Texas Instruments

TI UHF Gen2 Protocol

Reference Guide

11-09-21-700 June 2006

TI-RFid

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Edition One – June 2006

This is the first edition of this **TI's UHF Gen 2 Protocol - Reference Manual.**

It contains a description of the IC, its functionality, command set and operations.

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PREFACE

Read This First

About this Guide

This **Reference Guide (11-09-21-700)** is written for the use by TI partners who are engineers experienced with Radio Frequency Identification Devices (RFID).

Regulatory and safety notes that need to be followed are given Chapter 3.

Conventions

WARNING:

A warning is used where care must be taken or a certain procedure must be followed, in order to prevent injury or harm to your health.

CAUTION:

This indicates information on conditions, which must be met, or a procedure, which must be followed, which if not heeded could cause permanent damage to the system.

Note:

Indicates conditions, which must be met, or procedures, which must be followed, to ensure proper functioning of any hardware or software.

Information:

Indicates conditions, which must be met, or procedures, which must be followed, to ensure proper functioning of any hardware or software.

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http://www.ti-rfid.com.

CHAPTER 1

Introduction

This chapter introduces you to the TI Gen 2 IC

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Introduction

1.1 General

Large retailers like Wal-mart and Target in the US and Metro in EU have issued mandates to their suppliers to ship cases & pallets of goods/products with RFID Smart Labels attached. TI's Gen2 IC is intended to be primarily used in case & pallet level retail supply chain applications and is based on the EPCGlobal™ Gen 2 (V1.0.9) specification approved in December of 2004.

TI's UHF Gen 2 IC operates with extremely low power and yet provides long read and write ranges, fast data transfer and high Smart Label throughput, which are all crucial for the following applications:

- Express parcel delivery
- Airline baggage handling
- Distribution logistics and supply chain management
- Building access badges
- Asset tagging

This low power passive IC is designed to operate on the energy extracted from the RF signals transmitted from the reader (interrogator) via its antenna. It (IC) does not require a battery to operate. The IC returns data to the reader using modulated backscatter.

System Description

To form a functional transponder, the IC (sometimes called a Die) requires bonding to an antenna. When the parameters of this antenna match the characteristics of the IC, the antenna resonates at the required frequency and is capable of receiving power and instructions and returning data.

For operation, a reader with antenna is required to send a command to the transponder and to receive its response (see figure 1). The inlay does not transmit data until the reader sends a valid request (Reader talks first principle).

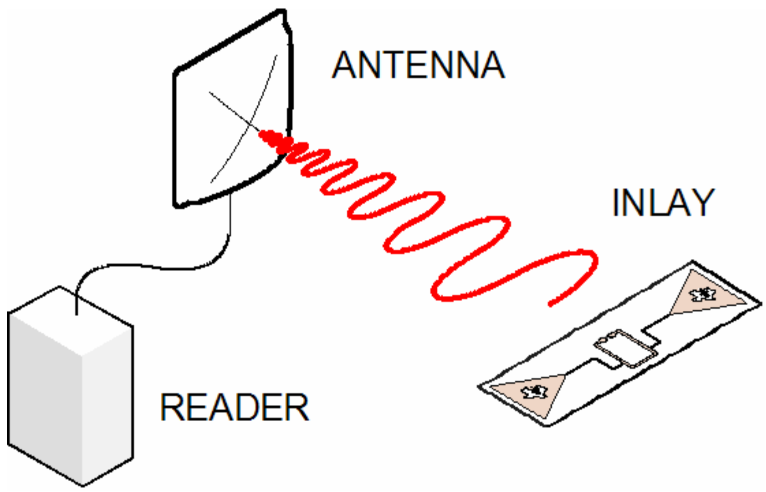

Figure 1. System Overview

1.2 Product Description

The IC has been manufactured to fully meet the EPCGlobal™ Gen 2 specification and can be used to create a functional transponder in three main ways:

a) Forming an Inlay
The TI Gen2 IC can be bonded to an antenna, printed on a plastic or paper substrate or etched from copper or aluminium. This creates an ‘inlay’ which can then be converted into a ‘wet inlay’ having a peel-off adhesive layer or integrated directly into a Smart Label. Currently, the majority of the RFID applications use inlays to make Smart Labels for use on cases and pallets.

b) Direct attach to Label

The TI Gen2 IC can be mounted directly on an antenna that is part of a printed Label substrate, to construct a Smart Label. Currently, a number of manufacturers are exploring this approach.

c) Attach to FR4

The TI Gen2 IC can also be mounted on FR4 antennas or antennas designed on printed circuit boards.

1.3 Functional Description

The IC is composed of a number of building blocks which include the Analog Front End (AFE) which converts RF to digital, Digital Logic and memory

The Digital logic includes a 'State Machine' where groups of commands become available once the chip has transitioned to the correct state. This manual describes the functional operation of the State Machine

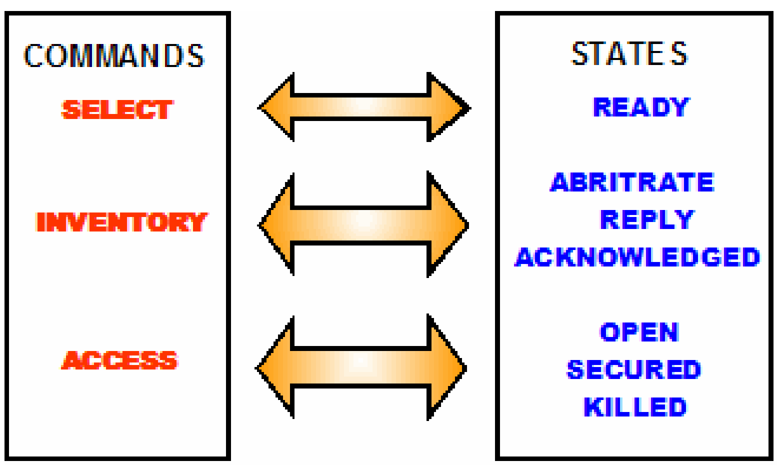

Figure 2. IC States

As soon as the chip enters the RF field it changes to the **Ready** state and will accept ***Select*** commands. ***Select*** commands are sent to all IC's to inform each one if it is to take part in the **Inventory** process that is to follow. Multiple ***Select*** commands can be used to precisely define which IC's are to respond. All exchanges between readers and IC's start with one or more ***Select*** commands. IC's don't respond to the ***Select*** command.

Now the "**Inventory**" group of commands can be used to initiate the singulation process, where each individual IC is identified and processed. Each Inventory round starts with a ***Query*** command being broadcast - this command passes a Q-value (0 to 15) from which each IC generates a slot counter number in the range (0, 2^Q - 1). Most Readers dynamically adjust the Q-value depending on the number of IC's in the field, thereby increasing the potential reading rate.

If an IC generates a slot counter value of zero it is allowed to reply by sending a 16-bit random number and at the same time transitioning to the **Reply** state. The other IC's change state to **Arbitrate** and wait for further commands. If the IC's response is successfully received, the Reader replies by sending an ***ACK*** command, together with the same 16-bit random number. This response now allows the IC to send back its EPC data and change state to **Acknowledged.**

It is at this point that the Reader is able to transition the IC to the **Open** (or **Secured**) state allowing operations such as ***Read***, ***Write***, ***Lock*** and ***KILL*** (which are described in the following sections) but normally this exchange would terminate when the reader sends a ***QueryAdjust*** command and the IC switches state back to the **Ready** state and changes its inventoried flag to show it has been singulated. The ***QueryAdjust*** command also affects the other IC's causing them to decrement their slot counters and any IC whose counter is now zero is allowed to reply – so in this way with successive ***QueryAdjust*** or ***QueryRep*** commands all IC's will be found.

If two IC's reply at the same time, unless the Reader is able to identify each one and send an ***ACK*** and the correct 16-bit random number, each one will timeout, re-generate a slot counter value and return to **Arbitrate**.

If further actions need to be performed on an IC, once the IC has returned its EPC number and is in the **Acknowledged** state, the Reader sends a ***Req_RN*** (Request Random Number) command. The IC replies with a new 16-bit random number that is called the **Handle** and changes its state to **Open**. The Handle then becomes the token for further commands such as Reading, Writing or Killing. If the Lock command is required and the **Access** password is non-zero, the ***Access*** command (complete with Access Password) must be sent, to cause the IC to change to the **Secured** state. Once in **Secured** state, all commands are available.

1.4 Memory Organization

The memory structure conforms to the EPCGlobal™ UHF Gen 2 specification v.1.0.9. During manufacturing Texas Instruments probes each chip and wafer lot information is programmed into the EPC field. This information will later be overwritten when the IC is put into service but in the meantime serves as a unique identifier of each chip.

Data Bank	Address	Default IC Data$_{hex}$	Description
Reserved (Bank 00_{bin})	$00\sim1F_{hex}$	00000000	KILL Password
	$20\sim3F_{hex}$	00000000	ACCESS Password
EPC (Bank 01_{bin})	$00\sim1F_{hex}$	CRC 2800	CRC-16 / Protocol Bits
	$20\sim3F_{hex}$	01234567	Wafer (EPC) Data
	$40\sim5F_{hex}$	00240154	
	$60\sim7F_{hex}$	30020000	
TID (Bank 10_{bin})	$00\sim1F_{hex}$	E2002000	TID Data

Figure 3. The Memory Structure

1.4.1 Reserved Memory

This data is Bank 00_{binary} and contains the KILL password in locations 00 to $1F_{hex}$ and the ACCESS password in locations 20 to $3F_{hex}$. These locations are shipped full of zeroes and unlocked. The passwords are only valid when programmed with non-zero values and (optionally) locked. When the passwords are locked they become unreadable and unwriteable. If the Access password is zero, the IC will automatically transition to the **Secured** State rather than the normal **Open** state.

1.4.2 EPC Memory

This data is Bank 01_{binary} and contains a 16-Bit CRC which is calculated by the chip on the rest of the data in the EPC memory, 16-bits that are the Protocol Control bits and 96-bits that contain the EPC number.

Texas Instruments programs unique wafer data, similar to the following, into the EPC field:

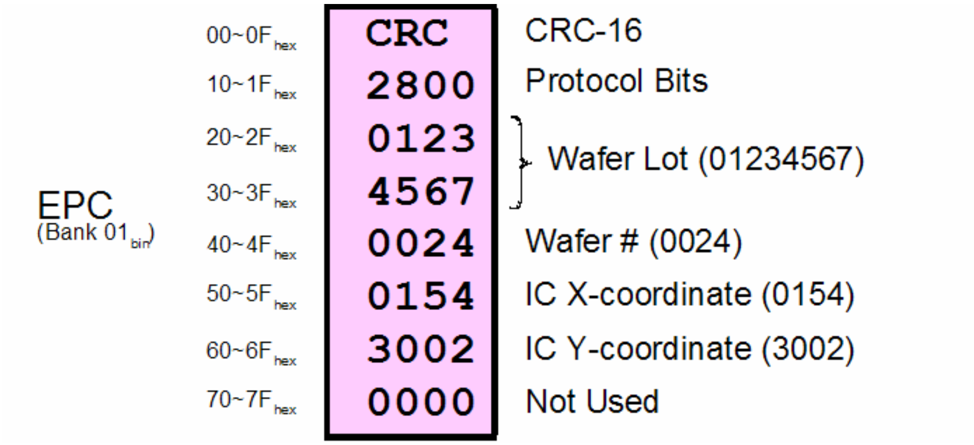

Figure 4. Default EPC Data

1.4.3 TID Memory

This data is Bank 10_{binary} and contains manufacture information. "E2" is prescribed in the EPC Gen 2 specification as a class identifier for EPCGlobal™, "002", identifies the manufacturer as Texas Instruments and "000" is the IC revision number. TID memory is permanently locked.

1.4.4 User Memory

There is no "User Memory"

CHAPTER 2

IC Commands

This chapter details the commands supported by the TI Gen 2 IC. For each command, the format and examples of request and response strings are given.

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2 Command Set

The Texas Instruments' Gen 2 IC implements all mandatory and all optional commands as defined in the EPCGlobal™ Gen 2 specification.

Command	Code	Group	Mandatory
Select	**1011**	SELECT	Yes
ACK	**01**	INVENTORY	Yes
NAK	**11000000**	INVENTORY	Yes
Query	**1000**	INVENTORY	Yes
QueryAdjust	**1001**	INVENTORY	Yes
QueryRep	**00**	INVENTORY	Yes
Req_RN	**11000001**	INVENTORY	Yes
Read	**11000010**	ACCESS	Yes
Write	**11000011**	ACCESS	Yes
Kill	**11000100**	ACCESS	Yes
Lock	**11000101**	ACCESS	Yes
Access	**11000110**	ACCESS	No
BlockWrite	**11000111**	ACCESS	No
BlockErase	**11001000**	ACCESS	No

Table 1. Command Set

2.1 The *Select* Command

The ***Select*** command is the first message that is sent to the IC. It contains user-defined criteria to allow the precise selection of groups of IC's. It can also set or re-set the IC's **SL** flag or change the **Inventoried** flag.

The following parameters are sent:

- **Target** Instructs the IC to select one of four sessions and either the **SL** flag or the **Inventoried** flag associated with that session.
- **Action** How to set the selected flag.
- **MemBank** Selects a memory bank (EPC or TID)

- **Pointer** Where to look in that memory bank
- **Length** How many bits (0 to 255) from the memory bank.
- **Mask** Data string ("Length" bits long) that will be compared with the data selected in the memory bank
- **Truncate** If a ***Query*** command specifies "Sel=10" or "Sel=11" then the response will be truncated to only the EPC data after the mask and not the complete 96-bits
- **CRC-16** Checksum calculated on command string

For a more comprehensive description of this command, please consult the EPCGlobal™ Gen 2 specification.

Example:

1010 100 000 10 01111000 0001000 00000000 1 0111100000010011

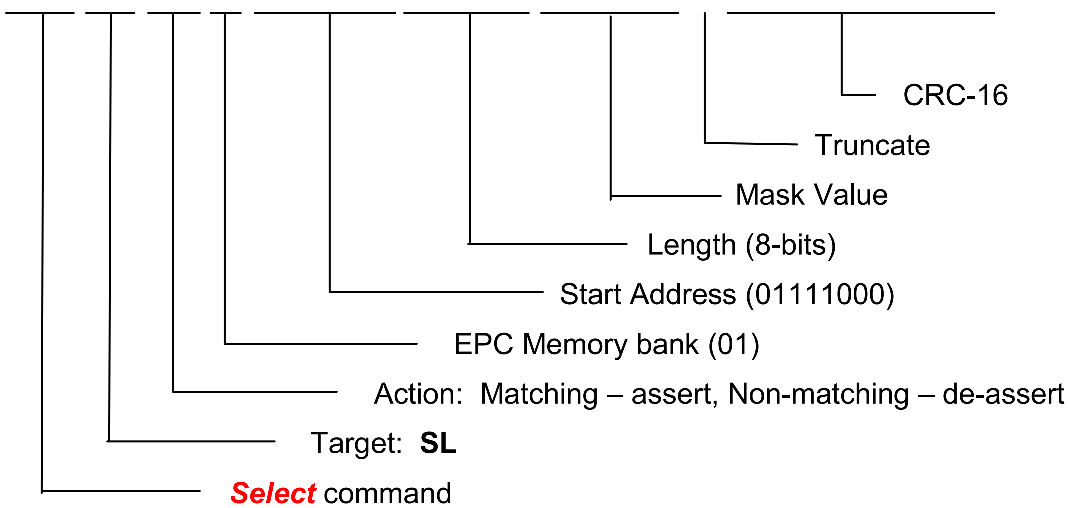

Figure 5. *Select* Command

There is no response to a ***Select*** command

2.2 The *Query* Command

This mandatory command initiates the **Inventory** process where individual IC's are identified. It takes the following parameters:

- **DR (**Divide Ratio) This is where the IC to Reader link frequency is defined.

- **M** (Cycles per second) Sets the IC to Reader data rate and modulation format.
- **TRext** Switches ON/OFF the pre-amble pilot tone.
- **Sel** Chooses which IC's respond (All, SL or ~SL)
- **Session** Selects a session (S0, S1, S2 or S3)
- **Target** Selects between A and B Inventoried flags
- **Q** Sets the number of Slots for the Inventory round.
- **CRC-5** 5-bit Checksum calculated on command string

Example:

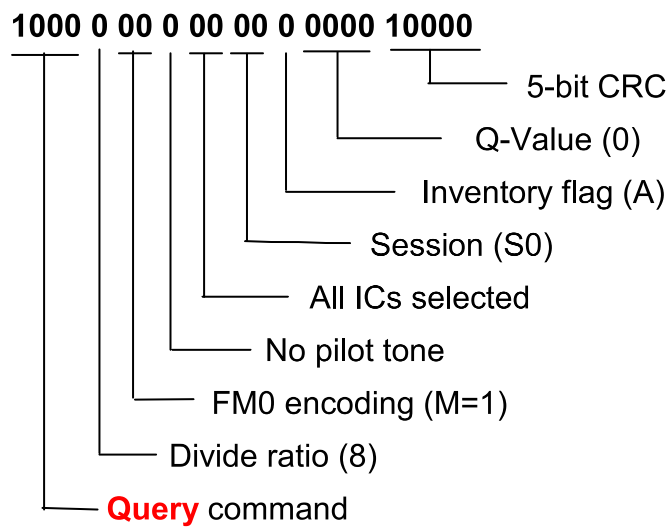

Figure 6. *Query* Command

If an IC's slot counter is zero, the response will be a 16-bit random number similar to the following:

0100111111001000

2.3 The *QueryAdjust* Command

The ***QueryAdjust*** command is mandatory and instructs the IC to increment or decrement its slot counter value. It takes the following parameters:

- **Session** By sending the session number (S0, S1, S2 or S3) it confirms to the IC that it is responding to the correct reader.
- **UpDn** This parameter tells the IC to count up or down

Example:

1001 00 011

Decrement count (Q = Q -1)
Session (S0)
QueryAdjust Command

Figure 7. *QueryAdjust* Command

If an IC's slot counter value is now zero as the result of the decrement, the response will be a 16-bit random number similar to:

0000111111001000

2.4 The *QueryRep* Command

QueryRep instructs IC's to decrement their slot counters and if the resulting value is zero, backscatter a 16-bit random number to the reader.

There is only one parameter:

- **Session** Confirm the session for this inventory round

Example:

00 01

Session (01)
QueryRep Command

Figure 8. *QueryRep* Command

If an IC's slot counter value is now zero as the result of the decrement, the response will be a 16-bit random number similar to:

0111111111001000

2.5 The *ACK* Command

This mandatory command is used to acknowledge the 16-bit random number response from a singulated IC.

Example:

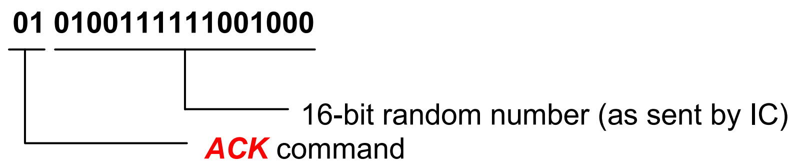

***Figure 9. ACK* Command**

When an IC receives the ***ACK*** command, it will respond with its EPC data. This data may be Truncated, if the Truncate-bit is set in the ***Select*** command or non-Truncated.

Non-Truncated

The general form is: {PC-bits, 96-bits EPC, CRC-16}

In this example the 96-bits EPC data = “00000000000000000000000000000000000000000000000000000000000000000000
0000000000000000000000000000”

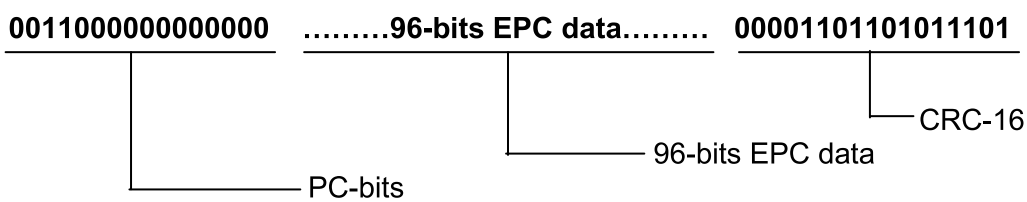

Figure 10. *ACK* Command: Non-Truncated Response

Truncated

The general form is: {00000_2, truncated EPC data, CRC-16}

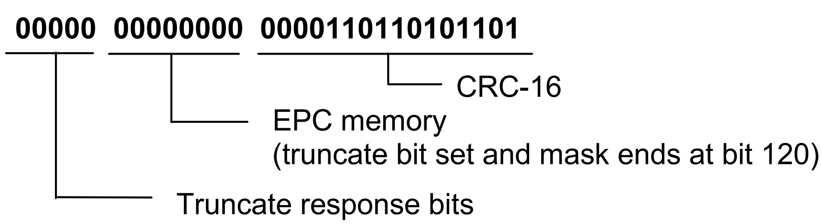

Figure 11. *ACK* Command: Truncated Response

2.6 The *NAK* Command

This mandatory command is used to return all IC's back to the **Arbitrate** state

Example:

11000000

NAK Command

Figure 12. *NAK* Command

There is no response to a ***NAK*** command

2.7 The *Req_RN* Command

This mandatory command instructs the IC to generate and return a new 16-bit Random number. The Reader request and IC's response will depend on the state:

Acknowledged State The reader is required to include the last 16-bit random number with the request. In return, the IC will send a new 16-bit CRC called the **Handle** that will be the identifier between the IC and the reader for future commands. At the same time the IC will change to the **Open** or **Secured** state, depending on the Access password.

a) Access password = 0 : IC changes to **Secured** State

b) Access password <> 0 : IC changes to **Open** State

Open or Secured State The reader must send the 'Handle' with the request. The state will remain as set.

Example:

11000001 0000000011110000 1100110110111011

CRC-16
Prior 16-bit random number (or Handle)
Req_RN command

Figure 13. *Req_RN* Command

The response to the command will be similar to:

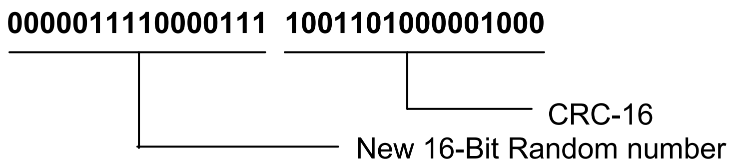

Figure 14. *Req_RN* Response

2.8 The *Read* Command

The ***Read*** command is mandatory and allows reading of part or all of the IC's memory. Data is read in multiples of 16-bit Blocks. The command takes the following parameters:

- **MemBank** Specifies which of the three memory areas (Reserved, EPC or TID) to read.
- **WordPtr** The specifies the start word address. E.g. WordPtr = 00_{hex} specifies the first word in the memory bank.
- **WordCount** This specifies the number of 16-bit words to be read, starting at 'WordPtr'.
- **Handle** This is the identifier between IC and Reader.
- **CRC-16** This checksum is calculated from the first command bit to the last handle bit

Example:

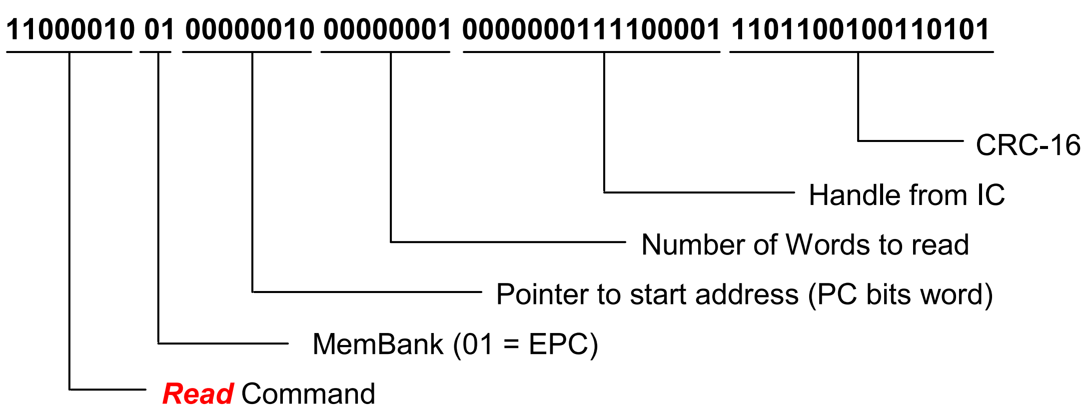

Figure 15. *Read* Command

The response to a ***Read*** command will be similar to:

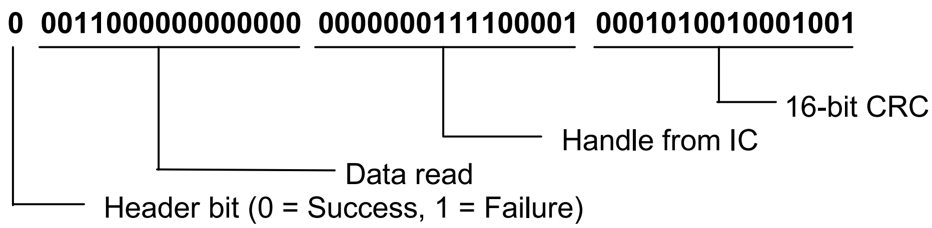

Figure 16. *Read* Response

2.9 The *Write* Command

This mandatory command allows a word of data to be written to any of the IC's memory locations. Before a ***Write*** command can be sent, a new RN16 must be requested from the IC. The data is link cover coded by Exclusive ORing the data with the RN16. The command takes the following parameters:

- **MemBank** Specifies which memory bank to write.
- **WordPtr** The start address for the data to be written
- **Data** The 16-bits to be written (XORed with RN16)
- **Handle** The identifier used between IC and Reader
- **CRC-16** A 16-bit checksum calculated on the command string

Example:

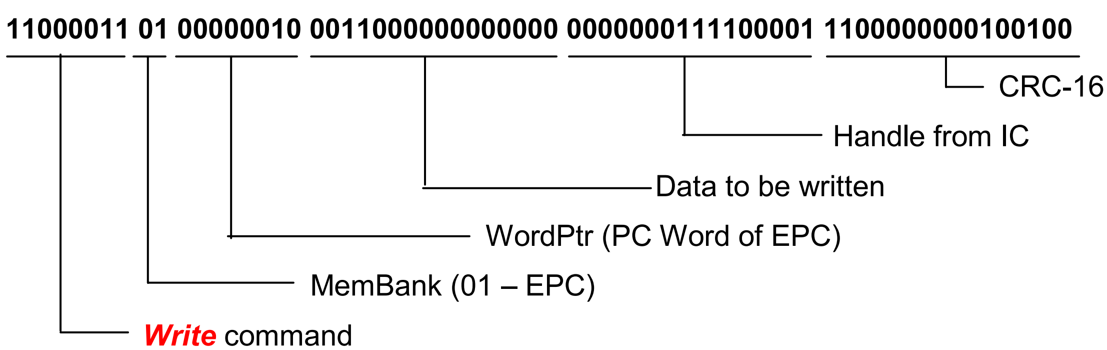

Figure 17. *Write* Command

The response to a ***Write*** **command** will be similar to:

0 0000000111100001 0001101111011111

16-bit CRC
Handle from IC
Header bit (0 = Success, 1 = Failure)

Figure 18. *Write* Response

2.10 The *KILL* Command

The mandatory ***KILL*** command permanently disables the IC. This is a multi-step command:

- Request a new 16-Bit random number (RN16) from the IC.
- The 16 Most Significant Bits of the KILL password are XORed with the RN16 (Link cover coding) and sent to the IC
- Request a new 16-Bit Random number (RN16) from the IC
- The 16 Least Significant Bits of the KILL password are XORed with new RN16 and sent to the IC.

For the KILL command to be accepted by the IC, the Password must be written with a non-zero number and the state must be **Open** or **Secured**.

***KILL* 1** (Send 16 Most Significant Bits of the KILL password)

11000100 1111011101110111 000 0000000001111000 1101001000010001

CRC-16
Handle
RFU bits
KILL 1 password (XORed with RN16)
Command

Figure 19. *KILL* 1 Command

KILL **1** Response

0000000001111000 0001111010110111 1

- 0000000001111000 — Handle from IC
- 0001111010110111 1 — CRC-16

Figure 20. *KILL* 1 Response

KILL **2** (Send 16 Least Significant Bits of the KILL password)

11000100 0001000100011100 000 0000000001111000 0011101001111110

- 11000100 — *KILL* Command
- 0001000100011100 — KILL 2 password (XORed with RX16)
- 000 — RFU bits
- 0000000001111000 — Handle
- 0011101001111110 — CRC-16

Figure 21. *KILL* 2 Command

***KILL* 2 Response**

0 0000000001111000 0011101001111110

- 0 — Header bit (0= Success, 1 = Failure)
- 0000000001111000 — Handle from IC
- 0011101001111110 — CRC-16

Figure 22. *KILL 2* Response

After the second successful response, the IC has transitioned to the **Killed** state and the IC will not reply again.

2.11 The *Lock* Command

This is a mandatory command and is used to:

- Lock individual passwords – preventing or *allowing* subsequent reads and/or writes of that password.
- Lock individual memory banks – preventing or *allowing* subsequent writes to that memory bank
- Permalock – make permanently unchangeable the lock status for a password or memory bank.

For the Lock command to be accepted, the IC must be in the **Secured** state. If the **Access** password is set to zero, the IC will automatically change to this state when a ***Req_RN*** command is sent. If the **Access** password is non-zero, the IC has to be forced into the **Secured** State by issuing an ***Access*** command with the **Access** password. The Lock command takes the following parameters:

- **Payload** A 20-bit mask that indicates memory locations and the actions to be performed at those locations
- **Handle** The 16-bit random number used for mutual identification.
- **CRC-16** Checksum on the preceding data

The 20-bit ***Lock*** command payload comprises **Mask** and **Action** fields:

0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
KILL Mask		ACCESS Mask		EPC Mask		TID Mask		USER Mask		KILL Action		ACCESS Action		EPC Action		TID Action		USER Action	

Table 2. *Lock* Command Payload

The first 10 payload bits are Mask bits and defined as follows:

- **Mask = 0** Ignore this action – keep present settings
- **Mask = 1** Implement the associated **Action** field.

Kill Mask 0	Kill Mask 1	Access Mask 2	Access Mask 3	EPC Mask 4	EPC Mask 5	TID Mask 6	TID Mask 7	User Mask 8	User Mask 9
Skip/ write	Skip/ write	Skip/ write	Skip/ write	Skip/ write	Skip/ write	Skip/ write	Skip/ write	N/A	N/A

Table 3. *Lock* Command 'Mask' Bits

The second 10 payload bits are Action bits and are defined as follows:

- **Action = 0** Deassert lock for the associated location
- **Action = 1** Assert Lock or Permalock for the associated location

Kill Action 0	1	Access Action 2	3	EPC Action 4	5	TID Action 6	7	User Action 8	9
Pwd read/ write	Perma lock	Pwd read/ write	Perma lock	Pwd write	Perma lock	Pwd write	Perma lock	N/A	N/A

Table 4. ***Lock*** **Command 'Action' Bits**

The combinations of Action bits are shown in the table below

Pwd Write	Perma lock	Description
0	0	Associated memory bank is writeable from either **Open** or **Secured** state
0	1	Associated memory bank is permanently writeable from either **Open** or **Secured** and can never be locked
1	0	Associated memory bank is writeable from **Secured** but not from the **Open** state.
1	1	Associated memory bank is not writeable in any state
Pwd read/ write	**Perma lock**	**Description**
0	0	Associated password is readable and writeable from either **Open** or **Secured** state
0	1	Associated password is permanently readable and writeable from either **Open** or **Secured** state
1	0	Associated password is only readable and writeable from the **Secured** state.
1	1	Associated password is not readable or writeable in any state.

Table 5. ***Lock*** **Command 'Action' Bits Table**

Example:

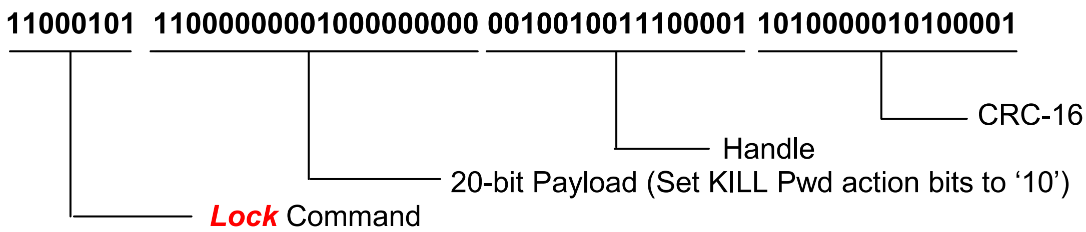

Figure 23. *Lock* Command

The response from a Lock command will be similar to the following:

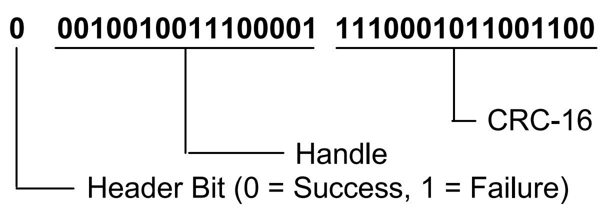

Figure 24. *Lock* Response

2.12 The *Access* Command

This optional command is required when the **Access** password is set (non-zero) and the IC has to be put into the **Secured** state, to allow the use of the ***Lock*** command. This is a multi-part command requiring separate commands for each 16-bits for the 32-bit **Access** password:

- Request a new 16-Bit random number (RN16) from the IC.
- The 16 Most Significant Bits of the password are XORed with the RN16 (Link cover coding) and sent to the IC
- Request a new 16-Bit Random number (RN16) from the IC
- The 16 Least Significant Bits of the password are XORed with the new RN16 and sent to the IC.

For the ***Access*** command to be accepted by the IC, the password must be written with a non-zero number.

Access **1** (Send 16 Most Significant Bits of **Access** password)

11000110 0001000101011101 0010010011100001 0100011001101111

- 11000110 — ***Access*** Command
- 0001000101011101 — Access 1 password (XORed with RN16)
- 0010010011100001 — Handle
- 0100011001101111 — CRC-16

Figure 25. *Access* 1 Command

The response to the ***Access*** command will be similar to the following:

Access **1 Response**

0010010011100001 1100010111011101

- 0010010011100001 — Handle from IC
- 1100010111011101 — CRC-16

Figure 26. *Access* 1 Response

Access **2** (Send 16 Least Significant Bits of **Access** password)

11000110 1100010100010111 0010010011100001 1111111011110001

- 11000110 — ***Access*** Command
- 1100010100010111 — Access 2 password (XORed with RN16)
- 0010010011100001 — Handle
- 1111111011110001 — CRC-16

Figure 27. *Access* 2 Command

Access **2 Response**

0010010011100001 1100010111011101

- 0010010011100001 — Handle from IC
- 1100010111011101 — CRC-16

Figure 28. *Access* 2 Response

After the second successful response, the IC will be in **Secured** state.

2.13 The *BlockWrite* Command

This optional command allows multiple words to be written to the IC's Reserved or EPC memory with a single command. Words are 16-bits long.

The command takes the following parameters:

- **MemBank** The memory bank to be written (Reserved, EPC)
- **WordPtr** The starting word address for the data.
- **WordCount** The number of 16-bit words to be written.
- **Data** The data to be written
- **Handle** The identifier between IC and reader
- **CRC-16** A checksum calculated on the data string.

Example: (Where: Data = 11111111111111111111111111111111)

11000111 01 00000011 00000010 Data 1111000011110110 1001110001101011

- 11000111 – BlockWrite Command
- 01 – Memory Bank (01 = EPC)
- 00000011 – Word Pointer (00000011)
- 00000010 – Word Count (00000010 = 2)
- Data – Data ($FFFFFFFF_{hex}$)
- 1111000011110110 – Handle
- 1001110001101011 – CRC-16

Figure 29. *BlockWrite* Command

The ***BlockWrite*** response will be similar to:

0 1111000011110110 0101100111111001

- 0 – Header (0 = Success, 1 = Failure)
- 1111000011110110 – Handle from IC
- 0101100111111001 – CRC-16

Figure 30. *BlockWrite* Command

2.14 The *BlockErase* Command

This optional command allows the erasing of multiple words in a single command. The command takes the following parameters:

- **MemBank** The memory bank to erase (Reserved, EPC)
- **WordPtr** The starting word address for deletion
- **WordCount** The number of 16-bit words to be erase.
- **Handle** The identifier between IC and reader
- **CRC-16** A checksum calculated on the data string.

Example

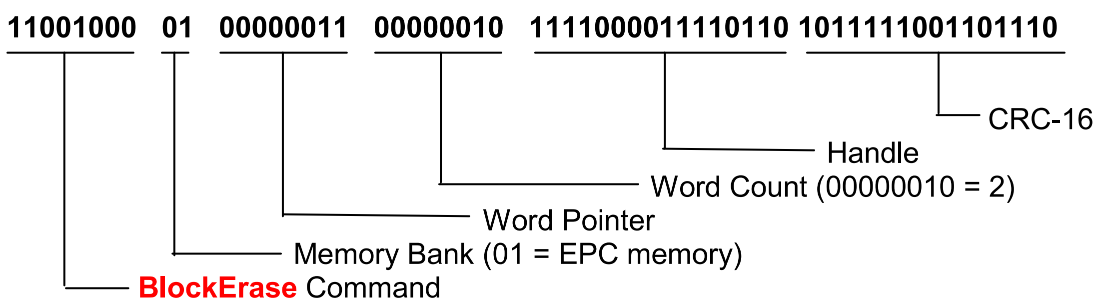

Figure 31. *BlockErase* Command

The response will be similar to:

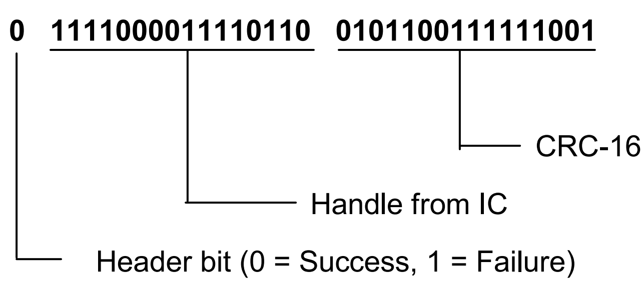

Figure 32. *BlockErase* Response

CHAPTER 3

Regulatory, Safety and Warranty Notices

This chapter describes important safety precautions and regulations

Topic **Page**

3 Regulatory, Safety and Warranty Notices

3.1 Regulatory and Safety Notices

An RFID system comprises an RF transmission device, and is therefore subject to national and international regulations.

Any system reading from or writing to a transponder created from an IC, may be operated only under an experimental license or final approval issued by the relevant approval authority. Before any such device or system can be marketed, an equipment authorization must be obtained form the relevant approval authority.

The TI Gen 2 IC's have been manufactured using state-of-the-art technology and in accordance with the recognized safety rules.

Observe precautions in operating instructions

- **Condition for the safe processing, handling and fault-free operation of TI Gen 2 IC's is the knowledge of the basic safety regulations.**
- **All persons who operate with TI Gen 2 IC's must observe the guidelines and particularly the safety precautions outlined in this document.**
- **In addition, basic rules and regulations for accident prevention applicable to the operating site must also be considered.**

3.2 Warranty and Liability

- The "General Conditions of Sale and Delivery" of Texas Instruments Inc or a TI subsidiary apply.

CAUTION:

TI's Transponder IC's are 100% thoroughly tested. It is the responsibility of TI´s customers to evaluate their equipment to ensure, through appropriate process controls, that machine and material parameters are met on an ongoing basis.

TI does not accept warranty claims for material that has already undergone packaging or conversion process.

3.3 Hazards from Electrostatic Discharge (ESD)

During handling of IC's and wafers, due regard must be given to the build-up of electrostatic charges. See the datasheet.

CAUTION:

ELECTRONIC DEVICES CAN BE DESTROYED BY ELECTROSTATIC ENERGY.

APPENDIX A

Appendix A - Terms & Abbreviations

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

TI-RFID Product Manuals – Terms & Abbreviations

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