# Heat Shield

## User's manual

**Document**          Heat Shield – User's manual

**Pages**             28

**Revision list**

| Issue | Date | Author | Changed description |
|---|---|---|---|
| Origin | 02/02/2015 | Reschiotto - Astori | |
| a | 09/03/2015 | Reschiotto - Astori | CE compliance declaration; other minor edits. |
| b | 21/12/2015 | Astori | Added the survey pause function description (from FW 1.02.00). |
| c | 28/12/2016 | Astori | Added the description of the temperature calibration function. Extended the measurement range of the globe thermometer. |
| d | 23/03/2017 | Astori | Added the description of the hot wire anemometer calibration function. |
| e | 06/03/2018 | Astori | Specified power consumption and instrument working battery life. |
| f | 30/09/2019 | Astori | Specified the reason for the possible error in the globe-thermometer measurement as consequence of the error in the anemometer measurement. |
| g | 09/03/2022 | Reschiotto | Adaptation based on new MASTER models |

## About this manual

The information contained in this manual may be changed without prior notification. No part of this manual may be reproduced, neither electronically nor mechanically, under any circumstance, without the prior written permission of LSI LASTEM.

LSI LASTEM reserves the right to carry out changes to this product without timely updating of this document.

# Summary

# 1 Introduction

Heat Shield is a compact measuring system including radiant temperature sensors, wet bulb temperature, air relative temperature and humidity for the calculation and display of globe temperature, wet bulb temperature, dry bulb temperature and relative humidity, displaying as well indoor & outdoor WBGT indexes, Heat Index and Humidex in a single unit.

ELR610M and ELR615M Heat Shield MASTER module can support up to two SATELLITE units for the calculation of time-weighted WBGT index at three levels (as required by standard ISO 7243: 1989) or of all indexes in three different environments. Refer to §11 for some examples of use.

Heat Shield can be connected to an anemometer; being so, it is able to acquire all the quantities needed to GlDAS TEA program for the calculation of other indexes for thermal comfort (PMV/PPD, TO, ISO 7730), thermal stress (PHS, ISO 7933) and cold stress (IREQ, Dlim, ISO 11079). GIDAS TEA allows you to perform in-depth analyses, simulations and reports.

Heat Shield provides also *MW6501* USB pen drive with *HS Manager* program installed. HS Manager allows you to transfer data from the instrument to your PC, perform analyses and evaluate the working limits of operators in the environments according to the variables defined in ISO 7243. The software can also be downloaded from the website www.lsi-lastem.com.

## 1.1 Models

| Code (PN) | Description |
|---|---|
| ELR600M | Heat Shield MASTER module with small globe thermometer (5 cm diameter). Includes 110÷220 Vac power charger, PC serial cable, USB adapter and HS Manager software. |
| ELR605M | Heat Shield MASTER module with standard globe thermometer (15 cm diameter). Includes 110÷220 Vac power charger, PC serial cable, USB adapter and HS Manager software. |
| ELR610M | Heat Shield MASTER module with small globe thermometer (5 cm diameter). Compatible with ELR610S Satellite radio unit. Includes 110÷220 Vac power charger, PC serial cable, USB adapter and HS Manager software. |
| ELR615M | Heat Shield MASTER module with standard globe thermometer (15 cm diameter). Compatible with ELR615S Satellite radio unit. Includes 110÷220 Vac power charger, PC serial cable, USB adapter and HS Manager software. |
| ELR610S | Heat Shield SATELLITE module with small globe thermometer (5 cm diameter). |
| ELR615S | Heat Shield SATELLITE module with standard globe thermometer (15 cm diameter). |

## 1.2   Instruments description



(1) - LCD display 4x20 chr.
(2) - Keyboard
(3) - Base mounting
(4) - Tripod mounting (BVA325)
(5) - Reset
(6) - Power supply / battery charger
(7) - Anemometer input
(8) - RS232 port
(9) - Wet bulb temperature sensor
(10) - Air tempetaure sensor
(11) - Radiant temperature sensor
(12) - Working status leds
(13) - Protective shell

**MASTER Unit**
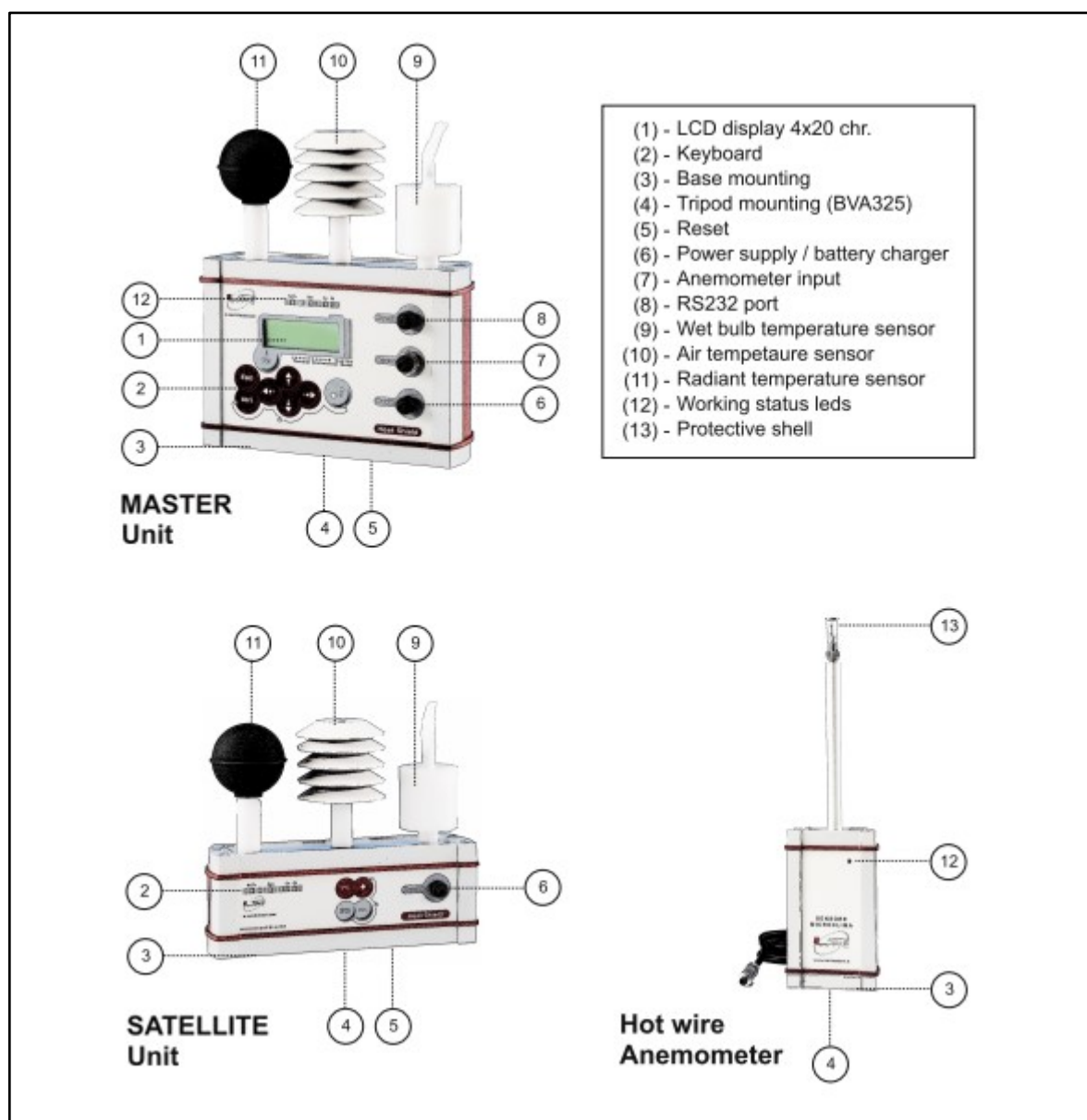
**SATELLITE Unit**

**Hot wire Anemometer**

**Fig. 1 – Instruments description.**

# 2   Product installation

## 2.1   General safety rules

Please read the following general safety rules in order to avoid injuries to people and to prevent damages to the product or to products that may be used in connection with it. In order to avoid damages, use this product exclusively according to the instructions herein contained.

**Installation and maintenance interventions are to be exclusively carried out by authorized and skilled people only**.

**Install the instrument in a clean, dry and safe place**. Humidity, dust and extreme temperatures may deteriorate or damage the instrument. In such cases, we advise installing the instrument inside a suitable container.

**Power the instrument in a suitable manner**. Connect the instrument to the power supply indicated in the model in your possession.

Carry out the electrical wiring in an appropriate manner. Carefully follow the wiring diagrams supplied along with the instrument.

**Do not use the product in case of suspected malfunction.** In case of suspected malfunction, do not power the instrument; contact authorized technical support immediately.

**Before every maintenance of electrical connections, power supply, sensors and computer-equipment:**

- **disconnect the power supply,**
- **discharge the electrostatic discharges touching one conductor or one earth apparatus.**


**Do not use the product in the presence of water or condensing humidity**.

**Do not use the product in a potentially explosive atmosphere**.

**Internal lithium battery.** Do not replace the battery with incorrect type. Risk of explosion!


## 2.2   Mechanical installation and positioning

Heat Shield MASTER and SATELLITE can be placed on a flat surface or installed on a tripod. The choice is generally made based on the type of survey to be performed and to the ease of use. The tripod installation can be selected for surveys in *WBGT 1 amb.*, *WBGT 2 amb.*, *WBGT 3 amb.* modes without anemometer. Hot wire anemometers require the use of BVA325 support, which can be placed on a flat surface or mounted on a tripod. Cup anemometers require the use of BVA325 support, BVA308 pole and tripod.

Surveys in *subject WBGT* mode require the use of the tripod along with BVA326 pole and BVA325 support. Units must be positioned as indicated in Fig. 5.

Some examples of use are described in chap. 25.

### 2.2.1 Installation with BVA325 support

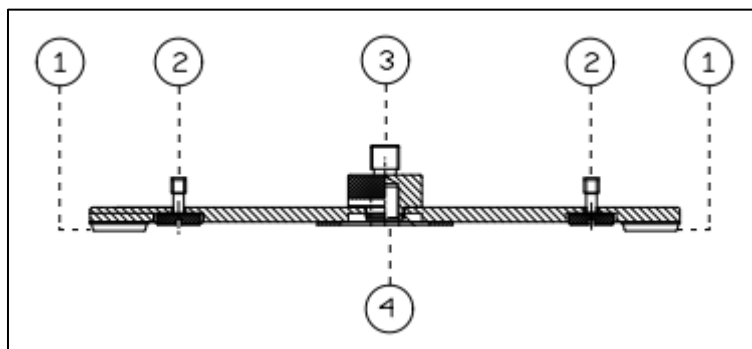BVA325 retention bracket can be used in different ways.

Fig. 2 - BVA325 retention bracket– Front view.

**Heat Shield MASTER**

Fasten the unit to one of the two available knurls (2) on the bracket. Mount the bracket on the tripod using the knurl (4).

**Heat Shield MASTER and SATELLITE**

Fasten the SATELLITE unit to the knurl (3) by means of the BVA326 pole. Fasten the MASTER unit to one of the two available knurls (2). Mount the bracket on the tripod using the knurl (4).

**Hot wire anemometer**

Screw the sensor onto one of the two available knurls (2); secure the MASTER unit to the other knurl (2). The bracket can be mounted on the tripod using the knurl (4) or placed on a flat surface. The rubber feet (1) allow the instrument to be stable.

**Cup anemometer**

Fasten the sensor to the knurl (3) using the BVA308 pole. Mount the bracket on the tripod using the knurl (4).

# 3 How to use Heat Shield MASTER

## 3.1 Switching on

Use ⬤+⬤ key combination to switch on the unit.

At each switch on, Heat Shield shows its ID data (PN, version and serial number) for a few seconds. Then the system time is displayed and finally the measurements.

```
LSI  LASTEM         Italy
HS001           V01.00.00
     Heat  Shield
SN  12345678
```

```
              LANGUAGE
>English
 Italian
 Portuguese
```

During the first switch on Heat Shield prompts you to select the program language. Select the language using ⬤ and ⬤ and confirm with ⬤.

If the system time is correct, select ⬤ otherwise refer to the chapter concerning the system time change (§3.2).

## 3.2 Changing the time

Move the double cursor "^^" on the element to be changed using ⬤ ⬤; increase or decrease the value with ⬤ ⬤. Press ⬤ to confirm the changes (the time of the second line is updated with the new value), then press ⬤ to exit.

```
              SYSTEM  TIME
 30/09/14  09:31:23
 30/09/14  09:24:15
                      ^ ^
```

## 3.3 Displaying measurements

Heat Shield MASTER displays the indexes calculated according to reference standards and the measurements acquired by sensors (9) (10) (11) (see Fig. 1), either those physically connected to the instrument and those received by any SATELLITE units connected by radio.

The display is divided into groups. The first group to be displayed is that of MASTER unit indexes, followed by SATELLITE 1 (if any) and SATELLITE 2 groups (if any). These are followed by the group of MASTER measurements and subsequently by SATELLITE 1 (if any) and SATELLITE 2 (if any) ones.

```
                      B =
WBGT_I        23.4    'C
WBGT_O        23.3    'C
```

```
                      B =
WBGT_I1       23.4    'C
WBGT_O1       23.4    'C
```

```
                      B =
WBGT_I2       23.3    'C
WBGT_O2       23.3    'C
```

```
                      B =
tg            23.5    'C
tnw           23.2    'C
ta            23.2    'C
```

```
                      B =
tg1           23.6    'C
tnw1          23.3    'C
ta1           23.3    'C
```

```
                      B =
tg2           23.6    'C
tnw2          23.4    'C
ta2           23.4    'C
```

keys allow you to scroll between one group and the other while allow you to scroll through measurements vertically.

The first line is reserved to the status bar (see §3.7 for more info).

## 3.4 Switching off

To switch off the unit, go to the measurement mask, press + key combination and confirm with

## 3.5 Reset

In case of incorrect operation (the *Ok* LED doesn't light up), power the instrument by connecting the power supply unit to the *Power* jack; after about ten minutes, reset the unit by removing the protective plug under the base and by pressing the internal button by means of a small pointed tool. Keep powering the instrument until the battery is fully charged (see §7.4).

## 3.6 Using the keyboard

The keyboard consists of four directional keys and four function keys.
The following table summarizes the main functions of each key, according to the status of the instrument.
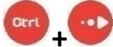
| | |
|---|---|
| + | Switch the unit on/off. |
| | Confirms switch off. |

During menu display:

| | |
|---|---|
| | Scroll menu items upward and downward. |
| | Enters the menu item indicated by the ">" cursor. Changes the selection setting through the menu and returns to the previous menu (except for language). |
| | Exits the displayed menu and returns to the previous menu. If pressed in MAIN MENU, returns to the measurement display. |

During measurement display:

| | |
|---|---|
| | Scroll measurements/indexes upward and downward. |
| | Call up the window with the previous/following group of indexes/measurements. |
| + | Start survey (and data logging). |
| + | Stop survey (and data logging). |

During the display of the value edit mask (for example the SYSTEM TIME mask):

| | |
|---|---|
| | Increase/decrease the value indicated by the cursor "^" or double cursor "^^". |
| | Move the cursor "^" or the double cursor "^^" to the left/right. |

## 3.7   Status bar

The status bar contains an overview of Heat Shield operating state. It is the first line in the measurement mask and is represented as follows:
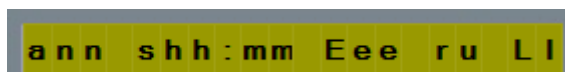


where:

| | |
|---|---|
| a: | storage of measurements in progress. It appears only if the survey (and data logging) is enabled. |
| nn: | survey identification number. It appears only if the survey (and data logging) is enabled |
| shh:mm: | can have the following meanings:<br>- it is the time needed to reach the starting time of the survey if the survey is not in progress (*ann* is not shown) and the starting time has been already scheduled (s = '-');<br>- it is the time needed to reach the ending time of the survey if the survey is in progress (*ann* is shown) and the ending time has been already scheduled (s = '-');<br>- during survey (*ann* is shown), it is the time elapsed since the beginning of the survey. It is available only if survey end has not been scheduled (s = '+'). |
| Eee: | error number. It appears only if an error has occurred. |
| ru: | radio signal with battery level. '-' radio on, '1' receiving data from SATELLITE unit 1, '2' receiving data from SATELLITE unit 2. It does not appear if in *WBGT 1 amb* mode (no SATELLITE is used) and in models without the radio module. |
| LI: | shows alternatively the (B)attery level and the (M)emory status.<br>(█ 100%: battery charge/memory full; ☐ 0%: discharged battery /empty memory; other levels shown: ▮ 80%, ▮ 60%, ▮ 40%, ☐ 20%). |

# 4   Using Heat Shield SATELLITE

To use the SATELLITE units it is necessary to have Heat Shield MASTER ELR610M or ELR615M.

## 4.1   Switching on/off

Press  +  key combination to switch on and off the instrument.

It is advisable to switch on the SATELLITE units only after switching on the MASTER unit to allow radio connection between units. The MASTER unit must be configured in the appropriate MODE (§5.2) to receive data transmitted by the SATELLITE units.

## 4.2   Reset

In case of malfunction (the *Ok* LED doesn't light up), power the instrument by connecting the power supply unit to the *Power* jack; after about ten minutes, reset the unit by removing the protective plug under the base and by pressing the internal button by means of a small pointed tool. Keep powering the instrument until the battery is fully charged (see §7.4).

## 4.3   Using the keyboard

The keyboard consists of four keys and has the following features:

| | |
|---|---|
|  | Switch on/off the unit. |
|  | Forces the connection of the radio with the MASTER unit. To be used if the MASTER unit was switched on after the SATELLITE unit. |

## 4.4   Diagnostics

Heat Shield SATELLITE is provided with 4 illuminated indicators showing the following functions:

- *Rx/Tx*: Radio communication with MASTER unit; when connection is established with the MASTER unit, the indicator lights up in both units at the same time.
- *Batt*: the LED indicator is illuminated during the internal battery charge by means of the power supply unit connected to the *Power* input: the LED can have a high or a low luminous intensity, showing an intensive or maintenance charging current respectively. The LED indicator switches off when the battery is fully charged and can switch on during the maintenance charge.
- *Err*: indicates an error condition, typically due to a lack of connection with the MASTER unit. The number of flashes during a signalling cycle indicates the cause of the detected problem, as shown in the table below.
- *Ok*: indicates the on/off state and proper operation of the instrument.

| *Number of flashes* | *Typology of problem* | *Troubleshooting* |
|---|---|---|
| 1 | The configuration memory is not working. | Try to reset the unit; consult your dealer if the problem persists. |
| 2 | The instrument cannot connect to the ELR610M or ELR615M MASTER unit. | Make sure that the MASTER unit is on and located in close proximity to the SATELLITE unit; check that the two MASTER and SLAVE units make use of the same radio network number: when you have several MASTER units, these may have been configured to work with their corresponding SATELLITE units; therefore, make sure to be using the proper and mutually compatible instruments. In case of failed connection, press the *Fn* key on the SATELLITE unit and check that the MASTER unit notifies the successful radio reception within a few minutes; otherwise, reset the unit (see §4.2). |
| 3 | The measuring system of the sensor is not working. | Try to reset the unit; consult your dealer if the problem persists. |
| 4 | The configuration data of the unit are not correct. | Try to reset the unit; consult your dealer if the problem persists. |
| 5 o 6 | Internal error | Try to reset the unit; consult your dealer if the problem persists. |

# 5 Survey

After switching on, the Heat Shield is in acquisition status: it starts reading and displaying the measurements of its sensors and the ones transmitted by the SATELLITE units every 10"; while in this status, the adaptation conditions of sensors can be checked before performing their recording.

When launching the survey, (§5.3) the instrument starts logging the measured data, calculating their mean value and recording results every minute. Measurement and display are in any event performed every 10", even in logging conditions.

Wind speed measurement is performed in a slightly different manner, in that the value is sampled by the anemometer every second and rolling average measured by using the previous 60 samples; the display shows both measurements: the last acquired instant value and the rolling average value. The recorded data is in any event the average measured every minute.

Thermal stress indexes are also calculated with 10" rate and recorded as mean value every minute.

## 5.1 Getting started

1. Make sure batteries are fully charged, otherwise use the supplied power supply units.
2. Make sure there is enough memory available in the MASTER unit to store the data of the surveys to be performed.
3. Mount and position the instruments based on the desired calculation typology. In this respect, see the examples given at the end of the manual.
4. Switch on the MASTER unit and subsequently SATELLITE units, if used.
5. Check the reception of the measurements coming from the sensors in use on the Heat Shield MASTER display, especially those of SATELLITE units, if used.
6. Let sensors acclimate checking for stable measurements on the display. The globe-thermometer may need a 20-minute acclimatization period.

## 5.2 Setting a survey

Access the *Setup survey* menu and set in the following order:

1. **First survey nr.**: after executing a survey, the instrument associates a progressive number to each survey starting from the set value. During the measurement campaign, it can be useful to assign a numbering scheme to each survey; in this case, set a value from *1* to *99* or leave the default value.
2. **Mode**: select *subject WBGT 1 env.*, *WBGT 2 env.*, *WBGT 3 env.*, *WBGT subject* based on the type of survey you wish to execute. See §11 for some sample images.
3. **Anemometer**: If no anemometer is connected, select *Not used*, otherwise specify the type: *Hot wire* or *Rotor*.
4. **Measure unit**: select *Celsius* or *Fahrenheit* to set the measurement unit used by the instrument.
5. **Start/Stop**: select the start-up mode (manual/at given time) and stop mode (manual/ at a given time /after a given time) of the survey. Starting the survey activates measurement storage in the memory.

## 5.3   Starting/Stopping a survey

Surveys are started and stopped (data logging) based on the settings stored in the instrument. If you select the *Manual* start-up, press [Ctrl] + [▸] to start the survey (and measurement logging).

To stop the survey, press [Ctrl] + [◂]. Pressing these keys stops the survey even if an automatic stop has been set.

## 5.4   Pausing a survey

You can pause an active survey at any time by pressing [Ctrl] + [↕]. While paused, the instrument will update and show measures on the display, but data logging is stopped. By pressing the same key combination again, the data logging resumes normally. While paused, the instrument will show a 'P' in the top left of the display.

## 5.5   Globe thermometer compensation

Heat Shield models equipped with a small-sized globe thermometer (diam. 5 cm), use a compensation algorithm to obtain measurements equal to those obtained by a standard globe thermometer (diam. 15 cm). The formulas used are derived from EN ISO 7726:2001 regulation which specifies different equations based on convective regimes, natural or forced, the sensor is exposed to.

Heat Shield continuously determines the convective regime based on the following considerations:
- If the anemometer measures an air speed greater than 0.176 m/s, the convective regime is forced, otherwise it is natural.
- If the instrument doesn't use an anemometer, the convective regime will be the natural one, as there is no air speed measurement value to be taken into consideration.
- The air speed measurement used in the compensation formula is that calculated as the last-minute moving average, to adapt to the measuring inertness of the globe thermometer, markedly higher than that of the anemometer.

It is important to note that if Heat Shield is programmed to use the hot wire anemometer (see §5.2), where this is not connected to the MASTER unit, a measurement error will be signalled ('---') and consequently also the globe thermometer measurement along with all related calculated indexes will be signalled as fault. It is therefore important to consider this potential situation in the event an inexplicable error condition is detected in these data.

The compensation of the globe-thermometer temperatures measured by the SATELLITE units will take the convective regime deriving from the air speed measured by the MASTER unit, since SATELLITE units do not provide this type of measurement.

It is important to point out that the MASTER unit equipped with a small-sized globe thermometer cannot use data provided by SATELLITE units equipped with big-sized globe thermometers and vice versa, since compensation functions would (or would not) be improperly applied to the MASTER unit.

# 6   Setup

Heat Shield is factory-configured. Some operating parameters can be menu displayed and changed.

## 6.1   Menu navigation

Press ⬤ in the measurement mask to access the main menu.

The first line in the menu is reserved for the title.

Use ⬤ ⬤ to scroll the menu items; press ⬤ to enter the item pointed to by the cursor ">" and ⬤ to return to the previous menu (it returns to the measurement display if pressed in main menu).

## 6.2   Changing parameters

Depending on the type of parameter, changes can be made by selecting an element displayed in the menu or by changing the value using the arrow keys. Language selection is an example of menu-driven change while time setup is an example of change using arrow keys.

## 6.3   Utilities Menu

Heat Shield is provided with an UTILITIES menu that allows access to the following functions:

- **Memory**: the instrument shows the percentage of available memory, which is useful for data logging; the same information is more approximately shown in the status bar (§3.7). This function allows you to erase the data memory and at the same time the log memory, where start/stop logging-related events and other diagnostic details are stored, using ⬤+⬤ key combination. Attention: make sure to transfer the logged data to your PC before erasing the memory! Data memory is used only when survey recording has been activated (see §5.3). Autonomy depends on the set MODE and is illustrated in the table below.

- **Communications**: this function indicates bytes and messages received and transmitted by the instrument during communication with your PC (C1) and SATELLITE units (C2). The latter only for the ELR610M and ELR615M models. Use ⬤ and ⬤ keys to move from C1 to C2 and vice versa.

- **System errors**: indicates any errors detected by the instrument during operation. The error report is stored until user recognition; it may therefore indicate a previous error condition, which has been already settled but not yet recognized. Use ⬤+⬤ key combination to clear the fault condition.

| *Mode* | *Data columns produced* | *Autonomy (dd)* |
|---|:---:|:---:|
| WBGT 1 environment | 9 | 134 |
| WBGT 2 environment | 17 | 70 |
| WBGT 3 environment | 25 | 48 |
| WBGT subject | 23 | 52 |

## 6.4   System parameters

Besides survey parameters, indicated in §5.2, the instrument uses some system settings relating to other functions. These parameters, available in the SYSTEM menu, are:

- **System time**: allows you to adjust the date/time setting in the internal clock; for safety purposes this adjustment is required with instrument start up.

- **Acoustic alerts**: the internal buzzer can be activated in the following situations:
    - At the touch of a button.
    - During storage of survey start/stop.
    - In the event of operating errors.
- **Radio**: Heat Shield model ELR610M and ELR615M uses a radio able to operate in one of the possible 9 logical instrument networks; in the event only one MASTER unit is used with one or two SATELLITE units, this parameter doesn't need to be changed; otherwise, in the presence of more than one MASTER unit within an area where the units might interfere with each other, the parameter will need to be changed by selecting an unique network number as compared with the other devices; at the same time, you will have additionally to change the network number of the SATELLITE units belonging to your MASTER unit; consult your Heat Shield dealer to change this parameter.
- **Comm. port**: allows you to select a communication speed depending on the maximum performances that can be reached by the communication port used on your PC. By default, the instrument uses its maximum reachable speed (115200 bps).
- **Display auto off**: you can ask your instrument to switch off the display after the keyboard has been unused for some minutes, for energy saving purposes; the instrument functions remain still active even with the display switched off; the instrument indicators will show the on/off state.
- **Language**: the user interface has multiple languages available; use this function to select the desired language.

# 7   Diagnostics

## 7.1   Error messages

Heat Shield may indicate operational errors in different ways:
- *E* is displayed on the status bar.
- Audible signal (if enabled, see *Acoustic Alerts*, §6.4).
- The red indicator *Err* on the instrument keyboard flashes: the flashing modes indicate the error typology based on the table below:

| Number of flashes | Problem typology | Troubleshooting |
|---|---|---|
| 1 | Log memory full | The space available for event logging is nearly or completely finished. Stop measurement logging as soon as possible, transfer data to your PC and erase data from memory (see *Memory*, §6.3). |
| 2 | Low battery level | The battery charge of the MASTER unit and/or the SATELLITE unit has been detected to be below low limit; use the status bar to check which unit should be connected to the external power supply device to charge its own battery; wait for the charge indicator led to switch off before disconnecting the instrument from power supply source. |
| 3 | Radio (only for ELR610M and ELR615M) | The instrument indicates a fault to the radio and consequently cannot receive the data measured by the SATELLITE units; contact your dealer for this kind of problem. |
| 4 | Data logging | The instrument indicates a fault to the data logging system; transfer immediately the data to your PC, then erase the data from memory (see *Memory*, §6.3) and perform a survey with storage testing; contact your dealer if the problem persists. |
| 5 | Configuration | The instrument indicates a fault in configuration data; contact your dealer for this kind of problem. |
| 6 | Data memory | The instrument has detected a severe fault in the use of data memory; contact your dealer for this kind of problem. |
| 7 | Sensor sampling | The sensor measuring electronics is detecting an internal fault; contact your dealer for this kind of problem. Note: see §7.3 for further details. |
| 8 | Communication | The system of interpretation of commands sent by your PC is detecting a fault condition; check the connection cable and the communication port used on your PC, if necessary also with another instrument; try to reduce the communication speed (see §6.4); contact your dealer if the problem persists. |

## 7.2 Disabling error signals

There are two possibilities to disable error signalling:

1) With the error code displayed in the UTILITY mask, press ⬤ and ⬤ to reset the error condition.
2) During data transfer between instrument and PC: in this case the instrument resets the error since it considers the error to have been already detected by the computer operator.

## 7.3 Error signals during measurement

Measurement values can indicate the error status, marked by the indication '---', under the following conditions:

- Acquired measurement:
  - Sensor interrupted or faulty.
  - If the measurement comes from a SATELLITE unit: SATELLITE sensor interrupted or faulty or transmission not receivable by the MASTER unit; move the SATELLITE unit in proximity of the master unit and check reception conditions on the status bar; gradually distance the SATELLITE unit checking each time the correct reception of the signal by the MASTER unit.
  - Sensor not connected: if the use of a hot wire anemometer has been programmed, (see §5.2), and the sensor is not connected, the corresponding measurement fault will be signalled. Take into consideration the compensation function of the globe thermometer (see §5.5).
  - In case of error in the globe-thermometer measurement see §5.5, for the air speed measurement using the hot wire anemometer.
- Index measurement:
  - Off scale or faulty value of one or more measurements for index calculation.
  - If the measurement comes from a SATELLITE unit: off scale or faulty value of one or more SATELLITE measurements for index calculation, or transmission not receivable by the MASTER unit; follow the indications referred to in the preceding subparagraph.

When the number to be displayed is < -999999 or > 9999999, E-Log signals an overflow error by the message "Overfl."

## 7.4 Low battery signal

A low battery status is signalled by the ▄-Err LED blinking on the data logger; the blinking LED condition on the instrument disappears automatically when the battery is fully charged.

When the battery voltage is very low, the instrument might work abnormally, or might not switch on at all; it might also switch on and off continuously. If this is the case, we recommend switching off the instrument and keep it charging for enough time to fully recharge the battery; then proceed to save the data in your PC and erase data memory.

# 8   Maintenance

Heat Shield MASTER and SATELLITE units are precision units. The instrument can operate for a long time without any significant problems or maintenance requirements. To make sure that the instrument does not exceed the measurement accuracy value indicated in the technical characteristics over time, LSI LASTEM recommends calibrating the instrument yearly.

We also propose to replace the relative humidity sensors with a frequency based on the operational conditions the instrument has been subject to, considering that long-lasting conditions of high humidity levels, pollution, presence of dust and chemicals lead to a faster deterioration of the sensitive element. It is however good practice to replace the relative humidity sensor every two years.

Consider also that the wet bulb thermometer sleeve should be replaced when it becomes dirt or deteriorated.

## 8.1   Calibration

### 8.1.1   Temperature

Temperature measures produced by Heat Shield Master and SATELLITE units can be field-calibrated with LSI Lastem reference sensor EST100 (FW version 1.04 or required on Heat Shield Master unit). Adopt the following procedure:

1) Place the units in a place protected from direct sunshine or other radiant sources.
2) Remove the copper sphere from the globe thermometer and the cotton wick from the wet bulb sensor; ensure the latter is perfectly dry.
3) Connect reference sensor EST100 to the Master unit *Comm* port. Wait at least 20 minutes to allow proper acclimatization of the sensors.
4) Select the mode *Calibr* (see §5.2); in this mode, two groups of measurements are created: the first displays the readings from the reference sensor and from the Master and SATELLITE units; the second group displays the differences between the Master and SATELLITE units' readings and the reference sensor reading.
5) Based on the applied standard, determine if the differences are within your quality specifications or if the instruments need to be calibrated; in such case, contact your local LSI LASTEM subsidiary.

### 8.1.2   Hot wire anemometer

Starting from FW version 1.05 of Heat Shield MASTER unit, the hot wire anemometer measure can be calibrated using an external reference system (wind tunnel). The calibration should be executed on two different reference points, though one single reference point can be used, leaving the second measure point to the nominal value. Adopt the following procedure:

1) The new re-calibration must be done with actual user calibration disabled; the instrument will then perform air speed measurements without applying any correction factor. Disable the current user calibration using the *Survey setup – Anemometer - Calibration* menu.
2) Place the hot wire anemometer inside the test chamber, connect and enable it on Heat Shield MASTER unit; ensure that the anemometer is enabled on *Survey setup – Anemometer – Type* menu.
3) Escape to the instant values measurement display and scroll down to the anemometer value (*va*).

4) Apply the reference wind speed to the sensor and take note of the set point value (from the wind tunnel control) and the corresponding measured wind speed (on the Heat Shield display); repeat the same for the second reference point.

5) Using the *Survey setup – Anemometer - Calibration* menu, insert in the measured values; *Ref1* and *Ref2* are the reference wind speeds; *Msr1* and *Mrs2* are the wind speeds measured by the instrument without user calibration. Ensure to enable the user calibration on the same display mask. After pressing *Enter* on this mask the instrument calculates three polynomial function factors (quadratic formula), using as first reference point a zero value; this assure the zero intercept, so when the sensor measures zero wind speed, the instrument shows zero value.

6) Test the new calibration using the same test points used in the calibration; the instrument now should measure values within ±0.1 m/s of the reference point. Check also the instrument response at different wind speeds. Consider that the quadratic formula can over-compensate the measured value, causing differences with the reference wind speed greater than ±0.1 m/s; this is normal and is due to the nature of the quadratic polynomial formula behaviour; for this reason LSI LASTEM suggest to choose wind speed reference points near to the specific user application measurement scale.

# 9 Accessories / Spare parts

| PN | Description |
|---|---|
| BVA304 | Tripod |
| BWA048 | Soft bag for tripod and supports |
| BVA325 | Support for Heat Shield and ESV125 anemometer when installed on tripods or surfaces and DNA205 anemometer |
| BVA326 | Tripod extension for 3-level measurements and/or BVA308 mounting |
| BVA308 | H.80 cm pole for DNA205 anemometer installation on tripod |
| ESV125 | Hot wire anemometer |
| DNA205 | Cup anemometer |
| EST100 | Reference temperature sensor for field calibration |
| BWA317 | Carrying case for 1 ELR610M and 2 ELR610S modules plus accessories |
| BWA318 | Carrying case for 1 ELR615M and 2 ELR615S modules plus accessories |

# 10 Technical specifications

## 10.1 MASTER unit

| Acquired measurements | | | |
|---|---|---|---|
| **Measurement** | **Type** | **Measur. scale** | **Accuracy** |
| *Natural wet bulb thermometer* | 1/3 DIN-A Pt100 | -20 ÷ 100 °C | ±0.3 °C (@ 25 °C) |
| *Globe thermometer*<br>*ELR610M (sphere Ø 5 cm, 2 inch)*<br>*ELR615M (sphere Ø 15 cm, 6 inch)* | 1/3 DIN-A Pt100 | -20 ÷ 125 °C | ±0.3 °C (@ 25 °C) |
| *Environmental thermometer* | Silicon band-gap | -20 ÷ 60 °C | ±0.3 °C, ±0.4 °C (@10, 40 °C),<br>±0.8 °C (@60 °C) |
| *Relative humidity sensor* | Capacitive (replaceable) | 0 ÷ 100 % | 1.8 % (10 ÷ 90 %) |
| *ESV125 – Air flow*<br>*(optional)* | Hot wire (tungsten wire Ø 9.45 µm) | 0.01 ÷ 20 m/s | ±10 cm/s (0.5 ÷ 1.5 m/s)<br>4 % (< 1.5 m/s) |
| *DNA205 – Anemometer for outdoor use (optional)* | Reed relay | 0 ÷ 0.75 m/s | 2.5 % |
| **Indexes** | | | |
| *WBGT (indoor)*<br>*WBGT (outdoor)* | According to ISO7243.<br>For up to three locations simultaneously (requires two SATELLITES units) | | |
| *Head-Torso-Ankle Weighted Average WBGT* | According to ISO7243 (requires two SATELLITES units) | | |
| *Heat Index* | According to *National Weather Service (NWS) Technical Attachment (SR 90-23)* | | |
| *Humidex* | According to J.M. Masterton and F.A. Richardson of Canadàs Atmospheric Environment Service equation (1979) | | |
| **Elaboration of the measurements** | | | |
| *Sampling rate* | 10" for all the acquired and calculated measurements, except for *Va* (anemometer) which is sampled every 1" | | |
| *Recording rate* | 60" as average value of sampled measurements | | |
| **Connectors** | | | |
| *Anemometer* | For ESV125 hot wire and DNA205 cup anemometer | | |
| *RS-232 serial line* | 1200 ÷ 115200 bps | | |
| *Power/Charger* | 8 ÷ 14 Vdc | | |
| **Radio (only for ELR610M and ELR615M)** | | | |
| *Type* | ZigBee | | |
| *Frequency* | ISM 2.4 GHz direct sequence channels | | |
| *Power* | 10 mW (+10 dBm) | | |
| **Power** | | | |
| *Input voltage* | 8 ÷ 14 Vdc | | |
| *Consumption* | 500 mA max | | |
| **Battery** | | | |
| *Type* | 2 Ah (4.2 V) Lithium rechargeable | | |
| *Rechanging time* | ~ 8 hours | | |
| *Battery life* | Standby: 9 months<br>Operating without satellite: 400 hours<br>Operating with satellite: 20 hours | | |
| **Other features** | | | |
| *Internal calendar clock* | Format: day-month-year hour-minutes-seconds<br>Drift: 30 seconds/month (@ Tamb = 25 °C) | | |
| *Display* | LCD 4 x 20 alphanumeric characters | | |
| *Keyboard* | Membrane, 8 keys, operating status indicators (LED), communication from and to external devices, battery charger | | |
| (continued on next page) | | | |

| **Other features** (continued from previous page) | |
|---:|:---|
| *Processor* | 1 RISC 8-bit architecture, clock 32 MHz |
| *ADC resolution* | 18 bits rounded to 16 bits<br>Sample duration (rejection 50/60 Hz): 80 ms @ rejection 50 Hz |
| *Environmental limits* | -20 ÷ 60 °C, 15 ÷ 100 % UR (not condensing) |
| *Mechanical protection* | IP 54 |
| *Weight* | 1.4 kg |
| *Dimensions* | 185 x 220 x 55 mm |
| *Mounting* | On level ground or on tripod by means of BVA325 and BVA326 supports |

## 10.2 SATELLITE unit

| **Acquired measurements** | | | |
|:---|:---:|:---:|:---:|
| **Measurements** | **Type** | **Scale** | **Accuracy** |
| *Natural wet bulb thermometer* | 1/3 DIN-A Pt100 | -20 ÷ 100 °C | ±0.5 °C (@ 25°C) |
| *Globe thermometer*<br>*ELR610M (sphere Ø 5 cm, 2 inch)*<br>*ELR615M (sphere Ø 15 cm, 6 inch)* | 1/3 DIN-A Pt100 | -20 ÷ 125 °C | ±0.5 °C (@ 25°C) |
| *Dry bulb thermometer* | Silicon band-gap | -20 ÷ 60 °C | ±0.3 °C, ±0.4 °C (@10, 40 °C),<br>±0.8 °C (@60 °C) |
| *Relative humidity sensor* | Capacitive (replaceable) | 0 ÷ 100 % | 1.8 % (10 ÷ 90 %) |
| **Elaboration of measurements** | | | |
| *Sampling rate* | 10" for all acquired measurements | | |
| *Transmission rate* | 10" | | |
| **Connectors** | | | |
| *Power/Charger* | 8 ÷ 14 Vdc | | |
| **Radio** | | | |
| *Type* | ZigBee | | |
| *Frequency* | ISM 2.4 GHz direct sequence channels | | |
| *Power* | 10 mW (+10 dBm) | | |
| **Power** | | | |
| *Input voltage* | 8 ÷ 14 Vdc | | |
| *Consumption* | 500 mA max | | |
| **Battery** | | | |
| *Type* | 2 Ah (4.2 V) Lithium rechargeable | | |
| *Rechanging time* | ~ 8 hours | | |
| *Battery life* | Standby: > 2 years<br>Working: about 1 year | | |
| **Other features** | | | |
| *Keyboard* | Membrane, 8 keys, operating status indicators (LED), communication from and to external devices, battery charger | | |
| *Processor* | 1 RISC 8-bit architecture, clock 16 MHz | | |
| *ADC resolution* | 10 bits | | |
| *Environmental limits* | -20 ÷ 60 °C, 15 ÷ 100 % UR (not condensing) | | |
| *Mechanical protection* | IP 54 | | |
| *Weight* | 1.05 kg | | |
| *Dimensions* | 185 x 150 x 55 mm | | |
| *Mounting* | On level ground or on tripod by means of BVA325 and BVA326 supports | | |

# 11 Examples



**Fig. 3 - WBGT 1 environment measurement and index from MASTER unit only.**



**Fig. 4 - WBGT environments: separate measurements and indexes from MASTER unit and one SATELLITE unit.**
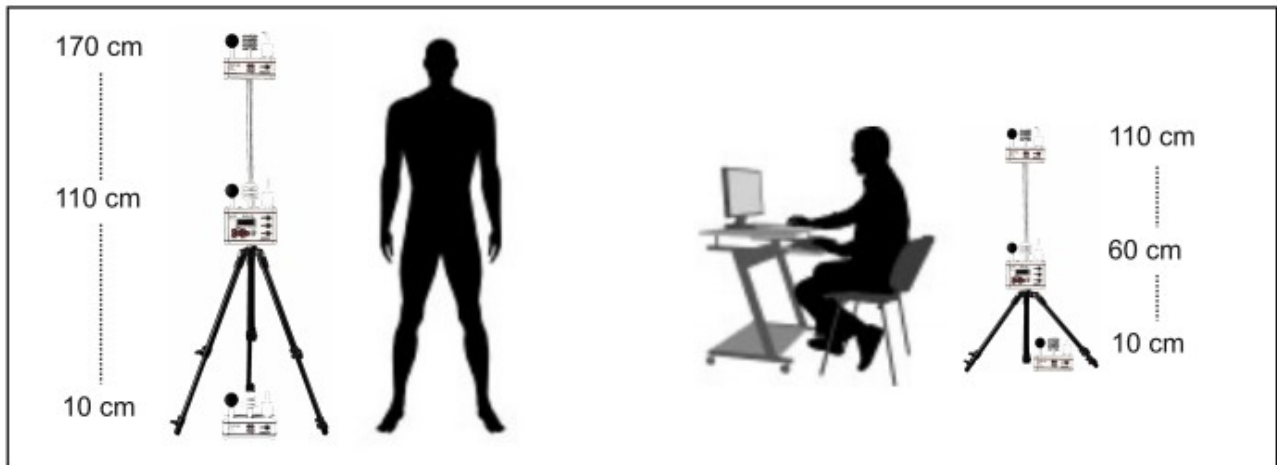
**Fig. 5 - WBGT environments: separate measurements and indexes from MASTER unit and one SATELLITE unit.**
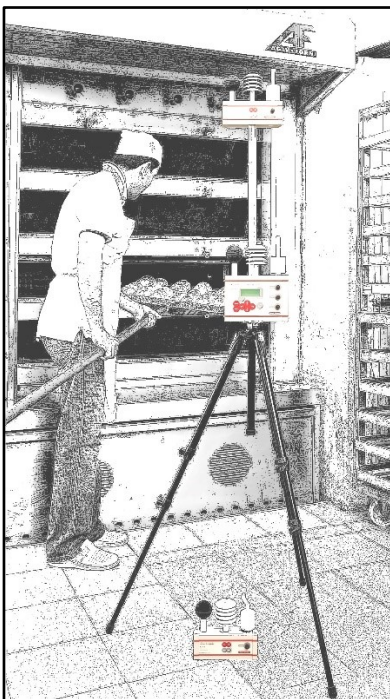


**Fig. 6 - WBGT subject: measurements and indexes averages from one MASTER and two SATELLITE units.**
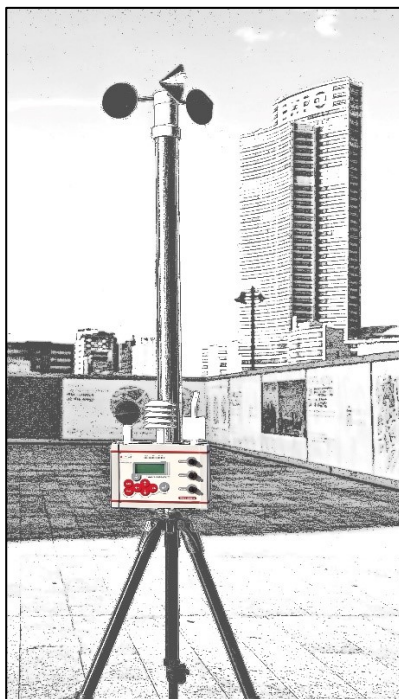


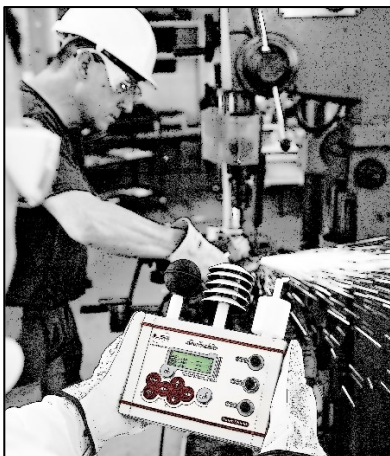**Fig. 7 - Usage of WBGT 1 env. with cup anemometer.**
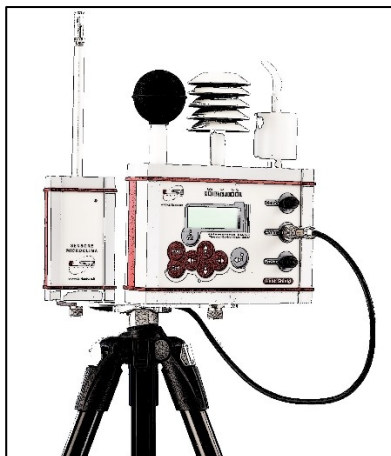


**Fig. 8 - Use without data storing.**



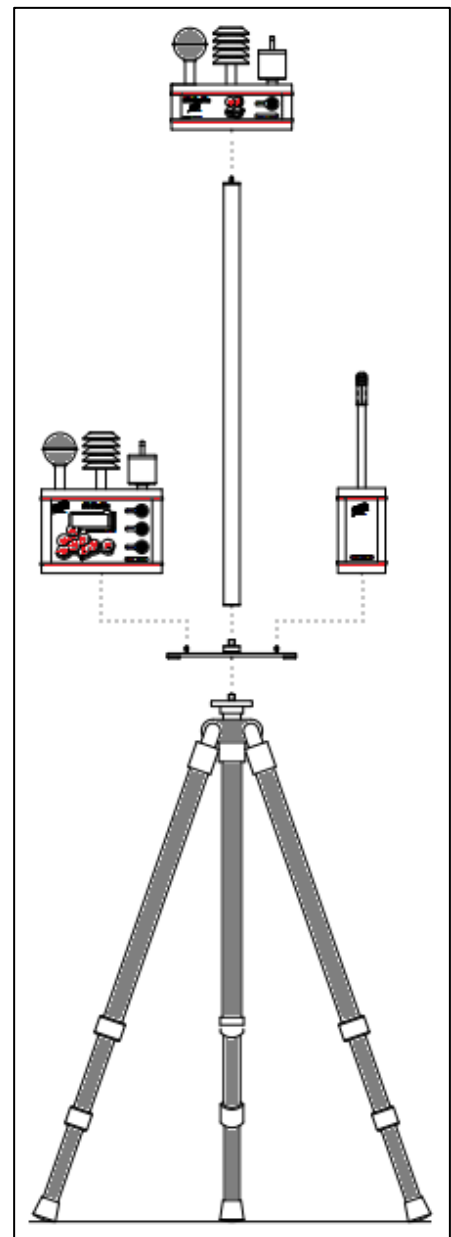**Fig. 9 - Usage of WBGT 1 env. with hot wire anemometer.**



**Fig. 10 - Exploded diagram.**

# 12 Disposal

Heat Shield is a highly electronic scientific device. In accordance with the standards of environmental protection and collection, LSI LASTEM advises to handle the product as waste of electrical and electronic equipment (WEEE). It is therefore not to be collected with any other kind of waste.

LSI LASTEM is liable for the compliance of the production, sales and disposal lines of the product, safeguarding the rights of the consumer. Unauthorized disposal will be punished by the law. Dispose of the dead batteries according to the regulations in force.

# 13 How to contact LSI LASTEM

In case of problems contact the LSI LASTEM technical support at support@lsi-lastem.com, or fill in the *On-line technical support request* form accessible from the home page of the website www.lsi-lastem.com.

For further information:

- Telephone:          +39 02 95.414.1 (switchboard operator)
- Address:            Via ex S.P. 161 Dosso n. 9 - 20049 Settala Premenugo, Milano, Italy
- Web site:           www.lsi-lastem.com
- Sales:              info@lsi-lastem.com
- After-sales service: support@lsi-lastem.com, Repairs: riparazioni@lsi-lastem.com
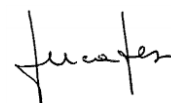
# 14 CE compliance declaration

**Product description**: WBGT index acquisition/elaboration system.

**Models**: ELR600M, ELR605, ELR610M, ELR615M, ELR610S, ELR615S

**Issuer**: LSI LASTEM Srl

LSI Lastem Srl declare under sole responsibility the above products are made under European directives 2004/108/EC and, specifically to the electromagnetic conformity, with the relevant provision of the following harmonized standards:

- ETSI EN 300 328 v 1.7.1 (2006-10)
- ETSI EN 301 489-1 v 1.8.1 (2008)  -  ETSI EN 301 489-3 v 1.4.1 (2002)
- ETSI EN 301 487-17 v 2.1.1 (2009-05)
- EN 62311 (2008)
- EN 61000-4-2 (1995) + A1 (1998) + A2 (2001)
- EN61000-4-3 (2006) + A1 (2008)
- EN61000-4-4 (2004)  -  EN 61000-4-5 (2006)  -  EN61000-4-6 (2007)

Settala, 28 of April 2015                                                                                    Luca Lesi