

EVM User's Guide: TRF-X-AFE7950EVM

TRF-X-AFE7950 评估模块



说明

TRF-X-AFE7950EVM 评估模块用于评估 TI [AFE79xx](#) 系列集成射频采样收发器的性能，该收发器在 RX 上具有 TI [TRF1213](#) 单端转差分 (S2D) 放大器。TRF-X-AFE7950EVM 特别采用了 [AFE7950](#) 收发器。AFE79xx 器件支持多达四个发送通道、四个接收通道和两个反馈通道 (4T4R2F)，并集成了一个锁相环 (PLL) 和压控振荡器 (VCO)，用于生成数据转换器时钟。AFE79xx 集成了八个兼容 JESD204B 和 JESD204C 的串行器或解串器 (SerDes) 收发器。这些收发器能够以高达 29.5Gbps 的速率运行，并通过板载 FPGA 夹层卡 (FMC) 连接器发送和接收数字数据。

该 EVM 包括 [LMK04828](#) 时钟发生器，用于为模拟前端 (AFE) 和采集卡 (现场可编程门阵列, FPGA) 提供参考时钟和 SYSREF。该评估模块 (EVM) 具有单个 5.5V 输入，而且包含完整的电源管理电路。外部时钟选项包括对馈送参考时钟 (用于片上 PLL) 提供支持。该设计可与 TI 图形和采集卡设计 (TSW14J58EVM) 以及许多 FPGA 开发套件相连接。

开始使用

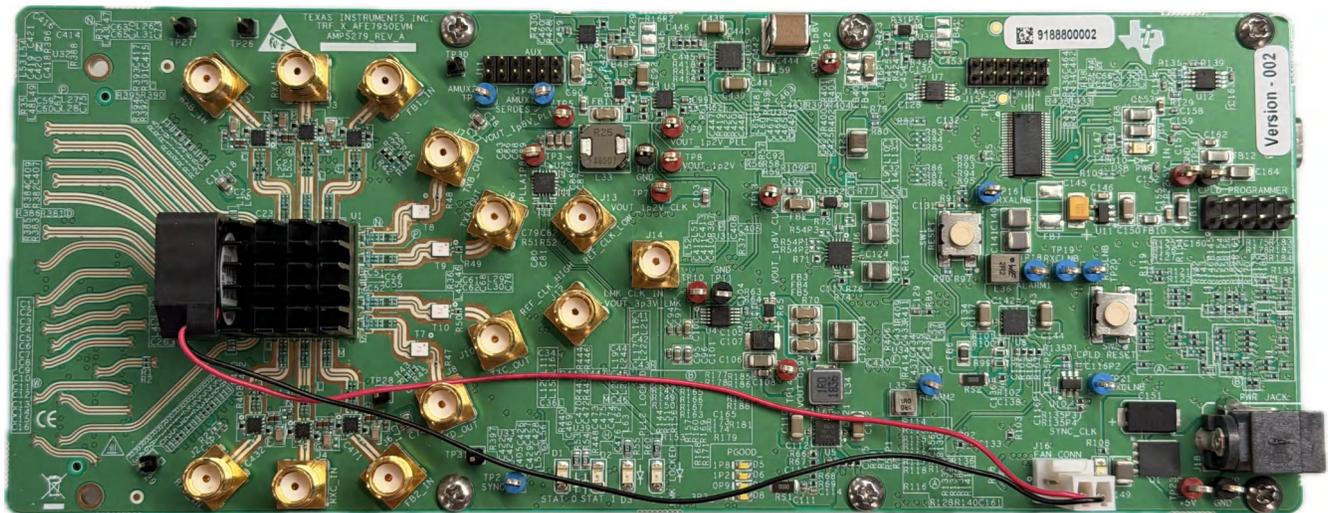
1. 订购 TRF-X-AFE7950EVM
2. 订购 [TSW14J58EVM](#)
3. 下载最新软件和库。
4. 下载全面的参考设计文件。
5. 有关最新信息，请参阅 [AFE79XX-HSC-DESIGN](#) 文件夹。

特性

- 5.5V 单电源供电
- 包括板载时钟生成
- 射频前端采用 X 波段设计，并配备了 TRF1213 S2D 放大器进行调谐

应用

- [导引头前端](#)
- [雷达](#)
- [国防无线电](#)
- [战术通信基础设施](#)
- [无线通信测试](#)



TRF-X-AFE7950EVM 电路板

1 评估模块概述

TRF-X-AFE7950EVM 包括一个时钟和电源解决方案，并采用 5.5V 单电源供电。图 1-1 显示，使用 SMA 连接器的射频输入和输出位于 EVM 顶部。通过 SMA J14 (LMK_CLK_IN) 连接器使用 10MHz 参考时钟，以使用 LMK04828 锁定板载压控晶体振荡器 (VCXO)。通常，实验室设备具有 10MHz 振荡器输出，用于同步多个实验室系统。板载 LMK04828 接受来自外部实验室设备的 10MHz 时钟，以保持数据采集和生成与 TRF-X-AFE7950EVM 同步和一致。

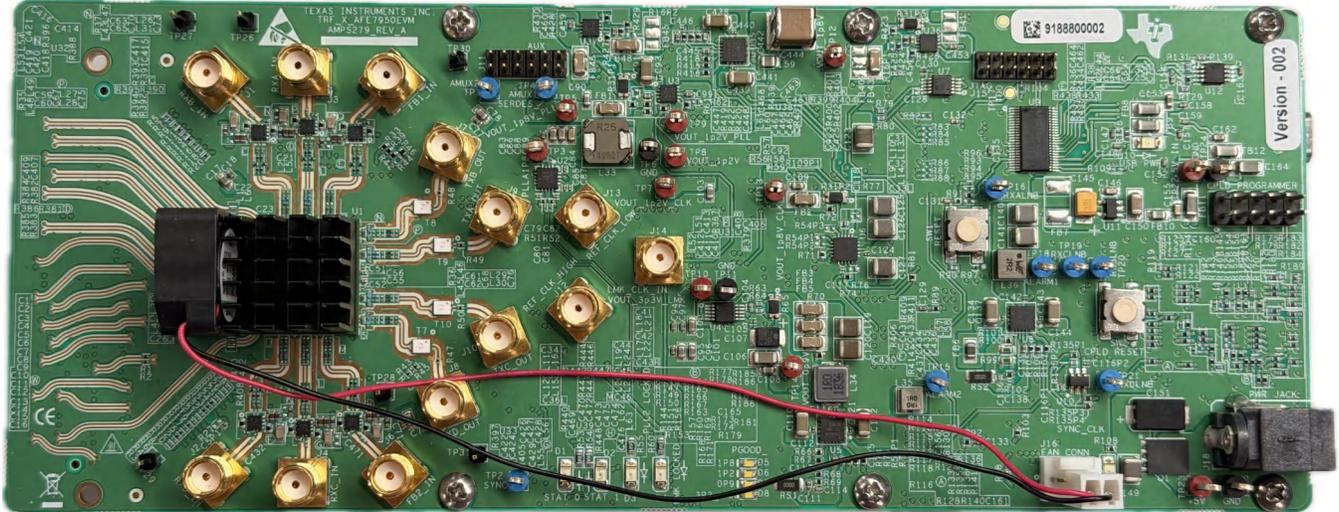


图 1-1. TRF-X-AFE7950EVM 顶视图

要馈送外部参考时钟以锁定 AFE79xx 中的 PLL，可使用 SMA J12 (REF_CLK_HIGH) 或 SMA J13 (REF_CLK_LOW)。USB 连接器和 5.5V 连接器位于电路板右侧。

图 1-2 显示了 TRF-X-AFE7950EVM 的底视图。

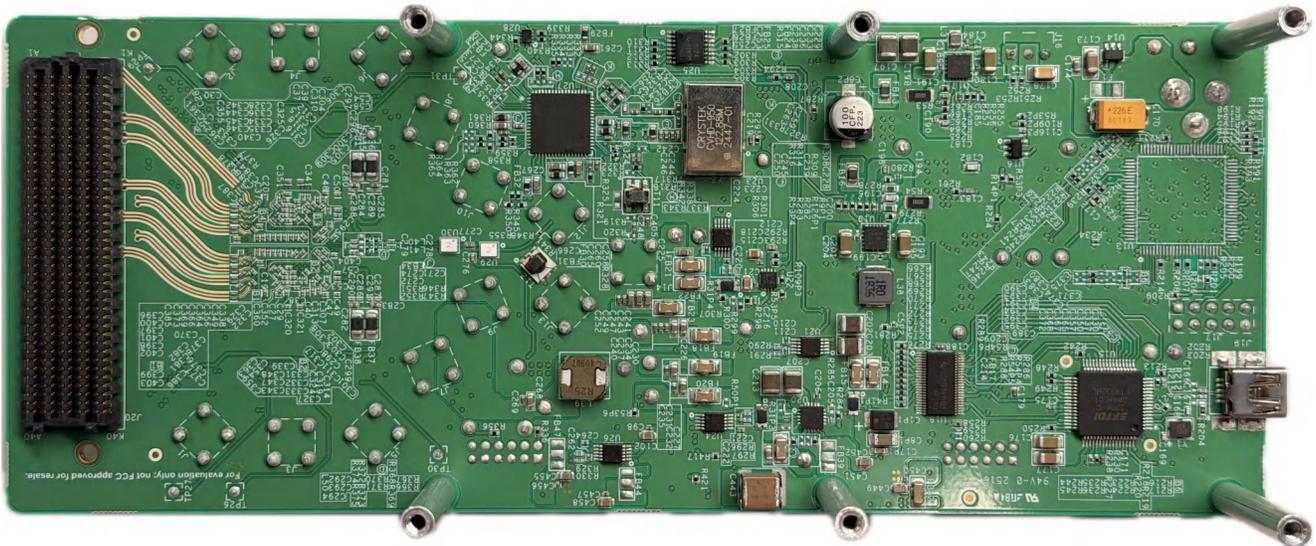


图 1-2. TRF-X-AFE7950EVM 底视图

与 TRF-X-AFE7950EVM 一同使用的采集卡通常是 TSW14J58EVM。TSW14J58EVM 可进行动态配置，以支持 1Gbps 到 24.5Gbps 的通道速度 (1 到 16 个通道)。

1.1 简介

TRF-X-AFE7950EVM 评估模块支持多达四个发送通道、四个接收通道和两个反馈通道 (4T4R2F)，这些通道全都调频至 X 频带。

	<p style="text-align: center;">小心</p> <p style="text-align: center;">表面高温。接触会导致烫伤。请勿触摸。</p>
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	<p style="text-align: center;">警告</p> <ol style="list-style-type: none">1. 活动器件：在运行过程中，请勿触摸旋转盘或电机。2. 外部连接：对于系统中连接的所有硬件/元件，与硬件的所有外部连接必须保持在建议的工作条件和预期用途范围内。
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1.2 套件内容

套件中包含：

- TRF-X-AFE7950EVM
- USB Type Mini-B 电缆
- 电源线

该套件不包括：

TSW14J58EVM 采集卡。可从 [TSW14J58EVM 网页](#) 订购此采集卡。

1.3 规格

图 1-3 展示了该板的信号链方框图。

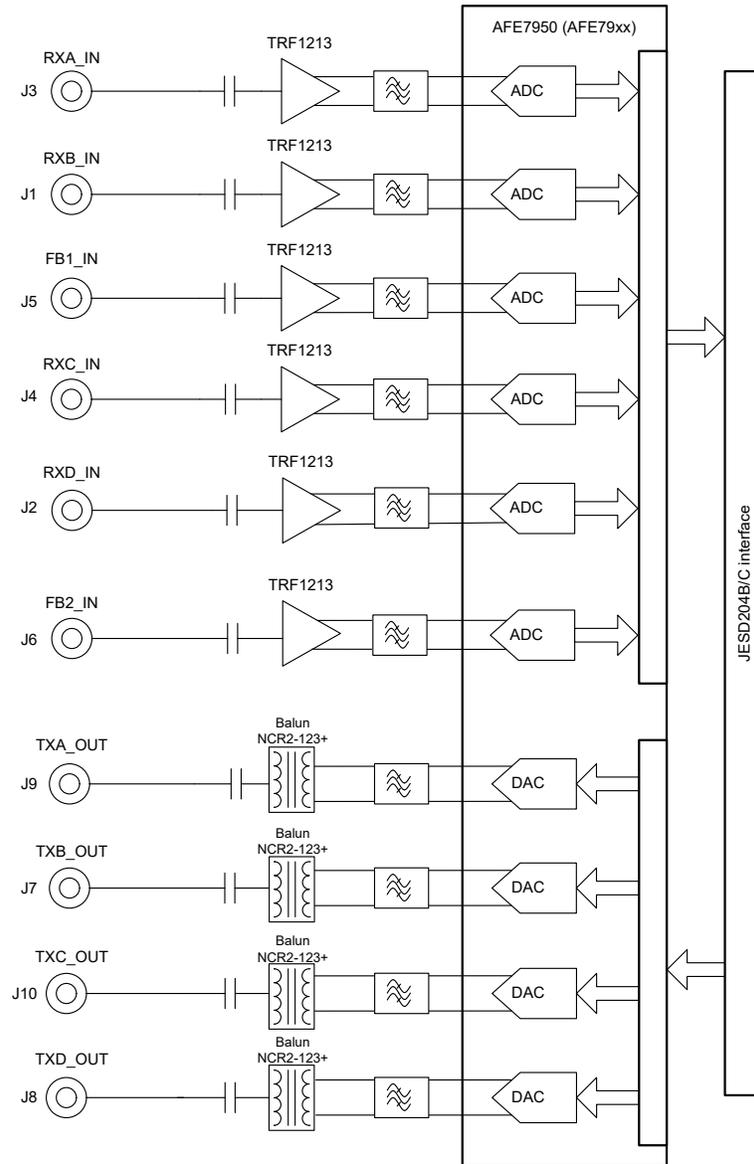


图 1-3. TRF-X-AFE7950EVM 方框图

1.4 器件信息

AFE7950 是一款高性能、高带宽、多通道收发器，集成了四个射频采样发送链、四个射频采样接收链和两个射频采样反馈链（总计六个射频采样 ADC）。此器件具有高达 12GHz 的工作频率，支持直接在 L、S、C 和 X 频段频率范围内进行射频采样，无需额外的频率转换级。

TRF1213 器件是一款单端转差分 (S2D) 放大器，可驱动 AFE7950 的接收和反馈路径 ADC。

LMK0482x 系列是一款符合 JESD204B 标准且集成 VCO 的超低噪声时钟抖动清除器。

2 硬件

2.1 电源要求

按照以下步骤设置电源：

1. 将 5.5V 电源连接到 TRF-X-AFE7950EVM 的电源插孔 (PWR_JACK) 连接器 (J18)。
2. 检查 D9 (PWR) LED 灯是否亮起。电源应消耗约 1600mA 电流。
3. 将 USB Type Mini-B 电缆从 PC 连接到 TRF-X-AFE7950EVM 的 USB 端口 (J19)。
4. 检查 D10 (USB_PWR) LED 灯是否亮起。LED 灯的亮度取决于 USB 电缆的长度。如果 LED 灯未亮起，则使用较短的 USB 电缆。TI 使用三英尺 USB 线缆测试了 EVM。
5. TRF-X-AFE7950EVM 上的电源序列显示了每个电源轨的电源状态。如果电源正常 (PGOOD) 引脚处于逻辑高电平，则相应的电源轨已正确供电。相应的 LED 灯会亮起。检查以下 LED 灯是否亮起。
 - D5 (1P8) LED
 - D6 (1P2) LED
 - D7 (0P9) LED
 - D8 (3P3_LMK) LED

2.2 设置

射频测试设置需要射频信号发生器、频谱分析仪、衰减器垫、功率组合器、电缆等实验室元件。根据测试类型使用适当的设置。[TRF1213 评估模块用户指南](#)提供了射频测试设置的示例。

2.3 接口

按照 [AFE79XX-HSC-DESIGN](#) 中的步骤，连接 TRF-X-AFE7950EVM 和 TSW14J58EVM。

3 软件

[AFE79XX-HSC-DESIGN](#) 文件夹中提供了软件和说明。

4 硬件设计文件

4.1 原理图

要下载原理图，请参阅[设计文件](#)页面。

4.2 PCB 布局

如需下载 PCB 指南和示例布局，请参阅[设计文件](#)页面。

4.3 物料清单 (BOM)

如需下载物料清单 (BOM)，请参阅[设计文件](#)文件夹。

5 其他信息

5.1 商标

所有商标均为其各自所有者的财产。

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.
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 - 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.

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.

3.3 Japan

3.3.1 *Notice for EVMs delivered in Japan:* Please see http://www.tij.co.jp/llds/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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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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8. *Limitations on Damages and Liability:*

8.1 *General Limitations.* IN NO EVENT SHALL TI BE LIABLE FOR ANY SPECIAL, COLLATERAL, INDIRECT, PUNITIVE, INCIDENTAL, CONSEQUENTIAL, OR EXEMPLARY DAMAGES IN CONNECTION WITH OR ARISING OUT OF THESE TERMS OR THE USE OF THE EVMS , REGARDLESS OF WHETHER TI HAS BEEN ADVISED OF THE POSSIBILITY OF SUCH DAMAGES. EXCLUDED DAMAGES INCLUDE, BUT ARE NOT LIMITED TO, COST OF REMOVAL OR REINSTALLATION, ANCILLARY COSTS TO THE PROCUREMENT OF SUBSTITUTE GOODS OR SERVICES, RETESTING, OUTSIDE COMPUTER TIME, LABOR COSTS, LOSS OF GOODWILL, LOSS OF PROFITS, LOSS OF SAVINGS, LOSS OF USE, LOSS OF DATA, OR BUSINESS INTERRUPTION. NO CLAIM, SUIT OR ACTION SHALL BE BROUGHT AGAINST TI MORE THAN TWELVE (12) MONTHS AFTER THE EVENT THAT GAVE RISE TO THE CAUSE OF ACTION HAS OCCURRED.

8.2 *Specific Limitations.* IN NO EVENT SHALL TI'S AGGREGATE LIABILITY FROM ANY USE OF AN EVM PROVIDED HEREUNDER, INCLUDING FROM ANY WARRANTY, INDEMNITY OR OTHER OBLIGATION ARISING OUT OF OR IN CONNECTION WITH THESE TERMS, , EXCEED THE TOTAL AMOUNT PAID TO TI BY USER FOR THE PARTICULAR EVM(S) AT ISSUE DURING THE PRIOR TWELVE (12) MONTHS WITH RESPECT TO WHICH LOSSES OR DAMAGES ARE CLAIMED. THE EXISTENCE OF MORE THAN ONE CLAIM SHALL NOT ENLARGE OR EXTEND THIS LIMIT.

9. *Return Policy.* Except as otherwise provided, TI does not offer any refunds, returns, or exchanges. Furthermore, no return of EVM(s) will be accepted if the package has been opened and no return of the EVM(s) will be accepted if they are damaged or otherwise not in a resalable condition. If User feels it has been incorrectly charged for the EVM(s) it ordered or that delivery violates the applicable order, User should contact TI. All refunds will be made in full within thirty (30) working days from the return of the components(s), excluding any postage or packaging costs.

10. *Governing Law:* These terms and conditions shall be governed by and interpreted in accordance with the laws of the State of Texas, without reference to conflict-of-laws principles. User agrees that non-exclusive jurisdiction for any dispute arising out of or relating to these terms and conditions lies within courts located in the State of Texas and consents to venue in Dallas County, Texas. Notwithstanding the foregoing, any judgment may be enforced in any United States or foreign court, and TI may seek injunctive relief in any United States or foreign court.

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