Tag-it™ HF-I Pro Transponder Chip/Inlays

Commands and Options

Reference Guide

Literature Number: SCBU008A
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Read This First

Edition Two – December 2011

This is the first edition of this manual; it describes the Commands as well as additional features/options that can be used with the Tag-it HF-I Pro Transponder Chip / Inlays.

About This Guide

This guide describes the commands that can be used with the Tag-it™ HF-I pro transponder chip/inlays, as well as additional features/options that can be used with the Tag-it HF-I pro transponder chip/inlays. It is designed for use by TI partners who are engineers experienced with radio frequency identification devices (RFIDs) and software development, and wants to integrate the extended commands and additional features of the Tag-it HF-I pro transponder chip/inlays into an own reader. This reference guide should be used in conjunction with the ISO/IEC 15693 standard, which specifies the standard protocol, commands, and other parameters required to initialize communication between the transponder and the reader.

Conventions

NOTE: Indicates conditions that must be met or must be followed, to ensure proper functioning

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1 Tag-it™ HF-I Pro Transponder Chip/Inlays Implemented Commands

Table 1 shows the list of implemented commands and the corresponding request modes of these commands as implemented in the TI ISO/IEC 15693-compliant the Tag-it HF-I pro transponder chip/inlays. The request mode defines the set of transponders that shall answer to the request.

Table 1. Tag-it HF-I Pro Transponder Chip/Inlays Implemented Commands

REQUEST	REQUEST MODE [1]					
	REQUEST CODE	INVENTORY	ADDRESSED	NON-ADDRESSED	AFI	OPT. FLAG
ISO 15693 Mandatory and Optional Commands						
Inventory	0x01	✓	–	–	✓	0/–
Stay Quiet	0x02	–	✓	–	–	0/–
Read_Single_Block	0x20	–	✓	✓	–	–/1
Write_Single_Block	0x21	–	✓	✓	–	–/1
Lock_Block	0x22	–	✓	✓	–	–/1
TI Custom Commands						
Kill	0xA4	–	✓	–	–	–/1
WriteSingleBlockPwd	0xA5	–	✓	–	–	–/1

(1) ✓ = Implemented,
– = Not applicable

2 Memory Architecture

The physical memory structure is byte oriented and is organized in blocks of fixed size (see Figure 1).

2.1 User Memory

The available user-memory size is eight blocks of 32 bits each (block 0x00 to 0x07). This results in a capacity of 256 bits available user memory.

2.2 Additional Blocks

- Two blocks (block address 0x08 and 0x09) for the 64-bit unique identification code (UID), programmed and factory locked at IC manufacturing
- One block (block address 0x0A) of 32 bits that includes the 8-bit application family identifier (AFI) in the least significant bit (LSB).
- One block (block address 0x0B) of 32 bits, user-programmable password for Kill Command or Password Protected Write command (depending on product version).

Each user block has a lock function, allowing individual block locking.

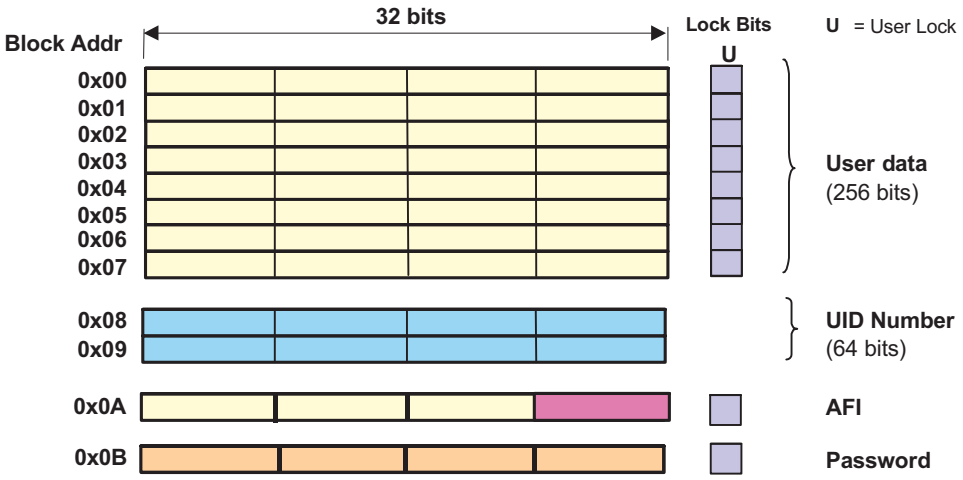

Figure 1. Tag-it HF-I Pro Memory Structure

3 UID Coding

The UID is programmed at wafer probe test. The coding of the UID is different for the individual product configurations.

Table 2. UID Numbering Scheme

UID CODING					
b63 … b56	**b55 … b48**	**b47 … b41** [(1)]	**b40 … b21**	**b20 … b16**	**b15 … b0**
E0	07	b'xxxx nnn	TI Internal Numbering		

(1) xxxx = 4-bit product ID
nnn = 3-bit product configuration

Table 3. UID Coding

PRODUCT VERSION	PRODUCT ID/CONFIG
Tag-it HF-I Plus Inlay	b'0000 000
Tag-it HF-I Plus Chip	b'1000 000
Tag-it HF-I Standard Chip/Inlays	b'1100 000
Tag-it HF-I Pro Chip/Inlays	b'1100 010

4 Tag-it HF-I Pro Supported Commands

The syntax of the ISO-defined commands can be found in the ISO/IEC 15693-3. The syntax of the TI custom commands is described in the following sections.

4.1 Custom Commands

The format of custom commands is generic and allows unambiguous attribution of custom command codes and procedures to each transponder (IC) manufacturer.

For the execution of a custom command, the transponder (IC) manufacturer code has to be included in the request.

The manufacturer code for TI is 0x07.

Table 4. TI Custom Commands

REQUEST	REQUEST MODE [1]					
	REQUEST CODE	INVENTORY	ADDRESSED	NON-ADDRESSED	AFI	OPT. FLAG
TI Custom Commands						
Kill	0xA4	–	✓	–	–	–/1
WriteSingleBlockPwd	0xA5	–	✓	–	–	–/1

(1) ✓ = Implemented,
– = Not applicable

4.1.1 Kill Command

The Kill command is a custom command. It allows to irreversibly disable the functionality of the IC. After receipt and successful processing of a Kill command, the IC no longer responds to any request.

The command must be executed in addressed mode only. The command supports the Option_Flag = 1 (Reader sends EOF to end programming). The programming time required for processing the Kill command is the same as for other EEPROM write commands (Write Single Block, Lock Block).

A 32-bit-long password is stored on the IC in the EEPROM memory. The Reader sends the addressed request, including the passwords to the IC. Upon receipt of such a valid request, the IC is programming the Kill bit, if the UID and password match. After programming, when the Reader has sent the EOF, the IC responds with the status information. If the programming of the Kill bit was successful, the IC no longer processes any other request and does not respond to any other Reader request.

The customer can write the password into block 0x0B using the Write Single Block command. The password can be verified afterwards using the Read Single Block command. If the password is verified successfully, the password must be locked using the Lock Block command to disable read access to the password (ULB of block 0x0B is set to 1) and activate the Kill command.

Table 5. Kill Command Request Format

SOF	FLAGS	CMD 0xA4	IC MFG CODE 0x07	UID	PASSWORD	CRC 16	EOF
	8 bits	8 bits	8 bits	64 bits	32 bits	16 bits	

NOTE: Since the password is transmitted in plain text over the air interface, it is recommended that unique, diversified passwords are used for each transponder.

Table 6. Kill Command Response Format When Error_Flag Is Set

SOF	FLAGS 0x01	ERROR CODE	CRC 16	EOF
	8 bits	8 bits	16 bits	

Table 7. Kill Command Response Format When Error_Flag Is Not Set

SOF	FLAGS 0x00	CRC 16	EOF
	8 bits	16 bits	

4.1.2 WriteSingleBlockPwd Command

The WriteSingleBlockPwd command is a custom command. It allows protected EEPROM data write access to any addressed memory block, where the user lock bit has been set by using the WriteSingleBlockPwd command with the correct 32-bit password.

The command must be executed in addressed mode only. The command supports the Option_Flag = 1 (Reader sends EOF to end programming). The programming time required for processing the WriteSingleBlockPwd command is the same as for other EEPROM write commands (Write Single Block, Lock Block).

Table 8. WriteSingleBlockPwd Command Request Format

SOF	FLAGS	CMD 0xA5	IC MFG CODE 0x07	UID	PASSWORD	BLK ADDR	BLK DATA	CRC 16	EOF
	8 bits	8 bits	8 bits	64 bits	32 bits	8 bits	32 bits	16 bits	

NOTE: Since the password is transmitted in plain text over the air interface, it is recommended that unique, diversified pass words are used for each transponder.

Table 9. WriteSingleBlockPwd Command Response Format If Error_Flag Is Set

SOF	FLAGS 0x01	ERROR CODE	CRC 16	EOF
	8 bits	8 bits	16 bits	

Table 10. WriteSingleBlockPwd Command Response Format If Error_Flag Is Not Set

SOF	FLAGS 0x00	CRC 16	EOF
	8 bits	16 bits	

5 Fast Simultaneous IDentification (FastSID)

To differentiate between the ISO/IEC 15693-defined Inventory mode and the TI-defined Inventory mode, the term FastSID is introduced.

FastSID defines TI's patented Fast Simultaneous IDentification concept.

The main advantages of the FastSID concept are:

The Quiet command is transmitted within the time slot where the transponder responds and not at the end of the Inventory cycle.

Instead of sending the 64-bit UID to address and set the Transponder Quiet (plus command and frame overhead), only 16 bits will be sent to the transponder. The 16 bits represent the calculated CRC of the data of the last Response (without SOF/EOF). All tags having the same sub-address (4-bit) but different CRC will not be set Quiet.

Based on the system timing definition in ISO/IEC 15693, the concept is fully ISO/IEC 15693 compliant. If a mixed population of transponders is used in Inventory mode (with Transponders that do not support FastID), the concept does not interfere with the executed Inventory process.

The advantage of this concept is a higher detection speed for the Inventory mode executed in FastSID mode.

The FastSID mode can be seen as an extension of the Inventory command to improve the system performance.

The execution of the FastSID is controlled by the Reader. All Request and Response Formats as already defined in Inventory Command as well as the defined timings, are used for the execution of the FastSID. The additional information transmitted within the timeslots can only be interpreted by TI's Tag-it HF-I pro transponder chips/inlays, but does not interfere with transponders of other manufacturer in the field. It is possible for the reader, based on the received manufacturer's code (part of the UID), to decide on the fy whether FastSID is applicable (Tag-it HF-I pro) or not.

NOTE: The concept is designed to be used in the 1 out of 4 mode. The use in 1-out-of-256 mode is possible but not ISO compliant because of the defined system timings in ISO/IEC 15693.

To keep the ISO compatibility in both modes, 1 out of 4 and 1 out of 256, the 16-bit response will always be sent in 1-out-of-4 mode.

The concept of the FastSID is based on the pulse slotted concept as defined in ISO/IEC 15693, with the following modifications:

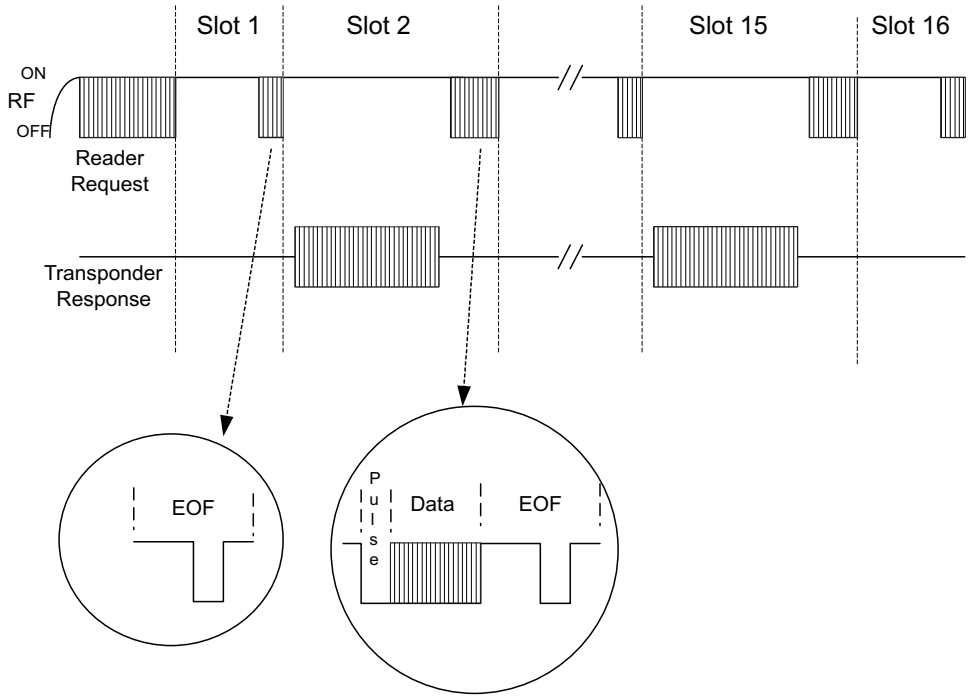

Figure 2. FastSID Mode Concept

- The Quiet command for a transponder is not addressed at the end of the Inventory cycle. Instead, a 16-bit request is sent to the transponder within the response time slot, which is interpreted by the transponder as a Quiet request.
- If a valid transponder response was received within a time slot, the reader will send within the slot and after the validated response a:
  - SID_Pulse followed by
  - 16-bit CRC of the tag's response followed by
  - EOF to switch to the next time slot
- The SID_Pulse is used to synchronize the data transmission within a time slot.
- The SID_Pulse and EOF pulse can be detected in 10% and 100% modulation depth mode depending on the Request mode.

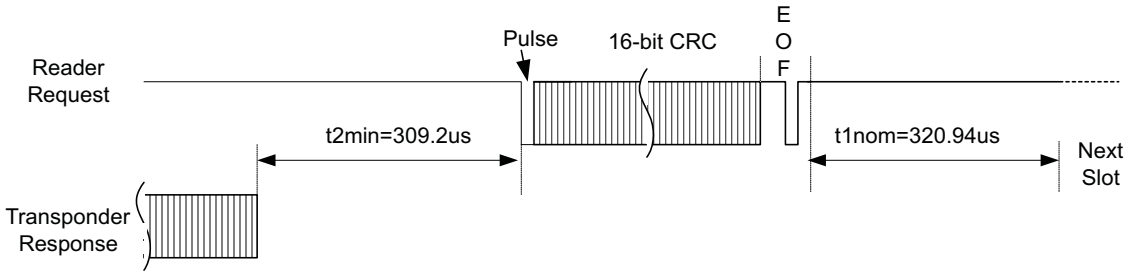

Figure 3. FastSID Mode Details

6 Transponder to Reader Interruption Conditions

The conditions for the transponder to reader response interruption are:

The transponder to reader communication can be interrupted any time with 100% modulated EOF.

If in Inventory mode, the responding tag shall interrupt the response transmission if the reader applies a 100% modulated EOF. The same EOF is used by all transponders in the field as the EOF to switch to the next inventory slot.

7 Error Codes and Priorities

Additional to the implementation of the commands and error code definitions as described in the ISO/IEC 15693 standard, general error conditions and command specific error conditions are defined. The response and error codes are defined in Table 6 and Table 7. General error conditions have higher priority than command-specific error codes.

Table 11. General Error Conditions

ERROR CONDITION	RESPONSE ERROR CODE
CRC Mismatch	No response
Protocol Extension_Flag = 1	No response
Select_Flag = 1	No response
RFU Flag = 1	No response
Address_Flag = 1 and UID mismatch	No response
Command is not supported	No response
Format Error (i.e., wrong number of bits)	No response
Command Option_Flag not supported (except for Inventory and Stay Quiet command)	03

Table 12. Command-Specific Error Conditions

COMMAND	ERROR CONDITION	RESPONSE ERROR CODE
Inventory	AFI Flag = 1 and AFI not match	No response
	Command Option Flag not supported	
	Invalid mask length or mask value	
Read Single Block	Invalid block address	10
	No read access	B0
Write Single Block	Invalid block address	10
	Block already locked	12
	Block not successfully programmed	13
Lock Block	Invalid block address	10
	Block already locked	11
	Block not successfully locked	14
Kill	Kill bit not successfully written	14
WriteSingleBlockPwd	Invalid block address	10
	Block already locked	12
	Block not successfully programmed	13

Appendix A Terms and Abbreviations

A list of the abbreviations and terms used in the various TI-RFid™ manuals can be found in a separate manual:

TI-RFid™ Product Manual Terms & Abbreviations (SCBU014) (11-03-21-002)

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