

## Using the CEESCOPE-R™ with a Motion Sensor and HYPACK® for Personal Watercraft (Jet Ski) Surveys over WiFi

*The CEESCOPE-R™ echo sounder offers a high-power WiFi module and an enhanced motion sensor interface, making it uniquely suited to surveying on a personal watercraft (PWC - Jet Ski). The motion sensor is connected directly to the CEESCOPE-R, with GNSS-aided motion data fully embedded within the proprietary CEE bathymetry data packets and time-stamped for a precise single beam solution when using HYPACK®. GNSS aiding and DC power for the motion sensor are passed out from the CEESCOPE-R creating an elegant configuration requiring the minimum number of interconnecting cables. With RTK GNSS, internal memory data logging, raw GNSS logging for post processing, built-in RTK UHF radio, and the ability to receive network RTK corrections using NTRIP, the CEESCOPE-R is a unique survey package ready to be installed on any third party PWC.*

The CEESCOPE-R™ is ideal for Jet Ski surveying where minimizing the size and number of components is a crucial advantage. The CEESCOPE-R is identical in operation to the standard CEESCOPE™ echo sounder; however, additional features are present to allow the long range and high bandwidth wireless telemetry of data. The CEESCOPE-R has an internal Ethernet switch to increase network flexibility, and Power over Ethernet (POE) output integrated with a Ubiquiti Bullet long-range WiFi radio. Powered by the CEESCOPE-R, the WiFi radio generates a “hot spot” Access Point discoverable by any tablet or PC within range. This means survey data may be acquired using only a small fully-waterproof tablet or even by a second surveyor on the shore. With a high gain antenna installed on the Bullet radio, data telemetry range exceeds 1km when used with the CEE-LINK™ receiving station.

The CEESCOPE-R has a new, more highly integrated motion sensor interface. Users wishing to obtain heave and attitude measurements simply plug a compatible motion sensor (MRU) or Inertial Navigation System (INS) into the CEESCOPE-R; no other cables or connections are needed. High rate RTK position data are passed out to the MRU from the CEESCOPE-R's internal GNSS receiver along with DC power; precise “GNSS aided” motion data are then output back from the MRU to the CEESCOPE-R, recorded internally, and incorporated into the unique CEE data format for acquisition and subsequent processing in HYPACK® acquisition software.

The data messages are as follows:

**CEESCOPE-R™ to MRU:** Selected NMEA 0183 GPS messages at up to 20Hz.

**MRU to CEESCOPE-R™:** TSS1 heave pitch roll attitude output.

In addition to its simple physical connectivity, the data handling approach of the CEESCOPE-R further advances the usefulness of the system for challenging and space-constrained applications such as a PWC. Just like the standard CEESCOPE, the CEESCOPE-R applies a precise millisecond time tag to all data messages, keeping timing exceptionally consistent. HYPACK and Hydromagic software can use this time tag in data acquisition for bathymetry (position and depth) data but currently only HYPACK is able to also acquire motion data using the time-tagged format. The benefit for these types of applications is that WiFi may be used to acquire the data with no concerns about latency or lag errors. The use of the CEE format time tag means there is never a concern about any timing problems when telemetering all bathymetry, position, and attitude data to the acquisition device.



*CEESCOPE-R™ system with internal Trimble RTK GNSS, SBG Systems Ellipse2-E MRU*

An identical dataset may be acquired inside the CEESCOPE internal memory and / or collected by a surveyor on the PWC or elsewhere. HYPACK may be run on the PWC tablet for a conventional acquisition process or the tablet may be used in a more basic approach, merely to control recording of the HYPACK data inside the CEESCOPE – or both approaches can be used simultaneously. While the surveyor on the PWC will likely need to see the survey track in real time, it is possible for the entire dataset to be separately acquired by a second surveyor on the shore.

Alongside the existing built-in UHF radio for RTK corrections, the CEESCOPE-R further enhances the available options for accurate positioning with post processed (PPK) and Network RTK. The CEESCOPE-R adds high-rate 20Hz raw GNSS data recording on its internal memory for a PPK solution using third party software. For network RTK, the CEESCOPE's WiFi interface allows users to simply pass NTRIP corrections from the acquisition device to the CEESCOPE with no cables, serial ports, or additional connections.

When using the SBG Systems Ellipse2-E, motion data specifications are as follows:

- 0.1° Roll and Pitch over 360°
- 0.5° Heading (When connected to GPS)
- 5 cm Real-time Heave, adjusted to the wave period



*Bullet WiFi Radio Installed with Omnidirectional antenna suitable for PWC*



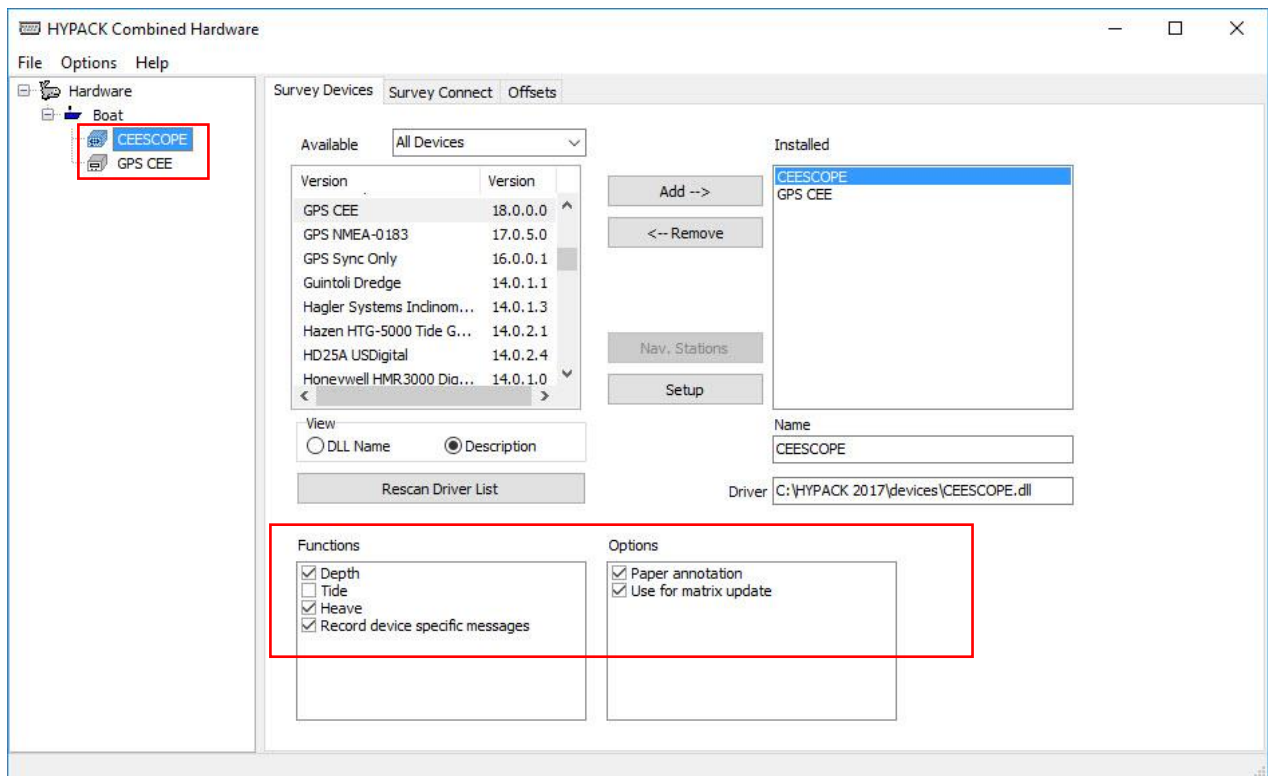
*SBG Systems Ellipse2-E connected to heave / tide port*

The HYPACK drivers for use with the CEESCOPE-R™ over WiFi are the following:

CEESCOPE.DLL:                   2018 version MUST be used.

GPS-CEE:                         Custom GPS driver located in the “custom drivers” folder.

Both drivers use the time stamp applied to the data by the CEESCOPE-R and not the time as received by HYPACK (ie PC time). This is a critical feature to avoid latency errors in the data streamed over WiFi. The CEESCOPE-R accepts heave data in TSS1 format, which is “passed through”. These data may also contain acceleration, pitch, and roll information however the CEESCOPE-R does not use these other data for the depth correction but instead time-stamps and records the motion data for use by the acquisition software.



*HYPACK Hardware configuration for CEESCOPE-R™ with motion sensor such as SBG Ellipse2-E*

The CEESCOPE-R can receive RTK correction data over the WiFi network connection as well as the wired Ethernet LAN, if the connected acquisition PC or tablet is equipped with a cell modem or connected to a cell phone. Survey data are streamed from the CEESCOPE-R to the acquisition device and at the same time, corrections are passing back to the CEESCOPE-R with no requirement for additional cabling. A cell phone or cell modem cannot be connected directly to the CEESCOPE-R. To receive network (or any) RTK corrections, the appropriate RTCM input mode must be selected in the CEESCOPE-R “RTCM” menu.