

# **Encompass® MultiProtocol Reader System Guide**

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**TransCore  
8600 Jefferson Street NE  
Albuquerque, New Mexico 87113**

P/N 411880

**PRELIMINARY**

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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 and Canada. FCC ID number is FIHE6PT90V1. IC ID number is 1584A-E6RSS137V1. Access the FCC Web site at [www.fcc.gov/Forms/Form601/601.html](http://www.fcc.gov/Forms/Form601/601.html) or at [wireless.fcc.gov/index.htm?job=online\\_filing](http://wireless.fcc.gov/index.htm?job=online_filing) to obtain 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 and earth grounding the unit is recommended for this equipment to comply with FCC regulations.

**TransCore, LP  
USA**

## ***Health Limits for Encompass<sup>®</sup> Multiprotocol Reader Using External Antenna (902 to 921.5 MHz)***

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Within the United States, environmental guidelines regulating safe exposure levels are issued by the Occupational Safety and Health Administration (OSHA).

Section 1910.97 of OSHA Safety and Health Standards 2206 legislates a maximum safe exposure limit of 10 milliwatts per square centimeter ( $\text{mW}/\text{cm}^2$ ) averaged over 6 minutes at 902 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 (ANSI C95.1). ANSI guidelines recommend a maximum safe power density in  $\text{mW}/\text{cm}^2$  of:

### **Frequency (in MHz)** **1500**

Thus, the maximum permissible exposure for general population/uncontrolled exposure at 902 MHz is  $0.60 \text{ mW}/\text{cm}^2$ . The average time is thirty minutes.

The maximum permissible exposure for occupational/controlled exposures is  $3.0 \text{ mW}/\text{cm}^2$ . The average time is six minutes.

The RF power density generated by the Encompass Multiprotocol Reader was calculated using a maximum antenna gain of 14.0 dBi, equivalent to the antenna gain of the external AA3152 Universal Toll Antenna (UTA).

### **Warning**



*At 2 W transmitted power, 0 dB transmit attenuation, and a distance of 33 inches (82 cm) from the antenna, the maximum power density calculated was less than  $0.60 \text{ mW}/\text{cm}^2$ . Install the antenna at least 33 inches (82 cm) from the general public. Maintenance personnel must remain at least 15 inches (37 cm) from the antenna when the system is operating.*

The data confirms that when the UTA, or equivalent antenna, is used with the TransCore Encompass Multiprotocol Reader, the antenna effectively meets OSHA requirements and thus does not represent an operating hazard to either the general public or maintenance personnel.

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## Before You Begin

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# Chapter 1

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## Before You Begin

*This chapter provides an overview of the Encompass Multi-Protocol Reader System Guide.*

### **Purpose of the Guide**

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This *Encompass Multi-Protocol System Guide* provides an overview of the reader systems as well as a list of the reader software commands and diagnostic and hardware interface information.

### **Intended Audience**

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The intended audience for this guide is those personnel responsible for operating the Encompass Multi-Protocol Reader.

### **Guide Topics**

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The *Encompass Multi-Protocol System Guide* presents the following information.

<b>Chapter 1 - Before You Begin</b>	In process
<b>Chapter 2 - Theory of Operation</b>	In process
<b>Chapter 3 - System Components</b>	In process
<b>Chapter 4 - Encompass System Operation</b>	In process
<b>Chapter 5 - Diagnostics Information</b>	In process
<b>Appendix A - Acronyms and Glossary</b>	In process
<b>Appendix B - Block Diagrams</b>	In process
<b>Appendix C - System Technical Specifications</b>	In process
<b>Appendix D - Hardware Interfaces</b>	In process
<b>Appendix E - Reader Defaults</b>	In process
<b>Index</b>	In process

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## Related Documentation

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See the following related document:



*Encompass Reader Quick Reference Guide (in process)*

## Typographical Conventions Used in this Manual

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The following conventions are used in this manual. Not all of the conventions are used in this version.

**Table 1-1** *Typographical Conventions*

Convention	Indication
	This procedure might cause harm to the equipment and/or the user.
	A caution sign indicates 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.
<b>Dialog Box Title</b>	Title of a dialog box as it appears on screen.
<b>Screen Title</b>	Title of a screen as it appears on screen.
<b>Menu Item</b>	Appears on a menu.
<i>Note</i>	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.
<b>Cancel button</b>	Bold text identifies the labeling of items as they actually appear on the keyboard, on a button, as a menu item, and so forth.
<b>Ctrl-Esc</b>	A hyphen indicates actions you should perform simultaneously. For example, Ctrl-Esc means to press the <b>Ctrl</b> and <b>Esc</b> 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.
<i>before</i>	Text in italics indicates emphasis.
<b>Customer &gt; Find</b>	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.

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## Licensing Requirements

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To operate a radio frequency (RF) system in a given country, the user first must obtain permission from the regulatory agency that controls radio operations in that country. Most countries require type and safety approval, as well as licensing for RF transmitters. Users in all countries should check with the appropriate local authorities for licensing requirements.

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### **Licensing: United States and Canada**

This MPI6000 Reader requires a Federal Communications Commission (FCC) Part 90 license to operate in the United States, or an Industry Canada (IC) license to operate in Canada. The authorized *continuous wave* frequency bands are 902.25 to 903.75 MHz and 910.00 to 921.50 MHz.

The modulated frequency bands are shown in Table 1-2. For the Emission Designator, see the FCC or IC grant.

Operational Mode	Frequency Range
eGo and SeGo	911.75-919.75 MHz
18000-6C Low and High Data Rates	912.75-918.75 MHz
Allegro and T21	912.75-918.75 MHz
IAG and CVISN	914.75-916.75 MHz

**Table 1-2 Modulated Frequency Bands**

The user is responsible for filing the FCC or IC license according to FCC and IC regulations. You can obtain the needed FCC forms and instructions for your license application by accessing the FCC Web site at [www.fcc.gov/Forms](http://www.fcc.gov/Forms).

**Note:** The FCC ID is FIHE6PT90V1. The IC ID is 1584A-E6RSS137V1.  
Models: E5, E6.

An FCC or IC license provides the user with the legal authorization to operate the radio frequency identification (RFID) systems on the licensed frequencies at the site specified in the license. Only an authorized installer or service technician can set the frequency for the reader to that specified in the FCC or IC site license.

The FCC or IC license also provides the user with protection and authorization to maintain the system should any other RFID be used in the licensed area after the reader is installed.

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Developing the Installation Site Plan

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## Developing the Installation Site Plan

*This chapter will provide guidelines for the following tasks:*

***Assessing the Site and Formulating a Frequency Plan***

***Site Layout and Traffic Flow***

***Electrical and Communications Requirements***

***Encompass and Tag Model Interoperability***

*Reading of Mixed Population Tags*

***Antenna Selection***

***Antenna and Tag Alignment***

*Polarization*

***Site Preparation Checklist***

***Components Checklist***

***Task Checklist***

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## Installing and Configuring the Encompass

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# Installing and Configuring the Encompass

*This chapter provides instructions for installing and configuring the Encompass system. It also describes the individual components of the Encompass system.*

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## Overview of the Encompass

TransCore's Encompass is an integrated high-speed, multi-protocol 915-MHz radio frequency identification (RFID) reader system that includes an RF transceiver board and processor in a single assembly.

The Encompass can be integrated into an onsite lane controller or a NEMA enclosure. The Encompass transmits and receives signals through a single antenna.

The Encompass is capable of supporting any of the following protocols in a given installation:

- American Trucking Association (ATA), full-frame and half-frame (read-only)
- California Title 21 (read-only)
- eGo®<sup>1</sup> (read-only)
- Inter-Agency Group (IAG) (read/write)
- Super eGo (SeGo)\* (read/write)
- TransCore IT2200 (read/write)

Where multiple tag protocols are used in the same installation, the Encompass is capable of supporting any two of the above protocols.

The Encompass is also suitable for a wide variety of automatic vehicle identification transportation applications, including electronic tolling, open road tolling, electronic vehicle registration, parking, and rail applications.

The following sections describe the specifications for the external connections from the Encompass housing.

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## Connecting the Encompass for Operation

### External Connectors

This section lists the Encompass external connections. Figure 3-1 shows the Encompass connector locations.

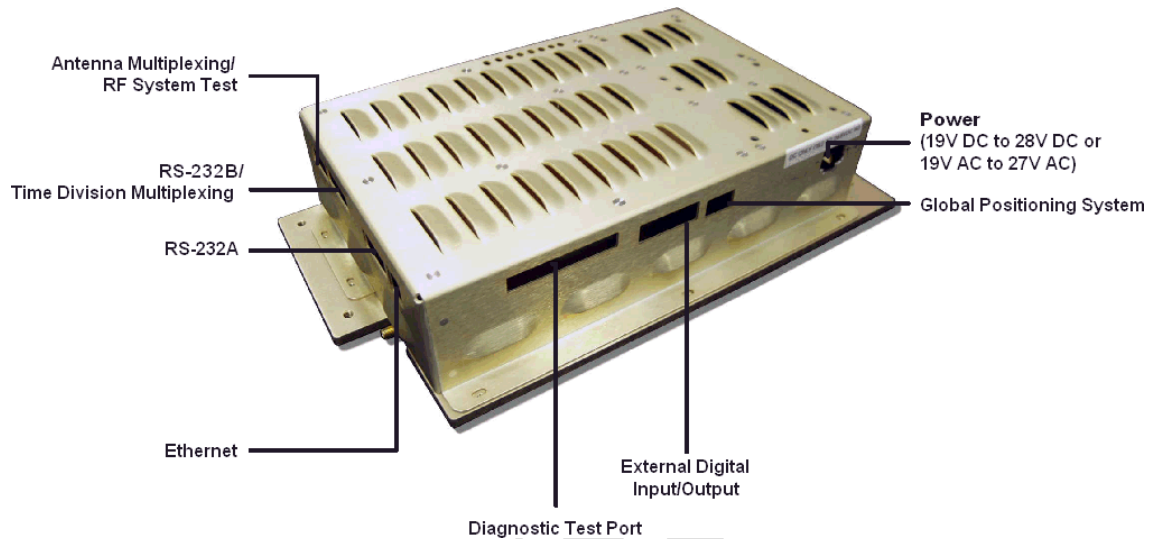
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1. \*eGo tags are fully compliant with ANSI INCITS 256:2001 and ISO 18000-6 standards. SeGo is a superset of the eGo protocol.



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## Encompass Multi-Protocol Reader System Guide



**Figure 3-1 Connector Locations on Encompass Enclosure**

### **Power**

The Encompass requires 19V DC to 28V DC or 19V AC to 27V AC RMS voltage source. Table 3-1 lists the Encompass external power connector specifications.

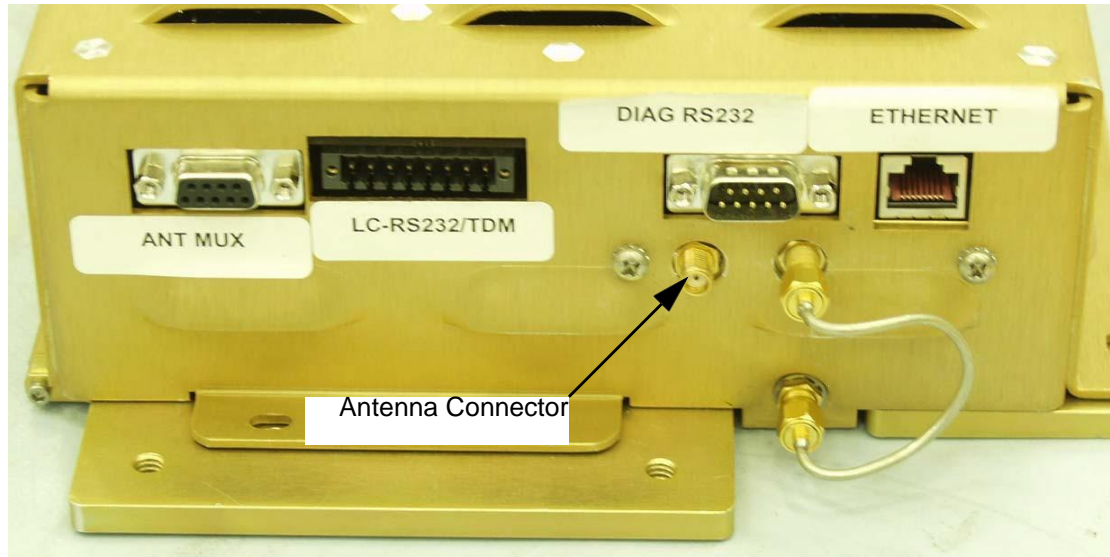
**Table 3-1 Encompass Power Connection Specifications**

<b>Connector Type</b>	Two-Pin Terminal Block
<b>Wire Gauge</b>	12 – 30 AWG
<b>Voltage</b>	19V to 28V DC or 19V to 27V AC RMS <b>Note</b> If AC is used do not ground one end of the AC input, the AC supply must float.
<b>Polarity</b>	Either, power supply is polarity independent
<b>Current</b>	2 amps

### **RF Antenna Connector**

The Encompass Reader typically is connected to an AA3152 Universal Toll Antenna by a single low-loss RF cable. The antenna configuration is designed for overhead mounting on a gantry or sign structure. Figure 3-2 shows the antenna connector on the Encompass enclosure.

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**Figure 3-2 Antenna Connector Location**

Table 3-2 lists the RF antenna connector parameters.

**Table 3-2 RF Antenna Connector Specifications**

<b>Connector Type</b>	SMA Female
<b>Output Power</b>	Up to 2 watts

**RF Antenna Multiplexing/RF System Test Connector**

This connector is used when a single Encompass is used to operate multiple lanes.

**Ethernet Connector**

The Encompass communicates with a host via an Ethernet communications protocol. This connection requires an RJ-45 connector. If you use a switch between the Encompass and a host PC, you do not need a crossover cable. If you connect the Encompass directly to a host PC then you need a crossover cable. If you set the host PC to *Dynamic*, TransCore recommends that you set the IP address to *Static*.

**RS-232A Serial Communications Connector**

The Encompass communicates via a serial, RS-232, communications protocol (Table 3-3). The diagnostic RS-232 port can be used to display the operating system boot sequence.

**Table 3-3 RS-232 Connector Specifications**

<b>Connector Type</b>	9 pin D-sub male
<b>Protocol</b>	RS-232

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**Table 3-3 RS-232 Connector Specifications (continued)**

<b>Baud</b>	9600
<b>Bits</b>	8
<b>Parity</b>	None
<b>Stop Bits</b>	1
<b>Flow Control</b>	None

*Note: If you connect the Encompass directly to a PC's serial port, you must use a null-modem.*

By using the version command, you can display data about the configuration of the Encompass including its Internet Protocol (IP) address. *(Mike, any more info here?)*

**RS-232B/TDM Connector**

Information to be provided.

**RS-232 Diagnostic Test Port Connector**

Information to be provided.

**External Digital Input/Output Connector**

Information to be provided.

**Global Positioning System Connector**

Information to be provided.

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## **Installing and Using the Encompass Host Software**

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This section provides instructions for installing the Encompass host software on your host computer. You do not need the host to operate the Encompass, you can design an application programming interface using the Encompass commands. Those configuration commands are explained in "Configuration Commands and Responses" on page 7-3 of this system guide.

If you choose to use TransCore's host software program, follow the instructions in the following sections.

---

### **Installing the Host Software**

The Encompass host program is used to communicate with the Encompass and also display tag reads.

#### **To install the Encompass Host software**

1. Load (*what media is used? CD? FTP site?*) the host software onto the host computer.

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2. Run setup.exe and follow the commands to install the Host. The setup procedure installs an icon named **Encompass Host** on your computer desktop.

The following sections tell you how to use the Encompass Host software.

### ***Connecting to the Encompass Reader with the Host Software***

1. Double-click on the **Encompass Host** icon.
2. Select **UDP** on the main screen.
3. In the **UDP Command Link Config** field, enter the IP address of the reader.  
Write the IP address near the Ethernet connector on the Encompass enclosure for future reference.
4. Select **Establish Command Link**.
5. Select **E.xit**.

### ***Configuring the Encompass Reader Operating Frequency***

1. Select the **Configuration** tab.
2. Select the **Transceiver Configuration** sub-tab.
3. Set the frequencies to desire values. Nominal values are 918.75 for downlink and 903 for uplink. Values must be between 902.25 and 903.75 or between 910 and 918.75 for the downlink. Values must be between 912.75 and 918.75 for the uplink.

### ***Operating the Encompass Reader***

1. Select **Tags > FDOT**.
2. Enter hex data into the **IT2200 Write Data** and **SeGo Page Data** fields. Use 32 hex characters for IT2200 (Allegro) and 16 hex characters for SeGo. This is the data that is going to be written to the tag.
3. Select **Read** or **Write** in the SeGo Sequence Field. This sets the Read or Write parameters for both IT2200 and SeGo tags.
4. Press **Start** to begin tag processing.
5. Tag responses should appear in the IT2200 and SeGo fields.
6. To stop the display or the response count, select the check boxes.
7. Press **Stop** to end tag processing.
8. Press **Exit** to close the FDOT page.

Encompass Readers have been preconfigured for most needed operations. Parameters such as attenuation, step-lock settings, and tag command sequences are set when the reader powers up.



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## Lane Tuning Guidelines

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# Lane Tuning Guidelines

*This chapter explains the importance of lane tuning for optimum automatic vehicle identification (AVI) system performance and describes the Encompass functions and features that can assist you in tuning an AVI lane.*

## ***Why You Need to Tune a Lane***

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Lane tuning is the procedure by which an installer can optimize the radio frequency (RF) characteristics and the signal timing of an AVI-equipped toll lane for the performance dictated by the lane's traffic requirements. Typically, consideration of these factors is necessary for each individual lane, although in some installations it may be possible to identify broader solutions, then apply these solutions to certain classes of lanes having similar characteristics, followed by additional fine tuning on an individual lane-by-lane basis. This process is necessitated by the radio link, which is subject to varying factors such as lane type, the geometry of fixed objects near the capture zone, interference from external sources, adjacent lane interference, natural non-homogeneity of RF field strength within the ideal capture zone, and varying tag environments. These factors may vary widely within an installation and from lane to lane within the same plaza. Furthermore, the type of technologies involved, either IT2200, American Trucking Association (ATA), eGo, eGo Plus, Title 21 or Inter-Agency Group (IAG), will play a significant role in tuning the lanes for operation. Knowing the appropriate factors and available tools is necessary for the set-up and troubleshooting of AVI lanes.

## ***Required Equipment***

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You will need the following equipment and tools when you tune a lane:

TBD

## ***Lane Tuning Parameters***

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Lane tuning parameters can be altered to effect required outcomes. This section lists the properties that can be used to tune a lane.

### ***Traffic Requirements***

The traffic requirements of lane tuning include the following characteristics:

- The duration of the tag transaction, also known as handshake

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- Maximum traffic speed in the lane, which is used to determine the required length of the capture zone; also known as the footprint
- The type of lane, that is, express or mixed-use lane
- The presence of vehicle framing devices such as light curtains, which may dictate the desired location of the first read point
- The presence of alternate toll collection devices, such as coin machines in mixed-use lanes, which may dictate the desired first read point
- The width of the lane

Traffic requirements are further defined by two terms, tag transaction or handshake and capture zone or lane footprint.

### ***Tag Transaction or Handshake***

A handshake is defined as one complete transaction between a tag and the AVI equipment. The handshake is defined as a complete transaction because in many cases the transaction consists of more than a simple read. The transaction may be a read command followed by a general acknowledgment (GENACK), or a read command followed by a write command followed by a GENACK, or some other complex sequence of commands. Each part of the handshake requires time, and the transaction with the tag cannot be considered complete unless all the components have been completed. To this end, there will be a minimum time associated with the handshake. It may be as little as a few milliseconds, or as high as 30 milliseconds or more.

### ***Capture Zone or Lane Footprint***

The footprint is the length of the capture zone measured on the pavement, starting at the point of the first tag read and ending where tag reads stop, typically three or four feet past the receive antenna (Figure 4-1). This value is based on the actual measurements of the capture zones of at least five diversely different vehicles equipped with properly mounted tags. Ideally, RF margin plots taken at the time the footprint are measured on a foot-by-foot basis, but for the basic measurements discussed in this guide, all that is needed is the total footprint length from first read to last read.



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To Be Provided.

**Figure 4-1 Field Size, Shape, and Antenna Polarization Define the Reading Range**

One concern for lane tuning is how large the footprint needs to be for acceptable system reliability. A rule of thumb frequently applied to this problem is that there should be time for a minimum of four complete transactions as the vehicle passes through the capture zone. Thus, the system that has the more complex transaction requires the larger footprint.

For example, if a toll agency requires an IT2200 tag read followed by a string of five GENACKs, this constitutes a complete transaction, and the total time would be four milliseconds for the IT2200 tag read plus four milliseconds for the five GENACKs for a total of eight milliseconds for the entire handshake. Four complete handshakes require 32 milliseconds. If the same agency has a maximum speed requirement of 60 mph through the lane, this translates to 88 feet per second, or 11.36 milliseconds/foot. The agency could use the system with a footprint that is 32 milliseconds in duration, which at 60 mph, translates to 11.36 milliseconds per foot or 2.82 feet. Any additional footprint increases the reliability of the system because the system provides more chances for the tag to interact with the reader.

1 read @ 4 milliseconds per read	= 4 milliseconds
5 GENACK @ 0.8 milliseconds per GENACK= <u>4 milliseconds</u>	
	= 8 milliseconds total, each full handshake

For another example, if the toll agency requires three pages to be read from the tag, followed by three pages of data to be written to the tag, followed by five GENACKS, the total transaction time is

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3 reads @ 4 milliseconds each = 12 milliseconds  
3 writes @ 4 milliseconds each = 12 milliseconds  
5 GENACKs @ 0.8 milliseconds each = 4 milliseconds  
= 28 milliseconds total, each full handshake

To complete 4 full handshakes (simply a rule of thumb), the vehicle would need to be in the footprint for 112 milliseconds. If the agency requires 100 mph operation, the vehicles travel one foot in 6.8 milliseconds. At this speed, the footprint would need to be 16.47 feet long to satisfy this requirement.

This footprint value can change depending on the use of time division multiplexing (TDM), which will increase the footprint requirements, or by using more sophisticated polling methods, which may reduce the footprint requirements. Furthermore, the times presented in this example for the individual components of the transaction can vary. For example, a password-protected read or write operation can take longer to complete than an ordinary read or write and can impact the overall statistical reliability of the transaction.

*Note: Please consult with TransCore to assess the impact of the more sophisticated types of transactions.*

Given the uncertainties of any RF link due to reasons already discussed in this section, a short transaction of only a few milliseconds has a statistically better chance of succeeding than will a complex, longer 30-millisecond transaction. The tag is assumed to remain in the footprint for a minimum period of time relative to the maximum vehicle speed and the size of the footprint.

Once the length of the footprint has been determined, the presence of light curtains or detection loops may dictate the point at which the first tag read should occur. Also, manned lanes or mixed-use lanes typically require that the tag read occur at least a few feet in front of the toll collection point. The speed requirements may be reduced for these lanes and, hence, the footprint size. The point of the first read may be controlled by antenna placement, uptilt angle, and RF power, which are discussed later in this chapter. Likewise, if the lane is exceptionally wide or if there is a need for better coverage toward the lane sides, the antenna may be mounted higher or in line with other antennas. A lower gain antenna may be used to increase the side coverage.

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## **RF Factors**

The RF factors involved in tuning an AVI system may include the following parameters:

- The downlink and uplink transmitted RF power
- Range control adjustments that can be made to the receiver
- Antenna type
- Antenna mounting, that is, lane position (relative to payment point, angle, and height)

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- The downlink and uplink source frequencies and interference from lanes sharing same or close frequencies
- The antenna-tag orientation

RF power is the most important RF factor in lane tuning. Thirty dBm translates to one-watt nominal power. Increasing the RF power will, in general, increase the footprint. There are other factors involved such as antenna angle and placement that may affect the footprint, but increasing RF power will generally increase the signal and increase both the footprint and the RF margins in the lane.

Because the RF power can create interference in adjacent or nearby lanes and degrade the performance of the adjacent lane, the RF power should be adjusted so that minimum power is used to achieve the desired results.

### ***Downlink and Uplink Transmitted RF Power***

Downlink signal is the signal transmitted from the reader to the tag, and uplink signal is the signal reflected back to the receiver from the tag. The impact of the downlink and uplink power on footprint and lane performance is heavily dependent on the protocol type(s) in use in the lane. Table x-x (to be provided) is a general guide to the influence of RF power on the footprint by protocol. Some of these factors are interrelated to such aspects as antenna angle, antenna placement, and tag placement, so use this information as a starting point and consider other aspects of lane tuning when operating on any given lane.

Both downlink and uplink power are adjustable by tag protocol. In other words, in multiple protocol systems, the RF power can be adjusted for each tag protocol in use, independent of the other tag protocol.

### ***Range Control Adjustments***

Adjusting the range control allows the user to adjust the footprint separate from any setting of the RF power. It is an adjustment on the sensitivity of the receiver and is done independently for each tag protocol. The units are in decibels and vary from 0 to 20dB, with the higher number giving the smaller footprint. Range control always exerts an effect on the footprint and performance separate from the tag protocol, but the degree of the effect may be dependent on RF power and antenna parameters as well. The most common use of range control is in multiple protocol situations, where the first read point of tags with two differing protocols must be made to coincide within a lane. In this situation, the power and antenna parameters are adjusted so that the weaker protocol tags are reading at the appointed position, then range control is used to adjust the first read point of the stronger protocol tags down to the same position as the other protocol. Range control can also be used in a single protocol situation to fine tune the first read position.

### ***Frequency Considerations — Single Protocol***

TBD

#### ***IT2200 or Title 21 Tag Protocol***

TBD

This uplink frequency separation should repeat for additional lanes.

#### ***eGo Tag Protocol***

TBD

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**ATA Tag Protocol**

TBD

**IAG Tag Protocol**

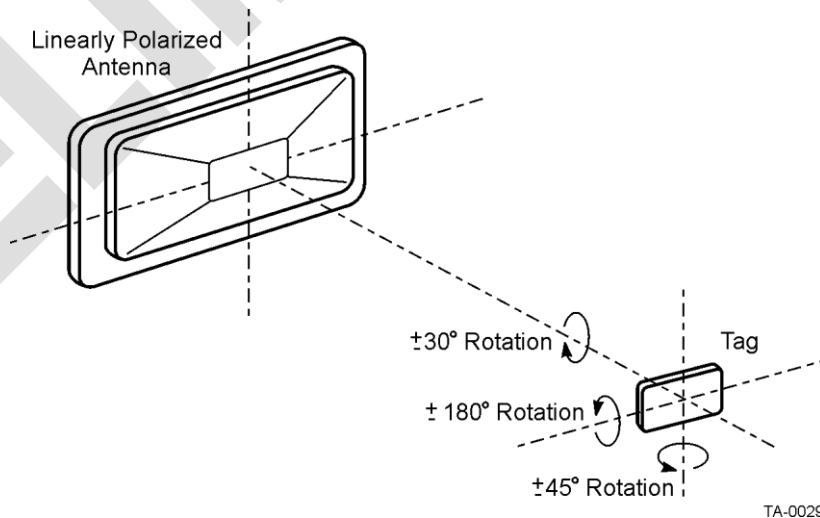
TBD

**Frequency Considerations — Multiple Protocols**

TBD

**Antenna-Tag Orientation**

Antennas need to be oriented to match the tag orientation (Figure 4-2). Antennas also need to match the tag placement and vice versa. For example, if the tag is placed in the center of the windshield, the antennas should be placed overhead, centered, or nearly centered in the lane. If the tag is placed to the side of the windshield, the antennas should be placed overhead to the side matching the tag placement, or a side-mounted antenna should be used. There are some exceptions to this, and in the overall system planning, any variation from this rule should be discussed with TransCore at the earliest possible time to minimize additional costs for altering the lane design, especially after construction has started. Incorrect antenna placement may render the system's performance unacceptable and result in the eventual and expensive refitting of antenna and communication hardware. Figure 4-3 shows interior tag mounting locations, and Figure 4-4 shows exterior tag mounting locations.



**Figure 4-2 Tag Orientation with Linearly Polarized Antenna**



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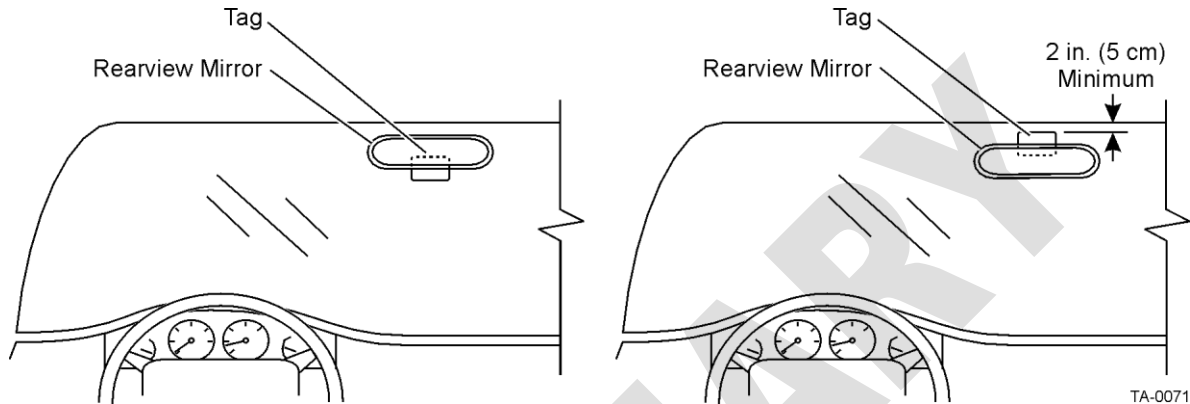


Figure 4-3 Upper Center Interior Windshield Tag Placement

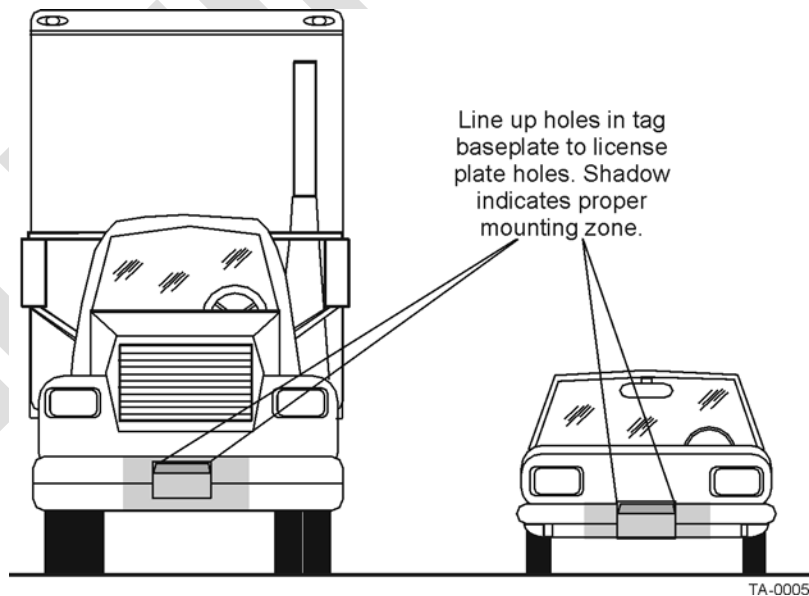


Figure 4-4 Correct Exterior Tag Placement

### Antenna Uptilt Angle

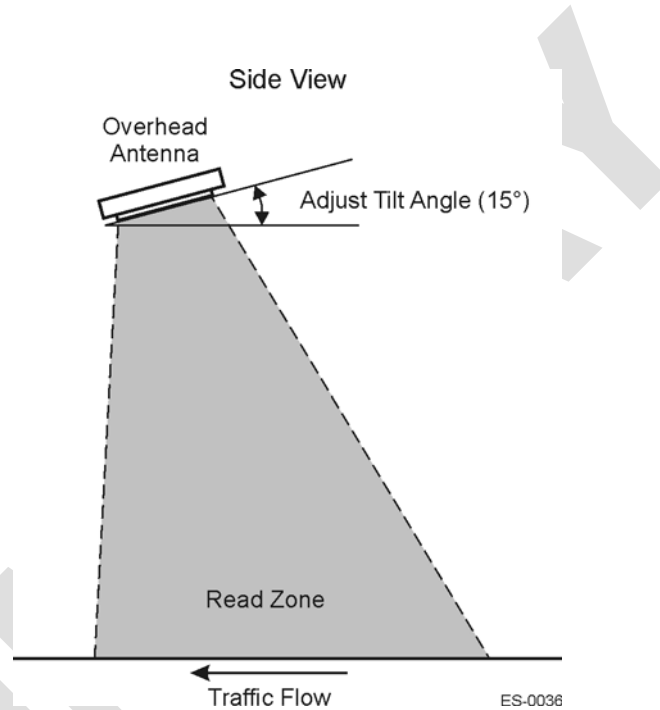
Adjusting the antenna uptilt angle directly affects the footprint and the point of first tag read (Figure 4-5). As expected, a greater uptilt angle will move the point of first tag read farther from the antenna. However, at some uptilt angle, a point of diminishing return is reached where the RF power is too dispersed to activate the tag at the start of the footprint. Increasing the antenna angle beyond this point will not move the first read point farther out and may actually decrease the RF margin within the capture zone. Also, increasing the angle may produce an area near the start of the capture zone with spotty reads. The most commonly used range for antenna uptilt angles is from 10 to 25 degrees with the lower angles producing the sharpest, most clearly

defined read zones. Setting the antenna uptilt angle below 10 degrees may cause problems in reading tags mounted on windshields that are nearly vertical and in read4-9

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ing license plate tags.

*Note: TransCore does not recommend placing the antenna uptilt angles at less than five degrees.*



**Figure 4-5 Overhead Antenna Tilt Angle**

### **Antenna Positioning Within the Lane**

In lanes where the antennas are mounted side by side, TransCore recommends that you install the transmit antenna toward the driver side of the traffic lane and the receive antenna toward the passenger side of the traffic lane. Antenna position in the lane also impacts lane performance.

Antenna mounting brackets should be designed so that you can adjust the antennas from front to back and from side to side. In lanes that have no vehicle framing, such as some express lanes, the front-to-back adjustment is not critical and can be minimized or eliminated. But, in these lanes it is still valid to have at least  $\pm 2$  feet ( $\pm 0.61$  m) of side adjustment. Side adjustment may be critical in places where vehicles tend to travel to one side or another, such as in lanes that are wider than 12 feet (3.65 m). You can move the pair of antennas from side to side so that the centerline between the antenna pair is located over the area of the lane where the majority of traffic travels. RF reflectors, such as toll booths and Jersey barriers, may require you to make side adjustments to achieve adequate coverage to one side or the other.

The portion of the footprint with the highest RF margin has the highest probability of a successful tag transaction. This portion of the footprint is the area directly under the antenna and extending forward (upstream) a number of feet. If the length of the footprint is not an issue, such as the situation in some lower speed mixed-use lanes, but the point of first read is critical, it may be advisable to use a low antenna angle. Next, adjust the antenna position so that the first read occurs at the desired point. Adjust the antenna position instead of fixing the antenna position and adjusting the first read point by manipulating the antenna uptilt angle or the RF power. This adjustment may

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enable you to operate the lane at a lower RF power, which is usually the preferred operational mode.

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***Signal Timing***

TBD

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Optimizing Encompass Reader System  
Performance

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# Optimizing Encompass Reader System Performance

*This chapter provides information to optimize the Encompass performance and reduce cross-lane interference.*

## **Cross-Lane Interference in RFID Systems**

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Radio frequency identification (RFID) systems are subject to various types of interference that can affect the level of communications between a tag and a reader system. A type of interference that can result from the operation of the reader system is called cross-lane interference.

### **What Is Cross-Lane Interference?**

Cross-lane interference occurs when the RF generated in one toll lane interrupts the RFID operation in another lane that causes the affected lane to perform poorly. Before diagnosing cross-lane interference, it is necessary to understand what constitutes a satisfactorily performing lane.

### **Determining Acceptable Lane Performance**

The criteria for optimal lane performance are usually set by the customer and can vary according to the site requirements. In testing, acceptable lane operation criteria typically are determined by the length of the RF footprint and the speed of the test vehicle. Usually, a test vehicle's speed is limited by the amount of the toll lane that can be used for starting and stopping distances. Usually, testing speed is limited to 20 miles per hour (mph) or 32 kilometers per hour (kph) or less.

An ideally performing toll lane will produce one handshake for every 4 milliseconds of transaction time. At 20 mph (32 kph), the vehicle uses 34 milliseconds to travel through 1.0 foot (0.3 m) of the footprint. If the footprint is 8 feet (2.4 m), this means that the vehicle will spend approximately 272 milliseconds in the footprint. Based on a vehicle speed of 20 mph (32 kph) and an 8-foot (2.4m) footprint, this yields an ideal maximum number of 68 handshakes. Nulls and voids within the RF footprint will lower this number, as will any other local sources of RF noise and stray reflections. A rule of thumb for lane performance is to have 40 to 60 handshakes within an 8-foot (2.4m) footprint with a test vehicle traveling at 20 mph (32 kph). A system that operates with less than 40 handshakes should be tested for cross-lane interference.



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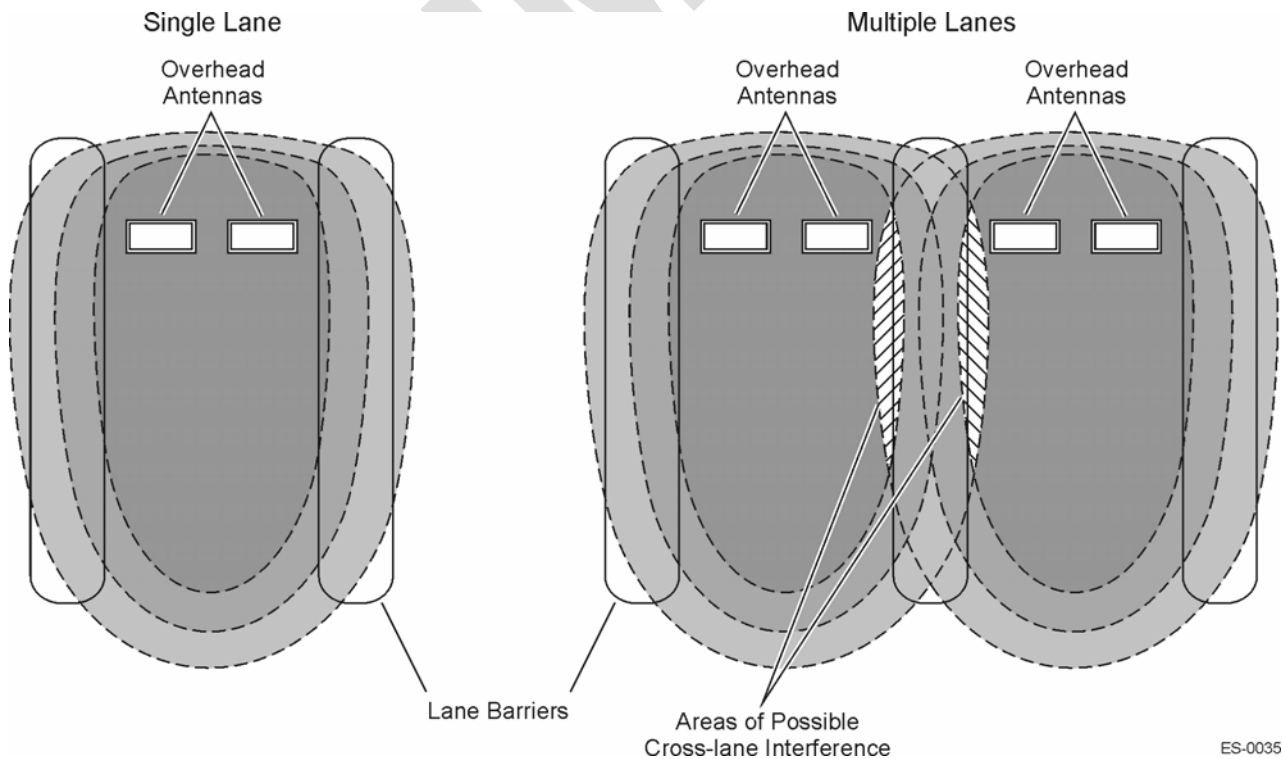
## Identifying Cross-Lane Interference

Cross-lane interference is identified by an area in the RF read zone, or footprint, which has areas where a tag cannot be read. If a toll lane has been operating satisfactorily and then begins to show a degradation in system performance, that is, an increasing number of missed reads or a spotty read pattern, there is a probability that cross-lane interference is occurring.

Cross-lane interference can be caused by the following:

- A downlink antenna transmitting strong RF beyond its lane boundaries
- Reflection of RF from fixed objects (e.g., toll plazas with low, metal roofs)
- Reflection of RF from moving objects (e.g., a passing tractor-trailer in an adjacent lane)

A typical toll lane application Encompasses more than a single lane. In some cases a toll plaza can have more than eight lanes with each lane having separate RF transmitting (downlink) and receiving (uplink) antennas. As shown in Figure 5-1, the RF transmitted within a lane is not bound by physical dividers such as lane barriers. With multiple-lane applications, transmissions out of a lane can create areas of possible cross-lane interference.



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**Figure 5-1 RF Footprint Extends Beyond Lane Boundaries**

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## Diagnosing Cross-Lane Interference

To diagnose this type of interference, first set the RF power in all lanes to a moderate setting of 6 to 9 decibels (dB) for both downlink and uplink antennas. Next, tune a single lane. When tuning a lane be sure to use a tag and vehicle that have been used consistently at your site.

Once the lane has been tuned and you determine that it is working satisfactorily, perform lane tuning procedures in the adjacent lane. Continue for each lane in the toll plaza.

If each adjacent lane tuning causes the previously tuned lane to start performing poorly (i.e., spotty read zone or areas of no reads), cross-lane interference is indicated.

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## Remedying Cross-Lane Interference

Several methods exist to remedy cross-lane interference. These remedies are accomplished by software or hardware changes, or a combination of both. A remedy at one site may not be appropriate at another site, so iterative methods of correcting this interference are necessary.

### Frequency Separation

Review the toll plaza frequency plan that was developed during the eGo 4110A Reader System installation phase. There are two frequencies for each reader: downlink and uplink. For the eGo 4110A Reader System, all readers share the same downlink frequency, which is generally set to 918.75 MHz. Uplink frequencies should alternate between 903.00 MHz and 910.00 MHz in adjacent lanes. For example, a four-lane plaza would have the frequencies shown in Table 5-1.

**Table 5-1 Frequency Plan for Four-Lane Toll Plaza Using IT2200-series or Title 21 Tag Protocol**

Lane	Downlink Frequency	Uplink Frequency
1	918.75 MHz	903.00 MHz
2	918.75 MHz	910.00 MHz
3	918.75 MHz	903.00 MHz
4	918.75 MHz	910.00 MHz

### RF Power

A good rule of thumb when configuring a toll plaza is to set the RF attenuation at a lower output and increase the RF power level as needed for optimal system operation. This practice may provide you with RF attenuation settings at which your reader system can operate with minimal adjustment for cross-lane interference.

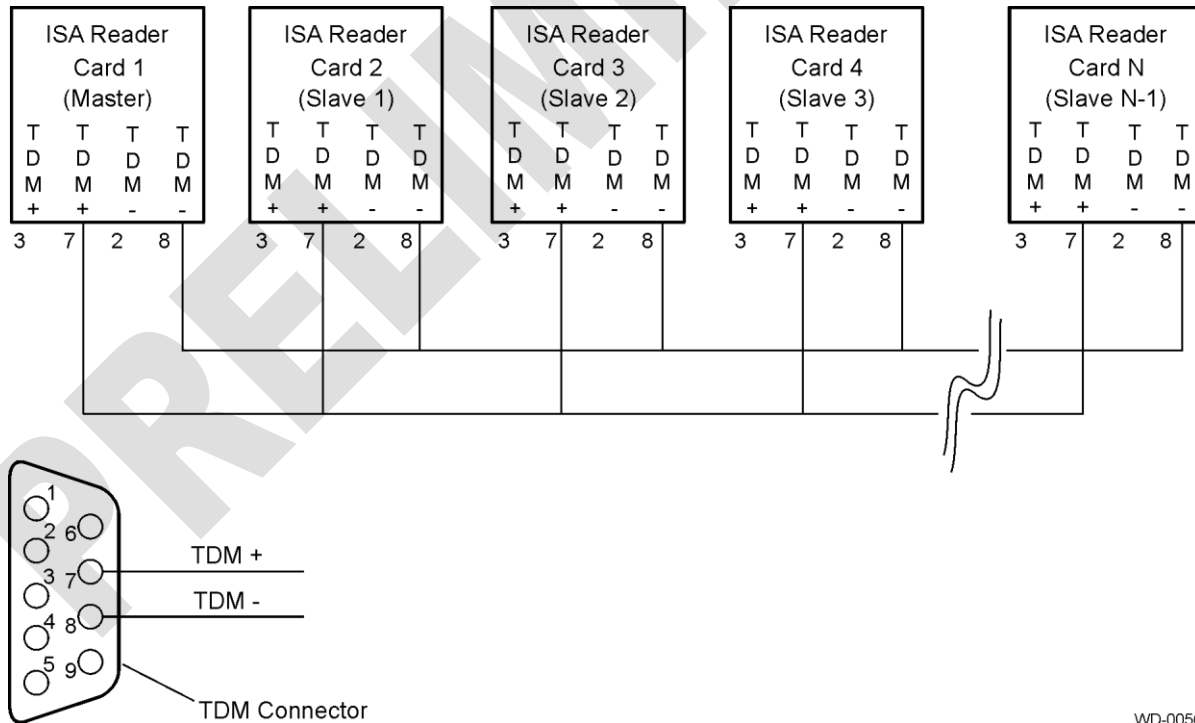
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### Time-Division Multiplexing

In situations where cross-lane interference can occur in an installation, and frequency management is not sufficient to solve the problem, you may need to use time-division multiplexing (TDM). By using the TDM function in readers, individual readers operate only during interleaved time periods.

The TDM interconnect is provided via a differential RS-485 interface to a DB9 connector that is located on the reader card's expansion board connector in slot 2. This connection provides a synchronization interface between readers where RF interference between readers is reduced by multiplexing the RF reader transmission to independent time slots. Allowing each reader or group of readers to operate at an allotted time eliminates interference from readers in adjacent lanes.

Although you need to configure the readers to operate using TDM, the interface connection for TDM can be provided to all the readers in a plaza before or during installation by connecting a pair of wires to the DB9 TDM connector of each reader as shown in Figure 5-2. No other equipment is necessary for the interconnection circuit. You need to follow the polarity conventions as shown because this interface is polarity dependent.



WD-0056

**Figure 5-2 TDM Configuration Example**

TransCore recommends Belden 89182 or 8132 cable. Using these low-loss, low-capacitance twisted-pair cable, the maximum distance is 1000 feet (305 m). Cables with lower capacitance can be used to run the TDM cables for longer distances while maintaining signal integrity. This maximum distance may be slightly longer or shorter depending on the cable used.

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Because the TDM signals are based on RS-485 signals, you can extend the length of the TDM bus by using RS-485 repeaters or by using fiber with converters. Either of these two modifications should be used only when absolutely necessary in situations where the TDM lengths need to exceed the 1000-foot (305-m) maximum distance. Table 5-2 shows the pin designations and descriptions for the TDM connector.

**Table 5-2 TDM Connector**

Pin	Name	In/Out	Description	Recommended Connection
1	N/C	N/A	No connection	N/C
2	N/C	N/A	No connection	N/C
3	N/C	N/A	No connection	N/C
4	N/C	N/A	No connection	N/C
5	N/C	N/A	No connection	N/C
6	N/C	N/A	No connection	N/C
7	TDM (+)	In/Out	TDM synchronization positive	Connect all red pin 7 wires together.
8	TDM (-)	In/Out	TDM synchronization negative	Connect all black pin 8 wires together.
9	N/C	N/A	No connection	N/C

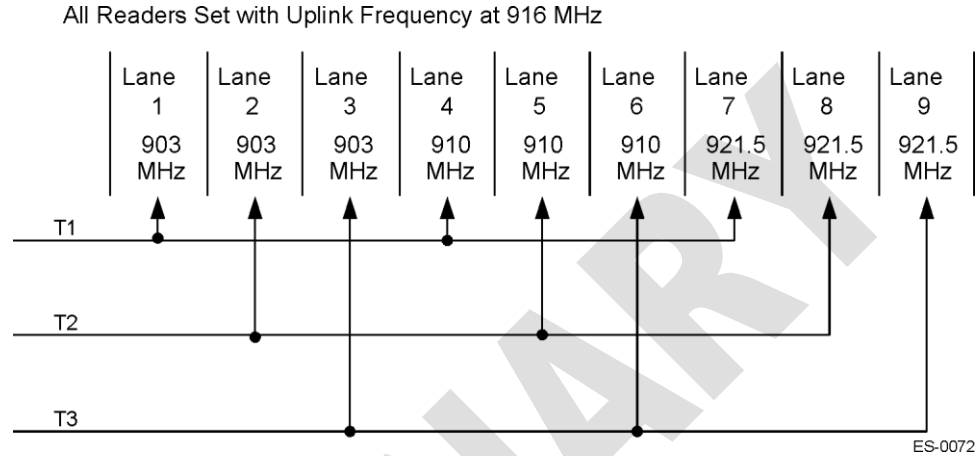
To implement TDM, you must configure only one reader in the group as a master reader for the TDM function. This reader will have a slightly shorter synchronization period than the rest of the readers connected to it.

**Note:** The TDM synchronization period is set in 1.0-millisecond increments, whereas the TDM delay and TDM duration are set in 0.5-millisecond increments.

Figure 5-3 illustrates a typical plaza configuration using TDM. There are three time slots with three uplink frequencies. All the readers are configured with a downlink frequency of 916 MHz.

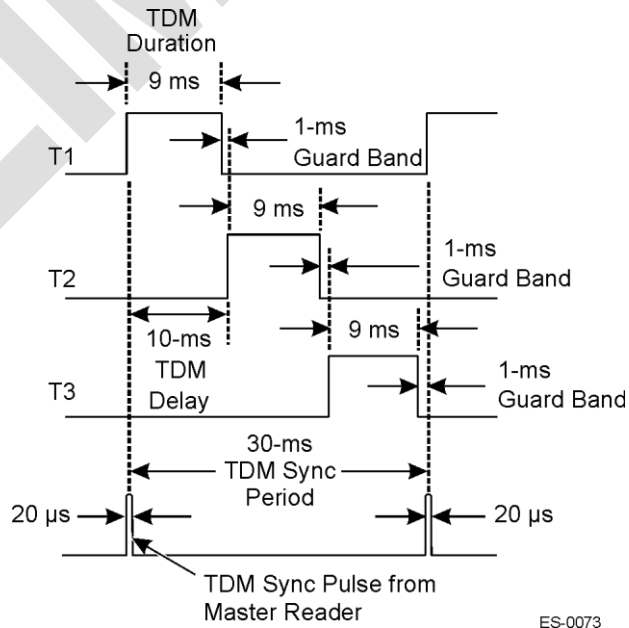


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**Figure 5-3 Typical Plaza Configuration Using TDM**

The frequency settings and the 9-millisecond TDM time slots were determined based on a Title 21 tag transaction. For other installations, the frequencies and TDM duration need to be determined based on the type of transaction and expected vehicle speeds for that installation. Figure 5-4 shows a timing diagram for the readers in each of the time slots. Table 5-3 lists the settings for each reader in each time slot.



**Figure 5-4 TDM Timing Diagram**

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**Table 5-3 TDM Timing Settings**

Time Slot	TDM Delay	TDM Duration	TDM Synchronization Period <sup>a</sup>
T1	0 ms (setting = 0)	9 ms (setting = 18)	31 ms (setting = 31)
T2	10 ms (setting = 20)	9 ms (setting = 18)	32 ms (setting = 32)
T3	20 ms (setting = 40)	9 ms (setting = 18)	33 ms (setting = 33)

a. Master reader TDM synchronization period equals 30 milliseconds.

*Note: The TDM synchronization period is set in 1.0-millisecond increments, and the TDM delay and TDM duration are set in 0.5-millisecond increments.*

The TDM example shown in Figure 5-4 and Table 5-3 was designed with three time slots; however, two time slots can be used instead depending on the number of frequency channels and the timing. Implementing TDM with three time slots reduces the time available for a transaction in a given lane by a factor of three. Similarly, implementing TDM with two time slots reduces the time available for a transaction in a given lane by a factor of two. Although it is possible to implement four or more time slots, it is unlikely that more than three time slots are necessary or beneficial.

TransCore recommends that a guard-band of 1 millisecond be used between each of the time slots to ensure that the readers in the previous time slot have sufficient time to settle before the readers in the next time slot become active. This procedure can be done by setting the TDM delay on each reader to account for a duration that is 1 millisecond longer than the actual duration and setting the TDM synchronization period to a value that accounts for a duration 1 millisecond longer than the actual duration.

All the readers designated as slave readers in the plaza on the same TDM bus are dependent on the synchronization signal from the master reader. In the event that the synchronization pulse from the master reader stops functioning, or the TDM signal from the master reader becomes disconnected from the rest of the readers in the plaza, a provision in the readers allows a slave reader to serve as a backup master reader and supply the synchronization pulse. Although this situation will cause the slave reader to send an error message to the lane controller, the slave reader will continue to function and provide the TDM synchronization pulse for the other operational readers on the remaining TDM bus.

Because the location in the plaza where the signal break may occur is unknown, TransCore recommends that provisions for a break anywhere in the line be considered. Although the TDM synchronization period settings for the slave readers could all be set at the same single value of 1 millisecond longer than the value used for the TDM synchronization period on the master reader, they should be set at unique values increasing at 1 millisecond for each reader, starting at a value 1 millisecond higher than that of the master reader. This setting ensures that only one reader will provide the synchronization pulse to a given group of readers in the plaza remaining on the

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TDM bus in the event of either a TDM connection failure, or a failure of the TDM circuit in the master reader, which also reduces the number of readers that will generate TDM failure messages in any one of these failure scenarios.

### **Physical Remedies**

By adjusting the angle or position of the downlink and uplink antennas, you may be able to minimize cross-lane interference.

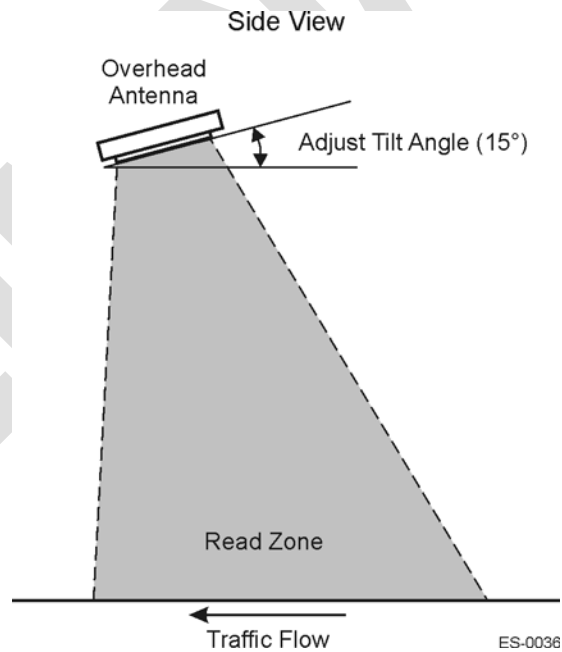


#### **Warning**

*Switch off RF power before working on antennas.*

#### **Adjusting the Antenna's Uptilt Angle**

Lowering an antenna's uptilt angle between the antenna cover and the horizon generally reduces the interference (Figure 5-5).

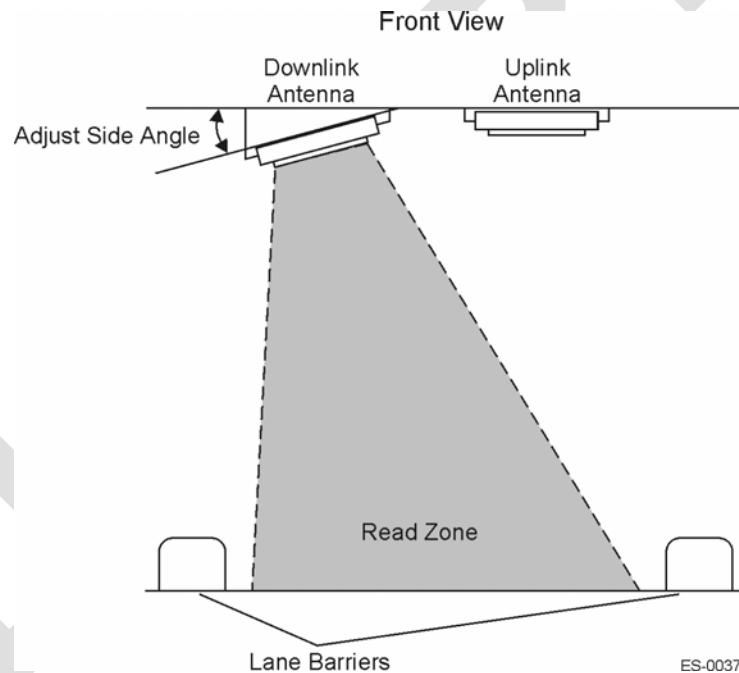


**Figure 5-5 Antenna Tilt Angle Adjustment**

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***Adjusting the Antenna Side Angle***

In the eGo 4110A Reader System, you can adjust an antenna's side angle so that the RF transmits toward the center of the toll lane, placing the RF footprint into the lane. If the side angle is too small, the footprint can project into the lane nearest to the tilted antenna. If the side angle is too large and the RF footprint is projecting toward the other antenna, you can reduce the side angle so that the antenna's RF footprint is evenly placed within the correct lane boundaries. Figure 5-6 shows the downlink antenna being tilted toward the center of the lane.



***Figure 5-6 Downlink Antenna Side Angle Adjustment***

***Adjusting the Antenna Placement***

Besides adjusting the antenna angles, you can also move the antenna farther back into its overhead location so that the read zone does not extend as far in front of the transaction area. By shortening the read zone, you may be able to reduce the required RF output power, which will result in reduced probability of cross-lane interference.

You can also move the antenna pair from side to side within the lane. This adjustment is used in lanes where the traffic travels closer to one side than another. For example, in manned toll lanes, traffic tends to drive closer to the left side of the lane. The centerline between the antennas can be shifted to the left to compensate for this tendency.

***Other Site Modifications***

In rare instances, applying radar-absorbing foam to fixed areas of the toll plaza (e.g., metal roof) may reduce the incidence of interference.



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General Software Information

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# General Software Information

*This chapter provides general software information about the design of Encompass system application software, as well as information required for using reader system components in the design and integration of an automated toll, traffic management, or automatic vehicle identification (AVI) system.*

## General Software Information

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All tag programmer commands are preceded by a start-of-message (<som>) ampersand character (&) followed by an end-of-message (<eom>) percent character (%). All data after the <eom> character is ignored until the next <som> is detected.

Any & character that occurs in the message between the <som> and <eom> is converted to the backslash and *at* character (\@) sequence. Any % character is converted to the \? character sequence. All \ characters are converted to the \\ sequence. All <som> and <eom> character conversions are performed after the cyclic redundancy check (CRC) has been performed on the transmit data and before the CRC is performed on the receive data.

Reader commands contain only the message information and are not preceded by the & and are not followed by the %.

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### **Plan and Organize**

Tags compatible with the eGo 4110A Reader System have sophisticated memory organization. TransCore encourages the user to become familiar with the use and organization of tag memory. Before starting a programming session, TransCore recommends that you plan and organize the development steps.

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## Communications Protocols

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The Encompass communicates with a host by Ethernet or serial communications protocols.

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### **Ethernet**

The Encompass can communicate via an Ethernet communications protocol. This connection requires an RJ-45 connector for the Ethernet receptacle. The Ethernet connector is an RJ-45 jack and uses a 10-base T interface. If you use a switch between the Encompass and the host personal computer (PC), no crossover cable is required. If the Encompass is connected directly to the host PC then a crossover cable is required. If the

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host PC is set to *Dynamic* TransCore recommends that you set the IP address to *Static*. Table 6-1 lists the connector pin assignments.

**Table 6-1 Ethernet Connector**

Pin	Signal	Description
1	TPTX+	Output Differential Transmit Data +
2	TPTX-	Output Differential Transmit Data -
3	TPRX+	Input Differential Receive Data +
4	NOT CONNECTED	N/A
5	NOT CONNECTED	N/A
6	TPRX-	Input Differential Receive Data -
7	NOT CONNECTED	N/A
8	NOT CONNECTED	N/A

---

## **Communications RS-232**

The connector is an industry standard DB-9M plug. Table 6-2 lists this connector pin assignments.

**Table 6-2 Communications RS-232 Connector Parameters**

Pin	Signal	Description
1	RSD	Received line signal detect (not connected)
2	RXD	Receive Data
3	TXD	Transmit Data
4	DTR	Data Terminal Ready (not connected)
5	GND	Ground
6	DSR	Data Set Ready (not connected)
7	RTS	Request to Send
8	CTS	Clear to Send
9	RI	Ring indicator (not connected)

The RS-232B/Time-division multiplexing (TDM) connector is an 8-pin terminal block header. The TDM signals must be isolated. Table 6-3 lists this connector pin assignments.



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**Table 6-3 RS-232B/TDM Connector Parameters**

Pin	Signal	Description
1	TXD	Transmit Data
2	RXD	Receive Data
3	DTR	Data Terminal Ready (not connected)
4	RTS	Request to Send
5	CTS	Clear to Send
6	GND	Ground
7	TDM +	TDM positive signal
8	TDM -	TDM negative signal

### **Diagnostic RS-232 Serial Communications**

The Encompass can communicate via a serial, RS-232, communications protocol (Table 6-4). The diagnostic RS-232 port can be used to display the operating system boot sequence.

**Table 6-4 RS-232 Connector Specifications**

<b>Connector Type</b>	9 pin D-sub male
<b>Protocol</b>	RS-232
<b>Baud</b>	9600
<b>Bits</b>	8
<b>Parity</b>	None
<b>Stop Bits</b>	1
<b>Flow Control</b>	None

If you connect the Encompass directly to a host PC serial port, you must use a null-modem connector.

#### **Diagnostic Commands (Mike?)**

By using the version command, you can display data about the configuration of the Encompass including its Internet protocol (IP) address.

The RS-232 diagnostic connector can be used to check the external input/output status. Table 6-5 lists this connector pin assignments.

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Table 6-5 Diagnostic RS-232 Connector Parameters

Pin	Signal	Description
1	5V PWR	5V power supply for I/O board
2	GND	GND
3	I/O Signal 1	Input/output signal 1
4	I/O Signal 2	Input/output signal 2
5	I/O Signal 3	Input/output signal 3
6	I/O Signal 4	Input/output signal 4
7	Tag in Field 1	Contact Closure 1 for Tag in Field Signal
8	Tag in Field 2	Contact Closure 2 for Tag in Field Signal

## Reader Command Protocol

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The Encompass implements command requests, data acknowledgements, command responses, asynchronous responses, software flow control, and unsolicited status messages as required for AVI system configuration and operation. The messages are defined in this section.

**Command request messages** are initiated and used by the host to request specific actions to be performed by the Encompass.

**Data acknowledge messages** are initiated and used by the Encompass to signal the reception of command request messages received from the host. Additionally, data acknowledge messages are initiated and used by the host to signal the reception of command response, asynchronous response, software flow control and unsolicited status messages received from the Encompass.

**Command response messages** are initiated by the Encompass in response to specific command request messages received from the host.

**Asynchronous response messages** are optionally initiated by the Encompass in response to specific command request messages received from the host.

**Software flow control messages** are initiated and used by the Encompass System to inform the host to start or stop sending command request messages. Additionally, software flow control messages are initiated and used by the host to inform the Encompass System to start or stop sending messages.

**Unsolicited status messages** are initiated and used by the Encompass System to inform the host about specific warning or error conditions in the Encompass System.

The host sends command request messages to the Encompass. The Encompass after receiving command request messages from the host sends data acknowledge mes-

sages, command response messages, asynchronous response messages and if required

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software flow control messages to the host. The host on receiving command response messages, asynchronous response messages and software flow control messages from the Encompass sends data acknowledge messages to the Encompass.

Additionally, the Encompass sends unsolicited status messages to the host. The host on receiving unsolicited status messages from the Encompass sends data acknowledge messages to the Encompass.

The Encompass implements message sequence numbers and command sequence numbers in all of the message types (e.g. command request, data acknowledge, command response, asynchronous response, software flow control and unsolicited status). The host and the Encompass must implement independent transmit and receive counters for both the message sequence numbers and the command sequence numbers. The transmit counters are used in the generation of the transmitted messages and the receive counters are used in the received message out-of-sequence error checking. An out-of-sequence error indicates that a message has been missed.

The host's message sequence numbers independently track the number of messages sent to the Encompass. The Encompass's message sequence numbers independently track the number of messages sent to the host. These message sequence numbers are used on the receiving end to determine if a message has been missed. See the software communication sequence number controls section for more details.

The host's command sequence numbers for each command group independently track the number of command request messages sent to the Encompass. The Encompass's command sequence numbers for each command group independently track the number of software flow control and unsolicited status messages sent to the host. These command sequence numbers are used on the receiving end to determine if the appropriate message as specified above has been missed. See the software communication sequence number controls section for more details.

---

## **UDP/IP Fast Ethernet Communications Protocol**

The UDP/IP fast Ethernet communications protocol implements the UDP/IP fast Ethernet protocol as specified in the *RealFast UDP/IP Core Design Specification* (RealFast Document Number RFHC04026-V042).

### **Command Request Message**

The host sends command request messages to the Encompass as required for system operation. The host and the Encompass uses the following UDP/IP fast Ethernet communications command request message shown here:

```
<len> <msgSeqNum> <cmd> <cmdSeqNum> [<data>] <checksum>
```

where

<len> = length, a word that specifies the number of bytes in the entire message.

<msgSeqNum> = message sequence number, a byte that specifies the message sequence number of the message. See the software communication sequence number controls section for details.

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*<cmd>* = command, a word that specifies the system command. See the command sections for details.

*<cmdSeqNum>* = command sequence number, a byte that specifies the command sequence number of the message. See the software communication sequence number controls section for details.

*[<data>]* = optional data payload that varies in length from 0 to 65 bytes and is associated with each specific command. See the command sections for details.

*<checksum>* = checksum, a byte that specifies the checksum of the message.

### **Data Acknowledge Message**

The Encompass sends data acknowledge messages to the host after receiving command request messages from the host.

The host sends data acknowledge messages to the Encompass after receiving command response messages, asynchronous response messages, software flow control messages and unsolicited status messages from the Encompass. The host and the Encompass uses the following UDP/IP fast Ethernet communications data acknowledge message as shown here:

*<len>* *<msgSeqNum>* *<cmd>* *<cmdSeqNum>* *<resp>* *<msgSeqNumAck>* *<checksum>*

*where*

*<len>* - length, word that specifies the number of bytes in the entire message.

*<msgSeqNum>* - message sequence number, byte that specifies the message sequence number of the message. See the software communication sequence number controls section for details.

*<cmd>* - command, word that specifies the system command. See the command sections for details.

*<cmdSeqNum>* - command sequence number, byte that specifies the command sequence number of the message. See the software communication sequence number controls section for details.

*<resp>* - response, word that specifies the system response. See the response sections for details.

*<msgSeqNumAck>* - message sequence number acknowledge, byte that specifies the message sequence number of the message being acknowledged. See the software communication sequence number controls section for details.

*<checksum>* - checksum, byte that specifies the checksum of the message.

### **Command Response Message**

The Encompass after receiving command request messages from the host sends command response messages to the host.

The host and the Encompass uses the following UDP/IP fast Ethernet communications command response message shown here:



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<len> <msgSeqNum> <cmd> <cmdSeqNum> <resp> [<data>] <checksum>

where

<len> = length, a word that specifies the number of bytes in the entire message.

<msgSeqNum> = message sequence number, a byte that specifies the message sequence number of the message. See the software communication sequence number controls section for details.

<cmd> = command, word that specifies the system command. See the command sections for details.

<cmdSeqNum> = command sequence number, a byte that specifies the command sequence number of the message. See the software communication sequence number controls section for details.

<resp> = response, a word that specifies the system response. See the response sections for details.

[<data>] = optional data payload that varies in length from 0 to 63 bytes and is associated with each specific response. See the response sections for details.

<checksum> = checksum, a byte that specifies the checksum of the message.

### **Asynchronous Response Message**

The Encompass after receiving command request messages from the host optionally sends asynchronous response messages to the host.

The host and the Encompass uses the following UDP/IP fast Ethernet communications asynchronous response message shown here:

<len> <msgSeqNum> <cmd> <cmdSeqNum> <resp> [<data>] <checksum>

where

<len> = length, a word that specifies the number of bytes in the entire message.

<msgSeqNum> = message sequence number, a byte that specifies the message sequence number of the message. See the software communication sequence number controls section for details.

<cmd> = command, word that specifies the system command. See the command sections for details.

<cmdSeqNum> = command sequence number, a byte that specifies the command sequence number of the message. See the software communication sequence number controls section for details.

<resp> = response, a word that specifies the system response. See the response sections for details.

[<data>] - optional data payload that varies in length from 0 to 63 bytes and is associated with each specific response. See the response sections for details.

<checksum> = checksum, a byte that specifies the checksum of the message.

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### **Software Flow Control Message**

The Encompass after receiving command request messages from the host optionally sends software flow control messages to the host as required for system operation.

The host optionally sends software flow control messages to the Encompass as required for host operation.

The host and the Encompass uses the following UDP/IP fast Ethernet communications software flow control message shown here:

`<len> <msgSeqNum> <cmd> <cmdSeqNum> <resp> <checksum>`

*where*

`<len>` = length, a word that specifies the number of bytes in the entire message.

`<msgSeqNum>` = message sequence number, a byte that specifies the message sequence number of the message. See the software communication sequence number controls section for details.

`<cmd>` = command, a word that specifies the system command. See the command sections for details.

`<cmdSeqNum>` - command sequence number, a byte that specifies the command sequence number of the message. See the software communication sequence number controls section for details.

`<resp>` = response, a word that specifies the system response. See the response sections for details.

`<checksum>` = checksum, a byte that specifies the checksum of the message.

### **Unsolicited Status Message**

The Encompass sends unsolicited status messages to the host as required for system operation.

The host and the Encompass uses the following UDP/IP fast Ethernet communications unsolicited status message shown here:

`<len> <msgSeqNum> <cmd> <cmdSeqNum> <status> [<data>] <checksum>`

*where*

`<len>` = length, a word that specifies the number of bytes in the entire message.

`<msgSeqNum>` = message sequence number, a byte that specifies the message sequence number of the message. See the software communication sequence number controls section for details.

`<cmd>` = command, a word that specifies the system command. See the command sections for details.

`<cmdSeqNum>` = command sequence number, a byte that specifies the command sequence number of the message. See the software communication sequence number controls section for details.

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<status> = status, a word that specifies the system status. See the response sections for details.

[<data>] = optional data payload that varies in length from 0 to 63 bytes and is associated with each specific response. See the response sections for details.

<checksum> = checksum, a byte that specifies the checksum of the message.

---

## Serial Communications Protocol

The serial communications protocol implements the TransCore error correction protocol (ECP) serial standard.

### Command Request Message

The host sends command request messages to the Encompass as required for system operation.

The host and the Encompass uses the following serial communications command request message as shown here:

```
<som> <len> <msgSeqNum> <cmd> <cmdSeqNum> [<data>] <crc16> <eom>
```

where

<som> - start of message, byte that specifies the start of the message which is defined as the ASCII character &.

<len> - length, word that specifies the number of bytes in the entire message.

<msgSeqNum> - message sequence number, byte that specifies the message sequence number of the message. See the software communication sequence number controls section for details.

<cmd> - command, word that specifies the system command. See the command sections for details.

<cmdSeqNum> - command sequence number, byte that specifies the command sequence number of the message. See the software communication sequence number controls section for details.

[<data>] - optional data payload that varies in length from 0 to 65 bytes and is associated with each specific command. See the command sections for details.

<crc16> - 16 bit cyclic redundancy check, word that specifies the 16 bit cyclic redundancy check of the message exclusive of the <som> and <eom> bytes. The polynomial for the CRC calculation is  $X^{16}+X^{12}+X^5+1$  with a divisor polynome of 1021H and an initial value of FFFFH for a CCITT16 type CRC.

<eom> - end of message, byte that specifies the end of the message which is defined as the ASCII character %.

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### **Data Acknowledge Message**

The Encompass after receiving command request messages from the host sends data acknowledge messages to the host.

The host after receiving command response messages, asynchronous response messages, software flow control messages and unsolicited status messages from the Encompass sends data acknowledge messages to the Encompass.

The host and the Encompass uses the following serial communications data acknowledge message as shown here:

<som> <len> <msgSeqNum> <cmd> <cmdSeqNum> <resp> <msgSeqNumAck> <crc16> <eom>

where

<som> - start of message, byte that specifies the start of the message which is defined as the ASCII character &.

<len> - length, word that specifies the number of bytes in the entire message.

<msgSeqNum> - message sequence number, byte that specifies the message sequence number of the message. See the software communication sequence number controls section for details.

<cmd> - command, word that specifies the system command. See the command sections for details.

<cmdSeqNum> - command sequence number, byte that specifies the command sequence number of the message. See the software communication sequence number controls section for details.

<resp> - response, word that specifies the system response. See the response sections for details.

<msgSeqNumAck> - message sequence number acknowledge, byte that specifies the message sequence number of the message being acknowledged. See the software communication sequence number controls section for details.

<crc16> - 16 bit cyclic redundancy check, word that specifies the 16 bit cyclic redundancy check of the message exclusive of the <som> and <eom> bytes. The polynomial for the CRC calculation is  $X^{16}+X^{12}+X^5+1$  with a divisor polynome of 1021H and an initial value of FFFFH for a CCITT16 type CRC.

<eom> - end of message, byte that specifies the end of the message which is defined as the ASCII character %.

### **Command Response Message**

The Encompass after receiving command request messages from the host sends command response messages to the host.

The host and the Encompass uses the following serial communications command response message as shown here:

<som> <len> <msgSeqNum> <cmd> <cmdSeqNum> <resp> [<data>] <crc16> <eom>



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where

<som> - start of message, byte that specifies the start of the message which is defined as the ASCII character &.

<len> - length, word that specifies the number of bytes in the entire message.

<msgSeqNum> - message sequence number, byte that specifies the message sequence number of the message. See the software communication sequence number controls section for details.

<cmd> - command, word that specifies the system command. See the command sections for details.

<cmdSeqNum> - command sequence number, byte that specifies the command sequence number of the message. See the software communication sequence number controls section for details.

<resp> - response, word that specifies the system response. See the response sections for details.

[<data>] - optional data payload that varies in length from 0 to 63 bytes and is associated with each specific response. See the response sections for details.

<crc16> - 16 bit cyclic redundancy check, word that specifies the 16 bit cyclic redundancy check of the message exclusive of the <som> and <eom> bytes. The polynomial for the CRC calculation is  $X^{16}+X^{12}+X^5+1$  with a divisor polynome of 1021H and an initial value of FFFFH for a CCITT16 type CRC.

<eom> - end of message, byte that specifies the end of the message which is defined as the ASCII character %.

### **Asynchronous Response Message**

The Encompass after receiving command request messages from the host optionally sends asynchronous response messages to the host.

The host and the Encompass uses the following serial communications asynchronous response message as shown here:

<som> <len> <msgSeqNum> <cmd> <cmdSeqNum> <resp> [<data>] <crc16> <eom>

where

<som> - start of message, byte that specifies the start of the message which is defined as the ASCII character &.

<len> - length, word that specifies the number of bytes in the entire message.

<msgSeqNum> - message sequence number, byte that specifies the message sequence number of the message. See the software communication sequence number controls section for details.

<cmd> - command, word that specifies the system command. See the command sections for details.

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*<cmdSeqNum>* - command sequence number, byte that specifies the command sequence number of the message. See the software communication sequence number controls section for details.

*<resp>* - response, word that specifies the system response. See the response sections for details.

*[<data>]* - optional data payload that varies in length from 0 to 63 bytes and is associated with each specific response. See the response sections for details.

*<crc16>* - 16 bit cyclic redundancy check, word that specifies the 16 bit cyclic redundancy check of the message exclusive of the *<som>* and *<eom>* bytes. The polynomial for the CRC calculation is  $X^{16}+X^{12}+X^5+1$  with a divisor polynomial of 1021H and an initial value of FFFFH for a CCITT16 type CRC.

*<eom>* - end of message, byte that specifies the end of the message which is defined as the ASCII character %.

### **Software Flow Control Message**

The Encompass after receiving command request messages from the host optionally sends software flow control messages to the host as required for system operation.

The host optionally sends software flow control messages to the Encompass as required for host operation.

The host and the Encompass uses the following serial communications software flow control message as shown here:

*<som>* *<len>* *<msgSeqNum>* *<cmd>* *<cmdSeqNum>* *<resp>* *<crc16>* *<eom>*

where

*<som>* - start of message, byte that specifies the start of the message which is defined as the ASCII character &.

*<len>* - length, word that specifies the number of bytes in the entire message.

*<msgSeqNum>* - message sequence number, byte that specifies the message sequence number of the message. See the software communication sequence number controls section for details.

*<cmd>* - command, word that specifies the system command. See the command sections for details.

*<cmdSeqNum>* - command sequence number, byte that specifies the command sequence number of the message. See the software communication sequence number controls section for details.

*<resp>* - response, word that specifies the system response. See the response sections for details.

*<crc16>* - 16 bit cyclic redundancy check, word that specifies the 16 bit cyclic redundancy check of the message exclusive of the *<som>* and *<eom>* bytes. The polynomial for the CRC calculation is  $X^{16}+X^{12}+X^5+1$  with a divisor polynome of 1021H and an initial value of FFFFH for a CCITT16 type CRC.

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<eom> - end of message, byte that specifies the end of the message which is defined as the ASCII character %.

### **Unsolicited Status Message**

The Encompass sends unsolicited status messages to the host as required for system operation.

The host and the Encompass uses the following serial communications unsolicited status message as shown here:

```
<som> <len> <msgSeqNum> <cmd> <cmdSeqNum> <status> [<data>] <crc16> <eom>
```

where

<som> - start of message, byte that specifies the start of the message which is defined as the ASCII character &.

<len> - length, word that specifies the number of bytes in the entire message.

<msgSeqNum> - message sequence number, byte that specifies the message sequence number of the message. See the software communication sequence number controls section for details.

<cmd> - command, word that specifies the system command. See the command sections for details.

<cmdSeqNum> - command sequence number, byte that specifies the command sequence number of the message. See the software communication sequence number controls section for details.

<status> - status, word that specifies the system status. See the response sections for details.

[<data>] - optional data payload that varies in length from 0 to 63 bytes and is associated with each specific response. See the response sections for details.

<crc16> - 16 bit cyclic redundancy check, word that specifies the 16 bit cyclic redundancy check of the message exclusive of the <som> and <eom> bytes. The polynomial for the CRC calculation is  $X^{16}+X^{12}+X^5+1$  with a divisor polynomial of 1021H and an initial value of FFFFH for a CCITT16 type CRC.

<eom> - end of message, byte that specifies the end of the message which is defined as the ASCII character %.

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Configuration Commands and  
Responses

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# Configuration Commands and Responses

*This chapter describes the Encompass interface commands that are used to configure the reader.*

## Configuring the Encompass

Encompass Readers have been preconfigured for most needed operations. Parameters such as attenuation, step-lock settings, and tag command sequences are set when the reader powers up. The Set Frequency command is the only required configuration command. You must issue this command before the Encompass Reader can read tags.

### Required Commands to Set Up Encompass Reader

This section describes the configuration commands that are used to set up the Encompass.

#### Set Frequency

This section describes the Set Frequency command that is used to set the Encompass frequency. Figure 7-1 shows the command transaction process. Table 7-1 lists the Set Frequency command data.



**Figure 7-1 Set Frequency Command Process**

This command sets the A Counter and B Counter least significant bits (LSB) for the specified source.

**Table 7-1 Set Frequency Command Parameters**

Set Frequency Command Data								Data Payload
Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0	
Set Frequency Command								08H

Unused	Source	0XH
--------	--------	-----

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**Table 7-1 Set Frequency Command Parameters**

Unused	A Counter	XXH
Unused	B Counter LSBs	0XH
Carriage Return		0DH

Table 7-2 shows the Set Frequency Response parameters.

**Table 7-2 Set Frequency Response Parameters**

Set Frequency Response Data								Data Payload
Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0	
Set Frequency Command								08H
Unused							Source	0XH
Acknowledge								00H
Carriage Return								0DH

The Source field identifies the source for the associated N Counter information (Table 7-3).

**Table 7-3 Descriptions of Sources**

Source	Definition
0	Source 1
1	Source 2

**A Counter** – This field contains the data for the binary five-bit A Counter of the PLL. The A and B counters combine to form the 18-bit N Counter. The valid range of the A Counter data field is 00H to 1FH.

**B Counter LSBs** – This field contains the LSB for the binary 13-bit B Counter of the PLL. The A and B counters combine to form the 18-bit N Counter. The valid range of the data field is 0H to 3H. The B Counter value is 007XH, where X = B Counter LSBs.

The PLL frequency spreadsheet contains the values used to set the A Counter and the B Counter. This command will be modified to allow the system to send frequency values instead of A and B counters.

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## System Interface Command Group Commands

This section describes the system commands used to configure the Encompass.

**Table 7-4 System Interface Command Group**

System Interface Command	Command Code
System Identify	0000H
Set Communications Baud Rate	0001H
Get Communications Baud Rate	0002H
Set Time and Date	0003H
Get Time and Date	0004H
Firmware Download	0005H
Reset Reader	0006H
Get Stored Tag Response Message	0007H
Get Number of Stored Tag Response Messages	0008H
Delete All Stored Tag Response Messages	0009H
Get System Startup Status	000AH
Get Lane Controller Interface Status	000BH
Get System Interface Status	000CH
Get DigBrd Hdwr Remote Inventory	000DH
Get DigBrd CPU Boot Fmwr Remote Inventory	000EH
Get DigBrd CPU Appl Fmwr Remote Inventory	000FH
Get DigBrd FPGA UDP/IP Core Fmwr Remote Inventory	0010H
Set UDP/IP Core Lane Controller IP Address and Port Number Parameters	0011H
Get UDP/IP Core Lane Controller IP Address and Port Number Parameters	0012H
Set UDP/IP Core IP Address	0013H
Get UDP/IP Core IP Address	0014H
Get UDP/IP Core UDP Port Number	0015H

Each of the system command group commands is listed in this section.



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### **System Identify**

<b>System Identify Command Data</b>	<b>Data Payload</b>
System Identify Command	0000H

<b>System Identify Response Data</b>	<b>Data Payload</b>
System Identify Command	0000H
Vendor Name	
Version ID	
Part Number	
Serial Number	

### **System Identify Data Sizes**

<b>System Identify Data</b>	<b>Data Size</b>
Vendor Name	15 Bytes
Version ID	15 Bytes
Part Number	15 Bytes
Serial Number	15 Bytes

### **Set Communications Baud Rate**

<b>Set Communications Baud Rate Command Data</b>	<b>Data Payload</b>
Set Communications Baud Rate Command	0001H

Baud Rate Data Code	XXH
---------------------	-----

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## Configuration Commands and Responses

<b>Set Communications Baud Rate Response Data</b>	<b>Data Payload</b>
Set Communications Baud Rate Command	0001H

### **Baud Rate Data Codes**

<b>Baud Rate</b>	<b>Data Code</b>
19,200 bps	0CH
38,400 bps (System Default)	0DH
57,600 bps	0EH
115,200 bps	0FH

### **Get Communications Baud Rate**

<b>Get Communications Baud Rate Command Data</b>	<b>Data Payload</b>
Get Communications Baud Rate Command	0002H

<b>Get Communications Baud Rate Response Data</b>	<b>Data Payload</b>
Get Communications Baud Rate Command	0002H
Baud Rate Data Code	XXH

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### Set Time and Date

Set Time and Data Command Data	Data Payload
Set Time and Date Command	0003H
Hours	XXH
Minutes	XXH
Seconds	XXH
Hundredths of Seconds	XXH
Month	XXH
Day	XXH
Year	XXH

Set Time and Data Response Data	Data Payload
Set Time and Date Command	0003H

### Time and Date Data Ranges

Time and Date Data	Data Range
Hours	0 to 23 (00H to 17H)
Minutes	0 to 59 (00H to 3BH)
Seconds	0 to 59 (00H to 3BH)
Hundredths of Seconds	0 to 99 (00H to 63H)
Month	1 to 12 (01H to 0CH)
Day	1 to 31 (01H to 1FH)
Year	0 to 99 (00H to 63H)

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**Get Time and Date**

Get Time and Data Command Data	Data Payload
Get Time and Date Command	0004H

Get Time and Data Response Data	Data Payload
Set Time and Date Command	0004H
Hours	XXH
Minutes	XXH
Seconds	XXH
Hundredths of Seconds	XXH
Month	XXH
Day	XXH
Year	XXH

**Firmware Download**

Firmware Download Command Data	Data Payload
Firmware Download Command	0005H

Firmware Download Response Data	Data Payload
Firmware Download Command	0005H



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The Firmware Download command is implemented as defined for both UDP/IP Fast Ethernet and serial communications.

***Reset Reader***

<b>Reset Reader Command Data</b>	<b>Data Payload</b>
Reset Reader Command	0006H
Reset Reader Control Word	A5A5H

<b>Reset Reader Response Data</b>	<b>Data Payload</b>
Reset Reader Command	0006H

***Get Stored Tag Response Message***

<b>Get Stored Tag Response Message Command Data</b>	<b>Data Payload</b>
Get Stored Tag Response Message Command	0007H
Stored Tag Response Message Number	XXXXH

<b>Get Stored Tag Response Message Response Data</b>	<b>Data Payload</b>
Get Stored Tag Response Message Command	0007H
Stored Tag Response Message Number	XXXXH
Stored Tag Response Message Data	

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**Get Number of Stored Tag Response Messages**

Get Number of Stored Tag Response Messages Command Data	Data Payload
Get Number of Stored Tag Response Messages Command	0008H

Get Number of Stored Tag Response Messages Response Data	Data Payload
Get Number of Stored Tag Response Messages Command	0008H
Number of Stored Tag Response Messages	XXXXH

**Delete All Stored Tag Response Messages**

Delete All Stored Tag Response Messages Command Data	Data Payload
Delete All Stored Tag Response Messages Command	0009H
Delete All Stored Tag Response Messages Control Word	A5A5H

Delete All Stored Tag Response Messages Response Data	Data Payload
Delete All Stored Tag Response Messages Command	0009H

**Get System Startup Status**

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<b>Get System Startup Status Command Data</b>	<b>Data Payload</b>
Get System Startup Status Command	000AH

<b>Get System Startup Status Response Data</b>	<b>Data Payload</b>
Get System Startup Status Command	000AH
System Startup Module Number (System Initialization)	XXXXH
System Timer Initialization Status Error Number	XXXXH
System BMU Initialization Status Error Number	XXXXH
System Queue Create Status Error Number	XXXXH
System Task Create Status Error Number	XXXXH

***Get Lane Controller Interface Status***

<b>Get Lane Controller Interface Status Command Data</b>	<b>Data Payload</b>
Get Lane Controller Interface Status Command	000BH

<b>Get Lane Controller Interface Status Response Data</b>	<b>Data Payload</b>
Get Lane Controller Interface Status Command	000BH
Module Number	XXXXH
Error Number	XXXXH

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**Get System Interface Status**

Get System Interface Status Command Data	Data Payload
Get System Interface Status Command	000CH

Get System Interface Status Response Data	Data Payload
Get System Interface Status Command	000CH
Module Number	XXXXH
Error Number	XXXXH

**Get DigBrd Hdwr Remote Inventory**

Get Digital Board Hardware Remote Inventory Command Data	Data Payload
Get Digital Board Hardware Remote Inventory Command	000DH

Get Digital Board Hardware Remote Inventory Response Data	Data Payload
Get Digital Board Hardware Remote Inventory Command	000DH
Vendor Name	
Version ID	
Part Number	
Serial Number	



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**Hardware Remote Inventory Data Sizes**

Hardware Remote Inventory Data	Data Size
Vendor Name	15 Bytes
Version ID	15 Bytes
Part Number	15 Bytes
Serial Number	15 Bytes

**Get DigBrd CPU Boot Fmwr Remote Inventory**

Get Digital Board CPU Boot Firmware Remote Inventory Command Data	Data Payload
Get Digital Board CPU Boot Firmware Remote Inventory Command	000EH

Get Digital Board CPU Boot Firmware Remote Inventory Response Data	Data Payload
Get Digital Board CPU Boot Firmware Remote Inventory Command	000EH
Vendor Name	
Version ID	
Part Number	

**Get DigBrd CPU Appl Fmwr Remote Inventory**

Get Digital Board CPU Application Firmware Remote Inventory Command Data	Data Payload
Get Digital Board CPU Application Firmware Remote Inventory Command	000FH

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## Configuration Commands and Responses

<b>Get Digital Board CPU Application Firmware Remote Inventory Response Data</b>	<b>Data Payload</b>
Get Digital Board CPU Application Firmware Remote Inventory Command	000FH
Vendor Name	
Version ID	
Part Number	

### ***Get DigBrd FPGA UDP/IP Core Fmwr Remote Inventory***

<b>Get Digital Board FPGA UDP/IP Core Firmware Remote Inventory Command Data</b>	<b>Data Payload</b>
Get Digital Board FPGA UPD/IP Core Firmware Remote Inventory Command	0010H

<b>Get Digital Board FPGA UDP/IP Core Firmware Remote Inventory Response Data</b>	<b>Data Payload</b>
Get Digital Board FPGA UPD/IP Core Firmware Remote Inventory Command	0010H
Vendor Name	
Version ID	
Part Number	

### ***Firmware Remote Inventory Data Sizes***

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<b>Firmware Remote Inventory Data</b>	<b>Data Size</b>
Vendor Name	15 Bytes
Version ID	15 Bytes
Part Number	15 Bytes

**Set UDP/IP Core Lane Controller Parameters**

<b>Set UDP/IP Core Lane Controller Parameters Command Data</b>	<b>Data Payload</b>
Set UDP/IP Core Lane Controller Parameters Command	0011H
IP Address (MSW)	XXXXH
IP Address (LSW)	XXXXH
Port Number	XXXXH

<b>Set UDP/IP Core Lane Controller Parameters Response Data</b>	<b>Data Payload</b>
Set UDP/IP Core Lane Controller Parameters Command	0011H

**Get UDP/IP Core Lane Controller Parameters**

<b>Get UDP/IP Core Lane Controller Parameters Command Data</b>	<b>Data Payload</b>
Get UDP/IP Core Lane Controller Parameters Command	0012H

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Get UDP/IP Core Lane Controller Parameters Response Data	Data Payload
Get UDP/IP Core Lane Controller Parameters Command	0012H
IP Address (MSW)	XXXXH
IP Address (LSW)	XXXXH
Port Number	XXXXH

**Set UDP/IP Core IP Address**

Set UDP/IP Core IP Address Command Data	Data Payload
Set UDP/IP Core IP Address Command	0013H
IP Address (MSW)	XXXXH
IP Address (LSW)	XXXXH

Set UDP/IP Core IP Address Response Data	Data Payload
Set UDP/IP Core IP Address Command	0013H

**Get UDP/IP Core IP Address**

Get UDP/IP Core IP Address Command Data	Data Payload
Get UDP/IP Core IP Address Command	0014H



**PRELIMINARY**

<b>Get UDP/IP Core Lane Controller Parameters Command Data</b>	<b>Data Payload</b>
Get UDP/IP Core IP Address Command	0014H
IP Address (MSW)	XXXXH
IP Address (LSW)	XXXXH

***Get UDP/IP Core Port Number***

<b>Get UDP/IP Core Port Number Command Data</b>	<b>Data Payload</b>
Get UDP/IP Core Port Number Command	0015H

<b>Get UDP/IP Core Port Number Command Data</b>	<b>Data Payload</b>
Get UDP/IP Core Port Number Command	0015H
Port Number	XXXXH

**PRELIMINARY**

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Tag Command Processing

PRELIMINARY

**PRELIMINARY**

## Tag Command Processing

*This chapter provides definitions of and instructions for reading from and writing to a tag, as well as explanations of the tag command codes.*

### ***Reader Operation***

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The reader can operate in one of two command sequences, either read or write. The tag command sequences for the Read and Write operations are detailed in the following sections.

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#### ***Write Commands***

To be provided.

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#### ***Read Commands***

To be provided

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#### ***Host Commands Required for Tag Processing***

To be provided.

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**PRELIMINARY**



**PRELIMINARY**

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System Diagnostics and  
Preventive Maintenance

PRELIMINARY

**PRELIMINARY**

## System Diagnostics and Preventive Maintenance

*This chapter provides information on the following subjects:*

*Error Messages*

*Troubleshooting*

*Preventive Maintenance Schedule*

*Visual Inspection*

*Encompass Repair*

*Removal and Replacement Procedures*

*Technical Support*

### ***Troubleshooting Indications and Actions***

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To be provided.

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**PRELIMINARY**

**PRELIMINARY**

A

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Acronyms and Glossary

PRELIMINARY



**PRELIMINARY**

# Acronyms and Glossary

## A

<b>AC</b>	alternating current
<b>ACK</b>	acknowledge (data valid)
<b>antenna</b>	passive device that converts RF energy into magnetic energy (RF signal)
<b>ATA</b>	American Trucking Associations refers to a standard RF communications protocol and data storage method. ATA-type tags are read only.
<b>AVI</b>	automatic vehicle identification

## B

<b>backscatter</b>	portion of an RF signal that is modulated by a tag and radiated back to the reader
<b>baud</b>	measure of number of bits per second of a digital signal; for example, 9600 baud = 9600 bits per second
<b>bit</b>	The smallest unit of information, consisting of a 0 or 1, that is formed from a binary digit
<b>byte</b>	binary character; for example, one 8-bit ASCII character

## C

<b>cm</b>	centimeter(s)
<b>command</b>	data set that is recognized by the receiving device as intending to elicit a specific response
<b>CRC</b>	cyclic redundancy check
<b>CTRL</b>	control
<b>CTS</b>	clear to send

## D

<b>data</b>	information that is processed by a computing device
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## ***Encompass Multi-Protocol Reader System Guide***

<b>DC</b>	direct current
<b>dB</b>	decibel(s)
<b>dB<sub>i</sub></b>	decibel(s), referencing isotropic radiator
<b>E</b>	
<b>ECP</b>	error correcting protocol
<b>eGo</b>	Proprietary name for ANS INCITS 256-2001 and ISO 18000-6 compliant TransCore products. A registered trademark of TC IP, Ltd.
<b>eom</b>	end of message
<b>EEPROM</b>	electrically erasable programmable read-only memory
<b>ESD</b>	electrostatic discharge
<b>F</b>	
<b>FCC</b>	Federal Communications Commission
<b>field</b>	physical area/space in which a tag can be read by the reader; also, an element of a data record/frame, for example, division within a tag's data frame
<b>frame</b>	consecutive bits of data in memory that are read and written as a group
<b>frequency bands</b>	range of RF frequencies assigned for transmission by an RF device
<b>ft</b>	foot or feet
<b>H</b>	
<b>hex</b>	hexadecimal
<b>hexadecimal</b>	base 16 numbering system that uses the characters 0 through 9 and A through F to represent the digits 0 through 15
<b>host</b>	device, generally a computer, that is connected to reader system components through the communications port
<b>Hz</b>	hertz

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**I**

<b>I/O</b>	input/output
<b>IAG</b>	Inter-Agency Group, distributor of IAG tags
<b>ID</b>	identification; encoded information unique to a particular tag
<b>in</b>	inch(es)
<b>interface</b>	connection point for communications with another device
<b>IRQ</b>	interrupt request

**J**

<b>JP</b>	jumper pin
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**K**

<b>k</b>	kilo ( $10^3$ )
<b>kg</b>	kilogram(s)

**L**

<b>lane controller</b>	device that is used to integrate all activity that occurs in a toll lane.
<b>lb</b>	pound(s)
<b>LED</b>	light-emitting diode

**M**

<b>message</b>	combination of fields, frames, and pages as required by the system to transmit or receive associated command and response data to and from the reader and host computer
<b>m</b>	meter(s)
<b>mA</b>	milliamp(s)
<b>Mega</b>	million ( $10^6$ )
<b>MB</b>	megabyte(s)
<b>MHz</b>	megahertz

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## ***Encompass Multi-Protocol Reader System Guide***

<b>milli</b>	one-thousandth ( $10^{-3}$ )
<b>mode</b>	method of operation
<b>MPI</b>	TransCore's Multi-Protocol Reader
<b>ms</b>	milliseconds
<b>mW</b>	milliwatt(s)
<b>N</b>	
<b>NEMA</b>	National Electrical Manufacturers Association
<b>O</b>	
<b>OSHA</b>	Occupational Safety and Health Administration
<b>P</b>	
<b>PC</b>	personal computer
<b>PLL</b>	phase-lock loop
<b>protocol</b>	specified convention for the format of data messages communicated between devices
<b>PWA</b>	printed wiring assembly
<b>R</b>	
<b>RAM</b>	random access memory
<b>read</b>	process of acquiring data from a device, for example, from a tag or from computer memory
<b>reader</b>	controlled interrogating device capable of acquiring data from a device, for example, acquiring and interrupting data from a tag
<b>read zone</b>	physical area in which a tag can be read by the reader system
<b>RF</b>	radio frequency
<b>RFID</b>	radio frequency identification
<b>RTS</b>	request to send



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**S**

<b>s</b>	second(s)
<b>SeGo</b>	SeGo is a superset of the TransCore eGo protocol.
<b>SRAM</b>	static random access memory
<b>som</b>	start of message
<b>system</b>	a reader, RF module, antenna, and tag, which are described by the general application and interfaces with each other and any connected devices that are defined as being outside the system.

**T**

<b>tag</b>	small, self-contained device acting as an identifying transponder
<b>TDM</b>	time-division multiplexing, used in this document to refer to the use of time-division multiplexing of multiple readers in proximity of each other.
<b>Title 21</b>	state of California code of regulations, Chapter 16, Title 21, which is the standard used for AVI/DSRC (digital short-range communications) protocol
<b>toll</b>	any application of the system equipment wherein the equipment is used to assist in the orderly collection of money in exchange for the passage of a vehicle through a particular installation point
<b>TrAC</b>	TransCore Action Center
<b>transponder</b>	a tag

**U**

<b>UART</b>	universal asynchronous receiver-transmitter
<b>UTA</b>	universal toll antenna

**V**

<b>V</b>	volt(s)
<b>VCC</b>	voltage controlled current
<b>Ver</b>	version (software)

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**W**

**W**

watt(s)

**write**

process of recording data, for example, writing to computer memory or to a tag's memory. Writing erases previous data stored at the specified memory locations.

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**PRELIMINARY**

# B

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## Block Diagrams

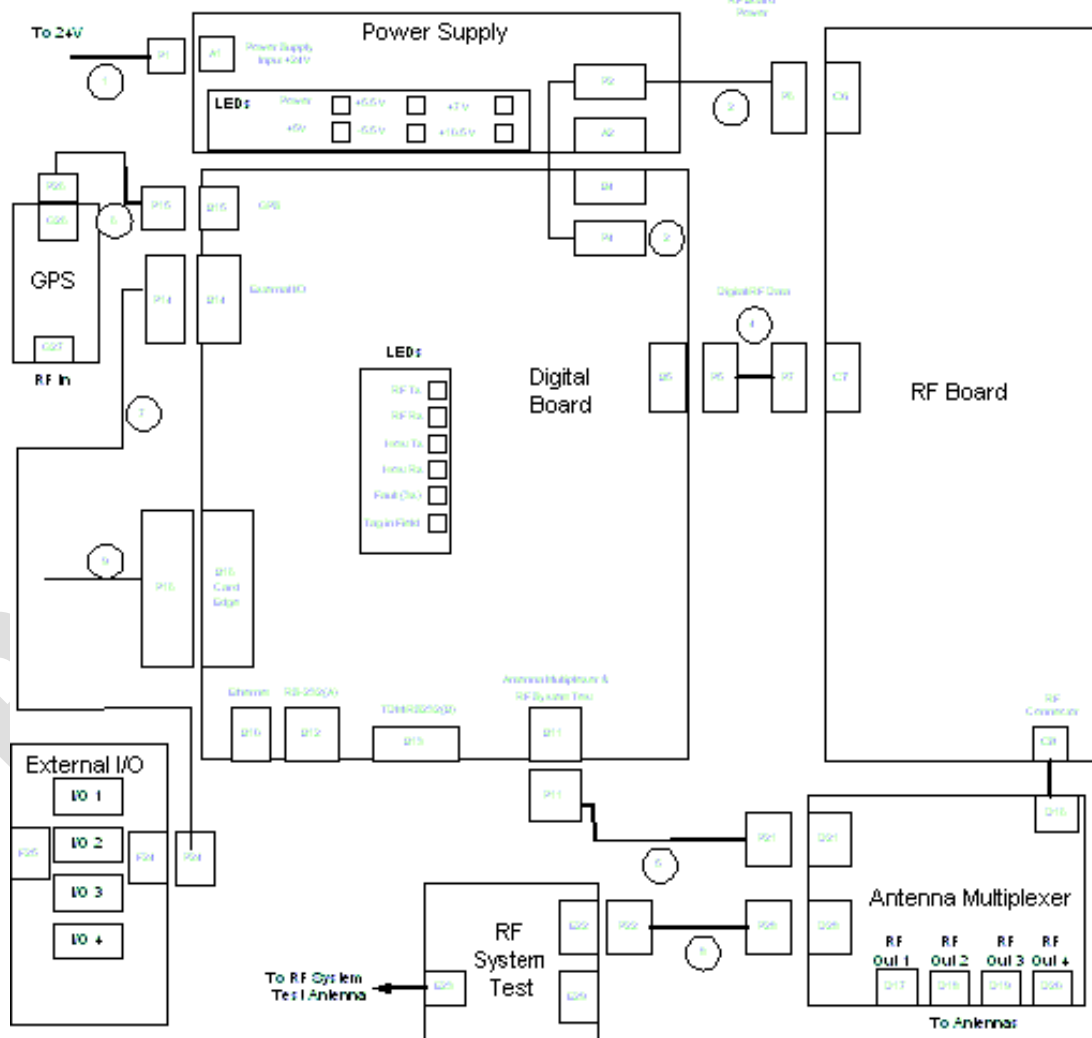
PRELIMINARY

**PRELIMINARY**

# Block Diagrams

*This appendix shows the block diagrams for the interface connections between the components as well as the individual Encompass System components.*

## Encompass System



**Figure B-1 Encompass Hardware Interconnection Block Diagram**



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C

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# System Technical Specifications

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**PRELIMINARY**

# System Technical Specifications

*This appendix provides reference information for the Encompass System components.*

## **Component Specifications**

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This appendix describes the engineering specifications for the Encompass System components.

### **Encompass Multi-Protocol Reader**

#### **Power Supply Fault Detection**

Each voltage supply has fault detection to determine if the voltage supply is functioning correctly. Output tolerance is tested to  $\pm 5$  percent. If any of the voltage supplies fail, the fault signal from the power supply to the digital board defaults to low.

### **AA3152 Universal Toll Antenna**

The AA3152 antenna specifications are as follows:

- Operates in the location and monitoring service band (902 to 928 MHz).
- Optimum radiation pattern — Virtually no side or back lobes help to confine antenna coverage to a single lane.
- Weatherproof — Each antenna is housed in a radome made of materials with favorable electrical characteristics and resistance to ultraviolet radiation.
- Bandpass filtering helps to attenuate interference from other RF sources.

#### **Environmental Specifications**

The AA3152 UTAs can withstand the environmental tolerances shown in Table C-1.

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**Table C-1 Antenna Environmental Tolerances**

<b>Environment</b>	<b>Specification</b>
Dust	NEMA pub 250-1991, Sec. 6.5, page 18
Rain	NEMA pub 250-1991, Sec. 6.4, page 17 and Sec. 6.7, page 19
Corrosion resistance	NEMA pub 250-1991, Sec. 6.9, page 20
Shock	5 G ½-sine pulse, 10 ms duration, 3 axes
Vibration	0.5 G <sub>rms</sub> 10-500 Hz
Temperature range	-40°F to +167°F (-40°C to +75°C)
Humidity	100% condensing



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# D

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## Hardware Interfaces

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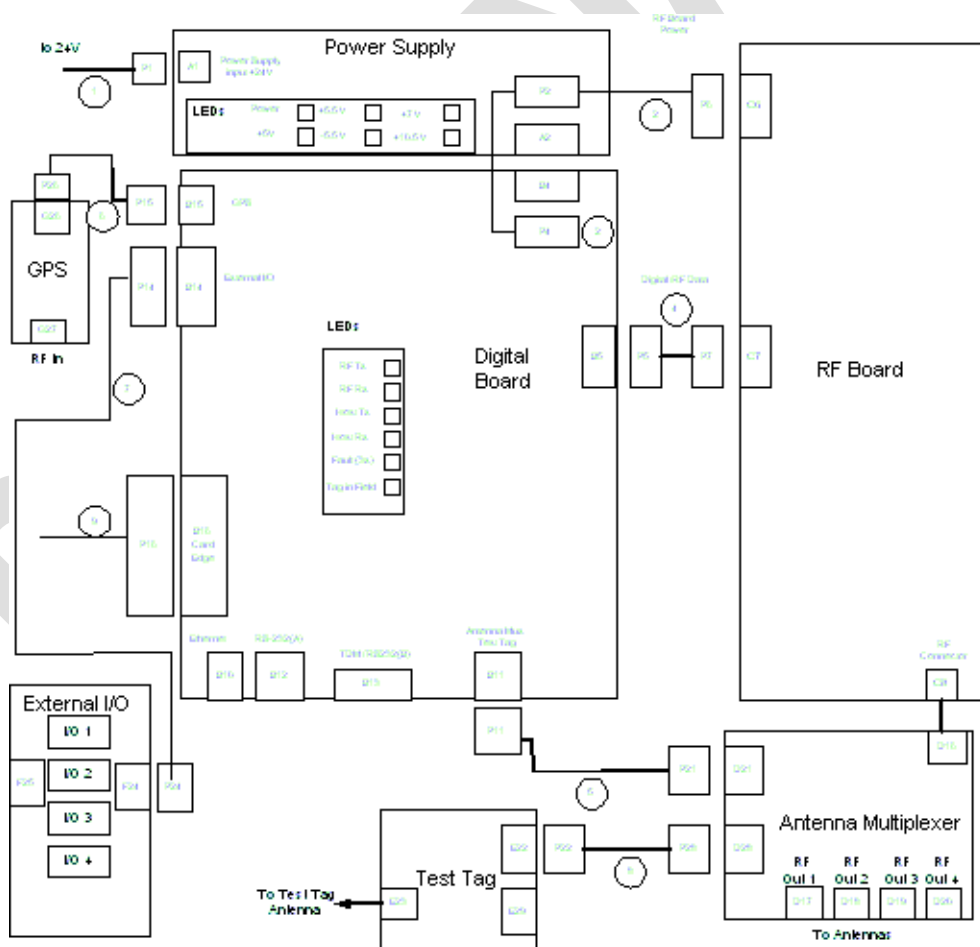
## Hardware Interfaces

*This appendix describes the physical interconnections within an Encompass System.*

### Hardware Interfaces

This appendix describes the hardware interfaces in the Encompass and to external components, such as antennas.

Figure D-1 shows the basic hardware interconnections for the Encompass.



**Figure D-1 Encompass Hardware Interconnection Block Diagram**

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## Communications

The Encompass communicates with a host via Ethernet or serial communications.

### Ethernet

The connector is an RJ-45 jack. This interface is 10-base T. Table D-1 lists the pin-outs.

**Table D-1 Ethernet Connector Pin-outs**

Pin	Signal	Description
1	TPTX+	Output Differential Transmit Data (+)
2	TPTX-	Output Differential Transmit Data (-)
3	TPRX+	Input Differential Receive Data (+)
4	Not connected	N/A
5	Not connected	N/A
6	TPRX-	Input Differential Receive Data (-)
7	Not connected	N/A
	Not connected	N/A

### RS-232 Connectors

**Table D-2 RS-232A Communications Connector Parameters**

Pin	Signal	Description
1	RSD	Received line signal detect (not connected)
2	RXD	Receive Data
3	TXD	Transmit Data
4	DTR	Data Terminal Ready (not connected)
5	GND	Ground
6	DSR	Data Set Ready (not connected)
7	RTS	Request to Send
8	CTS	Clear to Send
9	RI	Ring indicator (not connected)

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**Table D-3 RS-232B/TDM Connector Parameters**

Pin	Signal	Description
1	TXD	Transmit Data
2	RXD	Receive Data
3	DTR	Data Terminal Ready (not connected)
4	RTS	Request to Send
5	CTS	Clear to Send
6	GND	Ground
7	TDM +	TDM positive signal
8	TDM -	TDM negative signal

**Table D-4 RS-232 Diagnostics Connector Parameters**

Pin	Signal	Description
1	5V PWR	5V power supply for I/O board
2	GND	GND
3	I/O Signal 1	
4	I/O Signal 2	
5	I/O Signal 3	
6	I/O Signal 4	
7	Tag in Field 1	Contact Closure 1 for Tag in Field Signal
8	Tag in Field 2	Contact Closure 2 for Tag in Field Signal



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## Hardware Diagnostic Port

**Table D-5 Encompass Hardware Diagnostic Port Parameters**

Pin	Signal	Source	Description
1	I	RF	I Channel from RF receiver
2	Q	RF	Q Channel from RF receiver
3	RSSI	RF	RSSI Detector Output, high for I low for Q.
4	RANGE_ADJ_CNTL	RF	Range Adjust_Control Signal
5	+3.3V	Digital	+3.3V
6	Spare	RF	
7	GND		Ground
8	Spare	RF	
9	Spare	RF	
10	IAG_New_Sig_Det	RF	IAG New Signal Detection Line
11	IAG	RF	IAG Channel from RF receiver
12	GND		Ground
13	Config Type 0	Digital	Configuration Selection bit 1
14	Config Type 1	Digital	Configuration Selection bit 2
15	Config Type 2	Digital	Configuration Selection bit 3
16	Config Type 3	Digital	Configuration Selection bit 4
17	Tag Type Ack	RF	Acks the tag type inputs and indicates that the DL & DOM DACS are settled.
18	Ready to Tx	RF	Ready to Transmit
19	Config Load	Digital	Signal to RF to load new config.
20	MOD	Digital	RF Modulation Signal
21	RF ON/OFF	Digital	RF On Off Control
22	UL/DL Cntrl	Digital	Controls whether active source is Uplink or Downlink
23	TDM	Digital	TDM Sync Pulse
24	GPS 1pps	Digital	1 pulse per second signal for Frequency stabilization
25	Error (txcvr fault)	RF	RF Error Indicator active low
26	Power Supply Fault	Digital	Fault Signal from the Power Supply Board

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**Table D-5 Encompass Hardware Diagnostic Port Parameters (continued)**

27	GND		Ground
28	Tx Serial Comm	Digital	Transmit Serial Signal
29	Rx Serial Comm	RF	Receive Serial Signal
30	GoodTagRead	Digital	Active High Pulse from FPGA1
31	CRC Failed	Digital	Active High Pulse from FPGA1
32	ActivatePort	Digital	Enable the Test Port Buffer when the Connector plugged in
33	GND		Ground
34	SW1	Digital	GPIO from MPC852
35	SW2	Digital	GPIO from MPC852
36	SW3	Digital	GPIO from MPC852
37	SW4	Digital	GPIO from MPC852
38	DecoderOutput	Digital	Decoder Bit Stream from FPGA1
39	PLL Clock (decoder)	Digital	PLL Clock from FPGA1
40	GND	Digital	Ground

### **Antenna Multiplexer Connectors**

The antenna multiplexer is used to drive multiple antennas in multiple AVI lanes.

**Table D-6 Antenna Multiplexer Connector Pin-outs**

Connector	Designator	Pin	Signal	Description
D16	RF input1	1	RF Input/Output	RF input/output signal
D17	RF output 1	1	RF Input/Output	RF input/output signal
D18	RF output 2	1	RF Input/Output	RF input/output signal
D19	RF output 3	1	RF Input/Output	RF input/output signal
D20	RF output 4	1	RF Input/Output	RF input/output signal

Connector D21 is the same as connector B11 on the digital board. Connector D28 is the same as connector B11 on the digital board. This connector is used to connect the data cables from the Encompass to the antenna multiplexer and the RF System Test boards.

### **RF System Test Connectors**

The RF system test checks the ...

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## ***Encompass Multi-Protocol Reader System Guide***

- Connector E22, RF system test data is the same as connector B11 on the digital board.
- Connector E29, RF system test data is the same as connector B11 on the digital board. This connector is used to connect the data cables from the Encompass to the antenna multiplexer board and the RF system test boards.
- Connector E23 is the RF in signal.

***Table D-7 RF System Test Connector Pin-out***

<b>Pin</b>	<b>Signal</b>	<b>Description</b>
1	RF Input/Output	RF input output signal

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