Storm front distance sensor

User manual

Document Storm front distance sensor – User manual
Pages 15

Revision list

Issue	*Date*	*Description of changes*
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Notes on this manual

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LSI LASTEM reserves the right to intervene on the product, without the obligation to promptly update this document.

Table of content

1 Introduction

The *storm front distance* sensor is a sensor capable of providing an estimate of the distance of the storm front in a radius of about 40 km from the place where it is installed.

Through a sensitive RF receiver and an integrated proprietary algorithm, the sensor can detect discharges both between clouds and earth and between clouds and clouds, eliminating the interference caused by artificial signals such as motors and microwave ovens.

The estimated distance does not represent the distance of a single lightning bolt, but the distance from the line of the storm front.

2 Technical specifications

Models

Code	DQA601.1	DQA601.2	DQA601.3 DQA601A.3
Output	RS-232	USB	TTL-UART
Compatibility	Alpha-Log	PC (Terminal Emulation program)	MSB
Connector	DB9-DTE	USB type A	Free wires

Technical specifications

Range	5 ÷ 40 km
Resolution	14 steps (5, 6, 8, 10, 12, 14, 17, 20, 24, 27, 31, 34, 37, 40 km)
Protocol	ASCII proprietary
Filter	Disturber rejection algorithm & auto antenna tuning
Power supply	5 ÷ 24 Vdc
Power consumption	Max 350 µA
Operative temperature	-40 ÷ 85°C
Cable	L=5 m
EMC	EN 61326-1: 2013
Protection rate	IP66
Installation	• DYA032 arm and DYA049 collar on pole (diam. 45 ÷ 65 mm) • On DYA046 bar

Accessories

DYA032	Mounting for Storm front distance sensor on DYA049 collar
DYA049	Collar for fixing DYA032 on meteo pole Ø 45 ÷ 65 mm

3 Installation and configuration

3.1 Installation

Choosing the right site is essential for the effective operation of the storm front distance sensor. It should be free from noise-generating equipment such as electromagnetic fields. These could be a source of noise, causing the sensor to provide incorrect measurements. Below are the sources of noise to avoid:

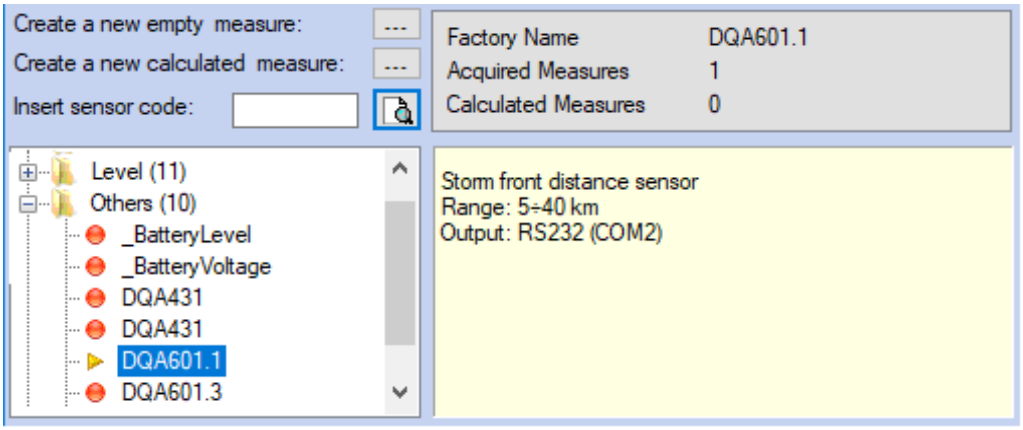
- Inductor based DC-DC converters
- Smartphone and smartwatch display

Once the site has been identified, connect the sensor to the LSI LASTEM Alpha-Log data logger or directly to a PC, depending on the type of electrical connection (USB, RS-232 or TTL-UART).

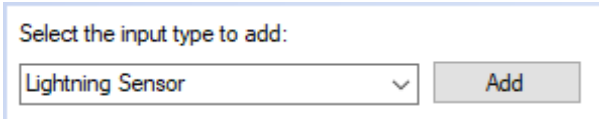
3.1.1 Use with Alpha-Log

DQA601.1, DQA601.3 and DQA601A.3 can be used with Alpha-Log, if properly configured. For the configuration of the data logger, proceed as follows:

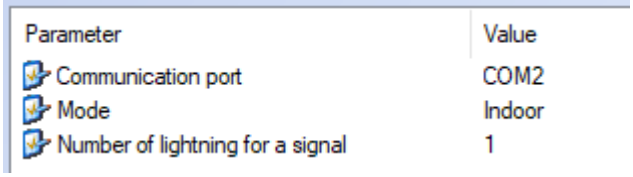
1. Launch the 3DOM software.
2. Open the current configuration in the data logger.
3. Add the sensor by selecting its code (e.g. DQA601.1) from the *3DOM Sensor Library*.



4. Add the proposed input type.



5. Set the parameters related to the measurements produced.



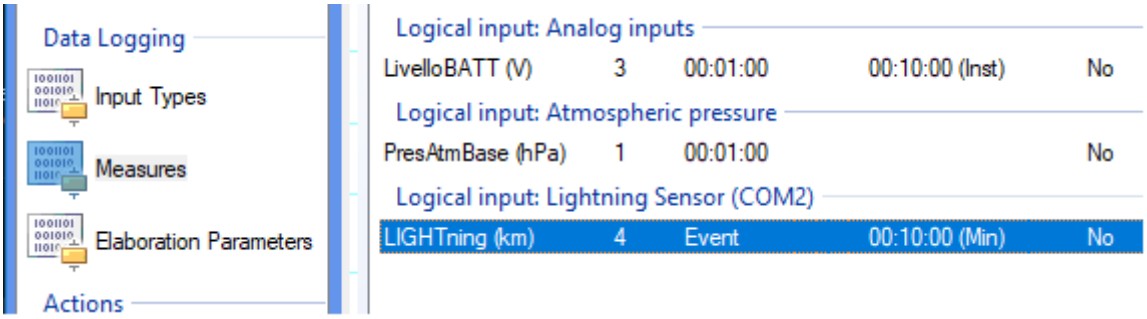
Where:

- *Communication port*: is Alpha-Log's serial port where the sensor is connected.
- *Mode*: is the sensor operation mode. Select *Internal* or *External* depending on where it is installed.

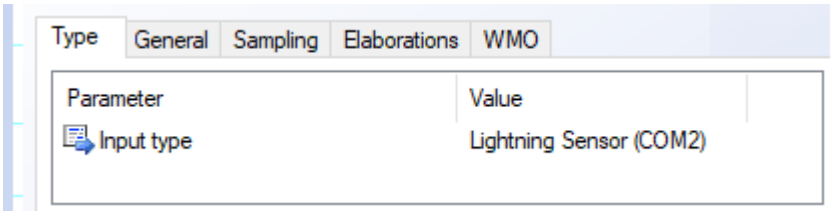
- *Number of lightning strikes per signal*: it is the minimum number of electric shocks needed to determine the distance of the storm front.

For more information on sensor configuration, refer to §3.2.

6. If you want to change some parameter, such as measure name or acquisition installment, open the measure you just added



7. Then, select the tabs of interest to display their parameters.



8. Save the configuration and send it to the data logger.

More information about the configuration can be found in the Alpha-Log manual.

To connect the sensor to the data logger, please use the following tables:

DQA601.1 (RS-232)	
Pin	**Signal**
2	Rx
3	Tx
5	GND
9	Power 5 ÷ 24 Vdc

DQA601.3 (TTL-UART)		Alpha-Log
Filo	**Signal**	**Terminal**
Green	Rx	20
Red	Tx	19
Blue	GND	21
Brown	Power 5 ÷ 24 Vdc	22
Shield	Shield	30

DQA601A.3 (TTL-UART)		Alpha-Log
Filo	**Signal**	**Terminal**
Brown	Rx (TTL)	20
Green	Tx (TTL)	19
White	GND	21
Yellow	Power 5 ÷ 24 Vdc	22
Shield	Shield	30

DQA601.1 has DB9 serial connector, so it can be connected directly to the RS-232 COM2 serial port.
Models DQA601.3 and DQA601A.3 have free wire connection. They should be connected to the 19-20-21-22 terminals of the TTL COM4 serial port.

For more information on the signals, refer to the respective drawings supplied with the product:

- DQA601.1: DISACC210137
- DQA601.3: DISACC210156
- DQA601A.3: DISACC210147

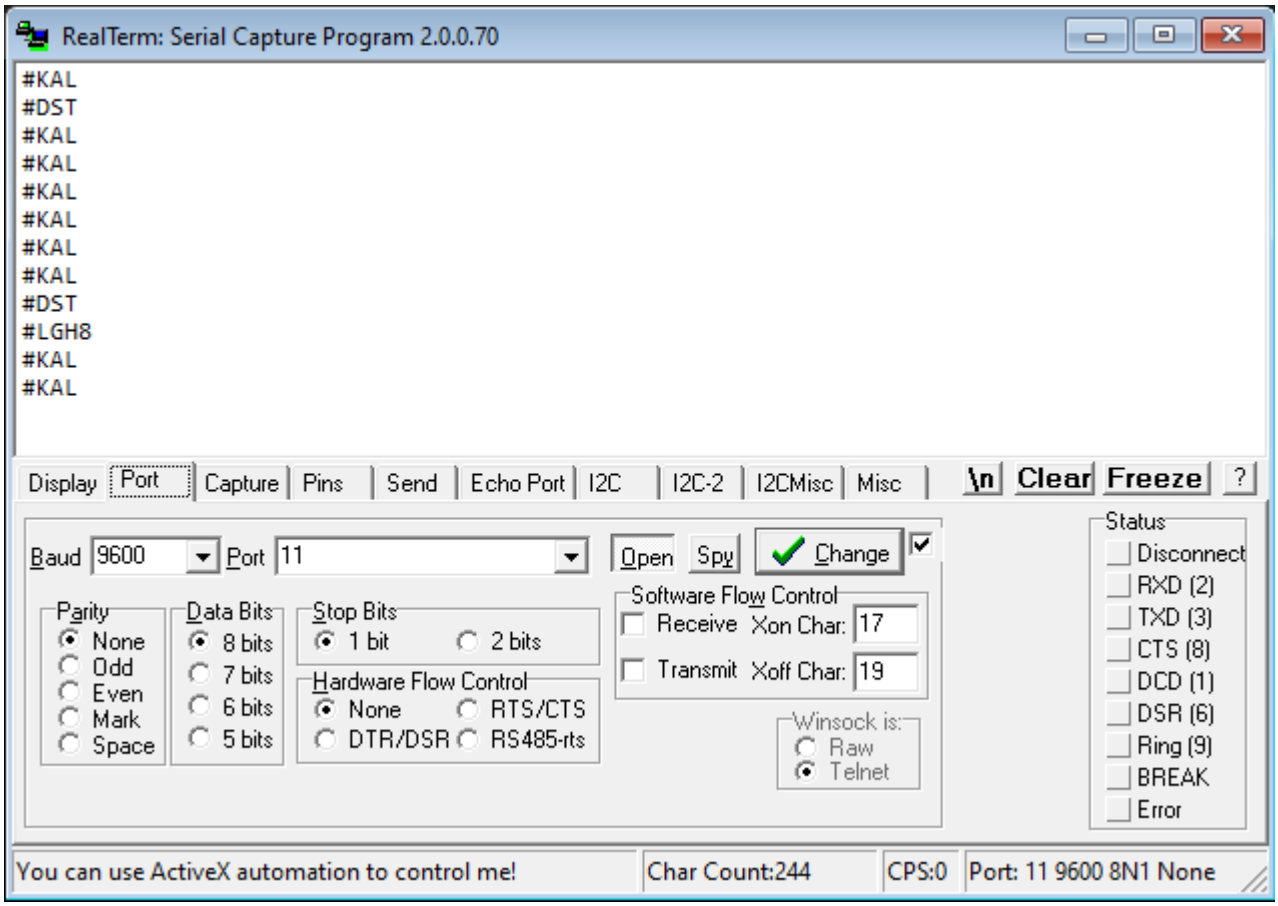
3.1.2 Use with the PC

DQA601.2 can be connected to a PC via the USB port. Proceed as follows:

1. Connect the sensor to the PC and identify the serial port assigned to it.
2. Start a terminal emulation program (e.g. Realterm), choose the serial port to which the sensor is connected and set the communication parameters as follows:

    - Speed: 9600 bps
    - Data bits: 8
    - Parity: None
    - Stop bits: 1
    - Flow control: None

When communication is established, the terminal program will begin to display the information sent spontaneously by the sensor.



For more information about communication with the sensor, refer to Chapter 4.

3.2 Sensor configuration

The sensor comes with a standard configuration. However, through a terminal emulation program installed on a PC, you can change some operating parameters. Commands and parameters are described in §4.3

4 SAP Communication Protocol

The sensor implements SAP (*Simple ASCII Protocol*), the proprietary communication protocol of LSI LASTEM that provides the services of configuration, diagnostics and transfer of the data measured by the sensor.

The sensor supports two ways of sending data:

- on demand
- spontaneous

"On demand" mode is the one set by default, in which the master part (applicant) interrogates the sensor via the MIV command; alternatively, the "spontaneous" mode is available, with which the sensor autonomously transmits messages related to particular events concerning the measurements made.

The following table summarizes the events reported by the "spontaneous" mode:

Field	Parameters	Description
#LGH	d	Detection of a temporal front at a distance *d*
#DST	-	Disturbance detection
#NSE	-	Noise detection
#KAL	-	Generic message (*keep alive*), every 60 seconds
#INI	-	Device initialization message, sent only after sensor power on

4.1 Messages format

Messages are carried by plots where the beginning of the message is the character '!' or '$' and the term is identified by the character ASCII *CR* (Carriage Return); the ASCII character *LF* (Line Feed) can optionally follow *CR*, for terminal display reasons, but is in any case ignored during reception; during transmission it is always transmitted after *CR*.

The message start character '!' is used to simplify communication that takes place via a terminal emulation program. When you want to have more security or use a communication bus where multiple devices are connected, the message start character is '$' and the plot will have more *device address* and *checksum fields*. If an error condition is identified by the slave, it produces a response with an error identification code, or it does not respond at all when the packet is not decoded in its entirety (e.g. the terminal part is missing); if the packet is received incorrectly by the master part or not received in the expected time (timeout), the latter may send the slave a retransmission request command; the sending party of the retransmission command regulates the number of maximum attempts through which this operation is repeated; the receiving party does not limit the number of attempts received and consequently managed.

In summary, for manual terminal communications (or *point to point*):

Field	Meaning
!	Message start identifier
c	Data flow control
cmd	Specific code of the request or response command

param	Command data, variable length
CR	Message end identifier

In case of communication produced between a *master* and one or more *slaves* (*point to multipoint*):

Field	Meaning
$	Message start identifier
dd	Address of the unit for which the message is intended
ss	Address of the unit that generated the message
c	Data flow control
cmd	Specific code of the request or response command
param	Command data, variable length
XXXX	Hexadecimal encoding in 4 ASCII characters of the control field
CR	Message end identifier

The address fields *dd* and *ss* are two-digit ASCII numbers, making it possible to address up to 99 different units; the value "00" is intended as a response to the master unit, while the value "--" indicates a broadcast message, intended for any apparatus connected to the master; the broadcast message is not followed by any response by the receiving slave units.
The control field *c* is used to manage data flow and can take the following values:

Field	Meaning
' '	First message in a series
'.'	Single message or last message in a series
','	Other messages to follow
'-'	Retransmission request of previous message (same data)
'+'	Request for transmission of next message (next data)

The field of control (checksum) is calculated using the algorithm CCITT CRC16 (polynomial X^16 + X^12 + X^5 + 1) of the characters starting from the one after the message header (! or $) and ending at the character immediately preceding the checksum field itself. The start value of the calculation is zero. To test the CRC calculation, you can send the test command:

$0100.DPV46FD[CR][LF] (CRC = 0x46FD)

to which the instrument (ID = 01) responds with a message like this:

$0001.DPV1.00.00EA78[CR][LF] (CRC = 0xEA78)

The *cmd* command code consists of three characters. **It is not case sensitive, so for example the DPV and dpv commands for the instrument are equivalent.**

The transmission of data that, by volume, cannot be packed in a single message, is done by specifying the control byte *c* according to the following rules:

- Data transported in a single message: the control byte is *period*;

- Data carried in more than one message: the control byte can be *comma* or *period*; upon receipt of the message containing the control byte *comma*, the receiving party must send the message '*+*' to indicate to the transmitter the possibility of transmitting the next part of the data; upon receiving the message with control byte *period*, the receiving party may refrain from replying (if the reception was correct), because sending a subsequent message '*+*' results in the return of a message containing the error code *NoMoreData*.

A specific limit is not imposed on the number of messages into which the data part is divided; for performance issues on some lines of communication, particularly slow or high risk of interference (typically via radio), the data transmitted in each message should be relatively small in size, so the whole data set is, in this case, divided into more messages.
The maximum size of the transmitted data in each message is an editable system parameter (*SMS* command).

The functions set out in the communication protocol are:

- Commands to regulate the communication.
- Commands to manage the configuration.
- Diagnostic commands.
- Commands to read the measured data.
- System management commands.

4.2 Commands to regulate the communication

The commands in the table do not generate any response.

Code	Parameter type	Description
OKs	-	*OK*: response message, without return data part, positive confirmation of the previous command received (*s* indicates *space*)
ERs	num	*ERror*: response message as a negative confirmation of the received request; the error status code is indicated by *num* in the response message (*s* indicates *space*)

In general, for all commands that allow the setting of a parameter, if this is not specified in the request message (the field is left completely empty), the response that the slave unit produces indicates the value of the parameter itself currently stored (reading of parameter).

The error states returned by the ER message are identified by the following table:

Value	Description
0	No error (normally not transmitted)
1	Tool not configured
2	Command code not being managed
3	Incorrect parameter of the command
4	Parameter outside the limits
5	Unexpected flow control with compared to the received command
6	Command not allowed at this time
7	Command not allowed by current access profile
8	No additional data to be transmitted in the queue to those already sent

9	Error encountered while storing received data

The payload part of the message is typically charged to the application level of the protocol which interprets the received data and formats the data to be transmitted. While formatting data, these rules are followed when possible:

- Several parameters (both request and response) are separated by the *space* character; some answers, for clarity when the values are numerous and heterogeneous from the semantic point of view, use tags in the *tag:value* format.
- The date and time are expressed in ISO 8601 format; normally the instrument expresses the time internally, in transmissions and in GMT-related files; the durations are expressed in the format "gg hh:mm:ss".
- Logical states:
  - "Y", "YES", "1", "TRUE", "ON" for *true* value
  - "N", "NO", "0", "FALSE", "OFF" for *false* value
- Integers: decimal places in number dependent on the number of bits dedicated to the variable to contain the data
- Floating point values:
  - Decimal separator: *period*
  - Decimal places: dependent on the transmitted value; when appropriate, the scientific format is used (mantissaEexponent)

4.3 Commands to manage the configuration

Code	Parameter type	Description
CWM	Integer	*Config Working Mode*: operating mode of the sensor. Allowed values: 0=Indoor, 1=Outdoor. Default value: 1
CNL	Integer	*Config Number Lightning*: number of electric discharges needed to let the sensor to calculate the thunderstorm distance; if greater than 1 let the sensor to ignores sporadic discharges detected in short time, thus avoiding false lightning detections. Allowed values: 1, 5, 9, 16. Default value: 1
CLA	Integer	*Config Lightning Absence*: corresponds to the time, in minutes, in which the absence of detection of electrical discharges determines the return of the system to the condition of absence of lightning (100 km). Allowed values: 0 ÷ 255. Default value: 20
CNF	Integer	*Config Noise Floor*: filter adjustment threshold for background noise; higher values determine a reduction in sensitivity to lightning detection; if you want to set this parameter in a fixed way, verify that the CAN parameter is set to *false*. Allowed values: 0 ÷ 7. Default value: 2
CAN	Boolean	*Config Auto Noise floor*: enabling automatic calculation of the filter adjustment threshold for background noise; the most recent calculated value can be read with the CNF command. Allowed values: true, false. Default value: true
CWT	Integer	*Config Watchdog Threshold*: sets the sensitivity of the sensor to electrical discharges on a scale of 0 ÷ 15; higher is this value, and lower is the sensor sensitivity to the discharges, therefore greater is the risk of not detecting discharges; lower is this value, higher is the sensitivity of the sensor, therefore greater is the risk of false readings due to background discharges and not due to real lightning strikes; this

		parameter is active only when the *Auto watchdog threshold* parameter is set to *false*. Allowed values: 0 ÷ 15. Default value: 2
CAW	Boolean	*Config Auto Watchdog threshold*: determines an automatic sensitivity of the sensor with respect to the detected background noise; when this parameter is set to *true* it determines that the sensor ignores the value set in the *Watchdog threshold* parameter. The most recent calculated value can be read with the CWT command. Allowed values: true, false. Default value: true.
CSR	Integer	*Config Spike Rejection*: sets the sensor's ability to accept or reject false electric discharges not due to lightning strikes; this parameter is additional to the *Watchdog threshold* parameter and allows to set an additional filtering system to unwanted electrical discharges; the parameter has a scale from 0 to 15; a low value determines a lower ability of the sensor to reject false signals, therefore it determines a greater sensitivity of the sensor to disturbances; in the case of installations in areas without disturbance it is possible / advisable to increase this value. Allowed values: 0 ÷ 15. Default value: 2
CMD	Boolean	*Config Mask Disturbance*: determines whether noise masking is active; if set to *true*, the sensor does not provide an indication (on trace log, see DET command) of disturbance if it determines its presence. Allowed values: true, false. Default value: false.
CRS	Boolean	*Config Reset Statistic*: the *true* value disables the statistical calculation system inside the sensor which determines the distance from the storm front considering a series of lightning strikes; this determines that the distance calculation is made only considering the last single electrical discharge measured. Allowed values: true, false. Default value: false.
CSV	-	*Config SaVe*: saves the configuration parameters in the sensor memory.
CLD	-	*Config LoaD*: loads the configuration parameters from the sensor memory.
CPM	Boolean	*Config Push Mode*: enable/disable the spontaneous sending mode (*push mode*) of the measurement events.

4.4 Commands relating to measurements

Code	Parameter type	Description
MIV	-	*Measures Instant Value:* requests the value of the distance from the temporal front calculated on the basis of the electrical discharge measurements. Answer: float value (km)
MRD	-	*Measures Reset Distance*: set the value of the last detected distance of the storm front to the distance value *Not Defined*

4.5 Diagnostic commands

Code	Parameter type	Description
DET	Boolean	*Diagnostic Enable Trace log*
DPV	Boolean	*Diagnostic Progam Version*: returns the current firmware version on the sensor
DFR	-	*Diagnostic Full Report*: provides as an answer a set of values indicating the internal state of operation. They are: ● *ATE*: error state of antenna tuning algorithm (Y/N);

		Answer: ATE:boolean value • *RCE*: error state of the calibration algorithm RCO (Y/N); Answer: RCE:boolean value • *ATF*: antenna tuning frequency (nominal 500 kHz); Answer: ATF:integer value • *ATRV*: register value used for antenna tuning; Answer: ATRV:integer value • *NFL*: background noise level set manually (CNF command) or automatically adjusted (CAN command); Answer: NFL:whole value • *WT*: the threshold value of the watchdog set manually (CWT command) or automatically adjusted (CAW command); Answer: WT:whole value • *SRL*: manually set noise rejection value (CSR command); Answer: SRL:full value • *LL*: time elapsed since the last lightning detected warning (seconds); Answer: LL:integer value • *LD*: time elapsed since the last detected noise report (seconds); Answer: LD:integer value • *LN*: time elapsed since last detected background noise (seconds); Answer: LN:integer value

4.6 Sample communications

To clarify the different possible combinations of messages exchanged between master and slave, some explanatory examples follow.

Master	Slave	Description
!.DPV\r	-	Master requests slave's program version
-	!.DPV1.00.00\r	Answer sent by slave

Master	Slave	Description
!,DPV\r	-	Master requests the slave version of the program, but uses the indication of other messages to follow
-	!.ER xx\r	Slave indicates that the command does not support the communication flow control that has been indicated by master

Master	Slave	Description
!.DPV\r	-	Master requests slave's program version
-	!.DPV1.00.00\r	Answer sent by slave
!-\r	-	Master requests the previous message again
-	!.DPV1.00.00\r	Slave responds by sending the same previous message

Master	Slave	Description
!.XXX\r	-	Master sends an unsupported command
-	!.ER xx\r	Slave responds with error code

Master	Slave	Description
!.MIV\r	-	Master requests the value of measurements
-	!.MIV5.0\r	Answer sent by slave (in this example: distance from the storm front = 5 km); in case of an absent or unidentified storm front, the sensor sends the value 100 (see the *CLA* configuration parameter).

5 Disposal

This product is a high electronic content device. In accordance with environmental protection and recovery regulations, LSI LASTEM recommends treating the product as a waste of electrical and electronic equipment (RAEE). Its collection at the end of its life must be separated from other waste.

LSI LASTEM is responsible for the conformity of the production, sale and disposal chain of the product, ensuring the rights of the user. Improper disposal of this product will result in law penalties.

6 Contacting LSI LASTEM

LSI LASTEM offers its assistance service at support@lsi-lastem.com, or filling out the Request for technical assistance module, downloadable from www.lsi-lastem.com.

See the following addresses for more information:

- Telephone number: +39 02 95.414.1 (switchboard)
- Address: Via ex S.P. 161 – Dosso n. 9 - 20049 Settala, Milano
- Website: www.lsi-lastem.com
- Post-sale service: support@lsi-lastem.com, Repairs: riparazioni@lsi-lastem.com