



Goodrich ISR Systems

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## Piccolo Iridium Integration Guide

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## Piccolo Iridium Integration Guide Change Log:

### **May 6, 2010**

- Section 2.2: Added reference to A3LA-X adapter plate for Portable Ground Station.
- Section 2.4: Added A3LA-X with PGS adapter plate photo.
- Section 4.3: Added handset setup and integration note for Portable Ground Station.

### **January 19, 2010**

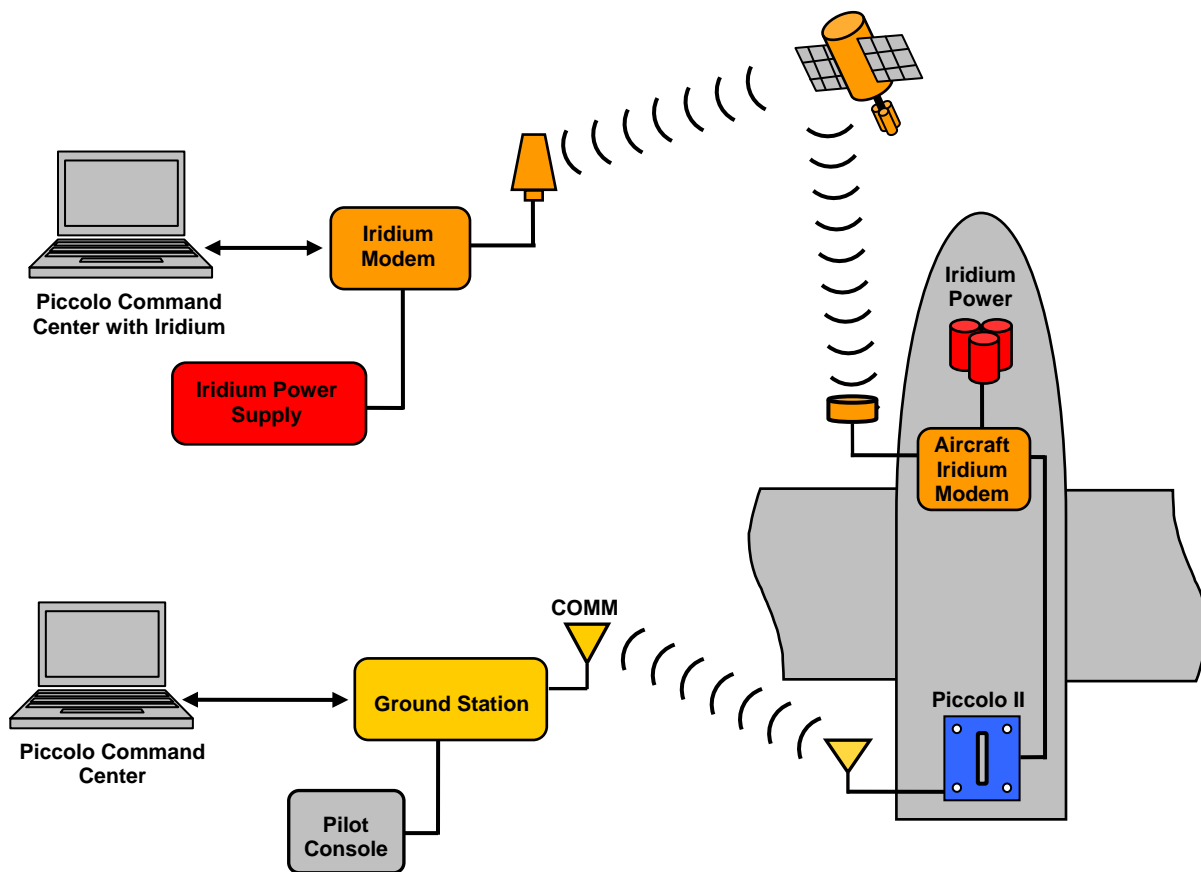
- Section 2.4: Replaced information and specifications for models A3LA-D and A3LA-SA previously used for CCT aircraft and ground stations with information for the A3LA-X modem. The A3LA-D and A3LA-SA are no longer available from NAL Research.
- Section 4.1: Added ground connection to the aircraft/Iridium\Piccolo-to-power board diagram.
- Section 4.2: Updated Desktop Ground Station diagram and information for the A3LA-X modem.
- Section: 4.3: Updated PGS diagram and information for the A3LA-X.
- Section: 4.4: Added single PC ground station Iridium configuration options.
- Section 8.1: Added legacy aircraft/Iridium/Piccolo-to-power board diagram for the 3LA-SC Iridium modem that is no longer available from NAL research.

# 1 Introduction

This document covers the setup and hardware required to integrate the Piccolo autopilot system into the Iridium network. This network is a satellite-based, wireless communications system designed to permit voice and data transmission to and from anywhere on the earth, at any time. The Piccolo autopilot and ground station rely on UHF signals for communication. UHF signals travel well over line-of-sight distances but are limited by radio range, mountainous terrain, and the earth's curvature. The Iridium global satellite network provides an immediate solution by providing coverage across all ocean areas, air routes, and all landmasses, even the poles. A host of Iridium satellite equipment options exist to meet your specific communications needs.

## 1.1 Piccolo Iridium Communications

There are a range of options made available to support Iridium communications within the Piccolo system to support customer operations as shown in **Figure 1**. The Iridium ground station system can also be configured with a single PC. A portable ground station with a built in Iridium modem option is also available from CCT. The Iridium path is connected to the Piccolo Command Center (PCC) on a separate COMM port. Communication with the Piccolo is through a separate instance of the PCC software.



**Figure 1 - Piccolo Iridium Communications**

## 2 Iridium Communications Hardware

### 2.1 Piccolo II

If you wish to utilize the Iridium communications option for your Piccolo autopilot system, we recommend using the Piccolo II with the Micro-D external interface cable. The interface cable plugs into the secondary interface I/O connector on the Piccolo II and provides additional connections for the aircraft Iridium modem.

If you are using the Piccolo Plus or Piccolo LT, see the *External Interface* document for more information about customizing the interface cable for Iridium communications.



**Figure 2 - Piccolo II I/O Connector**

### 2.2 Ground Stations

For the standard desktop Piccolo Ground Station setup (p/n 900-90002-00), the Iridium connections are independent of the ground station connections.

A Portable Ground Station is also available (p/n 900-90011-00) that supports an optional NAL Research modem that can be installed in the PGS case. The PGS is configured with all the harnesses and power connections for the Iridium modem (**Figure 3**).

**! The A3LA-X modem requires an adapter plate (p/n: A3LA-XPLATE) from NAL Research for installation in the Portable Ground Station (Figure 4).**



**Figure 3 - PGS with Iridium Connections**

The end-user is responsible for obtaining Iridium SIM cards and provisioning Iridium data service.

An optional audio handset is also supported, but to use the voice option your Iridium service must support both voice and data.

## 2.3 Modems

The system software and avionics interface is set up to work with any Motorola 9505 based Iridium modems. It is the responsibility of the end-user to acquire the modems, antennas and power sources for both the ground station and aircraft side of the modem link. There are a number of Iridium modems available that can be integrated into the Piccolo autopilot system, but the Portable Ground Station is configured to only accept the [A3LA-X](#) modem from [NAL Research](#).

**! The A3LA-X modem requires an adapter plate (p/n: A3LA-XPLATE) from NAL Research for installation in the Portable Ground Station (Figure 4).**

## 2.4 Recommended Modems

### 2.4.1 Aircraft Modem

For the aircraft and ground station, we recommend the A3LA-X from NAL Research.

***Note:** Model A3LA-X is a replacement for models A3LA-D and A3LA-SA previously used for CCT aircraft and ground stations. They are no longer available from NAL Research. All operating characteristics and software interfaces of an A3LA-X are the same as an A3LA-D and A3LA-SA.*



**Figure 4 - A3LA-X with PGS Adapter Plate**

Major differences between the A3LA-X and the A3LA-D/A3LA-SA include:

- Smaller form-factor
- Input voltage of 4-32VDC instead of 4-5VDC
- Two LED status lights
- ~10% higher in power consumption

### **A3LA-X Specifications:**

- Input voltage range: 4.0VDC to 32.0VDC
- Input Nominal Voltage: 12.0VDC
- Input Ripple Voltage: 40mV peak-to-peak
- Average data call current: 800mA @ 5.0VDC
- Avg. Standby Current: 300mA @ 5.0VDC
- Peak power-up current: 2.5A @ 5.0VDC
- Dimensions: 162 mm x 67 mm x 27 mm (6.38 in x 2.65 in x 1.06 in)
- Weight: 340 g (0.75 pound)
- I/O Interface: 25-Pin D-Sub, SIM Reader
- Operating temperature: -30°C to +70°C (-22°F to +158°F)

## 2.5 Recommended Antennas

### 2.5.1 Aircraft Iridium Antennas

Like modems, there are a number of sources available for Iridium antennas that would work in an aircraft fuselage. NAL Research has a small Iridium antenna (SYN7391-B) that weighs 31g and would be a good candidate, although CCT has not evaluated its performance. For most of our tests, we have used the Motorola mag-mount mobile antenna. The antenna options are detailed at [www.nalresearch.com/Antennas.html](http://www.nalresearch.com/Antennas.html).

*Note: All Iridium antennas require a ground plane except the mast mount antenna. The ground plane area figure typically quoted is 48 sq. inches, although we have successfully used less than that. Check the specifications for each antenna for the proper size and mounting configurations.*

### 2.5.2 Ground Station Antennas

We recommend the SAF5350-B mast mounted L-band antenna from NAL Research for most applications (**Figure 5**).



**Figure 5 - SAF5350-B Antenna**

### 2.5.3 Antenna Cables

There are a number of sources available for antenna cables. Times Microwave Systems has a small flexible coax cable (LMR-100A) that would be a good candidate. The antenna cable options are detailed at [www.timesmicrowave.com/](http://www.timesmicrowave.com/)

*Note: If you are running an antenna cable to the roof from inside a building, it must be a low-loss type (a 1.5 dB loss for the entire cable is acceptable).*

## 3 Iridium Services

Both the aircraft and Ground Station Iridium modems require a SIM card and service provisioning. There are a number of companies that provide these services and it is the end-users responsibility to coordinate them. The following are companies that provide Iridium services:

- NAL Research (provides data service only) 703-392-1136, [www.nalresearch.com/](http://www.nalresearch.com/)
- Personal Satellite Networks Inc, 703-330-9028, [www.skyhelp.net](http://www.skyhelp.net)
- World Communication Center, 800-211-2575, [www.wcclp.com](http://www.wcclp.com)

*Note: The information for Iridium services is provided for reference only. CCT does not have any history to verify the level of service provided by these contacts.*

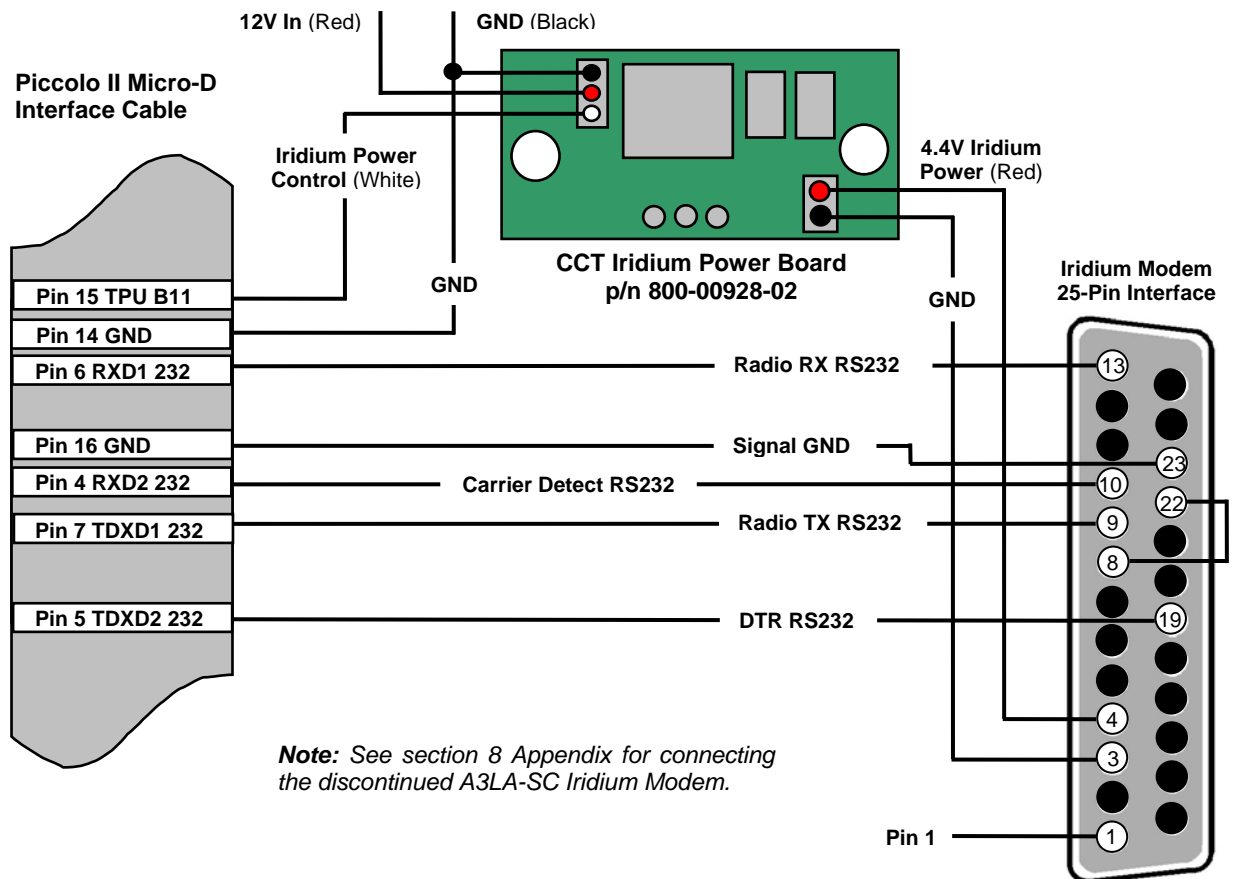
## 4 Hardware Setup

### 4.1 Piccolo to Aircraft Iridium Modem Connections

You can configure any 2 of the 5 available serial ports on the Piccolo II for connection to the Iridium hardware using the dropdown menu in the **Payload Com Settings** window of the PCC.

NAL Modem Pin #	Piccolo Interface Pin #	NAL Modem Signal	Piccolo Signal
*3	--	EXT_GND	Iridium Power Board External GND
*4	--	EXT_B+	Iridium Power Board 4.4 VDC
9	7	S_TX	Iridium TXD
10	4	DCD	Iridium Carrier Detect
13	6	S_RX	Iridium RXD
19	5	DTR	Iridium DTR
23	16	SIGNAL GND	Ground
--	*14	--	Power Board Ground
--	*15	--	TPU_B11 Iridium Power Control
8	--	RTS (Request to send)	--
22	--	CTS (Clear to send)	--

\*See Section 5 *Iridium Power Requirements* or more information about configuring this connection.



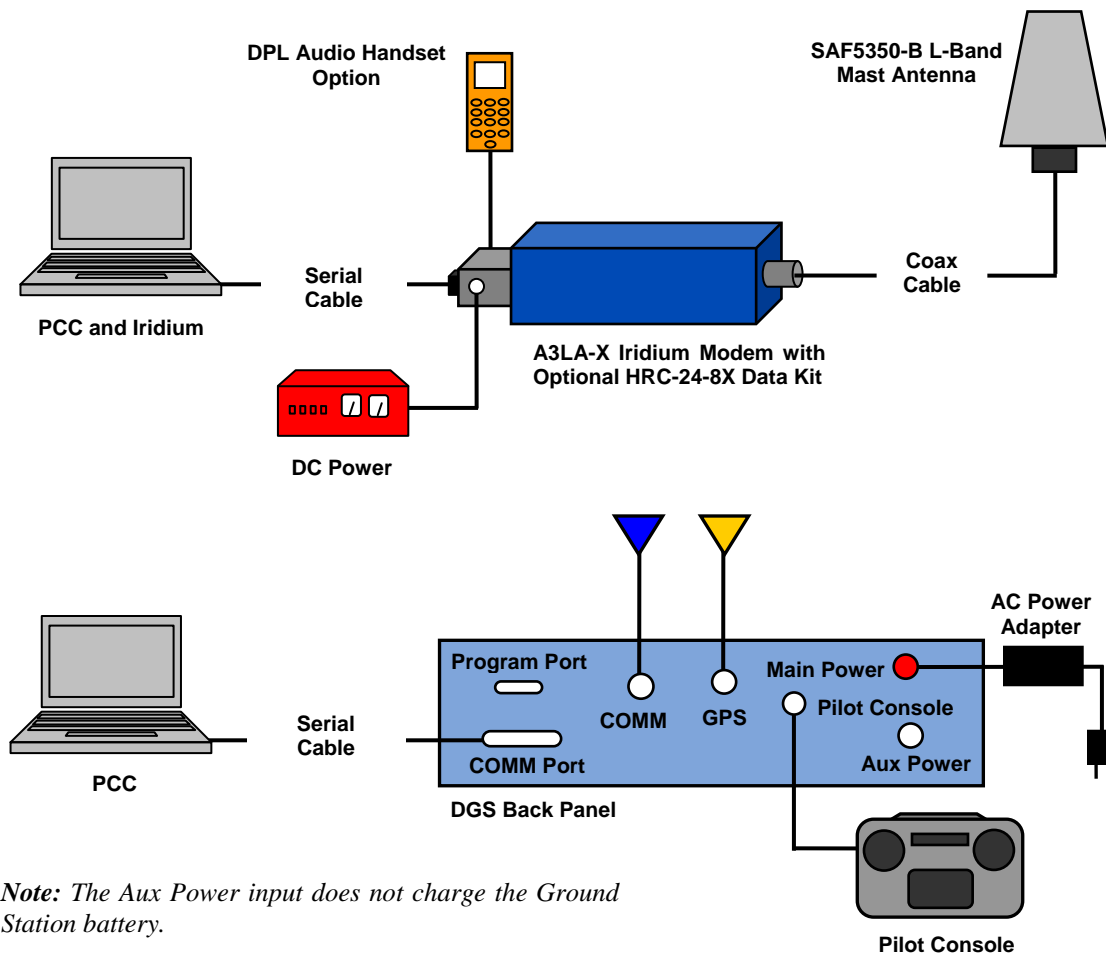
**Figure 6 - Piccolo to A3LA-X Aircraft Iridium Modem with Power Board Connection**

## 4.2 Desktop Ground Station with Iridium Modem

The [HRC-24-8X Data Kit](#) from NAL Research can be used to setup the Iridium modem with the Desktop Ground Station. It allows direct attachment of a DPL audio handset, a 9-pin RS-232 cable and DC power input to an A3LA-X series modem.

For a complete modem/handset solution, the [A3LA-XP](#) modem is a combination of an A3LA-X and a DPL handset. The added handset allows the A3LA-XP to place voice calls similar to an Iridium 9555 satellite phone. All data functionalities and hardware and software interfaces remain the same as the A3LA-X.

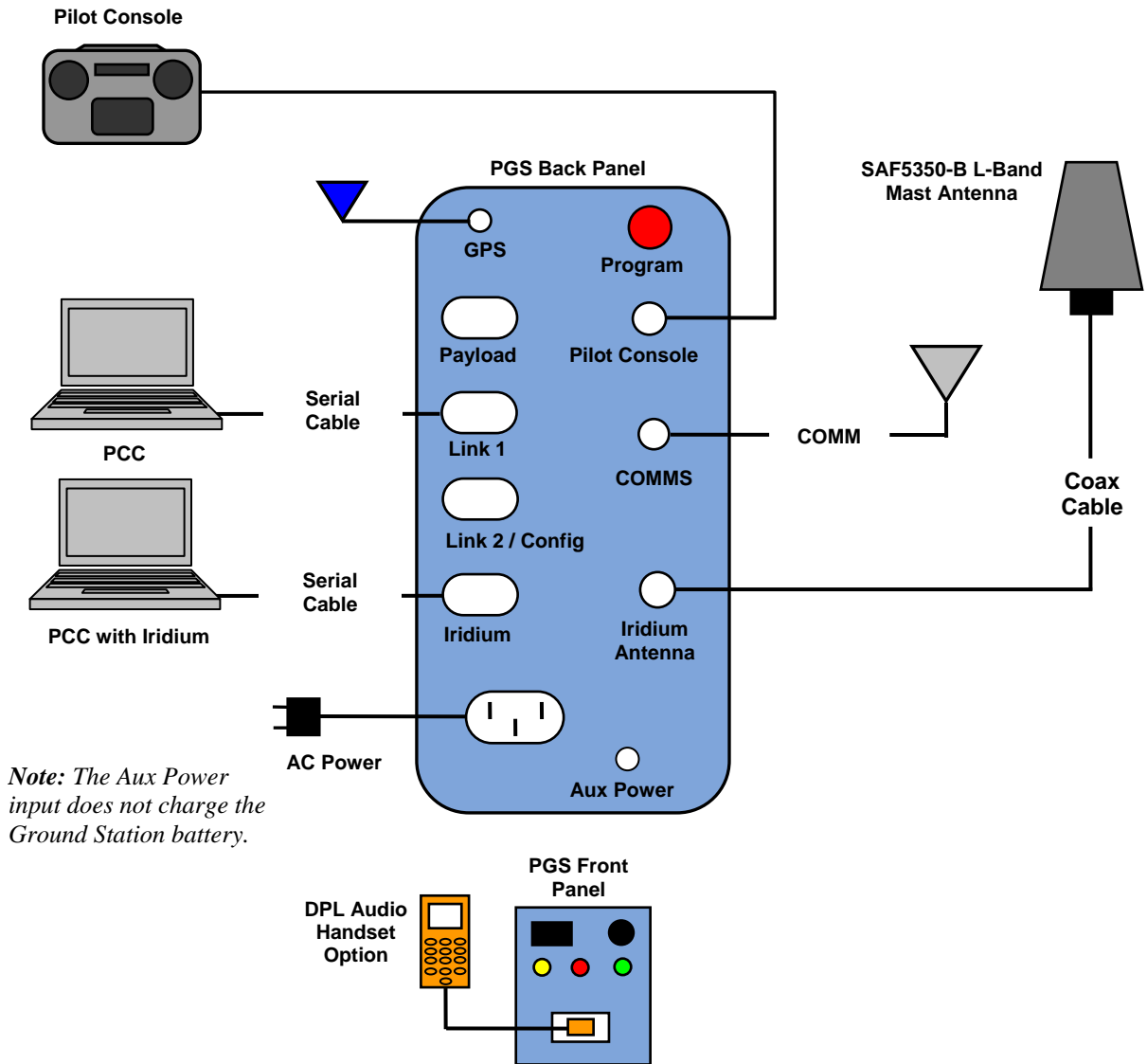
More information about Iridium modem accessories can be found at [NAL Research Accessories](#) page.



**Figure 7 - Desktop Ground Station with Iridium Modem**

*Note: The Iridium Desktop Ground Station system can also be configured with a single PC. See section 4.4 Single PC Ground Station Iridium Configuration for more information.*

### 4.3 Portable Ground Station with Iridium Modem



**Figure 8 - Portable Ground Station with Built-In Iridium Modem**

*Note: If you wish to use the DPL Audio Handset option with the A3LA-X modem in the Portable Ground Station, please [contact us](#) for integration and setup details.*

*Note: The Iridium PGS system can also be configured with a single PC. See section 4.4 Single PC Ground Station Iridium Configuration for more information.*

#### 4.4 Single PC Ground Station Iridium Configuration

The Iridium ground station systems can be configured with a single PC. The following are three configuration options:

- A single computer with one instance of PCC connected to the Iridium modem.
- A single computer with two instances of PCC running simultaneously, one for Iridium and one for the line of sight data link.
- A single computer running one instance of PCC, and one instance of [CommMaster](#). The CommMaster is a stand alone application from CCT that enables two active links to be established and maintained concurrently. For example, a single computer running a single instance of PCC can support two communication links (e.g. one radio link, and one iridium link). As the flight progresses, the operator has the choice to select which active communication link to use at any time.

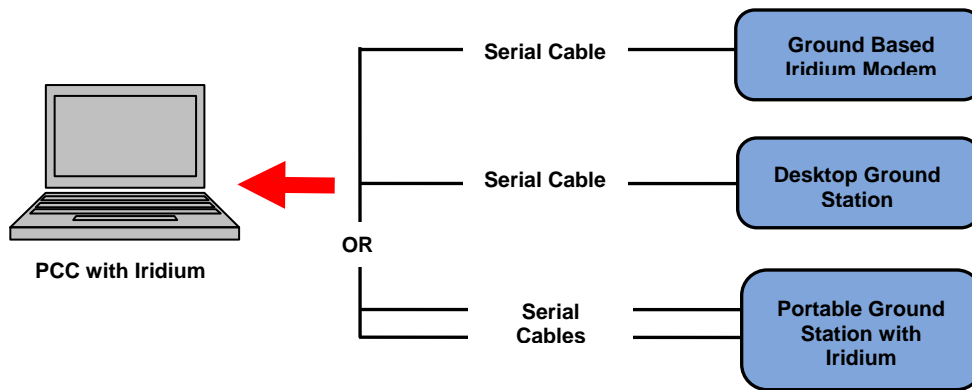


Figure 9 - Single PC Configuration

### 5 Iridium Power Requirements

The power requirements of the NAL Research Iridium modems have an input voltage range of 4.0VDC to 32.0VDC. Peak power-up current is 800mA @ 5.0VDC.

In some cases the modem may end up in a state where it does not auto-answer (no communications) and a reset is required. To address this issue, CCT provides an Iridium power board (p/n 800-00928-02). This power board is optional, but highly recommended. It is not only capable of powering the Iridium aircraft modem, it also includes a power control feature to allow the Piccolo to reset the modem in case of a lock-up by auto cycling the power.

Powering the modems directly from batteries without a way to reset the modem is **NOT** recommended.

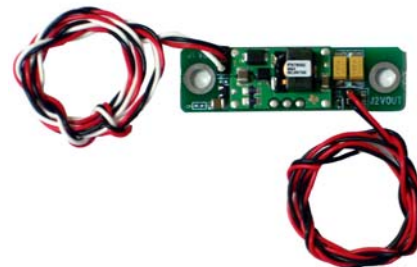
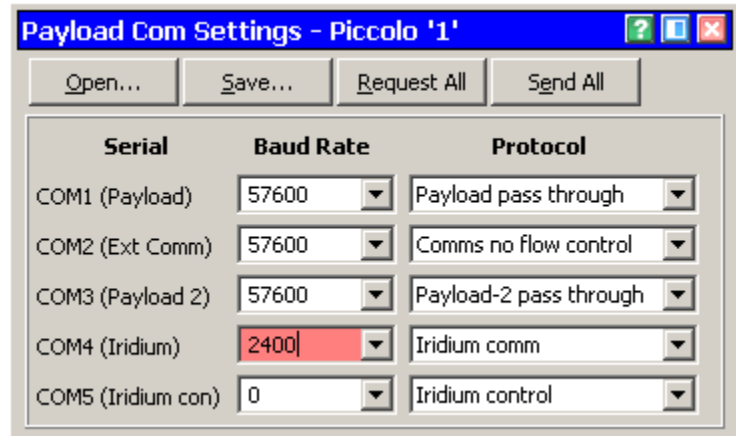


Figure 10 - CCT Iridium Power Board p/n 800-00928-02

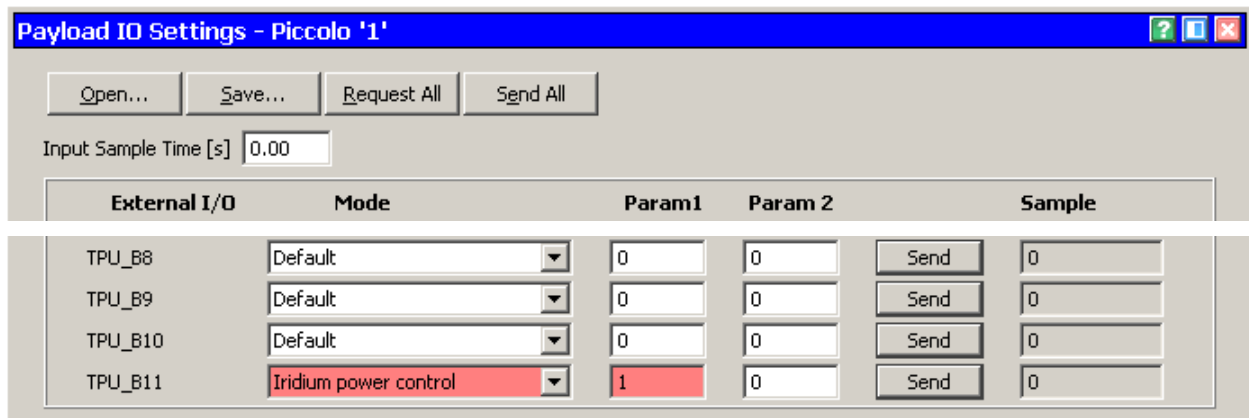
## 5.1 Configuring Power Control Option

Whatever power source you are using, the power control pin can be configured on any of the Piccolo payload pins in the PCC under the **Payload Com Setting** window. Any open digital I/O line can be used.



**Figure 11 - Payload Com Settings**

1. To configure the power control, start the Piccolo Command Center. Go to **Window » Preflight Windows » Payload Com Settings**.
1. Under **Protocol**, select **Iridium comm** in the pull down menu for **COM4**. For **COM5**, select **Iridium control** in the pull down menu. Set the Baud rate for **COM4** to **2400**.
2. Click **Send All** to set the Iridium protocols.
3. Go to **Window » Preflight Windows » Payload IO settings**. From any open External I/O line, select **Iridium power control**.
4. Under **Param1**, enter “1” to configure this parameter for the standard Piccolo Iridium power board. This parameter controls the voltage sense of the power control line. The value of “1” indicates the Iridium power line will be low for power on.
5. Click **Send All** to set this parameter.



**Figure 12 - Payload I/O Settings**

## 6 Using the Iridium Option

To use the Iridium option, you must a separate instance of PCC. The separate instance of PCC can be on the same computer or a separate computer.

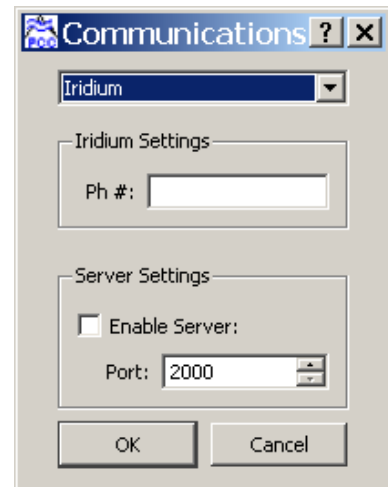
1. Make sure the Iridium modem is powered up and connected to the computer with PCC.
2. Start the Piccolo Command Center.
3. In the **Communications** window, select **Iridium**.
4. Select the serial port the Iridium modem is connected to.

*Note: If you are running two instances of PCC on the same machine and want both instances to be a network server, change the network server port number of the second instance of PCC to a new value (e.g. 2001). If you do not do this, you will see an error message when you click OK.*

5. Enter the Iridium phone number (the data number, not the voice number) in the **Iridium Phone Number** box.

*Note: When making an Iridium to Iridium call, dial “00” followed by the remaining phone number digits that begin with “88”.*

6. Click **OK**.
7. From the Ground Station window, go to the **window** pull down menu and select **Iridium**. Make sure the Iridium phone number (the data number, not the voice number) that you previously entered is displayed in the **Number** box, then click **Connect** (**Figure 14**).



**Figure 13 - Iridium Communications**



**Figure 14 - Iridium Interface**

The message in the **status** box starts the following sequence:

- |                              |                           |
|------------------------------|---------------------------|
| 1. Looking for modem         | 5. Dialing                |
| 2. Resetting modem           | 6. Waiting for connection |
| 3. Configuring flow control  | 7. Connected – waiting    |
| 4. Configuring bearer select | 8. Connected!             |

## 7 Troubleshooting

This section covers some basic troubleshooting procedures you can follow if you experience connectivity problems. If you are using the NAL Research modem A3LA-X, there is a CD included with the modem that has support documentation to use and troubleshoot the modem. Start with the *Getting Started with Model A3LA-X* document.

Also included on the NAL Research modem CD is a terminal emulator software package called SatTerm. You can use any terminal emulator software (Windows® HyperTerminal or RealTerm) and AT commands to communicate with the modem, but NAL Research recommends the use of SatTerm with the A3LA-X since it provides a complete reference manual for all AT commands through user selected buttons for quick and easy access.

When everything is working correctly, the Iridium should link up within 20 seconds (initial data within seconds after getting a connection) and stay connected.

### 7.1 Check Power

If a connection cannot be established or the connection seems to establish but does not stay connected, check the power supply first since it is the most common problem. (See section 5 *Iridium Power Requirements* for more information.)

We also recommend using the CCT Iridium power board for the aircraft and the ground Iridium modem integrated with the CCT portable ground station or an NAL provided power supply.

### 7.2 Check Antennas

- Check the signal strength on both the ground and aircraft antennas. The easiest way to do this is by looking at the signal strength on the Iridium handset. Look for 4 or 5 bars. To check the aircraft antenna you can plug the ground station Iridium modem into the aircraft antenna. If you do not have an Iridium handset, you can use a terminal program and issue AT commands to the modem (“at+csq [enter]” requests the signal strength from the modem). A signal strength of 4 or 5 is recommended. A connection with a signal strength of 3 is possible but marginal. Look for dropouts to zero that could indicate poor sky coverage.
- Make sure there is an adequate ground plane on the aircraft antenna.
- Make sure there is good electrical contact between the antenna ground and the ground plane.
- Make sure the low loss cable used for the ground station connection is rated for less than a 1.5 dB loss at 1.6 GHz.
- Check for adequate sky visibility. There are only at most, three Iridium satellites visible at any one time. Make sure the antenna is not set up too close to a building.

- Another common problem with Iridium installations is that the Iridium antenna is placed too close to the vehicle's GPS antenna. This may interfere and degrade GPS performance. Try to get as much separation as possible between the antennas as physically possible (at least 1 meter is recommended).

### 7.3 Test Gateway Call

- Using the PCC, dial one of the following test gateway numbers:
  - 008816000022
  - 008816000023
- Dialing one of these numbers is a useful way to test one side of the connection (e.g. to verify that one antenna is functioning correctly without needing both of them to work). You can also use a terminal program to dial the number by adding "atd" on the same line before the number. If the connection is successful, a connect message appears when the link is up. Hang up using the OI Iridium window or with a terminal program type in "+++" then "ath0".

### 7.4 Check Ground Station

If the connection does not function, or the Iridium status is in a loop of cycling messages, try hanging up and reconnecting, and then cycling the power on the ground station Iridium unit. If that does not work, try the following steps using a terminal program:

1. Set the Baud rate to "9600". Select the serial port you are connected to.
2. Type "at" then click **Enter**. Make sure the modem responds with **OK**.
3. Check the signal strength. Type in "at+csq" and click enter. The modem responds with a number between 0 and 5 indicating the signal strength (5 is best). This number corresponds to the number of signal bars displayed on an Iridium phone. A signal strength of 4 or 5 is recommended. A connection with a signal strength of 3 is possible but marginal.
4. Try this procedure several times as the quality may vary.

### 7.5 Check Piccolo

- When the Piccolo is first powered on, it will attempt to find the Iridium modem. If it is connected, there will be a burst of activity for a few seconds as the modem is detected and configured. If the modem is working properly, this activity will cease after the modem has been configured for auto-answer.
- If Piccolo cannot find the modem, it will try to initialize it a few times, and then cycle the DTR and the Iridium power control line if it is available. This will repeat approximately every 5 seconds.

## 7.6 Test Dialup Connection Between Iridium Modems

- Using a terminal program at 2400 baud, type in “ats0=1 [enter]” to enable auto-answer on the Iridium modem that will receive a call.
- Call the first modem from the other modem using a second instance of a terminal program. Dial using the command “atd0088xxxxxxx [enter]” using the receiving modem's phone number.
- Check that the comms are established every time and that data can be easily passed in both directions (with the characteristic satcomm delay of about 1 second).
- RealTerm allows you to send a burst of data. Check to see that the same number of bytes to arrive that is being transmitted (maximum of 4 kb due to the buffer within the modem).

## 7.7 Monitor Serial Lines

A serial spy cable can be used to monitor the serial lines. RealTerm can become a serial protocol analyzer with such a cable. Read [this article](#) for more information.

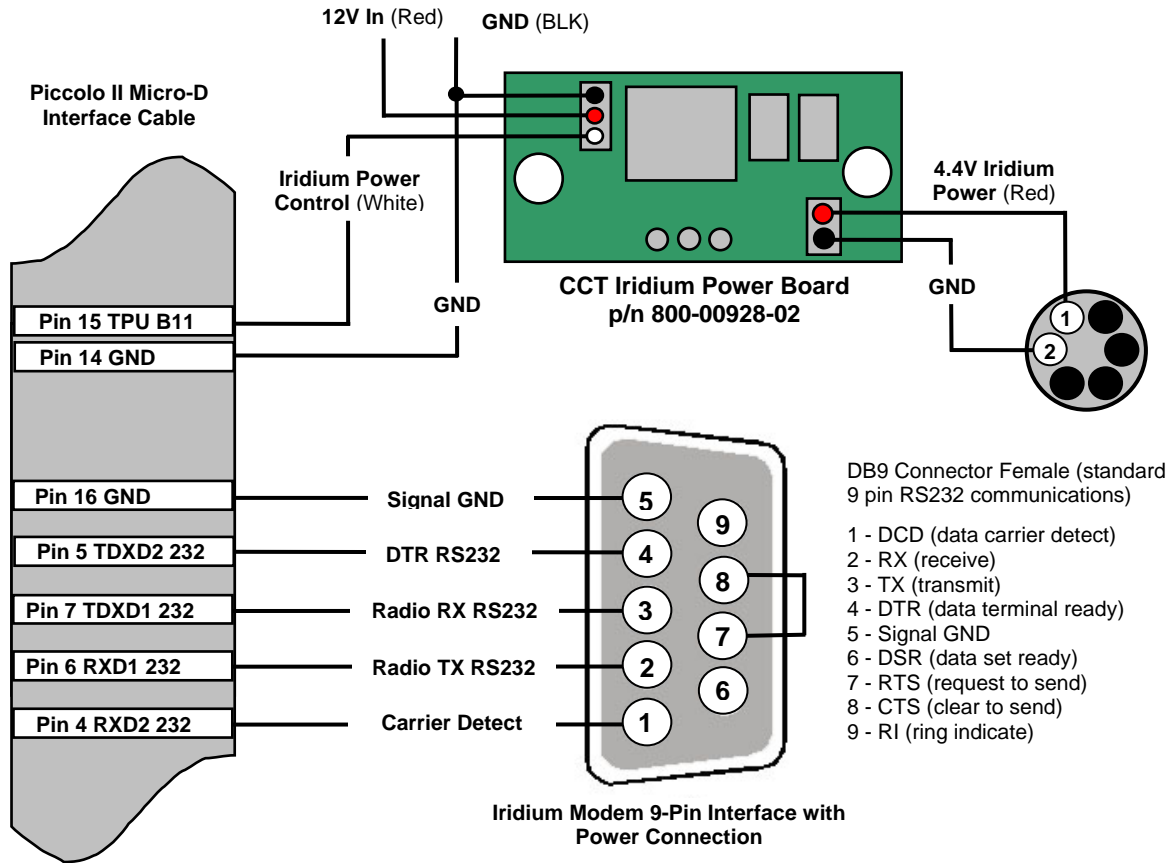
## 7.8 Technical Support

For technical support, contact us by e-mail at [support.cct@goodrich.com](mailto:support.cct@goodrich.com) or phone at +1.541.387.2120. You can also go to our [Support Forum](#) to view frequently asked questions or post new questions.

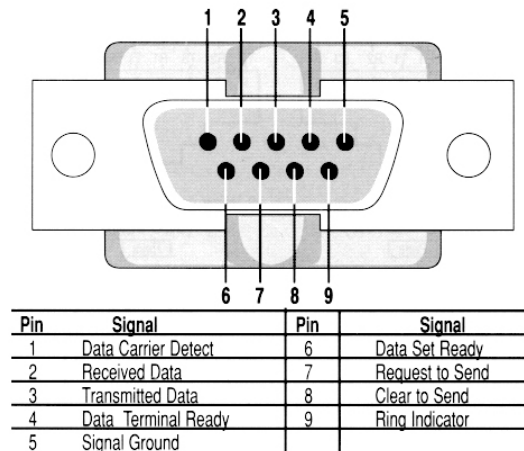
## 8 Appendix

### 8.1 A3LA-SC Iridium Modem

The A3LA-SC Iridium modem is no longer available from NAL Research. Legacy documentation can be found on the [NAL Research](#) web page.



**Figure 15 - Piccolo to A3LA-SC Aircraft Iridium Modem with Power Board Connection**



**Figure 16 - Standard 9-Pin RS232 Interface Connection**