APPENDIX GPS-CMP - INTEGRATED BEACON RECEIVER

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This appendix describes the unique features and procedures associated with the Differential GPS Compass navigation option.

2 Introduction

2.1 Manual Organization

This appendix is provided as a supplement to the baseline RC4600 manual. The corresponding paragraphs in the baseline RC4600 manual are referred to when data specific to the Differential GPS Compass option is described.

2.3 RC4600 Features

This option provides the RC4600 controller with the ability to sense latitude, longitude and true heading from a single GPS unit.

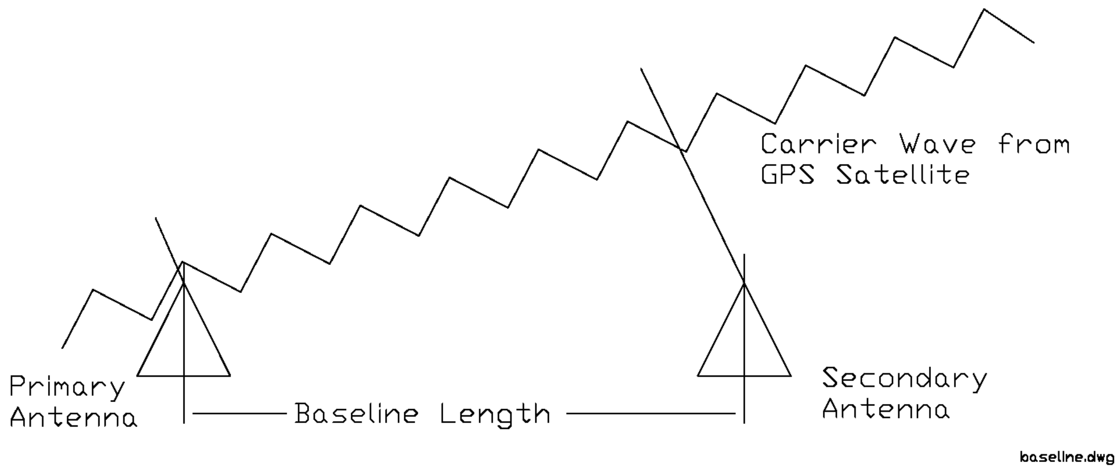
2.4 Hardware Overview

The differential GPS compass unit provides both latitude/longitude and true heading by measuring how the two GPS antennas are positioned relative to each other. The baseline RC4600 configuration gets this information from separate GPS and compass units.

Magnetic compass units can provide less than optimal performance in various poor magnetic environments. These include proximity to metal buildings, proximity to power lines and in areas where the horizontal component of the earth's magnetic field is weak such as high latitude locations. The differential GPS compass unit may provide better results in such situations since it is generating the heading solution based on signals from the constellation of GPS satellites.

Two GPS antennas are placed a known distance apart. The GPS engine instantaneously measures the phase at both antennas of the signal from the same set of GPS satellites. Knowing the instantaneous position of the GPS satellites, the GPS engine can determine how the two antennas must be oriented with respect to each other and thus determine the heading between the two antennas.

The following simple diagram illustrates the situation of the two antennas measuring the signal phase from one GPS satellite.



The vector between the two antennas is often referred to as the baseline. One antenna will be designated as the primary antenna and the other as the secondary antenna. The true heading derived will represent the heading from the primary antenna to the secondary antenna.

The GPS compass engine can measure the instantaneous phase of the carrier at both antennas, but it can't directly determine the total number of carrier waves between the antennas. The compass engine must be told the actual distance between the two antennas.

Knowing the baseline length and phase information from multiple GPS satellites, the compass engine sorts through the many (possibly thousands of) combinations of orientations between the two antennas. The compass engine's algorithm eventually determines what heading must exist between the two antennas in order to fit all the data collected.

2.6 Specifications

Item	Specification	
Receiver type	GNSS L1 RTK	
Signals Received	GPS, GLONASS, BeiDou, Galileo, QZSS, L-band	
Channels	540	
GNSS sensitivity	-142 dBm	
SBAS tracking	2-channel, parallel tracking	
Update rate	Standard 10 Hz, optional 50 Hz (position and heading)	
Positioning accuracy RMS (67%) Autonomous[1] SBAS (WAAS)[1] Code Differential GPS RTK[1,2]	 Horizontal 1.2 m 0.3 m 0.3 m 10 mm + 1 ppm	 Vertical 2.5 m 0.6 m 0.6 m 20 mm + 2 ppm
Atlas (L-band) Accuracy	30 cm	
Heading accuracy	< 0.30° RMS @ 0.5 m antenna separation < 0.15° RMS@ 1.0 m antenna separation < 0.08° RMS@ 2.0 m antenna separation < 0.04° RMS @ 5.0 m antenna separation	
Pitch/roll accuracy	< 1° RMS	
Heave accuracy	30 cm[3]	
Timing (1PPS) accuracy	20 ns	
Rate of turn	145°/s maximum	
Cold start	< 40 s typical (no almanac or RTC)	
Warm start	< 20 s typical (almanac and RTC)	
Hot start	< 5 s typical (almanac, RTC, and position)	
Heading fix	< 10 s typical (valid position)	
Maximum speed	1,850 kph (999 kts)	
Maximum altitude	18,288 m (60,000 ft)	

2.7 Part Number Scheme

RC4600 software configuration is presented in the form RC46-abc-vwxyz where abc-vwxyz represents: (Mount manufacturer/Model) ***abc*** (Nav Sensor Option) ***v*** (Tracking Option) ***w*** (Remote Option) ***x*** (Receiver Option) ***y*** (Thor Receiver Option) ***z***

This feature is categorized as one of the (Digit 14) Navigation options of the RC4600.

OPTION CATEGORY	DESIGNATOR	DESCRIPTION
Navigation	N	No GPS of Compass
	B	GPS and 3 – Axis Compass
	G	GPS and Fluxgate Compass
	H	Differential GPS Compass

Software supporting the integrated beacon receiver would therefore be designated in the form RC46-abc-**v**wxyz.

3 SOFTWARE

3.1 Operation Overview

3.1.1 Front Panel Software Operation

3.1.1.2 Front Panel Operating Group

3.1.1.2.2 MENU Mode

3.1.1.2.2.3 LOCATE

Upon entering LOCATE mode, the RC4600 will try to automatically initialize the antenna position. This includes the latitude, longitude and antenna bearing as described in this section of the baseline manual. When using the differential GPS compass, all of these items will come from the single unit.

3.1.1.3 Front Panel Programming Group

3.1.1.3.2 Maintenance Items

3.1.1.3.2.6 GPS COM

```
<BKSP> TO FREEZE DISPLAY        GPS COMM
7E  $GPRMC,233723,A,3857.3305,N,09445.26
00,W,000.0,000.0,171218,002.1,E*6B  $GPG
GA,233723,3857.3305,N,09445.2600,W,2,10,
```

As described in the baseline manual, this screen will reflect the raw data being received from the GPS unit. The data seen will be slightly different from that described in the baseline manual:

- $GPRMC
  - Instead of displaying a “V” for an invalid latitude and longitude, the differential GPS compass will display no data between the comma delimiters. The sentence will appear as “$GPRMC,,,,,,,,,,*66”.
- $GPGGA
  - This sentence will appear at a rate of once ever 5 seconds. The baseline GPS reports this sentence at once per second.
  - If the latitude and longitude are invalid, the differential GPS compass will display no data between the comma delimiters.
- $GPHDT
  - This sentence provides the differential GPS compass estimate of true heading.
  - Sentence will be of the forma “$GPHDT,123.4,T*5A” where 123.4 is the true heading.
  - If the true heading is invalid, the differential GPS compass will display no data between the comma delimiters

3.1.1.3.2.7 GPS HDG

Since the compass communication comes through the GPS COM screen. The CMP COM screen has been repurposed a diagnostic screen for the differential GPS compass.

```
                                  GPS COMPASS
HDT: 88.5 MAX: 88.9                 SEC: 1315
AVG: 88.4 MIN: 88.0                 CNT: 1300
                                    BLN:   15
```

This screen allows the user to observe the true heading generated by the HGPS compass over time. The ability to monitor the true heading over time should help in predicting the performance of the HGPS compass installation and calibration.

SEC:

This field displays the number of seconds that have elapsed since entering this screen.

CNT:

This field displays the number of valid $GPHDT sentences that have been received since entering this screen.

BLN:

This field displays the number of blank $GPHDT sentences that have been received since entering this screen.

HDT:

This field displays the latest value for true heading reported by the differential GPS compass.

AVG:

This field displays the average heading value since entering this screen. It only averages valid sentences.

MAX:

This field shows the maximum heading value received since entering this screen.

MIN:

This field shows the minimum heading value received since entering this screen.

3.1.1.3.2.8 CMP CAL

This screen allows the user to program items into the compass. These parameters tell the differential GPS compass important information about how the hardware is installed

```
 MSEP:1.000    MASK:**           CSI CAL
LEVEL:1
 TILT:0                    <MODE>SAVE&EXIT
ANT SEPERATION <0.200-2.000>METERS
```

Asterisks will be shown in all fields when the controller is not communicating with the compass. When the compass is communicating with the controller, all the values will be populated with the current values stored in the compass with the exception of the “MASK” field

MSEP: ANT SEPARATION <0.200-2.000>METERS

Enter the distance between the installed antennas. If the distance is off by more than 0.010 meters the differential GPS compass may not be able to calculate a true heading.

LEVEL: LEVEL OPERATION <0>NO <1>YES

This value tells the differential GPS compass module if the GNSS antennas are installed in a level plane. If the antenna are with 10 degrees of level, this values should be set to (1) “YES”.

When more than 10 degrees from a level position, it may take longer to generate a heading solution and there is a greater possibility of generating an incorrect solution.

TILT: TILT AIDING <0>NO <1>YES

This value allows the compass to be used as a tilt sensor. The RC4600 uses a separate two axis inclinometer to determine tilt. As such, the setting of this value has no effect on differential GPS compass operation.

MASK: ELEV CUTOFF MASK <5-20>DEGREES

This value is used to specify the elevation angle that puts the GPS satellites in an invalid position. If at a true elevation angle that is lower than this number, it will be considered unreliable for calculating the true heading.

In an open area, the only thing that would determine this number is atmospheric refraction. As such, the default value for this will be 10 degrees. If there are additional items on the horizon, that obstruct look angles higher than 10 degrees, it would be recommended that a higher angle be used.

Although this value is an important parameter, the differential GPS does not allow the ACU to query this value. As such, this value will always show up as ** when entering this screen.

4 Hardware

4.2 External Equipment

4.2.3 Compass

This section details specific installation procedures applicable only to the differential GPS compass option.

4.2.3.1 GPS Receiver Mounting

The PCB of the differential GPS compass option can be installed inside of the ACU enclosure, or on an outdoor rated enclosure on the antenna.

If the PCB is mounted in the ACU, the ACU will include two TNC connectors for the primary and secondary GNSS antennas.

The outdoor rated enclosure for the PCB, is a 6 in x 6 in x 4in box. The box will have a TNC connector for both the primary and secondary GNSS antennas. It will also have a cable that will connect back to the ACU.

4.2.3.2 GNSS Antenna Mounting

The differential GPS will require the use of the two GNSS antennas. The antenna should be installed at a separation of greater than .2 meters and less than 2 meters.

The antennas should be mounted such that they both have an unobstructed view of the sky. Additionally, the installation and controller configuration should be such that the location where the GPS antennas are mounted is level to the ground in the position where the true heading is acquired.

The separation of the GNSS antennas will need to be store in the MSEP parameter during installation as described in section 3.1.1.3.2.8.

4.2.3.3 GNSS RF cables

Phase differences between RF cables in the system can introduce an error when the compass attempts to acquire the heading. As such, the two cables should be identical. This includes both the connector and cable, as well as the length of the cable.

Additionally, great care should be taken to ensure that the signal loss between the GNSS antenna and the compass PCB be less than 15 dB.

5 SUPPORT

5.1 Troubleshooting

The differential GPS compass needs to be programmed prior to being able to work with the RC4600. As such, it is important to order any replacement modules from RCI to make sure they are programmed properly.

If the unit is not able to acquire a latitude and longitude, ensure that the view of the sky is clear and that the GNSS antennas are installed as described above.

If the unit is not able to acquire a true heading, ensure that there are no obstacles on the horizon that are affecting the GPS path signal to the GNSS antennas. Also ensure that the MSEP value is set correctly.