Piccolo Avionics External Interface Specification

8 Fourth Street

PO Box 1500

Hood River, OR 97031

(541) 387-2120 phone

(541) 387-2030 fax

CCT@gorge.net

www.uavautopilots.com

Bill Vaglienti

Ross Hoag

Updated April 20, 2005

Cloud Cap Technology

PO Box 1500, No 8 Fourth Street
Hood River, OR 97031
(541) 387-2120 ph (541) 387-2030

Table of Contents

PO Box 1500, No 8 Fourth Street
Hood River, OR 97031
(541) 387-2120 ph (541) 387-2030

Figures

Tables

Cloud Cap Technology

PO Box 1500, No 8 Fourth Street
Hood River, OR 97031
(541) 387-2120 ph (541) 387-2030

Piccolo External Interface

1 Vehicle Interface Connections

1.1 External I/O – Piccolo/Piccolo Plus/Piccolo II

Piccolo, Piccolo Plus, and Piccolo II support a single 44-pin high-density filtered external interface connector (see Figure 1). The connector chosen, while not the smallest or highest density available, provides a cost-effective solution in a small footprint whose benefits includes:

- Integral capacitive filtering for minimizing EMI;
- A robust "gorilla proof " electro-mechanical vehicle interface;
- Readily available low-cost industry standard mating connectors;
- No special tooling required for mating wire harness fabrication;
- Provision for continuous shielding across the connector interface for enhanced EMI protection.

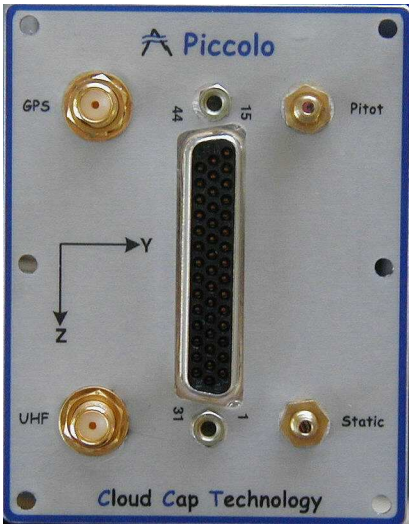

Figure 1 – Piccolo/Piccolo Plus Front Panel

All I/O pins are ESD protected at point of entry and the Maxim RS232 transceiver used provides enhanced on chip 15kV ESD protection for the two serial interfaces. The main DC input is reverse polarity as well as ESD protected.

1.1.1 Mating 44-pin connector specification

Connector, D-Sub HD 44 HD-22

- **CCT part number** **760-00330-00**
- **Digikey part number** **A2078-ND**
- **Amp part number** **748366-1**

Pins, 22-28 Awg HD-22

PO Box 1500, No 8 Fourth Street
Hood River, OR 97031
(541) 387-2120 ph (541) 387-2030

- **CCT part number** **760-00329-00**
- **Digikey part number** **A2088-ND**
- **Amp part number** **748333-4**

1.2 External I/O – Piccolo II

Piccolo II has a second external interface connector: a 25-pin Micro-D connector, that provides additional I/O, serial ports and analog inputs – see Figure 2.

Figure 2. - Piccolo II Front Panel

1.2.1 Mating 25-pin connector specification (Piccolo II only)

The mating connector is supplied with the Piccolo II. It comes with a 18" long pigtail which the user can mate to as needed. Note: It's up to the user to properly terminate the unused as well as the used connections.

Connector, 25 Position Socket Pigtail Harness

- **CCT part number** **760-00636-00**
- **Glenair part number** **MWDM2L-25S-6K1-18B**

1.3 UHF and GPS Antenna

Additionally the Piccolo front panel has two SMA coaxial connectors which are used for the vehicle UHF and GPS antenna connections. It is recommended that low loss RG174 or RG316 cable be used for all external cabling. SMA connectors were chosen due to their availability, ease of use and robustness.

1.3.1 GPS antenna power for active antennas

The default output voltage for active GPS antennas are outlined below.

- Piccolo/Piccolo Plus – 3V

PO Box 1500, No 8 Fourth Street
Hood River, OR 97031
(541) 387-2120 ph (541) 387-2030

- Piccolo II – 5V

Note: Piccolo or Piccolo Plus units can be alternately configured for 5V antenna power. Piccolo II is 5-volt output only.

1.4 Pitot and Static Pressure Ports

Two pressure port fittings provide the interface to the vehicle pitot/static system. The fittings accept 3/32 ID tubing. We use Cole Parmer 3/32" ID, 5/32" OD, 1/16" wall lab grade Tygon tubing (part number 06408-63 type R-3603).

2 Vehicle Interface Configurations

The mix of signals provided on the external interface connector support a multitude of different vehicle configurations. The most common configuration is outlined below but custom implementations that meet your specific interface requirements can also be accommodated.

2.1 Typical Configuration

A typical configuration (see Figure 3) would include: 10 PWM outputs for driving control surfaces; two serial connections (four for Piccolo II); GPS and UHF antenna connections; Flight termination and or ignition connection; power inputs; and optional payloads attached via the CAN bus. The two serial links are used for payload and for long-range UHF data links (Piccolo II includes a dedicated Iridium serial port and a second payload port). Seven unassigned TPU lines are available (by retasking the control surface lines) for discrete timing, I/O, or PWM. A switched Deadman's output is available that can be used for flight termination in the event of upstream hardware or software failure or as a general purpose On/Off switch for controlling payloads or other aircraft systems.

PO Box 1500, No 8 Fourth Street
Hood River, OR 97031
(541) 387-2120 ph (541) 387-2030

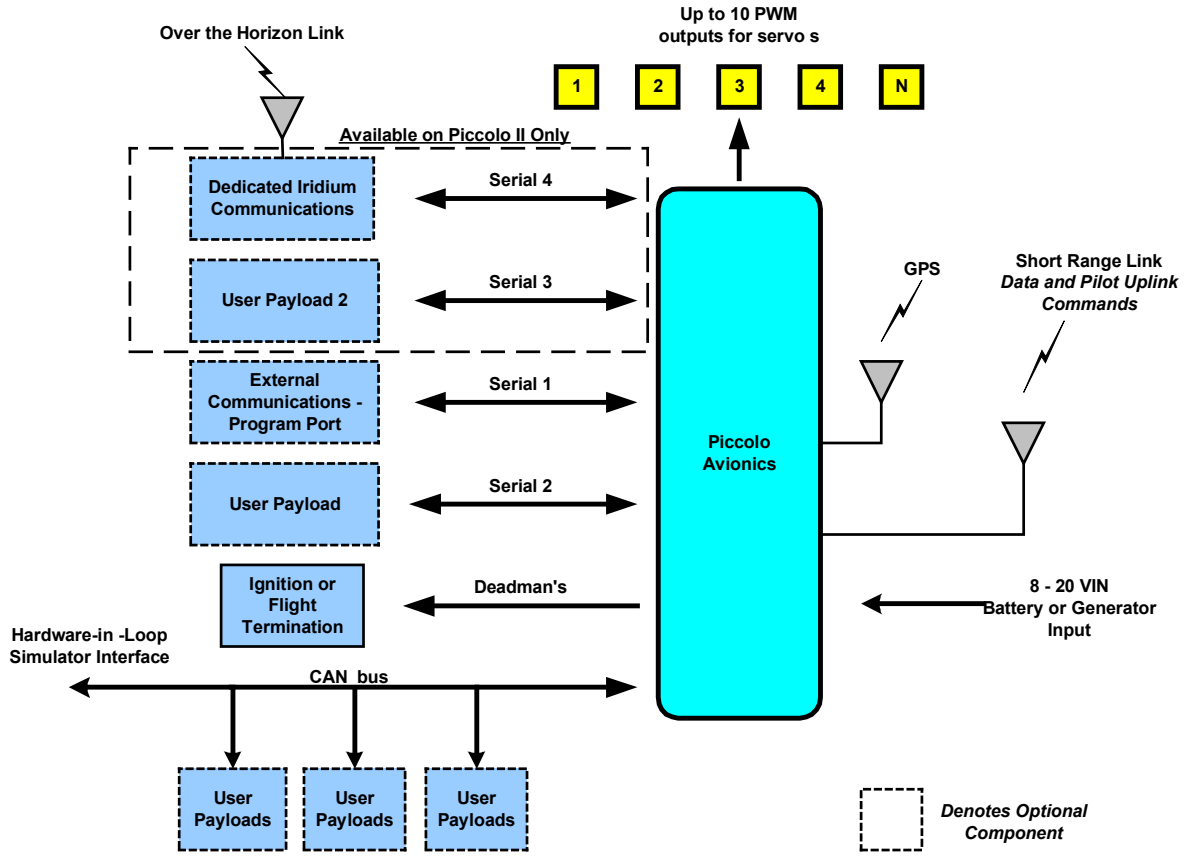

Figure 3 - Typical Configuration

3 Functional Descriptions

3.1 DC Inputs

3.1.1 Main VIN

Piccolo, Piccolo Plus and Piccolo II were designed for a nominal DC input **(VIN)** of 12 volts with an operational input voltage range of 8-20 VDC (see Figure 4).

3.1.2 Servo Power

Piccolo, Piccolo Plus and Piccolo II were designed for a nominal servo power input **(SERVO_Vin_1)** of 4.8 or 6.0 volts. This input was designed to accommodate typical RC hobby servos. Servo load current is limited to a maximum of 2-amps (limited by the 44-pin connector). If your servo load is expected to be greater than 2-amps and your Piccolo serial number is 555 or above a second servo power input **(SERVO_Vin_2)** is available. You can parallel the two input pins to double your servo load capacity (don't forget to double the ground pins as well). If you have questions regarding this configuration please give us a call for further details.

Note: Serial numbers prior to 555 do not support the second servo power input pin (SERVO_Vin_2) that pin is a No Connect (NC1).

PO Box 1500, No 8 Fourth Street
Hood River, OR 97031
(541) 387-2120 ph (541) 387-2030

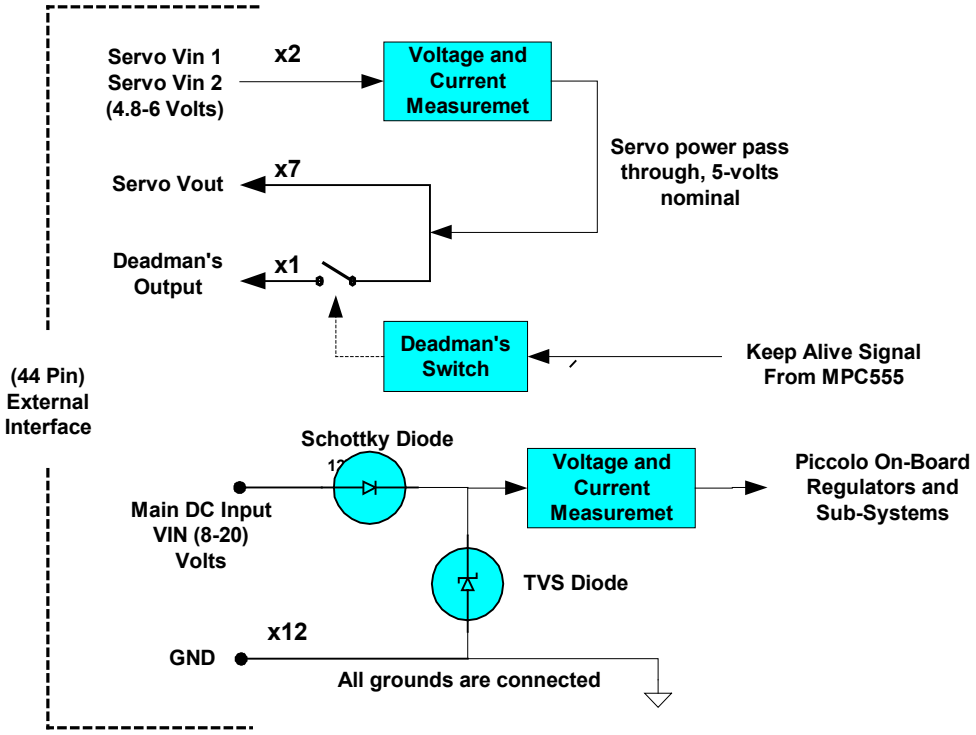

Figure 4 - Piccolo DC Inputs and Outputs

3.2 DC Outputs

The interface connector provides seven unswitched **(SERVO_Vout)** and one switched **(Deadman's Output)** DC outputs.

3.2.1 Servo DC Outputs

These outputs are used to power the vehicle control surface actuators, typically RC model servos. The voltage on these outputs will track whatever voltage is applied to the **SERVO_Vin** pin(s) – the Piccolo acts as a pass through and in the process measures both the voltage and current of this user supplied voltage rail.

3.2.2 Deadman's Output

The Deadman's switch consists of a power MOSFET driven by a watchdog timer circuit. The deadman's switch requires that software periodically service a hardware line to keep the switch active. Hence if the system fails, either due to software or hardware failure, the Deadman's switch turns off. This switch can be connected to an ignition system, or other flight termination system, and so provides a measure of safety in the event that the system fails. Please refer to the "Piccolo User's Manual" for further details on how to setup and use the Deadman's output. The MOSFET switch can drive up to a 3-amp load and is powered from SERVO_Vin. When activated (turned on) it will provide a voltage level of SERVO_Vout (4.8-6.0 volts nominal), when deactivated (turned off) it will float the output – disconnect the load.

PO Box 1500, No 8 Fourth Street
Hood River, OR 97031
(541) 387-2120 ph (541) 387-2030

3.3 Serial I/O

The Piccolo Plus external interface connector supports two dedicated RS232 universal asynchronous receiver transmitter (UART) serial ports; one for programming and/or general serial I/O (115K baud max); and the other for general serial I/O or payload communications (56K baud max). Note: any of the other TPU lines or PWM, if unused, can also be configured for use as GPIO, timing I/O or as PWM outputs.

In addition Piccolo II, which has an additional external interface connector, provides a dedicated 4-wire RS232 port for connection to an Iridium satellite terminal as well as and a second payload serial port.

3.4 PWM Outputs

The interface connector offers the option to directly drive up to 10 standard RC servos providing PWM outputs, powers and grounds for each. The PWM outputs are divided into two banks:

- **Bank 1** - ***PWMSM[0-4]*** are nominally PWM outputs used for servos 1-5. The can also be configured for GPIO or timing output
- **Bank 2** - ***TPU_A[0-4]*** are nominally PWM outputs sued for servos 6-10. They can also be configured for GPIO, or timing input and output.

3.5 Controller Area Network Interface

A *C*ontroller *A*rea *N*etwork (CAN) serial interface is also provided for bussed or multi-drop applications. The CAN bus is a robust two wire differential serial bus designed for use in high EMI environments. It has seen wide use in automotive and industrial control applications and should prove to be well suited for UAV applications. The CAN bus is also used to provide the link between the Piccolo avionics and the Piccolo hardware in the loop simulator[1]. Follow on products will include a number of payload modules that will connect using this interface. We envision a 5-wire interface *CANH, CANL, V1, V2, GND* plus an overall shield. Nominally *V1* and *V2* would be 5V and 12V respectively.

Piccolo II provides access to a second CAN bus on its additional interface connector. Functionality is TBD – added for custom applications.

3.6 No Connects

If you have a Piccolo or Piccolo plus prior to serial number 555 you have access to two no connects (NC1 and NC2) which if needed can be used for custom applications – call CCT for further details if you need to use them.

If you have a Piccolo Plus or Piccolo II serial number 555 or above, these pins are configured as secondary servo power inputs (SERVO_Vin_2 and GND). This was added to provide for operating with larger servo loads (current loads above 2-amps) . See section 3.1.2 for further details.

[1] Hardware in loop simulation is arguably one of the most important features of any UAV development system.

PO Box 1500, No 8 Fourth Street
Hood River, OR 97031
(541) 387-2120 ph (541) 387-2030

4 Signal Descriptions

4.1 Piccolo and Piccolo Plus

Table 1 P1 - External Interface Connector Pin Assignments

PIN	NAME	TYPE	LEVEL	FUNCTION	
15	GND			Gnd for servo 1	1
30	SERVO_Vout	O	!	Power for servo 1	
44	PWMSM[0]	O	5V	Servo 1 signal output - **Left Aileron**	
14	GND			Gnd for servo 2	2
29	SERVO_Vout	O	!	Power for servo 2	
43	PWMSM[1]	O	5V	Servo 2 signal output - **Left Elevator**	
13	GND			Gnd for servo 3	3
28	SERVO_Vout	O	!	Power for servo 3	
42	PWMSM[2]	O	5V	Servo 3 signal output - **Left Throttle**	
12	GND			Gnd for servo 4	4
27	SERVO_Vout	O	!	Power for servo 4	
41	PWMSM[3]	O	5V	Servo 4 signal output - **Left Rudder**	
11	GND			Gnd for servo 5	5
26	SERVO_Vout	O	!	Power for servo 5	
40	PWMSM[4]	O	5V	Servo 5 signal output - **Left Flap**	
39	TPU_A[0]	I/O	5V	Servo 6 signal output - **Right Aileron**	SPARE I/O
38	TPU_A[1]	I/O	5V	Servo 7 signal output - **Right Elevator**	
37	TPU_A[2]	I/O	5V	Servo 8 signal output - **Right Throttle**	
36	TPU_A[3]	I/O	5V	Servo 9 signal output - **Right Rudder**	
35	TPU_A[4]	I/O	5V	Servo 10 signal output - **Right Flap**	
25	SERVO_Vout	O	!		PWR/GND
24	SERVO_Vout	O	!		
23	SERVO_Vin_1	I		Servo power input 4.8-6V nominal	
6	Deadman's output	O		Servo power switched by deadman circuit	
10	GND			Ground	
9	GND			Ground	
8	GND			Ground	
7	CAN_GND			CAN Ground	CAN
22	CAN_HI_A	I/O	CAN	CAN A Serial High	
21	CAN_L0_A	I/O	CAN	CAN A Serial Low	
34	TXD_RS232	0	232	**Payload 1 TX** -User RS232 Output - TPU_B[0]	SERIAL COMMS
33	RXD_RS232	I	232	**Payload 1 RX** - User RS232 Input - TPU_B[1]	
5	TPU_B[2]	I/O	5V	User Configurable I/O	
20	TPU_B[3]	I/O	5V	User Configurable I/O	
4	GND				
19	*PROGRAM/USER	I	5V	Program/User Mode Control Input - MPIO32B5	
18	*HRESET	I	5V	Hardware Reset - actve low	
3	GND			Ground	
32	SCI_2_TX_232	O	RS232	**Ext Com/Program Port TX**	
31	SCI_2_RX_232	I	RS232	**Ext Com/Program Port RX**	
16	SERVO_Vin_2 / NC1	I		Before serial number 555, this is a no-connect	
1	VIN	I		Main DC Input - 5.5-20 Vin	
2	GND				
17	SERVO_GND / NC2			Before serial number 555, this is a no connect	

PWMSM[0-4] ***(0-5 volt output)*** In the default mode these are configured as PWM outputs and are used to control the actuators on left side of the airplane.

SERVO_Vin_1 ***(4.8-6.0 volt input)*** User supplied input voltage used to power the servos

PO Box 1500, No 8 Fourth Street
Hood River, OR 97031
(541) 387-2120 ph (541) 387-2030

SERVO_Vout (***output)*** DC output whose voltage matches the applied **SERVO_Vin** inputs. Nominally these are used as servo power pins.

Deadman's output (*output)* Switched DC output whose output voltage matches the applied **SERVO_Vin_1** input DC voltage. ON/OFF controlled via software by an onboard Deadman's circuit. Typically used for ON/OFF control of an ignition or flight termination system.

TPU_A[0-4] ***(0-5 volt input/output)*** In the default mode these are configured as PWM outputs and are used to control the right side of the airplane. They can be independently configured for GPIO, TTL level serial communications, or timing if not needed for actuator control.

TPU_B[2-3] ***(0-5 volt input/output)*** In the default mode these are configured as RPM inputs for a left and right engine respectively. They can also be independently configured for GPIO, TTL level serial communications, or timing.

CAN_HI_A - ***(CAN level I/O)***

CAN_LO_A - ***(CAN level I/O)***

CAN_GND - Same as system ground (GND).

TXD_RS232 ***(RS232 output)*** Driven by TPU B CH0 on the MPC555 – Payload 1 transmitter.

RXD_RS232 ***(RS232 input)*** Received by TPU B CH1 on the MPC555 – Payload 1 receiver.

PROGRAM/USER (*0-3.3 volt input) When held low during a reset the MPC555 boots in monitor mode from which application code can be loaded to flash; When left floating or driven high during a reset causes the MPC555 to boot and run user application code. The pin has a 10k pull-up to 3.3 volts.

HRESET (*0-3.3 volt input) When pulled low forces the MPC555 into a hard reset. The pin has a 10k pull-up to 3.3 volts.

SCI_2_TX_232 ***(RS232 level output)*** Driven by SCI CH2 TX on the MPC555. Each SCI is a full-duplex universal asynchronous receiver transmitter (UART) serial interface. External communications/Programming serial transmitter.

SCI_2_RX_232 ***(RS232 level input)*** Received by SCI CH2 RX on the MPC555. Each SCI is a full-duplex universal asynchronous receiver transmitter (UART) serial interface. External communications/Programming serial receiver.

NC[1-2] ***(User defined)*** User defined no connect pins for future applications on Piccolo and Piccolo Plus serial numbers below 555. On Piccolo Plus and Piccolo II's serial numbers 555 and above NC1 and NC2 are configured as secondary inputs for servo power, **SERVO_Vin_2** and **SERVO_GND** respectively.

VIN ***(8-20 volt input)*** DC input voltage used to power the onboard 5.5-volt and 3.3-volt switching regulators.

PO Box 1500, No 8 Fourth Street
Hood River, OR 97031
(541) 387-2120 ph (541) 387-2030

GND Common ground tied to the internal ground plane of the avionics and the shell of the main interface connector.

4.2 Piccolo II

Table 2 P2 - Piccolo II MicroDot Connector Pin-out

PIN	NAME	TYPE	LEVEL	FUNCTION
24	CAN_LO_B	I/O	CAN	Serial TX/RX
13	CAN_HI_B	I/O	CAN	Serial TX/RX
12	AIN0	I	5V	10 bit anlog input
11	AIN1	I	5V	10 bit anlog input
10	AIN2	I	5V	10 bit anlog input
9	AIN3	I	5V	10 bit analog input
22	AGND			Analog ground
23	AGND			Analog ground
21	TPU_B8	I/O	5V	GPIO3
19	TPU_B9	I/O	5V	GPIO4
17	TPU_B10	I/O	5V	GPIO5
15	TPU_B11	I/O	5V	GPIO6
8	GND			Ground
18	GND			Ground
20	GND			Ground
7	TXD1_232	O	RS232	Iridium TXD
6	RXD1_232	I	RS232	Iridium RXD
16	GND			Ground
5	TXD2_232	O	RS232	Iridium DTR
4	RXD2_232	I	RS232	Iridium CD
14	GND			Ground
3	TXD3_232	O	RS232	Payload 2 RS-232 Tx
2	RXD3_232	I	RS232	Payload 2 RS-232 Rx
1	GND			Ground
25	No Connection			

CAN_HI_B ***(CAN level I/O)***

CAN_LO_B ***(CAN level I/O)***

AIN[0-4] (0-5 volt inputs) User configurable 10-bit analog inputs. Each input has a 100pF capacitor to ground and a 1k ohm series resistor. See the "Piccolo User's Guide" for further details on configuration and use.

AGND – Returns for the four analog inputs.

TPU B[8-11] ***(0-5 volt I/O)*** Can also be independently configured for GPIO, or timing.

GND – Returns for any of the digital I/O.

TXD1 ***(RS232 output)*** Iridium transmit data.

RXD1 ***(RS232 input)*** Iridium receive data.

TXD2 ***(RS232 output)*** Data Terminal Ready (DTR) output to Iridium unit.

RXD2 ***(RS232 input)*** Carrier Detect (CD) from Iridium unit.

TXD3 ***(RS232 output)*** Payload 2 transmit data.

RXD3 ***(RS232 input)*** Payload 2 receive data.