Surveying in Local Coordinate Systems with RTK Corrections using the CEESCOPE™ or CEE ECHO™ – System Setup Overview

How the CEESCOPE™ uses a built-in RTK GNSS receiver and UHF radio modem to acquire RTK-quality position and elevation that is used in hydrographic surveying software to output xyz point cloud data files of bottom elevations in local coordinates and datums.

Surveyors familiar with collecting point position shots using a GPS / GNSS receiver and data collector, operating on a local UHF or VRS RTK network often are unfamiliar with the process used in hydrographic surveying to collect the same xyz data under water. As highly accurate bathymetric mapping using a precision echo sounder requires collecting many measurements (typically 10-20 soundings per second) and then filtering to ascertain the real bottom elevation, it is not feasible to collect this data using a standard field data collector. Instead, specialist hydrographic software running on a field PC or tablet manages data acquisition on the survey boat – essentially replacing both the data storage and geodetic computation functions of the data collector.

Figure 1. Configuration of the CEESCOPE™ with internal GNSS and UHF radio.

In RTK mode, the CEESCOPE™ may be directly connected to the local UHF base station radio after setting the frequency, channel spacing, and radio compatibility type in the CEESCOPE setup. The internal CEESCOPE GNSS receiver provides

accurate position data at 1-20Hz and the single beam echo sounder records soundings at up to 20Hz. Both data streams, plus any ancillary measurements fed into the unit such as heave, pitch, and roll are precisely time-tagged using a 1PPS signal and then recorded on the CEESCOPE internal memory. Simultaneously, the data are outputted to an acquisition PC or tablet via an Ethernet, Bluetooth, Wi-Fi or RS232 serial connection.

If using the CEE ECHO™ with an external GNSS receiver as shown in Figure 2, RTK-corrected NMEA0183 position information will be fed to the echo sounder from the external GNSS receiver, at the interval selected on the receiver. Except for the use of GPS time for time-stamping the CEE ECHO output data messages instead of 1PPS pulse timing used in the CEESCOPE, the handling and processing of the data is identical downstream of the GNSS and echo sounder data merging together. The CEESCOPE designation from here on in the document may be considered as relating to either CEESCOPE or CEE ECHO.

Figure 2. CEE ECHO™ setup with external GNSS.

The CEESCOPE collects and outputs position data in WGS84 format and displays UTM grid coordinates on its LCD screen. The survey PC running a hydrographic acquisition package such as HYPACK®, HydroMagic, QINSy or HydroPro manages all of the geodetic calculations for the survey, converting data from WGS84 to the desired local coordinate system – essentially replacing the data collector. In addition to managing geodesy and acquiring the data, the software provides a visual display of the boat position, soundings and ancillary detail such as the planned survey lines.

The desired coordinate system is selected in the software, for example NAD-83 State Plane. WGS84 lat / long position data being received from the CEESCOPE is converted into xy coordinates and the boat position is displayed. The CEESCOPE GNSS antenna height above the waterline is entered into the software and the relevant geoid model for the survey area is selected from the software database.

The WGS84 ellipsoidal heights from the CEESCOPE's GNSS are then converted into water surface elevation using the geoid model, after subtracting the antenna offset above the waterline. The water surface elevation above the datum is usually called the "RTK Tide" in the software acquisition packages.

To obtain the final bottom elevation, the software simply subtracts the sounding depth and echo sounder transducer draft from the water surface elevation ("RTK Tide"), to give the bottom elevation. As the survey progresses, an xyz point cloud is generated (up to 20 points per second) in the local coordinate system and datum that may be exported to AutoCAD or other software for further processing, usually after editing and thinning in the hydrographic software package. An example of the hydrographic data collection screen is shown below, with a river bed elevation at approximately 1120m (3670ft) elevation:

Figure 3. Example hydrographic survey software display in RTK mode.

The water surface elevation calculated by the software can be checked against a point shot using a GNSS receiver. The two results should be nearly exactly coincident if all settings are correct in the software, GNSS rover and base station.

If using NTRIP corrections, the CEESCOPE has an RTCM input port that may be connected to PC serial port set to output the appropriate corrections from a broadcaster.