OmniSense Moisture Monitoring System (MMS) Operating Manual

Revision 0.1 5/25/04

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1. Regulatory Compliance

1.1. FCC Compliance Statement

This Product Contains Transmitter Module FCC ID: RY20001
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.

Caution: To comply with FCC RF exposure compliance requirements, a separation distance of at least 2.5cm must be maintained between the antenna of this device and all persons.

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 instructions, 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 the 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.

This equipment has been certified to comply with the limits for a class B computing device, pursuant to FCC Rules. In order to maintain compliance with FCC regulations, shielded cables must be used with this equipment. Operation with non-approved equipment or unshielded cables is likely to result in interference to radio and TV reception. The user is cautioned that changes and modifications made to the equipment without the approval of manufacturer could void the user's authority to operate this equipment.

2. Overview

The OmniSense Moisture Monitoring System provides for wireless monitoring of environmental conditions such as relative humidity, temperature, and wood moisture. The three system components are Sensor, Gateway, and Central Host.

Sensors are battery operated with >15 year expected battery life in normal operating scenarios. Sensors measure the local environment conditions and periodically

connect wirelessly to the gateway to allow the gateway to read the sensors monitoring log file. Sensors use the 915 MHz unlicensed ISM band and frequency hopping modulation techniques to establish a reliable wireless connection to a gateway.

A gateway can serve multiple sensors, with the total number of serviceable sensors depending on the period with which the sensors are configured to connect with the gateway. The wireless range is ~100 meters in a normal building environment. For larger installations multiple gateways can be configured for complete facility coverage. Gateways connect to a facility's Local Area Network (LAN) via a standard 10/100 Ethernet connection, and require WAN access to the Internet to connect with the Central Host Web application.

The central host is a web application which is responsible for the sensor network configuration management and monitoring. The central host maintains an extensive database about customers, approved installers, gateways, and sensors.

3. Preparation

Prior to installation you should do a site survey to plan when the system will be installed, how the sensors will be mounted, where they will be mounted, where the gateway(s) will be installed and how the gateway(s) will be connected to the LAN/WAN.

3.1. When to Install

The system can be installed during new construction or as a retrofit to existing structures. Each installation will have its unique requirements and it is not possible for this manual to cover all possible installation scenarios. The two most common scenarios which are covered are new construction and retrofit during residing. In both scenarios access to exterior sheathing is possible.

3.1.1. New Construction

Installation during new construction offers the obvious advantage of full access to the structure during the different phases of construction. The best time to install the system is after the exterior sheathing is on and the electrical and plumbing are roughed in. This allows for full access, shows where possible plumbing leaks should be monitored, and helps avoid accidental damage to the system during the plumbing or electrical install process.

It is not required that the site have internet access during the installation procedure.

3.1.2. Retrofit During Residing

It is an attractive option to install the system coincident with the installation of a new siding/cladding system. It is practical in that the sheathing is exposed, and it makes financial sense to protect the investment in the new siding system. During retrofit it is possible to install the system at any time prior to the installation of the new siding. By removing the existing siding only at the sensor mounting points the installer can install the system independent of the siding installation process.

3.2. How To Mount The Sensors

For both new construction and retrofit the preferred mounting method uses 1.5" long insulated nylon standoffs to position the sensor in the midpoint of a typical wall cavity. This is done to minimize the chance of damage from screws/nails applied to either the interior or exterior wall.

3.2.1. Mounting During New Construction

During new construction sensor mounting options are virtually limitless. The preferred mounting method will be to attach the sensor on 1.5" insulated nylon standoffs using #12 x 2" sheet metal screws. The recommended mounting hardware is available from Dryvit. For best results you should pre-drill a pilot hole for each of the two #12 x 2" mounting screws. Do not use any sort of washer under the screw head as this may cause a short in the sensor.

3.2.2. Mounting During Residing

During residing, when access to the interior side of the sheathing is not possible, sensors must be mounted using a method which relies on access only to the exterior side of the sheathing. The preferred method is to use a sensor mounted to a 2.5"Ø wood plug as shown in Figure 1 which is then mounted as shown in Figure 3, Figure 4, and Figure 5.

Sensors can be obtained from Dryvit pre-mounted to 2.5"Ø wood plugs for this type of installation. A readily available 2.5" Ø hole saw is used to make the hole in the sheathing. Ideally the diameter of the sawn hole will be exactly 2.50". It is not the least bit difficult to use a hole saw improperly resulting in a hole which well exceeds the saw's rated diameter thus care should be taken to apply slow steady pressure in a single plane (i.e. perpendicular to the sheathing) during the sawing process for a nice clean hole with a proper diameter. Care should also be taken to saw the hole such that it does not intersect the framing and studs in the wall. Should a hole be sawn which hits a stud, the hole can be plugged with a blank (i.e. no sensor) wood plug also available from Dryvit.

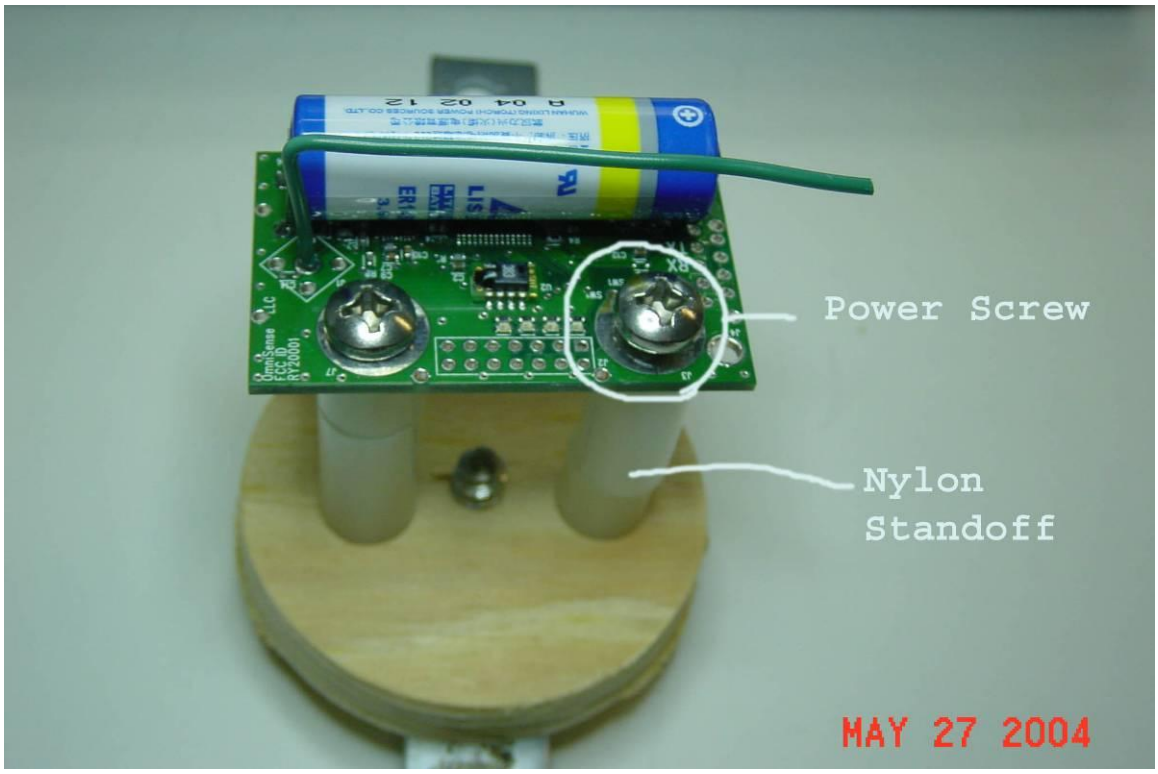

Figure 1 - Sensor Mounted to 2.5" Diameter Wood Plug

Once the hole has been sawn mount a “keeper” strap to the exterior side of the sensor’s wood plug as shown in Figure 2. The keeper will keep the sensor flush with sheathing and not allow it to go through the wall and potentially disappear in the wall cavity.

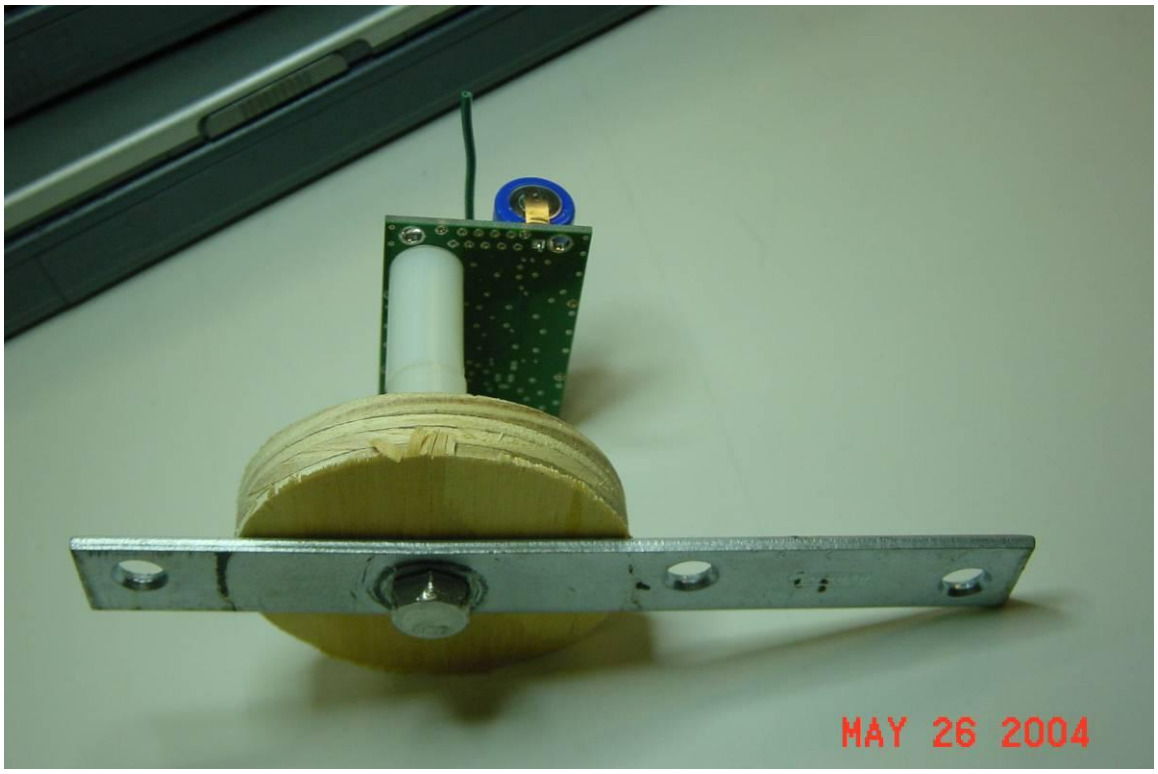

Figure 2 - Sensor with Keeper Strap

CAUTION

Caution: ***NEVER*** tap/hit/hammer the sensor to force it flush into the hole as this will permanently damage the sensor.

With the keeper strap mounted to the sensor, carefully angle the sensor into the hole and with firm pressure applied by ***hand*** push the plug into the hole. The fit should be snug but should not require excessive pressure to get it to seat flush with the sheathing. If it will not seat flush check the hole diameter, the hole saw used to create the hole, and check that there are no obstructions inside the hole which the sensor may be hitting such as studs, electric boxes, electrical wiring etc. If the hole diameter is slightly small the hole can be enlarged by making additional clearance passes with the hole saw through the hole.

Once the sensor is flush with the sheathing, use a #12 countersink drill to drill three holes on the seam as show in Figure 4. Use three #12 x ½" wood screws to permanently attach the sensor to the sheathing, and remove the keeper strap. The mounting is done!

Figure 3 - Close up of Sensor Prior to Mounting from Exterior Side of Sheathing

Figure 4 - Close up of Sensor Mounted from Exterior Side of Sheathing

Figure 5 - Typical Window Installation During Residing

3.3. Where to Mount Sensors

Choosing where to mount sensors is like a bit like fishing … if you pick the right spot you can catch a lot. Failure analysis of exterior cladding systems has shown that the most common points of failure are in the flashing. Where there is a hole in the wall there will be some sort of flashing, and since gravity makes water run down mounting a sensor underneath the flashed hole is the best spot to catch potential leaks. The lower left and right corners of windows and doors are ideal spots. The lowest points of flashed roof lines are good spots. Sub-floors in bathrooms, kitchens, and laundry rooms where plumbing leaks are possible are good spots. Note that sensors mounted to sub-floors would be done from underneath the sub-floor. A/C condensate drains are also a source of moisture damage and should be monitored when possible. Water dispensing systems such as refrigerators with in the door ice and water, or water coolers, coffee machines etc can also contribute to water damage and should be considered as sites to monitor.

3.4. Where to Mount the Gateway

Gateways require an AC power source and an Ethernet LAN connection. For best wireless performance the gateway should be positioned centrally and at a midpoint elevation in the structure to be monitored. For the average residential structure wireless range should not be an issue regardless of the gateway's location as the range is about 100 meters. For larger commercial structures choosing the optimal gateway location can

mean the difference between monitoring the site with just one well located gateway verses multiple poorly located gateways.

4. Pre-Installation Procedure

4.1. Obtaining the Network Address

The installer and the gateway must be configured with the same network address to enable communication between them and to enable the sensors, which will be configured with the network address by the installer, to communicate with the gateway. Normally this is the lower 4 bytes of the gateway's MAC address. For example, if the gateway's MAC address is:

- 00-20-4A-81-45-07

The network address would be entered as:

- 4A814507

The MAC address can be found on a label on the gateway as shown in Figure 6. For larger installations which may require multiple gateways the factory will provide, on special request, multiple gateway configured with the same network address.

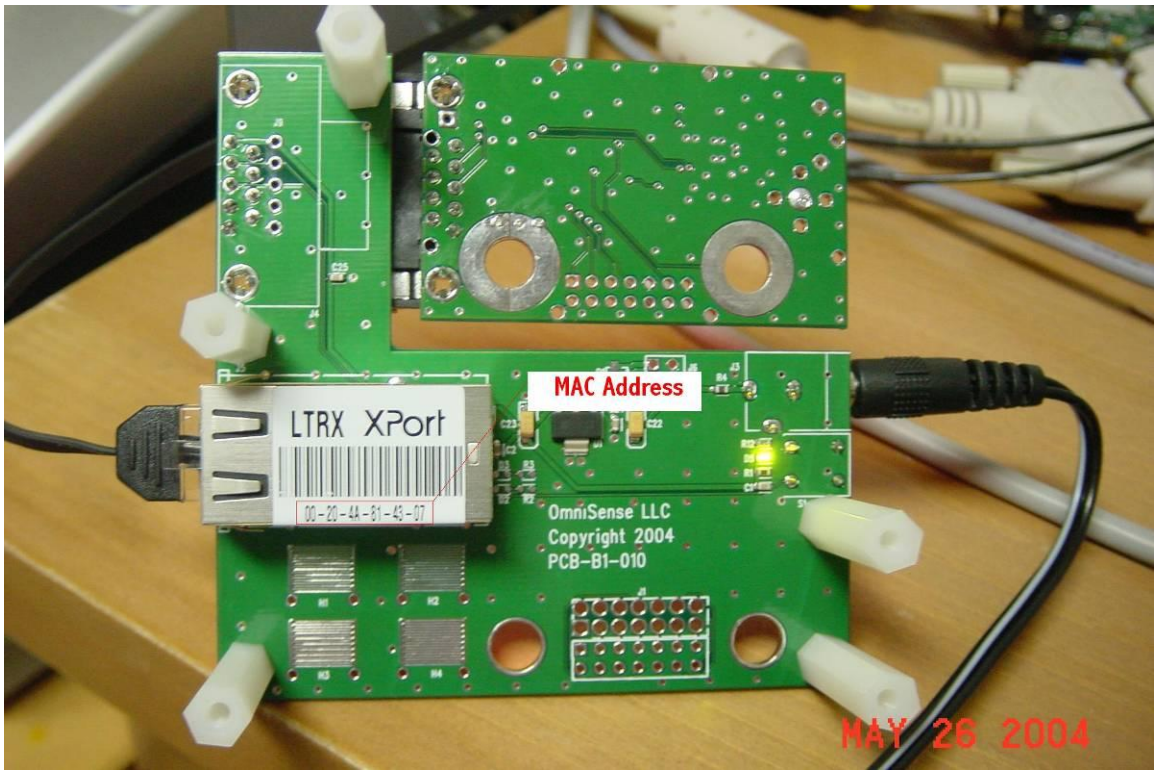

Figure 6 Finding Gateway's MAC Address

4.2. Configuring the Installer

First the installer must be connected to a PC using the cable provided. Then on the PC, start a HyperTerminal window by following the menus from Start->All Programs->Accessories->Communications->HyperTerminal and configure it to use COM1-COM4 depending on what port you plugged the RS_232 cable into. Configure it for 9600 baud, 8 bits, No Parity, 1 stop bit and no flow control as shown in Figure 7 then save the configuration (File->Save As)using a meaningful file name such as INSTALLER_COM1. In the future you can double click on the saved configuration file and it will start the HyperTerminal application with the saved settings.

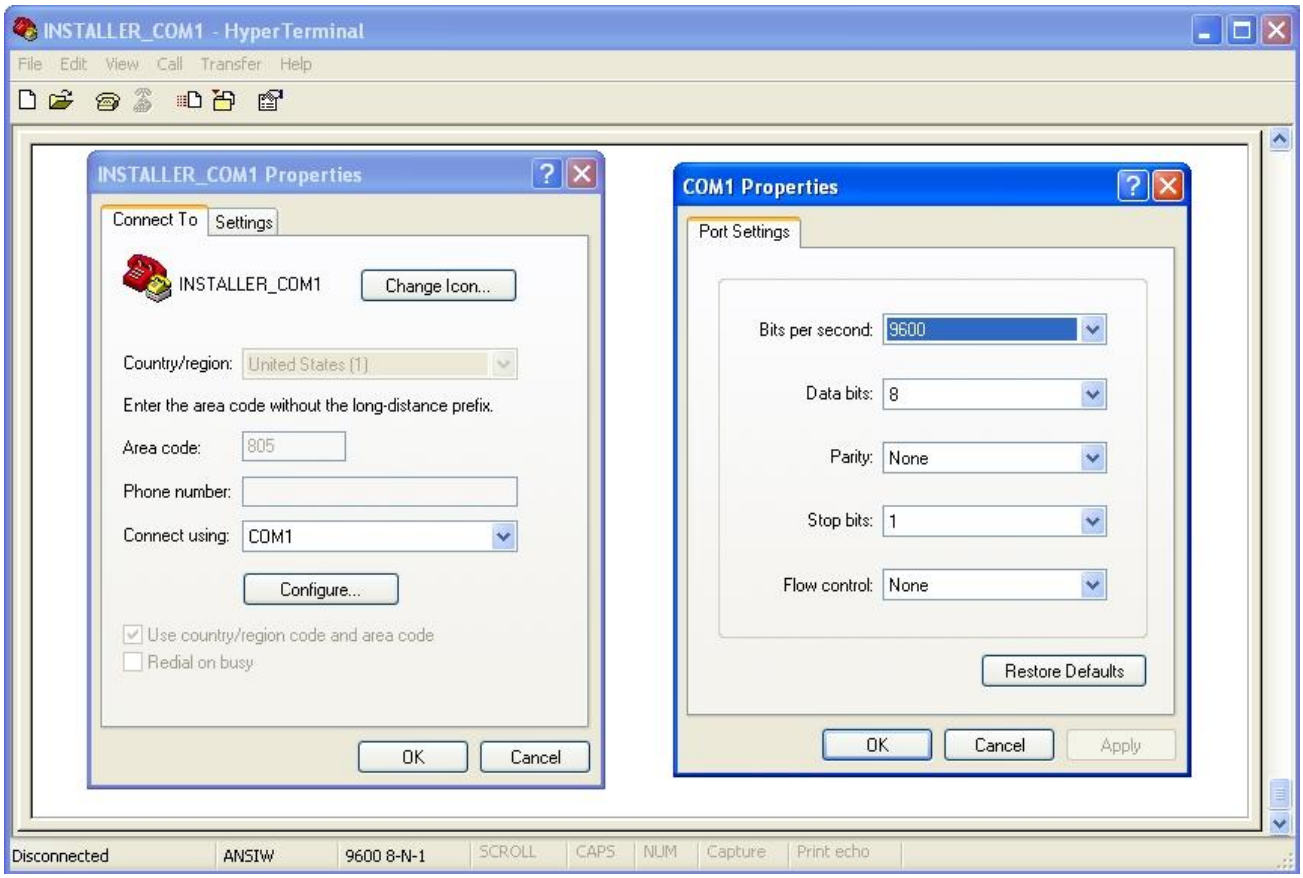

Figure 7 - HyperTerminal Configuration

Next, while holding down the "x" key on your keyboard, switch on the installer power, and then release the x key. You should see a configuration menu as shown in Figure 8. Use the configuration menu to program the network address as shown.

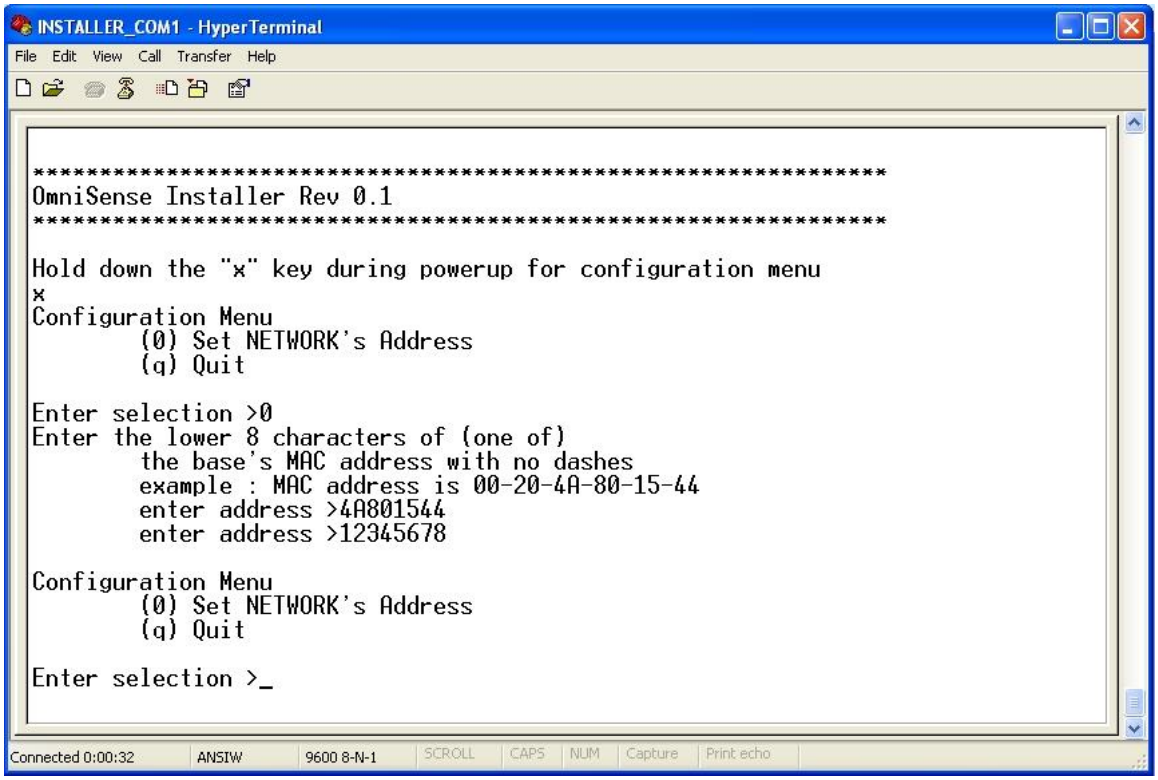

Figure 8 - Screenshot of installer configuration

4.2.1. Configuring Garmin GPS 76

The GPS must be setup to output the NMEA format data on its serial port. Follow your GPS's instructions to configure it for NMEA output. For the Garmin GPS 76 you would do the following: MENU->MENU->SETUP->INTERFACE->NMEA.

4.3. Configuring the Gateway

The gateway comes pre-configured and requires no configuration or setup in the field. In special cases where modification of the default configuration is required (ie programming multiple gateways to share the same network address) the procedure for modifying a gateways configuration is documented below.

To configure the gateway you must be able to connect to it using the gateway's Ethernet port. You will need to have the "X-Port Installer" software application loaded on a PC and the PC and the gateway must be connected to the same IP subnet/LAN segment. The X-Port Installer software application can be downloaded from ftp://ftp.lantronix.com/pub/XPortInstaller/v3.2/XPortInstaller.zip. Extract the ZIP file archive using WinZip or a similar utility, go to the folder where the files were extracted to, and click on "setup.exe" to install the software. If "setup.exe" does not run, you may

need to install the ".NET Framework" application which can be downloaded from ftp://ftp.lantronix.com/pub/XPortInstaller/v3.2/dotnetfx.zip.

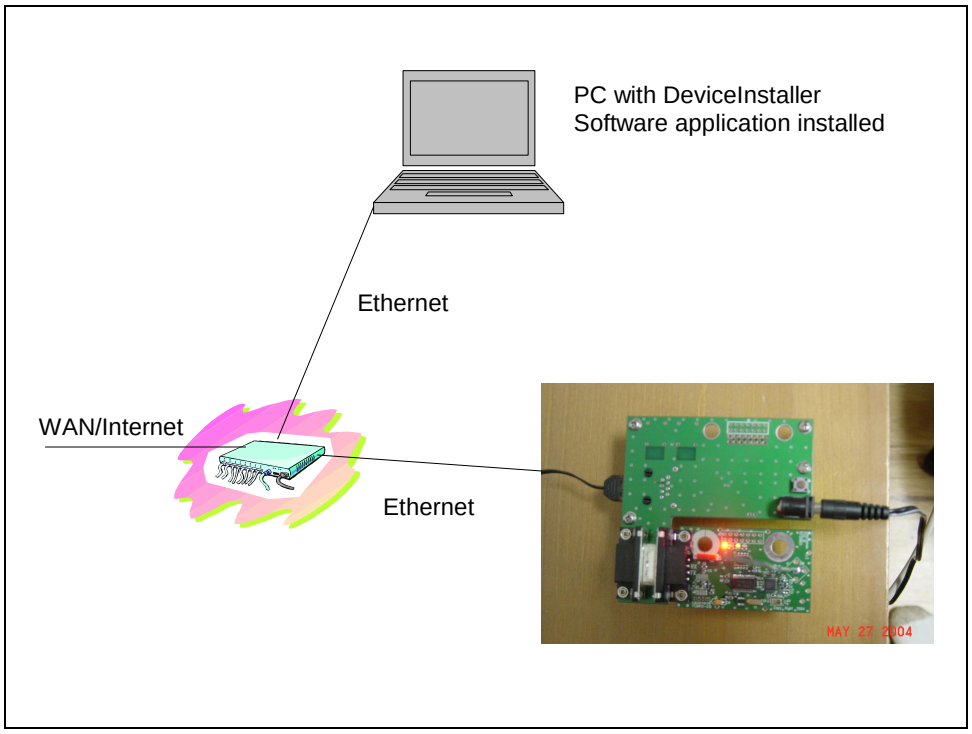

Figure 9 - Connecting the Gateway to the LAN

4.4. Installation Procedure

You must first complete the configuration procedure described in the Pre-Installation Procedure. Without the proper configuration of the installer the system will not work.

4.5. Installing the Gateway

The first step of installation is plugging in and powering up the gateway. During installation the gateway must be "reachable" by the sensors meaning:

- Gateway and Installer are programmed with the same Network Address
- Gateway is powered on
- The Gateway's Transceiver is powered on
- Gateway's TX LED is blinking rapidly, see Figure 10
- Gateway's Power LED is blinking slowly, see Figure 10
- Gateway is <~100m[1] from where sensors will be installed

During system installation it is not necessary for the gateway to be connected to the LAN/Internet which allows for system installation prior to the facility having internet connectivity and a data network. If LAN/internet connectivity is present, as it should be for residing projects, the gateway should be connected to the LAN/internet during

[1] 100 meters is an approximate maximum wireless range and is highly dependent on the installation sites physical characteristics. If sensors close to the gateway install properly and sensors farther from the gateway do not, that is a good indicator you are out of range from the gateway.

installation. The likely site for installing the gateway is in the data center for commercial sites and in the home office for residential sites.

If the gateway is connected to the LAN then it should automatically connect to the Central Host.

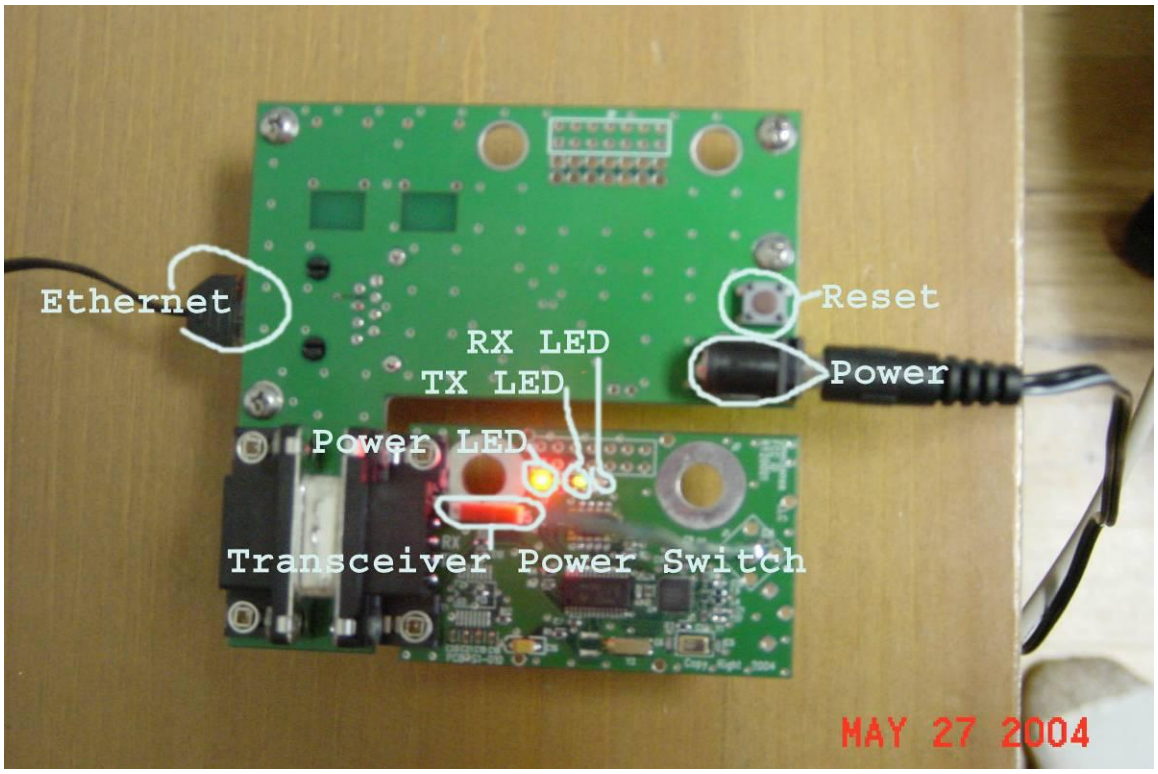

Figure 10 - Anatomy of a Gateway

4.6. Operating the Installer

Connect the installer to a Garmin GPS 76 using the supplied installer to GPS cable and then power the GPS on. Make sure you configured the GPS for NMEA format output on its serial port. Power on the installer and you should now see a slow 2 seconds on/2 second off blinking red light indicating power is on and a fast blinking yellow light indicating the installer is transmitting a beacon signal.

TIP

Try out the installation process indoors and verify the all system components are functioning before going into the field. The GPS can be operated in a "simulation" mode. What that means is even if the GPS does not have satellite reception, as will be the case indoors, it will output a simulated GPS position which the installer can use. Power on the GPS and then press Enter->Enter->Menu->Enter to start the simulator mode.

DO NOT FORGET TO EXIT SIMULATOR MODE FOR THE ACTUAL INSTALLATION OR SENSORS WILL BE LOADED WITH AN INVALID POSITION!!!

The GPS must be outputting a valid position. If it is not and you attempt a sensor install the installer will sound a "failure tone" of multiple high/low pitched beeps. The installer and GPS should be clipped onto your belt to ensure that it is physically close to the sensor when the sensor is powered on so that the sensor gets an accurate position from the GPS.

4.7. Installing a Sensor

- Using a 2.5" Ø hole saw, saw a hole where you want to install the sensor.
- Mount the keeper strap to the sensor
- Position the sensor and yourself (really the GPS on your belt) as close as possible to where the sensor will be installed
- Power up the sensor by screwing the "power" screw (see Figure 1) down tight. Do not use washers under the screw heads as they may cause a short
- On the sensor, installer, and base, you should see the left two LEDs blink rapidly. The yellow LED indicates a packet is being transmitted, and the orange LED indicates a packet is being received. These LEDS indicate wireless link activity.
- The first thing the sensor does is it looks for an installer using a default installer address. The installer is configured with both weak transmit power and a low gain antenna which means it has a very short transmit and receive range. This is done for two reasons. The first is it allows multiple installers to coexist on a job site, and the second is it forces the GPS to be close to the sensor at the time of installation to help ensure the sensor gets an accurate position from the GPS.
- When the sensor finds the installer, the installer waits for the next valid position to be output from the GPS, and then it loads the GPS position and the network address of the base into the sensor. The installer then closes its session with the sensor, but it always remembers the MAC address of the last sensor it talked to.
- The sensor then opens a communication session with the base and registers with the base.

- The base reads the sensor's MAC address and its GPS position and sends the information to the central host.
- The base then changes the sensor_state to REGISTERED and ends the communication session with the newly registered sensor.
- The sensor now once again opens a communication session with the installer. The installer reads the sensor_state variable and recognizing the sensor is REGISTERED and it has the same MAC address as the last sensor it talked to will sound a series of rapid beeps at the same pitch indicating a successful installation of the sensor.
- The install process is complete!

4.8. Sensor Monitoring

After Installation the sensor goes to sleep and wakes up periodically to log data to its log file. After taking a preset number of readings the sensor will attempt to open a communication session with the base such that the base can read the sensors log file and send the data up to the central host. A sensor can store up to 32 readings, and will continue to store readings either until it has been successfully read by the gateway or until the log file is full.