Appendix TRN – Training Software Option

Revision: 10 May 2005 Software Version: 1.50

This appendix describes the RC3000 antenna control unit training software option developed for General Dynamics AIS.

1.1 Manual Organization

This appendix is provided as a supplement to the baseline RC3000 manual. The corresponding paragraphs in the baseline RC3000 manual are referred to when data specific to the training software option is described. The mount specific data (User's Manual appendix B) should also be used for reference due to the large number of non-standard items associated with the Andrew TriFold antenna system. References to user's manual sections are made within parenthesis.

NOTE: the operation of the RC3000 antenna control unit running the training software is identical to that described by the RC3000 User's Manual. The User's manual should therefore be used for a reference as this appendix does not attempt to describe the operation of the RC3000 nor does it attempt to be a training syllabus.

Section 1 provides background and theory with respect to the unique features of the training software.

Hardware and software configuration procedures unique to the use of the training software are described in section 2.

Section 3 describes how the training software affects normal RC3000 operations.

1.2 RC3000 Features

This option provides the capability to train users to operate the RC3000 antenna controller in a classroom setting with no actual mount attached to the controller.

Software Configuration. If the training software option is purchased, an additional (fourth) option designator will appear on the power-up banner as "T".

Example: the software for a fully functional RC3000 purchased with GPS and Fluxgate, inclined orbit tracking and remote control capability would be designated RC3K-N1-GTR. When this set of options is supplied along with the training option, it would be designated as RC3K-N1-GTR**T**. NOTE: due to space limitations, the additional "T" designator will not be shown on the MAINTENACE MENU (3.3.2) screen.

1.3.2 System Interface Requirements

The only connection required to operate a RC3000 with training software installed is the AC power input. **NOTE: a controller with training software installed should not be connected to an actual antenna due to the fact that during simulated operation the antenna motor control signals will still be generated.**

If so desired, the GPS receiver and Fluxgate compass may be connected to a RC3000 running training software. The training software would be able to retrieve navigation data from these two sensors.

Also the remote control interface of the RC3000 will be active and respond normally.

1.3 Theory of Operation - Training Software

This section describes the mechanization of the training software.

In order to make it appear that the RC3000 is attached and dynamically controlling an antenna system, the training software performs two basic tasks:

1- simulates the movement of and feedback from an Andrew TriFold antenna and

2- simulates the signal strength feedback from satellite receiving equipment.

These two main areas of simulation are performed at a low level in the software. This approach allows for the operational modes of the RC3000 to be left untouched, thus allowing for realistic operation from the user's point of view.

These two simulation tasks will now be discussed in more detail.

Antenna Simulation

Normally the RC3000 monitors the position of an antenna by converting feedback signals from sensors on the azimuth, elevation and polarization axes. Rather than monitoring these sensors, the training software simulates their data by updating variables within the software whenever it is recognized that the controller is trying to move the antenna.

Internal variables that trigger antenna drive signals are monitored. According to the requested movement, the training software will change the apparent position of the resolvers normally attached to the azimuth, elevation and polarization axes. The training software will also change the apparent voltage coming from the inclinometer on the elevation axis.

When the RESET DEFAULTS (3.3.1.3.1) operation is performed, the simulated counts for the azimuth, elevation and polarization resolvers are all set to the value of 32768. This corresponds to the value produced by a resolver in the middle of its 360 degree travel. This 180 degree position of the resolvers corresponds to the suggested position of the three resolvers for calibration of an actual mount.

The default value for the azimuth_resolver_offset (3.3.1.2.3) is 180.00 degrees. Since the default simulated resolver position is 180.0 degrees, this will result in an apparent azimuth position of 0.0 (recommended reference position of the azimuth axis).

The default value for the polarization_resolver_offset (3.3.1.2.4) is 180.00 degrees. Since the default simulated resolver position is 180.0 degrees, this will result in an apparent polarization position of 0.0 (recommended reference position of the polarization axis).

The default value for the elevation_resolver_offset (3.3.1.2.2) is -120.00 degrees. Since the default simulated resolver position is 180.0 degrees, this will result in an apparent resolver-based elevation position of 60.0 (recommended reference position of the elevation axis). Additionally, the default simulated voltage from the inclinometer is set to 2.7 Volts corresponding to suggested position of the inclinometer at calibration. The default elevation_reference_voltage is 2.7 so the resulting inclinometer-derived elevation angle will also be 60.0.

Whenever the RC3000 commands movement, the corresponding simulated resolver value will be updated. For example, if the azimuth axis is to move clockwise, the azimuth resolver value will be incremented. The simulated movement for all three axes will be at a rate of 2.0 degrees per second for simulated fast movement and 0.4 degrees per second for simulated slow movement.

Physical limits of the mount are also simulated. Normally these limits are mechanized via the Andrew VS-1 antenna interface unit (AIU). The training software simulates these limits by 1) not allowing azimuth motion outside the range of +/- 165 degrees, 2) not allowing polarization motion outside the range of +/- 94 degrees and 3) not allowing elevation motion above 94 degrees or below 0.0 degrees (RF look angle). Limit indications generated by the RC3000 are via software configuration items. Setting these configuration items correctly will be discussed in section 2.

Signal Strength Simulation

Normally, the RC3000 monitors a DC voltage from receiving equipment as a relative indication of how well the antenna is pointed at a satellite. The training software simulates this signal strength voltage by comparing the current (simulated) azimuth and elevation positions of the mount with the position that the controller has predicted for the satellite. When the mount is positioned perfectly, simulated signal strength of 650 will be displayed. When the simulated satellite is positioned outside of the representative main lobe of a 4.5 m. antenna, signal strength of 50 (typical of noise) will be displayed. No attempt has been made to bias simulated signal strength due to polarization position.

NOTE: the training software assumes the simulated receiving equipment has been tuned correctly. Training for operation of receiving will have to be addressed separately.

A satellite's position will be simulated according to the operation currently being performed by the RC3000. The various cases will be discussed next. NOTE: only one "active" satellite at a time is simulated.

When the LOCATE function predicts the azimuth and elevation pointing angle to a non-inclined orbit satellite, the training software generates signal strength as a function of the distance (in terms of azimuth and elevation angle) of the mount from the predicted satellite position. For example, as the AUTOPEAK operation scans in azimuth, the simulated signal strength will peak as the mount position passes over the predicted position of the satellite. When the controller returns to MANUAL mode following the completion of the LOCATE function, the displayed signal strength will be with respect to the predicted position (i.e. if the user jogs the mount away from that position the displayed signal strength will decrease).

When the LOCATE function predicts the azimuth and elevation pointing angle to an inclined orbit satellite (satellite selection specified with non-zero inclination), the training software generates a simulated azimuth and elevation motion for the satellite indicative of its inclined orbit. This simulated motion will be centered on the position that a satellite of that nominal longitude would have. The amplitude of the motion will be indicative of the amount of inclination described for the selected satellite. The relative azimuth and elevation movement of the satellite (perpendicular to the satellite arc) will be simulated by factoring the difference between the antenna's latitude and longitude and the satellite's longitude. The instantaneous satellite position within this simulated movement will be according to current time within the sidereal day.

For example, during LOCATE (with AUTOPEAK enabled) the spiral search operation will halt when the mount position comes close enough to generate simulated signal strength above the spiral_search_threshold (3.3.1.2.6) value. In MANUAL mode, the displayed signal strength will change over time simulating the apparent motion of the inclined orbit satellite. In TRACK mode, the azimuth and elevation positions will be updated over time to maintain the maximum signal strength as the satellite apparently moves.

When STOREing a satellite, the current azimuth and elevation resolver counts (along with polarization H and V positions) will be recorded just as they would in the real operation of the controller. When the satellite is RECALLed, the simulated signal strength will be generated as a function of the mount distance from the STOREd azimuth and elevation values.

2.0 INSTALLATION

Following the RESET DEFAULTS operation, the simulated position of the mount will be: azimuth 0.0, polarization 0.0 and elevation 60.0. The following provides suggestions for exercises that could be performed to train calibration procedures (and RC3000 operation in general).

2.3.3 AZIMUTH CALIBRATION

STEP 1b. Azimuth Resolver Reference Angle.

From the default position, jog azimuth about 0.5 degrees counterclockwise. This will cause the azimuth resolver count to change by about 90. Convey to the student that this now represents the position where the azimuth axis is truly centered in its travel. Have the student note the raw azimuth resolver angle in the AD VOLTAGES screen (3.3.2.1). Subtract this observed angle from 0.0 (azimuth center of travel) and enter it as the azimuth_resolver_offset (3.3.1.2.). Return to the MANUAL screen and observe that the AZIM value is now 0.0.

STEP 4. Clockwise and Counterclockwise Limits.

From MANUAL mode, jog the antenna clockwise until it reaches the clockwise limit or jams. Since the default ccw_pulse_limit is outside of the simulated VS-1 limit, the azimuth jam error should flash on line 4. Discuss with the student why the antenna stopped but the controller kept trying to move. Instruct the student on how to clear the jam error either from the SETTINGS (3.2.2.8) or DRIVE ERROR RESETS (3.3.2.2) mode.

Now from the MANUAL mode, have the student move counterclockwise about 0.5 degrees. Observe the azimuth resolver count by pressing the SCROLL UP key. Enter the value in the clockwise_pulse_limit in the AZIMUTH PULSE DRIVE (3.3.1.3.3) screen. This will now be the trigger for the azimuth CW limit indication. Have the student move the antenna further counterclockwise and then drive it clockwise into the limit condition. Now the CW indication should appear and no azimuth jam alarm triggered.

Repeat the same exercise to set the azimuth CCW limit.

2.3.4 POLARIZATION CALIBRATION

In a similar fashion to the azimuth calibration, polarization could be moved slightly from the default position and the reference position set via the polarization_resolver_offset configuration item. At this time, it would be worthwhile to discuss that the feed system needs to be plumb/level in order for the controller to correctly relate sensed polarization position with the predicted physical angle of the polarized signals.

The polarization CW and CCW limits are triggered differently from azimuth and elevation limits. These limits will be triggered when the displayed polarization angle reaches the CW_polariation_limit and CCW_polarization_limit values.

With respect to polarization calibration training, it should be stressed that the platform be level during the calibration.

2.3.2 ELEVATION CALIBRATION

STEP 3a. - Inclinometer Reference Voltage

STEP 3b. - Elevation Resolver Reference.

From the default position, move elevation up or down about 0.5 degrees. Convey to the student that this represents the 60.0 degree elevation look angle of the antenna. From the AD VOLTAGES screen note the elevation voltage and the raw elevation resolver angle.

Enter the elevation reference voltage in the ELEVATION CALIBRATION screen. In MANUAL mode the displayed elevation angle should now be 60.0.

Subtract the raw elevation resolver angle from 60.0. This value should be entered into the elevation_resolver_offset item.

STEP 4. Elevation Scale Factor

NOTE: the training software simulates an inclinometer scale factor of 49.38 mV/deg. The default scale factor is 50.0. This exercise will instruct the student on how to characterize the correct scale factor.

From MANUAL mode, move the antenna about 30 degrees down. Go to the AD VOLTAGES screen and note the raw elevation angle and compare it to reference resolver angle previously noted. This difference will not be exactly the same number of degrees moved as the MANUAL screen indicated. Instruct the student that this difference (in resolver angle) is the exact amount of elevation movement experienced. The discrepancy between the amount of resolver movement and the indicated movement is due to the scale factor of the inclinometer being incorrect.

Have the student note the current elevation (inclinometer) voltage and determine the scale factor by the equation:

(Current_Voltage - Reference_Voltage) / (Current_Resolver_Angle - Reference_Resolver_Angle)

This calculation should yield a elevation_scale_factor close to 49.38 mV/deg. Enter the scale factor in the elevation calibration screen. Returning to MANUAL mode, the displayed angle should have changed reflecting the newly entered elevation scale factor.

ELEVATION LIMITS

The UP (STOW) and DOWN limits may be set as described in the TriFold installation instructions.

3.0 DETAILED OPERATION

When running the training software, all RC3000 modes should react as described in the User's Manual. A few mode specific items related to the training software are noted below.

MANUAL

Fast speed for all three axes is simulated at 2.0 degrees/sec and slow speed at 0.4 degrees/second.

Due to filtering on the displayed elevation angle, the first time MANUAL mode is entered following reset defaults the displayed elevation will change for a few seconds until it reaches 60.0.

All three signal strength indications (RF / SS1 / SS2) will show the same value calculated by the signal strength simulation.

LOCATE

If so desired, position data may be dynamically obtained from the GPS receiver and fluxgate compass. The GPS receiver would of course have to be positioned so that it would have a clear view of the sky.

Otherwise, lat/lon and heading may be manually entered from the POSITION mode.

As mentioned in the theory section, the AUTOPEAK scan will sense the highest signal strength around the predicted azimuth and elevation angles. During a SPIRAL SEARCH for an inclined orbit satellite, the point of highest signal strength will be a function of the current time within the sidereal day.

STOW / DEPLOY

These operations will operate normally. Remember to set the elevation stow limit.

STORE / RECALL

These operations will operate normally based on storing of the simulated azimuth and elevation resolver counts and horizontal and vertical polarization angles.

TRACK

The simulated motion of an inclined orbit satellite is not an exact representation. Rather than describing a narrow figure eight pattern, the simulated motion is a straight line. This straight line (azimuth and elevation) will be tilted perpendicular to the arc of satellites in a manner representative of an actual inclined orbit satellite at the same geometry from the antenna. The current position of the satellite is a function of sidereal time.

This inclined orbit simulation allows the TRACK mode to sequence correctly through all of its submodes.

REMOTE

Training and operational software should be transparent to a remote Monitor and Control application.

3.3 PROGRAMMING GROUP

3.3.1.3.1 Reset Defaults

All configuration items will be reset to their normal TriFold default values with a few exceptions. Since the simulated mount is very "tight" compared to an actual mount system, some of the move parameters have to be changed in order to get simulated automatic moves to perform smoothly. The following items therefore differ from the operational load values:

azim_max_position_error = 0.0 azim_max_position_pulse_error = 1

elev_max_position_error = 0.05 elev_max_position_pulse_error = 1

pol_max_position_error = 0.1

In addition to these changes, the azimuth, elevation and polarization resolver counts will be set to 32768.

NOTE: If an RC3000 that has been running training software is used as a spare for an operational unit, RESET DEFAULTS and calibration must be performed after the operational software has been installed in the unit.