Base Station User Guide Part 1

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01 - Base Station Introduction

The Racelogic DGNSS RTK Base Station is designed to improve positional accuracy of VBOX’s and other compatible GNSS systems by calculating and transmitting differential correction data. By setting up the Base Station in a known position, it is able to accurately monitor the difference between its known position and the position that it is calculating from GNSS satellite signals.

The difference is then transmitted via radio to allow a remote GNSS system to correct its position. The differential correction message can be broadcasted in RTCM v2, RTCM v3, RTCM v3.2 MSM4 and MSM7, or proprietary RTK formats using an internal or mast mounted radio modem transmitter. Depending on the type of base station and roving unit used, position accuracies of up to 2 cm (95 % CEP) are available.

The 95 % CEP value refers to the Circular Error Probable. For example, in the case of the RTK enabled base station in conjunction with an RTK enabled VBOX III or VBOX 3i, the GPS position calculated will be within a 2 cm radius of the true position 95 % of the time.

Features

- Survey grade GPS/GLONASS receiver with L1/ L2 (RLVBBS5) or GNSS multi-band receiver with GPS L1/L2/L1C/L2C, GLONASS L1/L2, Galileo E1/E5a/E5b and BeiDou B1/B2 (RLVBBS6).
- Accuracy:
  - RLVBBS5: Up to 2 cm.
  - RLVBBS6: Horizontal up to 5 mm + 0.5 ppm x Baseline; Vertical up to 10 mm + 0.8 ppm x Baseline.
- Outputs:
  - RLVBBS5: RTCM, CMR, RTCM v3 or proprietary
  - RLVBBS6: RTCM v2, RTCM v3, RTCM v3.2 MSM4 and MSM7 or proprietary
- 25-position memory to store and recall different reference locations
- Optional integral or mast mount radio transmitters with range of up to 10 km (approx 6.2 miles) line of sight and 2 km in a built up area
- Self-survey mode
- Up to 18 hours battery life (depending on radios in use) or external power
- Rugged IP 64 (splash proof) enclosure
- Compatible with wide range of radios to suit location and range requirements

The image below shows the results of static positional data from VBOX systems with and without local DGPS

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corrections.

- The **red** plot shows position scatter from a **non-corrected** VBOX.
- The **blue** plot shows position scatter from an **SBAS corrected** VBOX.
- The **green** plot shows position scatter from an **RTCM (40 cm) corrected** VBOX.
- The **purple** plot shows position scatter from a **20 cm corrected** VBOX 2 series product.
- The **yellow** plot shows position scatter from an **RTK (2 cm) corrected** VBOX 3 series product.

[Image of scatter plot]
02 - Base Station Operation

The Base Station is designed to operate outdoors and is housed in a rugged splash proof case. It is important to note however that the front panel is not waterproof so the lid must be shut if it is raining. Power can be obtained either from the internal battery supply or from an external source via a front panel (using the supplied mains power supply, or via an external waterproofed connector from a suitable 8 - 30 V DC supply). If powering from an external source, make sure that rainwater cannot run down the supply cable into the unit.

Both the radio cable and the GNSS antenna cables connect to the Base Station via screw-on TNC connectors and the antennas should be connected before the Base Station is switched on.
It is important to make sure that the GNSS and RADIO antennas are connected to the correct connectors on the Base Station.

Power and Environment

The Base Station will accept an input voltage range of 8 - 30 V for operation. 19 V is required to charge the internal battery cells. Charging is achieved by using the supplied mains power adapter. Before the Base Station is used for the first time it is advisable to charge the internal battery completely. When power is connected, battery fast charging will begin.

Fast charging is indicated on the LCD display panel when the unit is switched on. However, the unit will still charge...
when switched off at the front panel. Charging of the internal battery pack will normally take approximately 4 hours from empty. The fast charge temperature range of the internal battery pack is above 10°C and below 50°C. Outside this range, the internal charger will only charge in trickle mode to prevent damage to the battery cells. It is possible to charge the battery while the Base Station is operating.
03 - Base Station GNSS Antenna

The GNSS antenna must be placed in a position away from any buildings, trees, walls, high wire fences or any other obstacles that could cause satellite signals to be blocked or reflected.

Even solid objects below the height of the GNSS antenna should be avoided as they can also cause reflection of the satellite signals.

Wherever possible, place the GNSS antenna and tripod at the highest available spot to ensure the best un-affected satellite reception.

Make sure the legs of the tripod are fully extended to give maximum height.

If the Base Station is to be fitted on a permanent roof top location, then also ensure that the GNSS antenna is not shadowed by any other parts of the building or nearby objects.
Satellite Elevation Mask

This feature can be used to improve GNSS signal quality when nearby obstacles like trees and buildings are reflecting or temporarily obscuring the signal from satellites at low elevation. Raising the mask will cause the Base Station to ignore satellites below the mask angle, so must be used carefully as it also reduces the total number of received satellites.
The Base Station radio antenna must be placed in the highest available position in order to realise the maximum possible transmission range. Where possible the position should be close to the centre of the area over which the system is to be used.

For example, if used at a test or race circuit, mount the tripod in the centre of the circuit to give equal radio coverage to all points of the circuit.

If your Base Station is used in temporary locations, then it is recommended that you use a telescopic mast to raise the radio antenna as high as possible.
Telescopic Mast

A suitable telescopic mast including guy ropes can be purchased through Racelogic, please contact your local VBOX distributor for details. The telescopic mast can be easily erected by two people. One person should hold and extend the mast to the correct height whilst the other person pegs out the three supplied guy lines.

The guy rings on the mast should be at 2/3rds height of the antenna for stability.

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Once the three guy lines have been pegged out the antenna can be raised further to increase guy line tension.

Roof Location

The Base Station radio antenna can also be mounted on a roof top when the Base Station is required in a permanent location. The radio antenna is supplied with a “U” bolt fixing to enable a fixing to a suitable upright pole.

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Mast Mount Transmitter

The option of a mast mounted enclosure (RLACS153 for 868 MHz and 915 MHz radios, RLACS153-24 for 2.4 GHz radios, and RLACS153-VAR for SATEL Radios) is available, which greatly reduces the RF cable length between the transmitter and the antenna. This results in greatly reduced transmission line losses which in turn increases transmission power, giving better range. The mast mount enclosure is IP67 rated to protect the radio from harsh weather and is supplied with a 6 m serial/power connection cable (RLCAB105 for all radios) allowing full extension of the mast. The serial/power cable connects to an external IP68 rated connector on the Base Station, ensuring that the Base Station remains weatherproof.
05 - Base Station Front Panel

The front panel of the Base Station contains a display for indicating the operating status of the Base Station. User input for configuring the Base Station is via the three control buttons. The control buttons consist of left and right menu selection buttons and an ‘OK’ selection button.

An RS232 connector on the front panel is used for updating the operating firmware of the Base Station using a PC or porting to the GNSS engine or radio modem for update of firmware or manual configuration changes.

There is also a power input connector for charging the Base Station internal battery using the supplied mains adaptor. This can be used to permanently power the unit; however this should only be done if the Base Station is located indoors with the GNSS and radio antennas located outside as the Base Station is not weatherproof with the lid open.

A power ‘ON/OFF’ switch is located on the front panel which powers the unit for operation. However the unit can be charged even if the power switch is in the OFF position. The charge LED gives a status of the battery charger circuit at all times when an external supply is connected. Details of what this LED indicates can be found in the section entitled ‘Battery and Charging Status’.

For convenience, the Base Station contains a 25-location memory. This enables the user to store different reference locations and recall them at a later date. When storing a new location, the Base Station should be set to average the current antenna position over a period of time to obtain the best of location data accuracy.

Depending on the the type of VBOX used, The DGNSS accuracy ranges from 40 cm CEP to 2 cm CEP. There are two current options available for the Base Station; Base Station 5 includes GPS and GLONASS constellations, Base Station 6 includes GPS, GLONASS, Galileo and Beidou constellations. Both options have a 40 cm and 2 cm RTK DGNSS modes which can be used with all VBOX data loggers and third party GNSS equipment that can accept RTCM format corrections.

Base Station mode compatibility with VBOX data loggers and speed sensors can be seen in the ‘Compatibility Matrix’.

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06 - Base Station Setup - New Location

The Base Station is designed to be as simple to use as possible, but to get consistent results from the equipment requires some initial setup and future planning by the user. The ideal setup for the Base Station would be to permanently locate the GNSS and radio antennas in a position with a clear view of the sky and a clear view of the test area respectively.

A good example of this would be on top of a building like a control tower. However, this is not always possible and it may be necessary to use the Base Station in several different locations. A good compromise is to have marked locations that have been surveyed that the Base Station antennas can be returned to when required in a particular test area.

1. Set up the GNSS antenna on the tripod and radio antenna and mast in a suitable position. This should ideally be central to the test area. The GNSS antenna should be high enough to ensure a clear, unobstructed view of the sky away from buildings and trees. The radio antenna should be as high as possible to provide best coverage of the test area.

2. Connect the radio and GNSS antennas to the Base Station. Take care to connect the antenna plugs to the correct ports on the Base Station.
   
   Warning! Connecting the GNSS antenna to the radio port can cause permanent damage to the GNSS antenna and/or radio. Also ensure that the Radio antenna is connected to the Radio connector on the Base Station before power is switched to avoid damaging the internal radio modem.

3. If powering the unit from the internal battery supply ensure that the battery has been fully charged. This will normally take around 4 hours. If powering from an external source make sure that the source voltage is between 8 - 30 V DC. Switch the Base Station on using the on/off switch on the front panel.

4. After switch-on, the Base Station will begin searching for satellites. On start-up the status display will initially show the unit serial number and firmware revision. After a short time the status display will change to show satellite status.

   The usual number of satellites seen in an open area is 13 - 21. A minimum of 4 satellites are required for the Base Station to calculate the differential. The message ‘POSITION MISMATCH’ will be displayed, as the Base Station is being used in a different location to where it was last setup. Use the ‘OK’ button to clear this message.
5. Press ‘OK’ then scroll through the menu to the ‘Set to Average’ option and press ‘OK’.

Choose the period of time over which to average the location: 5 minutes, 12 hours or 24 hours. A countdown will be displayed for the duration of the averaging procedure. When this reaches zero and displays ‘LOCATION SET OK’ press ‘OK’. The averaged position is now set into the Base Station and it will transmit DGNSS correction information.

Alternatively a ‘SET TO CURRENT’ can be used in place of “SET TO AVERAGE” for instant operation without absolute positioning.

6. To store this new averaged location for future use at the same location, press ‘OK’ and scroll through the menu to display the ‘STORE LOCATION’ option. Press ‘OK’ to enter this option then use the arrow keys and the ‘OK’ button to select the letters to make the name of the location. Pressing ‘OK’ at the end of this procedure then saves this averaged location with the name you have chosen.

To ensure accuracy the VBOX must receive Local DGNSS corrections for at least 20 minutes before being used in 40 cm, 20 cm or 2 cm modes.
The Base Station is designed to be as simple to use as possible, but to get consistent results from the equipment requires some initial setup and future planning by the user. The ideal setup for the Base Station would be to permanently locate the GNSS and radio antennas in a position with a clear view of the sky and a clear view of the test area respectively. A good example of this would be on top of a building like a control tower. However, this is not always possible and it may be necessary to use the base station in several different locations. A good compromise is to have marked locations that have been surveyed that the Base Station antennas can be returned to when required in a particular test area.

1. Set up the tripod in exactly the same position as is used each time you return to the test area (ideally within 1 cm). It is recommended that the tripod leg positions are marked using survey nails for quick relocation, or that a plumb line be used and the centre point under the antenna be marked.

2. Connect the radio and GNSS antennas to the Base Station. Take care to connect the antenna plugs to the correct ports on the base station.
   
   Warning! Connecting the GNSS antenna to the radio port can cause permanent damage to the GNSS antenna and/or radio. Also ensure that the Radio antenna is connected to the Radio connector on the Base Station before power is switched to avoid damaging the internal radio modem.

3. If powering the unit from the internal battery supply ensure that the battery has been fully charged. This will normally take around 4 hours. If powering from an external source make sure that the source voltage is between 8 - 30 V DC. Switch the base station on using the on/off switch on the front panel.

4. After switch-on, the Base Station will begin searching for satellites. On start-up the status display will initially show the unit serial number and the firmware revision. After a short time it will change to show satellite status. The usual number of satellites seen in an open area is 13 - 21.

   A minimum of 4 satellites are required for the base station to calculate the differential. The message ‘POSITION MISMATCH’ will be displayed, as the base station is being used in a different location to where it was last setup. Use the ‘OK’ button to clear this message.

5. If the Base Station was last used at this position it will have remembered this location and be working immediately once satellites are in view. If the Base Station was last used somewhere else then you will need to load the stored location. Press ‘OK’ and scroll to the ‘Load Location’ option and press ‘OK’. Then select the previously stored location from the list of locations and press ‘OK’ to confirm. The base station will immediately start sending out DGNSS correction data.
It is important when recalling a stored position, that the GNSS antenna is in the same geographic position that it was when the location was originally stored. For example, if the GNSS antenna is placed 50 cm from the position where the stored location was originally created, the DGNSS output and hence the VBOX data logged will carry a 50 cm offset.

To ensure accuracy the VBOX must receive Local DGNSS corrections for at least 20 Minutes before being used in 40 cm or 20 cm modes.
08 - Base Station Menu Options

By pressing the ‘OK’ button from any of the status display screens the configuration menus can be accessed. These can be navigated using the ‘<’ and ‘>’ buttons to find an option and then the ‘OK’ button to select it. The first screen to be displayed is the ‘EXIT’ option to return to the last menu screen. To exit out from any area of the configuration menu select the ‘BACK’ and ‘EXIT’ options.

Setup

This menu contains general setup options to configure the Base Station.

Language

This setting changes the interface language. The options available are:

- English
- Deutsch
- Français

Brightness

This setting allows the brightness of the display to be increased and decreased.

Contrast

This setting allows the contrast of the display to be increased and decreased.

Set DGNSS mode (DGPS pre Firmware 2.13)

Allows the user to choose what type of differential correction should be transmitted. The options available are:

- RTCM 40 cm
- Racelogic 20 cm (only available on VBBS4)
- Racelogic 2 cm (only available on VBBS4RG/VBBS5)
- CMR 2 cm (only available on VBBS4RG/VBBS5)
- RTCM v3 2 cm (only available on VBBS4RG/VBBS5)

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The Racelogic options are proprietary modes that only work with 20 cm enabled VBOX 2 series products and RTK (2 cm) enabled VBOX 3 series products. The RTCM and CMR modes are industry standard modes that will work with any GNSS receiver that is capable of using these differential modes.

**Coldstart**

Coldstart will clear the GNSS receiver of its almanac and ensure it is configured correctly. The GPS almanac is information about the ‘health’ of each satellite in the constellation and navigational data regarding its orbit. This allows the receiver to quickly obtain a positional fix after it has been switched off.

However, if the almanac is old because the receiver has been switched off for several days or weeks; or if the receiver has been moved a long distance between being powered down and re powered, then the almanac no longer serves its purpose as the information is no longer relevant to the situation. In this case the data in the almanac can actually extend the time it takes to get a fix on the current position. It is recommended that a Coldstart be performed in the above instances.

**FP RS232 Conn**

This allows the RS232 serial connector on the front panel to be configured for various tasks. The options are:

- Radio Config - Ports to the radio modem to allow direct configuration or firmware update
- F/W Update - Allows the Base Station firmware to be upgraded using Racelogic Upgrader software and a .RUF firmware file
- GPS Update - Ports to the GNSS receiver to allow direct configuration or firmware update

**Radio Setup (Radio Mode pre Firmware 2.8)**

You should always check the local laws and regulations regarding radio transmissions in your country to ensure you are not broadcasting illegally. Racelogic and its representatives can offer guidance in this area, but it is the responsibility of the user to ensure that they are not breaking local transmission regulations.

**Pre Firmware version 2.8**

This allows the user to select what type of radio modem is connected to or fitted inside the Base Station. The options are:

- SATEL - Refers to SATEL SATELLINE-3ASd and SATEL M3-T1 which can be used in most countries but may require a licence
- 868 MHz - Refers to Racelogic 868 MHz medium range radio modems that are legal for licence free use in Europe
- 915 MHz - Refers to Racelogic 915 MHz medium range radio modems that are legal for licence free use in North America
- User - Allows user configuration of the radio communications baud rate and hardware handshaking for a custom radio solution. Selecting this option will enable the DGPS Baud and Handshaking menus within the Setup menu.
- 2.4 GHz - Refers to Racelogic 2.4 GHz short range radio modems that are legal for licence free use worldwide

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Post Firmware version 2.8 (compatible with VBBS4RG and later models only)

This allows user configuration of the radio communications baud rate and hardware handshaking.

DGNSS Baud

This setting allows for a compatible serial baud rate to be set to communicate with a radio. The available kbit/s rates are shown below:

- 1200
- 4800
- 9600
- 19200
- 38400
- 57600
- 115200

Handshaking

This setting allows for hardware handshaking to be turned ‘ON’ or ‘OFF’ when communicating with a radio. It is recommended that hardware handshaking be used where possible to prevent buffer overflows on the radio modem. If data is lost in this way then the transmission of partial correction messages may affect the performance of the rover unit and result in differential dropouts.

Elevation Mask

This allows a user configurable elevation mask to be set within the Base Station. Values of 5, 10, 15 or 20° can be set. The default setting is 5°.

DGPS Baud (pre Firmware 2.8)

This setting is only available when the ‘RADIO MODE’ is set to ‘USER’. It allows for a compatible serial baud rate to be set to communicate with a custom radio modem configuration. The available kbit/s rates are below.

- 1200
- 4800
- 9600
- 19200
- 38400
- 57600
- 115200

Handshaking (pre Firmware 2.8)

This setting is only available when the ‘RADIO MODE’ is set to ‘USER’. It allows for hardware handshaking to be turned ‘ON’ or ‘OFF’ when communicating with a custom radio modem configuration. It is recommended that hardware handshaking be used where possible to prevent buffer overflows on the radio modem. If data is lost in this way then the transmission of partial correction messages may affect the performance of the rover unit and result in differential dropouts.

Batt/Volt Mon (pre Firmware 2.13)

This allows the user to view two displays (using the < and > buttons) which provide status and fault indication for the power supply and battery charging circuits. If the operation of the Base Station battery charge and discharge functions are not operating as expected then you may be asked to provide information from these screens by Racelogic Support in order to help diagnose any possible fault.

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Enter Location

The 'ENTER LOCATION' option allows the user to manually enter the latitude and longitude in degrees and minutes and the altitude in metres. This option is useful when the Base Station antenna is being sited in a position that is known or has been surveyed.

Update Position

By selecting this option the values that have been entered for latitude, longitude and altitude in the other 'Enter Location' options are set as the reference location for the GNSS receiver antenna.

Latitude

This allows the user to define a latitude in the format DD°MM.mmmmm and suffixed by N for North or S for South. For example: 50°59.37252 N

Longitude

This allows the user to define a longitude in the format DDD°MM.mmmmm and suffixed by E for East or W for West. For example: 000°59.48398 W

Altitude

This allows the user to define an altitude in the format MMMMM.mm and is prefixed by a sign (+ or -) and suffixed by M for the unit metres. For Example: +00155.61 M

Live Location

The 'LIVE LOCATION' option allows the user to view the current latitude and longitude in degrees and minutes and the altitude in metres.

Satellites

This gives a bar graph representation of the number of satellites that are being tracked with one block representing each satellite.

Latitude

This displays the current latitude in the format DD°MM.mmmmm and is suffixed by N for North or S for South.

Longitude

This displays the current longitude in the format DDD°MM.mmmmm and is suffixed by E for East or W for West.

Altitude

This displays the current altitude in the format MMMMM.mm and is prefixed by a sign (+ or -) and suffixed by M for the unit metres.
Load Location

The **LOAD LOCATION** option is used to load a previously stored reference position from memory. A location is stored using the **STORE LOCATION** function described below.

Store Location

'**STORE LOCATION**' allows the user to store the position that has been obtained via 'SET TO CURRENT' or 'SET TO AVERAGE', or set using 'ENTER LOCATION' for use at a later date. This is useful if the Base Station is used in a number of different locations on a regular basis. It is also possible to give the location a meaningful name before it is stored. To do this, select '**STORE LOCATION**' and then press 'OK'. Use the arrow buttons to select an unused memory location and then press 'OK' again. The display should now show the location name with a flashing cursor at the beginning of the name. Use the arrow keys to select a letter and then press OK to move on to the next character position. Repeat this until the new name is complete. The Base Station can store a total of 25 unique locations.

Set to Current

The 'SET TO CURRENT' option can be used when the Base Station is required to be setup and operational as quickly as possible. It allows a DGPS reference point to be marked almost immediately after satisfactory satellite lock is achieved. Using this option will give relative positional stability during the period that equipment is being used, but with an offset of the absolute position on earth. 'SET TO CURRENT' should only be used where absolute positional accuracy is not important and all that is required is positional stability.

Set to Average

The 'SET TO AVERAGE' option should normally be used to set a DGPS reference position. You can choose to average the location over 5 minutes, 12 hours or 24 hours. The display will state the number of seconds remaining in the averaging process. Using this option ensures that a good average of the current position has been obtained. Press 'OK' to abort at any time.

*Note: From Firmware version 2.8 onwards (compatible with VBBS4RG only), when an averaging is in process, DGPS corrections are not transmitted.*

If a 24 hour average is being used then it is recommended that the Base Station be powered from an external source as if the battery power is depleted before the average is complete then the average data will be lost.

To obtain the best absolute positional accuracy a 24 hour average is recommended, however this only needs to be done once for a test site and can then be stored and recalled, so long as the GPS antenna is returned to exactly the same position for all subsequent uses.

After this time period, the Base Station computes an average of the latitude, longitude and height and then uses that as

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it’s reference position. This typically results in a reference position that will be within 10 cm of the true absolute earth location.

Exit

Selecting this option exits from the configuration menus back to the status display.
The status display is used to show the operating status of the Base Station including satellite lock, internal battery condition and location information.

After powering up the Base Station, the display will initially show the unit serial number and firmware version, then an initialisation screen with a 60 second countdown.

If the Base Station has no satellite reception fix within the initialisation period then a flashing zeros satellite count will be displayed and the message 'WAITING FOR STABLE SAT LOCK' will scroll across the bottom of the display. If the Base Station is tracking satellites but does not yet have a fix then it will flash the number of satellites being tracked instead of zeros.

When the Base Station attains a positional fix, if it is located in a different position than it was last used it will display a 'LOCATION MISMATCH' message. This indicates that the position of the Base Station must be set using a current, average, stored, or user entered location.

If the GPS antenna is located in the same location as the last time the Base Station was used then ‘LOCATION SET OK’ will be displayed to show that there is a set position and is ready to use. This should be used with caution as the previous position may have been set using ‘SET TO CURRENT’ which would give an offset in absolute position as compared to a ‘SET TO AVERAGE’. Also, if the antenna has been positioned near to, but not in the same place as it was previously sited it will give a positional offset equal to the location offset.
The ‘LOCATION SET OK’ message can be cleared by pressing the ‘OK’ button. The live satellite count is then displayed. This count will be for all constellations that the Base Station is able to track. So for a VBBS4RG unit this will be the total number of GPS and GLONASS satellites combined.

By using the '<' and '>' buttons various status screens can be viewed. These show the averaged or set position of the GPS antenna and NOT the live positional parameters. The first of these screens displays Altitude in metres to 1 cm resolution.

The next screen shows the longitudinal coordinate in the format DDD°MM.mmmmm to a resolution of 0.00001 minutes. The coordinate is suffixed with an E or W to indicate if the coordinate is East or West of the prime meridian.

The next screen shows the latitudinal coordinate in the format DD°MM.mmmmm to a resolution of 0.00001 minutes. The coordinate is suffixed with an N or S to indicate North or South of the equator.

The last screen shows the location name if the location being used is a stored and named location.
10 - Base Station Receiving Local DGPS

In order to receive DGPS corrections from the Base Station, the VBOX will need to be connected to a Racelogic telemetry modem that matches the type used in the Base Station setup. Example connections for VBOX 3i and VBOX II are as follows.

Hardware Configuration

Example of Local DGPS operation with VBOX 3i

VBOX receives RTCM correction data from radio module. Radio module acts as receiver for information transmitted by Racelogic DGPS Base Station.
Example of Local DGPS operation with VBOX II

VBOX receives RTCM correction data from radio module. Radio module acts as receiver for information transmitted by Racelogic DGPS Base Station.

Racelogic also provide solutions to use SATEL radio modems for long range applications on large test sites. The connection to the VBOX will be the same in this instance, but an RLCAB096L would be used which has a 15 way D-Sub connector for connection to the SATEL radio modem.

Software Configuration

In addition to connecting the radio modem to the VBOX, it is also necessary to inform the GPS engine that it must use the correction data in its calculations.

VBOX Tools and VBOX Setup software has options to enable the DGPS corrections in any VBOX II, VBOX III or VBOX 3i connected to it. The mode selection will be chosen to reflect the Base Station mode that is being used, and the baud rate to reflect the type of radio modems and data baud rate being used. If your VBOX is not enabled for RTK (2 cm) or 20 cm then this will not work and an error message will confirm this. Once configured, you can then close the software program before disconnecting the VBOX.

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VBOX Tools

To enable DGPS in a VBOX II, VBOX III or VBOX 3i, simply run the VBOX Tools software with the VBOX connected to the required COM port as usual, and then click on ‘VBOX Setup’.

The software will take a few seconds to communicate with the VBOX and open the VBOX Setup screen shown on the right. Once this appears, click on ‘GPS’, and then set the correct DGPS ‘Mode’ and ‘DGPS port RS232 Baud rate’ as shown in the drop down menus.

VBOX Setup

To enable DGPS in a VBOX II, VBOX III or VBOX 3i, simply run the VBOX Setup software and select the COM port that the VBOX is connected to. VBOX Setup then automatically connects to the selected device.

The software will take a few seconds to communicate with the VBOX and open the VBOX Setup screen shown on the right. Once this appears, click on ‘GPS’, and then on the ‘Settings’ tab set the correct DGPS ‘Mode’ and ‘RS232 baud rate’ shown in the area highlighted red.

VBOX Manager Configuration

A VBOX Manager can also be used to enable the correct DGPS mode. Within the menu, enter ‘SETUP’, select ‘VBOX’ and then ‘DGPS MODE’. Select the correct DGPS mode from the available options. Select ‘BACK’ and then select ‘DGPS RS232 RATE’ within the ‘VBOX’ menu. Choose the correct DGPS baud rate and select ‘EXIT’ to return to main menu.

https://racelogic.support/01VBOX_Automotive/05Telemetry_Systems/Base_Station/
Checking that you have DGPS Lock

VBOX Tools

No data

2 cm RTK fix

Receiving data but not yet fixed

Differential fix

https://racelogic.support/01VBOX_Automotive/05Telemetry_Systems/Base_Station/
VBOX Test Suite

0

No data

1

GNSS fix

2

GNSS DGPS (inc RTCMv2 40 cm) fix

3

Receiving data but not yet fixed

4

2 cm RTK fix

https://racelogic.support/01VBOX_Automotive/05Telemetry_Systems/Base_Station/
From approximately July 2004, all VBOX units have been shipped with DGPS reception enabled. However, VBOX units supplied before this date will require a small hardware modification to be carried out by Racelogic to accept the DGPS information via the radio modem. Please contact Racelogic for more information.
11 - Base Station Using User Supplied Radio Modems

Any radio modem can be connected to a Base Station to send out DGPS correction messages. You can connect these radios to the base station via:

1. The internal RS232 D-sub connector beneath the front panel
2. The internal Molex connector beneath the front panel
3. The external waterproof Bulgin connector

The connections in each of these positions are the same, and so only one radio should be connected at any one time to any of these connectors.

Pre Firmware version 2.8

For all radios, to configure the radio type and baud rate:

1. Press the ‘OK’ button on the front panel
2. Choose ‘Setup’ and press ‘OK’
3. Choose ‘Radio Mode’ and press ‘OK’
4. Choose ‘User’ and press ‘OK’
5. Having chosen a user supplied radio modem mode, there is now an additional option to select: DGPS Baud and Hardware Handshaking
6. Select ‘DGPS Baud’ and press ‘OK’
7. Choose the baud rate at which your radio modem is configured to communicate and press ‘OK’
8. Select ‘Handshaking’ and press ‘OK’
9. Choose whether hardware handshaking should be ‘On’ or ‘Off’ and press ‘OK’
10. Exit from the menus and follow the instructions on previous pages for normal operation

Post Firmware version 2.8

For all radios, to configure the baud rate:

1. Press the ‘OK’ button on the front panel
2. Choose ‘Setup’ and press ‘OK’
3. Choose ‘Radio Setup’ and press ‘OK’
4. There are now two further options to select: DGPS Baud and Hardware Handshaking

https://racelogic.support/01VBOX_Automotive/05Telemetry_Systems/Base_Station/
5. Select ‘**DGPS Baud**’ and press ‘**OK**’

6. Choose the baud rate at which your radio modem is configured to communicate and press ‘**OK**’

7. Select ‘**Handshaking**’ and press ‘**OK**’

8. Choose whether hardware handshaking should be ‘On’ or ‘Off’ and press ‘**OK**’

9. Exit from the menus and follow the instructions on previous pages for normal operation
There are several modes that allow the location of the Base Station to be set or surveyed, and the way these are used determines the type of positional accuracy and stability that is achieved. The amount of drift that is seen in the position of a roving receiver using the Base Station corrections is relative to the DGPS mode that is being used. For example, if RTCM 40 cm 95 % CEP is being used, then the rover position will drift no more than 40 cm from its relative position 95 % of the time.

Likewise for RTK 2 cm 95 % CEP, this will not drift more than 2 cm from its relative position 95 % of the time. The important word to note in this statement is relative. The Base Station provides drift corrections to the rover based on the positional information that has been set; so if the position that has been set in the Base Station is offset from the actual absolute position on earth then this offset will also be present in the rover position.

There are two positional plots below to illustrate this point below. The graph on the left shows a drive around a marked circle at different times of the day using 20 cm 95 % CEP DGPS corrections from a Base Station with a 24 hour averaged position that has been stored. You can see that the position of each circuit is in close proximity and that the positional error is due only to the 20 cm drift in relative accuracy.

The plot on the right shows the same drive logged immediately after each of the first plots, but with the Base Station position set using 'SET TO CURRENT' before each circuit. While the relative positional data for each individual circuit is stable to a 20 cm radius, a positional shift of nearly 2 m can be seen between the green and red plots. So in this case where a geographical feature is being referenced and data is being collected during different test sessions (even without the Base Station antenna being moved), this 'SET TO CURRENT' method is not suitable.

However, it should be noted that if the 'SET TO CURRENT' location had been stored and reused for each measurement; the results would have looked almost identical to those of the averaged position. This makes 'SET TO CURRENT' a perfectly valid method for comparing data with relative positioning from different test sessions. The difference would have shown when comparing the absolute geographical positions of the two sets of data.

The 'SET TO CURRENT' data would have had a positional offset as compared to the 'SET TO AVERAGE' data, and this is the important thing to keep in mind as it can cause problems if forgotten. For example, If the extents of a circuit were mapped not using the same location corrections as those being used during testing, the lines taken by the vehicle and the extents of the circuit could be misaligned by several metres.
The same effect of offsetting would be seen if an averaged position was used but the Base Station GPS antenna was not placed in the same position as the original average was taken. Any error in locating the antenna would be translated into the correction at the rover. It should also be noted that any error in a manually set location as compared to the actual position would result in the same type of error in the correction.

A similar effect to the right hand plot would be produced if stored location was used but without correctly locating the GPS antenna in the same position for each use. This is why it is important to mark the physical location carefully if you intend to reuse it.
### 13 - Base Station Battery and Charging Status

#### Front Panel LED

The following table describes the states of the charge status LED located on the front panel.

<table>
<thead>
<tr>
<th>Colour</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>No external power is connected and the unit is either switched off or running off the internal battery.</td>
</tr>
<tr>
<td></td>
<td>Unit is connected to a power supply and fast charging is complete or the battery does not need fast charging.</td>
</tr>
<tr>
<td></td>
<td>Unit is connected to a power supply and the battery is fast charging.</td>
</tr>
<tr>
<td></td>
<td>There is a fault with the charging circuit. Please contact Racelogic for support.</td>
</tr>
</tbody>
</table>

[https://racelogic.support/01VBOX_Automotive/05Telemetry_Systems/Base_Station/](https://racelogic.support/01VBOX_Automotive/05Telemetry_Systems/Base_Station/)
LCD Display

The following table describes the symbols showing battery and charging status in the top right corner of the display when the Base Station is switched on.

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td><img src="https://racelogic.support/01VBOX_Automotive/05Telemetry_Systems/Base_Station/" alt="Symbol 1" /></td>
<td>Unit is connected to a power supply and the battery is fast charging.</td>
</tr>
<tr>
<td><img src="https://racelogic.support/01VBOX_Automotive/05Telemetry_Systems/Base_Station/" alt="Symbol 2" /></td>
<td>Unit is connected to a power supply and fast charging is complete.</td>
</tr>
<tr>
<td><img src="https://racelogic.support/01VBOX_Automotive/05Telemetry_Systems/Base_Station/" alt="Symbol 3" /></td>
<td>Unit is running from internal battery power and has between 75 % and 100 % charge remaining.</td>
</tr>
<tr>
<td><img src="https://racelogic.support/01VBOX_Automotive/05Telemetry_Systems/Base_Station/" alt="Symbol 4" /></td>
<td>Unit is running from internal battery power and has between 50 % and 75 % charge remaining.</td>
</tr>
<tr>
<td><img src="https://racelogic.support/01VBOX_Automotive/05Telemetry_Systems/Base_Station/" alt="Symbol 5" /></td>
<td>Unit is running from internal battery power and has between 25 % and 50 % charge remaining.</td>
</tr>
<tr>
<td><img src="https://racelogic.support/01VBOX_Automotive/05Telemetry_Systems/Base_Station/" alt="Symbol 6" /></td>
<td>Unit is running from internal battery power and has between 0 % and 25 % charge remaining.</td>
</tr>
</tbody>
</table>
Flashing symbol. Unit is running from internal battery power and the battery charge is almost depleted. A power supply should be connected immediately to charge the battery.

There is a fault with the battery or battery charging circuitry. You should contact Racelogic support department if this symbol appears.
### 14 - Base Station Compatibility Matrix

#### VBOX Data Loggers

<table>
<thead>
<tr>
<th></th>
<th>SBAS (WAAS / EGNOS) DGPS</th>
<th>RTCM v2 40 cm (95 % CEP) DGPS</th>
<th>RL 20 cm (95 % CEP) DGPS (VBBS2*/VBBS4* only)</th>
<th>RL 2 cm (95 % CEP) RTK (VBBS3G*/VBBS4RG*/VBBS5 only)</th>
<th>RTCM v3 or CMR 2 cm (95 % CEP) (VBBS4RG*/VBBS5/VBBS6 only)</th>
<th>RTCM v3.2 MSM4 or MSM7 2 cm (95 % CEP) (VBBS6 only)</th>
</tr>
</thead>
<tbody>
<tr>
<td>VBOX Mini</td>
<td>✗</td>
<td>✗</td>
<td>✗</td>
<td>✗</td>
<td>✗</td>
<td>✗</td>
</tr>
<tr>
<td>VBOX Lite</td>
<td>✓</td>
<td>✗</td>
<td>✗</td>
<td>✗</td>
<td>✗</td>
<td>✗</td>
</tr>
<tr>
<td>VBOX II DCF</td>
<td>✓</td>
<td>✓</td>
<td>✗</td>
<td>✗</td>
<td>✗</td>
<td>✗</td>
</tr>
<tr>
<td>VBOX IIIS</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✗</td>
<td>✗</td>
<td>✗</td>
</tr>
<tr>
<td>VBOX IISX</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✗</td>
<td>✗</td>
<td>✗</td>
</tr>
<tr>
<td>VBOX 20SL</td>
<td>✓</td>
<td>✓</td>
<td>✗</td>
<td>✗</td>
<td>✗</td>
<td>✗</td>
</tr>
<tr>
<td>VBOX 20SL3</td>
<td>✓</td>
<td>✓</td>
<td>✗</td>
<td>✗</td>
<td>✗</td>
<td>✗</td>
</tr>
<tr>
<td>VBOX 3 and 3i</td>
<td>✓</td>
<td>✓</td>
<td>✗</td>
<td>✗</td>
<td>✗</td>
<td>✗</td>
</tr>
</tbody>
</table>

https://racelogic.support/01VBOX_Automotive/05Telemetry_Systems/Base_Station/
<table>
<thead>
<tr>
<th></th>
<th>SBAS (WAAS / EGNOS) DGPS</th>
<th>RTCM v2 40 cm (95% CEP) DGPS</th>
<th>RL 20 cm (95% CEP) DGPS (VBBS2*/VBBS4* only)</th>
<th>RL 2 cm (95% CEP) RTK (VBBS3G*/VBBS4RG*/VBBS5 only)</th>
<th>RTCM v3 or CMR 2 cm (95% CEP) (VBBS4RG*/VBBS5/ VBBS6 only)</th>
<th>RTCM v3.2 MSM4 or MSM7 2 cm (95% CEP) (VBBS6 only)</th>
</tr>
</thead>
<tbody>
<tr>
<td>VBOX 3i R2G2</td>
<td>✓</td>
<td>✓</td>
<td>x</td>
<td>x</td>
<td>✓</td>
<td>x</td>
</tr>
<tr>
<td>VBOX 3i R10G10</td>
<td>✓</td>
<td>✓</td>
<td>x</td>
<td>x</td>
<td>✓</td>
<td>x</td>
</tr>
<tr>
<td>VBOX 3i SL RTK</td>
<td>✓</td>
<td>✓</td>
<td>x</td>
<td>x</td>
<td>✓</td>
<td>x</td>
</tr>
</tbody>
</table>

**Speed Sensors**

<table>
<thead>
<tr>
<th></th>
<th>SBAS (WAAS / EGNOS) DGPS</th>
<th>RTCM v2 40 cm (95% CEP) DGPS</th>
<th>RL 20 cm (95% CEP) DGPS (VBBS2*/VBBS4* only)</th>
<th>RL 2 cm (95% CEP) RTK (VBBS3G*/VBBS4RG*/VBBS5 only)</th>
<th>RTCM v3 or CMR 2 cm (95% CEP) (VBBS4RG*/VBBS5/ VBBS6 only)</th>
<th>RTCM v3.2 MSM4 or MSM7 2 cm (95% CEP) (VBBS6 only)</th>
</tr>
</thead>
<tbody>
<tr>
<td>VBOX 5 Hz Speed Sensor</td>
<td>✓</td>
<td>✓</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
</tr>
<tr>
<td>VBOX 10 Hz &amp; 20 Hz Speed Sensors</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>x</td>
<td>x</td>
<td>x</td>
</tr>
<tr>
<td>VBOX 100 Hz Speed Sensor</td>
<td>✓</td>
<td>✓</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
</tr>
<tr>
<td>VBOX 100 Hz R10G10 Speed Sensor</td>
<td>✓</td>
<td>✓</td>
<td>x</td>
<td>✓</td>
<td>✓</td>
<td>x</td>
</tr>
</tbody>
</table>

[https://racelogic.support/01VBOX_Automotive/05Telemetry_Systems/Base_Station/](https://racelogic.support/01VBOX_Automotive/05Telemetry_Systems/Base_Station/)
<table>
<thead>
<tr>
<th></th>
<th>SBAS (WAAS / EGNOS) DGPS</th>
<th>RTCM v2 40 cm (95 % CEP) DGPS</th>
<th>RL 20 cm (95 % CEP) DGPS (VBBS2*/ VBBS4* only)</th>
<th>RL 2 cm 95 % CEP RTK (VBBS3G*/ VBBS5 only)</th>
<th>RTCM v3 or CMR 2 cm (95 % CEP) (VBBS4RG*/ VBBS5/ VBBS6 only)</th>
<th>RTCM v3.2 MSM4 or MSM7 2 cm (95 % CEP) (VBBS6 only)</th>
</tr>
</thead>
<tbody>
<tr>
<td>VBOX IISX 20 Hz Speed Sensor</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>VBOX 3iS</td>
<td>✓</td>
<td>✓</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>VBOX 3iSR</td>
<td>✓</td>
<td>✓</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Video Loggers**

<table>
<thead>
<tr>
<th></th>
<th>SBAS (WAAS / EGNOS) DGPS</th>
<th>RTCM v2 40 cm (95 % CEP) DGPS</th>
<th>RL 20 cm (95 % CEP) DGPS (VBBS2*/ VBBS4* only)</th>
<th>RL 2 cm 95 % CEP RTK (VBBS3G*/ VBBS5 only)</th>
<th>RTCM v3 or CMR 2 cm (95 % CEP) (VBBS4RG*/ VBBS5/ VBBS6 only)</th>
<th>RTCM v3.2 MSM4 or MSM7 2 cm (95 % CEP) (VBBS6 only)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Video VBOX Pro</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>VBOX Video HD2</td>
<td>✓</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Video VBOX Lite</td>
<td>✓</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Video VBOX Waterproof</td>
<td>✓</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

https://racelogic.support/01VBOX_Automotive/05Telemetry_Systems/Base_Station/
Key:

- = Compatible
- = Compatible with upgrade
- = Not compatible
* = Legacy product

https://racelogic.support/01VBOX_Automotive/05Telemetry_Systems/Base_Station/
15 - Base Station Technical Properties

Base Station Antenna Technical Specification

Base Station Technical Specification

Base Station PIN OUTS

Base Station Upgrade Firmware

https://racelogic.support/01VBOX_Automotive/05Telemetry_Systems/Base_Station/
2.4 GHz 5 dBi Base Station Antenna with LMR400 cable (PA0545LMR400)

The antenna is designed for wireless networks on 2.4 GHz band. Having a high gain and performance it can be customized with a particular selection of cable length and your choice of connector.

### Mechanical

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Termination</strong></td>
<td>Time microwave cable LMR400 with ‘N’ type crimp plug</td>
</tr>
<tr>
<td><strong>Protection</strong></td>
<td>Direct grounded</td>
</tr>
<tr>
<td><strong>Weight</strong></td>
<td>0.5 kg</td>
</tr>
<tr>
<td><strong>Length</strong></td>
<td>580 mm</td>
</tr>
<tr>
<td><strong>Radome</strong></td>
<td>Parallel glass fibre tube, white, 26 mm</td>
</tr>
<tr>
<td><strong>Mounting</strong></td>
<td>Integral diecast aluminium alloy LM6</td>
</tr>
<tr>
<td><strong>Fasteners</strong></td>
<td>M8 V bolts stainless steel</td>
</tr>
<tr>
<td><strong>Impedance</strong></td>
<td>50 Ohms (nominal)</td>
</tr>
</tbody>
</table>

https://racelogic.support/01VBOX_Automotive/05Telemetry_Systems/Base_Station/
## Electrical

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Specification</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gain</td>
<td>Time microwave cable LMR400 with ‘N’ type crimp plug</td>
</tr>
<tr>
<td>Impedance</td>
<td>50 Ohms (nominal)</td>
</tr>
<tr>
<td>Return loss</td>
<td>Better than -14 dB (at 2400–2483 MHz)</td>
</tr>
<tr>
<td>VSWR</td>
<td>Better than 1.5:1 (at 2400–2483 MHz)</td>
</tr>
<tr>
<td>Bandwidth</td>
<td>10% (approximate)</td>
</tr>
<tr>
<td>Maximum Power</td>
<td>25 W continuous</td>
</tr>
<tr>
<td>E Plane BW</td>
<td>33°</td>
</tr>
</tbody>
</table>

![Radiation Pattern E-Plane](https://racelogic.support/01VBOX_Automotive/05Telemetry_Systems/Base_Station/)

![Radiation Pattern H-Plane](https://racelogic.support/01VBOX_Automotive/05Telemetry_Systems/Base_Station/)
Base Station PIN OUTS

Connector 1 - POWER (Lemo 2 PIN)

<table>
<thead>
<tr>
<th>PIN</th>
<th>I/O</th>
<th>Function</th>
<th>Range</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>I</td>
<td>Power+</td>
<td>7 - 18 V</td>
</tr>
<tr>
<td>2</td>
<td>I</td>
<td>Ground</td>
<td>0 V</td>
</tr>
</tbody>
</table>

https://racelogic.support/01VBOX_Automotive/05Telemetry_Systems/Base_Station/
## Connector 2 - RS232 (9 PIN SUB-D)

![RS232 Connector Diagram]

<table>
<thead>
<tr>
<th>PIN</th>
<th>I/O</th>
<th>Function</th>
<th>Range</th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
<td>O</td>
<td>RS232 Transmit</td>
<td>+/- 12 V</td>
</tr>
<tr>
<td>3</td>
<td>I</td>
<td>RS232 Receive</td>
<td>+/- 12 V</td>
</tr>
<tr>
<td>5</td>
<td>I</td>
<td>Ground</td>
<td>0 V</td>
</tr>
</tbody>
</table>

[https://racelogic.support/01VBOX_Automotive/05Telemetry_Systems/Base_Station/](https://racelogic.support/01VBOX_Automotive/05Telemetry_Systems/Base_Station/)
Connector 3 - Power / RS232 (8 PIN Bulgin)

<table>
<thead>
<tr>
<th>PIN</th>
<th>I/O</th>
<th>Function</th>
<th>Range</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>O</td>
<td>RS232 RTS</td>
<td>+/- 12 V</td>
</tr>
<tr>
<td>2</td>
<td>O</td>
<td>RS232 Transmit</td>
<td>+/- 12 V</td>
</tr>
<tr>
<td>3</td>
<td>I</td>
<td>RS232 Receive</td>
<td>+/- 12 V</td>
</tr>
<tr>
<td>4</td>
<td>O</td>
<td>External Radio Power +</td>
<td>Vin</td>
</tr>
<tr>
<td>5</td>
<td></td>
<td>RS232 Ground</td>
<td>0V</td>
</tr>
<tr>
<td>6</td>
<td>I</td>
<td>Power +</td>
<td>Typically 19 V (30 V Max)</td>
</tr>
<tr>
<td>7</td>
<td>I</td>
<td>RS232 CTS</td>
<td>+/- 12 V</td>
</tr>
<tr>
<td>8</td>
<td></td>
<td>Power in/out Ground</td>
<td>0 V</td>
</tr>
</tbody>
</table>

Note: It is possible to power/charge the Base Station with the lid down using PIN 6 for power and PIN 8 for ground.

https://racelogic.support/01VBOX_Automotive/05Telemetry_Systems/Base_Station/
# Base Station Technical Specification

## Output Messages

### RTCM v3.2 MSM7 Messages Rate (VBBS6 only)

<table>
<thead>
<tr>
<th>Type</th>
<th>Description</th>
<th>Rate</th>
</tr>
</thead>
<tbody>
<tr>
<td>1006</td>
<td>Stationary RTK Reference Station ARP plus the Antenna Height</td>
<td>10 s</td>
</tr>
<tr>
<td>1008</td>
<td>Antenna Descriptor and Serial Number</td>
<td>10 s</td>
</tr>
<tr>
<td>1033</td>
<td>Receiver and Antenna Description</td>
<td>10 s</td>
</tr>
<tr>
<td>1230</td>
<td>GLONASS bias information</td>
<td>10 s</td>
</tr>
<tr>
<td>4091</td>
<td>Topcon Positioning Systems Proprietary</td>
<td>10 s</td>
</tr>
<tr>
<td>1077</td>
<td>GPS MSM7 containing L1 C/A, L2 C and L1/L2 P(Y) data</td>
<td>1 s*</td>
</tr>
<tr>
<td>1087</td>
<td>GLONASS MSM7 containing G1 and G2 C/A data</td>
<td>1 s*</td>
</tr>
<tr>
<td>1097</td>
<td>GALILEO MSM7 containing E1 and E5a, E5b and E5(a+b) data</td>
<td>1 s*</td>
</tr>
<tr>
<td>1127</td>
<td>BeiDou MSM7 containing B1 and B2 data</td>
<td>1 s*</td>
</tr>
</tbody>
</table>

* 2 s when set to 0.5 Hz update rate.

[Link to RACelogic Support](https://racelogic.support/01VBOX_Automotive/05Telemetry_Systems/Base_Station/)
## RTCM v3.2 MSM4 Messages Rate (VBBS6 only)

<table>
<thead>
<tr>
<th>Type</th>
<th>Description</th>
<th>Rate</th>
</tr>
</thead>
<tbody>
<tr>
<td>1006</td>
<td>Stationary RTK Reference Station ARP plus the Antenna Height</td>
<td>10 s</td>
</tr>
<tr>
<td>1008</td>
<td>Antenna Descriptor and Serial Number</td>
<td>10 s</td>
</tr>
<tr>
<td>1033</td>
<td>Receiver and Antenna Description</td>
<td>10 s</td>
</tr>
<tr>
<td>1230</td>
<td>GLONASS bias information</td>
<td>10 s</td>
</tr>
<tr>
<td>4091</td>
<td>Topcon Positioning Systems Proprietary</td>
<td>10 s</td>
</tr>
<tr>
<td>1074</td>
<td>GPS MSM4 containing L1 C/A, L2 C and L1/L2 P(Y) data</td>
<td>1 s*</td>
</tr>
<tr>
<td>1084</td>
<td>GLONASS MSM4 containing G1 and G2 C/A data</td>
<td>1 s*</td>
</tr>
<tr>
<td>1094</td>
<td>GALILEO MSM4 containing E1 and E5a, E5b and E5(a+b) data</td>
<td>1 s*</td>
</tr>
<tr>
<td>1124</td>
<td>BeiDou MSM4 containing B1 and B2 data</td>
<td>1 s*</td>
</tr>
</tbody>
</table>

* 2 s when set to 0.5 Hz update rate.

[https://racelogic.support/01VBOX_Automotive/05Telemetry_Systems/Base_Station/](https://racelogic.support/01VBOX_Automotive/05Telemetry_Systems/Base_Station/)
RTCM v3 Messages Rate (VBBS4RG/VBBS5/VBBS6 only)

<table>
<thead>
<tr>
<th>Type</th>
<th>Description</th>
<th>Rate</th>
</tr>
</thead>
<tbody>
<tr>
<td>1004</td>
<td>Extended L1&amp;L2 GPS RTK Observables for GPS RTK Use</td>
<td>1 s</td>
</tr>
<tr>
<td>1006</td>
<td>Stationary RTK Reference Station ARP plus the Antenna Height</td>
<td>10 s</td>
</tr>
<tr>
<td>1008</td>
<td>Antenna Descriptor and Serial Number</td>
<td>10 s</td>
</tr>
<tr>
<td>1012</td>
<td>Extended L1&amp;L2 GLONASS RTK Observables</td>
<td>1 s</td>
</tr>
</tbody>
</table>

CMR Message Rate (VBBS4RG/VBBS5 only)

<table>
<thead>
<tr>
<th>Type</th>
<th>Description</th>
<th>Rate</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>GPS Measurements</td>
<td>1 s</td>
</tr>
<tr>
<td>1</td>
<td>Reference Station Coordinates</td>
<td>10 s</td>
</tr>
<tr>
<td>3</td>
<td>GLONASS Measurements</td>
<td>1 s</td>
</tr>
</tbody>
</table>

RTCM v2 Messages Rate

<table>
<thead>
<tr>
<th>Type</th>
<th>Description</th>
<th>Rate</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Differential GPS Corrections</td>
<td>1 s</td>
</tr>
<tr>
<td>3</td>
<td>GPS Reference Station Parameters</td>
<td>10 s</td>
</tr>
<tr>
<td>31</td>
<td>Differential GLONASS Corrections (VBBS4RG/VBBS5 only)</td>
<td>1 s</td>
</tr>
<tr>
<td>32</td>
<td>GLONASS Reference Station Parameters (VBBS4RG/VBBS5 only)</td>
<td>10 s</td>
</tr>
</tbody>
</table>
## Temperature

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Storage</strong></td>
<td>-40°C to +50°C</td>
</tr>
<tr>
<td><strong>Operating</strong></td>
<td>0 – 45°C</td>
</tr>
<tr>
<td><strong>Limits for battery fast charge</strong></td>
<td>10 – 50°C</td>
</tr>
</tbody>
</table>

## Power

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Battery Life</strong></td>
<td>24 hours</td>
</tr>
<tr>
<td><strong>Input voltage range</strong></td>
<td>8 – 30 V</td>
</tr>
<tr>
<td><strong>Input Current</strong></td>
<td>Operating and charging (@19 V): 2.25 A</td>
</tr>
<tr>
<td></td>
<td>Operating and not charging (@19 V): &lt;0.5 A</td>
</tr>
</tbody>
</table>

## Radio Modem

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Frequency – Europe</strong></td>
<td>868 MHz</td>
</tr>
<tr>
<td><strong>Frequency – All other countries</strong></td>
<td>915 MHz</td>
</tr>
<tr>
<td><strong>Frequency – Satel</strong></td>
<td>430 MHz</td>
</tr>
<tr>
<td><strong>Power</strong></td>
<td>500 mW</td>
</tr>
<tr>
<td><strong>Max Range – Open area</strong></td>
<td></td>
</tr>
<tr>
<td><em>Obstacles such as trees and buildings will greatly reduce radio range</em></td>
<td>3.5 km (2.2 mi)</td>
</tr>
</tbody>
</table>

[https://racelogic.support/01VBOX_Automotive/05Telemetry_Systems/Base_Station/](https://racelogic.support/01VBOX_Automotive/05Telemetry_Systems/Base_Station/)
### 95 % Circle Error Probable (CEP)

<table>
<thead>
<tr>
<th>Mode</th>
<th>Error (m)</th>
</tr>
</thead>
<tbody>
<tr>
<td>RTCM 40 cm Mode</td>
<td>&lt;0.40 m</td>
</tr>
<tr>
<td>Racelogic 20 cm Mode</td>
<td>&lt;0.20 m</td>
</tr>
<tr>
<td>Racelogic 2 cm Mode</td>
<td>&lt;0.02 m</td>
</tr>
<tr>
<td>CMR 2 cm Mode</td>
<td>&lt;0.02 m</td>
</tr>
</tbody>
</table>

[https://racelogic.support/01VBOX_Automotive/05Telemetry_Systems/Base_Station/](https://racelogic.support/01VBOX_Automotive/05Telemetry_Systems/Base_Station/)
Base Station Upgrade Firmware

From time to time, Racelogic may release new versions of firmware to improve the operation of the Base Station. It is advisable to check the VBOX Automotive website for updates periodically to be sure that you have the latest firmware version.

To upgrade the Base Station, download the latest upgrade file from the VBOX Automotive website. The file will have a `.RUF` file extension. Link the RS232 connector on the base station to the serial port of the PC using the RS232 link cable provided. If you use an external radio, select F/W Update from the FP RS232 Conn Setup menu option. Double click the upgrade file and follow the on-screen instructions.