TPS2412/13 Evaluation Module, HPA227

User's Guide

January 2007 **Power Supply MAN**

sluu267

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Texas Instruments

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1 Purpose

This user guide is to facilitate operation of the TPS2412/13 Evaluation Module, HPA227. It is used by an engineer or technician and supplements the TPS2412/13 datasheet, HPA227 schematics, and HPA227 circuit board labeling.

2 Introduction

The TPS2412 controls an N-channel MOSFET to operate in circuit as an ideal diode. The MOSFET source and drain voltages are monitored by TPS2412 pins A and C. The TPS2412 drives the MOSFET gate high if V_{AC} exceeds 10 mV, and turns the MOSFET off if V_{AC} falls below a threshold that is both programmable and dependent on the choice of TPS2412 or TPS2413.

The TPS2412 has a fixed turn off point of 3.0 mV V_{AC}.

TPS2413 is similar to TPS2412 but has a resistor programmable MOSFET turn off point. The TPS2413 can even be set to slightly negative allowing some back current.

Figure 1 shows the conventional wire-OR of power supplies with diodes. Each diode D1 and D2 is replaced by a TPS2412 and MOSFET eliminating the voltage and power loss in the diode.

The evaluation module is set up to wire-OR two power supplies for redundant power to a load using two TPS2410s and MOSFETs. This document contains setup and user information about this evaluation module to assist with the operation of TPS2412.

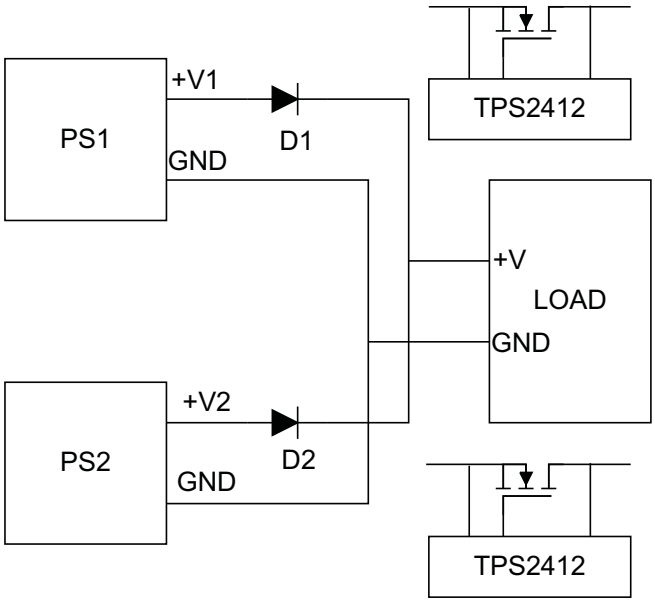

Figure 1. Conventional Wire-OR Power Supplies

Reference Figure 2, a block diagram of the HPA227.

- The 5-V supply is jumper selected to power V_{DD} on the TPS2412s and the glitch circuit if the control voltage is less than 3.0 V.
- The Glitch maker, discussed in the Test Methods section applies a 1-Ω load to the input supply for 1 ms. This disruption allows the user to scope test points and observe system recovery.
- The R_{SET} resistor is used to program the turn off point of the TPS2411.

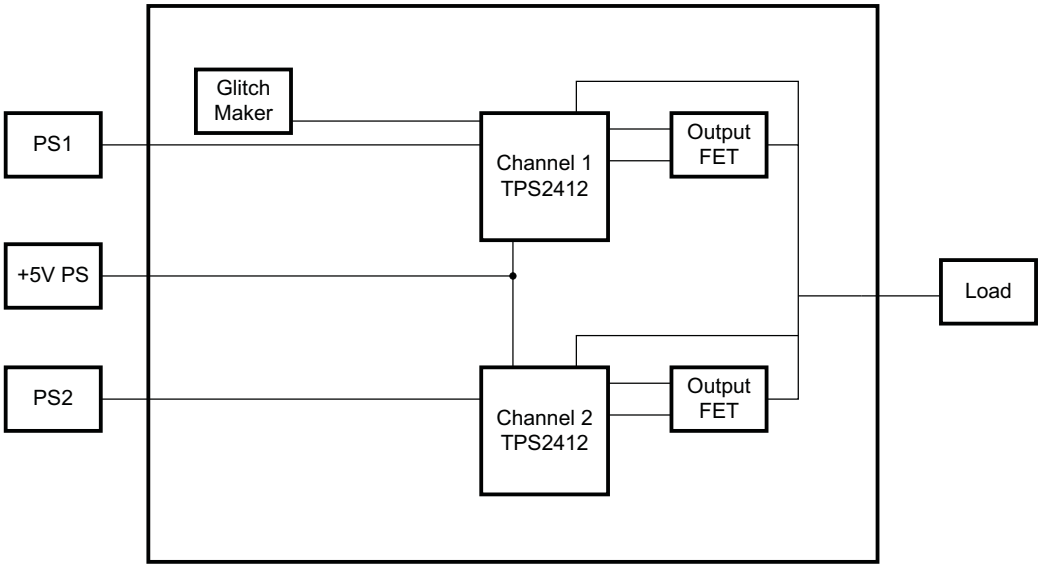

Figure 2. EVM Block Diagram

3 Materials Needed

TI Supplied:

- TPS2412 evaluation module
- TPS2412 reference design documentation
- TPS2412 datasheet

User Supplied:

- Two power supplies for wire–OR to load, up to 15 A
- 1-V to 5-V power supply for V_{DD}
- Power supply cables
- Load-active load, power resistors or actual load
- Oscilloscope
- Current probe
- Differential probe

4 Jumper Description

4.1 Jumpers J1, J2, J8, J9

V_{DD} can be powered by the input power supply pin A, Jump J1-2, 3 and J9-2, 3. When it is powered by the load, pin C, jump J1-1, 2 and J9-1, 2. If A and C are less than 3 V, connect the 5 V to V_{DD}, jumper J1-1 to J2 -2 and J8-1 to J9-2.

4.2 J13

Jumper J8 is the gate voltage for the Glitch FET. Jump J13-2, 3 when the PS1 voltage is greater than 5 volts. Jump J13-1, 2 to use the 5 volt supply when PS1 is less than 5 volts.

4.3 J14

J14 is used to short out the current limit resistor on glitching the power supply. This jumper is installed only when the voltage is less than 3 volts and a glitch is not generated because of current limit.

5 Procedure

5.1 Jumper Set-Up

An initial jumper setup is recommended in Table 1. The module has flexibility to operate in other modes. Change jumpers to operate in other configurations as required after getting started. After the initial setup, reference the schematic and set jumpers as required for testing. Other J reference designators on the schematic are simple connectors.

Table 1. Initial Jumper Settings

Jumper	Function	Selection	Comment
J1	5 V to V_{DD}, CH1	Open	
J2	A or C to V_{DD}, CH1	Jumper A – V_{DD}	Connects A
J8	5 V to V_{DD}, CH2	Open	
J9	A or C to V_{DD}, CH2	Jumper A - V_{DD}	Connects A
J13	PS1 to Glitcher	Jumper PS1 to Glitcher	Connects PS1
J14	Glitcher	Open	Shorts 1 Ω

5.2 Power Supply Connection

Connect the power supplies and load to the TPS2410 test card as shown in Table 2. Loading less than 30 A is safe for IRl3713S. The load can be a test load or the actual system load.

Table 2. Power Supply Connection

Connection	Supply	Terminal
PS1	+V	PS1, J3
	GND	PS1GND, J27
PS2	+V	PS2, J10
	GND	PS2GND, J11
5 V	5 V	J15-2
5GND	GND	J15-1
Load +	Load	J5
Load -	GND	J7

5.3 Test Points

Table 3 lists some common test points for observation. There are more test points shown on the Schematic.

Table 3. Common Test Points

Function	TP Channel 1	TP Channel 2
A	TP3	TP11
C	TP1	TP9
GATE	TP6	TP14

5.4 R_{SET}

R_{SET} is used in TPS2411 to program the MOSFET turn-off point. The R_{SET} calculation from the datasheet is:

$$R_{SET} = \left(\frac{-500}{V_{OFF} - 0.003} \right)$$

Calculate the R_{SET} resistor and install. The component reference designators for both channels are summarized in Table 4.

Table 4. Table 5, R_{SET} Resistor Setting

R_{SET}	CH1	CH2
Resistor	R2	R4

5.5 Test Methods

The EVM has a few operating modes to view the system response. The user can make modifications to the EVM to test in other ways.

5.6 Adjust Input Power Supplies

Vary the input voltages to observe system behavior. Jumpers can be set as in Table 1. Turn the power supplies to the application typical 12 V. The load is shared between the supplies. Both gates will be on and the power supply current meters show output. Decrease one supply voltage slightly and note the gate on that channel pass FET turn off and the other channel FET gate increases to keep the FET on to supply the load. Observe the FET gates with a scope. With a voltmeter, verify V_{DS} for the on channel to be tens of millivolts.

5.7 Glitch Maker

Set power supplies up for equal or slight differential voltage so that the PS1 supply is contributing to the load. Press momentary switch S1, labeled PULSE. The switch closure places a 1-Ω load across the input power supply for 1 ms. Observe the effect of an input power supply glitch at the MOSFET gates and load voltage.

5.8 Input Power Supplies

Input change can be tested by cycling power, opening input, hot plugging, and shorting the supply.

5.9 Load change

A dynamic change to the load can be made by switching additional load on or off with an external switch. Some power load test equipment can be used to dynamically change the load.

6 Schematic/Board Layout Diagrams

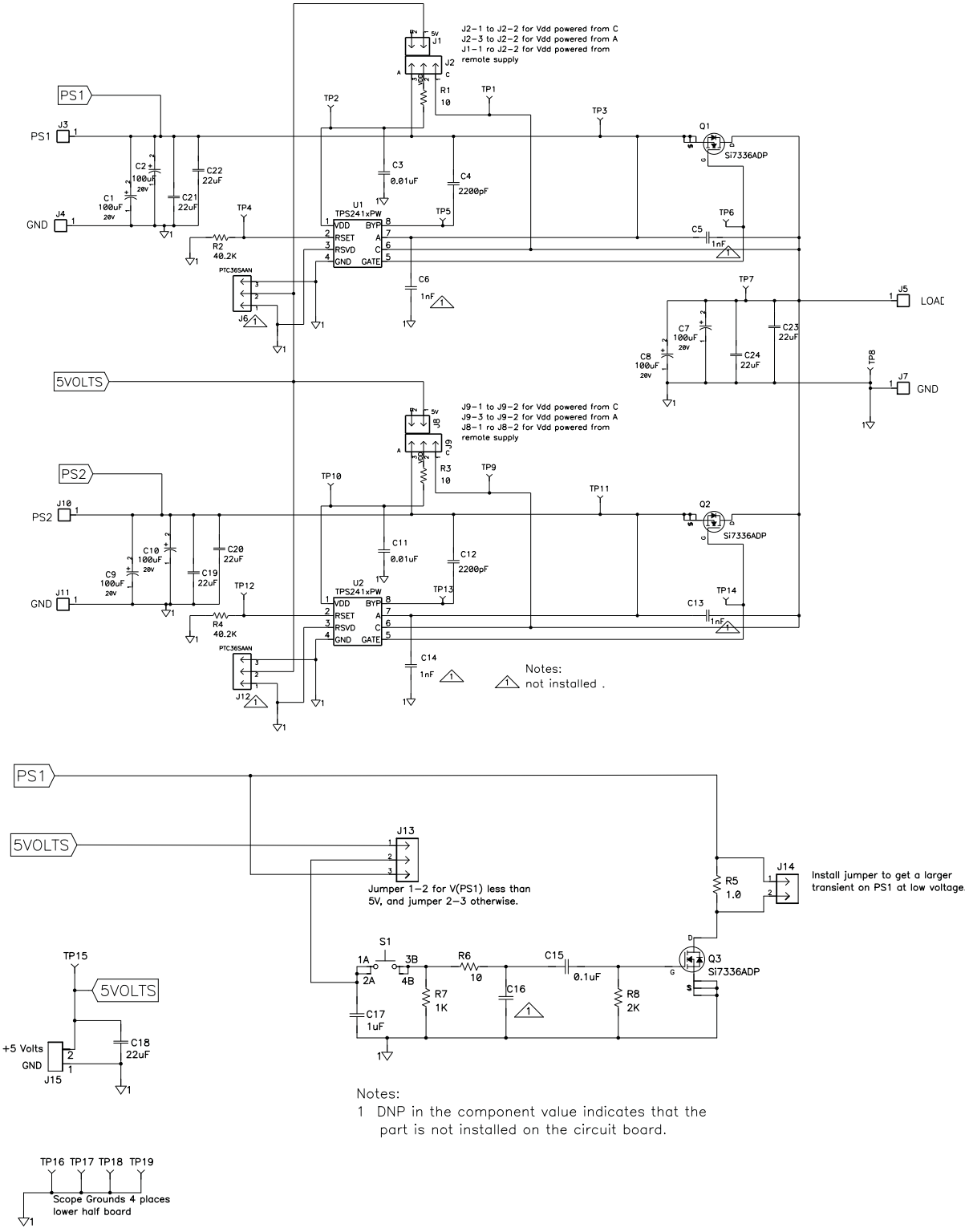

Figure 3. TPS2412/13 Schematic

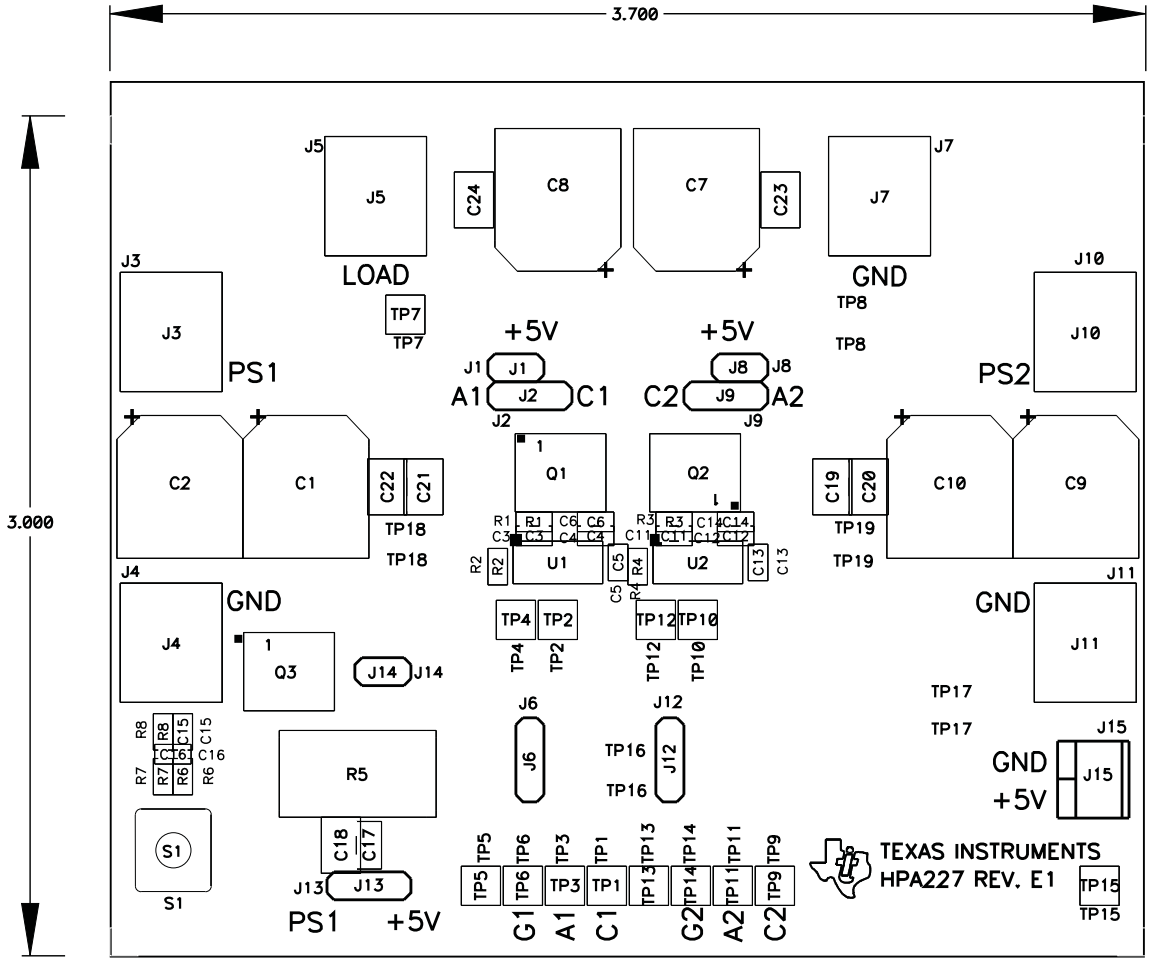

Figure 4. TPS2412/13 Layout

7 List of Materials

Table 5. List of Materials for the TPS2412/13 (1)(2)(3)(4)

REF DES	COUNT	DESCRIPTION	MFR	PART NUMBER
C1, C2, C7, C8, C9, C10	6	Capacitor, OSCON, SM, 100 µF, 20 V, 20%, G-case	Sanyo	20SVP100M
C15	1	Capacitor, ceramic, 0.1 µF, 16 V, X5R, 20%, '0603	STD	STD
C17	1	Capacitor, ceramic, 1 µF, 25 V, X5R, 20%, '0805	Panasonic	ECJ2FB1E105M
C18, C19, C20, C21, C22, C23, C24	7	Capacitor, ceramic, 22 µF, 25 V, X5R, 20%, '1210	Panasonic	ECJ4YB1E226M
C3, C11	2	Capacitor, ceramic, 0.01 µF, 25 V, X7R, 20%, '0603	STD	STD
C4, C12	2	Capacitor, ceramic, 2200 pF, 50 V, X7R, 10%, 0603	STD	STD
J1, J8, J14	3	Header, 2 pin, 100-mil spacing, (36-pin strip), 0.100 inch x 2	Sullins	PTC36SAAN
J15	1	Terminal block, 2-pin, 6-A, 3.5mm, 0.27 x 0.25 inch	OST	ED1514
J2, J9, J13	3	Header, 3 pin, 100-mil spacing, (36-pin strip), 0.100 inch x 3	Sullins	PTC36SAAN
J3, J4, J5, J7, J10, J11	6	Screw terminal, 0.310 x 0.310 inch	Keystone	7693
Q1, Q2, Q3	3	MOSFET, N-channel, 30 V, 30 A, R_{DS} 3 mΩ, PWRPAK S0-8	Vishay	Si7336ADP
R1, R3	2	Resistor, chip, 10 Ω,1/16 W, 1%, 0603	STD	STD
R2, R4	0	Resistor, chip, DNP, 1/16 W, 1%, 0603	STD	STD
R5	1	Resistor, power metal strip, 1 Ω, 2 W, 1%, 4527	Panasonic	WSR2 1R000 J EA
R6	1	Resistor, chip, 10 Ω, 1/16 W, 1%, 0603	STD	STD
R7	1	Resistor, chip, 1 kΩ, 1/16 W, 1%, 0603	STD	STD
R8	1	Resistor, chip, 2 kΩ, 1/16 W, 1%, 0603	STD	STD
S1	1	Switch, 1P1T, 20 mA, 15 V, 0.240 x 0.256	Panasonic	EVQPAC04M
SH1, SH2	2	Short jumper, 0.125 x 0.125 inch		
TP1, TP2, TP3, TP4, TP5, TP6, TP7, TP9, TP10, TP11, TP12, TP13, TP14, TP15	14	Test point, white, thru hole, 0.185 x 0.135 inch	Keystone	5012
TP8, TP16, TP17, TP18, TP19	5	Test point, SM, 0.150 x 0.090,	Keystone	5016
U1, U2	2	N+1 and O-Ring Power Rail Controller, TSSOP-8	TI	TPS241xPW

(1) These assemblies are ESD sensitive, ESD precautions shall be observed.
(2) These assemblies must be clean and free from flux and all contaminants. Use of no clean flux is not acceptable.
(3) These assemblies must comply with workmanship standards IPC-A-610 Class 2.
(4) Ref designators marked with an asterisk ('**') cannot be substituted. All other components can be substituted with equivalent MFG's components.

EVM WARNINGS AND RESTRICTIONS

It is important to operate this EVM within the input/output voltage range of 0.8 V to 18 V +/– 5%.

Exceeding the specified input range may cause unexpected operation and/or irreversible damage to the EVM. If there are questions concerning the input range, please contact a TI field representative prior to connecting the input power.

Applying loads outside of the specified output range may result in unintended operation and/or possible permanent damage to the EVM. Please consult the EVM User's 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, some circuit components may have case temperatures greater than 50°C. The EVM is designed to operate properly with certain components above 50°C as long as the input and output ranges are maintained. These components include but are not limited to linear regulators, switching transistors, pass transistors, and current sense resistors. These types of devices can be identified using the EVM schematic located in the EVM User's Guide. When placing measurement probes near these devices during operation, please be aware that these devices may be very warm to the touch.

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Dallas, Texas 75265

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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 DEGREDATION OR FAILURE OF THE EVALUATION KIT; TI RECOMMENDS STORAGE OF THE EVALUATION KIT IN A PROTECTIVE ESD BAG.

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 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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3.4.1 *For EVMs subject to EU Directive 2014/30/EU (Electromagnetic Compatibility Directive)*:

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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.

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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.

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