Piccolo Setup Guide

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Piccolo Setup Guide Change Log

December 4, 2009 - Software v2.1.1c

- Universal: Updated Map Actions Tool bar screen captures.

1 Introduction

This document supports users who have purchased a Piccolo autopilot system. The system contains the Piccolo autopilot, Ground Station Kit, and Developers Kit. This document also provides first time Piccolo users a step by step guide to set up both the Piccolo Hardware-in-Loop (HiL) simulation and the Software-in-Loop (SiL) simulation environment.

1.1 About the Simulation Environment

The simulation environment allows the aircraft control laws and mission functionality to be tested without risking the aircraft in a flight test. The simulation environment provides an ideal training tool that can be used in the lab. Although simulation cannot replace flight-testing, it measurably reduces the likelihood of failure by detecting bugs and deficiencies before the aircraft and related hardware are put at risk.

The HiL configuration uses the ground station and Piccolo autopilot hardware in the simulation loop. The SiL configuration provides the same functionality as the HiL setup, but without the autopilot and ground station hardware connected. In the SiL configuration, PC applications take the place of the ground station and autopilot. If you wish to run the Software-in-Loop simulation without installing the autopilot and ground station hardware, see section *8 Software-in-Loop (SiL) Quick Setup* in this document or for a more comprehensive guide, see the *Piccolo Software-in-Loop SiL Setup Guide*.

During HiL simulation (the Piccolo Command Center sends user commands to the ground station, which are then sent to the Piccolo autopilot. Simulator reads the actuator positions from the Piccolo, applies them to an aircraft dynamics model, calculates new sensor data, and sends it back to the Piccolo. Piccolo sends telemetry data to the ground station, which is then sent to the Piccolo Command Center. Location and orientation information are sent to FlightGear for visualization.

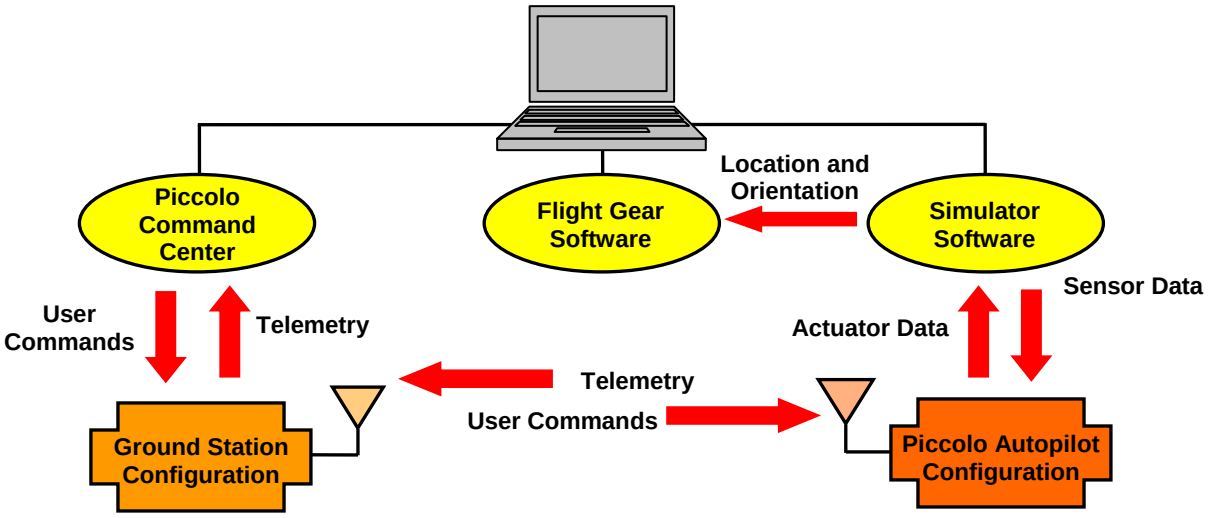


Figure 1 - HiL Simulation

2 Identifying the Hardware

2.1 Piccolo Autopilot System

Table 1 - Piccolo Autopilot System

Piccolo Autopilots			
P/N	**Autopilot**	**Description**	
900-90001-00	Piccolo Plus	Fixed wing UAS. Twelve (12) configurable GPIO lines. Multiple integrated RF Data Link Options.	
900-90010-00	Piccolo II	Fixed wing and VTOL UAS. Sixteen (16) configurable GPIO lines, Four, 0-5V input, 10 bit conversion. Multiple integrated RF Data Link Options.	
900-90014-00	Piccolo LT	Fixed wing and VTOL UAS. Seven (7) configurable GPIO lines. Limited integrated RF Data Link Options.	
900-90023-00	Piccolo SL	Fixed wing and VTOL UAS. Fourteen (14) configurable GPIO lines. Four with analog feedback. Optionally, four GPIO lines can be configured as analog inputs, 0-5V input, 10 bit conversion. Multiple integrated RF Data Link Options.	
Desktop Ground Station Kit P/N 900-90002-00			
P/N	**Description**	**P/N**	**Description**
800-00309-00	Desktop Ground Station	500-00256-00	Pilot Console Cable
500-00254-00	Desktop Power Supply	500-00253-00	900 MHz Ground Station Antenna
500-00251-00	AC Power Cord	500-00250-00	9 Pin Serial Cable
500-00229-00	Ground Station GPS Antenna		
Portable Ground Station Kit P/N 900-90015-00			
P/N	**Description**	**P/N**	**Description**
900-90011-00	Portable Ground Station	500-00250-00	9 pin serial Cable
500-00251-00	AC Power Cord	500-00253-00	900 MHz Ground Station Antenna
500-00260-00	Piccolo GPS Antenna 114 inches long	500-00303-00	Piccolo Interface Power Adapter Cable
500-00892-00	PGS-External Pilot Console Harness	500-00915-00	PGS Aux DC Cable
500-00916-00	Sermos to Alligator Clip Cable	500-00917-00	Sermos to Cigarette Lighter Cable
500-00920-00	Portable GS Accessories Bag		
Piccolo Developers Kit P/N 900-90003-00 / Piccolo LT Developer's Kit 900-02117-00 / Piccolo SL Developer's Kit 900-02111-00			
P/N	**Description**	**P/N**	**Description**
500-00252-00	USB to CAN Module with USB Cable	500-1468-00	Piccolo Plus, Piccolo II, Piccolo SL Power Supply
500-00259-00	Piccolo to CAN Cable	900-00317-00	Piccolo LT Power Supply
500-00261-00	900 MHz UHF Piccolo Antenna	500-00257-00	Piccolo Programming Cable
500-00304-00	Piccolo Interface Cable	500-00260-00	Piccolo GPS Antenna 114 inches long
500-2163-00	Piccolo SL Interface Cable	500-00303-00	Piccolo Interface Power Adapter
500-01152-00	Piccolo LT Interface Cable	500-00639-00	Futaba Pilot Console with Case
200-00500-00	Piccolo User's Manual	900-00317-00	Piccolo System Software CD
760-01178-00	Piccolo LT, Piccolo SL- SSMA to SMA Adapter		

2.2 Piccolo Autopilots

There are five versions of the Piccolo autopilot: Piccolo (no longer available), Piccolo Plus and Piccolo LT (both no longer available to *new* customers), Piccolo II, and Piccolo SL. All autopilots have GPS and UHF antenna inputs, static and pitot ports, and an external I/O interface connector.

Piccolo Plus

Piccolo II

Piccolo LT

Piccolo SL

Figure 2 - Piccolo Autopilots

2.2.1 UHF Antenna

The UHF SMA coaxial connector is used for the aircraft UHF communications antenna connection.

2.2.2 GPS Antenna

The SMA coaxial connector for the Piccolo avionics GPS input. The GPS antenna is not connected during HiL simulations.

2.2.3 External Interface Connector

The main interface connector that provides servo power control interface, payload and programming serial ports and general purpose I/O. (More information about the I/O pin out is defined in the *Piccolo External Interface* document.)

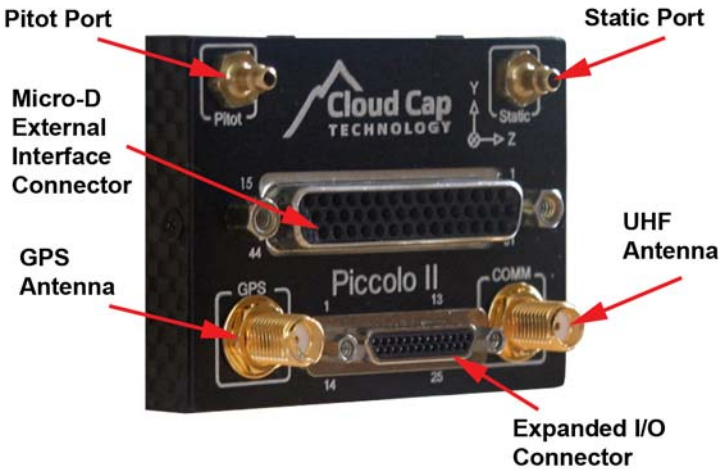


Figure 3 - Piccolo Interface Connections

2.2.4 Expanded I/O Connector

This connector is only available on the Piccolo II autopilot. Provides additional I/O, serial ports, and analog inputs.

2.2.5 Pitot and Static Ports

Two pressure port fittings provide the interface to the vehicle pitot/static system. The fittings accept 3/32 ID tubing. The pitot and static ports are not connected during HiL simulations.

2.3 Ground Stations

Cloud Cap Technology offers two types of ground stations, the Desktop Ground Station (DGS) shown in **Figure 4**, and the Portable Ground Station (PGS) shown in **Figure 5**. The DGS is optimized for use in an indoor, lab type environment. The PGS is transportable, and well suited for typical flight operation environments.

Figure 4 - Desktop Ground Station (DGS)

Figure 5 - Portable Ground Station (PGS)

2.4 Desktop Ground Station (DGS)

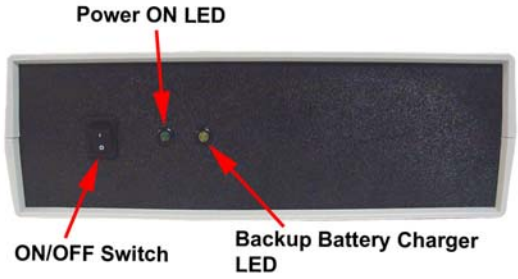


Figure 6 - DGS Front Panel

2.4.1 ON/OFF Switch

The ON/OFF switch allows on/off power control of the DGS.

2.4.2 Front Panel LEDs

The green LED is illuminated when the ON/OFF switch is in ON position and as long as there is power available from the battery, main power, or aux power. The orange backup battery charger LED is only illuminated when the unit is plugged into main AC power regardless of the ON/OFF switch position. The backup battery is trickle charged when the main AC power is connected. In case of a main power failure it can be used as the primary power for short periods of time.

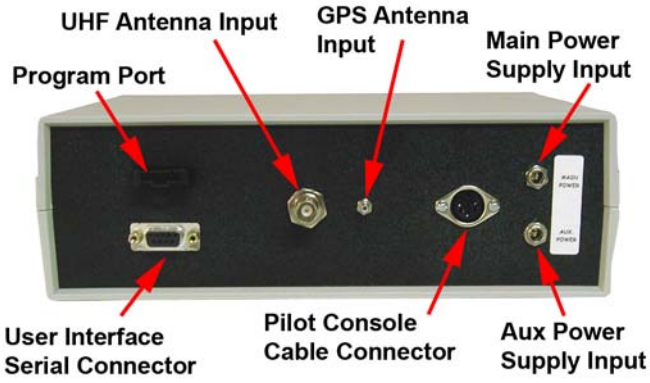


Figure 7 - DGS Back Panel

2.4.3 Program Port

The program port is used for updating the ground station software with the programming cable that is included with the Developers Kit. This port is not used or connected during normal operation. (See the *Piccolo Software Update Instructions* document for more information.)

2.4.4 User Interface Serial Connector

This is a standard DB9 serial connector (3-wire interface). This interface is used to connect the DGS to the PC running the Piccolo Command Center. A standard straight through serial cable can be used.

Note: *If your PC does not have a serial port to connect to the ground station, CCT recommends using the PA088U USB to serial (RS232) adapter from Targus.*

2.4.5 UHF Antenna Input

Provides the connection for the UHF antenna supplied with the ground station (see **Table 1**). Any antenna tuned for the 900MHz ISM band will work but users are cautioned to test the antenna setup on the ground before attempting to fly with it. The supplied antenna requires a ground plane to operate efficiently, i.e. provide a uniform radiation pattern. The top of a car or other metal roof that provides a large ground plane with an unobstructed view of the flight operations area works best. For simulation purposes place the UHF antenna in any convenient location in your lab, keeping as much separation as possible between it and the autopilot UHF antenna. We also recommend that the Piccolo and ground station radios be configured for a 0.1 watt output for lab use since they are in close proximity to on another.

2.4.6 GPS Antenna Input

Placement of the GPS antenna on a good ground plane is critical for reliable operation. The 3 to 5-volt active GPS antenna, included with the kit, has a push on SMB connector that is sufficient for most applications. If the supplied antenna is not long enough to reach the desired mounting location, an alternate antenna can be used. It should be passive or 3-volt active and the cable length should be kept to a minimum. Keeping the connector clean is important. Always check both contacts before connecting. During simulation the ground station GPS antenna is not required.

2.4.7 Pilot Console Cable Connector

A pilot console cable is included with the ground station kit. Plug one end of cable into the console and the other end into the ground station. If the ground station is powered you should hear an audible beep as the console powers up. The pilot console connector provides the interface to a Futaba pilot console used for manual piloting. The ground station provides power to the pilot console and the pilot console in turn provides a serial PWM stream which contains the servo position command taken from the joy-sticks and any active switches. See section *2.9 Futaba Pilot Console* for more information about the pilot console.

2.4.8 Main Power Supply Input

The main power supply input connector (**Figure 7**) was designed to take a 16-volt input from the desktop power supply included with the ground station kit. This provides power to run the ground station as well as charge the internal backup battery.

2.4.9 Auxiliary Supply Input

The auxiliary supply input is normally not connected for desktop operation. This input is for use when no convenient AC source is available to power the desktop power supply. The auxiliary supply input allows you to run the system off of an external 12-volt battery (10-16 VDC). This is especially useful in the field during flight operations when running from inside a vehicle or on the tarmac. The internal backup battery is diode connected, so if the auxiliary supply input source fails the internal battery then provides short-term backup power.

Note: *When the external battery is running (auxiliary supply input) the internal battery does not charge and must be fully charged before it can be relied on as a backup source.*

2.5 Portable Ground Station (PGS)

Figure 8 - PGS Front Panel

2.5.1 Power Button

The power button allows on/off power control of the PGS.

2.5.2 Front Panel LEDs

The green power LED is illuminated when the power button is on as long as there is power available from the battery, main AC power, or aux power. The orange AC power LED is illuminated when the unit is plugged into main AC power regardless if the Power button is on or off. The backup battery is trickle charged when the main AC power is connected. In case of a main power failure it can be used as the primary power for short periods of time. The DC power LED is only illuminated when the unit is plugged into a DC power source.

2.5.3 Iridium Handset Port

The Portable Ground Station supports the internal integration of an Iridium satellite communication modem. If an Iridium modem has been installed in the Portable Ground Station, a handset can be connected to the Iridium handset port allowing the ground station to be used as a satellite telephone.

2.5.4 Link Selector Switch

The link selector switch is used to select a link (1 or 2) that manual control and payload data is sent and received over. The Link 2 configuration adds the ability to have a second simultaneous radio link between the aircraft and ground station. This allows frequency diversity (jam protection) and higher power links (longer range). Link 2 configurations are not common.

Note: *If configured for a single link (Link 1), the switch must remain in the Link 1 position at all times.*

2.5.5 GPS Antenna Input

Placement of the GPS antenna on a good ground plane is critical for reliable operation. A 3 to 5-volt active GPS antenna included with the kit works fine for most applications. If the supplied antenna is not long enough to reach the desired mounting location, an alternate antenna can be used. It should be passive or 3-volt active and the cable length should be kept to a minimum. Keeping the connector clean is important so always check both contacts before connecting. During simulation the ground station GPS antenna is not required.

2.5.6 Payload serial connector

The payload serial connector provides a RS232 or RS422 connection to the configured payload port on the Piccolo. This is useful for customers who use a payload control source different from the Piccolo Command Center PC. The payload serial connector is not used during HiL simulation.

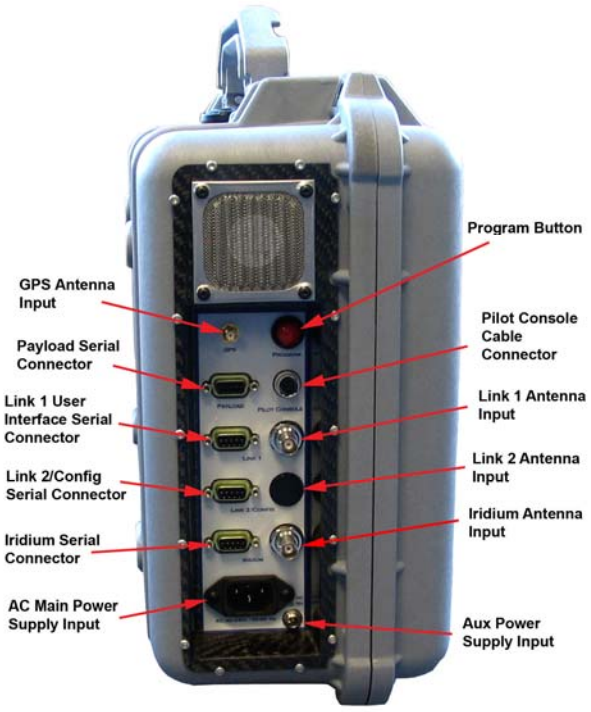


Figure 9 - PGS Back Panel

2.5.7 Link 1 Serial Connector

The PGS has two user interface serial connectors. These are standard DB9 serial connectors (3-wire interface). The link 1 interface is the primary link interface and is used to connect the PGS to the PC running the Piccolo Command Center. Use a standard straight through serial cable.

2.5.8 Link 2/Config Serial Connector

If a link 2 data link is incorporated into the PGS, this connector provides the serial interface to a PC running a second Piccolo Command Center. This connector is also used as a program interface port for the PGS. A standard serial cable is used to connect to the programming PC.

Note: *If your PC does not have a serial port to connect to the ground station, CCT recommends using the PA088U USB to serial (RS232) adapter from Targus.*

2.5.9 Link 1 and Link 2 Antenna Inputs

Provide connection for the RF antennas. Link 1 is the primary UHF link for the antenna supplied with the ground station (see **Table 1**). Any antenna tuned for the 900MHz ISM band will work, but users are cautioned to test the antenna setup on the ground before attempting to fly with it. The supplied antenna requires a ground plane to provide a uniform radiation pattern. The top of a car or other metal roof that provides a large ground plane with an unobstructed view of the flight operations area usually works best. For simulation purposes, place the UHF antenna in any convenient location, keeping as much separation as possible between it and the autopilot UHF antenna. We also recommend that the Piccolo and ground station radios be configured for a 0.1 watt output for lab use sine they are in close proximity to each other. If a Link 2 data link is incorporated in the PGS, BND antenna connector is installed to connect the Link 2 antenna.

2.5.10 Main Power Supply Input

The main power supply input connector is designed to plug directly into an AC power source using the provide a standard AC power cord (see **Figure 9**). This provides power to run the ground station as well as charge the internal backup battery.

2.5.11 Aux Supply Input

The Aux input is for use when no convenient AC source is available. The Aux input allows you to run the system off of an external 12-volt battery (10-16 VDC). This is especially useful in the field during flight operations when running from inside a van or out on the tarmac. Again the internal backup battery is diode connected so if the Aux source fails the internal battery will kick in and provide short-term backup power. When running on an external battery (Aux input) the internal battery does not charge and thus must be fully charged before it can be relied on as a backup source.

2.5.12 Program Button

The program button is used to put the PGS into program mode when updating the ground station software. (See the *Piccolo Software Update Instructions* document for more information.)

2.5.13 Pilot Console Cable Connector

A pilot console cable is included with the ground station kit. Plug one end of cable into the console the end into the ground station. If the ground station is powered on, there should be an audible beep as the console powers up. The pilot console connector provides the interface to a Futaba pilot console used for manual piloting. The ground station provides power to the pilot console and the pilot console in turn provides a serial PWM stream which contains the servo position command taken from the joy-sticks and any active switches. See section *2.9 Futaba Pilot Console* or more information about the pilot console.

2.5.14 Iridium Serial Connector

If an Iridium satellite modem is installed in the PGS, this connector provides the serial interface to a PC running another Piccolo Command Center. A standard serial cable is used to connect to the PC.

2.5.15 Iridium Antenna Input

If an Iridium modem is incorporated into the PGS, a BNC antenna connector is used to connect the Iridium antenna.

2.6 Piccolo Interface Cable

The interface cable plugs into the main interface I/O connector on the Piccolo and provides connections for autopilot power and the Controller Area Network (CAN) interface to the Simulator PC.

The autopilot power should be supplied from a 12-volt source as outlined in section *2.8 Power Supplies.*

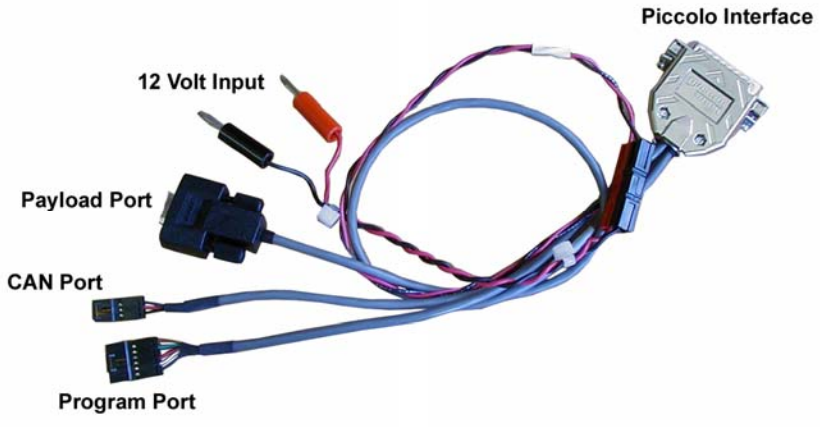


Figure 10 – Interface Cable for Piccolo Plus and Piccolo II

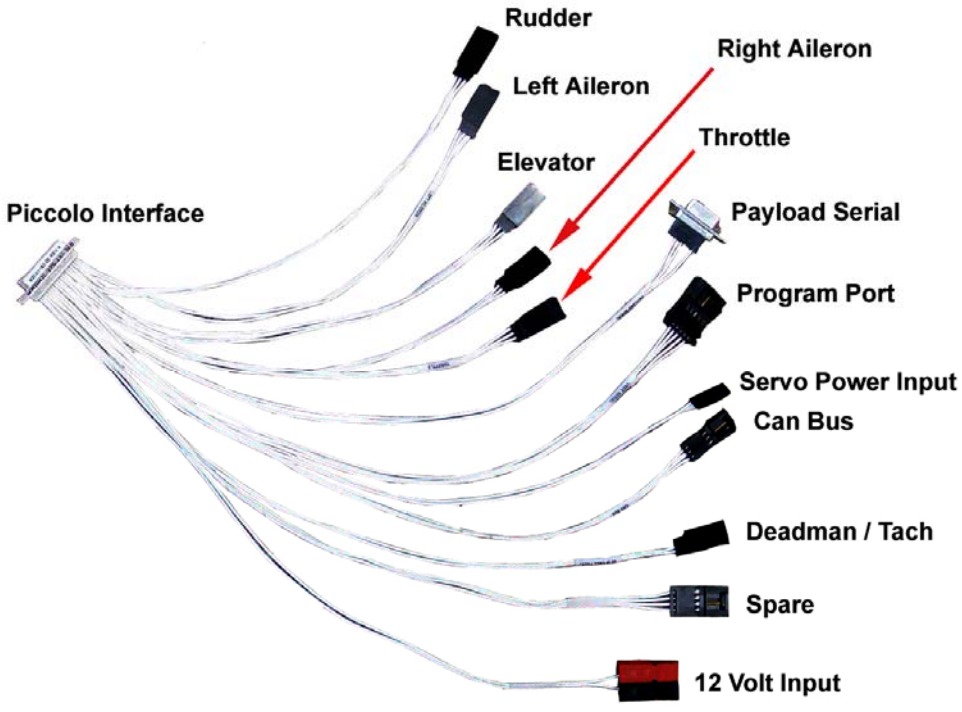


Figure 11 - Interface Cable for Piccolo LT

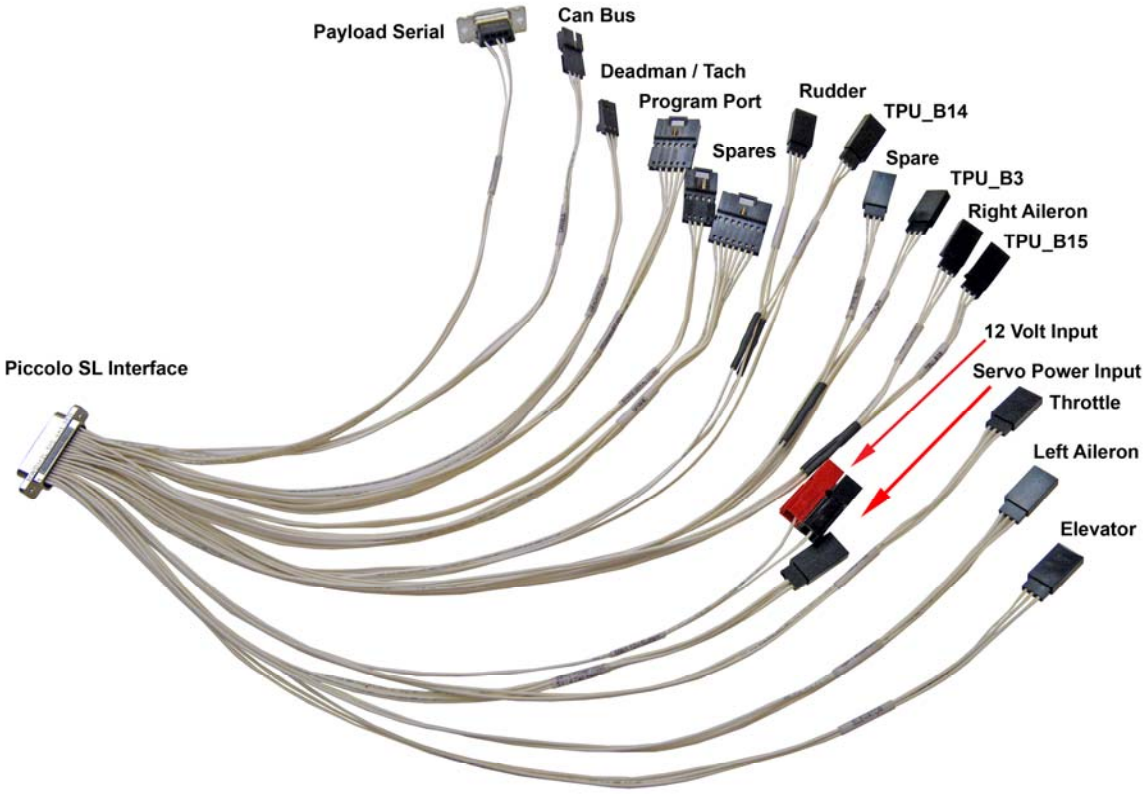


Figure 12 - Interface Cable for Piccolo SL

2.7 USB to CAN Interface

The USB to CAN Interface consists of a USB cable, USB to CAN module, and a Piccolo to CAN cable. In the HiL simulation environment, the autopilot sends servo control information and accepts external sensor data over this interface.

Important Note: *Do not connect a regular serial cable to the USB to CAN module. A serial cable does not have the correct connectors.*

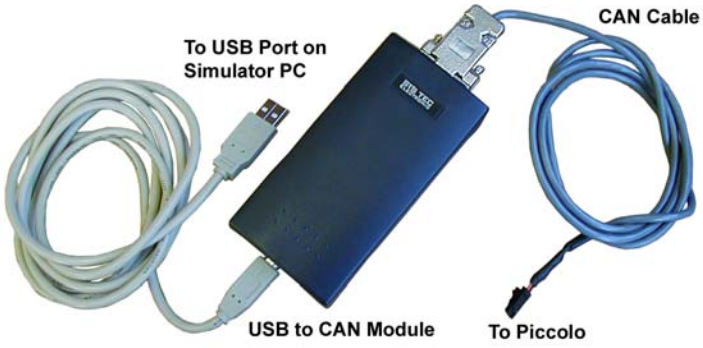


Figure 13 - USB to CAN Interface

2.8 Power Supplies

An AC power supply is provided for the Desktop Ground Station. As part of the ground station kit, a bench top DC power supply is needed for powering your Piccolo autopilot. It should be capable of supplying 12-volts DC at 1.5 amps**.** The Piccolo autopilot will accommodate from 8 to 20-volts. Typical current consumption is ~300ma with a 12-volt input during normal wireless operation and over 1 amp at startup. You can also use a 10-cell (12-volt) battery pack or other appropriate power source.

Note: *The power supply and autopilot should be physically separated as much as possible since the 1-watt output from the autopilot transceiver can feed into and interfere with the voltage and current controls on some power supplies causing output voltage and current regulation oscillations.*

2.9 Futaba Pilot Console

A Futaba pilot console or transmitter is also required for manual piloting both in simulation and during flight operations. A nine channel Futaba pilot console is provided as part of the Developers Kit. Manual piloting is used for takeoff and landing and during autopilot test and evaluation. The gear switch (channel 5) is used to switch between manual and automatic piloting mode. The pilot console power switch should remain off. In addition, note that the Piccolo system does not use the broadcast data from the pilot console. If using your own pilot console, you can remove the RF deck from the console if you wish in order to keep it from transmitting (contact Cloud Cap Technology about required modifications.)

3 Setting up the Hardware

The following section describes how to set up and connect all the hardware required to run the HiL simulation environment. Hardware connections that are not required for HiL simulation are shown and listed in each diagram.

3.1 PC Requirements

A Windows based PC is required to set up the Piccolo HiL simulation environment. For optimum results the CCT recommends the following PC configuration:

- Windows XP recommended (Vista optional)
- Intel Core 2 Duo 2.40 GHz Processor
- 2GB RAM
- Upgraded 3D Video Card (NVidia Quadro)
- PC-Card Slot

For flight testing and development Cloud Cap Technology recommends the Dell E6400 laptop computer. This is the commonly available solution that CCT uses in the lab and the field. The backlit display is optimal for night/day viewing. If you're really hard on electronics, try the Panasonic Toughbook CF-19 with Windows XP.

Note: *PCs without serial ports are supported using a USB to serial adaptor. CCT recommends the PA088U USB-Serial adapter from Targus.*

3.2 Typical Simulation Setup

Simulator communicates with Piccolo in real time and runs as a real time application. In Windows, a real time environment can be difficult to achieve especially when running multiple applications on an older computer. If you are experiencing delays and performance problems, FlightGear should be installed on a separate computer with a UDP network connection as shown in the two computer setup option diagram below. For more information about this delay in Simulation, see section *5.6.1 Communication Delay.*

Important Note: *Piccolo provides position and attitude data for the simulation environment over the USB to CAN interface. Do not connect the USB to CAN interface to the PC until after the USB to CAN interface drivers have been installed. See section 4 Software for more information.*

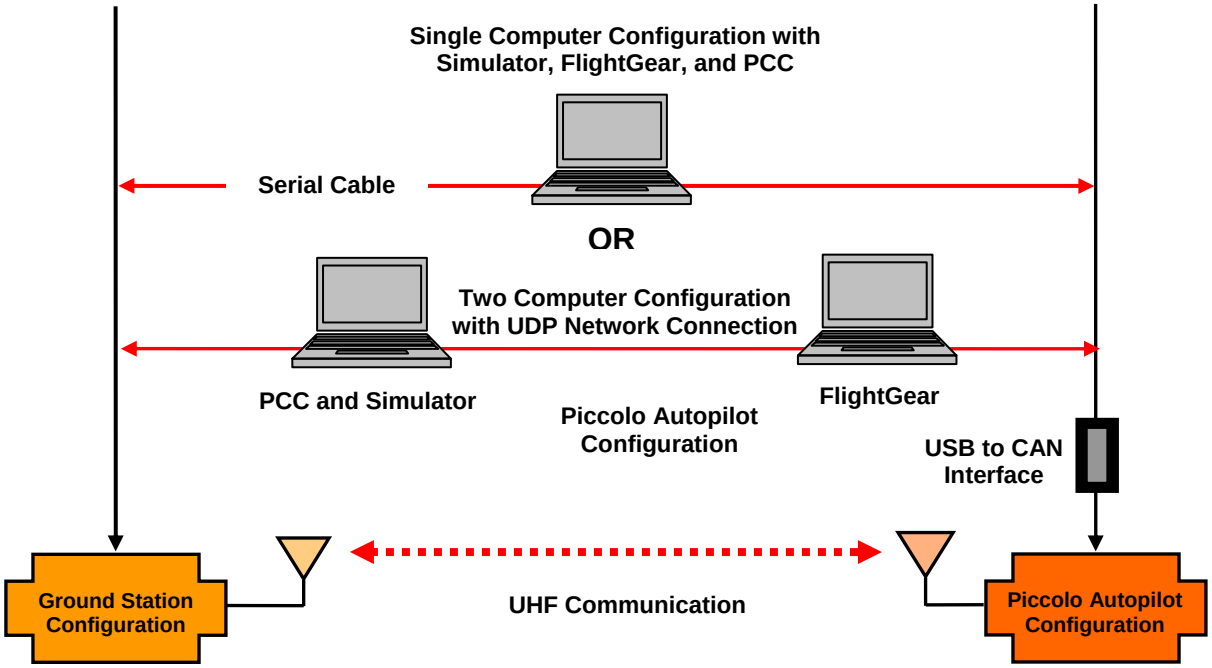


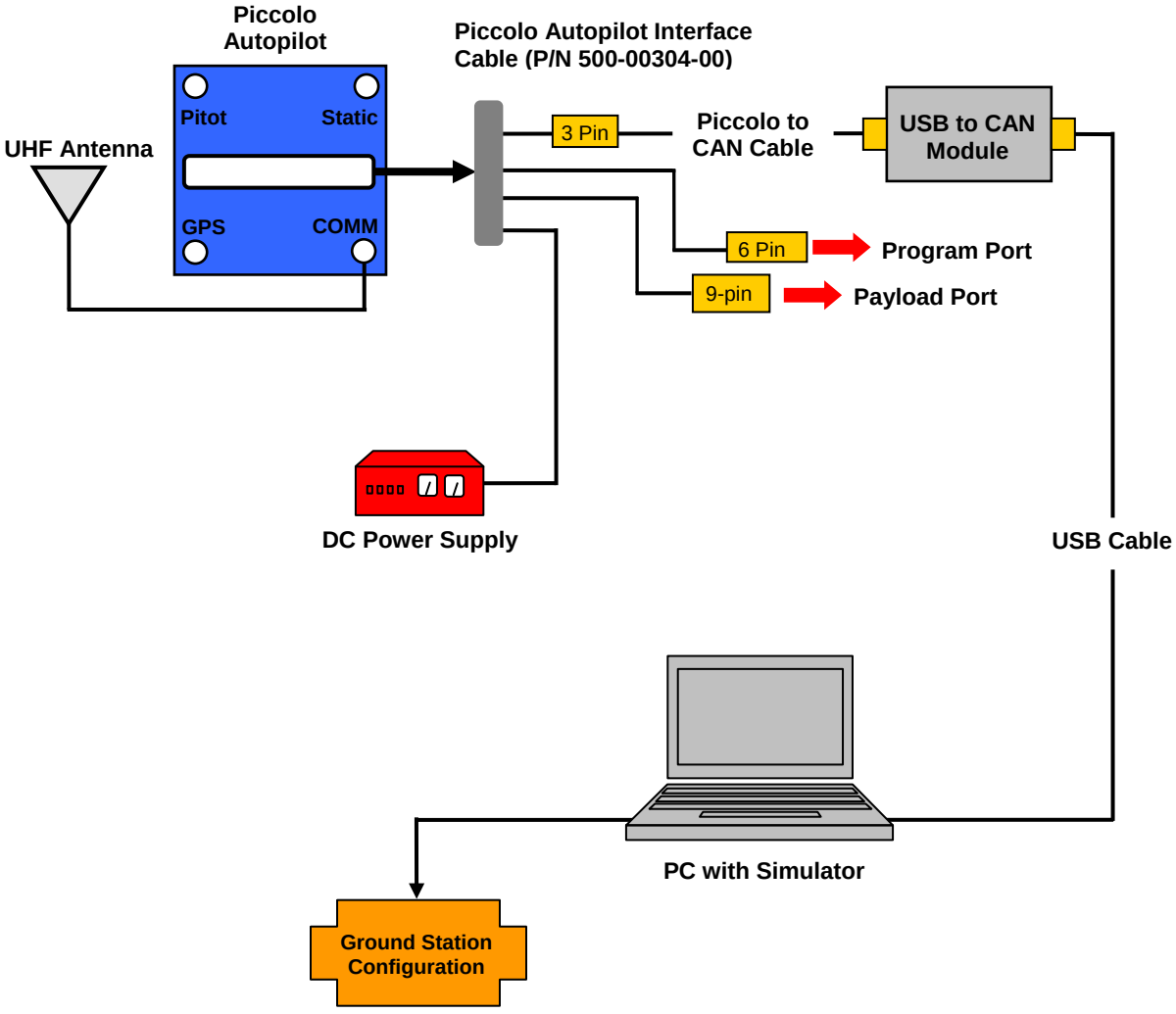
Figure 14 - Typical Simulation Setup

3.3 Piccolo Autopilot Configurations

3.3.1 Piccolo Plus and Piccolo II

Connections NOT required for HiL simulation:

- **GPS**
- **Pitot**
- **Static**
- **Program Port**
- **Payload Port**



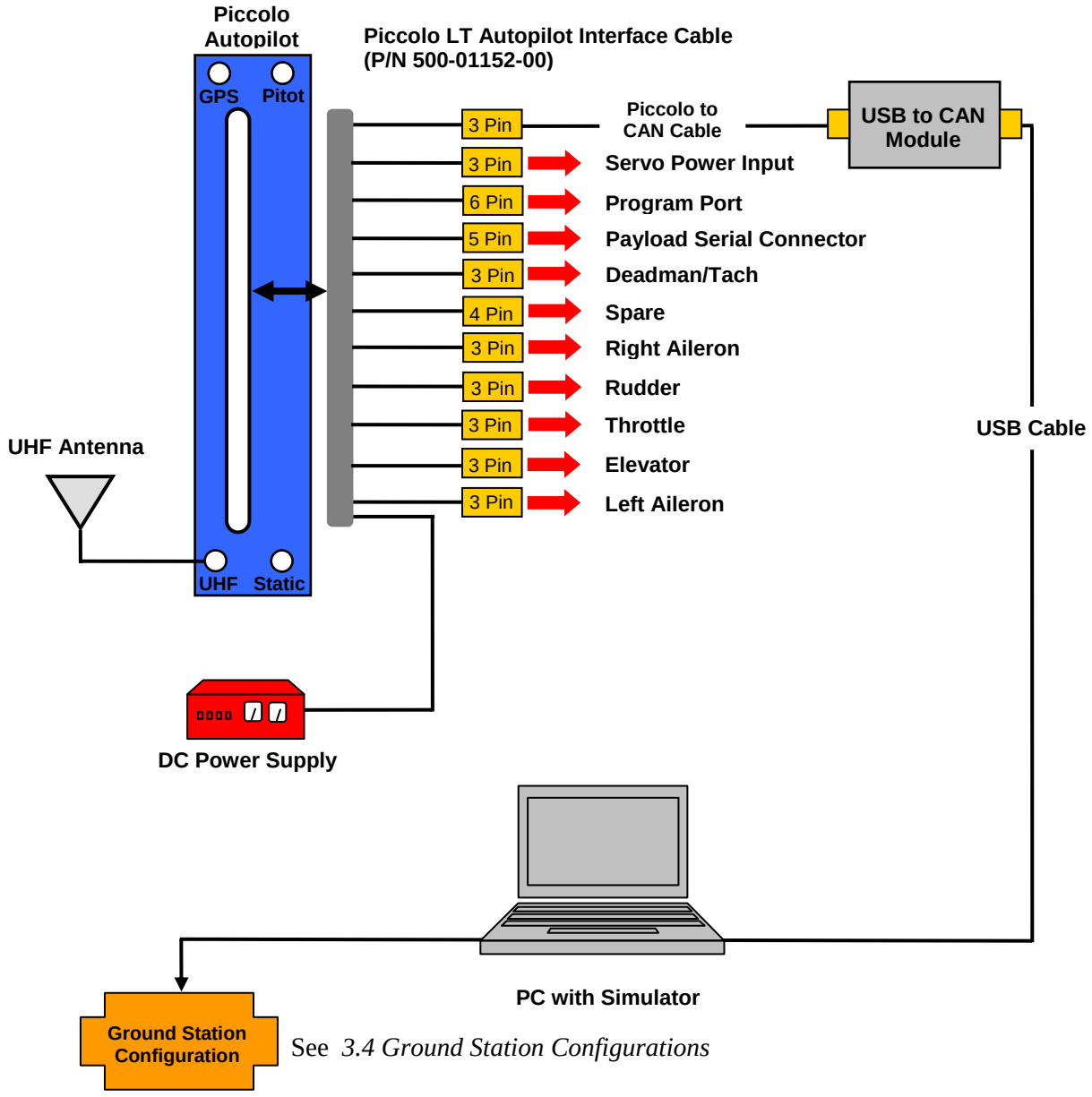
See section *3.4 Ground Station Configurations*

Figure 15 - Piccolo Plus and Piccolo II HiL Configurations

3.3.2 *Piccolo LT*

Connections NOT required for HiL simulation:

- **GPS**
- **Pitot**
- **Static**
- **Servo Power Input**
- **Left Aileron**
- **Right Aileron**
- **Throttle**
- **Rudder**
- **Elevator**
- **Payload Serial Connector**
- **Deadman/Tach**
- **Spare**
- **Program Port**



See *3.4 Ground Station Configurations*

Figure 16 - Piccolo LT HiL Configuration

3.3.3 *Piccolo SL*

Connections NOT required for HiL simulation:

- **GPS**
- **Pitot**
- **Static**
- **Servo Power Input**
- **Left Aileron**
- **Right Aileron**
- **Throttle**
- **Rudder**
- **Elevator**
- **Payload Serial Connector**
- **Deadman/Tach**
- **Spare**
- **Program Port**

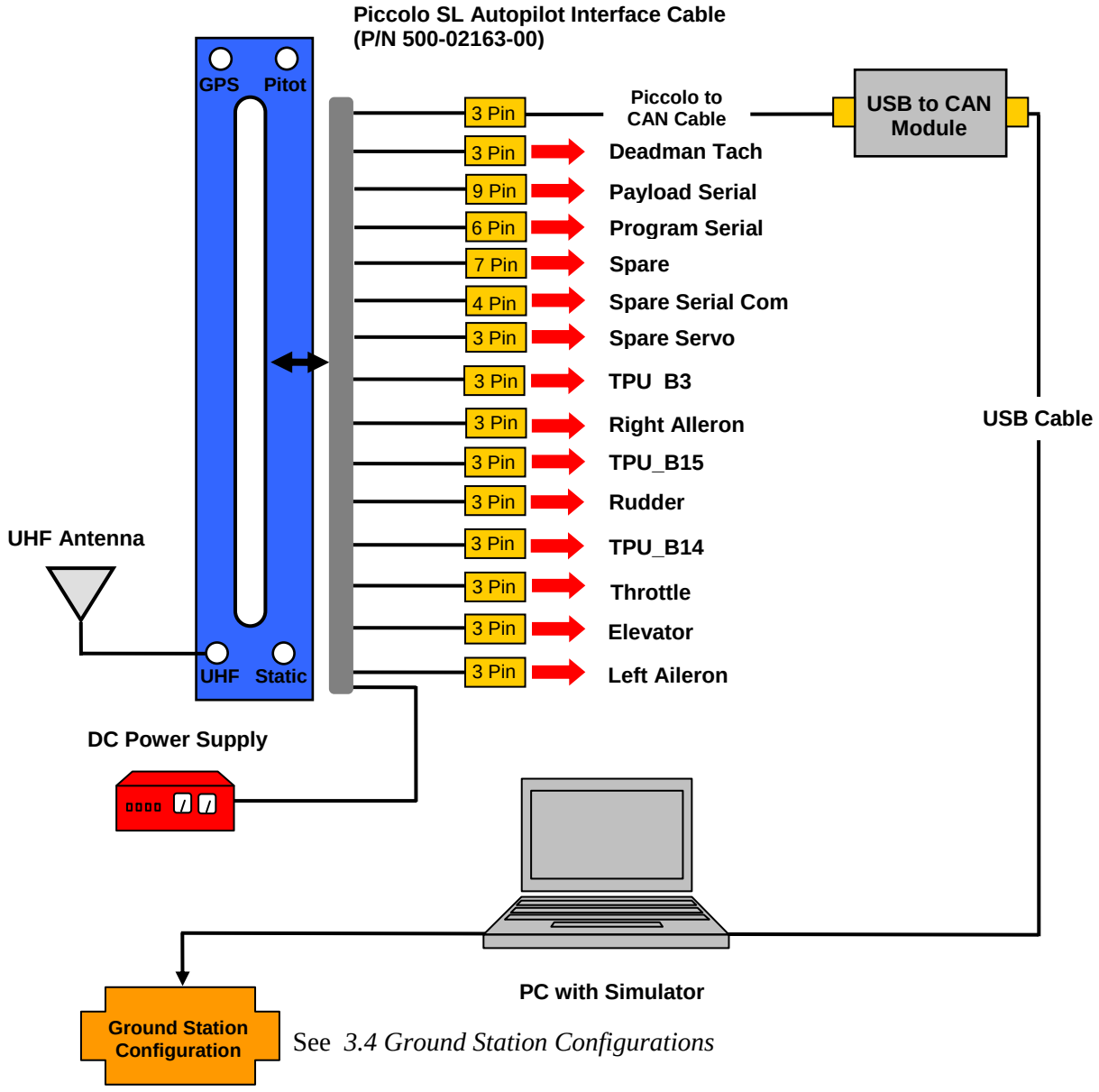


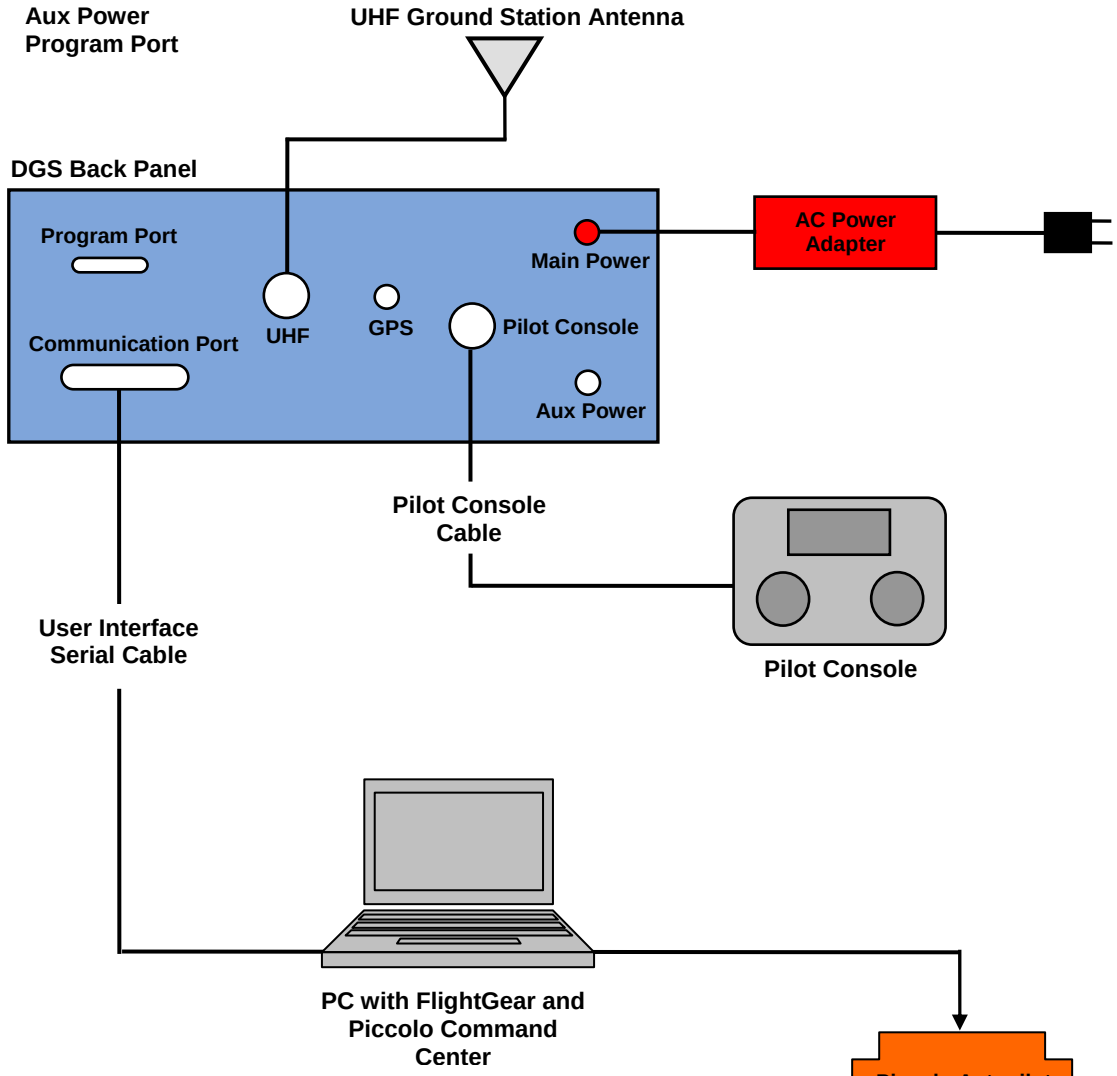
Figure 17 - Piccolo SL HiL Configuration

3.4 Ground Station Configurations

3.4.1 Desktop Ground Station (DGS)

Connections NOT required for HiL simulation:

- **GPS**
- **Aux Power**
- **Program Port**



***Note**: If your PC does not have a serial port to connect to the ground station, CCT recommends using the PA088U USB to serial (RS232) adapter from Targus.*

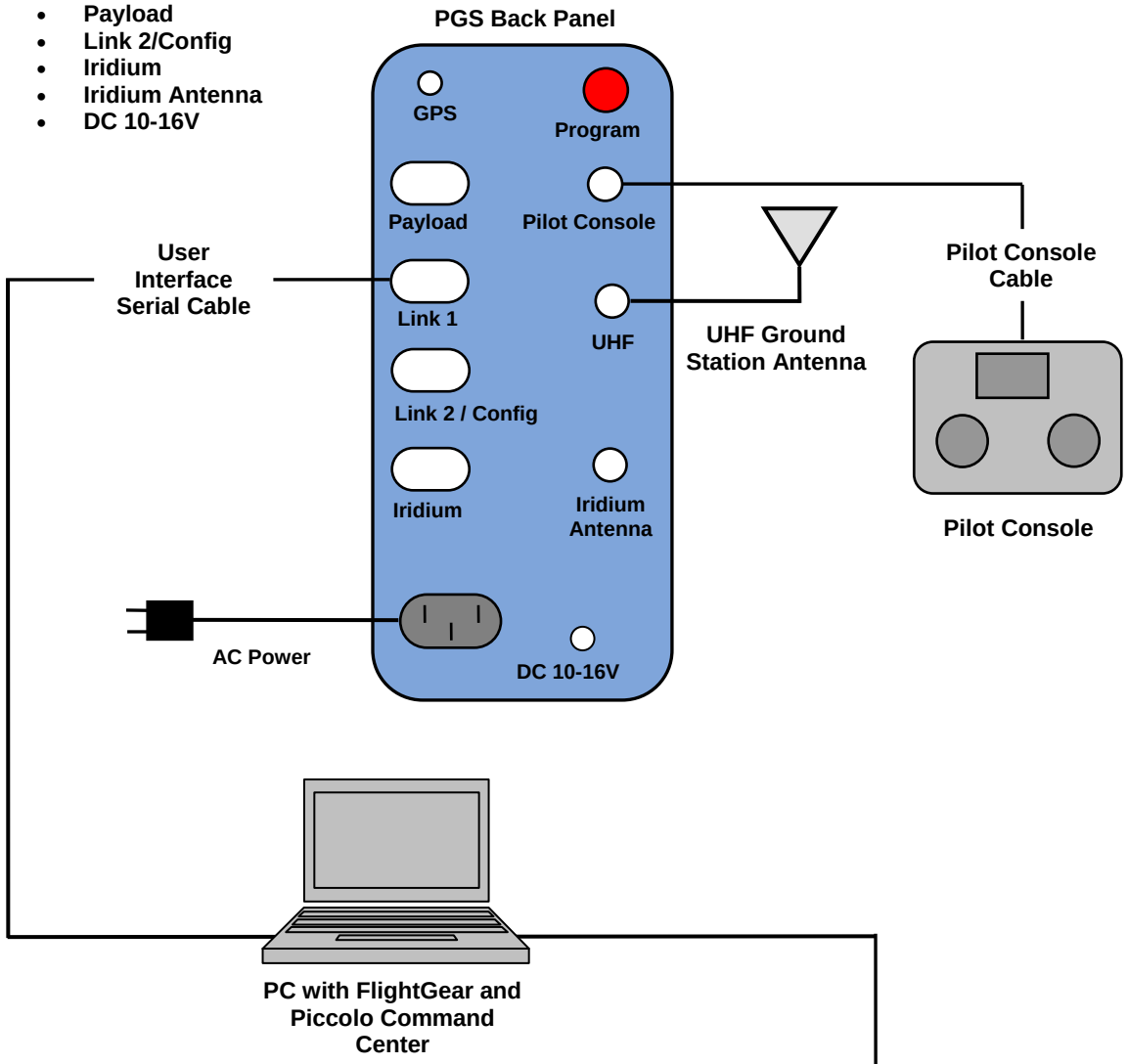
See section *3.3 Piccolo Autopilot Configurations*

Figure 18 - Desktop Ground Station HiL Configuration

3.5 Portable Ground Station (PGS)

Connections NOT required for HiL simulation:

- **GPS**
- **Payload**
- **Link 2/Config**
- **Iridium**
- **Iridium Antenna**
- **DC 10-16V**



***Note**: If your PC does not have a serial port to connect to the ground station, CCT recommends using the PA088U USB to serial (RS232) adapter from Targus.*

Piccolo Autopilot Configuration

See section *3.3 Piccolo Autopilot Configurations*

Figure 19 - Portable Ground Station HiL Configuration

4 Software

This section covers the main software applications, installers and drivers you will need to set-up and run a Hardware-in-Loop (HiL) simulation.

All the software and related support documentation are on a CD included in the Developers Kit. They can also be downloaded from our website at www.cloudcaptech.com. Check our website periodically for the latest software and firmware updates.

4.1 Software Installation

If you have a CD, insert it in your PC and copy all three folders from the CD to the hard drive (C) or create your own directory. The numbers behind the **`Dev Kit`** and **`FlightGear`** folders designate the latest software versions. If you are using two computers in a network, copy the same folders to both computers. If you don't have a CD, you can download these directories from our website at www.cloudcaptech.com

- **Dev Kit – 2.1.x**
- **Flight Gear 0.9.10**
- **Maps**

4.1.1 Piccolo Command Center (PCC)

The Piccolo Command Center (PCC) is a software application that runs on a Windows PC and provides a command and control interface for Piccolo operators. Once installed, PCC can be run like any windows application through the **`Start`** menu from the Cloud Cap folder. To install the PCC, go to **`Dev Kit`** » **`Installers`**. Click **`PccInstaller.msi`** to launch the installer. Follow the on-screen instructions. Leave all the defaults as they are.

4.1.2 Piccolo Software

The Piccolo software includes all the tools, documents, and related support applications that allow you to setup and operate the SiL and/or HiL simulation environments. Once installed, these items can be accessed through the **`Start`** menu from your computer. To install the Piccolo software, go to **`Dev Kit`** » **`Installers`**. Click on the **`PiccoloInstaller.msi`** to launch the installer. Follow the on-screen instructions.

4.1.3 USB to CAN Interface Drivers

In an HiL simulation, interface drivers are needed for the Piccolo autopilot and the Simulator to talk to one another through the USB CAN interface. In a software simulation, the drivers are not needed.

To install the USB to CAN drivers, go to **`Dev Kit`** » **`Tools`** » **`SO-387_310.zip`**. Open the zip file, and then click **`Setup.exe`**. Follow the on-screen instructions. After installation, restart the computer and connect the USB CAN interface to the PC (windows should find the new hardware).

Note: *You can also install the USB to CAN drivers through the* ***`START`*** *menu on your computer after you have installed the Piccolo software. Go to* ***`Start`*** *»* ***`Programs`*** *»* ***`Cloud Clap Piccolo 2.1.x`*** *»* ***`Tools`*** *»* ***`USB CAN Driver`***.

4.1.4 FlightGear

FlightGear is an open source application that offers a visualization of the aircraft attitude. Visualization is not required for HiL or SiL simulation, but provides the user with a better way to visualize the aircraft state.

To install FlightGear, go to the **`FlightGear`** folder and click **`fgsetup-0.9.10.exe`** to launch the installer. Follow the on-screen instructions. Leave all the main defaults as they are. Uncheck the **`Launch FlightGear`** box at the end of the installation. For the Simulator to work in synchronize with FlightGear, parameters for FlightGear must be set up and configured correctly. The batch file **`runfgfs-c172-netctrl.bat`** in the FlightGear directory does this for you. You can use this batch file to start FlightGear from this location, but we recommended creating a shortcut and starting it from the desktop.

5 Start HiL Simulation

1. Set up the ground station and autopilot hardware (see section *3 Setting up the Hardware*).
2. Install the software to your PC (see section *4.1 Software Installation*).
3. Turn the ground station on. Power-up the autopilot with a 12-volt DC input.
4. On your computer, go to the **`Start`** » **`Programs`** » **`Cloud Cap`** » **`Start airplane`** or **`helicopter hardware in loop simulation`**. This button automatically launches the PCC and Simulator (with an aircraft dynamics model loaded).

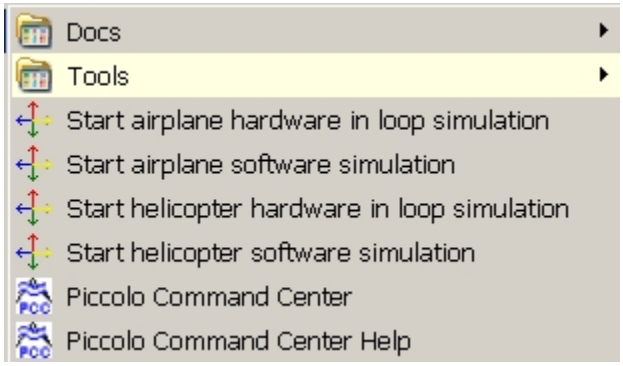


Figure 20 - HiL Start Menu

Note: *v2.1.1.b and v2.1.1.c software does not support helicopter operations at this time.*

5. The **`Communications`** dialog window for the PCC opens. This window configures the system to allow the PCC to talk to the ground station. Select "Direct Serial".

   Note: *If you are using the default start-up mode,* ***`AUTO`*** *is selected for you at a baud rate of 57600 run as a TCP/IP server on port 2000. If you have the ground station connected to a different serial port on the PC, select the appropriate port and click* ***OK****.*

   For information about other connection options, see the *Communications* section in the *Piccolo User's Guide.*

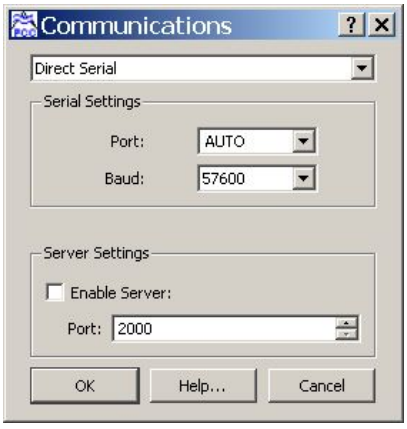


Figure 21 - Communications

5.1.1 Piccolo Command Center Display

In **Figure 22** there is one autopilot in the network and the **`Layers`**, **`Aircraft`**, and **`Primary Flight Display`** windows are docked to the main map window. The map window of the PCC is the largest display, and the most important. It cannot be turned off, moved or docked. All other windows are docked with respect to it.

***Note**: The red ring represents the ground station location at the San Francisco airport. The aircraft icon should be in the center of the ring. If the ground station and the aircraft are at 000 Longitude and Latitude, or you see a "No Active Aircraft" message in the **`Aircraft Window`**. See section 7 for HiL troubleshooting information.*

Zooms the map in or out. Hold the button down to do a continuous zoom.

Pan the map left, right, up, or down. Hold the button down to pan continuously.

For more information on how to use the PCC interface, see the *Piccolo User's Guide*.

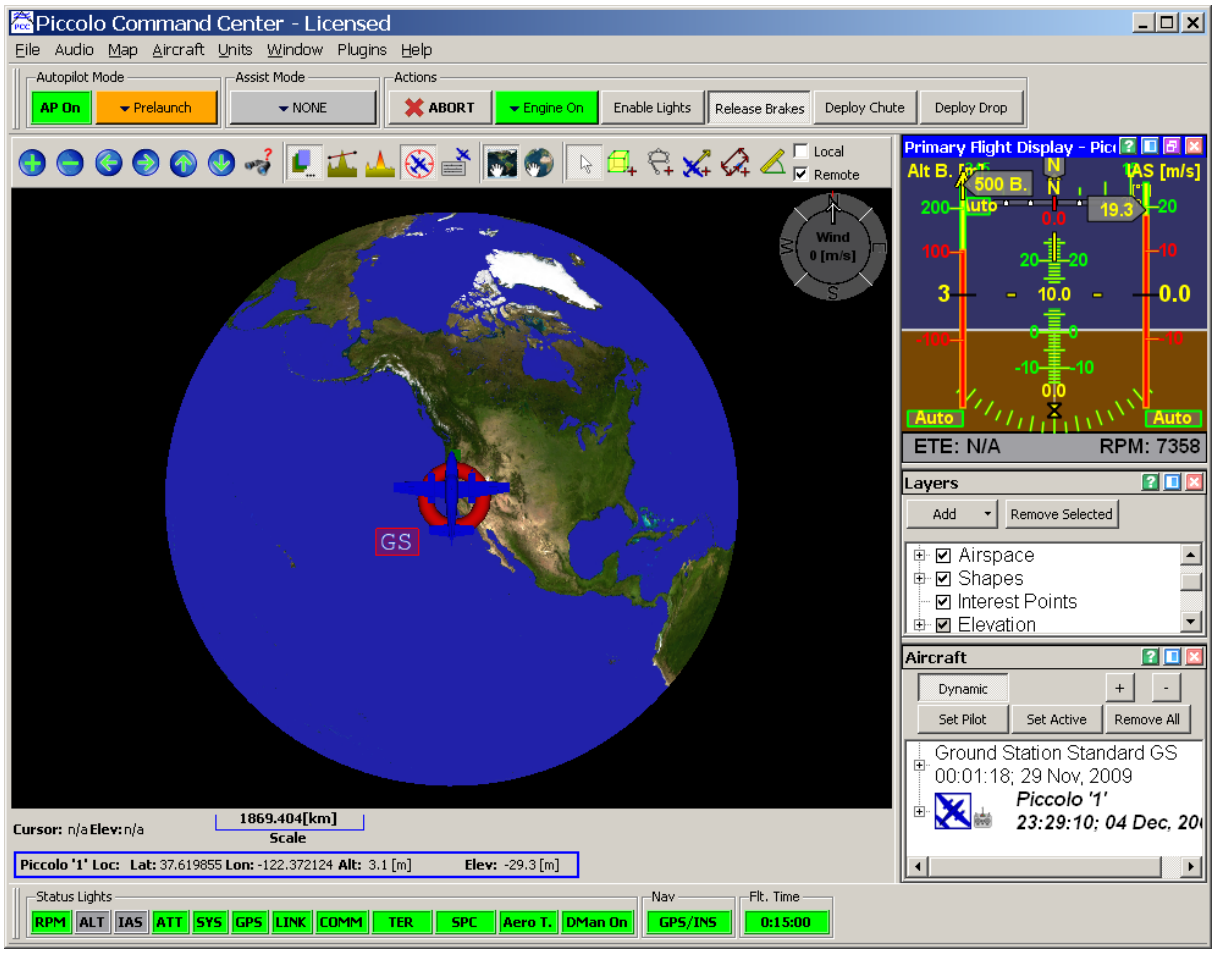


Figure 22 - Piccolo Command Center

5.1.2 Verify Communications

The following items should be verified for a proper HiL setup:

- ☑ In the **`Aircraft`** window, the aircraft icon should be surrounded by a square border to show it is the active autopilot in the PCC.
- ☑ The aircraft icon should have a small pilot console next to it to show that it is the pilot aircraft in the HiL.
- ☑ The timestamp numbers for the Ground Station and Piccolo should be incrementing continuously.

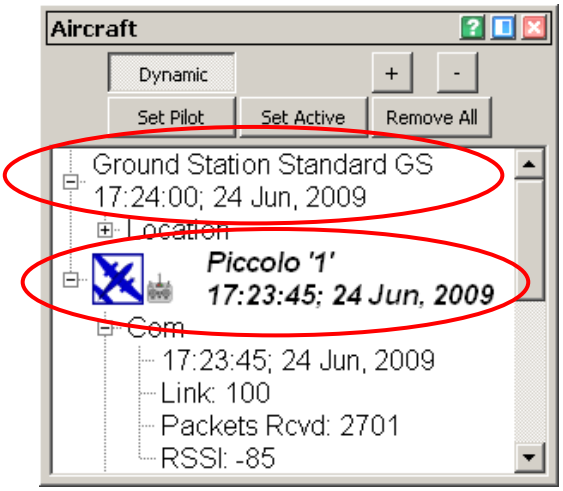


Figure 23 - Aircraft Window

***Note**: If there is a problem with any of the above items, see section 7 for HiL troubleshooting information.* See the *Aircraft Window section in the Piccolo User's Guide for more information about this window.*

- ☑ From the main menu, go to **`Window`** » **`Status Windows`** » **`System`**. In a proper HiL setup, **`Link`** should be at 100, and the **`RSSI`** (Return Signal Strength Integrity) should be between -71 and -108. (The lower the number, the better the signal strength.)

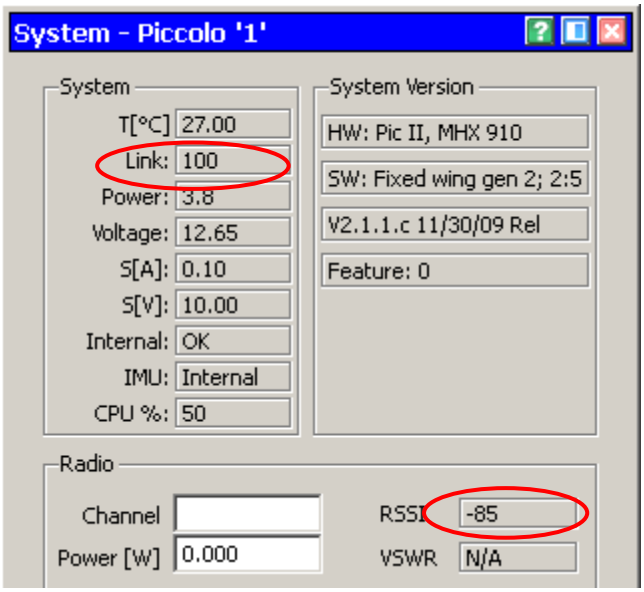


Figure 24 - System Window

- ☑ In the aircraft actions toolbar, you should see the autopilot status. For simulation purposes the autopilot should be ON.

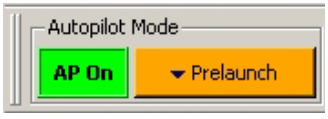


Figure 25 - Autopilot Status

☑ To verify communication between Piccolo and the ground station, use the gear CH 5 switch on the pilot console and toggle between **AUTOPILOT ON** and **MANUAL ON**.

Note: *If you cannot toggle between auto and manual, close the PCC, reset the autopilot power, check all the HiL connections, and start again. See section 7 for more HiL troubleshooting information.*

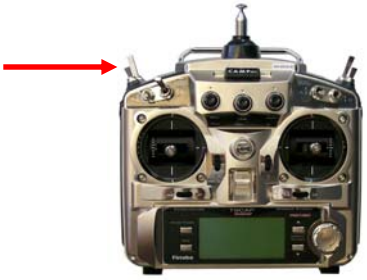


Figure 26 - Channel 5 Switch

5.2 Layers

Layers is a dockable window for selecting layers that are displayed on the map. There are seven categories of layers. Each layer has its own subcategory.

- To enable or disable a layer, click the check box next to the layer.
- To remove a layer completely, from the map and layer list, select it, and then click the **Remove Selected** button.
- To go to a image layer you have added to the map, right click on the image layer and select **View on Map**.

See the *Piccolo User's Guide* for more information about this window.

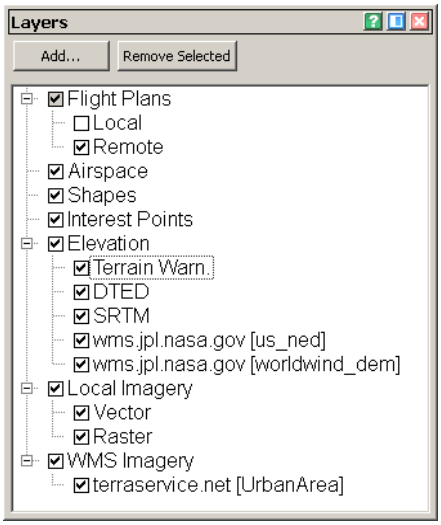


Figure 27 – Layers

5.2.1 Local Imagery Layer

Local imagery is a raster or vector map layer that only exists locally, i.e. on the hard drive.

5.2.2 WMS Imagery Layer

This imagery data is downloaded automatically from online sources specified by the user.

5.2.3 Adding Layers

To add a layer, click the **Add** button in the **Map Layers** window and select the type of layer to add to the map window (local images, elevation data or online imagery WMS). For local images and elevation data you can navigate to the directory where this information is stored. Click the **Open** button to add the layer to the **Map** window.

Note: *CCT includes a basic map directory with the installation CD or you can download the same map directory from the Piccolo software page.*

Map layers coming from the internet are referred to as WMS (Web Mapping Service). WMS defines a protocol that allows applications to query a map server for its capabilities. For example, the *terraserver*, a popular internet map service, supports three different map types:

- Uurban area imagery - 0.5 meter resolution in color, but only available in some large US cities
- Digital Orthographic Quadrangles (DOQ) - 1 meter resolution in black and white
- Topographic maps

For maps outside the U.S., select the *wms.jpl.nasagov* server and then select *global_mosaic – WMS Global Mosaic, pan sharpened*. The global mosaic layer is worldwide Landsat data with a 15 meter resolution. There are commercial services that offer WMS mapping data, such as GlobeXPlorer (http://www.globexplorer.com/products/imageconnect-wms.shtml).

To add map layers from the Internet:

1. Select **WMS** from the **`Add`** button menu.
2. Select the **URL** radio button. From the pull down menu, select a URL address to the server where you would like to obtain maps. The PCC has three default servers configured. More servers are available. You can also type in a WMS URL.

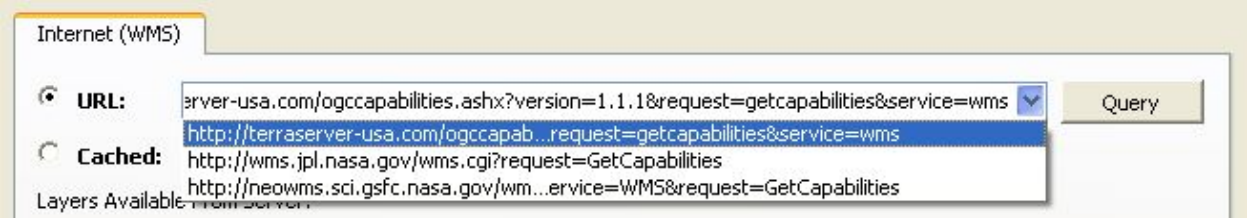


Figure 28 - Internet (WMS)

3. Click the **`Query`** button. The options from the server are displayed in the **`Layers Available From Server`** window.
4. Select the layers you would like to see displayed in the **`Map`** window.
5. Click the **Add Layer** » button. This populates the **Layers to Add** window.
6. Click the **Add Layers** » button. This adds the layers to the **Map** window. The map layers should become visible in the **Map** window.

***Note**: WMS layers are dynamic, automatically downloading map information in the correct location and resolution to match the current map settings. When using WMS layers it may take some time to get an adequate map to appear; however WMS data is cached locally in the user application or PCC program directory, in a directory called WMSCACHE. Once maps are downloaded, you may copy this directory to archive it or transfer it to another machine's PCC installation.*

The window in **Figure 29** gives an overview of what the PCC looks like with and urban area map of the San Francisco airport loaded from TerraServer.

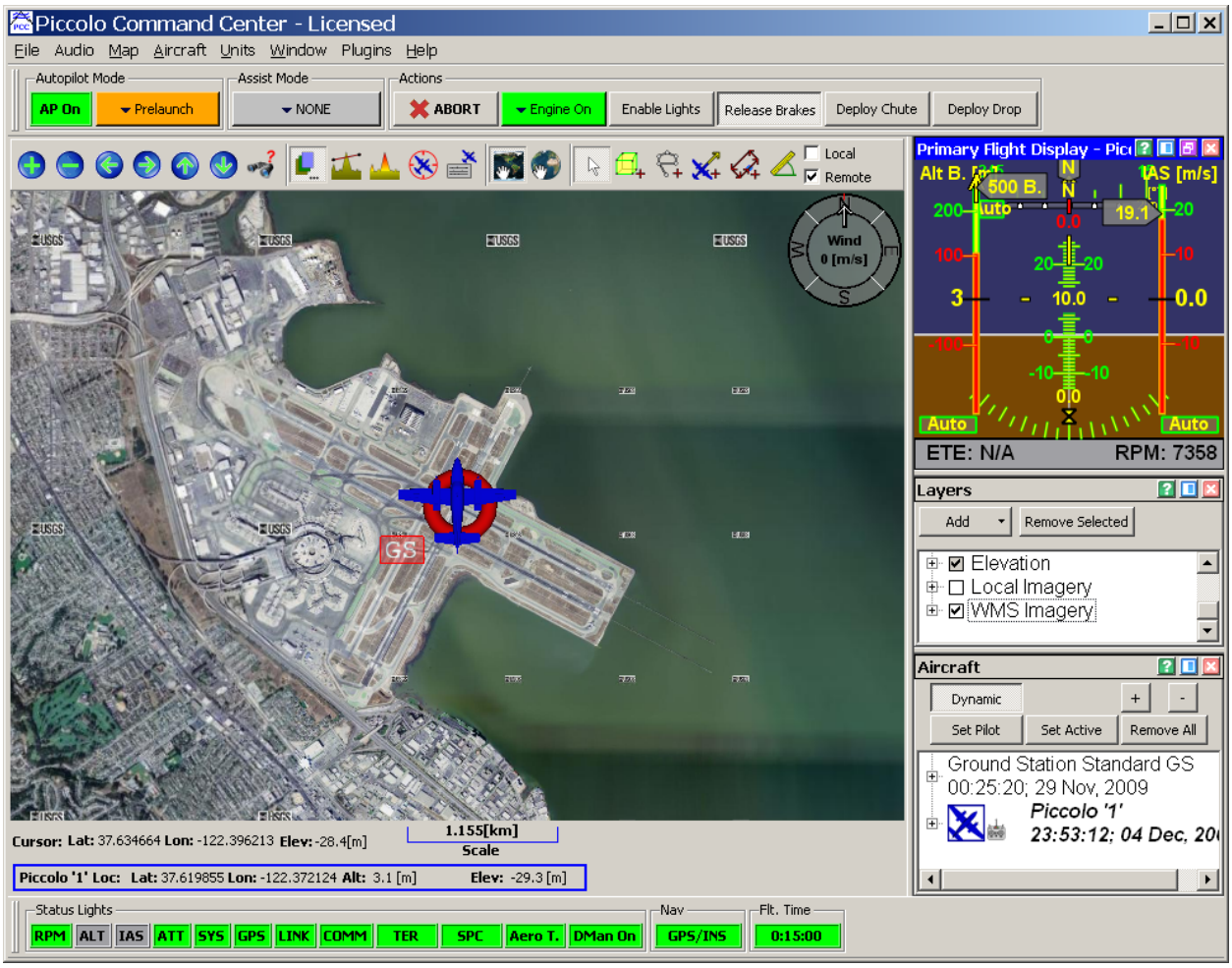


Figure 29 - WMS Imagery Layer

***Note**: WMS layers are dynamic, automatically downloading map information in the correct location and resolution to match the current map settings. When using WMS layers it may take some time to get an adequate map to appear; however WMS data is cached locally in the user application or PCC program directory, in a directory called WMSCACHE. Once maps are downloaded, you can copy this directory to archive it or transfer it to another machine's PCC installation.*

5.2.4 Geo-Referencing a Map File

If you have an image of an area you would like to use for your map you will need to geo-reference it. The map will accept geo-referenced TIFF image files. The first step is to get the image in TIFF format. The geo-referencing is done through a separate world file that has the same name as the image file, but with a "tfw" extension. The world file contains six numbers – one on each line – and has the following format:

```
degrees longitude per x pixel
0
0
degrees latitude per y pixel (negative)
```

Longitude of the upper left corner (positive East). Latitude of the upper left corner (positive North). The geo-referencing assumes that the image is linear, therefore it must be a rectilinear projection, and it must be oriented so that North and South are in the vertical direction. Note that the y-axis scale factor should be negative. This is a result of computer graphics coordinates systems which increase downwards. Shown below is an example world file for Wasco airport in Oregon.

0.00005140576	0.00000000	-120.68207806
0.00000000	-.00005140576	45.591328

5.3 Simulator

When the SiL is started, the Simulator application launches with a dynamics model of a small Piper Cub aircraft.

- ☑ Open the **`External`** menu and verify that **`CAN`** is checked (**Figure 30**). If it is not checked, it means the Simulator cannot find the CAN module.
- ☑ Make sure the USB to CAN interface is connected to the PC and the drivers have been installed.

***Note**: Simulator detects the USB to CAN interface and configures itself to use it as its source of control surface data. If the USB to CAN interface is not connected, Simulator attempts to use any installed joysticks for the control surface data.*

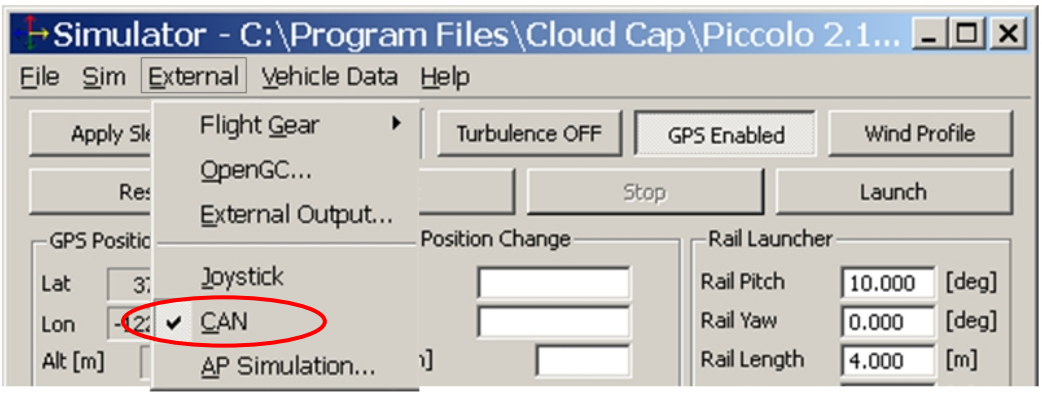


Figure 30 - CAN

☑ With the dynamics model loaded, it is important to verify that you have a good connection between the Simulator and Piccolo. Use the gear CH 5 switch on the pilot console and toggle to **MANUAL ON**. Move the sticks on the pilot console. The positions shown in the **Autopilot Data** window (**Figure 31**) in the Simulator should move accordingly. Once the connection is verified, switch back to **AUTOPILOT ON**.

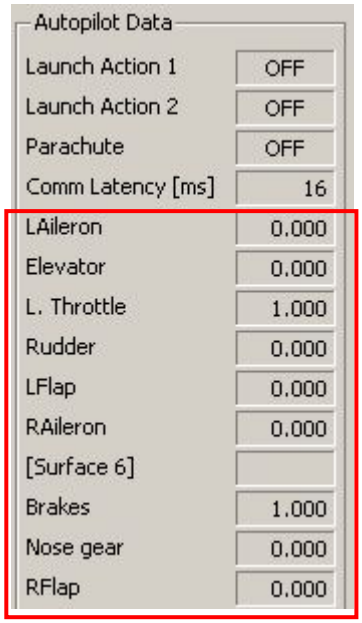


Figure 31 - Autopilot Data

5.4 Create a Quick Flight Plan

1. To create a simple flight plan, select the **Quick Flight Plan** icon on the map actions toolbar.

Figure 32 - Map Actions Toolbar

2. Move your mouse over to the map and click anywhere in the map area that you want to create a plan. The **Quick Plan** window opens (**Figure 33**) and displays the latitude and longitude of the position that was clicked in the map. In this window you can enable an orbit flight plan and select the altitude and radius for the aircraft to fly in.
3. For this simulation, enter a 500 meter altitude and a 1000 meter radius and click **OK**. See the *Map* section in the *Piccolo User's Guide* for more information on how to create detailed flight plans.

   When the aircraft is launched it will climb to the altitude set in this flight plan and fly in a 1000 meter radius of where you initially clicked on the map.

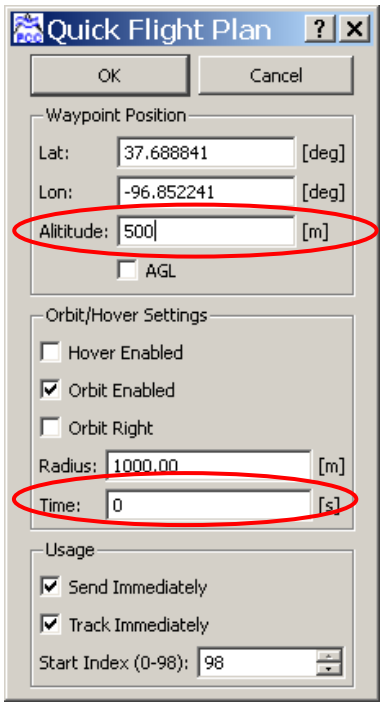


Figure 33 - Quick Flight Plan

5.5 FlightGear

1. If you wish to use FlightGear for visualization, open the **`External`** menu and select the latest version of FlightGear that is on your PC (**Figure 34**)

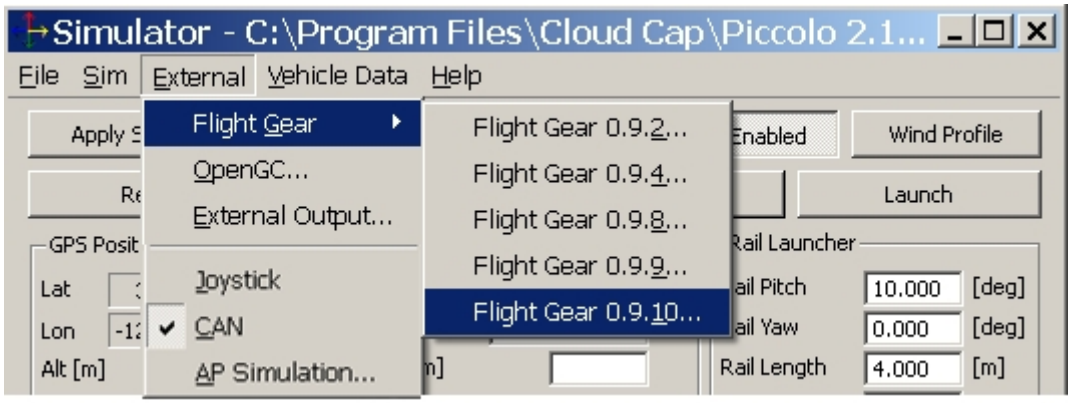


Figure 34 - Flight Gear

2. If FlightGear, Simulator, and PCC are installed on the same computer, leave the default in the **`Host`** field as "localhost" (**Figure 35**). If FlightGear is installed on a separate computer, enter the computer's IP address or the name of the FlightGear computer in the **`Host`** field. Click **`OK`**.

Note: *To determine the IP address of your computer. Open a Microsoft DOS command prompt shell window by clicking the* ***Start*** *menu at the lower-left of your computer's desktop and select* ***Run****. If you are using Windows XP or Vista, type "cmd" (without quotation marks) into the* ***Run*** *box and click* ***OK****. Otherwise, type "command" (without quotation marks) into the* ***Run*** *box and click* ***OK****. In the command prompt window, type in "ipconfig" and press* ***Enter*** *on your keyboard.*

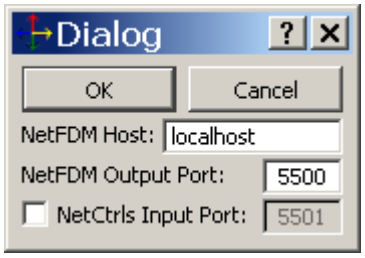


Figure 35 - Flight Gear Communications Dialog

2. Start FlightGear using the batch file **`runfgfs-c172-netctrl.bat`**.

5.6 Launch the Aircraft

1. From the PCC window, verify the following:

   ☑ The aircraft is in Prelaunch mode.

   ☑ The AP is on.

   ☑ The engine is on.

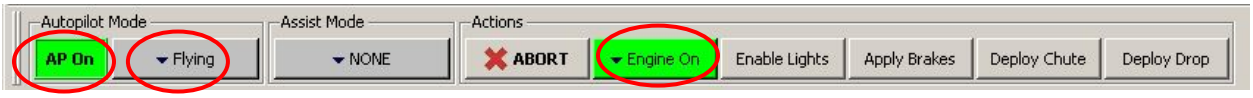


Figure 36 - Aircraft Actions Toolbar

2. Click **`Launch`** from the **`Simulator`** screen. Control of the aircraft is performed by Piccolo, and your interaction with the system is through the Piccolo Command Center.

   Note: *Once the dynamics model is loaded, you can change the state of the simulation. See the Piccolo Simulator document for more information on modifying this dynamics model.*

3. Once the aircraft is flying, you may wish to perform basic flight tasks with the aircraft. See the *Piccolo User's Guide* for more information on how to:

   - Create a multipoint flight plan
   - Create a landing plan
   - Create an airspace boundary
   - Track a waypoint
   - View a bread crumb trail
   - Change aircraft altitude

5.6.1 Communication Delay

Check the number in the **`Comm Latency`** field under **`Autopilot Data`** in the Simulator. This number indicates the communication delay between Piccolo and Simulator. Some delay is inevitable in a Windows operating environment. Even during optimal conditions this number will cycle between 10 to 20 milliseconds. If this number cycles up to 50 milliseconds, the communication delay between Piccolo and Simulator is too high to create an accurate simulation. If this happens, check to make sure no other Window applications are running.

If you are running FlightGear on the same computer, close it or install it in on a separate computer as shown in the two computer configuration setup in section *3.2*.

If you are having difficulties setting up a proper HiL environment, see section *7* for HiL troubleshooting information. If you are still having problems, contact us by e-mail at support.cct@goodrich.com or phone at +1.541.387.2120.

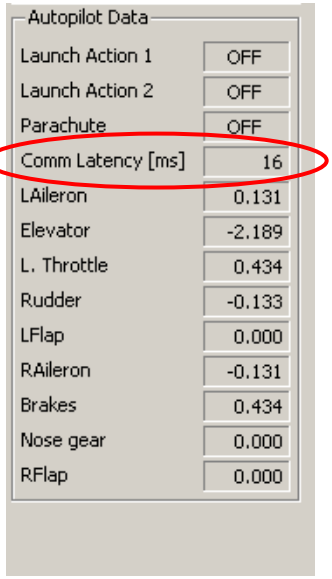
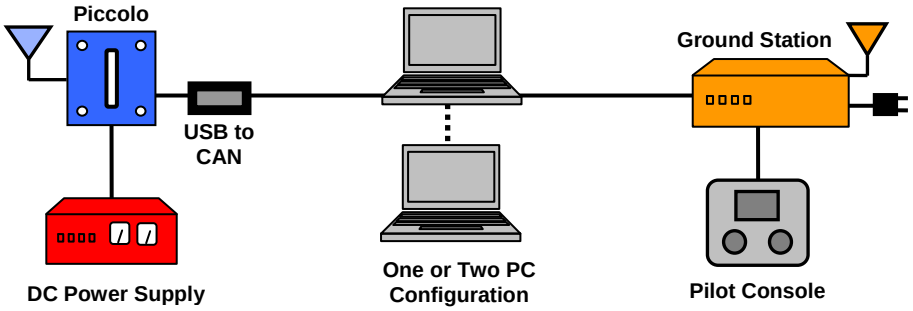


Figure 37 - Com Latency

6 HiL Checklist



- ☑ Setup the autopilot, ground station, and PC connections.
- ☑ Load the software to the PC.
- ☑ Power-up the ground station and autopilot.
- ☑ Start the Hard-in-Loop Simulation.
- ☑ In the Aircraft window of the Piccolo Command Center, verify that the Piccolo in the HiL is set as the active pilot aircraft.
- ☑ Verify communication between Piccolo and the ground station.

☑ Verify CAN is checked in the Simulator window.

☑ From the Piccolo Command Center window, create a simple flight plan.

☑ From the Simulator window, select the latest version of FlightGear.

☑ Enter the address of the FlightGear PC (if needed).

☑ Start FlightGear using the batch file *runfgfsnet-c172.bat*.

☑ Launch the aircraft from the Simulator window.

7 Troubleshooting the HiL

If the troubleshooting procedures do not resolve the problem, contact us by e-mail at support.cct@goodrich.com or by phone at +1.541.387.2120.

⚠ **Troubleshooting Tip #1 -** There is a "No Active Aircraft" message in the Primary Flight display window.

The ground station and autopilot are not communicating. Make sure the ground station is connected to the correct serial port of the PC. Check power to the autopilot and ground station. Check all the HiL connections. Close the PCC and start the HiL sequence again. If you still have not established communications with the avionics verify that the autopilot and ground station are communicating on the same channels. (See Troubleshooting Tip #2.)

⚠ **Troubleshooting Tip #2 -** The timestamps for the Piccolo and ground station are not incrementing.

The ground station and autopilot are not communicating. They may be set to different radio channels. To find out what channel the Piccolo is communicating on, you first need to communicate with the autopilot.

1. Connect the programming cable to the 6-pin MTE connector on the Piccolo interface cable.

2. Connect the DB-9 serial connector of the programming cable to the PC serial port. (For a connection diagram, see the *Piccolo Software Update Guide* for more information.)

3. Set the **`Program/User`** switch to **`User`**. Click the **`Reset`** button. Set the **`Program/User`** switch back to **`Program`**. This procedure will temporarily override any alternate protocol set on the Piccolo's program serial port, and set it to 'Piccolo no flow' at 57600 baud.

4. From the PCC main window open the **`System`** window. The **`Channel`** field displays the channel the Piccolo autopilot is using. Set the Piccolo channel as desired. Verify the Piccolo radio power output setting.

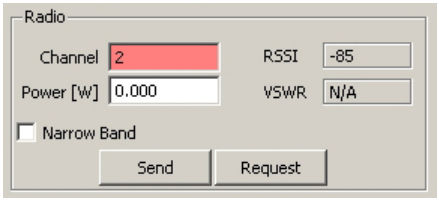


Figure 38 - Piccolo Autopilot Radio Channel

5. Unplug the programming cable from the PC (and Piccolo). Connect the DB-9 ground station cable to the PC. If you still do not have communications with the avionics, open the **`Ground Station`** window. Set the ground station to the same channel as the Piccolo. Verify the ground station radio power output setting.

Figure 39 - Ground Station Radio Channel

⚠ **Troubleshooting Tip # 3 -** The Ground Station and the aircraft are at 000 Longitude and Latitude. A "Comms" error is displayed in Aircraft window.

The Simulator and Piccolo are not communicating. Check the USB to CAN module connections. Make sure you are using the correct CAN cable with the 3-pin connector to connect to the CAN module. Many people mistakenly connect a serial cable to the CAN module.

⚠ **Troubleshooting Tip #4 -** There is no small console next to the Aircraft icon to show that it is the pilot aircraft in the HiL.

Make sure **`Dynamic`** is enabled in the **`Aircraft`** window. If there was a previous autopilot set as the pilot aircraft in the ground station memory, you may see it in the **`Aircraft`** window autopilot list even though that autopilot is no longer physically connected in the HiL. To set the autopilot in the HiL as the pilot aircraft:

1. Click on the autopilot in the **`Aircraft`** window that is connected in the HiL.
2. Select **`Set Pilot`** and click **`OK`**.
3. Select **`Remove All`** and the "ghost" autopilot should disappear.

See the *Aircraft Window* section in the *Piccolo User's Guide* for more information about this function.

8 Software-in-Loop (SiL) Quick Setup

This section provides a quick guide to setup and run the Software-in-Loop (SiL) simulation environment. For detailed SiL instructions, see the *Piccolo Software-in-Loop Setup Guide*. For more information on how to use the PCC interface, see the *Piccolo User's Guide*.

The SiL configuration provides the same functionality as a Hardware-in-Loop (HiL) setup, but without the autopilot and ground station hardware connected. In the SiL configuration, PC applications take the place of the ground station and autopilot. A Windows based PC is the only requirement to setup this environment.

☑ **Install the PCC and Piccolo Software:**

See section 4.1 Software Installation to install the software.

☑ **Start SiL Simulation:**

1. On your computer, go to the **`Start`** » **`Programs`** » **`Cloud Cap`** » **`Start airplane or helicopter software simulation.`** This automatically launches all the SiL applications required to run a simulation.

   Note: *v2.1.1.b and v2.1.1.c software does not support helicopter operations at this time.*

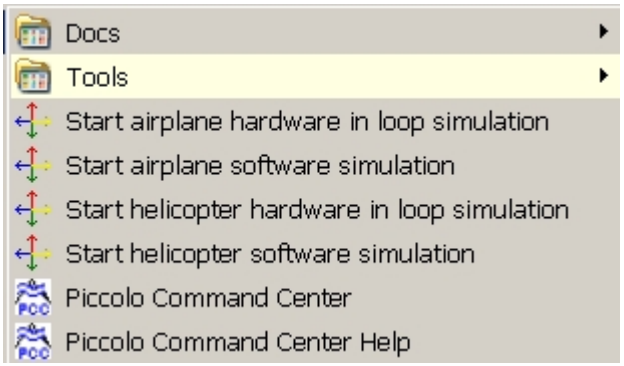


Figure 40 - Simulation Start Menu

2. The **`Communications`** window for the PCC opens. This window configures the system to allow all the SiL applications to talk to one another. Since the Ground Station and PiccoloPC applications are on the same computer, leave the default settings as they are,

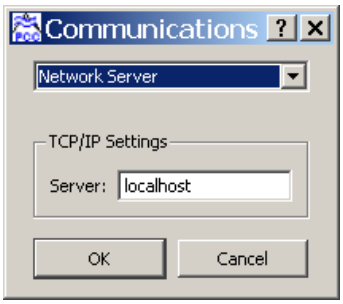


Figure 41 - Communications Window

Troubleshooting Tip: Some Firewalls may not allow local TCP connections and could interfere with setting up a suitable SiL environment. If you have a Firewall on your computer, check the Firewall settings and restart the SiL.

☑ **Verify communications:**

1. When the SiL is started, the Simulator application launches with a dynamics model of a small Piper Cub aircraft.
2. From the Simulator window, open the **`External`** menu and verify that **`AP Simulation`** is checked. This allows the Simulator to talk to the PiccoloPC application. If **`AP Simulation`** is not checked, it means Simulator cannot find the PiccoloPC application.
3. If the Simulator cannot find the PiccoloPC application, check the settings on your computer Firewall. Some Firewalls may not allow local TCP connections and could interfere with setting up a suitable SiL environment.

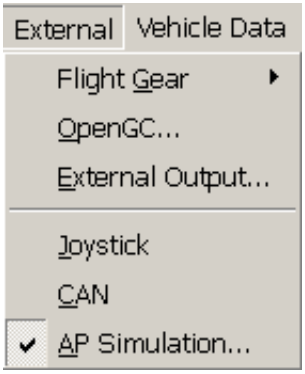


Figure 42 - External Menu

☑ **Create a simple flight plan:**

See section 5.2 Layers for more information about adding a local or internet map layer.

☑ **Start FlightGear:**

1. If you wish to use FlightGear for visualization, open the **`External`** menu and select the latest version of FlightGear that is on your PC (**Figure 43**).

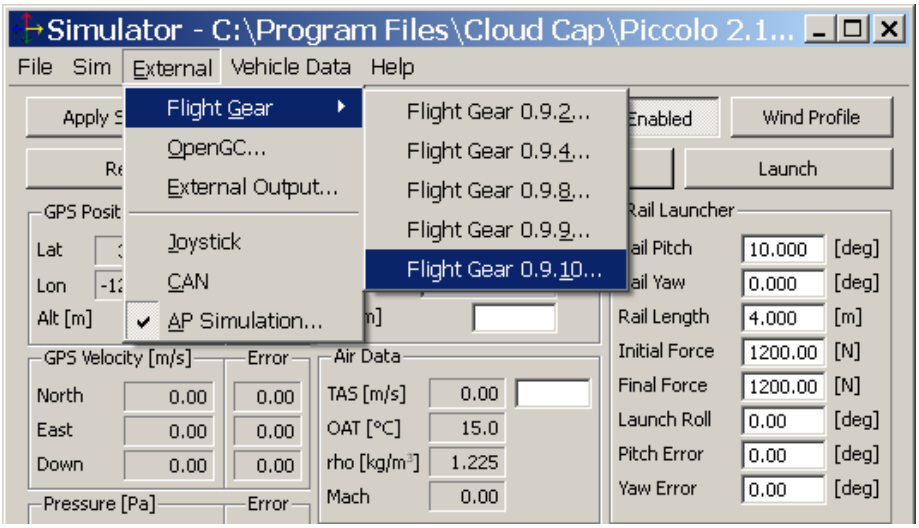


Figure 43 - FlightGear

2. If FlightGear, Simulator, and the PCC are installed on the same PC, leave the default in the **Host** field as "localhost". If FlighGear is installed on a separate PC, enter the IP address or the name of the FlightGear PC in the **Host** field.
3. Click **OK**.

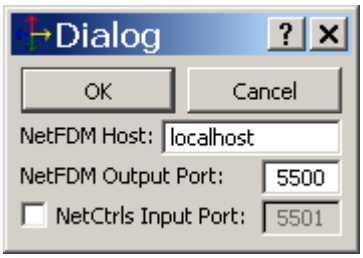


Figure 44 - FlightGear Dialog

Note: *To determine the IP address of your computer. Open a Microsoft DOS command prompt shell window by clicking the* ***Start*** *menu at the lower-left of your computer's desktop and select* ***Run****. If you are using Windows XP or Vista, type "cmd" (without quotation marks) into the* ***Run*** *box and click* ***OK****. Otherwise, type "command" (without quotation marks) into the* ***Run*** *box and click* ***OK****. In the command prompt window, type in "ipconfig" and press* ***Enter*** *on your keyboard.*

4. Start FlightGear using the supplied batch file **runfgfs-c172-netctrl.bat**.

☑ Launch the Aircraft:

1. From the PCC window, verify the following:
   - ☑ The aircraft is in **Prelaunch** mode
   - ☑ The AP is on
   - ☑ The engine is on

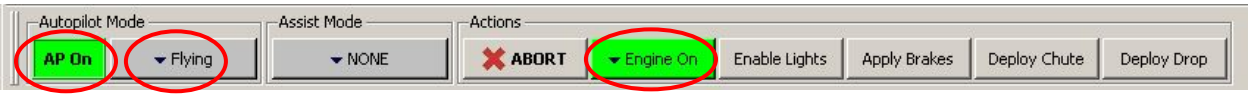


Figure 45 - Aircraft Actions Toolbar

2. Click **Launch** from the **Simulator** screen. Control of the aircraft is performed by Piccolo, and your interaction with the system is through the Piccolo Command Center.

Note: *Once the dynamics model is loaded, you can change the state of the simulation. See the Piccolo Simulator document for more information on modifying this dynamics model.*

3. Once the aircraft is flying, you may wish to perform basic flight tasks with the aircraft. See the *Piccolo User's Guide* for more information on how to:
   - Create a multipoint flight plan
   - Create a landing plan
   - Create an airspace boundary
   - Track a waypoint
   - View a bread crumb trail
   - Change aircraft altitude

If you are having problems setting up the SiL environment, contact us by e-mail at support.cct@goodrich.com or phone at +1.541.387.2120.

8.1 SiL Quick Checklist

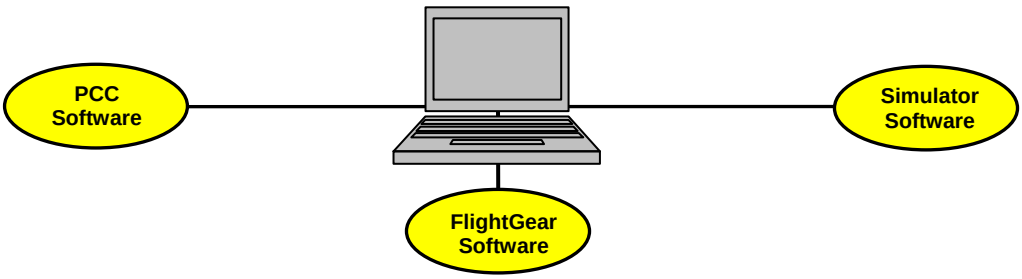


Figure 46 - SiL Environment

- ☑ Load the software to the PC.
- ☑ Start the Software-in-Loop Simulation.
- ☑ Verify communication between Piccolo and the ground station.
- ☑ Verify that AP Simulation is checked in the Simulator window.
- ☑ From the Piccolo Command Center window, create a simple flight plan.
- ☑ From the Simulator window, select the latest version of FlightGear.
- ☑ Enter the address of the FlightGear PC (if needed).
- ☑ Start FlightGear using the batch file *runfgfsnet-c172.bat.*
- ☑ Launch the aircraft from the Simulator window.