ABSTRACT
This application report is a reference for the firmware developer using TRF7960A in conjunction with microcontroller (for example, an MSP430™ or ARM™ device). This document supersedes TRF796x Software Design Hints (SLOA153).

Contents
1 ISO15693 Only – Direct Command (0x14) EOF/TX Next Slot ................................................................. 2
2 Missing IRQ ........................................................................................................................................... 2
3 Lost IRQ ............................................................................................................................................... 2
4 Wrong Data Due to Overshoots ........................................................................................................... 2
5 ISO14443A Decoder ............................................................................................................................. 3
6 Tags That Do Not Follow ISO14443A Layer 4 Framing ........................................................................ 3
7 Special SPI With SS Handling .............................................................................................................. 3

List of Tables
1 Firmware Hints Reference Table ........................................................................................................ 2
2 Known Limitations With Specific Tags ............................................................................................... 5
3 TRF7960A Special Functions Register (0x10) .................................................................................... 5
## Table 1. Firmware Hints Reference Table

<table>
<thead>
<tr>
<th>Item</th>
<th>TRF7960A</th>
<th>TRF7960</th>
<th>TRF7961</th>
</tr>
</thead>
<tbody>
<tr>
<td>#1 ISO15693 only - Direct command (0x14) 'Transmit next slot'</td>
<td></td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>#2 Missing IRQ</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>#3 Lost IRQ</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>#4 Wrong data due to overshoots</td>
<td>✓</td>
<td></td>
<td></td>
</tr>
<tr>
<td>#5 ISO14443A decoder</td>
<td></td>
<td></td>
<td>✓</td>
</tr>
<tr>
<td>#6 Tags that do not follow the 14443A Layer 4 framing</td>
<td></td>
<td></td>
<td>✓</td>
</tr>
<tr>
<td>#7 SPI with SS</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
</tbody>
</table>

### 1 ISO15693 Only – Direct Command (0x14) EOF/TX Next Slot

**Description**

Sending of 'Transmit next slot' direct command (0x14) can happen only once (ISO15693).

**Workaround**

Before sending the 'Transmit next slot' direct command, the 'Reset' direct command has to be send. This is only used in ISO15693 Inventory command (with 16 time slots). ISO 15693 'Write Single Block' and 'Lock Block' commands are affected also if the 'Option' bit is set.

### 2 Missing IRQ

**Description**

The device does not send (on pin13) any interrupt requests on certain condition. The chip can go to a state where the sending of additional interrupts during RX or TX is stopped. This happens when the Stop Condition is exactly aligned with the byte boundary on TX data.

**Workaround**

The loading and reading of the FIFO should be coded in such a way, that the Stop Condition does not fall directly on the TX byte boundary.

### 3 Lost IRQ

**Description**

Lost IRQ if the end of RX IRQ is to come exactly at the same time the IRQ register is being read. See also #6.

**Workaround**

Add additional checks to retrieve the RX data in case the IRQ is suppressed by a coinciding read operation.

### 4 Wrong Data Due to Overshoots

**Description**

The ISO14443A 106-kbps decoder gives wrong data in certain condition. When the analog front end filter overshoots, the digitizer might produce a rising edge on the subcarrier data. If this occurs within a small time window, the decoder produces false data. This happens extremely rarely and is dependent on the antenna and filter characteristics.

**Workaround**

Switch to PM channel or adjust gain to avoid overshoots in the analog filter.
5 ISO14443A Decoder

Description
ISO14443A subcarrier decoded incorrectly – reading holes.

Workaround
Adjust gain setting of main RX channel; repeat reading until correct data results. (This might require additional time.)

6 Tags That Do Not Follow ISO14443A Layer 4 Framing

Description
When a transmit frame starts with the code 0x93, 0x95, or 0x97, the reply is not correctly framed. This happens because the TRF796x devices have an automatic anti-collision broken byte framing system that is activated with the 0x93, 0x95, or 0x97 code.

Workaround
Use TRF7960 Direct Mode.

7 Special SPI With SS Handling

7.1 SPI With SS Pin Only – No High Impedance

Description
Serial interface with SS pin only, the interface does not go to high impedance when SS is high. It is not possible to multiplex the serial port interface lines.

Workaround
An external three-state buffer must be used if the chip is connected to a serial bus and the interface lines are multiplexed.

7.2 SPI With SS Pin Only – Direct Commands

Description
Serial interface with SS pin only, the direct commands are not executed if they are the last operation in the SPI communication. In the SPI interface with SS pin the Stop condition clock pulse is missing (compared to the parallel interface and SPI without SS pin). Some operations are relying on this clock and they do not work as expected.

Workaround
If a direct command is the last operation in the SPI communication, the SS pin goes high. Afterward, an additional clock pulse has to be sent.

7.3 SPI With SS Pin Only – IRQ Status Bit

Description
Serial interface with SS pin only, IRQ status bits are not cleared after the IRQ Status register (0x0C) is read.

Workaround
A dummy read has to be made after reading the 'IRQ status' register (0x0C). This can be done in non-continuous or continuous mode. In continuous mode only 8 clock pulses are needed. In non-continuous mode 16 clock pulses are needed: 8 for address and 8 for data.
7.4  **SPI With SS Pin Only – No TX If Single Bit in FIFO**

**Description**
Serial interface with SS pin only, the chip does not start with transmission if only one byte is loaded to the FIFO.

**Workaround**
The microcontroller must load an additional byte to the FIFO. The chip transmits only one byte on the TX if the "Number of complete bytes" in the registers 0x1D and 0x1E is 1.

7.5  **SPI With SS Pin Only – Clock Polarity Change**

**Description**
DATA_CLK clock polarity must be switched when FIFO read operation (single or continues) is executed. During SPI data transmission MOSI line is valid on rising edge, MISO line is valid on falling edge of Data CLK signal.

**Workaround**
Firmware need to switch clock polarity between FIFO writes and reads.

7.6  **SPI With SS Pin Only – IRQ Status Register Reset**

**Description**
The IRQ Status register (0x0C) is not automatically cleared after reading.

**Workaround**
Dummy register read is required to clear the content of the IRQ Status Register and drive the IRQ line to low.

7.7  **SPI With SS Pin Only – Single-Byte Direct Commands**

**Description**
All single byte direct commands need an additional CLK cycle to work.

**Workaround**
All direct command functions need to have an additional DATA_CLK cycle before Slave Select I line goes high.
### 7.8 SPI With SS Pin Only – Some Registers Do Not Take Default Values

#### Description

Some of the registers do not take the default values when the appropriate protocol is chosen in the ISO Control register.

#### Workaround

Manually program the default settings into the TRF796x during initialization.

Further information concerning the SPI can be found in *Using the SPI interface with the TRF7960 (SLOA140)*.

#### Table 2. Known Limitations With Specific Tags

<table>
<thead>
<tr>
<th>No.</th>
<th>Tag Type</th>
<th>Problem</th>
<th>Workaround</th>
</tr>
</thead>
<tbody>
<tr>
<td>T1</td>
<td>MIFARE™ ultralight</td>
<td>The 4-bit ACK and NAK reply can not be decoded with the integrated decoder/framer system. The 4-bit ACK is not according the standard ISO 14443A, so the internal data framing reports an error and must be by-passed.</td>
<td>Direct mode</td>
</tr>
<tr>
<td>T2</td>
<td>MIFARE classic (standard)</td>
<td>The parity check fails with the encrypted frames as the MIFARE standard encrypts also the parity bit.</td>
<td>Direct mode</td>
</tr>
<tr>
<td>T3</td>
<td>Tags that do not follow the ISO14443A Layer 4 framing</td>
<td>When a transmit frame starts with the code 0x93, 0x95, or 0x97, the reply is not correctly framed. This happens because the TRF796x devices have an automatic anticollision broken byte framer that is activated with the 0x93, 0x95 or 0x97 code.</td>
<td>Direct mode</td>
</tr>
<tr>
<td>T4</td>
<td>Cryptography cards such as JCOP or DESFire™</td>
<td>Using a cryptography card such as JCOP or DESFire at close proximity (&lt;1 cm) can cause a wrong collision error detection.</td>
<td>The reason is the 'calculation noise' emitted by the card which can be suppressed if the gain is drastically reduced. We proposed to use addition gain reduction enabled by test register.</td>
</tr>
<tr>
<td>T5</td>
<td>ISO15693 cards requiring a slot delimiter (EOF)</td>
<td>There are ISO15693 cards on the market requiring a slot delimiter (EOF).</td>
<td>A dedicated MCU timer must be used to generate the 37.76-µs timing grid.</td>
</tr>
</tbody>
</table>

#### Table 3. TRF7960A Special Functions Register (0x10)

<table>
<thead>
<tr>
<th>Bit</th>
<th>Bit Name</th>
<th>Function</th>
<th>Comment</th>
</tr>
</thead>
<tbody>
<tr>
<td>B7</td>
<td>RFU</td>
<td>RFU</td>
<td>RFU</td>
</tr>
<tr>
<td>B6</td>
<td>RFU</td>
<td>RFU</td>
<td>RFU</td>
</tr>
<tr>
<td>B5</td>
<td>RFU</td>
<td>RFU</td>
<td>RFU</td>
</tr>
<tr>
<td>B4</td>
<td>next_slot_37us</td>
<td>Sets the time grid for next slot command in ISO15693</td>
<td>0 = 18.88µs 1 = 37.77µs</td>
</tr>
<tr>
<td>B3</td>
<td>RFU</td>
<td>RFU</td>
<td>RFU</td>
</tr>
<tr>
<td>B2</td>
<td>4_bit_RX</td>
<td>Enable 4-bit replay (for example, ACK or NCK used by some cards such as MIFARE Ultralight)</td>
<td>0 = normal receive 1 = 4-bit receive</td>
</tr>
<tr>
<td>B1</td>
<td>14_anticoll</td>
<td>Disable anti-collision frames for 14443A (this bit should be set to 1 after anti-collision is finished)</td>
<td>0 = anti-collision framing (0x93, 0x95, 0x97) 1 = normal framing (no broken bytes)</td>
</tr>
<tr>
<td>B0</td>
<td>col_7_6</td>
<td>Selects the number of subcarrier pulses that trigger collision error in ISO14443A 106 kbps</td>
<td>0 = 7 subcarrier pulses 1 = 6 subcarrier pulses</td>
</tr>
</tbody>
</table>
IMPORTANT NOTICE

Texas Instruments Incorporated and its subsidiaries (TI) reserve the right to make corrections, modifications, enhancements, improvements, and other changes to its products and services at any time and to discontinue any product or service without notice. Customers should obtain the latest relevant information before placing orders and should verify that such information is current and complete. All products are sold subject to TI’s terms and conditions of sale supplied at the time of order acknowledgment.

TI warrants performance of its hardware products to the specifications applicable at the time of sale in accordance with TI’s standard warranty. Testing and other quality control techniques are used to the extent TI deems necessary to support this warranty. Except where mandated by government requirements, testing of all parameters of each product is not necessarily performed.

TI assumes no liability for applications assistance or customer product design. Customers are responsible for their products and applications using TI components. To minimize the risks associated with customer products and applications, customers should provide adequate design and operating safeguards.

TI does not warrant or represent that any license, either express or implied, is granted under any TI patent right, copyright, mask work right, or other TI intellectual property right relating to any combination, machine, or process in which TI products or services are used. Information published by TI regarding third-party products or services does not constitute a license from TI to use such products or services or a warranty or endorsement thereof. Use of such information may require a license from a third party under the patents or other intellectual property of the third party, or a license from TI under the patents or other intellectual property of TI.

Reproduction of TI information in TI data books or data sheets is permissible only if reproduction is without alteration and is accompanied by all associated warranties, conditions, limitations, and notices. Reproduction of this information with alteration is an unfair and deceptive business practice. TI is not responsible or liable for such altered documentation. Information of third parties may be subject to additional restrictions.

Resale of TI products or services with statements different from or beyond the parameters stated by TI for that product or service voids all express and any implied warranties for the associated TI product or service and is an unfair and deceptive business practice. TI is not responsible or liable for any such statements.

TI products are neither designed nor intended for use in safety-critical applications (such as life support) where a failure of the TI product would reasonably be expected to cause severe personal injury or death, unless officers of the parties have executed an agreement specifically governing such use. Buyers represent that they have all necessary expertise in the safety and regulatory ramifications of their applications, and acknowledge and agree that they are solely responsible for all legal, regulatory and safety-related requirements concerning their products and any use of TI products in such safety-critical applications, notwithstanding any applications-related information or support that may be provided by TI. Further, Buyers must fully indemnify TI and its representatives against any damages arising out of the use of TI products in such safety-critical applications.

TI products are neither designed nor intended for use in military/aerospace applications or environments unless the TI products are specifically designated by TI as military-grade or “enhanced plastic.” Only products designated by TI as military-grade meet military specifications. Buyers acknowledge and agree that any such use of TI products which TI has not designated as military-grade is solely at the Buyer’s risk, and that they are solely responsible for compliance with all legal and regulatory requirements in connection with such use.

TI products are neither designed nor intended for use in automotive applications or environments unless the specific TI products are designated by TI as compliant with ISO/TS 16949 requirements. Buyers acknowledge and agree that, if they use any non-designated products in automotive applications, TI will not be responsible for any failure to meet such requirements.

Following are URLs where you can obtain information on other Texas Instruments products and application solutions:

**Products**
- Audio: www.ti.com/audio
- Amplifiers: amplifier.ti.com
- Data Converters: dataconverter.ti.com
- DLP® Products: www.dlp.com
- DSP: dsp.ti.com
- Clocks and Timers: www.ti.com/clocks
- Interface: interface.ti.com
- Logic: logic.ti.com
- Power Mgmt: power.ti.com
- Microcontrollers: microcontroller.ti.com
- RFID: www.ti-rfid.com
- RF/IF and ZigBee® Solutions: www.ti.com/lprf

**Applications**
- Communications and Telecom: www.ti.com/communications
- Computers and Peripherals: www.ti.com/computers
- Consumer Electronics: www.ti.com/consumer-apps
- Energy and Lighting: www.ti.com/energy
- Industrial: www.ti.com/industrial
- Medical: www.ti.com/medical
- Security: www.ti.com/security
- Space, Avionics and Defense: www.ti.com/space-avionics-defense
- Transportation and Automotive: www.ti.com/automotive

**e2e Community Home Page**: e2e.ti.com

Mailing Address: Texas Instruments, Post Office Box 655303, Dallas, Texas 75265
Copyright © 2011, Texas Instruments Incorporated