

AI1422 Half-Frame Reader User Guide

DRAFT

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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**

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1

Before You Begin

Before You Begin

The AI1422 Half-Frame Reader User Guide provides information necessary for interfacing the AI1422 Half-Frame Reader System to a host computer system.

Purpose of This Guide

This user guide provides information for interfacing the AI1422 Half-Frame Reader System with a host processor system, also called a host computer system. This guide also provides on-site test procedures useful in troubleshooting any problems encountered after installation. Command codes, which allow the user to configure the reader system for communicating with the host computer, are discussed in Chapter 4. The ASCII character conversion to TransCore 6-bit character codes is provided in Appendix A.

Intended Audience

The intended audience for the *AI1422 Half-Frame Reader User Guide* is engineers and technicians. These people are involved in the design, specification, and installation of AI1422 Half-Frame Reader Systems.

Related Documents

AP4110 Programmer's Guide

Guide Topics

This document presents the following information:

Chapter 1 – Before You Begin	Describes the purpose, intended audience, guide topics, related documentation, and document conventions.
Chapter 2 – AI1422 Half-Frame Reader System Overview	Provides an overview of the AI1422 Half-Frame Reader System's features, options, and accessories.
Chapter 3 – Interface Connections	Describes the AI1422 Half-Frame Reader System interface connectors and identifies their primary functions.
Chapter 4 – System Test Procedures	Provides testing procedures that the user can use to fine-tune the AI1422 Half-Frame Reader System.

Chapter 5 – Firmware Command Codes Discusses the firmware command code that are used to configure the AI1422 Reader for communication with a personal computer or other host computer.



Chapter 6 – Maintenance and Troubleshooting Provides maintenance procedures and troubleshooting indications that are used to keep the AI1422 Half-Frame Reader System operating.

Appendix A – Character Conversions Provides TransCore 6-bit-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.
<i>Note</i>	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 boldface.
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.

System Overview

The AI1422 Half-Frame Reader System is a microprocessor-controlled, single-antenna unit that uses a unique communications protocol to interface with vehicle identification (ID) equipment.

System Overview

This reader system uses radio frequency (RF) energy to read data from tags. The AI1422 Half-Frame Reader System then decodes the tag ID information, validates the ID code, and transmits tag data directly to a host processor for real-time data processing and use.

Communications (terminal) programs usually do not provide adequate data processing capability. Your host computer software can be customized to provide the required capabilities.

The AI1422 Half-Frame Reader System consists of the AI1422 Transponder Interrogator, which consists of a reader and RF module, combined with a TransCore antenna, a TransCore tag, a host processor system, and a power source. Figure 2-1 illustrates a typical reader system configuration.

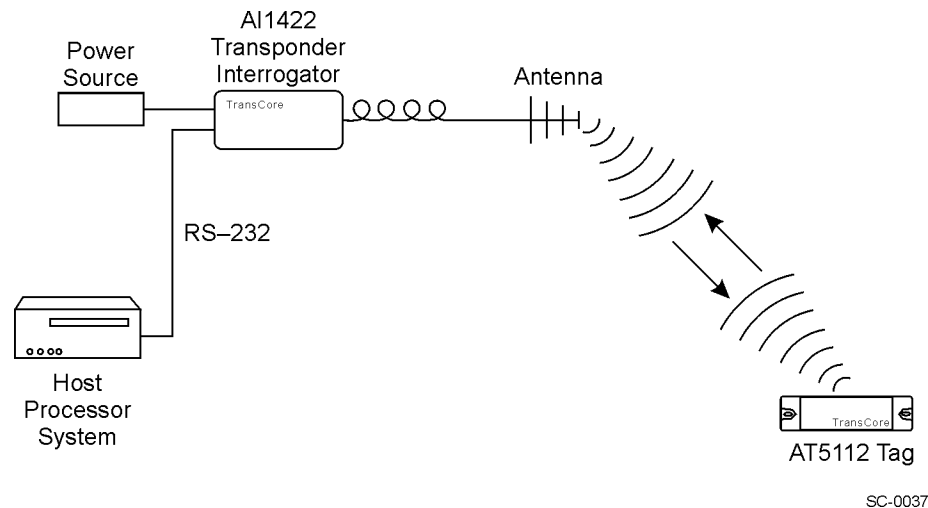


Figure 2-1 Typical Reader System Configuration

Transponder Interrogator

The transponder interrogator reads 60 bits of user-programmable data in the transponder.

The transponder interrogator is operated in a continuous read mode, and any tag entering its read field has its data automatically read and relayed to the host computer. In many applications this function is implemented by installing the reader on a vehicle with restricted movement, such as a railcar or monorail bus. The tags are imbedded in the roadway at various locations in the vehicle's path. The data read from the tag allows the host computer to assess the vehicle's location and make any appropriate response to that information.

The transponder interrogator is an independent tag decoder that combines a reader and RF source to provide automatic identification and data storage within a single, compact unit. The transponder interrogator includes the following components:

- 19-inch rack-mount design
- Serial input/output (I/O) link
- Real-time clock
- 32K buffer storage in static random access memory (SRAM) with battery backup
- Reader and RF module, combined in one unit

Reader Power Regulation and Filtering

The reader system uses an input voltage ranging from 8V DC to 140V DC. The AI1422 Reader System incorporates a high-performance, DC-to-DC power supply that converts voltage in this range to 13.5V DC. TransCore offers three input voltage options, 8V DC to 32V DC, 28V DC to 140V DC, and 14V DC to 70V DC.

Antenna

TransCore has two antennas that can operate with the AI1422 Half-Frame Reader System, the AA3233 Rail Antenna and the AA3234 Light Rail Antenna. The AA3233 Rail Antenna can be used where high shock and vibration conditions exist. The AA3234 Light Rail Antenna can be used for light rail applications that require a low profile for mounting on the carriage of commuter trains and people-mover systems.

Transponders (Tags)

The AI1422 Half-Frame Reader System can use TransCore's half-frame read-only tags.

Interface Connections

Interface Connections

This chapter describes the interface connections and their primary functions.

Description of AI1422 Reader System

Because the AI1422 Half-Frame Reader System combines a reader and radio frequency (RF) module into a single unit, you must connect the following items to the system: the external DC power, the customer input/output (I/O), the main and auxiliary RS-232 interfaces, and the antenna. These interface connectors are located on the AI1422 Half-Frame Reader System front panel as shown in Figure 3-1.

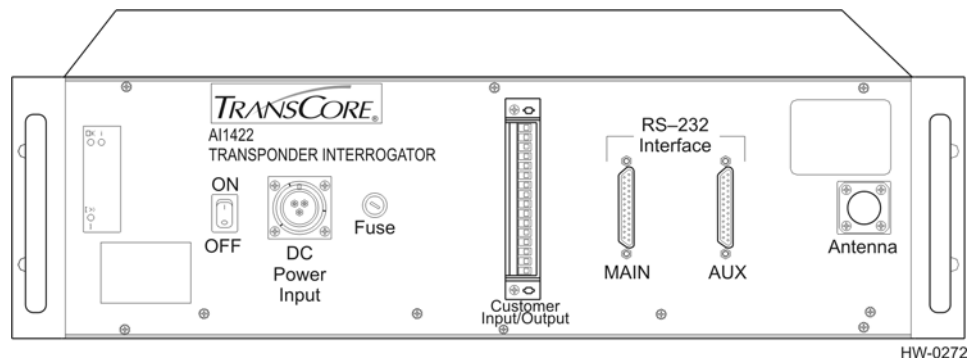


Figure 3-1 Front Panel of AI1422 Transponder Interrogator

Antenna Interface

Attach the antenna cable directly to the antenna interface on the front panel of the AI1422 Half-Frame Reader System. The antenna cable length depends on the installation.

Main RS-232 Interface

The main RS-232 interface is a standard DB25 plug connector used with a host processor. During operation, a host processor system uses the reader system functions in real-time operating mode. In real-time mode, tag IDs are read and passed on to the host processor. Figure 3-2 illustrates the RS-232, DB25 plug connector pin-outs.

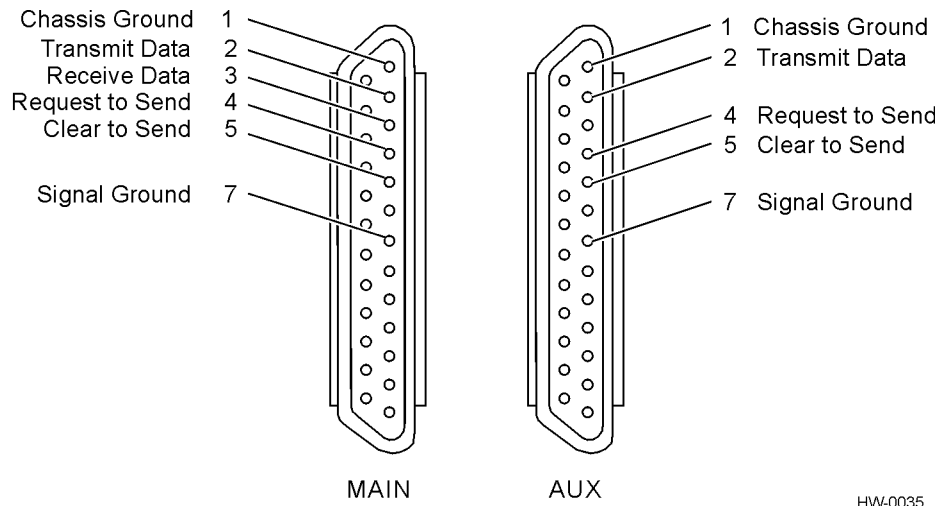


Figure 3-2 RS-232, DB25 Interface Connector Pin-outs

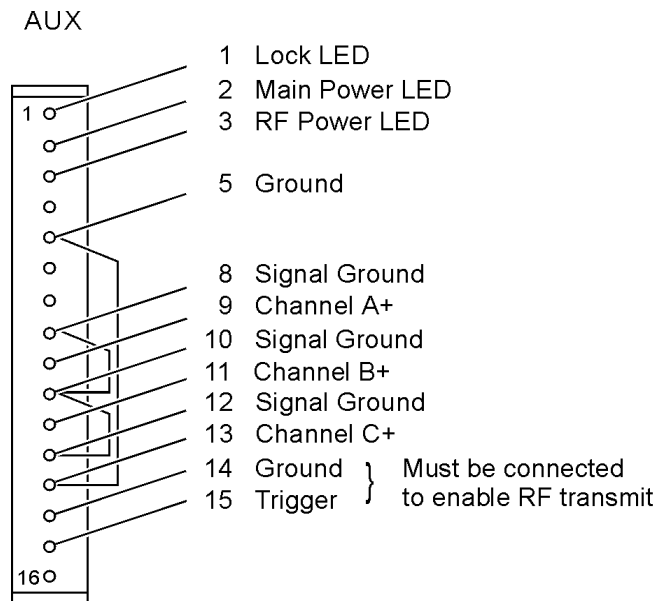
HW-0035

Aux RS-232 Interface

The auxiliary RS-232 interface is used as a backup monitoring system to the main RS-232 interface. The auxiliary interface monitors data from the transponder interrogator. The auxiliary RS-232 interface is a standard DB25 plug connector. This port is not wired to receive data and cannot accept commands.

Customer I/O Interface

A mating connector for the customer I/O interface is supplied with each unit. This connector allows a screw terminal, point-to-point wiring interface. Figure 3-3 shows the pin-outs on the customer I/O interface connector.



HW-0039

Figure 3-3 Customer I/O Interface Pin-outs

The customer I/O interface connector contains the lock light-emitting diode (LED), main power LED, RF power LED, the trigger signals, and channels A, B, and C.

Lock LED

The transistor-transistor-logic (TTL) lock signal shows the presence of a tag. The lock signal goes active high when a valid tag is in the RF field of the antenna and may be connected to an LED for monitoring purposes.

Main Power LED

The TTL main power signal goes active high when the ON/OFF switch on the front panel is switched to on. The switch is connected to +5V through a 300 ohm resistor and is connected to an LED on the front panel, which may be used for power monitoring purposes.

RF Power LED

The TTL RF power LED goes active high when the reader system is configured for the RF power to be on and the ON/OFF switch is set to on. It is connected to +12V through a resistor and may be connected to a LED for RF power monitoring purposes.

Trigger Signals

The trigger connection turns on the RF power when a ground is applied and the AI1422 Reader System has been programmed with the *RF Follows Trigger* command (!642).

Channels A, B, and C

The analog intermediate frequency channel A, B, and C signals represent the three channels generated by the AI1422 Reader System. These channels can be used to measure tag signal quality.

Power Connection

The power connector on the front panel of the AI1422 Half-Frame Reader System is a panel mount circular connector of type Cannon CA 3100 E16-10P-F80-T12.

System Test Procedures

System Test Procedures

This chapter provides testing procedures that will help you fine-tune your reader system and test basic operation, measure radio frequency (RF) power, measure system noise, read tags, and monitor the system.

Required Tools and Equipment

The following tools and equipment are required:

- 50-ohm, 5-watt (W) load (N-type connector)
- Personal computer (PC) with terminal emulator software
- Appropriate power source for your reader
- Digital multimeter
- RF power meter
- 100 MHz oscilloscope
- Antenna, cable, and connectors

Testing Basic Operation

To test the system operation, configure the reader system as outlined in the following steps.

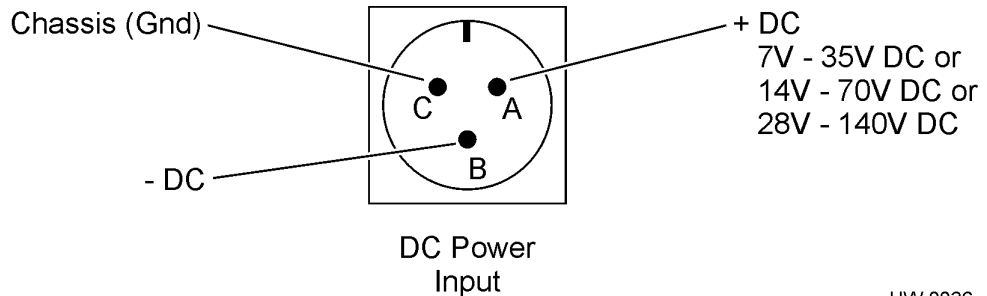


CAUTION

The following procedures will cause RF power to be turned on and off at various times. Do not operate the system without a 50-ohm, 5-W load attached to the RF output. When any RF cable is disconnected, the associated RF power measurement unit must be turned off.

1. Connect a 50-ohm, 5-W load (termination) to the antenna interface located on the front panel of the reader system.
2. Configure a terminal emulator (a PC running communications software) to 2400 or 9600 baud, no parity, 8 data bits, and 1 stop bit.
3. Connect the emulator to the main RS-232 interface located on the front panel of the reader system.
4. Switch off the ON/OFF switch located on the front panel of the reader system.

5. Connect a power source to pins A (+) and B (-) on the DC power input front panel connector (Figure 4-1).



HW-0036

Figure 4-1 Power Source Connections

6. Switch on the ON/OFF switch located on the front panel of the reader system.
7. Type the command `~~CC` (CC must be entered in upper case) and press **Enter**.

Note: For information on entering command codes, refer to Chapter 5, Command Codes.

8. Type `!22` and press **Enter**. The time and date will be returned.

If the time and date are not received, check communications connections, cycle power, and repeat.

If the time and date are incorrect, use `!20` and/or `!21` to correct this information, then type the following commands.

<code>!20hh:mm:ss</code>	sets time
<code>!21MM/DD/YY</code>	sets date
<code>!642</code>	sets RF to follow the trigger
<code>!41</code>	enables tag reporting

The entered command and `!Done` response will be returned after each properly executed command.

9. Connect a jumper between pins 14 (ground) and 15 (trigger) on the customer input/output (I/O) connector to turn on the RF power. Figure 3-3 on page 3-5 in Chapter 3 shows the location of pins 14 and 15.
10. Connect a voltage output meter to pins 20 (+) and 23 (-) at the back of the Melcher DC-DC converter. Figure 4-2 shows the location of pins 20 and 23.
11. Adjust the R1 knob (Figure 4-2) to obtain 13.5V DC.

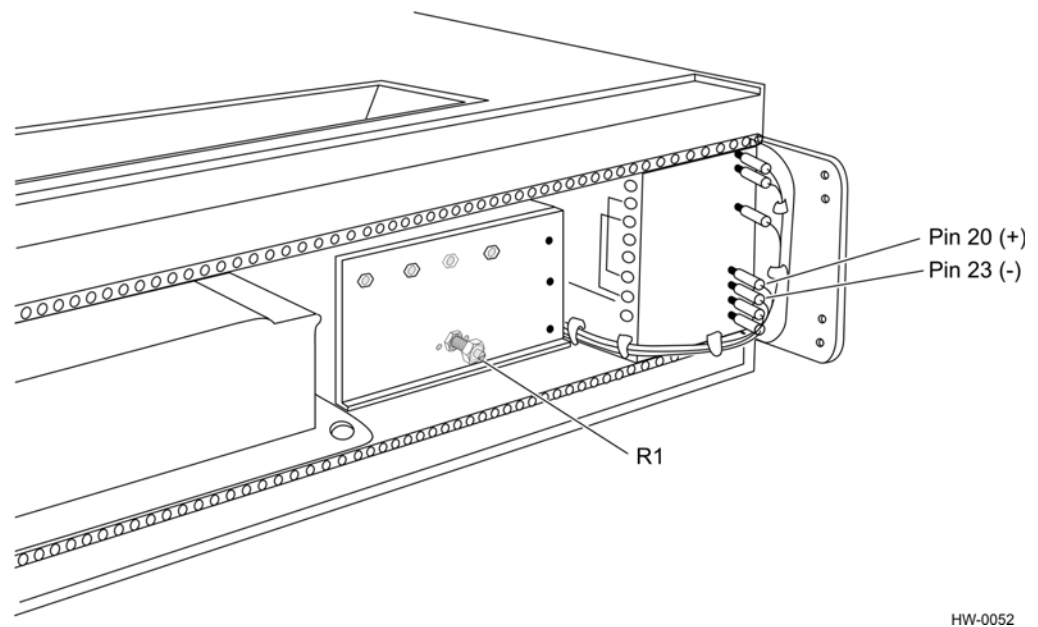


Figure 4-2 Locations for DC Voltage Adjustment Measuring RF Power

Measuring RF Power

To measure the RF power

1. Set the ON/OFF switch located on the front panel of the reader system to off.
2. Connect an RF power meter of known accuracy to the antenna interface on the front panel of the reader system (Figure 4-3). Power measured at the antenna connector should be 0.8 W (29 dBm).

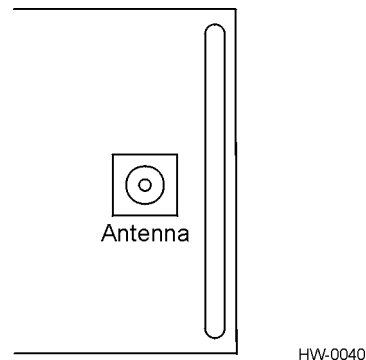


Figure 4-3 Antenna Interface on Front Panel



Caution

Some RF power meters have input power restrictions, and 0.8 W can severely damage the RF meter if applied directly. Use supplemental attenuators of known accuracy with these types of meters and add the attenuation amount to the resulting RF power measurement.

3. If a cable is used with the power meter, the cable loss must be determined by measuring all cables with an RF power meter of known accuracy. Calculate the resultant RF power levels using the formula $dB = 10_{\log} P_{in}/P_{out}$. Add this loss to the meter reading to determine the actual RF power output.
4. Set the ON/OFF switch located on the front panel of the reader system to on.
5. Repeat steps 6 through 8 under the section “Testing Basic Operation” on page 4-3 to configure the unit to operating conditions. The RF power measurement should read greater than 0.8 W.

Example of RF power measurement with a 645-mW meter reading using a cable:

$10_{\log} 645$	+28.1 dBm
Test cable loss	0.9 dB
Total	+29.0 dBm = 0.8 W

Measuring System Noise

With the equipment configured the same as for the RF power measurement test described above, connect a 100 MHz oscilloscope to the customer I/O interface according to the parameters listed in Table 4-1.

Table 4-1 System Noise Test Parameters

Channel	Pins
A	8 (ground) and 9
B	10 (ground) and 11
C	12 (ground) and 13

Figures 4-4 through 4-6 depict waveforms generated at selected channels, as shown by an oscilloscope.

Figure 4-4 illustrates the desired waveform generated during normal operation with a valid tag in the reader field.

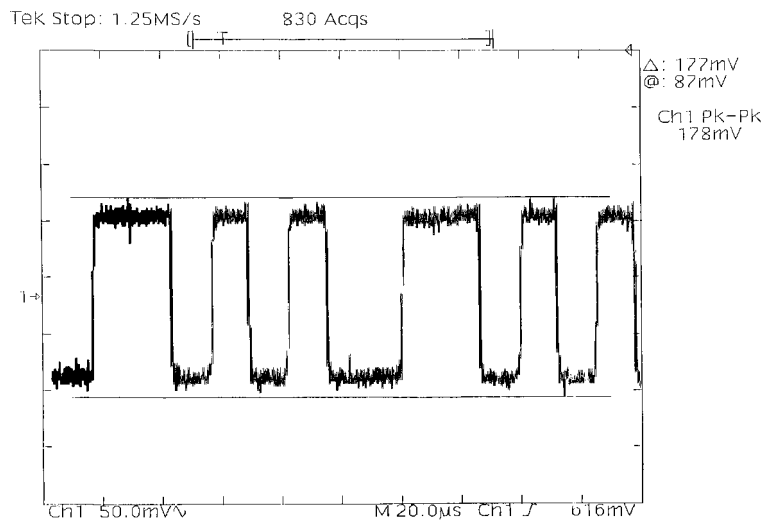


Figure 4-4 Typical Waveform with a Tag in the Reader Field

Figure 4-5 depicts typical quiescent noise levels with the RF connector configured with a 50-ohm, 5-W terminator. Quiescent noise levels vary from unit to unit with channel C having the most representative noise level.

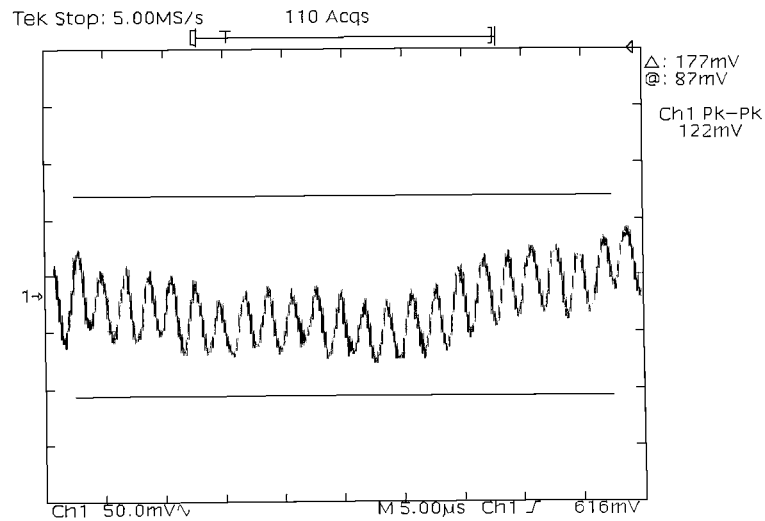


Figure 4-5 Typical Quiescent Noise Waveform

Figure 4-6 shows the typical beat frequency interference waveform caused by a similar frequency interrogator system connected to an antenna in proximity to the system under test.

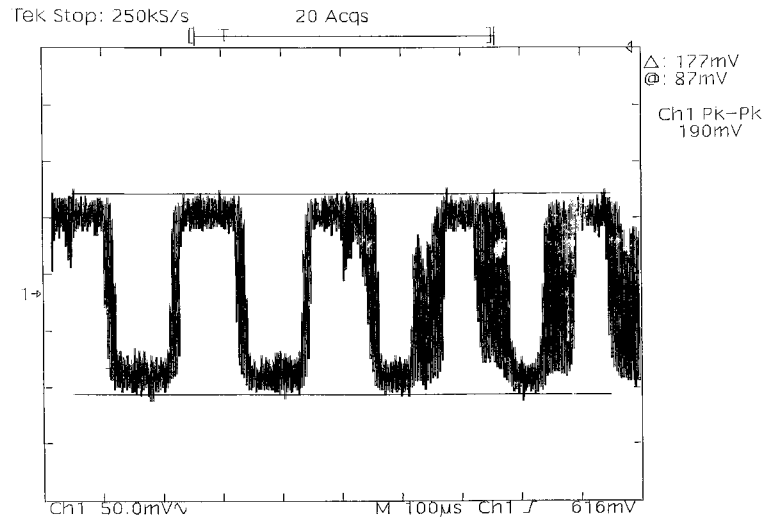


Figure 4-6 Typical Beat Frequency Interference Waveform

Reading the Tag

To verify that the AI1422 Half-Frame Reader System is properly reading tags

1. Switch the ON/OFF switch located on the front panel of the reader system to off.
2. Using your own cable, connect the laptop PC to the reader system at the main RS-232 interface.
3. Connect the antenna to the antenna interface on the front panel of the reader system.
4. Connect three customer-supplied light-emitting diodes (LED) between the ground pin and lock LED, the ground pin and the main power LED, and the ground pin and the RF power LED. All of these pins are located on the customer I/O interface on the front panel of the reader system.
5. Set the ON/OFF switch located on the front panel of the reader system to on.
6. Connect a jumper between pins 14 (ground) and 15 (trigger) on the customer I/O interface to trigger the RF on (Figure 3-3 on page 3-5).
7. Monitor the LEDs on the box, and verify that the main power LED and the RF power LED are lit.
8. Position a programmed TransCore half-frame rail tag with a backplate within 2 to 3 feet (0.6 to 0.9 m) of the antenna. No other tag can be in this 2 to 3 foot (0.6 to 0.9 m) area during this test.
9. Verify that the lock LED is lit and that the PC is acquiring the tag data.
10. Remove the tag from the antenna field. The PC should stop reading the tag data.

11. Disable the trigger by disconnecting the jumper.
12. Set the on/off switch located on the front panel of the reader system to off.

***Note:** Repeat this test several times. Each time, the lock LED should be lit and the PC should be reporting the tag data.*

Command Codes

Command Codes

This chapter describes the default and diagnostic command codes that enable you to develop host computer programs to control the functions of the AI1422 Half-Frame Reader System.

Default Command Codes

The default command codes enable communications between the host computer and the reader system. These codes, also referred to as the communications protocol, are in a binary format. TransCore strongly recommends that a person with software writing capabilities write this communications protocol.

The transponder identification (ID) can be 3 or 10 bytes, which corresponds to 2400 or 9600 baud, respectively. These bytes are 6-bits coded. See Appendix A, “Character Conversion,” of this user guide.

Asynchronous Reader Data Telegram

The reader system sends a data telegram when it reads a unique tag ID.

```
<7EH><7EH><01H><transponder count><transponder ID><CR>
```

Health Status Request

You will need to write a script file to download the following binary string for the health status request.

```
<7EH><7EH><40><CR>
```

The response is

```
<7EH><7EH><02H><Transponder count><host computer  
telegrams-bad CRC><incomplete host telegram>  
<Reserved><Reserved><Reserved><CR>
```

Retransmit Request

You will need to write a script file to download the retransmit request.

```
<7EH><7EH><42H><CR>
```

The response is

```
<7EH><7EH><01H><transponder count><transponder ID><CR>
```

Diagnostic Command Codes

Diagnostic commands are used to check or fine-tune the reader system.

Diagnostic Command Code Syntax

Unlike default command codes that require a script file, diagnostic codes are typed by the user. The general syntax of diagnostic commands is to begin with an exclamation character, !, followed by the command code and a list of parameters. No spaces should be between characters, and the command is sent by pressing **Enter** or carriage return <CR>.

As characters are typed, they are automatically displayed on the terminal (except for the ~~CC command). As soon as the command is terminated with **Enter** or a <CR>, the reader system responds to the command as follows:

!Done command recognized and accepted

or

!Error command not recognized

The normal response is !Done. Other responses, for example, the time/date response, provide a description of the entry made or command completed.

The reader system operates using two distinct command sets. The first command set contains the system default commands when the system is turned on. The second command set contains diagnostic and other fine-tuning codes.

Diagnostic Command Code Listing

The following commands are used for diagnostics or to fine-tune the reader system.

Escape Command

!~~CC

Pressing the escape command disables the reader system default command codes and allows the reader system to accept the other diagnostic and fine-tuning command codes.

The response is

No response is returned

Baud Rate Select

!100x

Command !100x selects the baud rate, 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 kbaud

The response is

!Done or !Error

***Note:** The !Done response is issued at the setting that existed before invoking the new command. All subsequent communications will be at the new baud rate.*

Stop Bits

!101x

Command !101x selects the stop bits, where x = 0 or 1:

- 0 = 1 stop bit** (factory setting)
- 1 = 2 stop bits

The response is

!Done or !Error

***Note:** The !Done response is issued at the setting that existed before invoking the new command. All subsequent communications will be at the stop bit mode.*

Parity Select

!102x

Command !102x is used to select parity, where x = 0 to 2:

- 0 = disable parity** (factory setting)
- 1 = enable even parity
- 2 = enable odd parity

The response is

!Done or !Error

***Note:** The !Done response is issued at the setting that existed before invoking the new command. All subsequent communications will be at the new parity mode.*

Set the Time in the Real-Time Clock

!20hh:mm:ss

where

hh = hours (00–23)

mm = minutes (00–59)

ss = seconds (00–59)

The response is

!Done or !Error

***Note:** The time must be entered exactly as shown with no spaces between characters and colons as delimiters. All entries use decimal characters 0 through 9.*

Set the Date in the Real-Time Clock

!21MM/DD/YY

where

MM = month (01–12)

DD = day (01–31)

YY = year (00–99)

The response is

!Done or !Error

***Note:** The date must be entered exactly as shown with no spaces between characters and with forward slashes (/) as delimiters. All entries use decimal characters 0 through 9.*

Display Time and Date

!22

where

hh = hours (00–23)

mm = minutes (00–59)

ss = seconds (00–59)

dd = hundredths of seconds

MM = month

DD = day

YY = year

The response is

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

or

!Error

***Note:** There are two spaces between the time and the date.*

Real-Time Transmission to Host Enabled (*factory setting*)

! 305

When a tag identification (ID) is acquired by the radio frequency (RF) source, it is immediately sent out on the RS-232 port. The tag ID is not stored in the data buffer.

The response is

!Done or !Error

Transmit All Tag ID Codes

! 41

Command ! 41 transmits to the host computer all tag IDs received by the antenna.

The response is

!Done or !Error

Note: This command is to be used for diagnostic purposes only.

Return to Default Command Codes

! 63

Command ! 63 returns the host computer to the default command codes.

The response is

No response is returned

RF Follows Trigger

! 642

Command ! 642 switches RF power on continuously.

The response is

!Done or !Error

Note: This command is for diagnostic purposes only.

6

Troubleshooting

Troubleshooting

This section lists routine maintenance procedures to keep the AI1422 Half-Frame Reader System operating correctly and diagnostic procedures for troubleshooting an improperly working reader system.

Required Tools and Equipment

The following tools and equipment are required:

- 50-ohm, 5-watt (W) load (N-type connector)
- Personal computer (PC) with terminal emulator software
- Appropriate power source for your reader
- Digital multimeter
- RF power meter
- 100 MHz oscilloscope
- Antenna and cable

Troubleshooting

No loop-back mode to restore defaults, such as baud rate, means that troubleshooting is required.

Failure Modes

No Communication — To determine if there is a problem in the communications hardware, the following two commands should be repeated together for testing purposes:

!~~CC escape to diagnostic mode

!22 display time and date

If functioning properly, the time and date will be displayed after the second command, which means that the reader is communicating. If the reader is not functioning properly, then perform the following checks.

- Does the AI1422 Half-Frame Reader System have adequate power? If not, ensure reader has 13.5V DC \pm 1.0V DC.
- Is the main power switch on? If not, switch it on.

- Is the main power switch light-emitting diode (LED) lit? If not, turn on power switch.
- Is the front panel fuse blown? If so, replace it with a 1.5 amp (A) slo-blo fuse.
- Is the reader's DC-DC converter functioning? If so, the OK LED on upper left corner of front panel will be lit.
- Are you using a null modem cable connection? If not, switch to a null modem connection.
- Have you set the correct baud rate? If an incorrect baud rate is suspected, select and send each baud rate in turn, using the !100x Baud Rate Select command, and wait for a response.

Unit Will Not Read Tags

The suggestions listed here assume that the user has already verified proper serial communications, and the command !305 has been entered successfully to enable real-time transmission to the host computer. If RF POWER LED, which is recommended for customer I/O connector, is lit, the indication is that the AI1422 is querying for tags. If the LOCK LED, which is recommended for the customer I/O connector, is lit, the indication is that the reader system is retrieving tag data. If either LED is not lit, then check the following items:

- Verify that the antenna connection is good.
- Verify that the antenna cable is in good condition.
- Verify that a single, known valid tag is in the antenna field.
- Verify that the trigger remains activated and the unit power is on.
- Verify that a tag being alternated with a tag containing different data to avoid uniqueness filtering.

Unit Will Not Retain Settings

If the unit will not retain information, such as time and date stamp or baud rate between power cycles, the internal battery backup has failed and the unit must be returned for repair. Contact TransCore at the telephone number listed at the front of this user guide.

Maintenance Procedures

Except for the 1.5-A slo-blo fuse in the front panel of the unit, there are no user-serviceable parts in the AI1422 Half-Frame Reader System.

A

Character Conversion

Appendix A

Character Conversion

Table A-1 lists the TransCore 6-bit-per-character conversion from the standard ASCII character set.

Table A-1 TransCore 6-Bit-Per-Character Conversion

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	101010		
5	010101	K	101011		

B

Technical Specifications

Appendix B

Technical Specifications

Table B-1 lists the specifications of the AI1422 Half-Frame Reader System.

Table B-1 AI1422 Half-Frame Reader System Specifications

Specification	Description
Size	19.0 x 5.25 x 9.0 in (48.3 x13.34 x 22.9 cm)
Weight	12.0 lb (5.4 kg)
Operating temperature	+32°F to +158°F (+0°C to +70°C)
Power requirement	13.5V DC \pm 1.0V DC @25W
Available frequency range	902–928 MHz
Approved frequency range for Federal Communications Commission and Industry Canada	902.25–903.75 MHz and 910.00–921.50 MHz
Receiver RF bandwidth	\cong 1.2 MHz
Receiver sensitivity	-48 dBm
Transmitter frequency stability	\pm 5.0 ppm over operating temperature range
Transmitter RF power	0.8W \pm 0.1W
Communications port	RS–232, 110 to 19,200 baud
Other features	Real-time calendar clock Optional 8V–32V DC, 14V–70V DC, or 28V-140V DC power supply

C

Diagnostic Command Codes List

Appendix C

Diagnostic Command Codes List

Command	Function
!~~CC	Escape (CC must be entered in upper case)
!100x	Baud Rate Select
!101x	Stop Bits
!102x	Parity Select
!20hh:mm:ss	Set the Time in the Real-Time Clock
!21MM/DD/YY	Set the Date in the Real-Time Clock
!22	Display Time and Date
!305	Real-Time Transmission to Host Enabled (<i>factory setting</i>)
!41	Transmit All Tag ID Codes
!63	Return to Default Command Codes
!642	RF Follows Trigger

