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

Extended Commands and Options

Reference Guide

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List of Figures

List of Tables

Read This First

About This Guide

This guide describes the Extended Commands that can be used with the Tag-it HF-I Plus Transponder Chip/Inlays as well as additional features/options that can be used with the Tag-it HF-I Plus Transponder Chip/Inlays. It is designed for use by TI partners who are engineers experienced with Radio Frequency Identification Devices (RFID) and software development and wants to integrate the extended commands and additional features of the Tag-it HF-I Plus Transponder Chip/Inlays into an own reader. This reference guide should be used in conjunction with the ISO15693 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 Overview of Tag-it™ HF-I Plus Transponder Chip/Inlays Implemented Commands

Table 1 shows the list of implemented and reserved (RFU) commands and the corresponding request modes of these commands as implemented in TI's ISO15693 compliant Tag-it HF-I Plus Transponder Chip/Inlays. The request mode defines the set of transponders that shall answer to the request. The command execution in Inventory Mode is further explained in Section 5.

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

FUNCTION	COMMAND CODE		REQUEST MODE (1)					
	HEX	BINARY (LSB)	INVENTORY	ADDRESSED	NON-ADDRESSED	SELECT	AFI	OPT. FLAG
ISO 15693 Mandatory Commands								
RFU	0x00	0000 0000	–	–	–	–	–	–
Inventory	0x01	0000 0001	✓	–	–	–	✓	0
Stay Quiet	0x02	0000 0010	–	✓	–	–	–	0
RFU	0x03–0x1F	0000 0100	–	–	–	–	–	–
ISO 15693 Optional Commands								
Read_Single_Block	0x20	0010 0000	✓	✓	✓	✓	✓	0/1
Write_Single_Block	0x21	0010 0001	–	✓	✓	✓	–	–/1
Lock_Block	0x22	0010 0010	–	✓	✓	✓	–	–/1
Read_Multi_Blocks	0x23	0010 0011	✓	✓	✓	✓	✓	0/1
Write_Multi_Blocks	0x24	0010 0100	–	–	–	–	–	–
Select_Tag	0x25	0010 0101	–	✓	–	–	–	0
Reset to Ready	0x26	0010 0110	–	✓	✓	✓	–	0
Write_AFI	0x27	0010 0111	–	✓	✓	✓	–	–/1
Lock_AFI	0x28	0010 1000	–	✓	✓	✓	–	–/1
Write_DSFID	0x29	0010 1001	–	✓	✓	✓	–	–/1
Lock_DSFID	0x2A	0010 1010	–	✓	✓	✓	✓	–/1
Get_System_info	0x2B	0010 1011	✓	✓	✓	✓	✓	0
Get_M_Blk_Sec_St	0x2C	0010 1100	✓	✓	✓	✓	✓	0
RFU	0x2D-0x9F	0010 1101	–	–	–	–	–	–
TI Custom Commands								
RFU	0xA0	1010 0000	–	–	–	–	–	–
RFU	0xA1	1010 0001	–	–	–	–	–	–
Write_2_Blocks	0xA2	1010 0010	–	✓	✓	✓	–	–/1
Lock_2_Blocks	0xA3	1010 0011	–	✓	✓	✓	–	–/1
RFU	0xA4-0xDF		–	–	–	–	–	–
TI Proprietary Commands								
RFU	0xE0 -0xFF		–	–	–	–	–	–

(1) ✓ = Implemented, – = Not applicable

2 Factory Lock Bit

How to program the User Lock bit of a block is described in ISO/IEC 15693-3.

For TI's Tag-it HF-I plus transponder chip/inlays a second bit per block is designated for the Factory Lock capability of every block, so that every block of the transponder's memory can be factory locked during production.

Bit 2 of the Block Security Status byte, defined in ISO/IEC 15693-3, is used to store the Factory Lock Status of the blocks.

Table 2. Lock Bit Definition

BLOCK SECURITY STATUS BYTE (ISO/IEC 15693-3)				
BIT NO.	**FLAG NAME**	**STATE**	**DESCRIPTION**	
1	User lock bit	0	Not user locked	ISO
		1	User locked	ISO
2	Factory lock bit	0	Not factory locked	TI
		1	Factory locked	TI
3–8	RFU	0	Set to 0	ISO

3 Memory Architecture

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

3.1 User Memory

The available user memory size is 64 blocks of 32 bits each. This results in a capacity of 2 KBits available user memory.

3.2 Additional Blocks

- Two blocks wide (64 Bit) factory programmed memory to store the UID.
- One wide factory programmed memory to store the IC Reference and the Physical memory info:
  - IC-Ref: 0x8x (0x081 is the Current version of the IC)
  - Block Size: 0x03 (Count from 0, =4 Bytes)
  - Number of Blocks: 0x3F (Count from 0, =64 Blocks)
- One block wide user programmable memory to store the DSFID field.
- One block wide user programmable memory to store the AFI field.

Each user block has two Lock Bits attached, allowing individual block locking.

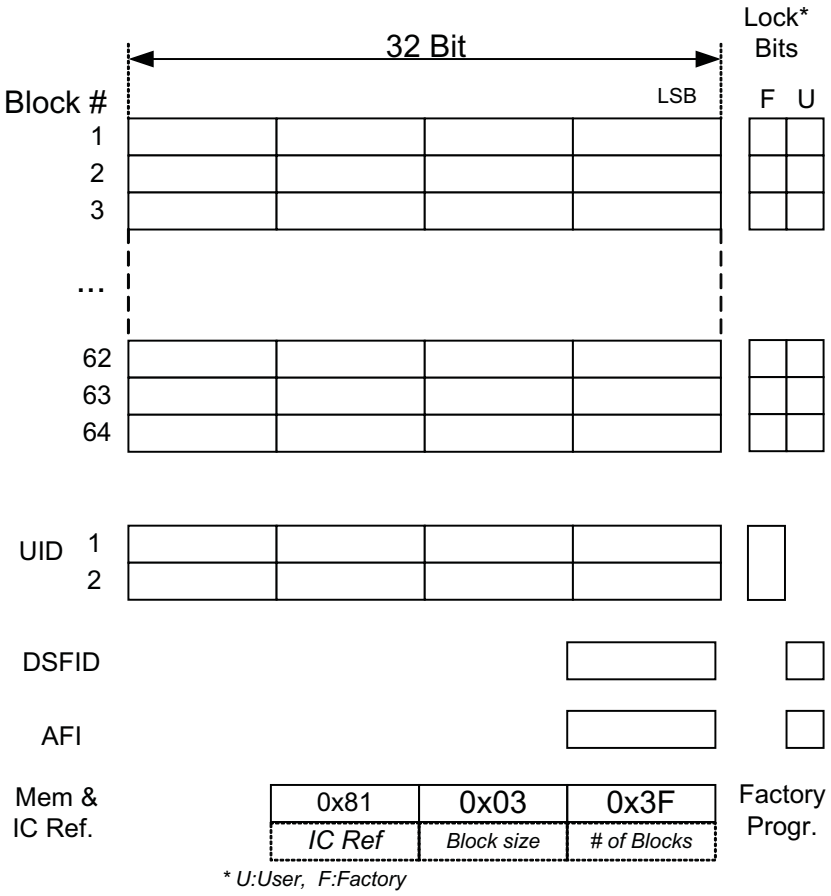

Figure 1. Tag-it HF-I Plus Memory Structure

4 Tag-it HF-I Plus 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 below.

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.

The implemented TI custom commands can be seen in Table 3.

Table 3. Custom Commands Table

FUNCTION	COMMAND CODE		REQUEST MODE (1)					
	HEX	BINARY (LSB)	INVENTORY	ADDRESSED	NON-ADDRESSED	SELECT	AFI	OPT. FLAG
RFU	0xA0	1010 0000	–	–	–	–	–	–
RFU	0xA1	1010 0001	–	–	–	–	–	–
Write_2_Blocks	0xA2	1010 0010	–	✓	✓	✓	–	–/1
Lock_2_Blocks	0xA3	1010 0011	–	✓	✓	✓	–	–/1
RFU	0xA4-0xDF		–	–	–	–	–	–

(1) ✓ = Implemented, – = Not applicable

4.1.1 Command Write_2_Blocks (0xA2)

When receiving the Write 2 Block Command, the Transponder shall program the requested blocks with the data contained in the Request and report the success of the operation in the Response.

The addressed pair of Blocks shall contain one Even and one Odd Block (e.g., Block number 2 and 3 or Block number 6 and 7). The start block address should be always the block with the even address (e.g., #2, #4, #6 etc.). If in the start block the odd address is used the Transponder shall not execute the write operation and return the Error code 0xA1.

If one or both of the addressed blocks are locked the Transponder shall not execute the write operation and return 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).

TRANSMITTED DATA	
LSB	MSB
0 1 2 3	4 5 6 7
EVEN BLOCK	ODD BLOCK

Figure 2. Write_2_Blocks, Order of Blocks

Table 4. Request Format Write_2_Blocks

Request : Write_2_Blocks (0xA2)			
Field Name	No. of Bytes	LSB Data MSB	Description
SOF	–		
Flags	1	xx00 xx10	
Command Code	1	0100 0101	0xA2
Mfg Code	1	1110 0000	0x07
UID(1)	8	X-X-X-X - X-X-X-X	
Start Block	1	X	(Even address)
Block Data	8	X-X-X-X - X-X-X-X	
CRC16	2	X-X	
EOF	-		
Note:			

(1) The UID (marked in grey) is only required in addressed mode

Response if Error-Flag is not set:

Table 5. Response Format "Write_2_Blocks" if "error_flag=0"

Write_2_Blocks (0xA2) for "error_flag=0"					
Field Name	**No. of Bytes**	**LSB**	**Data**	**MSB**	**Description**
SOF	–				
Flags	1	0000 0000			
CRC16	2	X-X			
EOF	–				
Note:					

Response if Error-Flag is set:

Table 6. Response Format "Write_2_Blocks" if "error_flag=1"

Write_2_Blocks (0xA2) for "error_flag=1"					
Field Name	**No. of Bytes**	**LSB**	**Data**	**MSB**	**Description**
SOF	–				
Flags	1	1000 0000			
Error Code	1	xxxx xxxx			
CRC16	2	X-X			
EOF	–				
Note:					

4.1.2 Command Lock_2_Blocks (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 should contain one even and one odd Block (e.g., Block number 2 and 3 or Block number 6 and 7). The start block address should be always the block with the even address (e.g., #2, #4, #6 etc.). If in the start block the odd address is used the Transponder shall not execute the Lock Block operation and return the Error code 0xA1.

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

Table 7. Request Format lock_2_Blocks

Request : Write_2_Blocks (0xA3)					
Field Name	**No. of Bytes**	**LSB**	**Data**	**MSB**	**Description**
SOF	–				
Flags	1			xx00 xx10	
Command Code	1			1100 0101	0xA3
Mfg Code	1			1110 0000	0x07
UID	8			X-X-X-X - X-X-X-X	
Start Block	1			X	(Even address)
CRC16	2			X-X	
EOF	-				
Note:					

Response if Error-Flag is not set:

Table 8. Response Format "Lock_2_Blocks" if "error_flag=0"

Write_2_Blocks (0xA3) for "error_flag=0"					
Field Name	**No. of Bytes**	**LSB**	**Data**	**MSB**	**Description**
SOF	–				
Flags	1	0000 0000			

Table 8. Response Format "Lock_2_Blocks" if "error_flag=0" (continued)

Write_2_Blocks (0xA3) for "error_flag=0"					
Field Name	**No. of Bytes**	**LSB**	**Data**	**MSB**	**Description**
CRC16	2	X-X			
EOF	–				
Note:					

Response if Error-Flag is set:

Table 9. Response Format "Lock_2_Blocks" if "error_flag=1"

Write_2_Blocks (0xA3) for "error_flag=1"					
Field Name	**No. of Bytes**	**LSB**	**Data**	**MSB**	**Description**
SOF	–				
Flags	1	1000 0000			
Error Code	1	xxxx xxxx			
CRC16	2	X-X			
EOF	–				
Note:					

5 Command Execution in “Inventory Mode”

The ISO Inventory Mode command (0x01) has been defined in the standard as a stand-alone command to address a defined set of Transponder’s information to be included in the response. The Response data for the Inventory command are DSFID and UID.

For more system flexibility the inventory mode should also be used in combination with additional ISO or manufacturer-defined commands.

For the execution of a "Command in inventory mode" the "Inventory flag" shall be set to "1". The list of the command codes applicable in Inventory Mode can be seen in Table 10.

Table 10. Commands Executable in Inventory Mode

FUNCTION	COMMAND CODE		REQUEST MODE (1)	AFI	INVENTORY FLAG
	HEX	BINARY (LSB)	INVENTORY		
Read_Single_Block	0x20	0010 0000	✓	✓	0/1
Read_Multi_Blocks	0x23	0010 0011	✓	✓	0/1
Get_System_info	0x2B	0010 1011	✓	✓	0/1
Get_M_Blk_Sec_St	0x2C	0010 1100	✓	✓	0/1

(1) ✓ = Implemented, – = Not applicable

When receiving a command request with the Inventory flag set to "1", the Transponder shall perform the inventory sequence. The Inventory Mode related fields which are "Mask Length" and "Mask Value" followed by the Requested Command related parameters shall be contained in the Request.

The syntax of the returned data in the Response will be as specified in the requested single Command code.

AFI is applicable for all commands executable in Inventory, as defined in Table 10.

NOTE: Get_System_Info command: for this command the DSFID flag in the Info flag byte shall be ignored.

Table 11. Request Format of Commands Executed in "Inventory Mode"

Request : Write_2_Blocks (0xA2)					
Field Name	**No. of Bytes**	**LSB**	**Data**	**MSB**	**Description**
SOF	–				
Flags	1	xx00 xx10			
Command Code	1	0100 0101			0xA2
AFI[(1)]	1	X			
Mask Length	1	X			0x07
Mask Value	0-8	X-X-X-X - X-X-X-X			
Parameter	z				as defined by the command
CRC16	2	X-X			
EOF	–				
Note:					

(1) The AFI is optional.

Response if Error-Flag is not set:

Table 12. Response Format of Commands executed in "Inventory Mode" if "error_flag=0"

Response to : Command execution in Inventory Mode for "error_flag=0"					
Field Name	**No. of Bytes**	**LSB**	**Data**	**MSB**	**Description**
SOF	–				
Flags	1	0000 0000			
DSFID	1	0000 0000			Default
UID	8	X-X-X-X - X-X-X-X			
Request Data	z				as defined by the command.
CRC16	2	X-X			
EOF	–				
Note:					

Response if Error-Flag is set:

Table 13. Response Format of Commands executed in "Inventory Mode" if "error_flag=1"

Response to : Command execution in Inventory Mode for "error_flag=1"					
Field Name	**No. of Bytes**	**LSB**	**Data**	**MSB**	**Description**
SOF	–				
Flags	1	1000 0000			
Error Code	1	xxxx xxxx			
CRC16	2	X-X			
EOF	–				
Note:					

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 TI Custom and Proprietary Error Codes

Table 14. TI Custom and Proprietary Error Codes

ERROR CODES	DESCRIPTION
0x01 – 0x9F	As defined in ISO 15693-3
0xA0	Factory Programming disabled
0xA1	Start block must be even
0xA2	One or both blocks are already locked
0xA3	Test Option not supported
0xA4-0xDF	Reserved

8 Error Codes and Priorities

The priority of the errors is from top of the list toward bottom.

Table 15. General Error Conditions

DESCRIPTION	ERROR CODE
CRC Mismatch	No response
Protocol Extension_Flag = 1	No response
RFU Flag = 1	No response
Address_Flag = 1 Select_flag = 1	No response
State/UID/AFI/Mfg code mismatch	NO RESPONSE
- Command with invalid flags -Inventory Flag=1 + any (defined or not defined) cmd where Inventory Flag is not defined (Write, Lock, Select, Reset to Ready, Stay Quite etc) - Option Flag= 1 + any (defined or not defined) cmd where Option Flag is not defined (option flag shall be 0)	NO RESPONSE
Command is not supported	0x01
Option Flag defined but not supported	0x03
Format error for supported commands (wrong # of Bits)	0x02

All error cases and priority described in Table 15 are applicable for all implemented commands.

The priority of the errors for each command is from top of the list toward bottom.

Table 16. Command-Specific Error Conditions

COMMAND	ERROR CONDITION		RESPONSE ERROR CODE
Inventory	- AFI mismatch (AFI_flag = 1)		NO RESPONSE
	- Mask length		NO RESPONSE
	- Mask value		NO RESPONSE
Read_Single_Block	Inv_flag = 0	- Block is not available	0x10
	Inv_flag = 1	- Mask length	NO RESPONSE
		- Mask value	NO RESPONSE
		- Block is not available	0x10
Read_Multi_Blocks	Inv_flag = 0	- Invalid Start Block / Nr. of Blocks	0x10
	Inv_flag = 1	- Mask length	NO RESPONSE
		- Mask value	NO RESPONSE
		- Invalid Start Block / Nr. of Blocks	0x10
Get_System_info	Inv_flag = 1	- Mask length	NO RESPONSE
		- Mask value	NO RESPONSE
Get_M_Blk_Sec_St	Inv_flag = 0	- Invalid Start Block / Nr. of Blocks	0x10
	Inv_flag = 1	- Mask length	NO RESPONSE
		- Mask value	NO RESPONSE
		- Invalid Start Block / Nr. of Blocks	0x10
Write_Single_Block	- Block is not available		0x10
	- Block already locked		0x12
	- Block not successfully programmed		0x13
Write_AFI	- Block already locked		0x12
	- Block not successfully programmed		0x13
Write_DSFID	- Block already locked		0x12
	- Block not successfully programmed		0x13
Write_2_Blocks	- Start Block = odd		0xA1
	- Block is not available		0x10
	- one or both blocks already locked		0xA2
	- Block not successfully programmed		0x13
Lock_Block	- Block is not available		0x10
	- Block already locked		0x11
	- Block not successfully locked		0x14
Lock_AFI	- Block already locked		0x11
	- Block not successfully locked		0x14
Lock_DSFID	- Block already locked		0x11
	- Block not successfully locked		0x14
	- Write_FP_Off not reliable		0x14
Lock_2_Blocks	- Start Block = odd		0xA1
	- Block is not available		0x10
	- one or both blocks already locked		0xA2
	- Block not successfully locked		0x14

Appendix A Terms and Abbreviations

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

TI-RFid™ Product Manual Terms & Abbreviations

Literature number SCBU014 (11-03-21-002)

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