Appendix DVB

Integrated DVB Receiver Option

Revision: 1 December 2005, software version 1.55

This appendix describes the additional functions provided by the RC3000's integrated DVB receiver option.

1.1 Appendix 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 Integrated DVB Receiver option is described.

1.2 Software Configuration

The Integrated DVB receiver option provides the ability to mechanize a positive satellite identification feature. This feature requires the presence of a GPS receiver and integrated DVB receiver.

The Integrated DVB receiver option may also be integrated with the fluxgate compass. This configuration would be required for mounts that have less than 360 degrees of travel in the azimuth axis. Software to support this option will have the designation letter "A" for the navigation sensor category.

Mounts with a full 360 degrees of azimuth travel may mechanize the positive identification feature using a "no compass" configuration. Software to support this option will have the designation letter "F" for the navigation sensor category.

For example, the software configuration RC3K-Z1-ATR will support the integrated DVB receiver option ("A") along with the tracking ("T") and remote control ("R") options.

1.3.10 Theory of "Positive Satellite Identification"

In order to overcome heading estimate errors inherent with a magnetic compass (or in the case of the "no compass" configuration - no heading estimate), an optional "positive identification" feature is available. This feature is mechanized by integrating a Digital Video Broadcasting (DVB) compatible receiver with the RC3000.

When positive identification via DVB is enabled, the LOCATE function will scan the sky looking for an identifiable satellite which will be called a "signpost". The signpost satellite will be identified via the DVB receiver locking onto a frequency / symbol rate / forward error correction code pattern stored in the RC3000 for that satellite. A positive identification of the satellite can be accomplished by recognizing a unique identification string encoded in the DVB data stream.

After peaking up on the identified signpost satellite, the RC3000 can perform a "fix" of the original heading estimate. After establishing the heading fix, the mount may then be moved with confidence to any satellite selected by the user.

2.0 INSTALLATION

In order for this option to work properly, all other normal calibration steps described in the baseline manual must be performed correctly.

2.1.5 DVB Receiver mounting

In RC3000s with updated hardware, the DVB receiver will be mounted internally.

The DVB receiver may also be mounted externally to RC3000s containing the original hardware configuration. The external DVB receiver may be mounted anywhere that will allow the coax and communication connections (see 2.2.8) to be made. There will be no user interaction to the external DVB receiver, so it may be placed behind the rack that contains the RC3000.

2.2.5 Signal Strength

The RC3000 monitors the AGC signal from the DVB receiver via the AGC1 input of the J2 connector. If the DVB receiver is internal, this connection will be made inside the RC3000. If the receiver is external, the AGC will be connected to pins 8 and 7 of J2.

NOTE: other receiving equipment used for tracking, etc. must therefore be connected via the AGC2 input.

2.2.8 RF connection

If the DVB receiver is housed internally in the RC3000, the connection to the coax from the LNB will be made at the J11 F connector. Internally this connection will be split to the DVB receiver and the L-band power detector.

2.4.8 DVB receiver checkout

To confirm that the DVB receiver is able to lock onto signpost satellites, use the DVB maintenance screen described in 3.3.2.11 of this appendix. Position the antenna onto candidate signpost satellites and observe that the DVB receiver obtains lock and that the anticipated identification string is recognized.

The user may want to edit the DVB signpost list (3.3.1.1.4) based on the antenna system's characteristics (LNB LO, etc) and the systems intended area of use.

Factors involved in choosing signpost satellites:

- signpost frequency within LNB range: transponder frequencies outside the LNB's specification may experience enough phase distortions that the DVB receiver can't lock onto the signal.

- signpost beam pointing vs. system's area of use: only signposts visible to the system will be of use.

- stability of signpost data: the most useful signposts will have their transponders active 24 hours a day, seven days a week. If a scan happens when the transponder is not active, a lock will obviously not occur. Direct to home broadcast signals are good candidates as signposts.

The following table may be used to log observations.

NAME	LON	POL	FREQ	SYMBR	FEC	ID

The user should also manually scan in azimuth across the signposts in SLOW speed. If a lock indication does not appear, it indicates that the mount's azimuth slow speed is too fast and the automatic scan function may not recognize the lock indication. Adjust the azimuth's slow speed (2.3.5 of baseline manual) to a point where a lock indication is apparent for at least one second as the antenna moves across the satellite.

3.0 DETAILED OPERATION

3.2.2.3.7 Unique LOCATE mode steps using the Integrated DVB Receiver

When the DVB identification feature is enabled, additional steps will be added to the normal LOCATE sequence.   Initiate the LOCATE mode as usual and select the satellite that you want to locate. As always lat/lon from the GPS and a heading "estimate" from the compass will be obtained and the estimated pointing angles to the selected satellite will be displayed. If the "no compass" configuration exists, the heading estimate will be blank and the displayed azimuth target reflects a true heading to the selected satellite. Press <ENTER> to proceed and then select the desired polarization as usual.

Descriptions of actions associated with this option will be displayed on the bottom line of the LCD. The following numbered steps describe the actions in the sequence they will occur.

NOTE: the user may want to review the configuration items described in this appendix associated with the DVB Detection Points (3.3.1.4) and DVB ID features (3.3.1.3.14) as they will be referred to in the following descriptions.

1) SORTING OF SIGNPOST CANDIDATES

The list of signpost satellites/transponders (3.3.1.1.4) will be sorted to decide the best signposts to first look for are. NOTE: the satellite the user wants to eventually go to (selected satellite) doesn't have to be one of the signpost satellites.

This step will prioritize the signposts according to the following criteria:
- all priority 1 signposts will be considered first
- signposts with the same priority will then be ranked according to their vicinity to the selected satellite of interest (i.e. the signpost closest to the selected satellite will be scanned for first).

This ranked list of signposts will determine the order in which signposts will be scanned.

After determining the first signpost to scan for, the bottom line will display "**SP:**" and the longitude of the signpost. For example, if a signpost at longitude 105 West is chosen, the bottom line will show "**SP:105 W**".   "**ADDITIONAL MESSAGES**" showing the sequence of events will be appended following the SP: string. The additional events and the messages displayed will now be described.

2) TILT DETERMINATION

If the polarization tilt compensation is enabled via the Autopeak configuration screen (3.3.1.2.6), the first movements made will be to characterize the pitch and roll of the antenna platform as described in 3.2.2.3.6 of the baseline manual.

If the "no compass" option is present, the azimuth axis will be moved to the 0.0, -90.0 and -180.0 positions to sample elevation. These positions are used since the scan for a signpost will begin at the minus 180 position. Otherwise, elevation will be sampled at azimuth positions 90 and 45 degrees away from the start of the signpost scan.

3) POSITIONING TO START OF AZIMUTH SCAN

The first movement of the positive identification feature will move the antenna to the starting position of the azimuth scan.

If the "with compass" option is present, the start of azimuth scan will be dvb_scan_range away from the estimated azimuth position of the signpost satellite.

If the "no compass" option is present, the controller will first start scanning from the -180.0 azimuth position. If the first ranked signpost is not found, the controller will then scan for the second ranked signpost from the +180.0 position since it will be at that position at the end of the initial scan. Starting from the -180 or +180 position will alternate until a signpost is found or the list of signpost candidates is exhausted.

During this action **"MOVING TO START OF SCAN"** will be displayed on the bottom line.

4) CHARACTERIZATION OF RF NOISE FLOOR

The RF value of open sky is sampled in order to determine an average noise floor coming from the L-Band power detector. This noise floor will be used during the azimuth scan to determine if the antenna is pointing at a satellite. During the scan, if the sampled RF value is dvb_scan_threshold above the noise floor, the controller will assume that it is pointed at a satellite and change the scan speed from fast to slow.

During this step the bottom line will display **"DETERMING RF NOISE FLOOR"**. The elevation will first be moved to the 45 degree position in order to hopefully look above surrounding buildings and trees. The RF value detected will be displayed. The elevation will next be moved up five degrees and the RF value again sampled.

If the two RF values are within 10 of each other, the controller assumes that it has looked at open sky and will use the average of the two samples as the noise floor during the scan.

If the two samples are not within 10 or each other, the controller assumes that one of the positions must have been pointing at the arc of satellites. The controller then moves five degrees more in the other direction and samples again. The controller will iterate above and below the starting position several times until it gets consecutive samples within dvb_scan_threshold of each other.

If during this step a satisfactory noise floor value is not determined, the controller assumes that from the current azimuth position the antenna's view of the sky must be blocked. The controller will then proceed to look for the next ranked signpost.

5) POSITIONING TO THE SIGNPOST ELEVATION

Next the controller moves to the elevation calculated for the signpost. During this time **"MOVING TO SIGNPOST ELEVATION"** will be displayed.

6) TUNING DVB RECEIVER

The DVB receiver is programmed with the frequency / symbol rate / FEC pattern for the currently used signpost. During this time **"INITIALIZING DVB RCVR"** will be displayed.

7) POLARIZATION ADJUSTMENT

If the signpost has a linear (H or V) orientation, polarization will then be moved to the correct position. During this time **"ADJUSTING POLARIZATION"** will be displayed.

8) AZIMUTH SCAN FOR SIGNPOST

A scan is performed looking for signal lock on the frequency/symbol rate/FEC of the currently selected signpost. The azimuth scan starts out in fast speed until it sees a RF value above a (RF noise_floor + dvb_scan_threshold) value. It then switches to slow speed and starts looking for a signal lock. The azimuth scan will go 3 degrees beyond the last indication of lock to make sure a lock from a sidelobe wasn't initially seen. During this time **"SCANNING AZIMUTH"** will be displayed.

9) CONFIRMING SIGNPOST

After scanning through a lock condition, the dish is returned to the midpoint in azimuth where lock was seen. During this time **"RETURNING TO LOCK CENTER"** will be displayed. From that position, the controller will double check that a lock condition exists.

If no lock is confirmed, the azimuth scan will continue. This condition will be annotated by the brief message **"NO LOCK FOUND – CONTINUING SCAN".**

If lock is confirmed, a local peak up of signal strength is performed in order to place the dish as precisely as possible on the signpost satellite. This peak up requires high resolution sensors (such as pulses) on the azimuth and elevation axes. During this time **"PERFORMING PEAK UP"** will be displayed. NOTE: this peak up will not occur if the positive identification feature is "enabled without lock" in the DVB ID configuration screen (3.3.1.1.14).

A "positive identification" of the signpost is then confirmed. Using the DVB receiver, this positive id is done by comparing the signpost_identification_string parsed from the DVB receiver with a string that had been placed in the signpost list. During this time **"CHECKING FOR POSITIVE ID"** will be displayed.

If a positive identification of the signpost is not confirmed, the scan for that signpost will be completed in case we had come across a satellite using the same freq/symbol rate/FEC combination. If no positive identification happens, then a scan looking for the next signpost from the list sorted in step #1 will be done.

If no positive identification of any signpost is accomplished, the LOCATE will stop and display the message "**NO POSITIVE IDENTIFICATION**". The hpa disable signal will remain to prevent transmission.

If a positive identification is confirmed, an azimuth delta will be computed and used to fix the original heading estimate.

10) POSITIONING TO SATELLITE OF INTEREST

If the selected satellite is at same longitude as the positively identified signpost, there is no need to perform further movement.

Otherwise, with the heading estimate fixed, the antenna can then be moved to the selected satellite with confidence. During this time **"SIGNPOST FOUND- GO TO SELECTED SATELLITE"** will be displayed.

11) SELECTED SATELLITE POLARIZATION ADJUSTMENT

The controller adjusts polarization to achieve the orientation requested for the selected satellite.

If tilt compensation has been enabled, the polarization angle is additionally adjusted according to which direction the satellite is with respect to the tilt of the platform. Hopefully this will leave the polarization axis positioned to achieve adequate cross-pol isolation. During this time **"ADJUST POL TO COMPENSATE FOR TILT"** will be displayed.

12) FINAL TARGET PEAKING

A final RF peakup may be performed to put the dish on the selected satellite as precisely as possible. During this time **"PERFORMING PEAKUP"** will be displayed.

NOTE: this peak up will occur according to how the target_peak configuration item is programmed in the DVB ID configuration screen (3.3.1.3.14).

3.3.1.1.4 DVB Detection Points

This group allows the user to customize a list of 10 "signpost" satellites. The LOCATE mode's positive identification feature will prioritize from this list.

```
SP#: 1                          CONFIG-DVBR
LON:121.0W FRQ:11724 FEC:1
POL:2      SYM:20000 PRI:1    ID:121W
<SCR> THRU LIST, <ENTER> TO SELECT
```

SP#:   **<SCR> THRU LIST, <ENTER> TO MODIFY DATA**
This field identifies the list number (1-10) that is currently being displayed. When in this field, the Scroll Up or Scroll Dn keys will move through the list.
To modify the data press the Enter key. The cursor will move to the LON field.

LON: **ENTER LON IN <DDD.TT> FORMAT**
This field allows a user to enter a signpost satellite's longitude in decimal format. See section 3.1.4 for instructions on how to enter satellite longitudes. After the longitude is entered, the cursor will move to the POL field.
If you do not wish to change the current longitude, pressing the Scroll Up key will move to the POL field. Scroll Dn will move back to the SP field.

POL: **POLARIZATION<1-H 2-V 3-R 4-L>**
This field allows the user to specify the polarization associated with this signpost. This data is used by the positive identification feature to orient the polarization axis correctly for receiving the DVB data.
R(ight) and L(eft) handed implies circular polarization and no polarization movement will be made.

FRQ: **FREQUENCY<1000 – 13000> MHZ**
This field allows the user to specify the frequency associated with this signpost. This data is used by the positive identification feature to tune the DVB receiver.

SYM: **SYMBOL RATE <1000 – 30000> kS/sec**
This field allows the user to specify the symbol rate associated with this signpost. This data is used by the positive identification feature to tune the DVB receiver.

FEC: **FEC <1-3, 5-7> ex. 3=3/4>**
This field allows the user to specify the forward error correction code associated with this signpost. This data is used by the positive identification feature to tune the DVB receiver.

Enter the first number of the FEC scheme. Example: to select 5/6, enter 5.

PRI: **PRIORITY <0-DISABLE, 1-TOP, 2-LOWER>**
This field allows the user to specify the priority to be placed on this signpost. This data is used by the positive identification feature to sort which signposts to search for first.

ID: **SIGNPOST ID STRING <6 CHARACTERS MAX>**
This field allows the user to specify the identification string associated with this signpost. This data is used by the positive identification feature to confirm the signpost.

NOTE: *make sure there is a space entered following last character of id string.*

NOTE: the signpost list only contains data about a DVB transport stream to be used as a "signpost". With respect to the RC3000 there is sometimes confusion between the preset list and the list of STOREd satellite data (3.2.2.4). STOREd data contains both satellite and mount (azimuth, elevation, polarization) position data. The signpost list is an additional list that should not be confused with the other lists mentioned.

The following table shows a typical list of signpost that might be used for a system operating in North America.

SP#	LON	POL	FRQ	SYM	FEC	ID	PRI
1	119.0W	R	12224	20000	5/6	119W	2
2	79.0W	V	11742	11110	3/4	0W	1
3	95.0W	H	11780	20760	3/4	191E	1
4	148.0W	R	12224	20000	5/6	148W	1
5	121.0W	V	11724	20000	1/2	121W	1
6	110.0W	R	12224	20000	5/6	110W	1
7	105.0W	V	11720	26000	2/3	15W	2
8	61.5W	R	12224	22000	5/6		2
9	119W	R	12239	20000	5/6	119W	1
10	103.0W	H	11840	26,670	7/8	23W	2

Notes:
SP #1 is given priority 2 since it is actual used by multiple spot beams that may not be visible in various areas of North America.
SP #8 does not have a ID string associated with it as its identification string has not been observed to be consistently available. It is given priority 2 since its FREQ/SYMBR/FEC pattern is the same as many other potential signpost satellites.
SP #10 is given priority 2 as it is only used occasionally for uplinks.

3.3.1.3.14 DVB ID

This group allows the user to customize the operation of the positive identification feature.

```
ENABLED:1                     CONFIG-DVB ID
 TARGET:2        RANGE:30
LO FREQ:10750      TH: 15
<0>DISABLED <1>WITH PEAK <2>W/O PEAK
```

ENABLED: **<0>DISABLED <1>WITH PEAK <2>W/O PEAK**

This field allows the positive identification feature to be disabled (0).

If the feature is enabled, it may be specified whether or not an automatic peakup on the signpost and selected satellites will be performed. If high resolution sensors are available for the azimuth and elevation axes, it is recommended that the automatic peakup (1) option be chosen. If high resolution sensors are not available, automatic peakups cannot be performed and option 2 should be chosen.

TARGET: **TARGET PEAK <0>NONE <1>AZEL <2>ELEV ONLY**

This item defines what the controller will do when it positions to the selected satellite following a successful identification of a signpost satellite.

If 0 is chosen, no attempt to peak up on the selected satellite is attempted. If 1 is chosen, the controller will attempt to peak the RF value in both azimuth and elevation while selecting 2 will cause the controller to peak RF in elevation only.

NOTE: since the controller at this time will be sampling the total L-Band power (RF), movements in azimuth may cause the RF value to be unduly biased by signals from adjacent satellites. To avoid this situation, choosing option 2 may be the preferred choice.

LO FREQ: **LNB LO FREQENCY <1000 – 30000>**

This field allows the frequency of the LNB's local oscillator to be specified.

This value will be automatically subtracted from a signpost's downlink frequency in order to describe the intermediate frequency that the DVB receiver will receive.

RANGE: **DVB SCAN RANGE +/- <10 -90> DEGREES**

This field specifies the number of degrees on either side of the estimated signpost position that will be scanned.

This number should be somewhat larger than the worst case error that can be obtained from the compass. Example: if you have confidence that the compass will never have more than a 15 degree error, then the scan range could be set to a value of 20.

TH: **DVB SCAN THRESHOLD <10 -500>**

This field specifies at what value above the open-sky noise floor that the scan for a signpost will transition from high speed to low speed.

This value should be set low enough that slow speed will be triggered quickly as the scan approaches a satellite. Conversely, it should be set at a high enough value that the transition won't be fooled by noise in the open-sky value.

3.3.2.11 DVB Receiver Maintenance

When the DVB option is present, the MAINTENANCE menu allows the user to select DVB maintenance by pressing the BKSP(+/-) key.

```
1-VOLTS    2-DRIVE   3-TIME   4-SIG MAINT
5-LIMITS   6-GPS COM 7-FG COM 8-MOVETO
9-FG CAL   0-SHAKE   +/-DVB   .-CI RECORD
                              Z1-FTRv1.55
```

This mode allows the user to test the DVB receiver's ability to lock onto a signpost satellite. When the mode is entered, the parameters for signpost # 1 are automatically loaded into the DVB receiver.

```
-208.3  CCW     SP: 1  FRQ:12224     DVB
  43.7          SLOW   SYM:20000 FEC:5
 -14.5          RF:452  LK:LOCK ID:119W
<5>SP <7>FRQ <9>SYM <BKSP>FEC
```

Manual Antenna Control

Azimuth, elevation and polarization angles and limit status on shown in the two left columns of the display. The antenna may be moved as it is in the MANUAL mode. The azimuth may be manually jogged via the 4 and 6 keys, elevation via the 2 and 8 keys, and polarization via the 1 and 3 keys. Speed may be toggled via the 0 key.

Other keys will be used to program the DVB receiver.

RF: / SS:

The signal level seen by the L-band (RF) power detector or the DVB receiver's AGC (SS) is shown in this field. The Scroll Down key will scroll between RF and SS.

<5>SP: ENTER SIGNPOST # 1-10

This key allows the user to select another signpost from the stored list of DVB signposts. The index of the signpost will be displayed. If individual signpost parameters are entered as described below, a "*" will be shown to indicate that the current set of parameters does not necessarily come from the stored signpost list.

<7> FRQ: ENTER FREQUENCY <10000 – 13000> MHz

The frequency for a potential signpost may be individually entered. After entering the frequency, the new frequency along with the current symbol rate and FEC will be programmed into the DVB receiver.

<9>SYM: ENTER SYMBOL RATE <1000 – 30000> kS/sec

The symbol rate for a potential signpost may be individually entered. After entering the symbol rate, the new symbol rate along with the current frequency and FEC will be programmed into the DVB receiver.

<BKSP>FEC: ENTER FEC <1-3, 5-7> ex. 3 = 3/4

The FEC for a potential signpost may be individually entered. After entering the FEC, the new FEC along with the current frequency and symbol rate will be programmed into the DVB receiver.

LK: ----, lock, LOCK

This field indicates the current lock status from the DVB receiver. "----" indicates that the DVB receiver currently has not established a lock on the programmed parameters. "lock" indicates that the DVB receiver has initial lock on the data stream. "LOCK" indicates that it has established a better lock indicating that it is able to internally estimate a bit error rate from the data stream.

ID:

This field indicates the current text that the DVB receiver has pulled off of a data stream.

Prior to establishing a lock, the string "RCIx" will appear indicating that the DVB receiver is trying to lock on the parameters defined by signpost # x. If any of the parameters have been individually programmed the string will be "RCI;".

When a lock is initially established, text such as "MPEG-2" may appear. This indicates that the DVB receiver recognizes a data stream but has not pulled the identification string from the stream.

A few seconds after lock is established, an identification string should appear. For example, "119W" will be extracted from data stream coming off of the EchoStar satellite located at 119.0 West longitude.

NOTE: not all uplinkers will faithfully multiplex an identification string into the data stream. One of the main reasons this maintenance screen exists is to monitor if identification data is being sent from a potential signpost.