



ABSTRACT

The DLP5532PROJHBQ1EVM Evaluation Module (EVM) is an automotive projector designed to support high brightness transparent window display applications such as advertisement and vehicle-to-vehicle and vehicle-to-pedestrian communication. The DLP5532PROJHBQ1EVM supports proof of concept demos and speeds up the development cycle by providing a high performance projector solution complete with optics, LED light sources, and adjustable throw distance. This EVM includes a complete electronic subsystem designed to control the DLP5532-Q1 chipset. The DLP5532-Q1 chipset consists of the DLP5532-Q1, the DLPC230-Q1, and the TPS99000-Q1. This projector enables high brightness displays with a luminous flux output of 600 lumens and contrast of 600:1 in a compact package. With additional development of the LED driver board - including higher LED current support per channel and a robust thermal design - this projection engine can provide upwards of 1,000 lumens. The projection lens is designed for a throw ratio of 1.8, 100% offset, and an adjustable focus distance from 450 mm to 1000 mm.

The DLP5532PROJHBQ1EVM is not a production design. It is intended for evaluation only.



Figure 1-1. The DLP5532PROJHBQ1EVM



This design incorporates HDMI® technology.

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1 User Guide Overview

This user's guide presents an overview and general description of the DLP5532PROJHBQ1EVM and provides first steps for getting started using the EVM.

1.1 What is in the DLP5532PROJHBQ1EVM

The DLP5532PROJHBQ1EVM consists of a controller PCB, an illumination driver PCB, cables, and a USB to SPI adapter. The DLP5532PROJHBQ1EVM also includes an optical module designed to combine with the electronic subsystem for evaluation of a fully functioning projector in an automotive setting.

1.1.1 Controller PCB

The controller PCB shown in [Figure 1-1](#) includes the DLP5532-Q1 DMD, the DLPC230-Q1 DMD Controller, and the TPS99000-Q1. The controller PCB supports video inputs from either a micro HDMI or OpenLDI interface and provides the formatting and control to display the video on the DLP5532-Q1 DMD. The EVM can be controlled with either a SPI or an I²C interface. The SPI or I²C interface can also be used to reprogram the serial Flash that is used to store DLPC230-Q1 software and configuration. An optional second SPI port is provided for monitoring the TPS99000-Q1. The EVM has an external photodiode input that is used to control white point and brightness over the dimming range. An optional second photodiode input is also provided. The EVM includes a flex interface to control and monitor the illumination driver PCB. It also provides an optional interface for thermistors on the red, green and blue illuminator PCBs that can be used to monitor the temperatures of the illuminators.

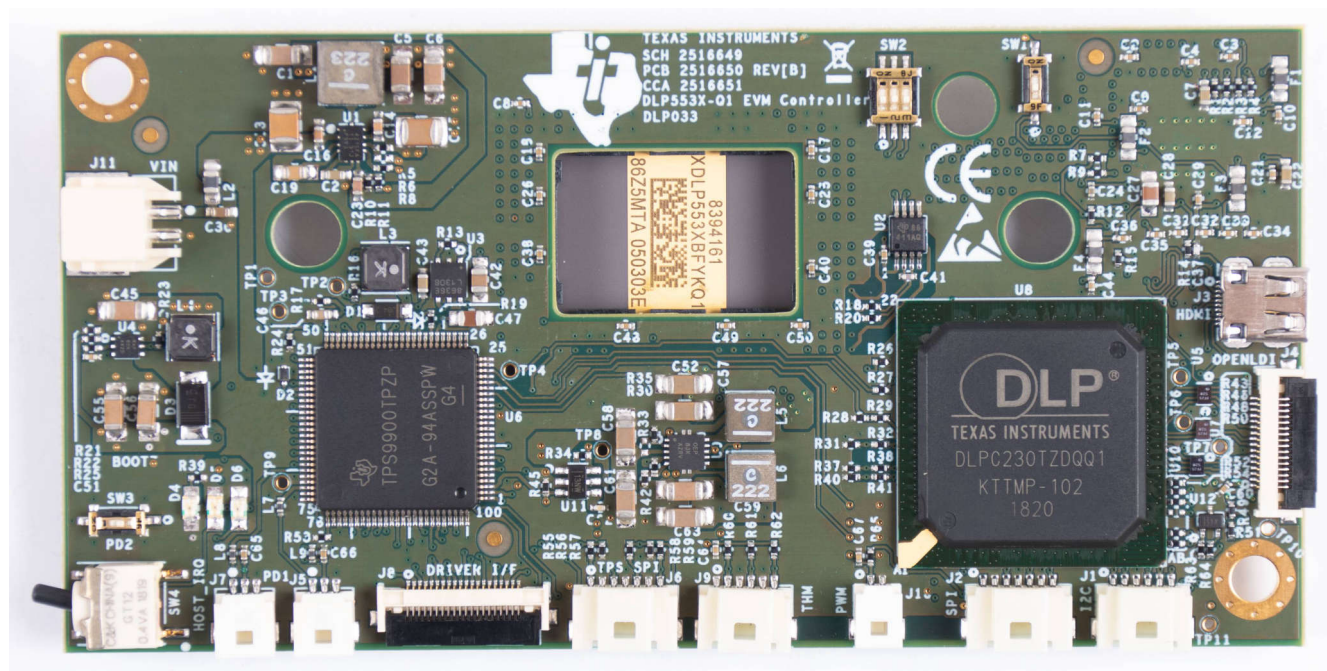


Figure 1-1. DLP5532PROJHBQ1EVM Controller PCB

The controller PCB contains the ports listed in [Table 1-1](#). Indicator LEDs are listed in [Table 1-2](#).

Table 1-1. Controller PCB Ports

Schematic Reference	Function
J1	Host I ² C, PROJ_ON, HOLD_BOOT, HOST_IRQ
J2	Host SPI
J3	Micro HDMI
J4	OpenLDI (Flex connector)
J5	Photodiode 1
J6	TPS99000-Q1 SPI Debug
J7	Photodiode 2
J8	HUD Driver Interface
J9	LED Thermistor
J10	Fan PWM output
J11	Formatter Controller Power

Table 1-2. Controller LED Indicators

Schematic Reference	Function
D4 (Green)	Input power to controller (from illumination driver) Off: No power connected On: Power connected
D5 (Green)	PROJ_ON Off: System Off On: System On
D6 (Red)	HOST_IRQ Off: Interrupt not asserted On: Interrupt asserted

The controller PCB switches are listed in [Table 1-3](#). SW4 is a toggle switch for PROJ_ON which is used to turn on and off the electronics. Note that parts of the board are still powered when PROJ_ON is in the off position. SW1, SW2 and SW3 are dip switches that control the states of configuration signals the DLPC230-Q1 reads when it comes out of reset. These switches must be set based on the desired configuration options.

Table 1-3. Controller PCB Switches

Schematic Reference / Signal Number	Function
SW1 (1)	Spread Spectrum Enable Off: Disabled On: Enabled
SW2 (1)	Host Port Checksum Select Off: CRC On: Checksum
SW2 (2)	Host Interface Select Off: Host SPI On: Host I ² C
SW2 (3)	Host SPI Mode Off: Mode 0 or 3 On: Mode 1 or 2
SW3	Hold in Boot Off: Do not hold in boot (continue to main application) On: Hold in boot
SW4	PROJ_ON Off: Turn off system On: Turn on system On state is toward the outer edge of the board (Figure 1-1)

1.1.2 Illumination Driver PCB

The illumination driver PCB shown in [Figure 1-2](#) is controlled and monitored by the controller PCB over a flex cable. Power can be input to the illumination driver from a bench top supply. The illumination driver provides reverse bias protection and supplies power to the controller PCB over a separate cable. The illumination driver PCB regulates the input power to 17 V prior to the illumination driver circuitry. The illumination driver has outputs for red, green and blue illuminators. These are typically LEDs, but it is possible other illuminators can be used. Together with the controller PCB, the illuminators are meant to be sequentially pulsed and synchronized with the operation of the DMD micromirrors. See [Electrical Specifications](#) for input and output specifications of the EVM. Depending on operating conditions, some parts and surfaces of the PCB can be hot.

CAUTION



Hot surface. Contact might cause burns. Do not touch!

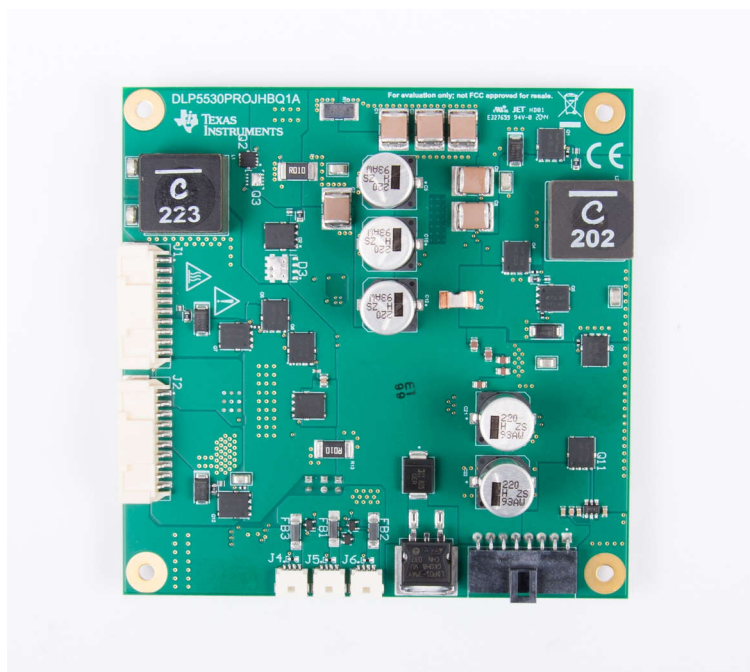


Figure 1-2. DLP5532PROJHBQ1EVM Illumination Driver PCB (Top)

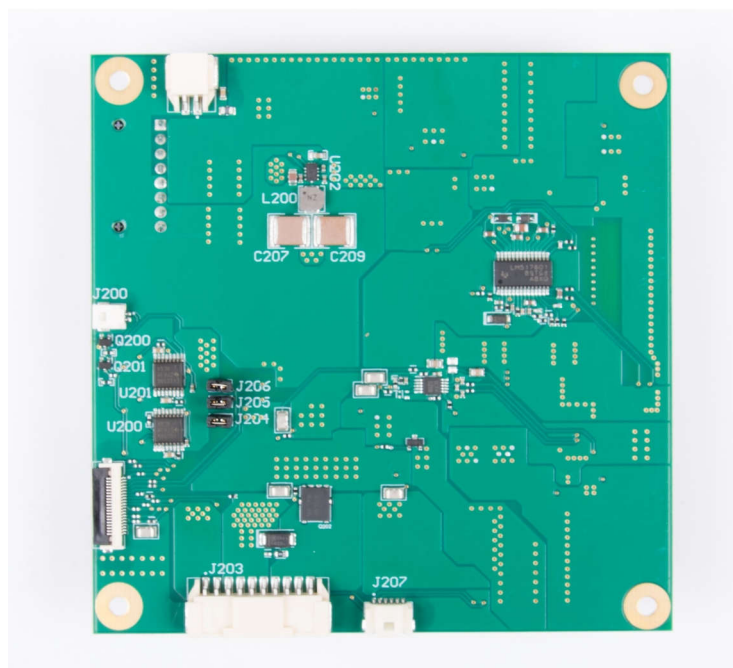


Figure 1-3. DLP5532PROJHBQ1EVM Illumination Driver PCB (Bottom)

The illumination driver PCB contains the ports listed in [Table 1-4](#). Note that all ports with the schematic reference J20# are located on the bottom of the illumination driver PCB board.

Table 1-4. Illumination Driver PCB Ports

Schematic Reference	Function
J1	Red Illumination Output - High current output up to 10 A
J2	Green Illumination Output - High current output up to 10 A
J3	Input Power
J4	Fan 1 Power Output
J5	Fan 2 Power Output
J6	Fan 3 Power Output
J200	Fan PWM from Controller
J201	Controller-Driver Control Interface
J202	Controller Power
J203	Blue Illumination Output - High current output up to 10 A
J207	Thermistors for Red, Green, and Blue LEDs

The illumination driver PCB contains the headers listed in [Table 1-5](#). These headers provide a protective feedback loop between the active cooling fans and the power regulator. In the event that one of the fans is not working or does not receive adequate input power, the feedback loop disables the power regulator and protects the illumination driver circuitry. The headers can be removed to disable the fan feedback loops if fans are not going to be used.

Table 1-5. Illumination Driver Header Pins

Header	PIN1	PIN2
J204	Fan 1 Feedback Signal	EN_UVLO
J205	Fan 2 Feedback Signal	EN_UVLO
J206	Fan 3 Feedback Signal	EN_UVLO

1.1.3 EVM Cables

The DLP5532PROJHBQ1EVM kit contains the cables and FTDI USB to SPI/I2C adapter listed in [Table 1-6](#).

Table 1-6. EVM Cables

Name	Reference	Quantity
Micro HDMI Cable	A	1
Input Power Cable	B	1
Host SPI Cable	C	1
FTDI SPI Host Adapter	D	1
Host I ² C Cable (Includes PROJ_ON, HOLD_BOOT, HOST_IRQ signals)	E	1

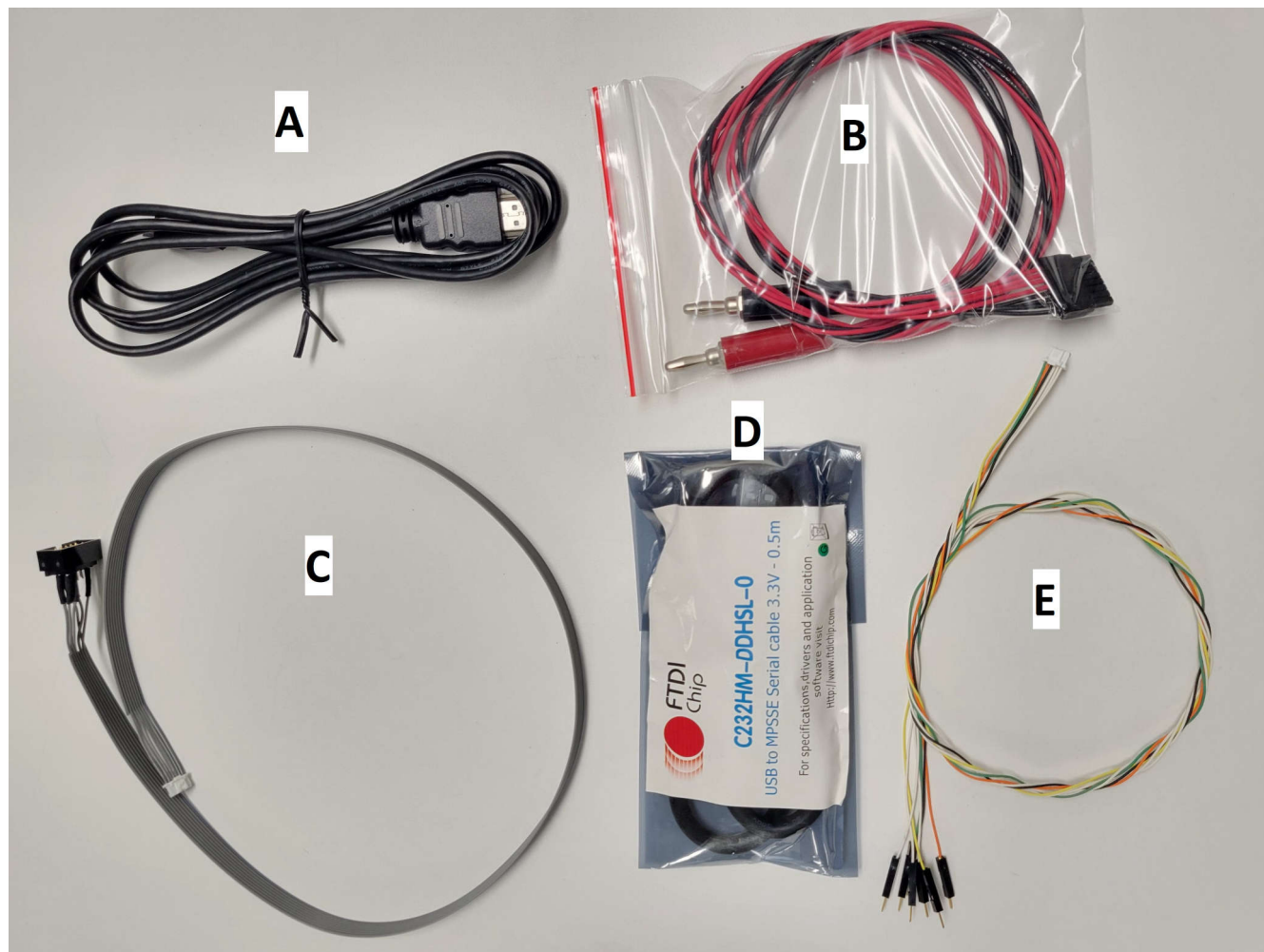


Figure 1-4. EVM Cables

1.2 Specifications

1.2.1 Electrical Specifications

Table 1-7. Electrical Specifications

Parameter	MIN	NOM	MAX	UNIT
Input				
Voltage	8	12	18	V
Power ⁽¹⁾		30	80	W
LED Pre-Regulator Output				
Voltage		17		V
Illumination Driver Output Load				
Voltage (Per LED Color Output)			17	V
Current (Per LED Color Output)			10	A
Temperature				
Operating DMD Temperature ⁽²⁾	–40		105 ⁽³⁾	°C

- (1) Conditions for maximum power: white balanced LED current up to 10 A, LED forward voltage = 12.3 V, display duty cycle = 90/10.
- (2) Care must be taken to ensure that individual components and PCB do not exceed their maximum temperature when driving high-power load.
- (3) Some components are only rated to 85°C. Refer to [Table 1-8](#) for a list of these components.

1.2.2 Component Temperature Ratings

The PCB materials and most of the PCB components are rated to operate between –40°C to 105°C, including the DLP5530-Q1, the DLPC230-Q1, and the TPS99000-Q1.

Some components on board, such as switches, connectors, and indicator LEDs, do not meet this temperature rating. The specifications for EVM components which are not rated between –40°C to 105°C are listed in [Table 1-8](#). Please refer to the EVM bill of materials to review the temperature specifications of all components used in the EVM design.

Table 1-8. EVM Components Which are Not Rated for –40°C to 105°C

Board	Reference	Part Number	Manufacturer	Description	Temperature Minimum (°C)	Temperature Maximum (°C)
Controller	D4, D5	LTST-C171KGKT	Lite-On	LED, GREEN 0805	–55	85
Controller	D6	LTST-C171KRKT	Lite-On	LED, RED 0805	–55	85
Controller	J3	685119248123	Wurth	CONN MICRO HDMI RIGHT ANGLE	–40	85
Controller	SW2	CVS-03TB	Copal Electronics Inc	SWITCH DIP SLIDE 3-POS 1 MM 6 V	–40	85
Controller	SW1,SW3	CVS-01TB	Copal Electronics Inc	SWITCH DIP SLIDE 1-POS 1 MM 6 V	–40	85
Controller	SW4	GT12MSCBE	C&K Comp	SWITCH, SPST, GULL	–30	85
Controller	U5, U7, U10, U503, U504	PCMF2HDMI2SZ	Nexperia	COMMON MODE CHOKE 4LN SMD ESD	–40	85
Controller	U501	TFP401AIPZPRQ1	Texas Instruments	IC PANELBUS DVI RCVR 100-HTQFP	–40	85

The controller and illumination driver PCBs have a UL flame rating of 130°C maximum.

This is not a production design. It is intended for evaluation only.

1.2.3 Input Video Specifications

The following input video resolutions are supported on the HDMI and OpenLDI interfaces. These input video resolutions are programmed in the Extended Display Identification Data (EDID) EEPROM for the EVM's HDMI interface allowing a connected computer to read the supported resolutions and timing. Note that some computers are not able to output all of these resolutions, in particular 576 × 288.

- 1152 × 1152
- 1152 × 576
- 576 × 288

The input source timing specified in the EVM's HDMI interface EDID are specified in [Table 1-9](#). TI also recommends these timing parameters for the OpenLDI interface.

Table 1-9. Typical Timing for Supported Source Resolutions

Horizontal Resolution	Vertical Resolution	Horizontal Blanking				Vertical Blanking				Vertical Rate (Hz)	Pixel Clock (MHz)
		Total	Sync (Pixel Clocks)	Back Porch (Pixel Clocks)	Front Porch (Pixel Clocks)	Total	Sync (Lines)	Back Porch (Lines)	Front Porch (Lines)		
1152	1152	80	8	32	40	33	8	22	3	60	87.59
1152	576	80	8	32	40	17	8	6	3	60	43.83
576	288	322	8	154	160	181	8	158	15	59.98	25.26

1.2.4 SPI and I²C Timing

For more information on SPI and I²C specifications, see the [DLPC230-Q1 Automotive DMD Controller for the DLP553x-Q1 Chipset data sheet](#).

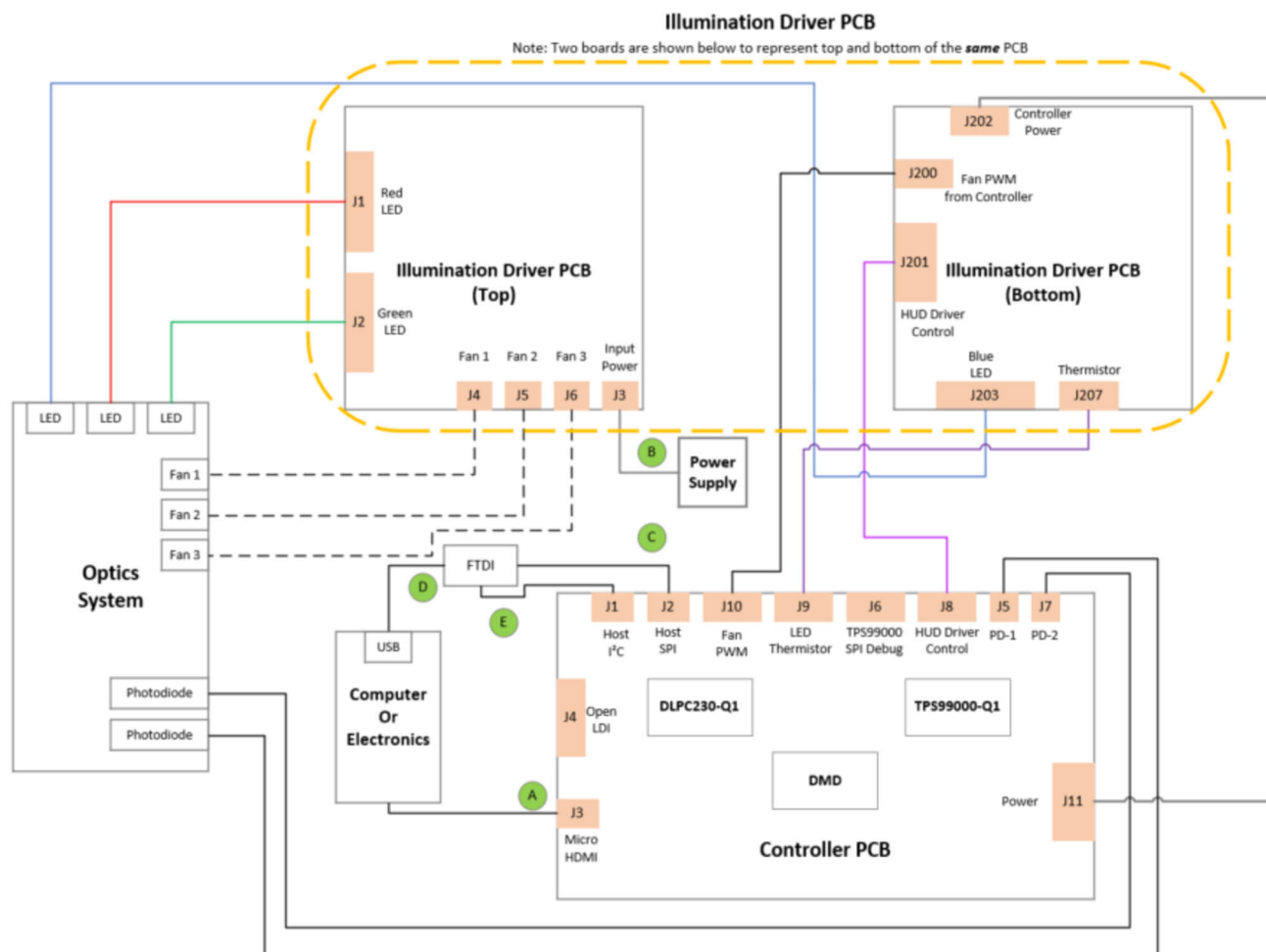
2 Quick Start

Use the following instructions to setup the DLP5532PROJHBQ1EVM and PC for video input and control communication.

2.1 Kit Assembly Instructions

A diagram of all connections is shown in [Figure 2-1](#).

1. Connect the host SPI/I2C cable to the controller PCB (J2/J1) and the FTDI adapter. Connect the FTDI adapter's USB cable to PC.
2. Connect the Micro HDMI cable to the controller PCB (J3). Connect the Micro HDMI cable to PC HDMI port.
3. Connect the power input cable to the illumination driver PCB (J3).



A. Reference letters refer to cables listed in [Table 1-6](#).

Figure 2-1. EVM Cable Connections

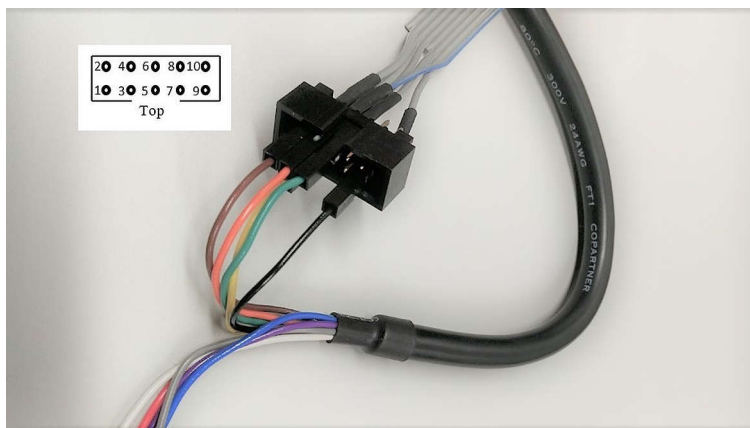


Figure 2-2. FTDI to SPI Cable Connection

For correct orientation of the numbering of leads notice that on the SPI cable there is a notch at the top. Note that there is some unused cables from the FTDI cable and unconnected pins on the SPI cable.

1. Connect brown wire of FTDI cable (Chip Select) to pin 9 of SPI cable.
2. Connect orange wire of FTDI cable (Clock) to pin 7 of SPI cable.
3. Connect green wire of FTDI cable (Serial In) to pin 5 of SPI cable.
4. Connect black wire of FTDI cable (Ground) to pin 2 of SPI cable.
5. Connect yellow wire of FTDI cable (Serial Out) to pin 8 of SPI cable.

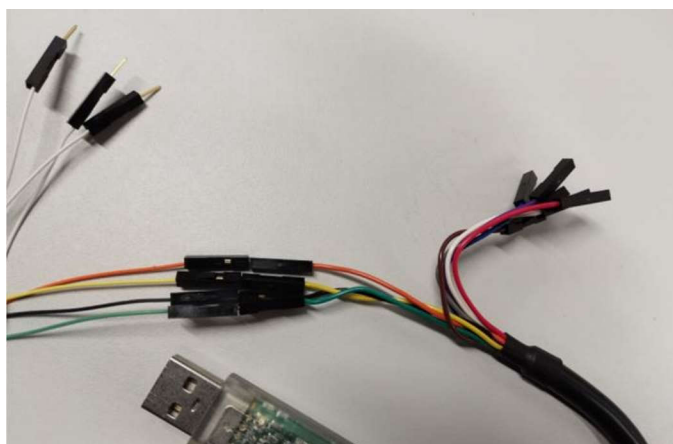


Figure 2-3. FTDI to I2C Connection

It is also possible to communicate with the EVM through I2C. Note that there is some unused cables from the FTDI cable and unused cables from the I2C cable.

1. Connect orange wire of FTDI cable (Clock) to orange wire of I2C cable.
2. Connect yellow wire of FTDI cable (Serial Out) to yellow wire of I2C cable.
3. Connect black wire of FTDI cable (Ground) to black wire of I2C cable.
4. Connect green wire of FTDI cable (Serial In) to green wire of I2C cable.

The following provide visual references for the fan cable connections involving the DLP5532PROJHBQ1EVM projector itself.

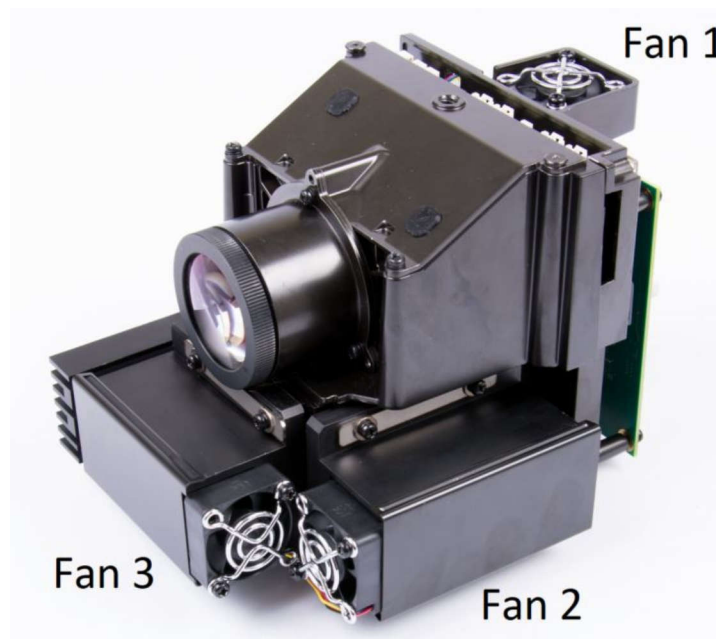
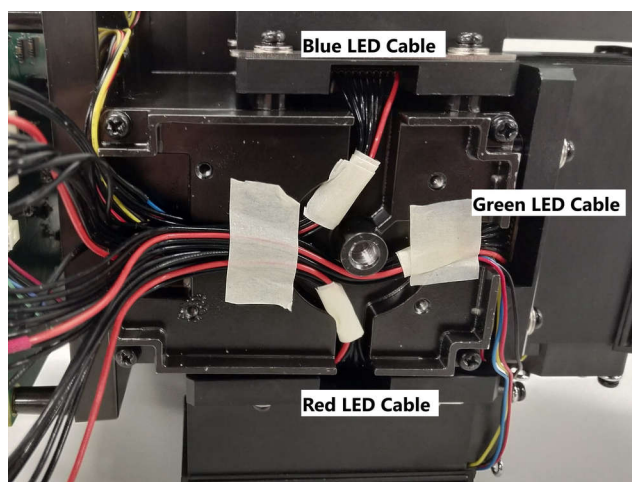


Figure 2-4. Fan Connection Cables

The following provide visual references for the LED cable connections involving the DLP5532PROJHBQ1EVM projector itself.



Note

The cables are already connected and assembled by the manufacturer. Please only disassemble if required. There is a back plate held together by four screws. The LED cables have no locking tabs and can be pulled out with force. To re-insert the LED cables, a tool like a screwdriver can be needed to push down on the connector to ensure a secure connection.

Figure 2-5. Illumination LED Connection Cables

WARNING

Please do not attempt to remove the four screws on the LED heat sinks as this impacts the alignment of the illumination system.

2.2 Software Installation

1. Download and install the [DLPC230-Q1 Control Program Lite](#) from TI.com.
2. Install [Total Phase Cheetah USB Adapter Drivers](#) from the Total Phase website.

2.3 Powering-Up EVM

1. Connect input power cable to a power supply that meets input power specifications defined in [Table 1-7](#). The red wire is the V+ terminal and black wire is the V– terminal.
2. Turn on the supply power. After powered up, a controller PCB LED indicator (D4) illuminates green.
3. Turn the PROJ_ON switch (SW4) ON. The ON position is away from the board, and OFF is toward the board. A controller PCB LED indicator (D5) illuminates green.

2.4 Connecting EVM to the DLPC230-Q1 Control Program

1. Start the DLPC230-Q1 Control Program Lite.
2. On the connection page, set the DLPC230-Q1 Host to SPI and select the Cheetah from the drop-down menu (see [Figure 2-6](#)). Note, the Cheetah must be connected to a computer with USB cable for it to show up in the drop-down menu.

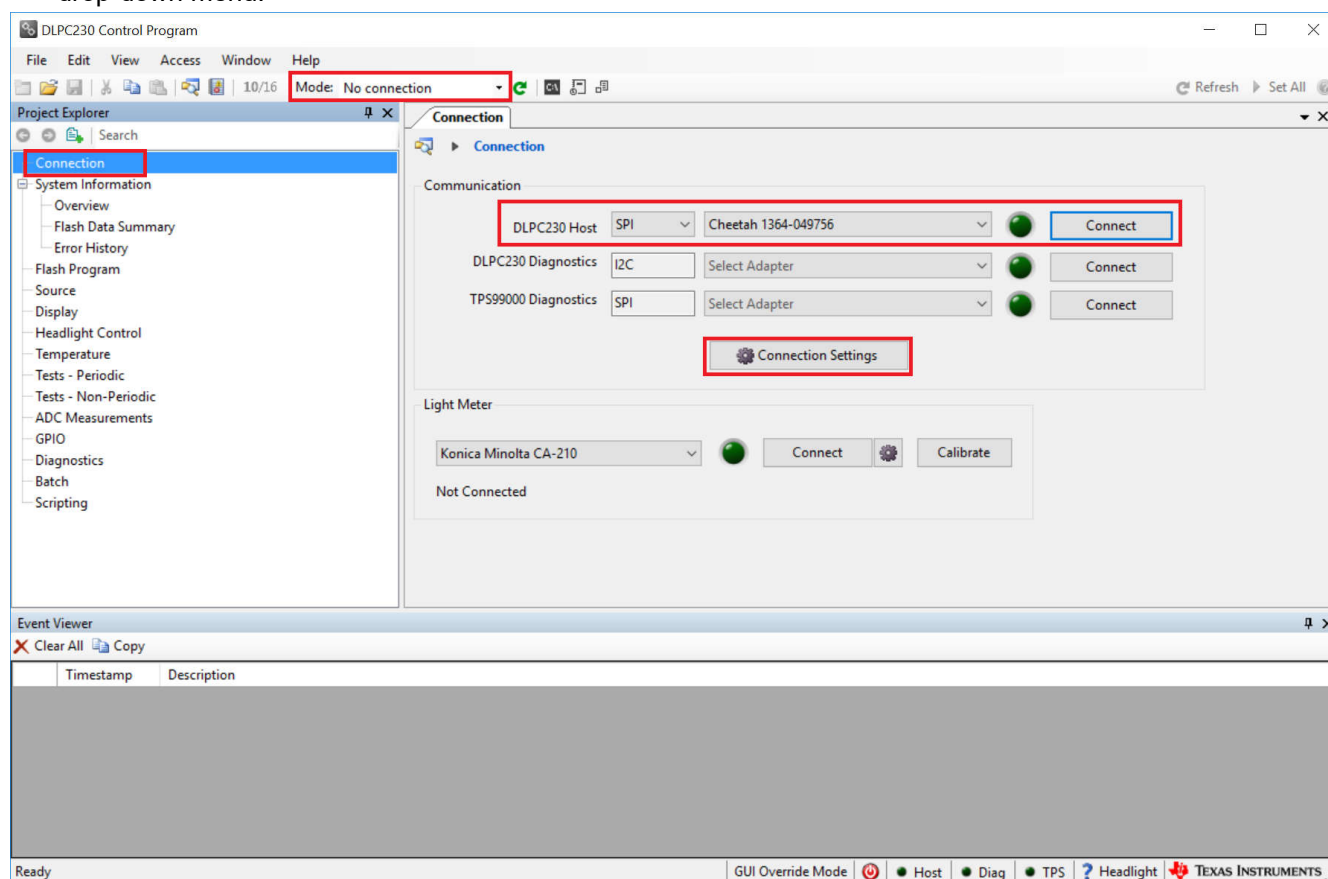


Figure 2-6. Connecting to the DLPC230-Q1 Using the DLPC230-Q1 Automotive Control Program

3. Select *Connection Settings* to confirm the SPI configuration shown in [Figure 2-7](#) matches the controller PCB switch settings described in [Table 1-3](#). Specifically, SPI mode and CRC/Checksum can vary based on switch settings. When configuration is complete, press **OK**.

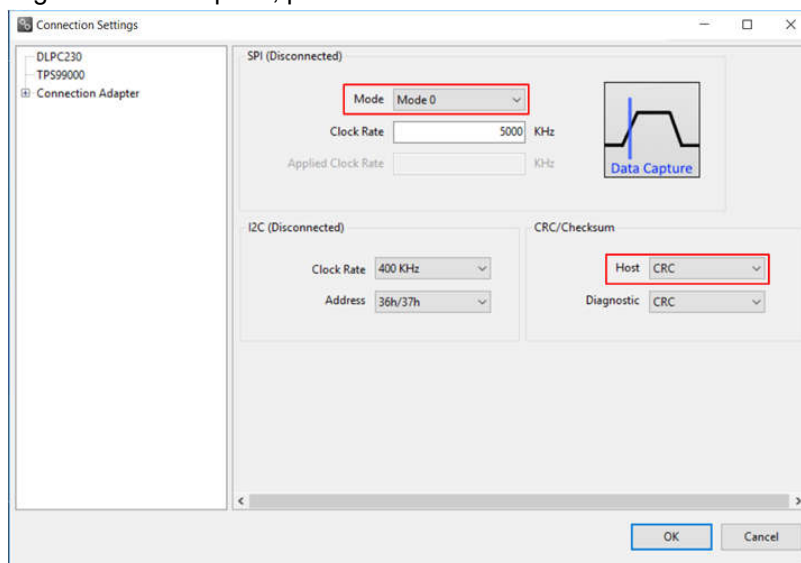


Figure 2-7. DLPC230-Q1 Automotive Control Program Communication Settings

4. Click the *Connect* button. The green circle next to the Connect button then lights up to indicate that connection was successful to the Cheetah Adapter.

2.5 Steps to Reprogram the Onboard Flash Memory

The DLP5532PROJHBQ1EVM comes with onboard serial Flash that is pre-programmed with software and basic configuration. The software and configuration can be updated by reprogramming the serial Flash with the DLPC230-Q1 Automotive Control Program. Steps to re-program the serial Flash are listed below.

1. Using the DLPC230-Q1 Automotive Control Program, that is connected to the EVM, navigate to the *Flash Program* tab.
2. Navigate to the *Read Flash* sub tab and select *entire flash* content to be saved to a local storage location. (Note that this step is optional but highly recommended to save the current flash content as a backup.
3. Navigate back to the *Program Flash* sub tab and using the folder icon, select an Image File (.bin) and open it.
4. Click *Program and Verify Flash Memory*.

Note that if the device is in Display mode, it is automatically be switched to Standby during programming.

3 Optical Engine Requirements and Specifications

The DLP5532PROJHBQ1EVM includes an optical projection system that can be used for transparent window display applications. The optical specifications are listed in [Table 3-1](#).

Table 3-1. Optical Module Specifications

Parameter	MIN	NOM	MAX	UNIT
Luminous flux output		600	1000*	lm
Throw ratio		1.8		
Throw distance	450	750	1000	mm
Image width	250	417	556	mm
f/#		1.8		
MTF	42%		72%	
Optical image offset		100%		
Light uniformity		62%		
FOFO contrast		600:1		

* Note: To achieve 1000 lumens, the LED driver PCB may need to be optimized to support higher currents per color channel, and the thermal robustness of the PCB must be considered as well.

Table 3-2. Included LEDs

Color	Manufacturer	Part Number
Red	Luminus	PTM-50X-RA
Green	Luminus	PTM-50X Converted Green
Blue	Luminus	PTM-50X Blue



CAUTION

Possibly hazardous optical radiation emitted from this product. Do not stare at operating lamp. Can be harmful to the eye.

4 Revision History

NOTE: Page numbers for previous revisions may differ from page numbers in the current version.

Changes from May 30, 2022 to October 31, 2025 (from Revision * (May 2022) to Revision A (October 2025))

	Page
• Added HDMI trademark information.....	3

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