Installation and Operations Manual

Model HF-3021E-RS232-USB

13.56 MHz Passive Tag Reader

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This radio transmitter, with ISED certification number IC: 27875-RFIDINC1356 has been approved by Innovation, Science and Economic Development Canada to operate with the antenna types listed below, with the maximum permissible gain indicated. Antenna types not included in this list that have a gain greater than the maximum gain indicated for any type listed are strictly prohibited for use with this device.

830-0719-02	Model 5102-6060 HF 13.56 MHz RFID Antenna, 60x60mm with 35mm diameter center hole, MMCX connector

Section 1 – General Information

This manual provides information pertaining to the installation and operation of the Model HF-3020 13.56 MHz Reader. This series of Readers is available as a single piece solution Reader + internal Antenna in enclosure, or Reader with external Antenna as a two piece solution, or as board level PCBA components. See part numbers on page

This Reader is unique in that it can operate with four different types RFID Tag chips, ISO 15693, ISO 14443A, ISO 14443B, and NXP's original Icode1 (the latter not being an ISO standard). Under these standards there are varying amounts of Tag memory, all of which include a non-alterable UID (unique identification) section that acts as a RO (read only) random identifier.

This Reader and the RFID Tags can also be provided as a proprietary product for brand protection applications. This Reader is simple to use, plug & play, in that all commands and reports are represented in standard human readable ASCII. It is not necessary to convert commands to hex nor translate the outputs from hex as this work is done in our processor.

The Reader operates as both a transmitter and receiver, providing a high frequency electromagnetic field at 13.56 MHz to energize and activate an electronic transponder (RFID Tag). Once the Tag is energized it modulates its data back to the Reader which in turn detects and demodulates this data for delivery to the serial or USB port.

Tag Memory

Generally, HF RFID passive Tag chips, containing a EEPROM with encoded data, have no finite life for read only operations and a finite life of 100k writes. There exist a plethora of HF Tag chips available on the market, thus Tag memory is not discussed in detail herein. RFID, Inc. can provide a specific memory organization map dependent upon the chip and size of memory you intend to use.

Data is represented in Hexadecimal and each byte will appear as two characters. The valid characters are 0 to 9 and A to F, so if a page has 8 bytes the reader will display it as 16 hexadecimal characters. If a block has 4 bytes the reader will display it as 8 hexadecimal characters.

ISO15693

The Transponder ID is 64 bits long (8 bytes). Example <LF>E0078077CDCD153E<CR>

Most ISO15693 transponders are divided in blocks of 4 bytes (32 bits) represented by 8 hexadecimal characters. Example <LF>05 00000578<CR>

In some very rare cases an ISO15693 transponder will be divided in blocks of 64 bits. The reader automatically recognizes these types of transponder and adjusts its data size to it. If you are not familiar with the block size of the transponder in use, it is recommended to read a block from it to discover the block size

ISO14443-B

The Transponder ID is 32 bits long (4 bytes). Example <LF>008B78B5<CR>

Transponders are divided in pages of 8 bytes (64 bits) represented by 16 hexadecimal characters, when reading a page the reader first sends the two digit page number followed by a space and the 16 characters of data. Example <LF>05 0000000000000056<CR>

Here are some examples of memory sizes available. With new chips being added to the market from time to time, this list may not be up to date.

ISO 15693	ISO 14443A	ISO 14443B
256 bits	512 bits	1k bits
512 bits	320 Bytes	2k bits
576 bits	1k bits	4k bits
1k bits	4k Bytes	8k bits
2k bits	8k bits	16k bits
2k Bytes		32k bits
10k bits		64k bits

Here is an example of a memory map for a 1k bit (1024 bits) Tag

Block	Byte 0 (LSB)		Byte 3 (MSB)	
-4	**UID0**	**UID1**	**UID2**	**UID3**
-3	**UID4**	**UID5**	**UID6**	**UID7**

-2	Reserved for Control Bytes
-1	Reserved for Write Access
0	32 bit data, 8 bytes
1	32 bit data, 8 bytes
2	32 bit data, 8 bytes
3	32 bit data, 8 bytes
4	32 bit data, 8 bytes
…….	……..
24	32 bit data, 8 bytes
25	32 bit data, 8 bytes
26	32 bit data, 8 bytes
27	32 bit data, 8 bytes

Product Part Numbers & Accessories

Part Number	Description
Readers	
710-0231-01	Model HF-3021-RS232/USBPCB HF 13.56 MHz RFID Reader, PCB level, no enclosure, w/o Antenna
830-0007-00	Model HF-3021E-USB HF 13.56 MHz RFID Reader, ABS housing, external Antenna needed
830-0007-00-IA	Model HF-3021E-USB-IA HF 13.56 MHz RFID Reader ABS housing w/internal Antenna
830-0006-00-9PPJ	Model HF-3021E-RS232-9PPJ HF 13.56 MHz RFID Reader, ABS housing, 9pin serial, power jack, needs ext Ant
830-0006-00-PJ	Model HF-3021E-RS232-PJ HF 13.56 MHz RFID Reader, ABS housing, serial pigtails, power jack, needs ext Ant
830-0006-00-9P	Model HF-3021E-RS232-9P HF 13.56 MHz RFID Reader, ABS housing, 9pin serial, power pigtails, needs ext Ant
830-0006-00	Model HF-3021E-RS232 HF 13.56 MHz RFID Reader, ABS housing, pigtails both serial & power, needs ext Ant
830-0006-00-9PPJ-IA	Model HF-3021E-RS232-9PPJ HF 13.56 MHz RFID Reader w/internal Antenna, ABS housing, 9pin serial, power jack
830-0006-00-PJ-IA	Model HF-3021E-RS232-PJ HF 13.56 MHz RFID Reader w/internal Antenna, ABS housing, serial pigtails, power jack
830-0006-00-9P-IA	Model HF-3021E-RS232-9P HF 13.56 MHz RFID Reader w/internal Antenna, ABS housing, 9pin serial, power pigtails
830-0006-00-IA	Model HF-3021E-RS232 HF 13.56 MHz RFID Reader w/internal Antenna, ABS housing, pigtails both serial & power
830-0006-00-9PPJ	Model HF-3021E-RS232-9PPJ HF 13.56 MHz RFID Reader, ABS housing, 9pin serial, power jack, needs ext Ant
Antennas	
830-0719-02	Model 5102-6060 HF 13.56 MHz RFID Antenna, 60x60mm with 35mm diameter center hole, MMCX connector
830-0719-03	Model 5102-5050 HF 13.56 MHz RFID Antenna, 50x50mm with 25mm diameter center hole, MMCX connector
830-0719-04	Model 5102-18 HF 13.56 MHz RFID Antenna, 18mm diameter prox barrel
Power Supplies	
720-0004-07	Model PS12PT Regulated AC power supply w/pigtail wiring, 12 vdc 750 mA
720-0004-06	Model PS12PJ Regulated AC power supply w/power jack plug, 12 vdc 750 mA

Specifications

The USB version of this Reader is powered over USB. For the serial version of this Reader, see table below:

Description	Min	Typ	Max	Units
Input Voltage	8	-	24	Volts DC
Input Current	250	350	500	mA
Cabling distance	-	-	50	Feet
Temperature range	0	-	85	Celsius

Serial Communications	
Baud Rate	115200bps
Data Bits	8
Parity	None
Stop Bits	1
Flow Control	None

J3 Pin out	
1	+VDC Input
2	0VDC, Ground
3	GROUND In
4	RS232 TX (Out)
5	RS232 RX (In)

Data Storage:	None		
Error Rate:	Less than 1 in 10 to the 14th readings		
Serial Connectors:	9 pin D-SUB Female		Twisted pair pigtails
Power Connectors:	Quick Connect Single Male Pole		Twisted pair pigtails
Cabling distance:	50' (RS232)		
Power Requirements:	Min = 7vdc Current Min = 250mA	Typical = 24V Current Typ = 300mA	Max = 28vdc Current Max = 500mA
Temperature range:	Operating 0C to 70C		Non-Operating -20C to 125C

Wire Specifications

Shielded (22 AWG for RS232 communication cable length up to 25' and 16 AWG for RS232 communication lengths beyond 25') insulated, stranded wire is recommended, and all wires should be stripped approximately 3/8 inches and tinned. RS232 has a maximum effective distance of 50', use RS232 to RS422 converters if distance up to 2k' is necessary. Whatever cable is selected, it should fit within the range allowed by the cable gland providing wire access to the Smart Antenna. The cable gland will accommodate diameters of .090 to .265 inches.

Power & Communication Connections

Regulated power supplies are preferred, linear power supplies are acceptable, switching power supplies should never be used as they affect the Smart Antenna's read range performance. Take care that while some supplies are labeled as regulated, they are actually switching. Contact the source of your supply or contact RFID, Inc. technical support with the make and model number of your supply. RFID, Inc. can provide an AC adaptable power supply suitable for use with this Reader.

Antenna Connection

Readers with the Antenna mounted in the enclosure incorporate a pre-connected Antenna. Readers in an enclosure for use with an external Antenna have an SMA connector ready for adaptation. Readers at a PCB level have 2 connection points for co-axial cable as shown below for Antenna connection.

USB Reader Version

The USB Reader version is power over USB however some older PC's USB ports do not offer sufficient power so there is the option to use external power as well, see photo below.

J3 Pins – For Power 24V+ and GND and RS232

JP1 Pins – External Power/USB Power in selector header.

J6 & J7 Pins – Place shunts on inside pins for USB power and outside pins for external power. Early versions of this PCB incorrectly printed J6 power options. Use the inside/outside rule explained in the previous sentence.

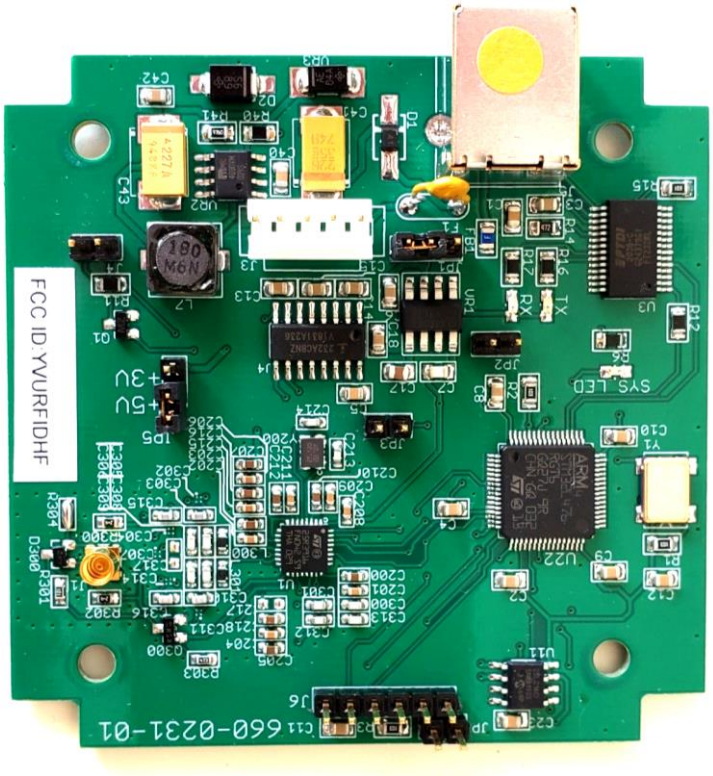
RS232 Reader Version

The serial Reader comes with either a quick connect jack mounted into the enclosure or pigtail wiring ready for adaptation to your own supply. With the pigtail power wiring you will see a set of 2 wires, white and black. White is +voltage and black is ground. If you ordered the quick connect power jack then you probably also ordered the mating AC adaptable power supply.

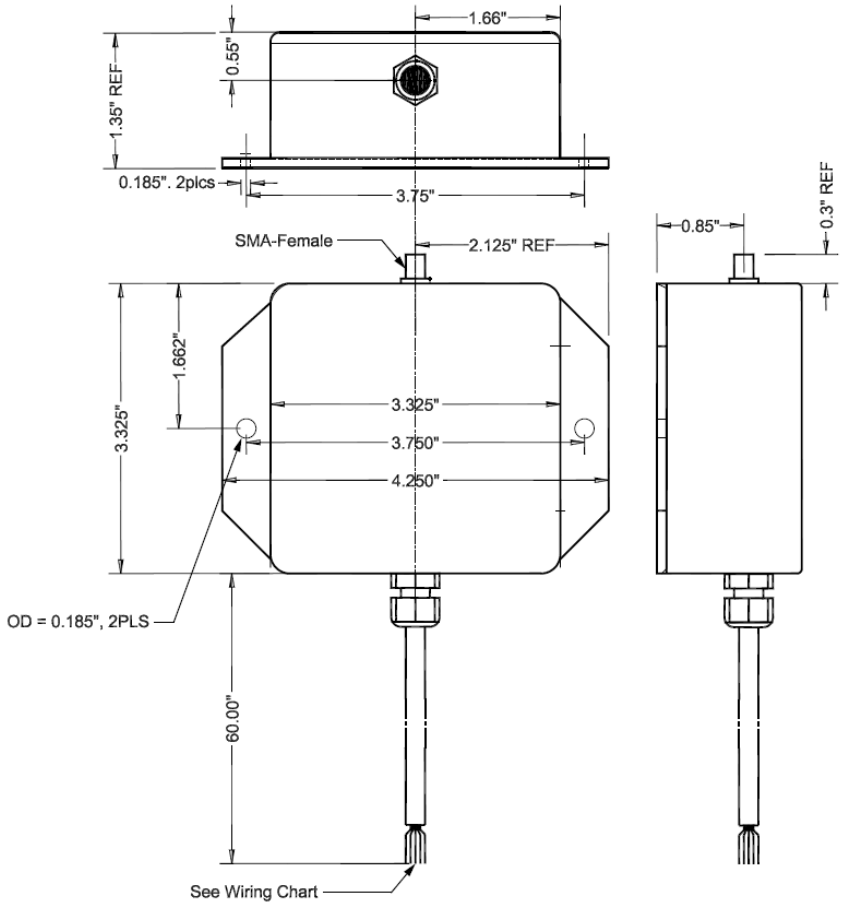
J3 Pins – Pin 1 is nearest to inscription "J2".

PIN#	SIGNAL NAME
1	+VDC IN
2	0VDC or Ground
3	Signal Ground
4	Tx – Transmit
5	Rx – Receive

9 pin D-SUB Female – If you have a Reader with 9 pin D-sub, the connections are pre-wired to act as a null modem with pins 2 and 3 being crossed. No null modem cable is necessary.


FCC ID:YVURFIDHF
660-0231-01

Drawing


1.66"
0.55"
1.35" REF
0.185". 2pics
3.75"
SMA-Female
2.125" REF
0.85"
0.3" REF
1.662"
3.325"
3.325"
3.750"
4.250"
OD = 0.185", 2PLS
60.00"
See Wiring Chart

Section 2 - Quick Start Installation Guide

Reading Mode

This Reader has three reading modes, commands for selecting these modes are detailed in section 3:

Single Tag Report Mode - meaning a Tag's base memory (UID) will be read and reported once. The Reader is defaulted to the Single Read Mode although any change will be held in non-volatile memory.

Duplicate Tag Report Mode - meaning a Tag's base memory will be continually read and reported.

Polling Tag Report Mode - whereby a Tag will only be reported if the Reader is queried and an RFID Tag is present to the Reader. Note that ISO 14443 type Tags are meant only to be polled, however in the Single and Duplicate read modes our Reader operates in a mode that polls continuously in order to present data without you the user having to poll the Reader although the normal Polling mode is fully functional. This is why you will see an "e" message at the end of either reading routine.

Reading Tags

Simply power the RS232 Reader or plug in the USB port to your host and an LED will illuminate. Solid illumination indicates power is applied and the Reader is ready for operation. If the Reader is in the correct reading mode, presenting a Tag at this point will result in the LED blinking off and back to solid indicating a successful read has been achieved.

Preparing to interface the Smart Antenna to your PC

There two options available to you for achieving Tag data to your PC screen, one to include log or text files. RFID, Inc. is also happy to provide the VB code, free of charge, we have written for our demo program. If you have already interfaced the Reader to a terminal program or your own software, upon powering the Reader you will see a power up message from the serial Reader. The USB version has no power up message.

Generic Terminal Program – Any common terminal emulation program can be used, for example HyperTerminal, ProComm, Teraterm, Putty, etc.

RFID, Inc.'s free of charge Terminal Program - RFID, Inc. provides a free software demo program called "RFID UHF Term or "RFID Demo Terminal Programmable" downloadable here https://www.rfidinc.com/resource-center/. It may appear in your Programs menu as RFIDIncUHFTerm. It is important to follow these steps in order for the program to scan and identify the ports available on your computer.

(1) Plug the RS232 9 pin connector into your computer (use an RS232 to USB converter if no 9 pin connector is available on your computer) or use the direct USB to USB connection.

(2) Power the Reader on (not necessary for USB).

(3) Execute the RFIDIncUHFTerm Program. Select "Scan Ports" found upper right. This allows the program to scan which port address is connected to the Reader. In the upper left, under "Ports" use the pull down menu to choose the port discovered.

(4) Set the baud rate and remaining communication settings, default is 115200 baud, 8 data bits, None Parity, 1 stop bit and None Flow Control (115200, 8, N, 1, N). You can also view which port is connected by going to your Desktop, right click on My Computer, choose Properties, Hardware and Device Manager, then open the Ports directory tree.

(5) Select "Connect." Presenting a Tag to the Antenna should now bring that Tag data onto the main screen and the lower body of the screen as well.

Remove Old Data - This program also offers the ability to "Remove Old Data" by checking this box under "Tag Read Settings," a process of deleting Tag reads from the screen set to the timeouts you choose in the pull down menu. For example if you choose 5,10,15 Timeout, Tag data will begin highlighted in green for the first 5 seconds, then become highlighted in yellow at 5 seconds time, then turn to red at 10 seconds time, and finally be deleted at 15 seconds time.

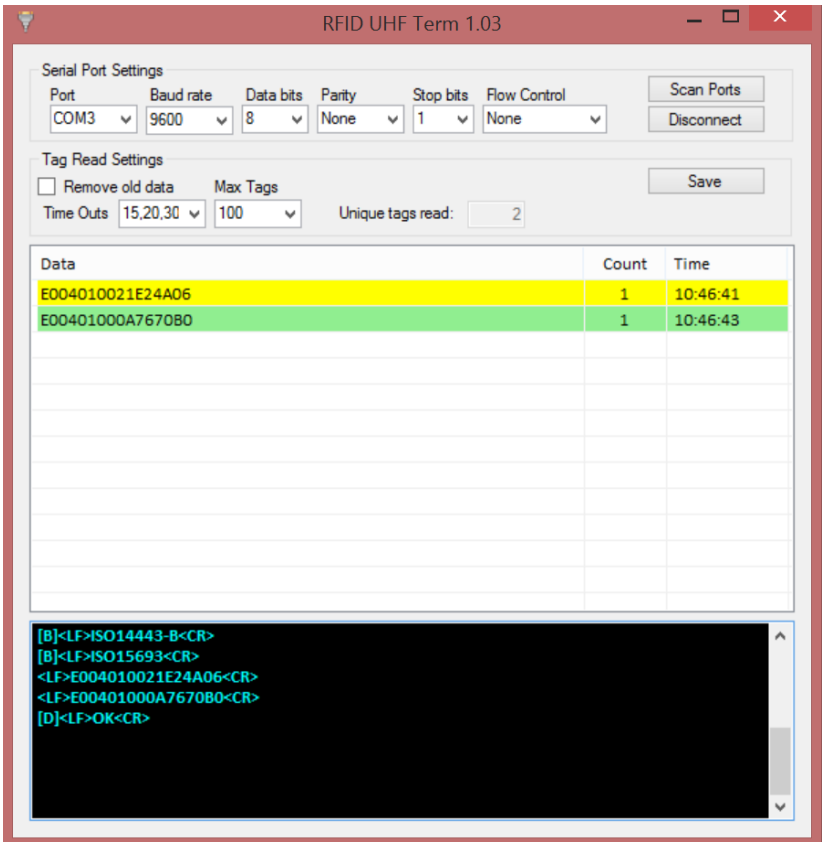
Maximum Tags – An option rarely used for HF Tags. This program also offers the ability to time how long it takes to read the amount of Tags you wish to test by choosing the number of Tags under the "Max Tags" setting. You will see the data field to the right increment as the Reader counts how many unique Tags have been read. If you choose 100 as your Max Tags setting, once the Reader has read 100 unique Tags a pop up box will appear advising you the amount of time this procedure took.

Save – This box will prompt you to save Tag data to a text file with time and date stamp.

The main screen area (white) is solely used for display of Tag data. The lower screen area (black) will display Tag data and also allow you to enter commands to the Reader. Note - All commands must be issued in CAPS, preceded by an open square bracket and ended with a closed square bracket [B] for example. There is more in depth information on how to read and write specific portions of Tag memory under the Commands section of this product manual.

Single Report Tag Read Mode – Place your cursor in the lower screen area and type [S]. This will initiate the Single Report Tag Read Mode and the Reader will respond with "OK."

Duplicate Report Tag Read Mode - Place your cursor in the lower screen area and type [D]. This will initiate the Duplicate Report Tag Read Mode and the Reader will respond with "OK."



Section 3 - Operating the Reader

This section explains operational commands and input received back from the Reader, commands, operating modes, and responses.

Note:

- All commands are issued in ASCII CAPITAL letters, and they are preceded by an open square bracket and ended with a closed square bracket. Some symbols and all numbers are permitted. No spaces are permitted.
- Commands are held in non-volatile memory, meaning that if power is taken away from the Smart Antenna the last command or settings will be retained when re-powered.

General Commands & Responses (ISO protocol independent)

Tag Data Delivery

Tag data will be sent to the serial port in the following format.

<LF>XXXXXXXX<CR>

Where: **<LF>** = Line Feed
XXXXXXXX = Tag data
<CR> = Carriage Return

Single Mode Command - [S]

This command causes the reader to enter SINGLE MODE. In this mode the reader will only report the Tag ID once when it arrives within antenna range. The Reader continues to read the ID but does not report it again. As long as a Tag is continually present to the Reader only 1 read will be reported however if the Tag leaves the Reader's RF field briefly and is re-presented the read will be re-reported.

Host: [**S**]
Where: **S** = command

Reader Response: **<LF>OK<CR>**
Where: **<LF>** = Line Feed
OK = Response
<CR> = Carriage Return

Duplicate Mode Command - [D]

This command causes the reader to enter DUPLICATE MODE. In this mode the Reader will continually report any Tag ID present to the Reader. This mode is mostly used as a test or demonstration mode to visually measure read range.

Host: [**D**]
Where: **D** = command

Reader Response: **<LF>OK<CR>**
Where: **<LF>** = Line Feed
OK = Response
<CR> = Carriage Return

Polling Mode Command - [P]

This command causes the transponder to enter POLLING MODE. In this mode the Reader does not capture Tag IDs automatically; the user must use the 'T' Transfer command to request an ID to be captured.

Host: [**P**]
Where: **P** = command

Reader Response: **<LF>OK<CR>**
Where: **<LF>** = Line Feed
OK = Response
<CR> = Carriage Return

Transponder ID Transfer Command (polling mode only) - [T]

This command can only be used in POLLING MODE, it causes the reader to attempt an ID read.

Host: [**T**]
Where: **T** = command

Reader Response: **<LF>Tag Data<CR>**
Where: **<LF>** = Line Feed

Tag Data = Response
<CR> = Carriage Return

or

Reader Response: **<LF>e<CR>**
Where: **<LF>** = Line Feed
e = Response indicating no Tag is present
<CR> = Carriage Return

Version Request Command - [I]

This command request the Reader's firmware version.

Host: [**I**]
Where: **I** = command

Reader Response: **<LF>Version 1.08<CR> (example)**

Where: **<LF>** = Line Feed
Version 1.13 = firmware version
<CR> = Carriage Return

ISO Protocol Switch Command - [B]

This command will cycle through the different ISO protocols supported by the Reader, each time it's used it responds with the resulting ISO protocol.

Host: [**B**]
Where: **B** = command

Reader Responses: **<LF>15693<CR>**
<LF>14443-A<CR>
<LF>14443-B<CR>
<LF>ICODE1<CR>
Where: **<LF>** = Line Feed
15693 = ISO protocol
<CR> = Carriage Return

ISO15693 Commands

Read Page – [RXX] Where XX = Page number

Enter the R command followed by a two digit page number (example 05).

Host: [**R05**]
Where: **R05** = command

Reader Responses: **<LF>05 00000578<CR>**
<LF>e<CR>

Where: **<LF>** = Line Feed
05 00000578 = page address and data held in that page
<CR> = Carriage Return

A response if "e" signifies the command failed or Tag is not present to Reader

Write Page – [WXXDDDDDDDD] Where XX = Page, DDDD… = Data in Hex

Enter the W command followed by a two digit page number and 8 digits of data to write (data must be hexadecimal values).

Host: [**W0512345678**]
Where: **W** = command
05 = page number
1234567805 = data to be written
Reader Responses: **<LF>12345678<CR>**
<LF>FAILED<CR>
Where: **<LF>** = Line Feed
00000578 = Data held in that page
<CR> = Carriage Return

ISO14443-B Commands

Note: ISO 14443-A Tags are not addressed in this manual as they are encrypted for security applications such as credit cards and passports. An NDA with the chip manufacturer will be necessary for this information to be disclosed. Ask your RFID, Inc. representative with assistance if this option is preferred.

Select Transponder – [0]

To use this command you must first have previously captured the Tag ID, be it by placing the Tag in range while in single mode or by issuing a T command while in polling mode. The Tag must remain in range after the ID capture. The Reader will use that ID to place the tag in selected state, which is the first step to be able to access the memory of the tag

Host: [**0**]
Where: **0** = command

Reader Responses: **<LF>SELECTED<CR>**
<LF>FAILED<CR>

Send Password – [10000000000000000]

To use this command you must first have previously selected the Tag with command 0. This command applies the password needed to access the user memory of the device. The default password for all transponders is 0000000000000000

Host: [**10000000000000000**]
Where: **1** = command

Reader Responses: **<LF>PASSWORD ACCEPTED<CR>**
<LF>INVALID PASSWORD<CR>

Read Page – [RXX] Where XX = Page number

To use this command you must first have previously selected the Tag with command 0 and successfully entered the password with command 1. Enter the R command followed by a two digit page number (example 05).

Host: [**R05**]
Where: **R** = command
05 = page number

Reader Responses: **<LF>05 1234123412341234<CR>**
<LF>e<CR>

Where: **<LF>** = Line Feed
05 1234123412341234 = page address and data held in that page
<CR> = Carriage Return

Write Page – [WXXDDDDDDDDDDDDDDDD] Where XX = Page, DDDD… = Data in Hex

To use this command you must first have previously selected the Tag with command 0 and successfully entered the password with command 1. Enter the W command followed by a two digit page number and 16 digits of data to write, data must be hexadecimal values.

Host: [**W051234567812345678**]
Where: **R** = command
05 = page number
1234567812345678 = data to be written

Reader Responses: **<LF>05 OK<CR>**
<LF>e<CR>

3.5.2 Error Messages

? – Invalid Command

e –no read or Tag present

FAILED – Write fail

These messages follow the same formatting as tag data. The '?' – Invalid command message indicates that the device detected a problem with the last command issued. The invalid command message is issued upon reception of the end of message delimiter when one of the following errors has been detected:

No command between delimiters – the receipt of a start and end delimiters without a command.

Illegal command between delimiters – the receipt of a message not contained within this specification.

Legal but invalid command received – i.e. the receipt of [T] Transfer/read request while not in MODE Polling.

Troubleshooting

My Reader is not responding.

Re-power the unit. Ensure the LED is on indicating power is applied? If not, check the source of your supply (change AC outlets or power supplies).

The LED is on but does not blink when a Tag is presented.

Ensure the Reader is in the correct Tag Mode specific to your specific ISO Tags, for example 15693. Change the Tag Mode using the [B] command.

The LED is on and blinks when a Tag is presented but I see no data on my PC.

Ensure communications are established by re-powering the Reader (RS232 only) and looking for a startup message or enter an invalid command which should bring the response of a question mark (?). If you do not see these occur, there is an issue with communications not be properly established. Ensure your COM port is addressed correctly if using HyperTerminal.

The Reader returns a question mark (?)

The command you are attempting is not being entered correctly. Ensure you use open square bracket, capital letters, and close square bracket.

FCC Statement

WARNING

FCC Info for FCC Part 15 Devices

Changes or modifications not expressly approved by the manufacturer could void the user's authority to operate this equipment.

This product meets the applicable FCC Part 15 rules. Operation is subject to the following two conditions: (1) this device may not cause interference, and (2) this device must accept any interference, including interference that may cause undesired operation of the device.

To limit RF exposure, please ensure 8 inches (20 cm) of separation from the device at all times.

WARRANTY

RFID, Inc. products are warranted against defects in materials and workmanship for one (1) year from date of shipment. RFID, Inc. shall, at its option, either repair or replace products that prove to be defective and are returned with freight prepaid to RFID, Inc.'s plant within the warranty period. The foregoing warranty shall not apply to defects resulting from abuse, misuse, accident, alteration, neglect or unauthorized repair or installation. RFID, Inc. shall have the right of final determination as to the existence and cause of the defect.

THE WARRANTY SET FORTH ABOVE IS EXCLUSIVE AND NO OTHER WARRANTY, WHETHER WRITTEN OR ORAL, IS EXPRESSED OR IMPLIED. RFID, Inc. SPECIFICALLY DISCLAIMS THE IMPLIED WARRANTIES OR MERCHANTABILITY AND FITNESS FOR A PARTICULAR PURPOSE.

The remedies provided herein are Buyer's sole and exclusive remedies. In no event shall RFID, Inc. be liable for direct, indirect, special, incidental or consequential damages, (including loss of profits) whether based on contract, tort, or any other legal theory.

ISED Info

FCC Info for FCC Part 15 Devices

This device contains licence-exempt transmitter(s)/receiver(s) that comply with Innovation, Science and Economic Development Canada's licence-exempt RSS(s). Operation is subject to the following two conditions:

1. **This device may not cause interference.**
2. **This device must accept any interference, including interference that may cause undesired operation of the device.**

To limit RF exposure, please ensure 8 inches (20 cm) of separation from the device at all

Cet instrument contient des émetteurs/récepteurs exemptés de licence qui sont conformes aux RSS exemptés de licence d'Innovation, Sciences et Développement économique Canada. Le fonctionnement est soumis aux deux conditions suivantes :

1. **Cet appareil ne peut pas causer d'interférences.**
2. **Cet appareil doit accepter toute interférence, y compris les interférences pouvant entraîner un fonctionnement indésirable de l'appareil.**

Pour limiter l'exposition aux RF, veuillez vous assurer d'une séparation de 8 pouces (20 cm) de l'appareil.