The GPS Smart Coupler
User Manual

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Smart Coupler Description

What is it?

The Smart Coupler is a device that allows you to connect your hand–held global positioning system (GPS) receiver to your autopilot. The only requirements are that the GPS receiver has an output that the Smart Coupler can decode and that the autopilot has a VOR tracking input. The Coupler can decode any output that transmits cross track error and that complies with the National Marine Electronics Association (NMEA) 183 standard. It can also decode the Argus output of the Magellan 5000/A and the NMEA 183 output of many Loran C receivers. Virtually all new GPS receivers meet the NMEA 183 standard. See Appendix A for a list of receivers.

Installation can be as simple as attaching two wires to your GPS receiver, two wires to your autopilot course input and two wires to your fused autopilot power source. Your may also choose to install two panel mounted options. The first is an indicator that shows when the Smart Coupler is sending a signal to the autopilot. The second is a course width selection switch.

Once installed, your autopilot will track your GPS as well or better than it will track your VOR. Remember that GPS course width is constant no matter how close you are to the waypoint. Practically, this means that you can track directly over a waypoint and your wings will never wiggle an inch! Also many GPS receivers calculate and follow a nicely radiused path when changing heading at a waypoint. Again, practically this means that you can track inbound on one heading, change headings to the outbound track and the aircraft will be well behaved throughout the heading change. Some autopilots will do this better than others, it depends on the rate of change of heading and the magnitude of heading change at the waypoint.

What does it do?

The Smart Coupler listens to the serial output of a GPS or other receiver, extracts the left-right course information and makes an analog signal that is suitable for a CDI or autopilot input. The coupler can decode any GPS serial output that meets the NMEA 183 standard. See the specification section for the exact NMEA sentences decoded. The Coupler can also decode the Argus output of the Magellan 5000A.

The Smart Coupler can produce a course width of 1.25, 2.5, 5 or 10 NM. This corresponds to 0.25, .5, 1 and 2 NM per dot on a normal course indicator. GPS course width does not depend on distance from a waypoint. The course width can be fixed on installation or can be wired to an external course width selection switch so the pilot can change the selection. Normally, course width is fixed at 1.25 NM (factory default). Autopilot course width is independant of the course width selected for the receivers's built-in course deviation indicator (CDI).

Any time the Smart Coupler receives valid course information from the GPS receiver it sets the autopilot output accordingly and turns on the valid course status indicator. If the Smart Coupler does not receive a new course value from the receiver for approximately 35 seconds, it sets the autopilot output to 0 volts and turns off the valid course status indicator.

When the coupler is turned off or if the coupler is not receiving valid left–right course information, the autopilot output is at 0 volts with respect to the reference. When the coupler is receiving course information from the GPS receiver, it drives the autopilot output in the range of ±150mv. The output is 0 volts when on course. It is plus or minus 150 mV when off course for the full course width and proportional in between. A minus output indicates right of course (turn left to get back

to course). Some avionics manufacturers refer to these signals as +Right Deflection and +Left Deflection. See the pinout table 1 below.

The status signal is generated with a switch to ground capable of sinking 100 mA. It can operate an indicator lamp or a small relay.

The serial input is designed to meet NMEA 183 and is optically isolated from the rest of the circuits and from aircraft ground.

Guarantee

Return the Coupler within 90 days for a full refund if you are not completely satisfied. It the Coupler does not work with your Magellan 5000A or your NMEA-183-compliant GPS or Loran receiver, either return the Coupler for a refund or let us borrow your receiver and we will make it work with the coupler. In order for the Coupler to work properly, the NMEA receiver must transmit cross track error using any of the sentences listed under *NMEA 183 Compliance* in the *Specifications* section of the manual.

Smart Coupler Installation

Mechanical installation

Install the Smart Coupler securely in the aircraft where it is protected from extreme heat or cold. A position near the instrument panel and radio stack is appropriate. Avoid placing the Coupler closer than 24 inches from a transmitting antenna.

Electrical connections

Refer to Figure 1 and Table I below for the Smart Coupler connector pinout and signal names. The coupler must be protected with a 1 amp fuse or circuit breaker. Wire the fuse or breaker to pins 2 and 10. Wire pins 1 and 9 to aircraft ground. The coupler can be left powered all the time or can be fed from a switched source such as the autopilot on–off switch or avionics master. Current draw is negligible, less than 50 mA.

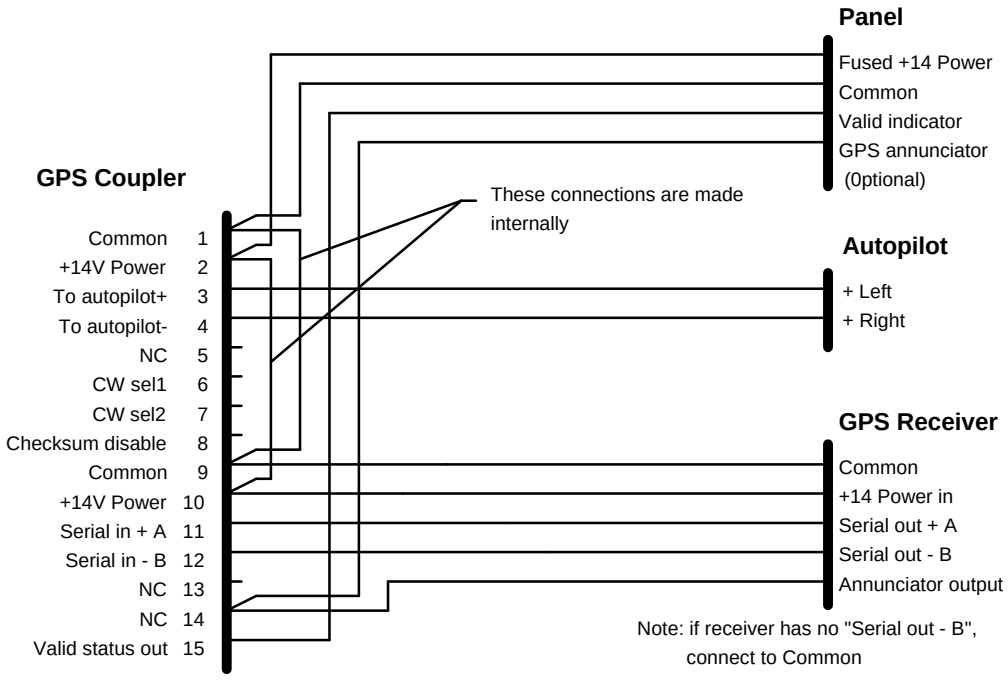
Connection to GPS

Consult your GPS manual for the pinout and signal names of the serial output. Use two conductor shielded wire similar to Beldon 9501 (one pair of 24 AWG stranded wire twisted in an overall shield) to make the connection to the Smart Coupler. The serial signals should be identified as signal “A”, signal “B” and shield. The shield is normally connected only at the GPS (the serial transmitter). Signal “A” is connected to the coupler pin 11 and signal “B” is connected to pin 12.

If your GPS only has one serial signal line, connect it to pin 11 and connect pin 12 to signal ground at the GPS. It is still important to use two conductor shielded wire with the shield connected only at the GPS.

Connection to autopilot

Consult the autopilot manual for appropriate connections. Use the same type of two conductor shielded wire as in the serial connections above. Connect the shield to aircraft ground at the Smart Coupler end only. Smart Coupler pin 3 has the active signal and pin 4 has the reference signal. The reference is nominally 175 mV above aircraft ground. The active signal moves ±150mv with respect to the reference. Pin 4 is sometimes called +Right Deflection while pin 3 is sometimes called +Left Deflection.



GPS Coupler wiring diagram

Figure 1

Connection of indicator lamp

An indicator lamp should be placed on the panel to show that the Smart Coupler is receiving valid data from the GPS. Pin 15 is internally switched to ground when the coupler has received a valid signal from the GPS within the last 35 seconds. Wire an indicator so that positive side is connected to the aircraft power bus or to the aircraft panel dimmer bus. The negative side of the indicator is connected to pin 15 of the coupler connector. The Coupler can sink up to 100ma.

We strongly recommend that this indicator be installed in the aircraft. It serves as a check that the GPS receiver and the Smart Coupler are connected, turned on and working. At the very least it will serve as a reminder to turn on the GPS receiver's serial output.

Optional GPS Receiver annunciator

Some GPS receivers (notably the Garmin) have provisions for an external annunciator. If you want to use this feature, use pin 14 of the GPS coupler as a common terminal. Connect the annunciator wire from the receiver and the lamp wire from your panel indicator to pin 14. Pin 14 has no internal connection to the GPS coupler. See your receiver manual for details of wiring the external annunciator.

pin	*description*
1	Aircraft ground
2	Aircraft power (+14V)
3	Autopilot Out+ (+Left Deflection)
4	Autopilot Out– (+Right Deflection)
5	No connection
6	Course width select input 1 (see table 2 below)
7	Course width select input 2 (see table 2 below)
8	NMEA checksum disable
9	Aircraft ground
10	Aircraft power (+14V)
11	Serial In+ (NMEA designation “A”)
12	Serial In– (NMEA designation “B”)
13	No connection
14	No connection – optionally used for GPS receiver annunciator connection point
15	Valid signal status output

Table 1

Smart Coupler Connector pinout

Selection of course width

Normally, the course width selection pins can be left unconnected. This sets the course width at 1.25 nautical miles.

Optionally, course width can be adjusted by selectively connecting pins 6 and 7 to ground. See Table 2 below. If both pins are left open, course width is set to one and a quarter nautical miles. This means that if the GPS signals the coupler that the aircraft is one and a quarter miles right or left of course, the coupler will output –150 mV or +150 mV respectively. If both pins are grounded, the coupler will output 150 mV for ten miles off course. Course width can be set to 1.25, 2.5, 5 or 10 nautical miles. The maximum voltage from the Smart Coupler is 150 mV. If the aircraft is more than the selected course width off course, the Smart Coupler will send full scale – either plus or minus 150 mV.

Course width can also be set internally by placing jumpers on header P1.

pin 6	*pin 7*	*Course Width*
open	open	1.25 nautical miles
grounded	open	2.5 nautical miles
open	grounded	5 nautical miles
grounded	grounded	10 nautical miles

Table 2

Course Width Selection

Course width affects system gain when the autopilot is in course mode. A course width of 1.25 has four times the gain of a course width of 10. Normally you choose the narrowest course width that the autopilot will follow and still be stable. If your autopilot is nice and stable in the heading mode but overshoots the course or continuously banks left and right while trying to follow a course, it usually means the gain is too high. Try increasing the course width.

Disabling NMEA Checksum

Some GPS receivers do not append the optional checksum to the end of the NMEA information sentence. See Appendix 1 for a table of receivers and their needs. If the checksum algorithm needs to be disabled in the Smart Coupler, connect pin 8 to ground.

Installation check

After the installation is completed, you can quickly check if the Coupler is receiving and decoding information from the GPS receiver.

1. Turn on the GPS receiver and put in a course from the present position to a nearby waypoint.
2. Enable the serial output to the Coupler.
3. Apply power to the Coupler.
4. The Coupler annunciator should light. There should be 0±2 millivolts difference between the wires connected to the autopilot. If you have a wing leveler type of autopilot and if you enable the autopilot in course mode, you should be able to center the ailerons with the trim knob.
5. Now enter a course such that your present position is at least 1.25NM (or whatever you have selected as course width) off course.
6. The Coupler annunciator should still be on. Now there should be 150±5 mV difference between the wires going to the autopilot. The ailerons should be at full deflection.
7. Turn off the GPS receiver but leave the power applied to the Coupler.
8. After approximately 35 seconds, the Coupler annunciator should go off.
9. This completes the installation check.

Smart Coupler Use

Normal procedure

- Put a course in to the GPS receiver.
- Enable the NMEA 183 or Argus output from the receiver. Ensure the receiver is not in battery saver mode.
- Fly your aircraft to place it on course and on the correct heading. Use the CDI in the GPS receiver to help do this.
- Note that the Smart Coupler annunciator is lighted. This indicates that the Coupler is receiving and decoding course information.
- Enable your autopilot.
- Relax!

Note that the sensitivity of the CDI built into the GPS receiver is separate from the course width that the Smart Coupler sends to the autopilot. Many GPS receivers allow you to set the sensitivity of the built in CDI. The autopilot output course width remains at whatever is selected on pins 6 and 7 independent of the CDI sensitivity.

Smart Coupler Specifications

Power

- Voltage: 7-16 VDC, Current: 50 mA

Enclosure

- 4 3/8 x 2 3/8 x 1 1/4 inches.
- Choice of cast aluminum box at 6 ounces or ABS plastic box at 4 ounces.

Autopilot output

- Differential analog signal, not referred to ground
- ±150mv full scale (selectable 1.25,2.5 5 or 10 NM off course).
- Positive means turn right to return to course.
- The transmitted output is cross track error. This is an analog signal representing the shortest distance from the current position to the selected ground track.
- There is a simple one pole filter on the autopilot output with a time constant of approximately two seconds. No other filtering or integration is done in the Smart Coupler. Serial information is translated to analog information and immediately transmitted.

Serial input

- True differential signal that is optically isolated from receiver circuit
- Designed to meet NMEA 183 standard
- Draws a maximum of 2 mA from transmitter for voltages from 0 to 15 volts
- Draws a maximum of 1 mA/volt from the transmitter for voltages from 0 to –15 volts..
- Logical true +2 volts or greater
- The input will withstand a maximum of ±15 volts from line to line and a maximum of ±600 volts from line to ground without damage.
- 4800 baud., 8 bits, no parity, 1 or 2 stop bits.

Status output

- Open collector transistor
- 100 mA maximum current, 60V maximum voltage, 1 Watt maximum power

Course width selection

- Connect to ground for TRUE.
- Leave unconnected for FALSE

NMEA 183 Compliance

The Smart Coupler complies with NMEA 183 version 2, January 1, 1992.

This device is classified as a LISTENER

Pin 11 is the A signal line, pin 12 is the B signal line.

The serial line load requirement is 2 mA maximum for positive voltages.

Decoded NMEA sentences are GPXTE, GPAPA, GPAPB, GPRMB, LCXTE, LCAPA, LCAPB and LCRMB. The sentences that are prefixed with GP are sent by GPS receivers while the ones

prefixed with LC are sent by Loran C receivers. The Smart Coupler extracts cross track error from each of the decoded sentences. For xxXTE, xxAPA and xxAPB the coupler requires that the first five fields are present. These are Status, Status, Magnitude, Direction and Units. For xxRMB the coupler requires only the first three fields be present: Status, Magnitude and Direction. The checksum must be present and match for all the sentences unless disabled via pin 8. The checksum is always required for xxRMB regardless of the state of pin 8.

The connector type on the Smart Coupler box is a male DB15 (see the installation section of this manual). A female connector is required on the connecting cable.

The serial interface circuit consists of a 6N138 or equivalent opto-isolator with a MPF102 or equivalent J-FET in series with the LED portion of the isolator. The J-FET is used as a current limiting device. There is a 1N4148 or equivalent diode placed across the opto-isolator LED to protect against reverse voltage. The serial input is completely floating, as there is no electrical connection from the “A” or the “B” input to local power or ground.

Appendix I

GPS Receivers and requirements

Receiver	Comments
Apollo 920	Tested - no special requirements
Garmin 55, 90, 95	Tested - no special requirements, use 0183 output
Magellan 5000/A	Tested - Jumper required on Smart Coupler printed wiring board. See the special instructions.
Magellan Meridian, Trailblazer	Tested - no special requirements
Other NMEA Magellan	183B output - tested, no special requirements 183A, 183C, or 183D output - The receiver does not send a checksum. If you must use one of these outputs instead of 183B, the Smart Coupler checksum algorithm must be disabled by placing a jumper from pin 8 to ground (pins 1 or 9).
Ross Engineering LCA 200	183-1, 183-3 - Must disable checksum 183-2 - No special requirements

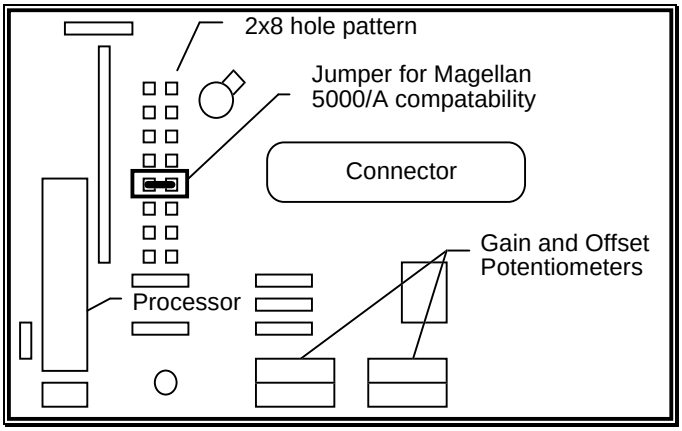
If your receiver is not included in the above list, it simply means that Porcine Associates has not yet had any experience with it. We have not yet seen a receiver that claimed to be NMEA 0183 compliant that was not compatible with the Smart Coupler.

GPS units that claim ARGUS compatibility should work with the Smart Coupler as long as they can transmit at 4800 baud. The Magellan 5000/A reciever is an ARGUS receiver that has been tested with the Smart Coupler.

Special instructions for Magellan 5000/A

The Magellan 5000/A is not NMEA 0183 compliant. Select the alternate Smart Coupler decoding scheme by doing the following:

1. Place a jumper on the Smart Coupler printed wiring board as shown below. The Smart Coupler must be removed from its case to place the jumper. The factory will supply a Smart Coupler with this modification done on request.



Top View Smart Coupler PWB showing selected components

2. Set the Magellan Argus Setup (Aux. 7) to OUTPUT ON and 4800 BAUD
3. Wire the Argus moving map high output to the Smart Coupler serial input + (orange wire in Magellan data cable) and the - output to the Smart Coupler serial input – (black wire).