

Addendum to CTI Satellite Antenna Controller Instruction Manual

COMTRACK Operating Software (Version 5.00 or higher) July 31, 2003

This document describes Comtrack satellite-tracking software (versions 5.00 and later) used for EC8/CTI850 Series of Satellite Antenna Controllers. Comtrack software utilizes AGC signal strength from satellite receivers as well as **Two-Line Element (TLE)** data sets. Each TLE data set describes the orbit for a specific satellite. Comtrack uses the TLE data to predict the current location of the satellite, and then uses that information to track the satellite's movements.

Equipment Requirements

Comtrack requires the following equipment:

1. A dual-axis satellite antenna. The antenna mount may be AZ/EL or polar. The antenna must be installed so that:
 - The antenna can follow an inclined-orbit satellite throughout the satellite's entire range of movement. An inclined-orbit satellite can move a large distance in the elevation or declination axis, as much as +/- 7° from the geostationary orbit.
 - The antenna operates at a slow speed. The maximum speed allowable for each antenna depends on the beamwidth of each antenna.
 - The coupling between each drive motor and the antenna must be free of backlash or overshoot.
2. EC8/CTI-850 Series of Satellite Antenna Controllers. The controller must be equipped as follows:
 - Accurate position sensors on the up/down and east/west axes.
 - An accurate on-board clock and calendar.
 - Comtrack Security Plug. This is an adapter that plugs into the controller's parallel port located on the rear panel. This plug unlocks the tracking feature in the software. The tracking features will not be available without the security plug.
3. To track satellites using signal-strength, your EC8/CTI-850 must be equipped with a voltage sensing card and adapter (part number DAS-08). Your receiver must also provide an analog voltage output indicating signal strength (AGC). This equipment is not required if you plan on exclusively using TLE data to track satellites (TLE-ONLY mode).
 - With a user-supplied cable, connect the AGC output of your receiver(s) to the RCA connector(s) on the AGC adapter. Connect the AGC adapter to the DAS-08 card (DB-37 port) on the back of your EC8/CTI-850.
 - The default AGC range that Comtrack uses is 0-10V, with 10V being maximum signal and 0V being minimum signal. If your receiver provides a different AGC output, please contact CTI.

Theory of Operation

Comtrack software builds upon the basic operation of the EC8/CTI-850 Series of Satellite Antenna Controllers. Additional features used to track inclined orbit satellites are described below:

Comtrack offers three tracking modes: TLE-ONLY tracking, AGC/TLE tracking, and AGC-ONLY tracking.

- In TLE-ONLY tracking mode, TLE data is the only input considered while tracking an inclined orbit satellite. AGC signal strength from the receiver is ignored. The EC8/CTI-850 Controller will track satellites based on TLE information alone.
- In AGC/TLE tracking mode, TLE data is used to initially locate the satellite position. Then, AGC signal strength from a receiver is used to peak the signal and track the satellite. If the signal disappears, the TLE data is used as a backup.
- AGC-ONLY mode is accessible only through TRACKING MENU < 1 >. This mode will start the antenna tracking from its current location using only AGC signal strength as input. TLE data is not used at any time during tracking.

In TLE or AGC/TLE tracking modes, Comtrack software uses the following information to predict the current position of a satellite:

- 1) Current Date and Time. The EC8/CTI-850 Series of Satellite Antenna Controllers must be set to GMT time. The user can set the date and time from the DISK DRIVE MENU <1> option.
- 2) TLE data for a satellite. The TLE data is stored in a file, which is located on the controller's software disk. See the description in the following section for format and naming conventions for these files.
- 3) Site Coordinates for the satellite antenna. This is part of the initial configuration setup for the satellite antenna controller.
- 4) Reference satellite information. This information is part of the initial configuration setup for the satellite antenna controller.
- 5) Mount type of the antenna. This information is part of the initial configuration setup for the satellite antenna controller.
- 6) CPR values for the encoders used on the satellite antenna. This information is part of the initial configuration setup for the satellite antenna controller.

The user commands the controller to move the antenna to a TLE position the same way that the user would command the controller to move to a calibrated position. The user simply enters the position number by using the controller's keypad. Note: The controller must be at the MAIN MENU level when entering the position number.

When the user enters the position number, Comtrack software does the following:

1. Check for a calibrated position in memory.
2. If calibrated position exists, the software does #3. Otherwise the software does #4.
3. Move antenna to the calibrated position.
4. Check for a TLE data file for the given position number.
5. If the TLE data file exists (for that position), the software does #6. Otherwise the software does #11.
6. Read in the TLE data.
7. Calculate the current satellite position (based on the controller's current date and time).
8. Move the antenna to the calculated satellite position.
9. If in TLE-ONLY mode, wait for two minutes then recalculate the current satellite position. (In AGC/TLE mode, peaking sessions will be triggered as determined by the AGC Threshold and Peaking Interval, described below.)
10. If the difference between the calculated satellite position and the antenna's current position is greater than the degree threshold, then the software does #8. Otherwise, the software does #9.
11. Return to MAIN MENU level.

The controller will continue to track the TLE position until the user halts tracking, TRACKING MENU <2>, or until the user moves the antenna to another position.

When the controller is tracking a satellite, the display will show a "T" next to the position number when the controller is displaying the MAIN MENU (also known as the top level). The "T" means that the controller is tracking.

If the AGC disappears while tracking in AGC/TLE or AGC-ONLY modes, the controller will enter "blind mode" and a lower case "t" will be displayed on the main screen instead of an upper-case "T". In AGC/TLE mode, the controller will continue to track using TLE data until the AGC signal returns. In the AGC-ONLY mode, the controller will simply wait until the AGC signal returns.

If an error occurs while tracking, an "E" will replace the "T" and tracking will halt. The error is then displayed in the CHECK TRACKING screen, TRACKING MENU < 3 >.

Description of TLE Data Files

The user assigns the TLE data to a specific satellite by giving that satellite a position number (001 – 500). The user then must create a data file containing the TLE information. The data file must then be transferred to proper directory on the floppy disk that is kept in the EC8/CTI850 controller. The TLE data file has the following file name, path, and format:

TLE data file name: TLExxx.DAT (where xxx is the position number, 001 – 500.)

TLE data path on Comtrack disk: TLE data sets for position numbers 100 to 199 must reside in the TLE100 directory on the Comtrack diskette. Position numbers 200 to 299 reside in TLE200, positions 300 to 399 in TLE300, and positions 400 to 499 in TLE400. TLE data files for positions 1 to 99 reside in the root directory of the Comtrack diskette. If the proper directory does not exist when transferring TLE data, you must create one.

TLE data file format:

```
1 SBS 4
1 15235U 84093B 00033.42978253 -.00000250 00000-0 10000-3 0 2081
2 15235 5.1710 63.1257 0001700 273.0802 233.4627 1.00271364 33306
```

Where the first line:

```
1 SBS 4
  ^----- Description (optional). Up to 24 characters followed by a CR and LF.
^----- Antenna number (1 – 4). The antenna number is always needed.
```

The next two lines are standard Two-Line Orbital Element Set Format data, which is identical to that used by NORAD and NASA.

An example of a TLE data file for antenna #2 would be:

```
2
1 15235U 84093B 00033.42978253 -.00000250 00000-0 10000-3 0 2081
2 15235 5.1710 63.1257 0001700 273.0802 233.4627 1.00271364 33306
```

Note: Notice that Line 1 does not contain a description, which is optional, but does have an antenna number.

The TLE data for each satellite should be updated at regular intervals. There is no absolute guideline as to how often the TLE data must be updated. However, a good rule of thumb would be to update the data as often as the owner of the satellite updates the data.

Companion programs are available to help with the transferring of TLE data files to the floppy disk located in the satellite antenna controller. Contact CTI for more information.

Tracking Menu Options

< 1 > BEGIN AGC-ONLY TRACKING

The Controller will begin tracking at the current location based on AGC signal strength from a receiver. TLE data is not used at all while tracking in this mode. The antenna must be manually peaked on the inclined orbit satellite before using this feature.

When using this feature, it does not matter which mode is selected in SET TRACKING MODE (see TRACK MENU < 8 > below). The antenna will continue to track using only AGC until the user halts tracking with the HALT TRACKING feature (TRACK MENU < 2 >).

< 2 > HALT TRACKING

If the controller is currently tracking a satellite, this menu choice will stop the tracking process. If more than one antenna is tracking, it will ask which antenna to halt tracking on.

< 3 > CHECK TRACKING

This menu option displays the current tracking status of the controller. If the controller is tracking a satellite, this option will display the date of the TLE data set that it is using for the tracking calculations. This option also displays the current AGC value if it is available (assuming the DAS08 card is present), and a description of any errors encountered during tracking..

< 4 > DEFINE TLE REFERENCE

This menu option allows the user to use a “local reference” for a particular TLE position. The EC8/CTI850 Series of Satellite Antenna Controllers has one reference point (one satellite) as the reference for the entire satellite arc. While this is sufficient in the normal operating environment, TLE tracking might require a more precise reference to account for less than perfect antenna mounts. Problems with the antenna mount could produce pointing errors, meaning that the current antenna pointing angles that the controller senses (from the optical encoders) are not the actual antenna pointing angles (because of antenna mount problems). This option allows the user to account for those errors by defining a “local reference” for the current TLE position.

The user must first start tracking on the TLE position, then select this menu option. The software will prompt the user to peak up the signal. Once the signal is peaked, the user presses the < ENT > key and the controller creates a file on the disk for that TLE position. This file contains the pointing correction information and will use this information every time the user sends the antenna to this TLE position.

< 5 > REMOVE TLE REFERENCE

This menu option allows the user to stop using the “local reference”. The TLE reference file will be removed and the regular reference information will be used.

< 6 > RESERVED

< 7 > RESERVED

< 8 > SET TRACKING MODE

This parameter lets the user choose between AGC/TLE tracking mode, and TLE-only tracking mode. See the “Theory of Operation” section above for a detailed description of tracking modes. The up and down arrow keys toggle between the two tracking modes. The tracking mode may be changed at any time.

AGC-ONLY mode cannot be selected from this screen. This mode can only be entered from the TRACK MENU < 1 > screen.

< 9 > SET TRACKING PARAMETERS

The tracking parameters that can be edited from this menu selection depend on the current tracking mode.

- TLE-ONLY MODE:
 - DEGREE THRESHOLD:

This parameter is used to decide when the tracking process needs to “repeak” the antenna. If the difference between the calculated satellite position and the actual antenna position is greater than this degree threshold value, then the software will move the antenna to the calculated satellite position. Note: The difference value is the absolute difference between the calculated and actual positions.
- AGC/TLE MODE or AGC-ONLY MODE:
 - AGC THRESHOLD: This parameter determines the minimum signal level that the system will allow before re-peaking the antenna. Pressing the up and down arrow keys will change the threshold (percentage of peak signal). For example, if the threshold is set to 90% and the system measures the peak signal to be 5.0V, then a peaking session will be triggered if the signal strength drops below 4.5V.
 - PEAKING INTERVAL: In addition to re-peaking the antenna when the AGC drops below threshold, the EC8/CTI-850 also periodically performs a peaking session as determined by the *Peaking Interval*. The peaking interval represents the number of seconds in between these peaking sessions. The peaking sessions happen even when the AGC is above threshold to make the system more immune to conditions that effect the AGC level (weather phenomenon, changes in uplink power, etc).
 - INCREMENT SIZES: When searching for the peak signal, the EC8/CTI-850 will repeatedly jog the antenna in both axes until the signal is maximized. The *Increment Sizes* determine how many counts the antenna will move during each jog.

Log Feature

The Comtrack software has a log file feature. The log file records events such as entering manual control screens, exiting manual control screens, moving to calibrated positions, moving to TLE positions, etc. The log file also logs communication problems that might be occurring between the rack-mounted controller and the outside equipment. This log file feature is used primarily for troubleshooting purposes.

This feature is disabled by default. The user can enable/disable the log file feature from the DISK DRIVE MENU < 9 > option, which is labeled "ENABLE/DISABLE LOGFILE".

Comtrack also offers a tracking log in addition to the standard logfile described above. This log records hourly data points for satellites being tracked, and records any errors encountered during tracking. This file is stored to disk as "LOGTRACK . TXT".

To enable the tracking log file (default is OFF), you must edit the "TRAKPARAM . DAT" file on disk. Using a PC with any text editor, change the following line:

```
TRACKLOG = OFF  
to:  
TRACKLOG = ON
```

The EC8/CTI-850 must be then re-booted for the change to take effect.

AGC Alarm Feature

This feature monitors the AGC voltage from a satellite receiver for a particular antenna. Once the AGC voltage falls below the user settable threshold, a set of contacts will be closed indicating an AGC alarm condition.

Equipment Required

The following equipment is required when using the AGC Alarm feature:

1. EC8/CTI850 Series of Satellite Antenna Controllers.
2. DAS08 card (also known as UIOC or AGC cards).
3. AGC Alarm Plug.
4. Satellite receiver to provide the AGC voltage for the signal.

Using the AGC Alarm Feature

The AGC Alarm settings are located in the ANTENNA MENU < 9 > option, labeled AGC ALARM ENABLE/ DISABLE. Note: This menu is only available if the software detects the DAS08 card that is required to use this feature. (If the DAS08 card is not detected, the ANTENNA MENU < 9 > option will be labeled RESERVED.) This feature is disabled by default.

The following describes the AGC Alarm setting procedure:

1. The user selects ANTENNA MENU < 9 > option.
2. The user is prompted to Enable < 1 > or Disable < 0 > the alarm. Pressing the < ENT > key keeps the original setting. Note: An asterisk (*) is used to show the current setting.
3. If < 0 > Disable is pressed, the alarm is turned OFF. The procedure will end here and return the user to the ANTENNA MENU.
4. If < 1 > Enable is pressed, the alarm is turned ON.
5. The user is asked whether to define the AGC peak value. The user presses < 1 > Yes or < 0 > No. The current AGC peak value is shown in brackets.
6. If < 0 > No is pressed, the procedure skips to #8.
7. If < 1 > Yes is pressed, the user is prompted to "FIND PEAK SIGNAL".
8. The user peaks the antenna for maximum AGC signal and then presses the < ENT > key. Pressing the < ESC > key will keep the original AGC peak value and then move on to the next step.
9. The user is asked whether to define the AGC threshold value. The user presses < 1 > Yes or < 0 > No. The current AGC threshold value is shown in brackets.
10. If < 0 > No is pressed, this procedure will end here and return the user to the ANTENNA MENU.

11. If < 1 > Yes is pressed, the user is prompted “FIND THRESHOLD”.
12. The user moves the antenna slightly off of the peak to define the AGC Threshold value for the alarm. The user presses the < ENT > key when an acceptable value is found. Once the < ENT > key is pressed, the current AGC value is stored as the new AGC threshold value. Pressing the < ESC > key will keep the original AGC threshold value. Note: If the AGC Threshold value that the user enters is greater than the AGC peak value, an error will be displayed. This step will then be repeated.
13. Return the user to the ANTENNA MENU.

With the AGC Alarm enabled, the AGC value will be checked once every two seconds.

The AGC Alarm is **TRIPPED** under the following conditions:

- The antenna is at a TLE position or at a calibrated position and the AGC value falls below the AGC threshold value.
- The user is in TRACKING MENU < 4 >, labeled DEFINE TLE REFERENCE, and moves the antenna such that the AGC falls below the AGC threshold.

When the AGC Alarm is TRIPPED, the AGC Alarm is **RESET** (or cleared) under one of the following conditions:

- The antenna must be at a TLE position or at a calibrated position and the AGC value must rise above the AGC threshold value by an additional 25% of the difference in AGC Peak and AGC threshold values. For example, if the current AGC value is 0.9 volts, the AGC peak value is 2.00 volts and the AGC threshold value is 1.00 volt, the AGC Alarm would be TRIPPED. The AGC value would have to get up to 1.25 volts before the AGC Alarm would be RESET (or cleared).
- Or, the user enters a manual control screen. Once the user enters a manual control screen, the software assumes that the antenna is no longer at a calibrated position, which automatically RESETs the AGC Alarm.
- Or, the user sends the antenna to a different TLE position or to a different calibrated position.
- Or, the user disables the AGC Alarm via the ANTENNA MENU < 9 > option.