

# **TPS22958/58N 5.5-V, 4-A/6-A, 14-mΩ On-Resistance Load Switch**

The TPS22958EVM and TPS22958NEVM evaluation modules (EVM) allow the user to connect power to and control the TPS22958 and TPS22958N 5.5-V, 14-mΩ On-Resistance Load Switches. [Table 1](#) summarizes the available EVMs and Package Options; refer to the device datasheet [SLVSCX7](#) for more details.

**Table 1. Device and Package Configurations**

EVM Orderable	Device	Device Package	Exposed Thermal Pad	Maximum Voltage	Maximum Continuous Current	Quick Output Discharge
TPS22958EVM	U1	TPS22958DGK	No	5.5V	4A	Yes
	U2	TPS22958DGN	Yes	5.5V	6A	Yes
TPS22958NEVM	U1	TPS22958NDGK	No	5.5V	4A	No
	U2	TPS22958NDGN	Yes	5.5V	6A	No

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## 1 Introduction

The TPS22958EVM and TPS22958NEVM evaluation modules (EVM) allow the user to connect power to and control the both package versions of the TPS22958 and TPS22958N 5.5-V, 4-A/6-A, 14-mΩ On-Resistance Load Switches. This allows for easy evaluation of ON Resistance and Adjustable Slew Rate.

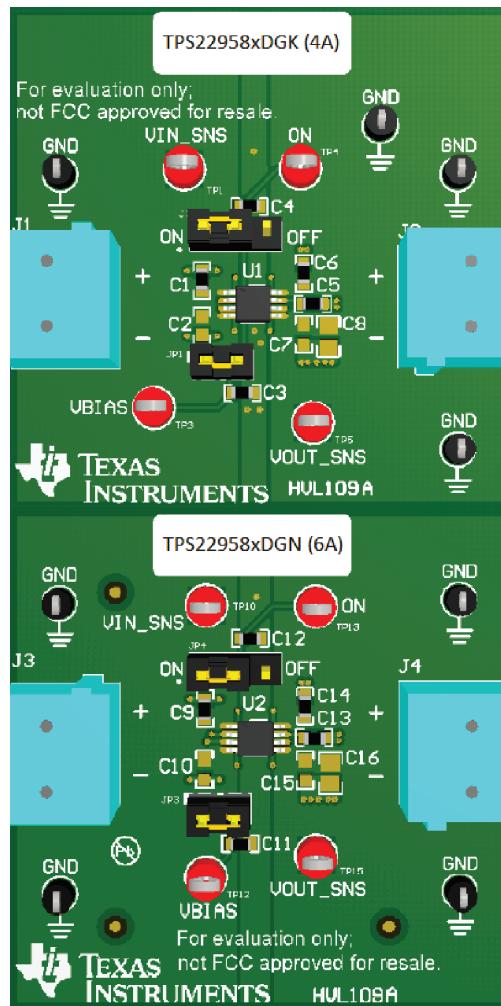


Figure 1. 3D Rendering of EVM

## 1.1 Typical Applications

- EPOS
- Factory Automation/Control
- Building Automation
- Printers
- Prototype Boards
- Wave Soldering Manufacturing

## 1.2 Features

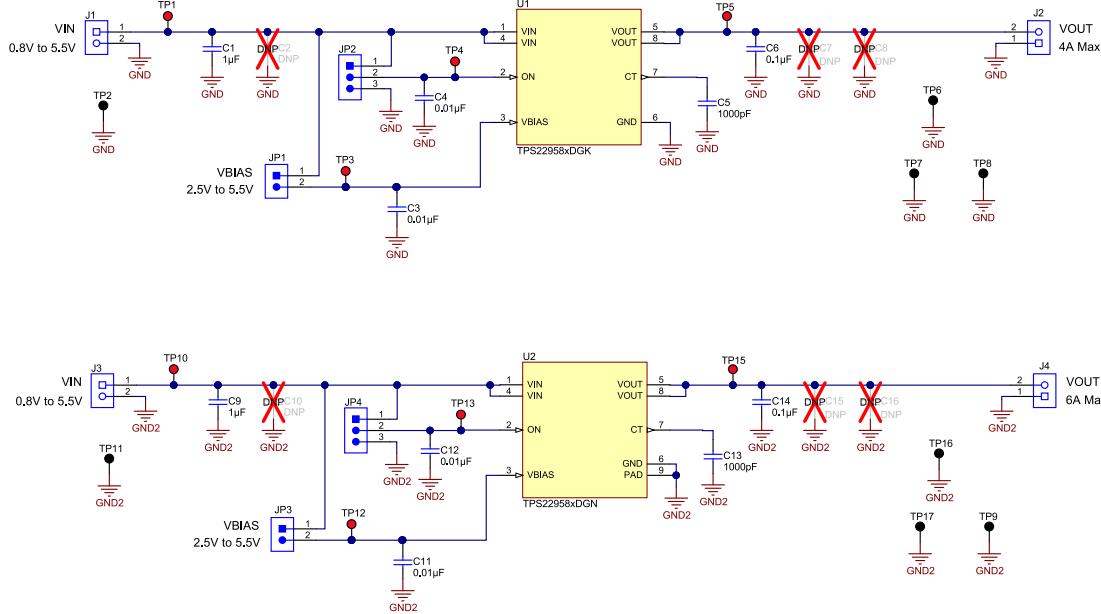
- VBIAS voltage range: 2.5 V to 5.5 V
- VIN input voltage range: 0.6 V to 5.5 V
- External capacitor for adjustable rise time
- High current connection terminals available for 6A maximum continuous switch current operation
- Test Point Connections to VIN, VOUT, VBIAS, and ON Pins
- SENSE connections for accurate measurement of VIN and VOUT voltages used for Voltage Drop and ON Resistance Calculations

## 2 Electrical Performance

Refer to the datasheet [SLVSCX7](#) for detailed electrical characteristics of the TPS22958 and TPS22958N.

## 3 Schematic

The schematic for the TPS22958 and TPS22958N EVMs is shown in [Figure 2](#).



**Figure 2. Schematic**

## 4 EVM Connections

This section describes the connectors, jumpers, and test points on the EVM.

### 4.1 J1/J3 – VIN Power Connections

These are the high current input connections from the power supply. Connect the positive lead to the top (+) thermal and the negative lead to the bottom (–) terminal.

### 4.2 J2/J4 – VOUT Power Connections

These are the high current output connections for loading the EVM. Connect the positive lead of the load to the top (+) terminal and the GND of the load to the bottom (–) terminal.

### 4.3 JP1/JP3 – VBIAS Power

These jumpers connect VBIAS to the respective VIN voltage source. VBIAS must be maintained between 2.5 V – 5.5 V for proper operation on the TPS22958 and TPS22958N devices. If testing conditions involve taking the VIN voltage below 2.5V, remove the shunt across JP1/JP3 and connect VBIAS voltage at TP3/TP12.

### 4.4 JP2/JP4 – ON Control

These three pin jumpers connect the ON pin either to VIN or to GND. This allow for quickly enabling/disabling the device after power is present.

### 4.5 TP1/TP10 – VIN Sense

These connects provide and low current path to the input pins of the device for accurate voltage measurements. These sense connections should be used when measuring the voltage drop from VIN to VOUT which is used to calculate the ON resistance. In cases where there is a large load current, it is recommended configure the power supply to use sense connections. Connect the positive sense lead to the VIN sense point to overcome voltage drop in cabling.

### 4.6 TP5/TP15 – VOUT Sense

These connects provide and low current path to the output pins of the device for accurate voltage measurements. These sense connections should be used when measuring the voltage drop from VIN to VOUT which is used to calculate the ON resistance.

### 4.7 TP4/TP13 – ON

These test points are used to monitor the EN pin voltage. These test points can also be used to drive the ON pin independently when JP2/JP4 is removed.

### 4.8 TP2/TP6/TP7/TP8/TP9/TP11/TP16/TP17 – GND

These are the GND connection points to the EVM.

### 4.9 List of Connections

The EVM Connections are summarized in [Table 2](#).

**Table 2. EVM Connection Points**

Connection	Name	Description
J1, J3	VIN	DC input to VIN
J2, J4	VOUT	Load connection for VOU
JP1, JP3	VBIAS Power	Connects VBIAS to VIN
JP2, JP4	ON Control	Connects EN resistors to VIN or GND

**Table 2. EVM Connection Points (continued)**

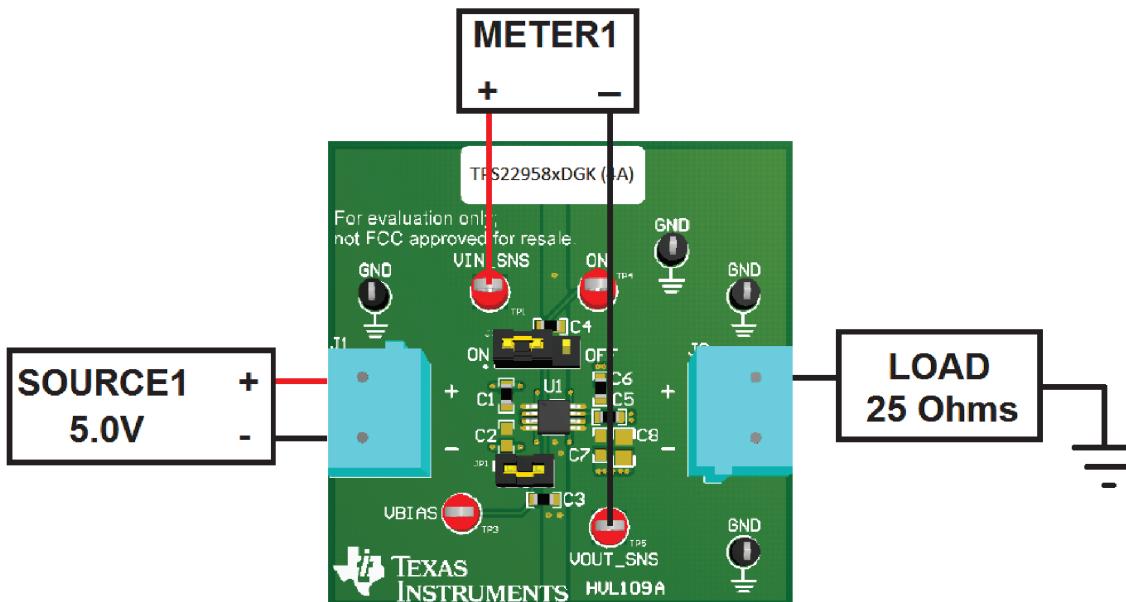
Connection	Name	Description
TP1, TP10	VIN Sense	Sense connection to VIN
TP3, TP12	VBIAS	VBIAS connection
TP4, TP13	ON	EN connection
TP5, TP15	VOUT Sense	Sense connection to VOUT
TP2, TPS6, TPS7, TP8, TP9, TP11, TP16, TP17	GND	Connection to board ground

## 5 Test Setup

This section will describe how to take key parameter measurements on the EVM.

### 5.1 RON Test Procedure

1. Setup the EVM per [Figure 3](#).
2. Set SOURCE1 level to 5.0 V.
3. Turn on SOURCE1.
4. Record the voltage reading from METER1 as well as the input current reading from SOURCE1.
5. Turn SOURCE1 off.
6. Calculate the Resistance of the switch by dividing the voltage reading from METER1 by the current reading from SOURCE1.


**Figure 3. RON Test Setup**

## 5.2 AC Parameter Test Procedure ( $tR$ , $tON$ , $tF$ , $tOFF$ , $tD$ )

1. A detailed description of  $tR$ ,  $tON$ ,  $tF$ ,  $tOFF$ , and  $tD$  are listed in the TPS22958/58N Datasheet ([SLVSCX7](#)) under the Switching Characteristics Section.
2. The rise time ( $tR$ ) is selected by the CT capacitor value on each switch channel. The EVM is shipped with a default CT value of 1 nF.
3. Set up the EVM per [Figure 4](#).
4. Set SOURCE1 level to 5.0 V.
5. Set Signal Generator output to 0–2 Vpp, 10–100 Hz, and 25% duty cycle.
6. Turn SOURCE1 on.
7. Enable the Signal Generator output.
8. Rise time ( $tR$ ), turn-on time ( $tON$ ), and delay time ( $tD$ ) can be observed with a Oscilloscope sync the scope trigger on the rising edge of the on signal..
9. Fall time ( $tF$ ) and turn-off time ( $tOFF$ ) can be observed from the oscilloscope by changing the scope triggering to sync with the falling edge of the ON signal.
10. Turn SOURCE1 off and disable the signal generator output.

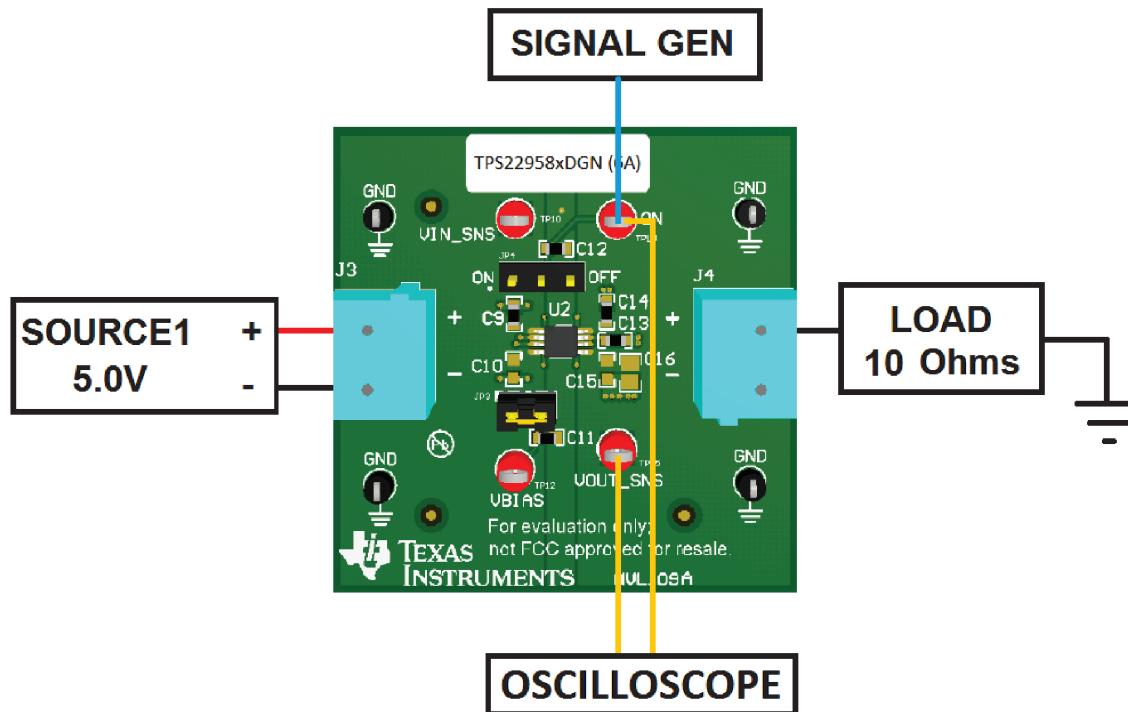
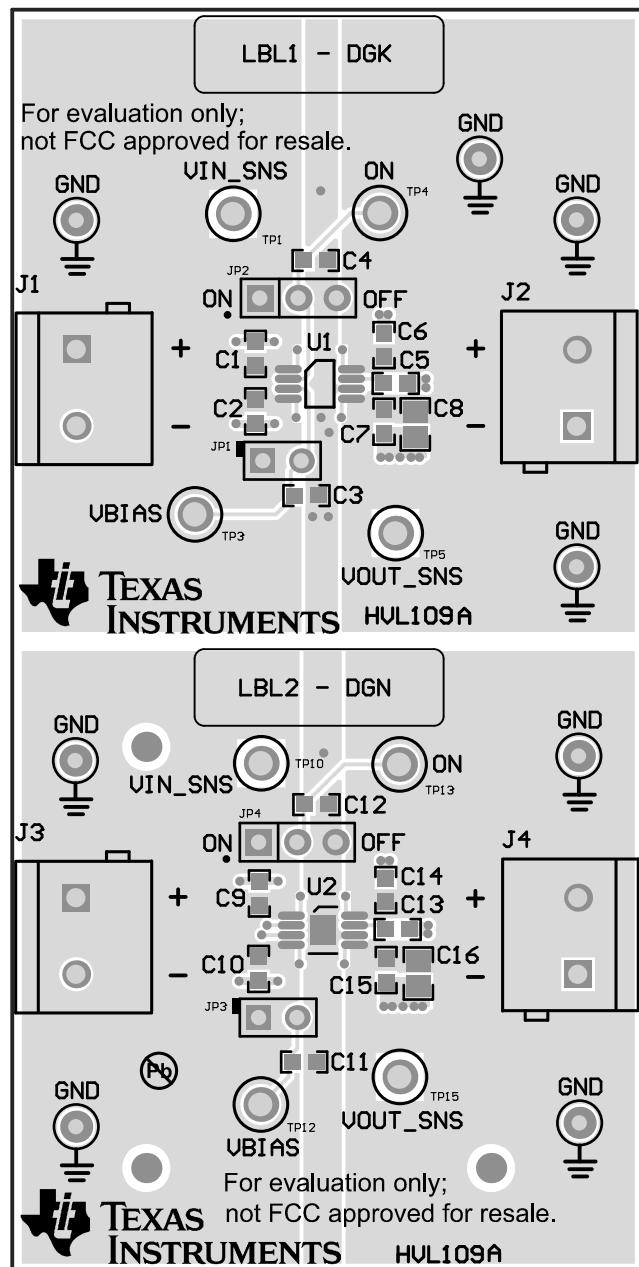
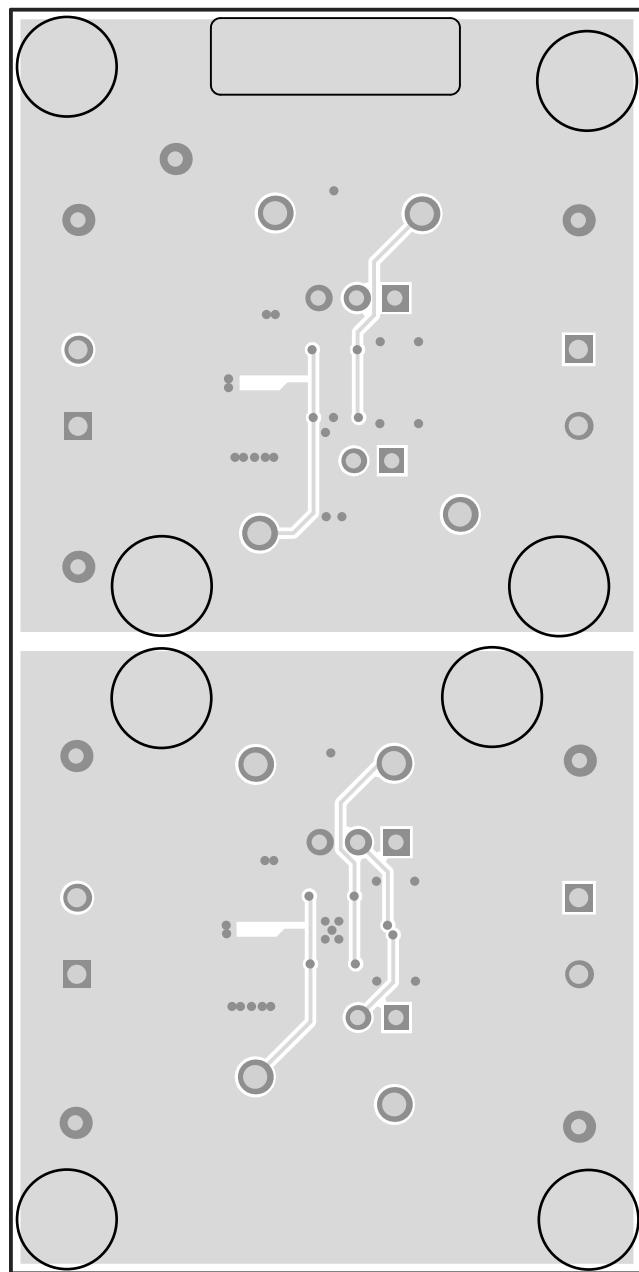


Figure 4. AC Parameter Test Setup

## 6 Board Assembly and Layout



**Figure 5. Top Side**



**Figure 6. Bottom Side**

## 7 TPS22958EVM Bill of Materials

This section contains details on the bill of materials for the TPS22958EVM. Unpopulated items have a quantity of 0.

**Table 3. TPS22958EVM Bill of Materials**

Designator	Qty	Description	Package Reference	Part Number	Manufacturer
C1, C9	2	CAP, CERM, 1 $\mu$ F, 16 V, $\pm$ 10%, X5R, 0603	0603	C1608X5R1C105K	TDK
C3, C4, C11, C12	4	CAP, CERM, 0.01 $\mu$ F, 50 V, $\pm$ 5%, X7R, 0603	0603	C0603C103J5RACTU	Kemet
C5, C13	2	CAP, CERM, 1000 pF, 50 V, $\pm$ 10%, X7R, 0603	0603	C0603C102K5RACTU	Kemet
C6, C14	2	CAP, CERM, 0.1 $\mu$ F, 25 V, $\pm$ 10%, X7R, 0603	0603	C1608X7R1E104K	TDK
J1, J2, J3, J4	4	TERMINAL BLOCK 5.08MM VERT 2POS, TH	TERM_BLK, 2pos, 5.08mm	ED120/2DS	On-Shore Technology
JP1, JP3	2	Header, 100mil, 2x1, Gold, TH	Header, 2.54mm, 2x1, TH	HMTSW-102-07-G-S-240	Samtec
JP2, JP4	2	Header, 100mil, 3x1, Gold, TH	3x1 Header	TSW-103-07-G-S	Samtec
SH-JP1, SH-JP2, SH-JP3, SH-JP4	4	Shunt, 100mil, Gold plated, Black	Shunt	969102-0000-DA	3M
TP1, TP3, TP4, TP5, TP10, TP12, TP13, TP15	8	Test Point, Compact, Red, TH	Red Compact Testpoint	5005	Keystone
TP2, TP6, TP7, TP8, TP9, TP11, TP16, TP17	8	Test Point, Miniature, Black, TH	Black Miniature Testpoint	5001	Keystone
U1	1	5.5-V, 4A, 14m $\Omega$ On-Resistance Load Switch, DGK0008A	DGK0008A	TPS22958DGKR	Texas Instruments
U2	1	5.5-V, 6A, 14-m $\Omega$ On-Resistance Load Switch, DGN0008D	DGN0008D	TPS22958DGNR	Texas Instruments
C2, C10	0	CAP, CERM, 1 $\mu$ F, 16 V, $\pm$ 10%, X5R, 0603	0603	C1608X5R1C105K	TDK
C7, C15	0	CAP, CERM, 0.1 $\mu$ F, 25 V, $\pm$ 10%, X7R, 0603	0603	C1608X7R1E104K	TDK
C8, C16	0	CAP, CERM, 10 $\mu$ F, 16 V, $\pm$ 10%, X6S, 0805	0805	C2012X6S1C106MT	TDK

## 8 TPS22958NEVM Bill of Materials

This section contains details on the bill of materials for the TPS22958NEVM. Unpopulated items have a quantity of 0.

**Table 4. TPS22958NEVM Bill of Materials**

Designator	Qty	Description	Package Reference	Part Number	Manufacturer
C1, C9	2	CAP, CERM, 1 $\mu$ F, 16 V, $\pm$ 10%, X5R, 0603	0603	C1608X5R1C105K	TDK
C3, C4, C11, C12	4	CAP, CERM, 0.01 $\mu$ F, 50 V, $\pm$ 5%, X7R, 0603	0603	C0603C103J5RACTU	Kemet
C5, C13	2	CAP, CERM, 1000 pF, 50 V, $\pm$ 10%, X7R, 0603	0603	C0603C102K5RACTU	Kemet
C6, C14	2	CAP, CERM, 0.1 $\mu$ F, 25 V, $\pm$ 10%, X7R, 0603	0603	C1608X7R1E104K	TDK
J1, J2, J3, J4	4	TERMINAL BLOCK 5.08MM VERT 2POS, TH	TERM_BLK, 2pos, 5.08mm	ED120/2DS	On-Shore Technology
JP1, JP3	2	Header, 100mil, 2x1, Gold, TH	Header, 2.54mm, 2x1, TH	HMTSW-102-07-G-S-240	Samtec
JP2, JP4	2	Header, 100mil, 3x1, Gold, TH	3x1 Header	TSW-103-07-G-S	Samtec
SH-JP1, SH-JP2, SH-JP3, SH-JP4	4	Shunt, 100mil, Gold plated, Black	Shunt	969102-0000-DA	3M
TP1, TP3, TP4, TP5, TP10, TP12, TP13, TP15	8	Test Point, Compact, Red, TH	Red Compact Testpoint	5005	Keystone
TP2, TP6, TP7, TP8, TP9, TP11, TP16, TP17	8	Test Point, Miniature, Black, TH	Black Miniature Testpoint	5001	Keystone
U1	1	5.5-V, 4A, 14m $\Omega$ On-Resistance Load Switch, DGK0008A	DGK0008A	TPS22958NDGKR	Texas Instruments
U2	1	5.5-V, 6A, 14-m $\Omega$ On-Resistance Load Switch, DGN0008D	DGN0008D	TPS22958NDGNR	Texas Instruments
C2, C10	0	CAP, CERM, 1 $\mu$ F, 16 V, $\pm$ 10%, X5R, 0603	0603	C1608X5R1C105K	TDK
C7, C15	0	CAP, CERM, 0.1 $\mu$ F, 25 V, $\pm$ 10%, X7R, 0603	0603	C1608X7R1E104K	TDK
C8, C16	0	CAP, CERM, 10 $\mu$ F, 16 V, $\pm$ 10%, X6S, 0805	0805	C2012X6S1C106MT	TDK

## STANDARD TERMS FOR EVALUATION MODULES

1. *Delivery:* TI delivers TI evaluation boards, kits, or modules, including any accompanying demonstration software, components, and/or documentation which may be provided together or separately (collectively, an "EVM" or "EVMs") to the User ("User") in accordance with the terms set forth herein. User's acceptance of the EVM is expressly subject to the following terms.
  - 1.1 EVMs are intended solely for product or software developers for use in a research and development setting to facilitate feasibility evaluation, experimentation, or scientific analysis of TI semiconductors products. EVMs have no direct function and are not finished products. EVMs shall not be directly or indirectly assembled as a part or subassembly in any finished product. For clarification, any software or software tools provided with the EVM ("Software") shall not be subject to the terms and conditions set forth herein but rather shall be subject to the applicable terms that accompany such Software
  - 1.2 EVMs are not intended for consumer or household use. EVMs may not be sold, sublicensed, leased, rented, loaned, assigned, or otherwise distributed for commercial purposes by Users, in whole or in part, or used in any finished product or production system.
- 2 *Limited Warranty and Related Remedies/Disclaimers:*
  - 2.1 These terms do not apply to Software. The warranty, if any, for Software is covered in the applicable Software License Agreement.
  - 2.2 TI warrants that the TI EVM will conform to TI's published specifications for ninety (90) days after the date TI delivers such EVM to User. Notwithstanding the foregoing, TI shall not be liable for a nonconforming EVM if (a) the nonconformity was caused by neglect, misuse or mistreatment by an entity other than TI, including improper installation or testing, or for any EVMs that have been altered or modified in any way by an entity other than TI, (b) the nonconformity resulted from User's design, specifications or instructions for such EVMs or improper system design, or (c) User has not paid on time. Testing and other quality control techniques are used to the extent TI deems necessary. TI does not test all parameters of each EVM. User's claims against TI under this Section 2 are void if User fails to notify TI of any apparent defects in the EVMs within ten (10) business days after delivery, or of any hidden defects with ten (10) business days after the defect has been detected.
  - 2.3 TI's sole liability shall be at its option to repair or replace EVMs that fail to conform to the warranty set forth above, or credit User's account for such EVM. TI's liability under this warranty shall be limited to EVMs that are returned during the warranty period to the address designated by TI and that are determined by TI not to conform to such warranty. If TI elects to repair or replace such EVM, TI shall have a reasonable time to repair such EVM or provide replacements. Repaired EVMs shall be warranted for the remainder of the original warranty period. Replaced EVMs shall be warranted for a new full ninety (90) day warranty period.

### **WARNING**

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

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

**NOTE:**

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

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### 3 Regulatory Notices:

#### 3.1 United States

##### 3.1.1 Notice applicable to EVMs not FCC-Approved:

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

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

#### CAUTION

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

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

#### FCC Interference Statement for Class A EVM devices

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

#### FCC Interference Statement for Class B EVM devices

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

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

#### 3.2 Canada

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

#### Concerning EVMs Including Radio Transmitters:

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

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

#### Concernant les EVMs avec appareils radio:

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

#### Concerning EVMs Including Detachable Antennas:

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

#### Concernant les EVMs avec antennes détachables

Conformément à la réglementation d'Industrie Canada, le présent émetteur radio peut fonctionner avec une antenne d'un type et d'un gain maximal (ou inférieur) approuvé pour l'émetteur par Industrie Canada. Dans le but de réduire les risques de brouillage radioélectrique à l'intention des autres utilisateurs, il faut choisir le type d'antenne et son gain de sorte que la puissance isotope 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/lsts/ti\\_ja/general/eStore/notice\\_01.page](http://www.tij.co.jp/lsts/ti_ja/general/eStore/notice_01.page) 日本国内に輸入される評価用キット、ボードについては、次のところをご覧ください。

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

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

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

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

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2. 実験局の免許を取得後ご使用いただく。
3. 技術基準適合証明を取得後ご使用いただく。

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

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