Operating Manual

MHX-910A

900 MHz Spread Spectrum OEM Module

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Regulatory Requirements

WARNING

To satisfy FCC RF exposure requirements for mobile transmitting devices, a separation distance of 23 cm or more should be maintained between the antenna of this device and persons during device operation. To ensure compliance, operations at closer than this distance is not recommended. The antenna used for this transmitter must not be co-located in conjunction with any other antenna or transmitter.

WARNING

This device can only be used with Antennas listed in Appendix A. Please Contact Microhard Systems Inc. if you need more information or would like to order an antenna.

WARNING

MAXIMUM ERP

FCC Regulations allow up to 36 dBm effective radiated power (ERP). Therefore, the sum of the transmitted power (in dBm), the cabling loss and the antenna gain cannot exceed 36 dBm.

WARNING

EQUIPMENT LABELING

This device has been modularly approved. The manufacturer, product name, and FCC and Industry Canada identifiers of this product must appear on the outside label of the end-user equipment.

SAMPLE LABEL REQUIREMENT:

FCCID: NS904P11
IC: 3143A-04P11

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

Contents

History

Revision	Date	Action	FW Rev.	Note
0.10	2004-11-01	Created		For FCC Approval

Tables and Figures

Tables

Figures

1. Introduction

1.0 Product Overview

The MHX-910A is a very high-performance wireless module. When used properly very long distance communication at very high speeds can be accomplished. The MHX-910A operates in the 902 - 928 MHz ISM band, using frequency-hopping spread-spectrum module is capable of providing reliable wireless data transfer between almost any equipment which uses an RS232, RS422, or RS485 interfaces. The small-size and superior RF performance of this product makes it ideal for many applications. Typical uses for this module include:

- SCADA
- Remote Telemetry
- Surveillance
- Traffic Control
- Industrial Controls
- Remote Monitoring
- Fleet Management
- GPS
- Wireless Video
- Robotics
- Security
- Display Signs
- Railway Signaling
- Many others

While a pair of MHX-910A modules can link two terminal devices ("point-to-point" operation), multiple modules can be used together to create a network of various topologies, including "point-to-multipoint" and "repeater" operation. Multiple independent networks can operate concurrently, so it is possible for unrelated communications to take place in the same or a nearby area without sacrificing privacy or reliability.

1.1 Features

Key features of the MHX-910A include:

- transmission within a public, license-exempt band of the radio spectrum[1] – this means that it can be used without access fees (such as those incurred by cellular airtime);
- Transparent, low latency link providing true 115.2 kbps continuous throughput
- Communicates with virtually all PLCs, RTUs, and serial devices through RS232, RS422 and RS485 interface
- 3.3V or 5V logic level compatibility
- Industrial temperature specifications
- Supports point-to-point, point-to-multipoint, Store and Forward Repeater, TDMA, Multimaster
- Maximum allowable transmit power, (1W)
- Low power consumption in Sleep Mode (Real-Time Clock wakeup)
- 32-bit CRC, selectable forward error correction with retransmission
- Separate diagnostics port - transparent remote diagnosis and online network control
- Backwards Compatible with MHX-910
- ease of installation and use – the MHX-910A module uses a subset of standard AT style commands, very similar to those used by traditional telephone line modules.

While the typical application for the MHX-910A is to provide a short- to mid-range wireless communications link between DTEs, it can be adapted to almost any situation where an asynchronous serial interface is used and data intercommunication is required.

[1] 902-928 MHz, which is license-free within North America; may need to be factory-configured differently for some countries.

2. Configuration

2.0 Overview

This chapter provides a detailed description of the various operating parameters of the MHX-910A.

2.1 Output Power Level

The Output Power Level determines at what power the MHX-910A transmits. The MHX-910A's sensitive receiver can operate with very low power levels, so it is recommended that the lowest power necessary is used; using excessive power contributes to unnecessary "RF pollution".

The allowable settings are:

0 1 mW
1 10 mW
***2 100 mW**
3 1000 mW

Ideally, you should test the communications performance between units starting from a low power level and working upward until the RSSI is sufficiently high and a reliable link is established. The conditions will vary widely between applications; the output power settings can be calculated based on following information.

- Transmitter antenna gain
- Cable loss
- Effective radiated power (ERP) requirement by FCC Regulations

Power Setting = 36 – Antenna Gain – Cable Loss

The power setting must be no more than the above calculation value. Any higher is a violation of FCC rules.

WARNING

In order to comply with the FCC/IC adopted RF exposure requirements, this transmitter system will be installed by the manufacturer's reseller professional. Installation of all antennas must be performed in a manner that will provide at least 23 cm clearance from the front radiating aperture, to any user or member of the public.

IMPORTANT:

FCC Regulations allow up to 36 dBi effective radiated power (ERP). Therefore, the sum of the transmitted power (in dBm), the cabling loss and the antenna gain cannot exceed 36 dBi.

1 mW = 0 dBm

10 mW = 10 dBm

100 mW = 20 dBm

1000 mW = 30 dBm

For example, when transmitting 1 Watt (30 dBm), with cabling losses of 2 dB, the antenna gain cannot exceed 36 - 30 + 2 = 8 dBi. If an antenna with a gain higher than 8 dBi were to be used, the power setting must be adjusted appropriately. Violation of FCC regulations can result in severe fines.

3. Installation

3.0 Overview

The installation, removal or maintenance of all antenna components must be carried out by qualified and experienced personnel.

The MHX-910A complies with FCC part 15 at the modular level for operation in the license-free 902-928 MHz ISM band. This chapter provides guidelines for installing and deploying equipment which incorporates the MHX-910A module.

3.1 Estimating the Gain Margin

Successful communication between MHX-910A modules is dependent on three main factors:

- System Gain
- Path Loss
- Interference

System gain is a calculation in dB describing the performance to be expected between a transmitter-receiver pair. The number can be calculated based on knowledge of the equipment being deployed. The following four factors make up a system gain calculation:

1. Transmitter power (user selectable 0, 20 to 30dBm)
2. Transmitter gain (transmitting antenna gain minus cabling loss between the transmitting antenna and the MHX-910A module)
3. Receiver gain (Receiving antenna gain minus cabling loss between the receiving antenna and the module)
4. Receiver sensitivity (Specified as -105dBm on the MHX-910A module)

In the following illustration, the transmitting antenna has a gain of 6 dB, and the receiving antenna has a gain of 3 dB. The cable loss between the module and the antenna is 2 dB on both the transmitting and receiving side.

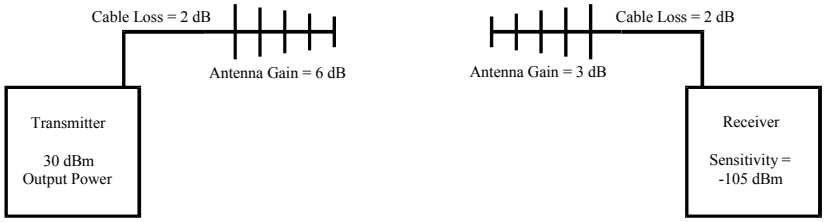

Figure 1 Gain Calculation

The power level has been set to 30dBm (1W) on the transmitter, and the receiver sensitivity for the MHX-910A is -105dBm.

System gain can be calculated:

30 - 2 + 6 + 3 - 2 + 105 = 140 dB.

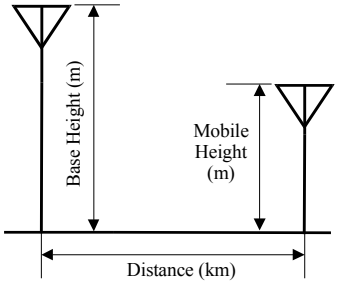

Figure 2 System Deploying

When deploying your system, care must be taken to ensure the **path loss** (reduction of signal strength from transmitter to receiver in dB) between equipment does not exceed the system gain (140 dB in the above example). It is recommended to design for a **gain margin** of at least 20 dB to ensure reliable communication. Gain margin is the difference between system gain and path loss. Referring to the same example, suppose the path loss is 113 dB, the gain margin would be 30 dB, which is more than adequate for reliable communication.

Path loss is a very complicated calculation which mainly depends on the terrain profile, and the height of the antennas off the ground.

The following table provides path loss numbers for varying antenna heights and antenna separation: These numbers are real averages taken from rural environments. They do not apply to urban, non-line-of-sight environments.

Table 1 Path Loss

Distance (km)	Base Height (m)	Mobile Height (m)	Path Loss (dB)
5	15	2.5	116.5
5	30	2.5	110.9
8	15	2.5	124.1
8	15	5	117.7
8	15	10	105
16	15	2.5	135.3
16	15	5	128.9
16	15	10	116.2
16	30	10	109.6
16	30	5	122.4
16	30	2.5	128.8

Once the equipment is deployed, you can verify the signal strength by entering into Command Mode and reading Register S123. This register provides the average signal strength in dBm. The minimum strength for communication is roughly -105dBm. For consistent reliable communication, you should try to deploy the equipment such that signal strength exceeds -85dBm.

3.2 Internal Cabling

This section describes the recommended procedure for installing cabling and antennas for use with the MHX-910A module.

The most common method for installing the module is to run a cable from the module's MCX connector to a reverse TNC bulkhead connector on the chassis of the equipment as shown in Figure 3. This cable can be purchased from Microhard Systems.

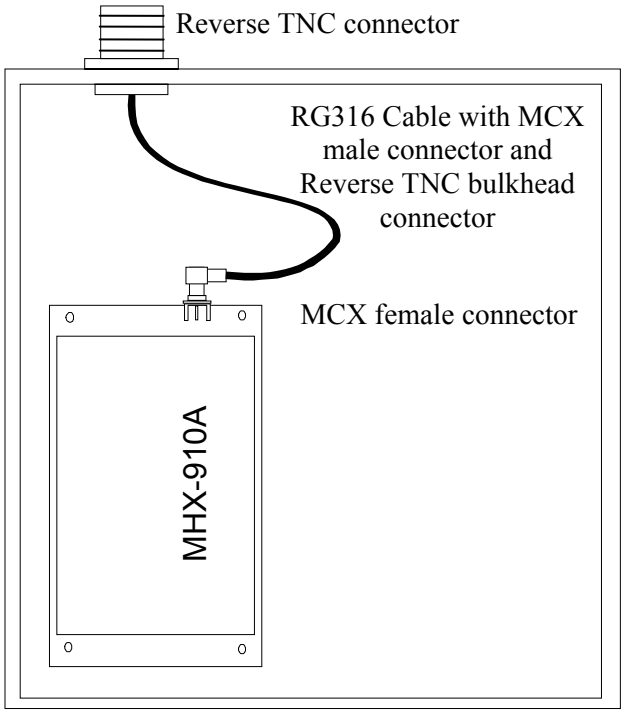

Figure 3 Suggested Internal Cabling

Cable losses are negligible for the short piece used within the chassis. Additional losses up to 0.5 dB may be present in the MCX and Reverse TNC connections.

3.3 Installing External Cables, Antennas and Lightning Arrestors

WARNING

To satisfy FCC RF exposure requirements for mobile transmitting devices, a separation distance of 23 cm or more should be maintained between the antenna of this device and persons during device operation. To ensure compliance, operations at closer than this distance is not recommended. The antenna used for this transmitter must not be co-located in conjunction with any other antenna or transmitter

WARNING

Direct human contact with the antenna is potentially unhealthy when a MHX-910A is generating RF energy. Always ensure that the MHX-910A equipment is powered down during installation.

WARNING

Never work on an antenna system when there is lightning in the area.

The installation, removal or maintenance of all antenna components must be carried out by qualified and experienced personnel.

Never work on an antenna system when there is lightning in the area.

Direct human contact with the antenna is potentially unhealthy when the MHX-910A is generating RF energy. Always ensure that the MHX-910A equipment is powered down during installation. At all time, a distance of 23 cm must be maintained between the antenna and any person when the device is in operation.

Surge Arrestors

The most effective protection against lightning is to install two lightning (surge) arrestors, one at the antenna, the other one at the interface with the equipment. The surge arrestor grounding system should be fully interconnected with the transmission tower and power grounding systems to form a single, fully integrated ground circuit. Typically, both ports on surge arrestors are N-female.

External Filter

Although the MHX-910A is capable of filtering out RF noise in most environments, there are circumstances that require external filtering. Paging towers, and cellular base stations in close proximity to the MHX-910A antenna can desensitize the receiver. Microhard Systems' external cavity filter eliminates this problem. The filter has two N-female ports and should be connected in line at the interface to the RF equipment.

Weatherproofing

Type N and RTNC connectors are not weatherproof. All connectors should be taped with rubber splicing tape (weatherproofing tape), and then coated with a sealant.

Cabling

The following coax cables are recommended:

Table 2 Cable Loss

Cable	Loss (dB/100ft)
LMR 195	10.7
LMR 400	3.9
LMR 600	2.5

Factors to take into consideration when choosing a cable are:

- price;
- bend radius limitations (the lower performance cables generally can bend more sharply)
- performance requirements; and,
- distance between the equipment and the antenna.

When installing the cable, always begin fastening at the top near the antenna connector/surge arrestor. The cable must be supported at the top with a hose clamp or wrap lock, and at 5 ft intervals down the length of the tower. Over-tightening the fasteners will dent the cable and reduce performance. If properly grounded surge arrestors are not installed at both the top and the bottom of the cable, then the cable should be grounded to the tower at these locations using a cable grounding kit. If the tower is non-conductive, then a separate conductor, physically separate from the cable, should be run down the tower.

Antenna

Before choosing an antenna, you should have some knowledge of the path loss and the topology of the equipment. If the equipment is in a fixed location and is to communicate with only one other unit also in a fixed location, then a Yagi antenna is suitable. Choose a Yagi with enough gain to ensure adequate gain margin. When deploying the Yagi, point the antenna towards the intended target, ensuring the antenna elements are perpendicular to the ground for vertical polarization.

In applications where there are multiple units that you must communicate with or units, which are in motion, you may select an Omni-directional antenna with appropriate gain.

FCC Regulations allow up to 36dBm effective radiated power (ERP). Therefore, the sum of the transmitted power (in dBm), the cabling loss and the antenna gain cannot exceed 36dBm with respect to the isotropic radiator.

To comply with FCC regulations, you must limit ERP to 36 dBm or less.

ERP is calculated as follows:

ERP = Tx Power (dBm) - Cable/Connector Loss (dB) + Antenna Gain (dBi)

Antenna Gains must be in dBi when calculating the 36dBm ERP limit.

1dBd = 2.15dBi

Use the guidelines in the previous section for calculating cable and connector losses. If cabling and connector losses are 2 dB, then the maximum allowable gain of the antenna will be 8 dB.

Examples:

FCC and Industry Canada Regulations allow up to 36dBm effective radiated power (ERP). Therefore, the sum of the transmitted power (in dBm), the cabling loss and the antenna gain cannot exceed 36dBm with respect to the isotropic radiator.

Example 1)

What is the maximum power the MHX-910A can be set to comply with FCC and IC given the following equipment given a Rubber Ducky Antenna Gain 2dBi and no cable or connectors in the system?

Max ERP 36dBm
Max TX power = ERP – Ant Gain(dBi) + Cable/Connector loss (dB)
Ant Gain dBi = 2dBi
Max TX power = 36dBm – 2dBi + 0dB = 34dBm
We can set the modem to the maximum power setting of 30dBm.

Example 2)

What is the maximum power the MHX-910A can be set to comply with FCC and IC given the following equipment given a Yagi Antenna Gain 12dBd and cable and connector loss of 4.5 dB?

Max ERP 36dBm
Max TX power = ERP – Ant Gain(dBi) + Cable/Connector loss (dB)
Ant Gain dBi = Ant Gain dBd + 2.15 dB
Yagi Gain (dBi) = 12 + 2.15 = 14.15dBi
Max TX power = 36dBm – 14.15dB + 4.5dB = 26.35dBm
We must round down
Hence Max TX power = 26dBm

Example 3)

What is the maximum power the MHX-910A can be set to comply with FCC and IC given the following equipment given a Omni Antenna Gain 6dBd and cable and connector loss of 2.5 dB?

Max ERP 36dBm
Max TX power = ERP – Ant Gain(dBi) + Cable/Connector loss (dB)
Ant Gain dBi = Ant Gain dBd + 2.15 dB
Omni Gain (dBi) = 6 + 2.15 = 8.15dBi
Max TX power = 36dBm – 8.15dB + 2.5dB = 30.35dBm
Hence Max TX power = 30dBm

A. Approved Antennas

Group	Part Number	Description
Quarter Wave		
	MHS031010	<1.5dBi, 900MHz 1/4 Wave Antenna Reverse SMA Right Angle
	MHS031020	<1.5dBi, 900MHz 1/4 Wave Antenna Reverse SMA Straight
	MHS031030	<1.5dBi, 900MHz 1/4 Wave Antenna Reverse SMA Right Angle MHS
	MHS031040	<1.5dBi, 900MHz 1/4 Wave Antenna Reverse SMA Straight MHS
	MHS031050	<1.5dBi, 900MHz 1/4 Wave Antenna MCX Right Angle MHS
	MHS031060	<1.5dBi, 900MHz 1/4 Wave Antenna Reverse SMA Straight
Rubber Ducky		
	MHS031000	2dBi, 900MHz Rubber Ducky Antenna RPTNC Swivel
	MHS031070	2dBi, 900MHz Rubber Ducky Antenna Reverse SMA Swivel
	MHS031080	2dBi, 900MHz Rubber Ducky Antenna Reverse SMA Straight
Transit Antennas		
	MHS031210	3dBd, 900 MHz Transit Antenna with Ground Plane
	MHS031220	3dBd, 900MHz Transit Antenna No Ground Plane
	MHS031230	3dBd, 900MHz Transit Antenna Permanent Mount GP
	MHS031240	3dBd, 900MHz Transit Antenna Permanent Mount NGP
		Mounts for Transit Antennas have a RPTNC Pigtail
Yagi Antennas		
	MHS031311	6dBd, 900MHz Yagi Directional Antenna Antenex, RPTNC Pigtail
	MHS031431	6.5dBd, 900MHz Yagi Directional Antenna Bluewave, RPTNC Pigtail
	MHS031501	9dBd, 900MHz Yagi Directional Antenna Antenex, RPTNC Pigtail
	MHS031441	10dBd, 900 MHz Yagi Directional Antenna Bluewave, RPTNC Pigtail
	MHS031451	11dBd, 900 MHz Yagi Directional Antenna Bluewave, RPTNC Pigtail
	MHS031401	12dBd, 900MHz Yagi Directional Antenna Antenex, RPTNC Pigtail
	MHS031411	12dBd, 900MHz Yagi Directional Antenna Bluewave, RPTNC Pigtail
Omni Directional		
	MHS031251	3dBd, 900MHz Omni Directional Antenna Antenex, RPTNC Pigtail
	MHS031461	3dBd, 900 MHz Omni Directional Antenna Bluewave, RPTNC Pigtail
	MHS031321	6dBd, 900MHz Omni Directional Antenna Antenex, RPTNC Pigtail
	MHS031471	6dBd, 900 MHz Omni Directional Antenna Bluewave, RPTNC Pigtail

WARNING

Changes or modifications not expressly approved by Microhard Systems Inc. could void the user's authority to operate the equipment. This device has been tested with MCX and Reverse Polarity SMA connectors with the antennas listed in Appendix A When integrated in OEM products, fixed antennas require installation preventing end-users from replacing them with non-approved antennas. Antennas not listed in the tables must be tested to comply with FCC Section 15.203 (unique antenna connectors) and Section 15.247 (emissions). Please Contact Microhard Systems Inc. if you need more information.