

# EVM User's Guide: TDP2004EVM

## TDP2004 Evaluation Module

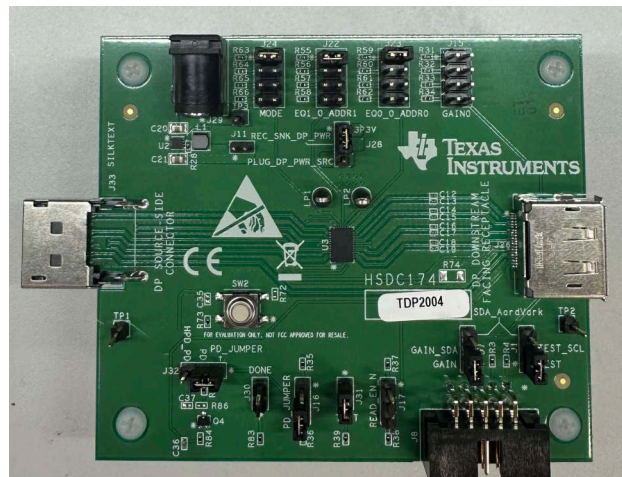


### Description

The TDP2004 EVM is a PCB created to help for customers evaluate the TDP2004 for video applications with Display Port (DP) interfaces. This EVM can also be used as a hardware reference design for implementations of the TDP2004. PCB design or layout files can be provided upon request to provide PCB design illustrations of the routing or placement rules with a TDP2004 component.

### Features

- Supports DisplayPort 2.1 up to 20Gbps - RBR, HBRx, UHBRx
- Protocol agnostic linear equalizer supporting most AC coupled interfaces up to 20Gbps
- Excellent electrical performance at 20Gbps (10GHz Nyquist):
  - 19dB equalization
  - 1.8V DC linearity, 1.08V AC linearity
  - -15dB/ -16dB Rx / Tx return loss
  - -60dB NEXT, -43 dB FEXT cross talk
  - 70 fs low additive RJ with PRBS data
- Transparent to DisplayPort 1.4 and 2.1 link training
- Single 3.3V supply with low active power: 160mW / channel
- Internal voltage regulator provides immunity to supply noise
- High linearity easing DP compliance ratio tests
- High channel BW resulting excellent linear EQ curves
- Pin-strap, I2C or EEPROM programming
  - 18 EQ boost settings
  - 5 flat gain settings
- TDP2004: 0°C to 70°C commercial temperature
- TDP2004I: -40°C to 85°C industrial temperature
- 4mm × 6mm, 40 pin WQFN package



# 1 Evaluation Module Overview

## 1.1 Introduction

This user's guide details how to use and configure the TDP2004EVM along with recommendations for system hardware implementation. These recommendations are only guidelines and the designer is responsible for all system characteristics and requirements. Engineers must refer to the data sheet for technical details, such as device operation, and terminal description.

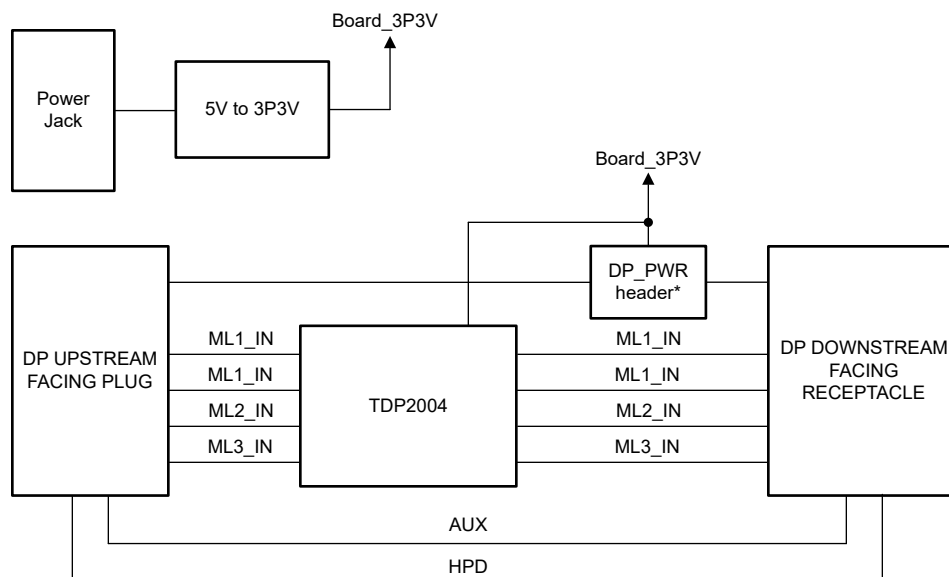
The TDP2004 EVM provides a source side redriver test platform. The EVM contains a DP plug (source side) and DP receptacle (sink side) to test the functionality of the device. This device can be plugged into any DP-2.1 receptacle to add redriver functionality to the system. The EVM also has multiple EQ settings to optimize signal integrity.

## 1.2 Kit Contents

The major components of the EVM are as below:

- The TDP2004 device
- Standard DP 2.1 source side connector (plug)
- Standard DP 2.1 downstream facing connector (receptacle)
- DC power regulators
- I2C programming interface for external I2C host connections
- Standard 5V barrel jack receptacle
- Headers for configuring various TDP2004 features

## 1.3 Specification



**Figure 1-1. Block Diagram**

## 1.4 Device Information

The TDP2004 EVM is used to implement the TDP2004. The TDP2004 is a 4-channel DisplayPort 2.1 redriver with a max data rate of 20Gbps. The TDP2004 is interfaced via two DP2.1 ports. One plug for the source side connection and one receptacle for the sink side connection. This device can be configured in either I2C mode or pin-strap mode (recommended). The TDP2004 EVM can be placed between a DP source (for example, PC, motherboard, monitor), and a DP sink (for example, monitor and TV).

## 2 Hardware

### 2.1 Hardware Configuration

#### 2.1.1 Power

A DC barrel jack (J29) to accept a 5V wall power adapter is provided on the EVM. The DC barrel jack (CUI Inc. PJ-202AH) has an inner diameter of 2.1mm and an outer diameter of 5.5mm. The tip of the +5V power supply must be positive. A +5V power supply of at least 1.5 amps that meets the above requirements can be used to power the TDP2004 EVM.

#### 2.1.2 Configuration Jumpers

Multiple jumpers are provided on the EVM for configuration of TDP2004 and also for probe points.

The following is a list of 5-level jumpers which are used to configure the TDP2004: J1, J7, J8, J11, J15, J16, J17, J22, J23, J24, J28, J30, J31, and J32. The jumper position to select between the different levels is detailed in [Table 2-1](#).

#### Note

The 5-level pins are sampled at power up. Therefore, any change in any 5-level pin state cannot be applied until after power cycling the device.

**Table 2-1. 5-Level Configuration Jumper Settings**

Jumper Position	5-level State
Short 1 to 2	L0
Short 3 to 4	L1
Short 5 to 6	L2
Short 7 to 8	L3
Open	L4

**Table 2-2. Jumpers**

Jumper	Default Position	Description
J1	Short 2 to 3	<b>TEST / SCL</b> Short 1 to 2: SCL in I2C mode Short 2 to 3: TEST (J31) pulled down in pin-strap mode.
J11	Open	<b>3.3V</b>
J15	Open	<b>GAIN</b> In Pin mode: Flat gain(DC and AC) from the input to the output of the device for channels 0-3. The pin is sampled at device power-up only. In SMBus/ I2C mode: 3.3V SMBus/ I2C data. External 1kΩ to 5kΩ pullup resistor is required as per SMBus/ I2C interface standard.
J16	Short 2 to 3	<b>PD_JUMPER</b> In pin-strap mode, this jumper alongside PD (J32) determines the state of PD.
J17	Open	<b>READ_EN_N</b> In SMBus/ I2C Primary mode: After device power up, when the pin is low, the pin initiates the SMBus / I2C Primary mode EEPROM read function. When EEPROM read is complete (indicated by assertion of DONEn low), this pin can be held low for normal device operation. During the EEPROM load process, the signal path of the device is disabled. In SMBus/I2C Secondary and Pin modes, the pin is not used. The pin can be left floating. The pin has internal 1MΩ weak pull-down resistor.
J22	Short 1 to 2 (L0)	<b>EQ1 / ADDR1</b> Refer to data sheet for details.
J23	Short 1 to 2 (L0)	<b>EQ0 / ADDR0</b> Refer to data sheet for details.
J31	Short 1 to 2	<b>TEST</b> In Pin mode: TI test mode. External 1kΩ pull down resistor must be installed.
J32	Short 1 to 2	<b>PD</b> Short 1 to 2: PD_JUMPER used to set PD. Short 2 to 3: HPD is used to set PD.

### 2.1.3 Rx EQ Configuration

There are twenty EQ, tune EQ value based on RX for application.

**Table 2-3. Rx Equalization Control**

EQUALIZATION SETTING							TYPICAL EQ BOOST (dB)
EQ INDEX	PIN MODE		I2C MODE				At 10GHz
	EQ0	EQ1	eq_stage1_3:0	eq_stage2_2:0	eq_profile_3:0	eq_stage1_bypass	
0	L0	L0	0	0	0	1	4.0
1	L0	L1	1	0	0	1	5.0
2	L0	L2	3	0	0	1	7.0
5	L1	L0	0	0	1	0	8.0
6	L1	L1	1	0	1	0	9.0
7	L1	L2	2	0	1	0	9.5
8	L1	L3	3	0	3	0	10.0
9	L1	L4	4	0	3	0	11.0
10	L2	L0	5	1	7	0	12.0
11	L2	L1	6	1	7	0	12.5
12	L2	L2	8	1	7	0	13.5
13	L2	L3	10	1	7	0	14.5
14	L2	L4	10	2	15	0	15.0
15	L3	L0	11	3	15	0	15.5
16	L3	L1	12	4	15	0	16.5
17	L3	L2	13	5	15	0	17.0
18	L3	L3	14	6	15	0	18.0
19	L3	L4	15	7	15	0	19.0

### 2.1.4 Local I2C Access

Access to the local I2C signals of TDP2004 is provided through the J8 connector. The TDP2004 supports 3.3V LVCMOS levels. Note the importance that the I2C signaling levels meet the TDP2004 LVCMOS levels when I2C interface is accessed through the connector.

A standalone external I2C host can be connected through J8 for debug and control purposes. An example of an external I2C Host controller is the Total Phase Aardvark I2C/SPI Host Adapter (Total Phase Part#: TP240141). Sample scripts for this I2C host controller are provided by request.

The target I2C address for the TDP2004 can be modified by the EVM jumpers J22 and J23. Please refer to the TDP2004 EQx/ADDRx pin settings and the corresponding I2C address. Refer to TDP2004 data sheet for the I2C target address options.

**Table 2-4. Aardvark I2C (J8) Pinout**

J5 pin #	Description	J5 pin #	Description
1	SCL_CTL	2	GND
3	SDA_CTL	4	NC
5	NC	6	NC
7	NC	8	NC
9	NC	10	GND

### 2.2 Quick Start Guide

The instructions below assume the EVM is configured for pin-strap mode and is powered from barrel jack.

1. If using external I2C configuration instead of pin-straps, then configure TDP2004 at this step.
2. Insertion +5V DC Power source into barrel jack.
3. Insert the TDP2004 source side connector to a DP source using DP plug (J33).
4. Insert a DP video sink into the DP downstream facing receptacle (J26) using a standard DP cable.
5. Video output on the DP sink must be observed.

## 3 Hardware Design Files

### 3.1 Schematics

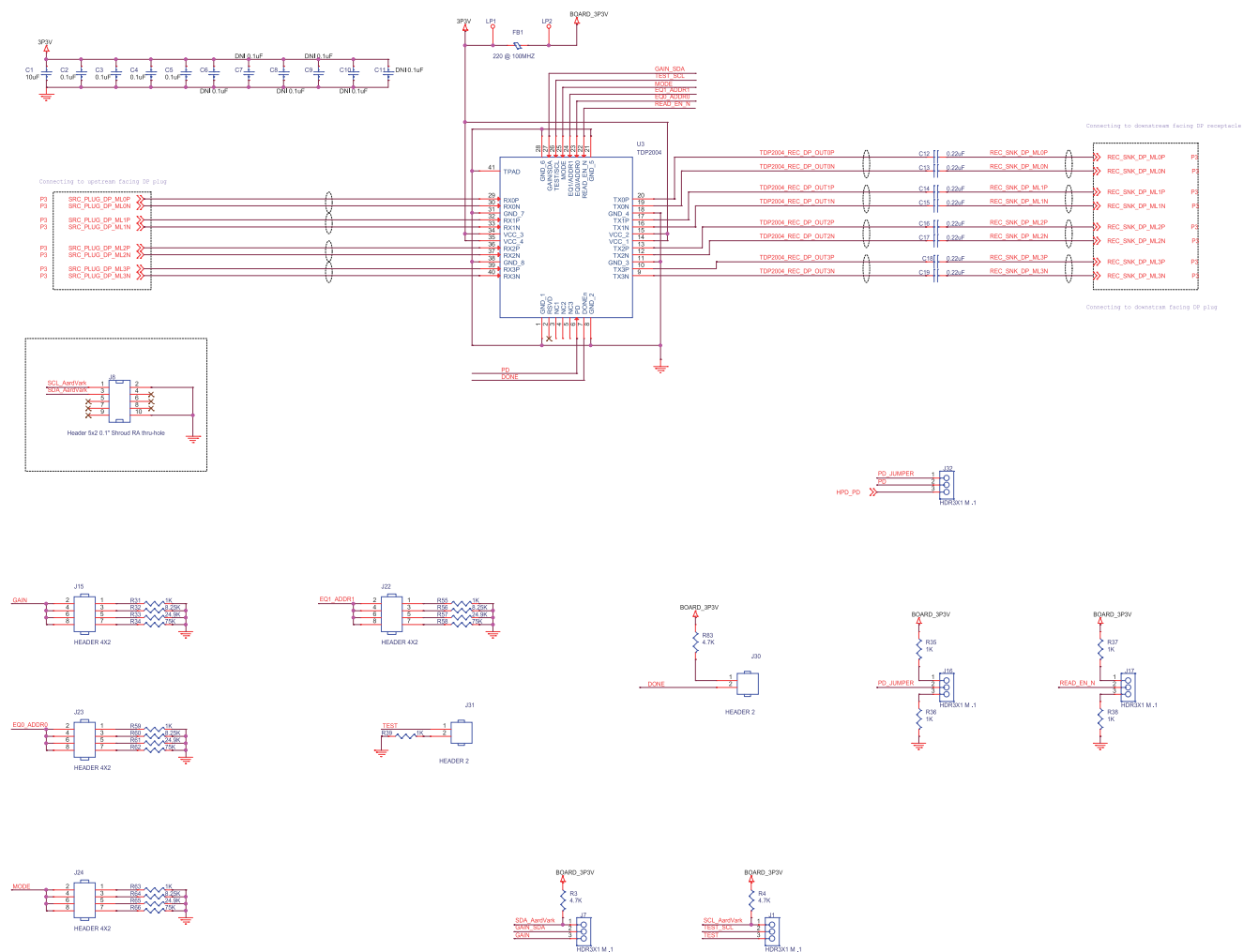
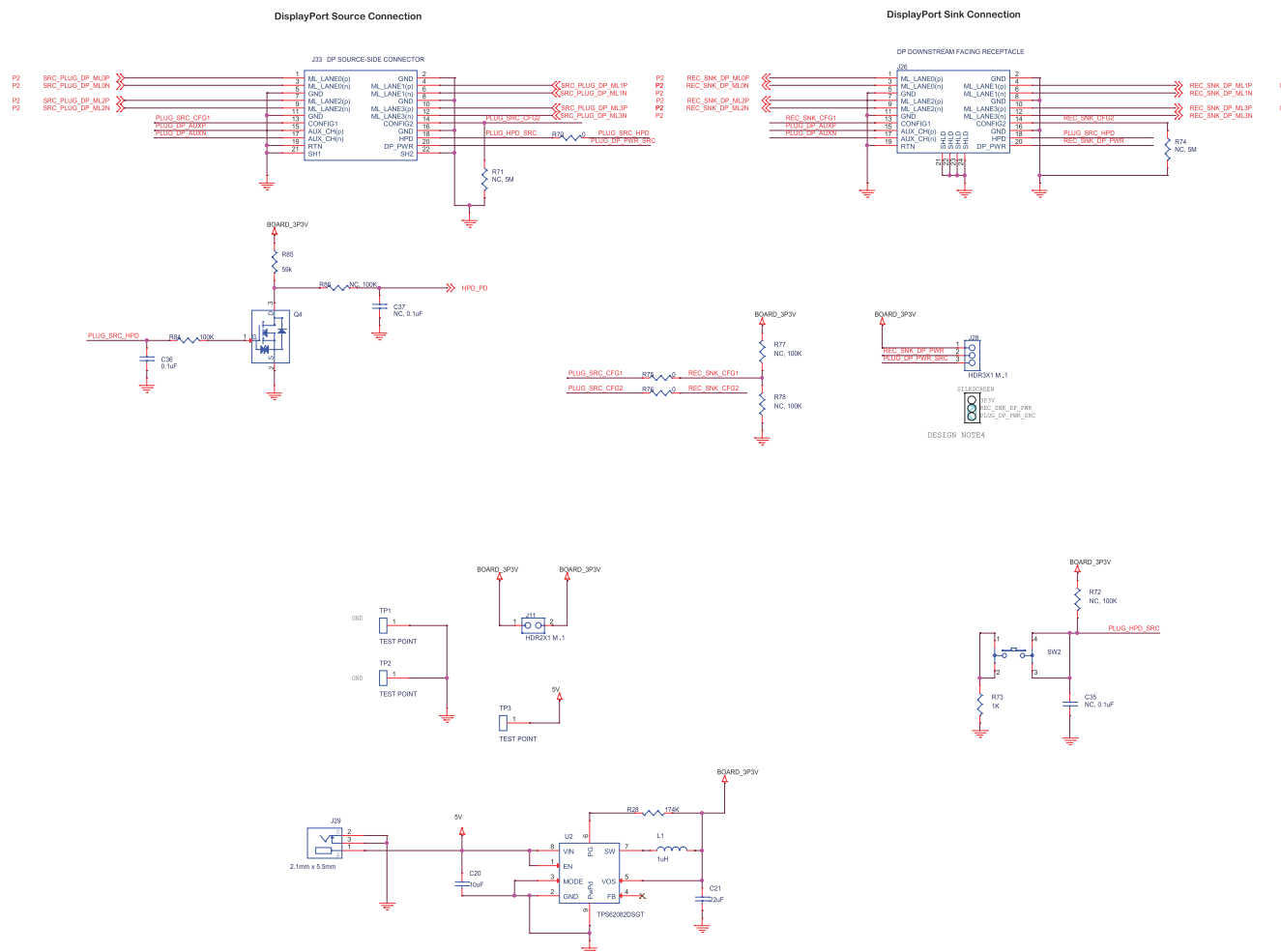
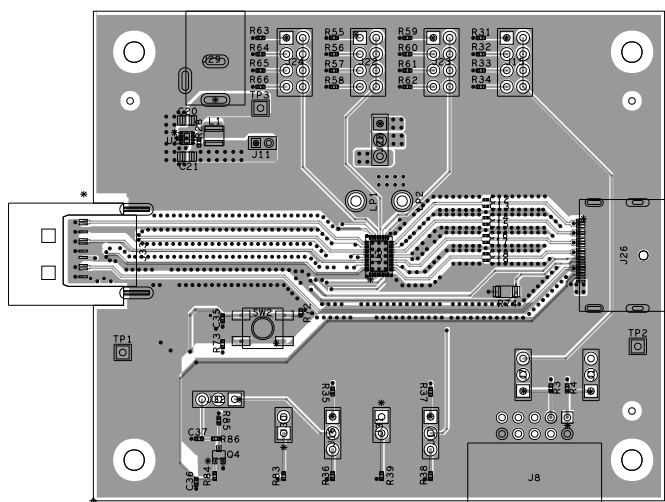


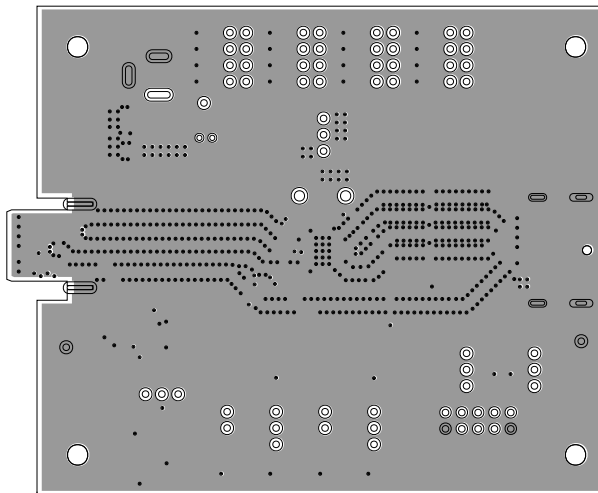
Figure 3-1. Schematic-1



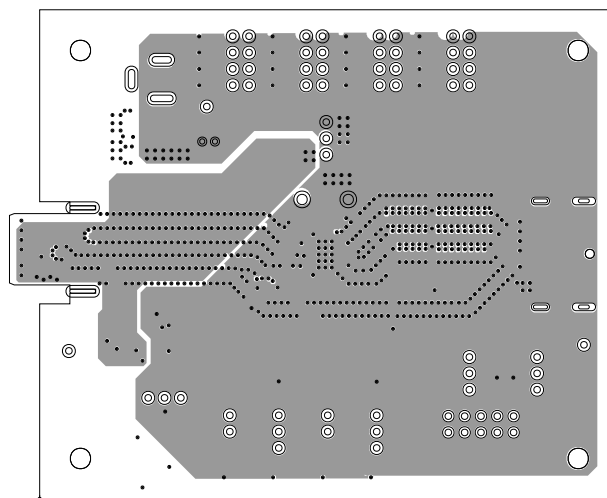
## 3.2 PCB Layouts



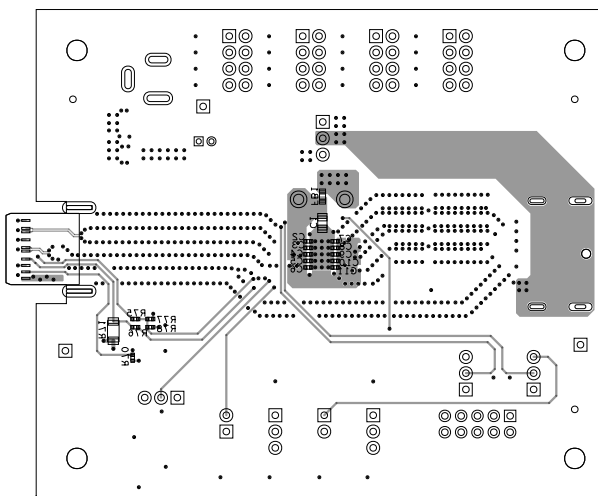
**Figure 3-3. Layer 1: Top**



**Figure 3-4. Layer 2: Ground Plane**



**Figure 3-5. Layer 3: Power Plane**



**Figure 3-6. Layer 4: Bottom**



### 3.3 Bill of Materials (BOM)

**Table 3-1. Bill of Materials**

Item	Quantity	Reference	Part	Manufacturer	Part Number	Footprint
1	2	C1,C20	10uF	TDK	C2012X5R1E106K125AB	805
2	5	C2,C3,C4,C5,C36	0.1uF	Yageo	CC0402KRX5R6BB104	402
3	0	C6,C7,C8,C9,C10,C11	DNI 0.1uF	Yageo	CC0402KRX5R6BB104	402
4	8	C12,C13,C14,C15,C16,C17, C18,C19	0.22uF	Yageo	CC0201KRX5R5BB224	201
5	1	C21	22uF	Murata	GRM21BR60J226ME39L	805
6	0	C35,C37	NC, 0.1uF	Yageo	CC0402KRX5R6BB104	402
7	1	FB1	220 @ 100MHZ	Murata	BLM18EG221SN1D	FB0603
8	6	J1,J7,J16,J17,J28,J32	HDR3X1 M .1	Harwin	HTSW-150-07-G-S	berg1x3
9	1	J8	Header 5x2 0.1" Shroud RA thru-hole	3M	30310-5002HB	HDR_THRT_2X5_100
10	1	J11	HDR2X1 M .1	Harwin	M22-2510205	BERG1X2
11	4	J15,J22,J23,J24	HEADER 4X2	Samtec	TSW-104-07-F-D	
12	1	J33	DP UPSTREAM FACING PLUG	Bizlink	663-201432SA0D300	DP Plug
13	1	J26	DP DOWNSTREAM FACING RECEPTACLE	Bizlink	663-200233SA0D4D0	DP Receptacle
14	1	J29	2.1mm x 5.5mm	CUI Inc.	CP-202AH-ND	2.1mm x 5.5mm
15	2	J30,J31	HEADER 2			HDR_THVT_1X2_254_820
16	1	LB1	PCB Label 0.650"H x 0.200"W	Brady	THT-46-487-10	THT-46-487-10
17	2	LP1,LP2	LP	Keystone Electronics	5006	THRU
18	1	L1	1uH	Taiyo Yuden	NR3015T1R0N	IND_NR3015
19	1	PCB1	HSDC174	HSDC	Any	
20	1	Q4	2N7002KW	Micro Commercial Co	2N7002KW	SOT-323_3_125X200_65
21	3	R3,R4,R83	4.7K	Panasonic Electronic Components	ERJ-2GEJ472X	RES_0402
22	1	R28	174K	Stackpole Electronics Inc.	RMCF0402FT174K	402
23	10	R31,R35,R36,R37,R38,R39, R55,R59,R63,R73	1K	Yageo	RC0402JR-071KL	402
24	4	R32,R56,R60,R64	8.25K	Yageo	RT0402BRE078K25L	402
25	4	R33,R57,R61,R65	24.9K	Yageo	RT0402FRE0724K9L	402

**Table 3-1. Bill of Materials (continued)**

Item	Quantity	Reference	Part	Manufacturer	Part Number	Footprint
26	4	R34,R58,R62,R66	75K	Yageo	RT0402FRE0775KL	402
27	3	R70,R75,R76	0	Panasonic	ERJ-2GE0R00X	402
28	0	R71,R74	NC, 5M	Stackpole Electronics Inc.	RMCF0402FT174K	402
29	0	R72,R77,R78,R86	NC, 100K	Yageo	RC0402JR-07100KL	402
30	1	R84	100K	Yageo	RC0402JR-07100KL	402
31	1	R85	59k	Yageo	RC0402FR-0759KL	402
32	4	SCRW1,SCRW2,SCRW3,SCRW4	NY PMS 440 005 PH	B&F Fastener	NY PMS 440 0050 PH	4-40 Phillips Panhead
33	13	SHNT1,SHNT2,SHNT3,SHNT4,	QPC02SXGN-RC	Samtec	SNT-100-BK-G	N/A
		SHNT5,SHNT6,SHNT7,SHNT8,				
		SHNT9,SHNT10,SHNT11,				
		SHNT12,SHNT13				
34	4	STDOFF1,STDOFF2,STDOFF3,	1902E	Keystone	1902E	OD3.96 L7.95 OL7.94
		STDOFF4				
35	1	SW2	B3SN-3012	Omron	B3SN-3012P	SWITCH_B3SN
36	3	TP1,TP2,TP3	TEST POINT	Samtec	HTSW-101-07-G-S	berg1x1
37	1	U2	TPS62082DSGT	Texas Instruments	TPS62082DSGT	DSG
38	1	U3	TDP2004	Texas Instruments	TDP2004	WQFN

## 4 Additional Information

### Trademarks

All trademarks are the property of their respective owners.

## 5 Revision History

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

<b>Changes from Revision A (March 2024) to Revision B (April 2025)</b>	<b>Page</b>
• Updated Schematics Images.....	<a href="#">6</a>

<b>Changes from Revision * (January 2024) to Revision A (March 2024)</b>	<b>Page</b>
• Updated <i>PCB Layout</i> images.....	<a href="#">8</a>

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**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.**

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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.

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##### 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/sds/ti\\_ja/general/eStore/notice\\_01.page](http://www.tij.co.jp/sds/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>

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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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3.3.3 *Notice for EVMs for Power Line Communication:* Please see [http://www.tij.co.jp/sds/ti\\_ja/general/eStore/notice\\_02.page](http://www.tij.co.jp/sds/ti_ja/general/eStore/notice_02.page)

電力線搬送波通信についての開発キットをお使いになる際の注意事項については、次のところをご覧ください。<https://www.ti.com/ja-jp/legal/notice-for-evaluation-kits-for-power-line-communication.html>

#### 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.

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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.

4.3 *Safety-Related Warnings and Restrictions:*

4.3.1 User shall operate the EVM within TI's recommended specifications and environmental considerations stated in the user guide, other available documentation provided by TI, and any other applicable requirements and employ reasonable and customary safeguards. Exceeding the specified performance ratings and specifications (including but not limited to input and output voltage, current, power, and environmental ranges) for the EVM may cause personal injury or death, or property damage. If there are questions concerning performance ratings and specifications, User should contact a TI field representative prior to connecting interface electronics including input power and intended loads. Any loads applied outside of the specified output range may also result in unintended and/or inaccurate operation and/or possible permanent damage to the EVM and/or interface electronics. Please consult the EVM user guide prior to connecting any load to the EVM output. If there is uncertainty as to the load specification, please contact a TI field representative. During normal operation, even with the inputs and outputs kept within the specified allowable ranges, some circuit components may have elevated case temperatures. These components include but are not limited to linear regulators, switching transistors, pass transistors, current sense resistors, and heat sinks, which can be identified using the information in the associated documentation. When working with the EVM, please be aware that the EVM may become very warm.

4.3.2 EVMs 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 assumes all responsibility and liability for proper and safe handling and use of the EVM by User or its employees, affiliates, contractors or designees. User assumes all responsibility and liability to ensure that any interfaces (electronic and/or mechanical) between the EVM and any human body are designed with suitable isolation and means to safely limit accessible leakage currents to minimize the risk of electrical shock hazard. User assumes all responsibility and liability for any improper or unsafe handling or use of the EVM by User or its employees, affiliates, contractors or designees.

4.4 User assumes all responsibility and liability to determine whether the EVM is subject to any applicable international, federal, state, or local laws and regulations related to User's handling and use of the EVM and, if applicable, User assumes all responsibility and liability for compliance in all respects with such laws and regulations. User assumes all responsibility and liability for proper disposal and recycling of the EVM consistent with all applicable international, federal, state, and local requirements.

5. *Accuracy of Information:* To the extent TI provides information on the availability and function of EVMs, TI attempts to be as accurate as possible. However, TI does not warrant the accuracy of EVM descriptions, EVM availability or other information on its websites as accurate, complete, reliable, current, or error-free.

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