TI Designs
Compact Full HD 1080p (up to 16 Amps) Projection Display Reference Design using DLP® Pico™ Technology

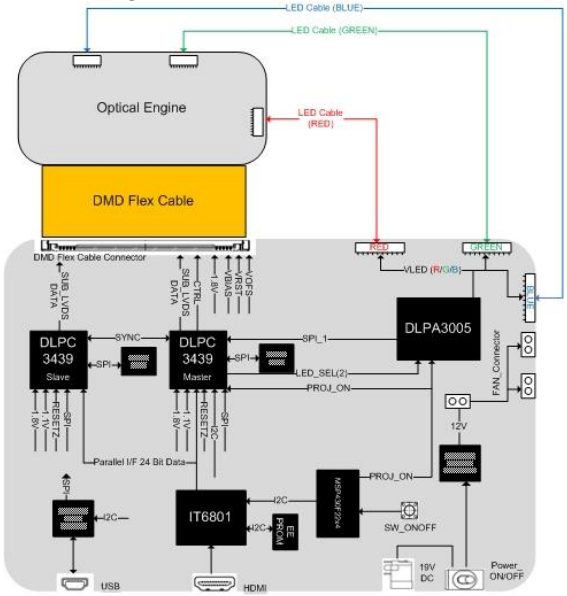
Design Overview

This reference design, featuring the DLP® Pico™ 0.47-inch TRP Full-HD 1080p display chipset and implemented in the DLP LightCrafter Display 4710 G2 evaluation module (EVM), enables use of full HD resolution for projection display applications such as accessory projectors, screenless displays, interactive displays, wearables (including head mounted displays), signage, industrial and medical displays. The chipset used in the design is comprised of the DLP4710 (.47 1080p) DMD, the DLPC3439 display controller and the DLPA3005 PMIC/LED driver

Design Resources

TIDA-01226	Design Folder
DLPC3439	Product Folder
DLP4710	Product Folder
DLPA3005	Product Folder
TIDA-00576	Tools Folder

Block Diagram



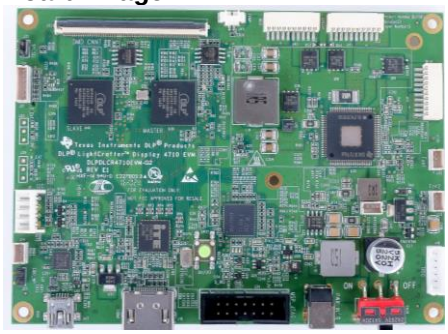
Design Features

- 1920 x 1080 resolution
- Brightness: **600** RGB lumens @ 16A LED current
- RGB LED-illuminated optical module
- Driver board includes DLC3439 controllers, DLPA3005 PMIC/LED driver
- System board includes HDMI and USB connectivity
- PC software GUI to customize display configurations

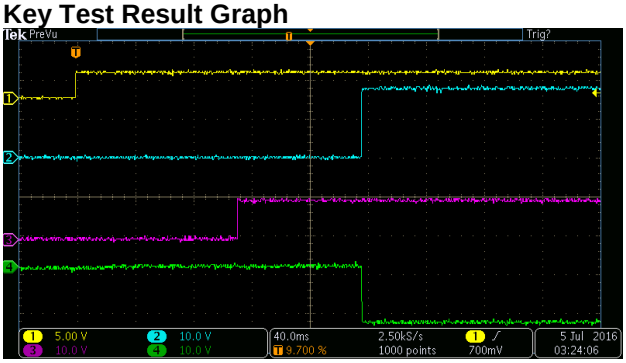
Featured Applications

- Screenless TV (mobile smart TV)
- Portable home cinema / business projector
- Low latency gaming display
- Digital signage
- Interactive surface display for retail, restaurant, or gaming applications

Board Image



Key Test Result Graph



1 Key System Specifications

The DLP LightCrafter Display module consists of three subsystems:

1. Light engine – includes the optics, red, green, blue LEDs and a 1920 x 1080 (1080p) DMD capable of 600 lumens out-of-the-box.

Parameter	Min	Typ.	Max	Unit
Brightness @ Red 12A / Green 16A / Blue 16A LED current		600		Lum
Red LED Current		12		A
Green / Blue LED Current		16		A
Brightness Uniformity	73			%
Offset		100		%
Focus Range (Wide)	40		120	inch
Image diagonal size	40		100	inch

Figure 1: Optical engine specification

2. DLP Driver – includes the DLP chipset comprising of DLPC3439 Controller and DLPA3005 PMIC/LED driver with up to 16A LED current.
3. System front end – includes MSP430, ITE HDMI receiver, USB-Serial Bridge Controller and several connectors for external inputs (HDMI, USB, etc.)

2 System Description

2.1 DLPC3439

The 2x DLPC3439 digital controllers, part of the DLP4710 (.47 1080p) chipset, supports reliable operation of the DLP4710 digital micromirror device (DMD). The DLPC3439 controller provides a convenient, multi-functional interface between system electronics and the DMD, enabling small form factor, low power, and high resolution full HD displays.

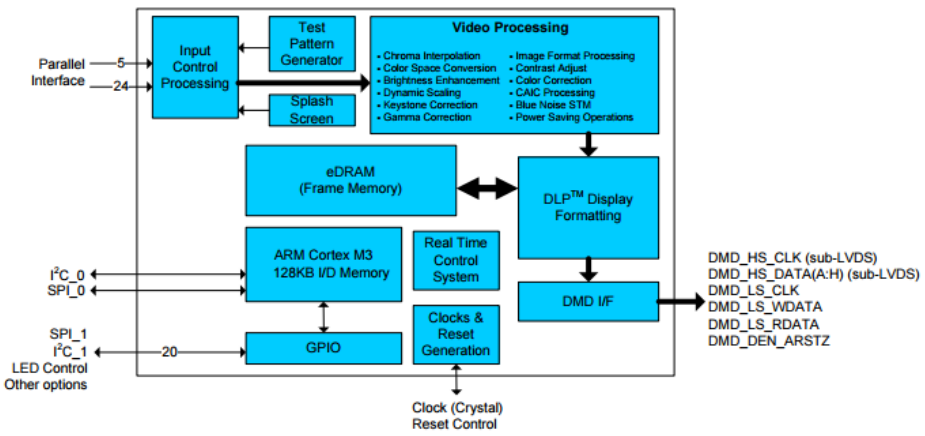


Figure 2: Functional Block Diagram

2.2 DLPA3005

The DLPA3005 is a highly-integrated power management IC optimized for DLP™ Pico ™Projector systems. The DLPA3005 supports LED projectors up to 16 A per LED, enabled by an integrated high efficiency buck controller. Additionally, the drivers control the RGB switches, supporting the sequencing of R, G, and B LEDs. The DLPA3005 contains five buck converters, two of which are dedicated for DLPC low voltage supplies. Another dedicated regulating supply generates the three timing-critical DC supplies for the DMD: VBIAS, VRST, and VOFS.

The DLPA3005 contains several auxiliary blocks which can be used in a flexible way. This enables a tailor-made Pico Projector system. Three 8-bit programmable buck converters can be used, for instance, to drive projector FANs or to make auxiliary supply lines. Two LDOs can be used for a lower-current supply, up to 200 mA. These LDOs are pre-defined to 2.5 V and 3.3 V.

Through the SPI, all blocks of the DLPA3005 can be addressed. Features included are the generation of the system reset, power sequencing, input signals for sequentially selecting the active LED, IC self-protections, and an analog MUX for routing analog information to an external ADC.

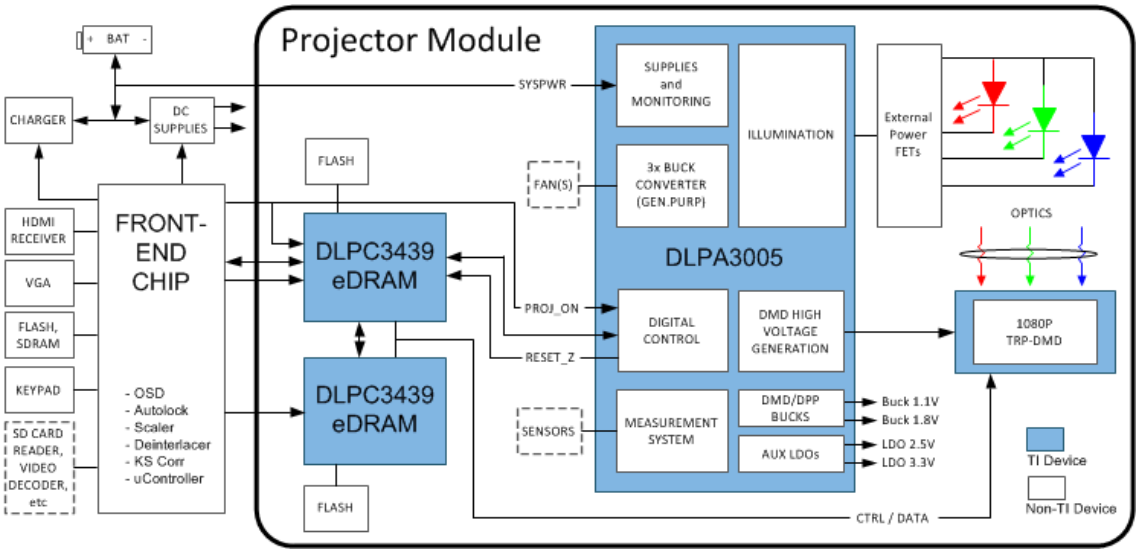


Figure 3: System Block Diagram

2.3 DLP4710

The DLP4710 digital micromirror device (DMD) is a digitally controlled micro-opto-electromechanical system (MEMS) spatial light modulator (SLM). When coupled to an appropriate optical system, the DLP4710 DMD displays a very crisp and high quality image or video. DLP4710 is part of the chipset comprising of the DLP4710 DMD, DLPC3439 display controller and DLPA3000/DLPA3005 PMIC/LED drivers. The compact physical size of the DLP4710 coupled with the controller and the PMIC/LED driver provides a complete system solution that enables small form factor, low power, and high resolution HD displays.

3 Block Diagram

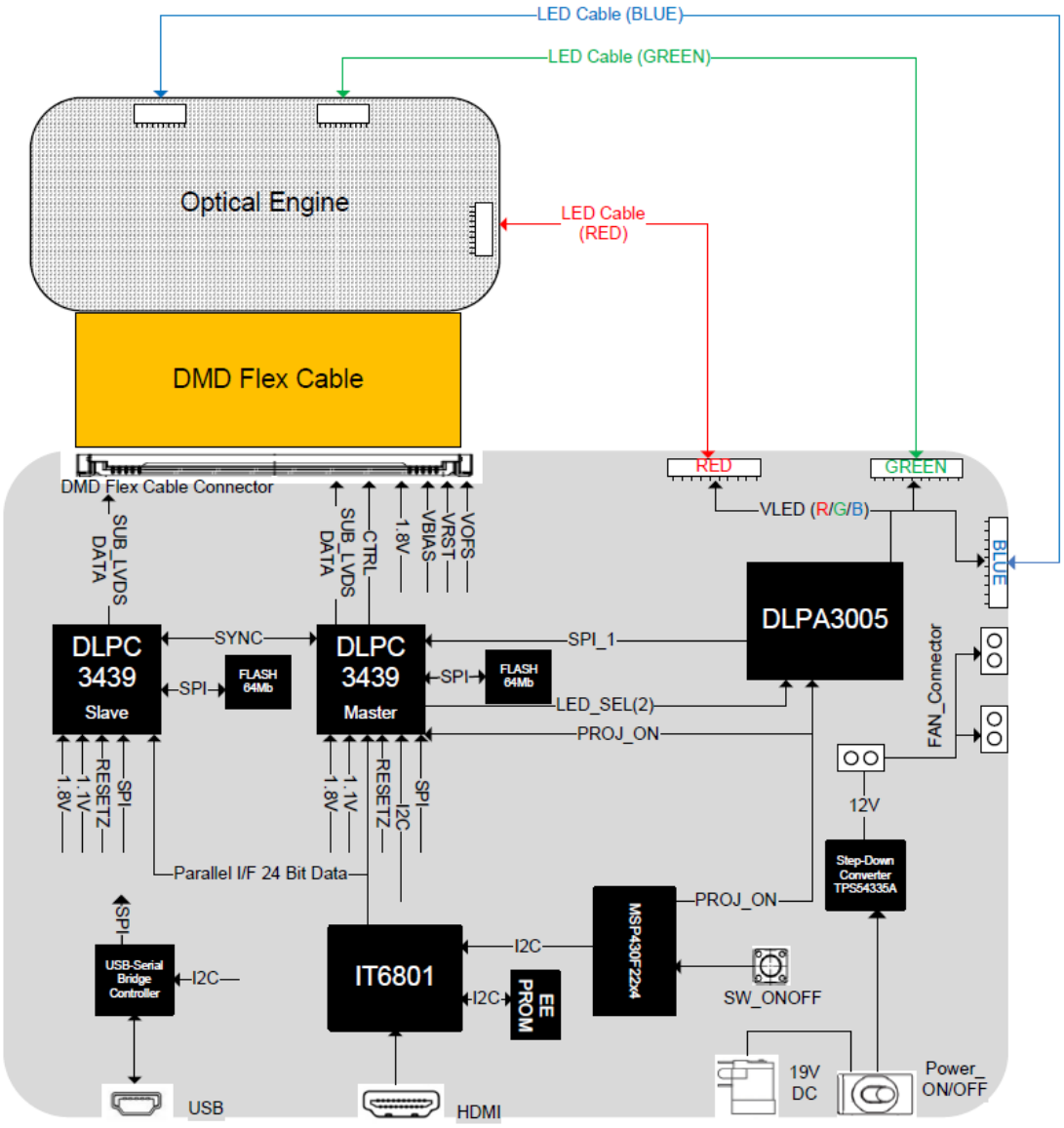


Figure 4: DLP LightCrafter 4710EVM Block Diagram

3.1 Highlighted Products

3.1.1 DLPC3439 Features

- Supports Input Image Sizes up to 1080p
- 24 Bit, Input Pixel Interface Support:
  - Parallel Interface
  - Pixel Clock up to 150MHz
- Pixel Data Processing
  - IntelliBright™ Suite of Image Processing Algorithms
  - Image Resizing (Scaling)
  - Color Coordinate Adjustment
  - Programmable Degamma
  - Active Power Management Processing
  - Color Space Conversion
- Auto DMD Parking at Power Down
- Compatible with the DLPA3000 and DLPA3005 PMIC/LED Drivers

3.1.2 DLPA3005 Features

- High-Efficiency, High-Current RGB LED Driver
- Drivers for External Buck FETs up to 16 A
- Drivers for External RGB Switches
- 10-Bit Programmable Current per Channel
- Inputs for Selecting Color-Sequential RGB LEDs
- Generation of DMD High Voltage Supplies
- Two High Efficiency Buck Converters to Generate the DLPC343x and DMD Supply
- Three High Efficiency, 8-Bit Programmable Buck Converters for Fan Driver Application or General Power Supply. General Purpose Buck2 (PWR6 currently supported, others may be available in the future)
- Two LDOs Supplying Auxiliary Voltages
- Analog MUX for Measuring internal and external nodes such as a thermistor and reference levels
- Monitoring/Protections: Thermal Shutdown, Hot Die, Low-Battery, and Undervoltage Lockout (UVLO)

3.1.3 DLP4710 Features

- 0.47-Inch (11.93-mm) Diagonal Micromirror Array
  - 1920 × 1080 Array of Aluminum Micrometer-Sized Mirrors, in an Orthogonal Layout
  - 5.4 – Micron Micromirror Pitch
  - ±17° Micromirror Tilt (Relative to Flat Surface)
  - Bottom Illumination for Optimal Efficiency and Optical Engine Size
  - Polarization Independent Aluminum Micromirror Surface
- 32-Bit SubLVDS Input Data Bus
- Dedicated DLPC3439 Display Controller and DLPA3000/DLPA3005 PMIC/LED Drivers for Reliable Operation

4 Getting Started Hardware

This getting started procedure assumes that the EVM default conditions are as shipped.

1. Power up the DLP LightCrafter™ Display 4710 EVM by applying an external DC power supply (19V DC, 4.74 A) to PWR_IN connector (J28).

External Power Supply Requirements:

Nom Output voltage: 19 VDC

Max Output Current: 4.74 A

Efficiency Level: V

NOTE: TI recommends using an external power supply that complies with applicable regional safety standards such as UL, CSA, VDE, CCC, PSE, etc.

2. Move PS_ON/OFF slide switch (SW28) to the ON position.
   +3.3V (D43) and INTZ (D57) LED will indicate when 19V power is applied.
3. Push ON/OFF switch (SW21) to turn on the DLP LightCrafter™ Display 4710 EVM.
   +3.3V (D43), SYS_ON-OFF (D36), M_IRQ (D33) and S_IRQ (D34) LED will indicate that the DLP LightCrafter™ Display 4710 EVM is turned on.
4. After the DLP LightCrafter™ Display 4710 EVM is turned on, the projector will show a DLP LightCrafter™ Display splash image by default.
5. The focus and zoom of the image can be adjusted on the optical engine.

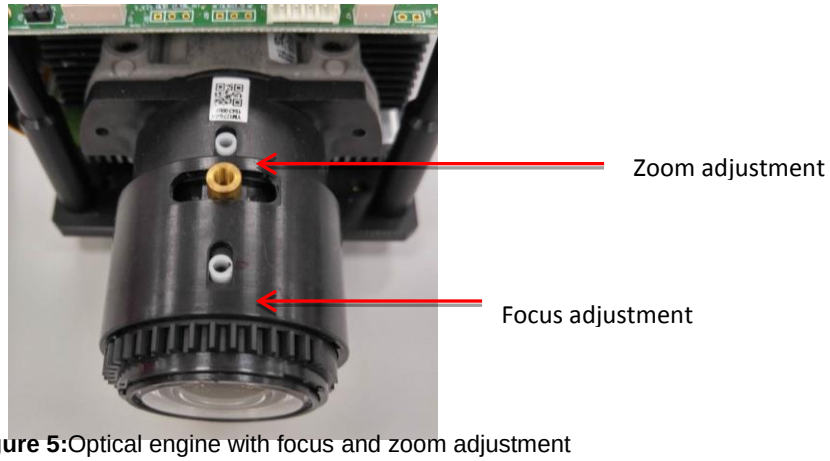


Figure 5: Optical engine with focus and zoom adjustment

6. Connect USB to the LightCrafter™ Display 4710 EVM and open the GUI for 4710 EVM on your Computer. Then you can communicate to the EVM over the GUI software. If needed, please connect a HDMI source to the EVM.
7. When turning off the projector, push ON/OFF switch (SW21) and then move slide switch (SW28) to the OFF position before removing the power cable.
   IMPORTANT NOTE: To avoid potential damage to the DMD, it is required to turn off the projector with the above sequence before disconnecting the power.

5 Getting Started Firmware

The TIDA-01226 reference design needs firmware for the DLPC3439 and the MSP430. The EVM GUI connects through the USB interface of the Cypress controller to the EVM.

5.1 DLPC3439 firmware

The DLPC3439 firmware is stored on the two 64 bit flash devices on the PCB board. The firmware contains the ARM code, LED sequences, Start up configuration, Splash images and LUT's (Look up Table).
The firmware can be downloaded on the DLP LightCrafter 4710 EVM tool folder:
http://www.ti.com/tool/dlpdlcr4710evm-g2

5.2 MSP430 code

The MSP430 code is used as a front-end processor in the DLP LightCrafter 4710 EVM. It drives Proj_ON and configures the DLPC3439 for the external HDMI input.

The full MSP430 code is available under the DLP LightCrafter4710EVM tool folder:
http://www.ti.com/tool/dlpdlcr4710evm-g2

It can be modified by using Code Composer and can be downloaded on the MSP430 with the USB Debugging Interface.

5.3 DLP LightCrafter GUI

The GUI (Graphical User Interface) allows users to evaluate the capabilities of the DLP chipset by sending I2C commands to the DLPC3439.

The DLP LightCrafter GUI is available under the DLP LightCrafter4710EVM tool folder:
http://www.ti.com/tool/dlpdlcr4710evm-g2

6 Test Setup

Testing of the TIDA-01226 reference design was performed using the DLP LightCrafter Display 4710 EVM-G2 which is the TI's implementation of the TIDA-01226 reference design. This EVM incorporates the DLP 0.47" 1080p chipset comprising of the DLP4710 DMD, DLPC3439 controller and DLPA3005 PMIC/Led Driver. The EVM and TI design enable faster development cycles for applications requiring full HD resolution and higher brightness projection display solutions. The entire test data contained below was measured on one DLP LightCrafter Display 4710 EVM-G2 to provide an example from a typical unit. Please note that performance will vary across EVMs due to variations in manufacturing. The performance data is not guaranteed

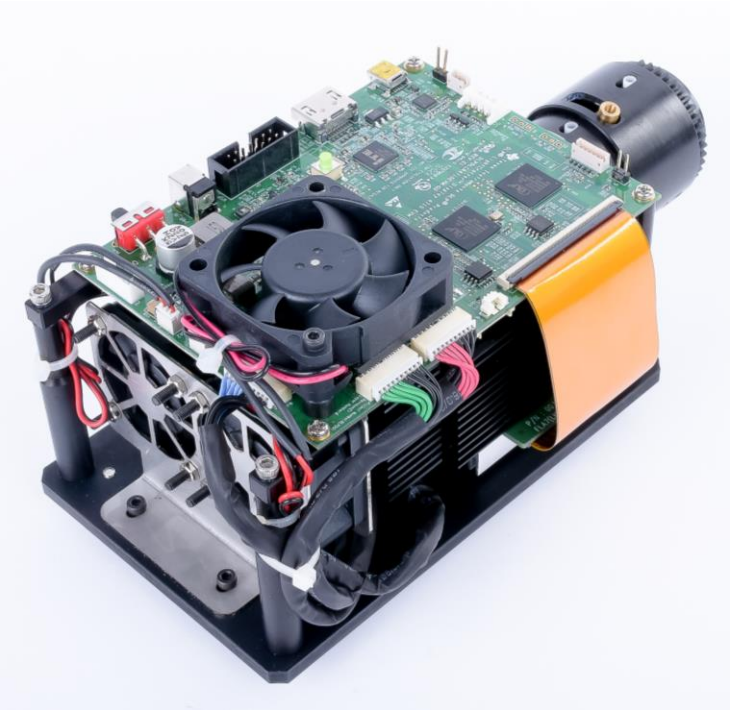


Figure 6: DLP LightCrafter 4710 EVM-G2

7 Test Data

7.1 Lumens Measurement

This section provides the lumens measured for the EVM, which is the TI's implementation of this reference design.

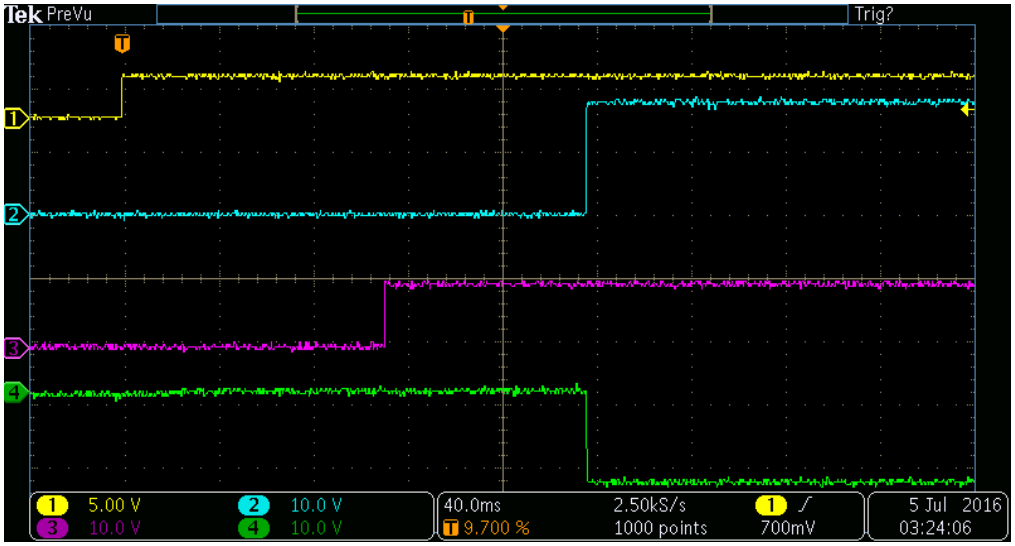
White Point: 6600K
Lumens: 600 (ANSI)

7.2 Power Up and Power Down Timing Measurements

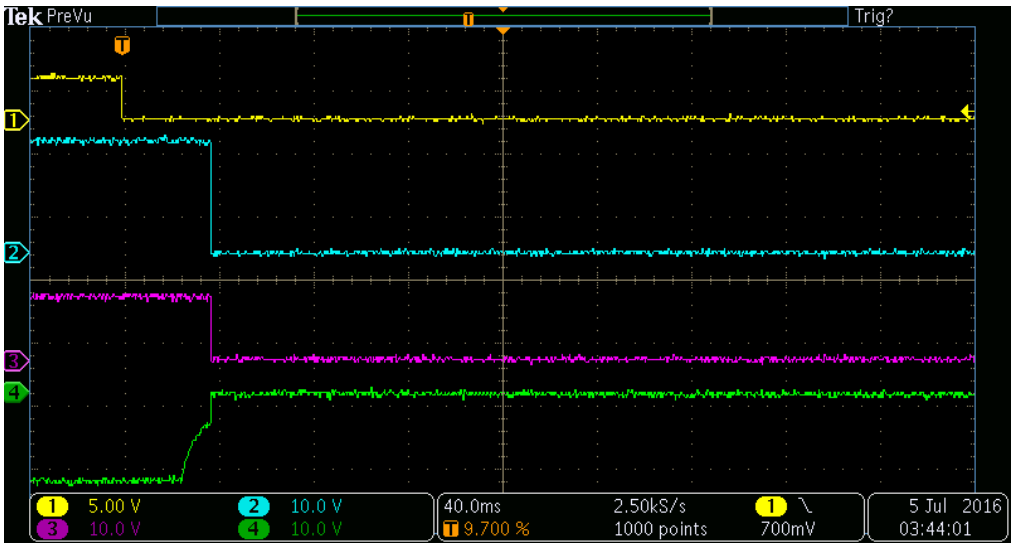
Power Up and Power Down timing requirements are described in detail in the DLP4710 datasheet. Key signals measured are PROJ_ON and the power supplies to the DMD- VBIAS, VOFFSET and VRESET. For more details on the timing requirements please refer the DLP4710 device datasheet.

Both measurements are showing following configuration:
CH 1: PROJ_ON; CH 2: VBIAS; CH 3: VOFS ; CH 4: VRST

Power Up Timing Measurements



Power down Timing Measurements



7.3 Optical engine size

DLP4710 is a key component of the 0.47" 1080p chipset and enables use of full HD resolution for projection display applications. The optical engine used in this DLPDLCR4710EVM is designed for +1000 Lumens applications. Dimensions are shown in mm.

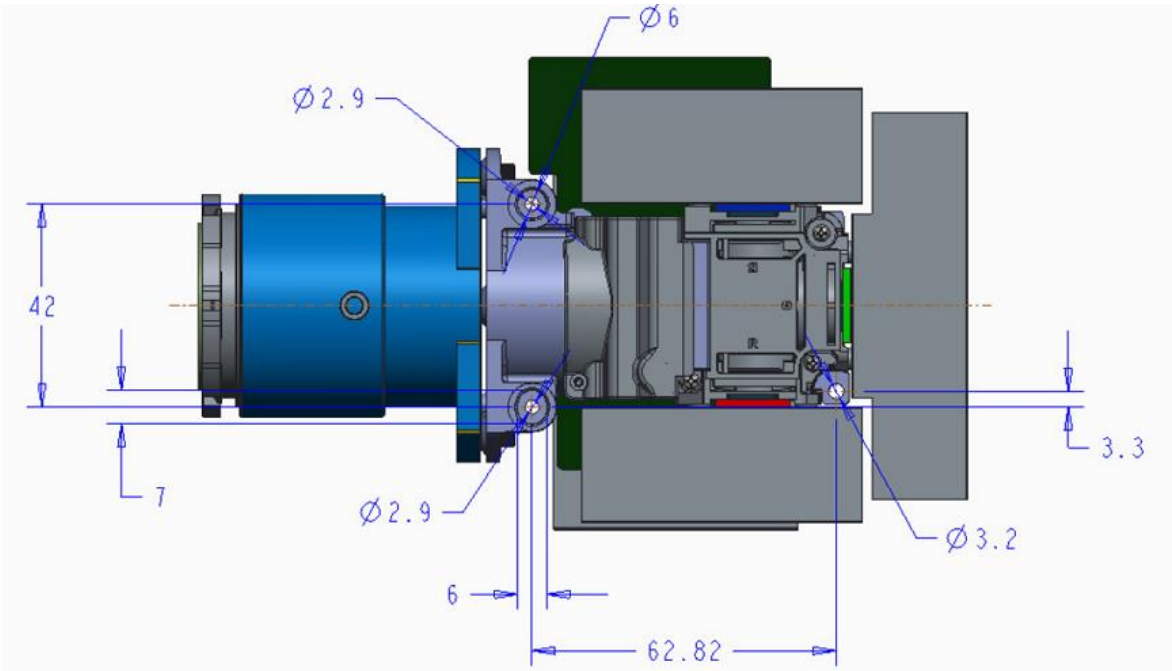


Figure 7: 1080p Optical Engine

7.4 Throw Ratio

An optical engine's throw ratio is defined as the ratio of the distance measured from lens to screen and the width of the projected image.

Throw Ratio = Distance/Width

The throw ratio for the optical engine used in this ref design is 1.39

8 Design Files

8.1 Schematics

To download the Schematics for each board, see the design files at http://www.ti.com/tool/TIDA-01226

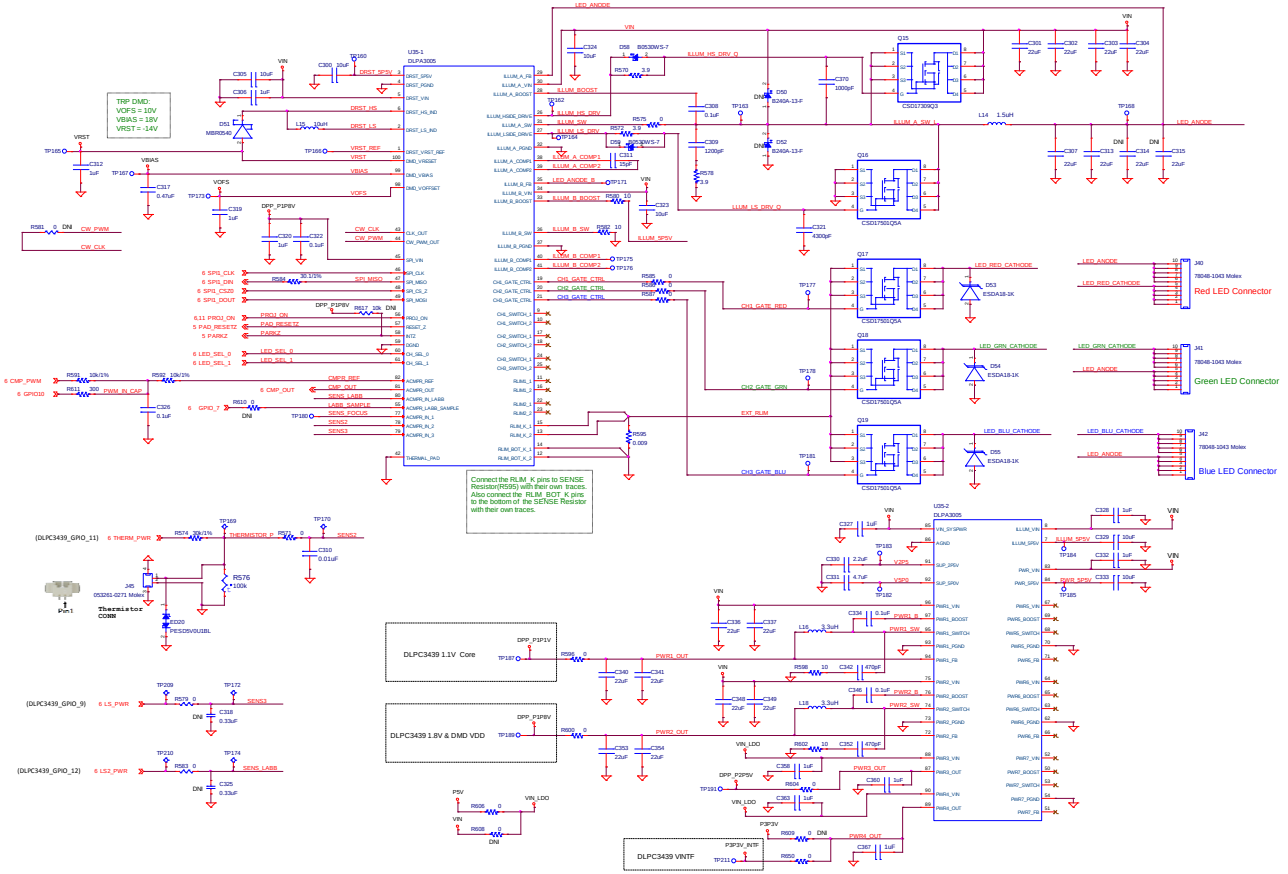


Figure 8: DLPDLCR4710EVM-G2 Schematic

8.2 Bill of Materials

To download the Bill of Materials for each board, see the design files at http://www.ti.com/tool/TIDA-01226

Table 1: Bill of Material

Item	Qty	Reference	Value	Part Description	Manufacturer	Manufacturer Part Number	Alternate Part	PCB Footprint	Note
1	47	C6,C49,C75,C190,C191,C225,C226,C227,C229,C233,C234,C236,C237,C238,C248,C250,C286,C287,C288,C308,C322,C326,C334,C346,C368,C369,C378,C379,C380,C381,C382,C383,C387,C388,C389,C390,C392,C393,C394,C395,C396,C397,C398,C420,C423,C424,C427	0.1uF	0.10µF ±10% 16V X7R Ceramic Capacitor	Yageo	CC0402KRX7R7BB104	311-1338-1-ND	0402	
2	75	C79,C89,C90,C91,C92,C93,C94,C95,C96,C97,C98,C99,C100,C101,C103,C104,C105,C106,C107,C108,C109,C110,C111,C112,C113,C114,C115,C116,C117,C118,C119,C120,C121,C122,C123,C124,C125,C126,C127,C128,C130,C131,C132,C146,C175,C176,C177,C178,C183,C186,C187,C188,C189,C194,C195,C196,C197,C198,C199,C202,C209,C211,C213,C215,C219,C220,C221,C222,C223,C224,C228,C276,C277,C278,C279	0.1uF	0.10µF ±10% 6.3V X5R Ceramic Capacitor	Yageo	CC0201KRX5R5BB104	311-1408-1-ND	0201	
3	3	C102,C129,C310	0.01uF	10000pF ±10% 25V X7R Ceramic Capacitor	Yageo	CC0402KRX7R8BB103	311-1337-1-ND	0402	
4	3	C179,C323,C412	10uF	10µF ±10% 25V X5R Ceramic Capacitor	Yageo	CC0805KKX5R8BB106	311-1869-1-ND	0805	
5	15	C180,C181,C184,C193,C200,C206,C207,C208,C210,C212,C214,C218,C249,C273,C285	10uF	10µF ±20% 6.3V X5R Ceramic Capacitor	Yageo	CC0603MRX5R5BB106	311-1448-1-ND	0603	
6	16	C182,C185,C192,C201,C203,C235,C245,C247,C274,C289,C320,C360,C367,C384,C386,C391	1uF	1µF ±10% 10V X5R Ceramic Capacitor	Yageo	CC0402KRX5R6BB105	311-1439-1-ND	0402	
7	2	C216,C217	18pF	18pF ±5% 50V C0G, NP0 Ceramic Capacitor	Yageo	CC0402JRNPO9BN180	311-1415-1-ND	0402	
8	9	C230,C231,C232,C239,C240,C241,C2	0.1uF	0.10µF ±10% 25V X5R Ceramic	Yageo	CC0402KRX5R	311-1697-1-ND	0402	

		70,C417,C419		Capacitor		8BB104			
9	2	C262,C410	0.1uF	0.10µF ±10% 50V X7R Ceramic Capacitor	Yageo	CC0603KRX7R9BB104	311-1344-1-ND	0603	
10	3	C263,C305,C324	10uF	Multilayer Ceramic Capacitors MLCC - SMD/SMT 1206 10uF 50volt X5R +/-10%	Yageo	CC1206KKX7R9BB106	GRM31CR61H106KA12L	1206	
11	1	C264	220uF	Aluminum Electrolytic Capacitors - SMD 50 Volts 220uF 20% 10x10.3	Lelon	VZH221M1HTR-1010	140-VZH221M1HTR1010	EC-10	
12	1	C266	120pF	Multilayer Ceramic Capacitors MLCC - SMD/SMT 120pF 50V NPO 5%	Yageo	CC0402JRNPO9BN121	603-CC402JRNPO9BN121	0402	(6 (c)); (7(c) I). Date: 03/31/16
13	5	C268,C271,C269,C416,C418	22uF	22µF ±10% 25V X5R Ceramic Capacitor	Murata	GRM32ER61E226KE15L	490-3889-1-ND	1210	
14	4	C272,C300,C329,C333	10uF	10µF ±20% 10V X5R Ceramic Capacitor	Yageo	CC0603MRX5R6BB106	311-1817-1-ND	0603	
15	1	C283	0.22uF	0.22µF ±10% 25V X7R Ceramic Capacitor	Yageo	CC0603KRX7R8BB224	311-1803-1-ND	0603	
16	10	C301,C302,C303,C304,C336,C337,C348,C349,C307,C313	22uF	22µF ±20% 35V X5R Ceramic Capacitor	TDK	C3216X5R1V226M160AC	445-8045-1-ND	1206	
17	6	C306,C327,C328,C332,C312,C319	1uF	1µF ±10% 50V X5R Ceramic Capacitor	Yageo	CC0603KRX5R9BB105	311-1787-1-ND	0603	
18	1	C309	1200pF	1200pF ±5% 50V C0G, NP0 Ceramic Capacitor	Yageo	CC1206JRNPO9BN122	603-CC126JRNPO9BN122	1206	(6 (c)); (7(c) I). Date: 03/31/16
19	1	C311	15pF	15pF ±5% 50V C0G, NP0 Ceramic Capacitor	Yageo	CC0402JRNPO9BN150	311-1017-1-ND	0402	
20	1	C317	0.47uF	0.47µF ±10% 50V X5R Ceramic Capacitor	Yageo	CC0603KRX7R9BB474	UMK107ABJ474KA-T	0603	
21	1	C321	4300pF	4300pF ±5% 50V U2J Ceramic Capacitor	Murata	GRM1887U1H432JA01	490-6397-1-ND	0603	
22	1	C330	2.2uF	2.2µF ±20% 6.3V X5R Ceramic Capacitor	Yageo	CC0402MRX5R5BB225	311-1442-1-ND	0402	
23	1	C331	4.7uF	4.7µF ±20% 6.3V X5R Ceramic Capacitor	Yageo	CC0402MRX5R5BB475	311-1730-1-ND	0402	
24	4	C340,C341,C353,C354	22uF	22µF ±20% 6.3V X5R Ceramic Capacitor	Yageo	CC0603MRX5R5BB226	311-1815-1-ND	0603	
25	2	C342,C352	470pF	470pF ±10% 50V X7R Ceramic Capacitor	Yageo	CC0603KRX7R9BB471	311-1078-1-ND	0603	
26	2	C358,C363	1uF	1µF ±10% 25V X5R Ceramic Capacitor	Yageo	CC0402KRX5R8BB105	311-1698-1-ND	0402	
27	1	C370	1000pF	1µF ±10% 25V X5R Ceramic Capacitor	Yageo	CC0603KRX7R9BB102	311-1080-1-ND	0603	
28	1	C411	0.012uF	0.012µF ±10% 50V X7R Ceramic	Yageo	CC0603KRX7R	311-1807-1-ND	0603	

				Capacitor		9BB123			
29	1	C413	22uF	22µF ±20% 10V X5R Ceramic Capacitor	Yageo	CC0805MKX5R6BB226	311-1900-1-ND	0805	
30	2	C414,C415	4.7uF	4.7µF ±10% 25V X7R Ceramic Capacitor	Yageo	CC0805KKX7R8BB475	311-1885-1-ND	0805	
31	1	C425	3300pF	3300pF ±10% 50V X7R Ceramic Capacitor	Yageo	CC0402KRX7R9BB332	311-1034-1-ND	0402	
32	36	ED1,ED2,ED3,ED4,ED5,ED6,ED7,ED8,ED9,ED10,ED11,ED12,ED13,ED14,ED15,ED16,ED19,D25,D26,ED21,ED22,ED17,ED18,ED20,ED23,ED24,ED25,ED26,ED27,ED36,ED37,ED38,ED39,ED40,ED41,ED42	PESD5V0U1BL.315	TVS DIODE 5VWM SOD882	NXP	PESD5V0U1BL.315	568-4803-1-ND	SOD882	
33	1	D32	BAT54CW	DIODE ARRAY SCHOTTKY 30V SOT323	Diodes Inc.	BAT54CW	568-1613-1-ND	SOT323	
34	11	D33,D34,D36,D44,D45,D46,D56,D57,D66,D67,D43	16-213SYGC/S530-E2/TR8	LED YELLOW-GRN CLEAR 0402 SMD	Everlight	16-213SYGC/S530-E2/TR8	16-213SYGC/S530-E3/TR8-ND	0402	
35	1	D51	MBR0540	DIODE SCHOTTKY 40V 500MA SOD123	ON Semi	MBR0540	MBR0540T1GOSCT-ND	SOD123	
36	3	D53,D54,D55	ESDA18-1K	TVS DIODE 15VWM 34VC SOD523	STMicroelectronics	ESDA18-1K	497-10767-1-ND	SOD523	
37	2	D58,D59	B0530WS-7	DIODE SCHOTTKY 30V 500MA SOD323	Diodes Inc.	B0530WS-7	B0530WS-FDICT-ND	SOD323	
38	2	D68,D69	SS0540	DIODE SCHOTTKY 40V 500MA SOD123	PANJIT	SS0540	B0540W-FDICT-ND	SOD123	
39	19	FB1,FB2,FB3,FB5,FB6,FB8,FB9,FB10,FB11,FB12,FB30,FB31,FB32,FB33,L5,L6,L7,L8,L9	GMLB-160808-0070S-N1	FERRITE BEAD 70 OHM 0603 1LN	MAG.LAYERS	GMLB-160808-0070S-N1	490-5253-1-ND	0603	
40	6	FB20,FB22,FB23,FB24,FB25,FB26	GMLB-100505-0120P-N8	FERRITE BEAD 120 OHM 0402 1LN	MAG.LAYERS	GMLB-100505-0120P-N8	490-4004-1-ND	0402	
41	1	J11	TU3007WNR-04	4 Positions Header, Shrouded Connector 0.098" (2.50mm) Through Hole, Right Angle Tin	TYU	TU3007WNR-04	455-1627-ND		
42	1	J18	47151-1101	HDMI Receptacle Connector 19 Position Surface Mount, Right Angle, Horizontal	Molex	47151-1101			

43	1	J21	TU1501WNV-06	6 Positions Header, Shrouded Connector 0.059" (1.50mm) Through Hole Tin	TYU	TU1501WNV-06	455-1661-ND		
44	1	J22	104060-8017	CONN FFC FPC 80POS 0.50MM R/A	Molex	104060-8017			
45	1	J23	TU1501WNR-03S	3 Positions Header, Shrouded Connector 0.059" (1.50mm) Surface Mount, Right Angle Tin	TYU	TU1501WNR-03S	455-1694-2-ND		
46	4	J24,J43,J32,J33	TU1501WNV-03	3 Positions Header, Shrouded Connector 0.059" (1.50mm) Through Hole Tin	TYU	TU1501WNV-03	455-1658-ND		
47	1	J26	TU1252WNR-08S	8 Positions Header, Shrouded Connector 0.049" (1.25mm) Surface Mount, Right Angle Tin	TYU	TU1252WNR-08S	WM7626TR-ND		
48	1	J28	IDJ-D43B2	CON PWR JCK 2.5 X 6.0MM W/SHLD	HCH	IDJ-D43B2	CP-047BH-ND		
49	1	J34	CH87142V200	14 Positions Header, Shrouded Connector 0.100" (2.54mm) Through Hole Gold	CviLux	CH87142V200	WM6547-ND		
50	1	J35	TU5005WNV-1x02	2 Positions Header, Unshrouded, Breakaway Connector 0.100" (2.54mm) Through Hole Tin	TYU	TU5005WNV-1x02	WM8072-ND		
51	3	J40,J41,J42	78048-1043	Headers & Wire Housings PCB HEADERS	Molex	78048-1043			
52	1	J45	TU1252WNR-02S	2 Positions Header, Shrouded Connector 0.049" (1.25mm) Surface Mount, Right Angle Tin	TYU	TU1252WNR-02S	WM7620TR-ND		
53	1	J47	MU-05F4-24	USB - mini B USB 2.0 OTG Receptacle Connector 5 Position Surface Mount, Right Angle, Horizontal	OBJECTIVE	MU-05F4-24	WM5461CT-ND		

54	1	J48	TU2001WNV-06	6 Positions Header, Shrouded Connector 0.079" (2.00mm) Through Hole Tin	TYU	TU2001WNV-06	455-1708-ND		
55	1	L10	15uH	FIXED IND 15UH 6.25A 45 MOHM SMD	MAG.LAYERS	MMD-10DZ-150M-M1	SRP1038A-150MCT-ND		
56	1	L11	2.2uH	Fixed Inductors XFL3012 Low DCR Ind 2.2 uH 20 % 1.9 A	MAG.LAYERS	MLPS-3015-2R2	994-XFL3012-222MEC		
57	1	L14	1.5uH	FIXED IND 1.5UH 23A 3.16 MOHM	MAG.LAYERS	MMD-12EZ-1R5M-V1	283-4548-1-ND		
58	1	L15	10uH	FIXED IND 10UH 1.8A 243 MOHM SMD	MAG.LAYERS	MMD-04BZ-100M-S1	SRP4020TA-100MTR-ND		
59	2	L16,L18	3.3uH	FIXED IND 3.3UH 6A 30 MOHM SMD	MAG.LAYERS	MMD-06CZ-3R3M-V1	541-1009-1-ND		
60	1	L21	CMM21T-900M-N	CMC 90 OHM 300MA 2 LN SMD	Chilisin	CMM21T-900M-N	445-5193-1-ND		
61	2	Q4,Q7	2N7002P,215	MOSFET N-CH 60V 0.36A SOT-23	NXP	2N7002P,215	568-5818-1-ND	SOT23	
62	1	Q8	DMN26D0UT	MOSFET N-CH 20V 230MA SOT523	Diodes Inc.	DMN26D0UT	DMN26D0UT-7DICT-ND	SOT523	
63	1	Q15	CSD17309Q3	MOSFET N-CH 30V 60A 8SON	Texas Instruments	CSD17309Q3	296-27250-1-ND	8SON	
64	4	Q16,Q17,Q18,Q19	CSD17501Q5A	MOSFET N-CH 30V 100A 8SON	Texas Instruments	CSD17501Q5A	296-28437-1-ND	8SON	
65	2	Q20,Q21	BCP68	TRANS NPN 20V 1A SOT223	NXP	BCP68	568-6107-1-ND	SOT223	
66	2	Q22,Q23	MMBT2222ALT1G	TRANS NPN 40V 0.6A SOT23	ON Semi	MMBT2222ALT1G	MMBT2222ALT1GOSCT-ND	SOT23	
67	6	RP1,RP2,RP3,RP4,RP5,RP6	YC124-JR-0733R	RES ARRAY 4 RES 33 OHM 0804	Yageo	YC124-JR-0733R	YC124J-33CT-ND	0402*4	
68	45	R1,R2,R6,R139,R149,R162,R172,R173,R175,R176,R179,R209,R210,R349,R350,R351,R365,R367,R432,R433,R447,R612,R651,R652,R661,R662,R665,R666,R667,R668,R670,R671,R677,R679,R680,R685,R693,R699,R704,R706,R708,R769,R770,R795,R729	10K	RES SMD 10K OHM 5% 1/16W 0402	Yageo	RC0402JR-0710K	11-10KJRCT-ND	0402	

69	119	R9,R109,R116,R120,R125,R140,R141,R171,R208,R211,R234,R235,R237,R239,R241,R242,R243,R356,R358,R359,R366,R368,R376,R377,R379,R387,R388,R389,R394,R395,R396,R397,R398,R399,R400,R402,R403,R404,R406,R408,R410,R411,R412,R413,R414,R415,R416,R417,R419,R425,R427,R430,R431,R435,R451,R452,R477,R478,R487,R488,R504,R505,R521,R525,R533,R534,R537,R538,R539,R540,R541,R542,R571,R579,R583,R604,R614,R615,R623,R629,R630,R631,R632,R636,R637,R638,R640,R641,R643,R644,R646,R650,R657,R659,R663,R664,R672,R673,R674,R676,R678,R682,R683,R684,R687,R688,R696,R702,R774,R775,R778,R779,R782,R798,R654,R655,R675,R619,R621	0	RES SMD 0.0OHM JUMPER 1/16W 0402	Yageo	RC0402JR-070R	311-0.0JRCT-ND	0402	
70	21	R12,R51,R52,R67,R68,R69,R71,R72,R73,R74,R75,R76,R121,R122,R123,R164,R182,R184,R186,R344,R584	30.1	RES SMD 30.1 OHM 1% 1/16W 0402	Yageo	RC0402FR-0730R1	YAG3111CT-ND	0402	
71	22	R35,R36,R37,R60,R63,R64,R65,R117,R118,R119,R142,R143,R169,R183,R185,R189,R345,R373,R393,R401,R436,R656	100K	RES SMD 100K OHM 5% 1/16W 0402	Yageo	RC0402JR-07100K	311-100KJRCT-ND	0402	
72	2	R114,R115	43	RES SMD 43 OHM 5% 1/16W 0402	Yageo	RC0402JR-0743R	311-43JRCT-ND	0402	
73	6	R124,R126,R127,R136,R206,R207	7.5K	RES SMD 7.5K OHM 1% 1/16W 0402	Yageo	RC0402FR-077K5	311-7.50KLRCT-ND	0402	
74	1	R348	300K	RES SMD 300K OHM 1% 1/16W 0402	Yageo	RC0402FR-07300K	311-300KLRCT-ND	0402	
75	3	R352,R524,R474	47K	RES SMD 47K OHM 5% 1/16W 0402	Yageo	RC0402JR-0747K	311-47KJRCT-ND	0402	
76	1	R355	2M	RES SMD 2M OHM 5% 1/16W 0402	Yageo	RC0402JR-072M	YAG3295CT-ND	0402	
77	1	R357	22K	RES SMD 22K OHM 1% 1/16W 0402	Yageo	RC0402FR-0722K	311-22.0KLRCT-ND	0402	
78	6	R360,R361,R363,R364,R362,R622	33	RES SMD 33 OHM 5% 1/16W 0402	Yageo	RC0402JR-0733R	311-33JRCT-ND	0402	
79	1	R375	4.75K	RES SMD 4.75K OHM 1% 1/16W 0402	Yageo	RC0402FR-074K75	311-4.75KLCT-ND	0402	
80	2	R378,R785	1M	RES SMD 1M OHM 1% 1/16W 0402	Yageo	RC0402FR-071M	311-1.00MLRCT-ND	0402	
81	1	R380	1.5K	RES SMD 1.5K OHM 1% 1/16W 0402	Yageo	RC0402FR-071K5	311-1.50KLRCT-ND	0402	

82	1	R381	3K	RES SMD 3K OHM 1% 1/16W 0402	Yageo	RC0402FR-073K	311-3KLRCT-ND	0402	
83	6	R383,R385,R613,R616,R689,R691	180	RES SMD 180 OHM 5% 1/16W 0402	Yageo	RC0402JR-07180R	311-180JRCT-ND	0402	
84	5	R437,R479,R526,R527,R528	390	RES SMD 390 OHM 5% 1/16W 0402	Yageo	RC0402JR-07390R	311-390JRCT-ND	0402	
85	1	R443	470K	RES SMD 470K OHM 1% 1/16W 0402	Yageo	RC0402FR-07470K	311-470KLRCT-ND	0402	
86	5	R472,R575,R596,R600,R606	0	RES SMD 0.0 OHM JUMPER 1/4W 1206	Yageo	RC1206JR-070R	311-0.0ERCT-ND	1206	
87	2	R480,R471	215K	RES SMD 215K OHM 1% 1/16W 0402	Yageo	RC0402FR-07215K	YAG3055CT-ND	0402	
88	1	R482	47.5K	RES SMD 47.5K OHM 1% 1/16W 0402	Yageo	RC0402FR-0747K5	311-47.5KLRCT-ND	0402	
89	4	R529,R530,R635,R749	2.2K	RES SMD 2.2K OHM 1% 1/16W 0402	Yageo	RC0402FR-072K2	311-2.20KLRCT-ND	0402	
90	2	R570,R572	3.9	RES SMD 3.9 OHM 5% 1/10W 0603	Yageo	RC0603JR-073R9	311-3.9GRCT-ND	0603	
91	1	R574	30K	RES SMD 30K OHM 1% 1/16W 0402	Yageo	RC0402FR-0730K	311-30.0KLRCT-ND	0402	
92	1	R576	100K	THERMISTOR NTC 100K OHM 1% 0402	THINKING	TSM0A104F39H1RZ	490-4803-2-ND	0402	
93	1	R578	3.9	Thick Film Resistors - SMD 3.9 OHM 5%	Yageo	RC1210JR-073R9	603-RC1210JR-073R9L	1210	
94	2	R580,R582	10	RES SMD 10 OHM 1% 1/16W 0402	Yageo	RC0402FR-0710R	311-10.0LRCT-ND	0402	
95	3	R585,R586,R587	0	RES SMD 0.0OHM JUMPER 1/10W 0603	Yageo	RC0603FR-070R	311-0.0HRCT-ND	0603	
96	2	R591,R592	10K	RES SMD 10K OHM 1% 1/16W 0402	Yageo	RC0402FR-0710K	311-10.0KLRCT-ND	0402	
97	1	R595	0.009	Current Sense Resistors - SMD 3watts .009ohms 1%	Ralec	LR2512-23R009F4	71-WSLP25129L000FEA	2512	(7(c) I). Date: 05/01/16
98	2	R598,R602	10	RES SMD 10 OHM 1% 1/10W 0603	Yageo	RC0603FR-0710R	311-10.0HRCT-ND	0603	
99	1	R611	300	RES SMD 300 OHM 5% 1/16W 0402	Yageo	RC0402JR-07300R	311-300JRCT-ND	0402	
100	8	R743,R761,R762,R763,R765,R767,R768,R797	3.3K	RES SMD 3.3K OHM 5% 1/16W 0402	Yageo	RC0402JR-073K3	311-3.3KJRCT-ND	0402	
101	1	R744	442	RES SMD 442 OHM 1% 1/10W 0603	Yageo	RC0603FR-07442R	311-442HRCT-ND	0603	
102	1	R745	140K	RES SMD 140K OHM 1% 1/10W 0603	Yageo	RC0603FR-07140K	311-140KHRCT-ND	0603	
103	1	R747	30.9K	RES SMD 30.9K OHM 1% 1/16W 0402	Yageo	RC0402FR-0730K9	YAG3110CT-ND	0402	

104	1	R793	75K	RES SMD 75K OHM 1% 1/16W 0402	Yageo	RC0402FR-0775K	311-75KLRCT-ND	0402	
105	1	SW21	STS-D5	SWITCH TACTILE SPST-NO 0.05A 12V	HCH	STS-D5	EG4375CT-ND		
106	1	SW28	DS_13P_S044	SWITCH SLIDE SPDT 5A 120V	Dawning	DS_13P_S044	EG2478-ND		
107	1	U11	CDCLVC1102PW	IC CLK BUFFER 1:2 250MHZ 8TSSOP	Texas Instruments	CDCLVC1102PW	296-27610-1-ND	8-TSSOP	
108	12	U15,U25,U26,U36,U37,U50,U51,U52,U53,U54,U55,U56	SN74AUP1G07DCKR	IC BUFF/DVR NON-INV 3.6V SC705	Texas Instruments	SN74AUP1G07DCKR	296-18256-1-ND	SC70-5	
109	2	U16,U18	W25Q64FVSSIG	IC FLASH 64MBIT 104MHZ 8SOIC	Winbond	W25Q64FVSSIG	W25Q64FVSSIG-ND	8-SOIC	
110	1	U20	LM1117IMPX-3.3/NOPB	IC REG LDO 3.3V 0.8A SOT223	Texas Instruments	LM1117IMPX-3.3/NOPB	LM1117IMPX-3.3/NOPBCT-ND	SOT-223	
111	1	U21	24LC02	IC EEPROM 2KBIT 400KHZ 8SOIC	Microchip	24LC02	24LC024T-I/SNCT-ND	8-SOIC	
112	1	U22	TPS2061DBV	IC SWITCH PWR DIST SNGL SOT23-5	Texas Instruments	TPS2061DBV	296-23968-1-ND	SOT23-5	
113	1	U23	IT6801FN	HDMI Receiver	ITE Tech Inc	IT6801FN	Contact Business Unit	76-QFN	
114	1	U24	TLV70012DDC	IC REG LDO 1.2V 0.2A 5SOT	Texas Instruments	TLV70012DDC	296-27218-1-ND	SOT23-5	
115	1	U27	SN74CBTLV3257D	IC LV DUAL FET MUX/DEMUX 16SSOP	Texas Instruments	SN74CBTLV3257D	296-9135-1-ND	16-SOIC	
116	2	U29,U47	TLV70033DDC	IC REG LDO 3.3V 0.2A 5SOT	Texas Instruments	TLV70033DDC	296-27937-1-ND	SOT23-5	
117	1	U32	TPS54335ADDAR	IC REG BCK ADJ 3A SYNC 8SOPWRPAD	Texas Instruments	TPS54335ADDAR	TPS54335ADDAR-ND	8-SOIC	
118	1	U33	TLV62565DBVR	IC REG BCK ADJ 1.5A SYNC SOT23-5	Texas Instruments	TLV62565DBVR	TLV62565DBVR-ND	SOT23-5	
119	1	U34	MSP430F5514IRGC	IC MCU 16BIT 64KB FLASH 64VQFN	Texas Instruments	MSP430F5514IRGC	296-31693-1-ND	64-QFN	
120	1	U35	DLPA3005DPFD	IC PMIC/LED DRIVER DLP 100HTQFP	Texas Instruments	DLPA3005DPFD	296-43149-1-ND	100-HTQFP	
121	2	U39,U40	DLPC3439	IC CTRLR DGRL DPP3439 176DLP	Texas Instruments	DLPC3439	296-42180-5-ND	201-VFBGA	

122	1	U44	TXS0102DCU	IC VOLT-LEVEL TRANSLATOR US8	Texas Instruments	TXS0102DCU	296-21931-1-ND	8-VSSOP	
123	2	U45,U46	SN74AVC4T774PWR	IC BUS TRANSCVR 4BIT DL 16TSSOP	Texas Instruments	SN74AVC4T774PWR	296-24739-1-ND	16-TSSOP	
124	1	U48	CY7C65215-32LTXI	IC USB TO SERIAL BRIDGE 32QFN	Cypress	CY7C65215-32LTXI	CY7C65215-32LTXI-ND	32-QFN	
125	1	U49	SN74LVC1G06DCK	IC INVERTER SINGLE 1INPUT SC705	Texas Instruments	SN74LVC1G06DCK	296-8484-1-ND	SC70-5	
126	1	U62	LM2940IMP-5	IC REG LDO 5V 1A SOT223	Texas Instruments	LAM2940IMP-5	LM2940IMP-5.0/NOPBCT-ND	SOT-223	
127	1	U65	SN74LVC1G08DCK	IC GATE AND 1CH 2-INP SC-70-5	Texas Instruments	SN74LVC1G08DCK	296-11602-1-ND	SC70-5	
128	1	X3	24MHz	OSC XO 24.000MHZ CMOS SMD	YOKE	SO3225-024000-F1A-BBA-YA	535-13158-1-ND	3.2*2.5mm	
129	1	Y1	27MHz	27MHz ±30ppm Crystal 18pF 50 Ohm	YOKE	S5032B-027000-FA-16-30-YA	887-1093-1-ND	5*3.2mm	
130	0	C11,C12,C13,C14,C204,C205,C246,C275,C385	0.1uF	0.10µF ±10% 16V X7R Ceramic Capacitor	Yageo	CC0402KRX7R7BB104	311-1338-1-ND	0402	
131	0	C318,C325	0.33uF	0.33µF ±10% 6.3V X5R Ceramic Capacitor	Yageo	CC0402KRX5R5BB334	311-1683-1-ND	0402	
132	0	C426	33nF	0.033µF ±10% 16V X5R Ceramic Capacitor	Yageo	CC0402KRX5R7BB333	311-1695-2-ND	0402	
133	0	D50,D52	B240A-13-F	DIODE SCHOTTKY 40V 2A SMA	Diodes Inc.	B240A-13-F	B240A-FDICT-ND	DO-214AC, SMA	
134	0	FB4,FB7	GMLB-160808-0070S-N1	FERRITE BEAD 70 OHM 0603 1LN	MAG.LAYERS	GMLB-160808-0070S-N1	490-5253-1-ND	0603	
135	0	FB21	GMLB-100505-0120P-N8	FERRITE BEAD 120 OHM 0402 1LN	MAG.LAYERS	GMLB-100505-0120P-N8	490-4004-1-ND	0402	
136	0	J20	TU5005WNV-1x02	2 Positions Header, Unshrouded,	TYU	TU5005WNV-1x02	WM8072-ND		
137	0	R3,R4,R107,R108,R128,R129,R382,R384,R653,R669,R681,R694,R698,R707,R709,R790,R791,R792,R390,R374,R485,R486,R784,R617,R794,R353	10K	RES SMD 10K OHM 5% 1/16W 0402	Yageo	RC0402JR-0710K	11-10KJRCT-ND	0402	

138	0	R131,R132,R145,R148,R150,R151,R177,R178,R197,R198,R220,R221,R240,R354,R386,R392,R409,R418,R481,R489,R535,R536,R610,R618,R620,R624,R639,R658,R660,R686,R690,R692,R701,R740,R757,R758,R759,R760,R764,R766,R771,R772,R780,R781,R799,R581,R609,R695,R697,R700,R703,R705,R776,R777,R796	0	RES SMD 0.0OHM JUMPER 1/16W 0402	Yageo	RC0402JR-070R	311-0.0JRCT-ND	0402	
139	0	R369,R370,R371,R372	100	RES SMD 100 OHM 5% 1/20W 0201	Yageo	RC0201JR-07100R	311-100NCT-ND	0201	
140	0	R407,R483,R788,R789	100K	RES SMD 100K OHM 5% 1/16W 0402	Yageo	RC0402JR-07100K	311-100KJRCT-ND	0402	
141	0	R608,R750	0	RES SMD 0.0 OHM JUMPER 1/4W 1206	Yageo	RC1206JR-070R	311-0.0ERCT-ND	1206	
142	0	R783	330	RES SMD 330 OHM 5% 1/16W 0402	Yageo	RC0402JR-07330R	311-330JRCT-ND	0402	
143	0	U28,U63	SN74AUP1G07DCKR	IC BUFF/DVR NON-INV 3.6V SC705	Texas Instruments	SN74AUP1G07DCKR	296-18256-1-ND	SC70-5	
144	0	R144	7.5K	RES SMD 7.5K OHM 1% 1/16W 0402	Yageo	RTT027501FTH	311-7.50KLRCT-ND	Ralec	
145	0	C284	2.2nF	2200pF ±10% 16V X7R Ceramic Capacitor	Yageo	CC0201KRX7R7BB222	311-1602-1-ND	0201	
146	0	C314,C315	22uF	22µF ±20% 35V X5R Ceramic Capacitor	TDK	C3216X5R1V226M160AC	445-8045-1-ND	1206	
147	0	J29,J30	TU5005WNV-1x03	3 Positions Header, Unshrouded	TYU	TU5005WNV-1x03	WM8073-ND		
148	0	U64	TPS3808G01DRV	IC VOLT SUPERVISOR ADJ 6SON	Texas Instruments	TPS3808G01DRV	296-23656-1-ND	6-SON	

8.3 PCB Layout Recommendations

The layout for the TIDA-01226 has been created in PADS. The PCB has been designed to fit the form factor of the optical engine.

8.3.1 Layout Prints

To download the Layout Prints for each board, see the design files at http://www.ti.com/tool/TIDA-01226

TOP SILKSCREEN

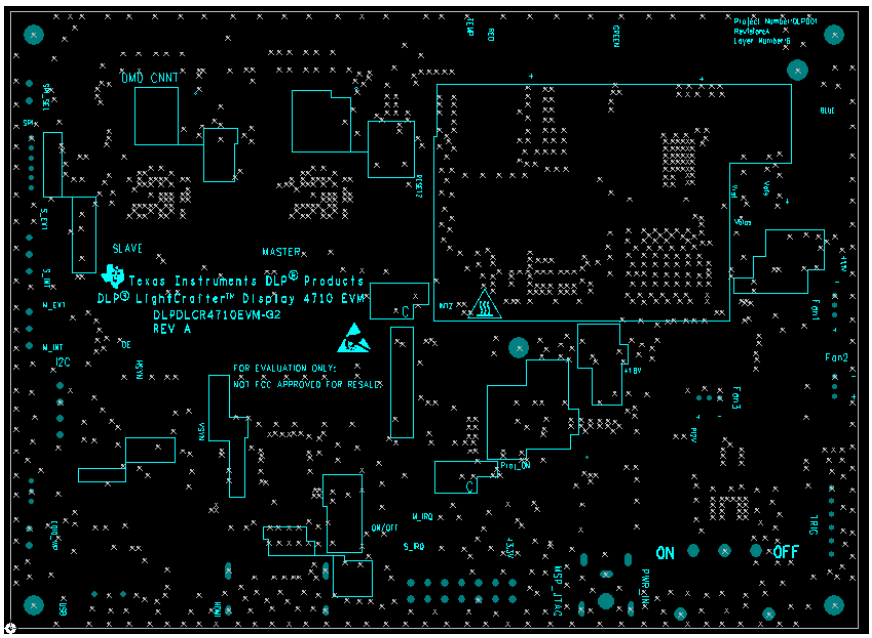


Figure 9: Silkscreen TOP

TOP SOLDER MASK

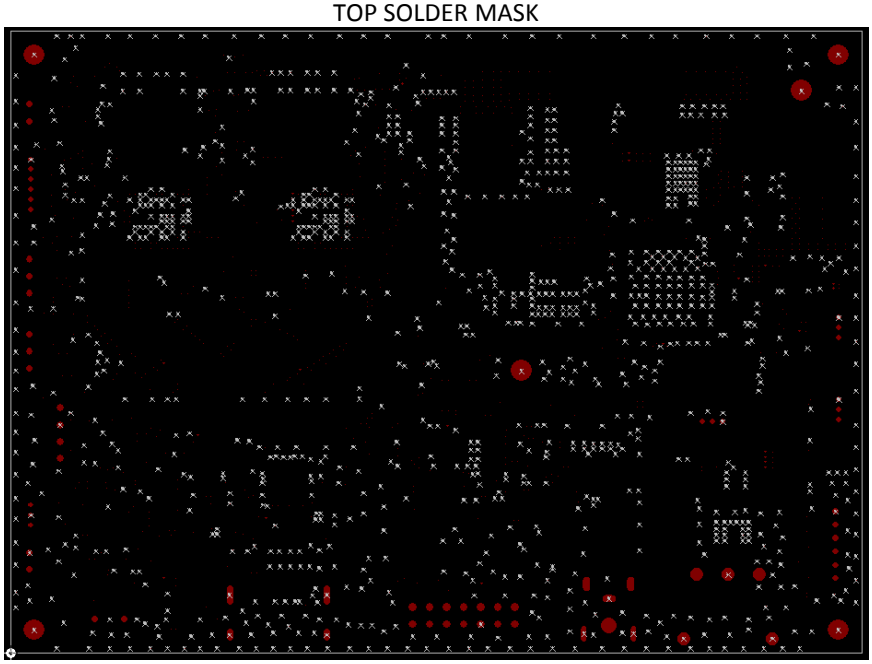


Figure 10: Solder Mask TOP

TOP LAYER

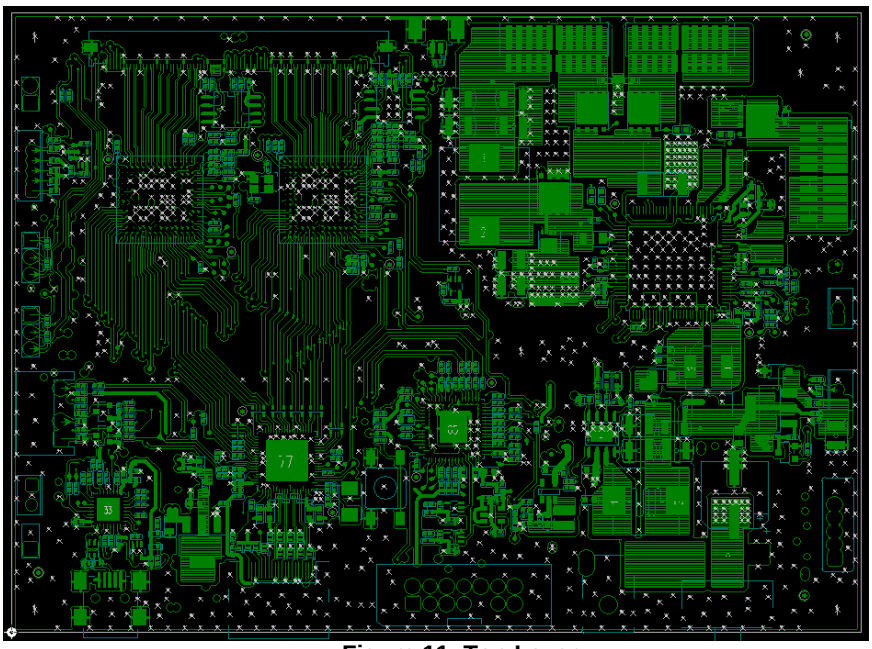


Figure 11: Top Layer

GROUND PLANE LAYER 2

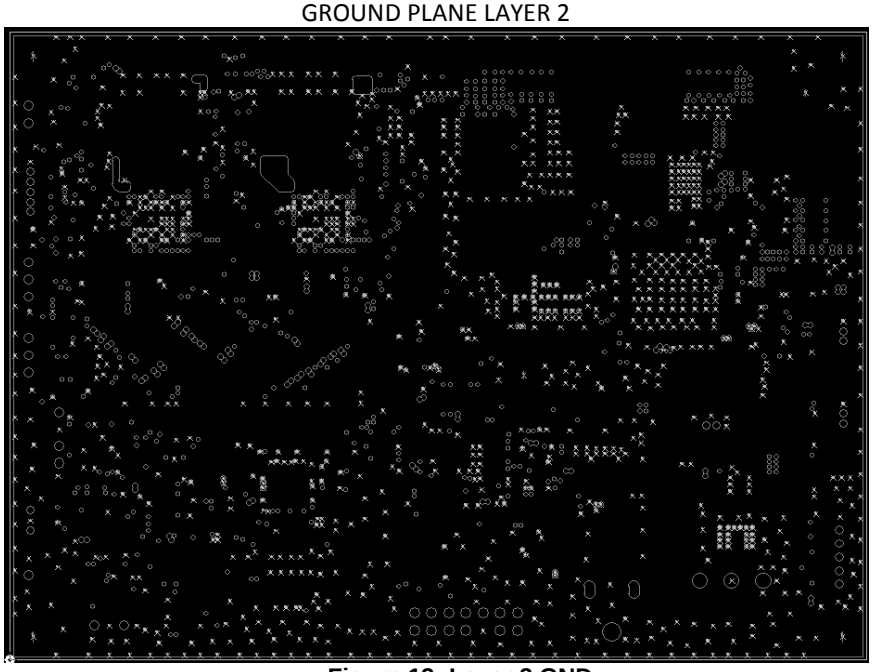


Figure 12: Layer 2 GND

SIGNAL LAYER 3

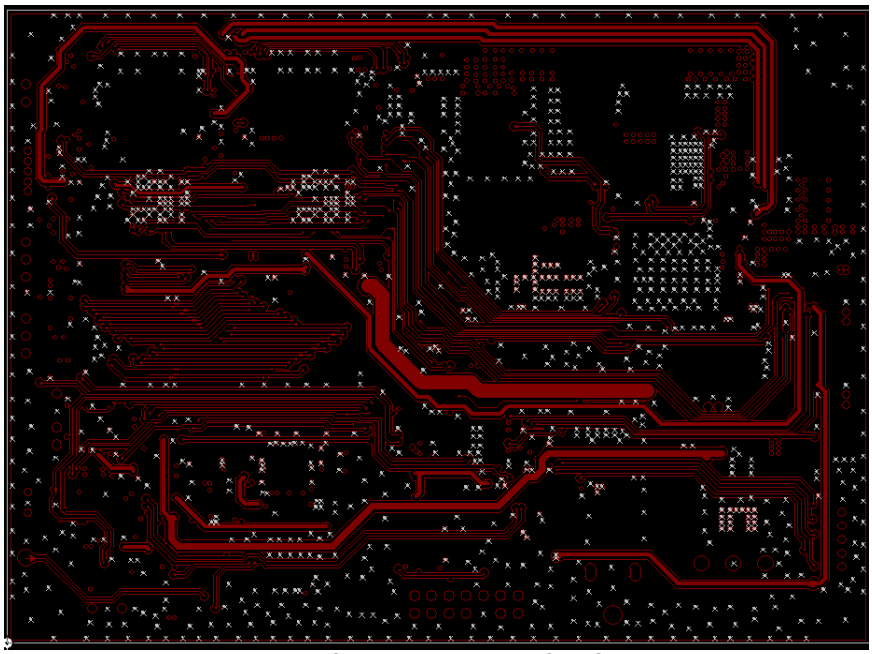


Figure 13: Layer 3 Signal

SIGNAL LAYER 4

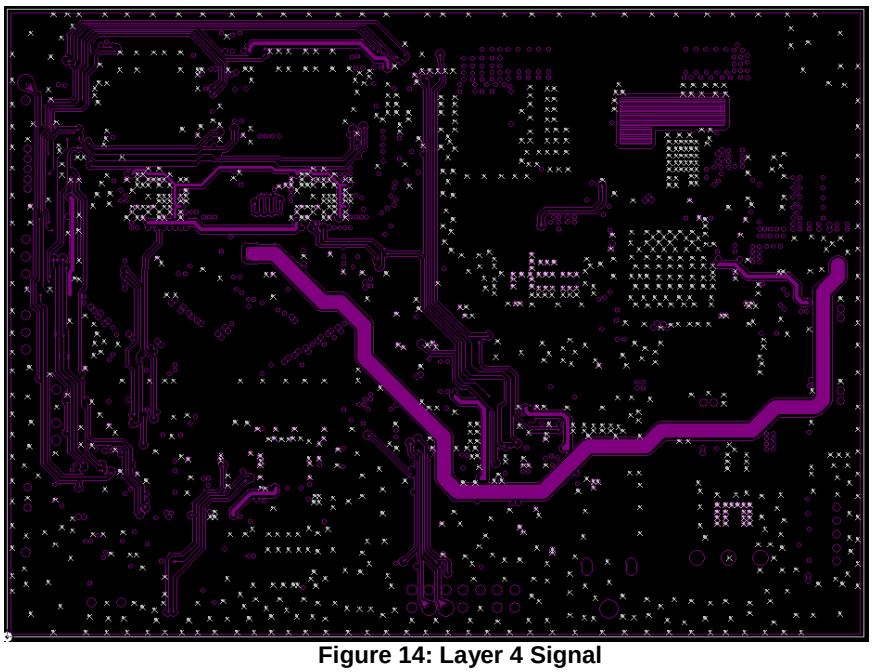


Figure 14: Layer 4 Signal

PWR LAYER 5

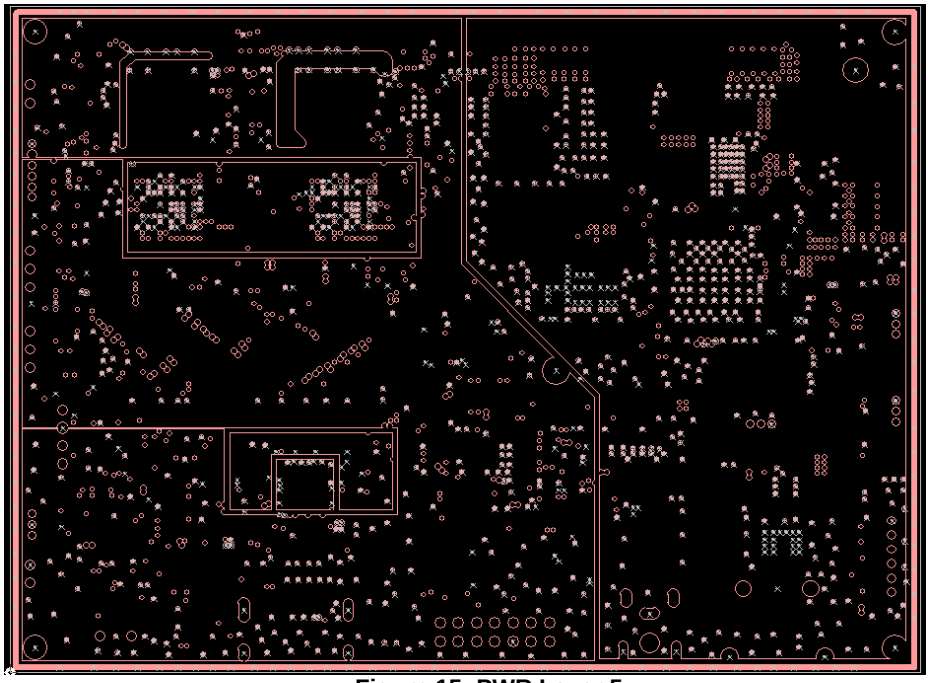


Figure 15: PWR Layer 5

BOTTOM LAYER

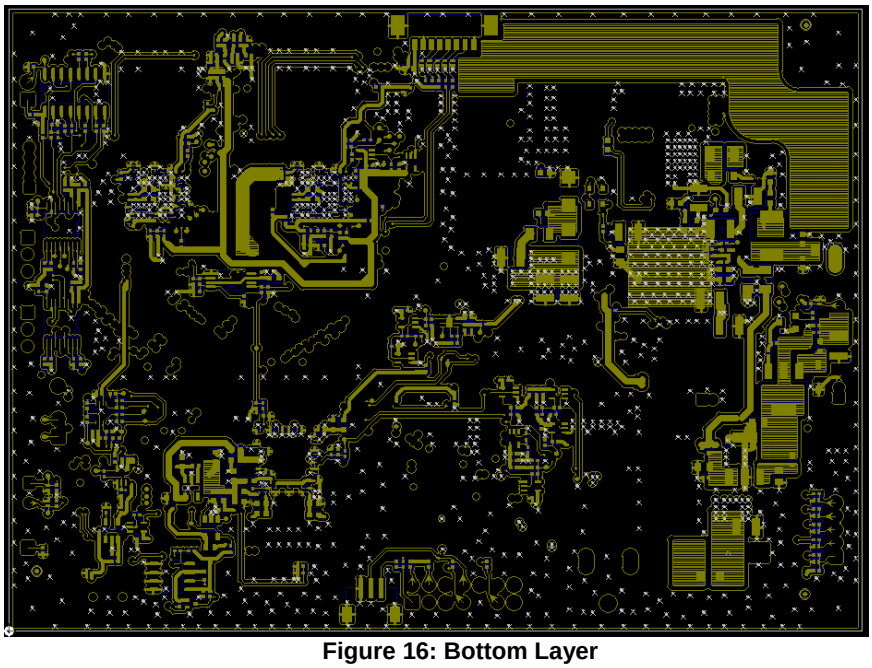


Figure 16: Bottom Layer

BOTTOM SOLDER MASK

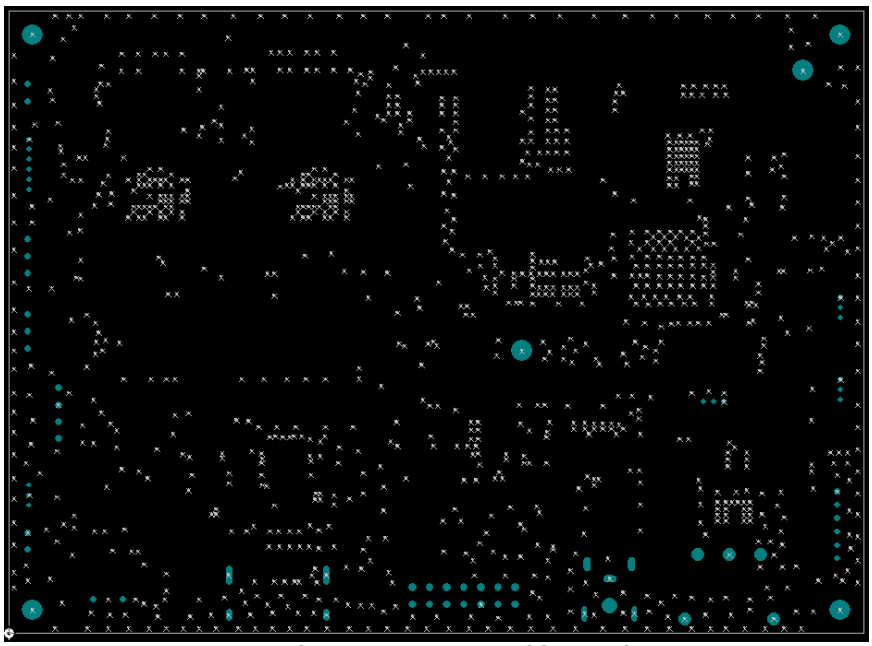


Figure 17: Bottom Solder Mask

BOTTOM SILKSCREEN

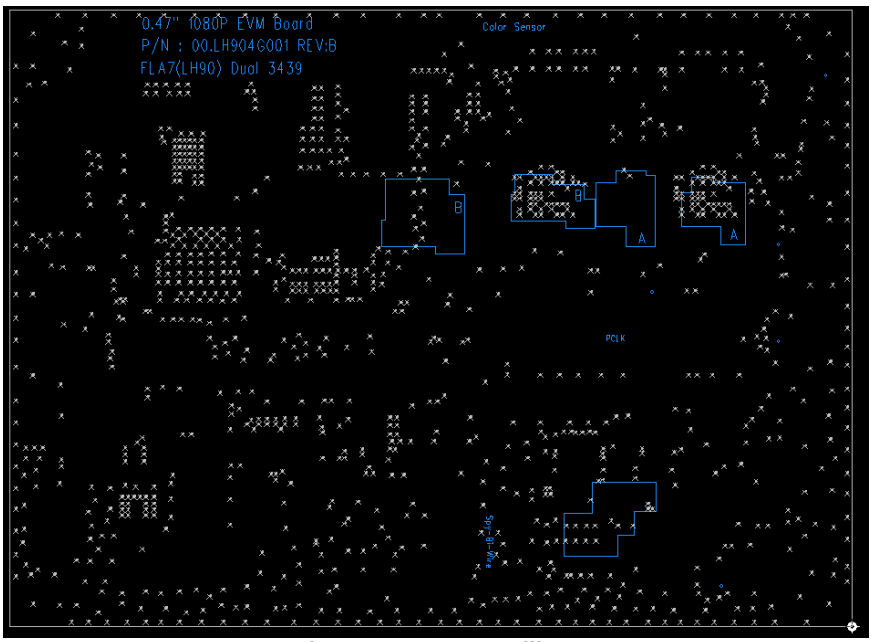


Figure 18: Bottom Silkscreen

MECHANICAL DIMENSIONS

Figure 19: Mechanical Dimensions

8.4 PADS Project

The PADS project files for each board can be downloaded from http://www.ti.com/tool/TIDA-01226

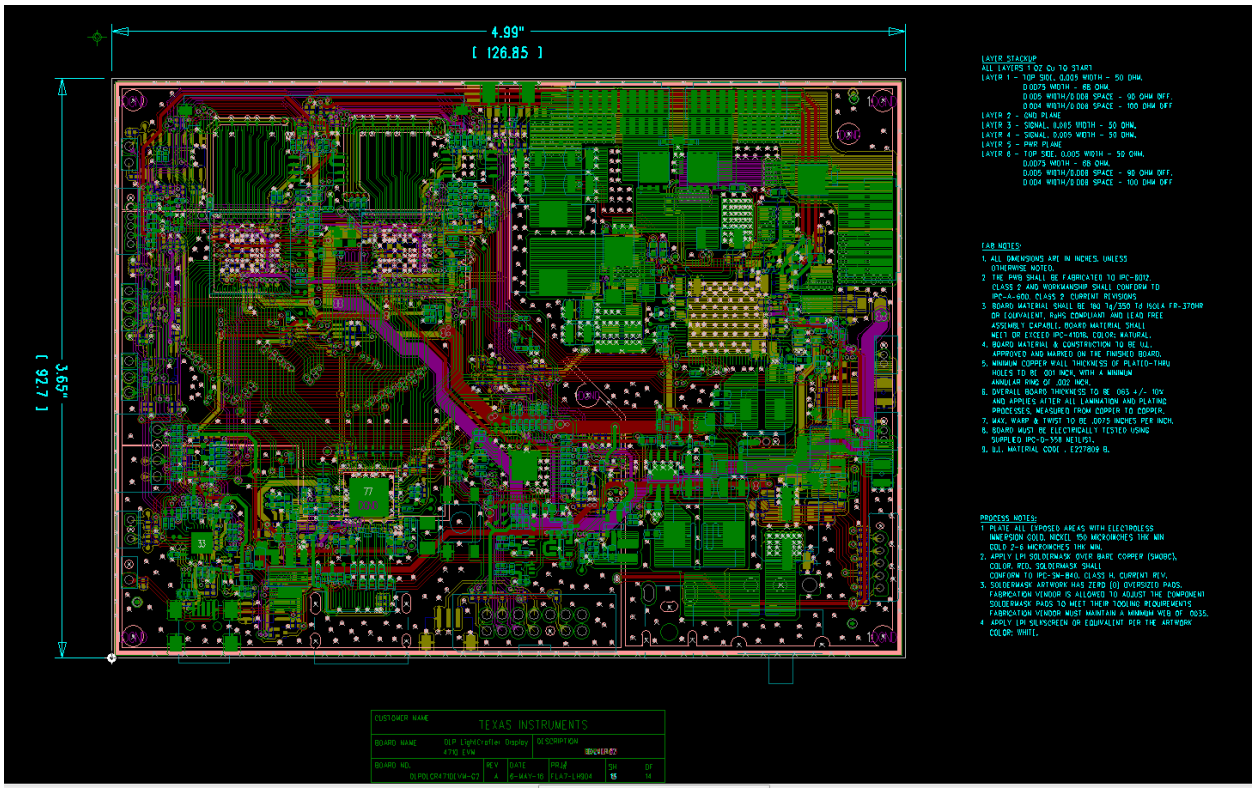


Figure 20: Layout

8.5 Layout Guidelines

The layout guidelines shown here are subsets of the guidelines included in the component datasheets. Please also refer to the DLPC3439, DLP4710 and DLPA3005 datasheet for more information.

8.5.1 DLPC3439 Layout Guidelines

TI recommends 1-oz. copper planes in the PCB design to achieve needed thermal connectivity.

8.5.1.1 PCB layout Guidelines for Internal ASIC PLL Power

The following guidelines are recommended to achieve desired ASIC performance relative to the internal PLL. Each DLPC3439 contains 2 internal PLLs which have dedicated analog supplies (VDD_PLLM , VSS_PLLM, VDD_PLLD, VSS_PLLD). As a minimum, VDD_PLLx power and VSS_PLLx ground pins should be isolated using a simple passive filter consisting of two series ferrites and two shunt capacitors (to widen the spectrum of noise absorption). It's recommended that one capacitor be a 0.1uf capacitor and the other be a 0.01-µF capacitor. All four components should be placed as close to the ASIC as possible but it's especially important to keep the leads of the high frequency capacitors as short as possible. Note that both capacitors should be connected across VDD_PLLM and VSS_PLLM / VDD_PLLD and VSS_PLLD respectfully on the ASIC side of the ferrites.
The characteristics for the ferrite beads should be as follows:

- DC resistance less than 0.40 Ω
- Impedance at 10 MHz equal to or greater than 180 Ω
- Impedance at 100 MHz equal to or greater than 600 Ω

The PCB layout is critical to PLL performance. It is vital that the quiet ground and power are treated like analog signals. Therefore, VDD_PLLM and VDD_PLLD must be a single trace from each DLPC3439 to both capacitors and then through the series ferrites to the power source. The power and ground traces should be as short as possible, parallel to each other, and as close as possible to each other.

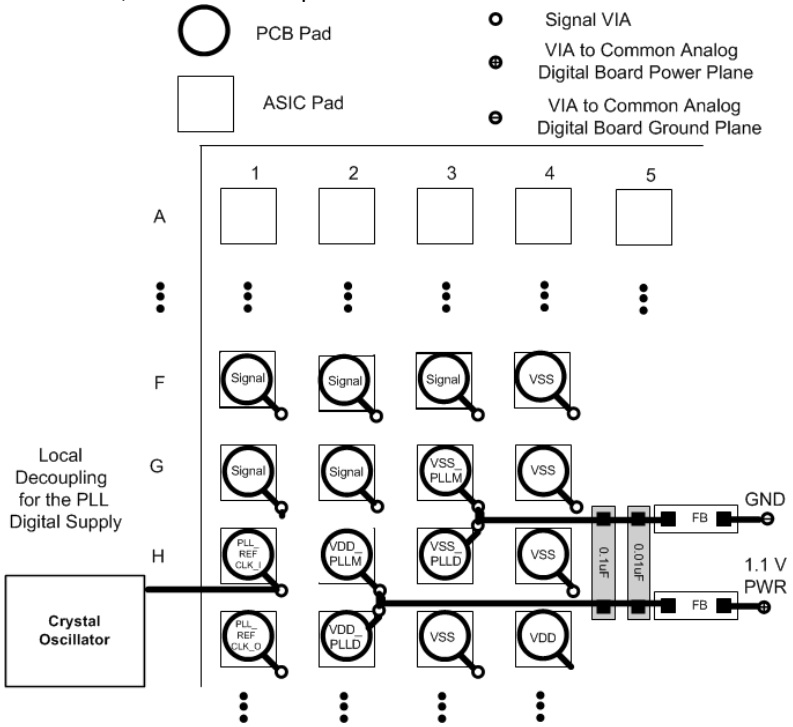


Figure 21: PLL Filter Layout

8.5.1.2 DLPC3439 Reference Clock

The DLPC3439 requires an external reference clock to feed its internal PLL. A crystal oscillator can supply this reference. For flexibility, the DLPC3439 accepts either of two reference clock frequencies, but both must have a

maximum frequency variation of ±200 ppm (including aging, temperature, and trim component variation). The two DLPC3439 devices require a single dedicated oscillator where the oscillator output drives both DLPC3439 devices. The oscillator must drive the PLL_REFCLK_I pin on each DLPC3439 and the PLL_REFCLK_O pins should be left unconnected. The external oscillator must be able to drive at least a 15-pF load. Routing length from the oscillator to each DLPC3439 should be closely matched.

8.5.1.3 Number of Layer Changes

- Single-ended signals: Minimize the number of layer changes
- Differential signals: Individual differential pairs can be routed on different layers, but the signals of a given pair should not change layers.

8.5.1.4 Terminations

- No external termination resistors are required on DMD_HS differential signals.
- The DMD_LS_CLK and DMD_LS_WDATA signal paths should include a 43-Ω series termination resistor located as close as possible to the corresponding ASIC pins.
- The DMD_LS_RDATA signal path should include a 43-Ω series termination resistor located as close as possible to the corresponding DMD pin.
- DMD_DEN_ARSTZ does not require a series resistor.
- Please refer to the DLPC3439 datasheet for length specifications.

8.5.1.5 Routing Vias and Stubs

- There should be no more than two vias on any DMD_HS_signal.
- Any and all vias on DMD_HS signals should be located as close to the ASIC as possible.
- There should be now more than two vias on the DMD_LS_CLK and DMD_LS_WDATA signals.
- Any and all vias on the DMD_LS_CLK and DMD_LS_WDATA signals should be located as close to the ASIC as possible.
- Stubs should be avoided.

8.5.2 DLPA3005 Layout Guidelines

For switching power supplies, the layout is an important step in the design, especially when it concerns high peak currents and high switching frequencies. If the layout is not carefully done, the regulator could show stability issues and/or EMI problems. Therefore, it is recommended to use wide and short traces for high current paths and for their return power ground paths. For the DMD HV regulator, the input capacitor, output capacitor, and the inductor should be placed as close as possible to the IC. In order to minimize ground noise coupling between different buck converters it is advised to separate their grounds and connect them together at a central point under the part. For the DMD HV regulator, the recommended value for the capacitors is 1 µF for VRST and VOFS, 470 nF for VBIAS. The inductor value is 10 µH.

The high currents of the buck converters concentrate around pins VIN, SWITCH and PGND (Figure 22). The voltage at the pins VIN, PGND and FB are DC voltages while the pin SWITCH has a switching voltage between VIN and PGND. When the FET betweenpins 52 – 53 is closed the red line indicates the current flow while the blue line indicates the current flow when the FET between pins 53 – 54 is closed. These paths carry the highest currents and must be kept as short as possible.

For the LDO supply to the DMD, it is recommended to use a 1 µF/16 V capacitor on the input and a 10 µF/6.3 V capacitor on the output of the LDO assuming an input voltage of 12 V. For LDO bucks, it is recommended to use a 1 µF/16 V capacitor on the input and a 1 µF/6.3 V capacitor on the output of the LDO.

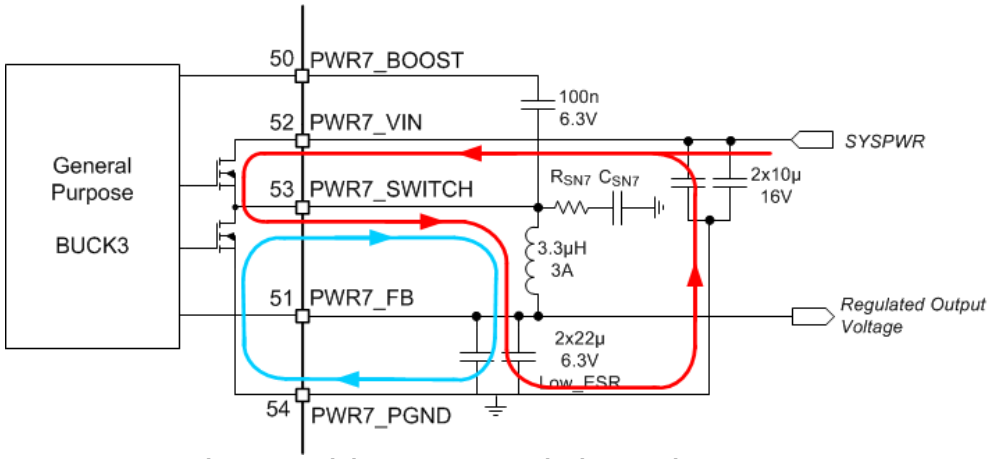


Figure 22: High AC Current Paths in a Buck Converter

The trace to the VIN pin carries high AC currents. Therefore the trace should have the lowest possible resistance to prevent voltage drop across the trace. Additionally the decoupling capacitors should be placed as close to the VIN pin as possible. The SWITCH pin is connected back and forth between the VIN or GND. This means a square wave voltage is present on the SWITCH pin with amplitude of VIN, and containing high frequencies. This can lead to EMI problems if not properly handled. To reduce EMI problems a snubber network (RSN7 & CSN7) is placed at the SWITCH pin to prevent and/or suppress unwanted high frequency ringing at the moment of switching. The PGND pin sinks high current and should also be connected to a star ground point such that it does not interfere with other ground connections.
The FB pin is the sense connection for the regulated output voltage which is a DC voltage; no current is flowing through this pin. The voltage on the FB pin is compared with the internal reference voltage in order to control the loop. The FB connection should be made at the load such that I•R drop is not affecting the sensed voltage.

8.5.2.1 SPI Connections

The SPI interface consists of several digital lines and the SPI supply. If routing of the interface lines is not done properly, communication errors can occur. The SPI lines should not be routed close to potential interfering sources. Noise cntamination can be prevented by ensuring that the SPI ground line is routed together with the digital lines as much as possible to the respective pins. The SPI interface should have a dedicated ground connection to the DGND of the DLPA3005 (Figure 23). This prevents ground noise between SPI ground references of DLPA3005 and DLPC due to the high current in the system.

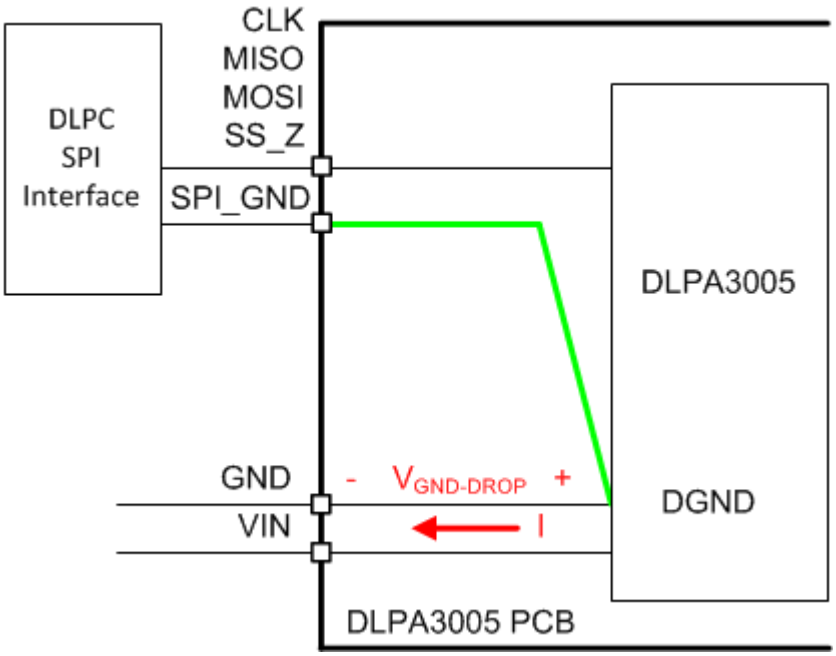


Figure 23: SPI Connections

Interfering sources should be kept away from the interface lines as much as possible. Especially high current lines such as neighboring PWR_7 should be routed carefully. If PWR_7 is routed too close to for instance the SPI_CLK it could lead to false clock pulses and thus communication errors.

8.5.2.2 R_{LIM} Routing

RLIM is used to sense the LED current. To accurately measure the LED current, the RLIM _K_1,2 lines should be connected close to the top-side of measurement resistor RLIM, while RLIM_BOT_K_1,2 should be connected close to the bottom-side of RLIM. The switched LED current is running through RLIM. Therefore a low-ohmic ground connection for RLIM is strongly advised.

8.5.2.3 LED Connection

The wiring from the external RGB switches to the LEDs carries large switching currents. Special attention needs to be paid to these connections.
Two perspectives apply to the LED-to-RGB switches wiring:

1. The resistance of the wiring, Rseries
2. The inductance of the wiring, Lseries

The location of the parasitic series impedances are depicted in Figure 24.

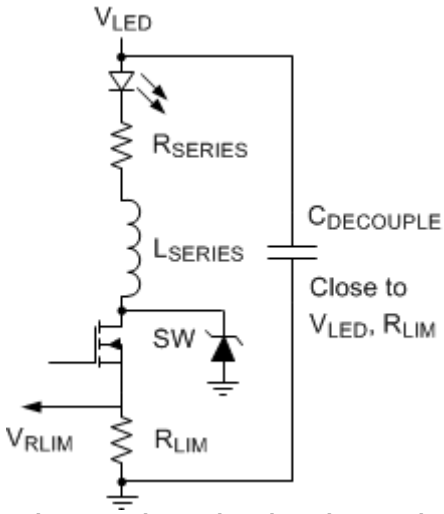


Figure 24: Parasitic Inductance (L_{Series}) and Resistance (R_{Series}) in Series with LED

Currents up to 16 A can run through the wires connecting the LEDs to the RGB switches. Even small resistances in these connections can cause noticeable power dissipation. Assuming 16A of LED current, every 10 mΩ of series resistance results in a parasitic power dissipation of 2.5 W. This might cause PCB heating, but more important overall system efficiency is deteriorated.
Additionally the resistance of the wiring might impact the control dynamics of the LED current. It should be noted that the routing resistance is part of the LED current control loop. The LED current is controlled by VLED. For a small change in VLED (ΔVLED) the resulting LED current variation (ΔILED) is given by the total differential resistance in that path, as:

$$\Delta I_{LED} = \frac{\Delta V_{LED}}{r_{LED} + R_{series} + R_{on\_SW\_Q3,Q4,Q5} + R_{LIM}}$$

where
rLED is the differential resistance of the LED
Ron_SW_P,Q,R the on resistance of the strobe decoder switch.

In this expression Lseries is ignored since realistic values are usually too low to cause any noticeable impact on the power dynamics. All the comprising differential resistances are in the range of 12.5 mΩ to several 100's mΩ. Without paying special attention a series resistance of 100 mΩ can easily be obtained. It is advised to keep this series resistance sufficiently low, i.e. <10 mΩ. The series inductance plays an important role when considering the switched nature of the LED current. While cycling through R, G and B LEDs, the current through these branches is turned-on and turned-off in short time duration. Specifically turning off is fast. A current of 16 A goes to 0 A in a matter of 50 ns. This implies a voltage spike of about 1 V for every 5 nH of parasitic inductance. It is recommended to minimize the series inductance of the LED wiring by:

- Short wires
- Thick wires / Multiple parallel wires
- Small enclosed area of the forward and return current path

If the inductance cannot be made sufficiently low, a Zener diode needs to be used to clamp the drain voltage of the RGB switch such it does not surpass the absolute maximum rating. The clamping voltage need to be chosen between the maximum expected VLED and the absolute maximum rating. Be sure to maintain sufficient margin of the clamping voltage relative to the mentioned minimum and maximum voltage.

8.5.3 DLP4710 Layout Guidelines

There are no specific layout guidelines for the DMD as the DMD is typically connected using a board to board connector to and a flex cable. The flex cable provides the interface of data and ctrl signals between the DLPC3439 controller and the DLP4710 DMD. Some layout guideline for the flex cable interface to the DMD are:

- Match lengths for the LS_WDATA and LS_CLK signals.
- Minimize vias, layer changes, and turns for the HS bus signals.
- Minimum of two 220-nF decoupling capacitor close to VBIAS.
- Minimum of two 220-nF decoupling capacitor close to VRST.
- Minimum of two 220-nF decoupling capacitor close to VOFS.
- Minimum of four 220-nF decoupling capacitor close to VDDI and VDD.

8.6 Gerber files

To download the Gerber files for each board, see the design files at http://www.ti.com/tool/TIDA-01226

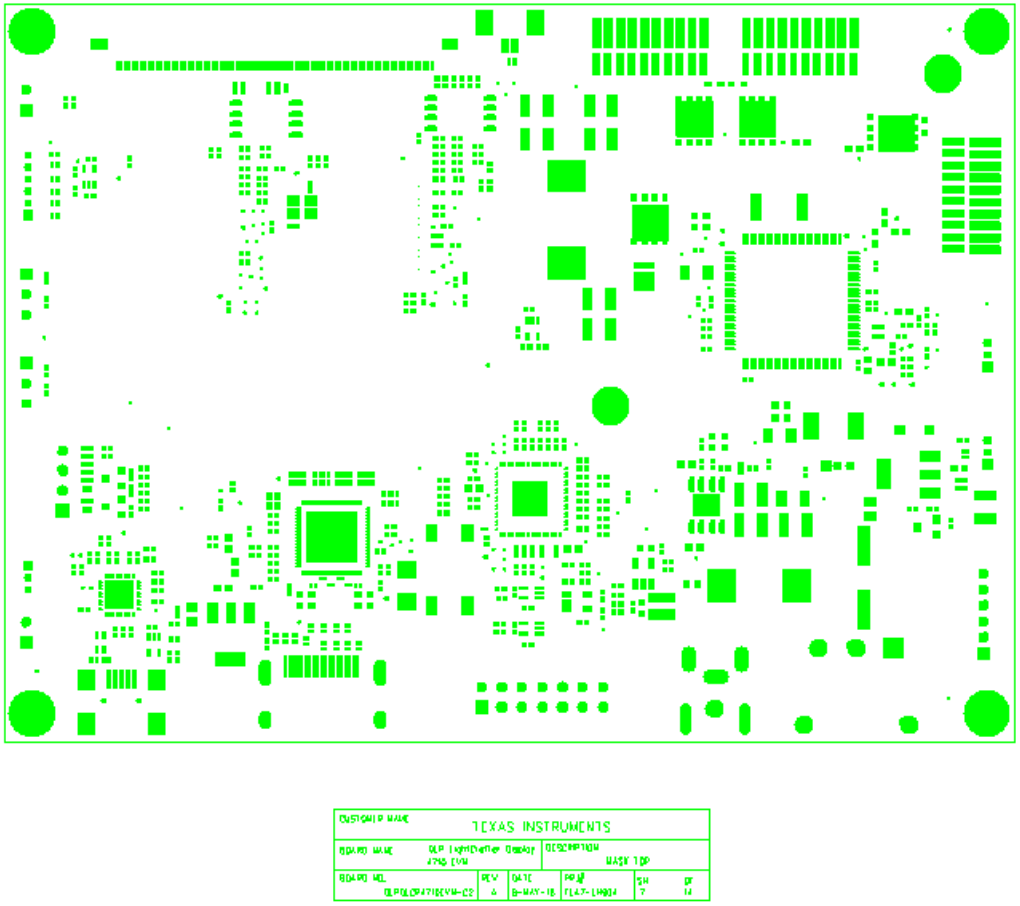


Figure 25: Gerber Layer 1

8.7 Assembly Drawings

To download the Assembly Drawings for each board, see the design files at http://www.ti.com/tool/TIDA-01226

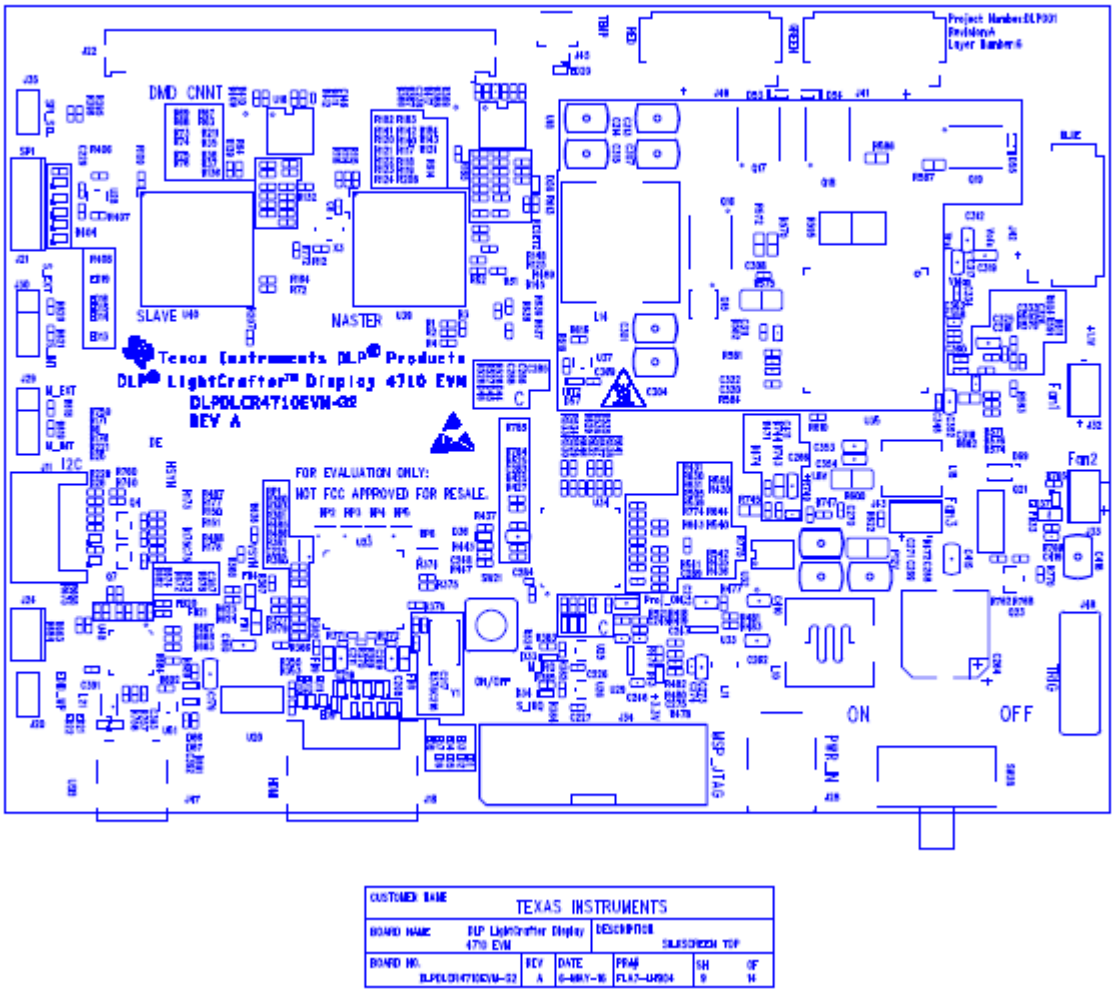


Figure 26: Assembly TOP

9 Software Files

To download the software files for this reference design, please see the link at http://www.ti.com/tool/DLPDLCR4710EVM-G2

10 References

1. Texas Instruments E2E Community, https://e2e.ti.com/support/dlp__mems_micro-electro-mechanical_systems
2. Texas Instruments DLPC3439 datasheet http://www.ti.com/lit/ds/symlink/dlpc3439.pdf
3. Texas Instruments DLPA3005 datasheet http://www.ti.com/lit/ds/symlink/dlpa3005.pdf
4. Texas Instruments DLP4710 datasheet http://www.ti.com/lit/ds/symlink/dlp4710.pdf

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