APPENDIX TAC – THREE AXIS COMPASS

Last Revised: 30 May 2019

This appendix describes the additional functions provided by the RC4000 when using an optional Three Axis Compass. It is provided as a supplement to the "baseline" RC4000 manual. Sections in the baseline manual are referred to when information specific to the Three Axis Compass is described.

1.0 INTRODUCTION

1.2 Features

The Three Axis Compass (TAC) is a small, inexpensive heading sensor packaged in the same enclosure as the Single-Axis Compass. It contains magnetic and gravitational sensors that mechanize an electronically-gimbaled digital compass. The TAC can determine the instantaneous heading, pitch, and roll of the antenna platform. This leads to shorter satellite acquisition times because time-consuming mount movements are not required.

1.5 Specifications

Enclosure Size	2.875" x 1.500" x 1.000"
Mounting Holes	2 Holes, 2.500" O.C.
Temperature (Operational)	-40 to +80 deg. C.
Voltage Input (Max)	20 V
Voltage Input (Min)	5 V
Current Consumption (Average)	33 mA
Compass Accuracy (Undisturbed Field)	3 deg. RMS, 0.1 deg. Resolution (while level)
Pitch Sensing	+/-90 deg.
Roll Sensing	+/-180 deg.
Calibration	Hard Iron

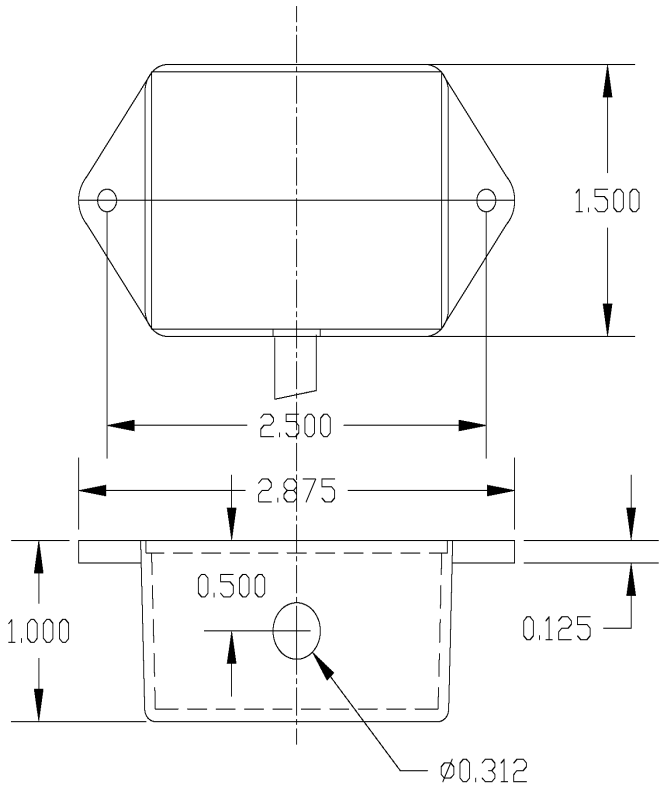
1.6 Part Number

The standard part number for the compass is: **FP-CMP-3AXIS-3-XXX-X.** This includes a 42 ft. un-terminated cable. Custom cables lengths and end connection options are available.

2.0 HARDWARE

2.1.1 Mechanical Mounting

The TAC is permanently sealed within a 2.875" x 1.500" x 1.000" plastic box. The box provides two mounting holes on end flanges. The cable extends from the middle of the box length side.



2.1.1.1 Mounting Considerations

The following factors should be considered when determining where to mount the TAC:

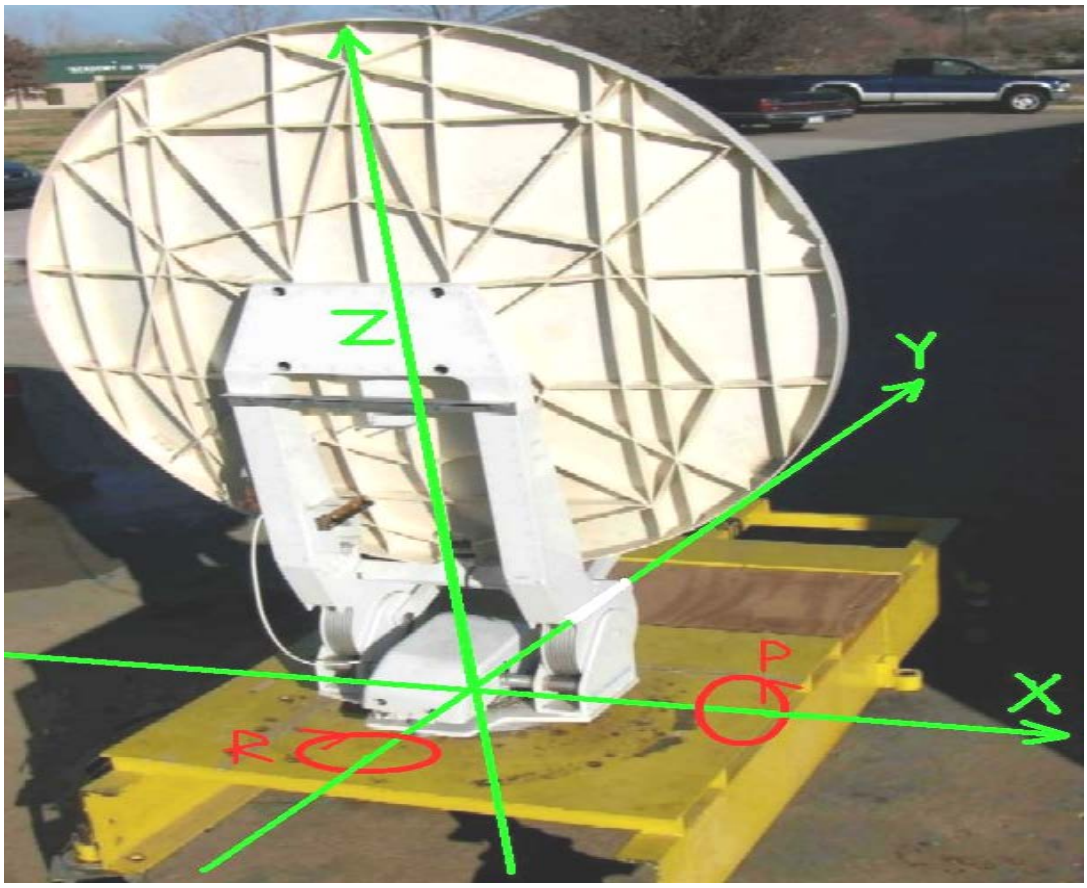
1) The box should be mounted as high on the antenna structure as feasible. In general, the sensed magnetic field will be cleaner and the heading more accurate when positioned far from the antenna base. **Poor performance is almost always due to nearby metal structures, motors, or high-current conductors.**

2) The box should be mounted such that the distance from the azimuth axis center of rotation is as small as possible. Preferably, with the elevation at deploy, the box would spin about a single point when the antenna is rotated in azimuth.

3) The box must be mounted such that one of its faces is aligned in the direction of the antenna bore sight. Tilt-sensing capability is only available when the TAC orientation is not offset from the antenna azimuth angle. See the following section for more detail on choosing a mounting orientation.

2.1.1.2 Mounting Orientations

The correct orientation must be chosen for the TAC to function properly. The orientation defines how the internal field measurements will be aligned with the antenna platform coordinate system. The following illustration depicts the expected axes of rotation. The platform heading must increase with CW rotation about the Z-axis, the platform pitch must increase with CCW rotation about the X-axis, and the platform roll must increase with CW rotation about the Y-axis. The positive-Y direction is often referred to as the "compass reference". Pitch and roll are commonly described together as "platform tilt".



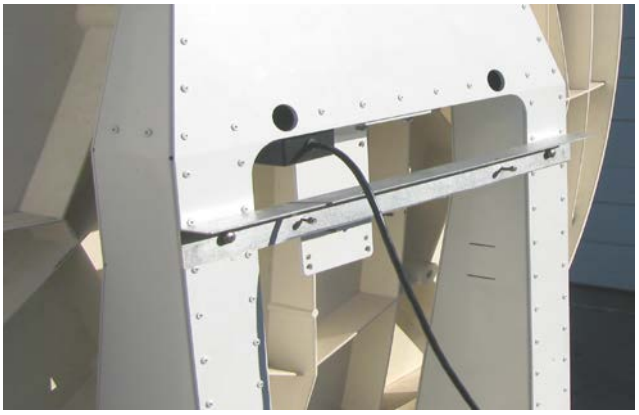
The TAC provides six possible orientations for maximum flexibility. The six orientations may be thought of as the six sides of a cube surrounding the antenna platform. A description of the cube face is given to each orientation as a way to help describe it.

Orientation #1 "TOP"

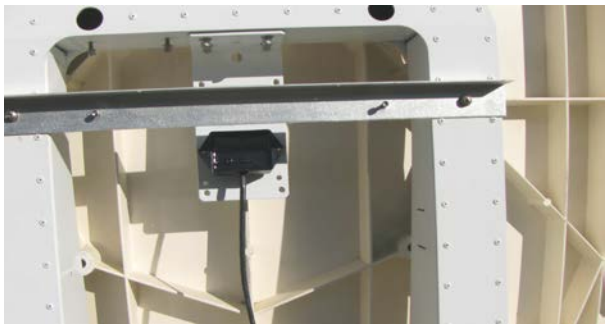
Orientation #2 "FRONT"

Orientation #3 "LEFT"

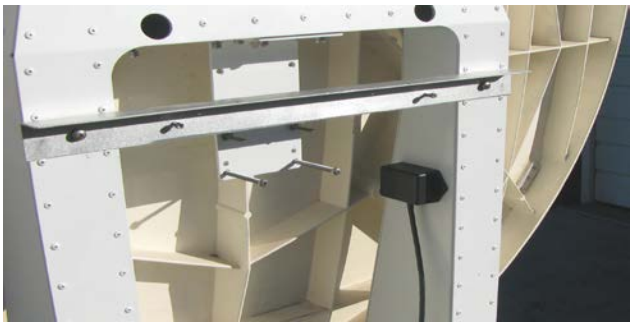
Orientation #4 "BOTTOM"



Orientation #5 "BACK"

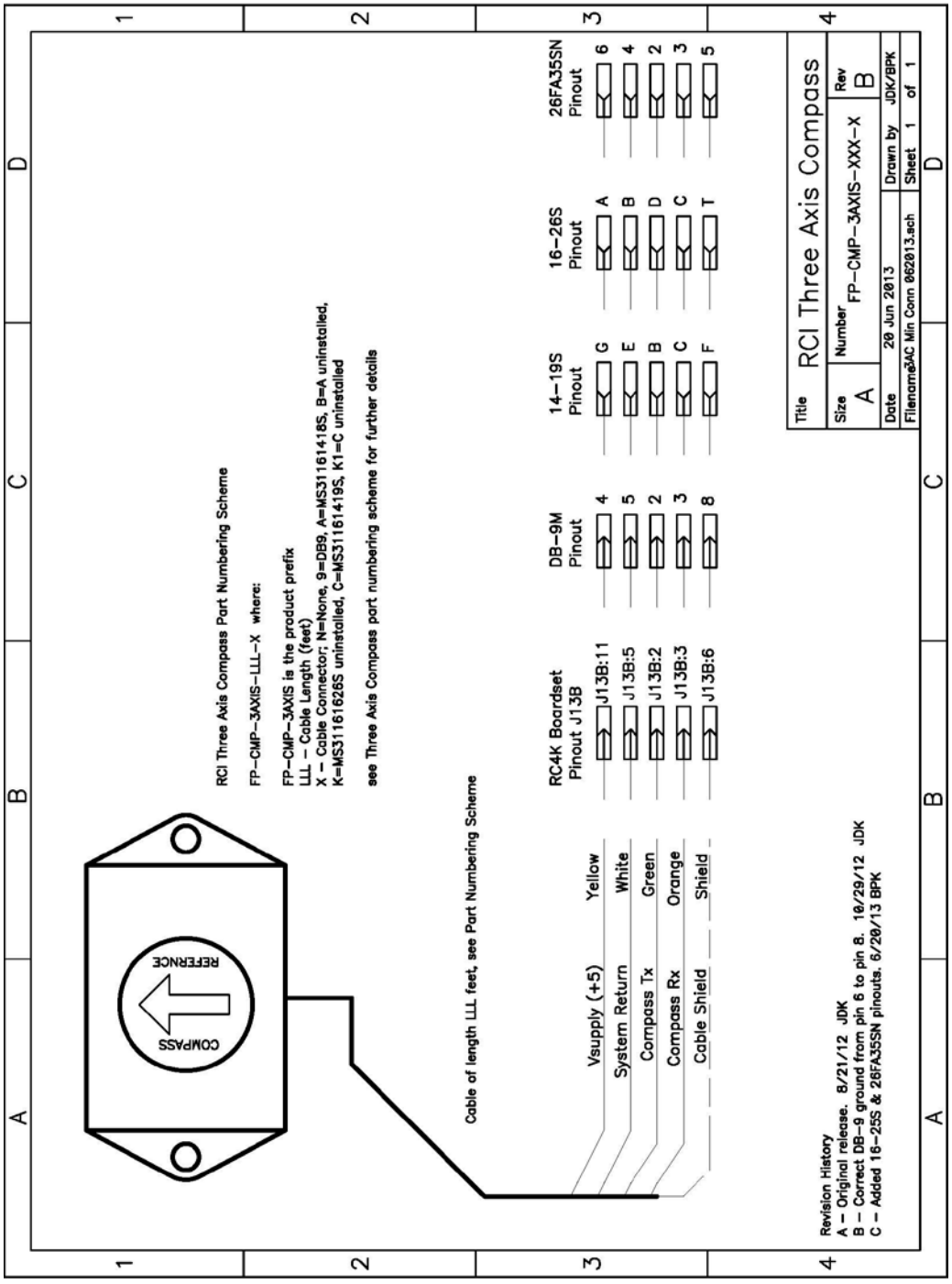


Orientation #6 "RIGHT"



2.1.2 Electrical Interfaces

The TAC connection depends upon connector type used on the RC4000 enclosure. The following diagram describes the signals on the provided cable with various connector types.



3.0 SOFTWARE

3.2.2.3 Unique Locate Steps

When the CONFIG-AUTOPEAK-TILT configuration item is set to 2 (COMPASS), the pitch and roll of the antenna platform is read directly from the TAC before the LOCATE sequence begins. If necessary, the antenna reflector will be moved to a repeatable position called “Compass Home”. This position is predetermined based on antenna geometry, but is commonly referenced from the upper edge of the down limit switch.

NOTE: The TAC will not be used to determine platform pitch and roll if the CONFIG-AZIM-COMP (compass offset) configuration item is not set to zero. If a compass offset is required, the TAC orientation should be changed instead.

3.2.2.3.6 Polarization Tilt Compensation

If the CONFIG-AUTOPEAK-TILT configuration item is set to 2 (COMPASS), the final polarization angle will be adjusted by directly reading the platform roll from the TAC after the LOCATE sequence has arrived at the target location.

NOTE: The TAC will not be used for polarization angle adjustment if the CONFIG-AZIM-COMP (compass offset) configuration item is not set to zero. If a compass offset is required, the TAC orientation should be changed instead.

3.3.1.2.1 System Definition

The CONFIG-SYSTEM-COMPASS configuration item is used to specify how the TAC is mounted. The following table lists the available choices.

ITEM VALUE	DESCRIPTION
<0> NONE	No compass is present.
<1> TRUCK	The compass is mounted on the truck or antenna platform. Tilt and heading data will be read without moving the antenna reflector.
<2> TOP	The compass is mounted on top of the antenna reflector. Tilt data will be read at the “compass home” position. Heading data will be read at the AZ/EL DEPLOY position.
<3> BACK	The compass is mounted on the back of the antenna reflector. Tilt data will be read at the “compass home” position. Heading data will be read at the AZ/EL STOW position.
<4> BASE	The compass is mounted on the base of the antenna. Moving the antenna in azimuth moves the compass. Tilt and heading data will be read at the AZIMUTH DEPLOY position.

3.3.1.2.3 Azimuth Calibration

The CONFIG-AZIM-COMP configuration item must be set to zero to use the TAC as a tilt data sensor. If a compass offset is required, the TAC orientation should be changed instead.

3.3.1.2.8 Azimuth Calibration

The CONFIG-AUTOPEAK-TILT configuration item should be set to **<2>3-AXIS COMPASS** to use the TAC as a tilt data sensor.

3.3.2.7 Compass Serial Port Diagnostics

The compass communication maintenance screen shows the raw ASCII data coming from the compass. The TAC reports sensor data in the standard NEMA-0183 message format. The only message from the TAC is "OHPR" which includes heading, pitch, and roll.

```
<BKSP> TO FREEZE DISPLAY        CMP COMM
$OHPR,266.1,0.8,0.1*2A==$OHPR,266.1,0.8,
0.1*2A==$OHPR,266.1,0.8,0.1*2A==$OHPR,26
6.1,0.8,-0.1*2A==$OHPR,266.1,0.8,-.1*2A=
```

3.3.2.9 Compass Calibration

The compass calibration maintenance screen allows the user to initiate antenna movements and compass calibration actions. The screen also displays real-time heading, pitch and roll currently being reported by the TAC.

```
  HDG:266.1  MOUNT:2                3AXIS
PITCH:  0.8
ROLL:  -1.1                     COUNT: 42
<.>X/Y CAL <BKSP>ZERO P/R <7>MNT <9>RST
```

COUNT:

This field shows the total number of correctly parsed messages from the compass. This number should be increasing at a rate of approximately 4 Hz.

HDG/PITCH/ROLL:

These fields show the instantaneous magnetic heading and accelerometer pitch/roll values. These values reflect any previous compass calibration that may have been done.

MOUNT:

This field shows the current orientation value.

3.3.2.9.*1* Calibration Procedure

All compass calibration actions must take place with the antenna platform level. Calibration actions should be done in the following order:

1) Orientation

Press the <7> key and enter the value that corresponds to how the TAC is mounted. See section 2.1.1.2 of this document for available orientation values. The ACU will display a message indicating that a X/Y calibration must be performed.

2) X/Y Calibration

NOTE 1: In the case of a vehicle-mounted system, this step should not be done until the antenna platform is in place.

NOTE 2: It is critical that the X/Y calibration is completed on a level surface. Refer to the baseline manual for guidance in picking a proper calibration sight.

Press the <.> (period) key to begin the X/Y (hard-iron) calibration.

```
                                    3AXIS
* X/Y CALIBRATION REQUIRES 30 SECOND,  *
* 360 DEGREE TURN WITH PLATFORM LEVEL  *
<ENTER>CONTINUE             <BKSP>CANCEL
```

Press the <ENTER> key to continue. The antenna will move to the DEPLOY position if necessary. When movement is complete, begin rotating the vehicle/platform slowly in a circle. For best results, take at least 30 seconds. After turning a complete circle, press the <STOP> key.

3) Zero Tilt Sensors

Press the <BKSP> key to begin calibrating the tilt sensor.

```
                                    3AXIS
*    PITCH AND ROLL ZEROING MUST BE    *
*   PERFORMED WITH THE PLATFORM LEVEL  *
<ENTER>CONTINUE             <BKSP>CANCEL
```

Press the <ENTER> key to continue. The antenna will move to the “compass home” position and gather pitch/roll offsets. These pitch and roll offset values will be applied to all future reported pitch and roll values.

4) Reset Calibration to Factory Default

Press the <9> key to reset the TAC to factory defaults. This option is useful when the calibration was completed incorrectly or done in an unsuitable environment. In this case, the resulting values of heading, pitch, and roll contain large errors. Resetting to factory defaults will make the TAC useable until the calibration can be done correctly.