

# TRF7970A Evaluation Module (EVM)

The Texas Instruments TRF7970A evaluation module (EVM) is intended to be used by to demonstrate the capabilities of the TRF7970A and help aid in the development process by providing a working hardware/firmware reference example for traditional HF (13.56 MHz) RFID and also NFC Forum operations.

This manual includes a list of EVM features, a brief description of the module, EVM specifications, details on connecting and using the EVM, and a discussion of the software interface for the EVM.



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## 1 TRF7970A EVM Description

The TRF7970A EVM features include:

- Support for:
  - ISO15693 standard based transponders
  - ISO14443 standard based transponders (Types A and B)
  - NFC Forum modes (RFID reader\writer, peer to peer, and card emulation)
- FeliCa<sup>™</sup> based transponders (UID read only)
- Standalone polling mode for quick demonstration of transponder detection
- Communication with host software graphical user interface (GUI) by USB VCP

The TRF7970A EVM also has the following hardware features specifically for development purposes:

- MSP430F2370 ultra-low power microcontroller with JTAG connectivity to development environment for custom firmware development.
- Parallel or SPI connectivity by 0-Ω jumpers
- Logic analyzer and oscilloscope test points for relevant signal observation during code development
- SMA (edge mount and through-hole) pads for connecting customer designed magnetic dipole circuit

NOTE: Onboard antenna circuit should be disconnected by removing R3 beforehand to maintain 50-  $\Omega$  impedance.

# 1.1 Default Configuration

As shipped, the TRF7970A EVM is fully functional as an RFID and NFC Forum reader and writer, NFC Forum Initiator, or NFC Forum Target. To evaluate the TRF7970A beyond the standalone mode, which only requires that power be applied through the USB connector, the TRF7970A EVM GUI must be used.

# CAUTION

The TRF7970A EVM contains components that can be potentially damaged by electrostatic discharge. Always store and transport the EVM in the supplied ESD bag when not in use. Always handle the TRF7970A EVM in an ESD controlled environment. For more information regarding proper ESD handling procedures see the *Electrostatic Discharge (ESD)* application report, <u>SSYA008</u>.

# 1.2 Hardware Description

As shown in Figure 1, the TRF7970A EVM is a self-contained development platform that can be used to independently evaluate or test the performance of the TRF7970A IC, custom firmware, customer designed magnetic dipole antennas, or potential transponders for a customer defined RFID or NFC Forum application. The TRF7970AEVM is configured from the factory in parallel communication mode between the MSP430F2370 and the TRF7970A using 0- $\Omega$  resistors between HDR\_4 and HDR\_5 pads. On power up, the preloaded MSP430F2370 firmware also checks the voltage level of P2.3 (pin 15), which is factory configured at HDR\_7 to have I/O\_SEL connected to Parallel connection by a 0- $\Omega$  resistor. To change to SPI with Slave Select operation, move all the 0- $\Omega$  resistors connecting HDR\_4 and HDR\_5 together so that HDR\_5 and HDR\_6 are connected and move the 0- $\Omega$  resistor on HDR\_7 so that I/O\_SEL and SPI are connected instead. The preloaded MSP430 firmware handles either hardware configuration case, parallel or SPI with SS.



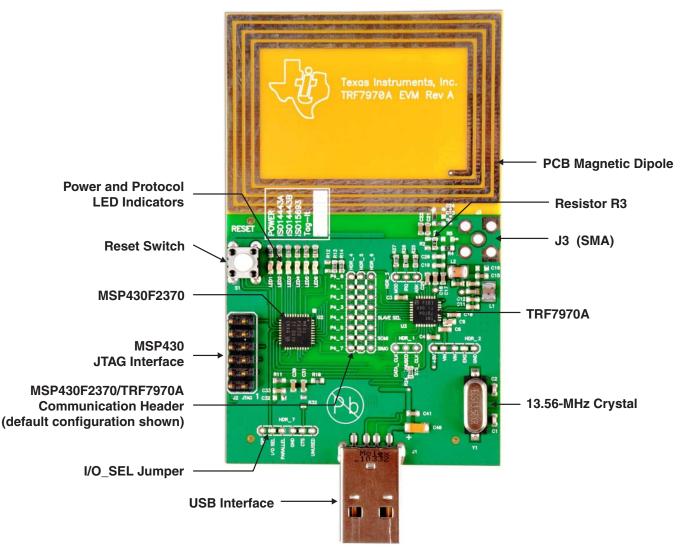


Figure 1. TRF7970A EVM (Top Side)

If a logic analyzer is to be connected to the TRF7970A EVM, the user can install three-position 2-mm board headers at positions HDR\_1 and HDR\_3 for observation of DATA\_CLK and IRQ signals. An 8-position 2-mm board header can be installed at position HDR\_5 for observation of the parallel or SPI signals between the MSP430F2370 and the TRF7970A. See the PCBA silkscreen or Table 1 and Table 2 for reference.

Table	1. Logic Analyzei	Connection Points	on EVM at HDR_5	

HDR_5 Pin	Parallel Name	SPI With SS Name	SPI Without SS Name
P5_7	I/O_7	MOSI	MOSI
P5_6	I/O_6	MISO	MISO
P5_5	I/O_5		
P5_4	I/O_4	Slave Select	
P5_3	I/O_3		
P5_2	I/O_2	VDD_I/O voltage level (VDD_X on EVM)	VDD_I/O voltage level (VDD_X on EVM)
P5_1	I/O_1		GND
P5_0	I/O_0	GND	GND



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		= /		
HDR_3 Pin	Parallel Name	SPI With SS Name	SPI Without SS Name	
P2	IRQ	IRQ	IRQ	
HDR_2 Pin	Parallel Name	SPI With SS Name	SPI Without SS Name	
P5	GND	GND	GND	
HDR_1 Pin	Parallel Name	SPI With SS Name	SPI Without SS Name	
P1	DATA_CLK	DATA_CLK	DATA_CLK	

Table 2. Logic Analyzer Connection Points on EVM at HDR\_1, HDR\_3 and HDR\_2

It is also possible to disconnect the MSP430F2370 from the TRF7970A and use these headers to wire in another MCU (for example, other members of the MSP430<sup>™</sup>, Stellaris<sup>™</sup> Cortex<sup>™</sup>-M3, or Sitara<sup>™</sup> ARM8<sup>™</sup> and ARM9<sup>™</sup> families)

Resistor R3 (0  $\Omega$ ) makes the electrical connection between the 50- $\Omega$  impedance matching circuit from the TRF7970A to the onboard magnetic dipole antenna circuit, also matched to 50  $\Omega$ . When testing application specific antennas using J3 (SMA port), disconnect or remove R3 to maintain 50- $\Omega$  impedance out from the TRF7970A circuitry to the application specific antenna being tested (see Figure 1).

# 1.3 Standalone Mode Description

The TRF7970A EVM has a standalone mode in which when power is applied (by the USB connector), then the preloaded MSP430F2370 firmware initializes the TRF7970A IC for full power operation, illuminates the power LED, and begins a polling loop for ISO15693, ISO14443A, and ISO14443B transponders.

When any (or all) of these types of transponders are presented to the onboard antenna, the corresponding LED is illuminated (see silkscreen or actual TRF7970A PCBA in kit or in Figure 1). The TRF7970A EVM kit comes with a sample selection of Texas Instruments ISO15693 transponders.

When the TRF7970A EVM is connected to a PC and the TRF7970A EVM GUI is started, the preloaded MSP430F2370 firmware detects this, stops the polling loop, and turns off any protocol LEDs that were illuminated to take direct host commands.

# 1.4 GUI Software Description

The TRF7970A EVM can be used with the TRF7970A EVM PC GUI to demonstrate the traditional RFID reader and writer operations as well as NFC Forum Initiator and Target operations. As the EVM enumerates as a serial port on a PC, the EVM can be used with almost any simple serial terminal based program such as (but not limited to) HyperTerminal, Docklight, or LabVIEW. How to use the TRF7970A EVM with the GUI is described in Section 2.



# 2 Using the TRF7970A EVM With PC GUI

#### 2.1 USB Driver

The TRF7970A EVM has SiLabs CP2102 USB to UART Bridge IC onboard. The USB driver must be loaded onto the PC before starting the TRF7970A EVM GUI.

https://www.silabs.com/products/mcu/pages/USBtoUARTbridgeVCPdrivers.aspx

# 2.2 TRF7970A EVM GUI Startup

The TRF7970A EVM GUI has a COM port auto-detect function that is limited to COM ports 1 through 12. Therefore, check the COM port that is enumerated after plugging in the TRF7970A EVM but before starting the GUI. Verify that the COM port is within this range by using Windows Control Panel, System, Hardware Tab, Device Manager, Ports, Port Properties, Port Settings and also verify that the COM port settings are 115200 bps, 8 data bits, no parity, and 1 stop bit (115200 8N1).

The TRF7970A EVM GUI should be downloaded from <u>http://ti.com</u>, unzipped into dedicated folder, and then executable can be launched. Figure 2 shows the first screen that is displayed when the executable launches and automatically connects to the TRF7970A EVM.

Scroll down in the data log window with the slider bar on the right side to see that the GUI has connected to the TRF7970A EVM.

N TRF7970 EVM Control	
15693       14443A       14443B       FeliCa       Find tags       Registers       NFC-PP       Test         Commands <ul> <li>Inventory</li> <li>Read Single Block</li> <li>Write Single Block</li> <li>Lock Block</li> <li>Lock Block</li> <li>Read Multiple Blocks</li> <li>Select</li> <li>Addressed</li> <li>Dption</li> <li>Set Protocol</li> <li>Image: Select Select</li> <li>Set Protocol</li> <li>Tag Info</li> <li>Number of Blocks</li> <li>Write AFI</li> <li>Lock DSFID</li> <li>Get System Info</li> <li>Get Mult.Blk.Sec Status</li> <li>T1 Custom Commands</li> <li>Execute</li> <li>Image: Select Select Select</li> <li>Select Select Select</li> <li>Dption</li> <li>Set Protocol</li> <li>Image: Select Sel</li></ul>	IRQ status         Tx       Parity         Rx       Framing         FIFO       S/EOF         CRC       Coll         FIFO status       High         High       Low         Level       #         # Full       Special functions         AGC on       Main channel AM         Image: Enable TRF7970       Select Port
13:57:46.621       COM3         13:57:46.636       -> 0108000304FF0000         13:57:46.636       < 108000304FF0000	Clear Log Exit



Figure 2 shows TRF7970A EVM connected to COM3 (as an example). The EVM and the GUI are now ready to be used together to demonstrate the RFID reader and writer and NFC Forum operations.



# 2.3 ISO15693 Tab

By default the TRF7970A EVM GUI starts up with the ISO15693 tab selected. Set the transponder and tag request flags as appropriate for the given operation (details on this to follow for each command) and by using the Set Protocol button in the GUI first before executing any commands so that the TRF7970A register settings match what is being sent to and expected back from the transponders in the field of the EVM antenna. Note that there are only two mandatory commands in ISO/IEC 15693 standard (Inventory and Stay Quiet). All other available commands are either Optional (as defined by the ISO/IEC 15693 standard) or Custom (as defined by the transponder IC manufacturer by means of the framework outlined in ISO/IEC 15693 standard). Always use the transponder or tag IC specific data sheet in conjunction with this guide to ensure settings and commands match what the transponder is designed to support. To avoid any misunderstanding regarding the transponder or tag request flags, see Table 3, Table 4, and Table 5 (taken from the ISO/IEC 15693-3 standard).

Bit	Flag Name	Value	Definition
b1	Sub corrier flog	0	A single sub-carrier shall be used by the VICC
DI	Sub-carrier_flag	1	Two sub-carriers shall be used by the VICC
	0	Low data rate shall be used	
b2	Data_rate_flag	1	High data rate shall be used
<b>b</b> 2	b3 Inventory_flag		Flags 5 to 8 according to Table 4
03			Flags 5 to 8 according to Table 5
b4	Protocol Extension_flag	0	No protocol format extension
04		1	Protocol format is extended. Reserved for Future Use (RFU)

#### Table 3. ISO/IEC 15693 Request Flags (b1 - b4)

#### Table 4. ISO/IEC 15693 Request Flags (b5 – b8) when Inventory Flag is NOT set

Bit	Flag Name	Value	Definition		
		0	Request shall be executed by any VICC according to the setting of the Address_flag		
b5	Select_flag	1	Request shall be executed by only the VICC in selected state. The Address_flag shall be set to 0 and the UID field shall not be included in the request.		
b6		Address flog	0	Request is not addressed. UID field is not included. It shall be executed by any VICC.	
00	b6 Address_flag		Request is addressed. UID field is included. It shall be executed only by the VICC whose UID matches the UID specified in the request.		
b7	Option_flag	0	Meaning defined by command description. It shall be set to 0 if not otherwise defined by the command.		
	1		Meaning defined by command description.		
b8	RFU	0	RFU		

#### Table 5. ISO/IEC 15693 Request Flags (b5 – b8) when Inventory Flag is set

Bit	Flag Name	Value	Definition		
b5 AFI_flag		0	AFI Field is not present		
		1	AFI Field is present		
b6 Nb_slots_flag -		0	16 slots		
		1	1 slot		
b7	Option_flag	0 Meaning defined by command description. It shall be set to 0 if not othe defined by the command.			
1 Meaning defined by		1	Meaning defined by command description.		
b8	RFU	0	RFU		

#### 2.3.1 Inventory (Command Code 0x01)

The ISO/IEC 15693 Inventory command is used to acquire the factory programmed and permanently locked 64 bit unique identifier(s) (UIDs) of transponders that are in within the read zone of the TRF7970A EVM antenna. They are used, as the name implies, to address each VICC uniquely and individually during the anticollision loop and for one to one exchange between a VCD and a VICC. The format of the UID is shown in Table 6.

Byte Position	MSB				L	SB
Bits	64	57	56	49	48	1
Hexadecimal Representation	0xE0			turing Code 0x07)	IC Seria	Number

As shown in Table 6, the ISO/IEC 15693 standard mandates the MSByte of the UID be 0xE0. The standard also mandates that the IC manufacturing code byte be according to the list shown in ISO/IEC7816-6. The remaining 48 bits (6 bytes) are to be assigned by the IC manufacturer.

There is a slotted ALOHA style anticollision algorithm used for the inventory sequence and as stated above, the purpose is to retrieve the UIDs of the tags in the field. This algorithm does not use timeslots but rather is keyed off nibbles of the UID, starting with the lower half of the LSByte and as collisions are detected, a mask value is incremented until the collisions seen by the VCD are arbitrated.

As indicated above by bit 6 of Table 5, the Inventory command can be issued either as a single slot command or a sixteen slot command. If the command is issued as a single slot and there are two or more transponders in the field, only a collision is indicated and no arbitration takes place. This is useful in applications where only one transponder is allowed to be in the field at a time, as the detection of a collision would be considered quite useful.

Another technique of pre-sorting transponders that are present in the field is to pre-program different AFI values on the transponders, then issue the inventory command (single or sixteen slot) with one of those values in the AFI field and also indicate that this field is present via the request flags (see Table 5, bit 5). Only the tags with the corresponding AFI value respond. See Section 2.3.10 and the ISO/IEC 15693-3 Standard for more information.

To perform single slot inventory using the GUI:

- 1. Select the radio button for Inventory.
- 2. Select Tag Flags accordingly (see Figure 3 for one example).
- 3. Click Set Protocol.
- 4. Place tags or transponders near enough to the TRF7970A EVM antenna to be read.
- 5. Click Execute.

See Figure 3 and Figure 4 for example results of one tag in field and a collision between two tags, respectively.



Commands Commands Read Single Block Write Single Block Lock Block Read Multiple Blocks Write Multiple Blocks Stay Quiet	Image: Second State Sta
C Select Reset to Ready Write AFI Lock AFI Vrite DSFID Lock DSFID Get System Info Get Mult.Blk.Sec Status TI Custom Commands	UID E007C08533C36010 Tag Info (First) Block Number of Blocks Data Block Size Data Block Size Data Block Size Data Block Size Data Block Size Size Line Size Size Line Size Size Size Line Size Size Size Line Size
14:05:24.123 < 0108000 ISO 15693 Inventory request.	04142601000000 <b>from host to EVM</b> 04142601000000 <b>echo back from EVM to host</b> UID, byte swapped, LSB first, plus combined RSSI value

Figure 3. Single Slot Inventory Command (One Tag in Field)

	14443A       14443B       Felit         nmands       Inventory         Read Single Block       Write Single Block         Lock Block       Read Multiple Blocks         Write Multiple Blocks       Stay Quiet         Select       Reset to Ready         Write AFI       Lock AFI         Lock DSFID       Lock DSFID         Get System Info       Get Mult.Blk. Sec Status         TI Custom Commands       Status	a   Find tags   Registers   NF Tag Flags Double Sub-carrier High Data Rate AFI is present Option UID (First) Block Number Number of Blocks Data DSFID AFI	C-PP Test Data Coding Mode 1 out of 4 Full Power Half Power Set Protocol		UID M. A
15:39	:08.155 < 010B0003 5693 Inventory request.	04142601000000 04142601000000	collision indicate EVM firmware ba host with the cha	ick to the	

Figure 4. Single Slot Inventory Command (Two Tags in Field With Collision)



In time sensitive applications in which the number of tags that are presented to the field should be one at one time but could be from 1 to n, polling or looking for tags using the single slot method first might be effective. If a collision is detected, the firmware could then change the tag request flags to sixteen slot method and then proceed as described here.

To perform sixteen slot Inventory using the GUI:

- 1. Select the radio button for Inventory.
- 2. Select the Tag Flags accordingly (see Figure 5 for one example).
- 3. Click Set Protocol.
- 4. Place tags or transponders near enough to the TRF7970A EVM antenna to be read.
- 5. Click Execute.

See Figure 5 and Figure 6 for example results of multiple tags in the field without and with collisions, respectively.

N TRF7970 EVM Control	
15693 14443A 14443B FeliCa Find tags Registers NFC-PP Test	
Commands	1996C11 6 6 3C37712 5 5
C Write AFI (First) Block Number Blocks	of Blocks
<ul> <li>Get Mult.Blk.Sec Status</li> <li>☐ TI Custom Commands</li> </ul>	5 Execute
[1060C33385C007E0.77] [116C99C1BC8107E0.76] [1277C33385C007E0.6D] [0368C33385C007E0.6E]	

NOTE: For graphics brevity, only four tags are shown.

# Figure 5. Sixteen Slot Inventory Command (Four Tags in Field With No Collision)



-	TRF 7970 EVM Control         15693       14443A       14443B       Feli0         Commands       Inventory       Read Single Block         Write Single Block       User Single Block         Kead Single Block       Read Multiple Blocks         Write Multiple Blocks       Write Multiple Blocks         Stay Quiet       Select         Reset to Ready       Write AFI         Lock DSFID       Lock DSFID         Get System Info       Get System Info         TI Custom Commands       TI Custom Commands	Find tags       Registers       NFC-PP       Test         Tag Flags       Double Sub-carrier       Data Coding Mode       #       UID       M.A.         Image: Double Sub-carrier       Image: Double Su
	[0368C33385C007E0.6D] [.40][.40][.40][.40][.40][.40][.40][.40]	tags (in slot 0 for this example) that collided in first round arbitrated out by the next nibble up (handled by the FVM firmware)

NOTE: For graphics brevity, only five tags are shown.

# Figure 6. Sixteen Slot Inventory Command (Five Tags in Field, Collision in Slot 0)



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#### 2.3.2 Read Single Block (Command Code 0x20)

The Read Single Block Command is an optional command that requests one block of user memory data from a VICC, with the block number specified in the request. If the Option\_flag is set in the request, the VICC also returns the block security status. This command can be sent as an addressed or unaddressed request.

To perform Read Single Block using the GUI:

- 1. Select the radio button for Read Single Block.
- 2. Select Tag Flags accordingly (see Figure 7 for one example).
- 3. Click Set Protocol.
- 4. Enter the Block number to be read (in hex).
- 5. Place tags or transponders near enough to the TRF7970A EVM antenna to be read.
- 6. Click Execute.

<ul> <li>TRF7970 EVM Control</li> <li>15693 14443A 14443B Feli</li> <li>Commands</li> <li>Inventory</li> <li>Read Single Block 1</li> <li>Write Single Block</li> <li>Lock Block</li> <li>Read Multiple Blocks</li> <li>Write Multiple Blocks</li> <li>Stay Quiet</li> <li>Select</li> <li>Reset to Ready</li> <li>Write AFI</li> <li>Lock DSFID</li> <li>Lock DSFID</li> <li>Get System Info</li> <li>Get Mult.Blk.Sec Status</li> <li>TI Custom Commands</li> </ul>	Ca Find tags Registers NFC-PP Test Tag Flags Double Sub-carrier High Data Rate 2 Select Addressed Dption UID (First) Block Number Data Double Sub-carrier Attack Sub-carrier Addressed Data Double Sub-carrier Teuth Power Set Protocol 3	UID M. A
16:29:40.802> 0108000	04F1FF0000 304180220000000 304180220000000 Block 00 Data (all zeros, as shipped from TI)	1

Figure 7. Read Single Block Command Example



#### 2.3.3 Write Single Block (Command Code 0x21)

The Write Single Block Command is an optional command that writes one block of user memory data on a VICC, with the block number and the block data specified in the request. For TI, TI based, and some other manufacturers' VICCs, the Option\_flag must be set in the request. This command can be sent as an addressed or unaddressed request, and the VICC returns an error or no error response after the write operation has been completed.

To perform Write Single Block using the GUI:

- 1. Select the radio button for Write Single Block.
- 2. Select Tag Flags accordingly (see Figure 8 for one example, and note use of option flag).
- 3. Click Set Protocol.
- 4. Enter the Block number to be written (in hex).
- 5. Enter the Data to be written (in hex).
- 6. Place tags or transponders near enough to the TRF7970A EVM antenna to be read.
- 7. Click Execute.

N TRF7970 EVM Control	
15693 14443A 14443B FeliC	a   Find tags   Registers   NFC-PP   Test
Commands C Inventory Read Single Block Write Single Block Lock Block Read Multiple Blocks C Write Multiple Blocks	Tag Flags     Data Coding Mode       Double Sub-carrier     1 out of 4       High Data Rate     Full Power       Addressed     Half Power       Option     Set Protocol       3
C Stay Quiet C Select C Reset to Ready C Write AFI C Lock AFI C Write DSFID C Lock DSFID C Get System Info	UID Tag Info (First) Block Number 00 4 Block Size Block Size Data Data DEADBEEF AFI 5
<ul> <li>⊂ Get Mult.Blk.Sec Status</li> <li>☐ TI Custom Commands</li> </ul>	7 Execute
16:35:57.520 < 010F00030 Bequest mode	0418422100EFBEADDE0000 0418422100EFBEADDE0000 0 Error Response Code (00) = User Memory Block was successfully written

Figure 8. Write Single Block Command Example



#### 2.3.4 Lock Block (Command Code 0x22)

The Lock Block Command is an optional command that locks one block of user memory data on a VICC, with the block number specified in the request. For TI, TI based, and some other manufacturers' VICCs, the Option\_flag must be set in the request. This command can be sent as an addressed or unaddressed request, and the VICC returns an error or no error response after the lock operation has been completed.

To perform Lock Block using the GUI:

- 1. Select the radio button for Lock Block.
- 2. Select Tag Flags accordingly (see Figure 9 for one example, and note use of option flag)
- 3. Click Set Protocol.
- 4. Enter the Block number to be locked.
- 5. Place tags or transponders near enough to the TRF7970A EVM antenna to be read.
- 6. Click Execute.

Commands C Inventory Read Single Block Write Single Block C Lock Block Read Multiple Blocks C Write Multiple Blocks	a Find tags Registers NFC-PP Test Tag Flags Double Sub-carrier High Data Rate Select Addressed Option Set Protocol 3
Stay Quiet     Select     Reset to Ready     Write AFI     Lock AFI     Write DSFID     Lock DSFID     Get System Info     Get Mult.Blk.Sec Status     TI Custom Commands	UID (First) Block Number of Blocks Number of Blocks Data DSFID AFI Execute 6
17:35:32.238 < 010B0003 Request mode.	04F1FF0000 04184222000000 04184222000000 o Error Response Code (00) = User Memory Block was successfully locked

Figure 9. Lock Block Command Example



#### 2.3.5 Read Multiple Blocks (Command Code 0x23)

The Read Multiple Blocks command is an optional command that requests more than one block of user memory data from a VICC at a time, with the first block number and the number of blocks specified in the request. This command can be sent as an addressed or unaddressed request. If the Option\_flag is set in the request, the VICC also returns the block security status, followed by the block value, sequentially.

To perform Read Multiple Blocks using the GUI (after connecting):

- 1. Select the radio button for Read Multiple Blocks
- 2. Select Tag Flags accordingly (see Figure 10 for one example)
- 3. Click Set Protocol.
- 4. Enter First Block number to be read
- 5. Enter number of blocks to be read (n 1)
- 6. Place tags or transponders near enough to the TRF7970A EVM antenna to be read.
- 7. Click Execute

<ul> <li>TRF7970 EVM Control</li> <li>15693 14443A 14443B FeliCa</li> <li>Commands <ul> <li>Inventory</li> <li>Read Single Block</li> <li>Write Single Block</li> <li>Lock Block</li> <li>Read Multiple Blocks</li> <li>Stay Quiet</li> <li>Select</li> <li>Reset to Ready</li> <li>Write AFI</li> <li>Lock DSFID</li> <li>Lock DSFID</li> <li>Get System Info</li> <li>Get Mult.Blk.Sec Status</li> <li>TI Custom Commands</li> </ul> </li> </ul>	Tag Flags Double Sub-carrier High Data Rate 2 Select Addressed Option UID (First) Block Number 00 Number of Blocks 03	Data Coding Mode 1 out of 4 Full Power Half Power Set Protocol 3 12233445566778893AAA	Block Size
	418022300030000 418022300030000	(4 Note that each b	d from VICC user memory 4 blocks total) lock is received LSByte first was preprogrammed with 00112233)

Figure 10. Read Multiple Blocks Command Example



# 2.3.6 Write Multiple Blocks (Command Code 0x24)

This optional command is not currently known to be supported by any ISO/IEC 15693 transponders available.

# 2.3.7 Stay Quiet (Command Code 0x02)

The Stay Quiet command is a mandatory command which instructs the VICC to enter the quiet state. The command is always issued as an addressed command and of course there is no response to the Stay Quiet Command. The VICC exits the quiet state when the transponder exits the field, receives a Reset to Ready command or a Select request.

To perform Stay Quiet command using the GUI:

- 1. Perform Inventory command (see Section 2.3.1) to obtain UID of VICC
- 2. Leave tag or transponder in field
- 3. Select the radio button for Stay Quiet
- 4. Select Tag Flags accordingly (see Figure 11 for one example)
- 5. Click Set Protocol. (if Data Rate or Sub-carrier Tag Request Flags are changed)
- 6. Click Execute

19693   14443A   14443B   Felit Commands C Inventory Read Single Block Write Single Block C Lock Block C Read Multiple Blocks C Write Multiple Blocks	a   Find tags   Registers   NFC-PP   Test   Tag Flags Double Sub-carrier High Data Rate Select Addressed Option Set Protocol   5	UID M. A 7000002352955 7 7
<ul> <li>Stay Quiet 3</li> <li>Select</li> <li>Reset to Ready</li> <li>Write AFI</li> <li>Lock AFI</li> <li>Write DSFID</li> <li>Lock DSFID</li> <li>Get System Info</li> </ul>	UID E007000002352955 - 1	CC in field to
C Get Mult.Blk.Sec Status		6 Execute
	0418220255293502000007E00000	JID in request

Figure 11. Stay Quiet Command Example

#### 2.3.8 Select (Command Code 0x25)

The Select command is an optional command that is always issued as an addressed command. If the UID sent as the address in the request matches the UID of the VICC, the VICC enters the Selected state. The intention of the Select Command is that only one VICC in the field should be in the Selected state at any one time.

To perform Select command using the GUI:

- 1. Perform sixteen slot Inventory command (see Section 2.3.1) to obtain UIDs of VICCs.
- 2. Leave VICCs in field.
- 3. Perform Stay Quiet command on each transponder (see Section 2.3.7).
- 4. Select the radio button for Select.
- 5. Select from the pulldown menu to choose which one of the tags is issued the Select Command.
- 6. Click Execute.

<ul> <li>Inventory</li> <li>Read Single Block</li> <li>Write Single Block</li> <li>Lock Block</li> <li>Read Multiple Blocks</li> <li>Stay Quiet</li> <li>Stay Quiet</li> <li>Select 4</li> <li>Reset to Ready</li> <li>Write AFI</li> <li>Lock AFI</li> <li>Lock DSFID</li> <li>Lock DSFID</li> <li>Get System Info</li> <li>Get Mult.Blk.Sec Status</li> <li>TI Custom Commands</li> </ul>	(Eirst) Plack Number E00	Data Coding Mode          1 out of 4         • Full Power         • Half Power         Set Protocol         70000002352955         70000002352955         70000002352955	#       UID       M. A         5       E007000002352955       7       7         11A       E007000002ED5BBA       2       1         2       Tag Info       Number of Blocks       Block Size         5       Block Size       Image: Comparison of Blocks       Execute         Usage of pull down menu to choose VICC       Execute       Image: Comparison of Blocks
			6

Figure 12. Select Command Example



#### 2.3.9 Reset to Ready (Command Code 0x26)

The Reset to Ready Command is an optional command that returns the VICC(s) in the Quiet state to the Ready state. This command can be sent as an addressed or unaddressed request and the same end result can also be achieved by turning off the activating field from the VCD or removing the VICC(s) from the activating field.

To perform Reset to Ready command using the GUI:

- 1. Perform sixteen slot Inventory command (see Section 2.3.1) to obtain UIDs of VICCs.
- 2. Leave VICCs in field.
- 3. Perform Stay Quiet command on each transponder (see Section 2.3.7).
- 4. Select the radio button for Reset to Ready.
- 5. Click Execute.

NRF7970 EVM Control			
15693 14443A 14443B FeliC	a   Find tags   Registers   NF(	C-PP Test	
Commands C Inventory Read Single Block Write Single Block Lock Block Read Multiple Blocks Write Multiple Blocks Stay Quiet	Tag Flags ☐ Double Sub-carrier ☑ High Data Rate ☐ Select ☐ Addressed ☐ Option	Data Coding Mode 1 out of 4 Full Power Half Power Set Protocol	UID M. A
<ul> <li>Stay dutet</li> <li>Select</li> <li>Reset to Ready 4</li> <li>Write AFI</li> <li>Lock AFI</li> <li>Write DSFID</li> <li>Lock DSFID</li> <li>Get System Info</li> </ul>	UID (First) Block Number Number of Blocks Data DSFID AFI		Tag Info Number of Blocks Block Size
	un requ (previ	ommand example was is addressed (or as a broad uest, thus all VICCs in the ously commanded to Sta now be reset to the Read	cast) : field y Quiet)

Figure 13. Reset to Ready Command Example

#### 2.3.10 Write AFI (Command Code 0x27)

The Write AFI Command is an optional command that writes a value to the AFI memory block on the VICC. For TI, TI based, and some other manufacturers' VICCs, the Option\_flag must be set in the request. This command can be sent as an addressed or unaddressed request, and the VICC returns an error or no error response after the write operation has been completed.

To perform Write AFI using the GUI:

- 1. Select the radio button for Write AFI.
- 2. Select Tag Flags accordingly (see Figure 14 for one example, note use of option flag)
- 3. Click Set Protocol.
- 4. Enter AFI value to be written (in hex).
- 5. Place tags or transponders near enough to the TRF7970A EVM antenna to be read.
- 6. Click Execute.

Commands C Inventory Read Single Block Write Single Block C Lock Block Read Multiple Blocks Write Multiple Blocks C Stay Quiet	Tag Flags     Data Coding Mode     #     UID     M. A.       Double Sub-carrier     1 out of 4      7     E007803402598037     7       High Data Rate     •     Full Power     •     Half Power     •     •       Addressed     •     Set Protocol     3     3
<ul> <li>Select</li> <li>Reset to Ready</li> <li>Write AFI</li> <li>Lock AFI</li> <li>Write DSFID</li> <li>Lock DSFID</li> <li>Get System Info</li> </ul>	UID E007803402598037  Tag Info Number of Blocks Block Size Data DSFID AFI 30 4
C Get Mult.Blk.Sec Status	6 Execute

Figure 14. Write AFI Command Example

#### 2.3.11 Lock AFI (Command Code 0x28)

The Lock AFI Command is an optional command that locks the value of the AFI memory block on the VICC. For TI, TI based, and some other manufacturers' VICCs, the Option\_flag must be set in the request. This command can be sent as an addressed or unaddressed request, and the VICC returns an error or no error response after the lock operation has been completed.

To perform Lock Block using the GUI:

- 1. Select the radio button for Lock AFI.
- 2. Select Tag Flags accordingly (see Figure 15 for one example, note use of option flag).
- 3. Click Set Protocol.
- 4. Place tags or transponders near enough to the TRF7970A EVM antenna to be read.
- 5. Click Execute.

	TRF7970 EVM Control         15693       14443A       14443B       FeliC         Commands       Inventory       Read Single Block         Write Single Block       Write Single Block         Lock Block       Read Multiple Blocks         Write Multiple Blocks       Select         Reset to Ready       Write AFI         Lock DSFID       Lock DSFID         Get System Info       Get Mult.Blk.Sec Status         TI Custom Commands       TI Custom Commands	Tag Flags ☐ Double Sub-carrier ☐ High Data Rate ☐ Select ☐ Addressed 2 ☐ Option	Data Coding Mode	#       UID       M. A         7       E007803402598037       7       7         1       Tag Info       Image: State of Blocks Block Size       Image: State of Block Size       Image: State of Block Size         5       Execute       5       Image: State of State
--	--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------	------------------------------------------------------------------------------------------------	------------------	------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------

Figure 15. Lock AFI Command Example

#### 2.3.12 Write DSFID (Command Code 0x29)

The Write DSFID Command is an optional command that writes a value to the DSFID memory block on the VICC. For TI, TI based, and some other manufacturers' VICCs, the Option\_flag must be set in the request. This command can be sent as an addressed or unaddressed request, and the VICC returns an error or no error response after the write operation has been completed.

To perform Write DSFID using the GUI:

- 1. Select the radio button for Write DSFID.
- 2. Select Tag Flags accordingly (see Figure 16 for one example, note use of option flag).
- 3. Click Set Protocol.
- 4. Enter Data to be written (in hex).
- 5. Place tags or transponders near enough to the TRF7970A EVM antenna to be read.
- 6. Click Execute.

<ul> <li>TRF7970 EVM Control</li> <li>15693 14443A 14443B FeliC</li> <li>Commands</li> <li>Conventory</li> <li>Read Single Block</li> <li>Write Single Block</li> <li>Lock Block</li> <li>Read Multiple Blocks</li> <li>Write Multiple Blocks</li> <li>Stay Quiet</li> </ul>	a Find tags Registers NFC-PP Test Tag Flags Double Sub-carrier W High Data Rate Select Addressed Set Protocol 3
C Select C Reset to Ready C Write AFI C Lock AFI Write DSFID C Lock DSFID	UID E007803402598037  Tag Info Number of Blocks Data DSFID A9 4 AFI 30
C Get Mult.Blk.Sec Status	6 Execute
	04184229A90000 04184229A90000 No Error Response Code (00) = DSFID was written successfully

Figure 16. Write DSFID Command Example



## 2.3.13 Lock DSFID (Command Code 0x2A)

The Lock DSFID Command is an optional command that locks the value of the DSFID memory block on the VICC. For TI, TI based, and some other manufacturers' VICCs, the Option\_flag must be set in the request. This command can be sent as an addressed or unaddressed request, and the VICC returns an error or no error response after the lock operation has been completed.

To perform Lock DSFID using the GUI:

- 1. Select the radio button for Lock DSFID.
- 2. Select Tag Flags accordingly (see Figure 17 for one example, note use of option flag).
- 3. Click Set Protocol.
- 4. Place tags or transponders near enough to the TRF7970A EVM antenna to be read.
- 5. Click Execute.

N TRF7970 EVM Control	
15693 14443A 14443B Felic Commands Inventory Read Single Block Write Single Block Cock Block Cock Block Read Multiple Blocks Cock Block Cock Block Cock Block Cock Block Cock Block Cock Block Cock AFI Cock AFI Cock AFI Cock DSFID Cock DSFID Cock System Info	a Find tags Registers NFC-PP Test Tag Flags Double Sub-carrier High Data Rate Select Option UID E007803402598037 7 7 Half Power Set Protocol 3 UID E007803402598037 7 Tag Info Number of Blocks Block Size Data DSFID A9 AFI 30
Get Mult.Blk.Sec Status     TI Custom Commands  Request mode. [00]	5 Execute
19:23:34.243 < 010A0003 Reguest mode.	0418422A0000 0418422A0000 Error Response Code (00) = DSFID was locked successfully

Figure 17. Lock DSFID Command Example



#### 2.3.14 Get System Information (Command Code 0x2B)

The Get System Information Command is an optional command that retrieves the system information values from the VICC information fields. This command can be sent as addressed or unaddressed request. These fields are summary of what is and is not supported on the tag, what the user memory size of the VICC is, and if there is an IC reference field. The IC reference field is defined by the VICC IC manufacturer.

To perform Get System Information using the GUI:

- 1. Select the radio button for Get System Info.
- 2. Select Tag Flags accordingly (see Figure 18 for one example).
- 3. Click Set Protocol.
- 4. Place tags or transponders near enough to the TRF7970A EVM antenna to be read.
- 5. Click Execute.

NRF7970 EVM Control	a   Find tags   Registers   NFC-PP   Test
Commands C Inventory Read Single Block Write Single Block C Lock Block Read Multiple Blocks Write Multiple Blocks	Tag Flags     Data Coding Mode     #     UID     M. A       Double Sub-carrier     1 out of 4        High Data Rate     •     Full Power       Addressed     •     Full Power       Option     Set Protocol
Stay Quiet  Select  Keset to Ready  Vite AFI  Couck AFI  Vite DSFID  Cock DSFID  Gode System Info	UID (First) Block Number Number of Blocks Data DSFID AFI Data Data Populated Find Data Data Data Data Data Data Data Data Data Data Data Data
	041802280000 041802280000

Figure 18. Get System Information Command Example



# 2.3.15 Get Multiple Block Security Status (Command Code 0x2C)

The Get Multiple Block Security Status Command is an optional command that retrieves the block security status on more than one block at a time, with the first block number and the number of blocks specified in the request. This command can be sent as addressed or unaddressed request.

To perform Get System Information using the GUI:

- 1. Select the radio button for Get Multiple Block Security Status.
- 2. Select Tag Flags accordingly (see Figure 19 for one example).
- 3. Click Set Protocol.
- 4. Type the first block number.
- 5. Type the number of blocks.
- 6. Place tags or transponders near enough to the TRF7970A EVM antenna to be read.
- 7. Click Execute.

C Lock Block C Read Multiple Blocks C Write Multiple Blocks C Stay Quiet C Select UID C Reset to Ready (First) Block Number 00 4 (First) Block Number 00 4 (First) Block Number 00 4 (First) Block S  DSFID C Lock DSFID C Get System Info C Get Mult.Blk.Sec Status 1  Execute
---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------

Figure 19. Get Multiple Block Security Status Command Example



#### 2.3.16 TI Custom Commands

The TRF7970A supports the two custom commands that are outlined in the ISO/IEC 15693 standard and defined by Texas Instruments. The format outlined in the standard for custom VICC commands is shown in Table 7. These commands are only supported by TI "Plus" silicon based transponders, which can be identified by part numbers containing RI-xxx-112A.

Table 7. Custom Commands Request Format	
-----------------------------------------	--

SOF	Request Flags	Custom Command Code	Manufacturer Code	Custom Request Parameters	CRC16	EOF
	1 byte	1 byte	1 byte (0x07 = TI)	Custom defined by IC manufacturer	2 bytes (handled by TRF7970A)	

# 2.3.16.1 Write Two Blocks (Command Code 0xA2)

When receiving the Write 2 Block Command, the transponder programs the requested blocks with the data contained in the request and reports the success of the operation in the response.

The addressed pair of blocks must contain one even and one odd block (for example, block numbers 2 and 3 or block numbers 6 and 7). The start block must have the even address (for example, number2, number4, or number6). If the odd address is used in the start block, the transponder does not execute the write operation and returns the error code 0xA1.

If one or both of the addressed blocks are locked, the transponder does not execute the write operation and returns the error code 0xA2.

The transmitted LSB block data are written to the LSB of the even addressed block (bytes 0-3) and the MSB transmitted data to the odd addressed block (bytes 4-7).

#### 2.3.16.2 Lock Two Blocks (Command Code 0xA3)

When receiving the Lock\_2\_Block Command, the Transponder shall lock the addressed blocks and report the success of the operation in the Response.

The addressed pair of blocks must contain one even and one odd block (for example, block numbers 2 and 3 or block numbers 6 and 7). The start block must have the even address (for example, number2, number4, or number6). If the odd address is used in the start block, the Transponder does not execute the Lock Block operation and returns the error code 0xA1.

If one or both of the addressed blocks are locked, the VICC returns the error code 0xA2.



#### 2.4 ISO14443A Tab

The ISO14443A tab is used to perform Layer 3 and some Layer 4 operations on ISO14443A PICCs, up to the stage at which transparent data is to be exchanged according to the ISO/IEC144443-4 standard.

#### 2.4.1 Anticollision

In the TRF7970A EVM GUI, this command performs the anticollision loop as outlined in the ISO/IEC14443-3 standard as outlined for one PICC (steps 1-5, flowchart for PCD). The TRF7970A EVM firmware and GUI also have provisions for resolving a collision between two Type A PICCs by using a special combination command (0xE6) and the Test tab. This section demonstrates the remaining steps (6-10) for this operation from the previously mentioned flowchart that occur before the select command is issued.

To perform anticollision loop on one tag using the GUI:

- 1. Select the radio button for anticollision
- 2. Click Set Protocol.
- 3. Place tag or transponder near enough to the TRF7970A EVM antenna to be read.
- 4. Click Execute.

NRF7970 EVM Control	
	Ca Find tags Registers NFC-PP Test
Commands Anticollision 1 Select HLTA Deselect RATS PPS	<ul> <li>Full Power</li> <li>Half Power</li> <li>Set Protocol</li> <li>2</li> </ul>
	UID 85CSA7A8 1 FSDI 1 0 CID CID supported FSCI NAD supproted DR 0 0 DS FW1 SFGI History
	3 Execute
20:22:18.850 < 01090003	304F1FF0000
	304A0010000 304A0010000 40](7F) <b>←───── ATQA, UID, UID BCC and RSSI</b>

Figure 20. Anticollision Command Example for One Type A PICC

To perform anticollision loop on up to two tags using the GUI:

- 1. Go to the ISO14443A tab.
- 2. Click Set Protocol.
- 3. Go to the Test tab.
- 4. Type the string *E600* in String to Send window (see Figure 21).
- 5. Place up to two ISO/IEC14443A PICCs near enough to the TRF7970A EVM antenna to be read.
- 6. Click Send.



TRF7970 EVM Control	
15693 14443A 14443B FeliCa Find tags Registers NFC-PP Test	
Current Test Program	
	New Test Program
Bun TP	
	6
String to send: E600	Send
4	Send Raw °
-	
Expert - keep settings when switching protocols	
Get Firmware Version	
Firmware Revision 07_20_2011	
20:40:58.096 →> 0109000304E6000000 20:40:58.315 < 0109000304E6000000 ATQA, UID, UID BCC and	
[0800][85C9A7AB40][85C9A7AB40][7F]  RSSI values for two ISO/IEC14443A PICCs	

Figure 21. Anticollision Command Example for Two Type A PICCs



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#### 2.4.2 Select, RATS, and PPS

The Select command radio button is automatically selected after the anticollision loop is complete when using the ISO14443A tab, because this command cannot be issued to a PICC until the UID is obtained. To issue Select command, leave the PICC in the field and click Execute (see Figure 22).

N TRF7970 EVM Control	
15693 14443A 14443B   FeliCa   Find tags   R	Registers NFC-PP Test
Commands C Anticollision Select C HLTA C Deselect C RATS C PPS	<ul> <li>Full Power</li> <li>Half Power</li> <li>Set Protocol</li> </ul>
	UID 85C3A7AB
14443A Select.	1 Execute
0 20:44:07.556> 010D000304A285C9A7AB4 20:44:07.791 < 010D000304A285C9A7AB4 14443A Select. 1080001201	

Figure 22. Select Command Example

After the Select command request is sent and a valid response is obtained, the GUI automatically selects the RATS radio button. Click the Execute button to process the command request (see Figure 23). Then the PPS radio button is automatically selected and is available as shown in the example, but the PICC must support it.



💀 TRF7970 EVM Control	
	Ca Find tags Registers NFC-PP Test
Commands C Anticollision C Select C HLTA C Deselect C BATS C PPS	<ul> <li>Full Power</li> <li>C Half Power</li> <li>Set Protocol</li> </ul>
	UID       1980F728       1         FSDI       1       0       CID       ✓ CID supported         FSCI       7       ✓       NAD supproted         DR       7       7       DS         FWI       0       0       SFGI         History       02200210       ✓
	0418E0100000 0418E0100000

Figure 23. RATS Command Example

#### 2.4.3 HLTA and Deselect

These commands are available in the GUI as needed to demonstrate stopping a card from responding while it remains in the field (HLTA) or to reset a card back to ready state once it has been selected (Deselect). Select the radio buttons as appropriate and click Execute.



# 2.5 ISO14443B Tab

The ISO14443B tab is used to perform Layer 3 and into Layer 4 operations on ISO14443B PICCs according to the ISO/IEC144443-4 standard. After selecting this tab, select the Set Protocol button.

#### 2.5.1 Request (REQ\_B)

This command is used to probe the field for ISO/IEC14443B PICCs, and it retrieves the PUPI and other relevant information needed by the ATTRIB command (see Figure 24).

<ul> <li>Full Power</li> <li>C Half Power</li> <li>Set Protocol</li> </ul>	
PUPI         628810E5         I           AFI         00         Fw1         ~ 4.83 ms           Bit Rate         00         ADC         7.9.3           Max Frame         2         F0         CID           Protocol Type         14443-4 compliant         F0         CID	TR0     TR1     EOF SOF     PCD to PICC     PICC to PCD     O     CID
	Execute
	C Half Power Set Protocol PUPI 628910E5 1 AFI 00 Number of Apps 00 Fw1 ~ 4.83 ms Bit Rate 00 ADC 7.9.3 Max Frame 2 F0 CD

Figure 24. REQ\_B Command Example

# 2.5.2 Wake-Up (WupB)

This command is used to bring ISO14443B PICCs out of the HALT state.



## 2.5.3 ATTRIB

This command is used to select an ISO14443B PICC and bring it into Layer 4. REQ\_B should be sent before this command so that the TRF7970A system has the information that is required in this command (see Figure 25).

NRF7970 EVM Control		
15693 14443A 14443B Feli	Ca Find tags Registers NFC-PP Test	
Commands C Request C Wake up C Attrib C Halt	<ul> <li>Full Pow</li> <li>Half Pov</li> <li>Set Protoc</li> </ul>	ver
	PUPI 628810E5 AFI 00 Number of Apps 00 FV Bit Rate 00 AD Max Frame 2 F Protocol Type 14443-4 compliant	
		Execute
	04181D628810E5005201000000 04181D628810E5005201000000	Answer to ATTRIB, CRC_B is checked and stripped off the response by the TRF7970A

Figure 25. ATTRIB Command Example

# 2.5.4 Halt

This command is used to halt or stop a card from responding while still in the activation field.

# 2.6 FeliCa Tab

This tab is used to poll for FeliCa transponders. This transponder technology is from the Sony Corporation and is primarily used for payment, and it is also included in the NFC Forum specification, just like ISO/IEC 15693 and ISO/IEC 14443 transponders.

#### 2.6.1 Polling

When inside the FeliCa tab, first select the radio button to select the protocol and click Set Protocol, then click Execute to retrieve the Manufacturer ID and the Manufacturer Parameters from the tag (see Figure 26). The Polling radio button is automatically selected.

15693   14443A   14443B Fe Commands	Ca   Find tags   Registers   NFC-PP   Test   Speed 212 kb/s • Full Power C Half Power Set Protocol
	Manufacturer ID     010106018E03C90C     1       Manufacturer param.     03014B024F4993FF       Requested data     00       Number of slots     00
	Execute
22:01:10.984> 0109000	304F1FF0000 30444000000 30444000000 18024E4993EF1

Figure 26. FeliCa Polling Example

# 2.7 Find Tags Tab

The Find Tags tab is a GUI-controlled version of the standalone mode that the reader defaults to when powered up but before the TRF7970A EVM GUI is executed. When this tab is selected, all of the supported protocols are selected to be polled for. Deselect any of the protocols that are not desired and click Run, which then turns into a Stop button (see Figure 27 and Figure 28). While this tab is useful for showing the multiprotocol capabilities of the TRF7970A EVM, it must be understood that the EVM antenna is a certain size and generates a specific magnetic field and also that the transponders are resonant circuits and can couple with each other, so some appropriate separation between the devices is recommended. The ISO15693 and ISO14443B transponders are polled for with multiple slot commands, while the FeliCa and ISO14443A transponders are polled for with single slot style commands only.

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😵 TRF7970 EVM Control		
	iCa Find tags Registers NFC-PP Test	
	14443A       Count       1       UIDs       7EA6A6E29C       14443B       Count       2       PUPIs       5A401BC8       54491BC8	FeliCa Count IDm
🗤 🔽 Select All	W W	o Stop

Figure 27. Find Tags Tab Example 1

NRF7970 EVM Control		
15693 14443A 14443B Feli	Ca Find tags Registers NFC-PP Test	
	14443A Count 1 UIDs 7EA6A6E29C 14443B Count 1 PUPIs	FeliCa Count 1 IDm 010106018E03C90C
I Select All	54401BC8	\\Stop

Figure 28. Find Tags Tab Example 2



#### 2.8 Registers Tab

The Registers tab is used to retrieve the values in the TRF7970A registers and to directly change the values of those registers.

Some of the register settings are coded in the TRF7970A EVM firmware for the various protocols commands; therefore, changes made in the Registers tab can be overwritten when going to a protocol tab and setting a different protocol. To keep the values that are manually set, go to the Test Tab and check Expert – keep settings when switching protocols. However, as some register settings are not compatible or do not make sense when looking across the protocols, these values are coded into the EVM firmware to provide (at the very least) sustaining performance. For example, the ISO Control Register value cannot be set to 0x02 (default setting for ISO15693) and still support operation of ISO14443A, ISO14443B, or FeliCa. See Figure 29 for example of this tab with registers set for default operation.

If the Set Defaults button is clicked, the EVM loses communication with the GUI. This is because the Modulator and Sys Clock register (register 0x09) value is changed, so the MSP430 is no longer running at the same clock speed as it was when communications were established. This causes the UART baud rate to be off time base, and the communications link is broken. To recover, close the GUI and reset the TRF7970A EVM either by pressing the reset button on the board or by removing and USB power; next, reconnect the EVM to USB and restart the GUI.

NRF7970 EVM Control			
15693 14443A 14443B F	eliCa Find tags	Registers NFC-PP Test	
Main Control		Status	
Chip Status Control	21	IRQ Status	
ISO Control	02	Oscillator Status and Interrupt Mask	
		Collision Position	
Protocol Sub-Setting	-	RSSI Level	
ISO Mode - Option 1	00		
ISO Mode - Option 2			Test
TX Timer (EPC) Setting - H	C1		Test Settings 1 00
TX Timer (EPC) Setting - L	BB		Test Settings 2 00
TX Pulse Length Control	00		
RX No Response Wait Time		NFC Settings	FIFO
RX Wait Time	1F	Low Field Det. 00	FIFO Water Level 00
Modulator Control	21		FIFO Status
RX Special Settings	40 T	arget Det. Level	TX Length Byte 1
Regulator Control	87	Target Protocol 00	TX Length Byte 2 00
Set Defaults			Write Read

Figure 29. Registers Tab

# 2.9 NFC-PP Tab

This tab is for demonstrating the Near Field Communications (NFC) capabilities of the TRF7970A. It requires two TRF7970A evaluation modules and two PCs with the TRF7970A EVM GUI loaded. The steps required to demonstrate these functions from an Initiator and a Target perspective are described in the following sections.

#### 2.9.1 Initiator Setup

To setup the first TRF7970A as an Initiator (Master) (after connecting on the first PC) (see Figure 30):

- 1. Click the NFC-PP tab.
- 2. Click Set Protocol.



TRF7970 EVM Control				×
15693       14443A       14443B       F         Commands       © SDD       Select.       Polling         Attribute       Polling       Attribute         Wake up       Parameter Selection       Data Exch. Protocol         Data Exch. Protocol       Deselect         Release       Release	Protocol Flags Target Passive C 106 kbs C 212 kbs C 424 kbs CID DID Transmit Bit Rate Receive Bit Rate	Send         Send           Send         Connect           0123456789ABCDEF0123         UID           00         FF	Connected Transm Generate 00 Number of 0 General Byte 0 NAD	Level # Ful Update Reset FIFD Special functions AGC on Main channel AM F Enable TRF7970
				Select Port
	adMode 003040 4030 4F00000 00304D 403D 4F00000			Clear Log

Figure 30. Setting up TRF7970A EVM as Initiator

#### 2.9.2 Target Setup

To set the second TRF7970A as a Target (Slave) (after connecting on the second PC) (see Figure 31):

- 1. Click the NFC-PP tab.
- 2. Check the Target Box in the Protocol Flags section of the GUI window.
- 3. Click Set Protocol.

NRF7970 EVM Control					
TRF2970 EVM Control      15693     14443A     14443B     Fe      Commands         Select         Polling         Attribute         Wake up         Parameter Selection         Data Exch. Protocol         Deselect         Release	Protocol Flags Target Assive 106 kbs 212 kbs 424 kbs CID DID	Save in Save in Connect Connect 0123456789ABCDEF0123 01 UID 01234567	Connected Generate	Browse Transmitting	IRQ status Tx Parity Rx Framing RFD S/EDF CRC Coll Coll FIFO status High Low Level High Low Level High Low
Register write request. 09:42:09.774> 0115000	Receive Bit Rate Buffer Length Data 30410002101210000 0304D40D0 40C0123456789			umber of slots eral Byte Execute	Update Reset FIFD Special functions AGC on Main channel AM Enable TRF7970 Select Port
	0304D 40DD 40C0123456789				Clear Log Exit

Figure 31. Setting up TRF7970A EVM as Target



After setting up the two separate TRF7970A evaluation modules, they should be arranged in a parallel orientation relative to each other for the best coupling and best performance (see Figure 32).

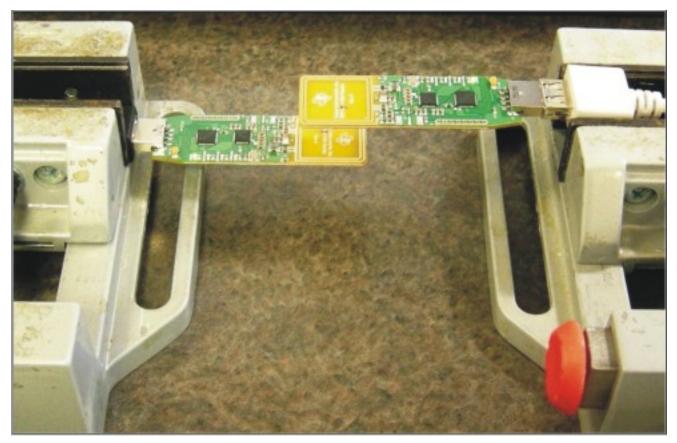


Figure 32. Demonstration Hardware Configuration Example

# 2.9.3 Peer-to-Peer Connection Step

To connect the two TRF7970A evaluation modules (see Figure 33):

- 1. In the GUI for the Initiator, click Connect (the button then changes to Disconnect).
- 2. The Initiator and Target GUI indicators turn green when connection is successful.

🔩 TRF7970 EVM Control	💶 🗹 🛃 TRF7970 EVM Control
15693 14443A 14443B FeliCa Find tags Registers NFC-PP Test	15693 144436 144438 Feilla England Registers NFCPP Text
Connect Selection     Connect Con	i     Paby     Taget     Taget     Taget     Bowe       i     Fanna     Connada     Taget     Taget     Bowe       i     Fanna     Connada     Potcol Rag     Bowe       i     Connada     Patrixe     Send     Bowe       i     Connada     Potcol Rag     Bowe     Rx     Fanna       i     Connada     Potcol Rag     Send     Bowe     Rx     Fanna       i     Connada     Connada     Connada     Bowe     Rx     Fanna       i     Connada     Connada     Connada     Connada     Rx     Fanna       i     Connada     Connada     Connada     Connada     Rx     Fanna       i     Diaconnest     Connada     Connada     Bible Connada     Bible Connada     Bible Connada       i     Diaconnest     Connada     Connada     Connada     Sectification     Sectification       i     Fieldse     Diaconnest     Connada     Gerenad Byte     Sectification     Sectification       i     Adocon     Diaconnest     Connada     Gerenad Byte     Sectification     Sectification       i     Adocon     Diaconnest     Connada     Gerenad Byte     Sectification     Sectone
Register wite request.	Image: Constant of the state of t

Not Connected (Initiator GUI)

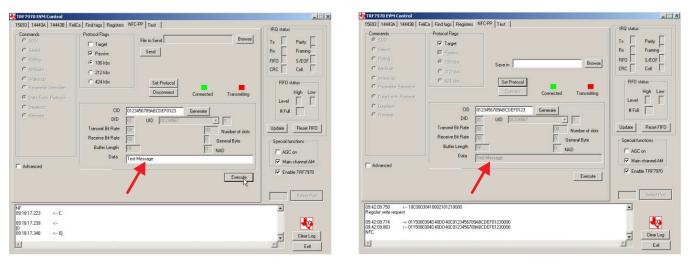
**Connected (Initiator GUI)** 

Figure 33. Peer-to-Peer Connection Step

# 2.9.4 NFC Text Message Transfer

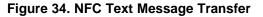
To transfer a text message from the Initiator hardware to the Target hardware for display in the Target GUI:

- 1. Perform peer-to-peer connection as described in Section 2.9.3.
- 2. Type in text to be sent into the Data entry text box.
- 3. Click Execute.
- 4. Look at the Target GUI window and observe text message that was sent (see red arrows in Figure 34).



Initiator GUI Window (Message Being Sent)

Target GUI Window (Message Received)





# 2.9.5 NFC File Transfer

While still in Initiator and Target modes as described in Section 2.9.3, files can also be transferred. This is done by selecting a file to be sent from the Initiator side and also a location (a file folder or directory) to store the file on the Target. Any file format can be transferred (for example, .doc, .xls, .jpg, or .zip). In this example, a firmware image file (.d43) is used.

- 1. Select file using the Browse button in the Initiator GUI.
- 2. Click Open (see Figure 35).

TRF7970 EVM Control				_ X	TRE7970 EVM Control				_ X
15693 14443A 14443B Fe	HCa   Find tags   Registers N	FC-PP Test		I FIRQ status	15693 14443A 14443B Fe	ICa   Find tags   Registers	NFC-PP Test		
Connects C Stop C Step: C Aning C Altrope C Miles on C Parameter Selection C Date Each Protocol C Parameter Selection C Date Each Protocol C Release	Protocol Flage     Target     F Parative     G 106 kbs     C 212 kbs     C 212 kbs     C 424 kbs      CID 0     Transmit Bit Pale     Receive Bit Rate     Buttercompt 175	File to Send Send Disconnect 2345/7894/CDEF0123 UID 01/234597	Corrected Transmitting Generate Transmitting Correcte Correct Discount of state Correct Discount of state Correct Discount of state	Tx Party Framma RrD ScOF CRC Col Col FFD Hatu Level High Low Level High Low Level RFD Ubdate Reset FFD	Connects C Sob C Select: C Pring C Antioxe C Marina C Parameter Selection C Data Seli, Porned C Dataset C Parameter C Referen	Polocol Regi Target Pleasive C 105 bbs 222 bbs 424 bbs Look in: Elsery 200 gard		Browne ۲ این د ت ت -	HR atabase T
T Advanced	Data Tr	est Message	Execute	AGC on Main channel AM Enable TRF7970 Select Port	C Advanced	File name: TF	RF7970_NFC-v1.0.d43	Cancel	AGC on     Main channel AM     Frable TRF7970     Select Part
11:47:59.316 <					11:47:59.316 <				
11.47:59.331 < [0 11.47:59.441 <0] ]				Clear Log Exit	11:47:59.331 < [0] 11:47:59.441 <0]				Clear Log

# Figure 35. NFC File Transfer, Select File on Initiator

- 3. Select file folder or directory using the Browse button in the Target GUI (in this case, a folder called NFC\_File\_Transfers was created for the demonstration).
- 4. Click Open (see Figure 36).

NRF7970 EVM Control				X	TRF7970 EVM Control				X
15693 14443A 14443B FeliC	Ca Find tags Registers NF	C-PP Test		1	15693 14443A 144438 Feli	Ca   Find tags   Registers	NFC-PP Test		
Commands Good State State State Commands	Plotocol Flags	Save in Set Policosi Correct 205678396CDEF0123 UID Message	Vumber of slots General Byte NAD	IPQ status       Tx     Park Parking       Rr     Parking       Rr     Parking       Rr     SrEOF       CRC     Cot       PFD status       Level     Image: second status       Update     Reset FIFD       Special functions       ADC on       Image: second status       Image: second status       Image: second status	Commads © ISDD © ISDD © Paring © Athbate © Wide op © Parenter Selection © Data Exish Protocol I © Data Exish Protocol I © Densisct © Release	Peteod Rage	Save in Carbonnel C. File_Transfers		FR0 tatue     Tx Pathy     Pathy     Pathy     Pro     Srcore     Cot     Cot     FF0     Srcore     FF0     tatue     FF0     For     FF0     Cot     Srcore     FF0     Srcore     Srcore     Acc     Social functions     Social functio
Register write request. 11:01:03.167> 01150003	0410002101210000 804D40DD40C0123456789AB6 804D40DD40C0123456789AB6	10 EF01230000 DEF01230000	Execute	Select Port	Register wite request. 11:01:03.167 -> 01150003	0410002101210000 304D 40D0 40C012345678 304D 40D0 40C012345678	9A8CDEF01230000	Zancel	Eekst Part

# Figure 36. NFC File Transfer, Save File on Target

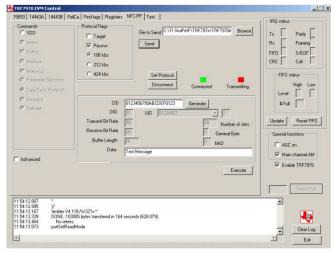
- 5. Click Send in the Initiator GUI (a status bar indicates activity) (see Figure 37).
- 6. When file transfer is complete, the status is reported in the Initiator protocol log window and the file is available on the Target PC. The Target GUI also indicates activity.



# Using the TRF7970A EVM With PC GUI

Transmit BX Rate 00 00 Number of tiols Update Preset FIF Receive BX Rate 000 00 00 Receive Byte Butter Length	Commands SDD Select Poling Altibute Waterup Parimeter Selection Data Exch. Protocol Data Exch. Protocol Pelence	AlCa Fred tagi Register: N Protocol Flags Passive C 106 kbs C 212 kbs C 424 kbs	File to Send C\T1 Stu Send Set Protocol Disconnect	Connected	79704 Biowee	FRQ status       Tx     Party       Rx     Franing       PFO     SEOF       CRC     Cat   FIFD status       Level     High       # Full     High
Advanced Data Text Message Text	Advanced	Receive Bit Rate	6. F.	pressore .	eneral Byte AD	Special functions AGE on Main channel AM

Initiator GUI File Transfer Being Started



Initiator GUI File Transfer Complete

	FeliCa   Find tags   Registers N	(and Liew 1	IRQ status
Somenda © SDD © Select © Paling © Anihudy © Wale von © Wale von © Wale von © Desket © Desket © Relevee	DID 07 Transmit Bit Rate 00 Receive Bit Rate 00 Buffer Length 07	Set Placed Set Placed Domestic Domestic UID Set Placed Corrected Transme Set Placed Corrected Transme Set Placed Corrected Set Placed Set Placed Se	Tx         Party           Rx         Franking           RRD         SkOF           CRC         Cold           RRD         SkOF           CRC         Cold           High         Lovel           Lovel         File           Lovel         File
gister write request. :01:03:167> 01150	0030410002101210000 00304D 40D D 40C012345678548 00304D 40D D 40C012345678548		Ae Enable TAF7970

File Edit View Favori 🕝 Back + 🕤 + 🍞 🗐	tes Too Search		ers 🛛 🕼 🎯 🗙	<b>19</b>     🕜	3
Address 🛅 C:\Documents	and Settin	igs\a08677	49\Desktop\NFC_File	_Transfers 💌	🔁 Go
Name	Size	T 🔺	Date Modified	1	
TRF7970_NFC-v1.0.d43	101 KB	D43 File	12/1/2010 11:36 AM		

**Target GUI File Transfer in Progress** 



#### 2.9.6 **Card Emulation Mode**

For card emulation mode, one TRF7970A EVM should be set up as a Target (see Section 2.9.2). Another TRF7970A EVM can be used as an RFID reader (in this example, the device is set up and used as an ISO14443A reader; see Section 2.4).

To use card emulation mode (see Figure 38):

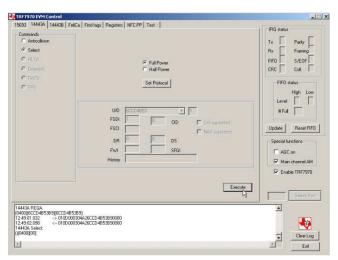
- 1. On the Initiator reader side, go to the NFC-PP tab.
- 2. Select the Advanced check box.
- 3. Click Set Protocol.
- 4. Click Execute.
- 5. The SDD and Select commands can now be used.



5693 14443A 144438 FeliCa	a   Find tags   Registers   NFC-PP   Test	I IRQ status
Commands C Anticolision C Anticolision C IntriA C Dranket C RATS C RATS C RES	Figl Power     Hall Power     Hall Power     Set Potocol      UD     CCD 4953     Figl     Figl	TX Puty F Rv Framp RPD SxEOF CRC Cot C FIFO Islau High Low Level F Full
4443A REQA. 2.48 00 909 → 01090003 2.48 01 159 <-01090003 4443A REQA. 9400(RCCD 485389)[SCCD 48538	4A0010000	Execute Security Construction Constructio

ISO14443A UID Read From TRF7970A in Card Emulation Mode

# Using the TRF7970A EVM With PC GUI



ISO14443A Select Command Response From TRF7970A in Card Emulation Mode

15000 144400 144400 150	Cal Endrand Residen	NEC-PP Text			TRE7570 EVEL CONTO	a la su la su	arcon la l		
19633         14443A         14443A         Fel           Commands         500         5 Select         F Select           C Select         C Palling         Arcbuse         C           C Available         C Available         C         C Available           C Available         C Available         C Available         C           C Date Excit:         Date Excit:         Protocol         C	Protocol Flags Target Passive C 106 kbs C 212 kbs C 424 kbs	File to Send Send Set Protocol Connect	Browse Connected Transmitting	Tx Pady Rx Francing Rr0 SxCoF CRC Cot FFO datus High Low Level F	Commands     Commands	Protocol Flags Target Passive 106 kbs C 212 kbs C 424 kbs	File to Send Send Set Protocol Connect	Browse Connected Transmiting	TRQ status Tx Purby F Rx Fromma RFD S.COF CRC Cot. FIFO Idstus FIFO Idstus Level []
C Relate	CID DID Transmit Bit Rote Receive Bit Rate Builter Length Data	012345678948COEF0123 01 UID 057554C9 02 07 07 07	Generate	IF Full Update Rest FIFD Special functions IF AGC on IF Main: channel AM IF Endel FIFF7370	<ul> <li>Pretowe</li> <li>C Relowe</li> <li>W Advanced</li> </ul>	CID DID Transmit Bit Rate Receive Bit Rate Buffer Length Data	012445678949CDEF0123 01 UID D57564C3 00 07 07	Generate To Number of slots General Byte To NAD Execute	II Ful Update Reset FIFD Special functions IF AGC on IF Main channel AM IF Enable TRF7370
14443A REQA. 0 12.52.37.727 → 0109000 14.4523.933 < 0109000 14.443A REQA. (0400)(D57564C300)(D57564C3 4	30440010000 30440010000 800]			Clear Log	14433 FEGA. (0407)575446300 (057544) 12531316 → 010000 125313394 ← 010000 14443 Select. (0400(00)	00   304420 57564C300 0000 304420 57564C300 0000			Select Por

ISO14443A UID Read From TRF7970A in Card Emulation Mode



Figure 38. Card Emulation Mode

# 2.10 Test Tab

The TRF7970A EVM GUI Test Tab is used to send specific command strings that the firmware supports but that are not built into the specific protocol tabs in the GUI and to assist in understanding the finer details of the TRF7970A EVM operations. This tab also allows retrieval of the version number of the firmware loaded in the MSP430F2370 on the EVM. The following example show how and why test strings might be used.

Two buttons are available for sending strings: Send and Send Raw. The Send button is used to send complete strings (including SOF and length). The Send Raw button prepends and appends the bytes required by the MSP4340F2370 host.c file for a properly concatenated string.

A few examples of when to use these features:

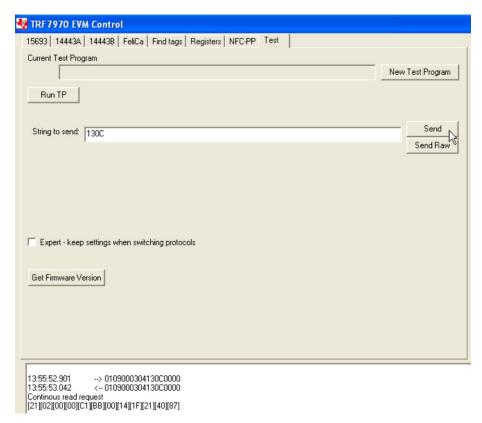
1. For observing a read or write continuous to the registers of the TRF7970A during code development with a logic analyzer. These examples are using the Send button which adds on the necessary bytes before and after data to send strings are entered. This example is setting up the TRF7970A for full power out and ISO15693 operation (see Figure 39 and Figure 40).



### Using the TRF7970A EVM With PC GUI

RF7970 EVM Control	
15693 14443A 14443B FeliCa Find tags Registers NFC-PP Test	
Current Test Program	
	New Test Program
BunTP	
Hun IP	
String to send: 110021020000C1BB00301F214087	Send
,	Send Raw
Expert - keep settings when switching protocols	
Get Firmware Version	
13:57:44.202 top update	
13:58:38.439 -> 0115000304110021020000C1BB00301F2140870000 13:58:38.579 <- 0115000304110021020000C1BB00301F2140870000	
Continous write request	

# Figure 39. Continuous Write to Registers 0x00 to 0x0B Example



# Figure 40. Continuous Read from Registers 0x00 to 0x0B Example

 To turn on or off the MSP430F2370 GPIO-controlled LEDs on the EVM. These could also be used in the development environment for other functions such as turning on or off other peripherals or for digital control of reed relays and switches (see Table 8 and Figure 41).

Table 8. Command Codes for GPIO Controlled Outputs on EVM
--------------------------------------------------------------

LED Number	Command Code to be Sent (Using Send Button in GUI)	State
2	FB	ON
2	FC	OFF
3	F9	ON
3	FA	OFF
4	F7	ON
4	F8	OFF
5	F5	ON
5	F6	OFF
6	F3	ON
6	F4	OFF

😼 TRF7970 EVM Control	
15693 14443A 14443B FeliCa Find tags Registers NFC-PP Test	
Current Test Program	
	New Test Program
Bun TP	
	Send N
String to send: F3	Send Raw
	Solid How
Expert - keep settings when switching protocols	
Get Firmware Version	
15:53:51.397 -> 0108000304F40000	
15:53:51.522 <- 0108000304F40000	
15:53:56.866> 0108000304F30000 15:53:56.975 < 0108000304F30000	

Figure 41. Sending GPIO Control Command



Using the TRF7970A EVM With PC GUI

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3. To retrieve the PUPI from an ISO14443B tag on which anticollision has been disabled (this is most often the instance for ISO14443B cards that are being used for payment applications), thus requiring a single slot REQB to be sent. Notice in Figure 42 that the Send Raw button is used. This could have also been sent using the Send button with only *B000* as the String to send.

RF7970 EVM Control	
15693 14443A 14443B FeliCa Find tags Registers NFC-PP Test	
Current Test Program	
	New Test Program
Run TP	
String to send: 01090003048000000	Send
String to send: 010900030480000000	Send Raw
This was changed to 0 from 4 to only do a single slot REQB command	
Expert - keep settings when switching protocols	
Get Firmware Version	
15:57:21.405> 01090003048000000 15:57:21.671 < 010900030480000000 144438 REQB.	
[508CAAE 3CD 0000000002184]	

Figure 42. Sending Single Slot REQB

# 3 Abbreviations

AFI	Application Family Identifier
BCC	Block Check Character
CRC	Cyclic Redundancy Check
DSFID	Data Storage Format Identifier
EOF	End of Frame
LSB	Least Significant Byte
MSB	Most Significant Byte
RFU	Reserved for Future Use
COL	Chart of Eromo

- SOF Start of Frame
- UID Unique Identifier
- PCD Proximity Coupling Device
- PICC Proximity Integrated Circuit Card
- PUPI Pseudo Unique PICC Identifier
- VCD Vicinity Coupling Device
- VICC Vicinity Integrated Circuit Card

# 4 References

- 1. TRF7970A Data Sheet (SLOS743)
- 2. TRF7970A Firmware Description (SLOA157)
- 3. TRF7970A Firmware Design Hints (SLOA159)
- 4. TRF7970A NFC BSL Application Note (SLOA160)
- 5. ISO/IEC 15693 (http://www.iso.org)
- 6. ISO/IEC 14443 (http://www.iso.org)
- 7. ISO/IEC18092 (http://www.iso.org)
- 8. ISO/IEC 21481 (http://www.iso.org)
- 9. FeliCa<sup>™</sup> (http://www.sony.net/Products/felica/)
- 10. MIFARE™ (<u>http://www.mifare.net/</u>)

# **EVALUATION BOARD/KIT/MODULE (EVM) ADDITIONAL TERMS**

Texas Instruments (TI) provides the enclosed Evaluation Board/Kit/Module (EVM) under the following conditions:

The user assumes all responsibility and liability for proper and safe handling of the goods. Further, the user indemnifies TI from all claims arising from the handling or use of the goods.

Should this evaluation board/kit not meet the specifications indicated in the User's Guide, the board/kit may be returned within 30 days from the date of delivery for a full refund. THE FOREGOING LIMITED WARRANTY IS THE EXCLUSIVE WARRANTY MADE BY SELLER TO BUYER AND IS IN LIEU OF ALL OTHER WARRANTIES, EXPRESSED, IMPLIED, OR STATUTORY, INCLUDING ANY WARRANTY OF MERCHANTABILITY OR FITNESS FOR ANY PARTICULAR PURPOSE. EXCEPT TO THE EXTENT OF THE INDEMNITY SET FORTH ABOVE, NEITHER PARTY SHALL BE LIABLE TO THE OTHER FOR ANY INDIRECT, SPECIAL, INCIDENTAL, OR CONSEQUENTIAL DAMAGES.

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# **REGULATORY COMPLIANCE INFORMATION**

As noted in the EVM User's Guide and/or EVM itself, this EVM and/or accompanying hardware may or may not be subject to the Federal Communications Commission (FCC) and Industry Canada (IC) rules.

For EVMs **not** subject to the above rules, this evaluation board/kit/module is intended for use for ENGINEERING DEVELOPMENT, DEMONSTRATION OR EVALUATION PURPOSES ONLY and is not considered by TI to be a finished end product fit for general consumer use. It generates, uses, and can radiate radio frequency energy and has not been tested for compliance with the limits of computing devices pursuant to part 15 of FCC or ICES-003 rules, which are designed to provide reasonable protection against radio frequency interference. Operation of the equipment may cause interference with radio communications, in which case the user at his own expense will be required to take whatever measures may be required to correct this interference.

### General Statement for EVMs including a radio

User Power/Frequency Use Obligations: This radio is intended for development/professional use only in legally allocated frequency and power limits. Any use of radio frequencies and/or power availability of this EVM and its development application(s) must comply with local laws governing radio spectrum allocation and power limits for this evaluation module. It is the user's sole responsibility to only operate this radio in legally acceptable frequency space and within legally mandated power limitations. Any exceptions to this are strictly prohibited and unauthorized by Texas Instruments unless user has obtained appropriate experimental/development licenses from local regulatory authorities, which is responsibility of user including its acceptable authorization.

### 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

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

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.

### For EVMs annotated as IC – INDUSTRY CANADA Compliant

This Class A or B digital apparatus complies with Canadian ICES-003.

Changes or modifications not expressly approved by the party responsible for compliance could void the user's authority to operate the equipment.

#### Concerning EVMs including radio transmitters

This device complies with Industry Canada licence-exempt RSS standard(s). 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.

#### 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.

Cet appareil numérique de la classe A ou B est conforme à la norme NMB-003 du Canada.

Les changements ou les modifications pas expressément approuvés par la partie responsable de la conformité ont pu vider l'autorité de l'utilisateur pour actionner l'équipement.

### 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.

### 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.

### [Important Notice for Users of this Product in Japan]

# This development kit is NOT certified as Confirming to Technical Regulations of Radio Law of Japan

If you use this product in Japan, you are required by Radio Law of Japan to follow the instructions below with respect to this product:

- Use this product 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 this product only after you obtained the license of Test Radio Station as provided in Radio Law of Japan with respect to this product, or
- 3. Use of this product only after you obtained the Technical Regulations Conformity Certification as provided in Radio Law of Japan with respect to this product. Also, please do not transfer this product, unless you give the same notice above to the transferee. Please note that if you could not follow the instructions above, you will be subject to penalties of Radio Law of Japan.

### Texas Instruments Japan Limited (address) 24-1, Nishi-Shinjuku 6 chome, Shinjuku-ku, Tokyo, Japan

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### EVALUATION BOARD/KIT/MODULE (EVM) WARNINGS, RESTRICTIONS AND DISCLAIMERS

For Feasibility Evaluation Only, in Laboratory/Development Environments. Unless otherwise indicated, this EVM is not a finished electrical equipment and not intended for consumer use. It is intended solely for use for preliminary feasibility evaluation in laboratory/development environments by technically qualified electronics experts who are familiar with the dangers and application risks associated with handling electrical mechanical components, systems and subsystems. It should not be used as all or part of a finished end product.

Your Sole Responsibility and Risk. You acknowledge, represent and agree that:

- 1. You have unique knowledge concerning Federal, State and local regulatory requirements (including but not limited to Food and Drug Administration regulations, if applicable) which relate to your products and which relate to your use (and/or that of your employees, affiliates, contractors or designees) of the EVM for evaluation, testing and other purposes.
- 2. You have full and exclusive responsibility to assure the safety and compliance of your products with all such laws and other applicable regulatory requirements, and also to assure the safety of any activities to be conducted by you and/or your employees, affiliates, contractors or designees, using the EVM. Further, you are responsible to assure 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.
- 3. You will employ reasonable safeguards to ensure that your use of the EVM will not result in any property damage, injury or death, even if the EVM should fail to perform as described or expected.
- 4. You will take care of proper disposal and recycling of the EVM's electronic components and packing materials.

**Certain Instructions.** It is important to operate this EVM within TI's recommended specifications and environmental considerations per the user guidelines. Exceeding the specified EVM ratings (including but not limited to input and output voltage, current, power, and environmental ranges) may cause property damage, personal injury or death. If there are questions concerning these ratings please 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 result in unintended and/or inaccurate operation and/or possible permanent damage to the EVM and/or interface electronics. 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 60°C as long as the input and output are maintained at a normal ambient operating temperature. These components include but are not limited to linear regulators, switching transistors, pass transistors, and current sense resistors which can be identified using the EVM schematic located in the EVM User's Guide. When placing measurement probes near these devices during normal operation, please be aware that these devices may be very warm to the touch. As with all electronic evaluation tools, only qualified personnel knowledgeable in electronic measurement and diagnostics normally found in development environments should use these EVMs.

Agreement to Defend, Indemnify and Hold Harmless. You agree to defend, indemnify and hold TI, its licensors and their representatives harmless from and against any and all claims, damages, losses, expenses, costs and liabilities (collectively, "Claims") arising out of or in connection with any use of the EVM that is not in accordance with the terms of the agreement. This obligation shall apply whether Claims arise under law of tort or contract or any other legal theory, and even if the EVM fails to perform as described or expected.

Safety-Critical or Life-Critical Applications. If you intend to evaluate the components for possible 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, such as devices which are classified as FDA Class III or similar classification, then you must specifically notify TI of such intent and enter into a separate Assurance and Indemnity Agreement.

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