

1 Evaluation Module Overview

1.1 Introduction

This user's guide describes the characteristics, operation, and use of the TPS22996 load switch evaluation module (EVM). This document contains the complete EVM schematic diagram, printed-circuit board layouts, bill of materials, and necessary instructions on how to operate the EVM.

1.2 Kit Contents

Table 1-1 lists the contents of the EVM kit. Contact the Texas Instruments Product Information Center nearest if any components are missing. TI highly recommends that users check the TI website at <https://www.ti.com> to verify that the latest versions of the related software is being used.

Table 1-1. Kit Contents

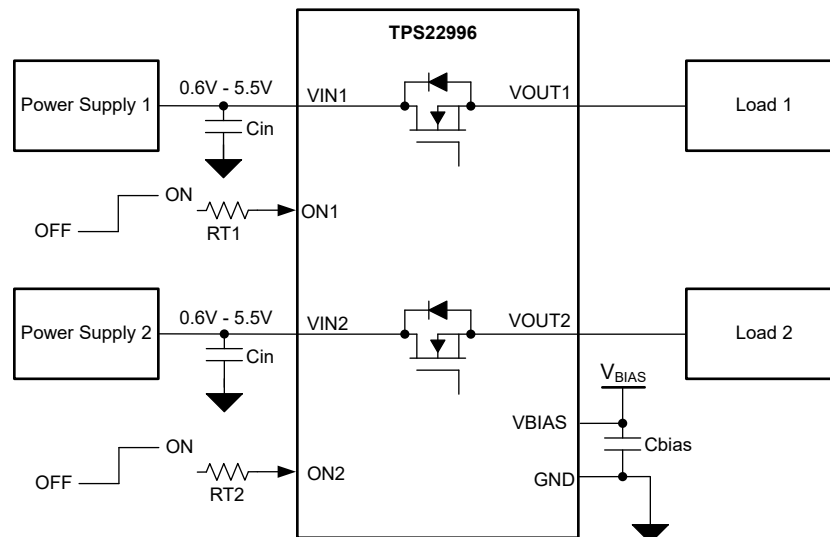
Item	Quantity
TPS22996EVM	1
TPS22996DRL	1

1.3 Specification

Table 1-2 lists a short description of the TPS22996 load switch performance specification. For additional details on load switch performance, application notes, and device data sheets, see www.ti.com/loadswitch.

Table 1-2. TPS22996 Characteristics

EVM	Device	Rise Time Typical (μ s)	V_{BIAS} (V)	V_{IN} (V)	Enable (ON Pin)	Quick Output Discharge Typical
LP110	TPS22996	Adjustable	2.5V to 5.5V	0.6V to V_{BIAS}	Active High	230 Ω



1.4 Device Information

The TPS22996 product family consists of two devices: TPS22996 and TPS22996N. Each device is a dual channel load switch with controlled turn on. The device contains two N-channel MOSFETs that can operate over an input voltage range of 0.6 V to 5.5 V, and can support a maximum continuous current of 4 A per channel. Each switch is independently controlled by an on and off input (ON1 and ON2), which can interface directly with low-voltage control signals. The TPS22996 is capable of thermal shutdown when the junction temperature is above the threshold, turning the switch off. The switch turns on again when the junction temperature stabilizes to a safe range. The TPS22996 also offers an optional integrated 230- Ω on-chip load resistor for quick output discharge when the switch is turned off.

2 Hardware

2.1 Setup

This section describes the jumpers and connectors on the EVM as well as how to properly connect, set up and use the EVM. [Table 2-1](#) describes the input and output connectors and jumpers. [Table 2-2](#) describes the different test points and functionality. [Table 2-3](#) describes the jumper functionality and configurations.

Table 2-1. TPS22996EVM Input and Output Connector Functionality

Input	Connector and Test Point	Label	Description
V_{INx} V_{BIAS}	J1, J2, J3	VSUP1, VSUP2, VSUP3	Input banana connectors for V_{INx} and V_{BIAS}
	J6, J7	J6, J7	Input selectors for V_{INx} and V_{BIAS}
	TP3, TP4, TP5	VIN1, VIN2, VBIAS	Input test points for V_{INx} and V_{BIAS}
V_{ONx}	J4	J4	Input header for ONx signals
	J8, J9	J8, J9	ON signal source selections
	TP1, TP2	VON1, VON2	Input test points for V_{ONx}
	SW1, SW2	SW1, SW2	Current-limit resistor selector
V_{OUTx}	J10, J12	VOUT1, VOUT2	Output banana connectors for V_{OUTx}
	TP6, TP7	VOUT1, VOUT2	Output test points for V_{OUTx}
GND	J5, J11, J13	GND	Banana connectors for GND
	TP8, TP9, TP10	GND	Test points for GND

Table 2-2. TPS22996EVM Test Point Description

Pin	Test Point	Label	Description
EN	TP13	ON	Enable signal test point
VBIAS	TP12	VBIAS	Bias voltage test point
PG	TP14	PG	Power good signal test point

Table 2-3. TPS22996EVM Jumper Configuration

Input	Jumper	Label	Description
VIN	JP2	EN_SEL	ON-pin enable signal <ul style="list-style-type: none"> Position 1 and 2 pulls ON-pin LO Position 2 and 3 pulls ON-pin to VIN
VOUT and VBIAS	JP1	PG_PU_SEL	PG pullup setting <ul style="list-style-type: none"> Position 1 and 2 pulls PG-pin to VBIAS Position 2 and 3 pulls PG-pin to VOUT

2.2 Operation

Connect a valid V_{BIAS} voltage, between 2.5V and 5.5V to J1 or TP5. Using a combination of J1, J2, J3, J6, and J7, select and apply valid V_{INx} voltages, between 0.6V and V_{BIAS} to V_{IN1} and V_{IN2} . For instance, $V_{IN1} = V_{BIAS} = VSUP1$ and $V_{IN2} = VSUP2$, connect shunts between the leftmost pins of J6 and the middle pins of J7.

To adjust the output slew rate upon enable, use SW1/SW2 to connect different equivalent resistor values between V_{ON1}/V_{ON2} and ON1/ON2, respectively. The slew rate can be calculated using Equation 1 and Table 9-1 of the TPS22996 data sheet.

External loads can be connected to J10 and J12. When the ON pin is toggled high, the device connects V_{INx} to V_{OUTx} with the slew rate previously referenced.

3 Implementation Results

3.1 Electrical Performance

See the *TPS22996 5.5V, 4A, 14mΩ On-Resistance Dual-Channel Load Switch* data sheet (SLVSH99) for detailed electrical characteristics of the TPS22996.

See the *TPS22996H-Q1 5.5V, 3.7A, 18mΩ On-Resistance Dual-Channel Load Switch* data sheet (SLVSHA3) for detailed electrical characteristics of the TPS22996H-Q1.

3.2 Test Configurations

3.2.1 Rise Time Test Setup

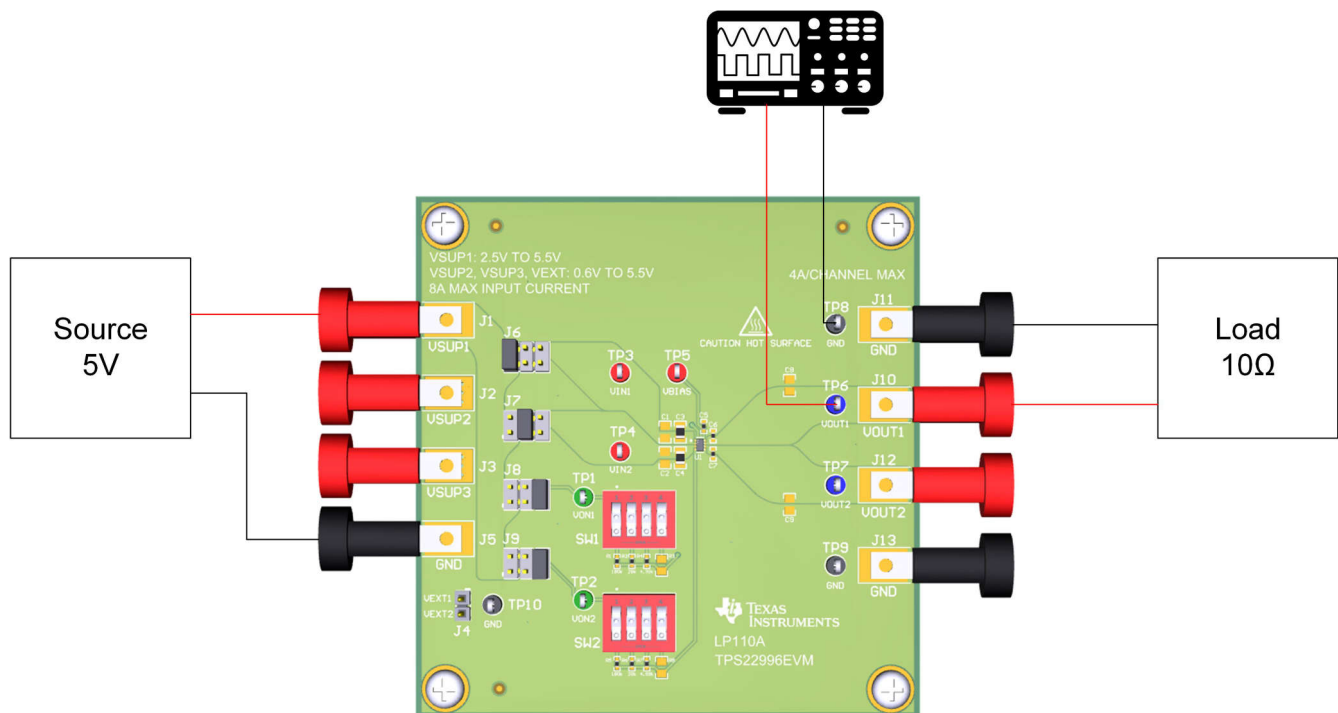


Figure 3-1. TPS22996 Rise Time Test Setup

4 Hardware Design Files

4.1 Schematic

VSUP1: 2.5V to 5.5V
 VSUP2, VSUP3, VEXT: 0.6V to 5.5V
 8A Max Input Current

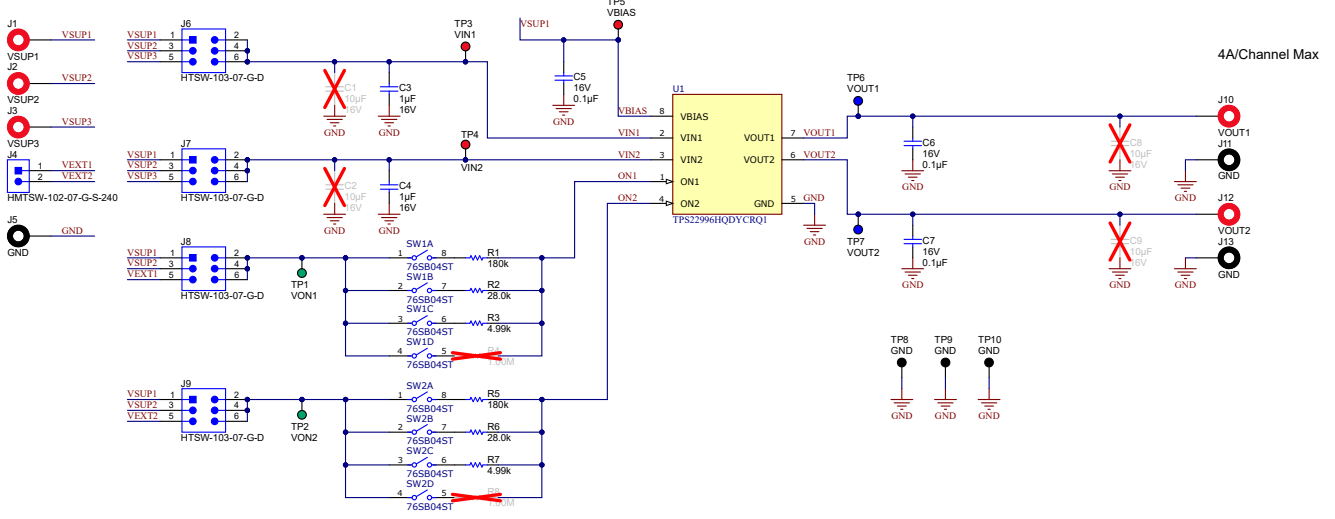


Figure 4-1. Schematic

4.2 PCB Layout

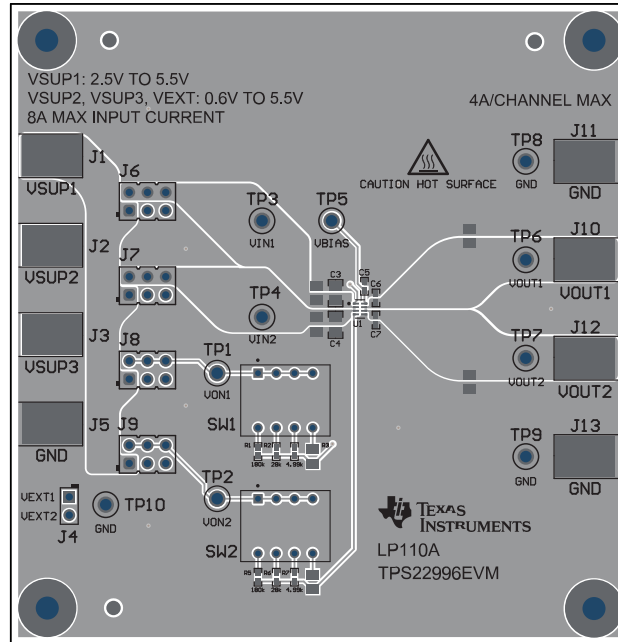


Figure 4-2. PCB Top

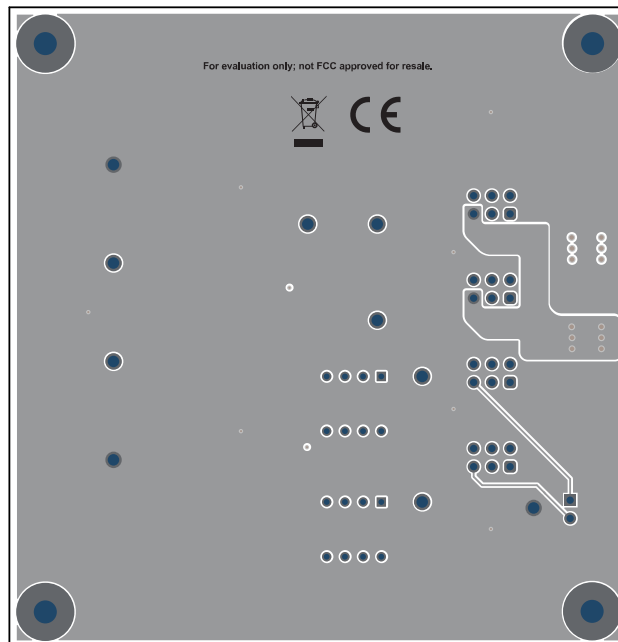


Figure 4-3. PCB Bottom

4.3 Bill of Materials (BOM)

Table 4-1. Bill of Materials

Designator	Quantity	Value	Description	Package Reference	Part Number	Manufacturer
PCB1	1		Printed Circuit Board		LP110	Any
C3, C4	2	1uF	CAP, CERM, 1uF, 16V, +/- 10%, X7R, 0805	0805	GRM21BR71C105KA01L	MuRata
C5, C6, C7	3	0.1uF	CAP, CERM, 0.1µF, 16V,+/- 10%, X7R, 0402	0402	CL05B104KO5NNNC	Walsin
FID1, FID2, FID3	3		Fiducial mark. There is nothing to buy or mount.	N/A	N/A	N/A
H2, H5, H8, H11	4		Standoff, Hex, 0.5"L #4-40 Nylon	Standoff	1902C	Keystone
H3, H6, H9, H12	4		Machine Screw, Round, #4-40 x 1/4, Nylon, Philips panhead	Screw	NY PMS 440 0025 PH	B&F Fastener Supply
J1, J2, J3, J10, J12	5		Standard Banana Jack, Insulated, Red	6091	6091	Keystone
J4	1		Header, 100mil, 2x1, Gold, TH	Header, 2.54mm, 2x1, TH	HMTSW-102-07-G-S-240	Samtec
J5, J11, J13	3		Standard Banana Jack, Insulated, Black	6092	6092	Keystone
J6, J7, J8, J9	4		Header, 2.54mm, 3x2, Gold, TH	Header, 2.54mm, 3x2, Gold, TH	HTSW-103-07-G-D	Samtec
R1, R5	2	180k	RES, 180 k, 1%, 0.063 W, 0402	0402	RC0402FR-07180KL	Yageo America
R2, R6	2	28.0k	RES, 28.0 k, 1%, 0.063 W, AEC-Q200 Grade 0, 0402	0402	CRCW040228K0FKED	Vishay-Dale
R3, R7	2	4.99k	RES, 4.99 k, 1%, 0.063 W, AEC-Q200 Grade 0, 0402	0402	CRCW04024K99FKED	Vishay-Dale
SH-J1, SH-J2, SH-J3, SH-J4	4	1x2	Shunt, 100mil, Flash Gold, Black	Closed Top 100mil Shunt	SPC02SYAN	Sullins Connector Solutions
SW1, SW2	2		Dip Switch SPST 4 Position Through Hole Rocker Actuator 150mA 30VDC	DIP8	76SB04ST	Grayhill
TP1, TP2	2		Test Point, Multipurpose, Green, TH	Green Multipurpose Test point	5126	Keystone Electronics
TP3, TP4, TP5	3		Test Point, Multipurpose, Red, TH	Red Multipurpose Test point	5010	Keystone Electronics
TP6, TP7	2		Test Point, Multipurpose, Blue, TH	Blue Multipurpose Test point	5127	Keystone Electronics
TP8, TP9, TP10	3		Test Point, Multipurpose, Black, TH	Black Multipurpose Test point	5011	Keystone Electronics

Table 4-1. Bill of Materials (continued)

Designator	Quantity	Value	Description	Package Reference	Part Number	Manufacturer
U1	1		5.5V, 4A, 11m Ω On-Resistance Dual-Channel Load Switch	SOT583	TPS22996HQDYCRQ1	Texas Instruments
C1, C2, C8, C9	0	10 μ F	CAP, CERM, 10 μ F, 16V,+/- 10%, X7R, 0805	0805	CL21B106KOQNNNG	Samsung
R4, R8	0	1.00Meg	RES, 1.00M, 1%, 0.125W, AEC-Q200 Grade 0, 0805	0805	ERJ-6ENF1004V	Panasonic

5 Additional Information

5.1 Trademarks

All trademarks are the property of their respective owners.

6 Revision History

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

Changes from Revision * (December 2023) to Revision A (March 2024)	Page
• Added TPS22996H-Q1 as a supported device.....	1

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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.

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:

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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.

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

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