Frequently asked questions for TRF7960A, TRF7962A, and TRF7963A devices

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ABSTRACT

For the purposes of this document, *TRF79xxA* refers to the following devices unless otherwise specified: TRF7960A, TRF7962A, and TRF7963A.

This guide contains a compilation of frequently asked questions concerning the TRF79xxA series of devices. It serves as a central resource for evaluating or designing with the TRF79xxA devices. This guide includes links to recommended evaluation modules, TI Designs, firmware examples, and other collateral that is relevant for the TRF79xxA family.

Contents

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1   General Questions

1.1   *What is the TRF79xxA?*

The TRF7960A is a high-performance 13.56-MHz analog front end (AFE) IC for RFID reader/writer applications with integrated data-framing system for ISO/IEC 15693, ISO/IEC 18000-3, ISO/IEC 14443A/B, and FeliCa. The TRF7962A supports ISO/IEC 15693 and ISO/IEC 18000-3 only. The TRF7963A supports ISO/IEC 14443A/B and FeliCa only. The devices have integrated encode, decode, and data framing capability for data rates up to 848 kbps, wide supply voltage range support (2.7 V to 5.5 V), and 12-byte FIFO buffer for RF communication. RFID software stack libraries are offered to allow for easy development efforts and robust, cost-effective designs. Eight selectable power modes and ultra-low-power operation enable long battery life applications. The devices also offer unparalleled flexibility through the various direct communication modes on the device, which allow implementations of custom and proprietary protocols as well as other 13.56-MHz standards. The receiver system enables AM and PM demodulation using a dual-input architecture to maximize communication robustness.

1.2   *What protocols are supported by the TRF7960A, TRF7970A, and variants?*

For this section, TRF79xxA includes the TRF7960A, TRF7962A, TRF7963A, TRF7964A, and TRF7970A.

Each TRF79xxA device includes integrated protocol handling for certain ISO/IEC or NFC Forum standards. Table 1 lists the protocols supported by all TRF79xxA devices in the TI portfolio.

Table 1. Supported Protocols

Standard	TRF7960A, TRF7964A	TRF7962A	TRF7963A	TRF7970A
ISO standards	ISO/IEC 14443A	ISO/IEC 15693	ISO/IEC 14443A	ISO/IEC 14443A
	ISO/IEC 14443B	ISO/IEC 18000-3	ISO/IEC 14443B	ISO/IEC 14443B
	FeliCa (JIS X 6319-4)		FeliCa (JIS X 6319-4)	FeliCa (JIS X 6319-4)
	ISO/IEC 15693			ISO/IEC 15693
	ISO/IEC 18000-3			ISO/IEC 18000-3
				ISO/IEC 18092
				ISO/IEC 21481
NFC Forum reader/writer standards	Type 2	Type 5	Type 2	Type 2
	Type 3		Type 3	Type 3
	Type 4A		Type 4A	Type 4A
	Type 4B		Type 4B	Type 4B
	Type 5			Type 5
NFC Forum peer-to-peer standards	N/A	N/A	N/A	Type A (initiator and target)
				Type F (initiator and target)
NFC Forum card emulation standards	N/A	N/A	N/A	Type 4A
				Type 4B

It is possible to communicate with unsupported NFC/RFID tags and devices by operating the TRF79xxA in Direct Mode 0, which requires the host MCU to run at a multiple of 13.56 MHz to encode and decode the raw subcarrier signal. This allows the raw data to be received by the host MCU, which must process the received data including handling all packet and byte framing, parity checks, and CRC calculations.

1.3 What evaluation hardware and firmware should I get to evaluate the TRF79xxA devices?

All of the latest TI EVM and example firmware offerings are for the TRF7970A. Therefore, TI recommends using a LaunchPad™ development kit and a BoosterPack™ plug-in module for the TRF7970A for evaluation of all TRF79xxA devices.

The TRF79xxA devices described in this FAQ guide have only one firmware example that does not require any modifications. All other firmware bases need the modifications outlined in Section 4.1.

The aforementioned firmware example only supports basic RFID reader functionality, and the evaluation hardware that goes with it uses the TRF7970A device:

- Hardware: DLP-7970ABP BoosterPack plug-in module and MSP-EXP430G2ET LaunchPad development kit
- Firmware: Basic RFID Reader Firmware Example

NOTE: The RFID Reader firmware example does not include full support for NDEF messages. For a TI example with full NDEF support, see Frequently asked questions for the TRF7970A and TRF7964A. If it is not clear whether or not NDEF support is required, see Section 2.1 for further details.

The TRF79xxA devices covered in this FAQ guide are not software compatible with the TRF7970A. See Section 4.1 for further details.

To evaluate the other TRF79xxA devices, it is possible to replace the TRF7970A on a TI EVM with the desired TRF79xxA device to help validate that the system, including firmware, is functional on TI hardware before producing any custom PCBs.

1.4 What are the expected read ranges for NFC/RFID tags with TRF79xxA evaluation hardware?

The expected read range for NFC/RFID tags is an application-specific characteristic. Factors that affect the read range performance for an NFC/RFID system include: the antenna sizes of both the NFC/RFID reader and NFC/RFID tag, the output power of the NFC/RFID reader, the NFC/RFID protocol being used, and the antenna tuning parameters.

A typical expected read range with the DLP-7970ABP BoosterPack plug-in module (3.3-V powered and tuned for ISO/IEC 14443 and ISO/IEC 15693 technologies), MSP-EXP430G2ET LaunchPad development kit with TI firmware, and credit card sized TI Tag-It ISO/IEC 15693 tags is within 3 to 5 cm.

It is possible to have longer read ranges with an optimized system for specific standards. For example, ISO/IEC 15693 uses lower data rates and allows the reader antenna to be tuned to have a tighter bandwidth, which improves read range performance. If an antenna equal in size to the DLP-7970ABP onboard antenna has been tuned for a narrower bandwidth, and the TRF79xxA is powered at 5 V (to maximize output power), it is possible to have a read range of 8 to 10 cm with credit card sized ISO/IEC 15693 tags. Using a much larger antenna such as a 300-mm by 300-mm antenna and credit card sized TI Tag-It ISO/IEC 15693 tags, it is possible to have up to 20-cm read range with the TRF79xxA.

Antenna design and tuning is covered in full detail in Antenna design guide for the TRF79xxA.

To achieve read ranges up to 1 m, using a high-power HF RFID reader (for example, 1 W to 10 W) and large gate antennas (for example, 800 mm by 600 mm) are required. TI does not provide or support any designs that can achieve such ranges.

2   NFC/RFID Operating Mode Questions

2.1   *Reader/Writer Mode*

2.1.1   What is the difference between an NFC tag and an HF RFID tag?

An RFID tag uses proprietary data storage methods, usually just storing data in specific blocks that are defined by the developer. An NFC/RFID reader would need to know how the data is stored to interpret it.

An NFC tag uses the NFC Data Exchange Format (NDEF) to store data in tags according to the NDEF standards. This allows any NFC-enabled devices to read the data from any NFC tag and interpret it. Most applications on NFC-enabled smartphones use NDEF when reading or writing data to NFC tags.

2.1.2   Why is NDEF used? What advantages does NDEF provide?

The concept of NDEF is to create a universal format for how to store data across all NFC tags. This allows NFC devices such as smartphones to have a standard for how to read data across each NFC technology type despite varying memory structures and features.

The advantage of using NDEF is that any NFC-compliant device is able to read and write to an NDEF formatted tag allowing for excellent interoperability with a large number of devices and tags in the market.

NDEF should be leveraged for applications in which any of the following is desired:
* Compatibility with NFC-enabled devices in the market
* Display of information (text, URL, contact information, and so on) in an easily readable format

NDEF may not be an ideal choice for some applications such as:
* Proprietary closed-loop applications
* Applications in which raw unformatted data should be transferred over NFC

3   Hardware and Design Questions

3.1   Where can I get schematics and layout files for the TRF79xxA devices?

Schematics: Near Field Communication (NFC) reference design schematic

Layout: Near Field Communication (NFC) reference design PCB layout files

Layout design guide: TRF79xxA HF-RFID reader layout design guide

> **NOTE:**   No layout files are available for Eagle, Altium, or other PCB design tools.

3.2   How do I design and tune an antenna to 13.56 MHz for the TRF79xxA devices?

Proper antenna design and tuning is described in full detail in Antenna design guide for the TRF79xxA.

3.3   Does TI provide FCC certification for the TRF79xxA devices?

No, it is not possible to get FCC certification for a bare IC, and TI does not offer any modules for the TRF79xxA devices. The entire system must be certified by the end customer.

TI evaluation hardware has received FCC certification to demonstrate that the schematic and layouts for their designs meet the requirements. Following TI reference schematics and layout is recommended to avoid design flaws; however, passing FCC certification is an application-specific design consideration and the full responsibility of the end customer who must submit their own boards to apply for FCC certification.

> **NOTE:**   Do not copy a TI reference design schematic and layout in an attempt to use the TI FCC ID.

3.4   What TI reference designs are available for the TRF79xxA devices?

General Hardware Design: Near Field Communications (NFC) Transceiver Reference Design

4   Software Questions

4.1   What are the software differences between TRF7960A and TRF7970A?

As the TRF7960A is an older version of the TRF7970A, there are a number of differences with handling it. When using TI firmware projects for the TRF7970A that do not natively support the TRF79xxA devices covered in this document, the following changes must be applied:

1. FIFO length difference between the TRF7970A and TRF7960A

    - The TRF7970A has a 127-byte FIFO, but the TRF7960A only has a 12-byte FIFO. This means the FIFO buffer needs to be managed when transmitting or receiving more than 12 bytes of data.
    - Monitoring the FIFO watermark through IRQ interrupts lets data be read out before the FIFO overflows during receive operations, or ensures that enough data is loaded into the FIFO during transmit operation.

2. SPI Handling

    - The TRF7960A requires special SPI handling for the following situations:
        - SCLK polarity switch between SPI reads and SPI writes
        - Clearing the IRQ Status register
        - Sending certain direct commands
    - Review Using the SPI Interface With TRF7960 for full details of how to handle the SPI correctly for each of the above items.

3. The TRF7960A does not always take on the correct default register settings when the ISO Control register is written for specific protocols. Specifically, the RX No Response Wait Time register (0x07) and the RX Wait Time register (0x08) are affected by this. Use the following list to properly configure these registers after each write to the ISO Control register:

    - ISO Control is set for ISO/IEC 14443A and ISO/IEC 14443B
        - RX No Response Wait Time register (0x07) = 0x0E
        - RX Wait Time register (0x08) = 0x07
    - ISO Control is set for ISO15693
        - RX No Response Wait Time register (0x07) = 0x15
        - RX Wait Time register (0x08) = 0x1F
    - ISO Control is set for FeliCa
        - RX No Response Wait Time register (0x07) = 0x0E
        - RX Wait Time register (0x08) = 0x01

4. When reading out the FIFO Status register (0x1C), the actual number of bytes within the FIFO is 1 byte larger than the value returned. For example, if reading out the FIFO Status register resulted in a returned value of 0x04, then the actual number of bytes within the FIFO buffer is 0x05.

5. The TRF7960A does not always trigger an IRQ when the RX operation has been completed (IRQ Status = 0x40) when the FIFO watermark IRQ is triggered during RX (IRQ Status = 0x60).

    - To handle this, a 5 millisecond time-out should be used every time an IRQ Status of 0x60 is received to check the IRQ Status register if no IRQ interrupt is received.

4.2   I need to read a non-NFC compliant tag or transponder, what firmware example should I use?

If using MIFARE Classic® or MIFARE® DESFire® tags, see Section 4.4 for further details.

For all other proprietary RFID tags or transponders that have nonstandard activation or data exchange processes, TI does not supply example firmware. Therefore, custom firmware must be developed by the end user to handle such transponders on an application-specific basis.

4.3 Are there any firmware examples available for TI MCUs other than MSP430™ and MSP432™ MCUs?

For the TM4C1294 family, there is a full reference design which uses TI-RTOS, Wi-Fi®(with CC3100), and NFC (with TRF7970A and RF430CL330H). See the Wi-Fi Enabled IoT Node With NFC Connection Handover Reference Design for the firmware, design guide, and hardware files. This example uses an up-to-date NFC stack.

There are no up-to-date NFC-only or non-RTOS examples available for TM4C devices.

For the AM335x processors, there is a Linux example available, see Linux NFC (neard) for TRF7970A.

> **NOTE:** These solutions are only offered for the TRF7970A devices.

Aside from these listed examples, there are no other firmware examples for TI MCU or processors that leverage the TRF79xxA devices.

4.4 Are authentication examples available for the TRF79xxA devices?

MIFARE Classic:

- The recommended authentication example requires either the TRF7970A or TRF7964A and is described in Using Special Direct Mode With the TRF7970A.
- Alternatively, the TRF79xxA devices covered in this guide can support MIFARE Classic tags by using Direct Mode 0 which requires the host MCU to run at a multiple of 13.56 MHz to encode and decode the raw subcarrier signal. The firmware example for this can be requested from http://www.ti.com/tool/TRF796X_TRF7970X_MIFARE_12_2013.

MIFARE DESFire AES authentication example is provided in MIFARE DESFire EV1 AES Authentication With TRF7970A. This example does not include example firmware for the exchange of encrypted data, only initial authentication with an AES key.

4.5 What are the recommended TRF79xxA register settings or device configuration?

For recommended register settings and proper procedures to start-up the TRF79xxA devices, consult the firmware examples provided by TI. These examples show proper device start-up sequences, recommended register settings, and how to handle sending and receiving data through the TRF79xxA FIFO.

4.6 What does an IRQ status of 0xC0 mean?

An IRQ status of 0xC0 indicates that both the TX complete and RX start bits have been set. This can be an issue as the TRF79xxA FIFO is supposed to be reset with the direct command 0x0F after a TX operation is finished and before an RX operation begins. Not resetting the FIFO can result in corrupted RX data.

The typical cause for this issue is that the interrupt for the TX complete event (IRQ status = 0x80) is not serviced quickly enough. This can either be an issue with priority of the interrupt or MCU clock speed. Ensure that the IRQ interrupt is serviced correctly and that the FIFO is reset with the direct command 0x0F after receiving the TX complete event. When done correctly, then the interrupt for either the RX complete event (IRQ status = 0x40) or the RX in progress event (IRQ status = 0x60) should be correctly received.

For the TRF79xxA devices with a 12-byte FIFO, another IRQ status that falls into this category is the IRQ status of 0xE0, which indicates that the TX complete bit has been set and that an RX operation is in progress and the FIFO is about to become full. This situation must be handled the same way by servicing the individual interrupts in a timely manner so the device is kept in a good state for each operation.

4.7   Are software examples available to read Topaz-512 (NFC Forum Type 1) tags?

TI does not have any example code for this transponder and does not plan to develop such firmware.

Due to the inter-byte timing requirements for Topaz-512 tags, the TRF79xxA devices cannot leverage the built-in hardware encoders and demodulators as it does for most NFC/RFID transponders. Communication with these tags using the TRF79xxA is possible through the use of Direct Mode 0.

Direct Mode 0 allows the TRF79xxA to pass the raw modulated signals to the host MCU or receive a subcarrier digital data stream from the host MCU. The host MCU must run at a multiple of 13.56 MHz to demodulate received signals or encode subcarrier data. Consult the appropriate TRF79xxA data sheet for further detail about Direct Mode 0.

4.8   Are software examples available to read iCLASS® or PicoPass™ tags?

TI does not have any example code for this application and does not plan to develop such firmware. iCLASS and PicoPass tags are not compliant with ISO/IEC or NFC forum standards and are not supported by TI.

5 Miscellaneous Questions

5.1 Is there any support for RF power amplifiers?

TI does not have any officially released power amplifier designs and does not offer support for designs including an RF power amplifiers for the NFC and HF RFID product portfolio. Some potential power amplifier designs have been proposed on the E2E™ Community forums for NFC/RFID, but these are not officially released designs and are not supported in any manner.

5.2 Are there Energia or Arduino examples for the TRF79xxA?

TI does not supply examples for the TRF79xxA for Energia or Arduino. The best option available would be to use a combination of a BoosterPack plug-in module and a LaunchPad development kit as a separate NFC host from the Energia system and communicate with the MCU on the LaunchPad development kit through UART commands.

5.3 What IDEs are supported for Texas Instruments TRF79xxA firmware examples?

Code Composer Studio™ IDE is the supported IDE used for NFC firmware development. It is possible to port the Code Composer Studio IDE projects into other IDEs if needed, but there are no existing projects outside of the Code Composer Studio IDE.

5.4 What Android handset interoperability is supported?

NFC functionality across various NFC-enabled Android phones and tablets varies based on the company and the model of the device. Different phones and tablets use different NFC chipsets and software stacks. Therefore, not all devices support the same subset of NFC modes. Only Android devices that support Host-based Card Emulation (HCE) can be used with the TRF79xxA devices covered by this guide.

5.5 How do I configure the TRF79xxA to output a continuous or unmodulated RF field?

When certifying a system that includes devices that radiate RF energy, one of the required tests for most regulations is to measure the output of an unmodulated RF field from the system for a period of time.

To meet that requirement with a TRF79xxA device, use the following register setting:

Set bit 5 in Register 0x00 (Chip Status Control) to 1 to turn on the RF field output.

Applying this setting enables the TRF79xxA device under test to output an unmodulated RF field.

No other registers, including the Modulator Control register (0x09), need to be modified for tests that require an unmodulated RF field. Modulation on the RF field occurs only when data bytes are loaded into the TRF79xxA device and a transmission is initiated. Therefore, the settings for register 0x09 do not affect tests that require an unmodulated RF field.

6 References

1. TRF7970A multiprotocol fully integrated 13.56-MHz RFID and NFC transceiver IC
2. NFC/HF RFID reader/writer using the TRF7970A
3. NFC active and passive peer-to-peer communication using the TRF7970A
4. NFC card emulation using the TRF7970A ○

Revision History

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

Changes from May 24, 2018 to March 13, 2019	**Page**
• Updated links to purchase hardware throughout document	1