (Pattern 2) in the new display order has a 105 µs dark pattern at the end of it. If Pattern 0 ("Bob") is placed in front of Pattern 3 ("Matt" - the triggered pattern) then the last bit-pattern of Pattern 0 ("Bob") continues to display in our new display order while waiting for the trigger in Pattern 3 ("Matt").

This behavior can be compensated for in one the following ways:

• Consider Pattern 2 and 3 ("Sue" and "Matt") as a set that must always be moved together in your new display order.

 - This is the simplest method, but the tradeoff is that these two patterns are not separable without the undesired behaviors described above.

• Add a 1-bit all-black pattern with the shortest duration allowed (105 µs) preceding the trigger pattern. Now consider this pattern and the triggered pattern following it as a set that must always be moved together.

 - This is method is more versatile, but means that this pattern must always be a triggered pattern.

• Add a 1-bit all-black pattern with the shortest duration allowed (105 µs) followed by a triggered 1-bit all-black pattern (also with 105 µs duration), and remove the trigger from the actual pattern of interest. These two patterns are now a versatile trigger set that can be used repeatedly wherever a trigger is desired. Note that since the triggered pattern is black, even if your exposure integration begins with the triggered black pattern there is no light contributing to your exposure.

 - This method is the most versatile since this standalone trigger set only has to be placed in the Pattern Index set (on the Pattern Mode page) once but can be used in many positions in a new display order (Pattern Display LUT Reorder Configuration).

3.6.5 Creating a Pattern Sequence in Video Pattern Mode

Creating a *Video Pattern Mode* sequence is also similar to *Pattern On-The-Fly Mode*. The difference is that the patterns are streamed from the input video source. The user must create the video images and then input them through the RGB parallel interface. The input video source vertical sync is used as the triggering mechanism. The input video source must be stable and locked and continuously being applied, otherwise the firmware detects that the source was lost and a solid curtain is displayed. While the video source is stable and locked, the status box for *Locked to External Source* remains checked.

Follow these steps to create a *Video Pattern Mode* sequence.

1. Make sure the EVM is powered up and operating correctly, and the *Connected* radio-button is lit **green**.
2. Select *Video Mode* from the *Operating Mode* group box, and then select the *HDMI* radio-button from the *IT6535 Receiver* group box and finally click the *Set* button. (Select the *DisplayPort* radio-button if using this input connector). The *Locked to External Source* status box is checked after a few seconds.
3. Verify the video source is displayed. If no video source is displayed, then make sure the PC or host is supplying the correct resolution and frame rate. See Section 3.5.1 for video support.
4. Select *Video Pattern Mode* from the *Operating Mode* group box, and then click the *Pattern Design* button so that the large black panel is displayed as shown in Figure 3-6.
5. Click the *Add Pattern* button on the *Menu* bar and add 3 patterns.
6. Click the *Select All Patterns* button to select all images.
7. Set exposure time to 1215 µs and dark time to 0 µs.
8. Select the first image and select a bit depth of 2, start bit G0, and color Green.
9. Select the second image and select a bit depth of 4, start bit R0, and color Red.
10. Select the third image and select a bit depth of 3, start bit B0, and color Blue
11. Click the *Select All Patterns* button.

12. Remove the check from the *Frame Change* box.

13. Select pattern 0 only and check the *Frame Change* box.

14. Click the *Update LUT* button.

15. Click the *Start* button to run the sequence. The system displays a green 2-bit sequence based on G0 & G1 for 1215 µs, a red 4-bit sequence based on R0 - R3 for 1215 µs, and a blue 3-bit sequence based on B0 - B2 for 1215 µs with the remainder of the video frame time dark. This sequence repeats every frame with the new video data for that frame.

16. Click the *Stop* button to end this example.
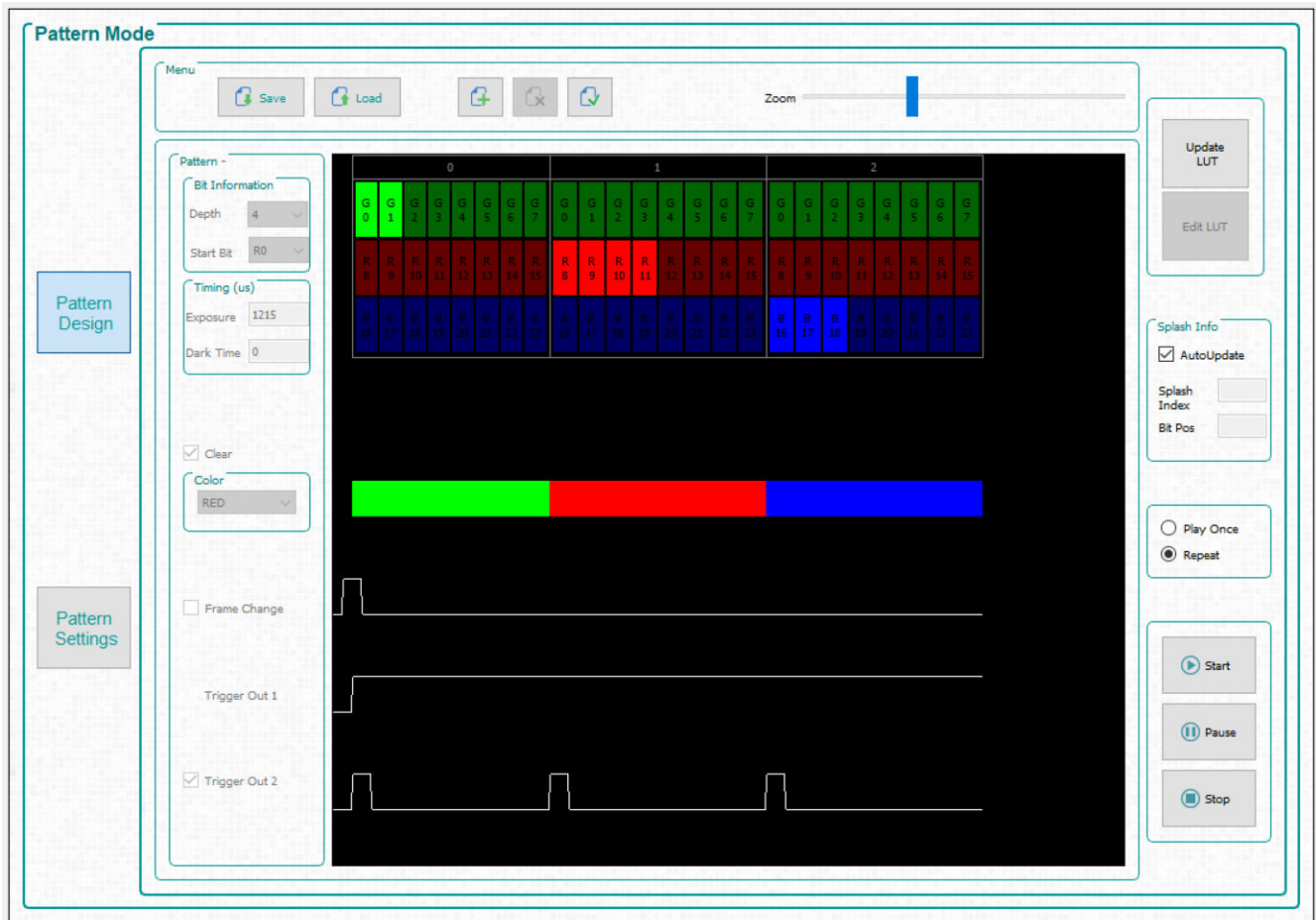
See Figure 3-14 after all settings have been applied.

Figure 3-14. Video Pattern Mode

3.6.6 Creating a Pattern Sequence With DMD Block Load

Creating a pattern sequences with DMD Block Load achieves higher pattern rates by using a subset of the DMD blocks. See DMD Block Load command in the DLPC900 Software Programmer's Guide (DLPU018) for a description of this command.

Follow these steps to create a *Pattern On-The-Fly* pattern sequence with only three DMD active blocks.

1. Make sure the EVM is powered up and operating correctly, and the *Connected* radio-button is lit **green**.
2. Select *Pattern On-The-Fly Mode* from the *Operating Mode* group box, and then select the *Pattern Design* button so that the large black panel is displayed as shown in Figure 3-6.
3. Select the *Load* button from the menu bar and select the **Block_Load.txt** file located in the sample images directory. Be sure to select the correct file for the EVM being used.
4. The pattern design looks similar to Figure 3-15.
5. Select the *Pattern Settings* button.
6. Within the *DMD Active Blocks*, select 6 for the *Start Block* and select 8 for the *End Block*, and then Select *Set*.
7. Select the *Pattern Design* button.
8. Select the *Update LUT* button.
9. Select the *Start* button to run the sequence. The system only loads data in blocks 6, 7, & 8 regardless of the thumbnail image shown in the Pattern Design window and displays each pattern for 180,000 µs.
10. Select the *Stop* button to end this example.

Notice that pattern 0 is displayed the same way as pattern 2 even though pattern 0 contains image data for all blocks. This shows that only blocks 6, 7, and 8 are active while all other blocks are in the off state.

Note

The performance of the mirrors in the blocks that are not active are affected by prolonged use of being in the off state. Enable *DMD Idle Mode* as often as possible to optimize the mirrors. This mode provides a 50/50 duty cycle across the entire DMD mirror array, where the mirrors are continuously flipped between the on and off states. See *DMD Idle Mode* command in the DLPC900 Software Programmer's Guide (DLPU018) for a description of this command. The *DMD Idle Mode* command is located in Section 3.6.7 within the *Pattern Mode* panel.

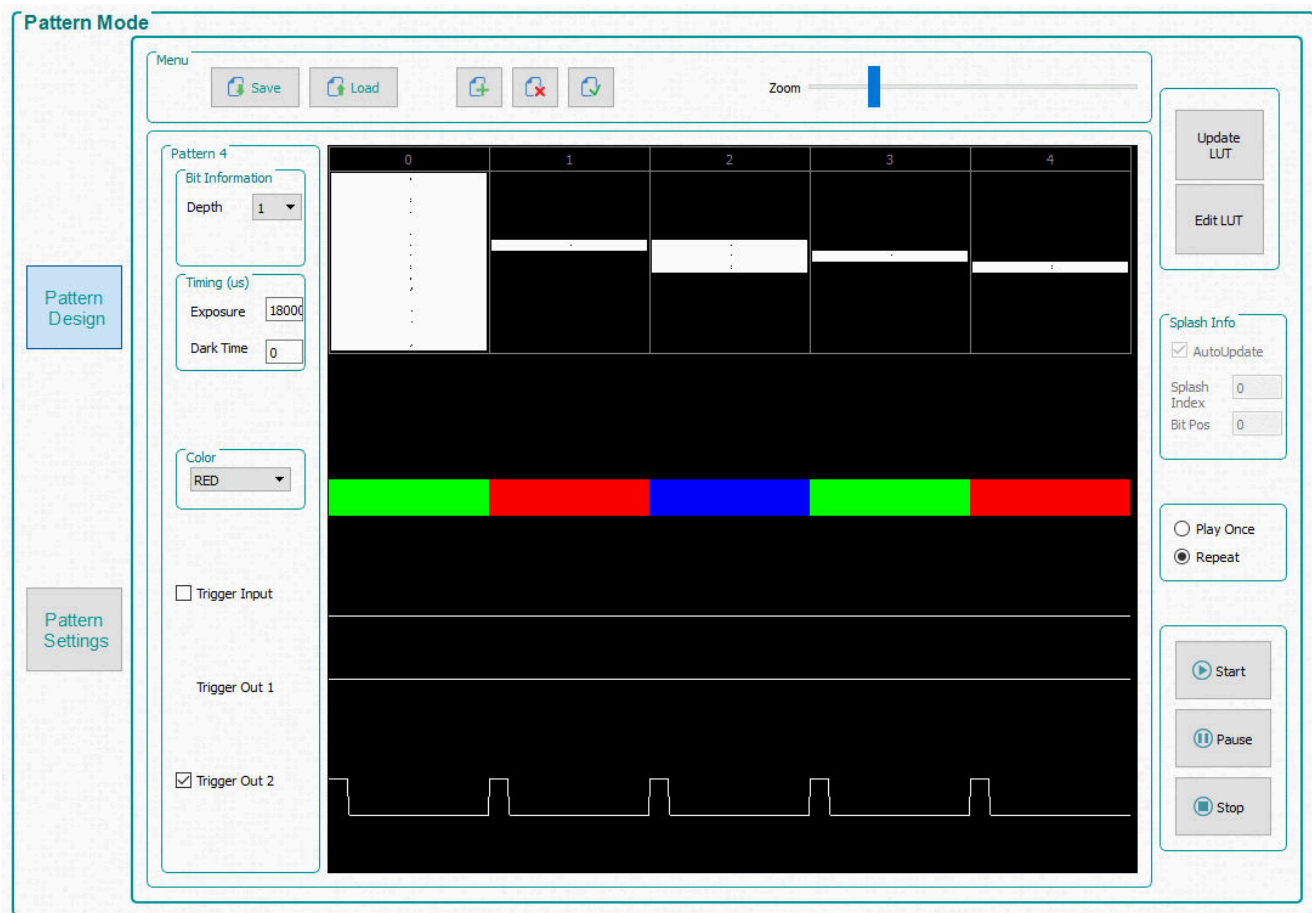**Figure 3-15. DMD Block Load Pattern Sequence**

3.6.7 Pattern Settings

To configure the output or input triggers click the *Pattern Settings* button as shown in Figure 3-16. Within this panel, the user can select the output delays of Trigger 1 and 2 and the input delay for Trigger In 1 and 2. The output delays are from the start of the pattern on the DMD.

Trigger In 1 and 2 can be delayed to have a later affect from when the external device performed the trigger. All signals can be inverted.

The LED controls can also be delayed. These delays are from the start of the pattern on the DMD.

Minimum LED Pulse Width control allows the system to have much higher pattern speeds. Input the minimum LED Pulse Width specific to your illumination system to achieve higher pattern speeds through illumination modulation. Illumination modulation occurs with 8-bit patterns at rates faster than 1031 Hz, by modulating the light source to shorten the shortest bits, therefore increasing the maximum pattern speed. The LED_EN signals from the DLPC900 can be used to control the illumination modulation of the LEDs.

The *DMD Active Blocks* allows a subset of DMD blocks to be activated, while the mirrors in the non-selected blocks are set to the off state. See Section 3.6.6 for an example of using this mode. **When operating with a subset of DMD blocks, enable the *DMD Idle Mode* as often as possible.** For example, whenever the system is idle, between exposures if the application allows for it, or when the exposure pattern sequence is stopped. To enable the *DMD Idle Mode*, the pattern sequence must be stopped. To restart the pattern sequence, the *DMD Idle Mode* must be disabled.

The *DMD Idle Mode* provides a 50/50 duty cycle across the entire DMD mirror array, where the mirrors are flipped between the on and off states to optimize the performance of the mirrors.

The *Image Compression* option allows for control of the compression type that occurs to the pattern images.
- The Uncompressed option does not attempt to compress the images.
- The Run Length Encoding (RLE) option is a lossless compression method that compresses the pattern data using horizontal pixel similarities.
- The Enhanced RLE option is a lossless compression method that compresses the pattern data using vertical and horizontal pixel similarities.
- The Auto option is capable of doing all three compression types. It then uses the one that takes up the smallest amount of data.

More information on these compression types can be found in the DLPC900 Programmer's Guide.

Figure 3-16. Pattern Settings Panel

3.7 Batch Files

Click the *Batch Files* button at the top of the GUI to display the *Batch Command Sequence* panel as shown in Figure 3-17. If the *Enable Command Logging* box is checked, the panel displays all the commands the user clicks on the GUI. When clicking the *Save Batch File* button, the content that is in the panel is saved to a text file containing the command descriptor followed by the command data. This batch file can then be re-loaded at a later time using the *Load Batch File* button and executed or it can be added to the firmware to be executed using the *Batch files Stored in the EVM* group box. This group box lists all the batch files currently in the firmware.
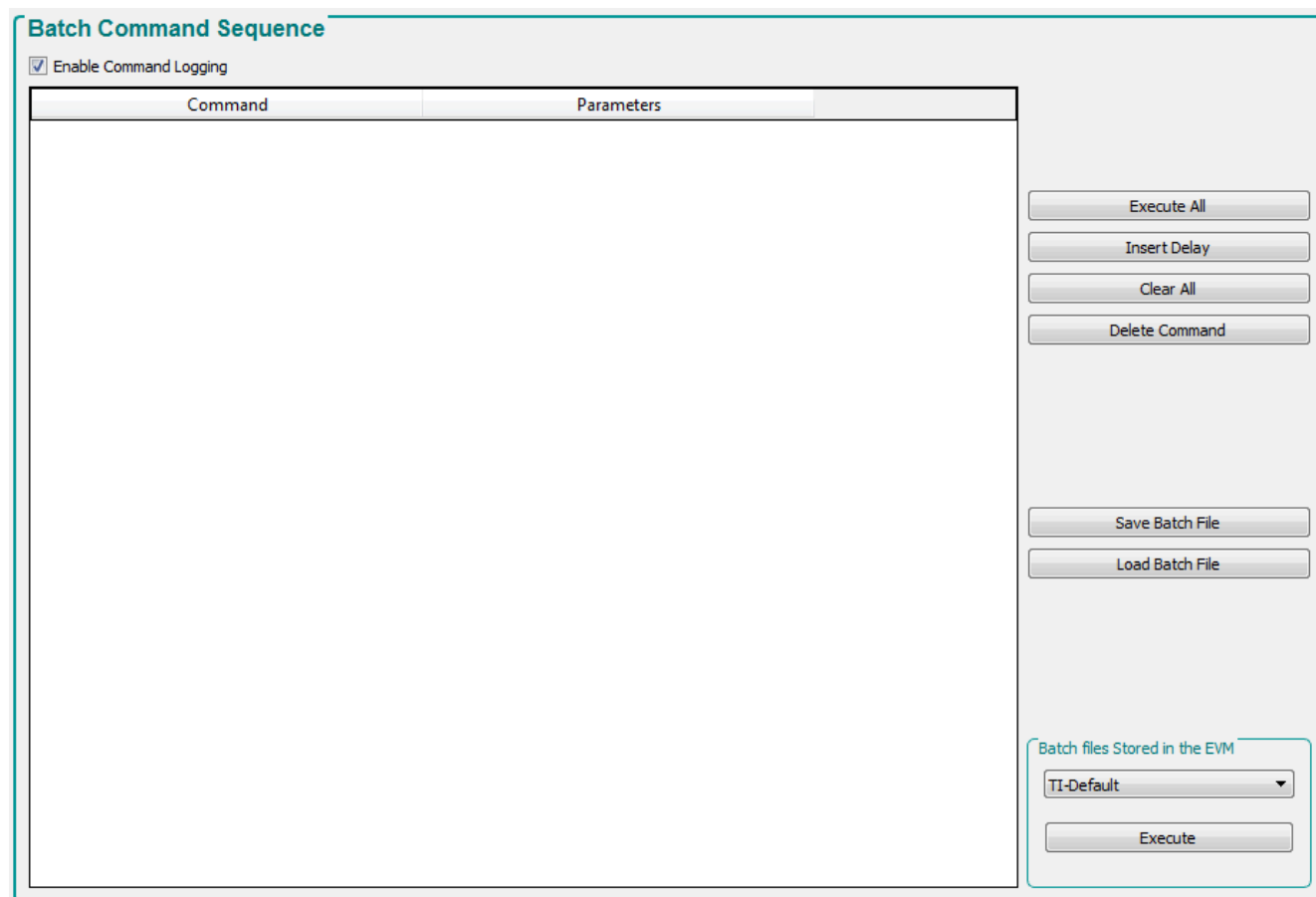
Figure 3-17. Batch Files Panel

3.7.1 Execute Batch File

The DLPC900 firmware has the option to store batch files within the firmware. These batch files contain commands that are executed to perform some sequence of settings without the user or host performing these commands. If the firmware contains batch files, the GUI queries the batch file names and list them in the *Batch Command Sequence* panel within the *Batch Files Stored in the EVM* group box. The user can then choose a batch file from the list to execute it.

The user can also designate a default batch file to be executed during the DLPC900 power-up sequence when the power is applied. For example, if the LEDs are to remain off after power has been applied to the EVM, a batch file can be created with the commands to turn the LEDs off, and then update the firmware with this batch file as the default. The updated firmware can then be uploaded to the EVM. The next time the power is applied to the EVM, the LEDs are disabled from turning on. See the DLPC900 Programmer's Guide for the batch file commands in Appendix B for a complete list of commands that can be used within a batch file.

3.7.2 Creating and Saving Batch Files

There are two methods to create and save batch files:

- Use the GUI
- Use a text editor

3.7.2.1 Creating and Saving a Batch File Using the GUI

This example contains the following set of commands:

1. Set the short axis image orientation.
2. Set the input channel swap to ABC->CBA.
3. Set the LED currents.

Follow these steps to add the commands and save to a text file

1. Power-up the EVM and select the RGB parallel interface.
2. Select *Video Mode* from the *Operating Mode* group box, and then select the *HDMI* radio-button from the *IT6535 Receiver* group box and finally click the *Set* button. (Select the *DisplayPort* radio-button if using this input connector).
3. Verify the EVM is displaying the input source correctly. If no video source is displayed, then make sure the PC or host is supplying the correct resolution and frame rate. See Section 3.5.1 for video support.
4. Click the *Batch Files* button at the top of the GUI.
5. Check the *Enable Command Logging* box to enable logging.
6. Click the *Clear All* button to clear the contents of the list box.
7. Click the *System Settings* button at the top of the GUI.
8. Click the *Get* button within the *Image Orientation* group box.
9. Check the *North/South* checkbox and click the *Set* button within the group box. The image orientation of the displayed image is flipped on it short axis.
10. Click the *Video Mode* button at the top of the GUI.
11. Select ABC->CBA from the drop-down list box within the *Input Port Data Swap* group box.
12. Click the *Set* button within the box. The colors of the image are adjusted for the setting.
13. Click the *System Settings* button at the top of the GUI.
14. Click the *Get* button within the *LED Controls* group box.
15. Enter 100 for each of the LEDs within the *LED Current* group box and click the *Set* button. The LED brightness may change after setting the LED current.
16. Click the *Batch Files* button at the top of the GUI.
17. Within the list box, all the commands that were applied on previous steps are listed.
18. Click the *Save Batch File* button to save as text file.

Figure 3-18 shows the contents of the list box. Notice that there are more than the three commands in the list box than are mentioned in this example. This is because, when clicking the *Set* button for some commands in the GUI, multiple commands are combined. For example, when clicking the *Set* button for image orientation, both long and short axis commands are included.

Within the Batch File panel, each command can also be deleted or a delay can be inserted between commands.

Figure 3-18. Batch File Example

3.7.2.2 Creating a Batch File Using a Text Editor

Use a text editor to add the same three commands in the previous example. Refer to Appendix B in the DLPC900 Programmer's Guide for the list of command descriptors supported by the DLPC900.

When adding a command descriptor to the file, a colon must be between the descriptor and the parameters. Use a space between the colon and each parameter and use '0x' for each byte in the parameter list. Remember that the parameters are least significant byte first. The lines below show what is to be in the text file.

```
FLIP_SHORT:             0x01
CHANNEL_SWAP:           0x0A
LED_CURRENT:            0x64 0x64 0x64
```

Once all three commands are added, save the file as a text file and use a name to describe what the batch file does.

3.7.3 Loading a Batch File

Once you have saved a batch file from either the GUI or a text editor, you can load the batch file into the GUI and execute the commands.

Use the button labeled **Load Batch File** (shown in Figure 3-18) on the right midway down, and navigate to and select a batch file. Once it is loaded, the commands can be executed or added to your firmware (see Section 3.7.4)

3.7.4 Adding a Batch File to the Firmware

A batch file can be added to the firmware to be used as the default batch file to be executed during the power-up sequence of the DLPC900. Or a batch file can be added to be executed at any time after the power-up sequence has completed to perform some action. Some special considerations must be taken if adding pattern images and a batch file to the firmware image. See NOTE at end of Section 3.9.1.2 for a description of these considerations. Follow these steps to add the example batch file from the previous section to the firmware.

CAUTION

The user must exercise caution when selecting the correct firmware file. Install DLP LightCrafter GUI version 5.x or later and FW version 6.x or later. Operating or updating the firmware on the DLP LightCrafter DLPC900 GUI version 4.x (or earlier) renders the EVM inoperable.

---

1. Power-up the EVM and verify it is operating normally.
2. Start the GUI and verify the connection has been established with the EVM.
3. Click the *Batch File* button at the top of the GUI.
4. Check the *Enable Command Logging* box to enable logging.
5. Click the *Clear All* button to clear the contents.
6. Click the *Load Batch File* button and browse for the text file that was saved in Section 3.7.2.
7. The panel displays the commands as they are in the file.
8. Click the *Firmware* button at the top of the GUI.
9. Click the *Browse* button and select the firmware file(s) for the EVM being used.

Note

When updating firmware for the DLP LightCrafter Dual DLPC900 EVM, the GUI creates two firmware files. One for the master controller and one for the slave controller. When selecting a firmware file or an updated version, select both firmwareimg-master.img and firmwareimg-slave.img files by clicking each while holding the Ctrl key.

---

10. Within the *Batch File and Patterns* group box, check the *Add Batch File* box.
11. In the *Batch File Name* edit box, enter a name for the batch file. Up to 16 characters are allowed without spaces and special characters.

Note

If the batch file is to be a default batch file to be executed during the power-up sequence, then continue to step 12, otherwise go to step 13.

---

12. Within the *Batch File and Patterns* group box, check the box next to *Set as Default Batch File*.
13. Click the *Update Firmware* button. The GUI displays a pop-up box providing the name of the updated firmware file.
14. Click the *Browse* button and locate the firmware file from step 13.
15. Click the *Upload* button. The GUI performs the necessary steps to update the firmware in the EVM.

Note

When updating firmware for the DLP LightCrafter Dual DLPC900 EVM, the GUI creates two firmware files. One for the master controller and one for the slave controller. When selecting a firmware file or an updated version, select both firmwareimg-master.img and firmwareimg-slave.img files by clicking each while holding the Ctrl key.

Note

The name of the firmware file created by the GUI includes a timestamp, ensuring that new firmware does not overwrite any previously created firmware files.

3.8 Peripherals

Click the *Peripherals* button at the top of the GUI to display the *Peripherals* panel as shown in Figure 3-19.

Figure 3-19. Peripherals Panel

- The I^{2}C group box allows external I^{2}C device to be controlled using one of the DLPC900 I^{2}C interfaces. For example, if an LED driver requires I^{2}C communications to enable the LEDs, then a command can be sent to the LED driver using this interface. When using the I^{2}C interfaces, first configure the I^{2}C port using the commands within the *I^{2}C Settings* and then perform data transfers using the commands within the *I^{2}C Read/ Write*.
- The Clock A Configuration group box allows the user to enable and control the output frequency of OCLKA. The clock can be used as a source to some external logic.
- The GPIO Configuration group box allows the user to configure any of the nine available GPIOs. These GPIOs can be configured as inputs or outputs.
- The Pulse Width Modulate Control group box allows a user to configure any of the four available PWM outputs.

Note

GPIO_00 – GPIO_03 are shared with the four PWM outputs.

3.9 Firmware

Click the *Firmware* button to display the Firmware panel as shown in Figure 3-20. In this panel a user can update the firmware with patterns, batch files, and set start-up conditions.

To update the firmware on the EVM click the *Browse* button and locate the firmware file for the EVM type. Before clicking the *Upload* button, verify the EVM is powered-up, operating normally, and connection has been established with the GUI.

Within the *Power up Defaults* group box, a user can select the default power-up state by checking the *Startup State* checkbox and then selecting the state from the drop-down list box.

If the IT6535 digital receiver is present on the hardware, then the user may enable the use of this receiver by checking the *HDMI/DP Receiver* checkbox.

If a default batch file is needed, then see the Batch File section in this guide.

The DLPC900 can also be controlled over the I^2C interface on I^2C port 0. The default DLPC900 slave address is 0x34. This address is programmable using the I^2C Slave Address within the *Power up Defaults* group box.

The GUI permits the user to perform a bus swap on the DMD by checking the *DMD Bus Swap* box and selecting between Channels A and B. This feature is a firmware configuration option that only takes effect after uploading the firmware onto the EVM. However, when using the DLP LightCrafter Dual DLPC900 EVM the user may perform a bus swap on both the Master and the Slave by selecting each checkbox per desired channel.

The GUI also permits the user to enable Spread Spectrum Clock Generator Support. The user can select from .5%, .75%, or 1% in the drop down menu. This option uses internally controlled clock spreading to help minimize EMI due to high-speed signals. More information on the spread spectrum feature and DMD bus swapping can be found in the DLPC900 datasheet.

Figure 3-20. Firmware Panel

3.9.1 Adding or Removing Patterns from the Firmware

For most efficient storage and compression of images, the GUI packs the images into groups of 24-bit RGB bitmap images. This means if there are 1-bit black and white images, 8-bit gray scale images, or any other image bit-depth (up to 24-bit images), they are combined to create a composite image. For example, a composite image could be composed of 24 1-bit images, 3 8-bit images, or a combination of images of various bit-depths which add up to a 24-bit composite image.

Note

An image cannot span two 24-bit composite images. For example three 7-bit images can fit in a composite 24-bit image, but a fourth 7-bit image would have to go into a separate 24-bit image. Only a 3-bit or smaller image can be put into the remaining bits of the first composite 24-bit image.

The GUI then compresses each 24-bit image using the Enhanced Run-Length Encoding described in the DLPC900 Programmer's Guide. These compressed images are then decompressed as they are loaded into the DLPC900 internal memory when operating in *Pre-Stored Pattern Mode* or *Pattern On-The-Fly Mode*.

The EVM is capable of holding up 400 1-bit binary or 50 8-bit binary compressed patterns in flash memory. Depending on the compression ratio, more than 400 patterns can be stored to have multiple pattern sets for multiple pattern sequences. These patterns are then loaded when the operating mode is set to *Pre-Stored Pattern Mode*. The remainder of this topic applies only to *Pre-Stored Pattern Mode*.

The DLP LightCrafter Dual EVM can be loaded with a pattern sequence that is displayed when power is applied to the EVMs. Since the GUI does not know the images that are stored in flash memory, it is advisable to delete all images from flash before storing new ones.

When adding images to the *Pattern Design* panel, the GUI always begins with image index Zero. However, the GUI saves the images to the firmware by appending them to the end of the last image that is in the firmware if any.

For example, assume there are two 24-bit images stored in the firmware. These two images have index values of 0 and 1. If then a pattern sequence is created in the *Pattern Design* panel, where the GUI packs all the images into four 24-bit images, and then saved to the firmware, the four images are appended to the firmware and have index values of 2, 3, 4, and 5. When the firmware is uploaded to the EVM and the pattern sequence is started, the sequence of images is 0, 1, 2, 3 rather than 2, 3, 4, 5.

First begin by examining the images that are currently in the firmware.

1. Apply power to the EVM and allow display of the pattern sequence.
2. Select *Video Mode* from the *Operating Mode* group box.
3. Click the *Source Select* drop-down list box, and select *Images From Flash*.
4. Below the *Source Select* drop-down list box, select 0.
5. Click the *Set* button.
6. Continue to index through all the values until the GUI gives an error that the image does not exist.

This represents the images that are stored in flash.

Return to the video source by selecting the *Parallel RGB* interface from the *Source Select* drop-down list box and click the *Set* button. If there is a video source connected to the EVM, the source is displayed, otherwise a solid curtain is displayed.

3.9.1.1 Deleting Images

When deleting images from flash, the flash device is erased and then updated with the firmware that contains the new images. In the event the flash is accidentally corrupted, follow the instructions under JTAG Flash Programming to reload the original firmware. To remove accidental erasing or corruption of the flash device, it is recommended to operate in *Pattern On-The-Fly Mode*.

CAUTION

The user must exercise caution when selecting the correct firmware file. Ensure that firmware file is version 3.0 or later. (Using version 2.0 or earlier renders the EVM inoperable).

Follow these steps to begin deleting images from the firmware file

1. Apply power the EVM and allow normal operation.
2. Click the *Firmware* button on the top of the GUI.
3. Click the *Browse* button.
4. Select a suitable firmware file or the original firmware file that comes with the EVM.
5. Add a tag name for this updated firmware file by adding a name in the *Firmware Tag* box.
6. Check the box next to *Clear All Existing Patterns Images and Batch Files*.
7. Click the *Update Firmware* button.
8. The GUI displays a pop-up box providing the name of the updated firmware file.

Note

When updating firmware for the DLP LightCrafter 9000, the GUI creates two firmware files: one for the master controller and one for the slave controller. When selecting a firmware file or an updated version, select both **firmwareimg-master.img** and **firmwareimg-slave.img** files by clicking both files while holding the Ctrl key.

---

9. Click the *Browse* button and select the firmware file from step 8.

The updated firmware file has no images. It is advisable to rename the updated firmware file with a specific name so that later it can be reused as a firmware file that has no images.

3.9.1.2 Adding Images

The bitmap images to be added to the firmware file must have the native resolution of the DMD that is being used. The GUI returns an error if it encounters an incorrect image size.

1. Continuing from the previous set of steps, click the *Browse* button and select the firmware file in step 8 or the renamed version.

Note

When updating firmware for the DLP LightCrafter Dual DLPC900 EVM, the GUI creates two firmware files: one for the master controller and one for the slave controller. When selecting a firmware file or an updated version, select both **firmwareimg-master.img** and **firmwareimg-slave.img** files by clicking both files while holding the Ctrl key.

---

2. Select *Pre-Stored Pattern Mode* from the *Operating Mode* group box. The *Pattern Mode* panel is displayed.
3. Click the *Load* button to add a list from the *Menu* bar and select **add_72.txt** file located in the sample images directory for the EVM being used (DLPC900REF-SW-x.x.x\DLPC900REF-GUI\ - subdirectory [LCR*DMD*]_Images. Be sure to select the correct file for the EVM being used. This file adds 72 images to the *Pattern Design* panel. See Figure 3-10.
4. Click the *Select All Patterns* button from *Menu* bar to select all the images.
5. Select bit depth 1 for all images.
6. Enter 120000 μs for the exposure time for all images.
7. Enter 10000 μs for the dark time for all images.
8. Select color **Red** for all images.
9. Click the *Firmware* button at the top of the GUI.
10. Check the box next to *Add Patterns Images*. Check the box next to *Clear Existing Patterns*. These patterns are from the *Pattern Design* panel. See Figure 3-10.
11. Click the *Update Firmware* button.
12. The GUI displays a pop-up box providing the name of the updated firmware file.
13. Click the *Browse* button and select the firmware file from step 12.
14. Click the *Upload* button and allow firmware to be uploaded to the flash memory.

Note

When a firmware file is uploaded, a cached version of that file is created on the PC in its original folder location. Each time a new firmware is uploaded the GUI compares it to the cache file on the PC and only reprogram the new sectors. The cache file is then updated to represent the latest firmware image. This can lead to significant download speed improvements if the new firmware and the previous firmware are similar. If a full reprogramming of the flash is desired, the user can delete the cache folder or select a firmware image from a different file location.

---

15. Once the EVM resets and displays a solid curtain, click the *Pre-Stored Pattern Mode* from the *Operating Mode* group box.
16. The *Pattern Design* panel (See Figure 3-10) is displayed which includes the pattern images that were added into the panel in step 3 with all the settings from steps 5-8. If the *Pattern Design* panel is not displayed, then click the *Pattern Mode* button at the top of the GUI. Press *Stop* if pattern sequence is currently playing.
17. Click the *Update LUT* button.
18. Click the *Start* button.
19. All 72 images are displayed with the settings that were entered in steps 5-8.

It is possible to add many images to the firmware without deleting all the images that are currently in the firmware, and then select which images and bit positions to choose for different pattern sequences. To do this

requires editing the image index and the bit position in the *Pattern LUT Definition* that is sent to the EVM, and then using the *Batch File* method to upload the *Pattern LUT Definition* and *Configuration* settings to the EVM.

The following example shows how to choose different images and bit positions from the 72 images that are stored in the firmware.

Follow these steps to edit the image index and bit position of the images to be used for the pattern sequence.

1. Stop the pattern sequence if it is currently running.
2. Delete all images except for the first two in the *Pattern Design* panel. See Figure 3-10.
3. Select the first image and set the color to Yellow.
4. Select the second image and set the color to Green.
5. Click the *Batch File* button at the top of the GUI.
6. Check the *Enable Command Logging* box, and then click the *Clear All* button.
7. Click the *Pattern Mode* button at the top of the GUI.
8. Click the *Update LUT* button.
9. Click the *Batch File* button at the top of the GUI.
10. Figure 3-21 shows the *Pattern LUT Definition* and *Configuration* of the pattern sequence.
11. Click the *Save Batch File* button to save the contents to a file.
12. Click the *Pattern Mode* button at the top of the GUI.
13. Click the *Start* button and take note of the images that are displayed, and then Click the *Stop* button.
14. Click the *Batch File* button at the top of the GUI.
15. Click the *Clear All button* and uncheck the *Enable Command Logging* box.
16. Use Notepad or a similar editor to open and edit the batch file saved in step 11. The file is typically stored in the folder named *DLPC900REF-GUI*, then [LCR*DMD*]_Images folder depending on which DLP Lightcrafter Dual DLPC900 EVM is being used. Change the image index and bit position as seen in Figure 3-22. See the DLPC900 Programmer's Guide (DLPU018) for details of the Pattern LUT Definition and Configuration commands.
17. Figure 3-22 shows the image index and the bit position of the images for the two patterns, where the values have been changed compared to the values in Figure 3-21. Click the *Save* to save the new batch file.
18. In the *Batch File* tab click the *Clear All* button, and then click the *Load Batch File* button and load the file from step 17.
19. Click the *Execute All* button.
20. Click the *Pattern Mode* button at the top of the GUI.
21. Click the *Start* button.

Notice that two different images or bit positions are displayed compared to the images in step 13.

Therefore, many different images can be added to the firmware and knowing the image index and the bit positions of each image, the user can create different *Pattern LUT Definition* and *Configuration* batch files that select different images and bit positions from the images stored in the firmware.

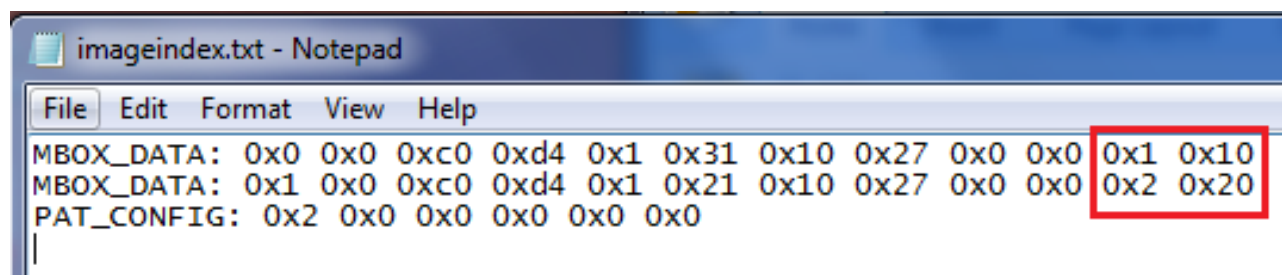**Figure 3-21. Pattern LUT Definition and Configuration**

Figure 3-22. Updating the Index and Bit Position

3.9.1.3 Adding Both Images and Batch Files

This section covers how to add pattern images and a batch file to the firmware. These steps allow the user to add patterns to the flash and have them automatically uploaded to the DLPC900 upon power up. The GUI is not connected when starting this process.

1. Check Virtual Connect in the System Controls box on the upper left of the GUI. Then select the platform that correlates to the attached Dual DLPC900 DMD EVM.
2. Navigate to the Batch File page and check the Enable Command Log box.
3. In the operating mode box on the left of the GUI select Pattern on-the-fly Mode.
4. Navigate to the pattern mode tab and add images.
5. Adjust exposure settings and other pattern configurations to desired values.
6. Click the update LUT button.
7. Click the start button if it is desired for the pattern sequence to be running upon start-up.
8. Navigate to the Firmware Page and browse to select a firmware to be modified.
9. Check all four boxes in the Batch File and Patterns Box on the bottom right of the firmware page.
10. Type in a name for the batch file.
11. Press the Update Firmware button.

This generates a new firmware image containing the pattern images and batch file located in the pattern mode tab and the batch file tab respectively. This firmware file is ready to be uploaded to the system when connected. If the user desires to load a previously created batch file, ensure that the batch file begins with a DISP_MODE : 0x03 command and ends with a PAT_START_STOP : 0x02 command in order to have the pre-stored patterns run upon start-up.

Note

An alternate method is to build a firmware adding only the images. Then add the batch file that updates the LUT and runs the images.

3.10 Flash Device Parameters

For EVM use with several different flash memory parts, the user can edit the FlashDeviceParameters.txt file to match the flash memory part that has been installed with the EVM. This file is located in the DLPC900REF-SW-x.x.x\DLPC900REF-GUI\Flash directory of the DLPC900REF-SW bundle. An example with the Cypress S70GL02GS2 part is shown in Figure 3-23 where the user comments out all lines EXCEPT for the top line which includes the user's chosen Micron flash part. More detailed information can be found in the comments at the top of the text file.

```
Version, 4
// Flash Device Information.
// DLPC900 info updated 12/11/2018
//
// The GUI reads mfg and device ID in sequential order in this file.
// The device used in the hardware MUST be first in the list in case the IDs are identical with another part.
//
// Micron M29DW128G and JS28F128M parts are no longer available to purchase
// Cypress S70GL02GS 2 gigabyte parts are now used in the EVMs
//
// Fields Description:
// Mfg - Manufacturer Name
// MgfID - Manufacturer ID
// LMgfID - Long Manufacturer ID
// Device - Part name
// DevID - Device ID
// LDevID - Long Device ID
// Mb - Flash size in Megabits
// Alg - Flash algo should be set to 0
// Size - Flash size in bytes
// #sec - Total number of sectors
// Sector_Addresses - Starting address of each sector. Include only sector adress maximum upto 16MB

// Mfg       MgfID  LMfgID,                Device   DevID  LDevID,        Mb Alg   Size #sec  Sector_Addresses
"Cypress",  0x0001, 0x0000000000000001, "S70GL02GS", 0x227E, 0x000000000000227E, 128, 0, 0x1000000, 128, 0x0, 0x20000, 0x40000,
//"Micron",   0x0020, 0x0000000000000020, "M29DW128G", 0x227E, 0x000000000000227E, 128, 0, 0x1000000, 70,  0, 0x10000, 0x20000,
//"Micron",   0x0089, 0x0000000000000089, "JS28F032M", 0x227E, 0x000000000000227E, 32, 0, 0x1000000, 128, 0x0, 0x10000, 0x20000,
//"Micron",   0x0089, 0x0000000000000089, "JS28F064M", 0x227E, 0x000000000000227E, 64, 0, 0x1000000, 128, 0x0, 0x10000, 0x20000,
//"Micron",   0x0089, 0x0000000000000089, "JS28F128M", 0x227E, 0x000000000000227E, 128, 0, 0x1000000, 128, 0x0, 0x20000, 0x40000
//"Micron",   0x0089, 0x0000000000000089, "MT28EW256", 0x227E, 0x000000000000227E, 128, 0, 0x1000000, 128, 0x0, 0x20000, 0x40000
//"Micron",   0x0089, 0x0000000000000089, "MT28EW512", 0x227E, 0x000000000000227E, 128, 0, 0x1000000, 128, 0x0, 0x20000, 0x40000
//"Cypress",  0x0001, 0x0000000000000001, "S29GL064P", 0x227E, 0x000000000000227E, 64, 0, 0x800000, 128, 0x0, 0x10000, 0x20000,
//"Cypress",  0x0001, 0x0000000000000001, "S29GL032P", 0x227E, 0x000000000000227E, 32, 0, 0x400000, 64, 0x0, 0x10000, 0x20000,
//"Cypress",  0x0001, 0x0000000000000001, "S29GL128P", 0x227E, 0x000000000000227E, 128, 0, 0x1000000, 128, 0x0, 0x20000, 0x4000
//"Cypress",  0x0001, 0x0000000000000001, "S29GL256P", 0x227E, 0x000000000000227E, 128, 0, 0x1000000, 128, 0x0, 0x20000, 0x4000
```

Figure 3-23. Flash Device Parameters Text File

3.11 JTAG Flash Programming

The DLPC900 JTAG Programmer Tool is included the DLPC900REF-SW bundle. It allows a user to program the bootloader image into the flash using the JTAG boundary scan connector if, for example, the bootloader becomes corrupted and the board is rendered inoperable. The tool can also be used for updating the entire firmware image. Programming the entire firmware image using this method may take a long time. It is suggested to program only the bootloader using this method, and then use the DLPC900 LightCrafter GUI with a USB connection to upload the entire firmware image. The following steps are for programming only the bootloader image.

> Before using JTAG to reload the bootloader, first install the BOOThold jumper (J12) and turn the system on. The system shows connected, but does not recognize the attached DMD. Manually select the radio button that matches your DMD and then go to the the firmware tab and select the master and slave FW images and reprogram. Then power down, remove the BOOThold jumper and restart the system. This often recovers a system without requiring reloading the bootloader through JTAG.

The DLPC900 JTAG Programmer Tool requires the UM232H module with modifications, which is manufactured by Future Technology Devices International Ltd (FTDI Chip), . The UM232H module can be purchased from Digi-key with the following part number: 768-1103-ND. The driver can be downloaded from the FTDI website (www.ftdichip.com). Select the VCP CDM WHQL Certified driver for Windows.

Make the following modifications to the UM232H and use Figure 3-24 and Figure 3-25 as a guide.

Connection Details

1. BUS power configuration

- • Short PIN #2 & PIN #3 of J1 (SYS PWR)
- • Short PIN #2 & PIN #3 of J2 (I/O PWR)
2. J2-6 → GND (PWR)
3. J2-7 → TCK (OUTPUT)
4. J2-8 → TDO1 (OUTPUT)
5. J2-9 → TDI (INPUT)
6. J2-10 → TMS1 (OUTPUT)
7. J2-11 → TRSTZ (OUTPUT)
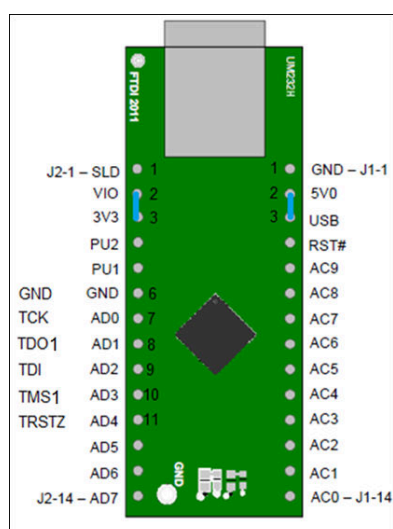
Figure 3-24. UM232H Module
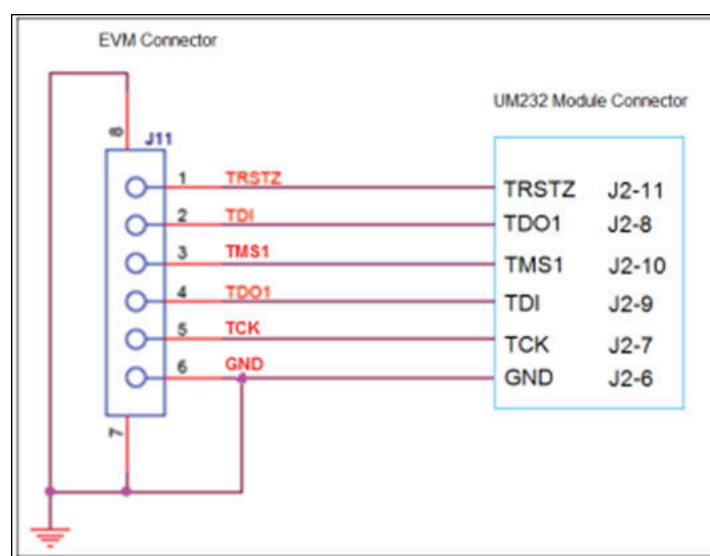
Figure 3-25. UM232H Wiring Diagram

Choose the driver found in the CDM WHQL Certified zip folder and allow driver installation to complete. Install a jumper at J10/J12 for the DLP LightCrafter Dual DLPC900 EVM. Populate R118 with a 0 ohm resistor and depopulate R117 near the center of the main board. Connect the JTAG signals at J11 on the DLP LightCrafter Dual DLPC900 EVM to the UM232H module as shown in Figure 3-25. Finally, connect the UM232H to the PC with USB cable.

Note

The JTAG programmer has its own copy of the FlashDeviceParameters.txt file which is located in the DLPC900REF-SW-x.x.x\\DLPC900REF-JTAG directory of the DLPC900REF-SW bundle. Please see Section 3.10 for instructions on how to edit this file to match your flash. If you have already made changes to the FlashDeviceParameters.txt file in the DLPC900REF-SW-x.x.x\DLPC900REF-GUI \Flash directory that work with the GUI, you may copy that file to the DLPC900REF-SW-x.x.x\ \DLPC900REF-JTAG directory

---

Start the DLPC900 Flash Programmer program and select the BoardFile.brd and the bootloader.bin included the install folder. Select USB as communication method from the Settings menu.

Power-up the EVM board and click the *Detect Chain* tool button. The tool detects the DLPC900 in JTAG chain and shows two DLPC900s. Now click on one of the DLPC900 to select it. On the EVM notice the Red/Green LEDs light up (D6/D7 or D8/D9) to confirm which DLPC900 is currently selected.

Click the *Flash Info* button and confirm the correct flash part is detected by the tool. Using the *Flash Erase* button select the first sector(s) (to cover first 128 kilobytes) and erase these sector(s).

Once sector erase is complete, set the *Start Address* (HEX) to 0x00000000 and set the *Size* (HEX) to 0x20000. Then click the *Program Flash* button, and then wait until write is complete.

Note

Make sure that **verify is 100%** complete!

Do the same *Erase* and *Flash* for the second DLPC900. Finally remove the UM232H JTAG and remove jumper at J10 & J12, and then cycle the board power to the EVM. Plug in a USB cable between the EVM and the PC and allow the PC to detect the EVM USB connection.

Once the EVM is detected, go to the firmware page and select the master and slave image files for your attached DMD EVM and program them.

3.12 Intel (Altera) FPGA Programming

Download the Intel (Altera) AN 370 Application note Using the Intel FPGA Serial Flash Loader with the Intel Quartus Prime Software and follow the instructions to program the FPGA on the EVM. Use J5 and the FPGA binary included in the DLPC900REF-SW bundle.

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This chapter describes the connector pins of the DLP LightCrafter Dual DLPC900 EVM.

4.1 Input Trigger Connectors

The input trigger connector J23 on the DLP LightCrafter Dual DLPC900 EVM pins are listed in Table 4-1. The trigger inputs have hysteresis. Two matching six-pin, 1.25-mm connector part numbers are:

- Molex part number: 51021-0600
- Digi-Key part number: WM1724-ND

The corresponding connector terminal (crimp) part numbers are:

- Molex part number: 50079-8100
- Digi-Key part number: WM2023-ND

Table 4-1. Trigger Input Connector Pins

Description	Pin	Supply Range
Trigger In 1 Supply	1	External or internal 1.8 V and 3.3 V.
Trigger In 1	2	
Ground	3	Ground
Trigger In 2 Supply	4	External or internal 1.8 V and 3.3 V.
Trigger In 2	5	
Ground	6	Ground

4.2 Output Trigger Connectors

The output trigger connector J27 on the DLP LightCrafter Dual DLPC900 EVM pins are listed in Table 4-2. Two matching six-pin, 1.25-mm connector part numbers are:

- Molex part number: 51021-0600
- Digi-Key part number: WM1724-ND

The corresponding connector terminal (crimp) part numbers are:

- Molex part number: 50079-8100
- Digi-Key part number: WM2023-ND

Table 4-2. Trigger Output Connector Pins

Description	Pin	Supply Range
Trigger Out 1 Supply	1	External or internal 1.8 V and 3.3 V.
Trigger Out 1	2	
Ground	3	Ground
Trigger Out 2 Supply	4	External or internal 1.8 V and 3.3 V.
Trigger Out 2	5	
Ground	6	Ground

4.3 DLPC900 UART

The UART output is shown in Table 4-3 and is used solely for debug message output to a terminal. The TX out is 3.3 V TTL level and requires on external transceiver to convert the TTL level signals to RS232. The connector is a 6 pin header.

Note
This header **must** be included in any design for debug purposes.

Table 4-3. UART Connector Pins

Description	Pin	Supply Range
Ground	1	0 V
RX	2	3.3 V
TX	3	3.3 V

4.4 DLPC900 I^{2}C Port 0

The I^{2}C-0 connector J14 on the DLP LightCrafter Dual DLPC900 EVM pins are shown in Table 4-4. Two matching four-pin, 1.25-mm connector part numbers are:

* Molex part number: 51021-0400
* Digi-Key part number: WM1722-ND

The corresponding terminal (crimp) part numbers are:

* Molex part number: 50079-8100
* Digi-Key part number: WM2023-ND

Table 4-4. I^{2}C Port 0 Connector Pins

Description	Pin	Supply Range
I^{2}C SCL	1	3.3 V
I^{2}C SDA	2	3.3 V
3.3 V supply	3	3.3 V
Ground	4	0 V

4.5 DLPC900 I^{2}C Port 1

The I^{2}C-1 connector J15 on the DLP LightCrafter Dual DLPC900 EVM pins are shown in Table 4-5 (see note). Two matching four-pin, 1.25-mm connector part numbers are:

* Molex part number: 51021-0400
* Digi-Key part number: WM1722-ND

The corresponding terminal (crimp) part numbers are:

* Molex part number: 50079-8100
* Digi-Key part number: WM2023-ND

Table 4-5. I^{2}C Port 1 Connector Pins

Description	Pin	Supply Range
I^{2}C SCL	1	3.3 V
I^{2}C SDA	2	3.3 V
3.3 V supply	3	3.3 V
Ground	4	0 V

4.6 DLPC900 I²C Port 2

The I²C2 connector J16 on the DLP LightCrafter Dual DLPC900 EVM pins are shown in Table 4-6. Two matching four-pin, 1.25-mm connector part numbers are:

- Molex part number: 51021-0400
- Digi-Key part number: WM1722-ND

The corresponding terminal (crimp) part numbers are:

- Molex part number: 50079-8100
- Digi-Key part number: WM2023-ND

Table 4-6. I²C Port 2 Connector Pins

Description	Pin	Supply Range
I²C SCL	1	3.3 V
I²C SDA	2	3.3 V
3.3 V supply	3	3.3 V
Ground	4	0 V

4.7 JTAG Boundary Scan

The JTAG Boundary connector J11 on the DLP LightCrafter Dual DLPC900 EVM pins are listed in Table 4-7. Two matching six-pin, 1.25-mm connector part numbers are:

- Molex part number: 51021-0600
- Digi-Key part number: WM1724-ND

The corresponding terminal (crimp) part numbers are:

- Molex part number: 50079-8100
- Digi-Key part number: WM2023-ND

Table 4-7. JTAG Boundary Scan Connector Pins

Description	Pin	Supply Range
TRST	1	3.3 V
TDI	2	3.3 V
TMS1	3	3.3 V
TDO1	4	3.3 V
TCK	5	3.3 V
Ground	6	Ground

4.8 GPIO and PWM

The GPIO and PWM connector J13 on the DLP LightCrafter Dual DLPC900 EVM pins are listed in Table 4-8. Two matching 14-pin, 2.00-mm connector part numbers are:

- Molex part number: 87832-1420
- Digi-Key part number: WM18641-ND

A corresponding mating connector part numbers are:

- Molex part number: 87568-1493
- Digi-Key part number: WM14314-ND

Table 4-8. GPIO and PWM Connector Pins

Description	Pin	Supply Range
3.3V	1	3.3 V
3.3V	2	3.3 V
GPIO_0 or PWM_0	3	3.3 V
GPIO_4	4	3.3 V
GPIO_1 or PWM_1	5	3.3 V
GPIO_5	6	3.3 V
GPIO_2 or PWM_2	7	3.3 V
GPIO_6	8	3.3 V
GPIO_3 or PWM_3	9	3.3 V
GPIO_7	10	3.3 V
GPIO_8	11	3.3 V
Ground	12	Ground
Ground	13	Ground
Ground	14	Ground

4.9 Power

The power socket J20 on the DLP LightCrafter Dual DLPC900 EVM pins are shown in Table 4-9. Two matching connector part numbers are:

- Switchcraft part number: 760
- Digi-Key part number: SC1051-ND

Table 4-9. Power Connector Pins

Description	Pin	Supply Range
Input Supply	1	12-V DC –5%/+10%
Ground	2	0 V
Ground	3	0 V

5.1 External Power Supply Requirements

The DLP LightCrafter Dual DLPC900 EVM does not include a power supply. The external power supply requirements are:

- Nominal voltage: 12-V DC -5%/+10%
- Minimum current: 0 A
- Maximum Current: 7 A
- DC connector size:
  - Inner diameter: 2.5 mm
  - Outer diameter: 5.5 mm
  - Shaft: 9.5-mm female, center positive
- A recommended power supply is Digi-Key part number 102-3811-ND, or equivalent

Note

External Power Supply Regulatory Compliance Certifications: Recommend selection and use of an external power supply which meets TI's required minimum electrical ratings in addition to complying with applicable regional product regulatory and safety certification requirements such as (by example) UL, CSA, VDE, CCC, PSE, and so forth.

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![Texas Instruments]

6.1 Caution Labels

	CAUTION
⚠️	To minimize the risk of fire or equipment damage, make sure that air is allowed to circulate freely around the DLP LightCrafter DLPC900 EVM board when operating.

	CAUTION
⚠️	The kit contains ESD-sensitive components. Handle with care to prevent permanent damage.