AI1401 Reader User Guide

DRAFT

TransCore, Inc.
19111 Dallas Parkway, Suite 300
Dallas, Texas 75287-3106

October 2004

P/N 411064-002

For further information, contact:

TransCore
19111 Dallas Parkway, Suite 300
Dallas, Texas 75287-3106 USA

Phone: (972) 733-6600
Fax: (972) 733-6699

TransCore Action Center (TrAC)
19111 Dallas Parkway, Suite 300
Dallas, Texas 75287-3106 USA

Phone: (800) 755-0378
Fax: (972) 733-6695

For comments or questions about this document, e-mail tech.pubs@transcore.com.

WARNING TO USERS IN THE UNITED STATES

FEDERAL COMMUNICATIONS COMMISSION (FCC) RADIO FREQUENCY INTERFERENCE STATEMENT
47 CFR §15.105(a)

NOTE: This equipment has been tested and found to comply with the limits for a Class A digital device pursuant to Part 15 of the Federal Communications Commission (FCC) rules. These limits are designed to provide reasonable protection against harmful interference when the equipment is operated in a commercial environment. This equipment generates, uses, and can radiate radio frequency (RF) energy and may cause harmful interference to radio communications if not installed and used in accordance with the instruction manual. Operating this equipment in a residential area is likely to cause harmful interference, in which case, depending on the laws in effect, the users may be required to correct the interference at their own expense.

NO UNAUTHORIZED MODIFICATIONS
47 CFR §15.21

CAUTION: This equipment may not be modified, altered, or changed in any way without permission from TransCore, Inc. Unauthorized modification may void the equipment authorization from the FCC and will void the TransCore warranty.

USE OF SHIELDED CABLES IS REQUIRED
47 CFR §15.27(a)

Shielded cables must be used with this equipment to comply with FCC regulations.

A license issued by the FCC is required to operate this RF identification device in the United States. Contact TransCore, Inc. for additional information concerning licensing requirements for specific devices.

TransCore, Inc.
USA

Contents

Contents

1 Before You Begin

2 Overview

3 AI1401 Reader Interface Capabilities

4 Firmware Command Groups and Parameters

A AI1401 Character Conversion

List of Figures

List of Tables

1

Before You Begin

Chapter 1

Before You Begin

The AI1401 Reader User Guide provides information necessary for interfacing the AI1401 Reader with a portable reader system.

Purpose

This guide provides the information necessary for TransCore-certified personnel to connect and operate the AI1401 Reader.

Intended Audience

This document is for those individuals interested in the AI1401 Reader, particularly technical personnel of TransCore and its distributors, and for trained, authorized customer and third-party systems integration personnel.

Guide Topics

Table 1-1 lists the information found in this user guide.

Table 1-1 AI1401 Reader User Guide Information

Chapter 1 – Before You Begin	Describes the purpose, intended audience, guide topics, related documentation, and document conventions.
Chapter 2 – AI1401 Reader Overview	Provides an overview of the AI1401 Reader's features, options, and accessories.
Chapter 3 – Interface Capabilities	Outlines the AI1401 Reader connectors and identifies their primary functions.
Appendix A – Firmware Command Codes and Parameters	Discusses the firmware command codes and parameters that are used to configure the AI1401 Reader for communication with a personal computer or other host computer.
Appendix B – Character Conversions	Provides TransCore six bits per character conversions from the standard ASCII character set.

Typographical Conventions

Table 1-2 lists the conventions used in this manual:

Table 1-2 Typographical Conventions

Convention	Indication
	This procedure might cause harm to the equipment and/or the user.
	Concerns about a procedure.
`Code`	Code, including keywords and variables within text and as separate paragraphs, and user-defined program elements within text appear in courier typeface.
Dialog Box Title	Title of a dialog box as it appears on screen.
Function	Start with the characters, G4, and are in mixed case with no underscores, and include parentheses after the name, as in G4FunctionName().
Menu Item	Appears on a menu. Capitalization follows the interface.
Note	Auxiliary information that further clarifies the current discussion. These important points require the user's attention. The paragraph is in italics and the word Note is bold.
NUL	Zero-value ASCII character or a zero-value byte.
NULL	Zero-value pointers. Null-terminated string refers to strings of printable ASCII characters with a zero-value byte placed in memory directly after the last printable character of the string.

2

Overview

Chapter 2

Overview

This chapter provides an overview of the AI1401 Reader and the system and technology it supports.

Introduction

The microprocessor-controlled, single output channel AI1401 Reader is an independent unit that combines a reader and a radio frequency (RF) source. The reader provides RF identification (RFID) and data storage within a single, compact unit (Figure 2-1). Due to its size and battery-powered operation, the AI1401 Reader is an invaluable component of any portable reader system.

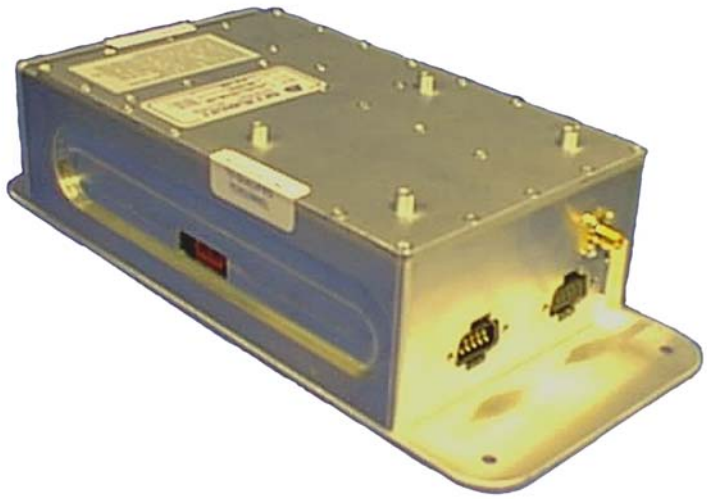


Figure 2-1 AI1401 Reader

When interfaced with the antenna and power source, the AI1401 Reader uses RF energy to read data from an electronic tag (a field disturbance device). Tags can contain a unique ID code and can be attached to a vehicle, mobile equipment, or shipping and storage containers. The AI1401 Reader decodes tag ID information and validates the ID code. Depending on whether you program the reader for buffering or real-time data transfer, the reader either stores tag data for later processing by a host computer or transmits the tag data directly to a host computer for real-time data processing and storage.

System Configuration

The AI1401 Reader is designed to interface with a range of user-supplied handheld antennas and other equipment for portable applications. A typical portable reader system consists of a tag that operates within the 915 MHz frequency band, an antenna/actuator, a direct current (DC) power source, the AI1401 Reader, a host computer, and communications hardware, for example, RF modems (Figure 2-2).

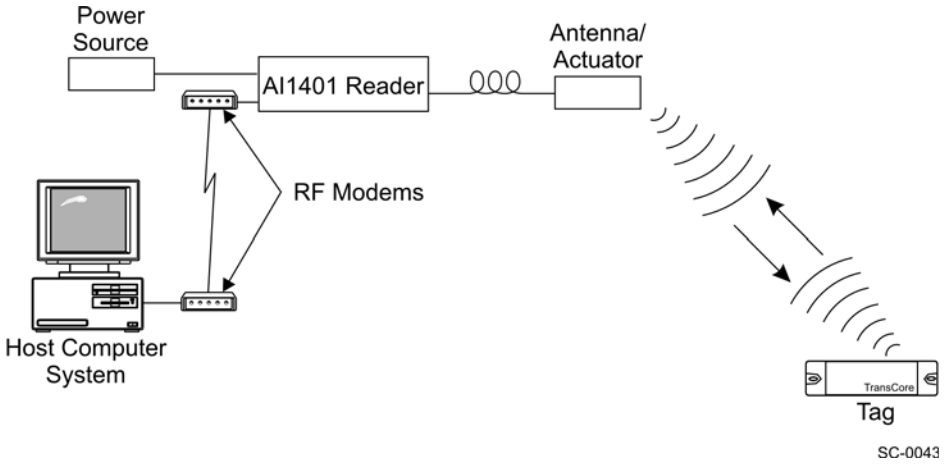


Figure 2-2 Example of AI1401 Reader System Configuration

The AI1401 Reader is designed to operate using a 13.2V rechargeable NiCad battery or equivalent DC power source. The reader can store approximately 1,000 tag reads of 128 bits within its 32K buffer. This information may then be transferred to a host computer. The system also supports real-time reader-to-host communication by connecting an RF modem to the AI1401 Reader's ASCII RS–232C port (Figure 2-3) or by connecting a PC, handheld, or other computer directly to the reader.

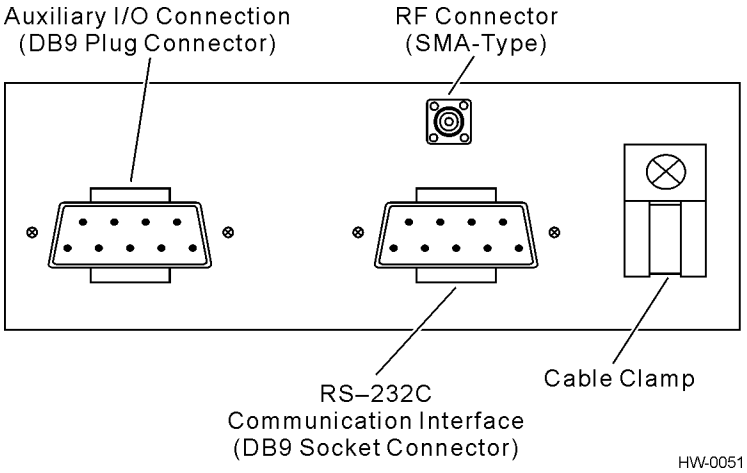


Figure 2-3 ASCII RS–232C Port

Note: *The host computer requires software to interpret tag data and to process the data for storage, retrieval, database manipulation, and records maintenance.Communications (terminal) programs usually do not provide the adequate data processing capability. Software written specifically for the host computer can be customized to provide the required capabilities.*

System Components and Functions

Components of the AI1401 Reader include:

- Real-time clock
- RS–232C communications port
- Standard DB9 connector for auxiliary input/output (I/O)
- RF channel (915 MHz with SMA-type RF connector for handheld antenna)
- PC board power connector
- Power-saving standby mode
- Auxiliary I/O functions (trigger, battery light, lock, etc.)
- Maximum 40-millisecond startup option

When interfaced with the user's antenna and power source and depending upon how the reader is programmed, the AI1401 Reader provides the following functions:

- Transmits carrier frequency to and receives modulated reflections from tags within the RF field of the antenna unit.
- Decodes and validates the tag ID information.
- Stores the tag ID code and any appended information for later transmission to the host computer system.
- Implements real-time reader-to-host communications. You must connect user-supplied RF modems to the AI1401 Reader and remote host computer or connect a handheld computer terminal to the AI1401 Reader.

Features

This section describes the features of the AI1401 Reader.

Robust Design

The AI1401 Reader is rugged. Surface-mount solid-state circuitry and strain-relief supports on connectors allow the reader to resist damage from jarring and vibration, typical conditions in portable applications.

Memory

The reader's standard 32-Kbyte static random access memory (SRAM) memory holds approximately 1,000 ID codes. Note that transmitting data to a host computer does not erase it from the data buffer. A separate command is used to erase all contents of the buffer, which then turns off the buffer signal.

Tag Compatibility

The AI1401 Reader reads all standard full-frame TransCore 915 MHz band tags, including read-write tags that have an ATA frame, such as the IT2101 Tag.

Appended Information

Date and time information can be appended to tag ID data for transmission to the host computer.

Power Supply

The AI1401 Reader uses a 13.2V rechargeable nickel-cadmium (NiCad) battery (not included) or equivalent DC power source.

Power-Saving Standby Mode

When not in active use, the AI1401 Reader turns off power to all circuitry except the SRAM and real-time clock. Use of this standby mode extends battery life.

Specifications

Table 2-1 lists the specifications for the AI1401 Reader.

Table 2-1 AI1401 Reader System Specifications

Parameter	Specification
Size	9.0 x 7.5 x 4.5 in (22.9 x 19.1 x 11.4 cm)
Weight	6.0 lb (2.7 kg)
Operating temperature	+32°F to +158°F (0°C to +70°C)
Power requirements	+13.5V DC ±1.0V DC at 1.3 amps
Power source	13.2V, 1.8A NiCad rechargeable battery (optional) or equivalent DC power source
Available frequency range	902–928 MHz
Approved frequency range by Federal Communications Commission (FCC) and Industry Canada	902.25–903.75 MHz and 910.00–921.50 MHz

Table 2-1 AI1401 Reader System Specifications (continued)

RF power	1.6W ±0.2W at ambient temperature
Typical working range[a]	Battery tag: 80 ft (24.4 m) Beam tag: 25 ft (7.6 m)
Buffer size	32 Kbytes (battery backed)
Data buffer capacity	1,000 tag reads of 128 bits (with appended data)
Communications port	RS–232C 110 to 19,200 Baud
Other features	Real-time calendar clock Power-saving algorithm 40-ms startup option

a. Depends upon tag type and RF power permitted by FCC licensing requirements.

3

AI1401 Reader Interface Capabilities

Chapter 3

AI1401 Reader Interface Capabilities

The AI1401 Reader is designed to interface with a variety of user antennas and other equipment. This chapter outlines the AI1401 Reader connectors and identifies their primary functions.

AI1401 Connectors

Because the AI1401 Reader combines the system reader and radio frequency (RF) module into a single unit, the only connections that must be made to the system are the antenna, actuator, and host computer connectors. These connectors are located at the end of the AI1401 Reader. (See Figure 2-1 for the location of the connectors.) Figure 3-1 identifies the connectors and their purposes.

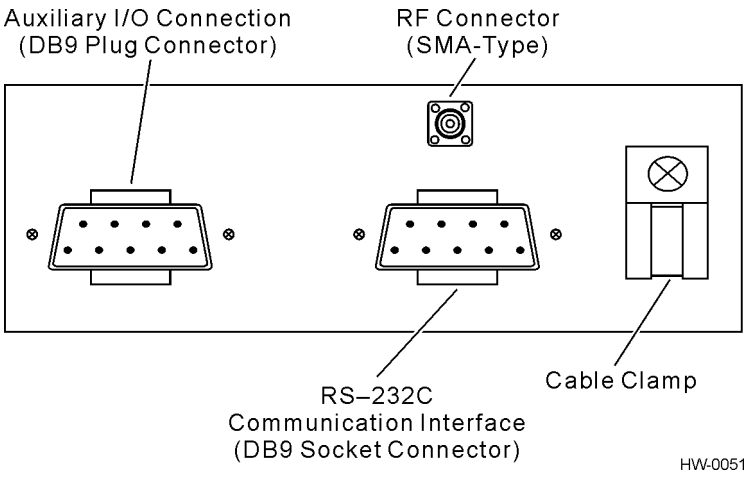


Figure 3-1 AI1401 Reader Connector Panel

RS–232C Interface

The RS–232C interface connector is a standard DB9 socket connector used for host computer communications.

Typically, during operation, a portable reader system using the AI1401 Reader functions in the real-time disabled operating mode. In the real-time disabled mode, tag identifications (ID) are read and stored in the buffer of the AI1401 Reader. After reading and storing all tag data, you can connect the AI1401 Reader to a host computer via the reader's standard RS–232C connector. Using customized host communications software, the contents of the buffer can then be transmitted to the host computer.

The RS–232C connector can also be used during system operation, if real-time communications are required. Using the RS–232C connector, the AI1401 Reader supports the following real-time methods of operation:

- AI1401 Reader to host using direct RS–232C cable connection
- AI1401 Reader to host using RF modems from the remote location to the base location
- AI1401 Reader to on-site handheld computer via an RS–232C cable connection

Figure 3-2 defines the pin positions of the RS–232C connector.

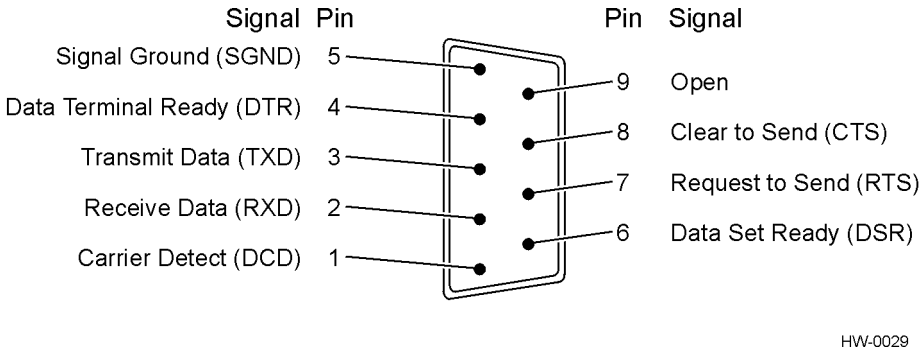


Figure 3-2 RS–232C DB9 Connector Pin-out

Auxiliary Input/Output Connector

The user's input/output (I/O) interface must provide a DB9 plug connector to terminate on the AI1401 Reader. The user must provide an actuator signal (trigger) that turns on RF power for reading tags. After tag data is acquired, RF power should be shut off to conserve power.

Note: *When connecting the 10-1401-01 Reader or the 10-1401-04 Reader to a terminal emulator, you may need to isolate Pin 9 of the I/O interface cable.*

Figure 3-3 illustrates the pin-outs for the I/O interface DB9 connector.

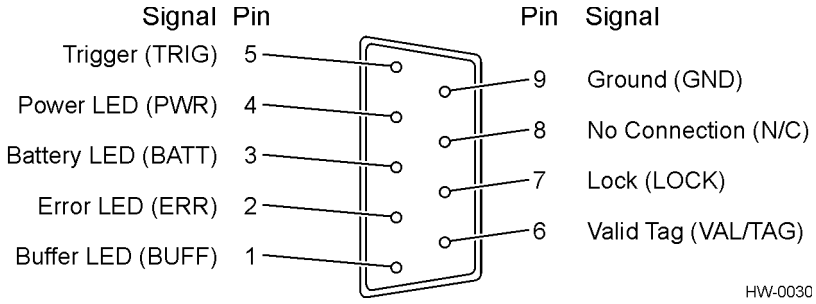


Figure 3-3 I/O Interface DB9 Connector Pin-out

The output signals on the I/O interface DB9 connector indicate operation status of the AI1401 Reader. These signals can be used to operate LED devices. The AI1401 Reader supports the following signals.

Power (PWR)

The power signal lights when power is applied to the reader unit via the user's RF actuator switch (trigger). To begin communicating with the reader, you must send a command within 10 seconds of triggering the device. Commands are discussed in Chapter 4 of this guide.

After initial power-up, the AI1401 Reader remains on if there is any RS–232C port activity. Reader power turns off after 10 seconds of inactivity from either the actuator switch or the RS–232C port. The 10-second power off time-out is a factory default value. The user can change the time-out to one minute using the !751 command.

Battery (BATT)

The battery signal is active when the main battery voltage drops below the preset level (usually about 12.5 volts).

If the battery voltage drops below a second preset level (usually about 11.5 volts), the microcontroller halts reader functions to prevent improper operation.

Buffer (BUFF)

The buffer signal is active whenever valid data is stored in the data buffer.

Transmitting data to a host computer will not erase it from the data buffer. Command !73 clears the buffer contents and turns off the buffer LED.

Error (ERR)

The error signal is active when the tag just read contains a parity error.

Lock (LOCK)

The lock signal is active briefly when a valid tag has been decoded.

After the successful acquisition of a tag that meets uniqueness criteria, the RF source turns off.

Valid Tag (VAL/TAG)

After successful acquisition of a tag ID, the valid tag signal is active continuously while the antenna signal is active.

When the antenna signal is deactivated and after a power-on time out, all signals are off. The power-on time out factory setting is 10 seconds.

Ground (GND)

Ground pin for the DB9 connector

Trigger (TRIG)

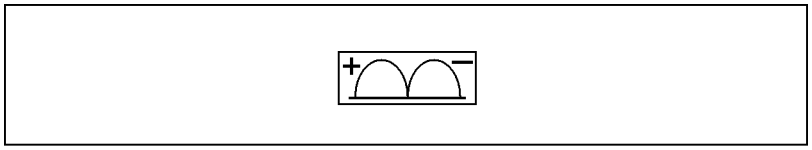
Actuator signal that turns on RF power

RF Connector

The user's I/O interface/actuator contains an antenna that broadcasts the RF signal generated by the RF module and retrieves the amplitude-modulated return signal from the tag. In addition to the DB9 connector described earlier, the I/O interface must also provide a SMA-type connector to terminate the RF connection to the AI1401 Reader.

Power

The power connector should be designed to connect to an AMP P/N 643226-1 connector. Power connections should be made as shown in Figure 3-4.



HW-0050

Figure 3-4 Portable Reader Power Connection

A

Firmware Command Groups and Parameters

Appendix A

Firmware Command Groups and Parameters

This chapter discusses the firmware command codes, which allow the user to configure the reader for communications with a personal computer (PC) or other host computer.

Command Syntax

Command codes enable you to use the features of the AI1401 Reader and to develop host computer programs for controlling the functions of the AI1401 Reader.

The general syntax of all commands begins with an exclamation character (`!`) followed by the command code and a list of parameters. No spaces exist between characters, and the command is terminated with **Enter** or a carriage return **<CR>**.

As characters are sent to the AI1401 Reader they are automatically echoed back to the host. As soon as the command is terminated with **Enter** or **<CR>**, the AI1401 Reader responds to the command with one of the following responses:

`!Done` — if the command is recognized and accepted

`!Error` — if it is not recognized

The most typical response is `!Done`. Other responses are indicated as part of the command descriptions.

Factory default value commands are shown in **bold** followed by *(factory setting)*.

Command Groups

Reader commands are divided by primary function into eight groups. Following is a list of the eight command groups:

- Group 1 — Communication Port Control
- Group 2 — Real-Time Clock
- Group 3 — ID Data Format
- Group 4 — This command group not used by AI1401 Reader
- Group 5 — This command group not used by AI1401 Reader
- Group 6 — Interrogator Control

- Group 7 — Buffer Control
- Group 8 — This command group not used by AI1401 Reader

Command Group 1 — Communication Port Control

Group 1 commands configure the communications parameters used by the serial communication port.

The user can set baud rate, stop bits, parity, and end-of-line delay using Command Group 1 commands.

Baud Rate Select

`!100x`

where x = 0 to 6

0 = 110 baud

1 = 300 baud

2 = 1200 baud

3 = 2400 baud

4 = 4800 baud

5 = 9600 baud *(factory setting)*

6 = 19.2 K baud

Response

!Done

or

!Error

Note: *The new baud rate setting takes effect after the host computer receives the !Done response from the reader. All subsequent communications will be at the new baud rate.*

Stop Bits

`!101x`

where x = 0 or 1

0 = 1 stop bit *(factory setting)*

1 = 2 stop bits

Response

```
!Done
```

or

```
!Error
```

Note: *The new stop bits setting takes effect after the host computer receives the !Done response from the reader. All subsequent communications will be at the new stop bits setting.*

Parity Select

```
!102x
```

where x = 0 to 2

0 = disable parity *(factory setting)*

1 = enable even parity

2 = enable odd parity

Response

```
!Done
```

```
or
```

```
!Error
```

Note: *The new parity select setting takes effect after the host computer receives the !Done response from the reader. All subsequent communications will be at the new parity setting.*

Command Group 2 — Real-Time Clock Control

Group 2 commands control the real-time clock, which maintains the time and date. The user can set or display the time and date using Group 2 commands.

The real-time clock is supported by an internal lithium battery so that time and date are preserved in case of power outage. The minimum life expectancy of the battery is five years, and the battery has a typical life expectancy of 19 years.

Set the Time in the Real-time Clock

```
!20hh:mm:ss
```

where

hh = hours (00-23)

mm = minutes (00-59)

ss = seconds (00-59)

Note: *Enter the time exactly as shown with no spaces between characters. All entries use decimal characters 0 through 9.*

Response

```
!Done
```

or

```
!Error
```

Set the Date in the Real-time Clock

```
!21MM/DD/YY
```

where

MM = months (01-12)

DD = days (01-31)

YY = years (00-99)

Note: *Enter the date exactly as shown with no spaces between characters. Use forward slashes (/) as delimiters. All entries use decimal characters 0 through 9.*

Response

```
!Done
```

or

```
!Error
```

Display Time and Date

!22

Response

```
!hh:mm:ss.dd  MM/DD/YY
```

where

hh = hours

mm = minutes

ss = seconds

dd = hundredths of seconds

MM = months

DD = days

YY = years

Note: *There are two spaces between time and date. Use forward slashes (/) as delimiters.*

or

```
!Error
```

Command Group 3 — ID Data Format

Group 3 commands append useful information to reader transmissions such as IDs and times and dates. Group 3 commands also switch on and off host computer transmissions. The reader is set at the factory not to append time and date to data.

Do Not Append Time and Date to Data

`!300` *(factory setting)*

The format of the displayed data is

<som><20 chrs><eom>

where

som = start of message character, (!)

20 chrs = 20 data characters

eom = end of message character

Response

```
!Done
```

or

```
!Error
```

Appends Time and Date to Data

```
!302
```

The format of the displayed data is

```
<som><20 chrs><%hh.mm.ss.dd%MM/DD/YY><eom>
```

where

som	=	start of message character, (!)
20 chrs	=	20 data characters
eom	=	end of message character
%	=	time and date string delimiter
hh.mm.ss.dd	=	see time command !20
MM/DD/YY	=	see date command !21

Disables Real-Time Transmission to Host

```
!304
```

Any acquired tag ID via the RF source is stored in the data buffer and is not sent out the RS–232C port.

Response

```
!Done
or
!Error
```

Enables Real-Time Transmission to Host

`!305` *(factory setting)*

When a tag is acquired via the RF source, its ID is immediately sent out on the RS–232C port. The tag ID is not stored in the data buffer. Previously stored data, while in the non-transmission mode (command !304), is retained and not cleared from the data buffer.

Response

```
!Done
or
!Error
```

Disables Uniqueness Mode

```
!306
```

The reader acquires and stores (or sends to the RS–232C port) the same tag ID when the user-provided RF actuator on the reader is pressed. Uniqueness of tag IDs is not maintained while in this mode.

Response

```
!Done
or
!Error
```

Enables Uniqueness Mode

`!307` *(factory setting)*

Tag ID uniqueness is maintained while in this mode. At least one unique tag ID must be read before the previously acquired tag ID reads and is stored again.

Response

```
!Done
or
!Error
```

Command Group 6 — Interrogator Control

Group 6 commands enable basic protocol or enable transmitter or hardware flow control.

Basic Protocol Enabled (disable all flow control)

`!610` *(factory setting)*

Response

```
!Done
```

or

```
!Error
```

XON/XOFF Flow Control Enabled

```
!6140
```

Response

!Done

or

!Error

Hardware Flow Control Enabled

```
!6141
```

The reader controls the data terminal ready line and monitors the readiness of the modem (or similar external RS–232C device) via the clear to send (CTS) line. When the CTS line goes false, the reader halts transmission within one character of the time that the command is received.

Response

```
!Done
```

or

```
!Error
```

Command Group 7 — Buffer Control

Group 7 commands control the reader's search control functions when performed through the MAIN port.

Display One Line of Data from the Reader Data Buffer

```
!70
```

The reader displays the next line of data from its data buffer. The data pointer then advances to the next location of data. The data is not erased and continues to be available for display.

Response

<next line of data>

or

!Error — if there is no more valid data to be displayed

Display the Remaining Contents of the Data Buffer

!71

The reader starts with the current location of the data pointer and displays all data until the last valid data entry. The data is not erased and continues to be available for display.

Response

Up to 1,000 lines of data, depending on the present position of the data pointer and the total number of data entries

or

!Error — if there is no more valid data to display

Reset Data Buffer Pointer to the Beginning

!72

Resets the data pointer to the beginning of the buffer. Resetting allows the displaying of the data buffer contents as often as needed.

Response

!Done

or

!Error

Clear the Contents of the Data Buffer

!73

Clears all valid data entries from the data buffer and resets the data pointer.

Request the Number of Entries in the Data Buffer

!74

The number returned is the number of valid data buffer entries in the range of 0 to 1000.

Response

`!xxxx`

where

`xxxx` = four-digit decimal number, in the range of 0000 to 1000

Note: *This number does not give an indication of the position of the display data pointer.*

or

`!Error`

Set Reader Power-off Time-out to 10 Seconds

`!750` *(factory setting)*

This time-out is the amount of idle time that elapses before the reader discontinues operation. Activity on the RS–232C port or activating the trigger signal restarts the timer.

Response

`!Done`

or

`!Error`

Set Reader Power-off Time-out to One Minute

`!751`

This time-out is the amount of idle time that elapses before the reader discontinues operation. Activity on the RS–232C port or activating the trigger signal restarts the timer.

Response

`!Done`

or

`!Error`

Set RF Power-off Time-out

`!76x`

Sets the amount of time the RF source stays on. The RF source is turned off after the time-out expires or when the successful acquisition of a tag ID occurs.

where x is

0 = feature disabled (operates continuous RF mode)

1 = 50 ms

2 = 100 ms

3 = 200 ms

4 = 300 ms

5 = 400 ms

6 = 500 ms

7 = 600 ms

8 = 700 ms

9 = 800 ms

A = 900 ms

B = 1 s *(factory setting)*

C = 2 s

D = 3 s

E = 4 s

F = 5 s

Response

```
!Done
or
!Error
```

B

AI1401 Character Conversion

Appendix B

AI1401 Character Conversion

TransCore Character Conversion Table

Table B-1 lists the TransCore 6-bits per character conversion from the standard ASCII character set.

Table B-1 ASCII to 6 Bits/Character Conversion Table

ASCII to 6 Bits Per Character Conversions					
spc	000000	6	010110	L	101100
!	000001	7	010111	M	101101
"	000010	8	011000	N	101110
#	000011	9	011001	O	101111
$	000100	:	011010	P	110000
%	000101	;	011011	Q	110001
&	000110	<	011100	R	110010
’	000111	=	011101	S	110011
(	001000	>	011110	T	110100
)	001001	?	011111	U	110101
*	001010	@	100000	V	110110
+	001011	A	100001	W	110111
,	001100	B	100010	X	111000
-	001101	C	100011	Y	111001
.	001110	D	100100	Z	111010
/	001111	E	100101	[	111011
0	010000	F	100110	\	111100
1	010001	G	100111	]	111101
2	010010	H	101000	^	111110
3	010011	I	101001	_	111111
4	010100	J			
5	010101	K			