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V740 Series RFID system Reader/Writer Antenna

Operation Manual



V740-B A50C04-US

**Mono-static
Reader/Writer(4ports)**

V740-B A50C24-US

**Mono-static
Reader/Writer(8ports)**

V740-HS01L

Mono-static Antenna

V740-HS01C

Mono-static Antenna



The OMRON V740 RFID Reader (herein after denoted as the V740 Reader) uses RFID (radio frequency identification) technology to read data stored on RFID tags. The V740 reader operates analogous to an SQL (structured query language) server, providing tag data in response to requests from another application. A separate software application may be used to direct its operation and provide a user interface.

The reader supports UHF (ultra high frequency) antennas, which are available separately. The reader supports multiple configurations of UHF antenna ports and transfers data to a remote computer over a network connection.

The V740 Reader is powered by ThingMagic LLC Mercury4® technologies.

FCC WARNING

Changes or modifications not expressly approved by the party responsible for compliance could void the user's authority to operate the equipment.

NOTICE

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 instructions, 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 his own expense.

Properly shielded a grounded cables and connectors must be used for connection to host computer and / or peripherals in order to meet FCC emission limits.

(AC adaptor) with ferrite core must be used for RF interference suppression.

1. Installation and Usage Guide

About this Guide

This installation and usage guide explains how to install the V740 Reader, how to use the browser-based interface, and how to control the reader remotely.

1.1 Before You Begin

1.1.1 Installation Requirements

- The reader is shipped with a certified limited power source with a cable length of 1.8m (6ft).
- Use only authorized antennas and cables to maintain FCC approval (see page 4).
- In order to comply with FCC requirements for RF exposure safety, a separation distance of at least 23 cm (9.1 in) needs to be maintained between the radiating elements of the antenna and the bodies of nearby persons.
- Provide strain relief for all reader connections.
- The minimum screw size for mounting the reader is #12 (M5). Use suitable wall anchors when mounting to drywall or masonry.
- A Shielded Ethernet cable must be used to communicate with other devices.
- Multiple readers and antennas can be used in combination to enhance detection at specific locations provided the software application is able to synchronize antenna operation.
- Recommended minimum configuration for a computer running an application that interfaces with the V740 Reader:
 - Pentium® 400 MHz processor
 - 128MB memory
 - 10 GB hard disk drive
 - Base-T-10/100 Ethernet® port

1.1.2 Performance Considerations

Reader performance may be affected by external factors including tag variables and environment.

Performance tests conducted under typical operating conditions at your site are recommended to help you optimize system performance.

Tag Variables

There are several variables associated with tags that can affect reader performance:

- Application surface — Some materials interfere with tag performance including metal and moisture. Tags applied to items made from or containing these materials may not perform as expected.
- Tag orientation — Reader performance is affected by the orientation of the tag in the antenna field.
- Tag model — many tag models are available. Each model has its own performance characteristics (refer to Chapter 3).

Environment

Reader performance may be affected by the following:

- Metal surfaces such as desks, filing cabinets, bookshelves, and wastebaskets may enhance or degrade reader performance.

Mount antennas as far as possible from metal surfaces that are adversely affecting system performance.

- Devices that operate at 900 MHz, such as cordless phones and wireless LANs, can interfere with reader performance.

These devices may degrade performance of the reader. The reader may also adversely affect performance of 900 MHz devices.

- Antennas operating in close proximity may interfere with one another, thus degrading reader performance.
- Interference from other antennas may be eliminated or reduced by using either one or both of the following strategies:
 - Affected antennas may be synchronized by a separate user application using a time-multiplexing strategy.
 - Antenna power can be reduced by reconfiguring the RF Transmit Power setting for the reader.

1.2 Authorized Antennas

The antenna authorized by the FCC for use with the V740 Reader is described below.

IMPORTANT: No other antennas may be used with the V740 Reader without violating FCC regulations. It is the responsibility of the user to comply with this requirement.

1.2.1 Antennas

OMRON Mono-static Antenna(Options)

Model: V740-HS01L, V740-HS01C
Gain: 6 dBi max.
Connector: N
Cable length : 0.3m(0.98')

1.2.2 Antenna Cables(Options)

The only cables authorized by the FCC for use with the V740 Reader are listed below:

Short cable

Model: V740-A01-3.0M
Length: 3.0m(9.8')
Insertion Loss: 1.5 dB min.
Cable Type: 3D-2V
Connector: Reverse TNC to Type N
Cable Diameter : 5.5mm(0.22")

Long cable

Model: V740-A01-10M
Length: 10m(32.8')
Insertion Loss: 1.5 dB min.
Cable Type: 5D-SFA
Connector: Reverse TNC to Type N
Cable Diameter : 7.6mm(0.30")

1.2.3 Setting the Reader RF Power

During initial installation, the reader must be properly configured to use the correct RF power to comply with FCC regulations. DO NOT increase the power beyond the recommended power setting as calculated below.

The maximum RF power is determined from antenna gain and antenna cable loss using the formula:

$$P_{max} = 36 \text{ dBm} - \text{Antenna Gain} + \text{Cable Loss}$$

For example, if the antenna has a maximum gain of 6 dBi, and the cable has a minimum loss of 1.5 dB, the maximum RF power that may be set is $(36 - 6 + 1.5) = 31.5 \text{ dBm}$.

The Reader RF Power is set through the **Settings Page** as described on Page 14.

Note that in no case may the power be set higher than 32.5 dBm.

Recommended Power Settings

Antenna Type	Short Cable/Long Cable
V740-HS01L V740-HS01C	31.5 dBm

1.3 Reader Installation

The following parts are provided with the reader:

Part	Qty.	Part Number
V740-Reader/Writer	1	V740-BA50C04-US or V740-BA50C24-US
Power Supply	1	-

IMPORTANT: Be sure the user reads the section on *Declarations* to maintain compliance with FCC regulations. The Reader and the antennas are to be installed only by professionals at specific locations. For human safety maintain a 23 cm (9.1in) distance from the antennas.

1.3.1 Install the Reader

You can place the reader on a shelf or mount it to a wall. Mounting shelf and wall should be flat to fix the reader securely.

To mount the reader on a wall:

1. Hold the reader in its two mounting location and mark the position of the mounting screws



2. Drill holes for the screws and install wall anchors if required. Be sure anchors must have enough strength to fixed the reader against vibration.
3. Insert the M5x16 screws with spring washers and flat washers and tighten until almost flush with the wall.
4. Slip the reader over the screws and slide down to lock the screws in the keyhole openings.
5. Tighten the screws securely.
6. Fix the AC adaptor so that not to move by vibration and tense DC plug cables. Do not bundle the adaptor cable with other signal or power lines.

Mechanical Loading - Mounting of the equipment in the rack should be such that a hazardous condition is not achieved due to uneven mechanical loading.

1.3.2 Install the Antennas

The antennas can be mounted directly to a variety of surfaces. Mounting surfaces should be flat to fix the antenna securely.

To mount the reader on a wall :

1. Hold the antenna in its mounting location and mark the position of the mounting screws with minimum (4) points. The antenna has several mounting holes for each side. Choose 4 of those with diagonal position according to the mounting location.



2. Drill holes for the screws and install wall anchors if required.
3. Insert the M4x20 screws with spring washers and flat washers and tighten until almost flush with the wall.
4. Tighten the screws securely.

Note: For best performance, mount the antenna in the horizontal orientation as pictured above.

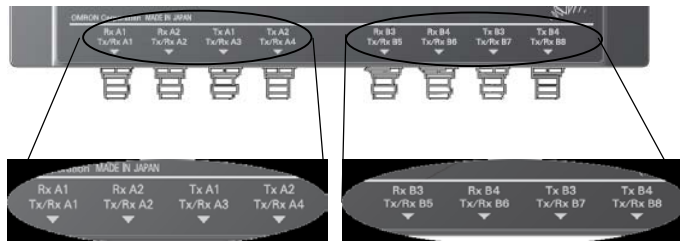
1.3.3 Connect the Reader



- A** = RJ-45 Ethernet port 10/100Base-T
B = Safe Mode button
C = RS232C (Reserved for future use)
D = GPIO
E = DC power input

One to four OMRON Bi-static antennas(V740-HS02C) can be connected to the reader, depending on the application requirements. The upper row silk-screen markings on the reader identifies the port number and antenna connections.

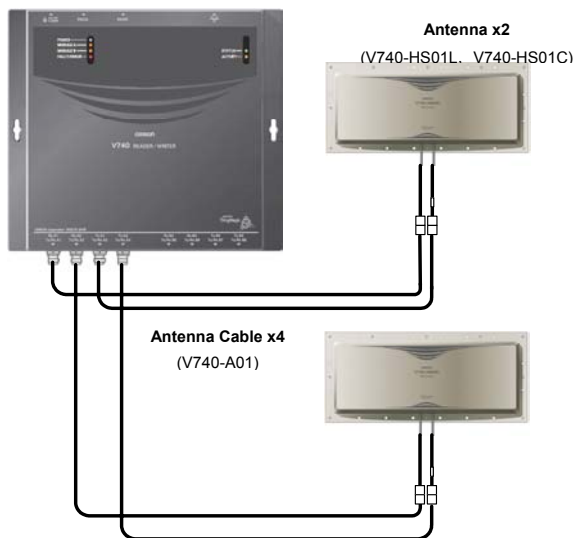
Note: Lower row of silk-screen marking on the reader is reserved for future use.



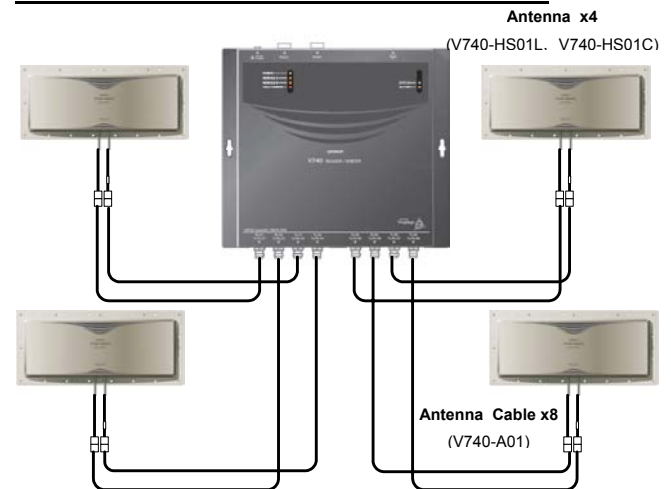
1. Connect required UHF antennas to the antenna ports on the reader .

IMPORTANT: Connect antennas to the antenna ports before applying power to the reader. Any antenna port not having an antenna connected to it will be disabled when the reader is powered on.

Antenna Connection : V740-BA50C04-US



Antenna Connections : V740-BA50C24-US



Note: When two antenna configuration, there are possibility to read the tag by not activated antenna when the tag is located proximately (within 20cm).

2. Verify that all antennas are securely connected.
3. Connect the reader to the network by plugging a Shielded Ethernet cable into the Ethernet port.

or

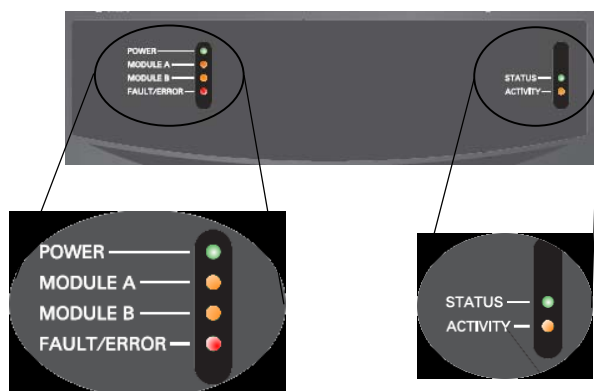
Connect the reader to a PC (personal computer) by plugging a crossover Shielded Ethernet cable into the Ethernet port.

Note: If DHCP is to be used, then the network and server must be connected **before** powering up the reader. If a DHCP server is not found the reader will fall back to the IP address: "10.0.0.101".

Note: If NTP is to be used, then the network must be connected and the server must be available **before** powering up the reader. If a NTP server is not found. The reader will not set the current time.

4. Plug the power adapter provided with the reader into the DC power input connector. Then connect the power cord to a power outlet.

While the reader is powering up, one green light will be on. After the reader finishes its power-on self-test, approximately 45 seconds, the green light will pulse. The reader is now ready for operation.



LED Indicators

Name	Meaning
POWER	Lights while booting. Blinks when the reader is running.
MODULE A	Lights when communicating with tags via MODULE A(Antenna port 1 and 2)
MODULE B	Lights when communicating with tags via MODULE B(Antenna port 3 and 4)
FAULT/ERROR	Lights when system error occurs.
STATUS	Reserved for Future Use
ACTIVITY	Reserved for Future Use

IMPORTANT: DO NOT disconnect power during startup. Disconnecting power while booting the V740 reader may result in improper startup.

1.4 Reader Configuration

In some cases, the application software may provide support for reader configuration. If so, follow the instructions provided with the application.

The following procedure describes how to configure the reader directly from a network PC using the browser-based interface.

The reader is shipped to use DHCP by default but will fall back to the following static network configuration if it does not get a DHCP lease:

IP Address: 10.0.0.101
Subnet Mask: 255.255.255.0
Gateway: 10.0.0.1

You must know the IP address and subnet mask settings for the network environment in which the reader will be running or you may use Apple's Rendezvous™ protocol (download Rendezvous™ from Apple's website) to browse to it. Also if DHCP and the DNS function are available on the server such as Microsoft® Windows® 2000 server operating system, it can tell you an IP address and a hostname.

Note: Please contact Apple about operating the Rendezvous™ technology.

1. Exit any reader applications that are running on the network.

IMPORTANT: Running another reader application while using the browser-based interface may cause a reader error. If this happens, reboot the reader or restart the system using the browser-based interface.

2. Verify that the reader is operational. All LED's should be out except for the green power LED which should be pulsing.
3. Start a Java-enabled web browser from any network-enabled PC. This PC must be configured with an IP address and subnet mask compatible with the reader's settings. For example:

IP address 10.0.0.10
Subnet mask 255.255.255.0

4. Browse to...

http://mercury4 (dhcp name) or

http://10.0.0.101

The V740 Reader browser-based interface to the reader is displayed.

5. Click the **Settings** link in the navigation menu. The Modify Settings page appears.

6. If you wish to use DHCP, modify the "Use DHCP?" setting by selecting the "Yes" radio button; otherwise, enter the required network settings in the IP Address, Subnet Mask, and Gateway fields. The fields will turn red if the gateway is not on the same subnet as the IP address. Then, click the [Save Changes] button.

IMPORTANT: Do not disconnect power until the save process is completed.

7. Set the reader RF power per instructions on page 5 to correspond to antenna and cable types.
8. Verify that the settings shown are correct. Then, restart the reader by disconnecting the power cable and then reconnecting it.

It may take about 60 seconds for the reader to restart. If the reader IP address was changed, you must type the new address into the PC browser address field to communicate with the reader.

IMPORTANT: Do not disconnect and connect power cable at the DC cord. Always disconnect and connect power cable at the AC cord.

9. Once the system restarts, click **Settings**. You are taken to the **Modify Settings** page. Your changes will be saved and then applied. After the reader reconfigures its network interfaces, it will automatically redirect you to its status page. There is no need to restart the reader.

IMPORTANT: Do not disconnect power while the reader is saving its new configuration.

The reader is now ready to receive commands from the network.

10. Use the **Query** page of the browser-based interface to verify the reader and antenna operation by reading tags.
11. Close the browser window. Start an application to control the reader on the network.

1.5 Reader Service

1.5.1 Using the Browser-Based Interface

The browser-based interface communicates directly with the V740 reader. It includes several tools that enable you to monitor reader performance, change reader settings, and upgrade reader firmware.

A navigation menu provides access to the following pages:

- **Status**—Displays current operational settings.
- **Query**—Allows the user to set timing of operation, set antennas, set RF air interface protocols, and read tags.
- **Write**—Allows the user to write tags; this is only applicable to tags that are writeable.
- **Settings**—Allows the user to modify radio and network settings.
- **Firmware**—Allows the user to upgrade the V740 reader with new firmware images supplied by OMRON.
- **Restart**—Allows the user to restart the reader.
- **Diagnostics**—Provides the current operating settings of the reader.
- **Help**—Provides information that is helpful in operating the reader.

The browser-based interface can be run from any PC on the network. Care must be taken to configure the PC with an IP address and subnet mask compatible with the current operational settings of the reader.

To start the browser-based interface:

1. Exit all reader applications on the network.
IMPORTANT: Running another reader application while using the browser-based interface may cause a reader error. If this happens, reboot the reader or restart it using the browser-based interface.
2. Start a Java-enabled web browser from any network-enabled PC.
3. Type the IP address of the reader to which you want to communicate in the address field of the browser or use Apple's Rendezvous™ protocol to browse to it.
4. A navigation menu and the **V740 Reader "Mercury4" Status** page appear in the browser.

Navigation menu

Status	Mercury4 Status	
Query	Device Status	
Write	LAN Connection:	Online
Settings	Wireless Connection:	Disabled
Firmware	Connected Antenna Ports:	Port 1: Connected
Restart	Port 2:	Not Connected
Diagnostics	RadiOS and AFE Versions	
Help	RadiOS Version:	2.0.61 (2005-01-06T16:40:12-05:00)
	Slot 1:	US 2-port UHF (02011101)
	Slot 2:	None
	LAN Configuration	
	LAN IP Address:	10.0.0.103
	LAN Subnet Mask:	255.255.255.0
	LAN Gateway:	10.0.0.1
	LAN MAC Address:	00:00:0A:89:03:4A

Description for each page are the following:

Status Page

The **Status** page shows the current settings of the reader.

Status	Mercury4 Status	
Query	Device Status	
Write	LAN Connection: Online	
Settings	Wireless Connection: Disabled	
Firmware	Connected Antenna Ports: Port 1: Connected Port 2: Not Connected	
Restart		
Diagnostics	RadiOS and AFE Versions	
Help	RadioS Version: 2.0.61 (2005-01-06T16:40:12-05:00)	
	Slot 1: US 2-port UHF (02011101)	
	Slot 2: None	
	LAN Configuration	
	LAN IP Address: 10.0.0.103	
	LAN Subnet Mask: 255.255.255.0	
	LAN Gateway: 10.0.0.1	
	LAN MAC Address: 00:00:0A:89:03:4A	

1. Click the **Status** link in the navigation menu to display the **Status** page.
2. Close the browser window if you are finished using the browser-based interface.

Note: The status of 'Connected Antenna Ports' is displayed as 'Connected' only for the antennas connected to the V740 reader when it starts up.

Query Page

Use the **Query** page to monitor reader performance (read rags). The **Query** page is useful for verifying performance when installation is complete and for troubleshooting performance issues.

The Query field includes a drop-down list (at the bottom-right of the screen) that enables you to specify the operating mode. The operating mode specifies the tag protocols and the maximum number of tags count to be used in conjunction with the Query page.

Note: The selected settings DO NOT affect reader performance associated with other applications.

5 results: Mon Jan 13 03:10:56 EST 2008				
1	25	E1254553A56BC098801	UHF1	EPC1
2	26	EFFA0C12540E1188DC	UHF1	EPC1
3	52	03080507A802001000175572C505	UHF1	EPC0
4	47	03080507A8020010001755C8C3C0	UHF1	EPC0
5	35	03080507A8020010001755FF85F0	UHF1	EPC0

Query: [SELECT read_count, protocol_id, antenna_id, id FROM tag_id WHERE (protocol_id = 'EPC0' or ...)]

Operating Modes (Stock Queries):

- Default
- less than 10 EPC0 tags
- less than 10 EPC1 tags
- less than 20 total EPC0 and EPC1 tags
- less than 20 total EPC0 and EPC1 tags
- less than 50 EPC0 tags
- less than 50 EPC1 tags
- less than 100 total EPC0 and EPC1 tags
- less than 100 EPC0 tags
- less than 100 EPC1 tags
- less than 200 total EPC0 and EPC1 tags

The following operating modes are available for use with the Query page:

Each mode provides the most suitable time out value for the protocols and the number of tags to be read.

- less than 10 EPC0 tags
- less than 10 EPC1 tags
- less than 20 total EPC0 and EPC1 tags
- less than 50 EPC0 tags
- less than 50 EPC1 tags
- less than 100 total EPC0 and EPC1 tags
- less than 100 EPC0 tags
- less than 100 EPC1 tags
- less than 200 total EPC0 and EPC1 tags

Note: The modes that contains ISO18000-6B are not supported in the firmware version 2.0.61.To confirm the version of the firmware see the status page.

To read Tag data;

1. Click the **Query** link on the navigation menu. The Query page appears.
2. Select the operating mode from the pull-down list.
3. Click the **Start** button to begin reading tags.

If there are tags, tag data is displayed. Each entry shows sequential tag number, number of times tag was read, tag data, antenna, and protocol.



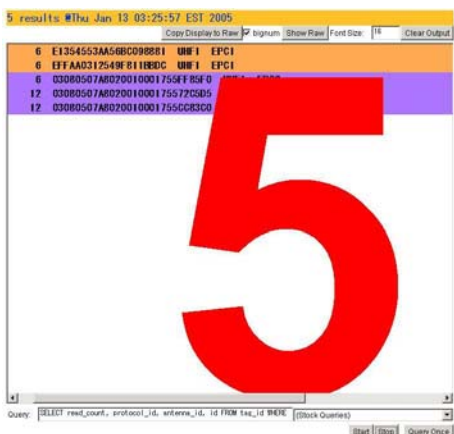
4. Click **Stop** to stop the tag search.

IMPORTANT: You MUST stop the query before changing the operating mode or RQL command. If you do not click STOP before exiting the browser-based interface, the reader will continue to poll antennas.

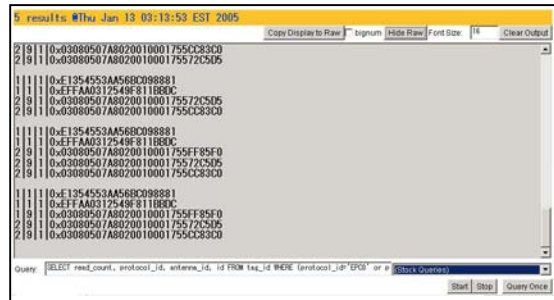
Note: The SELECT clause may be modified. However changing the SELECT clause may cause incorrect display of data.

The Query page provides additional options that enable you to control the data that is gathered and how it is displayed:

- **Bignum** checkbox (when checked) displays the total number of unique tags read. The total is displayed in large red numbers directly over the tags read list. This function is not available when Show Raw screen is displayed.



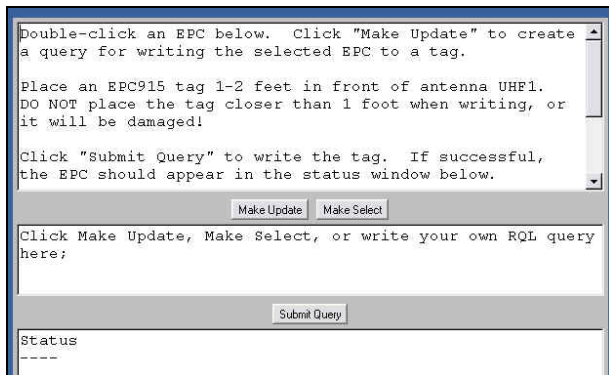
- **Show Raw** button displays raw tag data on the Query page. Each entry shows read count, protocol, antenna, and tag data.



- **Hide Raw** button stops the display of raw tag data.
- **Font Size** text box decides the character size of tags read list. It can be applied from 1 to 128.
- **Clear Output** button clears the tags read list displayed.
- **Query Once** button initiates a single search cycle.

Write Page

To write data, use the Write page to replace the EPC data that is encoded on a 915 MHz EPC Class 1 tag.



Consider the following guidelines when writing to tags:

- Always place a tag 0.3–0.6m (1–2ft) from the antenna when writing data. The tag may be damaged if it is too close to the antenna.
- Only unlocked 915 MHz EPC Class1/1B tags can be used.
- The data to be written must be exactly 16 or 24 hexadecimal characters (numerals from 0–9 and letters from A–F)(16 characters for 64 bit tag, 24 characters for 96 bit tag).
- Always place only one tag in the antenna's field when writing. If multiple tags are present, they will all be encoded with the same EPC data.
- Use the antenna connected to port 1 of the reader

To write data to a tag:

1. Click the **Write** link on the navigation menu. The Write page appears.
2. Type tag ID data in the upper window, type 16 hexadecimal digits for 64bits class 1 tag, or type 24 hexadecimal digits for 96bit class 1B tag.
3. Highlight the hexadecimal data.
4. Click the **Make Update** button. A query designed to write the highlighted data to the tag appears in the center window.
5. Place the tag 0.3–0.6m (1–2ft) from the antenna connected to the port 1.

Verify that no other tags are in the antenna's field.

6. Click the **Submit Query** button to write the data. If the write was successful, the command line and the new tag data appears in the bottom window. If the write is not successful, the response will include an error message.

To read data from a tag:

1. Display the Write page (click the Write link on the navigation menu).
2. Click the Make Select button. A query designed to read data from the antenna connected to the port 1 appears in the center window.
3. Place the tag to be read within the detection zone of the antenna.
4. Click the Submit Query button to read tag data. Query results appear in the bottom window.

Settings Page

Use the **Modify Settings** page to change network settings.

Modify Settings

Use the following dialog to change the reader settings. For help on the acceptable values of a given field, please see Settings Help. Note that these settings only affect non-safe mode operation.

Device Settings

UHF Power (dBm)

32.5

Class 1 96-bit Support¹

On ☒ Off ☐

Hostname²

mercury4

NTP Server³

louis.udel.edu

Domain Name³

Primary DNS Server^{3, 4}

Secondary DNS Server^{3, 4}

Default Gateway

Lan ☒ Wireless ☐

Lan TCP/IP Settings

Use DHCP?

Yes ☐ No ☒

Vendor Class Identifier

mercury2

Use DHCP-Server supplied hostname

Yes ☐ No ☒

LAN IP Address

10.0.0.101

LAN Netmask

255.255.255.0

LAN Gateway

10.0.0.1

Save Changes

1. Leaving Class 1 96-bit support turned off will optimize the reader for better performance by not searching for Class 1 96-bit tags; however, Class 1 96-bit tags will not be read unless this setting is turned on.

2. The hostname will give the device a name; however, resolving the device name from inside your network is dependent upon your DNS server's configuration. With a properly configured DNS and DHCP server the DHCP server will register this name with the DNS server for proper name resolution. If you are not using DHCP you will need to configure the DNS server by hand.

3. When using DHCP, assigning values here will override any DHCP assigned DNS servers. DNS servers are optional; however, if DNS servers are not specified either through DHCP or manually, you will have to specify IP addresses instead of names for each setting as the NTP server.

4. Changing the Wireless Channel is not recommended except for experts. It should only be used to force the Mercury 4 to use a different access point.

5. Note: Changes to NTP servers and DNS servers currently require a reboot.

1. Click the **Settings** link on the navigation menu. The Modify Settings page appears.
2. Enter the required settings.
3. Click the **Save Changes** button to save the new settings.

IMPORTANT: Do not disconnect power until the save process is complete.

The new settings DO NOT take effect until the reader is restarted by rebooting the reader (see 1.5.2 Restarting the Reader on page 15).

Instructions for Modifying the Settings

Changing these parameters changes the readers settings used on startup. Both radio settings and network settings can be modified. Care must be taken to use correct values or you might be unable to connect the reader without restarting into safe mode.

Static network settings are ignored when in DHCP mode, and DHCP related settings are ignored when in static IP mode. Please note that your network needs to have properly configured DNS servers if you wish

to connect to the reader via its hostname. Usually when using DHCP, the DHCP server will add the hostname to the DNS server's database.

The reader adjusts time by NTP only once when it starts up. You should confirm if the time is correct using **Get information** command (Ref. Section 2.2.4.4).

Note: Please ask the network administrator about the network settings in your environment.

Device and LAN settings

Item	Describe	Setting Requirement	Default
Device Settings			
UHF Power (dBm)	UHF Output power in dBm. This setting must be adjusted carefully to comply with FCC regulations.	Mandatory	30.0
Class 1 96-bit Support	Radio button that enables 96-bit tag support. To optimize the reader keep this setting turned off unless it is needed.	-	ON
Hostname	Specify a name that is unique on the network for the reader.	Mandatory	mercury4
NTP Server	Specify the IP address (or machine name) of the server to get current time from the network (either LAN or WAN). The reader obtains correct time from another device since it doesn't have a hardware clock. Example) 129.6.15.8(NIST, Gaithersburg, Maryland)	Optional	(none)
Domain Name	Specify the group name when using devices on the network as a group. Omit unless using devices as a group.	Optional	(none)
Primary DNS Server	Specify the IP address (or machine name) of the server that replaces a domain name with an IP address on the network. It is used at first, the secondary DNS server is used next. Omit if you access by the static IP address.	Optional	10.0.0.1
Secondary DNS Server	Specify the IP address (or machine name) of the server that replaces a domain name with an ID address. The server is used only when the primary DNS server can not find the domain name. Omit if you access by the static IP address.	Optional	(none)
Default Gateway	Select whether the reader uses LAN wired or air interface.	-	LAN(fixed)
LAN TCP/IP Settings			
Use DHCP	Select whether the reader gets an IP address on the network automatically by DHCP or manual setting. You must not check the item if you use a manually set IP address.	Optional	Yes
Vendor Class Identifier	Specify an extra DHCP parameter for integration and customization. It is not supported on the firmware version 2.0.61.	Optional	mercury4
Use DHCP Server Supplied Hostname	Set this to yes to allow the DHCP server to assign the reader a hostname.	-	No
LAN IP Address	Specify a unique IP address on the network when manually set. It is given automatically by the DHCP server, if using DHCP.	Mandatory (in the case of not using DHCP)	10.0.0.101
LAN Netmask	Specify the mask value to determine the network address of the subnet from the IP address. It is not used if using DHCP.	Mandatory (in the case of not using DHCP)	255.255.255.0
LAN Gateway	Specify a unique IP address for the gateway machine only when communicating with the device on another LAN. You don't have to set the item when communicating with the device on the same LAN. Also It is not used if using DHCP.	Optional (in the case of not using DHCP)	10.0.0.1

Firmware Upgrade Page

Use the **Firmware upgrade** page to update firmware. Only the update firmware file provided by OMRON can be used.

1. Click the **Firmware** link on the navigation menu. The **Firmware upgrade** page appears.
2. Place the cursor in the **Filename** field and type the complete network pathname of the firmware file or click the **Browse** button to locate the new firmware file.
3. Be sure to click both check boxes if you want the reader to revert to safe-mode settings(Ref. section 1.5.3.).

The lower check box becomes enabled after clicking the check box above.
4. Click the **Upgrade** button to download the new firmware to the reader.

The status frame at the bottom of the page displays the progress of the upgrade if the web browser supports automatic page reload. Click the **Refresh** button to update the status bar if the web browser does not support automatic page reload.

The firmware downloaded to the reader IS NOT implemented until the reader is restarted.

If an error occurs during the firmware upgrade, use Safe Mode to recover.

IMPORTANT: DO NOT disconnect power from the reader while the firmware is being updated. You may get unpredictable results.

Restart Page

Use the **Restart** page to restart the reader.

1. Click the **Restart** link on the navigation menu. The **Restart Reader** page appears.

2. To restart the reader, click the **Restart System** button. The following dialog box appears.

3. Click **OK**. The following message appears and remains on the screen until the reader restarts. Then the **Status** page appears.

Diagnostics Page

The **Diagnostics** page provides a wealth of information, including the current settings of the reader, comprehensive version information, and current status of network interfaces.

Status	Mercury4 Diagnostics
Query	Device Status
Write	LAN Connection: Online
Settings	Wireless Connection: Disabled
Firmware	Connected Antenna Ports: Port 1: Connected
Restart	Port 2: Not Connected
Diagnostics	RadiOS and AFE Versions
Help	RadiOS Version: 2.0.61 (2005-01-06T16:40:12-05:00)
	Slot 1: US 2-port UHF (02011101)
	Slot 2: None
	Kernel Version: Linux 2.4.22-uc0 2004-10-06T18:27:54-0400
	LAN Configuration
	LAN IP Address: 10.0.0.103
	LAN Subnet Mask: 255.255.255.0
	LAN Gateway: 10.0.0.1
	LAN MAC Address: 00:00:0A:89:03:4A
	Other Settings
	Primary DNS Server: 10.0.0.1
	Secondary DNS Server:
	NTP server: louie.udel.edu
	Uptime: 12:04am up 4 min, load average: 0.99, 0.61, 0.25
	View Log File
	Click the View Log button to view the log file.
	View Log
	There are no log files at this time
	Restart Reader
	Click the Restart System button to restart the reader.
	Restart System

- **View Log** is used for maintenance of the reader. For use by OMRON only.

Help Page

Use the Help page to view descriptions of system operations.

Quick Reference
Status
Displays the current status and configuration of the reader.
Query
Provides a browser-based tag reading interface.
- Click "Start" to start reading tags. - Click "Stop" to stop reading tags. - Click "Show/Hide Raw" to change the output mode. - Click "Query Clear" to reset a limited number of tag readings. "Stock Queries" provides common query strings.
Write
Provides a browser-based tag writing interface.
- Select an EPC from the top box (double-click), mouse drag, or Shift+click. If you want enter your own EPC's here, too. - Click "Write Update" to generate a query that will write the selected EPC. - Click "Submit Query" to execute the query. - Check the results in the bottom box.
Settings
Display and change device settings.
Click "Save Changes" to apply your changes and save them.
Firmware
Updates the reader firmware.
Revert to a new firmware file and click "Upgrade" to send it to the reader. Select the system to make the new firmware take effect.
Restart
Provides a means to restart the reader.
Diagnostics
Displays extended diagnostic information about the reader including log files.

1.5.2 Restarting the Reader

Use this procedure to recover from a reader error.

1. Click the restart link on the navigation menu.
2. Click the **restart** button and the **OK** button on the confirmation dialog.

Wait for at least 60 seconds for the reader to boot up. The Power/Heartbeat LED is solid green while the reader boots. When the LED begins blinking, the boot process is complete.

1.5.3 Using Safe Mode

Use the Safe Mode button on the reader connector panel to recover from errors that disable the reader.

Safe mode operation restores factory default settings as follows:

Firmware Version:factory installed version

Item	Default Value
UHF Power	30.0
Class 1 96 -bit Support	OFF
Hostname	mercury4
NTP Server	louie.udel.edu
Domain Name	thingmagic.com
Primary DNS Server	10.0.0.1
Secondary DNS Server	none
Default Gateway	LAN

The browser-based interface pages are displayed in red when operating in Safe mode and the reader function is restricted. Only functions for changing settings are available, functions for tag operation are not available. In most cases, the reader will need to be reconfigured for operation with the reader application after starting in Safe mode.

1. Disconnect power from the reader.
2. Depress and hold the Safe Mode button, using a nonconductive object, while restoring power to the reader. Keep the Safe Mode button depressed until the reader boots completely (the green Power/Heartbeat LED blinks).



3. Factory-default settings are restored.
4. Use the browser-based interface to configure the reader for use with your system.

This PC must be configured with an IP address and subnet mask compatible with the reader default settings. For example: IP address 10.0.0.10, net mask 255.255.255.0.



5. Click the **Settings** link on the navigation menu and verify the new settings. Be sure to click [SAVE] to store all settings changes.
6. Restart the reader with the new settings. Once the restart is complete, the reader is no longer in Safe Mode.

A navigation menu provides access to the following pages:

- **Status**—Displays current settings in safe mode.
- **Settings**—Displays current settings in normal mode. And allows the user to modify network settings.
- **Firmware**—This page can be used to upgrade the tag reader with new firmware images supplied by OMRON.
- **Restart**—Allows the user to restart the reader.
- **Diagnostics**—This page provides the current operating settings in safe mode.

Help—This page provides information that is helpful in operating the tag reader.

Note: Enabling Safe-Mode resets all settings to factory default. Modify settings in the normal mode as required for the application.

1.6 Tag Fundamentals

Tag Memory Structure

Protocols and the tag memory structures supported by the V740 reader are described below. For additional information regarding tag operation, refer to each tag specification.

Class 0 Tags

Class 0 tags contain 112 bits of read only memory. It consists of EPC Code and Check Code data. 96 bits of them are EPC Code and the rest 16 bits are Check Code data for the EPC Code.

Byte	Bit	Contents
1	0-7	
2	8-15	
3	16-23	
4	24-31	
5	32-39	 EPC Code
6	40-47	
7	48-55	
8	56-63	
9	64-71	 12bytes (96bits)
10	72-79	
11	80-87	
12	88-95	
13	96-103	Check Code (CRC)
14	104-111	

Class 1 Tags

Class 1 tags contain 96 bits of programmable memory. It consists of EPC Code, Check Code data. 64 bits of them are EPC Code, and the first 16 bits of them are Check Code for the EPC Code.

Byte	Bit	Contents
1	0-7	Check Code (CRC)
2	8-15	
3	16-23	
4	24-31	
5	32-39	 EPC Code
6	40-47	
7	48-55	
8	56-63	
9	64-71	 8bytes (64bits)
10	72-79	

Class 1B Tags

Class 1B tags contain 128 bits of programmable memory. The format is almost the same as the Class 1 tags. Bit count of EPC code is 96.

Byte	Bit	Contents
1	0-7	Check Code (CRC)
2	8-15	
3	16-23	
4	24-31	
5	32-39	 EPC Code
6	40-47	
7	48-55	
8	56-63	
9	64-71	 12bytes (96bits)
10	72-79	
11	80-87	
12	88-95	
13	96-103	
14	104-111	

1.7 Specifications

Supported Tag Protocols

915 MHz..... EPC Class 1/1B

Electrical

Reader

UHF operating frequency 902–928MHz
Input voltage 24Vdc, 2.0A

Separate Power Supply

Input voltage Nominal 100–240Vac, 50/60Hz
AC line current Nominal 1.6A at 115V
Output voltage Nominal 24Vdc, 2.5A peak
Certified limited power source

Antenna

Operating frequency 902–928MHz
Gain 6dBi max.
V.S.W.R. < 1.5 :1
Polarization Linear/Circular
Impedance 50ohm
Cable length 30cm(11.8')

Environmental

Reader

Operating temperature: ... 0° to 40°C (32° to 104°F)
Storage temperature: -20° to 65°C (-4° to 149°F)
Relative humidity: 25 to 85%RH non-condensing

Antenna

Operating temperature: -10° to 55°C (14° to 122°F)
Storage temperature: .. -25° to 65°C (-13° to 149°F)
Relative humidity: 25 to 85%RH non-condensing

Mechanical

Reader

Dimension 308 X 286 X 40mm
Weight 1.5kg (3.4 lbs)
Protection IP40

Antenna

Dimension 256X 256 X 57mm
Weight 1.5kg (3.4 lbs)
Protection IP50

Outline Drawings

See on the page 43 to 44.

2. Query Protocol

Reference Guide

This chapter lays the groundwork for the communication protocol between client software running on a remote computer and the V740 Reader. The client software may be a database system, enterprise software, or user software.

In this chapter, we discuss the underlying transport protocol used and present the initial communication protocol RQL. This protocol is loosely based on the SQL language with extensions for a better notion of time. This protocol was designed for rapid prototyping of applications, where a full query to the reader can be encapsulated in a single line of ASCII text. A simple polling mechanism exists for automatically receiving tag events and for testing.

2.1 Transport Protocol

In the current implementation, TCP/IP is used as the transport protocol. TCP is a connection-oriented protocol that provides a reliable, in-order data transport layer with end-to-end checksums and flow control.

2.1.1 TCP Connection Setup and Teardown

A session between client software and the reader consists of connection setup, data transactions, and connection teardown.

At present, all connections are initiated only by the client software. If, for example, the reader is configured to automatically forward events and/or data to the client software but the client software has not established a connection, then no attempt is made by the reader to contact the client software to establish a connection. Furthermore, if an extant connection terminates unexpectedly, the reader will not attempt to contact the client software to re-establish a connection. All responsibility for opening, maintaining, and closing the connection during a session rests with client software.

The client software sets up a TCP socket connection on reader port 8080. After connecting successfully, communication between the client software and the reader can proceed as described below. Once the client software has determined that communication has concluded, the connection must be terminated at the TCP level. In order to prevent synchronization issues, each reader will support only one TCP connection.

Other transport protocols may be used to communicate between the client software and its subjugate readers. The application-level protocol discussed below is neutral with respect to the transport layer.

2.2 Event/Query Protocol

The client software can control the reader using RQL via TCP connection and can acquire data from the readers in two modes: 1) by requesting specific data or 2) by automatically receiving events. The two modes are discussed in further detail in the following subsections.

In order to keep the protocol comprehensive and easy to use, we specify a small set of commands that allow the client software to fully configure the readers and exploit their capabilities.

This minimal set of commands includes the ability to request reads based on several relevant criteria (for example, group reads, range reads, reads by prefix, and so on). The ability to reset the reader database and other control capabilities are also provided.

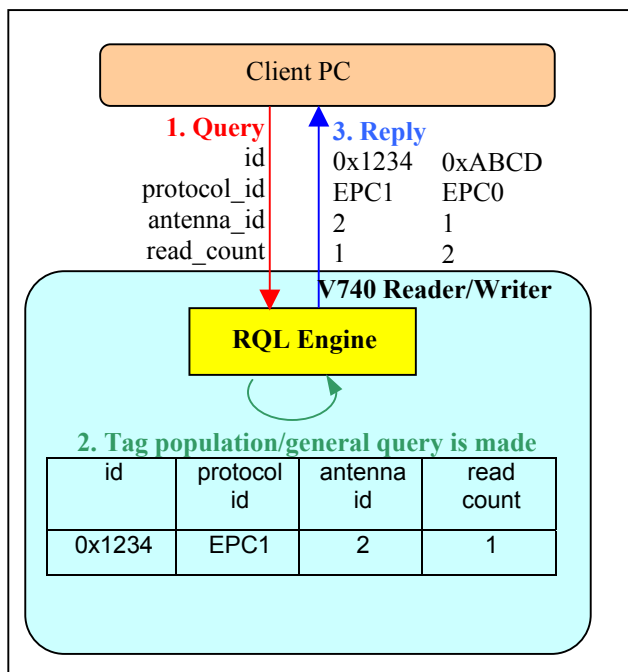


Figure 1 : Conceptual diagram of control flow

2.2.1 Client Software Requests/Functionality

The client software is able to make the following requests of a reader:

- Read IDs of all tags within range of all antennas.
- Read IDs of all tags within range of a given antenna.
- Read IDs of all tags within a certain subset of tag IDs within range of all antennas.
- Read IDs of all tags within a certain subset of tag IDs within range of a specific antenna.
- Read Individual tag IDs within range of a certain antenna or all antennas.
- Read only the IDs of tags communicating a given RF communication protocol.
- Return the number of times a given tag was read per query.
- Read IDs from a variety of tag protocols
- Write IDs to a tag from a variety of protocols as they are supported.
- Register any commands as aliases (cursor) to the V740 reader.
- Execute any aliases (cursor) one time
- Execute any aliases (cursor) repeatedly at the indicated interval.
- Execute any aliases (cursor) repeatedly in the specified term.

2.2.2 General Observations, Commands, and Syntax

We note that a reader behaves very much like database wherein each individual tag represents an entry in the database with a given set of attributes. Due to memory constraints of the reader, the system will remove entries from the database as they are queried.

The syntax for querying against this database is derived from SQL syntax.

In the simplest case, the client software explicitly requests data by polling the readers. The request protocol is implemented in such a way that the client software specifies:

Required information.

- What subset of tags the reader should consider.
- Which read constraints should be applied.

Example commands:

- ```
SELECT id FROM tag_id WHERE
id=0x1234567890ABCDEF AND antenna_id=1 AND
protocol_id='EPC1';
```

Would return a tag only if its tag ID was 0x1234567890ABCDEF.

- ```
SELECT id FROM tag_id WHERE (antenna_id=1
OR antenna_id=2) AND protocol_id='EPC1'
SET time_out=1000;
```

Would return a tag only if the antenna ID was 1 or 2 and will search for at least 1000ms.

Note: The RQL command is terminated by a semicolon. When you use sample commands in this manual, you must input a command in one line without line feed characters.

2.2.3 Extended RQL Command Structure supported by the V740 Reader

Extended Command Set for Data and Write, and Lock operations

ID Read : Identify tags, including anti-collision.

ID Write : Change tag ID

ID Lock : Prevent further changes of tag ID

Kill : Initialize tag

Password : Set a pass-code to kill a tag

Table1: Supported Protocols for each function

Function		EPC1	EPC1B	EPC0
ID	Read	○	○	○
	Write	○	○	N/A
	Lock	N/S	N/S	N/A
Kill		N/S	N/S	N/A
Password		N/S	N/S	N/A

N/S:Not Supported in firmware Ver.2.0.61 N/A:Not Applicable

With the exception of the 'ID Read' command, all commands are protocol and antenna specific and can only be used with a single protocol at a time and with a single antenna at a time. Hence all queries with the exception 'ID Read' need to be constrained to one protocol and one antenna, for example

```
WHERE protocol_id='EPC1' and
antenna_id=1
```

A complete example of an 'ID Write' query would be

```
UPDATE tag_id SET
id=0x0123456789ABCDEF WHERE
protocol_id='EPC1' AND antenna_id=1.
```

'ID Read' (enumerate tags) is, by definition, a multi-target command, since it determines what the individual targets are in the first place.

There are some special cases to the single-target rule. For example, ID Write is semantically tricky – what does it mean to target a tag if its target ID is going to be changing? In the current state of the art, most protocols do not support addressed ID writes (ID write targets all tag IDs) or disallow tag ID changes entirely.

2.2.4 Detailed Command Structure

2.2.4.1 ID Read

The client software would use the SELECT command to read IDs of tags. The SELECT command is for querying the tag population of the reader as well as static variables such as firmware version. The structure of a SELECT command is as follows:

```
SELECT entry_list FROM
table_expression where_specification
[set_specification];
```

Ref. Table 2 for entry_list details.

A SELECT clause is entered as:

```
SELECT entry1, entry2, entry3, ...
```

one or more entries can be specified, for multiple entries, a comma delimiter is required.

A table_expression is specified by only one table name.

```
FROM table
```

In the function ID Read, you always use 'tag_id' as a table name. And so the table_expression is as follows:

```
From tag_id
```

A where_specification is entered as:

```
WHERE boolean_expr
```

boolean_expr can consist of any expression which evaluates to a boolean value. In many cases, this expression will be:

```
entry binary_operator value
```

where *binary_operator* can be one of =, <, <=, >, >=, <>, AND, or OR. Parentheses may also be used to create associations of subexpressions. In the presence of a 'where_specification', SELECT will not return any rows for which the WHERE condition does not evaluate to TRUE.

Note: You must specify one or more protocols in 'where_specification'.

A set_specification is entered as:

```
SET expression
```

expression consists of entry and the value.

In response, all IDs delimited by LF code are sent. The format is as follows:

```
[id1] <LF> [id2] <LF>.....[idn] <LF><LF>
```

The response includes the check code and ID. The first 4 digits are the check code, and the ID follows for the EPC1/1B protocols. For EPC0, the 24 digits ID is first, followed by the 4 digit check code.

Below are some examples for reading tag ID:

- To query a tag on a specific antenna and protocol, you can specify a specific antenna and protocol in the 'where_specification':

```
SELECT id FROM tag_id WHERE
antenna_id=1 AND protocol_id='EPC1';
```

```
SELECT id FROM tag_id WHERE
antenna_id=2 AND protocol_id='EPC0';
```

The first specifies 1 as an antenna id, and EPC1 as a protocol id. The second specifies 2 as an antenna id, and EPC0 as a protocol id. The reader searches tags that corresponds to the condition, and returns the tag ID if the tag is present followed by LF code, an empty event (only LF code) results if tags matching the 'where_specification' are not present.

- To query a tag on multiple antennas and protocols, you can specify multiple antennas and protocols by 'OR' operator in the 'where_specification':

```
SELECT id FROM tag_id WHERE
(antenna_id=1 OR antenna_id=2) AND
protocol_id='EPC1';
```

```
SELECT id FROM tag_id WHERE
antenna_id=2 AND (protocol_id='EPC1'
OR protocol_id='EPC0');
```

The first specifies 2 antennas, and the second specifies 2 protocols.

- To query a specific tag, given its EPC code, one can specify a specific tag with an ID as a hexadecimal number:

```
SELECT id FROM tag_id WHERE
id=0x1234567890ABCDEF AND
antenna_id=1 AND protocol_id='EPC1';
```

When Indicating id in the 'where_specification', the reader searches the ID from the higher order. If the value is shorter than 16 digit for EPC1(24 digit when using EPC1B), it examines only upper bits.

```
SELECT id FROM tag_id WHERE
antenna_id=1 AND protocol_id='EPC1' AND
id=0x1234;
```

- To query a specific sub class of tags, given a range of tag ID values:

```
SELECT id FROM tag_id WHERE
protocol_id='EPC1' AND
tag_id>=min_tag_id AND
tag_id<=max_tag_id;
```

The reader returns the tag ID values for all the present tags between *min_tag_id* and *max_tag_id*, which are hexadecimal values.

- To query tags by specific or all antennas:

```
SELECT id FROM tag_id WHERE
antenna_id=1 AND protocol_id='EPC1';

SELECT id FROM tag_id WHERE
protocol_id='EPC1';
```

At the first, the reader searches tags only by antenna 1. Second the reader searches tags by all antennas available. Omitting the antenna indication in the 'where_specification' means to search all antennas available.

Note: When specifying multiple antennas even if an antenna that does not exist is specified, the reader obtains the tag ID only using antenna 1 and doesn't return any an error message.

```
SELECT id FROM tag_id WHERE
(antenna_id=1 OR antenna_id=5) AND
protocol_id='EPC1';
```

- The client software can specify multiple entries in the *select_list* field of the SELECT command:

```
SELECT id, antenna_id FROM tag_id
WHERE antenna_id=1 AND
protocol_id='EPC1';

SELECT protocol_id, timestamp, id,
antenna_id FROM tag_id WHERE
antenna_id=1 AND protocol_id='EPC1';
```

The first example returns the tag IDs and antenna_ids, and the second returns protocol_ids and the time that the tag was read (seconds from the unix epoch, Jan 1, 1970) with the tag IDs and antennas_ids.

Note: To read timestamp, the NTP sever must be set up in advance.

The reader returns protocol_id as an integer value. The value '1' represents 'EPC1', and the value '9' represents 'EPC0'. For example, the query with protocol_id and the response is as follows:

```
[Query] SELECT protocol_id, id FROM
tag_id WHERE antenna_id=1 AND
protocol_id='EPC1';
```

```
[Res] 1|0xCE7911111111111111111111<LF><LF>
```

- To query EPC0 tags:

When the client software reads tags of the 'EPC0' protocol, it should indicate 'read_count>1' in the 'where_specification'.

For example, the command is as follows:

```
SELECT id FROM tag_id WHERE
antenna_id=1 AND protocol_id='EPC0' AND
read_count>1;
```

To read EPC1 and EPC0 tags at the same time:

```
SELECT id FROM tag_id WHERE
protocol_id='EPC1' OR
(protocol_id='EPC0' AND read_count>1);
```

Note: If you don't specify the 'read_count>1', the reader returns ghost data occasionally. 'Ghost data' means the data which is returned even if tags do not exist in the antenna field.

- To query during a specific time:

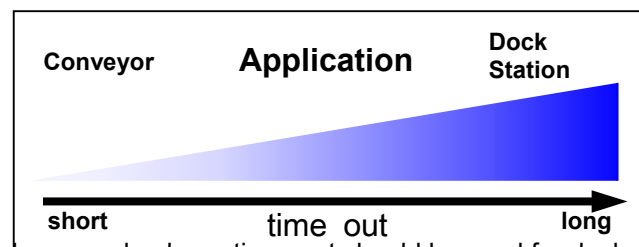
```
SELECT id FROM tag_id WHERE
antenna_id=1 AND protocol_id='EPC1'
SET time_out=500;
```

The command imposes a time out constraint of 500ms; i.e., the reader stops reading and returns all collected data after 500ms. The order in which specifying arguments are used is irrelevant. The default timeout is 250ms if none is specified.

It is important to always use a timeout in specifying a query to achieve optimal performance for a given application. Detailed information will be discussed in the next section

Timeout

The client software can impose a time limit on a read operation, requesting the reader to search only for a limited time (specified in milliseconds). The reader may fail to detect some tags if insufficient time is allocated to the search operation. The *time_out* is the parameter used for specifying the time allocated for the read operation.



In general, a large *time_out* should be used for dock stations (>2000ms), and short *time_out*s should be used for conveyor belts (<100ms).

```
SELECT id FROM tag_id SET time_out=1000;
```

(See 3.2 Communications Time)

The constraints on the scheduler in the reader for the time_out are shown below. Time is equally divided among the specified protocols. The reader searches sequentially for each antenna in the time provided for the protocol. When the last antenna completes searching, the reader returns to the first antenna again. Following chart shows an example of time schedule given by the model command as below.

```
SELECT id FROM tag_id WHERE
(protocol_id='protocol1' or
protocol_id='protocol2') and
(antenna_id=ant1 or antenna_id=ant2);
```

time_out							
protocol 1				protocol 2			
ant1	ant2	ant1	...	ant1	ant2	ant1	...

The antenna arbitration algorithm is optimized to maximize the read rate of all the tags in the field. For EPC0, each antenna will be given 150ms of search time. The time division for each antenna within a protocol is determined automatically by the reader and cannot be specified by the user.

It is important to specify the protocols in the RQL commands, if no protocol is specified, the reader searches for tags using all possible protocols, resulting the slower read rates. When specifying multiple protocols, calculate the minimum time_out value using the following calculation.

minimum time_out = max{# of protocol 1 tags x read time of (1) tag), (# of protocol 2 tags x read time of (1) tag),...} x (# of protocols) x (# of antennas) (ms)

e.g. if 40 EPC0 tags takes 450 ms (cf. 3.2 Communications Time) and 10 EPC1 tags takes 20 ms per tag on average. With two antennas:

minimum time_out =
max{450, 10 x 20} x 2 x 2 = 1800 ms.

As another example, if the goal is to search for EPC1 and EPC0 tags on antennas 1, 2 for 20 strong tags on each protocol. The query specified is;

```
SELECT read_count, protocol_id,
antenna_id, id FROM tag_id WHERE
(antenna_id = 1 OR antenna_id = 2)
AND (protocol_id='EPC1' OR
protocol_id='EPC0') SET
time_out=700;
```

time_out 700 ms						
EPC1 350 ms				EPC0 450 ms		
ant1	ant2	ant1	...	ant1	ant2	ant1

EPC0 and EPC1 will each get a 350 ms slot. This will allow all 20 EPC0 tags to be read, but not all EPC1 tags.

If the EPC0 tags are present only on the 2nd antenna, the reader will never arbitrate time to this antenna. A better query would be:

```
SELECT read_count, protocol_id,
antenna_id, id FROM tag_id WHERE
(antenna_id = 1 OR antenna_id = 2) AND
(protocol_id='EPC1' OR
protocol_id='EPC0') SET time_out=1600;
```

time_out 1600 ms							
EPC1 800 ms				EPC0 900 ms			
ant1	ant2	ant1	...	ant1	ant2	ant1	...

Both EPC0 and EPC1 will get 800 ms: each antenna for EPC0 will get 400 ms (above 150ms) should read all 20 EPC0 and 20 EPC1.

Note: It is caused by following reasons that difference between the time_out value actual time required for reading.

1. It spends 20 ms to switch protocols.
2. It is fixed on 150 ms to read EPC0 tag.

The max of the difference can be calculated by summing up the time caused by the reasons. You need consider time lag to avoid mutual interface due to time sharing.

Table 2: Table Schema - Tag Read

Keyword	Entry	Table	Arguments	Range	Example Value	Comments
SELECT	id	tag_id	Hex String	-	0xFEDCBA0987654321	Requests the id tag data (tag id) of the tag
	antenna_id	tag_id	Int	-	2	Requests the antenna id used to read the tag
	protocol_id	tag_id	Int	-	9 (EPC0), 1 (EPC1/1B)	Requests the protocol id of the tag
	read_count (*1)	tag_id	Int	-	1	Requests the number of times a tag ID was read
	timestamp	tag_id	String	-	1101973245.003590	Requests the time M4 read data from the tag. To get the correct time, you need to adjust the clock by setting NTP server.
FROM	tag_id	-	-	-	-	The name of the internal tag data table(fixed)
WHERE	antenna_id	tag_id	Int	[1...4]	1	Specifies the antenna used to read a tag
	protocol_id	tag_id	String	'EPC1' or 'EPC0'	'EPC1'	Specifies the protocol used to read a tag. Must be uppercase.
	read_count	tag_id	Int	1 and over	2	Specifies the number of times a tag was read
	id	tag_id	Hex String	-	0xFEDCBA0987654321	Specifies the tag id to be read.
SET	time_out	tag_id	Int	[1...65535]	500	Specifies the amount of time the SELECT command will read tags in milliseconds.

Note(*1): If you specify 'read_count' on 'EPC1' protocol, the reader returns '1' due to the search algorithm.

2.2.4.2 ID Write

The UPDATE command is used to write new data to a tag. This can be used to write a new tag_id. The structure of an UPDATE command is as follows:

```
UPDATE table_expression set_specification
    where_specification;
```

table_expression and entries specified in set_specification are provided in Table 3.

A table_expression is specified by only one table name:

```
UPDATE tag_id
```

A set_specification is entered as:

```
SET entry=value
```

A where_specification is entered as:

```
WHERE boolean_expr
```

In a where_specification, both protocol_id and antenna_id must be specified.

The tag_id (tag data) is returned with a check code as follows:

```
EPC0: [id][check_code]<LF><LF>
```

```
EPC1:[check_code][tag_id]<LF><LF>
```

The 'where_specification' is specified in the same manner as the SELECT in the previous section.:

- Example : To write tag data(tag_id) a 64-bit EPC tag:

```
UPDATE tag_id SET id=0x1234567890ABCDEF
WHERE protocol='EPC1' AND antenna_id=1;
```

The reader returns the tag_id if the write operation was successful. For example the response is as follows:

```
0xCE851234567890ABCDEF<LF><LF>
```

In this case, "CE85" is the check code.
"1234567890ABCDEF" is tag data(tag id).

If the operation is failed, "Error 0102: Error performing query<LF><LF>" returend.

Note: The format of the tag data in the command must much the selected protocol or an error will result.

For example :

- A 64 bit EPC1 tag requires 16 hexadecimal digits
- A 96 bit EPC1 tag requires 24 hexadecimal digits

(See section 1.6)

If wrong data is written to the tag, the tag may be unreadable. In this case, write correct tag ID again, after that, the tag would turn to be readable.

Table3 : Table Schema - Tag Write

Keyword	Entry	Table	Arguments	Range	Example Value	Comments
UPDATE	tag_id	-	-	-	-	Tag id data database table(fixed)
SET	id	tag_id	Hex String	-	0xFEDCB A0987654 321	Specifies the tag id(tag data) to be written
WHERE	antenna_id	tag_id	Int	[1...4]	1	Specifies the antenna used to read a tag
	protocol_id	tag_id	String	'EPC1'	'EPC1'	Specifies the protocol used to read a tag. Must be uppercase.

2.2.4.3 Reader Control

The client software can register a command with a cursor name to the reader. This section describes Cursors(Stored Procedures or Aliases) and Reader settings.

i. Cursors

Declare

The client software has the ability to declare cursors (saved queries), which it can then use to request data repeatedly using the FETCH or the AUTO_MODE command. Only One cursor can be executed at one time. A maximum of 16 cursors can be defined.

To create a cursor:

```
DECLARE cursorname CURSOR FOR query;
```

cursorname — an arbitrary string.

query — an RQL query (SELECT/UPDATE statement), as defined above.

If the query is valid in its syntax,an empty event (only LF code) is returned. If invalid, an error message is shown(Ref. Table 6).

Example:

```
DECLARE cursor1 CURSOR FOR SELECT id,
antenna_id FROM tag_id WHERE
protocol_id='EPC1';

DECLARE cursor2 CURSOR FOR UPDATE
tag_data SET id=0xFEDCBA9876543210
WHERE protocol_id='EPC1' and
antenna_id=1;
```

Note: Commands for getting information and setting the separator can not be used as cursors.

Close

To close(delete) a cursor and free its resources(only 16 cursors may be defined simultaneously). Only one cursor can be closed at one time. The client software issues the command:

```
CLOSE cursorname;
```

If the cursorname is valid, following the command, an empty event (only LF code) is returned.

Reset

To reset the reader RQL server, for example, if the RQL state is undefined or questionable, use:

```
RESET;
```

Following the command, an empty event (only LF code) is returned. The command returns the RQL

daemon to its initial state; that is, resets the reader, deletes cursors used clears memory.

ii. Execution

Commands stored as cursors can be executed in 3 ways as described below.

Fetch

To execute the stored cursor,a FETCH command is sent by the client software. Only one cursor can be executed at one time.

```
FETCH cursorname;
```

which performs all actions appropriate to the declared query and sends the result back.

Example:

```
DECLARE cursor3 CURSOR FOR SELECT id,
antenna_id FROM tag_id WHERE id =
0x1111111111111111 AND
protocol_id='EPC1';

FETCH cursor3;
```

could return:

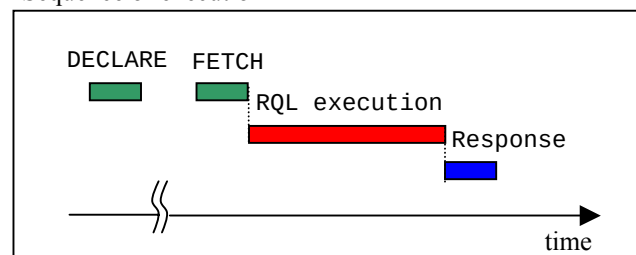
if the tag was read by antenna 2,

```
0xCE79111111111111|2<LF><LF>
```

or if the tag was not found.

```
<LF>
```

Sequence of execution



Auto Mode

The client software may switch the reader into Auto Mode, causing the reader to repeatedly execute a cursor indefinitely.

```
SET auto cursorname = ON, repeat = interval;
```

For example,

```
DECLARE cursor4 CURSOR FOR SELECT id,
antenna_id FROM tag_id WHERE
protocol_id='EPC1' SET time_out=250;

SET auto cursor4 = ON, repeat = 500;
```

Every 500 milliseconds, the cursor executes for 250milliseconds querying for tags. The remaining 250

milliseconds are spent with cursor idle(RF off). This syntax can be used for controlling the duty cycle of the reader. For full reader utilization, ensure that the value of *time_out* is less than the value of *repeat*, if not the cursor is executed continuously.

Auto Mode can be terminated by sending the command:

```
SET auto = OFF;
```

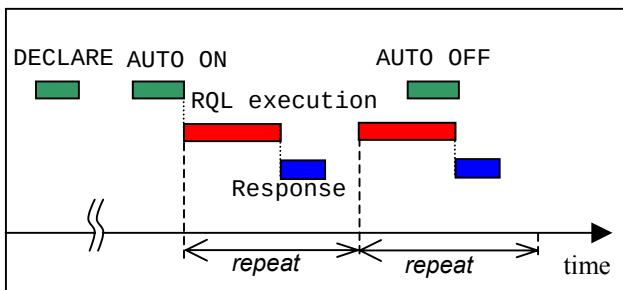
No other command can be used while Auto Mode is active.

To schedule intermittent reads with off times of 1 second starting at a specific time use:

Example:

```
DECLARE cursor5 CURSOR FOR SELECT id
FROM tag_id WHERE protocol_id='EPC1'
SET time_out=500;

SET auto cursor5 = ON, repeat = 1000;
(get responses...)
SET auto = OFF;
```



Scheduled Reads

The reader uses the Network Time Protocol as a means to establish absolute time on the reader. With that capability in place the reader is enabled to execute tag operations that have been scheduled relative to absolute time. The reader adjusts UTC time of the NTP server, whatever time zone it works on. Here is how it works.

First the user declares a cursor , in a way similar to how to you use cursors in auto mode.

To run the query once at a specific time you use a command of the form:

```
SET trigger_time cursorname = 'starttime';
```

To run the query in auto mode over a given interval:

```
SET auto_time cursorname = 'starttime',
repeat=interval;
```

or

```
SET auto_time cursorname =
'starttime/stoptime', repeat=interval;
```

The first form here starts the auto mode at a given time, and then just continues until you stop it, the same way you would stop normal auto mode.

The second form runs during the specified interval.

The start and stop time are specified in ISO8601 time strings, of the form

```
YYYY-MM-DDTHH:mm:ss.DDDDZZZZZ
```

Where YYYY is the year, MM is the month, DD is the day, HH is the hour, mm is the minute, SS is the second, and DDDD is the fraction of a second, and ZZZZZ is the time zone. The seconds and fractions of a second are both optional (but if you want fractions of a second, you must specify seconds as well). The time zone can either be specified as GMT or Zulu time by using a 'Z' or it can be an offset from GMT using +HH:MM or -HH:MM. For example, in Eastern time, that would be -05:00.

Some examples:

```
C6: DECLARE cursor6 CURSOR FOR SELECT id
FROM tag_id WHERE antenna_id=1 AND
protocol_id='EPC1';
```

```
C7: DECLARE cursor7 CURSOR FOR SELECT id
FROM tag_id WHERE antenna_id=2 AND
protocol_id='EPC1';
```

To run c6 once on February 14th 2004 at 18:54:50 GMT:

```
SET trigger_time cursor6 = '2004-02-14T18:54:50Z';
```

To run c7 for 10 seconds starting in intervals of 1000 ms at 2004-01-20 at 15:37 in Eastern Standard Time:

```
SET auto_time cursor7 = '2004-01-20T15:37-05:00/2004-01-20T15:37:10-05:00', repeat=2000;
```

Note: If only the start time is specified, and the current time has passed the start time, the cursor is executed immediately.

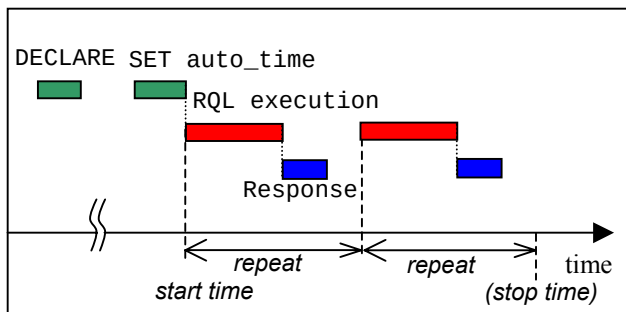
If the current time has passed the start time and the stop time specified in the future, the cursor is executed immediately and finished at the specified stop time.

Example:

The following example schedules reads to execute 1 time per second with an off time of 750ms, starting at a specific time:

```
DECLARE cursor8 CURSOR FOR SELECT id
FROM tag_id WHERE protocol_id='EPC1';

SET auto_time cursor8 = '2004-01-
22T12:43:08-05:00', repeat=1000;
```



iii. Setting

Separator

The client software can change the separator between the entries of the response for ID reading.(Ref. 2.2.4.1 ID Read).

```
SET separator = 'c';
```

Following the command, an empty event (only LF code) is returned. The default separator is '|'. The separator must be one character. Example is as follows:

```
SET separator='#';

SELECT id, protocol_id, antenna_id FROM
tag_id WHERE protocol_id='EPC1';
```

The response would be as follows.

```
0xCE85123467890ABCDEF#1#1<LF><LF>
```

Table4 : Table Schema - Reader Control

Keyword	Entry	Table	Arguments	Range	Example Value	Comments
DECLARE	-	n/a	cursorname, query	-	cursor1	Defines the cursor name for the query.
FETCH	-	n/a	cursorname	-	cursor1	Executes a cursor and sends the data
CLOSE	-	n/a	cursorname	-	cursor1	Deletes a defined cursor
RESET	-	n/a	-	-	-	Resets the reader, deletes cursors, clears memory
SET	tirgger_time	n/a	cursorname, time	-	-	Set a cursor to run at the specified time once.
	auto_time	n/a	cursorname, start time, stop time	-	-	Set a cursor to keep running from the start time to the stop time repeatedly.
	auto	n/a	cursorname, ON, OFF	-	cursor1 = ON	Turns auto-mode of cursors on/off.
	repeat	n/a	Integer	-	-	Sets a cursor to keep running
	separator	n/a	character	except ,, ,	' '	Changes the separator in the output format of a query.

2.2.4.4 Get Information

The client software can get the information about the status of the reader. For example, firmware version and current time of the system. To get firmware version information, The format is as follows:

```
SELECT entry FROM table_expression
```

Table5 : Table Schema - Get Information

Keyword	Entry	Table	Arguments	Range	Example Value	Comments
SELECT	version	Firmware	String	-	2.0.61 (2005-01-06T16:40:12-05:00)	Requests the firmware version of the reader
	current_time	Settings	String	-	2005-01-01T00:01:39.891808	Requests the current time of the reader.
FROM	Firmware	-	-	-	-	Table for the information about the reader's firmware.
	Settings	-	-	-	-	Table for the information about the reader's settings.

2.2.5 Errors

If the reader is unable to execute a command issued by the client software, the reader issues an error message, which has the basic form:

Error *error_code* : *string*

where *error_code* is an integer. Error codes and strings are documented in Table 6.

For example:

```
DECLARE cursor9 CURSOR FOR SELECT id
FROM tag_id;
FETCH cursor10;
```

Would result in the error message:

```
Error 0100: Cursor does not
exist<LF><LF>
```

Table 6: Error codes and Strings

Error Codes	Strings	Explanation/Cause
0100 : ERROR_INVALID_ARGUMENTS	No protocol specified	Indicates missing or more than 17 protocol_id are declared(only for UPDATE command)
	Too many protocols specified	Indicates too many protocols are declared (only for UPDATE command)
	No antenna specified	Indicates more than 17 antenna_id or no antenna are declared (only for UPDATE command)
	Too many antennas specified	Indicates multiple antennas are declared(only for UPDATE command)
	Unknown table	
	Cursor already exists	Declared cursor name already exists
	Unknown setting	Indicates no entry item in the table
	Cursor does not exist	Fetch non-existent cursor
	Unknown field	Indicates items for GetInfo command (only for UPDATE command)
	Invalid set clause entry	
	DELETE: Cursor does not exist	Indicate a cursor name for CLOSE command that is not defined by DECLARE command
	Start_time not specified correctly	Indicate time format incorrectly for start or finish time.
	time_out value out of range	Set sleep time_out value out of range
	Unknown protocol	Indicates nonexistent protocol
	Syntax Error	Syntax error or spelling mistake etc
	Invalid argument	
0101 : ERROR_INVALID_DATA	Unknown setting	
	Time is invalid	
	Unknown protocol ID	
	Invalid command in current mode	Execute a command while another command is running on auto mode
0102 : ERROR_REMOTE	Error performing query	Tag is absent. argument is illegal.(only for UPDATE command)
	Error setting ping threshold	
	Error setting saved ping threshold	
	Error setting saved IP address	
	Error setting saved gateway	
	Error setting saved netmask	

	Error setting firmware version	
	Error setting safemode version	
	Error setting OS version	
	Error setting supported protocols	
	Error getting operation state	
0106 : ERROR_INVALID _ANTENNA	Antenna does not exist in current hardware configuration	Antenna does not exist in current hardware configuration.
0107 : ERROR_UNCON NECTED_ANTEN NA	Antenna port exists.But no antenna connected	Antenna port exists.But no antenna connected.
0128: ERROR_UNKNO WN	Tag data access failed	Table name on update command is invalid
	Error getting entry	
	Error getting ip address entry	
	Error getting netmask entry	
	Error getting gateway entry	

2.2.6 Protocol Specific Functionality and Parameter Settings

While the standard ID_read and anti-collision searches are supported by practically all offered protocols, therefore no protocol-specific information is required to issue RQL search. More specific commands, such as data_read and data_write require protocol specific information when formatting the query and interpreting the results. The tables below provide that information.

2.2.6.1 915 MHz EPC Class 1/1B

		Parameters / Constraints	Return Value (String)	Example
ID	Read	()	Class1: 80 bits (64 bits ID and 16 bits CRC, hex format) Class1B: 112 bits (96 bits ID and 16 bits CRC)	SELECT id FROM tag_id WHERE protocol_id='EPC1';
	Write	id: 64 bits or 96 bits (hex)	new_id or error_code with string	UPDATE tag_id SET id=0x1234567890ABCDEF WHERE protocol_id='EPC1' AND antenna_id=1;
	Lock	N/S	-	-
Kill		N/S	-	-
Password		N/S	-	-

Note: The state of the tag becomes 'Quiet' after reading by RQL. If you wish to communicate with the tag using a 2nd reader, a 'Talk' command must be sent to change the tag to active mode.(for more detailed information about the status of the tag see 'Communication Interface Specification' for EPC1)

2.2.6.2 915 MHz EPC Class 0

		Parameters / Constraints	Return Value (String)	Example
ID	Read	()	112 bits (96 bits ID and 16 bits CRC)	SELECT id FROM tag_id WHERE protocol_id='EPC0' AND read_count>1;
	Write	N/A	-	-
	Lock	N/A	-	-
Kill		N/A	-	-
Password		N/A	-	-

2.3 Examples

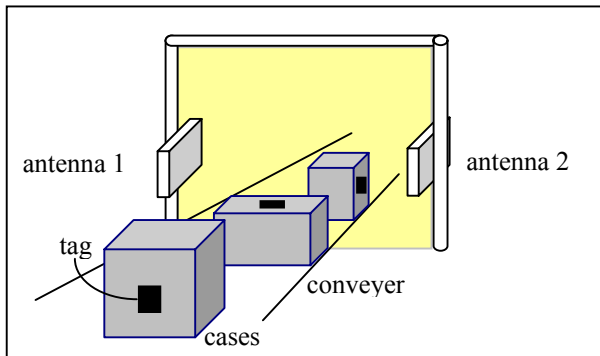
Examples given in this chapter are provided as a guide for the user in determining suitability and does not constitute a warranty. Users must verify operation in their specific environment and application.

2.3.1 Example 1

To read tags attached to cases passed through a gate on a conveyor, the client software finds tags using 2 antennas. For the example pictured below, the command is as follows:

```
SELECT id, antenna_id FROM tag_id
WHERE (antenna_id=1 OR antenna_id=2)
AND protocol_id='EPC1' SET
time_out=500;
```

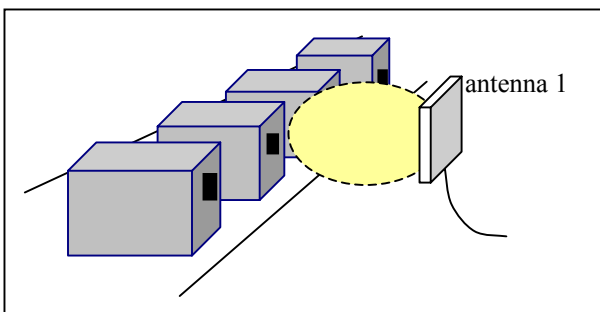
Then the reader continues to read tags through the gate.



2.3.2 Example 2

To read tags and send a response repeatedly every 1 second using one antenna. For the example pictured below, the command is as follows:

```
DECLARE query1 CURSOR FOR SELECT id
FROM tag_id WHERE antenna_id=1 AND
protocol_id='EPC1' SET time_out=500;
SET AUTO query1=ON, repeat=1000;
```



2.3.3 Example 3

To synchronize two readers see the following instructions.

On Reader 1:

```
DECLARE cursor_one CURSOR FOR SELECT
id FROM tag_id WHERE
protocol_id='EPC1' SET time_out=300;
SET auto_time cursor_one = '2005-02-
01T13:00:00Z', repeat=1000;
```

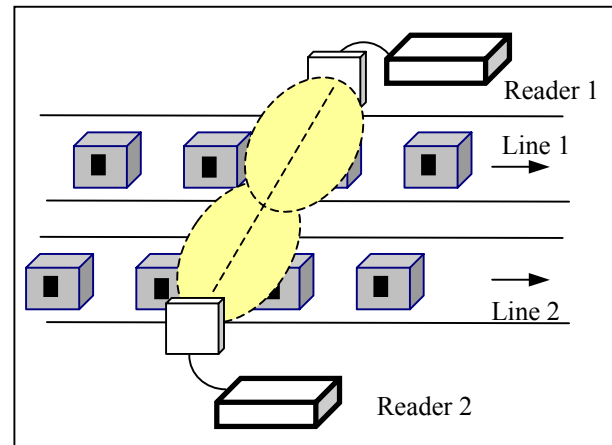
The first reader will start reading for no less than 300 ms at just 13 o'clock, and it will repeat the command 1000ms.

On Reader 2:

```
DECLARE cursor_two CURSOR FOR SELECT
id FROM tag_id WHERE
protocol_id='EPC0' AND read_count>1
SET time_out=300;
SET auto_time cursor_two = '2005-02-
01T13:00:00.5Z', repeat = 1000;
```

The second reader will start reading for no less than 300ms starting at time 0.5 second after 13 o'clock, and it will repeat the command every 1000ms.

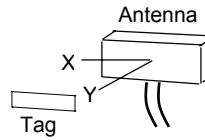
The effect will be that each reader will have a almost 50% duty cycle with each one only active when the other one is off.



3 Characteristics(Reference)

Characteristics data given in this chapter is provided as a guide for the user in determining suitability and does not constitute a warranty. Actual performance may vary based on actual user conditions.

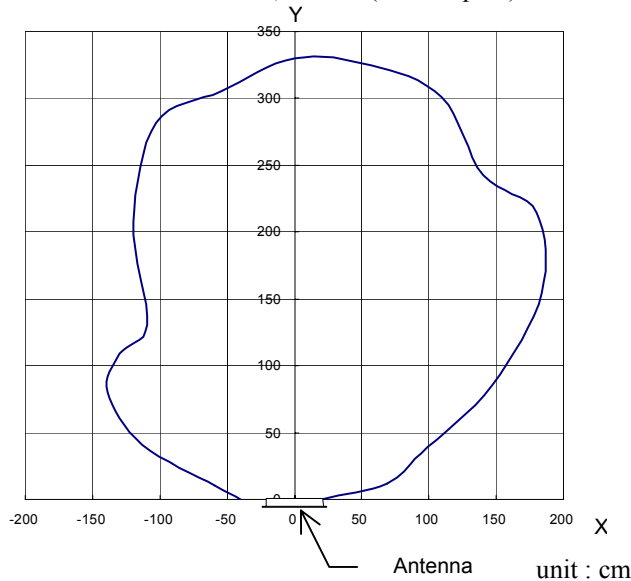
<Measurement Set-up>



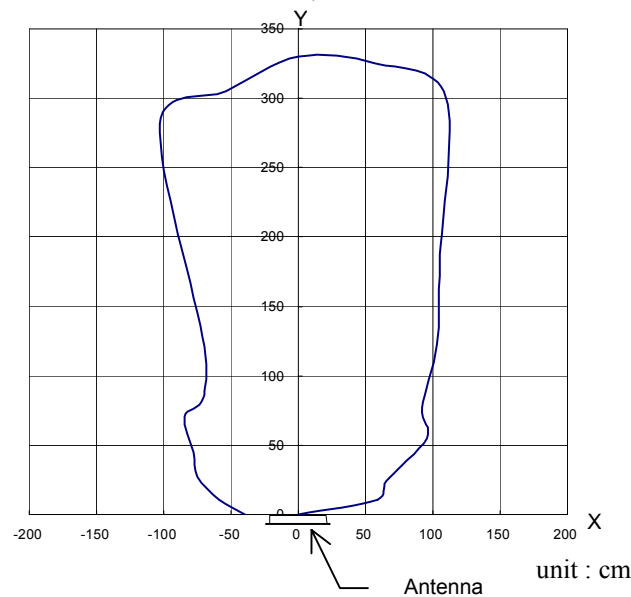
- *. There are no RF reflection objects around the Antenna and Tag in the measurement environment.
- *. There are some areas where communication is possible outside the communications range shown in the graph by the effect of reflection off of the ground.
- *. Tag attached to styrene resin.
- *. The UHF power setting of the reader is "31.5" dBm with 3.0m cable.

3.1 Communications Range

EPC Class 0 : X1020-LBL,Matrics (Dual Dipole)



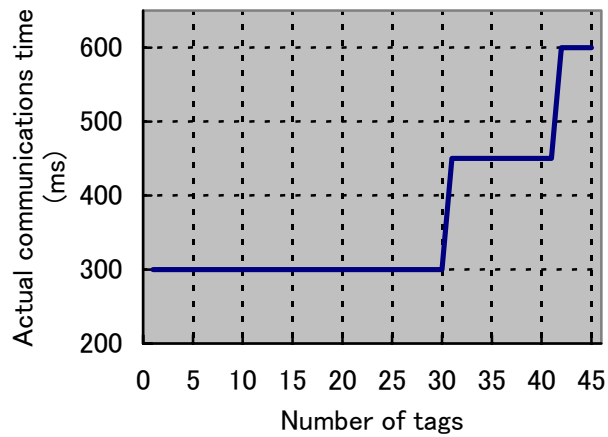
EPC Class 1b : V740-D12P01, OMRON



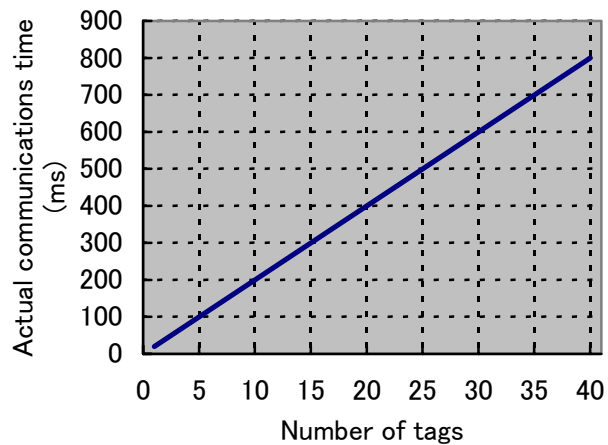
3.2 Communications Time

Communications time varies for several reasons such as the actual noise environment and the distance between tags and antennas. The chart below shows the communication time vs. the number of tags in the antenna read range. One may use the communication time value as a reference when setting time out values in the RQL command.

Class0 Tags

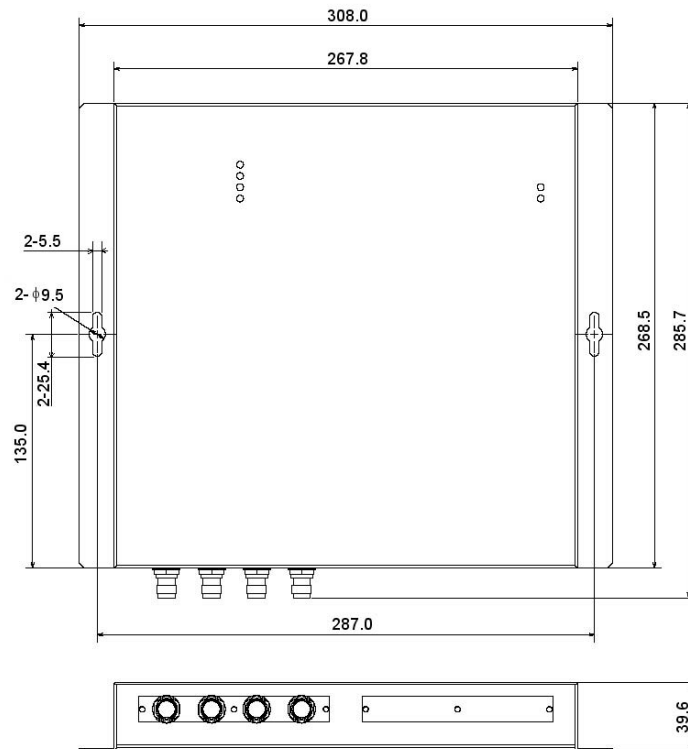


Class1/1b Tags



APPENDIX : OUTLINE DRAWINGS

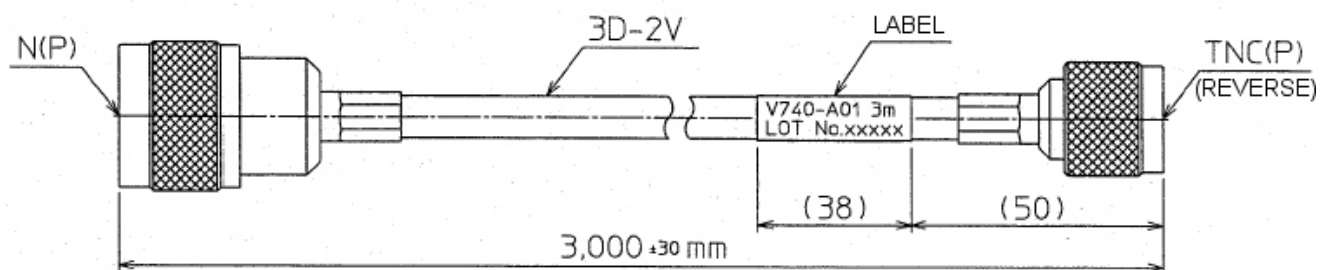
Reader : (V740-BA50C04-US)



Material : Aluminium

Antenna Cable:

Short cable (V740-A01-3.0M)



Long cable (V740-A01-10M)

