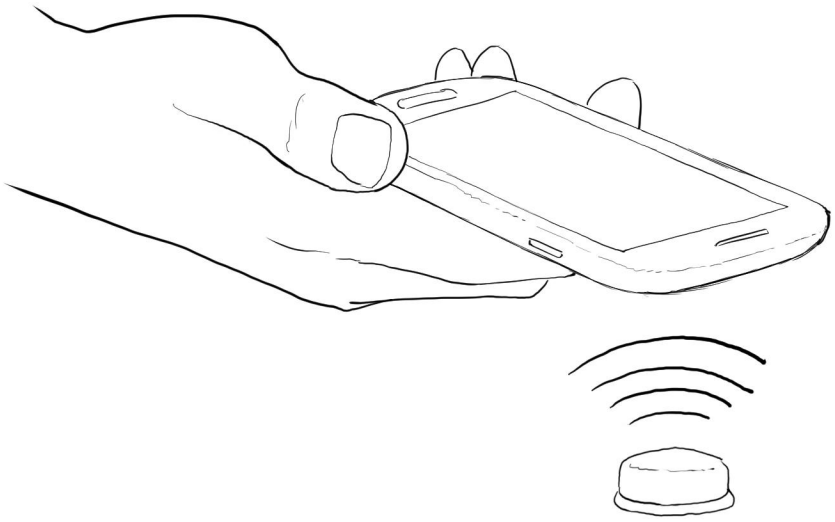
ElectricBlue CRL

EnvLogger System

A rugged and autonomous temperature logging system with contactless communication



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ElectricBlue CRL tools for environmental monitoring and biologging

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Overview

The EnvLogger system is composed of two symbiotic parts, hardware and software.

The hardware, or in other words, the EnvLogger instrument *per se*, is a rugged, miniaturized and autonomous temperature logger. It has a vast number of applications in the fields of environmental and climate monitoring, thermal stress, ecology, cold chain monitoring, and pharmaceutic and medic industries.

EnvLogger devices communicate with a smartphone using Near Field Communication technology (NFC). There are no cables or plugs to be connected when programming loggers or retrieving data. It is only necessary to "tap" the loggers with the smartphone. This means that when compared to equivalent conventional loggers, they can be completely watertight and much more resistant to mechanical stress. An additional advantage is that logger servicing in the field or in the lab is extremely quick and easy.

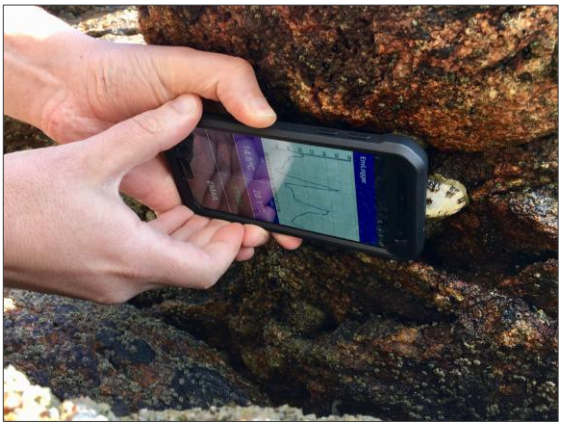

Figure 1 Temperature data being retrieved from an EnvLogger in the field. This particular EnvLogger was previously encapsulated in a limpet shell and attached to the rock surface.

Hardware

EnvLoggers are available in four main formats: (A) naked electronics, (B) as biomimicking loggers, (C) encapsulated in hard plastic-like packages, and (D) enclosed in 3D printed capsules. Format A has exposed electronics and thus should not be deployed directly as is. This format is provided so that customers can employ EnvLoggers on their specific applications. One typical example is the inclusion of loggers in real shells making biomimetic loggers such as robomussels[1], robolimpets[2] or robobarnacles[3]. Loggers can also be embedded in acrylic resins or 3D prints (B-D). B and C are highly resistant to environmental hazards such as UV, dirt, moisture, water and shock. They can even be deployed in areas submerged by seawater and pounded by waves (see Figure 2, bottom right).

Figure 2. Variety of EnvLogger packages. (A) naked electronics, (B) biomimicking logger (robolimpet), (C) encapsulated in acrylic, (D) enclosed in a 3D printed capsule. B and C can even be safely deployed in the intertidal zone, a hazardous environment for electronics featuring significant wave forces, sharp thermal transitions and salt water corrosion.

Software

The software, called *EnvLogger Viewer*, is an app that runs on Android smartphones (v 4.4 or higher) with Near Field Communication (NFC) capabilities. Examples are CAT S41 or higher, Ulefone 2, X, and most Samsung, Huawei, LGE and HTC models. *EnvLogger Viewer* is freely available from the Android app store, Google Play.

Drawing from several years of field experience, the app has been specifically designed with clarity and reliability in mind. Graphics have high contrast to improving readability in adverse lighting conditions, and menus are designed to minimize any possibility of accidental data loss (in other words, it is a “fool-proof” design as far as it goes). For example, as soon as the user accesses the data of a given logger, they are automatically downloaded and saved in the background, ensuring that even in the event of a mishap, data will not be lost.

Data can be easily shared by email at the touch of a button, providing that there is mobile coverage.

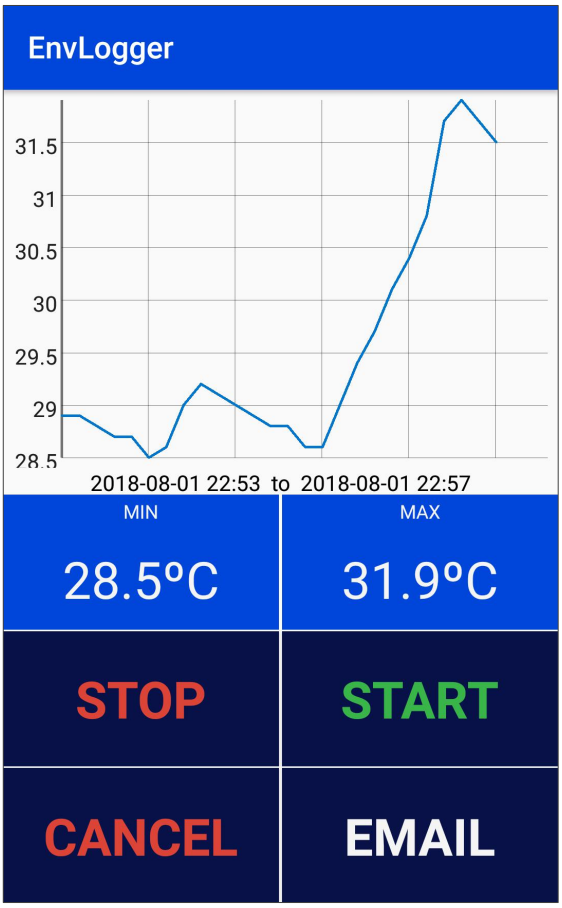

Figure 3. Screenshot of the data plotting screen of the EnvLogger View app. Note that there’s no “save data” option. Data is always saved automatically in the background.

Main features

- Quick deployment and servicing. Programming individual loggers takes a few seconds, and because last mission’s settings remain in memory, it is possible to “tap” and program a long sequence of loggers in a couple of minutes. Downloading data takes approximately 60 seconds for a logger with its memory full. The ability to quickly service loggers is highly valuable in hazardous environments such as the surf zone.
- Data are saved as CSV files, which are human-readable and easily imported into Excel, R, MatLab, or similar.
- The memory stores between a minimum of 15,000 and a maximum of 25,000 readings at a resolution of 0.1 ºC. The firmware uses a data compression algorithm and the amount of compression depends on the data structure. When readings are more similar, more compression is achieved and more data are stored. If readings are very variable, then less compression is possible and less data can be stored, but the minimum number of readings is 15,000. Typically, is about 20,000.
- Memory is non-volatile, meaning that data can still be accessed after battery depletion.
- Mission can be started immediately or at a later date (see below). The “pretty dates” option allows the user to choose a friendly and “rounded” date and hour.
- Competitive price. Refer to www.electricblue.eu for more information including up-to-date pricing.
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Technical specifications

- Clock drift of 10 ppm at most.
- Measures temperature with a user-defined resolution of 0.0625 °C, 0.1 ºC, or 0.5 ºC.
- The user can choose the sampling frequency at equidistant intervals ranging from 10 seconds to 18 hours.

- Missions can be started immediately or at any given date up to 10 years in the future. This is useful whenever there is the need to synchronize readings among several loggers.
- The average temperature precision (average dispersion among multiple EnvLoggers at a given point) is less than 0.1 ºC.
- The average temperature accuracy (average deviation from EnvLogger readings and a reference temperature) is less than 0.2 ºC.
- Battery lifespan of at least 2 years sampling at every hour*.

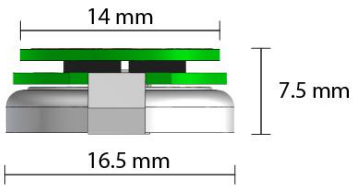
References

1. Helmuth, B. S., & Hofmann, G. E. (2001). Microhabitats, thermal heterogeneity, and patterns of physiological stress in the rocky intertidal zone. *The Biological Bulletin*, *201*(3), 374-384.
2. Lima, F. P., & Wethey, D. S. (2009). Robolimpets: measuring intertidal body temperatures using biomimetic loggers. *Limnology and Oceanography: Methods*, *7*(5), 347-353.
3. Chan, B. K., Lima, F. P., Williams, G. A., Seabra, R., & Wang, H. Y. (2016). A simplified biomimetic temperature logger for recording intertidal barnacle body temperatures. *Limnology and Oceanography: Methods*, *14*(7), 448-455.

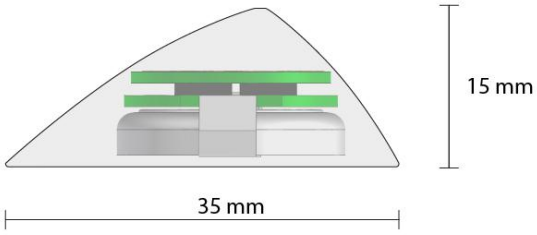
* an improved version of this logger is being developed which will feature a battery life approximately one order of magnitude higher.

Dimensions

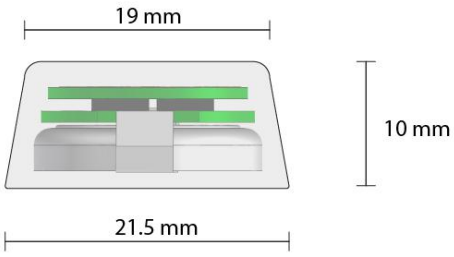
A - Naked electronics. Only for embedding in custom applications.



B - Biomimetic logger. using a real shell (robolimpet). Waterproof. High mechanical and thermal resistance.



C - Stand-alone logger embedded in a hard plastic pill. Waterproof. High mechanical and thermal resistance



D - Cased logger with a lightweight case. Not waterproof. Low mechanicall robustness.