INSTRUCTION MANUAL

Iridium Satellite Modem

May 2008



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1. Disclaimer

This manual addresses the concerns of interfacing another manufacturer's product with Campbell Scientific Dataloggers. At the time of writing the information in this manual is currently accurate and up-to-date. However, changes to the manufacturer's product are beyond our control. Such changes may affect equipment setup, configuration, and even safe use of the product. This manual should be used in conjunction with the original manufacturer's technical information concerning product use and safety. If you encounter out-of-date, incomplete, or incorrect information, please contact us so we can attempt to remedy the situation.

Because this product is manufactured by another company, their warranty applies. Contact the original manufacturer for warranty information, and servicing.

Our website (www.campbellsci.ca) lists the updated manuals.

2. Overview

2.1. General Description and Modes of Operation

The Iridium satellite network consists of a constellation of 66 satellites situated in 6 planes in low-earth orbit. Each plane is populated by 11 satellites in polar orbits, giving the Iridium network excellent coverage in high latitudes that equatorial satellites often cannot reach.

Iridium provides 5 different services: dial-up data, Short Burst Data (SBD), Short Messaging Service (SMS), Internet Connection, and Router Based Unrestricted Digital Internetworking Connectivity Solution (RUDICS). For the purposes of this manual only dial-up data will be discussed as this is the preferred method of connecting with Campbell Scientific dataloggers. However, while other services may not be directly relevant to datalogger operations, the end user may find them valuable. Please contact your Iridium service provider with questions on these methods.

2.2. Modem Models and Accessories

The Iridium Satellite System used with Campbell Scientific consists of the modem, data/power kit, data cables and antennae. The base station utilizes the standard A3LA-D modem, whereas the remote station utilizes a modified version of this modem called the A3LA-MPT. The A3LA-MPT is a modification produced by NAL Research of Manassas, Virginia which keeps the modem “awake” at the remote site if power is cycled. Table 1 lists all the necessary equipment for a base and remote station.

Power/Data kits are required to connect the modem to the datalogger or computer and an appropriate power source. For remote applications the SYN-DC-936R converter is used to power the modem from a 9-36 VDC power source. The converter has a DB25 female connector, a DB9 serial cable connector, and two power leads with ring connectors. For remote applications where AC power is not available it is recommended to operate the modem on a schedule to avoid discharging the battery power supply. This can be accomplished using an external relay (C1701) activated through the control ports on the datalogger.

Please note that in some remote applications it may be beneficial to use the Campbell Scientific Terminal Strip Expander. The Terminal Strip provides two sets of four channels, which can be used for power distribution between the power supply and the station components (i.e. the Iridium modem, the relay, and the

datalogger). The Terminal Strip requires only bare leads to make connections and bypasses the need for ring terminals or battery splitters. Please contact Campbell Scientific for more information regarding the Terminal Strip Expander and its use with the Iridium Satellite System.

The HRC248 power/data kit is used for the base station. It has a DB25 female connector for connecting to the modem, a DB9 female plug to connect to a serial cable, a DC power plug for connecting an AC Adapter (LA-3098), and an RJ-45 jack for the Iridium handset. This kit can only be used with an AC power source.

The antenna used for both Iridium modems is the # SAF5350A mast mount antenna. For best signal reception the antenna should be mounted so that it has an unobstructed view of the sky and horizon. Reception quality changes as satellites move overhead so it is critical that the view be clear. The antenna mounts to a ¾" diameter threaded pipe which can be connected to a horizontal arm using a nu-rail connector. The nu-rail connector used will depend on the type of horizontal pipe. For a ¾" pipe, use #L1017, for a 1" pipe use #L1049.

Base Station	**Remote Station**
A3LA-D Modem	A3LA-MPT Modem
SAF5350A antenna plus cable	SAF5350A antenna plus cable
HRC248 DB25 Data Kit	SYN-DC-936R DC/DC converter
L10873 serial cable	L18663 null modem cable (RS-232)
LA3098 AC Adapter	SC932A & L13916 Mounting Bracket (when using datalogger CS I/O communication port)
Iridium SIM card	Iridium SIM card
DPLS0401-412 Handset (recommended)	L1180 - ¾ inch threaded vertical pipe L1017 ¾" - ¾" Nu rail or L1049 ¾" - 1" Nu rail
L1180 - ¾ inch threaded vertical pipe L1017 ¾" - ¾" Nu rail or L1049 ¾" - 1" Nu rail	

Table 1: Equipment List for Base and Remote Stations

2.3. *Hardware Overview*

Figures 1 to 3 display the hardware typically used for both a Base and Remote stations. At this time the datalogger, the power supply, and other peripherals are not shown. Please refer to Appendix B for a thorough description of the installation procedure for both the Base and Remote stations.

Warning:	**Be sure that the SAF5350A antenna is connected to either of the A3LA-MPT or A3LA-D modems before applying power, as damage to the equipment may occur.**

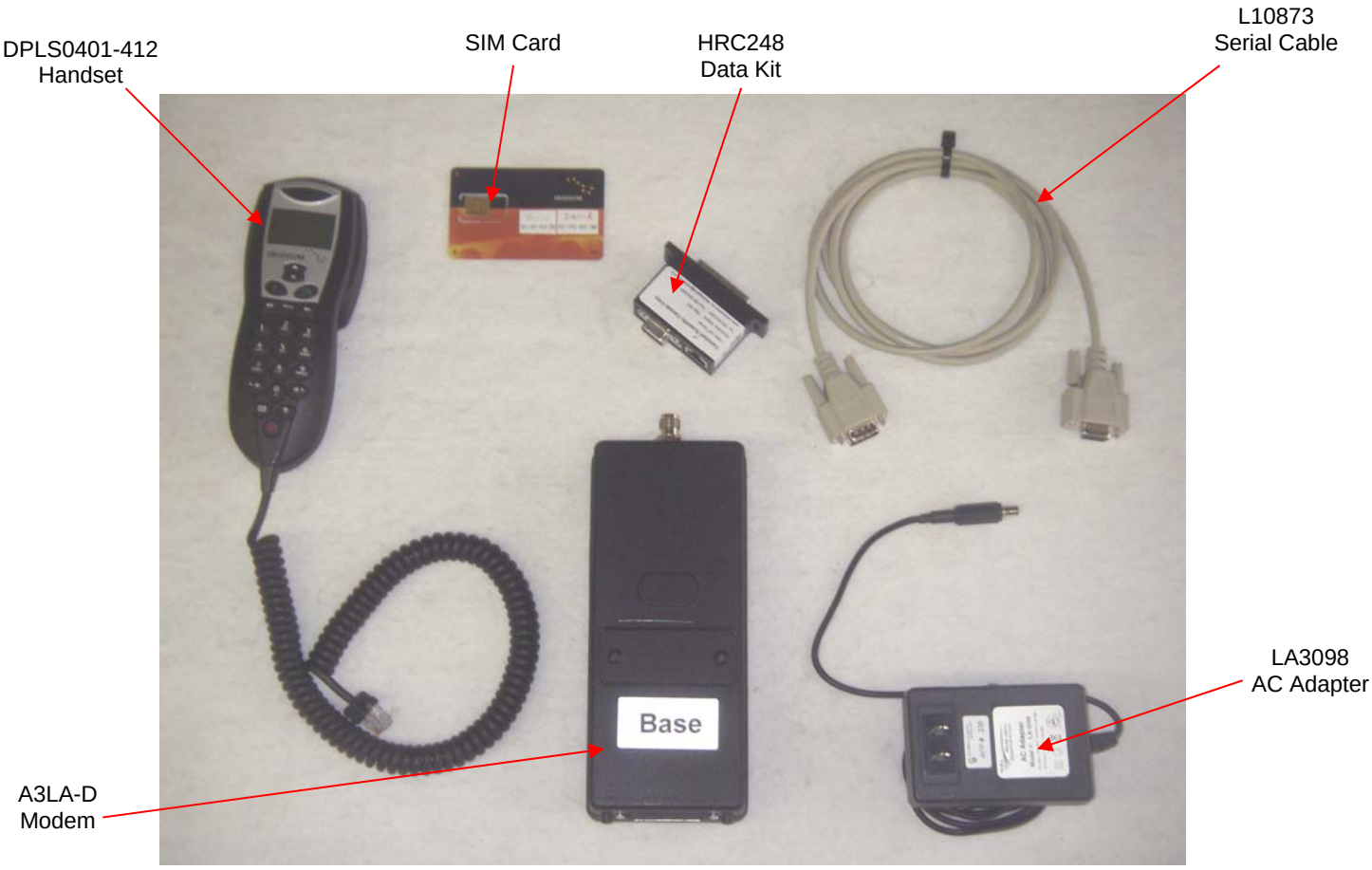


Figure 1: Base Station Components

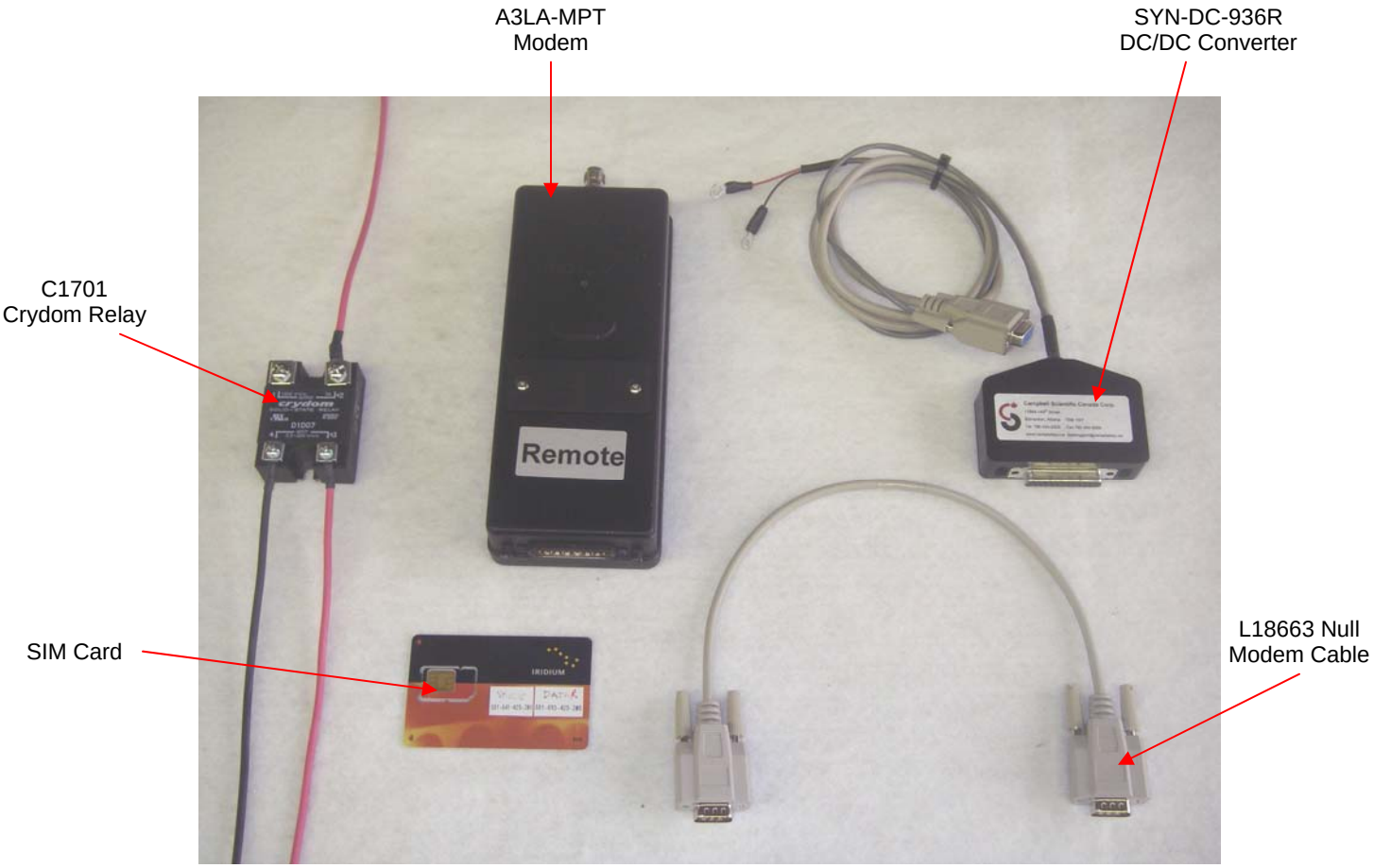


Figure 2: Remote Station Components



Figure 3: Antenna Components

2.4. *Power Consumption*

The Iridium Modem initially draws 2000 mA when first powering up and draws approximately 1000 mA when transmitting. Due to this power draw modems at remote sites should be powered on and off by using an external relay like a C1701. It is recommended that a separate power source be used for the modem to avoid catastrophic loss of data in case of power failure.

2.5. *Where it works*

Unlike other satellite systems the Iridium satellite system is located in a low polar orbit, giving the system complete global coverage.

Their relatively low altitude (780 km) means that they are situated close to transmitting modems and therefore require less transmission energy. Additionally, the Iridium network consists of 66 satellites in eleven planes with an extra 6 satellite reserved as backups. This redundancy potentially gives the iridium system excellent reliability versus other systems that rely on two or three satellites.

3. Iridium SIM card & Modem Setup

3.1. *Iridium SIM Card Use*

When installing a new SIM card in any Iridium modem it is critical to unlock it prior to operating the modem. This simple procedure is outlined in the manual titled 'How to use Model A3LA-D technical note' which is included in the A3LA modem product CD.

3.2. *Setup of Iridium Modems*

Once the SIM card is unlocked it is necessary to set up the remote modem using a terminal emulation program such as ProComm, Hyperterminal, or the SatTerm software included with the A3LA modem product CD. The following examples are taken using Hyperterminal, which comes standard with the Windows XP operating system.

NOTE:	**It is only necessary to set up the Remote Station Iridium modem (A3LA-MPT). The Base Station modem (A3LA-D) will function in its default state.**

3.2.1. Step 1: Hardware Connections

Connect the A3LA-MPT Iridium Satellite Modem to the HRC248 Data Kit and connect a serial cable from the data kit to a COM Port on your computer. Plug the AC adapter into the Data Kit. Please note that for the A3LA-D modem, if the DPLS0401-412 handset is used it will automatically power up and register on the satellite network.

3.2.2. Step 2: Start Hyperterminal

Open a new session of Hyperterminal from the Start Menu under: Start, All Programs, Accessories, Communications (Figure 4).

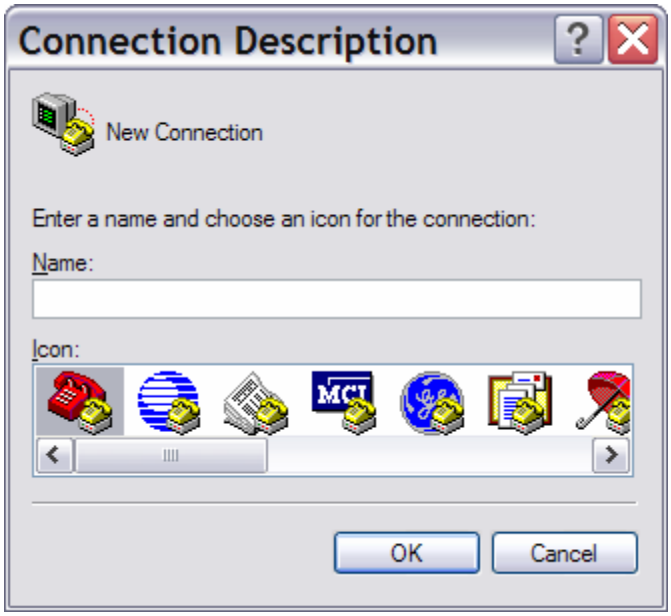


Figure 4: Starting Hyperterminal

Choose a name for the connection. For this example we will use the name 'Iridium Modem'. Click OK (Figure 5).

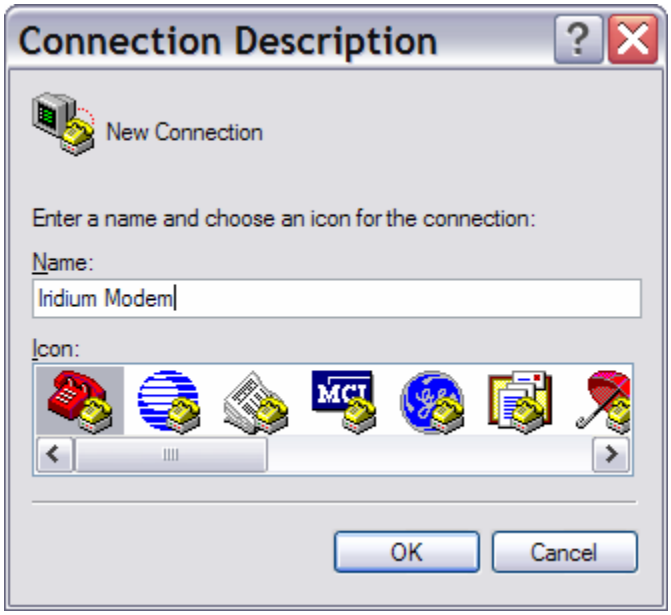


Figure 5: Hyperterminal Session Name

3.2.3. Step 3: Hyperterminal Connection Type

After clicking OK the next screen should resemble Figure 6. This screen allows you to select what type of connection you will establish.



Figure 6: Hyperterminal Connection Type

Click on the pull down tab next to the box marked 'Connect using'. Select the COM port to which the modem is currently connected. In this example we use COM3 (Figure 7). Click OK.



Figure 7: Hyperterminal ComPort Connection

3.2.4. Step 4: Hyperterminal Port Settings

As in Figure 8 this screen allows you to select the port settings required for communications between the Datalogger and A3LA-MPT modem.

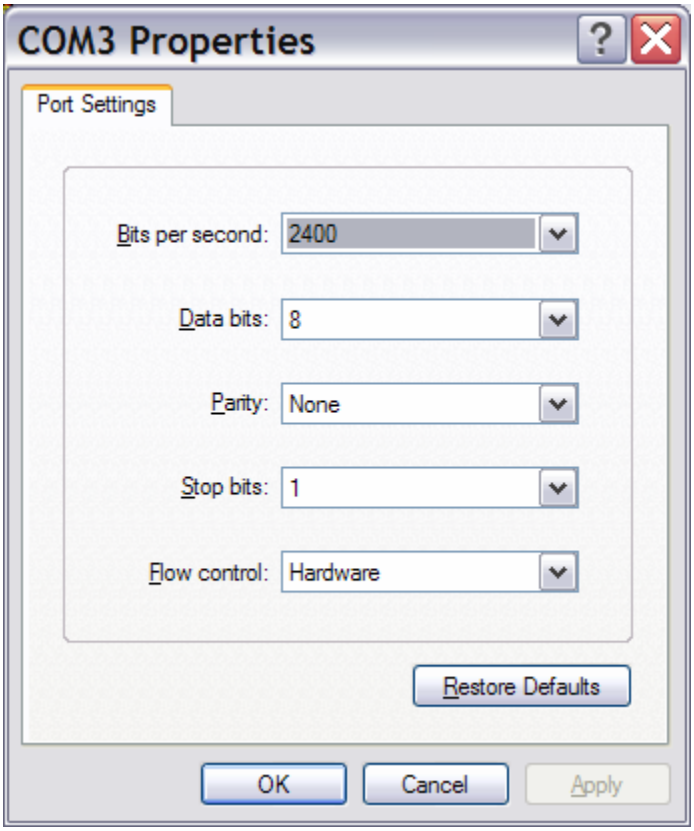


Figure 8: Hyperterminal Port Settings

3.2.5. Step 5: Configuring Port Settings

Select 19200 bits per second (Baud rate) if you are using a modem set at 19200 Baud, which is recommended for the CR800 series, the CR1000, and CR3000 dataloggers (Figure 9). Select 9600 bits per second if you are using a modem set at 9600 Baud (eg. CR10X). The remaining settings (Data bits, Parity, Stop bits, and Flow control) can be left as the default setting. Click Apply, and then click OK.

Note:	**The datalogger being used at the remote station will dictate which modem type is to be used. For example if you are using a CR10X, then you will require a modem set to 9600 Baud. This must be determined before ordering an Iridium Satellite System.**

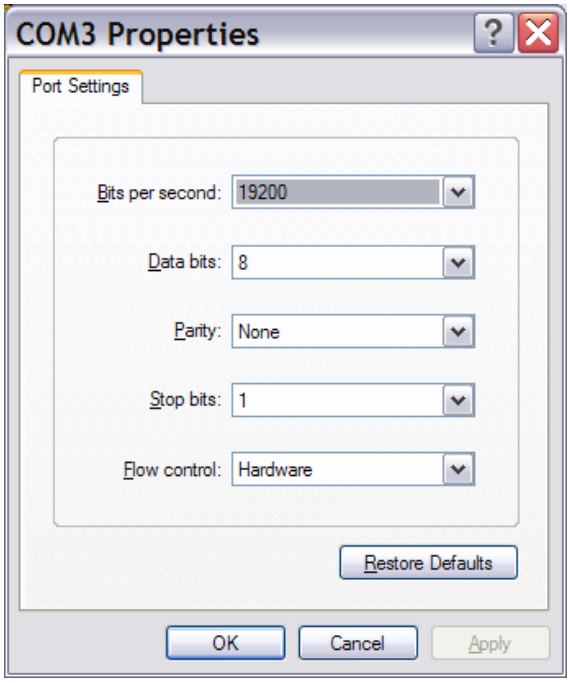


Figure 9: Port Settings Configured

3.2.6. Step 6: Hyperterminal Communications

Once you have clicked OK you should be connected to the modem (Figure 10). The counter in the bottom left hand corner of the screen will inform you that you are connected and begin counting up from 0.

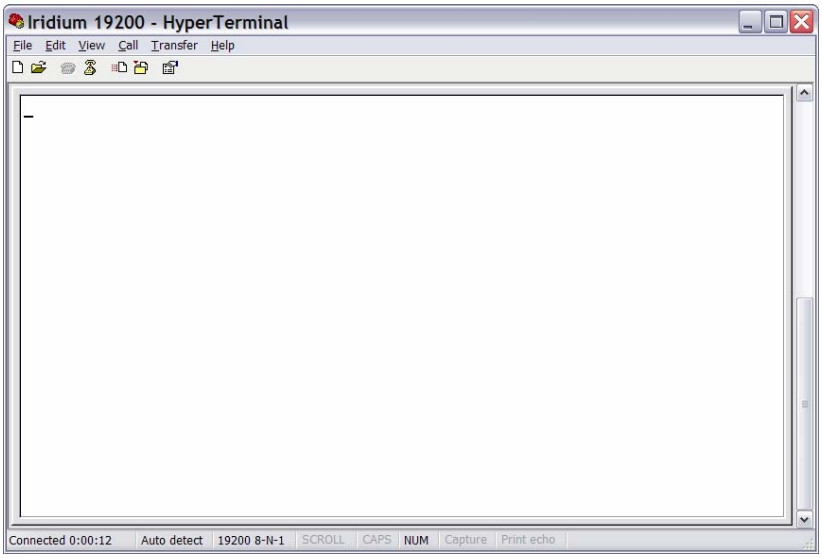


Figure 10: Hyperterminal Screen

The following AT commands are for modems released after March 30, 2006 (AT command Ref V2.6). Begin with typing:

ATV0 then press the “Enter” key.

This will bring the modem out of its verbose mode and the modem should return: **0TV0**

Then type the following command string that correlates to the datalogger and/or Baud rate being used:

CR1000 OR 19200 BAUD: **AT&F0 S0=1 &D3 +IPR=6 V0 &K0 &W0 &Y0**

CR10X OR 9600 BAUD: **AT&F0 S0=1 &D3 +IPR=5 V0 &K0 &W0 &Y0**

Press “Enter” once the string has been input. See Figures 11 and 12 for an example.

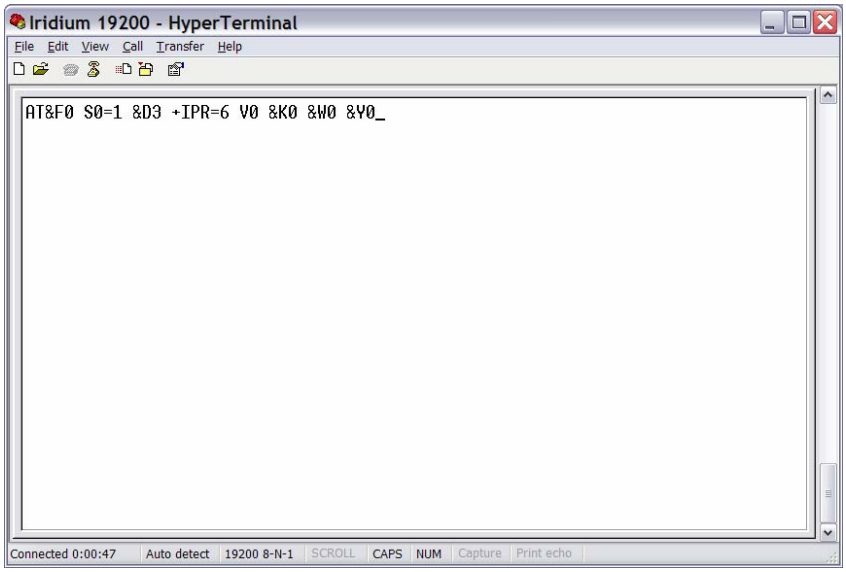


Figure 11: CR1000 AT Command String

The modem should return a 0 in the place of the first character (Figure 12).

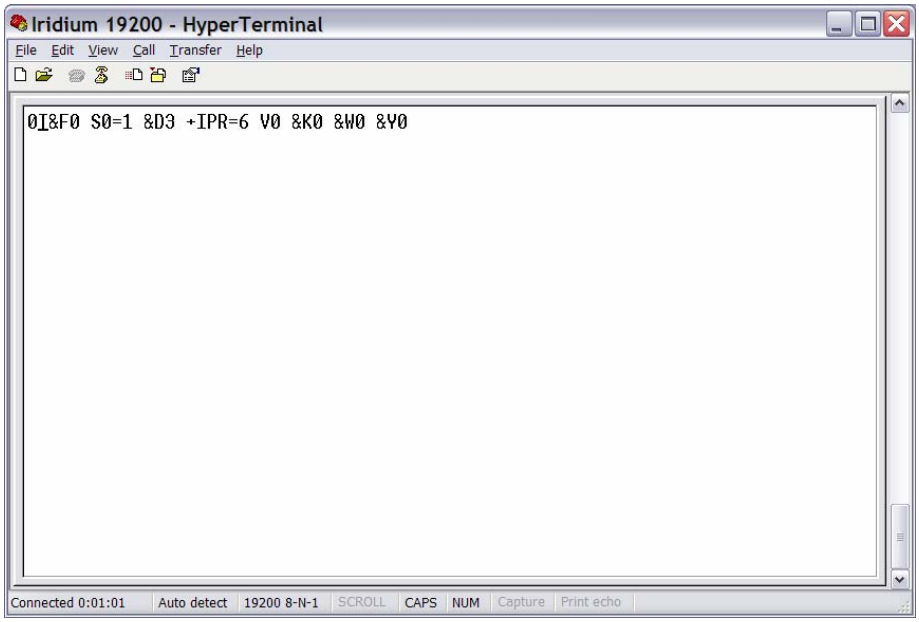


Figure 12: A3LA-MPT Modem Reply to Command String

To ensure that the settings have been stored in the modem type the command: **AT&V**

The modem will return the following as seen in Figure 13.

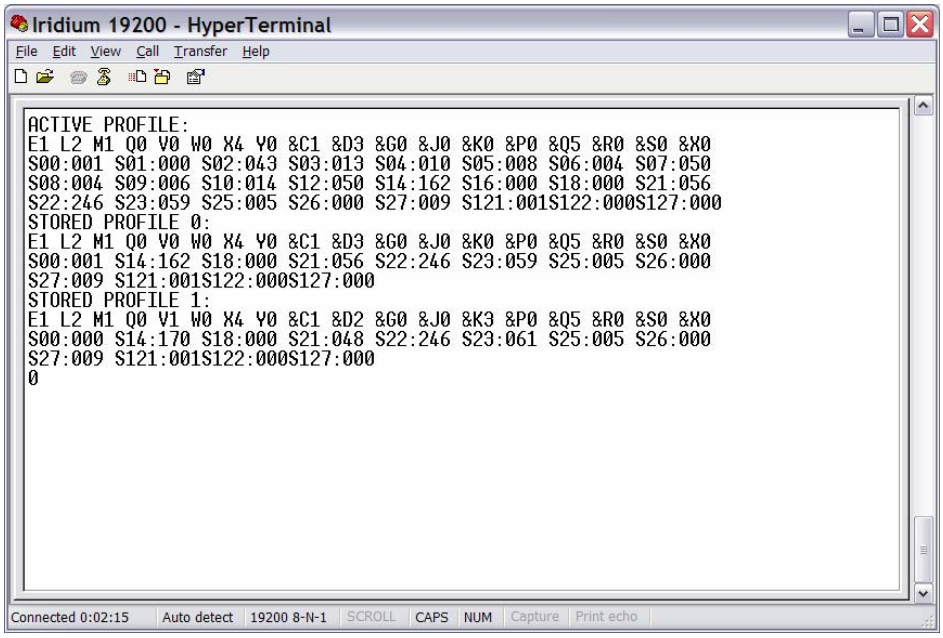


Figure 13: A3LA-MPT Modem Setting Confirmation

This is a summary of the currently active modem profile and ensures that when power is cycled to the modem it will have the correct baud rate and auto-answer settings. For more

information on the AT commands used by the modem, see the document entitled 'ISU AT Command Reference' included on the A3LA product CD. Once the final command is entered the modem is ready to use. Exit Hyperterminal and save your settings for later.

4. LoggerNet Configuration

This Section deals with the proper software setup of a remote station in Campbell Scientific's LoggerNet datalogger support software. All screenshots are based on the CR1000 datalogger. Please note that the array based dataloggers (i.e. CR10X) can also be configured in a similar fashion in LoggerNet.

4.1.1. Step 1: LoggerNet Setup

Start the LoggerNet software package and open the Setup applet from the main menu. Start the configuration by clicking on the Add Root button. From the "Add" submenu make the following selections:

- ComPort,
- PhoneBase,
- PhoneRemote,
- Generic,
- PakBusPort
- CR1000

Finally click the close button in "Add" submenu. Your setup tree should appear as in Figure 14.

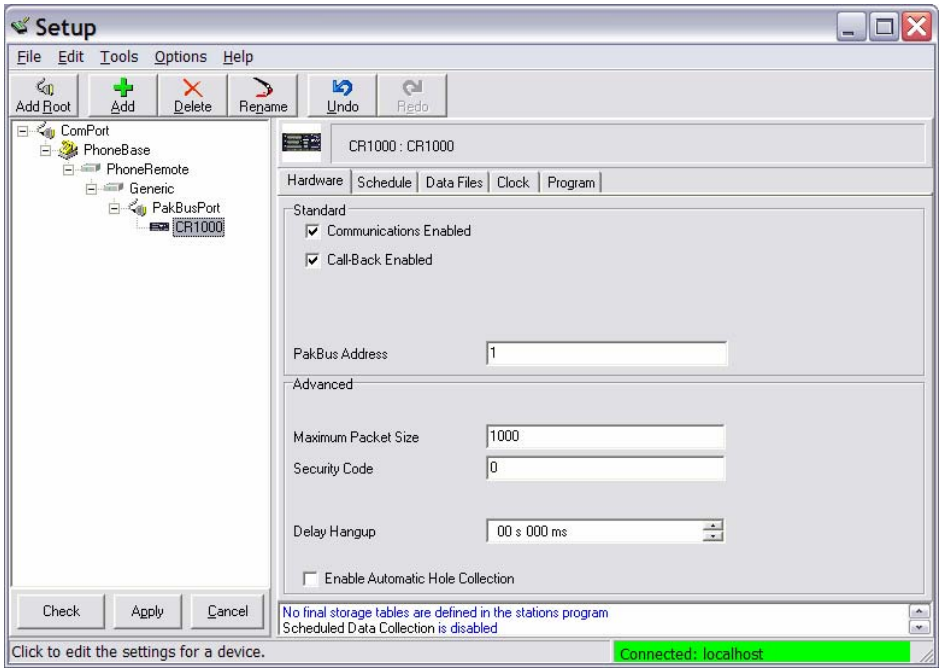


Figure 14: LoggerNet Setup Tree

4.1.2. Step 2: ComPort Configuration

With the Setup tree entered, you will now need to complete the configuration of each element. Start with selecting the ComPort element at the root of the tree (Figure 15). Be sure that the Com Port Connection is correct for the computer used as part of your Base Station, and make sure that the Communications Enabled box is checked. Under Delay Hangup, add a delay of 200 ms. This will prevent LoggerNet from hanging up whenever there is a slight lag in transmission time, which is common in Satellite applications.

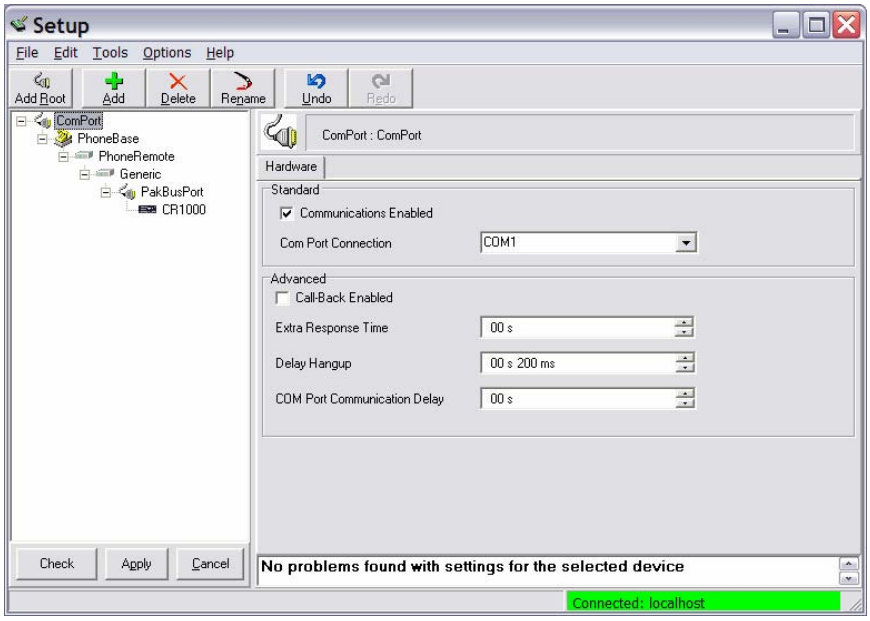


Figure 15: ComPort Configuration

4.1.3. Step 3: PhoneBase Configuration

Select the PhoneBase element as in Figure 16. Be sure the Communications Enabled box is checked. Adjust the Maximum Baud Rate to 19200 Baud (9600 for a CR10X) and add a 200 ms delay. Move to the PhoneRemote element once complete.

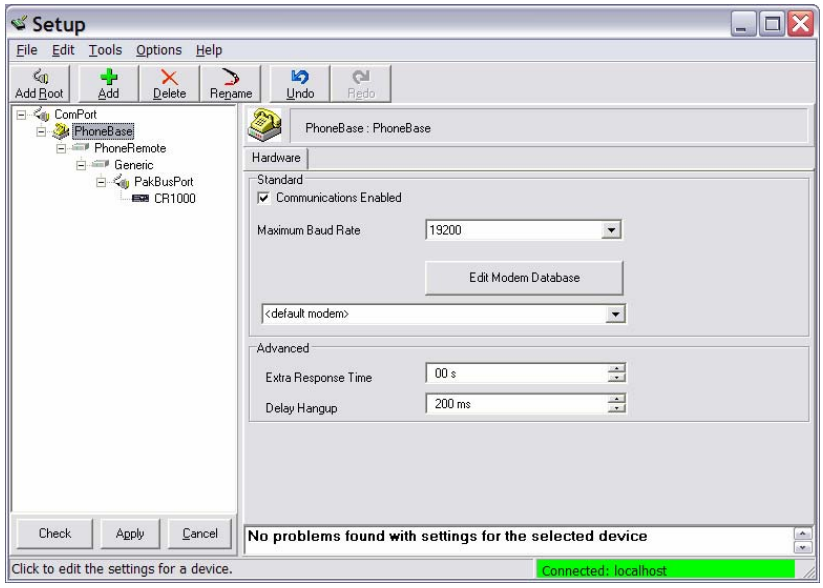


Figure 16: PhoneBase Configuration

4.1.4. Step 4: PhoneRemote Configuration

In the Delay section add 200 ms and in the Phone Number section type “00” followed by the 12 digit voice number supplied with the SIM card installed in the modem you will be dialing (Figure 17). Make sure that the Communications Enabled box is checked.

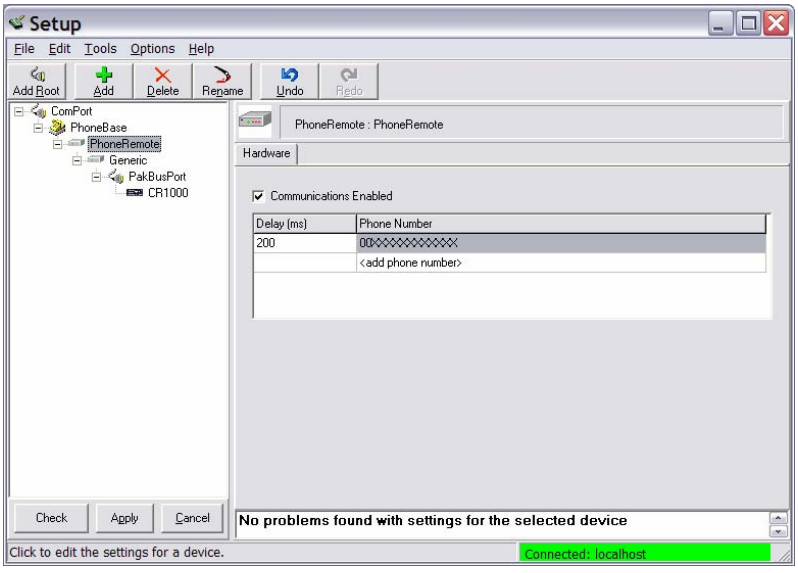


Figure 17: PhoneRemote Configuration

4.1.5. Step 5: Generic Hardware Configuration

In the Generic element be sure that the Communications Enabled box is checked, change the Maximum Baud Rate to

19200 (9600 for a CR10X), add 2 seconds to the Extra Response Time, and add 200 ms to the Delay Hangup (Figure 18). The remaining settings can be left in their default state. Once complete move to Step 6 to finish the configuration of the Generic element.

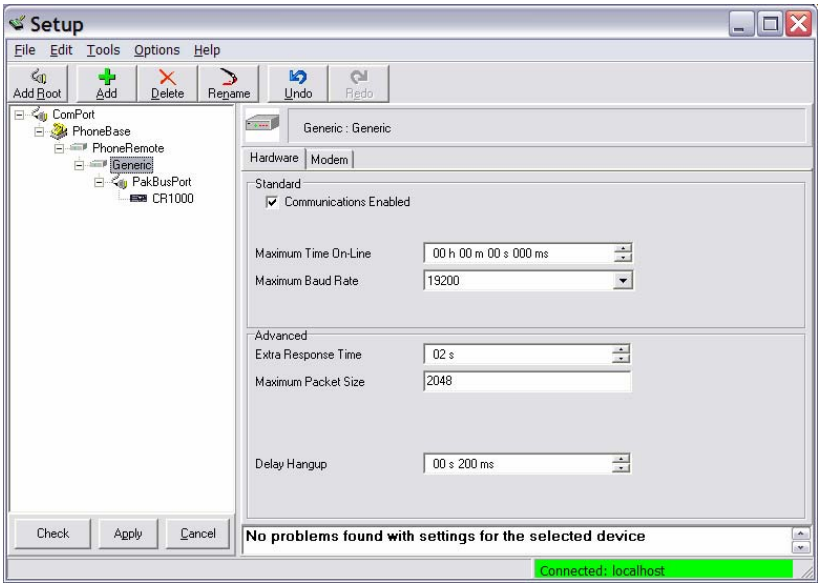


Figure 18: Generic - Hardware Configuration

4.1.6. Step 6: Generic Modem Configuration

Click on the Modem tab located next to the Hardware tab (Figure 19). In the Dial Script box enter D8000. This will program the software to expect an 8 second delay in communications, which common in many satellite applications. The remaining settings can be left in their default state.

If you are communicating with a PakBus datalogger, then follow the configuration listed in Step 7. Otherwise ignore Step 7 and move to Step 8.

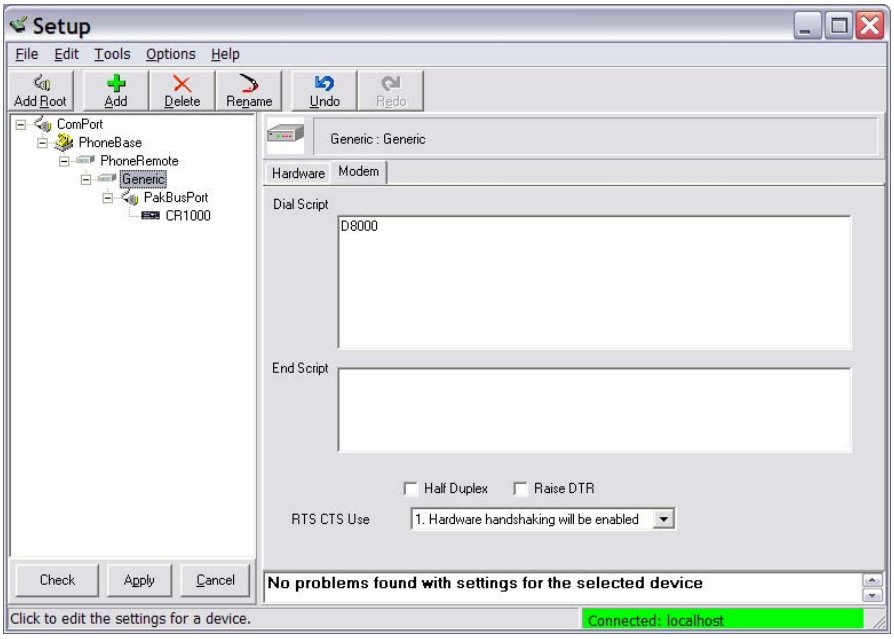


Figure 19: Generic - Modem Configuration

4.1.7. Step 7: PakBusPort Configuration

As in Figure 20, be sure the Communications Enabled box is checked, change the Maximum Baud Rate to 19200 (9600 for a CR10X), and add a 200 ms delay under Delay Hangup. You may change other settings in this configuration to suit your particular application. Once complete move to Step 8 in order to configure the datalogger.

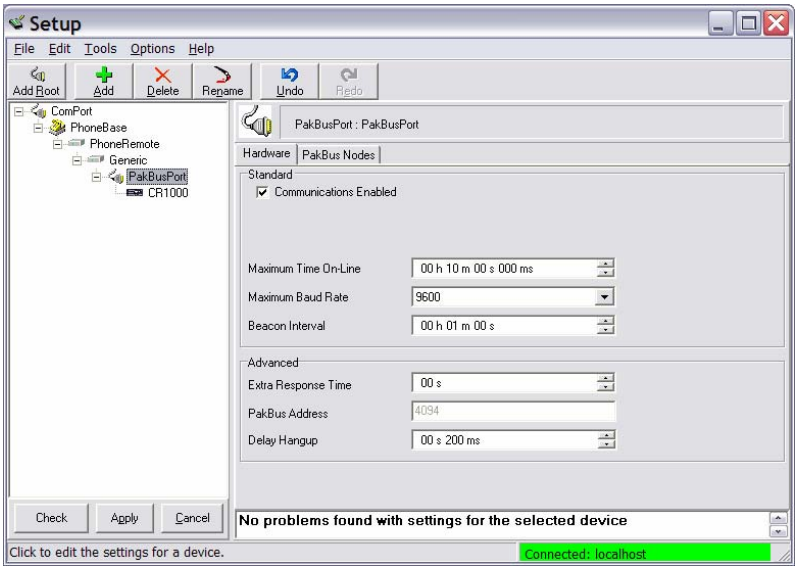


Figure 20: PakBus Port Configuration

4.1.8. Step 8: CR1000 Configuration

Be sure that the Communications Enabled box is checked and that the PakBus Address is correct for the datalogger being used. Add 200 ms under Delay Hangup (Figure 21).

Once all configuration are complete click the Apply button in the lower left hand corner. The station is now set up in LoggerNet.

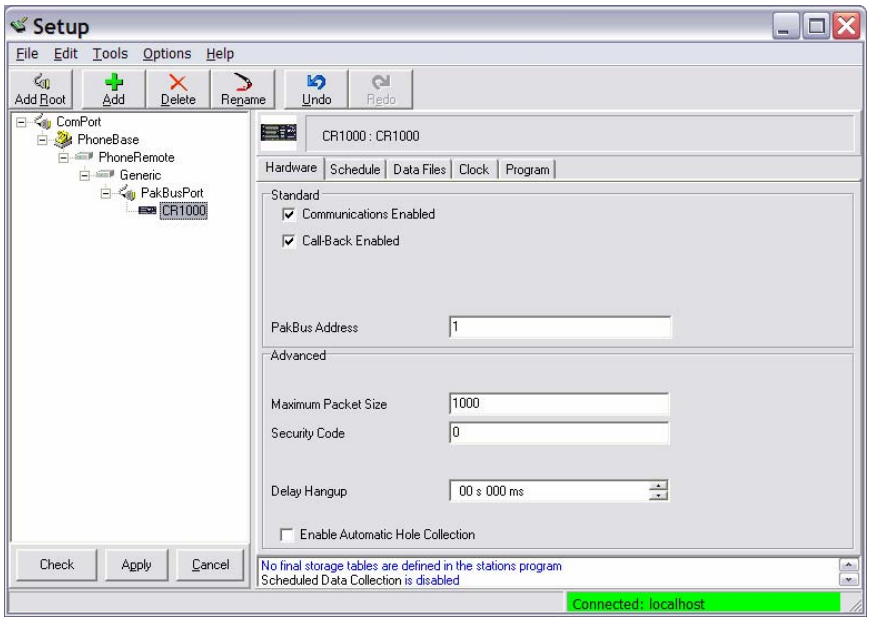


Figure 21: CR1000 Configuration

5. Troubleshooting Tools and Tips

Problem: I have intermittent successful connections between the remote and base station modem, but my signal strength is weak and the data transfer speeds are slow.

Solution: The antenna may not have a complete 180° view of the sky. Some objects and debris such as snow and trees can interfere with communications. Make sure that there are no obstructions to the antennas when installing. You may need to reposition or elevate your antenna to obtain the best reception.

Problem: LoggerNet immediately brings back an error message saying that communications with the station have failed.

Solution: Sometimes PakBus© beacons sent to other stations by LoggerNet interfere with successful communications using Iridium Satellite Modems. Either turn PakBus© beaconing off or disable communications with your other stations when you attempt to download using Iridium. This can be accomplished in the Setup applet in LoggerNet. Finally, reboot LoggerNet to clear the communications queue of any tasks.

Problem: I am using Iridium to communicate through the CS I/O port on my datalogger. Whenever I try connecting with the datalogger LoggerNet reports that communication with the station has failed. This message takes several seconds to appear.

Solution: You may have connected your SC932A device backwards at the remote station. When you install the SC932A it is imperative to make sure that the device is connected in the proper way. Follow the label on the device for the proper connections.

6. Appendix A: Sample Data Transfer Calculations

Note:	**The calculations below are based upon maximum theoretical throughputs. Real world transmission times for the Iridium Satellite Network have proven to be as much as twice as slow.**

When transmitting the data back from the station, the power consumption of the A3LA modem must be taken into account in order to avoid excessive discharge of the battery power supply. To get an idea of what the transmission time and associated power drain might be for a typical metrological station, consider the following example:

A station measures wind-speed and direction, precipitation, temperature and relative humidity, solar radiation, and barometric pressure. The datalogger is a CR1000. The monthly data file contains 2 data tables; a small maintenance table and a 30 parameter meteorological data table. The size of a monthly ASCII data file is 124Kb.

If the station's data were downloaded monthly, the time (T) for the data transfer could be calculated as shown below:

$\mathbf{T}_{(\text{Download})}$ = File size (Kb) / Transfer Rate (72 Kb/min)

With a file size of 124 Kb and a transfer rate of 72 Kbytes per minute, the download time is approximately 2 minutes.

If the data were downloaded daily, the file would be much smaller, approximately 5KB. A daily data transfer time would be approximately 5 seconds. Please note that a 4 to 15 second connection time should be added to the above times to account for the initial connection time.

Table 2 below shows the transfer time depending on whether data is collected daily, weekly or monthly.

Collection Interval	File size (Kbytes)	Transfer time
Monthly	124	2 minutes
Weekly	35	30 seconds
Daily	5	5 seconds

Table 2: Data Transfer Time Estimates

The CR10X datalogger generates data arrays which are very similar in size to the table-based dataloggers. For example the station mentioned above generates a 124 Kb meteorological data table and a 2 Kb maintenance table each month. If a CR10X is employed to measure the same parameters the data arrays would be the same size.

Power Calculation

Note:	**When configuring a power supply (i.e. solar panel and battery) for a remote station it essential to design with the worst case scenario in mind. This will help to ensure that the station will perform as expected.**

The power calculation for data transfer can be carried out now that the transfer time is known. The A3LA series modem has the following power consumption characteristics:

- 0 mA when powered off
- 130 mA stand-by
- 1000 mA transmit

In order to minimize the current draw of the A3LA-MPT modem, it is recommended that a C1701 Relay be used to switch power for modem. The time slot for powering the modem must be long enough to allow for the complete downloading of the datalogger's data. Refer to Table 2 or make your own calculation based on the collection interval you intend to use.

It is advisable to make the time slot longer than the minimum download time required to allow for initial connection times and possible retries. It is also advisable to arrange the time slot during a time of day when the power supply is its most robust. For a solar powered station this would be the early afternoon.

The periods of power consumption in a day can be divided up as follows:

Period A: the modem is powered off – 0 mA
Period B: the modem powered up in stand-by mode – 130 mA
Period C: the modem is transmitting the data – 1000 mA

Now consider a 35 Kbyte data file size and a datalogger programmed power time slot of 1 hour; the Periods above become:

Period A = 24 hours - Period B – Period C
Period B = 1 hour – Period C
Period C = 30 Seconds (from Table 2)

We can substitute in the Period B and C values to obtain all Periods:

Period A = 23 hours = 0.0 Ah/Day
Period B = 59.5 minutes @ 130 mA = .1289 Ah/Day
Period C = 30 Seconds @1000 mA = .008 Ah/Day

The total draw for the data transfer is the sum of the periods, 0.1367 Ah/Day, one day per week.

Note:	**The Ah/Day value is obtained by multiplying the minutes in the Period by the current draw in Amperes and dividing the product by 60.**

7. Appendix B: Hardware Installation

The hardware shown in this Appendix consists only of hardware listed in Table 1. Although it may be possible to use other hardware, it will not be addressed in this Appendix.

Warning:	**Do not connect power to either the A3LA-MPT or A3LA-D modems, as damage to the equipment may occur.**

7.1. *SIM Card Installation*

These installation steps apply to both the Base and Remote modems. Be sure that the correct card is installed in the proper modem. Start by removing the cover on the top of the modem (Figure 22). This will require the use of either a 5/64 Allen Key or a Phillips screwdriver.

Open the card slot from the end labelled “Lock”, until it is in the position shown in Figure 23. Place the card in the slot in the proper orientation. The card notch will need to line up with the notch of the card slot. Close and lock the card slot into place (Figure 24). Once complete, replace the housing cover.

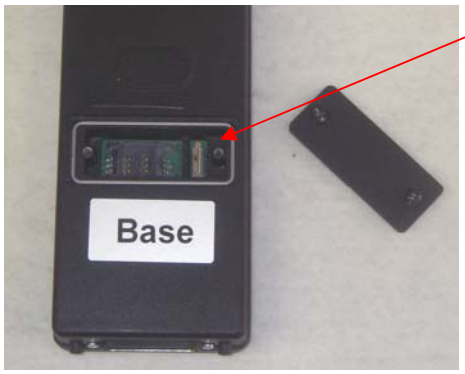


Figure 22: SIM Card Housing

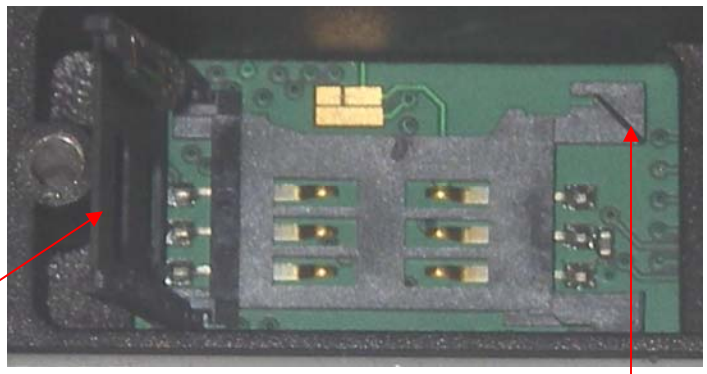


Figure 23: SIM Card Slot

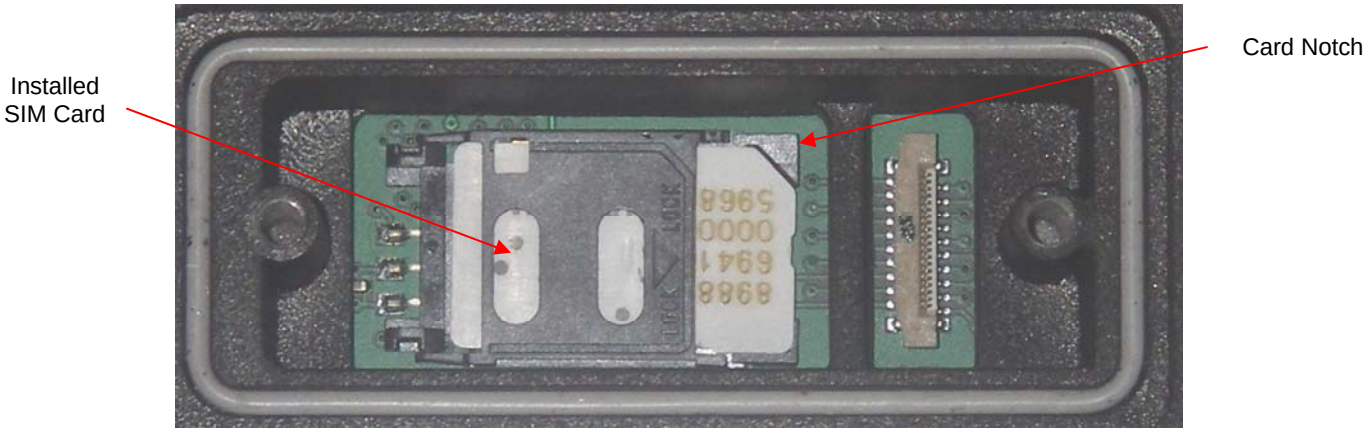


Figure24: Installed SIM Card

7.2. *Antenna Installation*

These instructions apply to both the Base and Remote stations. This installation does not have to precede the modem installation. It should be conducted in the must convenient and logical order.

The installation of the SAF5350A antenna and cable should begin with securing the Nu rail to the threaded pipe, and then feed the antenna cable through the threaded pipe (Figure 25). Next loosen the four Phillips screws at the base of the antenna and separate the two pieces. Feed the antenna cable through the bottom half and secure the cable to the connector of the other half (Figure 26). Once the cable is in place, reattach the bottom half of the antenna and secure the four Phillips screws. Be sure to use the alignment notches on the two halves before securing the antenna together.

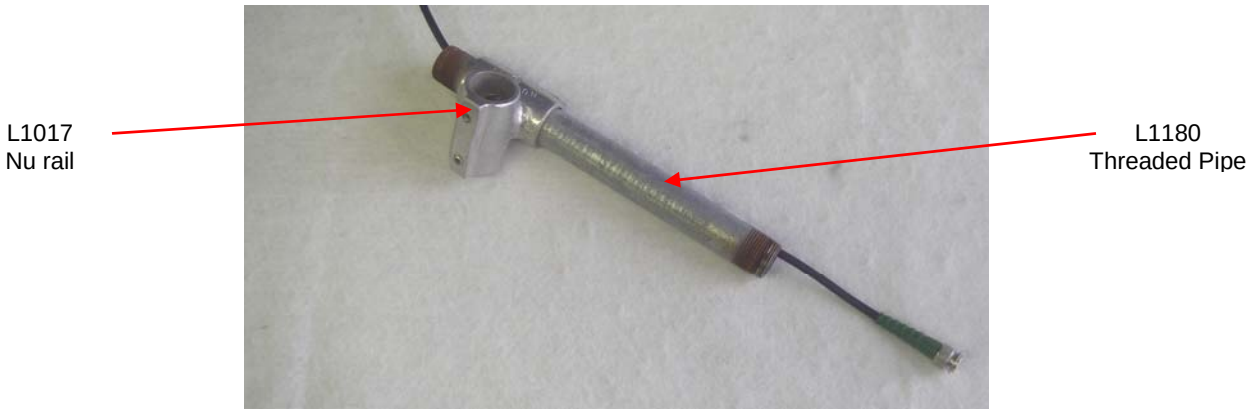


Figure 25: Antenna Mount and Cabling



Figure 26: Antenna and Cable Connected

Thread the antenna onto the L1180 pipe, being sure not to cross the threads (Figure 27).



Figure 27: Antenna Attached to Mount

With the antenna attached to the L1180 pipe it is now possible to mount the unit to the structure to be used. As shown in Figure 28 the Nu rail is mounted to a ¾" by 6' crossarm. It is also possible to use the 019WM or 019WMTOW, which are available from Campbell Scientific. These will allow you to mount the antenna to Campbell Scientific's standard suite of tripods and towers.

Secure the cable at the antenna, providing a dew loop, and secure the remaining cable to the mounting structure.

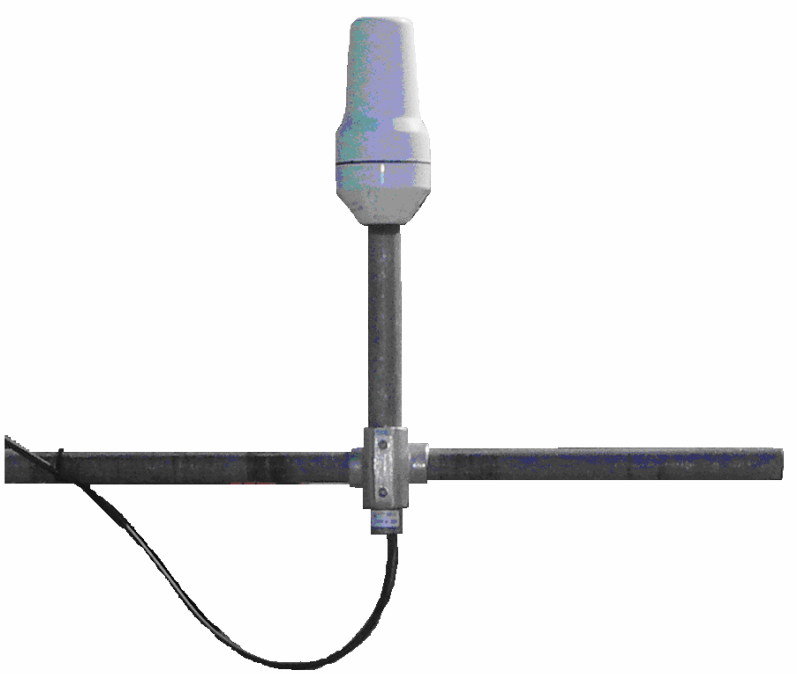


Figure 28: SAF5350A Antenna Mounted

7.3. *Base Station Installation*

The Base station installation should be conducted before proceeding to the field to conduct the Remote station installation. With the Base station installed first, it will provide the opportunity to test the communications from the Base station while still in the field. If something is malfunctioning you may be able to address the problem without having to return to the Remote station.

Start the Base station installation by securing the 25-pin D-Sub of the HRC248 Data Kit to the 25-pin connector of the A3LA-D modem (Figure 29). Conduct the following steps as part of the installation procedure (Figure 29):

1. Connect the DPLS0401-412 Handset to the DPL port on the HRC248 Data Kit.
2. Connect the L10873 serial cable to the Data port of the HRC248 Data Kit.
3. Connect the Antenna Cable with Antenna to the A3LA-D modem.
4. Connect the LA3098 AC Adapter to the DC IN port of the HRC248 Data Kit. Only connect to power if the Antenna is attached to the modem.

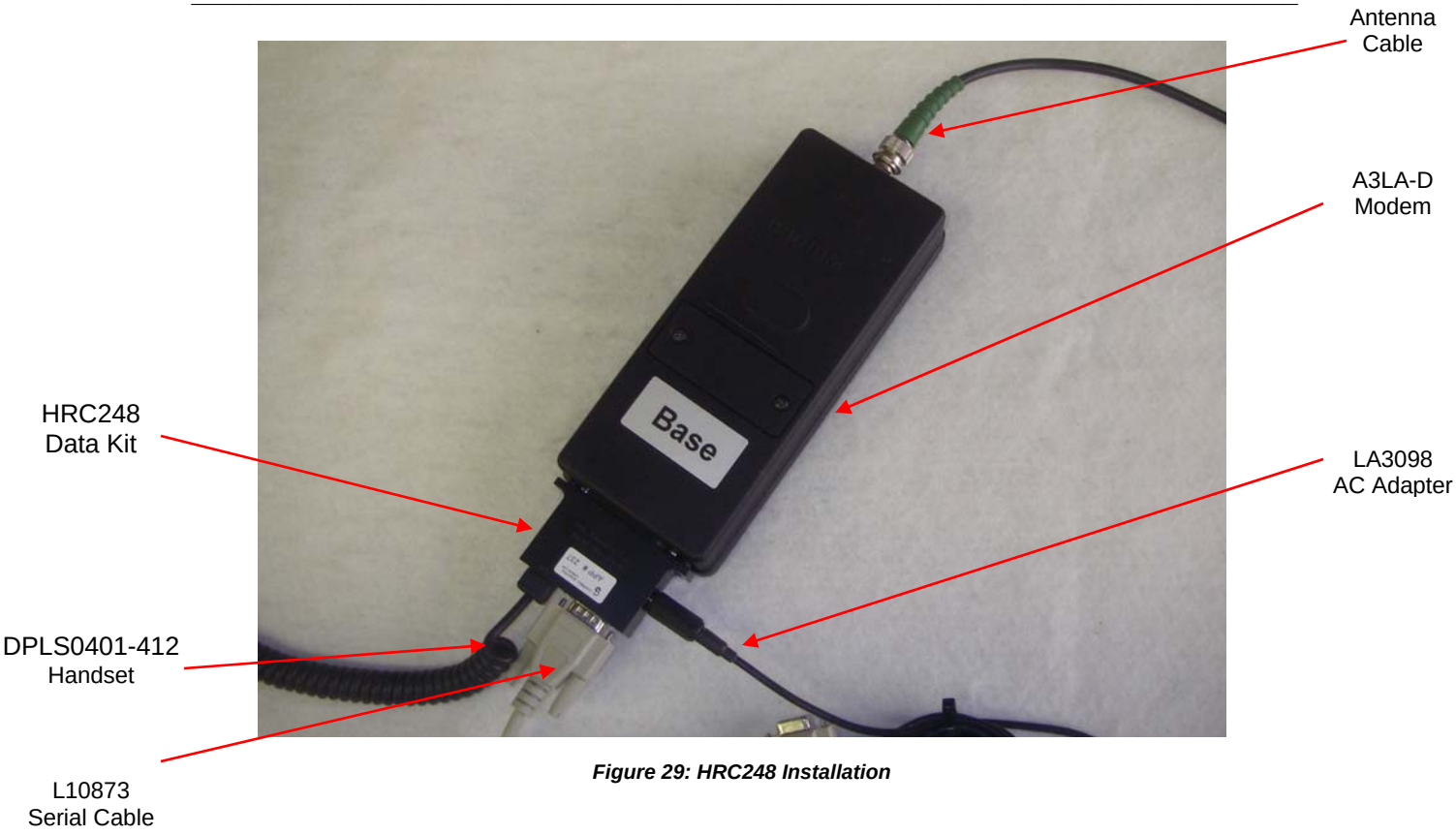


Figure 29: HRC248 Installation

Once all the items are attached, connect the AC adapter to power. With power applied the handset should power up and start searching for service (Figure 30). When service is found the modem will automatically complete the registration process. When complete the modem will go to its default state (Figure 31).

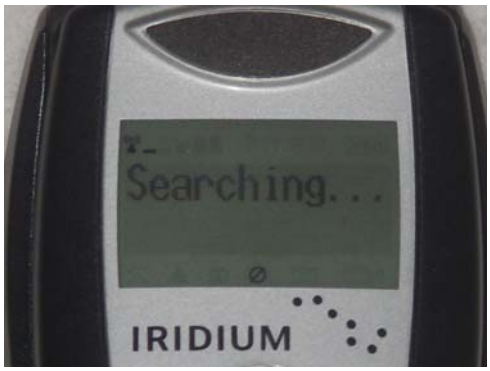


Figure 30: A3LA-D Powering Up



Figure 31: Active A3LA-D Modem

The Base station modem is now active and ready for use. The modem can be powered down in the meantime while the Remote station modem is being installed. This can be done with the power button located on the handset.

7.4. *Remote Station Installation*

The following schematic in Figure 32 is an example of a typical Remote station installation. This schematic will be addressed in the installation instruction below. It is however not the only possible configuration. If you intend to use a different configuration please contact Campbell Scientific to discuss any possible requirements.

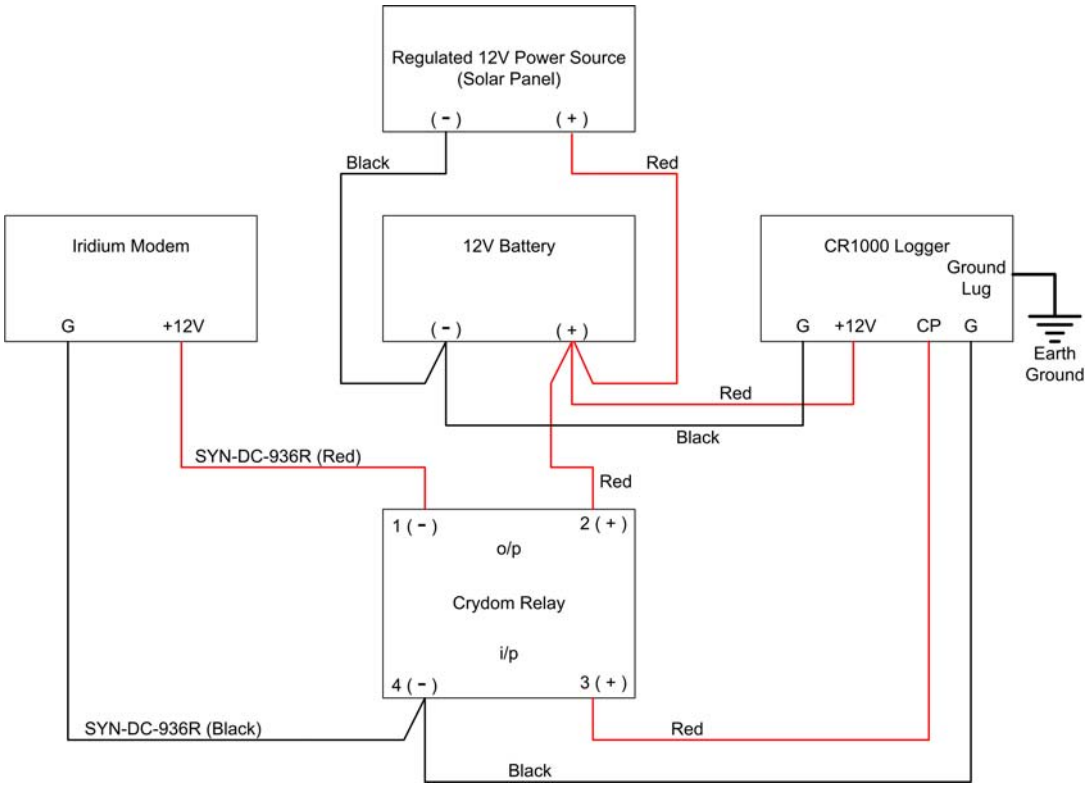


Figure 32: Remote Station Installation Schematic

A central component in this installation is the C1701 Crydom relay, and the available literature for the relay should be referenced. Being controlled by the datalogger, the relay switches power from the battery to the A3LA-MPT modem with the use of a Control Port. As in the example to follow a ring terminal (or other connector) could be required to connect the relay to the battery power supply.

The predetermined communications window must be included as part of the datalogger programming, and must also be coordinated with the Campbell Scientific Software being used to retrieve data (Contact Campbell Scientific for support if required). Once power is switched off by the relay communications are no longer possible until the next communications window.

Note:	**An Earth Ground connection must be made at the datalogger in order to provide a common ground for all components (Figure 32).**

Start the installation by connecting the SYN-DC-936R to the A3LA-MPT modem (Figure 33). Next connect either end of the L18663 null modem cable to the 9-pin serial port of the SYN-DC-936R (Figure 34).



Figure 33: SYN-DC-936R Connected

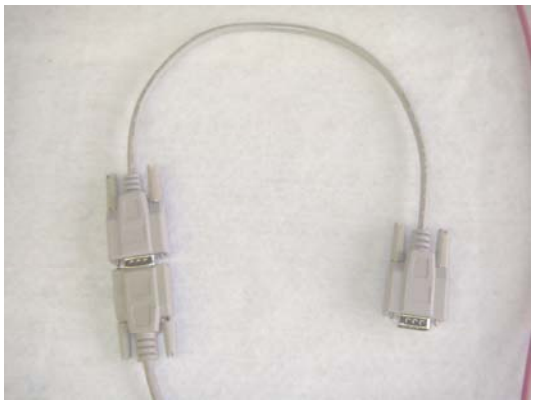


Figure 34: L18663 Null Modem Cable

With the null modem cable connected, you will need to connect the SYN-DC-936R ring terminals to the Crydom relay. Please note that in this configuration the lead from terminal one of the relay is not required and should be removed.

Start with removing the screw from terminal 1 of the relay. Attach the larger ring connector of the red lead to terminal 1 (Figure 36). Next remove the screw from terminal 4 and attach the smaller ring connector of the black lead to terminal 4. Be sure that the second black lead of terminal 4 also remains connected (Figure 36). Refer to the schematic in Figure 32 for additional information regarding these relay connections. An overview of these steps can be seen in Figure 37.

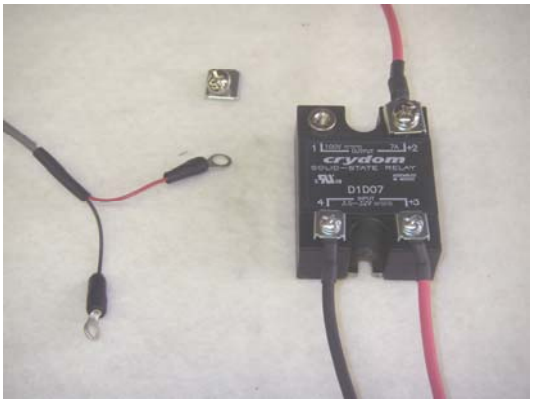


Figure 35: Ring Terminals & Relay



Figure 36: SYN-DC-936R & Relay Connected

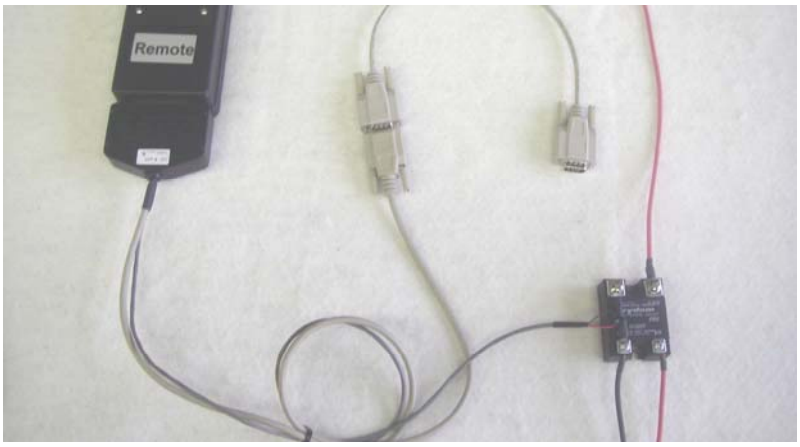


Figure 37: SYN-DC-936R, Relay, and Null Modem Cable Connected

With the previous steps completed, you can now connect the L18663 null modem cable to the RS232 port of the datalogger (Figure 38). Connect the Antenna cable to the A3LA-MPT modem. Next connect the black bare lead of the relay terminal 4 to a Ground terminal on the datalogger, and the red bare lead of terminal 3 to the corresponding datalogger Control Port (Figure 38 Inset).

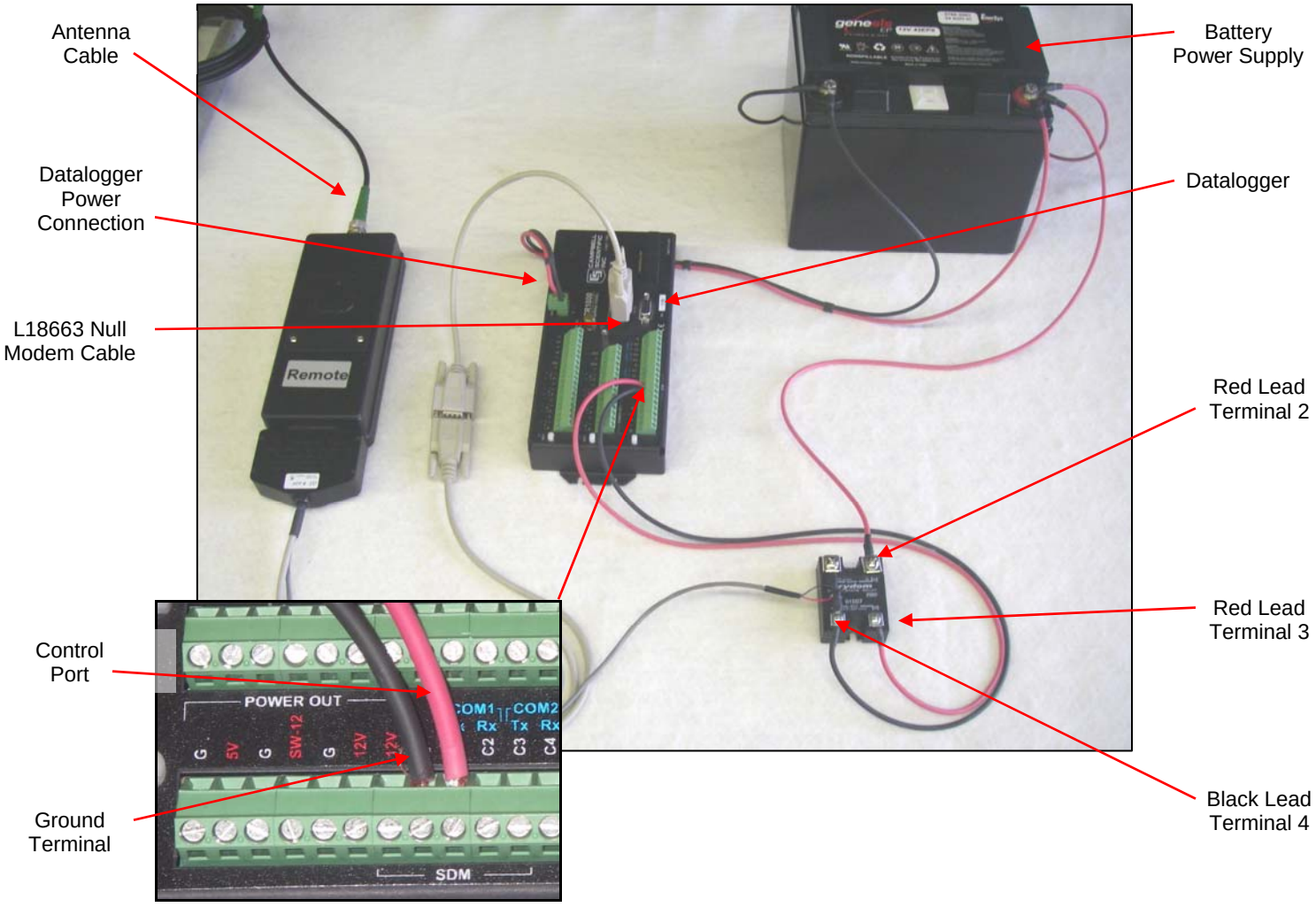


Figure 38: Remote Station Installation with Datalogger Inset

The datalogger receives power from the battery via the green power connection plug shown in Figure 38. The black lead connected to the "G" of the plug is connected to the negative terminal of the battery. The red lead connected to the "12V" of the plug is connected to the positive terminal of the battery (Figure 38).

The Crydom relay also receives power from the battery power supply. The red lead of terminal 2 is connected to the positive terminal of the battery (Figures 32, 38 & 39). The final connection to the battery is from the regulated power source (i.e. Solar Panel). This connection to the battery can be seen in Figures 32 and 39.



Figure 39: Battery Power Supply Terminals

With these connections made and power available to the modem you should be able to test the Remote station communications. You will need to ensure that the Control Port used can be switched on so that power can be supplied to the modem. Once this is arranged, have the Base station call the Remote station to ensure that a connection can be made and communications can be performed with the datalogger.