# NERS01
# Network Extender Radio System

**USA FCC Part15:247: OUR-9EXTEND**

**INDUSTRY CANADA: 4214A-9XTEND**

Document No. 11337, Revision C

February 2012

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## Revision Notes

**First Release – May 2, 2011**

**Revision A – June 27, 2011**

- Add FCC / Industry Canada Notices

**Revision B– July 22, 2011**

- General revisions for clarity

**Revision C– February 6, 2012**

- Revise generator running speed and voltage
- Fix termination switch notation

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# 1. Overview

The NERS01 Network Extender Radio System is intended to allow the extension of the bus converter RS-485 Modbus network without cables. Typical application would be for monitoring belt trippers and other moveable machines that are not easily cabled. The system can also be used to extend the network between buildings or where cabling is impractical. The system is packaged in an explosion proof cast aluminum housing rated for Class I, Groups C & D, Divisions 1 & 2, and Class II, Groups E, F & G, Divisions 1 & 2. The system employs an Intrinsically Safe antenna coupler rated for the same areas as the enclosure.

The system utilizes a prepackaged 900 MHz radio module and supporting power supplies. To facilitate use on machinery without power, the product has a 45VDC input power supply to accept power from an optional machine mounted generator. In a addition the housing can accept a 120VAC power supply module to power a unit that is fixed mounted. Both directional and omni-directional antenna options are offered.

********** **Safety Warning** **********

**Do not alter the system's enclosure in anyway. Do not drill additional holes in the enclosure. Do not add or substitute any components not supplied with the system. Apply power to the system only as indicated in this document. Do not alter the Intrinsically Safe antenna adapter. Only use the supplied antenna and antenna connecting cable. If mounted on a moveable machine, ensure the system will clear all fixed objects when the machine travels. Do not operate or apply power to the system if the hazardous atmosphere is present.**

**********

********** **FCC / Industry Canada Notice** **********

This manual is intended for professional installers with experience and expertise in the installation and configuration of RF transceivers. Do not adjust the transmit power level of this product without consideration of the maximum EIRP permitted under the FCC approval for this product. The maximum EIRP is 1W with an antenna gain of 6DBi. Higher gain antennas are permitted if sufficient antenna cable is used to reduce the EIRP at the antenna to 1W @ 6DBi gain.

**FCC IDENTIFIER: OUR-9EXTEND / IC: 4214A-9XTEND**

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# 2. Description of Indicators

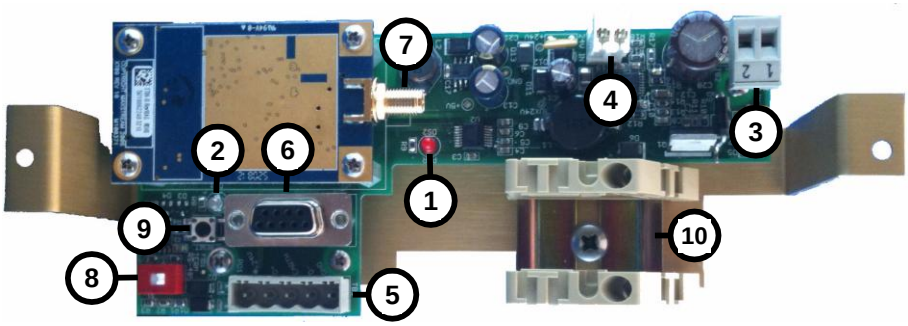


**Figure 1 - Illustration of Connectors, Indicators and Switches**

The sensor requires no settings. There are 2 indicator lamps:

| ID | Description |
|---|---|
| 1 | Power on indicator |
| 2 | Data present indicator |
| 3 | 45VDC supply input from generator |
| 4 | Connector for optional 24VDC power supply |
| 5 | RS-485 network connector |
| 6 | RS-232 radio modem setup connector |
| 7 | Antenna connector |
| 8 | Termination switch |
| 9 | Enter command mode switch |
| 10 | DIN rail bracket for optional power supply |

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# 3. Installation

The system is intended to be installed in a hazardous location. Observe all requirements of the electrical code for the area where the system is installed. The system is rated as follows:

- Class I, Groups C & D, Divisions 1 & 2
- Class II, Groups E, F & G, Divisions 1 & 2

The system is intended to be operated in a master – slave scenario. The master station is mounted to the building or super-structure. The master station is connected to a WS1 or WS2 Webserver or an EZSentinel128. The slave stations are mounted to the moving machinery or at the remote site. The slave stations connect to one or more bus converters. If possible, directional yagi antennas should be used to minimize interference and improve range. The radios operate in the 900mHZ band and with appropriate antennas can achieve 20 mile range. Selection of radio power levels and operating channel is described under the configuration section of this manual.

********** **Safety Warning** **********

**Do not alter the system's enclosure in anyway. Do not drill additional holes in the enclosure. Do not add or substitute any components not supplied with the system. Apply power to the system only as indicated in this document. Do not alter the Intrinsically Safe antenna adapter. Only use the supplied antenna and antenna connecting cable. If mounted on a moveable machine, ensure the system will clear all fixed objects when the machine travels. Do not operate or apply power to the system if the hazardous atmosphere is present.**

**********

## *3.1 Mounting the NERS01*

Mount the NERS01using the drilling guide as shown in Figure 2. Do not over-tighten the mounting nuts. Use thread locking compound or self-locking nuts if required. Mount the enclosure on an even, flat surface. Mount the enclosure where easily accessible for service. The location should be high on the machine within reach of the antenna using the supplied cable.

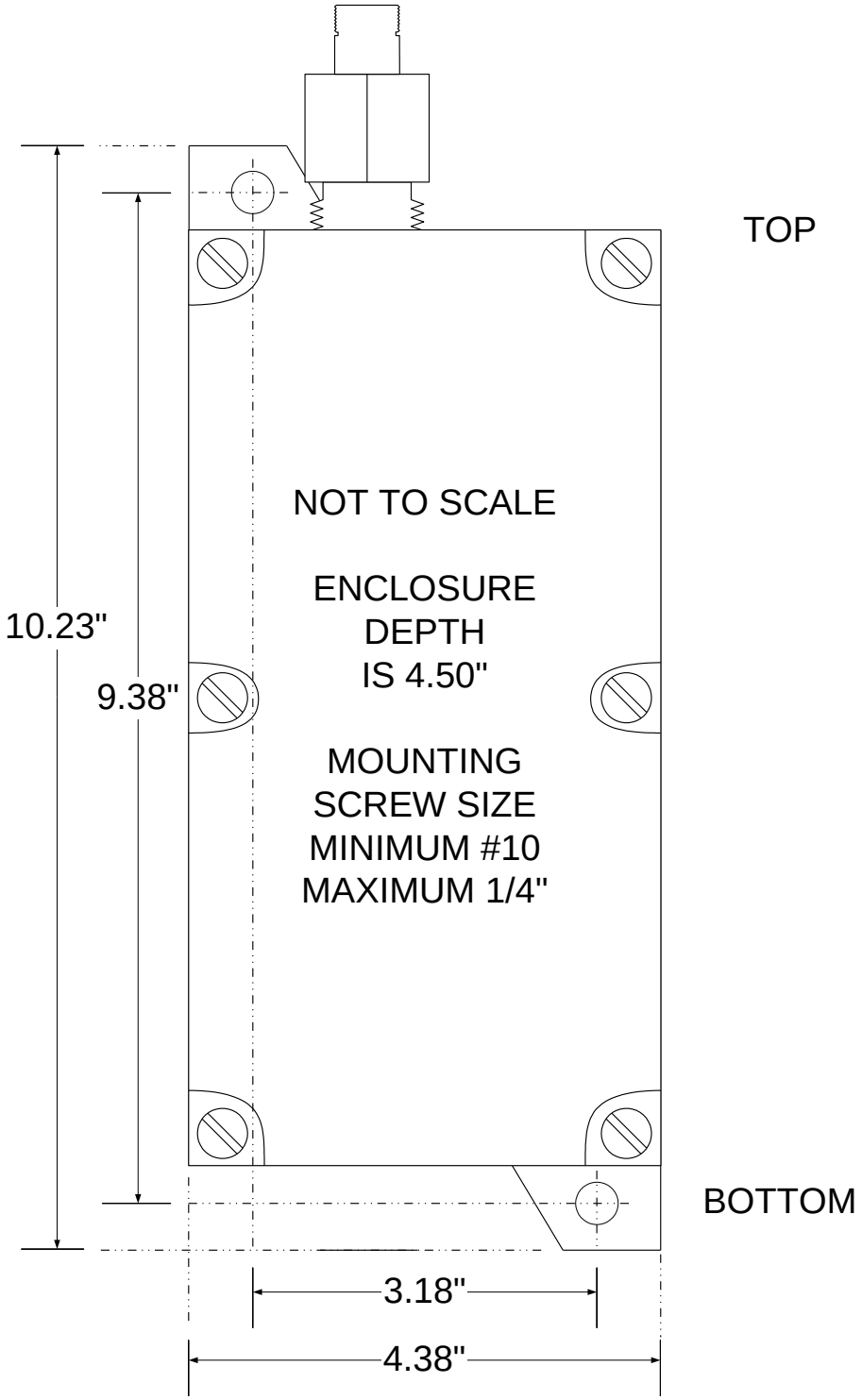



**Figure 2 – Drilling Guide, Front View**

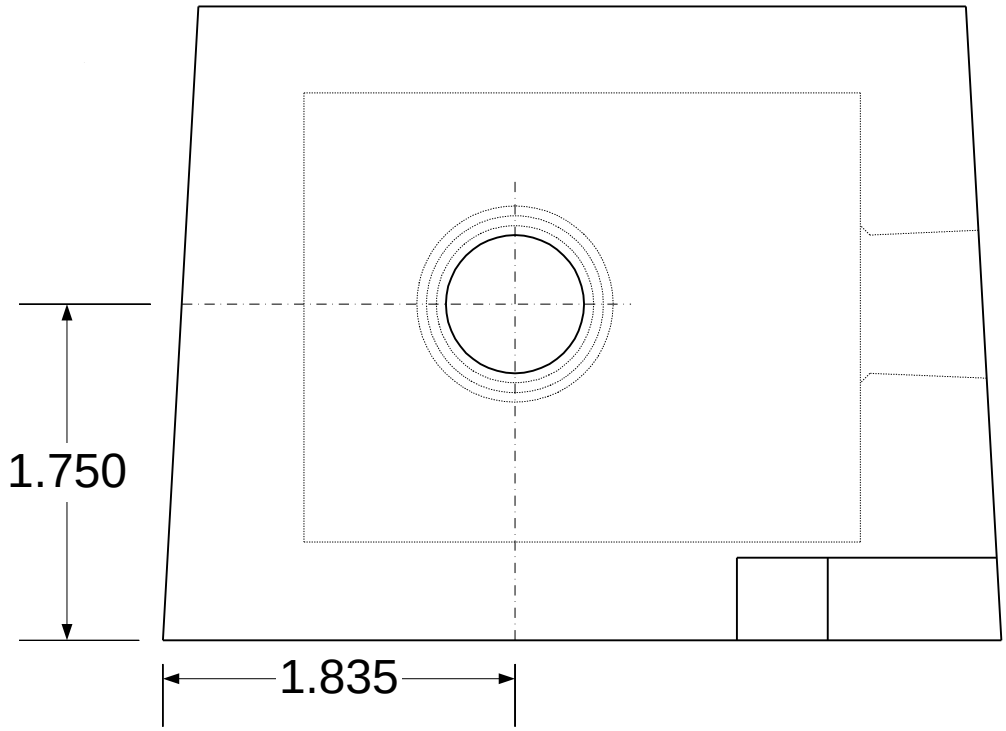



**Figure 3 – Modbus RS-485 Cable ½" Conduit Entry on Bottom**

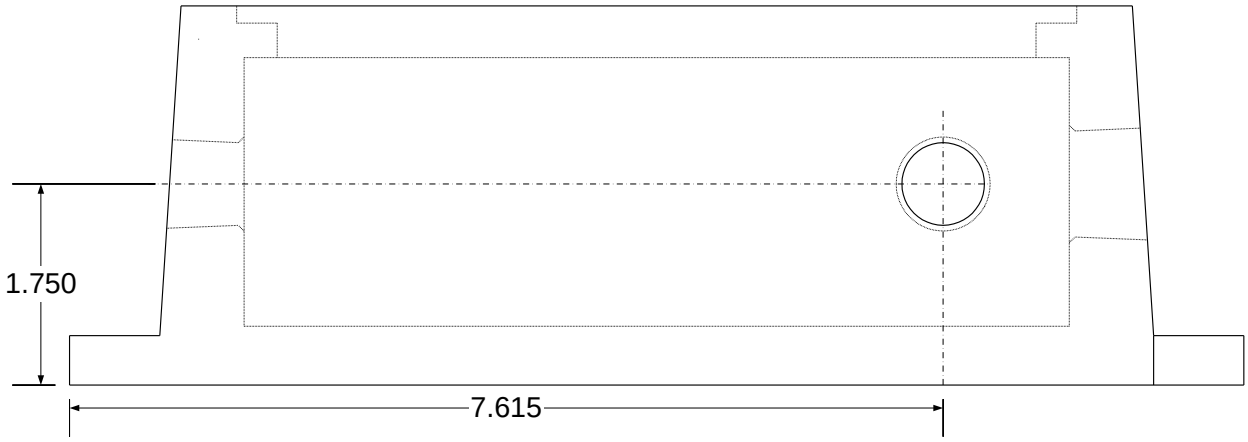



**Figure 4 – Power Supply ½" Conduit Entry on Right Side**

## 3.2 Electrical Connections

There are three electrical connections required when installing the system:

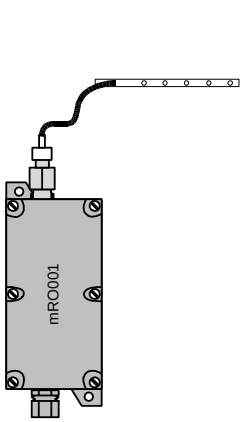
1. Connect the antenna using the supplied antenna cable and connectors;
2. Connect the Modbus RS-485 network;
3. Connect a power source, if required (see Section 3.22).

### 3.2.1 Mounting the Antenna

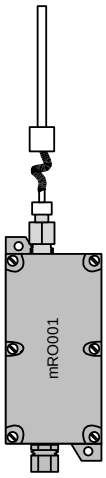
Two types of antennas are available for the system, a omni-directional and yagi style antenna. The antenna on the moving equipment should always be a yagi antenna, mounted in direct line of sight of the master station radio antenna. The master station antenna may be either a yagi or omni antenna. If the master station is in the middle of the structure, use an omni antenna. If the master station is at the end of the structure use a yagi antenna. For further information on the optional antenna, see Appendix 2 of this manual.

Mount the antennas to a rigid metal mast using the supplied hardware. Minimize movement or shaking of the antennas as much as possible. Always point the antennas directly at each other, the small ends of yagi antennas pointing together. Observe line of sight if possible.

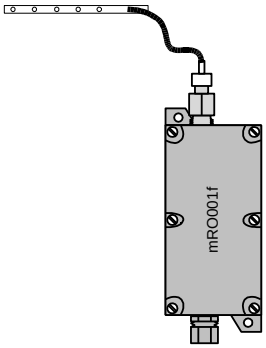
The illustrations below detail typical installations:




mRI001 mounted on moving machine at one end of a structure using yagi antenna

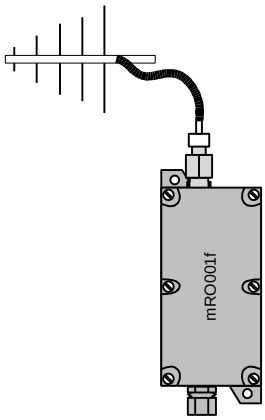



mRI001 mounted on the fixed structure in the middle of the structure using omni antenna

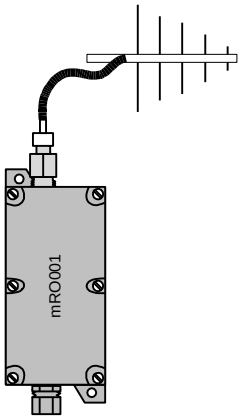



mRI001 mounted on moving machine at one end of a structure using yagi antenna

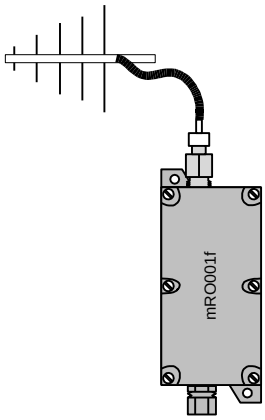
**Figure 5 – Typical Antenna Selection, Master Station in Middle Configuration**




mRI001 mounted on moving machine at one end of a structure using yagi antenna




mRI001 mounted on the fixed structure in the middle of the structure using yagi antenna




mRI001 mounted on moving machine at one end of a structure using yagi antenna

**Figure 6 – Typical Antenna Selection, Master Station at One End Configuration**

The antennas and radios are supplied with Type N connectors. Tighten the connectors and apply heat shrink tubing to prevent water ingress into the connectors. Protect the radio connector from direct water exposure. If the antenna connections are exposed to the weather, use heat shrink tubing on the connectors to prevent water ingress. Observe antenna orientation as shown below:

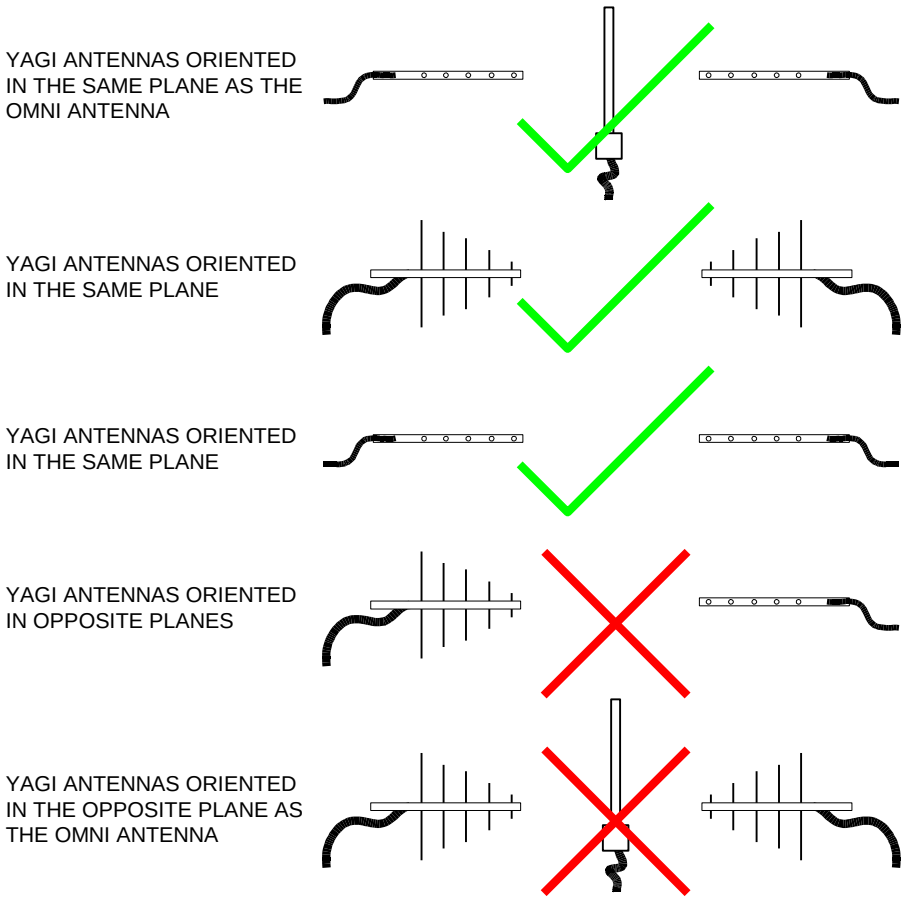



**Figure 7 – Antenna Orientation**

### 3.2.2 Connecting the Modbus RS-485 Network

The Modbus network connects using a 5 position pluggable terminal strip. The system can either supply or receive 24VDC power from this connector. Possible power sources include:

1. An optional generator mounted on the moveable machine;
2. An option AC line powered DIN rail power supply;
3. Power supplied by an existing WS1 or EZSentinel128

Connect the Modbus network using the conduit opening on the bottom of the enclosure.

If the system is a master radio, it may receive power from the WS1 or WS2 webserver or the EZSentinel128. If this is the case no optional power supply is required. If the system receives power from a generator on moving equipment or uses the optional line power supply the system will supply power to the bus converter on this network.

Connect the Modbus network as shown below:

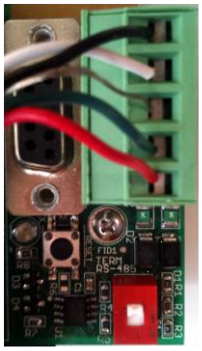



**Figure 8 – Modbus RS-485 Network Connections**

The termination switch must be set according to the location of the system on the network. If the system is at end of line in the network, turn the termination switch on. Otherwise the switch must be off. The illustration below illustrates a typical network configuration:

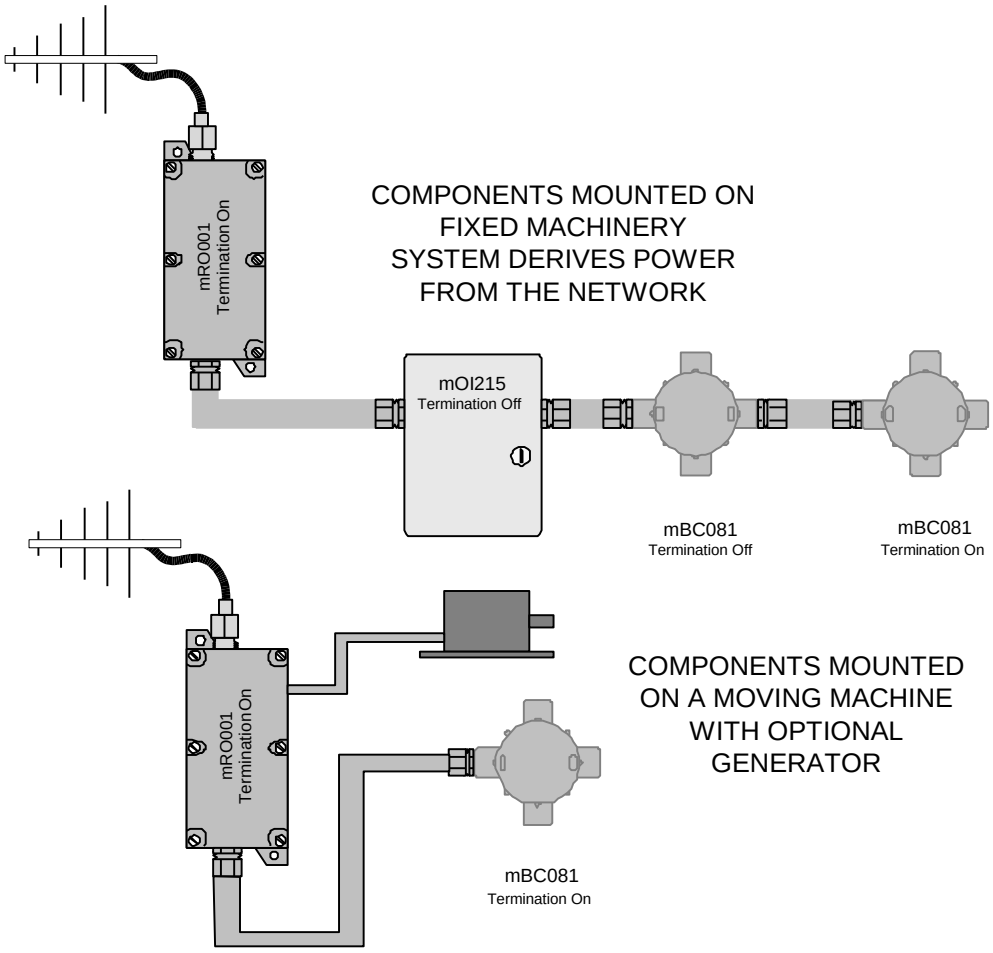



**Figure 9 – Typical Modbus RS-485 Network Configurations**

## *3.3 Powering the Network Extender*

The system can receive power from three sources the EZSentinel Webserver, an optional generator, or an optional line powered 24VDC power supply.

If the system is mounted on a moveable machine, the energy for the power source will have to be obtained from the machine. The optional generator can be connected to a driven pulley to provide the power.

If the system is stationary it can derive power from two sources. If it is connected to a EZSentinel webserver, in most cases, the webservers power supply can be used. When the number of bus converters directly connected to the webserver exceeds 5 the radio's power level must be reduced if the optional power supply is not used as shown in this table:

| No of Bus Converters Directly Connected to the Webserver | Radio Output Power | External Power Required |
|---|---|---|
| 1 | up to 1W | No |
| 2 | up to 1W | No |
| 3 | up to 1W | No |
| 4 | up to 1W | No |
| 5 | up to 1W | No |
| 6 | up to 0.5W | No |
| 6 | Greater than 0.5W | Yes |
| 7 | Up to 100mW | No |
| 7 | Greater than 100mW | Yes |

If the system is standalone and not connected to a webserver the optional 24VDC line powered supply can be used.

### 3.3.1 Connecting the Optional Power Supplies

Power supply cables must only enter the enclosure using the ½" conduit opening on the right side of the enclosure. If this opening is not used it must be plugged using an approved hole plug.

The power source for mobile applications will be the optional generator. The optional generator is rated for Class II, Group G, Division 1 & 2 locations.

**Figure 10 – Optional Generator**

The generator is powered by a rotating shaft on the machine. The output of the generator is RPM / 10 = VDC OUT. The average generator output voltage should be 45VDC. The output voltage must not exceed 60VDV or be less than 30VDC. The shaft RPM for 45VDC would be 450 RPM. Size the pulley or gear reducer reduction ratio to provide 450 RPM to the generator input shaft.

Wiring between the generator and radio enclosure must meet the electrical code requirements for the rated area. Connect the generator to the input terminals as shown below. Be sure to measure the output polarity and voltage of the generator before connecting the generator. Incorrect polarity will not cause damage, but no power will be supplied. Should the generator supply voltage exceed 60VDC , a resettable fuse will prevent damage to the system. Remove power to reset the fuse.

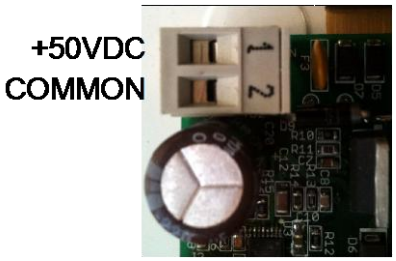



**Figure 11 – Optional Generator Electrical Connections**

If the system is mounted in a fixed location and 120VAC power is available the optional line powered power supply can be used. Mount the power supply using the supplied hardware and DIN rail. Connect the power supply using the supplied connector. Connect the 120VAC line directly to the power supply as shown below:


**Figure 12 – Optional Line Powered Power Supply Connections**

## *3.4 Mounting the Optional Generator*

An optional generator rated for Class II, group G, Divisions 1 & 2 is available. The generator is a permanent magnet motor used as a generator. The generator is designed for continuous duty use. The generator requires minimal mechanical energy in operation. A picture of the generator is below:

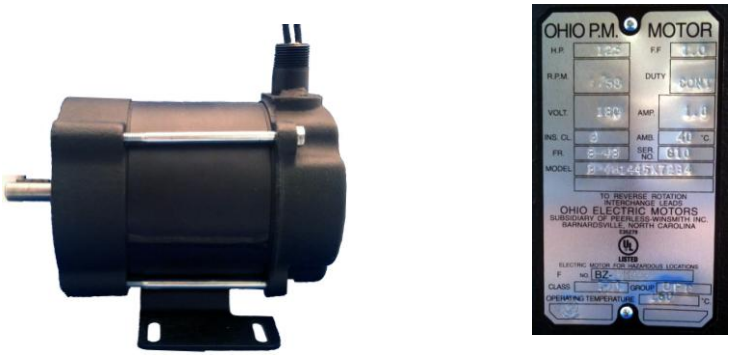



**Figure 13 – Picture of Motor and Nameplate**

The following steps are required to install the generator:

1. Before beginning the installation run the machine and record the speed of the shaft that will be used to drive the generator;
2. Calculate the gear or belt ratio required to drive the generator at 450 RPM;
3. Select pulleys or a gear reducer to achieve the ratio;
4. Locate a secure position on the machine to mount the generator;
5. Fabricate a mounting bracket to hold the generator and allow for adjustment of the drive system;
6. Select a belt to fit the final installation if a belt drive is used;
7. After verifying alignment, start the machine and measure the voltage and polarity of the generator output. The generator must not be connected to radio system at this time. The voltage will not change when connected to the radio system.
8. Verify the generator output is between 35 and 60 VDC. Mark the generator + output lead;
9. If the machine can move on the belt, such as a belt tripper, ensure the voltage remains in range with the machine moving;
10. Fabricate and install a belt guard if belt drive is used;
11. Connect the generator to radio system observing the generator output polarity. Use wiring suitable for the hazardous location.

A drawing of the generator is shown below:

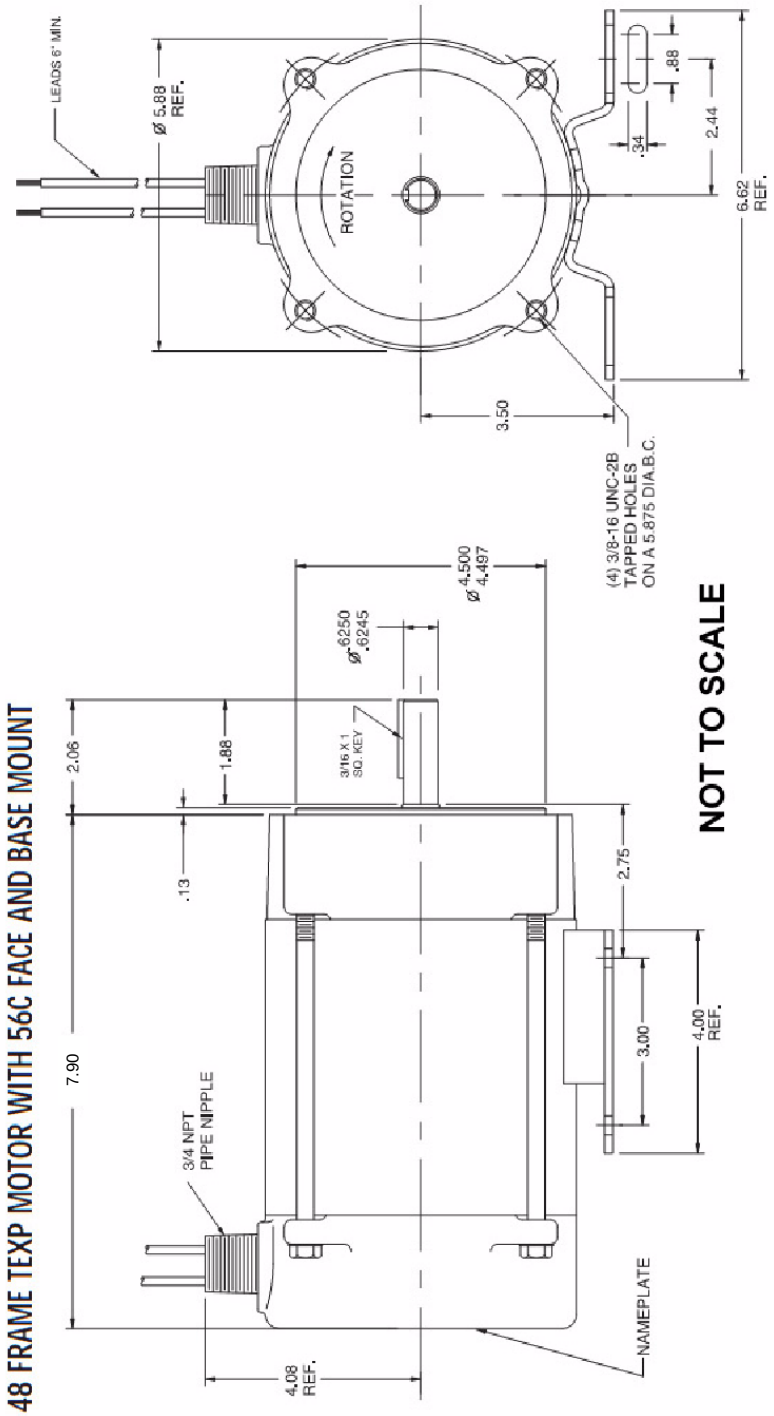



**Figure 14 – Drawing of Motor and Mounting Plate**

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# 4. Specifications

| Description | Characteristic |
|---|---|
| **Radio** | |
| Frequency | 900 MHz ISM band |
| Channels | 10 hop sequences (50 channels) |
| Transmit power | 1 mW to 1W adjustable |
| Data rate | 19.2 KBaud |
| Approval USA | FCC ID : OUR-9XTEND |
| Approval Canada | IC ID : 4214A-9XTEND |
| **Modbus Network** | |
| Communications | RS-485 differential |
| **System Power Requirements** | |
| Voltage | 24 VDC |
| Average load, radio only, 0.5W transmit power | 30 mA |
| Peak load, radio only, 1W, during transmit | 150 mA |
| **Generator Power Supply Input** | |
| Voltage range | 30 – 60 VDC |
| Average load radio only, 0.5W transmit power | 20 mA |
| Peak load, radio only, 1W, during transmit | 100 mA |
| Additional load each bus converter | 50 mA |
| Optional Generator output | 45VDC @ 450 RPM, 250mA |
| **Environment** | |
| Temperature | -40 to 55°C (-40 to 130°F) |
| Relative Humidity | 0 to 95% non-condensing |
| **Dimensions** | |
| Length | 260mm (10.3in) |
| Width | 112mm (4.4in) |
| Depth | 115mm (4.5in) |

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# Appendix 1 – Configuring the Radio Module

********** Note **********

**The radio module comes pre-configured with CMC defaults if purchased from CMC.**

**********

The system uses a Digi Xtend radio module. The modules must be configured before use or if channel selection or power output changes are required. Configuration can be accomplished using HyperTerm or any similar serial terminal program.

The default parameters for the radio are described in the table below:

| Parameter | AT Command | Digi Default | CMC Default |
|---|---|---|---|
| Interface baud rate | BD | 3 (9600) | 4 (19,200) |
| Parity | NB | 0 (no parity) | 0 (no parity) |
| Stop bits | SB | 0 (1 stop bit) | 0 (1 stop bit) |
| Channel | HP | 0 (Channel 0) | 0 (Channel 0) |
| Radio baud rate | BR | 1 (115,200) | 1 (115,200) |
| Transmit power | PL | 4 (1 Watt) | 2 (100 mW) |
| RX LED enable | CD | 2 (disabled) | 0 (enabled) |
| RS-485 transmit enable | CS | 0 (disabled) | 3 (enabled) |
| Echo on | E | 0 (echo off) | 1 (echo on) |

The radio must be configured as shown above for CMC defaults, with the exception of channel and power level to operate on a CMC system.

## Connecting to the Radio Modem

Power the radio with 24VDC using the Modbus network connector or by connecting the optional 120VAC power supply. Connect the radio to the PC using a standard RS-232 modem cable with male and female DB-9 connectors. Do not use a null modem cable. USB to serial adapters can be used for configuration.

Set the serial port parameters on the PC to 19.2KBaud, no parity, 1 stop bit, no flow control. If you are using a radio not pre-configured by CMC set the baud rate to 9600.

The radio is configured using standard AT command sequences as indicated in table. The command string will consist of “AT” then the 1 or 2 letter command, followed by the parameter value. The command is terminated with a <ENTER> (carriage return).

Establish command mode on the radio by sending the string +++. The three +’s must be sent in quick succession and no <ENTER> is required. The modem will respond with OK.

If you are unable to see the characters you are typing the radio modem is in “echo off” mode. To enter “echo on” mode, type ATE1<ENTER>. The radio modem will respond with OK and any further typed characters will be displayed.

If you are unable to establish communications with the modem, first check your connections and insure the “power on” light is illuminated on the radio system. You can force the modem into command mode by pressing the “Enter command mode” pushbutton switch next to the module while cycling power. Contact the factory is you are unable to connect with the module.

## Setting the Power Level

**********  **FCC / Industry Canada Notice**  **********

This manual is intended for professional installers with experience and expertise in the installation and configuration of RF transceivers. Do not adjust the transmit power level of this product without consideration of the maximum EIRP permitted under the FCC approval for this product. The maximum EIRP is 1W with an antenna gain of 6DBi. Higher gain antennas are permitted if sufficient antenna cable is used to reduce the EIRP at the antenna to 1W @ 6DBi gain.

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The power level should be set as low as possible while maintaining reliable communications. In general, power levels below 100 mW are not recommended. Excess power levels will broadcast your signal farther than necessary, possibly interfering with other radio systems. Start with 100 mW power level and increase only if required. The power level is changed by entering command mode and using the PL command. The command sequence for 100 mW is ATPL2<ENTER>. The following table lists the available power levels:

| Power level | AT Command |
|---|---|
| 1 mW | ATPL0<ENTER>. |
| 10 mW | ATPL1<ENTER>. |
| 100 mW | ATPL2<ENTER>. |
| 500 mW | ATPL3<ENTER>. |
| 1 W | ATPL4<ENTER>. |

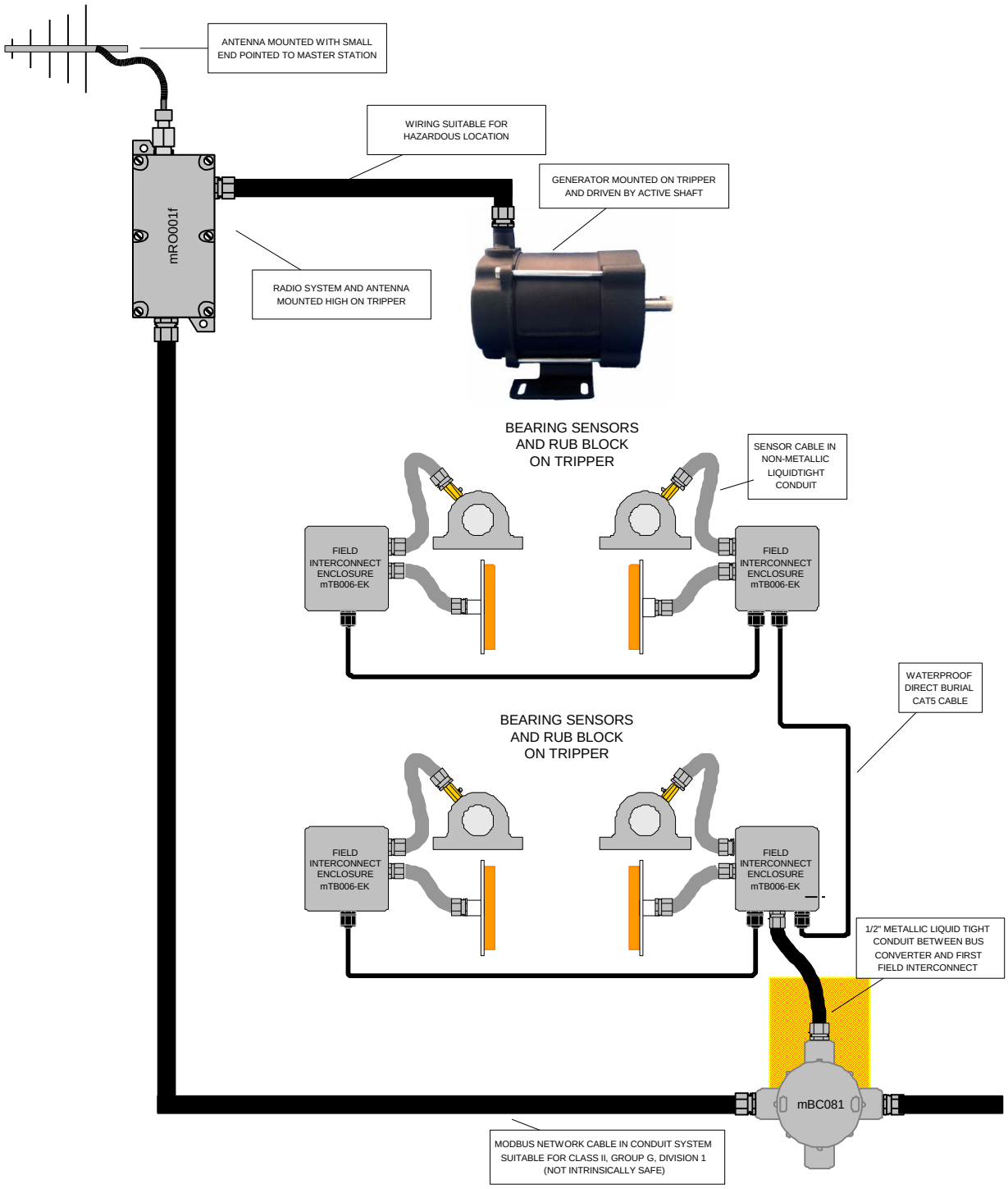
## Setting the Channel

The radio uses spread spectrum technology to reduce interference. The radios can hop over 50 frequencies in 10 possible bands. The default is hopping channel 0. The range of hopping channels is 0 – 9. You will have to set the hopping channel if you have more than one master radio in close proximity. Master and slave radios on the same network must be on the same hopping channel. The AT command for setting the hopping channel to 0 is ATHP0<ENTER>.

## Saving the Configuration

If the configuration has been modified, it must be saved to non-volatile memory in the radio modem. The command is ATWR<ENTER>. The radio modem will respond with OK if the write was successful.

# Appendix 2 – Typical Installation on a Belt Tripper



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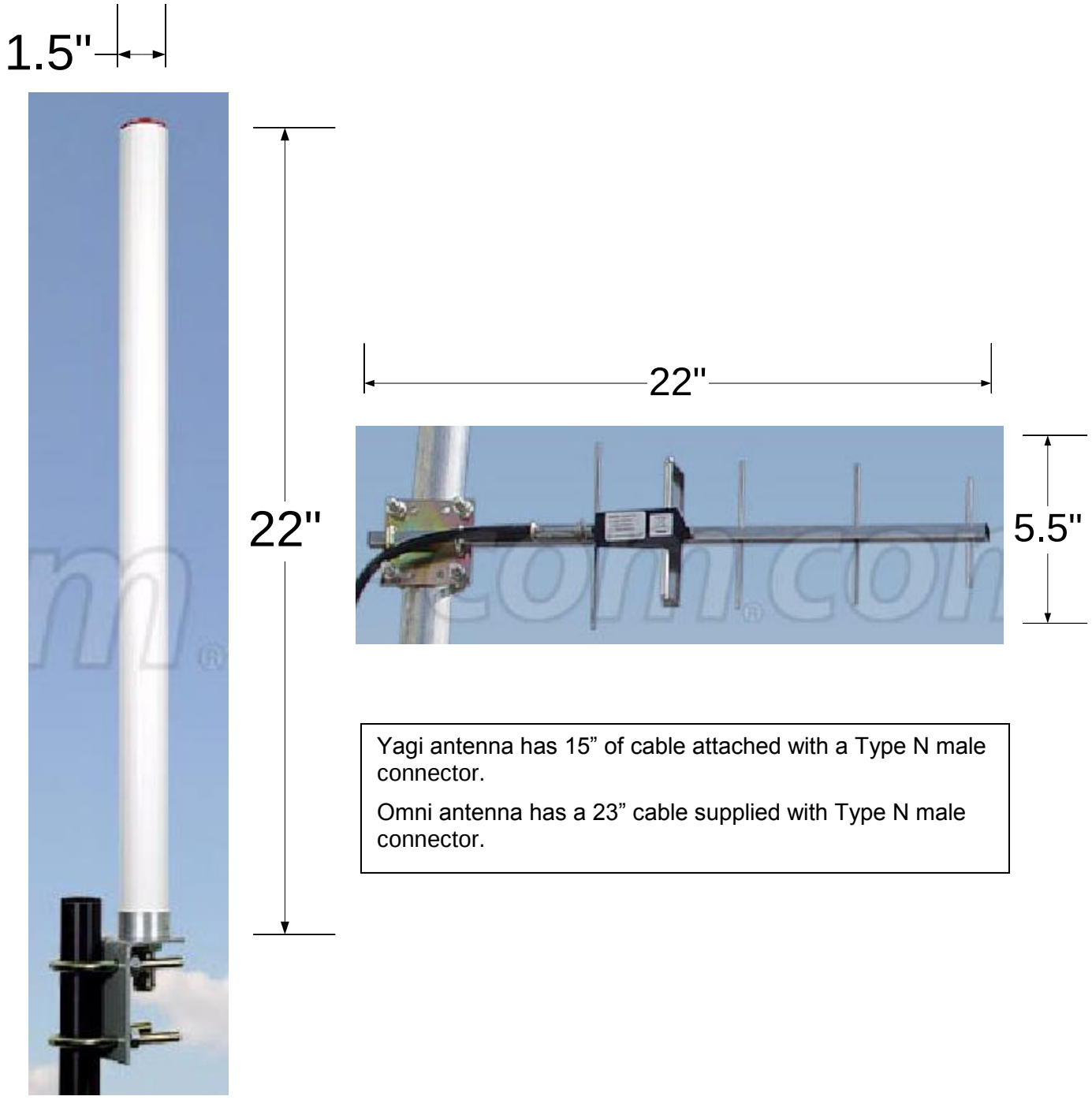
# Appendix 3 –Antenna Dimensions




Yagi antenna has 15” of cable attached with a Type N male connector.

Omni antenna has a 23” cable supplied with Type N male connector.

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# Appendix 4 – System Part Numbers

The following system part numbers should be used for ordering:

| Description | Part no. |
|---|---|
| NERS01 Network Extender Radio System | 11330 |
| Generator, 45VDV/1A @ 450RPM | B-481445X7284 |
| Line voltage power supply kit, 120VAC/0.3A – 24VDV 0.41A | 11344 |
| 900Mhz Omni antenna with 23” cable and Type N male connector | 11345 |
| 900Mhz 9DBi gain Yagi antenna with 15” cable and Type N male connector | 11341 |

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