AI1200 System
User's Guide

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WARNING TO USERS IN THE UNITED STATES

FEDERAL COMMUNICATIONS COMMISSION (FCC)
LOCATION AND MONITORING SERVICE STATEMENT
47 CFR §90.351

NOTE: The user is required to obtain a Part 90 site license from the FCC to operate this radio frequency identification (RFID) device in the United States. See product label for FCC ID number. Access the FCC Web site at www.fcc.gov/Forms/Form601/601.html for additional information concerning licensing requirements.

Note: Users in all countries should check with the appropriate local authorities for licensing requirements.

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 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 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 regulations in effect, the user 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, LP. 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)

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

TransCore, LP
USA

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Introduction

Chapter 1
Introduction

This chapter provides an overview of the AI1200 System User's Guide.

Purpose of the Guide

The *AI1200 System User's Guide* provides overview information and describes how to operate the AI1200 System.

Intended Audience

The intended audience for this guide is those personnel responsible for the operation of the AI1200 System. The following information is provided in the *AI1200 System User's Guide*:

- Chapter 1 - Introduction
- Chapter 2 - AI1200 Systems Overview
- Chapter 3 - Licensing Requirements
- Chapter 4 - AI1200 System Operations
- Appendix A - Glossary
- Appendix B - Reader Commands
- Appendix C - Reader Default Settings
- Appendix D - Troubleshooting

Related Documentation

See the following related documentation:

- *Radio Frequency Identification Concepts Guide*
- *AI1200 Installation and Maintenance Guide*

Typographical Conventions Used in this Manual

The following conventions are used in this manual:

Table 1-1 Typographical Conventions

Convention	Indication
	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.
Screen Title	Title of a screen as it appears on screen.
Menu Item	Appears on a menu. Capitalization follows the plaza computer.
Note	Additional 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.
	This procedure might cause harm to the equipment and/or the user.
Cancel button	Bold text identifies the labeling of items as they actually appear on the keyboard, on a button, as a menu item, and so forth.
Ctrl-**Esc**	A hyphen indicates actions you should perform at the same time. For example, Ctrl-Esc means to press the **Ctrl** and **Esc** keys at the same time.
5 Return	A space indicates that you should press the specified keys in the sequence listed, not at the same time.
before	Text in italics indicates emphasis.
Customer > **Find**	Bold text followed by a > and more bold text indicates the order of command selections to reach a specific function.
click	Click means that you should press and release the left mouse button.
cursor	The cursor is the flashing vertical line that appears in a selected edit box.
pointer	The pointer is the arrow in the window that shows the movement of the mouse.

2

AI1200 Systems Overview

Chapter 2

AI1200 Systems Overview

This chapter provides an overview to radio frequency identification (RFID) technology and the AI1200 system components. Also provided is an example of how the technology and components are used in a typical installation.

Introduction to RFID Technology

The RFID system uses radio frequency (RF) waves in a process called *modulated backscatter* to identify objects. A small electronic *tag* is attached to an object to be identified. Each tag is programmed with a unique alphanumeric message or identification number.

The RF module(s) generates an RF signal and broadcast through the system antenna(s). The system can support two separate antennas, each providing a separate broadcast field (reading range). Tags entering an antenna's reading range modify and reflect a portion of this signal back to the originating antenna.

The antenna receives this modified, or modulated, signal and transmits it back through the RF module to the system reader. The reader decodes the signal, validates the ID code, appends pertinent information to the code, and transmits the code to a host computer system for further processing. The modulated backscatter process is illustrated in Figure 2-1.

Operational control of the system is accessible to the user through reader commands. These commands are detailed in chapter 4.

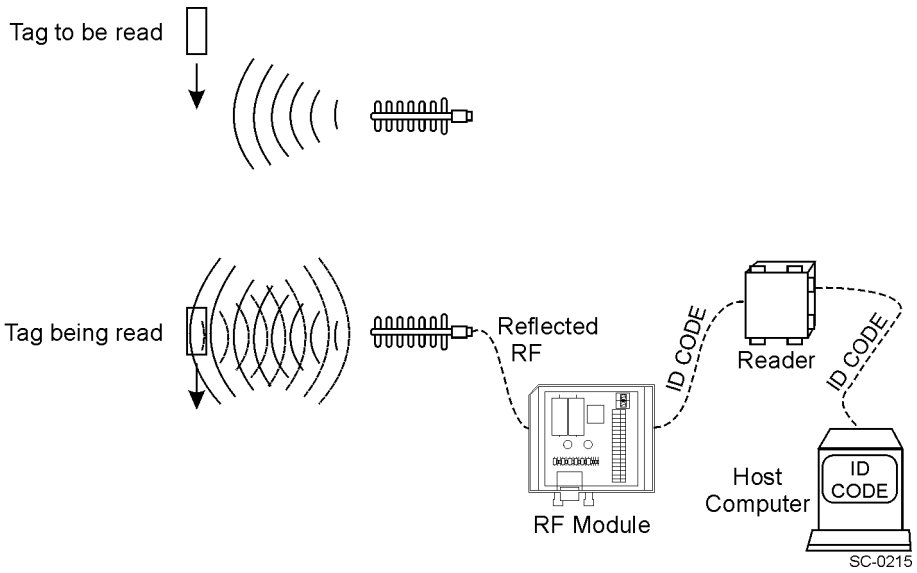


Figure 2-1 Modulated Backscatter Process

System Components

The AI1200 System consists of four fundamental components:

- Reader
- RF module
- Antenna
- Tag

The *RF module* generates a continuous-wave RF signal. The *antenna*, in turn, broadcasts the signal into the environment. In the presence of this signal from the system, the *tag* reflects back to the antenna a modified form of the original signal containing the tag's unique, encoded message. The RF module demodulates this signal, preconditions it, then transmits it to the reader. The *reader* then processes information and transmits it to the host computer

It is important to note that *tags are not radio transmitters and do not radiate signals by themselves.* They serve only as coded reflectors for the RF signal emitted through the antenna.

Figure 2-2 shows the basic arrangement of the four principal components. Also shown are a proximity sensor and host computer, both of which are optional items.

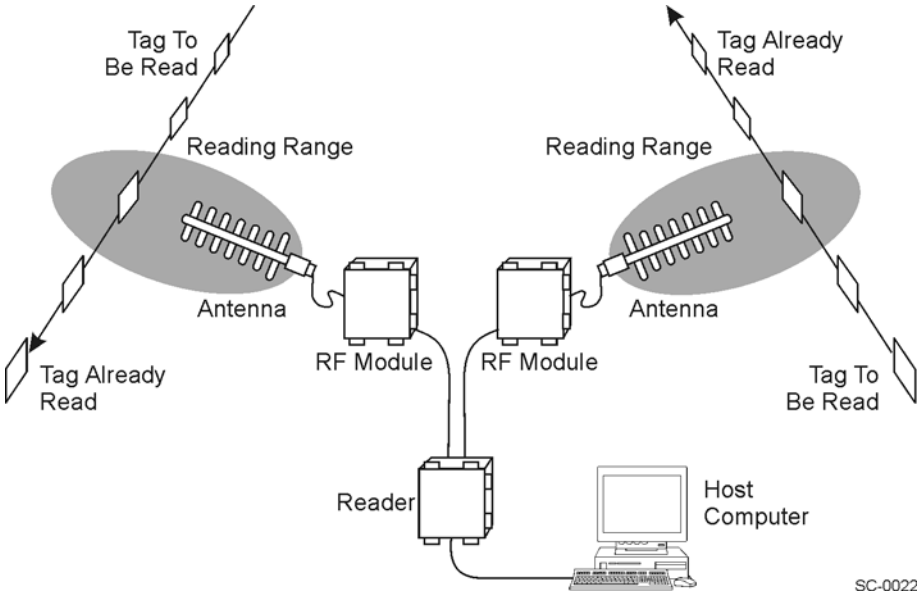


Figure 2-2 Basic Arrangements of The Principal System Components in a Two-Lane Configuration

When a tagged object nears an antenna, the optional proximity sensor causes the RF module to turn on and the antenna to broadcast an RF signal. Proximity sensors are often used when power conservation is desirable, such as with battery-operated readers.

Typical Installation

Figure 2-3 shows a typical RFID installation. The figure shows a system designed to identify trailers as they enter or exit the terminal yard. The tag is mounted at a convenient location on the outside of the trailer. When the trailer reaches the gate, the system reads the tag and forwards the information to the trucking company's host computer. If commanded, the system can append the time, date, location, and other important information to the tag's ID code.

This installation is designed to read only the tag on the trailer in the desired lane and not a tag on a truck waiting in line or parked nearby.

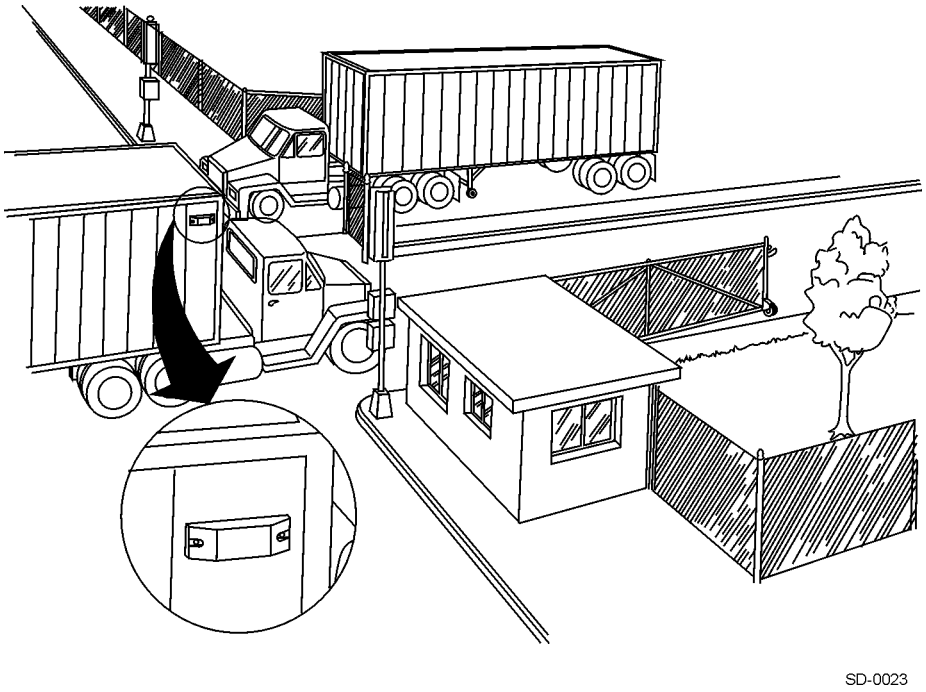


Figure 2-3 Typical RFID Installation

Firmware in the reader registers the arrival or exit of the trailers and transmits its tag's ID to the host computer. The host computer enters the information in the yard's daily log and then signals the reader to activate a signal light allowing the trailer to enter the yard. The system does not require the truck to stop. The vehicle can move through the gate at a speed limited only by safety considerations.

In the event an untagged trailer arrives, a gate attendant can obtain the trailer's ID from the drier and manually enter it into the company's host computer using a local terminal connected through the optional input port on the reader. Manual entry of the ID results in the ID being processed by the reader just as if it had been received through the RF channel. Manually entered IDs are noted as such in the appended data.

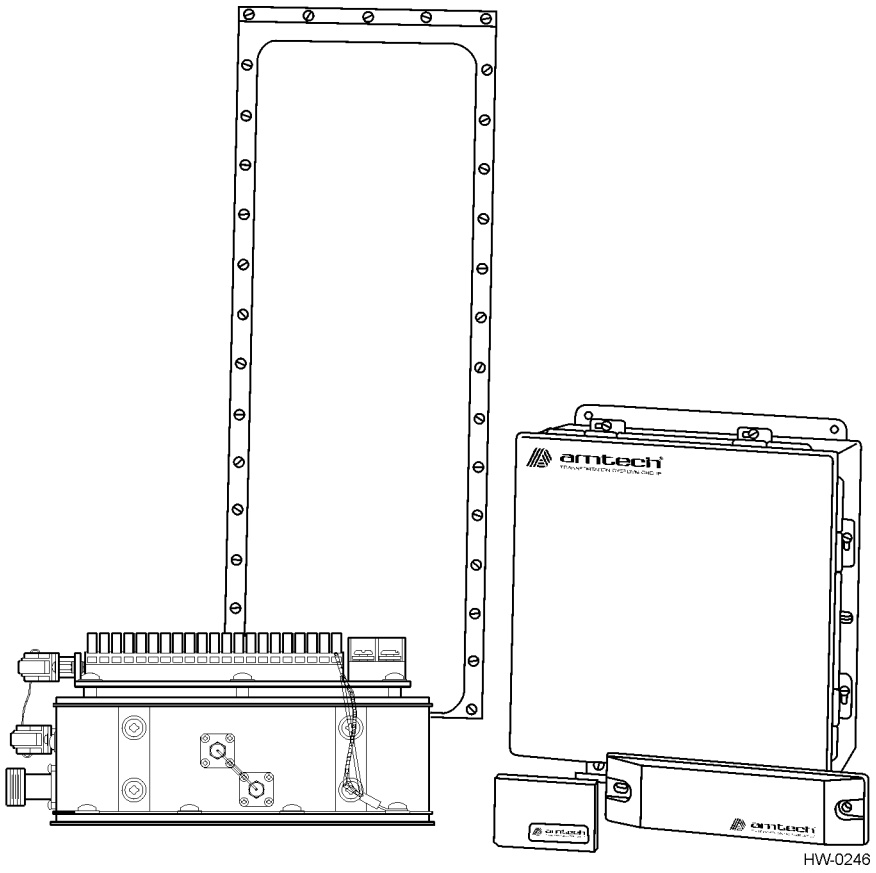


Figure 2-4 The AR2200 RF Module, Parapanel Antenna, AI1200 Reader, and AT5100 and AT5110 Tags

AI1200 Reader

The AI1200 reader provides the operational link between tagged objects and in-house information management systems. The reader receives the demodulated signal from the RF module, decodes the ID code, validates and filters the ID code, and transmits the code along with any appended information to the host computer system.

Permanent programming (firmware) in the reader controls reader operation. The firmware accepts commands from the user through the host computer system (or a local terminal), which can customize the reader's operations to the user's needs. Commands and host computer communications are discussed in chapter 4.

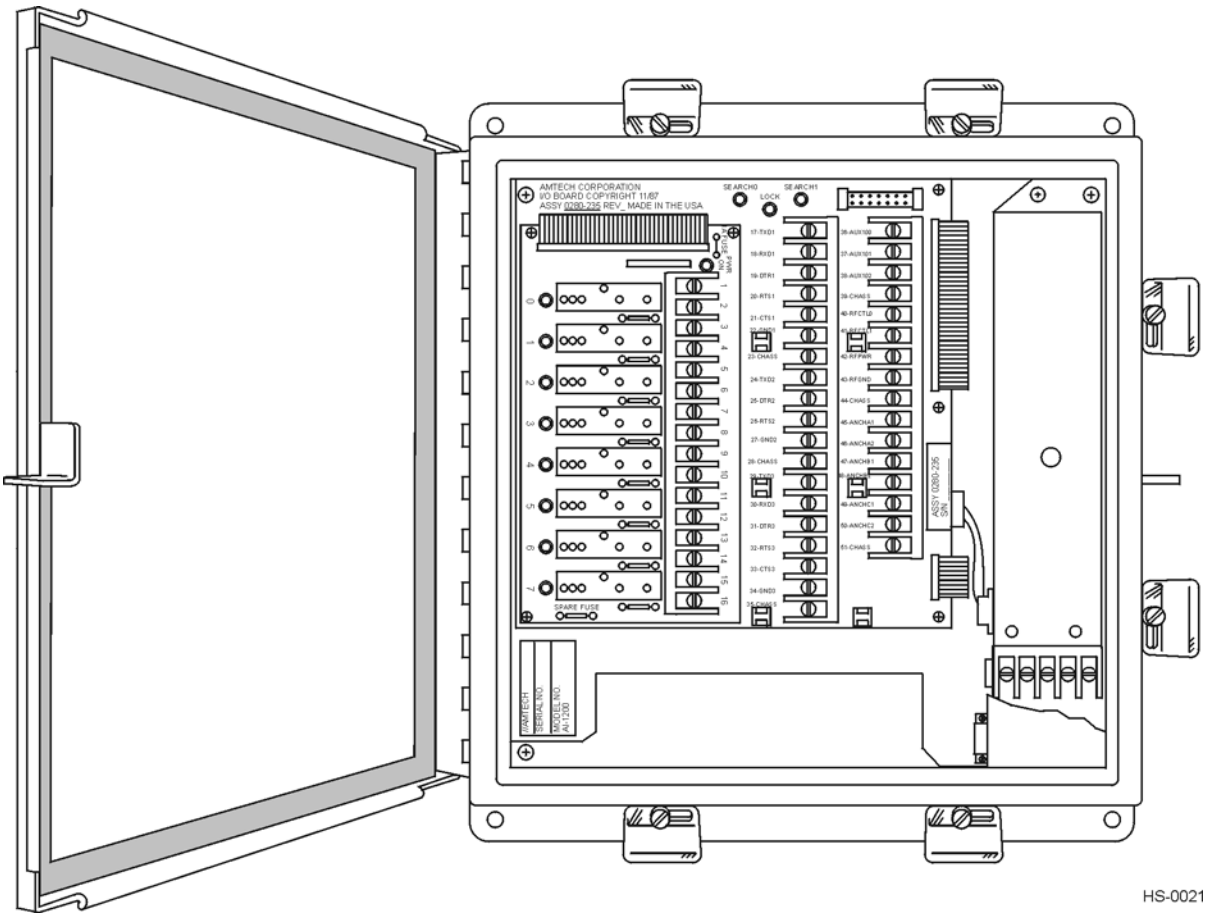


Figure 2-5 AI1200 Reader Enclosed in a NEMA Box

Reader Functions

The AI1200 Reader's functions are described in this section.

Signal Processing

The reader receives the demodulated signal from the RF module. It amplifies the signal and then decodes and validates it.

Data Management

The reader transmits the ID codes to a host computer system. The IDs can also be transmitted to a printer or other data collection device.

The user can instruct the reader to append certain information to the ID codes prior to transmission to the host computer. This information can be time, time and date, and/or auxiliary information. Auxiliary information consists of reader and antenna identification, number of times the previous tag was read, and sensor status information.

The reader's standard 64K memory holds approximately 4,000 ID codes without appended information and 2,000 ID codes with additional information appended.

AUX-2, an additional serial communications port, can be installed in the reader at the factory. Through a local terminal connected to this optional **AUX-2** port, the user can manually enter IDs for untagged objects.

The reader can search for specified ID codes. The reader's ID search function can be controlled through reader commands entered at the host computer or through the terminal connected to the **AUX-2** port.

RF Control

The reader is configured at the factory for dual-channel, multiplexed operation of the AR2200 RF module. Control of the RF module(s) depends on reader commands for either single channel or multiplex operation or by input from proximity sensors connected to the reader's sense input terminals.

Output Control

The reader can control the operation of external equipment, such as gates or signal lights, connected to the reader's status output terminals. Reader commands allow the user to set and change output operation parameters as necessary.

Host Communications

The reader's communication ports provide standard RS-232 data terminal equipment (DTE) communications. Reader firmware sets reader-to-host communications parameters, such as baud rate, parity, number of stop bits, and EOL communications link delay. These commands provide XON/XOFF and data inquire host communication protocols.

Modem control parameters can be set through the reader. The parameters define the communications conditions for which a reader will call or be called by the host computer.

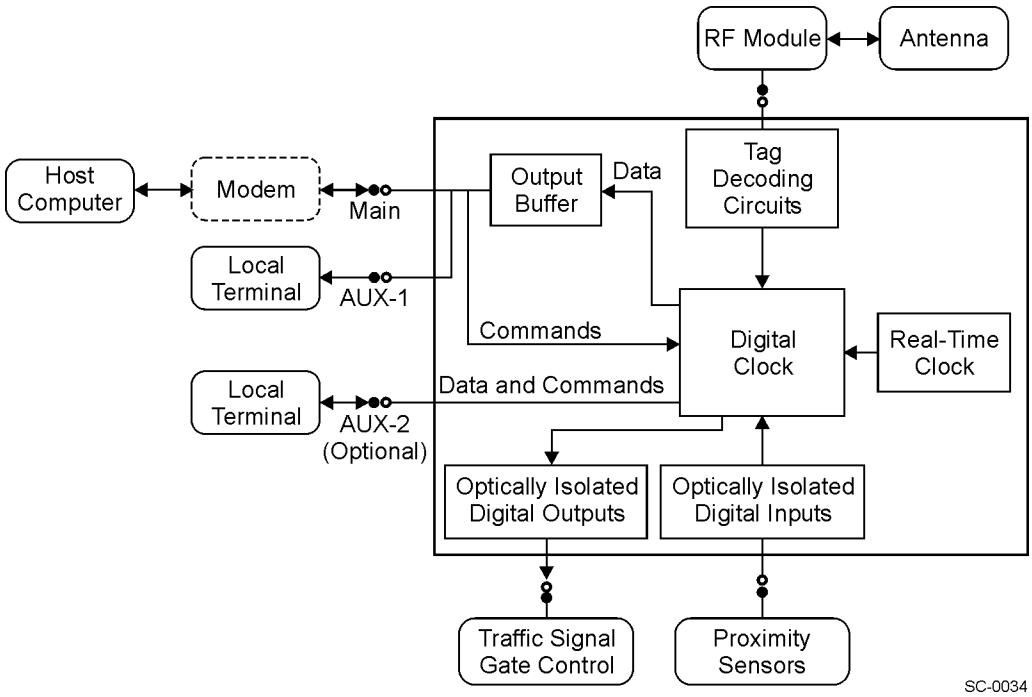


Figure 2-6 Host Communications

Standard Reader Features

The AI1200 Reader has a standard 32Kbyte data storage buffer. The **Main** and **AUX-1** serial communication ports are standard on the AI1200.

The reader operates on 110 or 220 VAC, which the reader converts to DC for use by the system. The AI1200 Reader is housed in a weatherproof type 4X NEMA[1] enclosure. Standard operating temperature range for the reader is 0° C to 70° C.

Reader Options

A second serial communications port, the optional **AUX-2** port, can be specified when ordering the AI1200 Reader.

The reader can be ordered with a 12, 24 or 72 VDC power supply.

The AI1200 Reader is available in an optional, ruggedized industrial version that is vibration-resistant and operates at temperatures between -40° C and 70° C.

RF Modules

The AR2200 RF module operates in the 902-928 MHz frequency band. The AR2600-series RF module operates in the 2400-2500 MHz radio frequency band. The RF mod-

1. NEMA is the acronym for National Electrical Manufacturers Association.

ule generates a continuous-wave RF signal, which is broadcast by one or two system antennas. The RF module also receives the tag signal from the antenna. The RF module demodulates the signal (deciphers the signal from the modulated RF signal), preamplifies the signal, and sends it to the reader for processing.

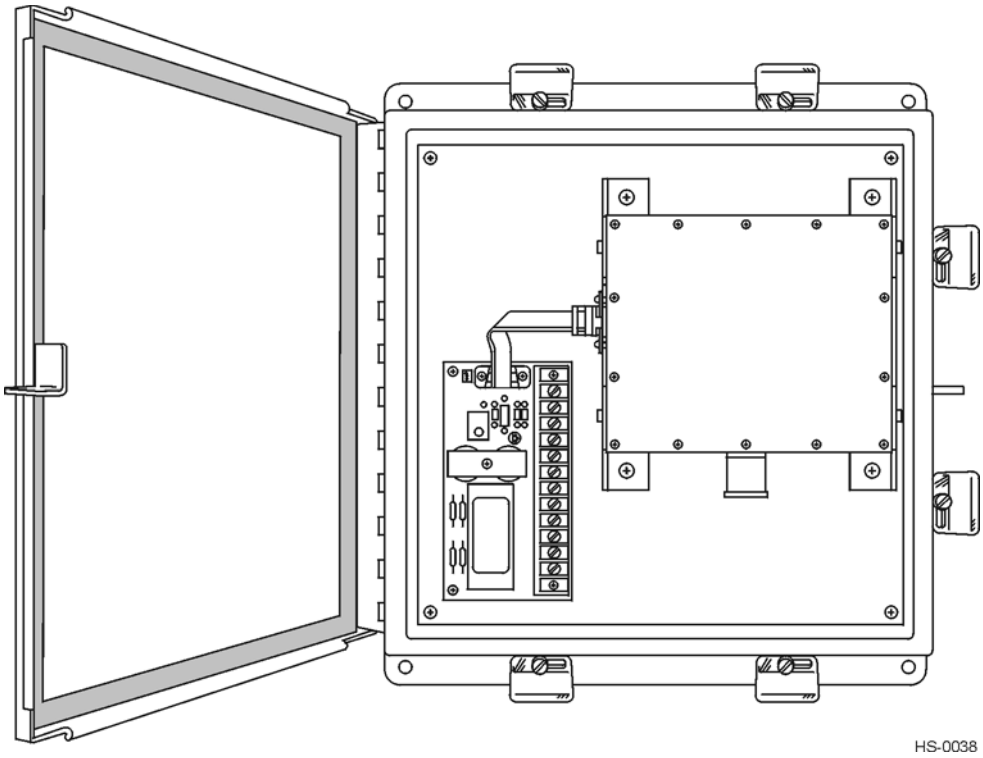


Figure 2-7 The AR2200 RF Module Enclosed in a NEMA Box

All RF module versions are housed in weatherproof NEMA-4 enclosures. The AR2200 RF Module operates at temperatures between -40° C and 70° C.

The RF module can be configured to turn on and off through reader commands or to operate in conjunction with another RF module in compatibility mode. It can also be set to turn on only when a proximity sensor detects the presence of an object to be identified. The RF module can then be set to turn off again, after a preset delay, after reading a tag or if no other tags are detected.

Installations requiring multiple, closely spaced reading stations can use several RF modules that are factory-set to individual RF frequencies with a 2 MHz separation. This arrangement allows the system to discriminate between direct tag signals and stray signals entering the field from nearby stations.

The AR2200 RF module can operate two antennas when only one RF module is connected to the reader configured in normal mode. Normal mode configuration can be used when the desired reading areas are within 80 feet of one another and the required cable length is less than 40 feet.

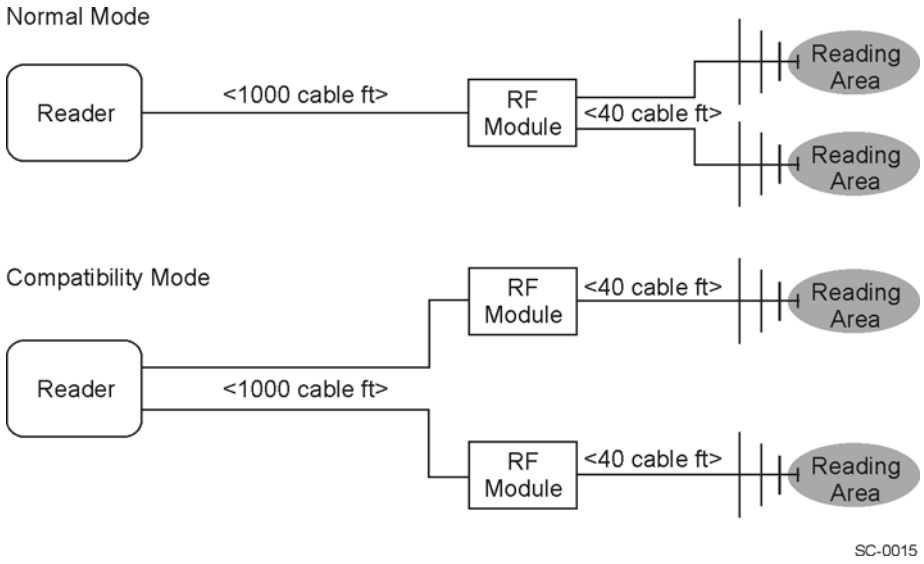


Figure 2-8 Normal and Compatibility Mode RF Module Configuration

In *compatibility* mode, two RF modules are connected to the reader, and each module operates one antenna. Compatibility mode is the recommended configuration when the desired reading areas are widely separated and long cable runs of more than 40 feet are required.

Note: *To enter compatibility mode, the AI1200 logic board must be modified. See the AI1200 Installation and Maintenance Manual.*

The AR2200 RF module also contains a built-in range sensitivity adjustment feature that allows variable control of the system's sensitivity to RF noise and stray signals.

Antennas

TransCore system antennas are designed to broadcast an RF signal and receive tag-modulated reflections of that signal within a specified optimal area called the reading range. Contact TransCore for product literature on antennas.

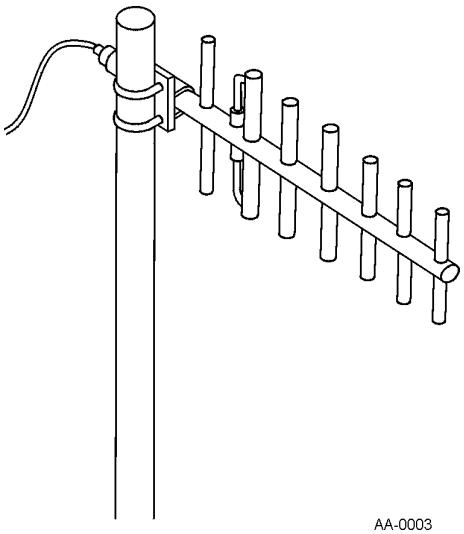


Figure 2-9 AA3100 Yagi Antenna without Radome Mounted for Vertical Polarization

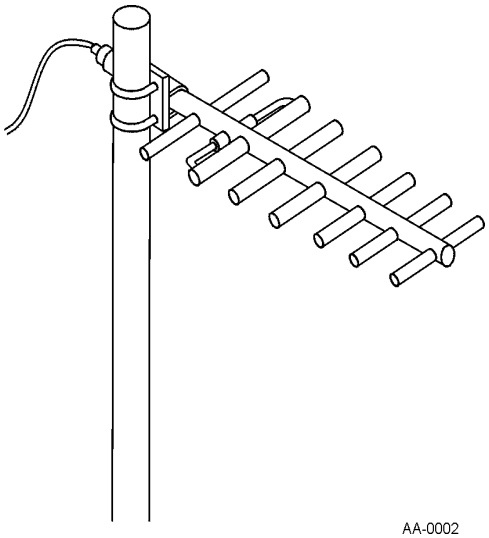


Figure 2-10 AA3100 Yagi Antenna without Radome Mounted for Horizontal Polarization

Broadcast field size and shape and *polarization*, which is directional sensitivity of energy emitted from the antenna, are used to further define the reading range to desired specifications.

Each type of antenna broadcasts RF energy generated by the RF module in a characteristic pattern. The shape of the reading range generated by each antenna can be related directly to the radiation pattern. In the Yagi AA3100 and AA3101 antennas, this pattern is balloon-shaped. These antennas are ideal when the reading range must be relatively symmetrical. When mounted with its elements oriented vertically, the Yagi antennas are vertically polarized.

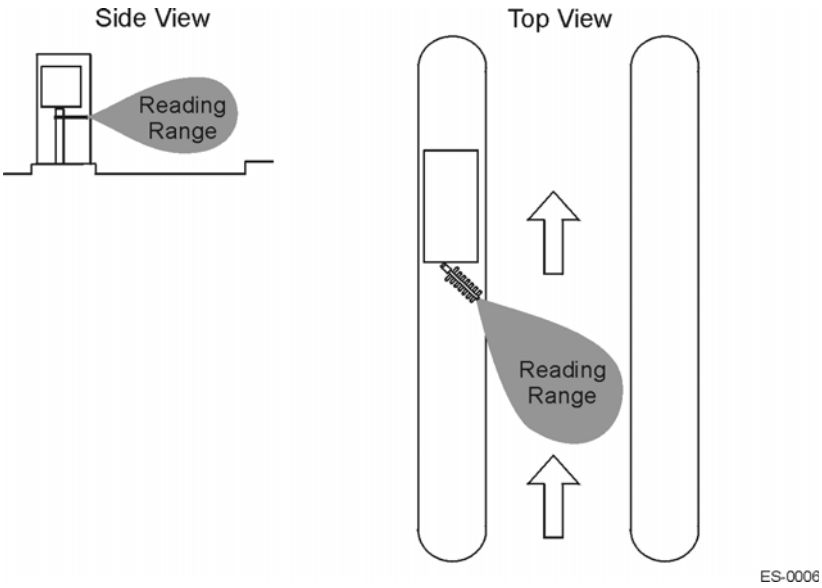


Figure 2-11 Reading Range Defined by Field Size, Shape, and Polarization of Antenna

The AA3110 Parapanel and AA3120 Flat Panel Antennas have teardrop-shaped radiation patterns, broad in one dimension and shallow in another. This type of antenna is ideal when the reading range must be confined to a relatively narrow space. When mounted vertically, the parapanel is horizontally polarized and the flat panel is vertically polarized.

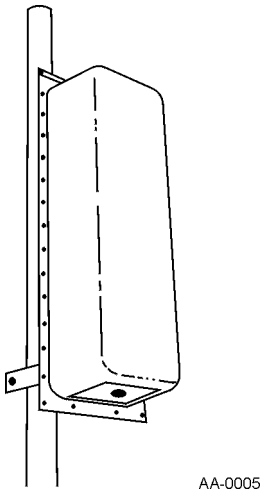


Figure 2-12 Parapanel Antenna Mounted for Vertical Polarization

The parapanel and flat panel antennas are nominal for installations requiring low antenna profile, such as toll lanes or entry gates.

The parapanel, flat panel, and AA3101 Yagi Antennas are enclosed in a weatherproof radome. The AA3100 Yagi Antenna without radome is suitable for non-icing conditions.

The Yagi, parapanel, and flat panel antennas are designed for use in 915 MHz systems.

The AA3500 Horn Antenna has a weatherproof radome, a relatively symmetrical, cone-shaped pattern and is used in 2450 MHz systems.

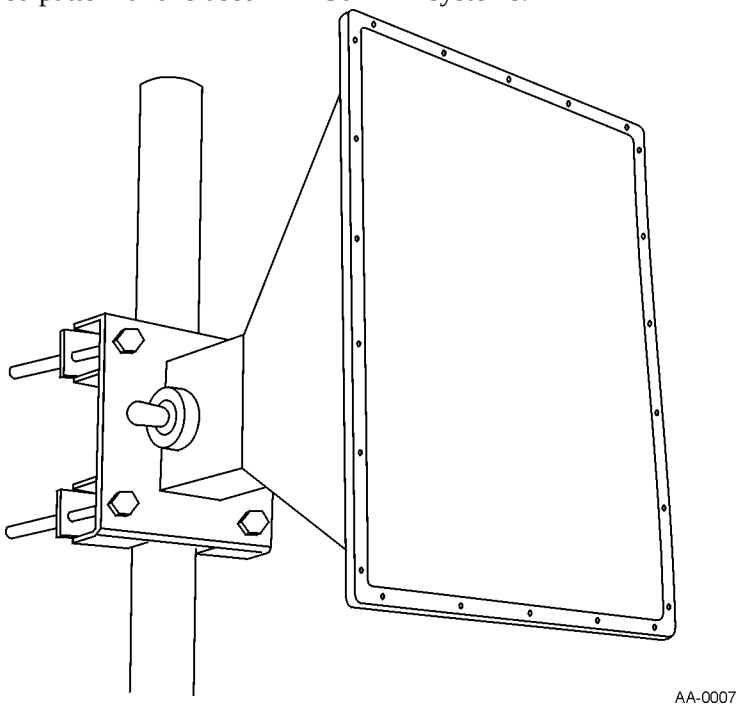


Figure 2-13 AA3500 Horn Antenna Used in 2450 MHz Systems

The AA3140 PCB Log Periodic Antenna is ideal for installations requiring maximum coverage at close range. It can be installed horizontally or vertically and is used to broadcast and receive signals in the 845 to 950 MHz range.

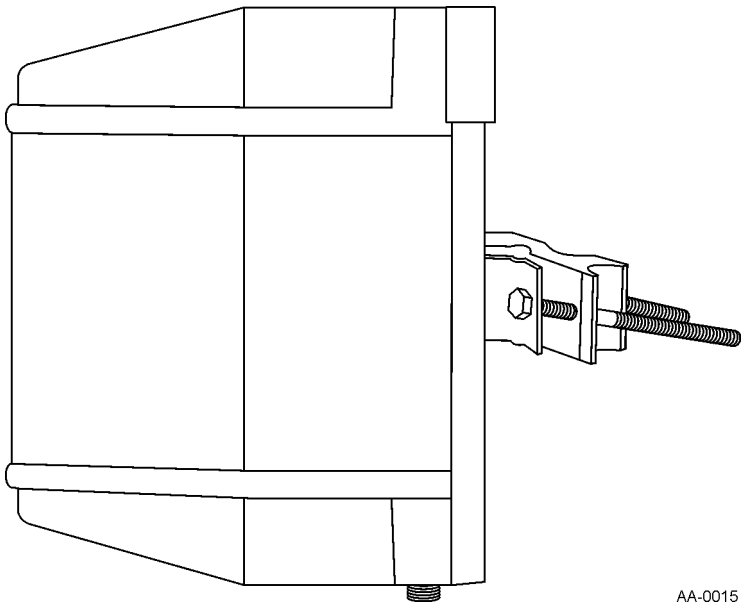


Figure 2-14 AA3140 PCB Log Periodic Antenna

Tags

Tags (sometimes called *transponders*) contain electronic circuitry that responds with a 128-bit message in the presence of a signal from the system. A tag can contain up to 20 user-selected alphanumeric characters.

Tags are divided into categories by *operating frequency*, *power source*, and *industry environment*.

Operating Frequency

For applications in the United States, tags operate in the 915 MHz band (902-928 MHz) as allowed by the Federal Communications Commission (FCC). Other countries permit operation of RFID equipment at 2450 MHz or 880 MHz.

Power Source

Although tags are not RF transmitters, a minute amount of power is needed to operate the internal circuitry.

Passive tags derive this power directly from the incoming RF signal and are *beam*-powered. Beam-powered tags have an indefinite life since there is no battery and no moving parts.

Other tags use a small lithium battery to drive the internal circuitry. These *active* tags are *battery*-powered. Battery-powered tags have a life of eight to fifteen years. These tags can be read further from the antenna than beam-powered tags.

Industry Environment

Each tag case design specifically meets the rigors defined by three major industry environments: the toll industry, the intermodal/general transportation industries, and the rail industry.

Tag Models

The AT5100 TollTag is designed primarily for use at toll and parking facilities. The case design is ideal for non-permanent mounting inside a vehicle windshield. The TollTag is similar to the size of a credit card being 3.58 x 2.32 x .43 inches (9.1 x 5.9 x 1.09 cm).

The AT5100 TollTag case is dustproof. It should be protected from exposure to moisture. A vehicle interior provides an appropriate environment for a TollTag, as long as there is no moisture seepage around the tag. Conditions *external* to the vehicle, such as dirt or ice, have little effect on tag performance.

The AT5110**,** AT5510, and AT5515 tags have been developed for use in the general transportation and intermodal industries. These tags are used when permanent, external attachment is required. They are larger than the TollTag being 9.3 x 2.36 x .69 inches (23.6 x 6.0 x 1.75 cm).

Transportation tags are weatherproof. They are designed to perform in all types of inclement weather and at any level of ambient light. Tag operation is not significantly degraded by dirt, grease, ice, or non-conductive surface contamination.

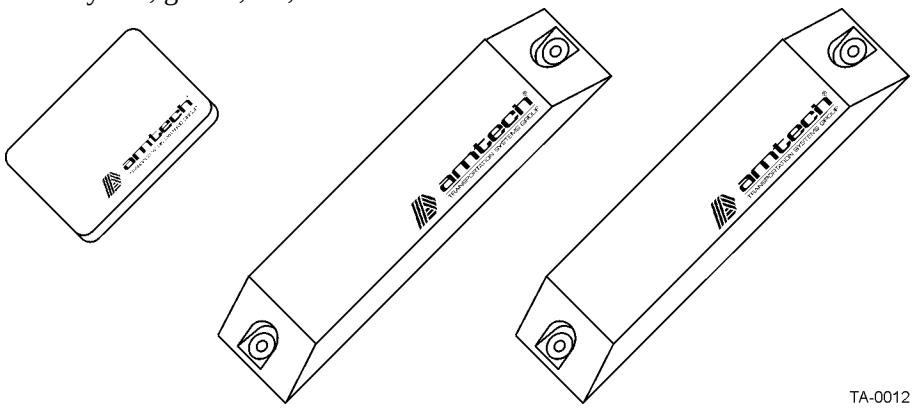


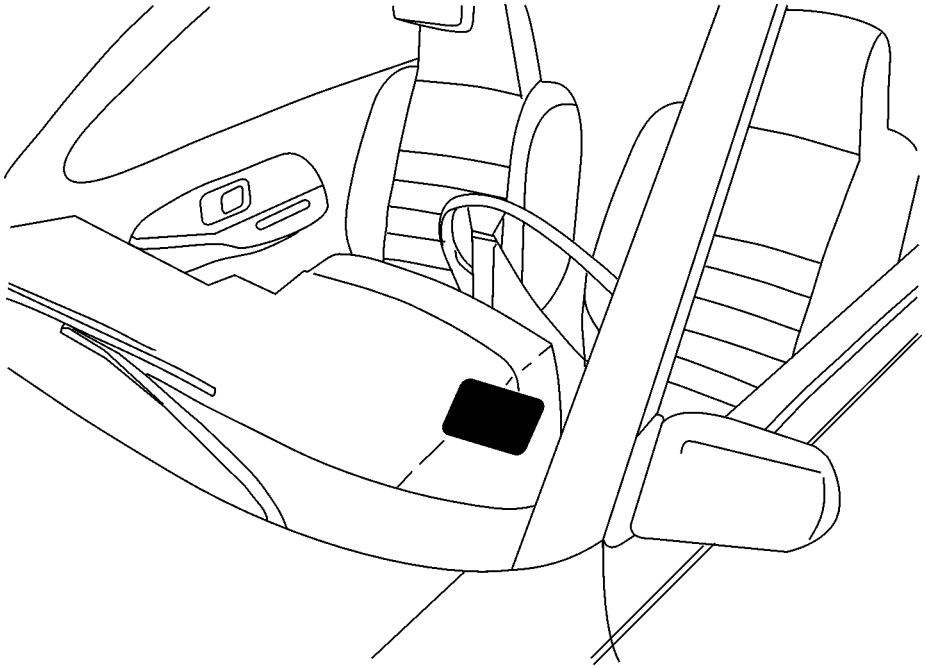
Figure 2-15 AT5100 TollTag and the AT5110 and AT5510 Transportation Tags

Tag Mounting

Proper tag mounting is a major factor in system performance. Tags should be mounted to correspond to antenna polarization. Additionally, each tag model has specific needs based on environment.

The Amtech-brand TollTags are designed to be mounted on a non-conductive surface, such as the inside of a vehicle windshield, using a detachable non-metallic holder or hook-and-loop attachment. The tag should not be mounted behind any metallic object, such as behind the car hood or windshield wipers. Other metal structures or objects should be at least 2 inches away from the tag. For example, the tag should not be

mounted directly on the dash or rearview mirror, and metal objects on the dash should not be behind the tag.



TA-0028

Figure 2-16 AT5100 TollTag® Mounted on the Inside of an Automobile Windshield

The transportation tags, including the AT5110, AT5510, and AT5515 tags, are designed to be mounted on an external metal surface using blind rivets. Alternatively, these tags can be mounted using specific TransCore-approved double-sided tape. Use of unapproved tape or other mounting devices can damage the tag case or fail to secure the tag properly.

TA-0011

Figure 2-17 Transportation Tag Mounted with Rivets

These tags can be mounted on a non-metallic surface if they are first attached to a metal plate. The plate must be flat and larger than the tag by at least 2 inches on all sides.

Caution

Use of nuts and bolts to mount the tags can crack the tag case and damage the electronic circuitry. Enlarging the mounting holes can damage the case seal and damage the tag.

ID Codes

The electronically encoded message, or ID code, is stored in the non-volatile memory of the tag. The ID code lasts for the lifetime of the tag or until the circuitry is reprogrammed. The ID is not affected by the number of times the tag is read.

Tag Programming

Tags can be *programmed* at the factory according to a user-provided list of identification codes (factory programming). Transportation tags can be programmed directly by the user in the field (field programming) with the Amtech-brand AP4100 Programmer.

After programming, the tag case is closed or sealed to prevent moisture and other contaminants from entering the tag case. Field-programmed TollTag cases are snapped shut. Transportation tags have their programming ports sealed with a removable plug.

The Amtech-brand AP4100 Programmer allows the user to program into tags the identification codes matching those assigned to vehicles and containers. Field programming provides complete user control over the data contained in the tags.

The programmer is portable and is available with programming heads compatible with all transportation tags.

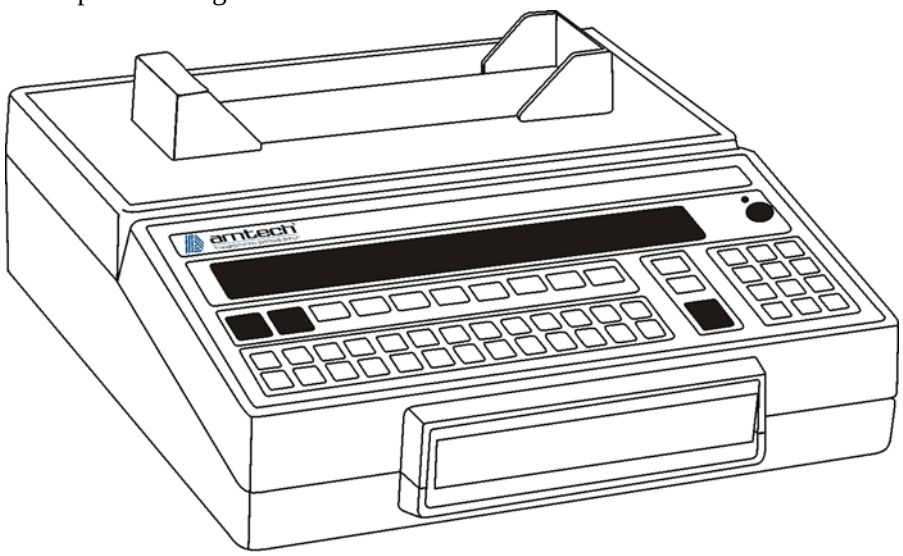


Figure 2-18 Amtech-brand AP4100 Programmer

System Design

RFID technology primarily uses tag-to-antenna *polarization*, RF *signal strength*, and *antenna radiation pattern* to define the optimal reading range for each antenna in a system. Other factors, such as *RF reflectors* and *interference*, must also be considered in system design.

Polarization

The use of antenna polarization and the proper orientation of tags is highly effective in establishing fine discrimination between closely situated tags. An antenna's polarization is usually aligned in the direction of its elements, although the elements may not be visible if the antenna is enclosed in a weatherproof radome.

Like antennas, tags are polarized. Matching the tag and antenna polarization is a major factor in obtaining optimal system performance.

Generally, tag orientation can deviate up to 15° from ideal orientation without appreciable decline in system performance.

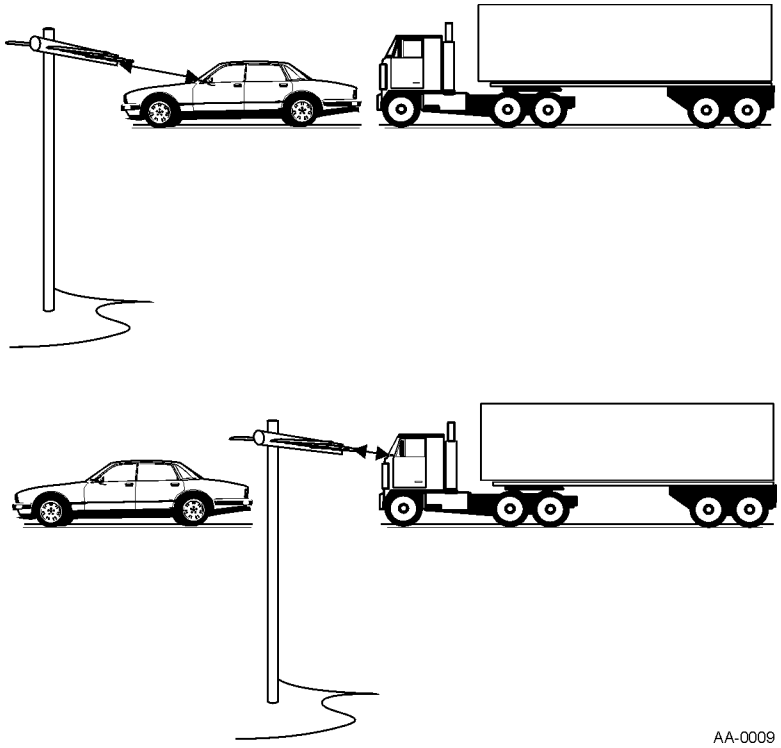


Figure 2-19 Vehicle Tag Orientation

Oriented favorably in the direction of the antenna's polarization, a tag is easily read even at greater than normally expected distances. Oriented unfavorably, a tag within the reading range may not be read.

Signal Strength

When designing a system, TransCore-certified personnel establish an optimal reading range by taking advantage of the antenna's characteristic polarization and radiation pattern and by increasing or decreasing the strength of the signal transmitted. Decreasing, or *attenuating*, the signal can limit the reading range to cover only the desired area.

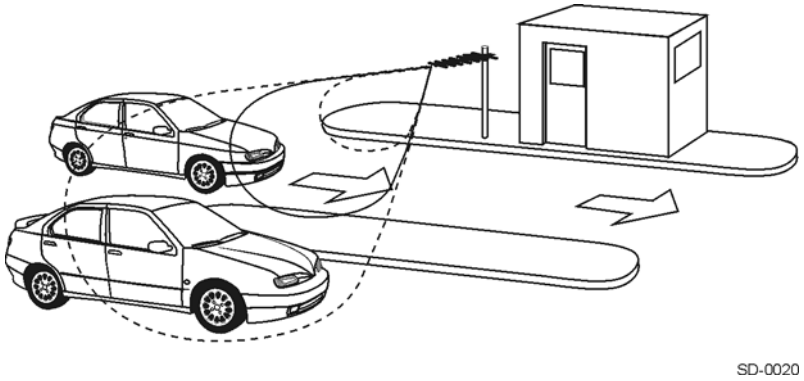


Figure 2-20 Attenuating the RF Signal

Antenna Pattern

Each type of antenna broadcasts RF energy generated by the RF module in a characteristic pattern. The shape of the reading range generated by each antenna can be related directly to the radiation pattern.

Figure 2-21 shows the radiation pattern of a Yagi antenna.

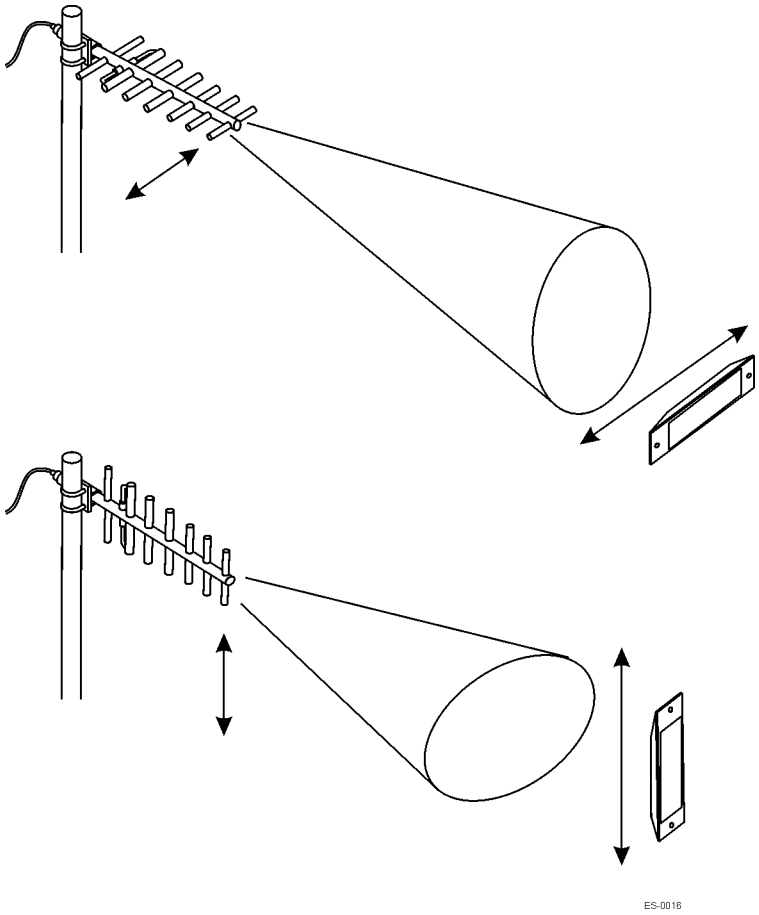


Figure 2-21 Yagi Antenna's Radiation Pattern

Lobes and Nulls

Generally, an antenna's radiation pattern is relatively uniform directly in front of and at a distance from, the antenna. Certain regions of irregular RF patterns are called *lobes* and *nulls*. *Lobes* emanate from the antenna elements into three-dimensional space, extending the reading range into peripheral areas. Between the lobes are the *null* regions, where RF signal strength is diminished.These regions are located behind and, primarily, to the side of the antenna. Lobes and nulls impact the reading range most significantly at the boundaries where a tag enters and exits the antenna's field, but these lobes and nulls also exist in the space above and below the antenna.

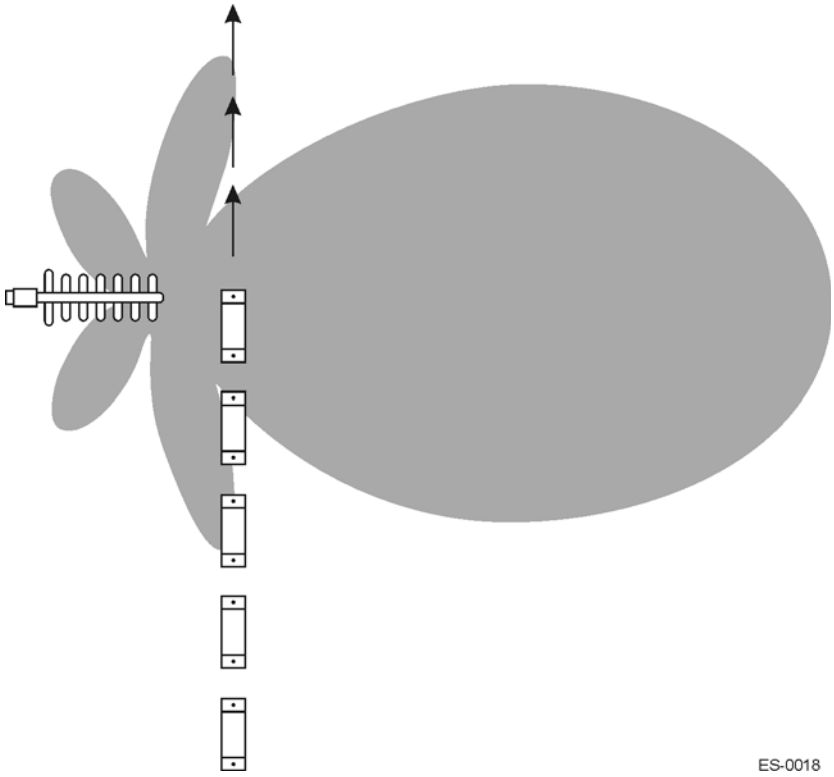


Figure 2-22 Lobes and Null Regions in Field

Within these regions, the quality of signal reception can vary dramatically with relatively little change in tag position. A tag whose signal is exceptionally strong when entering a lobe at the boundary of the reading range may return no signal at all as it passes through the null region. When it reaches the main field, the tag once again returns a strong signal, which continues until the tag passes through the nulls and lobes at the other side of the field.

RF Reflection and Interference

RF reflection and *interference* are factors that can affect system performance and cause tags to be read outside the designated reading range or, conversely, prevent tags inside the range from returning an adequate signal.

Just as light reflects off a shiny surface, the RF signal can be reflected by metal objects, walls, and even wet pavement or ice. The system designer takes into account any permanent structures that would be *RF reflectors*. Also anticipated are transient factors, such as passing traffic and local weather conditions, such as ice, that could temporarily reflect RF energy.

The system must be capable of acquiring the IDs from all tags properly within the reading range and to ignore all others. At installation, the antenna is positioned to allow the RF signal to reach, and return from, tags within its designated range. Ideally,

signals will not reach tags outside the designated field, as long as the antenna and tag positions and original design conditions remain as they were at installation.

Should the antenna become misaligned or some permanent structure be added or removed, system operation can be seriously affected.

Note: *Any reconfiguration or restoration of the system should be supervised by TransCore-certified personnel.*

Interference from RF and electrical sources can degrade system performance and is factored into system design and installation. Existing sources of interference at the site can be shielded or removed, affected equipment can be positioned at an adequate distance from the source, or filters can be added to the system. Fluorescent lights, neon signs, nearby radio stations or power lines can interfere, to some degree, with the optimal performance of the system. Even the *noise* from relays, such as the opening and closing control that operates a gate, can disrupt the RF signal.

Note: *TransCore designed the system to perform optimally under all site conditions that exist and reasonably can be expected to exist intermittently at the time of installation. Therefore, any subsequent changes can potentially affect system performance and should only be made with the advice of TransCore-certified personnel.*

Reader Firmware Control

After the on-site physical environment has been factored into system design, the system can be further configured through *reader firmware control*.

Through reader firmware commands, the system can filter and manipulate signals received, testing them against user-accessible criteria prior to transmitting them to the host.

ID filter parameter commands allow the user to control the conditions upon which an ID that has been read will be buffered and transmitted. A tag can be read many thousand times a minute when in the system reading range. It is normally useful to set conditions to filter out unwanted acquisitions of the same tag or occasional IDs received from the fringes of the reading range. These conditions include the number of times in succession a tag must be read before its ID is buffered or logged (`Select Valid ID`); the number of different codes that must separate an ID code from itself in previous reads (`Select Unique ID`); and the time limit (`Variable Time-Out`) applicable to the unique ID filter.

The `Select Valid ID` command enables the system to filter out unwanted tag signals. In most cases, tags passing through the designated reading range will be read many times before exiting the range. This command allows the system to require a minimum number of successive reads to consider an ID code valid. Although signals that stray into range can be picked up by the antenna, they generally will not be strong enough to register the minimum number of successive reads to be considered valid. Figure 2-23 illustrates a validation sequence of four reads before the system buffers and transmits the ID.

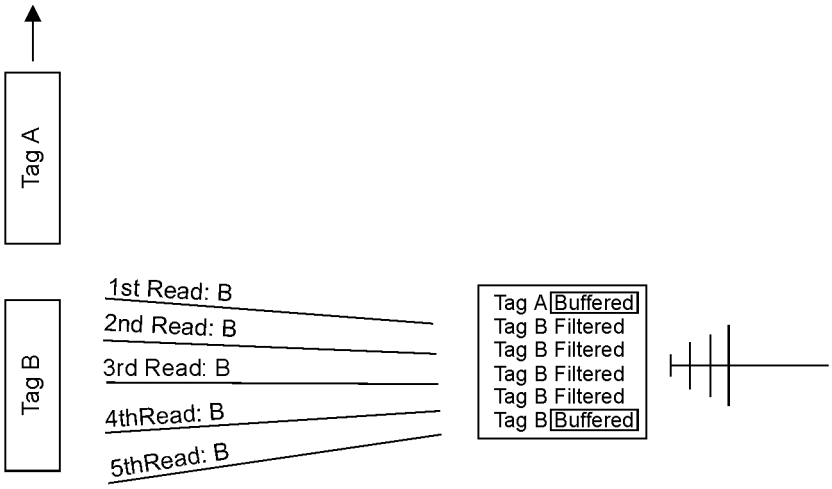


Figure 2-23 Valid ID Filter

Because the system receives and decodes a tag's ID many times a second while the tag is in the antenna's reading range, it is normal to filter the duplicate reads of a single tag. The `Select Unique ID` command sets the number of different ID codes that must separate an ID code from previous reads of itself (*separation criteria*).

As an example, consider a tagged railcar standing a full minute next to a switchyard antenna. The system would receive this ID code several thousand times during this minute. To prevent the reader's output buffer from filling with the same ID, the reader's `Select Unique ID` filtering function permits the ID to be stored in the buffer only the first time it is acquired.

With a separation criterion of 1, the system will not buffer the railcar's tag until at least one different ID has been acquired. With a required separation of 2, two different IDs must be acquired before the first can be read and buffered again and so on.

Table 2-1 Effect of the Select Unique ID Criteria

Tags Read Select Valid ID of 1 Read	Tags Buffered for Comparison	Tags Transmitted Select Unique ID Separation 1	2	3	4
A	A	A	A	A	A
B	B	B	B	B	B
C	C	C	C	C	C
C	-	-	-	-	-
A	A	A	A	-	-
A	-	-	-	-	-
B	B	B	B	-	-
A	A	A	-	-	-
C	C	C	C	C	-

In some cases, however, duplicate or successive reads of a tag ID may be appropriate, as in the case of a train entering and then backing out of a blind rail siding.

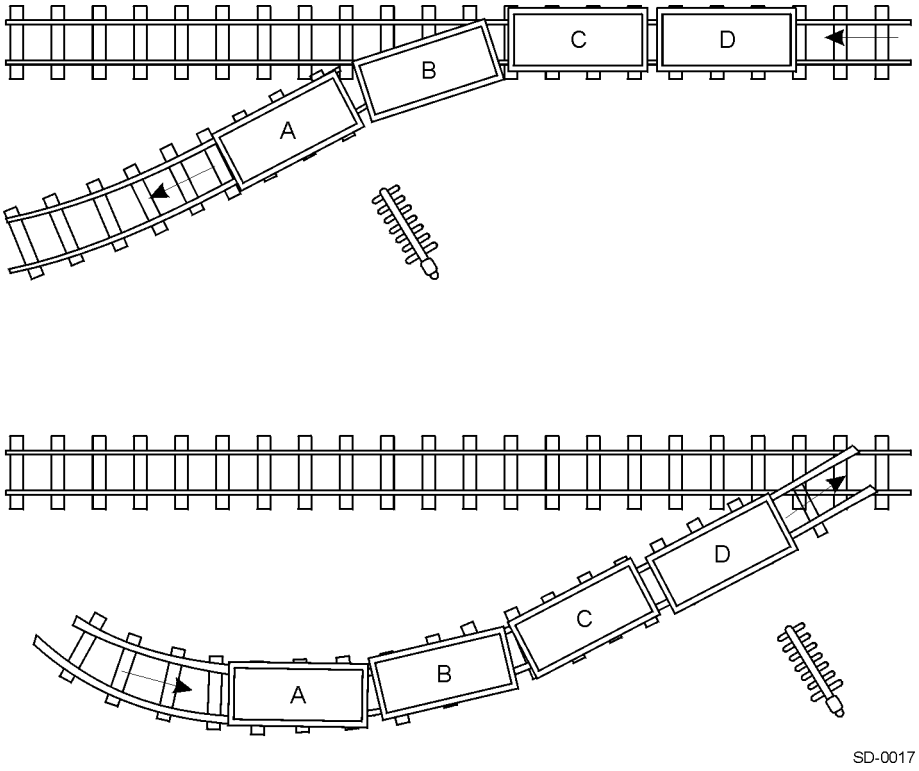


Figure 2-24 Appropriate or Duplicate Successive Tag Reads

As the train enters past the antenna, the tags on its cars are read in normal order, **ABCD**. As the train backs out of the siding, its tags are read again in reverse order, **DCBA**. If successive reads were filtered out, the system would not register the exit of car **D** from the siding because **D** was the ID most recently buffered.

The `Variable Time-Out` command can be used to limit the duration of the unique ID filter so that successive reads can be buffered after a requisite amount of time has passed since the prior read. The clock resets whenever a new ID is buffered.

The `Variable Time-Out` clock is continuously reset (does not expire) with each duplicate read of a tag's ID. Thus, in the railcar example, car **D** must be removed from the reading range for a period long enough to allow the time-out to expire so the system will accept the car's ID as valid when it backs out.

Figure 2-25 illustrates examples of the time-out effect on the unique ID filter. In the first example, as the tag continues to be read, each successive read resets the timer. Thus, tag **D** could not be acquired a second time.

In the second example, as tag **D** enters the siding, it is read and buffered once and moves out of the reading range until the time-out period has expired. It is read and buffered a second time as it backs out because the time-out period has expired and the system now identifies its ID as new.

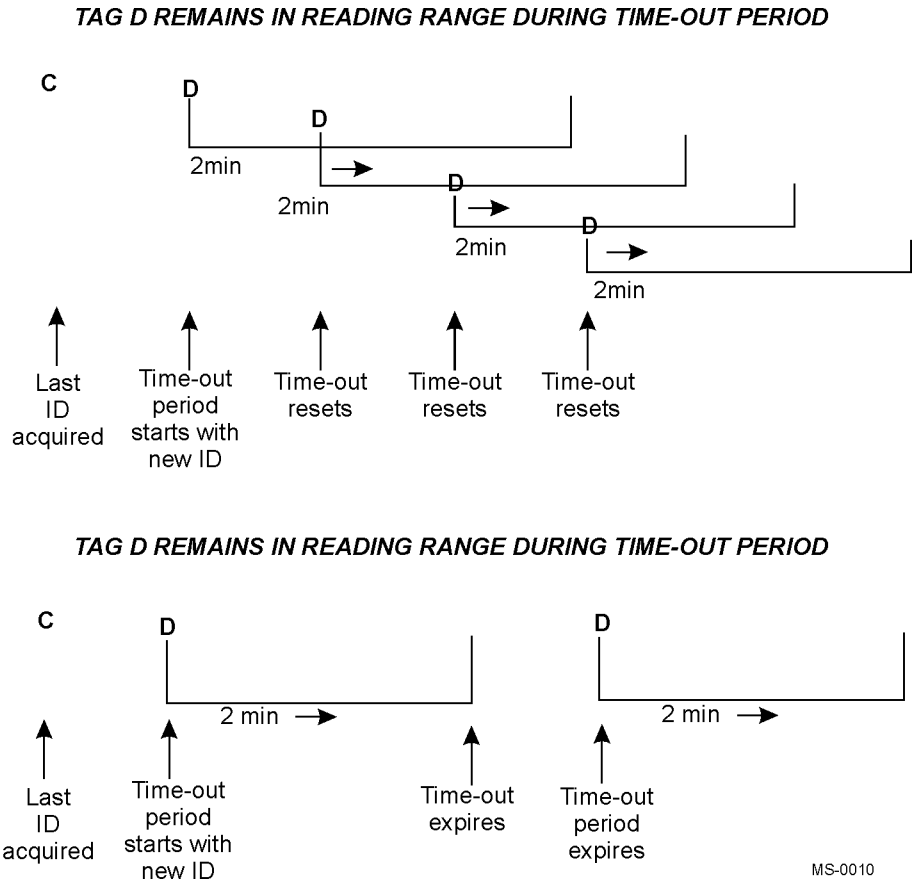


Figure 2-25 Examples of Variable Time-Out

The uniqueness can also be reset directly at any time with the `Reset Uniqueness` command.

System Control

The user controls the system through commands given to the reader through the **Main** port using the host computer or attached terminal. These commands are divided into eight groups according to their primary function.

Table 2-2 Reader Commands

Command Group	Function
0	Data and Command Mode Control
1	Communication Port Control
2	Real-Time Clock Control

Table 2-2 Reader Commands (continued)

Command Group	Function
3	Format ID (Append Information)
4	ID Filter Parameters
5	Reader Status
6	Reader Control Functions
7	Search Functions
8	Auxiliary Reader Control

These commands are discussed in depth in chapter 4.

3

Licensing Requirements and Health Limits

Chapter 3

Licensing Requirements and Health Limits

This chapter explains TransCore radio frequency identification (RFID) systems licensing requirements and how to obtain permission from the government radio regulatory agency to operate an RF system. Occupational Safety and Health Administration (OSHA) environmental guidelines regulating safe exposure levels are also discussed.

System Licensing

TransCore systems must be licensed by government radio regulatory agencies in the country of installation. Because of the length of time needed for the licensing process, licensing applications are normally filed during the site survey phase of system design. This licensing must be complete prior to the operation of the TransCore system.

Frequency and Power

Operation of the TransCore equipment must comply with the government regulatory licensing requirements of the country in which it is installed. These requirements regulate the operating RF range and power of installations emitting RF.

TransCore RFID systems operate in the United States using RF in the 902 to 928 MHz band. This band complies with regulations of the Federal Communications Commission (FCC) for this type of equipment.

United States Licensing

The user is required to obtain a Part 90 site license from the FCC to operate this RFID device in the United States. See product label for FCC ID number. Access the FCC Web site at www.fcc.gov/Forms/Form601/601.html for additional information concerning licensing requirements.

Site licenses are granted through Part 90 for operation in the frequency ranges 902.25 to 903.75 MHz and 910 to 921.5 MHz.

International Licensing

For operation in certain countries in the Far East and Europe, TransCore manufactures Amtech-brand equipment that operates between 2400 and 2500 MHz.

Note: *Users in all countries should check with the appropriate local authorities for licensing requirements.*

Health Limits

Within the United States, environmental guidelines regulating safe exposure levels are issued by OSHA.

Section 1910.97 of OSHA Safety and Health Standards 2206 legislates a maximum safe exposure limit of 10 milliwatts per square cm averaged over 6 minutes at both 915 and 2450 MHz.

Although not binding, other organizations, such as the American National Standards Institute (ANSI) have issued similar guidelines that are more restrictive than the OSHA limits. See ANSI C95.1.

ANSI guidelines recommend a maximum of 3 milliwatts per square cm at 915 MHz, and 5 milliwatts per square cm at 2450 MHz. The power limit is a 6 minute average. At 915 MHZ, Exclusion 4.2(2) provides an exclusion of the limits if transmitted power is 7 watts or less.

Measurements of radiated power at 2 watts transmitted power for the four antennas presently available for use at 915 MHz, established that all these antennas function within both OSHA and ANSI standards at maximum output.

The power density measured at the face of the AA3500 Horn Antenna at 0.3 watts RF power was also found to be within both guidelines.

The data confirm that the TransCore system effectively meets OSHA requirements and, thus, does not represent an operating hazard to either the general public or maintenance personnel.

4

AI1200 System Operations

Chapter 4

AI1200 System Operations

This chapter describes the operations of the installed AI1200 System.

System Component Operation

The AI1200 System is designed and installed to provide optimal performance within each site's unique operating environment. Such factors as RF signal power, antenna type and orientation, and tag type have been carefully selected to provide the desired performance with respect to such elements as proximity of other antennas, speed and angle of tag passage, and RF signal obstructions, reflectors, and sources of interference.

Component operation addresses the physical components of the system. It describes the basic functions of the components and physical manipulation of the system accessible by the user.

Note: *The user should not attempt to modify system configuration except through reader commands provided in Appendix C, or upon instruction from TransCore-certified personnel.*

Connecting Components

The reader provides central control for the function of external components. Sense input modules, status output modules, serial communication connections, and system RF modules are physically connected through the AI1200 backplane. Connections to these components are made from terminal blocks inside the reader case. The terminals are labeled from 1 through 51 and are grouped according to function.

AI1200 Reader

The AI1200 reader's main functions are to *process* the tag signal arriving from one or both RF channels, *decode* it to an ID, and temporarily *store* and *transmit* the information to the user's host computer. Additionally, the reader can *control* external hardware (such as traffic signals or gates), *perform* logical operations, *append* useful information to the processed ID codes (such as date, time, and location), *allow manual entry* of ID codes, and *search* for specific IDs. The majority of these functions are controlled by permanent reader firmware programming or manipulated through commands described later in this chapter.

Physical connections to external devices (such as antennas and host computers) and power regulation are accomplished through the AI1200 terminal connectors. Figure 4-1 shows the reader terminal connectors and primary features.

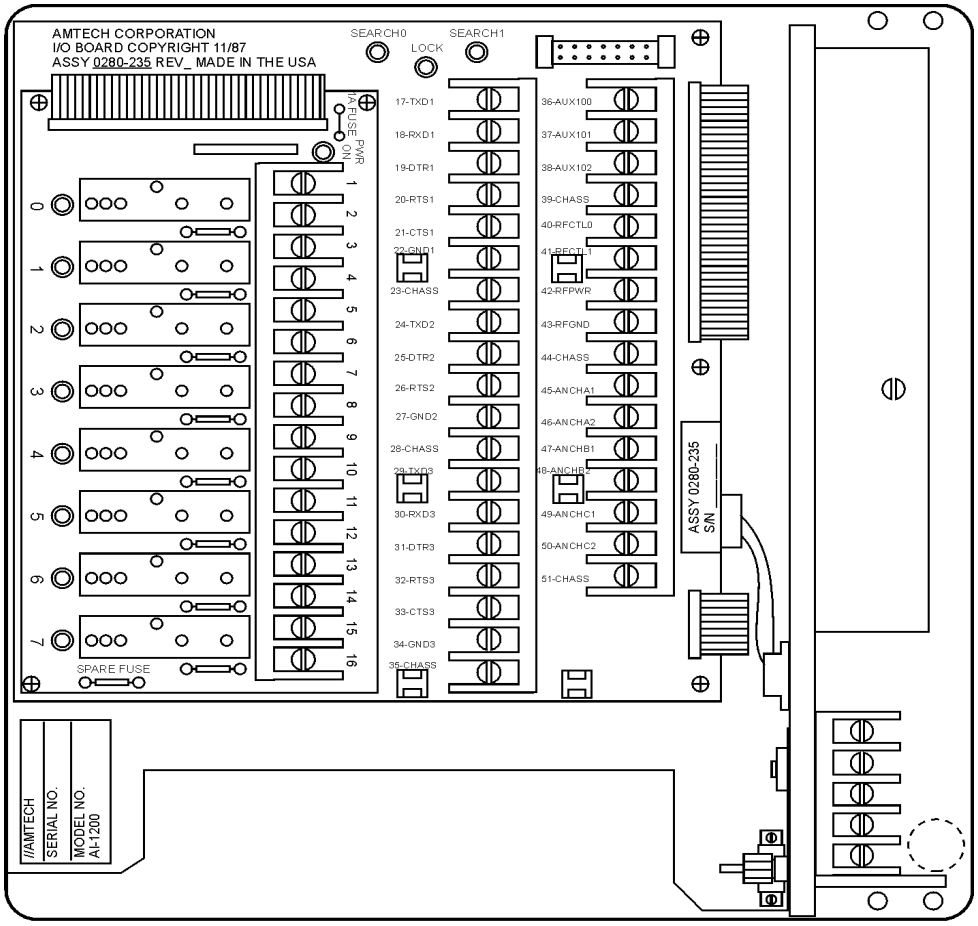


Figure 4-1 Reader Terminal Connectors

Reader Power

The reader supplies all electrical power to the system. The reader converts AC, or optional DC, power into DC power for use by the other components.

Power Switch and Supply

The reader power switch is located on the side of the power supply housing. Turning power off to the reader also turns power off to the RF module and antenna. The reader power supply unit is wired directly to the power source.

Caution

Do not service the power supply unless the power has been turned off through a circuit breaker or other means.

Voltage Selection

The reader is factory-wired to operate on AC voltage at 110 V or 220 V, 50 or 60 Hz. The reader can also be ordered with a DC power supply operating at 12, 24, or 72 VDC. The voltage selection switch, located on the top of the power supply unit, is set and tested during installation of the system. In the unlikely event that the voltage selection should need to be altered, follow the steps in this section.

Warning

Operating the AI1200 System with an incorrect voltage setting can severely damage the reader. It is recommended that TransCore-certified personnel or an electrician make voltage selection adjustments to the reader.

To alter voltage selection

1. *If the reader has active power connections,* turn off power to the circuit, then turn off the power supply switch.

Caution

Do not attempt to change the voltage selection with live power connected to the power supply.

2. With all power to the reader completely turned off, disconnect existing wires to the power supply unit.
3. Use a medium screwdriver to turn the voltage selection switch to the new setting.
4. Connect the reader power supply unit to the new power source.
5. Turn on the power to the circuit; then turn on the reader power supply switch.

Note: *DC and harsh environment power module options have no voltage selection switch. Operate these units within their specified voltage input ranges.*

Fuse

A fuse located next to the power switch protects the reader's internal circuitry from faults causing excessive current demands. If necessary, the fuse can be replaced with an equivalent fuse whose rating matches that shown on the power module's input ratings decal.

Note: *The primary power terminal block is still active even when the fuse is blown.*

Status Output and Sense Input Modules

Reader terminals 1 through 16 are associated with the sense input and status output modules. Status output modules provide signals for the control of external equipment, such as lights or gates. Sense input modules receive signals from external equipment, such as proximity sensors.

The configuration and connection of these modules is accomplished during design and installation. Only TransCore-certified personnel should alter the modules or their terminal connections.

Serial Communication Ports

The dual-channel reader has three RS-232 serial communications ports, designated **Main** port terminals 17 through 23, **AUX-1** port terminals 24 through 28, and the optional **AUX-2** port terminals 29 through 35.

All connections made to these communications ports require minimum 22 gauge RS-232 cable. *FCC regulations require that this cable and all adapters be shielded.* In permanent installations, all cables are run through metallic conduit into the NEMA box.

Main Port Communications

The **Main** port transmits ID information to and receives commands from the host computer. When the **Main** port is receiving commands, it cannot transmit data, and vice-versa. Also, the **Main** port can be *locked* (unable to receive commands) either by the optional **AUX-2** port or directly through host computer commands. The terminal connections are shown in Table 4-1.

Table 4-1 Main Port Terminal Connections

Terminal Number	Labeled	RS-232 Signal	Function
17	TXD1	TD	Transmit Data
18	RXD1	RD	Receive Data
19	DTR1	DTR	Data Terminal Ready
20	RTS1	RTS	Request to Send
21	CTS1	CTS	Clear to Send
22	GND1	GND	Signal Ground
23	CHASS	None	Chassis Ground

The **Main** port has the following factory communication parameter settings:

Baud	300
Parity	Disabled
Stop Bits	1
Data Bits	8
EOL Delay	0 ms

These parameters can be changed using reader commands described later in this chapter.

Note: *All communications parameter commands for the **Main** port also apply to the **AUX-1** port.*

AUX-1 Port Communications

The **AUX-1** port is a transmit-only port that echoes all information transmitted via the **Main** port. **AUX-1** allows information being transmitted via the **Main** port to also be sent to a printer or other logging device.

Table 4-2 AUX-1 Terminal Connections

Terminal Number	Labeled	RS-232 Signal	Function
24	TXD2	TD	Transmit Data
25	DTR2	DTR	Data Terminal Ready
26	RTS2	RTS	Request to Send
27	GND2	GND	Signal Ground
28	CHASS	None	Chassis Ground

The factory-set communication parameters for the **AUX-1** port are the same as the **Main** port, and can only be changed simultaneously with the **Main** port.

AUX-2 Port Communications

The optional **AUX-2** RS-232 port allows additional communication and control of reader functions through a secondary local terminal. This port is used primarily for special reader functions, such as manual entry of IDs and ID search.

Table 4-3 AUX-2 Terminal Connections

Terminal Number	Labeled	RS-232 Signal	Function
29	TXD3	TD	Transmit Data
30	RXD3	RD	Receive Data
31	DTR3	DTR	Data Terminal Ready
32	RTS3	RTS	Request to Send
33	CTS3	CTS	Clear to Send
34	GND3	GND	Signal Ground
35	CHASS	None	Chassis Ground

The **AUX-2** port has the following factory-set communication parameters:

Baud	300
Parity	Disabled
Stop Bits	1

Data Bits	8
EOL Delay	0 ms

Terminals 36 through 39

Terminals 36 through 39 are reserved for future use and normally will not be connected in an installed operating system.

RF Module Connection

Terminals 40 through 51 are used to connect the RF modules. These terminals transmit DC power to the RF modules, transmit the RF power on/off signal to the modules, and receive the ID-bearing IF (intermediate frequency) signals from the modules. These connections are made during the installation of the system. Terminals 40 through 51 are used in two-antenna systems. In systems using only one antenna, only terminal 40 or terminal 41, but not both, are used.

Reader Indicator Lights

Indicator lights on the AI1200 Reader reflect system status. The **PWR ON** light indicates power to the reader is on.

SEARCH 0 and **SEARCH 1** indicate the control lines to RF channels 0 and 1, respectively, are activated and the RF power is turned on. With the reader operating in multiplex mode, **SEARCH0** and **SEARCH1** light alternately when no tags are present in either antenna reading range. In systems operating with single RF, only the active RF channel's **SEARCH** light is on. **SEARCH 0** is operational if RF channel 0 is being utilized.

The **LOCK** light indicates that signal reception is taking place for the antenna/RF channel whose **SEARCH** light is on.

Stat Output LIGHTS 0 through 3 indicate output module activation. **Sense Input LIGHTS** 4 through 7 indicate input module activation.

RF Module

The RF module generates the RF power necessary to read a tag. It also contains receiver and pre-amplifier circuitry to preprocess the tag signal returned through the antenna. The RF module is connected to the reader and antenna during installation and should require no further mechanical adjustment from the user.

Note: *Always ensure an antenna or termination is connected before turning on power to the reader. Turning on RF power with either antenna port disconnected could damage the RF module. Always terminate unused antenna ports with a 50 ohm load.*

The RF module receives DC power through cable connections made to the reader. The reader-to-RF module cable also carries the demodulated tag signal from the RF module to the reader and the on/off control signal from the reader to the RF module.

As a factory setting, RF power is on whenever the system is on. However, one or both RF channels can be turned off through reader firmware commands. RF power can also

be controlled through interfacing proximity sensors with the reader. Proximity sensors allow RF power to be turned on only in the presence of objects to be identified. Proximity sensors are useful in installations using battery power or where continuous RF power is not desirable. Proximity sensors are interfaced through the **SENSE 0** through **SENSE 3** input modules during installation.

Increases or decreases of the RF signal strength directly impact the system's reading range. To confine the reading range to its optimal area, attenuators to decrease the RF signal can be installed in the coaxial cable between the RF module and the antenna, or in the jumper cable on an AR2200 RF module. Increasing the RF signal strength should not be attempted by the user. This is to preserve system design integrity and to ensure the RF module conforms to its FCC certification parameters.

Long cable runs between the RF module and antenna can degrade system performance and are avoided in system configuration.

Antenna

The antenna has two functions: to transmit the RF signal to the tag and to collect the coded signal reflected by the tag. The antenna is connected to the RF module during system installation and should require no further mechanical adjustment from the user.

The TransCore system designers determined antenna type and alignment to deliver optimal performance within each location's unique operating environment.

Note: *If an antenna becomes misaligned, or if permanent obstructions are placed in the installation area, contact TransCore immediately.*

Reader Functions and Command Operations

This section describes the reader functions and the command operation of the installed AI1200 System.

Reader Functions

Reader functions are characterized as *principal, auxiliary,* and *special* functions.

Principal functions are to decode the signal acquired through the RF channels, filter and store IDs in the output buffer, and transmit buffered IDs to the host or local terminal.

Auxiliary functions are subordinate to the principal functions but give the reader great flexibility in handling the retrieved ID information. These functions are manipulated through the use of reader commands. These functions include controlling external hardware and appending information to the ID codes and other transmissions sent to the host computer.

Special functions normally require the use of the optional **AUX-2** port. These functions include manually entering ID codes of untagged equipment and using the reader to search for a specific ID number.

Many system operations are controlled through *reader commands*, including the auxiliary and special functions. Although the reader firmware is set to default values at the factory, the user can change those values through the use of reader commands.

Reader Operating Modes

The reader has two primary modes of operation. The data mode permits transmission of data to the host computer and the command mode accepts commands sent from the host computer. Data mode is the factory setting mode for the reader. Data mode allows the transmission of IDs from the reader to the host computer via the **Main** port. The only command accepted by the reader in data mode is to switch the reader into command mode.

Note: *The reader is always in data mode on power up.*

Command mode allows commands to be sent from the host computer to the reader via the **Main** port. Command mode halts the transmission of IDs from the reader to the host computer. Any IDs acquired by the reader while in command mode are stored in the output buffer until the buffer is full. When the buffer is full, the reader issues an error message to the host computer and all new IDs are lost. It is important to return from command mode to data mode once all reader commands are complete.

The reader also operates in a third mode when the **AUX-2** port is active. The **AUX-2** port can *lock-out* transmissions from the **Main** port. When the **Main** port is locked out, the reader ignores commands from the host computer as it does in data mode.

Reader Command Groups

Reader commands are divided by primary function into nine groups. Following is a general discussion of the functions of the nine command groups.

Group 0 – Reader Mode Control

Command group 0 controls reader mode and locks or unlocks the **Main** port.

Data mode is the factory-default setting that allows the reader to transmit buffered IDs to the host computer via the **Main** port.

Command mode permits the host computer to transmit commands to the reader via the **Main** port. Tag ID data transmission from the reader is suspended while the reader is in command mode.

Note: *The reader supports XON/XOFF flow control for output while in data mode. However, transmission of reader output (IDs) is never suspended until the current ID has been completed transmission.*

The reader also supports hardware flow control via the RTS and CTS lines in both data and command modes. Transmission of reader output is suspended within one character after the CTS line goes *false*.

Group 1 – Communication Port Control

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

Note: *Applying Group 1 commands to the* ***Main*** *port automatically applies them to the* ***AUX-1*** *port as well. Parameters for the optional* ***AUX-2*** *port are set separately.*

Through Command Group 1, the user can set baud rate, stop bits, parity, and end-of-line delay.

Group 2 – Real-Time Clock

Group 2 commands control the real-time clock, which maintains the time and date. Group 2 commands allow the user to set or display the time and date.

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

Group 3 – Append Information

Group 3 commands append useful information to reader transmissions, such as IDs, error messages, and sensor input reports. The reader is set at the factory to append time and date to all IDs. Auxiliary information, such as reader number, antenna number (or manual entry code), number of times the previous tag was read, and sensor input status, can also be appended to the ID through the use of Group 3 commands.

Group 4 – ID Filtering

Group 4 commands perform three different filtering functions: `Select Unique ID`, `Variable Time-Out`, and `Select Valid ID`.

The `Select Unique ID` commands filter out repetitive IDs and only transmit a single ID to the host computer. This feature is valuable because a tag's ID code can be acquired approximately 70 times per second. The factory setting is to compare a new ID to the most recently buffered ID to see if it is the same. The reader can compare new IDs up to the four most recently buffered IDs.

For practical reasons, the `Select Unique ID` commands have an expiration limit imposed by the `Variable Time-Out` commands.

The three `Variable Time-Out` commands are used in conjunction with the `Select Unique ID` commands. They place a time limit on the `Unique ID` filter. The time-out period can be set to 2, 20, or 60 minutes. These commands allow the same ID to be buffered twice, after a period of time, rather than being filtered out. The time-out period can also be directly reset by the `Reset Uniqueness` command.

The four `Select Valid ID` commands filter IDs decoded by the reader. These commands instruct the reader to read an ID a specific number of times in succession before storing it in the output buffer. The reader can be set to require sequences of 1, 4, 16, or 64 reads.

These commands are applied before the `Select Unique ID` parameters. An ID must be read the specified number of times *prior* to being compared to the specifications defined by the `Select Unique ID` commands.

The validation test is primarily useful in multiple antenna installations to filter out IDs received from fringe areas of the reading range.

Group 5 – Reader Status

Group 5 commands provide status reports on the parameters and operation of the reader. The user can display operational conditions of the reader, such as the status of the I/O modules or communication port parameters. Parameter information set through reader commands is also obtainable through this group, such as filtering criteria and appended information status.

Group 6 – Reader Control Functions

Group 6 commands set reader control functions, such as output pulse duration, RF control, and modem control. They also invoke the diagnostic menu of the reader. These commands are also used to turn on an automatic report when presence detectors are activated, but no tag ID is acquired. The majority of these commands are used by TransCore-certified personnel in the installation or modification of the system. Some of these commands, such as `OUTPUT CONTROL` (`#620N`), can be sent by host computer systems to control external equipment.

Error-correcting protocol is accessed through the `#611` command and its timeout is specified by using the `#612` command.

Group 7 – Search Control Functions

Group 7 commands control the reader's search control functions when performed through the **Main** port. These search functions can also be implemented through the optional **AUX-2** port.

Group 8 – Auxiliary Reader Control

Group 8 commands provide control of reader functions, such as the system check tag. These commands also control writing parameters to and restoring parameters from the EEPROM.

Reader Command Protocol

The reader only accepts commands from the device connected to the **Main** port - either the host computer or local terminal. Functions performed through the **AUX-2** port are accomplished through menu selections rather than commands. The **AUX-2** functions are discussed in a separate section later in this chapter.

To give commands to the reader

1. Put the reader into command mode using the `SWITCH TO COMMAND MODE [#01]` command.
2. Issue the appropriate commands.
3. Return the reader to data mode using the `SWITCH TO DATA MODE [#00]` command.

The reader must be returned to data mode after any command operations to ensure proper transmission of acquired IDs. If the buffer fills to 75% while the reader is in command mode, the reader issues an error message. This message prompts the user to return the reader to data mode before the buffer completely fills and new IDs are lost.

All reader commands are preceded by the # character, and the reader echoes all characters beginning with this character.

Command Entry Conventions

Commands are preceded by the # character and are completed by pressing **Enter** or **Return**. For example, the `SWITCH TO COMMAND MODE (#01)` command is typed as follows:

`#01`<**Enter**>

where <**Enter**> is the **Enter** or **Return** key.

In the following paragraphs, command characters can be represented by the letter `N`. This `N` indicates the user is to supply a value. Maximum valid entries are the numbers `0` through `9` and the uppercase letters `A` through `F`, which allows up to 16 available user responses and is based on the hexadecimal numbering system.)

Commands have at least two characters following the # character. Figure 4-1 shows the basic structure of a four-character command.

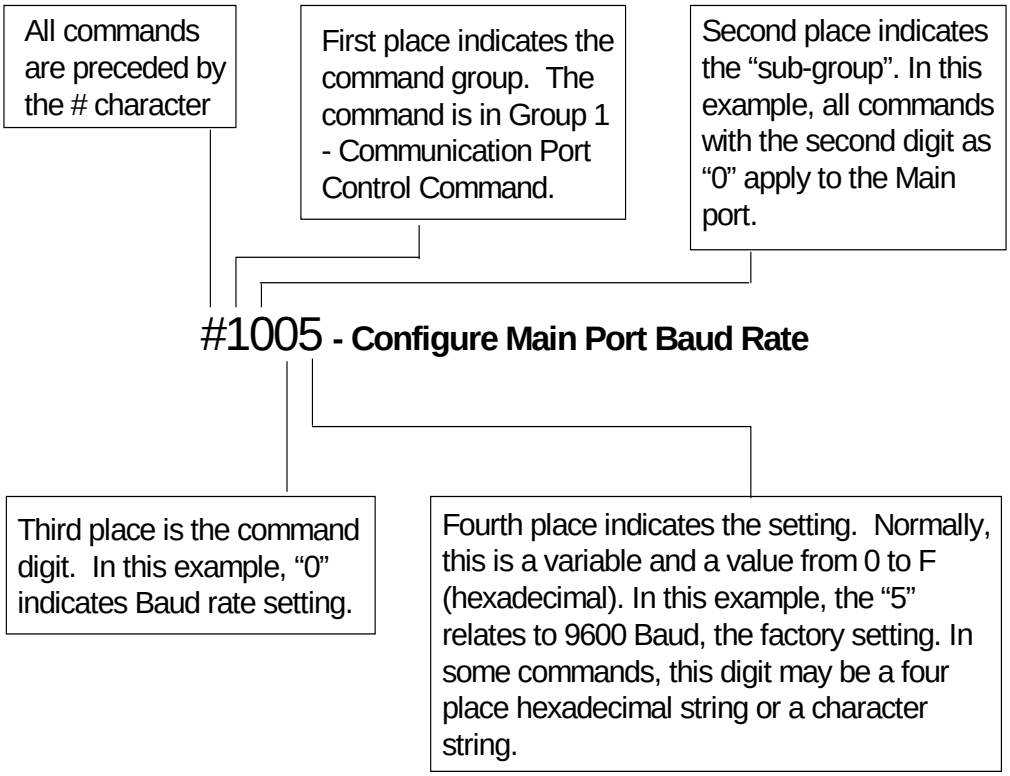


Figure 4-2 Basic Four-Character Command Structure

Command Response Conventions

Like reader commands, responses are preceded with the # character.

Many reader commands respond with `#Done` or `#Error` indicating the command was or was not recognized and completed.

Note: *Both* `#Done` *and* `#Error` *are six-character responses followed by carriage return and line feed. The* `#Done` *response has a trailing space (for example,* `#Done`*).*

Other commands respond with a four-character identifier followed by one or more values.

In the command discussions that follow, reader response characters may be shown in brackets <>, which indicates that the response is a value in the range of characters in the brackets. *The brackets are not part of the response.* For example, the `DISPLAY POWER OUTAGE BIT (#520)` command responds with either a `0` or a `1.` In the command discussion, the response is shown as:

```
#PWRB <0-1>
```

The *actual* reader response is one of the following:

#PWRB 0

#PWRB 1

In the previous example, PWRB is the 4-character identifier for power outage bit, and the 0 or 1 is the value. All spaces shown in the response are actual spaces sent from the reader. In the example above, there is one space between the letter B and the number.

Carriage return and line feed characters are at the end of each reader response.

Reader Command List

Each reader command is listed in order with an explanation of the corresponding reader action. Factory settings of the reader are indicated. A condensed listing of commands without explanatory text is found in Appendix C of this guide.

Command Group 0 – Mode Control

Group 0 commands determine whether the reader is operating in data or command mode. These commands also lock and unlock the **Main** port on the reader.

Note: *All Group 0 Commands respond with either* #Done *or* #Error.

Table 4-4 Group 0 Commands

Command Number	Command Text	Command Description
#00	SWITCH TO DATA MODE (factory setting)	Switches the reader to data mode, which allows transmission ID codes to the host computer. Data mode is the mode the reader assumes on power up. It is the factory setting. While in this mode, the reader accepts the following commands only: SWITCH TO COMMAND MODE (#01), PERFORM SYSTEM CHECK TAG TESTS (#811X), and SWITCH TO DATA MODE (#00). The reader supports XON/XOFF protocol while in data mode. However, transmission of reader output (for example, IDs) is never suspended until the current ID has been completely transmitted.The reader also supports hardware flow control via RTS and CTS lines.

Table 4-4 Group 0 Commands (continued)

Command Number	Command Text	Command Description
#01	SWITCH TO COMMAND MODE	Switches the reader to command mode, which allows the reader to receive commands from a host computer or terminal. While in this mode, the reader does not transmit IDs to the host computer but instead stores them in its output buffer for later transmission. If the buffer becomes full, new IDs are lost, and the reader sends an Error 02 message to the host computer. The SWITCH TO DATA MODE (#00) command must be issued to resume transmissions of IDs to the host computer. ***Note:*** *The reader also issues an error when the buffer fills to 75% capacity and another error when it empties to 50%.*
#02	LOCK OUT MAIN PORT	Disables the **Main** port from receiving commands from the host computer. The only commands accepted from the **Main** port when it is locked is SWITCH TO COMMAND MODE (#01) followed by UNLOCK MAIN PORT (#03). ID transmission still occurs when the **Main** port is locked, as long as the reader is in data mode. ***Note:*** *When the **Main** port is locked, the reader continues to echo any command characters. However, the reader returns* #Error *in response to any command except those listed above.*
#03	UNLOCK MAIN PORT (factory setting)	Unlocks **Main** port, whether the **Main** port was locked by the LOCK OUT MAIN PORT (#02) command or through the optional **AUX-2** port. Unlocked is the factory setting.

Command Group 1 – Communication Port Control

Group 1 commands configure the communication links between the reader and the host computer, local terminal, printer, or modem. Applying Group 1 commands to the **Main** port simultaneously applies them to the **AUX-1** port as well. **AUX-2** port parameters are set independently.

Note: *Commands applying to the **AUX-2** port return* #Error *if the **AUX-2** port is not installed.*

Note: *Reader response to Group 1 commands is at the pre-command setting. For example, when changing the baud rate from 300 baud to 1200 baud, the reader responds with* #Done *at the pre-command setting of 300 baud. Once the* #Done *response is transmitted, the new configuration becomes effective.*

Note: *All Command Group 1 commands respond with either* #Done *or* #Error.

Table 4-5 Group 1 Commands

Command Number	Command Text	Command Description
#100N	CONFIGURE MAIN AND AUX-1 PORT BAUD RATE	Sets the baud rate for the **Main** and **AUX-1** ports. The factory setting is 300 baud. The N variable sets the baud rate as follows: Baud Command Rate #1000 110 #1001 300(factory setting) #1002 1200 #1003 2400 #1004 4800 #1005 9600 #1006 19200
#101N	SET MAIN AND AUX-1 PORT STOP BITS	Specifies stop bits for **Main** and **AUX-1** port character transmission. The factory setting is one stop bit. The N variable sets the stop bits as follows: Command Stop Bits #1010 1 (*factory setting*) #1011 2
#102N	SELECT MAIN AND AUX-1 PORT PARITY	Selects **Main** and **AUX-1** port parity setting. The factory setting is parity disabled. The N variable sets the parity as follows: Command Parity #1020 disable parity (*factory setting*) #1021 enable even parity #1022 enable odd parity Command #1020 provides eight data bits and parity disabled. Command #1021 provides seven data bits and even parity; command #1022 provides seven data bits and odd parity.

Table 4-5 Group 1 Commands (continued)

Command Number	Command Text	Command Description
#103N	SET MAIN AND AUX-1 PORT END-OF-LINE DELAY	Sets the delay necessary to allow slow output devices (such as printers) connected to the **Main** or **AUX-1** ports to reset or perform a carriage return before receiving the next line of communications. The factory default value is no delay. The delay ranges from 0 to 1500 milliseconds depending on the N variable as follows: Command Delay (ms) #1030 0 (*factory setting*) #1031 100 #1032 200 #1033 300 #1034 400 #1035 500 #1036 600 #1037 700 #1038 800 #1039 900 #103A 1000 #103B 1100 #103C 1200 #103D 1300 #103E 1400 #103F 1500
#110N	CONFIGURE AUX-2 PORT BAUD RATE	Sets the **AUX-2** port baud rate. The factory value is 300 baud. The N variable sets the baud rate as follows: Baud Command Rate #1100 110 #1101 300 *(factory setting*) #1102 1200 #1103 2400 #1104 4800 #1105 9600 #1106 19200

Table 4-5 Group 1 Commands (continued)

Command Number	Command Text	Command Description
#111N	SET AUX-2 PORT STOP BITS	Specifies stop bits for **AUX-2** port character transmission. The factory setting is one stop bit. The N variable sets the stop bits as follows: Command — Stop Bits #1110 — 1 (*factory setting*) #1111 — 2
#112N	SELECT AUX-2 PORT PARITY	Selects **AUX-2** port parity setting. The factory setting is parity disabled. The N variable sets the parity as follows: Command — Parity #1120 — disable parity *(factory setting)* #1121 — enable even parity #1122 — enable odd parity Command #1120 provides eight data bits with parity disabled. Command #1121 provides seven data bits and even parity; command #1122 provides seven data bits and odd parity.
#113N	SET AUX-2 PORTEND-OF-LINE DELAY	Sets the delay necessary to allow slow output devices (such as terminals) connected to the **AUX-2** port to reset or perform a carriage return before receiving the next line of communications. The factory value is no delay. The amount of delay ranges from 0 to 1500 milliseconds (ms) depending on the N variable as follows: Command — Delay (ms) #1130 — 0 (*factory setting*) #1131 — 100 #1132 — 200 #1133 — 300 #1134 — 400 #1135 — 500 #1136 — 600 #1137 — 700 #1138 — 800 #1139 — 900 #113A — 1000 #113B — 1100 #113C — 1200 #113D — 1300 #113E — 1400 #113F — 1500

Command Group 2 – Real-Time Clock Control

Group 2 commands control the real-time clock, which maintains the time and date. This time and date can be appended to IDs, error messages, and sensor input reports.

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 of the battery is 5 years and has a typical life expectancy of 19 years.

Note: *All Group 2 commands respond with either* #Done *or* #Error *except* DISPLAY TIME AND DATE (#22)*, which responds with the time and date.*

Table 4-6 Group 2 Commands

Command Number	Command Text	Command Description
#20	SET TIME	Sets the time. The entry format is #20HH:MM:SS where HH, MM, and SS represent hours, minutes, and seconds, respectively. Values for HH (hours) range from 00 to 23; values for MM (minutes) and SS (seconds) range from 00 to 59. The time must be entered exactly as shown, as two-digit decimal entries with no spaces between characters and using colons (:) as delimiters.
#21	SET DATE	Sets the date. The entry format is #21MM/DD/YY where MM, DD, and YY represent the month, day, and year, respectively. Values for MM (month) range from 01 to 12; values for DD (day) range from 01 to 31; and values for YY range from 00 to 99. The date must be entered exactly as shown, as two-digit entries with no spaces between characters and with forward slashes (/) as delimiters.
#22	DISPLAY TIME AND DATE	Displays the reader's current time and date. The reader response is: #HH:MM:SS.hh MM/DD/YY where HH, MM, SS, and hh represent time as hours, minutes, seconds, and hundredths of seconds, respectively; and MM, DD, and YY represent the month, day, and last two digits of the year, respectively. There are two spaces between the time and the date output.

Command Group 3 – Transmission Formats

Command Group 3 commands determine what, if any, information is appended to IDs, error messages, sensor input reports, and modem connect and disconnect messages. This information includes time, date, and auxiliary information. Auxiliary information consists of reader number, antenna number, number of reads of the previous tag, and sensor input status.

Note: *All Group 3 commands respond with either* #Done *or* #Error.

Table 4-7 Group 3 Commands

Command Number	Command Text	Command Description
#30N	APPEND TIME AND DATE SELECTION	Selects the options of appending time and date to transmitted IDs, error messages, sensor input reports, and modem connect and disconnect messages. The factory setting is time and date appended. The N variable selections are as follows: Command Selection #300 no time and date appended #301 time only appended #302 time and date appended (factory setting) The output to the host computer with time or time and date appended is as follows: *Time only:*#<string>&HH:MM:SS.hh<%aux> *Time and date:*#<string>&HH:MM:SS.hh MM/DD/YY<%aux> where string is the tag ID number, error message, sensor input report, or modem connect/disconnect messages. (The brackets are not included in the response.) & separates the string from the time and provides a means for the host computer to determine if time or time and date are appended. % separates any auxiliary information <aux> defined by the #31N commands and provides a means for the host computer to determine if auxiliary information is appended : are time delimiters / are date delimiters Two spaces separate the time from the date. HH, MM, SS, and hh represent time as hours, minutes, seconds, and hundredths of seconds, respectively; and MM, DD, and YY represent the month, day, and the last two digits of the year, respectively. Hundredths of seconds are not appended to the error messages. These commands can execute only if the ID buffer is empty. The RESET READER (#63) command can be given first to clear the buffer losing any buffered IDs, or the output buffer can be allowed to empty. These commands will not apply to Error 1 - RAM error. They do apply equally to other error messages, ID output, the sensor input report, and modem connect messages.

Table 4-7 Group 3 Commands (continued)

Command Number	Command Text	Command Description
#31N	APPEND AUXILIARY INFORMATION SELECTION	Selects the options of appending auxiliary information to the ID output. The N variable selections are as follows: **Command** **Selection** #310 no auxiliary information appended #311 auxiliary information appended (*factory setting*) The output to the host computer with auxiliary information appended is: #<string><&time date>%xx-y-zz-q where: string is the tag ID code, error message, or sensor input report. Brackets are not included. & separates the string from any optional time and date information <time date> appended by the #30N commands and provides a means for the host computer to determine if time or time and date are appended. % separates the auxiliary information and provides a means for the host computer to determine if auxiliary information is appended, xx is the reader ID value in hex from 00 to FF. y is the antenna number (value of 0 or 1), manual ID entry (value of M), or sensor input report or sensor status change (value of S). zz is the number of reads of the previous tag in hexidecimal (hex). q is the sensor input status in hex from 0 to F. - are auxiliary information delimiters. Sensor input status data represents the status of **Sense0** through **Sense3**. The exact meaning of the sensor input status depends upon whether it is appended to a tag ID, a sensor input report, or a sensor status change report. In the case of a tag or a sensor status change report, a true status indicates that an active true state was detected and debounced at one or more of the sense inputs. In the case of a sensor input report, a true status indicates that input has completed the presence true criteria: debounced false to true transition, minimum true period, followed by a debounced true to false. See command #526 DISPLAY I/O status for further discussion of the values of q. The values are inverted if command #6941 sense input inversion is enabled. These commands can execute only if the ID buffer is empty. The RESET READER(#63)command can be given first to clear the buffer losing any buffered IDs, or the output buffer can be allowed to empty.

Command Group 4 – ID Filter Parameters

Group 4 commands set criteria for buffering or discarding ID codes (for example, filtering). These commands are useful for elimination of duplicate ID codes and filtering unwanted IDs obtained from fringe areas of the antenna reading range.

It should be noted that these commands utilize a *comparison register*. The comparison register keeps track of IDs for filtering purposes. When an ID passes all the filtering tests, it is stored in the reader's main buffer prior to transmission to the host computer.

Note: *All Command Group 4 commands respond with* `#Done` *or* `#Error`.

Table 4-8 Group 4 Commands

Command Number	Command Text	Command Description
`#40`	`TRANSMIT ALL ID CODES`	Transmits to the host computer all IDs received by the antenna. Uniqueness testing is bypassed and no data is buffered. *The command is useful for diagnostic purposes only*. Any IDs received by the reader during serial port transmission are lost.
`#410N`	`SELECT UNIQUE ID CODE CRITE-RIA FOR RF CHANNEL 0`	Directs the reader to select, buffer, and transmit ID codes processed by RF channel 0 according to the following test: an ID is buffered, if, in the time interval since the new ID was last received, previously decoded IDs have changed value at least N+1 times, or uniqueness time-out has been achieved or reset. IDs that do not pass the test are lost. The factory setting is `#4100` (N=0) separation of one ID. **Command** **Output occurs only with** #4100 Separation of 1 ID (*factory setting*) #4101 Separation of 2 IDs #4102 Separation of 3 IDs #4103 Separation of 4 IDs Each time the reader receives an ID from RF channel 0, the uniqueness filter compares it with the contents of a comparison register. This register contains four items. The first item is the most recently acquired ID, but only if it differs from the second item. The second item is the second most recent ID, but only if it differs from the third item. This process applies to the third and fourth items in the register as well. **Comparison Register** Item 1 Most recently acquired ID (different from Item 2) Item 2 Second most recent ID (different from Item 3) Item 3 Third most recent ID (different from Item 4) Item 4 Fourth most recent ID

Table 4-8 Group 4 Commands (continued)

Command Number	Command Text	Command Description
		When the uniqueness filter is set to separation of one ID, the newly acquired ID is transmitted only if it is different from the first item. Separation of two IDs allows transmission if the new ID is different from Items 1 and 2 in the comparison register. Separation of three and four IDs transmit the new ID only if it is different from the first three and the first four items, respectively. A new ID can fail the filter test and not be transmitted; however, it is stored in the comparison register for comparison if it differs from Item 1. Assuming the uniqueness time-out criteria has not been met, the following table illustrates the uniqueness filter. The √ indicates that the ID passed the filtering test and was transmitted. The - indicates the ID was filtered out. **Reception Sequence** / **ID** / **Separation Criteria 1 2 3 4** 1 D √ √ √ √ 2 A √ √ √ √ 3 D √ - - - 4 B √ √ √ √ 5 C √ √ √ √ 6 A √ √ √ - 7 C √ - - - 8 B √ √ √ - 9 A √ √ - - 10 D √ √ √ √ The uniqueness test has a time limit imposed by the SET VARIABLE TIME-OUT (#44N) commands. Expiration of the time-out clock effectively erases the comparison register. In effect, the first ID that the reader acquires after the clock expires always appears to be new and is buffered and transmitted. Newly acquired IDs are only tested against IDs that are registered after the clock expires. This time-out clock can be reset with the #440 RESET UNIQUENESS command.

Table 4-8 Group 4 Commands (continued)

Command Number	Command Text	Command Description
#411N	SELECT UNIQUE ID CODE CRITE-RIA FOR RF CHANNEL 1	Directs the reader to select, buffer, and transmit ID codes processed by RF channel 1 according to the following test: An ID is buffered if, in the time interval since the new ID was last received, the previously decoded IDs have changed value at least N+1 times or uniqueness time-out has been achieved. IDs that do not pass the test are lost. The factory setting is #4110 (N=0). See the #410N commands for further information concerning selection algorithms and examples. **Command** — **Output occurs only with** #4110 — separation of 1 ID (factory setting) #4111 — separation of 2 IDs #4112 — separation of 3 IDs #4113 — separation of 4 IDs

Table 4-8 Group 4 Commands (continued)

Command Number	Command Text	Command Description
#420N	SELECT VALID ID CODE CRITERIA FOR RF CHANNEL 0	Directs the reader to validate an ID received from RF channel 0 only after it has been obtained a specified number of times in sequence. Values for N are 0 through F. The factory setting is one acquisition (N=0). **Identical Code Acquisitions** **Command** **Valid Code Frames** #4200 1 (factory setting) #4201 2 #4202 3 #4203 4 #4204 5 #4205 6 #4206 7 #4207 8 #4208 9 #4209 10 #420A 11 #420B 12 #420C 13 #420D 14 #420E 15 #420F 16 The validation procedure is executed before the unique ID test (SELECT UNIQUE ID CODE CRITERIA [#410N] commands). IDs that do not pass the validation test are lost. For example, command #420F specifies that the same ID must be obtained from the antenna/RF module 16 times in succession before it is considered for the uniqueness test. This feature is useful in installations where RF reflections may cause a single tag to be read multiple times or where an occasional ID might be read from fringe areas. **Note** For check tag on channel 0 to operate, the valid ID code criteria for channel 0 must be set to the factory setting of "1" (#4200).

Table 4-8 Group 4 Commands (continued)

Command Number	Command Text	Command Description
#421N	SELECT VALID ID CODE CRITERIA FOR RF CHANNEL 1	Directs the reader to validate an ID received from RF channel 1 only after it has been obtained a specified number of times in sequence. Values for N are 0 - F. The factory setting is one acquisition (N=0). **Identical Code Acquisitions** **Command** — **Valid Code Frames** #4210 — 1 (*factory setting*) #4211 — 2 #4212 — 3 #4213 — 4 #4214 — 5 #4215 — 6 #4216 — 7 #4217 — 8 #4218 — 9 #4219 — 10 #421A — 11 #421B — 12 #421C — 13 #421D — 14 #421E — 15 #421F — 16 This validation procedure is executed before the unique ID test (SELECT UNIQUE ID CODE CRITERIA (#410N) commands). IDs that do not pass the validation test are lost. For example, command #421F specifies that the same ID must be obtained from the antenna/RF module 16 times in succession before it is considered for the uniqueness test. This feature is useful in installations where RF reflections can cause a single tag to be read multiple times or where an occasional ID might be read from fringe areas. **Note** For check tag on channel 1 to operate, the valid ID code criteria for channel 1 must be set to the factory setting of "1" (#4210).
#43	BUFFER ALL ID CODES	Buffers and transmits all acquired ID codes. This command ignores any uniqueness and validation criteria set by the SELECT UNIQUE ID CODE CRITERIA (#410N) and SELECT VALID ID CODE CRITERIA (#420N) commands. *This command is used for diagnostic purposes only.*

Table 4-8 Group 4 Commands (continued)

Command Number	Command Text	Command Description
#440	RESET UNIQUENESS	Causes the ID filtering process set by SELECT UNIQUE ID CODE CRITERIA (#410N) to restart. It is used in conjunction with the VARIABLE TIME-OUT (#44N) commands. This command applies to both RF channels. This command provides a one-time reset at which point the previously set time-out interval resumes.
#44N	SET VARIABLETIME-OUT	Places a time limit on the uniqueness criterion set by SELECT UNIQUE ID CODE CRITERIA (#410N). The parameter N sets the number of minutes on the time-out clock. The factory setting is two minutes (N=1). Each RF channel has an independent timer. These commands set the time-out period for both channels, that is, *both* channels are set to 2, 20, or 60 minutes. **Command** **Time-Out Clock** #441 2 minutes (*factory setting*) #442 20 minutes #443 60 minutes Entering these commands effectively expires the time-out clock, which erases all current IDs in the comparison register. In effect, the first ID that is acquired after the clock expires always appears to be new and is stored. Newly acquired IDs are only tested against IDs that are registered after the clock resets. The reader restarts the time-out clock for an RF channel when a new ID is buffered from that RF channel. For example, when a new ID is buffered from RF1, the time-out clock is reset for RF1 but does not affect the time-out clock for RF0. The time-out clock is continually reset (does not expire) as long as the reader receives the same tag ID. For example, assume that the time-out clock is set for 2 minutes and there is a railcar parked on a siding in front of the reader. Without this reset feature, the railcar's ID would be reported every 2 minutes (each time the time-out clock expired).

Command Group 5 – Reader Status

Group 5 commands provide status reports on the parameters and operation of the reader. Because of this, each command has a different response. Reader response characters may be shown in brackets <>. The brackets indicate that the response is a value in the range of numbers in the brackets; the brackets are not part of the response. For example, the DISPLAY READER ID NUMBER (#521) command responds with a hex value ranging between 00 and FF. In the command discussion, the response is shown as:

```
#RDID <00-FF>
```

If the reader ID number is 7, for example, the actual response is:

```
#RDID 07
```

All spaces shown in the response are actual spaces sent from the reader. In the example above, there is one space between the letter D and the 07.

Commands requesting status of the **AUX-2** port return #Error if the **AUX-2** port, which is the secondary microcontroller option, is not installed.

Table 4-9 Group 5 Commands

Command Number	Command Text	Command Description
#505	DISPLAY PRIMARY MICROCONTROLLER FIRMWARE VERSION/ OPTIONS	Displays the primary microcontroller firmware version number. The reader responds as follows: #Model AI1200 Ver X.XX SNYYYYY where X.XX is the firmware version number, and YYYYY is the serial number expressed in decimal digits (0 through 9) with the first two digits representing the year. Refer to the firmware version number when contacting TransCore about the firmware.
#515	DISPLAY SECONDARY MICROCONTROLLER FIRMWARE VERSION/ OPTIONS	Displays the secondary microcontroller firmware version number. The reader responds as follows: #Model AI1200 Ver X.XX where X.XX is the firmware version number. Refer to the firmware version number when contacting TransCore about the firmware. The reader returns #Error if the second user option is not installed, that is, no secondary microcontroller.
#520	DISPLAY POWER OUTAGE AND RESTORE BITS	Displays the value of the reader's power outage and restore bits. The power outage bit value changes from 0 to 1 when power to the reader is interrupted. To reset the bit, use the RESET READER (#63) command or the RESET POWER OUTAGE BIT (#65). On initial power up, one of these two commands must be used to properly initialize this bit. The restore bit indicates the status of the automatic restoration of EEPROM parameter. See command #8000. The reader responds as follows: #PWRB P<0-1> R<0-1> where **P0** indicates power to reader has been maintained since last zeroing of this bit. **P1** indicates power to reader was lost since last zeroing of this bit. **R0** indicates automatic restoration of EEPROM parameters is disabled. **R1** indicates automatic restoration of EEPROM parameters is enabled.
#521	DISPLAY READER ID NUMBER	Displays the reader identification number. The reader responds as follows: #RDID <00-FF> This value is hex from 00 to FF and is set by the SET READER ID NUMBER (#60N) command. This number is stored in non-volatile EEPROM and is preserved across a power interruption.

Table 4-9 Group 5 Commands (continued)

Command Number	Command Text	Command Description

#522	DISPLAY MAIN PORT COMMUNICATION PARAMETERS	Displays the parameters set for the **Main** and **AUX-1** ports communications. Values correspond to those used to set the communications parameters through the CONFIGURE COMMUNICATION LINKS (#10NN) commands. The reader responds as follows:
		`#MAIN B<0-6> S<0-1> P<0-2> D<0-F>`
		where B is the baud rate, S is the stop bits, P is the parity, and D is the end-of-line delay. There is one space between each value. For example, if the reader has the factory settings, the display reads:
		`#MAIN B1 S0 P0 D0`
		This corresponds to a baud rate of 300, one stop bit, parity disabled, and no end-of-line delay.

#523	DISPLAY AUX-2 PORT COMMUNICATION PARAMETERS	Displays the parameters set for the **AUX-2** port communications. Values correspond to those used to set the communications parameters through the CONFIGURE COMMUNICATION LINKS (#11NN) commands. The reader responds as follows:
		`#AUX2 B<0-6> S<0-1> P<0-2> D<0-F>`
		where B is the baud rate, S is the stop bits, P is the parity, and D is the end-of-line delay. There is one space between each of the values. For example, if the reader has the factory settings, the following display appears:
		`#AUX2 B1 S0 P0 D0`
		This corresponds to a baud rate of 300, one stop bit, parity disabled, and no end-of-line delay.
		The reader responds with `#Error` if the optional **AUX-2** port is not installed.

Table 4-9 Group 5 Commands (continued)

Command Number	Command Text	Command Description

#524	DISPLAY APPENDED INFORMATION STATUS	Displays the information being appended to reader transmissions. The information can be a combination of time, date, and auxiliary information, such as reader identification number, antenna number, number of times the previous tag was read, and sensor input status. The reader responds as follows:
		`#IDAP T<0-1> D<0-1> X<0-1>`
		where
		T0 indicates time is not appended.
		T1 indicates time is appended.
		D0 indicates date is not appended.
		D1 indicates date is appended.
		X0 indicates auxiliary information is not appended.
		X1 indicates auxiliary information appended.
		There is one space between each of the values. For example, if the reader has the factory settings, the display reads
		`#IDAP T1 D1 X1`
		This corresponds to time, date, and auxiliary information appended.
		When time and date are appended, they are appended to ID codes, error messages, sensor input reports, and modem connect messages.

Table 4-9 Group 5 Commands (continued)

Command Number	Command Text	Command Description
#525	ENQUIRE COMMUNICATION PROTOCOL STATUS	Displays the communication protocol status set by the #61N command. The reader responds as follows: #ECPS P<0-2> T<00-FF> X<0-2> S<0-5> where: **P0** basic protocol enabled (factory default) **P1** error correcting protocol enabled **P2** data enquire protocol enabled **T** ECP acknowledgment timeout **X0** disable flow control **X1** enable XON/XOFF flow control (factory default) **X2** enable hardware flow control **S0** <som> = # (23 hex) (factory default) **S1** <som> = ` (60 hex) **S2** <som> = { (7B hex) **S3** <som> = | (7C hex) **S4** <som> = } (7D hex) **S5** <som> = ~ (7E hex) If the reader has factory settings, the response is #ECPS P0 T03 X1 S0 This message corresponds to basic protocol enabled, time-out set to 3 (@150 ms), with XON/XOFF flow control enabled, and # as <som> character.

Table 4-9 Group 5 Commands (continued)

Command Number	Command Text	Command Description
#526	DISPLAY I/O STATUS	Displays the I/O status. Indicates whether the output status modules are controlled externally through the #620N OUTPUT CONTROL commands or internally through the #621 PREDEFINED OUTPUT CONTROL command. If the output modules are controlled externally, it displays the current energized or deenergized states. If #643 RF SYNCHRONIZATION MODE is enabled, this command displays the output control algorithm for synchronization. This command also displays the condition of the four sensor input circuits. The final value displayed is the output pulse duration set by the 67N SET OUTPUT PULSE DURATION command. The reader responds: #IOST C<0-2> O<0-F> I<0-F> D<0-F> where **C0** control is external (See #620N commands.) **C1** control is internal (See #621 command.) **C2** RF synchronization output control algorithm (See #643 command.)

output stat 0	**output stat 1**	**output stat 2**	**output stat 3**	
00	-	-	-	-
01	X	-	-	-
02	-	X	-	-
03	X	X	-	-
04	-	-	X	-
05	X	-	X	-
06	-	X	X	-
07	X	X	X	-
08	-	-	-	X
09	X	-	-	X
0A	-	X	-	X
0B	X	X	-	X
0C	-	-	X	X
0D	X	-	X	X
0E	-	X	X	X
0F	X	X	X	X

where X = on; - = off

Table 4-9 Group 5 Commands (continued)

Command Number	Command Text	Command Description

input sense	input sense 0	input sense 1	input sense 2	input sense 3
I0	-	-	-	-
I1	X	-	-	-
I2	-	X	-	-
I3	X	X	-	-
I4	-	-	X	-
I5	X	-	X	-
I6	-	X	X	-
I7	X	X	X	-
I8	-	-	-	X
I9	X	-	-	X
IA	-	X	-	X
IB	X	X	-	X
IC-	-	X	X	
ID	X	-	X	X
IE	-	X	X	X
IF	X	X	X	X

where X = on; - = off

D = output pulse duration. The values for D correspond to the values entered through the SET OUTPUT PULSE DURATION (#67N) commands and range from 0 (4 milliseconds) to F (752 milliseconds).

Table 4-9 Group 5 Commands (continued)

Command Number	Command Text	Command Description
#527	DISPLAY RF STATUS	Displays the current status of the RF modules. Shows if the RF modules are controlled through external host commands, sense input, or in dual channel multiplex mode; whether the RF modules are off or on; and the uniqueness time-out setting determined by the VARIABLE TIME-OUT (#44N) commands. The reader responds as follows: #RFST C<0-3> O<0-2> T<1-3> where C0 external control C1 proximity sensor control C2 dual channel multiplex mode C3 RF synchronization mode O0 RF signals off O1 RF 0 signal on, RF 1 signal off O2 RF 1 signal on, RF 0 signal off T1 variable time-out clock set to 2 minutes T2 variable time-out clock set to 20 minutes T3 variable time-out clock set to 60 minutes For example, if the reader has the factory settings, it will respond with #RFST C2 O<1-2> T1 This corresponds to dual-channel multiplex mode, and a uniqueness time-out period of two minutes. Depending upon which RF channel is active at the time, the O parameter will respond with 1 for RF channel 0 or 2 for RF channel 1.

Table 4-9 Group 5 Commands (continued)

Command Number	Command Text	Command Description
#528	DISPLAY MODEM CONTROL STATUS	Displays the current modem control status as set by the #68N commands. The reader responds as follows: #MODM C<0-1> M<1> A<0-1> T<0-F> I<0-F> Q<0-F> R<0-4> where C modem control enabled (see command #6800 or #6801) M modem type (see command #681) A algorithm number (see command #682) T preset tag ID count (see command #683) I call interval (see command #684) Q inactivity (quiescent) period (see command #685) R redial interval (see command #686) For example, if the reader has the factory settings, it will respond with #MODM C0 M1 A0 I6 T1 Q1 R4 This message corresponds to modem control disabled, MultiTech 224E modem (type 1) selected, enable calls if all conditions are met, call interval of one hour, 1 tag ID acquired, no tags acquired for 2 minutes, redial interval of 15 minutes.

Table 4-9 Group 5 Commands (continued)

Command Number	Command Text	Command Description
#529	DISPLAY PRESENCE STATUS	Displays the parameters set for presence detector status as defined by the #69N commands. The reader returns as follows: #PRST P<0-1> D<0-F> A<0-2> T<0-F> I<0-1> where P0 sensor input reports disabled , (see command #6900) P1 sensor input reports enabled (see command #6901) D presence minimum true period (see command #691) A0 RF off on time-out only (see command #6920) A1 RF off on time-out or tag (see command #6921) A2 RF off on time-out or presence conditions false (see command #6922) T presence control time-out (see command #693) I0 sense input energized for true (see command #6940) I1 sense input de-energized for true (see command #6941) For example, if the reader has the factory settings, it will respond with: #PRST P0 D6 A0 T6 I0 which corresponds to no reporting with presence detect but no tag acquisition, presence true period of 30 milliseconds, RF control off on time-out only, presence RF control time-out of 30 milliseconds, digital sense input module energized for true logic.
#530	DISPLAY FILTER PARAMETER STATUS FOR RF CHANNEL 0	Displays the parameters set for the RF 0 channel input. The reader responds as follows: #RF0S U<0-3> V<0-F> where U is the uniqueness filter criteria, and V is the valid ID code criteria. Values correspond to those used to set the uniqueness and valid ID code parameters through the SELECT UNIQUE ID CODE CRITERIA (#410N) and SELECT VALID ID CODE CRITERIA (#420N) commands. For example, if the reader is set to the factory values, the display would read #RF0S U0 V0 This message corresponds to separation of one ID for uniqueness filtering and obtaining an ID one time to consider it valid.

Table 4-9 Group 5 Commands (continued)

Command Number	Command Text	Command Description
#531	DISPLAY FILTER PARAMETER STATUS FOR RF CHANNEL 1	Shows the parameters set for the RF 1 channel input. The reader responds as follows: #RF1S U<0-3> V<0-F> where U is the uniqueness filter criteria, and V is the valid ID code criteria. Values correspond to those used to set the uniqueness and valid ID code parameters through the SELECT UNIQUE ID CODE CRITERIA (#411N) and SELECT VALID ID CODE CRITERIA (#421N) commands. For example, if the reader is set to the factory values, the display would read #RF1S U0 V0 This message corresponds to separation of one ID for uniqueness filtering and obtaining an ID one time to consider it valid.
#540	PRIMARY MICROCONTROLLER CHECKSUM	Provides primary microcontroller program code checksum and includes both the primary microcontroller and external UVPROM program code. Used for diagnostic purposes and relates directly to the version of firmware installed in the reader. The reader responds as follows: #PCKS Ixxxx Exxxx where Ixxxx is the letter I followed by a four-character ASCII hex checksum of internal microcontroller program code; and Exxxx is the letter E followed by a four-character ASCII hex checksum of external UVPROM program code memory.
#541	RAM SIZE	Displays external RAM size. The reader responds as follows: #RAMS N where N is the amount of memory in units of 8K bytes. For example, if the reader has 32K bytes of memory, the response is #RAMS 4
#542	SECONDARY MICROCONTROLLER CHECKSUM	Provides secondary microcontroller program code checksum. Used for diagnostic purposes and relates directly to the version of firmware installed in the reader. The reader responds as follows: #SCKS xxxx where xxxx is a four-character ASCII hex checksum of secondary microcontroller program code. Returns #Error if the optional secondary microcontroller is not installed.

Table 4-9 Group 5 Commands (continued)

Command Number	Command Text	Command Description
#550	SYSTEM CHECK TAG CONTROL STATUS	Displays the control parameters for the system check tag. The reader responds as follows: #SCTS M<0-3> T<0-F> where M0 indicates periodic test mode disabled. M1 indicates periodic test mode enabled - RF channel 0. M2 indicates periodic test mode enabled - RF channel 1. M3 indicates periodic test mode enabled - both RF channels. T is repetitive time interval (see #813N command).

Table 4-9 Group 5 Commands (continued)

<table>
<tr><th>Command Number</th><th>Command Text</th><th>Command Description</th></tr>
<tr><td>#560</td><td>REQUEST SENSOR STATUS CHANGE STATUS</td><td>Displays the sensor status change feature status. The reader responds as follows:
#SSTC E<0-1> M<0-F>
where
E0 indicates sensor status change status disabled.
E1 indicates sensor status change status enabled.
M indicates value of mask for inputs enabled.
<table><tr><th></th><th>input sense 0</th><th>input sense 1</th><th>input sense 2</th><th>input sense 3</th></tr><tr><td>M0</td><td>-</td><td>-</td><td>-</td><td>-</td></tr><tr><td>M1</td><td>X</td><td>-</td><td>-</td><td>-</td></tr><tr><td>M2</td><td>-</td><td>X</td><td>-</td><td>-</td></tr><tr><td>M3</td><td>X</td><td>X</td><td>-</td><td>-</td></tr><tr><td>M4</td><td>-</td><td>-</td><td>X</td><td>-</td></tr><tr><td>M5</td><td>X</td><td>-</td><td>X</td><td>-</td></tr><tr><td>M6</td><td>-</td><td>X</td><td>X</td><td>-</td></tr><tr><td>M7</td><td>X</td><td>X</td><td>X</td><td>-</td></tr><tr><td>M8</td><td>-</td><td>-</td><td>-</td><td>X</td></tr><tr><td>M9</td><td>X</td><td>-</td><td>-</td><td>X</td></tr><tr><td>MA</td><td>-</td><td>X</td><td>-</td><td>X</td></tr><tr><td>MB</td><td>X</td><td>X</td><td>-</td><td>X</td></tr><tr><td>MC</td><td>-</td><td>-</td><td>X</td><td>X</td></tr><tr><td>MD</td><td>X</td><td>-</td><td>X</td><td>X</td></tr><tr><td>ME</td><td>-</td><td>X</td><td>X</td><td>X</td></tr><tr><td>MF</td><td>X</td><td>X</td><td>X</td><td>X</td></tr></table>where X = on; - = off</td></tr>
<tr><td>#561</td><td>REQUEST RF SYNCHRONIZATION STATUS</td><td>Displays the RF synchronization feature status. The reader responds as follows:
#RSYN E<0-1> P<0-F>
where
E0 indicates RF synchronization disabled
E1 indicates RF synchronization enabled
P indicates period interval (see #643 command)</td></tr>
</table>

Command Group 6 – Reader Control Functions

Command Group 6 commands set reader control functions such as output pulse, RF control, and modem control.

Note: *Unless otherwise indicated, Command Group 6 commands return* #Done *or* #Error.

Table 4-10 Group 6 Commands

Command Number	Command Text	Command Description
#60N	SET READER ID NUMBER	Assigns an ID number (N) to the reader. Values for N are hexadecimal entries of 00 through FF. The factory value is N=00. This number can be displayed by using the DISPLAY READER ID (#521) command. As a factory setting, this number is appended to the output transmissions along with other auxiliary information. See APPEND AUXILIARY INFORMATION SELECTION (#31N) commands. The reader number is stored and is preserved in case of power outages.
#61N	SELECT COMMUNI-CATION PROTOCOL	Selects between the communication protocol options. The values for N indicate the following conditions: #610 enables basic protocol (factory setting). #611 enables error-correcting protocol. (A description of error correcting protocol is available on request.) #612yy**sets error correcting protocol timeout to yy. #613 enables data enquire protocol. #6140 disables flow control. #6141 enables XON/XOFF flow control (factory setting). #6142 enables *hardware* flow control. The reader controls the RTS line and monitors the readiness of the modem (or similar external device) via the CTS line. When the CTS line goes *false*, the reader will halt transmission within one character. ** Values for error-correcting protocol (yy above) range from 00 to FF with 03 being the default. The time-out value in milliseconds is approximated by the following formula: T (ms) = 50 * yy (+12% - 0) The time-out value applies to both transmission and receipt of serial data over the **Main** communication port. The time-out on transmission is initiated immediately following the transmission of the last character of a message (<eom>). The time-out on receive is initiated immediately after the <som> character is received. If yy = FF, then the time-out is disabled.

Table 4-10 Group 6 Commands (continued)

Command Number	Command Text	Command Description
		In data enquire mode, the reader transmits a single ID for each **<ctrl-E>** character received through the **Main** and **AUX-1** ports. The reader does not echo the **<ctrl-E>** character. The reader also does not respond to **<ctrl-E>** unless the buffer contains IDs available for transmission to the host computer. The ID buffer must be empty prior to changing communication protocol. Either allow the buffer to empty or issue #63 RESET READER command to empty the buffer. Selectable <som> character. The #615N series commands allow selection of <som> (start-of-message) character. Status of these commands can be accessed through the #525 Enquire Communication Protocol Status command. Characters available are as follows: #6150 Select <som> character # (23 hex) factory default #6151 Select <som> character ` (60 hex) #6152 Select <som> character { (7B hex) #6153 Select <som> character | (7C hex) #6153 Select <som> character } (7D hex) #6154 Select <som> character ~ (7E hex)
#620N	OUTPUT CONTROL	Sets the reader's four output sensor circuits. These commands can be used by the host computer to operate external hardware, such as gates or traffic lights. Command execution disables #621 PREDEFINED OUTPUT CONTROL. These commands are stored only in volatile memory. After a power outage or reader reset, all status output modules return to their off positions.

Table 4-10 Group 6 Commands (continued)

Command Number	Command Text	Command Description
		Commands: **output stat 0** **output stat 1** **output stat 2** **output stat 3** #6200 - - - - #6201 X - - - #6202 - X - - #6203 X X - - #6204 - - X - #6205 X - X - #6206 - X X - #6207 X X X - #6208 - - - X #6209 X - - X #620A - X - X #620B X X - X #620C - - X X #620D X - X X #620E - X X X #620F X X X X where X = on, - = off. This command will not execute if the system is in the #643 RF Synchronization mode.
#621	PREDEFINED OUTPUT CONTROL (factory setting)	As a factory setting, **Output Stat0** is activated for a valid tag read on RF channel 0, **Stat1** is activated for a valid tag read on RF channel 1, **Stat2** is activated for search success, and **Stat3** is activated for full buffer error. The **Stat0**, **Stat1**, and **Stat2** are activated for the amount of time defined by the #670 SET OUTPUT PULSE DURATION commands. To override these functions, use the #620N OUTPUT CONTROL commands. **Stat3** stays activated continuously as long as the output buffer is full. This command will not execute if the system is in the #643 RF Synchronization mode.

Table 4-10 Group 6 Commands (continued)

Command Number	Command Text	Command Description

#63	RESET READER	Performs a software reset of the reader. All settings return to the last programmed state prior to reset, except for the power outage bit that is reset to 0 and the status output modules are set to off. Reader responds with sign-on message:
		`#Model AI1200 Ver X.XX SNYYYYY`
		`#Copyright 1988 AMTECH Corp.`
		where X.XX is the firmware version number and YYYYY the hardware serial number with the first two characters representing the year.
		Caution
		All buffered data is lost when this command is executed.

#640N	RF CONTROL	Controls the RF channel selection. The N variable controls the RF power as follows: **Command** **RF Control** #6400 Both RF channels off #6401 RF channel 0 on, RF channel 1 off #6402 RF channel 1 on, RF channel 0 off RF channels are never on simultaneously. Also, see #641 SET RF BY SENSORcommand.
#641	SET RF BY SENSOR	RF channel control by sense input modules. **Sense0** controls RF channel 0, **Sense1** controls RF channel 1. RF is controlled according to the algorithm set under the Presence RF control selection determined by the SELECT PRESENCE RF CONTROL (#692N) commands.
#642	RF CONTROL IN TWO CHANNEL MULTIPLEX MODE (factory setting)	Places RF power in multiplex mode. This mode switches RF power continuously between the two RF channels. The two channel RF switching algorithm is based on an intelligent onboard RF detection circuit that determines if a tag is within the range of an antenna in much less time than it would take to acquire the full tag data frame.

Table 4-10 Group 6 Commands (continued)

Command Number	Command Text	Command Description
#643N	RF SYNCHRO-NIZATION CONTROL MODE	Enables and disables RF synchronization control mode and sets synchronization period. **Command** — **Time Period Interval** #6430 — Feature Disabled #6431 — 64 ms #6432 — 72 ms #6433 — 80 ms #6434 — 88 ms #6435 — 96 ms #6436 — 112 ms #6437 — 128 ms #6438 — 144 ms #6439 — 160 ms #643A — 192 ms #643B — 224 ms #643C — 256 ms #643D — 320 ms #643E — 384 ms #643F — 512 ms ***Note:*** *The specified time is the total interval. Each RF channel will be powered up for a duration equal to half the total time interval. Channel 0 is active during the first half of the interval and Channel 1 is active during the second half.* When RF Synchronization mode is invoked, an output algorithm specific to this control mode is active. Under this algorithm, the Opto-22 outputs and inputs are defined as follows: **Stat0** — Good tag pulse for Channel 0 **Stat1** — Good tag pulse for Channel 1 **Stat2** — Used for global bus configuration **Stat3** — Full Buffer indicator **Sense0** — Presence sensor for Channel 0 **Sense1** — Presence sensor fro Channel 1 **Sense2** — Used for global bus configuration **Sense3** — Available for the user

Table 4-10 Group 6 Commands (continued)

Command Number	Command Text	Command Description
		To connect readers together for the RF Synchronization mode, a power supply and 100,000 ohm resistor is needed. **Stat2** (Opto module 2 on the rack) and **Sense2** (Opto module 6 on the rack) are used. Connect the negative terminal of **Stat2** (module 2) to the ground (–) line of the power supply. Connect the positive terminal of **Sense2** (module 6) to the positive (+) line of the power supply. Connect one end of the 100,000 ohm resistor to the positive (+) line of the power supply. The other side of the resistor should connect to two points that are (1) the positive terminal of **Stat2** (module 2) and (2) the **negative** terminal of **Sense2** (module 6). ***Caution should be exercised when using the*** `#67x` ***command while operating in this*** `#643x` ***mode.*** If a long pulse period is specified by the `#67x`, relative to the period specified by the `643x` command, IDs may be missed. As a general rule, specify pulse period (`#67x`) and RF synch interval (`#643x`) according to the following formula: $$\text{Pulse time (ms)} < -30\text{ ms} \left(\frac{RF\ \ synchinterval}{2}\right)$$ Also, when in this RF control mode, the commands `#620x` and `#621` (which affect the definitions of the output modules) cannot be executed. The reader responds with `#Done` or `#Error`.
`#65`	`RESET POWER OUTAGE BIT`	Resets the power outage bit to zero. The bit changes from 0 to 1 when the power to the reader is restored. On reader power up, this command or `RESET READER (#63)` must be executed to properly initialize this bit. To display the status of the power outage bit, use the `DISPLAY POWER OUTAGE BIT (#520)` command.

Table 4-10 Group 6 Commands (continued)

Command Number	Command Text	Command Description
#66	INVOKE DIAGNOSTIC MODE	Invokes the reader diagnostic mode. This is intended for troubleshooting at the component level and, therefore, is intended for use by TransCore-certified service personnel. Any stored IDs are lost once the diagnostic mode is entered. All non-volatile parameters will be restored to their factory settings if either **EEPROM** or **Set Defaults** are selected. The reader returns the **Diagnostic** menu as follows: 0 RAM Chk 1 EEPROM 2 Inter-uC 3 I/O 4 RTC 5 RF Detect 6 Reserved 7 Reserved 8 Reserved 9 Reserved A Sniff B Mn RS C Aux RS D SW Reset E Setup RTC F Set Defaults Select one… The user selects an option by entering a character 0-F and pressing **Enter**. The character is not echoed to the terminal until **Enter** is pressed. where 0 - RAM Chk performs a write/read verify of all external data memory (32 Kbytes standard or 64 Kbytes optional). The RAM Chk operates in a continuous mode until **Enter** is pressed. After checking all memory, the routine returns a 0 followed by + for a pass or - for fail.

Table 4-10 Group 6 Commands (continued)

Command Number	Command Text	Command Description
		`1 - EEPROM` Performs write/read verify of all EEPROM non-volatile data memory (that is, 1 K bit standard). Non-volatile parameters are returned to the factory settings upon exit from this menu selection. The EEPROM is rated for 10,000 write cycles and this command should be exercised with restraint. Each invocation of this command causes two write cycles. `2 - Inter-uC` Verifies inter-microcontroller communications (only applicable if the **AUX-2** option is installed in the reader). `3 - I/O` Verifies all status inputs and outputs. I/O modules and loop back connector required on digital I/O backplane. `4 - RTC` Verifies real-time clock. Previous time and date setting are lost and should be reset with the `SET TIME (#20)` and `SET DATE (#21)` commands. `5 - RF Detect` Verifies RF detection circuitry used to detect the presence of a tag within the range of an antenna. Tag must be placed within range of antenna 0. `A - Sniff` Detailed statistical summary of RF presence detect circuitry. Used to help diagnose problems in the event the RF Detect test fails. `B- Mn RS` Verifies Main RS-232 operation. Requires Amtech-brand RS-232 loop back connector. `C - Aux RS` Not implemented. `D - SW Reset` Exit Diagnostic Mode and perform software reset. This option returns to the operational mode of the reader. Factory settings will be in effect if **Set Defaults** or **EEPROM** had been previously invoked. `E - Setup RTC` Reconfigures the real-time clock to enable crystal oscillator trim at factory. `F - Set Defaults` Writes factory settings to EEPROM.

Table 4-10 Group 6 Commands (continued)

Command Number	Command Text	Command Description
#67N	SET OUTPUT PULSE DURATION	Sets the output pulse duration for the PREDEFINED OUTPUT CONTROL (#621) command. The factory setting is 4 milliseconds. The variable N has a value from 0 to F and ranges from 4 to 752 milliseconds (ms): **Command** — **Delay (ms)** #670 — 4 (*factory setting*) #671 — 8 #672 — 12 #673 — 16 #674 — 20 #675 — 24 #676 — 32 #677 — 40 #678 — 48 #679 — 60 #67A — 76 #67B — 152 #67C — 228 #67D — 300 #67E — 376 #67F — 752 ***Note:*** *The durations indicated apply to both minimum energized and de-energized periods. For example, the command #67F (752 milliseconds) provides a 0.752 second energized period and a 0.752 second de-energized period to the stat output modules.* Additional IDs can be acquired during either the energized or de-energized period; however, the timing is restarted upon each successive ID acquisition. **This command should be used with discretion:** when the tag acquisition interval is short compared to the programmed pulse period, distinct pulses cannot be generated.

Table 4-10 Group 6 Commands (continued)

Command Number	Command Text	Command Description
#6800	DISABLE MODEM CONTROL (factory setting)	Disables modem control. This command must be invoked twice before modem control is actually disabled to ensure against accidental loss of modem control. The first attempt to disable the modem returns #Error, and the second attempt returns #Done. The reader will not respond to DCD (data carrier detect). Once this command is invoked, it is possible to remotely connect to the reader. However, the reader does not assume responsibility for initializing the modem.
#6801	ENABLE MODEM CONTROL	Enables modem control. Each time modem control is enabled, the modem is initialized. This can be used by the host to force initialization of the modem. The modem is initialized to the auto answer mode and goes on-hook (disconnect). Devices (such as a terminal) can be connected directly to the **Main** port even while modem control is enabled. The reader behaves normally while in command mode (DCD is not sensed in command mode). In addition, the reader transmits tag IDs while in data mode provided DCD is held true (the reader believes that a host-initiated call is in progress). The command sequence #+++ is not a valid command, and the host computer should NOT send this to the reader. The reader determines that this is an invalid command and continues to dump tag IDs in the event that it was in data mode. However, the modem on the host side will respond to it as an attention sequence and can subsequently terminate the connection. The reader will then continue to dump the tag IDs into a bit bucket (non-existent modem connection), losing all tag ID data transmitted after the termination of the connection.

Table 4-10 Group 6 Commands (continued)

<table>
<tr><th>Command Number</th><th>Command Text</th><th>Command Description</th></tr>
<tr><td>#6811</td><td>SELECT MODEM TYPE</td><td>Selects modem type. This command selects the modem, initializes the modem for optimum performance with the reader, and stores the initialized parameters in the modem.

Note: The modem attached to the reader must have firmware version 6.08 or later. The ISSUE COMMAND STRING TO MODEM (#6870) command will not work on earlier versions. When the #6811 command executes, the reader initializes the attached modem with the following commands in the order listed.

Command — Effect
AT — Clear command buffer
AT&F&W — Set factory defaults and store
AT&E7 — Modem passes through XON/XOFF
AT$BA0 — Baud adjust off - speed convert on
AT&E2 — Reliable (error correcting) mode
AT&E5 — Modem initiated XON/XOFF enabled
AT&D3 — Reset on loss of DTR
AT&I1 — Hang up on 10 minute inactivity
AT&W — Store parameters

In addition, switch #1 of the modem’s 8-position DIP switch in must be up to select external DTR control. All other conditions are met by factory default, and all other DIP switches remain in factory default setting. The configuration of the modem’s 8 position modem DIP switch should be as follows:

Switch — Position
1,2,4,5,6,7 — Up
3,8 — Down

Set the host computer modem to match the reader modem settings, except it may not be necessary or desirable to set the DIP switch #1 to the up position.</td></tr>
</table>

Table 4-10 Group 6 Commands (continued)

Command Number	Command Text	Command Description

#682N	SELECT CALL CRITERIA ALGORITHM	Selects the algorithm for reader initiation of a call based on certain conditions. Values for N are as follows:
		6820 Enable a call if all the following conditions are met (factory setting):
		a. Call interval exceeds the preset call interval. This interval is set by the SELECT MODEM CALL INTERVAL (#684N) commands. If the call interval is set to 0, this condition is always satisfied.
		b. Inactivity period exceeds preset inactivity period. This period is set by the SELECT TAG INACTIVITY PERIOD (#685N) commands. If the inactivity period is set to 0, this condition is always satisfied.
		c. The number of IDs buffered is equal to or greater than the preset number of IDs. This number is set by the SELECT MODEM PRESET IDS (#683N) commands. If the number is set to 0, this condition is always satisfied.
		6821 Enable a call if any of the conditions are met:
		a. Call interval exceeds the preset call interval, which is set by the SELECT MODEM CALL INTERVAL (#684N) commands. If the call interval is set to F, this condition is never satisfied.
		b. Inactivity period exceeds preset inactivity period, which is set by the SELECT TAG INACTIVITY PERIOD (#685N) commands. If the inactivity period is set to F, this condition is never satisfied.
		c. The number of IDs buffered is equal to or greater than the preset number of IDs. This number is set by the SELECT MODEM PRESET IDS (#683N) commands. If the number is set to F, this condition is never satisfied. The exception to this condition is the 75% full condition described as follows.
		Call request criteria are *unconditionally* met when the tag ID buffer reaches 75% of capacity. This ensures that tag ID acquisition may continue even under circumstances involving inappropriate algorithm selection or extremely high tag throughput.
		When the reader modem establishes a connection, the following message is transmitted:
		`#Connect <&time date><%aux>`
		Before the reader breaks a connection, the following message is transmitted:
		`#Disconn <&time date><%aux>`
		Time or time and date is appended to these messages if instructed by TIME ONLY APPENDED (#301) or TIME AND DATE APPENDED (#302) commands.

Table 4-10 Group 6 Commands (continued)

Command Number	Command Text	Command Description
#683N	SELECT MODEM PRE-SET NUMBER OF IDS	Sets the number of tag IDs to be buffered as part of the call criteria algorithm. When the number of buffered IDs equals or exceeds this value, this part of the criteria is true. See SELECT CALL CRITERIA ALGORITHM (#682) command for further information. Values for N range from 0 (condition always satisfied) to F (condition never satisfied) and are as follows: **Command** **Value** #6830 ≥ 0(*always true*) #6831 ≥ 1(*factory setting*) #6832 ≥2 #6833 ≥4 #6834 ≥8 #6835 ≥16 #6836 ≥ 32 #6837 ≥ 64 #6838 ≥ 128 #6839 ≥ 256 #683A ≥ 512 #683F infinite(*never true*)

Table 4-10 Group 6 Commands (continued)

Command Number	Command Text	Command Description
#684N	SELECT MODEM CALL INTERVAL	Sets the modem call interval as part of the call criteria algorithm. When the time interval since the last call meets or exceeds this value, this part of the criteria is true. Values for N range from 0 (condition always satisfied) to F (condition never satisfied). The call interval is reset whenever the command is invoked or when a call transaction has been completed. The algorithms, based upon time interval, have an accuracy of 1% +30 seconds. See SELECT CALL CRITERIA ALGORITHM (#682) command for further information. **Command** **Value** #6840 ≥ 0 minutes (*always true*) #6841 ≥ 2 minutes #6842 ≥ 4 minutes #6843 ≥ 8 minutes #6844 ≥ 15 minutes #6845 ≥ 30 minutes #6846 ≥ 1 hour (*factory setting*) #6847 ≥ 2 hours #6848 ≥ 4 hours #6849 ≥ 8 hours #684A ≥ 12 hours #684B ≥ 24 hours #684C ≥ 36 hours #684D ≥ 48 hours #684E ≥ 72 hours #684F infinite (*never true)*

Table 4-10 Group 6 Commands (continued)

Command Number	Command Text	Command Description
#685N	SELECT TAG INACTIVITY PERIOD	Sets the tag inactivity period as part of the call criteria algorithm. When the period without tag acquisition meets or exceeds this value, this part of the criteria is true. Values for N range from 0 (condition always true) to F (condition never satisfied). The inactivity period is reset each time an ID is acquired. The algorithms, based upon time interval, have an accuracy of 1% +30 seconds. **Command** — **Value** #6850 — ≥ 0 minutes (*always true*) #6851 — ≥ 2 minutes #6852 — ≥ 4 minutes #6853 — ≥ 8 minutes #6854 — ≥ 15 minutes #6855 — ≥ 30 minutes #6856 — ≥ 1 hour (*factory setting*) #6857 — ≥ 2 hours #6858 — ≥ 4 hours #6859 — ≥ 8 hours #685A — ≥ 12 hours #685B — ≥ 24 hours #685C — ≥ 36 hours #685D — ≥ 48 hours #685E — ≥ 72 hours #685F — infinite (*never true*) See SELECT CALL CRITERIA ALGORITHM (#682) command for further information.
#686N	SELECT MODEM REDIAL INTERVAL	Selects the redial interval used to determine the interval between attempts to establish a call once the call criteria have been met. If a connection is broken during the middle of a transmission, the redial interval is used to determine the period of time before the next attempt to reestablish the connection. Values for N range from 0 (continuous) to 4 (every 15 minutes). The algorithms, based upon time interval, have an accuracy of 1% +30 seconds. **Command** — **Value** #6860 — 0 minutes (*continuous*) #6861 — 2 minutes #6862 — 4 minutes #6863 — 8 minutes #6864 — 15 minutes (*factory setting*)

Table 4-10 Group 6 Commands (continued)

Command Number	Command Text	Command Description
#6870	ISSUE COMMAND STRING TO MODEM	This command issues a string of up to 27 characters from the reader to the modem. Multiple invocations of this command are allowed. This command includes a modem-specific header and trailer which automatically switches the modem to command mode prior to issuing the string and then switches the modem on line after the command string is issued. Inappropriate commands could force a disconnect. If this occurs, the reader reinitializes the modem to a predetermined auto answer configuration.The command format is as follows: #6870<str> where" <str> is an ASCII string representing modem command that the reader issues to the modem , causes a 1 second delay if it appears in <str> The reader returns +++#Done or Error. As an example, to issue the command to store a telephone number, #6870ATDT1234567N0 where: #6870 is the reader command AT is the modem attention code DT is the modem dial tone dial code 1234567 is a seven-digit phone number N0 is the modem command to store the phone number in position 0
#6900	DISABLE SENSOR INPUT REPORTS (factory setting)	Turns off reporting when presence true conditions are satisfied, but no tag acquisition occurs. (See #6901 ENABLE SENSOR INPUT REPORTS command for more information.)
#6901	ENABLE SENSOR INPUT REPORTS	Issues a report when sensor input presence true conditions are satisfied, but tag ID acquisition does not occur. This command issues a report when presence detectors indicate passage of a vehicle, but there was no tag ID received. This command is useful for reporting the passage of untagged vehicles. The format of the report is as follows: #SENSOR INPUT REPORT <&time date><%aux> where: <&time date> is optionally appended time or time and date <%aux> is optionally appended auxiliary information There is one space between SENSOR INPUT REPORT and any optionally appended information. Optionally appended information is controlled through the Group 3 commands.

Table 4-10 Group 6 Commands (continued)

Command Number	Command Text	Command Description
#691N	SET MINIMUM PRESENCE TRUE PERIOD	Sets the presence sensor minimum true time. Values for N range from 0 (0 ms, always true) to F (infinite, never true). This variable determines the minimum amount of time an object must be continuously detected (presence true period) to be considered a valid presence. **Command** — **True Period (ms)** #6910 — 0 (*always true*) #6911 — 4 #6912 — 8 #6913 — 12 #6914 — 20 #6915 — 24 #6916 — 32 (*factory setting*) #6917 — 48 #6918 — 60 #6919 — 92 #691A — 152 #691B — 300 #691C — 452 #691D — 600 #691E — 752 #691F — infinite (*never true*) The presence signal is debounced for 12 ms prior to applying the true criteria. An additional 12 ms debounce period is applied to the presence signal transition to no presence.
#692N	SELECT PRESENCE RF CONTROL ALGORITHM	Selects the algorithm for turning RF power off when the RF power is controlled by sense input modules (#641 SET RF BY SENSOR). The factory setting (#6920) turns off RF power based on the time-out established by the #693N commands. The #6921 command allows turning off RF power either after the time-out period, or the acquisition of a tag ID, whichever occurs first. The #6922 command turns off RF power either after the time-out period, or when the sense input modules indicate the vehicle has passed, whichever occurs first. The values for N select as follows: **Command** — **RF Power Off** #6920 — on time-out only (*factory setting*) #6921 — time-out OR tag ID acquired #6922 — time-out OR presence false

Table 4-10 Group 6 Commands (continued)

Command Number	Command Text	Command Description
#693N	SELECT PRESENCE RF CONTROL TIME-OUT PERIOD	Sets the time-out period used for the #692N Presence Control Algorithm. Values for N range from 0 always expired to F never expires. **Command** **Time-out (ms)** #6930 0 (always expired) #6931 4 #6932 8 #6933 12 #6934 20 #6935 24 #6936 32 (factory setting) #6937 48 #6938 60 #6939 92 #693A 152 #693B 300 #693C 452 #693D 600 #693E 752 #693F infinite (never expires)
#694N	SELECT SENSE INPUT INVERSION	Selects either energized or de-energized digital I/O modules for the logic true algorithm. This feature allows greater flexibility in the attachment of external equipment to the reader sense inputs. For example, some proximity sensors indicate presence with a voltage drop. In this instance, command #6941 de-energize for logic true would be utilized. All four inputs are configured by this command. The value for N selections are as follows: **Command** **Option** #6940 energized digital I/O modules for logic true (factory setting) #6941 de-energized digital I/O modules for logic true (inverted logic)

Command Group 7 – Search Control Functions

Group 7 commands control the reader's optional search functions. Search mode is also supported from the optional **AUX-2** port. The search mode through the **AUX-2** port is menu-driven.

Table 4-11 Group 7 Commands

Command Number	Command Text	Command Description
#70	DISABLE SEARCH MODE (factory setting)	Disables search capability enabled by command #71. Returns #Done or #Error.
#71	ENABLE SEARCH MODE	Directs the reader to begin the examination of all incoming IDs for a possible match with IDs in a user-entered list. This list is entered using #730 ADD ENTRY TO SEARCH LIST command and can contain up to 16 entries. When a match occurs, the reader issues the message: *** Matched <ID> where <ID> is the tag ID with a maximum of 20 characters. The brackets are not part of the response. Returns #Done or #Error.

Table 4-11 Group 7 Commands (continued)

Command Number	Command Text	Command Description
#720N	INSPECT SEARCH LIST	Displays the N entry in the list of IDs to be searched. The value N is a four-digit hexadecimal entry from 0000 to 000F. The reader responds with the value N, followed by the ID code in the list. If the entry has been previously matched with an acquired ID, through the search capability, the number will have *** appended to it. For example, to inspect the twelfth ID in the list, issue the following command: #720000B <ENTER> The reader responds with #000B<ID> or#000B<ID>*** where <ID> is the ID code (up to 20 characters) in the list and *** indicates the ID has been matched through the search capability. ***Note:*** *The brackets are not part of the response.* Care must be taken to enter the correct value of N. Alphabetic characters must be uppercase. The commands are as follows: **Command** — **To Inspect** #7200000 — First List Entry #7200001 — Second List Entry #7200002 — Third List Entry • — • • — • • — • #7200009 — Tenth List Entry #720000A — Eleventh List Entry #720000B — Twelfth List Entry #720000C — Thirteenth List Entry #720000D — Fourteenth List Entry #720000E — Fifteenth List Entry #720000F — Sixteenth List Entry

Table 4-11 Group 7 Commands (continued)

Command Number	Command Text	Command Description
#7300N	ADD ENTRY TO SEARCH LIST	Allows user to add one ID number to the list of IDs to be searched. The list can contain up to 16 entries. The new entry will be placed in the first available opening in the list. The ID number can contain up to 20 alphanumeric characters. The command format is as follows: #7300<ID> where <ID> is the ID to add to the list. There should be no spaces between the command and the ID. Brackets should not be entered. An error message results if the ID entered contains more than 20 characters. An error message will also occur if the list already has 16 entries. If this occurs, remove one of the existing entries with the #731 DELETE SEARCH LIST ENTRY commands. Returns #Done or Error.
#731N	DELETE SEARCH LIST ENTRY	Removes the N entry from the list of IDs to be searched. Here, N is a four-digit hexadecimal number, 0000 through 000F. Removing an ID leaves the remaining IDs intact. For example, to remove the twelfth ID in the list, issue the following command: #731000B <ENTER> Care must be taken to enter the correct value of N. The commands are as follows: **Command** — **To Delete** #7200000 — First List Entry #7200001 — Second List Entry #7200002 — Third List Entry • — • • — • • — • #7200009 — Tenth List Entry #720000A — Eleventh List Entry #720000B — Twelfth List Entry #720000C — Thirteenth List Entry #720000D — Fourteenth List Entry #720000E — Fifteenth List Entry #720000F — Sixteenth List Entry
#732	DELETE ENTIRE SEARCH LIST	Erases all entries from the list of IDs to be searched. Returns #Done or #Error.

Command Group 8 – Auxiliary Reader Control

Group 8 commands provide control over the reader functions, such as the system check tag. These commands control writing parameters to and restoring parameters from the EEPROM.

Note: *All Group 8 commands return* #Done *or* #Error.

Table 4-12 Group 8 Commands

Command Number	Command Text	Command Description
#8000	DISABLE AUTOMATIC RESTORA-TION OF EEPROM PARAMETERS	Disables the automatic restoration of parameters as they are stored in the EEPROM. See command #8001 and #801 for further information.
#8001	ENABLE AUTOMATIC RESTORA-TION OF EEPROM PARAMETERS (factory setting)	When this feature is enabled, one parameter from EEPROM is restored to volatile memory every 2 minutes. If either the #8000 or the #8001 are issued, then the #801 should be issued to save them to the EEPROM. Otherwise, it is possible for the value to revert to the previous setting through the automatic restoration feature.
#801	SAVE PARAM-ETERS TO EEPROM	Writes current parameters to the EEPROM. It must be remembered that when volatile memory parameters are changed, they are not automatically saved to the EEPROM. Therefore, issue this command following changes to the reader configuration if those changes are to survive a power outage or to prevent automatic restoration of the previous values. See command #8001.
#802	RESTORE ALL PARAMETERS FROM EEPROM	Restores reader configuration parameters as they were last saved to the EEPROM.
#810	DISABLE THE SYSTEM CHECK TAG PERIODIC MODE (factory setting)	Disables the period operation of the system check tag enabled by the #812N command.

Table 4-12 Group 8 Commands (continued)

Command Number	Command Text	Command Description
#811N	PERFORM SYSTEM CHECK TAG TESTS	Performs system check tag tests as needed. This command may be executed either in data or command mode. The system check tag(s) emits a single ID that will be acquired and stored by the reader in the normal manner. The system check tag read by RF channel 0 must have address 0 and the system check tag read by RF channel 1 must have address 1. The check tag tests are performed as follows: **Command Test** #8110 Invoke RF channel 0 check tag #8111 Invoke RF channel 1 check tag #8112 Invoke both RF channel check tags This command disables the #812N ENABLE PERIODIC SYSTEM CHECK TAG MODE.
#812N	ENABLE PERIODIC SYSTEM CHECK TAG TEST MODE	When this feature is enabled, a system check tag test is performed on the specified channel(s) at the time intervals specified by the #813 command. These tests will continue until the #810 or #811N command is issued. The variable N specifies the affected RF channel as follows: **Command Test** #8120 Enable RF channel 0 periodic testing #8121 Enable RF channel 1 periodic testing #8122 Enable both RF channels' periodic testing

Note For commands #811N and #812N, valid ID code criteria - RF channel 0 parameter must be set for "1," Consequtive Acquisition, (#4200) for check tag to operate on channel 0.

Valid ID code criteria - RF channel 0 parameter must be set for "1," Consequtive Acquisition, (#4210) for check tag to operate on channel 1.

Table 4-12 Group 8 Commands (continued)

Command Number	Command Text	Command Description
#813N	SET PERIODIC CHECK TAG TESTING TIME INTERVAL	This command sets the time interval for the periodic system check tag test enabled by the #812N commands. The variable N has a value of 0 (30 seconds) to F (infinite - never true) and is set as follows: **Command Value** #8130 30 seconds (*factory setting*) #8131 2 minutes #8132 4 minutes #8133 8 minutes #8134 15 minutes #8135 30 minutes #8136 1 hour #8137 2 hours #8138 4 hours #8139 8 hours #813A 12 hours #813B 24 hours #813C 36 hours #813D 48 hours #813E 72 hours #813F infinite (*never true*)
#8142X	SELECT SYSTEM CHECK TAG SIGNATURE CHARACTER	This command sets the signature character to be stored in the system check tag. The value X can be any Amtech-brand 6-bit character. The signature character is stored in the first 12 locations of the system check tag ID code frame. (The following 6 locations are reserved; position 19 identifies the system check tag address; and the last (20th) location is a frame counter used to override the reader's filtering capabilities. All check tags connected to the **AUXIO0** channel receive this command and will change their signatures.
#8150	SET SYSTEM CHECK TAG ADDRESS TO 0	This command sets the system check tag's address to 0. All system check tags connected to the **AUXIO0** line will set their address to 0. Therefore, the system check tag read by RF channel 1 should be disconnected prior to invocation of this command. Command #8150 is included to maintain backwards compatibility with all Amtech-brand products and may not be effective in some system installations.

Table 4-12 Group 8 Commands (continued)

Command Number	Command Text	Command Description
#8151	SET SYSTEM CHECK TAG ADDRESS TO 1	This command sets the system check tag's address to 1. All system check tags connected to the **AUXIO0** line will set their address to 1. Therefore, the system check tag read by RF channel 0 should be disconnected prior to invocation of this command. Command #8151 is included to maintain backward compatibility with all Amtech-brand products and may not be effective in some system installations.
#82X	SET SENSOR STATUS CHANGE MODE	This command selects the sense input lines to be monitored for status change. Selected sense input status is displayed using command #560. The following commands are used to enable selected sense input lines: **Command** — **Enable Mask** (Sense Input Selections) #820 — All disabled (feature disabled) #821 — Sense0 #822 — Sense1 #823 — Sense1, Sense0 #824 — Sense2 #825 — Sense2, Sense0 #826 — Sense2, Sense1 #827 — Sense2, Sense1, Sense0 #828 — Sense3 #829 — Sense3, Sense0 #82A — Sense3, Sense1 #82B — Sense3, Sense1, Sense0 #82C — Sense3, Sense2 #82D — Sense3, Sense2, Sense0 #82E — Sense3, Sense2, Sense1 #82F — Sense3, Sense2, Sense1, Sense0 The reader responds with #Done or #Error. The enabled sense input lines are monitored for any changes in their logic states. If a change is detected, a STATUS SENSOR CHANGE message is generated and treated as a tag ID. If the auxiliary information option is enabled, the sensor input status field will display the current debounced input values.

Error Messages

The reader can issue any of the following error messages to the host computer. Error messages can be sent in either data mode or command mode. Carriage return and line-

feed are at the end of each error message. See the "Reader Transmission Formats" section in this chapter for further information on error message formats.

Table 4-13 Error Messages

Error Number	Error Description
#Error 01	Random access memory (RAM) error occurred on power up or after the reader was reset, which indicates an equipment malfunction. If the system halts on this error, contact TransCore. ***Note:*** *Time and date cannot be appended to this error message.*
#Error 02	The output buffer is full and newly acquired IDs cannot be stored. This condition usually occurs when the reading of IDs takes place faster than their subsequent transmission to the host computer. It also occurs when the host issues an XOFF command for an excessively long period of time. This condition also occurs is if the reader is left in command mode instead of being reset to data mode, preventing the reader from transmitting buffered IDs.
#Error 03	The buffer has been partially cleared and new IDs are once again being stored. This error message appears when the Error 02 condition is corrected.
#Error 04	The output buffer has filled to 75% full.
#Error 05	The output buffer has emptied to 50% full. Once Error 04 appears, it will not appear again until Error 05 is given. Once the buffer is 75% full, you will not receive this error message again until the buffer empties to 50% (producing Error 05) and then refills to 75% full. Error 05 is only issued after Error 04. Once the buffer fills to 75% full (producing Error 04), then empties to 50%, Error 05 is issued. Error 05 will not be issued again until the buffer fills again to 75% full (producing Error 04) and empties to 50%.
#Error 06	EEPROM write error condition. Indicates that data could not be written to an EEPROM location. It implies that the EEPROM may have reached the maximum 10,000 write cycles. Contact TransCore. Commands listed under the factory settings section involve writes to the EEPROM. As an example, a host computer issues command #6400 followed by the #6401 to alternately turn RF off and then on to RF channel 0. This sequence causes two writes to the EEPROM. If the host performs this sequence once every 12 hours, the EEPROM will reach the write limit in approximately 7 years.
#Error 07	Inter-micro timeout condition. Indicates that the secondary microcontroller has not responded within the allocated time. This condition is signalled because during initialization the secondary microcontroller responded to the startup messages, but it is not presently responding to messages.

Table 4-13 Error Messages (continued)

Error Number	Error Description
#Error 08	Loss of RF synchronization pulse condition. Occurs when a reader is in the RF Synchronization (#643x) mode. This condition indicates that a reader is not receiving synchronization pulses. This message will be issued every 5 seconds unless: (1) the reader receives synchronization pulses; or (2) the reader is taken out of RF Synchronization mode.

Reader Transmission Formats

The reader transmits the following information to the host computer:

- Tag ID codes
- Error messages
- Sensor input reports
- Sign-on message
- Modem connect/disconnect messages

Tag ID codes, error messages, sensor input reports, and modem connect/disconnect messages can have optional information appended to them. This information is appended through the Group 3 commands. When time or time and date are appended, they apply equally to tag ID codes, error messages, sensor input reports, and modem connect messages. Auxiliary information can be appended to tag ID codes and sensor input reports but not to error reports or modem messages. For further information see the Group 3 commands earlier in this chapter.

ID Code Only

The ID code is transmitted as a # sign followed by 20 characters. Spaces are legitimate characters, and if the ID code is not 20 characters long, spaces are appended to the ID code to equal 20 characters. For example:

```
#12345678901234567890
#ABC 12347655 TARE
```

To transmit IDs with no appended information, enter both `#300` and `#310` commands.

Error Message Only

Error messages are in the format of the #, the word `Error`, and a two-digit error code. For example:

```
#Error02
#Error03
```

To transmit the error code only, enter the #300 command, which removes the time and date.

Sensor Input Reports Only

Sensor input reports are in the format of the #, the words SENSOR INPUT REPORT, and a space. There are 21 characters total, including the # character.

Note: *Sensor input reports are not automatic. They must be requested through the* #6901 SENSOR INPUT REPORTS ENABLED *command.*

Sign-on Message

The sign-on message is in the following format:

```
#Model AI1200 Ver X.X SNYYYYY

#Copyright 1988  AMTECH Corp.
```

The sign-on message never contains any appended information.

Time Only Appended

Time can be appended to ID codes, error messages (except Error 01), sensor input reports, and modem connect/disconnect messages. The format of the transmission is as follows:

```
#<string>&HH:MM:SS.hh
```

where <string> is the ID code, error message, or sensor input report. HH:MM:SS.hh represent hours, minutes, seconds, and hundredths of seconds, respectively. Colons (:) separate hours, minutes, and seconds and a period (.) separates hundredths of seconds. The & character provides a means for the host computer to determine if time is appended to the string.

Note: *Hundredths of seconds are not appended to error messages.*

Time and Date Appended

Time and date can be appended to ID codes, error messages (except Error 01), sensor input reports, and modem connect disconnect messages. The format of the transmission is as follows:

```
#<string>&HH:MM:SS.hh MM/DD/YY
```

The format is exactly like *time only appended* described previously, except that two spaces and the date follow the time. MM, DD, and YY represent the month, day, and two-digit year, respectively. The forward slash (/) separates the month, day, and year entries.

Note: *Hundredths of seconds are not appended to error messages.*

Auxiliary Information Only Appended

Auxiliary information can be appended to ID codes and sensor input reports. Auxiliary information is never appended to error or modem messages. Auxiliary information consists of reader number, antenna number, number of reads of previous tag, and sensor input status. The format is as follows:

```
#<string>%XX-Y-ZZ-Q
```

where `<string>` is the ID code or sensor input report. `XX` represents the reader number in hex from `00` to `FF`; `Y` represents the antenna number (`0` or `1` for antenna, `M` for manual ID entry, `S` for sensor input report); `ZZ` is the number of reads of the previous tag in hex from `00` to `FF`; and `Q` represents the sensor input status in hex from `0` to `F`. The `%` character provides a means for the host computer to determine if auxiliary information is appended to the string. The `-` separates the values of the auxiliary information.

Time and Auxiliary Information Appended

Time and auxiliary information can be appended to ID codes and sensor input reports. The format is as follows:

```
#<string>&HH:MM:SS.hh%XX-Y-ZZ-Q
```

The time and auxiliary information follow the formats described previously.

Time, Date, and Auxiliary Information Appended

Time, date, and auxiliary information can be appended to ID codes and sensor input reports. This is the factory setting of the reader. The format is as follows:

```
#<string>&HH:MM:SS.hh MM/DD/YY%XX-Y-ZZ-Q
```

The time, date, and auxiliary information follow the formats described previously.

AUX-2 Port Functions

The optional **AUX-2** port permits local terminal functions to be performed with the AI1200 Reader. These functions include *manually entering ID codes* for untagged equipment or vehicles and *performing search functions*.

Manually entering IDs is ideally suited for situations such as entrance/exit gates at terminal yards where both tagged and untagged vehicles pass. Manually entering the identification codes for untagged vehicles lets the reader process these codes just as if they were acquired by the RF channel.

Search functions permit the user to define a list of IDs for which to search. This capability is very useful, for example, with mobile inventory vehicles that search a terminal yard for a particular chassis or trailer. It is also useful at terminal yards for notification when a particular vehicle enters or exits the yard. Search functions can also be performed through commands entered through the **Main** communication port and using the host computer.

Unlike commands given through the **Main** port, **AUX-2** provides a menu. Figure 4-3 shows the basic structure of the **AUX-2** menu commands. The *text* listed under each menu are the options for that menu. The *numbers* in the text are the responses to select those options. For example, on the main menu, the user selects **Manual ID** entry by typing **1**. *Arrows* on the diagram indicate the next level of prompt. For example, if the user selects manual ID entry by typing **1**, the next prompt is for the ID code, which is a maximum of 20 characters. If the user selects the **Search** option (2**)** from the main menu, the next prompts come from the search submenu.

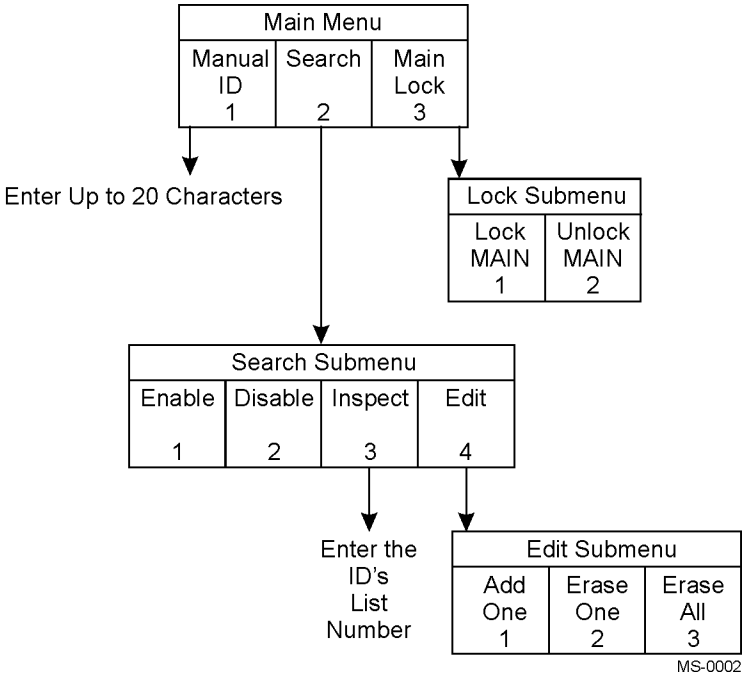


Figure 4-3 Basic Structure of the AUX-2 Menu Commands

Initial Setup

This section describes the initial setup of the optional **AUX-2** port.

Hardware Requirements

This discussion assumes that the **AUX-2** option was purchased and is installed in the AI1200 Reader. It also assumes that the terminal connections have been made to the reader during system installation. **AUX-2** connections are made using terminals 29 through 35 on the AI1200 Reader backplane. All connections made to the reader require entrance through the reader's NEMA enclosure. To properly secure the NEMA box, all connections should be made during system installation and/or by TransCore-certified personnel.

The **AUX-2** port is a standard RS-232 DTE serial port.

Initial setup of the optional **AUX-2** port is described in the following sections.

Communication Port Parameters

Factory settings of the **AUX-2** communications parameters are as follows:

Number of data bits: 8

Parity: Disabled

Number of stop bits: 1

Baud rate: 300

These parameters can be changed using commands `#110N` through `#113N`. These commands must be issued through the host computer or a terminal connected to the **Main** port.

Busy Message

Any command issued from the secondary microcontroller (**AUX-2** port) can receive the `BUSY...RE-ENTER DATA` message. This message signifies that the primary microcontroller was busy and did not receive or execute the command.

Obtaining the Main Menu

The following conditions must be met to obtain the main menu:

- Proper terminal connection to the reader (as described previously)
- Proper communications parameters set for the terminal/reader connection (as described previously)
- Power on to the reader
- Power on to the terminal

If the main menu does not appear, press **Return** or **Enter** twice.

The options on the main menu are:

1. **Man ID** - Manual entry of ID codes
2. **Search** - Search functions
3. **Main Lk** - Lock out the **Main** port.

Information is sent to the reader by typing the necessary information, such as a menu selection or an ID code, and press **Return** or **Enter**.

Note: *Turn **CAP LOCKS** on for alphabetic characters. They must be entered as uppercase.*

Lock Out the Main Port

Locking the **Main** port ensures control of the reader by the terminal attached to the **AUX-2** port.

To lock out the Main port

1. Select **3** (**Main Lk**) on the main menu. The submenu appears.
2. Select **1** (**Lock Main**). Then press **Enter** to return to the main menu.

Locking the **Main** port prevents commands or other messages transmitted via this port from interfering with the reader while the **AUX-2** port is active. The **Main** port can only be unlocked by reversing the above procedure or with the `#03 UNLOCK MAIN PORT` command issued through the **Main** port.

Unlock the Main Port

Unlocking the **Main** port returns the reader to normal operations controlled by the host computer.

To unlock the Main port

1. When the main menu appears on the screen, enter **3** (**Main Lk**). The submenu appears.
2. Select **2** (**Unlock Main**). Then press **Enter** to return to the main menu.

Manually Entering ID Codes

Manual entry of ID codes is a three-step process.

To manually enter ID codes

1. Lock out the **Main** port to prevent commands or communications from the host computer from interfering with the manual entry.
2. Manually enter the IDs.
3. Unlock the **Main** port so normal operations can resume.

Lock out the Main Port

Lock out the **Main** port as described in the previous section. When the reader responds with `#Done`, press **Return** or **Enter** to return to the main menu.

Manually Enter the IDs

Follow these steps when the main menu appears on the screen:

To manually enter IDs

1. Select **1** (**Man ID**).
2. Type the ID from the untagged object, then press **Enter**. The system automatically returns to the main menu after the ID is entered.

   Note: *An attempt to enter more than 20 characters results in an error message. Press* ***Enter*** *to clear the error message, which returns the* ***New ID*** *prompt.*

   Note: *To return to the main menu without entering an ID, press the* ***Esc*** *key.*

A successful entry results in the ID being processed by the reader just as if it had been received through the RF channel, except that ID filtering is bypassed. If auxiliary

information is appended to ID codes, the antenna number indicates the letter M for manual entry.

Unlock the Main Port

Unlock the **Main** port as described previously. When the reader responds with #Done, press **Return** or **Enter** to return to the main menu.

Search Function

The search function enables the user to locate specific IDs from among those newly acquired. The procedure is useful in locating equipment in a terminal yard, for example.

When the search function is enabled in the reader, the reader compares every newly acquired ID with a set of user-defined IDs. When a match occurs, the reader alerts the user with a bell, issues a message that a match has been made, and appends a special character to the matched ID in the search list. The search list can contain up to 16 entries.

To search

1. Lock out the **Main** port to prevent commands or communications from the host computer from interfering with the manual entry.
2. Enter and, if necessary, edit the search list of IDs.
3. Enable the search function.
4. Unlock the **Main** port so normal operations can resume.

Lock out the Main Port

Lock out the **Main** port as described previously in this chapter. When the reader responds with # Done, press **Enter** or **Return** to return to the main menu.

Enter and Edit ID List

To edit the ID list

1. When the main menu appears on the screen, select **2** (**Search**). The **Search** submenu appears.
2. Select **4** (**Edit**). The submenu displays.
3. To add IDs to the list, select **1** (**Add One**).
4. Enter the tag ID (up to 20 characters) and press **Enter** or **Return**. The reader responds.
5. Press **Return** or **Enter**. The reader prompts for the next new ID. Continue entering IDs following the above procedure.

   Note: *To return to the main menu without entering an ID, press* ***Esc*** *(escape).*

You can add up to 16 IDs to the list. The list entries are numbered from 0 through F. IDs will be added to the first available place in the list.

Editing the ID list consists of removing and re-entering the IDs in the list.

To remove (or erase) an ID from the list

1. Select **2** (**Erase One**).
2. Enter the appropriate ID list number. The reader responds.
3. Select **3** (**Erase All**) to erase all IDs in the list. This selection clears the list of all existing IDs.

Enabling the Search Function

Enabling the search function starts the process of comparing newly acquired tag IDs with the list. The search function is enabled at the main menu.

To enable the search function

1. Enter **2** (**Search**), which brings up the **Search** submenu.
2. Select **1** (**Enable**).

   When an ID on the list is matched with a newly acquired ID, messages appear both on the **AUX-2** port terminal and the **Main** port terminal.

   `<ID>` represents the matched ID.

   In the message on the **Main** port terminal, `<ID>` represents the matched ID; <time date> and <aux> represent optionally appended information.

Note: *Only the first occurrence of a match is signalled.*

Inspecting the ID List

To inspect the ID list

1. From the main menu, enter **2** (**Search**), which brings up the **Search** submenu.
2. Select **3** (**Inspect**).
3. To inspect a single ID, enter the list number from 0 through F. The reader responds with the tag ID number. Press **Esc** to return to the main menu.
4. To scroll through the ID list, enter the beginning ID list number, such as 0. Press **Return** or **Enter** twice after each reader response.

Disabling the Search Function

Disabling the search function ends the process of comparing newly acquired tag IDs with the list. The search function is disabled at the main menu.

To disable the search function

1. Select **2** (**Search**), which brings up the **Search** submenu.
2. Select **2** (**Disable**).

Unlock the Main Port

Unlock the **Main** port as described earlier in this section. When the reader responds with # Done, press **Return** or **Enter** to return to the main menu.

Search Function from the Main Port

The search function can be controlled from the terminal or host computer attached to the **Main** port. The same procedures are followed; however, they are accomplished by using the Group 7 commands as follows:

#70	Disable Search Mode
#71	Enable Search Mode
#720000X	Inspect Search List Item
#7300<ID>	Add Entry to Search List
#731000X	Delete Search List Item Number
#732	Delete Entire Search List

A

Glossary

Appendix A
Glossary

This glossary provides a description of terms used in the AI1200 System.

A

Antenna gain — The ratio of the maximum (forward) power density of an antenna to the power density of an isotropic radiator emitting the same total amount of power

ASCII — American Standard Code for Information Exchange

Asynchronous transmission — Data transmission in which time intervals between transmitted characters may be of unequal length. Transmission is controlled by start and stop bits at the beginning and end of each character.

Attenuation — Reduction of signal amplitude

Attenuator — A circuit used for reducing a given voltage to a lower value

B

Bandpass filter — A filter designed to transmit a band of frequencies with negligible loss while rejecting all other frequencies

C

Cable shielding — A protective covering that reduces electromagnetic and radio frequency interference

Capacitive coupling — The most common type of electrical interference, capacitive coupling results from capacitances between signal circuits and interference circuits.

Capacitive shielding — The positioning and connecting of conductors such that capacitively coupled interference currents are returned to their sources without flowing through signal lines or impedances.

Conductive coupling — The direct electrical contact to interference sources through metallic conductors. Contact may be intentional for grounding or may be undesired leakage conductance.

Constructive interference — The combined, positive effect of a main RF beam intersecting in phase with one or more reflected beams. Although the reflected beams are considered to be interference, the net result is a constructive one, creating field enhancement and an extended reading range.

D

Data frame A cluster of bits that make up a binary character or a cluster of binary characters that make up a segment of a coded message

Debounce The controlled elimination of redundant electrical signals produced by relay closure

Dielectric A material that is a non-conductor of electricity

EEPROM Electrically erasable programmable read-only memory circuit

EMI Electromagnetic interference

Extended reading range See Constructive interference

F

Far Field A distance of 3 feet or more from an antenna.

Field Enhancement See Constructive interference.

Floating Ground A dedicated ground connection that remains isolated from common circuit ground

G

Ground Loop An undesirable current path through a grounded body, such as a metal chassis. A ground loop can result when various parts of a circuit are returned to separate ground points on a chassis. A ground loop sometimes provides a common impedance.

H

Half Power Beamwidth (HPBW) The angular wideness of the main lobe of the pattern of radiation from a directional antenna. The HPBW is defined as that angle on an antenna's radiation pattern which subtends a power density of at least 50% of the forward (maximum) power density.

Handshakes Exchange of predetermined signals between two devices making a connection that is usually part of a communications protocol. In the TransCore system, handshakes are the number of consecutive reads of a tag. See Valid ID filter.

Homodyne device Uses electrical and magnetic fields to distinguish return signal from output signal in a single-frequency, continuous-wave system

I

Inductive Coupling Transfer of energy between two inductors by a linking electromagnetic field. Inductive coupling results from magnet flux coupling between interference sources and signal circuits. Equipment in the near field (i.e., closer than one wavelength) is affected by inductive coupling.

Interference Any undesired electrical energy within the system

L

Lobe In an antenna directivity pattern, a figure (such as a circle or ellipse) enclosing an area of intensified response

Lossy The quality of a dielectric material that causes attenuation or dissipation of electrical energy

M

Modem A modulator-demodulator device used to convert serial digital data from a transmitting terminal to a signal suitable for transmission over a telephone channel or used to reconvert the transmitted signal to serial digital data for acceptance by a receiving terminal

Modulated backscatter Coded reflection of an unmodulated RF signal returned from a field disturbance device, such as a tag

Multipath transmission Transmission of a signal over two or more paths, one being direct and the others via reflection from some object

N

Near field A distance of less than 3 feet from an antenna

Null A region in an antenna's broadcast field where the signal is effectively zero that may be at the sides or back of an antenna, outside the main lobe, between smaller incidental lobes, within a main lobe as a result of a multipath signal intersection out of phase

P

Parity check The addition of non-information bits that make up a transmission block to ensure the total number of 1s is always either even (even parity) or odd (odd parity) and used to verify data integrity from transmission to reception

R

Radiative coupling The reception or transmission of propagating electromagnetic energy. Radiative energy may be received by one circuit and transmitted conductively to another circuit

RFI Radio frequency interference

RF/Radio frequency Electromagnetic waves in the 100 MHz to 10 GHz range

RS-232 Electronics Industries Association (EIA) standard applicable to the 25-pin interconnection of data terminal equipment (DTE) and data communication equipment (DCE) employing serial binary interchange

S

Standard tag A hypothetical tag conforming to certain established performance criteria. Quality assurance for all tags is determined as a function of deviation within allowed tolerances from the performance characteristics of the standard tag

Start bit In asynchronous transmission, the first bit or element in each character, normally a space that prepares the receiving equipment for the reception and registration of a character. A low voltage signal on the data line marks the beginning of a start bit. The receiving device can then begin looking for 1s and 0s.

Stop bit In asynchronous transmission, the last bit It is used to indicate the end of a character; normally a mark condition that serves to return the line to its idle or rest state.

V

Valid ID filter Reader firmware control requiring a predetermined number of consecutive reads of a tag prior to buffering the ID

B

AI1200 Reader Command List

Appendix B

AI1200 Reader Command List

This appendix provides a list of AI1200 reader commands supported by version 2.8 of the reader firmware. All commands are listed although some commands may only be useful to TransCore-certified personnel.

Introduction

The reader accepts commands from the host computer or a terminal when in command mode. The default mode for the reader is data mode, which allows the transmission of IDs to the host computer. The only commands accepted in data mode are `#00`, `#01`, `#8110`, `#8111`, and `#8112`.

Software commands are divided into nine groups according to their main function. The first character of the command determines the group to which it belongs.

Table B-1 Software Command Groups

Command Group	Function
0	Data and Command Mode Control
1	Communication Port Control
2	Real-Time Clock Control
3	Format ID (Append Information)
4	ID Filter Parameters
5	Reader Status
6	Reader Control Functions
7	Search Functions
8	Auxiliary Reader Control

Commands are preceded by the # character and are completed by pressing **Enter** or **Return**. For example, the `#01 SWITCH TO COMMAND MODE` command is typed as:

```
#01<Enter>
```

where <Enter> is the **Enter** or **Return** key.

Default values are printed in bold, italic type. An expanded listing of reader commands is included in the *AI1200 System User's Guide.*

Note: *You can only use commands* `1100 to 113F` *if the optional* ***AUX-2*** *port is installed.*

Table B-2 Command Numbers and Names

Command Number	Command Name/Action *(Factory settings are in bold italic type.)*
#00	SWITCH TO DATA MODE
#01	SWITCH TO COMMAND MODE
#02	LOCK OUT MAIN PORT
#03	UNLOCK MAIN PORT
#1000	CONFIGURE MAIN AND AUX-1 PORTS RATE - 110 BAUD
#1001	" " - 300 BAUD
#1002	" " - 1200 BAUD
#1003	" " - 2400 BAUD
#1004	" " - 4800 BAUD
#1005	" " - 9600 BAUD
#1006	" " - 19200 BAUD
#1010	SET MAIN AND AUX-1 PORTS STOP BITS TO ONE
#1011	" " " " TO TWO
#1020	DISABLE MAIN AND AUX-1 PORTS PARITY
#1021	SET MAIN AND AUX-1 PORTS PARITY TO EVEN
#1022	SET MAIN AND AUX-1 PORTS PARITY TO ODD
#1030	SET MAIN AND AUX-1 PORTS END-OF-LINE DELAY - 0 MILLISECONDS (MS)
#1031	" " - 100 MS
#1032	" " - 200 MS
#1033	" " - 300 MS
#1034	" " - 400 MS
#1035	" " - 500 MS
#1036	" " - 600 MS
#1037	" " - 700 MS
#1038	" " - 800 MS

Table B-2 Command Numbers and Names (continued)

Command Number	Command Name/Action *(Factory settings are in bold italic type.)*
#1039	" " - 900 MS
#103A	" " - 1000 MS
#103B	" " - 1100 MS
#103C	" " - 1200 MS
#103D	" " - 1300 MS
#103E	" " - 1400 MS
#103F	" " - 1500 MS
#1100	CONFIGURE AUX-2 PORT BAUD RATE - 110 BAUD
#1101	" " - 300 BAUD
#1102	" " - 1200 BAUD
#1103	" " - 2400 BAUD
#1104	" " - 4800 BAUD
#1105	" " - 9600 BAUD
#1106	" " - 19200 BAUD
#1110	SET AUX-2 PORT STOP BITS TO ONE
#1111	" " TO TWO
#1120	DISABLE AUX-2 PORT PARITY
#1121	SET AUX-2 PORT PARITY TO EVEN
#1122	SET AUX-2 PORT PARITY TO ODD
#1130	SET AUX-2 PORT END-OF-LINE DELAY - 0 MILLISECONDS (MS)
#1131	" " - 100 MS
#1132	" " - 200 MS
#1133	" " - 300 MS
#1134	" " - 400 MS
#1135	" " - 500 MS
#1136	" " - 600 MS
#1137	" " - 700 MS

Table B-2 Command Numbers and Names (continued)

Command Number	Command Name/Action *(Factory settings are in bold italic type.)*
#1138	" " - 800 MS
#1139	" " - 900 MS
#113A	" " - 1000 MS
#113B	" " - 1100 MS
#113C	" " - 1200 MS
#113D	" " - 1300 MS
#113E	" " - 1400 MS
#113F	" " - 1500 MS
#20	SET TIME
#21	SET DATE
#22	DISPLAY TIME AND DATE
#300	NO TIME AND DATE APPENDED
#301	TIME ONLY APPENDED
#302	TIME AND DATE APPENDED
#310	NO AUXILIARY INFORMATION APPENDED
#311	AUXILIARY INFORMATION APPENDED
#40	TRANSMIT ALL ID CODES
#4100	UNIQUE ID CODE CRITERIA – RF CHANNEL 0 - SEPARATION OF 1 ID
#4101	" " - SEPARATION OF 2 IDS
#4102	" " - SEPARATION OF 3 IDS
#4103	" " - SEPARATION OF 4 IDS
#4110	UNIQUE ID CODE CRITERIA – RF CHANNEL 1 - SEPARATION OF 1 ID
#4111	" " - SEPARATION OF 2 IDS
#4112	" " - SEPARATION OF 3 IDS
#4113	" " - SEPARATION OF 4 IDS
#4200	VALID ID CODE CRITERIA – RF CHANNEL 0 - 1 CONSECUTIVE ACQUISITION

Table B-2 Command Numbers and Names (continued)

Command Number	Command Name/Action *(Factory settings are in bold italic type.)*
#4201	" " - 2 CONSECUTIVE ACQUISITIONS
#4202	" " - 3 CONSECUTIVE ACQUISITIONS
#4203	" " - 4 CONSECUTIVE ACQUISITIONS
#4204	" " - 5 CONSECUTIVE ACQUISITIONS
#4205	" " - 6 CONSECUTIVE ACQUISITIONS
#4206	" " - 7 CONSECUTIVE ACQUISITIONS
#4207	" " - 8 CONSECUTIVE ACQUISITIONS
#4208	" " - 9 CONSECUTIVE ACQUISITIONS
#4209	" " - 10 CONSECUTIVE ACQUISITIONS
#420A	" " - 11 CONSECUTIVE ACQUISITIONS
#420B	" " - 12 CONSECUTIVE ACQUISITIONS
#420C	" " - 13 CONSECUTIVE ACQUISITIONS
#420D	" " - 14 CONSECUTIVE ACQUISITIONS
#420E	" " - 15 CONSECUTIVE ACQUISITIONS
#420F	" " - 16 CONSECUTIVE ACQUISITIONS
#4210	VALID ID CODE CRITERIA – RF CHANNEL 1 - 1 CONSECUTIVE ACQUISITION
#4211	" " - 2 CONSECUTIVE ACQUISITIONS
#4212	" " - 3 CONSECUTIVE ACQUISITIONS
#4213	" " - 4 CONSECUTIVE ACQUISITIONS
#4214	" " - 5 CONSECUTIVE ACQUISITIONS
#4215	" " - 6 CONSECUTIVE ACQUISITIONS
#4216	" " - 7 CONSECUTIVE ACQUISITIONS
#4217	" " - 8 CONSECUTIVE ACQUISITIONS
#4218	" " - 9 CONSECUTIVE ACQUISITIONS
#4219	" " - 10 CONSECUTIVE ACQUISITIONS
#421A	" " - 11 CONSECUTIVE ACQUISITIONS
#421B	" " - 12 CONSECUTIVE ACQUISITIONS

Table B-2 Command Numbers and Names (continued)

Command Number	Command Name/Action *(Factory settings are in bold italic type.)*
#421C	" " - 13 CONSECUTIVE ACQUISITIONS
#421D	" " - 14 CONSECUTIVE ACQUISITIONS
#421E	" " - 15 CONSECUTIVE ACQUISITIONS
#421F	" " - 16 CONSECUTIVE ACQUISITIONS
#43	BUFFER ALL ID CODES
#440	RESET UNIQUENESS
#441	SET VARIABLE TIME-OUT - 2 MINUTES
#442	" " - 20 MINUTES
#443	" " - 60 MINUTES
#505	DISPLAY FIRMWARE VERSION - MICRO-1
#515	" " - MICRO 2
#520	DISPLAY POWER OUTAGE AND RESTORE BITS
#521	DISPLAY READER ID NUMBER
#522	DISPLAY COMMUNICATION PARAMETERS - MAIN AND AUX-1 PORTS
#523	" " - AUX-2 PORT
#524	DISPLAY APPENDED INFORMATION STATUS
#525	INQUIRE COMMUNICATION PROTOCOL STATUS
#526	DISPLAY I/O STATUS
#527	DISPLAY RF STATUS
#528	DISPLAY MODEM CONTROL STATUS
#529	DISPLAY PRESENCE INPUT STATUS
#530	DISPLAY FILTER PARAMETER STATUS - RF CHANNEL 0
#531	" " - RF CHANNEL 1
#540	PRIMARY MICROCONTROLLER CHECKSUM
#541	DISPLAY EXTERNAL RAM SIZE
#542	SECONDARY MICROCONTROLLER CHECKSUM
#550	REQUEST SYSTEM CHECK TAG CONTROL STATUS

Table B-2 Command Numbers and Names (continued)

Command Number	Command Name/Action *(Factory settings are in bold italic type.)*
#560	REQUEST SENSOR STATUS CHANGE STATUS
#561	REQUEST RF SYNCHRONIZATION STATUS
#570	HANDSHAKE COUNT
#60N	SET READER ID NUMBER
#610	ENABLE BASIC COMMUNICATION PROTOCOL
#611	ENABLE ERROR CORRECTING PROTOCOL
#612N	SET ERROR CORRECTING PROTOCOL TIMEOUT
#613	ENABLE DATA ENQUIRE PROTOCOL
#6140	DISABLE FLOW CONTROL
#6141	ENABLE XON/XOFF FLOW CONTROL
#6142	ENABLE HARDWARE FLOW CONTROL
#6150	SELECT <SOM> CHARACTER = # (23 HEX)
#6151	SELECT <SOM> CHARACTER = ` (60 HEX)
#6152	SELECT <SOM> CHARACTER = { (7BHEX)
#6153	SELECT <SOM> CHARACTER = | (7C HEX)
#6154	SELECT <SOM> CHARACTER = } (7DHEX)
#6155	SELECT <SOM> CHARACTER = ~ (7E HEX)
#6200	ALL OUTPUT STATUS LINES OFF
#6201	OUTPUT STATUS LINES ON = STAT0
#6202	" " = STAT1
#6203	" " = STAT0, STAT1
#6204	" " = STAT2
#6205	" " = STAT0, STAT2
#6206	" " = STAT1, STAT2
#6207	" " = STAT0, STAT1, STAT2
#6208	" " = STAT3
#6209	" " = STAT0, STAT3

Table B-2 Command Numbers and Names (continued)

Command Number	Command Name/Action *(Factory settings are in bold italic type.)*
#620A	" " = STAT1, STAT3
#620B	" " = STAT0, STAT1, STAT3
#620C	" " = STAT2, STAT3
#620D	" " = STAT0, STAT2, STAT3
#620E	" " = STAT1, STAT2, STAT3
#620F	" " = ALL
#621	PREDEFINED OUTPUT CONTROL
#63	RESET READER
#6400	RF CONTROL-OFF FOR BOTH CHANNELS
#6401	" " -CHANNEL 0 ON, CHANNEL 1 OFF
#6402	" " -CHANNEL 1 ON, CHANNEL 0 OFF
#641	SET RF BY SENSOR
#642	SET RF CONTROL IN 2 CHANNEL MULTIPLEX MODE
#6430	DISABLE RF SYNCHRONIZATION CONTROL MODE
#6431	SET RF SYNCHRONIZATION PERIOD - 64 MS
#6432	" " - 72 MS
#6433	" " - 80 MS
#6434	" " - 88 MS
#6435	" " - 96 MS
#6436	" " - 112 MS
#6437	" " - 128 MS
#6438	" " - 144 MS
#6439	" " - 160 MS
#643A	" " - 192 MS
#643B	" " - 224 MS
#643C	" " - 256 MS
#643D	" " - 320 MS

Table B-2 Command Numbers and Names (continued)

Command Number	Command Name/Action *(Factory settings are in bold italic type.)*
#643E	" " - 384 MS
#643F	" " - 512 MS
#65	RESET POWER OUTAGE BIT
#66	INVOKE DIAGNOSTIC MODE
#670	SET OUTPUT PULSE DURATION - 4 MS
#671	" " - 8 MS
#672	" " - 12 MS
#673	" " - 16 MS
#674	" " - 20 MS
#675	" " - 24 MS
#676	" " - 32 MS
#677	" " - 40 MS
#678	" " - 48 MS
#679	" " - 60 MS
#67A	" " - 76 MS
#67B	" " - 152 MS
#67C	" " - 228 MS
#67D	" " - 300 MS
#67E	" " - 376 MS
#67F	" " - 752 MS
#6800	DISABLE MODEM CONTROL
#6801	ENABLE MODEM CONTROL
#6811	SELECT MODEM TYPE: MULTITECH MODEL 224E MODEM
#6812	SELECT MODEM TYPE: GENERIC MULTTECH COMPATIBLE
#6813	SELECT MODEM TYPE: GENERIC HAYES COMPATIBLE
#6820	ENABLE CALL IF ALL CONDITIONS ARE SATISFIED
#6821	ENABLE CALL IF ANY CONDITIONS ARE SATISFIED

Table B-2 Command Numbers and Names (continued)

Command Number	Command Name/Action *(Factory settings are in bold italic type.)*
#6830	SELECT MODEM PRESET NUMBER OF IDS ≥ 0 (ALWAYS TRUE)
#6831	" " ≥1
#6832	" " ≥ 2
#6833	" " ≥ 4
#6834	" " ≥ 8
#6835	" " ≥ 16
#6836	" " ≥ 32
#6837	" " ≥ 64
#6838	" " ≥ 128
#6839	" " ≥ 256
#683A	" " ≥ 512
#683F	" " INFINITE (NEVER TRUE)
#6840	SELECT MODEM CALL INTERVAL - 0 MINUTES (ALWAYS TRUE)
#6841	" " - 2 MINUTES
#6842	" " - 4 MINUTES
#6843	" "- 8 MINUTES
#6844	" " - 15 MINUTES
#6845	" " - 30 MINUTES
#6846	" " - 1 HOUR
#6847	" " - 2 HOURS
#6848	" " - 4 HOURS
#6849	" " - 8 HOURS
#684A	" " - 12 HOURS
#684B	" " - 24 HOURS
#684C	" " - 36 HOURS
#684D	" " - 48 HOURS
#684E	" " - 72 HOURS

Table B-2 Command Numbers and Names (continued)

Command Number	Command Name/Action *(Factory settings are in bold italic type.)*
#684F	" " - INFINITE (NEVER TRUE)
#6850	SELECT TAG INACTIVITY PERIOD - 0 MINUTES (ALWAYS TRUE)
#6851	" " - 2 MINUTES
#6852	" " - 4 MINUTES
#6853	" " - 8 MINUTES
#6854	" " - 15 MINUTES
#6855	" " - 30 MINUTES
#6856	" " - 1 HOUR
#6857	" " - 2 HOURS
#6858	" " - 4 HOURS
#6859	" " - 8 HOURS
#685A	" " - 12 HOURS
#685B	" " - 24 HOURS
#685C	" " - 36 HOURS
#685D	" " - 48 HOURS
#685E	" " - 72 HOURS
#685F	" " - INFINITE (NEVER TRUE)
#6860	SELECT MODEM REDIAL INTERVAL - 0 MINUTES (ALWAYS TRUE)
#6861	" "- 2 MINUTES
#6862	" " - 4 MINUTES
#6863	" " - 8 MINUTES
#6864	" "- 15 MINUTES
#6870 <STR>	ISSUE COMMAND TO MODEM FROM READER
#6900	DISABLE “PRESENCE WITHOUT TAG” REPORTING
#6901	ENABLE “PRESENCE WITHOUT TAG” REPORTING
#6910	SET MINIMUM PRESENCE TRUE PERIOD - 0 MS (ALWAYS TRUE)

Table B-2 Command Numbers and Names (continued)

Command Number	Command Name/Action *(Factory settings are in bold italic type.)*
#6911	" " - 4 MS
#6912	" " - 8 MS
#6913	" " - 12 MS
#6914	" " - 20 MS
#6915	" " - 24 MS
#6916	" " - 32 MS
#6917	" " - 48 MS
#6918	" " - 60 MS
#6919	" " - 92 MS
#691A	" " - 152 MS
#691B	" " - 300 MS
#691C	" " - 452 MS
#691D	" " - 600 MS
#691E	" " - 752 MS
#691F	" " - INFINITE (NEVER TRUE)
#6920	PRESENCE RF CONTROL - OFF ON TIME-OUT ONLY
#6921	PRESENCE RF CONTROL - OFF ON TIME-OUT 'OR' TAG
#6922	PRESENCE RF CONTROL - OFF ON TIME-OUT 'OR' PRESENCE “FALSE”
#6930	PRESENCE RF CONTROL TIME-OUT PERIOD - 0 MS (ALWAYS TRUE)
#6931	" " - 20 MS
#6932	" " - 32 MS
#6933	" " - 60 MS
#6934	" " - 92 MS
#6935	" " - 152 MS
#6936	" " - 300 MS
#6937	" " - 452 MS

Table B-2 Command Numbers and Names (continued)

Command Number	Command Name/Action *(Factory settings are in bold italic type.)*
#6938	" " - 600 MS
#6939	" " - 752 MS
#693A	" " - 1.5 S
#693B	" " - 3 S
#693C	" " - 6 S
#693D	" " - 12 S
#693E	" " - 24 S
#693F	" " - INFINITE (NEVER TRUE)
#6940	SENSE INPUT ENERGIZED FOR LOGIC TRUE
#6941	SENSE INPUT DE-ENERGIZED FOR LOGIC TRUE
#70	DISABLE SEARCH MODE
#71	ENABLE SEARCH MODE
#720000N	INSPECT SEARCH LIST ITEM NUMBER N (0-F)
#7300	ADD ENTRY TO SEARCH LIST
#731000N	DELETE SEARCH LIST ITEM NUMBER N (0-F)
#732	DELETE ENTIRE SEARCH LIST
#8000	DISABLE THE AUTOMATIC RESTORATION OF EEPROM PARAMETERS
#8001	ENABLE AUTOMATIC RESTORATION OF EEPROM PARAMETERS
#801	SAVE PARAMETERS TO EEPROM
#802	RESTORE PARAMETERS FROM EEPROM
#810	DISABLE THE SYSTEM CHECK TAG PERIODIC MODE
#8110	INVOKE SYSTEM CHECK TAG - RF CHANNEL 0
#8111	" " - RF CHANNEL 1
#8112	" " - BOTH RF CHANNELS
#812N	ENABLE PERIODIC SYSTEM CHECK TAG TEST MODE
#8130	SELECT SYSTEM CHECK TAG PERIODIC TIME INTERVAL = 30 SECONDS

Table B-2 Command Numbers and Names (continued)

Command Number	Command Name/Action *(Factory settings are in bold italic type.)*
#8131	" " = 2 MINUTES
#8132	" " = 4 MINUTES
#8133	" " = 8 MINUTES
#8134	" " 15 MINUTES
#8136	" " = 1 HOUR
#8137	" " = 2 HOURS
#8138	" " = 4 HOURS
#8139	" " = 8 HOURS
#813A	" " = 12 HOURS
#813B	" " = 24 HOURS
#813C	" " = 36 HOURS
#813D	" " = 48 HOURS
#813E	" " = 72 HOURS
#813F	" " = INFINITE (NEVER TRUE)
#8142x	SELECT THE SYSTEM CHECK TAG SIGNATURE CHARACTER
#8150	SET SYSTEM CHECK TAG ADDRESS TO 0
#8151	" " TO 1
#820	DISABLE SENSOR STATUS CHANGE MODE
#821	SET SENSOR STATUS CHANGE FEATURE - SENSE0
#822	" " - SENSE1
#823	" " - SENSE1, SENSE0
#824	" " - SENSE2
#825	" " - SENSE2, SENSE0
#826	" " - SENSE2, SENSE1
#827	" " - SENSE2, SENSE1, SENSE0
#828	" " - SENSE3
#829	" " - SENSE3, SENSE0

Table B-2 Command Numbers and Names (continued)

Command Number	Command Name/Action *(Factory settings are in bold italic type.)*
#82A	" " - SENSE3, SENSE1
#82B	" " - SENSE3, SENSE1, SENSE0
#82C	" " - SENSE3, SENSE2
#82D	" " - SENSE3, SENSE2, SENSE0
#82E	" " - SENSE3, SENSE2, SENSE1
#82F	" " - SENSE3, SENSE2, SENSE1, SENSE0
ERROR MESSAGES	
ERROR01	RAM ERROR
ERROR02	ID BUFFER FULL ERROR03
ERROR03	ID BUFFER RESTART
ERROR04	ID BUFFER ABOVE 75%
ERROR05	ID BUFFER BELOW 50%
ERROR06	EEPROM WRITE ERROR
ERROR07	INTER-MICRO COMMUNICATION TIMEOUT
ERROR08	LOSS OF RF SYNCHRONIZATION PULSE (#643X)
MOST COMMONLY USED READER COMMANDS	
#00	SWITCH TO DATA MODE
#01	SWITCH TO COMMAND MODE
#03	UNLOCK MAIN PORT
#1001	CONFIGURE MAIN & AUX-1PORTS RATE300 BAUD
#1002	1200 BAUD
#1005	9600 BAUD
#1010	SET MAIN AND AUX-1 PORTS STOP BITS TO ONE (1)
#1020	DISABLE MAIN & AUX-1 PORTS PARITY
#1021	SET MAIN & AUX-1PORTS PARITY TO EVEN
#1030	SET MAIN AND AUX-1 PORTS END-OF-LINE DELAV0 MS
#22	DISPLAY TIME AND DATE

Table B-2 Command Numbers and Names (continued)

Command Number	Command Name/Action *(Factory settings are in bold italic type.)*
#300	NO TIME AND DATE APPENDED
#311	AUXILIARY INFORMATION APPENDED
#40	TRANSMIT ALL ID CODES (DIAGNOSTIC USE ONLY)
#4100	UNIQIE ID CODE CRITERIA-RFCH 01 ID SEPARATION
#4110	UNIQIE ID CODE CRITERIA-RF CH 11 ID SEPARATION
#4200	VALID ID CODE CRITERIA-RF CH 01ACQUISITION
#4210	VALID ID CODE CRITERIA-RF CH 11ACQUISITION
#43	BUFFER ALL ID CODE (DIAGNOSTIC USE ONLY)
#440	RESET UNIQUENESS
#441	SET VARIABLE TIME-OUT2 MINUTES
#505	DISPLAY MICRO-1 FIRMWARE VERSION/OPTIONS
#520	DISPLAY POWER OUTAGE BIT
#525	INQUIRE COMMUNICATION PROTOCOL STATUS
#526	DISPLAY I/O STATUS
#527	DISPLAY RF STATUS
#610	ENABLE BASIC COMMUNICATION PROTOCOL
#6141	ENABLE XON/XOFF FLOW CONTROL
#6142	ENABLE HARDWARE FLOW CONTROL
#621	PREDEFINED OUTPUT CONTROL
#63	RESET READER
#6400	RF CONTROLOFF FOR BOTH CHANNELS
#6401	CHANNEL 0 ON, CHANNEL 1 OFF
#6402	CHANNEL 1 ON, CHANNEL 0 OFF
#641	SET RF BY SENSOR
#642	SET RF CONTROL IN 2-CHANNEL MULTIPLEX MODE
#643x	SET RF SYNCHRONIZATION PERIOD
#66	INVOKE DIAGNOSTIC MODE

Table B-2 Command Numbers and Names (continued)

Command Number	**Command Name/Action** ***(Factory settings are in bold italic type.)***
#670	SET OUTPUT PULSE DURATION4 MS
#676	32 MS
#67A	76 MS
#6916	SET MINUMUM PRESENCE TRUE PERIOD32 MS
#691F	INFINITE (NEVER TRUE)
#6920	PRESENCE RF CONTROL OFF ON TIME-OUT ONLY
#6921	OFF ON TIME-OUT OR TAG
#6922	OFF ON TIME-OUT OR PRESENCE “FALSE”
#6936	PRESENCE CONTROL TIME-OUT PERIOD 32 MS

C

Reader Default Settings

Appendix C

Reader Default Settings

This appendix provides a list of the default factory settings of the AI1200 Reader supporting firmware version 2.8. Each setting is given with its corresponding reader firmware command. These settings may be modified through reader firmware commands.

Default Settings

To restore the reader to the factory default settings, select the **F** option (set defaults) from the **Diagnostic** menu. See command #66. When the factory defaults are set, select D (software reset) to return to the reader operational mode.

Note: *The reader is always in data mode upon power-up.*

Note: *If the default factory setting values are changed, they must be saved with the* #801 *command to survive a power failure or reader reset. Also, if the changed parameters are not saved, they will be restored to their previous values by the automatic restoration feature of the firmware.*

Table C-1 Mode Default Settings

Command	Description
#00	Data mode
#03	Main port unlocked

Table C-2 Communications Default Settings

Command	Description
#1001	AUX-2 port 300 baud
#1101	AUX-2 port 300 baud
#1020	Main & AUX-1 ports parity disabled
#1120	AUX-2 port parity disabled
#1010	Main & AUX-1 ports 1 stop bit
#1110	AUX-2 port 1 stop bit
#1030	Main & AUX-1 ports 0 ms EOL delay
#1130	AUX-2 port 0 ms EOL delay

Table C-3 ID Format Default Settings

Command	Description
#302	Append time and date
#311	Append auxiliary information

Table C-4 ID Filter Default Settings

Command	Description
#4100	RF0 - Uniqueness separation 1 ID
#4110	RF1 - Uniqueness separation 1 ID
#4200	RF0 - Valid code 1 code
#4210	RF1 - Valid code 1 code
#441	Uniqueness time-out 2 minutes

Table C-5 Control Default Settings

Command	Description
#6000	Set reader ID to 00
#610	Enable basic communication protocol
#61203	Set ECP time-out to 03 (150 ms)

Table C-5 Control Default Settings (continued)

Command	Description
#6141	Enable XON/XOFF flow control
#6150	Select <som> character # (23 hex)
#621	Predefined status output control
#642	Two channel RF multiplex mode
#670	Set output pulse duration 4 ms
#6800	Disable modem control
#6811	Select modem type #1
#6820	Select modem call algorithm #0
#6831	Select one or more IDs
#6846	Select call interval = 1 hour
#6851	Select inactivity period = 2 minutes
#6864	Select redial interval = 15 minutes
#6900	Disable presence without tag reporting
#6916	Set minimum presence true = 32 ms
#6920	Set RF presence control to RF off on time-out
#6936	Select RF presence time-out = 32 ms
#6940	Select non-inverted sense input logic

Table C-6 Search Default Settings

Command	Description
#70	Disable search mode

Table C-7 Auxiliary Control Default Settings

Command	Description
#8001	Enable auto-restoration of EEPROM parameters
#810	Disable system check tag periodic mode
#8130	Select system check tagtagsreaders interval = 30 seconds
#820	Disable the sensor status change feature

Other Default Settings

The power outage bit is set to **1** on reader power-up.

D

Troubleshooting Guide

Appendix D

Troubleshooting Guide

This appendix provides a list of conditions and the actions the user can take to correct them.

Problems and Solutions

Table D-1 Problems and Solutions

Problem	Solution
Power light does not come on.	1. Verify the reader on/off switch is turned on. 2. Verify reader power cord is properly connected to the power source. 3. Verify the circuit to the power source is active. Check circuit breaker. 4. Verify reader fuse is intact. Replace the reader fuse. 5. Contact TransCore.
Search lights do not come on.	1. Verify reader power as described above. 2. Verify that `#6400 RF Control Off` command has not been issued. 3. Contact TransCore.
One search light does not come on.	1. Verify that neither `#6401` nor `#6402 RF Control Off` one channel has been issued. 2. Contact TransCore.

Table D-1 Problems and Solutions

Problem	Solution
LOCK light does not come on with tag in designated range.	1. Verify that the **SEARCH** light for the proper antenna is lit. 2. Verify proper tag-antenna polarization orientation. 3. Test for **LOCK** light with known operating tag. 4. Verify reader to RF module connections. 5. Verify RF module to antenna connections. 6. Contact TransCore.
System is not receiving/ transmitting IDs of tags in range.	1. Verify **Search** lights are on. 2. Verify **LOCK** light comes on with tag in range. 3. Verify proper tag-antenna polarization orientation. 4. Check monitor for `#Error02 Output Buffer Full Message`. 5. Verify reader is not in command mode. 6. Enter <**ctrl-Q**>. 7. Try a different tag known to work. 8. If **LOCK** light comes on, and `#620 Predefined Output Control` is in effect, set `#670 Set Output Pulse Duration` to a shorter time. 9. Contact TransCore.
System is reading tags outside of range.	1. Check for and remove transient RF reflective surfaces. 2. Contact TransCore.

Table D-1 Problems and Solutions

Problem	Solution
Tags are being read more than once in a single pass through the range.	1. Verify that neither command #40 Transmit all ID Codes nor #43 Buffer all ID Codes has been issued. 2. Use reader commands #41NN to select higher value valid ID acquisition requirement. 3. Contact TransCore.
Output function (lights/gates) is not operating on valid read.	1. Verify output module parameters set correctly (#620N commands). 2. Verify power to output-controlled equipment. 3. Verify equipment connections to reader. 4. Contact TransCore.
Tag IDs are garbled.	1. Make sure **Main** port communication parameters correspond to host computer settings. 2. Contact TransCore.
Objects are not turning on RF module through proximity sensor.	1. Verify that #642 Set RF by Sensor command is in effect. 2. Verify power to proximity sensor. 3. Verify reader-RF module connections. 4. Contact TransCore.
Commands are not echoed to the monitor.	1. Check **Main** port communication parameters. 2. Contact TransCore.
All commands respond with #Error.	1. Verify reader is in command mode. 2. Verify reader's **Main** port is unlocked. 3. Contact TransCore.
#Error01 condition (RAM error)	1. Repower the reader. 2. Contact TransCore.

Table D-1 Problems and Solutions

Problem	Solution
#Error02 condition Output buffer full	1. Exit command mode to allow transmission of IDs. 2. Type <**ctrl-Q**>. 3. Unlock **Main** port and exit command mode to allow transmission of IDs.
#Error03 condition (Output buffer restart).	No action required.
#Error04 condition (Output buffer above 75%).	1. Exit command mode to allow transmission of IDs. 2. Type <**ctrl-Q**>. 3. Unlock **Main** port and exit command mode to allow transmission of IDs.
#Error05 condition (Output buffer below 50%).	No action required.
#Error06 condition (EEPROM write error).	Contact TransCore.
#Error07 condition (Inter-micro communications time-out).	Contact TransCore.

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