RC4500 ACU Calibration Quick Start

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1.0 INTRODUCTION

The RC4500 Antenna Control Unit (ACU) is designed to work with an Antenna Interface Unit (AIU) to control large fixed based antennas equipped with resolvers on the azimuth and elevation axes. The polarization axis may be equipped with either a resolver or potentiometer. The goal of RC4500 ACU calibration is to synchronize the azimuth, elevation and polarization sensors with known physical angles.

This quick start guide provides an overview of the typical actions required to calibrate the antenna system. More detailed information is contained in RC4500 Users Manual (UM) and sections from that manual will be referenced throughout.

NOTE: this quick start document assumes that
1) the antenna's motors and limit switches have been correctly wired. Typically this can be accomplished and confirmed via the AIU's local control panel
2) the user interface (typically via a web based GUI) to the RC4500 ACU has been established. Refer to the appropriate hardware and GUI documents if required.

1.1 INITIAL DEFINITION

From the factory the RC4500 will arrive with all configuration items in the default state. To return the RC4500 to this "reset defaults" state see section 3.3.1.3.1 of the RC4500 manual.

1.1.1 LAT/LON

Since the RC4500 controls antennas that will remain in one place, it is highly recommended that the first action taken is to define the antenna's latitude and longitude. Defining the lat/lon will enable the RC4500 to correctly calculate pointing solutions to a target satellite.

If no lat/lon has been defined, the ACU will prompt the user at power up with a MOUNT POSITION reminder screen (UM 3.1.5). Before proceeding the user should determine the antenna's lat/lon to the second using a GPS or map. Next go the the LAT/LON maintenance screen (UM 3.3.2.9) to enter the antenna's position. The lat/lon will only need to be entered once and the setting will remain in the ACU.

NOTE: it is highly recommended that this initial step not be skipped as knowing the antenna's position will allow the RC4500 to calculate azimuth positioning with respect to True North.

1.1.2 ANTENNA SIZE

Another one time definition that should be initially made is to define the antenna's aperture size. Go to the System Definition configuration screen (UM 3.3.1.2.1) and enter the size.

This antenna size definition will allow the ACU to calculate movement size (with respect to beamwidth) based on theoretical aperture angle vs. signal loss.

1.1.3 TIME

An additional recommended step is to check and set if necessary the date/time within the ACU. Date/Time will be set to UTC at the factory but the internal clock may drift several seconds per month. Go to the TIME MAINTENANCE screen (UM 3.3.2.3) to check and set date and time. Accurate date/time is particularly important for installations performing Two Line Element (TLE) tracking.

1.2 INITIAL Calibration

The goal of these initial steps is to do an approximate calibration of the azimuth, elevation and polarization sensors. This initial calibration may involve mechanical realignment (rigging) of the resolvers, etc. Note: a more precise calibration will occur later when the antenna is peaked up on a known satellite.

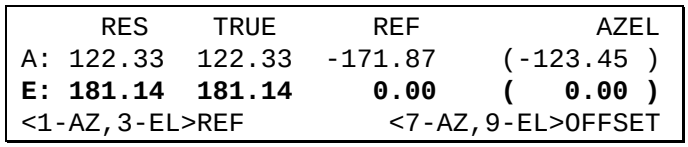
1.2.1 ELEVATION

The goal of this step is to approximately align the elevation axis' displayed angle to a known reference RF look angle. For example: a prime focus antenna might achieve an approximate 0.0 degree look angle by placing the feedhorn in a level position.

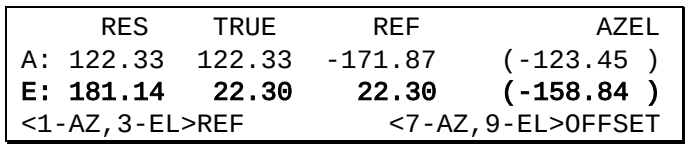
STEP 1: manually move the elevation axis to a known physical angle (with respect to the local horizontal).

STEP 2: fix the elevation resolver to approximately its center of travel (180.00). This "raw" resolver angle may be observed on the AZEL maintenance screen (3.3.2.7).
After centering the elevation resolver observe whether or not the raw resolver angle increases or decreases as the elevation axis moves up from the local horizontal. If the resolver angle decreases (due to how it is attached to axis), then the resolver direction must be set to "reversed" in the ELEVATION COUNT MOVEMENT (3.3.1.3.6) configuration screen.

STEP 3: adjust the elevation resolver offset so that the displayed elevation matches the reference elevation. This can be done via the AZEL maintenance screen (3.3.2.7). The following screen shows how elevation data may first appear in the AZEL mode. The elevation resolver has been approximately centered and after tightening it down the raw resolver angle is 181.14. The default elevation offset is 0.0 and thus the displayed true elevation angle is 181.14 (181.14 – 0.00).



Now suppose that at this reference elevation position it is known that the true elevation RF look angle should be 22.30 degrees. This angle will be entered in the elevation REF field after pressing 3. After entering this reference angle, the elevation resolver offset is recalculated by pressing the 9 key.



The resulting display shows a displayed angle of 22.30 (181.14 – 158.84).

1.2.2 AZIMUTH

The goal of this step is to approximately align the azimuth axis' displayed true heading angle to True South (if antenna is in Northern hemisphere) or True North (if in Southern hemisphere). True South or True North will be referred to as the azimuth reference position. As with the initial elevation calibration, a more precise azimuth calibration will be done later with respect to a known satellite.

NOTE: there are 3 angles discussed with respect to azimuth angle. They are defined here to try to avoid confusion:

- resolver angle – actual angle read from the resolver sensor. This angle will read from 0.00 to 359.99. It is important that throughout the antenna's full range of azimuth movement the resolver does not "wrap around" (i.e. move from 0.0 to 359.99 or from 359.99 to 0.00). The recommended way to achieve this situation is to rig the resolver close to its center of travel (180.00 deg.) when the antenna is approximately at its reference position (either True North or South).

- true heading angle – this is the azimuth angle (TRUE) most commonly displayed for the RC4500. This represents the true (not magnetic) heading that the antenna is pointing. For fixed-based applications this is the most common angle used when referring to the antenna's azimuth position.

- antenna angle – internally within the RC4500, the "antenna" angle (AZIM) is calculated as a value between -180.00 and 180.00 with 0.00 typically being around the center of travel of the axis. This version of azimuth angle is more commonly used throughout the RC4000 mobile antenna controller applications that the RC4500 was derived from. Some automatic movements (such as STOW and DEPLOY) will display this antenna referenced angle vs. a true heading referenced angle.

STEP 1: manually move the antenna to approximately True North (if in Southern hemisphere or True South (if in Northern hemisphere). True North or South doesn't have to be exactly determined as a more precise calibration will occur later. This reference position will be used while mechanically centering the azimuth resolver.

STEP 2: fix the azimuth resolver in approximately its center of travel (180.00 deg.). The instantaneous azimuth resolver angle (RES) may be viewed from the AZEL maintenance screen (UM 3.3.2.7).
After centering the azimuth resolver, observe whether or not the raw resolver angle increases or decreases as the azimuth axis is moved clockwise when viewed from above. If the resolver angle decreases (due to how it is attached to axis), then the resolver direction (DIR) must be set to "reversed" in the AZIMUTH COUNT MOVEMENT (UM 3.3.1.3.3) configuration screen.

STEP 3: adjust the azimuth resolver offset so that the displayed TRUE heading matches the azimuth reference true heading. This can be done via the AZEL maintenance screen (3.3.2.7).

The following screen shows how azimuth data may first appear in the AZEL mode. The azimuth resolver has been approximately centered and after tightening it down the raw resolver angle is 179.87. The default azimuth offset is 0.0. The displayed true azimuth angle is 359.87 since in this example the antenna is located in the Northern hemisphere and the reference true heading of the center of azimuth travel is 180.0.

```
     RES    TRUE      REF            AZEL
A: 179.87  359.87     0.00     (   0.00 )
E: 181.14   22.30    22.30     (-158.84 )
<1-AZ,3-EL>REF          <7-AZ,9-EL>OFFSET
```

Now suppose that at this reference azimuth position is changed to 180.00 for True South. This angle will be entered in the azimuth REF field after pressing 1. After entering this reference angle, the azimuth resolver offset is recalculated by pressing the 7 key.

```
     RES    TRUE      REF            AZEL
A: 179.87  180.00   180.00     (-179.86 )
E: 181.14   22.30    22.30     (-158.84 )
<1-AZ,3-EL>REF          <7-AZ,9-EL>OFFSET
```

The resulting display shows a displayed true heading angle of 180.00 (179.87 – 179.87 + 180.0).

Note that in the MANUAL display the default azimuth angle would be displayed as TRUE (180.00) but if the azimuth display would be switched to AZIM (antenna referenced) it would show as 0.00.

1.2.3 POLARIZATION

The goal of this step is to approximately align the polarization axis' displayed angle to a local horizontal reference. The steps required to accomplish this depends on whether the polarization axis is equipped with a resolver or potentiometer.

Please refer to section 4.1.4 of the RC4500 Users Manual for the lengthy discussion of polarization reference position. Note that the ACU thinks in terms of receive (downlink) polarization angle vs. the transmit position.

1.2.3.1 Potentiometer

Section 4.1.4 of the RC4500 manual describes in detail how to calibrate the polarization axis when it is mechanized with a potentiometer.

1.2.3.2 Resolver

Calibration of a system with a resolver on the polarization axis is very similar to that of a system with a potentiometer.

In MANUAL mode the raw resolver angle may be displayed by pressing the SCROLL UP key until PL-R: legend is shown. Suppose that after placing the polarization in a reference position that should represent 0.00, the raw polarization angle is shown as 185.46 (resolver approximately centered). Going to the POLARIZATION CALIBRATION screen a resolver offset (RES) of -185.46 should be entered. Returning to manual mode a POL angle of 0.00 should then be observed.

1.3 Final Calibration

The goal of these steps is to do a precise calibration of the azimuth, elevation and polarization sensors. Having done an initial calibration, the RC4500 should be able to be used to position the antenna in the vicinity of a reference satellite. When the antenna is peaked on the satellite (as observed via a spectrum analyzer or other precise signal strength indicator), a final tweaking of azimuth and elevation resolver offsets may be performed in order for the displayed angles to meet the theoretical calculated pointing angles to the satellite.

1.3.1 Locate to Reference Satellite

From the LOCATE screen (3.2.2.3), select the reference satellite's longitude. The calculated TRUE heading and elevation to the satellite should be displayed. Allow the LOCATE mode to automatically move the antenna to these calculated angles.

NOTE: following this first LOCATE, the antenna may not be exactly on the satellite due to the approximate nature of the initial calibration. From MANUAL mode and observing relative signal strength from a receiver or spectrum analyzer, peak the antenna in azimuth and elevation.

1.3.2 Final AZ/EL Resolver Offset

After peaking on the satellite, return to the AZEL mode (3.3.2.7). The reference angles displayed should reflect the angles calculated in the LOCATE screen. Pressing the 7 and 9 keys should refine the azimuth and elevation resolver offsets with the final effect being that the displayed angles match within 0.01 of the calculated reference angles. NOTE: displayed and calculated angles may not exactly match due to internal rounding errors.

As an example, suppose that the LOCATE function calculated that the TRUE heading to a known satellite would be 193.03 and the elevation would be 44.31. After manually peaking on the satellite the displayed angles are 192.59 and 44.99. Entering the AZEL screen the data would look like the following screen.

```
     RES    TRUE      REF            AZEL
A: 192.45  192.59   193.03    (-179.86 )
E: 203.83   44.99    44.31    (-158.84 )
<1-AZ,3-EL>REF          <7-AZ,9-EL>OFFSET
```

After pressing the 7 and 9 keys, the azimuth and elevation resolver offsets would be adjusted to synchronize the displayed angles with the known reference angles.

```
     RES    TRUE      REF            AZEL
A: 192.45  193.03   193.03    (-179.42 )
E: 203.83   44.31    44.31    (-159.52 )
<1-AZ,3-EL>REF          <7-AZ,9-EL>OFFSET
```

1.3.3 Final Polarization Resolver Offset

The polarization offset should be checked against a known reference also. If for example a cross polarization exercise shows that the displayed polarization angle is slightly different from the angle calculated by the LOCATE mode, then the polarization offset should be adjusted so that calculated and displayed values are the same.

1.4 Other Actions

The goal of this quick start guide was to assist in tuning the azimuth, elevation and polarization sensors. There may be many other items such as adjusting automatic movements, etc. that may need to be accomplished to tune the performance of an antenna system. Please refer to the RC4500 Users Manual for assistance.