EVM User's Guide: TLC6984EVM

TLC6984 48 × 16 Common Cathode Matrix LED Display Driver Evaluation Module

Description

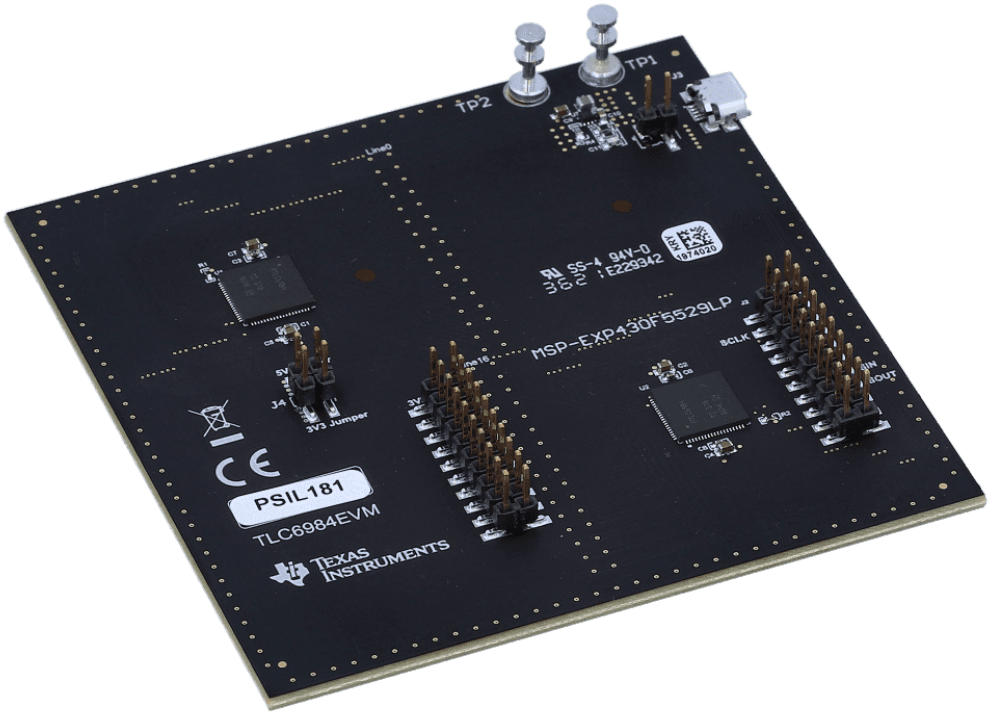
The TLC6984 evaluation module is used as a reference for engineering demonstration and evaluation. Included in this user's guide are setup instructions, a schematic diagram, printed board (PCB) layout and a bill of materials (BOM).

Features

- 48 current source channels from 0.2mA to 20mA
- 16 scan line Switches with 190mΩ RDS(ON)
- Ultra low power consumption
- High speed and low EMI continuous clock series interface (CCSI)

Applications

- Narrow Pixel Pitch (NPP) LED display
- Mini and micro-LED products



1 Evaluation Module Overview

1.1 Introduction

The TLC6984 is a highly integrated, common cathode matrix LED display driver with 48 constant current sources and 16 scanning FETs. One TLC6984 is capable of driving 16 × 16 RGB LED pixels, while stacking two TLC6984s can drive 32 × 32 RGB LED pixels, three TLC6984s are capable of driving 48 × 48 RGB LED pixels, and stacking four TLC6984s can drive 64 × 64 RGB LED pixels. To achieve low power consumption, the device supports separated power supplies for the red, green, and blue LEDs by the common cathode structure. Furthermore, the operation power of the TLC6984 is significantly reduced by ultra-low operation voltage range (Vcc down to 2.5V) and ultra-low operation current (Icc down to 3.6mA).

This user's guide describes the TLC6984 evaluation module used as a reference for engineering demonstration and evaluation. Included in this user's guide are setup instructions, a schematic diagram, printed board (PCB) layout, and a bill of materials (BOM).

1.2 Kit Contents

- One TLC6984EVM board

Note that this EVM requires a controller (for example, MCU), which is not included.

1.3 Specification

The TLC6984 device supports per-channel current from 0.2mA to 20mA, with typical 1% channel-to-channel current deviation and typical 1% device-to-device current deviation. The DC current value of all 48 channels is set by an external IREF resistor and can be adjusted by the 8-step global brightness control (BC) and the 256-step per-color group brightness control (CC_R/CC_G/CC_B).

1.4 Device Information

The TLC6984 implements a high speed, dual-edge transmission interface to support high device count daisy-chained and high refresh rate while minimizing electrical-magnetic interference (EMI). The device supports up to 25MHz SCLK (external) and up to 160MHz GCLK (internal). Meanwhile, the device integrates enhanced circuits and intelligent algorithms to solve the various display challenges in Narrow Pixel Pitch (NPP) LED display applications and mini and micro-LED products. The display challenges are dim at the fist scan line, upper and downside ghosting, non-uniformity in low gray scale, coupling, caterpillar caused by open or short LEDs, which make the TLC6984 an excellent choice in such applications.

The TLC6984 also implements LED open and weak, short and short detections and removals during operations and can also report this information out to the accompanying digital processor.

2 Hardware

2.1 TLC6984 EVM Board

The driver IC side of the TLC6984EVM board is shown in Figure 2-1.

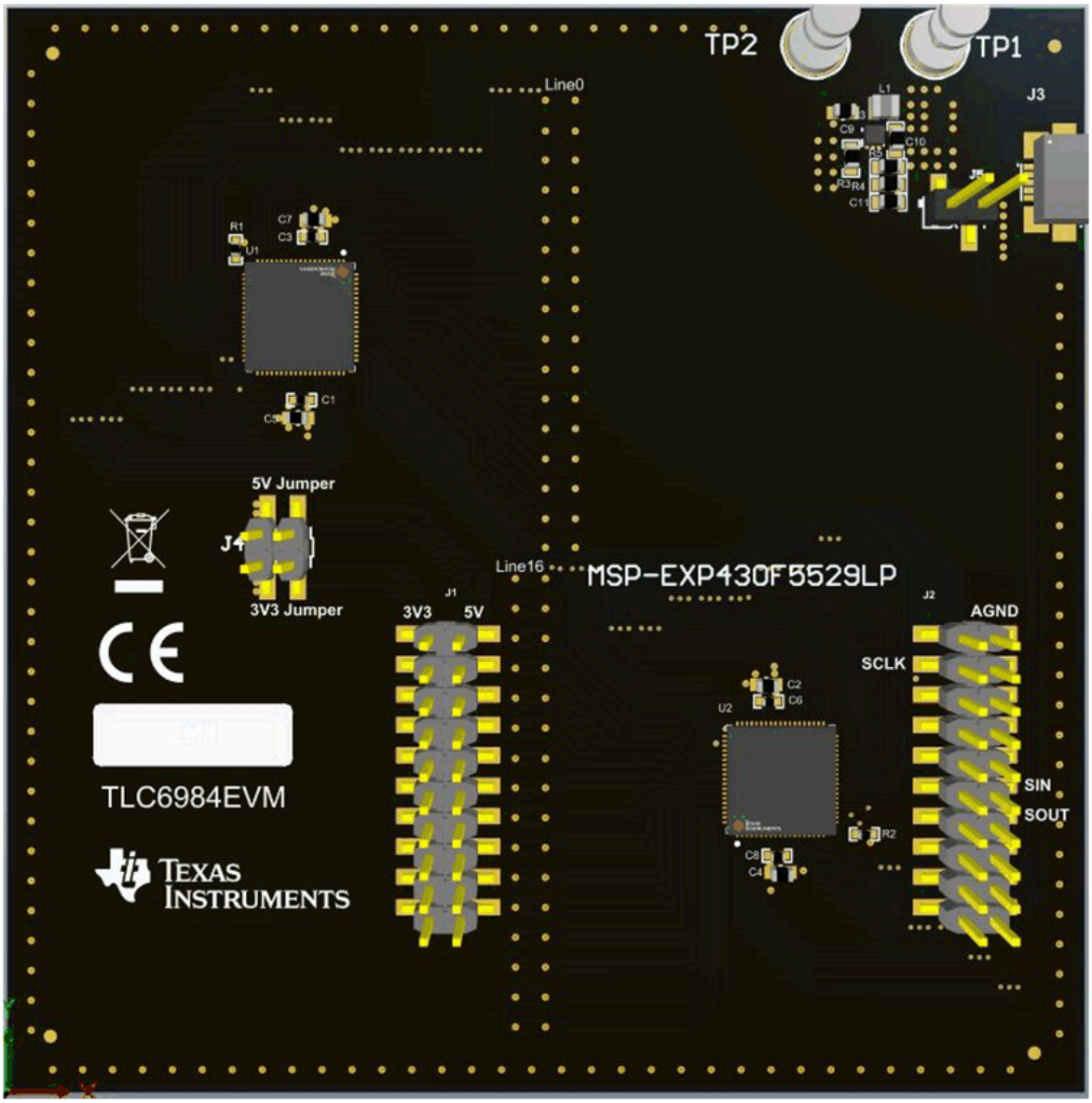


Figure 2-1. Driver IC Side of the TLC6984EVM Board

2.2 Connectors

The TLC6984EVM has the following connectors:

- TP1 (+5 V): input power supply for VLEDG/VLEDB and DC/DC
- TP2 (GND): supply ground
- J1, J2: boosterpack connectors for connecting with the TMS320F280039C LaunchPad™ for C2000™ real-time MCU
- J3: mini-USB connector for 5V power input

2.3 Jumpers

The TLC6984EVM has the following jumpers:

- J4 (5V Jumper): input 5V power supply from J3 or J1/J2
- J4 (3V3 Jumper): input 3V3 power supply from J3 (DC/DC) or J1/J2
- J5: 3.3V power supply from DC/DC

3 Software

3.1 Software Setup

To set up the software for the TMS320F280039C LaunchPad, please follow the steps documented in the sample code user's guide which can be downloaded from *LP589x(-Q1)/TLC698x Sample Code User's Guide*. This user's guide also provides guidance on software setup for LED fault diagnostics, multiple CCSI buses, cascading devices, and animation control.

4 Implementation Results

4.1 Test Setup

The typical parameters for TLC6984 EVM are shown in Table 4-1.

Table 4-1. TLC6984EVM Parameters

Parameter	Value
VCC device supply voltage	2.5–5.5 V
VLEDR/G/B supply voltage	2.5–5.5 V
ICH constant output source current	0.2–20 mA

The TLC6984EVM can be setup and tested by following these steps:

1. USB power supply
   a. Download the code to TMS320F280039C LaunchPad with TI Code Composer Studio software.
   b. Connect boosterpack connectors (J1, J2 on EVM board) with the TMS320F280039C LaunchPad. The connection method is shown in Figure 4-1.
   c. Disconnect J4 jumpers (5V/ 3V3) block, connect J5 jumper, and connect J3 with the mini-USB cable (the same cable with the TMS320F280039C LaunchPad).
2. External power supply
   a. Download the code to TMS320F280039C LaunchPad with TI Code Composer Studio software.
   b. Connect boosterpack connectors (J1, J2 on EVM board) with the TMS320F280039C LaunchPad. The connection method is shown in Figure 4-1.
   c. Disconnect J4 jumpers (5V/ 3V3), connect J5 jumper, and connect TP1/TP2 to 5V/GND power source.
   d. Power on 5V/GND power supply.

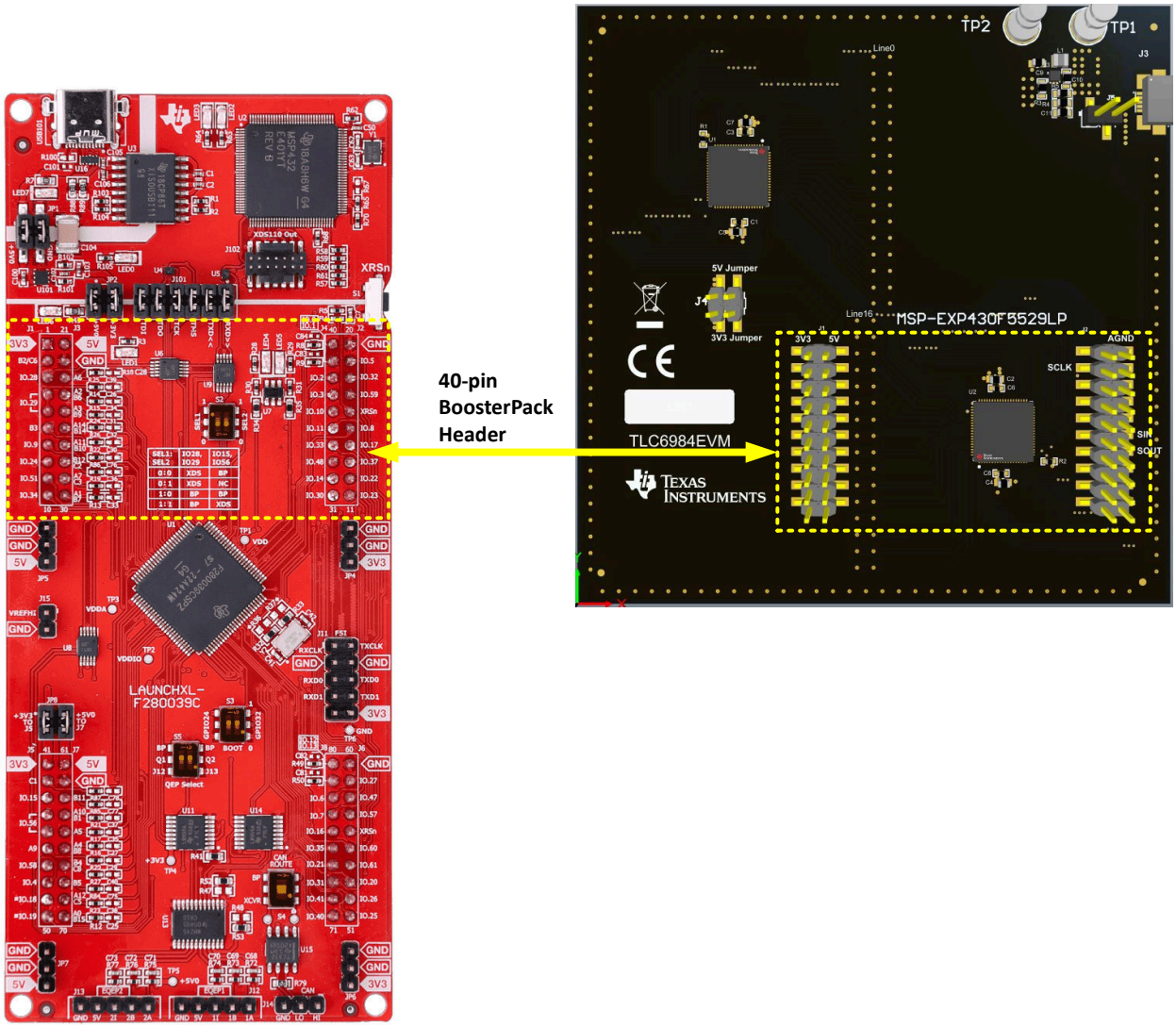


Figure 4-1. TLC6984EVM and TMS320F280039C LaunchPad

5 Hardware Design Files

5.1 Schematics

EVM schematics are shown as below.

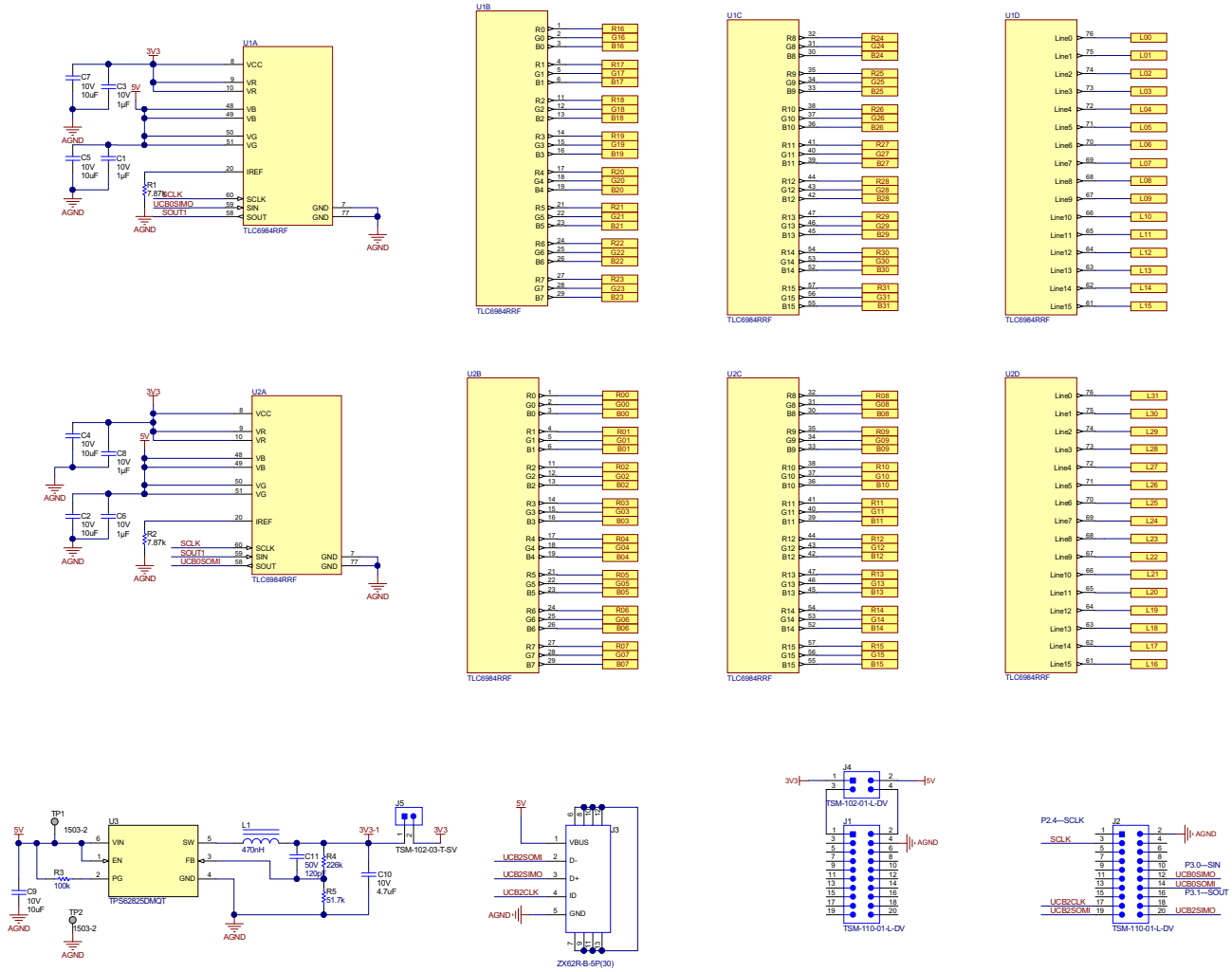


Figure 5-1. TLC6984EVM Schematic (1 of 3)

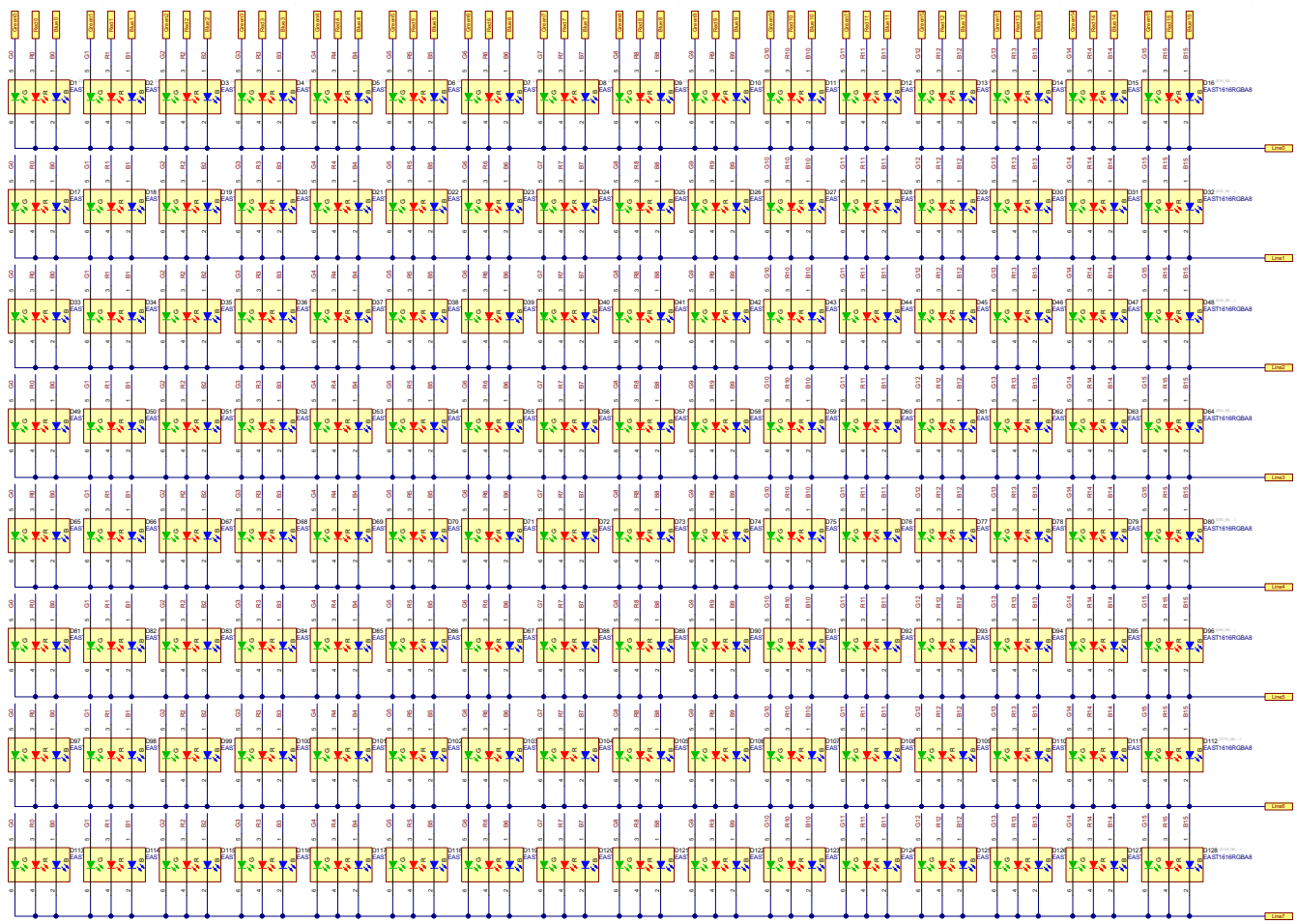


Figure 5-2. TLC6984EVM Schematic (2 of 3)

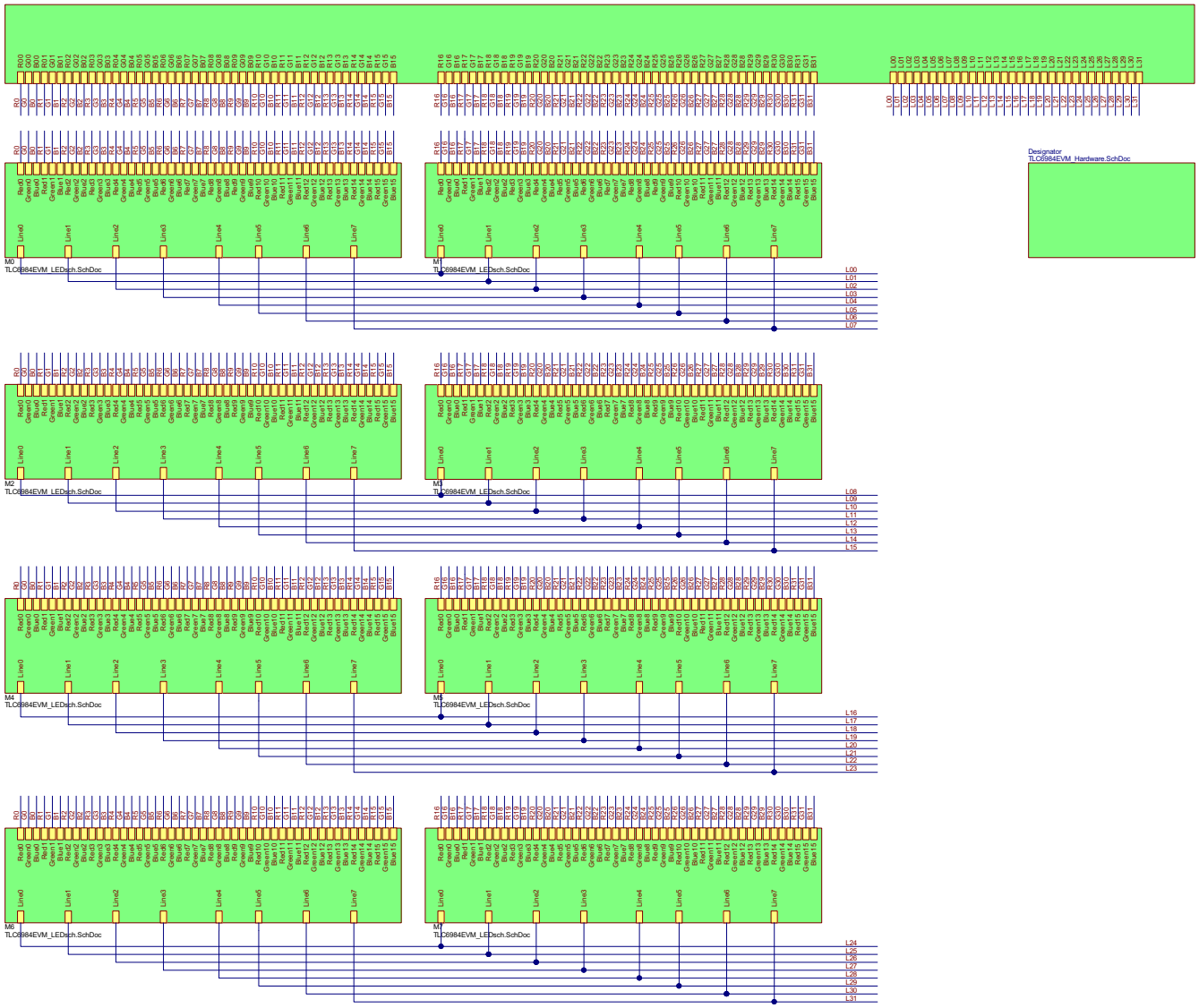


Figure 5-3. TLC6984EVM Schematic (3 of 3)

5.2 Board Layout

The EVM board layout is shown in Figure 5-4.

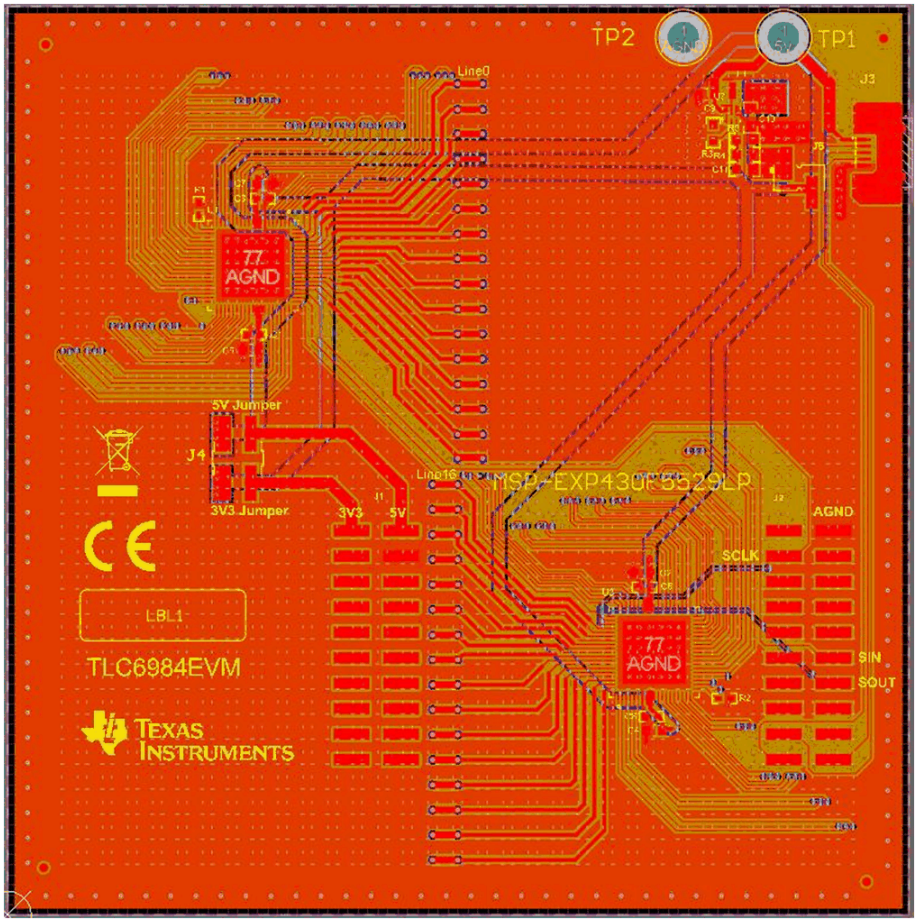


Figure 5-4. TLC6984EVM Layout

5.3 Bill of Materials

The TLC6984 EVM BOM is listed in Table 5-1.

Table 5-1. TLC6984 EVM Bill of Materials

Item No.	Designator	QTY	Value	Part Number	Manufacturer	Description	Package Reference
1	C1, C3, C6, C8	4	1 uF	CL05A105MP5NNNC	Walsin	CAP, CERM, 1µF, 10V,+/- 20%, X5R, 0402	0402
2	C2, C4, C5, C7, C9	5	10 uF	ZRB18AD71A106KE01L	MuRata	CAP, CERM, 10uF, 10V, +/- 10%, X7T, 0603	0603
3	C10	1	4.7 uF	CGB3B1X5R1A475K055AC	TDK	CAP, CERM, 4.7uF, 10V, +/- 10%, X5R, 0603	0603
4	C11	1	120pF	VJ0603A121FXACW1BC	Vishay-Sprague	CAP, CERM, 120pF, 50V, +/- 1%, C0G/NP0, 0603	0603
5	D1_M0…D128_M7	1024	RGB	EAST1616RGBA8	Everlight	LED, RGB, SMD	1.6x1.6mm
6	J1, J2	2		TSM-110-01-L-DV	Samtec	Header, 2.54mm, 10x2, Gold, SMT	Header, 2.54mm, 10x2, SMT
7	J3	1		ZX62R-B-5P(30)	Hirose Electric Co. Ltd.	Connector, Receptacle, Micro-USB Type B, Top Mount SMT	Connector USB Mini B
8	J4	1		TSM-102-01-L-DV	Samtec	Header, 2.54mm, 2x2, Gold, SMT	Header, 2.54mm, 2x2, SMT
9	J5	1		TSM-102-03-T-SV	Samtec	Header, 2.54mm, 2x1, Tin, SMT	Header, 2.54mm, 1x2, SMT
10	L1	1	470 nH	DFE201610E-R47M=P2	MuRata	Inductor, Shielded, Metal Composite, 470nH, 3.6A, 0.032 ohm, SMD	1.6x2mm
11	LBL1	1		THT-14-423-10	Brady	Thermal Transfer Printable Labels, 0.650" W x 0.200" H - 10,000 per roll	PCB Label 0.650 x 0.200 inch
12	R1, R2	2	7.87 k	CRCW04027K87FKED	Vishay-Dale	RES, 7.87 k, 1%, 0.063 W, AEC-Q200 Grade 0, 0402	0402
13	R3	1	100 k	CRCW0603100KFKEA	Vishay-Dale	RES, 100 k, 1%, 0.1 W, 0603	0603
14	R4	1	226 k	CRCW0603226KFKEA	Vishay-Dale	RES, 226 k, 1%, 0.1 W, 0603	0603
15	R5	1	51.7 k	RT0603BRD0751K7L	Yageo America	RES, 51.7 k, 0.1%, 0.1 W, 0603	0603
16	TP1, TP2	2		1503-2	Keystone	Terminal, Turret, TH, Double	Keystone1503-2
17	U1, U2	2		TLC6984RRF	Texas Instruments	48x16 Common Cathode Matrix LED Display Driver with Ultra Low Power	VQFN76
18	U3	1		TPS62825DMQT	Texas Instruments	2A High Efficiency Synchronous Buck Converter, DMQ0006A (VSON-HR-6)	DMQ0006A

6 Additional Information

6.1 Trademarks

LaunchPad™ and C2000™ are trademarks of Texas Instruments.
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7 Revision History

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

Changes from Revision * (October 2021) to Revision A (September 2024)	Page
• Updated hardware setup figures to use TMS320F280039C	3
• Add *Software Setup* section with instructions in *Sample Code User's Guide*	4
• Changed instructions to use LAUNCHXL-F280039C instead of MSP430F5529 LaunchPad	4

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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

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

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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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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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