

EVM User's Guide: TRF-X-AFE7950EVM

TRF-X-AFE7950 Evaluation Module



Description

The TRF-X-AFE7950EVM evaluation module is used to evaluate the performance of TI's [AFE79xx](#) family of integrated RF sampling transceivers with TI's [TRF1213](#) single-ended-to-differential (S2D) amplifier on RX. TRF-X-AFE7950EVM specifically uses [AFE7950](#) transceiver. The AFE79xx devices support up to four transmit, four receive, and two feedback channels (4T4R2F) and integrates a phase-locked loop (PLL) and voltage-controlled oscillator (VCO) for generating data-converter clocks. The AFE79xx integrates eight JESD204B- and JESD204C-compatible serializer or deserializer (SerDes) transceivers. These transceivers are capable of running up to 29.5Gbps to transmit and receive digital data through the onboard FPGA mezzanine card (FMC) connector.

The EVM includes the [LMK04828](#) clock generator to provide reference clocks and SYSREF to the analog front end (AFE) and capture card (field-programmable gate array, FPGA). The evaluation module (EVM) uses a single 5.5V input and includes complete power-management circuitry. External clocking options include support for feeding the reference clock (for the on-chip PLL). The design

interfaces with the TI pattern and capture card design (TSW14J58EVM), as well as many FPGA development kits.

Get Started

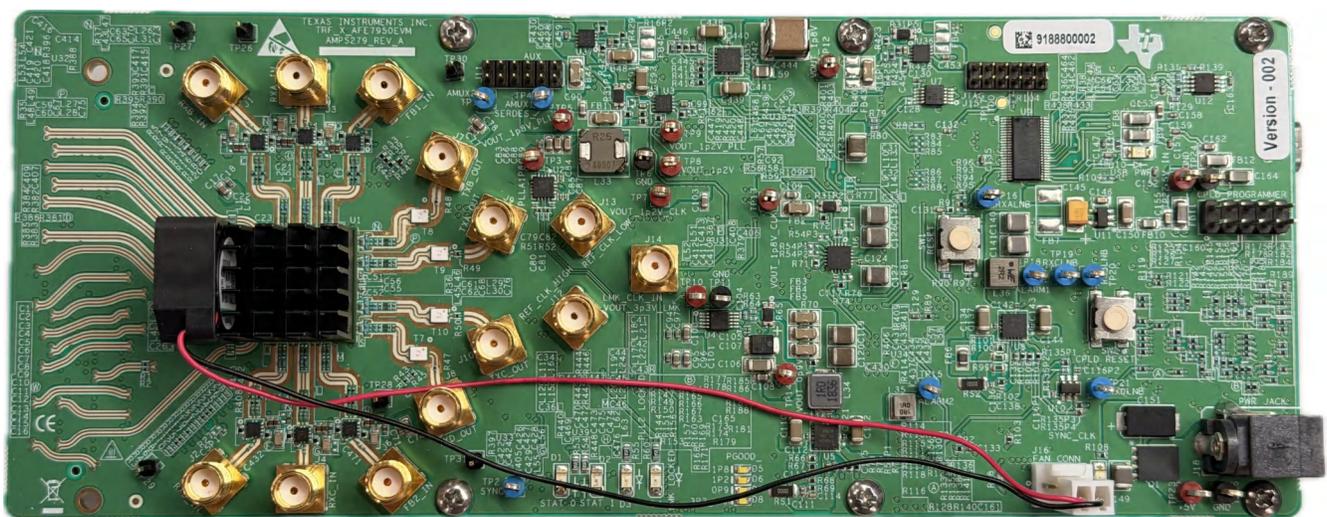
1. Order the TRF-X-AFE7950EVM
2. Order [TSW14J58EVM](#)
3. Download the latest software and libraries.
4. Download the comprehensive reference design files.
5. For latest info please refer to [AFE79XX-HSC-DESIGN](#) folder.

Features

- Operates on single 5.5V supply
- Includes on-board clock generation
- RF front end tuned to X-band with TRF1213 S2D amplifiers

Applications

- [Seeker front end](#)
- [Radar](#)
- [Defense radio](#)
- Tactical communications infrastructure
- [Wireless communications test](#)



TRF-X-AFE7950EVM Board

1 Evaluation Module Overview

The TRF-X-AFE7950EVM includes a clocking and power solution, and runs on a single 5.5V supply. [Figure 1-1](#) shows that the RF inputs and outputs using SMA connectors are on the top side of the EVM. Use a 10MHz reference clock through the SMA J14 (LMK_CLK_IN) connector to lock the onboard voltage-controlled crystal oscillator (VCXO) with the LMK04828. Typically, lab equipment has a 10MHz oscillator output to synchronize multiple lab systems. The onboard LMK04828 accepts the 10MHz clock from the external lab equipment to maintain synchronization and coherency of the data capture and generation to the TRF-X-AFE7950EVM.

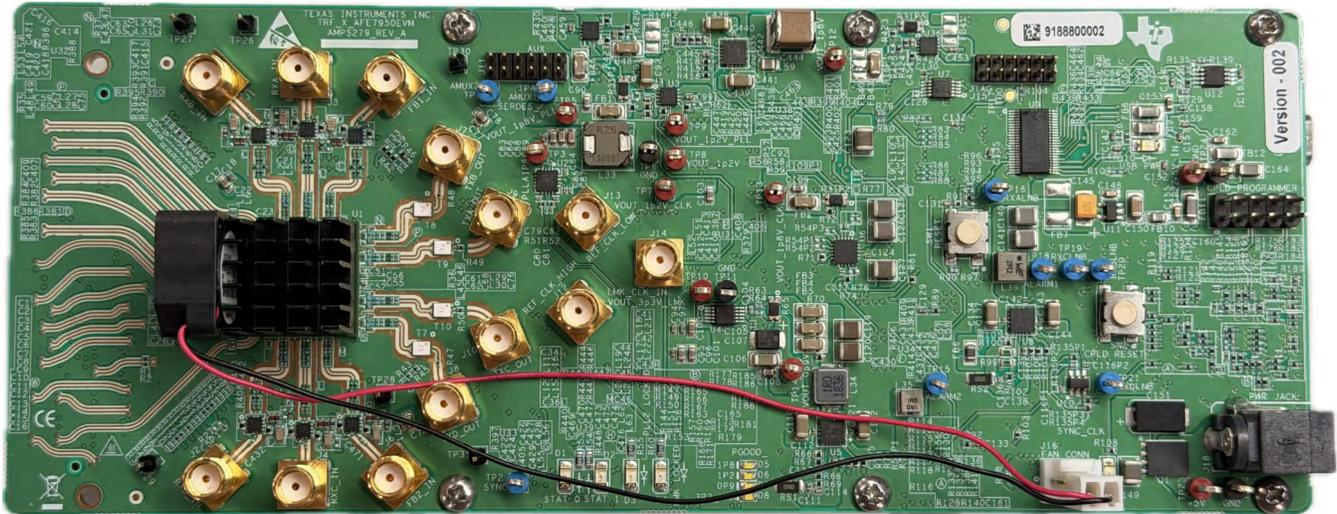


Figure 1-1. TRF-X-AFE7950EVM Top View

To feed an external reference clock to lock the PLLs in the AFE79xx, use SMA J12 (REF_CLK_HIGH) or SMA J13 (REF_CLK_LOW). The USB connector and the 5.5V connector are on the right side of the board.

[Figure 1-2](#) shows the bottom view of the TRF-X-AFE7950EVM.

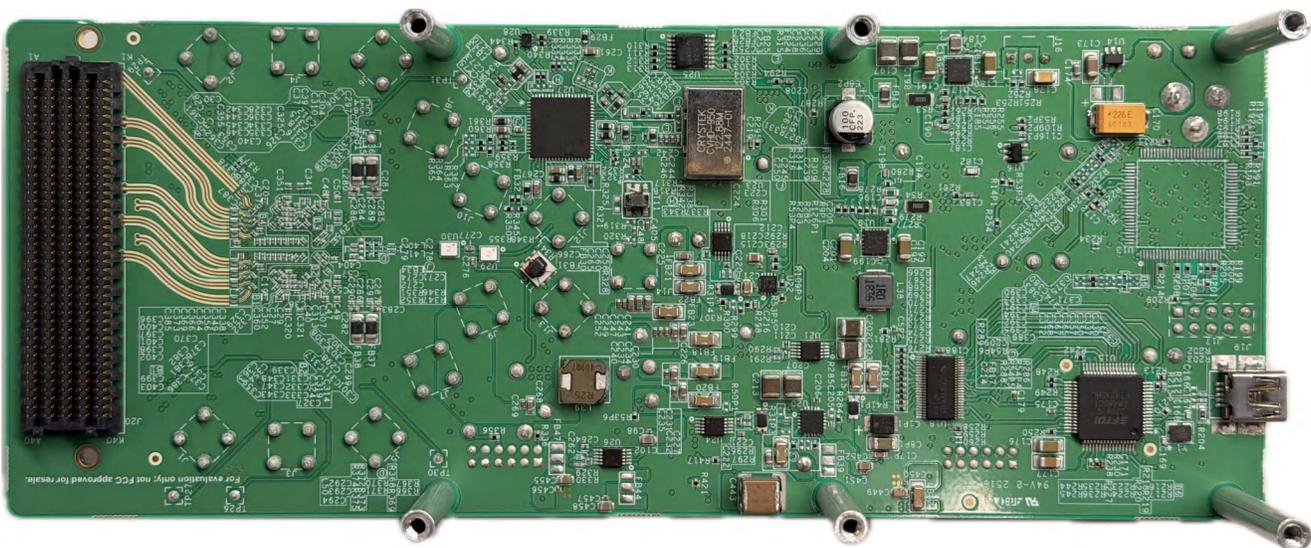


Figure 1-2. TRF-X-AFE7950EVM Bottom View

The capture card used with the TRF-X-AFE7950EVM is typically the TSW14J58EVM. The TSW14J58EVM is dynamically configurable to support lane speeds from 1Gbps to 24.5Gbps, and from 1 to 16 lanes.

1.1 Introduction

The TRF-X-AFE7950EVM evaluation module supports up to four transmit, four receive, and two feedback channels (4T4R2F), all tuned for X-band.

	<p style="text-align: center;">CAUTION</p> <p style="text-align: center;">Hot surface. Contact can cause burns. Do not touch.</p>
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	<p style="text-align: center;">WARNING</p> <ol style="list-style-type: none">1. Moving parts: Do not touch the spinning disk or motor during operation.2. External Connections: All external connections to the hardware must stay within the recommended operating conditions and intended usage for all hardware/components connected in the system.
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1.2 Kit Contents

The kit includes:

- TRF-X-AFE7950EVM
- USB Type Mini-B cable
- Power cable

The kit does not include:

The TSW14J58EVM capture card. Order this capture card from [TSW14J58EVM webpage](#).

1.3 Specification

Figure 1-3 shows the signal chain block diagram of the board.

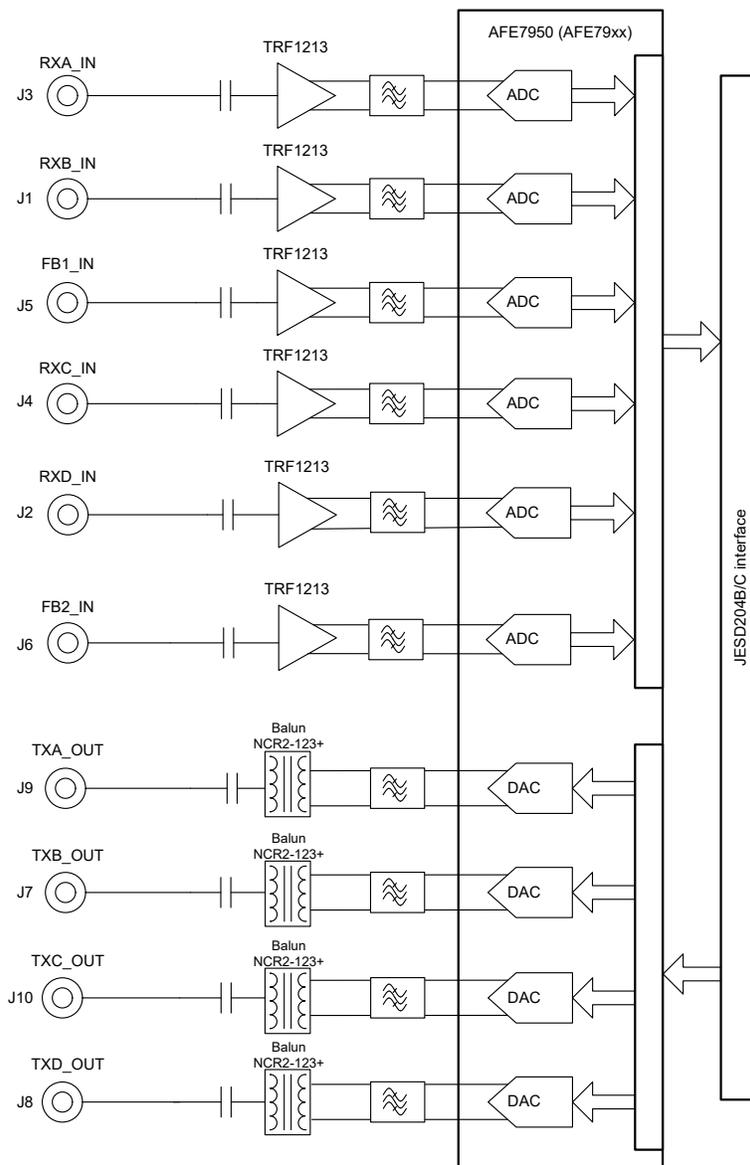


Figure 1-3. TRF-X-AFE7950EVM Block Diagram

1.4 Device Information

The AFE7950 is a high-performance, wide-bandwidth multichannel transceiver, integrating four RF sampling transmitter chains, four RF sampling receiver chains, and two RF sampling feedback chains (six RF sampling ADCs total). With operation up to 12GHz, this device enables direct RF sampling in the L-, S-, C-, and X-band frequency ranges without the need for additional frequency conversion stages.

The TRF1213 device is a single-ended-to-differential (S2D) amplifier that drives the receive and feedback path ADCs of the AFE7950.

The LMK0482x family is an ultra-low-noise, JESD204B-compliant clock-jitter cleaner with integrated VCO.

2 Hardware

2.1 Power Requirements

Follow these steps to set up the power supply:

1. Connect 5.5V power supply to the power jack (PWR_JACK) connector (J18) of the TRF-X-AFE7950EVM.
2. Check that the D9 (PWR) LED light is on. The power supply draws approximately 1600mA.
3. Connect a USB type mini-B cable from the PC to the USB port (J19) of the TRF-X-AFE7950EVM.
4. Check that the D10 (USB_PWR) LED light is on. The LED light strength depends on the USB cable length. If the LED light is not on, then use a shorter USB cable. TI tested the EVM with a three-foot USB cable.
5. The power-supply sequencer on the TRF-X-AFE7950EVM has a power status for each rail. If the power good (PGOOD) is logic high, then the corresponding power supply rail is powered correctly. The respective LED lights are on. Check that the following LEDs lights are on.
 - D5 (1P8) LED
 - D6 (1P2) LED
 - D7 (0P9) LED
 - D8 (3P3_LMK) LED

2.2 Setup

RF test setup requires RF signal generators, spectrum analyzer, attenuator pads, power combiners, cables, and such lab components. Use the appropriate setup based on the type of test. The [TRF1213 Evaluation Module user's guide](#) shows examples of the RF test setup.

2.3 Interfaces

Follow the steps from [AFE79XX-HSC-DESIGN](#) to connect the TRF-X-AFE7950EVM and TSW14J58EVM.

3 Software

Software and instructions are available in [AFE79XX-HSC-DESIGN](#) folder.

4 Hardware Design Files

4.1 Schematics

To download the schematics, see the [Design files](#) page.

4.2 PCB Layouts

To download the PCB guidelines and example layouts, see the [Design files](#) page.

4.3 Bill of Materials (BOM)

To download the bill of materials (BOM), see the [Design files](#) folder.

5 Additional Information

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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 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/lstds/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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