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## MPR 4.1 READER

### OPERATIONS AND MAINTENANCE MANUAL

QMS EDITION – ISO 9001:2015

**DOCUMENT: UM360479-100**

**REVISION: B**

**DATE: May 19, 2022**

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## **MPR 4.1 READER**

### **OPERATIONS AND MAINTENANCE MANUAL**

QMS EDITION – ISO 9001:2015

**DOCUMENT: UM360479-100**

**REVISION: Draft B4**

**DATE: May 19, 2022**

**Kapsch TrafficCom:**

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MCLEAN, VA 22102  
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**FCC License Notice:**

This equipment emits RF signals. In order to operate this equipment the customer must obtain a separate FCC Part 90 Site license for each location. In addition, the FCC ID component identification **JQU802890**, must appear on a label on the front of the MPR 4.1 Reader.

The power output of a Reader at ambient ( $P_{\text{out(amb)}}$ ) shall be constrained using internal or external Tx attenuation so that the following is satisfied:

$$P_{\text{out(amb)}} \leq 43.77 \text{ dBd} - G_{\text{fund}}$$

Where  $G_{\text{fund}}$  is the net gain from antenna connector on the Reader to the antenna radiated signal. The antenna gain is expressed in **dBd**.  $P_{\text{out(amb)}}$  is expressed in **dBm**

**Note:** This device complies with Part 15 of the FCC Rules. Operation is subject to the following two conditions: (1) this device may not cause harmful interference and (2) this device must accept any interference received, including interference that may cause undesired operation.

**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 radio frequency energy and, if not installed and used in accordance with the instruction manual, may cause harmful interference to radio communications. Operation of this equipment in a residential area is likely to cause harmful interference in which case the user will be required to correct the interference at their expense.

**Changes or modifications not expressly approved by Kapsch TrafficCom could void FCC compliance and the authority to operate the equipment.**

**Note:** IEC 60950-1 and/or EN60950-1, First Edition, Information Technology Equipment – Safety – Part 1: General Requirements require that this equipment must be located in a RESTRICTED ACCESS LOCATION (RAL). Only authorized personnel can have access to the equipment.

**SOFTWARE/FIRMWARE Note**

**The current software set is identified in the Software Release document.**  
The active Reader software and firmware version is displayed in the Reader browser interface.

**FACTORY SUPPORT SERVICE**

For Return Material Authorization (RMA) numbers please telephone: 905 624-3020.  
**For Kapsch Service information and other requests please FAX: 905 624-4572.**

**NOTICE**

The information presented in this document is current although it is subject to change. As such, **Kapsch TrafficCom** assumes no liability on behalf of the USER with respect to interpretation based on the use of this information

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**NOTICE OF PATENTS:**

**Kapsch TrafficCom**

has patented or has patents pending on critical design features of the item or items described herein. Contact Kapsch TrafficCom for all queries regarding patents.

## Document Revision Control

Version Date	Revision	Editor	Changes
Draft	B4	E. Rolo	Updates for FCC filing, Pg 4 resize box for IEC 60950, Pg 15 change last sentence for keep away to 100cm, update FCC frequency table on Pg 157.
DRAFT	B3	S. Lee	Updated reader name and software filename. Added details to MESSAGE LED in Troubleshooting section. Updates for FCC 1 M from antenna face.
2019-05-22	B2	E. Rolo	Updated page 42 to replace RF Module page with Radio Page
2019-05-14	B1	E. Rolo	Initial Release

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# **1. ABOUT THIS MANUAL**

The MPR 4.1 Reader Operations and Maintenance Manual consists of two main parts :

- Operations
- Maintenance

Sections and subsections within these main parts are used to present theoretical as well as practical and procedural information. See the table of contents for more details on each section.

This manual is the main reference document used during training. Training is provided by Kapsch TrafficCom for the following personnel.

- Operations
- Installations
- Maintenance
- Service

This manual is also used as a reference by Kapsch TrafficCom for its service-certified technical service personnel in the field once training has been completed.

This version of the manual is current to and uses screens and information pertaining to software version 2019nov04a-MPR41 (2019nov04a-MPR41.en.sign). Earlier versions may not support all control parameters and features shown or described, while later versions may have additional features and control parameters.

## **Technical Background**

Personnel must have an electrical/electronic technical background, understanding of toll and RF, and some prior experience using web browsers.

## **Warnings and Cautions**

### ***Warnings***

Warnings indicate a risk of bodily harm and include a symbol indicating the type of injury risked.

	<p><b>WARNING:</b></p> <p>WARNING DESCRIPTION HERE.</p>
---	---

The following warnings appear in the manual:



AN IMPROPERLY GROUNDED READER COULD RESULT IN ELECTRIC SHOCK. ENSURE A HIGH CURRENT EARTH GROUND CONNECTION IS ESTABLISHED BEFORE CONNECTING SUPPLY POWER TO THE READER.



THE READER MAY HAVE SHARP EDGES. HANDLE THE READERS CAREFULLY.

**Cautions**

Cautions indicate a risk of damage to equipment or loss of data.



The following cautions appear in the manual:

Improper modification of configuration parameters may adversely affect system operation. The default values may not be appropriate for the specific application. It is the system integrator's responsibility to tailor the configuration parameters to the specific operating environment.

Log file formats are not under ICD control and the format may change without prior notification. Log files are for diagnostic purposes only and are not guaranteed to be maintained in non-volatile storage.

Excessive bending or kinking can damage the RF feedline cables. Do not excessively bend or kink the RF feedline cables when installing them between the antennas to the Reader enclosure.

Activating inactive factory software/firmware on a running system is not recommended. The factory software/firmware may not be appropriate for the specific application.

During software/firmware activation (typically less than 60 seconds), the Reader is unable to process or report transactions.

The factory default configuration should not be restored on a running Reader. The factory software/firmware may not be appropriate for the specific application. Save the current Reader configuration before resetting the Reader configuration to the factory default.

Keep at least 100 centimeters away from the radiating face of the antenna when the antenna port is connected and operating.

## Conventions used in this manual

The following information is provided to the user to aid in understanding and readability.

Highlighting and callouts are used in the guide to indicate importance, or to indicate a change to the user.

Example:

Bolding of words is used in the following cases:

- To indicate that an action is required (example: Click the **Next** button.)
- To indicate a main menu item and/or a menu option (example: From the **Tag Protocol** screen, select the **Enable TMP** check box.

When required, tables listing screen fieldnames and/or column headings and their definitions or meanings are placed below selected screens to aid in understanding technical terms.

Decision tables are used when procedures have more than one option from which to choose.

Example:

IF ...	THEN ...
you click the <b>Login</b> button and a dialog box requesting a username and password appears,	go to step 5.
a 403 Forbidden error message appears,	ensure the IP address entered in the address bar is correct and that the IP address is preceded by <b>https://</b> <b>Note:</b> When you connect to the Reader with the laptop for the first time accept the secure certificate before continuing.
a web browser message indicating there is a connection problem appears,	confirm that the IP address entered in step 3 is the correct record of system IP addresses.
a security warning appears	follow the instructions the web browser provides.

The terms **Tag**, **Transponder** and **On-board Unit** or **OBU** are interchangeable in this manual.

The terms **IAG** and **TDM** are interchangeable in this manual when referring to screens or the TDM protocol.

The terms **Channel** and **Port** are interchangeable in this manual

## How to use this manual

The MPR 4.1 Reader Operations and Maintenance Manual requires no special instructions on how to use it.

Topics can be found in the Table of Contents at the beginning of the manual to help with navigation.

If an online version of the guide is used, both the Table of Contents topics, and page and subject cross-references within the body of the document are hyperlinked to their associated subject matter.

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# OPERATING INSTRUCTIONS

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## **2. OVERVIEW**

### **Introduction**

The MPR 4.1 Reader is part of the Electronic Toll Collection (ETC) Subsystem. Toll collection is the primary use of the Reader.

### **Overview of the MPR 4.1 Electronic Toll Collection (ETC) Subsystem**

The MPR 4.1 Reader is a single multi-protocol radio with four multiplexed ports. The MPR 4.1 is a Nema 4 enclosed reader that can be pole or wall mounted. The reader operates from DC power (19 – 30VDC) and consumes 50 Watts of power. The reader can interact with both active and passive OBUs.

#### ***Active OBU***

For an active OBU, overhead antennas send out RF signals. As a vehicle equipped with an active OBU approaches a toll zone, the OBU receives an RF signal from the antenna. The OBU then starts transmitting data, which is received by the antenna and passed on to the Reader. The Reader processes and logs the OBU data, and then sends the information to the Lane Controllers (LCs). The Reader can also send data back to the OBU, such as an updated toll account balance.

#### ***Passive OBU***

For a passive OBU, the antenna sends out a command or a continuous wave via an RF signal. As a vehicle equipped with a passive OBU approaches a toll zone, the OBU receives an RF signal from the antenna. If commanded, the OBU then starts transmitting data, which is received by the antenna and passed on to the Reader. The Reader processes and logs the OBU data, and then sends the information to the Lane Controllers (LCs). The Reader can also send data back to the OBU, such as an updated toll account balance.

The MPR 4.1 is factory configured to enable all protocols.

For an in-depth description of protocols and the MPR 4.1 ETC Subsystem, see Theory of Operations page 72.

## MPR 4.1 Reader

*Operating Instructions*

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**MPR 4.1 system components**

An MPR 4.1 reader System consists of the following components:

- MPR 4.1 Reader shown in Figure 2-1: MPR 4.1 Reader with four multiplexed ports,
- An antenna shown in Figure 2-4.

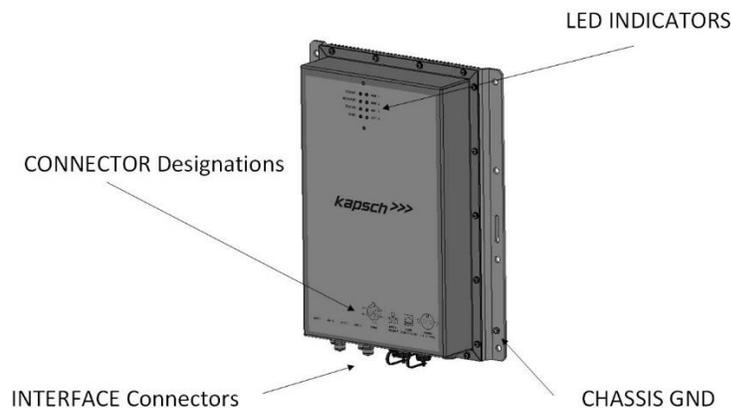
Additional installation components required are:

- An RF cable from Reader to Antenna
- Sealing tapes for RF connectors exposed to weather
- Lightning arrestors
- Optional Ethernet switch modules (ESMs)
- Sync and inter-reader Ethernet cabling (if required)
- Ethernet cables

Additional Site requirements are:

- DC Power and grounding,
- Mounting structure for the MPR 4.1 and the antenna
- Mounting Hardware for the MPR 4.1

**Figure 2-1: MPR 4.1 Reader**



**MPR 4.1 LED Indicators****Figure 2-2: MPR 4.1 Reader LED Indicators**

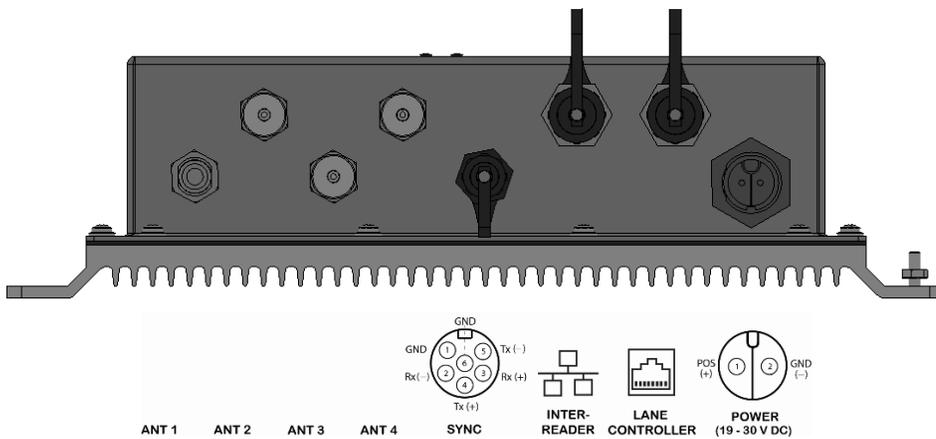
The MPR 4.1 Reader provides the following status information based on the LEDs shown in Figure 2-2: MPR 4.1 Reader LED Indicators.

<b>LED</b>	<b>DESCRIPTION</b>
POWER	<p>Green LED illuminated – Indicates that the MPR 4.1 reader has external power and all internal power supplies are working correctly.</p> <p>Flashing Amber LED illuminated – Indicates that the MPR 4.1 reader has external Power but there is a fault with one of the internal power supplies.</p> <p>No LED illuminated – Indicates that the MPR 4.1 reader either has no or improper external power or a fault with the internal power supplies.</p>
MESSAGE	<p>Flashing Amber LED illuminated – Indicates that there are recorded errors or messages that need to be addressed by the user. Example: NTP time offset exceeded, Lane Controller connection down, Frame Configuration error.</p> <p>No LED illuminated - Indicates that there are no recorded errors or messages.</p>
STATUS	<p>Flashing Green LED - Indicates that the reader CPU is functioning correctly.</p> <p>Flashing Amber LED– Indicates that the reader CPU is experiencing heavy load.</p> <p>Flashing Red LED - Indicates that the reader CPU is operating under extreme load.</p>

- No LED illuminated – Indicates that the reader software is not operating.
  
- SYNC
  - Green LED illuminated – Indicates that the reader is correctly syncing with other reader on the sync connection.
  - Flashing Amber LED illuminated – Indicates that the reader is out of sync and in recovery mode with other readers on the sync connection.
  - Flashing Red LED illuminated – Indicates that the reader is out of sync with other readers on the sync connection.
  - No LED illuminated – Indicates that Sync is not enabled on the MPR 4.1 reader.
  
- ANT (1 through 4)
  - Green LED illuminated – Indicates that the port is actively transmitting.
  - Flashing Green LED illuminated – Indicates that the port is active but a fault exists on the Port.
  - No LED illuminated – Indicates that the port is not selected.

**MPR 4.1 External Connectors**

**Figure 2-3: MPR 4.1 External Connectors**



The MPR 4.1 reader includes the following external interfaces:

Connector	Description
ANT 1	A female N type connector for RF connection to one antenna.

## MPR 4.1 Reader

*Operating Instructions*

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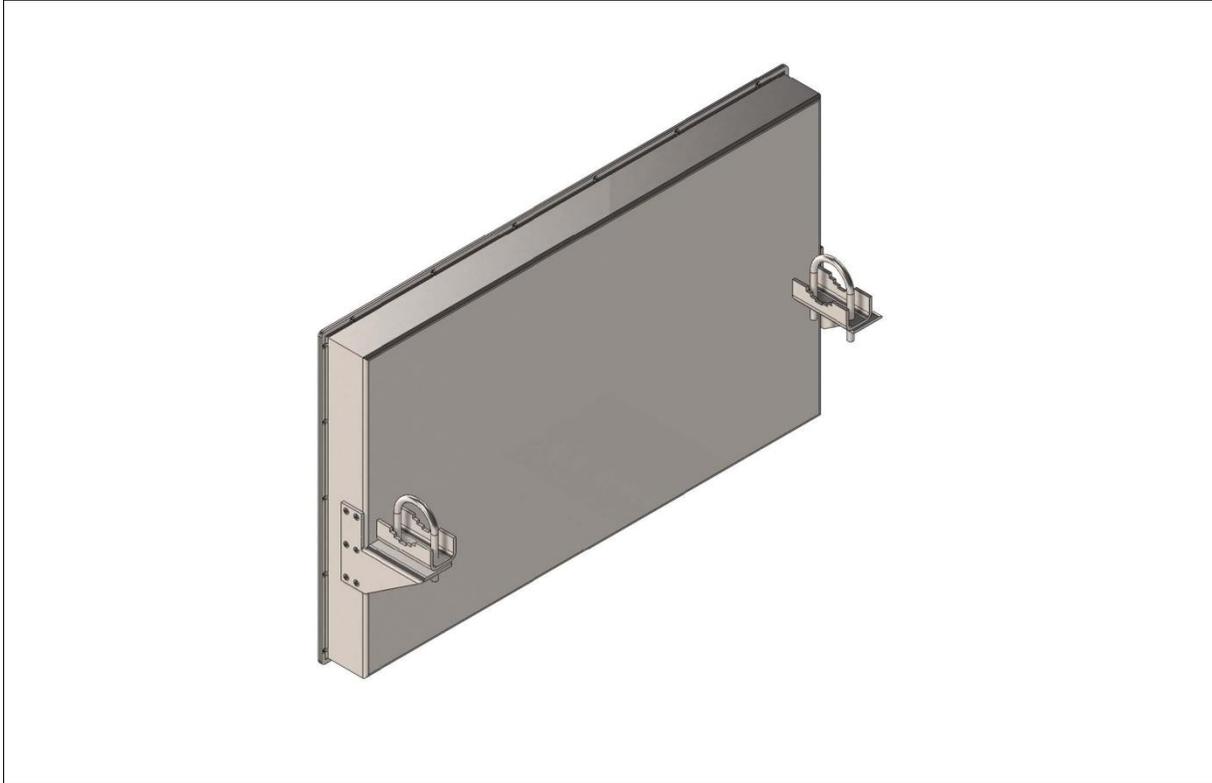
ANT 2	A female N type connector for RF connection to one antenna
ANT 3	A female N type connector for RF connection to one antenna
ANT 4	A female N type connector for RF connection to one antenna
SYNC	A synchronization connector used to sync multiple readers together.
INTER-READER	An ethernet connector used to connect several readers together to support inter-reader voting.
LANE CONTROLER	An ethernet connector used to connect the MPR 4.1 reader with an external lane controller.
POWER	A power connector used to provide DC power to the MPR 4.1 (19 to 30VDC)

**Note:** Mating connector information is provided in the section: Technical Specifications and Pin outs on page 139.

**Antenna**

The antenna sends and receives RF signals to and from the vehicle On Board Units (OBUs). The IAG 3 antenna is recommended for the MPR 4.1 reader. See Antenna Specifications, page 142 for more details. Figure 2-4 shows an illustration of the IAG 3 antenna, the recommended antenna for the MPR 4.1 Reader.

**Figure 2-4: IAG 3 Antenna**



MPR 4.1 Reader

*Operating Instructions*

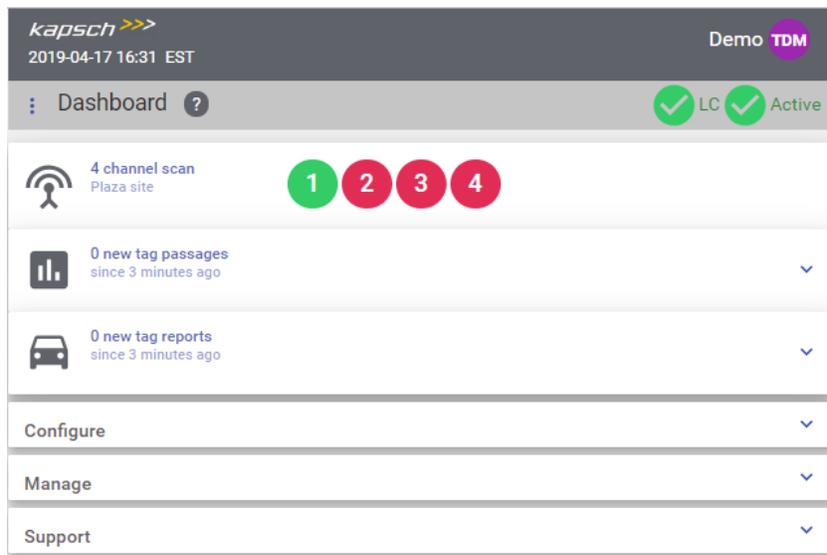
---

**The web interface**

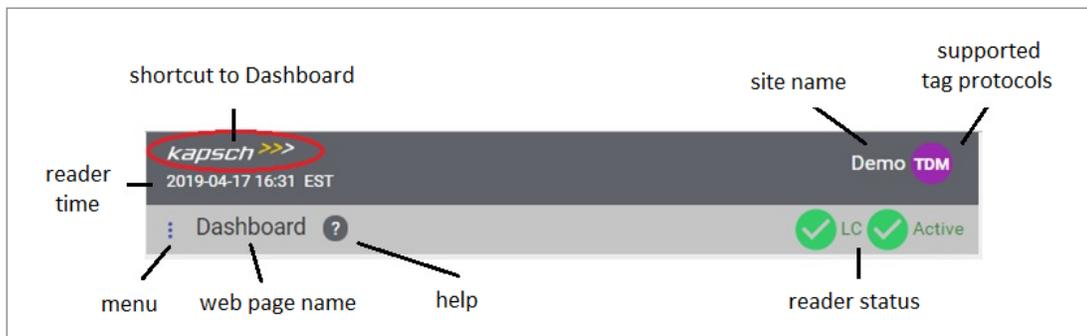
You can use a service laptop equipped with a web browser to access the web interface, shown below.

**Note:** Depending on the permissions given a user by the administrator, the menu can offer different options.

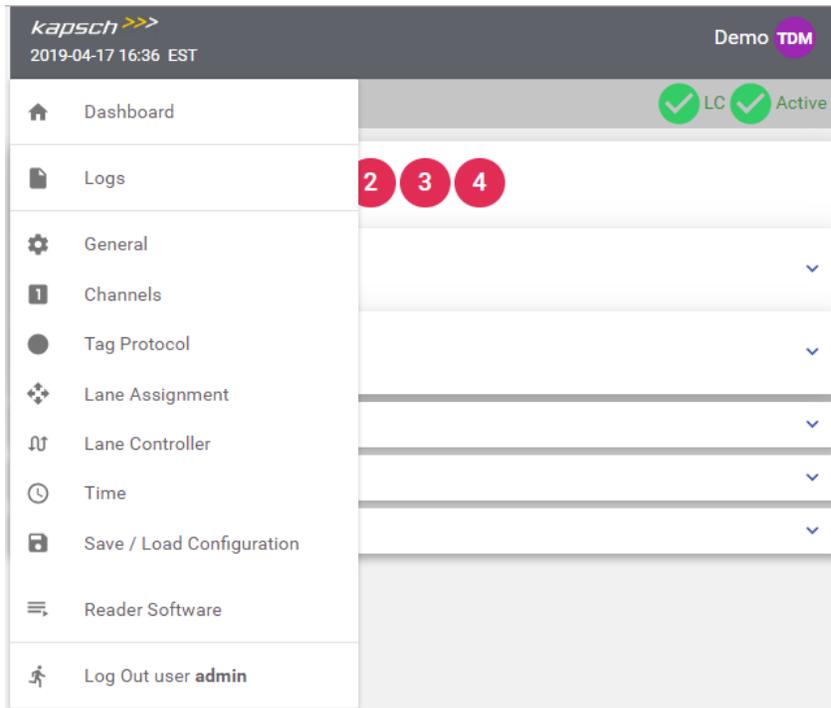
After entering your user name and password, you can monitor and configure the Reader depending on the permissions assigned to your user account. From the **Dashboard** page one can navigate to all the web pages by clicking on the links **Configure**, **Manage**, and **Support**



The banner at the top of a web page provides the reader status and menu for navigating to commonly accessed pages.



Click the menu icon  to navigate to the commonly accessed web pages.



**Table 2-1: Web interface menu**

Option	Description
Dashboard	Select to display the Dashboard panel in the web interface. The Dashboard panel provides an at-a-glance view of transactions happening in real time, handshake chart, RF Ports' status, system configuration, system management and system support.
Logs	Select to access reader log files that includes Tag Transaction logs, Event logs, Trouble logs, NTP and Dev logs.
General	Select to access the configuration on Site, Network, SNMP and Reader Statistics.

Channels	Select to access the configuration on Channels and Channel groups
Tag Protocol	Select to access the configuration on Frame and Firing Sequence, TX and RX attenuation of enabled protocols, Protocol Frequency, Tag Programming and Advanced options.
Lane Assignment	Select to access the configuration on Lane Assignment algorithm, Inter-reader, TDM Low and Early Read logic.
Lane Controller	Select to access the configuration on Lane Controller interface, Destination and Reporting modes
Time	Select to set Reader Date, Time and Time Zone, disable/enable Network Time Protocol (NTP).
Save / Load	Select to manage Reader Configuration, upload, download as well as reset reader configuration to defaults.
Reader Software	Select to manage Reader Software, upload, activate or delete software version.
Log out	Select to quit session and log out of the system.

### 3. OPERATING PROCEDURES

	<b><u>CAUTION:</u></b> Improper modification of configuration parameters may adversely affect system operation. The default values may not be appropriate for the specific application. It is the system integrator's responsibility to tailor the configuration parameters to the specific operating environment, with the aid of the Kapsch Operations Group.
---	--

#### Starting up the Reader

This procedure outlines the correct way to power on and boot up a Reader.

Prerequisites: External DC Power Source (19 to 30VDC).

1. Connect the external Power source to the MPR 4.1

**Result:** The POWER LED illuminates green.

2. Wait for the MPR 4.1 to complete its power up cycle (approximately 60 Seconds).

**Result:** The POWER LED illuminates green. The STATUS LED illuminates green to indicate MPR 4.1 is functional.

**Note:** If the STATUS LED indicates an abnormal state, (see Table 6-1: LED Indicator states explained on page 113) perform the necessary troubleshooting procedure. See Troubleshooting Methodology on page 111 for more information.

#### Shutting down the Reader

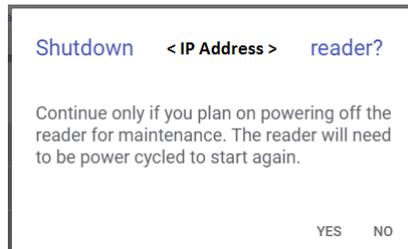
This procedure outlines the correct way to power down a Reader.

Prerequisites: None.

1. Click **Dashboard** link located on the upper left side panel.
2. On the Manage panel, click the  Shutdown icon.



**Result:** The following dialog appears.



3. Click the **YES** button to confirm.



4. When the Reader has completed an orderly software shut down disconnect the external power supply.

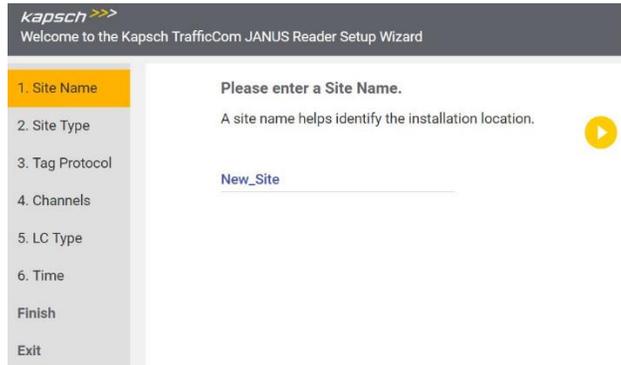
## Using the Wizard

This procedure outlines the quick way to set the Reader parameters.

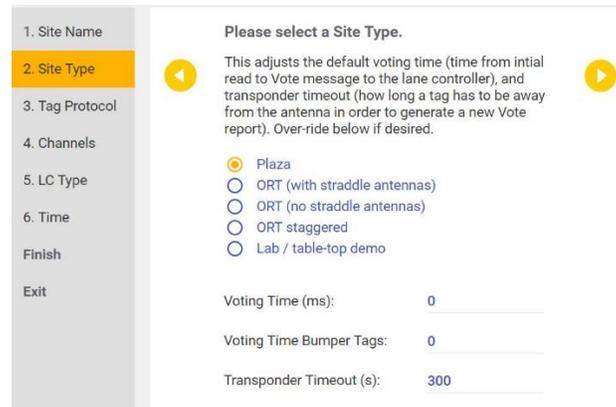
1. To start the Wizard, go to the **Dashboard**. On the **Configure** panel, click the **Wizard** link.



2. Enter the Site Name.



3. Select the Site type.



4. Select all required tag protocols.

MPR 4.1 Reader

*Operating Instructions*

1. Site Name
2. Site Type
3. Tag Protocol
4. Channels
5. LC Type
6. Time
- Finish
- Exit

Please select the tag protocols.

Protocol	Rx Attn	Tx Attn	Freq
TDM	5	0	915.75
+	5	0	902.50

**Protocol** To add a protocol, or enable reader sync, click the + sign and select an item. The TDM protocol is enabled by default.

**Rx Attn** Enter a number to specify each channel's receive attenuation (in dB). A value of 0 means full sensitivity.

**Tx Attn** Enter a number to specify each channel's transmit attenuation (in dB). A value of 0 means full power. For lab testing with a patch antenna, try 15.

**Freq** For passive protocols, specify the starting frequency for channel 1. The wizard automatically assigns 2.5 MHz channel spacing for adjacent channels. For TDM protocol the frequency is fixed.

*Note: Independent configuration for all channels can be made after the wizard exits.*

5. Enter the number of the antennas.

1. Site Name
2. Site Type
3. Tag Protocol
4. Channels
5. LC Type
6. Time
- Finish
- Exit

Enter the number of antennas to be configured for this reader.

4

6. Select the LC Interface.

1. Site Name
2. Site Type
3. Tag Protocol
4. Channels
5. LC Type
6. Time
- Finish
- Exit

Please select the Lane Controller Interface Type.

Specify default settings for Ethernet and Serial.

Ethernet  
 None

Enter Lane Controller Ethernet IP address and Port number.

IP Address: 192.168.1.50

Port: 0

7. Set the time.

## MPR 4.1 Reader

---

*Operating Instructions*


---

1. Site Name
2. Site Type
3. Tag Protocol
4. Channels
5. LC Type
6. Time
- Finish
- Exit

Please select how reader time will be set.

NTP means the reader time will sync with a time server available on the network. Manual allows you to set a specific time. LC means the Lane Controller is expected to set the time.

NTP
  Manual
  LC

Set NTP Server /Peer IP

0.0.0.0

Set Reader Time Zone

US/Eastern (EST)

8. Review the settings.

1. Site Name
2. Site Type
3. Tag Protocol
4. Channels
5. LC Type
6. Time
- Finish
- Exit

Please review the settings below.

You can go back and make changes if need be. Otherwise, click **FINISH** to apply settings.

Site Name : New\_Site  
 Site Type : Plaza  
 Voting Time (ms) : 0  
 LPT/FME Voting Time (ms) : 0  
 Transponder Timeout (s) : 300

Protocol	Rx Attn[dB]	Tx Attn[dB]	Freq
TDM	5	0	915.75

Number of Antennas : 4  
 Lane Controller Interface Type : Ethernet  
 LC Ethernet IP : 192.168.1.50  
 LC Ethernet Port : 0  
 Time Setting Method : NTP  
 Reader Time Zone : EST  
 NTP Server : 0.0.0.0

9. Click **FINISH** to apply the settings.

## Connecting a service laptop to the Reader

You can use a service laptop to access the web interface by connecting directly to the **Lane Controller** port.

### Changing the service laptop IP address

1. In Windows, go to **Start → Control Panel → Network and Sharing Center → Change Adapter Settings → Local Area Connection → Properties → Internet Protocol Version 4 (TCP/IP v4) → Properties**.
2. Select **Use the following IP address**, then enter the IP address using the Reader network number in the first three fields (ex. 192.168.1.\_) followed by a unique host number in the fourth field.
3. Enter 255.255.255.0 in the subnet mask and leave the default gateway blank.
4. Click **OK**

## MPR 4.1 Reader

*Operating Instructions***Testing the connection to the reader**

5. In Windows, go to the **Search** box at the bottom of the **Start** menu.
6. Type 'ping', followed by the Reader LC Port IP address.  
**Note:** Ping response times are less than 2ms on average.
7. Press **Enter**.

**Result:** Several replies from the Reader IP address display momentarily in a DOS window. You are ready to access the Web interface (see Accessing the Web interface page 35).

**Note:** If a reply is not received during the test, check the cable, connections, and IP addresses, then repeat step 5.

**Accessing the Web interface**

The Web interface monitors and configures the MPR 4.1.

Prerequisites: A service laptop connected to **Lane Controller** port, accessing the Web interface.

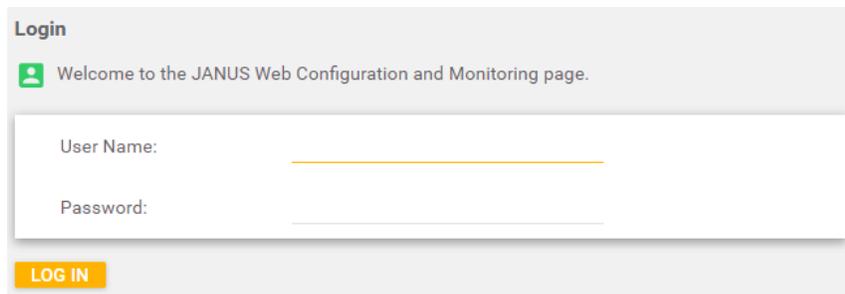
1. Launch the web browser on the computer.  
**Note:** You can use recent versions of any popular browser.  
**ATTENTION:** When using certain versions of Internet Explorer, you may experience missing strings of text when a screen displays. Press Control and F5 (Ctrl+F5) simultaneously. This action clears the buffer and refreshes the screen.  
**Note:** The default IP address of the Lane Controller port is 192.168.1.50. The IP address may change during installation.
2. Consult the record of system IP addresses to determine the correct IP address. See Appendix A.
3. In the address bar of the web browser, type: **https://** followed by the IP address of the **Lane Controller** Port.
4. Use the following decision table to continue the procedure.

IF ...	THEN ...
you click the <b>Login</b> button and a dialog box requesting a username and password appears,	go to step 5.
a 403 Forbidden error message appears,	ensure the IP address entered in the address bar is correct and that the IP address is preceded by <b>https://</b> <b>Note:</b> When you connect to the Reader with the laptop for the first time accept the secure certificate before continuing.

IF ...	THEN ...
a web browser message indicating there is a connection problem appears,	confirm that the IP address entered in step 3 is the correct record of system IP addresses.
a security warning appears	follow the instructions the web browser provides.

**Note:** Usernames and passwords are case-sensitive.

5. Enter your username and password then press Enter key or click **LOGIN** button



**Result:** The following **Dashboard** panel appears.

6. If login is successful, the following **Dashboard** page will appear.

**Note:** The top section shows tag transactions in live.

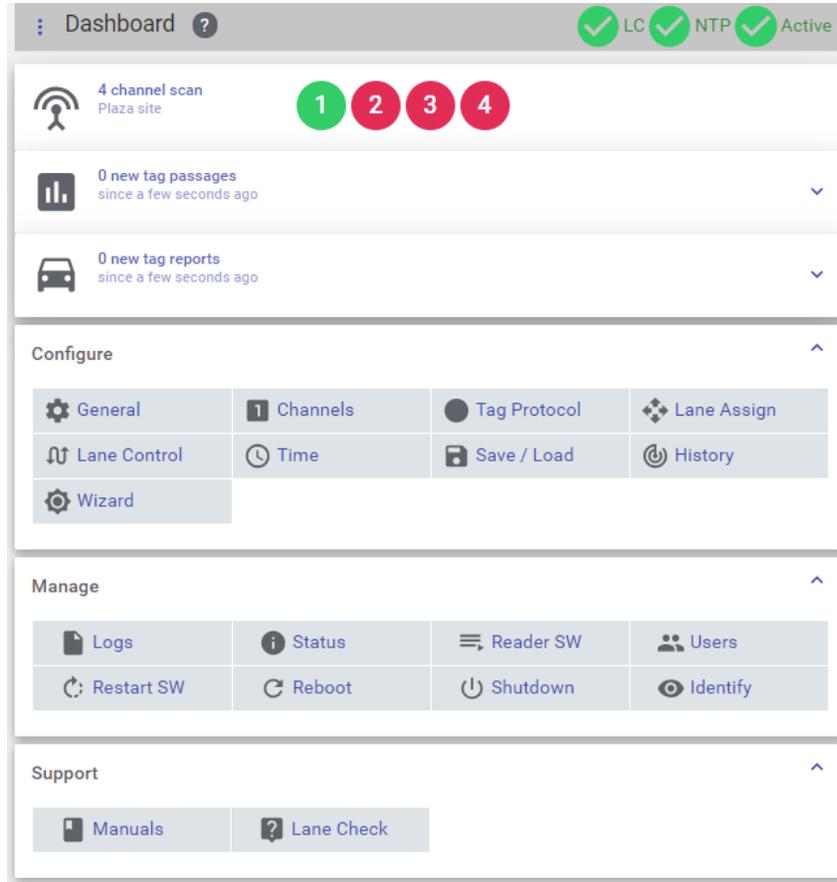
The Configure section provides links to web pages for reader configuration.

The **Manage** section provides links to web pages for managing software and user, for viewing log files and reader status, and provides links to restart /reboot /shutdown /identify the reader

The Support section provides links to user manual and diagnostic tool.

MPR 4.1 Reader

*Operating Instructions*



- In **Manage** panel, click the **Identify** icon to confirm which Reader web interface you are viewing, and that the computer is communicating successfully.



**Result:** The STATUS LED of the Reader flashes. For short period of time.

## Logging out of the Web interface

Logging out of the Web interface terminates the connection between the service laptop and the Web interface.

**Prerequisites:** A service laptop is connected to the Reader through the **Lane Controller** port to access the Web interface.

1. Click **Log Out** from the Menu icon .

**Result:** You are immediately logged out from the Web interface.

## Changing your password

Any user can change their own password. Empty password is not allowed. This procedure outlines how to change a password.

**Prerequisites:** Connect a service laptop to the Reader Ethernet 1 port to access the web interface. Refer to Connecting a service laptop to the Reader, page 34.

1. Login to the user account that requires a password change.
2. Navigate to **Users** page and select the logged in user.
3. Click Change Password  icon.
4. Enter your new password in the **New Password** and **Confirm New Password** fields.
5. Click the **SAVE** button.

**Result:** Your password is now changed

6. If, after you have changed your password, an authentication window appears, enter your user name and new password to return to the browser interface.

## Resetting a forgotten password

If a user forgets their password, the password can be reset to 'password' by another user with **User Admin** permissions. This procedure requires two users; a user with **User Admin** permissions and the user requiring a reset password.

**Prerequisites:** The user resetting the password must have User Admin permissions.

**Note:** The User Administrator should ensure that the user sets a new password after the password is reset.

1. Login as administrative user.

MPR 4.1 Reader

*Operating Instructions*

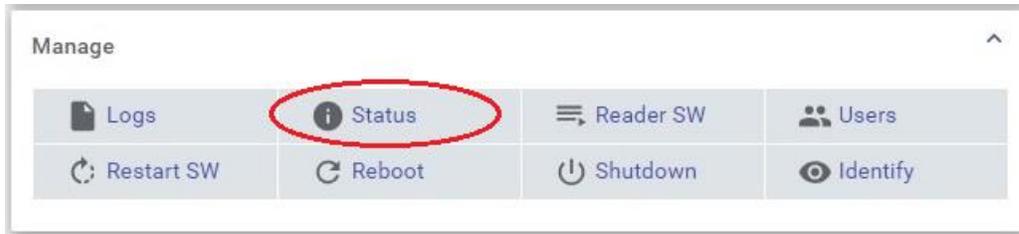
---

2. Navigate to the **Users** page.
3. Select the user whose password needs to be reset.
4. Click **Reset Password**  icon.
5. Click **Yes** to confirm.

**Result:** Your password resets.

## Monitoring the Reader

You can monitor and gather information about the Reader from the Web interface using the **Status** page.



### **Reader status**

The **Status** page on the Web interface displays the state of the communication links, the Reader power, and the CPU.

**Communications**

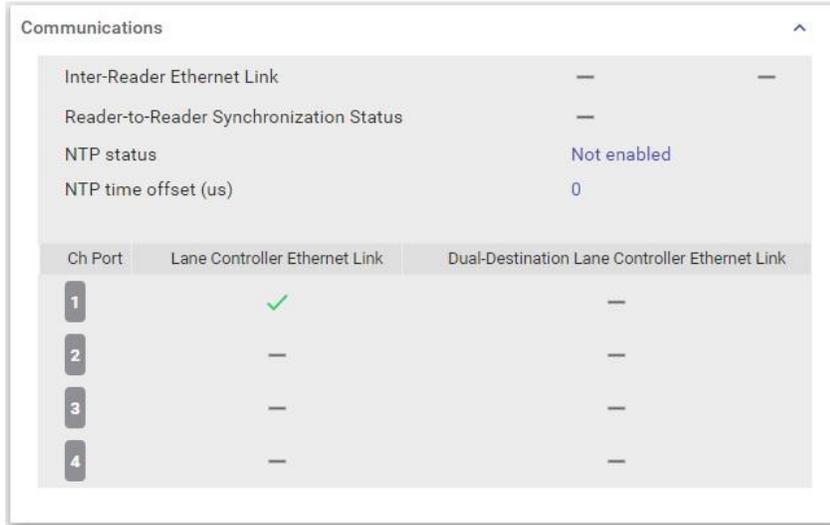


Table 3-1 lists and describes the fields in the **Communications** tab on the **Status** page.

**Table 3-1: Communications fields**

Communications panel		
Field	Status	Description
Inter-Reader Ethernet link	✓	successful link connection
	✗	link failure
	—	link not enabled
Reader-to-Reader Synchronization Status	✓	successful link connection
	✗	link failure
	—	Synchronization not enabled
NTP status	Synced	Time is synchronized with NTP server
	Synced, time offset > threshold	Time is synchronized but the offset is over limit

Communications panel		
Field	Status	Description
	Unsynchronized	Time is not synchronized with NTP server
	NTP not enabled	NTP time is not enabled
NTP time offset (us)	Numerical read	NTP time offset in microseconds
Lane Controller Ethernet link	✓	successful link connection
	✗	link failure
	—	link not enabled
Dual-Destination Lane Controller Ethernet Link	✓	successful link connection
	✗	link failure
	—	link not enabled

**Radio**

Table 3-2 lists and describes the fields in the **Radio** panel on the Status page.

Radio	
Firmware Version:	2019Feb20-1433-04
Comm. Status:	OK
	Antenna Status
1	✓
2	?
3	?
4	?

**Table 3-2: RF Radio fields**

RF Modules tab		
Field	Status	Description
Firmware Version	Date with part number shown	yyyymmdd-xxxx-xx
		Status not known
		Status not known
Comm Status		Comm States working
		Fault in one or more Comm States. RF module not responding or not operating.
		Receiving and/or transmitting
Antenna Status		Fault in receiving and/or transmitting
		Status not known

**Reader Status**

Table 3-3 lists and describes the fields in the **Reader Status** part on the Status page.

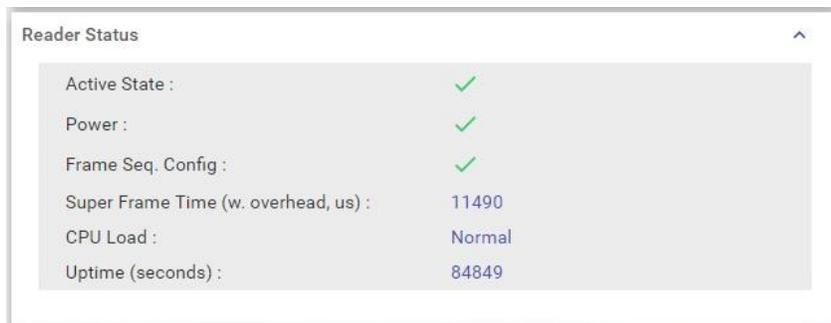


Table 3-3: Reader Status fields

Reader Status		
Field	Status	Description
Active State		CTM is active
		CTM is not active
Power		DC input operational
		DC input failure
Frame Seq. Config.		Indicates whether or not the last attempted frame configuration contains errors. If an error is indicated, consult the event/trouble logs for more detailed information.
		
		
	?	
Super Frame Time (w. overhead, us)	Numerical read	Reader timing information In microseconds
CPU Load	Normal	Normal
		High (over 50%)
		Extreme (over 80%)
Uptime (seconds)	Numerical read	Time of the reader activity measured in seconds

**Transaction Buffering**

Transaction buffering shows the user how much each Port is using for buffering. The following screen shows an example.

**Transaction Buffering** ^

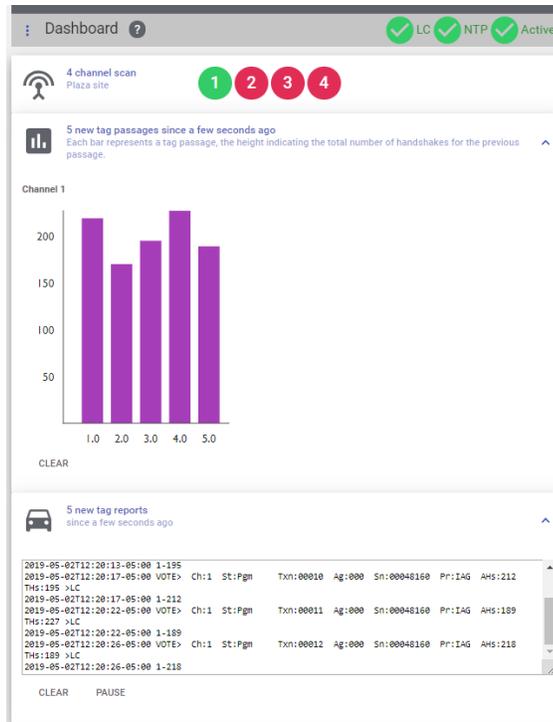
Clear buffered transactions ✕

<b>Total buffered:</b>	<b>851</b>
Channel 1:	buffered 851 oldest: Mon Mar 4 16:43:22 2019 newest: Thu Mar 7 14:21:28 2019
Channel 2:	buffered 0
Channel 3:	buffered 0
Channel 4:	buffered 0
Dual Channel 1:	buffered 0
Dual Channel 2:	buffered 0
Dual Channel 3:	buffered 0
Dual Channel 4:	buffered 0

**View Live Transactions**

You can view live tag transactions from the web interface by navigating to the Dashboard page. Click the expand icon to see the transactions record and bar chart.

## MPR 4.1 Reader

*Operating Instructions*

## Configuration via Web

The reader provides the ability to configure the reader operation via the web interface. There are multiple configuration screen tabs available, each with multiple parameter settings. A list of settings available and their function is provided in Appendix D

The tabs listed in Table 3-4 are available in configuration. It is recommended that the following order is used in setting a new configuration to ensure all necessary parameters are set:

- General
- Lane Assignment
- Tag Protocol – Frame Sequence, Tag programming
- Channel and Group
- Lane Controller

**Note1:** The parameters available in some screens, or the ability to change them, in some cases are dependent on enabling settings in other screens first.

**Note2:** After making changes in data field (Textbox, Checkbox, Toggle switch etc.), set data field out of focus to accept changes and new settings will be updated in the reader automatically .

The Frequency and RF Attenuation settings are often set on site as part of lane tuning.

Prerequisites: Connect a service laptop to the Reader LANE CONTROLLER port adapter to access the Web interface. Refer to Connecting a service laptop to the Reader, page 34.

1. Go to **Dashboard** page **Configure** panel.

**Result:** The following screen appears.



**Table 3-4: Configuration page**

Configuration Page	Function
General	<p>Configure Site Information, Network settings, SNMP and Reader Statistics.</p>

<p>Channels</p>	<p>Declare MRFM-S assigned status and some voting parameters.</p> <table border="1"> <thead> <tr> <th>Ch Port</th> <th>RF State</th> <th>Voting Time (ms)</th> <th>LPT/FME Voting Time (ms)</th> <th>Channel Weight (%)</th> <th>Group #</th> <th>Dynamic Voting</th> </tr> </thead> <tbody> <tr> <td>1</td> <td>Active</td> <td>100</td> <td>300</td> <td>100</td> <td>0</td> <td>Disabled</td> </tr> <tr> <td>2</td> <td>Offline</td> <td>100</td> <td>300</td> <td>100</td> <td>0</td> <td>Disabled</td> </tr> <tr> <td>3</td> <td>Offline</td> <td>100</td> <td>300</td> <td>100</td> <td>0</td> <td>Disabled</td> </tr> <tr> <td>4</td> <td>Offline</td> <td>100</td> <td>300</td> <td>100</td> <td>0</td> <td>Disabled</td> </tr> </tbody> </table>	Ch Port	RF State	Voting Time (ms)	LPT/FME Voting Time (ms)	Channel Weight (%)	Group #	Dynamic Voting	1	Active	100	300	100	0	Disabled	2	Offline	100	300	100	0	Disabled	3	Offline	100	300	100	0	Disabled	4	Offline	100	300	100	0	Disabled
Ch Port	RF State	Voting Time (ms)	LPT/FME Voting Time (ms)	Channel Weight (%)	Group #	Dynamic Voting																														
1	Active	100	300	100	0	Disabled																														
2	Offline	100	300	100	0	Disabled																														
3	Offline	100	300	100	0	Disabled																														
4	Offline	100	300	100	0	Disabled																														
<p>Tag Protocol</p>	<p>Used to define the over the air protocol order and synchronization reference point.</p> <table border="1"> <thead> <tr> <th>Ch Port</th> <th>Rx Attenuation (dB)</th> <th>Tx Attenuation (dB)</th> <th>Frequency (MHz)</th> <th>Time Slot</th> </tr> </thead> <tbody> <tr> <td>1</td> <td>5</td> <td>0</td> <td>915.75</td> <td>...</td> </tr> <tr> <td>2</td> <td>5</td> <td>0</td> <td>915.75</td> <td>...</td> </tr> <tr> <td>3</td> <td>5</td> <td>0</td> <td>915.75</td> <td>...</td> </tr> <tr> <td>4</td> <td>5</td> <td>0</td> <td>915.75</td> <td>...</td> </tr> </tbody> </table>	Ch Port	Rx Attenuation (dB)	Tx Attenuation (dB)	Frequency (MHz)	Time Slot	1	5	0	915.75	...	2	5	0	915.75	...	3	5	0	915.75	...	4	5	0	915.75	...										
Ch Port	Rx Attenuation (dB)	Tx Attenuation (dB)	Frequency (MHz)	Time Slot																																
1	5	0	915.75	...																																
2	5	0	915.75	...																																
3	5	0	915.75	...																																
4	5	0	915.75	...																																

<p>Lane Assign</p>	<p>Define means of channel voting and inter-reader voting mechanisms.</p>
<p>Lane Control</p>	<p>Define the interface parameters to send messages to Lane Controller(s) and messages to be reported to the Lane Controller(s)</p>

MPR 4.1 Reader

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<p>Time</p>	<p>Used to set the time and to define the NTP servers.</p>
<p>Save/Load</p>	<p>Allows configurations to be saved, loaded or reset to the defaults .</p>

<p>History</p>	<p>Used to show configuration change history.</p>
<p>Wizard</p>	<p>Used to help initial setup.</p>

MPR 4.1 Reader

*Operating Instructions*

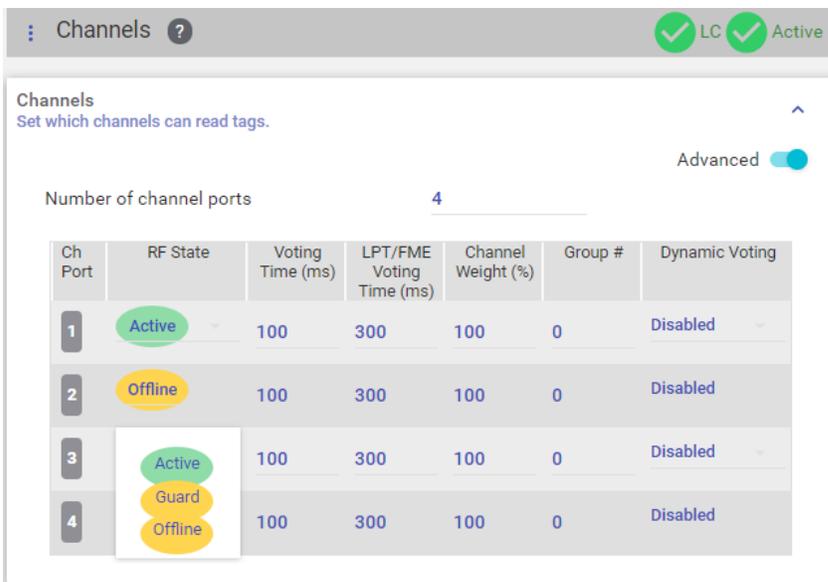
---

**MPR 4.1 ports configuration**

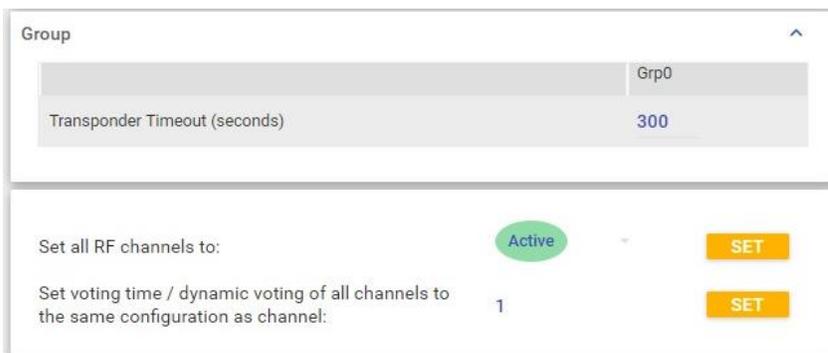
The MPR 4.1 Ports status is provided by the **Channel** page. Go to this page and declare the state of each port in the reader.

The **Channel** page defines the RF state and key voting parameters such as voting time, channel weight and (voting) Group ID.

The following screen is shown as an example.



The **Group** page permits selection of independent tag timeouts for each (voting) Group ID. The following screen is shown as example.



### Frequency and Time Multiplexing

In any toll site involving multiple simultaneous transmitting antennas either frequency division or time division between adjacent transmitting antennas is required. The required spacing and re-use guidelines are discussed in Installing an Antenna and Appendix B FCC Approved Port Frequencies and Selection which provides details on the FCC permitted Frequencies and ERP.

The TDM time sequence is controlled by the TDM Panel as part of the frame sequence, see **Frame Sequence building**, page 59

### Frequency Selection

In **Tag Protocol** page, click protocol icon to show details. In the Frequency panel, choose the desired operation frequency for each port.

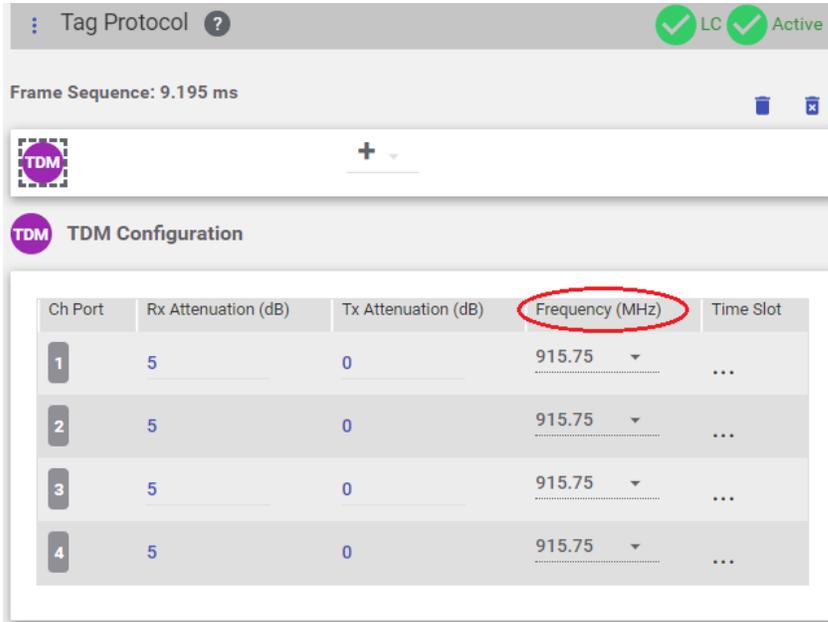
- Note1:** There should be at least a **2.5 MHz separation** between adjacent Ports both on Ports in a reader and between adjacent Ports of adjacent readers.
- Note2:** The FCC allowed frequencies are protocol specific. See Appendix B
- Note3:** Normally the frequency selected will be the same for all FDM protocols on a Port
- Note4:** The TDM frequencies cannot be changed

**Result:** The following screen is shown as an example (TDM protocol in 4 Port configuration).

MPR 4.1 Reader

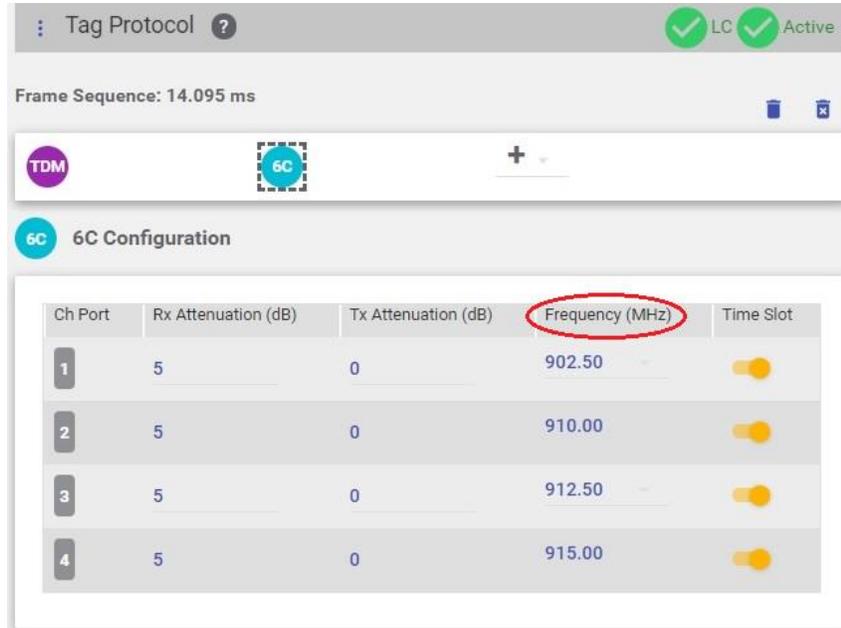
*Operating Instructions*

---



**Result:** The following screen is shown as an example (6C protocol in 4 channels configuration).

MPR 4.1 Reader

*Operating Instructions*

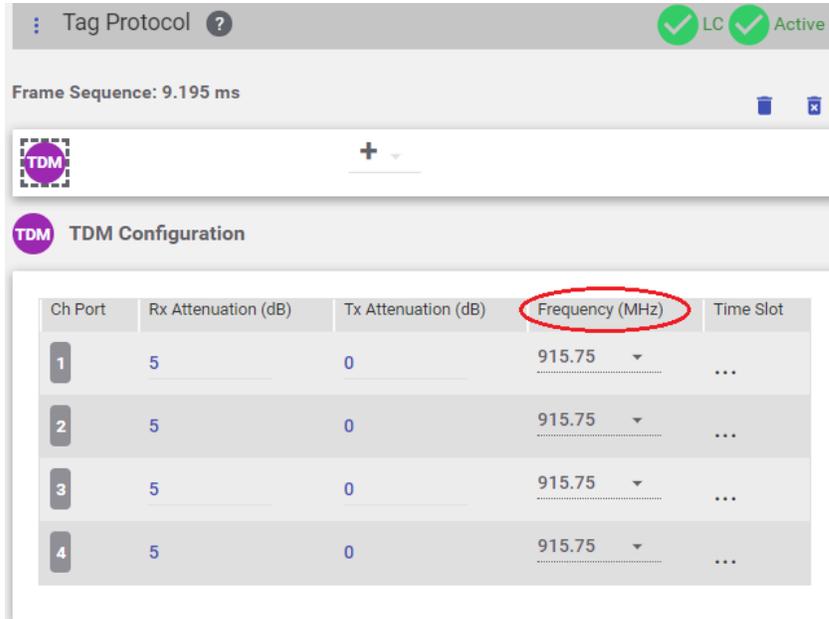
### RF Attenuation

The transmit power is programmable individually by protocol and Port by setting the TX attenuation. Similarly the receive sensitivity can be adjusted individually by protocol and Port by controlling the RX attenuation.

Select the **RF Attenuation** panel and choose the desired attenuation for each Port and protocol.

**Result:** The following screen is shown as an example.

MPR 4.1 Reader

*Operating Instructions***Programming tags****Configuring TDM tag programming**

The Reader can write data to a TDM tag as it passes through a toll plaza. The following procedures outline how to enable tag programming and how to configure the data that is written to the tags.

1. Select **TDM** protocol, **Tag Programming** panel.

**Result:** The following screen appears.

## MPR 4.1 Reader

*Operating Instructions*

**TDM Tag Programming**  
Update toll collection fields in the transponder memory.

Enable

Group ID:	65
Plaza ID:	0
Agency ID:	0
Reader ID:	0

**Lane Number Assignment**  
Specify Lane Number for each channel from left to right.

Lane Number	1	2	3	4
-------------	---	---	---	---

**Configuring TDM tag programming for Traffic Management Applications**

1. From the **Tag Programming** screen, select the **Enable TMP** check box.
2. Select the **Reader ID** check box to enable writing the Reader ID to tags.
3. Enter a unique Reader ID.
4. Select the **TM Date/Time** check box to write the Reader TM time to tags.

**Example:** The following screen is shown.

**Traffic Management Programming (TMP)**  
Set Read-Write enables of data fields.

Enable

Reader ID:	<input checked="" type="checkbox"/>
TM Date/Time:	<input checked="" type="checkbox"/>

**Note:** Reader ID is required to support Badger Style CRA operation.

**Configuring TDM tag programming for Toll Collection applications**

1. From the above **Tag Programming** screen, select the **Enable TCP** check box.

**Result:** The following screen appears.

**Toll Collection Programming (TCP)**  
Set Read-Write enables of data fields.

Enable

Plaza ID:	<input checked="" type="checkbox"/>
Agency ID:	<input checked="" type="checkbox"/>
Transaction Number Programming:	<input checked="" type="checkbox"/>
Transaction Number Programming format:	16 bit sequential number
TC Date/Time:	<input checked="" type="checkbox"/>
TC R/W Format:	<input checked="" type="checkbox"/>
TC Lane Number:	<input checked="" type="checkbox"/>
<hr/>	
HOT (High-Occupancy Toll) Lane: <input checked="" type="checkbox"/>	
Enable HOT Lane for each channel from left to right.	
HOT Lane Enable	<input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/>
<hr/>	
OBU Feedback: <input checked="" type="checkbox"/>	
Specify audible and visual indication for various OBU Feedback type.	
OBU Feedback Type:	<input checked="" type="radio"/> Type 1 <input type="radio"/> Type 2

2. Enter the **Plaza ID** and **Agency ID** in the fields at the top of the screen.
3. Select the **Transaction Number Programming** check box to choose how the Reader determines the toll transaction number.
4. Click the **Transaction Number Programming** drop-down list.
5. Select the desired transaction numbering calculation from the drop-down list.
6. The following checkboxes should appear checked; if not, make sure you check them.
  - TC Date/Time
  - RW Format
  - Lane number
7. Select the **OBU Feedback** check box to enable OBU (tag) feedback.
8. Assign a Lane Number to each RF Port.

**Note:** When a transaction occurs between an OBU and a Port, the Lane Number specified here will be used when recording the transaction in OBU memory.

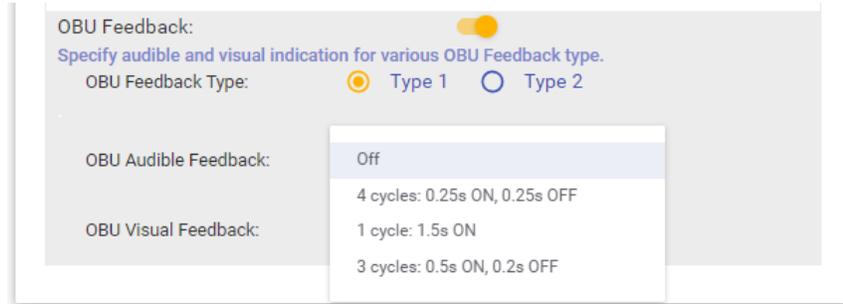
### Configuring OBU Feedback for TDM

If OBU Feedback is selected as enabled in the TDM Toll Collection panel it is necessary to set up the OBU feedback settings

Select the **OBU Feedback** panel.

**Result:** The following screen appears.

## MPR 4.1 Reader

*Operating Instructions*

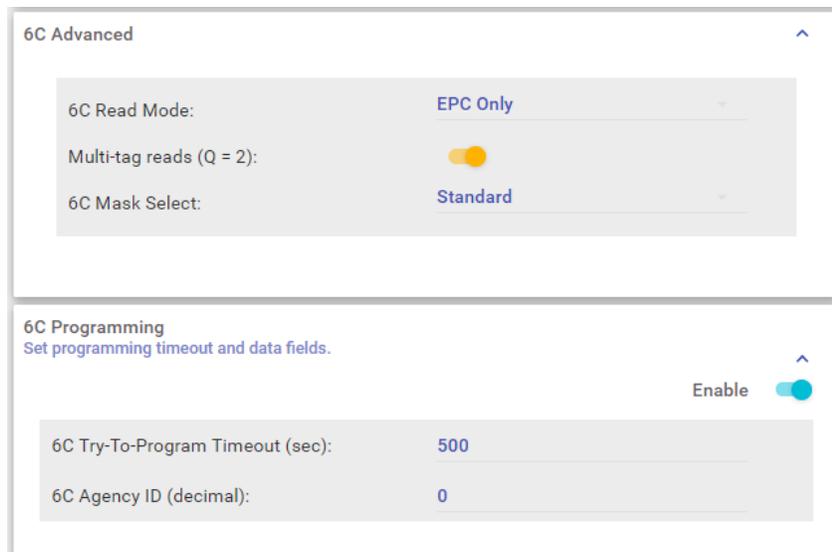
1. Select either **Type 1** or **Type 2** feedback.
2. Select the desired audible feedback to control OBU beeping when a transaction occurs.
3. Select the desired visual feedback to control OBU LED flashing when a transaction occurs.

**Configuring 6C tag programming for Toll Collection applications**

The Reader can write data to a 6C tag as it passes through a toll plaza. The following procedures outline how to enable tag programming and how to configure the data that is written to the tags.

1. Select the **Tag Programming** tab.

**Result:** The following screen appears.



## Frame Sequence building

Frame Sequence building, allows the user to customize over the air protocol sequences that a Reader or a network of Readers can use to identify, register, and track multiple protocols in a toll environment.

### **Modular approach**

The modular design approach for Frame Sequences allows for the following specializations.

- Balanced weighting between all protocols regardless of TDM or FDM division
- The inclusion of parallel TDM Port firing sequences.
- Protocol synchronization

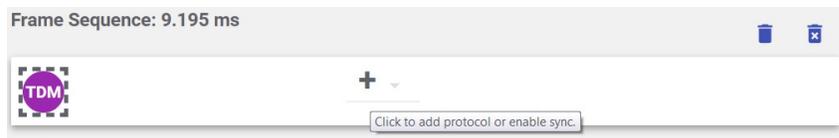
The frame sequence is configured using the **Tag Protocol** page to define the time order over the air of protocols and other operations, and individual tabs for protocols that each define what operations are executed within that protocol's frame and which Ports are employed for that protocol. The frame sequence continually repeats over the air.

- Note 1:** The frame sequence defines the repeating protocol time sequence that will be followed by the reader, irrespective of the assigned Port status in the **Channels** page.
- Note 2:** For an RF Port to participate in a protocol it must both be enabled for that protocol in the applicable protocol tab and also set to Active or Guard in the **Channels** page.
- Note 3:** It is possible to create a sequence with Ports and timeslots assigned for Ports that are not active in the reader. This often occurs and is required when synchronizing two readers with different number of Ports populated as the time structure of the frame sequence needs to be the same on both readers.

### To create a frame Sequence

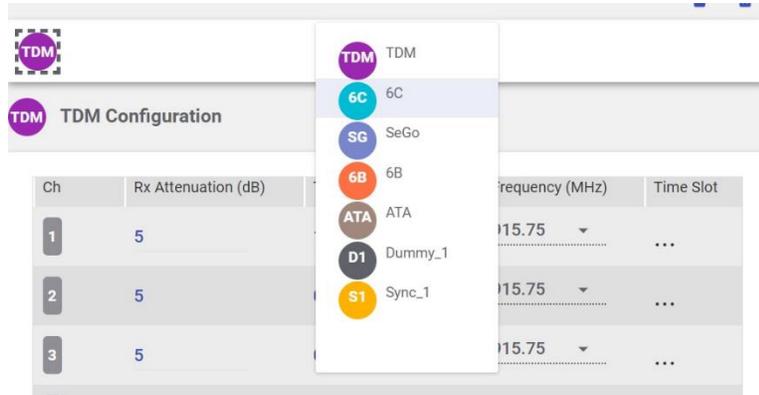
1. Go to **Tag Protocol** page.

**Result:** The following screen appears.



- Click the dropdown under **+** icon.

**Result:** The following screen is shown as an example.



- Select the required protocol
- Repeat this sequentially for each Seq# (frame) in order to build up a sequence.

**Note 1:** To build a frame sequence, work from left to right starting in the first frame. To change or delete frames from a sequence, you must always start with the last frame and work towards the left.

**Note 2:** The maximum number of actively transmitting frames (Seq#'s) must be kept to 8 or less. Sync frames and Dummy frames that do not transmit are not counted.

- Select the options required under each individual frame type tab for Seq# types selected.

The following three diagrams show examples of different Flexible Over the Air frame sequences that can be selected using the modular approach.

**Figure 3-1: Example: Flexible Over the Air frame sequence (Balanced Protocol Weighting)**

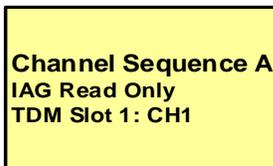


Figure 3-2: Example Flexible Over the Air Frame Sequence (6B Weighted)



Figure 3-3: Example Flexible Over the Air Frame Sequence with Dummy Frame



### Reader-supported protocols

The Reader supports the following protocols.

- TDM
- Title 21
- SeGo
- ISO-6B
- ISO-6C
- ATA

### Dummy frame

A dummy frame is a software configurable time interval or block that the operator can insert in the firing sequence. A dummy frame can be configured in one of the following two ways.

- Constant carrier is applied at the desired frequency and TX attenuation is enabled through the web interface. The receivers are turned off.
- Both the transmitter and receiver are turned off.

### Reader Frame Sequence synchronization

The reader synchronizes air transmission timing to its own Ports, as well as to other readers, if these readers are on the sync network and correctly enabled. To support reader sync at least 1 Sync frame must be declared. For more information see page 74.

Sync frame

The reader executes the synchronization function wherever a sync frame has been inserted in the firing sequence. This allows for flexibility between inter-reader and multi-protocol synchronization, and also allows for syncing to older versions of readers.



**ATTENTION:** When syncing newer versions of readers with older versions of readers, an advanced knowledge of sync configuration is required. Therefore, it is recommended that Kapsch Service be consulted, as boundaries and limits of variables may not be the default and will need to be reconfigured

### **Frame sequence Synchronization rules**

When building a frame sequence where readers are required to be synchronized, the following rules must be followed to avoid errors or warnings.

- Only one sync block may be used when only 1 or 2 protocol sequences are enabled in the Frame sequence.
- If **2 or more** sync blocks are used in the Frame sequence, one of the blocks must be enabled to **Skip-on-Sync**.
- With multiple sync blocks in an frame sequence, they should each be different (e.g. Sync\_1, Sync\_2) to ensure correct alignment.
- The sequences on the readers must be the same or at least have the same time length(s) between sync block(s). Dummy frames may be used to achieve this if the sequences are different.

### **How to build a Frame sequence**

Two examples are provided, one using a single protocol and no sync, while the other is a multi-protocol sequence with sync.

A service laptop is connected to the **ETHERNET 1** port of the Reader and a browser is activated.

- Note 1:** To build a frame sequence, work from left to right starting in the first frame. To change or delete frames from a sequence, you must always start with the last frame and work towards the left.
- Note 2:** Frame Sequence will be updated automatically when add /delete protocol or when change firing sequence (time slot). No update button is required.

**Example 1: TDM only, read/write operation, four (4) lane plaza, not synced to another Reader.**

**Note 1:** To use the sequence over the air it is also necessary to set Ports to Active or Guard in the **Channel** page, and to set appropriate attenuations for each Port

**Note 2 :** To support read/write operation it is necessary to configure the TDM programming configuration, see Programming tags, page 55

The following panels in **Tag Protocol** page will be used to create the frame sequence

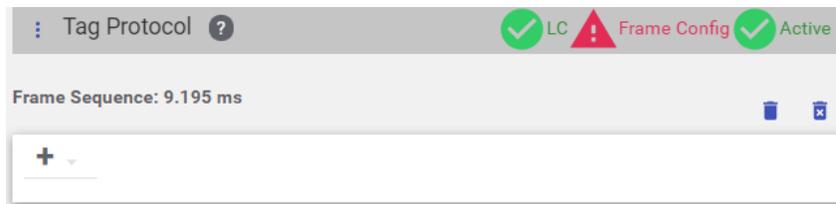
**Tag Protocol** panel: Set 1<sup>st</sup> sequence to TDM, all others are deselected

**TDM** panel: Enable channel 1 to 4 sequentially in time slot 1 to 4

The detailed steps are as follows

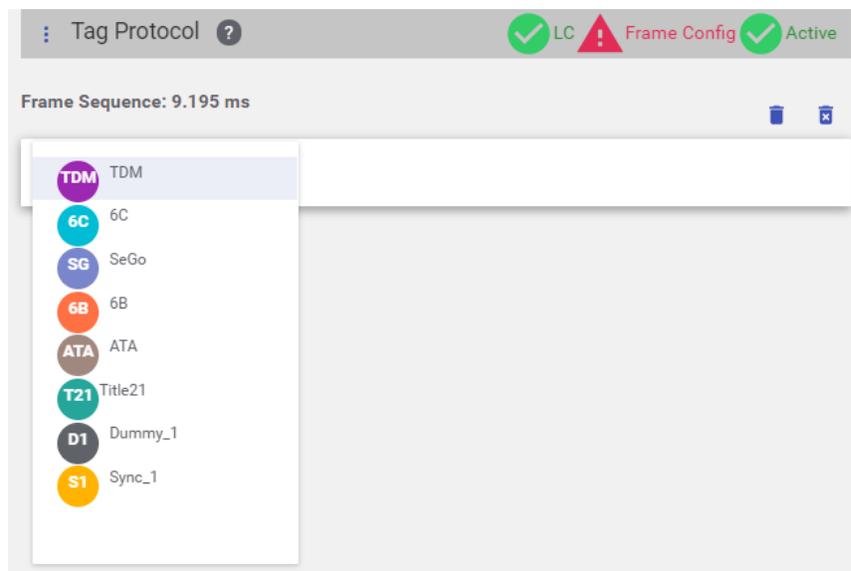
1. Go to Tag Protocol page Frame Sequence panel .

**Result:** The following screen appears.



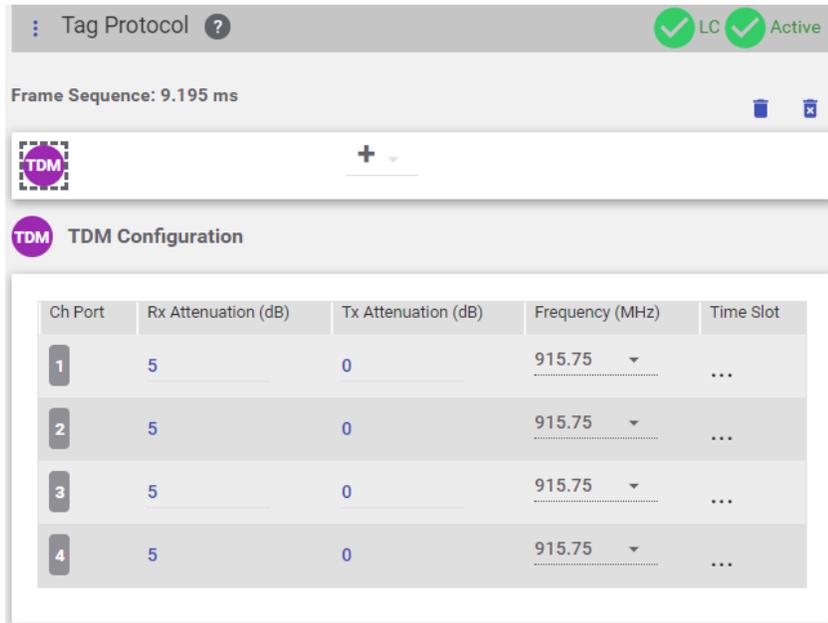
1. Click the dropdown under  icon.

**Result:** The following screen is shown as an example.



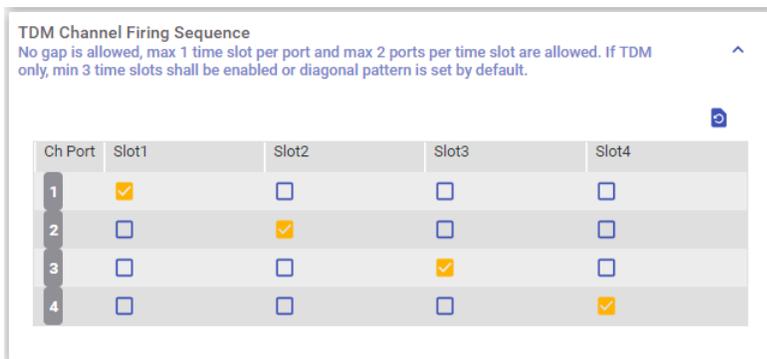
2. Select the **TDM** protocol.

**Result:** The following screen is shown as an example.



- Under the **TDM Channel Firing Sequence** panel enable slots 1 to 4 sequentially for the 4 Ports.

**Result:** The following screen is shown as an example.



**Example 2: TDM, 6C (6CTOC compliant), and 6B, two (2) Lane ORT with one Shoulder (four (4) Ports) with four (4) Port scan) and synchronization between readers**

**Note 1:** To fully use the sequence over the air it is also necessary to set Ports 1-5 to Active or Guard in the **Channel** page, and to set appropriate attenuations for each Port

MPR 4.1 Reader

*Operating Instructions*

**Note 2:** For the FDM protocols it is also necessary to set up Port frequencies for each Port, see Frequency Selection, page 52

**Note 3 :** To support read/write operation it is necessary to configure the programming configuration, see Programming tags, page 55

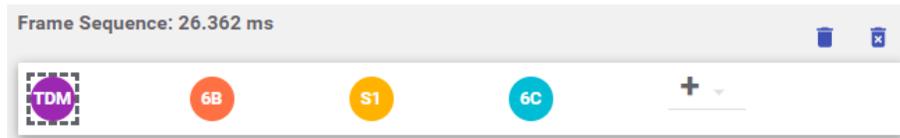
The following tabs will be used to create the frame sequence

- **Tag Protocol panel:** Seq #1 set to TDM, Seq#2 set to 6B, Seq#3 set to SYNC\_1 and Seq#4 set to 6C, all others set to empty.
- **TDM panel:** Channels 1 to 4 enabled sequentially in slots 1-4.
- **6B panel:** Enable Channels 1 to 4 and select the appropriate Tag Read mode from the pull down menu. Enable Dual Tag Preamble.
- **6C panel:** Enable Channels 1 to 4 and select the appropriate Tag Read mode and over-air tag masking from the pull down menus.
- **Sync panel:** Set the Reader-Reader sync parameters.

The detailed steps are as follows

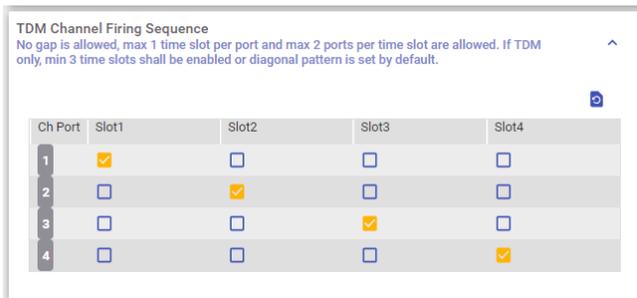
1. Go to the **Tag Protocol** page **Frame Sequence** panel.
2. Set Seq #1 to TDM, Seq#2 to 6B, Seq#3 to SYNC\_1 and Seq#4 to 6C.

**Result:** The following screen is shown as an example.



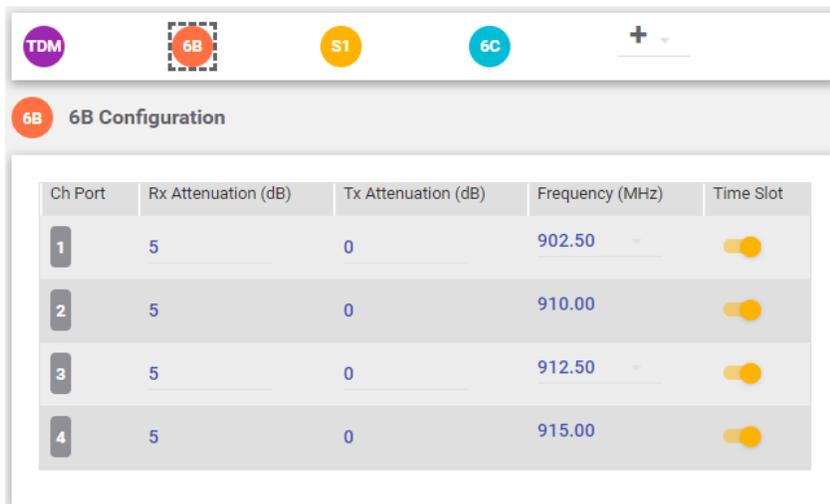
3. Click the TDM icon  on the Frame Sequence panel to show TDM protocol settings. Under the TDM Channel Firing Sequence panel, enable time slot 1 to 4 sequentially for the 4 channels.

**Result** The following screen is shown as an example.



- Click the **ISO-18000-6B** icon  on the Frame Sequence panel to show 6B protocol settings. Enable slots 1 to 4 and then click the **6B Read Mode** dropdown menu to choose the desired option. Check the **Dual Tag Preamble** checkbox.

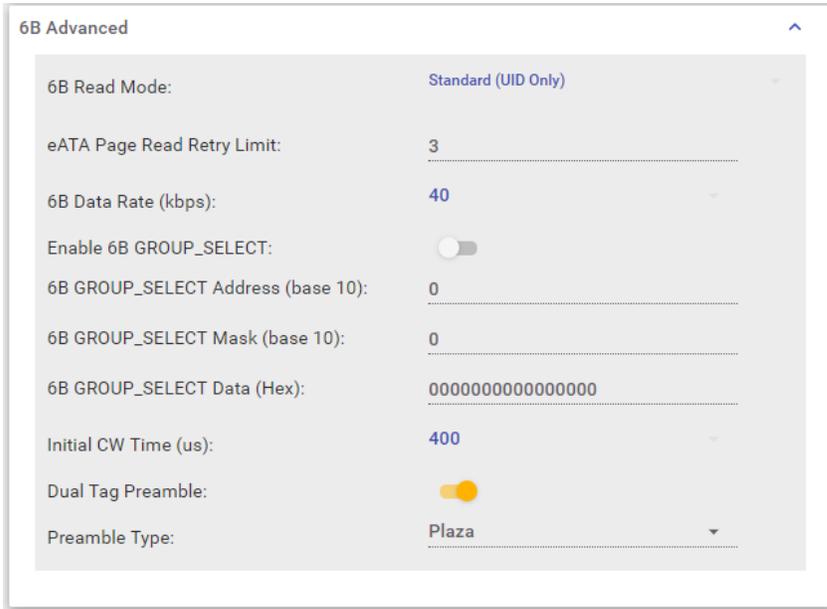
**Result:** The following screen is shown as an example.



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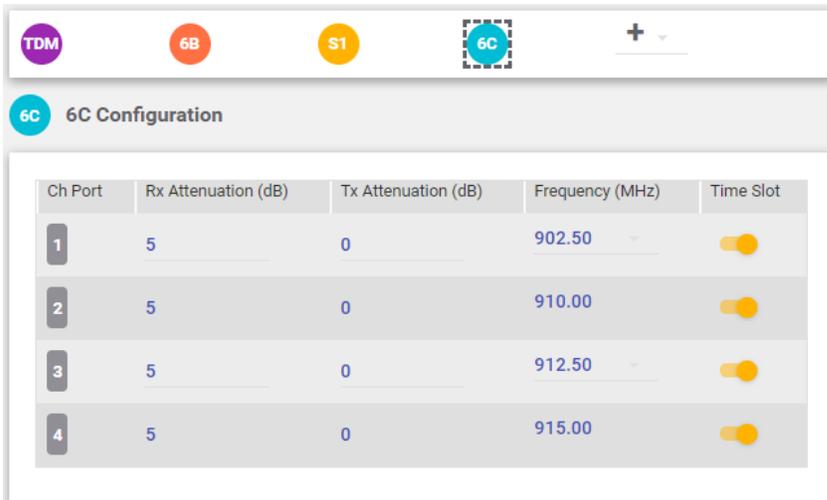
*Operating Instructions*

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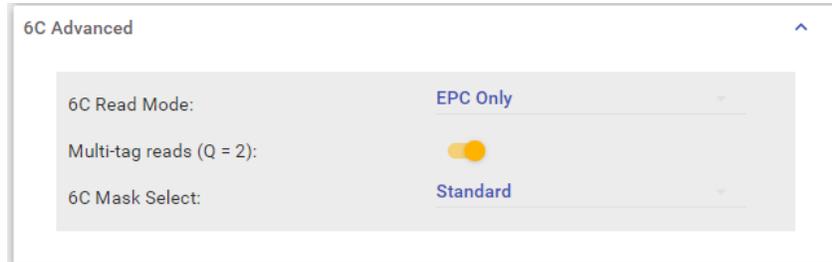


- Click the **ISO-18000-6C** icon  on the Frame Sequence panel to show 6C protocol settings. Enable slots 1 to 4 and then click the **6C Read Mode** dropdown menu to choose the desired option.

**Result:** The following screen is shown as an example.

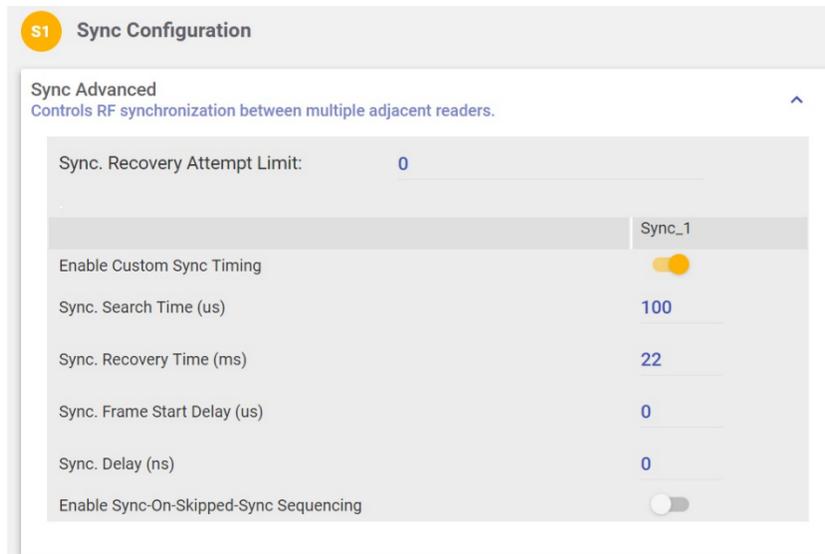


## MPR 4.1 Reader

Operating Instructions

6. Click the **Sync** icon  on the Frame Sequence panel to show Sync settings.

**Result:** The following screen is shown as an example.



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# MAINTENANCE INSTRUCTIONS

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## **4. THEORY OF OPERATIONS**

This section offers a more detailed overview of the Reader components than the introductory overview provided in Overview Section 2 page 21.

MPR 4.1 Reader can communicate with both active and passive OBUs. The Reader uses a combination of **Time Division Multiplexed (TDM)** and **Frequency Division Multiplexed (FDM)** periods to read active and passive OBUs respectively.

Each Antenna Port and antenna pair, referred to as a port, creates an RF capture zone on the roadway. The antennas are usually situated to create overlapping capture zones between ports. One reader can support up to 4 ports. When required, multiple readers can be synced together to support additional ports.

The reader processes the OBU information and provides transaction reports to the Lane Controller interfaces. When required, the reader can write data to the OBU.

### ***Active OBUs***

Active OBUs are battery powered and transmit a signal to the Reader antennas. As a vehicle equipped with an active OBU approaches a toll plaza, the OBU receives a trigger signal from the Tx antenna. The OBU then starts transmitting data, which is received by the Rx antenna.

The MPR 4.1 decodes the active OBU signal and processes and logs the OBU data and then sends the information to the Lane Controllers (LCs). The Reader may also send data back to the active OBUs, such as an updated toll account balance.

### ***Passive OBUs***

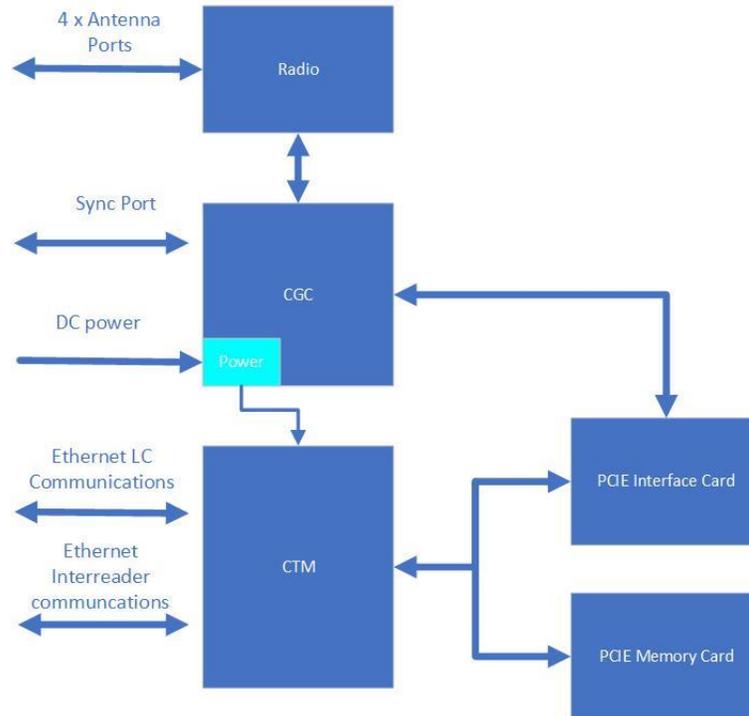
Passive tags are not battery powered and cannot transmit a signal. As a vehicle equipped with a passive OBU approaches the antenna, the OBU receives a transmit signal from the antenna. This signal is then reflected from the passive OBU back to the antenna. The reflected signal is uniquely modulated by each passive OBU, allowing the OBU to be identified.

The MPR 4.1 decodes the passive OBU signal and processes and logs the OBU data and then sends the information to the Lane Controllers (LCs). The Reader may also send data back to the active OBUs, such as an updated toll account balance.

### ***Capture zones***

The capture zone is the area of antenna RF coverage. An antenna can communicate with an OBU once the OBU enters the antenna's capture zone. These capture zones and the number of antennas required per lane varies depending on the site and/or lane configuration.

Figure 4-1: MPR 4.1 Block Diagram



The internal block Diagram is shown in Figure 4-1: MPR 4.1 Block Diagram. The controller Module (CTM) communicates with the Lane Controller and other readers. Through the Channel Group Controller (CGC) the CTM communicates to the radio to interact with Transponders in the capture zone.

## External Power

The MPR 4.1 operates from an external DC power source that provides 19 to 30VDC at 50 Watts of power.

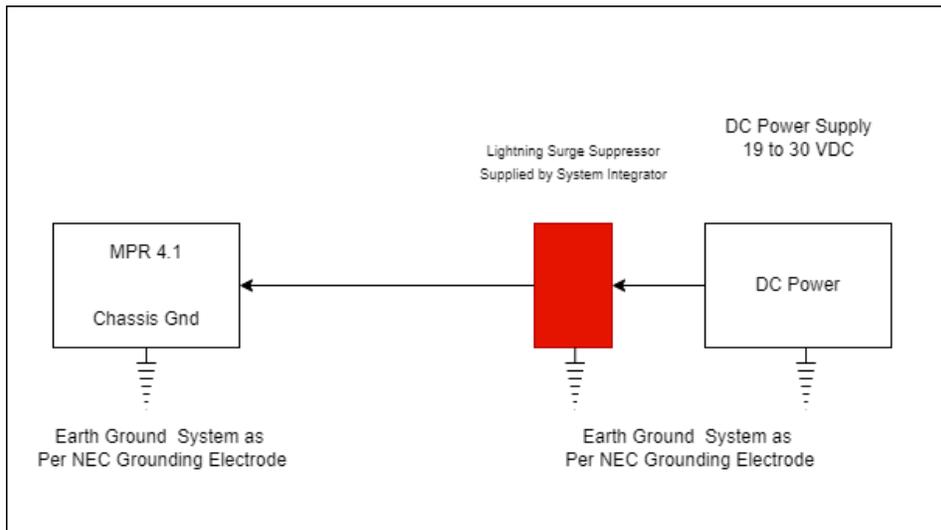
The external power supply shall supply clean DC power at the MPR 4.1 connector that meets the following requirements:

- 19 to 30 VDC at the MPR 4.1 connector

- 50 Watts of DC Power
- **clean**

The external power supply shall provide appropriate lightning protection, see Figure 4-2, page 74.

**Figure 4-2: External Power Source**



**Note:** Lightning/surge suppressor and external DC Power supply, supplied by system integrator.

## Multiple reader synchronization

Readers must be synchronized under the following conditions.

- If they have overlapping capture zones,
- If they are connected in an IR network
- If Reader-to-Reader RF interference is present.

Sync is recommended for installations that are less than 600 feet apart. For distances above this up to the sync cable maximum distance (1500 ft) tests for in-band interference should be carried out to ensure no Reader-Reader interference occurs.



**ATTENTION:** To avoid interference and loss of data between adjacent reader, readers must be synced.

Tests should be carried out under live traffic conditions to ensure that RF signal reflections that come off moving vehicles do not cause interference.

If Reader-to-Reader RF interference exceeds the in-band limits then the Readers must be synchronized

#### ***Reader-to-Reader synchronization***

Reader-to-Reader synchronization requires the following programmable options on the web interface:

- Synchronization Search Time (maps to sync frame timeout in MPR2)
- Synchronization Delay (new feature not supported in MPR2 used for cable delays)
- Synchronization Frame Start Delay
- Sync Recovery Time (currently hardcoded default 20ms in MPR2)
- Sync Recovery Attempt Limit (new feature not supported in MPR2)
- Sync on Skipped Sync Frame

**Note:** Reader-to-Reader Sync Recovery occurs on a loss of synchronization with the external reader network.

#### ***Synchronization search time***

Synchronization search time indicates how long the reader waits for reader to reader sync before falling into synchronization recovery.

If the reader detects synchronization prior to the expiry of this timer, it exits search mode and performs one of the following actions.

- Falls into Synchronization Delay if programmed
- Falls into synchronization frame start delay if programmed
- Begins firing its Frame sequence.

#### ***Synchronization delay***

Synchronization delay indicates how long the reader holds its sync driver low after synchronization has occurred. This feature is used to calibrate out cable length delays.

If the reader detects that the sync bus is driven high prior to the expiry of this delay, the reader exits delay mode and performs one of the following actions.

- Sets its driver high and falls into synchronization frame start delay if programmed
- Sets its driver high and begins firing its Frame sequence.

#### ***Synchronization frame start delay***

Synchronization frame start delay programs how long the Reader waits after Reader-to-Reader sync has occurred. Its internal driver is set to a high state before firing the next frame and/or frame sequence.

#### ***Sync recovery time***

Sync recovery time is a programmable variable that indicates how long the reader searches/waits for synchronization on the reader network before firing its frame sequence. It is recommended that this value be programmed at least 125% of the total frame sequence.

If the reader detects that the sync bus is driven high prior to the expiry of this time, the reader exits recovery mode, sets its driver high and begins firing its frame sequence.

#### ***Sync recovery attempt limit:***

Sync recovery attempt limit is used to indicate how many Sync Recovery Time periods must expire before the Reader no longer searches/waits for synchronization before firing its tag acquisition sequence independent of the reader network. A loss of reader synchronization message will be transmitted via the lane controller interface.

If this limit is programmed with a zero (0) value, the Reader will always wait for Sync Recovery Time to expire before firing its sequence.

#### ***Sync-on-skipped-sync frame***

Sync-on-skipped-sync frame is used when more than 3 protocols are selected in the frame sequence. A two sequences-skip is used to indicate where the sequence starts.

How Reader synchronization operates at the toll location

After interrogating all of the assigned ports, each Reader will provide a 'sync ready' signal on its SYNC Connector. Only when the configuration parameter **Enable Reader –to-Reader Sync** checkbox is selected under the SYNC tab does synchronization occur.

As busy Readers become ready they will not send any more RF trigger signals until the sync bus indicates that all Readers are ready. Once the last Reader in the network generates its ready signal, all Readers on the sync bus simultaneously generate OBU trigger pulses starting with the RF module in

slot 1. This can be seen in the truth table shown below for synchronization circuit consisting of two Readers.

**Table 4-1: Boolean Logic Truth Table for Synchronization of two Readers**

Reader 1 sync port Tx	Reader 2 sync port Tx	Reader 1 or 2 sync port Rx
0 ( <i>ready</i> )	0 ( <i>ready</i> )	0 ( <i>ready</i> )
0 ( <i>ready</i> )	1 ( <i>busy</i> )	1 ( <i>busy</i> )
1 ( <i>busy</i> )	0 ( <i>ready</i> )	1 ( <i>busy</i> )
1 ( <i>busy</i> )	1 ( <i>busy</i> )	1 ( <i>busy</i> )

The truth table above demonstrates the following rule of synchronization operation:

- The sync bus will only be in the ready state when all Readers in the group are in the ready state.

The last Reader to acquire a ready state controls the system synchronization. Most of the time (greater than 95%), the sync bus will be in the busy state. If operating correctly, the sync bus will normally be in the ready state for about 100 µsec.

## Transaction Buffering

Transactions from OBUs, are processed by the Reader. When a Reader loses communications with a Lane Controller (LC), the Reader buffers OBU transactions and error messages (up to a combined total of 1,000,000) in non-volatile memory (i.e., buffered messages will not be lost during power interruptions or Reader resets). When the memory is full, new transactions overwrite the oldest buffered transactions. The memory available for buffering is shared by all RF Ports.

When the communication link between an LC and the Reader is re-established, the Reader begins to upload the buffered transactions to the LC. The Reader will pause uploading buffered transactions to the LC to report any new transactions as they occur. Buffered transaction reporting resumes after the new transactions have been reported. Messages from the LC will continue to be acknowledged and acted upon during the upload process.

## Log files

The log files for OBU transactions are saved by the Reader. Once space is filled on the respective memory partition, the oldest file from the same file type is deleted to create memory space for the new data.

A listing of the main log file types appears below. Other log files that may be present are for Kapsch TrafficCom use only.

**Table 4-2: List of Available Log Files**

Log File Type	Description
tagtxns_YYYY-MM-DD	Daily tag Transaction log.
event_YYYY-MM-DD	Daily event log files. Event log contain a periodic report of system health and transaction count totals.
trouble_YYYY-MM-DD	Trouble Log. Content lists any unusual system anomaly (e.g. switchover).

### Transaction logs



**CAUTION:**

Log file formats are not under ICD control and the format may change without prior notification. Log files are for diagnostic purposes only and are not guaranteed to be maintained in non-volatile storage.

Each transaction can generate multiple report for a transaction. Which reports are provided depend on the selection of reports in the **Lane Controller** page. The report types and the fields they contain described in Table 4-3.

Table 4-3: List of Fields in a Transaction Log Report

Field	Description
IREAD	Optional initial read report when transponder first enters capture zone. Informational report
VOTE	Transaction report at voting time
POST	Optional post-capture zone report if lane assignment or programming status has changed. Informational report
Ch	Port number. Indicates the assigned Port (1-8). Port 1 corresponds to the leftmost RF module in the RF rack.
St	Transaction status. Pgm indicates successful transponder programming. PU indicates transponder programming status is Unknown (tag left zone before verify could complete). PF indicates transponder was not programmed successfully. Read indicates the Reader is in read only mode. CrossR indicates an informational report (not a transaction).
Txn	Transaction number. Note that transaction numbers may appear to skip when using 2 or more Readers with Ethernet connection between them.

Field	Description
Ag	Agency ID of transponder in capture zone.
Ahs	The number of handshakes (Reads) that occurred on the assigned Port up to voting time. (note RPVs currently count as 1)
THs	For a TDM Transaction: The total number of handshakes (Reads) that occurred on the assigned Port for the previous TDM transaction on the same RF Port. (Note RPVs currently count as 1). A value of 00 is reported after reset or power-up. A value greater than 99 is indicated as 99.  For a Non-TDM Transaction: The total number of handshakes (Reads) that occurred on the assigned Port for the previous non-TDM transaction on the same RF Port. A value of 00 is reported after reset or power-up. A value greater than 99 is indicated as 99.
GUARD	Shown for a transaction assigned to a RF Port set to Guard. These transactions will always show !LC to indicate that no report for the LC is generated. Tag programming is disabled for Guard Ports.
?LA	In a POST report, indicates that a lane assignment change was detected between the voting time report and the post time report. May be an indication that voting time is not optimal.
?PS	In a POST report, indicates that a programming status change was detected between the voting time report and the post time report.
>LC	>LC indicates transaction is to be reported to lane controller (connection present or not). Only appears on the Active CTM
!LC	!LC indicates transaction is suppressed (e.g. GUARD lane or CrossR transactions or CTM is Inactive).
Cx-HS	HS tag handshakes seen up to voting/post time on the MasterSet center Reader. <b>Note:</b> Does not appear unless there is inter-reader communication.
Lx-HS	HS tag handshakes seen up to voting/post time on the MasterSet left Reader. <b>Note:</b> Does not appear unless there is inter-reader communication.
Rx-HS	HS tag handshakes seen up to voting/post time on the MasterSet right Reader. <b>Note:</b> Does not appear unless there is inter-reader communication.

### Event Logs

The event log is generated to record any reader events or changes (for example, if the power supply status changes). During service, the technician should first examine the event log files to see if there are any reported events with the reader.

The following list depicts the possible sources of event messages found in the event log.

- Changes to the reader configuration

- Changes to the reader configuration at power up
- Reader status changes, such as PSM status, etc.
- Reader faults detected

### **Trouble Logs**

Unusual Reader issues generate trouble logs. During service, the technician should first examine these trouble log files to see if there are any reported issues with the Reader.

Examine the **Log Files** page for instances of one or more trouble <date> file in the list of log files.

A typical report in a trouble log is:

```
2010-05-31T10:52:35.723+00:00 [lab3_5] SYNCR: Reader SYNC lost
```

**Note:** As an alternative, Kapsch Service can remotely connect to the Reader and examine the trouble log to quickly identify and resolve any issues. It is up to the system administrator or integrator to determine when to grant Kapsch Service remote access to the LC network IP addresses.

The following list depicts the possible sources of trouble messages found in the **trouble <date>** file.

- The Status file integrity check fails. Possible cause: there may be data for up to 40 million OBUs in a Status file.
- The Reader software recorded a:
  - Failed CGC health
  - Failed Ethernet LC link. Possible cause: a fault external to the Reader
  - Failed Ethernet inter-Reader link (when enabled). Possible cause: a fault external to the Reader

## 5. INSTALLATION

### Introduction

The Reader is shipped with necessary mating connectors for Sync, Power, and Ethernet connections. The Antennas are supplied separate from the Reader.

After the equipment is installed, the Reader must be configured via the WEB browser interface. After configuration is complete, the Reader configuration needs saving (see Saving the Reader configuration, page 127) for future reference.

The toll agency and/or system integrator must select the configuration and setup that is suitable for the application and the desired system performance.

	<b><u>CAUTION:</u></b> Improper modification of configuration parameters may adversely affect system operation. The default values may not be appropriate for the specific application. It is the system integrator's responsibility to tailor the configuration parameters to the specific operating environment.
--	---

## The earth ground system



The system integrator supplies the earth ground system for the Reader as per the IEEE 142-2007 standard, particularly; *chapter 5: Sensitive Electronic Equipment Grounding*; and *chapter 3* pertaining to lightning protection; and all other chapter sections describing bonding applications.

The system integrator is responsible for ensuring that grounding and power conforms to local regulatory and safety requirements. The recommendations herein are those ensuring bad grounding does not degrade the reader performance.

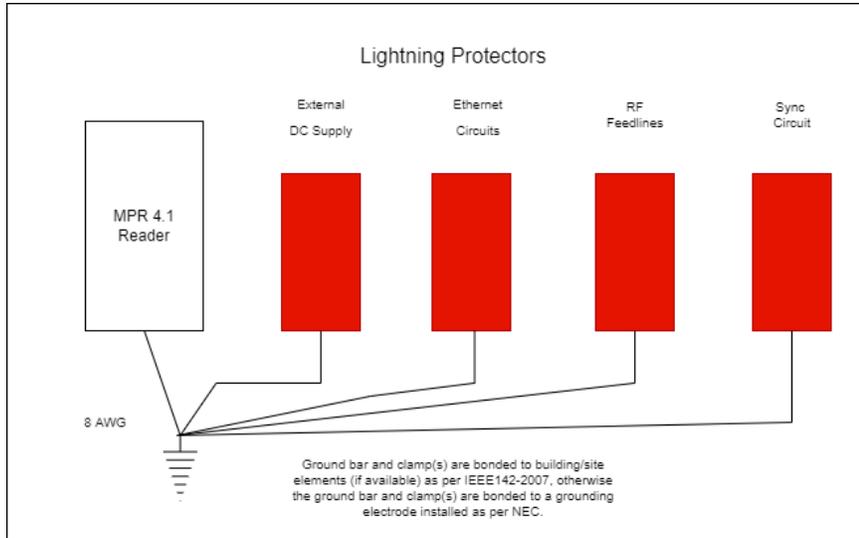
In accordance with IEEE 142-2007 all of the following building/site elements (if available) must be bonded together:

- Metal frame of the building (if effectively grounded)
- Metal underground water pipe
- Ground ring, concrete encased electrode

The Reader ground bar (supplied by the system integrator) is bonded to the above-mentioned elements. If none of these elements are available on site, only then a grounding electrode is installed as per NEC to which the Reader ground bar is bonded. The Reader components ground wires are then connected to the ground bar clamps as shown in Figure 5-1.

Lightning arrestors should be installed on the interfaces where lightning induced surges can occur.

**Figure 5-1: Earth Ground System (with recommended lightning protectors shown)**



### Lightning protectors

**Note:** It is the system integrator’s responsibility to determine the necessity of installing lightning/surge protection equipment between the data inputs and the earth ground system at the Lane Controller (LC).

**Table 5-1: Locations for the Installation of Lightning Protectors**

Location required	Schematic Figure number
In-line with antenna RF feed	Figure 5-1: Earth Ground System (with recommended lightning protectors shown), page 84
External DC Supply	Figure 5-2: External DC Supply, page 85
LC Ethernet	Figure 5-3: LC Data Cable installation, page 86
ESM power	Figure 5-10: Synchronization circuit schematic for three Readers, page 95
Synchronization circuit	Figure 5-10: Synchronization circuit schematic for three Readers, page 95

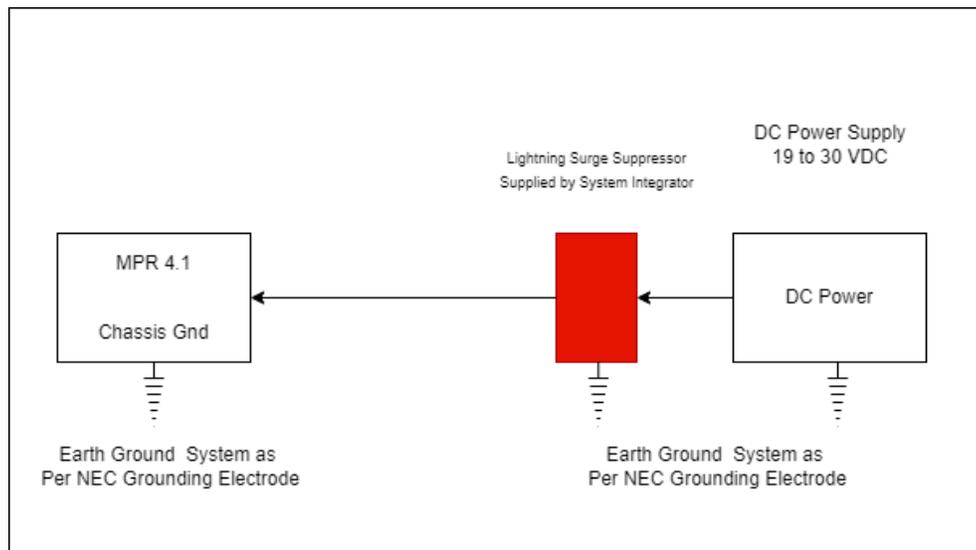
## Installing the Reader hardware

Prerequisites: A suitable mounting location has been selected and the earth ground system has been installed as per IEEE 142-2007, see the earth ground system on page 83.

**Note:** When handling the Readers and hardware, always follow accepted Electrostatic Discharge (ESD) practices and standards.

1. Mount the reader as needed, see Figure 5-4: Wall/Shelf Mounting an MPR 4.1 or Figure 5-5: Pole Mounting an MPR 4.1
2. Connect the Reader ground lug to earth ground:
3. Connect the power cable from the External DC power source to the Reader. Appropriate lightning/surge protection equipment should be installed between the DC power source input and the earth ground system at the Reader, see Figure 5-2 on page 85.

**Figure 5-2: External DC Supply**



Connect the appropriate cables from the Reader to the LC as shown in Figure 5-3: LC Data Cable installation on page 86.

Figure 5-3: LC Data Cable installation

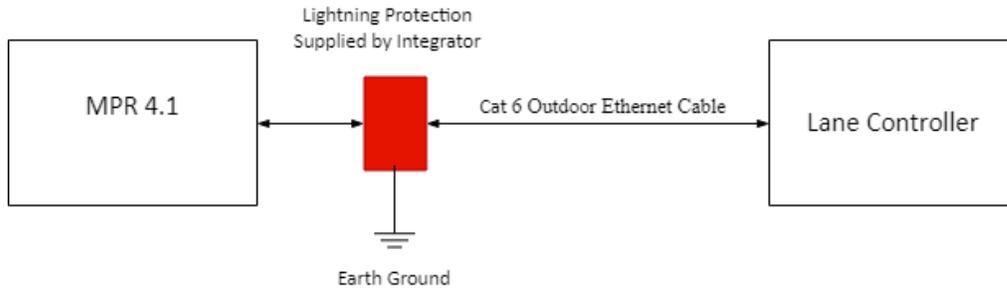
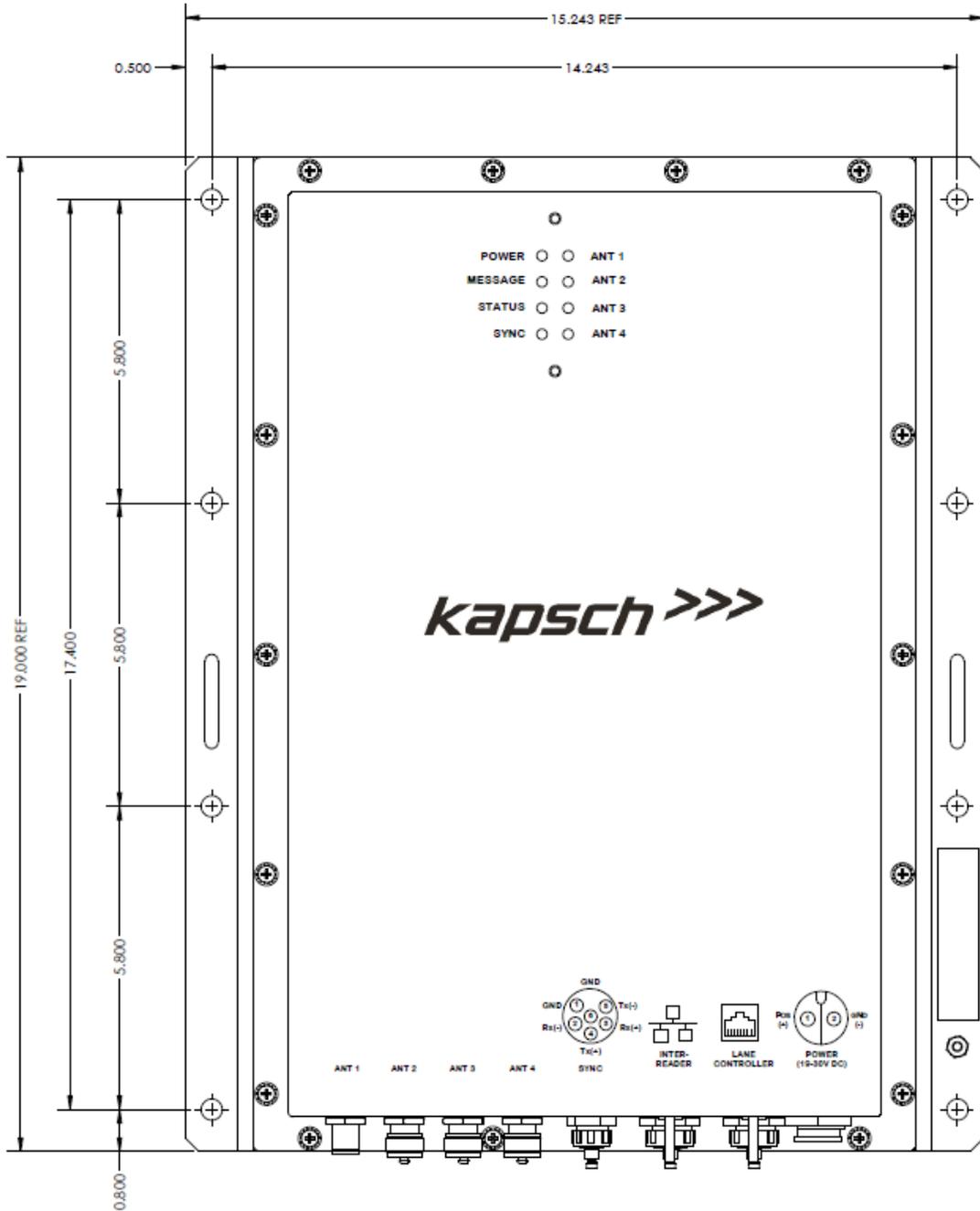
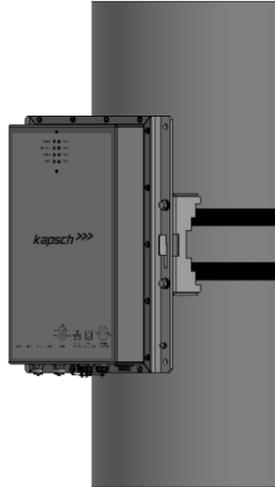


Figure 5-4: Wall/Shelf Mounting an MPR 4.1 provides the mounting hole dimensions for mounting the MPR 4.1 on either a wall or shelf. The reader will accept mounting bolts of 3/8 inch in diameter. If the unit is mounted on a wall it is recommended that the unit be oriented such that the connectors are facing down to avoid the accumulation of water.

Figure 5-5: Pole Mounting an MPR 4.1A illustrates how to mount the MPR 4.1 reader to a vertical pole. A bracket is available (P/N 802894-002) that will allow the reader to be installed on either a vertical or horizontal pole. In addition to the bracket the installer will need to provide Stainless Steel straps sized to fit the pole. The bracket is suitable for a pole from 4 inches to 14 inches in diameter. The bracket has two mounting hooks to help locate the MPR 4.1 reader on the bracket then four 3/8-16 screws are used to secure the MPR 4.1 to the bracket.

Figure 5-4: Wall/Shelf Mounting an MPR 4.1



**Figure 5-5: Pole Mounting an MPR 4.1**

## Installing an Antenna

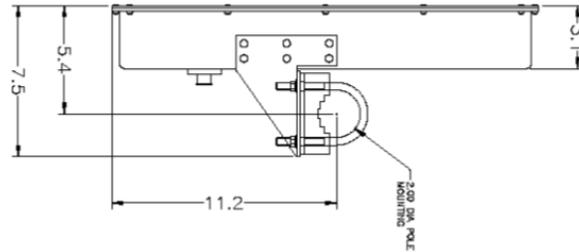
1. The antenna mounts on a frame using 2-inch diameter galvanized pipe clamps. For 12 ft wide lanes position the center antenna at lane center of the defined lane. For ORT applications with 12 ft wide lanes, the straddle antenna must be at the midpoint between the left and right antennas. Note straddle min/max measurements in Table 5-2.
2. Orient the weep holes down, such that the radome is facing oncoming traffic.
3. Using a tilt meter, measure the road pitch and cross lane slope directly under each IAG antenna. Record the results.
4. Using a tilt meter, align each antenna plate to the tilt angle specified in Table 5-2, in relation to the road pitch measured in step 3 (e.g., If the road pitch is 2 degrees, and the antenna tilt must be 10 degrees, mount the antenna at 8 or 12 degrees depending on the pitch of the road.)
5. Ensure that the height of the antenna at the center of the radiating face of the antenna as tilted falls within the height range given Table 5-2. Please contact Kapsch Technical Service when considering mounting the antennas outside the specified heights.
6. Adjust the roll angle of the antenna equal to 0 degrees with respect to the cross lane slope obtained in step 3.
7. For TDM-only protocol, an ORT antenna installation may be all antennas (IAG 1 or IAG 2 or IAG 3) inline across the roadway as shown

8. For TDM protocol, and/or ISO18000-6C protocol (read only) only, an ORT antenna installation may be all antennas (IAG 3 only) inline across the roadway as shown in Figure 5-7.
9. For all FDM protocols (other than ISO18000-6C read only) an ORT antenna installation must be all antennas (IAG 3 only) staggered across the roadway as shown in Figure 5-8.

**Table 5-2: Antenna mounting and lane configuration**

Antenna	Application	Lane Width	Height	ORT Tilt (off horizontal)	Straddle (min/max c to c)
IAG-3	ORT or Plaza	12 ft. (3.65 m.)	17 ft. (5.18 m) ±1 ft. (0.31 m)	10 deg.	5.5 ft.(1.68 m)/6.5ft.(1.98 m)
IAG-1	ORT or Plaza	12 ft. (3.65 m.)	16 ft. (4.88 m) ±1 ft. (0.31 m)	10 deg.	5.5 ft.(1.68 m)/6.5ft.(1.98 m)
IAG-2	ORT	12 ft. (3.65m)	15 ft. (4.57m) ±1 ft. (0.31 m)	10 deg.	5.5 ft.(1.68 m)/6.5ft.(1.98 m)

**Figure 5-6: Generic IAG3 Mounting Dimension Information**



This figure shows the general relationship between the mounting pipe and the antennas. The current antenna drawing should be obtained from Kapsch for accurate dimensions.

**Figure 5-7: Inline ORT Antenna Installation**

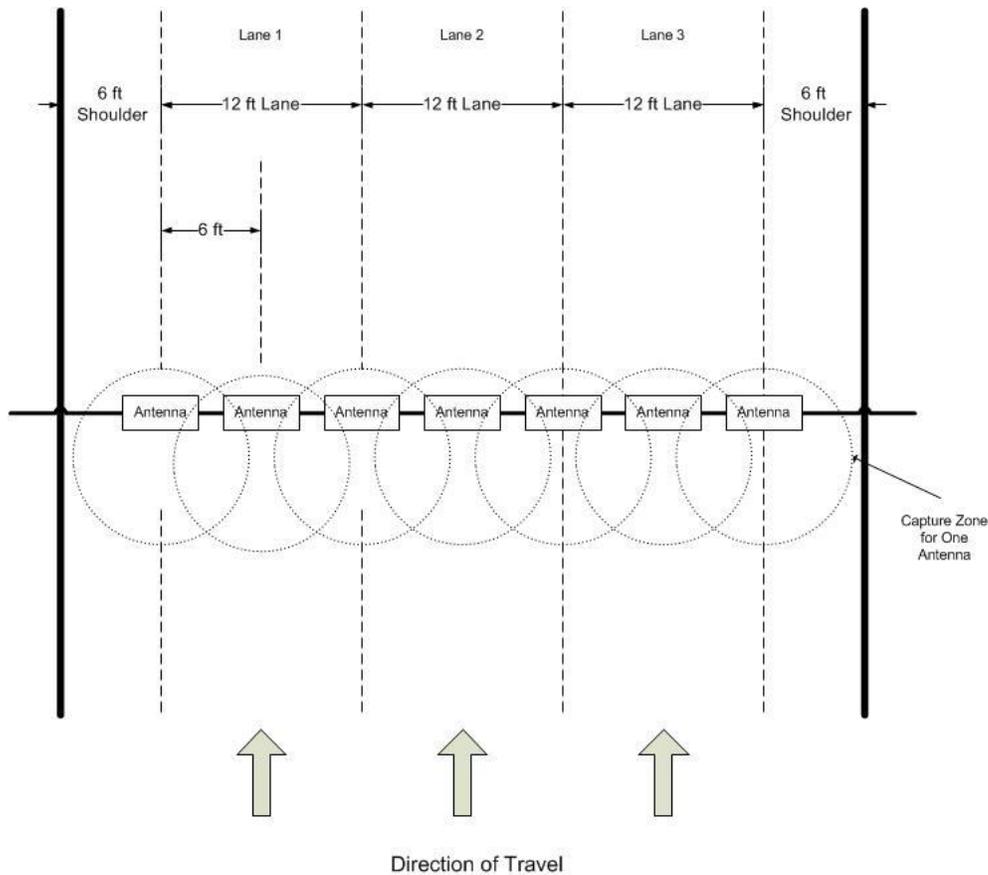
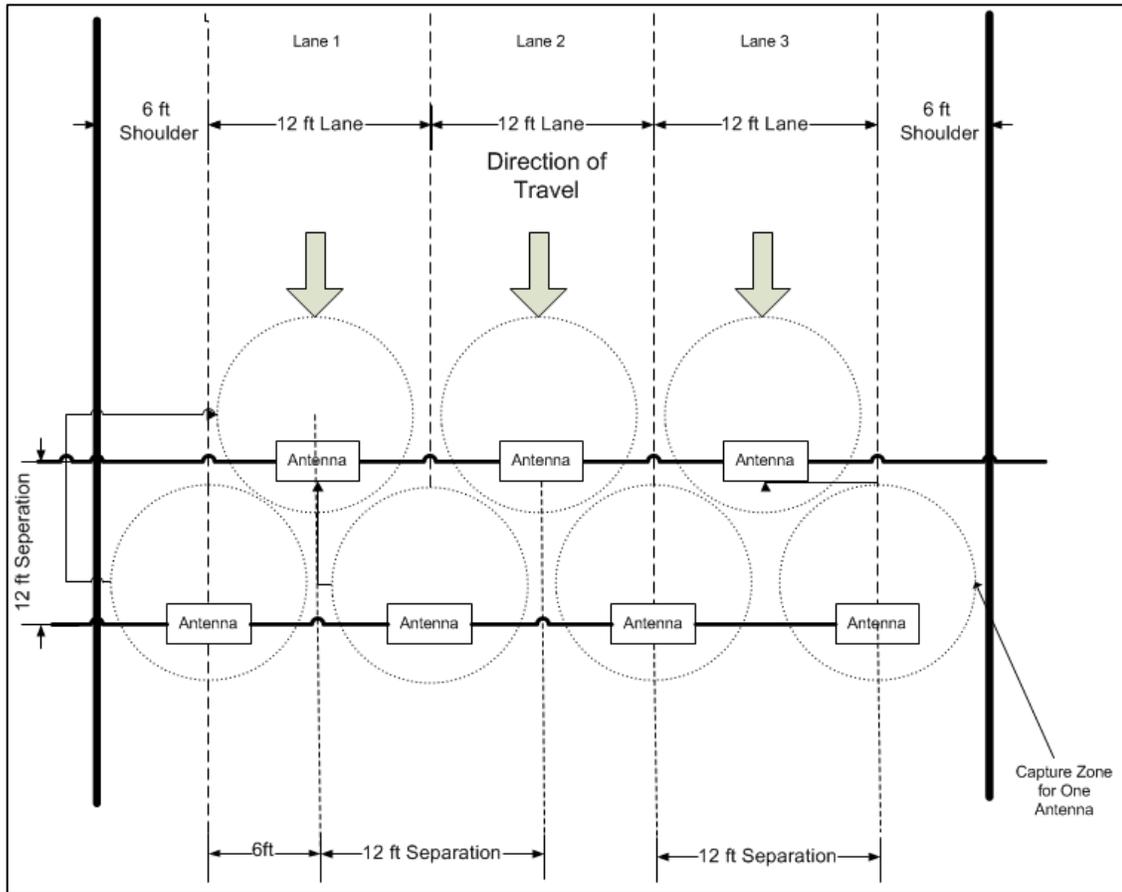


Figure 5-8: Staggered ORT Antenna Installation



The MPR4.1 reader system and antennas are optimized for applications using 12 foot lane widths. The antenna placement requirements and support for this and other lane widths are as follows.

- The lane centerline is the mid-point between the lane markings.
- The antenna bore site should be on the lane centerline and lane markings.
- Physical lane widths below 12 ft. (3.66 m) are not an issue provided the separation between lane centers is 12 ft. or greater.
  - If separations are below this there is a higher risk of reports from multiple lanes for the same tag. Note the use of the voting algorithms will correctly assign the tag to the correct lane). There may also be some reduction in the read performance for FDM protocols.

- If the physical lane width exceeds 15 ft.(4.57 m), the lane should be treated as a multi-lane free flow configuration and multiple antennas are used per lane. The antenna spacings should be kept at 12 ft separation in each row.
- The same FDM Port frequency should not be used on adjacent lanes, including straddle and shoulder lanes (recommended at least 24 ft. separation between in-line antennas and 21 ft for staggered antennas).
- NOTE: It is preferable to use more frequencies where possible to minimize inter-Port interference due to FDM.

### **Along track alignment**

The capture zone created by an antenna is a function of tuning, tilt angle, antenna used, height and reflective properties of the site. There is no single value that can be used to define the alignment of the antenna center to the capture zone. As a guideline nominally 75% of the Capture zone is in front of the antenna center.

### **Multiple readers**

Where multiple readers are on a site, the following additional guidelines apply:

- The readers must be synchronized and running the same frame sequence configuration, or compatible frame sequence configurations.

### **Installing Antenna Cables**



#### **CAUTION:**

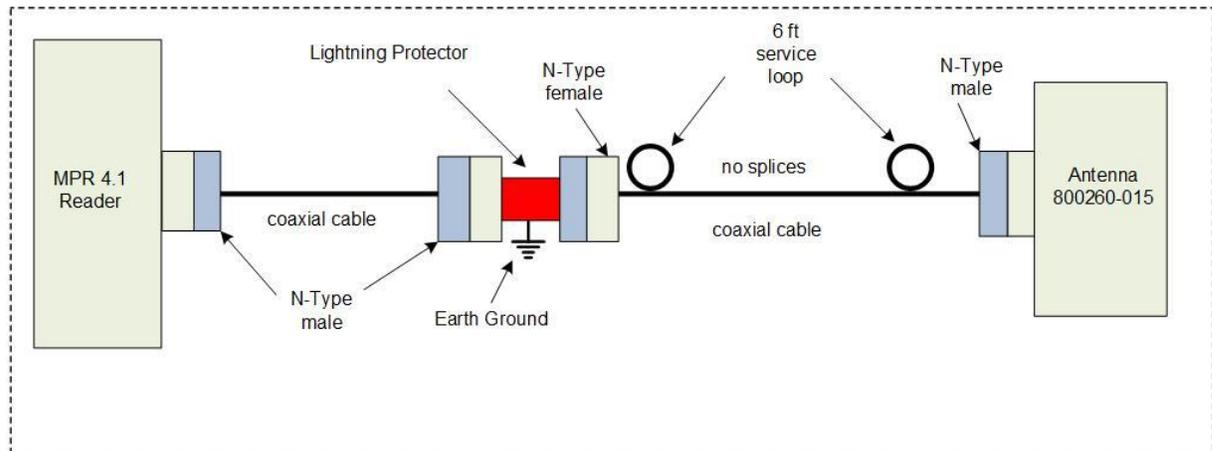
Excessive bending or kinking can damage the RF feedline cables. Do not excessively bend or kink the RF feedline cables while fishing them through the rigid conduit from the antenna to the Reader enclosure.

1. Place the RF feedline cable(s) in position. Use an appropriate cable type (coaxial or Heliac) to ensure the RF feedline cable does not produce a signal loss greater than permitted, see Appendix A RF Cable Specification. Use flexible cable (LMR400 preferred) for the short feedline cable between the circulator and the antenna
2. Using tie wraps, create a service loop of 6 ft. at both ends of the RF feedline cable(s). Trim the excess cable length.
3. Install spiral wraps on the RF feedline cable(s) where necessary to protect it from abrasion.
4. Attach the N-Type male connector to the antenna end of the RF feedline cable(s) . Firmly crimp the male connector.
5. Using a 10in-lb torque wrench, connect the RF feedline cable to the desired MPR 4.1 Port. Using self-amalgamating tape, wrap the connection to ensure water cannot enter.
6. Using a 10in-lb torque wrench, connect the other end of the RF feedline cable to the antenna. Using self-amalgamating tape, wrap the connection to ensure water cannot enter.
7. Tie all RF Adapter cables neatly and label both ends of each adapter cable.

8. Secure the service loop portion of the feedline to the antenna-mounting bracket using the tie wraps. Do not severely bend or kink the RF feedline cable.

**Note:** The N type connectors are weather resistant, but should be entirely wrapped in self-amalgamating tape to ensure a water tight seal.

**Figure 5-9: RF Cable Installation Schematic**



## Performing Lane Tuning

Lane Tuning consists of selecting the frequencies to be used on the Ports and setting the attenuation for the Ports to control the ERP of the reader. These are configured using the web interface. It is recommended that Kapsch Services perform lane tuning to properly configure a site. If the integrator/operator wishes to perform the lane tuning, the following guidelines apply.

- When using multiple adjacent readers, the same FDM Port frequency should not be used on adjacent lanes, including straddle and shoulder (recommended at least 24ft. separation between antennas for in-line antennas, 21ft (18ft lateral) between antennas for staggered antennas).
- When using multiple adjacent readers, TDM Ports that are configured active in the same time should not be used on adjacent lanes, including straddle and shoulder (recommended at least 24 feet separation between antennas, 21ft (18ft lateral) between antennas for staggered antennas).
- The TX attenuation should be adjusted to obtain capture zones nominally 8 to 12 ft. (1.83 to 2.44 m.) along direction of vehicle traffic.

**ATTENTION:** When installing or replacing a MPR 4.1, RF cables, or antenna, the lane must be re-tuned.

## The Synchronization circuit

Synchronization is required between readers located within reader-reader interference range, or which have overlapping or near-adjacent capture zones, or which may have RF signal reflections (interference) due to any one or combination of varying vehicle sizes, varying traffic patterns or fixed site terrain features. The sync feature eliminates interference between the readers that might otherwise reduce system performance. The synchronization circuit connects MPR 4.1 readers together in a star network. All readers connected on a sync circuit shall be configured with the same or compatible frame sequence.

Prerequisites: Sync hub terminal block mounted in a location central to the Readers.

- Note 1:** The exact location of this terminal block should be marked on a site map to aid system maintenance.
- Readers arranged so that no Reader is farther than 1500 ft. (457.2 m.) from the sync hub terminal block
  - Readers arranged so that the total synchronization network cable length is no greater than 2000 ft. (609.6m.).
  - No more than six (6) Readers in the synchronization circuit
- Note 2:** It is recommended that each synchronization cable have two or more spare conductors to support future service repair calls.

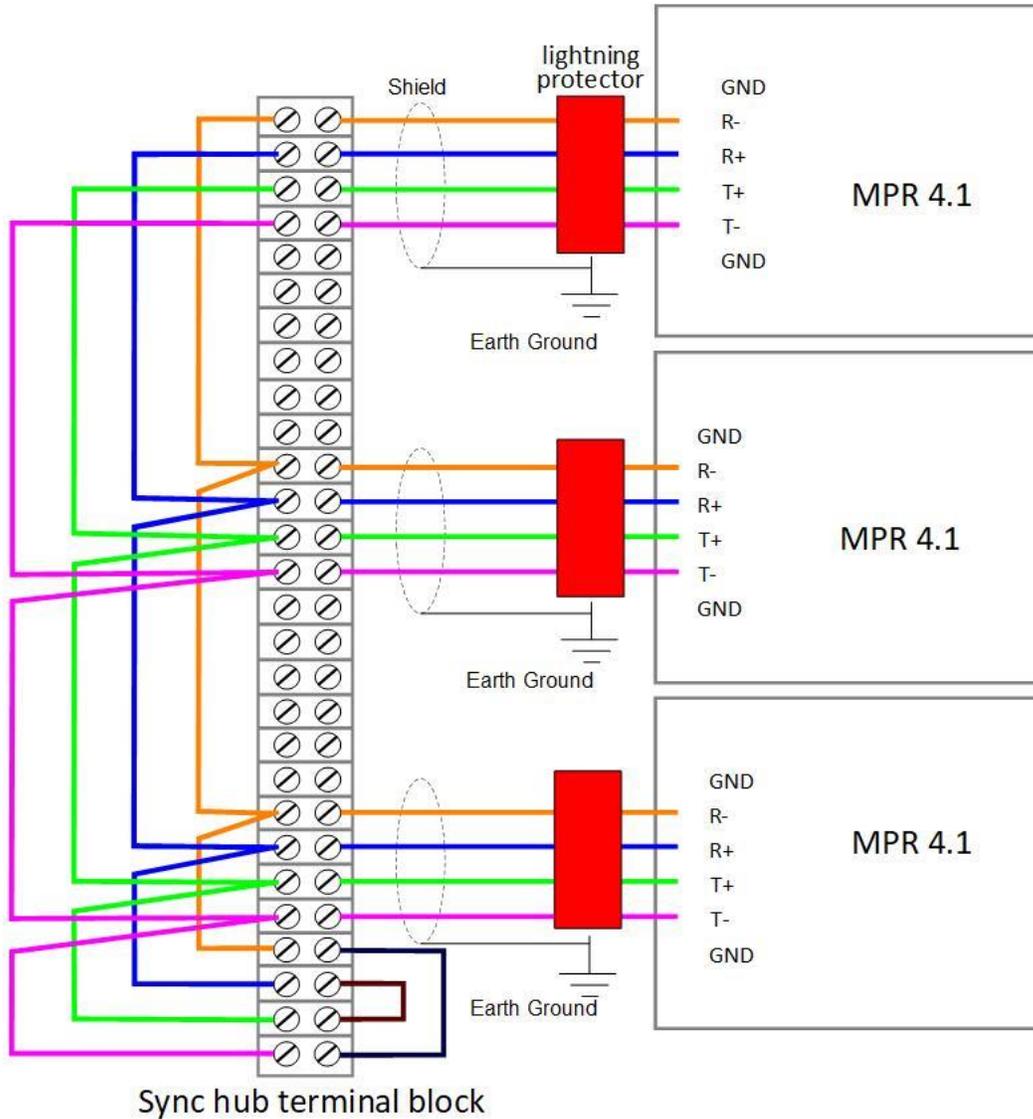
### *Installing a synchronization circuit*

1. Connect the Readers to the Sync hub terminal block as in Figure 5-10 on page 95.

**Attention:** Ensure that cables do not connect from the GND terminal on the MPR 4.1 to the Sync hub terminal block, as this can create a ground loop and affect synchronization performance.

- Note:** Before you continue, you will need to gain access to the web interface through a computer or service laptop connected to the Lane Controller port of the Reader. See the following procedures for more information.
- Connecting a service laptop to the Reader on page 34
  - Changing the service laptop IP address on page 34
  - Testing the connection to the reader on page 35
  - Accessing the Web interface on page 35

Figure 5-10: Synchronization circuit schematic for three Readers



**Note:** Up to six (6) Readers can be added to a synchronization circuit.

**Synchronization between MPR 4.1 Readers**

All Readers in a synchronization circuit must be configured correctly for synchronization to work.

### Configuring synchronization

Prerequisites: Connect a service laptop to the Reader Lane Controller port to access the Web interface.

See the following procedures for more information.

- Connecting a service laptop to the Reader on page 34
- Changing the service laptop IP address on page 34
- Testing the connection to the reader on page 35
- Accessing the Web interface on page 35
- Synchronization rules on page 62

**Note:** Reader synchronization is also enabled remotely by the LC if the Remote LC Configuration is enabled.

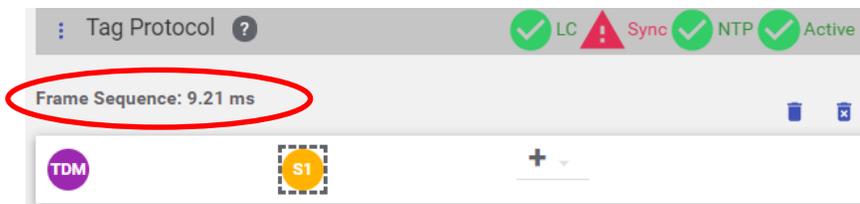
**Example:** TDM only 2 Lane ORT with Shoulders (4-Channel scan) and synchronization

- **Frame Sequence panel:** Seq #1 set to TDM, Seq#2 set to Sync\_1.
- **Sync panel:** Sync enabled and Sync\_1 set. Verify the Sync parameters.

**Note:** The following procedure indicates how to compose the given example.

2. Go to **Tag Protocol** web page.
3. Set frame sequence : Seq #1 set to TDM; Seq #2 set to Sync 1.

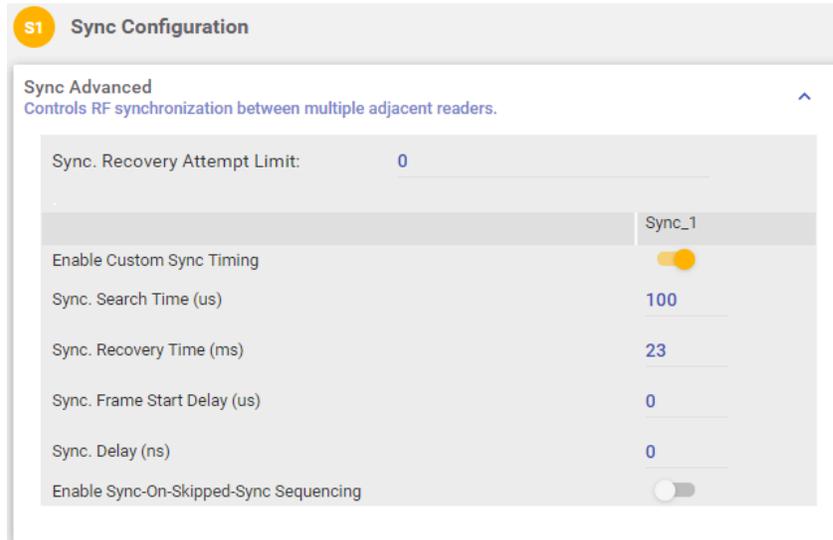
**Result:** The following screen is shown as an example.



**Note:** The Frame Sequence time, circled above in red, should be the same on all readers connected to the sync circuit to ensure reader sync is achieved.

4. Click the **Sync** icon  on the Frame Sequence panel and set the Sync parameters.

**Result:** The following screen is shown as an example.



## The Ethernet Network

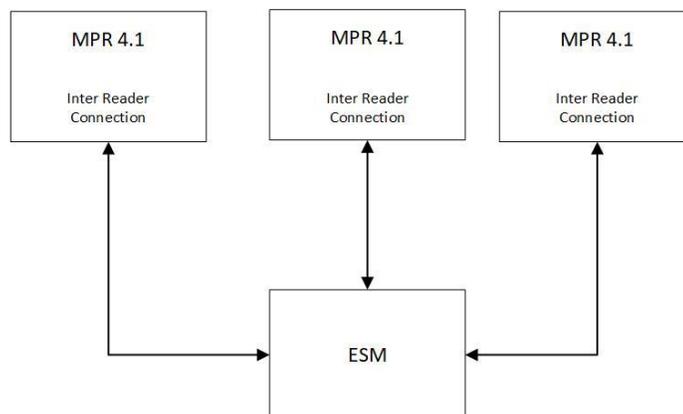
These are general instructions for using Ethernet Switch Modules (ESMs) to create an Inter-Reader (IR) Ethernet network or a Lane Controller (LC) Ethernet network.

### Installing an Ethernet network

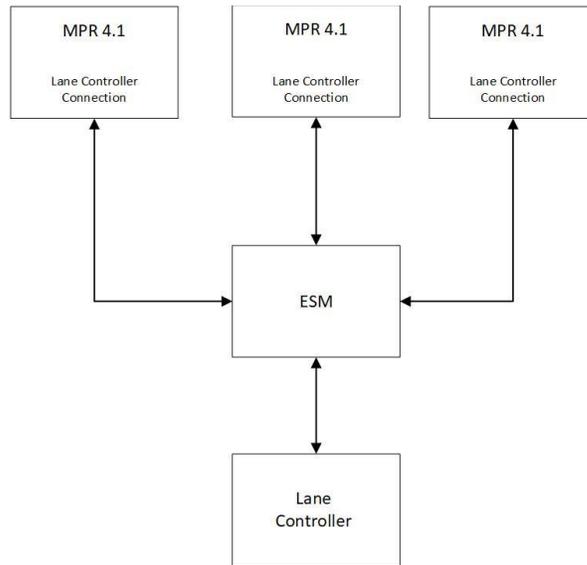
Prerequisites: ESMs mounted according to the manufacturer's instructions.

1. Use CAT 6 Ethernet cables to connect the components in the Ethernet network together as shown in the examples in Figure 5-10. Consult the ESM manufacturer's instructions for more details.

**Figure 5-11: Schematic of a three-Reader IR network**



**Figure 5-12 Schematic of a three-Reader LC network**



## Reader connections to the LC and Inter-Reader via Ethernet

### Reader IP addresses

Each ethernet port in an IR or LC network must have a unique IP address. The IP addresses should be set as required for the site network topology. Default reader IP addresses are:

- Lane Controller Ethernet port: **192.168.1.50**
- Inter Reader Ethernet port: **192.168.0.50**

### Setting the reader IP addresses

Prerequisites: Connect the service laptop to the Lane Controller port to access the Web interface.

Refer to Connecting a service laptop to the Reader, page 34.

**Note:** A secure record of the IP addresses should be maintained to aid network troubleshooting. The Lane controller Ethernet IP addresses will be required if requesting remote assistance from Kapsch Service.

1. Go to the **General** web page.
2. Assign an IP address to the parameter **Reader IP Address** so that the Reader is accessible on the LC network.
3. Assign the gateway IP address to the parameter **Default Gateway IP** so that the Reader can communicate via a gateway device such as a router.

4. Go to the **Lane Assignment** web page.
5. Assign an IP address to the parameter **Inter-Reader alias** on a given Reader so that the Reader is accessible on the IR network, if necessary.
6. Assign an IP address to the parameter **Inter Reader IP Address** so that the Reader is accessible on the IR network, if necessary.

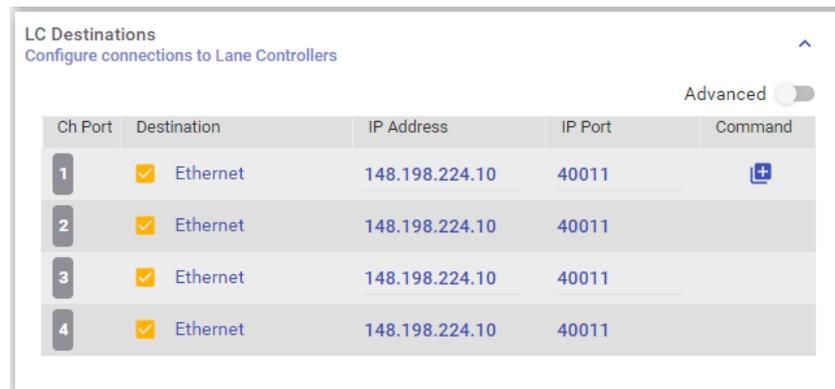
### Configuring an LC Ethernet network

The Reader data can be sent to the LC via an Ethernet network. Note the data can be sent to up to 3 Ethernet destinations

Prerequisites: Connect a service laptop to the **Lane Controller** port to access the web interface. Refer to Connecting a service laptop to the Reader, page 34. You must have **Change Configuration** permissions.

1. Go to the **Lane controller** web page.
2. In the **Destination** row, select the **Ethernet** check box for each RF Port that will communicate with the LC via Ethernet.

**Result:** The following screen appears.



Ch Port	Destination	IP Address	IP Port	Command
1	<input checked="" type="checkbox"/> Ethernet	148.198.224.10	40011	
2	<input checked="" type="checkbox"/> Ethernet	148.198.224.10	40011	
3	<input checked="" type="checkbox"/> Ethernet	148.198.224.10	40011	
4	<input checked="" type="checkbox"/> Ethernet	148.198.224.10	40011	

3. Enter the LC IP address and Port number for each RF Port.
4. If all the RF Ports will be communicating with the LC at the same IP address, click the clone icon  to duplicate settings automatically to all channels.

**Result:** All RF Ports selected to communicate over Ethernet will now have the same destination LC IP.

5. Enter a time, in milliseconds (ms), in the **LC Ethernet TCP-Socket Timeout** field.

**Note:** If an LC does not respond within this time, the Reader will consider Ethernet communications to the LC to be down.

**Attention:** Contact Kapsch Service to set the Land Controller port IP address if the IP address has been lost or cannot be determined.

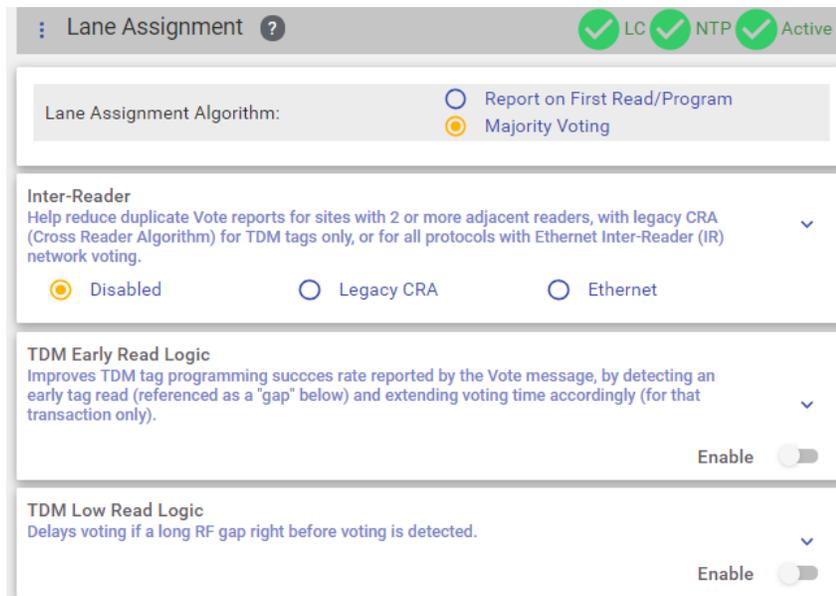
## Lane Assignment

The reader can perform lane assignment (voting) to identify the most probable lane in which the OBU resides. This is used when producing VOTE or POST messages to the Lane Controller. The settings for voting method and voting communication are defined on the Lane Assignment page, shown below.

1. Go to the **Lane Assignment** page.



**Result:** The following screen appears.



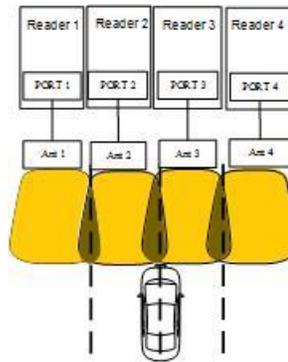
The Lane Assignment algorithm block allows the voting method to be individually selected.

The voting methods are defined in the Glossary.

## Multiple Reader Lane Assignment

ORT lanes allow OBUs to cross multiple capture zones which may cross between readers. The Readers should assign an OBU to one RF Port to prevent duplicate transactions.

**Figure 5-13: Two Readers communicating with one OBU**



#### **Selecting the correct communication method between reader**

The communication method determines how Readers communicate with each other to share information for determining lane assignments. This is important for situations similar to that shown in Figure 5-13, where, to assign the OBU to a lane, Reader 2 and Reader 3 need to share handshaking information. The available communication methods are:

**Legacy CRA:** there is no physical link between the Readers, such as an IR Network. Instead, the first Reader to contact an OBU, programs the OBU. All other Readers that subsequently contact the OBU recognize it was recently programmed and ignore the OBU.

- Note:** CRA only works on the TDM protocol when it is write enabled.
- Note:** The Reader ID number on the Tag Programming tab must be different for each reader.
- Note:** The Plaza ID number on the Tag Programming tab must be the same for each reader.
- Note:** The readers must be time synchronized
- Note:** The transponder timeout, set in the Group panel on the Channels web page, must be greater than the time difference between all Reader clocks in the network.

**Ethernet:** An IR Ethernet network connects the Readers together and handshaking information is shared between Readers. The Readers assign the OBU to one Port and all other transaction reports from other Readers are suppressed. Reader information is only shared between one reader and the reader on either side of that reader.

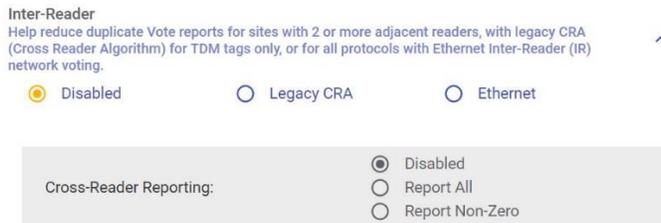
- Note:** The Reader ID number on the Tag Programming tab must be different for each reader.
- Note:** The Plaza ID number on the Tag Programming tab must be the same for each reader.
- Note:** The readers must be time synchronized
- Note:** The transponder timeout, set in the Group panel on the Channels web page, must be greater than the time difference between all Reader clocks in the network.
- Note:** Multiple (voting) group IDs are not supported across multiple Readers.

### Configuring Lane Voting over an Inter-Reader (IR) network

This procedure allows you to configure the Reader correctly to ensure accurate lane assignment and to prevent duplicate reports.

Prerequisites: Connect a service laptop to the Lane Controller port to access the Web interface. Go to the **Lane Assignment** web page.

Refer to Connecting a service laptop to the Reader, page 34. You must have **Change Configuration** permissions.



1. On the Lane Assignment panel select **Ethernet**.

### Configure how multiple transactions are reported to the LC in IR network:

- To send one transaction report per OBU to the LC without informing the LC of suppressed reports, select **Disabled** from the **Cross-Reader Reporting** drop-down list.
- To send all transaction reports (one per reader) for an OBU to the LC, select **Report All** from the **Cross-Reader Reporting** drop-down list.
- To send one transaction report per OBU to the LC and also inform the LC of suppressed reports, select **Report Non-zero** from the **Cross-Reader Reporting** drop-down list.

**Configuring the IR network topology**

It is necessary to tell the readers cooperating on the IR network about each other via the configuration settings.

Each reader can communicate to one reader on its “Left” and one reader on its “Right”. Each can be separately enabled. The reader on which the network settings are being entered is the “Center” from its own perspective but will be Left or Right reader to the adjacent readers.

**Left Reader:** The Left Reader is the reader whose highest Port number antenna is adjacent to the antenna with the lowest Port number on the Center Reader.

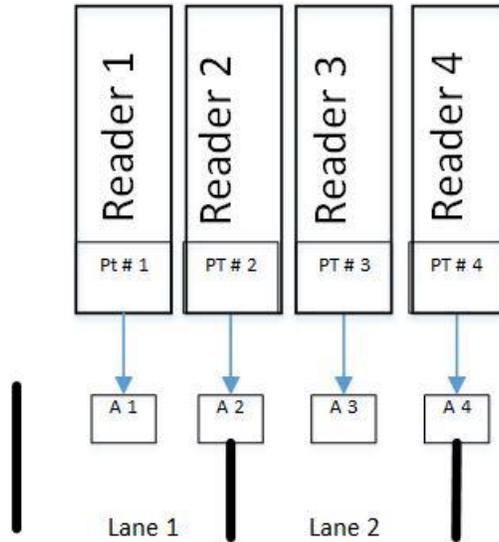
**Right Reader:** The Right Reader is the reader whose lowest Port number antenna is adjacent to the antenna with the highest Port number on the Center Reader.

- Note:** While the MPR 4.1 supports separating the antenna position from the Port order, in order to use IR the antenna order must be matched to Port order and run from left to right (or right to left) in the IR cooperating readers.
- Note:** A single (voting) Group ID must be used in each reader
- Note:** The transponder timeout values for the (voting) Group IDs must be the same across all readers.
- Note:** The transponder timeout, set in the Group tab on the Configure panel, must be greater than the time difference between all Reader clocks in the network.
- Note:** The protocol and tag programming settings must be the same on each reader for the protocols involved in the IR network
- Note:** A reader restart is usually required when the IR network configuration is completed on all readers

The following example shows how to configure the IR network based on where the Reader sits in the site.

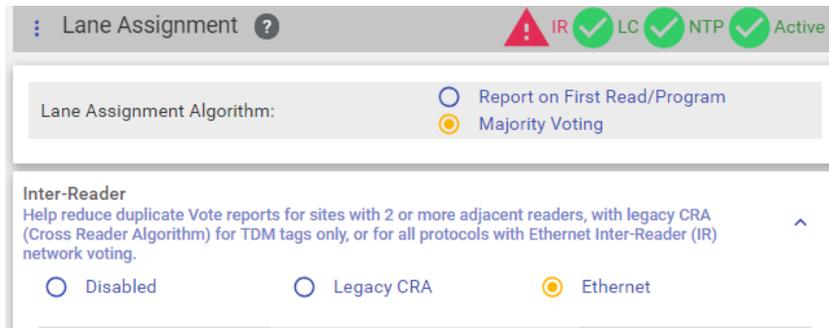
**Example:** Reader 1 in Figure 5-14 has a Reader on its right (Reader 2) but no Reader on the left. Reader 2 in Figure 5-14 has a Reader on its right (Reader 3) and a Reader on its left (Reader 1). Reader 3 in Figure 5-14 has a Reader on its right (Reader 4) and a Reader on its left (Reader 2).

**Figure 5-14: Four readers covering one direction of wide lane ORT traffic**



1. Select a set of unique IP addresses, one per reader for the IR Network.
2. Go to the **Lane Assignment** web page.
3. Select **Ethernet** for **Inter-reader Communication** Method.

**Result:** The following screen appears.



4. Set the **Inter-Reader alias** to the chosen ip address for the reader.
  - Note:** The **Inter-Reader alias** applies to the whole Reader and is not for individual Ethernet port.
5. If there is a Reader on the left, set **Left Reader** toggle switch to ON. Thus for this example this must be done on both Reader 2 and Reader 3 (reader 2 is left reader to Reader 3)
6. Enter the ip address of the left Reader in **Left Inter-Reader alias** field.
7. If there is a Reader on the right, set **Right Reader** toggle switch to ON. Thus for this example this must be done on both Reader 1 and Reader 2 (reader 3 is right reader to Reader 2)
8. Enter the ip address of the right Reader in **Right Inter-Reader alias** field.

9. Enter the Reader IP Address of the right Reader.

To ensure correct operation it is also necessary to:

10. On the **Tag Protocol** page **TDM Tag Programming** panel (see Programming on page 55) ensure that:
  - TMP and TCP are enabled
  - The Plaza IDs of all Readers at the plaza match
  - The Reader ID for each Reader is different.
11. Configure the Reader clocks in the IR network to have the same time (see NTP Server, page 132).
12. From the **Channels** web page, ensure all channels covering one direction of traffic have the same (voting) Group ID.

Figure 5-15: Sample inter-reader setup

**Inter-Reader**  
 Help reduce duplicate Vote reports for sites with 2 or more adjacent readers, with legacy CRA (Cross Reader Algorithm) for TDM tags only, or for all protocols with Ethernet Inter-Reader (IR) network voting.

Disabled     
  Legacy CRA     
  Ethernet

Left Reader	This reader	Right Reader
<input checked="" type="checkbox"/>		<input checked="" type="checkbox"/>
Left Inter-Reader alias: <b>192.168.0.150</b>	Inter-Reader alias: <b>192.168.0.151</b>	Right Inter-Reader alias: <b>192.168.0.152</b>
	Ethernet 2 IP Address: <b>192.168.0.51</b>	

Cross-Reader Reporting:     
  Disabled  
 Report All  
 Report Non-Zero

Align tag-timeout expiry between readers:     

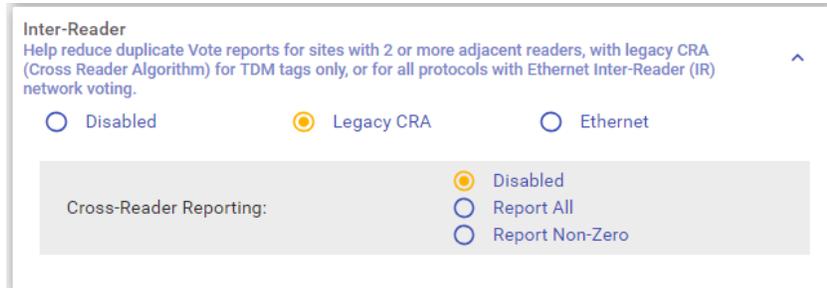
Inter-Reader network timeout (ms):      **50**

### **Configuring Legacy Cross Reader Algorithm (CRA) communication**

Prerequisites: Connect a service laptop to the Lane Controller port to access the web interface. Refer to Connecting a service laptop to the Reader, page 34.

1. Go to the **Lane Assignment** web page.
2. Select **Legacy CRA** for **Inter-Reader Communication Method**

**Result:** The following screen appears.



3. Configure how multiple transactions are reported to the LC:
  - To send one transaction report per OBU to the LC without informing the LC of suppressed reports, select **Disabled** in **Cross-Reader Reporting**.
  - To send one transaction report per OBU to the LC and also inform the LC of suppressed reports, select **Report Non-zero** in **Cross-Reader Reporting**.

To ensure correct operation it is also necessary to:

4. On the **Tag Protocol page, TDM Tag Programming** panel (see Programming on page 45) ensuring that:
  - TMP and TCP are enabled
  - the Plaza IDs of all Readers at the plaza match
  - the Reader ID for each Reader is different
5. On the **Channels** web page, ensure all Ports covering one direction of traffic have the same (voting) Group ID.
 

**Note:** Multiple (voting) group IDs are not supported across multiple Readers.
6. Set the Reader clocks to within 2 seconds of the same time (either Manually setting the Reader time and date procedure on page 133, or via the LC) or use NTP to time synchronize if there is an NTP server on the LC network.
 

**Note:** The transponder timeout, set in the Group tab on the Configure panel, must be greater than the time difference between all Reader clocks in the network.

### Selecting the Voting Algorithm

Prerequisites: Connect a service laptop to the Reader Lane Controller 1 port to access the web interface. Refer to Connecting a service laptop to the Reader, page 34.

- Report on First Read/Program: The OBU is assigned to the channel with the first handshake.
  - Majority: The OBU is assigned to the Port with the most handshakes.
1. Go to the **Lane Assignment** web page.
  2. Select either **Report on First Read/Program** or **Majority** from the drop-down list of the required protocol located in the **Lane Assignment Algorithm** box.

## Configuring Voting Time

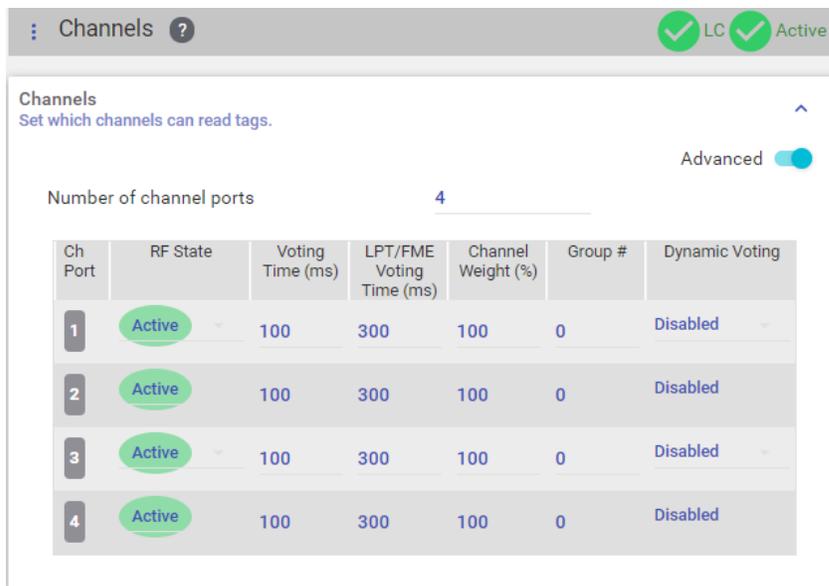
Manually setting a voting time gives a fixed voting time to each Port. Dynamic voting time allows the Reader to calculate and base the voting time on the average capture zone span time (the average time it takes for OBUs to pass through a capture zone).

### Manually set the voting time for a Port

Prerequisites: Connect a service laptop to the Reader **Lane Configuration** port to access the web interface. Refer to Connecting a service laptop to the Reader, page 34.

1. Go to the **Channels** web page.

**Result:** The following screen appears.



Channels ? ✓ LC ✓ Active

Channels  
Set which channels can read tags. ^

Advanced

Number of channel ports

Ch Port	RF State	Voting Time (ms)	LPT/FME Voting Time (ms)	Channel Weight (%)	Group #	Dynamic Voting
1	Active	100	300	100	0	Disabled
2	Active	100	300	100	0	Disabled
3	Active	100	300	100	0	Disabled
4	Active	100	300	100	0	Disabled

2. In the **LPT/FME Voting Time** field enter a voting time in milliseconds, to set the voting time for LPT and FME OBUs.
3. In the **Voting Time (all other tags)** field enter a voting time in milliseconds, to set the voting time for all OBUs that are not LPT or FME.
4. Click on the **Group** tab.

**Result:** The following screen appears.

Group	
	Grp0
Transponder Timeout (seconds)	300

- Enter a time, in seconds (s), in the **Transponder Timeout** field

**Note:** This specifies an amount of time a transponder must be away from a capture zone before it is reported again as a new transaction when it is detected.

- Repeat steps 2 through 5 to individually configure the other Ports, or enter the number of a configured Port in the field and click **Set** button to duplicate setting automatically to the remaining channels.

Set all RF channels to:	Active	SET
Set voting time / dynamic voting of all channels to the same configuration as channel:	1	SET

### ***Allowing the Reader to calculate the optimum voting time using Dynamic Voting Control***

Prerequisites: Connect a service laptop to the **Lane controller** port to access the web interface.

Refer to Connecting a service laptop to the Reader, page 34.

- Go to the **Channels** web page.
- Set the **Dynamic Voting Control** to **Reader** to allow the Reader to automatically set the voting time by calculating the average capture zone span time.

**Result:** The following screen appears.

Channels ?
✔ LC ✔ Active

Channels  
Set which channels can read tags. ^

Advanced

Number of channel ports

Ch Port	RF State	Voting Time (ms)	LPT/FME Voting Time (ms)	Channel Weight (%)	Group #	Dynamic Voting
1	Active	100	300	100	0	Reader
2	Active	100	300	100	0	Disabled
3	Active	100	300	100	0	Disabled
4	Active	100	300	100	0	Disabled

Dynamic Voting ^

Ch Port	Dynamic Voting	Dynamic Voting Sample Size	Dynamic Voting Threshold (%)	Dynamic Voting Capture Zone Span Multiplier
1	Reader	20	20	2
2	Disabled			
3	Disabled			
4	Disabled			

3. Enter a sample size in the **Dynamic Voting Sample Size** field.
  - Note 1:** This is the number of previous transactions the Reader includes when calculating the average capture zone span time.
  - Note 2:** The Reader calculates the capture zone span time after each OBU transaction. The Reader will not update the Dynamic Voting Time unless the capture zone span time changes more than the Dynamic Voting Threshold percentage.
4. Enter a percentage in the **Dynamic Voting Threshold** field.

### Configuring Port Weight for straddle antennas

The handshake count of straddle Ports (Ports 1 and 3 in Figure 5-16) typically have less weight assigned to them than non-straddle Ports (Ports 2, and 4 in Figure 5-16).

Prerequisites: Connect a service laptop to the **Lane Controller** port to access the web interface.  
Refer to Connecting a service laptop to the Reader, page 34.

1. Go to the **Channels** web page.
2. Enter a percentage in the **Port Weight** field for each Port.

**Result:** The following screen appears.

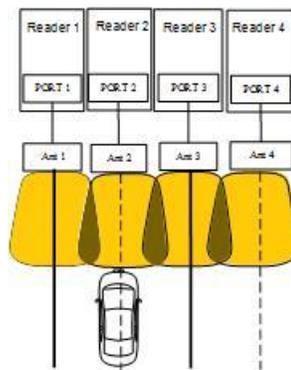
**Note:** A Port weight of 100% means the full handshake count is considered at voting time, while a Port weight of 50% means only half the handshake count is considered at voting time.

**Channels**  
Set which channels can read tags. Advanced

Number of channel ports

Ch Port	RF State	Voting Time (ms)	LPT/FME Voting Time (ms)	Channel Weight (%)	Group #	Dynamic Voting
1	Active	2000	6000	100	0	Disabled
2	Active	3000	2000	50	0	Disabled
3	Active	100	300	100	0	Disabled
4	Active	100	300	100	0	Disabled

**Figure 5-16: Wide ORT lanes with two straddle antennas**



## **6. TROUBLESHOOTING AND TESTING**

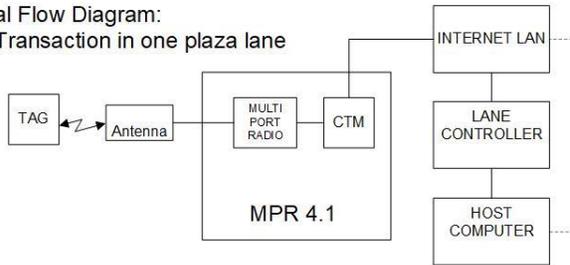
### **Troubleshooting Methodology**

Troubleshooting trees are provided for resolving the most common Reader issues. A **Test and Replace** methodology is used for servicing the Reader system. The general steps are:

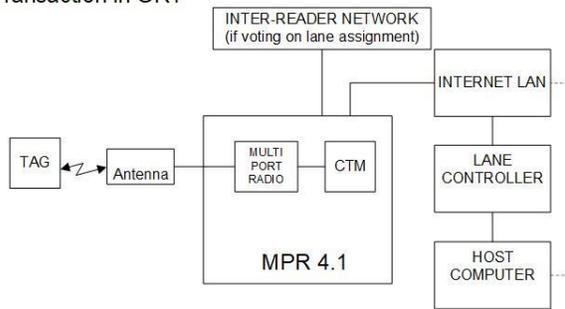
1. **Test** all symptoms that may have attributed to the reported system fault. Use the following suggestions to reveal faults:
  - Examine the Reader status on the Reader browser STATUS page (see Reader status, page 39).
  - Examine the trouble log files for any reported issues with the Reader (page 80).
  - Observe the LED Indicators on the Reader front panel (see LED Indicators, page 112).
2. **Replace** a suspected faulty component.
3. **Continue** with symptom testing and component replacement until there are no fault symptoms.

Figure 6-1: Signal Flow Diagrams

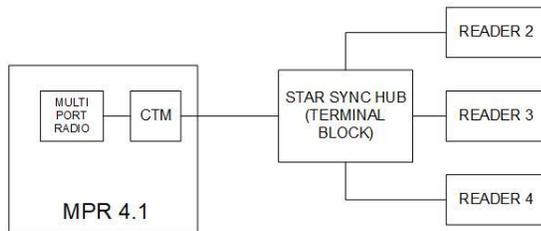
Signal Flow Diagram:  
Tag Transaction in one plaza lane



Signal Flow Diagram:  
Tag Transaction in ORT



Signal Flow Diagram:  
Synchronization



## LED Indicators

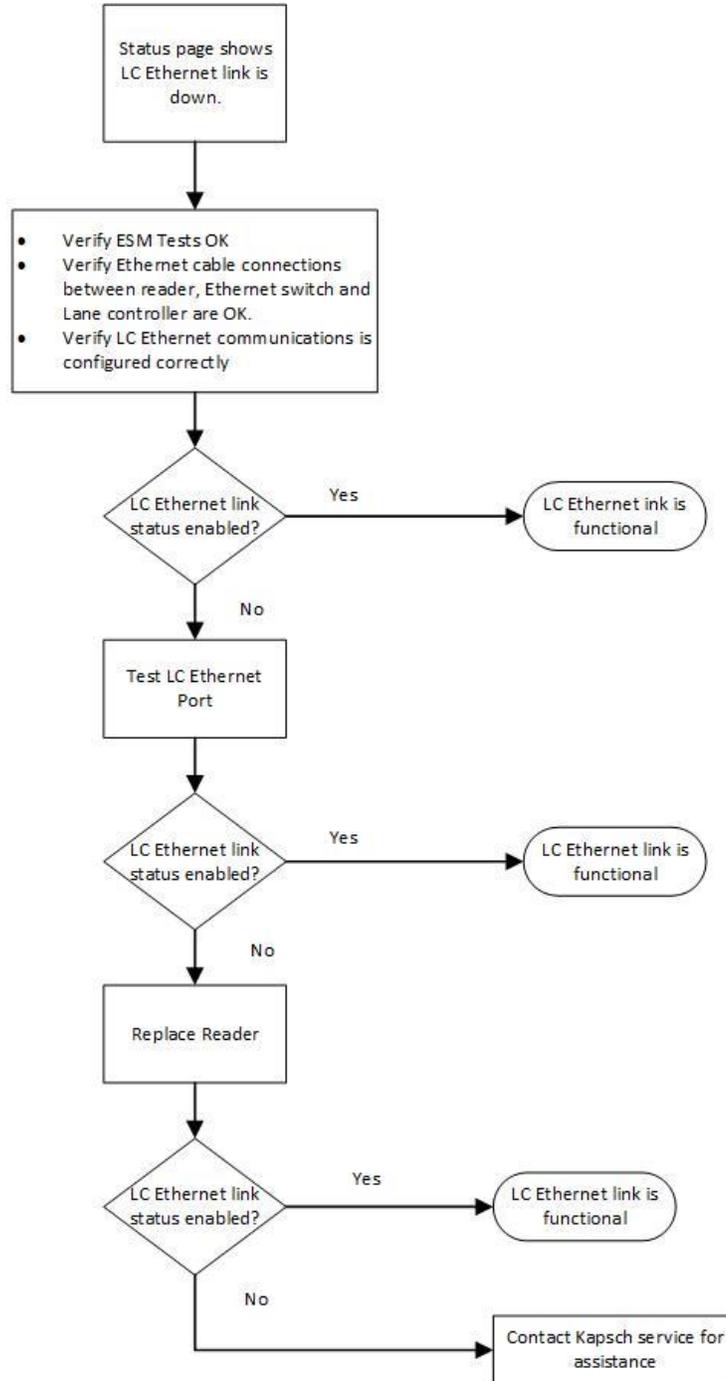
The following table gives an overview of all the LEDs on the Reader. See the Troubleshooting Trees beginning on page 115 to resolve any issues.

Table 6-1: LED Indicator states explained

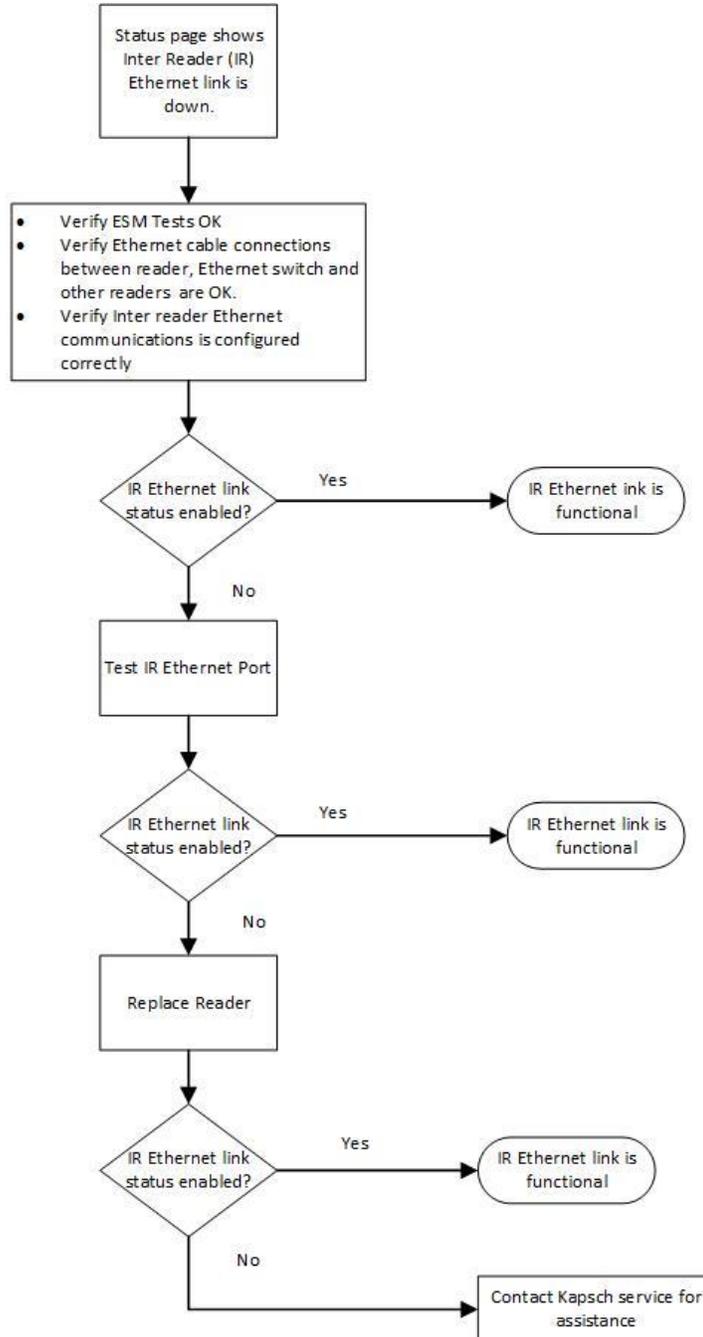
CTM LEDs		
LED	State	Meaning
STATUS	Flashing green	Reader CPU is functional
	Flashing amber	CPU is experiencing Heavy Load
	Flashing red	CPU has a fault
	No LED	CPU is not operating
ANT (1 – 4)	Solid green	Port is active
	Flashing green	Port is active but Faulty
	No LED	Port is Inactive or Faulty
SYNC	Solid green	Reader is synchronized with other readers on the sync network.
	Flashing green/amber	Reader is out of sync with other readers on the sync network and attempting recovery
	Flashing red	Reader out of sync with other readers on the sync network, or,
		No activity detected from other readers on the sync network
	No LED	Synchronization is disabled

CTM LEDs		
LED	State	Meaning
MESSAGE	Flashing amber	Indicates there are errors or messages logged that need to be reviewed. Possible errors include: <ul style="list-style-type: none"> <li>- NTP Time Sync warning</li> <li>- LC connection is down (one or more)</li> <li>- Inter-Reader connection is down</li> <li>- Frame Sequence configuration error</li> <li>- CGC Health error</li> </ul>
	No LED	There are no logged errors or messages.
POWER	Solid green	Good external power and internal supplies working
	Flashing amber	External power but fault with internal supplies
	No LED	No or improper external supply or faulty internal supplies.

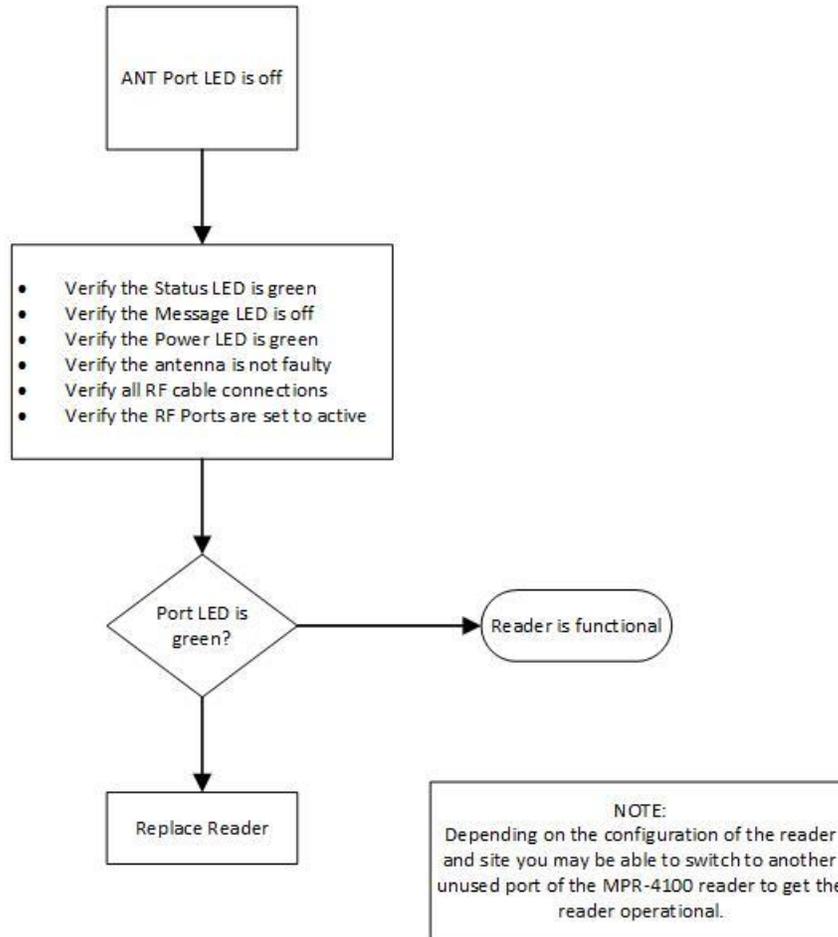
### Troubleshooting tree: Lane Controller Ethernet Port not working



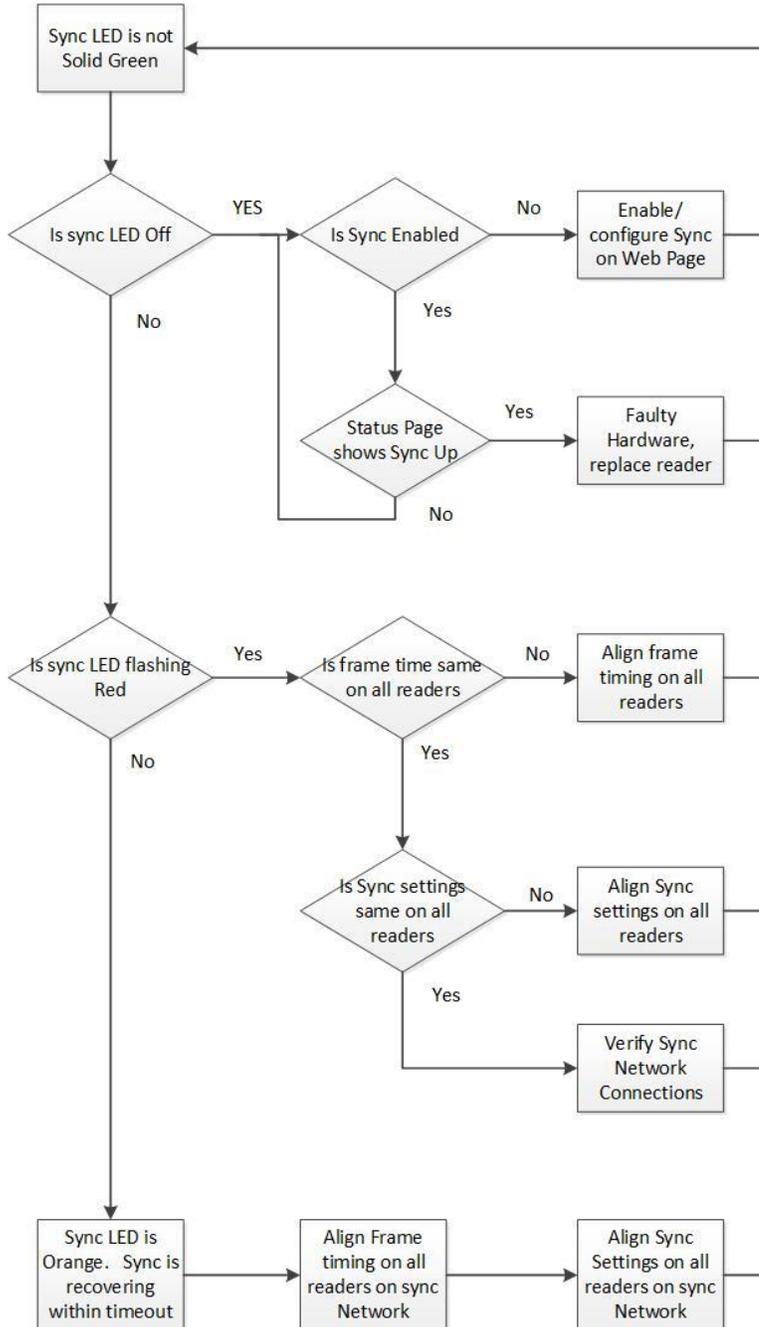
### Troubleshooting tree: Inter Reader Ethernet Port not working



### Troubleshooting tree: Antenna ports not working



### Troubleshooting tree: Synchronization not working



**Constant busy state on sync bus**

A Reader that erroneously holds the sync bus in a BUSY state causes all other Readers connected to the bus to time-out while waiting for the READY state. As a result, all of their SYNC LEDs will be flashing red. Disconnect each Reader one at a time from the sync hub until the fault clears then reconnect each Reader in the order of removal until the fault reappears. Service each faulty Reader.

**Sync Failure Indicator for incomplete cable connections**

The SYNC LED will flash steadily red if there is no activity on the Rx port of the sync connector. If both transmit and receive connections are cut off from the sync hub the indicator will flash red. If only the transmit connection is disconnected and there are other Readers in the synchronization network, the SYNC LED stays green.

**Identifying failures on the reader**

Reader failure is indicated by any of the following conditions:

- Ethernet LC link down, as indicated on the Reader browser **Status** page.
- Ethernet IR network link down, as indicated on the Reader browser **Status** page.
- STATUS LED is red

## Reader recovery actions

For certain failures, the Reader will automatically initiate the recovery actions outlined in Table 6-2.

**Table 6-2: Failures and the Reader Recovery Actions they trigger**

Failure	Reader Recovery Action
CTM Health failure	reinitializes CTM
Ethernet LC link down	re-attempts connection once every second or up to 10 seconds based on load
Inter-Reader Ethernet link down	switches to Badger style CRA and re-attempts connection

## Testing the LC Ethernet port

This test verifies that a LC Ethernet port is working properly.

Prerequisites: A service laptop.

1. Connect a service laptop directly to LC Ethernet port (see Connecting a service laptop to the Reader, page 34).

**Note:** Ensure that you can access the web interface with the service laptop (see Accessing the Web interface, page 35). This confirms the Ethernet port is functional.

## Testing the Synchronization Circuit

This first part of this test checks the functionality of the Reader's Sync Port.

### Testing the Sync circuit

1. Disconnect the Synchronization circuit wiring from the Sync port
2. Using two short jumper wires connect Tx+ to Rx+ and Tx- to Rx- on the Sync port, leaving the GND terminals unconnected (see Sync Port connections, page 140).
3. If the SYNC LED illuminates solid green, the Sync circuit is functioning properly.
4. Reconnect the synchronization circuit to the Sync port.

### Testing the Synchronization hub cabling

1. If the SYNC LED does not illuminate solid green with another functional reader connected to the Synchronization circuit, the problem is with the wiring between the reader and the synchronization hub terminal block.

## Testing the MPR 4.1 Antenna Ports

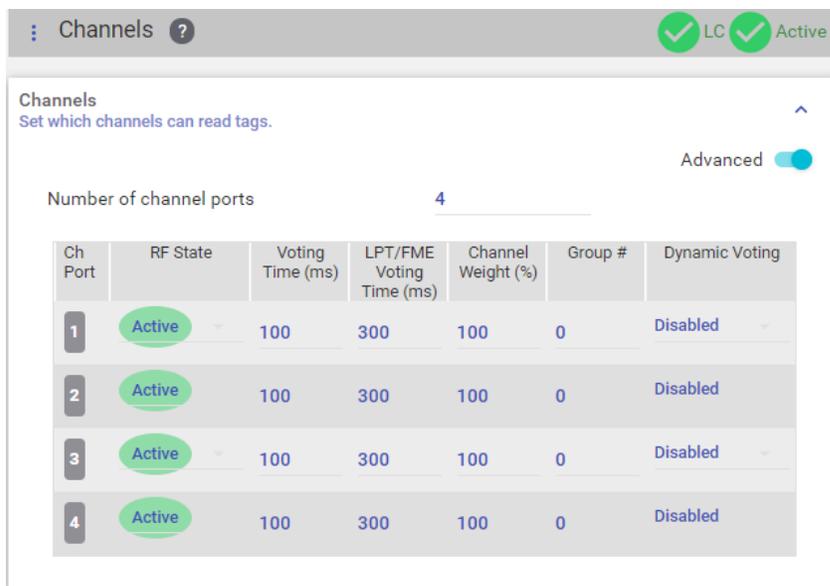
The following test is to verify that all antenna ports of the Reader are functional.

Prerequisites: Connect a service laptop to **Lane Controller** port to access the web interface. Refer to Connecting a service laptop to the Reader, page 34.

**Note:** All four Ports in a Frame Sequence configuration must be enabled to fire, otherwise this test will not work.

1. Go the **Channels** we page.

**Result:** The following screen appears.



The screenshot shows the 'Channels' web interface. At the top, there are two green checkmarks with 'LC' and 'Active' labels. Below the title 'Channels', there is a subtitle 'Set which channels can read tags.' and an 'Advanced' toggle switch which is turned on. A text input field shows 'Number of channel ports' set to '4'. Below this is a table with the following data:

Ch Port	RF State	Voting Time (ms)	LPT/FME Voting Time (ms)	Channel Weight (%)	Group #	Dynamic Voting
1	Active	100	300	100	0	Disabled
2	Active	100	300	100	0	Disabled
3	Active	100	300	100	0	Disabled
4	Active	100	300	100	0	Disabled

2. Set **Ch#** to **Active**.
3. Ensure that the selected Antenna LED on the Reader illuminates solid green.
4. From the **Channels** web page, select **Offline** from the **RF State** drop-down list.
5. Ensure that the Antenna LED on the Reader is off.
6. Repeat steps 1 and 5 for each Port.

## 7. MAINTENANCE PROCEDURES

	<b>CAUTION:</b> Improper modification of configuration parameters may adversely affect system operation. The default values may not be appropriate for the specific application. It is the system integrator's responsibility to tailor the configuration parameters to the specific operating environment.
---	--

### Corrective maintenance procedures

**Note:** When removing or installing ESD sensitive equipment always follow the accepted practices for ESD protection.

The **inspect, clean, and system re-test** methodology is used for all system maintenance. This type of maintenance consists of the following general steps.

1. Inspect all Reader connections.

Determine if the connections require cleaning. To clean component connector contacts, use a contact cleaner spray that does not contain a trichloroethylene based solvent or a Freon® based propellant.

**Attention:** Pre-authorized lane closure is required if the connectors need to be cleaned.

### Preventive maintenance procedures and scheduling

**Attention:** Only Kapsch Service-trained service maintenance personnel are to perform these tasks.

Once a year:

1. Perform RF measurements to verify the cables and reader. It is recommended a commercial off-the shelf instrument is used which supports Cable Analyzer Testing, to show faults inside cables, and Voltage Network Analysis, to verify connection integrity and end to end connectivity and gain.
2. Verify reader output power and power at antenna using a commercial off-the shelf spectrum analyzer.

**With power off:**

1. Inspect and clean the Reader as needed, depending on the site environmental conditions, such as contamination by dust. As a minimum, inspect and clean the reader once per year.
2. Inspect the antenna waterproofing and ensure that any seal is secure.
3. Inspect the antenna weep hole. Remove any dust, dirt or other obstructions.

4. Check ground connectivity for exterior ground connection to reader system ground

**Attention:** Pre-authorized lane closure is required before continuing with this procedure.

**Note:** For each port, go into the web interface and disable the port to be tested.

1. Disconnect and inspect in-line lightning suppressor.
2. Disconnect and inspect the exterior RF feedline cable and connectors exposed to the elements.
3. If corrosion is visible, replace the corroded connector and, if necessary, cut out the entire corroded portion of the feedline cable. The antenna may require replacement if the mating female connector is corroded.
4. When reconnecting connectors after inspection is complete, discard and replace self-amalgamating tape.

Every 4 1/2 years:

**Note:** The CMOS battery is not field-replaceable.

1. Replace the CMOS battery.

## Antenna replacement

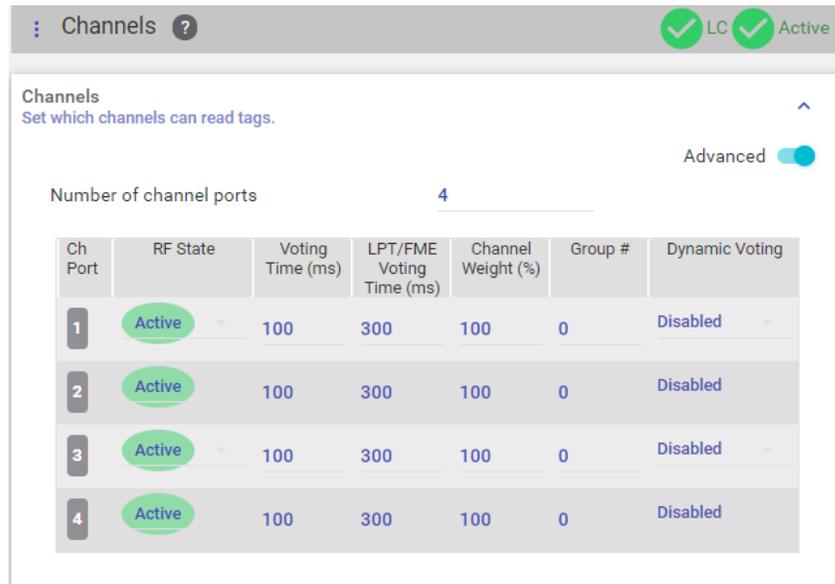
**Note:** The Reader does not need shutting down to replace an antenna.

Prerequisites: Connect a service laptop to the **Lane Controller** port to access the web interface. Refer to Connecting a service laptop to the Reader, page 34.

### Removing an antenna

1. Go to the Channels web page.

**Result:** The following screen appears.



2. Set the RF state of the direct port to **Offline**.
3. Remove the antenna.

#### ***Installing an antenna***

1. Install the antenna (see Installing an Antenna).
2. Go to the **Channels** web page.
3. Set the **Offline** Port back to **Active**.
4. Verify the ANT LED illuminates solid green.
5. Verify reader's output power and power at antenna using a commercial off-the shelf spectrum analyzer .
6. Ensure the reader is capturing OBU data.

## **RF cable or connector replacement**

Prerequisites: Connect a service laptop to the **Lane Controller** port to access the web interface.

**Note:** The Reader does not need shutting down to replace an RF cable or connector.

#### ***Removing RF cable/connector***

1. Go to the Channels web page.
2. Set the **RF State** of the Port whose cable or connector is being replaced to **Offline**.
3. Remove the RF cables or connectors.

#### ***Installing an RF cable/connector***

Prerequisites: Self-amalgamating tape for connections. Connect a service laptop to the **Lane Controller** port to access the web interface. Refer to Connecting a service laptop to the Reader, page 34.

1. Install the RF cables or connectors.
2. Apply new self-amalgamating tape to the connections.
3. Go to the **Channels** web page.
4. Set the **Offline** Port **RF State** back to **Active**.
5. Verify that the ANT LED illuminates solid green.
6. Verify reader output powers and power at antenna using a commercial off-the shelf spectrum analyzer.
7. Ensure the reader is capturing OBU data.

## Software Management

### New software/firmware

Periodically, Kapsch Service will release a new version of the Reader software (and firmware) in a single file. The software names indicate the year, month, day, and revision number of the release.

This procedure outlines how to upload the new software/firmware to the Reader so it can then be activated.

### Uploading new firmware

Prerequisites: Connect a service laptop containing a copy of the latest software/firmware to the **Lane controller** port to access the web interface.

You must have **Manage Software** permissions.

1. Go to the **Reader Software** web page.

**Result:** The following screen appears.



Software Version:	2019nov05c-MPR41
CGC Version:	MPR41_A2_190527_01
CTM ID:	0
Board:	MS-9816

**Other Available Software Versions** + ▶ 🗑️

2019oct22d-MPR41	2019oct30b-MPR41	2019nov04a-MPR41
------------------	------------------	------------------

**Update History**

2019-10-23 16:31:41	2019oct22d-MPR41
2019-11-06 18:12:20	2019oct30b-MPR41
2019-11-06 18:13:36	2019nov04a-MPR41
2019-11-07 09:40:42	2019nov05c-MPR41

**Note:** Ensure that the new software version is more recent than the active software version

2. Click the  icon button
3. Select the new software file to be loaded.
4. Click **Yes** to confirm.

**Result:** The software file will be uploaded from the computer to the Reader. When the upload is complete, the new the software will appear in the table of available software versions as INACTIVE.

**Note:** To begin using the new software, activate the software (see Activating new software).

### **Activating new software**

The currently active software version becomes inactive once another software version is activated.

The following procedures outline the steps for activating an inactive software version stored on the Reader.

Prerequisites: You must have **Manage Software** permissions. The Reader must be running normally. The required software is uploaded to the Reader (see New software/firmware , page 125).



**CAUTION:**

Activating inactive factory software/firmware on a running system is not recommended. The factory software/firmware may not be appropriate for the specific application.



**CAUTION:**

During software/firmware activation (typically less than 60 seconds), a Reader is unable to process or report transactions.

### **Software Update:**

1. Save the current configuration file, (see Saving the Reader configuration, page 127).
2. On the **Reader Software** web page. Select the inactive software version to be activated in the available software version table.
3. Click the **Activate** icon  to activate the software
4. Click **Yes** to confirm and to acknowledge that the reader will be stopped while switching to a different software version.
5. If necessary, restore the configuration file saved in step 1 (see Uploading a saved configuration, page 128).

### **Deleting software**

The Factory software and active software cannot be deleted. This procedure outlines the steps for deleting an inactive software version stored on the Reader.

Prerequisites: You must have **Manage Software** permissions.

1. On the Reader Software web page, select the inactive software version to be deleted in the available software version table.
2. Click the **Delete** icon .
3. Click **Yes** to confirm.

**Result:** The software will be deleted and will no longer appear in the software version table.

## Configuration management

### Saving the Reader configuration

Each Reader has a unique configuration file stored. This configuration file can be downloaded and saved to a computer. Use a saved configuration file to do the following.

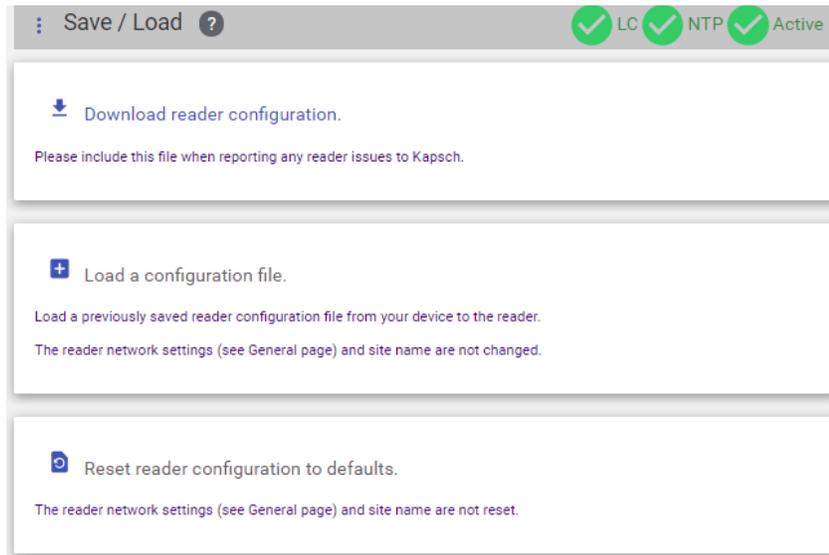
- Quickly configure another Reader requiring the same or similar configuration.
- Restore the Reader to a known configuration.
- Troubleshoot problems by comparing the current configuration to past configurations.

This procedure outlines the steps for saving the Reader configuration to a service laptop which is logged into a Reader.

Prerequisites: Connect a service laptop connected to the **Lane Controller** port to access the web interface. Refer to Connecting a service laptop to the Reader, page 34.

1. Go to **Save/Load Configuration** web page.

**Result:** The following screen appears.



2. Click the **Download reader configuration**  icon to save the new configuration.

**Note:** Different ways to save the configuration file appear depending on the web browser you use.

### Uploading a saved configuration

Uploading a saved configuration will overwrite the current Reader configuration. There are two options for uploading a saved configuration: updating all configuration settings except for the IP settings, or updating all configuration settings including the IP settings.

**Prerequisites:** A service laptop connected to the Reader LC port to access the web interface. Refer to Connecting a service laptop to the Reader, page 34.

A version of the configuration file to be loaded is saved on the service laptop connected to the Reader.

**CAUTION:**



Improper modification of configuration parameters may adversely affect system operation. The default values may not be appropriate for the specific application. It is the system integrator's responsibility to tailor the configuration parameters to the specific operating environment.

1. Go to the **Save / Load** panel on the **Configuration** web page.
2. Click the **Load a configuration file** icon  and select configuration file to be uploaded.

### Resetting the Reader configuration to the factory default

Certain field service tests use the factory default configuration. This procedure outlines how to restore the factory default values without changing the Reader IP addresses.

Prerequisites: Connect a service laptop connected to **Lane Controller Port** to access the web interface. Refer to Connecting a service laptop to the Reader, page 34.

Save the current Reader configuration, see Saving the Reader configuration, page 127.

**CAUTION:**



The factory default configuration should not be restored on a running Reader. The factory software/firmware may not be appropriate for the specific application. Save the current Reader configuration before resetting the Reader configuration to the factory default.

1. Go to the **Save/Load Configuration** Web page.
2. Click the **Reset reader configuration to defaults** icon .

**Result:** All configuration values, except for the Reader IP addresses, will change to the factory defaults.

## Administration

User administration permissions are needed when a new user account needs to be created, when an account needs to be changed, or deleted. The user can be given access to any combination of the five following access areas.

- Admin - User
- Manage Software
- Manage logs
- Change Configuration

### Creating a new user

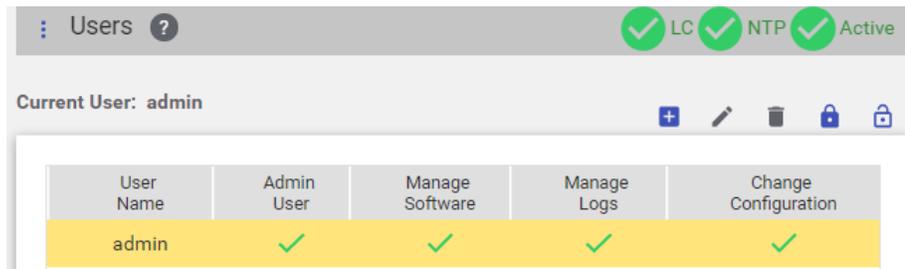
This procedure outlines how to create a new user account, and set the user permissions.

Prerequisites: Connect a service laptop connected to the **Lane Controller Port** to access the web interface. Refer to Connecting a service laptop to the Reader, page 34. You must have **User Admin** permissions.

1. Go to the Dashboard **Manage** panel. Click on the **Users** link

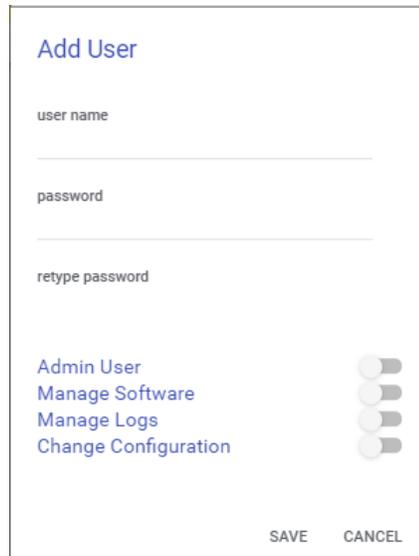


**Result:** The following screen appears.



2. To create new user click the **Add**  icon.

**Result:** The following screen appears.



The screenshot shows the 'Add User' form. It has three text input fields: 'user name', 'password', and 'retype password'. Below these are four toggle switches for permissions: 'Admin User', 'Manage Software', 'Manage Logs', and 'Change Configuration'. At the bottom, there are 'SAVE' and 'CANCEL' buttons.

3. Enter a unique user name in the **User Name** text box.
4. Enter the new user's password in the **Password** and **Confirm Password** text boxes.
5. Select **Enabled** for any of the five access areas to give the user the appropriate permissions.

- Click **SAVE** to create the new user account and return to the **Users** tab.

**Note:** If you decide not to create the user at this time, click Cancel to return to the Users tab

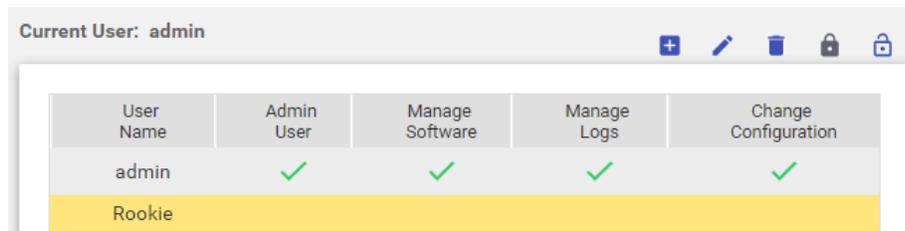
### Changing a user's access permissions

A user's access permissions are set when the user account is created. As a user's responsibilities change, they may need access to more or fewer areas of the Reader configuration. This procedure outlines how to change the access permissions of an existing user.

**Prerequisites:** Connect a service laptop connected to the **Lane Controller Port** to access the web interface. Refer to Connecting a service laptop to the Reader, page 34. You must have **User Admin** permissions.

- Go to **Users** web page.

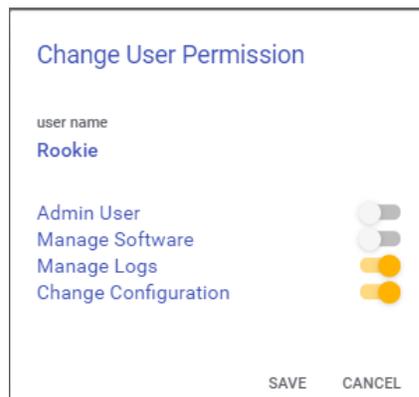
**Result:** The following screen appears.



User Name	Admin User	Manage Software	Manage Logs	Change Configuration
admin	✓	✓	✓	✓
Rookie				

- Select the user whose access permissions need changing.
- Click the **Edit** icon  to display **Change User Permission** dialog..

**Result:** The following screen appears.



**Change User Permission**

user name  
**Rookie**

Admin User

Manage Software

Manage Logs

Change Configuration

SAVE CANCEL

- After the appropriate permissions changes are made, click the **Save** button.

5. Click **Yes** to confirm.

**Note:** If you click the **Cancel** button, the permissions changes are not saved.

### ***Deleting a user***

**Note:** A deleted user will no longer be able to access the web interface.

Prerequisites: Connect a service laptop to the **Lane Controller** Port to access the web interface.

Refer to Connecting a service laptop to the Reader, page 34. You must have **User Admin** permissions.

1. Go to **Users** web page.
2. Select the user to be deleted.
3. Click the **Delete**  icon.
4. Click **Yes** to confirm

## **NTP Server**

Readers can use NTP servers to accurately regulate the time of all Readers. This procedure outlines how to enable NTP time synchronization, set IP addresses for the NTP servers, and select the time zone for display purposes.

**Note:** NTP time sync can be used when a single reader is in use, as well as multiple readers.

### ***Using an NTP Server to synchronize the clocks of Readers***

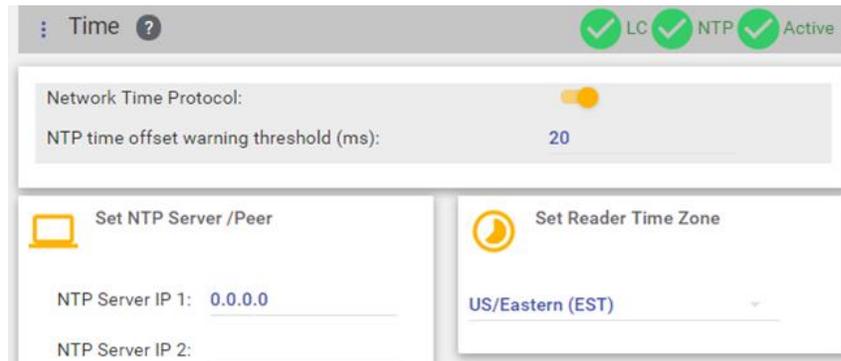
Prerequisites: The Reader must be on a network connected to the Internet. Connect a service laptop to the **Lane Controller** Port to access the web interface. Refer to Connecting a service laptop to the Reader, page 34. You must have **Change Configuration** permissions.

1. Visit <http://support.ntp.org/bin/view/Servers/StratumTwoTimeServers> to see a list of NTP servers.
2. Identify an NTP server in your geographic region (the **ISO** column) that has an **OpenAccess** policy (the **AccessPolicy** column).
3. Click on the host name of the NTP server (the **HostName** column). The **ServerForm** table appears.
4. Record the IP address of the NTP server.

**Note:** The following step is optional.

5. Repeat steps 2 through 4 to obtain a total of four (4) IP addresses, each from a different NTP server.
6. Navigate to the **Time** web page.

**Result:** The following screen appears.



7. From the **Set Time** screen, select **Enable** to enable the Reader time updates from an NTP server.
8. Enter the three unique IP addresses recorded in step 4 in the **NTP Server 1, 2 and 3** text boxes.
9. Select the appropriate time zone from the **Time Zone** drop-down list. This is for display purposes only.
10. Click the **Update NTP Setting** button.

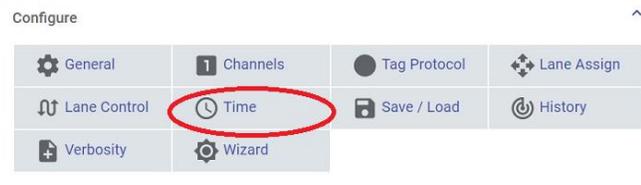
**Result:** The first available NTP server updates the Reader time.

#### **Manually setting the Reader time and date**

The Reader time can be set manually when it is not part of an Inter-Reader network. This procedure outlines how to set manually the Reader time.

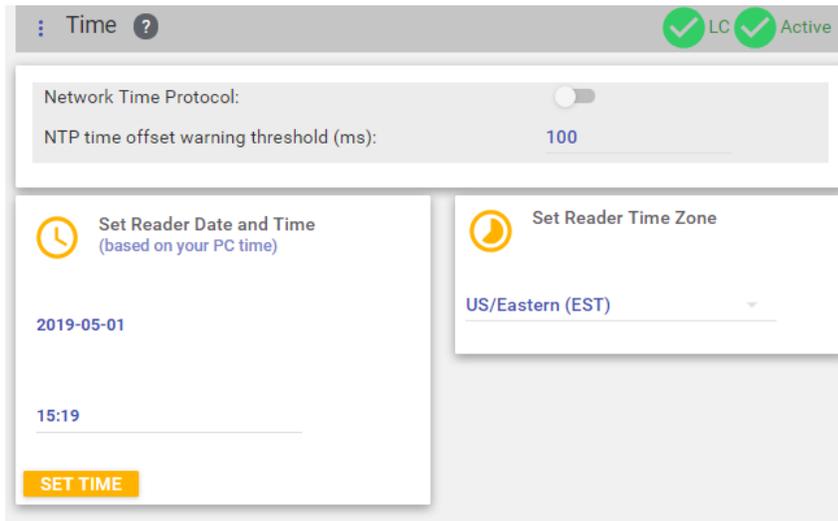
Prerequisites: Connect a service laptop to the **Lane Controller** Port to access the web interface. Refer to Connecting a service laptop to the Reader, page 34.

1. Go to the **Time** web page.



**Note:** If Network Time Protocol is enabled, you will have to disable it to set the time manually.

**Result:** The following screen appears.



2. Select a time zone.
3. Enter a numeric value for the date and time in the **Set System Time** field. The format is 'MMDDYY<space>HHMMSS', using a 24-hour clock.
4. Click the **Time** button.

**Result:** The Reader updates to the time entered in the field.

## Log files

### **Monitoring OBU transactions as they occur via the Lane Controller port**

Use the **Lane Controller** port to view OBU transactions as they occur.

Prerequisites: Connect a service laptop to the **Lane Controller** port. Refer to Connecting a service laptop to the Reader, page 34.

- see Using PuTTY to connect to the Lane Controller Port, page 137.
- 

**Note:** The operator must ensure that there is only one active connection to diag1 for any given Reader. Having more than one simultaneous diag1 connection per reader is not supported.

1. Press the **Enter** key a few times until the command prompt is displayed.
2. At the login: prompt, enter **diag1** as the user id and **diag1** as the password.

**Note:** Any OBU transactions will be displayed as they occur.

### **Saving Reader log files to a computer**

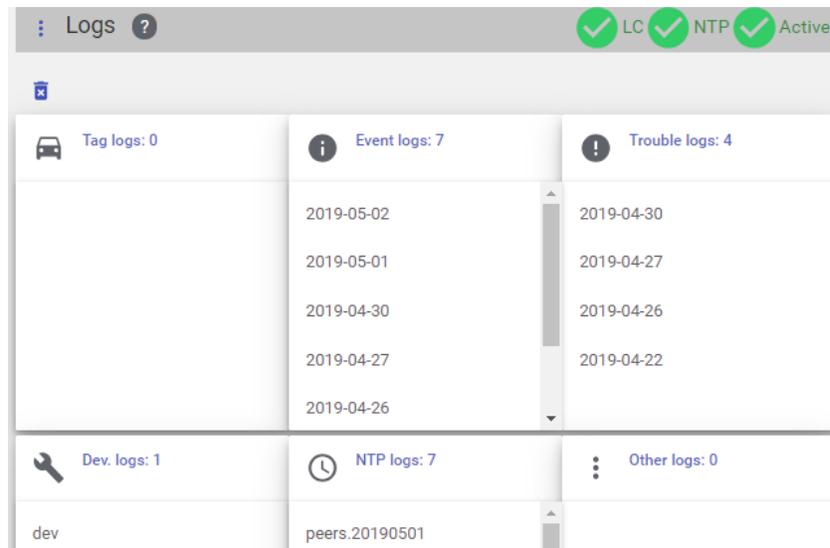
This procedure outlines how to save any log file currently saved on the Reader to a computer.

Prerequisites: Connect a service laptop to the **Lane Controller** port to access the web interface. Refer to Connecting a service laptop to the Reader, page 34.

1. Go to the **Logs** web page.

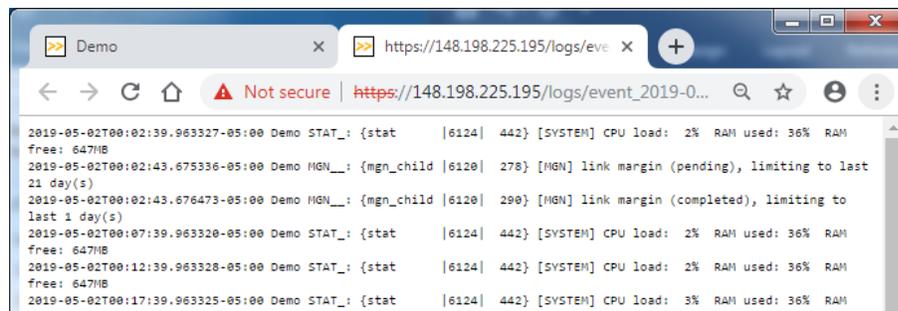


**Result:** The following screen appears.



2. Click on the log file you want to view from the list.

**Result:** The following screen appears.



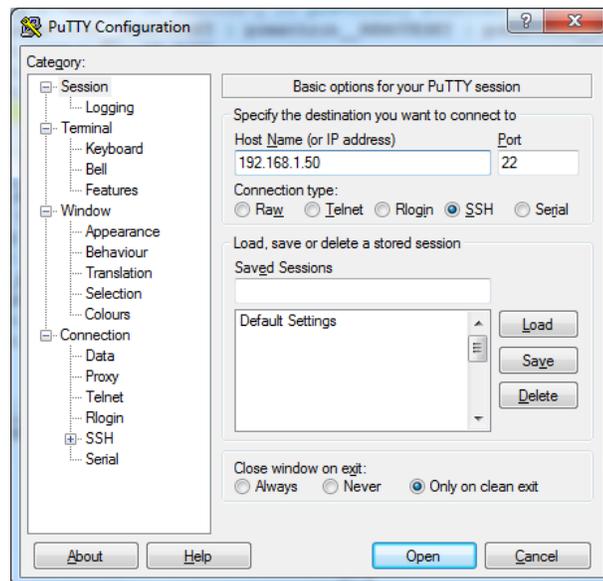
3. A new tab with the log file is opened.
4. Use print function on Browser to save file on laptop.

## Appendix A Miscellaneous

### Using PuTTY to connect to the Lane Controller Port

1. Launch PuTTY.
2. Select **SSH** as your Connection Type.
3. Enter the reader IP address of the **Lane Controller** port as specified in the **General** web pages **Reader IP Address** Field.
4. Click **Open**.

**Result:** The following configuration screen appears.



5. Console screen displays and the login prompt appear.

### Accessing Documentation

You can access the documentation package for the MPR 2.3 online at <http://dds.kapsch.ca>

A Username and Password can be obtained from Kapsch Service.

The documentation package includes the following.

- Bill of Materials
- Assembly Drawings
- Schematic Drawings

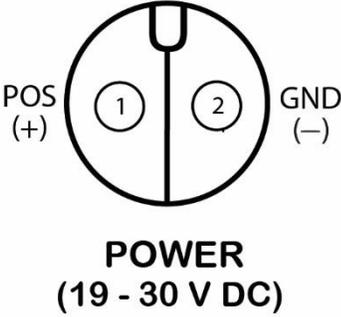
- Parts Specifications (for purchased items)
- Operator and Maintenance Manuals
- Installation Instructions
- Training slides
- Software Design Documents: Context Diagrams, Data Flows
- As-built installation drawings (services)

## Technical Specifications and Pin outs

MPR 4.1 Reader Technical Specifications		
Operation subject to FCC Site licensing (per FCC Part 90, Subpart M)		
Dimensions		
Height = 4.0 inch	Width = 15.25 inch	Depth = 19.0 inch
Weight (excluding enclosure)		
Weight 18 lbs.		
Reader Enclosure		
NEMA 4 rated		
Operating Temperature Range		
-29.2°F to +165.2°F (-34°C to +74°C).		
Power Requirements		
50W @ 19 to 30 VDC power supply. Power supply not provided.		
Software		
Latest release available at delivery. Reader ships with default configuration settings.		
Memory Capacity		
1,000,000 buffered transactions.		
RF Port Capacity		
Lane-based Ports: maximum of 4. ORT Ports: maximum of 2 (1 recommended for optimum performance).		

MPR 4.1 Ethernet Ports LC and IR pin out			
<b>Connector Type</b>			
8 pin RJ45 female, Mating connector: Kapsch P/N - 322389-124, MFG - Ghogori, MFG P/N - 33000111-02			
<b>Lightning Suppression</b>			
Recommended on all pins.			
Pin Number	Signal	Description	Diagram
1	BI_DA+	Bi-directional pair A +	
2	BI_DA-	Bi-directional pair A -	
3	BI_DB+	Bi-directional pair B +	
4	BI_DC+	Bi-directional pair C +	
5	BI_DC-	Bi-directional pair C -	
6	BI_DB-	Bi-directional pair B -	
7	BI_DD+	Bi-directional pair D +	
8	BI_DD-	Bi-directional pair D -	

Sync Port connections			
<b>Connector Type</b>			
6 Pin Circular, Mating Connector: Kapsch P/N - 322389-123, MFG - Ghogori, MFG P/N - 22006131-01			
<b>Lightning Suppression</b>			
Recommended for all signal wires.			
Terminal Number	Signal	Description	Diagram
1	CGND	chassis ground, shield	
2	R-	Sync Rx (RS-422 -)	
3	R+	Sync Rx (RS-422 +)	
4	T+	Sync Tx (RS-422 +)	
5	T-	Sync Tx (RS-422 -)	
6	CGND	chassis ground, shield	

POWER Connector pin out			
<b>Connector Type</b>			
2 Pin Circular, Mating Connector: Kapsch P/N - 322389-122, MFG - Ghogori, MFG P/N - 24002231-02			
<b>Lightning Suppression</b>			
Recommended on all pins.			
Pin Number	Signal	Description	Diagram
1	Pos+	+19 to 30VDC at the power connector of the reader.	 <p><b>POWER</b> <b>(19 - 30 V DC)</b></p>
2	Gnd-	Negative side of external power supply.	

## Antenna Specifications

Antenna	IAG 1	IAG 3
P/N	800260-011	800260-015
Description	3x3 patch	3x4 dipole array
Antenna Gain (dBi)	16 ± 1	14 ± 1
Width (inches)	34.75	34.5
Length (inches)	31.75	21.25
Thickness (inches)	2.3	3.13
Weight <sup>1</sup> (Lbs)	33	19
Mounting	Horizontal	Horizontal
Application	Standard width or ORT Lane	Standard width or ORT Lane.

<sup>1</sup> Weight specified is applicable to the antenna structure only ie. It does not include mounting hardware

### Antenna Environmental Specifications

Operating Temperature: -34C to 74C

Vibration:

Frequency	Displacement
Below 1 Hz	10 inch sway
1-4 Hz	1 inch sway
4-10 Hz	0.1 amplitude
11-15 Hz	0.03 amplitude
16-25 Hz	0.02 amplitude
26-30 Hz	0.01 amplitude
31-40 Hz	0.005 amplitude
41-50 Hz	0.003 amplitude
Shock (all direction):	15 G, 11 ms saw tooth
Wind:	160 mph
Peak Displacement:	6 inches

### RF Cable Specifications

Kapsch TrafficCom recommends the following options for RF feedline cables.

Cable P/N	Manufacturer	Loss/100ft (dB)
LMR-400DB	Times Microwave	3.966
LMR-600DB	Times Microwave	2.542
LMR 900DB	Times Microwave	1.725
LDF4-50A	Andrews	2.1

The maximum cable length is limited by the permitted cable signal loss. The maximum cable signal loss is based on the protocols selected and is limited to the lowest value in the table below of all protocols enabled.

Protocol	Maximum cable loss (dB)
TDM	11
ISO18000-6C	11
ISO18000-6B	7
SeGo	7
Allegro	7
Title 21	?
10374/ATA/AAR S-918	7

**Connectors:** Use cable assembly tools recommended by the cable manufacturer.

**Cable splicing:** No splices are allowed, must be a continuous run

**Minimum Bend Radius:** See Manufacturers recommendation

Finished connection must be weatherproofed using self-amalgamating tape

Cable that run underground or may be submersed in water must be installed in conduit with no other cables capable of inducing RFI or EMI.

## Synchronization Cable and Terminal Block specifications

An example of the wiring detail is shown in Figure 5-10: Synchronization circuit schematic for three Readers, page 95. This cable must be run in conduit and should not be run with other cables capable of inducing RFI or EMI.

### Maximum Sync Cable Length

2000 feet (607 meters) max length, sum of all Readers cable segments to hub

1500 feet (457 meters) max length, any one Reader cable segment to hub

### Sync Cable Requirements

Temperature: as required for operating environment

Environmental: as required for operating environment (must be waterproof if immersion is possible)

Capacitance: 30 pF/ft or less

Sync Wire: 3 twisted pairs (2 active, 1 spare), shielded, single or multiple drain

Wire gauge: 24 AWG (minimum)

### Sync Terminal Block

Temperature and Environmental: as required for operating environment

Number of terminals: [4 X (number of Readers in the sync group) plus 4] e.g. 3 Readers require  $(4 \times 3) + 4 = 16$

Connection: See the example diagram of a three-Reader sync hub connection in Figure 5-10, page 95.

## Spares and Tools

The following table lists the recommended spares for the MPR 4.1 reader and the Antennas.

Part Number	Description
802890-TAB	MPR 4.1 Reader
800260-011	Antenna, IAG-1
800260-015	Antenna, IAG-3

### Test Equipment

- Two-way radios
- Measuring device (Tape rule, Wheel)
- Lane marking materials (paint or other)
- Plumb bob (25ft. line length)
- Electronic Level (digital display)
- Tool kits, appropriate cables, connectors etc.

### Test Vehicles

- Bucket / Lift Platform Truck
- Passenger Vehicle (Type to be determined by Kapsch Engineering)

## Reference Documents

Doc number	Title
ICD 360479-100	Lane Controller Interface Control document
322704-TAB	Calibration Procedures
322710-077	Gold Transponder and Production Tester Calibration and Maintenance Procedure
801850-002	Front Mount Exterior (FME) Transponder Mounting Instructions for passenger vehicles
801850-004	G4 Interior Transponder Mounting Instructions
801850-005	Front Mount Exterior (FME) Transponder Roof Mounting Instructions for trucks and buses
801850-006	Motorcycle Front Mount Exterior (FME) Transponder Mounting Instructions
801850-008	G4F Feedback Interior Transponder Mounting Instructions
801850-012	G4 Transponder Secure Mount Bracket Mounting Instructions
801850-014	G4P Permanent Interior Transponder Mounting Instructions
801850-015	Flat Pack Transponder (FPT) Mounting Instructions
801850-016	Roof-Mount Flat Pack Transponder (FPT) Mounting Instructions for trucks and buses
801850-018	Commercial Vehicle Operator (CVO) Self-Test Transponder Mounting Instructions
801850-019	Front Mount Exterior (FME) Transponder Front Mounting Instructions for trucks and buses
801850-020	Motorcycle Flat Pack Transponder (FPT) Mounting Instructions

## Acronyms and Synonyms

Term	Meaning	Reference or example
AC	Alternating current	
AM	Amplitude modulation	
AWG	American wire gauge	
BGR	Badger	a Kapsch TrafficCom manufactured Reader assembly
BOM	Bill Of Material	A parts list identifying individual components in the assembly of a system module
BPS	Bits per second	Data rate, or transmission speed
CAT	Category	an Ethernet cable type
CF	Compact flash	a memory storage type
CFM	Configuration Module	Non-volatile storage device containing the Reader configuration
CGC	Port Group Controller Module	PWA board to handle the Manchester encoded RF protocol between the transponder and the Reader
CGND	Chassis ground	Common grounding mechanism for components within an enclosure or chassis. Typically earth grounded. The earth ground system must comply with the U.S. National Electrical Code (NEC) requirements for a grounding electrode.
CMOS	complementary metal-oxide semiconductor	a technology for manufacturing ICs
COM	communications	ex. COM port
computer	the service laptop computer or the LC host computer	
CPS	Cycles per second	Hertz
CPU	Central processing unit	
CRA	Cross Reader Algorithm	Badger Reader legacy algorithm (tag based) used to suppress duplicate transaction reporting to the Lane Controller
CTM	Controller Module	A plug-in module containing an assembly of CGC and MC
CTS	Clear to send	RS232 pin assignment
DA	data	
DB or dB	decibel(s)	unit of measurement of RF signal strength
DC	direct current	
DCD	Data carrier detect	RS232 pin assignment

Term	Meaning	Reference or example
DCE	Data communications equipment	RS232 port configuration, transmit is pin 2
deg.	degrees	
DIN	Deutsches Institut für Normung	German national standards organization
DSM	Distribution Module	Reader's back plane carrying DC power distributions to each module and signal connectivity between modules.
DSR	Data set ready	RS232 pin assignment
DTE	Data terminal equipment	RS232 port configuration, transmit is pin 3
DTR	Data terminal ready	RS232 pin assignment
EBX	embedded board expandable form factor	compatible with legacy PC104 form factor
EIA	Electronic Industry Association	
EMI	Electromagnetic Interference	Disturbance to radio signals and electronic circuits due to undesirable B-field emissions from an external source. See also RFI.
EMP	Electromagnetic Pulse	Strong disturbance that negates the ability of all exposed electronics in the affected area.
EN	enable	
ESD	electro-static discharge	
ESM	Ethernet Switch Module	Used to create an inter-Reader network of up to 3 Readers in ORT installations, improves Voting
ETC	Electronic Toll Collection	Collection of tolls using electronic mechanisms such as RFID tags and Readers
FCC	Federal Communications Commission	
FDM	Frequency Division Multiplexing	An RF module that is able to scan multiple OBUs from the frequency being emitted by them.
FME	Front Mount Exterior	An exterior tag in a weatherproof package mounted using the front license plate mounting holes. This item replaces the LPT tag
FPGA	Field Programmable Gate Array	the FPGA file defines the bit stream
FPT	Flat Pack Transponder	An interior tag in flat package mounted on the inside of the windshield
GND	ground	

Term	Meaning	Reference or example
HS	handshake	
HTTPS	Hypertext Transfer Protocol Secure	
Hz	Hertz	Cycles per second
I/O	input/output	
IC	Integrated circuit	
ICD	Interface Control Document	Specification of the physical interface, protocol and file formats used for messages sent between two communications components.
ID	Identity or Identifier	Group ID in RF Port configuration
IEC	International Electrotechnical Commission	
IEEE	Institute of Electrical and Electronic Engineers	Worldwide non-profit professional organization that makes voluntary, consensus-based, standards
IF	Interface	
IP	Intellectual Property or Internet Protocol	reference an asset or reference an address
IR	Inter-Reader	
IRIF	Inter-Reader interface	An Ethernet network of Readers at an ORT site
ISO	International Organization for Standardization	International standards body. Members are the national standards bodies for each country.
JRE	Java Runtime Environment	Required for some JANUS functions
LA	lane assignment	
LAN	Local Area Network	A local computer network for communication between computers
LC	Lane Controller	Controls Readers and receives data and alerts from Readers.
LCD	Liquid Crystal Display	Thin flat display device, using multi-colored pixels in front of a light source
LED	Light Emitting Diode	Used as indicators on MPR 4.1 Reader
LPT	License Plate Transponder	An exterior tag in a weatherproof package mounted using the front license plate mounting holes (a legacy product now replaced by the FME)
MC	Main Controller	Intel-x86 based single-board computer that runs the Reader software

Term	Meaning	Reference or example
N/A	not available	
NEC	National Electric Code	
NEMA	National Electrical Manufacturers Association	Sets standards for electrical components. Equipment enclosures with a NEMA rating meet a certain standard. NEMA-4 is generally considered watertight.
NTP	Network Time Protocol	
OBU	On Board Unit	Transponder or tag
ORT	Open Road Tolling	ETC from high speed vehicles that do not slow down and may straddle lanes
PC	Personal computer	
PF	Programming failure	transponder programming by the Reader
Pgm	Program or programmed or programming	context related usage
PID	Plaza ID	a configurable Reader parameter
PS	Power supply	
PSM	Power Supply Module	PWA board to provide AC/DC power to the Reader
PTO	Programming timeout	
PU	Programming unverified	transponder programming by the Reader
PWA	printed wiring assembly	All of the digital rack plug-in boards have PWAs
QMS	Quality management system	
R/W	Read / Write	
RAL	Restricted Access Location	Physical security enforced for safety and system integrity.
RAM	Random Access Memory	Data stored in this type of memory can be accessed in any order
Reader	MPR 4.1 Reader	
RF	radio frequency	Broadcast band transmission frequencies
RFI	Radio Frequency Interference	Disturbance to radio signals and electronic circuits due to undesirable E-field emissions from an external source. See also EMI.
RFID	RF Identification	An automatic Identification methodology relying on storing and retrieving data remotely using OBUs or RFID Tags (transponders) and Readers.

Term	Meaning	Reference or example
RFIF	RF Interface	Internal connection from the CTM via the DSM to the RF modules
RID	Reader ID	a configurable Reader parameter
ROM	Read Only Memory	Data, such as software, in this type of storage device cannot be modified
RSE	Roadside Equipment	The collection of all AVI equipment at the roadside, including Reader, antennas, Ethernet switches, power supplies, cables and connectors. (incorrect, only includes Reader rack)
RTS	Ready to send	RS232 pin assignment
RX or Rx	receive or receiver	Communications or RF Module functions
RXD	Transmit data	RS232 pin assignment
SGND	System ground	
SMA	Sub-miniature version A	An RF connector type
SNR or S/N	Signal to noise ratio	A comparison of desired signal to the level of background noise.
SSH	Secure shell	
SSL	Secure sockets layer	Internet site security access via certificates
Sync	Synchronization	
TAB	Tabulation	System of indexing used for variations of assembly drawings. A drawing number ending in the suffix "-TAB" will have a list of all other variations of the drawing (can be from -001 to -999).
TC	Toll collection	a Reader application
TCP	Toll Collection Programming	Software modules used to collect tolls
TCP/IP	Transmission Control Protocol/Internet Protocol	The Internet Protocol Suite is the set of protocols used for the Internet, and other systems or Intranets
TDM	Time Division Multiplexing	An RF module that is able to scan OBUs through time sequencing by using time difference between one OBU and another.
TM	Traffic management	a Reader application
TMP	Traffic Management Programming	Software modules used for traffic management
TTO	Transponder timeout	
TX or Tx	transmit or transmitter	Communications or RF Module functions
TXD	Transmit data	RS232 pin assignment

Term	Meaning	Reference or example
UDP	User Datagram Protocol	an Internet protocol that is faster than TCP but offers no error correction
UL	Underwriter Laboratories	Underwriter Laboratories Inc.
URL	Uniform resource locator	
USB	Universal Serial Bus	Standard protocol for peripherals, enables plug-and-play
UTC	Coordinated Universal Time	the time standard used to regulate time around the world
VAC	Voltage AC	
VDC	Voltage DC	
VSWR	Voltage Standing Wave Ratio	

## Glossary

Name Term or Component	Alias or explanation
Capture Zone	An area where an OBU is detected by the Reader.
Capture Zone Span Time	The amount of time it takes an OBU to pass through a capture zone.
Port	One RF Port
Dummy frame	A time interval placeholder
Dynamic voting	<p><b>Channels</b> page Voting algorithm. If the dynamic voting algorithm is set to anything other than "Disabled", the Reader generates a transaction report at some period in time (called the "Voting timeout") after the initial read of an OBU. The voting timeout is configured on the web interface <b>Channels</b> page. The voting timeout is either;</p> <ol style="list-style-type: none"> <li>1. Set manually by the operator, or</li> <li>2. dynamically set according to prevailing traffic speeds on a Port-by-Port basis.</li> </ol>
Earth ground system	The earth ground system must comply with the U.S. National Electrical Code (NEC) requirements for a grounding electrode.
Express Lane - Wide	No barriers between lanes, straddle antennas required. Same as ORT
feedline	The cable that carries the RF signal to or from the antenna. Also called transmission line.
frame	one scan of an RF Port. There can be a maximum of eight frames for one Reader
Format Incompatible report	A report sent to the Lane controller, generated when a non-TDM tag is seen by the Reader.
Host Computer	Not supplied by Kapsch TrafficCom. Computer used to monitor/control the LC within the Toll Plaza. The Reader is accessible to a Toll Plaza Host computer (if available) via the web interface.
Inter-Reader network	An Ethernet network of Readers at an ORT site used for ORT installations having more than 8 regular-width lanes (or 5 wide lanes) in one direction
Lane assignment	The process of providing a transaction report to the lane controller, with the intent of correctly identifying the lane of travel of the transponder equipped vehicle. The overall goal is high programming success rate, high lane assignment accuracy, and low consistent reporting latency.
Majority (Voting)	Lane Assignment tab Voting algorithm
Plaza	Structure for toll collection, typically with barriers between lanes and canopy overhead. Vehicles slow for ETC.
Reader	Generic term for the MPR 4.1 Reader in this manual

Name Term or Component	Alias or explanation
Service Laptop Computer	Service tool used to configure, setup, troubleshoot, and monitor the Reader.
Skip-on-sync	Skip-on-sync indicates what protocol the reader should start reading next.
Superframe	A configuration used for MPR 4.1 and earlier versions of Reader software. The total number of frames that can be scanned in a Reader.
Status File	OBU Account Status File supplied by the client and made available in the lane controller for download to the Reader.
Tag	Transponder or OBU
Transponder	Tag or OBU
Voting Time	Represents the time delay after the initial read of the tag, at which point the Reader determines the lane assignment for the OBU in the transaction report sent to the lane controller.
Wide lane	A standard-width lane is 10 to 12 feet wide. Wide lanes are 12 to 14 feet wide.

## Appendix B FCC Approved Port Frequencies and Selection

The frequency plan used at a toll site is dependent on the antenna spacing rules, local RF interferers and the approved FCC (or other applicable regulatory body) frequencies.

Reader FCC ID JQU 802890 are approved for 30W ERP radiated power by the FCC for the following protocols.

**JQU802890 – FCC Approved Frequencies**

FDM Protocols	902-904 MHz Sub-Band	909.75-921.75 MHz Sub-Band
ATA	902.5-903.5	910-921.5
6B	903	910.5-920.5
SeGo	n/a	911-920
6C	903	910.5-920.5
Title 21	n/a	915.75
TDM	n/a	915.75

In addition the following rules apply for FDM protocols:

The same Port frequency should not be used on adjacent lanes, including straddle and shoulder lanes (recommended at least 24 ft separation between in-line antennas and 21 ft. separation between staggered arrangement antennas).

The frequency spacing used shall be at least 2.5 MHz between adjacent antennas (i.e. in-line or straddle antennas).

For 6C read in ORT an in-line configuration can be used. For all other FDM protocols in ORT and for 6C write in ORT a staggered configuration should be used.

For the in-line and staggered antenna configurations outlined in, page 86, this means that a 4 or more frequency plan (i.e. can repeat every 5<sup>th</sup> antenna) must be used for in-line configurations and a 3 or more frequency plan (i.e. can repeat every 4<sup>th</sup> antenna) must be used for staggered configurations.

For example within the FCC limits and a staggered ORT antenna configuration a suitable selection can be made that covers all protocols with the following ranges

F1	F2 (+2.5 MHz)	F3 (+5.0 MHz)
911.5 to 914.5	914 to 917	916.5 to 919.5

For example using this, a larger 7 Port frequency plan can be easily realized without re-use and respecting all the rules on a staggered site.

Antenna #	1	2	3	4	5	6	7
Position	Main	Straddle	Main	Straddle	Main	Straddle	Main
Frequency	911.5	914	916.5	919	913	915.5	918

## Appendix C UI Reader Indicators

The User Interface can report the following problems at a glance:

	Indicates a problem with one or more lane (zone) controllers or the connections to those lane (zone) controllers.
	Indicates problem with Reader to Reader Synchronization.
	Indicates the reader's time offset while NTP is enabled is higher than the configured maximum limit.
	Indicates a problem with the reader Channel Group Controller (CGC). The reader software automatically attempts to resolve this issue.
	Indicates a problem with the Reader frame sequence configuration. For example, an empty frame sequence can trigger this.
	Indicates a problem connecting with adjacent readers via the Inter-Reader (IR) network.
	The reader CPU load is high (above 50%).
	The reader CPU load is extreme (above 80%).
	The browser UI can't communicate with the reader. Trouble shoot: Check if the reader has been powered off.

	<p>Primary CTM configuration is mirrored to Secondary CTM.</p>
	<p>Reader configuration Compare operation is in progress.</p>

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## Appendix D Command and Controls

Table 7-1 lists and describes the commands and controls that can be deployed in the various Configuration screens that are available to a user.

**Note 1:** In the table, 0 = Disable, 1 = Enable

**Note 2:** Parameter name is the name of a parameter in the text configuration file that can be saved or loaded to reader, see Saving the Reader configuration, page 127

**Note 3:** The parameters available in some screens, or the ability to change them, in some cases are dependent on enabling other settings in the same screens first.

**Note 4:** The parameters available in some screens, or the ability to change them, in some cases are dependent on enabling settings in other screens first.

**Note 5:** Dashboard page shows all the available web pages while menu Icon only shows short cuts to commonly accessed web pages.

**Table 7-1: Commands and Controls**

Command	How to execute	Who can execute	Parameter Name	Default Value	Parameter Range	Purpose of command
Dashboard	Click Kapsch icon on the top left corner in banner to go to Dashboard.	anyone	N/A	N/A	N/A	Displays the <b>Dashboard</b> in the CTM web interface.  Used to show all available web pages for accessing.

Command	How to execute	Who can execute	Parameter Name	Default Value	Parameter Range	Purpose of command
Configuration	In <b>Configure</b> panel, click any link to view / change reader settings.	anyone can view but only user with <b>Change Configuration</b> permissions can edit	N/A	N/A	N/A	Displays the selected configuration page in the CTM web interface.  Used to access a variety of Reader configuration parameters.
Maange Reader Software	In Manage panel, click Reader SW link.	user with Manage Software permissions	N/A	N/A	N/A	Displays the <b>Reader Software</b> page in the CTM web interface.  Used to access upload and verify, activate, and delete software commands.
Manage Users	In Manage panel, click Users link.	user with <b>User Admin</b> permissions	N/A	N/A	N/A	Displays the <b>Users</b> page in the CTM web interface.  Used to access user profiles, create new users, delete users, change permissions, change passwords.

Command	How to execute	Who can execute	Parameter Name	Default Value	Parameter Range	Purpose of command
View Log Files	In Manage panel, click <b>Logs</b> link.	anyone	N/A	N/A	N/A	Displays the Logs page in the CTM web interface.  Views or manages log files depending on user permissions.
View Status	In Manage panel, click <b>Status</b> link.	anyone	N/A	N/A	N/A	Displays the <b>Status</b> page in the CTM web interface.  Used to monitor communication, power supply, CTM status and CGC health
Restart	In Manage panel, click the <b>Restart</b> link.	anyone	N/A	N/A	N/A	Restart the Reader application. This takes faster than reboot.
Reboot	In Manage panel, click the <b>Reboot</b> link.	anyone	N/A	N/A	N/A	Reboot the Reader.

Command	How to execute	Who can execute	Parameter Name	Default Value	Parameter Range	Purpose of command
Shutdown	In Manage panel, click the <b>Shutdown</b> link.	anyone	N/A	N/A	N/A	Shutdown the Reader. Need to manually power cycle the Reader to start again.
System Identification	In Manage panel, click Identify link.	anyone	N/A	N/A	N/A	Causes the CTM MC LED to flash green-red-amber-green three times.  Used to confirm which CTM web interface is being viewed and that the computer is successfully communicating with.

General Page

Command	How to execute	Who can execute	Parameter Name	Default Value	Parameter Range	Purpose of command
General Page: Site Information Panel						
Site Name	Type a Reader name in <b>Site Name</b> field.	user with <b>Change Configuration</b> permissions	SITENM	no default value	String length: 32	Sets the site name used in the log file strings and is used in the name of the configuration files  <b>Highly recommend</b> to enter a descriptive name, as this name is used in various log files. Used to identify which Reader the log files and configuration files originated from

Command	How to execute	Who can execute	Parameter Name	Default Value	Parameter Range	Purpose of command
Site Type	Select sign type in drop-down list.	user with <b>Change Configuration</b> permissions	SITETY	Plaza	Plaza ORT (with straddle antennas) ORT (no straddle antennas) ORT staggered Lab / table-top demo	This provides an indication of the site configuration which is intended to help site maintainers. This is also used in the setup wizard to provide certain parameter defaults.
General Page: Network Panel						
Reader IP Address	Type an ETHERNET 1 port IP address in Reader IP Address field.	user with <b>Change Configuration</b> permissions	LETHIF	192.168.1.50	N/A	Sets the IP address of the Lane Controller Ethernet interface  Used to specify an appropriate ETHERNET 1 IP address when configuring an LC network

Command	How to execute	Who can execute	Parameter Name	Default Value	Parameter Range	Purpose of command
Reader IP Subnet Mask	Type the subnet mask in the Reader IP Subnet Mask field.	user with <b>Change Configuration</b> permissions	LETHNM	255.255.255.0:0	N/A	Initializes this field to a subnet mask for sites that utilize subnet addressing.  Required by sites that utilize subnet addressing.
Default Gateway IP	Type an IP address in the <b>Default Gateway IP</b> field	user with <b>Change Configuration</b> permissions  <b>Note:</b> Initialize this field to a IPv4 address if IP traffic needs to be routed via a gateway.	DFGWIP	0.0.0.0:0	N/A	Tells the Reader the default gateway IP address of the gateway device  Used to allow the Reader on a network to connect to a larger network (such as the Internet) via a gateway device (such as a router)
General Page: SNMP Panel						

Command	How to execute	Who can execute	Parameter Name	Default Value	Parameter Range	Purpose of command
SNMP Traps	Toggle switch to enable /disable SNMP trap.	user with <b>Change Configuration</b> permissions	CSTRAP	0	0 - 1	Configure whether the reader sends SNMP traps on status changes.
TRAPIP 1	Type in a SNMP Trap destination IP address and port in field.	user with <b>Change Configuration</b> permissions	TRAPIP	Ip 0.0.0.0 and port 162	N/A	Sets IP address and Port of the 1 <sup>st</sup> SNMP Trap destination.  Used to send a trap to this destination. Set to 0.0.0.0 to disable this destination. By default traps are sent to port 162.
TRAPIP 2	Type in 2 <sup>nd</sup> SNMP Trap destination IP address in field.	user with <b>Change Configuration</b> permissions	TRAP_2	Ip 0.0.0.0 and port 162	N/A	Send a simultaneous trap to this 2 <sup>nd</sup> destination. Set to 0.0.0.0 to disable this destination.

Command	How to execute	Who can execute	Parameter Name	Default Value	Parameter Range	Purpose of command
TRAPIP 3	Type in 3 <sup>rd</sup> SNMP Trap destination IP address in field.	user with <b>Change Configuration</b> permissions	TRAP_3	Ip 0.0.0.0 and port 162	N/A	Send a simultaneous trap to this 3 <sup>rd</sup> destination. Set to 0.0.0.0 to disable this destination.
General Page: Reader Statistics Panel						
Statistics retention period (7-90 days)	Enter the appropriate quantity in field	user with <b>Change Configuration</b> permissions	SDSRET	30	7 - 90	Use to specify how many days transaction summary data is retained.

Command	How to execute	Who can execute	Parameter Name	Default Value	Parameter Range	Purpose of command
Statistics summary interval (1-30 minutes)	Enter the time interval in minutes.	user with <b>Change Configuration</b> permissions	SDSINT	15	1 - 30	<p>Generates transaction summary records into database at specified time interval. Values below 5 minutes for testing only. May be automatically adjusted by reader based on load and retention period</p> <p>Generates transaction summary records into database at specified time interval.</p>

## Channels Page

(set Advanced toggle switch to ON to show more settings)

Command	How to execute	Who can execute	Parameter Name	Default Value	Parameter Range	Purpose of command
RF State	Select state of RF module from the drop down menu for each channel.	user with <b>Change Configuration</b> permissions	RF_STS	Offline	Offline Active Guard	Offline means the MRFM-S module is off.  Active means the MRFM-S module is on and reports transactions on this channel.  Guard means MRFM-S module is on, but transactions assigned to this channel are not reported.
Voting Time (ms)	Type the voting time in ms for each channel.	user with <b>Change Configuration</b> permissions	VOTETO	100	0-9999	Specifies the time after the initial entry of the transponder into the capture zone at which a VOTE report is generated. A value of 0 means no voting, subject to the Programming Timeout parameter.

Command	How to execute	Who can execute	Parameter Name	Default Value	Parameter Range	Purpose of command
LPT/FME Voting time (ms)	Type the voting time in ms for each channel.	user with <b>Change Configuration</b> permissions	LPTVTO	300	0-9999	Specifies the time after the initial entry of the transponder into the capture zone at which a VOTE report is generated. This is a trade-off between lane assignments versus latency. A value of 0 means no voting, subject to the Programming Timeout parameter. Specific to [L]icense [P]late [T]ags and (F)ront (M)ount (E)xterior tags only.
Channel Weight (%)	In Advanced mode: Type the channel weight as a percent for each channel.	user with <b>Change Configuration</b> permissions	RFWGHT	100	0-100	Enter a value from 0 to 100. At lane assignment time, the reader applies the weighting factor to all channels seeing the same transponder in a group. A channel weight of 50 means only half of the

Command	How to execute	Who can execute	Parameter Name	Default Value	Parameter Range	Purpose of command
						handshakes are used in comparing with adjacent channels. Typically a value other than 100 is used only for channels that straddle two physical lanes.
Group #	In Advanced mode: Type the (voting) Group ID for each channel.	user with <b>Change Configuration</b> permissions	RFGPID	0	0-7	By default all channels are in one group, such that any cross lane reads within the group generate only one transaction. By specifying different (voting) group IDs, multiple independent capture zones can be created. This is useful for certain applications.
Dynamic Voting Control	In Advanced mode:	user with <b>Change</b>	DVCTRL	Disabled	Disabled Reader	Disabled: no voting control

Command	How to execute	Who can execute	Parameter Name	Default Value	Parameter Range	Purpose of command
	Select Disabled or Reader from the Dynamic voting control drop-down list (LC Speed and LC Ends are not supported).	<b>Configuration</b> permissions			LC Speed LC End	Reader: the Reader monitors the average time an OBU is in the capture zone and uses this time to determine an appropriate voting time.  LC Speed: not currently supported.  LC End: not currently supported.  To set type of voting control.
<b>Channels Page: Dynamic Voting Panel</b> (this panel will appear when Dynamic Voting Control is not in Disabled mode)						
Dynamic Voting Sample Size	With Dynamic Voting Control for a channel set to Reader, enter the desired number of samples in field.	user with <b>Change Configuration</b> permissions	DVSPSZ	20	1-50	Sets the sample size used in the Dynamic Voting Calculation.  To configure the Dynamic Voting Control calculation. The number entered here is the number of previous transactions used when

Command	How to execute	Who can execute	Parameter Name	Default Value	Parameter Range	Purpose of command
						calculating the average voting time.
Dynamic Voting Threshold [%]	With Dynamic Voting Control for a channel set to Reader, enter the voting threshold percentage in field.	user with <b>Change Configuration</b> permissions	DVTHSD	20	5-100	Sets the voting threshold percentage  To configure when the average Voting time is adjusted. The Voting time will only be updated when the Reader determines the percent change is larger than the threshold entered here.
Dynamic Voting Capture Zone Span Multiplier	With Dynamic Voting Control for a channel set to Reader, enter a voting time multiplier in field.	user with <b>Change Configuration</b> permissions	DVCZTM	2	1-5	Sets the Capture Zone Span Time multiplier  Determines when the Reader checks for voting time updates.
Channels Page: Group Panel						

Command	How to execute	Who can execute	Parameter Name	Default Value	Parameter Range	Purpose of command
Transponder Timeout	Enter a time, in seconds, for each voting group.	user with <b>Change Configuration</b> permissions	GRPTTO	300	1-300	Sets the amount of time an OBU must be out of a capture zone before communication with the OBU is reported as a new transaction
Programming Timeout (ms)	Enter a time in ms for each voting group.	user with <b>Change Configuration</b> permissions	GRPPTG	300	1-300	This field will be shown when any channel has Voting time or LPT/FME Voting time equals to 0.  If programming is not successful the reader will keep trying until the programming timeout value (in milliseconds) is reached.

Tag Protocol Page

Command	How to execute	Who can execute	Parameter Name	Default Value	Parameter Range	Purpose of command
Frame Sequence	Click the <b>Add</b> icon and select a tag protocol from the drop-down list.	user with <b>Change Configuration</b> permissions	FRSEQ1	Empty (0)	Empty (0) Dummy_1 (1) Dummy_2 (2) Dummy_3 (3) Dummy_4 (4) Sync_1 (5) Sync_2 (6) Sync_3 (7) Sync_4 (8) TDM (9) SeGo (12) 6B (13) 6C (14) ATA (15) Title21 (17)	Specifies the Frame Sequence Slot protocol/function.  Used to specify the protocol firing and/or the Synchronization Sequence of the Reader.  Sync is NOT allowed to be the 1 <sup>st</sup> in frame sequence.  Only after Dummy_1 is selected will Dummy_2 appear in drop-down list for selection and so on.  Same to Sync. Only after Sync_1 is selected will Sync_2 appear in drop-down list for selection and so on.

Command	How to execute	Who can execute	Parameter Name	Default Value	Parameter Range	Purpose of command
Tag Protocol Page: Attenuation, Frequency and Time Slot Panel						
Rx Attenuation (dB)	Select a protocol from the Frame Sequence. For each channel, input a number in the <b>Rx Attenuation</b> table column.	user with <b>Change Configuration</b> permissions	TA6RX1 TA6RX3 FA6RX1 FA6RX2 FA6RX3 FA6RX4	5	0 - 31	Set the tag protocol receive attenuation. 0 means maximum sensitivity. Not applicable to Dummy and Sync.
Tx Attenuation (dB)	Select a protocol from the Frame Sequence. For each channel, input a number in the <b>Tx Attenuation</b> table column.	user with <b>Change Configuration</b> permissions	TA6TX1 TA6TX3 FA6TX1 FA6TX2 FA6TX3 FA6TX4 DA6TX1	0	0 - 31	Set the tag protocol transmit attenuation. 0 means maximum sensitivity. Not applicable to Sync. Apply to Dummy as Dummy (CW) transmit attenuation.

<p>Frequency (MHz)</p>	<p>Select a protocol from the Frame Sequence. For each channel, select a frequency from the drop-down list in the <b>Frequency</b> table column.</p>	<p>user with <b>Change Configuration</b> permissions</p>	<p>IAGFRQ T21FRQ SGOFRQ I6BFRQ I6CFRQ ATAFRQ DUMFRQ</p>	<p>915.75 (15) 915.75 (15) 902.50 (0) 902.50 (0) 902.50 (0) 902.50 (0) 902.50 (0)</p>	<p>902.50 (0), 903.00 (1), 903.50 (2), 910.00 (3), 910.50 (4), 911.00 (5), 911.50 (6), 912.00 (7), 912.50 (8), 913.00 (9), 913.50 (10), 914.00 (11), 914.50 (12), 915.00 (13), 915.50 (14), 915.75 (15), 916.00 (16), 916.50 (17), 917.00 (18), 917.50 (19), 918.00 (20), 918.50 (21), 919.00 (22), 919.50 (23), 920.00 (24), 920.50 (25), 921.00 (26), 921.50 (27)</p>	<p>Specify the tag protocol frequencies.  For TDM protocol, the frequency is fixed at 915.75  For FDM protocols, ensure 2.5 MHz channel spacing for adjacent channels.</p>
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Command	How to execute	Who can execute	Parameter Name	Default Value	Parameter Range	Purpose of command
Time Slot enable	When a FDM protocol (6B, 6C, SeGo, ATA) is selected from the Frame Sequence, set toggle switch to ON in <b>Time Slot</b> table column to enable firing for each channel.  For TDM /Title 21 protocol, see the <b>Channel Firing Sequence</b> panel in below.	user with <b>Change Configuration</b> permissions	6C_TSC SGOTSC 6B_TSC ATATSC	0	0-1	For FDM protocol, specify the tag protocol channel/slot firing sequence.
<p><b>Tag Protocol Page: Channel Firing Sequence Panel</b> (this panel expands <b>Time Slot enable</b> in above and will appear when TDM or Title 21 protocol is selected)</p>						

Command	How to execute	Who can execute	Parameter Name	Default Value	Parameter Range	Purpose of command
Time Slot enable	When TDM or Title 21 protocol is selected from the Frame Sequence, for each channel, select checkbox in time slot to enable firing.	user with <b>Change Configuration</b> permissions	IAGTSC T21TSC	0	00-FF (hex) where each bit represents one time slot	For TDM /Title 21 protocol, specify which channel transmits in each time slot. Normally, channel 1 transmits in slot 1, channel 2 in slot 2, etc.

## TDM Protocol

(select TDM protocol in Frame Sequence panel)

Command	How to execute	Who can execute	Parameter Name	Default Value	Parameter Range	Purpose of command
Tag Protocol Page: TDM Advanced Panel						
RxR Autoread	Set toggle switch to ON to enable autoread.	user with <b>Change Configuration</b> permissions	RxRARD	0	0-1	When enabled, the reader schedules 2 TDM reads back to back instead of one, which increases handshake counts. This feature is only available for the TDM protocol.
Suppress Non-TDM Tags	Set toggle switch to ON to suppress non-TDM tags.	user with <b>Change Configuration</b> permissions	NONIAG	1	0 - 1	Used to suppress reporting of non-IAG tags (i.e. tags whose encoded group ID is not 65) from being sent to the LC.  <b>Disabled:</b> All transactions are reported  <b>Enabled:</b> Suppresses reporting of OBUs not matching the TDM protocol Group ID with which the Reader is provisioned

Command	How to execute	Who can execute	Parameter Name	Default Value	Parameter Range	Purpose of command
Tag Protocol Page: TDM Tag Programming Panel						
TDM Read-Only Mode	Set <b>Enable</b> toggle switch to ON to enable write and OFF for TDM Read-Only Mode.	user with <b>Change Configuration</b> permissions	RONLY	0	0-1	Controls whether the reader writes or does not write to TDM tags.
Group ID	Group ID (cannot be changed)	No one	RDRGID	0	0-255	Set the Group ID
Plaza ID	Enter a numeric Plaza ID.	user with <b>Change Configuration</b> permissions	PID__	0	0-127	Set the Plaza ID which will be written into the TDM OBU read/write memory as it goes through the capture zone. Must be unique between plaza installations when using legacy TDM Cross Reader Algorithm (CRA) between adjacent readers.

Command	How to execute	Who can execute	Parameter Name	Default Value	Parameter Range	Purpose of command
Agency ID	Enter a numeric Agency ID.	user with <b>Change Configuration</b> permissions	AID___	0	0 - 127	Set the agency ID which identifies the host agency. The agency ID will be written into the TDM OBU read/write memory as it goes through the capture zone. This identifies the last agency writing to the TDM OBU.
Reader ID	Enter a numeric Reader ID.	user with <b>Change Configuration</b> permissions	RID___	0	0 - 4095	Set the reader ID which will be written to the TDM OBU read/write memory as it goes through the capture zone, if Traffic Management or Cross Reader Algorithm (Classic) is enabled. Make sure a unique Reader ID is used when there are multiple readers at a plaza.

Command	How to execute	Who can execute	Parameter Name	Default Value	Parameter Range	Purpose of command
<b>Lane Number</b> (channel assignment)	Enter a numeric value in each channel number field.	user with <b>Change Configuration</b> permissions	RFLNUM	Per-instance defaults. Instance:0 value:1  instance:1 value:2  .  .  instance:30 value:31	0-31	Indicate in OBU data which lane an OBU was in when a transaction occurred. Assigns a lane number to each channel. <b>ATTENTION:</b> this field should be used with care as the value may not reflect the channel on which the tag was reported.
<b>Tag Protocol Page: Traffic Management Programming (TMP) Panel</b> (this panel is editable when the reader is NOT in TDM Read-Only Mode)						
Enable TMP	Set <b>Enable</b> toggle switch to ON to enable TMP.	user with <b>Change Configuration</b> permissions	TMP__	1	0-1	Control if traffic management fields will be written to OBUs.  <b>Disabled:</b> Reader does not update traffic management fields.

Command	How to execute	Who can execute	Parameter Name	Default Value	Parameter Range	Purpose of command
						<b>Enabled:</b> Reader updates traffic management fields.
Reader ID	Set toggle switch to ON to enable write on Reader ID field in tag.	user with <b>Change Configuration</b> permissions	rw_RID	1	0-1	Determines whether or not to program the TM-DATA reader ID field of the tag's R/W area.
TM Date/Time	Set toggle switch to ON to enable write on TM Date/Time field in tag.	user with <b>Change Configuration</b> permissions	rwTMDT	1	0-1	Determines whether or not to program the TM-DATA date/time fields of the tag's R/W area.
<b>Tag Protocol Page: Toll Collection Programming (TCP) Panel</b> (this panel is editable when the reader is NOT in TDM Read-Only Mode and TCP is enabled)						
Enable TCP	Set <b>Enable</b> toggle switch to ON to enable TCP.	user with <b>Change Configuration</b> permissions	TCP___	1	0-1	Control if toll collection fields will be written to OBUs.

Command	How to execute	Who can execute	Parameter Name	Default Value	Parameter Range	Purpose of command
						<p><b>Disabled:</b> Reader is not permitted to update toll collection fields in OBUs.</p> <p><b>Enabled:</b> Reader is permitted to update toll collection fields in OBUs.</p>
Plaza ID (enable)	Set toggle switch to ON to enable write.	user with <b>Change Configuration</b> permissions	rwPZID	1	0-1	Determines whether or not to program the TC-DATA plaza ID field of the tag's R/W area.
Agency ID (enable)	Set toggle switch to ON to enable write.	user with <b>Change Configuration</b> permissions	rw_AID	1	0-1	Determines whether or not to program the TC-DATA agency ID field of the tag's R/W area.
Transaction number programming (enable)	Set toggle switch to ON to enable write.	user with <b>Change Configuration</b> permissions	rw_TXN	1	0-1	Determines whether or not to program the TC-DATA transaction number field of the tag's R/W area.

Command	How to execute	Who can execute	Parameter Name	Default Value	Parameter Range	Purpose of command
Transaction number programming format	Select the appropriate calculation method from the drop-down list.	user with <b>Change Configuration</b> permissions	TFRM__	Reprogram with 16 bit sequential transaction number. (2)	Do not reprogram transaction field. (0) Reprogram with 16 bit random number. (1) Reprogram with 16 bit sequential transaction number. (2) Reprogram with 8 bit random number and 8 bit sequential number. (3)	Set the way the Reader creates an OBU transaction number.
TC Date/Time (enable)	Set toggle switch to ON to enable write.	user with <b>Change Configuration</b> permissions	rwTCDT	0	0-1	Determines whether or not to program the TC-DATA date/time field of the tag's R/W area.

Command	How to execute	Who can execute	Parameter Name	Default Value	Parameter Range	Purpose of command
TC RW Format (enable)	Set toggle switch to ON to enable write.	user with <b>Change Configuration</b> permissions	rw__RW	0	0-1	Determines whether or not to program the TC-DATA RW format field of the tag's R/W area.
TC Lane Number (enable)	Set toggle switch to ON to enable write.	user with <b>Change Configuration</b> permissions	rwLANE	1	0-1	Determines whether or not to program the TC-DATA lane field of the tag's R/W area.
HOT (High Occupancy Toll) lane enable	With <b>HOT Lane</b> enabled, select the <b>HOT Lane Enable</b> check box for each channel starting from left to right.	user with <b>Change Configuration</b> permissions	HOT_LN	0	0 - 1	Determines whether or not to program the HOT/HOV lane field of the tag's R/W area.
<b>Tag Protocol Page: OBU Feedback Panel</b> (this panel is editable when the reader is NOT in TDM Read-Only Mode and TCP is enabled)						
OBU Feedback (enable)	Set toggle switch to ON to enable write.	user with <b>Change Configuration</b> permissions	rw_OBU	0	0-1	Determines whether or not to program the TC-DATA OBU feedback fields of the tag's R/W area.

Command	How to execute	Who can execute	Parameter Name	Default Value	Parameter Range	Purpose of command
OBU Feedback type	With <b>OBU feedback</b> enabled, select <b>Type 1</b> or <b>Type 2</b> from drop-box menu.	user with <b>Change Configuration</b> permissions	OBU TYP	Type 1 (0)	Type 1 (0) Type 2 (1)	Specifies which type of OBU feedback to employ:  <b>TYPE1:</b> all tags provide the same feedback. <b>TYPE2:</b> per-tag feedback based on previously downloaded OBU Status File.
OBU Feedback Type 1						
OBU Audible Feedback	With <b>OBU feedback Type 1</b> selected, select a feedback option from the <b>OBU Audible Feedback</b> drop-down list.	user with <b>Change Configuration</b> permissions	OBU AUD	Off (0)	Off (0) 4 cycles: 0.25s ON, 0.25s OFF (1) 1 cycle: 1.5s ON (2) 3 cycles: 0.5s ON, 0.2s OFF (3)	Enable or disable audible OBU feedback.

Command	How to execute	Who can execute	Parameter Name	Default Value	Parameter Range	Purpose of command
OBU Visual Feedback	With <b>OBU feedback</b> enabled and <b>Type 1</b> selected, select a feedback option from the <b>OBU Visual Feedback</b> drop-down list.	user with <b>Change Configuration</b> permissions	OBUVIS	Off (0)	Off (0) Green: 2s (1) Red: 2s (2) Yellow: 2s (3)	Enable or disable visual OBU feedback.
<b>OBU Feedback Type 2</b> (OBU feedback type 2 parameters only apply to TDM tags if a status file has been transferred to the Reader)						
Valid Tag: Audible	With <b>OBU feedback</b> enabled, and <b>Type 2</b> selected, select a feedback option from the <b>OBU Audible Feedback</b> drop-down list.	user with <b>Change Configuration</b> permissions	O2VLDA	Off (0)	Off (0) 4 cycles: 0.25s ON, 0.25s OFF (1) 1 cycle: 1.5s ON (2) 3 cycles: 0.5s ON, 0.2s OFF (3)	Specify the audible feedback to provide for a valid tag.

Command	How to execute	Who can execute	Parameter Name	Default Value	Parameter Range	Purpose of command
Valid Tag: Visual	With <b>OBU feedback</b> enabled, and <b>Type 2</b> selected, select a feedback option from the <b>OBU Visual Feedback</b> drop-down list.	user with <b>Change Configuration</b> permissions	O2VLDV	Off (0)	Off (0) Green: 2s (1) Red: 2s (2) Yellow: 2s (3)	Specify the visual feedback to provide for a valid tag.
Invalid Tag: Audible	With <b>OBU feedback</b> enabled, and <b>Type 2</b> selected, select a feedback option from the <b>OBU Audible Feedback</b> drop-down list.	user with <b>Change Configuration</b> permissions	O2IVDA	Off (0)	Off (0) 4 cycles: 0.25s ON, 0.25s OFF (1) 1 cycle: 1.5s ON (2) 3 cycles: 0.5s ON, 0.2s OFF (3)	Specify the audible feedback to provide for an invalid tag.
Invalid Tag: Visual	With <b>OBU feedback</b> enabled, and <b>Type 2</b> selected, select a	user with <b>Change Configuration</b> permissions	O2IVDV	Off (0)	Off (0) Green: 2s (1)	Specify the visual feedback to provide for an invalid tag.

Command	How to execute	Who can execute	Parameter Name	Default Value	Parameter Range	Purpose of command
	feedback option from the <b>OBU Visual Feedback</b> drop-down list.				Red: 2s (2) Yellow: 2s (3)	
Lost/Stolen Tag: Audible	With <b>OBU feedback</b> enabled, and <b>Type 2</b> selected, select a feedback option from the <b>OBU Audible Feedback</b> drop-down list.	user with <b>Change Configuration</b> permissions	O2LSTA	Off (0)	Off (0) 4 cycles: 0.25s ON, 0.25s OFF (1) 1 cycle: 1.5s ON (2) 3 cycles: 0.5s ON, 0.2s OFF (3)	Specify the audible feedback to provide for a lost/stolen tag.
Lost/Stolen Tag: Visual	With <b>OBU feedback</b> enabled, and <b>Type 2</b> selected, select a feedback option from the <b>OBU Visual Feedback</b> drop-down list.	user with <b>Change Configuration</b> permissions	O2LSTV	Off (0)	Off (0) Green: 2s (1) Red: 2s (2) Yellow: 2s (3)	Specify the visual feedback to provide for a lost/stolen tag.

Command	How to execute	Who can execute	Parameter Name	Default Value	Parameter Range	Purpose of command
Low Balance Tag: Audible	With <b>OBU feedback</b> enabled, and <b>Type 2</b> selected, select a feedback option from the <b>OBU Audible Feedback</b> drop-down list.	user with <b>Change Configuration</b> permissions	O2LBLA	Off (0)	Off (0) 4 cycles: 0.25s ON, 0.25s OFF (1) 1 cycle: 1.5s ON (2) 3 cycles: 0.5s ON, 0.2s OFF (3)	Specify the audible feedback to provide for a low balance tag.
Low Balance Tag: Visual	With <b>OBU feedback</b> enabled, and <b>Type 2</b> selected, select a feedback option from the <b>OBU Visual Feedback</b> drop-down list.	user with <b>Change Configuration</b> permissions	O2LBLV	Off (0)	Off (0) Green: 2s (1) Red: 2s (2) Yellow: 2s (3)	Specify the visual feedback to provide for a low balance tag.

Command	How to execute	Who can execute	Parameter Name	Default Value	Parameter Range	Purpose of command
Not Available / Internal Error: Audible	With <b>OBU feedback</b> enabled, and <b>Type 2</b> selected, select a feedback option from the <b>OBU Audible Feedback</b> drop-down list.	user with <b>Change Configuration</b> permissions	O2NA_A	Off (0)	Off (0) 4 cycles: 0.25s ON, 0.25s OFF (1) 1 cycle: 1.5s ON (2) 3 cycles: 0.5s ON, 0.2s OFF (3)	Specify the audible feedback to provide for a not available / internal error.
Not Available / Internal Error: Visual	With <b>OBU feedback</b> enabled, and <b>Type 2</b> selected, select a feedback option from the <b>OBU Visual Feedback</b> drop-down list.	user with <b>Change Configuration</b> permissions	O2NA_V	Off (0)	Off (0) Green: 2s (1) Red: 2s (2) Yellow: 2s (3)	Specify the visual feedback to provide for a not available / internal error

ISO 18000-6B Protocol

(select 6B protocol in Frame Sequence panel)

Command	How to execute	Who can execute	Parameter Name	Default Value	Parameter Range	Purpose of command
Tag Protocol Page: 6B Advanced Panel						
6B Read Mode:	Select read mode from the drop-down list.	user with Change Configuration permissions	6B_RDM	Standard (UDI only) (0)	Standard (UDI only) (0) eATA read – Single-page mode (UDI+eATA) (1) eATA read – 3-page mode (UDI+eATA) (2)	Specifies what mode to use when reading ISO 18000-6B tags.  Standard Mode: reads the UID of the tag only.  Single-Page eATA Read Mode: reads both the UID and the eATA data in the tag, one page at a time, per superframe, and is a legacy mode that should be used when

Command	How to execute	Who can execute	Parameter Name	Default Value	Parameter Range	Purpose of command
						<p>SYNCing to legacy MPR2 readers.</p> <p>3-Page eATA Read Mode: is the preferred option to attempt to read all 3 pages (UID+eATA in a single superframe scan).</p>
eATA Page Read Retry Limit	Input a numeric value for retry limit.	user with <b>Change Configuration</b> permissions	6B3PRR	3	0-10	When 6B is enabled and eATA data is being requested, one page at a time, this value determines, in the event of an eATA page read error, the maximum number of consecutive retries that will be attempted when trying to read a

Command	How to execute	Who can execute	Parameter Name	Default Value	Parameter Range	Purpose of command
						given eATA page.
6B Data Rate (kbps)	Select data rate from the drop-down list.	user with <b>Change Configuration</b> permissions	6BRATE	40 (1)	31.25 (0) 40 (1)	Specify the 6B Data Rate
Enable 6B GROUP_SELECT	Set toggle switch to ON to enable	user with <b>Change Configuration</b> permissions	6BMSKE	0	0-1	Enable this parameter to allow the reader to instruct the Reader to activate the 6B GROUP_SELECT function. This allows the Reader to select a subset of tags from a given tag population.
6B GROUP_SELECT Address (base 10)	With 6B GROUP_SELECT enabled, input select address.	user with <b>Change Configuration</b> permissions	6BADDR	0	0-FF	Specify the 6B GROUP_SELECT address to use (in base 10, not hex).

Command	How to execute	Who can execute	Parameter Name	Default Value	Parameter Range	Purpose of command
6B GROUP_SELECT Mask (base 10)	With 6B GROUP_SELECT enabled, input mask.	user with <b>Change Configuration</b> permissions	6BMASK	0	0-FF	Specify the 6B GROUP_SELECT mask to use (in base 10, not hex).
6B GROUP_SELECT Data (Hex)	With 6B GROUP_SELECT enabled, input data.	user with <b>Change Configuration</b> permissions	6BDATA	0000000000000000	0000000000000000 - FFFFFFFFFFFFFFFF	Specify the 6B GROUP_SELECT Data to use. Please enter a 16-digit (64-bit) hexadecimal value.
Initial CW Time ( $\mu$ s)	Select cw time from the drop-down list.	user with Change Configuration permissions	6BICWT	400 (4)	Off (0) 100 (1) - 1500 (15) (in 100 $\mu$ s steps)	Specifies the initial CW time (in $\mu$ s)
Dual Tag Preamble	Set toggle switch to ON to enable	user with Change Configuration permissions	6B_DTP	0	0 - 1	Specifies whether or not the Dual Tag Preamble is transmitted during the ISO 18000-6B frame.

Command	How to execute	Who can execute	Parameter Name	Default Value	Parameter Range	Purpose of command
Preamble Type	Select preamble type from the drop-down list.	user with <b>Change Configuration</b> permissions	6B_PRT	Plaza (0)	Plaza (0) ORT (1)	Specify the 6B preamble type.

## ISO 18000 6C Protocol

(select 6C protocol in Frame Sequence panel)

Command	How to execute	Who can execute	Parameter Name	Default Value	Parameter Range	Purpose of command
Tag Protocol Page: 6C Advanced Panel						
6C Read Mode:	Select 6C Read Mode from the drop-down list.	user with <b>Change Configuration</b> permissions	6C_RDM	EPC only (0)	EPC only (0) EPC+TID (1) EPC + UM (2)	Specifies what mode to use when reading ISO 18000-6C tags.

Command	How to execute	Who can execute	Parameter Name	Default Value	Parameter Range	Purpose of command
Multi-tag reads (Q = 2)	Set toggle switch to ON to enable.	user with <b>Change Configuration</b> permissions	6C__MT	0	0 - 1	Enable to allow multiple ISO 18000-6C tags to be read per frame, at the expense of a longer frame time. When disabled, only one 6C tag may be read per frame. When enabled, the 6C Q-value = 2; when disabled the Q-value is 0.
6C Mask Select	Select 6C mask from the drop-down list.	user with <b>Change Configuration</b> permissions	6C_MSX	Standard (0)	Standard (0) Puerto Rico (1) Custom (2)	Specify what 6C Read Masking to use when reading 6C tags.
6C Custom Mask Select	Select 6C custom mask from the drop-down list.	user with <b>Change Configuration</b> permissions	6CCMSK	None (0)	None (0) TOC V2.1 (or later) (1) TOC V2.0 (WSDOT) (2) Legacy WSDOT (3)	Specify what custom tag matching option to use when reading 6C tags.

Command	How to execute	Who can execute	Parameter Name	Default Value	Parameter Range	Purpose of command
					TOC V0.7-V1.0 (E470) (4) TOC V0.7-V1.0 (TI Corp.) (5) Legacy SRTA (6)	
6C Sub-Mask Enable	When TOC V2.1 or TOC V2.0 are selected, checkbox will be shown in Agency Sub-Mask. Select checkbox to enable.	user with <b>Change Configuration</b> permissions	6C_SME	Off (0)	Off (0) – Agency 1 (0x00000001)   Agency 2 (0x00000002)   Agency 3 (0x00000004)	Specify whether or not a Sub Mask is to be enabled for the selected 6C Custom Mask.
Agency 1 Sub-Mask (dec)	With 6C Sub-Mask enabled, enter 6C Agency ID Sub-Mask.	user with <b>Change Configuration</b> permissions	6CSMAI	0	0-4294967295	Specify the 6C Agency ID Sub-Mask to use. Please specify a (maximum of 32-bits) value in decimal. An Agency ID Mask value of 0 represents no mask in effect. Note: The maximum allowed value is determined by the selected mask.

Command	How to execute	Who can execute	Parameter Name	Default Value	Parameter Range	Purpose of command
Agency 2 Sub-Mask (dec)	With 6C Sub-Mask enabled, enter 6C Agency ID Sub-Mask.	user with <b>Change Configuration</b> permissions	6CSMA2	0	0-4294967295	Specify the 6C Agency ID Sub-Mask to use.
Agency 3 Sub-Mask (dec)	With 6C Sub-Mask enabled, enter 6C Agency ID Sub-Mask.	user with <b>Change Configuration</b> permissions	6CSMA3	0	0-4294967295	Specify the 6C Agency ID Sub-Mask to use.
Tag Protocol Page: 6C Programming Panel						
6C Read-Only Mode	Set <b>Enable</b> toggle switch to ON to enable programming and OFF for 6C Read-Only Mode.	user with <b>Change Configuration</b> permissions	6CROLY	1	0-1	Configure whether or not the reader will attempt to perform 6C writes..
6C Try-To-Program Timeout [sec]	With 6C programming enabled,	user with <b>Change Configuration</b> permissions	6C_TTP	500	0-4294967295	Specifies, in seconds, the duration after which additional programming attempts will be made with an existing 6C tag.

Command	How to execute	Who can execute	Parameter Name	Default Value	Parameter Range	Purpose of command
	enter timeout in seconds.					
6C Agency ID (Decimal)	With 6C programming enabled, enter a numeric Agency ID.	user with <b>Change Configuration</b> permissions	6C_AID	0	0 - 4095	Specify the 6C Agency ID value that will be written to the 6C tag's User Memory Area.

SeGo Protocol

(select SeGo protocol in Frame Sequence panel)

No special settings are required.

## ATA Protocol

(select ATA protocol in Frame Sequence panel)

Command	How to execute	Who can execute	Parameter Name	Default Value	Parameter Range	Purpose of command
Tag Protocol Page: ATA Advanced Panel						
ATA Frame Length (ms)	select frame length in ms from the drop-down list.	user with Change Configuration permissions	ATA_FL	19.5 (6)	16.5 ms (0) – 21.5 ms (10) (in 0.5 ms steps)	Specifies the length of the ATA frame in milliseconds (ms).
ATA Hold-Off Delay Enable	Set toggle switch to ON to enable delay.	user with Change Configuration permissions	ATAHOE	0	0 - 1	Controls whether ATA CW transmission is held off at the start of the ATA frame for a period of time in order to provide a sufficient gap in air time from the end of transmission of the previous timeslot.

Command	How to execute	Who can execute	Parameter Name	Default Value	Parameter Range	Purpose of command
ATA Hold-Off Delay ( $\mu$ s)	Select hold off delay in us from drop-down list.	user with Change Configuration permissions	ATAHOD	600 us (3)	0 us (0) - 1400 $\mu$ s (7) (in 200 $\mu$ s steps)	Specifies how long the ATA CW transmission is delayed from the start of the ATA frame in order to provide a sufficient gap in air time from the previous timeslot.

## Title 21 Protocol

(select T21 protocol in Frame Sequence panel)

Command	How to execute	Who can execute	Parameter Name	Default Value	Parameter Range	Purpose of command
Tag Protocol Page: Title 21 Advanced Panel						
Agency ID	Enter a numeric agency id.	user with <b>Change Configuration</b> permissions	T21AID	0	0- 65535	Specify the desired Title21 Agency ID, in decimal.

Command	How to execute	Who can execute	Parameter Name	Default Value	Parameter Range	Purpose of command
Reader ID	Enter a numeric reader id.	user with <b>Change Configuration</b> permissions	T21RID	0	0-4294967295	Specify the desired Title21 Reader ID, in decimal.
Enable Title21 Acknowledge Messages	Set toggle switch to ON to enable.	user with <b>Change Configuration</b> permissions	T21AME	0	0-1	Select whether or not to enable the transmission of Title21 Acknowledge Messages to the transponder at the end of the transaction.

Dummy

(select Dummy in Frame Sequence panel)

Command	How to execute	Who can execute	Parameter Name	Default Value	Parameter Range	Purpose of command
Tag Protocol Page: Dummy Timeslot CW Enable Panel						

Command	How to execute	Who can execute	Parameter Name	Default Value	Parameter Range	Purpose of command
Dummy Timeslot (CW) Enable	With Dummy_1/2/3/4 protocol selected, for each channel, select Dummy checkbox to enable CW.	user with <b>Change Configuration</b> permissions	DUMTS1 DUMTS2 DUMTS3 DUMTS4	0	per channel instance: 0-1	Specify the channel/slot firing sequence for the Dummy_x (CW) frame sequence timeslot where 'x' is 1/2/3/4.
Tag Protocol Page: Dummy Advanced						
Dummy Frame Length	Enter frame length in the field.	user with Change Configuration permissions	DUMTSD	500	per dummy instance (up to 4 instances): 500 - 32767	Specifies the duration of the Dummy (CW) timeslot.  <b>Note:</b> When combined with the Dummy Frame Length Units parameter, below, the (min, max) allowable Dummy Frame Length when CW is enabled is (500 $\mu$ s, 200 ms)
Dummy Frame Length Units	Select the required multiple from drop-down list.	user with Change	DUMTSU	x1 $\mu$ s (0)	per dummy instance (up to 4 instances): x1 $\mu$ s (0)	Specifies the units to be used when specifying the duration of the Dummy timeslot.

Command	How to execute	Who can execute	Parameter Name	Default Value	Parameter Range	Purpose of command
		Configuration permissions			x 100 $\mu$ s (1)	<b>Note:</b> When combined with the Dummy Frame Length Units parameter, above, the (min, max) allowable Dummy Frame Length when CW is enabled is (500 $\mu$ s, 200 ms)

## Sync

(select Sync in Frame Sequence panel)

Note: Sync cannot be the 1<sup>st</sup> in frame sequence

Command	How to execute	Who can execute	Parameter Name	Default Value	Parameter Range	Purpose of command
Reader-to-Reader Sync. Enable	When Sync is selected in frame sequence, Reader-to-Reader sync will be enabled automatically. If Sync is deselected, Reader-to-Reader sync will be disabled automatically.	user with Change Configuration permissions	RFSYNC	0	0 - 1	Controls whether RF transmission is synchronized between adjacent readers.  <b>Note:</b> A sync cable to connect readers is required if Reader-to-Reader sync is to be enabled.
Sync. Recovery Attempt Limit	Enter attempt limit in field.	user with Change Configuration permissions	SYNRTL	0	0 – 100	This value specifies how many Sync Recovery Time Periods must expire before the reader will no longer search/wait for sync before firing its tag acquisition sequences independently of

Command	How to execute	Who can execute	Parameter Name	Default Value	Parameter Range	Purpose of command
						the reader sync network. If set to zero, the Reader will always wait for the Sync Recovery Time to expire before firing its tag acquisition sequence.
Enable Custom Sync Timing	Set toggle switch to ON to enable.	user with Change Configuration permissions	SYNCSE	0	0-1	Enables/disable custom sync timing.
Sync Search Time ( $\mu$ s)	With Custom Sync Timing enabled, enter sync search time in us.	user with Change Configuration permissions	SYNSTO	100 $\mu$ s	20 - 65535 $\mu$ s	Specify how long the Sync function will search for the synchronization signal in microseconds ( $\mu$ s) before switching to recovery mode.
Sync Recovery Time (ms)	With Custom Sync Timing enabled, enter sync recovery time in ms.	user with Change Configuration permissions	SYNRTO	20 ms	0 - 65535 ms	Specify how long the Sync function will attempt synchronization recovery in the event that the sync signal

Command	How to execute	Who can execute	Parameter Name	Default Value	Parameter Range	Purpose of command
						is not seen during the Sync Search phase.  Note: It is recommended that this value be set to at least 125% of the total multi-protocol tag acquisition sequence.
Sync Frame Start Delay ( $\mu$ s)	With Custom Sync Timing enabled, enter sync frame start delay in $\mu$ s.	user with Change Configuration permissions	SYNFSD	0	0 $\mu$ s – 255 $\mu$ s	This value specifies how long the Reader will delay from the rising edge of the sync pulse to the rising edge of the trigger pulse in the frame.
Sync Delay (ns)	Enter sync delay in ns.	user with Change Configuration permissions	SYNCDL	0	0 - 10000ns	This value specifies, in 100 nanosecond (ns) increments, how long the Reader will wait after Reader-to-Reader synchronization has occurred before firing the next tag acquisition sequence. This value should be calculated

Command	How to execute	Who can execute	Parameter Name	Default Value	Parameter Range	Purpose of command
						based on the length of the Sync Cable.
Enable Sync-on-Skipped-Sync Sequencing	Set toggle switch to ON to enable.	user with Change Configuration permissions	SYNSKP	0	0-1	<p>Instruct the reader to search for the missing sync sequence to indicate when the protocol synchronization is to occur.</p> <p><b>Note:</b> This feature should be used when more than 3 protocols are selected in the frame sequence.</p>

## Lane Assignment Page

Command	How to execute	Who can execute	Parameter Name	Default Value	Parameter Range	Purpose of command
Lane Assignment Algorithm	Select <b>Report on First Read/Program</b> or <b>Majority Voting</b> from the Lane Assignment Algorithm box.	user with <b>Change Configuration</b> permissions	VTALGO VTAG6B VTAG6C VTAGAG VTAGAA VTAGSG	Majority (1)	First to read/program, Majority	Sets which algorithm is used for determining OBU lane assignment between channels.  Majority voting makes channel assignment decision based on handshake count from each channel at the time of voting (and post-voting)  Same algorithm will be used for all tag protocols.
Lane Assignment Page: Inter-Reader Panel						
Communication Method	Select <b>Disabled, Legacy CRA, or Ethernet</b> communication method.	user with <b>Change Configuration</b> permissions	MULTRD	Disabled	Disabled Legacy CRA Ethernet	This helps to reduce duplicate Vote reports for sites with 2 or more adjacent readers, with legacy CRA (Cross Reader Algorithm) for TDM tags only, or with

Command	How to execute	Who can execute	Parameter Name	Default Value	Parameter Range	Purpose of command
						<p>Ethernet Inter-Reader (IR) network voting for all protocols.</p> <p><b>Disabled:</b> Reader is not set to communicate with other Readers.</p> <p><b>Legacy CRA:</b> Voting between Readers relies on writing to TDM tags.</p> <p><b>Ethernet:</b> Voting between Readers relies on communicating between readers on IR network.</p> <p>Sets how Readers communicate when determining lane assignments between multiple Readers</p>
Cross-Reader Reporting	With Legacy CRA or Ethernet	user with <b>Change</b>	CRARPT	Disabled	Disabled Report All	Specify if the reader sends the informational CrossR

Command	How to execute	Who can execute	Parameter Name	Default Value	Parameter Range	Purpose of command
	communication method enabled:  Select Disabled, Report All, or Report Non-Zero mode.	<b>Configuration</b> permissions			Report Non-Zero	Vote messages to the LC. A CrossR report means an adjacent reader has reported the Vote message to a LC.  <b>Disabled:</b> Reader is not set to communicate with other Readers.  <b>Report All</b> results in all transactions being sent to the LC.
Align tag-timeout expiry between readers	With Ethernet communication method enabled:  Toggle switch to enable /disable.	user with <b>Change Configuration</b> permissions	IR_TTO	1	0-1	This helps to align Tag Timeout events between readers to prevent missing transactions due to TTO expired on one reader but not the other.
Inter-Reader network timeout (ms)	With Ethernet communication method enabled:	user with <b>Change Configuration</b> permissions	IRIFTO	50	30-5000	Specifies the timeout in milliseconds for Ethernet-based inter-reader communication. If this time is

Command	How to execute	Who can execute	Parameter Name	Default Value	Parameter Range	Purpose of command
(make sure the TTO values of all IRIF readers are the same)	Enter a time, in milliseconds, in field.					exceeded before a reply is seen the reader will assume the other side is not awake.  This sets the threshold for determining an IR network problem and triggers a switchover if enabled.
Inter-Reader alias	With Ethernet communication method enabled:  Enter IP address of this Reader in field.	user with <b>Change Configuration</b> permissions	READIP	192.168.0.151	N/A	Assign a unique IPv4 address to the reader as a whole. This address is used for inter-reader communication (e.g. inter reader voting). If there is only one reader at a site, this can be set to 0.0.0.0
Ethernet 2 IP address	With Ethernet communication method enabled:  Enter IP address of the left Reader in field.	user with <b>Change Configuration</b> permissions	PRIMIP	192.168.0.50	N/A	Assign a unique IPv4 address to Ethernet 2 interface for inter-reader voting. This address should be provided by the SI network planner. <b>MUST NOT BE ON THE SAME</b>

Command	How to execute	Who can execute	Parameter Name	Default Value	Parameter Range	Purpose of command
						SUBNET AS Ethernet 1 interface!
Left Reader	With Ethernet communication method enabled: Toggle switch to enable /disable left reader.	user with <b>Change Configuration</b> permissions	LEFTRD	0	0-1	<p>Tells this Reader if there is another Reader in the IR network that is covering ORT lanes that are to the left of the lanes this Reader is covering.</p> <p><b>Disabled:</b> Reader does not coordinate voting with Reader covering lanes to the left.</p> <p><b>Enabled:</b> Reader coordinated lane assignment voting with Reader covering lanes to the left.</p>
Left Inter-Reader alias	With Left Reader enabled,	user with <b>Change</b>	LEFTIP	0.0.0.0	N/A	Provides IP address of the Reader covering lanes to the

Command	How to execute	Who can execute	Parameter Name	Default Value	Parameter Range	Purpose of command
	enter IP address of the left Reader in field.	<b>Configuration</b> permissions				left of this Reader in the IR network  Sets to 0.0.0.0 to indicate there is no left reader.
Right Reader	With Ethernet communication method enabled:  Toggle switch to enable /disable right reader.	user with <b>Change Configuration</b> permissions	RGHTRD	0	0-1	Tells this Reader if there is another Reader in the IR network that is covering ORT lanes that are to the right of the lanes this Reader is covering.  <b>Disabled:</b> Reader does not coordinate voting with Reader covering lanes to the right.  <b>Enabled:</b> Reader coordinated lane assignment voting with Reader covering lanes to the right.

Command	How to execute	Who can execute	Parameter Name	Default Value	Parameter Range	Purpose of command
Right Inter-Reader alias	With Right Reader enabled, enter IP address of the right Reader in field.	user with <b>Change Configuration</b> permissions	RGHTIP	0.0.0.0	N/A	Provides IP address of the Reader covering lanes to the right of this Reader in the IR network.  Sets to 0.0.0.0 to indicate there is no right reader.
Lane Assignment Page: TDM Early Read Logic Panel						
Enable Early Read Logic	Toggle Enable switch to enable /disable	user with <b>Change Configuration</b> permissions	EREAD_	0	0 - 1	Improves TDM programming success rate by detecting early reads and delaying voting according to the extent (i.e., time gap) of the early read.
Max Delay (ms)	Input delay time in ms in field.	user with <b>Change Configuration</b> permissions	ERDMAX	1000	1 - 1000	Specifies the maximum time in milliseconds allowed to delay voting

Command	How to execute	Who can execute	Parameter Name	Default Value	Parameter Range	Purpose of command
Min Gap Size (ms)	Input time in ms in field.	user with <b>Change Configuration</b> permissions	ERDGAP	50	1 - 10000	An early read Specifies the minimum allowed gap size
Voting Delay Gap Scaling Factor (%)	Input percent in field.	user with <b>Change Configuration</b> permissions	ERDVSF	100	0 - 500	Specifies the voting delay scaling factor to apply
Minimum Post Gap HS Ratio (0-100%)	Input percent in field.	user with <b>Change Configuration</b> permissions	ERDHSR	50	0 - 100	Specifies the minimum post gap to cumulative HS ratio (e.g. 50% means at least half of the HS on any channel must be after the RF gap).
Lane Assignment Page: TDM Low Read Logic Panel						
Enable Low Read Logic	Toggle Enable switch to enable /disable	user with <b>Change Configuration</b> permissions	LWREAD	0	0 - 1	Delays voting if a long RF gap right before voting is detected.

Command	How to execute	Who can execute	Parameter Name	Default Value	Parameter Range	Purpose of command
Max Delay (ms)	Input delay time in ms in field.	user with <b>Change Configuration</b> permissions	LRDMAX	1000	1 - 10000	Specifies the maximum time in milliseconds allowed to delay voting
Min Gap Size (ms)	Input time in ms in field.	user with <b>Change Configuration</b> permissions	LRDGAP	50	1 - 10000	Specifies the minimum allowed gap size
Voting Delay Gap Scaling Factor (%)	Input percent in field.	user with <b>Change Configuration</b> permissions	LRDVSF	100	0 - 500	Specifies the voting delay scaling factor to apply

## Lane Controller Page

Command	How to execute	Who can execute	Parameter Name	Default Value	Parameter Range	Purpose of command
LC Ethernet TCP-Socket Local Port	Keep the default value if necessary.	user with Change Configuration permissions	LcEtPn	default: 6666	min: 1024 max: 65535	Used to select the local TCP Protocol Port Number that the Reader will listen on to accept incoming TCP connections from the Lane Controller.
LC Ethernet TCP-Socket Timeout (ms)	With at least one RF Channel configured to send data to the LC via Ethernet, type a time in milliseconds in field.	user with Change Configuration permissions	LcEtTo	500	100-5000	Sets the timeout for a response from the LC via the LC Ethernet network.  To determine if there is an Ethernet communication problem between the Reader and the LC.
LC Ethernet Connection Mode	Select option in connection mode.	user with <b>Change Configuration</b> permissions	LcECnM	Standard (Legacy)	Standard (Legacy) TCP - Long Lived	Specifies how the Reader will connect to the Lane Controller. Select 'Standard (Legacy)' for the traditional 'Open-Send-Close' TCP Socket paradigm. Select

Command	How to execute	Who can execute	Parameter Name	Default Value	Parameter Range	Purpose of command
						'TCP - Long Lived' for long-lived TCP/IP socket connections with the Lane Controller. Note that there are message encapsulation, connection establishment, and protocol changes as well. refer to ICD 360467-121 for details.
Send Ethernet Heartbeats	With LC Ethernet Connection Mode in TCP - Long Lived, set Toggle switch to enable heartbeat.	user with <b>Change Configuration</b> permissions	LCHTBT	1	0-1	Used to detect communication problems between the Reader and the LC.  <b>Disabled:</b> no heartbeat messages are sent to LC.  <b>Enabled:</b> causes the Reader to send heartbeat messages to the LC.
Ethernet Heartbeat Interval (sec)	With send heartbeat	user with <b>Change</b>	LCHBTM	2	1-30	Sets the heartbeat message interval,

Command	How to execute	Who can execute	Parameter Name	Default Value	Parameter Range	Purpose of command
	messages enabled, enter interval time in seconds.	<b>Configuration</b> permissions				i.e. how often heartbeat messages are sent from the Reader to the LC.
<b>Lane Controller Page: LC Destinations Panel</b> (set Advanced toggle switch to ON to show more settings)						
Destination	Select checkbox to enable <b>Ethernet</b> and/or <b>Dual Ethernet</b> for each RF channel	user with <b>Change Configuration</b> permissions	LCDEST	1	0 - 15	Specifies the type of interface (Ethernet, Dual Ethernet) communication with the lane controller.
Destination IP Address and Port	Select <b>Ethernet</b> checkbox and input ip address in field.	user with <b>Change Configuration</b> permissions	LCIPPT	N/A	N/A	This specifies the destination IP address and port.
Dual Destination IP Address and Port	In Advanced mode: select <b>Dual Ethernet</b> checkbox	user with <b>Change Configuration</b> permissions	LC2IPP	N/A	N/A	This specifies the Dual Destination IP address and port.

Command	How to execute	Who can execute	Parameter Name	Default Value	Parameter Range	Purpose of command
	and input ip address in field.					
Lane Controller Page: LC Reporting Panel						
Voting Report	Set toggle switch to ON to enable report type for all tag protocols.	user with Change Configuration permissions	VOTRPT	1	0-1	Used to choose to send a voting report
Initial Read (IREAD) Report	Set toggle switch to ON to enable report type for all tag protocols.	user with Change Configuration permissions	INIRPT	0	0-1	Used to choose to send or not to send an initial report the first time a new tag is seen
Raw Handshake Report	Set toggle switch to ON to enable report type for all tag protocols.	user with Change Configuration permissions	RAWRPT	0	0-1	Used to send a handshake to the LC for every tag read

Command	How to execute	Who can execute	Parameter Name	Default Value	Parameter Range	Purpose of command
Post-Capture-Zone Report	Set toggle switch to ON to enable report type for all tag protocols.	user with Change Configuration permissions	PCZRPT	0	0-1	Used to choose to generate and potentially send a post-capture-zone report
Post-Capture-Zone Voting Time (multiples of VT)	With Post-Capture-Zone Report enabled, input multiple count for all tag protocols.	user with <b>Change Configuration</b> permissions	PCZRTx	1	1 - 5	Specifies how many multiples of VT to wait after voting time to perform post-capture-zone report calculations.
Departure Report	Set toggle switch to ON to enable report type for all tag protocols.	user with <b>Change Configuration</b> permissions	EVS RPT	0	0-1	Used to choose to generate and send an Estimated Vehicle Speed report
Departure Report Delay (ms)	With Departure Report enabled, input delay for all tag protocols.	user with <b>Change Configuration</b> permissions	EVSMSS	1000	100 - 9999	Specifies the delay to send departure report after a tag is last seen.

Command	How to execute	Who can execute	Parameter Name	Default Value	Parameter Range	Purpose of command
Estimated-Vehicle-Speed (EVS) Report	Set toggle switch to ON to enable report type for all tag protocols.	user with Change Configuration permissions	EVSRPT	0	0-1	Used to choose to generate and send an Estimated Vehicle Speed report
Minimum Speed Report sample count	With Estimated-Vehicle-Speed (EVS) Report enabled, input sample count for all tag protocols.	user with Change Configuration permissions	EVSMSS	1	1 - 10	The reader sets the ZC field in EVS Report to 9999 when the sample count is less than the specified minimum.
Lane Controller Page: LC Extended Reporting Panel						
Status Reports	Click on checkbox to enable /disable what to be included in report.	user with <b>Change Configuration</b> permissions	EIR_SR	0	0-1	Specifies which Extended Information values are to be included in Status Reports sent to the Lane Controller.

Command	How to execute	Who can execute	Parameter Name	Default Value	Parameter Range	Purpose of command
Transaction Reports (Initial-Read, Voting, Post-Capture, Est.Veh.Speed)	Click on checkbox to enable /disable what to be included in report.	user with <b>Change Configuration</b> permissions	EIR_TN	0	0-1	Specifies which Extended Information values are to be included in Transaction Reports (Initial Read, Voting, Post-Capture, and/or Estimate Vehicle Speed) reports sent to the Lane Controller.
Raw Handshake Reports	Click on checkbox to enable /disable what to be included in report.	user with <b>Change Configuration</b> permissions	EIR_RH	0	0 - 31	Specifies which Extended Information values are to be included in Raw Handshake reports sent to the Lane Controller.
<b>Lane Controller Page: LC Report Format Panel</b> (this panel will appear when selected protocols require special report format)						
6B Transponder Data Format	Select format from the drop-down list.	user with <b>Change</b>	I6BFmt	Standard UID (0)	Standard UID (0)	Specifies the type of 6B report formatting to employ

Command	How to execute	Who can execute	Parameter Name	Default Value	Parameter Range	Purpose of command
		<b>Configuration</b> permissions			eATA 8-bit ASCII Alphanumeric (2)  Combined UID+eATA (3)	
Suppress 6B Clone Tags	Set toggle switch to ON to suppress report.	user with <b>Change Configuration</b> permissions	NO6BCT	1	0 - 1	If enabled, instructs the Reader to suppress the reporting of 6B Clone Tags.
ATA Tag Report Filtering/Threshold:	From the LC tab on the Configure panel, select the ATA Tag Report Filtering/Threshold checkbox	user with <b>Change Configuration</b> permissions	ATAFLT	0	Disabled 0 Enabled:1 Read Enabled:2 Reads Enabled:3 Reads	Use this option to perform filtering of ATA tag reports (Voting, Post Capture) based on a set handshake count threshold.  Sets the minimum number of ATA tag reads that must occur on any given channel before a given tag is processed and/or reported to the Lane Controller.

Command	How to execute	Who can execute	Parameter Name	Default Value	Parameter Range	Purpose of command
						Set appropriately, this feature can help reduce the incidence of ATA 'Phantom' reads/reports.
Verify ATA Data CRC:	From the <b>LC</b> tab on the <b>Configure panel</b>	user with <b>Change Configuration</b> permissions	ATAVDC	1	0 - 1	If enabled, instructs the Reader to perform a CRC validation check on the received ATA data. If the incoming data does not pass the CRC check, handshake messages, <b>Note:</b> if enabled, may be flagged as invalid, or suppressed entirely.
Suppress ATA Bad CRC Handshake Reports	Set toggle switch to ON to suppress report.	user with <b>Change Configuration</b> permissions	NOATAC	0	0 - 1	Enable this option to suppress the reporting of ATA Handshake Reports that have failed an ATA Data-CRC check.

Command	How to execute	Who can execute	Parameter Name	Default Value	Parameter Range	Purpose of command
Suppress ATA 'Phantom' Handshake Reports	Set toggle switch to ON to suppress report.	user with <b>Change Configuration</b> permissions	NOATAP	0	0 - 1	Enable to suppress the reporting of ATA 'Phantom' Read Handshake Reports. A read is deemed a 'Phantom' if the ATA Frame-Check fails and/or the reader is unable to extract a valid serial number from the data.
Lane Controller Page: LC Report Latency by Tag Type Panel						
0 - Interior FPT Delay [ms]	Enter a time (in milliseconds) in the <b>0- Interior FPT Delay</b> field	user with <b>Change Configuration</b> permissions	LYCTLO	0	0-5000	Sets report delay time in milliseconds for Interior FPT OBU's (Type 0)  Used to slow down the transaction report of Type 0 OBU's to the LC for those legacy sites where the LC is expecting BADGER Reader timing

Command	How to execute	Who can execute	Parameter Name	Default Value	Parameter Range	Purpose of command
1 - Exterior FPT Delay [ms]	Enter a time (in milliseconds) in the <b>Exterior FPT Delay</b> field	user with <b>Change Configuration</b> permissions	LYCTL1	0	0-5000	<p>Sets report delay time in milliseconds for Exterior FTP OBUs (Type 1).</p> <p>Used to slow down the transaction report of Type 1 OBUs to the LC for those legacy sites where the LC is expecting BADGER Reader timing</p>
2 - Exterior LPT Delay [ms]	Enter a time (in milliseconds) in the <b>Exterior LPT Delay</b> field..	user with <b>Change Configuration</b> permissions	LYCTL2	0	0-5000	<p>Sets report delay time in milliseconds for Exterior LPT OBUs (Type 2).</p> <p>Used to slow down the transaction report of Type 2 OBUs to the LC for those legacy sites where the LC is expecting BADGER Reader timing</p>

Command	How to execute	Who can execute	Parameter Name	Default Value	Parameter Range	Purpose of command
3 - LCD Display Delay [ms]	Enter a time (in milliseconds) in the <b>LCD Display Delay</b> field..	user with <b>Change Configuration</b> permissions	LYCTL3	0	0-5000	<p>Sets report delay time in milliseconds for LCD Display OBUs (Type 3).</p> <p>Used to slow down the transaction report of Type 3 OBUs to the LC for those legacy sites where the LC is expecting BADGER Reader timing</p>
4 - Commercial Vehicle (CVO) Delay [ms]	Enter a time (in milliseconds) in the <b>Commercial Vehicle (CVO) Delay</b> field..	user with <b>Change Configuration</b> permissions	LYCTL4	0	0-5000	<p>Sets report delay time in milliseconds for CVO OBUs (Type 4).</p> <p>Used to slow down the transaction report of Type 4 OBUs to the LC for those legacy sites where the LC is expecting BADGER Reader timing</p>

Command	How to execute	Who can execute	Parameter Name	Default Value	Parameter Range	Purpose of command
5 - OBU Feedback Tag Delay [ms]	Enter a time (in milliseconds) in the <b>OBU Feedback Tag Delay</b> field..	user with <b>Change Configuration</b> permissions	LYCTL5	0	0-5000	<p>Sets report delay time in milliseconds for Feedback OBUs (Type 5).</p> <p>Used to slow down the transaction report of Type 5 OBUs to the LC for those legacy sites where the LC is expecting BADGER Reader timing</p>
6 - HOT Tag Delay [ms]	Enter a time (in milliseconds) in the <b>HOT Tag Delay</b> field..	user with <b>Change Configuration</b> permissions	LYCTL6	0	0-5000	<p>Sets report delay time in milliseconds for HOT OBUs (Type 6).</p> <p>Used to slow down the transaction report of Type 6 OBUs to the LC for those legacy sites where the LC is expecting BADGER Reader timing.</p>

Lane Controller Page: LC Advanced Panel

Command	How to execute	Who can execute	Parameter Name	Default Value	Parameter Range	Purpose of command
Dual-Destination Buffering Mode	Select mode from the drop-down list.	user with <b>Change Configuration</b> permissions	LCDDBM	Fully Independent	Standard (Legacy) Fully Independent	Specifies how Dual-Destination message buffering is to be performed. Select 'Standard (Legacy)' mode to have buffering starts when both Ethernet and Dual-Ethernet links are down, buffered messages are drained when both Ethernet and Dual-Ethernet links are resumed. Set to 'Fully Independent' to have fully independent buffering between the Ethernet and Dual-Ethernet links when link failures occur.
Status Message Buffering	Set toggle switch to ON to enable buffering.	user with <b>Change Configuration</b> permissions	LcStBf	0	0-1	If enabled, instructs the Reader to buffer status messages in the event of a

Command	How to execute	Who can execute	Parameter Name	Default Value	Parameter Range	Purpose of command
						communications link loss with the Lane Controller.
Initial Read Report (IREAD) Message Buffering	Set toggle switch to ON to enable buffering.	user with <b>Change Configuration</b> permissions	LcIrbf	0	0-1	If enabled, the Reader buffers Initial Read Report (IREAD) messages in the event of a communications link loss with the the Lane Controller.
Departure Report Message Buffering	Set toggle switch to ON to enable buffering.	user with <b>Change Configuration</b> permissions	LcDrBf	0	0-1	If enabled, the Reader buffers Departure Report messages in the event of a communications link loss with the the Lane Controller.
TCP (Long-Lived) Keepalive Time (sec)	Input time in seconds.	user with <b>Change Configuration</b> permissions	LcTKaT	10	5-7200	Specifies the time (in seconds) a TCP Long-Lived connection between the Reader and the Lane Controller needs to remain idle before the Reader

Command	How to execute	Who can execute	Parameter Name	Default Value	Parameter Range	Purpose of command
						begins sending TCP Keepalive probes.
TCP (Long-Lived) Keepalive Probes	Input number in field.	user with <b>Change Configuration</b> permissions	LcTKaP	3	1-10	For TCP Long-Lived Connections, specifies the maximum number of TCP Keepalive probes the Reader should send before dropping the connection.
TCP (Long-Lived) Keepalive Interval (sec)	Input time in seconds.	user with <b>Change Configuration</b> permissions	LcTKal	2	1-100	For TCP Long-Lived Connections, specifies the time (in seconds) between individual TCP Keepalive probes.
TCP (Long-Lived) User Timeout (msec)	Input timeout in milliseconds.	user with <b>Change Configuration</b> permissions	LcTUTo	5000	5000-60000	For TCP Long-Lived Connections, specifies the maximum time (in milliseconds) that transmitted data may remain unacknowledged by the Lane Controller (at the

Command	How to execute	Who can execute	Parameter Name	Default Value	Parameter Range	Purpose of command
						TCP layer) before the Reader will forcibly close the connection. This feature can be used to detect the presence of link drops (e.g. cable disconnects and/or peer crashes), especially if Ethernet Heartbeats have been disabled.

Time Page

Command	How to execute	Who can execute	Parameter Name	Default Value	Parameter Range	Purpose of command
Network Time Protocol	Set toggle switch to ON to enable NTP.	user with <b>Change Configuration</b> permissions	NTP__	0	0-1	Enables or disables setting the Reader time via an NTP server  to ensure readers are time synced to a time server.

Command	How to execute	Who can execute	Parameter Name	Default Value	Parameter Range	Purpose of command
NTP time offset warning threshold (ms)	With NTP enabled, Input threshold in milliseconds.	user with <b>Change Configuration</b> permissions	NTPMAX	20	1-100	Specify a maximum threshold (default 20 ms) for the largest NTP time offset tolerated in the system. When NTP is enabled, the reader periodically checks its NTP time offset, and if it is greater than the threshold, change the NTP status parameter to one of the Alarm values. An alert is also shown in the UI banner.
NTP Server 1, 2, 3 and 4	With NTP enabled, enter three different valid NTP server IP address in the <b>NTP Server</b> fields.	user with <b>Change Configuration</b> permissions	NTP__1 NTP__2 NTP__3 NTP__4	N/A	N/A	Sets the NTP server IP addresses.  Provides the Reader with four NTP servers it can access to accurately maintain time with other Readers in an IR network.

Command	How to execute	Who can execute	Parameter Name	Default Value	Parameter Range	Purpose of command
NTP peers 1, 2, 3, 4, 5	With NTP enabled, enter NTP peers.	user with <b>Change Configuration</b> permissions	NTPPR1 NTPPR2 NTPPR3 NTPPR4 NTPPR5	N/A	N/A	
Set Reader Time Zone	Select time zone in the drop-down list.	User with <b>Change Configuration</b> permissions	T_ZONE	UTC	N/A	Set time zone.
Set Reader Date and Time	With NTP disabled, Click the edit box to set date and time to the Reader, then click the <b>SET TIME</b> button to confirm.	User with <b>Change Configuration</b> permissions	N/A	N/A	N/A	Manually set the Reader time.

## Save /Load Configuration Page

Command	How to execute	Who can execute	Parameter Name	Default Value	Parameter Range	Purpose of command
Save Config	Click the Download reader configuration icon to save.	User with <b>Change Configuration</b> permissions	N/A	N/A	N/A	Save current Reader configuration into a file. The file can then be reloaded later or used to configure other Readers.
Upload Config	Click the Load a configuration file icon to load.	User with <b>Change Configuration</b> permissions	N/A	N/A	N/A	Load a previously saved reader configuration file from your device to the reader. The reader network settings (see General page) and site name are not changed.
Reset Config	Click the Reset reader configuration to defaults icon to reset.	User with <b>Change Configuration</b> permissions	N/A	N/A	N/A	Restore all Reader configuration settings to the factory default values except for the reader network settings (see General page) and site name.

## Reader Software Page

Command	How to execute	Who can execute	Parameter Name	Default Value	Parameter Range	Purpose of command
Upload File	Click the <b>Load</b> icon and select a file to upload.	user with Software Management permissions	N/A	N/A	N/A	Upload a software/firmware version to the Reader so that it can be activated later.
Activate Software Version	Select version in the list of Available Software Versions, then click the <b>Activate</b> icon.	user with <b>Software Management</b> permissions	N/A	N/A	N/A	Activate the selected software/firmware version.  This will also deactivate the currently running software/firmware version.

Command	How to execute	Who can execute	Parameter Name	Default Value	Parameter Range	Purpose of command
Delete Software Version	Select version in the list of Available Software Versions, then click the <b>Delete</b> icon.	user with <b>Software Management</b> permissions	N/A	N/A	N/A	Delete the selected software/firmware version.  This is delete an inactive, non-factory software/firmware version that is no longer required to free up space for newer versions.

## Users Page

Command	How to execute	Who can execute	Parameter Name	Default Value	Parameter Range	Purpose of command
Create New User	Click the <b>Add User</b> icon to create new user.	user with <b>Admin User</b> permissions	N/A	N/A	N/A	Create a new user.

Command	How to execute	Who can execute	Parameter Name	Default Value	Parameter Range	Purpose of command
Change Permissions	Select a user name in the user list and click the <b>Edit User</b> icon to change permissions.	user with <b>Admin User</b> permissions	N/A	N/A	N/A	Enable any permission changes for a given user except the user with name as "admin".
Change Password	Select the user name of the currently logged in user and click the <b>Change Password</b> icon.	the logged in user	N/A	N/A	N/A	Change the password of the user currently logged into the CTM web interface.
Reset Password	Select a user name in the user list and click the <b>Reset Password</b> icon.	user with <b>Admin User</b> permissions	N/A	N/A	N/A	Reset a user's password to "password" and let the user to create a new password if they have forgotten their existing one.

Command	How to execute	Who can execute	Parameter Name	Default Value	Parameter Range	Purpose of command
Delete User	Select a user name in the user list and click the <b>Delete User</b> icon.	user with <b>Admin User</b> permissions	N/A	N/A	N/A	Remove a user who is no longer required to access the CTM web interface.

## Logs Page

Command	How to execute	Who can execute	Parameter Name	Default Value	Parameter Range	Purpose of command
Delete All Logs	Click the Delete All Logs icon.	user with Manage Log Files permissions	N/A	N/A	N/A	Deletes all logs. Frees up memory for more logs.