TEXAS INSTRUMENTS

HF Reader System Series 6000

S6350 Midrange Reader Module
RI-STU-TRDC-02

Reference Guide

11-06-21-700 September 2002

TI-RFid
A TEXAS INSTRUMENTS TECHNOLOGY

Third Edition - September 2002

This is the third edition of this manual. It describes the following product:

S6350 Midrange Reader Module **RI-STU-TRDC-02**

Firmware Version 1.44

Major Changes: - Addition of Baud Rate Configuration Command
- Note to ISO Read Multiple Blocks Command

Read This First

About This Manual

This reference guide for the S6350 Midrange Reader Module is designed for use by TI customers who are engineers experienced with RFID Systems and Radio Frequency Identification Devices (RFID).

Regulatory, safety and warranty notices that must be followed are provided in Chapter 4.

Conventions

The following pictograms and designations are used in these operating instructions:

CAUTION:

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

Note:

Indicates conditions, which must be met, or procedures which must be followed, to ensure proper functioning.

If You Need Assistance

For more information, please contact the sales office or distributor nearest you. This contact information can be found on our web site at:

http://www.ti-rfid.com

Terms and Abbreviations

The terms and abbreviations used in this manual can be found in the Terms and Abbreviations Manual, document number 11-03-21-002. This manual can be found in the document center on our web site at:

http://www.ti-rfid.com

Numerical Representations

Unless otherwise noted, numbers are represented as decimal.

Hexadecimal numbers are represented with the suffix $_{hex}$, e.g. $A5F1_{hex}$

Binary numbers are represented with the suffix $_2$, e.g. 1011_2

Byte representations: the least significant bit (lsb) is bit 0 and the most significant bit (msb) is bit 7.

Document Overview

Chapter 1

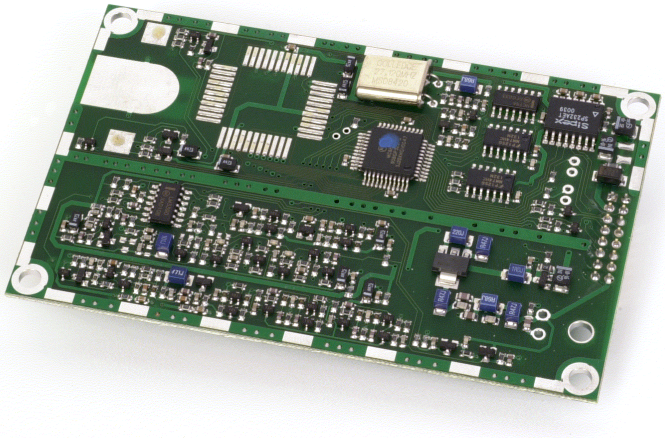
Introduction

Topic **Page**

1.1 Description

This document describes the features and operational characteristics of the S6350 Midrange Reader Module as shown in **Figure 1**. The S6350 Reader operates at a frequency of 13.56MHz and handles all RF and digital functionsin in order to communicate with Tag-it HF, Tag-it HF-I (ISO15693 compliant) and all other ISO15693 compliant transponders from various suppliers. This reference guide provides the details that are necessary to properly interface and use the reader as a part of an integrated system.

Figure 1: S6350 High Frequency Reader



1.2 Programming Interface

The S6350 Reader is designed to operate as a part of a host-based reader system, which essentially relegates the reader to be a slave to the host. Host-to-Reader serial communications are accomplished within data packets whereby communications from the host to the reader are known as requests, and replies from the reader to the host are known as responses. This communication occurs at RS-232 levels using 1 start bit, 8 data bits, 1 stop bit, no parity and the baud rate is configurable to 9600, 19200, 38400 and 57600baud. By definition, the host is always the primary station and initiates all communication sequences. These sequences consist of request/response pairs where the host waits for a response prior to continuing.

Chapter 2

Hardware Description

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2.1 General Specification

This chapter describes the electrical and mechanical specifications of the S6350 Midrange Reader Module (RI-STU-TRDC-02). Operating at a frequency of 13.56 MHz, this low profile, low power device is designed to be easily integrated into many systems as an embedded device. All reader I/O is accomplished through the use of a 16-pin header connector (labeled as CN1), to include all communication, which is asynchronous RS232 as controlled by a host system.

2.1.1 Functional Requirements

The following parameters define the functional requirements and operational environment of the S6350 reader.

Parameter	Specifications
Operating temperature	-20°C to +70° C
Storage temperature	-40°C to +85°C
Mechanical shock	According to MIL STD-801E, Method 516.3 (5 Gs at 10 ms, half sinusoidal waves, 6 axes)
Vibration	According to MIL-STD-810E, Method 514.4 (15 Hz to 500 Hz, 1 g peak, 30 minutes sweep, logarithmic
Operating frequencies	13.56 MHz
Supported Transponder types	Tag-it HF Tag-it HF-I and all other ISO15693 compliant transponders

2.1.2 Power Supply

Input Voltage	5 ± 0.5 VDC
Average quiescent current	90mA
Average current during read (Dependent on read rate)	200mA (for Tag-it HF tags)
Maximum current during read	250mA

2.1.3 Output Power

Output Power	120mW into 50 Ohms (Typical)

2.1.4 RF Physical Layer

Reader to Transponder: 10% - 30% (nominally set at 20%) or 100% modulation (set by software) - **ASK**.

Data Coding Mode: **1 / 4 or 1 / 256**.

Transponder to Reader: **FSK** / Fast Data Rate.

2.1.5 Required Antenna Parameters

Impedance	50Ω ± 5Ω at 13.56 MHz
Loaded Q	10 < Q < 30

Note:

As no standard antenna is provided by Texas Instruments for the S6350 reader, the noted required antenna parameters must be closely followed by the integrator for the reader to operate properly.

2.1.6 Input / output pins (CN1 pins 3 and 4)

Pins 3 and 4 on CN1 may be configured by software commands to read a logic level input or to switch an external load to ground (no pull-up is provided). **See Figure 2.**

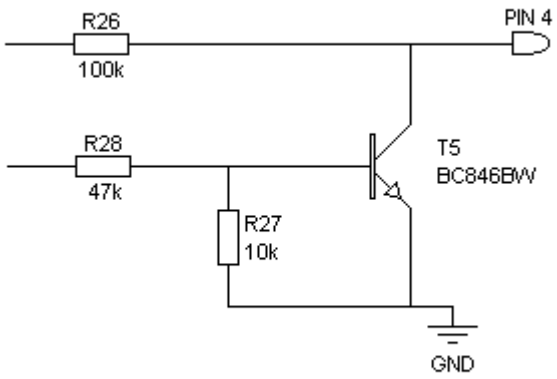


Figure 2: Example Circuit Diagram of an IO pin

When used as a switch to ground the following ratings should not be exceeded:

Maximum voltage **20V**
Maximum current **50mA**

CAUTION:

Exceeding this Voltage and Current limit could cause permanent damage to the reader.

Note:

That if an output has been set by a software command the state will always read back as a logic 0.

2.1.7 Baseband receiver

Minimum data pulse width	5µs
Maximum data pulse width	500µs
Typical settling time	50µs from the first transition

Note:

The receiver extracts the mean level of the incoming data stream as a reference. This takes approximately 50µs; therefore the data output of the receiver is not valid until after this time.

2.1.8 Connector Details

All reader input and output is provided through a 16-pin header connector that is mounted on the backside of the RI-STU-TRDC-02 reader. The details and orientation of each connector pin are provided in the following tables.

2.1.9 16-pin Header Connector CN1

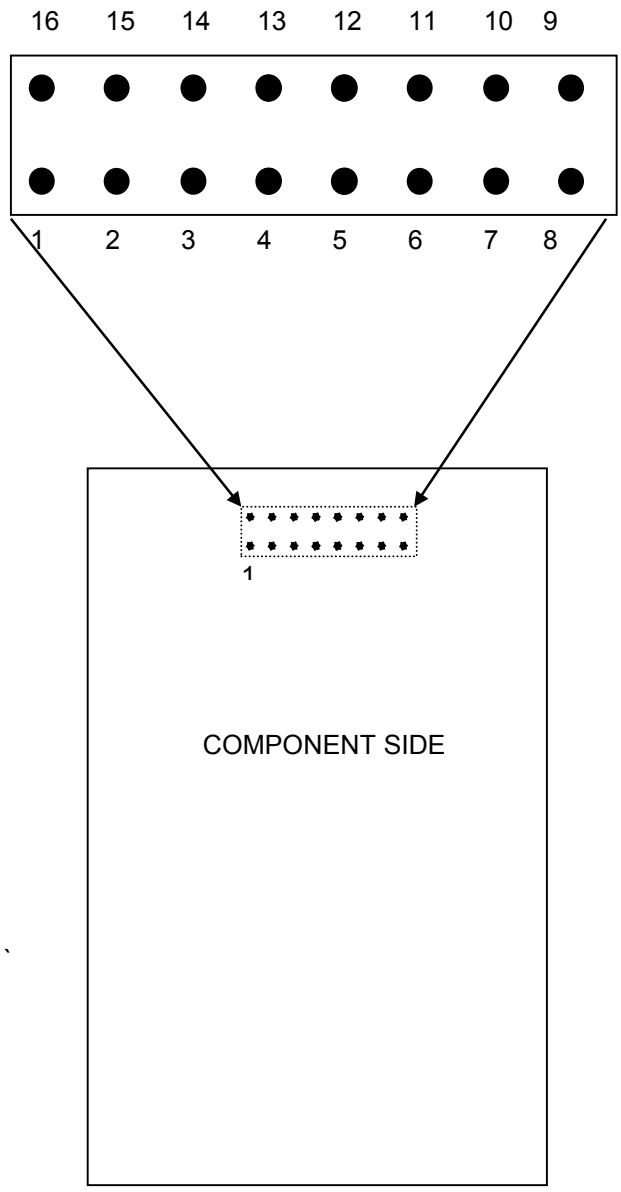
Pin	Function
1	0 Volts
2	+5 Volts
3	Open collector output / data input 2
4	Open collector output / data input 1
5	RS232 TxD (output from reader)
6	RS232 RxD (input to reader)
7	No connection (antenna guard)
8	Antenna screen
9	Antenna signal
10	No connection (antenna guard)
11	RS232 ground
12	No connection (reserved for future expansion)
13	No connection (reserved for future expansion)
14	No connection (reserved for future expansion)
15	No connection (reserved for future expansion)
16	No connection (reserved for future expansion)

CAUTION:

Only pins 8 and 9 of connector CN1 should be used for the antenna connection.

2.1.10 RI-STU-TRDC-02 (CN1) Pin Assignments

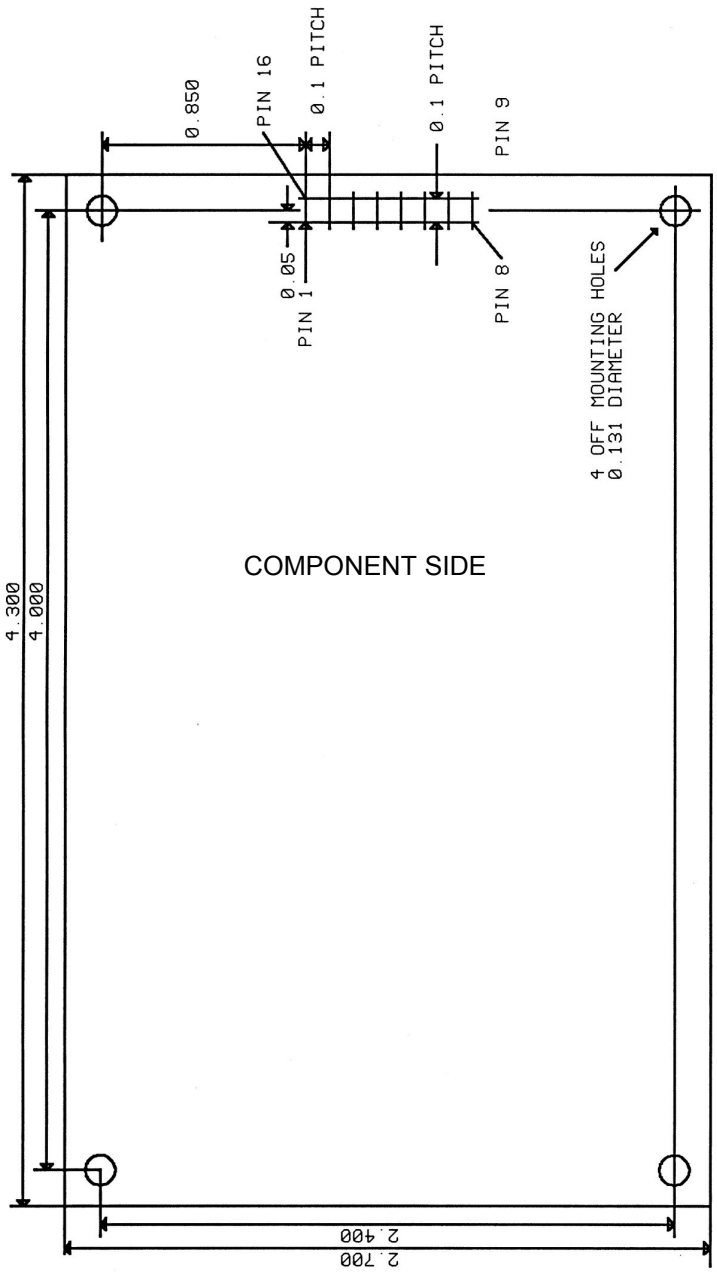
Figure 4: 16-pin Header Connector (CN1) viewed from component side.



2.2 Mechanical Specifications

2.2.1 RI-STU-TRDC-02 with 16-pin Straight Header Connector

Figure 6: Note: All dimensions are in inches



Chapter 3

Reader Protocol

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3.1 Serial Protocol Definition

The S6350 Midrange Reader Module accepts and sends data at RS232 levels using 1 start bit, 8 data bits, 1 stop bit, no parity and the baud rate is configurable to 9600, 19200, 38400 and 57600baud. The data packet from the host to the reader is known as the request and the reply from the reader to the host as the response. The host is always the primary station and initiates all communication sequences. These consist of request/response pairs where the host waits for a response before continuing. The S6350 Midrange Reader Module does not use the node address.

3.1.1 Request Packet Format (Host to Reader)

Field Name	SOF
Field Size	1 byte
Field Value	01_{hex}
Purpose	Start of Frame

Field Name	Length
Field Size	2 byte LSB first
Field Value	Packet dependent
Purpose	Describes the length of the whole packet including SOF

Field Name	Node Address
Field Size	2 byte LSB first
Field Value	0000_{hex}
Purpose	Must be 0000_{hex} for upward compatibility

Field Name	Command flags
Field Size	1 byte
Field Value	Varies by command
Purpose	Specifies the action to be taken by the reader

Field Name	Command
Field Size	1 byte
Field Value	Varies by command
Purpose	Specifies the action to be taken by the reader

Field Name	Data
Field Size	0 to xx bytes
Field Value	Command dependent
Purpose	Contains the parameters and data for the command

Field Name	BCC
Field Size	2 bytes
Field Value	16 bit LRC of the preceding packet including the SOF
Purpose	Allows the reader to validate the correct reception of the request packet

3.1.2 Response Packet Format (Reader to Host)

Field Name	SOF
Field Size	1 byte
Field Value	01_{hex}
Purpose	Start of Frame

Field Name	Length
Field Size	2 byte LSB first
Field Value	Packet dependent
Purpose	Describes the length of the whole packet including SOF

Field Name	Node Address
Field Size	2 byte LSB first
Field Value	0000_{hex}
Purpose	always 0000_{hex}

Field Name	Command flags
Field Size	1 byte
Field Value	Varies by command
Purpose	Specifies the action just taken by the reader

Field Name	Command
Field Size	1 byte
Field Value	Varies by command
Purpose	Specifies the action just taken by the reader

Field Name	Data
Field Size	0 to 23 bytes
Field Value	Command dependent
Purpose	Contains the parameters and data for the command just processed

Field Name	BCC
Field Size	2 bytes
Field Value	16 bit LRC of the preceding packet including the SOF
Purpose	Allows the host to validate the correct reception of the response packet

3.1.3 Command Flags Request

The command flags in the request packet control the actions of the reader. The meanings of the bits are defined below.

Bits 0-3	Reserved for future use and should be set to ‘0’ for upward compatibility.
Bit 4	Is the address flag and if set, the command is only performed on transponders whose address matches the data section of the packet.
Bits 5-7	Reserved for future use and should be set to ‘0’ for upward compatibility.

3.1.4 Command Flags Response

The command flags in the response packet report the actions of the reader. The meanings of the bits are defined below.

Bits 0-3 Reserved for future use.

Bit 4 Error flag. If this flag is set the command was unsuccessful and the data section of the response packet contains the error code. (See section Appendix B for a list of error codes.)

Bits 5-7 Reserved for future use.

3.1.5 BCC

A Block Check Character (BCC) is used for error detection and is attached to the end of the packet. The 16 bit BCC is calculated on all the bytes of the packet including the SOF. The BCC consists of two parts: the LSbyte is a Longitudinal Redundancy Check (LRC) and the MSbyte is the ones compliment of the LRC. The LRC is calculated by performing a cumulative Exclusive-OR operation on all the bytes of the packet.

3.1.6 Example Request Packet

01_{hex}	SOF
$0A_{hex}$	LSbyte of length
00_{hex}	MSbyte of length
00_{hex}	LSbyte of node address
00_{hex}	MSbyte of node address
00_{hex}	Command flags (Not addressed)
02_{hex}	Command (Tag-it™ Read block)
01_{hex}	Data (Block number 1)
08_{hex}	LSbyte of Checksum
$F7_{hex}$	MSbyte of Checksum

3.2 Command Definitions

3.2.1 Tag-it HF Command Definitions

Command Function (Tag-it HF)	Command Code
Read Single Non-addressed & Addressed Block	**02_{hex}**
Write Single Non-addressed & Addressed Block	**03_{hex}**
Lock Single Non-addressed & Addressed Block	**04_{hex}**
Read Transponder Details	**05_{hex}**
Special Read Block Command	**$0F_{hex}$**

Read Block Command (02_{hex})

Reads a single block of data from a Tag-it HF transponder. If the address flag is set, the address forms the first part of the data section (LSbyte first), followed by a single byte containing the block number to be read. If the address flag is clear the data section only contains the block number.

Example
Read block 3 of a Tag-it HF transponder whose address is $0134A4D5_{hex}$
Request packet
01 0E 00 00 00 10 02 D5 A4 34 01 03 5A $A5_{hex}$

The response packet is similar to the request packet, with the data section containing the data received from the transponder (LSbyte first) followed by a single byte indicating the lock status and then another single byte containing the block address. The two LSB's of the lock status byte reflect the two lock bits in the transponder.

Example
Response packet
01 0F 00 00 00 00 02 33 22 11 00 00 03 0F $F0_{hex}$
00112233_{hex} read from unlocked block 3 of a Tag-it™ transponder.

Write Block Command (03_{hex})

Writes a single block of data to a Tag-it HF transponder. If the address flag is set, the address forms the first part of the data section, followed by a single byte containing the block number to be written. The data to be written follows the block number. If the address flag is clear the data section only contains the block byte and the data to be written.

Example
Write Block 4 of a Tag-it HF transponder whose address is $000134A4_{hex}$ with data 01234567_{hex}
Request packet
01 12 00 00 00 10 03 A4 34 01 00 04 67 45 23 01 95 $6A_{hex}$

The response packet is similar to the request packet; with the data section containing 00_{hex} for a successful write operation.

Example
Response packet
01 0A 00 00 00 00 03 00 08 $F7_{hex}$
Successful write.

Lock Block Command (04_{hex})

Locks a single block of data in a Tag-it HF transponder. If the address flag is set, the address forms the first part of the data section, followed by a single byte containing the number of the block to lock.

Example
Lock Block 4 of a Tag-it HF transponder whose address is $000134A4_{hex}$
Request packet
01 0E 00 00 00 10 04 A4 34 01 00 04 8E 71_{hex}

The response packet is similar to the request packet, with the data section containing 00_{hex} for a successful lock operation.

Example
Response packet
01 0A 00 00 00 00 04 00 0F $F0_{hex}$
Successful lock.

Read Transponder Details Command (05_{hex})

Reads the details of a Tag-it HF transponder. If the address flag is set, the address forms the data section.

Example
Read the details of a Tag-it HF transponder non-address
Request packet
01 09 00 00 00 00 05 0D $F2_{hex}$

The response packet is similar to the request packet, with the data section containing the transponder address (4 bytes), manufacturers code (1 byte), transponder version number (2 bytes), the number of blocks (1 byte) and the number of bytes per block (1byte).

Example
Response packet
01 12 00 00 00 00 05 A4 34 01 00 01 05 00 08 04 8F 70_{hex}

Transponder ID	$000134A4_{hex}$
Manufacturers Number	01_{hex}
Version Number	0005_{hex}
Number of blocks	08_{hex}
Number of bytes per block	04_{hex}

Special Read Block Command ($0F_{hex}$)

Reads blocks of data from a Tag-it HF transponder. The address flag should not be used. The data section contains a single byte detailing the blocks to be read. Each bit of this byte represents a block of data (bit 0 = block 0 etc) if a bit is set then that block is read. If the data byte is zero then only the SID is returned. The SID is always retrieved first and then used to read the selected blocks in addressed mode.

Example
Read blocks 0, 3 & 4 of a Tag-it HF transponder (data byte = 00011001_{bin} = 19_{hex})
Request packet
01 0A 00 00 00 00 0F 19 1D $E2_{hex}$

The data section of the response packet contains:

The SID address (LSbyte first),
Block 0 data (if selected) followed by a single byte indicating the lock status and then another single byte containing the block address,
Block 1 data (if selected) followed by a single byte indicating the lock status and then another single byte containing the block address,
Block 7 data (if selected) followed by a single byte indicating the lock status and then another single byte containing the block address,
(The two LSB's of the lock status bytes reflect the blocks two lock bits in the transponder.)

Example
Response packet
01 1F 00 00 00 00 0F 23 4F 10 00 EF CD AB 89 00 00 33 22 11 00 00 03
67 45 23 01 00 04 6A 95_{hex}

$00104F23_{hex}$ SID
$89ABCDEF_{hex}$ read from unlocked block 0 of a Tag-it HF transponder.
00112233_{hex} read from unlocked block 3 of a Tag-it HF transponder.
01234567_{hex} read from unlocked block 4 of a Tag-it HF transponder.

3.2.2 Miscellaneous Commands

Command Function	Command Code
Initiate FLASH Loader Command	**$D0_{hex}$**
Send Data to FLASH Command	**$D8_{hex}$**
Reader Version Command	**$F0_{hex}$**
Read Inputs Command	**$F1_{hex}$**
Write Reader Outputs Command	**$F2_{hex}$**
RF Carrier on/off Command	**$F4_{hex}$**
Baud Rate Configuration Command	**FF_{hex}**

Initiate FLASH Loader Command ($D0_{hex}$)

This command is used to initialize and transfer control to the FLASH loader software.

Example
Request packet
01 09 00 00 00 00 D0 D8 27_{hex}

The response packet is similar to the request packet with the data section containing '00' if successful.

Example
Response packet
01 0A 00 00 00 00 D0 00 DB 24_{hex}

FLASH loader initialised and control transferred.

Send Data to FLASH Command ($D8_{hex}$)

This command is used to load data into the FLASH memory.

Example
Request packet
01 8D 00 00 00 00 D8 <132 bytes of data> <2 byte checksum>$_{hex}$
The Data section must always contain 132 bytes

The response packet data section contains '00' if successful.

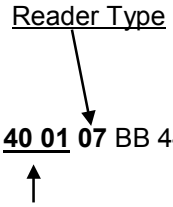
Example
Response packet
01 0A 00 00 00 00 D8 00 D3 $2C_{hex}$
The section of FLASH memory was programmed correctly.

Reader Version Command ($F0_{hex}$)

Requests the version number of the reader. The flags are ignored for this command.

Example
Get the version number of the reader.
Request packet
01 09 00 00 00 00 F0 F8 07_{hex}

The response packet is similar to the request packet with the data section containing the 2 byte version number LSB first followed by a single byte representing the reader type.



Example
Response packet
01 0C 00 00 00 00 F0 **40 01 07** BB 44_{hex}

The version number is 1.4

The reader type response can be defined as follows:

Type 07 = Indicates that the reader has been successfully loaded with the noted application firmware version number (in this example, version 1.4).

Type 00 = Indicates that the reader has not been loaded with application firmware, but does have the boot-loader firmware in place with which to download the appropriate application firmware. (Please refer to **Appendix A: Downloading Data to FLASH Memory**)

Reader inputs Command ($F1_{hex}$)

Reads the state of the reader inputs. The flags are ignored for this command.

Example
Get the status of the reader inputs.
Request packet
01 09 00 00 00 00 F1 F9 06_{hex}

The response packet is similar to the request packet with the data section containing a byte representing the state of the inputs. Bit 0 of this byte represents input 1 and bit 1 represents input 2 all other bits are reserved.

Example
Response packet
01 0A 00 00 00 00 F1 01 FB 04_{hex}
Input 1 is at Logic 1
Input 2 is at Logic 0

Write reader outputs Command ($F2_{hex}$)

Writes the state of the reader outputs. The flags are ignored for this command. The data section contains 1 byte with bits defined as follows:

Bit 0	1 = Output 1 switched on (output is pulled to ground)
Bit 1	1 = Output 2 switched on (output is pulled to ground)
Bit 2	Reserved
Bit 3	Reserved
Bit 4	1 = Bit 0 enabled (output 1 is controlled)
Bit 5	1 = Bit 1 enabled (output 2 is controlled)
Bit 6	Reserved
Bit 7	Reserved

Example
Switch output 2 on without affecting output 1.
Request packet
01 0A 00 00 00 00 F2 22 DB 24_{hex}
The response packet is similar to the request packet with the data section containing '00_{hex}' for a successful write operation.

Example
Response packet
01 0A 00 00 00 00 F2 00 F9 06_{hex}
Write successful.

RF Carrier on/off Command ($F4_{hex}$)

Switches the RF carrier on or off. The data section contains one byte FF_{hex} to turn the carrier on or 00_{hex} to turn the carrier off.

Example
Switch the carrier on.
Request packet
01 0A 00 00 00 00 F4 FF 00 FF_{hex}

The response packet is similar to the request packet with the data section containing '00_{hex}' for a successful operation.

Example
Response packet
01 0A 00 00 00 00 F4 00 FF 00_{hex}
Command successful.

Baud Rate Configuration Command (FF $_{hex}$)

This command is used to change the baud rate of the reader.

Data Byte (1byte) = Baud rate code

09 = 57600 baud (default)
08 = 38400 baud
07 = 19200 baud
06 = 9600 baud

Example

Set Baud rate to 57600baud.
Request packet
01 0A 00 00 00 00 FF 09 FD 02_{hex}

Set Baud rate to 38400baud.
Request packet
01 0A 00 00 00 00 FF 08 FC 03_{hex}

Set Baud rate to 19200baud.
Request packet
01 0A 00 00 00 00 FF 07 F3 $0C_{hex}$

Set Baud rate to 9600baud.
Request packet
01 0A 00 00 00 00 FF 06 F2 $0D_{hex}$

The response packet is similar to the request packet with the data section containing '00_{hex}' for a successful operation.

Example
Response packet
01 0A 00 00 00 00 FF 00 F4 $0B_{hex}$
Command successful.

Note:

Changing this parameter only becomes effective after a power-on reset of the reader.

3.2.3 ISO/IEC 15693 Part 3 Transmission Protocol

In addition to supporting the Tag-it HF transponder protocol outlined within the preceding section, the S6350 Midrange Reader Module complies with the standard RF interface and transmission protocol of ISO/IEC 15693-2, -3. Please note that each of the ISO protocol command and response packets outlined within the following sections are contained within the standard reader protocol as outlined within Section 3.1.
The ISO 15693-3 commands that are specifically applicable to the S6350 Reader are defined within the following table.

3.2.3.1 ISO/IEC 15693-3 Command Codes

Command Function	Command Code
Inventory (Mandatory Command)	**01_{hex}**
Stay Quiet (Mandatory Command)	**02_{hex}**
Read Single Block	**20_{hex}**
Write Single Block*	**21_{hex}**
Lock Block*	**22_{hex}**
Read Multiple Blocks	**23_{hex}**
Write AFI*	**27_{hex}**
Lock AFI*	**28_{hex}**
Write DSFID*	**29_{hex}**
Lock DSFID*	**$2A_{hex}$**
Get Multiple Block Security Status	**$2C_{hex}$**

Note:

* **Bit 7** of the ISO 15693 protocol **Option_Flag** must be set to **1** for all **Write** and **Lock** commands to respond properly.

3.2.3.2 Request/Response Packet Format for ISO/IEC 15693-3

The data packet from the host to the reader is known as the request and the reply from the reader to the host as the response. The host is always the primary station and initiates all communication sequences. These consist of request/response pairs where the host waits for a response before continuing. All ISO/IEC 15693-3 command request packets are contained within the standard reader command request packet format. In all cases, reader command 60_{hex} is used to pass through ISO 15693 Part 3 commands to the reader.

Note:

The Reader's RF Physical Layer is defined as:

Reader to Transponder: 10% - 30% (nominally set at 20%) or 100% modulation (set by software) - **ASK**. Data Coding Mode: **1 / 4 or 1 / 256**

Transponder to Reader: FSK / Fast Data Rate.

The Configuration Byte (ISO Command Data Byte 0)

As detailed in ISO/IEC 15693-2, the Configuration Byte (ISO Command Data Byte 0) is an 8-bit byte that is used to configure the Data Coding Mode and Modulation Depth of the reader.

Modulation Depth

Bit 4 of the Configuration Byte is used to set Modulation Depth. When set high the reader is configured for 100% Modulation Depth, when set low the reader will operate at 10% to 30% (with a 20% nominal setting) Modulation Depth.

Data Coding Mode

Bit 0 of the Configuration Byte is used to set the Data Coding Mode. When set high the reader is configured for Data Coding Mode 1 / 4; when set low the reader is configured for Data Coding Mode 1 / 256.

Request Packet Format for ISO/IEC 15693-3

The request packet consists of the header, packet length, node address, command flags, reader command (60_{hex}), ISO/IEC 15693-3 command/data bytes **0** to some number **"n"** (where byte 0 is the configuration byte) and the checksum.

ISO 15693 Command Data Request Structure

The structure of the ISO 15693 Command Data Request is contained within the Data section of the ISO Command Data, bytes 1 - n. Specific to the S6350 Midrange Reader Module, the ISO 15693 SOF, CRC16 and EOF fields must not be included in the message data packet. Please refer to ISO/IEC 15693-3 for details about the ISO packet format. Specific to the S6350 reader, the ISO 15693 SOF, CRC16 and EOF fields must not be included.

Note:

The protocol of S6350 Midrange Reader Modue does not use the ISO 15693 SOF, CRC16 and EOF fields within its message packet.

Note:

Please refer to ISO/IEC 15693-3 for details about the ISO message packet.

Request Packet Format

<table>
<tr><td colspan="10">Standard reader Request Packet Format (See Section 3.1)</td></tr>
<tr><td rowspan="2">Header</td><td colspan="2" rowspan="2">Packet Length</td><td colspan="2" rowspan="2">Node Address</td><td rowspan="2">Command Flag</td><td rowspan="2">Command</td><td colspan="2">ISO Command Data</td><td colspan="2" rowspan="2">Checksum</td></tr>
<tr><td>Config. Byte</td><td>Data</td></tr>
<tr><td>‘01_{hex}’</td><td>LSB</td><td>MSB</td><td>LSB</td><td>MSB</td><td>Flags</td><td>‘60_{hex}’</td><td>XX_{hex}</td><td>Data</td><td>Byte 1</td><td>Byte 2</td></tr>
<tr><td rowspan="2">1 byte</td><td colspan="2" rowspan="2">2 bytes</td><td colspan="2" rowspan="2">2 bytes</td><td rowspan="2">1 byte</td><td rowspan="2">1 byte</td><td>Byte 0</td><td>bytes 1 - n</td><td colspan="2" rowspan="2">2 bytes</td></tr>
<tr><td>1 byte</td><td>n bytes</td></tr>
</table>

Request Packet Description

Field	Length	Description
Header	1 byte	Defines the start of the packet (01_{hex}).
Packet Length	2 bytes	Defines the length of the packet, including checksum.
Node Address	2 bytes	Defines the Node address of the reader.
Command Flags	1 byte	Defines how a command will be executed.
Command	1 byte	Defines the command for the reader to execute (60_{hex} for ISO 15693-3 commands)
Data	0 - n bytes	Defines the data required by the reader for a command.
Checksum	2 bytes	Byte 1 is an XOR checksum of all elements from the header to the last byte

Response Packet Format for ISO/IEC 15693-3

Similar to the request packet, the response packet consists of the header, packet length, node address, command flags, reader command (60_{hex}), ISO/IEC 15693-3 command/data bytes **0** to some number **"m"** and the checksum.

The ISO Response Data packet can come in one of two possible generic formats: (a) One for the ISO Inventory Response, and (b) all other ISO responses. These will be highlighted in the following sections.

Note:

With the exception of the ISO Inventory Response packet, the format for each standard response packet is the same.

The Error Byte (ISO Response Data Byte 0)

There are three possible reader errors that can be generated in response to an ISO 15693 command. This error code will be returned within the Error Byte (Byte 0) of the ISO Response Data. The error codes are as follows:

01_{hex} Transponder not found
02_{hex} Command not supported
04_{hex} Invalid flags

Response Packet Format

Standard reader Response Packet Format (See Section 3.1)								
Header	Packet Length		Node Address		Response Flags	Command	ISO Response Data	Checksum	
							Data bytes 0 - 'm'		
'01_{hex}'	**LSB**	**MSB**	**LSB**	**MSB**	**Flags**	**'60_{hex}'**		**Byte 1**	**Byte 2**
1 byte	2 bytes		2 bytes		1 byte	1 byte	'm' bytes	2 bytes	

Response Packet Description

Field	Length	Description
Header	1 byte	Defines the start of the packet (01_{hex}).
Packet Length	2 bytes	Defines the length of the packet, including checksum.
Node Address	2 bytes	Defines the Node address of the reader.
Response Flags	1 byte	Defines the response of the reader to the request. Bit 4 defines the error status; a set value indicates that an error has occurred. (Other values reserved for future use)
Command	1 byte	Defines the command that the reader executed (60_{hex} for ISO 15693-3 commands)
Data	0-m bytes	Defines the data returned by the reader in response to a command.
Checksum	2 bytes	Byte 1 is an XOR checksum of all elements from the header to the last byte of the data field. Byte 2 is calculated as (FF_{hex}) XOR (byte 1)

3.2.3.3 Mandatory Commands

The data packet from the host to the reader is known as the request and the reply from the reader to the host as the response. The host is always the primary station and initiates all communication sequences. These consist of request/response pairs where the host waits for a response before continuing. All ISO/IEC 15693-3 command request packets are contained within the standard reader command request packet format. In all cases, reader command 60_{hex} is used to pass through ISO 15693 Part 3 commands to the reader.

Inventory: Command Code (01_{hex})

ISO Inventory Request Command Packet

Header	Packet Length	Node Address	Cmd Flag	Cmd	ISO Command Data		Check -sum
					Config. Byte	**Data**	
'01_{hex}'	2 bytes	2 bytes	1 byte	**'60_{hex}'**	Byte 0	**bytes 1 - n**	2 bytes

ISO Inventory Request Format

SOF	Flags	Inventory Command	Opt. AFI	Mask Length	Mask Value	**CRC16**	**EOF**
Not Used	1 byte	**'$O1_{hex}$'**	1 byte	1 byte	0 - 7 bytes	**Not Used**	**Not Used**

ISO Inventory Response Packet

The inventory response packet format, while complying with ISO 15693, is unique to the reader and is described within the following illustrations. All other ISO 15693 packet responses contain ISO 15693 data as detailed within ISO/IEC 15693-3.

Header	Packet Length	Node Address	Response Flags	Command	ISO Response Data	Check sum
					Data	
'01_{hex}'	2 bytes	2 bytes	1 byte	**'60_{hex}'**	**bytes 0 - m**	2 bytes

ISO Inventory Response Format

SOF	Valid Data Flags	Collision Flags	80-bit response to Inventory Command	Etc…	**CRC16**	**EOF**
Not Used	2 bytes **LSB/MSB**	2 bytes **LSB/MSB**	Data returned from 1st valid time slot	Etc…	**Not Used**	**Not Used**

Valid Data & Collision Flags

Valid Data Flags: This 16-bit field corresponds to whether valid data was received in the 16 possible Time Slots. **Bits 0** to **7** of the **LSB** respectively correspond to **Time Slots 1** to **8**, while **bits 0** to **7** of the **MSB** correspond to **Time Slots 9** to **16** respectively. A set bit corresponds to valid data being received in that particular Time slot.

Collision Flags: This 16-bit field corresponding to whether a collision occurred in the 16 possible Time Slots. **Bits 0** to **7** of the **LSB** respectively correspond to **Time Slots 1** to **8**, while **bits 0** to **7** of the **MSB** correspond to **Time Slots 9** to **16** respectively. A set bit corresponds to a collision being detected in that particular Time Slot.

Note:

It is possible to issue the Inventory Command for just 1 Time Slot instead of 16. In this case, the preceding packet structure is still valid; the required Valid Data flag and Collision flag reside in bit 0 of the LSB of their respective fields. It follows that issuing the Inventory Command for a single Time Slot will result in a maximum of one 80-bit response being returned

If both a Valid Data flag and its corresponding Collision flag are both clear then this indicates that no transponder was detected for that particular Time Slot.

Starting from Time Slot 1 and progressing to Time Slot 16, for each Time Slot where a transponder was successfully read (without collision), its 80-bit data is appended to the Data section of the message packet.

ISO Stay Quiet Request Command Packet: Command Code (02_{hex})

Upon receipt of the Stay Quiet command, the Tag-it HF-I (ISO15693) tag will enter the quiet state and will not initiate a response.

Note: There is no response to the Stay Quiet command.

The Stay Quiet command is always executed in the Addressed mode:

Select_flag set to 0
Addressed_flag set to 1

Header	Packet Length	Node Address	Cmd Flag	Cmd	ISO Command Data		Check -sum
					Config. Byte	**Data**	
'01_{hex}'	2 bytes	2 bytes	1 byte	**'60_{hex}'**	Byte 0	**bytes 1 - n**	2 bytes

ISO Stay Quiet Request Format

SOF	Flags	Stay Quiet Command	UID	**CRC16**	**EOF**
Not Used	1 byte	**'$O2_{hex}$'**	8 bytes	**Not Used**	**Not Used**

3.2.3.4 Optional Commands

Read Single Block: Command Code (20_{hex})

ISO Read Single Block Request Command Packet

Header	Packet Length	Node Address	Cmd Flag	Cmd	ISO Command Data		Check -sum
					Config. Byte	**Data**	
'01_{hex}'	2 bytes	2 bytes	1 byte	**'60_{hex}'**	Byte 0	**bytes 1 - n**	2 bytes

ISO Request Format

SOF	Flags	Read Single Block	UID	Block number	**CRC16**	**EOF**
Not Used	1 byte	**'20_{hex}'**	8 bytes	1 byte	**Not Used**	**Not Used**

ISO Read Single Block Response Packet

Header	Packet Length	Node Address	Response Flags	Command	ISO Response Data	Check sum
					Data	
'01_{hex}'	2 bytes	2 bytes	1 byte	**'60_{hex}'**	**bytes 0 - m**	2 bytes

Response when Error_flag is set

SOF	Flags	Error Code	CRC16	EOF
Not Used	1 byte	1 byte	**Not Used**	**Not Used**

OR

Response when Error_flag is not set

SOF	Flags	Block Security status	Data	CRC16	EOF
Not Used	1 byte	1 byte	Block length	**Not Used**	**Not Used**

ISO Write Single Block: Command Code (21_{hex})

ISO Write Single Block Request Command Packet

Header	Packet Length	Node Address	Cmd Flag	Cmd	ISO Command Data		Check-sum
					Config. Byte	**Data**	
'01_{hex}'	2 bytes	2 bytes	1 byte	**'60_{hex}'**	Byte 0	**bytes 1 - n**	2 bytes

ISO Request Format

SOF	*Flags	Write Single Block	UID	Block number	**CRC16**	**EOF**
Not Used	1 byte	**'21_{hex}'**	8 bytes	1 byte	**Not Used**	**Not Used**

ISO Write Single Block Response Packet

Header	Packet Length	Node Address	Response Flags	Command	ISO Response Data	Check sum
					Data	
'01_{hex}'	2 bytes	2 bytes	1 byte	**'60_{hex}'**	**bytes 1 - m**	2 bytes

Response when Error_flag is set

SOF	Flags	Error Code	**CRC16**	**EOF**
Not Used	1 byte	1 byte	**Not Used**	**Not Used**

OR

Response when Error_flag is not set

SOF	Flags	**CRC16**	**EOF**
Not Used	1 byte	**Not Used**	**Not Used**

Note:

* **Bit 7** of the ISO 15693 protocol **Option_Flag** must be set to **1** for all **Write** and **Lock** commands to respond properly.

ISO Lock Block: Command Code (22_{hex})

ISO Lock Block Request Command Packet

Header	Packet Length	Node Address	Cmd Flag	Cmd	ISO Command Data		Check-sum
					Config. Byte	**Data**	
'01_{hex}'	2 bytes	2 bytes	1 byte	**'60_{hex}'**	Byte 0	**bytes 1 - n**	2 bytes

ISO Request Format

SOF	*Flags	Lock Block	UID	Block number	**CRC16**	**EOF**
Not Used	1 byte	**'22_{hex}'**	8 bytes	1 byte	**Not Used**	**Not Used**

ISO Lock Block Response Packet

Header	Packet Length	Node Address	Response Flags	Command	ISO Response Data	Check sum
					Data	
'01_{hex}'	2 bytes	2 bytes	1 byte	**'60_{hex}'**	**bytes 1 - m**	2 bytes

Response when Error_flag is set

SOF	Flags	Error Code	**CRC16**	**EOF**
Not Used	1 byte	1 byte	**Not Used**	**Not Used**

OR

Response when Error_flag is not set

SOF	Flags	**CRC16**	**EOF**
Not Used	1 byte	**Not Used**	**Not Used**

Note:

* **Bit 7** of the ISO 15693 protocol **Option_Flag** must be set to **1** for all **Write** and **Lock** commands to respond properly.

ISO Read Multiple Blocks: Command Code (23_{hex})

ISO Read Multiple Blocks Request Command Packet

Header	Packet Length	Node Address	Cmd Flag	Cmd	ISO Command Data		Check-sum
					Config. Byte	**Data**	
'01_{hex}'	2 bytes	2 bytes	1 byte	**'60_{hex}'**	Byte 0	**bytes 1 - n**	2 bytes

ISO Request Format

SOF	Flags	Read Multiple Blocks	UID	1st Block #	# of blocks	**CRC16**	**EOF**
Not Used	1 byte	**'23_{hex}'**	8 bytes	1 byte	1 byte	**Not Used**	**Not Used**

ISO Read Multiple Blocks Response Packet

Header	Packet Length	Node Address	Response Flags	Command	ISO Response Data	Check sum
					Data	
'01_{hex}'	2 bytes	2 bytes	1 byte	**'60_{hex}'**	**bytes 1 - m**	2 bytes

Response when Error_flag is set

SOF	Flags	Error Code	**CRC16**	**EOF**
Not Used	1 byte	1 byte	**Not Used**	**Not Used**

OR

Response when Error_flag is not set

SOF	Flags	Block Security Status	Data	**CRC16**	**EOF**
Not Used	1 byte	1 byte	Block length	**Not Used**	**Not Used**
		Repeat as needed			

Note:

The maximum number of data blocks which can be requested with one ISO Read Multiple Blocks Command is 61.

ISO Write AFI: Command Code (27_{hex})

ISO Write AFI Request Command Packet

Header	Packet Length	Node Address	Cmd Flag	Cmd	ISO Command Data		Chec k-sum
					Config. Byte	**Data**	
'01_{hex}'	2 bytes	2 bytes	1 byte	**'60_{hex}'**	Byte 0	**bytes 1 - n**	2 bytes

ISO Request Format

SOF	*Flags	Write AFI	UID	AFI	**CRC16**	**EOF**
Not Used	1 byte	**'27_{hex}'**	8 bytes	1 byte	**Not Used**	**Not Used**

ISO Write AFI Response Packet

Header	Packet Length	Node Address	Response Flags	Command	ISO Response Data	Check sum
					Data	
'01_{hex}'	2 bytes	2 bytes	1 byte	**'60_{hex}'**	**bytes 1 - m**	2 bytes

Response when Error_flag is set

SOF	Flags	Error Code	**CRC16**	**EOF**
Not Used	1 byte	1 byte	**Not Used**	**Not Used**

OR

Response when Error_flag is not set

SOF	Flags	**CRC16**	**EOF**
Not Used	1 byte	**Not Used**	**Not Used**

Note:

* **Bit 7** of the ISO 15693 protocol **Option_Flag** must be set to **1** for all **Write** and **Lock** commands to respond properly.

ISO Lock AFI: Command Code (28_{hex})

ISO Lock AFI Request Command Packet

Header	Packet Length	Node Address	Cmd Flag	Cmd	ISO Command Data		Check-sum
					Config. Byte	**Data**	
'01_{hex}'	2 bytes	2 bytes	1 byte	**'60_{hex}'**	Byte 0	**bytes 1 - n**	2 bytes

ISO Request Format

SOF	*Flags	Lock AFI	UID	AFI	**CRC16**	**EOF**
Not Used	1 byte	**'28_{hex}'**	8 bytes	1 byte	**Not Used**	**Not Used**

ISO Lock AFI Response Packet

Header	Packet Length	Node Address	Response Flags	Command	ISO Response Data	Check sum
					Data	
'01_{hex}'	2 bytes	2 bytes	1 byte	**'60_{hex}'**	**bytes 1 - m**	2 bytes

Response when Error_flag is set

SOF	Flags	Error Code	**CRC16**	**EOF**
Not Used	1 byte	1 byte	**Not Used**	**Not Used**

OR

Response when Error_flag is not set

SOF	Flags	**CRC16**	**EOF**
Not Used	1 byte	**Not Used**	**Not Used**

Note:

* **Bit 7** of the ISO 15693 protocol **Option_Flag** must be set to **1** for all **Write** and **Lock** commands to respond properly.

ISO Write DSFID: Command Code (29_{hex})

ISO Write DSFID Request Command Packet

Header	Packet Length	Node Address	Cmd Flag	Cmd	ISO Command Data		Check-sum
					Config. Byte	**Data**	
'01_{hex}'	2 bytes	2 bytes	1 byte	**'60_{hex}'**	Byte 0	**bytes 1 - n**	2 bytes

ISO Request Format

SOF	*Flags	Write DSFID	UID	DSFID	**CRC16**	**EOF**
Not Used	1 byte	**'29_{hex}'**	8 bytes	1 byte	**Not Used**	**Not Used**

ISO Write DSFID Response Packet

Header	Packet Length	Node Address	Response Flags	Command	ISO Response Data	Check sum
					Data	
'01_{hex}'	2 bytes	2 bytes	1 byte	**'60_{hex}'**	**bytes 1 - m**	2 bytes

Response when Error_flag is set

SOF	Flags	Error Code	**CRC16**	**EOF**
Not Used	1 byte	1 byte	**Not Used**	**Not Used**

OR

Response when Error_flag is not set

SOF	Flags	**CRC16**	**EOF**
Not Used	1 byte	**Not Used**	**Not Used**

Note:

* **Bit 7** of the ISO 15693 protocol **Option_Flag** must be set to **1** for all **Write** and **Lock** commands to respond properly.

ISO Lock DSFID: Command Code ($2A_{hex}$)

ISO Lock DSFID Request Command Packet

Header	Packet Length	Node Address	Cmd Flag	Cmd	ISO Command Data		Check-sum
					Config. Byte	**Data**	
'01_{hex}'	2 bytes	2 bytes	1 byte	**'60_{hex}'**	Byte 0	**bytes 1 - n**	2 bytes

ISO Request Format

SOF	*Flags	Lock DSFID	UID	**CRC16**	**EOF**
Not Used	1 byte	**'$2A_{hex}$'**	8 bytes	**Not Used**	**Not Used**

ISO Lock DSFID Response Packet

Header	Packet Length	Node Address	Response Flags	Command	ISO Response Data	Check sum
					Data	
'01_{hex}'	2 bytes	2 bytes	1 byte	**'60_{hex}'**	**bytes 1 - m**	2 bytes

Response when Error_flag is set

SOF	Flags	Error Code	**CRC16**	**EOF**
Not Used	1 byte	1 byte	**Not Used**	**Not Used**

OR

Response when Error_flag is not set

SOF	Flags	**CRC16**	**EOF**
Not Used	1 byte	**Not Used**	**Not Used**

Note:

* **Bit 7** of the ISO 15693 protocol **Option_Flag** must be set to **1** for all **Write** and **Lock** commands to respond properly.

ISO Get Multiple Block Security Status: Command Code ($2C_{hex}$)

ISO Get Multiple Block Security Status Request Command Packet

Header	Packet Length	Node Address	Cmd Flag	Cmd	ISO Command Data		Check-sum
					Config. Byte	**Data**	
'01_{hex}'	2 bytes	2 bytes	1 byte	**'60_{hex}'**	Byte 0	**bytes 1 - n**	2 bytes

ISO Request Format

SOF	Flags	Get Multiple Block Security Status	UID	1st Block #	# of Blocks	**CRC16**	**EOF**
Not Used	1 byte	**'$2C_{hex}$'**	8 bytes		8 bytes	**Not Used**	**Not Used**

ISO Get Multiple Block Security Status Response Packet

Header	Packet Length	Node Address	Response Flags	Command	ISO Response Data	Check sum
					Data	
'01_{hex}'	2 bytes	2 bytes	1 byte	**'60_{hex}'**	**bytes 1 - m**	2 bytes

Response when Error_flag is set

SOF	Flags	Error Code	**CRC16**	**EOF**
Not Used	1 byte	1 byte	**Not Used**	**Not Used**

OR

Response when Error_flag is not set

SOF	Flags	Block Security Status	**CRC16**	**EOF**
Not Used	1 byte	1 byte	**Not Used**	**Not Used**
		Repeat as needed		

Chapter 4

Regulatory and Warranty Notices

Topic **Page**

4.1 Regulatory Notes

An RFID system comprises an RF transmission device, and is therefore subject to national and international regulations.
Prior to operating the S6350 Midrange Reader Module together with antenna and power supply, the required FCC, PTT or relevant government agency approval must be obtained. Sales, lease or operation in some countries may be subject to prior approval by the government or other organization.

4.2 FCC Notices (U.S.A.)

A typical system configuration containing the S6350 Midrange Reader Module has been tested and found to comply with the limits for a Class A digital device, pursuant to Part 15 of the FCC Rules.

It is the responsibility of the system integrators to get their complete system tested and to obtain approvals from the appropriate local authorities before operating or selling this system.

4.3 R&TTE Conformity (Europe)

A typical system configuration containing the S6350 Midrange Reader Module has been tested and found to comply with the requirements of the Telecommunication Terminal Equipment Act (FTEG) and the R&TTE Directive 1999/5/EC. Any device or system incorporating the S6350 Midrange Reader Module in any other than the originally tested configuration needs to be verified against the requirements of the Telecommunication Terminal Equipment Act (FTEG) and the R&TTE Directive 1999/5/EC. A separate Declaration of Conformity must be issued by the System Integrator or user of such a system prior to marketing and operating it in European Community.

It is the responsibility of the system integrator to get their complete system tested and obtain approvals from the appropriate local authorities before operating or selling the system.

4.4 Warranty and Liability

The "General Conditions of Sale and Delivery" of Texas Instruments Incorporated or a TI subsidiary apply. Warranty and liability claims for defect products, injuries to persons and property damages are void if they are the result of one or more of the following causes:

- Improper use of the reader module.
- Unauthorized assembly, operation and maintenance of the reader module.
- Operation of the reader modules with defective and/or non-functioning safety and protective equipment.
- Failure to observe the instructions during transport, storage, assembly, operation, maintenance and setting up of the reader modules.
- Unauthorized changes to the reader modules.
- Insufficient monitoring of the reader modules' operation or environmental conditions.
- Improperly conducted repairs.
- Catastrophes caused by foreign bodies and acts of God.

Appendix A

Downloading Data to FLASH Memory

The S 6350 Reader FLASH memory contains two areas: the application area for the Reader application firmware and a boot-loader area for the boot-loader firmware. The boot-loader memory is factory locked.

After a reset the boot-loader firmware runs the following sequence:

- Control registers are initialized
- IO ports are initialized
- Application memory is scanned and verified
- If the application memory checksums are valid then control is transferred to the application memory
- If the checksums fail then the boot-loader takes control of the communications.

The boot-loader will only accept the following commands:

- Initiate FLASH Loader Command ($D0_{hex}$)
- Send Data to FLASH Command ($D8_{hex}$)
- Read reader Version Command ($F0_{hex}$)

The boot loader only operates at 57600 baud with 8 data bits, 1 start bit, 1 stop bit and no parity.

The application firmware will always accept the **Initiate FLASH Loader Command ($D0_{hex}$)**. When this command is received by the application firmware, control is transferred to the boot-loader. If the boot-loader does not receive a **Send Data to FLASH Command ($D8_{hex}$)** within 5 seconds of the **Initiate FLASH Loader Command ($D0_{hex}$)** then a system reset is generated.

The application firmware is provided in a single file and contains all the necessary checksums. The file will always contain 29700 bytes of data.

The file must be sent to the reader in one session if any errors occur the whole file must be resent. The file is sent in 225 segments, 132 bytes at a time (225 x 132 = 29700). Each segment is sent using the **Send Data to FLASH Command ($D8_{hex}$).** The 132 bytes of data are contained in the data section of the packet.

Appendix B

Error Codes

Code number	Meaning
01_{hex}	Transponder not found
02_{hex}	Command not supported
03_{hex}	Packet BCC invalid
04_{hex}	Packet flags invalid for command
05_{hex}	General write failure
06_{hex}	Write failure due to locked block
07_{hex}	Transponder does not support function
$0F_{hex}$	Undefined error