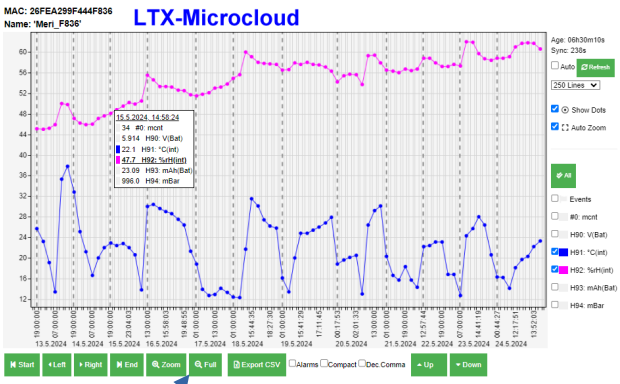
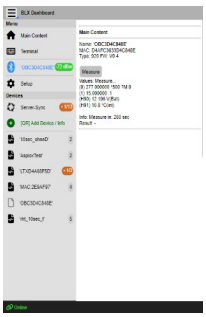
Aquatos OBC

Satellite Gateway for SDI-12, Type 920
Data Sheet and Quick Start Guide

1 Overview



LTX-Microcloud



BLX-Dashboard-APP

Aquatos OBC-MINI

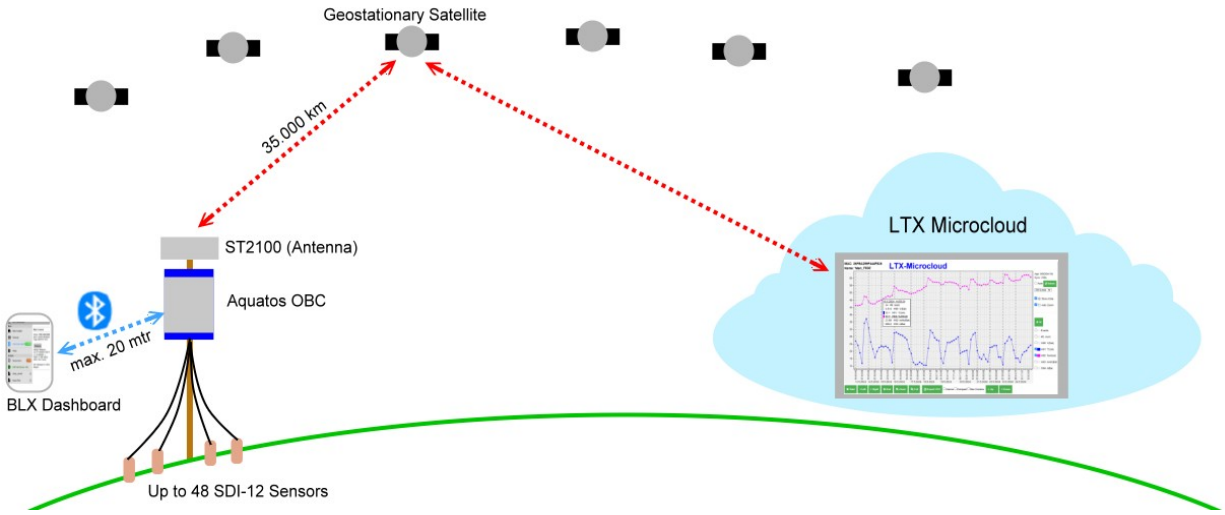
"**Aquatos OBC**" is a small satellite gateway for use almost worldwide with sensors networked via an SDI-12 bus. Up to 48 measurement channels in full resolution (floating point values) are possible. The device can reliably transport measurement data to the cloud for years using conventional batteries and in almost real time , has a high-performance antenna that is insensitive to orientation and is very easy to configure (both via the cloud and locally via Bluetooth APP). GPS positions can also be transmitted if required. The complete cloud software and APP are available as a freely available open source solution!

The Aquatos OBC is available in 2 versions:

- "MINI" (as shown above) with 4 internal CR123a standard batteries (3.0V, approx. 1.5Ah) and (optional) additional external power supply (12V – 14.4V). The internal batteries allow operation for up to 1 year.
- "STD-D/AA" with (version "-D"): 3 internal standard lithium D cells (3.6V, approx. 12Ah) or (version "-AA") 8 lithium AA cells (1.5V, approx. 3.5Ah). This enables operation for up to more than 8 years ("-D") or 3 years ("-AA").

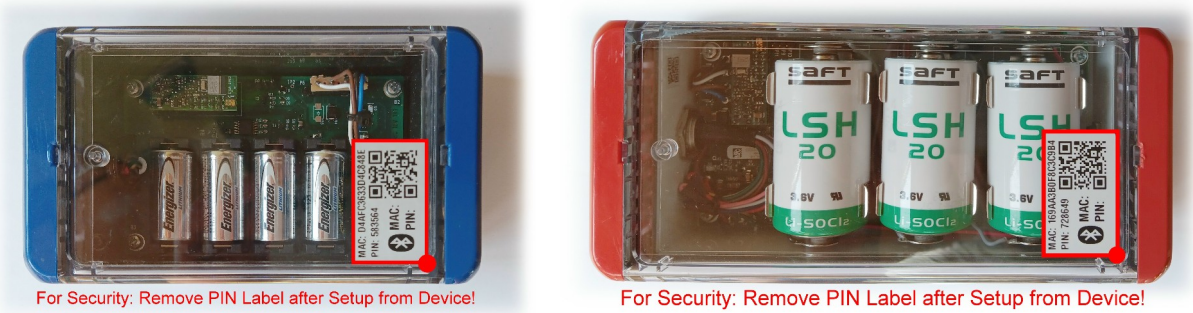
1.1 The system

Aquatos OBC works with geostationary satellites (Orbcomm Inmarsat). These satellites are located in fixed positions at an altitude of around 35,000 km above the equator. The Aquatos OBC can communicate reliably with them at latitudes between -70° and +70°. The antenna only needs to be aligned "very roughly" towards the sky. Mobile use (e.g. on buoys or vehicles) is also possible without any problems. Stationary locations are possible in the peripheral areas down to -80° and up to +80°. Only the regions near the poles are not suitable for the Aquatos OBC.



The communication between Aquatos OBC and the cloud is very fast and takes place almost in real time. Data usually only needs a few seconds to be transmitted! It is also bidirectional and if required, GPS coordinates can also be transmitted from the Aquatos OBC.

1.2 Versions



Left: Version “Mini” with 4 inexpensive photo batteries (CR123a), Right: “STD-D/AA” (in version “-D”): 3 internal standard lithium D cells (3.6V, approx. 12Ah).

Important: For security reasons, remove the red-bordered label with the access PIN from the device after setup and store it elsewhere!

To open the housing you need a small screwdriver (slotted):

A small practical tip: Removing the batteries (at least the first one) is not that easy mechanically. It can therefore be very helpful to place a flat, somewhat tear-resistant ribbon band underneath the batteries before inserting them. The batteries can then be easily removed from the holders by pulling on the band:

1.3 Software

The “BLX Dashboard” app was developed for local communication with Aquatos OBC via Bluetooth. It is a so-called “PWA”, an app that can be started directly from the browser on Android and Windows systems, but can also be used completely offline. Its use is briefly shown below.

As a complete cloud software, the "LTX Microcloud" is available in two versions (with and without SQL database connection). Commands can also be sent to the Aquatos OBC from the "LTX Microcloud"! For example, to change the measurement interval or to request GPS position data.

Important : We provide the complete cloud functionality for operating almost any number of Aquatos OBCs (and various other types of our data loggers and transmitters), the "LTX Microcloud", as well as the APPs for local communication "BLX Dashboard" free of charge, as open source and licensed for

commercial use for each of our devices! The "LTX Microcloud" is available in 2 versions (with and without SQL database connection):

- https://github.com/joembedded/LTX_Server
  LTX Microcloud: Full version for SQL database
- https://github.com/joembedded/LTX_Legacy
  LTX Microcloud: purely file-based “light” version, without SQL database
- https://github.com/joembedded/ltx_ble_demo
  BLX.JS, minimal website for Bluetooth communication. Precursor/starting point for an APP.
- https://github.com/joembedded/JoEm-Dashboard
  BLX Dashboard, communication app as a real PWA. Based on the same drivers and commands as BLX.JS.
- https://joembedded.de/x3/blueshell/
  The BlueShell is a third communication APP (only for PC (from Windows 10))

Detailed instructions for the LTX Microcloud and the associated apps can be found in the respective projects. Only the operation of the Aquatos OBC is described here.

2 Setup and installation

Each system comes with a short instruction manual for the corresponding variant. The system consists of 2 components and is completely weatherproof (IP67):

- Aquatos OBC - The picture shows the lower housing. It contains the control electronics and the power supply. The operating temperature range depends on the batteries used:
  - "STD-D" with 3 * type "SAFT-LSH20": use **-40°C to +85°C**
  - " STD-AA" with 8 * type "Energizer L91": use -40°C to +60°C
  - "MINI" with 4 * type "Energizer CR123a": use -40°C to +60°C
- Orbcomm satellite antenna (ST2100) – The picture shows the upper housing. The main beam direction is towards the flat side. In the picture it is optimally aligned for the geographical latitude at about 50°. The antenna has an operating temperature range of **-40°C to +85°C .**

Essentially, it is important to ensure that the antenna has a reasonably good and wide view of the sky. As a rough guide, the average position of the sun at midday in spring or autumn is a good guide. Good contact with the satellites also reduces energy consumption. The antenna should not be covered.

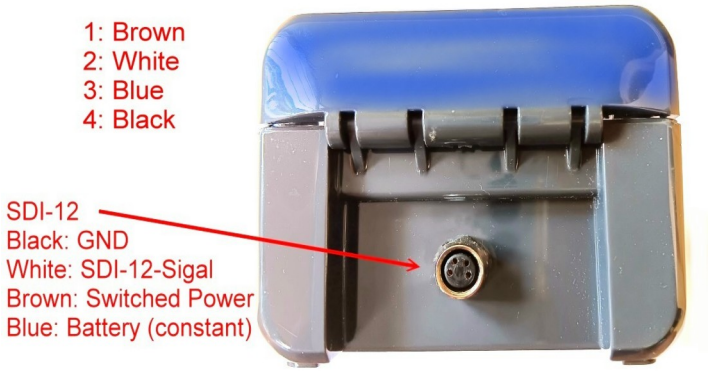
In the picture on the right, the antenna was mounted on a support together with the Aquato OBC using two simple metal brackets.

Info: The Orbcomm satellite antenna can be extended up to 5 meters from the Aquatos OBC using a standard M12-8 extension cable.

Safety note : The certification regulations require that a minimum distance of 20 cm from people and animals is maintained during continuous operation.

3 Technical setup

The “M8 - 4-pin” socket on the housing is used to connect the SDI-12 sensors (and optionally provide direct access to the internal supply voltage):



The SDI-12 bus is connected via the three lines black, white and brown (standard colors of M8 cables). Brown is the switched battery voltage, blue can be used for the permanent supply of sensors.

The device has BluetoothLE ("BLE") and can be easily operated using a PC (Windows 10 or later) or a smartphone with Android and BLE. BlueShell, BLX Dashboard or BLX.JS can be used.

Technical information on Low-Voltage-SDI12 and BLE can be found here (currently available only in German): https://joembedded.de/x3/ltx_firmware/GeneralDocus/open_sdi12_1v4_Bericht_DE.pdf

In the delivery state, BLE is active, but the sensors and transmission are deactivated.

3.1 The dataplan

The Aquatos OBC transmits its data in a compressed format.

On average, around 17 bytes are required per transmission plus 4 bytes per active measuring channel (a typical pressure sensor (pressure/temperature) would therefore have a total of 25 bytes per transmission, a temperature measuring chain with 10 measuring points would have 57 bytes per transmission). In addition, there is a small overhead for commands and per modem registration. Usually, however, this overhead can be virtually ignored.

Example: A device with a measuring period of 3600 seconds and a 2-channel sensor would therefore consume about 600 bytes per day and about 18.2 kByte per month, while a temperature measuring

chain with 10 measuring points and transmission every 6 hours would consume about 7.1 kByte per month.

Important: The various data plans of the Aquatos OBC only allow a maximum amount of data per month (as of 2024, data plans between 0.5 kB / month and 100 kB / month are possible and must be booked before using the device)! The required information is included with the device. Therefore, do not set the period faster than the corresponding data plan allows!

3.2 Commands

The following commands are important via BLE terminal:

' p': measurement period in seconds, default: "3600".

Important: To avoid additional costs, do not exceed the data plan you have booked !

' r': Command period in seconds, default: "1800". It is also possible to send all commands to the device via satellite. To save energy, however, the value should only be reduced if necessary.

'a ': " Packet index", starts with 0 and is increased by 1 per transmission. 64999 is followed by 0.

, f': The operating mode of the device (as a numerical value) :

0: " OFF": Permanently off (default setting)
1: "ON ": This operating mode keeps the satellite modem always in operation.

Important: below approx. 7.5 V (“battery empty”) the device switches to deep sleep, where only BLE is active, below approx. 9.0 V the “battery low” applies. However, when powered by lithium batteries, the measured battery voltage is only of limited significance, as these normally maintain their voltage almost until the end.

' ?': Lists all settings and the MAC of the satellite modem.
Info: The "Signal" value should ideally be above 4000.

' c': The SDI-12 measurement command (following section). Default is "*500 ?M" (without '!' character)

' zCMD': Sends CMD as SDI-12 command (at the end a '!' character)
'z+': Switches on the SDI-12 power supply for at least 5 minutes (enables communication with sensors via BLE, for example)
'z-'; Switches off the SDI-12 power supply in all cases

' i': Starts a measurement with subsequent transmission (if 'f' is not 0).

' Write': Saves the settings non-volatilely

'FactoryReset': Clears all settings, sets 'f' to the value 3 ("On-Smart").

'e' (or button "Measure" in the APP): Shows a measurement (pure display)

3.3 Parameterization and measurements

In practice, if there is no or only a poor connection to the satellite for a while, outgoing messages could build up. Therefore, only a maximum of around 20 messages are stored.

Furthermore, it is also possible that packets can arrive in the cloud in the wrong order if there are problems, but this is not a problem for the “LTX Microcloud” because the “LTX Microcloud” arranges the data in the correct order (based on the “packet index”).

3.3.1 The 'c' command and an example

'cCMD' sends CMD to the SDI-12 bus. If necessary, the SDI-12 power supply is switched on with a wake-up time of 250 msec. Optionally, a wait time of XXX msec can be inserted at any time using '*XXX'.

The 'M' or 'R' commands are suitable as CMDs. The command (without the '!' sign at the end) can be followed by a list of the channels to be measured (not all channels of a sensor are always necessary). If nothing is specified, all channels of the sensor are used.

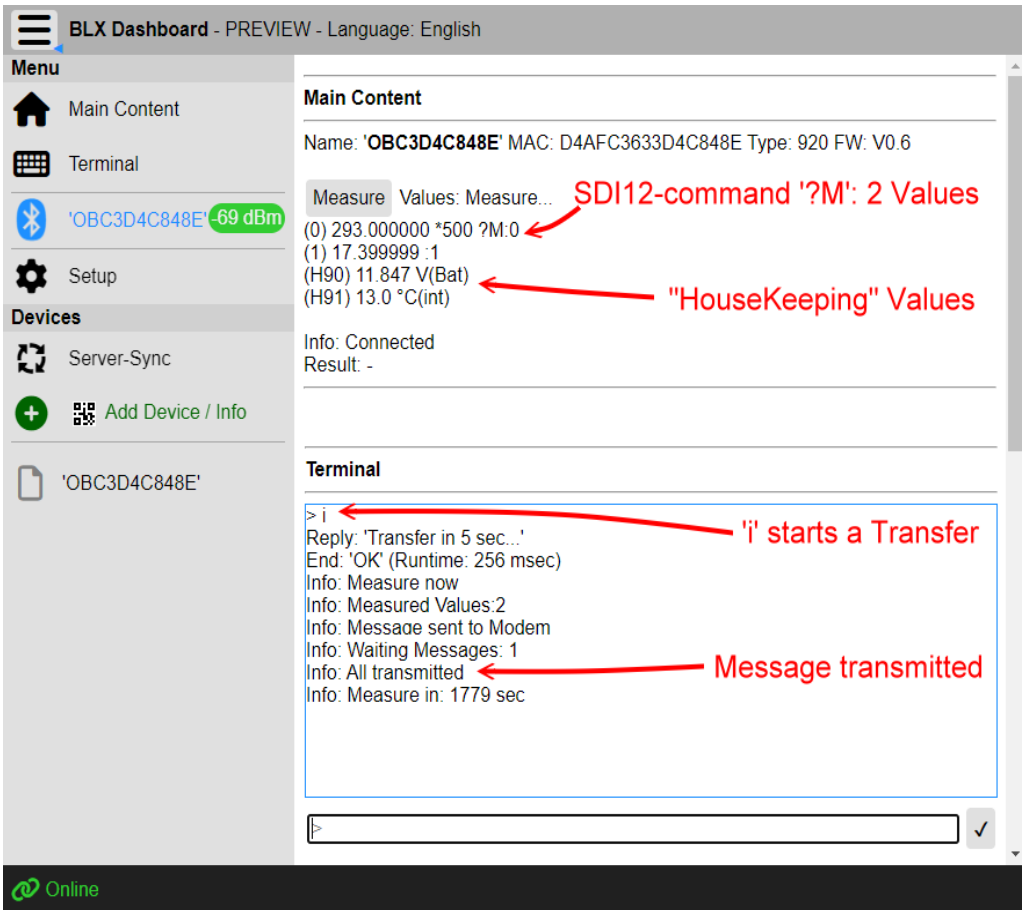
Some examples (without leading 'c'). Separator is a space or an underscore ('_'):

? M	If only a single SDI-12 sensor is connected, all of its channels are measured (SDI-12 V1.2 compatible without CRC).
* 1800 ?MC	As above, but the power-up time is 1800 msec and it is measured with CRC (SDI-12 V1.3 compatible). Value range is 0 – 9999 msec.
+ ?MC	'+' is identical to '*', leaves the SDI-12 power supply permanently on after the measurement (switches off when the battery is empty). This mode is necessary for sensors with ongoing measurements, such as counters or averaging wind sensors.
0M:0	The 1st value of the sensor with the address '0' is measured.
1MC:1:3	The 2nd and 4th values of the sensor with the address '1' (with CRC) are measured.
1M:0-4	5 measured values from sensor '1' are recorded.

In the following example, two sensors are connected: Address '1' is a 2-channel temperature measuring chain, address '5' is a conductivity sensor (conductivity in µS/cm and temperature). Both sensors are ready within 200 msec. All channels should always be recorded.

So the SDI-12 measurement command (with CRC) is: “c1MC:0-1 5MC:0-1”. An excerpt from the communication (via the BlueShell terminal, BLX Dashboard or BLX.JS):

```
> ?                                                    Check Parameter
: 'Modem MAC:'012345678SKY0123 ''                      MAC of the modem
: 'Modem: OFF'
: 'CMD:'*500 ?M''
: 'Period: 3600 sec'
: 'Mode-Flags:'0''                                     Mode “Off”
: 'Packet ID:'0''
> f1                                                   Mode “On”
: 'Mode flags:'1''
> z1I!                                                 Check ID '1'
: 'SDI CMD: '1I!''
: 'SDI:'113TT_TN_2W_0410_OSX713F9C22<CR><LF>''
> z5I!                                                 Check ID '5'
: 'SDI CMD: '5I!''
: 'SDI:'513DECAGON ES-2 385<CR><LF>''
> c1MC:0-1 5MC:0-1                                     Set SDI-12 Measure Cmd.
: 'CMD:'1MC:0-1 5MC:0-1''
> e                                                    Test Measure
Measure…                                               Looks good!
(0)12.545002 1MC:0                                     Unit: #0: °C_T0
(1)12.488001 (...):1                                   Unit: #1: °C_T1
(2)396.000000 5MC:0                                    Unit: #2: µS/cm
(3)13.300001 (...):1                                   Unit: #0: °C_H2O
(H90)3.799V(Bat)
(H91)14.3 °C(int)
> f                                                    Check Mode
: 'Mode flags:'1''
> p                                                    Check Period
: 'Period: 3600 sec'
> Write                                                Write Reset-proof
: 'Write OK'
> i                                                    Start a Measure & Transfer
: 'Transfer in 5 sec'
```



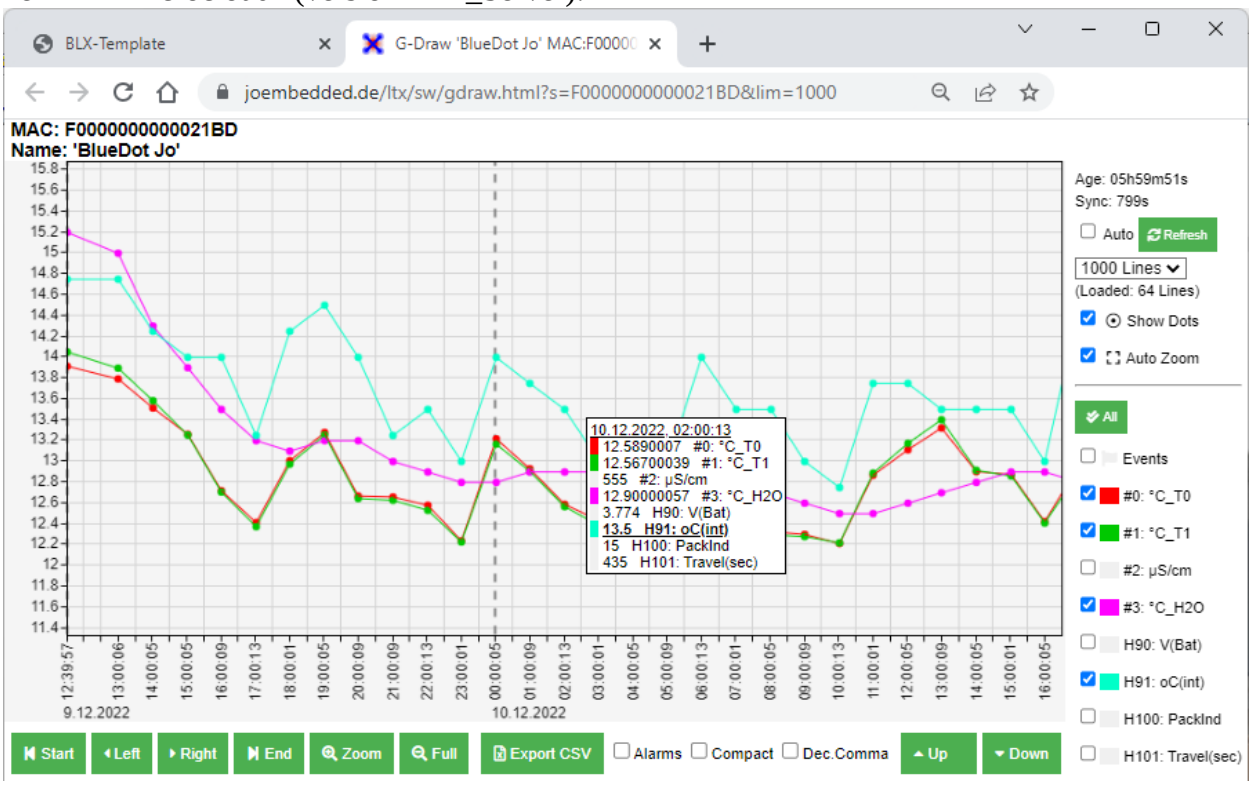
It is important to note that SDI-12 does not know the units of the channels, so these should be stored once (manually) in the “LTX Microcloud”.

In the return direction, currently only the measurement period is transmitted from the “LTX Microcloud” to the device.

Note: There are a number of other, less important commands. If you are interested in more technical details, please ask us, we will be happy to help!

After a short time the data arrived.

The “LTX Microcloud” (version LTX_Server):



The values HK100:PacketInd and HK101:Traveltime are generated by the “LTX Microcloud”:

HK100:PacketInd	Each measurement is numbered for identification (0..64999)
HK101:Traveltime	The total travel time (in seconds) of the message from the sensor to the cloud (this is typically in the range of 10-30 seconds with a reasonably good signal for the Aquatos OBC)

3.3.2 Demo video: Measurement and satellite transmission

This is a short video
https://joembedded.de/x3/ltx_firmware/Open-SDI12-Blue-Sensors/0920_Aquatos_OBC/aquatos_obc_testsession_video_EN.mp4

4 Power consumption

Modem “Off ”: approx. 20 µA BLE unconnected approx
. 100 µA BLE connected

Modem “On ”: approx. 0.12 – 0.5 mA on average (with 1 – 24 transmitted measurements per day) , with short peaks of up to 0.7 amps

For 1 measurement per day, a minimum of around 3.3mAh is required, and for 24 measurements per day, around 10mAh is required. Added to this is the power consumption of the sensors (usually negligible) and possible self-discharge of the battery.

5 Compliance (Aquatos OBC, Type 920)

Remark: This declaration only applies to the device AQUATOS OBC .
The Orbcomm Satellite Antenna (ST2100) has its own manufacturer's certification.

5.1 Compliance: CE, RoHS

- EN 55022 Emission, class B < 30 dBµV/m (0.03...1 GHz)
- EN 61000-4-2 Electrostatic discharge 4 kV contact / 8 kV air
- EN 61000-4-3 Irradiated RF 10V/m (0.1...1 GHz)
- EN 61000-4-4 Transients (burst) 4 kV
- EN 61000-4-8 Power frequency magnetic EMC
- EN 301 489-1 V2.2.3:2019-11 and EN 301 489-20 V1.1.1:2019-04 EMC
- EN 62311:2008 Health
- EN 62368-1:2014 Safety

5.2 Additional

- Bluetooth SIG listed: ID 138612

The device “Aquatos OBC” complies with:

- The essential requirements of Radio Equipment Directive (RED) 2014/53/EU and with the Directive 2011/65/EU (EU RoHS 2) and its amendment Directive (EU) 2015/863 (EU RoHS 3).

Manufacturers:

GeoPrecision GmbH
Am Dickhäuterplatz 8
D-76275 Ettlingen

TerratransferGmbH
Ottostr. 19a
D-44867 Bochum

25.05.2024

Jürgen Wickenhäuser (R&D)

***