Orion® Reader System Guide

Star Systems International, Ltd.

August 2014

P/N 16-0024-001

A Acronyms and Glossary

B Hardware Interfaces

C System Technical Specifications

D Orion Reader Options

E Command-Based Pre- and Post-Conditions

For further information, contact:

WARNING TO USERS IN THE UNITED STATES AND CANADA

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 Federal Communications Commission (FCC), or an equivalent delivered by Industry Canada (IC), to operate this radio frequency identification (RFID) device in the United States or Canada. FCC ID number is 2AA7K-ORION. IC ID number is 20068-ORION. Access the FCC website at www.fcc.gov/Forms/Form601/601.html or at http://wireless.fcc.gov/index.htm?job=online_filing or at the IC website at http://www.ic.gc.ca/eic/site/sd-sd.nsf/eng/h_00023.html 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. Unauthorized modification may void the equipment authorization from the FCC and will void the warranty.

USE OF SHIELDED CABLES AND GROUNDING
47 CFR §15.27(a)

NOTE: Shielded cables and Earth Grounding the unit is recommended for this equipment to comply with FCC regulations.

USA

AVERTISSEMENT POUR LES UTILISATEURS DES ÉTATS-UNIS ET DU CANADA

DÉCLARATION SUR L'UTILISATION ET L'EMPLACEMENT DES APPAREILS, CONFORMÉMENT AUX EXIGENCES DE LA FCC (COMMISSION FÉDÉRALE DES COMMUNICATIONS DES ÉTATS-UNIS)
47 CFR §90.351

NOTE : L'utilisateur est tenu d'obtenir une licence de site de la FCC aux termes de la partie 90 du Code des règlements fédéraux des États-Unis (CFR), ou un équivalent délivré par Industrie Canada (IC), pour pouvoir se servir de ce dispositif d'identification par radiofréquence (RFID) aux États-Unis et au Canada. Le numéro d'identification pour la FCC est 2AA7K-ORION. Le numéro d'identification pour IC est 20068-ORION. Prière de consulter le site Web de la FCC au www.fcc.gov/Forms/Form601/601.html ou au http://wireless.fcc.gov/index.htm?job=online_filing, ou encore le site Web d'IC à http://www.ic.gc.ca/eic/site/sd-sd.nsf/fra/h_00023.html?Open&src=mm1, pour obtenir des renseignements supplémentaires sur les exigences en matière de licence.

NOTE : Les utilisateurs de tous les pays sont priés de vérifier, auprès des autorités concernées, les exigences locales en matière de licence.

DÉCLARATION SUR LE BROUILLAGE RADIOÉLECTRIQUE, CONFORMÉMENT AUX EXIGENCES DE LA FCC
47 CFR §15.105(a)

NOTE : Cet appareil a été testé et jugé conforme aux limites établies pour un dispositif numérique de classe A, selon la partie 15 des règlements de la FCC. Ces limites visent à assurer un degré raisonnable de protection contre le brouillage préjudiciable lorsque l'appareil est utilisé dans un environnement commercial. Cet appareil génère, utilise et peut diffuser de l'énergie sous forme de radiofréquences (RF) et peut causer un brouillage préjudiciable aux communications radio s'il n'est pas installé conformément au mode d'emploi. L'utilisation de cet appareil en zone résidentielle est susceptible de causer un brouillage préjudiciable, auquel cas, selon la réglementation applicable, l'utilisateur pourrait être tenu d'éliminer le signal parasite à ses propres frais.

AUCUNE MODIFICATION SANS AUTORISATION
47 CFR §15.21

MISE EN GARDE

MISE EN GARDE : Cet appareil ne peut en aucune façon être modifié, altéré ou transformé sans l'autorisation. Toute modification non autorisée pourrait invalider l'autorisation de la FCC au regard de l'appareil et annulera la garantie.

UTILISATION DE CÂBLES BLINDÉS ET MISE À LA TERRE
47 CFR §15.27(a)

NOTE : Il est recommandé d'utiliser des câbles blindés et de mettre l'appareil à la terre pour assurer la conformité aux règlements de la FCC.

États-Unis

Health Limits for Orion® Reader Using External Antenna (902 to 921.5 MHz)

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 (mW/cm^2) averaged over 6 minutes at 902 MHz.

Industry Canada, RSS-102, Issue 5 guidelines recommend a maximum safe power density in W/m^2 of:

$$\mathbf{(0.02619)(Frequency\ (in\ MHz))^{0.6834} = (0.02619)(915)^{0.6834} = 2.77\ W/m^2}$$

Thus, the maximum permissible exposure for general population/uncontrolled exposure at 915 MHz is 2.77 W/m^2. The average time is 6 minutes.

The maximum permissible exposure for occupational/controlled exposures is 19.53 W/m^2. The average time is 6 minutes.

The RF power density generated by the Orion Reader was calculated using a maximum antenna gain of 14.0 dBi, equivalent to the antenna gain of the external toll antenna.

Warning

WARNING

At 1.6 W transmitted power, 0 dB transmit attenuation, and a distance of 42.5 inches (108 cm) from the antenna, the maximum power density calculated was less than 2.77 W/m^2. Install the antenna at least 42.5 inches (108 cm) from the general public. Maintenance personnel must remain at least 16.4 inches (41 cm) from the antenna when the system is operating.

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

Limites d'innocuité du lecteur Orion^{MD} utilisé avec une antenne externe (902 à 921,5 MHz)

Aux États-Unis, les directives environnementales concernant les niveaux d'exposition acceptables sont émises par l'OSHA (Occupational Safety and Health Administration).

L'article 1910.97 de la norme de santé et de sécurité 2206 de l'OSHA fixe la limite d'exposition acceptable à une moyenne de 10 milliwatts par centimètre carré (mW/cm^2) sur une période de 6 minutes à 902 MHz.

Les normes de l'Industrie Canada, CNR-102, 5^e édition recommandent de ne pas dépasser la densité de puissance suivante, exprimée en W/m^2 :

$$\mathit{(0{,}02619)(Fréquence\ (en\ MHz))}^{0{,}6834} \quad = \quad (0{,}02619)(915)^{0{,}6834} \quad = \quad \mathit{2{,}77}\ \mathrm{W/m^2}$$

Ainsi, le niveau maximal d'exposition permis pour la population générale et les situations d'exposition non contrôlée à 915 MHz est de 2,77 W/m^2 en moyenne sur une période de 6 minutes.

Le niveau maximal d'exposition permis dans un cadre professionnel ou contrôlé est de19,53W/m^2 en moyenne sur une période de 6 minutes.

La densité de puissance des RF générées par le lecteur Orion a été calculée pour un gain d'antenne maximal de 14,0 dBi, soit l'équivalent du gain de l'antenne de péage universelle.

Mise en garde

Avec une puissance transmise de 1,6 W et une atténuation de transmission de 0 dB, la densité de puissance maximale calculée à 42,5 pouces (108 cm) de l'antenne était inférieure à 2,77 W/m^2. Par mesure de précaution, installer l'antenne à au moins 42,5 pouces (108 cm) de la population générale. Le personnel d'entretien doit se tenir à au moins 16,4 pouces (41 cm) de l'antenne lorsque le système est en cours d'utilisation.

Les données confirment que l'utilisation de l'toll antenna ou d'une antenne équivalente avec le lecteur multiprotocole Orion répond aux exigences de l'OSHA et ne présente pas de danger lié à son utilisation, que ce soit pour la population générale ou le personnel d'entretien.

1

Before You Begin

Chapter 1 Orion Reader System Guide

Before You Begin

This chapter provides an overview of the Orion® Reader System Guide.

Purpose of the Guide

This *Orion® Reader System Guide* provides detailed information about the reader system, including site installation and planning, troubleshooting, and preventive maintenance tasks, as well as a detailed list of the reader software commands and diagnostic and hardware interface information for developing your customized application software. Also included is an appendix that describes the optional assemblies available with the Orion system.

Intended Audience

The intended audience for this guide is those personnel responsible for installing, configuring, operating, and maintaining the Orion Reader.

Guide Topics

This system guide presents the following information.

Chapter 1 – **Before You Begin**	This chapter provides an overview of the system guide as well as related documents, typographical conventions, and licensing requirements.
Chapter 2 – **Developing the Orion Reader System Site Plan**	This chapter discusses factors to be considered when developing the site plan in preparation for installing the Orion Reader system equipment.
Chapter 3 – **Installing the Orion Reader**	This chapter describes the Orion Reader and instructs the user in installing the Orion Reader system.
Chapter 4 – **Software Information**	This chapter provides transmission control protocol (TCP) software-related information for the Orion Reader.
Chapter 5 – **Communication Protocols**	This chapter describes the TCP communications via Ethernet for the Orion Reader.
Chapter 6 – **Configuring and Operating the Orion Reader Using TCP Commands**	This chapter describes the Orion Reader mode and TCP commands that are used to configure and operate the reader. This chapter also contains system commands and responses that are needed to develop host software for the TCP command set.

Chapter 7 – **Tag Responses**	This chapter provides tag responses for transmission control protocol (TCP)
Chapter 8 – **Configuring the Lane**	This chapter provides information on the importance of lane tuning for optimum automatic vehicle identification (AVI) system performance. This chapter also describes the Orion Reader functions and features that can assist you in tuning an AVI lane.
Chapter 9 – **System Diagnostics and Preventive Maintenance**	This chapter provides information on error messages, troubleshooting, preventive maintenance schedule, visual inspection, Orion Reader repair, removal and replacement procedures, and technical support.
Appendix A – **Acronyms and Glossary**	This appendix defines the acronyms and terms used in this system guide.
Appendix B – **Hardware Interfaces**	This appendix describes the physical interconnections within an Orion Reader system.
Appendix C – **System Technical Specifications**	This appendix provides reference specifications for the Orion Reader system components.
Appendix D – **Reader System Options**	This appendix describes the options available with the Orion Reader system.
Appendix E – **Command-Based Pre- and Post Conditions**	This appendix lists the pre- and post-conditions for TCP commands.
Index	This index provides an alphabetical listing of the system guide topics.

Typographical Conventions Used in this Manual

Table 1-1 lists the typographical conventions that may be 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.
Dialog Box Title	Title of a dialog box as it appears on screen.
Screen Title	Title of a screen as it appears on screen.
Menu Item	Appears on a menu.
Note	Additional information that further clarifies the current discussion. These important points require the user’s attention. The paragraph is in italics and the word Note is bold.
Cancel button	Bold text identifies the labeling of items as they actually appear on the keyboard, on a button, as a menu item, and so forth.
Ctrl-**Esc**	A hyphen indicates actions you should perform simultaneously. For example, Ctrl-Esc means to press the **Ctrl** and **Esc** keys at the same time.
5 Return	A space indicates that you should press the specified keys in the sequence listed, not at the same time.
before	Text in italics indicates emphasis.
Customer > **Find**	Bold text followed by a > and more bold text indicates the order of command selections to reach a specific function.
click	Click means that you should press and release the left mouse button.
cursor	The cursor is the flashing vertical line that appears in a selected edit box.
pointer	The pointer is the arrow in the window that shows the movement of the mouse.

2

Developing the Installation Site Plan

Chapter 2

Developing the Installation Site Plan

This chapter provides guidelines for the following tasks:

- ***Assessing and formulating the site plan***
- ***Preparing the site***
- ***Choosing locations to mount the system components***
- ***Determining electrical and communications requirements***

Assessing and Formulating a Site Plan

You will need to perform a general geographic RF site survey to check for RF noise sources near the automatic vehicle identification (AVI) installation.

You will need to formulate a frequency plan for each plaza. Each reader has two frequencies: downlink (reader-to-tag communications) and uplink (tag-to-reader responses). An Orion Reader deployed for use in the U.S. uses the following frequency ranges:

- **Downlink**: 911.75 to 919.75 MHz, adjustable in 0.25 MHz steps
- **Uplink**: 902.25 to 903.75 MHz and 910.00 to 921.50 MHz, adjustable in 0.25 MHz steps. Actual frequency range is protocol dependent.[1]

Consult with the Star Systems engineer or other systems integrator assisting with the installation of the Orion Readers.

Preparing the Installation Site

Prepare the site according to the design parameters determined by your system integrator.

Site Preparation Checklist

Complete the following tasks, depending on the individual site.

❑	Acquire a construction license.
❑	Acquire a Federal Communications Commission (FCC) license.

1. The above frequency ranges are in the location monitoring service band.

❑	Acquire an environmental assessment permit.
❑	Ensure that you have assembled all the lights, buzzers, and vehicle detectors that will interface with the Orion Reader system.
❑	Ensure that you have software for a desktop or laptop computer to interface with the Orion Reader firmware.
❑	Pull communications, coaxial, and power cables through outdoor-grade conduit.
❑	Ensure that construction work required for mounting the equipment is completed.
❑	Ensure that 120V AC service is available.

You will need to determine if Sync is required in your installation. If Sync is required, then you may need to wire the installation for Sync configuration. Chapter 9 contains detailed Sync information. You can also use a GPS option if hardwiring is not an option. See Appendix D for more information on the GPS timing assembly option.

Components Checklist

Ensure you have the following components available for the installation:

❑	Orion Reader(s)
❑	One toll antenna for each lane
❑	All optional equipment to the basic Orion Reader. Appendix D lists the optional equipment that can be used with the Orion Reader.

Task Checklist

The following checklist summarizes the installation procedure. Instructions for each task are provided in the “Mounting the Orion Reader” section in Chapter 3.

❑	Install Orion Reader (and any options).
❑	Connect power cable from power supply to Orion Reader.
❑	Install antenna(s) and connect them to Orion Reader.

Where to Mount the Components

The location for mounting the components is designated in the site installation plan. Many AVI site layouts are similar.

The Orion Reader can be installed in a housing along with the host computer or lane controller.

Overhead Gantry Mount

For an overhead gantry mount, the Orion Reader is installed with the host computer or lane controller. The toll antenna may be attached to a 2- to 3-inch (5.0- to 7.6-cm) diameter pipe that is supported from a gantry that spans the lanes. These components are mounted approximately 15 to 18 feet (4.5 to 5.5 m) above the road surface. Figure 2-1 illustrates a typical overhead gantry mount.

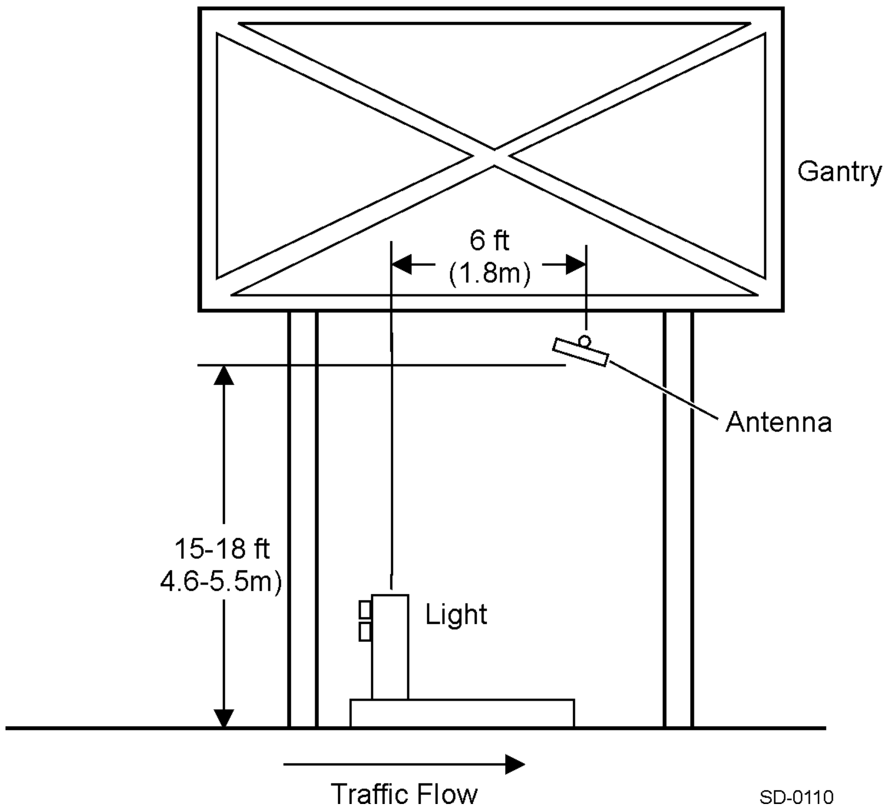

Figure 2-1 Overhead Gantry Mount

Overpass Mount

For the overpass mount, the Orion Reader is installed with the host computer or lane controller. The toll antenna is attached to a 2- to 3-inch (5.0- to 7.6-cm) diameter pipe that is supported from an overpass. The toll antenna is centered over the traffic lane and is mounted approximately 15 to 18 feet (4.5 to 5.5 m) above the road surface. Figure 2-2 illustrates a typical overpass mount.

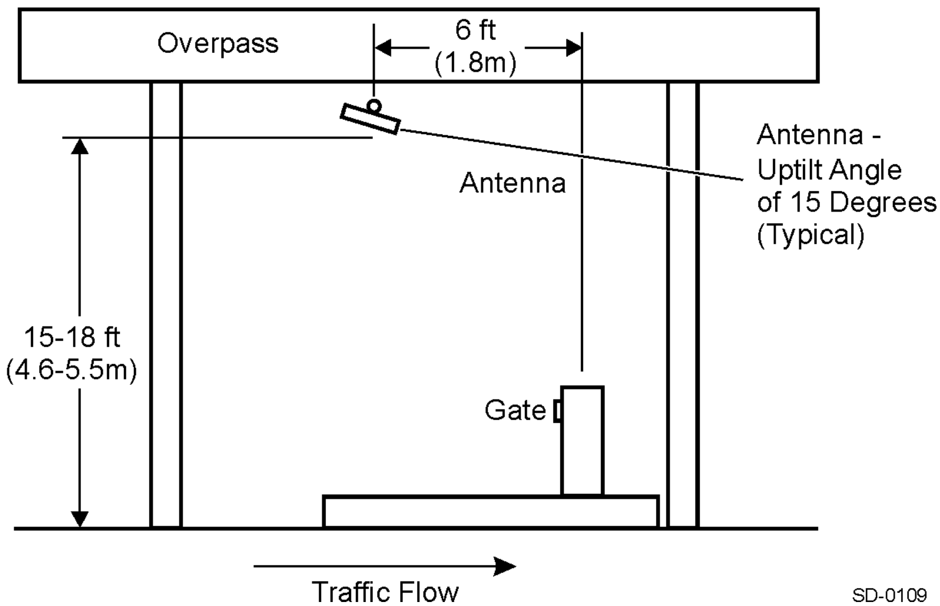

Figure 2-2 Overpass Mount

Cantilever Arm Mount

For the cantilever arm mount, the Orion Reader is installed with the host computer or lane controller. The toll antenna is attached to a 2- to 3-inch (5.0- to 7.6-cm) diameter pipe at the end of the cantilever arm. The toll antenna is centered over the traffic lane and is mounted approximately 15 to 18 feet (4.5 to 5.5 m) above the road surface. Figure 2-3 illustrates a typical laneside cantilever arm mount with an antenna.

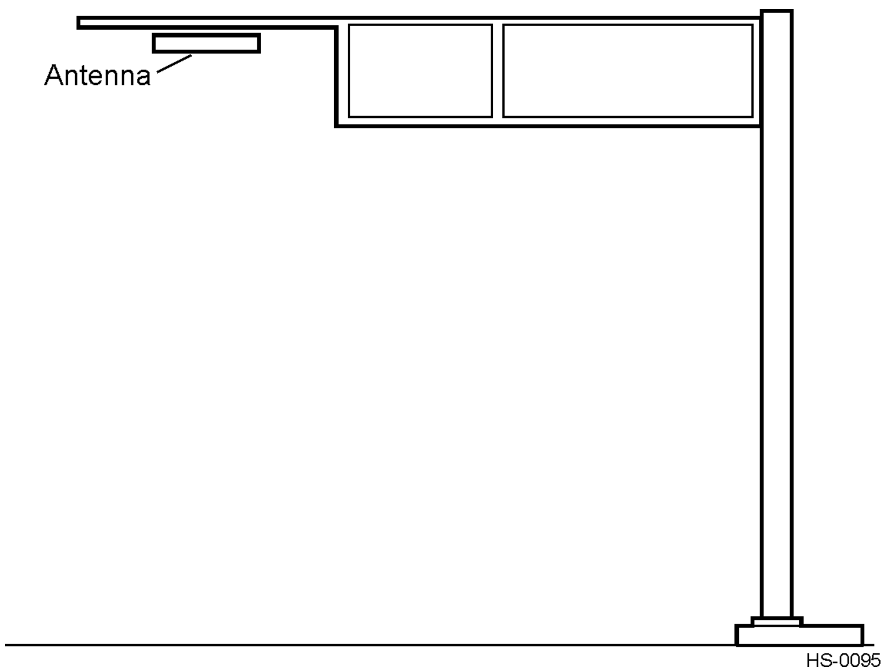

Figure 2-3 Cantilever Arm Mount

Open Road Tolling Gantry

For typical ORT gantry installations, the Orion Reader may be installed in a laneside equipment cabinet. The toll antenna is attached to a 2- to 3-inch (5.0- to 7.6-cm) diameter pipe mounted approximately 15 to 18 feet (4.5 to 5.5 m) above the road surface. For ORT applications, one set of toll antennas may be centered over the lane and a second set of toll antennas may be centered over the stripes dividing the lanes (Figure 2-4). This configuration ensures that vehicle traffic, traveling inside and outside the lanes, is covered by the toll antennas.

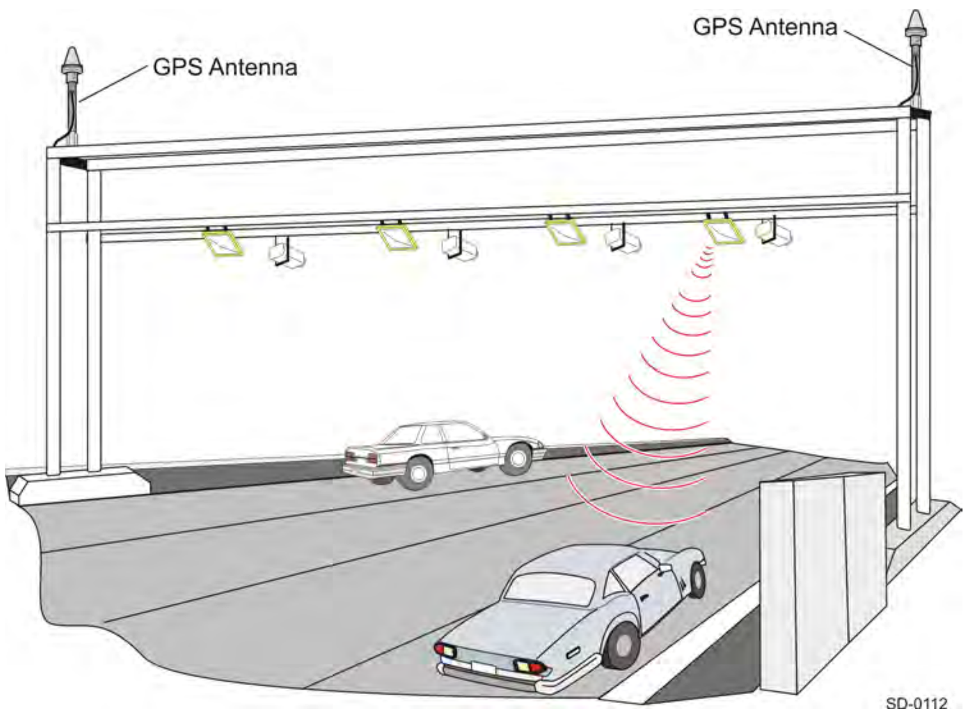

Figure 2-4 ORT Gantry Mount

3

Installing the Orion Reader

Chapter 3

Installing the Orion Reader

This chapter describes the Orion® Reader system and provides instructions for installing the Orion Reader system.

Orion Reader Components

Star Systems' Orion Reader is an integrated, multiprotocol 915-MHz radio frequency identification (RFID) reader system that includes an RF transceiver board and processor in a single assembly.

The Orion Reader is suitable for a wide variety of automatic vehicle identification applications, including airport ground transportation management systems, parking, secure access, and rail applications.

The Orion Reader can be installed in a cabinet with a host computer or onsite lane controller, or alone in a NEMA enclosure.

The Orion Reader transmits and receives signals through a single antenna.

The Orion Reader is capable of reading tags of any of the following protocols in a given installation:

- ISO 18000-6C (EPC)
- California Title 21
- Interagency Group (IAG)
- CVISN (ASTM Draft 6)

Caution

Where multiple tag protocols are used in the same installation, an Orion Reader operating in Mode 88 is capable of reading any combination of the protocols; however, no more than two protocols should be used for high speed operations.

Orion Reader Features

The following sections describe the Orion Reader features and list the specifications for the external connections and performance indicators located in the Orion Reader housing.

External Device Connectors

This section lists the Orion Reader connectors. Figure 3-1 shows the Orion Reader connector and indicator locations. Table 3-1 shows the pin assignments for the Power, Sync, and I/O Connector.

Figure 3-1 Connector Locations on the Orion Reader

Table 3-1 Power, Sync, and I/O Connector Pin Assignments (DB15)

Wire	Pin No
Power +24V	5
Power +24V	6

Table 3-1 Power, Sync, and I/O Connector Pin Assignments (DB15)

Wire	Pin No
Power Return	7
Power Return	8
Sync-	3
Sync+	4
I/O 1	1
I/O 1 Return	15
I/O 2	14
I/O 2 Return	13
I/O 3	12
I/O 3 Return	11
I/O 4	10
I/O 4 Return	9

Power Supply

The Orion Reader requires 19V DC to 30V DC or 19V AC to 27V AC RMS power supply. Table 3-2 lists the external power connector specifications. Star Systems offers a Class B transformer accessory kit (part number 76-6000-001) for sites where either 110V AC or 220V AC is available. Accessory kit information is shown in Table 3-3.

Selecting a Power Supply

Table 3-2 Orion Reader External Power Connector Specifications

Connector Type	DB15 Connector
Wire Gauge	12 – 22 AWG **Note** Installer must consider the wire resistance versus overall length with respect to the Orion Reader's specified voltage range

Table 3-2 Orion Reader External Power Connector Specifications (continued)

Input Supply Voltage	19V to 30V DC 19V to 27V AC RMS **Note** See Figure 3-2 for AC power source wiring and Figure 3-3 for DC power source wiring.
Input Power	DC or AC: 40 watts maximum
In-Rush Current	8 amps maximum, ≤25 milliseconds
Polarity	Power supply is polarity independent

You should consider the following factors when selecting a power supply.

- Input voltage: 19V to 30V DC, or 19V to 27V AC RMS @47 to 63 Hz
- Operating temperature of the power supply and the power cable
- Power cord gauge and length. Star Systems recommends that you use 12 to 22 AWG cable for the power cord.

Table 3-3 Orion Power Supply Accessory Kit

Part Number	Description
76-6000-001	**110V AC or 220V AC to 24 V AC Class B transformer**

CAUTION
Wire gauge depends on wire resistance versus overall wire length with respect to the Orion Reader’s specified voltage range and power rating.

Connecting the Orion Reader to Power Supply

Star Systems strongly recommends that you connect the Orion Reader to the power supply as shown in Figure 3-2.

Caution
Loosen mounting screws on power supply connector before removing plug.

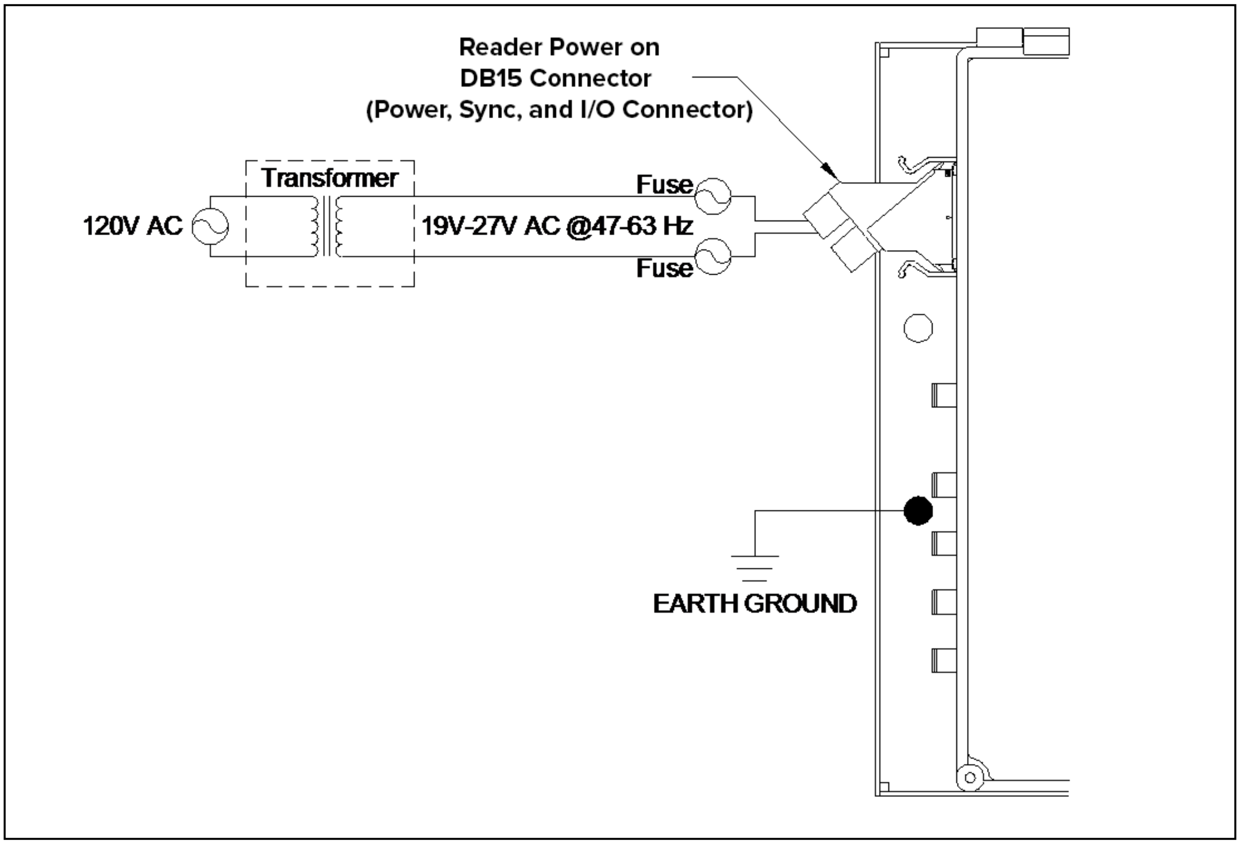

Figure 3-2 Connecting Reader to Power Supply

Sync

At installations where cross-lane interference can occur and frequency management is not sufficient to solve the problem, you may need to use Sync. By using the Sync function in the Orion Readers, the readers operate only during interleaved time periods.

Note: *In sites where installing Sync cabling is not an option, you can use the global positioning system (GPS) timing alternative. See Appendix D, "Orion Reader Options," for more information.*

The Orion Reader can support multiple lanes using Sync cabling. 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 Sync, the interface connection for Sync, can be provided to all the readers in a plaza before or during installation by connecting a pair of wires to the Sync pins on DB15 connector of each reader as shown in Figure 3-3.

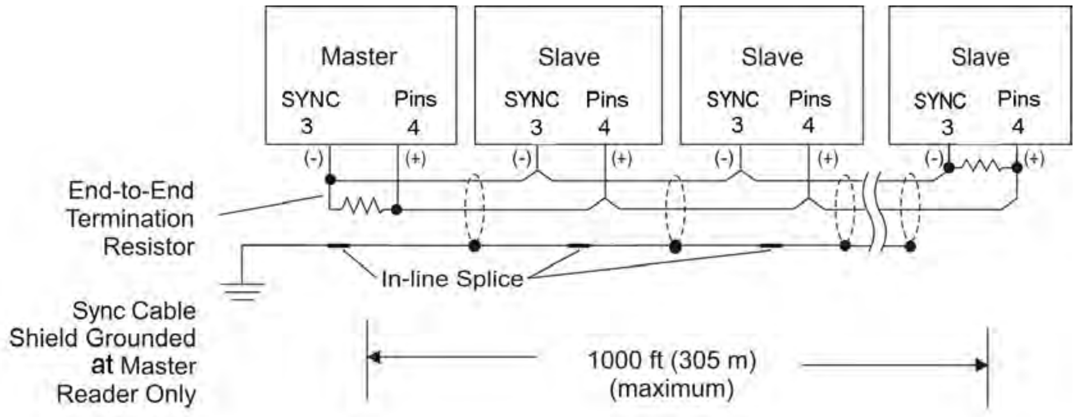

Figure 3-3 Sync Configuration Example

Star Systems recommends Belden 89182 (150 Ω impedance), which is a single twisted-pair shielded cable rated for outdoor use, or 8132 (120 Ω impedance), which is a double twisted-pair shielded cable that must be installed in conduit. The Belden 8132 cable has an extra pair that is not used. Using these low-loss, low-capacitance twisted-pair cable, a distance of 1000 feet (305 m) has been obtained. Cables with lower capacitance can be used to run the Sync cables for longer distances while maintaining signal integrity. This maximum distance may be slightly longer or shorter depending on the cable used.

Because the Sync signals are based on RS–485 signals, you can extend the length of the Sync bus by using RS–485 repeaters or by using fiber with converters. The standard Sync interconnect is provided via pins 3 and 4 of the DB15 connector (Table 3-1).

External Digital Input/Output Connector

The External Digital Input/Output Assembly is used to interface the Orion Reader with external inputs and outputs. Inputs can be devices such as light curtains or loops, and outputs can be devices such as gates or lights. (Connector is P/N 33357-01). This option is described in detail in Appendix D, “Orion Reader Options.” The I/O Board is pre-installed in the Orion Reader but I/O modules must be purchased separately.

Connecting to Antenna

Connect the Orion Reader to a toll antenna using the single low-loss coaxial cable. Figure 3-4 shows the antenna connectors on the Orion Reader enclosure. For a single-antenna installation, where the transmit and receive data is communicated over a single cable, use the connector labeled ANT1.

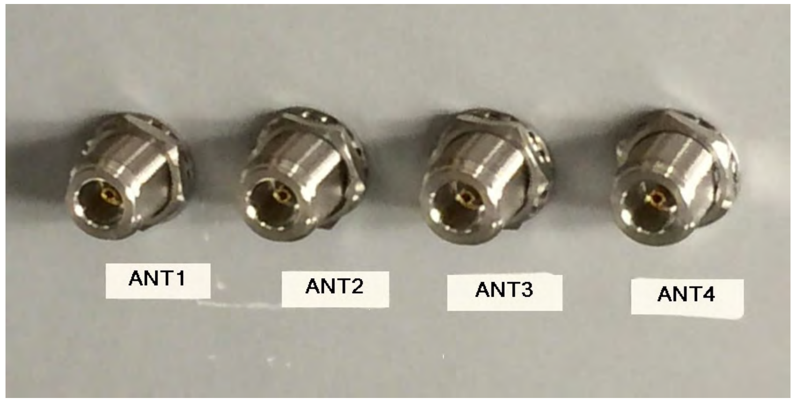

Figure 3-4 Antenna Connector Locations

Table 3-4 lists the RF antenna connector parameters.

Table 3-4 RF Antenna Connector Specifications

Connector Type	N-Type Female
Output Power	Up to 2 watts

Connecting to Host Computer

You can use TCP commands to operate the Orion Reader and communicate with the host computer via the Ethernet port.

For TCP operation, the Orion Reader communicates with the host computer via the Ethernet port. A single Orion Reader can be connected directly to a single host, which is known as point-to-point connection. Multiple Orion Readers also can be connected to a single host on a private local area network, or LAN.

In a multiple reader-to-host configuration, Star Systems recommends that the setup has a dedicated network interface card (NIC) on the host that is then connected to an Ethernet switch into which **only** the Orion Readers are connected.

Note: *Do not connect any other device to that switch.*

In this configuration the host would have another NIC that is connected to the main network infrastructure to interact with the remainder of the toll system components.

The Ethernet switch should support 100 Mb/s full duplex operation to be fully compatible with the Orion Reader.

Ethernet Connector for TCP Communications

The Orion Reader communicates with a host via an Ethernet communications protocol. This connection requires an RJ–45 connector. If you connect the Orion Reader directly to a host personal computer (PC) then you need a crossover cable. Star Systems recommends that you use Belden 7929A Category 5e twisted-pair cable for Ethernet connections. Table 3-5 lists the Ethernet connector pin assignments.

Table 3-5 Ethernet Connector

Pin	Signal	Description	568A[a]	568B[a]
1	TX+	Output Differential Transmit Data (+)	White w/ green stripe	White w/ orange stripe
2	TX-	Output Differential Transmit Data (-)	Green w/ white stripe or solid green	Orange w/ white stripe or solid orange
3	RX+	Input Differential Receive Data (+)	White w/ orange stripe	White w/ green stripe
4	Not connected	N/A	Blue w/ white stripe or solid blue	Blue w/ white stripe or solid blue
5	Not connected	N/A	White w/ blue stripe	White w/ blue stripe
6	RX-	Input Differential Receive Data (-)	Orange w/ white stripe or solid orange	Green w/ white stripe or solid green
7	Not connected	N/A	White w/ brown stripe or solid brown	White w/ brown stripe
8	Not connected	N/A	Brown w/ white stripe or solid brown	Brown w/ white stripe or solid brown

a. 568A and 568B are Ethernet cable designations.

Connecting to Additional System Components

Diagnostic Communications Connector (COM2)

The Orion Reader communicates diagnostic data via a serial communications protocol (Table 3-6 and Table 3-7). The diagnostic port can be used to display the operating system boot sequence, diagnostic, and error messages. By using the version command (“Diagnostic Commands” on page 9-8), you can display data about the configuration of the Orion Reader including its Internet Protocol (IP) address. Refer to “Communicating Via Diagnostic Port (COM2)” on page 9-4 for complete diagnostic information.

Table 3-6 RS–232 Serial Specifications

Connector Type	9-pin D-subminiature plug
Protocol	RS–232
Baud	9600

Table 3-6 RS–232 Serial Specifications (continued)

Bits	8
Parity	None
Stop Bits	1
Flow Control	None

Note: *If you connect the Orion Reader COM2 port directly to a PC's serial port, you must use a null-modem serial cable or adapter.*

Table 3-7 Diagnostic 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)

Diagnostic Test Port Internal Connector

The Diagnostic Test Port Internal Connector is a 40-pin card-edge connector that should be accessed by Star Systems factory-trained personnel only.

Global Positioning System Connector

The Global Positioning System (GPS) timing option is used when traditional Sync cabling linking readers is not feasible. This option is described in detail in Appendix D, "Orion Reader Options."

Installing the Reader System Components

This section contains instructions for installing each component of the reader system. You will need the following tools to install the system.

- Standard tools, such as Phillips and slotted screwdrivers, and wrenches

- Hydraulic lift or ladder for installing antennas
- Torque wrench for securing antenna connections
- Inclinometer or angle finder for measuring antenna angles
- Multimeter, Fluke 87 or equivalent for measuring electrical signals

Note: *Chapter 9, "Configuring the Lane," lists additional equipment required for configuring lanes to optimize system performance.*

Mounting the Toll Antenna in an Overhead Location

For most overhead installations, the toll antenna is mounted on a 2- to 3-inch (5.0- to 7.6-cm) diameter pipe to accommodate various angles for lane configuring. Star Systems provides a mounting kit that includes the following hardware:

- Antenna
- Two U-bolts with hex nuts
- Two brackets
- Spacers
- Lock washers
- Fender washers (may not be included in your accessory kit)
- One 1.0-inch (2.5 cm) length of 1.1-inch (2.8-cm) diameter heat-shrink tubing

Figure 3-5 shows the standard way to mount and connect a toll antenna.

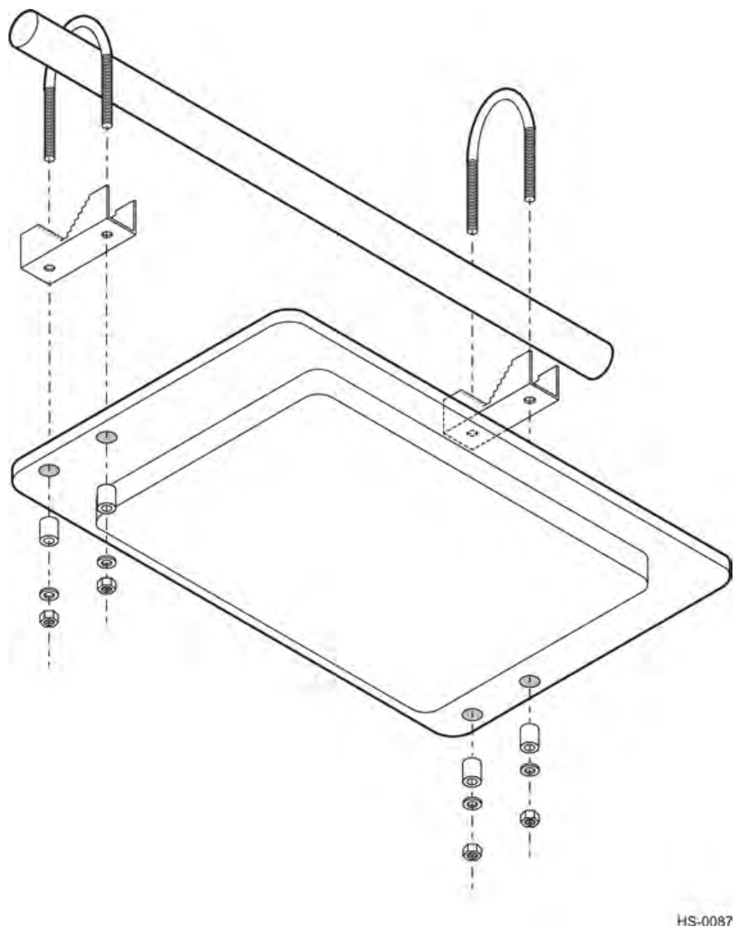

Figure 3-5 Toll Antenna Mounting and Connections

CAUTION

Caution

When installing the toll antenna use only the mounting hardware provided. Do not use oversized washers to secure the plastic radome to the bracket. This practice can weaken the radome material.

To install the toll antenna

1. Place the toll antenna below the mounting pipe and insert a U-bolt around the pole and down through the bracket on the side of the antenna closest to the center of the lane. This antenna should be mounted toward the driver side of the traffic lane. Place a spacer, lock washer, and nut over each end of the U-bolt, but do not tighten the nuts. Repeat for the other U-bolt.

2. Rotate the antenna up and toward oncoming traffic. Rotate up 15° from horizontal for a lane. Use an inclinometer or angle finder to check the angle.

3. Tighten nuts with a torque wrench to 50 ft-lb (68 N-m).

4. Slide the shrink tubing over the coaxial cable, but do not heat it.
5. Connect the coaxial cable to the antenna and to the appropriate connector on the Orion Reader. Leave the shrink tubing loose until you have finished configuring the lane.

Starting the Orion Reader

Once the system components are in place, you need to connect them to the Orion Reader, and power up and start the Orion Reader.

To start the Orion Reader

1. Connect coaxial cable from toll antenna to ANT 1 port on Orion Reader for a single antenna configuration. Antenna ports 2-4 may also be used for systems requiring multiple antennas.
2. Connect host PC or lane controller to Orion Reader using the Ethernet TCP communications port (see Table 3-5.)
3. If using Sync to operate multiple lanes with Orion Reader, connect Sync cable to pins 3 and 4 of the Power, Sync, and I/O Connector on the Orion Reader.
4. Connect other options as required. See Appendix D, “Orion Reader Options” for detailed installation and operation information.
5. Connect the Orion Reader to 19V to 30V DC or 19V to 27V AC RMS @47-63 Hz power supply. See Figure 3-2 and Figure 3-3 for recommended wiring directions.

Resetting the Orion Reader

If you need to restart the Orion Reader, the only information that is maintained by the reader is the reader IP address, buffered tag data, and error logs. All other information must be resent or reconfigured before the Orion Reader can be operated again.

4

General Software Information

Chapter 4

General Software Information

This chapter provides transmission control protocol (TCP) information for the Orion® Reader.

Software Information

This chapter presents various software-related topics arranged in alphabetical order by subject. In addition to this chapter, refer to Chapter 5, “Communication Protocols,” and Chapter 6, “Configuring and Operating the Orion Reader Using TCP Commands,” for more information.

The Orion Reader operates using TCP commands. This chapter presents TCP command information.

TCP Command and Response Conventions

The Orion Reader implements TCP command requests, data acknowledgments, command responses, asynchronous responses, and unsolicited status messages as required for configuration and operation. The messages are listed in Table 4-1.

Table 4-1 TCP Command Messages

Message	Description
Command request	The host initiates and uses these messages to request the Orion Reader to perform specific actions.
Data acknowledge	The Orion Reader initiates and uses these messages to signal the reception of command request messages received from the host. Additionally, the host initiates and uses data acknowledge messages to signal the receipt of command response, asynchronous response, and unsolicited status messages from the Orion Reader.
Command response	The Orion Reader initiates these messages in response to specific command request messages received from the host.
Asynchronous response	The Orion Reader optionally initiates these messages in response to specific command request messages received from the host.
Unsolicited status	The Orion Reader initiates and uses these messages to inform the host about specific status conditions in the Orion Reader.

Note: *Throughout this chapter, host or host system refers to a host personal computer (PC) or lane controller.*

Lane Controller Heartbeat Controls

After the Lane Controller or host connects to the Orion Reader via TCP/IP, the Orion Reader sends the LC Heartbeat message (unsolicited OK status message format) to the Lane Controller or host every 10 seconds.

On receiving the LC Heartbeat message from the Orion Reader, the Lane Controller or host sends the appropriate data acknowledge message to the Orion Reader. If the Lane Controller or host does not acknowledge this message after three times, the Orion Reader closes the connection. Figure 4-1 shows the Orion Reader LC heartbeat controls in detail.

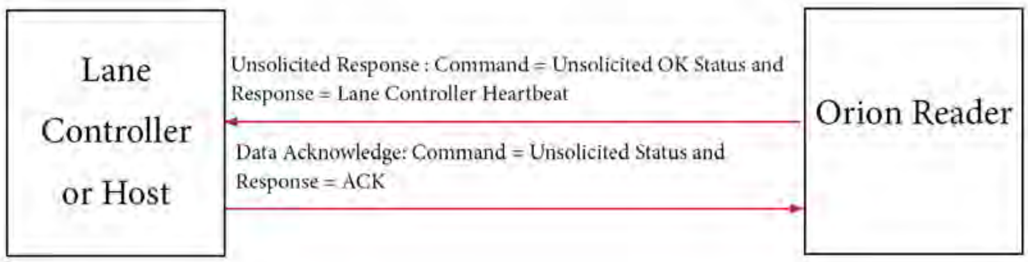

Figure 4-1 Orion Reader LC Heartbeat Controls

Sequence Number Controls

The Orion Reader implements message sequence numbers (MSN) and command sequence numbers (CSN) in all of the message types (e.g., command request, data acknowledge, command response, asynchronous response, and unsolicited status). All transmitted messages, except for the data acknowledge message, increment the MSN and CSN. The host and the Orion Reader must implement independent transmit and receive counters for both the MSNs and the CSNs. The transmit counters are used in generating 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 was missed.

Note: *CSNs are checked and generated by the reader for the System Interface Command Group only. For all other command groups the reader ignores host-generated CSNs, and the reader does not implement CSNs on any reader-generated message. The host should ignore CSNs on all messages from the reader for all command groups except for the System Interface Command Group.*

With the exception of received data acknowledge messages, the Orion Reader performs automatic MSN and CSN resynchronizations on all received messages that are out-of-sequence. Upon receiving an out-of-sequence MSN, the Orion Reader sets the receive MSN counter to the out-of-sequence MSN plus one. Similarly, upon receiving an out-of-sequence CSN, the Orion Reader sets the receive CSN counter to the out-of-sequence CSN plus one.

The host MSNs independently track the number of messages sent to the Orion Reader and the Orion Reader MSNs independently track the number of messages sent to the host. These MSNs are used on the receiving end to determine if a message has been missed.

The host CSNs for each command group independently track the number of command request messages sent to the Orion Reader. The Orion Reader CSNs for each command group independently track the number of command response, asynchronous response, and unsolicited status messages sent to the host. These CSNs are used on the receiving end to determine if the appropriate message as specified above has been missed.

The host and the Orion Reader use software communication sequence number controls as defined in the following paragraphs.

The Orion Reader sends data acknowledge, command response, asynchronous response, and unsolicited status messages to the host with MSNs starting at zero and incremented by one for each message sent, except for the data acknowledge message. Additionally, the CSNs for each command group start at zero and are incremented by one for each command response, asynchronous response, and unsolicited status message sent. Figure 4-2 and Figure 4-3 provide details on the sequence number controls.

The host receives data acknowledge, command response, asynchronous response, and unsolicited status messages from the Orion Reader and checks that the MSNs and CSNs are correct for all received message types except for the data acknowledge message.

The Orion Reader receives command request messages and data acknowledge messages from the host and checks that the MSNs and CSNs are correct for all command request messages received. The Orion Reader performs automatic MSN and CSN resynchronizations on all received command request messages that are out-of-sequence. Currently, the CSN resynchronizations are not fully supported.

If the Orion Reader detects either a message sequence error or command sequence error, the Orion Reader sends the appropriate error message to the host that includes the expected and received sequence numbers and then continues processing the received message. Currently the message sequence error and command sequence error messages are not fully supported.

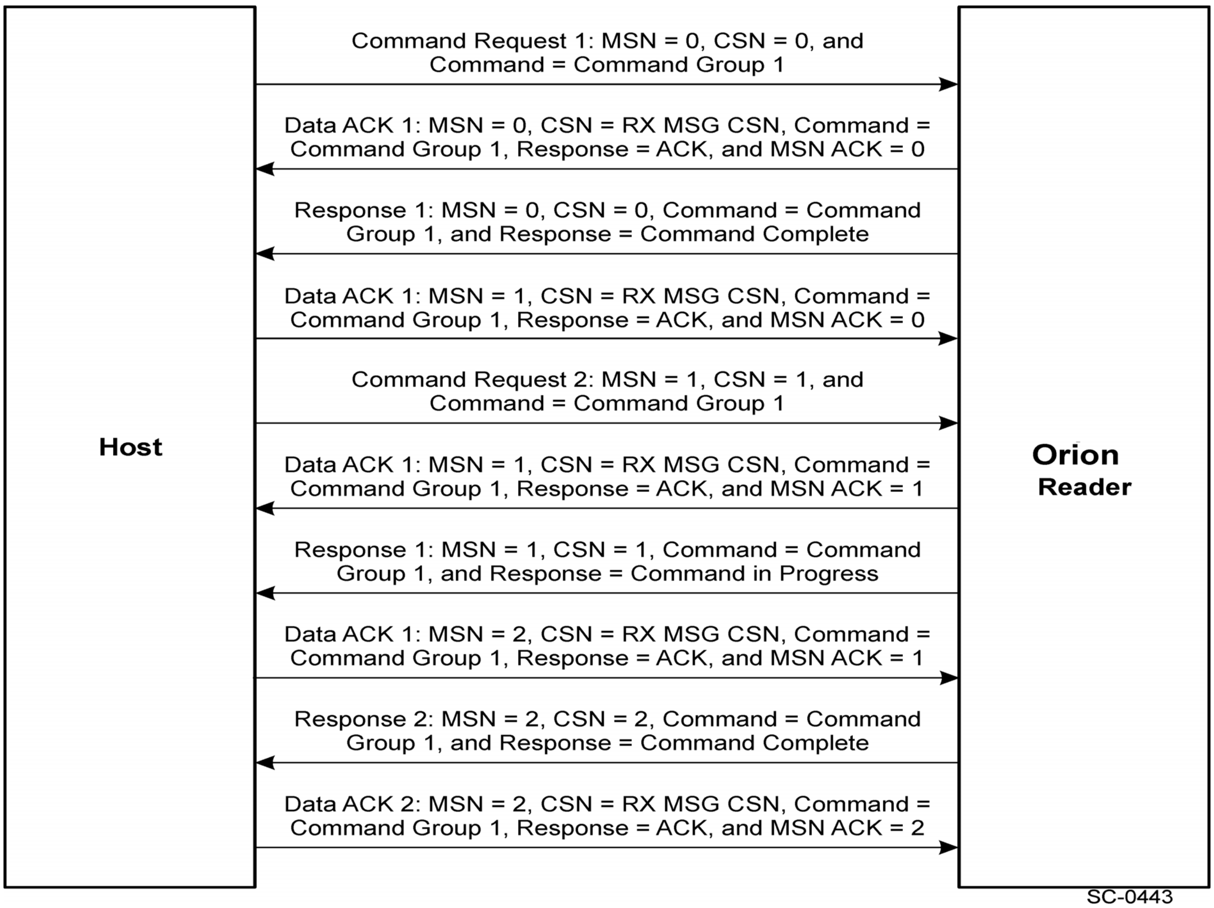

Figure 4-2 Orion Reader Sequence Number Controls

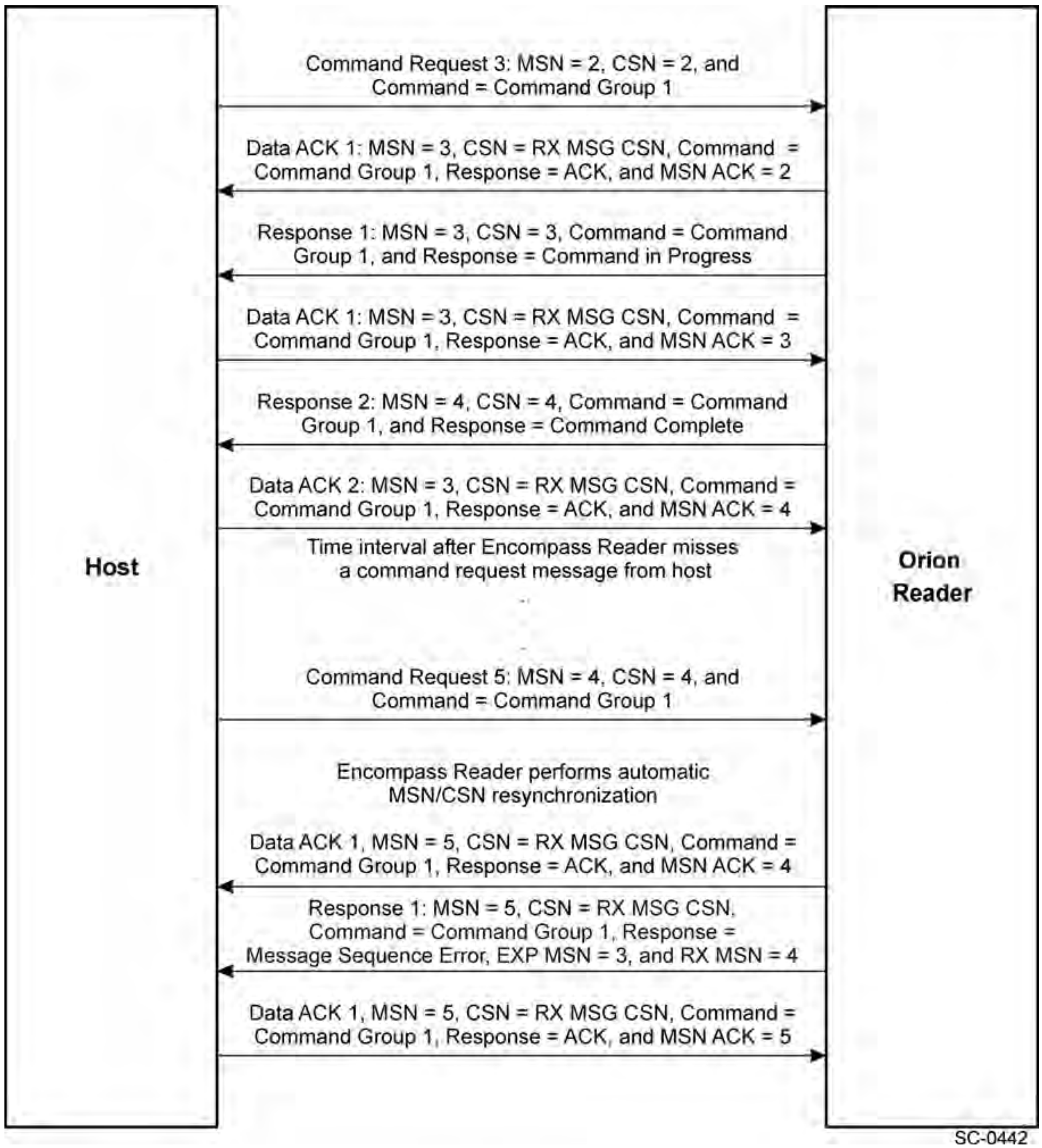

Figure 4-3 Orion Reader Sequence Number Controls (cont'd.)

Data Acknowledge Controls

The Orion Reader initiates and uses data acknowledge messages to signal the reception of command request messages received from the host. Additionally, the host initiates and uses data acknowledge messages to signal the receipt of command response, asynchronous response, and unsolicited status messages from the Orion Reader.

After receiving command request messages from the host, the Orion Reader sends data acknowledge, command response, asynchronous response, and unsolicited status messages to the host.

After receiving command response, asynchronous response, and unsolicited status messages from the Orion Reader, the host sends data acknowledge messages to the Orion Reader.

Use of Data Acknowledge Controls by Host and Orion Reader

The host and the Orion Reader use software communication data acknowledge controls as defined here.

- The host sends command request messages to the Orion Reader.
- The host receives data acknowledge messages, or a data acknowledge time-out occurs for each command request message sent to the Orion Reader.
- The host receives command response, asynchronous response, and unsolicited status messages from the Orion Reader, and sends data acknowledge messages for these message types.
- The Orion Reader receives command request messages from the host and sends data acknowledge, command response, asynchronous response, and unsolicited status messages to the host.
- The Orion Reader receives data acknowledge messages, or a data acknowledge time-out occurs for each command response, asynchronous response, and unsolicited status messages sent to the host.

For more details on the Orion Reader Data Acknowledge Controls, see Figure 4-4.

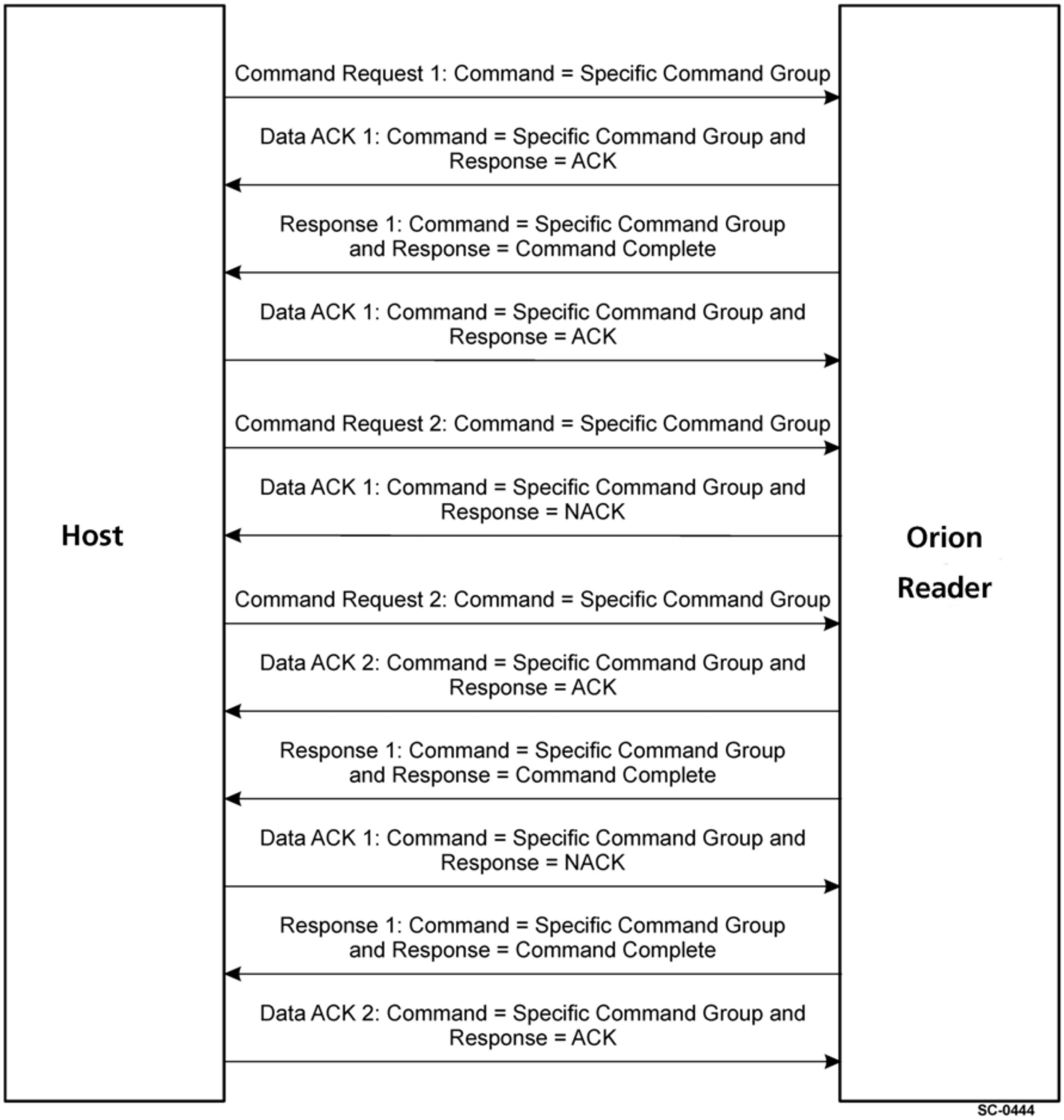

Figure 4-4 Orion Reader Data Acknowledge Controls

5

Communication Protocols

Chapter 5

Communication Protocols

This chapter describes the transmission control protocol (TCP) communications via Ethernet for the Orion® Reader.

Communication Between Orion Reader and Host

The Orion Reader can communicate with a host using TCP/IP Fast Ethernet communications protocol.

TCP/IP Fast Ethernet Connection

The Ethernet connector is an RJ-45 jack and uses a 100-base T interface. If the Orion Reader is connected directly to the host system then a crossover cable is required. Table 5-1 lists the Ethernet connector pin assignments.

Table 5-1 Ethernet Connector

Pin	Signal	Description	568A[a]	568B[a]
1	TX+	Output Differential Transmit Data (+)	White w/ green stripe	White w/ orange stripe
2	TX-	Output Differential Transmit Data (-)	Green w/ white stripe or solid green	Orange w/ white stripe or solid orange
3	RX+	Input Differential Receive Data (+)	White w/ orange stripe	White w/ green stripe
4	Not connected	N/A	Blue w/ white stripe or solid blue	Blue w/ white stripe or solid blue
5	Not connected	N/A	White w/ blue stripe	White w/ blue stripe
6	RX-	Input Differential Receive Data (-)	Orange w/ white stripe or solid orange	Green w/ white stripe or solid green
7	Not connected	N/A	White w/ brown stripe or solid brown	White w/ brown stripe
8	Not connected	N/A	Brown w/ white stripe or solid brown	Brown w/ white stripe or solid brown

a. 568A and 568B are Ethernet cable designations.

TCP/IP Fast Ethernet Communications Protocol

The TCP/IP Fast Ethernet communications protocol implements the TCP/IP Fast Ethernet protocol. Table 5-2 lists the message parts.

Table 5-2 TCP/IP Communications Message Field Descriptions

Field	Length (bytes)	Description
LENGTH	2	Two-byte field specifying the number of bytes in the message.
MSN	1	One-byte field specifying the message sequence number of the message. See the “Sequence Number Controls” section in Chapter 4 for details.
CMD	2	Two-byte field specifying the system command. See the “Command Request Message” for details.
CSN	1	One-byte field specifying the command sequence number of the message. See the “Sequence Number Controls” section in Chapter 4 for details.
OPTIONAL DATA PAYLOAD	Varies	Optional data payload field varying in length from 0 to 64 bytes or 0 to 62 bytes and specifies the data transmitted in message or data received in message.
CRC	2	Two-byte field specifying the cyclic redundancy check of the message.
RESP	2	Field specifying the system response and is typically two bytes. See the response sections for details.
MSN ACK	1	One-byte field specifying the MSN of message being acknowledged.
STATUS	2	Field specifying the system status and is typically two bytes.

Not all fields are used in each command message. The following sections provide specific message descriptions.

Command Request Message

The host sends command request messages to the Orion Reader as required for system operation. The host and Orion Reader use the TCP/IP Fast Ethernet communications command request message shown in Figure 5-1. Refer to Table 5-2 for message field descriptions.

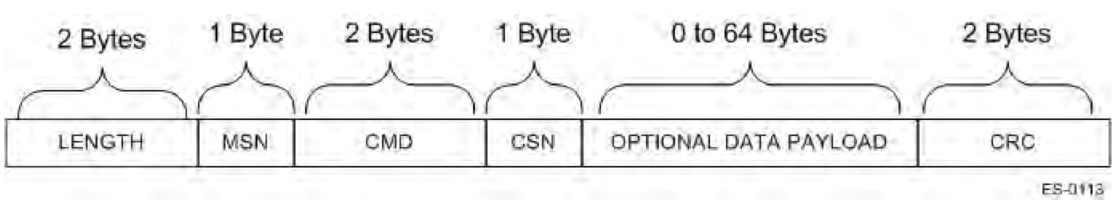

Figure 5-1 Command Request Message Fields

Data Acknowledge Message

The host returns data acknowledge messages after receiving command response messages, asynchronous response messages, and unsolicited status messages. The host and Orion Reader use the TCP/IP Fast Ethernet communications data acknowledge message shown in Figure 5-2. Refer to Table 5-2 for message field descriptions.

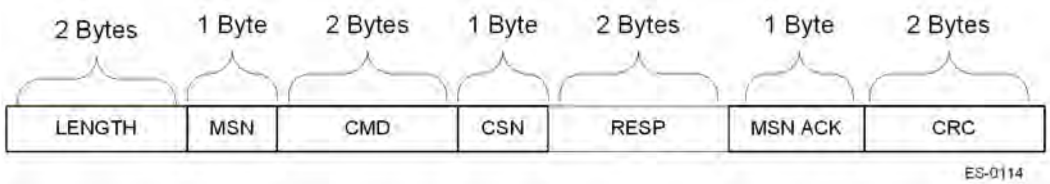

Figure 5-2 Data Acknowledge Message Fields

Command Response Message

After receiving command request messages from the host, the Orion Reader returns command response messages. The host and Orion Reader use the TCP/IP Fast Ethernet communications command response message shown in Figure 5-3. Refer to Table 5-2 for message field descriptions.

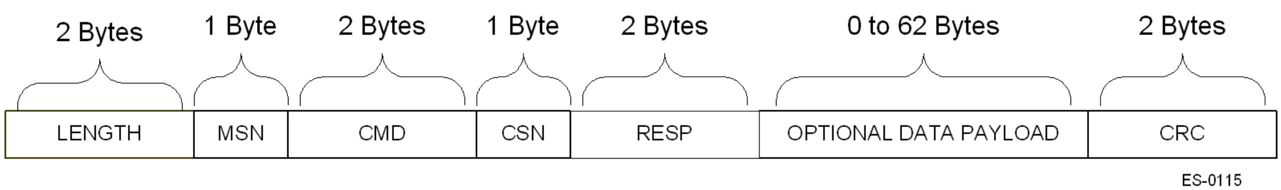

Figure 5-3 Command Response Message Fields

Asynchronous Response Message

After receiving command request messages from the host, the Orion Reader optionally returns asynchronous response messages. The host and Orion Reader use the TCP/IP Fast Ethernet communications asynchronous response message shown in . Refer to Table 5-2 for message field descriptions.

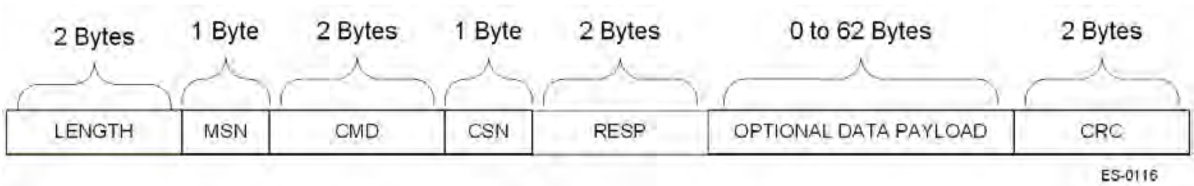

Figure 5-4 Asynchronous Response Message Fields

Unsolicited Status Message

The Orion Reader sends unsolicited status messages as required for system operation. The host and Orion Reader use the TCP/IP Fast Ethernet communications unsolicited status message shown in Figure 5-5. Refer to Table 5-2 for message field descriptions.

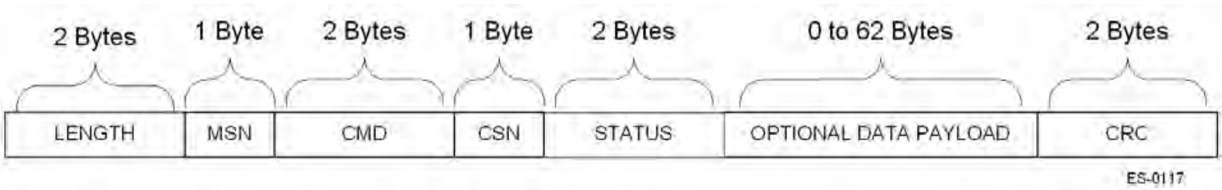

Figure 5-5 Unsolicited Status Message Fields

6

Configuring and Operating the Orion Reader Using TCP Commands

Chapter 6

Configuring and Operating the Orion Reader Using TCP Commands

This chapter describes the Orion® Reader mode and commands that are used to configure and operate the reader. This chapter also contains system commands and responses that are needed to develop host software for the TCP command set.

Chapter Organization

The Orion Reader is controlled through mode settings, which configure the reader for specific applications. The Orion Reader starts in Mode 0, Stop Mode, and must be changed to another mode as needed for a specific application.

This chapter first lists the operating mode to show what TCP-based command operations are available with this Orion Reader application.

The remainder of the chapter provides a complete listing of system commands and responses that are required to develop host interface software for configuring the Orion Reader. The system commands are divided into system command groups:

"System Interface Command Group Commands (8000H)" on page 6-13

"Digital I/O Command Group Commands (4000H)" on page 6-37

"RF Transceiver Command Group Commands (2000H)" on page 6-77

"Tag Transaction Configuration Command Group Commands (1000H)" on page 6-95

"Mode Command Group Commands (0400H)" on page 6-114

"Diagnostic Command Group Commands (0200H)" on page 6-127

Information for each of these command groups is grouped in the following manner:

- One table that lists the system command group commands
- One table that lists the system command group responses
- A series of tables that present system command group response data
- A full set of commands that are used to set an Orion Reader function and obtain data resulting from that function within the specific system command group

Operating the Orion Reader in Mode 88

An Orion Reader operating in Mode 88 can read any combination of tag protocols (ISO 18000-6C (EPC), Title 21, IAG or CVISN (ASTM Draft 6)) by using the Ethernet port for transmission control protocol communications.

Caution
Where multiple tag protocols are used in the same installation, an Orion Reader operating in Mode 88 is capable of reading any combination of the protocols; however, no more than two protocols should be used for high speed operations.

Working with Mode 88

The Orion Reader powers up in Mode 0, Stop Mode. You must issue the commands (Table 6-1), via the host computer, to configure the reader.

Table 6-1 Commands Used to Configure Orion Reader in Mode 88

Sequence #	Command	Definition
1	Set Protocol(s)[a]	This command sets the protocols needed for a specific application. The user can choose to set any number of protocols in any combination.
2	Set Secondary Tag Sequence[a]	This command specifies which state machine to run by selecting the Title 21 tag protocol. The user must also set the acknowledge (Ack) for Title 21, as well as the antenna number.
3	Reset[a]	This command resets the Orion Reader so that the previously entered command(s) can take effect.
	The following commands are required to configure Mode 88	
4	If running a configuration script, re-execute script at this time.	Ensure that any changes made to protocols and secondary tag sequences are reflected in the script file. Set the reader to Stop Mode before executing the script file.
5	Set Frequency in MHz	Sets the Orion Reader uplink and downlink frequencies. Reader must be in Stop Mode.
6	Set Master/Slave	This command specifies which Orion Reader is to be designated as master, setting all other readers as slaves.
8	Set RF Attenuation	This command sets the attenuation for a specific tag protocol.
9	Set Retry Count	This command sets the number of times the Orion Reader attempts to retry tag read. Some modes require that this command is set more than once because of multiple tag protocols. Note: the retry count for Title 21 is fixed.

Table 6-1 Commands Used to Configure Orion Reader in Mode 88

Sequence #	Command	Definition
10	Set Data Detect	This command sets the data detect value for a specific tag protocol: ISO 18000-6C (EPC), Title 21, IAG, or CVISN. This value is an independent detection threshold level for backscatter protocols of up to 20dB. Data Detect can be incremented or decremented in 1dB steps through the command interface port. The threshold level for CVISN is 15 dB.
11	Set Seen Count and Uniqueness Count	This command sets a counter that records the number of times a tag is read after the system had finished a complete transaction.
13	Set Time and Date	This command sets the Orion Reader real-time clock to the time and date specified in the request data.
14	Set Line Loss	This command sets the Orion Reader system line loss value from 0 to 3 decibels (dB) in 1-dB increments via the command interface port. This command must be set only after RF attenuation is set.
15	Set Manual Antenna Channel	This command sets the antenna channel.
16	Set Antenna Multiplexer Configuration Data	This command selects the antenna multiplexer mode.
18	Set IAG Slot	This command sets the IAG trigger pulse slot, which allows multiple readers to have non-overlapping IAG time slots.
19	Append Time-stamp	This command is optional.
21	Set Mode	This command sets the Orion Reader to Mode 88.

Set Protocol(s), Set Secondary Tag Sequence, and Reset commands must be transmitted in the order shown in table.

System Commands

This section lists the Orion Reader system commands. Table 6-2 lists the system commands, command groups, and command codes that are used with the Orion Reader.

Table 6-2 System Commands Used in Orion Reader

System Command	Command Code
System Interface (SI) Command Group	8000H
SI Command Group Data Acknowledge	8001H
Reserved	8002H
Reserved	8003H
Reserved	8004H
Reserved	8005H
Reserved	8008H
Reserved	8009H
SI Command Group Unsolicited Status	8010H
SI Command Group Unsolicited Status Data Acknowledge	8011H
Digital I/O Command Group	4000H
Digital I/O Command Group Data Acknowledge	4001H
Reserved	4002H
Reserved	4003H
Reserved	4004H
Reserved	4005H
Reserved	4008H
Reserved	4009H
Digital I/O Command Group Unsolicited Status	4010H
Digital I/O Command Group Unsolicited Status Data Acknowledge	4011H
RF Transceiver (RFT) Command Group	2000H
RFT Command Group Data Acknowledge	2001H

Table 6-2 System Commands Used in Orion Reader

System Command	Command Code
Reserved	2002H
Reserved	2003H
Reserved	2004H
Reserved	2005H
Reserved	2008H
Reserved	2009H
RFT Command Group Unsolicited Status	2010H
RFT Command Group Unsolicited Status Data Acknowledge	2011H
Tag Transaction Configuration (TTC) Command Group	1000H
TTC Command Group Data Acknowledge	1001H
Reserved	1002H
Reserved	1003H
Reserved	1004H
Reserved	1005H
Reserved	1008H
Reserved	1009H
TTC Command Group Unsolicited Status	1010H
TTC Command Group Unsolicited Status Data Acknowledge	1011H
Tag Transaction (TT) Command Group[a]	0800H
TT Command Group Data Acknowledge	0801H
Reserved	0802H
Reserved	0803H
Reserved	0804H
Reserved	0805H
Reserved	0808H

Table 6-2 System Commands Used in Orion Reader

System Command	Command Code
Reserved	0809H
TT Command Group Unsolicited Status	0810H
TT Command Group Unsolicited Status Data Acknowledge	0811H
Mode Command Group	0400H
Mode Command Group Data Acknowledge	0401H
Reserved	0402H
Reserved	0403H
Reserved	0404H
Reserved	0405H
Reserved	0408H
Reserved	0409H
Mode Command Group Unsolicited Status	0410H
Mode Command Group Unsolicited Status Data Acknowledge	0411H
Diagnostic (Diag) Command Group	0200H
Diag Command Group Data Acknowledge	0201H
Reserved	0202H
Reserved	0203H
Reserved	0204H
Reserved	0205H
Reserved	0208H
Reserved	0209H
Diag Command Group Unsolicited Status	0210H
Diag Command Group Unsolicited Status Data Acknowledge	0211H

a. Tag Transaction Command Group commands and responses are discussed in detail in Chapter 8, “Tag Responses.”

Table 6-3 lists the bit definitions for the system commands.

Table 6-3 System Command Bit Definitions

Bit Definition	Description	System Command Bit Code
Bit 15	System Interface Command Group Bit Field	8000H
Bit 14	Digital Input/Output (I/O) Command Group Bit Field	4000H
Bit 13	RF Transceiver Command Group Bit Field	2000H
Bit 12	Tag Transaction Configuration Command Group Bit Field	1000H
Bit 11	Reserved	0800H
Bit 10	Mode Command Group Bit Field	0400H
Bit 9	Diagnostic Command Group Bit Field	0200H
Bit 8	Reserved	0100H
Bit 7	Reserved	0080H
Bit 6	Reserved	0040H
Bit 5	Reserved	0020H
Bit 4	Unsolicited Status Bit Field	0010H
Bit 3	Reserved	0008H
Bit 2	Reserved	0004H
Bit 1	Reserved	0002H
Bit 0	Data Acknowledge Bit Field	0001H

Command Group Bit Fields

The host sets the appropriate command group bit fields in the system command when sending command request and data acknowledge messages to the Orion Reader.

The Orion Reader sets the appropriate command group bit fields in the system command when sending data acknowledge, command response, asynchronous response, and unsolicited status messages to the host.

Unsolicited Status Bit Field

The Orion Reader sets this bit field in the system command when sending unsolicited status messages to the host.

Data Acknowledge Bit Field

The host sets this bit field in the system command when sending data acknowledge messages to the Orion Reader. The Orion Reader sets this bit field in the system command when sending data acknowledge messages to the host.

Responses to System Commands

This section lists the responses to the Orion Reader system commands.

Responses and Codes for System Commands

Table 6-4 lists the response definitions and codes that are applicable to all system commands.

Table 6-4 System Responses

System Response	System Response Code
Synchronous OK Status	88XXH
Asynchronous OK Status	48XXH
Unsolicited OK Status	28XXH
Reserved	84XXH
Reserved	44XXH
Reserved	24XXH
Synchronous Error Status	82XXH
Asynchronous Error Status	42XXH
Unsolicited Error Status	22XXH
Synchronous Control Status	81XXH
Asynchronous Control Status	41XXH
Unsolicited Control Status	21XXH

Table 6-5 lists the bit definitions for the responses.

Table 6-5 System Command Response Bit Definitions

Bit Definition	Description	System Response Bit Code
Bit 15	Synchronous Response Bit Field	8000H
Bit 14	Asynchronous Response Bit Field	4000H
Bit 13	Unsolicited Response Bit Field	2000H
Bit 12	Reserved	1000H
Bit 11	OK Status Bit Field	0800H
Bit 10	Reserved	0400H
Bit 9	Error Status Bit Field	0200H
Bit 8	Control Status Bit Field	0100H
Bit 7	Command Group Command Response Bit 7	0080H
Bit 6	Command Group Command Response Bit 6	0040H
Bit 5	Command Group Command Response Bit 5	0020H
Bit 4	Command Group Command Response Bit 4	0010H
Bit 3	Command Group Command Response Bit 3	0008H
Bit 2	Command Group Command Response Bit 2	0004H
Bit 1	Command Group Command Response Bit 1	0002H
Bit 0	Command Group Command Response Bit 0	0001H

Synchronous Response Bit Field

The host sets this bit field in the system response when sending data acknowledge messages to the Orion Reader. The Orion Reader sets this bit in the system response when sending data acknowledge and command response messages to the host.

Asynchronous Response Bit Field

The Orion Reader sets this bit in the system response when sending asynchronous response messages to the host.

Unsolicited Response Bit Field

The Orion Reader sets this bit in the system response when sending unsolicited status messages to the host.

OK Status Bit Field

The Orion Reader sets this bit field in the system response when the response is an OK status.

Error Status Bit Field

The Orion Reader sets this bit field in the system response when the response is an error status.

Control Status Bit Field

The host sets this bit field in the system response when sending data acknowledge messages to the Orion Reader. The Orion Reader sets this bit field in the system response when sending data acknowledge messages to the host.

Command Group Command Response Bit Fields

The host and the Orion Reader sets these bit fields in the system response to indicate the command group command response. See the individual command group command response sections for details.

System Interface Command Group Commands (8000H)

The following sections detail the individual system command group commands and responses. Refer to page 6-3 for an ordered list of the command groups.

Table 6-6 lists the System Interface Command Group commands that are used in the Orion Reader.

Table 6-6 System Interface Command Group (8000H)

System Interface Commands	Command Code
System Identify	0000H
Set Time and Date	0003H
Get Time and Date	0004H
CPU App Firmware Download	0005H
Reset Reader	0006H
Get Buffered Tag Transaction	0007H
Get Number of Buffered Tag Transactions	0008H
Delete All Buffered Tag Transactions	0009H
Get System Startup Status	000AH
Get Lane Controller Interface Status	000BH
Get System Interface Status	000CH
Reserved	0011H
Reserved	0012H
Reserved	0013H
Reserved	0014H
Reserved	0015H
Set Buffered Tag Transaction Mode	0016H
Get Buffered Tag Transaction Mode	0017H
Set Data Acknowledge Time-out Period	0018H
Get Data Acknowledge Time-out Period	0019H
Set Switch Buffered Tag Transaction Mode Enable	001AH
Get Switch Buffered Tag Transaction Mode Enable	001BH

Table 6-6 System Interface Command Group (8000H)

System Interface Commands	Command Code
FPGA Firmware Download	001CH
CPU Boot Firmware Download	001DH
Reserved	001EH
Get System Serial Number	001FH
Get Firmware Version Numbers	0021H
Reserved	0022H to 0029H
Load Default Operating Parameters	002BH
Set Lane Controller/Host IP Address	0040H
Get Lane Controller/Host IP Address	0041H
Set IP Address and Subnet Mask	0042H
Get IP Address and Subnet Mask	0043H
Get TCP Port Number	0044H

System Interface Command Group Responses

Table 6-7 lists the responses and codes for the system interface command group.

Table 6-7 System Interface Command Group Responses

System Interface Response	Response Code
Synchronous OK Status Responses	88XXH
Reserved	8800H
Reserved	8801H
Asynchronous OK Status Responses	48XXH
Command Complete	4800H
Command In Progress	4801H
Firmware Download Active	4802H
Firmware Download Complete	4803H

Table 6-7 System Interface Command Group Responses

System Interface Response	Response Code
S-Record Processed	4804H
Unsolicited OK Status Responses	28XXH
LC Heartbeat	2811H
Reserved	84XXH
Reserved	44XXH
Reserved	24XXH
Synchronous Error Status Responses	82XXH
Message Length Error	8200H
Message Sequence Error	8201H
Reserved	8202H
Command Group Error	8203H
Reserved	8204H
Reserved	8205H
Reserved	8206H
Reserved	8207H
Reserved	8208H
Data Acknowledge Response Error	8209H
Reserved	820AH
Asynchronous Error Status Responses	42XXH
Message Length Error	4200H
Command Sequence Error	4201H

Table 6-7 System Interface Command Group Responses

System Interface Response	Response Code
Reserved	4202H
Command Group Error	4203H
Command Time-out Error	4204H
Reserved	4205H
Command Failed Error	4206H
System Command Error	4207H
Sub-command Error	4208H
Reserved	4209H
Invalid Control Word Error	420AH
Invalid Command Data Error	420BH
Erase Flash Error	420EH
Write Flash Error	420FH
Unsolicited Error Status Responses	22XXH
Synchronous Control Status Responses	81XXH
Data Acknowledge (Ack), data valid	8100H
Data Negative Acknowledge (Nack), data invalid	8101H
Reserved	8102H
Reserved	8104H
Asynchronous Control Status Responses	41XXH
Unsolicited Control Status Responses	21XXH

System Interface Command Group Response Data

Asynchronous OK Status Responses

The following system interface command group asynchronous OK status responses use the specified data payload.

Command Complete (4800H)

Command Complete Data	Data Payload
System Interface Command Group Command (sub-command)	XXXXH

Command In Progress (4801H)

Command In Progress Response Data	Data Payload
System Interface Command Group Command (sub-command)	XXXXH

Firmware Download Active System (4802H)

Firmware Download Active Response Data	Data Payload
System Interface Command Group Command (sub-command)	XXXXH

Firmware Download Complete System (4803H)

Firmware Download Complete Response Data	Data Payload
System Interface Command Group Command (sub-command)	XXXXH

S-Record Processed System (4804H)

S-Record Processed Response Data	Data Payload
System Interface Command Group Command (sub-command)	XXXXH

Synchronous Error Status Responses

The following system interface command group synchronous error status responses use the specified data payload.

Message Length Error Response Data (8200H)

Message Length Error Response Data	Data Payload
Expected Message Length	XXXXH
Received Message Length	XXXXH

Message Sequence Error Response Data (8201H)

Message Sequence Error Response Data	Data Payload
Expected Message Sequence Number	XXH
Received Message Sequence Number	XXH

Command Group Error Response Data (8203H)

Command Group Error Response Data	Data Payload
Invalid Command Group	XXXXH

Data Acknowledge Response Error Response Data (8209H)

Data Acknowledge Response Error Response Data	Data Payload
Invalid Data Acknowledge Response	XXXXH

Asynchronous Error Status Responses

The following system interface command group asynchronous error status responses use the specified data payload.

Message Length Error Response Data (4200H)

Message Length Error Response Data	Data Payload
Expected Message Length	XXXXH
Received Message Length	XXXXH

Command Sequence Error Response Data (4201H)

Command Sequence Error Response Data	Data Payload
Expected Command Sequence Number	XXH
Received Command Sequence Number	XXH

Command Group Error (4203H)

Command Group Error Response Data	Data Payload
Invalid Command Group	XXXXH

Command Time-out Error (4204H)

Command Time-out Error Response Data	Data Payload
N/A	

Command Failed Error (4206H)

Command Failed Error Response Data	Data Payload
System Interface Command Group Command (sub-command)	XXXXH

System Command Error (4207H)

System Command Error Response Data	Data Payload
N/A	

Sub-Command Error (4208H)

Sub-Command Error Response Data	Data Payload
Sub-command	XXXXH

Invalid Control Word Error (420AH)

Invalid Control Word Error Response Data	Data Payload
N/A	

Invalid Command Data Error (420BH)

Invalid Command Data Error Response Data	Data Payload
N/A	

Erase Flash Error System (420EH)

Erase Flash Error Response Data	Data Payload
System Interface Command Group Command (sub-command)	XXXXH

Write Flash Error System (420FH)

Write Flash Error Response Data	Data Payload
System Interface Command Group Command (sub-command)	XXXXH

System Interface Command Group Unsolicited Status Messages

The System Interface Command Group supports the generation of the following unsolicited status messages as defined by the response code (Table 6-8).

Table 6-8 System Interface Command Group Unsolicited Status Messages

System Interface Command Group Unsolicited Status Messages	Response Code
LC Heartbeat message	2811H

System Identify

This command gets the reader's system identify remote inventory. Table 6-9 and Table 6-10 list the command and response data.

Table 6-9 System Identify Command (0000H)

System Identify Command Data	Data Payload
System Identify Command	0000H

Table 6-10 System Identify Response

System Identify Response Data	Data Payload
System Identify Command	0000H
Vendor Name	*
Version ID	*
Part Number	*
Serial Number	*

*The information in this field is specific to each reader.

Each field's data size is listed in Table 6-11.

Table 6-11 System Identify Data

System Identify Data	Data Size
Vendor Name	15 bytes
Version ID	15 bytes
Part Number	15 bytes
Serial Number	15 bytes

Set Time and Date

The Set Time and Date command sets the Orion Reader real-time clock to the time and date specified in the request data.

The data associated with the Set Time and Date defines the format of the time and date (Table 6-12). You can modify and read this data at any time. This field is used with the tag read parameters to append time and date to any response to the host system. The Orion Reader has a battery-backed clock. Table 6-13 lists the response data.

Table 6-12 Set Time and Date Command (0003H)

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

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)

Table 6-13 Set Time and Date Response

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

Get Time and Date

The Get Time and Date command requests the current time and date that is set on the Orion Reader real-time clock. The data associated with the Get Time and Date defines the format of the time and date (Table 6-14). You can modify and read this data at any time. This field is used with the tag read parameters to append time and date to any response to the host system. Table 6-15 lists the response data.

Table 6-14 Get Time and Date Command (0004H)

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

Table 6-15 Get Time and Date Response

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

CPU App Firmware Download

This command downloads the reader's CPU application firmware. Table 6-16 and Table 6-17 list the command data and response.

Table 6-16 CPU App Firmware Download Command (0005H)

CPU App Firmware Download Command Data	Data Payload
CPU App Firmware Download Command	0005H

Table 6-17 CPU App Firmware Download Response

CPU App Firmware Download Response Data	Data Payload
CPU App Firmware Download Command	0005H

Reset Reader

The Reset Reader command initializes a power-up state (based on the nonvolatile settings) of all of the Orion Reader parameters and starts the Orion Reader power-on diagnostics. Table 6-18 and Table 6-19 list the command and response data.

Table 6-18 Reset Reader Command (0006H)

Reset Reader Command Data	Data Payload
Reset Reader Command	0006H
Reset Reader Control Word	A5A5H

Table 6-19 Reset Reader Response

Reset Reader Response Data	Data Payload
Reset Reader Command	0006H

When the Orion Reader is reset, the reader IP address, buffered tags, and error log are maintained, all other information must be resent or reconfigured before the Orion Reader can be operated again.

Get Buffered Tag Transaction

This command gets a specific buffered tag transaction from the reader. Table 6-20 and Table 6-21 list the command and response data.

Table 6-20 Get Buffered Tag Transaction Command (0007H)

Get Buffered Tag Transaction Command Data	Data Payload
Get Buffered Tag Transaction Command	0007H
Buffered Tag Transaction Number (MSW)	XXXXH
Buffered Tag Transaction Number (LSW)	XXXXH

Table 6-21 Get Buffered Tag Transaction Response

Get Buffered Tag Transaction Response Data	Data Payload
Get Buffered Tag Transaction Command	0007H
Buffered Tag Transaction Number (MSW)	XXXXH
Buffered Tag Transaction Number (LSW)	XXXXH
Buffered Tag Transaction Data	

The Buffered Tag Transaction Number field specifies the number of the buffered tag transactions to be retrieved. The data values for this field range from `01H` to `0FFFFFFFFH`.

The Buffered Tag Transaction Data field contains the buffered tag transaction response data that has a maximum byte length of 57.

Get Number of Buffered Tag Transactions

This command gets the number of buffered tag transactions that are stored in the reader. Table 6-22 and Table 6-23 list the command and response data.

Table 6-22 Get Number of Buffered Tag Transactions Command (0008H)

Get Number of Buffered Tag Transactions Command Data	Data Payload
Get Number of Buffered Tag Transactions Command	0008H

Table 6-23 Get Number of Buffered Tag Transactions Response Data

Get Number of Buffered Tag Transactions Response Data	Data Payload
Get Number of Buffered Tag Transactions Command	0008H
Number of Buffered Tag Transactions (MSW)	XXXXH
Number of Buffered Tag Transactions (LSW)	XXXXH
Buffered Tag Transaction Overflow Status: 0 = no overflow, 1 = overflow	XXH

The buffered tag transaction overflow status is returned as 0 for no overflow or 1 for overflow. The Number of Buffered Tag Transactions field specifies the current number of buffered tag transactions. The data values for this field range from `0H` to `0FFFFFFFFH`. Using the TCP command set, the Orion Reader can store up to 500,000 tag IDs in the buffer and the buffered tag information is saved upon reader reset. The data values for this field range from 0H to 0FFFFFFFFH.

Delete All Buffered Tag Transactions

This command deletes all buffered tag transactions stored in the reader. Table 6-24 and Table 6-25 list the command and response data.

Table 6-24 Delete All Buffered Tag Transactions Command (0009H)

Delete All Buffered Tag Transactions Command Data	Data Payload
Delete All Buffered Tag Transactions Command	0009H
Delete All Buffered Tag Transactions Control Word	A5A5H

Table 6-25 Delete All Buffered Tag Transactions Response

Delete All Buffered Tag Transactions Response Data	Data Payload
Delete All Buffered Tag Transactions Command	0009H

Get System Startup Status

This command gets the Orion Reader system startup status. Table 6-26 and Table 6-27 list the command and response data.

Table 6-26 Get System Startup Status Command (000AH)

Get System Startup Status Command Data	Data Payload
Get System Startup Status Command	000AH

Table 6-27 Get System Startup Status Response

Get System Startup Status Response Data	Data Payload
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

This command gets the status of the reader's lane controller interface software. Table 6-28 and Table 6-29 list the command and response data.

Table 6-28 Get Lane Controller Interface Status Command (000BH)

Get Lane Controller Interface Status Command Data	Data Payload
Get Lane Controller Interface Status Command	000BH

Table 6-29 Get Lane Controller Interface Status Response

Get Lane Controller Interface Status Response Data	Data Payload
Get Lane Controller Interface Status Command	000BH
Module Number	XXXXH
Error Number	XXXXH

Get System Interface Status

This command gets the status of the reader's system interface software. Table 6-30 and Table 6-31 list the command and response data.

Table 6-30 Get System Interface Status Command (000CH)

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

Table 6-31 Get System Interface Status Response

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

Set Buffered Tag Transaction Mode

This command sets the buffered tag transaction mode in the reader. The mode control byte can be set to 0 for real-time mode or 1 for buffered mode. Table 6-32 and Table

6-33 list the command and response data.

Table 6-32 Set Buffered Tag Transaction Mode Command (0016H)

Set Buffered Tag Transaction Mode Command Data	Data Payload
Set Buffered Tag Transaction Command	0016H
Mode Control Byte: 0 = Real-Time Mode, 1 = Buffered Mode	XXH

Table 6-33 Set Buffered Tag Transaction Mode Response

Set Buffered Tag Transaction Mode Response Data	Data Payload
Set Buffered Tag Transaction Command	0016H

Get Buffered Tag Transaction Mode

This command gets the buffered tag transaction mode from the reader. The mode control byte is returned as 0 for real-time mode or 1 for buffered mode. Table 6-34 and Table 6-35 list the command and response data.

Table 6-34 Get Buffered Tag Transaction Mode Command (0017H)

Get Buffered Tag Transaction Mode Command Data	Data Payload
Get Buffered Tag Transaction Command	0017H

Table 6-35 Get Buffered Tag Transaction Mode Response Data

Get Buffered Tag Transaction Mode Response Data	Data Payload
Get Buffered Tag Transaction Command	0017H
Mode Control Byte: 0 = Real-Time Mode, 1 = Buffered Mode	XXH

Set Data Acknowledge Time-out Period

This command sets the reader's data acknowledge time-out period in milliseconds. Table 6-36 and Table 6-37 list the command and response data.

Table 6-36 Set Acknowledge Time-out Period Command (0018H)

Set Data Acknowledge Time-out Period Command Data	Data Payload
Set Data Acknowledge Time-out Period Command	0018H
Communication Protocol	XXH

Table 6-36 Set Acknowledge Time-out Period Command (0018H)

Time-out Period in ms (MSB)	XXH
Time-out Period in ms (LSB)	XXH

Table 6-37 Set Acknowledge Time-out Period Response

Set Data Acknowledge Time-out Period Response Data	Data Payload
Set Data Acknowledge Time-out Period Command	0018H
Communication Protocol	XXH

Communication Protocols

Table 6-38 lists the communication protocols that can be returned by the response.

Table 6-38 Set Acknowledge Time-Out Period Communication Protocols

Communication Protocol	Data Code
TCP/IP Communication	01H
Serial Communication	02H
Serial Debug Communication	03H

Get Data Acknowledge Time-out Period

This command gets the data acknowledge time-out period from the reader. Table 6-39 and Table 6-40 list the command and response data.

Table 6-39 Get Acknowledge Time-Out Period Command (0019H)

Get Data Acknowledge Time-out Period Command Data	Data Payload
Get Data Acknowledge Time-out Period Command	0019H
Communication Protocol	XXH

Table 6-40 Get Acknowledge Time-out Period Response Data

Get Data Acknowledge Time-out Period Response Data	Data Payload
Get Data Acknowledge Time-out Period Command	0019H
Communication Protocol	XXH
Time-out Period in ms (MSB)	XXH

Table 6-40 Get Acknowledge Time-out Period Response Data

Time-out Period in ms (LSB)	XXH

Table 6-41 lists the response protocols.

Table 6-41 Get Acknowledge Time-out Period Communication Protocols

Communication Protocol	Data Code
TCP/IP Communication	01H
Serial Communication	02H
Serial Debug Communication	03H

Set Switch Buffered Tag Transaction Mode Enable

This command sets the switch buffered tag transaction mode enable in the reader. The enable control byte is returned as 0 for disabled or 1 for enabled. Table 6-42 and Table 6-43 list the command and response data.

Table 6-42 Set Switch Buffered Tag Transaction Mode Enable Command (001AH)

Set Switch Buffered Tag Transaction Mode Enable Command Data	Data Payload
Set Switch Buffered Tag Transaction Mode Enable Command	001AH
Enable Control Byte: 0 = Disabled, 1 = Enabled	XXH

Table 6-43 Set Switch Buffered Tag Transaction Mode Enable Response

Set Switch Buffered Tag Transaction Mode Enable Response Data	Data Payload
Set Switch Buffered Tag Transaction Mode Enable Command	001AH

Get Switch Buffered Tag Transaction Mode Enable

This command gets the switch buffered tag transaction mode enable from the reader. The enable control byte is returned as 0 for disabled or 1 for enabled. Table 6-44 and Table 6-45 list the command and response data.

Table 6-44 Get Switch Buffered Tag Transaction Mode Enable Command (001BH)

Get Switch Buffered Tag Transaction Mode Enable Command Data	Data Payload
Get Switch Buffered Tag Transaction Mode Enable Command	001BH

Table 6-45 Get Switch Buffered Tag Transaction Mode Enable Response

Get Switch Buffered Tag Transaction Mode Enable Response Data	Data Payload
Get Switch Buffered Tag Transaction Mode Enable Command	001BH
Enable Control Byte: 0 = Disabled, 1 = Enabled	XXH

FPGA Firmware Download

This command downloads the reader's FPGA firmware. Table 6-46 and Table 6-47 list the command and response data.

Table 6-46 FPGA Firmware Download Command (001CH)

FPGA Firmware Download Command Data	Data Payload
FPGA Firmware Download Command	001CH

Table 6-47 FPGA Firmware Download Response

FPGA Firmware Download Response Data	Data Payload
FPGA Firmware Download Command	001CH

CPU Boot Firmware Download

This command downloads the reader's CPU boot firmware. Table 6-48 and Table 6-49 list the command and response data.

Table 6-48 CPU Boot Firmware Download Command (001DH)

CPU Boot Firmware Download Command Data	Data Payload
CPU Boot Firmware Download Command	001DH

Table 6-49 CPU Boot Firmware Download Response

CPU Boot Firmware Download Response Data	Data Payload
CPU Boot Firmware Download Command	001DH

Get System Serial Number

This command gets the reader's serial number. Table 6-50 and Table 6-51 list the command and response data.

Table 6-50 Get System Serial Number Command (001FH)

Get System Serial Number Command Data	Data Payload
Get System Serial Number Command	001FH

Table 6-51 Get System Serial Number Response

Get System Serial Number Response Data	Data Payload
Get System Serial Number Command	001FH
Serial Number Data: 15 bytes	

Get Firmware Version Numbers

This command gets the reader's firmware version numbers. Table 6-52 and Table 6-53 list the command and response data.

Table 6-52 Get Firmware Version Numbers Command (0021H)

Get Firmware Version Numbers Command Data	Data Payload
Get Firmware Version Numbers Command	0021H

Table 6-53 Get Firmware Version Numbers Response

Get Firmware Version Numbers Response Data	Data Payload
Get Firmware Version Numbers Command	0021H
Digital Board Central Processing Unit (CPU) Boot Firmware Version Number (MSW)	XXXXH
Digital Board CPU Boot Firmware Version Number (LSW)	XXXXH
Digital Board CPU Application Firmware Version Number (MSW)	XXXXH
Digital Board CPU Application Firmware Version Number (LSW)	XXXXH
Digital Board FPGA1 Firmware Version Number (MSW)	XXXXH
Digital Board FPGA1 Firmware Version Number (LSW)	XXXXH
Daughter Board FPGA2 Firmware Version Number (MSW)	XXXXH
Daughter Board FPGA2 Firmware Version Number (LSW)	XXXXH
RF Transceiver FPGA Firmware Version Number (MSW)	XXXXH
RF Transceiver FPGA Firmware Version Number (LSW)	XXXXH

Load Default Operating Parameters

This command loads the reader’s default operating parameters. Table 6-54 and Table 6-55 list the command and response data.

Table 6-54 Load Default Operating Parameters Command (002BH)

Load Default Operating Parameters Command Data	Data Payload
Load Default Operating Parameters Command	002BH
Load Default Operating Parameters Control Word (MSB)	A5H
Load Default Operating Parameters Control Word (LSB)	A5H

Table 6-55 Load Default Operating Parameters Response

Load Default Operating Parameters Response	Data Payload
Load Default Operating Parameters Command	002BH

Set Lane Controller/Host IP Address

This command sets the reader’s lane controller/host IP address. Table 6-56 and Table 6-57 list the command and response data.

Table 6-56 Set Lane Controller/Host IP Address Command (0040H)

Set Lane Controller/Host IP Address Command Data	Data Payload
Set Lane Controller/Host IP Address Command	0040H
IP Address (MSW)	XXXXH
IP Address (LSW)	XXXXH

Table 6-57 Set Lane Controller/Host IP Address Response

Set Lane Controller/Host IP Address Response Data	Data Payload
Set Lane Controller/Host IP Address Command	0040H

Get Lane Controller/Host IP Address

This command gets the reader’s lane controller/host IP address. Table 6-58 and Table 6-59 list the command and response data.

Table 6-58 Get Lane Controller/Host IP Address Command (0041H)

Get Lane Controller/Host IP Address Command Data	Data Payload
Get Lane Controller/Host IP Address Command	0041H

Table 6-59 Get Lane Controller/Host IP Address Response

Get Lane Controller/Host IP Address Response Data	Data Payload
Get Lane Controller/Host IP Address Command	0041H
IP Address (MSW)	XXXXH
IP Address (LSW)	XXXXH

Set IP Address and Subnet Mask

This command sets the reader's IP address and subnet mask. Table 6-60 and Table 6-61 list the command and response data.

Table 6-60 Set IP Address and Subnet Mask Command (0042H)

Set IP Address and Subnet Mask Command Data	Data Payload
Set IP Address and Subnet Mask Command	0042H
IP Address (MSW)	XXXXH
IP Address (LSW)	XXXXH
Subnet Mask (MSW)	XXXXH
Subnet Mask (LSW)	XXXXH

Table 6-61 Set IP Address and Subnet Mask Response

Set IP Address and Subnet Mask Response Data	Data Payload
Set IP Address and Subnet Mask Command	0042H

Get IP Address and Subnet Mask

This command gets the reader's IP address and subnet mask. Table 6-62 and Table 6-63 list the command and response data.

Table 6-62 Get IP Address and Subnet Mask Command (0043H)

Get IP Address and Subnet Mask Command Data	Data Payload
Get IP Address and Subnet Mask Command	0043H

Table 6-63 Get IP Address and Subnet Mask Response

Get IP Address and Subnet Mask Response Data	Data Payload
Get IP Address and Subnet Mask Command	0043H
IP Address (MSW)	XXXXH
IP Address (LSW)	XXXXH
Subnet Mask (MSW)	XXXXH
Subnet Mask (LSW)	XXXXH

Get TCP Port Number

This command gets the reader's TCP port number. Table 6-64 and Table 6-65 lists the command and response data.

Table 6-64 Get TCP Port Number Command (0044H)

Get TCP Port Number Command Data	Data Payload
Get TCP Port Number Command	0044H

Table 6-65 Get TCP Port Number Response

Get TCP Port Number Response Data	Data Payload
Get TCP Port Number Command	0044H
Port Number	XXXXH

Digital I/O Command Group Commands (4000H)

The digital input/output (I/O) assembly is used to interface the Orion Reader with external inputs and outputs. Inputs can be devices such as light curtains or loops, and outputs can be devices such as gates or lights. Table 6-66 lists the Digital I/O Command Group commands that are used in the Orion multiprotocol reader.

Table 6-66 Digital I/O Command Group Commands

Digital I/O Configuration Command	Command Code
Set Digital I/O Sensor Status Change Report	0000H
Get Digital I/O Sensor Status Change Report	0001H
Set Digital I/O Output Host Control	0002H
Get Digital I/O Output Host Control	0003H
Set Digital I/O Output Tag Read Control	0004H
Get Digital I/O Output Tag Read Control	0005H
Set Digital I/O RF Control	0006H
Get Digital I/O RF Control	0007H
Set Digital I/O RF Multiplexing Mode	0008H
Get Digital I/O RF Multiplexing Mode	0009H
Set Digital I/O Output Pulse Duration	000AH
Get Digital I/O Output Pulse Duration	000BH
Set Digital I/O Minimum Presence True Period	000CH
Get Digital I/O Minimum Presence True Period	000DH
Set Digital I/O Sensor Input Inversion	000EH
Get Digital I/O Sensor Input Inversion	000FH
Set Digital I/O Port Configuration	0010H
Get Digital I/O Port Configuration	0011H
Set Digital I/O Sensor Input Report	0012H
Get Digital I/O Sensor Input Report	0013H
Set Digital I/O Presence RF Control Algorithm	0014H
Get Digital I/O Presence RF Control Algorithm	0015H

Table 6-66 Digital I/O Command Group Commands

Digital I/O Configuration Command	Command Code
Set Digital I/O Presence RF Control Time-Out Period	0016H
Get Digital I/O Presence RF Control Time-Out Period	0017H
Get Digital I/O Port Status	0018H
Set Digital I/O Mode	0019H
Get Digital I/O Mode	001AH
Set External Interrupt Control	056DH
Get External Interrupt Control	06ADH

Digital I/O Command Group Responses

Table 6-67 lists the responses and codes for the Digital I/O command group.

Table 6-67 Digital I/O Command Group Responses

Digital I/O Responses	Response Code
Synchronous OK Status Responses	88XXH
Reserved	8800H
Reserved	8801H
Asynchronous OK Status Responses	48XXH
Command Complete	4800H
Command In Progress	4801H
Unsolicited OK Status Responses	28XXH
Reserved	84XXH
Reserved	44XXH

Table 6-67 Digital I/O Command Group Responses

Digital I/O Responses	Response Code
Reserved	24XXH
Synchronous Error Status Responses	82XXH
Message Length Error	8200H
Message Sequence Error	8201H
Reserved	8202H
Command Group Error	8203H
Reserved	8204H
Reserved	8205H
Reserved	8206H
Reserved	8207H
Reserved	8208H
Data Acknowledge Response Error	8209H
Reserved	820AH
Asynchronous Error Status Responses	42XXH
Message Length Error	4200H
Command Sequence Error	4201H
Reserved	4202H
Command Group Error	4203H
Command Time-out Error	4204H
Reserved	4205H
Command Failed Error	4206H
System Command Error	4207H
Sub-command Error	4208H
Reserved	4209H
Invalid Control Word Error	420AH

Table 6-67 Digital I/O Command Group Responses

Digital I/O Responses	Response Code
Invalid Command Data Error System	420BH
Unsolicited Error Status Responses	22XXH
Synchronous Control Status Responses	81XXH
Data Acknowledge (Ack), data valid	8100H
Data Negative Acknowledge (Nack), data invalid	8101H
Reserved	8102H
Reserved	8104H
Asynchronous Control Status Responses	41XXH
Unsolicited Control Status Responses	21XXH

Digital I/O Command Group Response Data

Asynchronous OK Status Responses

The following Digital I/O command group asynchronous OK status responses use the specified data payload.

Command Complete (4800H)

Command In Progress Response Data	Data Payload
Digital I/O Command Group Command (sub-command)	XXXXH

Command In Progress (4801H)

Command In Progress Response Data	Data Payload
Digital I/O Command Group Command (sub-command)	XXXXH

Synchronous Error Status Responses

The following Digital I/O command group synchronous error status responses use the specified data payload.

Message Length Error Response Data (8200H)

Message Length Error Response Data	Data Payload
Expected Message Length	XXXXH
Received Message Length	XXXXH

Message Sequence Error Response Data (8201H)

Message Sequence Error Response Data	Data Payload
Expected Message Sequence Number	XXH
Received Message Sequence Number	XXH

Command Group Error Response Data (8203H)

Command Group Error Response Data	Data Payload
Invalid Command Group	XXXXH

Data Acknowledge Response Error Response Data (8209H)

Data Acknowledge Response Error Response Data	Data Payload
Invalid Data Acknowledge Response	XXXXH

Asynchronous Error Status Responses

The following Digital I/O command group asynchronous error status responses use the specified data payload.

Message Length Error Response Data (4200H)

Message Length Error Response Data	Data Payload
Expected Message Length	XXXXH
Received Message Length	XXXXH

Command Sequence Error Response Data (4201H)

Command Sequence Error Response Data	Data Payload
Expected Command Sequence Number	XXH
Received Command Sequence Number	XXH

Command Group Error (4203H)

Command Group Error Response Data	Data Payload
Invalid Command Group	XXXXH

Command Time-out Error (4204H)

Command Time-out Error Response Data	Data Payload
N/A	

Command Failed Error (4206H)

Command Failed Error Response Data	Data Payload
Digital I/O Command Group Command (sub-command)	XXXXH

System Command Error (4207H)

System Command Error Response Data	Data Payload
N/A	

Sub-Command Error (4208H)

Sub-Command Error Response Data	Data Payload
Sub-command	XXXXH

Invalid Control Word Error (420AH)

Invalid Control Word Error Response Data	Data Payload
N/A	

Invalid Command Data Error (420BH)

Invalid Command Data Error Response Data	Data Payload
N/A	

Digital I/O Asynchronous Reports

The Digital I/O supports the generation of the following asynchronous response message reports as defined by the transaction record type code (Table 6-68).

Table 6-68 Digital I/O Asynchronous Reports

Digital I/O Asynchronous Report Type	Code
Sensor Status Change Report	3050H
Sensor Input Report	3051H

Sensor Status Change Report

This Digital I/O report is generated when a sensor detects a presence change and that sensor is configured to generate a report (Table 6-69).

Table 6-69 Sensor Status Change Report

Sensor Status Change Report	Data Payload
Sensor Status Change Report Transaction Record Type	3050H
Port Configuration	0XH
Port number Reporting Status Change: 0–3 for Port0–Port 3	0XH
Port Status	0XH

Port Configuration — This field specifies the digital port input/output configuration. In Table 6-70, INPUT = 0 and OUTPUT = 1.

Table 6-70 Port Configuration

Configuration Value	Digital Port 3	Digital Port 2	Digital Port 1	Digital Port 0
00H	INPUT	INPUT	INPUT	INPUT
01H	INPUT	INPUT	INPUT	OUTPUT
02H	INPUT	INPUT	OUTPUT	INPUT
03H	INPUT	INPUT	OUTPUT	OUTPUT
04H	INPUT	OUTPUT	INPUT	INPUT
05H	INPUT	OUTPUT	INPUT	OUTPUT
06H	INPUT	OUTPUT	OUTPUT	INPUT
07H	INPUT	OUTPUT	OUTPUT	OUTPUT
08H	OUTPUT	INPUT	INPUT	INPUT
09H	OUTPUT	INPUT	INPUT	OUTPUT
0AH	OUTPUT	INPUT	OUTPUT	INPUT
0BH	OUTPUT	INPUT	OUTPUT	OUTPUT
0CH	OUTPUT	OUTPUT	INPUT	INPUT
0DH	OUTPUT	OUTPUT	INPUT	OUTPUT
0EH	OUTPUT	OUTPUT	OUTPUT	INPUT
0FH	OUTPUT	OUTPUT	OUTPUT	OUTPUT

Port Status — This field specifies the digital port status. In Table 6-71, LOW = 0 and HIGH = 1.

Table 6-71 Port Status

Status Value	Digital Port 3	Digital Port 2	Digital Port 1	Digital Port 0
00H	LOW	LOW	LOW	LOW
01H	LOW	LOW	LOW	HIGH
02H	LOW	LOW	HIGH	LOW
03H	LOW	LOW	HIGH	HIGH

Table 6-71 Port Status

Status Value	Digital Port 3	Digital Port 2	Digital Port 1	Digital Port 0
04H	LOW	HIGH	LOW	LOW
05H	LOW	HIGH	LOW	HIGH
06H	LOW	HIGH	HIGH	LOW
07H	LOW	HIGH	HIGH	HIGH
08H	HIGH	LOW	LOW	LOW
09H	HIGH	LOW	LOW	HIGH
0AH	HIGH	LOW	HIGH	LOW
0BH	HIGH	LOW	HIGH	HIGH
0CH	HIGH	HIGH	LOW	LOW
0DH	HIGH	HIGH	LOW	HIGH
0EH	HIGH	HIGH	HIGH	LOW
0FH	HIGH	HIGH	HIGH	HIGH

Sensor Input Report

This digital I/O report generates when a sensor detects a vehicle presence but no valid tag read occurs (Table 6-72).

Table 6-72 Sensor Input Report

Sensor Input Report	Data Payload
Sensor Input Report Transaction Record Type	3051H
Port Configuration	0XH
Port Number Reporting Missed Tag Read: 0–3 for Port0–Port3	0XH

Port Configuration — This field specifies the digital port input/output configuration. In Table 6-73, INPUT = 0 and OUTPUT = 1.

Table 6-73 Port Configuration

Configuration Value	Digital Port 3	Digital Port 2	Digital Port 1	Digital Port 0
00H	INPUT	INPUT	INPUT	INPUT
01H	INPUT	INPUT	INPUT	OUTPUT

Table 6-73 Port Configuration

Configuration Value	Digital Port 3	Digital Port 2	Digital Port 1	Digital Port 0
02H	INPUT	INPUT	OUTPUT	INPUT
03H	INPUT	INPUT	OUTPUT	OUTPUT
04H	INPUT	OUTPUT	INPUT	INPUT
05H	INPUT	OUTPUT	INPUT	OUTPUT
06H	INPUT	OUTPUT	OUTPUT	INPUT
07H	INPUT	OUTPUT	OUTPUT	OUTPUT
08H	OUTPUT	INPUT	INPUT	INPUT
09H	OUTPUT	INPUT	INPUT	OUTPUT
0AH	OUTPUT	INPUT	OUTPUT	INPUT
0BH	OUTPUT	INPUT	OUTPUT	OUTPUT
0CH	OUTPUT	OUTPUT	INPUT	INPUT
0DH	OUTPUT	OUTPUT	INPUT	OUTPUT
0EH	OUTPUT	OUTPUT	OUTPUT	INPUT
0FH	OUTPUT	OUTPUT	OUTPUT	OUTPUT

Set Digital I/O Sensor Status Change Report

This command sets the digital I/O sensor status change report mask. Table 6-74 and Table 6-75 list the command and response data.

Table 6-74 Set Digital I/O Sensor Status Change Report Command (0000H)

Set Digital I/O Sensor Status Change Report Data	Data Payload
Set Digital I/O Sensor Status Change Report	0000H
Sensor Status Change Report Mask	0XH

Table 6-75 Set Digital I/O Sensor Status Change Report Response

Set Digital I/O Sensor Status Change Report Response Data	Data Payload
Set Digital I/O Sensor Status Change Report Command	0000H

Sensor Status Change Report Mask — This field specifies the sensor inputs that are monitored for status change and associated sensor status change report generation. In Table 6-76, OFF = 0 and ON = 1.

Table 6-76 Sensor Status Change Report Mask Values

Mask Value	Sensor Input 3	Sensor Input 2	Sensor Input 1	Sensor Input 0
00H	OFF	OFF	OFF	OFF
01H	OFF	OFF	OFF	ON
02H	OFF	OFF	ON	OFF
03H	OFF	OFF	ON	ON
04H	OFF	ON	OFF	OFF
05H	OFF	ON	OFF	ON
06H	OFF	ON	ON	OFF
07H	OFF	ON	ON	ON
08H	ON	OFF	OFF	OFF
09H	ON	OFF	OFF	ON
0AH	ON	OFF	ON	OFF
0BH	ON	OFF	ON	ON
0CH	ON	ON	OFF	OFF
0DH	ON	ON	OFF	ON
0EH	ON	ON	ON	OFF
0FH	ON	ON	ON	ON

Get Digital I/O Sensor Status Change Report

This command gets the digital I/O sensor status change report mask. Table 6-77 and Table 6-78 list the command and response data.

Table 6-77 Get Digital I/O Sensor Status Change Report Command (0001H)

Get Digital I/O Sensor Status Change Report Data	Data Payload
Get Digital I/O Sensor Status Change Report	0001H

Table 6-78 Get Digital I/O Sensor Status Change Report Response

Get Digital I/O Sensor Status Change Report Response Data	Data Payload
Get Digital I/O Sensor Status Change Report Command	0001H
Sensor Status Change Report Mask	0XH

Sensor Status Change Report Mask — This field specifies the sensor inputs that are monitored for status change and associated sensor status change report generation. In Table 6-79, OFF = 0 and ON = 1.

Table 6-79 Sensor Status Change Report Mask Values

Mask Value	Sensor Input 3	Sensor Input 2	Sensor Input 1	Sensor Input 0
00H	OFF	OFF	OFF	OFF
01H	OFF	OFF	OFF	ON
02H	OFF	OFF	ON	OFF
03H	OFF	OFF	ON	ON
04H	OFF	ON	OFF	OFF
05H	OFF	ON	OFF	ON
06H	OFF	ON	ON	OFF
07H	OFF	ON	ON	ON
08H	ON	OFF	OFF	OFF
09H	ON	OFF	OFF	ON
0AH	ON	OFF	ON	OFF
0BH	ON	OFF	ON	ON
0CH	ON	ON	OFF	OFF
0DH	ON	ON	OFF	ON
0EH	ON	ON	ON	OFF
0FH	ON	ON	ON	ON

Set Digital I/O Output Host Control

This command sets the digital I/O outputs that the host controls. Table 6-80 and Table 6-81 list the command and response data.

Table 6-80 Set Digital I/O Output Host Control Command (0002H)

Set Digital I/O Output Host Control Data	Data Payload
Set Digital I/O Output Host Control Command	0002H
Output Control	0XH

Table 6-81 Set Digital I/O Output Host Control Response

Set Digital I/O Output Host Control Response Data	Data Payload
Set Digital I/O Output Host Control Command	0002H

Output Control — This field specifies the digital outputs that the host controls. In Table 6-82, OFF = 0 and ON = 1.

Table 6-82 Output Control Values

Control Value	Output Control 3	Output Control 2	Output Control 1	Output Control 0
00H	OFF	OFF	OFF	OFF
01H	OFF	OFF	OFF	ON
02H	OFF	OFF	ON	OFF
03H	OFF	OFF	ON	ON
04H	OFF	ON	OFF	OFF
05H	OFF	ON	OFF	ON
06H	OFF	ON	ON	OFF
07H	OFF	ON	ON	ON
08H	ON	OFF	OFF	OFF
09H	ON	OFF	OFF	ON
0AH	ON	OFF	ON	OFF
0BH	ON	OFF	ON	ON
0CH	ON	ON	OFF	OFF
0DH	ON	ON	OFF	ON
0EH	ON	ON	ON	OFF

Table 6-82 Output Control Values

Control Value	**Output Control 3**	**Output Control 2**	**Output Control 1**	**Output Control 0**
0FH	ON	ON	ON	ON

Note: *RESET READER command required to set output host control, but not required if only asserting outputs.*

Get Digital I/O Output Host Control

This command gets the digital I/O outputs that the host controls. Table 6-83 and Table 6-84 list the command and response data.

Table 6-83 Get Digital I/O Output Host Control Command (0003H)

Get Digital I/O Output Host Control Data	Data Payload
Get Digital I/O Output Host Control Command	0003H

Table 6-84 Get Digital I/O Output Host Control Response

Get Digital I/O Output Host Control Response Data	Data Payload
Get Digital I/O Output Host Control Command	0003H
Output Control	0XH

Output Control — This field specifies the digital outputs that the host controls. In Table 6-85, OFF = 0 and ON = 1.

Table 6-85 Output Control Values

Control Value	Output Control 3	Output Control 2	Output Control 1	Output Control 0
00H	OFF	OFF	OFF	OFF
01H	OFF	OFF	OFF	ON
02H	OFF	OFF	ON	OFF
03H	OFF	OFF	ON	ON
04H	OFF	ON	OFF	OFF
05H	OFF	ON	OFF	ON
06H	OFF	ON	ON	OFF
07H	OFF	ON	ON	ON
08H	ON	OFF	OFF	OFF
09H	ON	OFF	OFF	ON
0AH	ON	OFF	ON	OFF
0BH	ON	OFF	ON	ON
0CH	ON	ON	OFF	OFF

Table 6-85 Output Control Values

Control Value	Output Control 3	Output Control 2	Output Control 1	Output Control 0
0DH	ON	ON	OFF	ON
0EH	ON	ON	ON	OFF
0FH	ON	ON	ON	ON

Set Digital I/O Output Tag Read Control

This command sets the digital I/O outputs that are controlled by a good tag read. Table 6-86 and Table 6-87 list the command and response data.

Table 6-86 Set Digital I/O Output Tag Read Control Command (0004H)

Set Digital I/O Output Tag Read Control Command Data	Data Payload
Set Digital I/O Output Tag Read Control Command	0004H

Table 6-87 Set Digital I/O Output Tag Read Control Response

Set Digital I/O Output Tag Read Control Response Data	Data Payload
Set Digital I/O Output Tag Read Control Command	0004H

Note: *RESET READER command required for changes to take effect.*

Get Digital I/O Output Tag Read Control

This command gets the digital I/O outputs that are controlled by a good tag read. Table 6-88 and Table 6-89 list the command and response data.

Table 6-88 Get Digital I/O Output Tag Read Control Command (0005H)

Get Digital I/O Output Tag Read Control Command Data	Data Payload
Get Digital I/O Output Tag Read Control Command	0005H

Table 6-89 Get Digital I/O Output Tag Read Control Response

Get Digital I/O Output Tag Read Control Response Data	Data Payload
Get Digital I/O Output Tag Read Control Command	0005H

Table 6-89 Get Digital I/O Output Tag Read Control Response

Get Digital I/O Output Tag Read Control Response Data	Data Payload
Output Control	0XH

Output Control — This field specifies the digital outputs that are controlled by a good tag read. In Table 6-90, OFF = 0 and ON = 1.

Table 6-90 Output Control Values

Control Value	Output Control 3	Output Control 2	Output Control 1	Output Control 0
00H	OFF	OFF	OFF	OFF
01H	OFF	OFF	OFF	ON
02H	OFF	OFF	ON	OFF
03H	OFF	OFF	ON	ON
04H	OFF	ON	OFF	OFF
05H	OFF	ON	OFF	ON
06H	OFF	ON	ON	OFF
07H	OFF	ON	ON	ON
08H	ON	OFF	OFF	OFF
09H	ON	OFF	OFF	ON
0AH	ON	OFF	ON	OFF
0BH	ON	OFF	ON	ON
0CH	ON	ON	OFF	OFF
0DH	ON	ON	OFF	ON
0EH	ON	ON	ON	OFF
0FH	ON	ON	ON	ON

Set Digital I/O RF Control

This command sets the digital I/O RF control mode. Table 6-91 and Table 6-92 list the command and response data.

Table 6-91 Set Digital I/O RF Control Command (0006H)

Set Digital I/O RF Control Command Data	Data Payload
Set Digital I/O RF Control Command	0006H
RF Control Mode	0XH

Table 6-92 Set Digital I/O RF Control Response

Set Digital I/O RF Control Response Data	Data Payload
Set Digital I/O RF Control Command	0006H

RF Control Mode — This field specifies the RF control mode.

Mode Value	RF Control Mode
00H	RF controlled by sensor
01H	RF on continuously

Note: *RESET READER command required for changes to take effect.*

Get Digital I/O RF Control

This command gets the digital I/O RF control mode. Table 6-93 and Table 6-94 list the command and response data.

Table 6-93 Get Digital I/O RF Control Command (0007H)

Get Digital I/O RF Control Command Data	Data Payload
Get Digital I/O RF Control Command	0007H

Table 6-94 Get Digital I/O RF Control Response

Get Digital I/O RF Control Response Data	Data Payload
Get Digital I/O RF Control Command	0007H
RF Control Mode	0XH

RF Control Mode — This field specifies the RF control mode.

Mode Value	RF Control Mode
00H	RF controlled by sensor
01H	RF on continuously

Set Digital I/O RF Multiplexing Mode

This command sets the digital I/O RF multiplexing mode. Table 6-95 and Table 6-96 list the command and response data.

Table 6-95 Set Digital I/O RF Multiplexing Mode Command (0008H)

Set Digital I/O RF Multiplexing Mode Command Data	Data Payload
Set Digital I/O RF Multiplexing Mode Command	0008H
RF Multiplexing Mode	0XH

Table 6-96 Set Digital I/O RF Multiplexing Mode Response

Set Digital I/O RF Multiplexing Mode Response Data	Data Payload
Set Digital I/O RF Multiplexing Mode Command	0008H

RF Multiplexing Mode — This field specifies the RF multiplexing mode (Table 6-97).

Table 6-97 RF Multiplexing Mode Values

Mode Value	RF Multiplexing Mode
00H	No RF multiplexing
01H	One-channel multiplexing (channel 0)
03H	Two-channel multiplexing (channels 0 and 1)
0CH	Two-channel multiplexing (channels 2 and 3)
07H	Three-channel multiplexing (channels 0, 1, and 2)
0FH	Four-channel multiplexing (channels 0, 1, 2, and 3)

Note: *RESET READER command required for changes to take effect.*

Get Digital I/O RF Multiplexing Mode

This command gets the digital I/O RF multiplexing mode. Table 6-98 and Table 6-99 list the command and response data.

Table 6-98 Get Digital I/O RF Multiplexing Mode Command (0009H)

Get Digital I/O RF Multiplexing Mode Command Data	Data Payload
Get Digital I/O RF Multiplexing Mode Command	0009H

Table 6-99 Get Digital I/O RF Multiplexing Mode Response

Set Digital I/O RF Multiplexing Mode Response Data	Data Payload
Set Digital I/O RF Multiplexing Mode Command	0009H
RF Multiplexing Mode	0XH

RF Multiplexing Mode — This field specifies the RF multiplexing mode (Table 6-100).

Table 6-100 RF Multiplexing Mode Values

Mode Value	RF Multiplexing Mode
00H	No RF multiplexing
01H	One-channel multiplexing (channel 0)

Table 6-100 RF Multiplexing Mode Values

Mode Value	RF Multiplexing Mode
03H	Two-channel multiplexing (channels 0 and 1)
0CH	Two-channel multiplexing (channels 2 and 3)
07H	Three-channel multiplexing (channels 0, 1, and 2)
0FH	Four-channel multiplexing (channels 0, 1, 2, and 3)

Set Digital I/O Output Pulse Duration

This command sets the Digital I/O output pulse duration. Table 6-101 and Table 6-102 list the command and response data.

Table 6-101 Set Digital I/O Output Pulse Duration Command (000AH)

Set Digital I/O Output Pulse Duration Command Data	Data Payload
Set Digital I/O Output Pulse Duration Command	000AH
Output Port Number: 0–3 for Port0–Port3	0XH
Output Pulse Duration	0XH

Table 6-102 Set Digital I/O Output Pulse Duration Response

Set Digital I/O Output Pulse Duration Response Data	Data Payload
Set Digital I/O Output Pulse Duration Command	000AH

Output Pulse Duration — This field specifies the output pulse duration (digital outputs ON and OFF times). The digital outputs have a 50% duty cycle (Table 6-103).

Table 6-103 Output Pulse Duration Values

Duration Value	Pulse Duration (ms)
00H	4
01H	8
02H	12
03H	16
04H	20

Table 6-103 Output Pulse Duration Values

Duration Value	Pulse Duration (ms)
05H	24
06H	32
07H	40
08H	48
09H	60
0AH	76
0BH	152
0CH	228
0DH	300
0EH	376
0FH	752

Get Digital I/O Output Pulse Duration

This command gets the Digital I/O output pulse duration. Table 6-104 and Table 6-105 list the command and response data.

Table 6-104 Get Digital I/O Output Pulse Duration Command (000BH)

Get Digital I/O Output Pulse Duration Command Data	Data Payload
Get Digital I/O Output Pulse Duration Command	000BH
Output Port Number: 0–3 for Port0–Port3	0XH

Table 6-105 Get Digital I/O Output Pulse Duration Response

Get Digital I/O Output Pulse Duration Response Data	Data Payload
Get Digital I/O Output Pulse Duration Command	000BH
Output Port Number: 0–3 for Port0–Port3	0XH
Output Pulse Duration	0XH

Output Pulse Duration — This field specifies the output pulse duration (digital outputs ON and OFF times). The digital outputs have a 50% duty cycle (Table 6-106).

Table 6-106 Output Pulse Duration Values

Duration Value	Pulse Duration (ms)
00H	4
01H	8
02H	12
03H	16
04H	20
05H	24
06H	32
07H	40
08H	48
09H	60
0AH	76
0BH	152
0CH	228
0DH	300
0EH	376
0FH	752

Set Digital I/O Minimum Presence True Period

This command sets the digital I/O minimum presence true period, which is the minimum amount of time that the input must be valid. Table 6-107 and Table 6-108 list the command and response data.

Table 6-107 Set Digital I/O Minimum Presence True Period Command (000CH)

Set Digital I/O Minimum Presence True Period Command Data	Data Payload
Set Digital I/O Minimum Presence True Period Command	000CH
Minimum Presence True Period	0XH

Table 6-108 Set Digital I/O Minimum Presence True Period Response

Set Digital I/O Minimum Presence True Period Response Data	Data Payload
Set Digital I/O Minimum Presence True Period Command	000CH

Minimum Presence True Period — This field specifies the minimum presence true period (Table 6-109).

Table 6-109 Minimum Presence True Period Values

True Period Value	True Period (ms)
00H	0 (always true)
01H	4
02H	8
03H	12
04H	20
05H	24
06H	**32 (default)**
07H	48
08H	60
09H	92
0AH	152
0BH	300

Table 6-109 Minimum Presence True Period Values

True Period Value	True Period (ms)
0CH	452
0DH	600
0EH	752
0FH	Infinite (never true)

Get Digital I/O Minimum Presence True Period

This command gets the digital I/O minimum presence true period, which is the minimum amount of time that the input must be valid. Table 6-110 and Table 6-111 list the command and response data.

Table 6-110 Get Digital I/O Minimum Presence True Period Command (000DH)

Get Digital I/O Minimum Presence True Period Command Data	Data Payload
Get Digital I/O Minimum Presence True Period Command	000DH

Table 6-111 Get Digital I/O Minimum Presence True Period Response

Set Digital I/O Minimum Presence True Period Response Data	Data Payload
Set Digital I/O Minimum Presence True Period Command	000DH
Minimum Presence True Period	0XH

Minimum Presence True Period — This field specifies the minimum presence true period (Table 6-112).

Table 6-112 Minimum Presence True Period Values

True Period Value	True Period (ms)
00H	0 (always true)
01H	4
02H	8

Table 6-112 Minimum Presence True Period Values

True Period Value	True Period (ms)
03H	12
04H	20
05H	24
06H	**32 (default)**
07H	48
08H	60
09H	92
0AH	152
0BH	300
0CH	452
0DH	600
0EH	752
0FH	Infinite (never true)

Set Digital I/O Sensor Input Inversion

This command sets the digital I/O sensor input inversion. Table 6-113 and Table 6-114 list the command and response data.

Table 6-113 Set Digital I/O Sensor Input Inversion Command (000EH)

Set Digital I/O Sensor Input Inversion Command Data	Data Payload
Set Digital I/O Sensor Input Inversion Command	000EH
Logic True Inversion: 0 = normal logic true, 1 = inverted logic true	0XH

Table 6-114 Set Digital I/O Sensor Input Inversion Command Response

Set Digital I/O Sensor Input Inversion Response Data	Data Payload
Set Digital I/O Sensor Input Inversion Command	000EH

The logic true inversion is in relationship with the OPTO22 digital input.

Get Digital I/O Sensor Input Inversion

This command gets the digital I/O sensor input inversion. Table 6-115 and Table 6-116 list the command and response data.

Table 6-115 Get Digital I/O Sensor Input Inversion Command (000FH)

Get Digital I/O Sensor Input Inversion Command Data	Data Payload
Get Digital I/O Sensor Input Inversion Command	000FH

Table 6-116 Get Digital I/O Sensor Input Inversion Response

Get Digital I/O Sensor Input Inversion Response Data	Data Payload
Get Digital I/O Sensor Input Inversion Command	000FH
Logic True Inversion: 0 = normal logic true, 1 = inverted logic true	0XH

The logic true inversion is in relationship with the OPTO22 digital input.

Set Digital I/O Port Configuration

This command configures the digital I/O ports. Table 6-117 and Table 6-118 list the command and response data.

Table 6-117 Set Digital I/O Port Configuration Command (0010H)

Set Digital I/O Port Configuration Command Data	Data Payload
Set Digital I/O Port Configuration Command	0010H
Port Configuration	0XH

Table 6-118 Set Digital I/O Port Configuration Response

Set Digital I/O Port Configuration Response Data	Data Payload
Set Digital I/O Port Configuration Command	0010H

Port Configuration — This field specifies the digital port input/output configuration. In Table 6-119, INPUT = 0 and OUTPUT = 1.

Table 6-119 Digital I/O Port Configuration Values

Configuration Value	Digital Port 3	Digital Port 2	Digital Port 1	Digital Port 0
00H	INPUT	INPUT	INPUT	INPUT
01H	INPUT	INPUT	INPUT	OUTPUT
02H	INPUT	INPUT	OUTPUT	INPUT
03H	INPUT	INPUT	OUTPUT	OUTPUT
04H	INPUT	OUTPUT	INPUT	INPUT
05H	INPUT	OUTPUT	INPUT	OUTPUT
06H	INPUT	OUTPUT	OUTPUT	INPUT
07H	INPUT	OUTPUT	OUTPUT	OUTPUT
08H	OUTPUT	INPUT	INPUT	INPUT
09H	OUTPUT	INPUT	INPUT	OUTPUT
0AH	OUTPUT	INPUT	OUTPUT	INPUT
0BH	OUTPUT	INPUT	OUTPUT	OUTPUT
0CH	OUTPUT	OUTPUT	INPUT	INPUT
0DH	OUTPUT	OUTPUT	INPUT	OUTPUT
0EH	OUTPUT	OUTPUT	OUTPUT	INPUT
0FH	OUTPUT	OUTPUT	OUTPUT	OUTPUT

Note: *RESET READER command required for changes to take effect.*

Get Digital I/O Port Configuration

This command gets the digital I/O port configuration settings. Table 6-120 and Table 6-121 list the command and response data.

Table 6-120 Get Digital I/O Port Configuration Command (0011H)

Get Digital I/O Port Configuration Command Data	Data Payload
Get Digital I/O Port Configuration Command	0011H

Table 6-121 Set Digital I/O Port Configuration Response

Get Digital I/O Port Configuration Response Data	Data Payload
Get Digital I/O Port Configuration Command	0011H
Port Configuration	0XH

Port Configuration — This field specifies the digital port input/output configuration. In Table 6-122, INPUT = 0 and OUTPUT = 1.

Table 6-122 Digital I/O Port Configuration Values

Configuration Value	Digital Port 3	Digital Port 2	Digital Port 1	Digital Port 0
00H	INPUT	INPUT	INPUT	INPUT
01H	INPUT	INPUT	INPUT	OUTPUT
02H	INPUT	INPUT	OUTPUT	INPUT
03H	INPUT	INPUT	OUTPUT	OUTPUT
04H	INPUT	OUTPUT	INPUT	INPUT
05H	INPUT	OUTPUT	INPUT	OUTPUT
06H	INPUT	OUTPUT	OUTPUT	INPUT
07H	INPUT	OUTPUT	OUTPUT	OUTPUT
08H	OUTPUT	INPUT	INPUT	INPUT
09H	OUTPUT	INPUT	INPUT	OUTPUT
0AH	OUTPUT	INPUT	OUTPUT	INPUT
0BH	OUTPUT	INPUT	OUTPUT	OUTPUT
0CH	OUTPUT	OUTPUT	INPUT	INPUT
0DH	OUTPUT	OUTPUT	INPUT	OUTPUT
0EH	OUTPUT	OUTPUT	OUTPUT	INPUT
0FH	OUTPUT	OUTPUT	OUTPUT	OUTPUT

Set Digital I/O Sensor Input Report

This command sets the digital I/O sensor input report mask. Table 6-123 and Table 6-124 list the command and response data.

Table 6-123 Set Digital I/O Sensor Input Report Command (0012H)

Set Digital I/O Sensor Input Report Command Data	Data Payload
Set Digital I/O Sensor Input Report Command	0012H
Sensor Input Report Mask: 0 = reports disabled, 1 = reports enabled	0XH

Table 6-124 Set Digital I/O Sensor Input Report Response

Set Digital I/O Sensor Input Report Response Data	Data Payload
Set Digital I/O Sensor Input Report Command	0012H

Get Digital I/O Sensor Input Report

This command gets the digital I/O sensor input report mask. Table 6-125 and Table 6-126 list the command and response data.

Table 6-125 Get Digital I/O Sensor Input Report Command (0013H)

Get Digital I/O Sensor Input Report Command Data	Data Payload
Get Digital I/O Sensor Input Report Command	0013H

Table 6-126 Set Digital I/O Sensor Input Report Response

Get Digital I/O Sensor Input Report Response Data	Data Payload
Get Digital I/O Sensor Input Report Command	0013H
Sensor Input Report Mask: 0 = reports disabled, 1 = reports enabled	0XH

Set Digital I/O Presence RF Control Algorithm

This command sets the digital I/O presence RF control algorithm. Table 6-127 and Table 6-128 list the command and response data.

Table 6-127 Set Digital I/O Presence RF Control Algorithm Command (0014H)

Set Digital I/O Presence RF Control Algorithm Command Data	Data Payload
Set Digital I/O Presence RF Control Algorithm Command	0014H
RF Control Algorithm	0XH

Table 6-128 Set Digital I/O Presence RF Control Algorithm Response

Set Digital I/O RF Control Response Data	Data Payload
Set Digital I/O Presence RF Control Algorithm Command	0014H

RF Control Algorithm — This field specifies the trigger for RF de-assertion.

Control Value	RF Power Off
00H	On time-out only
01H	Time-out or good tag read
02H	Time-out or presence false

Get Digital I/O Presence RF Control Algorithm

This command gets the digital I/O presence RF control algorithm. Table 6-129 and Table 6-130 list the command and response data.

Table 6-129 Get Digital I/O Presence RF Control Algorithm Command (0015H)

Get Digital I/O Presence RF Control Algorithm Command Data	Data Payload
Get Digital I/O Presence RF Control Algorithm Command	0015H

Table 6-130 Get Digital I/O Presence RF Control Algorithm Response

Get Digital I/O RF Control Response Data	Data Payload
Get Digital I/O Presence RF Control Algorithm Command	0015H
RF Control Algorithm	0XH

RF Control Algorithm — This field specifies the trigger for RF de-assertion.

Control Value	RF Power Off
00H	On time-out only
01H	Time-out or good tag read
02H	Time-out or presence false

Set Digital I/O Presence RF Control Time-out Period

This command sets the digital I/O presence RF control time-out period. Table 6-131 and Table 6-132 list the command and response data.

Table 6-131 Set Digital I/O Presence RF Control Time-out Period Command (0016H)

Set Digital I/O Presence RF Control Time-out Period Command Data	Data Payload
Set Digital I/O Presence RF Control Time-out Period Command	0016H
RF Assertion Duration	0XH

Table 6-132 Set Digital I/O Presence RF Control Time-out Period Response

Set Digital I/O Presence RF Control Time-out Period Response Data	Data Payload
Set Digital I/O Presence RF Control Time-out Period Command	0016H

RF Assertion Duration — This field specifies the RF assertion duration (time-out period) (Table 6-133).

Table 6-133 RF Assertion Duration Values

Duration Value	Assertion Duration (ms)
00H	0 (always true)
01H	20
02H	32
03H	60
04H	92
05H	152
06H	**300 (factory setting)**
07H	452
08H	600
09H	752
0AH	1500

Table 6-133 RF Assertion Duration Values

Duration Value	Assertion Duration (ms)
0BH	3000
0CH	6000
0DH	12000
0EH	24000
0FH	Infinite (never true)

Get Digital I/O Presence RF Control Time-out Period

This command gets the digital I/O presence RF control time-out period. Table 6-134 and Table 6-135 list the command and response data.

Table 6-134 Get Digital I/O Presence RF Control Time-out Period Command (0017H)

Get Digital I/O Presence RF Control Time-out Period Command Data	Data Payload
Get Digital I/O Presence RF Control Time-out Period Command	0017H

Table 6-135 Get Digital I/O Presence RF Control Time-out Period Response)

Get Digital I/O Presence RF Control Time-out Period Response Data	Data Payload
Get Digital I/O Presence RF Control Time-out Period Command	0017H
RF Assertion Duration	0XH

RF Assertion Duration — This field specifies the RF assertion duration (time-out period) (Table 6-136).

Table 6-136 RF Assertion Duration Values

Duration Value	Assertion Duration (ms)
00H	0 (always true)
01H	20
02H	32

Table 6-136 RF Assertion Duration Values

Duration Value	Assertion Duration (ms)
03H	60
04H	92
05H	152
06H	**300 (factory setting)**
07H	452
08H	600
09H	752
0AH	1500
0BH	3000
0CH	6000
0DH	12000
0EH	24000
0FH	Infinite (never true)

Get Digital I/O Port Status

This command gets the digital I/O port configuration and status. Table 6-137 and Table 6-138 list the command and response data.

Table 6-137 Get Digital I/O Port Status Command (0018H)

Get Digital I/O Port Status Command Data	Data Payload
Get Digital I/O Port Status Command	0018H

Table 6-138 Get Digital I/O Port Status Response

Get Digital I/O Port Status Response Data	Data Payload
Get Digital I/O Port Status Command	0018H
Port Configuration	0XH
Port Status	0XH

Port Configuration — This field specifies the digital port input/output configuration. In Table 6-139, INPUT = 0 and OUTPUT = 1.

Table 6-139 Port Configuration Values

Configuration Value	Digital Port 3	Digital Port 2	Digital Port 1	Digital Port 0
00H	INPUT	INPUT	INPUT	INPUT
01H	INPUT	INPUT	INPUT	OUTPUT
02H	INPUT	INPUT	OUTPUT	INPUT
03H	INPUT	INPUT	OUTPUT	OUTPUT
04H	INPUT	OUTPUT	INPUT	INPUT
05H	INPUT	OUTPUT	INPUT	OUTPUT
06H	INPUT	OUTPUT	OUTPUT	INPUT
07H	INPUT	OUTPUT	OUTPUT	OUTPUT
08H	OUTPUT	INPUT	INPUT	INPUT
09H	OUTPUT	INPUT	INPUT	OUTPUT
0AH	OUTPUT	INPUT	OUTPUT	INPUT
0BH	OUTPUT	INPUT	OUTPUT	OUTPUT
0CH	OUTPUT	OUTPUT	INPUT	INPUT
0DH	OUTPUT	OUTPUT	INPUT	OUTPUT
0EH	OUTPUT	OUTPUT	OUTPUT	INPUT
0FH	OUTPUT	OUTPUT	OUTPUT	OUTPUT

Port Status — This field specifies the digital port status. In Table 6-140, LOW = 0 and HIGH = 1.

Table 6-140 Port Status Values

Status Value	Digital Port 3	Digital Port 2	Digital Port 1	Digital Port 0
00H	LOW	LOW	LOW	LOW
01H	LOW	LOW	LOW	HIGH
02H	LOW	LOW	HIGH	LOW
03H	LOW	LOW	HIGH	HIGH
04H	LOW	HIGH	LOW	LOW

Table 6-140 Port Status Values

Status Value	Digital Port 3	Digital Port 2	Digital Port 1	Digital Port 0
05H	LOW	HIGH	LOW	HIGH
06H	LOW	HIGH	HIGH	LOW
07H	LOW	HIGH	HIGH	HIGH
08H	HIGH	LOW	LOW	LOW
09H	HIGH	LOW	LOW	HIGH
0AH	HIGH	LOW	HIGH	LOW
0BH	HIGH	LOW	HIGH	HIGH
0CH	HIGH	HIGH	LOW	LOW
0DH	HIGH	HIGH	LOW	HIGH
0EH	HIGH	HIGH	HIGH	LOW
0FH	HIGH	HIGH	HIGH	HIGH

Set Digital I/O Mode

This command sets the digital I/O start and stop modes. Table 6-141 and Table 6-142 list the command and response data.

Table 6-141 Set Digital I/O Mode Command (0019H)

Set Digital I/O Mode Command Data	Data Payload
Set Digital I/O Mode Command	0019H
Digital I/O Mode: 0 = stop, 1 = start	0XH

Table 6-142 Set Digital I/O Mode Response

Set Digital I/O Mode Response Data	Data Payload
Set Digital I/O Mode Command	0019H

Get Digital I/O Mode

This command gets the digital I/O mode. Table 6-143 and Table 6-144 list the command and response data.

Table 6-143 Get Digital I/O Mode Command (001AH)

Get Digital I/O Mode Command Data	Data Payload
Get Digital I/O Mode Command	001AH

Table 6-144 Get Digital I/O Mode Response

Get Digital I/O Mode Response Data	Data Payload
Get Digital I/O Mode Command	001AH
Digital I/O Mode: 0 = stop, 1 = start	0XH

Set External Interrupt Control

This command sets the external interrupt control for the digital I/O devices. Table 6-145 and Table 6-146 list the command and response data.

Table 6-145 Set External Interrupt Control Command (056DH)

Set External Interrupt Control Command Data	Data Payload
Bits 7–0	
Set External Interrupt Control Command	05H
Command (continued)	6DH
Lead time	XXH
Lead time (continued)	XXH
Lag time	XXH
Lag time (continued)	XXH
Polarity	XXH
Event Mode	XXH

Polarity — used to establish the polarity of the external interrupt

Bit Value	Event Type
0	Positive polarity (default)

Bit Value	Event Type
1	Negative polarity

Event Mode — specifies type of event

Lead and Lag Times — equal to 10 milliseconds multiplied by the decimal equivalent of the data payload

Event Mode Command Data								Data Payload
Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0	
Reserved			Second car entry enable	No tag read enable	Light curtain entry enable	Light curtain exit enable	Lag timer time-out enable	XXH

Table 6-146 Set External Interrupt Control Response

Set External Interrupt Control Response Data	Data Payload
Bits 7–0	
Set External Interrupt Control Command	05H
Command (continued)	6DH

Changing the polarity for a light curtain using the Set External Interrupt Control command after the polarity has been initially established requires that two digital I/O command group commands be sent prior to using the Set External Interrupt Control command. Issue the commands in the order shown in Table 6-147.

Table 6-147 Digital I/O Commands

Digital I/O Commands	Command Code
Set Digital I/O Mode	0019H
Set Digital I/O Sensor Input Inversion	000EH

When issuing these commands, ensure that the Digital I/O mode is stopped and the sensor input inversion command is set to inverted.

Note: *RESET READER command required for changes to take effect.*

Get External Interrupt Control

This command gets the external interrupt control for the digital I/O devices. Table 6-148 and Table 6-149 list the command and response data.

Table 6-148 Get External Interrupt Control Command (06ADH)

Get External Interrupt Control Command Data	Data Payload
Bits 7–0	
Get External Interrupt Control Command	06H
Command (continued)	ADH

Table 6-149 Get External Interrupt Control Response

Get External Interrupt Control Response Data	Data Payload
Bits 7–0	
Get External Interrupt Control Command	06H
Command (continued)	ADH
Lead time	XXH
Lead time (continued)	XXH
Lag time	XXH
Lag time (continued)	XXH
Polarity	XXH
Event Mode	XXH

Table 6-150 lists the light curtain asynchronous responses.

Table 6-150 Light Curtain Asynchronous Response (8003H)

Light Curtain Asynchronous Response Data	Data Payload
Bits 7–0	
Record Type (MSB)	80H
Record Type (LSB)	03H
Event	XXH

Table 6-150 Light Curtain Asynchronous Response (8003H)

Hour	XXH
Minute	XXH
Second	XXH
Hundredths of Seconds	XXH
Month	XXH
Day	XXH
Year	XXH

Event — This field specifies the event type.

Field Value	Event Type
01H	Lag timer time-out
02H	Light curtain exit
04H	Light curtain entry
08H	No tag read
10H	Second car entry

RF Transceiver Command Group Commands (2000H)

Table 6-151 lists the RF Transceiver Command Group commands that are used in the Orion multiprotocol reader.

Table 6-151 RF Transceiver Command Group Command

RF Transceiver Configuration Command	Command Code
Set Attenuation	51H
Get Attenuation	52H
Set Data Detect	53H
Get Data Detect	54H
Set Line Loss	55H

Table 6-151 RF Transceiver Command Group Command

RF Transceiver Configuration Command	Command Code
Get Line Loss	56H
Set Uplink Source Control	57H
Get Uplink Source Control	58H
Reserved	59H
Set Frequency in MHz	60H
Get Frequency in MHz	61H

RF Transceiver Command Group Responses

Table 6-152 lists the responses and codes for the RF transceiver command group.

Table 6-152 RF Tranceiver Command Group Responses

RF Transceiver Response	Response Code
Synchronous OK Status Responses	88XXH
Reserved	8800H
Reserved	8801H
Asynchronous OK Status Responses	48XXH
Command Complete	4800H
Command In Progress	4801H
Unsolicited OK Status Responses	28XXH
Reserved	84XXH
Reserved	44XXH
Reserved	24XXH

Table 6-152 RF Tranceiver Command Group Responses

RF Transceiver Response	Response Code
Synchronous Error Status Responses	82XXH
Message Length Error	8200H
Message Sequence Error	8201H
Reserved	8202H
Command Group Error	8203H
Reserved	8204H
Reserved	8205H
Reserved	8206H
Reserved	8207H
Reserved	8208H
Data Acknowledge Response Error	8209H
Reserved	820AH
Asynchronous Error Status Responses	42XXH
Message Length Error	4200H
Command Sequence Error	4201H
Reserved	4202H
Command Group Error	4203H
Command Time-out Error	4204H
Reserved	4205H
Command Failed Error	4206H
System Command Error	4207H
Sub-command Error	4208H
Reserved	4209H
Invalid Control Word Error	420AH

Table 6-152 RF Tranceiver Command Group Responses

RF Transceiver Response	Response Code
Unsolicited Error Status Responses	22XXH
Synchronous Control Status Responses	81XXH
Data Acknowledge (Ack), data valid	8100H
Data Negative Acknowledge (Nack), data invalid	8101H
Reserved	8102H
Reserved	8104H
Asynchronous Control Status Responses	41XXH
Unsolicited Control Status Responses	21XXH

RF Transceiver Command Group Response Data

Synchronous OK Status Responses

The following Digital I/O command group asynchronous OK status responses use the specified data payload.

Command Complete (4800H)

Command In Progress Response Data	Data Payload
Digital I/O Command Group Command (sub-command)	XXXXH

Command In Progress (4801H)

Command In Progress Response Data	Data Payload
Digital I/O Command Group Command (sub-command)	XXXXH

Synchronous Error Status Responses

The following RF Transceiver command group synchronous error status responses use the specified data payload.

Message Length Error Response Data (8200H)

Message Length Error Response Data	Data Payload
Expected Message Length	XXXXH
Received Message Length	XXXXH

Message Sequence Error Response Data (8201H)

Message Sequence Error Response Data	Data Payload
Expected Message Sequence Number	XXH
Received Message Sequence Number	XXH

Command Group Error Response Data (8203H)

Command Group Error Response Data	Data Payload
Invalid Command Group	XXXXH

Data Acknowledge Response Error Response Data (8209H)

Data Acknowledge Response Error Response Data	Data Payload
Invalid Data Acknowledge Response	XXXXH

Asynchronous Error Status Responses

The following RF Transceiver command group asynchronous error status responses use the specified data payload.

Message Length Error Response Data (4200H)

Message Length Error Response Data	Data Payload
Expected Message Length	XXXXH
Received Message Length	XXXXH

Command Sequence Error Response Data (4201H)

Command Sequence Error Response Data	Data Payload
Expected Command Sequence Number	XXH
Received Command Sequence Number	XXH

Command Group Error (4203H)

Command Group Error Response Data	Data Payload
Invalid Command Group	XXXXH

Command Time-out Error (4204H)

Command Time-out Error Response Data	Data Payload
N/A	

Command Failed Error (4206H)

Command Failed Error Response Data	Data Payload
RF Transceiver Command Group Command (sub-command)	XXXXH

System Command Error (4207H)

System Command Error Response Data	Data Payload
N/A	

Sub-Command Error (4208H))

Sub-Command Error Response Data	Data Payload
Sub-Command	XXH

Invalid Control Word Error (420AH)

Invalid Control Word Error Response Data	Data Payload
N/A	

Set RF Attenuation

This command sets the RF attenuation for the specific protocol from 0 to 15 decibels (dB) in 1-dB increments. Table 6-153 and Table 6-154 list the command and response data.

Table 6-153 Set RF Attenuation Command (51H)

Set RF Attenuation Command Data								Data Payload
Bit 7	**Bit 6**	**Bit 5**	**Bit 4**	**Bit 3**	**Bit 2**	**Bit 1**	**Bit 0**	
Set RF Attenuation Command								51H
Protocol				Reserved				X0H
Downlink Attenuation				Uplink Attenuation				XXH
Carriage Return								0DH

Table 6-154 Set RF Attenuation Response

Set RF Attenuation Response Data								Data Payload
Bit 7	**Bit 6**	**Bit 5**	**Bit 4**	**Bit 3**	**Bit 2**	**Bit 1**	**Bit 0**	
Set RF Attenuation Command								51H
Protocol				Reserved				X0H
ACK or NACK, where ACK = 0 and NACK = 1								0XH
Carriage Return								0DH

Protocol — This field sets the protocol for the RF Attenuation command

Protocol	Definition
2	IAG
3	CVISN
4	Title 21
8	ISO 18000-6C (EPC)

Get RF Attenuation

This command gets the RF attenuation as set using the Set RF Attenuation command. Table 6-155 and Table 6-156 list the command and response data.

Table 6-155 Get RF Attenuation Command (52H)

Get RF Attenuation Command Data								Data Payload
Bit 7	**Bit 6**	**Bit 5**	**Bit 4**	**Bit 3**	**Bit 2**	**Bit 1**	**Bit 0**	
Get RF Attenuation Command								52H
Protocol				Reserved				X0H
Carriage Return								0DH

Table 6-156 Get RF Attenuation Response

Get RF Attenuation Response Data								Data Payload
Bit 7	**Bit 6**	**Bit 5**	**Bit 4**	**Bit 3**	**Bit 2**	**Bit 1**	**Bit 0**	
Get RF Attenuation Command								52H
Protocol				Reserved				X0H
Downlink Attenuation				Uplink Attenuation				XXH
ACK or NACK, where ACK = 0 and NACK = 1								0XH
Carriage Return								0DH

Protocol — This field specifies the protocol for the Get RF Attenuation command.

Protocol	Definition
2	IAG
3	CVISN
4	Title 21
8	ISO 18000-6C (EPC)

Set Data Detect

This command sets the independent detection threshold levels for backscatter protocols of up to 20 dB in 1-dB increments via the command interface port. The respective protocol response is not passed until the data detect threshold has been exceeded. Table 6-157 and Table 6-158 list the command and response data.

Table 6-157 Set Data Detect Command (53H)

Set Data Detect Command Data								Data Payload
Bit 7	**Bit 6**	**Bit 5**	**Bit 4**	**Bit 3**	**Bit 2**	**Bit 1**	**Bit 0**	
Set Data Detect Command								53H
Protocol				Reserved				X0H
Data Detect Value (0–20)								XXH
Carriage Return								0DH

Table 6-158 Set Data Detect Response

Set Data Detect Response Data								Data Payload
Bit 7	**Bit 6**	**Bit 5**	**Bit 4**	**Bit 3**	**Bit 2**	**Bit 1**	**Bit 0**	
Set Data Detect Command								53H
Protocol				Reserved				X0H
ACK or NACK, where ACK = 0 and NACK = 1								0XH
Carriage Return								0DH

Protocol — This field sets the protocol for the Data Detect command.

Protocol	Definition

2	IAG
3	CVISN
4	Title 21
8	ISO 18000-6C (EPC)

Get Data Detect

This command gets the data detect value. Table 6-159 and Table 6-160 list the command and response data.

Table 6-159 Get Data Detect Command

Get Data Detect Command Data								Data Payload
Bit 7	**Bit 6**	**Bit 5**	**Bit 4**	**Bit 3**	**Bit 2**	**Bit 1**	**Bit 0**	
Get Data Detect Command								54H
Protocol				Reserved				X0H
Carriage Return								0DH

Table 6-160 Get Data Detect Response

Get Data Detect Response Data								Data Payload
Bit 7	**Bit 6**	**Bit 5**	**Bit 4**	**Bit 3**	**Bit 2**	**Bit 1**	**Bit 0**	
Get Data Detect Command								54H
Protocol				Reserved				X0H
Data Detect Value								XXH
ACK or NACK, where ACK = 0 and NACK = 1								0XH
Carriage Return								0DH

Protocol — This field specifies the protocol for the Data Detect command.

Protocol	Definition
2	IAG
3	CVISN

4	Title 21
8	ISO 18000-6C (EPC)

Set Line Loss

This command sets the Orion Reader system line loss value from 0 to 3 dB. Table 6-161 and Table 6-162 list the command and response data.

Note: *This command should be set only after you set the RF attenuation(s).*

Table 6-161 Set Line Loss Command (55H)

Set Line Loss Command Data	Data Payload
Bits 7–0	
Set Line Loss Command	55H
Line Loss Value (0, 1, 2, or 3)	0XH
Carriage Return	0DH

Table 6-162 Set Line Loss Response

Set Line Loss Response Data	Data Payload
Bits 7–0	
Set Line Loss Command	55H
Line Loss Value (0, 1, 2, or 3)	0XH
ACK or NACK, where ACK = 0 and NACK = 1	0XH
Carriage Return	0DH

Get Line Loss

This command gets the Orion Reader system line loss value. Table 6-163 and Table 6-164 list the command and response data.

Table 6-163 Get Line Loss Command (56H)

Get Line Loss Command Data	Data Payload
Bits 7–0	
Get Line Loss Command	56H
Carriage Return	0DH

Table 6-164 Get Line Loss Response

Get Line Loss Response Data	Data Payload
Bits 7–0	
Get Line Loss Command	56H
Line Loss Value (0, 1, 2, or 3)	0XH
ACK or NACK, where ACK = 0 and NACK = 1	0XH
Carriage Return	0DH

Set Uplink Source Control

The protocol-dependent Set Uplink Source Control command is used if the RF uplink needs to use the RF downlink frequency, that is, Title 21 while running step-lock. There are four uplink frequencies available. If more than four frequencies are needed, then the Uplink Source Control command must be used to provide the remaining needed frequencies with downlink frequency capability. Table 6-165 and Table 6-166 list the command and response data.

Table 6-165 Set Uplink Source Control Command (57H)

Set Uplink Source Control Command Data								Data Payload
Bit 7	**Bit 6**	**Bit 5**	**Bit 4**	**Bit 3**	**Bit 2**	**Bit 1**	**Bit 0**	
Set Uplink Source Control Command								57H
Protocol				Control				XXH

Table 6-165 Set Uplink Source Control Command (57H)

Set Uplink Source Control Command Data	Data Payload
Carriage Return	0DH

Table 6-166 Set Uplink Source Control Response

Set Uplink Source Response Data								Data Payload
Bit 7	**Bit 6**	**Bit 5**	**Bit 4**	**Bit 3**	**Bit 2**	**Bit 1**	**Bit 0**	
Set Uplink Source Control Command								57H
Protocol				Control				XXH
Acknowledge								00H
Carriage Return								0DH

Protocol — This field specifies the protocol for the Uplink Source Control command.

Protocol	Definition
2	IAG
3	CVISN
4	Title 21
8	ISO 18000-6C (EPC)

Control — This field specifies the protocol for the Uplink Source Control command.

Control	Definition
0	Use Uplink Source (source 2)
1	Use Uplink Source (source 1)

Get Uplink Source Control

The Get Uplink Source Control command retrieves the source control information. Table 6-167 and Table 6-168 list the command and response data.

Table 6-167 Get Uplink Source Control Command (58H)

Get Uplink Source Control Command Data								Data Payload
Bit 7	**Bit 6**	**Bit 5**	**Bit 4**	**Bit 3**	**Bit 2**	**Bit 1**	**Bit 0**	

Table 6-167 Get Uplink Source Control Command (58H)

Get Uplink Source Control Command Data		Data Payload
Get Uplink Source Control Command		58H
Protocol	Control	XXH
Carriage Return		0DH

Table 6-168 Get Uplink Source Control Response

Get Uplink Source Control Response Data								Data Payload
Bit 7	**Bit 6**	**Bit 5**	**Bit 4**	**Bit 3**	**Bit 2**	**Bit 1**	**Bit 0**	
Get Uplink Source Control Command								58H
Protocol				Control				XXH
Acknowledge								00H
Carriage Return								0DH

Protocol — This field specifies the protocol for the Source Control command

Protocol	Definition
2	IAG
3	CVISN
4	Title 21
8	ISO 18000-6C (EPC)

Control — This field specifies the Uplink Source.

Control	Definition
0	Uplink Source (source 2)
1	Uplink Source (source 1)

Set Frequency in MHz

Note: *Set the reader to Stop Mode 0 before issuing the Set Frequency in MHz command.*

This command is used to set the RF frequency of source 1 (downlink) and source2 (uplink). Table 6-169 and Table 6-170 list the command and response data.

Table 6-169 Set Frequency in MHz Command (60H)

Set Frequency in MHz Command Data								Data Payload
Bit 7	**Bit 6**	**Bit 5**	**Bit 4**	**Bit 3**	**Bit 2**	**Bit 1**	**Bit 0**	
Set Frequency in MHz Command								60H
Reserved							Source	0XH
Frequency Control MSB								XXH
Frequency Control LSB								XXH
Carriage Return								0DH

Table 6-170 Set Frequency in MHz Rresponse

Set Frequency in MHz Response Data								Data Payload
Bit 7	**Bit 6**	**Bit 5**	**Bit 4**	**Bit 3**	**Bit 2**	**Bit 1**	**Bit 0**	
Set Frequency in MHz Command								60H
Reserved							Source	0XH
Acknowledge								00H
Carriage Return								0DH

Source — This field sets the source for the RF Frequency Control.

Protocol	Definition
0	Source 1
1	Source 2

Frequency Control — Two-byte word to set frequency in 250-kHz steps starting at 800MHz. Examples of frequency settings are listed here.

Setting	Frequency
0118H	870.00 MHz
0198H	902.00 MHz

0199H	902.25 MHz
01E8H	922.00 MHz

Get Frequency in MHz

This command is used to get the RF frequency of source 1 (downlink) and source2 (uplink). Table 6-171 and Table 6-172 list the command and response data.

Table 6-171 Get Frequency in MHz Command (61H)

Get Frequency in MHz Command Data								Data Payload
Bit 7	**Bit 6**	**Bit 5**	**Bit 4**	**Bit 3**	**Bit 2**	**Bit 1**	**Bit 0**	
Get Frequency in MHz Command								61H
Reserved							Source	0XH
Carriage Return								0DH

Table 6-172 Get Frequency in MHz Response

Get Frequency in MHz Response Data								Data Payload
Bit 7	**Bit 6**	**Bit 5**	**Bit 4**	**Bit 3**	**Bit 2**	**Bit 1**	**Bit 0**	
Get Frequency in MHz Command								61H
Reserved							Source	0XH
Frequency Control MSB								XXH
Frequency Control LSB								XXH
Acknowledge								00H
Carriage Return								0DH

Source — This field sets the source for the RF Frequency Control

Protocol	Definition
0	Source 1
1	Source 2

Frequency Control — Two-byte word to set frequency in 250-kHz steps starting with 0000H at 800MHz. Examples of frequency settings are listed here.

Setting	Frequency
0118H	870.00 MHz
0198H	902.00 MHz

0199H	902.25 MHz
01E8H	922.00 MHz

Allowable Frequency Ranges by Protocol — There are permitted frequency ranges that are protocol-dependent. When operating within North America, the following are the *approved* defaulted uplink frequencies:

MIN_UL_FREQ1 902.25 MHz

MAX_UL_FREQ1 903.75 MHz

MIN_UL_FREQ2 910.00 MHz

MAX_UL_FREQ2 921.50 MHz

The downlink frequencies are protocol-dependent and are set to an allowable minimum and maximum range. The frequency range combinations of protocols must be set within these allowable frequency ranges.

IAG/CVSN MIN_FREQ 914.75 MHz

IAG/CVSN MAX_FREQ 916.75 MHz

T21 MIN_FREQ 912.75 MHz

T21 MAX_FREQ 918.75 MHz

Tag Transaction Configuration Command Group Commands (1000H)

Table 6-173 lists the Tag Transaction Configuration Command Group commands that are used in the Orion multiprotocol reader.

Table 6-173 Tag Transaction Configuration Command Group Commands

Tag Transaction Configuration Command	Command Code
Reserved	0000H to 0001H
Set Asynchronous Response Append Data	0002H
Get Asynchronous Response Append Data	0003H
Reserved	004H to 0024H
Set Manual Antenna Channel Control	002AH
Get Manual Antenna Channel Control	002BH
Get Configuration Table Version Number Command	002FH
Set IAG Slot	0030H
Get IAG Slot	0031H
Set Secondary Tag Sequence	0040H
Get Secondary Tag Sequence	0041H
Set Master/Slave Mode	0045H
Get Master/Slave Mode	0046H
Reserved	0047H to 0049H

Tag Transaction Configuration Command Group Responses

Table 6-174 lists the responses and codes for the Tag Transaction Configuration command group.

Table 6-174 Tag Transaction Configuration Command Group Responses

Tag Transaction Configuration Response	Response Code
Synchronous OK Status Responses	88XXH
Reserved	8800H
Reserved	8801H
Asynchronous OK Status Responses	48XXH
Command Complete	4800H
Command In Progress	4801H
Unsolicited OK Status Responses	28XXH
Reserved	84XXH
Reserved	44XXH
Reserved	24XXH
Synchronous Error Status Responses	82XXH
Message Length Error	8200H
Message Sequence Error	8201H
Reserved	8202H
Command Group Error	8203H
Reserved	8204H
Reserved	8205H

Table 6-174 Tag Transaction Configuration Command Group Responses

Tag Transaction Configuration Response	Response Code
Reserved	8206H
Reserved	8207H
Reserved	8208H
Data Acknowledge Response Error	8209H
Reserved	820AH
Asynchronous Error Status Responses	42XXH
Message Length Error	4200H
Command Sequence Error	4201H
Message Queue Full Error	4202H
Command Group Error	4203H
Command Time-out Error	4204H
Command Nack Error	4205H
Command Failed Error	4206H
System Command Error	4207H
Sub-Command Error	4208H
Data Acknowledge Time-out Error	4209H
Invalid Control Word Error	420AH
Invalid Command Data Error System	420BH
Unsolicited Error Status Responses	22XXH
Synchronous Control Status Responses	81XXH
Data Acknowledge (Ack), data valid	8100H
Data Negative Acknowledge (Nack), data invalid	8101H
Reserved	8102H
Reserved	8104H

Table 6-174 Tag Transaction Configuration Command Group Responses

Tag Transaction Configuration Response	Response Code
Asynchronous Control Status Responses	41XXH
Unsolicited Control Status Responses	21XXH

Tag Transaction Configuration Command Group Response Data

Asynchronous OK Status Responses

The following tag transaction configuration command group asynchronous OK status responses use the specified data payload.

Command Complete (4800H)

Command In Progress Response Data	Data Payload
TTC Command Group Command (sub-command)	XXXXH

Command In Progress (4801H)

Command In Progress Response Data	Data Payload
TTC Command Group Command (sub-command)	XXXXH

Synchronous Error Status Responses

The following tag transaction configuration command group synchronous error status responses use the specified data payload.

Message Length Error Response Data (8200H)

Message Length Error Response Data	Data Payload
Expected Message Length	XXXXH
Received Message Length	XXXXH

Message Sequence Error Response Data (8201H)

Message Sequence Error Response Data	Data Payload
Expected Message Sequence Number	XXH
Received Message Sequence Number	XXH

Command Group Error Response Data (8203H)

Command Group Error Response Data	Data Payload
Invalid Command Group	XXXXH

Data Acknowledge Response Error Response Data (8209H)

Data Acknowledge Response Error Response Data	Data Payload
Invalid Data Acknowledge Response	XXXXH

Asynchronous Error Status Responses

The following tag transaction configuration command group asynchronous error status responses use the specified data payload.

Message Length Error Response Data (4200H)

Message Length Error Response Data	Data Payload
Expected Message Length	XXXXH
Received Message Length	XXXXH

Command Sequence Error Response Data (4201H)

Command Sequence Error Response Data	Data Payload
Expected Command Sequence Number	XXH
Received Command Sequence Number	XXH

Command Group Error (4203H)

Command Group Error Response Data	Data Payload
Invalid Command Group	XXXXH

Command Time-out Error (4204H)

Command Time-out Error Response Data	Data Payload
N/A	

Command Failed Error (4206H)

Command Failed Error Response Data	Data Payload
TTC Command Group Command (sub-command)	XXXXH

System Command Error (4207H)

System Command Error Response Data	Data Payload
N/A	

Sub-Command Error (4208H)

Sub-Command Error Response Data	Data Payload
Sub-command	XXXXH

Invalid Control Word Error (420AH)

Invalid Control Word Error Response Data	Data Payload
N/A	

Invalid Command Data Error System (420BH)

Invalid Command Data Error System Response Data	Data Payload
N/A	

Set Asynchronous Response Append Data

This command sets the append time-stamp data control parameter for all asynchronous tag responses. Table 6-175 and Table 6-176 list the command and response data.

Table 6-175 Set Asynchronous Response Append Data Command (0002H)

Set Asynchronous Response Append Command		Data Payload
Bits 7–0		
Set Asynchronous Response Append Data Command (MSB)		00H
Set Asynchronous Response Append Data Command (LSB)		02H
Reserved	Append Data Control	0XH

Table 6-176 Set Asynchronous Response Append Data Response

Set Asynchronous Response Append Data Response	Data Payload
Bits 7–0	
Set Asynchronous Response Append Data Command (MSB)	00H
Set Asynchronous Response Append Data Command (LSB)	02H

Append data control — This field controls whether the date and time-stamp is appended to all tag asynchronous responses.

Append Data Control	Definition
0	Disable
1	Append time and date time-stamp

Formats for Time and Date Time-stamp

Table 6-177 lists the time and date time-stamp formats.

Table 6-177 Time and Date Time-Stamp Formats

Time and Date Time-stamp Format	Data Payload
Hours	XXH
Minutes	XXH
Seconds	XXH
Hundredths of Seconds	XXH
Month	XXH
Day	XXH
Year	XXH

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)

Get Asynchronous Response Append Data

This command gets the append time-stamp data control parameter for all asynchronous tag responses. Table 6-178 and Table 6-179 list the command and response data.

Table 6-178 Get Asynchronous Response Append Data Command (0003H)

Get Asynchronous Response Append Data Response	Data Payload
Bits 7–0	
Get Asynchronous Response Append Data Command (MSB)	00H
Get Asynchronous Response Append Data Command (LSB)	03H

Table 6-179 Get Asynchronous Response Append Data Response

Get Asynchronous Response Append Command								Data Payload
Bit 7	**Bit 6**	**Bit 5**	**Bit 4**	**Bit 3**	**Bit 2**	**Bit 1**	**Bit 0**	
Get Asynchronous Response Append Data Command (MSB)								00H
Get Asynchronous Response Append Data Command (LSB)								03H
Reserved							Append Data Control	0XH

Append Data Control — This field controls whether the time and date time-stamp is appended to all tag asynchronous responses.

Append Data Control	Definition
0	Disable
1	Append time and date time-stamp

Set Manual Antenna Channel Control

This command sets the reader's manual antenna channel control. Table 6-180 and Table 6-181 list the command and response data.

Table 6-180 Set Manual Antenna Channel Control Command (002AH)

Set Manual Antenna Channel Control Command	Data Payload
Bits 7–0	
Set Manual Antenna Channel Control Command	002AH
Channel Control	0XH

The channel control definitions are as follows:

Channel Control	Definition
01H	Channel 0 on
02H	Channel 1 on
03H	Channel 2 on
04H	Channel 3 on
05H	Disable manual channel control

Table 6-181 Set Manual Antenna Channel Control Response

Set Manual Antenna Channel Control Response Data	Data Payload
Bits 7–0	
Set Manual Antenna Channel Control Command	002AH

Get Manual Antenna Channel Control

This command gets the reader's manual antenna channel control. Table 6-182 and Table 6-183 list the command and response data.

Table 6-182 Get Manual Antenna Channel Control Command (002BH)

Get Manual Antenna Channel Control Command	Data Payload
Bits 7–0	
Get Manual Antenna Channel Control Command	002BH

Table 6-183 Get Manual Antenna Channel Control Response

Get Manual Antenna Channel Control Response Data	Data Payload
Bits 7–0	
Get Manual Antenna Channel Control Command	002BH
Channel Control	0XH

Get Universal Configuration Table Version Number

This command returns the version number of the Universal Configuration Table. It is one of two commands that are used in the Orion Reader to help support a single configuration file. Table 6-184 and Table 6-185 list the command and response data.

Precondition: None

Post Condition: Command takes effect immediately.

Table 6-184 Get Universal Configuration Table Version Number Command (002FH)

Get Universal Configuration Table Version Number Command Data								Data Payload
Bit 7	**Bit 6**	**Bit 5**	**Bit 4**	**Bit 3**	**Bit 2**	**Bit 1**	**Bit 0**	
Get Universal Configuration Table Version Number Command (MSB)								00H
Get Universal Configuration Table Version Number Command (LSB)								2FH

Table 6-185 Get Universal Configuration Table Version Number Response

Get Universal Configuration Table Version Number Response Data								Data Payload
Bit 7	**Bit 6**	**Bit 5**	**Bit 4**	**Bit 3**	**Bit 2**	**Bit 1**	**Bit 0**	
Get Universal Configuration Table Version Number Command (MSB)								00H
Get Universal Configuration Table Version Number Command (LSB)								2FH
Universal Configuration Table Version								XXH x 13

Set IAG Slot

The Set IAG Slot Command configures the downlink values used with IAG modes. Table 6-186 and Table 6-187 list the command and response data.

Table 6-186 Set IAG Slot Command (0030H)

Set IAG Slot Command Data	Data Payload
Bits 7–0	
Set IAG Slot Command (MSB)	00H
Set IAG Slot Command (LSB)	30H
Slot	0XH

Table 6-187 Set IAG Slot Response

Set IAG Slot Response Data	Data Payload
Bits 7–0	
Set IAG Slot Command (MSB)	00H
Set IAG Slot Command (LSB)	30H

Slot — The value of the downlink slot for setting up the IAG sequence, the value can be 1, 2, or 3.

1 = Downlink on slots 1 and 4

2 = Downlink on slots 2 and 5

3 = Downlink on slots 3 and 6

Get IAG Slot

The Get IAG Slot command returns the downlink values used with IAG modes. Table 6-188 and Table 6-189 list the command and response data.

Table 6-188 Get IAG Slot Command (0031H)

Get IAG Slot Command Data	Data Payload
Bits 7–0	
Get IAG Slot Command (MSB)	00H
Get IAG Slot Command (LSB)	31H

Table 6-189 Get IAG Slot Command Data Response

Get IAG Slot Response Data	Data Payload
Bits 7–0	
Get IAG Slot Command (MSB)	00H
Get IAG Slot Command (LSB)	31H
Slot	0XH

Slot — The value of the downlink slot for setting up the IAG sequence, the value can be 1, 2, or 3.

1 = Slots 1 and 4

2 = Slots 2 and 5

3 = Slots 3 and 6

Set Secondary Tag Sequence

The Set Secondary Tag Sequence Command specifies which tag sequence to run, which allows the user to select from a set of protocols and the respective Ack/No Ack. Table 6-190 and Table 6-191 list the command and response data.

Table 6-190 Set Secondary Tag Sequence Command (0040H)

Set Secondary Tag Sequence Command Data								Data Payload
Bit 7	**Bit 6**	**Bit 5**	**Bit 4**	**Bit 3**	**Bit 2**	**Bit 1**	**Bit 0**	
Set Secondary Tag Sequence Command (MSB)								00H
Set Secondary Tag Sequence Command (LSB)								40H
Reserved								00H
Protocol ID				Configuration ID				XXH
Antenna Number								0XH

Table 6-191 Set Secondary Tag Sequence Response

Set Secondary Tag Sequence Response Data	Data Payload
Bits 7–0	
Set Secondary Tag Sequence Command (MSB)	00H
Set Secondary Tag Sequence Command (LSB)	40H

Protocol — This field sets the protocol for the secondary tag sequence.

Protocol	Definition
4	Title 21

Configuration ID — This field sets the configuration ID for IT2200 and Title 21 protocols.

Configuration ID	Definition
0	No Ack
1	Ack

Antenna Number — This field specifies the antenna number, which ranges from 0 to 03H.

Note: *Reset the Orion Reader after setting the secondary tag sequence. See "Reset Reader" on page 6-24 for command information.*

Get Secondary Tag Sequence

The Get Secondary Tag Sequence Command retrieves the tag sequence. Table 6-192 and Table 6-193 list the command and response data.

Table 6-192 Get Secondary Tag Sequence Command (0041H)

Get Secondary Tag Sequence Command Data	Data Payload
Bits 7–0	
Get Secondary Tag Sequence Command (MSB)	00H
Get Secondary Tag Sequence Command (LSB)	41H
Protocol ID	0XH
Antenna Number	0XH

Table 6-193 Get Secondary Tag Sequence Response

Get Secondary Tag Sequence Response Data								Data Payload
Bit 7	**Bit 6**	**Bit 5**	**Bit 4**	**Bit 3**	**Bit 2**	**Bit 1**	**Bit 0**	
Get Secondary Tag Sequence Command (MSB)								00H
Get Secondary Tag Sequence Command (LSB)								41H

Table 6-193 Get Secondary Tag Sequence Response

Get Secondary Tag Sequence Response Data		Data Payload
Reserved		00H
Protocol ID	Configuration ID	XXH
Antenna Number		0XH

Protocol — This field gets the protocol for the secondary tag sequence.

Protocol	Definition
4	Title 21

Configuration ID — This field gets the configuration ID for IT2200 and Title 21 protocols.

Configuration ID	Definition
0	No Ack
1	Ack

Antenna Number — This field gets the antenna number, which ranges from 0 to 03H.

Set Master/Slave Mode

The Set Master/Slave Mode Command specifies which reader to set as master, which then enables all other readers as slaves. Table 6-194 and Table 6-195 list the command and response data.

Table 6-194 Set Master/Slave Mode Command (0045H)

Set Master/Slave Mode Command Data								Data Payload
Bit 7	**Bit 6**	**Bit 5**	**Bit 4**	**Bit 3**	**Bit 2**	**Bit 1**	**Bit 0**	
Set Master/Slave Mode Command (MSB)								00H
Set Master/Slave Mode Command (LSB)								45H
Reserved				GPS Primary	GPS Secondary	Master	Slave	0XH
Slave Select Count								XXH

Table 6-195 Set Master/Slave Mode Response

Set Master/Slave Mode Response Data	Data Payload
Bits 7–0	
Set Master/Slave Mode Command (MSB)	00H
Set Master/Slave Mode Command (LSB)	45H

Mode — This field sets the protocol for the secondary tag sequence.

Mode*	Data Payload
Slave	01
Master	02
GPS Secondary	04
GPS Primary	08

Note: **Select only one mode from this list.*

Choose one field only, for example, GPS primary, GPS secondary, master, or slave.

GPS Primary — This field specifies whether the reader is to be configured as the GPS primary.

GPS Primary	Definition
0	Not GPS Primary
1	GPS Primary

GPS Secondary — This field specifies whether the reader is to be configured as the GPS secondary.

GPS Secondary	Definition
0	Not GPS Secondary
1	GPS Secondary

Master — This field specifies whether the reader is to be configured as the master.

Master	Definition

0	Not Master
1	Master

Slave — This field specifies whether the reader is to be configured as the slave.

Slave	Definition
0	Not Slave
1	Slave

For this example, the sum of the delay and duration period is 19.9 milliseconds, which is less than the synchronization rate of 20 milliseconds. If the sum of the delay and duration periods equals the synchronization rate, unexpected results can occur.

Slave Select Count — This field specifies the order that a slave or GPS primary or secondary reader issues a synchronization pulse whenever a given reader within a synchronization group fails to recognize the signal from the preassigned master or whenever a GPS receiver fails to issue a 1-pps signal, respectively. The maximum slave count = 26.

Scenario 1 — One master, n slaves. The master has no slave behavior, therefore it is assigned a slave select count of 0. Each slave is assigned an increasingly greater number from 1 to n. When the master fails, slave 1 becomes the master, and so on.

Scenario 2 — GPS primary, GPS secondary, N slave readers. When in fault mode (1-pps signal missing), a GPS primary is slave to a GPS secondary and all other slaves and is assigned the last slave select count, n. A GPS secondary takes over when a GPS primary is in fault mode, therefore it is assigned a slave select count of 1. All slaves are assigned increasingly greater numbers from 2 to n+1.

Scenario 3 — One GPS primary and n slaves. This scenario forces the GPS primary to have no slave behavior by specifying a slave select count of 0. Each slave is an increasingly higher number from 1 to n. When the master fails, slave 1 becomes the master. If slave 1 should fail, slave 2 takes over, and so on (Table 6-196).

Table 6-196 Reader Slave Configuration Table

Scenario 1 — One Master, n Slaves						
Reader Mode	Master	Slave	Slave	Slave	Slave	Slave
Slave Select Count	0	1	2	…	n-1	n
Scenario 2 — GPS Primary, GPS Secondary, n Slaves						
Reader Mode	GPS Secondary	Slave	Slave	Slave	Slave	GPS Primary
Slave Select Count	1	2	3	…	n+1	n+2

Table 6-196 Reader Slave Configuration Table

Scenario 3 — One GPS Primary, n Slaves						
Reader Mode	GPS Primary	Slave	Slave	Slave	Slave	Slave
Slave Select Count	0	1	2	…	n-1	n
n = Total number of slave readers						

Get Master/Slave Mode

The Get Master/Slave Mode Command retrieves the reader that is set as master. Table 6-197 and Table 6-198 list the command and response data.

Table 6-197 Get Master/Slave Mode Command (0046H)

Get Master/Slave Mode Command Data	Data Payload
Bits 7–0	
Get Master/Slave Mode Command (MSB)	00H
Get Master/Slave Mode Command (LSB)	46H

Table 6-198 Get Master/Slave Mode Response Data

Get Master/Slave Mode Response Data								Data Payload
Bit 7	**Bit 6**	**Bit 5**	**Bit 4**	**Bit 3**	**Bit 2**	**Bit 1**	**Bit 0**	
Get Master/Slave Mode Command (MSB)								00H
Get Master/Slave Mode Command (LSB)								46H
Reserved				GPS Primary	GPS Secondary	Master	Slave	0XH
Slave Select Count								XXH

Mode — This field sets the protocol for the secondary tag sequence.

Mode*	Data Payload
Slave	01
Master	02
GPS Secondary	04
GPS Primary	08

Note: **Select only one mode from this list.*

Mode Command Group Commands (0400H)

Table 6-199 lists the Mode Command Group commands that are used to configure and operate the Orion multiprotocol reader in any of the modes.

Table 6-199 Mode Command Group Commands

Mode Command Group Command	Command Code
Set Mode	0001H
Get Mode	0002H
Set Protocol	0003H
Get Protocol	0004H
CVISN Enforcement Last Tag Status Reset	0043H
Set ISO 18000-6C (EPC) Configuration Data	0043H
Reserved	0052H
Reserved	0053H
Set Seen Count	0066H
Get Seen Count	0067H

Mode Command Group Responses

Table 6-200 lists the responses and codes for the Mode command group.

Table 6-200 Mode Command Group Responses

Mode Command Group Responses	Response Code
Synchronous OK Status Responses	88XXH
Reserved	8800H
Reserved	8801H
Asynchronous OK Status Responses	48XXH
Command Complete	4800H
Command In Progress	4801H
Unsolicited OK Status Responses	28XXH
Reserved	84XXH
Reserved	44XXH
Reserved	24XXH
Synchronous Error Status Responses	82XXH
Message Length Error	8200H
Message Sequence Error	8201H
Reserved	8202H
Command Group Error	8203H
Reserved	8204H
Reserved	8205H
Reserved	8206H
Reserved	8207H

Table 6-200 Mode Command Group Responses

Mode Command Group Responses	Response Code
Reserved	8208H
Data Acknowledge Response Error	8209H
Reserved	820AH
Asynchronous Error Status Responses	42XXH
Message Length Error	4200H
Command Sequence Error	4201H
Reserved	4202H
Command Group Error	4203H
Command Time-out Error	4204H
Reserved	4205H
Command Failed Error	4206H
System Command Error	4207H
Sub-Command Error	4208H
Reserved	4209H
Invalid Control Word Error	420AH
Invalid Command Data Error System	420BH
Unsolicited Error Status Responses	22XXH
Synchronous Control Status Responses	81XXH
Data Acknowledge (Ack), data valid	8100H
Data Negative Acknowledge (Nack), data invalid	8101H
Reserved	8102H
Reserved	8104H
Asynchronous Control Status Responses	41XXH

Table 6-200 Mode Command Group Responses

Mode Command Group Responses	Response Code
Unsolicited Control Status Responses	21XXH

Table 6-201 lists the mode command group asynchronous response codes and record types.

Table 6-201 Mode Command Group Asynchronous Responses

Mode Command Group Asynchronous Response	Response Code	Record Type
Reserved	4800H	3020H
Read Verify Page	4800H	3022H
Title 21 Read Response	4800H	3024H
Seen Frame Counter Error Report	4204H	3042H
Seen Frame Counter Report	4800H	3043H
Reserved	4204H	3044H
Reserved	4800H	2303H
Reserved	4204H	3040H
Reserved	4204H	3041H
CVISN Read Response	4800H	5014H
Reserved	4800H	5013H
IAG Read		5026H
IAG Cross-Lane Read		5027H

Mode Command Group Response Data

Asynchronous OK Status Responses

The following mode command group asynchronous OK status responses use the specified data payload.

Command Complete (4800H)

Command In Progress Response Data	Data Payload
Mode Command Group Command (sub-command)	XXXXH

Command In Progress (4801H)

Command In Progress Response Data	Data Payload
Mode Command Group Command (sub-command)	XXXXH

Synchronous Error Status Responses

The following mode command group synchronous error status responses use the specified data payload.

Message Length Error Response Data (8200H)

Message Length Error Response Data	Data Payload
Expected Message Length	XXXXH
Received Message Length	XXXXH

Message Sequence Error Response Data (8201H)

Message Sequence Error Response Data	Data Payload
Expected Message Sequence Number	XXH
Received Message Sequence Number	XXH

Command Group Error Response Data (8203H)

Command Group Error Response Data	Data Payload
Invalid Command Group	XXXXH

Data Acknowledge Response Error Response Data (8209H)

Data Acknowledge Response Error Response Data	Data Payload
Invalid Data Acknowledge Response	XXXXH

Asynchronous Error Status Responses

The following mode command group asynchronous error status responses use the specified data payload.

Message Length Error Response Data (4200H)

Message Length Error Response Data	Data Payload
Expected Message Length	XXXXH
Received Message Length	XXXXH

Command Sequence Error Response Data (4201H)

Command Sequence Error Response Data	Data Payload
Expected Command Sequence Number	XXH
Received Command Sequence Number	XXH

Command Group Error (4203H)

Command Group Error Response Data	Data Payload
Invalid Command Group	XXXXH

Command Time-out Error (4204H)

Command Time-out Error Response Data	Data Payload
N/A	

Command Failed Error (4206H)

Command Failed Error Response Data	Data Payload
Mode Command Group Command (sub-command)	XXXXH

System Command Error (4207H)

System Command Error Response Data	Data Payload
N/A	

Sub-Command Error (4208H)

Sub-Command Error Response Data	Data Payload
Sub-command	XXXXH

Invalid Control Word Error (420AH)

Invalid Control Word Error Response Data	Data Payload
N/A	

Invalid Command Data Error (420BH)

Invalid Command Data Error Response Data	Data Payload
N/A	

Set Mode

This command sets the Orion Reader to mode 88. Table 6-202 and Table 6-203 list the command and response data.

Table 6-202 Set Mode Command (0001H)

Set Mode Command Data	Data Payload
Bits 7–0	
Set Mode Command (MSB)	00H
Set Mode Command (LSB)	01H
Mode Number	58H

Table 6-203 Set Mode Response

Set Mode Command Response Data	Data Payload
Bits 7–0	
Set Mode Command (MSB)	00H
Set Mode Command (LSB)	02H
Mode Number	58H

Mode Number — This field identifies mode as 88.

Note: *RESET READER command required for changes to take effect.*

Get Mode

This command gets the Orion Reader mode. Table 6-204 and Table 6-205 list the command and response data.

Table 6-204 Get Mode Command (0002H)

Get Mode Command Data	Data Payload
Bits 7–0	
Get Mode Command (MSB)	00H
Get Mode Command (LSB)	02H

Table 6-205 Get Mode Command Response

Get Mode Command Response Data	Data Payload
Bits 7–0	
Get Mode Command (MSB)	00H
Get Mode Command (LSB)	02H
Mode Number	58H

Mode Number — This field identifies mode as 88.

Set Protocol

This command configures the Orion Reader to enable specified protocols. Table 6-206 and Table 6-207 list the command and response data.

Note: *Reset the Orion Reader after setting the protocol. See “Reset Reader” on page 6-24 for command information.*

Table 6-206 Set Protocol Command (0003H)

Set Protocol Command Data								Data Payload
Bits 7–0								
Set Protocol Command (MSB)								00H
Set Protocol Command (LSB)								03H
Reserved				6C (EPC)		CVISN	IAG Rsvd	0XH
IAG Read				Title 21			Reserved	XXH

Table 6-207 Set Protocol Response

Set Protocol Response Data	Data Payload
Bits 7–0	
Set Protocol Command (MSB)	00H
Set Protocol Command (LSB)	03H

Protocols — These fields specify the protocol to enable. The example shows two enabled protocols.

All protocols off	0000H
Enabling two protocols:	
6C (EPC)	0800H
Title 21	0008H
	0808H

Note: *RESET READER command required for changes to take effect.*

Get Protocol

This command retrieves the Orion Reader specified protocols. Table 6-208 and Table 6-209 list the command and response data.

Table 6-208 Get Protocol Command (0004H)

Set Protocol Command Data	Data Payload
Bits 7–0	
Get Protocol Command (MSB)	00H
Get Protocol Command (LSB)	04H

Table 6-209 Get Protocol Response

Set Protocol Response Data								Data Payload
Bits 7–0								
Get Protocol Command (MSB)								00H
Get Protocol Command (LSB)								04H
Reserved				6C (EPC)		CVISN	IAG Rsvd	0XH
IAG Read				Title 21			Reserved	XXH

Set Seen Count

This command records the number of times the Orion Reader reads a tag after the system has finished the complete transaction. Table 6-210 and Table 6-211 list the command and response data.

Table 6-210 Set Seen Count Command (0066H)

Set Seen Count Command Data								Data Payload
Bit 7	**Bit 6**	**Bit 5**	**Bit 4**	**Bit 3**	**Bit 2**	**Bit 1**	**Bit 0**	
Set Seen Count Command (MSB)								00H
Set Seen Count Command (LSB)								66H
Protocol								0XH
Seen Frame Counter in Sync Frames (MSB)								XXH
Seen Frame Counter in Sync Frames (LSB)								XXH

Table 6-210 Set Seen Count Command (0066H)

Uniqueness Counter in Sync Frames (MSB)	XXH
Uniqueness Counter in Sync Frames (LSB)	XXH

Table 6-211 Set Seen Count Response

Set Seen Count Response Data								Data Payload
Bit 7	**Bit 6**	**Bit 5**	**Bit 4**	**Bit 3**	**Bit 2**	**Bit 1**	**Bit 0**	
Set Seen Count Command (MSB)								00H
Set Seen Count Command (LSB)								66H
Protocol								0XH

Protocol — This field specifies the protocol for the counters.

Protocol	Definition
2	IAG
3	CVISN
4	Title 21
8	ISO 18000-6C (EPC)

Seen Frame Counter — Length of Seen Frame Counter in number of frames. Counts the specified number of Sync frames, then reports the Seen Count to the host. This field is used to vary the time interval between seen count messages.

Uniqueness Counter — Length of Uniqueness Counter in number of frames. This field removes a tag from the seen table when that tag has not been read for the specified number of Sync frames.

Get Seen Count

This command gets the seen count. Table 6-212 and Table 6-213 list the command and response data.

Table 6-212 Get Seen Count Command (0067H)

Get Seen Count Command Data								Data Payload
Bit 7	**Bit 6**	**Bit 5**	**Bit 4**	**Bit 3**	**Bit 2**	**Bit 1**	**Bit 0**	

Table 6-212 Get Seen Count Command (0067H)

Get Seen Count Command (MSB)	00H
Get Seen Count Command (LSB)	67H
Protocol	0XH

Table 6-213 Get Seen Count Response

Get Seen Count Response Data								Data Payload
Bit 7	**Bit 6**	**Bit 5**	**Bit 4**	**Bit 3**	**Bit 2**	**Bit 1**	**Bit 0**	
Get Seen Count Command (MSB)								00H
Get Seen Count Command (LSB)								67H
Protocol								0XH
Seen Frame Counter in Sync Frames (MSB)								XXH
Seen Frame Counter in Sync Frames (LSB)								XXH
Uniqueness Counter in Sync Frames (MSB)								XXH
Uniqueness Counter in Sync Frames (LSB)								XXH

Protocol — This field specifies the protocol for the counters.

Protocol	Definition
2	IAG
3	CVISN
4	Title 21
8	ISO 18000-6C (EPC)

Seen Frame Counter — Length of Seen Frame Counter in number of frames. Counts the specified number of Sync frames, then reports the Seen Count to the host. This field is used to vary the time interval between seen count messages.

Uniqueness Counter — Length of Uniqueness Counter in number of frames. This field removes a tag from the seen table when that tag has not been read for the specified number of Sync frames.

Diagnostic Command Group Commands (0200H)

Table 6-214 lists the Diagnostic Command Group commands that are used in the Orion multiprotocol reader.

Table 6-214 Diagnostic Command Group Commands

Diagnostic Command	Command Code
Get Diagnostic Status	0001H
Get Diagnostic Interface Status	0002H
Get Error Log	0003H
Get Number of Error Logs	0004H
Clear Error Logs	0005H
Reserved	0006H
Reserved	0007H

Diagnostic Command Group Responses

Table 6-215 lists the responses and codes for the Diagnostic Command Group.

Table 6-215 Diagnostic Command Group Responses

Diagnostic Response	Response Code
Synchronous OK Status Responses	88XXH
Reserved	8800H
Reserved	8801H
Asynchronous OK Status Responses	48XXH
Command Complete	4800H
Command In Progress	4801H
Unsolicited OK Status Responses	28XXH
Diagnostic Status Change OK Report	2810H

Table 6-215 Diagnostic Command Group Responses

Diagnostic Response	Response Code
Reserved	84XXH
Reserved	44XXH
Reserved	24XXH
Reserved	2410H
Synchronous Error Status Responses	82XXH
Message Length Error	8200H
Message Sequence Error	8201H
Reserved	8202H
Command Group Error	8203H
Reserved	8204H
Reserved	8205H
Reserved	8206H
Reserved	8207H
Reserved	8208H
Data Acknowledge Response Error	8209H
Reserved	820AH
Asynchronous Error Status Responses	42XXH
Message Length Error	4200H
Command Sequence Error	4201H
Reserved	4202H
Command Group Error	4203H
Command Time-out Error	4204H

Table 6-215 Diagnostic Command Group Responses

Diagnostic Response	Response Code
Reserved	4205H
Command Failed Error	4206H
System Command Error	4207H
Sub-Command Error	4208H
Reserved	4209H
Invalid Control Word Error	420AH
Unsolicited Error Status Responses	22XXH
Diagnostic Status Change Error Report	2210H
Synchronous Control Status Responses	81XXH
Data Acknowledge (Ack), data valid	8100H
Data Negative Acknowledge (Nack), data invalid	8101H
Reserved	8102H
Reserved	8104H
Asynchronous Control Status Responses	41XXH
Unsolicited Control Status Responses	21XXH

Diagnostic Command Group Response Data

Asynchronous OK Status Responses

The following diagnostic command group asynchronous OK status responses use the specified data payload.

Command Complete (4800H)

Command In Progress Response Data	Data Payload
Diagnostic Command Group Command (sub-command)	XXXXH

Command In Progress (4801H)

Command In Progress Response Data	Data Payload
Diagnostic Command Group Command (sub-command)	XXXXH

Synchronous Error Status Responses

The following diagnostic command group synchronous error status responses use the specified data payload.

Message Length Error Response Data (8200H)

Message Length Error Response Data	Data Payload
Expected Message Length	XXXXH
Received Message Length	XXXXH

Message Sequence Error Response Data (8201H)

Message Sequence Error Response Data	Data Payload
Expected Message Sequence Number	XXH
Received Message Sequence Number	XXH

Command Group Error Response Data (8203H)

Command Group Error Response Data	Data Payload
Invalid Command Group	XXXXH

Data Acknowledge Response Error Response Data (8209H)

Data Acknowledge Response Error Response Data	Data Payload
Invalid Data Acknowledge Response	XXXXH

Asynchronous Error Status Responses

The following diagnostic command group asynchronous error status responses use the specified data payload.

Message Length Error Response Data (4200H)

Message Length Error Response Data	Data Payload
Expected Message Length	XXXXH
Received Message Length	XXXXH

Command Sequence Error Response Data (4201H)

Command Sequence Error Response Data	Data Payload
Expected Command Sequence Number	XXH
Received Command Sequence Number	XXH

Command Group Error (4203H)

Command Group Error Response Data	Data Payload
Invalid Command Group	XXXXH

Command Time-out Error (4204H)

Command Time-out Error Response Data	Data Payload
N/A	

Command Failed Error (4206H)

Command Failed Error Response Data	Data Payload
Diagnostic Command Group Command (sub-command)	XXXXH

System Command Error (4207H)

System Command Error Response Data	Data Payload
N/A	

Sub-Command Error (4208H)

Sub-Command Error Response Data	Data Payload
Sub-command	XXXXH

Invalid Control Word Error (420AH)

Invalid Control Word Error Response Data	Data Payload
N/A	

Unsolicited Diagnostic Status Reports

Diagnostics supports the generation of the following unsolicited status message reports as defined by the response code (Table 6-216).

Table 6-216 Diagnostic Unsolicited Status Reports

Diagnostic Unsolicited Status Reports	Response Code
Diagnostic Status Change OK Report	2810H
Reserved	2410H
Diagnostic Status Change Error Report	2210H

Get Diagnostic Status

This command gets the current diagnostic status of the Orion Reader as defined by the Diagnostic Status Bit definitions that include FRAM test status, FPGA1/FPGA2 test status, digital board power supply status, RF transceiver status, GPS status, Sync status, communication link status, reset count, CPU firmware fault status, buffered tag transaction entries status, and error log entries status. Table 6-217 and Table 6-218 list the command and response data.

Table 6-217 Get Diagnostic Status Command (0001H)

Get Diagnostic Status Command Data	Data Payload
Get Diagnostic Status Command	0001H

Table 6-218 Get Diagnostic Status Response

Get Diagnostic Status Response Data	Data Payload
Get Diagnostic Status Command	0001H
Diagnostic Status (MSB)	XXH
Diagnostic Status	XXH
Diagnostic Status	XXH
Diagnostic Status	XXH
Diagnostic Status	XXH
Diagnostic Status	XXH
Diagnostic Status	XXH
Diagnostic Status (LSB)	XXH

Diagnostic Status Bit Definitions

Table 6-219 lists the bit definitions for the diagnostic status response.

Table 6-219 Diagnostic Status Bit Definitions

Bit	Diagnostic Status Bit Definition
63	Reserved
62	Reserved
61	Reserved
60	Reserved
59	Reserved
58	FRAM test status, where 0 = OK, 1 = error
57	FRAM data storage test status, where 0 = OK, 1 = error
56	Reserved
55	Reserved
54	Reserved
53	Reserved
52	Reserved
51	Reserved
50	FPGA1 test status, where 0 = OK, 1 = error
49	FPGA2 test status, where 0 = OK, 1 = error
48	Power supply status, where 0 = OK, 1 = error
47	Digital board overvoltage error, where 0 = no error, 1 = error
46	Digital board undervoltage error, where 0 = no error, 1 = error
45	Reserved
44	Reserved
43	RF transceiver ADC above maximum error, where 0 = no error, 1 = error
42	RF transceiver ADC below minimum error, where 0 = no error, 1 = error
41	RF transceiver ATTN DAC1 above maximum error, where 0 = no error, 1 = error
40	RF transceiver ATTN DAC1 below minimum error, where 0 = no error, 1 = error
39	RF transceiver ATTN DAC2 above maximum error, where 0 = no error, 1 = error
38	RF transceiver ATTN DAC2 below minimum error, where 0 = no error, 1 = error

Table 6-219 Diagnostic Status Bit Definitions

Bit	Diagnostic Status Bit Definition
37	RF transceiver DOM DAC above maximum error, where 0 = no error, 1 = error
36	RF transceiver DOM DAC below minimum error, where 0 = no error, 1 = error
35	RF transceiver source1 PLL unlocked error, where 0 = no error, 1 = error
34	RF transceiver source2 PLL unlocked error, where 0 = no error, 1 = error
33	RF transceiver uncalibrated error, where 0 = no error, 1 = error
32	RF transceiver 5VDC overvoltage error, where 0 = no error, 1 = error
31	RF transceiver 5VDC undervoltage error, where 0 = no error, 1 = error
30-23	Reserved
22	GPS T-RAIM alarm set, where 0 = alarm not set, 1 = alarm set
21	GPS self-test fault, where 0 = no fault, 1 = fault
20	GPS power-on fault, where 0 = no fault, 1 = fault
19	Sync two masters error, where 0 = no error, 1 = error
18	Sync master-slave error, where 0 = no error, 1 = error
17	Sync clock error, where 0 = no error, 1 = error
16	GPS window error, where 0 = no error, 1 = error
15	GPS one-PPS error, where 0 = no error, 1 = error
14	GPS communication link status, where 0 = link up, 1 = link down
13	Serial communication link status, where 0 = link up, 1 = link down
12	TCP/IP communication link status, where 0 = link up, 1 = link down
11	Serial debug communication link status, where 0 = link up, 1 = link down
10	RF transceiver communication link status, where 0 = link up, 1 = link down
9	Reserved
8	Reserved
7	Reset count (MSB)
6	Reset count
5	Reset count
4	Reset count (LSB)
3	CPU firmware fault, where 0 = no fault, 1 = fault

Table 6-219 Diagnostic Status Bit Definitions

Bit	Diagnostic Status Bit Definition
2	Reserved
1	Buffered tag transaction entries, where 0 = no entries, 1 = entries
0	Error log entries, where 0 = no entries, 1 = entries

Get Diagnostic Interface Status

This command gets the reader's current diagnostic interface software status. Table 6-220 and Table 6-221 list the command and response data.

Table 6-220 Get Diagnostic Interface Status Command (0002H)

Get Diagnostic Interface Status Command Data	Data Payload
Get Diagnostic Interface Status Command	0002H

Table 6-221 Get Diagnostic Interface Status Response

Get Diagnostic Interface Status Response Data	Data Payload
Get Diagnostic Interface Status Command	0002H
Module Number	XXXXH
Error Number	XXXXH

Get Error Log

This command gets the error log. The error log lists the errors in chronological order. Table 6-222 and Table 6-223 list the command and response data.

Table 6-222 Get Error Log Command (0003H)

Get Error Log Command Data	Data Payload
Get Error Log Command	0003H
Error Log Number	XXXXH

Table 6-223 Get Error Log Response

Get Error Log Response Data	Data Payload
Get Error Log Command	0003H
Error log number	XXXXH
Module number	XXXXH
Error number	XXXXH
Time stamp: hours	XXH
Time stamp: minutes	XXH

Table 6-223 Get Error Log Response

Get Error Log Response Data	Data Payload
Time stamp: seconds	XXH
Time stamp: hundredths of seconds	XXH
Time stamp: month	XXH
Time stamp: day	XXH
Time stamp: year	XXH

Get Number of Error Logs

This command gets the number of error logs. The error log overflow status is returned as 0 for no overflow or 1 for overflow. Table 6-224 and Table 6-225 list the command and response data..

Table 6-224 Get Number Error Logs Command (0004H)

Get Number of Error Logs Command Data	Data Payload
Get Number of Error Logs Command	0004H

Table 6-225 Get Number Error Logs Response

Get Number of Error Logs Response Data	Data Payload
Get Number of Error Logs Command	0004H
Number of error logs	XXXXH
Error log overflow status, where 0 = no overflow, 1 = overflow	XXH

Clear Error Logs

This command clears entries from the error log. Table 6-226 and Table 6-227 list the command and response data

Table 6-226 Clear Error Logs Command (0005H)

Clear Error Logs Command Data	Data Payload
Clear Error Logs Command	0005H
Clear Error Logs Control Word	A5A5H

Table 6-227 Clear Error Logs Response

Clear Error Logs Response Data	Data Payload
Clear Error Logs Command	0005H

7

Tag Responses

Chapter 7
Tag Responses

This chapter provides tag responses for transmission control protocol (TCP).

TCP Tag Responses

In general, the tag response is transmitted as the record type code and the tag response data. Response lengths vary depending on the tag response record type. The tag response record type communicates to the host the tag response type that the reader processed.

TCP Tag Response Field Definitions

Tag command processing allows the host-Orion® Reader interface to be more understandable and maintainable. All of the interfaces closely parallel the Orion Reader-to-tag interface. Tag processing responses are listed in Table 7-1.

Table 7-1 Tag Transaction Record Types

Record Type Code	Corresponding Tag Response
3024H	Title 21 Read Response
3043H	Seen Frame Counter Report
5014H	CVISN Read Response
5026H	IAG Read Response
5027H	IAG Cross-Lane Read Response
7000H	EPC Read Response
7010H	EPC + TID Read Response (Mode 89 Only)

Specific TCP Tag Responses

This section describes the various tag responses to requests.

Tag Data and CRC are used for parsing and format purposes only. The record types shown contain valid data.

Title 21 Read Response

The Title 21 Read Response is as follows: 3024<Data><CRC>. Table 7-2 lists the response data.

Table 7-2 Title 21 Read Response (3024H)

Title 21 Read Response Data									Data Payload
Field	**Bit 7**	**Bit 6**	**Bit 5**	**Bit 4**	**Bit 3**	**Bit 2**	**Bit 1**	**Bit 0**	
Record	Record Type (MSB)								30H
Record	Record Type (LSB)								24H
Data (MSB)	Tag Type (4 bits)				Facility Code (18 bits)				XXH
Data	Facility Code								
Data	Facility Code						Internal Tag ID		XXH
Data (LSB)	Internal Tag ID (10 bits)								XXH
CRC	CRC								XXH
CRC	CRC								XXH
Antenna							Antenna Number		0XH

Note: *A Title 21 response consists of a 0001 record type; however, there is a response code conflict with the Set Mode Command response (0001) in TCP. The Orion Reader addresses this conflict by replacing the 0001 Title 21 response code with a 3024 response code.*

Record Type

This field identifies the message as a Title 21 Read Response message. This field contains the following value: 3024H - Title 21 Read_Response.

Tag Type

This four-bit field is used to uniquely differentiate the State of California tags/transponders from those originating in other state agencies. Currently, the tag type value defaults to 0 (California). Values of 1 to 15 are unassigned at this time.

Internal Tag ID

This field contains the Title 21 ID for the responding tag.

CRC

This field contains the standard message CRC. The CRC is calculated for all data beginning with the transaction record type code and includes everything occurring previous to the error detection code field.

Facility Code

This field identifies the agency issuing the tags.

Title 21 Read Response Example:

Title 21 Tag Read Response	`30240FCE8E7DD4E400 0 258979 637`

where

`3024`	Title 21 tag response code
`0FCE8E7D`	32-bit tag ID
`D4E4`	CRC
`00`	Antenna number (single channel)
`0 258979 637`	Parsed Title 21 32-bit tag ID (decimal)

where

`0`	Tag type
`258979`	Facility code
`637`	Internal tag ID

CVISN Seen Frame Counter Report

This message reports the seen count value when the seen frame counter times out if the seen count is greater than zero for a tag listed in the table. The seen frame counter report is populated with a minimum of one tag and a maximum of eight tags. The report is always the same size. Active tags are packed in ascending order; the first active tag and associated seen count read from the FPGA firmware seen count table is placed in the report at tag ID 0. The first seen count field in the report (MSB and LSB) that is set to zero indicates the end of the active tag list in the report (Table 7-3).

Table 7-3 CVISN Seen Frame Counter Report (5012H)

CVISN Seen Frame Counter Report Data	Data Payload
Bits 7–0	
Record Type (MSB)	50H
Record Type (LSB)	12H
Protocol	0XH
Seen Count (MSB)	XXH
Seen Count (LSB)	XXH
Tag ID 0 (32 bits)	XXXXXXXXH
Seen Count (MSB)	XXH
Seen Count (LSB)	XXH
Tag ID 1 (32 bits)	XXXXXXXXH
Seen Count (MSB)	XXH
Seen Count (LSB)	XXH
Tag ID 2 (32 bits)	XXXXXXXXH
Seen Count (MSB)	XXH
Seen Count (LSB)	XXH
Tag ID 2 (32 bits)	XXXXXXXXH
Seen Count (MSB)	XXH
Seen Count (LSB)	XXH
Tag ID 3 (32 bits)	XXXXXXXXH
Seen Count (MSB)	XXH
Seen Count (LSB)	XXH

Table 7-3 CVISN Seen Frame Counter Report (5012H)

Tag ID 4 (32 bits)	XXXXXXXXH
Seen Count (MSB)	XXH
Seen Count (LSB)	XXH
Tag ID 5 (32 bits)	XXXXXXXXH
Seen Count (MSB)	XXH
Seen Count (LSB)	XXH
Tag ID 6 (32 bits)	XXXXXXXXH
Seen Count (MSB)	XXH
Seen Count (LSB)	XXH
Tag ID 7 (32 bits)	XXXXXXXXH

Seen Frame Counter Report

This message is use to report the value of the Seen Count when the Seen Frame Counter times out and if the Seen Count is greater than zero. The Seen Frame Counter Response is as follows: `3043<Data><CRC>` Table 7-4 lists the response data.

Table 7-4 Seen Frame Counter Report (3043H)

Seen Frame Counter Report		Data Payload
Field	**Bits 7–0**	
Record	Record Type (MSB)	30H
Record	Record Type (LSB)	43H
Data	Protocol	0XH
Data	Seen Count (MSB)	XXH
Data	Seen Count (LSB)	XXH
Antenna	Antenna	0XH

Protocol — This field specifies the protocol for the counters.

Protocol	Definition
2	IAG
3	CVISN
4	Title 21
8	ISO 18000-6C (EPC)

CVISN Read Response

The CVISN Read Response format is as follows: 5014<Data><CRC>. Table 7-5 lists the response data.

Table 7-5 CVISN Read Response (5014H)

CVISN Read Response Data		Data Payload
Field	**Bits 7–0**	
Record	Record Type (MSB)	50H
Record	Record Type (LSB)	14H

Table 7-5 CVISN Read Response (5014H) (continued)

Data	Valid Tag 1	0000H/0001H
Data	Valid Tag 2	0000H/0001H
Data	Valid Tag 3	0000H/0001H
Data	Valid Tag 4	0000H/0001H
Data	Transponder Message and Message Type Tag 1 (not used)	XXH
Data	Transponder ID Tag 1	XXXX.XXXXH
CRC	CRC Tag 1	XXXXH
Data	Tag Type Indicator (Toll Tag = 01H)	XXH
Data	Transponder Message and Message Type Tag 2 (not used)	XXH
Data	Transponder ID Tag 2	XXXX.XXXXH
CRC	CRC Tag 2	XXXXH
Data	Tag Type Indicator (Toll Tag = 01H)	XXH
Data	Transponder Message and Message Type Tag 3 (not used)	XXH
Data	Transponder ID Tag 3	XXXX.XXXXH
CRC	CRC Tag 3	XXXXH
Data	Tag Type Indicator (Toll Tag = 01H)	XXH
Data	Transponder Message and Message Type Tag 4 (not used)	XXH
Data	Transponder ID Tag 4	XXXX.XXXXH
CRC	CRC Tag 4	XXXXH
Data	Tag Type Indicator (Toll Tag = 01H)	XXH
Antenna	Antenna Number	XXH

The valid tags are set to 0 for tag not in frame slot and 1 for tag in frame slot. The transponder message is the high-order nibble and the message type tag is the low-order nibble. This byte is passed with each tag but currently is not used. The transponder ID tag is the identifier read from the tag. There may be one to four tags read for a given response. A read with no transponder ID tags is not forwarded to the host. The reader also presents a tag's CRC to the host as part of the response in the CRC field.

IAG Read Response

The IAG Read Response format is as follows: 5026<Data><CRC>. Table 7-6 lists the response data.

Table 7-6 IAG Read Response Data Parameters (5026H)

IAG Read Response									Data Payload
Field	**Bit 7**	**Bit 6**	**Bit 5**	**Bit 4**	**Bit 3**	**Bit 2**	**Bit 1**	**Bit 0**	
Record	Record Type (MSB)								50H
Record	Record Type (LSB)								26H
	Read Only Partition								
Data	Header (3 bits)			Tag Type (3 bits)			App ID (3 bits)		XXH
Data	App ID	Group ID (7 bits)							XXH
Data	Agency ID (7 bits)							Ser Num	XXH
Data	Serial Number (24 bits)								XXH
Data	Serial Number								XXH
Data	Serial Number							V. Class	XXH
Data	Vehicle Class (11 bits)								XXH
Data	Vehicle Class		Revenue Type (4 bits)				C. S.	M. L.	XXH
Data	M. L.		Agency Data 1 (3 bits)			ISTHA Class (4 bits)			XXH
Data	Agency Data 2 (24 bits)								XXH
Data	Agency Data 2								XXH
Data	Agency Data 2								XXH
	Read/Write Partition								
Data	Reader ID (12 bits)								XXH
Data	Reader ID				TM Date (9 bits)				XXH
Data	TM Date					TM Time (17 bits)			XXH
Data	TM Time								XXH
Data	TM Time						Agency ID (7 bits)		XXH
Data	Agency ID					Plaza ID (7)			XXH
Data	Plaza ID				Lane ID (5 bits)				XXH
Data	Lane ID	Data (9 bits)							XXH

Table 7-6 IAG Read Response Data Parameters (5026H) (continued)

IAG Read Response									Data Payload
Field	**Bit 7**	**Bit 6**	**Bit 5**	**Bit 4**	**Bit 3**	**Bit 2**	**Bit 1**	**Bit 0**	
Data	Date			Time (17 bits)					XXH
Data	Time								XXH
Data	Time				Vehicle Class (11 bits)				XXH
Data	Vehicle Class						Future (4 bits)		XXH
Data	Future		Agency Data (30 bits)						XXH
Data	Agency Data								XXH
Data	Agency Data								XXH
Data	Agency Data								XXH
Data	Transaction Number (16 bits)								XXH
Data	Transaction Number								XXH
CRC	CRC								XXH
CRC	CRC								XXH
Antenna							Antenna		

IAG Read Response Example

`#5026ECC11E01FCB21200010587052DBAAAD1607852D89687D54E03060001AAFB5983`

where

`5026` IAG Read Record Type, 2 bytes in hex

Note: *Due to overlap of byte boundaries by tag data fields, all further data breakdown will be in binary.*

Hex tag data:

`MSB ECC11E01FCB21200 010587052DBAAAD1 607852D89687D54E 03060001AAFB5983 LSB`

32 bytes tag data*8 bits/byte = 256 bits

32 bytes/8 bytes per line = 4 lines

256 bits/4 lines = 64 bits/line from MSB to LSB

MSB

```
1110110011000001000111100000000111111100101100100001001000000000
0000000100000101100001110000010100101101101110101010101011010001
0110000001111000010100101101100010010110100001111101010101001110
000000011000001100000000000000000110101010111110110101100110000011     LSB
```

Response breakdown is from MSB to LSB, starting with the header field and ending with the CRC.

Read-Only Partition

Field (# of bits)	:	Bit Pattern	:	Decimal
Header (3 bits)	:	111	:	7
Tag Type (3 bits)	:	011	:	3
Application ID (3 bits)	:	001	:	1
Group ID (7 bits)	:	1000001	:	65
Agency ID (7 bits)	:	0001111	:	15
Serial Number (24 bits)	:	000000001111111001011001	:	65113
Vehicle Class (11 bits)	:	00001001000	:	72
Revenue Type (4 bits)	:	0000	:	0
Commission Status (1 bit)	:	0	:	0
Mounting Location (2 bits)	:	00	:	00
Agency Data 1 (3 bits)	:	000	:	000
ISTHA Class (4 bits)	:	0001	:	1
Agency Data 2 (24 bits)	:	000001011000011100000101	:	362245

Read/Write Partition

Field (# of bits)	:	Bit Pattern	:	Decimal
Reader ID (12 bits)	:	001011011011	:	731
TM Date (9 bits)	:	101010101	:	341
TM Time (17 bits)	:	01011010001011000	:	46168
Agency ID (7 bits)	:	0001111	:	15
Plaza ID (7 bits)	:	0000101	:	5
Lane ID (5 bits)	:	00101	:	5
Date (9 bits)	:	101100010	:	354

Time (17 bits)	:	01011010000111110	:	46142
Vehicle Class (11 bits)	:	10101010011	:	1363
Future (4 bits)	:	1000	:	8
Agency Data (30 bits)	:	000011000000110000000000000001	:	50724865
Transaction Number (16 bits)	:	1010101011111011	:	43771
CRC (16 bits)	:	0101100110000011	:	22915

IAG Cross-Lane Read Response

The IAG Cross-Lane Read Response format is as follows: 5027<Data><CRC>. Table 7-7 lists the response data.

Table 7-7 IAG Cross-Lane Read Response (5027H)

IAG Cross-Lane Read Response									Data Payload
Field	**Bit 7**	**Bit 6**	**Bit 5**	**Bit 4**	**Bit 3**	**Bit 2**	**Bit 1**	**Bit 0**	
Record	Record Type (MSB)								50H
Record	Record Type (LSB)								27H
	Read-Only Partition								
Data	Header (3 bits)			Tag Type (3 bits)			App. ID (3 bits)		XXH
Data	App ID	Group ID (7 bits)							XXH
Data	Agency ID (7 bits)							Ser Num	XXH
Data	Serial Number (24 bits)								XXH
Data	Serial Number								XXH
Data	Serial Number							V. Class	XXH
Data	Vehicle Class (11 bits)								XXH
Data	Vehicle Class		Revenue Type (4 bits)				C. S.	M. L	XXH
Data	M. L.	Agency Data 1 (3 bits)			ISTHA Class (4 bits)				XXH
Data	Agency Data 2 (24 bits)								XXH
Data	Agency Data 2								XXH
Data	Agency Data 2								XXH
	Read/Write Partition								

Table 7-7 IAG Cross-Lane Read Response (5027H) (continued)

IAG Cross-Lane Read Response									Data Payload
Field	**Bit 7**	**Bit 6**	**Bit 5**	**Bit 4**	**Bit 3**	**Bit 2**	**Bit 1**	**Bit 0**	
Data	Reader ID (12 bits)								XXH
Data	Reader ID				TM Date (9 bits)				XXH
Data	TM Date					TM Time (17 bits)			XXH
Data	TM Time								XXH
Data	TM Time						Agency ID (7 bits)		XXH
Data	Agency ID					Plaza ID (7)			XXH
Data	Plaza ID				Lane ID (5 bits)				XXH
Data	Lane ID	Date (9 bits)							XXH
Data	Date		Time (17 bits)						XXH
Data	Time								XXH
Data	Time				Vehicle Class (11 bits)				XXH
Data	Vehicle Class						Future (4 bits)		XXH
Data	Future		Agency Data (30 bits)						XXH
Data	Agency Data								XXH
Data	Agency Data								XXH
Data	Agency Data								XXH
Data	Transaction Number (16 bits)								XXH
Data	Transaction Number								XXH
CRC	CRC								XXH
CRC	CRC								XXH
Antenna							Antenna Number		

IAG Cross-Lane Read Response Example

The IAG Cross-Lane Read Response example is

`#5027ECC11E01FCB21200010587052DBAAAD1607852D89687D54E03060001AAFB5983`

where

`5027` IAG Cross-Lane Read Record Type, 2 bytes in hex

Note: *Due to overlap of byte boundaries by tag data fields, all field breakdowns are in binary.*

Hex tag data:

`MSB ECC11E01FCB21200 010587052DBAAAD1 607852D89687D54E 03060001AAFB5983 LSB`

32 bytes tag data*8 bits/byte = 256 bits

32 bytes/8 bytes per line = 4 lines

256 bits/4 lines = 64 bits/line from MSB to LSB

```
MSB 1110110011000001000111100000000111111100101100100001001000000000
    0000000100000101100001110000010100101101101110101010101011010001
    0110000001111000010100101101100010010110100001111101010101001110
    0000001100000110000000000000000110101010111110110101100110000011   LSB
```

Response breakdown is from MSB to LSB, starting with the header field and ending with the CRC.

Read-Only Partition

Field (# of bits)	:	Bit Pattern	:	Decimal
Header (3 bits)	:	111	:	7
Tag Type (3 bits)	:	011	:	3
Application ID (17 bits)	:	001	:	1
Group ID (7 bits)	:	1000001	:	65
Agency ID (7 bits)	:	0001111	:	15
Serial Number (24 bits)	:	000000001111111001011001	:	65113
Vehicle Class (11 bits)	:	00001001000	:	72
Revenue Type (4 bits)	:	0000	:	0
Commission Status (11 bits)	:	0	:	0
Mounting Location (2 bits)	:	00	:	00
Agency Data 1 (3 bits)	:	000	:	000
ISTHA Class (4 bits)	:	0001	:	1
Agency Data 2 (24 bits)	:	000001011000011100000101	:	362245

```
Read/Write Partition
```

Field (# of bits)	:	Bit Pattern	:	Decimal
Reader ID (12 bits)	:	001011011011	:	731
TM Date (9 bits)	:	101010101	:	341
TM Time (17 bits)	:	01011010001011000	:	46168
Agency ID (7 bits)	:	0001111	:	15
Plaza ID (7 bits)	:	0000101	:	5
Lane ID (5 bits)	:	00101	:	5
Date (9 bits)	:	101100010	:	354
Time (17 bits)	:	01011010000111110	:	46142
Vehicle Class (11 bits)	:	10101010011	:	1363
Future (4 bits)	:	1000	:	8
Agency Data (30 bits)	:	000011000000110000000000000001	:	50724865
Transaction Number (16 bits)	:	1010101011111011	:	43771
CRC (16 bits)	:	0101100110000011	:	22915

8

Configuring the Lane

Chapter 8

Configuring the Lane

This chapter provides information on the importance of lane tuning for optimum automatic vehicle identification (AVI) system performance. This chapter also describes the Orion® Reader functions and features that can assist you in tuning an AVI lane.

Why You Need to Configure a Lane

Lane configuration optimizes the radio frequency (RF) characteristics and signal timing of an AVI-equipped toll lane to maximize the performance prescribed 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 adjustment 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
- 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
- Varying tag environments

These factors may vary within an installation and from lane to lane within the same plaza.The tag protocol types used at an installation play a significant role in configuring the lanes for operation. Knowing the appropriate factors and available tools is necessary for the set-up and troubleshooting of AVI lanes.

Marking the Read Zone

The area where the Orion Reader reads tags at the current RF range is called the read zone. The antenna pattern, or read zone, of the Orion Reader would look roughly like a pear-shaped balloon if you were able to see it. When installing the toll antenna, you should first mark the unit's read zone using the RF range set at the factory-default maximum.

If two toll antennas are installed near each other, Star Systems recommends that you fine-tune each reader for the ideal read zone before connecting it permanently to sense input/sense output and communications cables.

Required Supplies

You need the following supplies to mark the read zone:

- Test tags, supplied by the Star Systems dealer or distributor
- Audible circuit tester and 9V DC battery for circuit tester power as described in the section
- Piece of chalk or roll of tape
- Plastic or wooden yardstick for tags
- Vinyl electrical tape or hook-and-loop material

Guidelines

Note: *Using test tags that are not mounted to vehicles give a general idea of the read pattern, but the pattern will vary somewhat when actual vehicles with tags are tested. Final adjustments must be made with tags properly mounted on a variety of vehicles.*

To mark the read zone

1. Turn on continuous RF power using the #6411 command.
2. Secure the test tag to the end of the yardstick using electrical tape or hook-and-loop material. Be sure the tag polarization (horizontal or vertical alignment) matches that of the toll antenna.
3. Stand directly in front of and about 5 feet (1.5 m) away from the overhead toll antenna. Hold the stick so that the tag is positioned at a height and angle consistent with a tag installed on a vehicle. The audible tester sounds upon tag read. If the tester does not sound, try a different tag. If the tester still does not sound, verify that the tester is working correctly and retest the tag.

   Note: *If you hold the test tag in your hand, your hand absorbs the RF signal and the test results are not accurate.*
4. Mark the spot with chalk or tape.
5. Move to the left until the sound stops and mark the ground with chalk or tape at the location of the tag when the sound stopped.
6. Return to the center and then move to the right until the sound stops and mark the ground with chalk or tape at the location of the tag when the sound stopped.
7. Return to the center and step backward 2 feet (0.6 m) and repeat steps 5 through 7.

8. Continue moving the tag in this manner, placing marks on the ground to identify the boundary of the read zone each time the sound stops. Continue moving the tag to various locations until the read zone is fully marked.

9. You can now connect the outer marks to draw the outer boundary of the read zone.

   Figure 8-1 is a view of a sample read zone within a controlled lane. The outer *X* marks show the outside edges of the read zone.

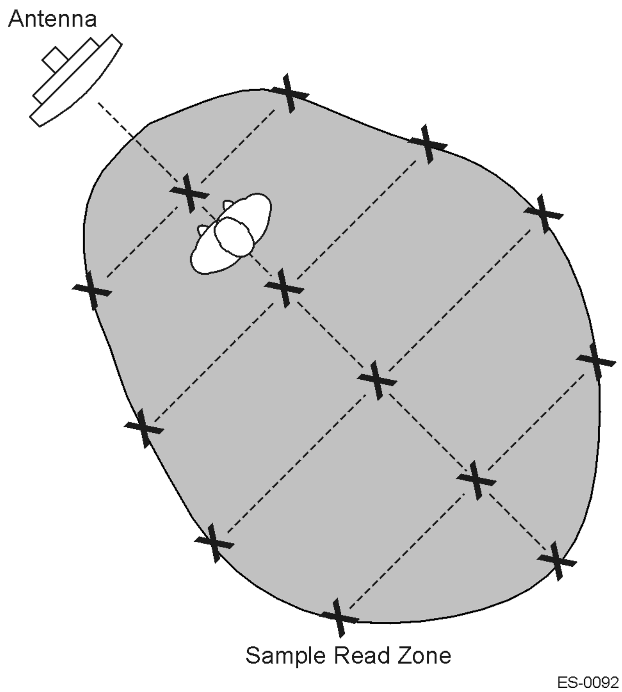

Figure 8-1 Sample Read Zone Marking Pattern

10. Standing at the farthest point of the pattern, walk toward the toll antenna and listen for a continuous sound from the audible tester. If the sound is not continuous, it could indicate a weak or *patchy* RF pattern.

    Use the appropriate TCP command (Set RF Attenuation (0051H) or Set Data Detect (0053H) or both) to adjust the footprint for the installation's tag protocols. To decrease the size of the footprint, increase the attenuation, which lowers the transmit RF power.

Lane Configuration Examples

This section presents starting values for lane configuration parameters that can be used for various protocol combinations. The tables do not represent all of the possible protocol combinations available with the Orion Reader, but they provide a framework for developing installation-specific configuration parameters.

Lane Configuration Parameters for Title 21 Protocols

To configure the reader for initial use reading Title 21 protocols, set the recommended starting values for the parameters listed in Table 8-1.

Table 8-1 Initial Configuration Parameters for Title 21 Protocols

Parameter	Recommended Starting Value
Protocol Selection	Title 21
Enable Sequence	Title 21 → Ack or Nack → Antenna → Set
[c]*Tag ID*	*8-byte tag request ID; however, it is not used in Mode 88 so value should be set to 0000000000000000H*
[c]*Command Control*	*Always set to 00H for GSE*
[c]*Page Data*	*Contains 8 bytes of configurable comparison data. Set to 0 by default*
[c]*Antenna*	*Set antenna with values between 0 to 0FH. Set to 0 by default*
[c]*Address*	*Tag memory address for byte mask. Tag memory address varies, so values for this field may vary*
[c]*Mask*	*Set mask to desired bit, range = 0–FF*
[c]*Start Address*	*Set to 00H*
[c]*Command Depth*	*Set to 00H*
Reset	Reset reader for changes to take effect
Downlink Frequency	Set downlink frequency to 916.00 dB
Uplink Frequency	Set uplink frequency to 903.00 dB
Title 21 Downlink Attenuation	Set Attenuation so that the line loss and attenuation value = 10 dB
Title 21 Uplink Attenuation	Set Attenuation so that the line loss and attenuation value = 0 dB
Retry Count	Recommend setting of 5 for all required retry counts
Title 21 Data Detect	Set to 0 dB
Title 21 Seen Count	Set to 10 (every 140 ms) for both tag types
Title 21 Uniqueness Count	Set to 1000 every 140 seconds for both tag types
Line Loss	Set the RF cable loss (line loss from reader to antenna) to the nearest dB value or 0, 1, 2, or 3

9

System Diagnostics and Preventive Maintenance

Chapter 9

System Diagnostics and Preventive Maintenance

This chapter provides information on diagnosing problems with the Orion® Reader components and schedule and instructions for preventive maintenance.

Error Indicators

The Orion Reader has light-emitting diodes (LED) that display operational functions and error conditions. Figure 9-1 shows the LED locations.

Note: *The NEMA box must be open in order to view the Operational LEDs.*

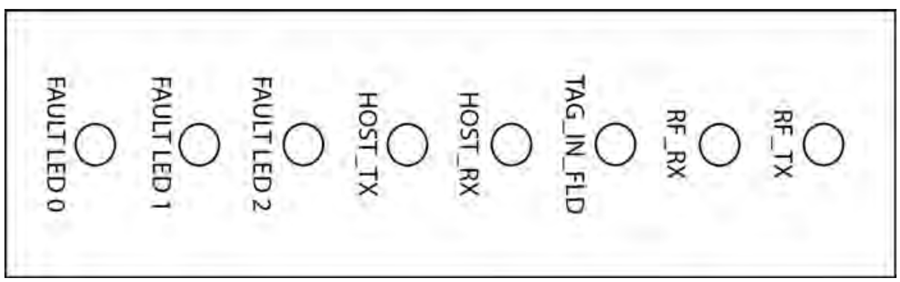

Figure 9-1 Operational LEDs

Table 9-1 describes the LED indications.

Table 9-1 Operational LED Indicator Descriptions

Operational LED			Description
Three fault indication LEDs			
Fault LED 0	**Fault LED 1**	**Fault LED 2**	**Failure Mode**
●	●	●	Microprocessor resetting
●	●	❍	Power supply failure
●	❍	●	Transceiver failure

Table 9-1 Operational LED Indicator Descriptions (continued)

Operational LED			Description
●	❍	❍	Sync/GPS failure
❍	●	●	No communication with lane controller/host system
❍	●	❍	Other failure
❍	❍	●	Data in buffer
❍	❍	❍	No failure
HOST_TX			Orion Reader communicating with host
HOST_RX			Host communicating with Orion Reader
TAG_IN_FLD			Orion Reader is transacting with tag. LED lit when Orion Reader receives correctly decoded tag message including correct CRC for message. The LED is lit for 250 ms following a tag transaction.
RF_RX			RF uplink signal on
RF_TX			RF downlink signal on
Note All FAULT LEDs light red.			

Troubleshooting Guidelines

The Orion Reader is very reliable, so any service-related problems will most likely be due to external causes, such as damage to components. Visually inspect each system component and replace or repair components as needed.

To perform a visual inspection

1. Make sure all component connectors are secure.
2. Make sure that the antenna is connected to the Orion Reader.
3. Make sure the Orion Reader is powered up by checking the Orion Reader Power LEDs. The NEMA Box must be open.
4. Make sure the Orion Reader is communicating with the lane controller/host system by checking operational/fault LEDs.
5. Review diagnostic commands and responses by accessing diagnostic port (COM2). The NEMA Box must be open.

Communicating Via Diagnostic Port (COM2)

You can check the Orion Reader diagnostics by connecting a personal computer (PC) to the Orion Reader COM2 port using a serial null-modem cable. This cable crosses over the transmit and receive pins, which allows you to communicate with the Orion Reader. The COM2 port is located inside the NEMA box.

Once you have connected the PC to the Orion Reader, you need to configure the terminal emulation software.

Diagnostic COM2 Port Pin Assignments

This connector is a DB9 subminiature plug.

Table 9-2 Diagnostic 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)

Starting the Terminal Emulation Software

You can use a PC and any terminal emulation software to enter the host commands to retrieve diagnostic information. The following procedures show examples using Hyper Terminal™, an application included with Microsoft Windows. Most terminal emulation applications have a similar sequence for launching.

Note: *In this hyperterminal selection, COM1 refers to the PC communications port.*

To start the terminal emulation software

1. At the command prompt, type your terminal emulation start command, or if using Windows Hyper Terminal, select: `Programs>Accessories>Hyperterm` and press `ENTER`.

   The application displays the **Connection Description** dialog box as shown in Figure 9-2.

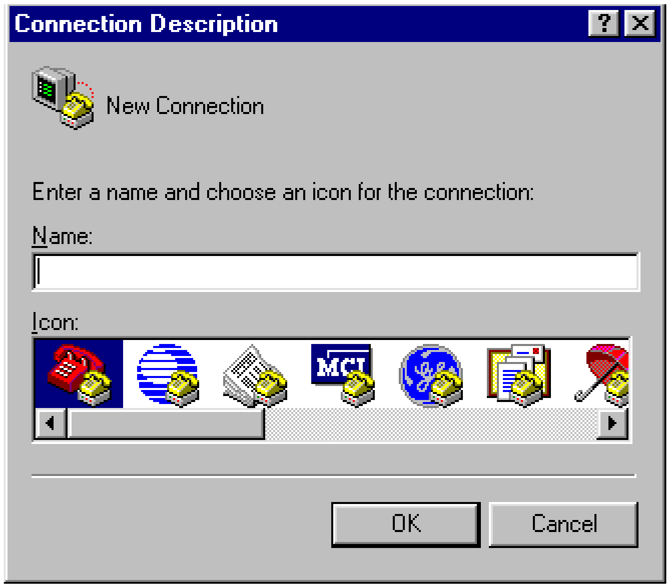

Figure 9-2 Connection Description Dialog Box

2. Enter a name for the session (e.g. **myCOM1**) and click **OK**.

   The application displays the **Phone Number** dialog box as shown in Figure 9-3.

Figure 9-3 Phone Number Dialog Box

3. From the **Connect using** pull-down list, choose the **COM1** option (or whichever com port on the PC to which the RS–232 cable is attached) and click **OK**.

   The application displays the **COM1 Properties** dialog box as shown in

Figure 9-4.

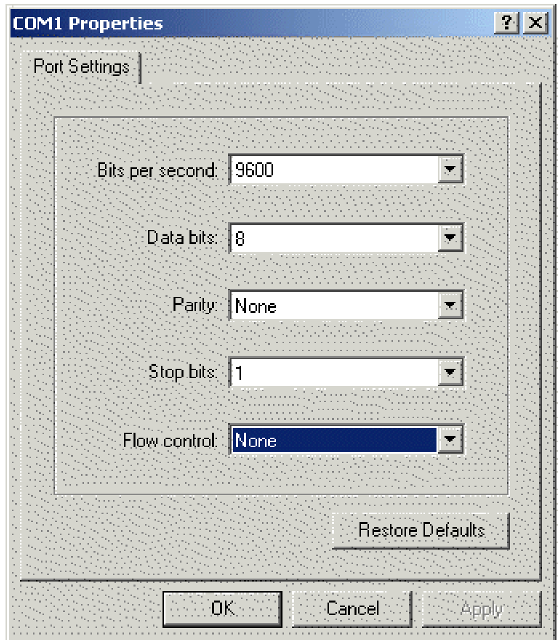

Figure 9-4 COM1 Properties Dialog Box

4. In the pull-down list on the **COM1 Properties** dialog box, choose the following settings:

    - Bits per second: 9600 baud
    - Data bits: 8
    - Parity: None
    - Stop bits: 1
    - Flow control: None

5. Click **OK**.

    The application displays the **myCOM1 - Hyper Terminal** main screen as shown in Figure 9-5.

.

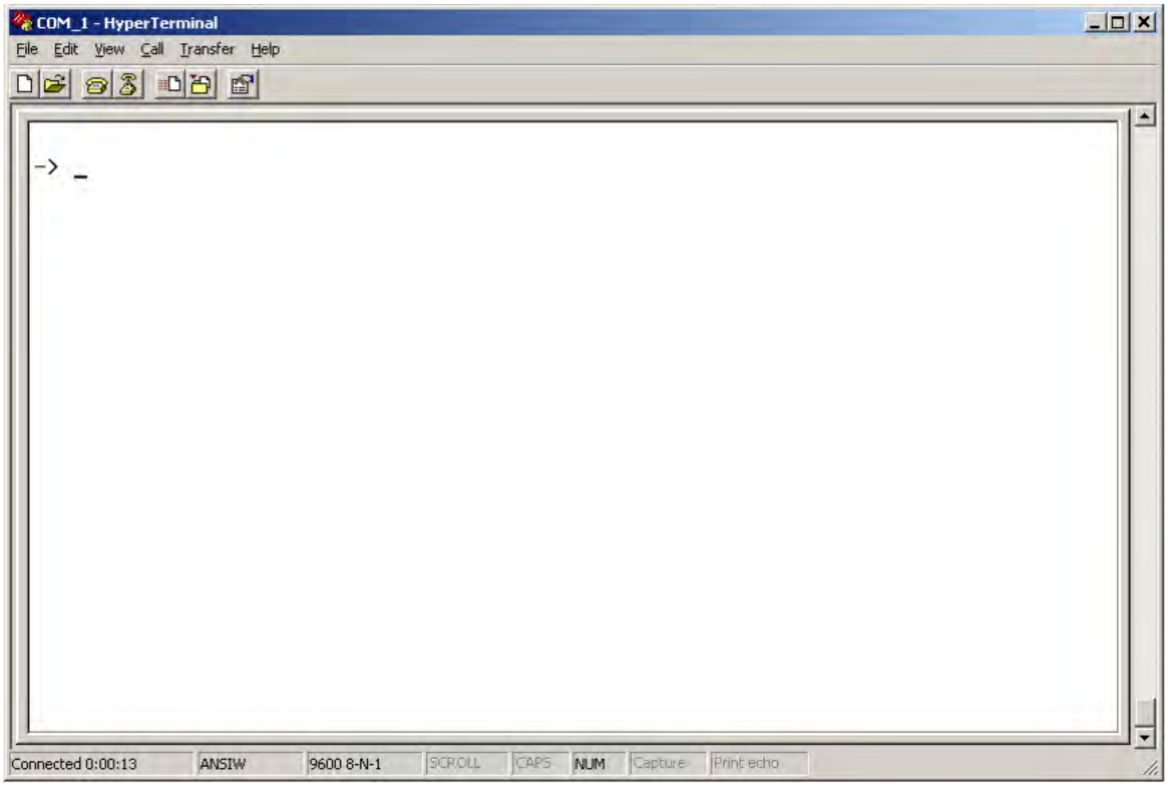

Figure 9-5 Hyper Terminal Main Screen

6. Press ENTER several times to get a flashing cursor prompt (– > _).

   You can enter any of the diagnostic commands as listed in Table 9-3.

Diagnostic Commands

The Orion Reader uses the commands outlined in this section to help you diagnose problems between the host and Orion Reader (Table 9-3).

Table 9-3 Diagnostic Commands

Diagnostic Command	Command Description
`version`	Used to display the VxWorks version information and the boot line parameters. The Orion Reader’s IP address and subnet mask are shown after the “e=” string.
`bootChange`	Used to change the boot line parameters including the Orion Reader’s IP address and subnet mask. See the “bootChange” section for details.

Table 9-3 Diagnostic Commands

`ShowErrorLog`	Scrolls the error log in chronological order.
`ClearErrorLog`	Clears all entries in the error log.
`ShowSysStatusBits`	Shows the status bits for error conditions in the Orion Reader.

Note: *All diagnostic host commands are case sensitive.*

bootChange

This section describes each line of the bootChange command and provides associated usage.

boot device		Required, must be motfec0
processor number		Required, must be 0
host name		Required, must be lcHost
file name		Not required, should be left as is or blank
inet on ethernet (e)	!	**Mandatory:** Orion Reader's IP address and subnet mask must be of the form xxx.xxx.xxx.xxx:yyyyyyyy
inet on backplane (b)		Not required, should be left as is or blank
host inet (h)		Required, should be set to IP address of host computer
gateway inet (g)		Not required, should be left as is or blank
user (u)		Not required, should be left as is or blank
ftp password (pw) (blank = use rsh)		Not required, should be left as is or blank
flags (f)		Required, should be 0x0
target name (tn)		Not required, should be left as is or blank
startup script (s)		Not required, should be left blank
other (o)		Not required, should be left as is or blank

Press Enter if you do not want to change an entry. To clear an entry on a line, type a "." (period). To change a line, type what is needed, then press Enter. On the "inet on ethernet (e)" line, enter the Orion Reader's IP address and subnet mask in the form xxx.xxx.xxx.xxx.yyyyyyyy where xxx.xxx.xxx.xxx is the Orion Reader's IP address in decimal format and yyyyyyyy is the Orion Reader's subnet mask in hexadecimal format.

Note: *If the Orion Reader's IP address and subnet mask are not entered in the format as shown, the Orion Reader's Ethernet communications may not work.*

When you have finished entering the bootChange, the screen displays the following information:

boot device	`motfec0`
processor number	`0`
host name	`lcHost`
file name	
inet on ethernet (e)	`10.3.11.96:ffff0000`
inet on backplane (b)	
host inet (h)	`10.3.11.94`
gateway inet (g)	
user (u)	
ftp password (pw) (blank = use rsh)	
flags (f)	`0x0`
target name (tn)	
startup script (s)	
other (o)	

Power Cycling the Orion Reader

If the Orion Reader stops communicating with the host system and does not respond to the RESET READER (0006H) command, try power cycling the reader.

To power cycle the reader

1. Display the version by typing **version**. This provides the IP addresses for the Orion Reader.
2. Display the error log by typing **ShowErrorLog**. Using the Hyper Terminal, save the error log to a file by selecting **Capture Text...** from the **Transfer** drop-down menu (Figure 9-6). The **Capture** feature in the menu bar at the bottom of the screen darkens to show text is captured.

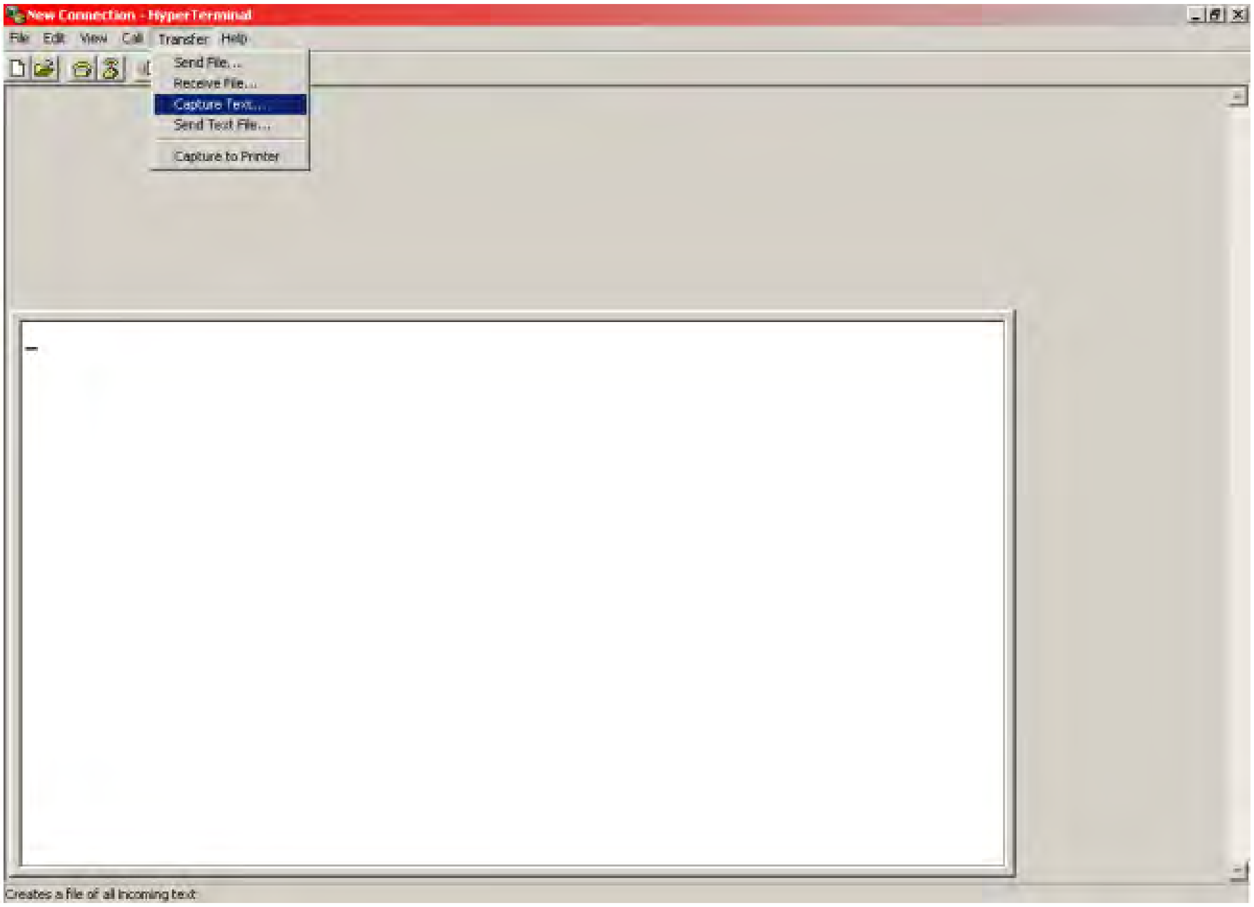

Figure 9-6 Capture Text Feature

Stop or pause the error log capture by selecting **Capture Text...** from the **Transfer** drop-down menu by selecting **Stop** or **Pause** from the **Capture Text...** feature (Figure 9-7).

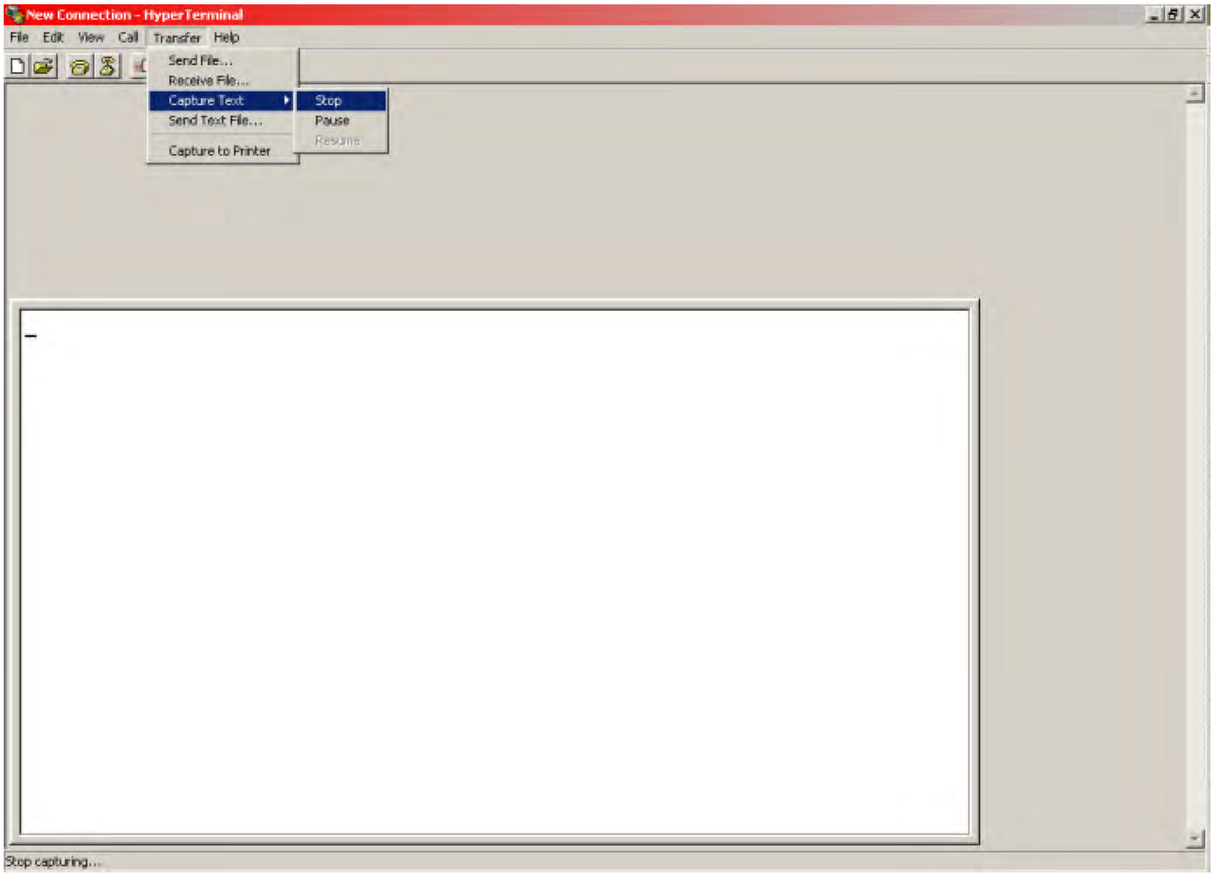

Figure 9-7 Stop or Pause Text Capture

3. Display the error condition status bits by typing **ShowSysStatusBits**.
4. Disconnect Power.
5. Reconnect Power.

Error Log Reference

This section lists all the error log messages that can occur in the Orion Reader system. Table 9-4 lists the Orion Reader software module numbers for reference.

Table 9-4 Software Module Numbers

Software Module	Module Number
System Initialization Module	0000H

Table 9-4 Software Module Numbers (continued)

Lane Controller Interface Module	0001H
System Interface Module	0002H
Mode Interface Module	0003H
Tag Interface Module	0004H
Sync Module	0005H
Global Positioning System (GPS) Module	0006H
Radio Frequency (RF) Transceiver Interface Module	0007H
Diagnostic Module	0008H
Reserved	0009H
Tag Buffer Module	000AH
Reserved	000BH
Reserved	000CH
Digital I/O (DIO) Module	000DH

Note: *Only those software module error logs that are currently being used in the Orion Reader are listed here.*

System Initialization Module Errors

Table 9-5 contains the system initialization module (MSIM) error numbers and log entry descriptions.

Table 9-5 System Initialization Module Errors (0000H)

Log Entry	Description	Error Number
Reserved	N/A	0000H
Timer Initialization Error	This error indicates that the system timer initialization failed. This error could prevent the Orion Reader’s ability to transact with tags.	0001H
Buffer Management (BM) Initialization Error	This error indicates that the BM system initialization failed. This error could prevent the Orion Reader’s ability to transact with tags.	0002H
Tag Buffer Initialization Error	This error indicates that the tag buffer module initialization failed.	0003H
System Queue Create Error	This error indicates that the creation of one or more system message queues failed. This error could prevent the Orion Reader’s ability to transact with tags.	0004H
System Task Create Error	This error indicates that the creation of one or more system tasks failed. This error could prevent the Orion Reader’s ability to transact with tags.	0005H
System Security Error	This error indicates that the system security was violated. This error could prevent the Orion Reader’s ability to transact with tags.	0006H
Error Recovery Event	One or more of the errors recovered.	0007H

Lane Controller Interface Module Errors

Table 9-6 contains the lane controller interface module (LCIM) error numbers and log entry descriptions.

Table 9-6 Lane Controller Interface Module Errors (0001H)

Log Entry	Description	Error Number
Reserved	N/A	0000H
Saved SysComMsgs Initialization Error	This error indicates that the system communication message buffer initialization failed. This error could prevent the Orion Reader’s ability to transact with tags.	0001H

Table 9-6 Lane Controller Interface Module Errors (0001H) (continued)

Buffer Management Create Queue Error	This error indicates that the creation of the LCI BM queue failed. This error could prevent the Orion Reader’s ability to transact with tags.	0002H
Buffer Management Not Initialized Error	This error indicates that BM is not initialized. This error could prevent the Orion Reader’s ability to transact with tags.	0003H
Reserved	N/A	0004H
System Serial Device Error	This error indicates that the initialization of the system serial port failed.	0005H
System Message Queue Full Error	This error indicates that the LC Message Queue is full. This error could prevent the Orion Reader’s ability to transact with tags.	0006H
Get Buffer Management Buffer Error	This error indicates that the get BM buffer failed. This error could prevent the Orion Reader’s ability to transact with tags.	0007H
Message Queue Send Error	This error indicates that the message queue send failed. This error could prevent the Orion Reader’s ability to transact with tags.	0008H
Reserved	N/A	0009H
Message Queue Receive Error	This error indicates that the message queue receive failed. This error could prevent the Orion Reader’s ability to transact with tags.	000AH
Return Buffer Management Buffer Error	This error indicates that the return BM buffer failed. This error could prevent the Orion Reader’s ability to transact with tags.	000BH
Reserved	N/A	000CH
Reserved	N/A	000DH
Reserved	N/A	000EH
Reserved	N/A	000FH
Tag Buffer Write Error	This error indicates that tag data failed to be written into the tag buffering location in flash memory.	0010H
Tag Buffer Overflow Error	This error indicates that there is a tag buffer overflow.	0011H
Tag Buffer State Not Idle Error	This error indicates that the tag buffering runtime state is not idle.	0012H
Serial Communication Link Error	This error indicates that the serial communication link is down.	0013H
TCP/IP Communication Link Error	This error indicates that the TCP/IP communication link is down. This error could prevent the Orion Reader’s ability to transact with tags.	0014H
Reserved	N/A	0015H
Error Recovery Event	One or more of the errors recovered.	0016H

System Interface Module Errors

Table 9-7 contains the system interface module (SIM) error numbers and log entry descriptions.

Table 9-7 System Interface Module Errors (0002H)

Log Entry	Description	Error Number
Reserved	N/A	0000H
Buffer Management Create Queue Error	This error indicates that the creation of the SI BM queue failed. This error could prevent the Orion Reader's ability to transact with tags.	0001H
Buffer Management Not Initialized Error	This error indicates that BM is not initialized. This error could prevent the Orion Reader's ability to transact with tags.	0002H
Message Queue Receive Error	This error indicates that the message queue receive failed. This error could prevent the Orion Reader's ability to transact with tags.	0003H
Return Buffer Management Buffer Error	This error indicates that the return BM buffer failed. This error could prevent the Orion Reader's ability to transact with tags.	0004H
Get Buffer Management Buffer Error	This error indicates that the get BM buffer failed. This error could prevent the Orion Reader's ability to transact with tags.	0005H
Message Queue Send Error	This error indicates that the message queue send failed. This error could prevent the Orion Reader's ability to transact with tags.	0006H
Tag Buffer Read Error	This error indicates that tag data failed to be read from the tag buffering location in flash memory.	0007H
Tag Buffer Overflow Error	This error indicates that there is a tag buffer overflow.	0008H
Erase Tag Buffers Error	Tags in the Tag Buffer location in Flash failed to erased.	0009H
Erase Entire Tag Buffer Space Error	This error indicates that erase entire tag buffers flash space failed.	000AH
Wait For Tag Buffer Idle State Time-out Error	This error indicates that the wait for tag buffering runtime idle state, timed out.	000BH
Reserved	N/A	000CH
Error Recovery Event	One or more of the errors recovered.	000DH

Mode Interface Module Error Numbers

Table 9-8 contains the mode interface module (MIM) error numbers and log entry descriptions.

Table 9-8 Mode Interface Module Errors (0003H)

Log Entry	Description	Error Number
Reserved	N/A	0000H
Prior Required Configuration Not Set Error	This error indicates that not all required configuration parameters are set for the system to be able to start running in the requested mode. This error could prevent the Orion Reader’s ability to transact with tags.	0001H
Reserved	N/A	0002H
Error Recovery Event	One or more of the errors recovered.	0003H

Tag Interface Module Error Numbers

Table 9-9 contains the tag interface module (TIM) error numbers and log entry descriptions.

Table 9-9 Tag Interface Module Errors (0004H)

Log Entry	Description	Error Number
Reserved	N/A	0000H
TIM System Error	This error indicates that a system call failed. This error could prevent the Orion Reader’s ability to transact with tags.	0001H
FPGA1 Not Ready Error	This error indicates that the FPGA1 is not ready. This error could prevent the Orion Reader’s ability to transact with tags.	0002H
RF Transceiver Not Ready Error	This error indicates that the RF Transceiver is not ready. This error could prevent the Orion Reader’s ability to transact with tags.	0003H
FPGA1 Memory Test Error	This error indicates that the FPGA1 memory test failed. This error could prevent the Orion Reader’s ability to transact with tags.	0004H
FPGA2 Memory Test Error	This error indicates that the FPGA2 memory test failed. This error could prevent the Orion Reader’s ability to transact with tags.	0005H
Queue Message Error	This error indicates that the source of the message is invalid. This error could prevent the Orion Reader’s ability to transact with tags.	0006H
Reserved	N/A	0007H

Table 9-9 Tag Interface Module Errors (0004H) (continued)

Tag Transaction Configuration Command Error	This error indicates that an invalid tag transaction configuration command was sent to the reader. This error could prevent the Orion Reader's ability to transact with tags.	0008H
Tag Transaction Sequence Command Error	This error indicates that an invalid tag transaction sequence command was sent to the reader. This error could prevent the Orion Reader's ability to transact with tags.	0009H
Reserved	N/A	000AH
Reserved	N/A	000BH
Reserved	N/A	000CH
Reserved	N/A	000DH
Reserved	N/A	000EH
Reserved	N/A	000FH
Buffer Management Create Queue Error	This error indicates that the creation of a BM queue failed. This error could prevent the Orion Reader's ability to transact with tags.	0010H
Get Buffer Management Buffer Error	This error indicates that the get BM buffer failed. This error could prevent the Orion Reader's ability to transact with tags.	0011H
Return Buffer Management Buffer Error	This error indicates that the return BM buffer failed. This error could prevent the Orion Reader's ability to transact with tags.	0012H
Get System Queue Identification (ID) Error	This error indicates that getting the system queue identification failed. This error could prevent the Orion Reader's ability to transact with tags.	0013H
Error Recovery Event	One or more of the errors recovered.	0014H
Product ID Error	This error indicates that the Orion Reader was set to an unsupported protocol.	0015H
Queue Create Error	This error indicates that the message queues create failed. This error could prevent the Orion Reader's ability to transact with tags.	0016H
Task Create Error	This error indicates that the creation of a tag interface task failed. This error could prevent the Orion Reader's ability to transact with tags.	0017H
Reserved	N/A	0018H
Reserved	N/A	0019H
Tag Interface Module Configuration Initialization Error	This error indicates that the tag interface configuration initialization failed. This error could prevent the Orion Reader's ability to transact with tags.	001AH

Sync Module Error Numbers

Table 9-10 contains the Sync module (SM) error numbers and log entry descriptions.

Table 9-10 Sync Module Errors (0005H)

Log Entry	Description	Error Number
Reserved	N/A	0000H
Sync Two Masters Error	This error indicates that two readers are configured as masters.	0001H
Sync Master Slave Error	This error indicates that a reader, configured as a slave, does not detect the master.	0002H
Sync Clock Error	This error indicates that a Sync clock error occurred.	0003H
GPS Window Error	This error indicates that a GPS window error occurred.	0004H
GPS One-PPS Error	This error indicates that the one-pulse per second failed.	0005H
Sync Two Masters Error Recovery Event	This event indicates that the two masters error, recovered.	0006H
Sync Master Slave Error Recovery Event	This event indicates that the master slave error, recovered.	0007H
Sync Clock Error Recovery Event	This event indicates that the Sync clock error, recovered.	0008H
GPS Window Error Recovery Event	This event indicates that the GPS Window error, recovered	0009H
GPS One PPS Error Recovery Event	This event indicates that the one-pulse per second, recovered.	000AH

GPS Module Error Numbers

Table 9-11 contains the GPS module (GPSM) error numbers and log entry descriptions.

Table 9-11 GPS Module Errors (0006H)

Log Entry	Description	Error Number
Reserved	N/A	0000H
GPS Communication Link Error	This error indicates that the communication with the GPS module is down.	0001H
GPS T-RAIM Alarm Set Event	This error indicates that the T-RAIM algorithm of the GPS module failed.	0002H

Table 9-11 GPS Module Errors (0006H) (continued)

GPS Self-Test Failed Event	This error indicates that the self-test of the GPS module failed.	0003H
GPS Power On Failure Event	This error indicates that the GPS module failed the power on test.	0004H
GPS Auto Survey Failure Event	This error indicates that the auto survey failed.	0005H
GPS Communication Link Error Recovery Event	This event indicates that GPS Communication link, recovered.	0006H
GPS T-RAIM Alarm Set Error Recovery Event	This event indicates that T-RAIM alarm cleared.	0007H
GPS Self-Test Failed Recovery Event	This event indicates that self-test error cleared.	0008H
GPS Power-On Failure Recovery Event	This event indicates that self-test error cleared.	0009H
GPS Auto Survey Failure Recovery Event	This event indicates that the auto survey failure cleared.	000AH

RF Transceiver Interface Module Error Numbers

Table 9-12 contains the RF transceiver interface module (RFTIM) error numbers and log entry descriptions.

Table 9-12 RF Transceiver Interface Module Errors (0007H)

Log Entry	Description	Error Number
Reserved	N/A	0000H
Buffer Management Create Queue Error	This error indicates that the creation of a BM queue failed. This error could prevent the Orion Reader’s ability to transact with tags.	0001H
Memory Allocate Error	This error indicates that the Memory allocation failed. This error could prevent the Orion Reader’s ability to transact with tags.	0002H
System Queue ID Retrieve Error	This error indicates that getting the system queue identification failed. This error could prevent the Orion Reader’s ability to transact with tags.	0003H
Serial SMC Open Error	This error indicates that opening the serial SMC failed. This error could prevent the Orion Reader’s ability to transact with tags.	0004H
Connect Interrupt Handler Error	This error indicates that connecting the interrupt handler failed. This error could prevent the Orion Reader’s ability to transact with tags.	0005H

Table 9-12 RF Transceiver Interface Module Errors (0007H) (continued)

Enable Interrupt Error	This error indicates that enabling the interrupt failed. This error could prevent the Orion Reader's ability to transact with tags.	0006H
I/O Semaphore Create Error	This error indicates that creating the I/O semaphore failed. This error could prevent the Orion Reader's ability to transact with tags.	0007H
Non-volatile Random Access Memory (NVRAM) Configuration Data Retrieve Error	This error indicates that retrieving configuration data from NVRAM failed. This error could prevent the Orion Reader's ability to transact with tags.	0008H
NVRAM Configuration Data Corrupt Error	This error indicates that the configuration data in NVRAM is corrupt. This error could prevent the Orion Reader's ability to transact with tags.	0009H
NVRAM Configuration Data Write Error	This error indicates that writing configuration data to NVRAM failed. This error could prevent the Orion Reader's ability to transact with tags.	000AH
RF Transceiver Reset Error	This error indicates that the transceiver reset failed. This error could prevent the Orion Reader's ability to transact with tags.	000BH
RF Heartbeat Task Create Error	This error indicates that the creation of the heartbeat task failed. This error could prevent the Orion Reader's ability to transact with tags.	000CH
Get Buffer Management Buffer Error	This error indicates that the get BM buffer failed. This error could prevent the Orion Reader's ability to transact with tags.	000DH
Return Buffer Management Buffer Error	This error indicates that the return BM buffer failed. This error could prevent the Orion Reader's ability to transact with tags.	000EH
Serial Command Code Error	This error indicates that an invalid command was received. This error could prevent the Orion Reader's ability to transact with tags.	000FH
Message Queue Send Error	This error indicates that the message queue send failed. This error could prevent the Orion Reader's ability to transact with tags.	0010H
Set Tx Attenuation (Attn) Invalid Input Error	This error indicates that invalid input was sent to the reader for setting the Tx Attn. This error could prevent the Orion Reader's ability to transact with tags.	0011H
Set Rx Attn Invalid Input Error	This error indicates that invalid input was sent to the reader for setting the Rx Attn. This error could prevent the Orion Reader's ability to transact with tags.	0012H
Set Range Adjust Invalid Input Error	This error indicates that invalid input was sent to the reader for setting the Range Adjust. This error could prevent the Orion Reader's ability to transact with tags.	0013H
Set Protocol Parameters Invalid Input Error	This error indicates that invalid input was sent to the reader for setting the protocol parameters. This error could prevent the Orion Reader's ability to transact with tags.	0014H

Table 9-12 RF Transceiver Interface Module Errors (0007H) (continued)

Set Frequency Invalid Input Error	This error indicates that invalid input was sent to the reader for setting the frequency. This error could prevent the Orion Reader's ability to transact with tags.	0015H
Reserved	N/A	0016H
Reserved	N/A	0017H
Reserved	N/A	0018H
Reserved	N/A	0019H
Reserved	N/A	001AH
Reserved	N/A	001BH
Message Queue Receive Error	This error indicates that the message queue receive failed. This error could prevent the Orion Reader's ability to transact with tags.	001CH
Error Recovery Event	One or more of the errors recovered.	001DH
Task Create Error	This error indicates that the creation of an RF transceiver task failed. This error could prevent the Orion Reader's ability to transact with tags.	001EH
Queue Create Error	This error indicates that the message queues create failed. This error could prevent the Orion Reader's ability to transact with tags.	001FH
Invalid Operation Mode Initialization	This error indicates that the RF transceiver interface module was given an invalid mode number. This error could prevent the Orion Reader's ability to transact with tags.	0040H
Transceiver Serial Communication Error	This error indicates that a serial communication link is down.	0041H
Transceiver Reset Error	This error indicates that the transceiver reset failed upon initialization. This error could prevent the Orion Reader's ability to transact with tags.	0042H
Frequency Initialization Error	This error indicates that the frequency initialization failed. This error could prevent the Orion Reader's ability to transact with tags.	0043H
Tx Attenuation Initialization Error	This error indicates that the transmit attenuation initialization failed. This error could prevent the Orion Reader's ability to transact with tags.	0044H
Rx Attenuation Initialization Error	This error indicates that the receive attenuation initialization failed. This error could prevent the Orion Reader's ability to transact with tags.	0045H
Data Detect Initialization Error	This error indicates that the data detect initialization failed. This error could prevent the Orion Reader's ability to transact with tags.	0046H

Table 9-12 RF Transceiver Interface Module Errors (0007H) (continued)

13-MHz Disable Initialization Error	This error indicates that there is a 13-MHz disable error. This error could prevent the Orion Reader's ability to transact with tags.	0047H
RF Transceiver ADC Above Maximum Error	This error indicates that the analog-to-digital converter (ADC) in the control feedback loop has exceeded a maximum set value. This error could prevent the Orion Reader's ability to transact with tags.	0201H
RF Transceiver ADC Below Minimum Error	This error indicates that the ADC in the control feedback loop has fallen below a minimum set value. This error could prevent the Orion Reader's ability to transact with tags.	0202H
RF Transceiver Attn DAC1 Above Maximum Error	This error indicates that the attenuation DAC for source 1 has exceeded a maximum set value. This error could prevent the Orion Reader's ability to transact with tags.	0203H
RF Transceiver Attn DAC1 Below Minimum Error	This error indicates that the attenuation DAC for source 1 has fallen below a minimum set value. This error could prevent the Orion Reader's ability to transact with tags.	0204H
RF Transceiver Attn DAC2 Above Maximum Error	This error indicates that the attenuation DAC for source 2 has exceeded a maximum set value. This error could prevent the Orion Reader's ability to transact with tags.	0205H
RF Transceiver Attn DAC2 Below Minimum Error	This error indicates that the attenuation DAC for source 2 has fallen below a minimum set value. This error could prevent the Orion Reader's ability to transact with tags.	0206H
RF Transceiver Depth-of-Modulation (DOM) DAC Above Maximum Error	This error indicates that the depth of modulation DAC has exceeded a maximum set value. This error could prevent the Orion Reader's ability to transact with tags.	0207H
RF Transceiver DOM DAC Below Minimum Error	This error indicates that the depth of modulation DAC has fallen below a minimum set value. This error could prevent the Orion Reader's ability to transact with tags.	0208H
RF Transceiver Source1 PLL Unlocked Error	This error indicates that the source 1 phase lock loop is unlocked. This error could prevent the Orion Reader's ability to transact with tags.	0209H
RF Transceiver Source2 PLL Unlocked Error	This error indicates that the source 2, phase lock loop is unlocked. This error could prevent the Orion Reader's ability to transact with tags.	020AH
RF Transceiver 13-MHz Control Error	This error indicates that there is a 13-MHz Control error. This error could prevent the Orion Reader's ability to transact with tags.	020BH
RF Transceiver 5V DC Fault Error	This error indicates that the 5VDC digital supply is above or below the threshold. This error could prevent the Orion Reader's ability to transact with tags.	020CH
RF Transceiver Uncalibrated Error	This error indicates that the Transceiver is uncalibrated. This error could prevent the Orion Reader's ability to transact with tags.	020DH
Reserved	N/A	020EH

Table 9-12 RF Transceiver Interface Module Errors (0007H) (continued)

RF Transceiver 5V DC Undervoltage Error	This error indicates that the 5VDC digital supply is below the threshold. This error could prevent the Orion Reader's ability to transact with tags.	020FH
Nack From RF Error	This error indicates that the digital board received a Nack from the Transceiver board. This error could prevent the Orion Reader's ability to transact with tags.	0401H
Serial Command Time-out Error	This error indicates that the digital board failed to send data to the Transceiver board. This error could prevent the Orion Reader's ability to transact with tags.	0402H
Reserved	N/A	0403H
Set Tx Attn Command Failure Error	This error indicates that the "Set Tx Attn Command" failed. This error could prevent the Orion Reader's ability to transact with tags.	0404H
Get Tx Attn Command Failure Error	This error indicates that the "Get Tx Attn Command" failed. This error could prevent the Orion Reader's ability to transact with tags.	0405H
Set Rx Attn Command Failure Error	This error indicates that the "Set Rx Attn Command" failed. This error could prevent the Orion Reader's ability to transact with tags.	0406H
Get Rx Attn Command Failure Error	This error indicates that the "Get Rx Attn Command" failed. This error could prevent the Orion Reader's ability to transact with tags.	0407H
Set Range Adjust Command Failure Error	This error indicates that the "Set Range Adjust Command" failed. This error could prevent the Orion Reader's ability to transact with tags.	0408H
Get Range Adjust Command Failure Error	This error indicates that the "Get Range Adjust Command" failed. This error could prevent the Orion Reader's ability to transact with tags.	0409H
Set Protocol Parameters Command Failure Error	This error indicates that the "Set Protocol Parameters Command" failed. This error could prevent the Orion Reader's ability to transact with tags.	040AH
Get Protocol Parameters Command Failure Error	This error indicates that the "Get Protocol Parameters Command" failed. This error could prevent the Orion Reader's ability to transact with tags.	040BH
Set Frequency Command Failure Error	This error indicates that the "Set Frequency Command" failed. This error could prevent the Orion Reader's ability to transact with tags.	040CH
Get Frequency Command Failure Error	This error indicates that the "Get Frequency Command" failed. This error could prevent the Orion Reader's ability to transact with tags.	040DH
Get Firmware ID Command Failure Error	This error indicates that the "Get Firmware ID Command" failed. This error could prevent the Orion Reader's ability to transact with tags.	040EH

Table 9-12 RF Transceiver Interface Module Errors (0007H) (continued)

Get Status Command Failure Error	This error indicates that the "Get Status Command" failed. This error could prevent the Orion Reader's ability to transact with tags.	040FH
13-MHz Control Command Failure Error	This error indicates that the "13-MHz Control Command" failed. This error could prevent the Orion Reader's ability to transact with tags.	0410H
RF Transceiver Reset Command Failure Error	This error indicates that the "RF Transceiver Reset Command" failed. This error could prevent the Orion Reader's ability to transact with tags.	0411H
Reference Synchronization Command Failure Error	This error indicates that the "Reference Synchronization Command" failed. This error could prevent the Orion Reader's ability to transact with tags.	0412H

Diagnostic Module Error Numbers

Table 9-13 contains the diagnostic module (DM) error numbers and log entry descriptions.

Table 9-13 Diagnostic Module Error Numbers (0008H)

Log Entry	Description	Error Number
Reserved	N/A	0000H
Buffer Management Create Queue Error	This error indicates that the creation of a BM queue failed.	0001H
Memory Allocate Error	This error indicates that allocation of memory failed.	0002H
System Queue ID Retrieve Error	This error indicates that getting the system queue identification failed.	0003H
Connect Interrupt Handler Error	This error indicates that connecting the interrupt handler failed.	0004H
Enable Interrupt Error	This error indicates that enabling the interrupt failed.	0005H
Get Buffer Management Buffer Error	This error indicates that the get BM buffer failed.	0006H
Return Buffer Management Buffer Error	This error indicates that the return BM buffer failed.	0007H
Illegal Command Code Error	This error indicates that illegal command was sent to the reader for setting the frequency.	0008H
Message Queue Send Error	This error indicates that the message queue send failed.	0009H
Message Queue Receive Error	This error indicates that the message queue receive failed.	000AH

Table 9-13 Diagnostic Module Error Numbers (0008H) (continued)

WatchDog Create Error	This error indicates that creation of a watchdog timer failed.	000BH
WatchDog Start Error	This error indicates that starting a watchdog timer failed.	000CH
Power On or Reset Event	This error indicates that a power on or reset event occurred. This error could prevent the Orion Reader's ability to transact with tags.	000DH
Power Supply Fault Error	This error indicates that a power supply fault occurred. This error could prevent the Orion Reader's ability to transact with tags.	000EH
Digital Board OverVoltage Error	This error indicates that an overvoltage fault occurred on the digital board power supply. This error could prevent the Orion Reader's ability to transact with tags.	000FH
Digital Board UnderVoltage Error	This error indicates that an undervoltage fault occurred on the digital board power supply. This error could prevent the Orion Reader's ability to transact with tags.	0010H
Reserved	N/A	0011H
Power Supply Fault Status Error	This error indicates that an invalid power supply fault occurred. This error could prevent the Orion Reader's ability to transact with tags.	0012H
Power Supply Fault Source Error	This error indicates that an erroneous power supply fault occurred. This error could prevent the Orion Reader's ability to transact with tags.	0013H
Error Recovery Event	One or more of the errors recovered.	0014H

Tag Buffer Module Error Numbers

Table 9-14 contains the tag buffer module (TBM) error numbers and log entry descriptions.

Table 9-14 Tag Buffer Module Errors (000AH)

Log Entry	Description	Error Number
Reserved	N/A	0000H
Tag Buffer Threshold Error	This error indicates that there is a tag buffer threshold error.	0001H
Error Recovery Event	One or more of the errors recovered.	0002H

Digital Input/Output Module Error Numbers

Table 9-15 contains the digital input/output module (DIOM) error numbers and log entry descriptions.

Table 9-15 Digital I/O Module Errors (000DH)

Log Entry	Description	Error Number
Reserved	N/A	0000H
DIOM Task Create Error	This error indicates that the creation of the digital I/O task failed. This error could prevent the Orion Reader's ability to transact with tags.	0001H
Buffer Management Create Queue Error	This error indicates that the creation of a BM queue failed. This error could prevent the Orion Reader's ability to transact with tags.	0002H
Get Buffer Management Buffer Error	This error indicates that the get BM buffer failed. This error could prevent the Orion Reader's ability to transact with tags.	0003H
Return Buffer Management Buffer Error	This error indicates that the return BM buffer failed. This error could prevent the Orion Reader's ability to transact with tags.	0004H
DIOM Synchronization Error	This error indicates that there is a synchronization error. This error could prevent the Orion Reader's ability to transact with tags.	0005H
Message Queue Create Error	This error indicates that the message queues create failed. This error could prevent the Orion Reader's ability to transact with tags.	0006H
Message Queue Send Error	This error indicates that the message queue send failed. This error could prevent the Orion Reader's ability to transact with tags.	0007H
Message Queue Receive Error	This error indicates that the message queue receive failed. This error could prevent the Orion Reader's ability to transact with tags.	0008H
DIOM Invalid Configuration Error	This error indicates that there is an invalid configuration command error. This error could prevent the Orion Reader's ability to transact with tags.	0009H
DIOM Event Error	This error indicates that there is an invalid event error.	000AH
DIOM Synchronization Error Recovery Event	One or more of the synchronization errors recovered.	000BH
Error Recovery Event	One or more of the errors recovered.	000CH

Hardware Preventive Maintenance and Troubleshooting Procedures

The Orion Reader system has limited serviceable parts, however, there are preventive maintenance steps that can help to keep the equipment operating to specification. This section describes the preventive maintenance steps and troubleshooting techniques that can help determine if a component is failing.

Hardware Preventive Maintenance Schedule

Table 9-16 lists the schedule of preventive maintenance activities for the Orion Reader system components.

Table 9-16 Preventive Maintenance Task Schedule

Period	Task Description
Weekly	Visually inspect the antennas for physical damage, such as cracks or stressed cables.
Quarterly	Visually inspect all transmit/receive antenna cables for signs of damage or water invasion.
Semiannually	Check the lane configuration. See Chapter 9 for detailed lane configuration settings. The toll antennas have two weep holes located at the lower left and right corners of the radome. Check that these holes are open to allow any trapped water to drain from the antenna. **Note** If the antennas are installed upside down (Star Systems logo is upside down) drill two new weep holes in the lower left and right corners of the radome.
Annually	Check NEMA enclosure seal for signs of damage or water invasion.

Visual Inspection

The Orion Reader system is very reliable, so any service-related problems most likely will be due to external causes, such as damage to components. Visually inspect each system component and replace or repair components, if serviceable, as needed.

To perform a visual inspection

1. Inspect the transmit/receive antenna for signs of damage or corrosion.
2. Check cables between the transmit/receive antenna and the Orion Reader. Look for damage or loose connections.

Figure 9-8 shows the visual inspection process.

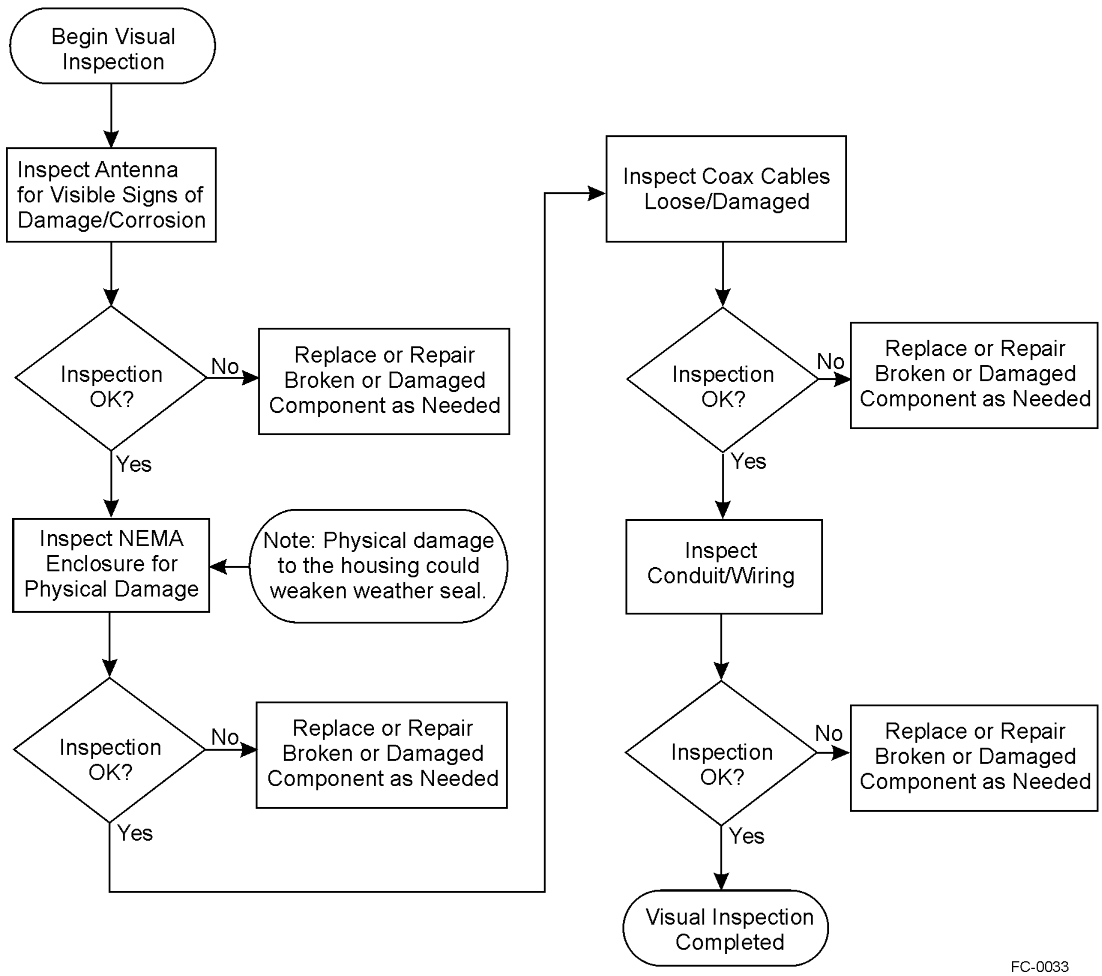

Figure 9-8 Visual Inspection Process

Replacement Instructions for Orion Reader and AVI Equipment

This section explains how to replace an Orion Reader and other AVI equipment. This section shows Orion Readers that are installed in NEMA enclosures at the factory.

These instructions provide the following:

- Replacement instructions for an Orion in a NEMA enclosure
- Replacement instructions for a transmit/receive antenna

Figure 9-9 shows the basic Orion Reader and its connection ports.

Figure 9-9 Connector and Indicator Locations on the Orion Reader

Replacing a Transmit/Receive Antenna on a Gantry

To remove an antenna

1. Close traffic lane below where the antenna is being replaced.
2. Shut off RF power to the antenna.
3. Use an inclinometer to record the antenna angle from horizontal before moving it.
4. Cut off the shrink tubing from around the RF coaxial cable connector.
5. Disconnect the RF connector from the rear of the antenna.
6. Remove nuts and washers from U-bolts.
7. Remove antenna from mounting pipe.
8. Return antenna to Star Systems.

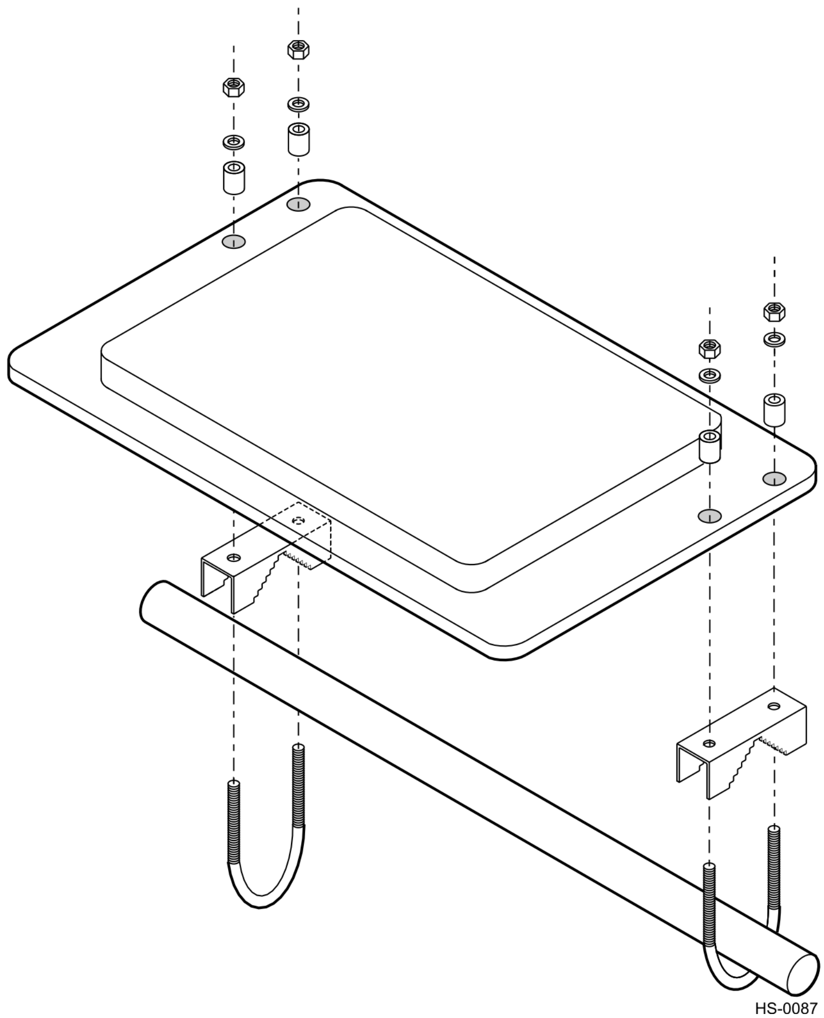

Figure 9-10 Transmit/Receive Antenna Mounting and Connections

To install a Transmit/Receive Antenna

1. Place the antenna below the mounting pipe and insert a U-bolt around the pole and down through the bracket on the side of the antenna closest to the center of the lane. This antenna should be mounted toward the driver side of the traffic lane. Place a spacer, lock washer, and nut over each end of the U-bolt, but do not tighten the nuts. Repeat for the other U-bolt (Figure 9-10).

Caution

When installing the antenna use only the mounting hardware provided. Do not use oversized washers to secure the plastic radome to the bracket. This practice can weaken the radome material.

2. Rotate the antenna up and toward oncoming traffic. Rotate up 15° from horizontal for a dedicated lane or 10° up for a mixed-use lane. Use an inclinometer or angle finder to check the angle.
3. Tighten nuts with a torque wrench to 50 ft-lb (68 N-m).
4. Slide the shrink tubing over the coaxial cable, but do not heat it.
5. Connect the coaxial cable to the antenna. Heat the shrink tubing at the back of the antenna after configuring the lane.

Preventive Maintenance Schedule

Table 9-17 lists the schedule of preventive maintenance activities for the Orion Reader components.

Table 9-17 Preventive Maintenance Schedule

Period	Task Description
Weekly	Visually inspect the antennas and NEMA enclosure for physical damage such as cracks or stressed cables.
Quarterly	Visually inspect all antenna and cables entering NEMA enclosure for signs of damage or water invasion.
Semiannually	Check the lane configuration. See Chapter 9, “Configuring the Lane.”

Removal and Replacement Procedures

This section outlines the procedures to remove or replace the Orion Reader components.

Transmit/Receive Antenna

Removal

To remove a transmit/receive antenna

1. Switch off power to the Orion Reader and disconnect the antenna from the port.
2. Remove shrink tubing covering connector.
3. Disconnect the antenna cable from the antenna.
4. Check the antenna mounting angle using an inclinometer and record the angle. Also, note the position of any spacers on the mounting bracket.
5. Remove the nuts holding the mounting bracket U-bolts, then remove the antenna.
6. When lane tuning is complete, use a heat gun to shrink the tubing covering the antenna cable connections.

Replacement

To install a replacement antenna

1. Position the new antenna along the mounting pipe.
2. Insert the U-bolts through the mounting brackets and secure with lock washers and nuts. Replace any spacers in the same position as before.
3. Set the antenna mounting angle to match the original antenna.
4. Tighten the mounting nuts to 50 ft-lb (68 N-m).
5. Put a length of heat shrink tubing over the antenna cable and connect the cable to the antenna.
6. Connect the RF cable to the Orion Reader.
7. Check the lane tuning.
8. When lane tuning is complete, use a heat gun to shrink the tubing covering the antenna cable connection.

Antenna Cable

Removal

To remove an antenna cable

1. Switch off power to the Orion Reader.
2. Disconnect the antenna cable from the Orion Reader antenna port.
3. Remove antenna cable from installation site. Because each installation may differ (e.g., cabling may be located inside or alongside mounting pipes), detailed removal instructions are not provided here.

Replacement

To install a replacement antenna cable

1. Route the new antenna cable between the antenna and Orion Reader as needed.
2. Connect the new cable to the Orion Reader at the antenna port.
3. Place a piece of heat shrink tubing over the antenna cable.
4. Connect the cable to the antenna.
5. Switch on power to the Orion Reader.
6. Check the lane tuning.
7. When lane tuning is complete, heat the shrink tubing covering the antenna cable connector.

A

Acronyms and Glossary

Appendix A

Acronyms and Glossary

Acronyms and Glossary

A

A	amp(s)
A/V	audio/visual
AC	alternating current
ACK	acknowledge (data valid)
ADC	analog-to-digital converter
antenna	passive device that converts RF energy into magnetic energy (RF signal)
APP	application
ASCII	American Standard Code for Information Interchange
AVI	automatic vehicle identification
AWG	American Wire Gauge

B

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

C

C	Centigrade
cm	centimeter(s)

CMD	command
command	data set that is recognized by the receiving device as intending to elicit a specific response
CPU	central processing unit
CR	carriage return
CRC	cyclic redundancy check
crossover cable	Ethernet cable equivalent of a null modem for serial cables. The crossover cable is used so that two systems that use the same transmit and receive pins on the RJ-45 connector can communicate.
CS	commission status
CSN	command sequence number
CTRL	control
CTS	clear to send
CVISN	Commercial Vehicle Information Systems and Networks application, an ASTM Draft 6 Specification
CW	continuous wave

D

DAC	digital-to-analog converter
data	information that is processed by a computing device
DC	direct current
dB	decibel(s)
dB_i	decibel(s), referencing isotropic radiator
DIAG	diagnostic (command)
DIO	digital input/output
DIOM	digital input/output module
DL	downlink
DLL	dynamic link library
DM	diagnostic module
DOM	depth of modulation
DSR	data set ready

DTR	data terminal ready

E

ECP	error correcting protocol
EEPROM	electrically erasable programmable read-only memory
eom	end of message
EPC	electronic product code
ERR	error
ESD	electrostatic discharge
ETC	electronic toll collection
Ethernet	family of computer networking technologies for local area network (LAN) and larger networks

F

f	frequency
F	Farenheit
FCC	Federal Communications Commission
field	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
FIFO	first-in, first-out
FPGA	field programmable gate-array
frame	consecutive bits of data in memory that are read and written as a group
frequency bands	range of RF frequencies assigned for transmission by an RF device
ft	foot or feet
ftp	file transfer protocol

G

G	antenna gain referenced to an isotropic radiator
G	giga (10^9)
Gen Ack	general acknowledgment
GHz	gigahertz

GND	ground
GPS	global positioning system
GPSM	GPS module
GSE	group select equals

H

hex	hexadecimal
hexadecimal	base 16 numbering system that uses the characters 0 through 9 and A through F to represent the digits 0 through 15
HH	hours
hh	hundredths of seconds
host	device, generally a computer, that is connected to reader system components through the communications port
Hz	hertz

I

IC	Industry Canada
I/O	Input/output
IAG	Interagency Group
ID	identification; for example, encoded information unique to a particular tag, or an FCC identifier number
IEC/EN	International Electrotechnical Commission/*Comite, Europe, en de Normalisation*
IHL	Internet protocol header length
in	inch(es)
interface	connection point for communications with another device
IP	Internet protocol
ISTHA	Illinois State Toll Highway Authority

K

k	kilo (10^3)
kg	kilogram(s)

kHz	kilohertz

L

L	uniqueness counter timing feature
LAN	local area network
lane controller	device that is used to integrate all activity that occurs in a toll lane
lb	pound(s)
LC	lane controller
LCD	liquid crystal display
LCIM	lane controller interface module
LED	light-emitting diode
LF	line feed
LSB	least significant byte
LSW	least significant word

M

μs	microsecond(s)
m	meter(s)
M	million (10^6)
mA	milliamp(s)
MB	megabyte(s)
message	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
MHz	megahertz
milli	one-thousandth (10^{-3})
MIM	mode interface module
ML	mounting location
mode	method of operation
MPI	multiprotocol interrogator

MPR	multiprotocol reader
ms	milliseconds
MSB	most significant byte
MSIM	system initialization module
MSW	most significant word
mW	milliwatt(s)

N

N-m	Newton-meter(s)
NACK	negative acknowledge
NEMA	National Electrical Manufacturers Association
NIC	network interface card
null modem	a communications cable that allows you to connect to another PC or serial device using modem protocol.
NVRAM	non-volatile random access memory

O

ORT	open road tolling
OSHA	Occupational Safety and Health Administration

P

P	antenna input power
P/N	part number
PC	personal computer
PLL	phase-lock loop
PPS	pulse-per-second
protocol	specified convention for the format of data messages communicated between devices
pw	password
PWA	printed wiring assembly

R

read	process of acquiring data from a device, for example, from a tag or from computer memory
reader	controlled interrogating device capable of acquiring data from a device, for example, acquiring and interrupting data from a tag
read zone	physical area in which a tag can be read by the reader system
RESP	response
RF	radio frequency
RFID	radio frequency identification
RFTIM	RF transceiver interface module
RI	ring indicator
RMS	root-mean-square
RSD	received line signal detect
RTS	request to send
RX	receive data
RXD	receive data

S

s	second(s)
S/N	serial number
SA	source address
S-record	an S-record file consists of a sequence of specially formatted ASCII character strings. An S-record is less than or equal to 78 bytes.
seq	sequence
Ser Num	serial number
SI	system interface (command)
SIM	system interface module
SL	step-lock
SM	sync module
SMA	sub-miniature A connectorr

SMC — serial management controller

SN — serial number

som — start of message

step-lock — a specific method of synchronizing RFID signals to eliminate or reduce the effect of interference among colocated RFID readers

sync — refers to the synchronization of multiple readers in proximity of each other

system — 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

tag — small, self-contained device acting as an identifying transponder

TBM — tag buffer module

TCP — transmission control protocol

TIM — tag interface module

Title 21 — state of California code of regulations, Chapter 16, Title 21, which is the standard used for AVI/DSRC (digital short-range communications) protocol

TM — traffic management

toll — 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

T-RAIM — Timing-Receiver Autonomous Integrity Monitoring

transponder — a tag

TX — transmit data

TXD — transmit data

som — start of message

step-lock — a specific method of synchronizing RFID signals to eliminate or reduce the effect of interference among colocated RFID readers

system — 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

tag	small, self-contained device acting as an identifying transponder
TCP	transmission control protocol
TBM	tag buffer module
TDM	time-division multiplexing, used in this document to refer to the use of time-division multiplexing of multiple readers in proximity of each other.
TDMM	TDM module
TIM	tag interface module
Title 21	state of California code of regulations, Chapter 16, Title 21, which is the standard used for AVI/DSRC (digital short-range communications) protocol
TM	traffic management
toll	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
T-RAIM	Timing-Receiver Autonomous Integrity Monitoring
transponder	a tag
TX	transmit data
TXD	transmit data

U

UL	uplink

V

V	volt(s)
V. Class	vehicle class
VCC	voltage controlled current
Ver	version (software)

W

W	watt(s)

B

Hardware Interfaces

Appendix B

Hardware Interfaces

This appendix describes the physical interconnections within the Orion® Reader.

Hardware Interfaces

This appendix describes the hardware interfaces in the Orion Reader and to external components, such as antennas. Figure B-1 shows the basic hardware interconnections for the Orion Reader.

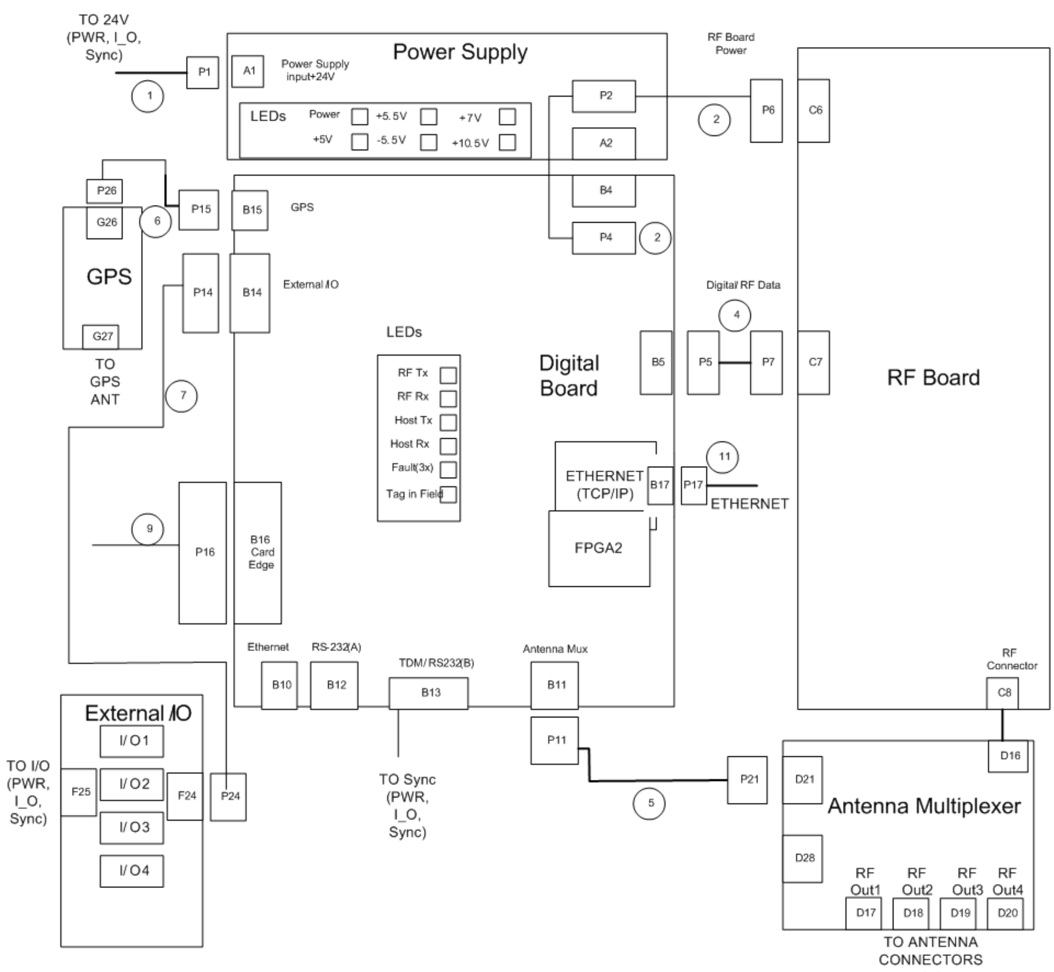

Figure B-1 Orion Reader Hardware Interconnection Block Diagram

Communications

The Orion Reader communicates with a host via an Ethernet communications protocol.

TCP/IP Fast Ethernet Connection

The Orion Reader communicates with a host via an Ethernet communications protocol. This connection requires an RJ–45 connector. If you connect the Orion Reader directly to a host personal computer (PC) then you need a crossover cable. Star Systems recommends that you use Belden 7929A Category 5e twisted-pair cable for Ethernet connections.

The Ethernet connector is an RJ-45 jack and uses a 100-base T interface. If the Orion Reader is connected directly to the host system then a crossover cable is required. Table B-1 lists the Ethernet connector pin assignments.

Table B-1 Ethernet Connector

Pin	Signal	Description	568A[a]	568B[a]
1	TX+	Output Differential Transmit Data (+)	White w/ green stripe	White w/ orange stripe
2	TX-	Output Differential Transmit Data (-)	Green w/ white stripe or solid green	Orange w/ white stripe or solid orange
3	RX+	Input Differential Receive Data (+)	White w/ orange stripe	White w/ green stripe
4	Not connected	N/A	Blue w/ white stripe or solid blue	Blue w/ white stripe or solid blue
5	Not connected	N/A	White w/ blue stripe	White w/ blue stripe
6	RX-	Input Differential Receive Data (-)	Orange w/ white stripe or solid orange	Green w/ white stripe or solid green
7	Not connected	N/A	White w/ brown stripe or solid brown	White w/ brown stripe
8	Not connected	N/A	Brown w/ white stripe or solid brown	Brown w/ white stripe or solid brown

a. 568A and 568B are Ethernet cable designations.

Sync/COM1 Port

This connector is an 8-pin block header receptacle. The signal descriptions are listed in Table B-2.

Table B-2 RS-232B/sync Connector Parameters

Pin	Signal	Description	DB-9 Socket Connector
1	TXD	Transmit Data	2
2	RXD	Receive Data	3
3	DTR	Data Terminal Ready (not connected)	4
4	RTS	Request to Send	7
5	CTS	Clear to Send	8
6	GND	Ground	5
7	SYNC+	sync positive signal	-
8	SYNC-	sync negative signal	-

External Digital Input/Output Connector

This connector is used for the digital input/output assembly, which is used to interface the Orion Reader with external inputs and outputs. Inputs can be devices such as light curtains or loops, and outputs can be devices such as gates or lights (connector is P/N 33357-01). The signal descriptions are listed in Table B-3.

Table B-3 Digital I/O Pin-outs on Power, Sync, and I/O Connector

Wire	Pin No
Power +24V	5
Power +24V	6
Power Return	7
Power Return	8
Sync-	3
Sync+	4
I/O 1	1

Wire	Pin No
I/O 1 Return	15
I/O 2	14
I/O 2 Return	13
I/O 3	12
I/O 3 Return	11
I/O 4	10
I/O 4 Return	9

C

System Technical Specifications

C

System Technical Specifications

This appendix provides reference specifications for the Orion® Reader components.

Component Specifications

This appendix describes the engineering specifications for the reader components. This appendix does not include specifications for reader options, those are described in Appendix D, “Options.”

Orion Reader

The reader environmental specifications are listed in Table C-1.

Table C-1 Orion Reader Environmental Specifications

Environment	Specification
Shock	10 G, sawtooth pulse @11ms duration
Vibration	5-20 Hz: 0.1 inch; peak to peak 20-200 Hz: 2 G peak **Note** No more than 2-dB tag-in-box sensitivity degradation under the vibration conditions on all 3 axis
Temperature range	Storage temperature range: –40C to +85C
Humidity	0% to 95% noncondensing over all temperatures.

Toll Antenna

A toll antenna should meet the specifications 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 toll antenna can withstand the environmental tolerances shown in Table C-2.

Table C-2 Antenna Environmental Tolerances

Environment	Specification
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_{rms} 10-500 Hz
Temperature range	-40°F to +167°F (-40°C to +75°C)
Humidity	100% condensing

D

Orion Reader Options

Appendix D

Orion Reader Options

This appendix will describe each of the options available with the Orion® Reader.

Orion Reader Options

This appendix describes the installation, operation, technical specifications, and preventive maintenance for the options available with the Orion Reader. Not all of the options can be used on the same Orion Reader due to conflicts between the connectors.

- "Digital Input/Output Modules"
- "Global Positioning System Timing Option"

Figure D-1 shows the optional assemblies.

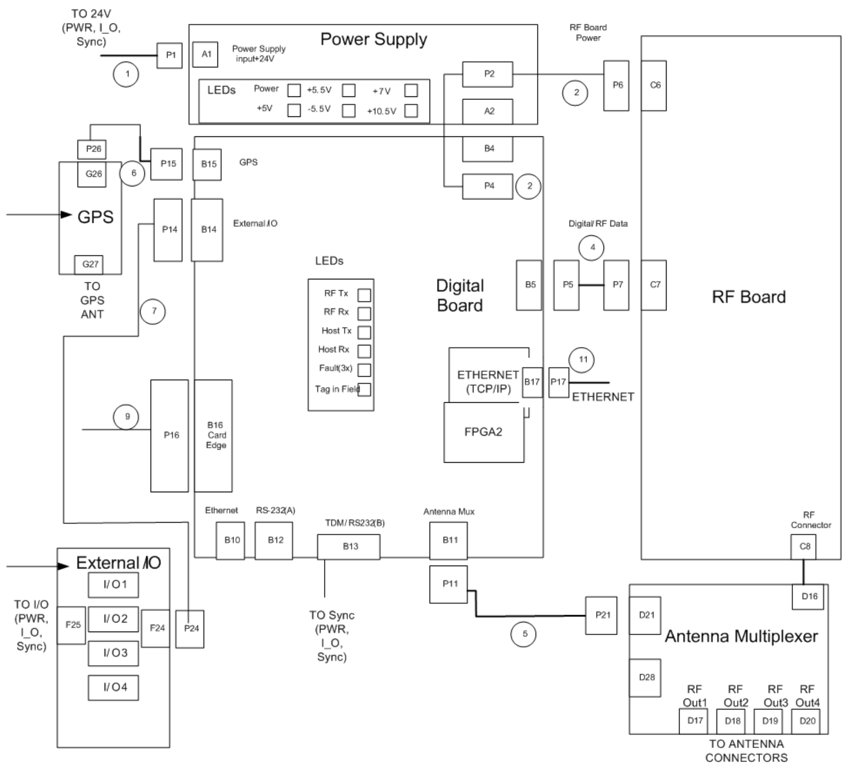

Figure D-1 Connector Locations for External Options

Digital Input/Output Modules

The digital input/output (I/O) assembly is used to interface the Orion Reader with external inputs and outputs. Inputs can be devices such as light curtains or loops, and outputs can be devices such as gates or lights.

The digital I/O circuit board can accommodate up to four OPTO 22 G4-model input or output modules and screw terminal connectors for connecting the Orion Reader to external interfaces. These modules are optional.

Presence detectors (loop detectors, wheel detectors, infrared/laser lights) can be installed through the input sense circuits to turn on the Orion Reader when an object is detected approaching the reading range.

Output functions such as traffic lights, cameras, signs and gates may be controlled through the reader's status output circuits.

The output modules are controlled by 5V signals from the Orion Reader. The output modules support voltages up to 100V DC or 130V AC on their output pins. The input module outputs a 5V signal to the Orion Reader. The input modules recommended by Star Systems use from 2.5V to 28V DC.

The OPTO 22 input/output modules are not supplied with the digital I/O assembly. Go to www.opto22.com for a listing of input and output modules.

Caution
The Orion Reader digital I/O port is not surge protected, therefore Star Systems strongly recommends that only OPTO 22 modules be used to configure any external I/O device that will be controlled through the digital I/O port. DO NOT connect any external device directly to the digital I/O port.

Damage to the Orion Reader caused by power surges or spikes linked to incorrect use of the digital I/O port will void the reader warranty.

Required Components/Tools

Before installing the digital I/O assembly and modules, make sure you have the necessary components.

- Digital I/O Kit (P/N 77-6000-001). Here is a parts list for the kit:

Quantity	Description
1	Mounting rack for OPTO modules
4	#6-32 x 1/4 inch Phillips screw

- Phillips head screwdriver for installing the I/O assembly and modules to the Orion Reader.

- Assortment of 14-22 AWG wires to connect modules to mounting rack.

Installation/Mounting/Grounding of the Reader

Connect the stainless steel backplate used to mount the NEMA enclosure to earth ground using a ground cable and stake. Follow the National Electric Code for lightning protection for the locale where you are installing the Orion Reader. Figure D-2 shows an example of a site installation using a NEMA enclosure.

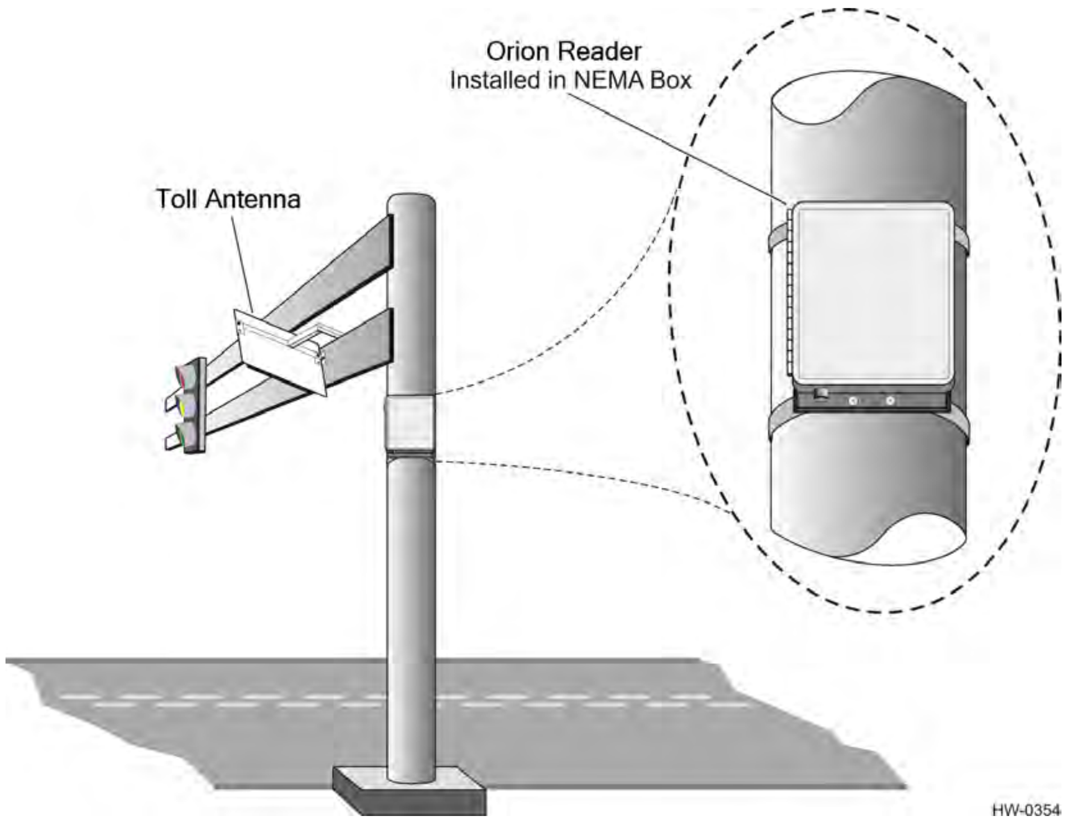

Figure D-2 Sample NEMA Enclosure Installation

Caution

CAUTION

To protect the Orion Reader, attach the mounting plate to the ground cable. To ensure that the mounting structure and NEMA enclosure housing the Orion Reader are sufficiently grounded, have a licensed electrician certify the grounding system.

If you install the backplate on a mounting pole or other assembly that is sufficiently grounded to earth, and all of the surfaces are good conductors, you may not need to use a grounding cable.

Tighten the mounting hardware to 50 ft-lb (68 N/m) to ensure that the box will sustain vibration requirements.

To Mount the Digital I/O Modules on the Orion Reader

1. Place the Digital I/O Module (Figure D-3) on the Orion Reader.

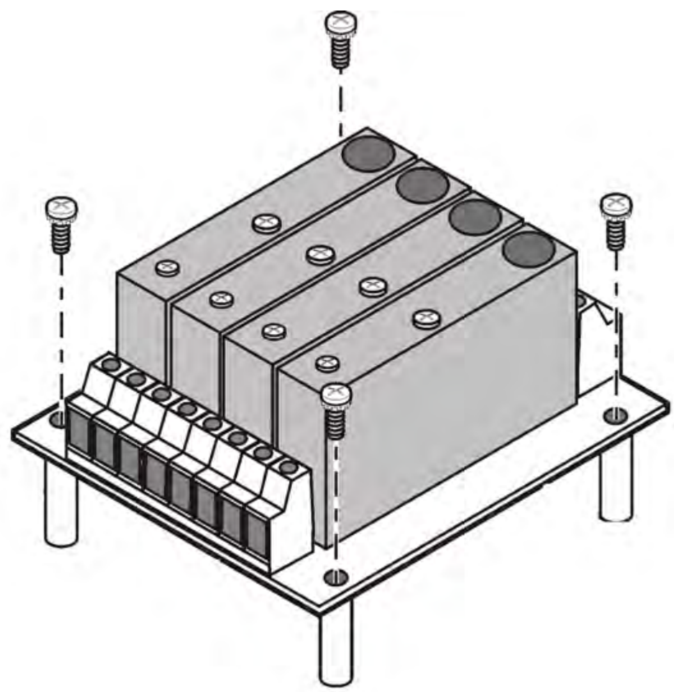

Figure D-3 Digital I/O Modules on Orion Reader

2. Insert I/O module(s) into assembly and tighten mounting screw at top of module.

Figure D-4 shows sample wiring schematic for digital I/O Input 1.

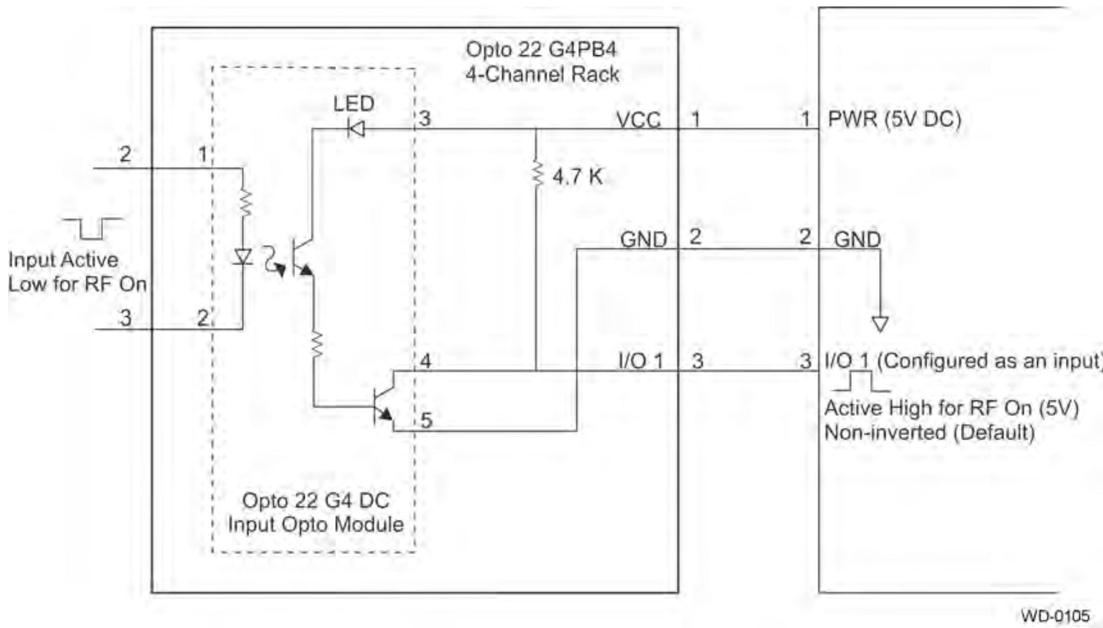

Figure D-4 Example of Digital I/O Input 1

Testing the Digital I/O Components Using TCP Commands

To test the digital I/O components using TCP commands, send the applicable TCP commands listed in Table D-1.

Table D-1 Digital I/O Command Group Commands

Digital I/O Configuration Command	Command Code
Set Digital I/O Sensor Status Change Report	0000H
Get Digital I/O Sensor Status Change Report	0001H
Set Digital I/O Output Host Control	0002H
Get Digital I/O Output Host Control	0003H
Set Digital I/O Output Tag Read Control	0004H
Get Digital I/O Output Tag Read Control	0005H
Set Digital I/O RF Control	0006H
Get Digital I/O RF Control	0007H

Table D-1 Digital I/O Command Group Commands (continued)

Digital I/O Configuration Command	Command Code
Set Digital I/O RF Multiplexing Mode	0008H
Get Digital I/O RF Multiplexing Mode	0009H
Set Digital I/O Output Pulse Duration	000AH
Get Digital I/O Output Pulse Duration	000BH
Set Digital I/O Minimum Presence True Period	000CH
Get Digital I/O Minimum Presence True Period	000DH
Set Digital I/O Sensor Input Inversion	000EH
Get Digital I/O Sensor Input Inversion	000FH
Set Digital I/O Port Configuration	0010H
Get Digital I/O Port Configuration	0011H
Set Digital I/O Sensor Input Report	0012H
Get Digital I/O Sensor Input Report	0013H
Set Digital I/O Presence RF Control Algorithm	0014H
Get Digital I/O Presence RF Control Algorithm	0015H
Set Digital I/O Presence RF Control Time-Out Period	0016H
Get Digital I/O Presence RF Control Time-Out Period	0017H
Get Digital I/O Port Status	0018H
Set Digital I/O Mode	0019H
Get Digital I/O Mode	001AH
Set External Interrupt Control	056DH
Get External Interrupt Control	06ADH

Guidelines for Ordering the I/O Modules

The digital I/O assembly can accommodate up to four OPTO 22 G4-model input or output modules for connecting the Orion Reader to external interfaces. Star Systems recommends that the I/O modules have the following specifications:

Input Module — input voltage from Orion Reader: 2.5V to 28V DC; output voltage to Orion Reader: 5V DC logic

Output Module — input voltage from Orion Reader: 5V DC logic; output voltages of up to 100V DC or 130V AC on their output pins.

Table D-2 lists the acceptable OPTO 22 input modules and Table D-3 lists the acceptable OPTO 22 output modules to be used with the Orion Reader.

Table D-2 Acceptable Input Modules

OPTO 22 MODULE P/N	INPUT VOLTAGE	OUTPUT VOLTAGE
G4IAC5	90V-140V AC or DC	4.5V-6V DC
G4IAC5L	90V-140V AC or DC	4.5V-6V DC
G4IAC5MA	90V-140V AC or DC	4.5V-6V DC
G4IDC5	10V-32V DC or 12V-32V AC	4.5V-6V DC
G4IDC5B	4V-16V DC or AC	4.5V-6V DC
G4IDC5D	2.5V-28V DC	4.5V- 6V DC
G4IDC5K	2.5V-16V DC	4.5V-6V DC
G4IDC5MA	10V-32V DC or 12V-32V AC	4.5V-6V DC
G4IDC5-SW	Dry contact	4.5V-6V DC
G4IDC5-SWNC	Dry contact	4.5V-6V DC

Table D-3 Acceptable Output Modules

OPTO 22 MODULE P/N	INPUT VOLTAGE	OUTPUT VOLTAGE
G4OAC5	4V-8V DC	12-140V AC
G4OAC5FM	4V-8V DC	12-140V AC
G4OAC5MA	4V-8V DC	12-140V AC
G4ODC5	4V-8V DC	5V-60V DC
G4ODC5FM	4V-8V DC	5V-60V DC
G4ODC5MA	4V-8V DC	5V-60V DC
G4ODC5R	4.8V-6V DC	100V DC or 130V AC
G4ODC5RFM	4.8V-6V DC	100V DC or 130V AC
G4ODC5R5	4.8V-6V DC	100V DC or 130V AC
G4ODC5R5FM	4.8V-6V DC	100V DC or 130V AC

You can configure the I/O assembly with any combination of the four modules; for instance, four inputs, four outputs, three inputs and one output, three outputs and one input, and so on.

Global Positioning System Timing Option

The Global Positioning System (GPS) timing option available on Orion Readers permits a GPS-equipped multiprotocol reader in one plaza to be synchronized with another GPS-equipped multiprotocol reader in another location without being physically connected by a sync cable. This configuration is highly useful when physical barriers or boundaries prevent a sync cable between plazas to be used. The GPS option also can be used to synchronize any number of GPS-equipped multiprotocol readers when no physical barrier is present.

The GPS timing assembly, which uses the globally available NAVSTAR GPS satellite navigation and timing service, can provide a precise 1 pulse per second (PPS) timing signal to the Orion Reader. The GPS timing assembly mounts to the top of the Orion Reader (Figure D-5).

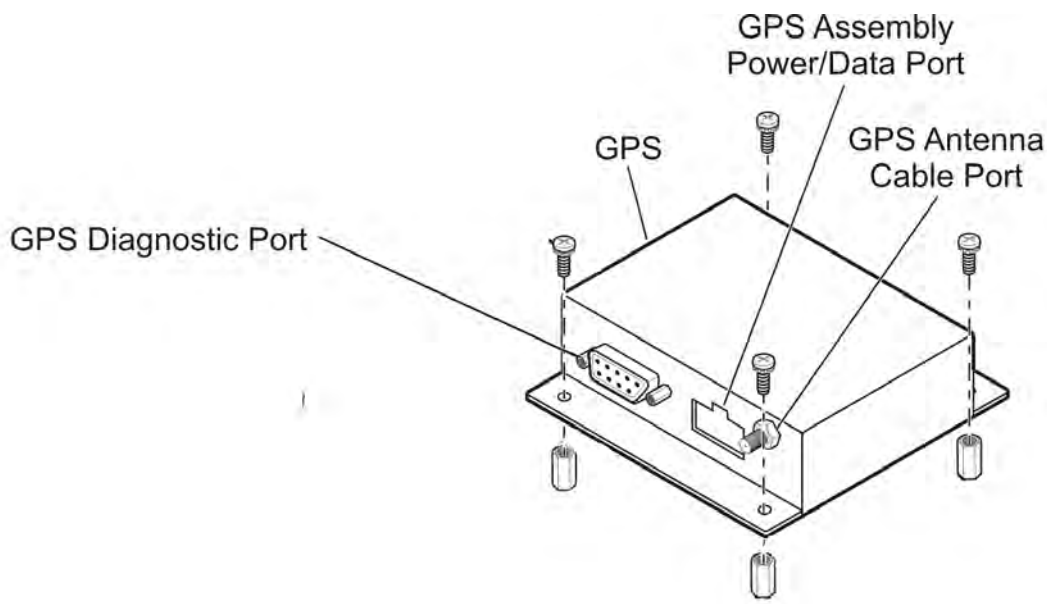

Figure D-5 GPS Assembly

This GPS timing option permits a GPS-equipped Orion Reader in one plaza to be synchronized with another GPS-equipped Orion Reader in another plaza without being physically connected by a Sync data cable (Figure D-6). This configuration is useful when physical barriers or long distances prevent a Sync data cable between plazas to be used.

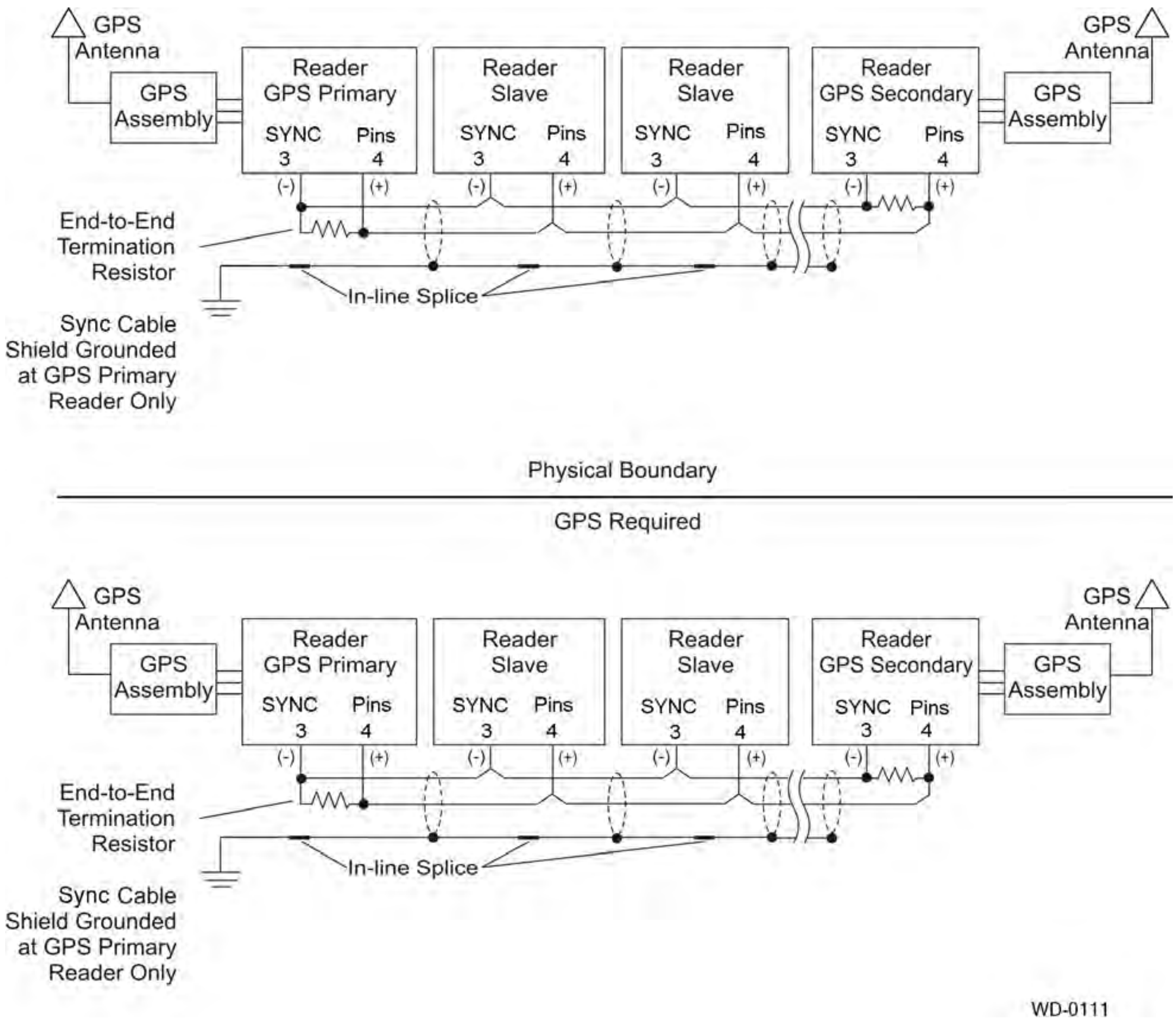

Figure D-6 Sync Configuration Using GPS Timing Option

Star Systems recommends Belden 89182 (150 Ω impedance), which is a single twisted-pair shielded cable rated for outdoor use, or 8132 (120 Ω impedance), which is a double twisted-pair shielded cable that must be installed in conduit. The Belden 8132 cable has an extra pair that is not used. Using these low-loss, low-capacitance twisted-pair cable, a distance of 1000 feet (305 m) has been obtained. This maximum distance may be slightly longer or shorter depending on the cable type used.

Star Systems recommends using the cable shielding and grounding scheme shown in Figure D-7 to reduce the risk of electromagnetic interference disrupting or damaging the Sync circuitry in the Orion Reader.

GPS Power and Data Connector

Figure D-7 shows the power and data connector and Table D-4 lists the connector pin assignments and descriptions.

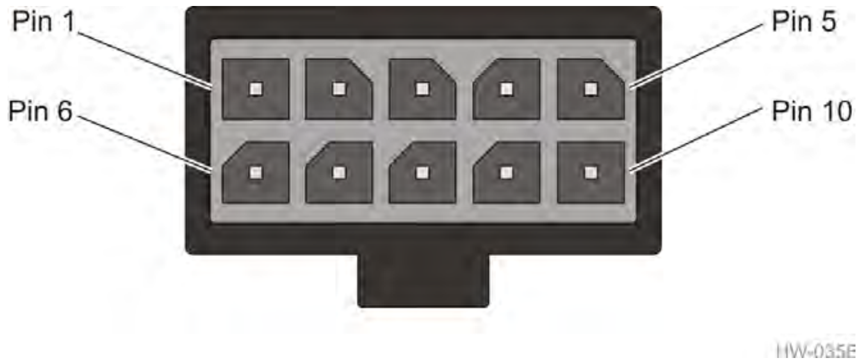

Figure D-7 GPS Assembly Power/Data Connector

Table D-4   GPS Assembly Connector Pin Assignments and Signal Descriptions

Pin	Signal	Description
1	TXD1	Transmit data (3V logic)
2	RXD1	Receive commands (3V logic)
3	Not connected	N/A
4	1 PPS	1 pulse-per-second output
5	Ground	Signal and power common
6	Not connected	N/A
7	Not connected	N/A
8	Not connected	N/A
9	GPS receiver and antenna power	+5V
10	Not connected	N/A

The GPS antenna mounts outside the plaza structure (Figure D-8). The antenna connects to the GPS assembly with a coaxial cable.

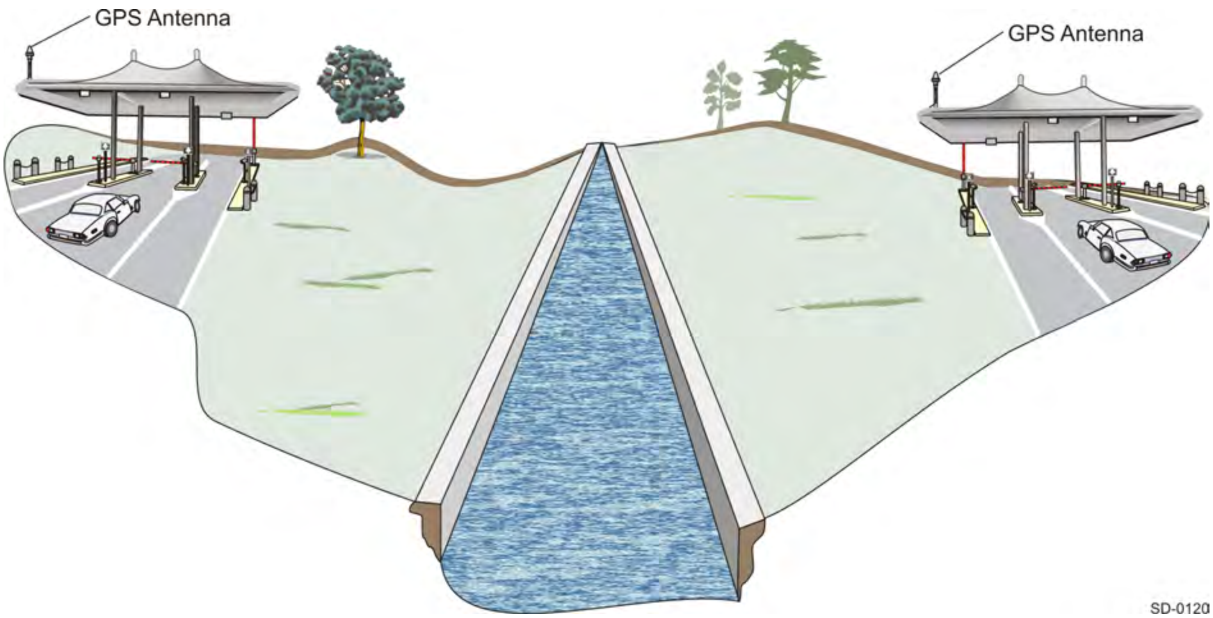

Figure D-8 Example of GPS Used to Connect Separate Parking Sites

Before Installing the GPS Antenna

Before installing the GPS for the toll plaza, you need to ensure that the antenna will be visible to GPS satellites. You should choose an antenna location that has clear, 360-degree visibility to the sky.

Once you are sure that the antenna reception will be unobstructed, you can begin installing the antenna. Make sure you have the following Star Systems-supplied items:

GPS kit (P/N 23-5000-001 or 23-6000-001) consists of the items listed in Table D-5:

Table D-5 Global Positioning System Accessory Kit Contents

Quantity	Description
1	Global positioning system assembly
1	Active GPS antenna
1	GPS power/data cable
4	#6-32 x 3/8 inch stand-off
4	#6-32 x 1/4 inch Phillips screw

Required Components/Tools

Once you are sure that the antenna reception will be unobstructed, you can begin installing the antenna. Make sure you have the following -supplied items:

- GPS timing accessory kit (GPS assembly, power/data cable, antenna, and mounting hardware, P/N 19100-02)

You need the following additional equipment and tools to complete the installation:

- Fifty-ohm antenna coaxial cable with attenuation loss of less than 12 dB @1.575 GHz.

Note: *Maximum cable length is determined by cable attenuation loss. Installer should calculate the cable loss for the specific cable being used.*

- Pole/pipe mounting hardware (e.g., anchor bolts)
- Length of 1 1/4-inch (3.175 cm) Schedule 40 pipe (stainless steel, aluminum, or galvanized steel) to be used for antenna pole
- Cable terminating/crimping tools
- Torque-limiting wrench (in-lb range)
- Standard set of tools (screwdrivers, pliers, wrenches) for fastening the GPS assembly to the Orion Reader.
- Special tools for installing the GPS antenna at site, for example, impact hammer for drilling into concrete, if needed.

You can order additional GPS antennas (P/N 20015-01) from Star Systems.

GPS Timing Assembly Mounting

1. Screw the four standoffs into the mounting holes of the Orion Reader as shown in Figure D-5.
2. Place the GPS assembly on the standoffs and secure with the Phillips screws provided in the kit.

Caution
Tighten the standoffs and mounting screws until snug. Do not overtighten.

3. Connect the GPS assembly to the reader with the power/data cable provided in the GPS assembly kit.

GPS Antenna Mounting

Note: *The GPS antenna installation must comply with applicable structural and building codes for the locale where it is being installed.*

1. Select a location for the GPS antenna that provides maximum visibility to the sky.
2. Secure the antenna pole mounting hardware to the site structure.
3. Connect the antenna pole to the mounting hardware.
4. Insert the RF coaxial cable up through the inside of the mounting pipe and connect the cable to the antenna using a Type-N plug connector.

   Refer to Figure D-9 when assembling the antenna components.

   You also can cut a 1-inch (2.54-cm) wide by 2-inch (5.1-cm) long slot in the side of the mounting pipe (Figure D-9). Star Systems recommends this procedure for installing the RF coaxial cable when it cannot be pulled through the bottom of the pipe.
5. Pull the cable up through the pipe bottom or slot and terminate it at the antenna port.

Note: *If you choose to use a different mounting pole material than the 1-¼ inch (3.175 cm) Schedule 40 pipe, the pole material should have a nominal outside diameter of 1.66 inches (4.2 cm). Proper material selection for the field installation is left to the system installers.*

6. Slip the antenna mount over the coaxial cable.
7. Screw the Type-N plug connector onto the type-N antenna receptacle connector and tighten until snug.
8. Connect the mount to the antenna by tightening the four captive screws until snug.
9. Push the antenna-mount assembly onto the antenna pipe or pole and tighten the hex-head set screws on the antenna mount.
10. Connect the antenna to the Orion Reader at the GPS antenna cable port (Figure D-5). Tighten this SMA connector to 10 in-lb.

.

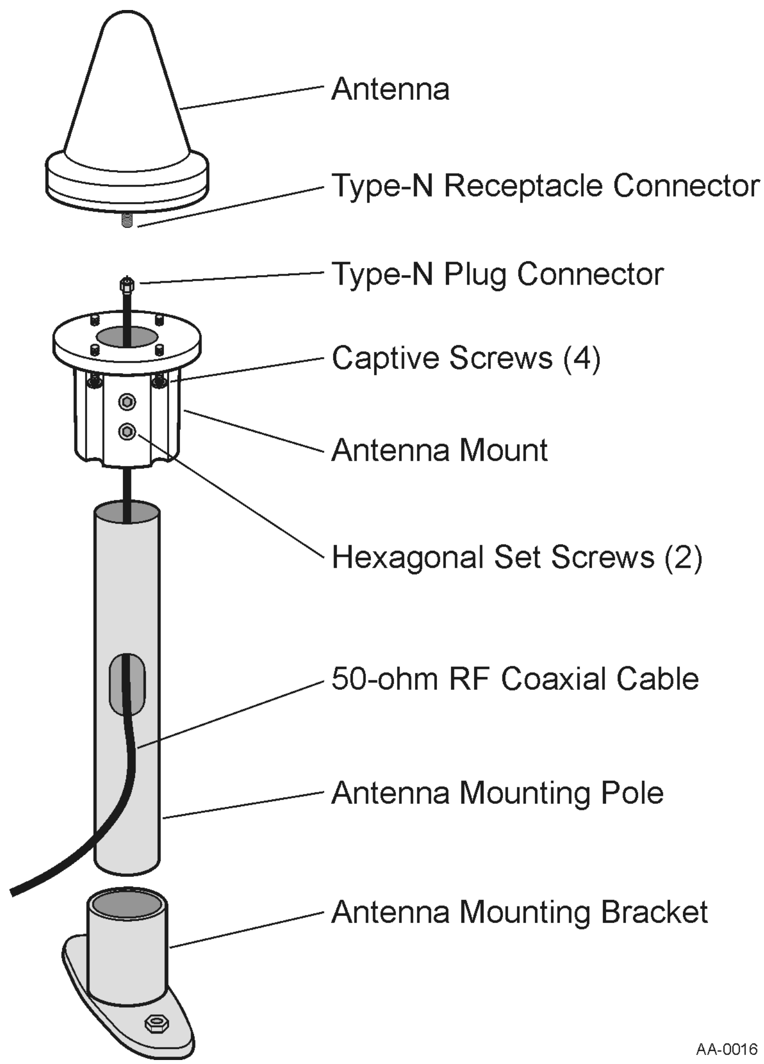

Figure D-9 GPS Antenna Assembly

Caution
To prevent damage to the SMA connector, Star Systems strongly recommends that you provide a strain-relief bracket or other means of securing the GPS antenna coaxial cable that terminates at the GPS timing assembly.

Note: *The antenna mount must be grounded in accordance with National Electrical Code regulations for the locale where the Orion Reader/GPS antenna system is being installed.*

Testing the GPS Timing System

The following sections list basic command information for testing using TCP.

Note: *As the GPS system activates, the Sync error LED lights on the Orion Reader. This error indication usually clears in about 1 minute, but it can take as long as 15 minutes.*

Using the TCP Command Set

Configure and test the GPS timing option using the TCP command set by sending the appropriate TCP command ("Set Master/Slave Mode" on page 6-109).

Configuring the Reader/Slave Count

This section explains how to configure the reader/slave hierarchy (GPS primary/GPS secondary or master/slave) using the GPS TCP command.

Choose one field only, for example, GPS primary, GPS secondary, master, or slave.

GPS Primary — This field specifies whether the reader is to be configured as the GPS primary.

GPS Primary	Definition
0	Not GPS Primary
1	GPS Primary

GPS Secondary — This field specifies whether the reader is to be configured as the GPS secondary.

GPS Secondary	Definition
0	Not GPS Secondary
1	GPS Secondary

Master — This field specifies whether the reader is to be configured as the master.

Master	Definition
0	Not Master
1	Master

Slave — This field specifies whether the reader is to be configured as the slave.

Slave	Definition
0	Not Slave
1	Slave

For this example, the sum of the delay and duration period is 19.9 milliseconds, which is less than the synchronization rate of 20 milliseconds. If the sum of the delay and duration periods equals the synchronization rate, unexpected results can occur.

Slave Select Count — This field specifies the order that a slave or GPS primary or secondary reader issues a synchronization pulse whenever a given reader within a synchronization group fails to recognize the signal from the preassigned master or whenever a GPS receiver fails to issue a 1-pps signal, respectively. The maximum slave count = 26.

Scenario 1 — One master, n slaves. The master has no slave behavior, therefore it is assigned a slave select count of 0. Each slave is assigned an increasingly greater number from 1 to n. When the master fails, slave 1 becomes the master, and so on.

Scenario 2 — GPS primary, GPS secondary, N slave readers. When in fault mode (1-pps signal missing), a GPS primary is slave to a GPS secondary and all other slaves and is assigned the last slave select count, n. A GPS secondary takes over when a GPS primary is in fault mode, therefore it is assigned a slave select count of 1. All slaves are assigned increasingly greater numbers from 2 to n+1.

Scenario 3 — One GPS primary and n slaves. This scenario forces the GPS primary to have no slave behavior by specifying a slave select count of 0. Each slave is an increasingly higher number from 1 to n. When the master fails, slave 1 becomes the master. If slave 1 should fail, slave 2 takes over, and so on (Table D-6).

Table D-6 Reader Slave Count Configuration Table

Scenario 1 — One Master, n Slaves						
Reader Mode	Master	Slave	Slave	Slave	Slave	Slave
Slave Select Count	0	1	2	…	n-1	n

Table D-6 Reader Slave Count Configuration Table (continued)

Scenario 2 — GPS Primary, GPS Secondary, n Slaves						
Reader Mode	GPS Secondary	Slave	Slave	Slave	Slave	GPS Primary
Slave Select Count	1	2	3	…	n+1	n+2
Scenario 3 — One GPS Primary, n Slaves						
Reader Mode	GPS Primary	Slave	Slave	Slave	Slave	Slave
Slave Select Count	0	1	2	…	n-1	n
n = Total number of slave readers						

Environmental

Temperature Range for GPS Assembly

The GPS assembly can operate within the following operating and storage temperature conditions (Table D-7).

Table D-7 Operating/Storage Temperature Limits and Conditions

Specification	Limits/Conditions
Operating temperature installed in NEMA	-40°F to +131°F (-40°C to +55°C)
Storage temperature range	-40°F to +185°F (-40°C to +85°C)

Humidity

The Orion Reader GPS assembly is rated to operate within humidity levels of 0% to 95%, non-condensing.

GPS Antenna

Table D-8 lists the GPS antenna specifications.

Table D-8 GPS Antenna Specifications

Parameter	Specification
Operating temperature	-40°F to +185°F (-40°C to +85°C)
Operating frequency	1527.42 ±1.023 MHz, typical
Power supply	5V DC
Current	27 mA maximum
Polarization	RT hand circular
Output VSWR	2.5 maximum
Gain	30 dB minimum

GPS Assembly Connector

GPS Diagnostic Port

The GPS diagnostic port is used for factory diagnostics only.

GPS Antenna Cable

The antenna connects to the GPS assembly via an RF coaxial cable that is supplied by the Orion Reader user. The GPS antenna cable connects the receiver to the assembly's end panel and is externally available.

For applications requiring lightning protection on the GPS assembly/antenna system, the lightning arrestor must be able to pass DC voltage or current on the center conductor of the coaxial cable. The GPS assembly transmits a DC bias voltage and current through the center conductor from to the antenna to power the low-noise amplifier, which is integrated into the active GPS antenna. Using a DC-block lightning protection system will not work. Star Systems recommends you use a gas-discharge-type system designed for an active GPS antenna.

Regulatory Requirements

Emissions

The GPS assembly complies with the requirements of FCC Part 90, FCC Part 15, and industry Canada RSS-137 (where applicable).

Safety

The GPS assembly is UL60950 approved.

Electrical Protection

ESD

With the GPS assembly installed and operated as part of a complete Orion chassis assembly, the assembly complies with the requirements of the International Electro-technical Commission/Comite, Europe, en de Normalisation (IEC/EN) 61000-4-2, Class 4 standard (Table D-9).

Table D-9 ESD Limits and Conditions

Discharge Voltage	16.0 kV
Polarity	Positive
Number of Repetitions	2 pulses
ESD System	NSG438 system, which complies with a 150-picofarad/330-ohm discharge network of the IEC/EN 61000-4-2 standard
Test conditions	All ESD tests are performed at +77°F (+25°C)

Antenna Drive and Protection Circuitry

The receiver uses an antenna sense circuit that detects under-current (open), over-current (shorted or exceeding maximum), or valid antenna connection. The receiver supplies up to 80 milliamps (mA) of current via the antenna power supply circuit.

If the antenna draws 15 mA or more, a status bit in the antenna status information is set, giving a good indication that an antenna is attached.

If the antenna draws less than 15 mA, an alarm bit is set indicating an under-current condition in the antenna status information.

If more then 80 mA is drawn through the antenna port, then the over-current detection circuitry will reduce the antenna feed current to approximately 45 mA until the fault is cleared.

Detection of an under-current situation will not prevent the receiver from operating. The receiver will continue to operate normally, but will issue an error flag indicating a possible antenna problem.

Antenna Drive Current Limits

Undercurrent detect @+77^{o}F (25^{o}C)

Good Indication: greater than 15 mA

Undercurrent Indication: less than 15 mA

Over-current Detect @+77^{o}F (25^{o}C): 80 mA maximum for normal operation

Troubleshooting the GPS System

Note: *See “Communicating Via Diagnostic Port (COM2)” on page 10-4 to learn how to access system diagnostics fault messages.*

When the GPS receiver initializes, it performs a self-test, which includes a check of the GPS antenna status. If a fault condition exists, the message displays GPS Self Test Fault = 1, which means that an error condition exists with either the GPS receiver or coaxial antenna cable. You can display the fault status by entering a ShowSysStatusBits command from a PC.

If a fault condition exists, first check the GPS coaxial cable and connections. After checking the cable, if the fault condition remains, switch the cable with another, good, cable. If the fault condition continues, return the GPS assembly to Star Systems.

If the GPS self-test reveals no faults, the status bit displays GPS Self Test Fault = 0. No further action is required.

E

Command-Based Pre- and Post-Conditions

Appendix E

Command-Based Pre- and Post-Conditions

This appendix lists pre- and post-conditions for transmission control protocol (TCP). In these tables, Stop Mode Required indicates that the reader first must be set to Stop Mode (Mode 0) as a pre-condition to entering the specified command. The post-conditions, Immediate or Reset Required, indicate that the command either takes effect immediately or that the reader must be reset after the command has been entered. This is a subset of the complete list of commands and lists only those commands that are needed to configure an Orion Reader.

TCP Command Pre- and Post-Conditions

Table E-1 lists the TCP command pre- and post-conditions.

Table E-1 Pre- and Post-Conditions for TCP Commands

TCP Command Group	Command #	Command	Stop Mode Required/ Immediate/Reset Required
0x0200 - Diagnostics	0x0005	Clear Error Logs	Immediate
0x0400 - Mode	0x0001	Set Mode	Immediate if 1) TCP host startup selected and mode and has not been set previously; 2) Stop Mode is requested; or 3) Mode has been set previously, Stop Mode is current mode, and requested mode is same as previous operational mode. Reset Required if 1) TCP non-volatile memory startup selected and requested mode is not Stop Mode; or 2) requested mode is different from previous operational mode.

Table E-1 Pre- and Post-Conditions for TCP Commands (continued)

TCP Command Group	Command #	Command	Stop Mode Required/ Immediate/Reset Required
0x0400 - Mode	0x0003	Set Protocol	Reset Required
0x0400 - Mode	0x0043	Set Tag Command Data	Immediate if 1) Protocol is CVISN. Stop Mode Required if 1) Request is not host driven. Reset Required if 1) Command Action is 0.
0x0400 - Mode	0x0066	Set Seen Count	Immediate
0x1000 - Tag	0x0002	Set Append Data	Immediate
0x1000 - Tag	0x0025	Run CRC	Immediate
0x1000 - Tag	0x002A	Set Manual Antenna Channel Control	Immediate
0x1000 - Tag	0x0030	Set IAG Slot	Reset Required
0x1000 - Tag	0x0040	Set Secondary Tag Sequence	Reset Required
0x1000 - Tag	0x0045	Set Master/Slave Mode	Immediate
0x2000 - RF	0x51	Set Attenuation	Immediate
0x2000 - RF	0x53	Set Data Detect	Immediate
0x2000 - RF	0x55	Set Line Loss	Immediate
0x2000 - RF	0x57	Set Uplink Source Control	Immediate
0x2000 - RF	0x60	Set Frequency in MHz	Stop Mode Required
0x4000 - Digital I/O	0x0000	Set Sensor Status Change Report	Immediate

Table E-1 Pre- and Post-Conditions for TCP Commands (continued)

TCP Command Group	Command #	Command	Stop Mode Required/ Immediate/Reset Required
0x4000 - Digital I/O	0x0002	Set Output Host Control	Immediate if output host control is enabled (i.e., both predefined output control and output by channel are disabled) Reset Required if output host control is disabled (i.e., either predefined output control or output by channel is disabled)
0x4000 - Digital I/O	0x0004	Set Output Tag Read Control	Reset Required
0x4000 - Digital I/O	0x0006	Set RF Control	Reset Required
0x4000 - Digital I/O	0x0008	Set RF Multiplexing Mode	Reset Required
0x4000 - Digital I/O	0x000A	Set Output Pulse Duration	Stop Mode Required
0x4000 - Digital I/O	0x000C	Set Minimum Presence True Period	Stop Mode Required
0x4000 - Digital I/O	0x000E	Set Sensor Input Inversion	Stop Mode Required
0x4000 - Digital I/O	0x0010	Set Port Configuration	Reset Required
0x4000 - Digital I/O	0x0012	Set Sensor Input Report	Immediate
0x4000 - Digital I/O	0x0014	Set Presence RF Control Algorithm	Stop Mode Required
0x4000 - Digital I/O	0x0016	Set Presence RF Control Time-out Period	Stop Mode Required
0x4000 - Digital I/O	0x056D	Set External Interrupt Control	Reset Required (may only be set if TCP Host Startup is configured, and must be set prior to setting mode. Reset is required to change parameters.)
0x8000 - System	0x0003	Set Time and Date	Immediate
0x8000 - System	0x0009	Delete All Buffered Tag Transactions	Immediate
0x8000 - System	0x0011	Set TCP/IP Core Lane Controller Parameters	Reset Required
0x8000 - System	0x0013	Set TCP/IP Core IP Address	Immediate

Table E-1 Pre- and Post-Conditions for TCP Commands (continued)

TCP Command Group	Command #	Command	Stop Mode Required/ Immediate/Reset Required
0x8000 - System	0x0016	Set Buffered Tag Transaction Mode	Immediate
0x8000 - System	0x0018	Set Data Acknowledge Time-out Period	Immediate
0x8000 - System	0x001A	Set Switch Buffered Tag Transaction Mode Enable	Immediate
0x8000 - System	0x001F	Get System Serial Number	Immediate

C