MAGELLAN TECHNOLOGY

HF RFID System

User Manual

MARS-1-2-4-6

Multiple Antenna Reader-Writer Systems

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Content

📖 Please read before proceeding

Please read and understand this document before using Magellan's Readers.

If you have any questions, comments or suggestions about the User Manual please contact Magellan Technology.

ⓘ Important Information

Installation Environment

For indoor use only unless otherwise specified.

Install Magellan's Readers within the temperature and humidity range according to the product specification.

The environment must not contain corrosive, flammable or explosive agents or be subject to rapid changes in temperature, to direct vibration or shock.

Installation

Magellan's RFID reader-writers communicate with data carriers (RFID inlets, labels and tags) using the 13.56 MHz High Frequency (HF) band. Some industrial machines and electronic devices can generate unwanted noise which may degrade communication. Make sure that other equipment is properly installed, grounded and at a reasonable distance from the Reader and/or Reader antennas.

Wireless communication can be degraded by high-voltage and high-current lines and other sources of strong electric and magnetic fields. Installation in such locations should be avoided.

! Magellan's RFID reader-writers are to be professionally installed by authorised, qualified and service-trained installation personnel only.

Maintenance

All Magellan's RFID readers-writers are low maintenance equipment. Except for externally accessible fuses there are no user-serviceable parts in any Reader. There is no requirement to remove the cover of the Reader.

! Removal of the Reader cover by unauthorised personnel will void the product warranty.

Do not attempt to clean internally. Periodic cleaning of external case parts with a damp cloth is advisable. Turn off the Reader before cleaning. Do not use a solvent of any kind.

Electrical Safety

⚠ In order to avoid electric shock do not remove the Reader cover or attempt to repair. The Reader must be maintained by authorised, qualified and service-trained personnel only.

Environmental

For disposal Readers should be treated as industrial waste.

This symbol on the product or on its packaging indicates that this product shall not be treated as household waste. Instead it shall be handed over to an appropriate collection point for the recycling of electrical and electronic equipment. By ensuring this product is disposed of correctly, you will help prevent potential negative consequences for the environment and human health, which could otherwise be caused by inappropriate waste handling of this product. The recycling of materials will help to conserve natural resources. For more detailed information about recycling of this product, please contact your local city office, your household waste disposal service or the Magellan Technology regional sales office.

1.Introduction

Thank you for your recent purchase of a Magellan RFID reader-writer.

This User Manual will provide you with information to rapidly adopt Magellan's PJM technology for your needs, to install the Reader hardware and ReaderManager software and get the Reader running.

Refer to the ReaderManager Guide (40-01-006-DOC) for a description of the various tools and advanced options available in the ReaderManager software.

Programming is covered in the Application Programmer's Guide (40-01-000-DOC).

1.1Regulation and Standards

RFID equipment is subject to national and international regulations.

FCC Radio Frequency Interference Statement (USA)

The FCC regards RFID equipment as low-power transmitting devices and, therefore, does not require users of RFID devices to obtain a license to operate them.

NOTE: This equipment has been tested and found to comply with the limits for a Class B digital device, pursuant to Part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference in a residential installation. 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. However, there is no guarantee that interference will not occur in a particular installation. If this equipment does cause harmful interference to radio or television reception, which can be determined by turning the equipment off and on, the user is encouraged to try to correct the interference by one or more of the following measures:

- Reorient or relocate of receiving antenna

- Increase the separation between the equipment and receiver

- Connect the equipment into an outlet on a circuit different from that to which the receiver is connected

- Consult the dealer or an experienced radio/TV technician for help

! Any changes or modifications to the equipment that are not expressly approved by the party responsible for compliance could void the user's authority granted under FCC Rules to operate this equipment.

FCC ID: TVN-Mars-1

Industry Canada Radio Frequency Interference Declaration of Conformity (Canada)

This Class A digital apparatus complies with Canadian ICES-003.

Cet appareil numérique de la classe A est conforme à la norme NMB-003 du Canada.

ICES\NMB-003 IC: 6596A-Mars1

Other regulations

EU	ETSI EN 300 330-1 v.1.3.1 (2001-06) ETSI EN 300 330-2 v.1.2.1 (2004-11) ETSI EN 489-1 v.1.5.1 (2004-11) ETSI EN 489-3 v.1.4.1 (2002-08) EN 61000-3.2: 2002 EN 61000-3.3: 1995 Safety: IEC/EN 60950	Pending
AS/NZS	CISPR 22: 2004 4268: 2003	Pending

ISO/IEC 18000 – 3 Mode 2 (Air Interface at 13.56 MHz) Compliance

Magellan's Readers fully complies with the ISO/IEC 18000 Part 3 Mode 2 (Information technology – Radio frequency identification for item management. Part 3: Parameters for air interface communications at 13.56 MHz) published in August, 2004.

1.2 Warranty

Magellan's warranty and liability with respect to products and/or services is for a period of 12 months from date of delivery and is limited to the rectification of faulty workmanship and/or non-compliance by Magellan.

Any liability with respect to components including purchased or free issued items and other materials used in the manufacture of products are covered by, and limited to, any warranty provided by the original manufacturer.

1.3 Limitation of Liability

Magellan's warranty excludes products that have been improperly installed or maintained, modified or misused. Notification of claims must occur within the warranty period.

End-users should contact the company from whom they purchase the products for replacement, repair or refund.

If purchases the Reader directly from Magellan, contact Magellan for a Return Authorization Number (RAN) before shipment.

1.4 Changes in Product Family, Specifications and User Manuals/Guides

This document is subject to change without notice in future editions.

Magellan reserves the rights to change its product design, specifications and product range.

1.5 Copyrights and Copy Permission

This document shall not be copied, reproduced or transmitted in any form or by any means without written permission from Magellan Technology Pty Limited. This document is protected by copyrights and is intended solely for use in conjunctions with Magellan's products only.

1.6 Meaning of Alert Symbols and Signal Words

	Notes and Tips. Application Notes.
!	This part of the Manual requires your attention.
! CAUTION	Indicates a potentially hazardous situation which, if not avoided, will result in minor or moderate injury. Can cause property damage.
! WARNING	Indicates a potentially hazardous situation which, if not avoided, will result in minor or moderate injury, or may result in serious injury or death. Can cause significant property damage.
	Warning! In order to avoid electric shock follow the instructions provided.

1.7 Glossary of Terms and Abbreviations

Antenna	A Reader antenna that emits radio waves and receives reply signals from tags. The Reader antenna can be internal which is integrated into the Reader and external which is connected to the Reader via a cable.
Antenna axis	The antenna port on the Reader antenna interface the antenna is plugged into.
Antenna tuning	Trimming a reader antenna to its highest possible field strength which corresponds to the highest operating voltage.
Create axis group	Create an antenna group. It means to combine antennas or antenna ports in one group that serve the same purposes or applications.
Configure axis group	Configure group antenna behaviour. It means to set up all antennas in the group to the same behavioural parameters which will be default parameters for this group.
D/C	Date Code (month/year)
DSB	Digital Support Board
HDF	High Density Fiberboard (for MARS only)
HF	High Frequency
GUI	Graphical Use Interface
IT	ItemTag (chips, inlets and labels)
ItemTag tags (IT tags)	Magellan's labels and inlets for item tagging (separated items) that work with Magellan's family of reader-writers
LAN	Local Area Network
LED	Light Emitting Diode
MDF	Medium Density Fiberboard (for MARS only)
MLC	Machine Level Control (System Configuration Control)
MRD	Maximum Read-Write Distance
Network Connections window	In Windows XP open *Start-> Control Panel-> Network Connections* or open *My Computer-> Other Places-> My Network Places-> View Network Connections*
OEM label	Original Equipment Manufacture label is located on the back of the equipment. It includes the Model Number, P/N, D/C, S/N and MLC.
PJM	Phase Jitter Modulation or PJM™ is a registered Trade Mark of Magellan Technology Pty Limited. PJM is a RFID communication technology developed and patented by Magellan Technology Pty Ltd and complies with ISO/IEC 18000-3 Mode 2. PJM technology products include a range of RFID chips, inlets, tags and Readers.
PJM ItemTag®	Registered Trade Mark for Magellan's ItemTag tags
PJM StackTag®	Registered Trade Mark for Magellan's StackTag tags
P/N	Part Number

Power cycle the PC	Shut up Windows and switch the PC off at the wall and wait for 30 seconds before powering the PC back up again. For laptops this means removing the battery and waiting for 30 seconds. This ensures that the USB host controller chips on the motherboard have had a chance to be fully reset.
Power cycle the Reader	Turn off the power or unplug the power cable (the power port on the Reader user interface). Open the *Network Connections* window in Windows. Wait for the Reader' network connection to be removed from the *Network Connections* window. Plug the Reader back and wait for the network connection to re-appear and become *Connected* in the *Network Connections* window. Connect to a Reader via the ReaderManager's *Connection* menu.
Reader/s	Magellan's RFID reader-writer/s
ReaderManager	Graphical user application for Windows/Linux which provides a platform for testing, demonstrations and application development
ReaderServer	Embedded application that provides the standard Application Programmer Interface to serve end-user applications. This application runs on the Reader.
RFID	Radio Frequency IDentification
RFID inlet	A RFID device comprising a microchip and a printed antenna (copper/aluminium/conductive inks) on a flexible substrate (PET plastic film)
RFID label	RFID inlet with adhesive backing (sticky label)
RFID tag	1. generic name for RFID inlet and label; 2. RFID inlet or label inserted into a housing (glass, polycarbonate, polyamid, epoxy, ABS, etc.)
RFID reader-writer	Device for reading and writing to RFID tags
RMA	Return Authorisation number
Setup axis	Setup antenna. To setup an antenna means to match the antenna with its corresponding antenna port by choosing the antenna type from list in the ReaderManager.
S/N	Serial Number
ST	StackTag (chips, inlets and labels)
StackTag tags (ST tags)	Magellan's labels and inlets for item tagging (stacked, touched or overlapping items) that work with Magellan's family of reader-writers

2.Product Overview

Intended use of Magellan's RFID Reader is to read and write information to individual Magellan ItemTags and multiple Magellan StackTags.

The communication protocol used by the Reader is compliant with ISO/IEC 18000 - 3 Mode 2 (Air Interface at 13.56 MHz).

MARS-1-2-4-6 family of the Readers comprises MARS-1, MARS-2, MARS-4 and MARS-6 reader-writers.

2.1MARS-1

Multiple Antenna Reader System – 1
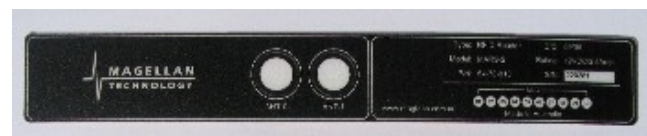
Operates with a single antenna

2 reply channels

2.2MARS-2

Multiple Antenna Reader System – 2

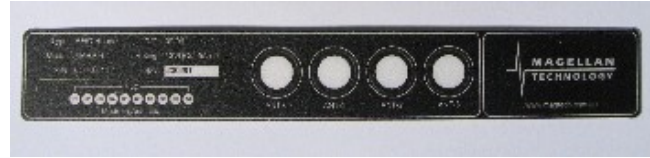Operates with up to 2 antennas

2 reply channels

2.3 MARS-4

Multiple Antenna Reader System – 4

Operates with up to 4 antennas

2 reply channels

2.4 MARS-6

Multiple Antenna Reader System – 6

Operates with up to 6 antennas

2 reply channels
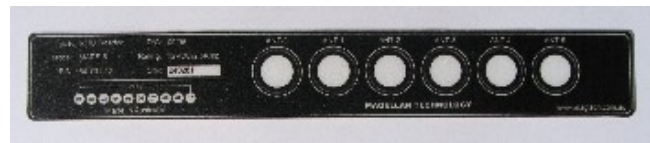
3.Before you begin

3.1Unpacking and Inspection

When you receive your system, inspect it for any obvious damage that may have occurred during shipment. If there is damage, notify the shipping carrier and the supplier of the equipment or Magellan if purchase directly from Magellan.

Until you have checked the system, save the shipping carton and packaging materials in the event the unit has to be returned.

The standard MARS package includes the following components:

- Reader-writer
- External antennas and connection RCA cables

MARS Model Name	Number of External Antennas	Number of RCA Cables
MARS-1	1	1
MARS-2	Up to 2	Up to 2
MARS-4	Up to 4	Up to 4
MARS-6	Up to 6	Up to 6

- Power adaptor
- USB data communication cable
- Quick Start Guide
- CD-ROM
- Test tag/s (required for Hardware Functionality Test and Communication Test)
- Magellan Antenna Tuning Kit (optional)

Power Pack

The Reader connection to the power source is realized via a low voltage power pack (12VDC output).

! A power cable is not included. End-users should purchase a power cable suitable for the country of use.

! CAUTION Only power cables and adaptors that are compliant with the regulations in the country of use may be connected to Magellan's equipment.

Data Communication Cables

Magellan supplies USB shielded cable (USB 2.0, 2 m long)

! USB cable should not be longer than 3m

! As shielded cables are generally required in order to comply with EMC emissions limits, the shielded cables recommended by Magellan Technology must be used. Unshielded cabled may be used where explicitly allowed in the Installation Requirements section of this User Manual.

Ethernet cable is not included with the supply.

Magellan recommends CAT5 Ethernet cable.

CD-ROM

The CD-ROM contains the following files:

AdbeRdrxx_enu_full.exe	Self-extracting installation kit for the Adobe Acrobat reader, which is required to read and print PDF files
40-01-000-DOC Application Programmer Guide.pdf	PDF document describing how to program all of Magellan's Readers
40-01-006-DOC ReaderManager Guide	PDF document describing various tools and advanced options available in ReaderManager software
64-70-017-DOC User Manual.pdf	PDF version of this document
ReaderManager-Install.exe	Self-extracting installation kit for the ReaderManager

Once you install the ReaderManager software the User Manuals and Guides can be open in Windows:
Start -> (All) Programs -> Magellan Technology -> User Manuals.

3.2 Installation Environment

Magellan's Readers are designed to operate in indoor environments where temperature and humidity are controlled unless other conditions are specified for customised Readers.

For standard Readers the temperature range is from +10°C to +45°C. The humidity range is from 10% to 80% (non-condensing humidity).

Install the Readers within the temperature and humidity ranges according to the product specification.

The environment must not contain corrosive, flammable or explosive agents and conductive dust or be subject to rapid changes in temperature, direct vibration or shock.

! WARNING	Do not operate this Reader in an environment which contains flammable or explosives gases or fumes.

Magellan's RFID reader-writers communicate with data carriers (RFID inlets, labels and tags) using the 13.56 MHz High Frequency (HF) band. Some industrial machines and electronic devices can generate unwanted noise which may degrade communication. Make sure that other equipment is properly installed, grounded and are at a reasonable distance from the Reader and/or Reader antennas.

Wireless communication can be degraded by high-voltage and high-current lines and other sources of strong electric and magnetic fields. Installation in such locations should be avoided.

⚠	In order to avoid electric shock do not remove the Reader cover or attempt to repair. Magellan's reader-writers are to be maintained by authorised, qualified and service-trained personnel only.

!	Removal of the Reader cover by unauthorised personnel will void the product warranty.

3.3 Recommended System Requirements

Recommended minimum host computer requirements:

Operating System:	Windows XP SP2
Memory:	128MB RAM
Hard Drive:	20 GB
CPU:	Intel Celeron 500
Interface:	USB or Ethernet

3.4 Installation Requirements

Power supply requirements:

Mains input:	110 - 240 VAC @ 50/60 Hz
Low voltage input (MARS-1-2-4-6):	12 VDC @ 1.5 A

MARS Readers require special installation and tuning of external antenna/s. Refer to the ReaderManager Guide (40-01-006-DOC) for the antenna matching, tuning and testing instructions using the *Reader Setup Wizard* tool.

The MARS model number corresponds with the maximum number of external antennas that can be connected to the MARS Reader.

MARS' external antennas are suitable for applications where one or many reading points are required. They are designed to be embedded into desk tops or shelves.

Once antennas are installed in the position they are to be used, it is essential that they are fixed in place and tuned. Tuning is done only once at installation. All antennas (except the small round antenna 30 mm radius) have an adjustable capacitor that allows for tuning.

Materials

The affect of materials and antenna position on antenna operation may be determined as follows:

Place an antenna on a Styrofoam block and tune for maximum voltage at the antenna center using an Antenna Tuning Probe, digital voltmeter and a trimming tool. Then place the antenna on/into the installation position, retune and measure the maximum voltage again. Compare the voltage values.

A difference of 10% or less is acceptable. If the voltage reduces more than 10%, this indicates the material is adversely affecting the antenna. The user should determine if the reduction in operation is acceptable by measuring read range and stacking operation. If the reduction is not acceptable the antenna may be relocated.

Alternatively use of a plastic spacer of 5 mm between the mounting material and the antenna is recommended where the mounting material is adversely affecting the antenna.

Reader antenna performance may be affected by conductive and metallic materials in the immediate vicinity of the antenna.

Metal, metallic or metallized objects placed next to the Reader antenna may change the characteristics of the antenna affecting the tuning operation and reducing the read range.

It's recommended that the antenna not to be placed closer than 35 cm to any metallic object that is of a similar or larger size to the antenna.

Small metallic objects such as jewelry or coins put on the antenna will have almost no affect on the antenna performance.

If metallic conveyor rollers are a part of an application it's advised to replace them with plastic parts if possible or apply shielding techniques as required.

The materials that antennas are mounted on/into should not be metallic or conductive.

Materials such as wood, laminated MDF, HDF or plywood have a limited conductivity. If an antenna is mounted into these materials some drop in the read range is expected in comparison with the equipment specification.

Plastics are the best materials to embed antenna into provided they are graphite/carbon free.

Try to avoid using black plastics as they may be conductive due to carbon/graphite based colouring agents.

Clear glass is generally not conductive and can be used as a desk top material. Smoked and tinted glass may be conductive and any affect on antenna operation should be determined by measurement.

Distance

Antennas mounted in a close proximity to each other may interfere with each other's operation.

For antennas connected to the same MARS Reader the safe distance between the antenna edges is antenna size dependent and varies from 5 cm (radius 30 mm round antenna) to 15 cm (202x352 mm antenna).

For antennas connected to two different MARS Readers the safe distance between the antenna edges is also antenna size dependent and varies from 30 cm (radius 30 mm round antenna) to 60 cm (202x352 mm antenna).

Do not mount an antenna on a desktop surface if there is a MARS reader immediately below and under the antenna. The distance between the antenna and the MARS reader should be no less than 20 cm. Use extended brackets to increase the distance if required. Alternatively the MARS can be screened from the antenna by a purpose built ferrite shield.

! In general no electronic devices are to be placed within 20 cm of the antenna in any direction.

Before such installations are attempted Magellan must be consulted.

Cables

Do not run any cables under or near antenna. Maintain a minimum distance of 15 cm.

! The cables that connect external antennas with the reader are provided by Magellan. The MARS Readers should only operate with antenna cables supplied by Magellan.

! Any changes or modifications to the equipment that are not expressly approved by the party responsible for compliance will void the product warranty.

How to shield antennas

Antennas may be shielded by a purpose built ferrite sheet only. In special circumstances devices such as keyboards and computers may be placed under antennas where a purpose built ferrite antenna shield (64-50-001) is provide to protect the antenna.

A ferrite shield consists of a sheet of aluminium with ferrite tiles, minimum thickness 5 mm.

Contact Magellan for further information on shielding antennas for you specific application and the specification of the Ferrite Antenna Shield (64-50-001) when planning your installation.

3.5 Antenna Maintenance (Tuning)

Antennas may require periodic re-tuning and testing. Detuning of an antenna may occur if physical environment around the antenna is changed. For example when large metal objects are located near the antenna or electronic devices or cables are placed in close proximity with the antenna. The severity of detuning is dependent upon the size of the metal object and can only be determined by measurement.

Before tuning make sure that metal objects, electronic devices and cables are not closer that the recommended distances in any direction from the antenna.

The purpose of the tuning procedure is to maintain an antenna at its correct operating point. Tuning the antenna means to trim it to its highest possible field strength which corresponds to the highest voltage as measured by a voltmeter with an Antenna Tuning Probe.

Contact Magellan for further instructions for your specific application.

Equipment and Software Required for Antenna Tuning and Testing

- 1 x Antenna Tuning Probe with cable (Magellan Antenna Tuning Kit)
- 1 x RF Trimming Tool (Magellan Antenna Tuning Kit)

Antenna Tuning Kit: Antenna Tuning Probe with a cable and RF Trimming Tool

- 1 x Universal Digital Voltmeter (to measure DC voltages between 1 and 15 volts)
- ReaderManager software– V2.05 or better
- 1 x Tag (fully powered tag)

Tuning Instructions

1. Connect the Antenna Tuning Probe terminals to the voltage and input terminals of the digital voltmeter.
2. Set the voltmeter to measure a DC voltage range greater than 10 volts.
3. Place the Antenna Tuning Probe in the center of the antenna.
4. Using an RF trimming tool adjust the tuning capacitor on the antenna for maximum voltage as measured by the tuning probe.

Quality Assurance/ Quality Control

If the maximum read distance is important for your application then the antennas have to be protected/shielded from the interference with a mounting material firstly and then tuned at maximum voltage.

In case the maximum read distance is not an issue the antennas can work properly even at lower voltage but at a reduced read range.

Method 1

To confirm optimum antenna operation measure the maximum read-write distance.

1. Take a single tag and position it over the Reader antenna center. Do not hold the tag antenna coil or tag inner area with you fingers. Preferably hold the tag edges or use a non metallic carrier to hold the tag.

2. Measure the maximum read distance in mm and compare with the value for the same antenna-tag type in the Maximum Read-Write Distance chart. Refer to this User Manual, Appendix.

3. If the maximum read-write distance is less than the chart value re-tuning may be necessary. If the antenna is correctly tuned then the user should determine if the reduction in read-write distance is acceptable.

Method 2

During an initial tuning procedure measure the maximum voltage using an Antenna Tuning Probe. Record the voltage value for every antenna in the ReaderManager software. To confirm tuning at any time measure the maximum voltage using the Antenna Tuning Probe and compare with the recorded results. The voltage values should be identical otherwise the antenna has to be tuned.

3.6 Working with Tags

Do not stack ItemTags on top of each other. Only StackTags can be stacked, overlapped or touch each other.

Single-axis Readers are tag orientation sensitive. Refer to the Tag-to-Reader/Tag-to-Antenna section of this document.

Reading and writing speeds depend on reader-tag communication speeds, the number of receiver channels, amount of information to be read and/or written and the number of tags presented at a time. The additional number of tags and information to be read and especially written slows down the read-write communication speed. Please consult Magellan or your support organisation regarding these issues for your specific application.

Be aware that tags and Readers can be incompatible with each other. Larger tags can work with all types of Readers. Smaller tags require higher field strengths and as a result they may not operate with some Readers or have to be closer to a Reader antenna to operate. Refer to the Reader-Tag Compatibility section of this document.

StackTag tags delivered on a roll are always fully powered (*ST normal power mode* or 6000 mode). Fully or normal powered tags are ON all the time and reply to each Reader command providing they are in the field of the Reader antenna.

To decrease tag clashing and increase anti-collision and stackability for some applications the tags can be reconfigured by end-users to a ¼ low power mode (*ST ¼ normal power mode* or 2000 mode). This means that tags in the ¼ low power mode are muted ¾ of the time and do not to reply to the Reader commands instantly.

Tags can be reconfigured individually (one by one) or on mass (many at once).

Before reconfiguring tags make sure the ReaderManager software has been installed and upgraded to the latest version, the Reader is running and the Reader is *Connected* to the ReaderManager software.

How to reconfigure tags individually or on mass

1. In the ReaderManager go to *Tools -> System -> Console.* Click with the right mouse button and tick *Show Tag Replies.*

2. Then go to *Reader Configuration* and choose *Config_Normal_Powered_Tag* or *Config_Quarter_Powered_Tag* (for the ReaderManager version 2.12 or higher).

3. Place a single tag or multiple tags into the reader antenna field.

4. Take the tag/tags off the reader.

5. Follow the step 3 to 4 for a new batch of tags.

6. Once completed go to *Reader Configuration* and click on *Clear All*.

How to check a tag configuration mode

1. In the ReaderManager go to *Tools -> System -> Interrogate Command*.

2. In *Reply* select *Normal* and click *Send*.

3. Then go to *Tools -> System -> Table of Tag Messages* to see the tag configuration in the *Config* column. The messages of all the tags currently in the reader antenna field can be seen. 2000 means that the tag has been reconfigured to *ST ¼ normal power mode* configuration. 6000 means that a tag is in *ST normal power mode*.

3.7 Tag-to-Antenna Orientation

Tags should always be presented face on to the external antenna surface. They may still work at some angle depending upon the distance between the tag and the external antenna.

Correct orientation
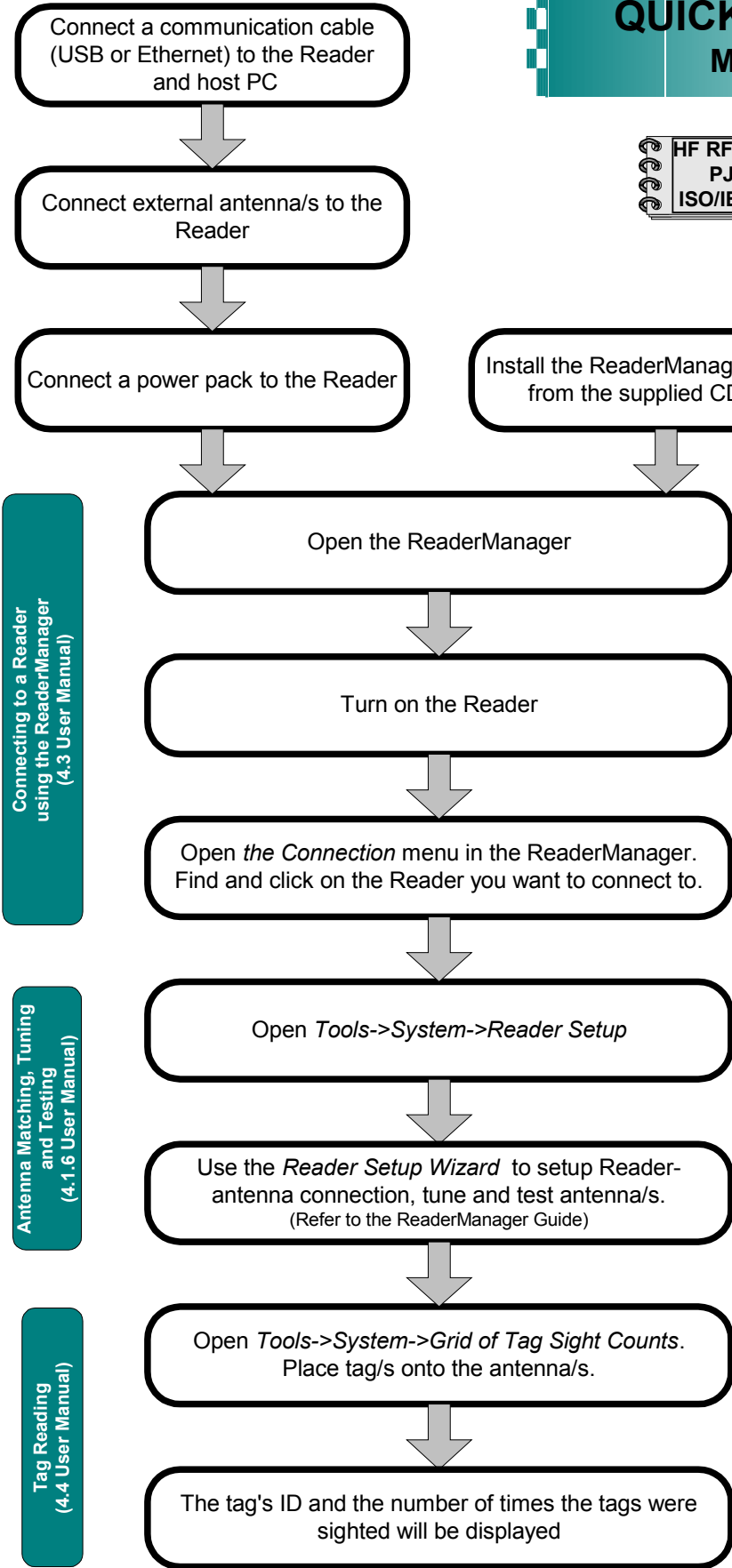

Incorrect orientation (90° angle)

4.Installation

HF RFID Readers-Writers
PJM® Technology
ISO/IEC 18000-3 Mode 2

Hardware Installation (4.1 User Manual)

Connect a communication cable (USB or Ethernet) to the Reader and host PC

⬇

Connect external antenna/s to the Reader

⬇

Connect a power pack to the Reader

Software Installation (4.2 User Manual)

Install the ReaderManager software from the supplied CD-ROM

⬇ ⬇

Connecting to a Reader using the ReaderManager (4.3 User Manual)

Open the ReaderManager

⬇

Turn on the Reader

⬇

Open *the Connection* menu in the ReaderManager. Find and click on the Reader you want to connect to.

⬇

Antenna Matching, Tuning and Testing (4.1.6 User Manual)

Open *Tools->System->Reader Setup*

⬇

Use the *Reader Setup Wizard* to setup Reader-antenna connection, tune and test antenna/s.
(Refer to the ReaderManager Guide)

⬇

Tag Reading (4.4 User Manual)

Open *Tools->System->Grid of Tag Sight Counts*. Place tag/s onto the antenna/s.

⬇

The tag's ID and the number of times the tags were sighted will be displayed

4.1 Hardware Installation
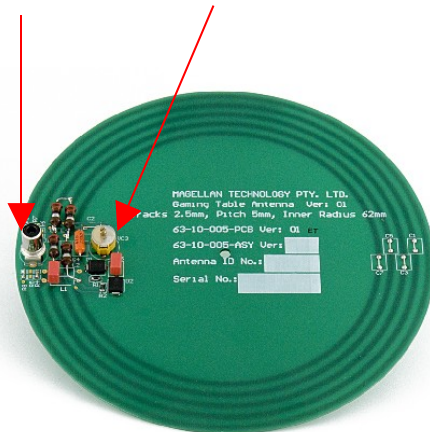
Antenna Port   OEM Label

MARS-1 Antenna Interface and OEM label panel

RJ45
(Ethernet port)

USB
host port

USB
device port

Power port

LEDs

Power
switch

MARS User Interface panel

RCA connector   Adjustable tuning capacitor

Round 60 mm antenna (63-10-005)

4.1.1 Connecting to a power supply

Step 1. Connect a low voltage power pack to the unit.

The connection to the power source is realized via a low voltage power pack.

The power cable is not supplied with the Reader and recommended to be purchased in the country of use.

Step 2. Plug the power supply into AC power mains. LEDs will come on.

When power is applied to an MARS Reader the LEDs on the Reader should operate as follows:

- the red LED and green LED will immediately come on; both LEDs will go off in about 1 minute

MARS with the red and green LEDs on

- the red LED will come on again in 1-3 seconds indicating that the Reader is in an operational mode; the green LED will be off

MARS with the red LED. The Reader is in an operational mode

- once the unit is in an operational mode the red LED will remain lit the green LED will flash every time a tag/tags is/are successfully read

LEDs are controlled by the MARS Reader software

4.1.2 Connecting a Reader to a Computer using USB

Connect the MARS Reader to a host computer using the USB data communication cable by plugging the USB cable into the MARS USB device port and the host computer USB port.

Only one Magellan Reader can be connected to the PC via USB at a time (limited by Windows).

! When the USB connection is used only a screened USB cable should be used.

MARS with the USB communication cable and power cable

4.1.3 Connecting a Reader to a Computer using Ethernet

Connect the MARS Reader to a host computer using a cross over Ethernet cable. Plug the Ethernet communication cable into the MARS RJ45 socket (Ethernet port) and the network interface port on the PC.

! Always connect Ethernet cable before power is applied to the Reader.

MARS-1 with the Ethernet communication cable and power cable

4.1.4 Connecting Multiple Readers to a local network

Multiple Readers can be connected to a local network using an Ethernet hub/switch. Plug the Ethernet communication cable into the MARS's RJ45 socket (Ethernet port) and Ethernet Hub.

! Always connect Ethernet cable before power is applied to the Reader.

4.1.5 Connecting External Antennas

Connect each external antenna to a Reader's Antenna Axis/port via a supplied RCA connection cable.

MARS-1 with the external 120x240 mm antenna connected

4.1.6Antenna Matching, Tuning and Testing

Before you start tuning and testing the antennas it's required to install the ReaderManager software and connect to a Reader in the ReaderManager's *Connection* menu.

Refer to the ReaderManager Guide (40-01-006-DOC) for the antenna matching, tuning and testing instructions using the *Wizard* tool in *Reader Setup*.

Follow the procedure, making sure that the Magellan Antenna Tuning Probe and voltmeter are used to measure when the tuning is correct.

The design of the antenna and the selection of the correct cable length is a critical factor in the reliability of a reader. Each antenna has unique set up values associated with it that are used by the software to ensure the reader and antenna are matched to each other.

The most critical part of the setup of MARS-2, MARS-4 and MARS-6 is telling the reader what type of antenna is connected to each antenna axis (*Setup Axis*).

This is done using the *Reader Setup* tool in the Reader Manager. It provides a fixed list of antennas with known set up values for that particular Reader.

If an antenna is not listed in this table it cannot be used with that Reader. Unless correct set up values are measured by Magellan and recorded in the list of known antennas, the antenna will not operate properly.

If you can not find your antenna on the list you have to upgrade the ReaderManger software to the latest version assuming that you purchased a new antenna type recently to be used with the Reader purchased some time before. You will also need to upgrade the ReaderServer on your Reader.

Update the ReaderManager from our website first. Then you can upgrade the ReaderServer using new version of the ReaderManager installed.

Note that different release versions (MLC number) of the same Reader may well have very different set up values, because of circuit changes. The Reader selection system accounts for this and automatically manages loading the correct values for a given version of the Reader.

4.2 ReaderManager Software Installation

The ReaderManager application software allows tag data to be viewed and programmed.

The ReaderManager can only connect to one Reader at a time. The *Connections* menu allows the user to connect to other Readers by disconnecting from the currently connected Reader and then establishing a connection to a new Reader.

It is possible to run many ReaderManagers on the same computer at the same time. Simply double click on the ReaderManager icon to open up multiple instances of the ReaderManager.

Refer to the ReaderManager Guide (40-01-006-DOC) for various tools and advanced options available in the ReaderManager.

4.2.1 Installation and Functionality Test

Step 1. Insert the CD supplied with the Reader into the CD-ROM.

Step 2. Open Windows Explorer, double click on *ReaderManager-Install.*

Step 3. Ensure all the items in *Install* dialog are ticked, and then click the *Install* button.

If Python is not installed on your computer, the installation program will prompt you if you would like to install Python. Click the *Yes* button and accept all the default options during installation.

When the ReaderManager and all the required libraries are installed the dialog box will be displayed. Ensure the dialog box shows *Completed* and no problems are reported.

There is an option to install only an Ethernet-over-USB driver. Tick only the *PJM Reader USB driver (RNDIS Ethernet)* box in *Install* dialog and press *Install*.

Step 4. Click the *Close* button to continue.

If the ReaderManager is already installed, double click *ReaderManager-Upgrade*. Follow steps 3 to 4 above.

If Python and PyQt are already installed, the installation program will not re-install them. To force the installation program in re-install these libraries, click the relevant check boxes.

Step 5. To start ReaderManager double click the *ReaderManager* icon or select *ReaderManager* from the *Programs Start* menu.

Step 6. Functionality test.

From menu select *Help>About ReaderManager* to see the version of the ReaderManager software and its status.

4.3 Connecting to a Reader using ReaderManager

Magellan's Readers are complex and powerful network devices. As most network devices they should be handled by well trained network administrators.

A Reader provides Ethernet and USB device interfaces to allow for client connection. The USB interface uses TCP/IP networking over USB as the protocol. This allows you to connect to a Reader as if it was a normal network. So all the usual services, such as telnet and FTP are available.

Step 1. Open the Reader Manager. Ensure a communication cable is plugged in and a Reader is turned on.

ReaderManager will automatically detect all Readers on the local network.

When a Reader is connected for the first time to a network using an Ethernet cable or a host computer using a USB cable, the Reader is identified by its Model Name-Serial Number (recommended to keep).

Customers can replace or add additional information to the Model Name-Serial Number such as a physical location or customer ID number.

Subsequently when a customer starts using the Reader the new name will appear on the list of Readers in the *Connection* menu.

Tip: If you want to use the new name immediately, simply unplug the power connector and plug in again to view the new name on the *Connection* menu list.

To change a Reader network name:

From the *Tools* menu, select *System* then *Configuration System*. The window shown below will be displayed.
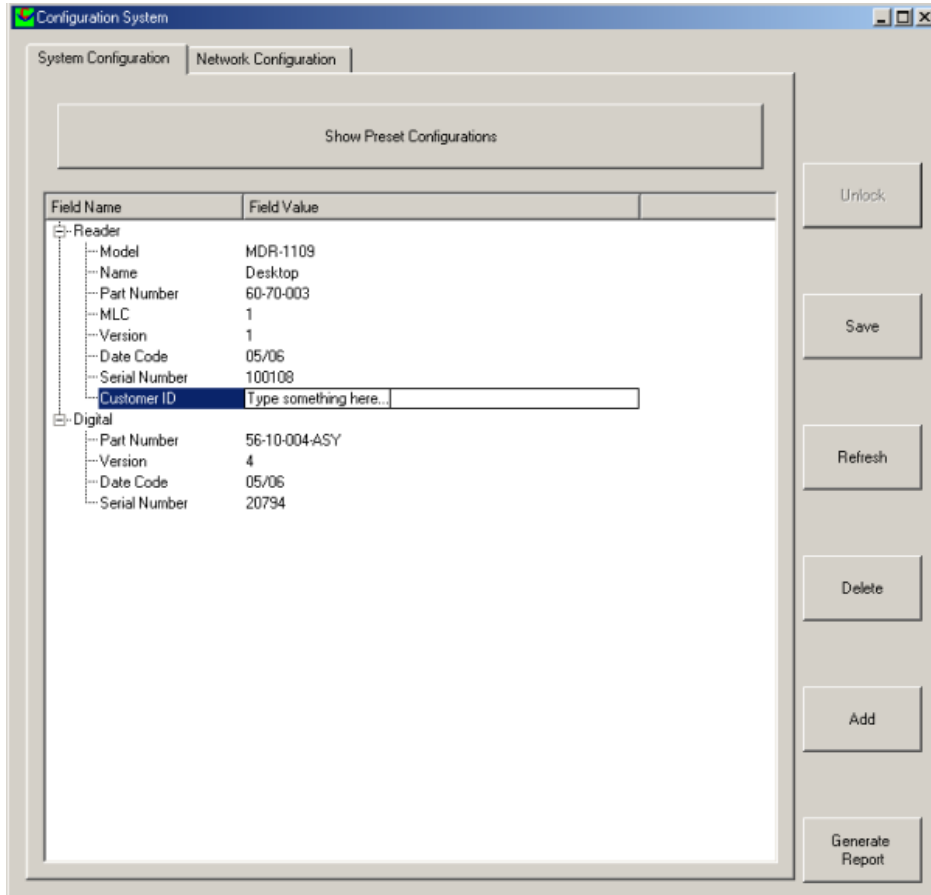

Click the column on the right of *Customer ID* and enter the name you would like the Reader to be identified as. This is the name that will appear on the *Connection* menu.

Click the *Save* button on the right to save your changes to the reader, or click the *Refresh* button to restore the previously saved name.

To change the Reader's network settings:

Click the *Network Configuration* tab.
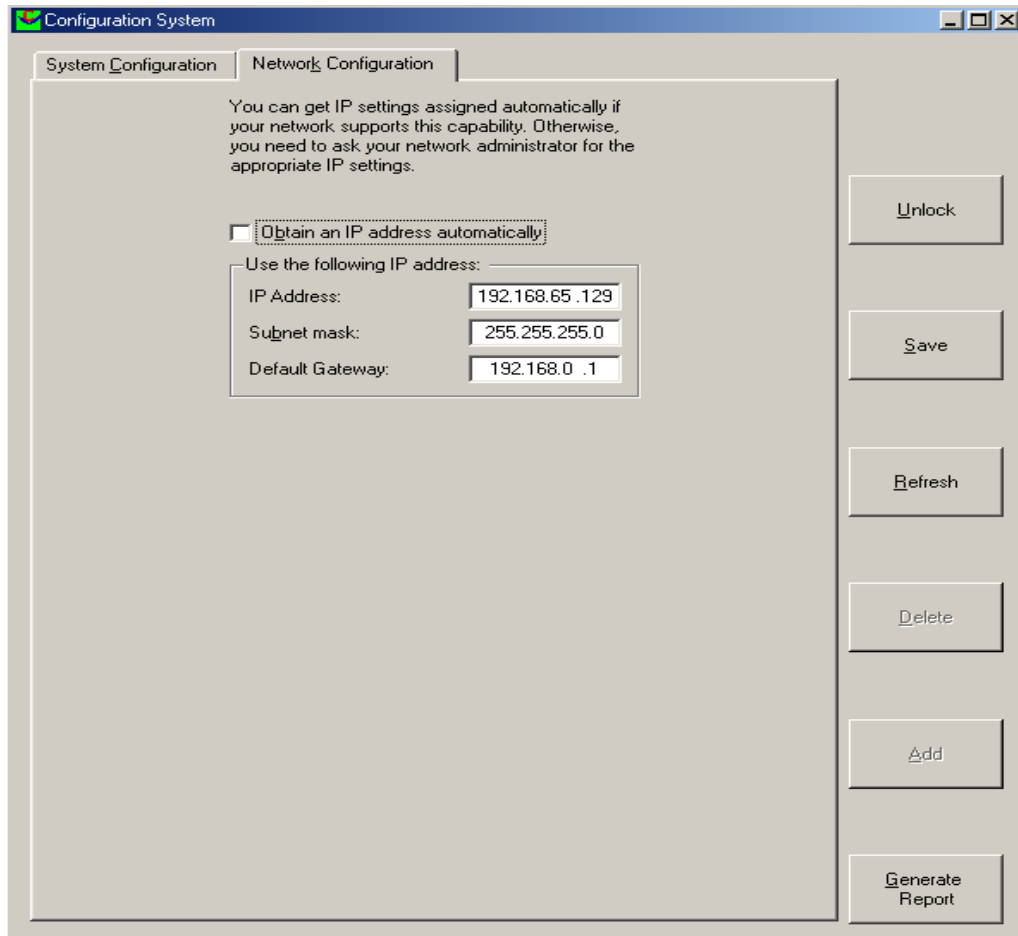
If the Reader is to be assigned an IP address from a DHCP server click the *Obtain an IP address automatically* check box.

To assign a static IP address, uncheck the check box and enter the IP address in the *IP address* text box. The box will turn red if the IP address is not valid. Care should be taken not to duplicate IP addresses on your network. If you are unsure what IP address to use consult your systems administrator.

Enter the network *Subnet mask* and *Default gateway* addresses in the text boxes provided.

Click the *Save* button to save these changes to the Reader, or click the *Refresh* button to restore the last saved values.

Restart the Reader for these changes to take effect.

Here is a general guide to the way reader network address assignment works:

The Ethernet interface is either served an IP address via DHCP or is assigned a static IP address by the user. If the reader is set to use a DHCP assigned address and no DHCP server is available it will automatically use a link local address of 169.254.0.0/16.

The reader must be powered up with the Ethernet connected to get a DHCP assigned IP address.

These are the networking rules:

USB will always choose a subnet different to Ethernet.

Both interfaces will try to obtain the 169.254.0.0 range, but Ethernet has priority.

172.16.0.0/16 is USB's fallover subnet if Ethernet has already taken it by either: DHCP, fixed, or link-local IP acquisition.

Step 2. Click the *Connection* menu item to view Readers found on the local network.

The ReaderManager will use network broadcasts to look for active readers via USB and Ethernet. If you click on the *Connection* menu, you can see readers defined in there automatically.

A list of Readers will be displayed. The IP address and MAC address will be shown on the status bar as you move the mouse over each Reader entry.

Step 3. To connect to a Reader, select the Reader you would like to connect to from the *Connection* menu, then click the left mouse button.

The status bar will change from a red to a green background to indicate that the ReaderManager was able to connect to a Reader. The tag type and IP address are also shown on the status bar.

To get more information how to setup static connections to Readers refer to the ReaderManager Guide (40-01-006-DOC).

4.3.1 Connecting to a Reader via USB for the first time

Any device hardware when it's first connected to a PC via USB requires a device driver. The device driver is provided by Microsoft. No USB device drivers are available instantly. They have to be installed and require a certain amount of configuration. The driver must be installed on the PC before Windows can use the connection. The device driver is installed on the PC via the ReaderManager.

> When you install a new Reader for the first time it can take from 1 to 5 minutes to create a network connection before the ReaderManager is able to recognize a new Reader.

Since every Reader has a unique serial number, Windows treats it as a new device and you will have to install the device driver again for each new Reader that you connect to the one PC. Since the device driver files are already on the Reader, Windows can search for the driver automatically.

In order to connect to a Reader via USB for the first time follow the steps below:

Step 1. Open *Network Connections* in Windows to view the network connection process.

You can verify that the reader is connected by looking at the *Network Connections* window. You can open this window from several places: *Start -> Control Panel -> Network Connections* or *My Computer -> Other Places -> My Network Places -> View Network Connections.*

Step 2. Open the ReaderManager. Plug in the USB and power cables. Turn on the Reader. The *Found New Hardware* dialog box will be displayed.

When a Reader is connected to a host computer for the first time using a USB, these are a few steps to go through before the ReaderManager is able to identify a new Reader:

1. In *Found New Hardware Wizard* tick *Yes*, *this time only* to search for software and press *Next*.

2. In *What do you want wizard to do?* tick *Install the software automatically* and press *Next*.

3. Wait while the wizard installs the *Linux USB Ethernet/RNDIS Gadget* device driver. Ignore other message and press *Continue anyway*.

4. Press *Finish*.

Step 3. Wait until you see a new entry appears in the *Network Connections* list called "*Linux USB Ethernet/RNDIS Gadget*". This is the Reader.

If it says *Acquiring IP address* then you must wait until it says *Connected.*

The Reader's network connection will say:

1. *Local Area Connection X*

2. *Connected*

3. *Linux USB Ethernet/RNDIS Gadget*

Once it says *Connected* in the Network Connections window (Windows XP SP2) you can go to the Step 4.

If it says *Disabled* or *Broken*, then right click and select *Repair* or *Enable* to try and fix the connection.

If this fails, disconnect the reader, reboot your PC and repeat from Step 1.

The Reader can disconnect in situations where the Reader has been repeatedly plugged and unplugged before Windows has had a chance to properly and completely process the network connection. In this situation it is possible for the Reader to appear on the network for about a minute before it is disconnected by the Windows networking system.

The solution is:

1. Unplug the Reader.

2. Wait for the Reader's network connection to be removed from the *Network Connections* window.

Once the network connection has been removed:

1. Plug the Reader back in.

2. Wait for the network connection to re-appear and become *Connected.*

3. Connect to the Reader via the ReaderManager.

Another solution is to try another USB port as USB ports can fail on PCs. As with the previous case:

1. Unplug the Reader.

2. Wait for the network connection to be removed.

3. Plug the Reader into another USB port.

Windows networking can take some time (a few minutes) to create the network connection if the Reader has been rapidly plugged and unplugged. If the Reader network device does not disappear within 5 minutes of being disconnected, reboot your PC because it is a problem with Windows Networking or the USB port has locked up.

You should NEVER have to power cycle a Reader because you are having problems with your PC or with Windows. Power cycling can just cause more problems with Windows and Windows networking.

It is important to understand that USB problems are usually caused by Windows networking delays and Windows networking problems which cause people to rapidly unplug and plug the USB cable and create even more problems.

Step 4. Open the *Connection* menu in the ReaderManager to see a list of Readers available on the network. The new Reader will be identified by its Model Name-Serial Number.

4.3.2 Upgrading software

Magellan recommends to upgrade the ReaderManager software at least once a month and ReaderServer software on network based Readers every 3-4 months.

You can download the latest version of the ReaderManager operating software from Magellan's website. Contact Magellan or its representatives to receive a user name and password.

Refer to the ReaderManager Guide (Upgrading Reader Software) for more information about how to upgrade the ReaderServer from the ReaderManager *File* menu.

4.4 Communication Test

Perform the tag reading test.

From the *Tools* menu, select *System -> Grid of tags sight count.*

Check some default settings in *Tools -> System-> Reader Settings*:

- *Tag Type*. Default is *IFX_STACK*. If you use ItemTags the default should be changed to *IFX_ITEM*.

- The *Powering Field* box should be ticked.

- *Tag Reply Mode*:

For 2 channel Readers, the default is:
CommandReplyChannelHoppin3_4muted
CommandReplyChannelHoppingUnmuted
FixedReplyChannel(G)

Using one of the test tag supplied with the Reader, place the tag on the Reader antenna.

The first square in the grid should turn from white to blue and display the tag's ID number and the number of times the tag was sighted (should be one). An example of this is shown below.

5. Reporting a Problem

If you are having a problem with a Magellan Reader, you will need to send a report to your support organisation. To make the diagnosis quicker and easier, please supply your problem report on a Service Form along with the following information:

- What kind of tags are you using and how many are you putting on the Reader at one time?

- Have this Reader and the tags you are using worked at any time in the past?

- Have you tried connecting to the Reader with a different PC?

- Have you successfully installed the ReaderManager application?

- In the ReaderManager, select the Help/About ReaderManager menu item and record on the Service Form what version numbers are shown in the window that appears.

The required information about Model Number, S/N, P/N and D/C is located on OEM label on the back of the equipment.

Warranty Repairs

Before shipping any Reader a Return Authorisation number (RMA) must be obtained.

End-users should contact the company from whom they purchased the Reader for repair, replacement or refund.

If you purchased the Reader directly from Magellan, contact Magellan for a Return Authorization number (RMA) before shipment.

The copy of the Service Form with RMA must be enclosed in the original or equivalent packing with the RMA number clearly marked on the outside of the box.

Non-Warranty Repairs

If a Reader needs repairing after one year warranty period expires, your support organization or Magellan if you purchased directly from Magellan will first provide an estimate of repair charges. Then upon receiving approval from you the Reader can be sent for repair. Refer to above Warranty Repairs information for return procedures.

5.1 Troubleshooting

Problem	Reason	Solution
LEDs		
Red LED is off	Power cable not connected	Ensure the power cable is connected correctly to both the mains power and to the Reader
	Power cable faulty	Replace the cable
	Power adaptor faulty	Replace the power adaptor
	Reader faulty	Send a service report on the Service Form
Absence of the flashing green LED during tag reading	Incorrectly oriented tag/tags	Ensure tag/tags are oriented correctly to the Reader Antenna (see Tag-to-Reader/Tag-to-Antenna Orientation).
	Faulty tag/tags	Replace tag/tags. Do not use tags with a black dot or black square marking (faulty tags).
	The *Powering Field* is off	Ensure the powering field is on. Go to *Tools>System>Reader Setting.* Tick the *Powering Field* box.
	Reader faulty	Send a service report on the Service Form.
Green LED flashes but I can not see any tag message in the ReaderManager	USB or Ethernet connection is not functioning	Ensure the communication cable is connected correctly.
	The reader is not *Connected*	Ensure the Reader is turned on and a communication cable is plugged in. The status bar in bottom right corner of the ReaderManager window has to show an indication *Connected,* the tag type and the IP address.
	The tag type is incompatible with the Reader	Use the appropriate tag type according to the chart in the Reader-Tag Compatibility section.
	A communication tool has not been chosen	Choose *Grid of tag sight counts* or *Table of Tag Messages* from *Tools->System* menu to view tag replies.
Antenna installation and maintenance		
Antenna test failed	Wrong tag. The tag used for the test is in a low power mode.	Make sure you use a normal/fully powered tag for testing (refer to the Working with Tags section in the Reader User Manual). Perform the test again.
	Faulty tag	Replace tag. Do not use a tag with a black dot or black square marking (faulty tag).
Antenna is not on the list of available antenna types	You have purchased new antenna type which is not in your version of the ReaderManager	Download the latest version of the ReaderManager available from Magellan's website. Then upgrade the ReaderServer on your Reader using the ReaderManager.
Antenna does not work as good as before (reduced read range, etc.)	The Antenna has been moved recently and was not tuned	Once you change the antenna position, moved the antenna or replaced the mounting material you should understand first whether the antenna is affected by the mounting material, put a plastic spacer if affected and tuned the antenna again.
	Metallic object/s, electronic devices or cables are in the close vicinity of the antenna and affect the antenna performance	Move all metallic objects, electronic devices and cables away from the antenna or shield the antenna by a purpose built ferrite shield. Once you do so the antenna should perform as before. Measure the maximum voltage, compare with the voltage previously recorded and tuned the antenna if it's required.
Connecting a Reader		
Can not find and connect to the Reader as the Reader is not shown on the *Connection* menu list	The Reader was not in the operational mode when you connected a communication cable and/or opened the *Connection* menu	Plug in the communication and power cables. Wait for about 1 minute after you apply the power to the Reader. The blue LED must to be permanently lit and the green LEDs off. In the ReaderManager open the *Connection* menu. Find the Reader you want to connect to on the list.

The PC does not recognise the Reader at all	The USB port on the PC is broken	Use another USB port known to be working.
	USB port has temporarily failed	Power cycle the PC.
	The Reader is faulty	Check the Reader on two other PCs. If no PC shows any response at all to the USB cable being plugged in then it's faulty. Send a service report on the Service Form.
	USB cable faulty	Change the USB cable.
The PC recognises the Reader, but claims that it is faulty in the Windows' *Device Manager* and does not create a network connection	Windows has previously marked the Reader as faulty and will not try to connect to it or load the Reader driver. Usually caused by rapidly unplugging and plugging of the USB cable.	Make sure that the USB cable is unplugged and the Reader is turned off. Remove/Unistall the faulty device from the *Device Manager*, then plug the USB in, turn the Reader on and wait for a network connection again. Alternatively you can connect a different Reader to the PC as it will have a different serial number and Windows will not flag it as faulty.
The Reader is connected, and appears to be working correctly but the network connection drops out after a few seconds	A Reader was replugged too quickly before Windows finished processing the previous network connection	Wait at least 30 seconds before replugging any Reader into the same PC or wait until the network connection disappears.
	USB hub does not work properly	Power cycle the PC. Try a rear USB port on PC to plug a USB cable. Avoid using an external USB hub.
No network connection can be made to a Reader but the *Network Connections* window shows that the Reader is connected and all other network status information indicates that networking should be working	The USB port on the PC has stopped working for an unknown reason.	Use another USB port. If this fails, power cycle the PC.

5.2 Service Form

<table>
<tr><td rowspan="1">CONTACT</td><td>

Company _____

Address _____

Country _____

Sales Order _____

PO Number _____

Purchase Date _____

</td><td>

Return Authorisation number (RMA) _____

Date _____

Technical Contact _____

Telephone _____

Fax _____

Email _____

</td></tr>
</table>

PRODUCT

From OEM label on the back of the equipment:

Model _____

P/N _____

D/C _____

S/N _____

MLC _____

   (first number in order after black dots)

Describe any hardware modifications made to the unit and modification date:

_____

_____

_____

_____

_____

REASON FOR RETURN

Describe problems (see Reporting a Problem):

_____

_____

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_____

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_____

_____

RETURN TO*

If purchased from Magellan:

Magellan Technology Pty Limited

65 Johnston St.
Annandale
NSW 2038
Australia

Tel.: +61 2 9562 9800
Fax: +61 2 9518 7620
Email: info@magtech.com.au
Website: www.magtech.com.au

* End-users should contact the company from whom they purchased the Reader

6.Contact Us

	Magellan Technology pty limited 65 Johnston St. Annandale NSW 2038 Australia Tel.: +61 2 9562 9800 Fax: +61 2 9518 7620 Email: info@magtech.com.au Website: www.magtech.com.au

7.Revision History

Version	Date	Person	Reason
Ver.1	09.2006	Olga Kolesnik	Initial User's Guide (40-01-005-DOC) has been split into separate User Manuals for each reader. New user-friendly document layout/design, new logo, new sections added (Alert Symbols, Glossary, Product Overview, Service Form, Specifications, Revision History)

8.Appendix

8.1Specification

MARS-1-2-4-6

Multiple Antenna Reader Systems

Read and write operations	
No user-serviceable parts	
ISO/IEC Compliance	18000-3 Mode 2
Operating Frequency	13.56 MHz
Number of Reply Channels	2
Command Data Rate	424 kbit/s
Reply Data Rate	106 kbit/s per channel
Tag Type	PJM StackTag® and PJM ItemTag®
External Dimensions (L x W x H):	300 x 213 x 46 mm with fixed mounting brackets
Net Weight	3 kg (without external antennas)
Low Voltage Input	12 VDC @ 1.5 A
Operation environment	Indoor use
Temperature range	+10ºC to +45ºC
Humidity	10% to 80% (non-condensing)
Recommended Minimum Host Computer Requirement	Windows XP SP2/ 500 MHz CPU/ 128MB RAM
Host Interface	USB and Ethernet
Number of External Antennas:	
MARS-1	1
MARS-2	Up to 2
MARS-4	Up to 4
MARS-6	Up to 6
External Antennas (custom design is available on request)	Single-axis antennas with inner coil dimensions: Round 60 mm diam. X 0.8 mm and 124 mm diam. X 0.8 mm Rectangular 60 x 420 x 0.8 mm, 120 x 240 x 0.8 mm, 202 x 352 x 0.8 mm and 202 x 353 x 3.2 mm
Antenna RCA Connection Cable Length	1.5 m

8.2External Antenna Types

These devices have been assigned to operate with the antennas listed below, and having maximum gain of 3.5 dB. Antennas not included in this list or having a gain greater than 3.5 dB are strictly prohibited for use with these devices. The required antenna impedance is 4 ohms.

Part Number	Description	Photo
61-10-002	Round, 30 mm inner antenna coil radius, thickness 0.8 mm, single axis	
63-10-005	Round, 60 mm inner antenna coil radius, thickness 0.8 mm, single axis	
63-10-004	Rectangular, inner antenna coil dimensions 120x240 mm, thickness 0.8 mm, single axis	
63-10-003	Rectangular, inner antenna coil dimensions 60x420 mm, thickness 0.8 mm, single axis	
64-10-002	Rectangular, inner antenna coil dimensions 202x352 mm, thickness 3.2 mm, single axis	

64-10-004	Rectangular, inner antenna coil dimensions 202x352 mm, thickness 0.8 mm, single axis	

8.3 Reader-Tag Compatibility

Maximum Read-Write Distance* (MRD), mm		READER-WRITERS					
		MPR- 5050	MARS and round external antenna (60 mm radius)	MSTRP- 5050	MDOCR- 2505	MDR- 1109	MTR- 1310
S T A C K T A G S	Rectangular, 76 x 45 mm, 5 turns	315	235	✔	✔	60	✔
	Rectangular, 76 x 45 mm, 2.5 turns	160	170	✔	✔	30	✔
	Rectangular, 56 x 26 mm	280	220	✔	✔	55	✔
	Round, 35 mm diameter	145	170	✔	✔	40	✔
	Round, 25 mm diameter		115			15	✔
	Round, 20 mm diameter		100			10	
	Rectangular, 28 x 16 mm		120			15	✔
	Rectangular, 20 x 15 mm		95			10	
I T E M T A G S	Rectangular, 76 x 45 mm, 5 turns	540	370	✔		110	✔
	Rectangular, 20 x 15 mm		135		✔	25	✔

* - Measured for a single tag
✔ - Tags operate inside an internal volume or shrouded area

8.4Maximum Read-Write Distance

Maximum Read-Write Distance: MARS with External Antennas

Maximum Read-Write Distance* (MRD), mm	External antenna type			
	60 mm radius	120x240 mm	60x420 mm	202x352 mm
StackTag tags				
20x15 mm	95	95	60	65
28x16 mm	120	125	75	110
20 mm diameter	100	100	60	70
25 mm diameter	115	120	75	110
35 mm diameter	170	195	130	205
56x26 mm	220	250	185	280
76x45 mm, 2.5 turns	170	195	130	205
76x45 mm, 5 turns	235	270	200	300
ItemTag tags				
20x15 mm	135	140	95	155
76x45 mm, 5 turns	370	440	350	505

* - Measured with a single tag

MRD ± 5 mm