



Installation of the MI Wireless Communications Assembly

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How to Use This Manual

The information provided in this document is intended to provide detailed information on the installation and setup of the MI Wireless assembly. Due to the nature of its design, some of the configurations and features described herein may not apply to a particular device.

In addition to this manual, it is recommended that you review the Customer Connection drawings and manufacturer component manuals for your specific MI Wireless Assembly.

Safety Message

During normal operation, this device may be connected to systems and devices including, but not limited to, gas transmission and distribution systems, gas measurement equipment, power devices, and external antennas.

This manual covers details specific to the MI Wireless instrumentation and/or communications assembly and is not meant to take precedence over any existing operational or safety requirement. Please observe all applicable safety procedures, local codes and ordinances, operating instructions, and company procedures and policies in the installation and operation of this device.

If a conflict does exist between the operation of this device and established procedures, contact the appropriate authority for resolution.

ESD

What is it?

Static electricity is defined as an electrical charge caused by an imbalance of electrons on the surface of a material. ESD (Electrostatic Discharge) is defined as the transfer of charge between bodies at different electrical potentials.

Electrostatic is most commonly created by the contact and separation of two materials, known as "Triboelectric charging". The amount of charge generated is affected by the type of materials, the area of contact, speed of separation, relative humidity and other factors. It's like walking across a carpet in winter (humidity is lower in winter) and then touching a grounded object. The table below shows typical voltage levels and effect of relative humidity (RH) on voltage levels.

Typical Static Generation Levels		
Means of Generation	10-25% RH	65-90% RH
Walking across Carpet	35,000 volts	1,500 volts
Walking across tile floor	12,000 volts	250 volts
Poly bag picked up from bench	20,000 volts	1,200 volts

Why is this important?

It has been estimated that on average 27 to 33 percent of end-user equipment failures could be caused by ESD. ESD damages electronic components in two ways; complete failure or degraded operation. The minimum perceivable static charge voltage level is approximately 3,500 volts. As shown in the table below, the voltage levels necessary to damage most classes of electronic components is well below the level where we can perceive the charge.

*HMB ESDS Component Classification

Class	Voltage Range for Damage
0	<250
1A	250 to <500
1B	500 to <1000
1C	1000 to < 2000
2	2000 to < 4000
3A	4000 to < 8000
3B	> or + 8000

*HMB – Human Body Model

How can I minimize the effects of ESD in the field?

Due to the nature of our fieldwork, standard ESD prevention techniques are impractical and could possibly create "less-safe" field conditions. In order to strike a balance between equipment and personnel safety, I recommend the following steps be added by field personnel when performing work under the meter cover or inside a solid-state recorder.

1. Make sure the equipment is grounded. (If a meter/recorder is properly installed, this is already done.)
2. If the equipment is not grounded, ground it. This can be done by attaching a non-fused jumper between the equipment and an earth ground.
3. Ground yourself to bleed off any charge. This can be accomplished by momentary touching anything grounded.

If you leave the immediate area or more than 10 minutes have passed since you bled off your charge, then perform step 3 again.

The principles behind these steps are to ensure the Technician and the equipment is at the same potential (grounded) without requiring a constant connection to ground.

These are the minimum recommended procedures for Field Technicians. Meter Plant and Lab environments require a higher level of ESD precautions.

MI Wireless Assembly

Integrated assembly

MI Wireless makes a variety of power, communication, and instrumentation assemblies. Most of these units are available with a CSA class 1 division 2 hazardous area certification. All units can be installed using standard installation methods. Fittings are provided on the bottom of the assembly for power and data wiring. If the assembly includes instrumentation, pressure transducers are located at the bottom of the enclosure.

The MI Wireless assembly is available in wall/pipe mount, pipe stand mount, UMB mount, and portable mount. Power choices include an array of sizes or solar panels, thermal-electric chargers, AC with battery backup, alkaline battery, and external DC supply.

The MI Wireless assembly is available with a Mercury ERX or Mini-Max instrument integral to the assembly.

These are available with all of the normal pressure and temperature options, serial options, and display options.

Figure 1 MI Wireless Mounts



Security Seal

The MI Wireless is a gasketed assembly with vent holes in the bottom. A lockable latch is provided on the side. When closing the assembly, be certain nothing is in the way of the gasket. Pay particular attention to the modem mounting bracket on the pivot panel as it can slide to the side to interfere with the gasket.

Antennas

A variety of antenna options are available to match your chosen communication methods. When a case mount cannot give adequate signal and performance, remote omni-directional and remote uni-directional high gain antennas are available. A uni-directional antenna such as a Yagi-Uda must be aimed at the

nearest cellular transmitter in order to function. Higher gain antennas offer greater distance. The trade off is a larger antenna size, or narrowed aperture in the antenna radiation pattern in the case of a uni-directional antenna. Uni-directional antennas also must be aimed at the communication source that you are attempting to reach.

Figure 2: Portable assembly



It is best to attempt to mount any of these antennas as high up as possible and avoid any obstructions for best performance. If the antenna is to be mounted on a non-metallic surface, it is important to specify a ground plane independent antenna. These antennas have built in ground planes or circuitry that performs that function internally and do not have to be mounted on a flat metallic surface.

Additional considerations must be made for cabling when using remote mounted antennas. Depending on the required distance to the antenna, a proper cable must be selected in order to not negate the effects of the increased antenna gain. It is recommended that RG58 not be used for more than 20 feet. LMR240 can be used for runs up to around 40 feet after which LMR400 is recommended. For extremely long runs, over 80 to 100 feet, other cable choices are available.

When remotely mounting an antenna, grounding and surge protection is an important consideration. Due to the nature of the remote mount antenna being mounted in locations that tend to be open and high in the air, antennas will have a tendency to attract lightning and surges. For continued functionality of the system and to prevent damage to the electronics in your MI Wireless system, it is vital to properly protect it from the effects of these occurrences. See installation section of the manual for more details on grounding and surge suppression.

Modems

The MI Wireless unit is available with a Mercury Messenger modem for use with a phone line, an Airlink Raven or Raven XT modem for cellular communications, as well a Freewave spread spectrum radio. The Raven or Raven XT with a serial port is available in CDMA, EVDO, GPRS, EDGE, and iDEN varieties to support nearly all of the North American wireless providers. Ethernet wireless modems are also available for special applications and to connect to a terminal server device to provide multiple serial connections at one location.

For locations where more than one serial device requires a communication link, the MI Wireless unit can also be equipped as a remote cellular gateway. When the devices are in proximity, it can be ordered with a terminal server device to permit communication with up to 4 devices simultaneously. If the remote devices are too far for RS232 cabling, a small radio network can be built behind the cellular modem.

Connections

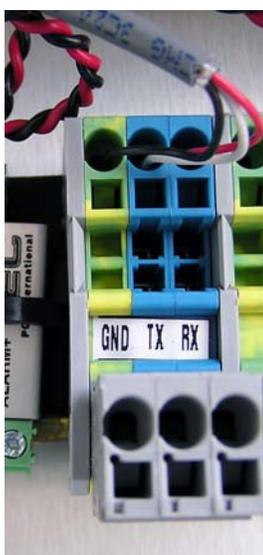
Data Connections

If your MI Wireless Assembly includes an instrument as well as a modem, the data connection between the two will already be complete. If you have elected an internal or external case connector, the data to the modem as well as the data to the instrument are available there. Each connection requires a separate cable as the case connector cap ties the modem data wires to the instrument data wires. Remember that in order for the modem to communicate with the instrument, the case connector must be installed.



Figure 3: Instrument Data Connection

Figure 4: Data Terminal



If your MI Wireless Assembly does not include an internal instrument board, the MI Wireless modem connection is available on the terminal internal connections. The Messenger Modem GND, TX, and RX should be wired straight through to the GND, TX, and RX of the part number 40-1074 or 40-2717 terminal blocks.

All Phoenix terminal blocks in the MI Wireless Assembly are wired as RX-red and TX-white.

Unlike the Messenger Modem, a cellular modem is a DCE (data communications equipment) device meaning that on a DB9 RS232 connector, the Rx pin 2 is an output and Tx pin 3 is an input. The DB9 cable to the modem is RX-white and TX-red, and is therefore crossed when being wired to the outgoing data terminal block.

On the instrument side, the 40-2717 PCB is wired as RX-white Tx-red. This card is used by both of the ERX and Mini-Max boards. This cable will also need to be crossed between the instrument and terminal block to make a correct connection to the cellular modem. For detailed wiring information, consult the Customer Connection Drawings.

There is a cable grip on the bottom of the box labeled RS232 for the cable to enter the MI Wireless box. See photo in Figure 5: Bottom of Enclosure.



Figure 5: Bottom of Enclosure

Remote Mini-AT

In order to make the connection from the communications/power assembly to the Mercury Mini AT instrument, use kit 40-3401. Connect the terminal block serial cable to plug on the main board connector TB2. Connect white to pin 3 RX, red to pin 4 TX, and black to pin 5 GND. Plug power cable into main board connector J7 or J8.

Identify a location for the terminal block to be mounted. Next, remove backing from the tape on the terminal strip and attach to inside wall. Press firmly. Carefully remove terminal strip by separating dual lock tape. Connect field wiring to terminal block Com, Rx, and Tx. Run wires carefully over to MI Wireless assembly and wire to Com, RX, and TX, respectively. Make certain that the wires do not interfere with closing of the door. For details, consult the included instructions 40-3401-A.

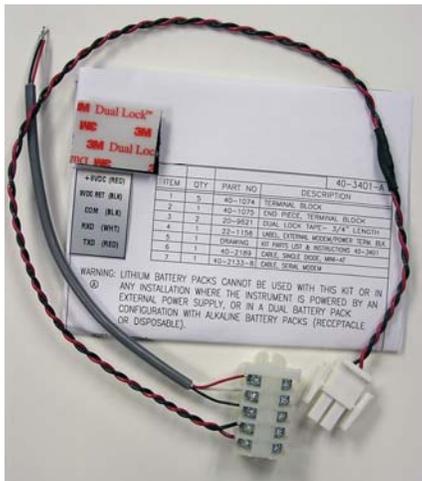


Figure 6: Connection Kit

connecting to the SCI board in an ECAT (See Figure 7: SCI Board) wire to TB1 in the lower right corner of the board. The board is labeled as C for common, T for transmit data, and R for receive data. Connect these to Gnd, Rx, and Tx, respectively in the communications enclosure. Be certain that T is wired to Rx

Remote ECAT

In order to connect between the ECAT and the MI Wireless assembly, use kit 40-1671. When

and R is wired to Tx. Again verify that no wires will be pinched when the door or chassis are closed.

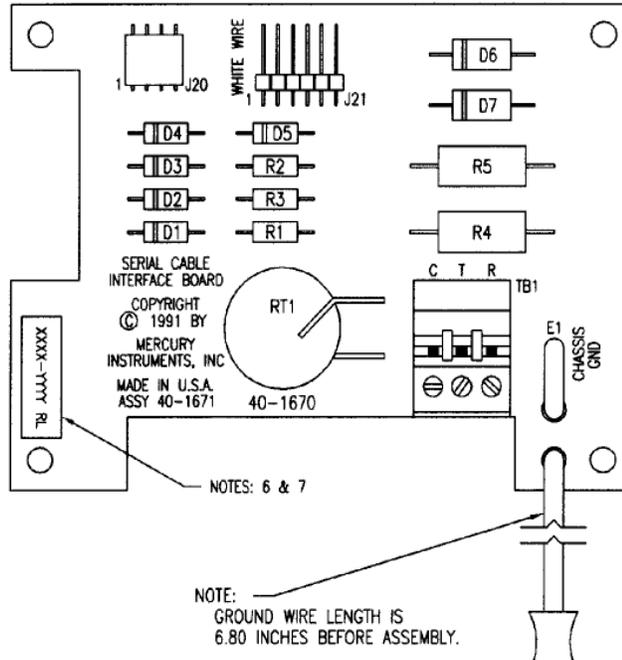


Figure 7: SCI Board

Antenna Connections

The MI Wireless assembly comes standard with a 3dB Meg helical low-profile case mounted antenna. It uses a standard NMO mount and is wired to the TNC or SMA connector on the modem.



Figure 8: Case-mounted Antenna

If snow buildup is expected to be a problem, a high profile case mount antenna can be substituted.

Caution! Do not use the antenna as a handle to carry the instrument.

In areas where the cellular signal level is insufficient to provide satisfactory service with these antennas, a variety of unidirectional and omni-directional antennas are available. Depending on the required distance to the antenna, several cabling options are available.

An antenna is one of the most critical junctures in any RF communications system. Its performance determines the quality and the continuity of your data flow in both directions. For basic antenna selection assistance, see the section on antennas in the introductory chapter on the MI Wireless Assembly.



Care must be taken when selecting high gain antennas as it is possible to overpower the cellular network. Particularly in spread spectrum networks like CDMA/EVDO, this excess power can cause reception problems for the telemetry device as well as other users in the area. There are limitations on the amount of power output permitted so it is important to properly design the system for optimum performance.

Figure 9: Modem Connections

Remote Antenna Installation

In order to connect a remote antenna, first disconnect power to the communication device. Attach cable to external bulkhead connector. Tighten connector and then cover with weather resistant covering or tape. After the antenna is mounted securely and connected to modem, power up the modem. Airlink Raven modems in packet-data mode will give a signal strength indication on the status page.

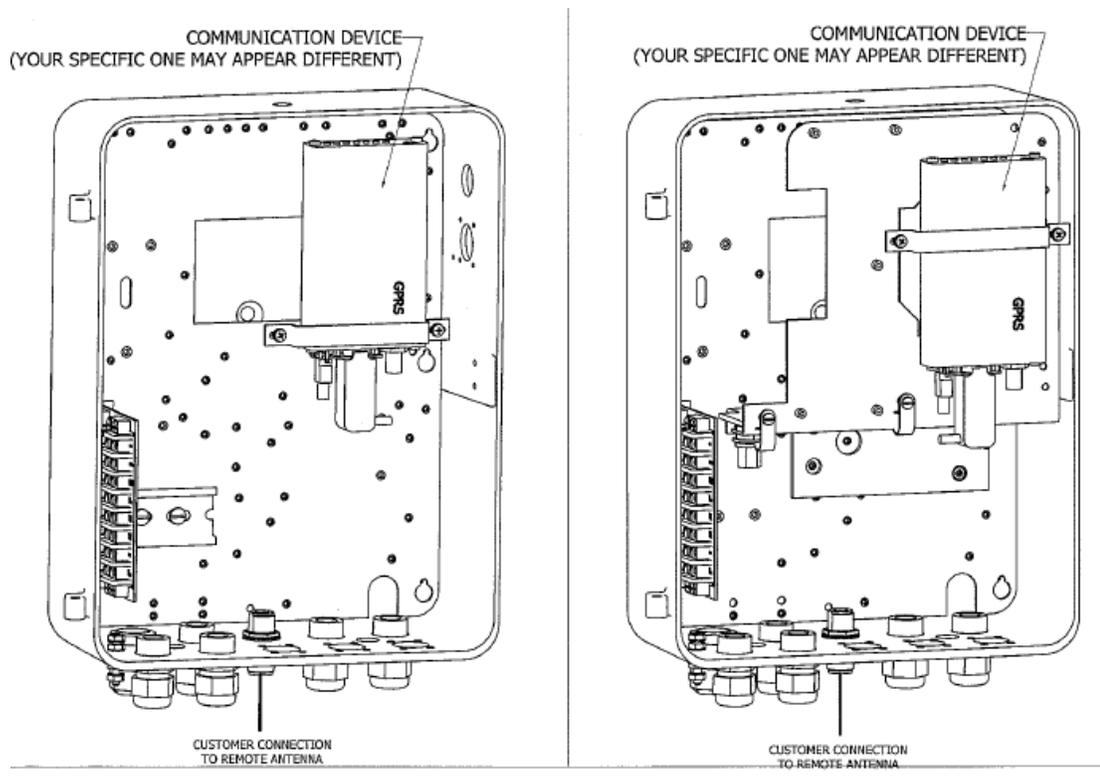


Figure 10: Remote Antenna Installation Diagram

Remote Antenna Installation Tips

- Do not mount antenna inside a metal enclosure
A metal enclosure will interfere with the transmission of the radio waves. In addition, the excess RF energy inside the metal enclosure can interfere with analog devices within the enclosure.
- Cellular modems work best when their antennas can see the cellular system antenna.
Try to avoid major obstructions in the line of sight between your antenna and the cellular system antenna. A direct path between transmitter and receiver will provide the best signal.
- Mount the antenna as high as possible
Even when a direct line of sight is not available, mounting an antenna high above as many obstructions as possible can improve performance. Cellular base station antennas are most often located on towers and increasing the height of the telemetry antenna can decrease transmission distance.
- Keep the antenna cable as short as possible
While path loss through the air is important, loss in a cable can be even more significant. Make certain that a sufficient cable size is chosen for the length of cable run. Longer runs will require larger and more expensive cable. It would not be logical to invest in a high gain antenna, only to lose all of that gain in a long and inadequate cable run. It is

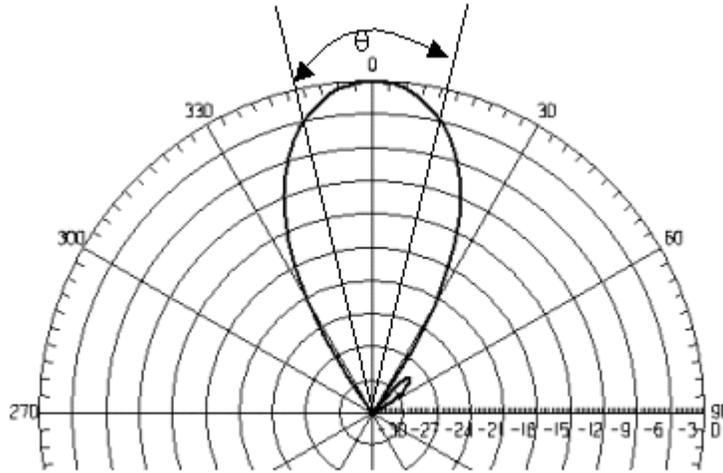
recommended that RG58 not be used for more than 20 feet. LMR240 can be used for runs up to around 40 feet after which LMR400 is recommended. For extremely long runs, over 80 to 100 feet, other cable choices are available.

- Always use proper grounding and surge suppression. Surge protectors can be installed "in-line" with existing antennas, between the antenna and radio jumper cable. The suppressor is environmentally sealed and is connected using threaded connectors on both sides. For proper operation the surge protector must be grounded – thus providing adequate grounding for the antenna cable sheath. A ground block is similar to a surge suppressor in that it provides a place for a ground wire to be connected in line with the antenna in a non-penetrating manner. The ground block will simply provide a relatively easy path to ground but will not suppress surges and will therefore leave RF equipment vulnerable. In tower installations or other situations where cable sheath bonding is required, a coaxial penetrating grounding device may be used. However, to maintain antenna integrity, this device should only be installed on jumpers. They should not be installed on cables which form an integral part of the antenna.
- Ensure all connectors are tight and dry. Use outdoor connectors and sealing tape.
- Unidirectional antennas must be pointed toward the cellular transmitter in order to be effective.

These antennas achieve their gain through using directivity to create a narrow beam width. Directivity is the ability of an antenna to focus energy in a particular direction when transmitting or to receive energy better from a particular direction when receiving. Gain is the practical value of the directivity. Beamwidth describes the angular aperture where the most important part of the power is radiated. In general, we talk about the 3db beamwidth which represents the aperture (in degrees) where more than 90% of the energy is radiated.

For example, for a 0 dB gain antenna shown in the diagram below, 3 db beamwidth is the area where the gain is higher than –3 dB.

Value of θ in degree = 3 dB beamwidth.



Value of θ in degree = 3 dB beamwidth.

Care must be taken when installing a uni-directional antenna because of the narrowed beamwidth. The antenna must be pointed or aimed at the nearest cellular base station. The antenna must also be carefully secured so that wind and other weather effects will not misalign it.

- High gain, omni-directional antennas do not have to be aimed at the cellular base station, but tend to be large and therefore have significant mounting requirements. Wind loading can be a concern as well attracting attention to become a target for vandalism.
- Use a proper ground plane
Most antennas require a ground plane in order to function efficiently. The ground plane functions as a reflector, or director, for the antenna. If it is not possible to provide a metallic ground plane for the antenna, be sure to specify a ground-plane-independent antenna. These have special circuitry or sometimes attachments that can function as a ground plane.
- When comparing antennas, a dBx is not a dBy.
A dB or decibel is a relative measurement term. In antennas, it means "gain relative to" and is commonly seen as dBi, dBd, or dBq for an isotropic, dipole, or quarter-wavelength antenna. Make certain that comparisons between antennas are done using the same units of measurement. For instance, 0 dBd=2.15dBi =.6dBq.
- Make certain the frequency band of the antenna matches your communication type.
In North America, there are cellular and PCS frequencies used by the CDMA and GSM carriers and iDEN frequency bands used by Nextel for their iDEN service.

The original cellular frequency band was 821 to 896 MHz, but as more companies wanted to join in the wireless business, PCS frequencies were sold by the FCC from December of 1994 through January of 1997. The PCS frequency band is from 1850-1990 MHz.

While some carriers only use some of the frequencies in some parts of the country, wireless carrier mergers cause changes in this frequently. For CDMA and GSM use, it is best to choose a dual band (cellular/pcs) antenna.

Nextel's iDEN service uses the frequency band 806-866 and very rarely also the iDEN 900 band 896-941. Due to very little usage of the second frequency band, a single band antenna is sufficient for iDEN.

Spread spectrum radio in the United States uses the 900 MHz band frequencies 902-928 MHz. Spread spectrum radios are also available in the 2.4 to 2.4835 GHz range.

Around the world, outside of North America, different frequency bands are used for cellular communication. In most countries, 890-960.MHz and 1710-1880 MHz are reserved for cellular communications.

The standard case mount antenna on an MI Wireless assembly is tuned to handle the North American and International frequencies of 821 to 960 and 1710 to 1990. Some of iDen is not included, but all of the 900MHz spread spectrum band is included. A different antenna is usually chosen for iDEN.

Power Connections

The MI Wireless assembly comes in several power options. One of these unit types is a solar assembly available in sizes from 5 to 40 Watts. The MI Wireless assembly is also available with a Thermal Electric Battery charger unit, an AC hybrid power source, a dual alkaline battery pack, and an external DC input. Solar radiation is the energy the earth receives every day as photons of light travel through space from the sun to the earth. For a standard unit of measure, the PV industry calculates the radiation on a 1 square meter piece of earth, at noon on a clear day with the sun directly overhead, as 1000 watts or 1 kilowatt (1kW). The PV industry refers to this calculation as one "peak sun". That same radiation, over the course of one hour, is called one peak sunhour.

It is important to consider the adjustment of the power input received on a flat or horizontal surface versus that of a tilted surface. Solar arrays are most often mounted at an angle to maximize the amount of energy received during the 'worst-case' month of the year for the location of the installation. Sizing the array and maximizing the output for the worst-case energy period minimizes the size of the array required and the subsequent cost of the system.

Before heading to the installation location to mount the solar panel, it is advantageous to know the desired tilt angle. This can be obtained from readily available charts from the solar panel manufacturer. Unless there are obstructions that shade the panel during portions of the day, it is best that the solar panel be pointed to true south. If it is not practical to point the solar panel at noon on a sunny day, a decent compass should be used. Be certain to take into account the magnetic declination (difference between true south and magnetic south) if the installation location is not near to the center of the US.

Solar Panel Mounting

Solar panels are most often shipped with wall/pipe mounting kits. U-bolts are included for pipe mounting. Lag screws and anchors that would be required for wall mounting are not included.

Mount the panel bracket to the panel using the hardware provided. Attach the mounting bracket to the panel bracket through the semi-circular slots. This permits the angle of the panel to be adjusted and then tightened down once on site.

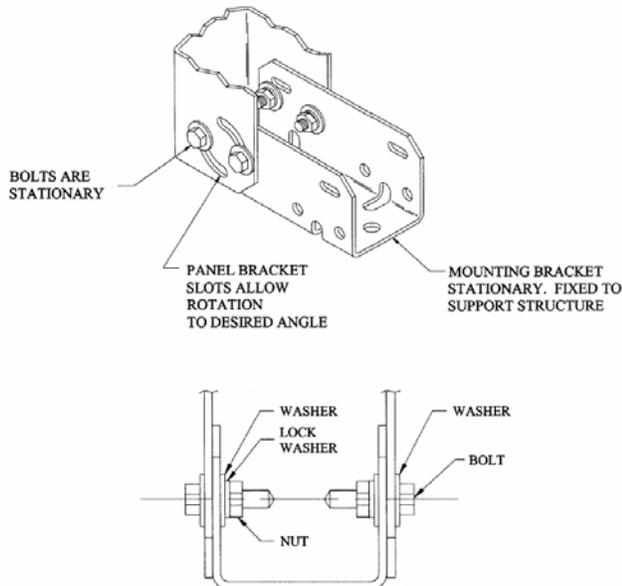


Figure 11: Solar Panel Mount

Solar Assembly

Connect the solar array to the terminal block through the opening in the bottom of the box labeled power. See Figure 5: Bottom of Enclosure. Be careful when installing the solar panel in full sun as voltage is present on the cable ends.

- Unplug battery if already connected.
- Remove plug from strain relief at the bottom of the enclosure. Feed cable through strain relief.
- Pull terminal block connector labeled "power" off of the terminal block for easier access.
- If using spring terminals, insert a very small screwdriver or meter probe into the square opening on the terminal plug. Otherwise loosen the screw terminal with the small screwdriver. See Figure 12: Terminal Block.
- Strip and insert the wire, paying attention to the labels for "GND", "+", and "-". The



Figure 12: Terminal Block

positive leg of the solar panel should be connected to "+" and the negative leg should be connected to "-". See wiring diagram on customer connection drawings or in picture below. In DC wiring, the black wire is typically used for the "-" negative terminal.

- Once the wire is inserted, only up to the insulation, remove the screwdriver and the terminal block will secure on the wire. If using screw terminal tighten screw to clamp tightly on wire. Look to be certain that the terminal is clamped on the wire itself, not the insulation.
- The terminals on the solar panel terminal block will handle up to a 12AWG wire. If needed, a properly made splice inside the enclosure, near the terminal block is acceptable in order to reduce the wire size to what will fit. Larger wire is only necessary if a very long run (more than 20 feet) is required between the solar panel and the MIW enclosure.
- Next, connect the battery.

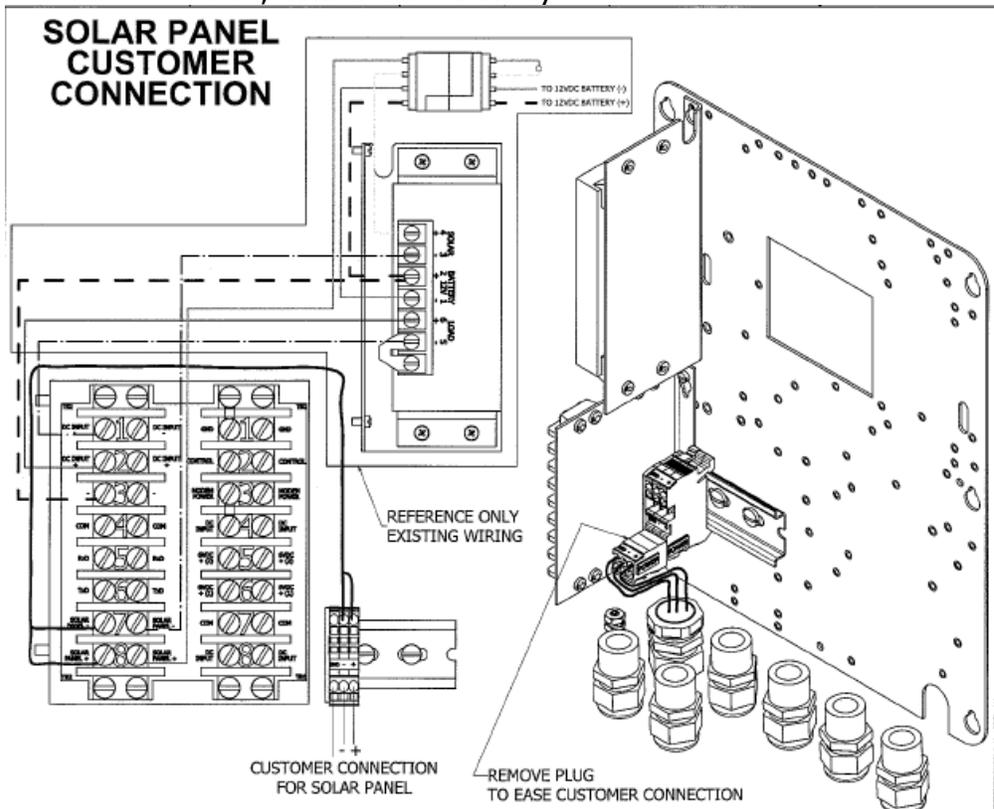


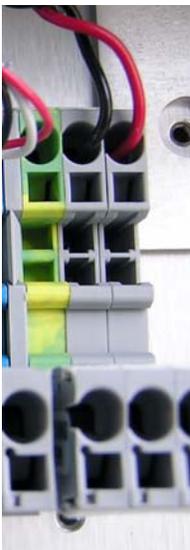
Figure 13: Solar Panel Assembly

- All sizes of solar assemblies include an 18 AH battery. To install the battery, connect the battery cable to the battery terminals, matching the colors and polarity. Open the battery door and carefully place the battery onto the battery shelf. Be cautious not to short the positive battery terminal against the pivot panel nut in the upper right hand corner. Use a small amount of electrical tape to cover the battery terminal, if necessary. Connect the black flat-4 style or white locking-style connector, and tuck the wires and connector in on top of the battery. Close the pivot panel/battery door and secure it with the screw.



Figure 14 Battery, Connector, and Fuse

Figure 15 DC Outgoing Power



Solar assemblies also are capable of providing 9VDC or 6VDC power out to a remote instrument. Be certain that you have specified the proper voltage for your device and that the power requirements of the device do not overload the system.

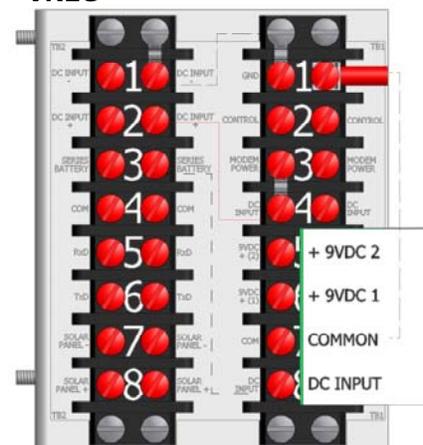
On the terminal block in the lower left corner of the assembly is a voltage regulator board which changes the 12VDC power supplied by the battery to the voltage required by a Mercury instrument. See Figure 16 Terminal block with VREG The output of the voltage regulator is available on the outgoing power connector. Power is to be wired out the bottom of the box through the cable grip connector labeled outgoing power.

- Remove plug from strain relief labeled outgoing power at the bottom of the enclosure.

Feed cable through strain relief.

- Pull terminal block connector labeled "outgoing power" off of the terminal block for easier access.
- Insert a very small screwdriver or meter probe into the square opening on the terminal plug.
- Strip and insert the wire, paying attention to the labels for "GND",

Figure 16 Terminal block with VREG



“+”, and “-”. The positive leg of the remote equipment should be connected to “+” and the negative leg should be connected to “-”. See wiring diagram on customer connection drawings or in picture below.

- Once the wire is inserted, only up to the insulation, remove the screwdriver and the terminal block will secure on the wire. Look to be certain that the terminal is clamped on the wire itself, not the insulation.

The terminals on the outgoing terminal block will handle up to a 12AWG wire. If connecting to a non-Mercury device, be certain that the power required does not exceed the capabilities of the MI Wireless power system.

Testing and Troubleshooting the Solar Assembly

If the battery receives no charging input from the solar panel, a fully charged 18Ah battery will power the modem and instrument for up to 7 days. The amount of time is largely dependent on the amount of time spent communicating with the modem.

The solar assembly includes a SunSaver solar controller mounted to the right of the battery. The solar controller charges the battery when power is being supplied by the solar panel, and disconnects the battery from the solar supply when it is completely charged in order to prevent overcharging.

The SunSaver is sent configured for sealed batteries only. When it is time to replace the MI Wireless battery, be certain that it is a sealed, not flooded, battery.

The SunSaver prevents the battery from discharging through the PV array at night. There is no need to install a blocking diode for this purpose. The SunSaver circuit also minimizes switching noise and filters all noise output to low levels when the system is properly grounded. It is very important to follow good grounding procedures.



Figure 17 SunSaver Solar Controller

The SunSaver has two LED indicators. See Figure 17 SunSaver Solar Controller. The green LED indicator will light whenever sunlight is available for battery charging. It will turn off at night. Because the SunSaver uses a PWM constant voltage charging process, there is usually some amount of energy going into the battery at all times. Although the charging current falls to very low levels when the battery reaches full charge, the green LED will continue to stay ON (during the daytime). This is to indicate that the controller is working and that energy is available from the PV array for charging.

The SunSaver also has a red LED to indicate the automatic load disconnect (LVD) feature. Whenever the battery charge state falls below the LVD set point, the load will be disconnected and the red LED will light. This indicates that the controller has disconnected the load to protect the battery from further discharge and possible damage.

After some period of recharging the battery such that it recover to approximately 40 to 50 percent of its rated capacity, the load will automatically be reconnected and the red LED will turn off. The low voltage disconnect and reconnect points are not settable. The SunSaver will disconnect power to the load when the battery drops to 11.5 VDC and will reconnect the load when the battery voltage raises to 12.6 VDC.

When the red LED is on, there will be NO power to the modem, however there will still be voltage to the instrument and at the output power terminal. The internal instrument power and output power terminal are sourced from the voltage regulator board which is powered directly from the battery.

Warning!

Do not short circuit the PV array or load while connected to the controller. This will Damage the controller. Do not exceed the voltage or current ratings of the controller. The PV system must be properly grounded and all wiring should comply with local codes.

If the battery voltage is below 11.5 volts, the load has been automatically disconnected due to a very low battery charge condition, and the battery must be recharged.



If the battery voltage is between 11.5 and 12.0 volts, the SunSaver will sometimes power-up during initial installation in the LVD state. This will automatically clear when the battery voltage rises above 12.6volts. If the battery voltage is above 11.5V the LVD can be reset

Figure 18: Battery Connection
by momentarily opening the battery fuse.

There are a limited number of field tests that can be done on the SunSaver to confirm its operation using only a handheld digital multimeter.

- With no power applied to the SunSaver,
 - Check for short circuits between PV+ and PV-, Battery + and Battery -, and Load + and Load - terminals.
 - Check the LVD FET by measuring a diode drop between the Battery + and Load + terminals. If no diode drop is present, or if an open circuit is measured, the LVD FET is damaged.
 - Check for continuity between the ground connections on the terminal strip PV-, Battery-, and Load -.
- With battery power applied to the battery terminals only
 - Measure the voltage at the battery terminals. Measure the voltage at the load terminals. The voltage should be the same as the battery voltage. If it is significantly lower, the SunSaver is

- damaged.
- Measure the voltage at the array terminals. The voltage should be about -2.5VDC. If the Green LED is on, and/or if the battery voltage is measured, the SunSaver input FET's are damaged.
 - A PC Board 'via' is located to the left of the SunSaver terminal strip. With no PV power connected, the voltage between this via and ground should be less than 1 VDC. If there is more than 1 volt, the SunSaver is damaged.
 - PV and battery power applied to the controller.
 - The voltage across the PV terminals should be the same as the voltage across the battery terminals if the batteries are not fully charged. If the batteries are charged, there will be a voltage difference between the Battery (+) terminal and the PV (+) terminal.
 - If your DVM has a frequency measuring option, a 300Hz AC signal should be measured between Battery (+) and PV (+). The duty cycle of this signal can also be measured to give a rough indication of the battery state of charge. The lower the duty cycle, the more fully charged the battery.
 - Measure the voltage at the via located at the left edge of the terminal strip. If the batteries are not fully charged, this voltage should be approximately 20-24Vdc. If the controller is in voltage regulation, this voltage will vary according to the state of charge of the battery. The frequency and duty cycle can be measured here as well.
 - PV, battery power, and load applied to the controller.
 - If battery is fully charged and SunSaver is not in LVD mode, the load voltage should be within .25V (ideally 20mV) of the battery voltage.

If the SunSaver tests correctly, but you still suspect it is not working properly, call the factory for further assistance.

ThermoElectric Charger Assembly

The PGI Tec-2 is a natural gas alternative to a solar panel system. It produces a 12V output used to keep a lead acid battery fully charged. The battery provides high peak power for short burst requirements, such as for wireless communications at remote monitoring sites. The battery's temperature and charge level are continuously monitored and the TEC-2 produces up to 2 watts to keep it charged.

The TEC-2 consumes .8 CFH of NG in a flameless oxidizing catalyst to heat the hot side of an array of Peltier thermoelectric modules. The other sides of the modules are kept cool by natural convection cooled aluminum fins. The temperature difference developed across the modules generates safe electrical power. It has a self-contained starting system for the catalytic heater. An open collector Alarm output can be used for remote monitoring. There are several internal tests performed on the thermal generator system to detect malfunctions and to safely shutdown the system. If the TEC shuts down, the battery will continue to power the connected device for a period of time determined by the battery size and device power requirements.

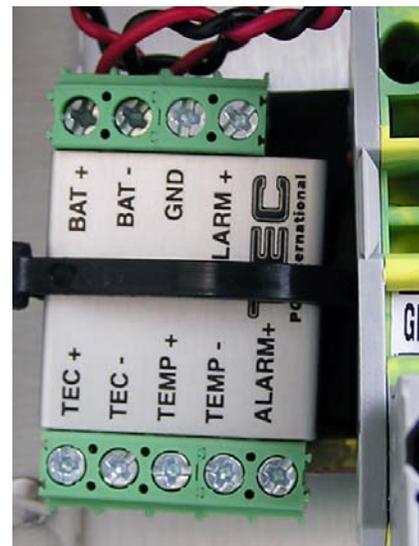
The thermoelectric charger unit is installed in its own enclosure, and should be mounted according to the instructions in the PGI TEC2 manual. See instructions [below](#) for installing and wiring the TEC2.

Figure 19: Battery Interface Module

The thermoelectric charger assembly includes a battery interface module inside the MIWireless enclosure for connection to the external charger unit, located near the power and communications terminal block.

The battery interface module is shipped loosely cable tied to the rail to make it easier to maneuver to get the cable secured in each terminal. Once the wiring from the TEC2 has been completed, pull the tie securely and snip the excess.

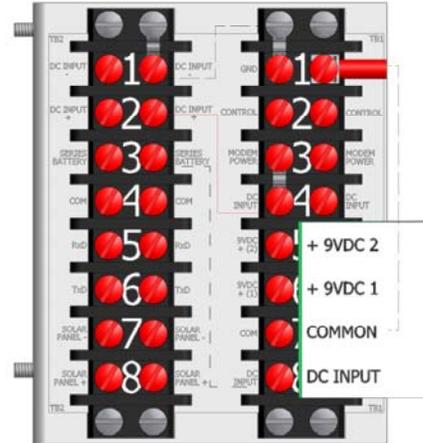
If the battery receives no charging input from the thermoelectric charger, a fully charged 18Ah battery will power the modem and instrument



for up to 7 days. The amount of time is largely dependent on the amount of time spent communicating with the modem.

If you are installing a thermoelectric charger, the battery should be connected in your MI Wireless assembly only **after** the TEC2 has been wired into the assembly. It is important that the battery be fully charged because it is needed as power to start the thermoelectric charger. To install the battery, connect the battery cable to the battery terminals, matching the colors and polarity. Open the battery door and place the battery onto the battery shelf. Be careful not to touch the positive terminal of the battery against the post in the upper right corner. Connect the black flat-4 or white locking connector, and tuck the wires and connector in on top of the battery. Close the battery door and secure it with the screw.

Figure 20 Terminal block with VREG



The thermoelectric power assembly is capable of providing DC power out to a remote instrument. On the terminal block in the lower left corner of the assembly is a voltage regulator board which changes the 12VDC power supplied by the battery to the voltage required by a Mercury instrument. See Figure 20 Terminal block with VREG The output of the voltage regulator is available on the outgoing power connector. Power is to be wired out the bottom of the box through the cable grip connector labeled outgoing power.

Figure 21: Bottom of Assembly



There is a cable grip on the bottom of the assembly box to run the TEC2 cable through. It is labeled "power". There is an additional cable grip for wiring power out to an external device labeled "outgoing power". Make the appropriate connections at the remote charger, as described in the next section, and then wire into the MI Wireless assembly as below.

- Remove plug from strain relief labeled power at the bottom of the

enclosure. Feed cable through strain relief.

- The battery interface module is shipped loosely cable tied to the rail to make it easier to maneuver to get the cable secured in each terminal.
- Pull the battery interface module away from the rail and wire the red wire to TEC + and the black wire to TEC -.
- Connect the white wire to "Temp +" and orange wire to "Temp -".
- Once the wiring from the TEC2 has been completed, pull the tie securely and snip the excess.
- If the instrument is equipped for outgoing power, pull the terminal block connector labeled "outgoing power" off of the terminal block for easier access.
 - Remove plug from strain relief labeled power at the bottom of the enclosure. Feed outgoing power cable through strain relief.
 - Insert a very small screwdriver or meter probe into the square opening on the terminal plug.
 - Strip and insert the wire, paying attention to the labels for "GND", "+", and "-". The positive leg of the remote equipment should be connected to "+" and the negative leg should be connected to "-". See wiring diagram on customer connection drawings or in picture below.
 - Once the wire is inserted, only up to the insulation, remove the screwdriver and the terminal block will secure on the wire. Look to be certain that the terminal is clamped on the wire itself, not the insulation.

The terminals on the outgoing terminal block will handle up to a 12AWG wire. If connecting to a non-Mercury device, be certain that the power required does not exceed the capabilities of the MI Wireless power system. Power is to be wired out the bottom of the box through the cable grip connector labeled outgoing power.

PGI Tec-2

TEC-2 Installation

The TEC must be installed upright and in a well-ventilated location. The catalytic heater does not produce harmful carbon monoxide gas, but does need adequate ventilation to ensure oxygen replenishment and removal of any carbon dioxide. Install vertically with the exhaust gas vent on top. The top and bottom vents should be unobstructed to allow fresh air in the bottom and hot gasses out the top.

DANGER!

The top vent is very hot and may cause severe burns. If installed in a location where contact is possible, protective grills should be used to prevent burns, or the TEC may be raised to restrict access to the top vent.

Filter

It is vital that the catalytic heater in the TEC receive a clean, dry fuel source. The optional Cartridge Filter Unit (CFU) removes contaminants, moisture, and H₂S from the gas supply. Using the CFU can extend the life of the catalyst. The CFU is outfitted with an AV106S-V-H8 bonnet assembly and a 1/8" NPT drain port to vent any liquids separated from the gas supply.

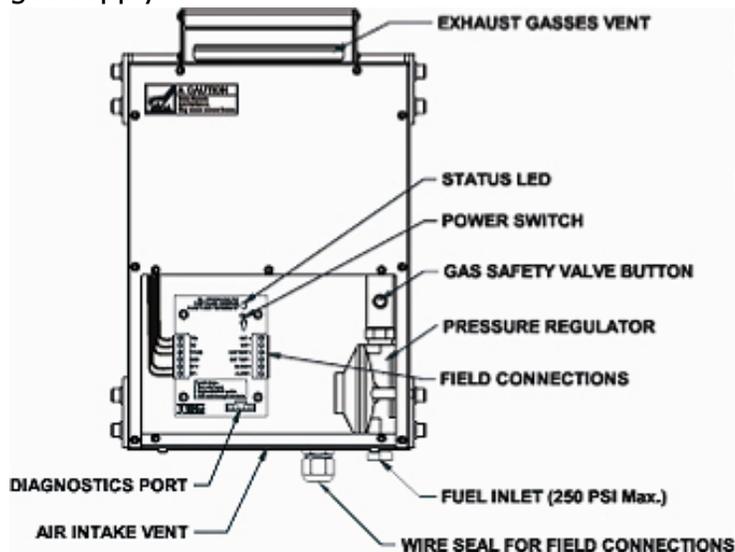


Figure 22: TEC-2 Layout

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content of 100 PPM H₂S
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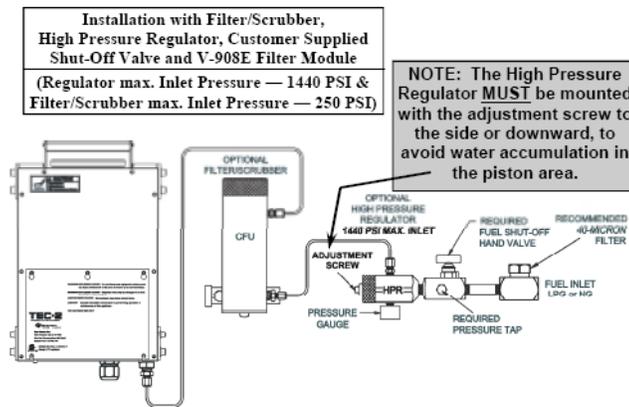
Fuel Connections

A CSA/UL listed main shut-off valve, such as the V-960EDT, must be installed upstream of all TEC components. The valve must be able to shut off the gas supply to the TEC without the use of tools and have a downstream test port. The inside diameter of the supply tubing must be larger than .08 inches

The High Pressure Regulator is required if the supply gas is over 250 PSI. It should be installed as close as possible to the high-pressure source. A hand operated shut-off valve must be installed upstream of the regulator. Typically a filter should be installed between the source and the regulator to prevent trash from building up inside the regulator.

If an existing shut-off valve is to be used, it is recommended that a V-908E Filter Module be installed to protect the HPR from contaminants. See the manual for specifics.

Fuel Connections (with an existing Shut-Off Valve and a V-908E)



Caution!

DO NOT USE TEFLON TAPE to seal threaded connections. Small pieces of tape can plug orifices in the low-pressure regulator and heater. Use Loctite 56747 PST or equivalent to seal threads.

See the Accessories section in the TEC-2 manual from PGI for more information on valves, regulators, and filters.

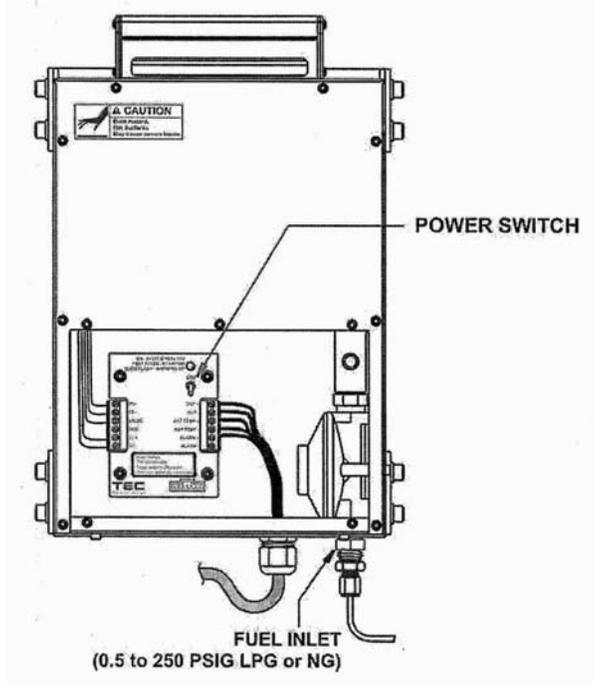
Warning!

The fuel supply must be clean and dry. Use filters and scrubbers if necessary to ensure a clean, dry fuel source.

See the manual for more information and diagrams on installation.

Remember to read and follow all manufacturer safety warnings.

TEC Wiring



The TEC-2 comes with a Battery Interface Module to interface the TEC to the external battery that it will keep charged. The TEC will not start with a "dead" battery. In order for the TEC to start, the remote battery to be used must measure greater than 11 volts. The Battery Interface Module contains a temperature sensor and an over-current protector and should be located near the battery being charged. The charging set point of the TEC2 is controlled by the diode temperature sensor.

WARNING!
Always have the TEC-2 Power Switch in the OFF position and the battery (+) lead disconnected when making field connections.

WARNING!
Always connect the TEC-2 side first, then the remote battery.

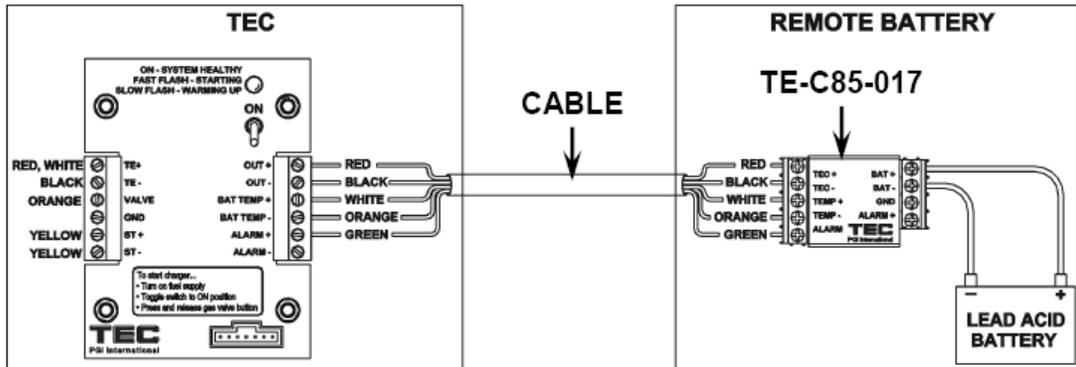


Figure 23: TEC-2 Cabling

The cable between the TEC and the battery can be ordered in 20' or 50' lengths. Follow manufacturer installation recommendations when using the longer cable in order to prevent ½ watt power loss.

Starting the TEC

Before starting

1. Check all field wiring and all connections.
2. Make certain that the battery is fully charged.
3. Test for gas leaks between the TEC fuel inlet and the gas source.
4. The air in the gas supply line must be bled as close as possible to the fuel inlet to the TEC.

Starting the charger

1. Open the main shut-off valve
2. Switch the TEC power switch to the ON position.
3. With the status LED blinking, press and release the Gas Safety Valve Button

When the power switch is switched ON, the starter begins to preheat the catalytic heater. Pressing the Gas Safety Valve Button opens the valve to allow gas into the heater. The valve is held open by the controller until either the power switch is toggled to the OFF position or the internal diagnostics detects a problem with system.

When the catalyst reaches the reaction temperature, the heater will begin to warm the ThermoElectric modules and produce power. After 2 to 3 minutes, or when an increase in the TE voltage is detected, the charger will turn off the starter and enter a warm up mode.

While starting, the status LED will flash fast. While warming up, the LED will flash slowly. When the TE voltage reaches 4.7 volts, the LED will switch to solid ON, indicating that the system has started. It may take up to one hour for the charger to stabilize at its peak power. During this time, the assembly will get quite hot. Be careful not to touch the top of the unit.

Testing as shown that when the power switch is turned on and unit goes into starting mode, it draws approximately 840ma from the battery for approximately 10-15 minutes. If there is no natural gas hooked to the unit, it will eventually drop down to drawing 4ma. Unit will talk to the TEC monitoring software any time that the switch is turned on. The monitor screen changes from startup to warming after about 10 minutes. At this time, the current draw drops to about 18mA.

Shutting down

1. Switch the Power switch to the Off position. The Gas Safety Valve will close automatically.
2. Close the Supply Gas Main Shut-Off Valve
3. Be certain to close the supply gas main shut-off valve before doing any service to the TEC heating system, or if the unit will be off for an extended time.

Troubleshooting

You will find a lengthy troubleshooting guide in the TEC2 manual. The latest version is available at www.pgiint.com

AC Hybrid

Figure 24: AC Power



The AC Hybrid power source includes a 12VDC adjustable power supply, 7AH rechargeable sealed lead acid backup battery, and SunSaver Solar Controller. The power supply will look similar but may not be identical than the one in Figure 24: AC Power. The 12VDC power supply is adjusted to 14.5VDC to provide optimum power to the SunSaver Solar controller to charge the battery. The SunSaver Solar Controller and battery are located behind the pivot panel.

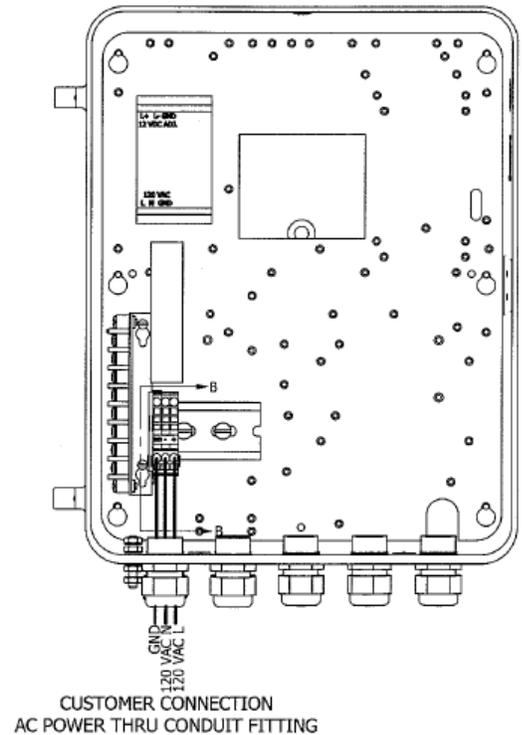
There is a metal conduit fitting on the bottom of the assembly box to run the AC supply wiring into the box. It is labeled "power".

AC Hybrid assemblies also are capable of providing DC power out to a remote instrument.

On the terminal block in the lower left corner of the assembly is a

voltage regulator board which changes the 12VDC power supplied by the battery to the voltage required by a Mercury instrument. See Figure 16 Terminal block with VREG. The output of the voltage regulator is available on the outgoing power connector. Power is to be wired out the bottom of the box through the cable grip connector labeled outgoing power. The terminals on the incoming AC terminal block and the outgoing DC terminal block will handle up to a 12AWG wire. If connecting to a non-Mercury device, be certain that the power required does not exceed the capabilities of the MI Wireless power system

Figure 25: AC Hybrid Wiring



Make the appropriate connections at the AC supply, and then wire into the MI Wireless assembly as below.

- Unplug battery, if already installed.
- Turn off AC power
- Install conduit to conduit fitting according to applicable codes.
- Pull wires through conduit.
- Pull the terminal block plug off the terminal block.
- Insert a very small screwdriver or meter probe into the square opening on the terminal plug. If screw terminal style terminal blocks are used, loosen the screw with a very small screwdriver.
- Strip and insert the wire, paying attention to the labels for "GND", "L", and "N" for ground, line, and neutral. See wiring diagram on customer connection drawings or in picture below.
- Once the wire is inserted, only up to the insulation, remove the screwdriver on the spring and the terminal block will secure on the wire. If using screw terminals, tighten screws. Inspect the connection to be certain that the terminal is clamped on the wire itself, not the insulation.
- If the instrument is equipped for outgoing power, pull the terminal block connector labeled "outgoing power" off of the terminal block for easier access.
 - Remove plug from strain relief labeled power at the bottom of the enclosure. Feed outgoing power cable through strain relief.
 - Insert a very small screwdriver or meter probe into the square opening on the terminal plug. . If screw terminal style terminal blocks are used, loosen the screw with a very small screwdriver.
 - Strip and insert the wire, paying attention to the labels for "GND", "+", and "-". The positive leg of the remote equipment should be connected to "+" and the negative leg should be connected to "-". See wiring diagram on customer connection drawings or in picture below.
 - Once the wire is inserted, only up to the insulation, remove the screwdriver on the spring terminal and the terminal block will secure on the wire. If using screw terminals, tighten the screws. Inspect the terminal connection

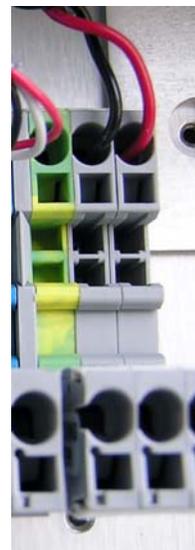


Figure 26: Power Terminal Block

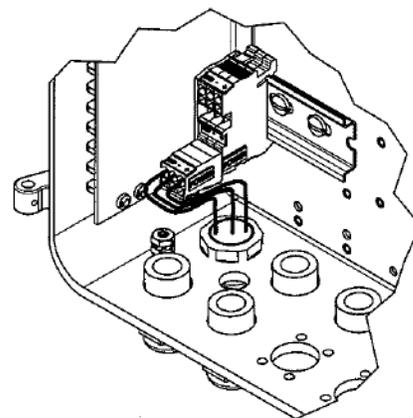


Figure 27: AC power entrance

to be certain that the terminal is clamped on the wire itself, not the insulation.

- Install battery or plug battery back in.

To install the battery, connect the battery cable to the battery terminals, matching the colors and polarity. Open the battery door and place the battery onto the battery shelf. Connect the black flat-4 RV style connector, and tuck the wires and connector in on top of the battery. Close the battery door and secure it with the screw.

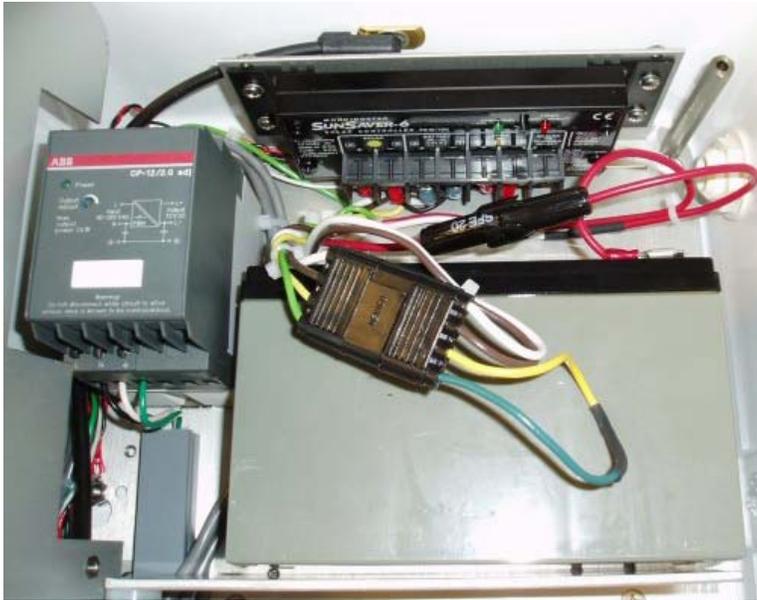


Figure 28 Battery, Connector, and Fuse

If the battery receives no charging input from the AC input, a fully charged 7Ah battery will power the modem and instrument for up to 2 days. The amount of time is largely dependent on the amount of time spent communicating with the modem.

The AC hybrid assembly includes a SunSaver solar controller mounted to the top of the battery. The solar controller charges the battery when power is being supplied by the AC input, and disconnects the battery from the power supply when it is completely charged in order to prevent overcharging.

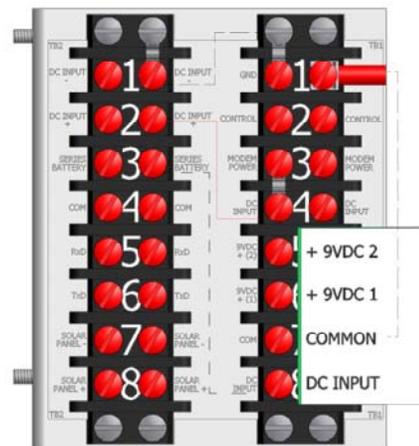


Figure 29 Terminal block with VREG

The SunSaver is sent configured for sealed batteries only. When it is time to replace the MI Wireless battery, be certain that it is a sealed, not flooded battery.

The SunSaver circuit minimizes switching noise and filters all noise output to low levels when the system is properly grounded. It is very important to follow good grounding procedures.



Figure 30 SunSaver Solar Controller

The SunSaver has two LED indicators. See Figure 17 SunSaver Solar Controller. The green LED indicator will light whenever AC power is available for battery charging. It will turn off when the AC power is disconnected. Because the SunSaver uses a PWM constant voltage charging process, there is usually some amount of energy going into the battery at all times. Although the charging current falls to very low levels when the battery reaches full charge, the green LED will continue to stay ON. This is to indicate that the controller is working and that energy is available from the AC supply for charging.

The SunSaver also has a red LED to indicate the automatic load disconnect (LVD) feature. Whenever the battery charge state falls below the LVD set point, the load will be disconnected and the red LED will light. This indicates that the controller has disconnected the load to protect the battery from further discharge and possible damage.

After some period of recharging the battery such that it recover to approximately 40 to 50 percent of its rated capacity, the load will

automatically be reconnected and the red LED will turn off. For the sealed-lead-acid batteries in the MI Wireless assembly, the cutoff voltage is 11.5VDC and the reconnect voltage is 12.6VDC.

When the red LED is on, there will be NO power to the modem, however there will still be voltage to the instrument and at the output power terminal. The internal instrument power and output power terminal are sourced from the voltage regulator board which is powered directly from the battery.

Warning!
Do not exceed the voltage or current ratings of the controller. The AC system must be properly grounded and all wiring should comply with local codes.

If the battery voltage is below 11.5 volts, the load has been automatically disconnected due to a very low battery charge condition, and the battery must be recharged. If the battery voltage is between 11.5 and 12.0 volts, the SunSaver will sometimes power-up during initial installation in the LVD state. This will automatically clear when the battery voltage rises above 12.6volts. If the battery voltage is above 11.5V the LVD can be reset by momentarily opening the battery fuse.

See the SunSaver manual for maintenance requirements and the troubleshooting guide in the [solar section](#).

Primary Alkaline

The MI Wireless assembly can be ordered with alkaline batteries as a primary power source. Dual alkaline power source includes two six D-cell battery packs mounted on the door. Quad alkaline systems have four six-D-cell battery packs mounted on the door. Either system can be purchased with battery packs placed all in parallel to make 9VDC or with two packs in series to make 18VDC. When packs are placed in parallel, a capacitor is used to mitigate modem surge current so that more of the capacity of the batteries can be used.

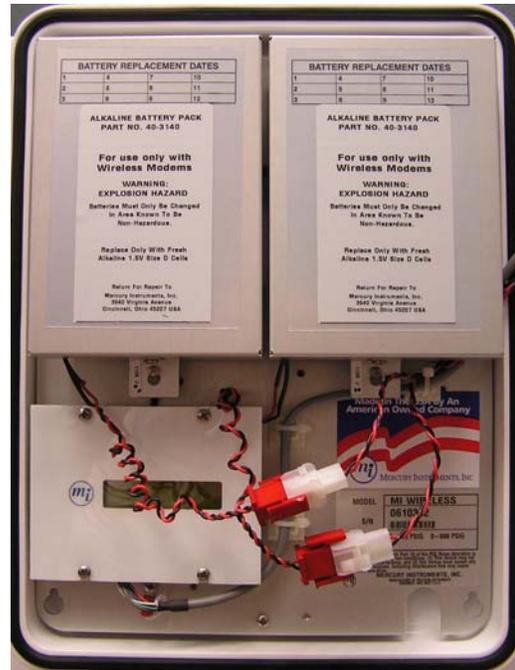
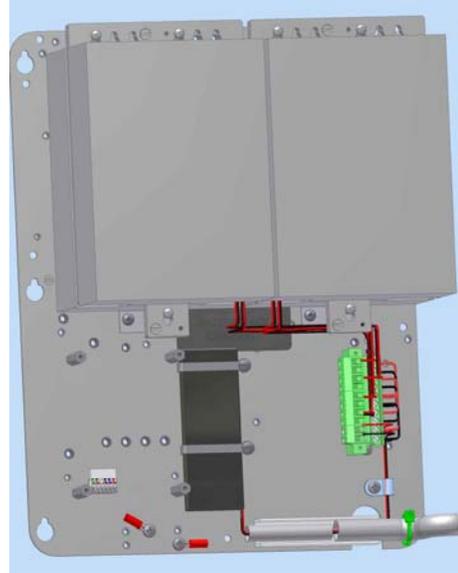


Figure 31: Dual Alkaline Assembly

To replace batteries in the quad pack, first remove the left or right side battery pack pair. Loosen the flat head screws on the top and bottom of each pack and slide the battery holders up to place the screw head into the key-hole. To open the packs to replace the batteries, loosen the screw on the top and bottom of each pack and spin the catch out of the way. Insert fresh batteries and replace the covers. When placing the packs back onto the screws, orient them so that the wires exit in the center of the door over the label.



It is important to replace all of the batteries at the same time and to use the all the same type, brand, and age of batteries during each change. Variations in manufacture for different brands will cause differences in the battery characteristics which will reduce the life of the battery pack.

When connecting the parallel dual or quad alkaline packs, hook up all of the batteries first, then plug in the supercapacitor so that it will charge evenly from all battery packs.

When connecting the series (18V) dual or quad alkaline battery packs to a communications and instrumentation assembly, insert the plugs in the order

labeled, with "1" first and "2" second. This is not a problem in parallel assemblies or if you have not disconnected all of the batteries. The battery packs are identical, but the connection to the instrument is only off one of the battery packs.

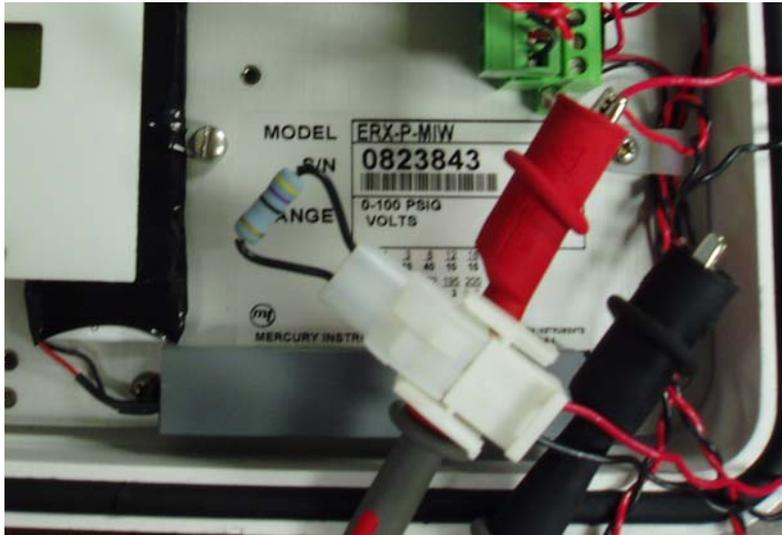


Figure 32: Quad Battery Pack

To avoid nuisance alarms in 18V systems, the instrument should be plugged in last. While the order of connection will never cause any damage to any of the devices, depending on the configuration of the instrument, it may be difficult to connect to clear the alarms. The instrument makes calling in on an alarm a top priority so it can be difficult to link to the instrument

while it is in that mode. In addition, if RBX is enabled, it will be similarly difficult to connect while the instrument is attempting to report the alarm clear.

If the assembly is equipped with a supercapacitor, it is found behind the door.



To check the function of the capacitor in the field, disconnect the capacitor from the rest of the system and measure the capacitance with a digital multi-meter. While capacitance will degrade over time, the capacitance should be 2.5F within 20%. Make certain that your meter has the ability to measure

large capacitance values.

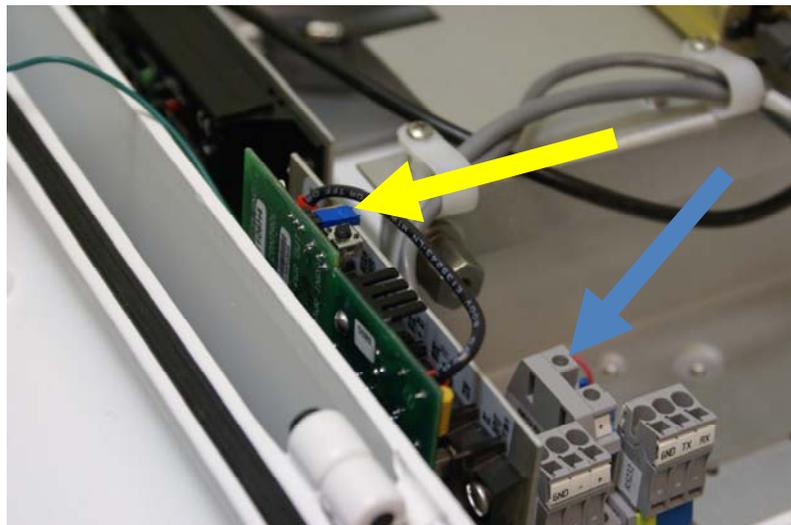
Alternately, it is possible to check the capacitor with a discharge test. Disconnect capacitor from the rest of the system and charge to 9.5V. Disconnect capacitor from supply and attach, with voltmeter clamp leads, to a cable with amp connector 40-1308 on its end. Plug in load resistor (part 40-1708) of 47 Ohms for 30 seconds. Remove load resistor and measure voltage. It should be above 7V. Recharge and then reconnect capacitor to circuit.

Other Connections

Modem Power Control

Modem Power Control enables an instrument to turn the power to a modem off and on only when required for alarm cry-out and on a recurring basis for scheduled calls and maintenance. It can be used to reduce the

Figure 33: Modem Power Control Board 40-2870-4

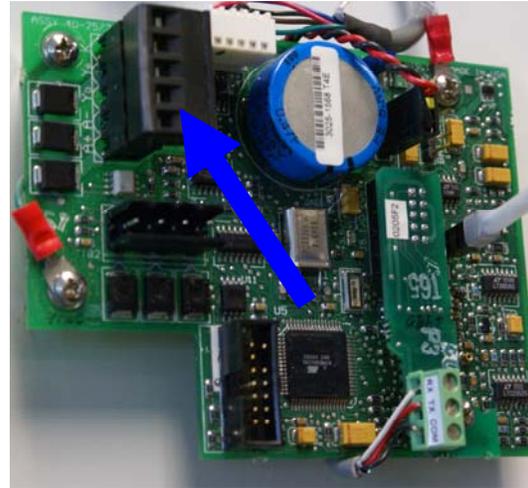


amount of power required by the modem assembly so that non-rechargeable batteries can be used or so that even smaller solar panels can be installed. It can also be used as a way to power cycle the communications device periodically to improve network reliability.

The MIW assembly comes standard with a Modem Power Control board.

The modem power control board is mounted on the top of the terminal block in the lower left corner of the assembly as indicated by the yellow arrow in Figure 33: Modem Power Control Board.

Figure 34: Instrument Terminal Block



If the MIW assembly comes with an integral instrument, the MPC board will already be wired to the instrument. If a remote-located instrument is used, a terminal block for the control wires will be in between the power input and the data output connectors on the MIW assembly. This is shown by the blue arrow in the figure. This terminal block + and – connectors should be wired to the A+ and A- terminals on the Mercury ERX or Mini-Max instrument TB1. On the Mini-AT, the terminal block - and + connectors should be wired to J20 Aux Modem pins 2 and 4 respectively.

MPC rev 4

The 40-2870-4 has a push button and one jumper. This modem power control board is configured default for the Mercury Mini-Max or Mercury ERX instruments. The Mercury Instruments Mini-AT uses a different modem power control signal, compared to these other instruments. The MPC board provides for monitoring of this signal with a moveable jumper. Place jumper on header pins 1 and 2 (marked I and II) for operation with a MAT. Place jumper on header pins 2 and 3 (marked II and III) for operation with a Mini-Max , ERX, or ER. Note that the Mini-AT must have firmware version 6.91 and a Rev K or newer main board in order to configure it for Modem Power control.

	Mini-AT	MMX/ERX –Level control	MMX/ERX -pulse control
Rev 4	Jumper 1 I-II	Jumper 1 II-III	N/A
Rev 7	Jumper 1 D-E Jumper 2 A-B	Jumper 1 E-F Jumper 2 A-B	Jumper 1 E-F Jumper 2 B-C

MPC rev 7

The 40-2870-7 board has two jumpers and a push button. Jumper one functions the same as in the -4 board in that it allows selection of the Mini-Max/ERX or the Mini-AT signaling input. The second jumper allows selection of a pulse signaling mode for the Mini-Max/ERX. Pulse signaling is not necessary or available in the Mini-AT, but it can be used to reduce power consumption in the Mini-Max/ERX instruments. In order to use the pulse function of the instrument, firmware must be 3.30 or later in the ERX or 2.80 in MMX.

To disable Modem Power Control so that the modem is always on, place the jumpers so that the board is in MMX/ERX Level control mode. Place a jumper wire on the MPC terminal block connecting the + and – terminals together. This will force the Modem Power Control board to keep the modem powered up at all times.

In the ERX and MMX, the instrument uses the Alarm Pulse channel on TB1 to control the power to the modem or radio. To enable this feature, set item 484 (Alarm Channel Control) to 1-Modem Power Control or 2-Modem Power Pulse. When Modem Power Control is enabled, the alarm channel acts as a power switch during user-specified times. When Modem Power Pulse is enabled, the alarm channel generates a pulsed signal to turn the modem on and off. When possible, it is recommended to use the pulsed signal from the ERX or MMX as the power consumption of the instrument will be less. When the ERX or MMX is stand-alone, powered by its own alkaline battery packs, the pulse method should always be chosen over the level method. Failure to do so will cause instrument batteries to be depleted very rapidly.

The following table indicates the item codes used to program modem power control.

ERX item code	MMX/MAT item Code	Function
484	484 (not used in MAT)	Alarm Channel Control Select "Modem Power Control" or "Modem Power Pulse" to turn it on
791	490	Call out start time
783	485	Call out stop time
792	488	Call out repeat interval
793	489	Call out keep alive time
790	487	Call in keep alive time

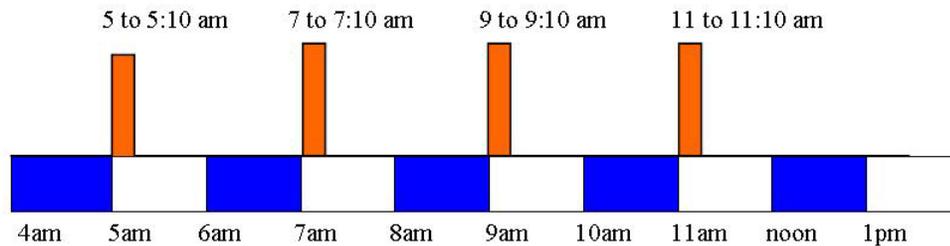
The call in keep-alive time indicates the number of minutes to keep the modem on to attempt to dial out when an alarm has occurred or during a scheduled call in. If the modem is on a call when this window ends, the call

will not be disconnected, but the modem will be powered down immediately after the call has ended or the connection was terminated.

The call out start time and call out stop time are used to set the absolute window of time during which some "on" periods are settable. This window can be set as any period during the day, but it must be a single period occurring during one calendar day. The stop time must be after the start time during a day.

The repeat interval and call out keep-alive time define the "on" periods during the window. These settings allow the creation of on-off cycles within the window.

For example, suppose the desired call window to the instrument is between 5 am and noon each day. A call will be attempted every 2 hours at the top of the hour during this time, until successful. Therefore, set the instrument to power on the modem for 10 minutes at the start of every 2 hour interval during the 5 am to 10 am window.



Call out start time	05:00:00
Call out stop time	12:00:00
Call out repeat interval	120
Call out keep alive time	10

Again, if there is an active call or connection when the interval or window ends, the call will not be disconnected until after the hang-up has occurred. It is important to minimize the number of on periods as well as the length of each only to a point where reliable communication can be maintained. On the flip side, the shorter amount of time that a modem is powered, the longer the batteries will last.

It is important that the time and date of the instrument be synchronized to the polling computer, otherwise time differences may cause the polling computer to miss the "on" time period of the modem. If the time and date of the instrument is synchronized during a poll, the modem will be powered off immediately after the call is disconnected regardless of the time remaining in that "on" period. The modem will be powered on again for the next "on" period as programmed in the repeat interval or the window.

As an alternative, to use the Modem Power Control function to power cycle the modem for network reliability, determine a frequency that is sufficient but will not interfere with the calling schedule. For example, to power cycle the modem once an hour, use the following settings:

Call out start time	00:00:00
Call out stop time	23:59:00
Call out repeat interval	60
Call out keep alive time	59

When the modem power control board is on and providing power to the communications device, a red LED on the modem power control board will be lit. For testing and troubleshooting purposes, there is a small pushbutton on the end of the board. When pressed, the modem power control board will turn on for a period of about 30 minutes.

Pressing the pushbutton on the front of the board will cause it to turn on for about 30 minutes on the -4 board and 10 minutes on the -7 board, and then turn itself off. This allows testing of the modem without altering the setup of the instrument to cause it to turn on the modem. If the timeout is too long, note that momentarily disconnecting and reconnecting power to the MPC should cause it to power up without turning the modem on. If the instrument is in level-mode and is still telling the modem to be 'on', the MPC board will turn on again.

The modem power control board will be on during any time that the instrument has instructed it to be on, or if the button has been pressed within the keep-on time. Either input is sufficient to power on the modem. MI Wireless assemblies with 9VDC power systems require the 40-2870-5 or 40-2870-7 modem power control board. The 40-2870-5 is configured identically to the 40-2870-4 board described above.

Battery Voltage Monitor Adapter

The 40-3530 battery voltage adapter provides for the measurement of up to 20 volts DC through a spare pressure transducer input in an ERX or Mini-Max instrument. It consists of a small, protected circuit board with an 8-position connector on a short pigtail wire from one end and a 32 inch purple wire terminated with a spade lug at the other end.

The 8-position connector plugs onto a transducer header with the green wire at pin number 8 (typically toward the bottom edge of the circuit board), similar to a pressure transducer. The spade lug is to be connected to a terminal carrying the voltage to be monitored. Typically, this will be a terminal marked Battery + or something similar. In systems using solar battery chargers, the lug should be connected as just described and not on the Load Disconnect terminal of the charging module, which is disconnected from the battery when it becomes low.

The purple wire may be connected to any DC voltage of interest as long as the voltage ranges between 0 and 20 volts. The wire may be shortened or coiled if it is too long. The resistance from the lug to chassis common is 845 kilohms minimum.

A special pressure transducer coefficient file must be loaded into the channel that is used. The file is named BATTVOLT.IEX for use with ERX instruments and BATTVOLT.IMX for the Mini-Max instruments. If the instrument came from the factory with the battery voltage adapter installed, the coefficients file will already be loaded. If this is not the case, the operator will need to transfer the file under Cal Items. Use the Transfer, Send Cal Items function in MasterLink to send the file, selecting only the appropriate pressure channel that will be used for voltage.

You can set the display units of any of the 3 pressure channels to VOLTS (items 549, 550, and 408 respectively), although in some cases the default pressure units will still appear – e.g., audit trail and such.

If the assembly came from the factory with the battery voltage adapter installed, the following alarm limits should already be set. If this is a field installation, the following are the recommended settings.

ItemP3	ItemP2	ItemP1	Function	Settings –Solar or AC	Settings – 18V Alk	Settings - 9V Alk
455	555	553	High Alarm	16.00	20.00	10.00

456	556	554	Low Alarm	11.80	14.40	6.90
807	817	813	High/High Alarm	18.00	20.00	10.00
808	818	814	Low/Low Alarm	11.00	13.80	6.60
459	811	770	Dead Band	1	1	1

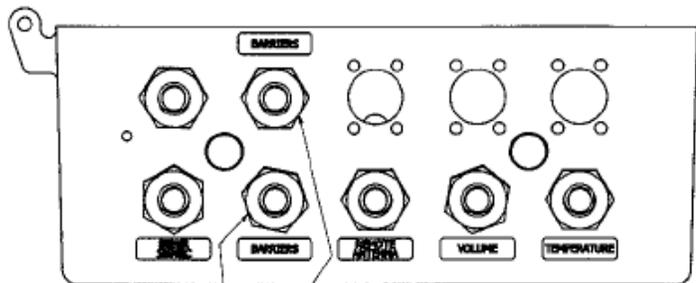
Use the Pressure Calibration functions in MasterLink to check or adjust the accuracy of the voltage measurement. Adjust the zero reading to 0.0 with the spade lug disconnected (or connected to a ground screw). Then adjust the upscale reading with the spade lug connected to the voltage to be measured (or a power supply) using the SPAN CALIB function, with a voltmeter as the reference.

Note: if you are calibrating to an upscale value less than 10 volts, **first** go to MasterLink's Instrument, Calibration Parameters, Minimum PCal Point Difference % function and reduce the value from 50% to 20% to avoid an error message. Restore this setting to 50% afterwards if you wish.

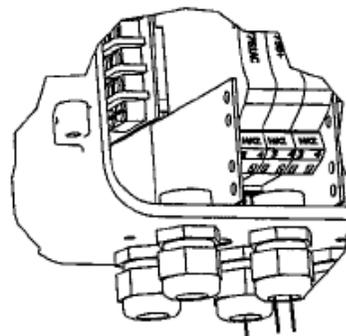
Connect the spade lug to the terminal to be measured and use a voltmeter to verify that the adapter is working properly. Route the wire in the best way and secure it in place. This completes the installation.

Safety Barriers

Series shunt-diode safety barriers are used as intrinsically safe (IS) interfaces between safe and hazardous areas. All installers of shunt-diode barriers should be familiar with the installation instructions provided by nationally accepted codes of practice. Essential checks should be carried out to ensure the safety of a barrier installation, in addition to a final check being



ALL WIRES ENTERING BARRIERS MUST ENTER THRU THESE TWO CORD GRIPS



TO CUSTOMER CONNECTIONS

Figure 35: Wiring into enclosure

made by someone other than the person(s) who carried out the installation work. For questions, refer to the appropriate authorities in your area.

Warning!
Follow proper safety procedures. Never disconnect wires in a gaseous area.

Safety barriers are available in the MI Wireless enclosure for connecting data, power, and alarm/pulse outputs from the MI Wireless enclosure in a Class 1 Division 2 area to an instrument in a Class 1 Division 1 hazardous area. A different type of safety barrier is used for each application. Serial barriers may be the MTL7761ac to wire to a remote Mini-AT or ECAT or MTL7758+ to wire to a remote Mini-Max or ERX.

Wires for barriers must enter the bottom of each instrument through the appropriate cord grips as shown in the figure.

To install, turn power off. Remove plug from strain relief. Feed cable through strain relief. Attach cable to appropriate barrier, wiring as given in diagram. Push additional cable into enclosure prior to tightening strain relief.

For additional information on wiring to each type of barrier, consult the MI

BARRIER SERIAL CUSTOMER CONNECTIONS

Wireless customer connection drawing for the particular application.

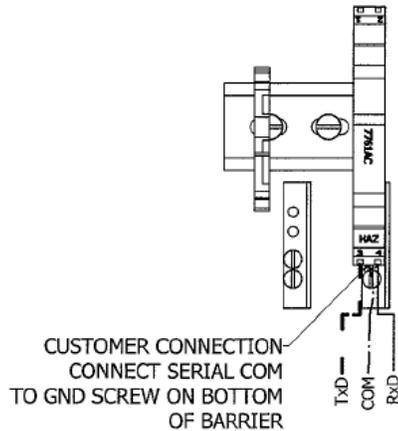


Figure 36: Serial Barrier

For serial barrier, wire TxD transmit data to pin 4 on the serial barrier and RxD receive data to pin 3 on the serial barrier. Connect signal ground or common to the ground screw on the bottom of the barrier.

For the output power barrier, positive voltage (6 or 9 VDC) is available on pin 3 of the power barrier. The common or reference ground is available on the screw that is near the bottom of the barrier.

In normal situations, a routine visual inspection is all that is needed of the safety barriers. However, if the performance of barriers is in any way suspect, carry out a resistance and diode test. To test the resistance of a barrier on site, carry out the following procedure:

- a) Unplug hazardous-area cables from terminals 3 and 4
- b) Unplug safe-area cables from terminals 1 & 2. Warning: Take care when handling safe-area cables; the relay contacts could be carrying voltage
- c) Measure the end-to-end resistance of the barrier by connecting a digital multimeter (set to a suitable ohms range) between terminals 1 and 3. The reading should typically be slightly less (1 to 3 %) than the maximum end-to-end resistance listed in the table for the appropriate barrier type.
- d) Check the functioning of the diode-return channel by selecting the diode test function on the multimeter and connecting between terminals 4 (+ve) and 2 (-ve). This measures the forward voltage drop of the diodes in the chain: the reading should be less than .9V. Repeat the test with connections reversed (terminal 4 –ve and terminal 2 +ve) for an expected reading of infinity for the reverse voltage drop.
- e) Tests c) and d) confirm the continuity of both barrier channels. If either channel is open-circuit it is most likely that the fuse has blown. The safe-area circuit should be investigated in an attempt to discover the cause of the fault.
- f) Note that if the barrier is removed, make sure the safe-area and hazardous-area cables disconnected during operations a) and b) are connected to an earth-rail, a dummy barrier or insulated completely.
- g) If it becomes necessary to remove and replace a safety barrier, the barrier can be removed from the DIN-rail mounting by inserting a screwdriver in the slot in the tab at the bottom of the barrier on the safe side. With a flat-blade screwdriver firmly in the slot, lever the screwdriver handle/arm against the barrier to pull the tab outward. With the tab extended, tilt up on the barrier until it has released the DIN rail on one side. Rock it until it releases the other side.

BARRIER DUAL POWER CUSTOMER CONNECTIONS

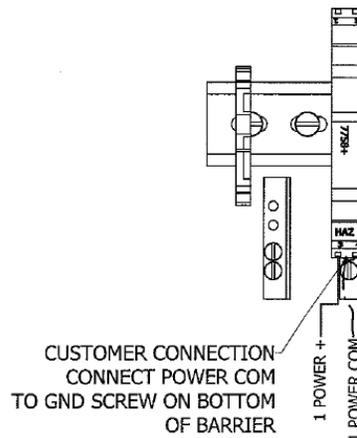


Figure 37: Power Barrier

Barrier	End to end resistance Min	End to end resistance Max	Diode test +ve	Diode Test -ve
7758+	14	17	∞	~.6V
7761ac	98	107	∞	∞
7715+	110	119	∞	~.6V
7767+	110	119	∞	~.6V

Cellular Evolution

Cellular Technologies

AMPS (Advanced Mobile Phone System)

In 1983, the analog cell phone standard called AMPS (Advanced Mobile Phone System) was approved by the FCC and first used in Chicago. AMPS uses a range of frequencies between 824 MHz and 894 MHz for analog cell phones. In order to encourage competition and keep prices low, the US government required the presence of two carriers in every market, known as A and B carriers. One of the carriers was normally the local exchange carrier (LEC); a fancy way of saying the local phone company.

Carriers A and B are each assigned 832 frequencies - 790 for voice and another 42 for data. A pair of frequencies (one for transmit and one for receive) is used to create one channel. The frequencies used in analog voice channels are typically 30 kHz wide. The reason that 30 kHz was chosen as the standard size is because it provides a voice quality almost comparable to a wired telephone.

TDMA (Time Division Multiple Access)

The original launch of TDMA in 1992 divided each analog 30kHz channel into three timeslots. For the carriers, it provided a three-fold increase in the number of conversations able to be carried on each frequency. The transmission scheme prevented easy real-time eavesdropping because each channel is divided, but was plagued with complaints of quality.

CDMA (Code Division Multiple Access)

CDMA was commercially introduced in 1995 with the IS-95A Standard, which is currently used by millions of cellular voice subscribers. CDMA / IS-95A is a second generation (2G) wireless standard. A unique code (one of 4.4 trillion) is used to separate the conversations, allowing multiple conversations to be transmitted over the same channel at the same time, providing a ten-fold increase over AMPS.

In 1999, the CDMA2000 series of standards were introduced as the path for CDMA to evolve into a 3G wireless network. The CDMA path to 3G is through CDMA2000 1X, then onto CDMA2000 1xEV-DO and 1xEV-DV.

The CDMA2000 network upgrades commercialized in North America in 2002 were the CDMA2000 1X standard. CDMA2000 1X supports high speed packet data services. CDMA2000 1X provides a maximum over-the-air data rate of 153.6kbps, and provides the efficiency of packet data so that more users can be connected simultaneously. Currently, the average throughput speed on the CDMA2000 1X network is between 40 and 70 kbps.

The addition of the EVDO service on CDMA2000 can operate at 153kbps in Rev 0 and up to 1.8Mbps with Rev. A. Plans are being made for a Rev. B, but no vendors have committed to this yet.

WiMAX, the Worldwide Interoperability for Microwave Access, is a 4G telecommunications technology aimed at providing wireless data over long distances in a variety of ways, from point-to-point links to full mobile cellular type access. It is based on the IEEE 802.16 standard, which is also called WirelessMAN. The name *WiMAX* was created by the WiMAX Forum, which was formed in June 2001 to promote conformance and interoperability of the standard. The forum describes WiMAX as "a standards-based technology enabling the delivery of last mile wireless broadband access as an alternative to cable and DSL." Sprint's soft launch in the three test markets went live in Chicago, Baltimore, and Washington DC as of January 11, 2008. Full commercial launch is still expected to be approximately spring of 2008.

GSM (Global Systems for Mobile Communications)

Developed in 1987 by Groupe Speciale Mobil, a committee comprised of representatives from four European countries to provide uniformity of service and roaming. In 1989 work done by the GSM group was transferred to the European Telecommunication Standards Institute (ETSI). The name GSM was transposed to name the type of service invented. The acronym GSM had been changed from Group Spécial Mobile to Global Systems Mobile Telecommunications.

GSM is based on TDMA technology with eight time slots. In GPRS, the timeslots are assigned on an as needed basis, and more than one timeslot can be assigned for a particular transmission depending on the network and the device. By using multiple time slots a user will experience data rates that would not be possible with a GSM circuit switched connection.

GSM has integrated encryption and an incorporated "key" which virtually eliminates fraud. GSM uses a subscriber identity module (SIM) card, which contains information necessary to use the phone. This allows the user to use multiple phones by switching SIM cards.

Enhanced Data rates for GSM Evolution, or EDGE, is a digital mobile phone technology which acts as a bolt-on enhancement to 2G and 2.5G General Packet Radio Service (GPRS) networks. This technology works in GSM networks. EDGE (also known as EGPRS) is a superset to GPRS and can function on any network with GPRS deployed on it, provided the carrier implements the necessary upgrades.

LTE (Long Term Evolution) is the name given to a project within the Third Generation Partnership Project to improve the UMTS mobile phone standard to cope with future requirements. Goals include improving efficiency, lowering costs, improving services, making use of new spectrum opportunities, and better integration with other open standards. The LTE project is not a standard, but it will result in the new evolved release 8 of the UMTS standard, including mostly or wholly extensions and modifications of the UMTS system.

While the project is ongoing and general in scope, it has set itself some specific goals, many of which are oriented around upgrading UMTS to a so-called fourth generation mobile communications technology, essentially a wireless broadband Internet system with voice and other services built on top.

Targets include:

- Download rates of 100 Mbit/s, and upload rates of 50 Mbit/s for every 20 MHz of spectrum

- Sub-5ms latency for small IP packets

- Co-existence with legacy standards (users can transparently start a call or transfer of data in an area using an LTE standard, and, should coverage be unavailable, continue the operation without any action on their part using GSM/GPRS or W-CDMA-based UMTS)

A large amount of the work is aimed at simplifying the architecture of the system, as it transitions from the existing UMTS circuit + packet switching combined network, to an all-IP system.

Why Switch from Analog?

The AMPS system could not support increasing consumer demand and customer feature requirements. The newer technologies were designed to allow more customers in the allotted bandwidth and allow the providers to sell more features. For cellular users interested in data services, these newer technologies sometimes provided a cost savings as well. Analog service is no longer supported since 2/18/2008.

Switching Methods

Circuit Switched

Circuit switched technologies operate like land-line phones. Once the phone number is dialed and a connection is made, you have a dedicated circuit from end to end. No one else can use it until you hang up. The big disadvantage of this technology is cost. Voice calls and dial-up modem calls are currently circuit switched. Some cellular service providers have phased out circuit switched data and will no longer support this service. Check with your carrier for more information.

Packet Switched

Packet switched is like having your own set of railroad cars that you are sharing with other railroad cars on the same track. You slice the information to send so it fits in the cars, which join other cars to travel on the railroad track to the other end. They will travel on different tracks until they reach the end. At the destination, they are reassembled in the order they were sent and then they are dropped off.

It is much more efficient to send data via a packet switched network than circuit switched. In the packet switched network, bandwidth can be granularly, dynamically assigned based on the amount of data. Circuit switched networks lose some of this capability.

In a packet switched network, data will reach the remote modem via an IP address. IP stands for Internet Protocol which includes some specifics about how packets are assembled and travel through to their destination. IP is considered layer three, the network layer, of the 7 layer OSI (Open Systems Interconnection) model. The network layer handles logical routing of data. For reference, the physical connection or cable medium is considered the first layer. The fourth layer of the protocol stack is also important as it provides for the transparent transfer of data between two devices. It is at this layer that the TCP (transmission control protocol) or UDP (user datagram protocol) port is selected. The higher levels of the stack are the host layers for the application processes.

It is common for packet switched modems to receive dynamic IP addresses because the most common use of the modems is for Internet access for mobile PC users. This does not work well with remote devices. It is **vital** to receive a static IP address for each modem in order to be able to initiate communication to the device. These IP addresses may be public or private depending on the needs and requirements of the company and its network for security and remote access. In order to use private static addresses or provide for limited access to otherwise public addresses, it is necessary to set up a dedicated line or a VPN connection to the cellular provider. A data services manager at the cellular provider of choice should be able to explain these options and associated costs.

HyperTerminal

HyperTerminal is a terminal emulation program that allows the user to send and receive commands directly to communications equipment such as modems and cellular phones. HyperTerminal can be used to program and verify information in digital cell phones. It is available and included in most Windows operation systems prior to Windows Vista. It is usually found under Accessories>Communications.

In order to communicate with a device you must know the communication settings of the device and your computer. The most important parameters are: communication port, baud rate, number of data and stop bits, parity and error checking protocol.

The common communication settings for Mercury Instruments are as follows:

Parameter	Setting
Baud Rate	9600
Data bits	8
Stop bits	1

Parity	None
Flow Control	None

HyperTerminal is used to send commands to the cellular modems and analyze the responses. The list of commands and responses are listed in the programming sections.

Since HyperTerminal is configured to use Comm. Port 1, your meter programming cable will have to be removed and all metering and communications software closed prior to starting.

These settings can also be commonly used to communicate with serial modems. A straight through DB9 serial cable from PC to modem is required. Hyperterminal can also be used to communicate with RavenE Ethernet modems by selecting TCP/IP Winsock instead of the serial com port on the PC.

HyperTerminal is included in many Windows operating systems, however it is not included in Windows Vista. There are terminal programs available for purchase that will run on Windows Vista.

Cellular Modem setup

Before energizing the modem, verify an antenna is connected to the modem. It is recommended that the modem be provisioned, activated, configured, and tested before being taken to the field. Account problems can usually be dealt with more easily from an office than a remote location.

Establishing CDMA Cellular Service (Provisioning)

In order to get the unit activated, you will need to establish service with the Cellular Carrier of your choice. You will need to provide the carrier with account setup information including:

1. ESN (Electronic Serial Number) in Hexadecimal or Decimal
2. Device type and model number
3. Area code/City of Installation
4. Type of service (circuit data or packet data) that you wish to have
5. If you are getting packet-switched service, you will need to specify the need for a static IP address
6. Amount of usage in minutes or Megabytes

The ESN is given in decimal and hexadecimal format on the modem label on the top of the modem.

Depending on your provider, the cellular carrier will provide you with a variety of parameters. Each provider uses different naming conventions for the parameters and has different requirements for what must be entered.

CDMA:

1. MIN (Mobile Identification Number) – Number in the phone
2. MDN (Mobile Dial Number) Number you dial
3. MSL (Master Subsidy Lock), or NAM Lock Code and password,
4. Alltel requires a SID (System ID) instead of the MSL
5. Bell Mobility also requires a NAI (user ID) and password
6. IP address for packet switched network

Note: For CDMA, the MDN and MIN may be the same or different, even if you are establishing a packet switched service.

iDEN Service Provisioning:

Your modem will come with a SIM card. You will need to provide Nextel with the SIM card number as well as the IMEI of the modem. You will get it provisioned with information about your service including the following items:

1. Data number if using circuit switched(number called for passing data)
2. Voice number (number used for billing)
3. IP address

GSM/GPRS/EDGE Service Provisioning:

You will need to provide the carrier with the IMEI number printed on the modem label on the top of the modem. The carrier will give you a SIM card provisioned with information about your service including the following items:

1. Data number if using circuit switched(number called for passing data)
2. Voice number (number used for billing)
3. IP address for GPRS/EDGE service, along with APN, and possibly user ID and password, depending on your account parameters. Wireless data networks are based on the concept of virtual routing instances for different customer groups. Each virtual routing instance is called an Access Point Name (APN). An APN represents the virtual router that will provide the basic termination point of Enterprise wireless data traffic.

When ordering your GPRS/EDGE service, it is important to understand the options available for the APN. There are several types of APNs available and each has different features and costs. If you require a secure network, it is also important to consider how to connect into the cellular service provider's network. VPN, Frame relay, and dedicated lines are commonly used.

- **Shared vs. Private APN**
 - Shared: (general and special purpose) same APN is used for a number of customers. The shared APN is available as a general or special purpose APN. The general APN is what is commonly provided at cellular stores and only allows dynamic IP addresses. A special purpose APN may be available when a very small number of static IP addresses are needed.
 - Private: (dedicated or custom) only one customer per APN; provides traffic isolation, helping prevent attacks on wireless devices from outside the Enterprise. Private APNs may be available in Dedicated and Custom options based on the number of devices.
- **IP Address White/Black List:** allows customer to block specific network destinations, or provide access to only certain destinations (custom firewall rule)
- **Protocol White/Black List:** allows customer to define the types of protocols wireless devices can accept (HTML, FTP, etc.)

- **Mobile Termination:** Enterprise host is able to initiate IP sessions to mobile devices
- **Mobile-to-Mobile:** allows mobile devices to initiate IP sessions to other mobile devices in the same APN
- **Sequential Static IP Addresses:** customer obtains sequentially numbered IP addresses, enabling efficient IP address management
- **IP Address Pool Blocks:** packaging of static IP addresses into finite size blocks – Custom APNs have customer-defined IP address pool blocks, other APNs have fixed size blocks
- **IP Block Assignment Options:** number of static IP addresses a customer can obtain on an APN, one per mobile device
 - Need enough IP addresses to cover current devices and future device growth
- **IP Address Type**
 - Private: per RFC1918, IP addresses not routable on the public internet because they can be used by multiple Enterprises; used due to limited availability of registered, public IP addresses
 - Public: registered IP addresses routable over the public internet
 - Static: mobile device IP address is constant; only used for applications requiring persistent device IP addressing
 - Dynamic: network assigns a new IP address to the mobile device each time the device connects to the network from a generally available pool of Enterprise specified IP addresses

GPRS/EDGE Activation

Once you have received your SIM card from your provider, remove the two rear screws from the Raven, RavenE or RavenXT modem. Slide out the board.



Figure 38: EDGE Modem

Using the tip of a closed pen or a paperclip, eject the SIM tray by pressing the tiny button on the edge of the board.

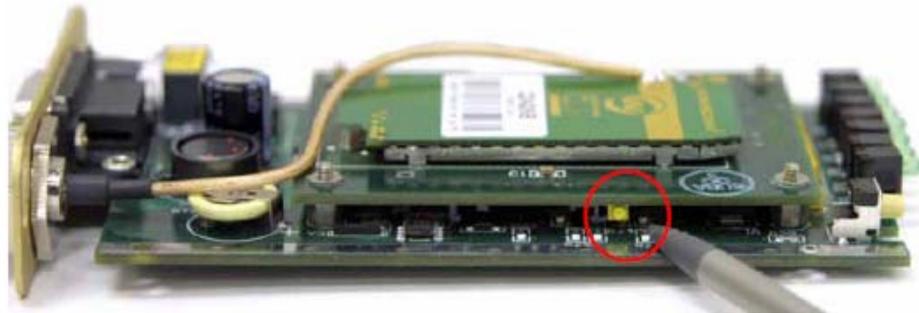


Figure 39: SIM Card Holder

On the Raven and RavenE, insert the SIM card into the holder with the terminals facing up. The SIM card will only fit one way due to the angle on one corner. Once in the holder, slide it back into the modem until it clicks and place the cover back on. In order to use your service, you will need to configure the modem for proper network parameters as shown in the configuration section.



Figure 40: SIM Card Tray

On the Raven XT, slide the SIM card into the SIM card receptacle. The contacts should be downward and the logo of the card should face up. Orient the card to match the white outline printed on the board so that the cut corner is aligned. Insert the card fully.



Figure 41: Raven XT SIM card

CDMA Activation

Once the account has been provisioned by the carrier, the modem can be activated. Some CDMA carriers, such as Verizon, currently allow OTA or "over the air activation". Using this, you will not be required to type in the phone number in order to activate the modem.

First, download the most recent setup wizard from Airlink at <http://www.sierrawireless.com/support/AirLink/>. Select the specific Raven being used and then the carrier. Confirm that the modem has the most recent firmware. If the modem does not have the most recent firmware, it is necessary to download that and install it first. The latest firmware version is listed on the web site.

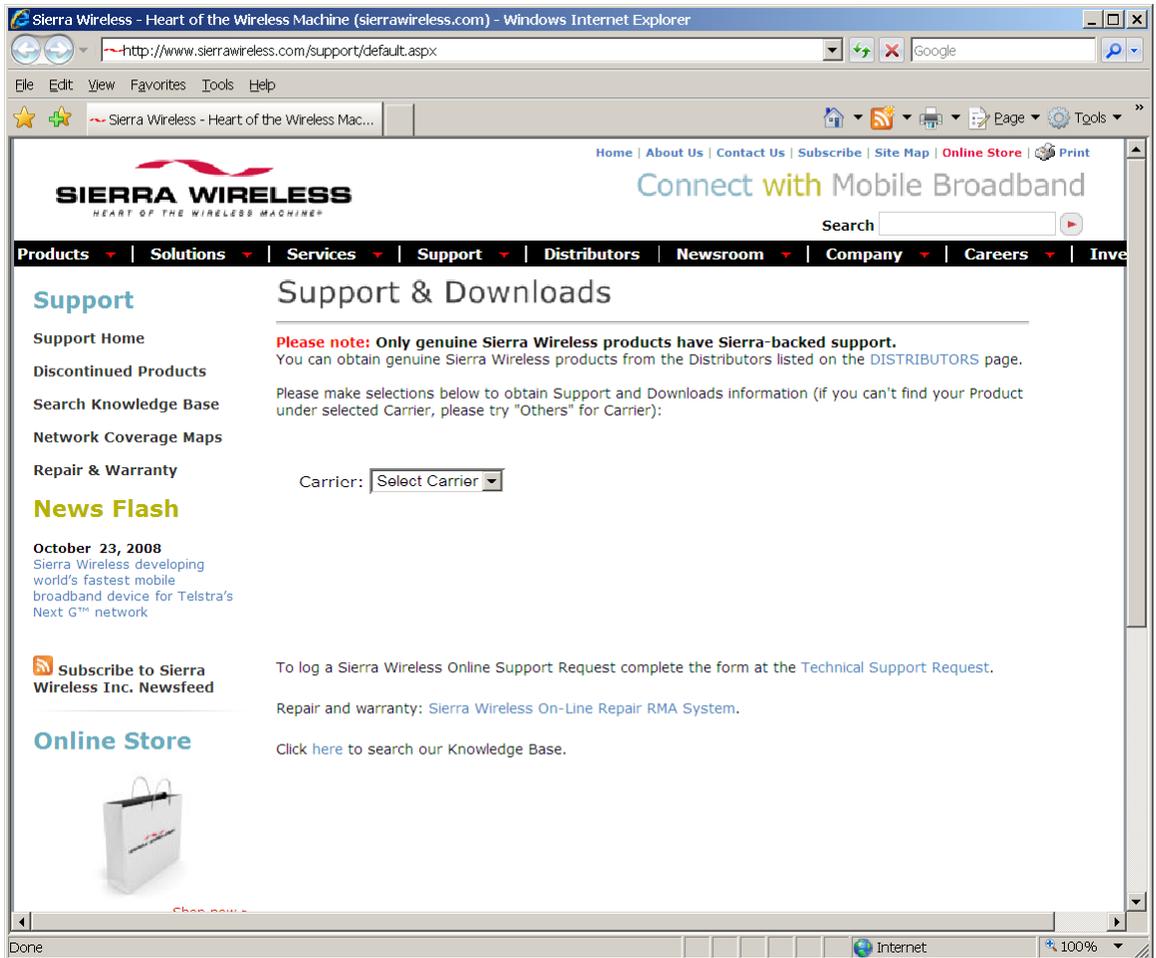


Figure 42: Airlink Support Page

Select your carrier and your modem type and then click Next. Download the setup wizard. It is vital that the modem has the most recent firmware and that the setup wizard is the most recent version. Wireless providers are constantly changing and upgrading their networks and this often resonates through the activation procedures and commands that are required in order to make a modem work on the network.

Install the setup wizard on the computer connected to the modem. The installation will automatically include a set of Adobe Acrobat files that are manuals for running the setup wizard.

Open and read the Raven setup wizard manual for your carrier. You will want to activate the modem, and may choose to test the connection. The connection test can take several minutes and is not necessary in order to complete the activation. Depending on your network setup and chosen carrier, you may need to select the box for

Data Link Setup.

You will not want to upgrade any firmware while running the setup wizard. Download and upgrade the firmware separately if needed. You also will not want to set up a DUN session, unless this modem is being used on a PC for network connection. This section of the setup wizard will setup the computer, not the modem.

If the modem fails to provision, retry several times. If the modem still fails to provision, call your provider.

EVDO Activation -Verizon

Once the account has been provisioned by the carrier, the modem can be activated. One of the features of EV-DO network devices is the ability to activate themselves automatically. Upon power up, the modem will check to see if it has been activated with account data. If it has not yet been activated, it will attempt to retrieve the account data using Over-the-Air Service Provisioning (OTASP).

OTA activation with EVDO Raven modems is very simple. Plug in the antenna, and then the power cord and wait.

1. The lights on the modem will cycle to indicate the power on self test.
2. All the lights will go out except the power light as the modem is attempting to download its account information. This may take a minute or two.
3. When the download is complete, the RavenE will reset itself, the power light will go out and the LED lights will cycle once more.
4. If the chan and link lights begin to flash together in a sequence, power cycle the modem.
5. Once the modem completes its registration, the Channel (Chan), link, and Registration (Reg), lights will be solid.

EVDO Activation –Other carriers

Once the account has been provisioned by the carrier, the modem can be activated.

First, download the most recent setup wizard from Airlink at <http://www.sierrawireless.com/support/AirLink/> Select the Raven and your carrier. Confirm that the modem has the most recent firmware. If the modem does not have the most recent firmware, it is necessary to download that and install it first. The latest firmware version is listed on the web site.

Download the setup wizard and any new firmware files. It is vital that

the modem has the most recent firmware and that the setup wizard is the most recent version. Wireless providers are constantly changing and upgrading their networks and this often resonates through the activation procedures and commands that are required in order to make a modem work on the network.

Install the setup wizard on the computer connected to the modem. The installation will automatically include a set of Adobe Acrobat files that are manuals for running the setup wizard.

Open and read the Raven setup wizard manual for your carrier. The manual can be opened by selecting Start> Programs> Airlink Communications >Setup Wizard> (carrier name) Manuals. You will want to activate the modem, and may choose to test the connection. The connection test can take several minutes and is not necessary in order to complete the activation.

If using Ethernet, connect an Ethernet crossover cable between your computer and your EVDO modem. It is best to directly connect between a computer and modem as the modem needs to set up a private network between itself and the computer. This is done automatically when the two devices are connected.

If using a serial connection, connect a DB-9 straight-through serial cable between the computer with the setup wizard and the serial port of the modem.

Follow the instructions for running the setup wizard in the manual. These manuals are updated each time the carriers make network changes requiring changes to the setup wizard. It is recommended that you view this file before activating the modem as it includes some helpful information.

You will not want to upgrade any firmware while running the setup wizard. Download and upgrade the firmware separately if needed.

If the modem fails to provision, retry several times. If the modem still fails to provision, call your provider.

Configuration and Programming

Serial or USB Modem Configuration

The modem must be configured to the proper settings to get it to function

on the cellular network as well as to get it to communicate with the instrument. Please note that some of the settings are the same for all modems regardless of cellular technology and switching type, and some of them are specific to only one of these categories.

1. Download Wireless Ace 3G from www.sierrawireless.com/support/AirLink/
2. Install Wireless Ace 3G on a computer that has a serial port or USB port if the modem is equipped with a USB port
3. Connect the serial port of the computer to the serial port of the modem using a straight-through DB9 extension cable. If the modem is equipped with USB, connect a USB A to mini-B cable to an open USB port on your computer. If the modem does not have USB, you will need to use a USB to serial converter in order to configure it from a USB port.
4. If the modem has a USB port, there are two modes in which the USB port can be set: USBNET or USB Serial. It is recommended that USBNET be used as it is more forgiving in the Windows operating systems. Download the driver from the Sierra Wireless/ Airlink Website and install. USBNET mode will make the connection type appear as if it were network-based rather than serial-based but it will not impact the function of the configuration.
5. Make certain there is an antenna on the modem and then apply power.
6. Run Wireless Ace 3G
7. Select the button in the upper left hand corner that says *connect*

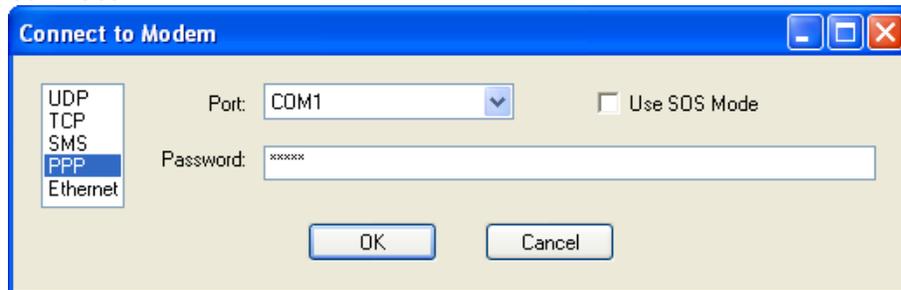


Figure 43 Connect to Modem with PPP

8. For serial modems, on the pop-up screen, select PPP in the left hand menu. Select the com port on the computer that is connected to the modem. You may need to use your system's device configuration menu to determine what com port is selected with a USB to serial converter
9. If the modem that is being configured is running in passthru mode, click the button that says "Use SOS mode". Note that you cannot use the USB port on the Raven XT in passthru mode. Computers with USB ports only and no serial ports will need to use a USB to serial converter and a serial cable in this case.

10. For USB-equipped modems, select UDP and enter the address 192.168.13.31.
11. Select the button that says *ok*
12. Watch the status bar under the *connect* button that indicates the connection being made to the modem.
13. Once you have connected to the modem, you should see the info screen as shown in Figure 44 Info Screen.

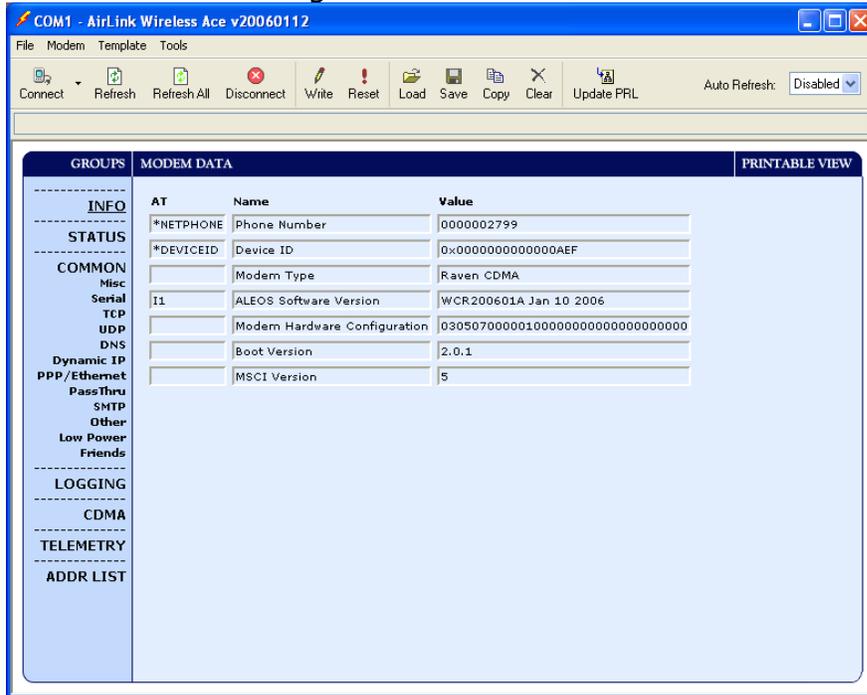


Figure 44 Info Screen

14. Confirm the Aleos software version to be the most recent.
15. Check the Status screen for the signal level.

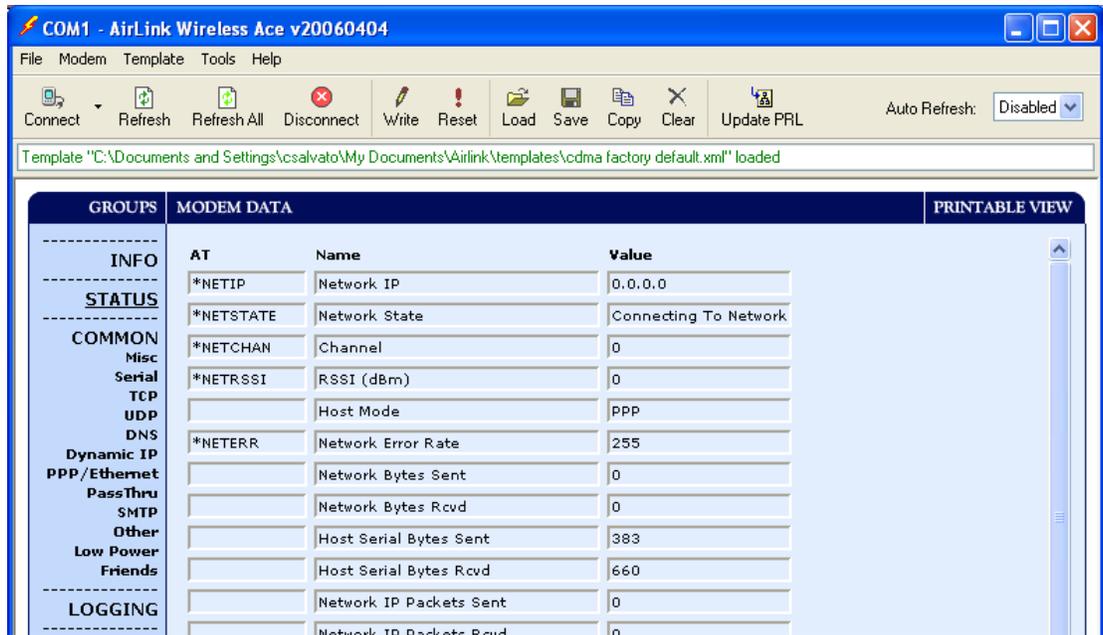


Figure 45: Status Screen

16. You have two options for configuring your modem. If you have a configuration file that you have saved or received from the factory, you may simply press the button that says **Load**, select the correct configuration file, and press open. Once the parameters are loaded into the right-hand column, then press **Write** to send all of the parameters to the modem.
17. If you do not have the configuration saved, you must configure the unit manually. Select each menu and change parameters. Note that the current value of the parameter is listed in the "Value" column. Enter the desired setting in the "New Value" column. Note that changes do NOT take place immediately. The values must be written to the modem and the modem must be reset before the new settings are used.

The serial parameters on the modem enable it to communicate with the instrument. The selections below assume that the instrument is set to 9600 baud. Adjust parameter s23 according to the instrument baud rate. In circuit switched mode, you are limited to no higher than 14,400 bps over the network (which is not a valid instrument data rate) and therefore 9600 baud in the instrument. In packet switched mode, you may set the number as high as your instrument will accept.

Select the menu on the left that says **Serial** and change the following:

Parameter	Change to value (All Technologies)
S23	9600,8N1
\Q	0
E	0
V	0

&D 0
S211 1

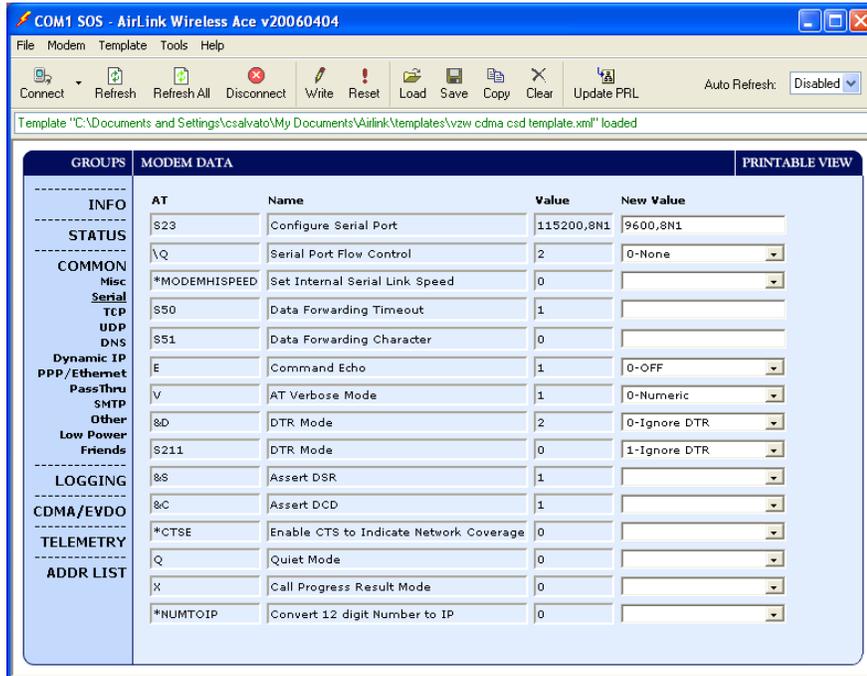


Figure 46 Serial Configuration

It is important that the modem be instructed to answer the phone when it rings as the instrument is not capable of issuing an answer command. Select the menu on the left that says **TCP** and change the following parameters

Parameter	Change to value (GSM/GPRS & CDMA)
S0	1
For packet modes	
TCPT	2 (TCP timeout value, depends on comm. frequency)
TCPS	0 (minutes)

The modem needs to be put into "passthru mode" in order to operate in circuit switched data mode. See Figure Figure 47 UDP Menu. Select the menu on the left that says **UDP** and change the following parameters

Parameter	Change to value (GSM & CDMA)
For circuit modes only	
MD	07
No changes for packet mode	

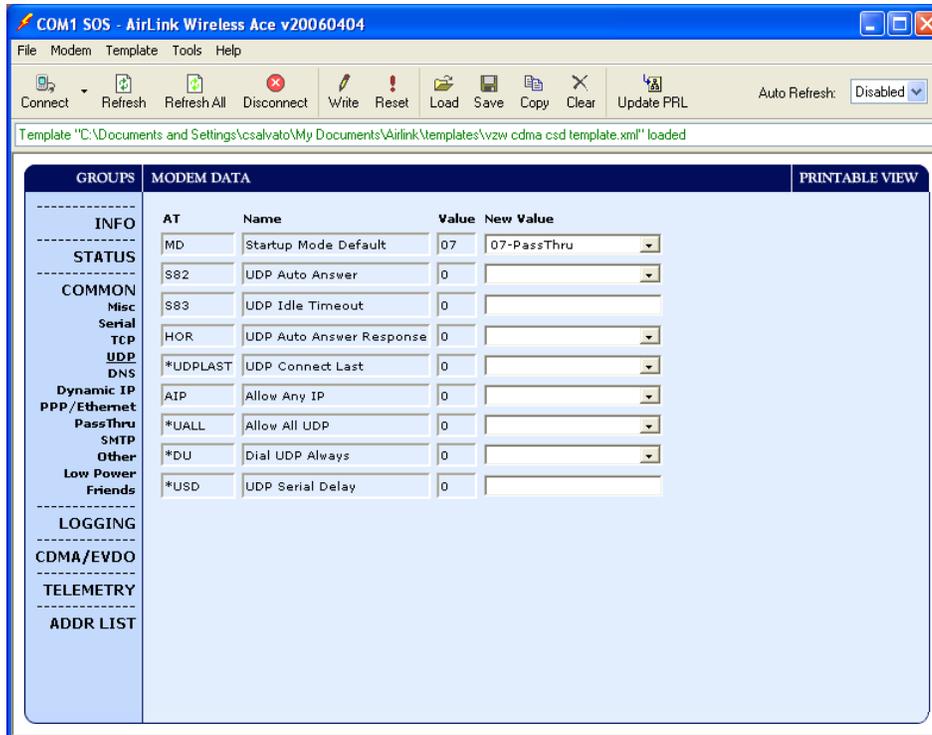


Figure 47 UDP Menu

When wireless devices remain inactive for a long period of time, the cellular network assumes that the devices have left the geographical area served by an individual cellular site and the devices get flushed out of the system. This cellular system then is unable to find the modem when a call for it is received by the network. In order to combat this, there are a couple of timeouts that are entered into the modem. The refresh period will check the amount of time since data has passed and send the initialization string to the modem. The reset period indicates the amount of time in hours that the modem will wait without passing any data before performing a reset. This reset is the same as someone pressing the reset button on the front of the modem.

For packet devices, network reliability tools such as pings and timeouts are covered later.

For Circuit Switched Data only, select the menu on the left that says **Passthru** and change the following parameters.

Parameter Change to value

For circuit modes only

- *PTINIT AT&D0S0=1+CICB=0 (Airlink Raven C3211 CDMA only)
- *PTINIT AT&D0S0=1\$QCVAD=4 (Airlink RavenXT CDMA only)
- *PTREFRESH 15
- *RESETPERIOD 4

No changes for packet mode

Note: You may choose to use different numbers for PTREFRESH and

RESETPERIOD. PTREFRESH is the number of minutes of inactivity in passthru mode that pass before the modem operating system sends the PTINIT string to the modem module. This functions to refresh the modem on the cellular network in the event that it loses registration. The RESETPERIOD is the time in hours in which the modem will completely reset itself if no data has been sent or received.

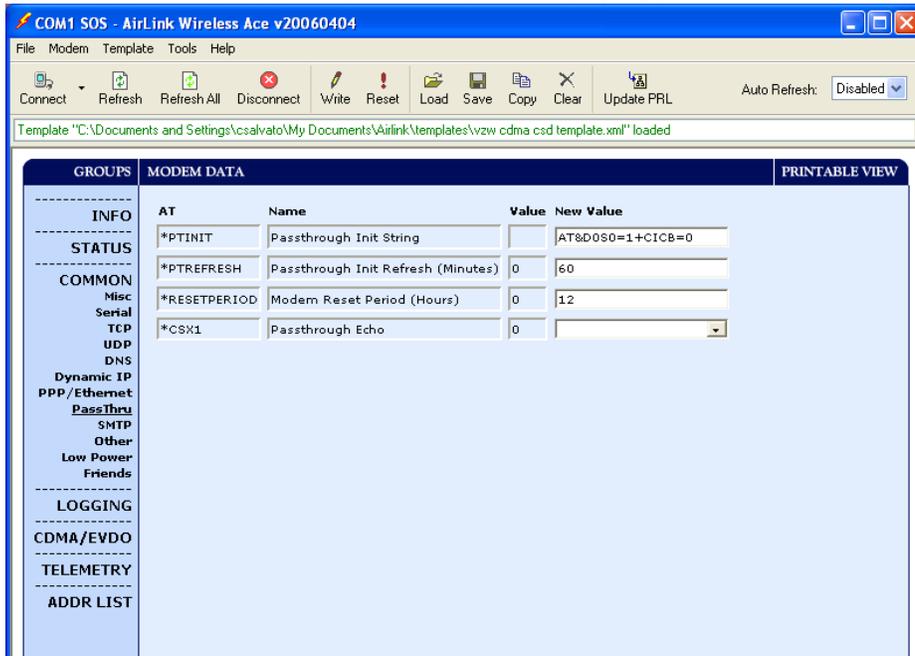


Figure 48 Passthru Menu

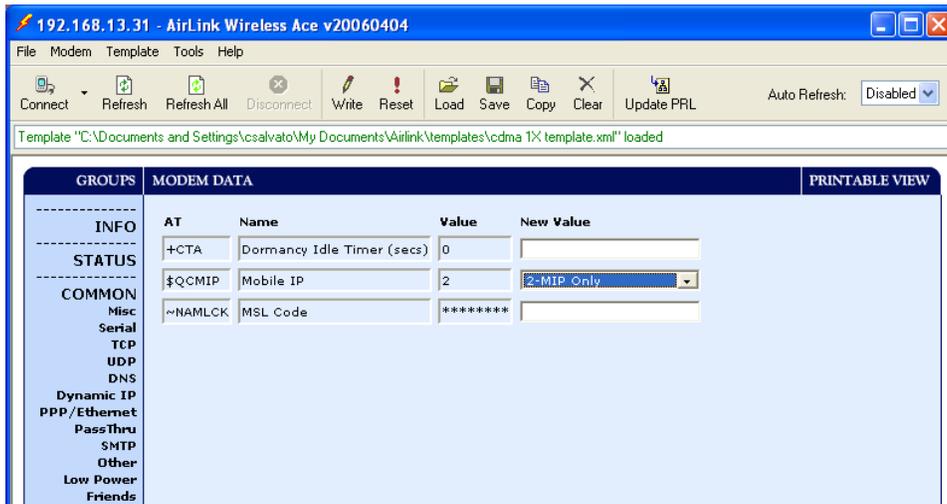


Figure 49: CDMA/EVDO Menu

Next, set the modem for static IP only by selecting the CDMA/EVDO menu in the menu bar.

Parameter Change to value (CDMA only)

For packet modes only

\$QCMIP 2-MIP Only

No changes for circuit mode

Next, set the port number to access the RS232 serial port on the rear of the modem. The default value is 12345, but it is recommended that this be changed. Choose a port that is unused elsewhere in the corporate network to avoid any conflicts and confusion. GPRS/EDGE modems will also set the user ID and password here if required.

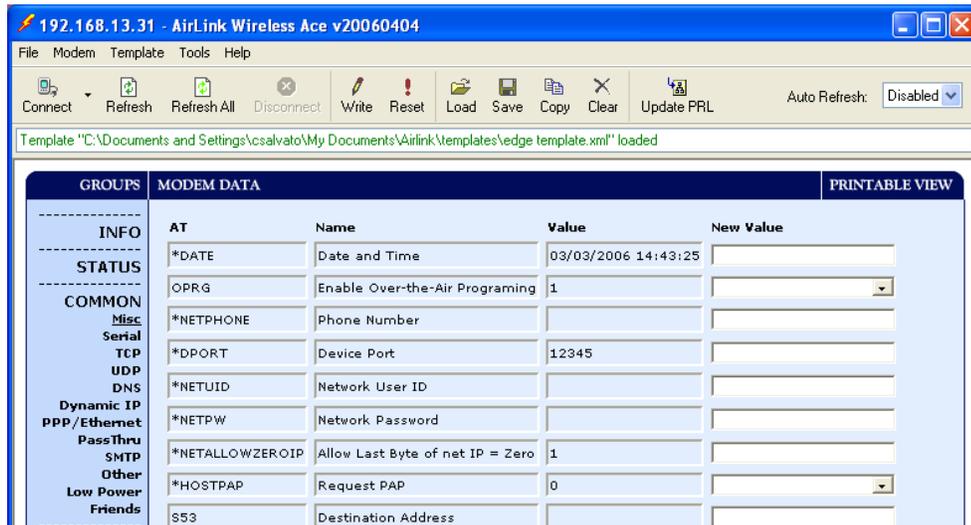


Figure 50: Misc menu

Parameter Change to value (Packet-switched modes only)

- For all technologies
 - *DPORT <value as desired>
- For CDMA/EVDO
 - *NETROAMPREF 0 for home only; 1 for roam on any carrier, 2 for prefer A-side carriers; 3 for prefer B-side carriers
- For GPRS/EDGE
 - *NETTUID <value as determined with provider, if required>
 - *NETPW <value as determined with provider, if required>

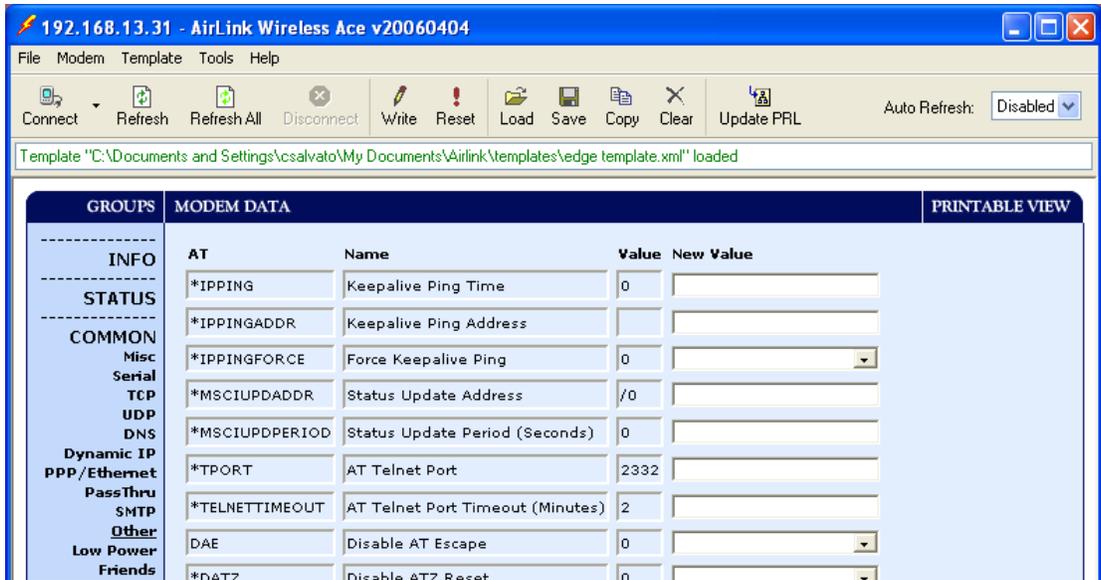


Figure 51: Other Menu

Select the **Other** menu to set up keep-alive pings. It is not uncommon for your Raven to be disconnected from your carrier after an extended period of inactivity. Depending on the carrier, this time can range from 1 to 12 hours. This is generally a feature intended to reduce your charges for inactive use. Keep-alive is used to test and maintain the Raven's connection to your carrier by pinging and IP address after a specified period of inactivity. It is recommended for users who have a remote terminated modem that infrequently communicates to the network. Keep-alive is also recommended if you have experienced issues where the modem can no longer be reached remotely.

When using keep-alive pings, make certain that a valid IP address that is reachable by that device is chosen.

When the keep-alive system pings the IP address, an acknowledgement indicates there is an active connection to the network. If the modem does not receive a response from the IP address, it will retry 5 times in 5 second intervals. The Raven will then reset the radio module after 5 failed attempts and reconnect to your carrier. If ping force is set to yes, the system will ping on the schedule regardless of any other traffic sent within that time.

Note that each ping moves approximately 66 bytes of billable data. A 5 minute keepalive will use 1.2mB per month. A 60 minute keepalive will use 100kB per month.

Parameter Change to value (Packet-switched modes only)

For all technologies

- *IPPING <ping time interval in minutes>
- *IPPINGADDR <address to ping>
- *IPPINGFORCE <force to ping regardless of activity 1=yes>

On the GPRS/EDGE menu, enter the context and APN (access point name)

that is set up for your SIM Card. Both fields are case sensitive. The context parameter is usually entered as follows: 1,IP,<APN> with <APN> replaced by the account holder's full access point name.

Parameter Change to value (GPRS/EDGE only)

For packet switched modes only

*NETAPN <APN as determined with provider, case sensitive>
*+CGDCONT <context as determined with provider, case sensitive>

18. Save the configuration, if desired, by pressing the *Save* button.
19. Press the button in the top menu bar that says *Write*.
20. Any time serial parameters are changed, the modem must be reset and connected to again. Press the button in the top menu bar that says *Reset*, and then the button that says *Disconnect*.
21. Once the modem has rebooted (lights will chase), press the button that says *Connect* to connect to the modem again and verify the settings.
22. For packet switched services, the IP address will not be visible until the modem has completed its registration on the network. You may need to press the *Refresh* button in Wireless Ace in order to see this value if you linked to it too soon. Completed registration is indicated on the modem by solid Chan, Link, and Reg lights on the Raven and Raven E. On the RavenXT, completed registration is indicated by a solid Network light. In all of these cases, the RSSI light will flash indicating signal strength. The larger part of the time that the light is on indicates higher signal strength.

Notes:

1. ***When a modem is in passthru/circuit switched mode, the first three lights (Chan, Link, and Reg) will flash in unison on the Raven or the Network and Signal lights will flash in unison on the RavenXT.***
2. ***When a modem is in passthru mode, the Airlink Aleos operating system is not running. This prevents any remote configuration of the modem. Commands can still be given in Hyperterminal to the modem module, if directly connected.***

3. After configuring the modem and putting it into passthru mode, you must check the box in Wireless Ace that says "Use SOS mode" in order to configure it with Wireless Ace.

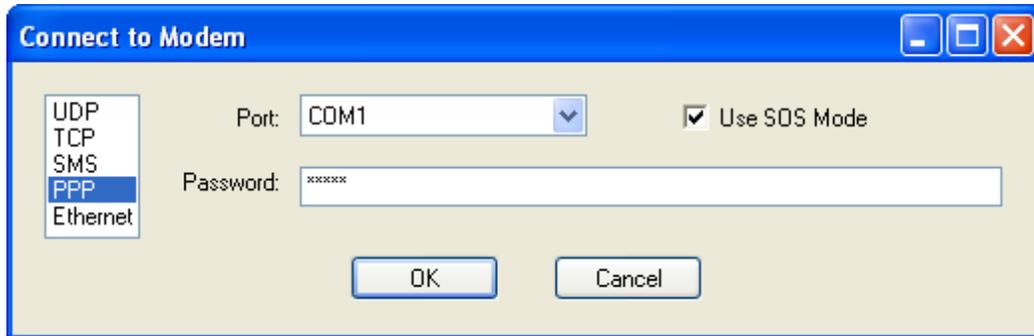


Figure 52 Use SOS Mode

Status Checking

Even with the Aleos operating system not running, you can run Wireless Ace to check the modem's serial parameters. Launch the software and connect to the modem as above, with "Use SOS Mode" checked.

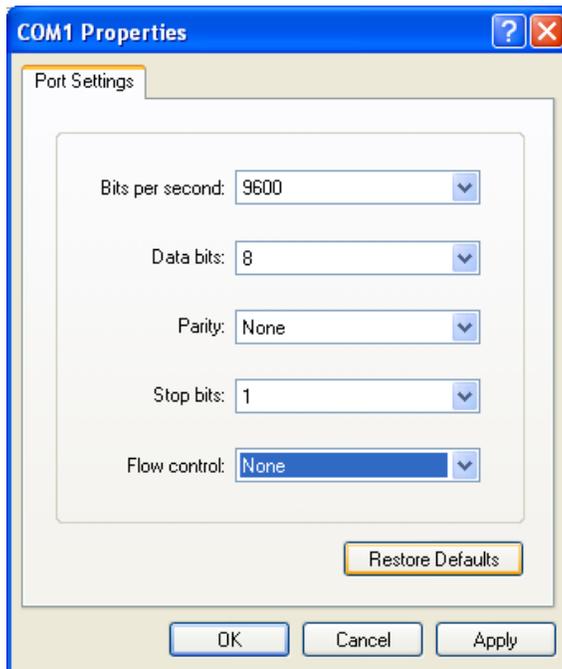


Figure 53 Hyperterminal Settings

Once you have physically connected your modem to the com port, and you have created a Hyperterminal session, press the reset button on the modem. You should see a character appear in the terminal window. If it does not appear, the physical connection to the modem has not been made. Check your wiring.

It is also often helpful to communicate with the modem via a terminal program such as HyperTerminal. Hyperterminal can be started by selecting Start>Run and typing "hypertrm". You will need to set up a communication session on the com port that is connected to the modem. Set the data rate to the rate that you programmed into the modem (9600). If you are unsure, you can connect to the modem with Wireless Ace in SOS Mode and check the serial menu. Be sure to set your Flow control to "none".

To confirm that you are able to communicate with the modem, type the attention command "at". If you do not get a response, again check your Hyperterminal settings.

Once you have connected to the modem, turn on echo and verbose. It will make it easier to see your typing. Even though you cannot see the characters, type ATE1V1<enter> to put the modem in echo and verbose mode.

Several commands are available to retrieve information about your modem and connection. It is important that you have sufficient signal strength in order to make and receive calls with the modem. It is also important that the phone be registered with the network and set up for data communication rather than voice. See section on circuit switched troubleshooting for more information.

Ethernet Modem Configuration

The modem must be configured to the proper settings to get it to function on the cellular network as well as to get it to communicate with the device to which it is connected. Please note that Ethernet modems will only operate in packet mode. Some of the configuration settings are the same for all modems regardless of cellular technology, and some of them are specific to only one of these categories. Many are the same as for serial modems.

1. Download Wireless Ace 3G from www.airlink.com
2. Install Wireless Ace 3G on a computer that has a serial port
3. Connect the Ethernet port of the computer to the Ethernet port of the modem using a crossover Ethernet cable.
4. Make certain there is an antenna on the modem and then energize it.
5. Run Wireless Ace 3G
6. Select the button in the upper left hand corner that says *connect*

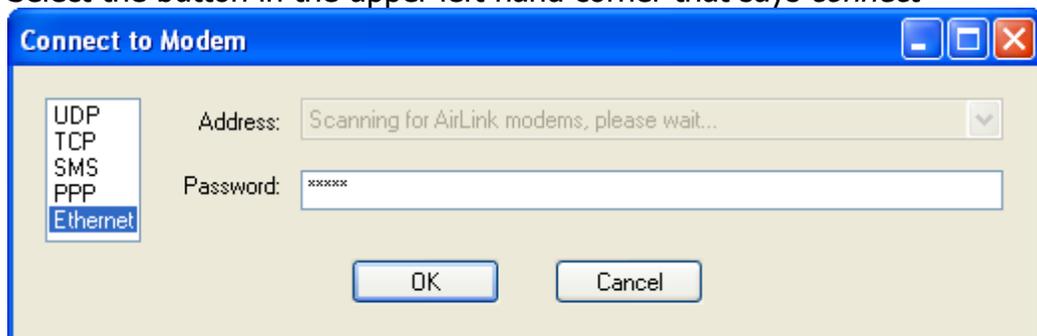


Figure 54: Connecting to Ethernet Modem

7. On the pop-up menu, select Ethernet in the left hand menu.
8. Wait for the software to find the modem. It will normally find an address

of 192.168.13.31.

9. Select the button that says *ok*
10. Watch the status bar under the *connect* button that indicates the connection being made to the modem.
11. Once you have connected to the modem, you should see the info screen as shown in Figure 55 Info Screen.

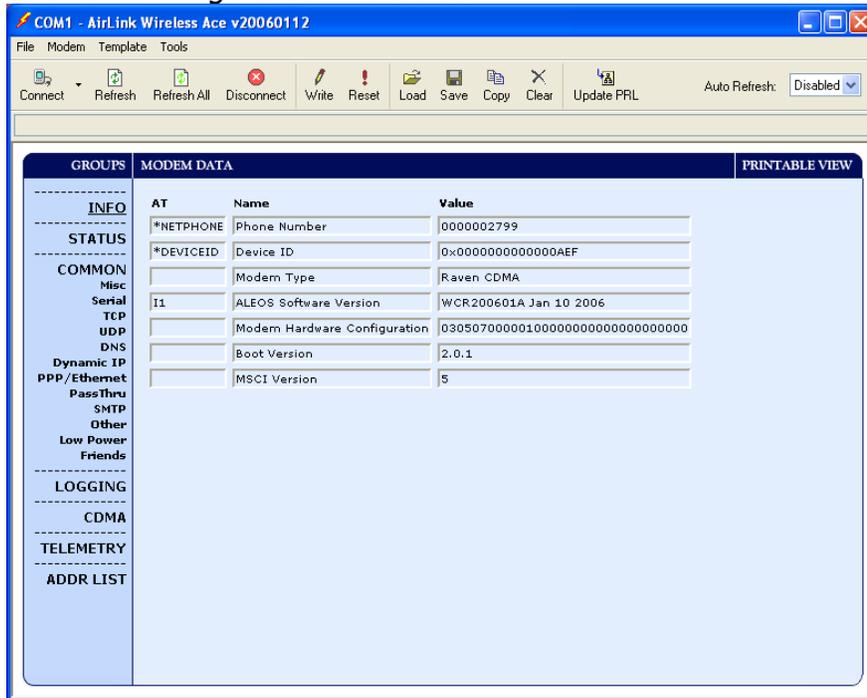


Figure 55 Info Screen

12. Confirm the Aleos software version to be the most recent.
13. Check the Status screen for the signal level.

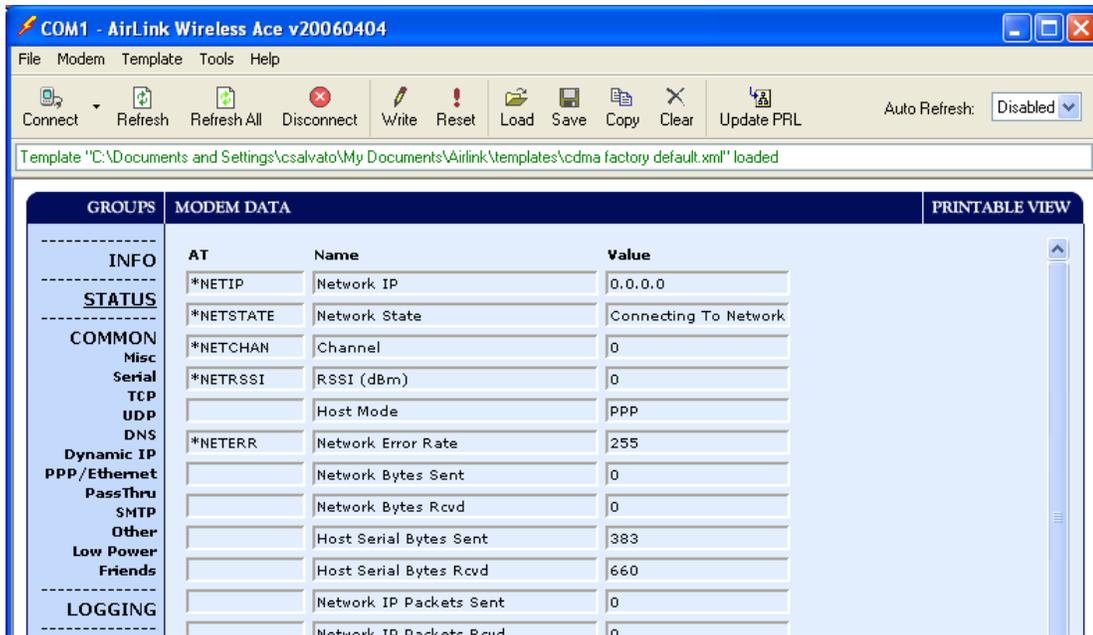


Figure 56: Status Screen

14. You have two options for configuring your modem. If you have a configuration file that you have saved or received from the factory, you may simply press the button that says **Load**, select the correct configuration file, and press open. Once the parameters are loaded into the right-hand column, then press **Write** to send all of the parameters to the modem.
15. If you do not have the configuration saved, you must configure the unit manually. Select each menu and change parameters. Note that the current value of the parameter is listed in the "Value" column. Enter the desired setting in the "New Value" column. Note that changes do NOT take place immediately. The values must be written to the modem and the modem must be reset before the new settings are used.

It is important that the modem be instructed to "answer" the connection when a remote device attempts to make a connection, as the instrument is not capable of issuing an answer command.

Select the menu on the left that says **TCP** and change the following parameters

Parameter	Change to value (GPRS/EDGE & CDMA/EVDO)
S0	1
TCPT	2 (TCP timeout value, depends on comm. frequency)
TCPS	0 (minutes)

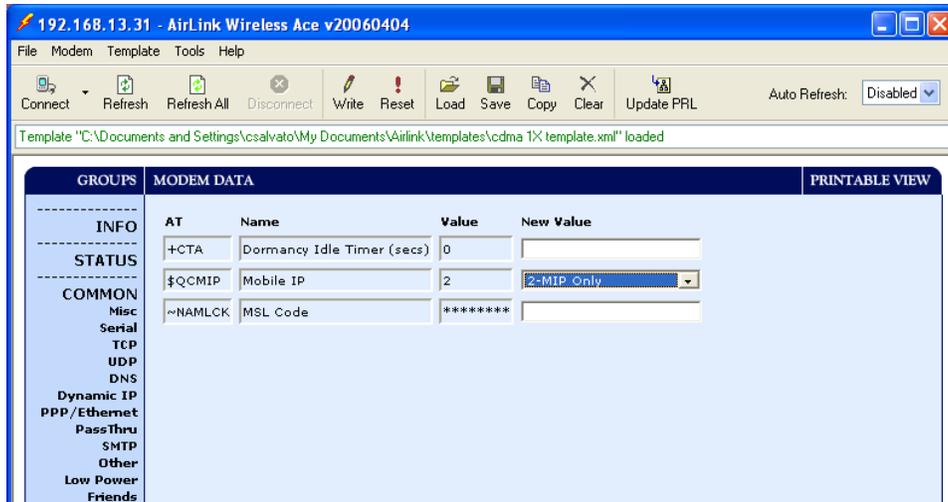


Figure 57: CDMA/EVDO Menu

Next, set the modem for static IP only by selecting the CDMA/EVDO menu in the menu bar.

Parameter	Change to value (CDMA/EVDO only)
\$QCMIP	2-MIP Only

Depending on your provider and your account setup, you may need to set the user ID and password. If these parameters are required, your cellular service provider will need to supply them.

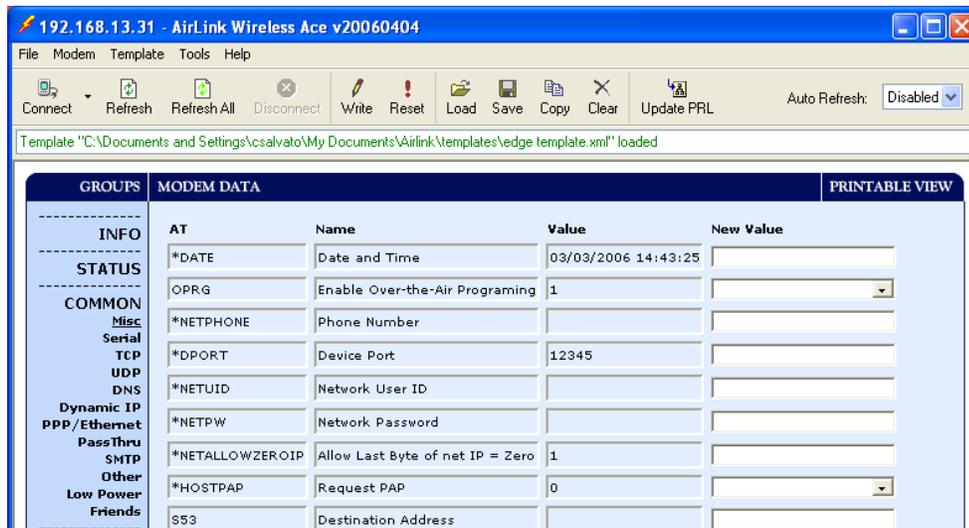


Figure 58: Misc menu

Parameter	Change to value (GPRS/EDGE only)
*NETUID	<value as determined with provider, if required>
*NETPW	<value as determined with provider, if required>

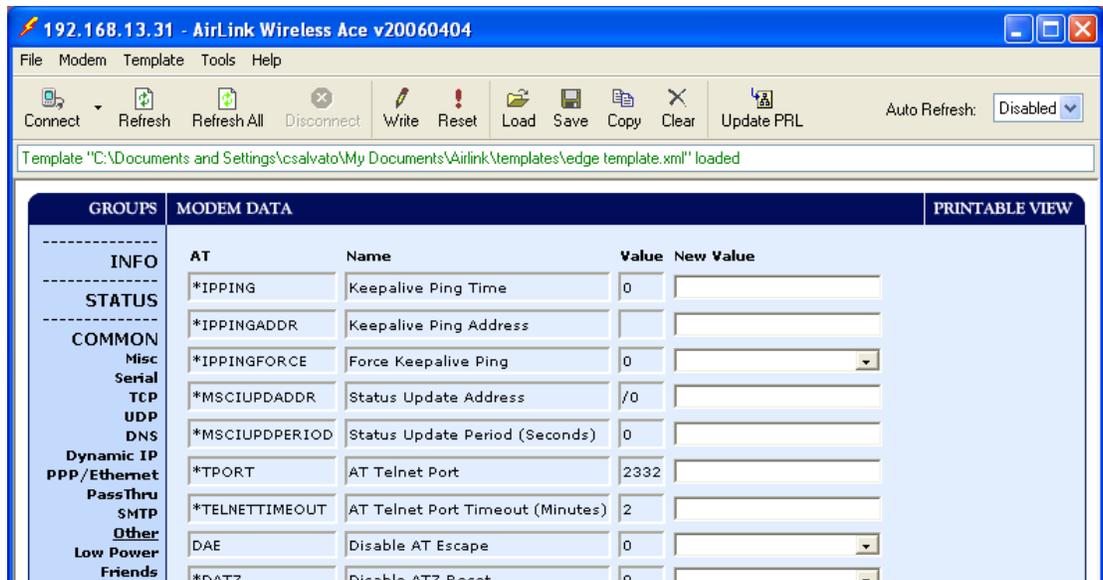


Figure 59: Other Menu

Select the **Other** menu to set up keep-alive pings. It is not uncommon for your Raven to be disconnected from your carrier after an extended period of inactivity. This is generally a feature intended to reduce your charges for inactive use. Keep-alive is used to test and maintain the Raven's connection to your carrier by pinging and IP address after a specified period of inactivity. It is recommended for users who have a remote terminated modem that infrequently communicates to the network. Keep-alive is also recommended if you have experienced issues where the modem can no longer be reached remotely.

When using keep-alive pings, make certain that a valid IP address that is reachable by that device is chosen.

When keep-alive pings the IP address, an acknowledgement indicates there is an active connection to the network. If the modem does not receive a response from the IP address, it will retry 5 times in 5 second intervals. The Raven will then reset the radio module after 5 failed attempts and reconnect to your carrier.

If ping force is set to yes, the keep-alive ping system will execute the ping on the schedule regardless of whether any data has passed.

Note that each ping moves approximately 66 bytes of billable data. A 5 minute keep-alive will use 1.2mB per month. A 60 minute keepalive will use 100kB per month.

Parameter Change to value (GPRS/EDGE and CDMA/EVDO)

For all technologies

*IPPING <ping time interval in minutes>
 *IPPINGADDR <address to ping>
 *IPPINGFORCE <force to ping regardless of activity 1=yes>

On the GPRS/EDGE menu, enter the context and APN (access point name) that is set up for your SIM Card. Both fields are case sensitive. The

context parameter is usually entered as follows: 1,IP,<APN> with <APN> replaced by the account holder's full access point name.

Parameter Change to value (GPRS/EDGE only)

For packet switched modes only

*NETAPN	<APN as determined with provider, case sensitive>
*+CGDCONT	<context as determined with provider, case sensitive>

23. Save the configuration, if desired, by pressing the *Save* button.
24. Press the button in the top menu bar that says *Write*.
25. Any time network parameters are changed, the modem must be reset and connected to again. Press the button in the top menu bar that says *Reset*, and then the button that says *Disconnect*.
26. Once the modem has rebooted (lights will chase), press the button that says *Connect* to connect to the modem again and verify the settings.
27. For packet switched services, the IP address will not be visible until the modem has completed its registration on the network. You may need to press the *Refresh* button in *Wireless Ace* in order to see this value if you linked to it too soon. Completed registration is indicated on the modem by solid Chan, Link, and Reg lights. In this case, the RSSI light will flash indicating signal strength. The larger part of the time that the light is on indicates higher signal strength.

Modem Status Lights

The Raven CDMA C3211 has several LED indicators. These indicate the status of the modem on the cellular network as well as if it is operating in circuit switched or packet switched data mode.

Pattern	Meaning
Pwr light solid	Indicates power is getting to the modem.
Chan, Link, Reg flash together	Modem is in PassThru (circuit-switched data) mode. In this mode, the RSSI light should come on and be solid when a connection is made to or from the modem.
All chasing	Modem is rebooting.
Chan light solid	Indicates the modem has acquired a network channel.
Link light solid	Modem has found the network and made a successful connection to it. Although a cellular network has been found, the modem has not yet registered.
Reg light solid	Modem has registered and acquired an IP address, in non-passthru mode.
RSSI light flashing	When not in passthru mode, the RSSI light indicates the signal strength. A light that is nearly solid indicates a strong signal and a light that only flashes on for a short period indicates a weak signal.
Tx/Rx light	Lights will flash when data is transferred to and from the Raven modem.



Figure 60: CDMA Modem LEDs

The Raven EV-DO also has several LED indicators. These indicate the

status of the modem on the cellular network.

Pattern	Meaning
Pwr light solid	Indicates power is getting to the modem.
All chasing	Modem is rebooting.
Chan light solid	Indicates the modem has acquired a network channel.
Link light solid	Modem has found the network and made a successful connection to it. Although a cellular network has been found, the modem has not yet registered.
Reg light solid	Modem has registered and acquired an IP address.
RSSI light flashing	The RSSI light indicates the signal strength. A light that is nearly solid indicates a strong signal and a light that only flashes on for a short period indicates a weak signal.
Tx/Rx light	Lights will flash when data is transferred to and from the Raven modem.
Srvc Light is solid	Modem has found EV-DO service capabilities with the registered provider. If this light is not illuminated, data services will be through CDMA 1xRTT.



Figure 61: Raven-E EVDO

The Raven G3211 and E3214 models have several LED indicators. These indicate the status of the modem on the cellular network as well as if it is operating in circuit switched or packet switched data mode.

Pattern	Meaning
Pwr light solid	Indicates power is getting to the modem.
Chan, Link, Reg flash together	Modem is in PassThru (circuit-switched data) mode. In this mode, the RSSI light should

	come on and be solid when a connection is made to or from the modem.
All chasing	Modem is rebooting.
Chan light solid	Indicates the modem has acquired a network channel.
Link light solid	Modem has found the network and made a successful connection to it. Although a cellular network has been found, the modem has not yet registered.
Reg light solid	Modem has registered and acquired an IP address, in non-passthru mode.
RSSI light flashing	When not in passthru mode, the RSSI light indicates the signal strength. A light that is nearly solid indicates a strong signal and a light that only flashes on for a short period indicates a weak signal.
Tx/Rx light	Lights will flash when data is transferred to and from the Raven modem.
Srvc Light is solid	Modem has found EDGE service capabilities with the registered provider. If this light is not illuminated, data services will be through GPRS.
Err Light is solid	Some EDGE modems are incorrectly labeled as "Err" on the front panel. This is functions the same as the Srvc light.



Figure 62: Raven GPRS/EDGE

Pattern	Meaning
Pwr light solid	Indicates power is getting to the modem.
All chasing	Modem is booting.
Network light solid	Indicates a successful connection to the cellular network with an IP address given and a channel acquired.
Signal light solid or flashing	Light shows the strength of the signal and may be nearly solid (strong signal) or flashing (weaker signal). A slow flash indicates a very weak signal.
Activity light	Light will flash when data is transferred to and from the Raven modem.
Reset Button (two functions)	If it is quickly depressed and released, the modem will simply power cycle the internal hardware. If, however, the reset is depressed and held for several seconds (count 10 slowly), the ALEOS configuration settings will return to the factory defaults. If you reset the modem configuration using the reset button, you may need to reactivate the Raven XT.
Network and Signal blink in Tandem	Indicates Passthru mode. Activity light is still functional
Network and Service alternate	SOS mode
Left to right chase 4 times	Configuration reset
Network, Signal, and Activity blink every 2 seconds	Authentication failure –modem is not authenticating with the network
Network, Signal, and Activity blink every 3 seconds	Data Retry –modem is not registering on the network



Figure 63: Raven XT

Modem ESN/IMEI Location

On a CDMA modem, the ESN is located on label on the top of the modem. It is given in Decimal format which is labeled as DEC or ESN(dec), as well as in Hexadecimal format. The hexadecimal ESN can be converted to decimal by first parsing the 8 digits to hh-hhhhhh and then converting each section.

CDMA modems are carrier specific. On the gold Raven CDMA modem, in the center of the label will be an indication of the carrier that the modem. Verizon is abbreviated VZW, Sprint as SPCS, and Alltel may be spelled out or abbreviated as ALT. Bell Mobility is abbreviated BMB, Manitoba Tel as MTS and Telus is usually spelled out. Model numbers on the gold Ravens may be C3210, C3211, or C3216 depending on the modem modules used internally. On the RavenXT modems, the carrier is indicated by a letter behind the dash after the model number.

For GPRS and iDEN modems, there is no ESN, but the IMEI number will be on the label in its place. GPRS modems are not carrier specific and iDEN modems will only work on Nextel (Sprint/Nextel).

Circuit Switched Troubleshooting Guide

A circuit switched connection is made by dialing a phone number, having a modem on the other end ring and answer, and then passing data through the connection.

Airlink cellular modems operating in circuit switched mode do not have many easy-to-use tools available for troubleshooting. Airlink modems in passthru or circuit-switched mode have the Aleos operating system turned off, so a great deal of functionality is lost. You can still run Wireless Ace 3G if you check the box that says "Use SOS mode" when you connect in PPP mode. Several of the items in Wireless Ace 3G are not valid while you are in passthru mode, so other than confirming the serial and passthru menu settings, you are likely to not get much information here.

You can connect to the modem using only PPP when it is in passthru mode. Remote over-the-air connections are not possible.

Look at the outside of the modem

For a gold Raven, in circuit switched mode, the Chan, Link, and Reg lights should flash together and the Pwr light should be on solid. On the Raven XT, the Network and Signal lights should flash together. Any other light patterns indicate the modem is not ready to make and receive calls. Check your power, your configuration, and your provisioning.

While booting, the modem will go through a sequence where different lights will flash and chase temporarily.

While you are connected to the modem with Wireless Ace 3G, the Err light may also flash on the gold Raven. On the Raven XT, the modem will indicate SOS mode when connected with Wireless Ace 3G.

Try to call the modem

With any telephone, dial the phone number of the modem. The modem should answer and you should hear modem tones. If the modem answers, but you do not hear tones, the modem is not receiving the right type of call. Check with your provider.

If you hear rings and either get voicemail or no answer, check first that you have auto-answer turned on by checking Wireless Ace TCP menu, parameter S0 should be 1. Confirm that the *PTINIT string is correct for your modem type and model.

After checking that the configuration is correct, confirm that your modem is actually receiving a call indication from the network. Hook a computer up to the modem using a straight-through com cable and Hyperterminal match the data rate that your modem is set. Type ATE1V1 at the prompt. If the response is OK, you are communicating with the modem. If not, check your cable and Hyperterminal settings. With your computer connected to your modem, call the modem again. You should see it say "RING".

If the modem does not say "RING", but the phone is ringing when you dial, then the network is not finding your modem. Try the following sequence in Hyperterminal.

ATE1V1	Turn on echo and verbose so that you can see what you are typing.
AT+CSQ	You will get a response that is in the form of <u>x,99</u> where x is a number between 0 and 30 that represents your signal strength. Higher numbers are better. At a minimum, you should have a number greater than 16.
AT+COPS?	You will get a response that tells you what system you are registered with and what your roaming carriers are. +COPS: <mode> [format [operator]]
AT+CNUM	On the C3211 modems, you will get a response that tells you what the modem thinks its phone number is.
AT~NAMVAL?0	For the Raven XT modems, you will get phone number info.
AT+CREG?	You will get a response that looks like <u>0,x</u> . If x is 1 you are on your home network, if x is 5 you are roaming, and if it is anything else you are not registered.

If you are registered, and have sufficient signal strength, contact your carrier if the modem does not ring. Also check to be certain that you have the most up-to-date firmware in your modem and that your passthru init string is correct for your modem model.

If the modem does say "RING", you can answer the call by typing "ATA". You should see a connect message following that command. This indicates that your modem is working. If it is correctly setup, the modem should answer automatically. Confirm that your passthru init string includes "S0=1".

Try dialing from the modem

One additional way to check if your modem is working is to make a call from the device. From your hyperterminal session, you can dial a number.

ATDTxxxxxxx	Insert your cell phone number for the x. This will make the modem attempt to dial your phone. You can answer the call on your cell phone.
-------------	---

Cellular Modem Quick Command Reference

Command	Response	Explanation	Mode passthru (model specific) or AT
AT	OK or 0	Attention	Both
ATE1V1	OK	Turn on echo and verbose	Both
AT+CSS?	V,W,X,Y,Z, Used to query the serving system	Band class 0,1,2; 0=no service, 1=800, 2=1900 Band A through C, PA-PF, or Z for not registered System ID where 99999=not registered Base station protocol revision Channel	PT
AT+CSQ	<0-31>,<99>	First number indicates signal with 99 meaning no signal. 24-31 is good. Less than 12 will not work well at all. Second number can indicate BER, or be not used.	PT
AT!RSSI?	RSSI	Gives signal strength	PT-XT
AT+GSN		In PT mode, gives hex ESN. Convert to decimal by converting two parts: hh-hhhhhh	PT
ATI3	Identification	Will give the modem firmware version in passthru mode, otherwise will give ESN	Both
AT+CNUM	Phone number	Phone number	PT-3211
AT~NAMVAL?0	Phone numbers	Phone numbers, SID, NID	PT-XT
AT+CREG?	0-1, 0-5 Mode, status	Status -1 is registered in home network, 5 is roaming, 0 & 2 are not registered, 4 is unknown	PT-3211

AT!STATUS	Status	Band, channel, System ID, roaming, registration, connecting to network, data retry, authentication failure, etc.	PT-XT
AT+CLIP?	0-on, 1-off	Turn on calling line identification	PT-3211
AT+FCLASS?	0-data, 1-fax	Operating mode for fax	PT
AT+CRC?	0-off, 1-on	Cellular result codes detailed information on incoming calls	PT
AT+IPR?	Many values	Value indicates the baud rate of the modem.	PT
AT+ICF?	Format, parity	Parity -3=none Format -3=8data 1 stop	PT
AT+IFC?	0,0	Flow Control none	PT
AT+COPS?	<mode>, <status>, <operator>	Operator selection –MCC/MNC of operator	PT-3211
AT*NETPHONE?	Phone number	Phone number	AT
AT*NETSTATE?	Network status	Connecting, etc.	AT
AT*NETCHAN?	Network channel	Channel number on the cellular network	AT
AT*NETIP?	IP address	IP address assigned to modem	AT
AT*NETRAOMPREF?	<1-4>	Indicates whether modem is allowed to roam or will only work on the home network provider.	AT
AT\$QCMIPGETP	Many values	Gives information on user profile. Numbers must match account setup.	PT
AT\$QCMIPNAI	NAI	Gives Network Address Identifier	PT
AT!PRLVER	PRL	Gives PRL version	PT-XT
AT*POWERIN	Input power	Gives the voltage of the power input	AT-XT

Packet Switched Troubleshooting Guide

A packet switched connection is made by entering an IP address, finding a route through a public or private network, making a connection to a specified port, and then passing data through the connection.

Airlink cellular modems operating in packet switched mode have many easy-to-use tools available for troubleshooting.

Look at the outside of the modem

When registered on the cellular network, the Chan, Link, and Reg lights will all be solid. The Pwr light will also be on solid. The RSSI light will flash with the "on" portion of its cycle indicating the strength of the signal.

Run Wireless Ace

Connect serially to the modem in the same manner as during configuration. Check the info screen for the following:

*NETPHONE –the modem gets its phone number from the network

I1 –the Aleos software version should be up to date.

Check the status screen for the following:

*NETIP –the modem gets its IP address from the network. Confirm that it matches what was expected.

*NETSTATE –Network Ready means that the modem has cellular service and is ready to pass data

*NETRSSI –This is the signal level reading in dBm. This number should be in the -70's or better for good performance. Signal levels in the -80's are still adequate. Service may be intermittent once signal levels fall into the -90's or lower.

Make a Connection

Once the modem has indicated that it is ready to pass data, find a computer with network access to that modem and MasterLink. Note that the computer must be granted full access through the corporate/local and cellular network to reach this device. If the modem is on a private network, the computer must be logically on that network or have access to that network.

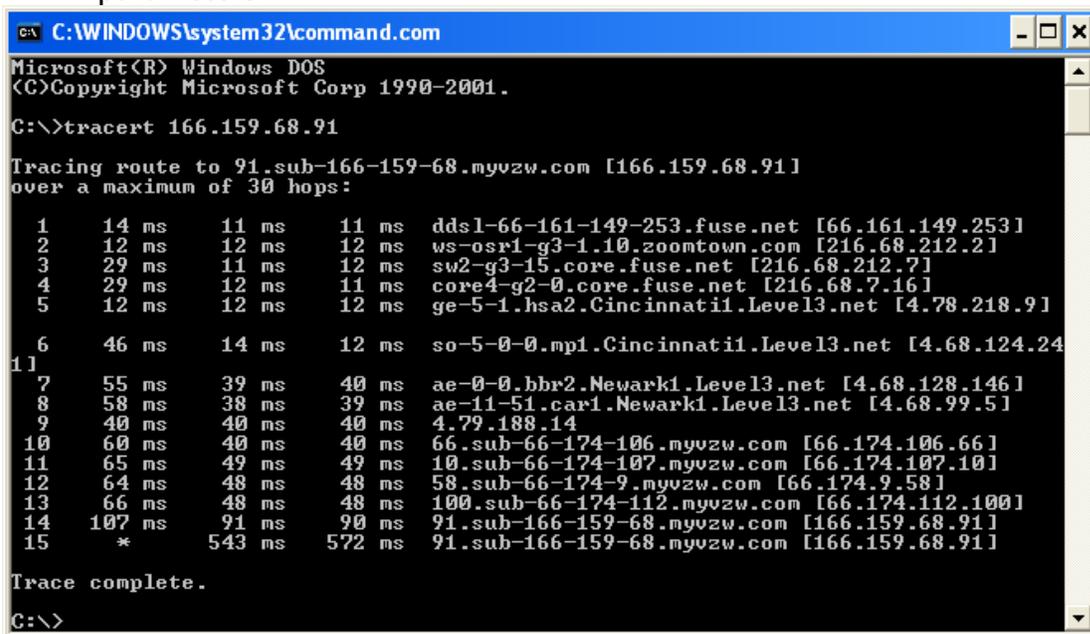
In place of the phone number, enter the IP address/port number. The port number is what you set up in the configuration as *DPORT. Press green link button to bring up the site list. Select the site and press the Internet button at the bottom. MasterLink will indicate "Initializing TCP/IP"

while it attempts to go out to the network and locate the device. If this indicator goes away without showing anything further, MasterLink was unable to reach the device. If it continues on with "Connecting to Instrument" any problems are on the serial side rather than network side.

If MasterLink was unable to reach the device through the network, attempt to Ping the device. A ping sends a small routing packet to a remote device in an attempt to determine if the device exists on the network. This is done from a DOS prompt. On your Windows-based computer, click Start>Run and type in "command". A window will appear. Type ping <ip address> and enter the IP address of your modem. No port number is necessary. In a few seconds, you will see an indication of success or failure. If the ping indicates success, confirm the port number and try MasterLink again.

If the ping indicates failure, try a trace-route. Trace route invokes a sequential ping that shows each part of the path used to get to the destination. Type tracert <ip address> and enter the IP address of the modem. No port number is necessary. If the packets are getting lost along the way, you will see it indicated with a * indicating that the packet was lost. Depending on where the packets are being lost, contact your IT department, Internet Service Provider, or Cellular Service Provider.

If ping is successful, run Wireless Ace 3G. Select UDP as the connection type and enter the IP address of the remote modem. Double check the parameters.



```
C:\WINDOWS\system32\command.com
Microsoft(R) Windows DOS
(C)Copyright Microsoft Corp 1990-2001.
C:\>tracert 166.159.68.91

Tracing route to 91.sub-166-159-68.myvzw.com [166.159.68.91]
over a maximum of 30 hops:

  0  14 ms  11 ms  11 ms  dds1-66-161-149-253.fuse.net [66.161.149.253]
  1  12 ms  12 ms  12 ms  ws-osr1-g3-1.10.zoomtown.com [216.68.212.2]
  2  29 ms  11 ms  12 ms  sw2-g3-15.core.fuse.net [216.68.212.7]
  3  29 ms  12 ms  11 ms  core4-g2-0.core.fuse.net [216.68.7.16]
  4  12 ms  12 ms  12 ms  ge-5-1.hsa2.Cincinnati.Level3.net [4.78.218.9]
  5  46 ms  14 ms  12 ms  so-5-0-0.mp1.Cincinnati.Level3.net [4.68.124.24]
  6  55 ms  39 ms  40 ms  ae-0-0.bbr2.Newark1.Level3.net [4.68.128.146]
  7  58 ms  38 ms  39 ms  ae-11-51.car1.Newark1.Level3.net [4.68.99.5]
  8  40 ms  40 ms  40 ms  4.79.188.14
  9  60 ms  40 ms  40 ms  66.sub-66-174-106.myvzw.com [66.174.106.66]
 10  65 ms  49 ms  49 ms  10.sub-66-174-107.myvzw.com [66.174.107.10]
 11  64 ms  48 ms  48 ms  58.sub-66-174-9.myvzw.com [66.174.9.58]
 12  66 ms  48 ms  48 ms  100.sub-66-174-112.myvzw.com [66.174.112.100]
 13  107 ms  91 ms  90 ms  91.sub-166-159-68.myvzw.com [166.159.68.91]
 14  *      543 ms  572 ms  91.sub-166-159-68.myvzw.com [166.159.68.91]
 15

Trace complete.
C:\>
```

Instrument Configuration

Many of the Mercury Instruments can be configured to receive from and initiate communication sessions to remote hosts.

The communications devices used in the MI Wireless assembly are all intelligent devices that will detect an incoming call or remote connection attempt, answer the request, and set up the connection. Your instrument needs only to be set for the specific baud rate of the communications device for this to function. All other settings are handled within the communications device. Note that the autobaud function that is available on certain instruments does not work very well with cellular modems and should not be used with these remote communication devices.

Many of the Mercury Instruments, such as the ERX, Mini-Max, and Mini-AT, can be configured for alarm and scheduled call in. These will work with land-line modems such as the Mercury Messenger and cellular modems with circuit switched data and packet data accounts. In the instrument setup screen for the call in phone number, circuit switched cellular accounts will use a phone number. Packet switched accounts will use an IP address and port number or domain name and port number. All current modems use a forward slash "/" character before the port number as a separator. Typical additional settings are shown in the table below. For further information, including specific item codes, see the manual for your specific instrument type.

Field	String	Communications device
Modem init string	ATE0V0	For cellular modems
Modem dial string	ATDT	Cellular and messenger
Modem hangup string	ATH0	Cellular and messenger

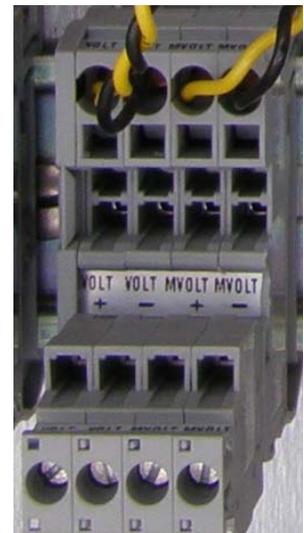
Cathodic Protection Application

Your MI Wireless ERX assembly can be built for Cathodic Protection applications. A CPRI board can be mounted inside your MI Wireless assembly. It allows use of



two pressure inputs on your ERX board as electrical monitoring inputs and is available in Quad-Alkaline, Solar, and AC-powered configurations. There is one voltage input that can be used for pipe to soil or rectifier voltage. The millivolt input can be used for rectifier current. A rectifier control option is also available in AC powered assemblies.

A terminal strip for the voltage and current inputs is provided in the lower left corner of the assembly. Wire into this terminal strip through the cord grip at the bottom of the assembly.



To operate the CPRI board, determine the full scale rectifier voltage and current shunt millivolt ranges and set the jumpers on the CPRI board accordingly. Note that the measuring range in the ERX is 80% of the jumper selections.



If not already loaded, load the matching coefficients file for the voltage range and input being used. Be sure to load them into the correct pressure channel. Contact the factory if you do not have the coefficients files.

Select the units of measurement for each channel. Use item 549 for P1, item 550 for P2, and item 408 for P3. Choose volts or millivolts. Calibrate each channel using MasterLink.

For additional information, see FD-549, using the 40-3200 Cathodic Protection Rectifier Interface Circuit Board in the ERX.

Cellular Gateway Application

For areas where multiple instruments or other serial devices are located in a reasonable proximity, one MI Wireless cellular assembly can function as a gateway to multiple devices. If these units are within a 50 to 100 foot radius of the wireless access point, direct serial cabling can be made to up to 4 devices from a singular MI Wireless assembly. Please be sure to follow all best practices and local codes for wiring, grounding, and surge protection between the cabled devices. For larger distances, a spread spectrum radio network can be deployed from the cellular gateway.

The MI Wireless standard cellular gateway includes a cellular modem with an Ethernet output interface. The Ethernet is connected to a two-port or four-port terminal server.

Figure 64: Cellular Gateway with Terminal Server



One serial terminal block is available in the lower left corner of the assembly for each serial output. Cable grips for each serial cable are available in the bottom of the assembly.

This configuration requires that the Airlink Raven Modem be operated in packet-switched data mode. The modem and the terminal share one static IP address.

The terminal server is configured at the factory to receive its IP address from the Ethernet-connected device. The Raven is configured to share its public IP address with the terminal server. In this way, both devices are remotely addressable and configurable on the single static public IP address.

Remote configuration of the Airlink RavenE modem is available using the Airlink Wireless Ace software. The terminal server can be remotely configured by typing the IP address in a standard browser window. Once the terminal server is reached, a login window will appear. The default login for the terminal server is **root** and the password is **dbps**. It is advisable that these be changed before the unit is field-deployed.

In order to support Mercury instruments on each of the serial ports, the terminal server is configured with each serial port set to 9600 bps, 8N1, with no flow control. Each of the serial ports is also configured for modem emulation and set to auto answer a connection, no echo, non-verbose mode. In modem emulation mode, the serial ports will respond to standard Hayes AT commands.

The support of AT commands permits the MIWireless system to perform alarm cry-out from the instrument. Configure the instrument as normally required for alarm cry-out or scheduled call-in with any modem device. In place of the phone number to dial, enter the IP address and port number of the remote communication server. The format of this field should be **x.x.x.x:y** where **x** represents one part of the dotted-decimal IP address and **y** represents the port number. The values for **x** range from 0 to 255 and the value for **y** can be between 1 and 65535. For port numbers, it is advisable that the number used is at least 1024 or above as the ones below that are considered "well-known".

Devices connected to the serial ports can be remotely reached using MasterLink or another communications program by opening a TCP socket. This is done simply in MasterLink by editing the site list to place the IP address and port number of the remote device into the phone number field. First type the IP address assigned to the cellular modem, using standard dotted-decimal notation. Then type the forward slash key "/" and the port number. Port 1 is 50001, port 2 is 50002 and so on. These port numbers only apply to ports configured for modem emulation. If non-Mercury devices are connected, if RS422/RS485 is required, or if other access configurations are needed, consult the device manual or contact technical support.

Spread Spectrum Radio

Features

The FreeWave spread spectrum radio offers a variety of useful features:

- Frequency hopping spread spectrum technology
- Error free communications with 32 bit CRC and automatic retransmission
- Industrial grade temperature functionality at -40° to +70° Celsius
- Up to 60 mile range with clear line of sight
- Superior noise immunity and performance in congested environments
- Secure proprietary spread spectrum technology
- 100% backwards compatible means 0 obsolescence
- Ability to use single radio simultaneously as a slave and repeater

System Design

Your FreeWave network begins with a detailed path study packet. The path study packet includes topographic maps of the terrain of your study area, link reports with equipment recommendations, fade margin, and signal strength calculations, and link profiles with graphical representation of the terrain between transmit and receive pair sites. Additional information and explanations are included in the path study report as needed.

Once the path study is completed and the physical network layout is completed, the required hardware can be procured. The path study includes information on antenna height, antenna gain, and cabling required for each site to make this process easier.

At customer request, the radios can be supplied with complete configuration files. These can be loaded into each radio simply by selecting File>Open radio file from the menu in FreeWave EZConfig, and the pressing the button that says "Program Radio".

Network Design

Due to the requirements for having each radio and instrument or other terminal device be addressable, an IP network scheme is required. The typical configuration is to use an Ethernet Master radio Ethernet on a LAN with a server running the FreeWave Enterprise Gateway software. The FEG software and the Ethernet Master Radio function together as the data gateway out to the devices on the radio network.

The FEG software must be configured with a link for each remote radio. Each of these links allows the FEG to take IP data in on a specific TCP port

and pass it out to the intended remote radio. For example, data destined to the FEG computer at 192.168.1.1 port 7010 could be passed to remote device #10 at IP address 192.168.1.10 while data destined to the FEG computer at 192.168.1.1 port 7011 would be passed to remote radio #11 at 192.168.1.11.

It is possible to set up a radio network at a remote location where the Master radio is not directly connected to a local LAN. In order to do this, an Ethernet Cellular modem and router must be connected to the Master Radio at the remote location. The router must be configured for port forwarding to pass packets destined to a specific port on its outside address to a specific radio's IP address and radio port number.

FEG setup

To configure FEG, first install the program according to the instructions in the Enterprise Gateway manual. Once installed, execute the program from the desktop icon. Create a new network configuration by going to File>New Configuration. Edit a link by double clicking on the link you wish to change. Add a link by selecting Edit>Add New Connection. One link will need to be created for each remote device.

1. Give the link a name and description.
2. The local TCP port number is the port number that Enterprise Gateway will listen on to wait for a connection to start polling. This number must be unique from all other entries. The port number entered here will be the identifying port number that is attached to the IP address of Enterprise Gateway to tell the software which IP address to equate the remote radio address to. This will be the port number in MasterLink.
3. The local UDP port number is set to the same as the local TCP port number (with rare exceptions).
4. Under "radio IP address" enter the Local IP address configured in the Set Operation Mode tab in the slave radio configuration. This is the radio that will be contacted by connecting to the FEG IP address and port number specified in step 2. If using a remote gateway to reach the master radio, this IP address is the public IP address of the cellular modem at the master radio. Further translation is done at that location.
5. This entry reflects the local port number that is set in the Set Operation Mode tab in the configuration of the remote radio. It should be left at default of 4131 in the remote radio and set to that in FEG.
6. The final two entries can be used to customize the packet size between the Master radio and the slave radio and to add a delay between when FEG receives the TCP packets and forwards them to the radio. Freewave recommends that these be left at default.

When all links have been completed click File>Save Configuration As and enter a name. To run the configuration, click Tools>Start.

Under the Tools>Options menu, the startup behavior of the program can be set to load a configuration file and begin running automatically.

Ethernet Master Radio Setup

There are a few settings that are unique to FreeWave Ethernet radios and to the serial radios when configured to be used with an Ethernet master radio. These settings have to be set properly to successfully pass data through the radio link. Included in this document are a few of the basic settings. A more detailed general discussion of the radio parameters can be found in the Freewave manual, and a listing of these is provided in the radio configuration files in the completed path study.

Configure the radio by running the software package EZConfig. Press the button "Read from radio" to verify communication with the radio and check current settings.

On the Set Operation Mode tab, select (2) Point to Multipoint Master. Under the Ethernet Options section, turn on Ethernet Mode and Slave IP Stack. Slave UDP Mode should be set to 0 and Duplex to Full. The IP addresses are normally left at 255.255.255.255 and the port at 65535. Generally in a FreeWave Ethernet network, Master radios do not have an IP address.

On the Set Baud Rate tab, select a baud rate of 230,400. Set flow control to RTS. Setup port is diag only.

On the Radio Parameters/Transmission Characteristics menu, set MCU speed to 1-High. Set the RF Data rate to (3) Normal. Set the FreqKey, Max Packet size, and Min packet size identical on all radios. On the Multipoint parameters page set the Network ID to a value between 1 and 4095, but not 255. Make sure all radios use this value.

All other parameters in the Master radio should be set according to the recommendations in the User Manual, or in accordance with the frequency scheme and multipoint parameters as in your network layout. See the provided path study for the configuration files related which will have the necessary parameters for your network layout. The parameters described here are only the ones specifically to the Ethernet/TCP/UDP communications protocol.

Serial Remote Repeater Setup

If your network uses repeaters, all slaves, repeaters, and the master radio will need to be set under the MultiPoint Parameters tab to use repeaters. It is important to note that in the Ethernet/serial configuration, repeaters cannot also be used as slaves.

Configure the repeaters with the base settings as sent in your path study.

On the Set Operation Mode tab, select (7) Point to Multipoint Repeater.

Under the Ethernet Options section, turn on Ethernet Mode and Slave IP

Stack. Slave UDP Mode should be set to 0 and Duplex to Full. The IP addresses are normally left at 255.255.255.255 and the port at 65535. Generally in a FreeWave Ethernet network, Repeater radios do not have an IP address.

On the Set Baud Rate tab, select a baud rate of 230,400. Set flow control to RTS. Setup port can be any selection.

On the Radio Parameters/Transmission Characteristics menu, set MCU speed to 1-High. Set the RF Data rate to (3) Normal. Set the FreqKey, Max Packet size, and Min packet size identical on all radios.

Serial Remote Slave

On the Set Operation Mode tab, select Modem Mode (3) point to multipoint slave. In Ethernet Options, select Ethernet Mode and Slave IP stack as On or 1. Duplex should be set to Full and Slave UDP mode should be set to 1 or on. This allows the slave radio to decode the incoming packets from the Ethernet Master into a serial stream, as well as to encode outgoing serial packets into UDP format for transmission over the air to the master radio. IP will not work unless this option is turned on. Under Local IP address, enter the IP address that you wish to assign to the remote radio. The port number should be left at 4131. For the Power On reply address, leave this as 255.255.255.255 port 65535.

On the Radio Parameters/Transmission Characteristics menu, set MCU speed to 1-High. Set the RF Data rate to (3) Normal. Set the FreqKey, Max Packet size, and Min packet size identical on all radios. On the Multipoint parameters page set the Network ID to a value between 1 and 4095, but not 255. Make sure all radios use this value.

On the Set Baud Rate tab, set the baud rate of the slave radio to that of the instrument to which it will be connected. Set the data to RS232 and Flow Control to none. Data and parity should be set to 8-none-1.

All other parameters in the slave radio should be set according to the recommendations in the User Manual, or in accordance with the frequency scheme and multipoint parameters as in your network layout. See the files in the path study for further information. The parameters listed here are only the ones specifically to the Ethernet/TCP/UDP communications protocol.

Security parameters can be set on the tab labeled Call Book. Enter the serial numbers of the devices that the radio is permitted to communicate with. In a Point to Multipoint network, the Slaves and Repeaters are not listed in the Master's Call Book but a Slave must have the Master and any repeater it is going to use in its Call Book. Turn on this feature by turning

on Slave Security on the Transmission Characteristics tab. See the manual for more detailed information.

Testing

Once the master and slave radios are configured, check the light pattern on each device. The master radio should have one solid red light and one dim or flickering red light. The slave radio should have one solid red and one solid green light when no data is being passed. The center light should be off.

Point-to-MultiPoint Operation LEDs.

Condition	Master			Slave			Repeater		
	Carrier Detect (CD)	Transmit (TX)	Clear to Send (CTS)	Carrier Detect (CD)	Transmit (TX)	Clear to Send (CTS)	Carrier Detect (CD)	Transmit (TX)	Clear to Send (CTS)
Powered, not linked	Solid red bright	Solid red dim	Off	Solid red bright	Off	Blinking red	Solid red bright	Off	Blinking red
Repeater and Slave linked to Master, no data	Solid red bright	Solid red dim	Off	Solid green	Off	* Solid red bright	Solid green	Solid red dim	* Solid red bright
Repeater and Slave linked to Master, Master sending data to Slave	Solid red bright	Solid red dim	Off	Solid green	Off	* Solid red bright	Solid green	Solid red dim	* Solid red bright
Repeater and Slave linked to Master, Slave sending data to Master	Solid green RCV data or Solid red bright	Solid red dim	Intermittent flash red	Solid green	Intermittent flash red	* Solid red bright	Solid green	Solid red bright	* Solid red bright
Master with diagnostics program running	Solid red bright	Solid red dim	Intermittent flash red	Solid green	Intermittent flash red	* Solid red bright	Solid green	Solid red bright	* Solid red bright

* Clear to Send LED will be solid red with a solid link, as the link weakens the Clear to Send LED light on the Repeater and Slave will begin to flash

Once the light patterns have confirmed that the master and slave radios have linked, attempt to ping the slave radio from the FEG computer. Next attempt to ping the slave radio from another computer on the FEG LAN. You should see the center LED on the slave radio flash as this is done.

Glossary

A

AAA Authentication, Authorization, and Accounting Network access security—whether it involves campus, dialup, or Internet access—is based on a modular architecture that has three components:

- **Authentication**—Requires users to prove that they really are who they say they are, utilizing a username and password, challenge/response, token cards, and other methods:
"I am user student, and my password validate me proves it."
- **Authorization**—After authenticating the user, authorization services decide which resources the user is allowed to access and which operations the user is allowed to perform:
"User student can access host NT_Server with Telnet."
- **Accounting**—Accounting records what the user actually did, what he accessed, and how long he accessed it, for accounting, billing, and auditing purposes. Accounting keeps track of how network resources are used. Auditing can be used to track network access and to detect network intrusions:
"User student accessed host NT_Server with Telnet 15 times."

ABR Average Bit Rate Average bit rate refers to the average amount of data transferred per second. This is commonly referred to for digital music or video. Average bit rate can also refer to a form of variable bit rate encoding where the encoder will try to average the use of data for high and low complexity areas so that the bitrate of every audio segment averaged yields a specified bitrate.

ACK Acknowledgement -can be a packet message used in TCP to acknowledge receipt of a packet and the basis of TCP's reliability. Also, the "acknowledge" control character (code 0x06) in the ASCII control code set. Also, a general term, in transmissions, asking for a reply.

ACL . access control list The access control list (ACL) is a concept in computer security used to enforce privilege separation. In networking, the term Access Control List (ACL) refers to a list of service ports that are available on a host, each with a list of hosts and/or networks permitted to use the service. Both individual servers as well as routers can have network ACLs. Access control lists can generally be configured to control both inbound and outbound traffic, and in this context they are similar to firewalls.

ADC Analog to digital converter. Also abbreviated A/D.

ADLC Asynchronous Data Link Control is a computer communications protocol. It is the layer 2 protocol for IBM's Systems Network Architecture (SNA). It was the basis for the HDLC protocol, which added features such as the balanced response mode.

ADPCM Adaptive Differential Pulse Code Modulation Adaptive DPCM (ADPCM) is a variant of DPCM that varies the size of the quantization step, to allow further reduction of the required bandwidth for a given signal-to-noise ratio.

AGC Automatic Gain Control

AGA The American Gas Association (AGA) represents 192 local energy utility companies that deliver natural gas to more than 53 million homes, businesses and industries throughout the United States.

AMPS Analog Mobile Phone Service. The initial, 1st generation mobile service available in the US.

AMR Adaptive Multi-Rate -new voice and data coding systems designed to increase capacity in the cellular over the air interface

Antenna: Commonly a tower used to transmit/receive radio waves.

API Application Programming Interface (API) is a set of software functions used by an application program as a means for providing access to a specific application or operating system's capabilities.

APN: Access Point Name –a name assigned to a GPRS or EDGE terminal to allow device identification and successful routing of data. An APN represents the virtual router that will provide the basic termination point of Enterprise wireless data traffic

ARP Address Resolution Protocol ARP/RARP is commonly used to map the layer 2 MAC address to an address in a layer 3 protocol such as Internet Protocol (IP). On broadcast networks such as Ethernet the MAC address allows each host to be uniquely identified and allows frames to be marked for specific hosts. It thus forms the basis of most of the layer 2 networking upon which higher OSI Layer protocols are built to produce complex, functioning networks.

ARQ Automatic Repeat Request Automatic Repeat-reQuest (ARQ) is an error control method for data transmission in which the receiver detects transmission errors in a message and automatically requests a retransmission from the transmitter. Usually, when the transmitter receives the ARQ, the transmitter retransmits the message until it is either correctly received or the error persists beyond a predetermined number of retransmissions. A few types of ARQ protocols are Stop-and-wait ARQ, Go-Back-N ARQ and Selective Repeat ARQ.

B

Bandwidth –a range of frequencies for a specific use, typically measured in hertz

Base Station: A combination of antennas and electronic equipment used to receive and transmit wireless telephone signals (radio waves). Also known as a Cell Site or Transmission Site. Abridged term for BTS or Base Transmission station

Baud Rate –a term used to describe the speed of a transmission from one point to another. Baud rate is often confused with bit rate, but the baud rate is actually a measure of the symbol rate; that is, the number of distinct symbolic changes (signalling event) made to the transmission medium per second in a digitally modulated signal. A symbol is made up of one or more bits. As each symbol may stand for more than one bit of information, the amount of information sent per second is the product of the rate in baud and the number of bits of information represented by each symbol.

BCD Binary Coded Decimal –encoding scheme whereby individual decimal digits are separately encoded into binary

BER Bit error Rate

BIOS Basic input/output system

Bit The smallest unit of digital information, a single binary digit (0 or 1)

Bit Rate –measure of throughput rate of bits in a connection. Circuit-switched technologies can achieve bit rates up to 14,400 bits per second, while GPRS can run 30-40kbps (kilobits per second). EDGE and EVDO can achieve higher rates.

BNC Bayonet Niell-Concelman connector - is a type of RF connector used for terminating coaxial cable. The connector was named after its bayonet mount locking mechanism and its two inventors.

BPS Bits per second

BPSK Binary phase shift keying -digital modulation system where the data bits (1s and 0s) are transmitted using two different phase carriers

BLER –Block Error Rate –An average of the ratio of blocks of information transmitted that contain an uncorrectable number of symbol errors to the total blocks transmitted.

Bluetooth: A short-range, wireless system that allows mobile devices to share information without cables.

BSC Base Station controller –manages several BTS's in a cellular network, controlling allocation of radio channels and handovers or handoffs between cells.

Buffer A temporary memory area used as storage during input and output operations.

BVM Battery Voltage Monitor is a Mercury device that adapts a pressure input into an instrument to accept a voltage from a desired monitoring point in the wireless assembly.

BW see Bandwidth

Byte A contiguous sequence of binary bits in a serial data stream, such as in modem or satellite communications, or from a disk-drive head, which is the smallest meaningful unit of data. These bytes might include start bits, stop bits, or parity bits, and thus could vary from 7 to 12 bits to contain a single 7-bit ASCII code, but are commonly thought of in 8-bit units.

C

Carrier: 1) The basic signal altered or modulated by a transmission device in order to carry information. A carrier wave is a waveform (usually sinusoidal) that is modulated (modified) to represent the information to be transmitted. This carrier wave is usually of much higher frequency than the modulating signal (the signal which contains the information). 2) As in Cellular Carrier Also 'Service Provider'. A company that provides telephone services to the subscriber (user).

CBR Constant bit rate -When referring to codecs, constant bit rate encoding means that the rate at which a codec's output data should be consumed is constant. CBR is useful for streaming multimedia content on limited capacity channels since it is the maximum bit rate that matters, not the average, so CBR would be used to take advantage of all of the capacity. CBR would not be the optimal choice for storage as it would not allocate enough data for complex sections (resulting in degraded quality) while wasting data on simple sections.

CDMA Code Division Multiple Access . A 2nd generation digital cellular system developed by Qualcomm. This standard was published in IS-95. It is primarily used in North America and Australia. CDMA uses direct sequence spread

spectrum technology as its over the air interface. As a phone or modem gains access to the network, it is assigned a unique “pseudorandom” sequence of frequency shifts that serves as a code to distinguish the communication session.

CDMA2000 IMT-2000 standard supported CDMA technology as the evolution for CDMA.

CDPD Cellular Digital Packet Data –an early packet data network operated over the AMPS network in the US providing up to 19.2 kbps of raw data speed. It included packet switching capabilities to allow users to time-share channels and allow multiple users on the same channel to increase capacity.

Cell Phone Also 'wireless telephone' or 'mobile phone'. A handheld "radio" capable of transmitting and receiving messages using radiofrequency energy.

Cell the coverage area of an individual BTS or base station in a wireless network. Can accommodate a hierarchical system of macrocells and microcells to increase coverage density. Area surrounding the Cell Site (Base Station). Cells are usually thought of in terms of a hexagon and fit together much like a honeycomb. As you travel from cell to cell, the signal is "handed off" to the next cell site.

Character a representation, coded in binary digits, of a letter, number, or other symbol.

Circuit switching a method of switching a call through a guaranteed, “nailed-up”, end-to-end connection for the duration of the call. Used for voice connections. Also used for data connections with considerable wastefulness when data transmission is not taking place. Contrasts with packet switching.

Class 1 and 2.0 International standards used by fax application programs and faxmodems for sending and receiving faxes.

Client A software program that is used to contact and obtain data from a Server software program either on the same computer or on another computer. A client makes a request and the server fulfills the request. An example of a client would be an e-mail program connecting to a mail server or an Internet browser client connecting to a web server. In the case of OPC, an HMI would be a client application that connects to an OPC sever. Also related is Server.

CMOS Complementary Metal Oxide Semiconductor is a major class of integrated circuits. CMOS chips include microprocessor, microcontroller, static RAM, and other digital logic circuits. Since around 1998 CMOS technology has also been used for a wide variety of analog circuits such as image sensors, Data Converters, and highly integrated Transceivers for many types of communication. Two important characteristics of CMOS devices are high noise immunity and low static power supply drain. Significant power is only drawn when its transistors are switching between on and off states; consequently, CMOS devices do not produce as much heat as other forms of logic such as TTL. CMOS also allows a high density of logic functions on a chip.

CNR Carrier to noise ratio. A measurement of transmission quality

Codec A Codec is a device or program capable of performing encoding and decoding on a digital data stream or signal. The word codec may be a combination of any of the following: 'Compressor-Decompressor', 'Coder-Decoder', or 'Compression/Decompression algorithm'.

COM Component Object Model (COM) is a Microsoft concept used to communicate between components on the same computer. Components from different machines can be combined using DCOM (See DCOM).

Cordless Phone: A portable telephone that transmits signals over a short distance to a receiver that is wired into the local telephone network. Cordless phones are generally limited to a fixed location such as the home or office. They are not considered "wireless phones".

Coverage Area: (Same as Service Area) The geographical area serviced by a given wireless system or carrier.

CPE Customer premise equipment. What the phone company calls the device attached to their network owned by their customer.

CPU Central Processing Unit (CPU) is the main processing chip of a computer. the part of the computer or computer system which performs core processing functions.

CRC Cyclic redundancy check. A type of error detection used in digital transmission systems. It consists of a test performed on each block or frame of data by both sending and receiving devices. The sending device inserts the results of its tests in each data block in the form of a CRC code. The receiving device compares the results with the received CRC code and responds with either a positive or negative acknowledgment.

CSD Circuit Switched Data. See circuit switching. Much like using a modem in a normal wireline telephone, the data connection on GSM is circuit-switched. Data is sent at 9600 bps. Faster transfer rates can be obtained by using HSCSD...High Speed Circuit Switched Data. An extension to GSM, data transfer rates are increased to 38,400 bps.

CSU Channel Service Unit. A device used to terminate a circuit. is a line bridging device that: (a) is used to perform loop-back testing, (b) may perform bit stuffing, (c) may also provide a framing and formatting pattern compatible with the network, and (d) is the last signal regeneration point, on the loop side, coming from the central office, before the regenerated signal reaches a multiplexer or data terminal equipment (DTE).

CSU/DSU is a digital-interface device used to connect a router or other terminal device to a digital circuit such as a T1 or T3 line. A CSU/DSU operates at the physical layer (layer 1) of the OSI model. It terminates physical data connections, provides signal timing and translates the digital data stream into bipolar signals which are suitable for line transmission. The CSU/DSU also performs some error-reporting and loopback functions. A CSU/DSU converts a digital data frame from a local area network (LAN) into a frame appropriate to a wide-area network (WAN) and vice versa. The CSU receives and transmits signals from and to the WAN line and provides a barrier for electrical interference from either side of the unit, and can also echo loopback signals from the phone company for testing purposes. The CSU originated at AT&T as an interface to its nonswitched digital data system.

The DSU manages line control, and converts input and output between RS-232C, RS-449, or V.xx frames from the LAN and the time-division multiplexed (TDM) DSX frames on the T1 line. It manages timing errors and signal regeneration. The

DSU provides an interface to the Data Terminal Equipment (DTE) using a standard (EIA/CCITT) interface. It also provides testing capabilities. CSU/DSUs are made as separate products, sometimes part of a T1 WAN card or integrated into a DTE.

CTIA Cellular Telecommunication Industries Association

CTS Clear to Send A signal on a serial connection that indicates a modem or DCE device is ready to accept the information from the computer or DTE device to send to a remote unit.

CW Continuous wave or Carrier Wave. A single frequency transmission or an un-modulated carrier.

D

DAC or D/A digital to analog converter

DAS or DAQ Also known as Data Acquisition System, DAQ is a system of one or more sensors, devices and communication links used to scan or collect and forward data to a central location for further processing, display, or archiving.

D-AMPS Digital Advanced Mobile Projects Agency

Data Compression Table –a table containing values assigned for each character during a call under MNP5 data compression. Default values in the table are continually altered and built during each call. The longer the table, the more efficient throughput gained.

Database A database is an organized collection of information in digital or electronic format.

Datagram In general, the term packet applies to any message formatted as a packet, while the term datagram is generally reserved for packets that are not transmitted reliably. Reliable delivery is independent of whether or not the network can detect transmission errors in packets: in a datagram network, damaged packets could be discarded without notifying the sender or receiver.

DCOM Distributed Component Object Model (DCOM) is a set of Microsoft concepts and program interfaces in which client program objects can request services from server program objects on other computers in a network. DCOM is based on the Component Object Model (COM), which provides a set of interfaces allowing clients and servers to communicate within the same computer.

DCS Distributed Control System (DCS) is a big Programmable Logic Controller (PLC) that is typically networked to other controllers, PLCs or field devices. It typically has a workstation to interface with the controller and can be very expensive due to built-in security and fail-over features.

DDE Dynamic Data Exchange (DDE) is a form of InterProcess Communication (IPC) in the Microsoft Windows operating environment. When two or more applications that support DDE are running simultaneously, they can exchange information, data and commands. DDE has been enhanced with Object Linking and Embedding (OLE) technology.

dB decibel A logarithmic relative measurement indicator

dBd gain with respect to a dipole antenna

dB_i gain with respect to an isotropic antenna.

dBq gain with respect to a quarterwave antenna

dBW decibel measurement with respect to 1 Watt

DC direct current

DCD Data Carrier Detect A signal that is set to a computer or DTE device to indicate that a modem or DCE is connected to the transmission network, or that the communication link has been established

DCE an abbreviation for Data Circuit-Terminating Equipment and its synonyms are Data Communications Equipment and Data Carrier Equipment. In a data station, the equipment that performs functions, such as signal conversion and coding, at the network end of the line between the data terminal equipment (DTE) and the line, and that may be a separate or an integral part of the DTE or of intermediate equipment. The interfacing equipment may be required to couple the data terminal equipment (DTE) into a transmission circuit or channel and from a transmission circuit or channel into the DTE. Although the terms are most commonly used with RS-232, several data communications standards define different types of interfaces between a DCE and a DTE. The Data Circuit-terminating Equipment (DCE) is a device that communicates with a Data Terminal Equipment (DTE) device in these standards. Usually, the DTE device is the terminal (or computer), and the DCE is a modem. When two devices that are both DTE or both DCE that must be connected together without a modem or a similar media translator between them, a Null modem must be used

DCS digital communication system, distributed control system, or digital cellular system -(DCS 1800 or GSM-1800), a mobile communications-based PCS network used outside of the U.S.

DBS direct broadcast satellite a term used to refer to satellite broadcasts intended for home reception (also known as direct-to-home), usually for television or radio services.

DDNS –dynamic domain name server- Dynamic DNS is a system which allows the domain name data held in a name server to be updated in real time. The most common use for this is in allowing an Internet domain name to be assigned to a device with a varying (dynamic) IP address. This makes it possible for other sites on the Internet to establish connections to the device without needing to track the IP address themselves. One common use is for making a data connection to a remote cellular modem that has a dynamic IP address. Since these devices are not always transmitting data, a pool of addresses can be shared among a larger group of devices thus saving the limited pool of addresses. Another common use is for running server software on a computer that has a dynamic IP address, as is the case with many consumer Internet service providers.

DHCP Dynamic host configuration protocol. System on a LAN whereby hosts can receive IP addresses when they are powered up courtesy of a server device. This allows a smaller number of addresses to be shared

Digital: A method of encoding information to be represented as a binary code of 1s and 0s. The newer wireless systems use this technology. This method is capable of handling many more subscribers per channel than the AMPS network. This efficiency has been a major factor in bringing down the cost of all cellular service.

Dipole antenna invented by Heinrich Rudolph Hertz around 1886, is an antenna with a center-fed driven element for transmitting or receiving radio frequency energy. These antennas are the simplest practical antennas from a theoretical point of view. Antenna gain is sometimes measured as "x dB above a dipole", which means that the antenna in question is being compared to a dipole, and has x dB more gain (has more directivity) than the dipole tuned to the same operating frequency. In this case one says the antenna has a gain of "x dBd" (see decibel). More often, gains are expressed relative to an isotropic radiator, which is an imaginary aerial that radiates equally in all directions. In this case one uses dBi instead of dBd (see decibel). As it is impossible to build an isotropic radiator, gain measurements expressed relative to a dipole are more practical when a reference dipole aerial is used for experimental measurements.

DMA direct memory access DMA is an essential feature of all modern computers, as it allows devices to transfer data without subjecting the CPU to a heavy overhead. Otherwise, the CPU would have to copy each piece of data from the source to the destination. This is typically slower than copying normal blocks of memory since access to I/O devices over a peripheral bus is generally slower than normal system RAM. During this time the CPU would be unavailable for any other tasks involving CPU bus access, although it could continue doing any work which did not require bus access.

DMM digital multimeter is an electronic measuring instrument that combines several functions in one unit. The most basic instruments include an ammeter, voltmeter, and ohmmeter.

DNP Distributed Network Protocol is a standards-based communications protocol developed to achieve interoperability among systems in the electric utility, oil & gas, water/waste water and security industries. DNP can be implemented in any SCADA system for efficient and reliable communications between substation computers, RTU's etc.; over serial or LAN-based systems.

DNS –domain name server –specialized internet server that contains a database of IP addresses and routing information. That database is continually updated and synchronized through a hierarchical network of domain name servers.

DPSK differential phase shift keying digital modulation system where the data bits (1s and 0s) are transmitted using different phase carriers based on the difference from the last carrier sent. The ones and zeros are represented as "change" or "no change".

DSR Data Set Ready A signal sent on a serial connection by a DCE device to indicate it is ready

DSSS Direct sequence spread spectrum In telecommunications, direct-sequence spread spectrum (DSSS) is a modulation technique. As with other spread-spectrum technologies, the transmitted signal takes up more bandwidth than the information signal that is being modulated. The carrier signals occur over the full bandwidth (spectrum) of a device transmitting frequency, which is why it is called "spread-spectrum". Put simply, direct-sequence spread-spectrum transmissions multiply the data being transmitted by a "noise" signal. This noise signal is a pseudorandom sequence of 1 and -1 values, at a frequency much

higher than that of the original signal, thereby spreading the energy of the original signal into a much wider band.

DTE Data terminal equipment DTE is an abbreviation for Data Terminal Equipment, and refers to an end instrument that converts user information into signals for transmission, or reconverts the received signals into user information. A DTE device communicates with the Data Circuit-terminating Equipment (DCE).

DTMF: Dual Tone Multi-Frequency, The system used by touch-tone telephones where one high and one low frequency, or tone, is assigned to each button on the phone.

DTR Data Terminal Ready: An acronym used in RS-232 serial communications. The DTR signal is sent via a dedicated wire from the transmitting computer to the transmission device to indicate that the computer is ready to receive data.

E

Eb/NO Energy per bit noise density ratio

EDGE: Enhanced Data Rates for GSM Evolution. Third generation technology enhancement to GSM/GPRS networks designed to handle data at high (up to 384 kbps) speed by altering the RF modulation to allow a maximum data rate per timeslot of 59.2kbps and the use of multiple timeslots.

EEPROM electrically-eraseable programmable read-only memory

EIA Electronic Industries Alliance (until 1997 **Electronic Industries Association**) is a trade organization for electronics manufacturers in the United States. EIA is accredited by ANSI to help develop standards on electronic components, consumer electronics, electronic information, telecommunications, and Internet security.

EID Equipment Identifier. A 6-octet unique number used to identify a specific piece of equipment. Functions as a serial number for modems.

EIRP effective isotropic radiated power is the amount of power that would have to be emitted by an isotropic antenna (that evenly distributes power in all directions and is a theoretical construct) to produce the peak power density observed in the direction of maximum antenna gain. EIRP can take into account the losses in transmission line and connectors and includes the gain of the antenna. The EIRP is often stated in terms of decibels over a reference power level, that would be the power emitted by an isotropic radiator with an equivalent signal strength. The EIRP allows making comparisons between different emitters regardless of type, size or form. From the EIRP, and with knowledge of a real antenna's gain, it is possible to calculate real power and field strength values.

EMC Electromagnetic Compatibility (EMC) is the branch of electrical sciences which studies the unintentional generation, propagation and reception of electromagnetic energy with reference to the unwanted effects that such an energy may induce. In particular, the aim of EMC is the correct operation, in the same environment, of different equipment which involve electromagnetic phenomena in their operation.

EMI Electromagnetic interference (also called Radio Frequency Interference, and RFI) is electromagnetic radiation which is emitted by electrical circuits carrying rapidly changing signals, as a by-product of their normal operation, and which causes unwanted signals (interference or noise) to be induced in other circuits. This interrupts, obstructs, or otherwise degrades or limits the effective performance of those other circuits. It can be induced intentionally, as in some forms of electronic warfare, or unintentionally, as a result of spurious emissions and responses, intermodulation products, and the like. Electromagnetic interference can also be emitted by things not normally considered to be electrical circuits, such as the Sun or the Northern Lights. EMI frequently affects the reception of AM radio in urban areas. It can also affect FM radio and television reception, although to a lesser extent.

EMR electromagnetic radiation is generally described as a self-propagating wave in space with electric and magnetic components. These components oscillate at right angles to each other and to the direction of propagation, and are in phase with each other. Electromagnetic radiation is classified into types according to the frequency of the wave: these types include, in order of increasing frequency, radio waves, microwaves, infrared radiation, visible light, ultraviolet radiation, X-rays and gamma rays. In some technical contexts the entire range is referred to as just 'light'.

EPROM erasable programmable read-only memory

ERP Enterprise Resource Planning (ERP) is an information system that integrates all manufacturing and related applications for an entire enterprise.

ESN: Electronic Serial Number. A unique number for each cell phone that identifies the unit to the network.

ETSI European Telecommunications Standards Institute –Europe’s primary body for development of telecom standards. GSM, GPRS, and early UMTS standards were developed by its Special Mobile Groupe (SMG)

F

FCC Federal Communications Commission

FDMA Frequency division multiple access is an access technology that is used by radio systems to share the radio spectrum. The terminology “multiple access” implies the sharing of the resource amongst users, and the “frequency division” describes how the sharing is done: by allocating users with different carrier frequencies of the radio spectrum. In FDMA the given Radio Frequency (RF) bandwidth is divided into smaller frequency bands called *subdivisions*. Each subdivision has its own carrier frequency. A control mechanism is used to ensure that two or more earth stations do not transmit in the same subdivision at the same time. Essentially, the control mechanism designates a receive station for each of the subdivisions.

FEC Forward error correction is a system of error control for data transmission, whereby the sender adds redundant data to its messages, which allows the receiver to detect and correct errors (within some bound) without the need to ask the sender for additional data. The advantage of forward error correction is that retransmission of data can often be avoided, at the cost of higher bandwidth

requirements on average, and is therefore applied in situations where retransmissions are relatively costly or impossible. FEC is accomplished by adding redundancy to the transmitted information using a predetermined algorithm. Each redundant bit is invariably a complex function of many original information bits. The original information may or may not appear in the encoded output; codes that include the unmodified input in the output are systematic, while those that do not are nonsystematic.

FHSS Frequency hopping spread spectrum is a spread-spectrum method of transmitting radio signals by rapidly switching a carrier among many frequency channels, using a pseudorandom sequence known to both transmitter and receiver. The overall bandwidth required for frequency hopping is much wider than that required to transmit the same information using only one carrier frequency. However, because transmission occurs only on a small portion of this bandwidth at any given time, the effective interference bandwidth is really the same.

FIFO First-in First out This expression describes the principle of a queue or first-come, first-served (FCFS) behavior: what comes in first is handled first, what comes in next waits until the first is finished, etc.

FM Frequency modulation is a form of modulation which represents information as variations in the instantaneous frequency of a carrier wave. (Contrast this with amplitude modulation, in which the amplitude of the carrier is varied while its frequency remains constant.) In analog applications, the carrier frequency is varied in direct proportion to changes in the amplitude of an input signal. Digital data can be represented by shifting the carrier frequency among a set of discrete values, a technique known as frequency-shift keying.

FME connectors are RF connectors and are used for mobile antenna applications. They are miniature screw coupling coaxial connectors that have a 50Ω impedance. They offer excellent electrical performance from DC to 2.0 GHz.

Full Duplex – Refers to the transmission of data in two directions simultaneously. Simultaneous sending and receiving of information

G

GGSN –Gateway GPRS Support Node –Connects the GPRS network to the Internet, ISPs, and corporate intranets, allowing simultaneous multiple secure data access points. The GGSN operates as the other end of the network to SGSN.

GEO Geostationary earth orbit - an orbit directly above the Earth's equator (0° latitude). It is a special case of the geosynchronous orbit (abbreviated GSO), and is the one which is of most interest to operators of artificial satellites (including communication and television satellites). Satellite locations may differ by longitude only (remember, in geostationary orbit, latitude is zero). Geostationary orbits are useful because they cause a satellite to appear stationary with respect to a fixed point on the rotating Earth. As a result, an antenna can point in a fixed direction and maintain a link with the satellite. The satellite orbits in the direction of the Earth's rotation, at an altitude of approximately 35,786 km (22,240 statute miles)

above ground. This altitude is significant because it produces an orbital period equal to the Earth's period of rotation, known as the sidereal day.

GHz Gigahertz 1 billion cycles per second

GPRS: General Packet Radio Service. An upgrade to older GSM and TDMA networks to use packet switching rather than circuit switching in the data network and across the radio interface. Packet switching is the technology used on the internet. Using GPRS a mobile phone can link to the internet through the GSM network.

GPS The GPS (Global Positioning System) is a "constellation" of at least 24 well-spaced satellites that orbit the Earth and make it possible for people with ground receivers to pinpoint their geographic location. The location accuracy is anywhere from 1 to 100 meters depending on the type of equipment used. The GPS is owned and operated by the U.S. Department of Defense, but is available for general use around the world.

In late 2005, the first in a series of next-generation GPS satellites was added to the constellation, offering several new capabilities, including a second civilian GPS signal called L2C for enhanced accuracy and reliability. In the coming years, additional next-generation satellites will increase coverage of L2C and add a third and fourth civilian signal to the system, as well as advanced military capabilities.

Ground Plane A Ground Plane is any flat metal (that a magnet will stick to) that is of proper size (28" x 28" for 800 -850 MHz, 12" x 12" for 1900 MHz) to aid in collecting a radio signal for an antenna. Examples would be a vehicle roof, top of a file cabinet, or a metal roof on a building.

Group 3 FAX Group 3 FAX is a type of transmission compatible with the great majority of fax machines in use today. Group 3 can be supported by an application making a voice-type call to a remote fax machine and may be, therefore, limited to modem-types speeds of 9600 or 14,400 baud.

GRX GPRS Roaming Exchange –An IP backbone network that connects GPRS networks around the world so whenever you roam with GPRS you use a common IP backbone. There are several potential providers of GRX services, so they must have peering arrangements with each other to ensure GPRS roaming can take place.

GSM: Global System for Mobile Communications. The original communications standard developed in Europe by the ETSI. Originally called the Groupe Speciale Mobile, it is now the dominant global cellular technology by users and footprint. GSM is gaining popularity in the US and is one of the major building blocks for the 3G technology.

GUI Graphical User Interface (GUI) enables a user to interact with a software application through graphics instead of text.

H

Half-Duplex Refers to the transmission of data in just one direction at a time. For example, a walkie-talkie is a half-duplex device because only one party can talk at a time.

Handoff: The process of transferring a wireless call from one transmission site to the next as the phone moves from cell to cell. This should be done without loss of

clarity or disconnection. In actual application, however, there is usually a deterioration of signal quality near the edge of the cell, and may be a loss of signal during the "handoff". This may be more pronounced during peak periods (rush hour).

HDLC High-Level Data Link Control (HDLC) is a bit-oriented synchronous data link layer protocol developed by the International Organization for Standardization (ISO). The current standard for HDLC is ISO 13239, which replaces all of those standards.

HDLC provides both connection oriented and connectionless service.

HDLC can be used for point to multipoint connections, but is now used almost exclusively to connect one device to another, using what is known as Asynchronous Balanced Mode (ABM). The other modes are Normal Response Mode and Asynchronous Response Mode.

Historian A historian is a type of database designed to store process data. Due to the enormous amount of process data some plants produce, some historians compress data using algorithms. Others historians are designed to act as a "rolling buffer" and are able to store high frequency data.

HMI Human Machine Interface (HMI) is a software application (typically a Graphical User Interface or GUI) that present information to the operator about the state of a process, and to accept and implement the operators control instructions. It may also interpret the plant information and guide the interaction of the operator with the system. Also known as Man Machine Interface (MMI).

Home Service Area: The geographic area designated by each carrier that is considered local and does not incur any roaming or long distance charges.

HTTP HyperText Transfer Protocol (HTTP) is the protocol for moving hypertext files across the Internet. Requires a HTTP client program on one end, and an HTTP server program on the other end.

Hz Hertz –cycles per second

I

iDEN Integrated Digital Enhanced Network (iDEN) is a mobile telecommunications technology, developed by Motorola, which provides its users the benefits of a trunked radio and a cellular telephone. iDEN places more users in a given spectral space, compared to analog cellular and two-way radio systems, by using speech compression and time division multiple access TDMA. Notably, iDEN is designed, and licensed, to operate on individual frequencies that may not be contiguous. iDEN operates on 25 kHz channels, but only occupies 20 kHz in order to provide interference protection via guard bands. iDEN handsets use SIM cards, just like GSM and compatible with GSM handsets. Also, the interconnect-side of the iDEN network uses GSM signalling for call set-up and mobility management, with the Abis protocol stack modified to support iDEN's additional features. Motorola has named this modified stack 'Mobis'. All things being equal, iDEN is an excellent technology, and if Motorola and Nextel had not kept iDEN proprietary, it would have been a contender for one of the most spectrum efficient and feature unique world-standards, at least until the introduction of UMTS.

IDLC Integrated digital loop carrier A digital loop carrier (DLC) is a system which uses digital transmission to extend the range of the local loop farther than would be possible using only twisted pair copper wires. A DLC digitizes and multiplexes the individual signals carried by the local loops onto a single datastream on the DLC segment. Long loops, such as those terminating at more than 18,000 feet from the central office, pose electrical challenges. When the subscriber goes off-hook, a cable pair behaves like a single loop inductance coil with a -48 Vdc potential and an electrical current flow of between 20 - 50 mA dc. Electrical current values vary with cable length and gauge. A minimum current of around 20 mA dc is required to convey terminal signaling information to the network. There is also a minimum power level required to provide adequate volume for the voice signal.

IEEE Institute of Electrical and Electronics Engineers

IEEE 802.11 Institute of Electrical and Electronics Engineers standard for wireless LAN devices

IETF The Internet Engineering Task Force (IETF) develops and promotes Internet standards, cooperating closely with the W3C and ISO/IEC standard bodies; and dealing in particular with standards of the TCP/IP and Internet protocol suite. It is an open, all-volunteer standards organization, with no formal membership or membership requirements.

IMSI International Mobile Station IS. This is an international 15 digit phone number that uniquely identifies a mobile. $IMSI = MCC + MNC + MIN$.

IMT2000 –International Mobile Telecommunications 2000 –body put together by the ITU (International Telecoms Union) to oversee the standardization of all potential 3G technologies. Originally it was intended that a single 3G standard would be approved, but ultimately a number of standards were approved.

IOTA Internet Over the Air

IP Internet Protocol -Standard protocol (Layer 3 of the OSI model) that allows all Internet-connected devices to communicate with each other. It controls the addressing and routing of data packets across the Internet.

IPC Inter-Process Communication (IPC) transfers information between processes or between the kernel and a process.

IPv4 –Internet protocol version 4. Current standard version of IP that uses 32 bit addressing broken down into 4 octets. Due to the address size restriction, IPv4 can only support around 5 billion devices.

IPv6 –future version of IP allowing 128 bit addressing, improved security, and QoS support, but limited compatibility with legacy IPv4.

IPSEC Internet Protocol Security IPsec (IP security) is a standardized framework for securing Internet Protocol (IP) communications by encrypting and/or authenticating each IP packet in a data stream. There are two modes of IPsec operation: transport mode and tunnel mode. In transport mode only the payload (message) of the IP packet is encrypted. It is fully-routable since the IP header is sent as plain text; however, it can not cross NAT interfaces, as this will invalidate its hash value. Transport mode is used for host-to-host communications over a LAN. In tunnel mode, the entire IP packet is encrypted. It must then be encapsulated into a new IP packet for routing to work. Tunnel mode is used for

network-to-network communications (secure tunnels between routers) or host-to-network and host-to-host communications over the Internet.

IrDA Infrared Data Association (IrDA) is agreed upon standard that enables data to be transferred between devices using infrared light instead of cables.

IS-54 Interim Standard 54 (original dual-mode TDMA/AMPS) IS-54 and IS-136 are second-generation (2G) mobile phone systems, known as Digital AMPS (D-AMPS). It is used throughout the Americas, particularly in the United States and Canada. D-AMPS is considered end-of-life, and existing networks are in the process of being replaced by GSM/GPRS and CDMA2000 technologies.

IS-95 Interim Standard 95 (dual mode CDMA) Interim Standard 95 (IS-95), is the first CDMA-based digital cellular standard pioneered by Qualcomm in 1993. The brand name for IS-95A is cdmaOne. IS-95A supports voice and 14.4kbps data rates. IS-95 is also known as TIA-EIA-95 and is the standard for North American CDMA cellular systems. It is a 2G mobile telecommunications standard that uses CDMA, a multiple access scheme for digital radio, to send voice, data and signaling data (such as a dialed telephone number) between mobile telephones and cell sites. It is widely deployed in North America and parts of Asia, South America, and Australia.

ISDN Integrated services digital network is a circuit-switched telephone network system, designed to allow digital transmission of voice and data over ordinary telephone copper wires, resulting in better quality and higher speeds than available with analog systems.

ISI intersymbol interference In a digital transmission system, ISI is distortion of the received signal, which distortion is manifested in the temporal spreading and consequent overlap of individual pulses to the degree that the receiver cannot reliably distinguish between changes of state, *i.e.*, between individual signal elements. At a certain threshold, intersymbol interference will compromise the integrity of the received data.

ISM Industrial, Scientific, and Medical the designation given to the 900MHz and 2.4GHz frequency bands allocated for general use.

ISO The International Organization for Standardization (ISO) is an international standard-setting body composed of representatives from national standards bodies. Founded on February 23, 1947, the organization produces world-wide industrial and commercial standards, the so-called ISO standards.

While the ISO defines itself as a non-governmental organization (NGO), its ability to set standards which often become law through treaties or national standards makes it more powerful than most NGOs, and in practice it acts as a consortium with strong links to governments.

ISP Internet Service Provider

Isotropic antenna An isotropic antenna is an ideal antenna that radiates power with unit gain uniformly in all directions and is often used as a reference for antenna gains in wireless systems. There is no actual physical isotropic antenna; a close approximation is a stack of two pairs of crossed dipole antennas driven in quadrature. The radiation pattern for the isotropic antenna is a sphere with the antenna at its center. Antenna gains are often specified in *dBi*, or decibels over

isotropic. This is the power in the strongest direction relative to the power that would be transmitted by an isotropic antenna emitting the same total power.

ITU International Telecommunication Union

K

Kbps kilobits per second

L

LAN Local Area Network (LAN) is a computer network typically limited to a small geographic area, usually the same building/plant or floor of a building/plant.

Landline: Traditional wired telephone service.

Latency –measure of the delay in transmission of information across a network. Many packet switched networks have high latency causing them to be inappropriate for voice transmission. Satellite networks have very high latency due to the distance that signals must travel in the air interface.

LEC local exchange carrier

LEO Low Earth Orbit satellite A low Earth orbit (LEO) is generally defined as an orbit within the locus extending from the Earth's surface up to an altitude of 2,000 km. Given the rapid orbital decay of objects below approximately 200 km, the commonly accepted definition for LEO is between 200 - 2000 km (124 - 1240 miles) above the Earth's surface. Objects in LEO encounter atmospheric drag in the form of gases in the thermosphere (approximately 80-500 km up) or exosphere (approximately 500 km and up), depending on orbit height. LEO is an orbit around Earth between the atmosphere and below the Van Allen radiation belts. Satellites placed in LEO travel at about 27,400 km/h (8 km/s), making one revolution in about 90 minutes.

LNP: Local Number Portability. Or, simply "porting", it refers to the process of moving your current landline phone number or your current mobile phone number to a new, wireless carrier. (For home landline phones, it may also refer to moving your current phone number to another local address)

M

MAC Media Access Control In computer networking a Media Access Control address (MAC address) is a unique identifier attached to most forms of networking equipment. Most layer 2 network protocols use one of three numbering spaces managed by the IEEE: MAC-48, EUI-48, and EUI-64, which are designed to be globally unique. Not all communications protocols use MAC addresses, and not all protocols require globally unique identifiers. The IEEE claims trademarks on the names "EUI-48" and "EUI-64". (The "EUI" stands for Extended Unique Identifier.)

MCC Mobile Country Code –A number that represents a country in the IMSI.

MDN Mobile Directory Number, Mobile Data Number also known as the mobile phone number.

MIN Mobile Identification Number or mobile user account number

MMI Man Machine Interface (MMI) is a software application (typically a Graphical User Interface or GUI) that present information to the operator about the state of a process, and to accept and implement the operators control instructions. It may also interpret the plant information and guide the interaction of the operator with the system. Also known as Human Machine Interface (HMI).

MNC Mobile Network Code. A 2 digit number that represents a sub-network in the IMSI (usually set to "00").

Modbus - a serial communications protocol published by Modicon in 1979 for use with its programmable logic controllers (PLCs). It has become a de facto standard communications protocol in industry, and is now the most commonly available means of connecting industrial electronic devices. The main reasons for the extensive use of Modbus over other communications protocols are:

1. it is openly published and royalty-free
2. it can be implemented in days, not months
3. it moves raw bits or words without placing many restrictions on vendors

Modbus allows for communication between many devices connected to the same network, for example a system that measures temperature and humidity and communicates the results to a computer. Modbus is often used to connect a supervisory computer with a remote terminal unit (RTU) in supervisory control and data acquisition (SCADA) systems. Versions of the Modbus protocol exist for serial port and Ethernet.

Two main variants exist, with different representations of numerical data and slightly different protocol details. Modbus RTU is a compact, binary representation of the data. Modbus ASCII is human readable, and more verbose. Both of these variants use serial communication. The RTU format follows the commands/data with a cyclic redundancy check checksum, while the ASCII format uses a longitudinal redundancy check checksum. Nodes configured for the RTU variant will not communicate with nodes set for ASCII, and the reverse. Modbus/TCP is very similar to Modbus RTU, but transmits the protocol packets within TCP/IP data packets.

MMS Multimedia Messaging Service –an evolution of SMS which allows images and sounds to be added to a basic text message. Unlike SMS, MMS uses GPRS as a bearer so there is no limit to the length of messages

MS Mobile Station –the wireless industry's generic term for a mobile device, ranging from data cards to wireless telemetry devices to cellular phones or handsets.

MSC Mobile Switching Center –The center of the cellular network where traffic (voice and data) is switched between the BTS and the core network. It is here that the traffic leaves the cellular provider and goes out to the Internet or out to the long distance or local carrier. The Base Station Systems (BSSs) are grouped and Switching controlled by Mobile Switching Stations. The MSC forms the heart of the system and performs the following essential tasks: routes calls to and from mobile phones; controls the set-up and termination of calls; provides data for billing; acts as the link between Mascom and the public network (Telecomms). Finally, the MSC also controls hand-off between itself and other MSCs.

MSM Mobile Station Modem

MT Mobile Terminated –an action, usually a call, that is first started from a land-based network. An incoming call or SMS message.

N

NAM Number assignment Module is a storage module in a mobile phone that is used to store the telephone number of the phone and other phone-specific information (access parameters, etc.)

N Connector: The **N connector** (in full, **Type N connector**) is a threaded RF connector used to join coaxial cables. It was one of the first connectors capable of carrying microwave-frequency signals, and was invented in the 1940s by Paul Neill of Bell Labs. The male connector is hand-tightened and has an air gap between center and outer conductors.

NID Network ID. The NID is an identification number that represents geographic location of a common coverage area. It is a subset of the SID, usually a neighborhood in a large city. NID is not usually used and is often set to zero.

No Service Indicator: Usually an LED or screen message on the cell phone that there is no wireless service in the immediate area. This could be due to the distance from the nearest cell tower, foliage, terrain, or buildings.

O

ODBC Open DataBase Connectivity (ODBC) is a Microsoft standard for accessing different database systems from Windows such as SQL, Access or Oracle.

OPC OLE for Process Control (OPC) is a set of standard interfaces based upon Microsoft's OLE/COM technology. The application of the OPC standard interface makes possible interoperability between automation/control applications, field systems/devices etc.

OPC A&E OPC Alarms and Events (OPC A&E) is used to exchange process alarms and events. OPC A&E can be used by operations to notify them of alarms and obtain a sequence of events.

OPC Batch OPC Batch is a specification published by the OPC Foundation. This specification carries the OPC philosophy to the specialized needs of batch processes. It provides interfaces for the exchange of equipment capabilities (corresponding to the S88.01 Physical Model) and current operating conditions.

OPC Commands A specification published and maintained by the OPC Foundation. OPC Commands defines a new set of interfaces that allow OPC clients and servers to identify, send and monitor control commands which execute on a device.

OPC Complex Data OPC Complex Data is a standard published by the OPC Foundation. It is a companion specification to OPC Data Access and OPC XML-DA that allows servers to expose and describe more complicated data types such as binary structures and XML documents.

OPC Compliant The OPC Foundation offers certification to ensure that OPC servers meet the defined specification. The OPC Foundation has produced automated tools used for vendors to test their OPC products. Those products that

past the test can be classified as OPC Certified and display the OPC Compliance logo.

OPC DA OPC Data Access (OPC DA) provides access to real time process data. Using OPC DA, one can ask the OPC server for the most recent value of flows, pressures, levels, temperatures, densities, and more. For historical data see OPC Historical Data Access (OPC HDA).

OPC Driver An OPC Driver is a software application that acts as an API (Application Programming Interface) or protocol converter. An OPC Driver will connect to a device such as a PLC, DCS, RTU, etc or a data source such as a database, HMI, etc and translate the data into a standard-based OPC format. OPC compliant applications such as an HMI, historian, spreadsheet, trending application, etc can connect to the OPC Driver and use it to read and write device data. An OPC Driver is analogous to the roll a printer driver plays to enable a computer to communicate with an ink jet printer. An OPC Driver is based on a Server/Client architecture.

OPC Server An OPC Server is a software application that acts as an API (Application Programming Interface) or protocol converter. An OPC Server will connect to a device such as a PLC, DCS, RTU, etc or a data source such as a database, HMI, etc and translate the data into a standard-based OPC format. OPC compliant applications such as an HMI, historian, spreadsheet, trending application, etc can connect to the OPC Server and use it to read and write device data. An OPC Server is analogous to the roll a printer driver plays to enable a computer to communicate with an ink jet printer. An OPC Server is based on a Server/Client architecture.

OS Operating System (OS) is a software program, which manages the basic operations of a computer system. These operations include memory appointment, the order and method of handling tasks, flow of information into and out the main processor and to peripherals, etc.

OSI Model The Open Systems Interconnection Reference Model (*OSI Reference Model* or *OSI Model* for short) is a layered, abstract description for communications and computer network protocol design, developed as part of the Open Systems Interconnection initiative. It is also called the OSI seven layer model. The OSI model divides the functions of a protocol into a series of layers. Each layer has the property that it only uses the functions of the layer below, and only exports functionality to the layer above. A system that implements protocol behavior consisting of a series of these layers is known as a 'protocol stack' or 'stack'. Protocol stacks can be implemented either in hardware or software, or a mixture of both. Typically, only the lower layers are implemented in hardware, with the higher layers being implemented in software. The OSI reference model is a hierarchical structure of seven layers that defines the requirements for communications between two computers. The model was defined by the International Organization for Standardization in the ISO standard 7498-1. It was conceived to allow interoperability across the various platforms offered by vendors. The model allows all network elements to operate together, regardless of who built them.

OTA Over the air programming (OTA) also known as over-the-air service provisioning (OTASP) or over-the-air parameter administration (OTAPA), is a method of distributing new software updates to cell phones or provisioning handsets with the necessary settings with which to access services such as WAP or MMS. Some phones with this capability are labeled as being "OTA capable." When OTA is used to update a phone's operating firmware, it is sometimes called "Firmware Over The Air" (FOTA). For service settings, the technology is often known as Device Configuration. Various standardization bodies were established to help develop, oversee, and manage OTA. One of them is the Open Mobile Alliance (OMA). The OTA mechanism requires the existing software and hardware of the target device to support the feature, namely the receipt and installation of new software received via the wireless network from the provider. When activated, new firmware and software are transferred to the phone, installed, and put into use. It is often necessary to turn the phone off and back on for the new programming to take effect, though many phones will automatically perform this action.

P

Packet A packet is a formatted block of information carried by a computer network. Computer communications links that do not support packets, such as traditional point-to-point telecommunications links, simply transmit data as a series of bytes, characters, or bits alone. When data is formatted into a packet, the network can transmit longer messages more efficiently and reliably. A packet consists of three elements: the first element is a header, which marks the beginning of the packet, and the second element is known as the Payload which contains the information to be carried in the packet. The third element of packet is a trailer, which marks the end of the packet.

Packet switching -a digital transmission method that divides a data stream into small groups of bits called packets that are then individually routed or "switched" through the network. At termination, the packets are realigned into the original message. By sending data via packet switching, the network gains greater efficiency per channel than circuit switching and allows always-on technologies such as GPRS to be billed only when data is sent.

PCM Pulse-code modulation (PCM) is a digital representation of an analog signal where the magnitude of the signal is sampled regularly at uniform intervals, then quantized to a series of symbols in a digital (usually binary) code. In telephony, a standard audio signal for a single phone call is encoded as 8000 analog samples per second, of 8 bits each, giving a 64 kbit/s digital signal known as DS0. The default encoding on a DS0 is either μ -law (mu-law) PCM (North America and Japan) or a-law PCM (Europe and most of the rest of the world). These are logarithmic compression systems where a 12 or 13 bit linear PCM sample number is mapped into an 8 bit value. This system is described by international standard G.711.

PDN Packet Data Network. Generic term for a packet-switched network.
Peering -a relationship between two ISPs for transferring and routing traffic directly.

PDP context –packet data protocol context –technical term for a GPRS session. The PDP context includes the necessary routing and control information for the GPRS connection.

PLC Programmable Logic Controller (PLC) is an industrial device that provides an interface for input sensors and output actuators. PLCs can be programmed using relay ladder logic to control the outputs based on input conditions and / or algorithms contained in the memory of the PLC.

PN Offset Pseudorandom Noise Offset –in a CDMA network, the PN offset is a variable time delay offset of a repeating random noise generator that is used to distinguish individual sectors of a base station.

POTS Phone: Plain Old Telephone Service. Usually refers to any telephone equipment designed to operate via landline. A standard or traditional phone.

PRL Preferred Roaming List: The PRL is a list of information that resides in the memory of a digital phone. It lists the frequency bands the phone can use in various parts of the country. (The smaller bands within Cellular or PCS.) The part of the list for each area is ordered by the bands the phone should try to use first. For example, say you had a Sprint PCS phone, and were traveling in an area with no Sprint coverage, weak Verizon coverage, and strong Qwest coverage. The PRL would tell the phone to look for towers using Sprint's band for that area. Finding none, it might tell the phone to search for towers in Verizon's band next, perhaps because Sprint's roaming agreement with Qwest was not as favorable, or none existed. The phone would use Verizon's towers, as dictated by the PRL, even though Qwest might provide a better signal.

The PRL is sent to the phone by the provider. If one finds a problem with roaming, the Raven allows us to tell the unit to only use the home network as defined by the PRL. It tells the modem that it does not matter who is available, only use the home network. That way, if Verizon updates the PRL, you will still never roam. Verizon will always list itself as “home” even if it gets different roaming agreements with other carriers. If there is sufficient Verizon signal, this should fix the problem.

PSTN: Public Service Telephone Network. A general term referring to a number of telephone networks and services. Usually referring to the landline services.

R

Relational Database A relational database is a collection of data items organized in a set of pre-defined tables from which data can be accessed without reorganizing the tables.

Repeater: A "repeater" is a bi-directional amplifier that will re-broadcast received signal. An indoor cellular repeater will receive and amplify the transmitted signal from the cell phone through the external antenna. A repeater in a point-to-point or point-to-multipoint radio network will receive a communication from a transmitter upstream and broadcast it to a receiver or receivers that are unable to see the upstream transmitter directly.

RF –radio frequency refers to that portion of the electromagnetic spectrum in which electromagnetic waves can be generated by alternating current fed to an

antenna. Such frequencies and the belonging wavelength account for the following parts of the spectrum shown from 3 Hz to over 300GHz.

Roaming: Use of the cell phone outside of the carrier's "home service area". The ability to make and receive calls on a mobile network other than the user's home network.

RSSI –Received Signal Strength Indication. The measured power of a received signal in dBm

RS-232 In telecommunications, RS-232 is a standard for serial binary data interconnection between a *DTE* (Data terminal equipment) and a *DCE* (Data Circuit-terminating Equipment). It is commonly used in computer serial ports. A similar ITU-T standard is V.24. The standard was originally promulgated by RETMA, a precursor of the Electronic Industries Alliance. RS is an abbreviation for RETMA Standard. Electrical signal characteristics such as voltage levels, signaling rate, timing and slew-rate of signals, voltage withstand level, short-circuit behavior, maximum stray capacitance and cable length The RS-232 standard defines the voltage levels that correspond to logical one and logical zero levels. Valid signals are plus or minus 3 to 15 volts. The range near zero volts is not a valid RS-232 level; logic one is defined as a negative voltage, the signal condition is called marking, and has the functional significance of OFF. Logic zero is positive, the signal condition is spacing, and has the function ON. The standard specifies a maximum open-circuit voltage of 25 volts; signal levels of $\pm 5V, \pm 10V, \pm 12V$, and $\pm 15V$ are all commonly seen depending on the power supplies available within a device.

- Interface mechanical characteristics, pluggable connectors and pin identification
- Functions of each circuit in the interface connector
- Standard subsets of interface circuits for selected telecom applications

The standard does not define such elements as character encoding (for example, ASCII, Baudot, or EBCDIC), or the framing of characters in the data stream (bits per character, start/stop bits, parity). The standard does not define protocols for error detection or algorithms for data compression.

RS-485 EIA-485 (formerly **RS-485** or **RS485**) is an OSI Model physical layer electrical specification of a two-wire, half-duplex, multipoint serial connection. The standard specifies a differential form of signalling. The difference between the wires' voltages is what conveys the data. One polarity of voltage indicates a logic 1 level, the reverse polarity indicates logic 0. The difference of potential must be at least 0.2 volts for valid operation, but any applied voltages between +12 V and -7 volts will allow correct operation of the receiver.

EIA-485 only specifies electrical characteristics of the driver and the receiver. It does not specify or recommend any data protocol. EIA-485 enables the configuration of inexpensive local networks and multidrop communications links. It offers high data transmission speeds (35 Mbit/s up to 10 m and 100 kbit/s at 1200 m). Since it uses a differential balanced line over twisted pair (like EIA-422), it can span relatively large distances (up to 4000 feet or just over 1200 meters). In contrast to EIA-422, which has a single driver circuit which cannot be switched off, EIA-485 drives need to be put in transmit mode explicitly by asserting a signal

to the driver. This allows EIA-485 to implement linear topologies using only two lines.

RTS –Request to Send A status signal on a serial communication that asks if the modem is free to receive data from the local computer.

RTU –Remote Terminal Unit (RTU) is an industrial data collection device typically located at a remote location and communicates data to a host system by using telemetry (such as radio, dial-up telephone, or leased lines).

Q

QoS –Quality of Service –a qualitative measure of the performance of a network. Also can be used to describe a parameter set by a packet data transmission that can specify priorities assigned to different packets.

S

SCADA Supervisory Control and Data Acquisition (SCADA) is a common process control application that collects data from sensors on the shop floor or in remote locations and sends them to a central computer for management and control.

SDLC Synchronous Data Link Control (SDLC) is a computer communications protocol. It is the layer 2 protocol for IBM's Systems Network Architecture (SNA). It was the basis for the HDLC protocol, which added features such as the balanced response mode.

Server A software application designed to bridge the communication between a device, controller or data source with a client application. Servers can only respond to requests made by a client. An example would be an HMI, an client, asking the OPC server for the latest value of a particular process value. Also related is Client.

Service Plan: The agreement between the carrier and the subscriber (cell phone user) that details the costs to the user and the benefits provided by the carrier.

SGSN –serving GPRS support node – a GPRS network element that converts protocols and interfaces between the IP core and the radio network. It also supports mobility management, user verification and collection of billing data. Compare with GGSN.

SID System ID. The SID is an identification number that represents geographic location of a common coverage area, usually a large city.

SIM Subscriber Identity Module – A small integrated circuit inserted in a GSM mobile terminal to authenticate user identity. The SIM card must be inserted into the GSM/GPRS/EDGE modem in order for it to function on the network.

SLIP Serial Line Interface Protocol. The de-facto standard for encapsulating TCP/IP protocol over dedicated and/or switched serial lines.

SMA Connector - SMA (*SubMiniature version A*) connectors are coaxial RF connectors developed in the 1960's as a minimal connector interface for coaxial cable with a screw type coupling mechanism. The connector has a 50 Ω impedance. The plugs have a threaded outer coupling interface that has a hexagonal shape, allowing it to be tightened with a spanner.

SMS –Short Message Service –A supplemental cellular service that is capable of sending and receiving short-length text messages to and from a mobile device. Also, a standard for short text messages of no more than 160 characters sent between mobiles and charged on a per-message basis. SMS is the most profitable mobile data revenue stream the industry has seen. It uses excess GSM capacity and existing GSM handsets. SMS messages are stored in the network and delivered when the termination capacity is available.

SMSC –SMS center –network server which process SMS messages

SQL Structured Query Language (SQL) is a standard computer language for communicating with a relational database.

T

TCP Transmission Control Protocol A virtual-circuit, connection-based protocol at layer 4 of the OSI model. Using TCP, applications on networked hosts can create *connections* to one another, over which they can exchange streams of data. The protocol guarantees reliable and in-order delivery of data from sender to receiver. TCP also distinguishes data for multiple connections by concurrent applications (e.g. Web server and e-mail server) running on the same host. TCP supports many of the Internet's most popular application protocols and resulting applications, including the World Wide Web, e-mail and Secure Shell. In the Internet protocol suite, TCP is the intermediate layer between the Internet Protocol (IP) below it, and an application above it.

TDMA: Time Division Multiple Access . In general, TDMA is a technology that takes a frequency band and divides it into timeslots and gives each user one or more slots. This method for digital transmission is used by GSM and IS-136.

Telemetry -The transmission of the readings of instruments or RTUs to and from a remote location.

TNC connector: The threaded Neill-Concelman (TNC) connector is a threaded version of the BNC connector. The connector has a 50 Ω impedance and operates best in the 0–11 GHz frequency spectrum. It has better performance than the BNC connector at microwave frequencies. Invented in the late 1950s and named after Paul Neill of Bell Labs and Carl Concelman of Amphenol, the TNC connector has been employed in a wide range of radio and wired applications.

U

UDP User datagram Protocol The **User Datagram Protocol (UDP)** is one of the core protocols of the Internet protocol suite. Using UDP, programs on networked computers can send short messages sometimes known as *datagrams* to one another. UDP does not provide the reliability and ordering guarantees that TCP does. Datagrams may arrive out of order or go missing without notice. Without the overhead of checking if every packet actually arrived, UDP is faster and more efficient for many lightweight or time-sensitive purposes. Also, its stateless nature is useful for servers that answer small queries from huge numbers of clients. Compared to TCP, UDP is required for broadcast (send to all on local network) and multicast (send to all subscribers). Common network applications that use

UDP include the Domain Name System (DNS), streaming media applications, Voice over IP, Trivial File Transfer Protocol (TFTP) and online games.

UHF connector is a pre-World War II threaded RF connector design, from an era when UHF referred to frequencies over 30 MHz. UHF connectors are generally usable through what is now know as the VHF frequencies and can handle RF power levels over one kilowatt. Technically, "PL-259" refers to one specific mechanical design, but the term is often used for any UHF cable plug. The thread is 5/8 inch 24tpi UNEF standard. Outside diameter is about 18 mm

UMTS –Universal Mobile Telephone Service –the 3G standard adopted as an evolutionary path by the GSM world. It uses the W-CDMA (wideband code division multiple access) over the air radio interface in order to allow more efficient spectrum usage and a higher theoretical bandwidth (up to 2MBps).

V

VREG Voltage Regulator is a device used by Mercury to take a power supply output and change it to a level that is suitable for a Mercury instrument. These are commonly 9VDC, 6VDC high power, and 6VDC low power versions.

W

WAN Wide Area Network (WAN) is a computer network covering a large geographical area, usually consisting of two or more LANs.

WAP-wireless application protocol –technical standard that allows mobile phones to access web-based content and formats online content in WML, and XML-family marku-up language. WAP will work with GSM, CDMA, and iDEN.

W-CDMA Wideband CDMA –form of spread spectrum technology adopted by UMTS for its RF transmission interface. Uses a bandwidth of 5 MHz rather than the 1.25 MHz of existing CDMA systems.

Wi-Fi: A wireless data networking protocol usually used to connect PCs and laptop computers to a network. Also known as 802.11b and WLAN (Wireless Local Area Network).

WLL (Wireless Local Loop): A wireless system operating without the landline to the traditional phone company. A home or business phone system linked to the public network by a wireless carrier.

X

XML Extensible Markup Language (XML) is a flexible way to create standard information formats and share both the format and the data on the World Wide Web and with disparate operating systems.

Revision Log

Revision	Date	Changes
1.5	Sep 2006	Added Freewave Radio information
1.6	Nov 2006	Added Glossary, barriers, BVM option
1.7	Jan 2007	Re-arranged sections, added How to Use this Manual section
1.8	Mar 2007	Added new MPC, changed photos for AC
1.9	Mar 2007	Added terminal server
2.1	Jan 2008	Added Raven XT with USB; netroampref; sunsaver testing
2.2	Feb 2008	Corrected barrier wiring; added barrier information
2.3	Nov 2008	Quad pack, CPM additions, Radio repeater corrections, MPC-7 board