



ABSTRACT

The DLP5534PROJQ1 Evaluation Module (EVM) is a complete electronic and optical 405 nm projector utilizing the DLP5534-Q1 chipset. The DLP5534-Q1 chipset consists of the DLP5534-Q1, the DLPC230-Q1, and the TPS99000-Q1. Electronics with the DLP5534-Q1 chipset is combined with illumination and projection optics and a 405 nm LED to make an automotive grade projector for applications such as transparent window display utilizing phosphor film(s) embedded in a window.

The DLP5534PROJQ1 EVM is not a production design. It is intended for evaluation only.



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 DLP5534PROJQ1 EVM and provides first steps for getting started using the EVM.

1.1 What is in the DLP5534PROJQ1 EVM

The DLP5534PROJQ1 EVM integrates the contents of the DLP5534Q1 electronics EVM with 405 nm illumination and projection optics to produce a complete projector shown in [Figure 1-1](#). The projector utilizes a Luminus CBM-25X-UV 405 nm LED to produce a very bright 405 nm projector. A heatsink and fans are provided for cooling of the LED and electronics.



Figure 1-1. DLP5534PROJQ1EVM Projector

The DLP5534Q1 electronics EVM that is integrated into the projector consists of a Controller PCB, an Illumination Driver PCB, cables, and a USB to SPI adapter.

1.1.1 Controller PCB

The Controller PCB shown in [Figure 1-2](#) includes the DLP5534-Q1 DMD, the DLPC230-Q1 DMD Controller, and the TPS99000-Q1. It supports video inputs from either a micro HDMI or OpenLDI interface and provides the formatting and control to display the video on the DLP5534-Q1 DMD. The EVM can be controlled with either an SPI or 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 includes a flex interface to control the Illumination Driver PCB. The EVM has external photodiode inputs and thermistor inputs which are not used for this application.

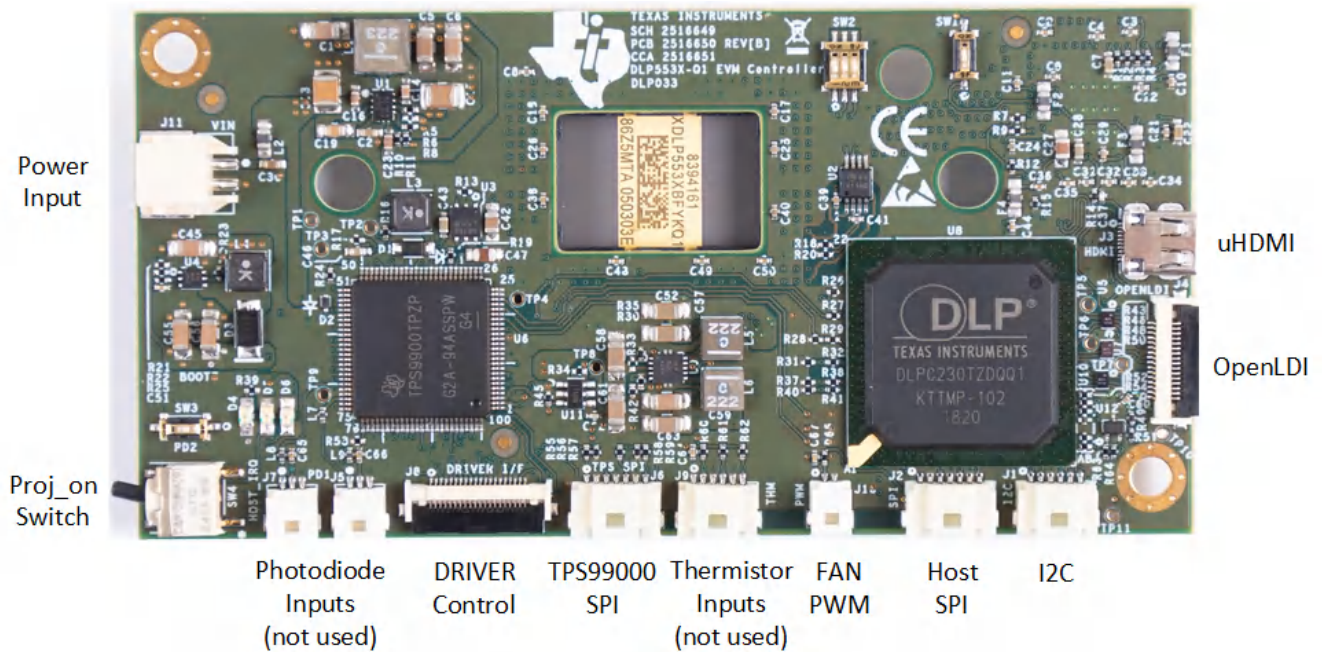


Figure 1-2. EVM Controller PCB

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 ⁽¹⁾
J6	TPS99000-Q1 SPI Debug
J7	Photodiode 2 ⁽¹⁾
J8	LED Driver Interface
J9	LED Thermistor ⁽¹⁾
J10	Fan PWM output (optional)
J11	Controller Power

(1) Port unused for this application. Cable not provided.

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 should 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 closest corner of the board Figure 1-2

1.1.2 Illumination Driver PCB

The Illumination Driver PCB shown in [Figure 1-3](#) is controlled by the Controller PCB over a flex cable. Power can be input to the Illumination Driver from a lab supply. The Illumination driver provides reverse bias protection and supplies power to the Controller PCB over a separate cable. The Illumination Driver has outputs for one to three illuminators. These are typically LEDs, but it is possible other illuminators could be used. See [Section 1.2.2](#) 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 may cause burns. Do not touch!

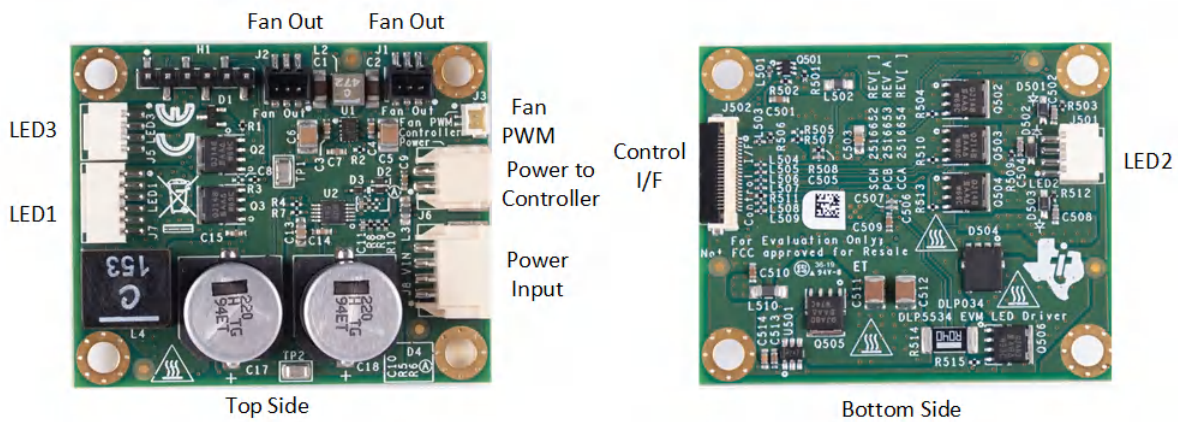


Figure 1-3. EVM Illumination Driver PCB

The Illumination Driver PCB contains the ports listed in [Table 1-4](#).

Table 1-4. Illumination Driver PCB Ports

SCHEMATIC REFERENCE	FUNCTION
J1	Fan Output
J2	Fan Output
J3	Fan PWM Input
J5	LED3 Illuminator Output (Not used)
J6	Controller Power
J7	LED1 Illumination Output
J8	Input Power
J501	LED2 Illumination Output (Not used)
J502	Controller to Driver Control Interface

1.1.3 EVM Cables

The EVM cables and Cheetah USB to SPI adapter are listed in [Table 1-5](#) and shown in [Figure 1-4](#).



Figure 1-4. EVM Cables

Table 1-5. EVM Cables

NAME	REFERENCE	QUANTITY
Cheetah™ SPI Host Adapter	A	1
Host SPI Cable	B	1
Host I ² C Cable (Includes PROJ_ON, HOLD_BOOT, HOST_IRQ signals)	C	1
Driver to Controller Power Cable	D	1
Input Power Cable	E	1
LED1 Illuminator Power Cable	F	1
LED2 Illuminator Power Cable	G	1
LED3 Illuminator Power Cable	H	1
Fan PWM	I	1
Controller to Driver Control Flex	J	1
OpenLDI Flex Cable	K	1
Micro HDMI Cable	L	1

1.2 Specifications


1.2.1 Optical Specifications

The DLP5534PROJQ1 EVM utilizes the Luminus CBM-25X-UV 405 nm LED. Optical specifications for the projector are listed in [Table 1-6](#). The optics are optimized for high brightness. If higher contrast is desired the optics can be designed for a higher $f/\#$ with some loss of brightness.

Table 1-6. Optical Specifications

PARAMETER	MIN	NOM	MAX	UNIT
Optical Output Power		2.7		W
LED Center Wavelength		405		nm
$f/\#$		2.0		
Throw Ratio (Distance/Width)		2.5		
Focus Range (Distance)	300		900	mm
Optical Offset		120%		
Contrast (Full on/off)		950:1		

WARNING



Eye or skin irritation may result from exposure. Use appropriate shielding. Do not look at the operating lamp. Eye injury may result.

1.2.2 Electrical Specifications

Table 1-7. Electrical Specifications

PARAMETER	MIN	NOM	MAX	UNIT
Input				
Voltage (Input voltage must be ~10 V or higher for maximum projector brightness)	8	12	18	V
Input Current ⁽¹⁾			3.9	A
Input Power ⁽¹⁾			42	W
Illumination Driver Output Load				
Voltage			9	V
Current			4	A RMS
Fan Output				
Voltage		5		V
Current (total for all fans)			0.5	A
Temperature				
Operating DMD Temperature	-40		105	°C
Projector Ambient Temperature ^{(1) (2) (3)}	-40		70	°C

- (1) 98/2 duty cycle, 4 A RMS current to LED, Fans at 100%.
- (2) Operation at higher ambient temperatures is possible at lower LED output power.
- (3) Some components are only rated to 85°C. Refer to [Table 1-8](#) for a list of these components.

1.2.3 Component Temperature Ratings

The PCB materials and most of the PCB components are rated to operate between -40°C to 105°C, including the DLP5534-Q1, the DLPC230-Q1, and the TPS99000-Q1.

Some components on PCBs, 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 PCB Components Which are Not Rated for -40°C to 105°C

Board	Reference	Part Number	Manufacturer	Description	Temperature Minimum ($^{\circ}\text{C}$)	Temperature Maximum ($^{\circ}\text{C}$)
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	Würth	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	GT12MSABETR	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.

1.2.4 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 may not be able to output all of these resolutions, in particular 576×288 .

- 1152×1152
- 1152×576
- 576×288

The recommended input source timings for the EVM's HDMI interface are specified in the DLPC230-Q1 data sheet. These timing parameters are also recommended for the OpenLDI interface.

1.2.5 SPI and I²C Timing

For more information on SPI and I²C specifications, see the DLPC230-Q1 data sheet.

2 Quick Start

Use the following instructions to setup your DLP5534PROJQ1 EVM and PC.

2.1 Kit Assembly Instructions

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

1. Connect the Micro HDMI cable to the Controller Board (J3). Connect the Micro HDMI cable to PC HDMI port.
2. Connect the Power Input cable to the Illumination Driver Board (J8).

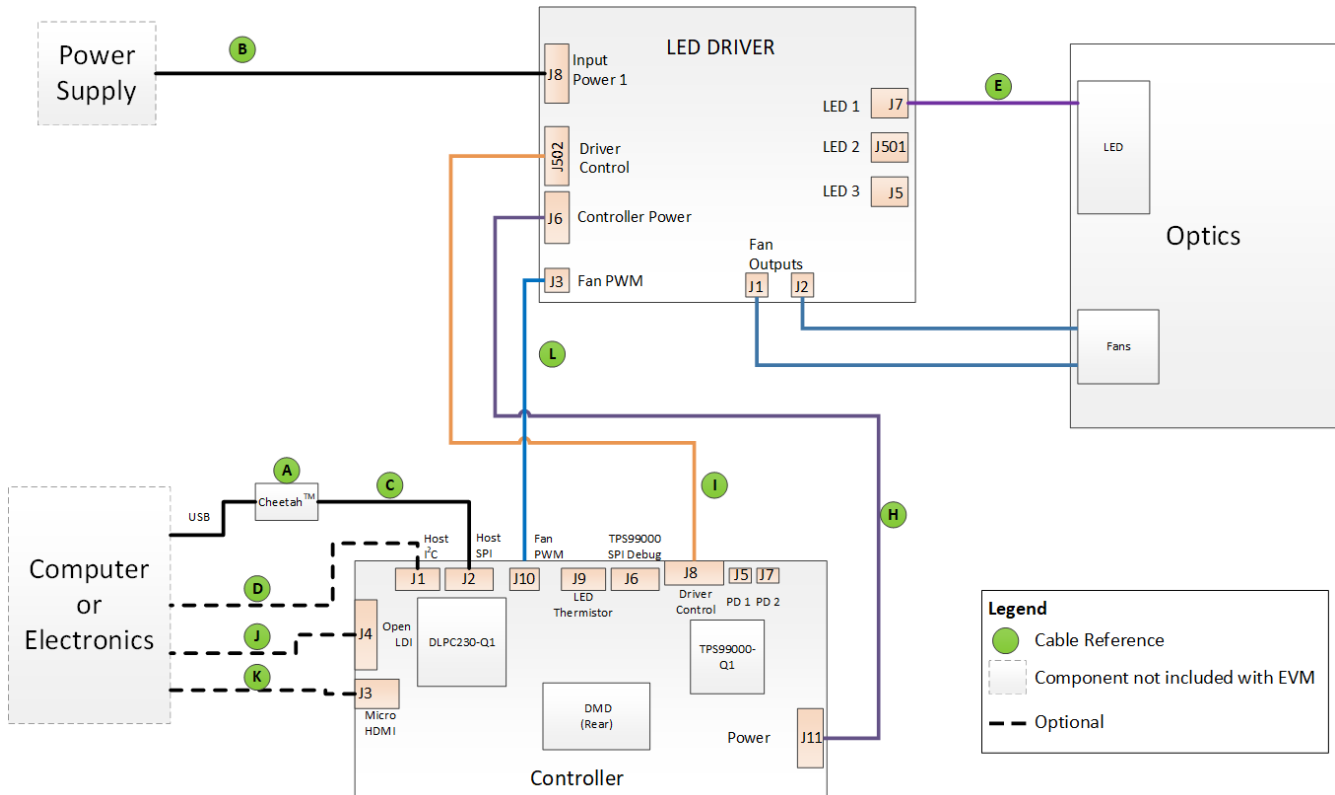


Figure 2-1. EVM Cable Connections

2.2 Software Installation

1. Install the DLPC230-Q1 Control Program (<http://www.ti.com/mysecuresoftware>).
2. Install Total Phase Cheetah USB adapter drivers (<https://www.totalphase.com/products/usb-drivers-windows>).

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. Once powered up, a Controller PCB LED indicator (D4) should illuminate green.
3. Turn the PROJ_ON switch (SW4) ON. The ON position is towards the closest corner of the board. A Controller PCB LED indicator (D5) should illuminate green. It is also acceptable to leave the PROJ_ON switch in the ON position when powering on and off.

2.4 Connecting EVM to the DLPC230-Q1 Control Program

1. Start the DLPC230-Q1 Control Program.

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

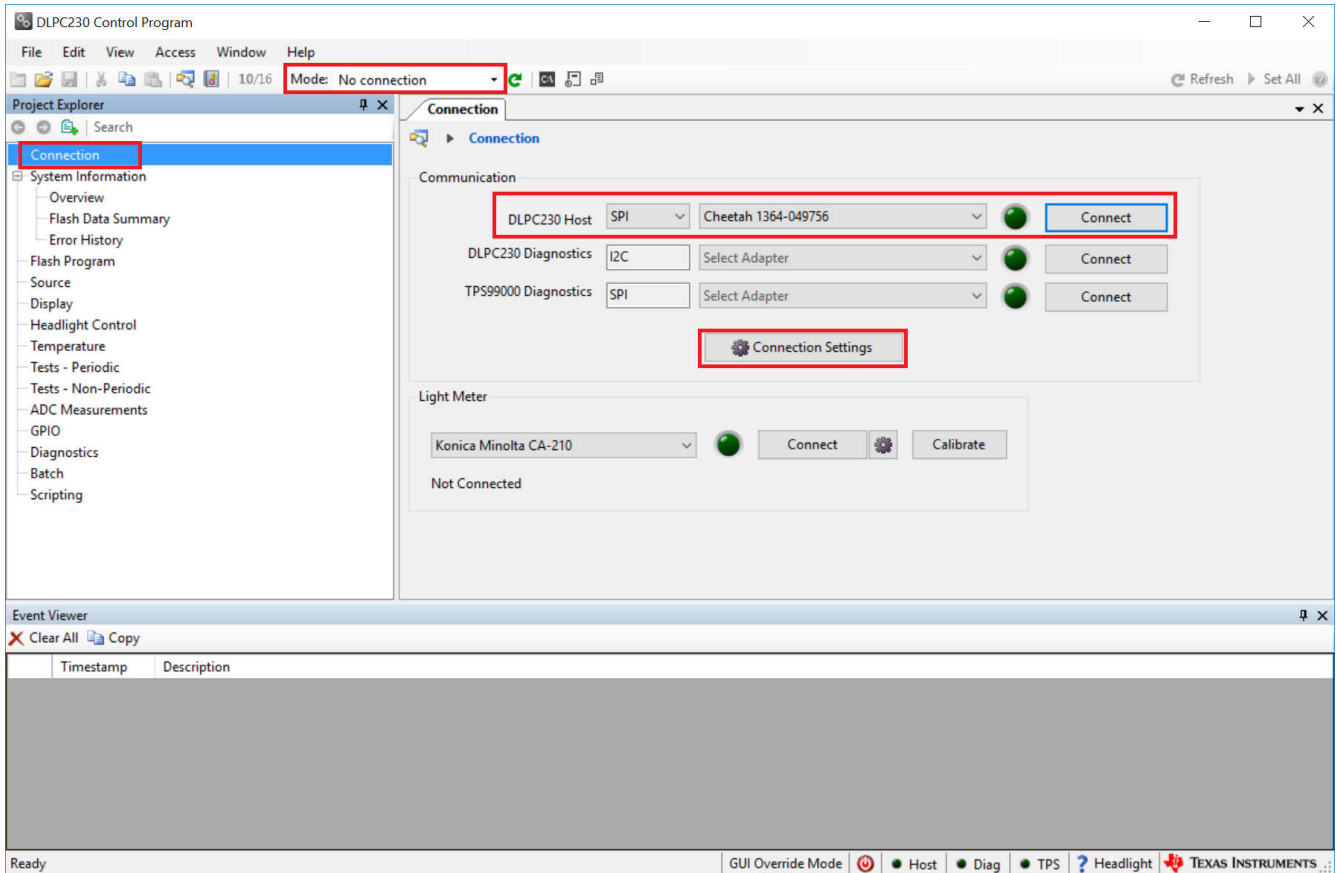


Figure 2-2. Connecting to the DLPC230-Q1 Using the DLPC230-Q1 Automotive Control Program

- Select "Connection Settings" to confirm the SPI configuration shown in [Figure 2-3](#) matches the Controller PCB switch settings described in [Table 1-3](#). Specifically, SPI mode and CRC/Checksum may vary based on switch settings. Press "OK" once configuration is complete.

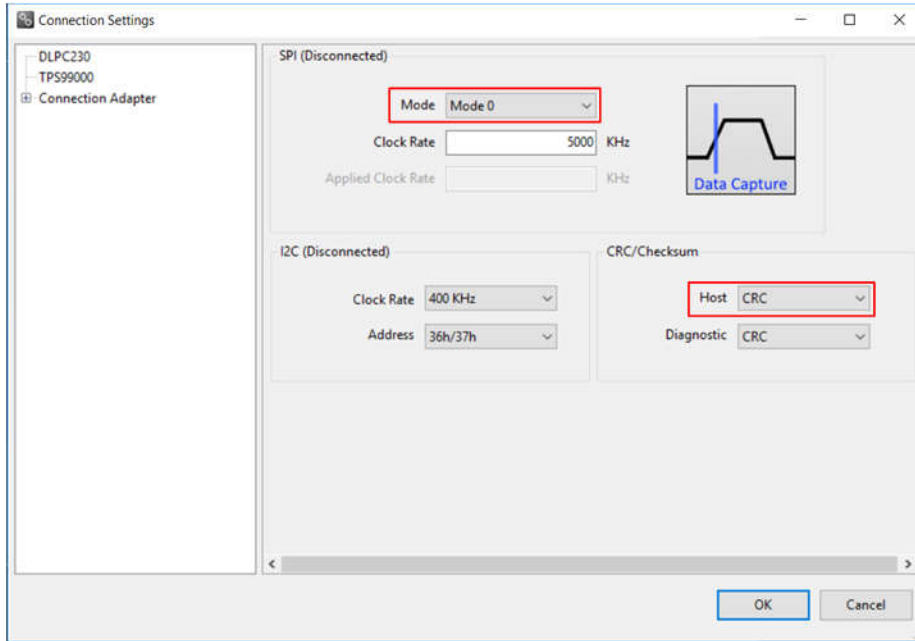


Figure 2-3. DLPC230-Q1 Automotive Control Program Communication Settings

- Click the Connect button. The green circle next to the Connect button should then light up to indicate that connection was successful to the Cheetah Adapter.

2.5 Steps to Reprogram the Onboard Flash Memory

The DLP5534PROJQ1 EVM 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.

- Using the DLPC230-Q1 Automotive Control Program, which is connected to the EVM, navigate to the "Flash Program" tab.
- Using the folder icon, select an Image File (.bin) and open it.
- Click "Program and Verify Flash Memory."

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

3 Revision History

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

Changes from November 30, 2019 to October 31, 2025 (from Revision * (November 2019) to Revision A (October 2025))

	Page
• Added HDMI trademark information.....	1

STANDARD TERMS FOR EVALUATION MODULES

1. *Delivery:* TI delivers TI evaluation boards, kits, or modules, including any accompanying demonstration software, components, and/or documentation which may be provided together or separately (collectively, an "EVM" or "EVMs") to the User ("User") in accordance with the terms set forth herein. User's acceptance of the EVM is expressly subject to the following terms.
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 - 2.1 These terms do not apply to Software. The warranty, if any, for Software is covered in the applicable Software License Agreement.
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 - 2.3 TI's sole liability shall be at its option to repair or replace EVMs that fail to conform to the warranty set forth above, or credit User's account for such EVM. TI's liability under this warranty shall be limited to EVMs that are returned during the warranty period to the address designated by TI and that are determined by TI not to conform to such warranty. If TI elects to repair or replace such EVM, TI shall have a reasonable time to repair such EVM or provide replacements. Repaired EVMs shall be warranted for the remainder of the original warranty period. Replaced EVMs shall be warranted for a new full ninety (90) day warranty period.

WARNING

Evaluation Kits are intended solely for use by technically qualified, professional electronics experts who are familiar with the dangers and application risks associated with handling electrical mechanical components, systems, and subsystems.

User shall operate the Evaluation Kit within TI's recommended guidelines and any applicable legal or environmental requirements as well as reasonable and customary safeguards. Failure to set up and/or operate the Evaluation Kit within TI's recommended guidelines may result in personal injury or death or property damage. Proper set up entails following TI's instructions for electrical ratings of interface circuits such as input, output and electrical loads.

NOTE:

EXPOSURE TO ELECTROSTATIC DISCHARGE (ESD) MAY CAUSE DEGRADATION OR FAILURE OF THE EVALUATION KIT; TI RECOMMENDS STORAGE OF THE EVALUATION KIT IN A PROTECTIVE ESD BAG.

3 Regulatory Notices:

3.1 United States

3.1.1 Notice applicable to EVMs not FCC-Approved:

FCC NOTICE: This kit is designed to allow product developers to evaluate electronic components, circuitry, or software associated with the kit to determine whether to incorporate such items in a finished product and software developers to write software applications for use with the end product. This kit is not a finished product and when assembled may not be resold or otherwise marketed unless all required FCC equipment authorizations are first obtained. Operation is subject to the condition that this product not cause harmful interference to licensed radio stations and that this product accept harmful interference. Unless the assembled kit is designed to operate under part 15, part 18 or part 95 of this chapter, the operator of the kit must operate under the authority of an FCC license holder or must secure an experimental authorization under part 5 of this chapter.

3.1.2 For EVMs annotated as FCC – FEDERAL COMMUNICATIONS COMMISSION Part 15 Compliant:

CAUTION

This device complies with part 15 of the FCC Rules. Operation is subject to the following two conditions: (1) This device may not cause harmful interference, and (2) this device must accept any interference received, including interference that may cause undesired operation.

Changes or modifications not expressly approved by the party responsible for compliance could void the user's authority to operate the equipment.

FCC Interference Statement for Class A EVM devices

NOTE: This equipment has been tested and found to comply with the limits for a Class A digital device, pursuant to part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference when the equipment is operated in a commercial environment. This equipment generates, uses, and can radiate radio frequency energy and, if not installed and used in accordance with the instruction manual, may cause harmful interference to radio communications. Operation of this equipment in a residential area is likely to cause harmful interference in which case the user will be required to correct the interference at his own expense.

FCC Interference Statement for Class B EVM devices

NOTE: This equipment has been tested and found to comply with the limits for a Class B digital device, pursuant to part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference in a residential installation. This equipment generates, uses and can radiate radio frequency energy and, if not installed and used in accordance with the instructions, may cause harmful interference to radio communications. However, there is no guarantee that interference will not occur in a particular installation. If this equipment does cause harmful interference to radio or television reception, which can be determined by turning the equipment off and on, the user is encouraged to try to correct the interference by one or more of the following measures:

- Reorient or relocate the receiving antenna.
- Increase the separation between the equipment and receiver.
- Connect the equipment into an outlet on a circuit different from that to which the receiver is connected.
- Consult the dealer or an experienced radio/TV technician for help.

3.2 Canada

3.2.1 For EVMs issued with an Industry Canada Certificate of Conformance to RSS-210 or RSS-247

Concerning EVMs Including Radio Transmitters:

This device complies with Industry Canada license-exempt RSSs. Operation is subject to the following two conditions:

(1) this device may not cause interference, and (2) this device must accept any interference, including interference that may cause undesired operation of the device.

Concernant les EVMs avec appareils radio:

Le présent appareil est conforme aux CNR d'Industrie Canada applicables aux appareils radio exempts de licence. L'exploitation est autorisée aux deux conditions suivantes: (1) l'appareil ne doit pas produire de brouillage, et (2) l'utilisateur de l'appareil doit accepter tout brouillage radioélectrique subi, même si le brouillage est susceptible d'en compromettre le fonctionnement.

Concerning EVMs Including Detachable Antennas:

Under Industry Canada regulations, this radio transmitter may only operate using an antenna of a type and maximum (or lesser) gain approved for the transmitter by Industry Canada. To reduce potential radio interference to other users, the antenna type and its gain should be so chosen that the equivalent isotropically radiated power (e.i.r.p.) is not more than that necessary for successful communication. This radio transmitter has been approved by Industry Canada to operate with the antenna types listed in the user guide with the maximum permissible gain and required antenna impedance for each antenna type indicated. Antenna types not included in this list, having a gain greater than the maximum gain indicated for that type, are strictly prohibited for use with this device.

Concernant les EVMs avec antennes détachables

Conformément à la réglementation d'Industrie Canada, le présent émetteur radio peut fonctionner avec une antenne d'un type et d'un gain maximal (ou inférieur) approuvé pour l'émetteur par Industrie Canada. Dans le but de réduire les risques de brouillage radioélectrique à l'intention des autres utilisateurs, il faut choisir le type d'antenne et son gain de sorte que la puissance isotrope rayonnée équivalente (p.i.r.e.) ne dépasse pas l'intensité nécessaire à l'établissement d'une communication satisfaisante. Le présent émetteur radio a été approuvé par Industrie Canada pour fonctionner avec les types d'antenne énumérés dans le manuel d'usage et ayant un gain admissible maximal et l'impédance requise pour chaque type d'antenne. Les types d'antenne non inclus dans cette liste, ou dont le gain est supérieur au gain maximal indiqué, sont strictement interdits pour l'exploitation de l'émetteur.

3.3 Japan

3.3.1 *Notice for EVMs delivered in Japan:* Please see http://www.tij.co.jp/lstds/ti_ja/general/eStore/notice_01.page 日本国内に輸入される評価用キット、ボードについては、次のところをご覧ください。

<https://www.ti.com/ja-jp/legal/notice-for-evaluation-kits-delivered-in-japan.html>

3.3.2 *Notice for Users of EVMs Considered "Radio Frequency Products" in Japan:* EVMs entering Japan may not be certified by TI as conforming to Technical Regulations of Radio Law of Japan.

If User uses EVMs in Japan, not certified to Technical Regulations of Radio Law of Japan, User is required to follow the instructions set forth by Radio Law of Japan, which includes, but is not limited to, the instructions below with respect to EVMs (which for the avoidance of doubt are stated strictly for convenience and should be verified by User):

1. Use EVMs in a shielded room or any other test facility as defined in the notification #173 issued by Ministry of Internal Affairs and Communications on March 28, 2006, based on Sub-section 1.1 of Article 6 of the Ministry's Rule for Enforcement of Radio Law of Japan,
2. Use EVMs only after User obtains the license of Test Radio Station as provided in Radio Law of Japan with respect to EVMs, or
3. Use of EVMs only after User obtains the Technical Regulations Conformity Certification as provided in Radio Law of Japan with respect to EVMs. Also, do not transfer EVMs, unless User gives the same notice above to the transferee. Please note that if User does not follow the instructions above, User will be subject to penalties of Radio Law of Japan.

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3.3.3 *Notice for EVMs for Power Line Communication:* Please see http://www.tij.co.jp/lstds/ti_ja/general/eStore/notice_02.page

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3.4 European Union

3.4.1 *For EVMs subject to EU Directive 2014/30/EU (Electromagnetic Compatibility Directive):*

This is a class A product intended for use in environments other than domestic environments that are connected to a low-voltage power-supply network that supplies buildings used for domestic purposes. In a domestic environment this product may cause radio interference in which case the user may be required to take adequate measures.

-
- 4 *EVM Use Restrictions and Warnings:*
 - 4.1 EVMS ARE NOT FOR USE IN FUNCTIONAL SAFETY AND/OR SAFETY CRITICAL EVALUATIONS, INCLUDING BUT NOT LIMITED TO EVALUATIONS OF LIFE SUPPORT APPLICATIONS.
 - 4.2 User must read and apply the user guide and other available documentation provided by TI regarding the EVM prior to handling or using the EVM, including without limitation any warning or restriction notices. The notices contain important safety information related to, for example, temperatures and voltages.
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